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V. N. KARAZIN, EMINENT RUSSIAN METEOROLOGIST

M. I. Budyko

The incompleteness of research in the history of our native meteorology sometimes leads one to the incorrect conclusion that from the death of M. V. Lomonosov up to the establishment of the work of the Main Physical Observatory there were no great meteorologists in Russia.

The complete inaccuracy of such a notion becomes apparent upon acquaintance with the notable meteorological works of Vasiliy Nazarovich Karazin (1773 - 1842), who, one must believe, is not the only forgotten or inadequately appreciated Russian meteorologist of the end of the eighteenth and first half of the nineteenth century.

In contemporary works on our native meteorology only one (the first) of V. N. Karazin's meteorological works is mentioned. To it a few lines are usually allotted, which do not reveal its enormous significance for the history of Russian meteorology and are not free from factual inaccuracies. No indication of Karazin's other extremely important meteorological investigations is found in these works, nor is any mention made of Karazin's years-long struggle with the stagnancy of the government circles of that time for the creation of a network of meteorological stations and central meteorological institutes in Russia.

V. N. Karazin was rather well known as a social worker in the beginning of the nineteenth century. Although his political opinions were inconsistent and did not in general go beyond the bounds of moderate aristocratic liberalism, Karazin came forth more than once with what were for his time extremely courageous criticisms of the many reactionary aspects of the serfdom system and thus provoked a whole series of repressions on the part of the government. During the whole latter half of his life he systematically exposed himself to arrest and exile. He spent several years in banishment on his own estate and in 1820, being suspected of inciting an insurrection of the Semenovskiy regiment, he spent nearly six months imprisoned in Shlissel'burg fortress. For the last twenty years and more of his life Karazin was forbidden entry to Petersburg.

Karazin's contributions toward enlightenment are deserving of mention; on his initiative, in particular, the first university in the south of Russia was founded (in Khar'kov, 1805). Karazin's services in the creation of the university were subsequently recognized by the erection of a monument to him near the university building.

It is also fitting to mention Karazin's organization of instructive societies in the Ukraine, in particular a philotechnical society established for the improvement of scientific methods of agriculture and industry in the Ukraine. The activity of this society had to some degree a democratic character; its meetings were sometimes attended by peasants, which was very unusual for that time.

Karazin's scientific activities developed for the most part after 1804, when he retired and moved to his estate in the

Ukraine, where he established a meteorological station, laboratory and experimental field. Karazin's scientific interests were extraordinarily versatile. Not touching upon his works in the field of the humanities, one may indicate Karazin's research into such diverse subjects as meteorology, chemistry, geography, agronomy, processing of agricultural products, forestry, and various fields of technics. All these works of Karazin were characterized by a distinctly marked applied direction and an immediate relation to the working out of one or another practical problem -- "pure" science little interested Karazin. The great significance Karazin attached to the close connection of theoretical research with the solution of practical problems is evident in his words: "Not so much theories, but rather their successful application in practice, makes an epoch in the history of people and of science."

The first result of Karazin's scientific work in the field of meteorology was a small but extraordinarily comprehensive paper, delivered on 15 March 1810, to a Moscow society of naturalists. (First printed in French in Khar'kov, 1812. First translated in "Syn Otechestva", 1817, No XLIX. For citations below of this and subsequent works, see V. N. Karazin: Works, Letters and Papers. Khar'kov, 1910.)

In this paper a whole series of considerations which are of enormous interest for the history of our native meteorology were presented.

Let us note, first of all, that in his speech Karazin indicated the possibility of human knowledge of the causes of atmospheric processes, declaring that "it cannot be that the causes of the changes in our atmosphere are hidden". This attitude is, at first glance, at variance with the division set forth by Karazin in another part of the paper of the causes of atmospheric processes into "first causes", of divine origin, and "secondary causes", knowable by man. This is, however, only a seeming contradiction. Such a division, which was in common usage in the works of the 18th century French materialists, was often used as a guard against the charge, very dangerous at that time, of atheism. That Karazin, although he resorted in this case to the stipulation of "first causes", in fact completely denied the possibility of the influence of unknowable "divine" factors in the changes of the weather, is distinctly proven in the discussion of his second meteorological work, which will be mentioned below.

Karazin further expressed the conviction that, foreseeing the development of atmospheric processes, man might "come to know methods of directing them to his own use and of averting the damage they might do." This attitude is directly related to the thoughts Karazin expressed concerning the enormous future practical significance of meteorology:

"There is no need for me...," wrote Karazin, "to prove the usefulness meteorology would have were it brought into regulation. The science which, guiding the farmer in his labors, would ward off the failure of his crops, the science which so evidently would promote the development of commerce, navigation and the art of war; the science which, finally, would have the power to indicate the time when one must expect meagre harvests of the earth's vegetation and take measures, if not for the prevention of their insufficiency, then at least for the aversion of famine -- such a science demands no wordy praise". These considerations of Karazin's had become essentially forgotten by the time of M. V. Lomonosov's brilliant thoughts on this question.

However, Karazin clearly understood that the level of the meteorology of his time was completely inadequate for the solution of the existing important practical problems. The general evaluation of the state of meteorology in the beginning of the 19th century which he gives in the introductory part of the paper reads: "In spite of the rapid progress of the natural sciences in our century, one of the divisions of physics remains to this day in almost the same form as it had in the days of the aristotelians. This is meteorology. True, many studies have been concerned with it... But up to now there is not one work on this subject from which one might derive positive and direct benefit."

In connection with this, Karazin formulated the chief aim of his paper as follows. In order that meteorology might rise to the position of a science of practical value and "might attain... to the degree of an exact science, certain procedures are necessary; the designation of these constitutes the chief subject of my present notes". After that Karazin indicated the only path possible in that time toward the transformation of meteorology into a genuine science -- the creation of a network of meteorological stations making systematic observations over extensive territories, and the study of the materials of these observations.

Karazin expressed these considerations in the following manner: "It is essential...to unite our forces. All partial observations, even if they are made by the most scientific and tireless people, will lead to no results whatever; they will only, perhaps, increase the mass of our knowledge by a few enlightened ideas, awaken our curiosity and cause our imaginations to construct various witty hypotheses, but they will not give us data for the derivation of exact rules.

"In astronomy we are already benefitting from constant and timely observations. May one not wish that just such observations might be the lot of meteorology as well? And what country...presents so many resources for that as our fatherland?

"The expanse of Russia, occupying nearly a sixth of the entire inhabited surface of the globe, with district colleges located at its various points, from Kola to Tiflis and from Libava to Nizhnekamchatsk, the subordination of these colleges to one authority and the responsibility that they should have physical instruments at their disposal -- all this promises happy results for constantly and judiciously produced observations".

It is interesting to note that this last thought of Karazin's -- concerning the particular advantages of Russia for extensive meteorological research -- was repeated many years later by A. I. Voyeykov in a well-known passage of "Climates of the Globe".

Then Karazin gave a series of deliberations concerning principles of organization of the work of a network of meteorological stations, pointing out that these observations must eliminate "the disconnectedness, scantiness and inaccuracy" of the then existing materials of observation. For this purpose Karazin considered it essential to effect the standardization of observational tables ("observational tables everywhere uniformly compiled") and to carry out a systematic inspection of the network. Karazin proposed to centralize the scientific processing and study of the materials of observation, creating for this purpose an appointed "Society of Scientists". This proposition, which took more definite form after Karazin's time, was apparently the first thought of the creation of a meteorological scientific-research institute in Russia.

In his paper Karazin also made several remarks concerning possible ways to develop scientific meteorology through the use of the materials of meteorological network observations. Some of these remarks which are worthy of mention are the considerations of the necessity for comparing the directions of the wind and the weights of the air (i.e., pressures) at various times of the year and various points of the globe, of the necessity for comparing the periodic with the non-periodic changes of weather, of the possibility of calculating the action of the sun's rays, of the possibility of using "local indications" based on folk signs, in addition to conformities to physical laws, in the forecasting of weather.

Karazin believed that on the basis of such research "we shall arrive at a theory which is not subject to doubt, which will offer us the possibility of predicting the weather at a given time of year and for the whole year in advance in a given place".

Certain of the deliberations expressed by Karazin in his 1810 paper subsequently received further development in his later utterances. Of very great interest, in particular, is the elaboration of Karazin's idea of "the possibility of directing atmospheric processes for human benefit" in his letter of 9 April 1814 to Count Arakcheyev, where Karazin wrote: "will man someday attain to the possibility of arranging, at least to some extent, the state of the atmosphere, of bringing forth rain and fine weather at will? You are so enlightened, dear sir, that you will not begin to laugh at a suggestion so impudent as this... The limits of the sciences, and especially of natural science, may by no means be defined. Human reason moves continuously forward, in spite of all obstacles". (V. N. Karazin. Works, Letters and Papers. Khar'kov, 1910.)

Karazin's naive assumption of Count Arakcheyev's "enlightenment" was not justified -- Arakcheyev did subsequently deride Karazin's ideas about the possibility of artificial alteration of the weather. (Biographies of Karazin mention Arakcheyev's mocking reply to the petition of the peasants of his Ukrainian estate for help in connection with a drought and crop failure: "It is strange that you are starving when at your side lives a sorcerer who calls down rain and thunder from the heavens when he wishes -- address yourselves to him".) This letter of Karazin's remains, however, an extraordinarily valuable document in the history of our native meteorology, as the first statement of the possibility of active human influence upon atmospheric processes.

Another important thought in Karazin's paper -- concerning the creation of a central scientific meteorological institute in Russia -- took on a more distinct form in his notes of 1818 "On the Possibility of Applying the Electric Power of the Upper Layers of the Atmosphere to Human Needs". In these notes (which will be discussed in more detail below) Karazin wrote of the necessity "to provide scientific and educational institutions...with uniform meteoscopic instruments...and in them teachers or supervisors... given the responsibility of making observations according to rules handed down to them and acting in subordination in this capacity to such a scientific group as might be called "The State Meteorological Committee".

In the same notes the idea of the desirability of organizing network observations of high-altitude atmospheric electricity with the aid of captive balloons was expressed. This was one of the first proposals that network aerological observations should be made.

For a correct evaluation of the real significance of Karazin's ideas concerning ways of creating a scientific meteorology it should be mentioned that in the 1810's in not a single country did a network of meteorological stations exist, and in the past there had been only separate and comparatively transitory attempts at organization of network meteorological observations, which, as it seemed to many representatives of the official science of the time, gave no results whatever (see the opinion of the academician Fuss on Karazin's 1818 notes). Similarly, in not a single country were there any meteorological institutes in those years, and the very idea of creating such an institute for the development of methods of weather forecasting would have seemed extremely audacious.

Also considerably ahead of his time were many of Karazin's deliberations on the possible directions of meteorological research and on the practical significance of "meteorology, brought into regulation".

Beginning in 1810 and up to the end of his life, that is through the course of more than thirty years, Karazin persistently strove for the realization of his meteorological projects, repeatedly turning for this purpose to Alexander I and various influential persons of that time, but all his efforts in this connection proved to be futile. In this case the stagnation of the governmental circles evidently united with the government's unfriendly attitude toward Karazin, who systematically exposed himself to repressions for political reasons. All this, certainly, made Karazin's mission extraordinarily difficult.

The single instance known to us of scientific discussion of Karazin's meteorological projects dates from 1818 when the academician Fuss was commissioned by Alexander I to examine their content. In relation to the scheme for the creation of a network of meteorological stations and a State Meteorological Committee Fuss declared that meteorology, very likely, never would attain to the status of a science, in consequence of which Karazin's scheme appeared to be useless. This conclusion, characteristic of the scornful and hostile attitude of the "German party" in the Academy toward Russian scientists, was approved by a conference of the Academy of Sciences.

On 27 July 1840 Karazin wrote bitterly to Count Benkendorf that the idea he had expressed 30 years before concerning the organization of meteorological stations in Russia "...was considered suspect, concealing some evil political intent. They rejected it, you know, and gave me not even a word in answer. In return for that urgent paper...they made the academicians write a sort of mockery unworthy of me". In this same year Karazin learned from Kupfer of the preparations which were underway for the organization of a meteorological service and was able to write to Benkendorf (23 October 1840), alluding to Kupfer's communication: "My scheme was no folly, for now it is being carried out...".

However, Karazin did not manage to live until the opening of the Main Geophysical Observatory and the network of stations in Russia -- he died in 1842, seven years before the realization of his ideas.

The second of Karazin's works, which is devoted to a considerable degree to meteorological questions -- "On the Importance of Forestry, Especially for Russia", printed in 1817 -- presents very great interest. ("Vestnik Evropy", ch. XCV, 1817. This article was printed simultaneously in "Dukh zhurnalov", in "Syn Otechestva" and in "Kazanskiye izvestiya".)

This work is one of the first attempts in world literature at scientific analysis of the influence of forests on climate, undertaken in order to establish the possibility of melioration of the climate through forestry measures.

Side by side with certain thoughts which are erroneous from a modern point of view, Karazin's deliberations on the possible forms of influence of forests on climate include a whole series of postulates which have been completely confirmed by the subsequent evolution of science. To this group of postulates belongs, first of all, the idea of the direct effect of forests on the transformation of air masses ("forests are directly blown away by shifts in the air, and in turn produce them"). Karazin's beliefs that the forests "by their exhalations moderate the temperature of the air", feed the sources of rivers and store up moisture in the soil, lessening the effect of the "earth-parching winds" are altogether correct. Similarly correct are the ideas that the influence of forests retards the melting of snow and allays flooding, and that the planting of forests on riverbanks reduces erosion.

This article of Karazin's concludes with a sharp protest against Buffon's hypothesis attributing climatic variation to the cooling-off of the globe, followed by an appeal for conservation of the remaining forests in the south of Russia and for the cultivation of forest plantings.

In Karazin's later appearances in print he continued to propagandize the idea of forest cultivation in the southern rayons of Russia; on his own estate he created a system of field-protective forest belts. However, it is altogether understandable that under the conditions prevailing in the Russia of the beginning of the 19th century, Karazin's initiative could have no great practical consequences.

Soon after the publication of Karazin's article, an anonymous author printed a critique (it was called "A Letter from Saint Petersburg to the Author of the Discourse on the Importance of Forestry, Especially for Russia"), in which he sharply polemized against Karazin and argued that, in the first place, it was impossible to struggle against the annihilation of the forests, since their destruction was an inevitable consequence of the growth of population and, in the second place, that the changes in climate which were being observed in that time were not connected with the effect of the felling of forests, but were of supernatural origin and presaged the approach of the end of the world. In witness to the correctness of the latter idea, the critic cited from the Gospel according to Matthew.

The anonymous critic's objection was undoubtedly characteristic of the weltanschauung of a considerable segment of the ruling circles of that time, in which extreme reactionism of political views was combined with mysticism and a sharply hostile attitude toward the development of the natural sciences. It may be mentioned that in approximately these same years governmental policy in the sphere of education, which was manifesting itself in the activities of the famous obscurantists Runich and Magnitskiy, led to the actual crushing of a series of Russian universities. The more noteworthy, therefore, is the courage with which Karazin answered this critic, refuting his objections.

In his replicatory note (V. Karazin's Answer to his Critic, <u>Ukrainskiy vestnik</u>, 1818) Karazin disagreed with the opinion concerning the inevitability of the annihilation of the forests, and then declared, with respect to people who consider anomalous weather phenomena as supernatural and portentous of the approach of the end of the world, as follows: "...A panic fear, which they themselves spread,... a wet summer in one place, a dry in another, some not altogether usual phenomena of nature, some too late or too early frosts seem to them the most sufficient omens. Dear sirs!" Karazin further exclaimed, "please remove yourselves a little way from the present time and that of our fathers and look into history. Was it so?"

Then Karazin enumerated a series of unusual floods, droughts, frosts and earthquakes which had been mentioned in chronicles and other historical sources, and concluded: "Read, dear sirs, read history and compose yourselves!"

This debate, apart from the interest which it presents as an illumination of the conditions in which Karazin had to propagandize his meteorological ideas, also has some significance as an additional proof that Karazin disclaimed the possibility of explaining not only the usual changes of weather, but also anomalous and extremely rare elemental phenomena, in terms of supernatural causes.

In the year following the publication of the work "On the Importance of Forestry" Karazin composed the notes "On the Possibility of Applying the Electric Power of the Upper Layers of the Atmosphere" (first printed in "Russkaya Starina", 1873), already cited above.

In relation to this work it may be mentioned that, in spite of the fact that some of its statements prove to be erroneous from the modern point of view, many of the ideas contained in it present considerable interest for the history of science. The idea, extraordinarily daring for the beginning of the 19th century, of the possibility of practical utilization of atmospheric electrical energy, draws especial attention. Although, as we know, the invention of the dynamo made it possible later on to find other convenient ways of obtaining large quantities of electrical energy, it is nonetheless necessary to note that Karazin's idea proved to be correct and that at the present time there are installations which utilize discharges of atmospheric electricity for applied purposes.

Considerably less interest, in comparison with the three articles of Karazin's which have been enumerated, is presented by three small articles on meteorology which he wrote in later years: "Something Pertaining to Meteorology" ("Syn Otechestva", ch. CXVIII, 1829), "On the Probable Cause of the General Change of Temperature" (Zhurnal ministerstva narodnovo prosveshchenia", ch. XVI, 1837), and "Information Concerning Weather Presages" (Khar'kovskiye gubernskiye vedomosti", No 12, 1839).

The establishment of the network of meteorological stations and the central scientific meteorological institute in Russia in the middle of the 19th century, which served as an example for other countries of the world, was considerably facilitated by Karazin's many-years' propaganda of his meteorological ideas. The rapid development of scientific meteorology in the second half of the 19th century, which is connected in the closest way with the accumulation of the material of systematic network observations, is therefore much indebted to the service of the eminent Russian meteorologist, V. N. Karazin.

ON THE SUBJECT AND AIMS OF AGRICULTURAL METEOROLOGY

M. S. Kulik

The dense network of meteorological and agrometeorological stations and observatories organized in the Soviet Union were strengthened yearly with properly qualified cadres and were equipped with instruments and means of communication. This made it possible to start as early as 1922 the first systematic operative agrometeorological service to agriculture in history. Agrometeorologists were presented with the opportunity of conducting series of profound research projects, on which basis works which have received high appreciation were created.

The results of this research became a scientific basis for the practical action of operative workers, and the results of the regular mass agrometeorological observations became the rich source of materials for scientific generalization which we have available today.

However, the achievements of agricultural meteorology represent only a small part of that which a planned socialist agriculture demands of it.

One of the causes of the failure of agricultural meteorology to keep abreast of the growing demands of agriculture is the underestimation on the part of agrometeorologists of the importance of certain theoretical problems without whose solution the normal course of development of agricultural meteorology is hampered.

"...theory becomes aimless if it is out of touch with revolutionary practice, precisely as practice becomes blind if it does not illuminate its path with revolutionary theory", I. V. Stalin teaches. (I.V. Stalin. Works, vol. 6, pages 88 - 89.) Among us, the agrometeorologists, however, as a result of the fact that the working out of theoretical problems is not always properly appreciated, there hitherto exists no generally accepted opinion concerning either the degree of independence of agricultural meteorology, or the object of its research, or methods of research. This in turn hampers the solution of its practical problems. All this, naturally, serves as an obstacle to the practical activity of agrometeorologists, especially in the planning of scientific-research works and measures guaranteeing the improvement of the agrometeorological service, in the designing of educational programs, textbooks, etc. Nothing regarding this has been published either in the journals or in the scientific transactions of the institutions of the hydrometeorological service, if one does not count F. F. Davitaya's article, "The Direction and Methods of Soviet Agrometeorology". But even it elicited no response in the published pages of the hydrometeorological service, although "it is generally accepted that no science can develop and succeed without a struggle of opinions, without free criticism". (I. V. Stalin. "Concerning Marxism in Linguistics." Gospolitizdat, 1950, page 28.)

Regarding the questions of the degree of independence of agricultural meteorology, of the objective of its research and its general practical aims, it seems to me appropriate to mention a series of well-known postulates.

The aim of every science is knowledge of the conformities to law of phenomena and processes related to the subject being studied, knowledge of their interconnections and historical dependency. Only the revelation of the laws which define the interconnection of phenomena offers practical possibility of guiding their processes of change in the desired direction.

It has been demonstrated that the aim of science consists not so much in the fixing of facts and their description as in the revelation of conformities to law, and we agrometeorologists are far from always taking this into account.

On the basis of study of the forms of motion of matter Engels worked out principles of classification of the sciences, according to which each of the sciences "analyze a separate form of motion or a series of motions which are interrelated among themselves and are transformed into one another". (F. Engels. The Dialectics of Nature. 1948, page 200.) In nature transformations of the forms of motion into one another take place, and there exist relationships and distinctions among them. From this proceed the relationships and distinctions among the separate sciences.

It follows that the criterion for the independence of a science is the presence of its own research objective, qualitatively distinct from the research objectives of other sciences.

Each science, according to the qualitative peculiarity of its subject, works out distinct procedures and practices of research, different from those which are accepted in the other sciences. All these procedures for the investigation of natural phenomena must always originate in the fundamental postulates of Marxist dialectical method.

In spite of these well-known postulates, the following definition is given in textbooks of agricultural meteorology: "Agricultural meteorology is the science which studies the influence of hydrometeorological conditions on the growth, development and production of agricultural plants and animals". (A. V. Fedorov, Agricultural Hydrometeorology, 1936.)

F. F. Davitaya, for all the comprehensiveness of his theoretical treatment, as a matter of fact repeats this same definition. He writes: "The foundation of agricultural biology should be the study of the needs of cultivated plants in a determined climate". (In the journal Agrobiologiya, No 3, 1948.) The difference from the foregoing definition consists in the exclusion of animals.

All these definitions, which formulate one of the five chief aims which P. I. Brounov advanced for agricultural meteorology, are one-sided and therefore false. They are oriented to the study of only one aspect of a phenomenon, disregarding its interconnection with other phenomena and their influence upon it; they do not include questions of evolution in research, etc. The soil, as we know, is the basic medium of agricultural production. Nowhere, however, is there given the definition that soil science is the science which studies the influence of the soil on the growth, development and composition of agricultural crops, etc.

Comrade Stalin, answering D. Belkin and S. Furer, emphasized what confusion comes into being if a man does not make clear to himself what subject is in question, if he is substituting one subject for another.

The indicated definitions leave unclear just what the proper object of investigation in agricultural meteorology is: meteorological conditions, plants, or both. Without a clear definition of its subject of research, it is impossible clearly to define its aims.

Thus the question is raised: just what is the subject of the study of agricultural meteorology?

Ecology, which studies the interrelationships between organisms and their environment, represents only one of the divisions of biology, and agricultural meteorology, within the definition which has been ascribed to it, represents only one of the divisions of ecology. T. D. Lysenko points out that agrobiology is the foundation of agronomy -- a science which has to do with living things: with plants, with animals and with microorganisms. This is why knowledge of conformities to biological law enters the theoretical foundation of agronomy. The basic aim of agrobiology is the revelation of conformities to law in the interrelationships of organisms with the conditions of their external environment. In general, for all the divisions of agrobiological science, knowledge of the requirements of plant organisms and of their reactions to the influences of the conditions of the external environment is essential.

Hence it is clear that one of the chief aims of agrobiology must be considered to be the study of the influence of the external environment upon plant organisms. The definition of agricultural meteorology which is given in the textbooks includes problems which are solved by agrobiology, but it does not make reference to the problems which of all the sciences only agricultural meteorology solves, as a science which has research objectives which are qualitatively distinct from the research objectives of the other sciences (which studies, in other words, something which other sciences do not study). It is just these specific problems which belong to it that have compelled recognition of the necessity for its independent existence, which has been approved in practice.

Agricultural meteorology answers questions of important significance in human activity which other sciences do not answer. To know the degree of favorability of the meteorological conditions in discrete geographical regions for agricultural cultivation, to study the changes in these conditions under the influence of communal toil -- this is the duty of agrometeorology. Therefore, <u>agricultural meteorology must study meteorological and climatic factors as conditions of the existence of agricultural objectives</u>. Weather and climate represent a unity and are characterized by complex interrelationships, motions and developments. However, in weather and climate there exists a combination of components which are "conditions of existence" for one or another group of objects of agricultural production, and also others which prove to be inessential in this connection. Agricultural meteorology therefore studies only the first of these.

The principal difference between the "medium of habitation" and the "conditions of existence", which we call, in speaking of climatic factors, agrometeorological conditions, was first established by Academician Lysenko.

Lysenko's theory of the phasic development of plants made it possible to concretize and enrich the content of the concept of "conditions of existence".

Academician Lysenko demonstrated that the "conditions of existence" of a development process must be distinguished both from the "medium of habitation" and from the external "influence factors". Not everything in the "medium of habitation" is a factor actively influencing the organism's course of development. Not every "influence factor" is a "condition of existence" of the organism's development.

"The conditions of existence of a plant's development cycle are those essential conditions without which the stages of development, their organs and indications of the plant's progress toward reproduction, do not exist". (D. T. Lysenko, Agrobiology, page 77.)

For example, light does not prove to be a necessary condition for a plant's passage through the first stage of development. As for the second (light) stage, an appropriate illumination (specific for each variety and species of plant) is a condition essential for its existence.

The determination of combinations of weather phenomena which will carry known biological consequences demands knowledge of the requirements of plants and animals in the determined meteorological conditions and of their reactions to changes in these conditions. As a basis for this knowledge agrometeorologists draw upon the agrobiological sciences. However, in studying its subject, agricultural meteorology not only depends upon agrobiology and meteorology, but enriches these sciences in its turn. This confirms the well-known postulate that neighboring sciences always supplement one another.

Thus, the basic aims of agricultural meteorology prove to be:

1. Knowledge of the degrees of favorability of the agrometeorological conditions in discrete geographical regions for agricultural crops.

2. Determination of the changes in agrometeorological conditions which arise as an effect of agrotechnical measures.

3. Calculation on an agrometeorological basis of differentiated applications of agrotechnical measures directed toward more rational utilization of the agroclimatic peculiarities of discrete geographical regions and toward effective struggle against weather phenomena harmful to agriculture.

4. Division of the territories of the USSR into districts according to indications of agroclimatic peculiarities suitable for specific agricultural crops.

5. Improvement of the methods of agrometeorological research.

In conformance with these aims it is necessary to work out organizational measures which will guarantee their realization, but this belongs to a separate consideration.

OCEANOGRAPHIC OPERATIONS IN THE USSR DURING THE LAST THIRTY YEARS

V. A. Lednev and L. F. Rudovits

Oceanographic research by Russian seamen was initiated at the beginning of the 19th century, at the time of the first round-the-world voyages, and after that oceanographic and meteorological observations were made on all more or less considerable ocean voyages. Outstanding results in the study of the hydrology of the oceans of the world were achieved by Admiral S. O. Makarov at the time of his round-the-world voyage in the corvette "Vityaz'" in the years 1886-1889. Almost simultaneously with Makarov's works, detailed studies of our native seas were begun. Thus, in 1890-1891 the Russian Geographical Society, in conjunction with the Navy Department, under the direction of I. B. Spindler, conducted deep-sea studies of the Black Sea and the Sea of Azov. At the end of the 19th and beginning of the 20th centuries the Murmansk science-commerce expedition under the direction of N. M. Knipovich initiated studies of the northern seas. In addition, recognition for oceanographic studies was given to work conducted by the Main Hydrographic Administration of the VMF in European, northern and far-eastern seas.

However, the data obtained up to the time of the Great October Socialist Revolution on the character of the seas and oceans could not satisfy all the growing demands of the national economy. Therefore, in the study of the seas which wash the shores of the Soviet Union, an exceptional place is occupied by the period beginning after the October revolution. Precisely in this period, for the most part, the works which for the first time gave a general characterization of the oceanography of the seas of our Native Land and allowed a first approach to study of the physical and chemical processes which take place in these waters were accomplished.

A radical change in oceanographic studies occurred immediately upon the conclusion of the civil war. On 16 March 1921 a decree was issued under the signature of V. I. Lenin for the establishment of a Floating Marine Science Institute whose task it was to enter upon a thorough and systematic study of the northern seas, their islands and shores. This institute was changed to the State Oceanographic Institute and then (in 1933) to the All-Union Science-Research Institute of the Fish Industry and Oceanography.

Parallel with Plavmornino [the Floating Marine Science Institute] there developed new marine research establishments with various applied-scientific tasks (the Institute for Study of the North, later the Arctic Institute, and the Marine Division of the Hydrological Institute). During this same period local science-research establishments were organized on the seas [coasts]: marine observatories of the VMF, marine institutes and observatories of the hydrometeorological service (gidrometsluzhba), institutes and stations of the fish industry, the hydrophysical station in Katsivel', etc. In the center [inland] during the last decade new oceanographic establishments have arisen: the State Oceanographic Institute of the GMS, the Marine Hydrophysical Institute and the Oceanology Institute of the Academy of Sciences USSR.

All the establishments named have carried on oceanographic studies of the seas of the USSR, the greatest attention being directed toward the northern seas and the Caspian Sea. Large-scale research works have been accomplished on the Barents Sea, on which nearly 500 voyages were made, more than 100 of which fell to the steamer "Persia", the first ship constructed by the soviet authority for such works. On the whole during these voyages over 25,000 hydrological stations were created, which gives one an idea of the scale of the expeditionary work of this period.

Within thirty years studies exceptional for their scientific understanding and innovation of thought were organized and carried out in the central Arctic Ocean, on drifting ice floes and on the iceboat "Sedov". As is known, the ice floe where the hydrometeorological station "North Pole" was organized drifted in the course of 274 days from the pole into the Greenland Sea to a latitude of 70 degrees 47 minutes north, and the vessel "Sedov" drifted in the course of 812 days from the Novosibirsk Islands almost to the outlet of the Greenland Sea. Both these expeditions conducted uninterrupted meteorological, oceanographic and other geophysical observations. In particular, reliable data were obtained on the great depths of the Polar Basin (up to 5000 meters) and on the distribution of hydrological elements within it. The accumulated material allowed light to be thrown with great accuracy upon the hydrometeorological peculiarities of the ocean, including the life-span of the ice masses. Extremely valuable data were collected by the high-latitude oceanographic expedition on the l/p [submarine?] "Sadko" and on the vessels which were accomplishing through navigation of the Northern waterway route, and similarly, in their time, by flights over the arctic waters.

It is interesting to note that in 1932 the GOIN's little expeditionary motor-sailboat "N. Knipovich" accomplished the first rounding of Franz Josef Land, conducting a succession of oceanographic works all the way. Beginning in 1923, oceanographic works of considerable detail were carried on on the White Sea and, somewhat later, on the Greenland Sea. All the ample material collected gave valuable information for navigation and the fish industry and for the solution of many problems of marine meteorology and oceanography.

In connection with the development of the fishing industry in the northern and central parts of the Caspian Sea, thorough oceanographic research and detailed studies of the water balance and fluctuation of the water level were carried on. The latter studies made it possible to ascertain the causes which give rise to the abrupt and considerable changes in this level.

Relatively less attention was paid to study of the oceanographic conditions of the open Baltic Sea, the work on this sea being adapted on the whole to the Gulf of Finland.

On the Black Sea and the Sea of Azov, beginning in 1923, research was conducted by four organizations: the Hydrographic Administration, the Sevastopol' Biological Station, the Azov-Black Sea Institute of the Fishing Industry and the Hydrometeorological Service (Gidrometsluzhba). These data completed and substantially amplified the representations of the characteristics of these seas which had been constructed on the basis of the work of the 1890-1891 expedition.

Oceanographic research began on the seas of the Far East immediately after the expulsion of the foreign usurpers from the Russian soil. Taking part in the research in the first years were the Hydrographic Service, the Hydrometeorological Service, represented by the Marine Division of the Hydrological Institute, and the Pacific Ocean Institute of the fishing industry. The oceanographic work encompassed the Japan, Okhotsk and Bering Seas. The materials on the Okhotsk and Bering Seas were especially valuable, since up to the time of the Great October Socialist Revolution information concerning them had been unusually scarce.

As a result of the oceanographic research which has been conducted, Soviet oceanographers have at their disposal materials which allow them to answer a series of questions concerning the characteristics of the open regions of the home seas.

For a more profound knowledge of the characteristics of the home seas and of the processes which go on within and upon them, study was begun of the characteristics of the adjoining oceans. Necessity for this study was also dictated by the demands of the fishing and whaling industries, of navigation and of the weather service. In the most recent times oceanographic and meteorological investigations have been undertaken for this purpose in the northern Atlantic ocean, on the principal maritime passages from Europe to the Far East seas and in the Atlantic sector of the antarctic waters. Thus the work in the Antarctic begun 125 years ago by the famous Russian seamen on the sloops "Mirnyy" and "Vostok" has been continued.

Apart from episodic expeditionary oceanographic research, regular observations of specific sections have been carried on from year to year on almost all the seas. These observations have had the purpose of determining the changes in oceanographic characteristics in the course of a year and through a succession of years. However, the maintenance of the projected program of standard sections did not everywhere succeed. The most continuous and regular observations were made along the Kola [?] meridian, starting at the very beginning of the 20th century, in accordance with the resolution of the International Council for Study of the Northern Seas.

Together with the development of expeditionary, principally complex, oceanographic research, a network of marine hydrological stations was vigorously developed. At the beginning of the first imperialistic [World] war (1914-1918) there existed a few more than 100 stations on our seacoasts. In the years of the civil war and the foreign intervention their number shrank to a few tens. After the organization of the Hydrometeorological Service the network of marine stations quickly began to be reestablished, the number of stations at the present time having reached 450 on shore and over 300 on ships. The robust development of the network of stations and posts in the Soviet sector of the Arctic should be especially stressed. Stations are today located at such high latitudes as could not have been dreamed of 30 years ago.

Simultaneously with the increase of the number of stations, the volume of work was also expanded as a result of the conducting of radio-sounding and pilot-balloon observations, detailed observations of ice and visibility conditions, etc., and also extension of the periods of observation (night observations).

In the beginning oceanographic research had as its object the collection of materials for knowledge of the system and constitution of the general characteristic of USSR seas. Later on it was directed toward the creation of practical hydrometeorological manuals on these seas. This trend in marine research was demanded by the national economy and by national defense, which were in acute need of descriptions of the seas and handbooks of information on them. A distinguishing feature of all the research which had been conducted proved to be its tendency to promote the successful development of various branches of the national economy.

The volume of oceanographic research, which was small in the first period (1921-1929), increased extraordinarily after 1930 and by 1934-35 had reached extremely large proportions. Parallel with this, beginning in 1931, extremely voluminous work was carried on in the compilation of the Marine Cadastral Survey. Thanks to the broad development of oceanographic research and cadastral works, a general idea of the fundamental characteristics of the USSR's seas was obtained by the end of the prewar period, thus creating a scientific basis for satisfaction of the needs of navigation and for various other branches of the national economy.

Parallel with oceanographic research of the seas, broad development was also given to theoretical works on general and particular problems of oceanography, and similarly on phenomena and processes within the sea.

A special direction in theoretical marine research was taken by the work of the Marine Hydrophysical Station in Katsivel, which far advanced our knowledge of the interactions between the atmosphere and the hydrosphere, the interactions between ocean and continents, the thermal balance of the sea, and problems of the technical and biological physics of the sea.

Exceptionally extensive work was conducted in the field of methods of marine hydrometeorological forecasting. This research was begun in the State Hydrological Institute and was later continued and expanded by the Central Forecasting Institute and the Arctic Institute. As a result of this work, methods of long-range prediction of ice conditions on a group of USSR seas were created, and bases for prediction of the thermal condition of a sea, the fluctuation of its level and of its waves were worked out.

Research was broadly developed on the vertical hibernal circulation and formation of intermediate cold layers, on the currents, tides and wave factors of specific USSR seas. In this work theoretical calculations were checked against experimental research in nature.

A collection of materials on the soils of the sea floor and their analysis was successfully developed. In addition, methods were worked out for hydrochemical determination of the chemism of the soils.

A completely original approach to the solution of a series of marine biological problems which have practical significance for shipbuilding and navigation was found. In the field of marine-engineering hydrometeorological research, whose results are essential for the design of technical measures, essential work was also carried on; the calculation of the water balance of the Caspian and Azov Seas may serve as an example. Successes were achieved in the field of construction of new marine instruments: the thermobathygraph, current self-recorder, wavegraph, marigraph, wave gauge, etc.

During the past thirty years there has been an increase in the publication of oceanographic works discussing separate problems in terms of the materials of native observation, as well as monographs devoted either to whole complexes of oceanographic problems or to separate divisions. Among the monographs the following works should be noted: Academician V. V. Shuleykin's Physics of the Sea, a work which has been honored with the Stalin prize; Professor N. N. Zubov's Marine Waters and Ice and Dynamic Oceanology; Honorary Academician Yu. M. Shokal'skiy's Physical Oceanography; Professor V. A. Berezkin's Dynamics of the Sea; Honorary Academician N. M. Knipovich's Hydrology of Seas and Brackish Waters; Professor M. V. Klenova's Geology of the Sea; Professor V. P. Zenkovich's Dynamics and Morphology of Seacoasts; and Professor O. V. Bruyevich's Hydrochemistry of the Central and Southern Caspian.

Notwithstanding the achievements in research on the USSR's home seas during the past thirty years, very, very much work is nonetheless necessary in order that we may have a thorough knowledge of the oceanographic conditions and phenomena in our seas and may apply it for the welfare of the national economy. For this the following steps are necessary: (1) to guarantee the continuous study at sea of the annual cycle of oceanographic characteristics and their changes in the succession of years, (2) to study the processes and disclose the causes of these changes, thus providing a reliable basis for short- and long-range forecasts of weather and changes of hydrological characteristics, and (3) to expand research to the oceans and to the seas which have been studied only slightly.

THE SETTING-UP OF EXPERIMENTAL RESEARCH IN FLOW STATIONS

Ye. G. Popov

We shall confine ourselves here to the selection of one problem which is most important for hydrological forecasting: the problem of setting up field experiments directed toward the development of a theory of formation of the spring flow.

The problem of experimental research consists in its aiding in the more rapid disclosure of the fundamental regularities which direct the flow processes so that these may be utilized in practical hydrological calculations and forecasts.

The most rapid and successful solution of this problem is possible only with observation of the following basic conditions:

(a) that experimental research should guarantee observation of all the fundamental processes conditioning the studied phenomenon;

(b) that the experiment itself should be purposeful;

(c) that the experimental results should give a clear picture of the possibility of utilization for practical calculations of given regular network hydrometeorological observations, indicating paths toward their improvement and rationalization and, finally,

(d) that the setting-up of experimentation in natural conditions should guarantee its own activity.

The last two conditions are important in that only their observation can guarantee the most rapid possible solution of the set problem and the possibility of generalization and application of the experimental results in practical hydrological calculations and forecasts.

Contemporary hydrology has not yet had sufficient experience in the setting up of active experimentation in natural conditions. Its research is for the present based principally upon analyses of the data of hydrometeorological observations of several years standing. Experimental studies of discrete, particular flow processes (the thawing of snow and its yielding of water, the absorption and yielding of thaw waters by a basin in the channel network, the movement of water along the channels, its storage and expenditure) lead at present to cases for the most part isolated from one another and offer no possibility of sufficiently profound analysis of the whole process of flow formation.

Experimental studies of hydrological processes must be organized in such a way that there may exist full possibility of tracing their interconnections within the overall process of spring flow formation and of determining all the basic characteristics of this process which are essential for its prereckoning. It is also necessary to ascertain the possible accuracy of this prereckoning by setting up variously detailed observations and by utilizing the regular network hydrometeorological observations.

The most important tasks along this path are:

1. Study of the heat exchange, the physical properties of snow, its water-retaining capacity, the rate of vertical filtration of water through a thickness of snow, and a series of other phenomena,

knowledge of which is essential for calculation of snow-melting and of the snow's water output.

2. Investigation of the character and rate of surface runoff of thaw water under various conditions, and also determination of the mean integral characteristics of water discharge into a ravine by way of determination of the total inflow and the time it takes the thaw water to run from different parts of the water accumulation to the closing alignment.

3. Investigation of the process of water motion in ravines, especially in the initial period of the flow, when most is told of the regulating effect the ravines exert through temporary retardation of the water due to the presence of considerable masses of snow in them [the ravines].

4. Study of the laws of motion of water along permanently active channels, and specifically: the velocities, the part played by the holding capacity of river beds and valleys flooded by rivers, the regularities in water absorption and discharge by flood valleys and the interactions of fluvial and subterranean waters.

We have enumerated in brief outline the fundamental problems without whose solution research on the formation of the spring flow cannot be complete. We consider it essential to emphasize the particular importance of such key questions as those of calculation of snow melting, of absorption and surface retention (losses) of thaw water in a basin and, finally, of the process of the water's reaching the primary channel network. From a practical point of view it is unusually important in this connection that the experimental results should in the greatest possible degree take into account and reflect the mean characteristics of each of these processes for a basin, since only in this case can they be representative and acquire general significance.

Let us illustrate this idea with a very simple example. Even the most careful and accurately conducted observations of snow melting cannot, if they are conducted on only one section of the basin, reveal a picture of its distribution throughout the basin. Consequently we will not obtain a true picture of the spring flow in this basin for analysis of the overall formational process of this phenomenon. This circumstance can lead to erroneous inferences for the analysis of other processes related to snow melting. Of immense significance for the correctness of basic inferences are the reliability and accuracy of measurements of such physical quantities as the reserves of water in snow, their diminution at the time of snow melting, the discharge of water, etc. Low accuracy of measurements may lead to incorrect and inconsistent inferences, decreasing the value of the whole experiment.

The great labor required by experimental works investigating the flow, even under the conditions in altogether small natural basins, demands that in their setting-up special care must be devoted to the development of methods for all observations, thus guaranteeing their more or less uniform reliability for all the components of the studied process.

With the aim of observance of the principle of complexity, which has paramount significance for the development of a theory of hydrological prognosis, it is essential that experimental research be conducted at flow stations on one or several small natural basins (rivulets or ravines), where it will be guaranteed that reliable and continuous measurements will be made at a series of alignments.

All investigations of basic processes of formation of the spring flood should be strictly related to the general direction of experimentation so that the comparability and possibility of analyzing all the observed phenomena in conjunction may be assured. Research on the effect of various specifications of the condition of the underlying surface upon the flow should be conducted parallelly on elementary areas where these specifications may be artificially assigned (different degrees of wetting and freezing, different types of cultivation, etc.).

Methods of observation of snow cover, snow melting and water discharge should result in the following:

1. Production of sufficiently accurate measurements of the initial water reserves in the snow in the basin by way of detailed snow-surveys.

2. Careful accounting for the liquid precipitations falling in the period of snow melting and shedding of thaw waters.

3. Setting up of observations of the evaporation from the surface of the snow during the thaw period.

4. Setting up of careful observation of all the elements of the heat balance of snow melting on one or several sections,

depending upon the dimensions of the studied basin.

Parallel with these observations, it is essential to assure as far as possible broad observations of the water discharge at various points of the reservoir, which may be easily accomplished by way of measurement of the flow from small water-impenetrable platforms 0.5 - 1 square meter in dimensions. These platforms should be located on all the characteristic slopes of the studied reservoir, in both field and forest. The course of flow from these platforms will characterize the water discharge from the thawing snow and with parallel measurements of the snow's moisture content may also be used for calculations of the intensity of thawing. It is easy to average these data for the whole basin and consequently to check to what extent the calculation of thawing by the method of thermal balance, according to measurements of its elements on the experimental platforms, proves to be representative.

5. Setting up of observations of the rate of vertical movement of thaw water in the snow mass.

6. Strict follow-up of the changes in degree of snow cover in the studied reservoir in the process of thawing, by way of ordinary land surveys or aerophotographic surveys.

All these observations will make it possible to take into account both the total quantity of water which has entered the basin and the course of this entry in time.

Observations of the processes of absorption, surface retention and discharge of water by the reservoir should include:

1. Observations on the velocity of thaw water under snow under conditions of various microtopographic forms and various times of reaching the ravines.

2. Calculation of the amount of water consumed in surface retention and ascertainment of the change in magnitude of the inactive (in the water discharge sense) areas of the reservoir.

3. Observations of the seepage of thaw water into the ground by way of determination of the changes in the moisture content of the soil through measurements at sections of the reservoir differing in soil and plant cover; observations of the flow from the water-impermeable and water-balance platforms and of the system of subsurface waters.

4. Calculation of the magnitude of the total diurnal flow of water into the ravine, which should characterize the magnitude of the total diurnal discharge of water by the basin. The latter quantity should be determined by the volume of water entering the ravine, for which purpose observations of the flow should be carried on at the final and at intermediate alignments, and also of the variation of the volume of water in the ravines.

All these observations should be constructed in such a way as to guarantee, on the one hand, the analysis of the physical nature of the process itself (for example, the process of infiltration), and, on the other hand, the possibility of generalization of the regularities of this process for conditions of a real basin with calculation of all its diverse forms. Obviously the complete solution of this problem is possible only through the conjunction of laboratory and field experimentation.

Research on the formation of the surface flow is unthinkable without the most careful study of the effect of the form and condition of the reservoir's surface upon the flow. This is one of the most complex and labor-consuming tasks.

The basic requirement for experimental research on the part played by the underlying surface in the formation of the spring flow is that this research should make possible generalization of the discovered regularities for the whole basin and their extension to other basins, provided the characteristic peculiarities of the latter are calculated. Proceeding from this basic requirement, a practical method of setting up these observations should be directed first of all:

(a) toward a topographical survey allowing the character of the microrelief and all the details of the basin's form to be ascertained with the maximum possible accuracy;

(b) toward a study of the soil cover and determination of the filtration properties of all the soils existing in the basins, with their various degrees of moistening and freezing;

(c) toward a hydrogeological survey of the basin giving an accurate picture of the depth of occurrence of the top water-impervious layers and of the extent of the subsurface waters.

Only the presence of these materials can make it possible to obtain the basin's average characteristics of surface retention and of water absorption by way of infiltration, and also the average rate and time of runoff of thaw water in the basin.

We emphasize the particular importance of constructing a distribution curve of the active (in the water-discharge sense) areas of the basin in relation to the depths of the absorption seats. This distribution curve proves to be (for the majority of basins, where it is certain that there will be sufficient soil moisture from autumn on and that this moisture will freeze in winter) a fundamental characteristic of the surface water retention in the basin and at the same time a characteristic of the losses in the spring flow, since the losses through infiltration will not be great in these conditions.

Observations of the motion of water in the channel network have great significance in research on the processes of flow formation.

These observations, in addition to providing a careful calculation of the quantity of water flowing through, should characterize the rate of flow and the time the water takes to run through the channels and also should make possible the determination of the total quantity of water which has flowed into the channels and that which has been absorbed in them. Not dwelling at length on the details of organization of these observations, let us only indicate the necessity of conducting this work not only at flow stations on small basins, but also on rather large rivers, with the aim of their cooperative coordination. The basic idea of these observations should be above all to ascertain the relationship between the rate and runthrough time of the water both up to the primary channel network and through the channels themselves.

All the enumerated aspects of the experimental work must be accompanied by the most careful meteorological observations, both through the standard program at auxiliary meteorological stations and by way of broad utilization of automatic recorders or repeated observations at special posts established in characteristic parts of the basin.

Not having the opportunity to dwell upon the details and technique of conducting the observations themselves, we believe that the State Hydrological Institute and the Central Forecasting Institute should initiate in the very near future the development of a program and methodology of observation, proceeding from the concrete technical possibilities of the existing flow stations.

In conclusion, a concise summary of the basic tasks of experimental research on the spring flow is given below.

SUMMARY OF THE BASIC TASKS IN A RESEARCH PROGRAM ON FORMATION OF THE SPRING FLOW TO BE FULFILLED ON THE BASIS OF EXPERIMENTAL FIELD WORK AT FLOW STATIONS

No [1]	Basic Tasks [2]	Purpose and End Result of Research [3]	Methods of Conducting Observations [4]
1	Research on the accuracy of calculation of water reserves in snow in a basin	Development of, and theoretical basis for, accuracy in performing snow measurements	Experimental research on the accuracy of various methods of snow-measurement survey and measurement of solid precipitation
2	Research on the processes of evaporation from the surface of the snow cover	Development of methods of observation and calculation of evaporation by meteorological factors	Experimental research on the processes of snow evaporation under laboratory and field conditions
3	Research on the process of snow-melting and of discharge of water by melting snow	Development of a theory, and methods of calculation,of snow-melting and water discharge for conditions of real river basins, according to meteorological data in relation to the physical pro-	1. Experimental research on the energy balance of snow-melting in relation to the physical properties of the snow itself in field and forest

[1]	[2]	[3]	[4]
		perties of the snow and the character of the topography	2. Observations of the intensity of snow-melting and water discharge under various conditions of snow deposit in the river basin by means of measurements of the flow from water-impermeable microplatforms 0.5-1 square meter in size, and of the water-retaining capacity of the snow by calorimetric or other methods
4	Research on the distribution of snow in the basin and the characteristics of its disappearance at the time of snow-melting	Development of reliable methods for calculating the changes in degree of snow cover of the basin in the process of melting, in relation to its initial distribution and to the intensity of melting	Terrestrial and aerophotographic surveys of the lay of the snow cover in the period of melting for formations within the territory differing in nature and extent
5	Research on the processes of seepage of thaw water into the	Development of reliable methods for calculating the intensity of infiltration in relation to the	1. Laboratory studies of the filtration properties of soils in their different states of moisture and freezing

[1]	[2]	[3]	[4]
	ground	properties and condition of the soil and to the intensity of snow-melting. Ascertainment of the relative role of infiltration in the overall process of water absorption and retention in the basin	2. Observations of snow-melting and flow on water-permeable [sic] and water-balance platforms. 3. Observations of the changes in moisture content in the soils before the onset and in the process of snow melting in various characteristic sections of the basin 4. Observations of the system of subsurface waters
6	Research on the processes of surface retention and regulation of flow in the basin	Development of methods for calculating surface water retention in a basin using data on the character of its surface structure, the filtration capacities of the soils and the intensity of snow-melting, and ascertainment of	1. Detailed topographic soil and hydrological surveys of the basin 2. Construction of a distribution curve of the active areas in relation to the depths of the seats of surface

[1]	[2]	[3]	[4]
		the relative role of surface retention in the overall process of flow formation	retention 3. Experimental calculation of the amount of water retained in the surface of the basin. 4. Comparison of the total amount of water discharged by the snow, determined in accordance with data on the flow from microplatforms, with the volume of flow into the channels
7	Research on the processes of runoff and motion of water in channels	Development of methods for calculating the runoff speed and the average speed with which the water runs up to [the channels] in a basin in relation to the topographical character, plant cover and degree of canalization of the basin and to the intensity of snow-melting	1. Observation of the runoff speed over the slopes and in the rivulet network under the different topographical conditions in the basin 2. Determination of the total flow of water into the channel by means of careful measurements of the volume of the channel and discharges of water at

[1]	[2]	[3]	[4]
			a sufficiently large number of alignments distributed along the entire basic channel network, among them a control closing alignment. Comparison at times of the progress of discharge of water from the snow with the total inflow and the flow at a given alignment

CHANGE IN THE DIRECTION OF AIR MASS TRANSFER IN THE TROPOSPHERE WITH THE CHANGE OF NATURAL SYNOPTIC PERIODS

A. L. Kats

In 1946, S. T. Pagav's work, Principles of the Synoptic Method of Long-Range, Short-Notice Weather Forecasting [1] was published, enriching B. P. Mul'tanovskiy's ideas on the natural synoptic period.

In this work maps of baric topography are employed for purposes of long-range weather forecasting, and the natural synoptic period is defined as the time interval during which a given high-altitude deformational field of the troposphere lasts.

It is also demonstrated in this work that the isallohypses of AT500 [the 500 millibar absolute topographic surface] of the tendency of a natural synoptic period in general maintain their signs during the whole period, since the coefficient of correlation among the isallohypses of the tendency and of the whole period proves to be equal to 0.676. The results obtained make it possible for S. T. Pagav to employ analysis of mean charts of AT500 of the tendency of natural synoptic periods in conjunction with the isallohypses of the tendency for prognosis of the synoptic processes of the following period [1]. In relation to the conjunction of the isallohypsic loci of the tendency of a period with the fields of convergence and divergence of the isohypses of AT500 of this same tendency, prognostic rules are obtained concerning the development of the synoptic processes in the following period. Utilization of isallohypses of the tendency of a period is based upon the demonstrated fact of their maintenance throughout the entire period and upon the assumption that the change of AT500 from one tendency to another depends on the whole upon changes in temperature in the layer between the earth's surface and the 500 millibar surface.

The task of the present work is to ascertain: (1) whether the loci of the isallohypses of AT500 of the tendency of a period may be interpreted like the corresponding loci of increase and decrease of temperature; (2) how the isallohypses of separate days change in the course of one natural synoptic period and with the onset of a new period; (3) what are the characteristics of the variation of a deformational field within a period and with a change in periods.

For this purpose the synoptic materials of the Central Forecasting Institute from 28 December 1948 to 1 December 1949 and a working breakdown of the continuous succession of synoptic processes into natural synoptic periods have been used. In the course of eleven months of the year 1949 the synoptic processes in the European region were differentiated into 60 natural synoptic periods, most of which lasted five or six days. For all 60 natural synoptic periods charts of the isallohypses of the tendency of AT500 were constructed by means of subtraction of the average values of the AT500 tendencies of the current and preceding periods. These isallohyps charts reflect the changes in the 500 millibar surface which take place in the tendency of the current period in comparison with the tendencies of the preceding period. On these charts the loci of negative isallohypses, regardless of what high-altitude baric formation they are related to, indicate a lowering of the isobaric surface which is being accomplished in the new period, and the loci of positive isallohypses correspondingly indicate a rise of the isobaric surface.

By exactly the same method charts of the isallohypses of OT 500/1000 [the relative 500/1000 millibar topography] of the tendencies of the periods were constructed. As a result of analysis of these charts it became evident that the loci of positive and negative changes in OT 500/1000 almost repeated the chart of changes in AT 500 in geographical distribution. The loci of the isallohypses of AT 500 and OT 500/1000 according to absolute value always differed from one another, this difference being the greater the more considerable was the total effect of advectional and dynamic changes of the pressure at the earth's surface. However, in all cases to each isallohyps locus of AT 500 there corresponded an isallohyps locus of like sign of OT 500/1000 of the tendency of the same period. For exposure of the qualitative relationship between the isallohypses of AT 500 and OT 500/1000 of the tendency of a period we performed a statistical processing of these two charts using the same formulas as were used in the work of S. T. Pagav which has been mentioned.

The results of this processing are cited in Table 1.

[See next page for Table 1]

The rather high coefficient of correlation between the distribution of the isallohypses of AT 500 and OT 500/1000 (0.776) corroborates the good and physically evident correlation between the changes of the isohypses of AT 500 and OT 500/1000 from one tendency

TABLE 1

RELATIONSHIP BETWEEN THE SIGN DISTRIBUTION OF ISALLOHYPSES OF AT 500 AND OT 500/1000 OF THE TENDENCIES OF NATURAL SYNOPTIC PERIODS

Type of Supposition	Number of Suppositions	Actual Number	Number of Verified Suppositions	Percent of Verification	Percent of Chance Verification	Coefficient of Correlation	Standard Deviation	Ratio of Coefficient of Correlation to its Standard Deviation
Maintenance of negative sign of isallohypses	3771	3769	3346	88.7	50.1	0.776	0.0114	68.2
Maintenance of positive sign of isallohypses	3786	3788	3363	88.8	49.9	0.776	0.0114	68.2

of a natural synoptic period to another. The good correlation also reflects the well known fact that variation of the 500 millibar surface depends chiefly upon changes in the average temperature of the underlying layer. This correlation also reveals that the loci of the isallohypses of AT 500 of a tendency of a period may in a certain sense be taken for the loci of decreases and increases in the average temperature of the five-kilometer-high layer.

If the relationship between the mean isallohypses of AT 500 of a tendency and of an entire natural synoptic period have, according to S. T. Pagav [1], the coefficient of correlation 0.676, then the relationship between the isallohypses of the tendency of contiguous periods turns out to be equal to 0.336. This confirms that the isallohypses of AT 500 of the tendencies of contiguous periods differ sharply from one another.

In connection with this we have set ourselves the task of explaining how the isallohypses of separate days within the period and at the limits of the period behave. For this purpose, in addition to the isallohypses of a tendency of a period, the isallohypses of all the days of the period have been separately constructed. The construction of these isallohypses was accomplished in the following manner. For construction of the isallohypses of AT 500 of the tendency of a period, the average values of AT 500 of the tendency of the preceding period were subtracted from the average values of AT 500 of two days of the current period (for each of 126 points evenly distributed over the field of a natural region). The algebraic differences represent the corresponding isallohypses of the tendency of the period. Analogously, for the construction of the isallohypses of the third, fourth, etc., days the same average values of the isohypses of AT 500 of the tendency of the preceding period were subtracted from the value of AT 500 of a definite day. These charts were constructed for all the days of a period. In addition, the isallohypses of each initial day of a new period were also constructed on the assumption that this day is still the last day of the preceding period. For this, the same average values of AT 500 of the tendency of the period as were used for the preceding days were subtracted from the value of AT 500 of the first day of a new period.

Since the loci of the isallohypses of the 500 millibar surface may be considered as the corresponding changes in the average temperature of the underlying layer, the construction of the isallohypses of separate days in this manner also shows the changes in the average temperature of the layer from day to day, both within a period and with the transition to a new period. In order to clarify the character of these changes, we have performed a statistical processing of all the isallohyps charts with the purpose of establishing the qualitative relation between the distributions of the isallohyps loci of separate days of a period. In the whole statistical processing, 278 isallohyps charts of separate days of periods were treated. A continuous series of 60 natural synoptic periods during 11 months of 1949, taken without any preliminary selection, fully suffices for statistical inferences. The results of this processing are brought forth in Tables 2 and 3. It is essential to note that in addition to the five-and six-day natural synoptic periods predominating during 11 months of 1949, there were also seven seven-day and one eight-day periods. Since seven cases cannot serve as a basis for statistical inferences, statistical processing of these periods is not presented in our tables.

[See next page for Table 2]

It is apparent from Table 2 that the qualitative coefficient of correlation between the isallohypses of a trend and of the remaining days of a period (0.664) almost exactly coincides with the coefficient of correlation (0.676) obtained by S.T. Pagav for the relation between the isallohypses of a tendency and the isallohypses of an entire period [1].

However, from the last rows of Table 2 it is apparent that this average coefficient of correlation, 0.664, turns out to be different for the third, fourth, etc., days of a period. The isallohypses of the third day, for which the coefficient of correlation is equal to 0.738, have the greatest resemblance to the geographical distribution of the isallohypses of a tendency of a period. During the following days there occurs a regular decrease of the correlation coefficient by 5 - 6 percent, the coefficient being equal, even on the last day, to 0.575. Such a change in the coefficient of correlation confirms the fact, which is observed on the isallohyps charts of separate days of a period, that a certain territorial displacement of the loci survives throughout the entire period. The meaning of such a change in the isallohypses is not difficult to explain. A natural synoptic period is characterized by the stability of a given high-altitude deformational field, which, at the same time, does not remain set nor invariable.

The high-altitude deformational field of a period is in continuous development and change. However, this change is evolutionary and does not disrupt the general distribution of the basic loci of heat and cold nor, consequently, of the high-altitude deformation field which is established in the tendency of the period. Each locus of positive and negative isallohypses corresponds to a definite high-

TABLE 2

RELATION BETWEEN THE SIGN DISTRIBUTION OF ISALLOHYPSES OF AT 500 OF SEPARATE DAYS OF A NATURAL SYNOPTIC PERIOD AND ISALLOHYPSES OF AT 500 OF A TENDENCY OF THE SAME PERIOD

Type of Supposition [1]	Number of Suppositions [2]	Actual Number [3]	Number of Verified Suppositions [4]	Percent of Verification [5]	Percent of Chance Verification [6]	Coefficient of Correlation [7]	Standard Deviation [8]	Ratio of Coefficient of Correlation to its Standard Deviation [9]
Maintenance of positive sign of isallohypses on all remaining days of period	13,267	13,416	11,107	83.7	50.2	0.664	0.0053	125
Maintenance of negative sign of isallohypses on all remaining days of period	13,442	13,293	11,133	82.8	49.8	0.664	0.0053	125

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]
Maintenance of positive sign of isallohypses on third day . .	3,774	3,794	3,289	87.1	50.1	0.738	0.0114	66
Maintenance of negative sign of isallohypses on third day . .	3,786	3,766	3,281	86.6	49.8	0.738	0.0114	66
Maintenance of positive sign of isallohypses on fourth day .	3,774	3,781	3,200	84.8	50.0	0.682	0.0114	62
Maintenance of negative sign of isallohypses on fourth day .	3,786	3,779	3,205	84.6	49.9	0.682	0.0114	62
Maintenance of positive sign of isallohypses on fifth day . .	3,394	3,496	2,787	82.0	50.4	0.621	0.0120	52
Maintenance of negative sign of isallohypses on fifth day . .	3,535	3,433	2,826	79.9	49.5	0.621	0.0120	52
Maintenance of positive sign of isallohypses on sixth day . .	1,883	1,912	1,496	79.4	50.6	0.575	0.0161	36
Maintenance of negative sign of isallohypses on sixth day . .	1,895	1,866	1,479	78.0	49.4	0.575	0.0161	36

altitude baric formation. This correspondence, however, does not always mean their complete coincidence. When positive isallohyps loci coincide with high-altitude anticyclones and negative loci coincide with high-altitude cyclones, as is noted in work [1], the high-altitude deformational field of the period turns out to be most stable. Together with these coinciding isallohypses, cases are also encountered when the locus of negative isallohypses is superposed, not upon a high-altitude cyclone, but upon its trough, and correspondingly, the locus of positive isallohypses is superposed upon its ridge, and not upon an anticyclone, since the isallohyps loci are generally displaced with relation to the high-altitude baric formation. In such cases advection of warm and cold air masses in the troposphere, with which powerful seats of positive and negative isallohypses are basically connected, promotes a certain deformation of the high-altitude baric field. Such a deformation turns out to be greater or less depending on other factors of change of the isobaric surface which may be applied to the advection factor with the same sign or with opposite sign. In the course of a natural synoptic period, as is evident from Table 2, a shift of the basic loci of heat and cold in the troposphere is localized in definite regions and does not lead to essential reorganization of the high-altitude deformational field established in the tendency of the period.

An altogether different kind of development both of the high-altitude deformational field and of the isallohyps loci corresponding to it proceeds at the beginning of the next natural synoptic period.

For establishment of the relation between the isallohypses of a tendency of one period and the isallohypses of the first day of the following period, assuming that this day still belongs to the old period, there appears an abrupt break in the regular change of this relation.

[See following pages for Tables 3 and 4]

From Tables 2 and 3 it is evident that instead of a regular decrease in the coefficient of correlation by 5 - 6 percent, as occurs within a natural synoptic period, with the transition to a new period the relation drops by 20 - 25 percent and the coefficient of correlation turns out to be equal to only 0.339.

As we have already noted, a change of natural synoptic period is determined by a reorganization of the high-altitude thermobaric field. This reorganization also corresponds to a sudden change in distribution of isallohypses, even if they are computed in relation to the same preceding tendency. This sudden change proves to be still more apparent if the isallohypses of the 500 millibar surface of the new tendency (or of the one first day) are constructed in relation to the tendency of the period just completed. In this case the coefficient of correlation turns out to be 0.336 [1]. In order to satisfy ourselves that just such a change is also proceeding in the thermal field of the lower half of the troposphere, we calculated the coefficient of correlation between the isallohypses of OT 500/1000 of tendencies of contiguous natural synoptic periods. The results of these calculations for the same 60 natural synoptic periods are presented in Table 4.

TABLE 3

RELATION BETWEEN ISALLOHYPSES OF THE TENDENCY OF A CURRENT PERIOD AND ISALLOHYPSES OF THE FIRST DAY OF A NEW PERIOD, WITH THE ASSUMPTION THAT THIS DAY IS STILL RELATED TO THE FORMER PERIOD

Type of Supposition	Number of Suppositions	Actual Number	Number of Verified Suppositions	Percent of Verification	Percent of Chance Verification	Coefficient of Correlation	Standard Deviation	Ratio of Coefficient of Correlation to its Standard Deviation
Maintenance of positive sign	3,774	3,812	2,545	67.4	50.4	0.339	0.0114	31
Maintenance of negative sign	3,786	3,748	2,519	66.5	49.5	0.339	0.0114	31

TABLE 4

RELATION BETWEEN THE SIGN DISTRIBUTION OF ISALLOHYPSES OF OT 500/1000 OF TENDENCIES OF NEIGHBORING NATURAL SYNOPTIC PERIODS

Type of Supposition	Number of Suppositions	Actual Number	Number of Verified Suppositions	Percent of Verification	Percent of Chance Verification	Coefficient of Correlation	Standard Deviation	Ratio of Coefficient of Correlation to its Standard Deviation
Maintenance of positive sign of isallohypses	3,769	3,724	1,282	34.3	49.9	-0.304	0.0113	26.8
Maintenance of negative sign of isallohypses	3,788	3,833	1,346	35.5	50.1	-0.304	0.0113	26.8

From this table it is evident that with the transition to a new natural synoptic period there takes place a reorganization of the high-altitude thermal field as well as of the high-altitude baric field, these reorganizations being accomplished abruptly. The latter attests that at the meeting point of natural synoptic periods the direction of transfer of air masses in the lower half of the troposphere changes sharply. Consequently, in spite of the continuous change and displacement of the seats of heat and cold, within a natural synoptic period these changes are localized in definite regions in such a way that the high-altitude thermobaric field established at the beginning of the period is not disrupted.

With the change of natural synoptic periods there occurs an abrupt redistribution of the seats of heat and cold in the troposphere and the direction of transfer of tropospheric air masses is changed, their new distribution being also territorially localized in definite geographical regions. Naturally, in the subsequent construction of isallohypses of separate days of the period in relation to one tendency one hardly expects an abrupt complete interchange of sign of the field over the entire range of the natural region. A natural synoptic period begins with a reorganization of the thermobaric field of the troposphere, but for this it is not compulsory that the deformational field of the old period should have disappeared entirely. It is known from practice that most often there occurs the breakdown or genesis of only one or two of the baric formations which constitute the high-altitude deformational field of the period.

In the works of S. T. Pagav [2,3] it is noted that cases are even encountered when a natural synoptic period begins with the genesis of a new baric formation in the high-altitude deformational field of the period in the same geographic region where a baric formation of the same sign was located in the preceding period. In this case it is difficult to detect the reorganization by taking only the signs of the daily isallohypses one by one, but it becomes clearly apparent if the new isallohypses are constructed in relation to the tendency of the completed natural synoptic period. As has already been noted above in the establishment of the relation between such isallohypses, the coefficient of correlation is 0.338 for the 500 millibar absolute topographic surface and 0.304 for the relative 500/1000 millibar topography. The latter indicates, for example, that a high-altitude cyclone which had deepened in the old period and lasted into the new period begins to be filled in, and vice versa. Analogously, an anticyclone which had been growing stronger in the old period lasts, as a rule, into the following period.

In the present work the qualitative characteristics of changes in the isallohyps fields of AT 500 and OT 500/1000 have been examined. It should be noted that the loci of isallohypses undergo, not only displacement, but also quantitative change. The nature of these changes in particular may be estimated by using charts of isallohyps variation.

Investigation of the possibilities of application of isallohyps variation charts for long-range, short-notice weather forecasting has especial significance. We hope to turn to this question in another article.

The research results cited above allow us to make the following inferences:

1. A natural synoptic period is characterized by the stability of the thermobaric field of the lower half of the troposphere and of the loci of the positive and negative isallohypses which correspond to it.

2. Within a period there proceeds a continuous evolutionary development of the thermobaric field. During this, the deformational field of the period and the isallohyps loci corresponding to it are practically maintained in the same geographical region as in the tendency of the period, as a result of the maintenance of the direction of transfer of the tropospheric air masses.

3. With a change in natural synoptic periods there occurs an abrupt change in the direction of transfer of air masses in the troposphere which finds its reflection in a reorganization of the deformational field and a redistribution of the isallohyps loci of separate days of the period.

4. Charts of the isallohypses of separate days of a period may serve as one of the auxiliary means for objective determination of the limits of the period.

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THE RELATION BETWEEN RELATIVE HUMIDITY AND THE DIFFERENCE BETWEEN TEMPERATURE AND DEW POINT

Ye. I. Gogoleva and
Ye. M. Dobryshman

Beginning with 1 January 1950 the dew point (τ) has been transmitted in the daily telegrams of USSR synoptic and aerologic stations instead of the relative humidity (r), and has been plotted on the synoptic charts and various graphs (emagrams, etc.). In the operational work of synopticians the relative humidity remains as before a very important characteristic, essential for the solution of many practical problems. The Central Forecasting Institute has therefore issued special nomographs for the determination of the relative humidity for various values of the dew point and for temperatures (t) from +40 to -52 degrees [2].

Ye. I. Gogoleva called attention to the simple, well-defined relation between r and the difference $t - \tau$, which caused us to occupy ourselves with this question. It was established that this difference ($t - \tau$) is an extremely stable criterion for the moisture-saturation characteristics of the air and is little dependent upon its temperature. For states approaching saturation this dependency is especially slight. Therefore, the quantity $t - \tau$ may be considered as an auxiliary characteristic of air moisture.

Thanks to this synoptician it has become possible to utilize the comparable quantities r and $t - \tau$. Our purpose consists in demonstrating that it is appropriate to utilize given values of the actual temperature (t) and the dew point (τ) as characteristics of the moisture-saturation of the air. As will become evident from what follows, this may be easily accomplished by means of simple multiplication of $t - \tau$ by a certain coefficient, or with the help of the tables presented below.

Let us consider two air moisture characteristics: the relative humidity (r) and the difference $t - \tau$. It is clear that there exists a close relationship between them and that the nature of this relationship is as follows: the smaller $t - \tau$, the greater the relative humidity. But it is obvious that with the difference $t - \tau$ remaining constant, the magnitude of the relative humidity will depend upon the temperature (t).

The degree of influence of the temperature on the relation between r and $t - \tau$ may be ascertained by computing the values of r, in accordance with psychrometric tables, for various values of $t - \tau$, taken for various temperatures (Table 1).

With a quick glance at this table we shall be satisfied that in states approaching saturation (i.e., for small values of the difference $t - \tau$) the temperature has almost no effect on the relation between r and $t - \tau$. This means that the difference $t - \tau$ is a fairly stable (only slightly dependent upon temperature) criterion for characterization of the moisture saturation of the air.

The empirical data obtained allow us to hope that a simple analytical relationship between r and $t - \tau$ may be established.

TABLE 1

VALUES OF RELATIVE HUMIDITY (IN PERCENT) FOR VARIOUS $t - \tau$ FOR THE TEMPERATURE INTERVAL FROM +30 DEGREES TO -20 DEGREES (FOR TEMPERATURES BELOW 0 DEGREES THE VAPOR TENSION IS TAKEN ABOVE ICE)

$t - \tau$	Temperature (degrees)					
(degrees)	+30	+20	+10	0	-10	-20
5	74.6	72.9	71.0	68.9	63.7	61.0
2	89.1	88.3	87.3	86.2	83.6	81.9
1	94.4	94.0	93.5	92.9	91.6	90.5

For establishment of the form of this relationship we shall use the well-known Magnus formula, which links the water-vapor saturation tension Q_{max} with the temperature. This formula has the form:

$$Q_{max} = Q_0 \exp\left[\frac{at}{b + t}\right], \quad (\exp[x] = e^x),$$

where Q_0 is the saturation tension at 0 degrees; a and b are constants which have various values depending upon what surface the moist air is located above. As V. A. Belinskiy [1] shows, the values of these constants are as follows:

Over water, $a = 75 \ln 10 = 17.2$; $b = 237.2$ degrees.

Over ice, $a = 9.45 \ln 10 = 21.8$; $b = 265.5$ degrees.

Let us write the Magnus formula for the dew point (τ) and for the actual temperature (t). We obtain, respectively:

$$q_{max} = Q_o \exp\left[\frac{a\tau}{b+\tau}\right],$$

$$Q_{max} = Q_o \exp\left[\frac{at}{b+t}\right].$$

By definition, the relative humidity (r) will be:

$$r = \frac{q_{max}}{Q_{max}} \cdot 100\% = \exp\left[-a\left(\frac{t}{t-b} - \frac{\tau}{\tau+b}\right)\right] 100\% \qquad (1)$$

Let us investigate this expression. We temporarily designate

$$t - \tau = \vartheta$$

Then we may write:

$$\frac{1}{\tau+b} = \frac{1}{t+b-\vartheta} = \frac{1}{t+b}\,\frac{1}{1-\dfrac{\vartheta}{t+\vartheta}} = \frac{1}{t+b}\left(1+\frac{\vartheta}{t+b}\right) = \frac{1}{t+b}$$

The last two approximate equalities are fulfilled with the greatest accuracy, since for conditions approaching saturation $\vartheta \leqslant 5$ degrees; $t + b > 235$ degrees, so that $\frac{\vartheta}{t+b} \leqslant 0.02$; substituting $\frac{1}{t+b}$ for $\frac{1}{\tau+b}$ in (1), we obtain

$$r \approx 100\% \exp\left[-\frac{a}{t+b}(t-\tau)\right].$$

Let us estimate the value of the power of the exponential. We put t = 10 degrees, t - τ = 5 degrees. Then

$$\frac{a}{t+b}(t-\tau) = \frac{1}{3};$$

therefore for calculation of

$$\exp\left[-\frac{a}{t+b}(t-\tau)\right]$$

we may confine ourselves to the first two or three terms of the Taylor development. Then

$$r = \left[1 - \frac{a}{t+b}(t-\tau) + \frac{1}{2}\left(\frac{a}{t+b}\right)^2 (t-\tau)^2\right] 100\%.$$

The average value of $\frac{a}{t+b}$ 100% for the interval from +30 degrees to 0 degrees will be 6.75, and for the interval from 0 to -20 degrees, 8.53. Therefore, the last formula will take the form:

$$r = 100\% - 6.75\,(t-\tau)\% + 0.228\,(t-\tau)^2\ \%\ \text{over water;} \qquad (2)$$
$$r = 100\% - 8.53\,(t-\tau)\% + 0.324\,(t-\tau)^2\ \%\ \text{over ice.} \qquad (2a)$$

For rough calculations we may use simpler formulas in which only the linear terms containing $(t - \tau)$ are retained. The coefficients (6.75 and 8.53) should be somewhat decreased in order to take into account the quadratic term of the development. It is best of all to calculate in accordance with the following formulas:

$$r = 100\% - 5.8\,(t-\tau)\ \%\ \text{over water;} \qquad (3)$$
$$r = 100\% - 8.0\,(t-\tau)\ \%\ \text{over ice.} \qquad (3a)$$

TABLE 2

VALUES OF THE RELATIVE HUMIDITY (IN PERCENT) CALCULATED ACCORDING TO FORMULAS (2), (2a) AND (3), (3a)

Formula	$t - \tau$ for $t > 0^\circ$ (degrees) 5	2	1	Formula	$t - \tau$ for $t < 0^\circ$ (degrees) 5	2	1
(3)	71.0	88.4	94.2	(3a)	60.0	84.0	92.0
(2)	72.0	85.6	93.5	(2a)	65.4	84.2	91.8

Comparison of the data in Tables 1 and 2 yields a fully satisfactory correspondence.

All that has been written above allows us to affirm that the difference $t - \tau$ characterizes with a great degree of accuracy the condition of an air mass which is close to saturation.

In operational work we may use Table 3, calculated according to formulas (2) and (2a), in which average values of the relative humidity are given in relation to the difference $t - \tau$ for the temperature interval from +30 to 0 degrees and from 0 to -20 degrees.

In conclusion, let us call attention to the following circumstances. The structure of formulas (2) and (3) is so simple that they may be applied in the computational basis for construction of an instrument consisting of a combination thermometer-hygrometer for purposes of obtaining more reliable data for measurement of the relative humidity.

TABLE 3

AVERAGE VALUES OF RELATIVE HUMIDITY (IN PERCENT) FOR VARIOUS $t - \tau$

$t - \tau$ (degrees)	Over Water	Over Ice	$t - \tau$ (degrees)	Over Water	Over Ice
8.0	60	52	3.0	82	77
7.5	62	54	2.8	83	78
7.0	64	56	2.6	84	80
6.5	66	58	2.4	85	81
6.0	68	60	2.2	86	83
5.5	70	63	2.0	87	84
5.0	72	66	1.8	88	86
4.8	73	67	1.6	90	87
4.6	74	68	1.4	91	89
4.4	75	69	1.2	92	90
4.2	76	70	1.0	94.7	93.4
4.0	77	71	0.6	96.1	95.0
3.8	78	72	0.4	97.3	96.7
3.6	79	73	0.2	98.6	98.3
3.4	80	75	0	100%	100%
3.2	81	76			

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ARTIFICIAL CLIMATE LABORATORIES

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The victory of the philosophical conception of I. V. Michurin and T. D. Lysenko, founders of our native agrobiological science, the victory of the materialistic theory of the role of the influence of external factors on the plant world, has reconstructed the scientific-research themes of all agricultural institutes and experimental stations in a new way.

For practical realization of the aims set before Michurinian agronomic science -- controlled raising of plants, study and alteration of their nature, development of new frost-resistant varieties -- a government resolution entrusted the Ministry of Agriculture USSR with construction of two artificial climate stations.

One of these stations was designed for work on the development of frost- and drought-resistant varieties of the fruit trees and berry cultures of the USSR's central zone and for the further advancement of better varieties in the northern rayons of our country where fruit culture is little developed. The second artificial climate station was basically designed for the solution of government problems -- the advancement of subtropical crops (citrus, etc.) in new rayons (by means of development of more frost-resistant varieties) -- and for the solution of other problems standing in the way of subtropical agriculture.

The projected assignments of these two stations represent a complicated technical system of equipment and installments which must assure the possibility of reproduction of changes in temperature and atmospheric humidity, temperatures of soil, wind, solar radiation, etc., which are observed in the natural conditions of the various geographical regions.

For solution of this problem, accumulated experience and a trained workers' organization are essential.

The great Russian scientists D. I. Mendeleyev and N. Ye. Zhukovskiy were the founders of laboratory experiments in meteorology. Mendeleyev, in particular, described several years before Sprung the famous experiment on the circulation of fluids in the presence of a temperature difference which is undeservedly called "the Sprung experiment".

In the winter of 1918-19, in accordance with the ideas of Zhukovskiy, in the Kuchinsk Geophysical Institute's aerodynamic tunnel experiments were first set up for the study of lycopodium spectra and snow deposits on railroad snowguards. This is set as the beginning of the laboratory works of soviet geophysicists.

Some of the works accomplished in this same institute continued Zhukovskiy's subject, while others had the purpose of studying the influence of wind on geophysical apparatus. Of works of the first type we should mention the theoretical and experimental research on "over-slope guards", set in a position slightly raised above the slopes of the dugout and forming with them a nozzle-shaped structure into which the wind blows the snow from the rails the more strongly the greater is its velocity. To the second type of work belong the studies of meteorological booths, rain-gauge shelters, etc.

It is impossible to show the subsequent rapid development of themes of meteorological laboratory work, the interest displayed by meteorologists in the mastering of this method, new for them, and their consciousness of its scientific value.

This thematic development was called forth by agriculture's need for the expansion of the growing areas of various crops and for auto- and railroad transport, by the solution of actual problems of construction on frozen and perpetually frozen grounds and by the struggle with chasms [opening in frozen ground].

It is obvious that the setting up of laboratory experimentation in the indicated directions demanded the reproduction of at least two of the most important characteristics of weather and climate: temperature and atmospheric humidity.

These demands were realized in Transport and Highway Institutes in the form of arrangements which came to be called "artifical climate laboratories" (LIK), the essential part of which is a closed aerodynamic tunnel where the air is conditioned with respect to temperature, humidity and speed of flow according to the demands of the experiment.

Within thirty years the propagation of citrus crops -- oranges and lemons -- in the damp, subtropical territories of the Soviet Union caused the All-Union Institute of Tea and Subtropical Crops to be faced with the problem of the freezing of citrus crops and of guarding them from frost. These problems were directly related to

LIK, since the experimental work could only be successfully and quickly conducted in laboratories where the plants could be subjected at the necessary time to appropriate chilling tests.

The Institute's laboratory, which was built in 1935-1936, has two working chambers: the first 14.25 square meters in area and 50 cubic meters in volume and the second 16.5 square meters in area and 58 cubic meters in volume, where the plants undergoing tests are placed, and also a chamber 10 square meters in area and 33 cubic meters in volume for storage of the plants after the tests (in the thawing period). The last chamber is essential for creation of the necessary warming conditions, analogous to natural conditions, and at the same time for augmentation of the capacity of the chambers.

For creation of uniform experimental conditions the glass working circuit of the air-cooler is mounted in the chambers, arranged on the diagonal.

The laboratory's machine room, in which the central controls of the ammonia system are located, has two VAK-10 vertical compressors with corresponding condensers and motors. The air-cooler room is located between the machine room and the working chambers.

Variation of the air-moisture conditions is guaranteed by an air-humidification apparatus which works through a vapor-jet feed.

Automatic signaling of disruption of the assigned parameters (at present only for temperature and air moisture) is provided in the laboratory by an installation of self-recording instruments equipped with stopping devices.

The further development of artificial climate laboratory works found its reflection in the peat industry.

The technological process of drying lump peat on the enterprises' fields wholly depends on the natural conditions in the seasonal period. The successful conjunction of the dimensions and shape of the blocks and the application of the optimal form of drying makes for intensification of peat drying and at the same time for an increase in final production yield.

In 1946, at the assignment of the peat industry, the Scientific-Research Department of the Moscow Technological Institute imeni L. M. Kaganovich, under the direction of Professor S. L. Bastamov and Professor M. M. Mayzel', designed an artificial climate laboratory for these purposes which was immediately made ready.

Whereas for construction of a model of frost zones of the humid subtropics a complex of three meteorological elements -- temperature, humidity and wind velocity -- sufficed, for the peat industry's artificial climate laboratory a more complete complex of meteorological conditions had to be designed. In this project direct and diffused solar radiation, precipitations and variations of the subsurface water level in the soil monolith were also provided.

The peat industry's artificial climate laboratory consists of a closed hermetic aerodynamic tunnel with a sealed work area of cubic form. The air circulating in the tunnel passes on its way a cooling system, a heating installation and a humidifying unit. The velocity of the air in the tunnel reaches 5 meters per second, the temperature, from 0 to plus 60 degrees and the humidity, from 20 to 100 percent.

Installed in the upper part of the operational chamber is a light-exposure chamber with an arrangement of daylight lamps for imitation of direct solar radiation. Diffused radiation is reproduced with the help of frosted glass and milk glass.

The drying of lump peat by various operations and in various shapes must be conducted on a natural underlying surface. For realization of this condition the operational chamber is supported at the bottom by a monolith with a peat bed in which the subsurface water level is regulated by a special device. Thus the upper surface of the peat monolith forms the bottom of the operations chamber.

In this chamber precipitations of various intensities are provided. For this purpose water-spray jets working off of a water-conducting network are arranged around the periphery in the upper part of the chamber.

A few remarks should be made on special features of the processing of materials in the various works conducted in artificial climate laboratories. The majority of these works require the establishment of comparison criteria which will assure the transition from the dimensions of a studied "model" to nature. One must, however, have the difficulty of this transition constantly in mind.

Let us give several examples.

The results obtained from experiments on snow precipitation on model railroad shelters were completely satisfactory, qualitatively and quantitatively, but their quantitative interpretation did not fall within the Reynolds comparison criterion. Indeed, with a model 4 - 5 times smaller than nature, the windstream velocity would have to be increased up to 40 - 50 meters per second, which was unrealizable for the given installation. Similarly, the coefficient of kinematic viscosity was not determined. Thus, in spite of the good conformity between the measurements of snow precipitation in the models and in natural conditions, the processing of the laboratory experiments could not be fully conclusive.

For work on the thermal conditions of soils an experimental comparison criterion was established of the Fourier type $F_0 = \frac{\alpha t}{x^{1.6}}$ = const, where α is the thermal conductivity, t is the time, and x is the determining dimension of the model. The cited expression fully proved its worth in the most careful works on construction of models of conditions in perpetually frozen grounds and of conditions in large monoliths of freezing damp grounds. Let us note that in the Fourier criterion the coefficient α is considered to be constant, whereas, as a result of the migration of moisture during through-freezing, the density of the ground, its thermal capacity and thermal conductivity change; moreover, the thermal capacity of the soil air is not the same in different levels of the soil. All these considerations, obviously, lead to the conclusion that in operation with models the sought-for temperatures will be observed at different depths ($x^{1.6}$) than one would expect according to the Fourier theory (x^2).

It should be noted that the comparison criterion obtained for generalization of experimental materials on the laboratory study of car lubricants proved to be completely satisfactory in the temperature range from plus 40 to minus 52 degrees.

The comparison criterion was obtained from the fundamental hydrodynamic equation of lubricant operation, rather than from the Sommerfeld "friction number".

In fact, under conditions of incompressibility of the lubricating fluid, we have:

$$\frac{\partial p}{\partial x} = \mu \Delta u$$

where p is the pressure on the axle expressed in absolute weight units, u is the rate of motion, μ is the coefficient of viscosity, and

$$\Delta u = \frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} + \frac{\partial^2 u}{\partial z^2}.$$

Applying the equation to the one direction perpendicular to the friction surface, we shall have:

$$\frac{\partial p}{\partial x} = \mu \frac{\partial^2 u}{\partial x^2}.$$

After this the comparison criterion will be written in the following form:

$$\frac{px}{\mu u} = \text{idem},$$

where x is the determining linear dimension, as has been confirmed.

The results of work on the dependence of evaporation upon the dimensions and form of the evaporating vessel are well represented by the criteria of Reynolds and Peklé.

There is no doubt that with the construction of two new artificial climate stations the application of meteorological experimentation will lead to the successful solution of a whole series of problems presented to various branches of the national economy.

SHORT REPORTS AND ARTICLES

A TECHNIQUE FOR CALCULATION OF ADVECTIONAL CHANGES OF TEMPERATURE USING PILOT-BALLOON OBSERVATION DATA

S. S. Klyucharev

In an earlier published work of the author [1] methods for determination of the advectional temperature variation by means of charts of baric topography and using data of pilot-balloon observations at a fixed point were described. Insufficient accuracy in the drawing of the isohypses on the baric topography charts often proves an obstacle to the calculation of the advectional temperature change by the first method. In many cases more reliable results may be obtained using the data of pilot-balloon observations, i.e., by the second method. Not dwelling upon questions of the foundation of this method in principle, we shall indicate here practical procedures which allow advectional temperature changes (or, to put it more briefly, advection) to be quantitatively calculated in a very simple way from data of pilot-balloon observations at a fixed point.

According to the author's work [1], the operational formula for calculation of advection in a layer of thickness $h_n - h_1$ is the expression

$$\left(\frac{\partial T}{\partial t}\right)_a = \frac{0.36}{h_n - h_1} \sum_{i=1}^{n} v_i v_{i+1} \sin \Delta\alpha, \qquad (1)$$

where $\left(\frac{\partial T}{\partial t}\right)_a$ is the advectional temperature change in degrees after three hours, 0.36 is the coefficient for latitude 56 degrees, $h_n - h_1$

is the thickness of the layer in hundreds of meters, v_i is the wind velocity at altitude h_i in meters per second, v_{i+1} is the velocity at altitude h_{i+1}, $\triangle\alpha$ is the angle between the vectors $\bar{v}_i$ and $\bar{v}_{i+1}$.

The results of calculation are the more accurate the greater is n, that is, the greater the number of measurements there are within the given layer $h_n - h_1$. The minimal thickness of a layer for which one may calculate advection is 1000 - 1500 meters. At the same time, wind measurements must be distributed at each 250 - 300 meters of altitude.

For elucidation of the calculation technique we present Table 1 as an example.

[See next page for Table 1]

The given calculation indicates that in the 1070 - 2590 meter layer, with a middle altitude of 1830 meters, in 16 hours on 4 June 1948, there occurred a considerable advection of heat with an intensity of 2.9 degrees per 3 hours. At the same time in the overlying 2590 - 5180 meter layer (with middle altitude 2890) there was an extremely weak advection of the same sign with an intensity of 0.3 degrees per 3 hours. Thus the advection was extremely irregularly distributed with respect to altitude. The synoptic situation on this day was characterized by the approach of a trough toward Moscow from the southeast. The given case is interesting in that here a strong invasion of warm air was proceeding in the lower atmospheric layers, accompanied by a strong development of instability. Within 18 hours of the same day there began in Moscow a strong thunder-

TABLE 1

CALCULATION OF ADVECTIONAL TEMPERATURE CHANGE BY PILOT-BALLOON DATA DURING 16 HOURS AT MOSCOW, 4 JUNE 1948

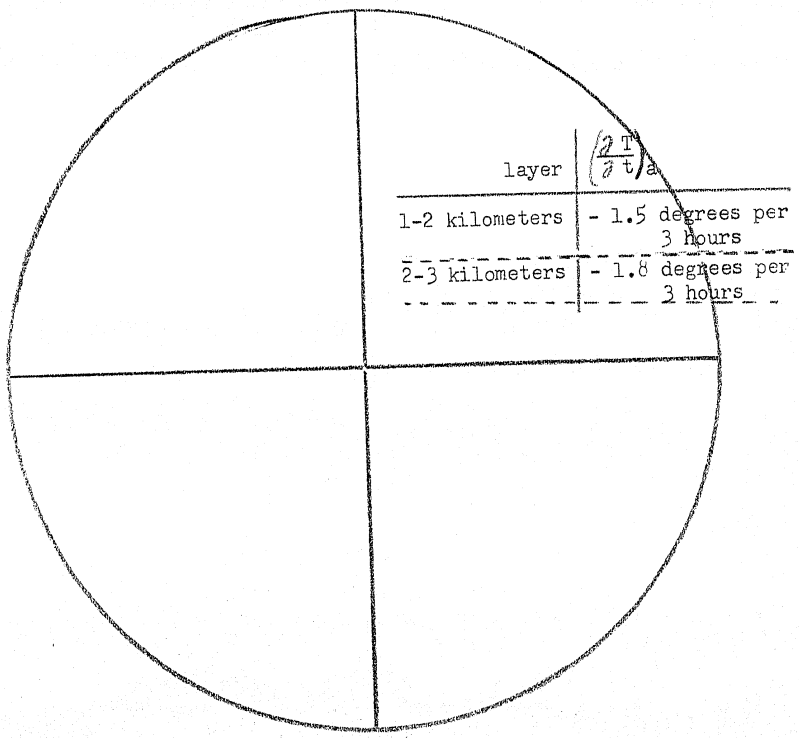
h [1]	α [2]	v [3]	$\Delta\alpha$ [4]	$\sin\Delta\alpha$ [5]	$v_i v_{i+1}$ [6]	$\Sigma\Pi$ [7]	Π [8]	Δh [9]	$\bar{h}$ [10]	$\left(\frac{\partial T}{\partial T}\right)_a$ [11]
10.7	55	7								
			+11	+0.19	56	+10.7				
13.7	66	8								
			+30	+0.50	64	+32.0				
16.8	96	8								
			+24	+0.41	72	+29.5	+121	15.2	18.3	+2.9
19.8	120	9								
			+ 7	+0.12	90	+10.8				
22.9	127	10								
			+29	+0.48	80	+38.4				
25.9	156	8								
			+ 1	+0.02	80	+ 1.6				
29.0	157	10								
			- 8	-0.14	100	-14.0				
33.5	149	10								

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]
			+ 9	+0.16	90	+14.4	+ 21	25.9	38.9	+0.3
39.6	158	9								
			- 5	-0.09	108	- 9.7				
45.7	153	12								
			+14	+0.24	120	+28.8				
51.8	167	10								

h is the altitude above the earth's surface in hundreds of meters, α is the direction of the wind in degrees, v is the velocity in meters per second, $\Pi = v_{i+1} \sin\Delta\alpha$, Δh is the thickness of the layer, h is the altitude of the middle of the layer.

storm with downpours yielding 20 millimeters precipitation.

Sometimes it is more convenient to determine the advection of temperature by another method, that is by a hodograph, which may be easily constructed on a Molchanov circle or on a special blank (Figure 1), plotting the wind vectors from a single point and joining their extremities with a continuous line, as is shown in the figure. It follows from formula (1) that the advectional change of temperature in the layer of atmosphere between altitudes h_1 and h_n is proportional to the area included between the vectors of the wind at the lower and upper boundaries of the layer and the curve of the hodograph. (An area formed by the rotation of the wind vector with altitude to the right is considered positive, and with a contrarily directed rotation, negative.)



layer	$\left(\frac{\partial T}{\partial t}\right)_a$
1-2 kilometers	- 1.5 degrees per 3 hours
2-3 kilometers	- 1.8 degrees per 3 hours

Figure 1. Wind Hodograph. Moscow, 2 June 1947, 00 hours 00 minutes.

For calculation of the advection one may determine this area by planimeter, but it is better to use a nomogram (Figure 2). This nomogram has two curve systems: the solid lines trace the isolines of advectional temperature change, and the dotted lines are arcs of circumferences centered at point O.

Figure 2. Nomogram for calculation of advection. Latitude 56 degrees, advection in degrees per 3 hours with $\Delta h = 1$ kilometer.

1 -- area corresponding to advection in 0.5 degrees per 3 hours

For measurement of the advection we place the nomogram, which is traced on transparent paper or celluloid, in such a position that point O of the nomogram coincides with point O on the draft of the hodograph, and line OL of the nomogram coincides with the vector of the wind at the lower boundary of the layer.

Then we select the dotted-line arc which forms a sector between the directions of the wind at the lower and upper boundaries of the layer, approximately equal to the area of the hodograph. After this we note the point of intersection of the selected arc with the vector of the wind at the upper boundary of the layer. The position of this point in the system of advection isolines gives the magnitude of advection in degrees per 3 hours, if the thickness of the layer in question is one kilometer. If the thickness is m kilometers, the obtained number must be divided by m.

Practical calculation of advection with data of pilot-balloon observations at a fixed point indicates that this method gives satisfactory results, if the original data (that is, the wind measurements) are sufficiently accurate. On the basis of pilot-balloon observations, the probable error in determining advection does not exceed 0.5 degrees per 3 hours for advection magnitude 2 degrees per three hours.

It is essential to note that one may determine advection by this method only in the free atmosphere. It is impossible to use wind data at an altitude less than one kilometer, and also in mountain regions where the local conditions of the terrestrial surface influence the distribution of the wind.

Formula (1) and the nomogram are calculated for latitude 56 degrees. With their aid one may compute the advection in accordance with observations at another latitude (φ) also, but then it is necessary to multiply the obtained result by the ratio sin φ/sin 56 degrees.

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THE QUESTION OF THE ROLE OF "SHIELDS" IN DETERMINATION OF PRECIPITATION

I. T. Bartishvili

Installations and instruments designed for measurement of precipitation make it possible to measure actually falling precipitations only in completely still, windless weather.

In windy weather, in order to decrease the blowing-off of the snow which has accumulated in the precipitation gauge, a so-called "shield" is attached to the gauge. Means to prevent this blowing-off are applied chiefly in the USSR and America, but in those countries where snow falls in small quantities, as, for example, in Western Europe, precipitation measurements are conducted with rain gauges without any shields. The famous Nifer shield, which was widely employed in rain-measurement stations in Russia from 1890 on, gradually went out of use, its place being taken by the Al'ter and Kodd baffle shield. But in a case where one apparatus is replaced by another this other apparatus must give better results than the first, or else the substitution is meaningless. It is asked, what is the function of the indicated "shields", and do they make possible even an approximate determination of the actually falling precipitation.

In order to answer this question, let us consider certain materials from the fourteen-years' observations at the Kazbeg high-mountain meteorological station. In the first two years precipitation measurements were produced by a rain gauge with a Nifer shield, in the third year (together with the rain gauge) a Tret'yakov precipitation gauge began to be applied, and since 1 January 1949 a so-called "composite" precipitation gauge, which I reconstructed, has been installed. The Tret'yakov and composite precipitation gauges were provided with baffle shields and were installed in a completely open place in identical conditions.

The results of precipitations measurements in the course of 1949 with the three indicated precipitation gauges are presented in Table 1.

TABLE 1

Quantity of Precipitation in 1949 in Millimeters

Precipitation Gauge	During the Year	During the Cold Period (January to April and October to December)	During February and March
Rain gauge (Nifer shield)	841.5	159.5	13.1
Tret'yakov precipitation gauge (baffle shield)	1210.9	451.3	65.4
Composite precipitation gauge (baffle shield)	1624.8	822.8	149.5

From the observational results it is clear that the rain gauge with a Nifer shield does not catch precipitations at the time of a snowstorm. The composite precipitation gauge collects 6 times as much precipitation as the Tret'yakov gauge during strong winds and 2-3 times as much as the latter during weak winds.

In February 1950 the shield was removed from the composite precipitation gauge and until 19 March observations were conducted with this instrument without a shield. The results of observation during this time interval are as follows:

Rain gauge (Nifer shield)	47.1 millimeters
Tret'yakov precipitation gauge (baffle shield).	135.5 millimeters
Composite precipitation gauge (without shield).	212.0 millimeters

It should be noted that on 4 February and 18 March more precipitation was measured by the Tret'yakov precipitation gauge than by the composite gauge. On 4 February 1.4 millimeters precipitation were measured by the Tret'yakov precipitation gauge at 19 hours and 1.0 millimeters each by the rain gauge and the composite precipitation gauge. On 18 March the three precipitation gauges registered the following quantities of precipitation at the times of the 7- and 19-hour observations:

	7 hours	19 hours
Rain gauge (Nifer shield)	4.1 millimeters	7.0 millimeters
Tret'yakov precipitation gauge (baffle shield)	4.5 millimeters	8.8 millimeters
Composite precipitation gauge (without shield)	3.8 millimeters	5.5 millimeters

On these days (4 February and 18 March) during the snowfall a slight wind was blowing, observed at times to be fully still. On 27 February and 15 March all of the precipitation gauges measured the same quantity of precipitation.

On 19 March 1950 the lid was also removed from the composite precipitation gauge, so that what was left of it was actually a Tret'yakov precipitation gauge without any shield. From 19 March to 1 May the following observational results were obtained:

Rain gauge (Nifer shield)	75.1 millimeters
Tret'yakov precipitation gauge (baffle shield). .	120.6 millimeters
Tret'yakov precipitation gauge (without shield) .	94.2 millimeters

As we see, the quantity of precipitation according to the data of the Tret'yakov precipitation gauge without shield is greater than the quantity of precipitation according to the rain gauge; in addition, the former data approach those of the rain gauge more closely than those of the Tret'yakov precipitation gauge with shield. In separate cases, in the presence of weak winds, the data of the rain gauge and the Tret'yakov precipitation gauge without shield approach one another very closely (the rain gauge data are just a trifle greater), and the data of the Tret'yakov precipitation gauge with shield are considerably greater than the data of both [the other] precipitation gauges.

The results of measurement with the precipitation gauge without shield remain on the average higher than those with the rain gauge, because during snowstorms, which are observed rather often at the Kazbeg station, the rain gauge is completely incapable of accumulating precipitations.

In the course of 1949 (when the Tret'yakov and composite precipitation gauges were located in identical conditions) the composite precipitation gauge measured 6 times more precipitation than the Tret'yakov gauge in the presence of winds with velocities of 25 - 40 meters per second. In 1950, when the shield was removed from the composite gauge, it accumulated almost 3 times more precipitation than the Tret'yakov gauge in the presence of winds of the same velocity.

The introduced materials show convincingly that precipitation gauges of different constructions give different readings, the difference being so great that it may introduce changes in principle into contemporary representations of the quantity of actually falling precipitation. Certain peculiarities of the indicated instruments are easily explained. Thus, for example, a slight increase of the quantity of precipitation given by the precipitation gauge with baffle shield as compared to that given by the instrument without shield in quiet weather is essentially explained by the blowing off of snow from the plates of the shield by light gusts of wind.

As we know, the baffle shield consists of 16 metallic plates which are curved outward at their upper ends, the area of the curved upper end of each plate being slightly different from the area of the collecting part of the Tret'yakov precipitation gauge. During a quiet snowfall the surface of the curved part of each of these plates collects approximately the same quantity of snow as falls into the precipitation gauge, and a rather insignificant whiff of a breeze will throw part of the heaps of snow accumulated on the plates into the precipitation gauge.

However, the basic problem is which precipitation gauge gives readings which constitute the best appraisal of the actually falling precipitation while remaining exposed, and the importance of the problem demands that we approach its solution without delay. The existing data on the role of "shields" lead us to the conclusion that this role is generally destructive. The study of the aerodynamic spectra of rain gauges which Basmatov and Vitkevich, and later Yakob, conducted, indicated that from the whirling motion of the wind a so-called "air cap" is formed at the edges of the rain gauge, and the wind, blowing the snow away from the surface of the rain gauge which is turned toward it, blocks it up inside the instrument.

If the comparatively small dimensions of a precipitation gauge change the natural course of the air flow, then any kind of shield, having larger dimensions, must change it more. We assume that the quantity of snow blown away from the surface of the precipitation gauge which faces the wind and blocking up inside it must be so insignificant that it will not exceed the error which is generally tolerated in precipitation measurement, whereas the quantity of snow which is collected by the action of the shield from its edges and surfaces and is blocked up inside the precipitation gauge is considerably larger. Therefore, in our opinion, observations of precipitation are better conducted with precipitation gauges without any shields.

Being ruled by this, we have constructed a new duplex precipitation gauge without shield which has been under test at the Kazbeg meteorological station since February 1950. On the basis of preliminary data we believe that this instrument will afford the possibility of sufficiently accurate determination of the quantity of precipitation in any weather.

MORPHOMETRICAL CHARACTERISTICS OF RIVERS

Z. A. Grinberg

As a result of the interaction of current and channel, according to the views of M. A. Velikanov, there develop relationships between the morphometrical elements and the hydraulic characteristics of the current, these relationships forming "a limited number of possible types of natural currents" [1].

In 1924 the State Hydrological Institute derived the relationship between the average width and average depth of rivers

$$\frac{\sqrt{B}}{H} = a, \qquad (1)$$

where coefficient a is equal on the average to 2.75. For rivers with easily eroded channels a reaches 5.5 and, on the contrary, for rocky channels, falls to 1.4.

This relationship was obtained for the state of a current which is actively developing a channel for itself, that is, for maximum levels which do not open onto bottom land.

S. I. Rybkin [4], on the basis of careful statistical processing of significant hydrometric material on the river basins of the Upper Volga and Oka, established the following morphometrical relationships for the sections of rivers which are without tributaries:

$$B = 4.67\ \bar{Q}^{0.57}\ K^{0.13}\ I^{-0.07}, \qquad (2)$$

$$H = 0.069\ \bar{Q}^{0.22}\ K^{0.50}\ I^{-0.24}, \qquad (3)$$

$$V - 3.10\,\overline{Q}^{0.21}\,K^{0.37}\,I^{0.31}, \qquad (4)$$

where B, H and V are respectively the average width, depth and velocity of the tributaryless section, $\overline{Q}$ is the perennial discharge of water, K is the coefficient of aqueosity [coefficient of discharge] $(K = \frac{Q}{\overline{Q}})$, and I is the incline of the water surface.

Absent from relationship (1) are hydraulic parameters of the current which in interaction with the various grounds of the channel bed condition such a relationship. Indeed, in S. I. Rybkin's relationships specifications of the alluvia, which show influence on the intensity of the channel processes and consequently on the morphology of the river channel, are absent from explicit view.

The circumstance that ratio (1) is correct for rivers with any magnitude of average perennial flow, from small brooks to large rivers, shows that in the construction of such a ratio from relationships (2-4) the magnitude of the average perennial flow as a climatic factor must drop out. Quantities a and b [sic] in ratio (1) depend not only on the grounds which make up the river bed but also on the degree of fullness of the channel and the incline of the water surface; that is, ratio (1) is in general a function of the Froude number, which is related to the average diameter of the bed particles. Finally, relationships (2-4) must conform to the law of quadratic resistances, that is, to the Chezy formula.

Proceeding from what has been stated above, we received the following exponents in the morphometrical relationships:

$$B = a_1 \bar{Q}^{0.57} K^{0.14} I^{-0.27}, \qquad (5)$$

$$H = a_2 \bar{Q}^{0.23} K^{0.46} I^{-0.23}, \qquad (6)$$

$$V = a_3 \bar{Q}^{0.20} K^{0.40} I^{0.30} \qquad (7)$$

with parameters a_1, a_2 and a_3 considered to be not constant for all rivers, including those flowing on plains. Relationships (5 - 7) are very close to S. I. Rybkin's relationships, but they better answer the above-indicated conditions.

Let us actually raise H to the power 2.5 and set up the ratio $\frac{B}{H^{2.5}}$:

$$\frac{B}{H^{2.5}} = \frac{a_1}{a_2^{2.5}} \cdot \frac{I^{0.5}}{K} .$$

Let us designate $A = \frac{a_2^{2.5}}{a_1}$ and transpose $H^{0.5}$ into the numerator of the right side:

$$\frac{B}{H^2} = \frac{H^{0.5} I^{0.5}}{AK} \qquad (8)$$

Let us square both sides of the equality and multiply the numerator and denominator of the right side by the acceleration of the force of gravity:

$$\frac{B^2}{H^4} = \frac{HgI}{A^2K^2g} \text{ or } \frac{\sqrt{B}}{H} = \sqrt[4]{\frac{HgI}{A^2K^2g}} . \qquad (9)$$

The only parameter representing the channel alluvium is apparently A^2 with the dimension $[A^2] = L^3$.

Let us introduce

$$K_1 A^2 = D^3,$$

where D is the average diameter of the bed particles and K_1 is a nondimensional coefficient; then

$$\frac{\sqrt{B}}{H} = \sqrt[4]{\frac{\frac{K_1}{K^2} HgI}{gD^3}} . \qquad (9a)$$

Since the numerator under the radical is the square of some velocity proportional to the average current velocity, then

$$\frac{\sqrt{B}}{H} = \sqrt[4]{\frac{\alpha u^2}{gD^3}} \qquad (10)$$

Multiplying the right and lefthand sides of the equality by D, we obtain the final form:

$$\frac{\sqrt{BD}}{H} = \sqrt[4]{\frac{\alpha u^2}{gD}} \qquad (11)$$

The nondimensional coefficient α is considered both as the change in inflow velocity and as the change in the quantity of alluvia transferred with the change in this velocity; α is the coefficient of interaction of current and channel.

The formula we have obtained (11) may play a big part in problems of construction of models of channel processes. Let us now reduce relationships (5 - 7) to the Chezy formula. For this purpose let us raise H to the power 1.87 and form the product $BH^{1.87}$:

$$BH^{1.87} = a_1 a_2^{1.87} \overline{Q} KI^{-0.5};$$

since

$$\bar{Q}K = Q,$$

then

$$BH^{1.87} = a_1 a_2^{1.87} QI^{-0.5},$$

hence

$$Q = \frac{H^{0.37}}{a_1 a_2^{1.87}} BH\sqrt{HI},$$

where

$$V = \frac{H^{0.37}}{a_1 a_2^{1.87}} \sqrt{HI} \qquad (12)$$

(We shall also obtain formula (12) if we set up the ratio $\frac{V}{H^{0.87}}$ from formulas (6, 7) and consider $a_3 = \frac{1}{a_1 a_2}$.)

and

$$C = \frac{H^{0.37}}{a_1 a_2^{1.87}} \qquad (13)$$

It follows from formula (13) that since the "roughness" of different rivers is different (for one and the same depth), then parameters a_1 and a_2 similarly cannot be identical for all rivers.

Let us write the Manning formula:

$$C = \frac{1}{n} H^{1/6} \qquad (14)$$

Comparing (13) and (14) we obtain

$$n = \frac{a_1 a_2^{1.87}}{H^{0.20}} . \qquad (15)$$

It follows from formulas (13) and (15) that the Manning formula (and also Forkheimer's $C = \frac{1}{n} H^{1/5}$) does not sufficiently take into consideration the dependence of "roughness" upon depth and therefore is not applicable to natural currents.

N. N. Pavlovskiy [3] shows that the value of y for natural channels (in Pavlovskiy's formula $C = \frac{1}{n} H^y$) exceeds 1/6 and 1/5 and reaches 1/3 and even 1/2.

Thus the Pavlovskiy formula

$$C = \frac{1}{n} H^y$$

takes preference over the Manning and Forkheimer formulas, and for natural channels the value $y = 0.37$ is proposed. Values of the roughness coefficient may be taken in relation to the stability of the river channels (Table 1). They are in close agreement with the values of the roughness coefficient recommended by M. F. Sribnyy.

Further, since $K_1 A^2 = D^3$, then $a_2 = \frac{a_1^{2/5}}{K_1^{1/5}} D^{3/5}$. Substituting the value of a_2 in formula (13), we obtain

$$C = P\left(\frac{H}{D^3}\right)^{0.37} \qquad (16)$$

where

$$P = \frac{K_1^{0.37}}{a_1^{1.75}}$$

Let us pass on to the quantitative determination of the parameters.

It follows from formula (1) that, other conditions being equal, the ratio $\frac{\sqrt{B}}{H}$ decreases with increase in the average diameter of the bed particles. Consequently, for more steady lowland rivers parameter A^2 increases, since $K_1A^2 = D^3$. In this case parameter a_1 will decrease and a_2 will increase. For less steady lowland rivers, on the other hand, a_1 must increase and a_2 decrease.

Thus, depth erosion predominates in the more steady rivers and lateral erosion in the less steady.

As a result of work with pilot charts of rivers of various steadiness we have obtained the various values of the parameters.

On the basis of comparison of the values of the parameters with values of the Lokhtin coefficient and in conformity with nomenclature [2] we propose the following values of the parameters, shown in Table 1. Also given in this table are values of the coefficient of roughness n (from formula (13) $n = a_1a_2^{1.87}$).

With regard to mountain rivers, where there obviously will occur an increase of the geometrical dimensions of the alluvion and of roughness and an increase of depth erosion, a_1 will apparently be still smaller and a_2 still larger than for steady rivers (we propose in rough approximation: $a_1 = 2.7$; $a_2 = 0.120$; $n = 0.050$).

TABLE 1

Category of Steadiness [1]	Character of River [2]	$\gamma = \frac{D\ mm}{\Delta H\ m/km}$ [3]	Recommended Values of Parameters a_1 [4]	a_2 [5]	Roughness Coefficient $n = a_1 a_2^{1.87}$ [6]
I	Lowland rivers of minimum steadiness, whose channels fluctuate both in depth and in surface plan	< 2.5	6.30	0.052	0.025
II	Rivers of little steadiness in which erosion and sedimentation limit fluctuation of channel depth without noticeable fluctuation of the contours of the channel in plan (for example, the Visla River).	2.5 - 5	5.45	0.060	0.029
III	Relatively steady rivers whose channels undergo periodic changes in isolated regions, the contours of the channel fluctuating around an average value (for example, the Volga).	5 - 20	4.67	0.069	0.032

[1]	[2]	[3]	[4]	[5]	[6]
IV	Steady rivers whose channels are made up of non-eroded grounds or whose currents have little erosion energy (for example, the Yenisei)	> 20	3.00	0.100	0.040

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VERTICAL FORCE EFFECTS OF AN ICE FIELD ON HYDRAULIC ENGINEERING STRUCTURES

Yu. N. Neronov

When an ice crust freezes to a structure, a certain stress, which may be of extremely significant proportions, is transmitted to that structure when the water level fluctuates.

One may distinguish three different cases of the force effect of adhering ice depending upon the nature of the structure:

(1) upon isolated structures -- piles, cluster piles, ice breakers -- situated at a considerable distance from other structures or from shore (30 - 40 meters and more);

(2) upon long, narrow structures of the mooring-dock type placed at right angles to the shore, or upon structures intersecting the ice surface of reservoirs (pile breakwaters, ice-pile bridges, and the like);

(3) upon structures of the quay or pile-wharf type situated parallel to shore.

In each of the enumerated cases, with an equal change in the water level, the adhering ice cover is deformed in a different way, which determines the magnitude of the stress transmitted to the structures. In the first case the ice crust acts under conditions of centralized curvature; that is, there is uniform buckling around the structure, forming a plan of buckling in the form of a circle, with maximum sag in the center (Figure 1).

Figure 1. Diagram of centralized flexure of the ice field.

In the second case the ice crust takes on a cylindrical curvature with the lines of equal deformation distributed symmetrically with respect to the longitudinal axis of the structure (Figure 2).

Figure 2. Diagram of cylindrical flexure of the ice field.

The third case, corresponding to the freezing of the ice cover to wharves or quays, conforms in general to the preceding case, but the stress transmitted to the structure will be substantially smaller, since it acts upon only one of the half-fields of the chart of cylindrical flexure of the ice field.

The conditions which have been considered exhaust all the most important types of transmission of the force action of the ice crust to a structure.

In the process of flexure of the ice in the vicinity of a structure, the stress in the ice crust will be somewhat diminished in cases where water flows onto the surface of the ice. In connection with the fact that this decrease will only begin after the ice has sagged a distance of approximately one tenth its thickness, the effect proves, in general, to be insignificant. It may be demonstrated that the decrease of the force action of ice as a result of outflow of water onto its surface does not exceed 20 percent for an ice thickness of from 30 to 50 centimeters; for a thicker ice crust the possible weakening of the force action will be still less. Thus the practical significance of outflow of water onto the ice surface is small and can present interest only in cases of relatively thin ice crusts.

Considering an ice crust as an elastic plate lying upon an elastic foundation, let us examine independently each of the cases of action of an ice crust outlined above.

FORCE ACTION OF THE ICE FIELD UPON AN ISOLATED STRUCTURE (THE CASE OF CENTRALIZED FLEXURE OF THE ICE PLATE)

According to Bernstein [1] the maximum sag of the ice field is related to the applied stress in accordance with the correlation

$$F = \frac{p}{8\ell^2} \beta(\alpha). \qquad (1)$$

(The basic formulas for the action of ice under stress in the given case and in the exposition which follows are taken from [1].)

where F is the maximum sag of the ice crust, p is the vertical stress of the ice crust, and ℓ is a characteristic of the ice. $\beta(\alpha)$ is a function expressing the influence of the distribution of the stress (the area of the structure) upon F, whence

$$p = 8F\ell^2 \beta(\alpha). \qquad (2)$$

Since function $\beta(\alpha)$ is close to unity, that is, the effect of the area of distribution of the stress on the magnitude of sagging is small, and the magnitude of the ice sag F is in our case equal to the change in the water level in the reservoir ΔH, the final form will be

$$p = 8 \Delta H \ell^2 \text{ tons}. \qquad (3)$$

The characteristic of the ice (ℓ) is equal to

$$\ell = \sqrt{\frac{m^2Eh^3}{12\ (m^2 - 1)}}$$

where m is a quantity which is the inverse of the Poisson coefficient, E is the modulus of elasticity of the ice (in tons per square meter), and h is the thickness of the ice (in meters).

The magnitude of m may be taken as equal to 3 (according to Weinberg [2] $\frac{1}{m}$ fluctuates from 0.3 to 0.37), whereas the magnitude of E should be selected in conformity with the concrete conditions of the state of the ice and the weather. For soft ice and warm weather, with air temperature close to zero, the magnitude of E is on the order of 100,000 - 200,000 tons per square meter; for firm ice with temperatures 15 - 20 degrees below freezing, E may be up to 500,000 tons per square meter.

The growth of p will proceed within the limits from $\triangle H = 0$ to $\triangle H_{max}$, when the stress in the ice crust attains the value of the temporary resistance of the ice to flexure σ_{max} and shattering of the ice sets in around the surface of adhesion, where the flexure of the ice, and hence the stress, is greatest. The freezing of ice to wood, concrete and other materials is extremely tight and the forces of adhesion originating in this process exceed the internal cohesive forces of the ice. In view of this, the normal stresses, which in centralized flexure are considerably greater than the shearing stresses, interest us first.

According to Bernstein the normal stress is determined by the relationship

$$\sigma = 3\,\frac{m+1}{m}\,\frac{p}{h^2}\,C(\alpha)$$

or, taking m = 3,

$$\sigma = 4\,\frac{p}{h^2}\,C(\alpha); \tag{4}$$

whence for maximum force action with ΔH_{max} we have:

$$P_{max} = \frac{\sigma_{max}\,h^2}{4\,C(\alpha)}, \tag{5}$$

where σ_{max} is the temporary resistance of the ice to flexure. The magnitude in formula (5) which is unknown to us is $C(\alpha)$, which expresses the influence of the area of the structure on σ in relation to the thickness of the ice and the modulus of elasticity. The analytic expression of function $C(\alpha)$ has an extremely complex form; for practical computations it is more convenient to use its graphic expression (Figure 3).

Figure 3. Values of the function $C(\alpha)$.

With $\alpha = \frac{a}{\ell}$ (where a is the radius of a circle whose area corresponds to that of the structure, and ℓ is the characteristic of the ice), the values of $C(\alpha)$ are readily determined from Figure 3. The radius of the chart of flexure of the ice is determined by the correlation.

$$R = 3.92\,\ell. \tag{6}$$

[FORCE ACTION OF THE ICE FIELD ON STRUCTURES OF THE PILE BREAKWATER TYPE (THE CASE OF CYLINDRICAL FLEXURE OF THE ICE PLATE)]

The case of centralized flexure of the ice field was analyzed above. If other structures are located within the limits of the chart of flexure the form of the chart will naturally change, taking on the form of an ellipse and, finally, with a continuous series of structures, will turn to a cylindrical surface (Figure 2). In this case changes also occur in the character of the action of the ice.

According to Shulman, under conditions of cylindrical flexure the relationship between the sagging of the ice (F) and the load (Q) has the form

$$F = \frac{Q}{2.82\ell}\eta_1(\beta), \qquad (7)$$

where $\eta_1(\beta)$ is a function expressing the effect of the width of the structure upon F. For small values of the correction $\eta_1(\beta)$, (7) may be presented as

$$F = \frac{Q}{2.82\ell}, \text{ or } Q = 2.82\ell F.$$

The value of the sagging, F, corresponds in our case to the change in the level, $\triangle H$, whence

$$Q = 2.82 \triangle H \ell \text{ tons per meter.} \qquad (8)$$

The increase of Q will proceed with change in the level to a certain $\triangle H_{max}$, at which time the normal stresses in the ice crust will attain the magnitude of the temporary resistance of the ice to flexure σ_{max}, and the ice will break in the vicinity of the structure.

For an extremely long and narrow structure Q_{max} may be determined by the expression

$$Q_{max} = 0.47 \frac{\sigma_{max} h^2}{\ell} . \qquad (9)$$

Particularly narrow but long structures are seldom encountered in practical conditions; more often the structure is rather wide. The effect of the width of the structure on Q_{max} may be calculated by the expression

$$Q_{max} = 0.47 \frac{\sigma_{max} h^2}{\ell} \eta (\beta)$$

where $\eta (\beta)$ is a function analogous to $C(\alpha)$ considered above.

In cylindrical flexure of the ice field, in distinction to the case of centralized flexure, the influence of the load distribution upon σ is considerably smaller and it seems possible to take it into account by a simpler means. With sufficient accuracy for practical calculations (especially with the thickness of the ice $\geqslant$ 0.5 meter), with the width of the structure within the limits from 2.4 to 5.0 meters, the following formula may be used:

$$Q_{max} = 0.6 \frac{\sigma_{max} h^2}{\ell} \text{ tons per meter.} \qquad (10)$$

The length of the chart of flexure in the givencase is determined by the correlation

$$R = 3.33 \ell \qquad (11)$$

[FORCE ACTION OF THE ICE FIELD UPON STRUCTURES OF THE QUAY TYPE]

In this case we have cylindrical flexure of the ice field analogous to that considered above, with one semifield of the general chart of flexure in action. Here we will obviously have only half of the force action transmitted to the structure with full cylindrical flexure of the ice field. (Proof of this is determined from an analysis of the stresses essential for the attainment of equal flexures of an attached beam with the load at the center and a beam with the load applied at one of the ends, which are attached to a movable support [3].) Using (8), we may write

$$q = 1.41 \, \Delta H \ell \text{ tons per meter.} \qquad (12)$$

The maximum force action which may be transmitted to a structure with given values of σ_{max}, h and E will consequently be, in accordance with (9)

$$q_{max} = 0.23 \frac{\sigma_{max} h^2}{\ell} . \qquad (13)$$

CONCLUSIONS

From what has been stated above, we may make the following conclusions:

1. The vertical force action which is transmitted to a structure by the adhering ice crust with change in the water level is determined:

(a) by the magnitude of the change in level, or what is the same thing, by the magnitude of the flexure of the ice chart (ΔH);

(b) by the thickness and elastic characteristics of the ice, accounted for by the magnitude of the ice characteristic (ℓ);

(c) by the magnitude of the temporary resistance of the ice to flexure (σ_{max});

(d) by the form of flexure of the ice crust;

(e) by the dimensions and type of the structure.

2. The intensity of the rise in the level is of great significance. The theory of the action of the ice crust as a plate situated on an elastic foundation considers the ice crust as an elastic body. Therefore the formulas obtained on the basis of this theory will be correct only for conditions under which the elastic characteristics of the ice are still maintained. This corresponds to a relatively rapid change in level. If the change in level proceeds slowly the obtained formulas will give values which are too high. A gradual decrease of the force action (resorption) will be observed if the water level, having changed rapidly by a magnitude ΔH, stops and does not change further for a certain time.

The enumerated problems are related with the action of the ice in the realm of manifestation of its plastic properties. These properties have at present been insufficiently studied, so that it does not as yet seem possible to introduce any quantitative indicators into the stated remarks.

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CHRONICLE

FIRST CONFERENCE ON MARINE GEOLOGY

Anonymous

In 1950 almost 30 years have passed since systematic geological studies of the sea were begun in accordance with the decree signed by V. I. Lenin.

In this comparatively short period the geology of the sea has been transformed from a division of oceanography into an independent science with its own subject of research, its methodology and its wide field of practical applications, a science in whose development soviet scientists have played the leading role and have considerably outstripped analogous works along the same lines.

In March 1950, at the direction of the Main Administration of the Hydrometeorological Service of the State Oceanographic Institute, a conference was called on the geology of the sea. The purpose of the conference was to bring forward the results of works accomplished and to expose the next problems set before marine geology in connection with the increased demands of the national economy and of national defense.

Along with representatives of the hydrometeorological service organizations, over 100 of their fellow workers in the ranks of institutions, institutes and universities took part in the work of the conference. The wide interest which was shown toward this conference imparted to it the character of an all-union conference on marine geology and demonstrated the growth of the new science -- marine geology -- and its significance for the most diverse branches of the national economy and for the defense of our country.

In opening the conference G. S. Ivanov, director of the State Oceanographic Institute, noted that the problems of marine geology now concern not only the marine geology laboratory of the GOIN [the State Oceanographic Institute] (which was organized 20 years ago), but also a considerable circle of institutes and institutions both central and local. He emphasized that the most important results of works accomplished should be considered the creation of ground charts of USSR seas, the development of standard methods, the establishment of a unified classification of grounds and the training of cadres of marine geologists.

M. V. Klenova, supervisor of the GOIN's marine geology laboratory, in a paper entitled "Results of Works in Marine Geology from 1930 to 1950", gave a sketch of the origin and development of marine geology in the USSR, characterized in detail the fundamental directions of this science which are capable of being followed out in various institutions, and designated the problems standing before them. Klenova criticized the works of Professor N. M. Strakhov, associate member of the Academy of Sciences USSR, and Professor S. V. Bruyevich in marine geology, noted their underestimation of the achievements of soviet marine geology and pointed out that in marine geology as in the whole of soviet science there cannot exist disconnection of the separate research workers nor lack of coordination in their scientific works.

Professor V. P. Zenkovich (Institute of Oceanology, Academy of Sciences USSR), in a paper entitled "Fundamental Problems in the

Study of Seacoasts", brought forward the results achieved by research in this field during the past four or five years.

The papers of L. A. Sergeyev, candidate in physical-mathematical sciences (Academy of Sciences Azerbaydzhan SSR), and S. Ya. Rapoport, laureate of the Stalin Prize (Glavneftegeofizika [Main Petroleum Geophysics organization]), were devoted to the study of the sea floor with the aid of echo sounding and marine seismic surveys. The speakers indicated the importance and perspicacity of geophysical methods for sea-floor research.

V. F. Solov'yev, candidate in geological and mineralogical sciences (Institute of Geological Sciences, Academy of Sciences USSR), in a paper entitled "Research in Marine Geology in Connection with Oil Production", gave a characterization of one of the newest directions in marine geology -- the petroleum geology of the sea, which has great practical significance.

Great interest was aroused by the papers of Professor V. N. Saks (Institute of Arctic Geology), P. S. Vinogradova (PINRO), V. A. Tokarev and N. N. Lapina (Institute of Arctic Geology).

The papers of T. I. Gorshkova (VNIRO), "Natural Moisture, Organic Matter and Carbonates as Indicators of Sediment Formation", and A. S. Pakhomova (GOIN), "Sesquioxides in Marine Sediments", were devoted to the chemism of sea-bottom sediments.

The papers of P. G. Popov (GOIN), "The Reflection of Fluctuations of the Level of the Caspian in the Stratifications of Its Sediments", and I. K. Avilov (GOIN), "The Thickness of the Sediments of the White Sea in Relation to its History in Late and Post-Glacial Times", illuminated the results of recent works in the GOIN's marine geology laboratory on the study of the bottom sediments of the Caspian and White Seas.

A. A. Aksenov (GOIN), in a paper entitled "Processes of Formation of the Northern Coast of the Sea of Azov", outlined the main features of the contemporary processes of the dynamics of the coast and pointed out certain consequences which are of essential importance for the improvement of navigation in the northern Azov.

Questions of the application of the regularities of marine geology to exposition of the genesis of marine medicinal muds were illuminated in the paper of A. M. Malakhov (Central Institute of Health Resort Science), "Marine Geology and The Study of Silty Medicinal Muds."

The works of the marine geology division of the Main Marine Atlas Editorial Office were characterized in the papers of Professor M. V. Klenova, "Charts of the Grounds of the Oceans of the World", M. A. Batalina, candidate in geological and mineralogical sciences, "Topography of the Floor of the World Ocean", K. P. Gorbacheva, "Geology of the Red Sea", L. A. Panova, "Charts of Outcroppings of Indigenous Rocks" and N. S. Skornyakova, "Sediments of the North American Shelf".

Preliminary results of certain works in marine geology being carried on in recent times were illuminated in the reports of V. P. Petelin, G. B. Udintsev (Institute of Oceanology, Academy of Sciences USSR) and D. Ye. Gershanovich (GOIN).

I. K. Avilov (GOIN) gave a brief exposition of the new method he has developed for mechanical analysis of grounds with the aid of a microscope.

Information on the status of the marine geological works of T. I. Gorshkova (VNIRO), P. S. Vinogradova (PINRO), Professor M. V. Klenova (GOIN), N. M. Arutyunova (Hydrometeorological Service Administration, Azerbaydzhan SSR), D. M. Suleymanov (Geological Institute, Academy of Sciences Azerbaydzhan SSR), M. N. Frolkina (Arkhangel Administration of the Hydrometeorological Service), and I. N. Lezin (Tuapsin Marine Science-Research Observatory) was heard at the conference.

Many of those present at the conference took part in the work of a committee for the consideration of and provision for a symposium, "Instructions in Marine Geology", which is being prepared for publication by the State Oceanographic Institute.

Those who came forward in the discussions gave positive appreciation of the initiative of the Main Administration of the Hydrometeorological Service in organizing the calling of the conference in marine geology and to the majority of those who had presented papers. The participants in the discussions made a considerable number of critical remarks.

In the concluding speech Professor M. V. Klenova pointed out that this conference had made it possible to become acquainted not only with the marine geological works conducted in the Hydrometeorological Service system, but also with many research projects which have been carried on in other organizations. After emphasizing the necessity for future expansion of geological works in the majority of oceanographic expeditions and research projects, Klenova noted with satisfaction that marine geology is entering a new phase -- the phase of application of advanced technology, allowing us to study not only the contemporary sediments, but also the deep layers of the sea floor.

In closing the conference G. S. Ivanov, Director of the GOIN noted the fruitfulness of its work, which had been carried out on the principle of criticism and self-criticism on a high scientific level.

The confererence approved the symposium "Instructions in Marine Geology" and a resolution to that effect was accepted.

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THE DISCUSSION OF A. A. BORISOV'S BOOK CLIMATOLOGY IN THE MAIN GEOPHYSICAL OBSERVATORY IMENI A. I. VOYEYKOV

T. Pokrovskaya

(A. A. Borisov, Climatology. Accepted by the Cadres Administration of the Main Administration of the Hydrometeorological Service Attached to the Council of Ministers USSR as a training manual for technical hydrometeorological schools. Gidrometeoizdat, Leningrad, 1949.)

A. A. Borisov's Climatology, a well-published little book, not large in size, was issued for circulation in 1949. The necessity for such publications was confirmed by the fact that this little book sold out in a short time.

However, in the preparation of this book for the press the following postulates, formulated by I. V. Stalin, A. A. Zhdanov, and S. M. Kirov in "Remarks Apropos of a Summary of Textbooks of the History of the USSR" (Symposium "The Study of History", Partizdat, 1937), were clearly forgotten: "The question is of the creation of textbooks, where each word and each definition must be weighed, and not of irresponsible magazine articles, where one may babble about everything just as one pleases, being diverted away from the feeling of responsibility."

The first reviewers, who were commissioned by the Hydrometeorological Publishing House to make the decision on the training manual when it was being released, did not signalize the serious faults it has, in spite of all their obviousness. When the book was already in circulation, a sharp, completely correct report was made by V. S. Samoylenko (Meteorologiya i gidrologiya, number 1, 1950). After that the directorate of the GUGMS [Main Administration of the Hydrometeorological Service] challenged the Main Geophysical Observatory to dispute A. A. Borisov's book at a meeting of the Educational Council and to make a decision on its ideological and scientific value.

The coworkers of the climatology section put I. A. Berlin an A. N. Lebedev, candidates in the geographical sciences, in charge of making a review. The preliminary discussion of the question at a scientific seminar of the section was extremely animated, and it was recommended that the reviewers' conclusions be proposed to the Educational Council as a basis for a decision.

In a series of active speeches about A. N. Lebedev's paper at two meetings, members of the Educational Council and others who were present sharply criticized the ideological, scientific, and stylistic inadequacies of the book (N. A. Bagrov, O. A. Crozdov, M. P. Timofeyev, R. F. Usmanov and others). Some of those who took part -- representatives of the Geographical Faculty of the Leningrad State University, and also the author and the editor -- smoothed over the general impression of the book, pointing out that not all its aspects, the ideological in particular, deserved such severe censure. However, the Council recognized the conclusions of the reviewers as correct and made the corresponding decision, declaring the edition in question to be rejected material, unacceptable for use as a training manual.

The fate of Borisov's book demonstrates once more the seriously unhappy state of affiars in meteorology textbooks. The failure is revealed to a significant degree in that the preparation of the book was conducted on an individual level, without the proper consultation of educational and scientific organizations, which, on their side, behaved passively and indifferently toward the whole important affair.

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THE DISCUSSION OF THE TRAINING MANUAL <u>THE FORECASTING OF MARINE HYDROLOGICAL CHARACTERISTICS</u> (A MANUSCRIPT BY K. I. KUDRYAVA) AT THE COUNCIL OF THE CENTRAL FORECASTING INSTITUTE

I. V. Ivanov

On 10 October 1950 a discussion of K. I. Kudryava's work, which was intended for publication as a training manual for higher institutes of learning, took place at the institute's Council.

The discussion of the manuscript proceeded in the presence of the author and the editor, and with the participation of representatives of the State Oceanographic Institute, The Leningrad Hydrometeorological Institute, Gidromteoizdat [The hydrometeorological publishing house] and the Ministry of Higher Education.

Six fellow workers of the marine hydrometeorological forecasting section, under the leadership of N. A. Belinskiy, candidate in physical and matehmatical sciences, reviewed the manuscript and offered a very detailed and thorough report.

In the discussion, the absence of training manuals in marine hydrological forecasting for higher institutes of learning at the present time was noted and the necessity for such a publication emphasized.

During the investigation of the manuscript at the council a series of its gross inadequacies were exposed. For example, it was noted that purpose and direction are lacking in Kudryava's work: the description of methods and research projects is given without proper criticism of them, as a consequence of which it is difficult to form a correct impression of their practical or theoretical value; the majority of the methods described in the manuscript have no practical application.

The grossest fault of Kudryava's work is expressed in the fact that the physical nature of the phenomena considered is not as a rule disclosed, and errors and unjustified simplifications are more than once admitted. Thus the physical laws which govern the processes evolving in the concrete physico-geographical conditions of the sea and the atmosphere, which consitute the foundation of marine hydrometeorological forecasting, remain unilluminated.

The completely incorrect reflection in the manuscript of the structure and function of the forecasting (science-research and operational) instruments of the Hydrometeorological Service and also of the organization of the forecasting service and of information within its system were noted at the Council.

It was also noted that Kudryava's manuscript requires considerable literary editing.

As a result of the discussion, the institute's Council agreed with the opinion of the authors of the report on the unacceptability of the manuscript for publication and recommended to the author that she revise it, taking into account the report and the remarks which had been made at the Council.

Thus the analysis of the manuscript at the council was of great assistance to the author.

During the discussion regret was expressed that the Gidrometeoizdat had launched upon the publication of Kudryava's work without having discussed the manuscript in a proper manner.

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CRITICISM AND BIBLIOGRAPHY

Ye. G. Popov

N.A. Belinskiy, Marine Hydrometeorological Information and Forecasts. Gidrometeoizdat, Leningrad, 1950. (Accepted by the Main Administration of the Hydrometeorological Service Attached to the Council of Ministers USSR as a training manual for technical hydrometeorological schools).

In the overall growth of the geophysical sciences hydrological forecasts, and among them marine hydrological forecasts, have arisen very recently. Called into life by practical demands, this branch of knowledge began precisely in our country with its planned socialistic system of economy.

The years of the first Stalin Five-Year Plans essentially constitute the period in which the scientific foundations of river and sea forecasting were laid and molded. The years of the Great Patriotic War and of the postwar period showed the full importance and significance of these forecasts for the national economy and national defense.

In the comparatively short period of its development, river and sea forecasting has not only come to stand on a firm scientific basis, but has also become included in the planning practice of all the most important branches of the national economy. In connection with this, the problem of preparation of cadres of specialists in hydrological and particularly marine forecasting has arisen in recent times in a new way and considerably more acutely. It is sufficient to say that the course in marine hydrometeorological forecasting, which began to be given systematically in the Leningrad

Hydrometeorological Institute in 1945, is now given in all the technical hydrometeorological schools. Naturally, the deficiency of educational literature for this course becomes ever more palpable with each year.

Under these circumstances the publication of the manual on marine forecasting which we are considering presents unusual interest. The very fact of the appearance of such a generalization bears witness to the great success our native science has attained in the development of marine hydrometerorological forecasting.

The release of N.A. Belinskiy's book, Marine Hydrometerological Information and Forecasts by Gidrometeoizdat represents the first generalization in world science of the achievements which this branch of geophysics has attained in recent times thanks to the labors of soviet hydrologists and navigators. (If one does not count V. Yu. Vize's well-known work, which is devoted to the single question of long-range forecasting of ice conditions on arctic seas.) There has been no similar work of generalization in foreign literature, and indeed there cannot yet be any, inasmuch as these problems have scarcely evolved all at there.

As a training manual, Belinskiy's book was intended for students of technical hydrometeorological schools; however, one may say with confidence that it will also be extremely useful for students of higher meteorological institutes and for all the specialists working in the organs of the marine hydrometeorological forecasting service.

The book is divided into eight chapters, not counting the introduction. At the beginning a short history of the development of marine hydrometeorological forecasts is given and their significance for the national economy is explained, after which general conceptions and definitions of forecasts themselves are given together with estimates of their effectiveness; further, an account is given of the fundamentals of methods of short-range forecast of sea level and of currents, agitation, water temperature and ice conditions of seas and, finally, the requirements for the setting-up and conducting of marine hydrometeorological observations essential for the further development and improvement of methods of marine forecasting are described.

From this short summary of the problems touched upon in the book it is already clearly apparent that it encompasses all the basic phenomena in the regime of the sea which it is extraordinarily important to foresee for the sake of the national economy.

This does not mean, however, that the book encompasses all the research works known in literature on each of the touched-upon problems. In creating a manual for students and a wide circle of specialists the author could not do this and it is completely correct (as is pointed out in the introduction) to stop with popular theoretical and empirical research works. These research works, giving a basis for understanding the physical nature of the phenomena considered, may be directly used in operational practice, or present interest with respect to methods. The importance of this last circumstance for marine forecasts should be particularly emphasized, since with the lack, and often low quality, of materials of marine observation, the methodology of solution of forecasting problems, even with a sufficiently good knowledge of the theory of the problem, presents unusually great and often insurmountable difficulty.

The distinguishing feature of N.A. Belinskiy's book is its tendency in dealing with all questions to give first a short characterization of the physical nature of the phenomenon and the theoretical foundation upon which forecasts must be based, and then to illustrate it with a concrete example of the methods used in the practice of the operational organs of the marine forecasting service. However, the author does not everywhere adhere to this excellent rule and in a series of cases gives a rather barren exposition of the working-up of the question or even of the general instructions on the procedure for this work (sections 25, 34, 36). In such cases it will be rather difficult for students of technical schools to discriminate by themselves on the problem being stated, without the help of an instructor.

Having considered each chapter of N.A. Belinskiy's book one wants above all to remark that the author has worked a great deal in order to generalize upon those rather disconnected research works and methods designs which were published in the literature in his time. He is aided in this by his good knowledge of both native and foreign literature and also by his long work in the operational forecasting service of the national economy.

Among the most successful chapters one should place chapters IV, V and VI, which deal with short-range forecasting of level, current, agitation and ice phenomena, in the first rank. Considerably more barren and sketchily presented are the chapters devoted to long-range forecasting and the concluding chapter, VIII, in which the author attempts to formulate the basic requirements for marine hydrological observations.

Chapter III, entiled by the author "Some General Conceptions", is the least successful chapter in the book. In this chapter the author gives a not altogether successful classification of forecasts according to how long they are made in advance, and also ideas on the estimation of the correctness and efficiency of forecasts. The whole chapter is extremely sketchy in writing and, one may say, in the degree of ~~[illegible] of~~ fact~~s~~ual reliability on such questions as the evalutation forecasts. An explanation of the probable character of all forecasts, and hence of the bases of existing methods for their evaluation, which is altogether essential in such a manual, is not given in this chapter. Much of this chapter will not be understandable to students of technical schools and to readers who are little acquainted with the theory of probability and mathematical statistics. Moreover, the calculations themselves of the range over many years, the computed range of verification of amethod and the concept of natural verification are presented very obscurely. The examples, which are adduced with extremely barren explanations (tables 1 and 2 and the curve of verification) in no way facilitate the understanding and assimilation of thismaterial.

The book isnot devoid of other faults, to whose number it is necessary to add the general barrenness of exposition and also the unsuccessful formulation in a series of cases of concepts and definitions. We draw particular attention to this only because the book is intended primarily for students of technical schools and this considerably increases the demands made of it in this area. In isolated cases there also exist faults on the purely editorial level.

The shortcomings we have noted certainly cannot extinguish the indubitable merit of N.A. Belinskiy's book, especially if one takes into consideration the circumstance that the author is the first to compile such a manual and naturally cannot make use of previous experience in this field.

Summing up what has been said, we consider that the publication of the manual which has been discussed will undoubtedly bring profit both in the work of preparing students and in the development of practicing specialists working in marine forecasting.

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1. The journal Meteorologiya i gidrologiya accepts articles containing results of scientific research in the fields of meteorology and hydrology, and also articles devoted to general problems of geophysics, the history of geophysical sciences and the practical work of hydrometeorological service. In addition, the section of criticism and bibliography includes articles of a controversial and critical, and also of a purely bibliographical, nature.

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