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* Denotes items which have been abstracted.

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* Denotes items which have been abstracted.

UDC 551.513+551.509.314(215-17)

INVESTIGATION OF INTENSITY OF WESTERLY AIR TRANSPORT IN NORTHERN HEMISPHERE BY PROBABILISTIC METHODS

Moscow METEOROLOGIYA I GIDROLOGIYA in Russian No 1, Jan 82 (manuscript received 16 Apr 81) pp 5-15

[Article by G. V. Gruza, professor, and V. T. Radyukhin, All-Union Scientific Research Institute of Hydrometeorological Information-World Data Center]

[Abstract] A method for a probabilistic analysis and investigation of the possibility of predicting the Ye. N. Blinova daily values of the circulation index for the northern hemisphere is presented. This index is employed in describing the intensity of zonal circulation at any level and represents the angular velocity of atmospheric movement relative to the earth's surface. The authors analyzed the archives of the daily values of the circulation index at the 500-gPa surface, computed by the usual method, for the zone 40-65° for the winter and summer seasons of 1949-1978. The potential predictors selected were the circulation index values for 10 successive days and the predictants employed were the circulation index values for the 11th, 12th,...,20th days (in other words, a forecast for 1, 2,...,10 days was considered). In writing the probabilistic expressions use was made of the 25 first years of the archives. Sixty "central" days were used for each season and the sample included observations with a three-day interval. The sample therefore contained 350 observations which had little dependence on one another. This investigation revealed that a statistically significant correlation between successive values of the circulation index disappears in winter after seven days and in summer after four days. Text and tables give the results of evaluations, made on the basis of independent material, of the quality of probabilistic predictions of the circulation index for 1, 4 and 6 days in winter and for 1, 3 days in summer. This is followed by an evaluation of probabilistic predictions that the circulation indices will not exceed a fixed level in the course of different time intervals. Figures 2, tables 4; references 17: 13 Russian, 4 Western.

UDC 551.515.8+551.509.313

DYNAMICS OF NONSTATIONARY ATMOSPHERIC FRONT

Moscow METEOROLOGIYA I GIDROLOGIYA in Russian No 1, Jan 82 (manuscript received 5 Jun 81) pp 16-23

[Article by G. I. Shapiro, candidate of physical and mathematical sciences, Institute of Oceanology, USSR Academy of Sciences]

[Abstract] A nonstationary three-dimensional hydrodynamic model of an atmospheric front is proposed in which allowance is made for the effects of turbulent viscosity, three-dimensionality and nonstationarity of movement. The author presents a detailed examination of the movement of air near the frontal discontinuity separating air masses with different temperatures. In his formulation of the model the author postulates that the potential temperature of the air masses is known and constant and that the field of geostrophic wind or high-altitude pressure field is stipulated. Moreover, the turbulent viscosity coefficient is assumed to be constant and identical in both air masses. The turbulent viscosity coefficient must not be dependent on altitude within the limits of the Ekman boundary layers where frictional forces play an important role (there can be two such layers in high-altitude fronts). The configuration and rate of frontal movement are unknown in advance and are determined in the course of solution of the problem. Simplifications are introduced in the course of the analysis due to the smallness of the slope of the frontal surface to the horizon, as well as the smallness of inertial forces in the momentum balance equation. In this complex formulation the author then proceeds to the derivation and analysis of an equation which describes evolution of the frontal surface h(x,y,t). Step-by-step the presentation reveals that this equation can be used in describing the nonstationary movement of a surface warm front, the formation of an occluded front and curvature of the cold front line at the center of a cyclone. The overall conclusion is drawn that the proposed model gives results which are in agreement with earlier known results. Figures 2; references 10: 8 Russian, 2 Western.

UDC 551.515.8(47)

MESOSCALE STRUCTURE OF OCCLUDED FRONT OVER CENTER OF EUROPEAN USSR ACCORDING TO DATA FROM SPECIAL MEASUREMENTS

Moscow METEOROLOGIYA I GIDROLOGIYA in Russian No 1, Jan 82 (manuscript received 24 Jun 81) pp 24-33

[Article by B. M. Matkovskiy and N. P. Shakina, candidate of physical and mathematical sciences, Institute of Experimental Meteorology and USSR Hydrometeorological Scientific Research Center]

[Abstract] An analysis was made of the mesoscale structure of an occluded frontal system using measurement data obtained in the lower half of the troposphere during a special experiment at Obninsk on 22 November 1972. Over a 24-hour period the experiment was carried out in 8 rawin and 11 aircraft soundings at intervals of 1.5-3 hours. These data were supplemented by observations from the 300-m high meteorological mast. The analysis revealed a complex picture. It was found that the mesoscale structure of the occluded cyclone includes a number of narrow baroclinic zones. A circulation develops in the neighborhood of these baroclinic zones which is thermally direct in some cases and thermally inverse in other cases, resulting in the formation of different types of cloud cover associated primarily with the baroclinic zones. Over the inversion layer, in the middle part of the occluded air mass, there is a tongue of relatively cold air, with which a decrease in cloud cover is associated. The rear part of the occluded air mass consists of the warmest and moistest air; in the baroclinic zone, separating it from the mesoscale cold wave, the warm air rises vigorously and Ns clouds are formed. The upper cold front is characterized by subsidence in the rear part of the zone and ascent in its forward part, especially in the neighborhood of the upper occlusion point. Convection develops there and the heaviest precipitation falls at the surface. There is a wind velocity maximum in this frontal zone. The air situated behind the upper cold front is drier. In this air cloud- and precipitation-formation processes weaken and the vertical thickness of clouds decreases. The species of clouds and the processes of their formation are different in different parts of the occluded zone: ordered ascent over the stable frontal layer (Ns-As clouds), some convection in the unstable layers (Ac and Sc clouds) and forced convection on the front (Cb and thick Ac). All these phenomena are observed over a stable layer occupying the upper part of the planetary boundary layer. Within this layer baroclinicity is relatively poorly expressed; only the passage of a surface occluded front substantially changes its structure. The boundary layer under the frontal inversion was dynamically unstable during the entire period and the lower part of the 300-m layer was also statically moist-unstable. Figures 4; references 13: 5 Russian, 8 Western.

UDC 551.509.319

TWO CLASSES OF SMALL-VARIANCE SCHEMES FOR SOLVING ADVECTION EQUATION

Moscow METEOROLOGIYA I GIDROLOGIYA in Russian No 1, Jan 82 (manuscript received 14 May 81) pp 34-40

[Article by Ye. Ye. Kalenkovich, candidate of physical and mathematical sciences, and I. V. Cholakh, West Siberian Regional Scientific Research Institute]

[Abstract] Amplitude and phase errors arise in difference schemes when using harmonic analysis, but it is the phase errors which give the forecaster the greatest difficulty. For example, they can cause errors in determining the rate of movement of high- and low-pressure formations and the fronts associated with them. In order to overcome this problem the authors investigated two classes of schemes for the advection equation in a one-dimensional case. This made it possible to formulate a method for constructing difference schemes which lessen the dispersion. The proposed method is both theoretically and experimentally compared with alternative schemes which have been published in the past by Crank-Nicholson, Lax-Wendroff and Gadd. The comparative results, presented in a number of tables, reveal that the authors have developed a superior scheme: the phase errors are decreased and dispersion is lessened in comparison with the schemes now in common use. This will facilitate solution of different problems encountered in weather forecasting and in studies of general circulation of the atmosphere. A number of variants are analyzed and two specific variants are recommended for routine use. Tables 3; references 6: 3 Russian, 3 Western.

UDC 551.501.5+551.509.14

REPRESENTATION OF FIELDS OF METEOROLOGICAL ELEMENTS STIPULATED AT POINTS OF INTERSECTION OF LATITUDE-LONGITUDE GRID

Moscow METEOROLOGIYA I GIDROLOGIYA in Russian No 1, Jan 82 (manuscript received 9 Apr 81) pp 41-48

[Article by G. S. Rivin, candidate of physical and mathematical sciences, and A. I. Kulikov, West Siberian Regional Scientific Research Institute]

[Abstract] Highly efficient plotting of isolines for the representation of the fields of meteorological elements in a latitude-longitude grid requires use of a curve plotter, but four problems must be solved for obtaining suitable representations: selection of the cartographic projection; plotting of isolines; seeking and plotting local extrema; representation of outlines of the continents in the required projection, plotting of parallels and meridians. Each of these four tasks is briefly discussed in this article in describing the experience accumulated in such work at the West Siberian Scientific Research Institute. Actual work is illustrated in the example of several such fields plotted in different cartographic projections when using BESM-6 and YeS-1052 electronic computers. Stereographic, Mercator and square projections can be used, the first two being conformal. The advantages, disadvantages and special uses of each of these are discussed. The procedures for plotting of isolines are discussed in detail, followed by a description of the procedures employed in finding local extrema. Two variants are described for ensuring that the meteorological fields will be plotted together with outlines of the continents (use of a preprinted "blank" and simultaneous plotting). All this is illustrated in specific examples. Figures 3; references: 12 Russian.

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CORRELATION OF SEASONAL PROCESSES OF RESTRUCTURING OF IONOSPHERIC F REGION AND STRATOSPHERIC CIRCULATION

Moscow METEOROLOGIYA I GIDROLOGIYA in Russian No 1, Jan 82 (manuscript received 26 May 81) pp 49-53

[Article by V. F. Chepura, candidate of technical sciences, Institute of Experimental Meteorology]

[Text]

Abstract: As a result of investigation of variations in the mean monthly midday values of the critical frequencies of the F_2 layer over Moscow, Leningrad and Ottawa during 1958-1980 it was established that the times of the spring and autumn restructuring of the ionospheric F region in the middle latitudes of the northern hemisphere outrun the times of the corresponding seasonal restructurings of stratospheric circulation in this region on the average by 4-6 weeks, whereas the spring restructuring of the F region outruns the restructuring of circulation in the meteor zone on the average by two weeks.

Introduction. The existence of a correlation between the change in circulation in the northern hemisphere stratosphere and other atmospheric processes, including the features of distribution of total ozone content [2] in the stratosphere and the spring restructuring of wind in the meteor zone (altitudes 80-100 km) [4, 6], has been demonstrated in a number of studies.

The principal reason for the change in stratospheric circulation in this hemisphere in the last analysis is a seasonal change in the influx of solar energy into this hemisphere. Accordingly, it is natural to expect the presence of a correlation between the seasonal change in stratospheric circulation and processes having a seasonal periodicity, not only in the strato-, meso- and lower thermosphere, but also in the higher layers of the latter.

In this study such a dependence was detected by a comparison of the variation in changes in the critical frequencies f_0F_2 of the ionospheric F_2 layer and the times of spring and autumn restructuring of stratospheric circulation according to Ped' [3] during the period 1958-1980.

Method. The seasonal periodicity in the ionosphere is manifested most clearly in the behavior of the F_2 layer. Its critical frequency experiences both diurnal changes, attaining a maximum after midday, and seasonal changes. By virtue of the peculiarities of structure, composition and dynamics of the F region the daytime f_0F_2 values in summer are less than in winter [7, 8]. The main reason for this is that in winter in the F region the ratio of the O/N_2 concentrations is greater than in the summer [8], which in the last analysis is evidently associated with the macroscale transport of air masses. It is known that the F_2-layer ionization is produced by solar radiation at wavelengths shorter than 800 A [5]. It is situated above 200-250 km, where the magnetic and electric fields to a considerable degree determine the dynamics of charged particles; therefore, changes in solar activity, regular and irregular, exert an extremely significant influence on the state of the layer and the f_0F2 values. In this connection, the latter, together with regular seasonal changes, are characterized by brief fluctuations. In order to exclude them and ascertain the changes correlating with the seasonal restructuring of circulation in the stratosphere, we found the increments of the midday f_0F2 values, averaged for periods from a week to a month, during successive intervals of time equal to the averaging interval. Since the restructuring of circulation in the stratosphere, according to Ped', relates primarily to the middle latitudes of the northern hemisphere, we analyzed the variation of change of such increments of f_0F2 for Ottawa (45.4°N, 75.9°W), Moscow (55°28'N, 37°19'E) and Leningrad (59°57'N, 30°42'E) during a 23-year period (1958-1980).

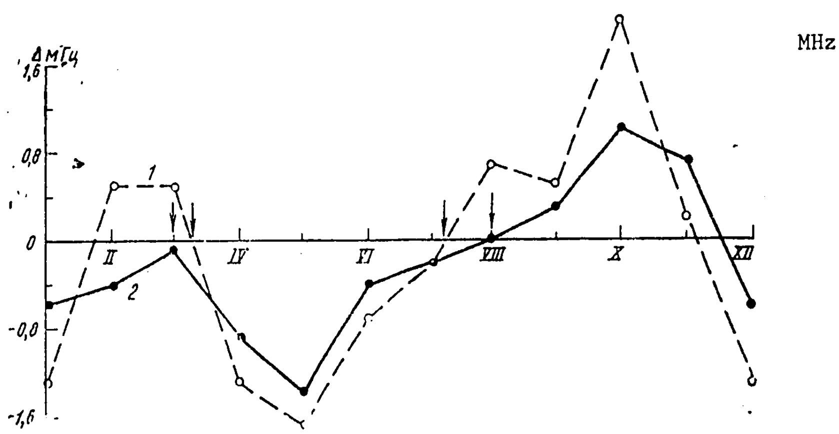

Fig. 1. Variation of change in increments Δ of mean-monthly midday f_0F_2 values over Moscow in 1969 (1) and in 1971 (2). The beginning of the spring and autumn restructurings of the F region is indicated by vertical arrows.

The increments Δ of the midday mean monthly f_0F2 values of the type $\Delta = f_0F_{2\ II} - f_0F_{2\ I}$, $f_0F_{2\ III} - f_0F_{2\ II}$, etc. correlated best with restructuring in the stratosphere. Using these data we constructed graphs of the change in Δ in the course of each year for the three mentioned stations similar to those shown in Fig. 1.

The seasonal changes in f_0F_2 are the most characteristic. With the approach of spring Δ decreases, usually changing sign from + to - (Fig. 1). This is evidence of the onset of spring restructuring of the F region -- the daytime appearance of the F_1 layer and a decrease in f_0F_2 in comparison with the preceding month. Sometimes as a result of the masking influence of solar activity variations this is manifested in the form of a sharp bend on the Δ curve. The dates when the Δ curve intersects the x-axis or a bend appears on this curve during the February-April period were used in our study as the onset of the spring restructuring of the F region. During July-August Δ increases, usually changing sign from - to +, or increases sharply (Fig. 1), indicating the onset of spring restructuring of the F region (decrease in the critical frequency of the F_1 layer and an increase in f_0F_2 during the daytime). We adopted the dates of these phenomena as the onset of the autumn restructuring of the F region. As already mentioned, the seasonal restructurings of the F region are probably associated with the macroscale transport of air masses.

It should be noted that since the F_2 layer is very sensitive to solar activity variations the averaging of f_0F2 for the month does not always make it possible to avoid the influence of its irregular changes. In order to clarify their influence on the seasonal Δ gradients, we analyzed the course of change in solar activity during the mentioned 23 years on the basis of the relative mean monthly increments of the Zurich Wolf numbers W of the type $\delta W = (W_{II} - W_I)W_I^{-1}$, $(W_{III} - W_{II})W_{II}^{-1}$, etc., where W_I, W_{II},... are the mean monthly W values, and on the basis of the similarly obtained relative mean monthly increments δS we obtained the densities of the solar radiation flux S at a wavelength 10.7 cm. Since in most cases $|\delta W| > |\delta S|$, for evaluating the influence of solar activity fluctuations we used the δW values.

Results

The table gives the dates of the onset of spring and autumn restructuring of the F region which we determined. For Leningrad and Ottawa we obtained results which are close in value. Since in determining them we used the mean monthly f_0F_2 values, the maximum deviation of the true dates of restructuring of the F region from those cited in the table can attain two weeks. This table also gives the relative mean monthly increments of Wolf numbers during the period (January-March) preceding the spring restructuring. As a comparison the table gives the dates of the spring and autumn restructurings of stratospheric circulation in the northern hemisphere according to Ped' [1, 3; during the years 1977-1980 the data were obtained from D. A. Ped'], the dates of the spring restructuring of the wind in the meteor zone according to measurements at Obninsk [4, 6] and the times of outrunning of the restructuring in the meteor zone and in the F region over Moscow relative to the restructuring in the stratosphere.

During the years 1958-1960 and 1975-1976 it was not possible to ascertain the times of the spring restructuring in the F region. During these years, as a result of the specific sequence of solar activity during January-March, the ordinary variation of change in the increments of the mean monthly f_0F_2 values was disrupted. With the approach of spring the Δ curve did not intersect, as usual, the x-axis, and there was no sharp bend on it. The table shows that such a situation is observed when $\delta W_1 \leqslant -0.25$ and $\delta W_2 \geqslant 0$.

Table

Год 1)	Даты перестройки циркуляции в стратосфере по Педю 2)		Весенняя перестройка циркуляции в метеорной зоне 3)		Перестройка в области F ионосферы над Москвой 4)				Среднемесячные приращения чисел Вольфа δW 5)	
	весна 6)	осень 7)	даты 8)	опереж., дни 9)	весна 6)		осень 7)			
					даты 8)	опереж., дни 9)	даты 8)	опереж., дни 9)		
	$T_{в1}$ 10)	$T_{о1}$ 11)	$T_{в2}$	$T_{в2}-T_{в1}$	$T_{в3}$	$T_{в3}-T_{в1}$	$T_{о3}$	$T_{о3}-T_{о1}$	$\delta W_1=\frac{W_{II}-W_I}{W_I}$	$\delta W_2=\frac{W_{III}-W_{II}}{W_{II}}$
1958	10 V	31 VIII	—	—	—	—	26 VI	66	—0,25	+0,31
1959	23 III	31	—	—	—	—	11 VII	51	—0,34	+0,30
1960	10 IV	30	—	—	—	—	29 VI	62	—0,26	0
1961	9 III	23	—	—	3 III	6	12 VII	42	—0,19	+0,18
1962	25 IV	25	—	—	22 II	62	11 VIII	14	+0,29	—0,13
1963	4 V	27	—	—	1 V	3	23 VII	35	+0,18	—0,25
1964	18 III	31	11 III	7	11 III	7	21 VII	41	+0,12	—0,11
1965	19 IV	27	28	22	13 III	37	1 VIII	27	—0,23	—0,21
1966	8	29	10	29	22 II	45	10 VII	50	—0,12	+0,04
1967	22	3 IX	20	33	13 III	40	16 VI	79	—0,15	+0,17
1968	27	29 VIII	25	33	1 IV	26	9 VII	51	—0,07	—0,14
1969	10	31	20	21	10 III	31	6 VII	56	+0,16	+0,15
1970	11	27	25	17	1 III	42	3 VIII	24	+0,12	—0,22
1971	18 III	1 IX	10	8	1 III	17	1 VIII	30	—0,11	—0,19
1972	25	6	16	9	13 III	12	1 VIII	36	+0,42	—0,08
1973	21 IV	2	29	32	9 II	71	1 VIII	32	0	+0,08
1974	23 III	7	2	21	18 II	33	15 VIII	23	—0,06	—0,13
1975	18	1	5	13	—	—	1 VIII	31	—0,38	+0,03
1976	31	1	21	10	—	—	18 VII	43	—0,46	+4,00
1977	29	1	23	6	19 II	38	18 VII	43	+0,44	—0,65
1978	25	3	24	1	2 III	23	3 VIII	30	+0,82	—0,18
1979	8 IV	6	18	21	20 II	49	10 VII	56	—0,17	—0,01
1980	6	1	1 IV	5	6 III	31	—	—	—0,02	—0,21

KEY TO TABLE

1. Year
2. Dates of restructuring of circulation in the stratosphere according to Ped'
3. Spring restructuring of circulation in meteor zone
4. Restructuring in ionospheric F region over Moscow
5. Mean monthly increments of Wolf numbers δW
6. Spring
7. Autumn
8. Dates
9. Outrunning, days
10. B = spring
11. O = autumn

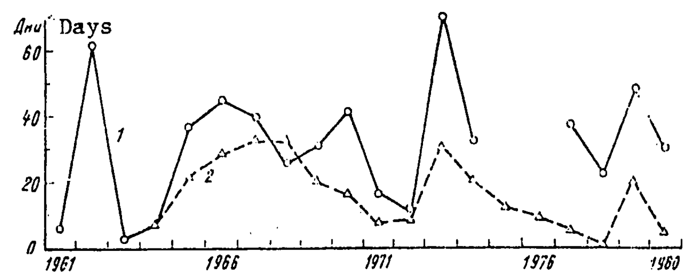

Fig. 2. Values of outrunning of spring restructuring in F region (1) and in meteor zone (2), restructuring in stratosphere according to Ped'.

We note that the scatter of values of outrunning of the autumn restructuring in the F region relative to the stratosphere is considerably less than for the spring restructuring, the same as the times of onset of the autumn restructuring in the stratosphere in comparison with the times of the spring restructuring. These variations in outrunning times are not directly related to the changes in Wolf numbers and the flux of solar radiation at a wavelength of 10.7 cm in periods preceding the corresponding seasonal restructurings.

We will cite the mean 23-year values of outrunning of restructuring in the upper layers of the atmosphere relative to the stratosphere: in the meteor zone in spring -- 17 days, in the F region in spring over Moscow, Leningrad and Ottawa -- 32, 34 and 37 days respectively, in autumn -- 41, 39 and 45 days respectively. The scatter of mean values of outrunning of restructuring in the F region relative to the stratosphere is probably determined by the difference in latitudes and longitudes of the observation points.

Conclusions

1. The spring and autumn restructuring of the ionospheric F region (altitudes 250-400 km) in the middle latitudes of the northern hemisphere on the average regularly outpace by 4-6 weeks the corresponding seasonal restructuring of wind in the stratosphere in this region.

2. The spring restructuring of the ionospheric F region on the average sets in two weeks earlier in comparison with the spring restructuring of the wind regime in the meteor zone. There is an appreciable correlation (Fig. 2) of outrunning of the spring restructuring in the F region and in the meteor zone ($T_{B2} - T_{B1}$ and $T_{B3} - T_{B1}$, see table [B = spring]).

3. The dates of onset of the seasonal restructurings in the ionospheric F region, meteor zone and the stratosphere in the course of approximately 20 years are evidence that these restructurings in the middle latitudes of the northern hemisphere are propagated in a downward direction, successively affecting the lower-lying layers to altitudes 20-30 km.

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UDC 551.576.11

INTERACTION OF CLOUDS WITH AMBIENT AEROSOL MEDIUM

Moscow METEOROLOGIYA I GIDROLOGIYA in Russian No 1, Jan 82 (manuscript received 20 Apr 81) pp 54-61

[Article by I. P. Mazin, professor, Central Aerological Observatory]

[Text]

Abstract: It is shown that the interaction of clouds with the ambient atmosphere leads to a transformation of its aerosol characteristics -- the concentration of fine aerosol particles (AP) decreases. There is a transformation of the spectrum of sizes and composition of aerosol particles, and their vertical distribution. As a result, there is also a change in the spectrum of sizes of cloud particles with time; the droplets coalesce. Their concentration decreases and there is an increase in the probability of the icing of a cloud at negative temperatures. The effectiveness of the considered processes is evaluated and on this basis it is postulated that the considered processes may play an important role in the formation of clouds and precipitation.

Origin of problem. The purpose of this article is to bring the attention of specialists in the field of cloud physics and atmospheric aerosols to the interesting physical process of interaction between a cloud and the ambient aerosol medium. This interaction is exceedingly diversified and can lead to extremely important consequences.

We will illustrate what has been said in the simple example of an individual cumulus cloud. It is known that such a cloud constantly exchanges mass with the ambient medium. For example, H. Wakeman and A. Rabb cite cases when on the basis of computations individual cumulonimbus clouds "drew in" about 12 000 and 27 000 km^3 of air respectively [6]. According to the estimates of Ye. L. Kogan, in his three-dimensional model a total of 15 km^3 of air passes through a cloud with a volume of about 2 km^3 in 60 minutes. In other words, due to ordered and turbulent exchange the air in the convective cloud can be replaced 5-10 times or more during its lifetime. In stratiform clouds the time of presence of air particles within a cloud may be less than the lifetime of the cloud as a whole by more than 1-3 orders of magnitude [3]. It can be said figuratively that in this case as well the air seemingly passes through the cloud.

In this case how do changes occur in the microstructure of the cloud and how do the aerosol characteristics of the ambient air change? It is evident that in passing through the cloud the air is purified of the air particles suspended in it, that is, the cloud operates as a filter. The aerosol particles are washed out by the cloud droplets and as a result the concentration of the air particles in the air passing through the cloud decreases sharply. On the other hand, soluble and insoluble air particles are collected in the droplets and when the droplets are transported from the cloud and evaporate only a dry residue remains in the air. Such a residue is a mixed condensation nucleus (CN). Within the condensation nucleus there are insoluble inclusions, surrounded by a hygroscopic substance which precipitated on them as the droplets evaporated.

Thus, the aerosol particles, entering the cloud together with the air, are collected by the cloud droplets and if precipitation does not fall from the cloud these particles are again transported into the ambient air already in the form of larger condensation nuclei with a complex structure and composition. The transformation of the aerosol component of air, essentially involving a decrease in the concentration of aerosol particles and the appearance of more effective condensation nuclei and ice nuclei, leads gradually to a change in cloud microstructure. The latter seemingly shifts to a microstructure of a marine type -- the concentration of droplets is reduced and the droplets themselves become larger.* At negative temperatures the presence of mixed nuclei favors the freezing of the droplets forming on them because the insoluble particles present in them can play the role of ice nuclei. The described transformation of the microstructure of clouds favors the generation of precipitation. The question arises: are the mentioned effects significant in magnitude?

Before proceeding to their evaluation we will enumerate again the spatial-temporal changes in the structure of clouds and the ambient aerosol medium resulting from the interaction between them.

Change in aerosol medium. Clouds (stratiform or convective) should lead to a gradual purification of the atmosphere in their neighborhood from small aerosol particles and the appearance of large aerosol particles of a mixed structure. It is not impossible that precisely this mechanism plays an important role in the formation of large mixed aerosol particles in the free atmosphere. If there is no precipitation the specific mass of the aerosol particles should not change substantially during the considered transformation.

The air enters the clouds primarily in their lower part and is propelled into the upper part. Since the propelled air should contain fewer small and more large particles, this should lead to a sharper decrease in the concentration of small aerosol particles with altitude and a slower decrease in the number of large particles.

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* The considered processes should be less effective in sea air containing considerably fewer submicron aerosol particles.

Thus, with increasing altitude not only should the concentration of aerosol particles begin to decrease, but there should also be a transformation of the droplet size spectrum and activity. In other words, the clouds transform the spectrum of aerosol particles in the direction of larger particles and a decrease in their total concentration and favor the transport of larger condensation nuclei and the formation of mixed condensation nuclei. The slowed decrease in the concentration of gigantic aerosol particles with altitude detected by V. G. Khorguani in the presence of cumulonimbus clouds and the multiple increase in their concentration in the layer below the clouds (see [5], pp 2-3) are possibly associated with the considered processes. According to the data of V. A. Devyatova and B. G. Andreyev [1], directly within stratiform and convective clouds the total concentration of aerosol particles decreases with altitude considerably more sharply than in the cloudless atmosphere.

The decrease in the concentration of submicron particles under clouds [8] discovered by L. Radke, P. Hobbs and M. Eltgroth can be fully attributed to the discussed effect of filtering of air by a cloud.

Change in cloud microstructure. A change in the aerosol medium also results in a change in cloud microstructure. As time elapses the clouds have larger droplets and the droplet concentration in them decreases. If the top of the clouds is situated above the zero isotherm, as time passes the probability of its icing will increase, which can cause, in particular, a change of Cu cong. to Cb. In general the transformation of cloud microstructure occurs in such a way that it, as already noted above, is shifted in the direction of a microstructure of the sea type, and in the last analysis there is an increase in the probability of formation of precipitation.

Concentration of Condensation Nuclei Transported Into Ambient Atmosphere by Evaporating Cloud Droplets

Now we will return to the question as to whether the effects enumerated above are so significant that they cause appreciable changes in the structure of clouds and the aerosol medium surrounding them. The simple estimates given below make it possible to give an affirmative answer to this question.

It was noted above that during its lifetime a convective cloud "draws through" itself, that is, "filters" in many cases more than a tenfold volume of air. Accordingly, a 2/10-3/10 field of cumulus clouds with a thickness of 1.5-2 km in 1-1.5 hours transforms the distribution of aerosols in a 3- - 4-km air layer. It transforms the aerosol characteristics in the adjacent layers of the atmosphere and the stratiform cloud. Here exchange with the above- and underlying layers occurs primarily as a result of turbulence. Thus, in a relatively short time (several hours) enormous masses of ambient air are entrained into the process of interaction with clouds. We will show that during these several hours there is a substantial change in such an important characteristic of the air mass as the aerosol component.

We will examine the quantity of large nuclei transported by a cloud into the atmosphere. In the case of absence of precipitation it is reasonable to assume that the quantity of such nuclei coincides with the quantity of evaporating droplets.

The droplet concentration in the clouds is hundreds per cubic centimeter. Over the course of several hours an order of magnitude more droplets (and accordingly nuclei) will be propelled into the atmosphere than is present at a given time in the cloud. If the air volume passed through a cloud mixes with a volume an order of magnitude greater, that is, is propagated virtually to the entire troposphere, in such a case as well the concentration of nuclei remaining after evaporation of the droplets will be about 10 per cubic centimeter. Thus, the concentration of condensation nuclei transported by the cloud into the ambient atmosphere can attain thousands per liter, and such nuclei, if they are adequately large, thereafter should play an important role in the formation of clouds and the formation of precipitation. In other words, if the condensation nuclei forming during the evaporation of cloud particles are sufficiently large, this means that in the evolution process the cloud itself produces large condensation nuclei which later, again entering into the cloud, become precipitation nuclei.

Naturally, important questions arise: how many large condensation nuclei are propelled into the atmosphere by cloud droplets and what is their size distribution? And related to this and not less important: to what degree is there a decrease in the concentration of submicron cloud condensation nuclei whose diameter is less than 0.1-0.2 μm*.

Size Spectrum of Aerosols Formed by Cloud Droplets

It is evident that the size of the condensation nuclei remaining after the evaporation of droplets is dependent on how effectively these droplets captured aerosol particles in the course of their lifetime. This question is exceedingly complex in a rigorous formulation of the problem. There is an extensive literature devoted to the washing-out of aerosol particles by precipitation, and unfortunately very little attention has been devoted to the washing-out of these particles by cloud droplets in the absence of precipitation. The "washing-out" coefficient is dependent on the size of the aerosol particles, on the size of the droplet, which changes with time, and on many other factors. However, a number of important results and convincing estimates can also be obtained with a simplified approach to the problem.

We will introduce a number of notations.

Assume that μ is the mass of the aerosol particle, $f_0(\mu)$ is the spectrum of the masses of aerosol particles in the air mass interacting with the cloud, $N\varphi(a)$ is the spectrum of the sizes of droplets in clouds, where $\varphi(a)$ is normalized to 1, K(r, a) is the coagulation (washing-out) coefficient of aerosol particles of the radius a. Numerically this coefficient is equal to the volume from which all particles of the radius r are washed out by a droplet of the radius a in 1 sec.

It is known that in the region $r < 0.01$ μm the K(r, a) coefficient is determined by Brownian diffusion, that is

$$K(r,\ a)=K_B(r,\ a)\ 4\pi D_r a. \tag{1}$$

* We recall that in continental air masses the concentration of such particles is initially $\sim 10^2$ cm^{-3}, whereas in marine air it is an order of magnitude less.

The coefficient of Brownian diffusion increases rapidly with a decrease in r

$$D_r = \frac{kT}{6\pi r\eta}(1 + \alpha \mathrm{Kn}). \quad (2)$$

The Cunningham correction for large Knudsen numbers, according to Davis [7], is

$$\alpha = 1,257 + 0,400 \exp(-1,10/\mathrm{Kn}). \quad (3)$$

For $r < 0.01$ it follows from (2) and (3) that

$$D_r \approx \frac{kT}{6\pi r\eta}\alpha \mathrm{Kn} \approx \frac{kT\lambda}{4\pi\eta r^2}. \quad (4)$$

Here k is the Boltzmann constant, T is absolute temperature, η is the coefficient of dynamic viscosity of air, λ is the length of the free path of molecules.

In the case of large particles ($r > 1\,\mu$m) washing-out transpires rather effectively as a result of inertia and turbulent diffusion. However, in the region from 0.01 to $1\,\mu$m in the enumerated washing-out mechanisms there is "gap" where the K(r, a) coefficient is very small. But the main mass of aerosol particles is concentrated precisely in this region. Investigations of recent years [7-9] have indicated that allowance for phoretic forces and the forces of electric interaction will make it possible to fill this gap.

As a result of thermal and diffusion phoresis the aerosol particles move against the the temperature and concentration gradients respectively so that in the neighborhood of a droplet growing and heating relative to the air thermophoresis impedes, whereas diffusion phoresis favors the capture of aerosol particles. In the neighborhood of an evaporating, and accordingly, colder droplet, on the other hand, diffusion phoresis impedes, whereas thermophoresis favors capture.

Due to turbulent eddies in the air the droplets move randomly in cloud space. In contrast to the partial reversibility of stochastic condensation processes (droplets moving upward increase, whereas droplets moving downward evaporate), the capture of aerosol particles can occur during the movement of a droplet in any direction. As a result, the mass of the aerosol particles in the droplet, all other conditions being equal, will increase with the "age" of the droplet.

It is impossible to carry out rigorous computations of the process of washing-out of aerosol particles by droplets without a knowledge of the detailed characteristics of microscale turbulence in clouds. We will limit ourselves here exclusively to the roughest estimates. Accordingly, as a simplification we will assume that the size of the cloud droplets and their spectrum is invariable with time. In addition, we will assume that in the region of aerosol particles with a radius from 0.01 to $r_0 = 1\,\mu$m the coagulation coefficientis not dependent on the size of the aerosol particles and is equal to K_w (0.01; a), that is

$$K(r, a) = \begin{cases} \frac{kT\lambda a}{\eta r^2} & \text{with } r \leqslant 0.01\,\mu\text{m} \\ 4\pi D_{0,01}a \approx 10^{-2} Da & \text{with } 0.01 \leqslant r \leqslant 1\,\mu\text{m}. \end{cases} \quad (5)$$

Here D is the coefficient of diffusion of vapor in air. Judging from the data in [7-9], such a simplification is entirely admissible for the estimates.

In the washing-out process the concentration of aerosol particles of the radius r decreases in conformity to the law [7]

$$n(r,\ t) = n(r,\ 0)\,e^{-\Lambda(r)t}, \tag{6}$$

where the washing-out coefficient is

$$\Lambda(r) = N\int_0^\infty K(r,\ a)\,\varphi(a)\,da. \tag{7}$$

Substituting the values (5) here, we find that

[p = r(elaxation)]

$$\Lambda(r) = \begin{cases} \dfrac{D_r}{D}\dfrac{1}{\tau_p} & \text{when } r < 0.01\,\mu\text{m} \\ 10^{-3}/\tau_p & \text{when } 0.01 \leqslant r \leqslant 1\,\mu\text{m}. \end{cases} \tag{8}$$

Then we have

$$\tau_r = (4\pi D N \bar{a})^{-1}, \tag{9}$$

the so-called phase relaxation time, being a characteristic parameter of cloud microstructure [4].

We will find the rate of washing-out of the aerosol mass present in particles of the radius $r < r_0 = 10^{-4}$ cm. The mass of such aerosol particles present in a unit volume of air is

$$M(t) = \frac{3}{4}\pi\rho_{AP}\int_0^{r_0} r^3 n(r,\ t)\,dz. \tag{10}$$

We find from (10), with (6)-(9) taken into account, assuming that the main mass of the aerosol particles (AP) is contained in particles with a radius from 0.01 to 1 μm, that

$$M(t) = \frac{4}{3}\pi\rho_{\Lambda\text{Ч}}\int_0^{r_0} r^3 n(r,\ 0)\exp\left(\frac{-10^{-3}t}{\tau_p}\right)dr = \tag{11}$$

$$= M(0)\exp\left(\frac{-10^{-3}t}{\tau_p}\right).$$

The time τ during which the mass of aerosol particles in cloud air is reduced to half is equal to $\tau \approx 10^3 \ln 2 \cdot \tau_r$.

For example, in a cloud whose liquid water content is w = 0.5 g/m^3, and $\bar{a} = 4\,\mu$m, $\tau_r \approx 1$ sec and $\tau = 16$ min. Thus, the air passing through clouds in the course of 20-30 min is purified by more than half from aerosols. These estimates are correct both for the loss of mass of aerosol particles present outside the droplets and for the concentration of aerosol particles whose radius falls in the range from 0.01 to 1 μm. The concentration of aerosol particles remaining after the evaporation of droplets and falling in this size range is relatively small and exerts no influence on the estimates.

It seems of more than a little significance to examine such additional problems as the following: how does the mass of soluble and insoluble particles increase in one droplet with time and what nucleus remains after the evaporation of a droplet of a stipulated size present in a cloud a certain time?*.

Assume that $\mu_a(t)$ is the mass of aerosol particles present in a droplet of the radius a present in a cloud for the time t. For the subsequent time segment dt this mass increases by the value

$$d\mu_a = dt\int_0^{r_0}\frac{4}{3}\pi\rho_{AP}r^3K(r, a)n(r)dr = \frac{4}{3}\pi\rho_{AP}dt\int_0^{r_0}r^3n(r, 0)\exp\times \tag{12}$$

[AЧ = aerosol particle = AP]

$$\times\left[-Nt\int_0^\infty K(r, a)\varphi(a)da\right]K(r, a)dz.$$

Integrating (12) for t, we find

$$\mu_a(t) = \frac{4}{3}\pi\rho_{AP}\int_0^{r_0}dr\left[r^3n(r, 0)K(r, a)\frac{1-e^{-\Lambda(r)t}}{\Lambda(r)}\right]. \tag{13}$$

In the case $t \gg \Lambda^{-1}(r)$, that is, in the case of complete washing-out, from (13), with allowance for (5) and (9), as might be expected, it follows that

$$\mu_a(t) = \frac{M(0)}{N\bar{a}}a. \tag{14}$$

It is evident that in this case

$$\int_0^\infty \mu_a(t)N\varphi(a)da = M(0) = \text{const}. \tag{15}$$

In this case the distribution of aerosol particles by masses (after the evaporation of droplets) has the form

$$f(\mu) = \varphi\left(\frac{\bar{a}N}{M(0)}\mu\right)\frac{\bar{a}N}{M(0)}. \tag{16}$$

In the case of arbitrary t, taking into account that the main mass of aerosol particles is concentrated in particles with a radius from 0.01 to 1μm, for which we used $K(r, a) = 10^{-3}\, 4\pi Da$, from (13) we find

$$\mu_a(t) = \frac{aM(0)}{N\bar{a}}\left(1 - e^{\frac{-10^{-3}t}{\tau_p}}\right). \tag{17}$$

We introduce the aerosol-cloud parameter $A = M(0)/N\bar{a}$. [If the coagulation coefficient is not described by expression (5), but a more general expression of the type $K(r, a) = cr^\alpha a^\beta$ (in particular, $\beta = 2$ is possible), the parameters A and X would have the form $A = \frac{M(0)}{N\overline{a^\beta}}$, $X = \frac{\mu}{a^\beta}$.]

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* The examination presented below can be applied separately to the soluble and insoluble components of aerosol particles.

This parameter characterizes the mean mass of the aerosol particles received per unit droplet radius and has the dimensionality g/cm. We also introduce the variable $X = \mu/a$; this aerosol parameter is related to droplets of the particular radius a. In the new notations (17) is written in the form

$$X = A\left(1 - e^{-\frac{10^{-3}t}{\tau_p}}\right). \qquad (18)$$

If the droplets leaving the cloud have a size and age distribution $\psi(a, t)$, then with (18) taken into account it would also be easy to determine the distribution $\vartheta(\mu)$ of the aerosol particles by masses after evaporation of the droplets. In actuality, from the expression

$$\psi(a, t)\, dt = \Theta(X)\, dX \qquad (19)$$

it follows that

$$\Theta(X) = \psi[a, t(X)]\frac{dt}{dX}. \qquad (20)$$

From (18) we find that

[p = r] $$t(X) = -10^3\tau_p \ln\left(1 - \frac{X}{A}\right), \quad \frac{dt}{dX} = \frac{10^3\tau_p}{X - A}. \qquad (21)$$

And, finally,

$$\vartheta(\mu) = N\int_0^\infty \Theta\left(\frac{\mu}{a}\right)\varphi(a)\, da. \qquad (22)$$

If the functions $\psi(a,t)$ and $\varphi(a)$ are known, it is possible to find $\Theta(X)$ using (20) and (21) and then also the explicit form of the function $\vartheta(\mu)$.

It is characteristic that $\vartheta(\mu)$ is not dependent on the initial distribution of AP by sizes, but is dependent only on the cloud parameters N and $\varphi(a)$, the aerosol-cloud parameter A and the distribution of droplets leaving the cloud by ages and sizes $\psi(a, t)$, which is determined directly by the nature of ordered and turbulent movements in the cloud and in its neighborhood.

Subsequently the air passing through the cloud is mixed with the ambient air and as a result the transformed spectrum of masses of aerosol particles $f(\mu)$ is a singular combination of the $f_0(\mu)$ and $\vartheta(\mu)$ spectra.

Thus, examining the influence of a cloud on the parameters of atmospheric aerosol it can be said that it must be significant and that the cloud serves as a sink for small aerosol particles and a source of large aerosol particles, including cloud condensation nuclei and ice nuclei. In examining the processes of formation of the spectrum of sizes of aerosol particles in the atmosphere it is necessary to take into account the role of clouds as sinks and sources and in creating a model of atmospheric aerosol it is desirable to take into account the regional peculiarities associated with the climatology of cloud cover.

The considered effects make it possible to formulate a number of problems for both theoreticians and experimenters. In particular, first of all a study should be made of the nature of the change in the parameters of atmospheric aerosol with time with the appearance of clouds. It is important to detect changes in the concentration of aerosol particles in the neighborhood of clouds and the transformation of the spectrum at different altitudes. It would be of unquestionable interest to investigate the transformation of the composition of aerosol particles, especially from the point of view of change in the percentage of the hygroscopic fraction.

With respect to clouds, it is important to trace the temporal change in the concentration and spectrum of droplet sizes and how ice crystals appear in clouds and how precipitation is generated. In a case when experimental investigations confirm the anticipated effects, theoreticians are faced with specific problems with respect to the development of a theory of interaction of a cloud with an aerosol medium. Here it is important to have a further comprehension of the processes of washing-out of aerosol particles by cloud droplets and crystals, associated, in particular, with the joint effect of phoretic forces and turbulence, creating inhomogeneities both in the field of air velocities and in the temperature field. A new stimulus is appearing in the finding of the distribution function of cloud particles by ages. The listing of the tasks arising in connection with this problem could be continued considerably further.

In conclusion we note once again that this communication by no means solves the problems set forth in the heading. It only emphasizes their importance and indicates the possible directions of changes in the characteristics of a cloud and atmospheric aerosols arising during their interaction; a number of qualitative patterns are established. In particular, here it is shown that the cloud transforms the spectrum of aerosol particles in the ambient atmosphere to a form not dependent on their initial distribution.

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CREATING NEW OBSERVATIONAL NETWORK FOR MONITORING ENVIRONMENTAL CONTAMINATION

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[Text]

Abstract: The authors validate the feasibility of creating a new observational network (on the basis of network snow surveys) for monitoring the contamination of natural media: atmosphere, surface waters and soils. The article examines the problems involved in organizing observations, their use for evaluating the state of contamination of the environment and prediction of change of this state. The examination is carried out on the basis of five years of experience in work in different regions of the USSR.

Introduction. As was indicated in [7], the network for measuring the parameters of snow cover (depth, density and moisture reserve) existing in the USSR State Committee on Hydrometeorology and Environmental Monitoring can be used in observations of environmental contamination. The snow cover is a natural accumulator of contaminating substances falling from the atmosphere in dry form and with precipitation. During thawing it is a source of contamination of soils and surface waters. Accordingly, data on the contamination of snow constitute an index characterizing the contamination of these natural media.

Five years of experience in carrying out observations of contamination of the snow cover at a number of meteorological stations indicated that these studies do not require an increase in the number of observers because the taking of samples, combined with measurement of snow cover density, is carried out quite rarely, once or twice a season.

The density of the existing snow-gaging network of the State Committee on Hydrometeorology and Environmental Monitoring is characterized by the following figures. The total number of hydrometeorological stations and posts at which the determination of snow depth and density is carried out regularly is about 7500 [6]. At each station or post the measurements are carried out along one or more snow-gaging lines which cross the principal landscape complexes of this territory [8].

We note that with respect to territorial coverage this network surpasses the network of the National Service for Observing and Monitoring Environmental Contamination, which includes systematic observations of atmospheric contamination in 350 cities and contamination of the surface waters of the land in 1200 water bodies [4, 5]. The location of stations for making observations in the snow-gaging network as a rule appropriately supplements the existing network for the monitoring of contamination. The snow-gaging observation network covers major industrial regions in the country as well as territories remote from them. In the industrial regions there are approximately 2500 meteorological stations and posts where measurements of snow parameters are made; over the remaining areas there are about 5000. Over the greater part of the European USSR (excluding the extreme northerly regions) there is one station or post in an area of 3000-6000 km^2, in the area of Western Siberia and Kazakhstan -- one each 8000-10 000 km^2, in Eastern Siberia and in the Northeastern USSR -- one each 13 000-17 000 km^2. Thus, the use of the snow-gaging network for observations of contamination should give more complete information on environmental contamination with extremely low expenditures of material and human resources.

In order to characterize the possibilities of any monitoring system, including the proposed network, it is necessary to examine the following questions: reliability and representativeness of the results of observations, effectiveness of their use in evaluating the state of the environment and predicting change of this state [4, 5]. Below, on the basis of this approach and five years experience in carrying out observations of snow cover contamination in a number of regions in the USSR, we will give an evaluation of the feasibility, on the basis of the existing standard snow-gaging network of the State Committee on Hydrometeorology and Environmental Monitoring, of creating a new observation network for the monitoring of contamination of the environment as a component of the national service for observing and monitoring environmental contamination.

Observation Method

Snow samples for determining the content of contaminating substances (dust, heavy metals, sulfates, etc.) are taken along snow-gaging lines while carrying out planned snow surveys. The planned snow surveys are carried out two or three times each month and therefore in case of necessity it is possible to obtain detailed data concerning the dynamics of contamination. However, as a characteristic of contamination during the time of accumulation of snow during the winter period it is sufficient to take a single sample at the time of the snow accumulation maximum. This considerably reduces the time required in sampling itself and the subsequent work load in laboratories.

In sampling the snow the results of the work can be influenced by contamination of the snow by the snow-gaging tool itself and contamination as a result of presence of soil particles.

The use of a standard metallic snow gage, as indicated by experience, does not introduce significant errors into the qualitative and quantitative composition of the sample because the sample is in contact with the metallic surface of the snow gage for a short time.

During the taking of a sample insignificant quantities of soil particles can enter the sample. According to our observations, made for a large number of snow-gaging lines, even in places separated by great distances from industrial sources, in most cases the ratios of the concentrations of elements in the dry precipitates of snow to their concentration in the soil is tens or hundreds of units. However, when these concentrations for any substance are close, this means that contamination is insignificant or completely absent.

In order for errors of this type to become minimum, the soil samples must be taken on snow-gaging lines at the places where the soil is entirely snow covered.

The samples can be analyzed by different methods, depending on the capabilities of the laboratory. For example, an analysis for the content of trace elements can be made by spectral methods: atomic-absorption or emission; an analysis for the content of benzapyrene can be made by the method of low-temperature luminescence, sulfates can be analyzed by the turbidimetric method, etc. The content of contaminating substances in a sample of snow water is determined by the total content of this substance in the insoluble fraction on the filter and the total content of the soluble fraction in the filtrate.

The levels of contamination of the snow cover are computed in the following way. We have

$$\sigma_{ij} = \frac{Q_{ij}}{S_i}, \qquad (1)$$

where σ_{ij} is the density of contamination by an ingredient according to data from the i-th sample, Q_{ij} is the total quantity of the j-th substance present in the i-th sample, S_i is the area from which the sample was taken.

The value

$$Q_{ij} = Q_{ij\ fil} + Q_{ij\ sub}, \qquad (2)$$

where $Q_{ij\ fil}$ is the quantity of substance remaining on the filter -- the conditionally insoluble part, $Q_{ij\ sub}$ is the quantity of substance in the conditionally soluble part of the sample passing through the filter.

We will designate by c_{ij} the concentration of substance in the conditionally soluble part of the sample and v_i will be used in designating the total volume of the melt water in the i-th sample. For the usually employed snow gages (circular cylinder) the area $S_i = k_i \pi r^2$, where k_i is the number of snow samplings at a particular point, r is the radius of the cylinder. Thus,

[Φ = fil; B = sub]

$$\sigma_{ij} = \frac{Q_{ij\Phi} + Q_{ijB}}{k_i \pi r^2} = \frac{Q_{ij\Phi} + c_{ij} v_i}{k_i \pi r^2}. \qquad (3)$$

On the basis of the σ_{ij} values we find the mean values

$$\sigma_j = \frac{1}{m} \sum_{i=1}^{m} \sigma_{ij} \qquad (4)$$

and on this basis the density of precipitation per unit time is

$$\sigma_j = \frac{\sigma_j}{T}, \tag{5}$$

where m is the number of samples taken along the line, T is the time of accumulation of contamination.

Spatial and Temporal Structure of Snow Cover Contaminations

Network observations of the level of snow cover contamination give some idea concerning the spatial and temporal structure of the snow cover. They make it possible to detect centers of contamination, determine the range of priority contaminants in a given industrial region and study the seasonal dynamics. These possibilities are indicated below in a number of examples.

Table 1

Relative Mean Rate of Fallout of Metals in Investigated Regions

Stations	Cu	Zn	Fe	Ni	Mn	Pb
I	57.0	2.0	19.0	43.00	11.0	4.00
II	1.5	2.5	6.0	3.00	3.0	26.00
III	1.9	34.7	15.3	~1*	37.0	~1*

*Within the limits of measurement accuracy.

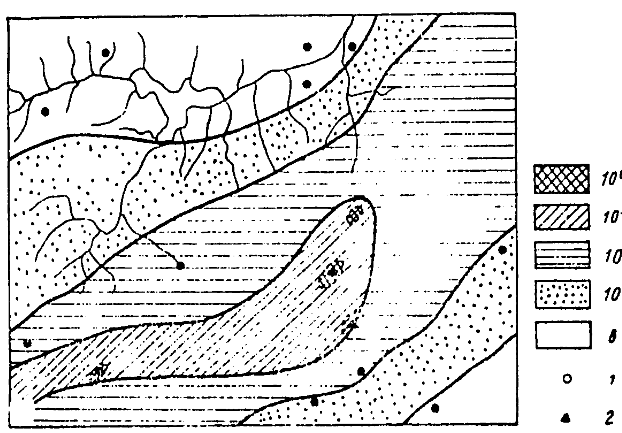

Fig. 1. Sketch map of contamination of territory with nickel. 1) sampling points, 2) contamination source.

1) We examined industrial regions with linear dimensions of several tens of kilometers each, situated at distances of hundreds of kilometers from one another. In the first of these regions there was a nonferrous metallurgy enterprise and in the

second -- an enterprise for the production of lead-zinc ores. The third region was in a zone of ferrous metallurgy enterprises. Table 1 gives the relative mean rate of fallout in these regions. Averagings of the results of analyses of snow cover samples were made over the territory and over a period of 3-4 months. As unity we employed the mean rate of fallout in a region distant from industrial centers. It can therefore be seen that in the region of nonferrous metallurgy the principal contaminants are copper and nickel, in the second -- lead and in the third -- zinc, iron and manganese.

2) As a result of use of the snow-gaging network we obtained maps of the distribution of heavy metals over the extensive territory with the use of 25 meteorological stations and posts; we detected zones of contamination associated with the activity of industrial enterprises, studied seasonal and annual dynamics and variations of fluxes at the surface. Figure 1 is a sketch map in relative units which shows the structure of the field of contamination by nickel. The principal source is located at the center of the investigated region. Near the source, at a distance of several kilometers, there are higher nickel levels in the fallout. At distances of 40-50 km from the source there is a zone of secondary contamination where the fallout density is approximately 7 times lower than near the source. Next there is an extensive zone where only traces of contamination are found, and finally, the part of the territory bordering the zones where the concentration of nickel in the fallout is below the sensitivity of the method. In this case the structure of the zones duplicates the character of local relief with an increase in the concentration in places of depressed relief; all the zones extend in a northeasterly direction, which coincides with the prevailing direction of the wind in this season. This sketch map shows that such a detailed study of the territory of a region makes it possible to detect sources of contamination, the distribution of fallout levels as a function of the location of the sources, their intensity, composition of effluent and landscape characteristics of the territory. Similar sketch maps could be constructed for 12-15 elements and it was possible to discriminate those elements whose presence for the most part is associated with effluent from anthropogenic sources.

3. The local fallout levels are dependent on meteorological conditions and can considerably change with time and over the area. However, as indicated by observations, with technology remaining unchanged the sum of fallout during the season over the territory in a range of 50-100 km around the enterprise remains virtually constant from year to year, varying only within the limits of measurement errors. For example, as a result of 5-year observations in a region with ferrous metallurgy enterprises it was found that the sum of dust fallout deviated from the mean value by ±30%. Accordingly, by knowing the mass of matter in effluent and the quantity of matter falling onto the territory around the enterprise or industrial center it is possible to estimate the fraction entering into distant transport.

Assume that the mean intensity of the effluent $\bar{q}$ is known, in kg/day. Then the mass of matter expelled into the atmosphere during the accumulation time T, in days, will be equal to $Q = \bar{q}T$. In the studied territory we will discriminate relatively homogeneous sectors with fallout densities exceeding the background values, much as was done in the figure. If the mean value of the total density of fallout (wet and dry fallout) per unit time in the i-th sector is σ_i, the quantity of matter accumulated in the snow cover in the i-th sector with an area S_i will be equal to

$\overline{\sigma}_i S_i T$ and the total quantity of matter falling on the studied territory will be

$$\sum_{i=1}^{n} \overline{\sigma}_i S_i T,$$

where the summation is carried out for all n sectors. The quantity of matter M, including in distant transport, can be found from the obvious relationship

$$M = \left(\overline{q} - \sum_{i=1}^{n} \overline{\sigma}_i S_i\right) T. \quad (6)$$

According to our data, the fraction $a = M/\overline{q}T \cdot 100$ falls in the range 40-80%, depending on the disperse composition of the effluent.

By knowing a it is possible to solve the inverse problem -- use the results of snow cover contamination to estimate the mean intensity of the effluent.

$$\overline{q} = \frac{\sum_{i=1}^{n} \overline{\sigma}_i S_i}{(1-a)}. \quad (7)$$

4) A substantial change in total fallout during a season can be evidence of a change in the technology of production or the functioning of purification structures. By determining the mean relationship between the intensity of the effluent and the total fallout on the snow for a particular point and the contaminating substances of interest to us, thereafter on the basis of data on the intensity of integral fallout it is possible to judge changes in effluent. An example of such observations is the data in Table 2, which gives the mean levels of the density of fallout of dust in relative units (the fallouts of 1975 were used as unity) in the region of the industrial center of ferrous metallurgy during the period 1975-1979 for a number of elements.

The table shows that a decrease in the fallout levels occurred in 1976 and 1978. This was associated with the starting-up of new dust-trapping apparatus, and as a result of this, a decrease in effluent.

Evaluation and Prediction of Contaminations of Atmosphere, Water and Soil

An evaluation -- a short-range forecast of meltwater pollution of rivers and soils -- is possible on the basis of data from network observations of the density levels of contamination of the snow cover.

A prediction of the contamination of river waters by melt water is of particular importance for rivers or their reaches into which waste water is not discharged or into which it is dumped in small quantities. Such forecasts have been made in a number of investigations. For example, according to studies [7, 9], the mean concentration of the j-th ingredient at the lowest-lying gaging station in the basin during the period of spring high water is

$$c = \frac{f_j N_j}{W}, \quad (8)$$

where f_j is the coefficient of the j-th substance or the fraction of its total reserve entering the river channel with the melt water;

N_j is the reserve of the j-th ingredient in the water discharge prior to the melting of the snow; W is the volume of the water runoff.

The prediction of soil contamination without allowance for evaporation of snow and contaminating substances can be accomplished on the basis of the following reasonings.

Assume that p(t) g/(cm^2·sec) of snow falls in a unit time. During the time dt the quantity of falling snow is

$$dh(t) = p(t)\,dt. \tag{9}$$

During the winter season the total snowfall is

$$h(T) = \int_0^T p(t)\,dt. \tag{10}$$

Assume that the weight concentration of contamination in the snow is c(t) g/g. Then during the time dt the falling of contaminating matter is

$$d\,\sigma(t) = c(t)\,p(t)\,dt. \tag{11}$$

During a season of the duration T the following quantity of matter falls

$$\sigma(T) = \int_0^T c(t)\,p(t)\,dt, \tag{12}$$

and the sorption of matter in the soil is

$$k_3\sigma(T) = k_3\int_0^T c(t)\,p(t)\,dt, \tag{13}$$

where k_3 is a coefficient determined experimentally. The loss with melt water is $(1 - k_3)\,\sigma(T)$.

Assume that the runoff coefficient is k_{run}; then the concentration in meltwater is

[CT = run(off)]

$$c_{water} = \frac{(1-k_3)\,\sigma(T)}{k_{CT}\,h(T)} = \frac{(1-k_3)\int_0^T c(t)\,q(t)\,dt}{k_{CT}\int_0^T p(t)\,dt}. \tag{14}$$

With allowance for evaporation of the contaminating substance and snow the computation of the balance has the following form. Contaminating substance $a_3\sigma(T)$ is returned to the air, where a_3 is the fraction of evaporating matter. The evaporation of snow is $a_{snow}(T)$. The quantity of matter $(1 - a_3)k_3\,\sigma(T)$ remains in the soil; the loss of matter with melt water is $(1 - a_3)(1 - k_3)\,\sigma(T)$. The concentration in the meltwater will be

$$c = \frac{(1 - a_3)(1 - k_3)\,\sigma(T)}{(1 - a_{snow})k_{run}h(T)}, \tag{15}$$

Table 2

Relative Density of Dust Fallout

Years	1975	1976	1977	1978	1979
Fallout	1	0.5	0.30	0.05	0.08

where all the coefficients are determined experimentally. The a_3 value is dependent on the properties of the investigated substance and the specific conditions and is also determined experimentally. Here we have cited only the most general reasonings which to some degree can be useful in studying contamination under the condition of availability of the necessary experimental data.

The concentration of contaminating substance falling in a unit time on a unit surface (flux) [1, 2] is related to the concentration of this substance in the atmosphere.

On the basis of the measured values of the flux of matter on the surface it is possible to estimate the concentration c in the atmosphere [1,2]. Near industrial enterprises it can be assumed that the flux on the earth's surface is $\Pi = cv$, where v is the rate of precipitation.

Evidently, for practical purposes for such computations it is possible to use a sketch map similar to that shown in the figure if the mean values for this region are adopted for the flux onto the surface from the atmosphere. Then

$$\bar{c} = \frac{\bar{\Pi}}{\bar{v}}. \tag{16}$$

The velocity values $\bar{v}$ vary little in a given place and for an evaluation it is adequate to obtain v for a particular region once. The averaging must be carried out over the selected territory and during the selected observation time. For a large territory it is possible to obtain approximately

$$\Pi = \frac{\sum_{i=1}^{n} \bar{\Pi}_i S_i}{\sum_{i=1}^{n} S_i}, \tag{17}$$

where n is the number of regions in which observations are made, Π_i is the mean flux on the surface for the i-th region; S_i is its area.

It must be taken into account that $\bar{\Pi}_t$ is the sum of the dry and wet fallout. The dry fallout near the source (in a radius of 50-100 km) is caused by this source. The wet fallout can in part be a result of transport from other regions and is not associated with the concentrations of impurities in the atmosphere in a particular place, but for industrial regions they can be neglected. The relationship between concentrations in the atmosphere and the flux on the surface can probably be used for establishing the conditional value of the maximum admissible flux on the surface for a conservative admixture if it is assumed that the maximum admissible concentration $\Pi_{MAC} = c_{MAC} \bar{v}$.

On the basis of the measured intensities of the fluxes onto the surface, using the sketch map, it is possible to obtain the $\bar{v}$ value. As indicated in the figure, all the studied territory is divided into several sectors with identical mean values of the fluxes onto the surface.

Data on the fluxes onto the surface near an industrial enterprise can be used in predicting contaminations of remote territories as a result of distant transport. A generalization of data on the content of a number of elements in the samples taken in regions remote from the industrial centers at different distances led to the conclusion that industrial aerosols are transported for thousands of kilometers from the source [3]. It was found that the weakening of the concentrations of elements, the density of fallout and fluxes onto the surface in this case conform to an exponential law [3]. The density of fallout of metals on the snow cover decreases with distance x from the source in conformity to the law

$$\sigma(x) = \sigma(0)\, e^{-kx}, \tag{18}$$

where $\sigma(0)$ is the density of fallout at the point used as the initial point. The k value is a constant value with a given mean wind velocity (that is, in a given direction) for a particular group of elements and falls in the range $(1.5-0.6)\cdot 10^{-3}$ km^{-1}.

As indicated above, systematic observations of the levels of contaminating substances in the snow cover make it possible to solve a whole series of scientific and practical problems, as is evidence of a number of advantages of such a method for making observations over such a method as a direct analysis of impurities in the atmosphere. Accordingly, in the future it is necessary to increase the number of points for observing the levels of contaminating substances in the snow cover in such a way as will take in all the regions where there is a stable snow cover so that the number of such stations will approach the number of stations in the snow-gaging network and the set of determined substances quite completely characterizes contamination of this region. The levels of contaminating substances in the fallout can serve as input data for normalizing effluent of industrial enterprises.

The most important merits of the method are the following. The data obtained by an analysis of snow cover samples are immediately averaged over a considerable time and therefore are more representative. The accumulation of the studied substances in the snow cover, used as a natural plane table, makes it possible in a number of cases to detect low concentrations of contaminating substances in regions remote from industrial centers, which may be impossible when using other methods. This cannot be achieved by any other methods in study of the global background. It is possible that such a network will make it possible to reduce the number of observations of the state of atmospheric air on the basis of measurements of the aerosol component of air at some points; in other cases, on the other hand, it is possible to detect previously unknown sources requiring more careful observation. The method makes possible a more complete study of the laws of propagation of an impurity in the atmosphere -- direction, range of transport and other characteristics of interest to the researcher. Only the possibilities of use of the proposed network are mentioned in the study. In the future, together with a broadening of network observations, it is necessary to improve the method for analyzing samples, to develop the theoretical principles of the method and to study the possibilities of obtaining input data for computing the formulas.

Conclusions

It was demonstrated that the use of the existing snow-gaging network, including several thousand observation points, in monitoring the level of atmospheric contamination can effectively supplement the network for both observations and monitoring of environmental contamination (OGSNK) and will make it possible to solve a number of important problems:

1. Carry out background monitoring over extensive areas, including monitoring of distant and transboundary transport.

2. Characterizing the dynamics of effluent of industrial enterprises.

3. Obtaining the spatial structure of aerosol contaminations near industrial centers.

4. Evaluating and predicting contamination of the atmosphere, river waters and the soil cover.

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OCEANIC PLANETARY WAVES OF SEASONAL ORIGIN

Moscow METEOROLOGIYA I GIDROLOGIYA in Russian No 1, Jan 82 (manuscript received 8 Apr 81) pp 71-77

[Article by A. A. Kutalo, candidate of physical and mathematical sciences, USSR Hydrometeorological Scientific Research Center]

[Text]

Abstract: This is an analysis of the observable features of water temperature distribution in the Northeastern Atlantic predictable by means of hydrodynamic modeling of the ocean. On the basis of the results of the analysis it is asserted that the basis for mesoscale organization of the temperature field is oceanic planetary waves of seasonal origin.

The results of hydrodynamic modeling of the ocean indicate the existence of planetary waves of seasonal origin (in the text which follows -- PS waves) [3, 4, 11-13]. The length of such waves of an annual period varies from 200-300 km in the high latitudes to 5000-10 000 km in the low latitudes. The extent of the waves is determined by the dimensions of the oceans.

There have been no direct observation of these waves. The available results of analysis of mesoscale (200-500 km) features of the distributions of hydrological characteristics in the temperate latitudes of the ocean only illustrate the possibility of their interpretation as a manifestation of PS waves [5-9, 13]. Such an ambiguity in interpretation of the results of observations is attributable to two main factors: commensurability of the spatial-temporal discreteness of measurements with the length of the PS waves and the small extent of oceanographic surveys in comparison with the extent of these waves.

Below we present the results of an analysis of measurement data on the temperature field of the northeastern part of the Atlantic Ocean, the discreteness of which was such that at the present time it makes possible the soundest evaluation of the existence and energy significance of PS waves in nature.

Now we will examine the principal parameters of PS waves and the thermal field, on the basis of which we will evaluate their correspondence to one another. According to [6, 7, 13], over the entire area of the ocean PS waves can create a stable intermittence of mesoscale cyclonic and anticyclonic circulatory formations. The wave nature of such circulatory formations causes purely advective

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cyclic redistributions of water masses in the baroclinic layer of the ocean and a corresponding vertical consistency in the distributions of characteristics. Thus, cyclonic formations, as a result of the divergence and upwelling of waters will be colder than anticyclonic formations in which there is a convergence of the upper, warmer waters. Thus, if PS waves are real and energetically significant, they will create in the thermal field of the baroclinic layer of the ocean alternating zones of warm and cold waters. These zones will be associated with the wave crests and troughs. The presence of such zones in the ocean, their number, orientation and correspondence of these characteristics to the computed phase field of PS waves will be regarded as parameters for evaluating the degree of manifestation of the latter in the thermal field of the baroclinic layer of the ocean.

For these purposes we carried out computations of the phase field of PS waves of an annual period. The computations were made for a two-layer model of the North Atlantic described in [10]. The lines of zero phases were determined using the equation

$$\lambda + ct = 2k\pi \ (k = 0, 1, 2, 3, \ldots),$$

where

$$c = \frac{\delta g h(\lambda, \varphi)}{2\omega\rho R^2 \sin^2\varphi}.$$

is the phase velocity of the waves, λ is longitude, reckoned from the eastern shore in a model of the ocean, φ is latitude, t is time, $h(\lambda, \varphi)$ is the thickness of the upper layer, δ is the difference in the density of the lower and upper layers, ρ is the density of the lower layer, ω, R is the angular velocity of the earth's rotation and its radius.

The computed isolines of the zero phases of the PS waves of an annual period are shown in Fig. 1 by wavy lines. Their numbering runs from the eastern shore in the direction of the phase velocity vector and begins from 1980. Computations were not made near the line of emergence of the interface between the layers at the surface, h = 0. In the model this line is identified with the southern boundary of the polar front. In the neighborhood of this line, that is, in the region of small h values, the adequacy of the model to nature is problematic.

Figure 1 shows that in the ocean, from its eastern shore to the polar front, there are not less than nine waves. This means that if the energy of PS waves is important, in the thermal field of the baroclinic layer there should be nine alternating warm and cold zones, oriented along the phase isolines. We will be guided by these characteristics in an analysis of the results of observations.

The structure of the thermal field of the region was determined using measurement data from the scientific research weather ship "Musson" (34th voyage, 1 October-30 December 1980, 220 days), the scientific research ship MI-0847 "Ayaks" (24th voyage, 23 August-4 November 1980, 137 days), scientific research weather ship "Passat" (33d voyage, 26 November-3 December 1980, 18 days). On the map in Fig. 1 the hydrological stations are designated by circles, the figures accompanying them designate the depth of the 10°C isotherm in meters, the lines indicate that the temperature from the surface to the bottom is below 10°C. The smoothing and filtering of the measurement data were omitted. The sixty-five stations occupied in the region 39-42°N and 25-30°W (in Fig. 1 the region of the "track") are not represented on the map because of the closeness of their spacing. In this polygon the stations were occupied in a regime of tracking the position of the boundaries of the observable mesoscale structural formations of the thermal field in the baroclinic layer of the ocean.

	T° C												
	20	19	18	17	16	15	14	13	12	11	10	9	8
$\tau (T_w, Z_T) \cdot 10^2$	29	44	59	56	50	65	61	63	63	60	56	54	49
$\tau (Z_T, Z_{T-1}) \cdot 10^2$	—	83	62	76	79	66	76	77	78	78	77	75	79

The oceanographic section along 50°N in the sector from 7 to 30°W was run three times: 1-5 November, 10-15 December and 17-25 December 1980. In the third repetition the profile was continued to 43°W. The profile along 30°W between 37 and 50°N was run twice: 5-10 November 1980 with a distance between stations of 30 miles and on 5-10 December 1980 with a discreteness of 120 miles to 40°W and 60 miles to 50°N. Figure 1 shows data from the first measurements.

As a characteristic structure of the thermal field of the investigated region of the North Atlantic we selected the topography of the 10°C isothermal surface. For the particular region of the ocean the depth of the 10°C isotherm characterizes the thickness of the baroclinic layer. A validation of such a choice is the consistency of the observable changes in the temperature of the water in a vertical direction in the baroclinic layer. The table gives the values of the rank correlation coefficient τ illustrating this consistency. The correlation was computed between the temperature of the surface layer of water T_w and the depths of the integral values of the isotherms Z_T from the surface layer to 8°C, and also between the depths of the adjacent isotherms. In the computations we used the stations No 7-150, 34th voyage of the scientific research weather ship "Musson." The correlation coefficient is considered reliable if its significance level is less than 0.01 [2]. For the cited τ this condition is satisfied, except for the correlation between T_w and Z_{20}. For this pair the significance level is 0.04.

The high values of the correlation coefficients in the entire thickness of waters of the baroclinic layer reflect the high consistency of vertical temperature changes. We note that in the region of the main thermocline (isotherm 13-8°C) there are some increases in the rank correlation coefficient. This means that the topography of the isothermal surfaces can serve as a more significant indicator of the structure of the thermal field of the entire baroclinic layer than the above-lying layers. The legitimacy of such an approach to description of the thermal field is also confirmed by the results of analysis of the vertical distributions of water temperature obtained in [1, 7-9].

Thus, on the basis of the presence of mesoscale disturbances in the topography of the 10°C isothermal surface and on the basis of the degree of their correspondence to the characteristics of the phase field of the PS waves we will also evaluate the reality of the latter.

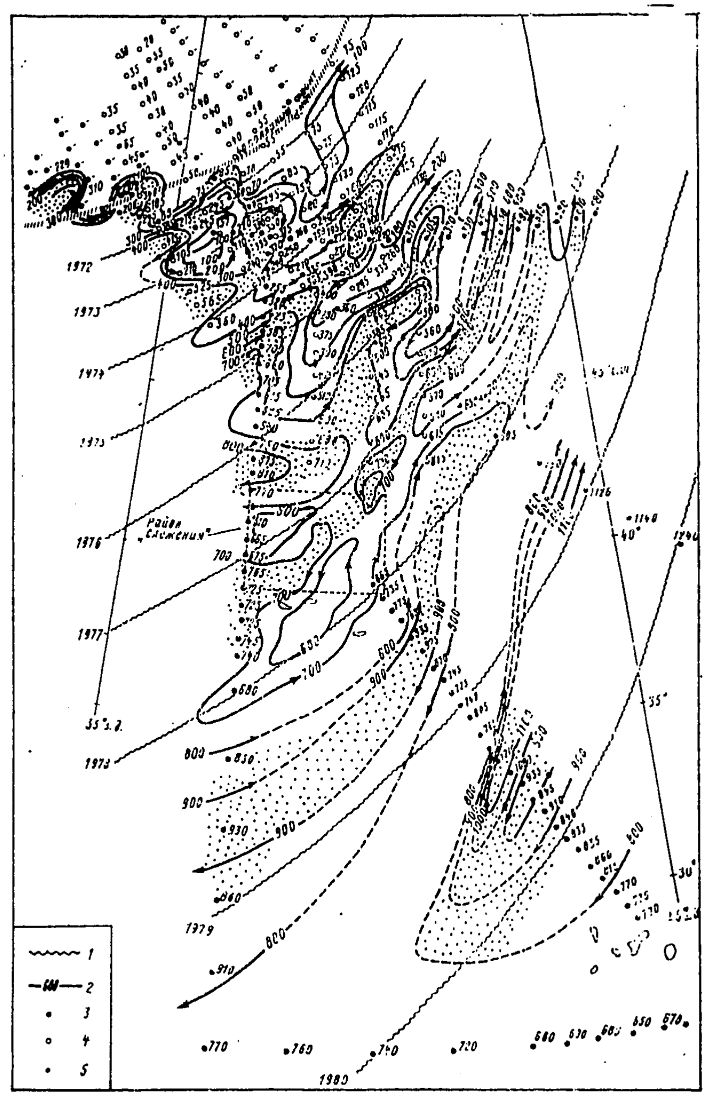

Fig. 1. Mesoscale formations of the thermal field in the baroclinic layer of the ocean. 1) zero-phase lines of PS waves of annual period, 2) isolines of depth of 10°C isotherm, m. Oceanographic stations: 3) scientific research weather ship "Musson," 4) scientific research ship MI-0347 "Ayaks," 5) "Passat" scientific research weather ship.

The time interval for carrying out the analyzed measurements takes in 4 months. During this time interval the PS waves of an annual period are displaced in a northwest direction by a third of their length. With an energetic significance of the waves such an effect in the thermal field is manifested in a corresponding displacement of the warm and cold zones. Since the greatest displacement in 4 months does not exceed half the wave length, in an analysis of the measurements their asynchronicity leads only to a curvature of the zones. The degree of curvature will be proportional to the time interval between the analyzed adjacent stations. On the whole, such an asynchronicity of the measurements, taking into account small displacements of the zones in comparison with the wave length, exerts no influence on the number of the discriminated zones and on the general character of their distribution in the region. It follows from the above that the first necessary conditions of the reality and energy significance of PS waves should be the presence and temporal stability in the thermal field of structural formations of the corresponding scales on any oceanographic section. We will check these conditions on the basis of the data from the sections represented in Fig. 2. These show the distributions of the depths of the 10°C isotherm and the temperature of the surface water layer as parameters of the structure of the thermal field and the vertical consistency of its changes. All the sections show the presence and alternating character of the warm and cold mesoscale formations. Repeated measurements along the runs $\varphi = 50°N$ and $\lambda = 30°W$ with interruptions of 1.5 and 2 months graphically illustrate the temporal stability of these formations. The third section serves these purposes; it intersects the ocean from Cape San Vicente (φ = 37°11'N, λ = 9°13'W) in a northwesterly direction to ocean station "C" (φ = 52°45'N, λ = 35°30'W). This section was run in 1978 and therefore it also shows that the represented structure of the thermal field is characteristic for other periods than the observation period 1980-1981.

We note the correspondence between the characteristic dimensions of the discriminated formations of the thermal field and the computed data on the PS waves. On virtually every one of the sections the number of waves coincides with the number of pairs of warm and cold alternating formations. The noncorrespondence of the scales is observed only near the shores and polar front. One of the reasons for such a noncorrespondence may be that the real complex configuration of the eastern shore of the ocean is simplified in the model. It has the form of a straight line and this, naturally, cannot but be manifested in the coastal regions. Near the polar front, as already noted, the model also cannot describe the real processes with an adequate accuracy. The mentioned noncorrespondence, however, cannot change the observed general character of the mesoscale structure of the thermal field. It can be stated that according to the considered data the necessary condition of reality of the PS waves is satisfied.

The next important link in the analysis is an evaluation of the features of distribution of mesoscale formations over the area of the ocean, their anisotropicity and the correspondence of the PS waves to the phase field. For these purposes, using the indicated measurement data, we constructed a map of the topography of the 10°C isothermal surface (Z_{10}, Fig. 1). On the map it can be seen that the values of the Z_{10} depths with respect to their positioning are clearly grouped into mesoscale formations. These formations of increased and decreased Z_{10} values have the form of alternating zones, that is, warm and cold tongues. In regions with a discreteness of observations allowing an ambiguity of interpretation such formations have been outlined by analogy with those situated nearby, discriminated unambiguously. Mesoscale formations of increased Z_{10} values have been stippled.

The nature of arrangement of the discriminated mesoscale formations and their number agree well with the computed phase field of PS waves of an annual period. The shaded formations correspond to the troughs of the waves and the regions of lesser Z_{10} values correspond to the crests. Nine such formations are discriminated in the considered ocean area; these have the form of alternating warm and cold zones. The same number of PS waves is given by computations using the model.

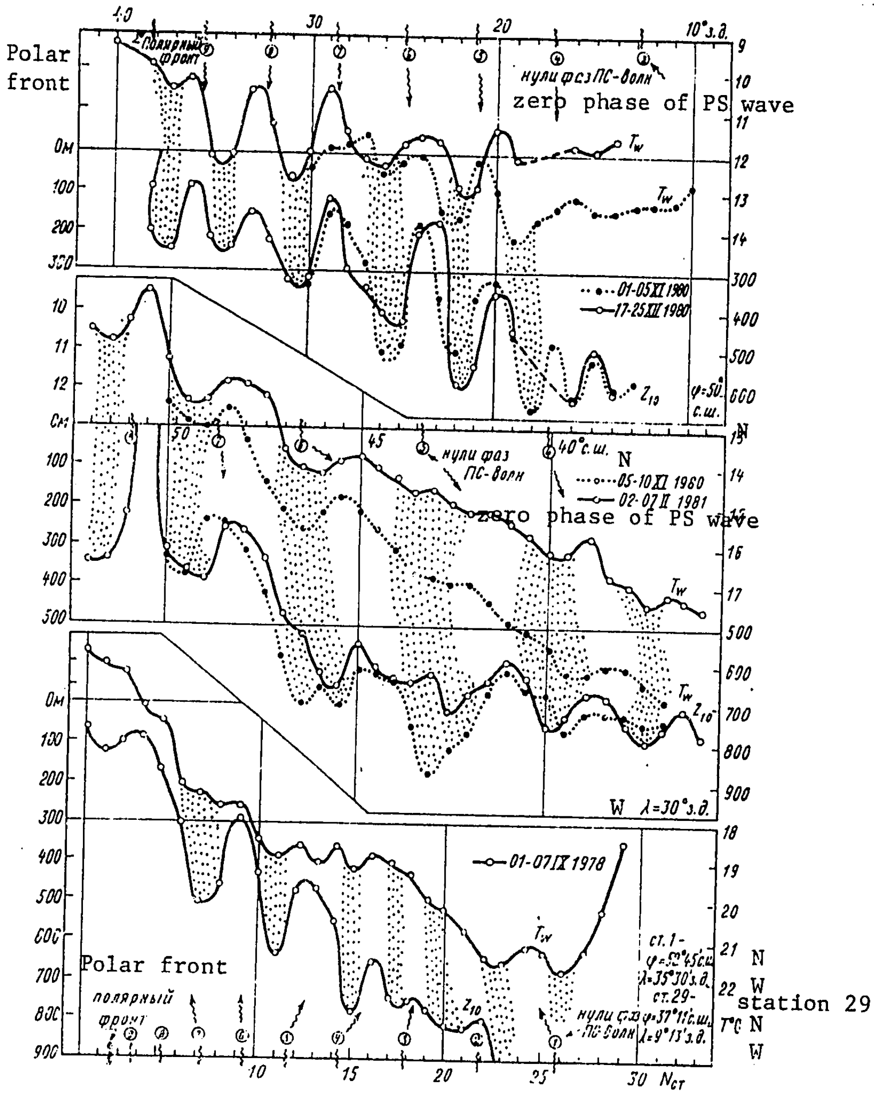

Fig. 2. Mesoscale formations of the temperature field in the distributions of depth of the 10°C isotherm (Z_{10}) and temperature T_w of the surface water layer on oceanographic sections.

It was noted that the measurement data were not subjected to any smoothing and filtering. The fact that the mesoscale formations are clearly discriminated on the basis of the data from these measurements indicates that the energetics of the tidal, inertial and other disturbances of the temperature field of lesser scales is considerably less than for mesoscale formations.

The results make it possible to conclude that the features of the temperature field of the baroclinic layer in the ocean predictable by modeling are observed in nature. For this reason it can be asserted that PS waves of an annual period are an objective reality, with significant energy, and thereby are responsible for the mesoscale structure of hydrological fields in the ocean.

We note that the characteristic differential in the depths of the 10°C isotherm between the discriminated warm and cold mesoscale formations is 200-300 m. Such a differential corresponds to the geostrophic transport of waters in the baroclinic layer amounting to 15-25 sverdrup. These values are commensurable with the transport in the components of macroscale circulatory systems in the ocean. This fact and the close correlation between the temperature of the surface layer of water and the structure of deep circulation make the mesoscale problem extremely timely in investigations of macroscale processes both in the ocean and in the atmosphere.

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VERTICAL COHERENCE OF TIDAL SEMIDIURNAL CURRENTS IN HYDROPHYSICAL POLYGON-70 IN ATLANTIC OCEAN

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[Article by V. N. Bol'shakov, candidate of geographical sciences, S. K. Gulev and A. S. Matygin, All-Union Scientific Research Institute of Hydrometeorological Information - World Data Center, State Oceanographic Institute and Odessa Hydrometeorological Institute]

[Text]

Abstract: On the basis of data from the processing of more than a million measurements of the current vector and investigations of the dependence of the coherence of semidiurnal currents on the spacing of instruments along the vertical it was established that the semidiurnal currents above and below the density jump layer are independent. Below the horizon 200 m in the layer of smooth changes in the Väisälä frequency the estimate of the scale of vertical coherence was 900 m.

An analysis of the coherence of fluctuations of oceanographic characteristics at different pairs of points is the simplest possibility for obtaining some idea concerning spatial field structure. In this article we examine the vertical coherence (coherence between data from instruments spaced along one vertical) of currents at a semidiurnal frequency -- one of the most conspicuous frequencies in the general variability of the ocean.

Observations. In this study in computing coherence values we used data from virtually all observations made in the course of the half-year experiment POLYGON-70 [2] at the standard horizons 25, 50, 100, 200, 300, 400, 500, 600, 800, 1000, 1200 and 1500 m at each of 17 points -- a total of more than 1.1 million measurements of the current vector with a discreteness of 30 minutes.*

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* The observations at the horizons 800 and 1200 m were continued only 1-1 1/2 months. The coherence values computed on the basis of series of observations at these horizons had a number of degrees of freedom sharply different from the mean and are not examined in the article, although qualitatively they do not change the results.

Method. The initial vector series were subjected component-by-component to low-frequency filtering by means of moving averaging of data for 2.5 hours. By successive sampling of each fourth term in the filtered series we formed series with a discreteness of 2 hours, entirely adequate for investigating the semidiurnal fluctuations. The new series were broken down into short, 2.5-day segments. This made it possible to postulate stationarity within each of them such as is necessary for the correct application of spectral analysis. In order to compensate the inhomogeneity in the intensity of vertical fluctuations associated with density stratification and then validly average coherence in the case of an identical spacing of instruments in different depth ranges, the smoothed segments of observations prior to cross-spectral analysis were normalized in accordance with [8]:

$$\begin{Bmatrix} u^* \\ v^* \end{Bmatrix} = \begin{Bmatrix} u \\ v \end{Bmatrix} [N(z)/N_0]^{-1/2}. \quad (1)$$

Here u, v are the initial and u^*, v^* are the normalized latitudinal and meridional components of the current vector; N(z) is the mean Väisälä frequency for the polygon at a particular horizon, and N_0 is a standard frequency equal to 3 cycles/hour and close to the mean weighted Väisälä frequency in the layer from the surface to the bottom in the open ocean.

A cross-spectral analysis of current fluctuations for each pair of horizons at each station was carried out for all those 2.5-day time intervals for which there were simultaneous observations and in which there were no shiftings of the positions of buoy stations. Twenty-nine such segments on the average were selected for each pair of horizons.

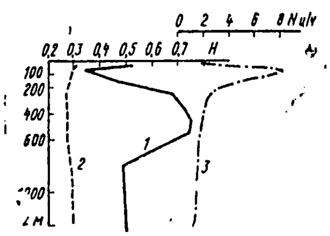

Fig. 1. Coherence of fluctuations of semidiurnal currents at adjacent horizons (1). 95% confidence level of zero true coherence (2); vertical distribution of Väisälä frequency for mean hydrological conditions in polygon (3).

The evaluations of the cross-spectra at the semidiurnal frequency were averaged and then were used for computing the full vertical coherence of current fluctuations at the horizons z_i and z_j in accordance with formula (2) from [4]

$$H(z_i z_j) = \frac{[\overline{C}_u(z_i z_j) + \overline{C}_v(z_i z_j)]^2 + [\overline{Q}_u(z_i z_j) + \overline{Q}_v(z_i z_j)]^2}{[\overline{S}_u(z_i) + \overline{S}_v(z_i)][\overline{S}_u(z_j) + \overline{S}_v(z_j)]}. \quad (2)$$

Here $\overline{C}_u(z_i z_j)$, $\overline{C}_v(z_i z_j)$ are the real and $\overline{Q}_u(z_i z_j)$ and $\overline{Q}_v(z_i z_j)$ are the imaginary parts of the cross-spectrum of identical u or v components of the current vector; $\overline{S}_u$ and $\overline{S}_v$ are the autospectra of these components at these same horizons. The line at top denotes the averaging of the spectral characteristics, computed for 2.5-day

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segments during the entire time of observations in the polygon.

Observation horizons, m (Горизонты наблюдений, м)

	25	0,53	0,23	0,22	0,23	0,21	0,25	0,25	0,26	0,24
50	1,68	50	0,35	0,27	0,25	0,25	0,30	0,26	0,29	0,31
100	0,95	1,18	100	0,46	0,36	0,33	0,30	0,25	0,24	0,28
200	0,72	0,91	1,62	200	0,68	0,57	0,46	0,40	0,24	0,28
300	0,75	0,89	1,27	2,51	300	0,72	0,58	0,50	0,28	0,28
400	0,68	0,85	1,14	2,04	2,63	400	0,75	0,60	0,35	0,27
500	0,83	1,03	1,04	1,62	2,08	2,69	500	0,75	0,41	0,29
600	0,82	0,90	0,92	1,45	1,89	2,16	2,71	600	0,49	0,35
1000	0,76	0,93	0,79	0,81	0,96	1,20	1,35	1,69	1000	0,50
1500	0,73	1,03	0,92	0,94	0,97	0,91	0,97	1,21	1,70	1500
	25	50	100	200	300	400	500	600	1000	

Горизонты наблюдений, м

Observation horizons, m

Fig. 2. Coherence of fluctuations of semidiurnal currents between any pair of horizons. Above main diagonal -- absolute coherence value, below diagonal -- related to 95% confidence level of zero coherence. The regions where coherence differs significantly from zero are shaded.

Formula (2) is also suitable and was used in computing the coherence of individual components: in the computation of coherence of the latitudinal components in (2) we omitted the spectral characteristics, also related to the meridional components, and vice versa.

The evaluation of the significance of the determined coherence values was accomplished by their comparison with the 95% confidence level for a zero true coherence [7]. In determining such levels for the coherence of individual components the number of independent averagings was assumed to be equal to the number of 2.5-day segments participating in the averaging. For total coherence the number of independent averagings with this same number of segments was assumed to be greater by a factor of 1.35.

This value follows from the formulas for the effective number of degrees of freedom contained in [5] on the assumption that the coherence among the components on the average is equal to 0.5. An increase in the number of degrees of freedom for evaluating the total coherence in comparison with the evaluations of coherence of individual components reflects the greater information yield of the evaluation computed on the basis of two components. We note, however, that this information yield is not doubled due to partial dependence of current vector components.

Results. The vertical coherence values computed in the manner described above were averaged for all stations in the polygon for each of the 45 possible instrument spacings at 10 horizons. The coherence values for spacings including only adjacent horizons are shown in Fig. 1. The lowest coherence was noted between the horizons 50 and 100 m, but for them it was higher than the 95% confidence level of the zero true coherence.

The matrix in Fig. 2 above the main diagonal contains the mean coherence values between each pair of horizons. Below the main diagonal we see the ratios of these coherence values to the 95% confidence level of the true zero coherence with the same number of degrees of freedom. The values of the ratios greater than unity show between what horizons the coherence values differ significantly from zero. It can be seen that the semidiurnal currents at the horizons 25 and 50 m, lying above the density jump layer, are significantly coherent only with the currents at adjacent horizons. Below the density jump layer the currents are coherent at several horizons. The small excesses of coherence values for the pairs of horizons 50-500 and 50-1500 m over the 95% confidence level of zero coherence can be attributed to the fact that near these horizons we find the theoretical maxima of the horizontal velocity of semidiurnal currents in the third mode of internal tides, which, according to [5], predominated in the neighborhood of the polygon.

The absence of a significant correlation of currents through the pycnocline indicates a considerable contribution of the baroclinic component to the semidiurnal currents since a barotropic tide must not react to the density stratification of ocean waters.

In connection with what has been stated above, the problem of the scale of vertical coherence, which we determined as the maximum vertical spacing of instruments with which the observed semidiurnal current variations are still coherent, should be raised only with respect to the layer below the horizon 200 m where there are no marked changes in the Väisälä frequency. This problem was solved in the following way: on the basis of observations at all 17 stations we determined the mean coherence for each of the possible (from 100 to 1300 m) vertical spacings in the layer 200-1500 m; the dependence of coherence H on instrument spacing Δz was approximated by an exponental function in the form

$$H = ae^{b\,\Delta z} + C. \tag{3}$$

Then in accordance with the mean number of degrees of freedom of the coherence value for each spacing we determined the 95% confidence level of the zero true coherence. The spacing corresponding to the intersection of the approximating curve and confidence level must be regarded as the vertical coherence scale.

Such scales were obtained both for the total coherence H_{u+v} (Fig. 3a) and for the coherence of the individual components H_u and H_v (Fig. 3b). The corresponding approximating expressions are:

$$H_{u+v} = 0{,}630\, e^{-\pi\Delta z} + 0{,}257,$$
$$H_u = 0{,}522\, e^{-\pi\Delta z} + 0{,}259,$$
$$H_v = 0{,}522\, e^{-\pi\Delta z} + 0{,}352.$$

The standard deviations of coherence values from the approximating curves do not exceed 0.04.

The mean scale of total vertical coherence obtained in this way is equal to approximately 900 m (Fig. 3a), which considerably exceeds the value 300 m determined from an 11-day observation segment only at the 9 central points of the polygon [3].

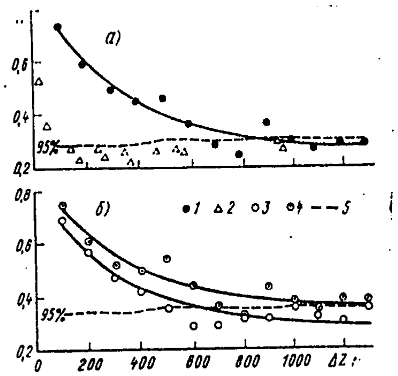

Fig. 3. Dependence of total coherence of fluctuations of semidiurnal currents (a) and coherence values for individual components (b) on vertical spacing. 1, 2, 3) total coherence and coherence of meridional and latitudinal components of currents respectively in layer 200-1500 m, 4) total coherence of current fluctuations for pairs of horizons with participation of horizons 25 and 50 m, 5) 95% confidence level of zero coherence.

We note in conclusion the higher coherence for the v component in comparison with the coherence for the u component, a fact which is easily confirmed graphically (Fig. 3b), and the considerable difference in the coherence scales: more than 1300 and 600 m respectively. This fact supports the idea of a predominant direction of propagation of internal tides along the meridian [2, 5].

Thus, the principal result obtained in the article can be summarized as follows: the semidiurnal currents at horizons separated by the pycnocline are poorly related to one another already at distances of 100 m, whereas below the pycnocline these currents are coherent at points separated vertically by distances up to 900 m.

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UDC 551.531.4

USE OF DATA ON THERMAL INDUSTRIAL EFFLUENT FOR STUDYING DISPERSION OF POLLUTANTS IN RIVERS

Moscow METEOROLOGIYA I GIDROLOGIYA in Russian No 1, Jan 82 (manuscript received 25 May 81) pp 82-87

[Article by V. A. Averkov, N. N. Del'vin and V. V. Pisarev, candidates of technical sciences, R. L. Struenze, and A. K. Sukhoruchkin, candidate of physical and mathematical sciences, Institute of Applied Geophysics]

[Abstract] A study was made of the possibility of using heated waste water for studying the dispersion of the pollutants which it carries into rivers. This essentially involved finding a sufficiently simple and reliable correlation between temperature and the concentration of matter which would be correct for any point in the mixing flow. An increased temperature is characteristic for the liquid wastes discharged by many metallurgical, chemical and other industries. The relatively pure heated waste waters of thermal and atomic electric power stations also contain chemical impurities. After examining the theoretical basis for such an investigation, the authors derive equation (13) which shows that there is a linear dependence between the heating of the water and the concentration of matter at each point in the flow. Unfortunately, this equation is inapplicable for practical purposes due to the complexity of the expression for one of the required functions. The authors therefore proceed to simplifying assumptions and give the results of numerical modeling. A simplified expression is obtained for the required function. Then a final expression (formula (17)) is obtained for the relationship between the relative concentration of pollutant and water heating. The results of computations are compared with in situ measurement data obtained on the Oka River in the neighborhood of entry of heated waters from an electric power station. As an analogue of the dissolved pollutant use was made of the radioactive isotope Au^{198}. Measurements of temperature and isotope concentration were made at four points 0.5, 1.5, 3.0 and 6.0 km distant from the discharge point. Computations using equation (17) give exaggerated concentrations in comparison with experimental data. Accordingly, a refined equation (18) is proposed for correcting this discrepancy. In order to find the concentration C in an arbitrary section of the heated flow, using equations (17) or (18), it is necessary to measure the initial concentration, the initial heating, heating at the pertinent point and distance from the point of discharge to the measurement point and ascertain the decay function. Different variants are examined. Figures 1; references: 7 Russian.

UDC 551.524.32:634.11

TEMPERATURE REGIME AND WINTERING OF APPLE TREE

Moscow METEOROLOGIYA I GIDROLOGIYA in Russian No 1, Jan 82 (manuscript received 26 May 81) pp 88-94

[Article by V. M. Stepanova, candidate of agricultural sciences, and V. I. Mayorova, candidate of biological sciences, All-Union Scientific Research Institute of Plant Cultivation]

[Abstract] The authors have established temperature criteria for the summer, autumn-winter and winter-spring periods for determining the successful wintering of different varieties of apples. Such an evaluation of winter-resistance of apples is extremely complex. Since apples have fluorished in the northwestern part of the nonchernozem zone in the RSFSR, the mean long-term temperature of that region was adopted as the optimum for apples and the conditions of individual winters were evaluated relative to it. A comparison of the mean long-term rates of development of apples with the temperature curve led the author to conclude that the following can be considered the main criteria of winter resistance. 1. Coincidence of the date of the end of flowering with the transition of air temperature through 15°C. 2. Duration of the period with an air temperature above 15°C. It is important that this temperature last a definite time, 70-75 days. 3. During autumn the accumulation of reserve substances in different organs and tissues is very important. By the time of transition of air temperature through 7-5°C the end of the growing season should begin and the period of temperatures 7-5°C to 0°C should last some 25-30 days. 4. The final dehydration of the cells, completion of physiological processes in the tree and change in the physicochemical properties of protoplasm occur with a drop in air temperatures from 0°C to -5, -6°C; this period lasts about 30 days. 5. The absolute temperature minimum is important, since it governs the range for planting and productivity of different species. All these criteria were tested against conditions and productivities for the years 1974-1978. This study revealed which varieties are most winter-resistant under differing conditions. Figures 2, tables 3; references: 6 Russian.

UDC 556.531.4+556.535.8

COMPUTING CONCENTRATION OF ATMOSPHERIC FALLOUT IN WATER BODY

Moscow METEOROLOGIYA I GIDROLOGIYA in Russian No 1, Jan 82 (manuscript received 31 Mar 81) pp 95-97

[Article by V. A. Borzilov, candidate of physical and mathematical sciences, and N. I. Troyanova, Institute of Experimental Meteorology]

[Abstract] The authors have presented a model for describing the redistribution of global atmospheric fallout of contaminating substances in a drainage basin containing rivers and lakes with a total surface and volume S_W and V. All parameters are averaged for a year, so that the fluctuations of S_W and V associated with the falling of precipitation and evaporation are neglected. All drainage basin characteristics are considered spatially uniform, making it possible to compare the results only with the concentration of contaminating substances in the soil, water and bottom deposits. In examining the processes determining exchange of pollutants between the atmosphere and these three media it is assumed that some of the fallout onto the soil surface will relatively rapidly be washed into surface water bodies and another part will migrate into the depths of the soil, be sorbed there and tend to be retained. With these and other assumptions, the model can be written as a system of four equations. The model is illustrated in the example of Sr^{90}. The drainage basin employed in the calculations was the Moscow basin with an area of about 60 000 km^2. Experimental data and the results of computations of the concentrations of Sr^{90} in the rivers of the Moscow basin are compared. The model must be regarded as approximate because it does not establish functional correlations between the characteristic times, meteorological parameters and drainage basin characteristics. Nonetheless, the use of the model gave results close to data collected in the field. A similar problem was examined by K. P. Makhon'ko in METEOROLOGIYA I GIDROLOGIYA, No 8, 1980, but deficiencies in his approach gave inferior results. Figures 2; references: 2 Russian.

UDC 556.535.6

DETERMINING RATE OF DEVELOPMENT OF MORPHOLOGICAL FORMATIONS IN RIVER CHANNELS USING INDIRECT CRITERIA

Moscow METEOROLOGIYA I GIDROLOGIYA in Russian No 1, Jan 82 (manuscript received 13 Apr 81) pp 97-99

[Article by A. A. Levashov, candidate of geographical sciences, Leningrad Hydrometeorological Institute]

[Abstract] An example is given of methods for investigating the channel process, including a morphological survey, which involves the use of indirect criteria. This is illustrated in the study of a beach along the Taz River, where the author interpreted the rate of its growth in the complete absence of photographs, charts or other archival data, that is, exclusively using data from one-time investigations of traces left by former positions of the downstream beach bar. The study was carried out in 1980 on a river meander; the beach was about 1700 m long; its greatest width was 155 m. Complete details are given concerning its structure and the seasonal and annual events leading to changes in its configuration. For example, it is shown how, on the basis of the number of layers, it is possible to date curvatures in the beach shoreline from the direction of the watercourse flowing into the river behind the beach. This makes it possible, measuring the length of built-up sectors, to evaluate the rate of increment of the bar during the year. The presence of willow and different species of scrub on the beach is also helpful in interpreting the history of its formation. In this way it was possible to determine the rate of bar augmentation during the period from 1973 through 1980. Also on the basis of the difference in the widths of the annual increments it is possible to ascertain the annual growth of the beach bar in width. By this method the age of the beach could be set at 19 years. A determination of the number and thickness of layers of deposits, on the other hand, gave an estimate of 23 years (but this discrepancy is resolved). Use of such indirect criteria as shoreline curves, stratification of deposits and age of vegetation make it possible to study channel deformations and determine the age of shore floodplain sectors when no other research data are available. Figures 1, tables 2; references: 1 Russian.

UDC 631.67:551.571(470.45)

CALCULATING TIMES AND NORMS FOR IRRIGATING AGRICULTURAL CROPS ON BASIS OF DEW POINT SPREAD

Moscow METEOROLOGIYA I GIDROLOGIYA in Russian No 1, Jan 82 (manuscript received 9 Feb 81) pp 99-102

[Article by I. N. Taran, candidate of agricultural sciences, and A. M. Gritsayeva, Volgograd Division, All-Union Scientific Research Institute of Hydroengineering and Melioration, and Volgograd Hydrometeorological Bureau]

[Abstract] Meteorological indices are being employed with increasing frequency in order to determine the proper times and norms for the irrigation of agricultural crops. But experience has shown that these methods have either limited applicability or have a low accuracy. This problem is acute in the Lower Volga region, which has a high evaporability, where even brief delays in irrigation lead to a decrease in soil moisture condition below the optimum level, this being harmful for the development of plants and crop yield. This led the authors to develop a simple method for determining irrigation times and norms for different moistening levels. The study was specifically directed to checking of the bioclimatic method for determining the irrigation times and norms for the conditions prevailing in Volgogradskaya Oblast during the years 1972-1975, 1977-1979. An effort was made to develop and analyze the bioclimatic coefficients for different moistening levels as a function of weather conditions. During the growing season the weather conditions were different in different years: 1972 and 1975 were dry and hot, 1973 was moist and 1974 was average. The coefficients were computed by the A. M. Alpat'yev method. The temperature and dew-point spread for the nearest meteorological station were used. An analysis of these coefficients revealed a dependence on ambient conditions: temperature and precipitation. In most cases the coefficients increased in the moist years and decreased in the dry years. The value of the coefficients of the biological curve, averaged for a number of years, always was lower than the coefficients for moist years and higher for the dry years. During rainy periods the coefficients increased and accordingly curve corrections were required. It is shown that such corrected curves can be used in computing irrigation times in Volgogradskaya Oblast. The maximum error in the computed moisture reserves during all the years of the investigations did not exceed 19 mm (14% of the actual values). Tables 2; references: 6 Russian.

UDC 551.508:629.531.5

MMR-06-M METEOROLOGICAL ROCKET AND INSTRUMENT COMPLEX FOR MEASURING DENSITY, TEMPERATURE, WIND AND ELECTRON CONCENTRATION

Moscow METEOROLOGIYA I GIDROLOGIYA in Russian No 1, Jan 82 (manuscript received 11 Mar 81) pp 103-105

[Article by D. Gaytandzhiyev, H. Gernandt, doctor, A. N. Mel'nikov, I. O. Neyelov and S. V. Pakhomov, candidate of technical sciences, Institute of Hydrology and Meteorology, People's Republic of Bulgaria, Lindenberg Aerological Observatory, GDR Meteorological Service, and Central Aerological Observatory, USSR State Committee on Hydrometeorology and Environmental Monitoring]

[Text]

Abstract: The article gives the results of development of two variants of the nosecones of the MMR-06-M small meteorological rocket for measurements of density, temperature and wind by the falling spheres method and for measurements of wind using radar dipole reflectors and electron concentration by the electrostatic probe method. The work was carried out by Soviet, East German and Bulgarian specialists under the "Intercosmos" program. The authors describe the design features of the instruments used and present design layouts of the meteorological rocket nosecones.

At the present time the family of Soviet meteorological rockets is being supplemented by the MMR-06-M rocket, which has undergone field tests. It was developed on the basis of the MMR-06 meteorological rocket by use of a nosecone of a sweptback configuration of the DART type. It is small in size and mass and can be used in densely populated regions with a low launching zone [5].

The separation of the nosecone from the rocket engine occurs at the time of ending of its operation due to the difference in the aerodynamic drag. An aerodynamically stabilized nosecone continues flight to an altitude of 85 km.

In a standard variant the on-board instrumentation of the rocket (sonde) contains a resistance thermometer or thermistor and a radio block ensuring the transmission of telemetric information to the earth and radar tracking of the sonde descending by parachute by means of the "Meteorit-R" radar with an additional device for the reception of telemetric information [6].

The program of cooperation of the socialist countries in the field of space meteorology ("Intercosmos") provided for the creation for the MMR-06-M rocket of instrumentation for measuring the thermodynamic parameters of the atmosphere and wind using inexpensive passive radar targets -- falling spheres [7] and dipole reflectors [8]. The problem was also formulated that instrumentation should be developed for measuring the parameters of the charged component, in particular, the electron concentration profile.

In this connection two variants were created for complexes of on-board instrumentation for the MMR-06-M rocket. The figure shows layouts of this rocket.

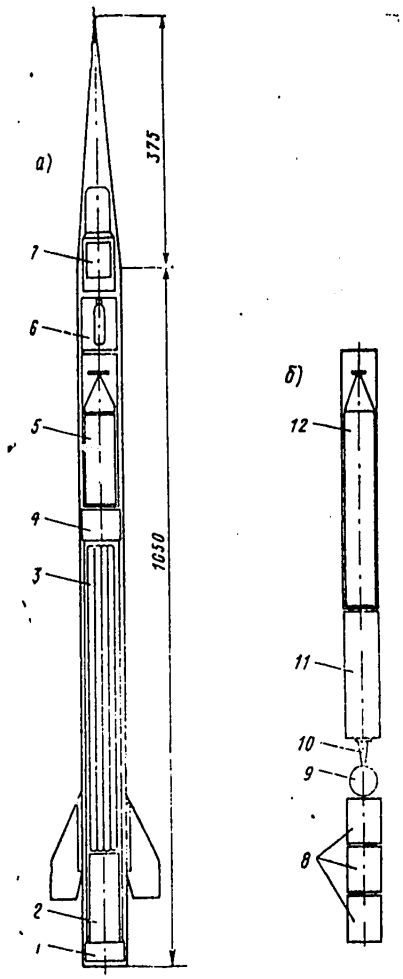
The first variant (figure a) ensures measurement of density, temperature and wind by the method of radar tracking of a light gas-filled spherical envelope ejected from the nosecone at the peak of the trajectory. The theoretical principles of the method and the methods for making measurements and processing data, as well as analyzing accuracy, are set forth in [7].

The spherical envelope with a diameter of 1.5 m is fabricated from a plastic film with a thickness of 15 μm. In order to ensure radar reflectivity the surface of the sphere is metallized. The spheres are filled by the evaporation of the working medium -- isopentane present in a capsule connected to the envelope. The design of the capsule provides for evacuation of the residual air present in the volume of the envelope packed in the container during rocket flight and gradual filling of the envelope with isopentane vapor after its ejection from the rocket. Such a design prevents the explosive filling of the envelope and its bursting. The packed envelope 3, together with the capsule 2, is placed in a container of cylindrical configuration 4 consisting of two flaps held together by an annular retainer 1. After ejection the container flaps are opened under the influence of internal springs, setting free the envelope and at the same time bringing into operation the mechanism for the opening of the capsule.

In order to ensure radar tracking of the rocket nosecone on the ascending segment of the trajectory the on-board instrumentation includes a radar responder 5, operating with the "Meteorit-R" radar, rigidly coupled to the nosecone housing by an elastic line. Such a design ensures a smooth separation of the envelope from the container and prevents impact of the container against the opening envelope.

Instead of the standard pyrotechnic system for ejecting the payload a pneumatic device 6 has been developed for the MMR-06-M rocket. This precludes damage to the envelope by hot powder gases of the pyrotechnic shell and reduces accelerations during ejection. It contains two cylinders with CO_2 in a volume of 5 cm^3 under a pressure of 60 atm. The cylinders are opened by a command sent by the timing device 7 which is triggered at the time of rocket launching.

This variant of the payload ensures the collection of data on the air temperature and density from the peak of the rocket trajectory to an altitude of 35-37 km where the internal pressure in the envelope becomes equal to the atmospheric pressure and the envelope loses its spherical configuration. Wind velocity and direction to the earth can be measured.



Layout diagrams of MMR-06-M meteorological rocket.

The second variant of the instrumentation (figure b) is used in measuring the wind by means of radar dipoles and the electron concentration profile employing a d-c probe. This complex is especially important for carrying out investigations of processes during the period of the winter anomaly in the ionospheric D region when the greatest variations are exhibited by the charged component under the influence of dynamic processes in the upper atmosphere.

The wind sensor used consisted of flat dipoles fabricated from aluminum foil with a thickness of 6μ m. As was indicated in [2], such dipoles, by virtue of the characteristics of aerodynamics, have a small vertical velocity at great heights and a high velocity relative to dipoles of other types at low altitudes. This makes it possible to obtain information on the wind in the altitude range 85-30 km with a mean square error not exceeding 10 m/sec. The dipoles are placed in three containers joined together in the magazine 8. After ejection from the rocket the containers are opened under the influence of ribbed springs and the dipoles form a radio-reflecting cloud drifting with the wind. The trajectory elements of the cloud formed by the dipoles are measured by radar for subsequent computation of the wind.

A sonde [1] was used for measuring the electron concentration. It consists of a spherical collector 9, guard electrode 10 and an electronic unit 11. The collector is under a constant potential equal to +4 V relative to the sonde housing. The potential of the guard electrode, insulated from the housing and collector, is equal to the collector potential; it is used in evening-out the electric field in the neighborhood of the collector. The collector current produced by the free electrons of ionospheric plasma collected by the collector is amplified by electrometric amplifiers with a dynamic range from 10^{-9} to $5 \cdot 10^{-7}$ A, which corresponds to measurements in the altitude range 55-85 km. The amplifier with a current source and a circuit for shaping calibration signals is placed in an electronic unit 11. The signals are fed from the electronic unit through an electronic commutator to the input of the radio unit 12, which does not in principle differ from that described in [6] and ensuring the transmission of telemetric information and radar tracking of the nosecone by means of the "Meteorit"

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radar. The pneumatic ejection unit and the command mechanism are similar to those used in the first variant. The radio unit is integrated with the body of the sonde electronic unit; in the measurement segment (85-60 km) the in-flight sonde retains a predominantly vertical orientation.

For converting the measured sonde current parameters into electron concentrations use is made of the calibration expressions obtained at the time of simultaneous launchings of rockets with sondes and coherent-frequency transmitters [3]. The conversion factor increases linearly from a value $9.2 \cdot 10^9$ electrons cm^{-1} A^{-1} at 55 km to $1.3 \cdot 10^{10}$ electrons cm^{-3} A^{-1} at 85 km [4].

In this system the collector can be replaced, for example, by an aspiration apparatus for measuring the concentration and mobility of ions [1].

The described instrument complexes were successfully tested at Volgograd in 1980.

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PROTECTION OF HYDROMETEOROLOGICAL INSTRUMENTATION AGAINST INFLUENCE OF AMBIENT CONDITIONS

Moscow METEOROLOGIYA I GIDROLOGIYA in Russian No 1, Jan 82 (manuscript received 26 May 81) pp 105-108.

[Article by I. M. Shenderovich, candidate of technical sciences, Scientific Research Institute of Instrument Making]

[Text]

Abstract: The article gives an analysis of the development of means for protecting hydrometeorological instrumentation against the influence of ambient factors and examines the present-day status of the testing facilities used in checking the quality of the methods and instruments employed.

Purpose and methods. An increase in the quality of apparatus and the effectiveness of its use applicable to hydrometeorological instrumentation (HMI) is very closely related to the problem of ensuring the reliability of operation of HMI under the diversified and complex conditions of its use. According to the USSR State Standard [3], reliability is defined as "the property of an apparatus to perform stipulated functions, retaining its operational indices within set limits during a required time interval or the required lifetime." In particular, the performance of the hydrometeorological instrumentation used for obtaining quantitative estimates of the physical characteristics of different processes and phenomena developing in the earth's atmosphere and hydrosphere is essentially dependent both on the conditions of the operative ambient factors and on the operating regime of this instrumentation.

Assurance of a high level of reliability of HMI is obtained in all stages in creation of the instrumentation -- during its development, fabrication and in the process of its use. An increase in reliability may involve both the use of new, more reliable elements forming part of the HMI and the use of progressive solutions and schematic diagrams, as well as use of different protective schemes involving the creation of such work conditions and operating regimes with which there is a lessening of the intensity of the transpiring of physicochemical processes in the elements of the instrumentation exerting an influence on the quality of the HMI.

The protective devices employed for hydrometeorological instrumentation, shielding them from the modifying factors in the environment, differ with respect to their purpose and their design characteristics. In a broad sense the term "protection" can be understood not only as the total exclusion of the influence of the modifying factor, but also as a decrease in this influence to a level acceptable for practical purposes or allowance for this factor when making observations and during the subsequent processing of the results.

Under real conditions of operation, storage and transporting of hydrometeorological instrumentation the individual parts, components and assemblies of hydrometeorological instrumentation as a whole are acted upon by a great many forces and processes causing different undesirable phenomena and leading to a decrease in the reliability of the hydrometeorological information. These forces and processes are usually called modifying factors which are determined by the conditions in the medium surrounding the instrumentation, use regime, as well as the quality of the circuitry, design and technological solutions adopted for the instrumentation in the stage of its development and manufacture. The effect of these factors can be manifested in a change in the metrological characteristics of the hydrometeorological instrumentation, reliability indices, technical parameters, decorative qualities and other properties of the apparatus.

In an analysis of the possible results of the effect of ambient factors it is also necessary to take into account the duration of operation, storage and transport of hydrometeorological instrumentation because the operating quality of the instrumentation deteriorates as time passes.

In a general case in order to ascertain the principal functional correlations between the values of the technical parameters of the hydrometeorological instrumentation and the magnitude of the modifying factors it is necessary to carry out an analysis which contains three principal investigation stages [9]:
1) the stage of analysis of the principal characteristics of the modifying factors (their origin, intensity and duration, type of energy transmitted during the operation of hydrometeorological information units and components);
2) the stage of analysis of physicochemical processes transpiring in hydrometeorological instrumentation under the influence of external factors (deformations of materials, changes in technical specifications, etc.);
3) the stage of analysis of the maximum admissible changes in characteristics of hydrometeorological instrumentation, the exceeding of whose level leads to a deterioration of the technical specifications of the instrumentation (metrological, accuracy, reliability indices, etc.).

In the first stage of the analysis it is necessary to examine the entire complex of factors exerting an influence on the instrumentation, which in a general case is usually subdivided into two groups [1]:
-- external (or objective) factors, caused by the influence of the environment, conditions and regime for operation of the apparatus, and
-- internal (or subjective) factors caused by the human element in the process of designing, fabrication and operation of hydrometeorological instrumentation.

The effect of factors in the first group is manifested in the process of operation of the hydrometeorological instrumentation without regard to man's wishes. However, the result of this effect can be foreseen for the purpose of undertaking appropriate measures directed to a decrease in its influence.

The manifestation of second-group factors is dependent on human actions: the correctness of choice of design and construction solutions in the course of development of instrumentation, adherence to technological standards in its manufacture, organization of technical servicing during the period of storage and operation of the hydrometeorological instrumentation, and timeliness in carrying out prescribed adjustment work and repair.

The external factors in turn can be subdivided into natural factors caused by the influence of the environment and factors dependent on the stipulated regimes of operation, storage and transport of hydrometeorological instruments and the influence of other technical (artificial) factors.

Among the external factors exerting an influence on the performance of hydrometeorological instrumentation the greatest influence is exerted by climatic factors [2].

Depending on the classification criterion adopted in the analysis, the influencing factors can also be subdivided into controllable and uncontrollable [10], reversible and irreversible [9], brief and prolonged, informative and noninformative [4], etc.

The second stage in the analysis is an investigation of the physicochemical processes transpiring in the hydrometeorological instrumentation under the influence of external factors. It shows that these processes can be reduced to three principal groups:
-- a group of processes changing the mechanical characteristics;
-- a group of processes changing the electrical characteristics;
-- a group of processes causing corrosion and a change in the state of surfaces.

This circumstance makes it possible, first of all, to reduce substantially the number of types of protection since there is no need to develop individual technical means of protection for each influencing factor, and second, affords a possibility for defining those fundamental methods which can serve as a basis for their development.

In a general case it is possible to use the following methods for creating technical protection devices: computation method, compensation method, insulation method and strength method.

The computation method is used in a case when the nature of the influence of the modifying factors on some output signal or technical parameter of the hydrometeorological instrumentation, determined in advance by theoretical or experimental investigations, can be taken into account in the processing of the readings of the hydrometeorological instrumentation. Accordingly, in the case of use of the computation method for taking into account the influence of the influencing factor it is necessary to carry out measurements of the parameters characterizing this factor. Unfortunately, as already noted, the quantitative dependences between the parameters of the hydrometeorological instrumentation and the magnitude of the influencing factor were determined sufficiently unambiguously only in some special cases.

For this reason the computation method is used for the most part when there is an influence of ambient temperature, and less frequently, when an influence is exerted by atmospheric and hydrostatic pressure. In the case of measuring instruments an allowance for the influence of the operative factor on the readings of hydrometeorological instrumentation essentially involves a determination of the additional error caused by this factor and the introduction of corresponding corrections into the final measurement result.

The compensation method differs from the computation method in that with a known character of the correlation between the output signal or parameter of the hydrometeorological instrumentation and the influencing factor this correlation is realized in hydrometeorological instrumentation for an automatic allowance for the influencing factor. The compensation may be complete (in the entire range of changes of the influencing factor) or partial. As in the case of the computation method, the compensation method is used for the most part for protection against the temperature effect.

The insulation method provides for the use of technical devices ensuring, wherever it is possible, a full or partial protection of the instrumentation against the influence of external factors by employing screens, hoods, sealed housings and different kinds of gaskets or coverings. This method is used for the most part in the protection of hydrometeorological instrumentation from the influence of water, solar radiation, air humidity, hydrostatic pressure, dust and sand, biological and corrosion factors and other such factors.

The strength method provides for the use of materials, coverings and construction parts resistant to the action of external factors in hydrometeorological instrumentation. Protection of such a type is used in cases of exposure to corrosion and biological factors, solar radiation, pressure, etc.

Naturally, all four protection methods enumerated above can be used in one apparatus both separately and in any combination with one another.

In the third stage of the analysis a study is made of the admissible changes in the technical parameters and characteristics of hydrometeorological instrumentation under the influence of external factors which can involve both a theoretical examination of the admissible limits of these changes and an experimental checking of the proposed variants of the protective methods.

Unfortunately, by no means for all cases can there be an adequately complete theoretical examination of the results of the effect of external factors and the principal criterion for the correctness of development of the means for the protection of hydrometeorological instrumentation remains experimental investigations carried out under both laboratory and operational conditions. Although field tests are used quite extensively in modern practice, in comparison with laboratory investigations they have a number of substantial shortcomings, the most important of which is the impossibility of monitoring the change in the external influencing factors and obtaining timely and reliable information on operation of the instrumentation [10]. Accordingly, the principal tests whose results are used in making a decision about the admissibility of standard apparatus are experimental investigations under laboratory conditions ensuring the possibility of creating the required levels of influencing factors, maintaining the necessary duration of the effect and monitoring using certification stands and chambers in studying the parameters of these factors and the readings of the hydrometeorological instrumentation [5].

Laboratory (factory) checking of the quality of the technical means for protecting hydrometeorological instrumentation at the present time is usually carried out successively for each type of influencing or modifying factor using special stands and in chambers. The numerical values of the characteristics of the external factor must correspond to those adopted for the particular design of the apparatus and the effect of others, not checkable in this test, must be of negligible importance or equal to zero.

It must be noted that these traditional methods for laboratory tests, based on the successive determination of the influence of each factor on the performance of the hydrometeorological instrumentation, do not always correspond to real operating conditions and do not make it possible to obtain a full idea concerning the quality of the developed protective procedures and devices.

In industry and in scientific investigations during recent years extensive use has been made of multifactor experiments making it possible to evaluate the nature of the simultaneous effect of several factors on the tested system [6, 8]. However, investigations of this type in actuality are not used in laboratory tests of hydrometeorological instrumentation. This is attributable primarily to the fact that until now no experimental base has been created making it possible under laboratory conditions to study the effect exerted on the performance of hydrometeorological instrumentation by several simultaneously operative factors. The necessity for carrying out such tests is confirmed by the circumstance that at the present time we do not know the reliable character of behavior of hydrometeorological instrumentation under real conditions with combined exposure to a number of meteorological factors since under laboratory conditions it is very difficult to reproduce these effects. Among such multifactor tests we must first of all include investigations of the simultaneous influence of solar radiation and air temperature, wind velocity and air temperature, precipitation and air temperature, precipitation and wind velocity.

The creation and use of combined-purpose test stands (or chambers) sufficiently fully modeling operational conditions is a complex technical problem which can be solved only with the participation of specialists in different areas of specialization. In addition, taking into account the uniqueness of such instrumentation, it is necessary to organize a departmental key center for carrying out multisided, including national, tests of means for measuring hydrometeorological parameters in the atmosphere.

In conclusion it must be emphasized once again that the range of problems related to the development of means for protecting hydrometeorological instrumentation from the effect of external factors constitutes a serious scientific-technical and organizational problem whose solution will ensure creation of reliable and high-quality apparatus and effective collection of hydrometeorological information.

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USE OF LASERS IN HYDROMETEOROLOGICAL RESEARCH

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[Article by V. M. Zakharov, doctor of physical and mathematical sciences, Central Aerological Observatory]

[Text]

Abstract: This article gives a review of the most important results of use of lasers in hydrometeorological research: optical and microphysical parameters of atmospheric aerosol; gas composition of atmosphere; standard meteorological parameters; microstructure, dynamics of generation and development of clouds and fogs, as well as the effect of their artificial modification; petroleum products on the water surface; parameters of sea waves. The author notes promising directions in the use of laser research methods, including from artificial earth satellites, as well as the most promising types of lasers for these investigations.

Introduction. Investigations of the atmosphere with the use of lasers began in the 1960's. Initially these were very simple laser sounding devices employing relatively low-power pulsed ruby and neodymium lasers and they were intended for the most part for investigation of cloud and fog aerosols.

The fields of application of lasers for hydrometeorological investigations have considerably expanded. We will examine some of them:

-- determination of the optical and microphysical parameters of atmospheric aerosol;
-- study of the gas composition and gas contaminants of the atmosphere;
-- remote measurements of standard meteorological parameters in the atmosphere;
-- investigation of microstructure, dynamics of generation and development of clouds and fogs, and also the effect of their artificial modification;
-- detection and identification of petroleum products on water surface;
-- measurement of sea surface parameters (characteristics of waves), etc.

For solution of these problems use is made of different effects of interaction of laser radiation with the investigated medium [12, 14, 16].

Aerosol

The aerosol scattering effect is virtually always observed during the propagation of laser radiation in the atmosphere. This is one of the most intense interaction processes. The relative simplicity of the laser apparatus employed in studying this effect already in the mid-1960's made it possible to begin investigations of tropospheric and stratospheric aerosol. The principal complexities arising in this case include ascertaining unambiguous correlations between the parameters of the backscattered signal, the optical characteristics of the atmosphere and aerosol parameters. A significant role here is played by numerous methodological problems, whose solution makes possible a correct interpretation of data from laser sounding of the atmosphere.

The authors of [12] proposed a method developed at the Central Aerological Observatory making it possible to reconstruct the profile of the backscattering index without a priori assumptions concerning the optical properties of the atmosphere. The data from single-frequency sounding of the atmosphere obtained on the basis of this method confirmed the global nature of the stratospheric layer of aerosols and demonstrated that the assumption made earlier concerning nonturbidity of the atmosphere is not applicable at an altitude of 30 km and confirmed the presence of an intensive layer of aerosol particles at altitudes of 40-45 km, which agrees with data on the aerosol stratification of the stratosphere obtained as a result of twilight and satellite observations.

At first the operational laser sounding of the stratosphere to an altitude of 50 km was in sessions which made it possible to observe a rapid variability of the altitude and intensity of the aerosol layers in the stratosphere during the course of two-hour changes.

The experiments also indicated considerable spatial and temporal variations of backscattering to altitudes of about 20 km. Above 20 km the aerosol stratification of the atmosphere was more stable.

The enumerated results also constitute information on atmospheric aerosol which cannot be obtained without the use of laser apparatus. This information is of great importance not only for atmospheric optics, but also for determining the role of atmospheric aerosol in changes of the radiation balance in the atmosphere. It therefore follows that these observations are important for investigations of possible climatic changes.

Somewhat later lasers came into use in experiments for studying atmospheric aerosol of anthropogenic origin. These experiments included, for example, determination of mass concentrations of aerosols in the plumes of industrial enterprises, the distribution of aerosols at industrial centers, etc. [12, 17].

Gas Composition

In investigations of the gas composition of the atmosphere it is customary to employ methods for sampling the air involving its drawing into a cell and its subsequent spectral analysis, as well as different remote methods for analysis with use of laser sounding.

The methods of IR absorption spectroscopy [16] have come into the widest use for a quantitative analysis of impurities in the sample. The use of ordinary IR spectrometers with low and intermediate resolution as a rule leads to significant errors in determining the content of minor impurities as a result of broadening of the lines or their complete overlapping at atmospheric pressure. In this case the use of lasers is extremely promising because at reduced pressures in the cell this makes it possible to obtain resolved spectra of the sample and thereby carry out precise quantitative measurements. The sensitivity of local analysis methods with the use of lasers falls in the range from 1 min^{-1} to 0.1 min^{-1}. Such a sensitivity is entirely adequate for an analysis of the air samples taken from the stacks of thermoelectric power stations, industrial enterprises and automobile exhaust. Source [13] gives the results of measurements of the content of C_2H_4, CO, NO in automobile exhaust obtained using adjustable semiconductor lasers operating in the IR range and also with use of the spin-flip of a Raman laser and an optical-acoustic detector.

The method for laser analysis of samples has been used in measuring the SO_2 content in effluent from the stacks of thermoelectric power stations [16]. The radiation source used was a continuous diode laser with frequency modulation operating in the range 8.7μm. In this case, as in the analysis of contaminations in the exhaust of automobile engines, there was complete exclusion of the influence of other sample components on the accuracy in analysis of sulfur dioxide.

Interesting possibilities of the method for laser spectroscopy of samples were successfully demonstrated by Patel in [13] in an analysis of nitric oxide and water vapor in the stratosphere. The measurement apparatus and the cell are situated in a sounding balloon raised into the stratosphere and operated in an automatic regime. As a result of an analysis made using the frequency-adjustable laser spin-flip and an optical-acoustic detector the air samples taken at an altitude of 28 km revealed the diurnal variation of NO concentration at this altitude. It is difficult to overestimate the importance of this result due to the need for studying the chemical and photochemical interactions of minor gas components of the atmosphere at these altitudes. The experimental data on the altitudinal distributions of nitrogen oxides and a number of other minor components available up to now are extremely limited and contradictory.

The use of adjustable semiconductor lasers for investigating atmospheric gases by spectral analysis methods is extremely promising. However, it seems that spectral instruments with the use of semiconductor lasers can find extensive practical use in such measurements only after a substantial improvement in their technical and operational characteristics, and in particular, after increasing their useful life when operating by means of radiation in the one mode 1-5 mW. It is also necessary to develop reliable closed-cycle condensers for operation of laser spectrometers under field conditions.

Remote methods for investigating composition of the atmosphere by means of lasers have now been considerably developed [9, 12]. We will analyze the results of use of the following methods:
-- spontaneous combination scattering of laser radiation and resonance fluororescence;
-- differential absorption;
-- laser heterodyne radiometry.

The first work on the practical use of the combination scattering of laser radiation (CSLR) effect for investigating atmospheric composition was published by Leonard in 1967 [12]. That study gave the results of measurements of the profiles of concentrations of atmospheric nitrogen and oxygen to an altitude of 2 km. Since 1969 a major series of studies has been carried out for determining the gas composition of the atmosphere by researchers in Japan, United States and West Germany [12, 16]. These researchers also carried out measurements of the concentrations of CO, CO_2, CH_4, C_2H_4, C_3H_6, H_2CO, SO_2, NO, H_2S in the exhaust gases of automobiles and in a specially contaminated atmosphere from a distance up to several hundreds of meters.

In our country similar investigations are being carried out for the most part at the Spectrometry Institute, USSR Academy of Sciences, Institute of Atmospheric Optics, Siberian Department, USSR Academy of Sciences and Central Aerological Observatory of the State Committee on Hydrometeorology and Environmental Monitoring.

In the remote excitation of the combination scattering spectra in a lidar developed at the Central Aerological Observatory [9], use was made of an yttrium-aluminum garnet laser with frequency conversion to the second and third harmonics. Sounding of the atmosphere at the converted frequencies made pos?ble an increase (by several times) in lidar sensitivity as a result of the increase in the combination scattering section.

Measurements of N_2, H_2O, CO_2 and CH_4 in a natural and in an artificially contaminated atmosphere indicated that the accuracy in measuring the concentration of gas components using combination radiation scattering is $\sim$10-15%.

The use of the combination radiation scattering method makes possible an unambiguous determination of the gas composition of the atmosphere. The intensity of the received signals at any particular frequency is related to the concentration of molecules causing them. This method for investigating the gas composition of the atmosphere has a good specificity and accuracy and a high spatial resolution because in the spectrum of scattered light the combination scattering lines of all gas components of the investigated objects are simultaneously present. However, due to the small cross section of the backscattered combination radiation ($\sim 10^{-30}$ $cm^2 \cdot sr^{-1}$) this method does not have an adequate sensitivity and effective range.

Further prospects of use of the combination scattering method are related to the use of more powerful pulsed lasers operating in the UV spectral range, that is, lasers with an energy to several J and a pulse frequency up to a few KHz. It appears that eximeter lasers may be extremely promising for this purpose. However, we feel that at the present time their demonstrated operational characteristics are not satisfactory. As was demonstrated in [26, 27], for some atmospheric contaminants, it can be seen clearly that with the excitation of both gases and aqueous aerosols by UV radiation there will be resonance combination scattering (RCS) or fluorescence. The scattering cross sections can be increased by several orders of magnitude. With such excitation the molecule can re-emit the absorbed energy of a photon more rapidly than it collides with another particle. In this case quenching does not occur as a result of collision and re-emission is insensitive to external pressure. In the experiments which were carried out [23] the intensity of scattering from I_2 vapors was 10^3 times greater than the intensity of the combination radiation signal from N_2.

In 1970 Nakahara, et al. [12] carried out a lidar experiment for detecting SO_2 at the output of a contamination source making use of resonance excitation of the second harmonic of an adjustable fluid laser with λ = 300.1 nm. The minimum concentration detected by the authors was 10^3 $mill^{-1}$ and was limited, according to them, by the presence of an elastic scattering component in the signal. The presence of a strong Mie component in the signal limits the lower range of the measured concentrations in the troposphere by the above-mentioned method to a value $\sim 10^3$ $mill^{-1}$. This interference can be eliminated with the reception of signals at a frequency displaced relative to the exciting line caused by the appearance of the Stokes wide-band fluorescence effect. A set of lidar measurements of the Stokes fluorescence of NO_2 was registered by Biribaum, et al. [12] in the case of excitation by an argon laser. On the basis of the intensity of the fluorescence signals it is possible to determine NO_2 in concentrations 10^{-1}-10^{-2} $mill^{-1}$ at atmospheric pressure. However, it is still not clear how the intensity of this fluorescence is influenced by changes in temperature and humidity. In addition, they discovered that the simultaneously present fluorescence of atmospheric aerosol also exerts an interfering influence on the identification of NO_2 fluorescence. In this very same study the authors proposed and described the testing of a method for two-wavelength sounding (λ = 0.4965μ m, λ = 0.5017μ m), making it possible to separate these two signals, since in the first case the signal from NO_2 is half as great as in the second, whereas the intensity of aerosol fluorescence remains constant.

The Stokes fluorescence of SO_2 in the atmosphere was observed by Panna [12] when using a double dye laser (λ = 0.3μm) and reception with a Stokes shift 1150.5 cm^{-1}. The registered detailed spectrum of the SO_2 electron absorption band (0.22-0.34μ m) indicates that the strongest absorption peaks fall at 0.29996 and at 0.30015μ m. The dependence of the intensity of SO_2 fluorescence on pressure found in this same study indicates that with a change in pressure from 600 to 800 mm Hg the effective re-emission section changes by not more than 15% and has a value $1 \cdot 10^{-25}$ cm^2/sr at atmospheric pressure, which is four orders of magnitude greater than the combination scattering section. A strong increase in the signal from SO_2 and O_3 was observed by Zaromb, et al. [12] when using a laser with λ = 266 nm, a pulse power of 0.1 J and a diameter of the receiving antenna 0.25 m. The presence of SO_2 with $N = S \cdot 10^{-2}$ $mill^{-1}$ and O_3 with $N = S \cdot 10^{-3}$ $mill^{-1}$ was discovered from distances up to 3 km. The measurements were made at the frequency shifts of combination scattering of these molecules, but it is not clear what was responsible for such a great increase in the lidar sensitivity: a resonance increase in the combination scattering signals or fluorescence.

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Laboratory investigations were carried out for the purpose of identifying the processes of re-emission of NO_2 and I_2 [24]. The determined dependence of re-emission of these molecules on pressure is evidence of fluorescence at a low gas pressure and on the mixture of resonance fluorescence and resonance combination scattering at atmospheric pressure. The authors also attribute the re-emission process observed during the excitation of vapors by a pulsed nitrogen laser ($0.3371 \mu m$) to resonance combination scattering.

Source [12] gives the results of computations of the resonance combination scattering cross sections and experimental data from measurement of these sections.

Using the lidar which was employed in determining the composition of the atmosphere on the basis of combination scattering, specialists at the Central Aerological Observatory carried out measurements of the gas components in the surface air layer by the resonance combination scattering and fluorescence methods [9].

In a lidar investigation of the spectrum of combination scattering by the pure atmosphere with excitation at $\lambda = 266$ nm it was possible to detect the preresonance amplification of signals of atmospheric oxygen, whose electron absorption band has a maximum at $\lambda = 143$ nm.

A comparison of the ratio of intensities of signals from SO_2 and N_2 with their excitation by the second and third harmonics of laser radiation gives an oxygen interaction section at $\lambda = 266$ nm which is 2.3 times greater than at $\lambda = 354.7$ nm. Such an increase in the section agrees well with computations using the well-known Shorygin formula [21] for resonance combination scattering. A still greater increase in the intensity of lidar signals was obtained in an analysis of the fluorescence spectra of of vapors and aerosols of benzenes, diesel fuels, soil dust and industrial haze.

With a concentration of matter (0.1-1) mg/m^3 the intensity of their fluorescence signals as a rule exceeded by a factor greater than 100 the combination scattering signals for atmospheric nitrogen with a signal-to-noise ratio of 100 even on clear sunny days. Using a portable model of a combination scattering lidar, specialists at the Central Aerological Observatory during 1973-1980 carried out an extensive cycle of studies for investigating air basin contaminations at a number of industrial centers in our country [11].

There is no question but that the resonance combination scattering-fluorescence methods are promising. However, at present there has been an inadequate study of the problems related to identification of the processes of re-emission of most of the gases at different pressures and also to the determination of gases from resonance combination scattering and fluorescence spectra in an absorbing medium. It is also necessary to carry out investigations for choice of the optimum wavelengths of exciting radiation under real atmospheric conditions.

We will examine the use of the differential absorption methods: its essence is measurement of two signals received in sounding at and outside the absorption line of the investigated gas. A great effective range of such measurements is achieved by the use of corner reflectors, topographic features and scattering on aerosols, which play the role of a volumetric reflector distributed in the atmosphere. Schemes with corner or topographic reflectors have a very high sensitivity, but make it possible to determine only the integral concentration of a contaminant along the entire ray path. A scheme with the use of scattering on aerosols makes it possible to eliminate this shortcoming and carry out measurements of spatial-temporal profiles, although, to be sure, by means of a decrease in response.

A scheme with a corner reflector was used in [16] for measurements of NO_2 in the urban atmosphere using an argon laser operating at the lines 496.5 nm and 501.7 nm. The radiation from the corner reflector at a distance of 7 km was received by an optical antenna with a diameter of 10 cm; it was focused on a holographic monochromator, from whose output it was sent to two photomultipliers by means of a fiber optical element. This instrument registered a NO_2 concentration of about 10^{-3} $million^{-1}$.

The reflection from the topographic reflector (the wall of a building was used for this purpose) was used by Japanese researchers [28] for detecting NO_2 in concentrations of 10^{-3} millionths on a path 1 km in length by means of an adjustable dye laser (λ = 463μm; λ = 465.8 nm) and a receiving system with a diameter of 50 cm with a spectral resolution 0.3 nm.

Spatially resolved NO_2 profiles were obtained in the studies of Rutkhe, et al., with the use of a Mie reflector [12]. They employed a lidar with a dye laser, adjustable in the range 455-470 nm with a line width of 0.1 nm, a pulse power of 10^{-3} J and a duration of 0.3μ sec. The radiation scattered from the aerosols was received by an antenna with a diameter of 60 cm and was focused onto the slit of a diffraction monochromator with a dispersion of 7 nm/mm. The registry system consisted of a photomultiplier and a five-channel system for synchronous photon counting. At distances up to 4 km the minimum measured NO_2 concentration at nighttime was 0.2 $mill^{-1}$. Later the apparatus was modernized and NO_2 measurements were made at the stack mouth of a chemical plant at distances up to 21 km. The authors of [9, 13, 14] described apparatus with the use of a CO_2 laser and cited data from NH_3 investigations on paths up to 1000 m in length with an apparatus response of 10^{-3} $million^{-1}$ and measurements in the surface air layer on a path with an extent of 2.1 km (ozone -- $6.7\cdot10^{-2}$-$6.3\cdot10^{-1}$ $million^{-1}$, ammonia -- $3.0\cdot10^{-3}$-$8.5\cdot10^{-2}$ $million^{-1}$, ethylene -- $(1.72\cdot6.0)\cdot10^{-2}$ $million^{-1}$).

Source [16] gives the maximum absorption sections of a number of gases measured at atmospheric pressure at the individual generation lines of CO_2 and CO lasers.

Definite progress in the technology of growing of semiconductor crystals has led during recent years to the creation of adjustable lasers with a power which has proven adequate for carrying out measurements of the absorption of laser radiation on extended paths in the atmosphere. Source [16] gives data on the content of CO and NO on surface paths at different times of day obtained using semiconductor lasers operating in the spectral region 4.7 μ m and 5.3 μ m respectively. These results give basis for assuming that with improvement in the characteristics of injection lasers and CO_2 and CO gas lasers there will be real possibilities for creating operational means for the monitoring of gas contaminations in the atmosphere on their basis, and most importantly, for investigating the content and variations of chemically active gas impurities in the atmosphere, obtaining experimental data for validating models of transport of contaminations, predicting air contamination levels, etc.

The successful use of the resonance absorption method requires detailed investigations and the development of special spectral high-resolution detection systems [15]. Using the developed apparatus it was possible to detect eight weak absorption lines not registered earlier by classical spectral instruments. The developed instrument can be employed in the receiving system of a meteorological lidar for measurements of the concentration of water vapor and oxygen, whose lines fall in the range of frequencies of thermal adjustment of a ruby laser. The operating principle for the apparatus can be developed on the basis of similar systems for other spectral regions.

The possibilities of the method of differential absorption of laser radiation have been demonstrated most clearly in measurements of the vertical distribution of ozone in the atmosphere [8], with use of a laser with radiation energy in the range of a wavelength $\lambda = 100\ \mu m$ W = 50 mJ. This makes it possible to carry out remote measurement of the ozone density profile to an altitude 25 km. It is evident that the sounding range can be increased when more powerful and frequency-adjustable lasers operating in the UV range become available.

Infrared heterodyne radiometry is one of the promising passive methods for remote measurement of contaminating and natural gases in the atmosphere [1]. The task of measuring the attenuation of monochromatic radiation by the entire thickness of the atmosphere in the IR spectral region must also be regarded as an extremely timely application of a heterodyne detector of thermal radiation. The principal merits of the heterodyne spectrometer are the possibility of achieving an ultra-high (relative to IR standards) resolution and response, limited by the level of quantum signal noise. This makes possible a successful solution of the problem of interference of the absorption bands of different gases when carrying out remote spectral investigations in the atmosphere. A practical confirmation of what has been said is provided by the results of investigations in IR stellar astronomy, obtained by the photoshift technique.

Considerable progress has now been attained abroad in the development of similar instruments for measuring contaminating gases in the earth's atmosphere. There are a considerable number of publications dealing with measurements of the fine structure of the absorption spectra of the gases NO_2, NH_3, C_2H_4, O_3, CO_2 and CO, as well as their concentrations in thermal emission spectra. Unique results are obtained in measurement of the absorption spectrum of solar radiation by the entire thickness of the atmosphere in the region 1010.9-1011.8 cm^{-1} with a resolution of 0.0067 cm^{-1}. Work is being carried out for creating surface, aircraft and satellite heterodyne radiometers for measuring the altitudinal profiles of O_3, NH_3 and other minor atmospheric components.

The heterodyne radiometer described in [23] makes it possible to carry out surface measurements of the vertical profile of ozone density in the entire thickness of the atmosphere. The method is based on the reception of solar radiation in the band 9.58μ m with a spectral resolution $\Delta\nu = 0.004\ cm^{-1}$. Further progress in the use of heterodyne methods for analysis of gas components in the atmosphere is contingent on the development of adjustable and frequency-stable lasers in the IR range, especially semiconductor diode lasers and waveguide-type CO_2 and CO lasers.

Without question, in the future heterodyne methods for the detection of gases will become a powerful tool for remote investigations of the atmosphere from aboard flightcraft.

Standard Meteorological Parameters

Naturally, information on aerosol in the gas medium without data on other atmospheric characteristics does not make it possible to create a full picture of the processes transpiring in the atmosphere. This pertains, in particular, to study of contamination of the air basins of industrial centers, where the interaction of aerosol with the humidity, wind and temperature fields leads to a change in the distribution and propagation of aerosol in the surface layer and to the formation of new components. If it is taken into account that the use of rockets and balloons, by means of which the standard atmospheric parameters are determined, in most cases is impossible under these conditions, the development of remote methods for measuring the standard atmospheric meteorological parameters seems extremely important.

Doppler lidars with heterodyne photoreception are in use for measuring wind velocity. In these the transmitter used is a CO_2 laser with a radiation power up to 30 W and an effective range up to 500 m and also lidars with use of correlation processing of the received signal [2, 13].

Remote methods for measuring the absolute content of water vapor in the atmosphere by means of a lidar are usually based on a comparison of the energies of combination vibrational-rotational scattering of laser radiation by water and nitrogen molecules, whose concentration in the lower troposphere changes insignificantly and can be considered known. For measurement of atmospheric temperature use is made of the effect of rotational combination scattering of laser radiation, with comparison of the scattered energy in two parts of the rotational spectrum of nitrogen [22].

Source [13] gives a description of a laser system for determining temperature, density, humidity, transparency, wind direction and velocity.

Measurements of wind velocity are made by the pulsed laser sounding method with the use of multiray optical reception and multichannel wide-band (with respect to radio frequency) receiving-registry apparatus. The employed processing methods make it possible to determine the position of the maximum of the cross-correlation function for signals received from two spatially separated volumes, and on the basis of the known distances between volumes to compute wind velocity. It should be noted that this method makes it possible to determine all three components of the velocity vector.

The basis of the method for measuring atmospheric temperature is the fact that atmospheric kinetic temperature has a functional dependence on the saturating elasticity of water vapor. In turn, a determination of the characteristics of moist air, the same as the elasticity and saturating elasticity of water vapor, is accomplished using laser sounding apparatus and employing the effect of combination vibrational-rotational scattering of laser radiation by water vapor and nitrogen molecules. The maximum computed mean square error in measuring temperature in the entire altitude range was 0.8°C, and humidity -- 0.25 g/m^3. During the daytime the sounding range was very short: it was only 200-500 m. In order to eliminate this shortcoming it is first necessary to increase the radiation energy of lasers and employ lasers operating in the UV range of wavelengths where the level of background noise of the atmosphere is considerably less. In order to obtain a sounding range up to 3 km during daytime, which is the minimum necessary range and which is dictated by the requirements of a number of specific problems in the national economy, such as the establishment of airport meteorological services, monitoring systems and systems for issuing storm warnings concerning dangerous meteorological phenomena, as well as other special-purpose systems, the energy of the laser radiation must be about 10 J in the range of working wavelengths of about 0.3 μm with a radiation pulse repetition rate of not less than 1 Hz.

Clouds and Fogs

In determining the microphysical characteristics of clouds and fogs application is made of measurements of the scattering and depolarization coefficients of laser radiation and also pulse deformations [12].

The successive layers method which has been proposed and experimentally checked makes it possible on the basis of laser sounding data to reconstruct the profile of the scattering index in clouds. With the adopted assumptions concerning the gamma distribution it is possible to ascertain the profiles of liquid-water content and the droplet concentration in liquid-droplet clouds.

A major cycle of investigations has also been carried out for clarifying the problem of determining the phase state of the cloud cover. Surface and aircraft measurements using the information contained in the polarization characteristics of laser radiation have demonstrated the possibility of determining different types of clouds [6].

An entire series of studies [7] has been devoted to investigations of changes in the characteristics of scattering and depolarization of laser radiation in the process of formation and disappearance of a fog. In the sounding of the aerosol atmosphere at wavelengths 0.53 and 1.06 μm the values of the scattering coefficients differ by several times if the size of the aerosol particles is less than the wavelength. In the fog formation process the size of the scattering particles increases and the difference in the numerical values of the scattering coefficients for the mentioned wavelengths decreases. During the scattering of a fog this relationship again increases. In a turbid atmosphere, when the asphericity of the aerosol particles to a considerable degree depolarizes the scattered radiation the condensation process is easily detected on the basis of an increase in the degree of polarization of the scattered radiation. In fogs the depolarization increases due to multiple scattering. As the fog scatters the depolarization again decreases. It should be noted that a change in the polarization is observed sooner than the visual appearance and scattering of the fog; this can be used for a timely forecast of the appearance and disappearance of a fog with a high probability. It is also desirable that lidar methods be employed in investigating the artificial modification of clouds and fogs, including a study of the dynamics of the process.

The use of the specific characteristics of pulsed laser sounding of clouds from the ground and an aircraft has made it possible to detect the phenomenon of the formation of a precloud layer -- a singular envelope with a thickness as great as several tens of meters around clouds in a prethunderstorm or thunderstorm state [10]. This affords new possibilities for the use of lasers in predicting clouds potentially producing thunderstorms.

Petroleum and Sea Surface

Recently much attention has been devoted to developing methods for the remote detection of petroleum and petroleum products on the surface of the seas and oceans [4, 5, 19]. The methods which are most promising in this respect are those based on the use of the difference in the reflection and scattering of electromagnetic waves by the water surface, both free from contaminants and covered by a film of petroleum products. Theoretical computations, laboratory and field experiments have now been carried out for a valid choice of the method for detecting contaminants. In the remote detection and monitoring of petroleum products at the sea surface by means of lasers it seems most realistic to employ two effects: change in optical characteristics of the surface or change in the physical state of the surface itself as a result of the change of evaporation conditions, waves, ion formation, etc. under the influence of a film. These changes are also reflected in the characteristics of reflection of electromagnetic waves. The first laser sounding investigations of the reflective properties of petroleum films on the sea surface were based on the contrasts in the reflective properties of pure water and a petroleum film. An example of such an approach can be a field experiment carried out in 1975 in the neighborhood of the "Neftyanyye Kamni" petroleum field for investigating the contrasts in the reflective properties of the sea surface under different wave conditions and with different degrees of contamination. In the investigations use was made of a lidar with $\lambda = 1.06 \mu m$ and $\lambda = 0.53 \mu m$, carried on an Il-18 aircraft. As a result, there was found to be a considerable increase in the reflection coefficient in places of accumulation of a petroleum film on the sea surface [5]. Methods have now been developed and models of apparatus have now been devised for the remote determination of wave height and length [12]. The basis of the methods is information on the deformation of the initial pulse after reflection from the sea surface. Comparative investigations with existing contact methods have indicated a satisfactory coincidence and competitiveness of remote laser sounding measurements.

Summary

A major complex of investigations of the reflective and polarization properties of clouds, fogs, land and sea surfaces was carried out from an aircraft [3, 6, 12, 19]. The main reliance has been on field investigations of the enumerated characteristics at the radiation wavelengths of those types of lasers which are most promising for use aboard artificial earth satellites. As a result it has been possible to obtain the statistical characteristics of the reflection coefficients, degree of polarization and deformations of laser radiation pulses upon reflection from the principal types of clouds and underlying surfaces. This will make it possible to refine the principal approaches for a technical solution of the problem of laser sounding of the atmosphere, land and sea surfaces from artificial earth satellites. It will also afford possibilities for a substantial increase in the information yield of meteorological space systems by introducing into the on-board instrument complex lidars capable not only of distinguishing clouds from the underlying surface, but also of determining with a high accuracy the altitude and phase composition of the upper boundary of clouds, the stratification of aerosols, the characteristics of waves and contamination of the sea surface by petroleum products.

We note in conclusion that in a number of cases, especially if it is necessary to carry out remote and operational observations, laser measurement apparatus is the only possible means which can be employed.

All these laser investigations required the development and creation of a whole series of special apparatus. The use of lasers is limited for the most part to solution of special research problems or a fundamental demonstration of their possibilities. It is still necessary to do considerable work in order that lasers could be used extensively in the practice of regular hydrometeorological observations.

Particular attention must be devoted to the creation of lasers capable of operating aboard aircraft laboratories and satellites, which on their basis will make it possible to create measurement systems for carrying out global observations of the state of the atmosphere and underlying surface.

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REVIEW OF MONOGRAPH BY T. V. ODROV; 'GIDROFIZIKA VODOYEMOV SUSHI' ('HYDROPHYSICS OF LAND WATER BODIES'), LENINGRAD, GIDROMETEOIZDAT, 1979, 311 PAGES

Moscow METEOROLOGIYA I GIDROLOGIYA in Russian No 1, Jan 82 pp 117-118

[Review by V. S. Mezentsev, professor]

[Abstract] The reviewed monograph is essentially intended as a college text and therefore much of the material is of a background description preparing the student for the more complex subject matter contained in the chapters which follow. Its basic content is a description of the hydrophysical phenomena transpiring in water bodies on the land and caused by the heating and cooling of water, its phase transitions and mixing conditions. Materials on water masses in lakes and reservoirs and on formation of water quality are included. It is possible to get a general idea concerning the methods employed for investigating and analyzing field data. The book, perhaps for the first time, gives a complete overview of the features of the thermal regime in lakes and reservoirs. This is accompanied by a detailed summary of methods for computing the heat balance components for a water surface. Much attention is devoted to the measurement and computation of evaporation from a water surface. While giving due attention to the standard computation method, the author demonstrates the further possibilities for developing computational methods and cites new formulas which at present have not come into wide use but are sounder in physical character. Both the setting-in and going-out of the ice on rivers and lakes are examined in detail. This is also true of methods for computing the growth of ice thickness. The role of the ice cover is analyzed in relation to the thermal regime of a water body, its influence on heat exchange with the surrounding area and its characteristics as an insulator. The author strives to describe processes from the point of view of their physical development, dealing with the role of the principal physical factors and presenting the best available computation methods. Approaches to further research are suggested. The text contains great quantities of factual material and clearly depicts the present-day status of study of the considered hydrophysical problems. There is a carefully selected bibliography of 153 items.

REVIEW OF HANDBOOK: 'GIDROMETEOROLOGICHESKIY REZHIM OZER I VODOKHRANILISHCH: IRKUTSKOYE VODOKHRANILISHCHE' ('HYDROMETEOROLOGICAL REGIME OF LAKES AND RESERVOIRS: IRKUTSKOYE RESERVOIR'), LENINGRAD, GIDROMETEOIZDAT, 1980, 140 PAGES

Moscow METEOROLOGIYA I GIDROLOGIYA in Russian No 1, Jan 82 pp 118-119

[Review by M. Furman, candidate of geographical sciences]

[Abstract] The Irkutskoye Reservoir is formed by the backwaters of the dam at the Irkutskaya Hydroelectric Power Station on the Angara River. It has an area of 154 km^2 and a volume of 2.1 km^3. The handbook reviewed here summarizes the results of studies of the hydrometeorological regime of this reservoir during the period of its normal operation from 1962 through 1975. All the data and analyses presented in this publication were prepared by personnel at the Irkutsk Hydrometeorological Observatory. The data were gathered in the network of stations and posts situated on the shores of this water body, except materials collected during a number of expeditions. The handbook was edited at the State Hydrological Institute to ensure that this handbook would conform to the standards of this series of publications. There are 11 chapters which give a description of the physiography of the reservoir area, meteorological conditions prevailing in the region and economic use of the water body. The different chapters give reference materials on such subjects as levels, ice and thermal conditions, water balance, wind waves and currents, hydrochemistry, etc. The changes in the regime of the Angara River as a result of creation of the Irkutskoye Reservoir are analyzed. Practical recommendations are given on exploitation of the zone surrounding the reservoir. The last chapter deals with the hydrochemical regime; it appears that this regime has changed insignificantly and for the most part remains the same as it was in the waters of the Angara prior to its regulation. There are 140 tables and 64 figures which illustrate the natural processes and phenomena transpiring in the water body. The presented materials can be used in formulating a scientifically sound scheme for improving the technical state and well-being of the reservoir and its coastal zones, as well as serving as a basis for evaluating changes in water quality under the influence of economic activity and hydrometeorological conditions.

SIXTIETH BIRTHDAY OF DMITRIY ANTONOVICH PED'

Moscow METEOROLOGIYA I GIDROLOGIYA in Russian No 1, Jan 82 p 120

[Article by staff of the USSR Hydrometeorological Scientific Research Center]

[Abstract] Professor Dmitriy Antonovich Ped', doctor of geographical sciences, head of the Seasonal Weather Forecasts Laboratory, marked his 60th birthday on 19 November. He graduated in 1944 from the Higher Military Hydrometeorological Institute of the Red Army and then served in the Administration of the Hydrometeorological Service on the Far Eastern Front, where he headed the weather bureau. After 1947 he was affiliated with the USSR Hydrometeorological Center, where he also received his candidate's and doctor's degrees. He has now spent 40 years in field and scientific work and has achieved reknown as an outstanding specialist in all types of weather forecasting, from 24-hour to seasonal. The results of his research work have been published in more than 170 articles. He has proposed methods for predicting anomalies of air temperature and the quantity of precipitation for 10 days and a month, as well as seasonal air temperature anomalies. His work has also included studies of seasonal weather conditions associated with the times of changes in stratospheric circulation. He formulated indices for characterizing droughts and excess moistening and demonstrated the possibility of forecasting such dangerous phenomena. In addition, he has examined in detail the conditions for the formation of atmospheric droughts and excessive humidity in different years, methods for ascertaining the limits and duration of seasons and clarifying their precursors. While continuing such important research work, he devotes great attention to the training of graduate students. In his current work emphasis continues on the development of seasonal weather forecasts. Figures 1.

CONFERENCES, MEETINGS AND SEMINARS

Moscow METEOROLOGIYA I GIDROLOGIYA in Russian No 1, Jan 82 pp 120-127

[Article by S. S. Khmelevtsov, N. M. Bazhin, G. I. Skubnevskaya, Yu. Ye. Kazakov, A. V. Tsvetkov and B. S. Ustyuzhanin]

[Text] An All-Union Symposium on "Influence of Environmental Contaminations on Change of the Earth's Climate" was held in Obninsk during the period 12-14 May 1981. It was organized by the Institute of Experimental Meteorology in collaboration with the Climate Commission of the Interdepartmental Geophysical Committee of the USSR Academy of Sciences Presidium.

The symposium was attended by 60 delegates representing 15 scientific institutes of the State Committee on Hydrometeorology and Environmental Monitoring, USSR Academy of Sciences and the Ministry of Education from seven cities in the country. Twenty-six reports were presented which dealt with the influence of atmospheric contamination by aerosols, minor gas impurities and heat on changes in the characteristics of the earth's climatic system and the earth's climate.

The results of the investigations reported at the symposium indicate that there is a rapid contamination of the atmosphere and ocean as a result of human activity and natural processes. Particularly alarming are the possible changes in climate due to the accelerating contamination of the oceans. A report by V. I. Mikhaylov (Odessa Division, State Oceanographic Institute) presented data on severe contamination with petroleum and petroleum products in many extensive regions of the Atlantic. In some of its regions (in the northern part of the Atlantic Ocean, in the subtropical zone) the content of contaminating substances in the upper millimeter layer of water is greater than the admissible level by a factor of 10.

A number of reports were devoted to a parameterization of the radiation budget of the atmosphere and the cloud cover and the tropospheric aerosol exerting an influence on it. Ye. M. Feygel'son and P. A. Tarasovoy (Institute of Physics of the Atmosphere, USSR Academy of Sciences) computed the albedo of the tropospheric aerosol as a function of the great number of particles and the rate of increase in contaminating soot particles. This work created a methodological basis for a global-scale determination of aerosol albedo values. A report by L. D. Krasnokutskaya (Institute of Atmospheric Physics, USSR Academy of Sciences) gave the computed values of albedo of the atmosphere-underlying surface system and the absorptivity of the cloudy atmosphere for the tropical, temperate and arctic latitudes. On a qualitatively new basis these data make it possible to parameterize the properties of the cloud cover for climatic problems. A report by I. I. Mokhov (Institute of Atmospheric Physics, USSR Academy of Sciences) gave an analysis of the influence of cloud cover on the energy balance of the earth's climatic system on the basis of the mean zonal data from satellite and surface measurements of planetary albedo, outgoing thermal radiation, surface temperature and extent of cloud cover. The derived expressions can be used in climatic models.

In the discussion of the role of the cloud cover the opinion was expressed that it plays a subordinate role in the formation of the radiation regime in the climatic system.

Several reports were devoted to an analysis of stratospheric aerosol of volcanic and anthropogenic origin on the physical parameters of the earth's climatic system. The report of A. P. Grinin, A. S. Kabanov and F. M. Kuni (Leningrad State University, Institute of Experimental Meteorology) developed a theory of formation of a nucleus from a two-component gas and applying this theory it was possible to demonstrate the possibility of homogeneous formation of nuclei by droplets of sulfuric acid in the stratosphere after powerful volcanic eruptions. The physical conditions in the stratosphere most favorable for the formation of a sulfuric acid aerosol were determined. It was postulated that the different effectiveness of formation of a sulfuric acid aerosol determines the different climatic effect of explosive eruptions occurring in different latitude zones. In several reports presented by a number of organizations (Institute of Experimental Meteorology, Institute of Applied Physics, Leningrad Division of the Institute of Oceanology, USSR Academy of Sciences, Leningrad Hydrometeorological Institute) the authors gave the results of computations of the radiation properties of stratospheric aerosol and the modeling of the thermal regime of different latitude zones with an increase in contamination of the stratosphere by aerosol. Proposals call for the creation of a new network of lidar sounding stations for climatic monitoring of stratospheric aerosol. The functional structure of the network is described and a number of station blocks have been developed.

A number of reports at the symposium were devoted to the study of climate using physicomathematical models of different complexity. G. P. Borisenkov, V. P. Meleshko and L. K. Yefimova (Main Geophysical Observatory) presented the results of numerical modeling using a three-dimensional hydrodynamic model of thermal contaminations and their influence on general circulation of the atmosphere and the earth's climate.

The reports presented by V. P. Dymnikov, V. N. Lykosov and V. Ya. Galin (Meteorological Computation Office, Computation Center, Siberian Department, USSR Academy of Sciences) and L. R. Dmitriyeva and L. V. Samoylova (USSR Hydrometeorological Center, Main Geophysical Observatory), by using numerical hydrodynamic models, investigated the influence of changes in albedo of the underlying surface and the type of parameterization of the cloud cover and radiation on change in the general circulation of the atmosphere. An interesting conclusion from these studies is that there is a low response of elements of general circulation of the atmosphere to the form of parameterization of radiation and cloud cover. Mention should also be made of an interesting study by V. K. Petukhov (Institute of Physics of the Atmosphere) in which, by means of a nonstationary energy balance two-level model of the thermal regime the authors made an analysis of variations in the troposphere-stratosphere system and a study was made of the influence of stratospheric contaminations on the change in the period of quasi-two-year temperature variations in the stratosphere. It was demonstrated that such initiators of variability may be explosive volcanic eruptions during which great masses of gas and aerosol are ejected into the stratosphere.

A resolution of the symposium noted the importance of further expansion and deepening of investigations of the influence of environmental contamination on climatic changes. The symposium recommends that attention be given to monitoring of aerosol contaminations of the stratosphere after explosive volcanic eruptions and anthropogenic contaminations of the stratosphere and the ocean surface and there must be further improvement in models of climate for use in evaluating its changes under the influence of contaminations and creation of data banks on environmental contamination.

S. S. Khmelevtsov

The Second All-Union Seminar on "Atmospheric Photochemistry" was held during the period 12-14 May 1981. It was called on the initiative of a number of institutes of the USSR Academy of Sciences and the State Committee on Hydrometeorology and Environmental Monitoring. The purpose of the seminar was a discussion of timely problems of atmospheric chemistry. The following subjects were examined: 1. Elementary chemical and photochemical processes in the lower and upper layers of the atmosphere. 2. Experimental and theoretical modeling of homogeneous and heterogeneous reactions, as well as photonucleation processes in the atmosphere. 3. Evaluations of possible effects of photochemical transformations of anthropogenic effluent on the state of the atmosphere. 4. Methods for investigating chemically active compounds and aerosols in the atmosphere.

The scientific program of the seminar included ten review reports, nine original communications and 34 stand reports. Participating in its work were more than 120 persons from 24 organizations. The organizing committee of the seminar under the chairmanship of Yu. N. Molin, corresponding member, USSR Academy of Sciences, made many efforts at a quite complete reflection of investigations on problems related to the transpiring of photochemical reactions in the atmosphere.

The seminar work was opened by V. L. Tal'roz, corresponding member, USSR Academy of Sciences, in a review report entitled "Chemical Kinetics of the Atmosphere," in which the interrelationship of the three principal branches of atmospheric chemistry was characterized (in the ionosphere, stratosphere and troposphere); he emphasized different possibilities of the transpiring of chemical reactions in the real atmosphere and model conditions. N. M. Bazhin, in a report entitled "Photochemical Reactions in the Troposphere," demonstrated that the lifetime of some small components, such as sulfur dioxide, nitrogen dioxide, formaldehyde, and methane can be dependent on the rate of transpiring of reactions with active atoms and free radicals generated under the influence of sunlight. A. I. Poroykov discussed possible schemes for transformations of organic substances in the atmosphere. The participation of free radicals in the photochemical oxidation of hydrocarbons was discussed by A. A. Mantashyan. The results of investigations of the influence of electron vibrational excitation of haloid atoms by light on their reactivity were reported by V. N. Panfilov. Photochemical reactions and photonucleation with the participation of sulfur dioxide in the atmosphere were analyzed in a report by G. I. Skubnevskaya and N. M. Bazhin. V. S. Komarov told of new data on the photochemical reactions of freons. A. G. Sutugin read a report entitled "Modeling of Chemically Nonstationary Nucleation in a Spatially Inhomogeneous Medium."

Some reports pertained to the use of new physical methods for investigating gas-phase reactions and measurements of the characteristics of atmospheric aerosol. The possibilities of use of lasers created at the Institute of Atmospheric Optics, Siberian Department, USSR Academy of Sciences, were discussed in detail by its director, V. Ye. Zuyev, corresponding member, USSR Academy of Sciences. The use of laser magnetic resonance and intraresonator laser spectroscopy for measuring the new constants of elementary reactions was demonstrated in the reports of Yu. M. Gershenzon, L. N. Krasnoperov and S. G. Cheskis. The methods for measuring the concentrations and size of aerosol were described in a report by K. P. Kutsenogiy. The possibilities of monitoring chemical compounds in the atmosphere by means of a lidar with an eximer laser were discussed in a study by I. I. Ippolitov, et al. The possibilities of a method for studying the kinetics of photonucleation and the features of the photochemical formation of aerosol developed at the IKhKiG [expansion unknown], Siberian Department, USSR Academy of Sciences, were outlined in a study by S. E. Pashchenko, et al.

The reports of V. V. Penenko and I. L. Karol' dealt with mathematical modeling of the processes of atmospheric transport, taking into account chemical and photochemical reactions and their influence on the climatic characteristics and atmospheric contamination. I. A. Shevchuk told of the problems in the Siberian region associated with contamination of the air basin of cities in Siberia and the Kuzbass. The seminar ended with an interesting report by O. F. Vasil'yev, corresponding member, USSR Academy of Sciences, entitled "Ecological Problems Within the Framework of the 'Sibir'' Program," in which it was demonstrated that such widely separated fields as atmospheric chemistry and the problem of shifting of the rivers of Siberia can be interrelated in the not distant future.

It was noted that from the time of the first seminar, held in 1979 in Leningrad, a substantial advance has been made in study of the photochemical and chemical processes transpiring in the pure and contaminated atmosphere. The following important results were obtained:

New physical methods have been developed for investigating the mechanisms of reactions which are of considerable importance for atmospheric chemistry.

For the first time it has been possible to determine and ascertain more precisely the constants of the rates of chemical reactions with the participation of atoms, free radicals and molecular ions, which serves as a basis for a quantitative description of chemical processes in the atmosphere.

It has been shown that in the chemical reactions in the atmosphere an important role can be played by electron- and vibrationally-excited particles.

Investigations were begun on mathematical modeling of the processes of atmospheric transport, taking into account chemical and photochemical reactions and their influence on climatic characteristics and atmospheric contamination.

It was noted that the total volume of investigations in the field of atmospheric chemistry is still disproportionally small in comparison with those requirements which are imposed primarily by the problem of predicting the danger created by anthropogenic contaminations of the troposphere and stratosphere. The coordination of the work of kinetic chemists and the work of other specialists engaged in study of the atmosphere from the point of view of these requirements is inadequate. Nevertheless, these results already make it possible to give some important practical recommendations.

Since interest in work in the field of atmospheric chemistry is increasingly undeviatingly and there is an increasing number of specialists concerned with the problems related to chemical reactions under atmospheric conditions, at the seminar a desire was expressed for its further transformation into a regularly held conference on atmospheric chemistry.

N. M. Bazhin and G. I. Skubnevskaya

A Soviet-American Symposium on "Influence of Solar Activity on Climate" was held in Vil'nyus during the period 26 May-2 June 1981. The co-chairmen of the symposium were Ye. P. Borisenkov (USSR) and G. A. Eddy (United States).

Among the principal problems discussed at the symposium were the following:

-- the nature of the change in solar activity with different time scales;
-- variations in solar activity (da[illegible] from direct measurements on satellites and at the earth's surface, and also changes of this constant, caused by disturbances of the earth's orbital parameters; comparison of variations of the solar constant with geological data);
-- modeling of global dynamic processes in the middle and lower atmosphere, changes in the chemical composition, wave characteristics of the troposphere, taking into account changes in solar activity and the solar constant;
-- possible mechanisms of the influence of solar activity on weather and climate, as well as means for their experimental checking;
-- use of dendrochronological information (tree rings) and radioisotopic methods for investigating changes in the earth's climate in the past and also a statistical analysis of meteorological data for clarifying their correlation with solar activity.

Long-period changes in solar activity were discussed in a report by G. A. Eddy, head of the United States delegation. In his opinion slow changes in solar activity play an appreciable role in weather and climatic processes. Accordingly, now it is very important to make precise measurements of the total flux of solar energy reaching the earth (solar constant).

K. Ya. Kondrat'yev and G. A. Nikol'skiy (Main Geophysical Observatory, Leningrad State University) devoted their report to results of recent investigations of changes in the solar constant (astronomical and meteorological). Variations in the astronomical solar constant constitute about 0.5% and changes of the meteorological constant -- up to 4%. An analysis indicated that cosmic rays play an important role in the change in the component makeup of the stratosphere and troposphere, and accordingly, also the meteorological solar constant. A report by P. Foukal (United States) examined the results of recent measurements of the solar constant on satellites and it was shown that the solar constant changes by tenths of a percent. The amplitude of the variations agrees with evaluations of the amplitudes of modulation of brightness of sunspot regions.

A report by Ye. P. Borisenkov, A. V. Tsvetkov and S. V. Agapopov (Main Geophysical Observatory) examined variations of the solar constant (secular and short-period), caused by disturbances of parameters of the earth's orbit. Against the background of secular changes of the solar constant with a period of 20, 40 and 100 thousand years there are variations with a period of 11.9, 18.6 and 2.7-3 years. The amplitude of the variations was about 0.02%.

E. R. Mustel', V. Ye. Chertoprud and N. B. Mulyukova (Astronomical Council, USSR Hydrometeorological Center) presented a report devoted to a statistical analysis of data on atmospheric circulation in relation to the change in solar activity manifested in the form of geomagnetic storms. The analysis indicated that the instability of the troposphere can increase on the 2d-4th day after the earth's entry into solar corpuscular streams. This effect is traced most clearly in the regions of temperature contrasts over the surfaces of the oceans and near the ocean-earth boundary. G. G. Gromova and V. F. Loginov (USSR Hydrometeorological Center, Main Geophysical Observatory) devoted their report to the problems involved in change in atmospheric energy after powerful solar flares. They confirmed the conclusion drawn earlier that the kinetic energy of the atmosphere in the high latitudes increases after large disturbances on the sun and in the earth's magnetic field.

M. Mitchell (United States) discussed problems relating to fluctuations of the earth's climate in different time intervals: from tens to several millions of years. In his opinion, short-period changes in solar activity give an insignificant contribution to the overall variability of climate, but long-period changes can cause a more appreciable effect in climate.

R. North (United States) gave two reviews on the results of investigations using simple models of the response of climate to solar activity changes. Models of the energy balance were also examined from the point of view of their response to changes in the solar constant. These models, describing the seasonal variation well, are nevertheless not responsive to changes in the solar constant as a result of disturbances of the earth's orbital parameters.

Hydrodynamic models of planetary waves, with allowance for the influence of solar activity, were presented in several reports. For example, L. R. Rakipova and N. I. Yakovleva (Main Geophysical Observatory) in their report presented quantitative evaluations of the influence of the 11-year cycle of solar activity on the amplitudes of stationary pressure waves propagating from the troposphere into the stratosphere.

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M. Heller (United States), within the framework of a two-dimensional quasigeostrophic model of stationary planetary waves, evaluated the effect of the mean zonal wind on the vertical profile of geopotential waves. Heller feels that disturbances of the zonal wind can be attributed 20% to solar activity. A. I. Ivanovskiy and A. A. Krivolutskiy (Central Aerological Observatory) examined macroscale waves with a period of 27 days. They postulate that planetary Rossby waves with a period of 27 days are resonance waves. The characteristics of waves which they computed with different heights and widths, given in the report, agree fairly well with the data obtained on the basis of geopotential and the index of zonal circulation. In the opinion of the authors, the excitation of 27-day planetary waves occurs as a result of rotation of active solar longitudes.

Among the reports devoted to the possible mechanisms of the influence of solar activity on processes in the lower atmosphere we should note the report of V. F. Loginov and B. I. Sazonov (Main Geophysical Observatory) which gave a review of the mechanisms of the influence of solar activity on weather changes.

The report of S. I. Avdyushin, V. V. Mikhnevich and R. V. Smirnov (Institute of Applied Geophysics) was devoted to the problems of the state and prospects for further investigations of the problem "Sun-Atmosphere." Some correlations were found between meteorological and cosmophysical phenomena. A report by L. A. Ryazanova and G. A. Kopin (Central Aerological Observatory) gave an analysis of the correlation between the directions and intensity of mesospheric and stratospheric winds and the solar activity level. Seasonal effects were discovered. A. Few (United States) presented a communication on evaluation of the influence of solar activity on weather and climate through changes in atmospheric electricity. He presented a review of the mechanisms by which there is an interaction between electric and meteorological characteristics (at the molecular level, with the participation of aerosols, by an electric effect on a cloud, global currents).

The report of I. L. Karol', A. M. Shelomyanskiy, et al. (Main Geophysical Observatory) was devoted to a new method for averaging the results of the total content of ozone for the main types of air masses, making possible a sharp decrease in the natural variability of the mean values of the total content and detection of weak indicators of the influence of solar activity on ozone content.

At the symposium reports were given on the results of investigation of dendrochronological data for the purpose of obtaining evaluations of the influence of the variability of solar activity on climate in different regions. L. A. Kayryukshtis (Academy of Sciences Lithuanian SSR) in his report discussed the results of an investigation of the dynamics of arid periods during the last several centuries and predicted drought in the future. T. T. Bitvinskas (Botany Institute, Lithuanian SSR) presented a report on the development of dendrochronological investigations in the northwestern part of the USSR. The report gives an analysis of the variability of the radial increment of trees in relation to the solar activity level. C. Stockton (United States) presented a report on the use of tree ring data for ascertaining the cyclicity of droughts in the western United States during the last 363 years. This material was analyzed in detail and on its basis it could be demonstrated that the main period in the change in aridity is a period of 22 years. There was found to be a high coherence between the 22-year period of droughts and the Hoyle solar cycle.

Among the reports presented at the symposium there were those devoted to the problem of use of radioactive isotopes in the investigation of changes in the earth's climate. G. Ye. Kocharov (Physicotechnical Institute, Leningrad) in his report discussed the problems involved in the distribution of cosmic isotopes in lunar ground and on the intensity of solar and galactic cosmic rays on a time scale from the present day to a million years ago.

M. Stoyver (United States) presented a communication on the formation of C^{14} radiocarbon and the streams of cosmic rays associated with it. Data on C^{14} "fitted in" with tree ring data. The analysis indicates that there is a small number of regions in which carbon content is modulated by solar activity.

Thus, the extensive subject matter of the reports presented by symposium participants is indicative of the great interest of scientists in the problem of the influence of solar activity on climate. However, further success is dependent on the appearance of new ideas concerning the mechanisms of the influence of solar activity on different processes in the earth's atmosphere and also on the organization of experiments for checking already known mechanisms.

Yu. Ye. Kazakov and A. V. Tsvetkov

A session of the Section on Use and Conservation of Water Resources of the European USSR of the Scientific Council "Multisided Use and Conservation of Water Resources" of the USSR State Committee on Science and Technology was held at Chelyabinsk during the period 30 June-2 July 1981. Problems in water supply of the Middle and Southern Urals were examined there. Participating in the work of the section were specialists in the field of hydrology, hydrogeology and water management of the leading scientific, planning and academic institutes of different ministries and departments, a total of 81 persons.

In opening the session the section chairman I. A. Shiklomanov emphasized that the water supply of the Middle and Southern Urals is an important link in the development of the productive forces of the Ural economic region, whose improvement must be devoted daily and very careful attention. Most important is the implementation of measures directed to the creation of systems for precise and reliable inventorying of water resources and their use. for the development of water-free technology and cycling systems in industry, for improvement in the quality of water (especially the waters of rivers, lakes and reservoirs) and their preservation from exhaustion and contamination.

Fourteen reports were examined. These characterize the present-day status of study of the surface waters of the Urals and ways to improve monitoring of their quantity and quality (report of V. N. Babchenko, M. A. Yeremina and G. P. Lashmanova), the present status of water supply and the prospects for the introduction of water cycling systems at the enterprises of the Middle Urals (report by P. A. Yermolayeva), the problems of water supply in the Southern Urals (report by I. T. Borodatyy), ground water in the Urals and its use in the national economy (report of V. S. Palkin), the creation of water-free technologies in industry (report of G. D. Kharlampovich and R. I. Kudryashcheva) and other problems. A report of considerable interest was that of the director of the Ural Scientific Research Institute of Water Management. This report by I. S. Shakhov was devoted to the main methodological reasons for planning the optimum development of water management in the Urals.

The conferees, discussing the problem of water supply in the Urals, noted the following:

1. The supply of the Ural Economic Region (UER) with river runoff resources, according to mean long-term data, is 136 km^3; about 3/4 of these resources are accounted for by the poorly developed regions of Permskaya and Sverdlovskaya Oblasts. The natural operational resources are about 75 km^3. The predicted operational resources of ground water are 7.5 km^3/year; proven resources are about 1 km^3/year.

2. Inventorying of water consumption and water diversion has been poorly organized. Accordingly, report data on the use of fresh water in the Ural Economic Region vary considerably, on the average being 12 km^3/year, and with respect to water diversion -- about 10 km^3/year.

3. The present-day water management system in the Ural Economic Region is the most extensive, complex and capital-demanding in comparison with other regions of the country. Here there is the country's highest level of water supply to industry by means of cycling systems (about 80%). Work has begun on the planning of systems for the water supply of industrial enterprises without runoff (shops of the Verkh-Isetsk Tin-Plate Metallurgical Plant in Sverdlovsk). Repeated use has been made of the purified urban waste water for industrial water supply (Krasnoural'sk). Purified industrial waste water is now coming into use in the irrigated agricultural fields in Orenburgskaya and Chelyabinskaya Oblasts.

4. The problem of reliable water supply of the national economy in the forseeable future must be solved on the basis of an intensification of the use of local resources and industrial renewal of industrial water in cycling water supply systems with a gradual changeover to systems without runoff.

5. A major contribution to the study of water resources and improvement of water management has been made by Ural scientific research and planning institutes, industrial and agricultural enterprises and organizations.

The Ural Territorial Administration of Hydrometeorology and Environmental Monitoring is carrying out a study of the water resources at 242 stations on rivers and 62 stations on lakes. A study was made of the regime of small rivers and its change under the influence of economic activity.

The Ural Scientific Research Institute of Multisided Use and Conservation of Water Resources has developed a strategy for the development of water management in the Urals for a long time in advance, including effective use of water resources by means of optimum regulation of local river runoff and its redistribution within the region, industrial renewal of waste water on the basis of cycled and runoff-free water supply with recovery of useful components. Limits have been set for use of water resources in the region and the optimum development of the water economy using an economic criterion. A long-term scheme was proposed for the use of ground water under complex hydrogeological conditions. The Ural and Chelyabinsk

Polytechnic Institutes have developed schemes for runoff-free water supply systems in the Urals and effective techniques for the purification of waste water at individual enterprises.

Perm' and Bashkir Universities have developed refined methods for computing local water resources and for the multisided use of major reservoirs.

The Chelyabinsk Affiliate of the All-Union Scientific Research Institute of Water Management has developed optimum schemes for water supply of industrial enterprises.

Planning institutes have determined the long-term requirements for water and have prepared schemes for the multisided use of water resources in individual river basins.

Economic institutes have developed economic evaluations of individual components of the water management system.

The Northern and Southern Ural Basin (Territorial) Administrations have carried out systematic work on improving the monitoring of water consumption and water withdrawal, the effective distribution of local water resources, the effectiveness of operation of purification structures and monitoring of allocation of capital investments in water conservation measures.

At the same time, the section noted a number of inadequacies in the study, use and conservation of the water resources of the Urals, in particular:

a) inadequate study of the conditions for formation, the regime and quality of runoff of small rivers and its transformation as a result of intensive economic use;
b) poor supplying of enterprises with measurement instruments for monitoring the consumption, withdrawal and quality of waste water, resulting in inadequate reliability of data on the use of water resources and making difficult the effective control of the water management system;
c) inadequate study of the interrelationship of surface and ground water, the influence of anthropogenic activity on the change in their resources and quality; poor rates of exploitation of explored reserves;
d) poor study of technical-economic evaluations of water management measures;
e) lack of reliable methods for the decontamination of purified household-waste water for use in different spheres of the national economy and also the utilization of solid precipitation;
f) inadequacy of water-balance investigations in regions of planned reservoirs, as well as those which under construction and in operation.

Among the shortcomings we should also note the poor coordination of work on the problem of water supply of the Ural Economic Region and the low level of planning of water supply features in the Southern Urals.

In order to improve the study and multisided use of water resources in the Middle and Southern Urals the section adopted a resolution concerning the feasibility of:
-- developing a scheme for the multisided use and conservation of water resources

in the Ural Economic Region, taking into account the interests of adjacent territories for the computation levels 1990, 2000 and 2020, as well as the creation of a "water management" branch in the country;
-- cessation of the constant cutting of forests in the Ural Economic Region, especially in Chelyabinskaya Oblast and in the Bashkirskaya ASSR, orientation of the lumber industry on the selective conservational cutting principle and a considerable increase in forest planting;
-- development of standardized methods for the chemical analysis of natural and waste water;
-- increase in production and improvement of water-gaging apparatus, whose lack is one of the principal reasons for the low accuracy in monitoring water withdrawal (in cases of highly contaminated waters) and irrational use of water resources;
-- organization of a hydrometeorological network for studying the water regime of small rivers and water bodies in the neighborhood of reservoirs under construction and in operation (for example, the Dolgobrodskoye, Kyshtymskoye, Yangel'skoye and other reservoirs), determination of the number of reservoirs for which it is necessary to determine water balances for the purpose of routine monitoring and use of the water resources which they contain, activation of work on creating a network of hydrological posts in national forest and animal preserves;
-- formulation of scientific principles, a scientific-technical program and practical recommendations on the optimum use of water resources in the Ural River basin;
-- continuation of investigations on compilation of a map showing the protection of ground waters against contamination within the limits of the Ural Economic Region and exploration for fresh and brackish waters, and also implementation of work for more precise determination of ground water resources and evaluating the influence of economic activity on their regime;
-- improvement in monitoring of water consumption and diversion of waste water (on the basis of quantitative and qualitative indices) with the use of instrumental monitoring methods;
-- development of effective and economical methods for the sanitizing and utilization of solid precipitation, demineralization of water during the purification of different categories of waste water, decontamination of household-waste and run-off waters at livestock farms, taking into account the presence of new aeration equipment and structures in water management systems;
-- formulation of validated technical-economic indices for different methods for reproduction, regulation and territorial redistribution of water applicable to the Ural Economic Region;
-- intensification of work on the introduction of water conservation measures for small rivers, reservoirs and lakes;
-- creation of an interdepartmental council on the coordination of scientific and technical problems of water resources and water management in the Ural Economic Region.

B. S. Ustyuzhanin

NOTES FROM ABROAD

Moscow METEOROLOGIYA I GIDROLOGIYA in Russian No 1, Jan 82 pp 127-128

[Article by B. I. Silkin]

[Abstract] As reported in NEW SCIENTIST, Vol 91, No 1256, p 331, 1980, the British Atomic Energy Agency has published a report on "Radioactivity of Air and Precipitation as of the End of 1980." During 1980 the level of radioactivity of precipitation throughout the world was less than 1% of its maximum level in 1963-1964. The concentration of long-lived decay products had dropped to 2/3 of its 1979 level. In December 1980 about half the long-lived radioactivity could be attributed exclusively to the Chinese nuclear test of 16 October 1980.

In FLIGHT INTERNATIONAL (Vol 119, No 3745, p 412, 1981) it is reported that the European Space Agency has decided to create an organization known as Eumetsat for observing and investigating meteorological phenomena from space. It will direct experiments using the "Meteosat-2" satellite, which is expected to remain functional until 1984-1985, and using a future satellite of this type. These satellites will transmit cloud cover images and will collect and disseminate meteorological information received from ground stations.

In SCIENCE NEWS, Vol 119, No 17, p 262, 1981, it is reported that G. Kitterman of Kansas City, Missouri, made a photographic study of lightning discharges over a period of 77 hours. The purpose was to ascertain if, and how frequently, lightning discharges may occur simultaneously. He registered 15 pairs of simultaneous lightning strokes. This phenomenon has been considered rare.

In JOURNAL OF PHYSICAL OCEANOGRAPHY, No 10, p 1228, 1980, there is an article concerning American studies of the dynamics of waters in the Bering Sea conducted under the auspicies of NOAA and the US Navy. The principal result of this work was the discovery of a quasistationary mesoscale eddy which exists in the southeastern region of this sea. The accumulation of a vast amount of data has made it possible to draw conclusions concerning the temperatures, salinity and velocity of movement of waters in the studied region.

OBITUARY OF DMITRIY ANDRIANOVICH DROGAYTSEV -- 1911-1981

Moscow METEOROLOGIYA I GIDROLOGIYA in Russian No 1, Jan 82 p 128

[Article by staff of USSR Order of Lenin Hydrometeorological Scientific Research Center]

[Abstract] Dmitriy Andrianovich Drogaytsev, doctor of geographical sciences, an outstanding specialist in the field of long-range weather forecasting, affiliated with the Seasonal Weather Forecasts Laboratory at the USSR Hydrometeorological Center, died on 17 November 1981. A graduate of the Moscow Hydrometeorological Institute, he devoted his entire life to the field of hydrometeorology. Among his initial posts was that of senior weatherman on Dikson Island, working for the Arctic Scientific Research Institute. After receiving his candidate's degree in 1941, he continued to work with the Arctic Scientific Research Institute of the Main Administration of the Northern Sea Route and almost every summer was in arctic seas where his assignment involved servicing of operations for guiding ships along the Northern Sea Route. By 1948 he had received his doctorate. During the period 1948-1950 he was director of the Central Institute of Forecasts. Thereafter he turned to research work and published more than 50 works devoted to long-range weather forecasts, predictions of ice, river runoff, precipitation and the thermal state of seas. He was also a lecturer on marine forecasts in the Oceanology Department at Moscow State University.

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