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This literature survey provides an extensive list of references in marine aerosol research, including investigations of marine aerosols found above the seashore and transport of sea salt over the mainland. It also includes discussions of the chemical composition of precipitated water and the complex question of how sea salt influences the precipitation mechanism.

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20. Abstract (continued)

The specific goal of the survey is to describe the generation, composition, and transportation of marine aerosols and the specific application of these factors to cloud physics and atmospheric optics. The survey covers the entire spectrum of particle sizes within the size range of 10^{-7} to 10^{-3} cm and concentrations between several thousandths to millions of particles per cm^3 cc. However, not many articles deal with particles in the 10^{-7} cm size range, and others exclude the cloud and precipitation elements.

The opinions of various authors on the historical development and importance of specific works in marine aerosol study are the subjects of the narrative sections. Summaries of these references are given in the second part of the report. A subject listing by key words is provided to systematize the several areas of research and indicate the nature of the publication. Each reference includes a number related to the main divisions of the subject.

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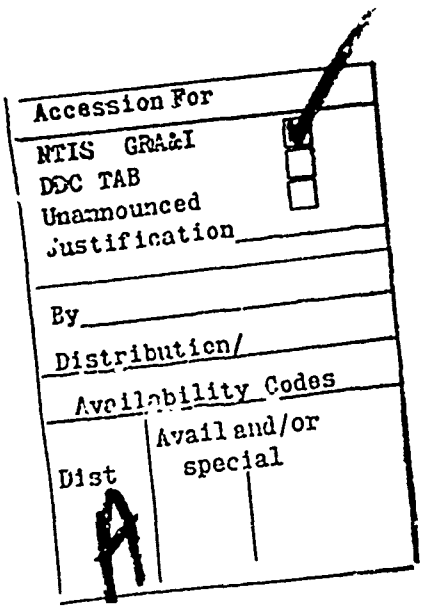

1. Introduction

The importance of studying the physico-chemical properties of maritime aerosols is obvious, because sea salts are suspected of influencing the formation of cloud and fogs in litoral regions, they can modify solar radiation, and they can change considerably the quality of the air we breath. Salt nuclei affect metal, and their impact on the genesis and quality of the soil and the growth of plants has been stressed in the literature. These hygroscopic particles play an important role in the propagation of optical and acoustical signals.

The history of cloud physics during the last century bears witness to the changing opinions of scientists about the potential part that sea salt nuclei plays in cloud forming processes. Since Aitken's publication in 1881 of his ideas about the importance of sea spray aerosols as "perhaps one of the most important sources of cloud-producing dust", the subject and its broader aspects have been discussed several times by atmospheric physicists. Sir G. C. Simpson in 1941 corrected some wrong interpretations of the measurements that had been made with Aitken counters. At approximately the same time, Cauer (1941) tried to classify and describe the function of nuclei in the atmosphere, when it was already known from the experiments of Wigand (1919) and Junge (1936) and from the theoretical studies of Volmer (1939) and Krastanov (1946) that sea salt particles were not the only ones involved in cloud formation. In spite of these findings and the pioneering work of Köhler (1921 to 1950) on the nature and physical chemical function of salt nuclei, few authors considered nuclei other than sea salt

and sulfuric acid while establishing microstructural models of warm clouds (Findeisen 1937, 1941; Simpson 1941).

The generating processes and the physical chemical properties of sea salt aerosols were largely unknown at the end of World War II. Under the influence of Köhler's theory, not much attention was paid to the possible generating processes that might lead to the production of very small nuclei. Ideas, such as Cauer's (1941, 1951), who in following Fellenberg's lead thought that nuclei of hydrochloric acid are generated above the sea's surface through the photochemical reactions of the free chlorine that is released from seawater under the action of strong oxydants with water vapor, and Melander's hypothesis (1897) explaining the origin of salt nuclei through direct evaporation of sea water, are now almost forgotten. The former idea nas been discredited by thorough quantitative analysis and direct measurements and the latter proven ineffective by the laboratory investigations of Lodge and McDonald (1954). Greater importance is given to the processes that generate salt solution droplets through the bursting of bubbles and emission of jets on the ocean's surface and to the simple spraying and drying of sea water on the shore and the subsequent transport of the salt nuclei in the atmospheric boundary layer.

One of the first attempts to estimate the concentration of sea salt nuclei produced by the splashing of waves and the evaporation of spray was made by Findeisen in 1937. He assumed the mean weight of the nuclei to be 10^{-10}g and obtained concentrations of between 10 and 20 nuclei per liter of air. Jacobs in 1937 and Owens in 1940 also believed that bursting bubbles were a source of salt nuclei. After 1950, Beliaiev presented a complete picture of how tiny water drops with radii between 10^{-5} to 10^{-2} cm originate through the bursting of bubbles above foaming wave crests at wind velocities surpassing 7.0 m/sec. Blinov (1950) provided a rough calculation for the

concentration of drops of similar size ($10^{-2}$to $5x10^{-2}$ cm^{-3}). The generating mechanism of sea salt particles has since been thoroughly analyzed by Woodcock (1953), Knelman et al. (1954), Kientzler et al. (1954), Blanchard (1957), Day and Lease (1968), and others. Both mechanisms, jet generation, which produces a few large drops, and bubble bursting have been found to be effective. When bubbles with diameters between $2.5x10^{-2}$ to $2.15x10^{-1}$ cm burst, several hundreds of drops with sizes between $2x10^{-5}$ to $5x10^{-5}$ cm are generated according to the calculations of B. J. Mason (1957). Relatively good correlations between calculated values and the concentrations measured above the sea's surface and in the laboratory have been found by Moore and Mason (1954). The production rate of nuclei calculated by Moore and Mason, and by Blanchard (1969) is between several tens to 100 $cm^{-2}sec^{-1}$. These values are certainly lower than those estimated by Squires (1966)($180cm^{-2}.sec^{-1}$) over the oceans on a global scale; however, they do not contradict the general picture drawn by Toba (1966) of the production and distribution of nuclei over the world's oceans. Recently, Lai and Shemdin (1974) have found through remote sensing of the air-sea interface that the droplet generating mechanism suggested by Blanchard (bubble bursting) accounts for only a portion of the total droplet production.

2. Sea Salt Nuclei Generation

The calculated concentrations of nuclei must be considered as mean values for a relatively long time interval. There will be large deviations from these numbers as the result of the several physical chemical processes that influence the release of drops and their evaporation above the ocean's surface.

First of all, wind velocity is mentioned as a dominating factor in the generation of nuclei through bubble bursting, jet emission, or the simple process of spraying. Many measurements have been made of this factor, but there is still little information on the extent to which high wind speeds contribute to the increase in the concentration of large and giant nuclei in the lowest meters above sea level. In regard to this one should consider two different situations: the generation of salt nuclei at the seashore and the high seas. Several articles have been published on the increase in the amounts of salt aerosol deposited by strong sea breezes at the seashore. Metnieks (1958) found a large content of sea salt nuclei on the west coast of Ireland at a wind velocity greater than 5.5 m/sec. Also, a good correlation between wind velocity and sea salt nuclei was found by Georgii and Metnieks (1958). Moore and Mason (1954) in their study of generation of large salt nuclei above the ocean's surface drew attention to an apparent break in the curve of the salt nuclei mass distribution at around 10^{-11}g. They explained that this break was attributable to a wind speed that exceeded 7 m/sec. Toba (1965) deduced from his analyses of the production rate of sea salt nuclei that the production increases with wind speed until it attains a rate of 8.0×10^{-1} $cm^{-2}sec^{-1}$ for nucleus mass $m = 10^{-9.5}$ g at 7 m/sec. From 7 to 10 m/sec, the production curve flattens. Above a velocity of 10 m/sec, the curve rises almost exponentially with the wind speed. The author explained this fact by assuming that the pull of gravity on the waves and wavelets is less effective in entrapping the bubbles before they manage to burst in this critical velocity range. Podzimek (1973) in a similar study did not find such a pronounced change in the nuclei size distribution curve on the shore of Padre Islands, Texas, but it was apparent to him that the generation of larger salt nuclei intensified at higher wind

speeds. Schmidt (1972) observed that on the west coast of Denmark extremely large concentrations of tiny salt nuclei (r=0.08 um) were airborne by strong winds that brought air masses from places over the ocean where a well developped cyclone had passed. In this case, the normal generating mechanism of marine salt nuclei could have been enhanced by the raindrops that struck the ocean's surface and also by the evaporation of the larger drops.

Several quantitative studies have been made recently by scientists of the influence that sea wind velocity has on the production of salt nuclei. Petrenchuk and Ionin (1974) and Petrenchuk et al. (1974) found very high concentrations of NaCl and $CaSO_4$ on the Crimean coast of the Black Sea when the winds blew in from the sea with velocities greater than 7 m/sec. Within a distance of 75 m from the coast the mass concentration of chlorine ions increased from 2 to 2000 ugm^{-3} if the wind velocity increased from 0 to 11 m/sec. A less pronounced relationship was found on the shore of th ov Sea where at wind speeds of between 7 and 9 m/sec chlorine ion concentrations of 1.8 ugm^{-3} were detected. This latter observation disagrees strongly with the earlier measurements of chlorine ions that were made by Burkser (1951) almost in the same area. He obtained a mean of 306 ugm^{-3} and a maximal value of 540 ugm^{-3}. The only explanation is that the samples taken by Burkser were influenced by the local sources of salt particles, i.e., the salt flats around the Azov Sea.

From the results of the many measurements that have been made to relate the generation rate of salt particles to wind velocity, one cannot expect to obtain a conclusive picture unless more is known about the wave forming mechanism and the formation of foaming wave crests. Especially on the seashore, the conditions of wave formation depend strongly on many factors, such as wind duration, direction,

variability, and turbulence, subaqueous bathymetry, and the geometry of the shore. All these factors control the breaking of waves in the surf zone. Other factors, such as air temperature and humidity, contribute to the evaporation of sea drops and to the formation of salt nuclei. And possibly, admixtures in sea water of inorganic or organic particles (surfactants) might be a contributing factor.

Temperature affects the production rate of salt nuclei on the sea surface in different ways. Myiake and Abe (1948) and Abe (1955) pointed out that the decay rate of a patch of foam on the sea's surface at 20°C is two times greater than it is at a temperature of 0°C. This idea was also accepted by Blanchard in 1971, who in several other articles stressed the importance of the surface active materials, that are concentrated in the uppermost layers of sea water (Blanchard 1963, 1968, 1974). These materials, which are analyzed later, are temperature dependent as well as being affected by droplet emission, the jet-mechanism, and bursting bubbles (Mac Intyre, 1972; Day and Lease, 1968). Woodcock in 1972 drew some interesting conclusions from the sea salt nuclei measurements he made around the Hawaiian Islands and Alaska. He concluded that there is a significant difference between the size spectra of salt nuclei measured over the biologically productive waters of Alaska and the size spectra of nuclei sampled over the less productive sea around the Hawaiian Islands. Evidently, the very small drops that are formed by the bursting of bubbles are suppressed because they are coated by a film of surface active material. In addition to this process, the temperature and temperature gradient in the uppermost layers of the ocean - according to Mac Intyre (1972) 3°C/cm at depths between 60 to 500 um - influence the transport of ions through the Ludwig-Soret effect and the concentration of ions on the sea surface for entropic reasons. The impact of such a very thin layer -

- 10 to 10^3 Å according to Mac Intyre (1972) - of concentrated organic substances on the lifetime of bubbles and the emission of droplets is obvious.

Air humidity determines the rate at which drops of sea water evaporate, and, possibly, when combined with insolation and a change in temperature, shatters the salt crystals that form. The effect of humidity on the formation of salt nuclei close to the sea's surface has been thoroughly analyzed by Toba (1965). For a steady state condition with no horizontal wind variations and a logarithmic wind profile over the ocean, he deduced that the vertical distribution of droplets with a certain amount of salt can be expressed by a straight line on a logarithmic diagram. However, he assumed that the salt droplets remain in a static condition even when the rel. humidity remains below 75% and thereis no subsequent transformation of the droplets into crystals that are shattered. Actually, for more than 30 years, an old hypothesis of Dessens (1946,1949) concerning the shattering of salt nuclei in the atmosphere persists and awaits proof or disproof. Laboratory observations by Facy (1951), Twomey and McMaster (1955) and Radke et al. (1972) support its validity in spite of the strong discrepencies in the observed number of generated nuclei. On the other hand, Lodge and Baer (1954) and Blanchard and Spencer (1964) were unable to find any evidence of the shattering of salt crystals after their generation. Podzimek and Saad (1974), who conducted laboratory experiments with a stored sodium chloride aerosol, found that after the salt nuclei had been generated only the Aitken nuclei increased in number for several hours, not the nuclei of the larger size fractions. The nuclei below 0.1 um in size, however, could hardly be detected by them with the techniques originally used by H. Dessens. In their opinion, the solution of this dilema can be found in the laboratory by performing experiments with well controlled conditions of temperature and humidity and in nature by

checking carefully the composition of the sea aerosol.

Day and Lease (1968) mentioned that the bursting of bubbles depended on humidity. Their empirical formula for the number of drops generated by the bursting of a bubble's film included a term related to the humidity of the air. In general, the number of emitted drops increases with increased supersaturation and reaches a limit that depends upon the film cap area, temperature and others factors. The authors concluded that under normal circumstances the drops above the ocean's surface will evaporate quickly and leave sea salt nuclei that have an approximate mass of 10^{-12} g.

The influence that the inorganic and organic substances, which are concentrated in the thin uppermost layer of the ocean, have upon evaporation and upon the production and growth of maritime nuclei probably has been the most frequently discussed subject in hydrology and marine meteorology during the last three decades. The importance of this influence is extraordinary, because it has very practical applications. However, the difficulty of drawing simple quantitative conclusions from laboratory experiments and observations in nature is well known (MacIntyre, 1974).

The generation of salt nuclei above the ocean cannot be separated from the fact that the uppermost layer of sea water has a chemical composition that is quite different, from that of deeper waters. An excellent survey of the problems related to the physics and chemistry of sea water, including its topmost layer, was published in a book by Horne (1969). There is not enough evidence to show that several ions are generated in the microlayer on the sea's surface. For example, Duce et al. (1972) found that lead, iron, nickel, fatty acids, hydrocarbons, and chlorinated hydrocarbons are enriched in the top 1.0 to 1.5 um thick layer of water in Narrangassett Bay. The enrichment of this layer is 1.5 to 50 times greater than the water 20 cm below the surface. It is interesting to note,

that most of the metal enrichment was observed in the particulates of the organic fraction. Barker and Zeitlin (1972) also found in a microlayer of water 150 um thick that the enrichment was due to C, P, NO_3^- and often to K, Na, Mg, and they stressed the fact that most of what they observed was organically bound trace metals. They postulated that most of the substances were scavenged by rising bubbles in the sea water and were transported into the air through the bubble bursting process. This hypothesis is supported by the experiments conducted by Wallace et al. (1972), who concluded that the formation of a salt aerosol might be strongly influenced by modifications in the composition of the ocean's surface. Additional evidence of the concentration of some substances at the sea's surface and of the modification of maritime aerosols has been provided by Bloch and Luecke (1972). They analyzed the ratios of different ions in ocean and river water, rain, snow, and dew and studied the relationship between dissolved inorganic salts in sea water and the surface tension of this natural solution. Because the surface tension of the solution rises with the salt concentration (at the same temperature), the characteristic value of the gradient of this rise can be found for each salt. Finally, Bloch and Luecke (1972) showed how the apex of a bursting bubble is the primary source of fine spray and why, during the transport and evaporation of the drops in the air, the enrichmen of K ions, for example, is much greater than that of Na. Experiments performed by Koske and Martin (1972) with a "film centrifuge" support the idea of changing surface tension as an explanation for ion fractionation. In this way, they explained the greater depletion of bivalent-univalent salts as compared with univalent-univalent salts on the sea's surface. The fractionating mechanism on the ocean's surface and on the drops of spray were thoroughly analyzed earlier by several authors. Sugawara et al. (1949) and Sugawara (1959) justified their hypothesis that the frac-

tionating mechanism is connected with the spray of wave-generated bursting bubbles. Sugawara distinguished two steps in the process: the change in the composition of the bubble-spray immediately after its formation (synfractionation) and the fractionating crystallization of the salts in the evaporating drops. The first process might be strongly influenced by the enrichment mechanism of the rising bubbles in the top layer of the sea (Wallace et al. 1972) and by the presence of surface active material, such as the phosphates studied by Baylor et al. (1962). Another mechanism of fractionation that is based in principle on the so-called "Ludwig-Soret effect" was suggested by Komabayashi (1962). He found that the enrichment of the sea's topmost layer is linearly proportional to the atomic weight of ions and that this fact can be explained by the differentiating thermal-diffusion process. However, this process is apparently too slow to explain the observed values of fractionated ions. Several authors studied the variations in ionic ratios in the aerosols and compared them to the sea water ratios. Hoffman and Duce (1972) found that there is no large scale ion fractionation in the Hawaiian atmosphere, and Korzh (1972) proposed the idea that sea salts are carried into continental airspace without the ratio of individual ions changing in the aerosol. This view does not agree with the results obtained by Chesselet et al. (1972), who found an enrichment of several ions, such as K. However, in the case of Cl/Na, the ratios in the aerosol were almost same as in sea water. The enrichment preferentially affected the small particulates ($<$ 1-2 um).

The influence of surfactants on the formation and growth of sea salt nuclei in a humid atmosphere is still one of the most investigated subjects in the physics and chemistry of the ocean and in cloud physics. Without mentioning details about the possible function of surfactants as agents that can retard the evaporation of large bodies of water or of tiny drops

(La Mer, 1962) it can be stated that there are several ways in which surface active material can influence the formation of salt nuclei above the ocean's surface. Many articles deal with the origin and amount of surface active material on the sea's surface (Vinogradov, 1953; Wilson, 1959; Neumann et al., 1959; Scheiman and Jarvic, 1963; Fog, 1965; Blanchard, 1968; Garrett, 1967, 1968; Woodcock, 1972; Barger and Garrett, 1970, 1976; Baier, 1972; Baier et al., 1974.). For the purpose of this report, one can leave aside the question of the nature of the coating material that was recently discussed on the basis of two different results of a similar investigation (Garrett, 1967; Baier et al., 1974; Blanchard, 1974; Marty and Saliol, 1974). However, there are not many quantitative analyses that show what type of organic substance is bound on certain sized drops of salt nuclei and at what concentration. There seems to be a prevailling general opinion that more organic material is bound on small particulates (Blanchard, 1968; Russell and Stampfer, 1976). The most important conclusion that has been derived from observations in nature (Woodcock, 1972) and from measurements in the laboratory (Garrett, 1967, 1968; Blanchard and Syzdek, 1972) is that the size of the bubbles and generated salt nuclei depends on the concentration of surface active material. For example, Garrett (1968) made the following statement in his article: "The increase in the number of salt particles measured is not due to a surface-chemical modification of either the sea water droplets or the surface of salt particles but is a consequence of alteration of the mechanics of the bubble bursting process. The insoluble film decreases the degree of foaming at the sea-water surface and enhances the immediate breaking of small bubbles". This conclusion stresses the importance of studying the proper adsorption of surface active organic material on bubble rising through the upper layer of the ocean (Riley, 1963; Baylor and Sutcliffe, 1963; Siegel and Burke, 1965; Neuzel, 1966; Blanchard and

Syzdek, 1972) in relation to the mechanism of formation and bursting of bubbles on the surface (Woodcock et al., 1953; Knelman et al., 1954; Mac Intyre, 1972). A possible mechanism of function of surface active material was described by Mac Intyre (1972, 1974) in a simple hydrodynamic model. He was able to show that a bubble's short lifetime is an indication of presence of surface active film. However, the question about the further role of the thin film during the evaporation of a salt solution drop is left unanswered. There is good reason to assume that the rate of evaporation and of salt crystalization is altered by the presence of a protecting film. Many laboratory investigations of this kind have been made by Russian scientists (Izmailova et al., 1957; Deryaguin et al., 1966; Leonov et al., 1969, 1971; Storozhilova, 1971; Silaiev, 1971; Bakhanova et al., 1974). Also there is a possibility that the structure and probably the shattering of salt nuclei can be changed by presence of surface active material. Several authors have indicated that the density of dried salt nuclei usually does not correspond to the bulk crystals and decreases with an increase in nuclei size (Duffie and Marshall, 1953; Crossby et al., 1958; Ueno and Sano, 1972). Podzimek (1974) concluded from his laboratory measurements and observations in nature that for the most part giant sodium chloride nuclei have crystaline structures that contain hollow spaces.However, the complexity of sea water drops and the salt nuclei coating process in nature is so great that many authors are quite skeptical about the successful simulation of natural conditions in the laboratory (Mac Intyre, 1974).

Another possible influence that surface active materials may have on the formation of the size spectrum of salt nuclei can be observed in the coagulation rate of coated and uncoated solution drops or salt nuclei. Morachevskii and Kiriukhin (1968, 1969) analyzed the conditions of the change in the coagulation process inside of a cloud by coating the drops with a surface

active material. They concluded that the coating layer affects the coalescence process in such a way that the Langmuir chain-like process starts early. The effect of a surface active substance on the stability of aquaeous salt solution aerosols was thoroughly investigated by Ueno and Sano (1971, 1973) and by Ueno (1974). The organic vapors deposited on the drops of NaCl and Na_2SO_4 solution that were several microns in size decreased the coalescence rate in a manner dissimilar to humidity, which acted as a coagulation-promoting agent.

Many questions pertaining to the function of salt nuclei with retarded activity in the formation of cloud drops are, however, unanswered in spite of some imple models which have been presented recently (Podzimek and Saad, 1975).

3. Measured and Estimated Concentrations of Salt Nuclei Immediately Above the Sea's Surface

The different physical and chemical processes described in the previous paragraphs strongly affect the nature and concentration of salt particles above the sea's surface. Several investigators have found the break in the size spectrum curves of salt particles to be in the domain of 10^{-14} to 10^{-13} g, which is explained by the transition from a bubble jet to a bubble film generating mechanism (Woodcock, 1972). Many authors have stressed the close relationship between the mechanism of bursting bubbles and the composition of salt nuclei (Oddie, 1960). Also, there is evidence that the water in clouds can considerably affect the composition of the nuclei remaining

in the air after the cloud drops have evaporated (Woodcock and Spencer, 1957; Rosinski and Nagamoto, 1972). Close to the sea shore, the mixed nature of nuclei (Pueschel et al., 1969; Pueschel and Van Valin 1972, 1974; Tsunogai et al., 1972; Green, 1972) is dominated to a very large portion by sulphates (Lodge et al., 1960; Hobbs and Radke, 1970; Junge et al., 1969). The necessity of properly analysing the meteorological and geographical conditions during the sampling of an aerosol on the seashore was strongly stressed in articles by Kuroiwa (1951), Junge et al.,(1969, 1972), Turpin et al.,(1974) and Green (1972). All found that the composition of marine nuclei depended strongly on the environmental sources of the particles that form the mixed character of the nuclei. Even over the high seas, a large portion of sulfates were found in the marine aerosols (Dinger et al., 1970; Georgii and Gravenhorst, 1972). Interestingly enough it was found that the SO_4 enrichment of the aerosol above the waters of the Gulf of Guinea balances the observed Cl loss in accordance with the gaseous HCl formation process in marine atmospheres (Buat-Menard et al., 1974).

There are still many questions that remain unanswered with respect to the measurement of salt nuclei above the sea's surface. Shattering and coating of the nuclei are some of these, but there are many other factors that affect the formation of the salt nuclei size spectrum. For example, coagulation and particle deposition on the surface of the sea can strongly influence the sampling technique and the results of nuclei counting. With this in mind, I will attempt to summarize some of the more important measurements that have been made.

The results of the older measurements of chloride ions in an atmospheric aerosol were usually presented in the form of integrated values of the ion in a unit volume of air and expressed either as $\gamma\ cm^{-3}$ or μg in m^3. Cauer (1951)

found the following amounts of chloride in ug in 1 m^3 of air: 7 ugm^{-3} in England, 32 ugm^{-3} in Schlesien (Central Europe), 70 ugm^{-3} in Vysoke Tatry (Czechoslovakia), and 149 ugm^{-3} in Kiel above the surface of the sea. A more detailed study was made by Junge (1956) over the territory of the U.S.A. and over West Germany with the aid of a cascade impactor. He divided the particles into giant and large nuclei and obtained a very interesting group of curves for the chloride concentration with respect to the distance from the ocean. The mass of large nuclei decreased as the seashore was approached. For example, in West Germany at Frankfurt it was 4 γcm^{-3}, and in Florida 0.05 γcm^{-3}. The high values in Frankfurt were measured during the winter, whereas in summer they were considerably lower (1.6 γcm^{-3} for large nuclei and 0.56 γcm^{-3} for giant nuclei). An analysis of aerosol particles composed mainly of chlorides was performed later by Junge (1957) at Hilo Harbor, Hawaii. There, the chloride concentrations ranged from 0.093 to 4.96 μgm^{-3}, if the particle radii were between $8x10^{-6}$ and $8x10^{-4}$ cm. These values are much lower than the chloride concentrations measured by Cauer, who measured the total chloride ion content in the air, including the gases.

Lodge (1955) found significant decrease in sea salt nuclei concentration with respect to the distance from the seashore when he made his measurements at Puerto Rico. Also, on Padre Island, Texas, Podzimek (1973) found a strong decrease in giant nuclei concentrations within a distance of several tens of meters from the surf zone. Hsu and Whelan (1976) measured the salt nuclei concentration with respect to the distance from the surf zone and established an analytical expression for the decreasing particle concentrations.

The large scale transport of salt particles from the ocean to the mainland was investigated by Byers et al.(1955) in the U.S.A. and by King and Maher (1976) over Central Queensland in Australia. The latter studies led to the con-

clusion that the salt particle concentration varied insignificantly (by a factor of two) between the level of 200 m and the base of the clouds, and that at a distance of 1000 km inland the concentration decreased by a factor of five.

Improved isopiestic techniques (Toba, 1968), impactors, and centrifuges when combined with mobile analyzers, flame photometric counters, chemical spot test methods, X-ray energy spectrum analyzers, and mass spectrometry have recently made possible the investigations of several important features of sea salt aerosols. The mean concentration of an aerosol at sea level and its change with increasing altitude as well as the transformation of the size distribution of sea salt particles transported over the mainland have always been of interest to investigators. The role played by sea salt particles in the total aerosol content above the sea and the smallest and largest salt particles found in the atmosphere at certain altitudes during a specific meteorological situation have been intensively investigated. The more important results have been applied in models that describe cloud element growth and the propagation of electromagnetic waves.

One of the most extensive studies on the distribution of sea salt particles above the ocean was made by Toba in 1965. He used available data and established a model for salt nuclei generation and transport. The measured and calculated concentrations of giant nuclei, $n.cm^{-3}$, in the mass range of $10^{-11.5}$ to 10^{-8} g for both summer and winter months are plotted in maps attached to this report (Figs. 1 and 2). The concentration isolines clearly show a minimum over the equatorial and subtropical regions (around 0.4 cm^{-3}) and a maximum in the polar latitudes (up to 1.6 cm^{-3}). The maxima are higher in the arctic regions. There are some discrepancies between Toba's data and the measurements made by Kikuchi and Yaura (1970), who observed high nuclei counts around the equator and close to Australia (Freemantle).

In general, however, Toba's picture of the salt particle distribution over the world's oceans is supported by the measurements made by Woodcock (1953) and Blanchard (1969) over the Pacific Ocean, by Lodge (1955) and Podzimek (1967) in the Caribbean, and by Moore and Mason (1954) and Durbin and White (1961) over the Atlantic Ocean. Most of the measurements made recently by investigators on ships in the Atlantic Ocean (Junge and Jaenicke, 1971; Jaenicke et al. 1972; Mészáros and Vissy, 1974; Gravenhorst and Georgii, 1972) and in the Pacific (Chaen, 1973) do not seem to deviate much from the geographical distribution of salt particles presented by Toba. Other measurements along the Pacific shore (Hobbs et al., 1976; Hindman et al., 1977) and over the Atlantic (Dinger et al., 1970) stress the presence of hygroscopic substances smaller than large salt nuclei. The composition of most of these nuclei is assumed to be ammonium sulfate as was mentioned earlier.

The vertical distribution of sea salt particles seems to be one of the most important parameters needed for any realistic model of nuclei generation and transport. Several contributions to the study of this parameter in the 10-m layer over the ocean have been made by Toba (1965). He assumed steady state conditions in the boundary layer above the ocean and used a logarithmic profile for wind velocity. No interaction with waves on the sea surface was assumed. The vertical distribution of the number of salt particles for each specific range of salt mass contained in sea water droplet could be expressed by a straight line on a logarithmic diagram. Another interesting study was made by Chaen (1973) in the Pacific. He measured the distribution of salt particles up to a height of 13 m above sea level. The investigated range of the masses of salt particles was between 10^{-11} to 10^{-7} g which enabled him to compare his results to Toba's. The results are to a certain extent similar to Toba's

except that Chaen took into account the effective relative humidity and the relationship to the state of the sea. He found that the concentration of sea-salt particles increases linearly on a logarithmic diagram with a dimensionless variable, u_*L/ν, in which u_* is the friction velocity, L the significant wave length, and ν the kinematic viscosity of air.

The distribution of salt particles at high altitudes (up to several km) above sea level was the subject of the investigations of Woodcock (1953), Lodge (1955), Byers et al.,(1955), Durbin and White (1961), Podzimek (1967), Hobbs et al (1970), Podzimek and Stampfer (1976), Hindman et al. (1977), and others. Toba (1965) summarized the measurements made by Woodcock (1953), Lodge (1955), Durbin and White (1961), and Toba and Tanaka (1963) and concluded that the concentration, n, of sea salt particles decreases with altitude, z, according to the formula

$$n = n_0 \exp \left[- \left(\frac{w}{D} + \beta \right) z \right] \qquad (1)$$

in which n_0 is value of n at z=0, w the terminal velocity of particles, D the eddy diffusivity, and $\beta = g/RT$, in which g is the acceleration of gravity, R the gas constant for air, and T the absolute temperature. However, there are substantial deviations from this vertical distribution even in the material presented by Toba or collected by different authors. Podzimek and Stampfer (1976) found above the Texas shore that the numerical value of the coefficient in the exponent is close to 7.0×10^{-6} cm^{-1}, however, large fluctuations of this value can be considered as a rule rather than an exception. In the immediate vicinity of a temperature inversion, the values of the coefficient surpass several times -3.0×10^{-4} cm^{-1}. One can expect that there are no great differences between salt nuclei counts at different altitudes until the top of the planetary boundary layer is reached and that the salt particle size distribution curves have almost the

same shapes (Podzimek and Stampfer, 1976).

The question about the smallest and largest salt nuclei found in the atmosphere is not yet completely answered. There is enough evidence to suggest that in the marine atmosphere close to the seashore there are salt particles smaller than 0.1 um in diameter. Their presence was postulated and found by H. Dessens (1949) and investigated by Podzimek (1973). Unfortunately, no systematic measurements have been made with the exception of some indirect studies in nature conducted by Twomey (1968). Others have made very interesting interpretations from flame-photometric measurements (Bodnaine and Pueschel, 1972; Doman, 1975). In general, it can be stated that very small sodium chloride nuclei ($d < 0.1$ um) do exist in the marine atmosphere in concentration of about ten particles per cm^3 (Doman, 1976). This is considerably less than the concentration of sulfates in this size range.

Sodium chloride particles larger than 1.0 um in radius are supposed to prevail in a marine aerosol under normal conditions except for high concentrations of Saharan dust and seashore pollution. Several authors have pointed out the fact that salt particles with radii larger than 10.0 um are found at altitudes above 1.0 km, a fact that disagrees with the simple model presented by Toba (1965). For example, Podzimek and Stampfer (1976) found concentrations of particles with radii larger than 10.0 um in the order of 10^{-4} particles per cm^3 in several samples taken above 1 km. However, because there is a rather large statistical error in the sampling of these ultragiant particles, the reliability of these numbers is very low. During the same flights, sodium chloride containing droplets with radii of 50 um were detected. In general, there is a strong indication that most sodium chloride particles larger than 2 um are droplets, which maintain this state even at relative humidities close to 50% (Podzimek and Stampfer, 1977). This statement is supported by a different slope in the exponential (Junge's) size distribution curve that was found at particle radii larger than 2.0 um.

4. Size Distribution of Marine Aerosols

The distribution of variously sized atmospheric aerosol particles is brought about by a complex process in which chemical or photochemical reactions influence the formation of the embryonic particles. Further increase in the size of the embryos by absorption and adsorption of water vapor molecules leads to the formation of cloud condensation nuclei which form cloud drops under favorable environmental conditions. At this stage, other processes, such as phoretic and electrostatic forces and coagulation, might be active and contribute to the formation of precipitation elements.

The cloud physics approach to the development of marine aerosols is, however, not the only one. Atmospheric optics is another in which "dry" aerosols as well as "wet" are of interest. For this reason, knowledge of both active aerosol (size-supersaturation spectrum) and normal size distribution is in order. Both are based on the mode of aerosol generation and on aerosol evolution and transformation.

Junge presented several papers (1952, 1953, 1956, 1963, 1971, 1972) in which he analyzed the different processes that shape the size distribution of marine aerosols. As early as 1952, he called attention to the hysteresis that occurs in the growth curve of sea salt particles during increasing or decreasing humidity. He also stressed at that time the importance of mixed nuclei and their anomalous behavior at increasing or decreasing humidities for the propagation of electromagnetic waves in a marine atmosphere. A simple calculation of the extinction coefficient in an aerosol containing ground layer led to the conclusion that its value increases more than two and half times if the relative humidity rises from 60 to 95% (Junge, 1952). An investigation of the shapes of the size distribution curves of aerosol particles sampled over a continent and over an ocean led to his frequently used density fun-

ction and to the distinction between continental and marine aerosol size distribution curves (Junge, 1956). The steeper slopes of the curves for samples taken over the continent are due to much higher counts of Aitken nuclei. Over the Atlantic Ocean, one assumes that the background concentration of Aitken nuclei is between 200 and 600 cm^{-3} and around 700 cm^{-3} for locations heavily polluted by the nuclei from highly populated areas or from the Sahara. In general, the dust mineral component over an ocean is mainly restricted to the range of $0.3 < r < 20$ um (1963, 1972).

Since 1963, many improvements on the size distribution model of marine aerosols formulated by Junge have been made by him and his fellow workers as well as by other investigators (Jaenicke et al., 1971). The main difference between the old model and the new size distribution curves is that the main peak, which was assumed to be between 0.01 and 0.1 um particle radius in continental aerosols, has been shifted towards the larger particles (r=0.2 um). The existence of large concentrations of very small particles was postulated by Junge (1972) and found by Jaenicke (1977). The latter found very high concentrations of Aitken nuclei with radii around 0.001 um and stressed their importance for the evolutionary dynamics of the marine aerosol size spectrum. One gets the impression from this that more refined techniques will be needed to illuminate the important question of marine aerosol size distribution for particles with sizes smaller than 0.01 um.

Another challenging subject concerns the general validity of the Junge's power distribution law. It is my conclusion that the r^{-3} distribution is an approximation best realized in polluted areas. One can expect large deviations in the case of one predominant source such as sea spray. Metnieks (1958) found that the exponent varied from 0.97 to 3.71 when he measured the sodium chloride particles on the east and

west coasts of Ireland. Larger deviations from the ideal value of the exponent were also found by Podzimek (1973) and by Podzimek and Saad (1974) after several tens of samples taken at the Texas seashore had been evaluated. Deviations from the ideal power distribution law can also be explained by the different states of the sodium chloride solution drops and crystals that depend on the mean size of particles. Large solution drops have been observed even at relative humidities lower than 50%, and it has been thought that the state of the ocean waves is responsible for the distortion of the size distribution of sea salt particles (Moore, 1952; Moore and Mason, 1954). There is enough evidence (Junge, 1963; Jaenicke et al., 1971; Mészáros and Vissy, 1974) to show that sea salts strongly influence the shapes of aerosol size distribution curves mainly in the particle radii range of 0.4 to 1.0 um. This range is characterized by a decrease in slope of the size distribution curve. The slope, however, depends on several other factors, which usually are not included in the simple Junge's formula, such as wind speed and relative humidity. The first systematic attempt to include wind speed as an important parameter was made by Lovett (1975). Also, Woodcock (1953) found substantial differences among size distribution curves of salt particles measured at different wind velocities.

Other density functions have been used to describe the size distribution of salt particles. Podzimek (1967, 1973, 1974) used the Mukiyama-Tanassava distribution function to describe the measurements of giant salt nuclei. This function represents a special case of the gamma distribution (Levin, 1958, 1961) in the form of

$$n(r) = A\, r^2\, e^{-Br^s}, \qquad (2)$$

in which A, B, and s are constants to be determined from the measurements. The best fit was found for s=0.5 or 0.33

for particles larger than 1.0 um in radius. The distinction between "dry" and "wet" sea salt aerosols in the particle radius range of 2.0 um was apparent from the many samples taken on a Texas seashore.

A wide application of formulas similar to the Nukiyama-Tanassava density function can be found in atmospheric optics. Deirmendjian's models for haze, fog, and dust particles have been used by Gal (1976) and by Wells et al. (1976). These models include the influence of wind velocity - below 7 m/sec, the sea aerosol distribution resembles that of continental aerosols - relative humidity, and change in aerosol densities with altitude. The formula used by Wells et al. (1976) also includes the mixing of a continental and marine aerosol in the form of S_C and S_M, which are exponential scale height factors for continental and marine aerosol components;

$$\frac{dn}{d \log \xi} = \beta \left[C \xi^{-3} S_C + \alpha A \xi^2 e^{-B \xi^S} S_M \right] . \quad (3)$$

In this equation, $\xi = r/F^*$. F^* is the relative growth factor of a nucleus defined by the relationship $F^* = F_{R.H.}/F_{80}$ for R.H. $\geq$ 40%. In the relation, $F = r_{R.H.}/r_o$, $r_{R.H.}$ and r_o are the radii of nuclei at a specific relative humidity (R.H.) and at R.H. equal to 80%. This formal combination of Junge's size distribution for continental aerosols with the Nukiyama-Tanassava density function for marine aerosols is based on the assumption that both aerosols do not interact. Also, the aerosol bearing air masses are assumed not to mix their water vapor contents nor to change their size distribution curves as a result of the change in air stability after the mixing. In spite of these unsolved problems, a formal combination of different distribution functions might be very useful for establishing some model situations. In a similar manner, multimodal distributions of urban aerosols have been success-

fully applied in the past (Whitby, 1974). However, the validity of corresponding models is strictly limited to the specific meteorological situation and aerosol composition.

Other studies include the logarithmic-normal particle size distribution and Best's model (Levin, 1961). Barnhardt and Streete's model (1970), and the application of the so-called self-preserving particle size distribution. The latter mechanism was described by Friedlander (1960), who assumed that the upper end of the aerosol particle size distribution approaches a quasi-steady state into which matter enters by coagulation from the range of Aitken nuclei and from which it is lost by sedimentation at the same rate. This asymptotic distribution is completely determined by the particle volume, total number of particles per unit volume of the gas, and the volume fraction of the dispersed phase (Friedlander and Hidy, 1969). An attempt to extend the applicability of this distribution to processes including condensation was made by Pich et al. (1970). The problems arising from a general application of the self-preserving mechanism to the formation of an atmospheric aerosol were discussed by Junge (1969). He concluded that the observed tendency for atmospheric aerosols to form a quasi-constant, log-volume distribution may simply be the result of statistics that include the many sources of tropospheric continental aerosols. For this reason, one should investigate the applicability of the self-preserving aerosol size distribution for a typical marine aerosol that is different from an aerosol in a highly polluted area.

5. Supersaturation Spectrum of Cloud Condensation Nuclei

One of the most important parameters, which determines the formation of haze or clouds, is the supersaturation spectrum of cloud condensation nuclei (CCN). Since 1959 when

Twomey derived from the number of activated nuclei an approximate formula for droplet formation (characterized by a corresponding supersaturation) in an updraft, several attempts have been made to make systematic measurements of concentrations of CCN at different supersaturations and geographical sites and during a variety of meteorological situations. Many of these measurements were summarized by Braham in 1976. Twomey in 1959 and Squires and Twomey in the same year pointed out the fact that there is a remarkable difference between marine and continental cloud nuclei.

During the second International Workshop on Condensation and Ice Nuclei, a survey of the different types of instruments used for CCN measurements was presented and in the final report Grant (1971) summarized some measurements, which enable one to make a rough comparison of individual counters. In general, this comparison demonstrates the usefulness of the measurements in the supersaturation range of 0.2 to 1.5%, but large discrepancies were found among individual counters based primarily on the thermal gradient diffusion chamber near the lower limit of supersaturation (0.2%). The upper limit, of course, is determined by the time required for the establishment of a steady state supersaturation profile in the thermal gradient diffusion chamber.

Hoppel and Wojciechowski (1976) presented an interesting analysis of the processes that occur in thermal gradient diffusion chambers. It appears that there are some parameters that might play an important role in CCN counting, such as the chamber's environmental humidity, the nature and concentration of the aerosol, and the timing of the camera exposure used to record the rate of fall of drops in the chamber at a specific supersaturation. Instantaneous photographic recording does not seem to give an adequate account of a nucleation process characterized by a low condensation coefficient value. In spite of the recent findings of high values

for the condensation coefficient of atmospheric aerosol particles (Neizvestnyi, 1974), this photographic deficiency might lead to a shift in the CCN supersaturation curves. A disturbing feature of using instantaneous recordings for counting is the absence of a well defined plateau. This indicates that not all nuclei activated at a certain supersaturation are counted.

On the other hand, the thermal gradient diffusion chamber was an improvement over the existing methods used for investigating the microstructure of clouds. It was a useful tool for gathering valuable data on nuclei supersaturation spectra over wide areas when flown on board an aircraft. The measurements of nuclei activity could be made in the important and very sensitive domain of supersaturation that corresponds to the region of cummulus cloud formation. In this way, one was able to obtain a picture of the main characteristics of active nuclei over both the ocean and mainland (Twomey and Wojciechowski, 1969; Radke and Turner, 1972; Hobbs et al., 1976; Hindman et al., 1977).

The parameters C and k that figure in the Twomey relationship, $n=C.S^k$, for the number of nuclei, n, activated at supersaturation, S, have been measured by different investigators at different locations. They were compared by Braham in 1976, but a simple interpretation of the data is impossible. Most of the measurements that have been made over the ocean are characterized by low values of the parameter C ($C<800$ cm^{-3}). Most of these measurements have k-values of around 0.55, except for one series of measurements made by Hoppel et al. (1973) over the Pacific. These showed the highest value of k (1.2). All measurements made over the mainland are featured by k-values ranging from 0.3 to 1.0, and the values for the concentration parameter, C, are between 600 and 3000 cm^{-3}. The comparability of the data is in general poor, because, except for the updraft velocity, the authors do not describe the environmental parameters in detail, and some of

them do not mention the exact procedure of counting. Johnson (1976) showed clearly how difficult it is to obtain a clear picture of the available data. In general, the change in the number of activated nuclei depends directly on the change in C or on the updraft velocity, U, and the importance of variations in U increases with the increasing value of k. The dependence of C and k on the assumed size distribution function was the subject of a study made by Podzimek and Saad in 1974.

Other interesting features pertaining to the measurement of CCN activity are discussed in a book by Sedunov (1972, pp. 70-93), and the problems related to the relaxation time of the growth of giant salt nuclei are to be found in a paper prepared by Carstens et al. (1974). According to these simple models, the growth process of sea salt giant nuclei lasts for hundreds of seconds at relative humidities close to saturation if one assumes the value of the condensation coefficient β = 0.036. This means that not all giant or ultragiant nuclei important in cloud forming processes would be detected in a counter due to their slow growth rate. However, some doubt has been recently expressed about the importance of giant chloride nuclei for cloud formation, mainly in subtropical and tropical regions (Woodcock et al., 1971; Takahashi, 1976; Hindman et al., 1977). This fact contradicts to the former studies of precipitation mechanism above the ocean by Findeisen (1944), which was supported by observations over the North Atlantic (Schulz, 1947).

An apparent discrepancy between the theory of CCN growth and the measurements has arisen since the time of the Second International Workshop on Condensation and Ice Nuclei, when it was found that the radii of salt particles nucleating water are larger than those predicted by theory (Grant, 1971). Later, Katz and Kocmond (1973) found that this discrepancy amounts to a factor of two or three and explained it as being caused by contamination. The issue of contamination by organic and other substances appears several times in the

history of cloud physics (Pueschel et al., 1969; Winkler and Junge, 1971; Blanchard, 1971; Podzimek and Saad, 1975). The careful experiments of Gerber et al.,(1977) with nearly monodisperse particles of NaCl and $(NH_4)_2SO_4$ show, however, that the supersaturation-particle radius curve deduced from their experiments follows the theoretical curve very well.

The need for reliable measurements in the domain of supersaturations very close to 100% R.H. led to a search for a simple counter devoid of all problems common to thermal gradient diffusion chambers. Laktionov (1972) based his chamber on an assumption of a relationship between the critical supersaturation and the nuclei radius at 100% R.H. This, however, posed several questions, such as the reliability of these measurements in polluted areas or in the regions containing mixed marine nuclei (Alofs and Podzimek, 1974). Later, a detailed calculation by Hoppel and Fitzgerald (1976) showed that there is a unique relationship between the equilibrium particle radius at saturation and the critical supersaturation. This relationship is almost independent of the fraction of soluble material in the nucleus provided that the particle contains more than 1% of soluble material by weight. It seems that this can provide one with a new effective instrument, the real value of which has to be checked in the near future.

4. Visibility and Optical Properties of Marine Aerosols

The optical properties of marine aerosols offer investigators a unique way to predict the propagation of electromagnetic waves under different environmental conditions. They also make it possible to use optical measurements to determine the composition of marine aerosols. The former application

is related to the very important question of visibility in hazy atmospheres, the latter helps to solve important problems in cloud physics (dispersion of fog) and in atmospheric chemistry.

The physical state of a marine aerosol is a result of several parameters that affect its generation and evolution, such as composition, size distribution, relative humidity, wind speed, air stability, and air mass trajectory. Several other parameters might be effective under specific conditions, such as the presence of organic materials, inactive dust, and solar radiation. Also, the color of the target might be an important factor in visibility measurements (Horvath and Presle, 1975).

Recently presented theoretical models that describe the propagation of optical signals in a marine atmosphere assume that the aerosol size distribution evolves from an initial distribution, which is gradually affected by relative humidity. The settling and transport of particulates in the turbulent boundary layer, and the changing intensity of their source. The source intensity and the transport of particulates is governed by wind velocity. Such a model was assumed by Wells et al. (1976), who in addition postulated a typical initial size distribution for continental and marine aerosols and the mixing of both air masses in the ratio of 1:2.5 as was stated earlier. This assumption corresponds to the model for calculation of the scattering coefficient in the infrared domain that was applied by Barnhardt and Streete (1970).

Fitzgerald's model (1975, 1976) deals in great detail with the dependence of the aerosol size on variations of the environmental humidity (Fitzgerald, 1975) and assumes that in a chemically homogeneous aerosol (NaCl) a one-to-one correspondence exists between the radius of a "wet" particle and its "dry" radius. His main premise in calculating the scattering coefficient is that due to the known hysteresis

in the behavior of a sea salt (NaCl) aerosol during increasing humidities one can assume that the sea salt nuclei exist as solution droplets in the boundary layer close to the ocean's surface. This assumption, however, requires a more detailed investigation, because there is some evidence that only large sea salt nuclei exist in a liquid state (Podzimek, 1977). Fitzgerald's model for the case of totally soluble sodium chloride particles shows that the visibility can decrease by a factor of 50 as the relative humidity increases from 50 to 100%. A comparison of the calculated visibilities with the measured ones in an advection fog off the coast of Nova Scottia in 1975 led to a good agreement between the theory and observation.

One of the most important parameters used in calculating the visibility range is the index of refraction. Its complex nature is usually reduced only to the real part when one deals with visible light (Fitzgerald, 1976), but the imaginary part, which corresponds to the absorption of radiation, can play an important role in the propagation of infrared radiation.

Several papers deal with the propagation of electromagnetic waves in fog and haze (Foitzig, 1938; Volz, 1954, 1956; Bullrich, 1960; Radke and Hobbs, 1969; Fischer, 1970). Foitzig's article contains notes on the influence of aerosol particles that grow at different relative humidities. Also, he calls attention to the investigation of the sudden change that takes place in visibility just prior to the onset of a fog. Interesting observations of the dependence of the extinction coefficient upon the wave length and the aerosol concentration were made by Middleton (1935). His book, "Vision Through the Atmosphere", (Middleton, 1952) like many other textbooks on atmospheric optics contains a paragraph dealing with the effect of atmosperic aerosols on visibility and its measurement.

Much attention has been paid recently to the propagation of infrared waves through an atmosphere containing aerosol particles. Irving and Pollack (1968), Remsberg (1971), and Volz (1972) investigated the absorption of infrared light by atmospheric aerosols. Volz collected rain residue samples from different geographical latitudes and locations and after measuring their optical parameters concluded that the water solube substance is independent of the climatic zone. Greater attention to the optical features of the samples might provide more insight concerning particle deposition on rain droplets. The real part of the refractive index of similar samples was calculated by Volz (1972 b) from the specular reflectance at near normal incidence of disks of a pure aerosol substance. His results, when combined with the absorptive part, enabled him to calculate total refractive index. The principal finding is that the extinction of a natural aerosol should have a minimum around the 8 um wavelength followed by a strongly expressed maximum near 9 um. This corresponds to an increase in extinction by a factor of three. Volz (1972 b) also analyzed the potential influence of a composite aerosol and of the presence of water absorbed in the samples. Several other articles published during the last decade deal with the infrared optical constants of aquaeous solutions of electrolytes and of water (Querry, 1972; Hale and Querry, 1973; Querry et al., 1974; Rhine et al., 1974 a and b). They constitute a useful basis for investigating the liquid phase of marine aerosols.

All the aforesaid notes on the role of marine aerosols in the propagation of optical signals stress the importance of a knowledge of how the relative humidity affects the physical and chemical parameters of the soluble and insoluble particles. Attempts to establish a model and to calculate the visual range in fog and haze have been made by several authors (Dickson and Hales, 1963; Kasven, 1969; Hänel, 1971, 1972). Particular attention has also been paid to the initial stage

of fog and haze when the most active part of an atmospheric aerosol begins to be involved (Hänel, 1968, 1972; Prishivalko and Astafyeva, 1974). Zuyev et al. (1973) presented an analysis of the results of simultaneous optical and microphysical measurements in the boundary layer. This led to the model of the complex refractive index of an atmospheric aerosol. The model included the physical and chemical properties of a tropospheric aerosol and assumed a specific size distribution for the particulates.

In a survey article, Hänel (1976) summarized the main results of his and his fellow-workers investigation into the optical properties of atmospheric aerosol particles as functions of relative humidity. Special equipment and procedures were used to obtain the necessary information on volume, mean density, and mean complex refractive index. The optical parameters of the salt aerosol particles gradually approached those of water drops during increasing relative humidities. In the case of decreasing relative humidities, the hysteresis of a salt aerosol was effective around 75% R.H. (Wall, 1942; Winkler, 1969). The behavior of salt particles in the region of hysteresis depends not only on the physical and chemical properties of the particles but also on their history, e.g., dwelling in the environment with high or low humidity (Hänel, 1972). The theory and techniques developed in the laboratory were applied to the measurement of the volume, density, and complex refractive index of aerosol particles collected in the Atlantic and subjected to different relative humidities (Fischer and Hänel, 1972). Generally, the values of the real part of the index of refraction varied between 1.55 and 1.35 and of the imaginary part from 0.047 to 0.003 for $\lambda = 0.589$ um, when the relative humidity gradually increased from 20 to 96%. A useful discussion of the importance of the imaginary part of the index of refraction (absorption) for visible light has been presented by Fischer (1970, 1976). He

concluded that under normal atmospheric conditions neglect of the absorption part in the complex index of refraction is justified. The same group of investigators later suggested (Hänel and Dlugi, 1976) a simplified procedure for calculating the part of the index of refraction that corresponds to the absorption in a contaminated atmosphere. This method produces results that do not deviate more than ±40% from the exact formula for wavelengths between 0.3 and 2.5 um and 9.25 to 12 um if one assumes that the range of relative humidities is between 0 and 95%.

One observes in all treatises the very important roles that are played by the droplet growth model (Goroch, 1978) and the evolutionary dynamics of the drop size spectrum in the deduction of optical parameters of marine aerosols. In many cases, just a steady state would lead to useful results (Fitzgerald, 1976), but one feels that the closer the measurements are made to sea level, the more one will need to know about the dynamics of the sources and sinks of particulates and the interaction with the ocean's surface.

7. Conclusion

In glancing over the subjects and text covered by this survey of marine aerosol advances, I see the broadness of the field and the shallow profile of some of my literary notes. This is the risk that the author of any survey takes upon himself, but I wished to make a survey during a six-month period that would call attention to all principal factors related to the heavily investigated field of marine aerosols, and I intentionally wanted to cite some papers, articles, and reports that are not frequently referred to in the United States. I regret if some of my notes are not useful

to an investigator working in his own narrow field of professional activity, on the other hand I will be very happy if some of the quotations and notes prove to be of use to my friends and colleagues. I hope to be able in the future to complete this survey and to improve its narrative.

My impression is that great progress has been made during the last decades in investigations of the physical and chemical properties of aerosol particles in the range of radii between 0.05 to 5.0 um. This progress is, in my opinion, due to the involvement of many highly qualified investigators who possess a thorough knowledge of the physics of aerosols, chemistry, meteorology, and oceanography. The improvement of old measuring techniques, the application of new technology in instrument design, and, the automatization of the measurements have revolutionized the research of marine aerosols. There is an indication that some phases of marine aerosol research will develop more in the future because of their scientific or practical importance.

In Aitken nuclei research, attention will be paid to the evolution of the size distribution spectra of nuclei and to the dynamics of the their transition from embryos to large particles. Some investigators might try to respond to the question of the source of Aitken nuclei over the ocean, which maintains the balance between deposited nuclei and those removed from the atmosphere. Investigations of the chemistry of small and ultrafine particulates will continue to probe the sources of sulfates above the surface of the seas, the potential existence of droplets of HCl, and the possible roles played by gaseous chlorine and some important organic materials (surface active substances) and metals. A very important question remains to be answered about the dynamics of Aitken nuclei formation during haze or cloud formation and dissipation.

Giant and ultragiant particles will be probably investi-

gated for their still insufficiently known part in stimulating special kinds of precipitation mechanisms over the ocean in the middle latitudes and for their impact on agricultural soil and their role in the degradation of materials. For the purpose of modeling the propagation of optical signals in marine atmospheres, it seems to be very important to know how the large nuclei grow into giant particles, and mainly, what part of the size spectrum can be considered as liquid drops and what remains in the solid (crystalline) state under specific environmental conditions. There is a need for a more definite model to explain the dependence of a particle's growth on relative humidity, wind velocity, and state of the sea surface. In general, one might ask what is the combined role of ultragiant particles and sea water droplets that are sprayed above the ocean's surface. Although small in number, together they have a pronounced influence on the propagation of signals in the visible and infrared domain of wavelengths. For this purpose, the application of modern techniques, such as counters based on light scattering and flame photometry and X-ray spectrum energy analyzers, in combination with classical sensitized layers, such as the Liesegang circle technique, could be very useful for determining the nature, size distribution, and time variability of giant and ultragiant particles.

The above remarks are made only in relation to the subject and aims of this survey. They cannot reflect the great variety of questions important to environmental studies, aerobiology, and the many other fields concerned with marine aerosols.

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Figures

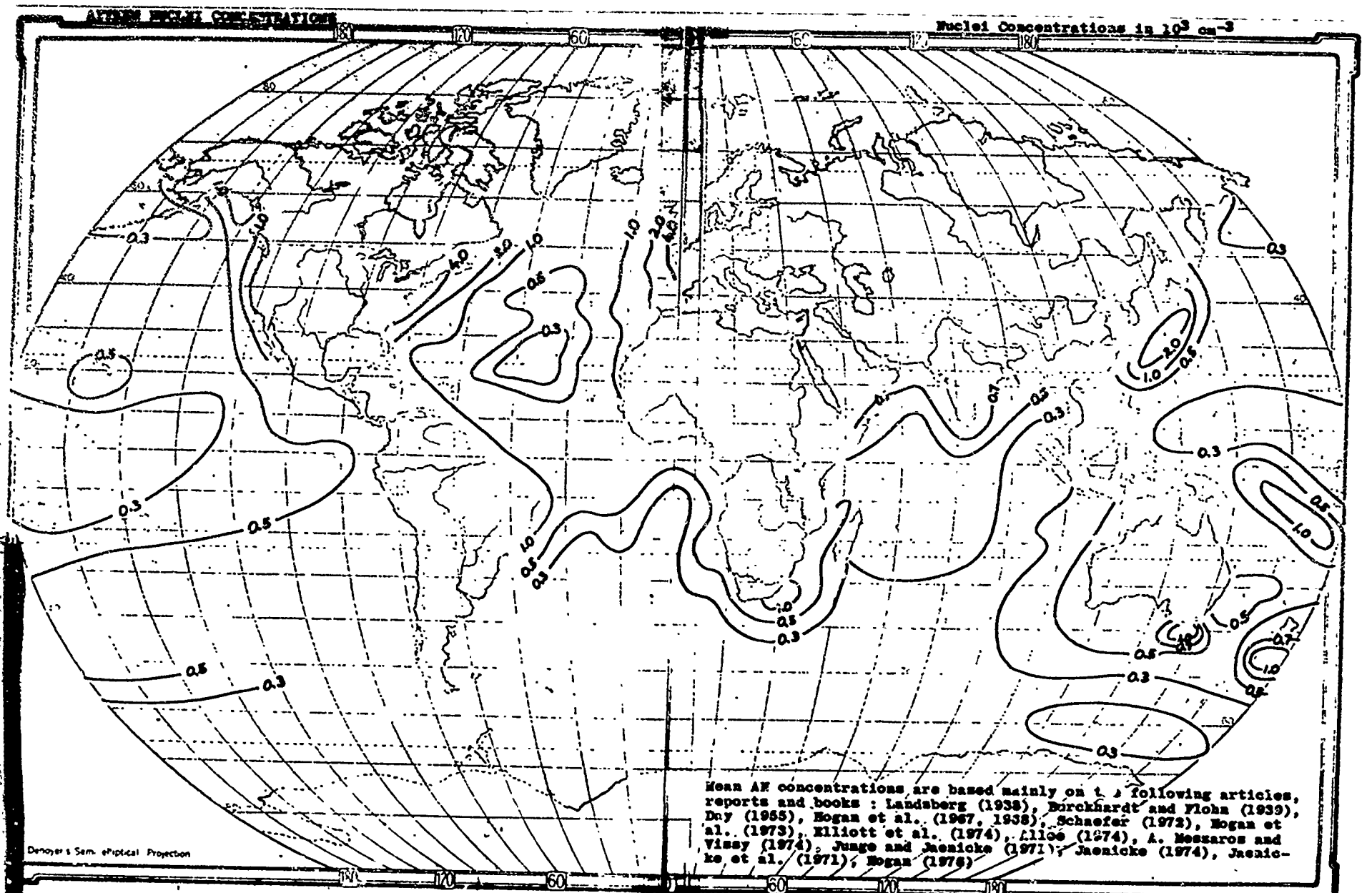
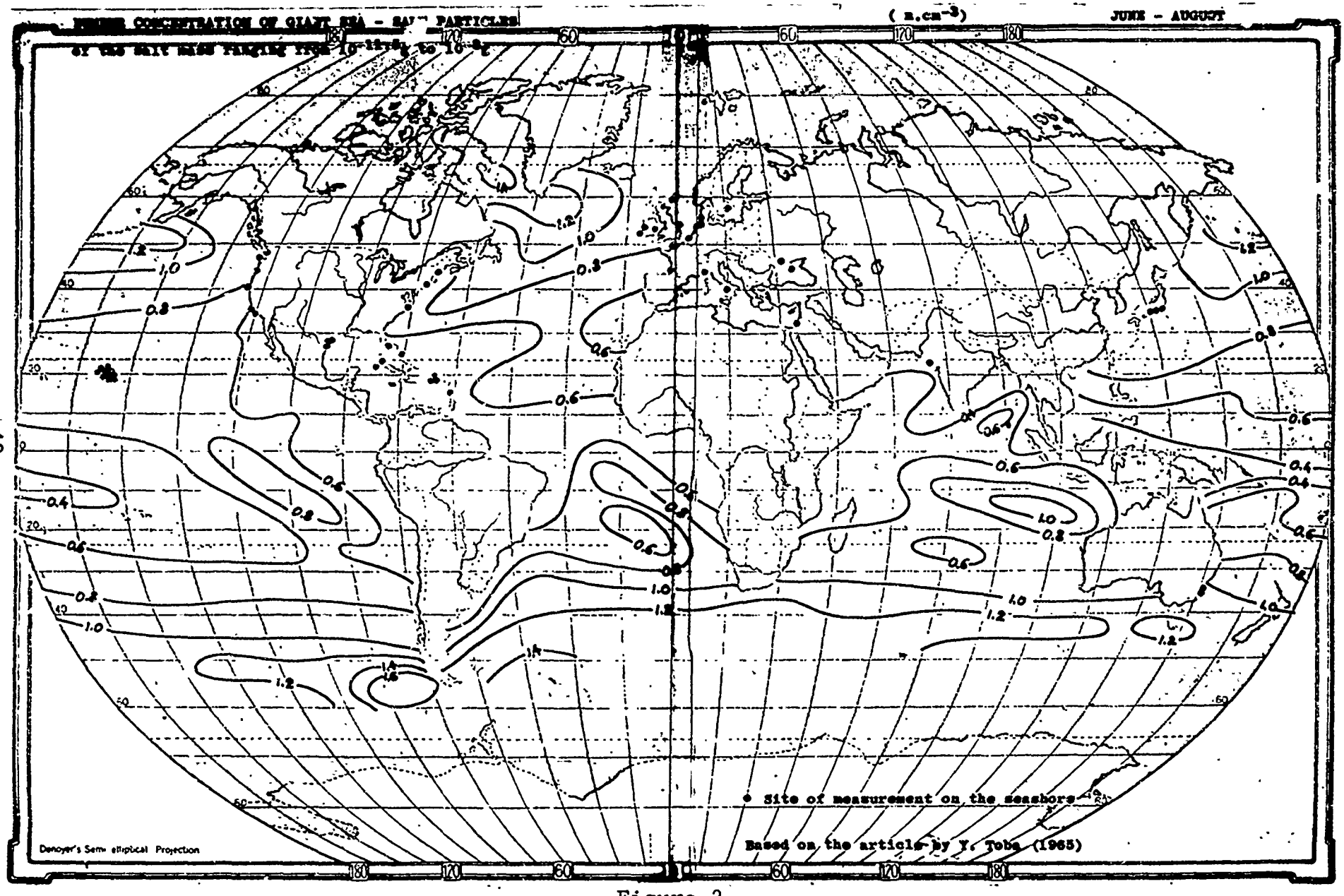


Figure 1.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JUNE - AUGUST
Denoyer's Semi-elliptical Projection
• Site of measurement on the seashore
Based on the article by Y. Toba (1965)

Figure 2.

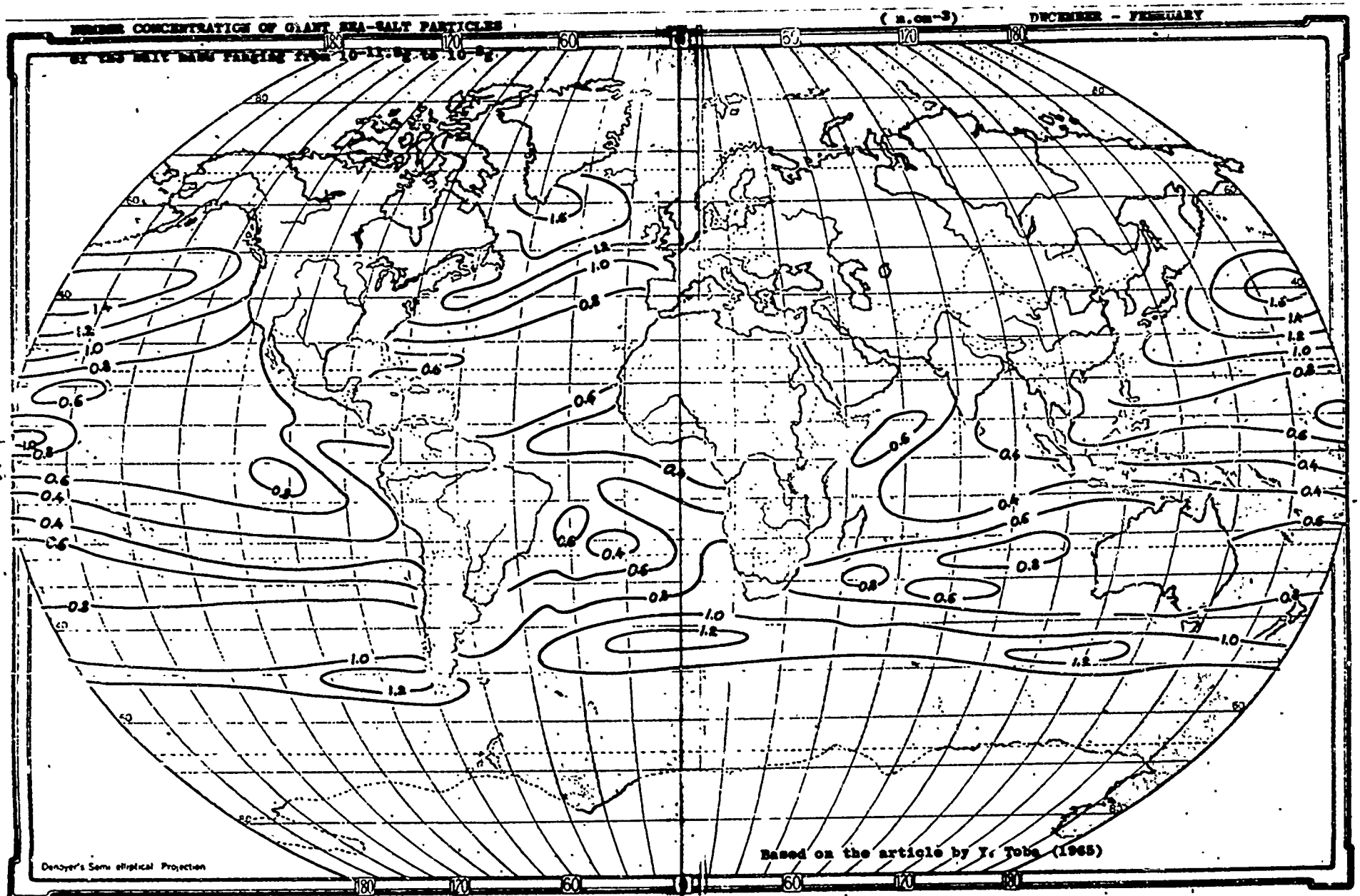
NUMBER CONCENTRATION OF GIANT SEA-SALT PARTICLES
(n.cm-3)
DECEMBER - FEBRUARY
Denoyer's Semi elliptical Projection
Based on the article by Y. Toba (1965)

Figure 3.

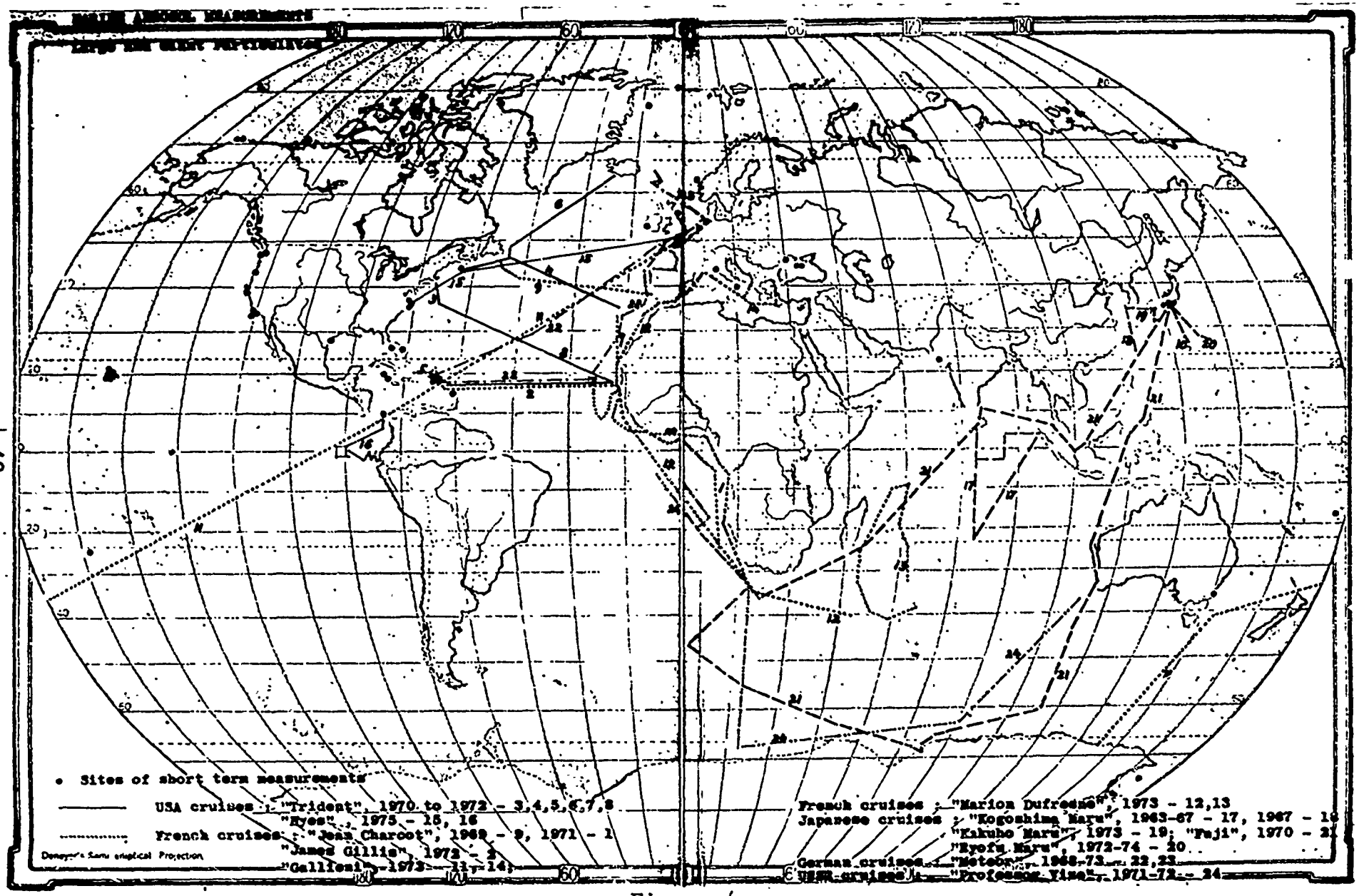
• Sites of short term measurements
USA cruises : "Trident", 1970 to 1972 - 3,4,5,6,7,8
"Eyes", 1975 - 15, 16
French cruises : "Jean Charcot", 1968 - 9, 1971 - 1
"James Gillis", 1972 - 2
"Gallieni", 1973 - 11, 14
French cruises : "Marion Dufresne", 1973 - 12,13
Japanese cruises : "Kogoshima Maru", 1963-67 - 17, 1967 - 18
"Kakuho Maru", 1973 - 19; "Fuji", 1970 - 21
"Ryofu Maru", 1972-74 - 20
German cruises : "Meteor", 1968-73 - 22,23
USSR cruises : "Professor Vize", 1971-72 - 24

Figure 4.

Division of Subjects in List of References

1 Physical and Chemical Properties of Marine Aerosol:

1.1 Concentration
1.2 Size distribution
1.3 Shape
1.4 Composition
1.5 Activity in cloud forming processes
1.6 Electrical (charge) properties
1.7 Properties of mixed nuclei
1.8 Surfactants - organic substances
1.9 Theoretical models of nuclei growth

2 Marine Aerosol Generation

2.1 Origin of Aitken nuclei
2.2 Origin of large and giant nuclei
2.3 Salt nuclei generation
2.4 Pollutants over the ocean
2.5 Salt nuclei measurement over the ocean
2.6 Continental dust over the ocean
2.7 Vertical distribution of salt nuclei and pollutants
2.8 Organic material in the marine atmosphere
2.9 Correlation with the state of the sea

3 Effect of Marine Aerosol on Optical Signals

3.1 Interaction of light with marine aerosol
3.2 Scattering by particles with a
3.3 Absorption of the visible radiative energy
3.4 Absorption of the infrared radiative energy
3.5 Index of refraction of marine aerosol
3.6 Visibility
3.7 Influence of the inhomogeneity in aerosol distribution

4 Geographical Distribution of Marine Aerosol

4.1 Distribution of Aitken nuclei
4.2 Distribution of large and giant nuclei
4.3 Chemical composition of rain water
4.4 Distribution of optical properties of marine aerosol

5 Measuring Techniques for Marine Aerosol

5.1 Concentration and size distribution of Aitken nuclei

5.2 Inertial deposition and filtering
5.3 Electrostatic precipitation
5.4 Thermal precipitation
5.5 Aerosol centrifuge
5.6 Thermal gradient CCN counter, Laktionov chamber
5.7 Light scattering counter
5.8 Flame photometer
5.9 Acoustical counter
5.10 X-ray spectral energy analysis
5.11 Calibration of AN counters
5.12 Calibration of CCN counters
5.13 Spot test methods
5.14 Particle diffusion
5.15 Aerosol particle evaluation techniques
5.16 Particle sedimentation

Abe, T., 1954

A study on the foaming of sea water. On the mechanism of the decay of bubbles and their size distribution in foam layer of sea water. Papers in Meteor. and Geophys. Japan, 5: 240-247

Considering the decay of foam layer of sea water, the concept of "activation energy" is introduced. This increases with increasing concentration of salt (in sea water) up to a certain maximum, and then decreases with further increase of concentration. Disscussed are the size distribution of sea bubbles. The calculated values are in fair agreement with experiments. Statistics of the bubble counting is described in details.

2.9

Abe, T., 1955

A study on the foaming of sea water. A note on the analogy between the coagulation process of colloidal particles and that of bubbles in foam layer of sea water. Papers in Meteor. and Geophys. Japan, 6: 56-62

The author treats the coagulation process of bubbles in foam layer of seawater. He applies the equations for coagulation process of colloidal particles for the coagulation process of bubbles. Maximum size of bubbles is determined.

2.9

Abe, T., 1955

A study on the foaming of seawater. A tentative analysis of wind-wave data in view of the foaming seawater, Papers in Meteor. and Geophys., Japan, 6: 2, 164-171

Relationship between the intensity of the foaming of seawater and of wave pattern which depends mainly on wind velocity is investigated. The author points out the main processes leading to foam formation and its stability.

2.9

Aitken, J., 1880

On dust, fogs and clouds, Proc.Roy.Soc.,Edinburgh, 29: 14-18
and 30 (1881) : 337-368.
Further comments Feb. 3, 1881, pp. 311-312
and Feb. 24, pp. 384-385

Describes experiments with two large glass containers ; one filled with ordinary air, the other with carefully filtered air. After the steam was let into both containers, in that filled with polluted air claudiness appeared. Concludes that fog and cloud are formed on dusts as condensation nuclei and that effective condensation nuclei can be formed by burning of common salt, or sulfur in fire or in alcohol flame.

1.1 - 2.1

Aitken, J., 1888-1889

On improvements in the apparatus for counting the dust particles in the atmosphere. Proc.Roy.Soc. Edinburgh, 16: 135 - 172

Apparatus comprises: test receiver, air pump, measuring apparatus, illuminating arrangement, and gasometer. Describes purpose and function of each component. The author presents tabulation of the results obtained in rooms, and in open air at various geographical locations.

5.1

Aitken, J., 1890-1891

On a simple pocket dust counter, Proc.Roy.Soc.Edinburg, 18: 39-52

The author discusses an improved model comprising a pump with which a definite volume of air can be aspirated trough a receiver, a stage in the receiver having a graduated screen on which the particles can be counted with the aid of a microscope or strong magnifier lens.

5.1

Aitken,J. 1890, 1891

On a method of observing and counting the number of water particles in a fog. Proc.Roy.Soc.Edinburgh, 18: 259-262

Haze, fog, mist and rain are successive developments of the same meteorological process. The author describes a modification of a "pocket dust counter" (described already in 1890). Number of drops which fell per minute in the counter varied between 300/cm^3 and 3,000/cm^3.

5.1

Aitken, J., 1891

On the solid and liquid particles in clouds, Nature, 44: 279

The author described observation on Rigi mountain where he found that clouded air contained more dust particles than the air outside of the cloud. He made measurements with the fog counter and investigated the formation and evaporation of droplets.

2.1

Aitken, J., 1892

On some phenomena connected with cloudy condensation, Proc.Roy.Soc.London, 51: 408-439;
also Smithsonian Inst. Ann. Rep. 1893, 201 - 230

Cloudy condensation is produced when a jet of steam mixes with ordinary air, by electrifical charging of dust nuclei and by low temperature of air. Discussed are: Color phenomena connected with cloudy condensation and color of steam jets are depicted. Describes also dust counting coniscope for measuring dust content of air.

1.1 - 2.1 - 5.1

Aitken, J., 1911, 1912

The sun as a fog producer, Proc.Royal Soc. Edinburgh, 32: 183-215

Sun also can produce fog during sunrise under favorable meteorological conditions. The author describes an apparatus for testing foggy air. Possible causes of fog formation are : radioactivity, electricity, gases which act on SO_2 (NH_3, H_2O_2, O_3) products of combustion of coal and of purified gases. The author concludes that the problem of how the sun- fogs are produced is not yet cleared.

2.1

Aitken, J., 1916

On some nuclei of cloudy condensation, Proc.Roy.Soc. Edinburgh, 37: 215-245

Some nuclei can codense water vapor when the air is unsaturated, owing to hygroscopic nature of the material. Elaborate apparatus is illustrated and described. Treats: electricity and nuclei; spark discharge; effects of sulfuric acid and light; electric discharge; nuclei produced by heat and chemical action; sources and nature of nuclei.

1.1 - 2.1.

Aitken, J., 1923

" Collection of Scientific Papers ", Cambridge Univ. Press, London & New York, 592pp.

Collection of articles by J. Aitken contains descriptions of experiments and many thoughts of the author of the " pocket counter " about the importance of the measurement of small particulates.

1.1 - 2.1 - 5.1

Albrecht, J., 1958

Methoden zum Nachweis von Microorganismen in Aerosolform, Zeitschr. Aerosol.-Forsch. und Therapie,7: 50-61

Determines the existence, number, and viability of small living organisms (virus, germs, bacteria, algae, molds, fungi, protozoa). For investigating these in the natural state several requirements which are briefly described must be fulfilled. Recommended sampling methods are also discussed.

1.1 - 1.5

Alexandrov, E.L. 1967

O ponizhenii davlenia parov vody nad rastvorami gigroskopicheskikh veschestv. Tr. Instituta prikl.geofiz.,9:77-82

A correction term for the presence of hygroscopic substance NaCl in a nucleus is suggested in the form which includes the radius of dry nucleus, the radius of a soluble part of a nucleus and two empirical constants which have to be determined from measurements.

1.9 - 1.5

Alexandrov,E.L., and N.V.Klepikova, 1971

Deformatsia spectra iader kondensatsii pri obvodnenii i otsenka ee vliania na vidimost'. Tr. Instituta eksper. meteorol., 20: 84-89

The authors investigated the behavior of the atmospheric aerosol and checked the suitability of the parameters governing the growth of individual particles. Using the data by Lee and Patterson they found a parameter $\alpha = \frac{1}{2}$ which describes the behavior of nuclei at higher relative humidities (Levin and Sedunov, 1966). Finally, they studied the influence of the growing hygroscopic particles on the visibility.

3.6 - 1.2

Alexandrov,E.L.,N.V.Klepikova,Yu.S.Sedunov, 1975

O vlianii parametrov iader kondensatsii na process oblakoobrazovania, Proc. 8th Int.Conf.on Nucleation, Leningrad, 1973, Gidrometeoizdat, Moscow, 416-424

The evolution of cloud droplet spectrum is calculated and based on the following assumptions: Steady updraft, field homogeneity, exponential density function of the size distribution of sodium chloride nuclei. The calculations covered a 15 minute period when most of the cloud microstructure is shaping. Maximum supersaturation (between 0.05 to 0.5%) level fluctuated from 5 to 25 m above the condensation levels.

1.9 - 1.5

Alexandrov,E.L., A.F.Kovalev, and N.P.Yasevitch, 1977

Altitude and time dependent variability of the natural atmospheric aerosol characteristics, Vol.of Abstr. 9th Int. Conf. on Atmos. Aerosols, Cond. and Ice Nuclei, Galway, 67

Measurement of the total and soluble mass of aerosol and light scattering were performed on the 300 m tower near Obninsk. In mean, the concentration of aerosol decreases with altitude (at 300 m level 0.3 to 0.7 of the concentration at 1 m above the ground). The ratio of aerosol scattering coefficient and weight concentration varies in wide ranges (from 0.4 to 2.6 m^2/g). During stable stratification Junge's exponent is close to 4 and during unstable 2.

1.4 - 3.2

Alexandrov,E.L., and N.P.Yasevitch, 1975

Opredelenie vesovoi kontsentratsii atmosfernykh aerozolei i soderzhania v nikh rastvorimykh veschestv, Proc.of 8th Int.Conf.on Nucleation, Leningrad, 1973, Gidrometeoizdat, Moscow, 454-461

Filter samples were taken in the daytime on the measuring tower at Obninsk at altitudes 2m and 300m above the ground.The aerosol mass concentration was calculated from the filter weight increase. The filter was washed twice with desstilled water and conductivity indicated the water soluble part of the aerosol. The mass concentration variability was very high, unlike that of the water soluble substance. The latter does not change much with the altitude.

-1.4 - 2.7

Allee, P.A., 1974

Atmospheric particulate concentrations measured over the Atlantic Ocean during the 1969 Bomex experiment, J. Rech. Atmos. 8: 947-955

The measurement of AN and CCN concentration was made together with ice nuclei in the vicinity of Barbados Island during the 1969 Bomex expedition. Results: Up to an altitude of 3.7 km AN concentrations varied within 200 and 350 particles per cm^3. CCN varied from approx. 100 to 200 cm^{-3} and IN varied from 0.1 to 0.2 l^{-1}. The AN and CCN concentrations were correlated stronger in the layer between 1.2 and 3.0 km, than below and above.

2.1

Aliverti, G, and G. Lovera, 1939

I fenomeni meteorologici sull' oceano e il campo elettrico terrestre, Atti Reale Acad. Sci. di Torino, 74: 573-590

The authors describe among other subjects an experiment based on bubbling the air through sea water or sodium chloride solution. They found nucleus concentrations of 10^5 cm^{-3} or higher in the air above the solution. The bubble spectrum - and not the amount of passing air - is the important factor in determining the nucleus formation on the surface.

1.1. - 2.1.

Aliverti, G., and G. Lovera, 1950

Sui nuclei di condensazione di origine maritima, Geofis. Purae Applic. 16: 133-135

Survey about the work by Junge and Koehler. Discusses different instruments: Aitken and Owens counters, Zeiss Konimeter, Dessens method of using spider webs for collecting salt particles. Also artificial condensation nuclei generated by cooking, boiling of liquids, and processes in which bubbling occurs are mentioned as a potential source of salt nuclei in the atmosphere.

1.1 - 2.1 - 5.1

Alofs, D.J., and J. Podzimek, 1974

A review of Laktionov's isothermal cloud nucleus counter, J. Appl. Meteorl. 13: 511-512

The principles of the counter measuring the size of water droplets formed at 100% relative humidity are described and the general validity of the simple relationship between a droplet size and the critical supersaturation of a nucleus discussed. A combination of the thermal diffusion chamber with Laktionov's counter is suggested.

5.6

Andreev, B.G., 1970

Polnyi spektr chastic iestestvennykh aerozolei i otsenka doli aktivnykh iader kondensatsii, V sbor. "Tr. VIII Vses. konfer. po fizike oblakov i aktivn. vozdeistviam", Leningrad, Gidrometeoizdat, 93-100

The measurements of the total spectrum of the atmospheric aerosol led to higher values than those predicted by Junge. In mean the values up to 6 were found.

1.2 - 1.5

Andren, A.W., and R.C. Harriss, 1971

Anomalies in the size distribution of magnesium, calcium and sodium in marine aerosols, J. Appl.Meteor. 10: 1349-1350

Cl, Br, I have distinct ratios in marine atmosphere for different particle size ranges and there are also some different characteristics between continental and marine aerosol. Using six-stage Andersen Air Sampler shipboard sampling was performed around Bahamas and Florida. Samples were taken also on a meteorological tower above the tree canopy in the Luquillo rain Forest, Puerto Rico. The element ratios from the atomic absoption measurements were: Ca/Na 0.17-0.4, Mg/Na 0.05-0.10, Ca/Mg 2.6-3.2

1.4 - 4.2

Atherton, E., and R.H.Peters, 1953

Some aspects of light scattering from polydisperse systems of spherical particles. Brit.J.Appl.Phys. 4: 344-349

Discussed are Debye's theory of light scattering and its application to polydisperse systems. Three measurements are possible: dissymmetry ratio, turbidity and dependence of turbidity on wavelength. By assuming model distribution functions, we can calculate the dissymmetry ratio which leads to a value close to the weight average. The wavelength dependence of turbidity gives a diameter close to the mean of the distribution.

3.2 - 3.6

Atherton,E., and R.H.Peters, 1953

Light scattering measurements on polydisperse systems of spherical particles, Brit.J.Appl.Phys. 4: 366-369

Theoretical findings published previously are applied to some commercially produced particles.Two examples are presented how to obtain size distribution of particulates from the measurement of dissymmetry ratio, turbidity and dependence of turbidity on the wavelength of the light.

3.2 - 3.6

Aubert, J., 1974

Les aerosols marins, vecteurs de microorganismes, J.Rech.Atmos. 8: 541-554

Studies realized on the basis of "in situ" measurements that in seashore polluted areas is an abundance of terrestrial bacteria (mainly coliforms). In offshore areas, the abundance of marine microorganisms was found. There was a difference, however, between aerosols collected over intercontinental seas (like Mediterranean Sea) and over Atlantic Ocean. Experiments "in vitro" showed the presence of some antibiotic substances of sea-water in the marine aerosol.
2.8

Bahethi, O.P., and R.S.Fraser, 1977

Comparison of results obtained by solving the radiative transfer equation with an iterative method and a spherical harmonics method, J.Atmos.Sci., 34: 553-556

Light scattered by a model atmosphere is computed by a spherical harmonics approximation and by an iterative method of solving the radiative transfer equation. Both methods are compared. The large differences found by other authors in the net fluxes and intensities for the two methods are considerably reduced. In the Mie atmosphere Deirmendjian's particle size distribution with a particle index of refraction m=1,5 and λ=0.777 um were used.

3.1

Baier,R.E.,D.W.Goupil,S.Perlmutter, and R.King, 1974

Dominant chemical composition of sea-surface films,natural slicks and foams, J.Rech.Atmos. 8: 571-600

The analyses of thousands of samples taken in seas, the Great Lakes, rivers and lakes in Northeastern USA were performed by a nondestructive analytical procedure, capable to detect films as thin as monomolecular layer (10^{-7}cm). The investigation led to the conclusion that ambient air/water interface are usually coated with films of glycoproteins and proteoglycans. ranging in thickness from 100 to 300 Å, negatively charged and exhibiting moderate surface free energies (about 35 dynes. $.cm^{-1}$).

2.8 - 1.8

Barnhardt,E.A., and J.L. Streete, 1970

A method of predicting atmospheric aerosol scattering coefficients in the infrared, Appl.Optics, 9: 1337-1344

A method predicting scattering coefficients in the atmospheric windows from 1.0 to 15.0 um is suggested. The method avoids the assumption that the index of refraction and the aerosol distribution are constant. A two-component continental and maritime aerosol is used. Although strictly applicable to the 1.0 - 15.0 um region, the calculations are extended with a lesser degree of accuracy into the visible region to that comparisons with measured data can be made.

3.2 - 3.5

Barrett, E.W., and O.Ben-Dor, 1967

Application of the lidar to air pollution measurements, J.Appl.Meteor. 6: 500-515

The paper presents the physical basis of the technique wherein equations based on Mie scattering theory and the radar equation are derived. This enables calculations of the particulate concentration, turbidity index, and horizontal visibility from the lidar data as function of height. The second part of the paper is devoted to a brief description of an operational lidar system.

-3.6 - 3.2

Barrett,E.W.,R.F.Pueschel,H.K.Weickmann,and P.M.Kuhn, 1970

Inadvertent modification of weather and climate by atmospheric pollutants. US Dep. of Commerce, ESSA, Res.Laboratories, Boulder, Colo.

Analysis of AN measurements around the Buffalo area over the Lake Ontario at an altitude approx. of 300 m is presented. The measurements were performed on November 22, 1969 and showed clearly the far reaching plume of polluted air over the Lake Ontario. More than 100 miles away there was still AN concentration higher than 6,000 AN cm^{-3} compared with the 14,000 AN cm^{-3} over the city.

2.1

Battan, L.J., and J.J. Riley, 1960

Ice-crystal nuclei and maritime air, J.Meteorol. 17: 675-676

The observations made on Mount Bigelow in southeastern Arizona indicate that the data by Georgii & Metnieks pertaining to the relationship between freezing and ice nuclei and sea-salts could be most readily reconciled with the hypothesis that the oceans are an important source of icecrystal nuclei.

1.1 - 1.5

Baxter, D.C., 1954

A review of radiation scattering methods for measuring cloud droplet size, Nat.Res.Council of Canada, Rep.No. MD-40, 28p.

Comparison of different techniques which might be useful to a cloud physicist is presented.

5.7

Beliaiev, V.I., 1964

Metod Lagrangea v kinetike oblachnykh processov, GIMIZ, Leningrad

The author describes the basic differece between the Lagrangian and Eulerian conception of modeling the growth of cloud elements. After establishing a closed system of equations, he makes several simplifying assumptions for the growth of elements in warm, ice and mixed clouds. A detailed analysis of the evolution of the drop size spectrum from salt nuclei and the transition from cloud to precipitation elements are also mentioned. Some applications of the Lagrangian description of the cloud drop spectrum evolution and of the water phase transition for the cloud seeding experiments is attached.
1.9

Belyashova, M.A., 1974

Soderzhanie v prizemnom sloie atmosfery melkodispersnykh aerozolei (iader Aitkena) na poberezhiakh Barentseva i Cernogo morei, Trudy GGO, Vyp. 343, Gidrometeoizdat, Leningrad, 20-33

Aitken nuclei measurements with the aid of a small Scholz counter on the Kolska peninsula and on the seashore of the Black Sea were performed. The distribution of AN concentrations followed the log-norm.distribution. The AN concentration decreased with the distance from the seashore, At high wind velocities ($v > 7$m/sec) a strong increase in AN concentration was observed pointing on the oceanic origin of the majority of AN.
2.1

Berlyand, M.E., 1973

Air Pollution and Atmospheric Diffusion, John Wiley & Sons, New York, Israel Program for Scient. Trans.(Jerusalem - London)

Collection of contributions on the air pollution made by different authors: pp.134-150 Belyashova,M.A.:Distribution of aerosols over seas. Study of AN concentration over the Baltic Sea (at 200 m altitude concentrations between 500 and 2,000 cm^{-3}). Over the Polar Sea (Kola) a strong decrease in AN concentration within 300 m above the sea surface was observed. Charts with AN concentration isolines over the Baltic Sea are attached.

2.1

Bertolotti,M., L.Muzii, and D.Sette, 1969

On the possibility of measuring optical visibility by using a ruby laser, Appl.Opt., 8: 117-120

The atmospheric attenuation of a ruby laser radiation is studied. The possibility of using the laser back scattered radiation to probe optical visibility is investigated. An experiment is described in which the amplitude of the signal received back from the target at 1.3 km and 0.5 km distance was examined and relationship with the visibility range at different atmospheric conditions found.

3.6

Bertrand, J., .Baudet, and A.Drochon, 1974

Importance des aerosols naturels en Afrique de l'ouest, J.Rech.Atmos., 8: 845-860

The detailed analysis of the occurence of dust haze over West Africa was made. Meteorological observations and the visibility measurements were used in order to trace the aerosol bringing the particles from Sudan, Algeria and Mauritania over the North Tropical Atlantic and from Tchad and North of Nigeria and South of Sahara. Applications of the visibility measurements at Abidjan support the general model suggested in the paper.

4.2 - 4.4

Best, A.C., 1953

Condensation nuclei and the development of radiation fog, J.Roy.Meteor.Soc. 79: 112-120

Analysis of the nuclei growth below 100% R.H. showed that shape of size-distribution curve of nuclei has small effect upon computed value of liquid-water content of fog and that visibility at saturation is not affected by mean nucleus mass, nor by size distribution of nuclei.

3.6

Best, A.C., 1954

Dimensionless equations for the growth of a drop of salt solution, Quart. J.Roy.Meteor.Soc.,80: 89-93

Equation for transfer of heat and water vapor deduced for a drop of salt solution for the atmosphere with which the drop is not in equilibrium. Some simplifications of the sophisticated rigorous solution are suggested.

1.9

Biscaye, P.E., R.Chesselet, and J.M. Prospero, 1974

Rb - Sr, $^{87}Sr/^{86}Sr$ isotope system as an index of provenance of continental dust in the open Atlantic Ocean. J.Rech.Atmos. 8: 819-829.

The dust sampled in different ways (high volume samplers with Whatman 41 filter paper and large filter meshes) was collected over a period of about five years in the direction East-West (Dakar-Azores) or North-South (Azores-Walvis Bay). The samples were analyzed by X-ray fluorescence analysis for Rb/Sr and by mass spectrometry for Sr isotopic ratios. Based on the evaluation of the samples one can trace two sources of dust plume, one from Sahara and the other from Kalahari Desert.

2.2

Blanchard, D.C., 1955

Electrified droplets from the bursting of bubbles at an air-sea water interface, Nature, 175: 334-336

Bursting of the bubbles is an effective mechanism of producing airborne droplets. Description of the jet mechanism, ejecting the drops 18 cm high, and generating 5-6 droplets is presented. An apparatus has been designed for the observation of droplets and measurement of their electric charges generated during the bubble bursting.

1.6

Blanchard, D.C., 1958

Electrically charged drops from bubbles in sea water and their meteorological significance, J.Meteor. 15: 383-396

Study of the electric charge during the bubble bursting with the aid of Millikan-type condensor has been made. The author speculates that the sea may be a source as well as a sink for the charge that in total maintains the earth's positive electric field.

1.6

Blanchard, D.C., 1963

The electrification of the atmosphere by particles from bubbles in the sea. Progr.Oceanogr. 1: 171-202

While studying the charging of water drops the author has demonstrated that organic surface active materials could be ejected into the atmosphere by bursting bubbles.

1.6 - 2.8

Blanchard, D.C., 1963

Condensation nuclei and raindrop spectra, J.Atm.Sci. 20: 624 - 625

A doubt is risen about the general validity of R.M. Griffith's statement about the close relation between the condensation nuclei and drop-size distribution spectra observed in warm - front rainfall. Author hesitates to accept the assumption, that the material analyzed was chosen from the same region and from the same meteorological situation. His measurements on Hawaiian islands do not support Griffith's findings.

1.2

Blanchard, D.C., 1969

The oceanic production rate of cloud nuclei, J.Rech. Atmosph. 4: 1-6

Measurement on Hawaiian Islands on the tower built on the top a lava ledge (23 m above the sea) with the Gardner photoelectric counter. The nuclei generation rate was 25-100 cm^{-2} sec^{-1}, what is only 5 to 20% of that estimated by Squires to be produced naturally by land sources. There was an intence production of nuclei in the surf zone. Fluctuations over the surf zone were large reaching occasionally several thousands of nuclei per cm^3. Nearly all of the high counts were associated with spray.

2.3

Blanchard, D.C., 1971

White caps at sea, J.Atmos.Sci, 28: 645

The formation of white caps is also strongly dependent upon the temperature: Miyake and Abe (1948), Abe (1955) found that the rate of decay of a foam patch on sea water at a temperature of 20°C was at least twice that of a foam patch on the sample of water at 0°C.

2.3

Blanchard, D.C. and A.T. Spencer, 1964

Condensation nuclei and the crystallization of saline drops, J.Atmos.Sci. 21: 182-186

Droplets were supported inside a small chamber, where the phase changes could be observed microscopically. The chamber was connected to a Scholz cond. nucleus counter. No evidence was found for the production of particles after droplet crystalization. Therefore the authors cannot support the hypothesis of small nuclei shattering during the crystallization process.

2.1 - 2.3

Blanchard, D.C., 1971

The oceanic production of volatile cloud nuclei, J.Atmos. Sci., 28: 811-812

Possible explanation of the finding by Dinger et al (1970) about the volatility of cloud nuclei over Atlantic. "Giant salt nuclei in marine air are composed, at least in part, of surface active material..."

2.3

Blanchard, D.C., 1974

International symposium on the chemistry of sea/air particulate exchange processes: summary and recommendations, J.Tech.Atm. 8: 509-513

Summary of the highlights of the symposium: Bubble size data are available from the seashore, not from the open sea. Importance of the direct mechanical spraying of drops is stressed. Apparently large bubbles generate primarily film drops, wheras small bubbles, jet drops. The question about the nature of the thin layer of organic substances on the ocean surface remains still unanswered. Baier et al. present an evidence that it is composed of glycoproteins and proteoglycans. The distance along which the bubble rises decides about the adsorption of organic substances and ions on its surface and influences the composition of aerosols. 1.1-1.4-1.8

Blanchard, D.C., and L.D. Syzdek, 1972

Variations in Aitken and giant nuclei in marine air, J.Phys. Oceanography, 2: 255-262

On Oahu, Hawaii measurements on a tower showed, that AN concentrations varied from 125 to 500 cm^{-3} with sudden pertrubations up to 2,000 cm^{-3}. Periodic changes in AN concentration with two main periods were identified: 30 days, and 5-6 days. Giant nuclei were measured by a technique enabling to sample the aerosol on a wire and the wire afterwards passed through destilled water which was analyzed on the content of Na (mass spectrometry). There is a strong evidence of the increase of salt load (up 30 ugm^{-3}) with wind speed.

2.2 - 2.1

Blanchard, D.C., and L.D. Syzdek, 1972

Concentration of bacteria in jet drops from bursting bubbles, J.Geophys.Res. 77: 5087-5099

The separation of the bacteria Serratia Marcenses in jet drops from bursting bubbles was investigated. Values of 1 to 100 in a drop of about 80 um in diameter have been found. A special "aging tube" has been developed for keeping a bubble below the water surface under controlled conditions. Surface- active organic material also has been absorbed onto a rising bubble. This proces lowered the surface- free energy, and in turn, results in a decreasing jet-drop size and ejection height.
2.8

Blanchard, D.C., and L.D. Syzdek, 1974

Importance of bubble scavenging in the water to air transfer of organic material and bacteria, J. Rech. Atm. 8: 529-540

Since the adsorption of surface active material onto the sea surface bubbles lowers the surface free energy which is the source of the kinetic energy of the jet drops, the heights to which the jet drops are ejected is seen to decrease with increasing dweling of bubbles in water. Experiments with bubbles rising through suspensions of the bacteria Sermatia marcenses were performed. Different paths were related to the bacteria content. After only 10 seconds of moving through the water sufficient organic material was adsorbed on the bubble surface to decrease the ejection height of the top jet drop from about 12 to 6 cm. Second drop did not show any markable effect. 1.8.- 2.3

Blanchard, D.C., and A.H. Woodcock, 1957

Bubble formation and modification in the sea and its meteorological significance, Tellus, 9: 145-158

Description of the mechanism of bubble bursting is based on the high-speed camera pictures. A detailed investigation of the jet formation showed that: 1) the bubbles forming nuclei are 2×10^{-2} cm, 2) most of the nuclei are produced via jet mechanism. They estimate the production rate at 34 $cm^{-2} sec^{-1}$, which corresponds to about 3 $cm^{-2} sec^{-1}$ if it is accepted that 10% of the sea surface is active in nuclei production by white caps.

2.3

Blifford, I.H., J.W. Burgmeier, and C.E. Junge, 1974

Modification of Aerosol Size Distributions in the Troposphere, NCAR Tech. Note/ STR-98, Boulder , August.

A detailed analysis of all processes contributing to the formation of the size distribution of aerosol particles in the troposphere is presented. Conclusion: After several days only particles of 0.1 um $\prec r \prec$ 1.0 um remain in the air at higher levels. Because over the ocean a large amount of particles with $r = 10^{-7}$ cm was recently found, one has to assume that there is a permanent source of those nuclei.

1.2

Blifford, I.H., Jr., and D.A. Gillette, 1973

An automated particle analysis system, The Microscope, 21: 121-130

Automated evaluation of aerosol pictures by an TV camera set is desribed and some features of the equipment mentioned.

5.15

Bloch,M.R., and W.Luecke, 1972

Geochemistry of ocean water bubble spray, J.Geophys. Res., 77: 5100-5105

The authors present a survey on the fractionating mechanism of different ions during bubble bursting and sea spray formation. "Ludwig-Soret" effect and others are discussed in details. The depletion of soluble inorganic salts below the surface of oceanic waters is due to the fact that the surface tension of their solution rises with their concentration. These materials can be cocentrated in the apex of the bursting bubbles and in this way transported into the air.

2.3 - 1.4 - 1.7

Bodhaine, B.A. 1977

Nuclei monitoring at baseline sites: Barrow, Alaska; Mauna Loa, Hawaii; American Samoa; and South Pole. Vol. of Abstr. 9th Int.Conf. on Atmos. Aerosols,Cond. and Ice Nuclei, Galway, 86-87

The US global background monitoring program includes the measurement of CO_2, O_3, surface aerosol and solar radiation. AN data show a distinct annual variation with cleanest conditions during winter of the corresponding hemisphere. Samoa station had concentrations within the range 110 to 200 cm^{-3} and Barrow 50 to 300 cm^{-3}. Total light scattering at Mauna Loa measured by a four wavelength nephelometer showed low wintertime monthly means of 2, 1.3, and 1.8 x 10^{-7} m^{-1} in 1974.

4.1 - 4.2 - 5.11

Bodhaine, B.A., and R.F. Pueschel, 1974

Source of seasonal variations in solar radiation at Mauna Loa, J.Atmos.Sci. 31: 840-845

Analysis of the solar radiation transmission at Mauna Loa supports a seasonal variation with the minimum in summer. It is suggested that these variations are due to the seasonal generation of aerosols of organic nature. An attempt was made to explain the observed turbidity variations by the changes in humidity. However, water vapor alone cannot account for the observed changes in solar radiation transmission.

3.1

Bonsang, B., B.C.Nguyen, A.Gaudry, and G.Lambert, 1977

Variation of the chemical composition of marine aerosols in a high biological productivity area, Vol.of Abstr. 9th Int.Conf. on Atmos. Aerosols, Cond. and Ice Nuclei, Galway, 154

In order to check how much the chemical composition of marine aerosols depends on the biological activity of the ocean surface measurements above the sea in Northern Britain in waters with a high biological production have been performed. A markable enrichment of sulfates (related to Na concentration) and of phosphates has been found.

1.4 - 1.8

Boyce, S.G., 1954

The salt spray community, Ecol.Monogr. 24: 29

The author discusses a hypothesis that most of the salt nuclei do originate from bursting of bubbles. He concludes that salt particles larger than 1 um can be produced by the bursting of numerous small air bubbles in the foam of breaking waves.

2.3

Böttger, A., G.Gravenhorst, and D.H.Ehhalt, 1977

Deposition rates of ammonium and nitrate in the northern hemisphere, Vol. of Abstr. 9th Int.Conf.on Atmos.Aerosols, Cond. and Ice Nuclei, Galway, 98

The available data on NO_3^- and NH_4^+ analysis in precipitation have been surveyed. The deposition rates show both a latitudinal dependence over both, land and ocean with maxima at middle and tropical latitudes. The oceans seem to be a minor source for nitrate and ammonium or their gaseous precursors. The high concentrations of NO_2 over tropical regions can be explained by thunderstorms or bushfires.

4.1 - 4.2

Bricard, J., 1974

Aerosols production in the atmosphere, in "Aerosole in Naturwissenschaft, Medizin und Technik", Jahreskongress GAF, p. 265-284

A general survey of the processes contributing to the aerosol formation and removal in the atmosphere includes: Gas to particle conversion mechanism, homogeneous and heterogeneous nucleation (the influence of the presence of inactive aerosol on the nucleation rate) and different mechanism affecting the transformation of particles suspended in the air. A survey of the potential sources of atmospheric aerosol is attached.

1.9 - 1.4

Brier, G.W., and D.B. Kline, 1959

Ocean water as a source of ice nuclei, Science, 130: 717-718

Laboratory experiments with agitated surface of sea water showed that the number of ice nuclei increased from 0.5 to 300 per liter if the air temperature was lowered from -15 to -30°C. The nature of nuclei is unknown.

2.1 - 2.2

Brown, R.T., Jr., 1967

Backscatter signature studies for horizontal and slant range visibility, Rep.No.RD-67-24 Sperry Rand Research Center, May

Transmissometer data in fog were simultaneously recorded for comparison with the backscatter data to determine the atmospheric extinction coefficients.

3.6 - 3.2

Brown, R.T.,Jr., 1973

A new lidar for meteorological application. J.Appl.Meteor. 12: 698-708

A new lidar with gallium-arsenide fiber coupling is described. The importance of measuring extinction coefficient profiles (and thus visibility profiles) through the fog is demonstrated. Also, examples of signals from some hydrometeors (rain, fog and clouds) using a 250W peak-power lidar are presented.

3.6

Buat-Menard,P., J.Morelli, and R. Chesselet, 1974

Water-soluble elements in atmospheric particulate matter over tropical and aquatorial Atlantic, J.Rech.Atmos. 8: 661-673

Samples of atmospheric particulate matter were collected on board the ships with the aid of Whatman No.41 filters through which was filtered 300 to 13,000 m^3 of oceanic air. Insoluble and soluble fraction was separated. Na, Mg, K, and Ca were analyzed by atomic absorption and Cl, S, and SO_4 by colorimetrical tests. Data show a strong geographical dependence of K and Ca enrichments (e.g. Ca soluble originated from African deserts).K enrichment was associated with the surface-active material.

1.4 - 2.6 - 2.8

Büchen, M., and H.J.Georgii, 1971

Ein Beitrag zum atmosphärischen Schwefelhaushalt über dem Atlantik, "Meteor. Forsch.-Ergebnisse", Reihe B, 7: 71-77

The investigation into the nature of the origin and variations of the SO_2 gas and sulfate aerosol was performed during the Atlantic-Expedition (GARP) in 1969. The SO_2 content showed a decreasing concentration from the temperate latitudes towards the tropics. The concentration of sulfate aerosols revealed no meridional trend. One assumes that sulfate aerosol is composed of a continental and matitime component.

4.2 - 1.4

Bullrich, K., 1973

Das atmosphärische Aerosol und seine Bedeutung für Energie-Transporte und Klimaänderungen, in "Aerosole in Physik, Medizin und Technik", Jahreskongress d. GAF, 50-56

A review of the current state of the investigation of the influence of atmospheric aerosols on the radiative energy transport and climatic changes on our earth. Discussed are: The composition, physical properties, size distribution and the distribution of aerosols in the atmosphere. Estimates are made about the contribution of the anthropogeneous sources of aerosols to the total budget and possible climatic changes.

4.4 - 3.1

Bullrich, K., 1960

Streulichtmessungen in Dunst und Nebel, Meteorol.Rundschau, 13: 21-29

Searchlight measurement of scattering function in ground air showed that down to scattering angles of 10^{0}, i.e. to the limit of these observations, the scattering function is practically independent of visibility. The drop of intensity was in good agreement with $\beta = 3$ (in agreement with Junge's particle distribution).

3.2 - 3.6

Burckhardt H., and H. Flohn, 1939

Die atmosphärischen Kondensationskerne in ihrer physikalischen und klimatologischen Beteutung, J.Springer,Berlin

The monograph presents a survey of the physical-chemical properties of AN and of the role of AN in the atmosphere. A detailed description of the instruments used for AN concentration measurement is accompanied by the analysis of the influence of individual meteorological elements on AN counts. Many measurements show a geographical distribution of AN concentration and its dependence on the main sources: highly populated and industrialized regions.

2.1 - 4.1 - 5.1

Burkser, E.S., and V.V. Burkser, 1951

Aerokhimicheskie issledovania na Ukraine. Trudy inst. geolog.nauk, ser. petrografii,mineral. i geochimii, AN USSR, 1

Chemical composition of rainwater and of some particulate material collected on the territory of Ukraine (later was included a network of 41 stations covering the whole territory of USSR) is described. Rain water samples were collected in raingauges. No special attention was paid to the storage of one week samples and to the separation of the dry fall-out and of the precipitation. The analysis included the ions: Cl, SO_4, HCO_3, NH_4, NO_2, Na, Ca, Mg.

4.3

Byers, H.R., J.R.Sievers, and B.J. Tufts, 1955

Distribution in the atmosphere of certain particles capable of serving as condensation nuclei. Proc.Conf.Physics of Cloud and Precip.Particles,Woods Hole Ocean.Inst., Woods Hole, Mass., 47-72

The authors have followed the maritime air from theGulf of Mexico along the Mississippi Valley. Usually large chloride particles were numerous at the same time sparse at the ground in the interior of the continent. Their concentration decreased with distance inland very slowly.The number of gigant nuclei aloft in particular exceeded those at ground level by one to two orders of magnitude. Conclusion: The surface of continents provides a sink for salt particles.

2.7 - 4.2

Carabine,M.D., J.E.L.Maddock, and A.P.Moore, 1977

A rational technique for determination of particle size distributions in aerosols by light scattering measurements, Vol. of Abstracts 9th Int.Conf. on Atmos. Aerosols, Cond. and Ice Nuclei, Galway, 136

A simple method of determining size distributions of spherical particles of known refractive index in the diameter range 0.1 to 2.0 um has been suggested and experimentally tested. Zero order log-normal distribution and light scattering measurements at angles over a wide arc (e.g. 150^{o}) are assumed. Experimental measurements assumed monochromatic light polarized with the vector normal to the plane of scattering.

3.2 - 1.2

Carlon, H.R., 1970

Infrared emission by fine water aerosols and fogs, Appl. Optics, 9: 2000-2006

Water aerosols are capable of very strong absorption and emission in the infrared. This effect is pronouced in the 8 - 13 um atmospheric window, due to the 10^4 increase in the absorptivity of liquid water there over that for water vapor. Water aerosol is represented by condensation nuclei activated at the R.H. > 60%. Water aerosol contributes significantly to radiance levels in the infrared, not only in the the obvious scattering role, but significantly as an emitter (at the longer wavelenghts extending to at least 15 um).

3.4

Carrier,L.W., G.A.Cato, and K.J.von Essen, 1967

The backscattering and extinction of visible and infrared radiation by selected major cloud models, Appl. Optics, 6: 1209-1216

Volume backscattering functions and optical extinction coefficient are computed for eight suggested cloud models using the Mie scattering theory for optical wavelenghts: 0.488, 0.694, 1,06, 4.0, and 10.6 um. Results show that there is no clear advantage of one wavelength over another for improving cloud transmission, however, the backscattering is significantly reduced at the longer wavelengths. Some calculations are made under the assumption of cloud inhomogeneity.

3.2 - 3.3 - 3.6

Carstens, J.C., W. Allen and J.T. Zung, 1970

Theory of droplet growth in clouds: II. Diffusional interaction between two growing droplets, J.Atm.Sci, 27: 798-803

The investigation of the heat and mass transport between two growing droplets in a supersaturated environment leads to the conclusion that the smaller droplet tends to "catch up" with the larger one (its radius grows faster that of the larger one), However, the growth rate of smaller droplets is not so fast as their isolated counterparts. Hence, a polydisperse system of drops approaches to monodispersity, but this approach is slower than predicted by conventional theory. In a real cloud the interaction between the droplets becomes only significant if the droplets considered would have nearly equal radii. 1.9

Carstens, J.C., and J.M. Carter, 1974

Current meteorological theory of drop growth by condensation and some comparisons with experiment, Tech. Rep., GCCPR, University of Missouri, Rolla.

A detailed analysis of all terms in the droplet growth equation is presented and a suitable model suggested. The measurement of the droplet growth in a Wilson type expansion chamber by means of height scattered by the drop supports the applicability of the suggested model.

1.9

Carstens, J.C., J. Podzimek, and A. Saad, 1974

On the analysis of the condensational growth of a stationary cloud droplet in the vicinity of activation, J.Atmos.Sci., 31: 592-595

The equation of droplet growth with its individual terms is explained. The individual terms are adapted to an analytical solution and calculation of the drop size change in dependence on time. The different regimes of the nuclei activation and of the droplet growth in the vicinity of activation are discussed.

Carstens, J.C., and J.T. Zung, 1970

Theory of droplet growth in clouds. I. The transient stage of the boundary- coupled simultaneous heat and mass transport in cloud formation, J.Coll.Interf.Sci. 33: 299-311
The heat and mass transport equations describing a droplet growing in a supersaturated atmosphere are presented and two solutions discussed. The first describes the transient initial stage of the growth and the second is valid for the state close to a steady-state condition. Comparison between the quasi-steady-state and transient solution leads to the conclusion that e.g. 10 um drop growth is satisfactorily described by the fixed-radius theory in conjunction with the quasi-steady-state theory.
1.9

Casella, 1959

Cascade Impactor, C.F.Casella and Co.Ltd.(Regent House, Fitzroy Square, London W.I), Instruction booklet No. 3018/RI, 29p.

The standard type of Casella impactor measuring the sizes of particulates in four different size ranges (corresponding to the air speeds at the nozzles: 2.2; 10,2; 27.5 and 77 $msec^{-1}$) is described. Particles in the size range of 0.5 to 200 um are deposited at a flow rate of 17.5 liters per minute.

5.1

Chaen, M., 1973

Studies on the production of sea-salt particles on the sea surface, Mem. Faculty of Fisheries, Kogoshima Univ., 22: 49-107

A detailed study of the sea-salt particles in the lowest atmospheric layer above the sea surface. The vertical distribution of particles with the masses ranging from 10^{-11} to 10^{-7} g support the validity of Toba's equilibrium theory of salt particle distribution. A rough calculation of the production of salt particles over the ocean is performed.

4.1 - 2.7

Chapman, S., 1938

Carrier mobility spectra of liquids electrified by bubbling. Phys.Rev. 54: 520-527
and Interpretation of carrier mobility spectra of liquids electrified by bubbling and spraying, 528-533

Investigated were: charged particles generated by bubbling through water and several aqueous solutions of salt, acid, base, sugar and soap with Erikson mobility tube. The importance of the effect of aging, humidity, concentration and temperature is stressed. Interpretation of mobility spectra and relation to the spraying method is discussed in details.

1.6

Charlson,R.J.,D.S.Covert,A.P.Waggoner, and N.C.Ahlquist, 1975

Studies of the hygroscopic/deliquescent nature of aerosols, Proceedings of the 8th Int.Conf.on Nucleation, Leningrad, 1973, Gidrometeoizdat, Moscow, 466-472

The laboratory equipment and the field measurements of deliquescent and hygroscopic nature of aerosol at humidities below 100% R.H. are described. The light scattering humidity response curves do not provide specific information on the composition of the aerosol, however, there was enough evidence, how the sea salts predominate on the seashore and influence the light scattering.

3.5 - 3.6 - 1.2 - 1.5

Chen, C.S., 1970

Drop growth by condensation in the entraining updraft, Conf. on Cloud Physics, AMS, Fort Collins, p. 113-114

The evolution of cloud droplet size spectra is described on the basis of the equations for droplet growth and the effect of the entrainment of the environmental air. Three different initial nucleus size distributions were used. The computed vertical velocities increased from 3 to 10 $msec^{-1}$ (at 0°C level). The entrainment did not slow down the condensation process. The number of large drops was dependent on the initial nucleus distribution.

1.9

Chesselet, R., J.Morelli, and P. Buat-Menard, 1972

Variations in ionic ratios between reference sea water and marine aerosols, J.Geophys.Res, 77: 5116-5131

Sampling was performed over the North and Equatorial Atlantic, Norwegian Sea, Antarctic Ocean by air filtration and impactor sampling. K/Na concentr. ratios exhibited marked variation and were greater than in the bulk water. Ca/Na ratios followed the K/Na ratios. Cl/Na ratios in aerosol were almost the same like in sea water. The enrichments seems to preferentially affect particles of small sizes ($\leq 1 - 2$ um).

1.4 - 2.4

Chester, R.,S.R.Aston,J.H.Stoner, and D.Bruty, 1974

Trace metals in soil-sized particles from the lower troposphere over the world ocean, J.Rech.Atmos. 8: 778-789

Measurements of particulate concentration and composition have been made on board of the ships in the North Atlantic, South Atlantic, in the Indian Ocean and in China Sea.Particles were collected by means of nylon meshes suspended from the bows of the ship, approximately 15 m above the sea surface. Mean concentrations found (p.p.m.)

	Sr	Co	Cr	V	Ba	Mn	Ni	Ga	Cu	Zn	Sn	Pb
Concentr.	101	9	85	145	487	1.312	91	21	157	683	30	465
Enrichment	0.35	0.45	1.2	1.4	1.4	1.5	1.5	1.6	3.4	13	19	49

1.4 - 2.6

Chien Chen-Wu, and Mack Dun-Pok, 1966

Computation of droplet growth from giant salt particles in ascending air below cloud base, J.Atmos.Sci. 23: 810-812

An equation similar to that by Mason and Ghosh (1957) is used for droplet growth in an updraft. If the droplet rise were exceedingly fast, the particle diameter would lag behind the equilibrium diameter at the various heights and humidities.At the updraft velocity of 6 m/sec a 10 um - diameter NaCl drop has much larger time response than a 5 um drop. The calculated values are discussed and the applicability of the results mentioned.

1.9

Chin,J.H., C.M.Sliepcewich, and M.Tribus, 1955

Particle-size distributions from angular variations of intensity of forward scattered light at very small angles. J.Phys.Chem. 59: 841-844

The authors present mathematical basis for the subject method.Possible applications of the integral formula are discussed and applied for a lens pinhole, a moving pinhole and a microdensitometric method. In the latter two the formula was modified to be applicable for forward scattering within a half angle of about 3 to 4 degrees.

3.2

Chin,J.H., C.M.Sliepcewich, and M.Tribus, 1955

Determination of particle-size distribution in polydisperse systems by means of measurements of angular variation of intensity of forward scattered light at very small angles. J.Phys.Chem., 59: 845-848

Experimental technique using the moving pinhole method is described. A known dispersion of glass spheres (2 to 40 micron) in water was used to test the validity of the method. The apparatus consists of monochromatic, parallel light source, a dispersion cell, a lens-moving-pinhole receiving unit, and a photomultiplier potentiometer measuring system.

3.2

Cinkotai, F.F., 1971

Behaviour of sodium chloride particles in moist air, J. Aerosol Sci., 2: 325-329

Thomson-Gibbs equation is deduced using more general terms for the dissolved substance from Landolt-Börnstein's book. Some solution droplets can exist even in an atmosphere supersaturated with water vapour. The diameter of a NaCl solution droplet changes enormously between 99 and 100 % R.H. The diameter ot these droplets may therefore serve as a sensitive measure of R.H. in the 99 and 100 % region.

1.9

Cobb, W.E., 1973

Oceanic aerosol levels deduced from measurements of the electrical conductivity of the atmosphere, J.Atmos.Sci. 30: 101-106

Discussion of the variation in AN counts during a long period of time of measurements is presented.

1.6 - 2.1

Cohen, L., 1959

A sedimentation balance for particle size analysis. Instrum.Pract.Automat.Electron.,G.Brit. 13: 10: 1036-1041

The article discusses the principle and functioning of a liquid sedimentation balance for granulometric analysis. Preparation of samples of liquids and dispersions is described in details.

5.16

Coppock, P.D., and G.T.Meiklejohn, 1951

The behaviour of gas bubbles in relation to mass transfer, Trans.Inst.Chem.Engin.,London, 29: 75-86

The authors present an expression for bubble size, as a function of the orifice diameter, surface tension and density of liquid. Upward velocity of bubble in water varies with diameter of bubble and of liquid column and of the rate of bubble production. Treats: Mass transfer from oxygen to water , mass transfer from bubbles.

2.3

Coulier, P.J., 1875

Note sur une nouvelle propriété de l'air, J. de Pharmacie et de Chimie, 4, 22: Sept.(1875),165, Oct.,254

Experiments with a simple equipment for the activation of atmospheric condensation nuclei are described. This can be considered as the forerunner of the nucleus counters designed many years later.

1.1

Cox, R.A., 1974

Particle formation from homogeneous reactions of sulphur dioxide and nitrogen dioxide.,Tellus, 26: 235-240

Some recent laboratory results relating to the conversion of gaseous sulphur dioxide and nitrogen dioxide into particulate material and the implication of these results on the atmospheric chemistry of these gases are discussed.

2.1

Crabb,J.A., and J.Latham, 1972

Multiplication of condensation nuclei by bursting droplets, J.Rech.Atmos., 6: 81-87

The evaporation of small water drops proceeds without appreciable loss of charge. As a result the relationship between radius and charge alters until the Rayleigh limit is reached. The drop becomes unstable and suffers a reduction in charge to mass ratio in order to again stability. It was found that the multiplication is unimportant over the ocean surfaces but may be significant at the boundaries of highly electrified clouds.

1.6

Cressmon, G., 1959

The value of phase microscopy for the examination of particulate material collected on membrane filters, J.Amer. Indust. Hyg. Assoc. 20, 3: 190-193

The author suggests the use of phase microscopy for examining particulate material such as quartz dust collected on millipore filters. The millipore filters have the refractive index close to the oil used for rendering filter transparent.

5.15 - 5.2

Crozier, W.D., B.K. Seely, and L.B. Wheeler, 1952

Correlation of chloride particle abundance with the synoptic situation on a cross-country flight. Bull.Am.Meteor.Soc., 33: 95-100

On a flight over the USA at a height of 3000 m were collected chloride particles larger than 10^{-1} g (r=0.5 um at 80% R.H.). The highest concentration of o.46/cm^3 was encountered in an air mass of marine origin.

4.2

Crozier, W.D., and B.K. Seely, 1949

Some techniques for sampling and identifying particulate matter in the air, First Natl.Air Poll.Symp.,Stanford Univ. Calif. 45-49

Describes several techniques for sampling and identifying particulate material in air (filters, sensitized sheets etc.).

5.2 - 5.13

Cuong, N.B., B.Bonsang, and G. Lambert, 1974

The atmospheric concentration of sulfur dioxide and sulfate aerosols over Antarctic, Subantarctic areas and oceans, Tellus, 26: 241-249

During several trips, measurements of sulfur dioxide and sulfate aerosols have been taken over Antarctic and Subantarctic areas and over the Mediterranean Sea. The results of the measurements are briefly discussed.

4.2

Davies, C.N., 1954

Survey of scattering and absorption of light by particles, Brit.J.Appl.Phys.Suppl : 64-65

The diffraction and the Mie theory are compared for different sizes of particles. The author calls attention to the simplification of the screening function in the case of opaque particles and discusses methods of measuring small particles in presence of large ones.

3.2 - 3.3

Davies, C.N., 1974

The retention of particles in filters. J.Aerosol Sci., 5: 487-495

The author analyses the mechanism of the aerosol retention in the filter material. If both the collision efficiency and the collision effectiveness of particles with the fibers in a filter are constant, the penetration decreases exponentially with increasing thickness of the filter. Departure from this behavior are discussed.

5.2

Day, G.J., 1955

Some airborne obsevations of condensation nucleus concentration. Proc.First Intern. Symposium Condensation Nuclei, Geofis. Pura e Appl. 31: 169-181

Counted are AN over England and the adjacent parts of the East Atlantic in an aircraft up to 2 km. Concentrations about 200/cm^3 in clean maritime air were found. Usually at the sea surface concentrations increased up to 3000/cm^3 and then rapidly decreased with altitude. However, the measurements were performed close to the British Islands so that contamination was probably high.

4.1 - 2.1 - 2.4

Day, J.A. and J.C. Lease, 1968

Cloud nuclei generated by bursting air bubbles at the air-sea interface, Proc.Int.Conf.on Cloud Physics, Univ. of Toronto, 20-24

Sea salt particles cross the sea-air interface principally through bursting of air bubbles. In the diffusion chamber the bubble film fragments are shot and/or dragged rapidly upward through the varying humidity. On the ocean, there is not fast supply of supersaturation: The drops will quickly evaporate leaving sea salt nuclei of 10^{-12} g. Only very small bubbles r < 0.3 mm contribute to the sea salt conden. nuclei generation.

2.3

De Bary, E., and Bullrich, K.,

Uber den Anteil der Rayleighstreung und den Einfluss der Aerosolgrössenverteilung auf die Extinktion und spektrale Intensität der Streustrahlung eines Luftvolumens, Arch. Meteorol.Geophys.u.Bioklimatol. B

Systematic calculations of the scattering function for various models of aerosol distribution.Results: A lack of smaller particles results primarily in a decrease of scattering intensity in the range of large scattering angles of about 130° and primarily for smaller wavelengths. A lack of large particles, results, in a decrease of scattering intensity at small scattering angles.

3.2

Delmas,R., J.Baudet, and J.Servant, 1977

Humid tropical media as a natural source of atmospheric sulphur compounds. Vol. of Abstr. 9th Int.Conf. on Atmos. Aerosols, Cond. and Ice Nuclei, Galway, 100

SO_2 and H_2S are shown to be present in the equatorial atmosphere. SO_2 concentrations are higher near the sea (7 to 31 ugm^{-3}). The most important contribution comes from coastal region and savanna. The average level near the sea is 1.80 ugm^{-3}. The atmospheric origin of sulfates is supported by the fact that 83% of the sulfate content is confined to particles with diameters smaller than 1.0 um.

2.1 - 2.2

Dennis, R., W.R. Samples, D.M.Anderson, and L.Silverman, 1957

Isokinetic sampling probes, Ind. and Engin. Chemistry 49: 294-302

The design of a tube for isokinetic sampling of particles is described. Measurements of different shapes of sampling bodies support the theoretical conclusions.

5.2

Deryaguin, B.V., and M.S. Khurgin, 1969

Theory of passivation of the growth of water condensation nuclei by cetyl alcohol vapour. Proc. 7th Int. Conf. on Cond. & Ice Nuclei , Prague & Vienna, Academia, Prague, 96-101

The rate of the drop growth depends on the ratio between the adsorption of cetylalcohol vapor and the growth of the drop in a supersaturated environment. The kinetics of the condensation of water vapor and the cetyl alcohol vapor deposition on the drop is described by the simple model including both molecular and diffusional transport. The results are in agreement with experiments.

1.8

Deryaguin, B., and G. Vlasenko, 1948

The flow method of ultramicroscopic measurement of the particle concentration of aerosols and other dispersion systems, Rep.Acad.Sci. USSR, Phys.Chem.Section, 63:155-188

Description of the apparatus in which the particles are moving parallel with the line of light is presented. Compared with the particle counting in a closed volume this method has many advantages. Applicability to a wide range of concentrations, from 3×10^7 down to 1 to 2 particles per cm^3 is stressed.

5.7

Dessens, H., 1946

Les noyaux de condensation de l'atmosphère, C.R. Acad. Sci. 223: 915-917

Observation of the shattering of salt particles. Discusses condensational growth of 1 to 10 um radius salt particles deposited on thin fibers of the thickness of 0.01 um radius.

2.2 - 2.5 - 5.2

Dessens, H., 1949

The use of spider's threads in the study of condensation nuclei, Quart.J.Roy.Meteor.Soc. 75: 23-27

Refers to the research by Koehler and Wright. The shattering of NaCl particles was observed, but it is relatively rare. Collection of particles on threads (of 0.01 um in diameter) made by small spiders is described. Electron micrograms of spider webs and the morfological changes of a salt nucleus caught on a spider web are shown.

2.2 - 2.5 - 5.2

Dickson, D.R., and J.V.Hales, 1963

Computation of visual range in fog and low clouds, J.Appl. Meteor., 2: 281

Visual ranges were computed for various values of extinction coefficient for five sets of data appropriate to fog and low clouds. The model involves the basic theories by Allard (1876) and Koschmieder (1924). Four values of the threshold of illumination (E_t) which Haig and Morton determined were used in the Allard theory computation.

3.6

Dinger, J.E., H.B.Howell, and T.A.Wojciechowski, 1970

On the source and composition of cloud condensation nuclei in the subsident air mass over the North Atlantic, J.Atmos.Sci., 27: 791-797

Measurements of CCN at a supersaturation of 0.75% onboard an aircraft were made over the North Atlantic and on the east coast of Barbados. Thermal diffusion chamber was used with heated tubes up to 600°C. Over Barbados 50% of all CCN were nonvolatile similar to sea salt.The fraction of volatile nuclei increased with altitude.Above the inversion at the situation characterized by air subsidence, all nuclei were volatile. Sea salt nuclei were confined to the few km above the ocean.

2.7 - 4.2

Dinger,J.E., and R.E.Ruskin, 19,0

On the source of cloud nuclei. Preprints Conf. on Cloud Physics, Ft. Collins, Colo. August.

The method was similar to that described by Twomey (the aerosol passed through 6 tubes heated up to 600°C and afterwards was introduced into a CCN counter). Results of the measurements over Florida, the North Atlantic and Barbados island: Maritime air at Barbados contains less than 50% of CCN of sea salt origin. Over the ocean the salt nuclei are accumulated close to the surface and smaller nuclei (sulfates) are concentrated above the inversion in subsident air.

2.2

Dobgaliuk, Ju. A., 1969

Zakonomernosti rosta oblachnykh kapel pri impulsnom rozvitii konvektivnykh oblakov, Trudy GGO, Leningrad, 239: 54-61

A simple one-dimensional model is described which includes a fluctuating updraft. The updraft ranged from 2 to 20 m/sec and the superimposed fluctuating component had a time period between 1 to 30 min. No substantial difference was found in sizes of drops falling out of a cloud with and without a fluctuating apdraft. Shorter periods than 15 min. do not contribute much to the cloud drop size evolution.

1.9

Doman, M.H. 1975

Flame scintilation spectral analysis of sodium chloride in marine aerosol, in "Aerosols in Naturwissenschaft, Medizin und Technik. Chemie der Umweltaerosole", Jahreskongress 1975 der GAF, 31-35

The use of flame photometry for the identification of sodium chloride aerosol is discussed. Measurements of the amount of sea salt transport on the West German Atlantic coast shows a spectacular bimodal distribution caused by the superposition of the influence of the "near aerosol" and of the "far aerosol". At the wind velocity greater than 6 m/sec concentrations up to 85 ug/m^3 were observed.

2.5 - 4.3

Doman, M.H., 1976

On the size spectrum of sea salt nuclei as determined with the Sartorius scintillation counter, in "Aerosole in Naturwissenschaft, Medizin und Technik, Bericht der 4. Tagung GAF, 106-111

The measurement of the sea salt particle size distribution was performed on the island of Sylt (North Atlantic) approx. 100 m from the surf zone during 18 months. The geometric means of particle diameters were found to fall within the range of 0,1 um to 0,5 um. Small particles predominated when the ocean was calm. Larger particles were found during rough sea conditions. During white-cap formation more of the soluble organic material was involved in the sea salt particle formation.
2.3 - 4.2

Duce, R.A., J.G.Quinn, Ch.E. Olney, S.R. Piotrowicz, B.J.Ray, and T.L. Wade, 1972

Enrichment of heavy metals and organic compounds in the surface microlayer of Narrangassett Bay, Rhode Island, Science, 176: 161-163

Concentrations of lead, iron, nickel, copper, fatty acids, hydrocarbons, and chlorinated hydrocarbons are enriched from 1.5 to 50 times in the top 1.0 to 1.5 um layer of Narrangasett Bay water relative to the bulk water 20 cm below the surface. The metal enrichment was observed in the particulate of organic fraction. Pollutants present in the surface microlayer of the coastal zone may easily be introduced into the atmosphere.

2.4 - 1.8

Duce, R.A., and A.H. Woodcock, 1971

Difference in chemical composition of atmospheric sea salt particles produced in the surf zone and on the open sea in Hawaii, Tellus 14: 427-435

Previous chemical analyses showed that only cloud droplets formed on large nuclei of m = 10^{-12} to 10^{-14}g coalesce to forme raindrops in the orographic clouds. The authors proved this hypothesis showing that concentrations of airborne particles (salts), cloud droplets and raindrops are in accordance. It seems clear that "giant" sea-salt nuclei (of 10^{-8} to 10^{-11}g) are not, after all, essential to the aceretional growth of raindrops in Hawaii orographic clouds.

2.5 - 2.7 - 1.5

Duce, R.A., A.H. Woodcock, and J.L.Mayers, 1967

Variation of ion ratios with size among particles in tropical oceanic air. Tellus, 19: 369-379

High iodine-to-chloride ratio of sea-salt particles compared with sea water and positive correlation with binding of organic substances containing iodine on small nuclei was found.

2.4 - 2.8

Dufour, L., and R. Defay, 1953

Étude thermodynamique de la pression de saturation par rapport a une gouttelette en suspension dans l'atmosphère, Publ. Inst. Roy. Meteorol. Belg.,Ser.B., 9: 20 p.

Derived are general formulas for the embryonal growth of a mixed nucleus, which is composed of a soluble and insoluble substance. As aspecial case the growth of sodium chloride nucleus is treated.

Dufour, L., and R. Defay, 1953

Sur la formation des germes de condensation et de solidification autour d'un noyau solide insoluble, Tellus, 5: 293-301

Discussion of the formation of germes of water drops and ice crystals based on the knowledge of deposition (condensation) coefficient is presented.

1.9

Dunham, S.B., 1960

Detection of photochemical oxidation of sulphur dioxide by condensation nuclei techniques. Nature, 188: 51-52

The author suggests that the measurement of AN concentration can be used to determine very small reaction rates of gases. He refers to a simple calculation by Lassen of the coagulation rate which shows that for continental aerosols the accretion rate has a maximum(similar to the radon products deposition) below 0.1 um radius. That means the particles produced by gas reactions (e.g. photooxydation of SO_2), should belong to this size range.

1.4 - 1.7 - 2.1

Durbin, W.G., 1959

Some aircraft observations of the vertical and horizontal distributions of chloride particles. Geofis.Pura e Appl. 42: 11

During 7 flights over the Canal Lamanche in 1959 was found: The total nuclei concentration was several units per cm^{-3}. Compared with Schmidt there were lower concentrations of particles with $R < 1.0$ um and larger concentrations of particles with $R > 1.0$ um. Enrichment of the air below the cloud base on salt nuclei was found. The nuclei concentration decreased relatively steeply with the altitude.

2.7 - 4.2

Durbin, W.G., and G.D. White, 1961

Measurement of the vertical distribution of atmospheric chloride particles, Tellus, 13: 260-275

Sea-salt giant particles measured over the sea were captured on sensitized gelatin sheets and evaluated for different sizes according to the impactor stage. The data show the decreasing concentration of nuclei with height and the slope was in accordance with the exponential law.

2.7 - 4.2

Easter, R.C., and P. Hobbs, 1974

The formation of sulfates and the enhancement of cloud condensation nuclei in cloud, J.Atmos. Sci.,31: 1586-1594

Calculation of the production rate of the $(NH_4)_2SO_4$ aerosol inside of the cloud explains the generation of these nuclei during evaporation of cloud drop in the air which contained SO_2 and NH_3. The Scott-Hobbs mechanism might be active, but the rate is lower. Greater importance is assigned to the presence of NH_3 than SO_2 in this process.

2.2

Elder,J.C., H.J.Ettinger, and R.Y.Nelson, 1974

Chamber studies of visbility-reducing aerosols, Atmos. Environ. 8: 1035-1048

Light scattering coefficients for several aerosols as a function of the particulate mass concentration were determined in the laboratory. The results are interpreted in terms of the light scattering and visibility measurements in the polluted atmosphere.

3.2 - 3.6

Eldridge, R.G., 1957

Measurement of cloud drop-size distributions, J.Meteor. 14: 55-59

Optical method to measure the drop-size distribution in clouds is suggested. Method goes down to 0.5 to 1.0 um radius. Concentrations from several to many thousands mainly in the range of particles smaller than 3 um were measured. Bimodal distribution measured on Mt.Washington was found. Second peak at 5 to 8 um radius and concentration 10^{-2} to 10^{-1} cm^{-3}. Important for visibility measurements in clouds. It is not proven that the large number of small droplets are identical with the nonactivated but grown nuclei.

5.7

Elliott, W.P., and R. Egami, 1975

CCN measurements over the ocean, J.Atmos.Sci. 32:371-374

Measurements were performed over Pacific Ocean (50 km upwind of Oregon coast) 5 m above the sea surface. Thermal diffusion chamber was similar to that of Squires and Twomey(1966). Salt particles were determined by passing the air through milliporefilters (and identifying the particles according to Rossknecht et al. 1973). Values in eq. $N = CS^k$ were C (30 to 510) and k (0.35 to 0.83). The bulk of CCN measured near the sea surface are not chlorides.

2.5 - 4.2

Elliott, W.P., F.L.Ramsey, and R.Johnston, 1974

Particle concentrarions over the oceans, J.Rech.Atmos., 8: 939-945

2,500 AN measurements were made on board an oceanographical research vessel Glomar Challenger with the Gardner counter over the Pacific, Indian ocean, the Mediterranean, Caribbean and Gulf of Mexico. Close to the continents the concentrations surpassed 1,000 cm^{-3} and far from the mainland the concentrations were around 300 cm^{-3}. The particle sizes follow the log-normal distribution with a dispersion $\sigma = 0.5$.

4.1

Ellison, J. Mek, 1954

Light scattering by polydisperse dust clouds. The physics of particle size analysis, J.Appl.Physics, 66-71

For forward scattering the relative values of the contributions of particles of all dimensions have been calculated as a function of their diameter. Two different approximate formulas for the angular distribution of the light scattered by spheres have been used: (1) that of Rayleigh and Gans, and (2) Kichhoff diffraction by opaque circular discs.

5.7

Elterman, L., 1968

UV, visible, and air attenuation for altitudes to 50 km, 1968, AFCRL-68-0153, Environmental Research Papers, No. 285, April

Attenuation model for UV, visible and IR was deduced in 1964. New data are based on scattering (molecules and aerosols) and ozone absorption. Seven sets of aerosol measurements are compared and a profile of aerosol attenuation coefficient vs. altitude is developed. Attenuation coefficients and optical thickness due to molecular, aerosol and ozone attenuation are computed and tabulated. The tables permit calculations, including horizontal, vertical and slant-path transmissions at kilometer intervals to an altitude of 50 km.
3.6

Elterman, L., 1970

Relationship between vertical attenuation and surface meteorological range, Appl.Optics, 9: 1804-1810

The author defines the limits of a haze regime. An examination of the haze regime, used in the sense of diminished surface mateorological range, shows that the lower and upper limits can be compared with the visibility ranges 1.2 km and 15 km, respectively. The calculated relationship between surface haze and vertical attenuation is based on eight meteorological ranges and on the calculation of vertical attenuation parameters.

3.6

Eriksson, E., 1959

The early circulation of chloride and sulfur in nature: Meteorological, geochemical and pedological implications. Part I., Tellus, 11: 375-403

Using a different size distribution than Junge's one the author calculated the total sea-salt content in a column of air from the available data and for different locations: Hawaii - 11.2; Caribbean - 7.2; Florida - 6.8 and Central USA - 5.0 mg/m^2. The assumption of the mean settling rate of salt particles of 0.7 cm/sec (which corresponds to the mean particle radius of 5 um) leads to a mean aerosol residence time of 8 days.
Note: Apparently too high altitude (5km) of settling salt aerosol was assumed.

1.2 - 2.2 - 4.2

Eriksson, E., 1960

The yearly circulation of chlorideand sulfur in nature: Meteorological, geochemical and pedological implications, Part II., Tellus 12: 63-109

The author claims that different arts of impaction are the dominant factor for sea salt deposition over Scandinavia which is in its majority covered with forests. Also, the proximity of the sea and the humid climate contribute to the high concentration found on the ground. The direct uptake of gases by the soil should also be considered. However, it seems that the release and absorption of sulfur containing gases (SO_2) at the earths surface are nearly equal.

1.2 - 2.2 - 4.2

Eschelbach, G., 1973

Computations of the influence of aerosols on the atmospheric radiation balance in the visible spectrum, Cont. Atmos. Phys. 46: 249-261

The author calculates solar radiant fluxes in an atmosphere containing aerosols. Numerical solution of the complete equation of radiative transfer includes polarization effects.

3.1

Facy, L., 1951

Embruns et noyaux de condensation. J. Sci. Meteor. 3: 62-68

Salt solution droplets with masses from 10^{-18} to 10^{-14} g, do crystallize at relat. humidity < 70% and emit several hundred of minute crystals which act as effective condensation nuclei.

2.3

Faraponova, G.P., 1965

Relation of transparency of the free atmosphere to certain meteorological characteristics, Izv. AN USSR, Atmos. and Ocean. Phys. Ser. 1: 607

The ralationship between the aerosol component of the coefficient of extinction (λ = 0.44 um) and the state of the atmosphere is studied. A change of atmospheric transparency during the 24 hours period was found. The role of humidity and temperature inversion is stressed in the study of the dependence of the extinction coefficient on height.

3.6

Farlow, N.H., 1956

A physicochemical system for water aerosol measurement, J. Colloid Sci. 11: 184-191

Need for durable precision collecting surface for water aerosols led to development of a 35 mm film sensitive to distilled water and sea water fog droplets in the size range 1 to 100 um. The film is polyvinylalcohol containing $AgNO_3$ and H_2O_2 coated on a substrate of cellulose acetate film. Developing process includes UV-light. Droplets with the content as small as 0.02% of NaCl can be distinguished from pure water.

5.13

Fenn, R.W., 1960

Measurement of the concentration and size distribution of particulates in the arctic air of Greenland, U.S. Army SignalResearch and Development Laboratory, USASRDL, Tech.Rep. 2097: 1-14

In Greenland the concentration of AN were often bellow the limit of detectability by AN counter (about 20 cm^{-3}).

4.1

Fenn, R.W., 1966

Correlation between atmospheric backscattering and meteorological range, Appl.Optics, 5: 293-295

The relation between the backscatter intensity and the visual range (extinction coefficient) is studied. The various parameters causing the changes in visibility (e.g. particle number, size distribution) result in different backscatter conditions. Different combination of these parameters might lead to the same final effect. For this reason it becomes clear that such a relation cannot be a unique one and several possible explanations lead to the observed visibility range.

3.6

Findeisen, W., 1944

Wasserdampf_über_sättigungen bei der Wolkenentstehung (internal report of the Wolkenforschungstelle d. RWD), Prague

One of the first models describing the evolution of salt aerosol into a cloud drop spectrum. The author assumed two updraft velocities (5 and 10 m/sec) and the concentration of 100 nuclei per cm^3. Two different kinds of nuclei were assumed according to their activity. The droplet coagulation was neglected.Main results: The maximal supersaturation in the cloud is proportional to the 3/4 power of the updraft velocity and to the(-1/2)power of the nuclei concentration.
1.9

Fischer, K., 1970

Bestimmung der Absorption von sichtbarer Strahlung durch Aerosolpartikeln, Beitr.Phys.Atmos. 43: 244-254

The order of magnitude of the imaginary part of the complex index of refraction has been determined as 10^{-2}. The collected particles show with a good approximation grey absorption. The imaginary part of the index of refraction is a function of the humidity. Aerosol particles were collected with a jet impactor. Scattered radiation on the aerosol particles was measured up to the angle of 42^{o}.

3.5 - 3.3

Fisher, K., 1971

Bestimmung der Absorption von sichtbarer Strahlung durch Aerosolpartikeln, Beitr.Phys.Atm. 43: 244-254

The author describes the method for calculating the imaginary part of the complex refractive index. The experimental approach to the problem and some results of measurements are described.

3.3

Fischer, K., 1976

The optical constants of atmospheric aerosol particles in the 7.5 - 12 um spectral region, Tellus 13: 266-274

Thin films of atmospheric aerosol particles have been collected by an automatic jet impactor and used for the deduction of the real and imaginary part of the mean complex refractive index of aerosol particles in the 7.5 - 12 um spectral region. A dispersion analysis of the measured IR-spectra of absorption of the particle film was performed. A theoretical relationship was found between the optical constants of the films and those of the aerosol particles.

3.5

Fischer, K., and G. Hänel 1972

Bestimmung physikalischer Eigenschaften atmosphärischer Aerosolteilchen über dem Atlantik, "Meteor" Forsch. - Erg. B, 8: 59-62

During a cruise of "Meteor" aerosol samples have been taken with an impactor and the following parameters measured: the imaginary and real part of the index of refraction, the aerosol density and relative humidity. The mean density and the mean complex index of refraction have been found to decrease with increasing humidity. Around 75 % occurred an hysteresis effect which was strongly dependent upon aerosol composition. An error analysis of the procedures is attached.

3.5

Fitzgerald, J.W., 1970

Non-steady-state supersaturations in thermal diffusion chambers, J.Atm.Sci., 27: 70-72

Analysis of the non-steady state in the diffusion chamber leads to the conclusion that when the incoming air sample is saturated and colder than the top plate the basic assumption (Squires, Twoney, 1966) that the maximum supersaturation will be attained at the center of the chamber, does not hold. We have to analyze the non steady case showing that after approx. 0,3 sec in the center of the chamber will the supersaturation three times outnumber that expected.

5.6

Fitzgerald, J.W., 1970

A re-examination of the classical theory of the growth of a population of cloud droplets by condensation, Conf. on Cloud Physics, Ft. Collins, Colo. Aug.,111-112

Calculation of the cloud drop size evolution in a warm cloud has been performed. As a basis an improved classical droplet growth model has been used and different forms of nuclei supersaturation spectra applied, such as Twomey's model for continental aerosol and Jiusto's model deduced from the measurements on Hawaiian Islands. The calculated cloud drop spectra are close to to those observed in nature.

1.9

Fitzgerald, J.W., 1974

Effect of aerosol composition on cloud droplet size distribution: A numerical Study, J.Atmos.Sci.31:1358-1367

Numerical one dimensional model was used for the calculation of droplet size distribution in dependence of the amount of soluble substance $(NH_4)_2SO_4$ in the nucleus. This amount is different for continental and maritime air. The effect of mixed nuclei is, however insignificant compared with pure salt nuclei and also the size dependent amount of a soluble substance. The calculated droplet spectra are in reasonable agreement with nature.
1.9

Fitzgerald, J.W., 1977

Effect of relative humidity on aerosol distribution and visibility: Modeling studies. Proc.Conf. on Optical/Submillimeter Atmos. Propagation. Office of the Dir.Defense Res. & Engin. 155-164

Approximate formulas for soluble and partly soluble particles were derived to describe their growth at different relative humidity. Combined with the formula for a dry aerosol size distribution the effect of relative humidity on visibility was calculated. Comparison with the measurements in fogs yielded good agreement.

3.6 - 1.5

Fitzgerald, J.W., and R.E. Ruskin, 1977

A marine aerosol model for the North Atlantic, submitted for publication (NRL, Washington D.C.)

Discussed are the measurements by Jaenicke et al.(1971), and Meszaros and Vissy (1974): In the size range above r = 0.1 um the maritime aerosol is composed of a background aerosol of continental origin and a sea salt component. Sea salt nuclei predominate above 1 um radius. Generally, the concentration of continental background aerosol between 0.3 and 1.0 um does not exceed the concentration of sea salt particles of this size. $(NH_4)_2SO_4$ is a principal constituent in the size range of 0.1 - 1.0 um radius. Lovett's measurements in the North Atlantic (1975) support the Junge's distribution.
4.2

Foitzik, L., 1938

Uber die Lichtdurchlässigkeit der stark getrübten Atmosphäre im sichtbaren Spektralbereich, Viss.Abhandl.Reichsamt Wetterdienst, No.5, 21pp.

A treatise on visibility in polluted atmosphere includes a discussion about the influence of humidity. At humidities below 95% particles of all sizes grow fairly uniformly, so that their size distribution does not change much. Above 95% particles of all sizes do not grow uniformly. Larger particulates grow faster. Just prior to the onset of fog formation, one shoud expect a sudden change in visibility. The observation supports this theoretical conclusion.

3.6

Forster, H., 1940

"Studie über Kondensationskerne", Promotionsarbeit, Eidgenössische Technische Hochschule, Zürich,pp. 1-163

The investigation of the possible sources of Aitken nuclei and of their function in the atmosphere. Includes a survey about AN studies before the World War II.

1.1

Fournier d'Albe, E.M., 1951

Sur les embruns marins, Bull.Inst.Oceanog. no.995, 1-7

The author measured the size distribution of giant salt nuclei over the Bay of Monaco. He found a change in the slope of the particle size distribution around the particle size 10^{-4}g at wind velocity of 9 $msec^{-1}$(similar to Moore and Mason).

2.5 - 1.2

Fournier d'Albe, E.M., 1955

Giant hygroscopic nuclei in the atmosphere and their role in the formation of rain and hail. Arch.Meteor.Geophys. Biokl., 8.(A), 216-228

The author measured in Pakistan at three stations sea salt nuclei by a method described by Woodcock and Gifford (1949). Near the sea (Karachi) he found giant salt nuclei in the concentration range between 8/m^3 (winter) to 700/m^3 (during monsoon); at Hyderabad (100 km from the sea) from 4/m^3 to 200/m^3.

4.2

Frank,E.R., J.P. Lodge, and A. Goetz, 1972

Experimental sea salt profiles, J.Geophys.Res., 77: 5147-5151

There is no substantial difference between the number of particles collected at an altitude 1 and 15 m above the ocean (Santa Barbara, Catalina Islands). Mean diameter of chloride particles was 2 um. Concetrations ranged over a wide span from a few thousands to a few millions of particles per cubic meter. Sulfuric acid and sulfates were predominant.

2.5 - 2.4 - 4.2

Friedländer, S.K., 1960

Similarity considerations for the particle size spectrum of a coagulating, sedimenting aerosol, J.Meteor. 17: 479-483

Size distribution is explained as an interaction of coagulation and sedimentation. He assumes that the upper end of the size spectrum tends to approach a quasistationary state into which matter enters by coagulation from the Aitken range and from which matter is lost by sedimentation at the same rate. The calculated distribution curve is not in disagreement with the observation.

1.2

Friedlander, S.K., and G.M. Hidy, 1969

New concepts in aerosol size spectrum theory, Proc. 7th Int.Conf.Condens.Ice Nuclei, Prague-Vienna, 1969, Academia, Prague, 21-25

When coagulation controls the evolution of the size distribution of particulates, the distribution of aged dispersions approaches an asymptotic form, independent of the initial distribution. This asymptotic distribution is completely determined by the particle volume, total number of particles per unit volume of gas and the volume fraction of dispersed phase. The authors show that in the case of tobaco smoke and atmospheric aerosol with $r \leq 1.0$ um "self preserving"distribudion is justified.
1.2

Fuchs, N.A., 1969

Recent progress in the theory of transfer processes in aerosols at intermediate values of Knudsen number, Proc. of the 7th Int. Conf. Cond. Ice Nuclei, Prague-Vienna, Prague, 10-16

Transfer at intermediate Kn values can be solved only on basis of Boltzmann kinetic equation. The author describes mainly the work by Brock and Willis and the simplification leading to the linearization of the kinetic equation. The calculated rate of drop evaporation is compared with the model by Sahni and Carcignani and Pagani. An application for momentum transfer and Brownian coagulation and comparison with few experimental data are mentioned.
1.2 - 1.9

Fymat, A.L., 1974

Determination of the complex refractive index and size distribution parameters of clouds and aerosols, Rep. of Proc. IAMAP - IUGG Assembly, Melbourne, IAMAP Publ. No.15a, Toronto, 83

The author discusses the results of numerical experiments aimed at demonstrating the capabilities of the author's Minimization Search Method in retrieving the complex index of refraction and the model parameters of typical size distributions from scattering measurements. Exemples include the calculation of the real refractive index of a single particle and of monodisperse aerosol and of the complex refractive index of terrestrial and Venusian aerosol.
3.5 - 1.2

Gaertner, H., 1947

The transmission of infrared in cloudy atmosphere, NAVORD, Rep. 429, US Gov. Print. Office.

The treatise on atmospheric IR radiation is divided into three main spheres: A) attenuation of light in an atmosphere free of cloud and fog elements (scattering by permanent gases, water vapor molecules, small particulates and selective absorption by permanent gases and water vapor); B) attenuation of light in fog (theory of light scattering and absorption, transmissivity in natural and artificial fogs); C) attenuation of light in rain.

3.2 - 3.4 - 3.6

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Gal, G., 1976

Particulate cloud diagnostics with optical measurements (mathematical model), Lockheed Palo Alto Research Laboratory, LMSC-D502379, April

Characteristics of the radiation scattered by a unit volume of atmosphere, containing suspended particulates depends on two aerosol properties: 1) Properties that appear as parameter in the Mie theory: relat. index of refraction, particle size and size distribution. 2) Properties that involve an approximation, such as the shape of the particle, orientation relative to the scattering plane, and optical depth, i.e. single or multiple scattering.

3.1

Gal, G., 1976

Particulate diagnostics with optical measurements, Lockheed Palo Alto Research Laboratory, LMSC-D506 765, Workshop on remote sensing of marine boundary layer, 9 August, Vail, Colo.

Various efforts of Lockheed Palo Alto Research Laboratory include: A diagnostic method to obtain the particle size distribution and index of refraction. Extinction of Mie theory in order to describe the scattering from polydispersions, chaff optimization, particulate diagnostics via matrix inversion techniques.

3.1

Garrett, W.D., 1967

The organic chemical composition of the ocean surface, Deap-Sea Res. 14: 221-227

Samples of the sea water were collected from the Atlantic. Pacific ocean, Gulf of Lower California, Gulf of Mexico, Bay of Panama in order to determine surface-active, chloroform-soluble components in the sea surface. Analysis was made with aid of gas chromatography. The major constituents found in the samples were: fatty esters, free fatty acids, fatty alcohols, hydrocarbons. The distribution of fatty acids and alcohols varies according to meteorological and oceanographic conditions.

2.8

Garrett, W.D., 1974

The surface activity of petroleum and its influence on the spreading and weathering of oil films at sea, J.Rech.Atmos. 8 : 555-562

Due to the spreading of petroleum over a large surface area the [illegible]est fraction of surface active substances and vola[illegible] substances is transported into the atmosphere by evaporation. The residues at the sea surface become progressively enriched in less volatile compounds which contain oxygen, nitrogen and sulfur. This conclusion has been supported by laboratory film balance measurements of a series of crude oil and petroleum products.

1.8

Garrett, W.D., C.O. Timmons, N.L.Jarvis, and R.E.Kagarise, 1963

Constitution and surface chemical properties of sea slicks, Part I. - Bay of Panama. NRL Rep. 5925, 16 pp., U.S. Naval Res. Lab., Wash. D.C.

Most of the samples revealed the presence of fatty acids, esters, alcohols and hydrocarbons. Under zero surface pressure about 0.7 ug of surfactant covered an area of 1 cm^2.

2.8

Gebhart, J., and C. Roth, 1973

Particle sizing by means of small angle scattering in the light beam of a mercury lamp, in "Aerosole in Physik, Medizin und Technik", Jahreskongress d. GAF, 41-44

The authors analyse the function of an optical aerosol spectrometer. The main elements of a high resolution instrument are a suitable calibration curve and the aerodynamic focusing of the aerosol flow. It is not favorable to cover the whole size range from 0.05 to about 5 um with one instrument. Below the wavelenght of the light used laser illumination is to be preferred. Above the wavelenght small angle scattering in white light is recommended.

5.7

Georgievskiy, Y.S., and G.V. Rozenberg, 1973

Humidity as a factor in aerosol variability, Atmos. Oceanic Physics, 9: 66-71

The influence of relative humidity on the transformation of atmospheric aerosols is studied on the basis of the variation of the scattering coefficient over the spectrum. This influence becomes important even at R.H.= 20-30%. The properties of condensation nuclei are the dominant factor. The submicron particle fraction of the aerosol is responsible for the turbidity of the atmosphere in the visible range. The coarse fraction contributes to the turbidity at higher wavelenghs ($\lambda >$ 1.5 um) and higher relative humidity (R.H. = 80-85%).

3.2

Georgii, H.W., 1959

Neue Untersuchungen über den Zusammenhang zwischen atmosphärischen Gefrierkernen und Kondensationskernen, Geofis.Purae Appl. 42: 62-72

Study of the relationship between ice nuclei and aerosol size spectra: The giant particles provide the ice nuclei which become active at the highest temperatures. Activation temperature decreases with decreasing particle size and is about -30°C for Aitken nuclei. One can conclude that most active ice nuclei are mineral particles from the soil.

1.5

Georgii, H.W., 1965

Untersuchungen über Ausregnen und Auswaschen atmosphärischer Spurenstoffe durch Wolken und Niederschlag, Ber. Deutsch. Wetterd. 14, No. 100

A general picture of the mechanism of rain out and wash out is presented. Conclusions from the theoretical studies are applied for the explanation of the measurements performed in the atmosphere.

1.2 - 1.4

Georgii, H.W., 1975

Recent research on atmospheric cloud nuclei, Proceedings of the 8th Int.Conf. on Nucleation, Leningrad, 1973, Gidrometeoizdat, Moscow, 398-403

An analysis of the role of nuclei in cloud forming processes is presented. Spectra of cloud nuclei for different maritime conditions show different concentrations at constant supersaturation due to a different contribution of admixed continental background aerosol (Junge). 50% of nuclei above the ocean surface are sea salts and their number decreases strongly with altitude. Mixed nature of aerosols prevails. The increase in cloud nuclei concentration could lead to a decreased efficiency of rain formation.

2.1 - 2.2

Georgii, H.W., 1975

Grossräumige Untersuchung maritimer und stratosphärischer Aerosole, in "Aerosole in Naturwissenschaft, Medizin und Technik.Chemie der Umweltaerosole", Jahreskongress der GDF, p. 18-21

Background aerosol over the ocean has the following features. Only up to 2 km above the ocean surface one can find the salt particles. Sulfate bearing particles represent the majority of the particle content between the size ranges $r=2\times10^{-5}$ and 1×10^{-4} um. Most of the particulates reveal the composition $(NH_4)_2SO_4$ and the surplus of sulfates in maritime aerosol compared with the sulfate content of sea water amounts to 5 or 6 times. This surplus is mainly confined to the particle size range $0.1 < r < 1.0$ um.

4.2 - 4.1

Georgii, H.W., and G.Gravenhorst, 1972

Untersuchungen zur Konstitution des Aerosols über dem Atlantischen Ozean, Meteor. Rundschau, 25: 180-181

The measurements of the sulfate aerosols over the Atlantic Ocean during the cruise of the research vessel "Meteor" show clearly that: 1) the ocean surface is not the main source of maritime aerosol, 2) the sea salt aerosol represents only a small portion of the total aerosol content. Sea salts are confined to the planetary boundary layer (up to 2 km altitude), 3) the sulfate aerosol and the insoluble particles represent the majority of the maritime aerosol in the radius range between 0.2 and 1.0 um.

4.2 - 1.4

Georgii, h.W., and A.L. Metnieks, 1958

An investigation into the properties of atmospheric freezing nuclei and sea-salt nuclei under maritime conditions at the west coast of Ireland, Geofis.pura e appl. 41: 159

"Stufen-Konimeter" measurements at the Island Valentia 1958. A good response between wind velocity and nuclei concentration similar to Schmidt's data, has been found, but not so strongly expressed.

4.2 - 2.5 - 2.9

Georgii, H.W., and E. Weber, 1960

The chemical composition of individual rainfalls. Tech. Note, Contract AF61 (052)-249, pp 1-28, Air Force Cambridge Research Center, Bedford, Massachusetts

Found that concentration of several constituents in rainwater is roughly twice as high in rainfalls after a dry period of at least 3 days than in rainfalls after a dry period of less than 12 hours . The largest variation of particle amount (per unit of volume of rain) was found in the case of very light rain ($h < 1$ mm) due to the possible evaporation of drops.

4.3

Gerber,H.E., W.A.Hoppel, and T.A.Wojciechowski, 1977

Experimental verification of the theoretical relationship between size and critical supersaturation of salt nuclei, J.Atmos.Sci., 34: 1836-1841

A polydisperse aerosol of NaCl and $(NH_4)_2SO_4$ salt particles was passed through or a Goetz centrifuge or through a mobility analyzer into the thermal gradient cloud chamber. The threshold supersaturation for activating nuclei was recorded. The critical supersaturation found for nearly monodisperse aerosols agreeded well with the theoretical calculation.

1.5

Gerhard, E.R., and H.F. Johnstone, 1975

Photochemical oxidation of sulfur dioxide in air, Ind.Eng.Chem. 47: 972-976

SO_2 is oxidized in bright sunlight at a rate of 0.1 to 0.2% per hour, forming H_2SO_4 droplets when traces of water are present. A concentration of 10 ug/m^3 of SO_2 would yield about 0.03 ug/m^3 of H_2SO_4 per hour which corresponds to the following rates of particle production:

r = 5 x 10-3 u	1 x 10^5/ cm^3 hr
r = 1 x 10-2 u	1 x 10^4/ cm^3 hr
r = 3 x 10-2 u	3 x 10^2/ cm^3 hr

However, several other processes complicate a simple model (e.g. primary clusters formation).

2.1

Giddings,W.P., and M.B.Baker, 1977

Sources and effects of monolayers on atmospheric water droplets, J.Atmos.Sci., 34: 1957-1964

Survey on the influence of surface active substances on the transport of vapor molecules towards a water droplet is presented. A simple model is applied for calculating the growth rate of coated droplets. It shows that the primary effect of surfactant is to decrease the steady-state portion of the droplet growth rate. A kinetic mechanism is proposed to describe the effect of a monolayer on the droplet growth and on the deposition coefficient.

1.8

Gillette, D.A., and Blifford J.H., 1971

Composition of tropospheric aerosols as a function of altitude, J.Atmos. Sci, 28: 1199-1210

A serie of flights were performed in order to measure the aerosol concentration over Nebraska, California and Pacific Ocean up to 10 km altitude with a three-stage impactor. Chemical analyses were made by means of X-ray techniques. The concentrations of Cl, S, K, Ca and Ti decreased rapidly from the ground up to 1 km and then remained almost constant up to 10 km. Low Cl concentration indicates a small sea salt contribution to the aerosol composition at higher altitudes. Mass median diameters of particles were < 0.3 um.

2.7

Goetz, A., 1960

Ursprung, Verhalten und Bestimmung der Submikronen - Aerosole des Smogs, Staub, 20: 303-308

Organic material on aerosols collected in Los Angeles retards or prevents the evaporation or condensation. A description of the experiments which illuminate the nature of the substances involved are described.

1.8

Goetz, A., 1965

The constitution of aerocolloidal particulates above ocean surface, Proc. Int. Conf. Cloud Phys. Tokyo-Sapporo, 42-45

The author states that because a natural organic film would concentrate at the surface of an evaporating drop, it might stabilize sea fogs at low humidities and create a rather permanent haze.

2.8 - 1.8

Goetz, A., 1957

An instrument for the quantitative separation and size-classification of air-borne particulate matter down to 0.2 micron., Geofis. Pure e Applic. 36: 49-69

The author discusses the theory of aerosol deposition in a centrifuge. The factors determinimg the particle behavior are: Radius and angular velocity of the helical channel, radial with of one channel, and relative velocity between air and channel. Individual parameters are analyzed and related to the described model of a centrifuge which was calibrated with five monodisperse aerosols, ranging between 1.19 and 0.19 um.

5.5 - 1.2

Goetz, A., and O.Klejnot, 1971

New methods for studying photochemical formation of aero-colloidal matter in the ambient atmosphere, Proc. 7th Int. Conf. Cond. Ice Nuclei, Prague-Vienna, 1969, Academia, Prague, Supl. Vol. 139-140

Using an UV- irradiation cascade the influence of radiation nuclei formation of HC was studied : In clean air predominantly the larger molecules ($\leq C_5$) contribute to the aerosol formation, and among these the unsaturated (olefins) are much more reactive than the aliphatic and aromatic (cyclic). The presence of moisture, traces of SO_2 and/or NH_3 have a large effect in the reaction itself.

1.8

Goetz, A., and O. Preining, 1960

The aerosol spectrometer and its application to nuclear condensation studies, In "Physics of precipitation", Monograph, 5, NAS-NRC No.746, Am.Geophys.Union, Washington, D.C., 164-182

The authors collected natural aerosols in forests and mountains, and in desert in the western part of the USA with an aerosol spectrometer over the radius range of 0.09 - 0.5 um. A repeated evaluation of the samples after time intervals of days showed that the smallest particles apparently decreased in size and /or in number. This can be explained by the slow evaporation of volatile organic substances.

Goldsmith, P., H.J. Delafield and L.C. Cox, 1961

Measurement of the deposition of submicron particles in gradients of vapour pressure and of the efficiency of this mechanism in the capture of particulate matter by cloud droplets in nature. Paper pres. at the Int. Symposium on Condensation Nuclei, Heidelberg, Geofis. Pura e Appl. 50: 278-280

The measurements have been performed with the aerosol deposition on a growing droplet under a vapor gradient G (mb/cm) for aerosol size between 0.03 and 0.1 um. The deposition velocity $v=2x10^{-4}$ G (cm/sec). Conclusion has been made that the Facy effect is quite unimportant for rainout.

1.2

Goodman, J.K., 1976

The microstructure of California coastal fog and stratus; Rep. No. 76-09, Dep. of Meteorology, San Jose State University, San Jose, Sep.

Measurements on the 250m-TV-tower enabled an analysis of the microstructure of the California fogs. The mean drop diameter was 4.5 to 8.3 um. Droplet concentration: 120 to 260 cm^{-3}, LWC; ($\frac{1}{2}$ of the true values) from $5.3x10^{-3}$ g/m^3 to $6.07x10^{-2}$ g/m^3. Nuclei concentration: AN 2.000/cm^3 in the inversion and 1.200 cm^{-3} on another day. CCN: $N = CS^k$, $k = 0.5$; C varied from 385 to 1238.

4.2 - 4.1

Goodman, J.K., and A. Miller, 1976

Mass transport across a temperature inversion, Dep. of Meteorology, San Jose State Univ., San Jose, Rep. No. - 76-10 Nov.

Transport of particulates trough the temperature inversion was observed:1) The concentration of trace elements in aerosols increased above the inversion base, 2) When the inversion is not extremaly intense, the diurnal variations of the nuclei concentration above and below the inversion base are well correlated. 3) The concetration of sea salt nuclei does not decrease with height above the inversion than it does below.

4.2 - 4.1

Gorham, E., 1958

The influence and the importance of daily water conditions in the supply of chloride, sulfate and other ions to fresh water from atmospheric precipitations, Phil.Trans.Roy.Soc. London, B 241: 147-178

With increasing amount of precipitation there is a decrease in the concetration of sulfates, nitrates and chlorides. The slope can be approximated by a power law $h^{-0.3}$ (h is the precipitation amount). Steep decrease of Cl' concetrations measured as a function of the distance from the seashore, was observed.

4.3

Goroch, A.K., 1977

Comparison of aerosol growth relationships, (private communication) February, pp. 9.

Particle growth factor (ratio of the mass of the "wet" particle to that of dry one) was calculated as a function of relative humidity from Fitzgerald's, Katz's, Well's et al., Bernhardt and Streete's and Hänel's formulas and potted in a diagram. Large discrepancies exist between individual formulas. Relatively good agreement exists between the models by Hänel, Fitzgerald and Wells et al. at humidities larger than 80%. Hysteresis effect might overshadow any change in relative humidity $40\% < R.H. < 100\%$.

1.5 - 3.1

Grabovskii, R.I., 1956

Atmosfernye iadra kondensatsii, (Atmospheric Condensation Nuclei), Gidromet.Izd., Leningrad

The monograph treats the condensation nuclei function in the atmosphere, different methods of nuclei measurement and summarizes the results of measurements of AN and of cloud condensation nuclei. It contains many references on Russian investigations in the domain of condensation nuclei prior to 1955.

1.1 - 2.1 - 2.2 - 2.7

Graedel, T.E., 1974

Channel width determination and electronic pulse processing losses in optical particle counters, J.Aerosol Sci. 5: 125-131

Serious inaccuracies and limitations can originate in optical particle counters as a result of pulse height analysis. It is shown that the mean particle size recorded on the several pulse height analyzer channels vary with the shape of the size distribution curve of the aerosol being measured.

5.7

Grams,G.W.,I.H.Blifford,Jr.,D.A.Gillette, and P.B.Russell, 1974

Complex index of refraction of airborne soil particles, J.Appl.Meteor. 13: 459-471

The angular variation of the intensity of light scattered from a collimated beam by airborne soil particles and the size distribution of the particles were measured simultaneously 1.5 m above the ground. These measurements gave an estimate of the complex index of refraction. From the microscopic analysis a value of the real part of the refractive index was determined (1.525) which is representative for airborne soil particles. The upper limit of the imaginary part was determined to be 0.005.

3.5

Grant, L.O., 1971

Report on the Second International Workshop on Condensation and Ice Nuclei, Dept.Atmos.Sci. Colorado State Univ., Fort Collins, pp. 149

The report includes the description of the facility and aerosol generating techniques used during the workshop at Fort Collins. The comparison and description of individual counters (AN, CCN, and IN) is attached.

5.1 - 5.6

Gravenhorst,G., and J.Müller, 1977

Mass distribution of aerosol components over the North Atlantic, Vol. of Abstr. 9th Int.Conf.on Atmos.Aerosols, Cond. and Ice Nuclei, Galway, 151

Impactor sampling has been performed over the North Atlantic and the different behavior of metal components and constituents ($SO_4^{=}$, NH_4, H) shown. Half of the sulfate and practically all ammonium did not originate in sea salt. Metal components were separated into insoluble and soluble part and the potential influence of Sahara dust was investigated.

1.4

Green, W.D., 1972

Maritime and mixed maritime-continental aerosols along the coast of southern California, J.Geophys.Res. 77: 5152-5160

The study of the aerosol nature during onshore winds (day time) and offshore winds (night). The main attention has been paid to the interaction between oxides of nitrogen and sodium chloride particles.Results: Large scale mixing of NO_2 fom continental air with reactions between salt particles and the gas is postulated. More than 90% of the particles sampled contained salt if they were in the range 5,5 to 7,0 um.

4.2 - 1.4

Greenfield, S.M., 1957

Rain scavenging of radioactive particulate matter from the atmosphere, J.Meteorol. 14: 115-125

Considering only the Brownian coagulation and the microturbulence the author found that a minimum in the rate of "wet" removal is in particle radius between 0.05 and 0.1 um.

1.2

Grosch, M., 1975

Elementaranalyse von atmosphärischen Aerosolen, in "Aerosols in Naturwissenschaft, Medizin und Technik. Chemie der Umweltaerosole", Jahreskongress der GAF, 82-85

Aerosol samples were taken on Schleicher & Schüll filter for neutron activation measurements over the North Atlantic, in Frankfurt and in the Alps. Over the North Atlantic the concentration (in ug/m^3) was as follows: H 0.002 Zn 0.05; Cl 3.6; Na 2.2; Fe 0.2; K 0.28; Br 0.01; Mn 0.23 and Cr 0.07. Na, Cl, K and Mn concentrations over the sea were much higher than at Frankfurt and were confined to larger particulates.

2.4 - 4.2

Gucker, F.T., 1949

Determination of concentration and size of particulate matter by light scattering and sonic techniques, Proc.First Nat. Air Pollution Symp., Pasadena, 14-25

Description of different methods (photoelectronic, electrostatic and sonic) for particle counting are discussed briefly.

5.3 - 5.7 - 5.15

Gucker, F.T., 1956

Aerosol particle counters, Proc. of the 11-th Industrial Waste Conf., 284-312, May

Extensive description of the following methods is presented: 1) collecting the particles on suitable slides and counting them, 2) particle counting by means of: a) electrostatic deposition, b) light scattering, c) visual counting, d) photographic counting, e) photoelectronic counting (Gucker), f) aerosoloscope (Fisher, Katz).

5.3 - 5.7 - 5.15

Gucker, F.T., and D.G.Rose, 1954

A photoelectronic instrument for counting and sizing aerosol particles. The physics of particle size analysis. J.Appl.Phys. 138-143

The instrument collects light scattered between 1^{o} and 24^{o} in forward directions and focuses it upon a photomultiplier tube. Pulses are magnified and counted. Instrument counts particle down to 0.17 um radius.

3.7

Gumprecht, R.O., and C.M. Sliepcewich, 1951

Tables of Light Scattering Functions for Spherical Particles. Eng.Res.Inst., Univ. of Michigan, 574p.

An extension of the tables published by Nat.Bureau of Standards, 1949. The present tables extend the calculations up to 60 um diameter of particles.

3.1

Hale, G.M., and M.R.Querry, 1973

Optical constants of water in the 200 nm to 200 um wavelength region, Appl. Optics, 12: 555-563

Extinction coefficients for water at 25°C were calculated through a broad spectral region by using the available data of optical refraction of water for the region 200 nm to 200 um.

3.5 - 3.4

Harris, F.S.,Jr., and M.P.McCormick, 1974

Scattering properties of an aerosol combining differing refractive indices and size distributions, in "Aerosole in Naturwissenschaft, Medizin und Technik", Jahreskongress GAF, p. 149-154

Models with a wide variety of complex refractive indices have been used and compared with the actually measured particle size distribution. The combination of the Junge's distribution with the Deirmendjian type was used. It was convenient to devide a size distribution initially into six log-normal components. The authors conclude that an appropriate selection of size distribution and of complex refractive index enable to simulate the behavior of aerosols in nature.

3.2

Harrison, H., J. Herbert, and A.P.Waggoner, 1972

Mie-theory computations of lidar and nephelometric scattering parameters for power law aerosols, Appl. Optics, 11: 2880-2885

The ratio of lidar backscatter to nephelometric total scattering cross section have been computed for Junge's aerosol particle size distribution. Various parameters of size distributions, indices of refraction, and of inhomogeneity of the scattering particles were assumed. Conclusion:Choosing suitable parameters one can obtain an agreement between computed and observed backscatter ratios. The differential scattering problem briefly is discussed.

3.2 - 1.2

Hasenclever, D., 1954

Bestimmung des Feinstaubgehal[illegible] Luft; eine Übersicht über Messgeräte und Messverfah[illegible] Chemie-Ingenieur-Technik, 26: 180-187

The author discusses approx. 30 different instruments (mainly classical) which are used [illegible] a narrow size distribution of aerosols.

5.2 - 5.3 - 5.4 - 5.7

Haugton, H.G., 1932

The size and size distribution of fog particles, Physics, 2: 467-475

5.2

Hänel, G., 1968

The real part of the mean complex refractive index and the mean density of samples of atmospheric aerosol particles, Tellus, 20: 371-379

The author describes the procedure enabling him to measure the mean complex refractive index and the mean density of aerosol particles. A theoretical model has been established to determine these parameters at different environmental conditions.

Hänel, G., 1971

New results concerning the dependence of visibility on relative humidity and their significance in a model for visibility forcast. Contrib.Atmos.Phys. 44: 137-167

The author analyzes conditions of deducing a realistic model for visibility prediction. The methodology of the measurement of the complex index of refraction is outlined and some preliminary results communicated.

3.6 - 3.5

Hänel, G., 1976

The properties of atmospheric aerosol particles as functions of the relative humidity at thermodynamic equilibrium with the surrounding moist air, 73-188 in the " Advances in Geophysics, Vol. 19, Academic Press, New York, by Landberg, H.E., and J. von Mieghem.
The subject of this very detailed study of the dependence of size, density and mean refractive index on the relative humidity. The difference between the growth of an individual particle and of a sample of aerosol (collected in an impactor) is described analytically and the possible errors discussed in details. The experimental results and calculations of the extinction, scattering and absorption coefficient are applied for atmospheric optics (e.g.visual range).
1.5 - 1.6

Hänel,G., and R. Dlugi, 1976

Eine ökonomische Näherungsformel für den Absorptionskoeffizienten atmosphärischer Aerosolteilchen, in "Aerosole in Naturwissenschaft, Medizin und Technik",Bericht der 4.Tagung der GAF, 172-176

An approximate formula for the coefficient of absorption is deduced, which does not deviate more than ± 40% of the exact formula for the wave length ranges between 0.3 and 2.5 um and 9.25 to 12 um (at relative humidities between 0% and 95%). The formula is independent of the particle size distribution.

3.3

Heintzenberg, J., 1974

On the determination of the in situ aerosol size distribution from measurements with a multi-wavelength integrating nephelometer and optical particle counters, in "Aerosole in Naturwissenschaft,Medizin und Technik, Jahreskongress GAF, p. 170-185.

4-channel intergrating nephelometer (λ = 0.451; 0.552; 0.701 and 0.875 um), Royco-225 particle counter and GE AN counter were used to investigate the particle distribution from the optical parameters of the aerosol in situ. Through a systematic variation of the parameters characterizing the model of the size spectrum, the simulated signals are matched to the measured data. Atmospheric size distribution was simulated by several log-normal distributions. Several examples of the measurement are presented.
3.2 - 3.6 - 1.2

Heintzenberg, J., and M. Baker, 1976

Spherical particle populations: Approximate analytic relationship between the size distribution parameters and integral optical properties, Appl.Optics, 15: 1178-1181

The absorption and scattering efficiencies of spherical particles in a certain size range can be approximated by a threeparameter formula. With this formula, a ralationship is developed between the extinction, scattering, or absorption coefficients and the parameters of log-normal size distribution of particulates. We can approx. calculate the optical coefficients from the mean radius, its standard deviation and the total number concentration.

3.1 - 1.2

Hermann,J., and H.J. Eiberweiser, 1974

The influence of particle size in extinction measurements. Staub, 34(5): 123-129

The influence of particle size distribution on the extinction measurement by a photo-electric sensor was investigated. Different kinds of test aerosol were used (glass, lime stone, fly ashes and coal) and varied in a systematic way.

Hess, V.F., 1948

On the concetration of condensation nuclei in the air over the North Atlantic, Terrestrial Magnetism Atmospheric Elec. 53: 395-403

The author found a difference in AN counts over the western (575-813 cm^{-3}) and eastern part (478-504 cm^{-3}) of the North Atlantic. This is apparently related to the pollution comming with the prevailing air circulation.

4.1

Hess, V.F., 1951

Further determinations of the concentration of condensation nuclei in the air over the North Atlantic, J.Geophys. Res. 56: 553-556

New series of measurements showed higher AN counts in western part (1229-1512 cm^{-3}) and lower in eastern (887-462) part of the North Atlantic.

4.1

Heyder, J., C. Roth, and W. Stahlhofen, 1971

A laser spectrometer for size analysis of small airborne particles, J.Aerosol Sci., 2: 341-352

The particle size distribution in an aerosol is measured by analyzing the light scattered by each particle in a nearly forward direction. The particles are illuminated with a laser beam, the light scattered is collected by a microscope objective and passed to a red sensitive photomultiphier. The signal-to-noise ratio of the spectrometer makes it possible to measure particles down to 0.1 u in diameter. This sensitivity was obtained by focusing both the laser beam and the aerosol beam.

5.7

Hill, T.L., 1950

Concerning the dependence of the surface energy and surface tension of spherical drops and bubbles on radius., J. Am. Chem. Soc., 72: 3923-3927

The aproximate model used by Fowler to investigate theoretically the surface energy and surface tension of a plane liquid surface is extended to spherical drops and bubbles, assuming liquid incompressibility. It is possible to derive an expression for the correction of the plane surface tension for curvature, which predicts that the surface tension decreases with radius. The magnitude of this effect is small.

1.9

Hindman, E.E., 1977

Aerosol particle workshop in a coastal environment, Bull. Amer.Met.Society 58: 592-595

At the top of Trinidad Head, Calif. in July 1976 was organized a workshop the aim of which was to measure AN and CCN. Instrumentation used: Gardner and Enviroment - One counter, cond. nucleus counters, el. aerosol analyzer, Royco 202, 225, and 245, Climet 208, Part. Meas. System's, active scattering aerosol spectrometer, class. scattering spectrometer, array probe (Knollenberg). Element. composition of particles was also determined. Good response of almost all counters has been found.

5.1 - 5.3 - 5.7

Hindman II.,E.E., and O.E.R. Heimdahl, 1977

Submicron haze droplets and their influence on visibility in fog, Preprints-Sixth Conf. on Inadvertant, and Planned Weather Modification, Oct., Champain-Urbana, AMS, Boston, 10-13

The authors determine from the recent optical particle counter measurements, the contribution of the haze droplets to the visibility in fog and the effect of haze droplets on calculated man made visibility improvements in fog. The measurements made in coastal region and in inland as well show the haze drop contributions ranging between 7% and 60% (San Diego). In the case of post-Santa Ana fogs at San Diego the haze droplets might retard improvements in visibility caused by injections of giant hygroscopic nuclei.

3.6 - 1.2 - 1.5

Hindman II, E.E., P.V.Hobbs, and L.F.Radke, 1977

Cloud condensation nucleus size distribution and their effects on cloud droplet size distributions, J.Atmos. Sci., 34: 951-956

An investigation into the importance of small, large and giant CCN in the formation of cloud drops with $d \geq 30$ um in warm clouds over the Washington State was made. Cloud droplet size distribution calculated from CCN measurements shows a reasonable agreement with the cloud drop measurement. Cloud droplets with $d \geq 30$ um were found only if low concentrations of small CCN ($0.06 \leq D \leq 0.2$ um) existed. If high concentrations of small CCN were present, there were very few large droplets, regardless of the concentration of giant CCN.

1.5 - 1.4

Ho,W., G.M.Hidy, and R.M.Govan, 1974

Microwave measurements of the liquid water content of atmospheric aerosols, J.Appl.Meteor. 13: 871-879

A new method of the measurement of the dielectric constant of atmospheric aerosols is discribed.From these measurements the free liquid water content of airborne particles can be deduced. Measurements in the urban air in Southern California are described. The liquid water content in aerosols (marine and urban aerosol) represents a significant fraction of their masses in the relative humidity range between 40 and 75%.

3.6 - 3.4 - 3.5

Hoang, Ch.T., and J. Servant, 1974

Exemple d'un apport continental de quelques metaux dans l'aerosol au-dessus de l'Atlantique Nord a la latitude de 40°N. J.Rech.Atmos. 8: 791-805

The aerosols were collected on board the ships over the North Atlantic Ocean, between New Founland and Portuguese coast. The samples were made on the filter Delbag Microsorban (60 cm^2) throug which 720 m^3 of air were filtered during one day. Te analysis was made by the neutron activation. The following concentrations were found: 10-20 ng/m^3 for Al and Fe; 0.1 to 0.2 ng/m^3 for Mn; 0.01 ng/m^3 for Co, 0.06 ng/m^3 for Cr. Total dust content amounted from 0.2 to 4 ug/m^3 of air.

4.2

Hobbs. P.V., 1971

Simultaneous airborne measurements of cloud condensation nuclei and sodium-containing particles over the ocean, Quart.J. RMS, 97: 263-271

Aircraft CCN measurements with Therm.Grad.Diff.Chamber (mostly at 0.5% supersatur.) were made over Seatle and adjacent Pacific Ocean area. Sodium containing particles were measured with the flame photometer. CCN concentrationwas over the ocean a few hundred per cm^{-3}. CCN decreased between the surface and 1.5 km but remained constant between 1.5 and 3.0 km. CCN a few hundred feet above the surf were not different from those over the open ocean.

4.2

Hobbs,P.V., L.Radke, and E.E.Hindman,II., 1976

An integrated airborne particle-measuring facility and its preliminary use in atmospheric aerosol studies, J.Aerosol Sci., 7: 195-211

A description of an integrated airborne system for the aircraft aerosol characteristics measurement is presented. The system covers the particle size range from 0.01 to 30 um and concentration range from 10^{-6} to 10^{7} cm^{-3}. Particles from 5 to 100 um are collected by impaction and their water solubility is determined in the laboratory. Samples collected over the Pacific Ocean show clearly the predominant role of NaCl particles in the giant and large nuclei range.

5.2 - 5.6 - 5.7

Hodkinson, J.R., 1966

Particle sizing by means of the forward scattering lobe, Appl.Optics, 5: 839-844

The angular distribution of the intensity of scattered light in the main lobe of the diffraction pattern of a particle chan strongly with size, but is largely independent of its refractive index. A measurement of the ratios between the scattered intensities at a pair of convenient angles within the lobe and at two different wavelengths might give a useful information about the particle sizes without knowing their refractive index.

3.1 - 3.5

Hoffer, T.E., and A.R.W. Presley, 1971

Detection of chloride ions in a Klucel medium, J.Appl.Met. 10: 1346-1348

Some of the gelatins now available have high residual chloride content. One may use as a substitute a substance with a trade name Klucel by Hercules Inc. A suitable gel will be prepared. Haloes became visible when the Klucel medium is exposed to light (after 3 - 15 min.). In the classical Liesegang method medium was sensitized with $AgNO_3$ to give pH = 2.5. Klucel medium can withstand temperatures as high as 34°C without distortion.

5.7 -

Hoffman, G.L., and R.A. Duce, 1972

Consideration of the chemical fractionation of alkali and alkaline earth metals in the Hawaiian marine atmosphere, J. Geophys.Res. 77: 5161-5169

Filter samples were taken by Gelman Huricane air sampler on Delbag Microsorban polystyrene filters (type 99/97). Atomic absorption analysis of Na, Mg, Ca, K, Sr showed that there is no large-scale chemical fractionation of Mg, Ca, K and Sr relative to Na in the Hawaiian Islands atmosphere.

1.4 - 4.2

Hoffman G.L., R.A. Duce, and E.J. Hoffman, 1972

Trace metals in the Hawaiian marine atmosphere, J.Geophys. Res. 77: 5322-5329

On 20 m tower on Oahu Island, Hawaii were made 200 atmospheric-particulate sample analyses by atomic absorption (for V, Al, Mn). Most of the metals were of continental crustal material.

1.4 - 4.2

Hogan, A.W., 1968

Experiments with Aitken counters in maritime atmosphere, J.Rech.Atmos., 4: 53-57

On a light house in Oregon (Yaquina) and on board the ship in Atlantic Ocean AN measurements were performed with the Gardner and GE Aitken nuclei counter. A median concentration of AN over the North Atlantic was 520 nuclei cm^{-3}. At Yaquina the concentrations were in mean 1100 ncm^{-3}. Land-sea breeze effect caused large variation of nuclei concentration. Along the seashore of the East of the USA a strong influence of air pollution on the AN counts was found.

4.1

Hogan, A.W., 1976

Physical Properties of the Atmospheric Aerosol, ASRC-SUNY, Scotia, Sep. pp. 168

Aerosol concentrations were measured with photoelectric aerosol detector, calibrated against a reference Pollak counter. Measurements were performed over the oceans and continents as well. At some sites aerial investigations supported surface measurements. Over the seas aerosol concentrations are regulated by high pressure areas, monsoons and over temperate oceanic regions the counts ranged from 300 to 500 AN/cm^3.

4.1

Hogan, A.W., 1976

Aerosols of the Trade Wind Region, J.Appl.Meteor., 15: 611-619

Several instruments were used for the measurement of the concentration of maritime aerosol on the north shore of Oahu: GE counter, Gardner counter, photographic AN counter with high sensitivity. Light scattering instrument were also used to determine the concentration of larger particulates. In mean, concentrations of 260 cm^{-3} were found, but variations over the range 30 to 400 cm^{-3} occured.

Hogan, A.W., 1977

Meteorological variation of maritime aerosols, Vol. of Abstr. 9-th Int. Conf. on Atmos. Aerosols, Cond. and Ice Nuclei, Galway, 152

A survey on the AN measurements from ships at sea, islands, mountains and polar regions is made and some conclusions about the sources and sinks of the tropospheric aerosol made. The Icelandic low pressure region, the area Poleward of the Antarctic convergence and the Trade Wind Region are characterized by concentrations of 300 cm^{-3} and lower. No secular variation of the AN ncentrations over the North Atlantic Ocean has been found.

4.1

Hogan,A.W., J.M.Bishop, A.L.Aymer, B.W.Harlow, J.C.Klepper, and C.Lupo, 1967

Aitken nuclei observations over the North Atlantic Ocean, J.Appl.Meteor. 6: 726-727

Systematic measurements of AN were performed over the North Atlantic Ocean, between latitude 30 and 40 N. The observations of 1966 were made six times per day with the Gardner counter. The median concentration was 520 cm^{-3} with 16% of observations less than 250 cm^{-3}.

4.1

Hogan,A.W., V.A.Mohnen, and V.J. Schaefer, 1973

Comment on "Oceanic aerosol levels deduced from measurements of the electrical conductivity of the atmosphere," J. Atmos.Sci., 30, 1455-1460

The distribution of AN concentrations over the North Atlantic is plotted in a chart which shows how the eastern part of the USA pollutes the North Atlantic. Close to the seashore AN concentrations range up to several thousands per cm^{-3}. Far over the ocean the AN background concentration amounts to several hudred per cm^{-3}.

4.1

Hoppel, W.A., and J.W.Fitzgerald, 1976

Measurement of CCN spectra at low supersaturations in relation to fog formation off the coast of Nova Scotia, Proc. of the Sympos. on Radiation in the Atmosphere, Garmisch-Partenkirchen, 1976, Science Press, Princeton, N.J., 62-64

The measurement of CCN at very low supersaturations with Thermal Gradient Diffusion Cloud Chamber and With Laktinov Chamber are discussed. A unique relationship between the equilibrium size at saturation and the critical supersaturation independent of the fraction of the soluble material has been found.

5.6

Hoppel,W.A., H.E.Gerber, and T.A.Wojciechowski, 1977

Measurement of the relationship between size and critical supersaturation for natural aerosols and salt nuclei, Vol. of Abstr. 9th Int.Conf. on Atmos.Aerosols, Cond. and Ice Nuclei, Galway, 75

An experiment with monodisperse NaCl and $(NH_4)_2SO_4$ particles and the relationship between particle size and critical supersaturation is described. Goetz centrifuge was used in order to eliminate large multiply-charged particles transmitted by the mobility analyzer. Discrepencies between the previous measurements by other authors were found. Similar measurements have been performed onboard the ship over the ocean.

1.5

Hoppel,W.A., and T.A.Wojciechowski, 1976

Accuracy limitations on CCN measurements with thermal gradient diffusion chambers, J.Appl.Meteor. 15: 107-112

The authors analyzed the function of thermal gradient diffusion cloud chambers and found not well-defined plateau (when the number of CCN is plotted as a function of time), and a discrepancy between CCN counts obtained by instantaneous photography and the time-exposure method. The latter method is recommended for application.

Hoppel, W.A., 1975

Growth of condensation nuclei by heteromolecular condensation, J.Rech.Atmos. 9: 167-180

A model for the growth of atmospheric CN by simultaneous addition of water vapor and H_2SO_4 vapor (formed from SO_2 and H_2S) indicates that H_2SO_4 solution will condense on existing aerosols and that the growth time of small AN into the size of sizes important for nucleation processes is shorter than the residence time of CCN in the troposphere. NH_3 reduces the nucleation barrier of gas-to-particle conversion.

1.5

Hoppel, W.A., and Dinger J.E., 1973

Production of cloud nuclei by ultraviolet radiation, J.Atmos.Sci. 30: 331-334

Experiments were performed both in the laboratory and from the airplane with Pollak and Environment One counters. CCN were measured with the thermal grad. diffusion chamber. Five heated quarz tubes permitted to separate the nuclei according to their different volatility. Conclusion: The properties of the CCN generated by UV radiation are similar to those found in nature.

2.2 - 2.1

Hoppel, W.A., J.E.Dinger, and R.E.Ruskin, 1973

Vertical profiles of CCN at various geographical locations, J.Atmos.Sci., 30: 1410-1420

Aircraft measurements up to 3,5 km (2flights up to 10,5 km) over Arizona, Central Pacific, Alaska and Florida were made. Air was introduced through five quartz tubes heated to different temperature into a therm. diffusion chamber. At low altitude over continental areas 10 x more CCN were found than in maritime air. The oceanic and arctic profiles indicate a downward movement of CCN with the possible source in the upper troposphere.

2.7 - 4.2

Horne, R.A., 1969

Marine Chemistry, Interscience, New York, pp.568

The monograph deals with the main subjects of marine chemistry such as composition of sea water with a special attention paid to the top most layer of the ocean. The separation of ions in the surface microlayer.

1.4 - 2.8

Horvath, H., and G. Presle, 1975

Der Einfluss der Farbe auf die Sichtweite in "Aerosole in Naturwissenschaft, Medizin und Technik. Chemie der Umweltaerosole", Jahreskongress der GAF, 86-89

The visibility is influenced by the amount of light scattered and by the extinction of light in the atmosphere containing particulates. Because the extinction caused by a certain kind of aerosol particles and also the sensitivity of the human eye depend on the wave length of light, the simple Koschmieder relationship for the"meteorological range" has to be corrected. The author describes experiments in a tank filled with hydrosol which enabled him to establish this correction.

3.6

Hoy, R.D., 1974

The calculation of infrared radiative cooling rates including the effects of water aerosols, IAMAP-IUGG Assembly, Melbourne, IAMAP, Publ. No.15, a, Toronto, 87

Absorption and scattering of infrared radiation is investigated for various ranges of aerosol sizes. The Junge size distribution is assumed. Aerosol particles with radii between 0.1 and 4.0 um appear to be most significant for infrared radiation transfer. The radioactive transfer depends partly on the slope of the size distribution curve and on the aerosol somposition. At humidities greater than 70% a considerable part of aerosol can be represented by water aerosol.

3.4 - 3.5

Hsu, S.A., and T. Whelan III, 1976

Transport of atmospheric sea salt in coastal zone, Env. Sci. & Techn. 10: 281-283

Studies on Padre Island (1972) and Barbados Island 1973 are described. Measured were: Ratio of Mg/Na and the distribution of the total amount of salt particles in the air. Air was bubbled through 250 ml of double-distilled water and then was determined Na, Mg by atomic absorption spectroscopy. The annual production rate of sea salts amounts to 1.1×10^{15} g/year.

2.3 - 4.2

Ibrahim, M.F.K., and W.J.Megaw, 1977

Condensation on soluble and insoluble particles, Vol. of Abstr., 9th Int.Conf.on Atmos. Aerosols, Cond.,and Ice Nuclei, Galway, 38

The description of a simple cloud condensation nucleus counter which can change from 100% R.H. to supersaturation rather rapidly is presented. The preliminary results of measurements agree well with theory, except for the case of completely insoluble particles.

5.14 - 1.4 - 1.5

Irvine, W.M., and J.B.Pollack, 1968

Infrared optical properties of water and ice, Icarus, 8: 324-360

The authors measured absorption spectra of water, ice, ammonium sulfate and of sea salt in the wave length range 1.0 um to 14,0 um. The absorption coefficient-wave length curve for sea salt resembles to that of ammonium sulfate except of the slight shifting of the peaks toward the shorter wave lengths.

3.4 - 3.5

Isono, K. 1957

On sea-salt nuclei in the atmosphere, Geofis.Pura Appl. 36: 156-164

Based on the chemical analysis of cloud elements the author concludes that in cloud drops at the summit of Japanese mountains 30% of nuclei were composed of salts.

1.4

Isono, K., and Y. Ishizaka, 1977

Sources and material composition of atmospheric aerosols, Vol.of Abstracts 9th Int.Conf.on Atmos.Aerosols,Cond. and Ice Nuclei, Galway, 82

Aerosol particles were collected at different sites and different altitudes in Japan an over the neighboring seas. The measurements showed that above 2500 m only $(NH_4)_2SO_4$, $(NH_4)_2Ca\ SO_4$, $CaSO_4$, $MgSO_4$ and silicates were present. The particle transport in the atmosphere is discussed in details.

4.2 - 1.4

Ito, T., 1977

On the size distribution of aerosols in North Pacific air mass, Vol.of Abstr. 9th Int.Conf. on Atmos.Aerosols, Cond. and Ice Nuclei, Galway, 150

Concetration and size distribution of marine aerosols in the North Pacific have been measured. A diffusion battery with an improved Pollak counter was used for determining the size distribution of particles with radii between 0.002 and 0.2 um. A strong correlation with the origin of the air mass has been found. Air mass coming from the mainland showed concentrations between 1,000 and 2,000 cm^{-3} and a narrow peak between 0.02 and 0.07 um radius.

4.1 - 1.2

Ivlev, L.S., and S.I. Popova, 1973

The complex refractive indices of substances in the atmospheric aerosol dispersed phase, Izv.Akad.Nauk USSR, Atmos. Ocean.Phys., 9 : 1034-1043

Evaluate the optical parameters of a model aerosol by assuming a linear relationship between the optical constants of the particle bulk constituents and the particle surface chemical composition.

3.5

Jacobs, W.C., 1937

Preliminary report on the study of atmospheric chlorides, Mon.Weath.Rev.US.Dep.Agric. 65: 147

A hypothesis of chloride particle generation from bursting bubbles on the sea surface is presented.

4.3

Jaenicke, R., 1974

Size distribution of condensation nuclei in the NE trade regime of the African coast. J.Rech.Atmos. 8: 723-733.

A combination of special diffusion battery with the GE AN counter enabled to measure AN size distribution below $r = 10^{-6}$cm. The measurements of AN were made on the Island of Sal (16°44' N; 22°57' W). AN total concentrations ranged from 450 to 1,200 cm^{-3}. The aerosol on the ground was of maritime origin, at higher levels of continental (Sahara dust). Two distinct maxima were found in the AN size distribution, one around 10^{-5} cm radius and the other around $2x10^{-6}$ cm.

4.1 - 1.2

Jaenicke, R., 1975

Absolute, direkte und relative Kondensationskernzähler, in "Aerosole in Naturwissenschaft, Medizin und Technik, Chemie der Umweltaerosole", Jahreskongress der GAF, 78-81

Comparison of the errors in particle counting by Scholz counter and by photographic nuclei counter is presented. Main attention is paid to the diffusional losses of nuclei, which could amount in the Scholz counter up to 12%. On the other hand, the photographic counter suffers of on an "increase" in nuclei counts due to the air expansion by means of a valve. The appropriateness of the words "absolute counter" is discussed.

5.1 - 1.2

Jaenicke,R., 1977

The size distribution of Aitken nuclei in background aerosols, Vol.of Abstr. 9th Int.Conf. on Atmos.Aerosols,Cond.& Ice Nuclei, Galway, 131

The author describes a method based on the use of diffusion batteries and condensation nuclei counter in order to establish the size distribution of AN with concentrations as low as 200 cm^{-3} AN of all sizes between 0.001 um and 0.1 um have been found over the North Atlantic with three isolated maxima.Their location seems to depend on the wind velocity and atmospheric turbulent exchange.

4.1 - 1.2

Jaenicke, R., C.Junge, and H.J.Kanter, 1971

Messungen der Aerosolgrössenverteilung über dem Atlantik. Meteor. Forschungsergebnisse, Reihe B, Nr.7, Verlag Bornträger, Berlin, 1-54

The particle size distribution of atmospheric aerosol along the 30°W longitude in the passat wind region of the Atlantic Ocean showed the presence of the aerosol of continental origin. The mineral component of the aerosol covers the size range between o.3 and 20 um in radius and increases the total aerosol concentration of one order of magnitude.

2.6 - 1.2

Jeck, R.K., 1976

Performance of the PM axially scattering spectrometer probe, NRL, Washington, pres. at the Aerosol Measurement Workshop, Univ.of Florida, March 24-26

Axially Scattering Spectrometer Probe (ASSP) has been calibrated in the laboratory and flown onboard an aircraft. The author investigated into several potential sources of errors which might cause serious distortions of the size distribution of particulates between the 0.5 to 40 um in diameter. The problems encountered during the field measurement are: electronics modul overheating, water in optics, anisokinetic sampling etc.

5.7

Jennings, S.G., 1977

The effect of particle size distribution and complex index of refraction of atmospheric aerosols on the visual range, Vol. of Abstracts 9th Int.Conf. on Atmos.Aerosols, Cond. and Ice Niclei, Galway, 132

A study of the effect of particle size distribution and complex index of refraction on the visual range has been made. The calculations were performed for $\lambda = 550$ nm using a generalized Mie scattering theory for particles log-normally distributed. It was found that the visual range is insensitive to the imaginary index k over the range $0.001 < k < 0.3$ for $r_g > 0.05$ um, however, it decreases by a factor of 5 as the real index n is increased from 1.33 to 1.8 for $0.01 \leq r_g \leq 0.1$ um.

3.6 - 3.5 - 1.2

Juisto, J.E., 1966

Maritime concentrations of condensation nuclei, J. Rech. Atmos., 2: 245-250

Found higher concentrations of AN on the top of an inversion over the island Hawaii. Those anomalous counts were approximately 400 cm^{-3} in a layer of about 100 m thickness. Above and below this layer the counts were about 200 cm^{-3}.

4.1 - 2.1

Jiusto, J.E., 1967

Aerosol and cloud microphysics measurements in Hawaii. Tellus, 19: 359-368

During the study of warm rain processes, microphysical properties of the clouds were investigated. Hawaiian CCN spectrum is described by $N = 53\ S^{0.46}$. If the particles would be NaCl with "dry" radius r_n, $N(r_n) = 2.5\ r_n^{0.7}$. Differences in the slopes of supersaturation-nucleus concentration spectra are related to the continental character of the aerosol advancing over the island.

4.2 - 1.5

Jiusto, J.E., 1968

Droplet growth on cloud nuclei, Proc.Int.Conf.on Cloud Physics, Univ. of Toronto, 62-66

Droplet growth on NaCl nuclei of sizes between 0.05 um (10^{-15} g) and 4.8 um (10^{-9} g) has been calculated for supersaturations of 3.0; 1.0; 0.1; 0.03; 0.01 and 0.00%. NaCl particles can be activated at a supersaturation of 0.01% and grow during a short time into the size of 1.2 um. At a supersaturation of 1% nonhygroscopic nuclei can be activated and reach the radius of 8 um (from the original 0.2 um) within 26 sec. Some conclusions have been made for the fog dispersion with hygroscopic substances.

1.9

Johnson, D.B., 1976

The relative importance of variations in CCN spectra and updraft strength, J. Atmos.Sci., 33: 345-346

Twomey expression relating CCN spectral parameters (C, k) and updraft speed U to the number of activated nuclei (N) in the base of a growing cloud is analyzed. The calculation shows the important meaning of the individual terms and their relationship to cloud dynamics.

1.5

Johnston, D.R., and D.E. Burch, 1967

Attenuation by artificial fogs in the visible, near infrared, and far infrared, Appl.Optics, 6: 1497

The attenuation coefficient ratios ($\alpha_\lambda / \alpha_{0.546}$) for artificial fogs have been measured at 345 um. In addition at 13.5; 10.0; 3.5; 1.01 and 0.436 um and acomparison was made between artificial and natural fogs. The authors conclude that their artificial fogs closely resemble natural fogs. Artifial fogs are generated and allowed to dissipate while attenuation measurements at several wavelengths were measured. The green mercury arc line $\lambda = 0.546$ um was used as reference.

3.6

Junge, C.E., 1935

Übersättigungsmessungen an atmosphärischen Kondensationskernen, Gerlands Beitr.Geophys. 46: 108-129

Experiments with different aerosols activated at a critical supersaturation in a spherical cloud chamber are described. The supersaturation (or undersaturation) was maintained in the chamber by using different liquids (with different vapor pressure) at the bottom. It was shown that several few percent of supersaturation can activate most the atmospheric nuclei, and that the nuclei grow in agreement with Koehler's theory.

1.5

Junge, C.E., 1936

Zur Frage der Kernwirksamkeit des Staubes, Meteorol. Z., 5: 186-188

Not all active nuclei are hygroscopic. Each nucleus can become at a sufficient humidity condensation nucleus. Physical-chemical properties of different kinds of nuclei found in nature and generated in the laboratory are discussed.

1.5

Junge, C.E., 1952

Die Konstitution des Atmosphärischen Aerosols, Ann.Meteorol. 5: Suppl. 1-55

Nuclei growth curves show a hysteresis at lowering or rising the relative humidity. Salt solution drops start to crystallize around 40% R.H.during decreasing R.H. Measurements of natural aerosol over a wide range of sizes indicate a value of $\varepsilon = 1.3$ for humidity change from 60% to 95%. For pure droplets of salt solution $\varepsilon = 1.8$. This means on increase in optical parameter σ_A by a factor of 2.2 and 5.8 respectively.

1.5 - 3.5

Junge, C.E., 1952

Gesetzmässigkeiten in der Grössenverteilung atmosphärischer Aerosole über dem Kontinent, Ber.deutsch.Wetterd. US-Zone, 35: 261-277

Based on the extensive measurements the author concludes that continental aerosols have an essentially coherent size distribution (not discrete groups of particles related to the different measuring technique).

2.1

Junge, C.E., 1952

Das Grössenwachstum der Aitkenkerne: Ber.deut.Wetterdienstes US-Zone, 38: 264-267

An average growth curve for Aitken nuclei over Central Europe shows, that continental aerosols are mixed particles which behave partly like droplets of a salt solution.Growth curves of individual natural giant particles show a great variety, which is to be expected for more complex chemical composition of the larger aerosol particles.

2.1

Junge, C., 1953

Die Rolle der Aerosole und der Gasförmigen Beimengungen der Luft im Spurenstoffhaushalt der Troposphäre, Tellus, 5: 1-26

The individual processes determining the budget of impurities in the atmosphere are discussed. The particle concentration was calculated for different sizes of nuclei and for two relative humidities (95 and 40%). The "growth characteristic ratio" defined as the ratio of the particle radii corresponding to these humidities is different for the continent (1.3) and for the oceanic site (1.6 or 1.8). The influence on particle sedimentation is considered.

1.4

Junge. C.E.. 1955

The size distribution and aging of natural aerosol as determined from electrical and optical data in the atmosphere, J.Meteor. 12: 13-25

The diffusion method and mobility ion measurements offer an information about particle size distribution up to the radii of 0.1 um. To convert a mobility ion spectrum into an aerosol spectrum one needs to know both the charge of particles and their charged fraction as a function of particle radius.The time for reaching ionization equilibrium is 0.5 hr for particles with $r = 3 \times 10^{-2}$ um. The measurements show that AN have their concentration maximum in the size range between 10^{-6} and 10^{-5} cm.
1.2

Junge, C.E., 1955

The vertical distribution of aerosols over the ocean. Artificial stimulation of rain, Proc.Conf.Phys. Cloud & Precipitation Particles, 1st,Woods Hole, 89-96

Neither gravity nor condensation would be able to establish an equilibrium between the upward transport of nuclei and their elimination by the condensation process at cloud level. It has been shown theoretically that the observations of sea-salt particles can be explained by the non-steady-state solution of the equations. The most important is apparently the removal of particulates by precipitation rather than by sedimentation.

2.7

Junge, C.E., 1956

Recent investigations in air chemistry, Tellus, 126-139

Two stage impactor separated particles from 8×10^{-6} to 8×10^{-5} and from 8×10^{-5} to 8×10^{-4}cm. Following ions and gases were identified: NH_4^+ , NO_3^- , Cl', $SO_4^=$, Na^+ and NH_3, N_xO_y, Cl_2, SO_2. Conclusions: NO_3^- was concentrated predominantly in giant particles. Its amount decreased with increasing maritime influence. Cl' was almost completely confined to the giant particles. NH_4^+ was confined almost completely to large nuclei. $SO_4^=$ not detected in large particles. Concentration of gases NH_3, N_xO_y, SO_2 are 10x higher than the corresponding particulate matter.

4.2 - 1.4

Junge, C.E., 1957

Chemical analysis of aerosol particles and of gas traces on the island of Hawaii, Tellus, 9: 528-537

The analysis of NH_4^+ , NO_3, Cl', SO_4 ions was made at Hilo Harbour, Hawaii. Two stage cascade impactors separated particles into two radius ranges from $8x10^{-6}$ to $8x10^{-5}$ cm. and from $8x10^{-5}$ to $8x10^{-4}$ cm. The analyses were confined to the substances soluble in distilled water. Results: NO_3 was concentrated predominantly in giant particles. Its amount decreased with increasing maritime influence.

4.2 - 1.4

Junge, C.E., 1960

Discussion remark. In "Physics of Precipitation", Monograph No.5 NAS-NRC No. 746, pp 216-218, Amer. Geophys. Union, Washington D.C.

One can explain satisfactorily the supersaturation spectra by the known size distribution curve of atmospheric particles.

1.5

Junge C.E., 1963

Air Chemistry and Radioactivity, Int. Geophysics Series, Vol.4, Acad. Press, New York, London

A monograph dealing with all main problems of air chemistry with a special reference to marine atmosphere. On page 117-122 important features of atmospheric aerosols are discussed and detailed analysis of the processes influencing the evolution of size distribution of particles is made. On pp. 141-146 the propagation of light in a polluted atmosphere and the visibility measurements are described.

1.1 - 1.2 - 1.4 - 3.1 - 3.6

Junge, C., 1971

The physical and chemical properties of atmospheric aerosols and their relation to condensation processes, Suppl.Vol.Proc. 7th Int.Conf.Cond.& Ice Nuclei, 1969, Prague - Vienna, Academia., Prague, 31-51

Conclusions: r^{-3} distribution is an approximation, best realized in polluted areas. The deviations can be expected in the case of one predominant source (sea spray). The exponents in the supersaturation cloud nuclei spectra formulas (k= 1.0 for continental and k = 0.6 for maritime air) provide useful informations on the particles with r < 0.1 um. However, it appears that the chemical composition is only of secondary importance for cloud drop growth compared with particle size.

1.2 - 1.4

Junge, C.E., 1972

Our knowledge of the physical-chemistry of aerosols in the undisturbed marine environment, J.Geophys.Res. 77: 5183-5200

A survey about the production and measurement of particulates over the ocean is presented. The main peak in the size distribution seems to be between r=0.01 and 0.1 um over the continent and around r=0.2 um over the ocean. The smallest salt particles were observed by Woodcock (4×10^{-12} g) and by Durbin and White (10^{-13} g). More of the small particulates were observed by Dinger (1970). Most of the NaCl particles are not produced by bubble bursting.

2.2

Junge, C.E., and P.E. Gustafson, 1957

On the distribution of the sea salt over the United States and its removal by precipitation, Tellus, 9: 164-173

A simple model is applied in order to calculate the removal of the aerosol by precipitation from the troposphere. The aerosol is supposed to be distributed evenly in the troposphere and removed during the precipitation process. From the fraction of the aerosol left in the air after a certain number of days, the average residence time is calculated. The simple model explains the steep gradient in chloride concentration found in the coastal region.

4.3

Junge, C., and R. Jaenicke, 1971

New results in background aerosols studies from the Atlantic expedition of the R.V. Meteor, Spring 1969, J. Aerosol Science, 2: 305-314.

Measurements from South America to Scotland were made with Kanter and Royco counters and several impactors covering the range from 0.001 to 100 um. Results: Background in AN was approx. 600 cm^{-3}. Particles below r=0.01um were found. They are apparently continuously produced. Daily variations of AN did not excede 10% of the average value and photochemical processes seem not to influence the production mechanism of AN. Particles larger than 20 um are primarily soluble.

4.1

Junge, Ch., and E. Mc Laren, 1971

Relationship of cloud nuclei spectra to aerosol size distribution and composition, J. Atmos. Sci., 28: 382-390

The nuclei size distribution is the most importantfactor in determining the condensation process. Compositional variations become important only for aerosols with very low content (< 10%) of soluble material or with very unusual distributions of the soluble material through the different size ranges. The author discuss how useful information can be obtained from the aercsol size distributions and from the measurement of physical-chemical properties of nuclei.

1.2 - 1.5

Junge, C.E., E.Robinson and F.L.Ludwig, 1969

A study of aerosols in Pacific air masses, J.Appl.Meteor. 8: 340-347

In the fall of 1965 measurements were made at Cape Blanco and Crater Lake, Ore. Aerosol size distribution was determined with a Royco particle counter and with CN counters. Cape Blanco data agree well with the sea-spray aerosol measurement. Size distrib. at Crater Lake (2200.m) may be characterized by Junge's distrib. with exponents between 3 and 4. The Goetz aerosol centrifuge was used to collect sulfur- and chloride containing particulates. The sea salt was virtually absent above the level of 2 km. Analysis of the size distrib. of chloride particles was made.

4.2 - 2.7

Junge, C.E., and T.G. Ryan, 1958

Study of the SO_2 oxidation in solution and its role in atmospheric chemistry. Quart.J.Roy. Meteor. Soc. 84: 46-55

If sea-spray is exposed to SO_2, oxidation will also occur in the solution as long as the pH value of the droplet does not decrease too much. Thus, oxidation can proceed also in presence of sufficient amount of NH_3 and will be enhanced by high relative humidities. However, this process does not provide a pH value sufficiently low to account for the observed gaseous chlorine component.

2.2

Junge C., and G. Scheich, 1971

Determination of the acid content of aerosol particles., Atmospheric Envir. 5: 165-175

Sulfuric acid present in aerosol particles is identified according the H^+ ion concentration (conductometric measurement) after dissolving all particles retained on the filter Whatman #1 in 2x redestilled water. Whatman #1 filter is supposed to retain 98% water soluble particle mass for r 0.1 um particles. The flow rate was 2 $m^3 hr^{-1}$. While the free H^+ ion fraction is largely concentrated in AN range, the water soluble substance is more prevalent in the large particles.

5.2 - 1.4

Junge, C.E., and R.T. Werby, 1958

The concetration of chloride, sodium, potassium, calcium and sulfate in rain water over the United States, J.Meteor., 15: 417-425

Measurements of the concentration of several chemical substances in rain water are described. The data show the main features of the elements characterizing the urban pollution and industrial activity such as calcium and sulfates, and of the chlorides which are supposed to be generated over the high sea and in coastal regions. A steep gradient in chloride concentrations close to the seashore is apparent.

4.3

Kabanov,A.S., I.P.Mazin, and V.I.Smirnov, 1969

Influence of spatial inhomogenity of condensation nuclei concentration on cloud drop-size distribution, Proc. 7th Int.Conf.Cond.& Ice Nuclei, Prague-Vienna, 329-332

The authors try to explain the discrepancy between theoretically deduced spectra and those found in nature (much broader) by assuming the inhomogeneity of condensation nuclei in the space. Monodisperse nuclei are initially confined to separated volumes, grow and exchange and reach a certain level where they are measured (averaged over a great number of isolated volumes). The authors succeded to explain the broadening of size spectra found in nature.

1.9

Kamiyama, K., and M. Moriguchi, 1953

Infra-red spectrometry of condensation nuclei, Papers in Meteor. Geophys. 3: 307-312

The authors describe a simple theory of the infrared spectrometry and its use for characterizing the growth of different nuclei into cloud drops. The experiments were performed in an expansion chamber into which the nuclei were introduced. Two different wavelengths (1.307 and 1.216 um) and the refractive index m=1.33 were applied. An investigation of the activity of AgI as condensation nuclei is described.

3.2

Kassner, J.L., J.C.Carstens, and L.B.Allen, 1968

Analysis of the heat and vapor propagation from the walls of the Nolan-Pollak and Gardner type condensation nucleus counters, J.Atm.Sci., 25: 919-926

Theoretical analysis of the vapor and heat propagation from the walls of a cylindrical container shows how important is the geometry of the expansion chamber if reliable measurements of Aitken nuclei concentrations should be made. Some criticism about the recently made measurements inside of a Pollak - Nolan counter is expressed.

5.1

Kassner, J.L.Jr., J.C.Carstens, M.A.Vietti, A.H.Biermann, P.C.P.Yue, L.B.Allen, M.R.Eastburn, D.D.Hoffman, H.A.Noble, and D.L.Packwood, 1968:

Expansion cloud chamber technique for absolute Aitken nuclei counting, J.Rech.Atmos. 3: 45-51

The principles of a new expansion chamber operating in a similar way like Wilson chamber and enabling to count the number of Aitken nuclei, are outlined. The cloud chamber program and individual parts of the automatic measurements at different supersaturation explain how the Aitken nuclei spectra can be obtained.

5.1

Kasten, F., 1968

Der Einfluss der Aerosol-Grössenverteilung und ihrer Änderung mit der relativen Feuchte auf die Sichtweite, Beitr. Phys.Atmos, 41: 33-51

The influence of the humidity on the change in aerosol size spectrum due to the swelling of hygroscopic particulates has been calculated. This change in aerosol size spectrum causes changes in visibility. A model for the calculation of visibility is suggested.

3.6

Kasten, F., 1969

Visibility forecast in the phase of precondensation, Tellus, 21: 631-635

A theoretical analysis of the effect of the swelling of aerosol particles due to the increasing humidity is presented. A simple formula for the increase in mass of the nucleus due to the moisture has been deduced. Based on the formula for the swelling of atmospheric particulates a corresponding change in visibility has been calculated.

3.6

Katz U., and W.C.Kocmond, 1973

An investigation of size-supersaturation relationship of soluble condensation nuclei, J.Atmos.Sci.30: 160-165

Measurements performed during the 2nd Int.Workshop on Condensation and Ice Nuclei in Fort Collins (1970) indicated discrepancies between the calculation of the size of a CN at the critical supersaturation and the measurement. The authors repeated the experiments and found that salt particles nucleating water at a given supersaturation had radii two to three times larger than the calculated ones.

1.5 - 5.6

Keating, J.H., 1966

A Climatic Isovisic and Nephanalysis Atlas of the North Atlantic, North Pacific and Indian Oceans, The MITRE Corporation, Bedford, Massachusetts, April

The study supports the optical environmental study conducted by the MITRE, Corp. for the Naval Research Defense Laboratory. The study includes a climatological analysis of visibility and total cloud cover for each of the months of January, April, July, and October. The geographical areas were selected according to their significance to naval operations.

3.6

Keily, D.P., and S.G.Millen, 1960

An airborne cloud-drop-size distribution meter. J.Meteor. 17: 349-356

An electrical method for the measurement of cloud drop-size distribution is described and some preliminary results communicated.

5.3

Ketseridis, G., 1975

Organische Komponenten des atmosphärischen Aerosols, in " Aerosols in Natur_wissenschaft, Medizin und Technik. Chemie der Unweltaerosole", Jahreskongress der GAF, 22-26

The description of the sampling of the air (2,000 to 4,000 m^3 air) through the glassfiber filters and the evaluation of the samples is presented. The samples were taken in Germany, in Ireland, at Cap Verde Islands and during the cruise of the ship "Meteor". The conclusion: The organic material is mainly injected into the atmosphere over the continents. In mean the organic material amounts to 10% of the total aerosol mass measured over the continent. The background concentration (1 um/m^3) was found over the oceans.

1.8 - 2.8

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Kientzler, C.F., A.B.Arons, D.C.Blanchard, and A.H.Woodcock, 1954

Photographic investigation of the projection of droplets by bubbles bursting at a water surface, Tellus, 6: 1-7

Detailed study of the bursting of bubble at the water surface and emission of the jet drops with the aid of high speed camera. The droplets are about 10-15% of the corresponding bubble size (diameter between $3x10^{-2}$ and $4,3x10^{-1}$ cm). The drops carry an appreciable electrical charge.

2.3

Kikuchi, K., 1971

Observations of cloud condensation nuclei at Syowa Station, Antarctica, J.Meteor.Soc.Jap. 49: 376-383

Observations of cloud nuclei max. concentrations using a chemical diffusion chamber are described. Reported mean concentrations are surprisingly high ($8x10^2 cm^{-3}$ at 1% supersaturation).

4.2

Kikuchi, K., and S. Yaura, 1970

Observations of gigant sea-salt particles over the ocean from Tokyo to Syowa station, Antarctica, J.of Meteor.Soc. Jap. 48: 377-380

Measurements showed an imperfect correlation between wind velocity and high nuclei concentrations. High counts were observed around equator, southwards of Australia and more than 1,000 particles per liter were found near ice edge. 50% of particles were smaller than 10^{-11}g. Close to the pack ice area (66°S, 39°E) concentrations were very low (226 n/liter) and above the Antarctic continent 200 n/liter. The use of the Farlow's reagent for the identification of chloride ions is described.

4.2 - 2.5 - 2.9

King, W.D., and C.T.Maher, 1976

The spatial distribution of salt particles at cloud levels in Central Queensland, Tellus, 28: 11-23

Large hygroscopic particles in the mass range 0.5-200 uug were collected on an aircraft. The concentrations varied insignificantly from the altitude 200 m to 1000 m. In general, the mass distribution curves were similar to those sampled on Hawaii. On a distance of 1100 km was reduced the concentration of salt particles by a factor of five.

4.1 - 2.7

Kline, D.B., 1972

Measurements of ice nucleus and associated chloride particle concentrations at Mauna Loa Observatory, J.Appl.Meteor. 11: 684-687

Relationship between ice crystal counts at an expansion temperature of -24°C and the number of chloride particles was investigated. Samples were taken by millipore filters which were later subjected to chemical analysis. The evaluated data support the idea of the contamination from the low-level sources. Both aerosols increased up to three orders of magnitude during diurnal upslope wind conditions. The depletion of chloride particle counts with distance from the shoreline is similar to that observed at Puerto Rico.

4.2 - 2.7

Knelman, F., N. Dombrowski, and D.M.Newitt, 1954

Mechanism of the bursting of bubbles, Nature, 173: 261

The authors suggest on the basis of their experiments that a large number of minute droplets were produced by the rupture of the liquid film which forms the upper surface of bubbles in sea water. A spherical bubble bursts near the summit, where is the thinnest layer. The photographs show how the crater is formed and how the incoming rush of liquid produces a jet and finally small drops.

2.3

Koglin, W., 1974

Dust collection in the electrostatic precipitator. Staub 34: 139-142

An analysis of the operation of an electrostatic precipitator is presented. In order to design an efficient precipitator the particle trajectories have been calculated. The author demonstrated that the specific efficiency of "flat plates" channel is very close to the specific efficiency of double field screen "pocket plates".

5.3

Koehler, H., 1936

The nucleus in and the growth of hygroscopic droplets, Trans.Faraday Soc., 32: 1152-1162

The author presents a formula describing the growth of a hygroscopic nucleus. It is based on the expression for the equilibrium water vapor pressure over a droplet which contained originally a specific amount of hygroscopic substance. The simplification of the concentration term is justified for very dilute electrolytes.

1.9

Köhler, H., 1929

Bemerkungen über die Kondenzationskerne, Meteor.Z., 46: 127-129

The author summarized some of his previous thoughts about the role of the active condensation nuclei in cloud and precipitation formation. The analysis of the most important factors influencing the clouddroplet growth leads to the conclusion that large hygroscopic nuclei are responsible for the colloidal instability of clouds.

1.9

Köhler, H., 1934

Über die Chlorverteilung und die Tropfengruppen in Nebel und über Farbenberechnung der Kränze im weissen Lichte nebst einigen kritischen Bemerkungen der Koagulationstheorie der Nebeltropfen, Ark.Math.Astron.Fys.,24:A,9,50 pp.

The author summarized several years observations and studies of the microstructure of fogs. He concludes that the nucleation of salt particles and coagulation droplets leads to a distinctive size distribution of droplets. The droplet mean size can be measured from the diffraction rings.

1.5 - 1.2

Koehler, H., 1956

Some thermodynamical formulae and their interpretation, Arkiv foer Geofysik, (Upsala, Sweden), Vol.2, No. 21: 453-470

Basic thermodynamical study of the surface tension as a function of the radius of curvature is made. Reference is taken to Willard Gibbs' treatment, based on thermodynamic potential. The conditions of equilibrium between the pressure within the droplet and the surrounding vapor pressure are investigated. In the very embryonal state, the surface tension can be regarded as the mathematical equivalent of the molecular forces (statistical thermodynamics).

1.9

Köhler, H., and M. Bath, 1952

Quantitative chemical analysis of condensation nuclei from sea water, Nova Acta Reg. Soc.Sci. Upsaliensis, S. 4, 15: 2-24

Laboratory experiments have suggested an enrichment of magnesium by chemical fractionation during sea salt aerosol formation.

1.4 - 2.2

Komabayasi, M., 1964

Primary fractionation of chemical components in the formation of submicron spray drops from sea salt solution, J.Meteor.Soc.Japan, 42: 309-316

In the absence of surfactants differences between Na and K ions were observed in small drops. This fractionation is related to the difference in ion diffusion of both species and to the process of drop formation.

1.4

Kondratyev, K.Y., and O.I. Smoktiy, 1974

Influence of aerosols on the radiative heat input into the atmosphere, Atmos.Oceanic Phys. 10: 115-119

The authors discuss the role of atmospheric aerosols and the variations of their optical properties in different environmental conditions in the thermal budget of the atmosphere and earth's surface. They conclude that the available data indicate a great importance of atmospheric aerosol for the heat budget of the ground and the atmosphere.

3.1

Kornfeld P., 1970

Numerical solution for condensation of atmospheric vapor on soluble and insoluble nuclei, J.Atm.Sci., 27: 256-264

A model of droplet growth by condensation of water vapor was established. The calculation shows that the spectrum of cloud drops is broader if the nuclei are composed of hygroscopic and insoluble particles. The spectrum becomes also broader if different numbers of nuclei are assumed in neighboring air parcels.
The calculated spectra are broad enough in order to initiate the coagulation process.

1.9

Kosarev,A.L., I.P.Mazin, A.N.Nevzorov, and V.F.Shugaiev, 1976

Opticheskaia plotnost' oblakov,Trudy CAO, Vyp. 124, 168pp.

A detailed description of the relationship between the light transmittance and cloud microstructure is presented. The authors explain the parts of an instrument which was used on board an aircraft for the measurement of the visibility or transmittance inside of the clouds Cu, St, Sc, FrSt, Ns and As over the different regions of the USSR. Diagrams and tables show the dependence of the extinction coefficients on the kind of cloud and its macro-and microstructure.

5.6

Korzh, V.D., 1974

Some general laws governing the turnover of substances within the ocean-atmosphere-continent-ocean cycle, J.Rech. Atmos. 8: 653-660.

The fractionation of ions passing over from the ocean into the atmosphere and precipitation elements depends mainly upon the ratio of ion concentrations in the sea water. In some cases the average chlorine ratios of Ca, K and SO_4 in rain water exceed the calculated ones. This indicates the influence of organic substences upon the sea-atmospheric exchange and the influence of continental air with high calcium and sulfate content.

1.4 - 1.8

Koske, P.H., 1974

Surface structure of aqueous salt solutions and ion fraction. J.Rech.Atmos., 8: 623-628

Two different sea water samples were used: One from a fairly clean oceanic region (between Iceland and the Farö Islands) and the other from the more polluted North Sea. To both samples $Na^{22}Cl$ and $Ba^{133}Cl_2$ were added as tracer nuclides. Bubbling through the solution showed quite different ratio of Ba/Na for the polluted water (strongly decreasing values of Ba/Na with the increasing volume of destilled water) than for clean sea water (Ba/Na almost constant).

2.3

Kottler, F., 1950

The distribution of particle sizes, J.Franklin Inst., 250 part I, 339-356, part II, 419-441

Critical review of previous literature on particle size distribution. The distrib. law should be connected with the law of crystal growth for which the exponential law is chosen. In the application of log- normal distribution graphical analysis is used. Suggests that this graphical analysis should be replaced by an algebraic one.

1.2

Kottler, F., 1951

The goodness of fit at the distribution of particle sizes, J.Franklin Inst., Part I: 251, No 5, 499-514, Part II: 251 (1951), No 6, 617-641

A method using χ^2 minimum principle is used for the analysis and shown on the example of a photographic emulsion that it is better than the least square method. The method is based on two parameters a is related to the time of crystals growth and b is innersely propertional to the velocity constant of growth.

1.2

Kottler, F., 1952

The logarithmico-normal distribution of particle sizes: homogeneity and heterogeneity. J.of Physic. Chem. 56: 442-448

Establishes statistical evidence that, in cases where the simple log - normal distribution is not valid, one faced with a heterogeneous population.

1.2

Krastanov, L., 1941

K teorii obrazovania kapel' i kristallov v atmosfere, Meteor.Z. 12

The author describes the system of equationsenabling him to establish the relationship between the rate of formation of a new phase and the molecular kinetical parameters. Calculations are compared with experimental data on homogeneous nucleation.

1.9

Kubie, G., 1971

A note on a treatment of impactor data for some aerosols, Aerosol Sci. 2: 23-29

A procedure for estimating the distribution parameters of log-normal aerosols from cascade impactor data is suggested. By expressing the individual stage collection efficiency curves by power series in particle size, the correponding percentage deposits of aerosol particulates can be plotted as functions of geometric mean particle size with the geometric variance as parameters.

5.2 - 1.2

Kuhn,P.M., H.K.Weickmann, M.J.Lojko, and L.P.Stearns, 1974

Transfer of infrared radiation through clouds, Appl.Optics, 13: 512-517

A radiative transfer model has been developed for absorption in clouds employing an experimentally determined absorption coefficient.The model evaluates the transmission for various cloud thickness and various absoption coefficients. It appears to be satisfactory for infrared radiative transfer through stratus cloud. A volume absorption coefficient was determined by adjusting upward and downward flux calculations to coincide with those observed at each level through the cloud.

3.4. - 3.1

Kuhn,P.M.,H.K.Weickmann, and L.P.Stearns, 1975

Longwave radiation effects of the Harmattan haze,J.Geophys. Res., 80: 3419-3424

Infrared (IR) radiace observations in the range $8.0 < \lambda < 14.0$ um and $9.5 < \lambda < 11,5$ um were performed in the haze over west Africa during the GARP. Radiometric observations were made in the haze within 0.6 and 6.25 km levels and the haze volume absorption coefficient (0.042 km^{-1}) was deduced from the upward- and downward-directed radiance. IR radiation cooling rate of $0.09^{o}Ch^{-1}$ for the haze layer compared to $0.06^{o}Ch^{-1}$ fog-haze-free layer was found.

3.6 - 3.1

Kuhn, P.M., V.S.Whitehed, and W.E.Marlatt, 1976

The SKYLAB concentrated atmospheric radiation project, Collected Reprints 1974-75 Atmos.Physics & Chem.Laboratory U.S.Dept. of Commerce, NOAA, Boulder, April, 267-274

Principal conclusions from the radiational measurements made onboard aircraft, balloon and with ground based sensors in the wave lenght ranges 0.4 to 1.1 um and 5.0 to 40 um: Haze transmissions range from 0.80 to 0.95 in litoral polluted regions (Houston). This corresponds to a bulk absorption coefficients 0.04, and 0.009 km^{-1} for the spectral interval 870 to 1050 cm^{-1}. In the atmosphere over desert areas were observed 0.30 and 0.052 km^{-1}.

3.4 - 3.6

Kumai, M., and J.G. Russell, 1969

Attenuation and backscattering of infrared radiation by ice fog and water fog, U.S. Cold Regions Res. and Engine Lab., Hanover, N.H. Res.Rep. 264: 7p.

Ice-fog cryatals consisting of many spherical, some hexagonal plates and columns at -40°C were used for the calculation and back scattering. The wavelengths of λ = 2,2; 2.7; 4.5; 5.75; 9.7; 10.9 um and the Mie theory were used. The minimum attenuation for ice fog was found to be at λ = 9.7 um. For fog drops minimum was at λ = 10.9 um.

3.6 - 3.2 - 3.4

Kup, J. 1942

Vergleichende Untersuchungen mit dem Konimeter and dem Owen'schen Dust-Counter, Bioklim.Beibl. 9: 34-52

Comparison of Owen's dust counter and Zeiss-Konimeter is presented. The coparability of both counters is not very well defined. The limit of collecting efficiency is around few tenths of a micron, but varies with the type of instrument and operating conditions. Owens dust counter has a limit of particle detectability below 0.1 um because water condenses on the particles prior to colletion.

5.2

Kurnick, S.W., R.N. Zitter, and D.B. Williams, 1959

Atmospheric transmission in the infrared during severe weather conditions, CML-TH-P-145-3, The University of Chicago, May

Infrared transmission for wavelengths from 1.7 to 12.0 um has been measured at different weather conditions. Fogs are increasingly transparent for longer wavelengths and precipitation elements show no spectral effects even when the visibility is very poor. A model of fog transmission was established with the size distribution $N(r) = C\, r^{-b}$. Values of the parameter b are correlated with humidity and visibility conditions.

3.4 - 3.2 - 3.6

Kuroiwa, D., 1953

Electron microscope study of stmospheric condensation nuclei, in " Studies on fog" Hokkaido Univ., Inst. of Low Temp. Sci., Sapporo, p. 349-382

Electronmicroscopical studies of the fog and cloud droplets near the coast of Japan showed that 40% of all particulates were combustion products, 20% were sea salt and soil particles. The investigation of the evaporation of cloud droplets did not show any correlation between the size of the cloud droplets and the size of the residue.

1.4

Kuroiwa, D., 1956

The composition of sea fog nuclei as identified by electron microscope, J.Meteor., 13: 408-410

In sea fog and in clouds in northern Japan, combustion products were most abundant followed by sea salt and soil particles. In fog most combustion and soil particles were smaller than 1 um, but most sea-salt particles were between 1 and 2 um radius.

1.4

Kuroiwa, D., 1957

Studies on physical and chemical properties of sea-fog nuclei and maritime aerosols by means of electron microscope, Teion Kaguka, A 16: 79-117

Nuclei in sea fog from about 10^{-5} to 10^{-3}cm in size and with $10^{-16} < m < 10^{-11}$ gm mass show the maximum frequency of occurence of water soluble nuclei between 10^{-14}gm in marine aerosol.

1.2

Lai, R.J., and O.H. Shemdin, 1974

Laboratory study of the generation of spray over water; J.Geophys. Res. 79: 3055-3063

The droplet production mechanism by bursting bubbles is found to account for only a portion of the total production. The amount of liquid water generated by spray and transported by air is considerable and might affect the measurements obtained from a radiometer.

2.3

Laktionov, A.G., 1968

Photoelectric measurement of condensation cloud nuclei. J.Rech.Atmos. 4: 63

The measurement of cloud conden sation nuclei applying the isothermal and different-temperature methods are discribed. The supersaturation range varied between 0.016 and 1.0%.

5.6

Laktionov, A.G., 1971

On the distribution of the condensation cloud nuclei in the free atmosphere and relationship between the concentration of cloud nuclei and the drop concentration in clouds, Proc. 7th Int.Conf.Cond. Ice Nuclei, Prague-Vienna, Sept. 1969, Suppl.Vol. NCSAV, Praha, 288-296

Numerous measurements carried out in various seasons and in different regions showed that the majority of received integral spectra of nuclei at the supersaturations in the range from 0.1 to 1.6% cannot be described by the simple power function offered by Twomey. Integral spectrum can be devided into 3 regions. Power functions of S lie between 0.5 to 2.0.

1.5

Laktionov, A.G., 1972

Soderzhanie rastvorimykh v vode veschestv v chastitsakh atmosfernogo aerozolia, Izv. AN SSSR, Fiz. atmosfery i okeana, 8: 389-395

Investigation into the nature of aerosols in the atmosphere and their behavior at higher relative humidities led to the value of $\alpha = 0$ (Levin and Sedunov, 1966) for the radii of dry nuclei smaller than 0.3 um.

1.2 - 1.5

Laktionov, A.G., 1972

Isotermicheskii metod opredelenia kontsentratsii oblachnykh iader kondensatsii. Fiz.atmos.i okeana, 8: 672

The principles of the method of the isothermal chamber measurenment of the concentration of cloud condensation nuclei are presented. Several measurements were performed over the European territory of the USSR and over the Atlantic tropical zone. The concentration-supersaturation curves from different sampling sites and for the supersaturation range from 0.025 to 1.0% are analyzed.

5.6

Laktionov, A.G., 1975

Spectra of cloud condensation nuclei in the supersaturation range 0.02 - 1%, Proc. 8th Int.Conf.on Nucleation, Leningrad, 1973, Gidrometeoizdat, Moscow, 437-444

The author analyzes the advantage of the isothermal diffusion method which enables to measure equilibrium droplet radii $r_{100} \leq 2.5$ um. Because the simple power law in the supersaturation spectra for nuclei does not hold, two domains for $S \leq 0.16\%$ and for $0.16 \leq S \leq 1.0\%$ were selected. Interesting relationship was found between the altitude and the exponent in the power law. One can conclude that there is a common source for the formation and washout of the most active condensation nuclei.

1.5 - 2.7

Laktionov,A.G., and Yu.P.Bogomolov, 1971

Mikrostrul.tura prizemnogo aerozolia, Izv. AN SSSR, Fiz. atmosfery i okeana, 7: 291-301

The authors investigated into the characteristics of the aerosol in the ground layer and its behavior at high r a- tive humidity. They concluded that both the dry aerosol and haze particle size distributions can be expressed as power law. The exponents ranged from 3 to 5 in the former case and from 3.8 to 4.5 in the latter.

1.2 - 1.5

La Mer,V.K., and P.K. Lee, 1950-1951

A forward angle scattering camera for the determination of particulate concentration of aerosols, Central Aerosol Lab. Columbia Univ. Progress Rep. No.5., Dec.1. - Feb.28., 12 p.

A forward-angle tyndallometer-type scattering camera was built to photograph confined aerosol streams 0.1 mm thick and smaller. Efficiency of filtering media was checked. Three methods for computing absolute particle concentrati- on from photographic data are suggested.

5.7

La Mer,V.K., and P.K.Lee, 1952

Polydispersity and nucleation in aerosols. Central Aerosol Labs.,Columbia Univ., Final Rep. March 31.

A forward-angle scattering camera was developped for measu- ring the degree of polydispersity of aerosols. The camera can photograph directly a thin sheet of flowing aerosol by very high intensity photoflashes, because 90 to 95% of the light scattered by aerosols with radii of 0.1 to 0.5 um is in forward direction. The optical densities of optical rings produced by difracting the light on aerosols are mea- sured from the projection of photograph on a screen and translated into radii of the droplets.

5.7

Landsberg, H., 1934

Zählungen von Kondensationskernen auf dem Taunusobservatorium und auf dem Nordatlantischen Ozean, Bioklim. Beibl. Meteor.Z., 1: 125-128

A comparison of AN measurements in Germany and over the Atlantic leads to the conclusion that over the ocean concentrations are of one or two orders of magnitude lower. Dependence on some meteorological factors is discussed in detail.

4.1

Landsberg, H., 1938

Atmospheric condensation nuclei, Ergeb. Kosmischen Physik 3: 155-252

AN concentrations measured onboard the US Research Vessel "Carnegie" on 221 oceanic localities were in 68% of all observations less than 400 cm^{-3}. Big cities had AN concentration in mean 147,000 cm^{-3} with the maximum of 4,000.000 cm^{-3}. In total, results of 900 measurements are reported and analyzed. There is a strong evidence that AN are in their majority of continental origin.

4.1

Langer, G., 1965

An acoustic particle counter-preliminary results. J.Coll. Sci. 20: 602-609

A description of a counter for the identification of submicron particles which grow at high relative humidity into sizes which can be detected by an acoustical sensor.

5.9

Langer, G., 1972

Further evaluation of the acoustical particle counter. Powder Techn. 6: 5-8

The description and physical principles of a counter detecting submicron and larger particulates are presented. The counter uses an acoustical sensor which counts all particles growing at a higher relative humidity into the size sufficient for being detected. Laboratory tests and field measurements showed high reproducibility and fast response of the counting technique.

5.9

Lapple, C.E., 1951

Dust and mist collection. Fluid and particle mechanics. A collection of papers ed. by C.E.Lapple, Stanford Res.Inst. Menlo Park, Calif. 295-323

Different techniques are discussed (gravitational and inertial deposition, filtration, electrostatic, physico-chemical, thermal and sonic). Impingement separators are described.

5.2 - 5.3 - 5.4

Laskin, S., 1952

The modified cascade impactor, U.S.Techn.Conf. on Air Pollution, McGraw-Hill Brook Co., New York, 656-671

Requirements for standardized sampling device are established and the results obtained from a modified cascade impactor described. Shattering of particulates is prevented by using a nondrying alkyd resin. Calibration of the instrument is described.

5.2

Lazrus, A.L., H.W.Baynton, and J.P. Lodge, 1970

Trace constituents in oceanic cloud, water and their origin, Tellus 12: 106-113

To clarify the mechanism of sea salt fractionation cloud water samples were collected in 1967 on the Pico del Oeste on Puerto Rico (1020 m above sea level). by impingement on an aluminium screen. Concentration of chloride ions was between 5,4 and 30,0 ppm and was determined colorimetrically.The measurements support the idea that chlorine gas is present over the open ocean. Mg^{+} in cloud water is of maritime and non maritime origin. $SO_4^{''}$ is in excess amounts, however from other sources like ^{+}Ca. Cl' excess occurs erratically.

4.3 - 4.2 - 1.4

Leaitch,W.R., and W.J.Megaw, 1977

[illegible] formation of thin layer haze, Vol. of Abstracts 9th Int.Conf. on Atmos, Aerosols, Cond. and Ice Nuclei, Galway, 64-65

The description of typical haze situations in the lakeshore region of Toronto is presented and measurements of microstructural and optical parameters described. Using a rotating stage impactor a narrow size distribution of particulates which peaked between 0.4 and 0.5 um radius was found. The optical measurements suggest the possibility of almost discrete transition between light blue or white and brown.

3.1 - 1.4

Leeflang, W., 1938

De chemische Samenstellung van den Neerslag in Nederland. Chem.Weekblad 35: 658-664

A detailed analysis of the decreasing Cl' ion concentrations in precipitation in dependence of the distance from the seashore in the Netherlands. Very steep decrease within the first 15 km from the shore.

4.3

Leonov,L.F., P.S. Prokhorov, and I.A. Zolotaryov, 1969

Experimental study of the possibility of passivating the hygroscopic nuclei by means of cetyl alcohol vapours, Proc. 7th. Int.Conf.Condens. Ice Nuclei, Prague - Vienna, Academia, Prague, 102-111

Sodium chloride aerosol generated by the condensation of its vapors was introduced into a 200 liter container. After adding water vapor which led to the fog formation the extinction of the light beam was measured. The same experiments were performed with sodium chloride nuclei coated by cetylalcohol. The results support the passivating effect of cetyl alcohol, which results in time lag of fog formation and in slight decrease in the final fog density.
1.8

Leonov,L.F., P.S.Prokhorov, and T.N.Voropayeva, 1975

Growth of water drops on sodium chloride microcrystals at variable humidity, Proc. 8th Int.Conf. on Nucleation, Leningrad, 1973, Gidrometeoizdat, Moscow, 480-483

The authors investigated the kinetics of the growth and evaporation of sodium chloride drops suspended on a plexiglass filament at variable humidity. If the humidity varied slowly (Max. 10% R.H. in 5 min.) the solution drop was in a state close to equilibrium. When the evaporating drop reached the state of supersaturation, the water vapor pressure over the drop proves to be lower than the equilibrium one.

1.5

Levin, L.M. 1958

O funktsiakh raspredelenia oblachnykh kapel' po razmeram. Opticheskaya plotnost' oblaka, Izv. AN SSSR, Ser.geofiz. 10: 1211

The author analyzed the samples of cloud droplets collected during the Elbrus expedition. Main attention has been paid to the application of the gamma-distribution function to the description of the characteristics of cloud microstructure such as the size distribution, liquid water content and the visibility in the cloud.

1.2

Levin, L.M., 1961

Issledovanie po fizike grubodispersnykh aerozolei, Izd. AN SSSR, Moskva, pp. 268

pp.186-203: The author discusses the features of cloud microstructure using the gamma and other distribution functions. A detailed discussion of the gamma distribution and its application for investigations in cloud physics is made.

1.2

Levin,L.M., and Yu.S.Sedunov, 1966

Nekotorye voprosy teorii atmosfernykh iader kondensatsii, Dokl. AN SSSR, 170: 81-84

The authors describe the system of equations governing the growth of drops containing soluble and insoluble material. A simple relationship between the radius of dry nucleus and that corresponding to the soluble part was obtained.

1.5 - 1.9

Lewis, P.C., and G.F. Lothian, 1954

Photo extinction measurements on spherical particles. The physics of particle size analysis, J.Appl.Phys. 71-75

Experimental determination of the total scattering coefficient of micron size particles of barium sulfate and of spores of Lycoperdon pyriforme. The wavelengths of the light ranged from 0.4 to 2.0 um. The same experimental arrangement can be used for the determination of the refractive index of the aerosol.

3.3 - 3.4 - 3.5 - 3.6

Lindauer, G.C., and A.W. Castleman Jr., 1971

Initial size distributions of aerosols, Nuclear Sci. & Engin. 43: 212-217

For high number density aerosols, calculations indicate that the initial size distribution rapidly approaches a self-preserving shape which can be presented by a log normal distribution with standard geometric deviation between 1.34 and 1.40. This log-normal distribution is utilized to calculate a pseudoinitial particle size distrobution for use as the initial condition in digital computer programs.

1.2

Liou Kuo-Nan, and T. Sasamori, 1975

On the transfer of solar radiation in aerosol atmospheres, J.Atmos.Sci. 32: 2166-2177

A radiation model has been developed which includes the absorption by water vapor in the near-infrared regions. The calculation led to the conclusion that in a hazy atmosphere the solar heating rates may be as much as 5 and 9°C/day for surface albedos of 0.1 and 0.8 respectively. An increase in aerosol loading leads to an increase of the total absorption in the atmosphere whereas it reduces the solar flux to the earth's surface. Power size distribution law for aerosol particles was assumed.

3.1

Liu, B.Y.H., R.N. Berglund, and J.K. Agarwal, 1973

On the response characteristics of optical particle counters, in "Aerosole in Physik, Medizin und Technik", Jahreskongress d. GAF, 35

Characteristics of optical aerosol counters have been checked with monodisperse aerosol generated by vibrating orifice generator. The index of refraction of the particles used varied between 1.4 to 1.7. The results support the idea that the counters operating with forward scattering have response characteristics less dependent on the particle refractive index. However, several of the forward scattering counters have a dip in their voltage-vs.-particle size calibration curve near a particle diameter of 1 um.

5.7

Liu, B.Y.H., R.N.Berglund and J.K.Agarwal, 1974

Experimental studies of optical counters, Atmos.Environ. 8: 717-732

The response characteristics of several commercially available optical particle counters have been studied experimentally using monodisperse aerosols generated by the vibrating-orifice generator. The differences between individual counters are explained mainly on the basis of different scattering angles used for particle identification.

5.7

Lodge, J.P.,Jr., 1955

A study of sea salt particles over Puerto Rico, J.Meteor., 12: 493-499

Impactor and milliporefilter sampling techniques were used for sampling and chemical identification of salt particles up to 3 km altitude. On the ground a discrepancy in counting particles larger than 10 um in impactor samples (200 m^{-3}) and by millipore technique (1,000 m^{-3}) was found. The decrease in nuclei concentration with altitude and with the distance from the seashore was demonstrated.

2.7 - 4.2

Lodge,J., and F. Baer, 1954

An experimental investigation of the shatter of salt particles on crystallization, J.Meteor. 11: 420-421

Test aerosol with r = 1.5 um from saline solution was collected on millipore filters both before and after the droplet aerosol had been dried. The filters were chemically developed to reveal traces of chlorides. The observation failed to show any increase in numbers of particles due to drying and crystallization.

2.3

Lodge, J.P.,Jr., J.E.McDonald, and F.Baer, 1954

An investigation of the Melander effect, J.Meteor.,II., 318-322.

Melander effect (direct generation of salt nuclei through evaporation of sea water) was found ineffective for nuclei production.

2.3

Lodge,J.P., A.J.Mc Donald, and E.Vihman, 1960

A study of the composition of marine atmospheres, Tellus 12: 184-187

Sampling at the oceanic station (30°N; 140°W) has been performed. The following constituents were analyzed: Cl; SO_4, NO_3, organic material and gaseous traces NO_2, CO, SO_2, O_3. Higher content of SO_4 than Cl was measured in the Atlantic. Organic material was found in an amount of about 1.6 ug/m³. The findings are published in the form of a cumulative frequency distribution with the 50% frequency for NaCl: 3.0 ug/m³ ; SO_4 : 2.0 ug/m³; NO_3 : 0.18 ug/m³.

2.4

Loeb, L.B., 1958

Static Electrification. Springer Verlag, Berlin, 240 p.

Chapter III. discusses the electrification by spraying and bubbling of liquids, generating a potential across liquid--gas and liquid-liquid surfaces. Discusses cataphoresis of gas bubbles with the formation of electrical double layer at liquid-gas interface. Spraying of bubbles above sea surface and the implications involving coastal haze are discussed: Some misinterpretations of droplet charging are critisized.

1.6

Lovett, R.F., 1975

The occurence of airborne sea salt and its meteorological dependence. Thesis, Heriot-Watt University, United Kingdom.

The author measured the mass-size distribution of sea-salt nuclei as a function of wind speed in the North Atlantic. The samples were taken at heighthsof 10 and 15 m above the ocean and the size distribution curves were established for particle sizes between 0.1 and 30 um. The distribution curves fit to the Junge's distribution, if the constants are expressed in terms of wind velocities.

4.2 - 2.9

Luchak, G., and G.O. Langstroth, 1950

Applications of diffusion theory to evaporation from droplets and flat surfaces. Canadian J. of Research, 28, Section A, 574-579

An attemt is made to solve the evaporation eguations with the moving boundary condition in the case of evaporating sphere and plane surface. The drop is considered to be situated in a spherical air-filled enclosure the walls of which maintain zero vapor concentration at their surface. Results indicate that the equations obtained by assuming quasi-stationary states represent a good and close approximation.

1.9

Ludlam, F.H., 1951

The production of showers by the coalescence of cloud droplets, Quart. J. R.M.S. 77: 402-417

The author claims that the rain-forming process can be started by a large number of giant nuclei (similar to the finding by W. Findeisen).

1.5

Ludwig, F.L., and E. Robinson, 1969

Condensation nuclei and aercsol populations related to fog formation, Standard Res.Inst.,Menlo Park, Cal., Contract DAHC04 - 67 - C - 0059, Final Rep. Dec., 53p.

Physical and chemical properties of fogs in San Francisco area are considered. Fog formation and dissipation process is discussed from the point of view of fog microstructure.

1.5

Lushnikov,A.A., and V.I.Smirnov, 1975

On size distribution formation mechanism of atmospheric aerosols, Proc. 8th Int.Conf. on Nucleation, Leningrad, 1973, Gidrometeoizdat, Moscow, 484-490

A theoretical model is suggested which explains the power law of atmospheric particle size distribution. The authors conclude that the steady-state coagulation might be responsible for the formation of power size spectra.

1.2

Mac Intyre, F., 1972

Flow patterns in breaking bubbles, J.Geophys.Res.,77: 5211-5228

A detailed theoretical and experimental study of the process of fluid flow emission during bubble colapse is presented. The main attention is paid to the thin film (of the thickness of 0.05% of the bubble diameter) in which the separation of ions and the interaction with surfactants occurs. The momentum and heat exchange in the layer explains the migration and separation of ions observed in experiments.

2.3 - 1.8

Mac Intyre, F., 1974

Non-lipid-related possibilities for chemical fractionation in bubble film caps, J.Rech.Atmos. 8: 515-527

Laboratory study of the chemical fractionation in bubble film caps is unreliable if the surface was not clean and if the surfactants used in the experiment were unlike oceanic surfactants. The surfactants are divided into dry surfactants (hydrophilic head groups attached to long hydrophobic chains which reside in the air phase), and wet surfactants (long hydrophilic chains which bear accasional hydrophobic side groups). Oceanic sufactants are principally of the wet variety. Model of fractionation is presented.

1.8 - 2.8

Macků,M., J.Podzimek, and L.Srámek, 1959

Results of chemical analyses of precipitation collected on the territory of Czechoslovak Republic in IGY, Trav. Inst. Geophys. Acad. Tchec. Sci.,No. 124: 441-519

Detailed analyses of precipitations collected on 11 stations. The following ions were analyzed: Cl^-, SO_4^{--}, NO_3^-, NO_2^-, Mg^{++}, Na^+, K^+, pH. Distribution is plotted in maps. Very high concentrations of chlorides were found in industrial regions. Influence of maritime airmasses is not strongly expressed. Most of the ions show a very high concentration in samples collected at foggy situation during drizzle precipitations and icing conditions.

4.3

Martens, C.S., 1974

Halogen chemistry of Puerto Rican and San Francisco Bay area marine aerosols, J.Rech.Atmos.,8: 989-991

Aerosol samples collected with the Andersen cascade impactor were investigated for the presence of Cl and Na by neutron activation analysis. The calculated Cl losses ... from Puerto Rican samples ranged from 0.18 to 0.27 um/m^3 for the San Francisco Bay samples. In all samples increasing loss of Cl corresponded to the decreasing particle size.

2.5

Marty, J.C., and A. Saliot, 1974

Etude chimique comparee du film de surface et de l'eau de mer sous-jacente: Acide gras. J.Rech.Atmos. 8: 563-570

Sea water samples have been taken in an coastal area in the Atlantic and the open Mediterranean Sea between Nice and Corsica. All samples had a similar composition: predominance of even saturated C_{16}, C_{14}, C_{18} over the unsaturated compounds C_{18} and C_{16} and the add acids C_{15} and C_{17}. Dissolved and particulate fatty acid concentrations may vary from 1 to 12 ug/l for Atlantic coast and from 5 to 170 um/l for Mediterranean Sea. For coastal samples, the enrichment factor is 5 to 6.

2.8

Mason, B.J., 1954

Bursting of air bubbles at the surface of sea water, Nature, 174: 470-471

The author provides an evidence that about 200 salt particles (in the 0.1 um range) are formed per bubble. The nuclei were counted in an expansion chamber. The largest particles had dry radii of 0.15 um.

2.3

Mason, B.J., 1957

The nuclei of atmospheric condensation, Geofis.Pura Appl. 36: 9-20

Discussion of the subdivision of the atmospheric nuclei and their physical-chemical properties.

1.5

Mason, B.J., 1957

The oceans as source of cloud-forming nuclei, Geof.Pura e Appl. 36: 148-155

A steady concentration of nuclei of 100 cm^{-3} requires a generation rate of 1,000 ncm^{-2} sec^{-1}, what was nearly justified by laboratory experiments. Observations were made in an expansion chamber, where bubbles ranging from 2.5 x 10^{-2} to 2.15x10^{-1} cm were bursting on the surface of sea water. This led to production rate of 300 ± 80 nuclei. An estimated nuclei concentration for $m > 10^{-15}$ g was 100cm^{-3}.

2.3

Mason, B.J., 1971

The Physics of Clouds, Clarendon Press, Oxford, pp.671 First Edition in 1957.

The book presents a review of the broad field of microphysics of clouds, mechanism of precipitation and atmospheric electricity. Chapter 2 is dedicated to atmospheric nuclei, their origin and transformation. Production of sea salt nuclei is described on pp. 75 to 79. Theoretical models of nuclei production over the ocean are compared with the observed nuclei features above the sea surface.

1.1 - 1.2 - 1.4

Matijevic, E., W.F. Espensheid, and M. Kerker, 1963

Aerosol consisting of spherical particles of sodium chloride, J.Coll.Sci. 18: 91-94

A modified Sinclair-La Mer generator was used. Sodium chloride was evaporated from a combustion boat placed in a Mc Danel combustion tube. Temperature ranged between 820-1000°C and the flow rate between 0.5 and 5.0 l/min. Particles were mainly amorphous and spherical (X-ray diffraction). Upon exposure to moisture, the particles changed from spheres to cubes, apperently owing to recrystallization.

1.3

May, K.R., 1945

The cascade impactor: An instrument for sampling coarse aerosols, J.Sci.Instr. 22: 187-195

Four stage impactor is described with the effective drop sizes caught on slide 2, 3, 4 : 14.5, 4 and 2.5 um in diam. The four jets have the flow velocity 2.2; 10.2; 20.4 and 34 m sec^{-1}.

5.2

May, K.R., 1950

The measurement of airborne droplets by the magnesium oxide method. J.Sci.Instr., 27: 128-130

The coating of slides in impactors by MgO and the evaluation of the method(measurement)is described. The calibration of the sampling techniques leads to the conclusion that a threshold of the droplet detection lies around several micrometers of particle size.

Mazin, I.P., 1969

Vozhmozhnye uproschenia pri raschete skorosti kondensatsionnogo rosta kapel' rastvora, Trudy CAO, 89: 90-91

The author investigates into the error which one makes assuming that the solution drop growing by water vapor condensation is composed of pure water. In most of the practical applications such an assumption is justified.

1.9

Mazin, I.P., and A.I.Neizvestniy, 1977

The condensation coefficient of water and its influence on the cloud droplet size spectra formation, Vol. of Abstracts 9th Int.Conf. on Atmos. Aerosols, Cond. and Ice Nuclei, Galway, 35

The authors assume that the correct value of the condensation coefficient is $\alpha = 1.0$. They studied a model in which α was two orders of magnitude lower than the assumed correct value. The calculation resulted in substantial change of the size distribution of the fraction of the spectrum corresponding to small particulates. The medium and large drops were not affected considerably.

1.2 - 1.4

Mazur, J., 1952

On the sampling of water droplets in natural clouds and in radiation fogs, Proc. Phys. Soc.(London) B., 65: 457-458

Discussion of the method described by Mason and Ludlam of coating the sampling slide is presented. The author suggests freshly melted mineral oil and vaseline for coating of slides.

5.2

Mc Clatchey, R.A., R.W.Fenn, J.E.A.Seaby, F.E.Volz, and J.S.Garing, 1972

Optical properties of the atmosphere (Third Edition), AFCRL-72-0497, Envir.Res.Papers, No.411, August 23

The report includes tables and charts and is based on a set of five atmospheric models ranging from tropical to arctic and including two aerosol models. A selected set of laser frequencies has been defined with known monochromatic transmittances. Charts have been attached in order to predict transmittance at a resolution of 20 wavenumbers. Other sections include the scattered solar radiation, infrared emission, refractive effects and attenuation by cloud and fog.

3.1

Mc Clatchey, R.A., and J.E.A.Seaby, 1972

Atmospheric attenuation of HF and DF laser radiation, AFCRL-72-0312, Envir.Res.Papers, No. 400, May, 23

The spectral region of HF emission from 2800 to 3700 cm^{-1} spans a very important water vapor absorption band and, in addition, there is a strong absorption by CO_2 and weaker absorption by O_3 and CH_4. The spectral region of DF emission (from 2,000 to 2,750 cm^{-1}) covers the very strong 4.3 um CO_2 absorption and absorption by N_2O and HDO. A series of attenuation tables has been constructed and tables based on two different aerosol scattering models included.

3.1 - 3.6

Mc Donald J.E., 1964

Cloud nucleation on insoluble particles, J.Atm.Sci. 21: 109-116

The thorougly investigation of the heterogenous nucleation on insoluble particles (Fletcher's theory) led to the conclusion that under natural conditions (in clouds it was assumed $S < 1.03$) the contact angle must be smaller than 12^{o} if the particles shoud be activated. Meteorologically interesting class represent the particles of silicate type which are wettable (Adamson 1960, Davies and Rideal 1961). The model of embryo growing on a silicate wettable disc is presented.

1.7

Mc Donald, R.K., 1965

Vertical and horizontal maritime visibility models, Proc. IRIS, Vol. [illegible] No.2, 47-51, June

Because time is seldom available to an operator for analysis of specific geographical and seasonal variations of the atmospheric transmission, so he must resort to models. Two models have been presented which are deduced for preliminary assesments of a naval weapons system. The models use 3 to 5 um and visible-wavelength sensors.

3.6

Megaw, W.J., and H. Flyger, 1973

Measurement of the background atmospheric aerosol, J. Aerosol Science 4: 179-181

Report on AE measurements in Greenland where the concentration are usually between 200 and 1,000 cm^{-3}.

4.1

Mészáros, A., 1971

On the variation of the size distribution of large and giant atmospheric particles as a function of relative humidity, Tellus, 23: 436-440

Aerosol particles captured by a cascade impactor were examined in the optical microscope at different relative humidity and relation between their sizes and humidity established. A seasonal difference in continental particle growth was found. In summer the growth of particles was more gradual than in winter.

1.2 - 1.4

Mészáros, E., 1973

Evidence of the role of indirect photochemical processes in the formation of atmospheric sulphate particulate, J. Aerosol Science, 4: 429-434

In summertime the sulfate concentration, and the logarithm of the mole ratio of sulphate to sulphur dioxide, correlated well with the intensity of solar radiation in wavelenghts o.29-0.50 um and with the temperature. It is expected that sulphate particle formation is activated by some primary photochemical reaction.

2.2

Mészáros, E., 1975

On the formation of atmospheric sulfate particles, in "Aerosols in Naturwissenschaft, Medizin und Technik. Chemie der Umweltaerosole", Jahreskongress der GAF, 57-62

The aim of the article is to estimate the possible ways of the transformation of SO_2 to SO_4'' on the basis of the correlation between atmospheric sulfate concentration and different chemical and meteorological parameters. In summer the sulfate concentration in Hungary was higher (intensity of radiation and higher temperature) than in the winter time (where a linear relationship between SO_2 and SO_4'' was found).A possible explanation of this difference in concentration rates is presented.
1.4

Mészáros, E., and L. Adamy, 1969

On the thermodynamics of the condensation of atmospheric water vapor, Proc. 7th Int. Conf. Cond. Ice Nuclei, Prague-Vienna, Academia - Prague, 54-58

A model of a growing mixed nucleus is presented. The model assumes that an insoluble wettable particle bears a solution droplet. Conclusions: Mixed nuclei have always a smaller supersaturation than a soluble nucleus containing the same quantity of water soluble substance. I soluble particles with a large contact angle with water droplets become very active after they coagulate wich hygroscopic aerosol particles.

1.9 - 1.7

Mészáros, A., and K. Vissy, 1974

Concetration, size distribution and chemical nature of atmospheric aerosol particles in remote oceanic areas, J. Aerosol Science 5: 101-109

AN were measured by Gardner counter. Atmospheric aerosol $0.03 \leq r \leq 64.0$ um was sampled by membrane ultrafilters and evaluated in optical and electron microscope. Sampling has been done on the ship over the southern Atlantic, and Indian Ocean. AN had concentrations 2/3 of the values measured over North Atlantic. Aerosol with $r \geq 0.03$ um is composed partly of sea salt (4to 50% of the total mass). Sulfur compounds are in smaller particulates which prevail between 0^0 and 20^0 S.

4.2 - 4.1

Mészáros,E., A.Mészáros, and K.Vissy, 1975

Estimation of the size and nature of cloud nuclei from aerosol measurements carried out in pure maritime air, Proc. of the 8th Int.Conf.on Nucleation,Leningrad, 1973, Gidrometeoizdat, Moscow, 431-436

The results of the measurements on the Soviet ship on the way to Antarctica and back are summarized: Concentration of AN lies between 300 to 450 cm^{-3}; concentration of particles with $r \geq 0.03$ um was between 25-50 cm^{-3} with their maximum concentration around 0.07-0.1 um. Particles collected on membrane filters are of 75 to 95% composed of sea salt and sulfates $(NH_4)_2SO_4$ and also H_2SO_4 droplets while approaching to Antarctica. Due to the state of the sea more NaCl particles were measured over the Indian ocean.
4.1 - 4.2

Metnieks, A.L., 1958

The size spectrum of large and giant sea-salt nuclei under maritime conditions, Geophys.Bull.School of Cosmic Phys. Dublin, 15: 1-50

Higher concentrations of the NaCl nuclei were found on the east coast of Ireland (Dublin) than on the west coast. In Ireland the Cl' aerosol concentrations were 1½ to 2 orders of magnitude lower than Woodcocks data.The peak of the Junge's extrapolated curve agrees well with the two curves by Metnieks around 0.2 um dry crystal, or 0.5 salt drop at 80% R.H.,or 1.0 um at 99% R.H.). A detailed description of the Liesegang circle technique used for Cl' particle identification is attached.

4.2 - 5.13

Middleton, W.E.K., 1935

Experiments with a telephotometer. The dependend of extinction coefficient upon wave length, Gerlands Beitr.Geophys. 44: 358-375

Summary of all data with the measurement of the α values (Angström $\lambda^{-\alpha}$) which scatter between 1,5 and 0.5 (with an overall average of 1.3). They tend to be lower at visibilities above 40 km and below 1 km. α does not vary systematically over a wide range of aerosol concentrations and visibilities between 1 and 100 km. This fact is very important and confirms the Junge's size distribution of aerosol particles.

3.6

Middleton, W.E.K., 1952

Vision through the Atmosphere, University of Toronto Press, Toronto, 250 pp.

Very detailed treatise on the physics of visibility and related problems, including different measuring techniques and instrumentation.

3.6

Misaki,M., M.Ikegami, and I.Kanazawa, 1975

Deformation of the size distribution of aerosol particles dispersing from land to ocean, J.Met.Soc.Japan,53:111-120

Aerosol particles with the radii between 0.003 to 4.0 um were identified and their concentrations measured in dependence on the distance from the shoreline. The ship was going 1,000 km Southward of Tokyo. The center of the particle size distribution was shifted towards smaller sizes with the increasing age of aerosols.

4.1 - 1.2

Mohnen, V.A., and J.P. Lodge, Jr., 1969

General review and survey of gas-to-particle conversion, Proc. 7th Int.Conf.Condens. Ice Nuclei, Prague-Vienna, 1969,Academia, Prague, 69-91

A general review of the subject includes the main processes contributing to the gas-to-particle conversion, such as condensation,chemical interaction in the gas phase, combustion, photolysis, electrical discharge, radiation chemistry and ice crystal formation. The survey includes 123 references which point out the importance of these mechanism for particle formation in the atmosphere.

2.1

Moore, D.J., 1952

Measurements of condensation nuclei over the North Atlantic, Quart.J.RMS, 78: 596-602.

The observation on board an Ocean Weather Ship in the North Atlantic show that the opacity for a given humidity increases with wind speed and wave height and is accompanied by the increase in the concentration of large and giant nuclei. The increase in wind speed up to 18 $msec^{-1}$ does not much affect the total AN counts. The lowest AN counts were 77 and the highest 2,460 cm^{-3}.

4.1 - 4.2

Moore, D.J., and B.J. Mason, 1954

The concentration, size distribution and production rate of large salt nuclei over the oceans. Quart.J.Roy.Met.Soc. 80: 583-590

Experimental investigation of the production of large salt nuclei in a wind-wave tunnel are described. The production rate of nuclei in the wind tunnel agreed well with that estimated from observations over the ocean. Concentrations of 40 $cm^{-2}sec^{-1}$ for nuclei with $m > 2x10^{-13}g$ and 86 $cm^{-2}.sec^{-1}$ for $m > 2x10^{-14}g$ were found at the wind velocity of 16 $msec^{-1}$. At small wind velocities a different size distribution was found and the authors claim that this aerosol component is of continental origin.

4.2 - 2.3

Mordy, W.A., 1959

Computations of the growth by condensation of a population of cloud droplets, Tellus, 11: 16-44

Theoretical calculations of the droplet growth have shown the dependence upon the rate of cooling. The observed concentrations of droplets in fog (10 cm^{-3}) and in clouds (100 cm^{-3}) and larger drop counts in continental aerosol were explained. The dividing line between activated and nonactivated nuclei is located in the range of 0.05 - 0.5 um radius. In pure maritime conditions salt particles, including the Aitken particles, may be activated.

1.9

Morell, J., P.Buat-Menard, and R. Chesselet, 1974

Production experimentale d'aerosols a la surface de la mer, J.Rech.Atmos., 8: 961-986

An experimental facility is described in which the air was bubbled through the natural sea water and the aerosol was collected in a plexiglass container (0.5 m^3 volume) placed on the sea surface. The water soluble fraction was collected on filters and analyzed by atomic absorption analysis for Ca, K, Mg and Na. The production rate of aerosols was reduced of one order of magnitude when oleic acid was added at the water interface.

2.3 - 2.8

Morell , J., P.Buat-Menard, and R. Chesselet, 1974

Magnesium depletion with increasing altitude in the water soluble particulate matter collected over the North Atlantic, J.Rech.Atmos. 8: 993-994

Aerosols were sampled by air filtration on board an aircraft and the water-soluble fraction of aerosols was analyzed by atomic absorption. The vertical profiles between 200 and 2,000 m (47°N, 6°W) show a decrease in concentration by a factor of 10 with the altitude. At an altitude of 2200-2800 m K/Na and Ca/Na weight ratios were higher than the sea water values. Mg/Na showed lower value than that above the sea surface.

2.5 - 2.7

Moyers, J.L., and R.A. Duce, 1972

Gaseous and particulate iodine in the marine atmosphere, J.Atmos.Res.,Vol.77: 5229-5238

The authors claim that it is possible that gaseous iodine is released to the atmosphere as iodine-rich organic material decomposed at the surface of the ocean and bound on sea salt particles. The facts that particulate iodine concentration is inversely proportional to particle size may be explained by the atmospheric particle residence time.

1.4

Murai,K.M., M.Kobayashi, and R.Goto, 1973

Scattering functions of the atmospheric aerosols measured by the polar nephelometer; Papers in Meteor. Geophys. 24: 233-248

The authors measured the scattering functions of atmospheric aerosol particles with their polar nephelometer. They analyzed the results and found a close correlation between the scattering function and the wind speed.

3.2

Naistat, S.S., 1950

Construction of instruments for measuring particle size, Central Aerosol Labs., Columbia Univ. Final Progess Rep. May 15 - Aug. 15, 5 p.

A tyndalometer was built for the quantitative detection of small particles (0.1 um) by measuring light scattered in the forward direction (0°- 30°). A light-intensity ratiometer, consisting of red and green light sensitive phototubes, and the "Navy Owl" was built to locate the angular positions of the red component in the scattering of white light.

5.7 - 3.2

NASA, 1976

Atmospheric aerosols: Their optical properties and effects.

A Digest of Technical Papers Presented at the Topical Meeting on Atmospheric Aerosols, their Properties and Effects, Dec. 13-15, Washington Williamsburg, Virginia. Optical Society of America and NASA Langley Research Center.

3.1

Nathan, A.M., 1957

A polarization technique for seeing through fogs with active optical systems, College of Engineering, New York Univ., Tech.Rep. 362.01, June

An improvement in visibility through fogs, smoke, and haze has been reached with the use of polarization technique at night with search-light illumination systems. The technique can be used with either visible or infrared radiation and is applicable to image forming or radiation-detecting active systems. Theory of the polarization properties of various types of scattering media with the aid of Mie model is presented.

3.6

Neizvestnyi, A.I., 1976

Rezultaty aksperimentalnogo opredelenia koeffitsienta kondensatsii vody, Ser. meteorologia, GUGMS, Vses.Nauchno-Issled. Institut Gidromet. Infor. - Mir. Centr. Dannykh, Obninsk, pp. 51

A detailed analysis of the calculation and experimental measurements of the condensation coefficient. The author stresses the importance of the accurate measurements of temperature and water vapor pressure and of the impurities which might explain large differences of different authors. From the 17 analyzed methods nine yielded coefficients of the order of 0.03 and seven very close to 1.0

1.9

Neumann, H.R., 1940

Messungen des Aerosols an der Nordsee. Gerlands Beitr. Geophys. 56: 49-91

The foam of the white caps might generate several few very large nuclei, but they will not remain airborne for long. These large particles may be partly responsible for the high sea-salt concentrations of 50 to 1000 ug/m3 observed immediately in the vicinity of the coast. This coastal concentration drops rapidly within a few kilometers inland. On the island of Sylt was measured 80 m^{-3} on the seashore, 30 m^{-3} (1.8 km from the seashore) and 4.5 m^{-3} (9 km from the seashore).

2.3 - 4.2

Neuman, G.H., S. Fonselius, and L. Wahlman, 1959

Measurements on the content of non-volatile organic material in atmospheric precipitation. Int.J.Air. Pollut. 2: 132-141

Studies suggest that the sea surface supplies organic material to the atmosphere.

4.3

Nevzorov,A.N., and V.F.Shugaiev, 1974

Samoletnyi registrator prozrachnosti oblakov, Trudy CAO, Vyp. 106, 3-10

The visibility or transmittance in clouds is closely related to the cloud microstructure. A theoretical basis of aircraft measurements is presented and two main methods such as nephelometric and transmission measurements are discussed in details. The authors describe the Aircraft Transmission- Meter designet by G.M.Zabrodskii. The instrument providing a continuous record measures the air transparency on a distance of 20 m (on the aircraft IL-18) and of 8 m (on IL-14). Its sensitivity extends to the corresponding optical range up to 3 km.

3.6

Nguyen Ba Cuong, B.Bonsang, J.L.Pasquier, and G.Lambert, 1974

Composantes marine et Africaine des aerosols de sulfates dans l'hemisphere sud, J.Rech.Atmos. 8: 831-844

During 1971 to 1973 cruises of the French ships around Antarctica and during special cruises in the Atlantic and Indian ocean radon 222, sulfate aerosols and SO_2 were measured. Conclusions: In Mediterranean waters $SO_4^{=}$ content amounted to 6 to 15 ug/m^3. Along the West Africa concentrations of 6.0 ug/m^3 were measured, while on the North Atlantic and South Pacific only 1.3 to 1.8 ug/m^3 were found. Far from Australia $SO_4^{=}$ concentration was 0.5 to 1.6 ug/m^3

4.2

Nolan, P.J., and D.J. Doherty, 1950

Size and charge distribution of atmospheric condensation nuclei. Proc.Roy.Irish Acad.,A 53: 163-179

The authors suggested to obtain the size distribution of small AN by measuring the diffusion coefficient of the particles. They found that the maximum frequency of large ions in the atmosphere lies between 0.01 um and 0.1um (usually around 0.03 um radius).

5.1

O'Connor, T.C., W.P. Sharkey, and V.P.Flanagan, 1961.

Observations on the Aitken nuclei in Atlantic air. Quart.J.Roy. Meteor. Soc., 87: 105-108

Measuring of the diffusion coefficient of AN showed that the concentration maximum of nuclei is between 10^{-6} and 10^{-5} cm in Atlantic air.

4.1

Oddie, B.C.V., 1959

The composition of precipitation at Lerwick, Shetland. Quart.J.Roy.Meteorol.Soc. 85: 163-165

Found Cl/Na monthly averages ranging from 1.17 to 1.69 in the precipitation instead of the value of 1.80 of Cl/Na ratio in sea water. Mg/Na and K/Na were very close to sea water. However, over the continents Mg/Na, K/Na and Ca/Na increase rapidly. The decrease of the Cl/Na ratio is claimed to be due to a release of Cl (without changing the cation composition). Over the continents will probably increase Mg, K, Ca more than Na.

4.3

Oddie, B.C.V., 1960

The variation in composition of sea-salt nuclei with mode of formation, Quart.J. RMS, 86: 549-551

The author differentiates between "coarse spray" produced during bursting of an air bubble below the surface film and "fine spray" which is released from the top film of bubbles bursting at the sea surface. The "fine spray" contains a much higher portion of potassium (Na/K ratio about 6) than that of sea water (Na/K = 28), whereas the "coarse spray" has a Na/K ratio of 24.

2.3 - 1.4

Ogiwara,S., and T.Kobayashi, 1954

On the growth of water droplets around hygroscopic particles in convective cloud and its application to the artificial precipitation, Committee for Rain-making in Japan, Tokyo, Report of Rain-making in Japan, I: 42-45

The possibility of using hygroscopic nuclei for cloud seeding is investigated. The authors used the observations of cumulus clouds for defining the environmental parameters influencing the growth of a cloud drop on an hygroscopic nucleus. It has been concluded that sea salt particles containing more than 10^{-10} g of salt can become rain drops through condensation of water vapor and coagulation with other droplets in a convective cloud.

1.9

Ohta, S., 1951

On the contents of condensation nuclei and uncharged nuclei on the Pacific Ocean and the Japan Sea, Bull.Amer. Meteorol.Soc. 32: 30-31

Made 67 measurements over the Pacific Ocean (39°N; 153°E) and 115 over the Japan Sea (43.3°N; 141°E). On the first site mean AN concentration was 290 cm^{-3}; on the second which was closer to the polluted mainland 1,040 cm^{-3}. On the same places the maximal values were 690 and 2,200 cm^{-3} and the minimal 70 and 480 cm^{-3}. There is no correlation between AN counts and wind speed or wave height.

4.1

Okita,T., 1962

Concentration of large and giant hygroscopic particles in the atmosphere. J.Meteor.Soc.Japan,Tokyo,Ser.2,40:163-169

The mass spectra of large and giant nuclei are measured with hand operated impactor and microscope. Size distributions are similar to those found by other authors. The concentration of giant nuclei decreases in the ratio 10:1 at a distance about 100 km from the coast. The results suggest that the main source of giant nuclei is the ocean and that their concentration is sufficient in order to start a drizzle drop formation.

4.2

Okita,T., and S.Ota, 1977

The concentrations of trace constituents in the atmosphere and in cloud water in relation to meteorological conditions and oxidant level, Vol. of Abstr. 9th Int.Conf. on Atmos.Aerosols,Cond. and Ice Nuclei, Galway, 85

Atmospheric gaseous components such as SO_2, NH_3, NO_2 and HNO_3, HCl together with particulates $SO_4^=$, NO_3^-, NH_4^+ and Cl^- were sampled in Tokyo and on a mountain (870 m altitude) north of Tokyo. Also, several samplings on tethered balloons and a helicopter have been performed. Larger $SO_4^=$ particulates were found at Tokyo and no markable decrease in concentrations of $SO_4^=$, NO_3^- and NH_4^+ with altitude was observed.

4.2

Orr,C.Jr., F.K.Hurd, and W.J. Corbett, 1958

Aerosol size and relative humidity, J.Coll.Sci.13: 472

A theoretical and experimental investigation was made of the gain or loss of water in dependence of the relative humidity for particles of NaCl, $(NH_4)_2SO_4$, $CaCl_2.6H_2O$, AgI, PbI_2, and KCl having radii between 0.01 and 0.1 um. The growth of nuclei at increasing humidity at different stages (molecular layers, dissolved salts etc.) was compared with the changes during decreasing humidity, and the hysteresis was found.

1.9 - 1.5

Orr,C.,F.K.Hurd, W.P.Hendrix, and C.E. Junge, 1958

The behavior of condensation nuclei under changing humidities, J.Meteorol. 15: 240-242

Measurements confirmed the calculated growth curves for Aitken size range. For these particles, the increase of water vapor pressure due to the curvature of the droplets can no longer be neglected and the phase transition of crystals into solution drop occurs at lower humidities due to the higher solubility of smaller crystals.

1.9

Owens, J.S., 1940

Sea-salt and condensation nuclei, Quart. J. Roy. Meteor. Soc. 66: 2

The author concluded from his observations that most of the condensation nuclei originate from the bursting bubbles on the sea surface.

2.1 - 2.3

Parkinson, W.C., 1952

Note on the concentration of condensation nuclei over the western Atlantic, J.Geophys. Res, 57: 314-315

The author concludes the measurement af AN over the Western Atlantic Ocean by the statement that 71% of all measured concentrations were lower than 800 cm^{-3}.

4.1

Paugam J. Y., 1975

Sur la formation de noyaux Aitken dans l'air au-dessus du litoral, C.R.Acad.Sci.Paris, 280, S.B., 821-824

From July to November 1974 AN measurements were made on the sea shore at the entrance to the canal La Manche. Several times extremaly high AN concentrations ($10^5 ncm^{-3}$) of the duration between 2 to 6 hrs were measured. Usually the high concentrations were observed between the low and high level of the sea at the wind blowing from WNW over the rocks along the shore where are many algee. Characteristic is a very strong fluctuation of AN concentration which was independent of the solar radiation and of wind velocity.

4.1

Penndorf, R., 1954

The vertical distribution of Mie particles in the troposphere. Geophys. Res. Papers USAF, 25: 1-12

Summary of the aerosol particle distribution (AN and large nuclei) over the Central Europe. The survey is based mainly on measurements by Ligand, Siedentopf and Rossmann.

3.1 - 2.7 - 4.4

Penndorf.R., 1962

Scattering and extinction coefficient for small spherical aerosols, J.Atmos.Sci. 19: 193

The author mentions the expressions for the total scattering coefficient (based on the knowledge of the real part of the refractive index) and for the scattering coefficient deduced from the complex index of refraction. These two formulas lead to reliable values up to about $\alpha = 0.8$ in the range n=1.25 to 1.75 and $k < 1$.

3.2 - 3.1

Perrin, F., and A. Abragam, 1951

Polarization of light scattered by spherical particles (in French), J.Phys.Radium, 12: 69-73

Scattering coefficients are calculated for a transparent sphere. Dimensions of particles in suspension are determined from the scattered light. Its degree of polarization is related to the incident light.

3.2

Petrenchuk, O.P., 1975

Estimation of condensation nuclei chemical composition from the results of cloud water analysis, Proc.of the 8th Int.Conf.on Nucleation, Leningrad, 1973, Gidrometeoizdat, Moscow, 445-449

The author describes the summary of the analysis of atmospheric precipitations performed over the territory of USSR since 1960. Sulfates represent an important constituent of the background aerosol. Also, in samples collected by M.A. Bliashova from frontal clouds over the Black Sea $SO_4^{=}$ ions were predominant. The author found a limited extent of sea salt transport inland.

4.3 - 1.4

Petrenchuk,O.P., and V.A. Ionin, 1974

Kontsentratsia i dispersnyi sostav aerozolei na morskom poberezhie Kryma, Trudy GGO, Vyp.343, Gidrometeoizdat, Leningrad, 3-11

Three stage impactor was used for sampling at 15-20 l/min on the seashore of Krym at the following distances from the seashore: 15, 213, 690 and 2023 m at the altitudes 7, 41, 111.3 and 377.7 m. In mean the sizes of aerosols with diameters 1 um $<$ d $<$ 12 um were sampled, however, occasionally particles with radii 75 um were caught.

	N cm^{-3}			(Junge)			Number of
	max	min	N	max	min		samples
15 m	1.93	0.23	0.84	4.0	1.4	2.4	26
2023 m	1.55	0.21	0.66	4.2	2.2	2.6	18

4.2

Petrenchuk,O.P., V.A. Ionin, and R.F. Lavrinenko, 1974

O khimicheskom sostave atmosfernykh aerozolei na poberezhiakh, Chernogo i Azovskogo morei, Trudy GGO, Vyp.343, Leningrad, 12-19

The concentration of Cl ions increased from 2 to 2,000 $\mu g.m^{-3}$ if the wind velocity increased from 0 to 11 m sec^{-1}. The concentration of SO_4 ions varied between 3 to 30 ugm^{-3}. Around Azovskii Sea the prevailing components were HCO_3, Ca and SO_4 ions. Cl ion concentration of 1.8 ugm^{-3} was only found at wind velocity larger than 7 $msec^{-1}$.

1.4 - 2.2

Pich J., 1972

A mathematical study of the Wiegner effect in colloid coagulation, from assessment of airborne particles by T.T. Mercer, P.E. Morrow, W. Stöber, Charles C. Thomas, Publ. Springfield, Illinois, Chap. I., p. 5

Wiegner, 1911 concluded that the coagulation rate of small particles increases in the presence of big particles. The new polydispersity factor and the collision parameter are deduced. Polydispersity of the system always increases the rate of Brownian coagulation in both the continuum region and in the range of small Knudsen numbers.

1.2

Pich,J., S.K.Friedlander, and F.S.Lai, 1970

The self-preserving particle size distribution for coagulation by Brownian motion - III., Aerosol Sci, 1: 115-126

A theoretical study of the dynamics of the coagulation with simultaneus condensation has been performed in order to follow the evolution of the particle size distribution function. The nondimensional parameter critical for the existence of the self-preserving spectra for coagulation and condensation has been deduced and several limitations to the applicability of the self-preserving spectra formation mechanism mentioned.

1.2

Plass, G.N., 1966

The absorption of laser radiation along atmospheric slant paths, Appl.Optics, 5: 149-154

The absorption of laser radiation along atmospheric slant paths is calculated on the basis of the validity of Lambert's law. An example of the absorption in gases uniformly distributed in space when the variations of temperature can be neglected is presented. This case is then generalized to include non uniformly distributed gases with a temperature variation. Further, the effect of overlapping of spectral lines is studied with the help of the Elsasser model.

3.4

Plass, G.N., and G.W. Kattawar, 1972

Effect of aerosol variation on radiance in the earth's atmosphere-ocean system, Appl.Optics, 11: 1598

The reflected and transmitted radiance is calculated for an atmosphere-ocean system in which multiple scattering and anisotropic scattering from aerosols are taken into account by a Monte Carlo technique.Also, the scattering and absorption by water molecules and by hydrosols are taken into account. The calculations are made for a normal aerosol distribution, and for λ = 0.7; 0.9; 1.67 um.

3.2 - 3.3 - 3.4

Plass, G.N., G.W.Kattawar, and S.J.Hitzfelder, 1974

Interior radiances in optically deep absorbing media, Rep. of Proc. IAMAP-IUGG Assembly, Melbourne, IAMAP, Publ. No. 15 a, Toronto, 83

The interior radiances are calculated by the matrix operator method assuming a deep absorbing medium. The author describes the development of the asymptotic angular distribution of the radiance. The ratio of the upward to downward flux is calculated and is shown to be almost constant. The variation of the polarization of the reflected and transmitted radiation as a function of the cloud depth is discussed.

3.1 - 3.6

Podzimek, J., 1959

Measurement of the concentration of large and giant chloride condensation nuclei during flight, Studia geoph. et geod., 3: 256-280

A detailed study of the formation of Liesegang circles for chlorides in sensitized gelatin showed that there is not a strong influence of either temperature or humidity on the value of the magnification factor. This amounts to values between 5.0 and 7.0 for particle radii between 0.5 to 3.0 um based on measurements of the settling of particulates in a drift-tube. Results from 7 flight measurements in Bohemia are presented.

5.13 - 4.2

Podzimek, J., 1959

Fysika oblaků a srážek (Physics of clouds and precipitation) NCSAV (Academia), Praha, pp. 501

The book written in Czech contains nine chapters dedicated to the transport of water in the atmosphere, to the formation of a new phase, to the microstructure and macrostructure of clouds and to the precipitation formation. P. 119-215 are dedicated to the condensation nuclei, to their physical-chemical function and their distribution in the atmosphere. The literary survey on marine aerosols until 1957 is included.

1.1 - 1.2 - 1.4 - 1.5

Podzimek, J., 1959

Determination of size spectrum of chloride giant condensation nuclei, Studia geoph.et geod. 3: 393-402

The results of aircraft measurements of chloride giant nuclei over the northern parts of Bohemia and over the High Tatras mountains in Slovakia were analyzed in order to find the best fit with some of the recommended size distribution functions. The best fit was found with Nukiyama-Tanassava distribution functi..

1.2 - 4.2

Podzimek, J., 1961

Uber die Bindung der Aerosole auf der Oberfläche der Wolkenelemente, Geofisica Pura e Applic., 50: 161-168

A model similar to the Brownian coagulation with an "outer-force" acting on small particulates is used in order to calculate the deposition rate of particles on the surface of a growing drop. Calculated values of the number of deposited small spherical particles show that this effect might explain some phenomena observed during cloud seeding experiments and scavenging of particulates by water drops.

1.4

Podzimek, J., 1962

On the influence of Stefan flow on the binding of aerosol particles on cloud elements, Aerosols, Phys.Chem. and Appl., Proc. 1st Nat.Conf. on Aerosols, Liblice,October 8-13, 173-180

A simple model of the aerosol deposition on a growing drop is suggested. Due to the binding of water vapor molecules on the surface of the droplet a force is exerted on a small insoluble particle. The force is proportional to the water vapor pressure difference between the environment and the surface of the drop. A potential use of the Stefan flow phenomenon in meteorology is mentioned.

1.4

Podzimek, J., 1967

Results of measurements of giant condensation nuclei of chlorides in Cuba, Studia Geoph. et Geod. 11: 470-476

Cascade impactor sampling in Havana and over the Caribbean sea chowed in mean giant salt nuclei concentrations 114 nuclei per one liter of air in Havana and 246 n/liter over the ocean. Vertical aircraft ascents over the ocean indicated very low nuclei concentrations above 2,000 m level and concentrations surpassing 1,000 particles per cm^{-3} around temperature inversions.

4.2

Podzimek, J., 1969

Mesures des noyaux de condensation geants dans les regions continertales et maritimes, Ann.Inst.Univ.Navale di Napoli, 38: 3-14

A survey of all measurements performed mainly during the time period between 1956-1966 when the spot test (Liesegang circle) method was applied for chlorides and sulfates in Bohemia and Cuba is presented. On the ground Cl^- giant nuclei concentr. amounted to 12 to 28 n/l and sulfates ranged from $2x10^3$ to $7x10^6$ n/l. Over Cuba Cl^- concentrations varied in mean from 114 n/l over mainland to 246 n/l over the ocean.

4.2

Podzimek, J., 1973

Contribution to the question of condensation nuclei formation on the seashore, J.Rech.Atmos.7: 137-152

24 samples collected with a cascade impactor along the Padre Island were analyzed for NaCl particles by Liesegang circle method: The concentration of giant nuclei amounted from 89 to 15,160 nuclei per liter of air. Nuclei size distribution was well described by Nukiyama-Tanassava density function. Electron microscopical examinations revealed many particles with $r < 0.03$ um.

4.2

Podzimek, J., 1977

Identification of sodium chloride particles by Liesegang circle method, paper pres. at 52nd Colloid & Surface Science Symposium, ACS, Buffalo,N.Y., June 19-22

The formation of circular spots in a sensitized gelatin sheet is investigated on the basis of a simple three dimensional model of the diffusion of outer ions. Comparison with simple measurement of diffusional rings is presented. The usefulness of the method is stressed by the establishment of the magnification factor with an aerosol centrifuge.

5.13

Podzimek. J., O. Preining, C.A.Russell, and J.F.Stampfer, 1978

Aerosol studies at the Texas seashore, Tech.Rep. No.AG-8, GCCPR, Univ. of Missouri-Rolla, February

Measurements of the concentration of AN point on continental sources. Particulates with $r < 0.7$ um are generated on the sea surface, but are not in their majority composed of sea salts like particles larger than 0.7 um. Giant salt nuclei follow the Nukiyama-Tanassava distribution and many of them have mixed nature. Organic material is bound mainly on particles with $d < 0.7$ um.

4.2

Podzimek, J., O.Preining, and J.F.Stamfer, 1977

Aerosol study during a sea breeze, Vol. of Abstracts 9th Int.Conf. on Atmos.Aerosols, Cond.and Ice Nuclei, Galway, 148

Maritime aerosol measurements have been performed on the seashore of the Padre Island and at higher altitudes at the same location in order to investigate into the transformation of the maritime aerosol during a sea breeze. AN counts were not related to the state of the sea surface, however, showed short term increase. Nukiyama- Tanassava function describes well the size distribution of chloride particles. Organic substances were primarily bound on particles with diameter smaller than 0.7 um.

4.2 - 2.2 - 2.7 197

Podzimek, J., and A.N. Saad, 1973

Metamorphosis of sea salt particles at changing humidity, paper pres.at the 54th Annual Meeting of the AMS, Jan 8-11, 1974, Honolulu, abstract in Bull. AMS,54:1106

The experiments with stored sodium chloride aerosol are described. The measurement of AN and of larger particulates with light scattering instrument (Royco 225) led to the conclusion that larger sodium chloride particles shatter, what finally leads to the increase of AN counts during several hours after the aerosol had been introduced into the storage bag. This confirms observations made in nature and in laboratory by other investigators.

1.2

Podzimek, J., and A.N. Saad, 1974

Evolution of giant chloride nuclei size spectrum on the seashore, Arch.Met.Geoph.Bioklim., A, 23: 77-86

Nukiyama-Tanassava size distribution function is used and applied with the model by Sedunov (definition of the activity of nuclei) for calculating the exponents in the spectral functions and in the supersaturation spectrum curve as well. The N.-T. distribution fits well (better than Junge's), however, there are some systematic deviations of the curves for particles with $r > 3$ um. The exponent s in the N.-T. formula $n = Ar^2 \exp(-Br^s)$ has the value $\frac{1}{2}$.

1.2 - 4.2

Podzimek,J., and A.N. Saad, 1975

Retardation of condensation nuclei growth by surfactant, J.Geophys.Res., 80: 3386-3392

A one-dimensional model has been used for the description of the retarded growth of sodium chloride nuclei due to the coating by thin layer of cetylalcohol. The protective layer can retard the activation of nuclei and cause the colloidal instability mainly by coating nuclei with radii smaller than 0.2 um. The concept of the critical thickness of the layer (Deryaguin et al.) is discussed in details.

1,8

Podzimek,J., and J.F.Stampfer, 1977

Vertical distribution of marine aerosol above the seashore, Tech.Rep. No. AG-7, GCCPR, University of Missouri-Rolla, (in print), 1977

Aircraft measurements were performed above Padre Island (Texas) at altitudes 15, 150, 300, 600 and 1,800 m. Climet optical counter showed different behavior of particles smaller and larger than 0.7 um around temperature inversions. The concentrations of smaller particulates amount to several tens per cm^3 and that of larger particulates to several tenths per cm^3. Large particulates are composed mainly of salts and follow the Nukiyama-Tanassava distribution.

4.2 - 2.7

Podzimek,J., and D.E.Wood, 1976

Possible effect of surfactants on the evolution of cloud droplet size spectrum, J.Rech.Atmos., 10: 129-142

The previous work (Podzimek and Saad, 1975) has been completed by assuming that only a part of the population of salt nuclei is coated by cetylalcohol.The calculated evolution of the drop size distribution indicated a significant effect which lasted at least for several minutes. A critical analysis of the numerical solution pointed out the necessity of finding a more realistic model for coated nuclei.

1.8

Prahm, L.P., 1974

Comments on "The background level of the summer tropospheric aerosol over Greenland and the North Atlantic Ocean", J.Appl.Meteor. 13: 730-733

The author claims that Flyger,Hansen,Megaw and Cox (1973) might not interprete correctly the measurements of AN over Greenland.They applied isobaric air trajectories instead of isentropic.The author shows that the high concentrations of AN might not be due to the local sources of pollution but by the polluted air passing from the heavily populated areas of the USA over Canada to the West coast of Greenland. The mean size of particulates was 0.03 um. Reply by Megaw: Over the seas surrounding Greenland the concentration was in the range 400-800 AN cm^{-3} with occasional peaks up to 5,000 cm^{-3}.Over the ice cap the concentrations were 200-400 cm^{-3}.

Preining, O., J.Podzimek, and P.Yue, 1976

The magnification factor for sodium chloride Liesegang circles established with an aerosol centrifuge, J.Aerosol Sci., 7: 351-358

Using an aerosol centrifuge magnification factors of dry salt particles in the diameter range from 0.5 to 2.0 um were established. Salt particles prepared of 1% NaCl solution yielded magnification factor around 1.25 and for 6% solution the factors varied between 1,6 and 2.8. Salt nuclei prepared from sea water droplets yielded the factors between 1.6 and 1.7

5.13 - 5.5

Prospero, J.M., and T.N. Carlson, 1972

Vertical and areal distribution of Saharan dust over the western equatorial North Atlantic Ocean, J.Geophys.Res. 77: 5255-5265

The authors found in the Caribbean area that Saharan dust content in the air ranges from several ug m^{-3} to 60 ug m^{-3}. The main air mass bringing the Saharan dust over the Atlantic Ocean proceeds fast above the passat-inversion zone and causes the "sudden" increase in measured concentration of continental aerosol several thousands of km from the African coast.

2.6

Pueschel,R.F.,R.J.Charlson, and N.C.Ahlquist, 1969

On the anomalous deliquescence of sea-spray aerosols, J.Appl.Met., 8: 995-998

Studies with the nephelometer and flame scintillating spectrophotometer led to the conclusion that the light scattering coefficient of an aerosol formed by condensing water vapor on sea-spray droplets (at 70% to 90% R.H.) is significantly less than that of "pure" salt solution droplets in an identical environment. There is a possible explanation that surfactants deposited on the surface of the drops formed by bursting of sea water bubbles might be responsible for this behavior.

1.8

Pueschel, R.F., and P.M. Kuhn, 1975

Infrared absorption of tropospheric aerosols: Urban and rural aerosols of Phoenix, Arizona, J.Geophys.Res. 80: 2960-2962

The IR absorption and scattering properties of an aerosol were calculated and compared with IR in situ radiance measurements in the 9.5 through 11.5 um spectral region. Mie calculation shows that at 10 um wavelength more than 95% of the IR extinction is caused by absorption. The imaginary part of the IR refraction index was 0.47 and 0.19 for the urban and rural aerosols, respectively.

3.4 - 3.2

Pueschel, R.F., and B.G. Mendonca, 1972

Sources of atmospheric particulate matter on Hawaii, Tellus 24: 139-149

Study of sources of aerosols on the island of Hawaii, particularly those affecting the Mauna Loa Observatory have been performed with a manually recording AN counter and a nephelometer. Significant changes in the nuclei concentration and in light scattering coefficients resulted from combustion activities on the island (man-made and volcanic). The relative contribution of the marine aerosol to the total particle population over the island is small.

4.2 - 4.1

Pueschel, R.F., and K.E. Noll, 1967

Visibility and aerosol size frequency distribution, J.Appl.Meteor. 6: 1045

A comparison is made between the calculated meteorological range based on measured size distribution of particulates and the visibility observations. An analysis of 16 size distributions shows that about 90% of particles have $d < 0.1$ um. However, their contribution to light extinction amounts only to 5%. Therefore, for visibility studies evaluation of particles of size greater than 0.1 um is sufficient.

3.6 - 1.2

Pueschel,R.F., and C.C.Van Valin, 1974

The mixed nature of laboratory-produced aerosols from seawater, J.Rech.Atmos. 8: 601-610

Light scattering measurements at varying relative humidities on maritime aerosols show a retarded droplet growth. Gas chromatographic and mass spectrometric analyses of solvent extract of the ocean water show a direct relationshi between the effect of retarded droplet growth and the quantity of organic matter in sea water. The organic material is transported as an aerosol.

1.8

Pueschel, R.F., and C.C.van Valin, 1974

The mixed nature of maritime aerosols, J.Rech.Atmos. 8: 601-610

Gas chromatographic and mass spectrometric analysis support the idea of the retarded activity of maritime nuclei due to the coating by organic materials.Most of the materials belong to the mono- and diunsaturated hydrocarbons which exist in concentration up to $1:10^9$ in the atmosphere over the sea, and are transfered onto the nuclei through bubble bursting. The surfactants do not influence the critical R.H. of salt nuclei, only their rate of growth.Light scattering measurements show that the retarded activity cannot be caused by inorganic ion combination.

1.8 - 2.8

Querry, M.R., R.C.Waring, W.E.Holland, G.M.Hale, and W.Nijm, 1972

Optical constants in the infrared for aqueous solutions of NaCl, J.Opt.Soc.America, 62: 849-855

The authors investigated relative specular reflectances of 1, 3, and 5 M aqueous solutions of NaCl in infrared region ($2 < \lambda < 20$ um). Distilled water was used as a reflectance standard. Water has infrared bands centered at 2.75, 6.10 and 14.60 um. The presence of Na and Cl ions can significantly influence the relative reflectance in infrared radiation.

3.5 - 3.4

Querry, M.R., R.C.Waring, W.E.Holland, L.M.Earls, M.D. Herrman, W.P.Nijm, and G.M.Hale, 1974

Optical constants in the infrared for K_2SO_4, $NH_4H_2PO_4$, and H_2SO_4 in water, J.Opt.Soc.America, 64: 39-46

The authors measured relative specular reflectances of 0.5 M aqueous solutions of K_2SO_4 and $NH_4H_2PO_4$, and of 3M H_2SO_4 in the 2-20 um infrared region. Spectacular changes in the molecular extinction coefficients in the region between the wavelengths 8 and 10 um were found.

3.5 - 3.4

Radke, L.F., 1977

Marine aerosol: Simultaneous size distributions of the total aerosol and the sea salt fraction from 0.1 to 10 micron diameter, Vol.of Abstr. 9th Int.Conf. on Atmos.Aerosols,Cond. and Ice Nuclei, Galway, 149

Concentration and size distribution of marine aerosol in the size range between 0.01 and 50 um (diameter) was measured by ion mobility and light scattering devices and by sodium specific flame scintillation spectrophotometer. During light winds the Pacific Ocean was the predominant source of 10 um diameter particles, but it is a negligible source of o.1 um particles (less than 0.1% of the total counts).

1.4 - 2.2 - 2.3

Radke, L.F., and D.Hegg, 1972

The shattering of saline droplets upon crystallization, J.Rech.Atmos. 6: 447-455

An experiment has been set up in order to check the efficiency of salt crystal shattering during crystallization of saline droplets. The number of salt particles was determined by a Na-sensitive flame photometer. The multiplication factor for larger particles was 1.88 while for particles with d < 0.062 um was around 5.

2.3 - 2.1

Radke, L.F., and P.V.Hobbs, 1969

Measurements of cloud condensation nuclei, light scattering coefficient, sodium containing particle and Aitken nuclei in the Olympic Mountains of Washington, J.Atmos. Sci., 26: 281-288

Dissipating clouds do not return to the atmosphere the same CCN spectra that formed them but rather produce an increase in the number of CCN at the lower supersaturation.

1.5 - 1.2 - 3.2

Radke, L.F., and F.M. Turner, 1972

An improved automatic cloud condensation nucleus counter, J.Appl.Meteor., 11: 407-409

The original cloud condensation nucleus counter developed by Radke and Hobbs has been improved by reducing the size and weight of the instrument and by increasing the sampling rate. During the nuclei workshop at Ft.Collins the instrument was compared with four other instruments based on thermal diffusion chamber principle. It was found that the improved automatic counter givescounts within ± 50% of the mean of all five counters.

5.6

Ranz,W.E., and J.B.Wong, 1952

Jet impactor for determining the particle-size distributions of aerosols, Amer.Med.Assoc.Archives of Industrial Hygiene and Occup.Medicine, 5: 464-477

Theoretical and experimental analysis of the impactors is presented. Rectangular and circular jet opening are considered and collection efficiencies are calculated. The calculations are compared with experiments and a reasonable agreement found. Particle size distribution is given for sulfuric acid and ammonium chloride.

5.2

Raschke, E., 1974

Absorption of solar radiation in a cloudy atmosphere above the ocean, IAMAP-IUGG Assembly, Melbourne, IAMAP, Publ. No. 15a, Toronto, 84

A multiple scattering calculation of the transfer of solar radiation between 0.25 and 3.28 um in a model of the atmosphere-ocean system is presented. The computational model is based on an iterative solution of the radiative transfer equation, which accounts for anisotropical scattering and absorption in both media. The results indicate a very strong absorption by atmospheric aerosol accounting for 50% of total solar heating.

3.3 3.4

Rath, R., and D.Pohl, 1974

Particle size determination with the particle counter, Staub 34: 108-114

The authors describe the basic theory of the light scattered by floating dust-like particles to count their number and to measure their diameters. The theory is applied to a specific particle counter.

5.7

Rau, W., 1956

Experimentelle Untersuchungen über die Erzeugung von Salzteilchen aus den Meeren, Geofis.Pura e Appl. 33: 210-214

The author was not able to justify Mason's results of the nuclei production rate from bursting bubbles (300 ± 80 nuclei per bubble). The measured mean concentrations of nuclei with $m > 10^{-15}$ g were about $10^{6} cm^{-3}$. There is some doubt, however, whether the level of efficiency of spraying mechanism in laboratory can be reached in nature.

2.3

Rau, W., 1956

Bestimmung der Grösse und Häufigkeit der Chloridteilchen in maritimen Aerosol, Meteor.Rundschau 9: 210-214

Salt nuclei measurements at Cuxhaven are described.The total concentration of all sizes was 12 cm^{-3} during the five days of measurements. The maximum particle size was 2r=7um. Instead of larger particles Rau found droplets from sea spray and claimed a reasonable agreement with Woodcock's (1953) measurement.

4.2

Rau, W., 1956

Eine vereinfachte Ausführungsweise der Vittori-Methode zum Nachweis von Chloridteilchen im Aerosol und die Bestimmung der Teilchengrösse, Arch.Met.Geophys.Bioklim.A9: 224

A detailed description of the Liesegang circle method (Vittori-method) for the identification of the sodium chloride particles in the sensitized gelatin sheet is presented. The magnification factor was determined by comparing the spot diameter with the size of salt solution drops. The sizes of drops were calculated from their fall velocity in a sedimentation tube.

5.13

Reist, P.C., and W.A. Burgess, 1968

A comparative evaluation of three aerosol sensing methods, Amer.Ind.Hygiene Assoc.J., 29: 123-128

Comparison of a piezoelectric particle sensor, acoustic particle counter and hot-wire sensor has been performed. The best results have been obtained with hot-wire sensor (anemometer).

5.9

Remsberg, E.E., 1971

Radiative Properties of Several Probable Constituents of Atmospheric Aerosols, Thesis, Univ. of Wisconsin

The author investigated into the optical properties of atmospheric aerosols. Absorption and refractive index of ammonium sulfate and nitric acid in the range of wave lengths from 7.5 to 14 um is presented.

5.5 - 1.3

Renoux, A., J.F.Butor, G.Tymen, and G.Madelaine, 1976

Une methode de détermination du spectre granulomètrique des aerosols présents dans différents types d'atmosphère, in "Aerosole in Naturwissenschaft, Medizin und Technik", Bericht der 4.Tagung GAF, 112-117

The combination of the Andersen impactor with nucleopore filter enabled to measure the aerosol size distribution in different environment: Paris (P), Brest (B), Kardalaes (K) in Canal La Manche and Midlante (M), close to Azores. The three modus of log-normal distribution were for (K): 1.3×10^{-3}; 0.22; 0.74 um and (M): 4.3×10^{-3}; 0.19 and 0.62um. The coefficients for the Junge's distribution were for 1 um < d < 20 um particles: (K) - B = 3.0 and (M) - B = 3.5

4.2 - 4.1 - 1.2

Renoux,A., J.Y.Paugam, G.Madelaine, and S.Fongang, 1977

A production of very high condensation nuclei concentration at a tidal seashore, Vol.of Abstracts 9th Int.Conf. on Atmos. Aerosols, Cond. and Ice Nuclei, Galway, 155

The measurements of AN concentration and size distribution have been performed on the North-Western shore of Great Britain. Highly fluctuating concentrations of AN (max. around $2 \times 10^{6} cm^{-3}$) have been measured and related to the living sea-weeds exposed during diurnal low tides. A hypothesis has been established that a fast process of photolysis is responsible for the high AN counts.

4.1 - 1.8 - 2.9

Renoux, A., G.Tymen, J.F.Butor, and G.Madeleine, 1974

Utilisation de cascades impactors pour l'etude de la repartition granulome-triques d' aerosols atmospheriques. Application a l'aerosol marin. J.Rech.Atmos. 8: 709-721

Aerosols were collected by cascade impactors (MM2 and Anderson) and by nucleopore filters. Obsevations were carried out by optical and electron microscope. Spectacular differences were found between continental aerosol (peak at D=0.20 um, minimum at 0.14 um) and the marine aerosol with the inflexion around D=0.6 um. The coefficient in the Junge's law varies according to whether the air is continental or maritime.

4.2 - 5.2

Rensch, D.B., 1968

Survey report on atmospheric scattering, TR 2476-1, Electro-Science Laboratory, Ohio State University, May

A survey report on the theoretical and experimental investigation of the atmospheric scattering by aerosol particles in the visible and infrared region.

3.2

Rensch, D.B., and R.K.Long, 1970

Comparative studies of extinction and backscatter[illegible] by aerosols, fog, and rain at 10.6 um and 0.63 u, Appl.O[illegible]cs, 9: 1563

Calculation of extinction coefficients for horizontal path at sea level is made for model situations in Continental aerosol, fog and precipitation. Calculations are made for wavelengths 0.34 u and 10.6 u and the results are compared with outdoor transmission maesurement.

3.2 - 3.6

Rex, R.W., and E.D. Goldberg, 1958

Quartz content of pelagic sediment of the Pacific Ocean, Tellus 10: 153-159

The authors investigated the mineral composition of pelagic clays from the eastern Pacific Ocean. There is a marked latitudinal dependence with a maximum around 30°N. There is the evidence that quartz and perhaps other minerals are transported from the exposed arid lands far into and across the Pacific Ocean. The size distribution of quartz has a maximum fraquency between 0.5 and 15.0 um.

2.6

Rich, T.A., and V.A. Mohnen, 1969

A proposed size distribution function for natural aerosol, Proc. 7th Int.Conf.Condens. Ice Nuclei, Prague-Vienna, Academia, Prague, 38-53

A distribution function $dP/dy = 12\ (y^{-4} - y^{-5})$ is suggested in which y is some function of the particle radius r (y=1 at minimum r). The main parameters of the suggested distribution, such as maximum frequency (with the corresponding particle radius), arithmetic and geometric mean, are deduced. Some experimental data are presented which support the suitability of the distribution for the description of the aerosol behavior.

1.2

Rhine,P., D.Williams, G.M.Hale, and M.R.Querry, 1974a

Infrared optical constants of aqueous solutions of electrolytes. The alkali halides, J.Phys.Chem., 78: 238-246

The authors measured the normal-incidence spectral reflectance of aqueous solutions of alkali halides in the spectral region of 350-5,000 cm^{-1}. The real and imaginary part of the complex refractive index has been calculated with the aid of Kramers-Kronig phase-shift analysis. The negative ions produce greater changes in the absorption spectrum of the solvent than do the positive ions.

3.5 - 3.4

Rhine,P., D.Williams, G.M.Hale, and M.R.Querry, 1974 b

Infrared optical constants of aqueous solutions of electrolytes. Acids and bases., J.Phys.Chem., 78: 1405-1410

The normal-incidence spectral reflectances of aqueous solutions of HCl, NaOH and KOH have been measured in the wave length spectral range of 350-5,000 cm^{-1}. The real and imaginary part of refractive indices of the solutions were evaluated with Kramers-Kronig phase-shift analysis from the measured values of reflectance. Reflectivity, refractive and absorption index are analyzed for each substance.

3.5 - 3.4

Rinehart, G.S., 1970

Improved method for the detection of micronsized sulfate and watersolube particles, Analytica Chimica Acta, 52: 295-303

15 g of polyvinylalcohol (PVA) and 200 ml of water were mixed. To this mixture 0.6 ml of glycerol, 4.5 ml of saturated $BaCl_2$ solution (25°), and 0.2 ml of aquaous Triton X-100 were added. The hot solution was filtred under suction through a membrane filter. After sampling, the slide was observed in a microscope and than exposed to a stream of water saturated air for a few minutes. The Liesegang reaction rings were examined and measured in a microscope.

5.13

Robbins, R.C., R.D. Cadle, and D.L. Eckhardt, 1959

The conversion of sodium chloride to hydrogen chloride in the atmosphere, J.Meteorol., 16: 53-56

The reactions were studied of the possible release of gaseous chlorine: $NaCl + 2NO_2$ -- $NaNO3 + NOCl$, $NOCl +$ $+ H_2O$ -- $HCl + HNO_2$, NOC[illegible]v -- NO + Cl. This reaction is slow but rather com[illegible]e. The author suggests that NO_2 forms HNO_3 by hydrolysis, which in turn is adsorbed by the dry NaCl particles or dissolved in solution droplets.This results in release of HCl.

1.4 - 2.3

Rogers,C.F., and P.Squires, 1977

A new device for studies of cloud condensation nuclei active at low supersaturations, Vol. of Abstr., 9th Int. Conf.on Atmos. Aerosols, Cond. and Ice Nuclei, Galway, 45

A new instrument, called "diffusion tube" which utilized the difference between the diffusivities of water vapor and heat in air is capable to provide supersaturations between 0.1 to 0.05%. The performance of the new device is compared with a thermal gradient diffusion chamber and the average ratio of concentrations indicated by both counters was 0.87.

5.6

Roll, H.U., 1965

Physics of the Marine Atmosphere, Academic Press, New York-London, pp.426

Monograph on the composition an state of marine atmosphere contains a detailed treatises on: Atmospheric nuclei above the ocean (pp.43-64), chemistry of marine atmosphere (pp. 64-84), electricity and radioactivity of the marine atmosphere (pp.84-100).

1.1 - 1.2 - 1.3 - 1.4

Rosinski,J., and C.T.Nagamoto, 1972

Water-affected fraction of natural 1.5 - 9 u diameter aerosol particles, J.Coll.& Interf. Sci., 40: 116-120

Changes in aerosol partially hydrosolized show that the water-affected fraction was mainly observed in the 1.5--3 u size group, when there was scattered rain and overcast sky. The aggregates formed through evaporation of cloud droplets seem to be often found in the atmosphere.

2.2

Rossknecht,G.F., W.P.Elliott, and F.L.Ramsey, 1973

The size distribution and inland penetration of sea-salt particles, J.Appl.Meteor., 12: 825-830

Chloride particles with d > 1.24 um were deposited on millipore filters and identified by mercuroussilicate technique; 18 samples were taken over the ocean and 49 over the mainland. Size distribution of particles follows the exponential formula. 0.3 km from the shore inland-particle concentrations ranged from 0.6 tc 1.2 cm^{-3}. Total mass of salt transported inland was 20 to 64 x 10^{-9}g per liter of air.

2.5 - 4.2

Roth, C., and J.Gebhart, 1973

Comments to the lower detection of a laser aerosol spectrometer, in "Aerosole in Physik, Medizin und Technik", Jahreskongress d. GAF, 36-40

The counting of single aerosol particle by light scattering in a laser beam is quite important because it enables to analyze the highly concentrated aerosol of polluted air. A description of the experiments during which particles in the size range from 0.05 to 5 um were detected is presented. Some general remarks pertaining to the spectrometer performance stress the potential applicability of this method.

5.7

Ruskin,R.E., R.K.Jeck, and H.E.Gerber, 1976

Progress report on sea salt measurements, September 1975-January 1976, NRL Memo Rpt. # 3270

Mean aerosol size distribution over the ocean in relationship to the ocean wind and relative humidity leave an uncertainty in integrated particle surface area of about ±4x. About half of this amount in due to the atmospheric stability and the other half to the history of the air mass.

1.2 - 2.9

Russell, C.A., and J.F. Stampfer, 1976

The dependence on particle size of the organic content of marine aerosols, Paper pres. at the Annual Meeting of the Missouri Academy of Sciences, Rolla, April 23-24

High volume filter samples of marine aerosol were taken in order to determine how the organic material is related to the size of the aerosol particles. The results of the analysis indicate that materials which can be converted to C_{14} to C_{20} methyl esters are concentrated primarily on particles smaller than about 0.7 um with the C_{16} ester the most abundant. Total concentrations of these methyl esters ranged from 10 to 100 ngm^{-3} of air. The corresponding amount of hydrocarbons was less than 15 ngm^{-3}.

1.8

Saad, A.N., J. Podzimek and J.C. Carstens, 1976

Some remarks on modeling of the early stage of cloud formation in a simulation chamber, J.Appl.Met., 15: 145-156

A model has been developed to describe the early stage of the cloud droplet growth on sodium chloride nuclei. The influence of different parameters such as fluctuating updraft, updraft velocity, temperature and the sudden increase of nuclei of a certain size has been investigated. Sudden injection of nuclei might explain the broader cloud droplet size distribution often found in natural clouds.

1.9

Sadasivan, S., S.J.S.Anand, and K.G.Vohra, 1974

Trace constituents in the monsoon rains near Bombay, J.Rech.Atmos. 8: 873-882

Rainwater samples were collected in India 60 km from the shore near Bombay. Most of the samples were taken 625 m above sea level and close to the cloud base during the south-west monsoon. On average Br/Cl ratio was around 3.1×10^{-3} and I/Cl ratio 2.1×10^{-3}. The enrichment factor for I shows a definite decrease with increasing Na or Cl.

4.3

Sagalyn, R.C., 1958

The production and removal of small ions and charged nuclei over the Atlantic Ocean, "Recent Advances in Atmospheric Electricity" (L.G.Smith, ed.), pp. 21-41, Pergamon Press, New York

AN have their concentration maximum in the size range between 10^{-6} and 10^{-5}cm. This conclusion is based on flight measurements performed over the Atlantic and over the eastern parts of the USA which have shown a close relationship between the concentration of light ions (el.conductivity of the air) and the concentration of AN. The coagulation of particulates within the exchange layer in the atmosphere is not a negligible factor.

2.1 - 4.1

Sagalyn, R.C., and G.A. Faucher, 1956

Space and time variations of charged nuclei and electrical conductivity of the atmosphere, Quart.J.Roy.Meteor. Soc., 82: 428-445

The authors measured the vertical distribution of the charged component of the Aitken nuclei at altitudes from 0.2 to 5 km over various parts of the USA at differrent times of the day. Flights were made during fair weather. During the day the height of the exchange layer increases from 1 to 3 km. During the night, the height of exchange layer decreases again. The coagulation of particles within the exchange layer is not negligible and is compatible with Smoluchowsky's theory.

2.1 - 4. 1

Sarkisov,C.L., T.B.Stepanov, and B.G.Khorguani, 1969

O raspredelenii chastic iestvestvennogo aerozolia po razmeram, Tr. Vysokogornogo Geofiz. Instituta, 13: 88-96

The analysis of the aerosol measurements in the atmosphere led to the conclusion that in mean the exponent in the Junge's distribution function is equal to 2.

1.2

Sawyer, K.F., and W.H.Walton, 1950

The "Conifuge" - A size-separating sampling device for airborne particles, J.Sci.Instr. 27: 272-276

Consists basically of a conical self-pumping centrifuge,in which the indrawn cloud is "winnowed" by an internally circulating stream of clean air in such a way that the particles are classified according to their settling velocities and deposited on a glass slide. For spherical particles of unit density the spectrum extends from about 30 to 0.5 um diameter at a sampling rate of 25 cm^3/min.

5.16

Saxena, V.K., J.N.Burford, and J.L.Kassner,Jr., 1970

Operation of a thermal diffusion chamber for measurements on cloud condensation nuclei, J.Atmos.Sci., 27: 73-80

The description and analysis of the function of a thermal diffusion chamber is presented. The solution of the equations governing the transient behavior of the chamber suggests the necessity for precise control of the temperature and of relative humidity of the incoming sample. The most important seems to be the study the transient behavior of the chamber while introducing the sample. Some preliminary results of measurements are presented.

5.6

Schadt,C., and R.D.Cadle, 1957

Criti al comparison of collective efficiencies of commonly used aerosol sampling devices, Anal.Chemistry, 29:864-868.

Compared are: Sedimentation chambers, electric. precipitator, Greenburg-Smith impinger, "Millipore" filters, Casella thermal precipitator, and impactor. A monodisperse aerosol was used for comparison.

5.16 - 5.3 - 5.2 - 5.4

Schaefer, V.J., 1972

Fine particle measurements in the air over the North Atlantic Ocean, J.Rech.Atmos., 7: 507-518

AN, CCN and ozone were measured onboard a ship "Meteor" from Lisbon to 43°46'W and 43°00'N and hence to Hamburg. Very clean air with AN counts not exceeding 300 cm^{-3} was found over the ocean south of Iceland and Greenland. Experiments with turpentine, ozone and other substances producing AN were performed.

4.1

Schaefer, V.J., 1977

Global patterns in size and number of airborne particles, Vol. Abstr. 9th Int.Conf. on Atmos.Aerosols, Cond. and Ice Nuclei, Galway, 144

The majority of the size distributions of particles ranging in size from 0.005 to 10 um fit into the bimodal pattern. Departure from the bimodal size distribution occur when high concentrations of submicroscopic particles are present, when haze develops and when particles are generated at the sea surface. The location of the gap between 0.1 and 2.0 um provides an important information about the nature and origin of particulates.

1.2 - 4.1

Schappert, G,T., 1971

Technique for measuring visibility, App Optics, 10:2325

A technique for measuring atmospheric extinction of light (visibility) from the backscattered signal of a modulated laser is presented. The extinction coefficient is contained in the amplitude and phase of the return signal and can be obtained from the measurements of these parameters. No assumption about a ralationship between the extinction coefficient and backscattering coefficient is needed.

3.6 - 3.2

Schmidt, J.M., 1948

Measurement of droplet sizes by the difraction ring method, J et Prop.Lab.Cal.Inst.Techn.Progr.Rep. 3-18

Brief theory of the formation of diffraction rings (coronas) around drops is presented. In many typical cases the drops vary so fast that the method is not applicable, but it can be used with sprays from hollow-cone injector. Comparison with other methods measuring size distribution of drops is made.

5.7

Schmidt, M., 1972

Registrierung der Chloridteilchenkonzentration der Luft an der Westküsste von Dänemark, Pure Appl.Geoph., 97: 219-233

Chloride particles were sampled every two hours for five months on the west coast of Denmark with the automatic impactor. Improved Liesegang circle technique was used for detection of nuclei with dry radii larger than $r > 0.08$um. Mean concentrations ranged from 300 to 500 particles per liter of air. Maximum concentration amounted to several ten thousand particles per liter of air and the total mass of chlorides ranged from 20 to 61 ugm^{-3}.

4.2 - 5.13

Schroeder, W.H., and P. Urone, 1974

Formation of nitrosyl chloride from salt particles in air. Environ.Sci.Tech. 8: 756-758

Investigations of the reaction of sodium chloride particles with 0.1-1.5% mixtures of nitrogen dioxide and sulfur dioxide in air showed that nitrogen dioxide reacted with sodium chloride to form nitrosyl chloride (NOCl), a corrosive gas. A potential importance of this reaction is discussed.

2.4

Schubert, G., und W.Hänsch, 1962

Beobachtung von Meersalzablagerung tief im Landesinnern von Mecklenburg nach dem zweiten Sturmtief am 16.-17. Februar 1962, Zeitschr.f.Met. 16: 2761

175 km from the seashore was found a heavy deposit of sea salt on the glass windows during the passage of a storm. In the area of the rear stream in a cyclone are transported salt nuclei at a very high concentration.

4.2

Schulz, G., 1947

Die Arbeiten und Foschungsergebnisse der Wolkenforschungsstelle des RfWD, Ber. Deutsch. Wetterd. in d. US-Zone, 1.

Collection of several papers of the Cloud Physics Group of the German Meteorological Office which was headed by Dr. H. Findeisen. The individual contributions concern the experiments with the cloud chambers, observations of cloud formation and cloud microstructure, icing on aircrafts etc.

1.5

Schütz, L., 1974

Transport und Verteilung von Sahara-Staub über dem Atlantik, in "Aerosole in Naturwissenschaft, Medizin und Technik", Jahreskongress GAF, p.258-264

The following aerosol measuring instruments were used on board the ship "Meteor" during its cruise from the Caribbean Sea to Canary Islands: GE AN counter, Royco 225, several kinds of impactors. AN counts ranged from 300 to 400 cm^{-3}. 1,500 km from the African coast an increase to 800-900 cm^{-3} was observed. In the size range from 0.3 to 3 um an increase from 1 cm^{-3} to 7 cm^{-3} was observed due to the dust and the portion of larger particulates of continental origin represented 20-50% of the total counts.

2.6 - 4.2

Sedunov, Y.S., 1969

Quantitative experiments on the effects of the introduction of additional condensational nuclei on the kinetics of cloud spectrumformation, Proc. 7th Int. Conf. Cond. Ice Nuclei, Prague-Vienna, Academia - Prague, 333-336

The model describes the situation when to a growing population of nuclei were suddenly added other nuclei of known composition and concentration. This leads to the increase of cloud droplet concetration. The effect is the greatest if the activity of nuclei is minimal in the total range of activated nuclei when the embryos are formed. In this way the nuclei become droplets at the maximum supersaturation. One can calculate the effective size of these nuclei.

1.9

Sedunov, Yu.S., 1972

Fizika obrazovania zhidkokapel'noi fazy v atmosfere, Gidrometeoizdat, Leningrad

pp.70-93: The author analyzes the properties of a soluble and mixed nucleus and deduces a formula relating the nucleus growth rate to the supersaturation. The evolution of the size spectrum of condensation nuclei is described for steady state conditions and for the fluctuating environmental parameters.

1.5

Sehmel, G.A., and S.L. Sutter, 1974

Particle deposition rates on a water surface as a function of particle diameter and air velocity, J.Rech.Atmos., 8: 911-920

Wind tunnel measurements were performed in order to investigate the deposition rates of airborne particulates onto a water surface. The mean airflow velocities were 2.2; 7,2 and 13.8 m/sec. Particle diameters ranged from 0.3 to 28 um. For particles greater than 1 um deposition rate is proportional to particle diameter and wind speed. For particles less than 1 um diameter, phoretic forces are comparable to the eddy diffusion.

2.9

Semmelhack, W., 1934

Die Staubfälle im Nord-West-Afrikanischen Gebiet des Atlantischen Ozeans, Ann.d.Hydr. 62: 273-277

The author describes the propagation of Saharan dust transported in the NE- passat over the Atlantic Ocean.

2.6 - 4.2

Semonin, R.G., 1972

Comparative chloride concentrations between Mauna Loa observatory and Hilo, Hawaii, J.Appl.Meteor. 11: 688-690

The author concludes from his measurements that " the percentage of particles removed is uniform from the shore to the mountain observatory regardless of size". The measurements were performed with millipore filters exposed for one hour and processed according the method described by Lodge (1954). The highest concentrations were found on the coastline, (300,000 m^{-3}). On the upslope they reached 70,000 m^{-3} and on the downslope 800 m^{-3}.

4.2

Seto, F.Y.B., and R.A. Duce, 1972

A laboratory study of iodine enrichment on atmospheric sea-salt particles produced by bubbles, J.Geophys.Res. 77: 5339-5349

Using I^{131} tracer in sea water and neutron activation the authors found that organically bound iodine probably accounts for an initial iodine enrichment on the particles and may explain the characteristic U shape of the iodine enrichment curve.

1.4 - 2.2 - 2.4

Shaw, G.E., 1975

The vertical distribution of tropospheric aerosols at Barrow, Alaska, Tellus, 27: 39-50

Airborne photometric measurements of the vertical distribution of aerosols up to 10 km altitude for periods of April and July 1972. For both periods concentration of aerosols decreased with an exponent with the scale height equal 1.4 ± 0.3 km. Spring turbidity values were higher than mid-summer. Aerosol might be ice crystals with approx 40% of sulfates transported from long distances.

2.7

Shaw, N., and J.S. Owens, 1928

Salt crystals as nuclei of sea fog particles, Nature, 121: 866

A description of the generation of salt particulates and their function as condensation nuclei in the marine atmosphere.

2.2

Siedentopf, H., 1947

Zur Streuung des Lichtes an Wassertropfen Zeitschr.f.Meteor. 1: 342-345

The author reviews the work of Holl (calculated the scatter functions according to Mie), of Bucerius (scattering of light by large drops) and of Reeger and Siedentopf and experimentally determines the scatter function by means of searchlight illumination in atmospheric haze.

3.2 - 3.6

Simpson, G.C., 1941

On the formation of cloud and rain, Quart. J. Roy. Meteor. Soc. 67: 99-183

The author reviews the work which has been done in cloud and precipitation physics and corrects some wrong interpretations of the measurements of AN. The importance of giant nuclei of hygroscopic substances is stressed. The author objects the presence of ice particles in clouds as a sole condition without which the precipitation could not develope.

1.9-1.4

Simpson, H.J., 1972

Aerosol cations at Mauna Loa observatory, J.Geophys.Res. 77: 5266-5277

Aerosol and precipitation samples collected 3.4 km above sea level have only 1% of the original concentration of Na in samples collected at sea level. This suggests short residence time for marine aerosols moving up the slopes of Mauna Loa. The major increase in the bulk substance of K, Ca and Mg relative to Na occurs during the rapid loss of the first 90% of aerosol mass.

1.4 - 2.4

Smirnov, V.I., 1975

Skorost' koagulatsionnogo i kondensatsionnogo rosta chastic aerozolei, Tr.Centr. aerolog. observ., 92: 106
A detailed analysis of the growth equation of an aerosol particle including the condensation and coagulation term is presented. The usefulness and correctness of the deduced terms is proven and several examples mentioned.

1.2

Smirnov,V.I., and B.N.Sergeiev, 1975

O vlianii raspredelenii po razmeram iader kondensatsii i krupnykh oblachnykh kapel', Dokl.AN SSSR, 208: 87-90

When water vapor condenses onto aerosol particles, the power nucleus size spectrum is converted into another one corresponding to the wetted nuclei (at relative humidity below 100%), and finally, into a spectrum of moderately large cloud drops. The relationship between individual stages is investigated.

1.2 - 1.5

Smirnov,V.I., and B.N.Sergeyev, 1975

The relation between the power size distributions of condensation nuclei, haze particles and large cloud drops, Proc. 8th Int.Conf. on Nucleation, Leningrad, 1973, Gidrometeoizdat, Moscow, 497-503

The investigation into the general validity of power size distribution function for dry aerosol, hazy particles and cloud droplets has been carried out. Simple model for nucleus growth and nucleus transformation into hazy particle, and finally, into cloud droplet has been applied. The applicability of power distribution function seems to be supported by some experiments.

1.2 - 1.5

Sinclair, D., 1950

Measurement of Particle Size and Size Distribution, Handbook on Aerosols, AEC, Washington D.C., pp. 97-116

Comparison with light and electron-microscope of the samples taken by: Cascade impactor, thermal precipitator, gravity settling, mass-concentration-meter (optical), corona method etc.

5.15

Sonkin, L.S., 1946

A modified cascade impactor, a device for sampling and sizing aerosols of particles below one micron diameter. J.Ind.Hygiene and Toxicology, 28: 269-272

Cascade impactor for mass-medium diameter as low as 0.25um. It separates clouds containing particles of glycerol-water, methylene-blue solution below one micron. Jets similar to May impactor are applied, but the velocity range is 10-times higher at a flow rate of 16.5 liters per minute.

5.2

Spurny, K.R., 1973

Zur Kinetik der Verstopfung bei Kernporenfiltern, in "Aerosole in Physik, Medizin und Technik", Jahreskongress d.GAF 81-85

The investigations of the clogging of nucleopore filters have been performed by the measurement of the time change of the pressure difference and of the retention efficiency of the filter. The number of latex aerosol particles ahead and behind the filter was measured with Royco counter. The formerly deduced semiempirical relationship between the filter efficiency and the time was justified.

5.2

Squires, P., 1966

An estimate of anthropogenic production of cloud nuclei., J.Rech.Atmos., 2: 297-308

The author astimated the production rate of aerosols by the land masses of the Northern Hemisphere in the order of 500 cm^{-2}/sec. He assumed that the cloud nuclei production by the ocean was negligible.

2.2

Squires, P., and S. Twomey, 1960

The relation between cloud drop numbers and the spectrum of cloud nuclei, Physics of Precip., Monogr. No. 5, AGU, Washington, D.C., 211-219

Since clouds with large numbers of small droplets are colloidally more stable than those with fewer and larger ones, the differences in the aerosol size distribution can account for the observed differences between maritime and continental clouds.

1.5-4.2

Squires, P., and S. Twomey, 1966

A comparison of cloud nucleus measurements over central North America and Caribbean Sea, J. Atmos. Sci. 23: 401 - 404

Higher concentrations of cloud condensation nuclei were found over Colorado up to the altitude of 1,500 m in comparison with a similar sampling over the Caribbean. The difference between both areas decreased upwards and at 5,100 m altitude there were no appreciable differences. The nuclei were activated at a supersaturation of 0.35 %. The concentrations decreased in the Caribbean from 300 cm^{-3} to 150 cm^{-3} (at 5 km altitude) and from 800 cm^{-3} to 160 cm^{-3} over the plains of Colorado.

2.7

Stahlhofen, W., L.Armbruster, and J. Gebhart, 1973

Particle sizing by single particle observation in a sedimentation cell, in "Aerosole in Physik, Medizin und Technik", Jahreskongress d. GAF, 45-47

The authors present a detailed analysis of the aerosol sedimentation technique, which is used for the comparison with light scattering spectrometer. The sedimentation tube was placed in a copper block in order to maintain the temperature constant. The slip correction for polystyrene spheresof 1.158 um diameter has been determined (A=1.4). The value is closer to the value of silicon oil (Schmidt: A=1.45) than to the value used by Millikan (A=1.246).

5.16 - 1.2

Stampfer, J.F.,Jr., 1972

an aircraft, aerosol sampling program: Some preliminary results, Atmos.Environ., 6: 743-757

Simple equipment for particle size and concentration measurement and instruments for the measurement of important meteorological parameters such as air temperature and humidity were installed onboard a light one engine aircraft. Some preliminary results of the measurements are described.

5.7

Stetter, D., 1952

Uber integrale optische Staubmessung, Staub 30: 10 pp

Measurements (absorbed and scattered light) are described. Principles of Rayleigh's scattering are explained and limitations of the methods and measuring techniques mentioned.

3.1

Stevenson, A.F., 1961

Tables of Scattering Function for Heterodisperse Systems. F.Stevenson & W.Heller, Detroit, Wayne State Univ. Press, 214 pp

3.2

Stewart, K.H., 1957

Some observations on the composition of fogs. Meteor.Res. Paper No. 1074, S.C. 111/246, Air Ministry, London,

Refined optical techniques for observations in fogs at Kew are described. Very high concentrations of particulates from 10^4 to 10^5 cm^{-3} below 0.5 um radius were found. Thin fogs with few larger drops occured usually after down in winter time, and persisted for several hours. They had a very low liquid water content. That points to SO_4 formation by SO_2 oxidation (gas to particle conversion within the nonactivated nuclei).

3.6

Streete, J.L., 1968

Infrared measurements of atmospheric transmission at sea level, Appl.Optics., 7: 1545

Atmospheric transmittance in the wavelengths from 0.56 to 10.7 microns was studied over a 25-km horizontal path at sea level. A calibrated radiospectrometer with NaCl prisms and a thermocouple detector was used. From these spectra the selective transmittance of four atmospheric windows was measured and plotted as a function of the square root of precipitable water.

3.4

Streete, J.L., J.H.Taylor, and S.L. Ball, 1967

Near infrared atmospheric absorption over a 25 km horizontal path at sea level, Appl. Optics, 6: 489

The laboratory of Atmospheric and Optical Physics at Memphis has developed a system for measuring atmospheric transmission over 25-km horizontal path in the Cape Kennedy area. Six 150-cm diameter carbon arc searchlights were positioned above the ground at 11 m and 17 m. Solar spectra were also measured for comparison. IR measurements covered the wavelengths from 0.6×10^{-4} um to 60×10^{-4} um. The amount of the water vapor in the path corresponded to 9 to 39 cm precipitation.

3.4

Stumpf, K.E., 1939

Die Bestimmung der Teilchenzahl aerokolloider Systeme mit dem Spaltultramikroskop und der Verlauf der Aggregation in Aerosolen, Kolloidzeitschr. 86: 339-361

A detailed analysis of the particle counting in an ultramicroscope is presented and the usefullness of this method demonstrated in the case of investigating the coagulation of aerosols.

5.7

Sugawara, K., S. Oana, and T. Kayana, 1949

Separation of the components of atmospheric salts and their distribution, Bull.Chem.Soc.Japan, 22: 47-52

Sugest that the change in the composition of rain water is opposed to sea water, e.g. the increase of the SO_4/Cl and Ca/Cl ratios with the distance from the coast is due to the disintegration of particles in dry air as a consequence of crystallization.

1.4

Thudium, J. 1975

Bestimmung der Aktivität des Wassers in hochverdünnten wässerigen Aerosolteilchenproben zur Berechnung der Wasseraufnahme von atmosphärischen Aerosolteilchen in Bereichen sehr hoher relativer Luftfeuchtigkeit, in "Aerosols in Naturwissenschaft, Medizin und Technik. Chemie der Umweltaerosole", Jahreskongress der GAF:90-93

Liquid water content of the atmosphere is also dependent on the size distribution and chemical nature of aerosol particles. The introduction of a factor - water activity (the ratio of the partial pressures over a solution and a water drop at the same temperature)- enables to judge upon the absorptive nature of the aerosols without knowing their specific composition. A description of an experiment with NaCl solution drop is presented and the results of the measurement discussed. 1.5

Thudium, J., 1976

Die Wasseraufnahme atmosphärischer Aerosolteilchen bei hohen Luftfeuchten in Abhängigkeit von der Zusammensetzung der gelösten Ionen, in "Aerosole in Naturwissenschaft, Medizin und Technik", Bericht der 4.Tagung der GFA: 208-213

A relationship between the chemical composition of the atmospheric aerosol and the content of liquid water in dependence on the relative humidity has been found. The comparison with the measured data for the mixture of different ions found in continental and maritime aerosol gave satisfactory results.

1.9 - 1.7

Toba, Y., 1961

Drop production by bursting of air bubbles on the sea surface (III). Study by use of a wind flume. Memoirs Coll.Sci. Univ. Kyoto, Ser.A 29: 313-344

An experiment with salt nuclei generation was carried out in a flume 21.6 m long. The size distribution of bubbles in the foamy patches and the distribution of the salt solution droplets at a height range of 8 cm to 25 cm were measured. The curves describing the production rate of salt solution droplets showed a different slope for jet and bubble bursting drops. However, the shape of the curves remained unaltered when wind speed varied.

2.3

Toba, Y., 1965

On the giant sea-salt particles in the atmosphere, I.General features of the distribution, Tellus 17: 131-145

The author discusses the distribution of salt particles over the sea. The particle concentration decrease with altitude is explained by the combination of sedimentation, diffusion and convection processes. The peculiarities of the boundary layer close to the sea surface explain a particle concentration maximum found several meters above the sea. Also, the distribution of salt particles over the continent is discussed.

2.7 - 2.9

Toba, Y., 1965

On the giant sea-salt particles in the atmosphere, II. Theory of the vertical distribution in the 10 m layer over the ocean, Tellus, 17: 365-382

Vertical distribution of temperature, humidity and logarithmic wind speed profile are assumed in order to explain the peculiarities of the observed vertical distribution of sea salt particles close to the ocean surface. The logarithm of the ratio of the concentration of the particles at the sea surface and at the 10 m level is proportional to the two thirds power of the mass of salt, and inversely proportional to the wind speed at the 10 m level and a friction factor.

2.7 - 2.9

Toba, Y., 1966

On the giant sea-salt particles in the atmosphere III. An estimate of the production and distribution over the world ocean, Tellus, 18: 132-145

An attempt has been made to draw the isolines of estimated distribution of giant sea salt particles at the sea surface and at the 1 km level. The production rate and the number concentration of particles of various class intervals of salt mass, and the number concentration at the 10 m and 2 km levels, were calculated and related to the data plotted into maps.

4.2

To a, Y., and M. Tanaka, 1963

Study of dry fall-out and its distribution of giant sea-salt nuclei in Japan, J.Meteor. Soc. Japan, 41: 135-144

Weight-number distribution of giant salt nuclei which fell to the ground in Japan were deduced. A conclusion was reached that the giant salt nuclei are generated on the sea surface and transported in the boundary layer over the mainland in accordance with the model established by Toba (1961). There are very strong variations in the weight-number distribution curves. The rate of dry fall-out was between 3×10^{-12} to 2×10^{-14} g $cm^{-2} sec^{-1}$.

4.2

Torreson, O.W., W.C.Parkinson, O.H.Gish and G.R.Wait, 1946

The number of condensation nuclei over the Atlantic and Pacific Ocean, Scient.Results of Cruise VII of the Carnegie during 1928 - 1929 under command of Captain J.P.Ault. Oceanography - III. Carnegie Inst. of Washington, Publ. No. 568: 153-156

No influence of day time on CN concentration was observed in the Pacific Ocean.

4.1

Tsunogai,S., O.Saito, K.Yamada, and S.Nakaya, 1972

Chemical composition of oceanic aerosol, J.Geophys. Res., 77: 5283-5292

The report deals with the measurement of marine aerosol in the Pacific Ocean and around Japan. Cl/Na ratios ranged from 3 to 6, on the island Hachijojima an excess of 10% sulfates and Ca was found. The concentration of sea salts increased about 10 times for each 4 m/sec increase of wind velocity.

4.2 - 2.9

Turner, J.S., 1955

The salimity of rainfall as a function of drop size, Quart.J.Roy.Meteor.Soc., 81: 418-429

A close correlation has been found between the raindrop size and the concentration k of chlorides in the drops of radius r. The exponent a in the equation $k \sim r^{-a}$ was equal to 1.0, but can be as high as 2.6. The author attributes the high values to the intense evaporation of droplets in the air below the clouds. The samples were taken at the coastal site in Australia.

4.3

Turpin,P.-Y., G.Madelaine, and J.Bricard, 1974

Granulometrie photoelectrique des aerosols en provenances de la mer dans la domaine 0.03 - 2 u, J.Rech. Atmos. 8: 699-708

A special photoelectric size analyzer measured particles from r=0.03 um to $r < 0.2$ um. It was completed by an AN counter and a counter for particulates with $r > 0.2$ um. The measurements on the seashore of the Canal la Manche yielded the concentration of particles larger than r=0.03 um about 7,000 cm^{-3} during a fog and 2,800 cm^{-3} on another day without fog. The particle size distribution followed Junge's function with a mode near to 0.05 um radius.

4.1 - 4.2 - 1.2

Twomey, S., 1954

The composition of hygroscopic particles in the atmosphere, J.Meteorol. 11: 334-338

Sea-salt particles in pure maritime air contain practically no insoluble components. The author used the sharp phase transition at 73% R.H. for identifying the salt nuclei.

1.4

Twomey, S., 1955

The distribution of sea-salt nuclei in air over land, J.Meteor., 12: 81-86

Aircraft measurements of the concentration of sea-salt particles in south-eastern Australia from the coast for about 700 miles inland are described. In an airstream the concentration of sea salt nuclei did not change appreciably when nuclei were transported inland. The number of nuclei at the 5,000 ft. level was found to be half the number at the 1,000 ft. level. Over the sea, however, the ratio at those levels was usually much less. Particle larger than 4.0 um (at 80% R.H.) were found at altitudes of 700 to 2700 m.

4.2- 1.7

Twomey, S. 1959

The nuclei of natural cloud formation. Part I.: The chemical diffusion method and its application to atmospheric nuclei. Geofis. Pura e Applic., 43: 227-242

For continental conditions was found $N = 945\ S^{-0.40}$ (N=nuclei concentration, S=supersaturation). If the particles would be NaCl with "dry" radius r_n, then $N(r_n) = 66\ r_n^{-0.6}$. An isothermal diffusion chamber with HCl solutions was used and a large variety of supersaturation spectra in southeastern Australia obtained. They could be grouped into continental, maritime and modified maritime spectra. Continental aerosols have one or two orders of magnitude higher counts (for higher supersaturation).
1.5

Twomey, S., 1960

On the nature and origin of natural cloud nuclei, Bull. de l'Obs. du Puy de Dome, 1: 1-19

Soil samples when heated by radiation could release considerable number of cloud nuclei. The author confirmed the production rate of sea salt nuclei calculated by Mason (200 particles in the 0.1 um size range per bubble). Particles formed in this way can be as small as 10^{-2} um and can account for most of the sea spray particles found over the ocean. Production rate of salt nuclei generated by the evaporation of ground water is 10^4 - 10^5 particles/cm^2 of very small particles.

2.3

Twomey,S., 1963

Measurements of natural cloud nuclei, J.Rech.Atmosph.,1: 101-105

Samples were taken into a thermal diffusion chamber near Washington, D.C. The supersaturation range was 0.1 to 1.0%. At 0.1% number of droplets range from 10 to 500 cm^{-3} and at 10% supersaturation from 20 to 3000 cm^{-3}. Lowest counts were obtained in maritime air and in polar outbrakes. Highest counts corresponded to slow- moving continental air. The counts in maritime air mass in the U.S.A. were higher than in Australia.

4.2

Twomey, S., 1968

On the composition of cloud nuclei in the north-eastern United States, J.Rech.Atm. 3: 281-285

The author demonstrated that most cloud nuclei, whether in continantal or maritime air, have a degree of volatility resembling that of ammonium chloride or sulfate,rather than of sodium chloride. Nuclei produced by bubbling air through a solution of salts leached from a soil sample were found to be much less volatile than natural cloud nuclei, and resembled NaCl. Most of the cloud nuclei are not produced at the earth's surface, but are formed by reactions of trace gases in the air (e.g. ammonia).

2.2

Twomey, S., 1977

On the minimum size of particle nucleation in clouds, J.Atmos.Sci., 34: 1832-1835

Carefully filtrated outside air was irradiated by UV light and stored in 150 l Mylar storage bag. Concentrations and size of nuclei in the storage bag were monitored and also passed into a thermal diffusion chamber. The size of nuclei was monitored by nucleopore filters with pores 1.0 um. A size-critical relationship was obtained and a substantial agreement with the theory resulted. There is no fundamental conflict in ascribing a radius of 0.01-0.025 um to natural atmospheric cloud nuclei.

1.5 - 1.9

Twomey, S., 1977

Atmospheric Aerosols, Elsevier Scient. Publ.Co., Amsterodam - New York, pp. 306.

The book covers the formation of atmospheric aerosol and transformation of a single particle under different environmental conditions. The dynamics of populations of aerosol particles forms a basis for the description of aerosol size spectrum evolution. A considerable part of the monograph is dedicated to the optics of the atmospheric aerosol. The author discusses in detail the impact of the aerosol on the climat.

1.1 - 1.2 - 1.4

Twomey, S., and H.B.Howell, 1965

The relative merit of white and monochromatic light for the determination of visibility by backscattering methods, Appl. Optics, 4: 501-506

A model case of a backscattering for monochromatic light ($\lambda = 0.7$ um ; rubby laser) and for white light (0.4 um $< \lambda < 0.7$ u) has been established which might simulate many fog and haze models. It was shown that the strong dependence of backscatter on the size distribution of the scatteres and on the spectral energy distribution of the source limits the use of the single-ended transmissometer as a device for determining the visibility in haze and fog.

3.2 - 3.3 - 3.6

Twomey, S., and K.N. Mc Master, 1955

The production of condensation nuclei by crystallizing salt particles, Tellus, 7: 458-461

Nuclei of salt were caught on spider threads and their behavior was investigated at controlled relative humidity. If the previous dessication proceeded below a R.H.= 72% the subsequent expansion produced a cloud. The authors deduced from these observations that each saline droplet produced several hundred minute particles (upon crystallization) in the size range of 0.01 and 0.1 um.

Twomey,S., and G.T.Severynse, 1963

Measurements of size distribution of natural aerosols. J.Atmos.Sci., 20: 392

The instrument based on two diffusion batteries is described in which the aerosol particle deposit and yield a decay curve which represents an integral transform of the distribution function with respect to diffusion coefficient. In this way the size distribution of aerosol particles is obtained.

5.14

Twomey, S., and J. Warner, 1967

Comparison of measurements of cloud droplets and cloud nuclei, J.Atmos.Sci. 24: 702-703

The measurement of cloud drop spectra and of cloud nuclei showed in fair weather Cu nice response of both concentrations. The corresponding updrafts were approx. 3 msec-1 and the used supersaturations were 0.2 and 2%. The results support the previous findings of Squires P. and Twomey S. (1961)

1.5 - 2.7

Twomey, S., and T.A. Wojciechowski, 1969

Observations of the geographical variation of cloud nuclei, Journ.Atm.Sci.,26: 684-688

Slopes of the spectra $N=cS^k$ (N=total number of nuclei activated at supersaturation S) indicate the differences between continental and maritime atmosphere. According to the Twomey's model:

Updraft m sec-1	Max. supersaturation % maritime	continental
0.3	0.4	0.3
1	0.75	0.4
3	1.25	0.75
10	2.50	1.50

1.5 - 4.2

Ueno, Y., and I. Sano, 1972

Studies of salt solution aerosols. VIII. The effect of humidity on the stability of spray-dried Na_2SO_4 aerosol and an estimate of the particle density, Bull. Chem. Soc. Japan, 45: 975-980

The author investigated the behavior of Na_2SO_4 (0.1 to 1.0% by weight) prepared by spraying and afterwards by heating the aerosol flow in a furnance at 200-800°C. The aerosol was stored in a container having at the bottom a tray with sulfuric acid of different concentration. In this way a dependence of the aerosol coagulation rate on the relative humidity (up to 90%) has been studied. As humidity increased, the aerosol decay- period got shorter and the particle size larger.

1.2

Ueno, Y., and I. Sano, 1973

Studies of salt solution aerosols. XI. The coagulation rate of an aqueous salt solution aerosol of sodium sulfate and its application to the estimate of the stability of aerosols, Chem.Letters (Chem.Soc.Japan), 1283-1288

The behavior of the stored Na_2SO_4 aerosol was investigated. The aerosol was assumed to be monodisperse and the rate of its concentration change was assumed to be caused by the coagulation, settling and deposition on the walls. The decrease in mass concentration was mainly controlled by coagulation and by change of the relative humidity which seems to be a coagulation - promoting agent.

1.2

Van Grieken, R.E., T.B. Johansson, and J.W. Winchester, 1974

Trace metal fractionation effects between sea water and aerosols from bubble bursting. J.Rech.Atmos, 8 : 611-621

Experiments with the radioactive tracers of ^{65}Zn, ^{75}Se, ^{137}Cs, and ^{152}Eu, were performed in order to check elemental composition difference between sea water and aerosol droplets as a function of particle size. Aerosol cloud was drawn through a cascade impactor (6 stage Andersen) which separated particle size fractions for analysis. The impaction surface was counted later by gamma ray spectrometer. Enrichment relative to Na ion has been found and it exceeded a factor of 10.

1,4 - 2.3

Verzár,F., and H.D. Evans, 1959

Production of atmospheric condensation nuclei by sunrays, Geofis. Pura e Applic. 43: 259-268

The origin of primary clusters and the transition to bigger particles which start coagulation is supported by the measurement of AN.

2.1

Viezee, W., and J. Oblanas, 1969

Lidar - observed haze layers associated with thermal structure in the lower atmosphere, J.Appl.Meteor. 8: 369-375

The observations of the vertical temperature and humidity profile below 1 km has been made with a Cricketsonde rocket system and compared with the simultaneous ruby lidar measurements. The lidar observed a deep layer of particulate matter the upper boundary of which rised in height from morning to afternoon. When a subsidence inversion is observed the largest change in optical density is detected at the level of the inversion.

3.7 - 3.1

Viezee, W., E.E.Uthe, and R.T.H.Collis, 1969

Lidar observations of airfield approach conditions: An exploratory study, J.Appl.Meteor. 81: 274

Lidar observations at Hamilton AFB, Cal. with the aim to determine the cloud ceiling and visibility for aircraft landing operations are described. Useful data on the spatial configuration of the low cloud structure in the direction of the landing path were obtained.

3.7 - 3.1

Vinelli,J., M.B.Baker, H.Harrison,and K.B.Erickson, 1977

A statistical approach to the study of aerosol life cycles, Vol.of Abstr.9th Int.Conf.on Atmos.Aerosols,Cond.and Ice Nuclei, Galway, 103

Simple models were applied to explain the potential sources, sinks and the transport of atmospheric particulates. Some discrepancies were found between the data from WMO measurements and calculated values, e.g. the lifetimes for sulfates deposited over the Atlantic and calculated with the aid of the model were longer than those deduced from the measurements.

4.2

Viskanta, R., R.W.Bergstrom, and R.O.Johnson, 1977

Radiative transfer in a polluted urban planetary boundary layer, J.Atmos.Sci. 34: 1091-1103

The authors present a model of the radiative transfer in a polluted urban atmosphere. The result of numerical computation shows clearly that air pollution plays an important role in the radiative regime and that the absorption of solar energy by aerosols is comparable to that caused by water vapor.

3.1

Volkov, V.V., V.M.Ivanov, L.F.Lebedev, N.G.Naumov, A.C. Nepogodina, and A.I.Omelaiev, 1974

K voprosu ob eksperimentalnom issledovanii prozrachnosti oblakov nizhnego i srednego iarusov, Trudy CAO, Vyp. 106, 11-16

The visibility in clouds (of lower and middle altitude) over Orenburg and Aktinbinsk region was measured with the aircraft differential photoelectric instrument. The light source was a semiconductor quantum generator (Ga As with λ = 9.100 Å). Simultaneously the automatic measurements of the cloud liquid content were performed. The dependence of the optical range on the liquid water content of different types of clouds was investigated.

3.6. - 3.7

Volkovitskii,O.A., L.B.Demina, A.F.Savchenko,and V.V.Smirnov, 1977

The evaluation of optical, microphysical and electrical aerosol properties against relative humidity variations, Vol. Abstracts, 9th Int.Conf.on Atmos.Aerosols, Cond. and Ice Nuclei, Galway, 56

Angular light scattering coefficients, particle size spectrum and electrical characteristics of aerosols have been measured in relation to the variation of relative humidity within the range 40 - 95%. The experiments performed in the 3,200 m^3 chamber with insoluble and soluble particulates. Strong particle electrization and considerable variation of the index of refraction have been observed.

3.5 - 3.1

Volmer, 1939

Kinetik der Phasenbildung, Steinkopf, Dresden-Leipzig. The monograph contains the elements of the phase transition theory based on molecular approach. The author calculates the growth rate of droplet and crystal embryos, mentions the potential applications of the theory of homogeneous nucleation and quotes some few experimental verifications of the theory.

1.9

Volz, F., 1954

Die Optik und Meteorologie der atmosphärischen Trübung. Ber.deut.Wetterdienstes, No.13, Teil 2

A comprehensive study on the optical phenomena in the atmosphere in relationship to the presence of atmospheric aerosols.

3.6 - 3.1

Volz, F., 1956

Optik des Dunstes. In "Handbuch der Geophysik" (F.Linke und Möller, eds.), Vol.8., Bornträger, Berlin, pp.823-897

Discussion of all main subjects related to the optics of atmospheric aerosols is presented. The author shows that α ($\alpha = \beta - 2$; β from Junge's distrib.) varies between 1,5 and 0.5 if the concentration of particles with r=0.5 um are varied by a factor of 2 with respect to the adjacent size distribution. Different values of α are summarized. Exceptionally high value of α was found in Mainz in summer (α=1.8). On Marshall Islands on the beach α = 0.

3.6 - 3.7

Volz, F.E., 1972

Infrared absorption by atmospheric aerosol substances, J.Geophys. Res. 77: 1017-1031

The author investigated transmission spectra of natural aerosol substances using a potassium bromide pellet technique in the wave length range from 2.5 to 15 um. The spectral variation of the absorption coefficient and the imaginary part of the refractive index for sea salt, ammonium sulfate, some insoluble and organic substances is presented.

3.4

Volz, F.E., 1973

Infrared optical constants of ammonium sulfate, Sahara dust, volcanic pumice and fly ash, Appl.Optics, 12: 564-567

Spectra of the real and imaginary parts of the refractive index for the important atmospheric aerosol constituents are measured. The wavelength used ranged from 2.5 um to 40 um and the particulate material used was ammonium sulfate, Sahara dust (collected at Barbados island), volcanic dust and dust from a cool-fired power plant. Sahara dust showed a peak absorption (index $n = 1.0$) at $\lambda = 10$ um. The dispersion is also very pronounced near 9 um and 20 um.

3.4 - 3.5

Volz, F.E., 1972

Infrared refractive index of atmospheric aerosol substances, Appl.Optics, 11: 755-759

The optical constants of dry and sea salt aerosol inthe IR range of 2.5 um $< \lambda <$ 40 um (4,000 - 250 cm^{-1}) are presented. The aerosol substances were obtained from rain and snow water by evaporation (soluble salts). The real part of the refractive index was calculeted from the specular reflectance at near normal incidence of disks of pure aerosol substance, optical constants of mixed aerosol are discussed. The extinction by natural aerosol should have a minimum near 8 um and a strong maximum near 9 um.

3.4 - 3.5

Waggoner, A.P., N.C.Ahlquist, and R.J.Charlson, 1972

Measurement of the aerosol total scatter-backscatter ratio, Appl.Optics, 11: 2886-2889

Simultaneous measurements of backscattering (using a rubby laser radar) and of the scattering portion of extinction using an integrating nephelometer were made in Seatle. Both instruments were calibrated in such a way that the separation of the molecular and aerosol scattering was possible. Backscatter and the scatterin portion of extinction were well correlated at relative humidities below 70%.

3.6 - 3.2

Wall, E., 1942

Zur Physik der Wasserdampfkondensation an Kernen, Z.Angew. Meteor., 59: 106-125

A qualitative analysis how different substances adsorb and absorb water molecules from the environment. Simple measurements of accretion of water on wettable and unwettable substances are described and interpreted for the growth of condensation nuclei. The author calls attention to the hysteresis effect in the growth of a salt particle at increasing and decreasing humidity.

1.5 - 1.3

Ward,G., K.M.Cushing, R.D.Mc.Peters, and A.E.S.Green, 1973

Atmospheric aerosol index of refraction and size-altitude distribution from biastatic laser scattering and solar aureole measurements, Appl. Optics, 12: 2585-2592

The polarisation and intensity of laser light scattered from a 500 m long horizontal column of air was measured for angles ranging from 8^{o} to 172^{o}. Photographing the sun aureole, the intensity of sunlight scattered from a column of air between the earth and the sun was measured from 2^{o} to 120^{o}. These three data sets were analyzed assuming the single Mie scattering corrected for Rayleigh scattering. The complex index of refraction is found to be typically $m_r = 1.50 * 0.05$, $m_i \leq 0.005$ for particles with liquid coating.

3.5

Wells,W.C., G.Gal, and M.W.Munn, 1976

Aerosol Distributions in Maritime Air and Predicted Scattering Coefficients in the Infrared, LMSC/D457849 Lockheed Palo Alto Research Laboratory, June

A model has been developed which describes maritime aerosol as a mixture of maritime and continental aerosol. The model takes into account the influence of wind velocity and relative humidity on the evolution of particle size spectrum. Infrared scattering coefficients were calculated from the model.

3.2 - 3.4 - 1.2

Whitby, K.T., 1949

Bibliography of particle size determination, Milling Engin.Res.,Mech. Engin. Dept. Univ. of Minnesota, 47 p.

The bibliography contains a description of 27 methods of particle size determination. Alphabetical bibliography of about 450 titles on particle size determination is attached. Included are microscopic techniques, microprojection, photomicrography, sedimentation,turbidimetric methods, hydrometer sedimentation methods, elutriation, sieving analysis and electron microscopy.

1.2

Whitby, K.T. 1974

Modeling of multimodal aerosol distribution, in "Aerosole in Naturwissenschaft, Medizin und Technik," Jahreskongress GAF, 136-142

The author used aerosol measurements from different locations in the USA for showing the usefulness of the multimodal distributions. Three log-normal distributions seem to describe truly the size distribution of natural aerosol the variability of which is surprisingly low.

1.2

Whitby, K.T., 1975

On the multimodal nature of atmospheric aerosol size distributions, Proc. 8th Int.Conf. on Nucleation, Leningrad, 1973, Gidrometeoizdat, Moscow, 404-415

From many measurements in different environments is apparent that the volume distribution is practically always bimodal with one mode between $0.1 < d < 1.0$ um and the second above 5.0 um. In addition, a transient nuclei mode between 0.01 and 0.03 um is often seen. Sea salt aerosol during conditions of heavy surf had a volume mode at 10 um.

..2

Whytlaw-Gray,R. and H.S. Patterson, 1932

Smoke. A study of aerial disperse systems. Adw.Arnold & Comp., London.

The authors suggest that the collision efficiency of aerosol particles may be altered either by physico-chemical structure of surface or by the changes in surface state (pp. 10-12, 184-186)
The experiments (p.27) have confirmed the validity of Smoluchowski's theory of aerosol coagulation at least for particles larger than 5×10^{-3} um.

1.2

Wigand, A., 1919

Die vertikale Verteilung der Kondensationskerne in der freien Atmosphäre, Ann.Physik, 59: 689-742

Description of the AN measurements on a balloon over Central Europe is presented. The vertical profiles of AN concentrations can be characterized by a decrease of concentrations corresponding to an exponential function of the altitude at fair weather conditions.

4.1

Wilkniss, P.E., and D.J. Bressan, 1971

Chemical processes at the air-sea interface: The behavior of fluorine, J.Geophys.Res. 76: 736-741

Radiochemical experiments showed a decrease in the F/Cl ratio for laboratory aerosols produced from sea water. Marine aerosols showed an increase in the F/Cl ratio with a possible contribution from airborne dust contamination. Jet drops in the laboratory and naturally occurring marine jet drops showed little to no difference. On the Beach of Oahu Island, Hawaii drops large as 30 - 300 u were found in the surf zone 10 cm above the crest of the wave.

1.4 - 2.3

Wilkniss, P.E., and D.J. Bressan, 1972

Fractionation of the elements F, Cl, Na and K at the sea-air interface, J.Geophys.Res., 77: 5307-5315

From the samples collected in the lower layers of the atmosphere we conclude, that the process of fractionation is effective and can lead to the enrichment of Na. Both mechanism: surface ion fractionation combined with the injection into the atmosphere and transformation due to the atmospheric pollutants of continental origin are effective.

1.4 - 2.4 - 2.3

Wilkniss, P.E., D.J.Bressan, R.A.Carr, and R.E.Larson,1974

Chemistry of marine aerosols and meteorological influences, J.Rech.Atmos., 8: 883-893

Radon 222, sea salt and continental dust (collected on a nylon mesh) were measured aboard ships over the Greenland Sea, the Caribbean, the North and South Pacific, and over the Ross Sea. The highest salt content of salt particles with $r > 2$ um was found over the Greenland Sea (8,890 ug/m^3) and over the Caribbean (6,000 ug/m^3). The highest content on continental aerosol was measured over the Caribbean (25,000 ug/m^3). The maximal ratio Cl/Na was found over the Greenland Sea (2,25)

4.2

Wills, T.L., and M.J. Matteson, 1974

Gas-liquid mass transfer in aerosol systems, in "Aerosole in Naturwissenschaft, Medizin und Technik", Jahreskongress GAF, p. 253-257

There is some evidence that the transfer of SO_2 to droplets growing by water vapor condensation is many times greater than the transfer in steady- state situation. The authors hypothesized that the decrease of surface tension with the concentration of dilute salt solution indicates an adsorption of dissolved ions at the surface. The exact nature of these receptor sites is not known. The transfer of SO_2 and O_2 to the falling droplets is now investigated experimentally.

1.4

Wilson, A.T., 1959

Air-borne nitrogeneous material and other plant nutrients, Nature, 4680: 99-101

In the mountains in New Zeeland above the vegetation line were collected nitrogeneous materials which were not contaminated by continental pollutants. The hypothesis is presented that the materials do originate on the sea surface from the foam. Potassium/sodium ratio in rainwater is often larger by a factor of 10 than at the sea. This can be explained by the fact the salts are transported from the sea surface where are the marine organisms, many of which are known to have much higher potassium/sodium ratios.

1.8 - 2.8

Winkler, P., 1971

Growth of natural aerosol particles with relative humidity, Suppl.Vol.Proc.7th Int.Conf.Condens.Ice Nuclei, Prague-Vienna,1969, Academia, Prague, 168-175

The main difference between continental and maritime aerosol is around 75% R.H. Different mixtures of inorganic salts might increase the total uptake of water and the steps on the growth curve are more and more reduced until a curve similar to that in the atmosphere is reached. Further, an interaction between soluble and insoluble material is studied.

2.7

Winkler, P., and Ch.E. Junge, 1971

Comments on "Anomalous deliquescence of sea spray aerosols", J.Appl.Met., 10: 159-163

Difference between the behavior of sea spray aerosol and aerosol prepared from the pure salt solution at different humidities is explained by the hysteresis and by the crystal water of the salts. No effect of organic materials was found in relationship to the observed retarded activity of nuclei.

1.5 - 1.7 - 1.8

Woodman, D.D., 1974

Limitations in using atmospheric models for laser transmission estimates, Appl.Optics, 13: 2193-2195

The prediction of the horizontal transmission of laser beams requires informations regarding the dependence of the scattering coefficient on the wavelength, visibility and aerosol characteristics. In the article the accuracy of transmission estimates is evaluated using the Elterman and McClatchey et al. models. Some features of the prediction of infrared transmission ar· discussed. The two most widely used aerosol models predict significantly different aerosol attenuation.

3.6 - 3.2 - 3.4

Woodcock, A.H., 1952

Atmospheric salt particles and raindrops, J.Meteor., 9: 200-212

The author finds that the chlorinity of rain varies with the intensity of rain in a similar manner. He attempts to explain this relationship by presenting distribution curves of sea-salt particles in the atmosphere sampled at different altitudes. The sampling has been done by exposing one millimeter wide glass slides to the free air stream.

1.5 - 2.7

Woodcock, A.H., 1953

Salt nuclei in marine air as a function of altitude and wind force, J.Meteor., 10: 362-371.

On Hawaiian islands isopiestic method was applied for salt nuclei identification at different altitudes. The concentrations for particles with $m > 10^{-9}$ g ranged from $1/m^3$ to $5000/m^3$ at the height near the cloud base. On a single day with a wind force 12 the concentration reached $10^5/m^3$. Smaller particulates down to the size $2r \geq 1$ um had concentrations from $0.1/cm^3$ to $3.5/cm^3$. Over the sea the concentration of the sea salt particles decreases rapidly with height; on the average in the ratio 1 to 5 every 500 meters.

2.7 - 4.2

Woodcock, A.H., 1957

Salt and rain. Scientific American, 197: 42-47

Recent studies indicate that particles of salts from the sea may play a key role in the process of transformation of small water droplets in a cloud growing into larger precipitation elements. General theories of rain formation (Findeisen- Bergeron and Langmuir- Schaefer) are discussed. Ordinary sea winds carry from 10 to 100 pounds of sea salt per cubic mile of air. Bubbles forming on white caps of waves are believed to be the source of sea-water droplets and crystals. The droplets also bear an electric charge.

2.3

Woodcock, A.H., 1957

Atmospheric sea salt nuclei data for project Shower, Tellus, 9: 521-524

It is assumed that sodium chloride particles have a decreasing concentration with altitude. The author found that at the cloud base, at about 500 m, the total sea-salt concentration is rather high for a given wind velocity. There was a rapid decrease in particle concentration within and above the clouds.

2.7 - 4.2

Woodcock, A.H., 1960

The origin of trade-wind orographic shower rains. Tellus, 12: 315-326

Woodcock compared observations of the chloride concentration in orographic rains in the trade winds on the slopes of the Island Hawaii with the theoretical value $k_1 = C/L$. Concentration of chlorides in the air C was taken from the aircraft measurement; L was calculated. The measured data for k_1 agreed with the calculated within 30%.

1.5

Woodcock, A.H., 1972

Smaller salt particles in oceanic air and bubble behavior in the sea, J.Geophys.Res., 77: 5316-5321

Sea salt particles over Hawaiian and Alaskan seas are investigated. Differences in size spectra are explained by different bubbling mechanism over both seas and different mean size of bubbles. The break in the size distribution curve occurs at $m = 10^{-13} - 10^{-14}$ g. This corresponds to the transition from bubble jet to a bubble film mechanism. Alaskan waters are relatively poor source of particles of $m < 10^{-14}$ g.

2.3 - 1.2

Woodcock, A.H., and D.C. Blanchard, 1955

Test of the salt-nuclei hypothesis of rain formation, Tellus, 7: 437-448

The authors found that in orographic showers in Hawaii the largest drops in the cloud form around the largest salt nuclei. There is a characteristic dependence of the chloride concentrations upon the size of droplets with a minimum around 1 mm diameter. One can conclude that either the drops grow only by condensation, or if coagulation is involved, the majority of cloud droplets do not grow on sea salt nuclei.

1.5

Woodcock, A.H., D.C. Blanchard, and C.G.H. Rooth, 1963

The latent heat released on sea-salt particles during a condensation process may be an important factor in the transport of moist air particles from near the sea surface to cloud base altitudes. These estimates are used to compute several models of temperature stratification. The addition of 20 to 40 mg finely divided sea salt particles per kg of air over ocean should result in ascending motions, and perhaps, to cause cloud formation.

1.5

Woodcock, A.H., and M.Gifford, 1949

Sampling atmospheric sea-salt nuclei over the ocean, J.Marine Res. 8: 177-197

The rate of nuclei decline with altitude was great in thermally stable air, where a little change with altitude was observed in well-mixed air over warmer waters. Sampling has been done by exposing 1x15 mm glass surfaces coated with hydrophobic Dri-film and examining the droplets by a microscope, in a box with thermostatic control of temperature and vapor pressure.

2.7

Woodcock, A.H., C.F.Kientzler, A.B.Arons, and D.C.Blanchard, 1953

Giant condensation nuclei from bursting bubbles, Nature, 172: 1144-1145

High-speed camera photographs of the bursting of sea-water bubbles and the generation of many tiny salt crystals are described.

2.3

Woodcock, A.H., and A.T. Spencer, 1957

An airborne flame photometer and its use in the scanning of marine atmospheres for sea-salt particles, J.Meteor. 14: 437-447

In relatively small non-precipitating cumulus clouds the weight of sea-salt was about double that of the clear air around the clouds. An increased concentration of sea-salt nuclei can be found in the space formerly occupied by the cloud, after its dissipation.

2.7

Woodcock, A.H., and A.T. Spencer, 1961

Lava-sea-air contact areas as sources of sea-salt particles in the atmosphere, J.Geophys.Res. 66: 2873-2887

Small sea salt particles can be generated in large quantity (1 to 6 million times greater) from steaming lava than from the sea surface. 1960 eruption of Kilauea volcano produced many nuclei on the places where lava entered the sea. Particles were almost all soluble with a large number of small NaCl nuclei. The steam cloud particles were artificially generated in laboratory under conditions similar to natural.

2.2

Wright, H.L., 1940

Atmospheric opacity at Valentia, Quart.J.Roy.Meteorol. Soc. 66: 66-77

Visibility decreases with relative humidity. Theoretically much larger change in visibility should be expected at the R.H. change from 40 to 75% than it was observed by the measurement on the seashore. One has to assume that the majority of maritime aerosol must contain a continental component. The data on visibility are grouped according to the relative humidity and the direction of the wind.

3.6

Yamamoto, G., and T. Ohtake, 1953

Electron microscope study of cloud and fog nuclei, Sci.Rep. Tohoku Univ. Ser.5, Geophys. 5: 141-159

Studies show that in maritime air the prevailing constituents of aerosols are combustion products and not sea-salt nuclei. The percentage of activated nuclei drops with decreasing size. The authors observed the particle evaporation with increasing electron beam intensity.

1.4

Yamamoto, G., and T. Ohtake, 1955

Electron microscope study of cloud and fog nuclei, Part II., Sci. Rep. Tohoku Univ. Rev. 5, Geophys.,7: 10-16

Fog and mist nuclei collected at various places were examined by an electron microscope. Mist nuclei are mainly sea salt crystals and the majority of fog nuclei are combustion products. Size distributions of nuclei are presented in histograms which are accompanied by the table of the ratios of drop size to nucleus size.

1.4

Zenker, H., 1953

Brandung und Kondensationskerne an der Ostseeküsste, Angew. Meteorol. 1: 372-375

The author found on the Baltic seashore a positive correlation between AN counts and the height of ocean waves at wind velocities higher than 7m/s.

2.9 - 4.1

Zerche, M., and W.Hänsch, 1966

Ergebnisse über die Bestimmung des Chloridgehaltes im Niederschlagswasser in Schwerin - Meckl., Zeitschr.f.Met. 19: 97

The analysis of the rainwater shows that a very high concentration of chloride ions occurred in the rear side of the advancing center of low pressure in a cyclone.

4.3

Zuev, V.E., 1974

Meteorological Optics. Propagation of Visible and Infrared Radiation in the Atmosphere, Transl. from Russian by D. Lederman. Wiley, New York, 1974, 405 pp.

The monograph contains a collection of contributions on all main subjects of the propagation of light in the real atmosphere. The reference list contains most of the recently published articles on this subject in the USSR.

3.1

Zuyev, V.Y., L.S.Ivlev and K.Y.Kondrat'yev, 1973

Recent results from studies of atmospheric aerosols, Atmos. Oceanic Physics 9: 204-212

The article includes simultaneous optical and microphysical measurements in the surface layer, a model of the complex refractive index and aerosol absorption in the troposphere. The chemical composition of troposperic aerosol, the structure of stratospheric aerosols, and the shape of the aerosol-particle size spectrum are discussed.

3.5 - 1.2 - 1.4