Meetings and Conferences

CONVENTION ON ACTINOMETRY AND ATMOSPHERIC OPTICS

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A conference on actinometry and atmospheric optics was held in Leningrad from January 28 through February 4, 1959. This convention was called by the Commission on Atmospheric Physics of the Division of Physical and Mathematical Sciences of the U.S.S.R. Academy of Sciences, the Leningrad University, and the Main Geophysical Observatory. The preparations for the convention were made by the Radiation Subcommission of the Commission on Atmospheric Physics, organized in 1958 and made up of K. Ya. Kondrat'ev (Leningrad State University, chairman), G. V. Rozenberg (Institute of Atmospheric Physics U.S.S.R. Academy of Sciences, Moscow, deputy chairman), V. G. Kastrov (Central Astronomical Observatory, Moscow), E. V. Pyaskovskaya-Fesenkova (Astrophysics Institute, Kazakh S.S.R., Alma-Ata), G. K. Sulakvelidze (El'brus expedition, Institute of Applied Geophysics, U.S.S.R. Academy of Sciences, Nal'chik), K. S. Shifrin (Main Geophysical Observatory, Leningrad), and Yu. D. Yanishevskiĭ, (Main Geophysical Observatory, Leningrad).

Attending the convention were 325 representatives of numerous scientific institutions from 33 cities, including Moscow, Leningrad, Kiev, Odessa, Simferopol, Minsk, Tbilisi, Tashkent, Alma-Ata, Tartu, Vilnius, Sverdlovsk, Omsk, Krasnoyarsk, and many astronomic observatories and actinometric stations. Guests at the convention were representatives from China, Poland, East Germany, Czechoslovakia, Bulgaria, and the Korean People's Republic.

At the 13 plenary sessions, 102 papers were delivered, grouped in accordance with the following problems: 1) Radiation balance and its components. 2) Brightness and polarization of the daylight and dusk sky. 3) Transparency of the atmosphere. 4) Study of the atmospheric aerosol by optical methods. 5) Reflectivity of the earth's surface. 6) Theory of radiation transfer in the atmosphere. 7) Methods of actinometric measurements. 8) Radiation and construction. All the sessions were followed by lively discussions. In view of the many problems on the agenda, it was resolved to consider many topics in atmospheric optics (visibility, ozonometry, etc.) at special conventions.

The convention has demonstrated the increase in the scope of the research on actinometry and atmospheric optics, and the much deeper approach to these problems now being made through clarification of the physical fundamentals of the processes that take place in atmospheric optics. The intense expansion of research in this field is due to the ever-increasing need of taking into account atmospheric radiation conditions in a great variety of problems in meteorology, agrobiology, medicine, construction, heliotechnics, and many other sciences and branches of the national economy. An important stimulus towards a further expansion in actinometry and atmospheric optics is the International Geophysical Year, which has raised new types of problems in connection with the broadened scope and the appearance of new methods of research (rockets or satellites). The calling together, for the first time in many years, of so representative a convention has been dictated primarily by the urgent need for summarizing the advances of recent years and coordinating further work by various institutions, so as to concentrate their efforts in solving the main problems.

The convention was opened by an introductory address by the Chairman of the Commission on Atmospheric Physics, corresponding member of the Academy of Sciences U.S.S.R., **A. M. Obukhov**. Noting that the convention was called together during the important days of the extraordinary 21st Congress of the Communist Party of the Soviet Union, against the background of an unprecedented labor and political uplift in our country, Obukhov emphasized the great scientific and practical significance of actinometry and atmospheric optics, and urged the participants to analyze critically their results and to plan future projects worthy of the historical tasks imposed by the 7-Year Plan for the development of the national economy. Obukhov paid particular attention to an all-out utilization of the data of the International Geophysical Year and towards continuing international collaboration on geophysics during 1959.

K. Ya. Kondrat'ev (Leningrad State University) in his paper "Progress and Prospects of Actinometry and Atmospheric Optics" reviewed briefly the advances made during the last 10 or 15 years, and expressed certain opinions concerning the unsolved problems, prospects of further development, and organization problems.

Included among the serious advances is the creation of a complete assortment of actinometric instruments, intended for the realization of an extensive measurement program and permitting the Soviet actinometrists to embark on the International Geophysical year fully equipped. However, there is a certain lag in physical research and in the theory of actinometric instruments, and also in the standardization procedure, which, for the time being, results in a reduced accuracy of measurement. It is necessary to search for new methods of actinometric measurement and to improve radically several of the existing instruments (for example the balance meter).

In spite of undisputed progress in experimental research on the propagation of radiation in free atmosphere and in clouds and fogs, many important divisions of actinometry and atmospheric optics are either slow to develop or are not being developed at all (research with the aid of rockets and satellites, spectral actinometry, investigations of the solar constant, etc.). One of the reasons for this is infrequent contact with physicists, astronomers, biologists, physicians and other scientists interested in the study of the radiation conditions of the atmosphere.

The progress in the theory of radiation transfer in the atmosphere, to which a substantial contributions were made by physicists and astrophysicists, is quite impressive. However, many important problems, such as a generalization of transport theory to include the real atmosphere with allowance for polarization, for the earth's curvature, and for inhomogeneities in the earth's surface and in the atmosphere itself, and also the problem of propagation of radiation in the upper layers of the atmosphere, still need to be solved.

Important progress has been made in actinoclimatology, where the use of the results of observations of an extensive actinometric network, in conjunction with improvement in semi-empirical methods of calculation, has made it possible to obtain unique material on radiation conditions over the whole earth's sphere.

Further development of research in actinometry and atmospheric optics requires more purposefulness, both for the purpose of discovering the principal laws and with an aim at satisfying practical demands. Therefore, research on borderline topics becomes quite urgent, along with research undertaken in close collaboration with the representatives of applied disciplines.

Organizational measures are needed to accelerate and expand research in actinometry and atmospheric optics. To coordinate the research and the exchange of information it is necessary to organize more frequently and more extensively thematic conferences, symposia, and seminars. The principal organization contributing to the coordination should be the Subcommission on Radiation.

It is very important to insure systematic publication of the materials of actinometric observations, to improve quality, and to increase the production of actinometric instruments and specialized apparatus for research in atmospheric optics. It is necessary to standardize the terminology. The problem of training and assignment of personnel remains unsolved.

In an article "Paths of Development of Atmospheric Optics" **G. V. Rozenberg** (Institute of Atmospheric Physics, U.S.S.R. Academy of Sciences, Moscow) noted that, as a result of having made substantial accomplishments, the era of observational and descriptive atmospheric optics has essentially exhausted itself. The widespread adoption of modern physico-mathematical research methods necessitates a radical review of both the problems of atmospheric optics and the methods of their solution.

The uncontrollable variability of atmospheric conditions makes it meaningless to accumulate random observed data, and the use of expensive equipment for this purpose makes for experiment costs out of proportion with the value of the results. Large scale systematic (network) observations (spectral, transparency, illumination, etc.), such as are necessary to formulate an optical climatology, should follow a strictly thought-out program and should employ specially designed simple and inexpensive apparatus. The use of complex apparatus requiring skilled operators should be restricted to pioneering research in entirely uninvestigated fields.

Of greatest importance at present is an all-out (experimental and theoretical) investigation of isolated phenomena, for the purpose of clarifying their physical nature and fundamental laws. These investigations require joint concerted efforts by many institutions, and should frequently be accompanied by laboratory experiments.

An important meteorological factor is the aerosol component of the atmosphere, which determines entirely its optical properties and influences substantially many of its other properties (thermal, electric, radiochemical, etc.), including fundamental processes such as condensation. It is therefore important to concentrate all efforts on a study of aerosols and their optical properties, and also on a development of optical methods for the investigation of aerosols at various altitudes.

Attention should be focused on a study of scattering and propagation of radiation in a real (foggy, inhomogeneous, turbulent) atmosphere, something that cannot be done without solving many general physical problems pertaining to the scattering and propagation of radiation. Indeed, many of these problems are best solved on a geophysical scale. An important problem is the development of optical methods of investigation of atmospheric processes.

Thus, along with expanding the research on radiation climatology, the principal problem lies in creating an experimental and theoretical basis for the clarification of the physical nature of atmospheric-optics phenomena and for establishment of quantitative laws that can be used to investigate the atmosphere and the processes that take place in it.

In view of the specific nature of the object of investigation (and particularly its variability), a solution to this problem requires many scientific-organizational measures and primarily the coordination of the activities of various institutions, the focusing of their attention to the main problems, and cooperation in their solution.

A paper by **Yu. D. Yanishevskiĭ** (Main Geophysical Observatory, Leningrad) "Actinometric Network of the U.S.S.R. and the International Geophysical Year" contained a description of the U.S.S.R. network of actinometric stations organized during the International Geophysical Year, and also a description of the apparatus used in the stations of the network and of the methods used to process the observation data. By the end of 1958 there were in operation in the U.S.S.R. 190 actinometric stations, including 14 in the Arctic and 4 in the Antarctic. The program of observations includes the measurement of the direct solar, scattered, summary, and reflected radiations, the radiation balance, and the principal meteorological elements. The principal apparatus includes an actinometer, a pyranometer, and a balance meter. Components of the radiation balance were recorded in more than 30 stations. The results of the observations were processed in accordance with a standard procedure and entered into the standard forms adopted for the International Geophysical Year.

S. I. Sivkov (Main Geophysical Observatory, Leningrad), in a paper "Scope and Problems of Actinoclimatology" discussed the problems encountered in the investigation of the laws of the geographical distribution of radiation conditions. A particular significant problem is how to eliminate from numerous observations the irregularities caused by differences in the apparatus employed and in the methods used to process the measurement results, and also how to normalize the series of observations to a single period of time. Since not all of the various elements of the radiation climate are studied to an equal extent, great interest attaches to the development of indirect methods of approximate calculation of the elements of the radiation climate from meteorological observations and from a minimum of actinometric observations.

The Convention paid great attention to the problem of the investigation of the laws of radiation balance and its components.

L. G. Mahkotkin (Main Geophysical Observatory, Leningrad), in a paper "Problems of Systemization of Data in Actinometry" told of various approaches to the generalization of the results of measurements of solar radiation. One of the important problems is to find the most satisfactory quantitative characteristic of the transparency of the atmosphere. The lecturer has succeeded in finding a new criterion of transparency, one that undoubtedly has advantages above all those previously employed (transparency coefficient, turbidity factor, etc.).

In a paper by **P. A. Vorontsov** and **T. V. Kirillova** (Main Geophysical Observatory, Leningrad) entitled "Connection Between the Radiation Balance and the Stratification of the Surface Layer," an attempt was made to establish a connection between the magnitude of the radiation balance and the vertical gradient of the temperature in the lower layer of the atmosphere. This attempt was successful, and gave grounds for expecting to be able to develop a method for investigating the thermal stratification of the atmosphere from the radiation balance as measured at the earth's surface.

Papers by **E. P. Barashkova** (Main Geophysical Observatory, Leningrad) "Certain Laws of the Radiation Conditions" and **L. I. Sakali** (Main Meteorological Institute, Odessa) "Comparative Characteristics of the Radiation Balance of the Underlying Surface of Dry Land and Sea" contain an analysis of actinometric observations made over long periods of time at various points. L. I. Sakali analyzed the features of radiation balance of the sea and of the dry land using data obtained by simultaneous measurements at sea (approximately 50 kilometers from the shore) and at two points (at sea and on land) near the shore.

K. Ya. Kondrat'ev and **M. P. Manolova** (Leningrad State University) in a paper "Radiation Balance of Slopes" reported on a method they developed for determining the radiation balance of slopes and of its components from known values of the components of the radiation balance of a horizontal surface. They propose empirical curves for the radiation fluxes (both short-wave and long-wave). It is possible to calculate the daily sums of the components of radiation balance of slopes by using the so-called "isotropic" approximation.

F. Zakrilaev (Central Asia Polytechnic Institute, Tashkent), in his paper "Brief Outline of the History of Actinometery and Atmospheric Optics in Central Asia," traced the history of the development of research on radiation during the time from the Middle Ages (Biruni and Ibn-Sina) to the present time. During the years of the Soviet regime, investigations on actinometry and atmospheric optics have been greatly expanded in the Republics of Central Asia and in Kazakhstan, and are now being carried out in many cities and in various observatories.

A paper by **A. I. Kartsivadze** (Institute of Geophysics, Academy of Sciences, Georgian S.S.R., Tbilisi), "Determination of the Angle of Incidence of the Sun's Rays on an Inclined Surface" contained equations and a nomogram for the angle of incidence of the sun's rays on a slope of arbitrary orientation, and also considered the radiation conditions on slopes with southern and northern exposures.

Sh. M. Chkhaidze (Abastumani Astrophysical Observatory), in his paper "Actinometric Observations of the Abastumani Observatory" reports that regular actinometric observations are carried out in Abastumani since 1934. Measurements are made of the solar radiation, with the aid of a Michelson actinometer equipped with two Schott optical filters. The use of the observation data has made it possible to study the radiation conditions of the point of observation, including such elements as insolation, and the integral and spectral transparencies.

Many papers were devoted to an investigation of the laws of geographical variability of the radiation balance and its components.

In the paper by **T. G. Berlyand** (Main Geophysical Observatory, Leningrad) "Propagation of Solar Radiation over the Earth's Sphere" he reported the results of observations of the world's actinometric network, and also materials obtained during the time of the International Geophysical Year. The use of new materials on previously unstudied regions (at polar and equatorial latitudes) has made it possible to modify the procedure for calculating the monthly average of the daily values of the summary radiation, and also to consider the features of the daily and annual course of the summary radiation and its components in the principal climatic zones of the earth, and to determine the relative annual amplitude of the summary radiation on the earth's sphere.

E. P. Barashkova, V. L. Gaevskiĭ, and **Z. I. Pivovarova** (Main Geophysical Observatory, Leningrad) have included in their paper "Principal Characteristics of the Radiation Conditions of the European Territory of the Union" extensive material on the radiation conditions of European Russia, based on the use of data of actinometric observations of 40 stations (transparency of the atmosphere; possible and effective sums of the direct, scattered, and summary radiation; daily, annual, and latitude variations of the radiation balance and its components). Using data obtained at the surface and on airplanes, they compiled a catalog of the albedo of natural surfaces of European Russia, and also studied the dependence of the albedo on the state and optical properties of the underlying surface.

N. A. Efimova (Main Geophysical Observatory, Leningrad) reported the results of a refinement introduced in the presently employed climatological methods of calculating the sums of the effective radiation, after considering, on the basis of the available results, the dependence of the effective radiation on the degree of cloudiness and on the difference in temperature between the soil and the air. The results of the calculations obtained by the refined procedure have been compared with the observational data from 68 actinometric stations in the U.S.S.R. during January and July 1958.

"The Effect of Cloudiness on the Thermal Radiation of the Atmosphere" was the subject of a paper by **B. M. Gal'perin** (Leningrad's Main Meteorological Institute). Using F. N. Shekhter's radiation nomogram, he calculated the average monthly values of the counter-radiation of the atmosphere in cloudless sky and for the case of overcast skies in different regions of the northern hemisphere, for a latitude range from 21 to 78° North. These data are used to calculate the "cloud" coefficients that enter into the empirical formulas for the counter-radiation. A very close connection was established between the "cloud" coefficients and the water vapor tension at the surface of the earth.

In a paper by **R. E. Borichevskiĭ** (Agricultural

Meteorological Station, Omsk) "Actinometric Data Obtained at the Omsk Agricultural Meteorological Station," he reported that systematic actinometric observations were started at the Omsk Agricultural Meteorological Station in January 1953. At the present time measurements are being made of all radiation elements. An actinometric summary was compiled for the entire period of observation. The actinometric data for the International Geophysical Year and for the preceding year were compared.

Analogous actinometric data are given in a paper by **A. I. Popov** (Agricultural Institute, Krasnoyarsk) "Summary and Scattered Radiation in the Krasnoyarsk Kray." The actinometric observations in Krasnoyarsk Kray began in 1954. The observation data for 1956 and 1957, made in five stations, were used to compile the actinometric summary. The results of the observations are compared with the actino-climatological data of T. G. Berlyand. The agreement between the observed and calculated values is quite satisfactory.

V. V. Mukhenberg and **T. A. Ogneva** (Main Geophysical Observatory, Leningrad) reported the results of their research on the radiation conditions in vineyards, carried out in 1957 on the south shore of Crimea. The dependence of the radiation conditions on the exposure of the slopes, on the degree of development of vines, and on other factors are considered.

A paper by **S. I. Sivkov** (Main Geophysical Observatory, Leningrad) "The Use of Actinometry in Agriculture" deals with the problem of use of radiant energy by the plants during photosynthesis. Along with using the customary concept of the technical coefficient of utilization of radiant energy by the plants, the author proposes to introduce the concept of physio-ecological coefficients that characterize the maximum possible utilization of radiant energy by plants at a given state of environment and growth. The physio-ecological coefficient makes it possible to estimate the maximum possible increase in dry bulk of the plant and consequently to establish the potentially possible crop as a function of the environmental conditions.

A special group of papers on the problem of radiation balance was devoted to an examination of the result of research in the Arctic and Antarctic.

N. P. Rusin (Main Geophysical Observatory, Leningrad) reported in his paper "Radiation Balance as Observed by the Soviet Expedition in the Antarctic" the results of actinometric observations of the first Antarctic expedition at the shores of the Antarctic Ocean (Mirnyĭ) and then the slope of the Antartic Plateau (Pionerskaya Station). Unusually large values of the summary radiation were observed in the summer. The monthly values of the summary radiation during the summer time exceeded the corresponding values at any other point on earth. Even the annual sum of the summary radiation in Mirnyĭ is comparable with the annual sums for the central belt of European Russia. The reasons for such high values of summary radiation are discussed. Data are given on the remaining components of the radiation balance. Substantial anomalies are observed frequently in the summer time as regards counter-radiation by the atmosphere, which exceeds the radiation from the snow in magnitude. The annual radiation balance is negative and fluctuates at various points within a range of several kilocalories per square centimeter.

V. N. Bogoslovskiĭ (Moscow Civil Engineering Institute) reported on "Thermo-physical and Glacio-actinometric Research in the Antarctic during 1957-1958," citing some preliminary results of an investigation of the thermal conditions of snow and ice. In particular, data were given on the penetration of solar radiation inside ice and snow covers.

N. T. Chernigovskiĭ (Arctic Scientific-Research Institute, Leningrad) surveyed, in a paper "Actinometric Observations in the Arctic," Arctic research on actinometry from 1921, when the first observations were started, up to the present time. All regions of the Arctic are characterized by large values of summary-radiation sums during the summer time, exceeding the corresponding values for southern regions of the U.S.S.R. in individual months. The influx of scattered radiation is particularly large. The lecturer cited data on the albedo of the underlying surface in the arctic, and also on the radiation balance. The annual radiation balance in the arctic is positive and fluctuates within a range of several kilocalories per square centimeter.

Extensive information on the albedo of ice fields were reported in the paper by **N. T. Chernigovskiĭ**, "Radiation Properties of the Ice Cap in the Central Arctic." He also reported on the result of radiation measurements under the snow and under the ice.

In a paper "Radiation Balance of the Arctic," **M. K. Gavrilova** (Yakutsk) reported an improved procedure she used for climatological computations of the radiation-balance components to investigate the laws of geographic distribution of radiation balance and its components in the arctic regions.

Much actinometric material on the summary and scattered radiation was presented in a paper by **B. M. Gal'perin** (Leningrad Hydrometeorological Institute) "Several Characteristics of the Insulation in the Soviet Arctic." The conclusions of this paper are based on the results of periodic observations made by three fixed and five drifting stations. The temporal and spatial variations of the sums of scattered and summary radiations are analyzed.

In a paper "Calculation of the Flux of Long-wave Radiation at the Earth's Surface under Arctic Conditions," **T. V. Kirillova** (Main Geophysical Observatory, Leningrad) proposes a new procedure for approximate calculations of the counter-radiation of the atmosphere, using special radiation charts. It is shown that, in the case of the arctic, the dependence of the counter-radiation on the degree of cloudiness is nearly linear. The values of the "cloud" coefficients are calculated for an empirical formula for the counter-radiation of the atmosphere. A comparison of the results of the calculations made with the proposed radiation charts and the observation data shows a considerable superiority of the new charts over calculation methods based on surface data, such as have been developed for medium latitudes.

Methods for computing radiation heat flux under arctic conditions were also considered by **M. S. Marshunova** (Arctic Research Institute, Leningrad) in a paper "Balance of Long-wave Radiation in the Arctic Troposphere." A satisfactory agreement was found between the values of the effective radiation for clear sky as measured with the aid of Yu. D. Yanishevskiĭ's pyrgeometer and those calculated with F. N. Shekhter's nomogram. Analogous comparisons were made under overcast sky conditions, and yielded the coefficients of radiating ability of the clouds as a function of the temperature of the cloud layer. Aerological soundings made from several drifting stations were used to compute the heat radiation flux at various levels in the troposphere, and also the radiative cooling of the atmosphere at various levels.

A paper by **V. S. Samoĭlenko** (Scientific Research Institute for Aeroclimatology, Moscow) "Radiative Heat Conduction and Boundary Radiation in the Sea and in the Atmosphere" discusses the problem of transfer of heat radiation in the sea and in the atmosphere. In the case of the sea, the absorption of long-wave radiation is so intense that even a layer of sea water several centimeters thick radiates practically as an absolutely black body. A formula analogous to Angstrom's empirical formula is derived from qualitative considerations for the thermal radiation of the atmosphere.

A comparison of the average monthly distributions of the summary radiation and temperature of surface waters for the Arral and Caspian seas is made in the paper by **V. S. Samoĭlenko** and **A. I. Sirotkina** (Science Research Institute for Aeroclimatology, Moscow) "Insolation and Temperature of Water in the Arral and Caspian Seas." It is noted that in neither sea does the distribution of the mean annual isotherms, or the isotherms of the months in which the thermal equillibrium exists, agree with the distribution of the insolation isolines. The causes of this lack of agreement are discussed.

Many papers touched upon the problem of "Radiation and Construction." **A. U. Franchuk** (Institute of Construction and Architecture, Academy of Sciences, Belorussian S.S.R., Minsk), in a paper "Influence of Solar Radiation on Building Wall Surfaces," called attention to the importance of taking into account solar radiation when investigating the heat conditions in buildings, and cited data that illustrate the conditions of selection and construction of building wall surfaces to prevent overheating of buildings during the summer.

The problem of the influx of summary radiation on vertical surfaces having various orientations was treated in a paper by **B. F. Vasil'eva**, (Housing Research Institute, U.S.S.R., Academy of Contruction and Architecture, Moscow) "Role of Reflected Radiation in the Southern Regions of the U.S.S.R." The observations made by the author have shown that in cities, when some of the sky is blocked by buildings, which are frequently painted white, the contribution of the reflected radiation to the summary radiation on the vertical surfaces is quite substantial. At 40° latitude the contribution of reflected radiation amounts to approximately 50% of the total radiation influx for half of the surface orientations.

B. A. Dunaev (Housing Research Institute, U.S.S.R. Academy of Construction and Architecture, ture, Moscow), in a paper "Allowance for Radiation in Housing Design," told of a graphic method he developed for calculating various indices of solar radiation, which must be allowed for in the design of living quarters (duration of exposure of various elements of the buildings, insolation in the rooms, etc.). The use of the charts proposed by the author makes it possible to plan apartments, developments, and houses correctly and to provide the best exposure for various building elements. **E. Yu. Braĭnina** (Housing Research Institute, U.S.S.R. Academy of Construction and Architecture, Moscow) reported the results of an analysis of the influence of radiation on the heating of roofs of buildings. The author of the paper expressed also certain ideas concerning problems that must be solved by actinometry in the interests of construction. The same problem was touched upon by **A. N. Borshchevskii** (Scientific Research Institute 200, Moscow) in his paper "The Role of Radiation in Construction."

Great interest was aroused by a discussion of problems concerning the procedures in network actinometric measurements. In papers by **Yu. D. Yanishevskii** (Main Geophysical Observatory, Leningrad), "Principles and Designs of Soviet and Foreign Actinometric Instruments," and "A Compensation Pyrheliometer and Improvements on It," the author surveyed modern actinometric apparatus, considered problems in the standardization of actinometric measurements, and reported the results of a comparison and an investigation of balance meters, and also described in detail an Angstrom pyrheliometer which he modified to increase its sensitivity, and which he provided with round diaphragms with standard aperture angles.

É. L. Podol'skaya (Leningrad State University) developed, in a paper "Principles of the General Theory of Balance Meters," the theory of the nonstationary dynamic boundary layer produced near the receiving plates of balance meters.

The papers by **Yu. K. Ross** (Institute of Physics and Astronomy, Academy of Sciences, Estonian S.S.R., Tartu), "Experience in the Use of the Electronic Potentiometer for Actinometry," and by **V. I. Mamaenko** (Institute of Atmospheric Physics, U.S.S.R. Academy of Sciences, Moscow) "Experience in the Use of the EPP-09 Instrument to Register Radiation," summarized and formulated the prospects of using electronic potentiometers for registration of radiation.

Various methodological problems of network actinometric observations were the subject of papers by **F. Zakrilaev** (Central Asia Polytechnic Institute, Tashkent), "Laboratory and Field Temperature Coefficients of Actinometric Instruments," and by **R. E. Borichevskii** (Agrometeorological Station, Omsk), "New Apparatus, Methods, and Data Processing used at the Omsk Agrometeorological Station."

D. L. Grishchenko reported on "A Procedure for Shipboard Actinometric Observations" in the atmosphere and on the sea.

Many papers discuss the results of investigations of brightness and polarization of daytime and twilight sky.

E. V. Pyaskovskaya-Fesenkova (Astrophysics Institute, Academy of Sciences, Kazakh S.S.R., Alma Ata) reported the results of a visual determination of the polarization of the daylight sky in the Libyan Desert (Egypt) and on a mountain observatory in the vicinity of Alma Ata. Systematic differences were found between the polarizations in the forenoon and afternoon hours. It was noted that the positions of the maximum and of the plane of polarization were frequently subject to slight shifts. The author plotted the scattering indicatrices for the polarized and unpolarized components of scattered light and separated the aerosol component of the scattering indicatrix.

D. G. Stamov (Crimean Pedagogical Institute, Simferopol'), in a paper "Possibility of Polarimetric Determination of the Turbidity of the Atmosphere in Various Directions," summarized his many years of visual measurements of the polarization of the daylight sky. He proposed relating the degree of polarization with the scattering angle and the turbidity factor by means of an empirical formula that describes satisfactorily the polarization map of the daytime cloudless sky.

In a paper by **S. I. Sivkov** (Main Geophysical Observatory, Leningrad) "Quantitative Characteristics of Depolarization of Light by Large Dust Particles in the Atmosphere," he proposed a quantity $D = 1 - P/P_i$, where P is the real degree of polarization at a given point in the sky for a given position of the sun, and P_i is the degree of polarization for a Rayleigh-type atmosphere under the same conditions (the author used the Tikhanovskii theory for the determination of P_i). Comparison with experiment has shown that D is linearly related to the turbidity factor, is much more sensitive to its variation than P, and depends little on the altitude of the sun (possibly because of the influence of the underlying surface).

Yu. N. Lipskii (P. K. Shternberg State Astronomical Institute, Moscow State University), in a paper "Spectral Polarization of Daytime and Twilight Sky," described a photographic procedure he used to measure the spectral dependence of the polarization of the sky. This procedure made it possible to reduce substantially the apparatus errors and to obtain simultaneous data for a wide spectral range from a section of the sky measuring 4 square minutes with an exposure time of 10 seconds. It was found that the degree of polarization experiences sharp random fluctuations during such a time interval (as much as doubling in value), depending on the region of the spectrum.

N. K. Turikova reported on a photoelectric investigation, performed jointly with **A. Ya. Driving** and **G. V. Rozenberg** (Institute of Atmospheric Physics, U.S.S.R. Academy of Sciences, Moscow) on the brightness and polarization of daytime and twilight sky in two regions of the spectrum, performed in the Northern Caucasus and in Crimea. Under daytime conditions, small shifts were observed in the maximum and in the plane of polarization, and these could be ascribed to the influence of the underlying surface. The maximum degree of polarization is approximately equal to the magnitude of the atmospheric transparency. In twilight the degree of polarization, the logarithmic brightness gradient, and the color index, along with their dependence on the depth of setting of the sun, change greatly from day to day. This evidences a variability of the scattering ability of the atmosphere at altitudes from 20 to 100 kilometers, a fact that can be ascribed only to the variability of the aerosol component of the atmosphere at these altitudes.

In a paper "Investigation of the Optical Properties of the Earth's Atmosphere by the Twilight Method," **T. G. Mergelishvili** (Abastumani Astrophysical Observatory) reported several average characteristics of the twilight sky (degree of polarization, logarithmic brightness gradient, color indices) based on data of many years' observation by the author since 1942, along with the results of the analysis of their seasonal variation and their connection with the atmospheric transparency.

G. V. Rozenberg, in a paper "On the Anatomy of Dawn," considers the influence of various factors (primarily the dispersion of the effective altitudes of the earth's shadow and the altitude gradient of the scattering ability of the atmosphere) on the color of the twilight sky in the sun's vertical. A simple approximate expression is proposed for calculating the color of the twilight sky with assumption of single scattering only. Comparison of the calculated values for the zenith with the experimental data obtained by various authors (including the data of Turikova, Driving, and Rozenberg) show a good quantitative agreement up to shadow altitudes of approximately 100 kilometers, when, in spite of the theory, the sky begins to redden rapidly. The latter can be ascribed to a sharp increase in the role of multiple scattering, which (contradicting Link and Yudalevich), should be "redder" than single scattering, as confirmed by qualitative calculation. It is shown that if the measurement program is sufficiently complete, the twilight data make it possible to investigate the scattering properties of the atmosphere up to altitudes on the order of 100 kilometers.

A. D. Zamorskiĭ (Leningrad) cited in his paper "Physical Nature of a Group of Phenomena in the Rosy (Purple) Light of the Dawn" several qualitative ideas concerning the mechanism of formation of the colors of dawn. **A. Kh. Darchiya** (Main Astronomical Observatory, Leningrad) reported briefly on the results of spectral photometric measurements of the dawn in Batum, Alma Ata, and Aktyubinsk. The processing of 138 spectrograms made it possible to segregate four types of dawn with different spectral characteristics, and to establish their connection with the turbidity of the atmosphere.

M. M. Fedorov (Pedagogical Institute, Zaporozh'e) reported on the results of "An Investigation of the Illumination and Density of Fogs in the Zaporozh'e Region." Smoke produced in the vicinity of industrial enterprises reduces the illumination by 8 to 44%. Smoke may also cause the formation of local fogs. Measurements made along a route 35 kilometers long, cutting through a city, showed that whereas the illumination outside the city was 1400 lux, the illumination in the region of city smog sometimes drops to 1 — 3 thousand lux (sic!) and the radius of the smog zone depends on the activity of the industrial enterprises.

Two sessions were entirely devoted to a discussion of data on atmospheric transparency.

V. V. Sharonov (Leningrad State University) outlined the "Present Status of the Problem of Determination of the Luminous Constants of the Sun and Moon." Numerous determination of the sun's luminous constant lead to a most probable value of 135,000 lux, with an error of several per cent. The moon's luminous constant can be assumed to equal 0.342 lux, with a possible error up to 10%. To obtain more accurate values it is necessary to employ in principle new methods for excluding atmospheric extinction, and primarily to organize measurements outside the atmosphere.

T. P. Toropova (Astrophysical Institute, Academy of Sciences, Kazakh S.S.R., Alma-Ata) reported "On the Role of Various Factors in the Attenuation of Light by the Earth's Atmosphere." The transparency of the atmosphere was determined experimentally in the region from 410 to 1010 $m\mu$ by Bouguer's long method, with the aid of a prism spectrograph. The 940-$m\mu$ band was used to determine the water-vapor content (the calibration was based on aerological data), which fluctuated from 0.20 to 2.2 cm of precipitated water. A seasonal course of the contents of water vapor was derived and correlated with the absolute humidity at the surface of the earth. Absorption by ozone and attenuation due to molecular scattering were separated. The Fowle method was used to separate the aerosol component of attenuation in excess of the atmospheric component into "wet" and "dry" terms, and their values and spectral relationships were estimated under different conditions.

V. A. Atroshenko read a paper by **N. V. Zolotavina** (Institute of Atmospheric Physics, U.S.S.R. Academy of Sciences, Moscow) "Certain Results of Measurement of the Transparency of the Atmosphere." An electro photometer with optical filters and Bouguer's long method were used to determine the brilliance of the sun and of stars outside of the atmosphere, from which the instantaneous value of the optical density of the atmosphere was found. The horizontal transparency was determined using a remote source of light. An abrupt and rapid variability of transparency, both in time and in azimuth, was noted and was found to be usually accompanied by a strong variability of the spectral behavior of the transparency. The absence of correlation between the horizontal and vertical transparencies was established. On the average, the aerosol attenuation of light does not depend on the wavelength, although cases of a more or less sharp selectivity are not rare.

M. V. Dolidze (Abastumani Astrophysical Observatory) reported on "Measurement of the Spectral Transparency on the Kanobili Mountain" in the wavelength interval from 4600 to 3790 A. Minima of transparency were observed for several wavelengths and their magnitudes were found to vary with time. An attempt was made to segregate the Rayleigh, "moist," and "dry" aerosol components of the optical layer and to estimate the dimensions of the aerosol particles responsible for the attenuation of light.

Several papers dealt with the altitude variation of the transparency of the atmosphere.

V. G. Kastrov (Central Astronomical Observatory, Moscow) reported the results of "An Investigation of Certain Errors in the Determination of Atmospheric Absorption of Solar Radiation by means of Pyranometers," using airplane sounding. The dependence of the sensitivity of the pyranometers on the angle of incidence of the light leads to errors that may reach 0.006 cal/cm^2-min-km, but can be eliminated by using a specially selected instrument. The error due to not strictly horizontal position of the instrument does not exceed 0.002 cal/cm^2-min-km, and that due to reflection from the surface of the airplane is $\sim$ 0.001 cal/cm^2-min-km. Thus, under an unfavorable combination of circumstances, the errors may reach the measured value of absorption (approx. 0.016 cal/cm-min-km). However, in many cases the measured absorption is known not to be attributable to the errors.

G. P. Faraponova (Central Astronomical Observatory, Moscow) reported in a paper "Attenuation of Light in the Free Atmosphere" the results of airplane measurements of atmospheric transparency, using electrophotometers with filters. The very rapid decrease in turbidity with altitude near the earth's surface (up to an altitude of 1 km) usually gives way to a relatively constant turbidity up to 3 or 4 km, followed by an almost exponential decrease with altitude. Up to 3 or 4 km, the attenuation of light is due essentially to the aerosol; above 3 or 4 km the molecular component of the attenuation either exceeds the aerosol component somewhat or is nearly equal to it. The aerosol attenuation of light was found, on the average, to depend little on the wavelength. The turbidity in the free atmosphere is somewhat greater than on a mountain slope at the same altitude.

Yu. I. Rabinovich (Main Geophysical Observatory, Leningrad) reported "On the Vertical Distribution of the Attenuation Coefficients in the Lower Troposphere," based on measurements made in various geographic regions under clear or slightly cloudy skies. The spectral variation of the mean value of the aerosol coefficient of attenuation and its variation with altitude were found to be exponential for the most part.

A paper by **G. P. Gushchin** (Main Geophysical Observatory, Leningrad), "Study of Atmospheric Aerosols," cited the results of two years' observation of the transparency of the atmosphere to 332 and 452 mμ rays from the earth (using a Dobson spectrophotometer) and to 370 mμ rays from an airplane at an altitude up to 6.6 km (using an airborne ozone meter). Assuming the aerosol to be formed by water drops and that the distribution of the drops by sizes is given by a two-parameter curve, the author determined the parameters of the distribution curve (the drop dimensions ranged from 0.1 to 0.7 μ). Absence of correlation between the inclined transparency and the visibility was noted. An indication was obtained of the existence of condensation-type aerosol clouds invisible to the eye. The turbidity of the atmosphere usually varied with altitude in a non-monotonic manner. Turbid layers are frequently observed at altitudes of 3 to 6 km. The discussions brought out the low reliability of the method used by the lecturer to interpret his data and to obtain the size distribution of the turbidity particles.

Yu. S. Dovgalyuk read a paper by **V. A. Myukhkyur'** "Concerning the Distribution of Aerosol Attenuation of Light at Different Levels." The observations were made by a photoelectric method from the window of an airplane, in clear sky. The index of attenuation varied non-monotonically with altitude, and "islands" of attenuation were noted. On the average, the index of attenuation decreases up to an altitude of 5 or 6 km, and then increases somewhat.

A paper by **E. V. Pyaskovskaya-Fesenkova** (Astrophysics Institute, Academy of Sciences, Kazakh S.S.R., Alma-Ata) dealt with her proposed "Methods for Determining the Transparency Coefficient of the Atmosphere from the Brightness of the Sky." Data obtained after prolonged observations showed that during the instant of maximum brightness of the solar aureole the mass m of the atmosphere (in the direction towards the sun) is related to the transparency P of the atmosphere by the equation $\log P = -1/m$, which can be used to determine P. On the other hand, at high transparency the optical density of the atmosphere can be found by integrating the scattering indicatrix, obtained by measuring the brightness along the solar altitude circle.

The problem of the reliability of the Bouguer-Lambert method as used to determine the spectral transparency of the atmosphere was treated in the paper by **N. I. Nikitinskaya** (Forestry Academy, Leningrad). It is noted that the linearity of the relation between the air mass and the logarithm of the brightness does not guarantee invariance of the atmosphere during the time of the measurements or the validity of the use of the Bouguer-Lambert method. The experimental investigations are used to establish a criterion for the selection of straight lines suitable for a determination of the brilliance outside the atmosphere. It is emphasized that the atmosphere very seldom satisfies these conditions.

E. A. Polyakova (Main Geophysical Observatory, Leningrad) reported on the results of four years of measurements of the "Horizontal Transparency in a Precipitation Zone." A linear correlation was obtained between the logarithm of the intensity I of the rain and the logarithm of the coefficient of attenuation α (correlation coefficient 0.59 ± 0.01), where $\alpha\,(\text{km}^{-1}) = 0.21\, I^{0.74}$ (mm/hr). Knowing the intensity and the transparency of the rain, it is possible to find the approximate size distribution of the drops, provided, the latter are greater than a certain size that depends on the intensity of the rain. For the transparency during falling snow, the correlation relation is $\alpha = 3.2\, I^{0.91}$, the correlation coefficient being 0.91 ± 0.02.

Several papers were devoted to procedures of measuring horizontal transparency in the visible and invisible regions of the spectrum.

O. I. Popov (State Oceanography Institute, Leningrad) described the construction of the "GOI (FM-45) recording photoelectric apparatus" for the measurement of the transparency of air in the visible region of the spectrum. The measurement is by the compensation method, through equalization of light signals from the source of light directly and from the same source after the light has passed through the atmosphere to a mirror (400 — 500 meters) and back.

A. M. Brounshteĭn (Main Geophysical Observatory, Leningrad) reported, in a paper "Methods and Certain Results of Measuring the Transmission Function of Long-wave Radiation," certain data on apparatus he built to measure the integral function of transmission of thermal radiation by a layer of atmosphere several meters thick. By taking certain precautions, the author was able to get rid essentially of most sources of errors and to ensure high reliability of measurement. An increase in atmospheric absorption of radiation with increasing temperature of the radiator was observed in the preliminary tests.

Preliminary results of measurements of the horizontal transparency of the atmosphere to infrared radiation, carried out by a group of authors in the Siberian Physico-Technical Institute (Tomsk), were reported by **V. A. Zuev.**

A. L. Osherovich (Leningrad State University), reviewed the parameters of the photomultipliers and photocells now in use.

A. P. Andreĭtsev and **O. P. Shelkova** (Biophysics Institute, U.S.S.R. Academy of Sciences) described apparatus they developed for systematic measurements of natural ultraviolet radiation. The apparatus is suitable for a wide range of applications.

Papers by **N. F. Galanin** (Institute of Radiation Hygiene, Leningrad), "Effect of Ultraviolet Radiation on the Human Organism" and by **A. N. Boĭko** (All-Union Scientific Research Institute of Metrology), "Ultraviolet Radiation of the Sun as a Climatic Factor and the Problem of its Measurement," dealt with the effect of ultraviolet radiation on the human organism, and reported measurement of ultraviolet radiation under natural conditions. The authors note the great variability of the spectral composition of ultraviolet radiation with different factors. In contrast with this, **N. A. Lebedev** (Crimean Pedagogical Institute, Simferopol') reached the conclusion, in his paper "Certain Observations on the Ultraviolet Radiation from the Sun in Crimea," that the spectral composition of the summary ultraviolet radiation is constant to a great degree.

The discussions of the papers devoted to the study of atmospheric aerosol aroused great interest.

The paper by **K. S. Shifrin** and **V. F. Raskin** (Main Geophysical Observatory, Leningrad) "On the Theory of the Atmospheric Scattering Indicatrix," contains a theoretical investigation of the scattering indicatrix for various types of distribution of haze particles by size (the Rocard and Young distribution). The investigation was based on the first approximation of the theory of scattering by particles with small index of refraction. An error made by Rocard was found and corrected.

O. D. Barteneva (Main Geophysical Observatory, Leningrad) reported the results of "An Investigation of the Scattering Indicatrix of Light in the Surface Layer of the Atmosphere." Extensive measurements carried out in the Leningrad region, in the region of Odessa, El'brus, and in the Atlantic Ocean under various meteorological conditions (meteorological visibility $S = 0.3$ to 230 km), made it possible to classify the indicatrices (with respect to the ratio K of the forward-scattered light flux to that scattered backward). A correlation was established between K and S. It is shown that within each class (with large K), the indicatrices break up into two types ("smooth" and "sharp," with a maximum in the scattering-angle range from 130 to 150°). It is confirmed that the scattering coefficient of light at 45° exhibits good correlation with the transparency.

T. P. Toporova (Astrophysics Institute, Kazakh S.S.R., Alma-Ata) reported the preliminary results of "An Investigation of the Scattering Indicatrix in the Surface Layer of the Atmosphere by a Photoelectric Method." The measurements were made in four portions of the spectrum and were accompanied by measurements of the polarization of the scattered light. The elongation of the indicatrices varied greatly from day to day. The degree of polarization for a scattering angle $\theta = 90°$ ranged from 54 to 71%. On the average, it diminished smoothly as θ deviated from 90°, but sometimes the maximum was noticeably shifted. Scattering indicatrices were plotted separately for the unpolarized and polarized components of the scattered light.

B. A. Chayanov (Central Astronomical Observatory, Moscow) reported the results of the measurement of the "Scattering Indicatrix in the Free Atmosphere." The measurements were carried out on auto-stratostats with the aid of an automatic photocell receiver with optical filters. The data were taken relative to the brightness of the sky in the altitude circle of the sun. In the lower 1-km layer, the elongation of the indicatrices diminished rapidly with altitude. However, in all altitudes up to 22 km, the indicatrices were strongly elongated. Layers with increased elongation of the indicatrix were noted in many cases (particularly in the region of the tropopause), probably owing to the presence of aerosol layers. It is noted that as the wavelength is increased, the elongation of the indicatrices also increases; this can be explained (**V. G. Kastrov**) by the reduced role of the molecular scattering.

G. V. Rozenberg, N. D. Rudometkina, and **I. M. Mikhailin** (Institute of Atmospheric Physics, U.S.S.R. Academy of Sciences) reported the results of their measurement of angular dependences of 12 components of the matrix of the scattering of light by the surface layer of the atmosphere. A polarized projector beam was photographed by a system of photographic cameras equipped with polaroid and optical filters ($\lambda_{eff} = 420 \pm 20$ mμ). The scattering indicatrix (the elongation of which increased with increasing scattering coefficient) clearly exhibited rings corresponding to particles 0.7μ in size. A simultaneous observation of the rainbow was also made. It is explained that the angular dependences of several of the components f_{ic} of the scattering matrix are much more sensitive to changes in the atmospheric conditions than the indicatrix (i.e., f_n). Several stable features of the angular dependences of f_{ic} are noted, characteristic of the presence or absence of large particles (weak fog). The presence of elliptic polarization of scattered light was established. A clearly pronounced anisotropy of the scattering properties of the atmosphere, probably due to aerodynamic causes, was observed. It is shown that measurements of the angular dependence of the scattering matrix add greatly to the amount of information on the properties of the scattering medium.

"Several Results of Work on Projector Sounding of the Atmosphere" were reported in a paper by **N. V. Zolotavina, A. Ya. Driving,** and **G. V. Rozenberg** (Institute of Atmospheric Physics, U.S.S.R. Academy of Sciences). A regular presence of aerosol was reliably observed not only in the troposphere, but also in the lower stratosphere (at any case, up to 30 km), which makes it ill-advised to attempt to determine the densities and the temperatures in the atmosphere by optical methods. The variability of the atmospheric aerosol results in an optical instability of the atmosphere — the scattering coefficient of directed light is subject to relatively fast local changes, up to a factor of three. This imposes stringent requirements on the apparatus used for projector sounding — high sensitivity, high accuracy, and high speed. Qualitatively, the form of the scattering indicatrices at various altitudes and the variation of the optical thickness of the atmosphere with altitude, as determined by the projector method, agree with the data published in the literature. However, neither data are reliable unless high speed and increased accuracy are insured.

A. Ya. Driving (Institute of Atmospheric Physics, U.S.S.R. Academy of Sciences) reported on "Clouds in the Stratosphere, from data of Projector Sounding." In some cases the method of projector sounding has disclosed thin clouds at altitudes of 23 — 24 km (in the outskirts of Moscow and the Caucasus). The appearance of the clouds is correlated with cooling over the entire vertical layer, making it possible to consider these clouds as condensation products. Polarization data (negative polarization at scattering angles near 150°) lead to an estimate of the size of the particles (approx. 1.5μ), and measurements of the brightness and transparency make it possible to estimate the concentration of the drops and the water content. All estimates correspond approximately to what would be expected in "mother of pearl" clouds.

B. I. Styro (Institute of Geology and Geography, Academy of Sciences, Lithuanian S.S.R.), in a paper "Distribution of Radioactive Aerosol in the Free Atmosphere," discusses the published results of an investigation of the altitude distribution of radioactive aerosol, and shows that the corresponding distribution can be obtained theoretically by assuming that convection develops in the atmosphere layer by layer and by adopting Laĭkhtman's or Budyko's boundary-sublayer scheme. The exchange coefficient can be calculated from the altitude distribution of the radioactivity and vice versa.

A special session was devoted to an examination of the results of research on the reflecting ability of the earth's surface.

A. B. Krasil'shchikov (Main Geophysical Observatory, Leningrad), reporting on "Summary Results of the Measurements of the Brightness Coefficient under Laboratory and Field Conditions," described the apparatus he developed and cited many measurement results on the visible and near-infrared regions of the spectrum. The brightness coefficients of most natural surfaces increase with increasing wavelength in the investigated region of the spectrum.

A paper by **K. S. Lyalikova** (Laboratory of Aerological Methods, U.S.S.R. Academy of Sciences, Leningrad), "Survey of Work of the Laboratory of Aerological Methods on the Spectral Brightness of Natural Formations," describes apparatus for surface and airborne measurements of the spectral brightness of natural formations. In particular, the Laboratory for Aerological Methods has developed a "spectrovisor" — an instrument for automatic rapid measurement of spectral brightness coefficients. This instrument has high angular resolution to permit airborne measurement of the spectral brightness of various details of natural formations, followed by statistical treatment of the observation results. Several measured spectral brightness coefficients of various natural formations are cited as examples.

The paper by **V. I. Matulevichene**, (State University, Vilnius) "Measurements and Calculations of the Albedo of Certain Surfaces in the Visible Spectrum Based on Given Spectral Brightness Coefficients" reports on the measurement of the albedo of certain natural surfaces, made with a pyranometer and a selenium photocell. Balloon-borne apparatus for the measurement of the albedo of a forest is described. The albedo measured with a selenium photocell is compared with the albedo calculated from measured values of the spectral brightness coefficient.

N. E. Ter-Markaryants (Main Geophysical Observatory, Leningrad) detailed a procedure she developed for the calculation of the albedo of the sea in a paper "Reflection of Radiation from the Sea." The investigation covered individual components of the albedo of the sea for the summary radiation. Data on the angular distribution of the intensity of the scattered radiation were used to calculate the albedo of the sea for scattered radiations in clear and heavily overcast skies. It is pointed out that it is essential to take into account the polarization of the scattered light in the calculation of the albedo for scattered radiation. The influence of the sea waves and of the backward scattering of the radiation from the sea on the albedo is investigated. A procedure is developed for calculating the albedo of the sea under all conditions of cloudiness and for all states of the sea surface. The results of the calculations, based on this procedure, are in satisfactory agreement with the observed data. It is shown that the more accurate albedo calculations made by this procedure necessitate substantial revisions of the magnitude of the radiation balance of the sea. The average daily values of the albedo are calculated for various conditions.

A paper "Spectral Albedo of Snow and Vegetation" by **K. Ya. Kondrat'ev, Z. F. Mironova,** and **L. V. Daeva** (Leningrad State University) contains a description of an electrospectrophotometer constructed by the authors to measure the spectral albedo of natural surfaces in the visible and in the near infrared regions of the spectrum. This instrument was used for the first spectrophotometric measurements of the albedo of various natural surfaces. Data are given on the spectral albedo of snow and several types of vegetation. These data disclose that the spectral albedo varies greatly with the state of the surface and with the illumination conditions, clearly illustrating that the albedo is by far not a single-valued characteristic of the properties of a given surface. The albedos of many types of vegetation decrease with increasing wavelengths, starting with 800 mμ.

The daily variation of the albedo of a grass or corn field is discussed by **H. G. Tooming** (Institute of Physics and Astronomy, Academy of Sciences, Estonian S.S.R., Tartu) in his paper "On the Daily Variation of the Albedo of a Surface Covered with Vegetation." The results of his observations show that the albedo diminishes monotonically with increasing elevation of the sun. The albedo is not symmetrical about its noontime value, owing apparently to the peculiarities of the daily course of photosynthesis. This conclusion is confirmed by a measurement of the spectral reflectivity of corn leaves and sunflowers during the day.

N. I. Goĭsa (Ukrainian Hydrometeorological Research Institute, Kiev) reported on the airborne measurements of the albedo of large territories, carried out in 1958 and also in 1951-1953, in different physico-geographic zones of the Ukraine. The measurements were made at altitudes of 200 — 1,000 meters. The measured data were used to chart the geographic distribution of the albedo of the Ukraine. Statistical data are also given on the distribution of the albedo.

Two sessions were devoted to a thorough discussion of the principal problems of the theory of radiation transfer in the atmosphere.

K. Ya. Kondrat'ev (Leningrad State University), in a paper "Approximate Equations of Radiant Energy Transfer," considered the possibility of approximating the equations of radiation transfer by means of ordinary differential equations with constant coefficients and calculating from the latter the short-wave radiation flux (scattered or summary radiation) in the atmosphere. It is shown that such equations are suitable only for semi-quantitative estimates. A paper by the same author, "Thermal Radiation of Carbon Dioxide in the Atmosphere" contains calculated results that cast doubts on the theory wherein climate fluctuations are connected with changes in the concentration of carbon dioxide in the atmosphere.

E. M. Feĭgel'son (Institute of Atmospheric Physics, U.S.S.R. Academy of Sciences, Moscow) considered the "Change of Cloud Temperature with Time" as a result of radiation cooling, with allowance for the water phase transformations and for turbulent heat exchange. The cooling is concentrated in a thin layer at the surface of the cloud and is practically independent of the temperature distribution in the cloud. Accounting for the condensation process introduces corrections on the order of 20 or 30% in the cloud temperature variations. The turbulent heat exchange decreases the degree of cooling at the upper boundary and causes the cooling to penetrate to substantial depths inside the cloud. A calculation of specific events of radiation cooling of a cloud during several hours, based on a measured altitude distribution of the temperature and humidity, has shown satisfactory agreement with reality.

A. M. Samson (Institute of Physics and Mathematics, Academy of Sciences, Belorussian S.S.R., Minsk) considered the "Transfer of Resonant Radiation in a Plane-Parallel Layer" on the basis of an approximate solution for the number of excited particles, assuming the structure of the light flux to remain constant with depth. The glow from the layer was investigated under stationary and nonstationary conditions and the nonstationary glow was found to be strongly dependent on the properties of the medium and on the conditions of radiation and observation.

I. N. Minin (Leningrad Electrotechnical Institute) reported on a generalization he obtained for "The Equation of Radiation Transfer with Allowance for Refraction." For many particular cases, the author has found either the transmission function or an estimate of the terms of the equation; it is shown furthermore that allowance for refraction may affect the result substantially in certain cases. (For example, if the earth's atmosphere is assumed spherical in the analysis of lunar eclipses).

G. V. Rozenberg (Institute of Atmospheric Physics, U.S.S.R. Academy of Sciences, Moscow) considered the "Illumination Conditions within a Scattering Medium" with allowanve for polarization of the radiation and for an arbitrary scattering matrix. It is shown that at sufficiently great depth, the bulk coefficient of true absorption of the medium is $\alpha = k'\Phi_V/\Phi_S$, where k' is the absorption coefficient, and Φ_V and Φ_S are the vertical and spherical light fluxes. This relation can be used to determine the spectrum of the true absorption of the medium. In the case of weak absorption, $k' = \sqrt{\alpha k/q}$, where k is the coefficient of extraction and q is a constant that depends on the type of scattering matrix. As the absorption increases, the brightness pattern becomes elongated, and this is accompanied by an increase in the polarization of the scattered radiation, and allowance for the polarization effect is very important. An approximate analytical expression is found for the type of the brightness pattern in the case of low absorption. The relations obtained are in good agreement with the experimental data available in the literature.

The radiation field in deep layers of a turbid medium was also considered in a paper by **S. G. Slyusarev** (Leningrad Hydrometeorological Institute). Using the method of V. V. Sobolev and expanding the particular indicatrix in a series of Legendre polynomials, the author calculated the form of the brightness pattern for various values of absorption and compared the solutions obtained with the results of numerical integration of the Ambartsumyan equation for the same indicatrix. It is shown that satisfactory agreement is obtained even when the expansion of the indicatrix is limited to the first three terms.

M. S. Malkevich (Institute of Atmospheric Physics, U.S.S.R. Academy of Sciences, Moscow) reported on the results obtained with an approximate method he developed for computing the horizontal variation of the albedo of the earth's surface, for the propagation of light in the atmosphere at a spherical scattering indicatrix. Periodic and step-like (land — sea) changes in the albedo are considered. In the case of a cloudless atmosphere, the horizontal irregularities of the atmosphere affect greatly the brightness of the light scattered by the atmosphere in a zone 2 or 3 km in radius, and give rise to a horizontal component of light flux in this zone; this component reaches a maximum at a certain altitude. In a second paper, the same author considered the effect of a non-orthotropic underlying surface. Cases of highly non-orthotropic surfaces (snow with frozen crust, wheat field) were compared with cases in which the Lambert law holds, with assumption of a spherical scattering indicatrix and a cloudless atmosphere. The conditions under which the non-orthotropic nature of the earth's surface has little influence under the foregoing assumptions are formulated.

The paper by **S. D. Gutshabash** (Naval School, Leningrad), "Scattering of Light in a Medium Adjacent to a Reflecting Surface," was devoted to an investigation of the effect of an orthotropic reflecting surface on the illumination conditions in a scattering medium. It is shown that, as in the case of a reflecting boundary, the solution can be expressed in terms of a function that depends only on the optical thickness. If the medium is illuminated by a parallel beam, the source function is expressed in terms of the function of a source without the reflecting boundary.

V. A. Atroshenko (Institute of Atmospheric Physics, U.S.S.R. Academy of Sciences, Moscow), reported on "Several Estimates of the Accuracy of Solutions of the Transport Equation by the Method of V. V. Sobolev." The Sobolev solution for several models of the atmosphere was compared with numerical solutions obtained at the Institute of Atmospheric Physics. In many cases the error in the calculation of multiple scattering by the Sobolev Method reaches 25 to 30% for upward radiation and 100 — 120% for downward radiation; the errors are randomly distributed and no region of satisfactory accuracy can be separated. It is shown that the errors connected with various assumptions made in the Sobolev method sometimes cancel each other (upward radiation) while in other cases they add up (downward radiation).

The paper by **O. A. Avaste** (Institute of Physics and Astronomy, Academy of Sciences, Estonian S.S.R., Tartu) "On the Accuracy of the Approximate Method of Computing the Brightness of Atmospheric Haze," was devoted to the same problem. Calculations made by the Sobolev method were also compared with the tables of the Institute of Atmospheric Physics. The influence of the optical thickness of the atmosphere and of the albedo of the earth's surface on the magnitude of the errors was evaluated, and it was shown that in many cases the errors are very large. The estimates of the errors were in agreement with those given in the paper by Artoshenko.

The concluding session was devoted to a general discussion and an evaluation of the resolutions, calling for steps in the development and coordination of work in the field of actinometry and atmospheric optics. Noting the substantial progress in the development of actinometry and atmospheric optics in the Soviet Union, the convention called attention to several serious shortcomings. In particular, the convention showed one of the most important problems to be the development of instrument building (apparatus for the actinometric networks as well as specialized apparatus for atmospheric-optical research). No less important is the concentration of efforts towards the solution of the crucial problems, and principally towards an investigation of the scattering of radiation by aerosols and the propagation of radiation in scattering media.

By way of measures that would contribute to greater coordination, the convention recommended that all organizations and persons active in the field of actinometry and atmospheric optics send the plans and programs of their activity, along with reprints of published articles, to the Commission for Atmospheric Physics (Moscow, Bol'shaya Gruzinskaya, 10, Institute of Atmospheric Physics, U.S.S.R. Academy of Sciences, attention of G. V. Rozenberg).

The convention charged the Subcommission on Radiation with several scientific and organizational tasks, particularly the preparations for the coming conferences. The next broad conference on actinometry and atmospheric optics is scheduled for the summer of 1960, in Vilnius A special conference on problems of atmospheric visibility is planned for the fall of 1959 in Leningrad.

Translated by J. G. Adashko