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No. 4, April 1982

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UDC 551.509.313.001.573

MESOSCALE NUMERICAL WEATHER FORECASTING

Moscow METEOROLOGIYA I GIDROLOGIYA in Russian No 4, Apr 82 (manuscript received 14 Jul 81) pp 5-15

[Article by N. F. Vel'tishchev, doctor of physical and mathematical sciences, A. A. Zhelnin, V. Z. Kisel'nikova, Ye. M. Pekelis and D. Ya. Pressman, candidates of physical and mathematical sciences, USSR Hydrometeorological Scientific Research Center]

[Abstract] Existing mesoscale models in most cases are specialized and intended for investigating individual atmospheric processes; at present there is not even one sufficiently complete mesoscale nonhydrostatic model which can be used for prognostic purposes. The authors felt that the results obtained with specialized models can be used as a foundation for more universal mesoscale models of prognostic importance. Such a model is presented here; it was developed at the USSR Hydrometeorological Center. It was formulated in such a way that it is possible to make a short-range forecast of the principal meteorological elements: temperature, pressure, three velocity components, humidity, cloud cover and precipitation with direct modeling of the mesoscale processes exerting a significant influence on weather conditions. The predictable elements include cloud cover and precipitation and moisture transport in the atmosphere (with parameterization of its phase transitions). Radiation transfer processes are included. Processes of transport of heat and moisture in the active soil layer with a depth of about a meter are included in the model for a more detailed allowance for the processes of heat and moisture exchange between the atmosphere and the underlying surface. As the initial equations use was made of the deep convection equations proposed by Y. Ogura, et al. (J. ATMOS. SCI., Vol 19, No 2, 1962) and R. Wilhelmson, et al. (J. ATMOS. SCI., Vol 29, No 7, 1972). These equations were supplemented by the corresponding moisture transfer equations and the equations for the transport of heat and moisture in the upper meter soil layer. Figures 2; references 20: 7 Russian, 13 Western.

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UDC 551.509.313

APPLICATION OF OBJECTIVE ANALYSIS FOR COMPUTING GRADIENTS IN LAGRANGIAN METHOD FOR INTEGRATING PROGNOSTIC EQUATIONS

Moscow METEOROLOGIYA I GIDROLOGIYA in Russian No 4, Apr 82 (manuscript received 15 Jun 81) pp 16-20

[Article by B. Bakirbayev and V. V. Kostyukov, candidate of physical and mathematical sciences, West Siberian Regional Scientific Research Institute]

[Abstract] Eulerian representations of independent variables are usually employed in numerical forecasting methods. In synoptic forecasts the basis is the trajectories method, providing a clear interpretation of developing processes. As a mathematical expression it is possible to use the equations of atmospheric dynamics in Lagrangian variables. The possibilities of these traditional approaches have reached their limits, dictating a search for new approaches. In actuality, in the schemes which have been employed the requirements on the properties of the initial and predicted fields have often not been satisfied; there may not be adequate accuracy in computations due to the high values of the residual terms in the Taylor expansion. It is proposed that such effects can be reduced by the use of variable grids adapted to the values of local gradients. The article therefore is a detailed discussion of the problems involved in application of this approach in the example of a barotropic model of the atmosphere. For example, one of the main difficulties in integration in Lagrangian variables involves computation of the gradients, since in the course of a forecast the positions of the particles change and become irregular. Usually in each interval there is a reinterpolation of the values of meteorological elements in a fixed regular grid, from which the required derivatives are then computed. Here it is shown that the derivatives can be found directly from a changing grid of particles by using the objective analysis procedure. There are three methods which can be employed for this purpose: polynomial approximation, optimum interpolation and weighted mean. Each is discussed and it is indicated that the most convenient is the weighted mean method due to the analytical form of the interpolation weights. The forecasting algorithm for each time interval consists of objective analysis for points at which the particles are situated at the current moment. Numerical experiments are discussed; both real and model data were used. The success of the described forecasting method is dependent on the accuracy in integration of the system of differential equations and approximation of the gradients. Figures 1, tables 1; references: 8 Russian.

UDC 551.509.313.001.57:551.54

NUMERICAL PREDICTION OF PRESSURE FIELD IN REGIONAL MODEL USING TWO GRID TYPES

Moscow METEOROLOGIYA I GIDROLOGIYA in Russian No 4, Apr 82 (manuscript received 11 Jan 81) pp 21-30

[Article by W. Ahrens, East German Meteorological Service]

[Abstract] Meshed grids are coming into increasingly wider use with the Arakawa C grid having considerable advantages in comparison with the so-called A grid. The author here outlines the changes which must be introduced in order to employ schemes using a C grid. The model presented here employs a system of primitive equations of atmospheric dynamics and a semi-implicit scheme for time integration. Particular attention is given to the behavior of the amplitudes of waves in a linear case for two types of grids. The purpose of this investigation was to ascertain how the form of approximation of the horizontal derivatives exerts an influence on the behavior of wave amplitudes, especially meteorologically significant Rossby waves. The difference approximations for both types of grids are obtained using a central differences scheme, but with approximation of the terms with adaptation and diffusion the grid C has an interval half as great as for grid A. Two variants of the model are examined applicable to short-range forecasts for the period 1 March 1978-5 March 1979 (30 cases). The horizontal spatial interval was 300 km and the values of the geopotential and wind variables were constant at the lateral boundary. A table gives the mean values of evaluations for the two cases. Improvement of variant C in comparison with variant A is significant for almost all levels of the model (1000, 850, 700, 500, 300 gPa), especially for 1000 and 850 gPa. Despite differences in variants of the model (change in the form of the equations, types of grids, filtering regime), they were quite identical -- same time intervals, space intervals, number of points and time expended on the computer for a 24-hour forecast (4 minutes). Accordingly, improvement of evaluations of the forecasts using the model with the C grid is quite convincing evidence of the advantage of this variant of the model. Figures 2, tables 2; references 6: 4 Russian, 2 Western.

UDC 551.509.313

PROBLEMS IN OBJECTIVE ANALYSIS OF DATA FROM INDIRECT METEOROLOGICAL OBSERVATIONS

Moscow METEOROLOGIYA I GIDROLOGIYA in Russian No 4, Apr 82 (manuscript received 25 May 81) pp 31-37

[Article by A. I. Belyavskiy and O. M. Pokrovskiy, candidate of physical and mathematical sciences, Main Geophysical Observatory]

[Abstract] Vigorous efforts are being made to use data from indirect observations in numerical analysis of meteorological fields. A generalized variant of this method makes possible the direct use of data from radiometric observations of outgoing radiation in a numerical analysis scheme. However, a two-stage approach is being developed in which the objective analysis scheme involves use of the vertical profiles of temperature and relative geopotential, first reconstructed using some method for solving the inverse problem. The authors sought to evaluate the validity of the two-stage approach. For this purpose a study was made of the three principal types of correlations in the distribution of errors in the remote sounding method. Formulas were derived making it possible to compute the theoretical values of the horizontal and vertical correlations of errors. A comparison with the corresponding empirical data is given. It was found that the errors in determining temperature by the indirect sounding method and the true values are strongly correlated. The nature of correlations of this type was clarified. The variability of all these correlations was investigated; it is shown that theoretical evaluations give a correct qualitative picture of the spatial distribution of the correlation coefficients. The significant seasonal and spatial variability of the correlation coefficients was clarified. It is concluded that since allowance for many varying correlations is difficult, but neglecting them leads to a decrease in the effectiveness of the optimum interpolation procedure, in numerical analysis it is better not to use the results of solution of the inverse problem, but initial data from radiometric measurements, whose errors are uncorrelated under ordinary experimental conditions. Figures 3; references 13: 8 Russian, 5 Western.

UDC 551.510.72(47+57)

RADIOACTIVE CONTAMINATION OF ATMOSPHERIC SURFACE LAYER OVER USSR IN 1980

Moscow METEOROLOGIYA I GIDROLOGIYA in Russian No 4, Apr 82 (manuscript received 10 Aug 81) pp 38-43

[Article by K. P. Makhon'ko, candidate of physical and mathematical sciences, V. P. Martynenko, V. B. Chumichev and F. A. Rabotnova, Institute of Experimental Meteorology]

[Abstract] During all of 1980 radioactive contamination of the surface layer of the atmosphere over the territory of the USSR was at a very low level, but a nuclear explosion in the atmosphere took place in the Chinese People's Republic on 16 October 1980. A marked increase in the levels of total beta activity was observed in the USSR in the southern part of Primorskiy Kray several days after the shot; there was also some increase in radioactive fallout in the Kirgiz and Uzbek SSRs. However, most of the decay products first encircled the earth before appearing over the western boundaries of the USSR, for the most part in the southern part of the country. In the remaining part of the USSR there was no appreciable increase in total beta activity but everywhere fission products were detected in samples. The greatest increase in the concentration of radioactive products in the air and their fallout was observed beginning in the middle of the first 10-day period in November. The article gives a careful review of the annual variation of total beta activity over the USSR during 1976, 1977, 1978, 1979 and 1980. Table 1 gives the concentration of nuclides in aerosol samples for the USSR in late October and mid-November 1980 for Kursk, Riga, Moscow and Tashkent. All the observed parameters were characteristic for nuclear shots set off in the atmosphere at a considerable altitude precluding the possibility of capture of soil and its entrainment into a fireball. Most of the fission products by the time of their arrival in the atmospheric surface layer over the territory of the USSR were quite well mixed and there was no significant change in isotopic composition in time or space. Figures 1, tables 2; references 5: 2 Russian, 3 Western.

UDC 551.571(571.1)(574)

SPACE CORRELATION FUNCTIONS OF AIR HUMIDITY IN WESTERN SIBERIA AND KAZAKHSTAN

Moscow METEOROLOGIYA I GIDROLOGIYA in Russian No 4, Apr 82 (manuscript received 25 May 81) pp 44-49

[Article by L. P. Kuznetsova, candidate of geographical sciences, and T. A. Mozhina, Institute of Water Problems]

[Abstract] A study was made of the spatial structure of the air humidity fields at the level of the isobaric surfaces 850 and 700 mb and the total moisture content in the troposphere within the territory of Western Siberia and Northern Kazakhstan. The spatial structure was represented by aerological observations at 35 stations, including several stations on the western slope of the Urals and in the Yenisey valley. Aerological data were available only for the 10-year period 1961-1970. The field of mean monthly atmospheric moisture content values was virtually isotropic in all seasons other than summer when there are closer correlations in the NW-SE direction, which corresponds to the direction of the prevailing transport of air masses in this season. There were no substantial differences between the correlation functions of atmospheric moisture content computed for 20 stations in the Ob' and Yenisey basins and for the 35 stations situated over the entire territory of Western Siberia and Kazakhstan. It was found that the space correlation functions computed using data from aerological sounding stations regardless of their geographical location correctly describe the spatial structure of the air humidity fields at the 850- and 700-mb levels and total moisture content. It is demonstrated that the space correlation functions, computed on the basis of the mean monthly moisture content values, were determined with sufficient reliability for their use in objective analysis. Figures 4, tables 1; references: 6 Russian.

UDC 551.526.6+551.524.34(261)(265)(267)

MEAN LATITUDINAL WATER AND AIR TEMPERATURE VALUES FOR WORLD OCEAN

Moscow METEOROLOGIYA I GIDROLOGIYA in Russian No 4, Apr 82 (manuscript received 14 Jul 81) pp 50-55

[Article L. A. Strokina, candidate of geographical sciences, State Hydrological Institute]

[Abstract] Climatic maps published during recent years were used in determining the mean latitudinal water and air temperature values for the entire world ocean for each month of the year. More than 31,000 values characterizing water and air temperature at the points of intersection of a regular 5° grid were used in determining the zonal water temperature (t_0) and air temperature (t_a) values in the ice-free parts of the world ocean. Monthly maps were used for this purpose. All these values are summarized in a two-page table. Among the conclusions which can be drawn from this tabulation are the following. The decrease in water and air temperatures with an increase in latitude occurs nonuniformly. The meridional gradients of t_0 and t_a increase from the equator toward the subtropical latitudes in both hemispheres and then decrease in the direction of the middle latitudes. The northern part of the world ocean is warmer than the southern part. In summer in the northern hemisphere the t_0 and t_a values are higher than the corresponding values in the southern hemisphere by 1-4°C in the tropical and by 5-7°C in the extratropical latitudes. In winter the temperature regime in the two hemispheres differs to a lesser degree. In the subtropical and temperate latitudes the air temperature in the northern hemisphere is lower than in the southern hemisphere. The mean t_0 and t_a values for the northern hemisphere exceed the corresponding means for the southern hemisphere by 3.5-4°C in winter and by 5.0-5.4°C in summer. For the world ocean as a whole the maximum t_0 and t_a values are in September and the minimum values are in March. During the period of heating the most intensive warming of the ocean and atmosphere is in the northern hemisphere from June through July, and in the southern hemisphere -- from November through December. During the entire year the effect of the surrounding continents exerts a stronger influence on the temperature regime of the atmosphere in comparison with the temperature regime of the ocean. Tables 1; references 19: 14 Russian, 5 Western.

UDC 551.464.(261.1)

SPATIAL-TEMPORAL VARIABILITY OF PETROLEUM HYDROCARBONS IN NORTH ATLANTIC WATERS

Moscow METEOROLOGIYA I GIDROLOGIYA in Russian No 4, Apr 82 (manuscript received 8 Jun 81) pp 56-65

[Article by Ye. A. Sobchenko, candidate of geographical sciences, I. G. Orlova, candidate of chemical sciences, V. A. Mikhaylov and R. I. Lisovskiy, Odessa Division, State Oceanographic Institute]

[Abstract] The results of observations of three forms of petroleum contamination in the North Atlantic for the three-year period 1977-1979 are given; these were made primarily between the 5th and the 70th parallels in the northern hemisphere. There were 16 000 observations of petroleum films, 2500 observations of petroleum aggregates and 1050 observations of the dissolved-emulsified fraction of petroleum hydrocarbons. Figure 1 is a map of the spatial distribution of petroleum films during this period. The most contaminated zone was that between the 10th and 50th parallels. These films are usually observed in shelf waters, regions of intensive navigation and transporting of petroleum. Table 1 gives the content of petroleum films in different parts of the North Atlantic; Table 2 gives the temporal variability of the occurrence of petroleum films. The maximum occurrence of films is along the shores of North America and Europe, where the pollution is 2-3 times greater than in the open part of the ocean. The regions of extremal contamination were the same during 1977-1979 as during 1975-1976. There were considerable year-to-year variations in the occurrence of films in different zones. In some areas there is a tendency to a decrease in the pollution level, and elsewhere -- an increase. Figure 2 is a map of the distribution of petroleum aggregates and Table 3 gives the temporal variability of these aggregates. This type of pollution is most common in the Gulf of Cadiz, along the shores of Africa and America. Dynamic factors are responsible for their concentration in the frontal zones of currents and at the center of the Sargasso Sea. Table 4 gives the temporal variability of the dissolved-emulsified fraction of petroleum hydrocarbons in the surface water layer in different zones. All this work was carried out within the framework of the IOC-WMO Pilot Project. Figures 2, tables 6; references 14: 12 Russian, 2 Western.

UDC 551.552:551.465.41

TURBULENT STRUCTURE OF NATURAL DENSITY FLOW IN ITS FORMATION REGION

Moscow METEOROLOGIYA I GIDROLOGIYA in Russian No 4, Apr 82 (manuscript received 20 Jan 81) pp 66-74

[Article by Yu. G. Pyrkin, doctor of physical and mathematical sciences, B. I. Samolyubov and A. A. Kuznetsov, candidates of physical and mathematical sciences, Moscow State University]

[Abstract] Expeditionary investigations by the authors indicated that the distributions of intensity of turbulence of a density current and its averaged characteristics are interrelated to the spectral composition of turbulence, which varies in different stages of flow development. The measurements were made in a sector of formation of a bottom stratified current of a fluvial suspension-carrying flow entering a deep natural water body of the canyon type. (The apparatus and the measurement method and certain aspects of the generation and subsequent propagation of the current on the basis of its averaged parameters were described earlier (Yu. G. Pyrkin, et al., VODNYYE RESURSY, No 6, 1978; OKEANOLOGIYA, 20, No 1, 1980; VODNYYE RESURSY, No 4, 1980)). This article essentially is a continuation of the work done earlier along these lines. Emphasis is on the period of autumn cooling of river waters and the receiving water body when the formation of the density flow is attributable to mechanical and thermal stratification, with a predominance of the latter. The measurements were made only during calms. Figure 1 shows the vertical distributions of the concentration of suspended matter, water temperature, current velocity, intensity of turbulence and spectral density of fluctuation energy in a bottom density flow at six points along a stream. The text gives a detailed analysis of the observations made in this reach. Figures 3, tables 3; references 9: 8 Russian, 1 Western.

UDC 556.165(47+57)

STUDYING TREND IN RIVER VOLUME CHANGES FOR EVALUATING NORMAL RUNOFF

Moscow METEOROLOGIYA I GIDROLOGIYA in Russian No 4, Apr 82 (manuscript received 15 Jul 81) pp 75-84

[Article by Ye. A. Leonov, candidate of technical sciences, and V. Ye. Leonov, State Hydrological Institute]

[Abstract] The authors investigated long-term variations in the runoff of major rivers in the USSR and analyzed the possibilities of predicting the "projected normal runoff" using statistical forecasting methods. ("Projected normal runoff" is defined as the mean long-term quantity anticipated during the period of operation of a projected water management enterprise or for any stage in operation and determined from the value of the norm for a past period with allowance for the corresponding changes introduced into physiographic conditions by man's economic activity and the trend in change in runoff in comparison with the past period due to secular fluctuations of climate). Table 1 gives the normal and mean values of annual runoff of major rivers during different periods (the rivers analyzed include: Severnaya Dvina, Neva, Vyatka, Volga, Neman, Don, Ural, Tura, Tobol, Nitsa, Ob', Irtysh, Yenisey and Amur). The materials presented here reveal that a statistical evaluation of water resources solely on the basis of the long-term normal runoff and its extrapolation to the future without correction for economic activity and the climatic trend is inadmissible. The data indicate that in the long-term variation of runoff there are prolonged tendencies to a dropoff and increase in water volume and that the change of runoff in these phases is described well by the equation for a complex exponential curve. The mean duration of the dropoff-increase period is 60-70 years. For European rivers since the end of the last century there has been a negative water volume trend, the dropoff being 5-25%, whereas for Asiatic rivers the volume has been 1-19% above the long-term norm. The analysis made it possible to predict water volumes for European and Asiatic rivers for the year 2000 and the years 2020-2040. Figures 3, tables 4; references: 18 Russian.

UDC 551.311.21:551.42(282.247.323)(282.247.325.8)

HYDRODYNAMICS OF EROSION OF ISLANDS IN KIYEVSKOYE AND KREMENCHUGSKOYE RESERVOIRS

Moscow METEOROLOGIYA I GIDROLOGIYA in Russian No 4, Apr 82 (manuscript received 25 May 81) pp 85-89

[Article by B. I. Novikov, candidate of geographical sciences, and Ye. G. Gladkaya, Hydrobiology Institute, Ukrainian Academy of Sciences]

[Abstract] The authors determined the hydrodynamic erosion of islands in Dnepr River reservoirs in the form of the temporal change in their size and volume. The investigation was important because it was found that the quantity of silts accumulated in Kiyevskoye Reservoir was 3.1 times greater than computed and the corresponding factor for the Kremenchugskoye Reservoir was 2.1. It became clear that this was attributable at least in part to the erosion of islands in these water bodies. The islands were mapped and their areas and volumes were precisely determined. The total area of the islands in Kiyevskoye Reservoir was 21.0 km^2; the area for Kremenchugskoye Reservoir was 94.5 km^2. In the upper reaches the islands were low and flat, essentially unflooded parts of the floodplain. They were eroded primarily by level fluctuations, although near the shipping channels the waves created by ships were a factor. In the middle and lower reaches the islands were 5-10 m above the surface, hilly, consisting of sand and loess, representing remnants of floodplain terraces and channel banks. For these islands erosion is caused for the most part by wind-wave processes. The initial survey was made in 1973-1974 and the repeated survey was made in 1980. It was found that as a result of hydrodynamic erosion the area of the islands has been reduced by 30-95%. The mean annual reduction in area is as much as 5.3%. Thus, by 1980 the two reservoirs had received 128,500 m^3 and 1,507,500 m^3 of material respectively. The islands may be completely eroded away in 13-15 years. The cited figures are comparable to the annual receipts of the erosional products of shores. The islands are also a source of a considerable quantity of biogenous elements -- carbon, nitrogen, phosphorus, iron, calcium, magnesium, sodium, potassium and others. These are capable of exerting an influence on water quality. Figures 2, tables 3; references: 3 Russian.

UDC 551.50:631.175

EVALUATION OF INFLUENCE OF METEOROLOGICAL FACTORS ON BIOLOGICAL PRODUCTIVITY OF LANDS

Moscow METEOROLOGIYA I GIDROLOGIYA in Russian No 4, Apr 82 (manuscript received 27 Aug 81) pp 90-99

[Article by V. D. Skalaban, candidate of biological sciences, State Institute of Land Resources]

[Text]

Abstract: The article sets forth the principles for evaluating the productivity of lands on the basis of a set of natural factors using the dimensionless relative index $K_{1,2,\ldots,N} = K_1 \cdot K_2 \ldots K_N$, where $K_1, K_2, \ldots, K_N$ are special indices for individual factors. The author gives evaluations of the principal meteorological factors and their comparison with actual productivity.

The increase in the earth's population and the development of productive forces is making increasingly timely the problem of the conservation and rational use of land resources, being the "principal means of production in agriculture and the areal basis for the siting and development of all branches of the national economy" [6]. Accordingly, the USSR "is carrying out a national land inventory involving the totality of reliable and necessary information on the natural...position of lands" [6], and a climatic survey is being made which takes in the totality of agrometeorological information. The required range of information on land resources is set forth in a definite system which includes the cadastral regionalization and classification of lands. All this information can be employed in monitoring agricultural production to the maximum degree if it can be used in obtaining some idea concerning the productivity of lands with respect to different crops.

In this communication we set forth a general approach to solution of the problem of multisided evaluation of the productivity of lands with respect to the principal production factors and specific procedures are proposed for evaluating land parcels on the basis of the most important of these factors, the most difficult to control, meteorological factors.

The process of production of a product of plant cultivation can be represented as one of the types of production subordinate to general patterns. With this in mind it can be shown that this final product is a function of many parameters

x_1, x_2, x_3, ...x_N [1]. The entire range of factors can be divided into four groups: light -- ℓ, heat -- T, moisture -- B, nutrients -- q [2]. Each parcel is characterized by a definite set of values of these parameters, which also determines its productivity with respect to one crop or another. In accordance with the above, it can be written that

$$M=f'(x_1, x_2, x_3, \ldots, x_N); \tag{1}$$

$$M=f(l, T, B, q). \tag{2}$$

Here M is the productivity of the agricultural crop, expressed in the form of total biomass and the quantity of commercial product of some substance (for example, sugars, oil, protein, etc.).

It is evident that for each type (variety) there is some optimum set of values ℓ_0, T_0, B_0, q_0 which ensures the maximum productivity M_0:

$$M_0 = f(l_0, T_0, B_0, q_0), \tag{3}$$

hence

$$\frac{M}{M_0} = \frac{1}{M_0} f(l, T, B, q). \tag{4}$$

Here M/M_0 is a function determined in a four-dimensional continuum and having a maximum equal to 1 with $\ell = \ell_0$, $T = T_0$, $B = B_0$, $q = q_0$, and a minimum equal to 0 with some extremal value of at least one of the factors.

Different values can be selected as the generalized parameters ℓ, T, B, q. For example, the averaged evaluations of extensive territories are given by the generalized indices: the relationship of the annual values of precipitation and evaporability, annual sum of active temperatures, etc. More detailed evaluations are given by the indices of moistening of the soils and growing season temperature. It is possible to use still more detailed indices taking into account the age requirements of plants for moisture, heat, etc.

In all cases it is better to express productivity and the factors determining it by dimensionless relative values. This procedure is employed by many researchers and makes it possible to give comparable evaluations of various types of objects.

For example, if the supply of plants with heat, moisture and light is not expressed in absolute values (degrees, millimeters, lux, watts, etc.), but in fractions of the requirement for a given type (variety), it is possible to give comparable evaluations for different crops and seek generalized expressions for productivity with these relative indices.

A complexity in characterizing the productivity of lands by the use of equations (1)-(4) is that first of all, the parameters have a stochastic character, and second, the production factors are related not only to productivity, but also to one another. Strictly speaking, equation (1) must be written in the following way [11]:

$$M = f'(x_1, x_2, x_3, \ldots, x_N, x_{1.2}, x_{1.3}, \ldots, x_{1.N}, x_{2.3}, x_{2.4}, \ldots, x_{2.N}, x_{3.4}, x_{3.5}, \ldots, x_{3N}, \ldots). \quad (5)$$

Equation (5) shows how diverse are the possibilities for combining the values of individual parameters. As a result of this diversity, complicated by the probabilistic character of the parameters, it is virtually impossible to reveal the essence of f' and on the basis of (5) establish the multifactor production functions by which it is possible to give complex evaluations of productivity on the basis of the principal production factors.

We attempted, using the general ecological patterns of interrelationship of factors, to break down the overall problem of multisided evaluation into individual components and to solve it by parts. We formulated these patterns on the basis of an analysis of materials from the investigations of different authors and our own experiments.

We will examine the influence of one factor, such as moisture supply, on the productivity of ear grain crops, averaged for drought resistance and moisture requirements. We will express the moisture supply in the form of soil moistening γ = W - WM/MMC - WM, where W are the moisture supplies in the soil layer used in the computations, WM is the same with wilting moisture, MMC is the same with minimum moisture capacity. The dependence of productivity on the means for the period of the active growing season, active moisture consumption and γ values is indicated in Fig. 1.

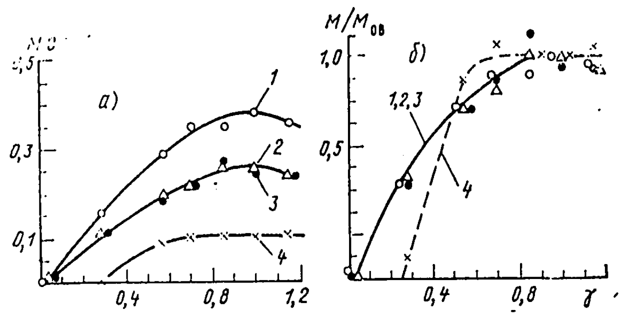

Fig. 1. Dependence of productivity of "Gerkules" oats on soil moistening with different supply of plants with nutrients. Soddy-slightly podzolic soil, moderate clayey loam, A_{cul}.

We obtained these data in growing experiments carried out in a closed laboratory room at constant temperature, air humidity and illumination. In all experiments the temperature was maintained at the level 23±1°C by the ordinary procedures of thermostating with the use of contact thermometers and temperature relays. A wet-bulb contact thermometer was paired with a dry thermometer.

The psychrometric difference was set by the contacts in accordance with a stipulated air humidity level of about 70%. In the transpiration process the plants increased the humidity, and as soon as it exceeded a stipulated level a relay connected to the wet-bulb contact thermometer was triggered and by means of ventilation fans fresh air was fed from the street, which, heating, reduced the relative air humidity to the stipulated level. This caused a gas exchange such as is necessary for photosynthesis. A device of such a type was used by I. I. Sudnitsyn and was described by him in [8]. Illumination was maintained at the level 4000-5000 lux by DRL-250 lamps.

Prior to the "tillering" phase the plants were cultivated with optimum moistening attained by capillary wetting from below with the subsequent outflow of water through drainage openings. Beginning with the phase of "leaf tube formation" different groups of pots were exposed to different moistening levels, first of all by differentiated watering from above to the computed weight and second by capillary wetting from below at different times. Watering from above was better in maintaining a constancy of soil moisture in the course of the experiment but it was nonuniformly distributed in the soil volume. Wetting from below resulted in a more uniform distribution of moisture in the soil volume but there was a considerable variation in moisture content in the course of the experiment.

In the maturing stage the plants were cut, dried at a temperature of 80°C and weighed. The mean dry weight of the plant was plotted on the y-axis in Fig. 1a. Optimum doses of lime and NPK were applied to the soil in variant 1 in the form of solutions of NH_4NO_3, KH_2PO_4, K_2SO_4 salts. In variants 2 and 3 partial doses of fertilizers were applied. In variant 4 the plants were cultivated with an acute shortage of nutrients achieved by triple cultivation of the same crop without the application of fertilizers. In variants 1, 2, 3 the curves $M = M(\gamma)$ have a one-dimensional geometric similarity, that is, with any stipulated moistening the ratio of the ordinates of these curves is constant (Fig. 1a). If the values M of each curve are represented in fractions of M_{OB}, these curves 1, 2, 3 merge into a single curve (Fig. 1b). A change in soil fertility to an equal degree exerts an influence on M and M_{OB}, not changing their relationship. In the case of an extremely low level of supplying of plants with nutrients their reaction to the moisture supply changes; the optimum γ value is displaced into the direction of low moisture contents. A zero productivity is not noted with the wilting moisture, but with a somewhat higher moisture content. Similar results have been noted by many authors: with a low supply of nutrients (especially nitrogen) to the plants there is a decrease in their resistance to drought and a reduction in moisture requirements; the lower boundary of optimum moistening is displaced into the direction of lesser moisture contents. These phenomena are observed when there is a considerable inadequacy of nutrients, which is inadmissible in production. With a moderate insufficiency of nutrients, causing a decrease in productivity by a factor of 2-2.5, the correlation between the relative M/M_0 value and γ is stable and is described by the equation which we proposed in [7]

$$M/M_{OB} = 1 - (\gamma - 1)^2. \qquad (6)$$

The data cited by V. S. Mezentsev using materials from a mass analysis of the yield of wheat as a function of soil moistening coincide with our conclusion: with different levels of soil fertility (differences in crop yield by a factor of 2) the dependences of crop yield on moistening are described by similar curves [5], which, being scaled in accordance with our proposal, merge into one, being approximated fairly well by equation (6).

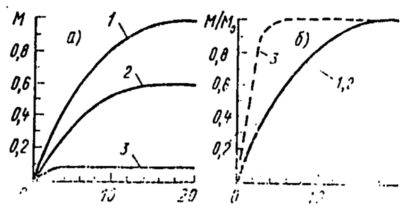

Fig. 2. Light curves of photosynthesis of wheat sprouts with different CO_2 concentrations in air (according to [4]). 1) illumination in thousands of lux. 1) 0.28%, 2) 0.13%, 3) 0.05% CO_2.

The influence of the illumination factor on the productivity of crops with a different supply of the elements necessary for the forming of production is manifested similarly. Figure 2,a shows data illustrating this influence. It is easy to see the analogy with Fig. 1a,b. With high and moderate supply of photosynthesis with CO_2 there is a geometric similarity of curves 1, 2 which would enable us to approximate them with the single equation

$$\frac{M}{M_{0l}} = 1 - 0{,}22\left(\frac{l - 20000}{10000}\right)^2. \qquad (7)$$

The extremely low level of supplying of CO_2 (curve 3) impairs this pattern similarly to Fig. 1: an increase in the intensity of illumination cannot be realized due to the insufficiency of CO_2 and photosynthesis is maintained at a level corresponding to ~2000 lux.

The noted pattern is observed in numerous series of curves constructed by D. I. Shashko for the correlation between crop yield and atmospheric moistening in regions with different heat supply [12].

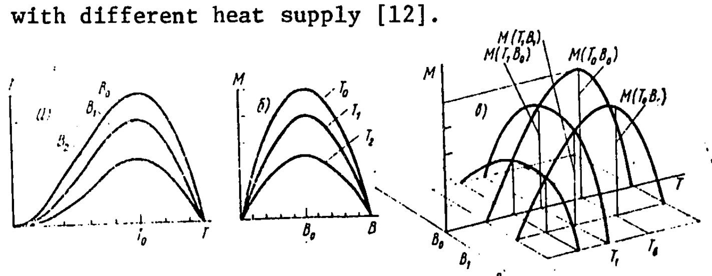

Fig. 3. Dependence of productivity M/M_{OBT} on moistening B and heat supply T indices. a) dependence of M/M_{OBT} on B against different temperature background; b) dependence of M/M_{OBT} on T against different moistening background; c) dependence of M/M_{OBT} on B and T.

The dependence of the productivity production functions on any factor was analyzed by Heddi and Dillon applicable to different types of agricultural production [9]. As a result they demonstrated that the production function of any factor can be represented by a family of such curves, each of which corresponds to a definite value of another factor. To this conclusion we add that with high levels of the "other" factor the curves have a uniform geometrical similarity, which makes it possible to represent them in relative units in the form of one generalized curve, and that with adequately low levels of the "other" factor the similarity is impaired in the direction of a convergence of the boundaries of the admissible and optimum values of the studied factor, in the direction of a reduction of the tolerance limits relative to this factor. The experimental data show that such an impairment occurs with such low values of the limiting factor that these conditions cannot be considered admissible for production.

Using these conclusions and making the assumption that under production conditions not one of these factors lessens productivity to the level at which the normal adaptation of plants to other factors is impaired, we will examine the complex influence exerted on productivity by two factors, such as moistening B and heat supply T. Figure 3 schematically shows the nature of this influence. The correlation of different functions of two variables, including the production functions of productivity due to any two factors [9], is expressed similarly. In much the same way, we express productivity in fractions of the maximum M_{OBT} values corresponding to the optimum moistening and heat supply values. With such an expression the changes in ℓ and q within the framework of the adopted assumptions are proportional to the change in the numerator and denominator, retaining the form of the dependence $M/M_{OBT} = M/M_{OBT}$ (B, T). Using the assertion of a uniform geometric similarity of the family of curves in Fig. 3a, b, it can be shown that at any point in the plane with the coordinates T, B the function $M/M_{OBT} = M/M_{OBT}$ (B, T) within the limits of the region of its determination can be represented as the product of the particular functions for one variable:

[OB = OB; OBT = OBT; OT = OT; OПT = opt]

$$\frac{M}{M_{\text{ОВТ}}}(B,T)=\underset{T=T_{\text{опт}}}{\frac{M}{M_{\text{ОВТ}}}}(B)\cdot\underset{B=B_{\text{опт}}}{\frac{M}{M_{\text{ОВТ}}}}(T)=\underset{T\neq T_{\text{опт}}}{\frac{M}{M_{\text{ОВ}}}}(B)\cdot\underset{B\neq B_{\text{опт}}}{\frac{M}{M_{\text{ОТ}}}}(T). \quad (8)$$

For the proof of equation (8) we will return to Fig. 3. Assume that some heat and moisture conditions B_1 and T_1 are stipulated.

$$\frac{M(T_0B_1)}{M(T_0B_0)}=\underset{T=T_{\text{опт}}}{\frac{M}{M_{\text{ОВТ}}}}(B_1);\quad \frac{M(T_1B_1)}{M(T_1B_0)}=\underset{T\neq T_{\text{опт}}}{\frac{M}{M_{\text{ОВ}}}}(B_1);$$

$$\frac{M(T_1B_0)}{M(T_0B_0)}=\underset{B=B_{\text{опт}}}{\frac{M}{M_{\text{ОВТ}}}}(T_1);\quad \frac{M(T_1B_1)}{H(T_0B_1)}=\underset{B\neq B_{\text{опт}}}{\frac{M}{M_{\text{ОТ}}}}(T_1).$$

It follows from the similarity of the curves in Fig. 3a that

$$\frac{M(T_0B_1)}{M(T_0B_0)}=\frac{M(T_1B_1)}{M(T_1B_0)}=\underset{T=T_{\text{опт}}}{\frac{M}{M_{\text{ОВТ}}}}(B_1)=\underset{T\neq T_{\text{опт}}}{\frac{M}{M_{\text{ОВ}}}}(B_1).$$

It follows from the similarity of the curves in Fig. 3b that

$$\frac{M(T_1B_0)}{M(T_0B_0)} = \frac{M(T_1B_1)}{M(T_0B_1)} = \underset{B=B_{\text{опт}}}{\frac{M}{M_{\text{опт}}}}(T_1) = \underset{B\neq B_{\text{опт}}}{\frac{M}{M_{\text{от}}}}(T_1).$$

Expressing the sought-for productivity $M(T_1B_1)$ in fractions of productivity under optimum heat and moisture conditions $M(T_0B_0)$ we obtain

$$\frac{M(T_1B_1)}{M(T_0B_0)} = \frac{M(T_0B_1)\cdot M(T_1B_1)}{M(T_0B_0)\cdot M(T_0B_1)} = \underset{T=T_{\text{опт}}}{\frac{M}{M_{\text{опт}}}}(B_1)\cdot\underset{B=B_{\text{опт}}}{\frac{M}{M_{\text{опт}}}}(T_1) = \underset{T\neq T_{\text{опт}}}{\frac{M}{M_{\text{оп}}}}(B_1)\cdot\underset{B\neq B_{\text{опт}}}{\frac{M}{M_{\text{от}}}}(T_1).$$

If, for example, $M(T_1B_1)$ is 0.80 of $M(T_1B_0)$, whereas $M(T_1B_0)$ is 0.90 of $M(T_0B_0)$, it is obvious that $M(T_1B_1)$ is $0.9\cdot0.8 = 0.72$ of $M(T_0B_0)$.

The principles set forth can be used in evaluating productivity on the basis of a great number of factors. In a general case, if the productivity of lands is evaluated on the basis of N factors (such as q is broken down into a number of individual factors: pH, supply with nitrogen, phosphorus, potassium, trace elements, etc.), as a comparison it is necessary to select the parameter $M_{0x_1}, x_2, \ldots, x_N = M_{0N}$, corresponding to the optimum supply for these N factors. The dependence $M/M_{0N} = f'(x_1, x_2, \ldots, x_N)$ does not have a geometrical representation if $N > 2$; for its analytical expression it is necessary to have recourse to the mathematical tool of N-dimensional space.

In this general case it can also be demonstrated that within the limits of the assumption made, when under production conditions not one of the factors drops to a level impairing the normal reaction to other factors (impairing the uniform geometrical similarity of the curves), the function $M/M_{0N} = M/M_{0N}(x_1, x_2, \ldots, x_N)$ can be represented in the form of the product of particular functions for one variable

$$\frac{M}{M_{0N}} = \frac{M}{M_{0x_1}}(x_1)\cdot\frac{M}{M_{0x_2}}(x)\cdot\frac{M}{M_{0x_3}}(x_3)\cdot\ldots\cdot\frac{M}{M_{0x_N}}(x_N) \tag{9}$$

or written more concisely

$$K_{1,\ldots,N} = K_1\cdot K_2\cdot K_3\cdot\ldots K_N. \tag{9'}$$

Since productivity as a function of n factors does not have a geometric representation, it is impossible to give a graphic illustration of the proof of equations (9) and (9').

A proof can be obtained similar to that given above for equation (8), successively examining the joint coefficient of two factors $K_{1,2} = K_1\cdot K_2$ with a coefficient of the third factor K_3, of three factors $K_{1,2,3}$ with the fourth K_4, etc.

$$K_{1,2,3} = K_{1,2}\cdot K_3 = K_1\cdot K_2\cdot K_3;$$
$$K_{1,2,3,4} = K_{1,2,3}\cdot K_4 = K_1\cdot K_2\cdot K_3\cdot K_4 \quad \text{etc.}$$

Thus, the overall problem of expression of productivity as a function of many variables can be divided into individual independent problems of expression of productivity as functions of the individual factors determined with arbitrary values of the other factors.

In order to use equations (8) and (9) for obtaining some idea concerning the productivity M/M_{OBT} as a function of the two variables B and T it is sufficient to have n experiments for determining M = M(B) with arbitrary values of the other factors (in Fig. 3c -- an arbitrary section of the "dome" along the T-axis), that is, a total of 2n experiments. It is easy to confirm that for solution of this problem without equations (8) and (9) it is necessary to carry out n experiments for determining M = M(B) with n temperature levels, that is, n^2 experiments. With an increase in the number of studied factors the use of equation (9) gives still greater advantages.

Equation (9) also simplifies conversion from the determined evaluations of productivity as a function of N production factors to probabilistic evaluations, which in direct computations are unwieldy and are possible on a practical basis only in the case of what are known to be incorrect simplifications [10]. For probabilistic evaluations of productivity in time it is sufficient to obtain long-term series of values of the necessary parameters, to compute the productivity for each year using equation (9) and find the parameters of the distribution of the determined series of M/M_{0N} values, on the basis of which usual procedures are employed in computing the integrals of probabilities.

We will show further how it is possible, using the principles set forth above, on a practical basis to make an evaluation of the productivity of lands using the most important production factors -- heat and moisture supply. It was indicated above that the generalized evaluations of large land parcels commensurable in size with geographic zones should be made using mean annual atmospheric indices of moistening and heat supply [7]. For practical production evaluations in a system for cadastral regionalization and classification of lands the resolution of these indices is inadequate. For these purposes we proposed more detailed indices, on the average characterizing the conditions of the growing season for different crops [7]. The dependence M/M_{0B} = M/M_{0B} (B) (see (8)) is described by equation (6). As the heat supply index we use the parameter T/T_0, where T is the mean air temperature for the growing season, T_0 is the optimum T value for the considered crop. An analysis of data in the literature on the correlation of the productivity of different crops and the temperature of their growing season enabled us to describe the dependence M/M_{0T} = M/M_{0T} (T) by the equation

[OT = OT] $$K_T = \frac{M}{M_{OT}} = 2{,}0\left(\frac{T}{T_0}\right)^{2,0}\cdot\left(1{,}50 - \frac{T}{T_0}\right). \tag{10}$$

Comparing equations (6), (8) and (10), we obtain

[BT = BT; OBT = OBT] $$K_{BT} = \frac{M}{M_{OBT}} = [1-(\gamma-1)^2]\cdot\left[2{,}0\left(\frac{T}{T_0}\right)^{2,0}\cdot\left(1{,}50-\frac{T}{T_0}\right)\right]. \tag{11}$$

As an illustration we will cite the following example. The mean long-term values of the γ and T/T_0 parameters for the meteorological stations Nemchinovka in Moskovskaya Oblast and Shemakha in the Nagorno-Kabardinskaya Autonomous Oblast applicable to winter wheat are equal to the following: γ for the soil layer 0-100 cm -- 0.75 and 0.45; T -- 15 and 19.5°C; T/T_0 -- 0.60 and 0.90.

For the Nemchinovka meteorological station $M/M_{OBT} = M/M_{OB}$ (B)$\cdot M/M_{OT}$ (T) = 0.93 $\cdot$0.65 = 0.60. For the Shemakha meteorological station the corresponding value is 0.70$\cdot$0.97 = 0.68.

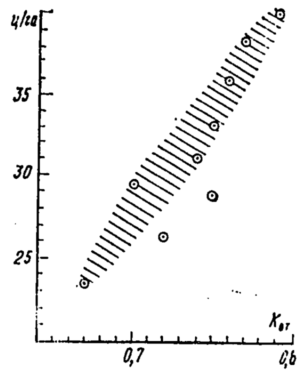

Fig. 4. Correlation between mean (1970-1975) yield of winter wheat and hydrothermal index K_{BT}.

Table 1

Winter Wheat Yield (1970-1975, Mean Rayon Data) and Mean Long-Term Indices of Heat and Moisture Supply of Spring-Summer Growing Season According to Data of Meteorological Stations in Krasnodarskiy Kray

Rayon center, meteorological station	γ	K_B	T°C	T/T_0	K_T	$K_B \cdot K_T$	centners, hectare
Belaya Glina	0.51	0.76	14.0	0.78	0.88	0.67	23.5
Kanevskaya	0.57	0.82	13.5	0.75	0.85	0.70	29.6
Tikhoretsk	0.61	0.85	13.5	0.75	0.85	0.72	26.3
Korenovsk	0.69	0.90	13.7	0.76	0.86	0.77	38.4
Slavyansk-na-Kubani	0.74	0.93	12.9	0.71	0.80	0.74	31.1
Ust'-Labinsk	0.70	0.91	13.9	0.77	0.87	0.79	40.1
Krasnodar (Kruglik)	0.63	0.87	14.1	0.78	0.88	0.76	35.9
Krymsk	0.68	0.90	13.4	0.74	0.84	0.75	33.1
Maykop	0.68	0.90	13.4	0.74	0.84	0.75	28.7

It is evident that an evaluation of productivity using equations (6), (10) and (11) is not comprehensive and complete because it does not take into account the dynamics of moistening and heat supply during the course of the growing season and does not take into account the probability of wintering of winter crops and the possibilities of frosts, the difference in nighttime and daytime temperatures, etc. This does not discredit the proposed principles for evaluating productivity. An evaluation using equations (6), (10) and (11) on the basis of the mean indices of the growing season is more detailed than mean annual evaluations, but is not the last degree of detail: each of the enumerated factors can be taken into account and included in the computations in accordance with equation (9). This requires a clarification of the influence of an individual factor on productivity, as was done by A. I. Korovin, et al. with respect to frosts [3].

We can add to the hydrothermal characteristic of productivity still another characteristic related to illumination (see equation (7)), but it will not have great practical importance because the agricultural zones of the country are adequately supplied with light. This characteristic is of significance in the case of cultivation of crops under a glass cover, when it is necessary to compare the energy expenditures on illumination and the anticipated increment of production. The illumination factor is interesting with respect to the influence of solar activity on the productivity of plants, but the lack of clear criteria of this factor and especially its quantitative correlations with productivity at present does not make possible its use in computations, although equation (9) in principle affords such a possibility.

In order to check the procedures which we have proposed for evaluating productivity on the basis of equation (11), we carried out computations for winter wheat using data from several meteorological stations located in Krasnodarskiy Kray, a rather uniform region favorable for agriculture, and compared these computations with the actual productivity, crop yield.

The results given in Table 1 and in Fig. 4 show that the high yields of winter wheat in the Ust'-Labinskiy Rayon and the relatively low yields in Beloglinskiy Rayon are regular and attributable to the characteristics of moistening and heat supply. One should not expect from the grain farmers in Beloglinskiy Rayon the same production as in Ust'-Labinskiy Rayon. The results also indicate that the yields in Maykopskiy and Tikhoretskiy Rayons are 5-6 centner/hectare below the level governed by their heat and moisture supply. The attainment of this level is possible with an increase in soil fertility and an upgrading of the crop cultivation system.

Summary

1. The productivity of agricultural crops, a target, the criterion of optimality of agricultural production -- can be represented mathematically as a function of many variables, the complex interrelationships between which do not make it possible to represent it in explicit form suitable for specific computations.

2. With a good and satisfactory supply of agricultural crops with growth conditions suitable for production the correlation between productivity and an individual factor is expressed by a family of similar curves, each of which corresponds to a definite level of assurance of other factors.

3. The uniform geometric similarity of the family of curves relating productivity and an individual factor makes it possible to represent them by a generalized function, and the general problem of expressing productivity as a function of many variables can be divided into special problems for individual factors and it is possible to give a quantitative evaluation of the influence of each of them.

4. The cited computations on the principal meteorological factors -- heat and moisture supply -- make it possible to evaluate the actual and potential productivity of crop cultivation in different land use areas at the level of cadastral regions.

The author expresses appreciation to Ye. M. Chirk and D. I. Shashko for consultations and assistance in carrying out this study.

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UDC 551.510.34:551.501.793+551.507.362.1

METHOD FOR MEASURING VERTICAL OZONE DISTRIBUTION BY OPTICAL METHOD ON METEOROLOGICAL ROCKETS

Moscow METEOROLOGIYA I GIDROLOGIYA in Russian No 4, Apr 82 (manuscript received 11 Jun 81) pp 100-105

[Article by N. I. Brezgin, Central Aerological Observatory]

[Abstract] Since 1973 specialists at the Central Aerological Observatory have been carrying out investigations of the vertical distribution of ozone by an optical method using meteorological rockets. Here the author describes the method for computing the vertical distribution of ozone on the basis of observations of the absorption of UV solar radiation. This is accompanied by a comparison of different methods for determining ozone content by the optical method employed by various authors (N. P. Bobkov, (TRUDY IPG, No 23, 1975; H. K. Paetzold, et al., BEITR. PHYS. ATMOSPHARE, Bd 34, Hf. 1/2, 1961; R. G. Roble, et al., PLANET SCI., Vol 20, 1972), as well as investigation of the error in measuring the vertical distribution of ozone by the optical method. The elements and characteristics of the MR-12 and M-100 meteorological rockets most important for evaluating the measurement errors are examined. The statistical tests reported here revealed that the photometers and methods for computing the vertical distribution of ozone developed for the MR-12 and M-100 meteorological rockets in fact make it possible to determine ozone content in the altitude range from 20 to 60 km with an error of 10-30%. The several comparisons of both the optical and electrochemical methods revealed that there was a good quantitative and qualitative agreement of the results of measurement of the vertical distribution of ozone for both the middle and equatorial latitudes. Figures 3, tables 1; references 16: 9 Russian, 7 Western.

UDC 551.513.1

AVAILABLE ATMOSPHERIC POTENTIAL ENERGY AND ITS TRANSFORMATION INTO KINETIC FORM

Moscow METEOROLOGIYA I GIDROLOGIYA in Russian No 4, Apr 82 (manuscript received 14 Aug 81) pp 106-116

[Article by N. Z. Pinus, professor, Central Aerological Observatory]

[Abstract] As early as 1903 M. Margules demonstrated that in principle only some part of the total potential energy can be transformed into kinetic energy; in 1955 E. N. Lorenz pointed out that that part of the total potential energy which only in principle can be transformed into kinetic energy can be called "available potential energy." This is the maximum possible quantity of total potential energy available for transformation into kinetic energy in a considered closed system. It is not only the quantity of heat entering the atmosphere. but also the degree of spatial nonuniformity of heating (or cooling) which is important for the generation of kinetic energy and the maintenance of atmospheric movements of the corresponding (synoptic or larger) scale. This review of the subject is based exclusively on the foreign literature. The following are examined: equation of available potential energy, Dutton-Johnson formula, quantitative evaluations of global available potential energy; budget of available potential energy; generation of available potential energy and its transformation into kinetic energy; budget of available potential energy for an unclosed system in a limited area; quantitative evaluation of generation of available potential energy in middle-latitude cyclones; sources of generation of atmospheric kinetic energy; generation of available and kinetic energy in cyclonic formations and in system of general circulation of atmosphere. A series of tables gives such data as: generation of kinetic energy in cyclones (in developing, mature and occluded stages); generation of kinetic energy in anticyclones. The presented materials make clear the the important role of the energetics of middle-latitude cyclones for the energetics of total circulation of the atmosphere and the complexity of energy transformations. Tables 7; references: 22 Russian.

REVIEW OF MONOGRAPH BY I. V. BUSALAYEV: 'COMPLEX WATER MANAGEMENT SYSTEMS (METHODS FOR HYDROLOGICAL VALIDATION, MODELING AND OPTIMIZATION OF DECISIONS)' (SLOZHNYYE VODOKHOZYAYSTVENNYYE SISTEMY (METODY GIDROLOGICHESKOGO OBOSNOVANIYA, MODELIROVANIYA I OPTIMIZATSII RESHENIY)), ALMA-ATA, "NAUKA," 1980, 230 PAGES

Moscow METEOROLOGIYA I GIDROLOGIYA in Russian No 4, Apr 82 pp 117-119

[Review by G. G. Svanidze, corresponding member, USSR Academy of Sciences]

[Abstract] The reviewed monograph is devoted to the timely problem of construction of water management structures: hydrological validation, modeling and optimization of the parameters of complex water management systems in the basins of major rivers. The author approaches solution of this problem by applicatio[n] of systems analysis and mathematical programming. The first two chapters, on the basis of an analysis of the structure and trends in the development of water management, give a formulation of the methodological principles for the optimum planning of water management systems. A hierarchical system of models taking in all the principal aspects of formation of complex water management systems is proposed. It is said that this is the very first examination of the problem in its full breadth and on a unified methodological basis. The third and fourth chapters examine methods for optimization of the parameters of the water management system in a river basin and also models related to the territorial redistribution of runoff. The fifth and sixth chapters are devoted to the formulation of models of natural conditions, such as local relief and river runoff. Methods and modeling algorithms developed for the most part by the author himself are outlined. The seventh chapter deals with the data support for the adopted decisions.

ACTIVITIES AT USSR STATE COMMITTEE ON HYDROMETEOROLOGY AND ENVIRONMENTAL MONITORING

Moscow METEOROLOGIYA I GIDROLOGIYA in Russian No 4, Apr 82 pp 120-121

[Article by G. K. Veselova]

[Abstract] The Central Methodological Commission on Hydrometeorological Forecasts held a meeting on 9 December 1981 for discussion of reports by representatives of various agencies on the results of testing and adoption of new forecasting methods. The commission approved a method for the short-range forecasting of meteorological conditions for atmospheric contamination developed at the USSR Hydrometeorological Center. Tests have revealed that the probable success of qualitative forecasts for 12-24 hours in advance was 84-87% and for 36 hours in advance -- from 77 to 82%. Details concerning the method are outlined in TRUDY GIDROMETTSENTRA SSSR, No 220, 1980. The commission also approved synoptic-statistical methods for background and detailed forecasts of the mean monthly air temperature anomaly for Western Siberia developed at the West Siberian Scientific Research Institute. The methods are based on joint allowance for various kinds of information on the preceding history of development of atmospheric processes, some characteristics of the underlying surface and solar activity. The background forecast is prepared using correlation curves and characterizes the most probable class of temperature anomalies in Western Siberia. The detailed forecast is computed using multiple regression equations for 15 points in Western Siberia. The fundamentals of the method are published in TRUDY ZSRNIGMI, No 42, 1979. On an interim basis the commission allowed the West Siberian Administration of Hydrometeorology and Environmental Monitoring to make routine use of a physicostatistical method for predicting the mean monthly air temperature anomaly and the monthly precipitation totals during 1982-1983. The method is based on a multiaspect evaluation of the significance of prognostic criteria characterizing the initial state of the atmosphere-ocean-continent system. The principles of this method were published in TRUDY ZSRNIGMI, No 34, 1978. A similar method is also to be tested for the southern part of Western Siberia, but in this case for the months of June-July, rather than April-July. This variant is described in TRUDY ZSRNIGMI, No 31, 1977. The commission also recommended continued (1982-1983) testing of a method for predicting droughts in the European USSR and Kazakhstan. Also discussed and approved was a method for predicting thunderstorms for 12 hours in advance -- a method published in TRUDY GIDROMETTSENTRA SSSR, No 185, 1977.

CONFERENCES, MEETINGS AND SEMINARS

Moscow METEOROLOGIYA I GIDROLOGIYA in Russian No 4, Apr 82 pp 121-123

[Article by G. N. Chichasov]

[Abstract] A conference on "Investigation of Interaction of Meso- and Macroprocesses in the Atmosphere and Application of Statistical Methods in Meteorology" was held at Alma-Ata during the period 20-23 October. A total of 123 reports were presented. Summaries of all the reports were published (TEZISY VSESOYUZNOY KONFERENTSII, Alma-Ata, FOL KazUGKS, 1981, 103 pages). The article cited above summarizes some of the most interesting reports (only a few lines or brief paragraph is devoted to each). Examples of the reports presented are as follows: Ye. M. Dobryshman, et al. -- on macroscale statistical characteristics of the global surface pressure field; Ye. P. Borisenkov, et al. -- on statistical analysis of different schemes for superlong-range forecasts of the air temperature anomaly for the northern hemisphere; V. P. Meleshko -- on the influence of processes in the atmospheric boundary layer on the formation of macroscale climatic characteristics; M. I. Yudin -- on determining the quality of meteorological information and the maximum possible effect of its use; Ye. Ye. Zhukovskiy -- on effective use of forecasts for different times in advance; N. A. Bagrov -- on combining several forecasting methods; A. P. Belyshev -- on methods for correlation and spectral analyses of time series of wind velocity in invariant form; V. Ye. Prival'skiy -- on stochastic models and predictability of macroscale processes in the atmosphere and hydrosphere; L. T. Matveyev -- on the global cloud cover field (statistical analysis and applications); A. A. Girs, et al. -- allowance for persistent trends and probabilistic characteristics and background forecasts; K. Ya. Vinnikov, et al. -- on the monitoring of changes in the global thermal regime of the northern hemisphere for the analysis and prediction of recent climatic changes; V. I. Vorob'yev -- seasonal features of distribution of clouds of different genera in the northern hemisphere on the basis of satellite data; V. V. Penenko -- on applications of methods of the theory of response in weather and climate forecasting; A. S. Ginzburg, et al. -- on numerical modeling of moist convection; V. Z. Kisel'nikova, et al. -- method for numerical hydrodynamic local weather forecasting; S. A. Vladimirov -- on numerical modeling of fronts and their cloud systems; T. P. Kapitanova, et al. -- on energetic and kinematic features of temperate-latitude cyclones; V. I. Ivanov, et al. -- on some types of interaction of processes at different scales in tropical atmosphere; Kh. A. Akhmedzhanov -- on the role of mesometeorological processes in the forming of general circulation of the atmosphere; D. M. Sonechkin -- on development, realization and results of testing of spectral objective analysis of meteorological fields for the northern hemisphere.

NEW SALINITY SCALE AND NEW EQUATION FOR STATE OF SEA WATER

Moscow METEOROLOGIYA I GIDROLOGIYA in Russian No 4, Apr 82 pp 123-125

[Article by O. I. Mamayev]

[Abstract] A group of UNESCO experts in the field of oceanographic tables and standards met at Sidney, British Columbia, during the period 1-5 September 1980 and adopted important recommendations on the introduction of new oceanographic standards: practical salinity scales (1978) and international equation for the state of sea water (1980). Constituting the product of 15 years of work, it was proposed that the recommendations become effective on 1 January 1982. (See TENTH REPORT OF THE JOINT PANEL ON OCEANOGRAPHIC TABLES AND STANDARDS, Sidney, B. C., Canada, 1-5 September 1980, sponsored by UNESCO, ICES, SCOR, IAPSO, UNESCO Technical Papers in Marine Science, No 36, 1981.) Both the official documents resulting from this meeting were published in OKEANOLOGIYA (Oceanology), No 2, 1982. This article summarizes the UNESCO publication. It is noted that numbers 37 and 38 of the TECHNICAL PAPERS will contain the technical documentation and measurement data serving as a basis for the standards. Numbers 39 and 40 will contain Volumes 3 and 4 of the "International Oceanographic Tables," devoted to the conversion of conductivity into salinity and vice versa, as well as computation of the density of sea water and other related parameters, such as the speed of sound, and each section will contain determinations of the functions and the algorithms for their computation, examples of the programs in FORTRAN and concise tables of oceanographic data.

NOTES FROM ABROAD

Moscow METEOROLOGIYA I GIDROLOGIYA in Russian No 4, Apr 82 pp 125-128

[Article by V. A. Znamenskiy and B. I. Silkin]

[Abstract] In 1981 UNESCO issued Volume I of METHODS OF COMPUTATION OF THE WATER BALANCE OF LARGE LAKES AND RESERVOIRS. This manual, briefly reviewed here, describes methods for determining individual balance components, criteria for determining the quantity of precipitation by radars and gives details on computing the quantity of precipitation by indirect methods. Other sections are devoted to the use of data on water masses for computing the balances of chemical and contaminating substances entering water bodies, use of evaporators of different types, turbulent diffusion, water- and heat balance methods. Volume II, prepared by Russian and Canadian specialists, will give the requirements on initial information necessary for the computations, a description of procedures for computing the balance and its components in specific and abstract examples, empirical methods for checking the correctness of computation of water balance elements and methods for using the water balance for evaluating the balance of chemical substances. A special section gives a review of the water balances of lakes and reservoirs prepared using data from 42 countries, all these data being systematized by continents for lakes with areas of more and less than 500 km^2 and for reservoirs.

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It is reported in CLIMATIC CHANGE, Vol 3, 1981, and NEW SCIENTIST, Vol 91, No 1274, 1981, that the researcher N. Rosenburg, a professor at the University of Nebraska, has made interesting studies of the influence of CO_2 accumulating in the atmosphere as a result of human activity on vegetation. It appears that "group C_3" crops, such as rice, oats, wheat, sugar beets and soybeans, are most sensitive to the content of CO_2, which favors a rapid increase in their green mass. Sugar cane, sorghum, corn and millet, in "group C_4," also undergo an activation of photosynthesis processes under the influence of an increase in the quantity of CO_2, but to a lesser degree. The pores in the leaves of "C_4" plants are closed to a greater degree with an increase in CO_2 and this results in a reduction in moisture and gas exchange with the atmosphere and plants in both groups have an increased efficiency in using water. An increase in atmospheric CO_2 content, predicted for the next 50 years, even if it leads to appreciable climatic changes, should exert a direct positive influence on the growth of many plants.

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In NATURE, Vol 291, 1981, and NEW SCIENTIST, Vol 91, No 1262, 1981 it was reported that the Australian geologist G. I. Williams, in studying siltstone and sandstone deposits in the Flinders Range, discovered easily discernable evidence of a periodicity coinciding with solar activity cycles. Since the age of these rocks dates back to the Precambrian, they can be used in judging the course of solar activity and its influence on climate. At that time it appears that the cyclicity of solar activity was the same as now but its influence on meteorological processes was greater than at the present time. A 180-year series indicates that the cycles were repeated on the average each 11.2-11.3 years, whereas the record for the last 203 years indicates that the mean périod between solar minima is 11.1 years and between maxima is an average of 10.9 years. The Flinders deposits also reveal evidence of a 22-year cycle of solar spot-forming activity. During the 22 years the magnetic field first changes its direction and then returns to the initial direction. A 90-year cycle is also reflected in these deposits. It was possible in this way to trace solar activity over the course of 1760 years. A hypothesis was advanced explaining why solar activity exerted such an influence on weather and climate 700 million years ago and why its effect has now greatly diminished. The geological evidence from the Flinders Range indicates that during the last 700 million years solar activity has remained virtually at the same level.

OBITUARY OF RUVIM LEYZEROVICH KAGAN (1928-1981)

Moscow METEOROLOGIYA I GIDROLOGIYA in Russian No 4, Apr 82 p 128

[Article by a group of associates]

[Abstract] Ruvim Leyzerovich Kagan, doctor of physical and mathematical sciences, a leading specialist in the field of statistical meteorology, died on 5 October 1981. Leyzerovich devoted 30 years of his life to the field of meteorology, 25 of them being spent at the Main Geophysical Observatory. His career began as a weatherman in Central Asia in 1951 after his graduation from the Physics Faculty of Leningrad University. After moving to the Main Geophysical Observatory in 1955, he carried out a series of investigations of the influence of stratification on the dynamics of macroscale atmospheric movements, work which led to receipt of his candidate's degree in 1960; his doctoral degree was awarded in 1968 for his investigations in the field of interpretation of meteorological observations. His monograph STATISTICHESKIYE METODY INTERPRETATSII METEOROLOGICHESKIKH DANNYKH (Statistical Methods for the Interpretation of Meteorological Data) was published in 1976. His fundamental studies in the field of the stochastic theory of averaging were generalized in the monograph OSREDNENIYE METEOROLOGICHESKIKH POLEY (Averaging of Meteorological Fields), the only monograph ever published on this subject. The author of more than 150 scientific studies, he made significant contributions in the development of the method for the climatological processing of data and the development of methods for computing climatic characteristics for the purposes of monitoring climate and solving practical problems.

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