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RESEARCH TRANSLATION

Frequency of Thick Convective Clouds Over the Ukraine

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FREQUENCY OF THICK CONVECTIVE CLOUDS OVER THE UKRAINE

Translation of

Poytoriaemost' moshchnoi konvektivnoi oblachnosti nad Ukrainoi

by

G. F. Prikhot'ko and Z. M. Iashovskaia

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FREOUENCY OF THICK CONVECTIVE CLOUDS OVER THE UKRAINE

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G. F. Prikhot'ko and Z. M. Iashovskaia

Data are given on the frequency of Cu cong and Cb of 5/10 or more sky cover over the Ukraine in summer. They are based on observations made six times daily at 103 weather stations.

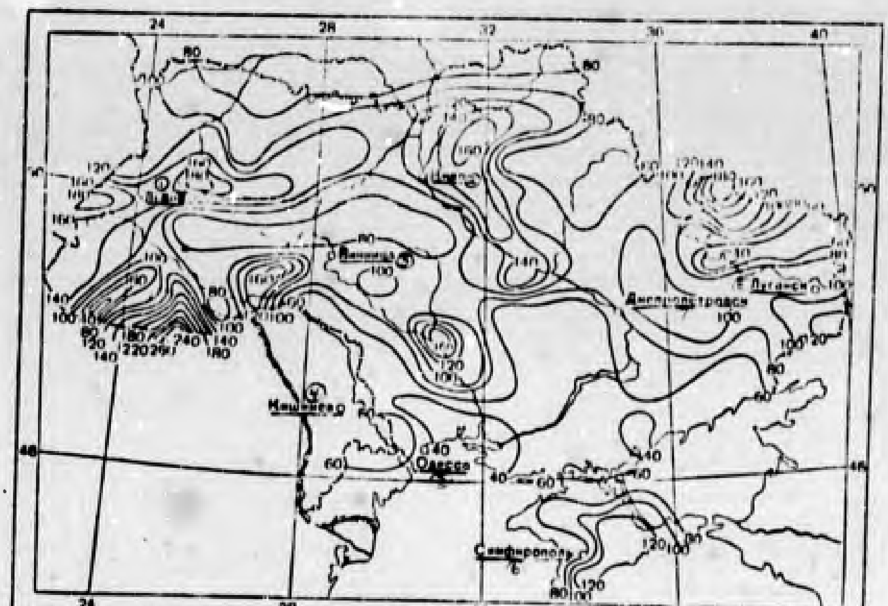
At present no data are available on which to base a reliable estimate of the frequency of convective clouds by regions of the Ukraine. Weather-station observations provide a rough approximation of both the number and type of clouds. It must be kept in mind that in planning cloud seeding operations to increase precipitation, it is important not only to know the amount and type of clouds, but to have information on the thickness of the clouds and the temperature at the cloud tops in order to obtain data on the precipitation potential of clouds. In view of the limited number of aerological observations available, weather-station data may be used. These lata may serve as a territorial index of the seeding potential of convective clouds. There are good ground for assuming that the effectiveness of artificial modification is directly proportional to the frequency of cumulus congestus clouds in a region.

We, together with G. I. Perelet, conducted an investigation along these lines earlier, at the weather experiment range (WER).

In the present paper, we examine the entire territory of the Ukraine using a somewhat different method. The experiment at the WER showed that when the cover consists of isolated, single clouds, they do not become thick enough for effective artificial modification. The number of clouds increases as the clouds develop in vertical thickness. In cases where weather-station observations show a Cu cong and Cb cover of 5/10 or more, it may be assumed, with a high degree of probability, that some of these clouds are suitable for artificial modification. Several conclusions about the possibilities of producing precipitation artificially can be drawn from an analysis of the frequency of such conditions in the Ukraine.

In our study, we employed observations from 103 Ukrainian weather stations for the summers of 1956-1961. From the daily observations at six intervals (0600, 0900, 1200, 1500, 1800, and 2100 LMT), we selected instances where the station recorded a Cu cong or Cu cong and Cb cover of 5/10 or more. Of course, the material thus selected was not uniform with respect to either the parameters of the convective clouds or the conditions of their formation. What is more, some differences are introduced by the influence of local factors (orography, local topography, et al.) on the development of convection in the vicinity of a particular station and by the subjective errors of the observers. On the whole, however, these data do provide a general idea of the frequency of conditions favorable for artificial modification of clouds in the various regions of the Ukraine.

Figure 1 is a map of the frequency of Cu cong and Cb that form a cover of 5/10 or more over the Ukraine during the daylight hours. The map shows a zone of high frequency of cloud cover that includes the Carpathians, the forest-steppe west of the Dnepr, and southern Poles'ye (forest) regions of the Ukraine. An area of lower frequency, running from Berezhany through Khmel'nitskiy to Starchenkovo, wedges into this high frequency zone. The picture is somewhat more diverse east of the Dnepr. Here the northern steppe and the Donets upland form the area of high cloud frequency. The number of cases is somewhat smaller in the forest-steppe zone in the vicinity of Sumy and Gadyach, and the same is true of the northern steppe, in the region of Izyum and Starobel'sk. The frequency of thick convective clouds decreases sharply in the steppe zone, particularly the southern steppe. Here, the frequency of thick convective clouds is smaller by a factor of 2 to 2.5 (in the southern steppe, by a factor of 3) than in the aforementioned regions, namely, isolines 120-190 pass through the Uzhgorod-L'vov-Shepetovka-Kiev-Konotop region, while isolines 40-55 pass through the Bekhtery-Melitopol'-Volnovakha region. Although the frequency of thick convective clouds is somewhat greater in the northern part of the steppe west of the Dnepr, it actually differs little from the southern steppe. Only in the Voznesensk-Pervomaysk region and east of the Dnepr from Krasnograd through Udachnoye to the Donets ridge (Donetskiy kryazh) does the number of cloud cover observations exceed that in the rest of the steppe by a factor of more than two. The frequency of convective clouds is also higher in the Crimea.



① L'vov; ② Kiev; ③ Vinnitsa; ④ Kishinev; ⑤ Odessa; ⑥ Simferopol'; ⑦ Dnepropetrovsk; ⑧ Lugansk.

Figure 1. Map of the frequency of Cu cong and Cb that form a cover of 5/10 or more over the Ukraine. The isolines show the mean-annual number of observation periods when these clouds were recorded during daylight (from 0600 to 2100 LMT at 3 hour intervals).

Synoptic conditions exert the greatest influence on the frequency of this type of cloud cover. The high frequency of anticyclonic processes in the second half of summer is the main cause of the decrease in the amount of cloud cover, but the irregularity of the drying of air masses over the Ukraine also plays some role in this decrease.

Table 1

Frequency of observations (number of cases) of thick convective cloud cover in the steppe zone in May and August.

Weather station	May	August
Zatish'ye	12.5	8.0
Bashtanka	16.5	13.3
Krivoy Rog	18.0	10.7
Nikopol'	17.5	12.0
Askaniya-Nova	12.7	3.7
Melitopol'	12.2	5.3

It is clear from table 1 that at the end of summer, when the soil is drying out, the number of cloud observations decreases by several factors at individual stations in the south. This decrease also occurs in other geographic zones, but is not so pronounced. However, all in all the distribution of the cloud cover depends on a number of general factors and a large number of local factors, among which the nature of the topography (presence of bodies of water, extent of forestation, etc.) and the orientation of the topographic features with respect to the prevailing winds play important roles.

In mountainous regions the frequency of cumulus clouds at individual stations depends on many conditions. Foehn effects in certain valleys, the shape of a valley, its forestation, etc., may produce situations where neighboring stations will show sharply different cloud frequencies. Therefore, the aeroclimatology of convective clouds must be studied very carefully in mountain regions before artificial modification of the clouds is attempted.

The general pattern of cloud cover distribution over the Ukraine during the warm season (fig. 1) remains the same during all four months of this period. Convective clouds are more frequent during the first half of the summer (May-June). The diurnal pattern shows maximum cloud cover from 1200 to 1800 LMT; 70 to 80% of all instances of daytime cloud cover are concentrated in this time interval. Convective clouds rarely appear at 0600 and 0900 LMT, but are somewhat more frequent at 2100 LMT. Thus, the curve of the diurnal pattern is asymmetric, with the maximum shifted somewhat toward the evening hours.

The weather experiment range (WER) is situated in the northern steppe zone, in a region of low cumulus cloud frequency. The test section of the WER is in the Krivoy Rog-Loshkarevka area; the control section lies to the west of Krivoy Rog and ends more than 100 km west of that city. It is quite clear in fig. 1 that the test section is in a region of low cloud frequency, while the control section (especially its western portion) enters a region of high frequency. This considerably complicates the evaluation of the effectiveness of the modification experiments conducted over the WER. Therefore, it is not surprising that the correlations between the control and test areas obtained by G. F. Prikhot'ko are not very satisfactory. This also explains why these correlations were much more reliable between the test section and the 50-km zone adjacent to it.

The large-scale seeding operations have shown (though not with sufficient reliability) the possibility of increasing the amount of precipitation at the test section by 10 to 15% over the natural precipitation. Assuming that the absolute number of Cu cong clouds that are suitable for seeding and that do not become Cb by natural evolution will be greater in regions with a high cloud frequency, we can expect that artificial modification will increase the amount of precipitation in such areas.