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# **Science & Technology**

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# Science & Technology

## USSR: Earth Sciences

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7 February 1989

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### Research Terms Sail To Site of Future Arctic Station SP-31

18650035a Moscow IZVESTIYA in Russian  
9 Oct 88 p 6

[Unattributed article]

[Text] On October 7, the electrically driven motor ship "Vladimir Arsenyev" left Pevek for the place where a new drifting station, "Severnnyy polyus-31 (SP-31)" will be located. Escorted by the icebreaker "Admiral Makarov", this powerful motor ship, which is intended for work at places on the Arctic coast which have no mooring facilities, has to pass through ice masses of the Central Arctic. This is the first time that the Far East seamen have headed for such high latitudes.

After passing Wrangel Island, the ship's crew will land winter research teams and unload equipment northeast of this island, for the teams' upcoming tour of duty on the drifting ice flow of SP-31. The polar specialists are to observe such remarkable phenomena as the Northern Lights and study the Earth's magnetic field and seabed relief, as well as the climate in an area which is the 'weather kitchen' for our planet's Northern Hemisphere.

En route to the future SP-31 station, the crew of the "Vladimir Arsenyev" will deliver cargo to coastal polar stations, access to which is obstructed by heavy ice. Unloading will be done with the aid of a ship-based helicopter of the giant vessel.

### Adaptation and Ozone-Hole Studies at Antarctic Station

18650048a Moscow IZVESTIYA in Russian  
30 Nov 88 p 8

[Article by B. Pilyatskin, correspondent]

[Extract] Replacement of the contingent on duty at Molodezhnaya station is being completed. An IL-76TD airplane which arrived from Leningrad delivered participants of the 34th Antarctic Expedition to this station.

After consulting with Yu. Khabarov, head of the station and an experienced polar scientist, I decided to inquire about a key topic: "Man and the Antarctic." How does the Antarctic affect vital activity of the human organism? And, on the other hand, don't people by their very presence and work 'disturb' the sixth continent with its ecological purity? Candidate of medical Sciences A. Dmitriyev is studying these problems.

"A fairly large knowledge of negative effects of antarctic conditions on the human organism has already been acquired. Geomagnetic disturbances and the outerspace background, sharp changes in the weather, specific features of diet, when it is based on foodstuffs that are stored for a long period of time—these and many other factors lower capacity for immune defense and affect

overall psychophysical condition. Ways of resisting and reversing these factors must therefore be thought about.

"A synchronous experiment with white mice is being conducted for the first time this year. One portion of these experimental animals was left in Leningrad, while another portion was delivered by air to Molodezhnaya. These studies are continuing, but interesting data in regard to immune defense have already been obtained. It has been found that immune defense is lowered by fresh melt, i.e., by water obtained by melting Antarctic ice, to put it more simply."

My last Antarctic interview was with senior engineer V. Terletskiy, who is studying the problem of the so-called 'ozone hole.'

"There is a zone in which the content of ozone in the atmosphere is lower as compared with the average climatic content. [Several years ago,] a sharp lowering of the ozone content (up to 70 percent) was recorded which took place in September-October. This is the initial period of reorganization of seasonal atmospheric processes on a global scale.

"We conducted comprehensive studies of this mysterious phenomenon at our stations for the first time this year.

"Data which were obtained have forced us to take a new look at the widespread hypothesis that 'holes' originate as a result of the action of chemicals (freons). The point is that the reorganization of atmospheric processes which I just mentioned came 40 days earlier this year, and the 'ozone hole' simply didn't have time to form.

"It must therefore be assumed that formation of the hole is controlled not by chemical but by dynamic atmospheric processes."

### "Ekspark" Group Plans Future Cargo Drops at Arctic Stations

18650048b Moscow TRUD in Russian 21 Nov 88 p 1

[Article by A. Trushin]

[Excerpt] "Ekspark" is an association of enthusiasts under the direction of A. Sidorenko, a meritorious master of sports of the USSR who took part in a unique parachute landing in the Pamirs. It was decided to lower the cost of delivering cargo to remote Arctic stations, using surplus military equipment. [See also the DAILY SNAP, 17 November 1988 p 2 col 2]

Ye. Kohevnikov, one of the organizers of "Ekspark," related:

"At first, our idea simply was not understood. How could costly cargo be dropped by parachute? But when the first platforms landed precisely where they were supposed to at a polar station, and not a single glass jar

in containers was broken, doubts disappeared. The USSR State Committee on Hydrometeorology was the first to decide to deliver cargo in this manner. We received excellent assistance from personnel of the Moscow Aviation Institute imeni Ordzhonikidze and the Design Bureau imeni Ilyushin."

"Ekspark" participants have made 150 jumps onto island and drifting stations so far. They have taken part in training exercises of the Unified Aviation Search and Rescue Service in which a satellite system is employed.

However, "Ekspark" still does not have official status, even though two expeditions to drifting stations have been conducted this year alone and two more are being prepared.

D. Zotov, deputy chairman of the USSR Council of Ministers' State Commission on Arctic Affairs, thinks that the "Ekspark" method holds much promise in the new conditions of economic management. The cost of delivering cargo from the mainland is reduced by 20 times when this technology is employed.

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**Constructing Reflecting Surfaces in  
Three-Dimensionally Inhomogeneous Media  
Using Data From Common Depth Point Method**  
18650042 Moscow VESTNIK MOSKOVSKOGO  
UNIVERSITETA: GEOLOGIYA in Russian No 5,  
Sep-Oct 88 (manuscript received 11 Jun 86) pp 61-70

[Article by T. I. Oblogina and I. Dzhabur, Moscow  
University]

[Abstract] One of the most important tasks in the common depth point method (CDPM) is the plotting of structural maps of reflecting horizons in multilayer media with variable velocities of seismic wave propagation. Presently known methods for solving this problem have been developed only for cases when velocity in the layers is either constant or is dependent on one vertical

coordinate or is a linear function of a coordinate of a point in the layer. This article describes a differential ray equations method which makes it possible to determine reflecting surfaces in a multilayer medium with curvilinear boundaries and variable stratum velocities. The method is based on construction of a mathematical model of reflection of waves in a medium described by a three-dimensional velocity function, piecewise-constant for the vertical coordinate  $z$  and arbitrary for the horizontal coordinates  $x, y$ . Computations are presented illustrating retrieval of reflecting boundaries corresponding to each of the time-coordinate relations with allowance for the refraction of rays at all the above-lying interfaces. This method for constructing reflecting surfaces was incorporated in an algorithm and in the "Plast-3D" program in FORTRAN-IV. Practical application of the method is illustrated for the Latakia area in northwestern Syria. Figures 6; references; 10 Russian.

**Baltic Sea: Regional Ecological Security**  
18650045a Moscow *ADVANCES OF SCIENCE AND TECHNOLOGY* in English No 31, 5 Nov 88

[Article by Doctor of Law Alexander Timoshenko, senior scientific fellow, the Institute of the State and Law, the USSR Academy of Sciences]

[Text] Mankind is equally threatened by a nuclear conflagration and by an ecological catastrophe due to a great disbalance in major biospheric mechanisms.

Maximum ecological security can, therefore, be reached only when it is guaranteed everywhere, in all parts of the world. But like a painting consists of individual strokes of the paint-brush, so solution of ecological security problems in individual regions of the world will ultimately ensure global ecological security.

The northern part of the European continent, especially the Baltic Sea, is a region which exemplifies problems that exist in most countries. Its natural environment is under heavy pressure of industrial and agricultural production, it is an area where armed (including nuclear) forces of two major military alliances are facing each other, it is a region with large movements in defence of nature. Lastly, the region has examples of constructive and mutually advantageous cooperation between countries of different social and economic systems.

The condition of the Baltic Sea has indeed become an indicator of the region's ecological security. Present in it are all kinds of man-made pollution. This sea is the subject of two international conventions: the Gdansk convention of 1973 on fishing and preservation of living resources, and the Helsinki convention of 1974 on the protection of the marine environment of the Baltic Sea.

The Helsinki convention set limits on the pollution of Baltic waters with toxic chemicals, waste, and municipal, industrial and agricultural effluents from shore sources. The convention contains a number of addenda specifying the sides' commitments on pollutants, mechanisms and procedures. There is a special government authority—the Baltic Commission—to supervise the observance of the convention.

One may wonder why the ecological condition of the Baltic Sea is continuing to cause concern? Experts say that the sea still gets about 50,000 tons of spilled oil and oil products annually. And although this is well below the figure for the middle 70s (that is, before the Helsinki convention came into effect), nevertheless the concentration of oil products in the Baltic is almost 10 times more than in high seas.

The answer to the question can be found in the way the Helsinki convention is implemented. It was not until May 1980 that it entered into force, that is 6 years after it was signed. The fact points to the lack of political will and funds in certain Baltic states, which prevented them

from starting to fulfill the convention from the moment it was adopted. Second, the dynamics of pollutants in the sea reflects the different obligations imposed by the Helsinki convention. There is an express ban only on two substances: polychlorobiphenyls and DDT. Obligations of the sides to reduce other pollutants, particularly those from ground sources, remain vague, and contain a number of reservations, exceptions and all sorts of loopholes. Efforts of Baltic states are mainly concentrated on research into the ecological problems of the sea. Despite the importance of this cooperation, it does not obviate the need for tougher control of the more dangerous pollutants.

Military activities in the area are another major factor determining the ecological security of the Baltic Sea. Ships carrying nuclear weapons and sailing in the Baltic waters represent not only a political and economic hazard, but also an ecological risk. It may be recalled that the Baltic Sea, with its temperature, chemical and biological conditions, is an ecological system very vulnerable to deleterious effects. Its capacity for self-purification and for self-regulation is smaller than that of other seas.

The Soviet Union and the European socialist countries are in favour of turning the Baltic Sea into a zone of cooperation and peace. The international legal regime of the Baltic Sea has historically evolved as the regime of a closed sea, or a landlocked sea, according to the UN convention on the Law of the Sea of 1982. The regime of a closed or landlocked sea entails special restrictions and prohibitions relating to war ships and planes in order to protect the economic and security interests of the coastal states. Curiously enough, as early as the 17th-19th centuries the Baltic states concluded a number of treaties banning foreign fleets from the Baltic Sea. The Soviet states, as soon as it came into being, adopted a policy of full implementation of the "closed sea" regime for the Baltic area. In its peace treaties with Finland (1920) and other Baltic states, Soviet Russia got the principle of neutralisation of the Baltic Sea accepted. At a conference on the limitation of naval weapons in 1924, a Soviet delegation proposed closing the Baltic Sea again to warships of non-Baltic countries.

The USSR continued its peace initiative in relation to the Baltic Sea also after the Second World War. In 1957, the Chairman of the USSR Council of Ministers, in a message to the prime minister of Denmark, proposed turning the Baltic Sea into a "sea of peace," without atomic and rocket weapons, free of military bases and ships of non-littoral states. But NATO's military doctrine and the policy of some of the Baltic states belonging to the Atlantic alliance prevented the adoption of the Soviet proposal. Today statesmen and Party leaders of the Scandinavian countries are insisting on a nuclear-free zone in Northern Europe. This puts in a new light the position of Denmark which as early as 1951 adopted so-called "Danish rules of passage," giving warships of NATO member-countries in fact an unlimited right to enter and stay in the Baltic Sea. The Soviet Union has

proposed some specific measures which it is ready to undertake in support of a nuclear-free regime in the European north. These are: unilateral reduction of nuclear delivery vehicles over Soviet territory adjoining the Baltic Sea; withdrawal of ballistic missile submarines from the Soviet Baltic fleet if the Baltic Sea is granted a nuclear-free status; and effective confidence-building measures both in Northern Europe and in the parts of the Northern, Norwegian, Barents and Baltic Seas adjoining it.

The peoples of Northern Europe and Baltic states today face a historic choice. Either they will turn the Baltic area into a region of peace and cooperation, with reliable ecological security, or they will wittingly or unwittingly contribute to a possible ecological death of the Baltic Sea.

**CMEA Countries' Cooperation in Baltic Studies**  
*18650045b Moscow ADVANCES OF SCIENCE AND TECHNOLOGY in English No 31, 5 Nov 88*

[Article by Vladimir Kuznetsov, Cand. Sc. (Georg.) senior researcher at the CMEA Cooperation Centre on the World Ocean problem]

[Text] The Baltic Sea is surrounded by seven countries—Sweden, Finland, the USSR, Poland, the GDR, the FRG, and Denmark. The zones of their economic interests practically cover the entire sea area, a narrow corridor alone being left free along the main southwestern-northeastern axis. These are all highly-developed countries exerting a powerful technogenic impact on the environment of this relatively shallow-water (maximum depth 450 m) basin. A crucial step in Baltic studies was the signing by these countries of a Convention for protection of the Baltic Sea environment and the setting up of its executive agency—the Helsinki Commission (1980). The socialist countries—the USSR, Poland and the GDR which account for the major portion of the eastern and southern Baltic coasts are participating in all common programs for research and monitoring.

Joint work for scientists from the CMEA countries involves the exchange of information and specialists, meetings, seminars, symposia, scientific schools. But the main thing are large scientific expeditions, both on ships and coastal. In charge of all these activities is the Coordination Centre in Moscow, affiliated to P.A. Shirshov Institute of Oceanology, USSR Academy of Sciences.

Since 1971 the CMEA countries have carried on researches in the Baltic, the results of which have been used for other sea areas as well. Precisely such universality distinguished the first major experiment in the Baltic, namely EKAM which took place in 1973, using as a base the Leipzig University's Marine Laboratory facilities at the Zingst township. This experiment involved the study of the sea-atmosphere interaction in the coastal

zone and it has yielded important measured and averaged physical characteristics of the processes taking place here, particularly during storms.

In the mid-1970s a series of complex experiments took place at the coastal station Lubiatowo affiliated to the Institute of Water Construction, Polish Academy of Sciences. The objects of research were the physical state of the sea (its temperature, stratification, salinity), water movement and the movement of suspended debris and loose sediments during storms, when these processes proceed with particular intensity. The obtained data are being used in hydroengineering construction, i.e. building ports, wharves, beaches, and in coast reinforcement work.

Scientists from the GDR, Poland and the USSR in a joint three-volume work "Essays on the Baltic Sea's Biological Productivity" have summarized the results of the expeditions studying various marine environment factors affecting the bioproduction process.

The Baltic Sea's open areas in May-June 1984 were explored by a major international expedition aboard the Soviet vessel Akademik Kurchatov. A similar cruise is to take place in the forthcoming autumn-winter period. Participants in the cruise of the Polish ship Professor Siedlecki were also Soviet researchers who studied primary sea produce and photosynthesis processes. First experimental studies on off shore ecosystems took place in 1987 in the Gulf of Gdansk on the initiative of the Institute of Oceanology, Polish Academy of Sciences. A small Polish vessel Oceania outfitted with nontraditional automated sails and an auxiliary engineer participated in them.

Specialists at the Institute of Marine Studies, the GDR's Academy of Sciences, in Rostock carried out a complex of researches on sea chemistry. They rather accurately determined the concentration of various metals in sea water, which, though expressed by infinitesimal fractions of a percent, have a great effect on the quality of the environment. It was found out, moreover, that discharges into the atmosphere from industrial enterprises are comparable to noxious substances coming into the sea with river runoffs.

First geophysical joint researches at the Baltic Sea's shelf took place as early as 1973 aboard a GDR vessel with the use of Soviet-made equipment (a gamma-radioprobe from the institute of Oceanology, USSR Academy of Sciences). The purpose of the research was lithologic mapping, particularly the registration of areas with an increased content of heavy minerals. This work was continued in 1974. A series of expeditions took place in 1975-1979 aboard the Professor Dobrynin and the Shelf (the USSR), the Albrecht Penk (the GDR), the Hydromet (Poland). The method of continuous radiometric surveying, developed at the Institute of Oceanology, the USSR Academy of Sciences, was used to identify the percentage of heavy minerals of commercial significance

in sea bottom. This resulted in outlining the fields of bottom sediments containing heavy minerals and in describing the regularities of their distribution at the seabed.

In the course of the expeditions there were, moreover, obtained new data on the seabed structure, as evidenced by the old submerged coastlines and terraces and a detailed study of the later sedimentary masses, these data being necessary for geological mapping and paleo-reconstruction of the Baltic Sea's development in the postglacial period.

In summer 1986 the Soviet ship Akademik Kurchatov was used by German, Polish and Bulgarian scientists to study hydrocarbonic manifestations (gaseous crater, fluid currents) at the Baltic seabed—their geography, chemical composition, outflow velocity and magnitude.

CMEA countries' specialists prepared stratigraphic schemes for late-glacial and postglacial depositions in the Baltic Sea, as well as correlations of subwater and above-water coastal formations.

The question of setting up CMEA's special permanent international laboratory on the Baltic Sea is being considered at present. The laboratory will be concerned with ecology, anthropogenic impacts on the environment and with the setting up of a common oceanological data bank for the Baltic Sea.

#### **Baltic Sea: Look from Above**

18650045c Moscow *ADVANCES OF SCIENCE AND TECHNOLOGY* in English No 31, 5 Nov 88

[Article by Sergei Viktorov, Cand. Sc. (Phys & Math), Head of Laboratory for Space Oceanography and Aeromethods, State Oceanographic Institute's Leningrad Department]

[Text] Studying the ocean-atmosphere interaction and the system of sea currents, assessing the state of biological resources in various sea areas, exercising control for pollution of the World Ocean can now be jointly carried out from aboard aircraft and satellites. To be able more accurately to interpret the space photos of sea areas, Soviet specialists are using subsatellite information, i.e., the results of full-scale experiments.

For instance, to be able to determine the distribution of the fields of suspended ground particles in the Gulf of Finland's eastern part, use was made of data obtained from the Soviet weather satellite Meteor. Images of water areas with a different optical density corresponded to a different purity of water. Validity in interpreting the satellite images was confirmed by visual determinations of water surface brightness, made from aboard the aircraft. The identified zones with an increased content of suspended ground particles along the northern and

southern coasts of the Gulf of Finland's eastern part are to be observed throughout the navigation period. They were found to be mainly due to ground being hydraulically washed away in the course of several years in the vicinity of the Lakhta bank. According to contact ship measurements, about 90 percent of suspended materials are mineral particles. A combined analysis of satellite images, aircraft observations and contact ship measurements enables us to conclude that in the area concerned, given favourable weather conditions, the information from the Meteor satellite can be used to study the zones with a high content of suspended particles of mineral origin, once the latter's concentration exceeds 20-30 milligrams to a liter.

Furthermore, satellites are making available a highly important hydrological characteristic, namely the distribution of the water surface temperature (WST). It is determined by measuring the proper radiation of the sea surface within the infra-red range, a particularly widespread method of space oceanography. The water surface temperature proved to be a principal physical characteristic of the state of the ocean-atmosphere interface. The WST largely determines the intensity of dynamic processes in the ocean mass, which, in their turn, are influencing the atmospheric circulation. The knowledge of the WST field in the Baltic region is necessary for thermal balance calculations, weather forecasting (including long-term one), as well as to meet the requirements of navigation, fishing, etc. Compilation of WST maps became possible after the appearance of satellites outfitted with infra-red radiometers.

Satellite WST maps were instrumental in finding out that the Baltic Sea possesses a complex spatial thermal structure, numerous thermal "spots" which are apparently vortical formations. The satellite once recorded at the sea surface simultaneously up to 80 such spots 20-60 kilometers in diameter. Cold spots or at least part of them are, in effect, cyclonic vortices. They are caused either by the existing system of sea currents or by the eruption of depth waters onto the surface. The temperature of such cold vortices according to satellite data is 9-12 degrees in summer time and that of warm vortices—16-20 degrees. To be able to calculate the velocity field of the surface currents we must have three successive WST maps at a day's interval at the maximum, the velocity field being plotted with respect to the middle map. Our calculations showed the order of surface current velocity values, as determined from satellite WST maps and synchronous aerial photography data, to be coincident.

Very fruitful has proved to be the cooperation between Soviet and German oceanologists from the Institute of Marine Studies, GDR's Academy of Sciences, in Rostock. In May 1985, in the period of hydrological spring, the Baltic Sea area was the site of the USSR-GDR's 3rd complex oceanographic subsatellite experiment (COSE). Aboard the Alexander von Humboldt, a research vessel of the GDR's Academy of Sciences,

members of the experiment put out to sea for studying the oceanographic objects recorded from aboard the satellite. Among them there was a particularly interesting one.

On 19 May 1985, an operational oceanological group discerned on the image received from the NOAA-6 satellite (the USA) some sea currents bent in the form of an enormous mushroom. The cap of this mushroom was transversely about 45 kilometers in size. Specialists for the first time embarked on studying these unusual sea currents looking like a mushroom structure (MS) from aboard the ship. Further work on COSE-3 involved remote and contact measurements of this structure, watching for its evolution, and identification of the causes behind its formation.

An analysis of satellite images indicated that the surface water circulation in the Baltic Sea's south-eastern part in spring time is primarily due to the formation and progress of a surface sea current of the thermal-bar type, as well as to the effect of the Neman river run-off into the Kurland Gulf (Kurski Zaliv). In accordance with the seabed topography the density current upon emerging from the Klaipeda Strait is spreading out further towards open sea in two flows—northward and westward. On the evidence of observation data, from 18 to 19 May there occurred a sufficiently abrupt change of direction to an eastern one. This contributed to the appearance of a powerful jet flow in the westward direction, a characteristic mushroom structure being formed in its head part... The Alexander von Humboldt entered in the centre of the mushroom structure' anticyclonic vortex, the oceanologists hydrologically registering the vortex by means of a cable probe and recording detailed characteristics of the water structure along the observation vertical.

The specialists have arrived at the conclusion that water stratification specifics are due to a residual effect of the anticyclonic portion of the mushroom cross-section. We presume that this phenomenon may serve as a kind of indicator of the "dissipation" process of this unusual structure. Measurements indicated that during the lifetime of MS there occur local temperature variations within vertical and horizontal observation boundaries.

Thus, satellite information allows of tracing the complex pattern of synoptical variability of surface-adjointing horizontal circulations in the frontal zones of the density current and of watching for the space-time evolution of separate elements in the vortical and mushroom structures.

The Baltic problem can and should be solved at the level of international scientific-technical cooperation. Joint researches and requisite protective measures taken by the Baltic states will be able to save the Baltic Sea from ruin.

**"Immunity" of the Baltic Sea Diminishes**  
*18650045d Moscow ADVANCES OF SCIENCE AND TECHNOLOGY in English No 31, 5 Nov 88*

[Article by Jaan Punning, deputy director of the Institute of Thermal and Electrical Physics of the Estonian Academy of Sciences, head of the Baltic Sea Department]

[Text] There are not insignificant factors in nature: sooner or later every part of the ecological chain goes into action. In case of the Baltic Sea, some of its once unimportant features have now moved to the fore. The centuries-old self-organising natural process has faltered, and the stressful condition of the Baltic Sea has acquired a chronic quality. The "immunity" of the sea has diminished.

Oxygen shortage in the Baltic Sea is now constant. The last 10 to 15 years have seen a phenomenon never observed in the Baltic Sea before: formation of steady hydrogen sulphide is a formidable symptom of an advancing marine waste.

Algal bloom is a spreading sight in the sea. The sea's pollution is growing, too. Oil products that accumulate in the bottom soil and in the water have an adverse effect on fish larvae and on bottom-dwelling fauna. Over the past few years there has been a considerable increase in dangerous substances and toxicants present in the food chain, from the crustaceans to birds and mammals.

The 1974 Helsinki convention obliged shipowners to fit their ships with appliances to collect pollutants, including oil products that used to be dumped into the sea. The result had been a visible cleaner sea. International cooperation and establishment of regional coordinating bodies help to achieve tangible successes in the protection of nature. No country on its own could achieve the desired result in such an undertaking.

Staff of our Institute take an active part in research under the Soviet Baltika Project. The project provides, among other things, for an overall characteristic of the Baltic Sea, taking into account its relationships with the atmosphere, dry land, the bottom and the Northern Sea. There are plans to create a hydrodynamic model of the Baltic Sea as a component part of a model of its ecological system. In addition, we must determine how the sea's physical, chemical, biological and hydro-optic fields arise, establish their structure, scale and interaction, and develop corresponding interpretative models. The changeability and non-uniformity of hydrological and hydrochemical fields, including their pollution, will be characterised, biological communities of the Baltic Sea ecosystem assessed, and also their structural and functional regularities studied.

This investigation will form a bank of oceanological data on the Baltic Sea. It is planned further to work out a primary climatic model of the sea's ecological system and to draw up recommendations for its preservation.

Sea expeditions are of great significance in studying the Baltic Sea. Since 1984 the Soviet research vessel Arnold Veimer has made 23 marine expeditions. The ship has on board meteorological, physical, chemical, biological and optical laboratories, as well as shipborne data handling systems, including computers. The ship's crew and scientific staff form a complement of 53 men.

Also taking part in sea expeditions on this ship are foreign specialists.

In 1986, on the initiative of the International Council for Sea Research, and with the support of the Helsinki Commission, an experiment was staged in the Baltic Sea which involved 14 research vessels from 6 Baltic countries, including the Arnold Veimer, and also aircraft and artificial Earth satellites. The purpose of the expedition was to study the patchiness of the sea south east of Gotland over an area of 20 by 40 nautical miles. Scientists aboard the Arnold Veimer studied physical, chemical and biological parameters of the sea.

It was found out that not only the plankton, but also chemical substances had the tendency to accumulate in the form of patches. All life in the sea depends largely on the pattern of distribution of biogenic elements and toxic substances that are dangerous for the environment. If living substance or hydrobionts get into a patch with a high concentration of nutritive substances, this favours their development, but when they find their way into an aggressive environment, they perish.

Studies of patchiness are of interest also for those engaged in fisheries, because fish shoals are distributed in the sea unevenly, and often their migration is connected with that phenomenon.

Pollution of the Baltic Sea causes concern in all Baltic countries. It is an interdisciplinary and international problem and is impossible to resolve without scientists of different specialties, without vigorous cooperation between the European countries.

**Shipwrecks and Pollution of the Sea**  
18650045e Moscow *ADVANCES OF SCIENCE AND TECHNOLOGY in English* No 31, 5 Nov 88

[Article by Eeva-Liisa Poutanen, D. Phil, scientific worker at the Institute for Marine Researches (Helsinki)]

[Text] Shipping safety is today in the focus of attention. However, accidents at sea are nevertheless not to be avoided. Statistics of accidents and shipwrecks in the Baltic and the analysis of their causes for 1980-1983 have revealed that the most widespread events of this kind at sea are the collisions of ships with one another (20 percent), as well as with the underwater rocks and stranding of ships (43 percent). What are the causes behind shipwrecks? First of all it is the human factor (30

percent), ship crew's errors, on many occasions associated with unfavourable weather conditions. Technical faults account for about 14 percent of shipwrecks. Although ships are built today with a double bottom and their technical characteristics are continuously improved, serious accidents involving oil tankers are, nonetheless, quite frequent.

The Gulf of Finland was the place of several serious outpourings of oil, for instance, the one resulting from the wreck of the Esso Nordia in 1970. Fortunately, her holds contained not crude oil, but light fuel, so that the damage involved was minimal. Far more serious was the case of the Antonio Gramsci oil-tanker running on a subsurface rock, this wreckage resulting in the outpouring of about 600 tons of crude oil into the sea.

How much oil found its way into the Baltic Sea after this catastrophe is practically unknown: the figures are quite conflicting. The explanation lies in the absence of analytical-assessment techniques. The latest report by the Helsinki Commission on the study of loadings on the sea said that every year about 36,000 tons of oil finds its way into the Baltic Sea.

When discharged into the sea, oil inevitably gets onto rocks, offshore cliffs and will preserve there for years. Such pollutions mean death for the feathered ones. Even a small amount of oil sullyng the feathers is capable of destroying the bird's thermal protective layer, so that it will simply succumb to freezing.

Oil getting into the water will dissolve, emulsify or enter into reaction with substances intended to do away with it. It is capable of penetrating into plankton and this, among other things, will have a harmful effect on fish, particularly the fry which feeds on plankton.

Chemical analyses of plankton, plants and benthonic living organisms have revealed that the sphere of influence of oil is in most cases much wider than the area of its spreading-out proper. Generally, at least a year's time is needed to eliminate the consequences of oil outpouring. Particularly noxious in this case prove to be pollutions due to crude oil and heavy petroleum products. They contain soluble and insoluble constituents capable of forming an aqueous-oil emulsion much more readily than do light hydrocarbons. In this case the water grows denser, the oil accumulates into lumps, falls onto the bottom and for the natural mechanism to do away with it is by no means simple.

Measurements made in the Gulf of Finland in 1980 to 1987 pointed to great variations in the content of hydrocarbons—from 0.2 to 2.1 mg/dm<sup>3</sup> (averaging 0.6 mg/dm<sup>3</sup>). It is thought that a high oil content recorded in some separate sea areas cannot however be accepted as evidence of the overall situation in the Gulf.

**Largest Oil Spills In the Gulf of Finland  
for the Past 20  
Years**

Year	Ship	Place	Quantity of Oil (in tons)	Quality of Oil
1969	Rafael	Elamasalo	250	Crude
1970	Esso Nordia	Pellinki	600	Light fuel
1980	Lloyd Beig	Helsinki	130	
1987	Antonio Gramsci	Near Porvoo	570	Crude

**Manned Submersible Craft "Osmotr" for  
Coastal-Shelf Studies**

18650046a Moscow SOTSIALISTICHESKAYA  
INDUSTRIYA in Russian 1 Dec 88 p 4

[Unattributed article]

[Text] "Osmotr" (inspection) is the name of a submersible craft which was developed at the design and experimental bureau of the USSR Academy of Sciences' Institute of Oceanology imeni Shirshov. The main purpose of this craft is to take divers to depths as great as 200 meters. Despite its small size, the craft can accommodate a five-man crew without difficulty. New possibilities have appeared for underwater scientific work by specialists who are studying the coastal shelf: marine geologists, biologists and oceanologists.

(A photograph is given showing the "Osmotr" on the water.)

UDC 551.465

**Linear Analysis of Stability of Macroscale  
Currents Using Data From Hydrophysical Test  
Ranges**

18650039a Moscow OKEANOLOGIYA in Russian  
Vol 28 No 5, Sep-Oct 88 (manuscript received 3 Jun 87,  
after revision 6 Jan 88) pp 715-720

[Article by M. I. Yaremchuk, Oceanology Institute imeni P. P. Shirshov, USSR Academy of Sciences, Moscow]

[Abstract] A linear model proposed by A. E. Gill, et al. (DEEP-SEA RES., Vol 21, No 7, pp 499-528, 1974) was used in an analysis of the stability of macroscale currents in the regions of the hydrophysical experiments Poligon-70 and POLIMODE. This article gives a comparison of the results of this analysis and the results of spectral processing of the synoptic currents measured in these test ranges. In contrast to earlier studies, in which the stability of macroscale currents was investigated using two-and three-layer models of the ocean, in this case use was made of a model with continuous stratification, which made possible a more precise reproduction of the structure of synoptic eddies, which was quite fully studied in both experiments. The study was made using climatic data on the density field and the values of the zonal and meridional components of current velocity averaged in horizontal coordinates and time obtained in the course of test range measurements. The results of

each of these two experiments are given separately and in detail. It was found that the vertical structure of the nonlinear synoptic disturbances observed in the ocean conserve the qualitative characteristics of the unstable disturbances described by linear theory. For example in the Poligon-70 experiment the special features of the vertical distribution of synoptic eddy characteristics are fairly well explained qualitatively within the framework of the theory of critical layers. Figures 4; references 14: 9 Russian, 5 Western.

UDC 551.465

**Synoptic Variability of Water Temperature in  
Region of Gulf Stream and North Atlantic Current**

18650039b Moscow OKEANOLOGIYA in Russian  
Vol 28 No 5, Sep-Oct 88 (manuscript received  
14 Aug 87) pp 721-727

[Article by S. K. Gulev, D. G. Kadeyev and I. M. Yashayayev, State Oceanographic Institute, Moscow]

[Abstract] An approach is proposed for analyzing the scales of spatial inhomogeneities of ocean surface temperature in the Gulf Stream region to the north of Cape Hatteras and the North Atlantic Current. The approach makes it possible to use the regular ocean surface temperature charts transmitted once in three days from Halifax. The temperatures on these maps are interpolated to the climatic isotherms associated with the maximum of the transfrontal gradients, that is, there is a transformation to a coordinate system referenced to the undisturbed position of the Gulf Stream axis. Processing of the records made it possible to determine the spatial scale of synoptic inhomogeneities of temperature associated with meandering and eddy formation. An estimate of the phase velocity of propagation of synoptic temperature disturbances at the surface along the Gulf Stream axis is obtained. The proposed approach makes possible effective research on the characteristics of synoptic variability in jet currents using readily available regular data. The use of this approach in the two mentioned regions made it possible to evaluate meandering and eddy formation parameters and ascertain the correlation between the scales of meanders and their intensity. Figures 3, references 16: 5 Russian, 11 Western.

UDC 551.463

**Possibility of Evaluation of Light Scattering and  
Absorption Indices From Depth of White Disk  
Visibility**

18650039c Moscow OKEANOLOGIYA in Russian  
Vol 28 No 5, Sep-Oct 88 (manuscript received 3 Apr 87,  
after revision 26 Oct 87) pp 736-741

[Article by O. V. Kopelevich and V. Ye. Shemshura, Oceanology Institute imeni P. P. Shirshov, USSR Academy of Sciences, Moscow]

[Abstract] The archives of measurements of depth of visibility of a white disk  $z_0$  include about 300 000 individual measurements, but have been used relatively

rarely for determining optical characteristics other than visibility per se, data needed for optical regionalization of the ocean. Section 1 of the article is an examination of the correlation between depth of visibility of a white disk and the scattering index, whereas Section 2 is a similar examination for the correlation with the vertical extinction and absorption indices. A table indicates that in waters of the open ocean the correlation between the scattering coefficient and the absorption index is weak. With a broadening of the range of the values of these two parameters due to the inflow of coastal waters the correlation between these two parameters becomes closer. This is partially associated with a decrease in the relative role of measurement errors and this can be attributed to the fact that the sources of matter operative in the ocean and especially in coastal waters usually give rise to both scattering and absorbing substances. In regions of increased bioproductivity these are phytoplankton cells containing light-absorbing pigments, detritus associated with phytoplankton and nonconservative yellow matter. In regions of river runoff there is an increase in the concentration of both suspended matter and yellow matter. Formulas are proposed for evaluating the scattering index from the depth of visibility of a white disk, for evaluating the vertical extinction index near 500 nm with an error of about 25 percent and for the absorption index. Figures 2; references 17: 15 Russian, 2 Western.

UDC 551.46

**Experimental Frequency Spectra of Internal Waves in Ice-Covered High-Latitude Basin**  
18650039d Moscow OKEANOLOGIYA in Russian  
Vol 28 No 5, Sep-Oct 88 (manuscript received 15 Jan 88  
pp 742-747

[Article by S. V. Pisarev, Acoustics Institute imeni Academician N. N. Andreyev, Moscow]

[Abstract] The results of two experiments for determining the frequency characteristics of internal waves (IW) in a high-latitude ice-covered basin are presented in detail. Low-frequency internal waves with an amplitude of 20 m and a period of about 12 hours are described. The registered spectra are compared with one another, with the model Garrett-Munk spectrum and with spectra obtained earlier under similar conditions. The correlation between energy oscillations of short-period IW and the amplitude and phase of low-frequency waves is traced. Observations on the shelf of such a basin revealed the presence of IW with a period close to 12 hours and a diurnal inequality of amplitude. There was a direct dependence between the intensity of these waves and bottom slope. The levels of the IW spectra in the presence of low-frequency oscillations of appreciable amplitude coincide with the Garrett-Munk level. When low-frequency IW are not expressed the spectrum level lies lower and coincides with the levels of spectra for an ice-covered high-latitude basin published earlier in the

literature. The behavior of the current spectra of short-period IW is evidence of the existence of a correlation between the phase and amplitude of low-frequency IW and energy oscillations of short-period internal waves. A periodic intensification of the latter occurs uniformly in the frequency band of short-period IW and in other cases in narrow frequency ranges. Figures 3; references 9: 3 Russian, 6 Western.

UDC 551.465.16

**Present Status of Layer of Coexistence of Oxygen and Sulfur Dioxide in Black Sea**  
18650043 Kiev DOKLADY AKADEMII NAUK  
UKRAINSKOY SSR: SERIYA B—  
GEOLOGICHESKIYE, KHIMICHESKIYE I  
BIOLOGICHESKIYE NAUKI in Russian No 9, Sep 88  
(manuscript received 28 Mar 88) pp 3-10

[A. A. Bezborodov, N. P. Bulgakov, corresponding member, Ukrainian Academy of Sciences, and A. A. Novoselov, Marine Hydrophysics Institute, Ukrainian Academy of Sciences, Sevastopol]

[Abstract] A new study has been made of the layer of coexistence of oxygen and hydrogen sulfide (c-layer) in the Black Sea for determining the position and thickness of the layer over the entire abyssal part of the sea. The data were collected on six expeditions (more than 300 stations) on ships of the Marine Hydrophysics Institute during 1984-1986; two expeditions were carried out annually: in summer and autumn. The stations were spaced at intervals of 30 miles. Samples were taken by bathometers from the surface to the bottom at standard horizons and at a 10-m interval in the c-layer. The microquantities of oxygen and hydrogen sulfide were determined by two independent methods: iodo- and colorimetric. The spatial and seasonal boundaries of the layer were determined. In the considered seasons there is a distinct dependence of the position of the boundaries on the dynamics of these waters. Toward the sea surface (70-115 m) the upper boundary of the hydrogen sulfide zone is in the regions of eastern and western stationary cyclonic circulations. On the peripheries of these circulations and in anticyclonic eddies it drops to 150-190 m. The topography of the lower boundary of c-layer has a similar pattern. The mean depth of the upper boundary of the hydrogen sulfide zone in the region of water upwelling is 105 m and in the subsidence region is 158 m. The lower boundary of the c-layer in regions of upwelling and subsidence is at 133 and 182 m respectively. The thickness of the c-layer varies from 5 to 70 m. There is no explicit correlation between thickness of the c-layer and the direction of the vertical component of water movement. In the autumn the thickness of the c-layer on the average is somewhat less than in summer. Maps show the topography of the upper boundary of the hydrogen sulfide zone in summer in 1984, 1985 and 1986 and the mean long-term characteristics of the c-layer in summer (1984-1986). Figures 2; references 10: 9 Russian, 1 Western.

### **Air Pollution Is Everybody's Concern**

18640045f Moscow *ADVANCES OF SCIENCE AND TECHNOLOGY* in English No 31, 5 Nov 88

[Article by Prof. Antti Kulmala, department head, Institute of Meteorology (Helsinki)]

[Text] More than 90 percent of the 100 million tons of sulfur dioxide discharged into the atmosphere annually gets into the Northern Hemisphere, Europe's share being 27 million and North America's 25 million tons. Unlike the rest of Europe, Finland has cut emissions by 38 percent, from 290,000 tons in 1980 to 180,000 tons in late 1984.

In July 1985, a protocol on a 30 percent reduction in sulfurous emissions was signed in Helsinki. A national program has been drawn for halving them by 1993 against the 1980 figure and the Council of State has taken corresponding steps.

Twenty-one countries have signed the Helsinki protocol. Most of them pledge to cut sulfurous discharges by 50 percent and Sweden, West Germany, Switzerland and Austria by even 70 percent. The Soviet national program maps out of a 30 percent reduction, especially in the European USSR and near its western borders, by the end of 1993. Presently, noxious emissions in Estonia, which are 10 percent-15 percent more than in Finland, come mostly from the burning of bituminous shale. Fluidised burning is expected to make power generation less harmful. Several such processes for big and small plants have been developed in Finland.

In southern Finland, maximal sulfur dioxide fallout adds up to 1.5-2.0 gr/sq m annually, in contrast to the 0.3-0.5 gr/sq m limit set by the northern countries last year. Anything above it will damage Northern European pine forests.

All European countries must work to minimize atmospheric pollution, Finnish specialists insist. As regards Finland, it has adopted a sulfur-utilisation program to spare its densely-populated and forest-rich southern parts.

Emissions of nitrogenous compounds alarm specialists. They get into the soil in the form of oxides, dioxides and monoxides of nitrogen, ammonia and carbohydrates. Migrating, they affect the weather and the distribution of solar energy and precipitation.

In the early 80s, my country cut nitrogenous emissions by about 10 percent-15 percent. This was explained by the high price on gas and burgeoning nuclear and hydraulic power production. The Council of State has set tougher limits on motor transport. By 1992 Finland will fix the ceilings in force in the USA since 1983. All new autos will have catalytical three-stroke exhaust purifiers.

In power generation, thorough burning of fuel is a way out. So-called NOX devices cut the exhaust nitrogen

content by several dozen percent. Finland is building many coal-firing power stations, which will necessitate far more efficient filters in the next decade.

Finland must stop nitrogenous emissions by 1990, not 2005 as earlier forecasted. This is to be attained through tougher demands on production.

Water conservancy stands in the focus of Soviet-Finnish combined environmental management efforts. In the 70s, the first air-quality protection steps were made with the backing of the joint Finnish gulf commission. Nearly 6 years passed before the HELCOM countries supported the idea of cooperation in Baltic air protection.

In 1979 the Soviet-Finnish working group on air protection was set up and two Baltic research expeditions held aboard the Soviet special ship Academician Shuleikin.

Research has shown that far more heavy metals get into the Baltic from the air than the rivers: 80 tons of cadmium, 400 tons of copper and 3,000 tons of zinc. Regrettably, we know too little about their impact on the Baltic ecosystem. But, biologists warn, even such doses can trigger off biomass growth and impact the oxygen content in the bottom waters.

### **Soviet Scientists Synthesize Two Freons Harmless to Ozone**

18650036 Moscow *TASS* in English 22 Oct 88

[Article by TASS Correspondent Vladimir Isachenkov]

[Text] Soviet scientists have succeeded in synthesizing two new types of freons which are harmless to the atmospheric ozone. Freons are synthetic gases which are widely used in household aerosol cans and refrigerators.

It is precisely the discharge of freons into the atmosphere that scientists blame on the formation of the ozone 'hole' over Antarctica—a zone where the density of the ozone layer is 50 percent thinner than elsewhere. In interacting with polar ice clouds, freons release chlorine which destroys ozone molecules.

Professor Boris Maksimov of the State Institute of Applied Chemistry has said the freons which have been synthesized by Soviet scientists have a basically different mechanism of disintegration—they break down under the action of hard ultraviolet radiation of the sun. One of the freons disintegrates without releasing any active chlorine because its molecules contain atoms of hydrogen which combines with chlorine. Chlorine is replaced by fluorine in the molecules of the other freon.

Boris Maksimov said the State Institute of Applied Chemistry is continuing to research alternative freons. Researchers are determining their toxicity, explosion

and fire risk and operational properties, and are developing a technology for their production.

A realistic period schedule for commercial production of the newly synthesized compounds is four or five years. The newly synthesized gases will be somewhat more expensive than those produced now, but since only 150 grams of freons are needed for household refrigerators, the latter's cost will be basically the same.

In the production of household aerosol cans, it is sufficient simply to replace freons by propane-butane. The household-chemical producing plant in Brest (Byelorussia) changed over to the technology as far as at the beginning of the year. By 1993 all aerosol cans made in the Soviet Union will become ecologically safe.

The Soviet Union took an active part in the drafting of the Vienna Convention of 1985 on the protection of the ozone layer and signed the Montreal protocol of 1987 which is aimed at restricting the production of ozone-depleting substances. Under the protocol the signatories pledge to freeze the use of freons at the 1986 level and subsequently to cut down their use: by 20 per cent from 1993 and by another 30 per cent from 1998.

To preserve the ozone layer, which protects everything living on earth from the hard ultraviolet radiation of the sun and influences the climate, is one of the most acute problems for mankind.

There was a good reason why the leaders of the Soviet Union and the United States in their joint statement deemed it necessary to express mutual concern over the problem of protection and preservation of the atmospheric ozone layer.

#### **Equipment for Aerial Surveying of Farmland in Aral Sea Zone**

18650046b Moscow VOZDUSHNYY TRANSPORT  
in Russian 26 Nov 88 p 6

[Article by N. Krupenio, head of a laboratory of the all-Union scientific research center of the automated management information system "Agroresursy" (agricultural resources)]

[Excerpt] One of the purposes of an expedition called "Aral-88" was to become more familiar with water-management activities in the zone of the Aral Sea and its main arteries.

Visual surveys are good, of course. But is it much more important to have documented information. Practical implementation of a program in this field was accomplished by the Remote Probing Center of the USSR State Agro-Industrial Committee and the all-Union scientific research center of the automated management information system "Agroresursy," at the request of the "Aral-88" expedition. This center has a specially equipped airplane, the TU-134SKh, at its disposal.

All of the water handling facilities in the basin of the Amu-Darya, the delta of this river, and water arteries of the region were studied from the air for 8 days, from 27 October to 4 November. A radar survey of this entire territory was also made.

A group of scientists and operators of remote-probing equipment worked in the airliner's passenger compartment. This group had carried out the experimental portion of the "Aral-88" aerial expedition's work successfully.

It should be mentioned that the TU-134SKh airplane is unique. It is intended for remote probing of ground covers and their condition, which is of much interest for agriculture.

This aircraft's equipment consists of a topographic camera and another camera with four channels. Also on board the laboratory airplane is a multichannel scanning system which is utilized intensively. This system makes it possible to record images of the Earth's surface in the visual and near and far (thermal) infrared frequency ranges, on magnetic tape. With the aid of a Soviet-built radar station called "Nit," images of the Earth's surface to the left and right of the airplane's line of flight can be obtained and recorded on specially developed aerial photographic film.

Unlike most other airborne radar stations, the "Nit" can obtain radar images at different polarizations and determine reflection characteristics of the Earth's surface quantitatively.

#### **Chemical Method for Measuring Concentration of Ozone in Atmosphere**

18650047a Frunze SOVETSKAYA KIRGIZIYA  
in Russian 21 Nov 88 p 4

[Unattributed article]

[Excerpt] International tests in Cuba have confirmed that all of the parameters of an instrument which Kirgiz physicists have developed surpass those of foreign counterparts. The new instrument—a device for measuring the concentration of ozone in the atmosphere—is simple to use and produce. It has been decided to employ it in large-scale experiments.

KirTAG correspondent Yu. Blyum talked with Doctor of Technical Sciences Sovetbek Zhaylobekovich Toktomyshev, a professor of the Frunze Polytechnical Institute (FPI), head of this institute's chair of general physics and director of work on development of the new instrument and a new method for measuring the ozone layer.

"As early as 1960s, a group of young scientists at Novosibirsk University, where I was studying, became interested in processes which occur during interaction of gases with metals in different states of a medium [said S. Toktomyshev].

"If effects are produced on a thin film of extra-pure silver by atomic oxygen or ozone whose molecule contains three atoms, the electric conductivity of the silver changes. The idea of using chemical detectors for studying the concentration of oxygen atoms in the upper layers of the atmosphere was based on this unexpected result. Articles which we wrote on this topic appeared in the journal *Kosmicheskiye Issledovaniya* (Space Research) of the USSR Academy of Sciences.

"Our silver detector expands the limits of research. It can be used in balloons, sondes and meteorological rockets as a part of a set of equipment including other measuring instruments; it will make it possible to record data practically continuously at any altitude and, in the more distant future, in space and on other planets.

"L. Tolbayev, M. Orozaliyev and A. Dzhusupov, science associates of FPI's chair of general physics, worked productively on development of the atmospheric-ozone concentration meter. In collaboration with colleagues of Novosibirsk University, S. Magarychev and T. Sargazakov, graduate students of Kirgiz State University, and others developed three-dimensional mathematical models for studying small components of atmosphere, which allows physics of the interaction of chemical, dynamic and photoradiation processes in the troposphere and stratosphere to be used to the fullest. Possibilities open up for studying how the ozone layer is affected not only by the action of chemicals but also by planetary waves and various currents and circulations of the atmosphere which are very sensitive to results of human activity."

(Three photographs are given showing S. Toktomyshev and Askar Musayevich Dzhunusov, a graduate student of FPI's chair of general physics, preparing a sonde for launching; a radar antenna which receives signals from instruments on the state of atmospheric ozone at different altitudes; and Candidate of Technical Sciences Linar Kadyrkulovich Tolbayev, a senior science associate of the chair of general physics and one of the developers of the ozone meter, examining a printout sheet.)

#### **Computerized Satellite-Aided Weather Communications Station Planned**

18650047b Vilnius SOVETSKAYA LITVA in Russian  
15 Nov 88 p 4

[Article by Yu. Stroganov]

[Excerpt] A satellite-aided communications station has gone into operation in the Lithuanian Republic Administration for Hydrometeorology and Monitoring of the Natural Environment.

S. Nutsulyak, head of the administration's communications service, and I observed the movement of an unusual spiral antenna aimed at the depths of the blue sky. This antenna responds sensitively to signals from a weather satellite.

I then examined a photograph taken from space. I asked weather forecasting engineer N. Nikolayenko to comment on it. Clearly visible in this photograph were clouds whose windings indicated the direction of their movement and the intensity of weather processes. Before our eyes were stages of the generation and disintegration of cyclones.

Installation of a still more effective satellite-communications station is in the administration's plans. The present station merely records the weather situation on Earth with an impartial lens at present. The future station will be connected to a computer and will provide weather forecasters with a large amount of precise data on which more reliable forecasts will be based.

(A photograph is given showing S. Nutsulyak checking the spiral antenna.)

UDC 551.511.6:551.576

#### **Mathematical Modeling of 'Cloud Streets' in Atmospheric Boundary Layer**

18650029a Moscow IZVESTIYA AKADEMII NAUK  
SSSR: FIZIKA ATMOSFERY I OKEANA in Russian  
Vol 24 No 9, Sep 88 (manuscript received 14 Jan 86,  
after revision 6 Feb 87) pp 922-931

[Article by A. Ye. Ordanovich, Moscow State University]

[Abstract] A closed system of equations (mathematical model) describing the boundary layer of the atmosphere is derived and investigated. The model takes into account ordered currents of parallel arranged horizontal, spindle-like vortices with dimensions approximately the same as the height of the boundary layer. A cumulus cloud cover which can arise when there are suitable conditions in the ascending flows of such vortices ("cloud streets") frequently serves as an indicator of such vortical systems. A core and a surface layer are discriminated in the boundary layer. Equations of the Reynolds equations type, taking into account the presence of large-scale ordered movements, are derived for describing processes in the core of the boundary layer and integral closure hypotheses are applied. The surface layer is described by the Monin-Obukhov similarity theory. Conditions for continuity of the solutions at the core-surface layer boundary are formulated. Finally, the derived system of equations is analyzed. Figure 1; references 12: 8 Russian, 4 Western.

UDC 551.511:551.465

#### **Experimental Research on Thermal Characteristics of Turbulent Convection in Rotating Fluid Layer**

18650029b Moscow IZVESTIYA AKADEMII NAUK  
SSSR: FIZIKA ATMOSFERY I OKEANA in Russian  
Vol 24 No 9, Sep 88 (manuscript received 30 Jun 87)  
pp 947-953

[Article by B. M. Bubnov, Atmospheric Physics Institute, USSR Academy of Sciences]

[Abstract] Many important mechanisms of the influence of rotation on convection have still not been adequately

studied. Accordingly, a study was made of the thermal characteristics of convective movements in a plane layer of fluid as a function of the rate of system rotation. A plane layer of fluid with a thickness  $h$ , heated from below and cooled from above, was examined. A cylindrical plastic vessel with a diameter 17 cm and a height 21 cm and a wall thickness 2 cm was used in the experiment. The cylinder was on a rotating platform with the axis of rotation coinciding with the axis of the cylinder and the direction of the gravity vector. The spectral characteristics of turbulent convection in the rotating fluid layer were examined. It was found that if on the stability diagram the system is far from the critical curve of generation of convection, rotation exerts virtually no influence on the form of the spectrum, coinciding with the form of the spectrum in a nonrotating fluid. In this case, however, the spectrum is displaced into the low-frequency region. With approach to the region of regular movements the form of the spectrum changes and a power-law sector with an exponent  $-2$  is discriminated in the spectrum. A time scale diagram of convection was constructed as a function of the external parameters of the system: Rayleigh and Taylor numbers. With large  $Ra$  and small  $Ta$  numbers rotation exerts no significant influence on the spectral characteristics of turbulent convection. This assumption is universally used in geophysics since the Earth's rotation is neglected in an analysis of temperature spectra. It is difficult to obtain purely convective spectra in the atmosphere because there is almost always mean air movement, which leads to Obukhov spectra. With approach to the region of stable vortical structures there is a fundamental change in the temperature characteristics and the energy spectrum is displaced to the left, narrowing and increasing in value. Figures 5; references 10: 5 Russian, 5 Western.

UDC 551.510.52

#### Variations in Vertical Refractivity Gradient in Polar Tropopause

18650029c Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian Vol 24 No 9, Sep 88 (manuscript received 4 Feb 87, after revision 25 May 87) pp 980-985  
v, G. S. Zhamsuyeva and N. B. Chimitdorzhiev, Natural Sciences Institute, Buryat Affiliate, Siberian Department, USSR Academy of Sciences]

[Abstract] A study was made of the vertical refractivity gradient in the high-latitude atmosphere. The research was based on data for five stations located in the central polar regions of Asia (Cape Chelyuskin and Tiksi, on the shores of the Arctic Ocean, and Verkhoyansk, Igarka and Zhigansk in the interior). Archival aerological sounding data for the central months of the seasons (morning, evening and nighttime observations) were used. The spatial-temporal characteristics of the vertical gradient of the refraction coefficient were analyzed using materials characterizing three layers in the atmospheric boundary layer: 2-300,

2-900 and 300-900 m. The vertical gradients are characterized by two types of seasonal variation: a single winter maximum and a single summer minimum at coastal arctic stations; two maxima (winter and summer) and two minima (spring and autumn) at continental stations. The range of refractivity change has a seasonal variation; the nature of the curve coincides with the seasonal variation of the mean monthly values. The mean refraction conditions during winter considerably exceed the standard refraction conditions. The formation of superrefraction conditions can be expected in these regions in winter. Figures 3; references: 7 Russian.

UDC 551.521:551.576

#### Evaluation of Sensitivity of Radiation Balance to Changes in Cloud Conditions

18650029d Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian Vol 24 No 9, Sep 88 (manuscript received 4 Jan 87, after revision 1 Jun 87) pp 993-996

[Article by O. Yu. Kyarner, Astrophysics and Atmospheric Physics Institute, Estonian Academy of Sciences]

[Abstract] Cloud cover exerts a dual influence on the radiation balance of the Earth-atmosphere system: it reduces the solar radiation absorbed in the system, but also attenuates outgoing long-wave radiation. The literature gives contradictory pictures of the distribution of these influences. Some authors contend that both influences are approximately equal, whereas others assert that the albedo effect of clouds predominates. Difficulties arise because meteorological satellites yield data only on two parameters of the Earth-atmosphere system (albedo  $a$  and outgoing long-wave radiation  $F$ ), whereas with a real change in cloud cover there can be a change in three effective cloud cover parameters (quantity over the averaging region, albedo and upper cloud boundary). In order to clarify this problem, a study was made of the joint changes of albedo and outgoing long-wave radiation and it was assumed that cloud cover plays the main role in their changes. The necessary and adequate condition for the radiation balance not to be dependent on the variability of  $a$  and  $F$  is defined and the possibility of checking this condition as a function of the averaging scale for  $a$  and  $F$  data is analyzed. The reasons for the discrepancies in earlier published results are explained. It was found that as an average for large regions (such as a hemisphere) the presence of a cloud cover reduces the radiation balance in comparison with cloudless conditions. The contradictions in the earlier literature are attributable to the methodological differences in research. The newly proposed method for checking the linear correlation between changes in  $a$  and  $F$  makes it possible to evaluate radiation balance sensitivity to changes in cloud conditions at small scales. Data from geostationary satellites would be useful in making such evaluations. References 10: 3 Russian, 7 Western.

UDC 551.510.42

**Stationary Coagulation of Aerosol in Presence of Bidisperse Source of Fine Particles**

18650029e Moscow *IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA* in Russian Vol 24 No 9, Sep 88 (manuscript received 27 Feb 87) pp 996-999

[Article by V. I. Smirnov and Yu. Ya. Smirnov, Theoretical Problems Section, USSR Academy of Sciences; Moscow Oblast Pedagogic Institute imeni N. K. Krupskaya]

[Abstract] A study was made of stationary coagulation in the presence of a polydisperse, especially bidisperse source of atmospheric aerosol. A bidisperse source is one which differs in its primary sources (chemical and photochemical gas-phase reactions), yielding particles measuring about 10-9 m and secondary sources, associated with high-temperature and some other processes (fires, volcanoes, industry, transport, etc.) yielding an aerosol coagulated in the place of its origin. The structure of the stationary spectrum of a coagulating system was investigated in the presence of such a bidisperse source of fine particles and a sink of large particles. A spatially homogeneous disperse system whose particles have masses multiples of a minimal mass were assigned the value unity. It is assumed that the source is continuous and introduces fine particles into the system with a constant intensity and the source is a quite rapidly decreasing function of the mass of particles. It was found that with a known ratio of the spectral densities at points in the interval of masses where the sources are situated (at the maxima) and at adjacent points (at the minima) it is possible to determine the ratio of the intensities of sources. With some combinations of parameters there is an effective suppression of the second source, even if its intensity considerably exceeds the intensity of the first. The greater the distance between the sources, the greater is the suppression. The results can be used in explaining the observed atmospheric aerosol particle spectra. The examined model simplifies the real picture because the Brownian coagulation coefficient can be considered constant only in the case of close masses of particles and this factor must be taken into account in further research. References: 4 Russian.

**USSR Adopts International Accord on Protection of Ozone Layer**

18650035b Moscow *IZVESTIYA* in Russian 8 Oct 88 p 3

[Article by R. Ignater]

[Excerpt] Extract: The USSR Council of Ministers has adopted a resolution calling for adoption by the Soviet Union of the Montreal memorandum to the Vienna convention on protecting the ozone layer. This memorandum pertains to substances which destroy the ozone layer.

Our country has thus assumed the obligation of reducing production of ozone-destroying substances by 50 percent

in 10 years. The USSR State Committee on Hydrometeorology and concerned ministries and agencies have been instructed jointly to carry out measures for ensuring fulfillment of the obligations that the Soviet Union has assumed in connection with adoption of the memorandum. This is a very complex task, since many production facilities have to be reorganized, production processes changed and substances found which would be capable of replacing chlorofluorocarbons.

Soviet chemists are now working on development of substances which are harmless to ozone. Work in this direction is proceeding successfully. Research aimed at determining the reasons for the formation of ozone holes is continuing at the same time.

The Montreal memorandum is to go into effect January 1, 1989.

UDC 535.241

**Acoustooptical Interaction in Anisotropic Medium in Two-Frequency Diffraction Mode**

18650040 Moscow *VESTNIK MOSKOVSKOGO UNIVERSITETA: FIZIKA, ASTRONOMIYA* in Russian Vol 29 No 5, Sep-Oct 88 (manuscript received 10 Apr 87) pp 50-56

[V. B. Voloshinov, V. N. Parygin and B. Traore (Mali), Physics of Oscillations Department, Moscow University]

[Abstract] Light diffraction on ultrasound in optically anisotropic media can be characterized by several Bragg light diffraction maxima. The phenomenon of multiple scattering of light on monochromatic sound in devices for monitoring optical radiation parameters and for the optical processing of information is highly promising. Double Bragg light scattering modes have been experimentally studied, but it has not been possible to achieve effective triple interaction of light and sound due to the limitations imposed on acoustooptical interaction by the symmetry of the used crystals and the smallness of the corresponding photoelastic constants of the materials employed. This article describes anisotropic diffraction modes during the propagation of two acoustic waves with different frequencies in one direction in a crystal. With a fixed angle of light incidence on sound and appropriate choice of the two frequencies the Bragg synchronism condition can be simultaneously satisfied for the interaction of light with two acoustic waves. The diffraction pattern will consist, as in earlier investigated cases of multiple diffraction, of three diffraction maxima in addition to the zero level. Each of the maxima is a Bragg maximum. The dependence of the intensities of the Bragg diffraction maxima on the amplitude and frequencies of the acoustic waves is computed. It can be expected that the diffraction mode described here will be promising for use in different devices for monitoring the parameters of optical radiation, such as deflectors, spectrum analyzers and filters. Figures 5; references 5: 4 Russian, 1 Western.

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