partly omitted, with the consequence that the theory yielded much better results. Investigators who want to do research in the field of atmospheric wave motions will have to study the "Physikalische Hydrodynamik" of V. Bjerknes and his collaborators. But those who desire only a brief account of the theoretical work of the Norwegians would certainly be indebted to Professor Brunt if he should find it possible in a future edition of his work to add a chapter on atmospheric wave motion to his excellent presentation of the other fields of dynamic meteorology.

In general, the book can be highly recommended to any serious student of dynamic meteorology and as a textbook for courses in this field. The presentation of the subject is very clear; and the limits and deficiencies of present theories are well brought out, which should stimulate interest in these problems and lead to further investigations. Professor Brunt's excellent treatise will help in the growing revival of dynamical meteorology in the United States.

There are a few misprints but otherwise the outer appearance, print, and reproduction of the figures are excellent.—Bernard Haurwitz.

**METEOROLOGY IN THE U. S. S. R.**

The Development, Organization, and Work Program of the Central Geophysical Observatory and its Central Institutes, Leningrad, U. S. S. R.

By ALEXANDER BREESE, U. S. Weather Bureau, Fresno, Calif.

The beginning of the Russian meteorological service dates back to 1869, when the department of storm warnings of the Central Physical Observatory was established. For the first twenty-five years the service, directed by Heinrich Wild, was under German influence. Even the instructions for meteorological observers were printed in German instead of Russian. This early habit of foreign co-operation, especially as Wild was chairman of the International Meteorological Commission, may be the reason for the world-wide grasp of meteorological problems which is a tradition of the Russian service. The predominance of German thought may also be the reason for the traditions of conscientious and accurate work firmly established in the service. The end of the century saw the development of Russian research along independent lines, questioning some of the doctrines then adopted everywhere in Europe. In Russian statements made at that time will be found the nuclei of many conceptions now widely admitted.

The World War and the Revolution rolled past, upsetting everything. How deeply the service was affected may be seen from the fact that of those stations functioning in 1914, viz., a few first order observatories, 1416 second order stations and 1470 third order, only 200 or 300 survived till 1920, and these emerged by no means unharmed. Since then the general setting for meteorological work has changed completely. It was no longer possible to attend to routine and abstract scientific work while disregarding the exigencies of practical life. Industry was assimilating and developing vast new areas, bringing rush calls for climatological data from all quarters. These manifold demands induced local organizations, enterprises and governments to un-
co-ordinate and often duplicate efforts in establishing weather stations. The situation reached a crisis in 1929, when the planned economic reconstruction and development of the Soviet Union was undertaken. At that time the government consolidated under the direction of the Central Hydrometeorological Committee of the U.S.S.R. the activities of the Central Geophysical Observatory (Leningrad), State Hydrological Institute, Central Weather Bureau (Moscow), State Institute of Oceanography, all Regional Hydrometeorological Committees and numerous local establishments, working in allied fields. The unification required readjustments in the organization of the institutions involved and took some time. The final regulations governing the Central Geophysical Observatory (CGO), formerly the Central Physical Observatory, were not approved by the Government until 1933, when its status was confirmed as "an All Union central scientific research and methodological institution in the fields of meteorology and geomagnetism." The responsibility for the scientific aspects of work of the entire United Hydrometeorological Service (UHMS) was entrusted to it. This justifies the assumption that the outline of this organization gives a fair basis for a general conception of present conditions of meteorological research in U.S.S.R.

The CGO is a scientific unit working under the absolute personal authority of the Director, appointed by, and responsible to, the Central Office of the UHMS. Four assistant directors (scientific, for military meteorology, for administration of Institutes at Sluts), eight directors of Institutes located at Sluts, scientific secretary and chiefs of six independent bureaux (rationalism and invention, guidance of the branches of UHMS, control and inspection of performance, personnel, labor economy and planning sector), are accountable to him personally. The Institutes are autonomous units, each devoted to the development of a certain branch of geophysics and its application to affairs, or to the problems of bringing geophysics into the service of a definite branch of the national economy.

The Central Institute of Theoretical Meteorology is an outgrowth of the mathematical bureau. Its work is centered on laying a foundation of theoretical basis for the improvement of weather forecasting. The study on the theory of dynamics and thermodynamics, atmospheric turbulence, development of graphical methods of description of atmospheric phenomena and their analysis, methods of application of mathematical statistics to meteorological problems occupy the attention of its staff. The verification of theoretical conclusions by laboratory methods and models are used when practicable.

The Central Institute of Actinometry and Atmospheric Optics conducts an exhaustive study of radiation energy in the atmosphere and hydrosphere. The Institute is a custodian of the standard instruments. It compares them with foreign ones, to maintain the work in U.S.S.R. in agreement with world standards and maintains a continuous check on the instruments used in U.S.S.R. The regular observations of the Institute's observatory are widened by planning, developing and guiding the work of local institutions and by out-

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2Carries on the regular synoptic work, making forecasts and publishing daily weather maps. The Bureau adopted air mass analysis several years ago under the instruction of Dr. T. Bergeron of Norway; and now publishes a daily air mass map of northern Eurasia, and also a map of the entire northern hemisphere.—Ed.
fitting expeditions. Regular observations are extended as far north as Selo Poliarneoe (Franz Josef Land) and Matochkin Shar. To the development of research methods and improvement of instruments considerable attention is given. The spectro-bolograph of Professor N. Kalitin is one of the latest achievements. The Institute is often called upon to work on practical problems for municipalities, organizations and producing units. The utilization of direct solar energy reached such a state of progress that it was necessary to establish the Heliotechnical Institute at Samarkand for its further development. It seems that this work is passing its experimental stage to the extent that now the water is pumped, food cooked, water boiled and public baths (at Kara-blanka and Tashkent) are operated by direct solar energy.4

ALL UNION INSTITUTE OF AEROLOGY is a rebirth of a similar one founded in 1912 and destroyed in 1918 by the withdrawing White forces, Romanoff’s Aerological Observatory at Pavlovsk (now Slutsk).

As long ago as the 1880’s, Prof. A. Voyeykoff (Woeikov) strongly advocated gathering data from the upper air. Somewhat later Prof. D. Mendeleeff, who constructed the periodic table of the chemical elements, stated that “the key to weather lies in the higher strata.” Thus though Russians early conceived the value of aerology it was decades before aerological research really got under way. After the Revolution stopped the work at Pavlovsk it was not until 1920 that the Moscow Aerological Institute was formed and work was resumed at Slutsk. This organization was then directly related to the military aviation service of Moscow. In time it grew organically from a military branch into the special Moscow Aerological Observatory incorporated under the State Geophysical Institute (now the CGO at Leningrad). In 1934 it was formed into the Aerological State Institute of Moscow. Its program comprises regular soundings by means of pilot balloons, kites, and tied aerostats, by free flights on aeroplanes and aerostats, and extensive soundings of the stratosphere by means of balloon sondes and “radio-pelengation.” Being situated in the very heart of the Russian plain, Moscow is a favorable place for high soundings. This Institute makes certain special investigations in relation to the economic program of the country, such, e.g., as the expedition to Ai-Petry, Crin.ca, for an aerological examination to locate superpowerful windmills, and also the 1934 expedition to the Russian drought sector to investigate the effect of proposed forest strips in the struggle against drying winds. Most of the researches of the Moscow Institute, even those used in national economic projects, have not yet been published.

In the meantime, since 1920, the All Union Institute of Aerology has been set up at Slutsk (Pavlovsk). Besides the exhaustive study of the atmosphere by soundings of all kinds, this Institute undertakes the development of methods for research and observation and the guidance of all the aerological work done elsewhere in the country. The methods are quite diverse. The older ones have been continued, more than 2700 kite flights having been made during the last 17 years. Since 1923 all pilot balloon ascents have been made with two theodolites, the single theodolite

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3 A radiation-proof platinum thermometer has been devised which reads in the sun only 0.1°C different from the shelter thermometer (at Tashkent Obsy.).

method being regarded as too in-
accurate. Professor P. Molchanov
has developed here methods of radio-
meteorograph sounding by which
ascents up to 15 to 20 km. under all
weather conditions in any locality
can be carried out.\footnote{See Moltchanoff, P.: articles in Beiträge z.
Phy. d.-fr.-Atmos., v. 14, no. 1-2, 1929, p. 45,
and in Gerland’s Beiträge z. Geophy., v. 34,
no. 3, 1931, p. 36; also “Erforschung der
höheren atmosphärenschichten mit Hilfe eines
Radiometerographen, Leningrad, 1930.}
Such ascents have been made daily for over a
year and the total number amounts
to more than 1000.

Some 130 aerological stations are
in operation. The use of airplanes
for observations is increasing and a
number of stations for regular me-
teorological flights have been estab-
lished. The Institute took a very
active part in the organization of the
stratostat flights not only by way of
theoretical work but also by con-
structing special instruments. It
conducts special work for developing
aviation by surveying airways and
airports. An installation is being
completed of an automatic radio-
meteorological station for use on the
airways. The detailed description
of this station is ready for publica-
tion. “... A method of investigat-
ing sudden air currents in the free
atmosphere ...” was developed in
1926 and “the observatory possesses
the only existing material on this
question today” (P. Molchanov).

\textbf{The Central Institute of Clima-
tology} has to combine in its activities
the old and the new. The urgent
request for data in connection with
the economic expansion is met by
compiling climatological atlases and
handbooks for different parts of the
U. S. S. R., from standard material.
The modern dynamic trend of meteoro-
logy, which has shown the inade-
quacy of means as indicators of actual
climatic conditions, makes work on a
new definition of climate and ways
of determining it imperative. The
approach to this problem was made
by organizing a number of brigades,
each consisting of scientists favoring
a specific set of principles to be taken
as basis. In the process some of the
sets of principles proved to be unus-
able for the purpose and were
therefore eliminated, gradually nar-
rowing the field of possible useful
ideas. It may be expected that it
will not be long before a new con-
ception of climatology with dynamic
complexes as its units will be pro-
posed for world-wide test. Micro-
climatology and correlation and peri-
dodicity are also studied.

During the recent Polar Year 90
special stations were set up, 20 in
the Arctic, 14 high mountain stations,
and the rest scattered through the
sub-Arctic and Asia. These have
been continued and because of the
special problems and methods in-
volved a separate administrative sub-
division has been organized for them.
Many of the manned stations are
supplemented now with self-register-
ing substations, e.g., as at auxiliary
slope stations (5600 and 6850 m) of
the Fedchenko Glacier Observatory
(4300 m) on Stalin Peak (7495 m)
in Middle Asia.

At Pacific Bay (Franz Josef Land)
a few sets of automatic radio-metec-
ographs are working quite satisfac-
torily. They report by radio, without human assistance, pressure temperature, wind direction and velocity, humidity, and temperature of a blackened thermometer to indicate cloudiness.

The present distribution and location of reporting stations is considered to be far from ideal and a study is being made of the possibility of systematically redistributing them so that by interpolation, the conditions at any desired place could be obtained. Archives are maintained which include data from as far back as 1725. Efforts are made to assemble every set of observations ever made in Russia. Accumulated observations are being catalogued and made accessible for use.

The Central Agro-Hydro-Meteorological Institute is directing the scientific aspects of the work of all institutions engaged in research in agricultural ecology, climatology and hydrology. Besides organizing the research on natural conditions it maintains laboratories of artificial climate, biochemistry and agrophysics. Among the subjects treated are: the value of planting forest strips in the Russian steppes, the possibility of extending the limits of certain crops to higher latitudes, and comparative study of Russian and foreign climates in their relation to agriculture. It works in close relation with the All Union Institute of Plant Industry.

The Central Institute of Terrestrial Magnetism and Atmospheric Electricity is engaged on problems of scientific or practical importance, in the domain of terrestrial magnetism, atmospheric and terrestrial electricity, as well as in radioactivity in natural conditions. Magnetic observatories serve as observational bases. Their number, six before the war, is augmented by eight new ones. The general magnetic survey is well under way, the work being performed by the central observatory at the Institute and the local observatories under its supervision.

The efficiency of the work is expected to increase greatly as a result of the development of a device called a “magnetoron” which permits uninterrupted observations on board a moving train or other vehicle. A catalogue of all magnetic determinations made on the territory of U. S. S. R. has been published by the Institute. The conditions affecting radio transmission as well as the electrical condition of the upper air and the study of cosmic rays find place in the Institute’s work.

The Central Institute for Verification of Meteorological Instruments assures the scientific value of the meteorological observations in Russia by insuring proper construction and functioning of the instruments in use. For this purpose the Institute is working on improvement and construction of instruments as well as on apparatus used for checking purposes, maintains the inspection and sealing of instruments at manufacturing plants at different stages of their production, and is supervising the work of local establishments for instrument verification. During 1931 there were presented for verification 85,069 instruments, and 82,442 were approved. A file of all verifications completed is maintained.

The Scientific Council with its Permanent Commissions is a consulting body. It determines the general policies directing the institutes, co-ordinates their activities in the guidance of local work and deliberates on the general problems of methodology. The council meets
under the chairmanship of the scientific assistant of the director of the observatory and consists of all assistants of the director, directors of institutes with their assistants, chiefs of bureaus, representatives from social organizations and the party.

Persons are employed by appointment of the director. Under the supervision of the scientific secretary the library is being built up very rapidly. At present it consists of over 60,000 titles. The bibliography of geophysics is compiled from 148 foreign and 70 Russian periodicals. Consultations on geophysical literature are given and references on special problems prepared on request.

The Bureau of Rationalization and Invention is organized to encourage the individual and local initiative toward improvement of procedure or organization.

The Bureau for the Guidance of the Organs of the UHMS and The Sector for the Control and Verification of Performance have to ensure scientific adequacy of the entire system embracing some 3000 stations. Each station is supposed to be inspected at least once a year.

The instructions for the inspectors, a booklet of 80 pages, in addition to technical advice, emphasizes the importance of the human coefficient in the meteorological work. It advises to observe tendencies toward individual errors and explain to the personnel their sources and ways to correct them, making the personnel at the same time conscious that the proper functioning of the smallest part of an integral system is as important as of the largest one, and that every slackening on the part of anyone impairs the entire organization.

The wide scope of work of the CGO presupposes a large and well-trained staff. In 1931 the personnel of the observatory numbered 650. A number of competent men are also required for the Central Weather Bureau and other allied organizations. Questions of grading the positions, technical requirements for different grades, and the problem of preparing candidates to fill them, are handled by the sector of personnel with the assistance of practically every department of the organization. The CGO supervises the courses in the universities and institutions for higher technical training. Agreements are made with the Moscow Hydrometeorological Institute, universities and other schools for admission by the Observatory of their students for the “compulsory production practice.” Scholarships are given to promising students with the understanding that their services will be used after graduation by the observatory. A number of long and short term courses are organized directly by the central and local observatories. Great efforts are made to assist those in service to improve their qualifications and to keep them up to date with the advancement of science. The observers are trained by local organizations.

The income of the organizations may be divided in two parts: That appropriated for planned activities and that for expenditures on the expansions not covered by the estimates. The necessary funds for the latter are forthcoming as contract payments from institutions which want certain research work performed. Among such in 1931 were: The institute of standards for the building industry, peat institute, city of Leningrad, all union civil air fleet, the institute for nonmetallic materials, railroads and collective farms.
Is Russia well enough informed to be able to follow the progress of the rest of the world and co-operate with other nations? The answer seems to be yes. In 1933, 70,000 scientific volumes were imported from the United States alone. "Dynamic Meteorology," by Hurd C. Willett, was translated and printed there soon after it was published in the United States. It is rarely that a popular Russian meteorological magazine fails to contain articles on our meteorological happenings, and the work of other countries receives its proper share.

As no opportunity has presented itself as yet for my personal acquaintance with the work of the Central Geophysical Observatory at Leningrad, this outline is limited by the material at hand, which consists of official reports, articles in scientific magazines and my private correspondence, and may have left unilluminated some important features in its activities.

All-Union (U. S. S. R.) Stratosphere Conference.—According to Nature, an article by Professor P. A. Molchanov in the Moscow News reports that the recent All-Union Conference for the Study of the Stratosphere decided to call an international conference, with the same objects to meet in the U. S. S. R. in 1936, the date to be fixed in relation to the total solar eclipse. The Soviet conference of last spring was mainly devoted to a review of the present state of knowledge of the problems of the extra-tropospheric regions of the atmosphere, with some references to their relation to the meteorological processes of the troposphere. Molchanov dealt with exploration by balloon sonde and radio sonde, and with the role of the stratosphere as stabilizer in atmospheric processes. Andriev discussed acoustic methods of investigation, and attention was specially directed to the prominence of the warm sound-reflecting regions during the polar night, at heights believed to be of the order of 30 km., and therefore likely to be accessible to the balloon sonde. Andriev also laid stress on the existence of air masses of unequal densities in the stratosphere, and urged their closer study. The conference passed resolutions dealing with the world conference and with the special need of co-operation among Soviet, American and Canadian scientific workers in polar atmospheric researches.

AN INTRODUCTION TO THE STUDY OF AIR MASS ANALYSIS

By Jerome Namias

VI. ELEMENTS OF FRONTAL STRUCTURE (Continued)

Cold fronts belong to the class of discontinuities in which the warm air lying above the cold wedge is forced to rise, the energy being supplied mainly by the moving wedge of cold air. The most pronounced cold fronts are easily recognizable on the surface weather map as marked wind discontinuities, the well known wind-shift lines. On the other hand, there are many cold fronts not characterized by abrupt changes, and thus not so easily identified. The slope of the cold front surfaces of discontinuity is characteristically greater than that of the warm fronts, the values being of the order of about 1/50 in the case of the cold front compared with perhaps 1/200 for the warm front. These are merely rough averages; in any individual case the slope may be appreciably different.

The importance of fronts in weather analysis lies in the fact that...