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Issue 159

Selected Translated Abstracts of Russian-Language Climate-Change Publications

II. Clouds

Research Institute of Hydrometeorological Information
Carbon Dioxide Information Analysis Center

GLOBAL CHANGE

ГЛОБАЛЬНЫЕ ИЗМЕНЕНИЯ

Выборочные аннотации русскоязычных публикаций по изменениям климата

II. Облачность

Научно-исследовательский институт гидрометеорологической информации
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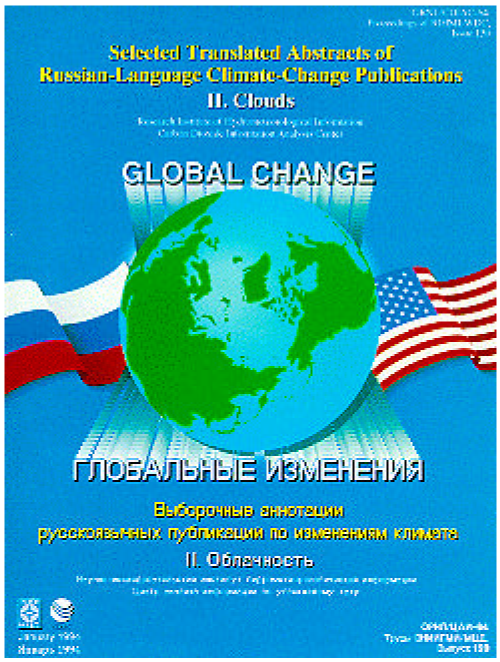
Abstract

Selected Translated Abstracts of Russian-Language Climate-Change Publications

II. Clouds



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Contents

Abstract

RAVINA, CAROLINA B., and MARVEL D. BURTIS. 1993. Selected translated abstracts of Russian-language climate-change publications: II. Clouds. ORNL/CDIAC-64; Proceedings of RIHMI-159. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, Oak Ridge, Tennessee. 106 pp.

This report presents abstracts (translated into English) of important Russian-language literature concerning clouds as they relate to climate change. In addition to the bibliographic citations and abstracts translated into English, this report presents the original citations and abstracts in Russian. Author and title indexes are included, to assist the reader in locating abstracts of particular interest.

Introduction

On May 23, 1972, Richard Nixon, President of the United States, and N.V. Podgorny, Chairman of the Presidium of the Supreme Soviet of the USSR, signed an Agreement on Cooperation in the Field of Environmental Protection Between the United States of America and the Union of Soviet Socialist Republics. This agreement was to be implemented for the following areas: air pollution; water pollution; environmental pollution associated with agricultural production; enhancement of the urban environment; preservation of nature and the organization of preserves; marine pollution; biological and genetic consequences of environmental pollution; influence of environmental changes on climate; earthquake prediction; arctic and subarctic ecological systems; and legal and administrative measures for protecting environmental quality.

Working Group VIII (WG VIII), established to address the issue of influence of environmental changes on climate, now includes five projects: climate change; atmospheric composition; radiative fluxes, cloud climatology, and climate modeling; data exchange management; and stratospheric ozone. The Office of the Deputy Assistant Secretary for International Interests of the National Oceanic and Atmospheric Administration is the U.S. coordinating agency for WG VIII projects, while the Russian Federal Agency for Hydrometeorology has been the coordinating agency within the former USSR. The Carbon Dioxide Information Analysis Center (CDIAC) has, since 1990, been active in the WG VIII project on data exchange.

CDIAC's participation in WG VIII activities has been facilitated by its participation in the Quantitative Links initiative of the U.S. Department of Energy's Global Change Research Program (USDOE/GCRP). CDIAC's role in this initiative has been to provide the quality-assured data sets needed for quantifying the relationship between changes in atmospheric composition and changes in climate. In support of this role, CDIAC has been collaborating with research institutions in the former USSR to identify, quality-assure, document, and package selected data sets as CDIAC numeric data packages (NDPs). In 1991, CDIAC published the NDP *Atmospheric* CO_2 *Concentrations Derived from Flask Samples Collected at U.S.S.R.-Operated Sampling Sites* (ORNL/CDIAC-51, NDP-033), compiled by Thomas A. Boden of CDIAC, with data contributed by A. M. Brounshtein, E. V. Faber, and A. A. Shashkov of the Main Geophysical Observatory (St. Petersburg, Russia). In 1993, CDIAC published the NDPs *Daily Temperature and Precipitation Data for 223 USSR Stations* (ORNL/CDIAC-56, NDP-040) compiled by Russell S. Vose of CDIAC, and *Three-Hourly Temperature and Precipitation Data for 223 USSR Stations* (ORNL/CDIAC-66, NDP-048), compiled by Dale P. Kaiser of CDIAC; data for both were contributed by V. N. Razuvayev, E. G. Apasova, and R. A. Martuganov of the Research Institute of Hydrometeorological Information (Obninsk, Russia). CDIAC has also hosted visits by Russian scientists, and CDIAC staff have visited Russian geophysical research institutions and data centers.

CDIAC sent a survey to 172 researchers in eleven countries in which they were asked to suggest data sets that would be of particular importance to the quantification of the links between changes in atmospheric chemistry, the Earth's radiative balance, and climate, but that were of limited usefulness because of problems with availability, documentation, or quality, or that did not currently exist but could be compiled from separate extant data sets. More than one hundred data sets were suggested, in areas ranging from climate and the cryosphere to the Earth's surface or cover and trace gas emissions and concentrations.

This, and a follow-up, survey, indicated that researchers in this area were especially interested in the Earth's surface energy budget, clouds, aerosols, and general circulation models.

To respond to the interest in these four areas, CDIAC and the All-Russian Research Institute of Hydrometeorological Information--World Data Center (RIHMI-WDC) in Obninsk, Russia, began a collaborative project to produce a series of dual-language bibliographies of Russian literature that had not previously been translated into English. This project included the assignment of RIHMI-WDC technical translator Carolina B. Ravina to CDIAC to work on these bibliographies. As part of this work, CDIAC and RIHMI-WDC decided to evaluate new personal-computer-based translation and word-processing software. The first report to result of that project, published in 1992, was *Selected Translated Abstracts of Russian-Language Climate-Change Publications: I. Surface Energy Budget*

(ORNL/CDIAC-57; Proceedings, RIHMI-158), translated by Carolina B. Ravina and compiled by Marvel D. Burtis (available on request from CDIAC, Oak Ridge National Laboratory, P. O. Box 2008, Oak Ridge, Tennessee 3781-6335, U.S.A.). This report, on clouds, is the second in the series. It is hoped to produce future reports on aerosols and general circulation models.

Acknowledgments

On behalf of the Carbon Dioxide Information Analysis Center (CDIAC), the Research Institute of Hydrometeorological Information -- World Data Centre (RIHMI-WDC), Carolina B. Ravina, and Marvel D. Burtis, I would like to thank the following individuals who have contributed, either directly or indirectly, to the production of this report:

Mike Riches of the U.S. Department of Energy's Global Change Research Program (in the Office of Energy Research, Office of Health and Environmental Research, Environmental Sciences Division), who, as program manager of the Quantitative Links initiative, funded the project under which CDIAC has been able to collaborate with Russian research and data centers.

Rudolf Reitenbach (RIHMI-WDC) and Roy Jenne (National Center for Atmospheric Research, Boulder, Colorado) who serve, respectively, as the Russian and U.S. leaders for exchanges under Working Group VIII (WG VIII) of the bilateral agreement under whose auspices this report has been produced.

Bob Etkins and Renee Tatusko of the Office of the Deputy Assistant Secretary for International Interests in the U.S. Department of Commerce's National Oceanic and Atmospheric Administration (Washington, D.C.), who have greatly facilitated scientific exchanges and visits between Russia and the United States under the auspices of WG VIII.

Paul Kanciruk of the Environmental Sciences Division (ESD), Environmental Information Analysis Program at Oak Ridge National Laboratory (ORNL), and former director of CDIAC, who helped shape CDIAC's involvement in WG VIII activities and establish contacts between CDIAC and its sister institutions in Russia.

Yelena Belous and Maria Makarova of RIHMI-WDC, who contributed most to compiling the list of abstracts.

Dale Kaiser of CDIAC, who assisted in the production of this report as scientific editor of the English translations of the abstracts.

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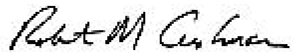

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September 1993

About the Translator

Carolina B. Ravina has been working as a translator and head of a translation group at the All-Russian Research Institute of Hydrometeorological Information--World Data Center since 1970.

She holds three master's degrees from the Moscow Foreign Language Institute (now the Linguistic Academy) in English language interpretation/translation, high school teacher of English, and University teacher of English.

She is a translator-interpreter of international class who participates as a simultaneous translator in many international fora which are held under the auspices of such United Nations Organization bodies as Intergovernmental Oceanographic Commission, World Meteorological Organization and International Atomic Energy Agency. She co-authored an English-Russian dictionary of abbreviations and acronyms. She has a number of published Russian-English translations in various branches of science and technology including plasma, solid-state and nuclear physics; climatology; oceanography; hydrology; mathematical modeling; environmental pollution; computer science; and many others.

Bibliography

Abakumova, G. M., T. V. Yevnevich, Ye. I. Nezval, N. Ye. Chubarova, and **O. A. Shilovtseva**. 1989. The effect of upper-air clouds on solar radiation in different parts of the spectrum on the basis of surface-based observations. Radiation Properties of Cirrus Clouds. pp. 130-148.

The effect of upper-air clouds on direct, scattered, and total solar radiation [integral (IR), ultraviolet (UV, **x** <380nm), photo-synthetically active (PAR) (PSA, $\Delta\lambda$ =380-710 nm), and close infrared (CIR, λ710 nm)] was investigated from land-based measurements made at the Zvenigorod Scientific Base of the Institute of Physics of Atmosphere of the Academy of Sciences of the USSR in April-May 1986-1987. The findings established the following:

1. The average attenuation of direct radiation by cirrus (**Ci, Cc, Cs**) is close to neutral; amounts to 12-14% for **Ci**, 10-14% for **Cc**, 23-24% for **Cs**, and 13-15% for all cloud types.

2. The optical thickness of cirrus either exceeds that of aerosols or is comparable with it.

3. The diffusion of CIR increases most (by a factor of 1.6) with upper-air clouds. PAR increases by 14%, UV radiation decreases by 3%. For cirrus, radiation scattering for the whole solar spectrum increases on the average of 35%.

4. The attenuation of total radiation by continuous upper-air clouds averages 4-6%. For all spectral ranges except for CIR attenuation is comparable with atmospheric turbidity. The effect of clouds on CIR exceeds that of aerosols.

Aldoshina, O. I., V. V. Bacherikov, Ye. Ye. Limar, and **V. A. Fabrikov**. 1990. Regression model of cloud top over the continents from FGGE data. Atmos. Opt. (3)4:404-413.

Algorithms and a software package for computing moments of density and distribution functions as well as correlation matrices and regression lines were developed for statistical analysis of cloudiness characteristics on the basis of FGGE data. Seasonal-geographical patterns of cloud amount and cloud top height distribution over the continents of the globe have been constructed. It was established that cloud amount and cloud top height distribution over continents can be approximated by the log-normal law. The approximation was made by the Kolmogoroff test at a significance level of 0.95. The data can be used for transcribing satellite data resulting from remote sensing in the visible range.

Aleksandrova, T. V., and **I. T. Bubukin**. 1989. Cloud structure from thermal sounding data. Radiometeorology: Proc. Seventh All-Union Meeting, Suzdal, 21-24 Oct. 1986. pp. 210-212.

To study cloud structure from radio contrasts, radio emission of the atmosphere in the zenith at wavelengths of 0.8 and 1.35 cm was investigated in the Tropical Atlantic in March-July 1985 (Cruise 41 of the Research Vessel *Academic Kurchatov*). Maximum values of cloud contrasts and the extent of cloud formations were determined from profiles of radio brightness temperatures obtained from convective clouds. Over two thirds of 95 cloud formations considered had a horizontal extent of less than 3 km. About 90% of clouds observed with the 1.35-cm sounder had maximum contrasts up to 30 K, whereas 60% of those observed with the 0.8-cm sounder fell within this range. The maximum values of cloud contrasts with wavelengths of 0.8 and 1.35 cm coincided in time and their ratio ranged from 1.2 to 3. Greatest contrasts were characteristic of rain clouds. Values of integral water vapor and liquid water content increments in the area of significant contrasts in comparison with the background are given for several cloud formations.

Alekseyeva-Obukhova, I. A. 1981. A technique for approximating cloud amount for different cloud types. Proc. 232:93-99. Hydrometeorol. Sci. Res. Cent. U.S.S.R.

Recommendations are given for approximating cloud amount for different cloud types. Factors that are taken into account and can be used in the numerical forecasting of meteorological elements are temperature and dew-point depression for summer and winter seasons.

Allenov, M. I., and **V. G. Bulgakov**. 1988. On determining cloud velocity on the basis of their 8-13μm spectrum range data. Optical Radiation Propagation in Randomly Non-homogeneous Media. Tomsk. pp. 79-82.

Results are given of theoretical and experimental research on the influence of the magnitude of cloud direction and velocity on the cross-correlation function of the luminosity value measured in two different directions from the Earth's surface. A method for determining the cloud velocity vector from 8-13-μm-range radiometer data is shown. The method is applicable both at night and in the daytime.

Allenov, M. I., and **V. G. Bulgakov**. 1981. The statistical structure of effective thicknesses of a cumulus cloud field. Proc. Inst. Exp. Met. U.S.S.R. State Comm. Hydrometeorol. Control Nat. Environ. (10)84:49-56.

The statistical structure of the effective thicknesses of a cumulus cloud field is investigated. The field is simulated on the ES-1050 computer by means of the Monte Carlo method. Moments and differential functions of the effective thickness distribution are given for various zenith angles and absolute amounts.

Anikin, P. P. 1989. On the contribution of scattered radiation to spectral transmission of semi-translucent clouds. Radiation Properties of Cirrus. Moscow. pp. 156-162.

Results of computing the scattered radiation contribution from measurements of solar radiation spectral transmission $\mathbf{P}_\lambda$ are given for semitranslucent cirrus and other cloud types. Measurements of $\mathbf{P}_\lambda$ were carried out at the Zvenigorod Research Station of the Institute of Physics of the Atmosphere of the Academy of Sciences of the USSR using instruments with a small angle of view (**a** ~15'). Indicatrices of diffusion were calculated for wave lengths λ equal to 0.6, 1.2, 2.1, 4.7, and 10 μm for several models of ice clouds consisting of spherical particles of radius **R** = 10, 20, 30, 40, 50, 75, 100 and 200 μm by using the Mie formulae. The Monte Carlo statistical modelling method was used. Flux values calculated by using the Monte Carlo method (i.e., taking into account multiple scattering) were compared with the results obtained by using single-scattering formulae. The calculations took into account the finite dimensions of the sun. They revealed the following:

1. It is necessary to introduce corrections for particles with **R** >10 μm taking into account the contribution of diffused light that gets into the receiver in the visible part of spectrum, even with instruments having a small angle of view.

2. For wavelengths λ = 2.1 μm the corrections are to be introduced with **R** >30 μm and for λ = 10 μm with **R** >100 μm.

3. With large particle sizes in clouds, the optical thickness is to be determined in the IR part of the spectrum.

4. For particles with **R** >10 μm, optical thickness can be measured with λ = 0.6 μm by using a receiver with a 10° view angle. This being the case, the optical thickness of the cloud will be twice as small.

Anikin, P. P., A. G. Petrushin, and **T. A. Tarasova**. 1989. Optical properties of cirrus clouds. Radiation Properties of Cirrus Clouds. Moscow. pp. 53-65.

Scattering and absorption characteristics of the cirrus volume element are given. Microstructure models of crystal medium as a system of ice hexagonal prisms and ice spheres with a certain size distribution are used. Results of calculating optical characteristics for these models were compared and possibilities of using the calculations for ice spheres with certain effective radii were determined for describing scattering of ice crystals. Scattering indicatrix normalized to scattering cross section is considered, with special emphasis on calculating the following: "average cosine" of scattering indicatrix (to be later used in solar radiation flux calculations); rated radiation flux falling on the spectral radiometer receiving aperture as a result of single scattering which is used for determining cirrus optical thickness; and single scattering albedo.

Anikin, P. P., and **A. H. Shukurov**. 1989. On the cirrus solar radiation transmission. Radiation Properties of the Cirrus. Moscow. pp. 100-108.

The probability distribution of cirrus cloud transmission and average transmission values obtained as a result of UV-, VIS-, and IR-measurements of solar radiation transmission by the cirrus at the Zvenigorod Research Station (ZRS) of the Institute of Physics of the Atmosphere in 1978-1987 are given. Cirrus which are observed at ZRS are basically thin and semitranslucent.

Anikin, P. P., and **A. H. Shukurov**. 1986. On the spectral attenuation of 0.3-12 µm radiation by clouds on the basis of ground based observations. Atmospheric Optics and Aerosol. Moscow. pp. 150-154.

The results of measuring the transmittance of thin cumulus and cirrus clouds in individual portions of the 0.31-12 µm spectrum range are analyzed. Observed data are compared with calculations. Additional radiation attenuation is observed both in cumulus and cirrus in the short-wave region of the spectrum.

Anikin, P. P., and **A. Ch. Shukurov**. 1986. On spectral transmission of cumulus and cirrus clouds from surface-based observations. Proc. of 8th All-Union Symposium on Laser Emission Propagation in the Atmosphere. Tomsk. Part 1, pp. 107-110.

Relative optical thicknesses of cumulus and cirrus clouds are compiled from 0.3-12.2 µm range measurement data and calculations. For cirrus, the necessity of taking into account scattered radiation is shown. Spectral relationships between relative optical thicknesses for different types of cirrus clouds are shown.

Aniskin, L. V., A. A. Borovikov, and **S. M. Persin**. 1987. A study of cloud base height variability.

Proc. Main Geophysical Observatory. 512:92-107.

The results of investigating cloud base height variability are given based on automatic measurements taken every 15 and 1.5 s. The effect of different processing procedures on cloud base height variability characteristics as well as the effect of measurement frequency and averaging period on extrapolation error are considered. Forecast error is shown to decrease with higher observation frequency and adequate choice of averaging period.

Apriamashvili, N. Sh., and **M. R. Vatyan**. 1987. Investigation of the space-time distribution of some convective cloud radar characteristics in East Georgia. Radar Meteorology: Materials of Methodological Center on Radar Meteorology of Socialist Countries. Leningrad. pp. 129-140.

Statistical characteristics of convective cloud parameters (CCP) are studied on the basis of radar observation data for the period 1981-1984. Average and extreme values are determined for (1) the number of days and half days with CCP and (2) the CCP system lifetime, taking into account monthly and diurnal variations.

Aristova, L. N., G. V. Gruza, and **L. R. Kachurina**. 1986. On zonal characteristics of global cloud field statistical structure. Proc. All-Union Res. Inst. Hydrometeorol. Inf. World Data Cent. 126:27-35.

Results of cloud field zonal structure analysis based on the 5 by 10 regular grid-point data of the satellite global cloud observation archive for 1966-1975 are considered. Zonal distribution data are compared with data available in published sources, and the two seem to agree rather well. Conclusions on space connections of clouds in various latitudinal zones and hemispheres are drawn on the basis of analyzing cross-correlation functions of cloud latitudinal means.

Arzhenenko, N. I. and **V. G. Bondur**. 1988. Classification of cloud types using satellite imagery spectra. Atmos. Opts. I(11):38-45

Optical-digital processing of satellite imagery was carried out that yielded some informative characteristics for quantitative analysis of two-dimensional spectra of various cloud types. Standard forms of two-dimensional imagery are described. The analysis of statistical separability of different cloud types is undertaken on the basis of maximum criterion of Euclidean distance in the five-dimensional space of informative characteristics of space spectra.

Bachshyan, G. G. 1988. On the polarization of electromagnetic waves by electrically active clouds. The physics of hail formation processes and physics of hail active modification. Proc. of the All-Union Workshop. Nalchick. 15-17 October 1985. pp. 32-38.

Results show that when the mechanical cloud motion power is partially transformed into electrostatic power, under certain conditions electromagnetic radiation is excited by time variations of the crystal

microdipole with the droplet overcooling. The electromagnetic wave emitted in this case is polarized. Methods of remote measurements of the cloud parameters (velocity, acceleration, electrostatic field strength, etc.) are suggested.

Balbutsky, I. M., G. B. Brilev, and **G. I. Kulikova**. 1989. Dependence of the height of the radio echo top of convective and stratiform clouds on the 0° C isotherm level. Radar Meteorology: Materials of the Methodological Center on Radar Meteorology of Socialist Countries. Leningrad. pp. 42-46.

Regularities in the increase in the top height of radio echo of convective and stratiform clouds with increasing 0° C isotherm level are revealed. Data are obtained on the thickness of the over-cooled part of downpour, thunderstorms, and widespread precipitation by using 4 years of observations of the meteorological radar of the Minsk Hydrometeorological Observatory for all seasons.

Balbutsky, I. M. 1987. Calculation of major cloud type frequency of occurrence from data of combined visual and radar observations. Radar Meteorology: Materials of Methodological Center for Radar Meteorology of Socialist Countries. Leningrad. pp. 143-151.

Possibilities for using a combination of visual and radar methods for studying cloud pattern and calculating their climatic characteristics are given.

Baranov, V. G., L. P. Bobylev, Yu. A. Dovgalyuk, Ye. V. Dorofeyev, and **G. G. Shchukin**. 1987. Numerical modeling of radiothermal radiation transfer in convective clouds. Proc. Main Geophys. Obs. 508:65-82.

Problems of developing numerical methods for mathematical modeling of microwave radiation transfer in convective clouds are considered. Algorithms for the numerical solution of the scalar transfer equation for space-bounded media for the afore-mentioned radiation are suggested on the basis of the Monte Carlo method. The software developed includes a subroutine for modeling a convective cloud and its surrounding atmosphere, a subroutine for calculating its optical properties, and a subroutine for performing a numerical solution of the radiothermal radiative transfer equation. A one-and-a-half-dimensional numerical model of a cumulonimbus cloud was used for the first subroutine. The subroutine for solving the transfer equation can be used for calculating radiothermal radiation characteristics of a cumulonimbus cloud, taking into account (1) the refraction and multiple radiowave scattering on hydrometeors, (2) the Earth's sphericity, and (3) the radiation pattern of the microwave radiometer antenna.

Belov, P. N., and **A. Ye. Bakhmatov**. 1988. Cloudiness characteristics from satellite outgoing radiation data and the parameterization method. Atmos. Opt. (1)10:88-94.

Methods for determining cloud amount and cloud top height from satellite outgoing radiation data are given, as well as a method for cumulus convection parameterization that makes it possible to calculate cloud top height, cloud amount, and heat influx due to water phase transitions. Cloud amount and cloud top height maps are given and analyzed, as well as diagrams of the cloud amount structural function and tables of cumulus convection parameters calculated by the parameterization method.

Belov, N. F., B. M. Vorobyov, V. A. Kamishanova, and **T. V. Khotenova**. 1988. Upper-air conditions for the development of intermass convective clouds in the Leningrad area. Proc. Main Geophys. Obs. 517:108-115.

Results of studying physical and meteorological conditions of intermass convection development in the Leningrad area are given within a radius of 40 km of the nearest radiosonde observation point. Ten various hygrometric and thermodynamic characteristics of the atmosphere were used as parameters. These were analyzed for days with thunderstorms, downpours, and convective clouds development to cumulonimbus stage. Results show that none of the parameters considered can serve as an unambiguous criterion for identifying the three basically different stages of the convective development.

Binenko, V. I. 1985. Cloud radiating power. Proc. Main Geophys. Obs. 489:24-27.

The effect of cloud thickness on the emissivity of low-, mid- and high-level clouds is considered.

Bobylev, L. P., Ye. V. Dorofeyev, S. Yu. Matrosov, and **G. G. S Shchukin**. 1988. Evaluating the effect of scattering on radiothermal radiation transfer in clouds and precipitation. Rep. Acad. of Sci. USSR (299)4:845-847.

The effect of scattering on radiothermal radiation (RTR) transfer is studied for two atmospheric patterns: (1) Stratocumulus clouds containing large droplets and (2) powerful convective clouds which have reached the stage of large droplet formation in their development. Model calculations showed that the effect of scattering on RTR largely depends on the wavelength, rain intensity, and convective cloud development stage. A decrease in the total RTR caused by multiple scattering can amount to 20 K. These effects must be t>aken into account at a wavelength of 0.6-1.2 cm and for precipitation intensity 4-7 mm/h.

Bondarenko, V. G., and **V. I. Khvorostyanov**. 1987. On changes in the atmospheric boundary layer conditions with cloud dissipation over large areas. Proc. Cent. Aerol. Obs. 163:92-100.

Consequences of cloud dissipation in winter and during transitional periods with different types of underlying surfaces at different times of the day were studied by using a two-dimensional nonstationary numerical cloud and fog model. It is established that cloud dissipation in winter over snow results in soil cooling (most pronounced at night and insignificant in the daytime), whereas surface temperature increases in the dissipation area during transitional periods (maximum when dissipation is carried out in the afternoon). The highest horizontal temperature contrast in the dissipation area and outside it is achieved in winter before sunrise.

Bondarenko, V. G., and **V. I. Khvorostyanov**. 1987. On cloud and fog formation in a horizontally nonuniform atmospheric boundary layer with heat advection. Proc. Cent. Aerol. Obs. 163:69-81.

Modeling processes of formation and further evolution of low stratiform clouds and fog with heat advection was undertaken by using a two-dimensional nonstationary numerical model involving a detailed calculation of microphysical parameters of clouds. The role of major factors of cloud formation (advection, turbulence, and radiation) is discussed. Results show that in the cold half of the year with advection, clouds form under the higher-temperature inversion layer, where advective moisture influx and turbulent heat outflow are maximum, the latter caused by a decreasing turbulence coefficient under the blocking layer with height. Diurnal variations of radiation balance components are studied for various types of underlying surfaces as well as the effect of the variations on the cloud boundary evolution.

Brylyov, G. B., Yu. A. Dovgalyuk, Ye. V. Orenburgskaya, V. D. Stepanenko, and **T. L. Uglanova**. 1986. On estimating cloud resources in individual geographical areas of the U.S.S.R. Proc. Main Geophys. Obs. 497:76-81

Characteristics of cumulonimbus clouds were calculated from radar data and land-based station observations for different physical and geographical regions of the USSR It was established that the rate of convective development increases with decreasing latitude. Cloud resources were estimated for certain areas of the USSR.

Budak, I. V., V. A. Dyachuck, N. N. Mikhailenko, and **Yu. S. Rudko**. 1983. Space-time structure of precipitation particle spectra from cumulonimbus clouds. Measurement techniques. Proc. Ukr. Reg. Sci. Res. Inst. 193:29-47.

Methods and results of combined surface observations of cumulonimbus precipitation are given. Rain droplet spectra were measured by using radar and rain gauges. Spectra were measured simultaneously at six points, 1-1.3 km away from one another. This made it possible to obtain a series of statistically valid individual ("instantaneous") samples of rain droplets from various parts of the cloud at different stages of its development. The rain intensity **J**, radar reflectivity **Z,** droplet volume-part concentration **N**, and some characteristics of droplet sizes are calculated from droplet spectra. The contribution of different size droplets to the values of **J, W** (water content), and **Z** is estimated. Areas of precipitation characterized by uniform particle-size distribution are identified. Microphysical characteristics of rain in terms of the precipitation area macrostructure are considered. It is shown that the droplet size distribution for clouds under consideration is different from exponential at certain moments. Average spectra for individual points and the average spectrum for all of the network were approximated by the expression $\mathbf{N(\alpha) = N_{1l}}\alpha$, whose parameters and **N** were determined by the peculiarities of the precipitation zone space structure.

Budovy, V. D., Z. M. Makhover, N. P. Nechayev, and **A. A. Radchenko**. 1986. On diurnal variations and time stability of clouds over Tropical Africa. Proc. All-Union Res. Inst. Meteorol. Inf. World Data Cent. 126:41-47.

The diurnal variations of cloud amount and the continuous occurrence of 0-3, 4-7, and 8-10-point cloudiness over Africa in April was studied on the basis of VIS satellite imagery for 1980-1982. Amplitudes of mean cloud amount in daytime and morning hours were used as a characteristic of diurnal variations. The amplitude of total cloud variations during the day is the largest (6.9 points) over the central tropical regions of the continent. Three types of amplitudes were specified with respect to minima and maxima: Type 1--an amplitude with a well-pronounced maximum in the afternoon hours and minimum in the morning, Type 2--that with insignificant (0-1 point) amplitudes, and Type 3--that with decreasing cloud amount in the afternoon. Areas with various amplitude types are identified. Periods of continuous occurrence of 0-3, 4-7, and 8-10 point cloudiness are specified. Weather with a small cloud amount (0-3 points) persists (to 14-19 days) basically in North Africa.

Budovy, V. D., Z. M. Makhover, and **N. P. Nechayev**. 1986. On cloud temporal variability. All-Union Res. Inst. Hydrometeorol. Inf. World Data Cent. 126:55-58.

Root-mean-square deviations of daytime total cloud amount were calculated on the basis of individual values and monthly means of 1962-1971 observations for the Northern Hemisphere meteorological station network. Mapping of the values showed that the root-mean-square deviations were minimal in regions with persistent meteorological conditions. However, the root-mean-square deviations calculated from individual values appeared to be larger than those computed from monthly means. In winter, root-mean-square deviations for individual values range within 1.5-3.5 octas and in summer the range is wider (from 0.5-3.5 octas), which can be explained by higher weather stability in the daytime in winter. The variation range for root-mean-square deviations calculated from monthly means appeared to be lower in July (0.5 octas) than in January (0-2 octas). It was established that the accuracy of climatic characteristics of clouds calculated on the basis of the 1962-1971 observation series is about the same as that obtained on the basis of a longer data series for 1936-1977.

Budovy, V. D., N. P. Nechayev, L. A. Nudelman, and **A. A. Radchenko**. 1986. On distinctive characteristics of the cloud distribution over tropical Africa. Proc. All-Union Res. Inst. Hydrometeorol. Inf. World Data Cent. 126:35-41.

Cloud distribution maps for tropical Africa for April and October are given, plotted on the basis of satellite data for the period 1980-1982. The satellite imagery was processed by 2.5° by 2.5° squares. Maps thus obtained make it possible to introduce corrections in the surface-based climatic cloud observation data for areas with sparse station networks and also increase the detail of the results of research undertaken on the basis of satellite data averaged over large areas.

Chernykh, I. V., A. P. Trishchenko, and **B. G. Sherstyukov**. 1990. Some specific features of cloud base height distribution of different cloud types (**St, Frnb, Sc,** and **Cb**). Proc. All-Union Res. Inst. Hydrometeorol. Inf. World Data Cent. 153:83-93.

Density probability of the height **H** of cloud base of cloud types **St, Frnb, Cu, Cb**, and **Sc** was analyzed for the European territory of the USSR. The single modality of the distribution of **H** was confirmed for **St** and **Frnb**. The multimodality of the distribution of **H** is shown for **Sc, Cu**, and **Cb,** with discrete values of **H** equal to 400-600, 800-1000, and 1600 m for **Sc** and 400-600, 800-1000, and 1600 m for **Cu** and **Cb**. Redistribution of **H** recurrence maximum from one discrete level to another takes place in the case of clouds with multimodel distribution, depending on the season and relative surface humidity. For example, the average height **H** of **Sc** increases from winter to summer not because they rise but because they occur more frequently at higher discrete levels and less frequently at low levels. It is supposed that multimodality and discreteness of **H** are related to different atmospheric processes causing clouds to form, which are characterized by their typical heights.

Dovgalyuk, Yu. A., and **Ye. N. Stankova**. 1989. The dynamic aspect of evaluating the stages of the lifetime of a cumulonimbus cloud. Proc. High-Mt. Geophys. Inst. 76:29-35.

Selecting parameters for quantitative estimation of the lifetime stages of a precipitating cloud is considered. Data obtained from numerical modeling of a single-cell convective cloud by using a one-and-a-half-dimensional nonstationary model developed in MGO are evaluated.

Dracheva, V. P., A. A. Sinkevich, and **Ye. V. Chubarina**. 1988. Convective cloud heterogeneity research. Proc. Main Geophys. Obs. 518:145-152.

Results of convective cloud research are analyzed with a view to revealing the relationship between the electric field intensity inhomogeneities and other cloud characteristics such as vertical flux velocity, temperature, and water content. It was established that the relationship between cloud overheating and vertical motion speed is most pronounced. The correlation coefficient was found to be 0.87.

Dubrovina, L. S. 1983. On statistical parameters of cloud top temperature distribution. Proc. All-Union Res. Inst. Hydrometeorol. Inf. World Data Cent. 107:22-27.

Distribution parameters (means, root-mean-square deviations, skewness and curtosis) of cloud top temperature are analyzed for all cloud types and also specifically for the main cloud forms: **Sc, St, Ns-(As-Ns), Ac** and **As** using aircraft network sounding data. Estimation using X^2 Pearson test revealed that mid-level cloud (**As** and **Ac**) temperature distribution curves are rather well approximated by the normal law while **Ns-(As-Ns), Sc** and **St** are approximated by the Sharlie distribution taking into account skewness and curtosis.

Dubrovina, L. S. 1974. Relationship between cloud thickness and their top and base heights. Proc. All-Union Res. Inst. Hydrometeorol. Inf. World Data Cent. 7:3-11.

Results of statistical analysis of variability of cloud thickness ΔH as well as their top and base heights

(H_b and H_t) and their correlations are given on the basis of network aircraft sounding data for Moscow (Vnukovo Airport) for 1957-1963. The root-mean-square deviations of H_b are not characterized by high diurnal and seasonal variability and are thus a stable characteristic of the cloud type. The top of vertical-development-type clouds **Cu-Cb, As-Ns** frontal systems and **St** clouds is unstable and much more variable than H_t. Stratocumulus and altocumulus clouds are characterized by almost the same variability of H_b and H_t. Correlation coefficient analysis showed that all clouds, except for **As-Ns** (in summer and autumn), are characterized by inverse correlation between the thickness and cloud base height and by direct correlation between cloud thickness and cloud top height. Significant differences in the values of *r* between cloud thickness and H_t of **Sc** and **St** cloud types (*r* ranges from 0.24 - 0.35 with the former and between 0.72 and 0.87 with the latter) were found. Still higher correlation coefficients were obtained for **As-Ns** (0.84-0.95) and **Cu-Cb** (0.80-0.86) for daytime of the warm season. High correlation between cloud thickness and height of **St** and **As-Ns** cloud top height is of practical value for determining cloud thickness from cloud top satellite data. Regression equations are given.

Dubrovina, L. S., and **V. D. Verzunova**. 1983. Evaluation of cloud thickness using satellite data. Proc. All-Union Res. Inst. Hydrometeorol. Inf. World Data Cent. 107:13-22.

The demand of science and the practical application for characteristics of cloud vertical structure, as well as poor data coverage for most of the globe were posed as problems of using proxy methods. The linear regression method $\mathbf{\Delta H}$ with respect to $\mathbf{H}_{B1}$ is suggested. The method is based on correlation between cloud thickness and cloud top height derived from aircraft data obtained from sounding over the USSR. Data taken from the cloud top height map plotted by V. I. Titov and T. Sh. Musaelyan on the basis of satellite radiation temperature and climatic mean temperature gradient were used as a predictor of cloud thickness. A schematic map of the calculated cloud thickness distribution over the Northern Hemisphere for July 1972 is given. The method is estimated by comparing average values of cloud top heights and thicknesses obtained from satellite and aircraft soundings over the USSR territory.

Falkovich, A. I. 1987. On stages of cloud cluster development and moist convection parameterization. Tropical Meteorology, Proc. Third Intern. Symp., Yalta, March 1985, Leningrad. pp. 500-509.

The problem under consideration is studied by analyzing the static energy conservation equations for dry air and water vapor with humid cumulus convection and by estimating the values of the equation terms from field measurements at different stages of cloud cluster development.

Feigelson, Ye. M. 1989. On the methods of experimental and theoretical research carried out on radiation properties of cirrus. Radiation Properties of Cirrus. Moscow. pp. 73-76.

The staging of a surface experiment and organizing of theoretical work with a view to studying radiative properties of cirrus (**Ci**) are considered. The experiment was carried out in May 1986 and 1987 at the Zvenigorod Research Station of the Institute of Physics of the Atmosphere of the USSR Academy of Sciences. May was chosen on the basis of long-term surface observations of clouds at the meteorological observatory of the Moscow State University on the Lenin Hills. According to their data, spring is characterized by the highest recurrence of **Ci**. The necessity of studying thin cirrus clouds is substantiated by the following:

1. Even very thin **Ci** with the optical depth $_T$~0.1-0.2 produces significant greenhouse effect and changes in the system albedo to 5%;

2. Thin clouds over an underlying surface with small albedo (A = 0.1-0.2) affect the albedo of the system more than dense ones;

3. It is this type of cloud that creates a variable greenhouse effect. With $_T$>2 the cloud becomes absolutely black, hence radiation from the bottom and top depends on the temperature alone;

4. Thin clouds are not readily detected from satellites.

The main objective of the experiment and theoretical research has been formulated: determining the effect of cirrus on integral albedo.

Gorodetsky, A. K. 1989. Determination of cloudiness characteristics from thermal radiation measurements in the 10- to 12-µm spectral region. Atmos. Opt. (2)2:198-205.

The emissivity of various cloud types in the spectral region 10-12 µm was determined from aircraft observation data. Cloud radiation and atmosphere counterradiation measurements were accompanied by measurements of meteorological parameters of the atmosphere. The emissivity values obtained are used for developing methods for remote sensing of cloud characteristics on the basis of combined spectral and angular distributions of radiation intensity. Integrated simultaneous measurements in IR and VIS spectral regions are used for determining temperature and cloud top height. Combined with UHF-range observations, they are also used for determining phase composition.

Gorodetsky, A. K., and **A. P. Orlova**. 1981. Radiation characteristics of clouds. Physical Aspects of Remote Sounding of the Ocean-Atmosphere System. pp. 178-191.

Downwelling and upwelling radiation from clouds was measured. The measurements were made with a radiometer sensitive in a range of 10.5-12 µm. The angular course of the radiance of dense clouds is close to isotropic, with a difference of 2-3%. The angular course of the radiance of low- and mid-level dense clouds was found to be equal to 0.96 ± 0.04.

Goryachev, B. V., V. V. Larionov, S. B. Mogilnitsky, B. A. Savelyev, and **G. G. Shchukin**. 1989. On the location of cloud formations in different regions of the spectrum. Proc. Tenth All-Union Symp. on Laser and Acoustic Sounding of the Atmosphere. Tomsk. Part 1. pp. 192-195.

Dependencies (*D*) of energy characteristics of radiation on medium parameters in various parts of spectrum and with various experiment types are investigated. Dependencies of absorption factors on the medium optical section for spherical and anisotropic scattering indicatrices are considered. Also considered are the dependencies of integral reflection factor on radiation wavelength with no absorption in the medium and the dependencies of integral reflection factor on the cloud water content. The authors point out that the use of optical measurement data makes it possible to use real cloud parameter values instead of climatic averages. In so doing, the error of determining cloud parameters is decreased taking into account its size, composition, and structure. On the basis of analyzing the dependencies obtained, the authors conclude is drawn that a combination of measurements in optical and microwave spectrum ranges allows one to decrease the amount of *a priori* meteorological information being used and increase the accuracy of the results.

Goryachev, B. V., V. V. Larionov, S. B. Mogilnitsky, B. A. Savelyev, and **G. G. Shchukin**. 1989. Radiation balance of the cloud layer in the course of its fragmentation. Radiometeorology: Proc. All-Union Meeting. Suzdal, 21-24 October 1986. Leningrad. pp. 36-38.

The effect of cloud medium "clearing" when it is breaking up was studied, not taking into account interaction between parts of the dissipating medium. The increase in the passing radiation flow when cloud medium of constant optical depth breaks into **n** parts of the same optical depth is referred to as the "clearing effect." The effect of the breaking extent of dissipating medium on radiation characteristics was investigated keeping lighting and observation conditions constant and taking into account the shape of the indicatrix of scattering, quantum survival probability, and the optical length of the medium. On the basis of the suggested analytical method of solving the problem of radiation transfer in space-limited dispersion media, it is shown that with the increase of the cloud field breaking extent of fixed length, the fraction of radiation which passes through the layer becomes larger because of the deformation of the multiple light-scattering field.

Goryachev, B. V., V. V. Larionov, S. B. Mogilnitsky, and **B. A. Savelyev**. 1987. On the effect of cloud breaking degree on the radiation balance in the atmosphere. Rep. of the Acad. Sci. U.S.S.R. (294)2:318-321.

The effect of "clearing" of clouds when they are broken is studied. The basic regularities of the effect are established. It is shown that the effect increases with increasing cloud optical thickness and absorption and decreases with decreasing optical thickness and absorption.

Greisukh, V. N., and **I. M. Levin**. 1990. Calculation of a flat cloud layer transmission taking absorption into account. Optics of the Ocean and the Atmosphere, Part 2. Krasnoyarsk, 2-7 September 1990. Krasnoyarsk. p. 93.

Asymptotic formulae and the Monte Carlo method were used to compare weakly absorbing scattering cloud layers for various sun ray incidence angles. It is shown that the use of asymptotic formulae is limited because it is impossible to determine the survival of photon in real clouds.

Gulyayev, Yu. N. 1989. The statistical description of convective cloud mesoscale fields with the help of the Weibull distribution. Physical Processes in the Atmosphere and Aircraft Flight Safety. Leningrad. pp. 115-120.

The analysis of average-resolution pictures obtained from satellites PRIRODA made it possible to identify over 60 ensembles of convective clouds in which measurements were made and different diameter clouds were counted. It is suggested that the statistical description of cloud size distribution can be made with the help of the Weibull distribution. It is shown that the Weibull distribution parameters depend on the air mass in which the clouds are observed.

Isayev, G. I. 1985. The effect of radiation heat transfer on cloud formation in the atmospheric boundary layer dynamics model. Numerical Methods in Atmospheric Physics. Physics and Environment Protection Problems, Novosibirsk. pp. 16-28.

Numerical experiments with a view to studying the effect of radiation heat influx on the process of stratus formation and the dynamics of the atmosphere are described. The integral transmission function was used to calculate long-wave radiation. The turbulent energy balance equation was added to the set of equations describing momentum, heat, and moisture transfer in use. To demonstrate the effect of radiation fluxes on cloud formation, experiments were staged with and without parameterization of radiant heat transfer. Radiation heat influx distribution shows that cooling is clearly localized in space and goes up as the cloud top goes up. Cooling rate at cloud top amounted to 1.32° C per hour. Atmospheric heating was observed at and below the cloud base. It was established that the effect of long-wave radiation is most pronounced at night when vertical exchanges caused by vertical motions and turbulence are weaker.

Istomina, L. G., and **V. S. Malkova**. 1986. Research on the spatial structure and optical parameters of clouds using satellites. Optics of the Atmosphere and Aerosols. Moscow. pp. 124-133.

A procedure for the quantitative description of two-dimensional cloud field structure is considered. Estimates of basic inhomogeneity ranges that characterize cloud formation structure over a wide range of spatial frequency spectra are given. Such parameters of clouds as optical thickness and specific absorption are also determined from radiation measurements in different portions of VIS and IR spectra. The results obtained confirm the existing ideas of the large value of radiation absorption in clouds.

Kachurina, L. R. 1989. Analysis of correlations in the Northern Hemisphere total cloudiness fields. Proc. All-Union Res. Inst. Hydrometeorol. Inf. World Data Cent. 150:78-90.

Results of analyzing the space correlation in the Northern Hemisphere total cloudiness fields are presented. Daily satellite observations are used from January and July 1966-1980 and from individual reference points for 1981-1985 in 5 by 10° regular grid points. An approach based on evaluating the spikes of the two-dimensional characteristics in the correlation fields was used for analysis. Quantitative descriptions of connectivity points (area, linear dimensions, and anisotropicity degree) were obtained as well as characteristics of their distribution in different latitudinal zones of the hemisphere. New empirical data on space correlation in the total cloudiness field in the hemisphere were obtained.

Kan, K. A. 1988. Synoptic processes resulting in the formation of low clouds in the Alma-Ata area. Proc. Kazakh. Reg. Sci. Res. Hydrometeorol. Inst. 100:121-127.

Data are used to study the synoptic conditions of low cloud (LC) formation in the Alma-Ata area. LC conditions were defined as those with cloud base heights of 200 m or less. The classification of weather processes resulting in the formation of LC is based on the geographical location of anticyclones (A) from outbreak to formation and at the moment of LC occurrence. It is shown that the air mass A type participating in the formation of LC can be judged on the basis of the geographical location of anticyclones and the trajectory of their movement. Three types of synoptic situations (south-west and north-west anticyclone outbreaks and stationary anticyclones) were identified. It was established that most often (in 35.4% of the total number of cases) LC formation is related to north-west outbreaks of anticyclones. LC maximum lifetime (to 39-40 hours in individual cases) was observed at times of south-west outbreaks whereas minimum lifetime (3-4 hours) was associated with north-west outbreaks.

Khvorostyanov, V. I. 1988. Modelling of artificial crystallization and clearance zone in the cloud with changes in the wind shear and turbulence coefficient with height. Proc. Cent. Aerol. Obs. 171:37-49.

A two-dimensional numerical model of low cloud artificial crystallization is given in which microphysical processes are calculated jointly with turbulence and wind fields, and radiation processes are calculated jointly with heat and moisture exchange with the surface. General regularities of crystallization and clearance zone development are investigated that result from the interaction of microphysics processes with the vertically nonuniform wind shear and turbulence coefficient by means of areal cloud seeding with granulated carbonic acid or linear seeding by using a generator. It was established that the clearance zone displacement rate is close to that at the cloud top. The width of the zone, its lifetime, distance between the lines of seeding, and distance to the object to be modified under given weather conditions are evaluated.

Kislov, A. V., and **Ye. K. Semyonov**. 1982. The spectral structure of meteorological fields and interannual fluctuations of cloud cover relating to El Niño. Proc. All-Union Res. Inst. Hydrometeorol. Inf. World Data Cent. 94:55-68.

The nature of cloud cover fluctuations in the West and Central Tropical Pacific (from interannual to diurnal) is studied. A dramatic difference in the cloud picture in 1972 was noted in comparison with the other 6 years considered, reflecting the presence of a large-scale circulation anomaly (El Niño). The spectral analysis of cloud, wind, temperature, and humidity field variability showed the presence of synoptic-scale (with a period of 3 to 7 days) and global-scale fluctuations. Fluctuations of meteorological elements with a period of about 1 day are observed throughout the troposphere.

Kondratyev, K. Ya., and **V. I. Binenko**. 1989. Specific features of spectral radiation characteristics of strata over the city. Interinst. Collection of Research Papers. Leningrad Hydrometeorological Institute.

pp. 5-9.

Specific features of strata spectral radiation characteristics over the city are considered in comparison with relatively clean clouds over a rural area and the sea on the basis of integrated analysis of subinversion layer clouds over Zaporozhye. The following characteristics of urban area clouds are identified: (1) a larger amount of condensation nuclei, and hence a higher concentration of droplets; (2) droplet size distribution intermediate between that seen in sea clouds, which have the largest amount of large droplets and rural area clouds which have the largest amount of small droplets; (3) a high degree of mineralization in cloud water samples, with the largest amount of pollutants observed close to cloud base; (4) decrease in the concentration of admixtures in the cloud water with the increase of intake level in the cloud over a city in comparison with a similar cloud over a rural area; (5) the prevalence of anion $\mathbf{SO_4}^{-2}$ and cation $\mathbf{NH}_{4+}$ and along with soluble admixtures a large amount of insoluble soot particles (organic substances are 30-50% of the total mass of insoluble deposition); (6) deeper sulphate, nitrate, and carbon dioxide absorption bands in relative brightness spectra which is a sign of a higher pollution level; (7) more pronounced decrease in the cloud albedo over a city for shorter wavelengths in comparison with the albedo of the same type over rural areas; and (8) increase in the absorptivity in the visible portion of spectrum because of the presence of an active aerosol.

Kondratyev, K. Ya., V. V. Kozodyorov, O. Yu. Kyarner, and **S. Ch. Keevallik**. 1989. Interannual variability of cloud amount distribution. Earth Res. Space 3:29-34.

Satellite cloud amount data are analyzed as well as solar radiation flux reflected because of clouds over areas of 0.25×10^5 km^2. The stability of annual means averaged over large areas is pointed out. It is shown that the probability distribution of cloud amount and the intensity of reflected radiation for various years are essentially different at the 95% significance level.

Kondratyev, K. Ya., V. I. Khvorostyanov, and **V. G. Bondarenok**. 1984. On the effect of the cloud microstructure and water content on the radiation regime at different latitudes. Rep. Acad. Sci. U.S.S.R. 276(1):92-95.

The effects of cloud microstructure and water content on radiation regime were calculated for tropical, middle, and polar latitudes. The computations were made on the basis of three models of the atmosphere with continuous strata at 400-800 altitudes. Radiation flux vertical profiles were calculated by using two-flux approximation. The analysis of computational results showed that the formation of cloud albedo and transmission is determined by their whole bulk. Comparison of computed and measured values showed good agreement. Snow cover albedo contributes most to forming cloud albedo in high latitudes. Difference in the microstructure of clouds over continents and oceans calls for separate parameterization of cloud albedo over continents and oceans. Maximum radiant heat influx caused by long-wave radiation decreases with decreasing water content and temperature, as well as with the increase in the water content of the atmosphere over the clouds and increasing average droplet size. Short-wave radiation influx is strongly dependent on the latitude (sun elevation) and is characterized by spectral distribution variability because it is always lower than the heat influx coupled with long-wave radiation, which is a major factor in the clouds functioning as a "thermal whole." It is very important that the variability of microstructure be taken into account in cloud formation models because an initial 15-20% error in the influx after 5-10 h of cloud evolution can result (because of very strong feedback between water content and influxes) in an error of about 30-50% in water content and cloud top and base heights.

Kondratyev, K. Ya., V. I. Binenko, L. N. Dyachenko, V. I. Korzov, and **V. V. Muchenberg**. 1981. The albedo and angular reflectance characteristics of clouds and underlying surfaces. Gidrometeoizdat. 232 pp.

Data obtained from land-based, aircraft, and satellite radiation measurements are used to analyze the integral and spectral albedo of continuous clouds, as well as the angular characteristics of the reflectance of major underlying surfaces types. The book consists of the following chapters: (1) Integral albedo of the underlying surface; (2) Spectral albedo and the underlying surface spectral brightness coefficient; (3) Albedo of the earth-atmosphere system; (4) Cloud reflectance; and (5) Angular characteristics of the underlying surface and cloud reflectance from aircraft measurement data.

Korotkov, A. I. 1989. Variability of meso-scale radar characteristics of clouds over tropical oceans. Tropical Meteorology Proc., Fourth International Symposium, Havana, 13-17 April 1987. pp. 372-378.

Experimental data of meteorological radars on board research vessels is used to analyze cloud variability in different circulation systems of the East Atlantic. Fluctuations of maximum cloud heights with a period of 3 to 8 h are pointed out. It is emphasized that fluctuations are most pronounced during cold outbreaks.

Korshunov, V. A., N. P. Romanov, and **A. S. Drofa**. 1991. Some results of studying strata base characteristics using lidar and other methods. Proc. Exp. Meteorol. Inst. 52(147):124-143.

Results of comparative measurements of low-level strata transparency that use lidar and base bar methods on an inclined route at a angle of 45° are given for two weather patterns. The two methods show good agreement when multiple scattering in backward scattering signals is eliminated. Microstructure is measured for one of the patterns, and extinction coefficients measured by lidar and base bar methods are compared. The paper contains an analysis of high-level profiles of extinction coefficients obtained by the lidar method in the low transitional strata layer, where the presence of an area with exponential dependence of extinction coefficient on height is confirmed. The maximum of the lidar signal corresponds to the position of the upper part of this area in the case of one-layer clouds.

Koryakov, T. A., and **T. N. Lebedev**. 1983. Three-dimensional numerical model of an isolated cloud. Proc. Inst. Appl. Geophys. 45:3-20.

Equations of the hydrodynamical model of an isolated droplet convective cloud are formulated, with microphysical processes parameterized according to the Taked scheme. Boundary conditions allow for incorporating the background wind with one-directional shear. The model equations are solved on a 25 × 11 × 41 point grid (with respect to x, y, and z, respectively), with **h** = 200 m. Some results of preliminary numerical experiments are discussed that were performed for a no-background wind scenario in which "closed type" boundary conditions were used for external boundaries. The experiments showed that at the cloud growth-stage pressure gradient in combination with turbulent momentum transfer compensates for 30% of buoyancy force. The latter is the main factor responsible for the development of convection. The updraft velocity, the temperature excess in it, and the water content of the model cloud quite agree with data measured directly in clouds.

Kosarev, A. L. and **I. P. Mazin**. 1989. An empirical model of mid-latitude upper-air cloud structure. Radiation Properties of Cirrus Clouds. pp. 39-53.

An empirical model of mid-latitude upper-air cloud (UAC) structure is suggested. The macrophysical model of the UAC structure incorporates UAC recurrence and the portion of the sky covered with UAC, UAC base and top height the cloud layer thickness and the temperature pattern. The following UAC microphysical characteristics are considered on the basis of observed data from the Central Aerological Observatory: microstructure integral characteristics, water content, visible light extinction coefficient, phase structure and crystal shapes, and UAC particle-size spectral. The Central Aerological Observatory instruments are also described.

Kosarev, A. L., I. P. Mazin, A. N. Nevzorov, and **V. F. Shugayev**. 1986. Microstructure of cirrus clouds. Problems of Cloud Physics. Leningrad. pp.160-186.

Results of many years of aircraft observations of cirrus microstructure primarily carried out over the European territory of the USSR during the period 1796-1984 are summarized. The notion of crystal effective diameter (α) is introduced, and methods to measure it by using conventional photoelectric spectrometers are substantiated. The equipment used made it possible to carry out direct measurements of the visible light extinction coefficient (γ), the amount of ice (ω), and the spectrum of effective ice crystal diameters f(α) in the range α >20 µm. Statistical data were obtained on the accumulated frequency of occurrence of integral parameters (i.e., concentrations of N, γ, and ω) proportional to different order distribution moments, as well as least detectable parameter distribution α_{oc} and crystal distribution parameters with respect to α. Commonly, the values of N (α >20 µm) range from 10^2-10^3 l^{-1}; in most cases γ does not exceed 5 km^{-1}, though sometimes it would amount to 20 km^{-1} and even more; and ω commonly ranges from 10^{-3} to 10^{-1} g/m^3. Phase relaxation time (T_r) is commonly measured in minutes and tens of minutes. The maximum sizes of can be as high as 2×10^3 µm and sometimes α_{oc} >200 µm. It is shown that in the range α >20 µm the local spectrum sizes (the space averaging scale does not exceed 50 m) can well be approximated by superposing two distributions--gamma and exponential. The gamma-distribution index can be taken to be equal to unity in the overwhelming majority of cases (>80%).

Kravets, L. V. 1990. Vertical distribution of visible light extinction coefficient in upper-level clouds. Atmos. Opt. 3(8):891-894.

Vertical profiles of visible light extinction coefficient in the (cirriform) clouds are studied experimentally on the basis of ground-based lidar observations. It was found that the profile form for the extinction coefficient was different for clouds with different base heights. Empirical relationships describing the dependence of the visible light extinction coefficient of cirriform clouds on altitude were ascertained.

Krupchatnikov, V. N., and **L. I. Kurbatskaya**. 1987. Assessment of the effect of cloud layer optical properties on the underlying surface radiation balance. Numerical Models in Problems of Physics of the Atmosphere and Environment Protection. Novosibirsk. pp. 48-60.

The effect of cloud layer optical properties on the distribution of short-wave and long-wave fluxes in the atmosphere and on the radiation balance at the earth's surface is studied. The results of computing radiational cooling and heating rates in cloudy atmospheres that differ in water content are presented. Radiation balance sensitivity to cloud layer albedo variations and radiating power is estimated. Balance profiles are shown as a function of cloud height and water content. Numerical experiments were staged with the help of the radiation scheme that is used in the midrange weather forecasting model of the Hydrometcentre of the USSR.

Letunovsky, V. A. 1987. Lifetime and height of different cloud types in the West Arctic. Polar Meteorology at the Service of National Economy. Abstracts. First All-Union Meeting, Murmansk, 27-29 October 1987. 47 pp.

Cloud regime characteristics (lifetime of different low-level and midlevel cloud types and cloud base height and its variability) were calculated from hourly low-level and midlevel cloud observations at eight Arctic stations during POLEX-NORTH-76 (April-July 1976). It was found that stratus and stratocumulus clouds are most recurrent in the Arctic. Their lifetime sometimes reaches several days. The frequency of one cloud type transition to another one is determined. Stratus are the lowest clouds. The frequency of their bases extending to 200 m above ground level exceeds 70% in the period under consideration.

Lev, T. D. 1984. Investigation of cloud formation factors and calculation of cloud amount. Proc. Ukr. Sci. Res. Inst. Goskomgidromet. 198:16-26.

Cloud formation factors are considered. Lower troposphere clouds and atmospheric boundary layer clouds formed in cold and transitional seasons are considered separately. An expanded set of predictors is used for describing tropospheric clouds: the dew-point deficit mean in the 850-500 hPa layer, the mean vertical velocity at 850 and 700 hPa levels, and the vertical temperature gradient in the layer 850-500 hPa. Empirical dependencies were constructed for calculating cloud amount for three gradations of . Relationships are improved if air stratification is taken into account. The validity of prevailingly overcast weather in the corresponding region of the diagram increases to 90-98% and that of partly cloudy weather increases to 86-93%.

For calculating cloud amount in the troposphere, two discriminant functions for discriminating between three cloudiness states (overcast, broken clouds, and scattered clouds) were constructed on the basis of the three predictors. Factors/ predictors for predicting cloudiness in the boundary layer were selected with the help of correlation analysis. A discriminant function differentiating between overcast and clear sky was constructed for calculating cloud amount. Testing the discriminant functions thus obtained on unbiased data showed that expanding the set of predictors for describing lower troposphere clouds and taking into account the boundary layer processes increases the reliability of cloud amount forecasting to 87%.

Makhover, Z. M. 1982. On time variability of clouds. Proc. All-Union Res. Inst. Hydrometeorol. Inf. World Data Cent. 95:32-38.

The variability of monthly averages of total and lower cloud amount was determined from observations for 1936-1977. In individual years, total and lower cloud amount averages can vary over a rather wide range (to about 6 to 7 octas). It is only in areas where there are practically no lower clouds in one of the seasons (in winter in Siberia and in summer in Central Asia) that interannual fluctuations of cloud amount averages are not high (to about 1 to 2 octas). Regularities in the distribution of average cloud amount were revealed. It was found that the contribution of average monthly cloud variability amounts to 15 to 40% of the total cloud variability. The contribution of diurnal variation is usually about to 20 to 40%. The nature of the temporal stability of clouds is also defined. The character of total cloud amount remains the same between 3-h observations in 65-78% of cases in January and in 54-68% of cases in July, whereas for lower cloud amounts a static character is observed in 71-78 and 55-61% of cases, respectively. The total cloud stability minimum was observed in 24 h, whereas lower cloud amount stability minimum is observed in 12 h.

Malkevich, M. S., V. S. Malkova, and **V. I. Syachinov**. 1981. Optical characteristics of clouds. Physical Aspects of Remote Sensing of the System Ocean. Atmosphere. Moscow. pp. 149-172.

Possibilities of determining the specific absorption of cloud mass for some portions of VIS and near-IR spectra are considered on the basis of optical measurements from the satellite KOSMOS-320. Papers on solar radiation absorption of clouds are reviewed. The nature of the cloud constituents responsible for the absorption is discussed.

Malkova, V. S., and **L. G. Istomina**. 1989. Determination of optical characteristics of clouds from experiment results. Earth Study Space 2:12-16.

The problem of determining remote sensing of cloud optical parameters from the radiation characteristics of the system surface-atmosphere is considered. As a result of calculations optical thickness and specific absorption values in several intervals of visual and near infrared regions were obtained. The role of solar radiation absorption in studying climate variations and environmental control is pointed out.

Maltsev, E. V., and **V. S. Fadeyev**. 1985. Techniques of cloud field classification according to the frequency of cloud base height occurrence. Meteorological Forecasts, Leningrad. pp. 85-90.

A technique for cloud field classification is given that was developed on the basis of K-intragroup averages. However, class centers are not chosen in the way they are in the algorithm, but from the condition of their most uniform positioning on the distance scale, and the number of classes is not preset. A criterion is offered for selecting optimum classification of cloud fields according to the frequency of occurrence of cloud base for April for Western Europe.

Marchenko, P. Ye., and **B. Kh. Thamokov**. 1986. The effect of microstructure on the Doppler radar characteristics of hail clouds. Proc. High-Mount. Geophys. Inst. 63:101-110.

Extinction and reflectance coefficients, average gravitation velocities, and root-mean-square widths of gravitation velocity spectrum widths for a two-phase rain-hail mixture are calculated. Hail is assumed to be melting with **h** = 0.01 cm. Calculations were made for different versions of the rain-hail mixture distribution function for λ = 3.2 cm. It is shown that the log-normal distribution in the case of rain does not describe the whole range of velocities observed. It is concluded that for theoretical calculations it is necessary to take into account the presence of the rain-hail mixture in hail clouds.

Martines, D., K. Peres, V. P. Belyayev, and **V. V. Petrov**. 1989. Thermodynamic characteristics of tropical convective clouds. Tropical Meteorology. Proc. Fourth International Symposium, Havana, 13-17 April 1987. Leningrad. pp. 351-360.

One hundred and two convective clouds from 0.4 to 10 km thick were examined with the help of aircraft on-board instruments that can measure vertical motions and temperature pulsations. Information was obtained on the thermodynamic characteristics of the warm parts of the convective clouds. It is shown that amplitudes of characteristics in clouds increase with the increase in their thickness. Vertical velocities in thick cumulus clouds amounted to -24.4 to 18.0 m/s and temperature disturbances from -2.6 to 2.5° C. Several updrafts, a few hundred meters deep were observed to alternate with downdrafts. Comparatively small cumulus clouds commonly have only one updraft in them 100-300 m in size.

Matveyev, L. T. 1981. On studying cloud dynamics. Interinst. Collect. of Leningrad Hydrometeorol. Inst. 73:31-45.

A review of papers on the dynamics of clouds, which was started in the Soviet Union about 5 years ago. Basic results and ideas underlying the methods of solving the set of equations are given.

Matveyev, L. T. and **S. A. Soldatenko**. 1988. Numerical models of cloud formation and forecasting. Opt. of the Atmos. 1(9):73-80.

Hydrodynamic models of a humid atmosphere, designed for numerical modeling and forecasting of cloud fields, air temperature and humidity are considered. The models suggested can be used in problems of numerical weather forecasting and forecasting of the optical properties of the Earth's atmosphere. The major role of horizontal baroclinicity (thermal inhomogeneity) and the processes of moisture circulation in the atmosphere in the generation and the development of synoptic vortices are demonstrated.

Matveyev, Yu. L. 1986. Cloud amount distribution functions. Proc. All-Union Sci. Res. Inst. Hydrometeorol. Inf. World Data Cent. 126:18-27.

Television imagery is used to construct cloud amount distribution functions. The dependence of the functions and other statistical parameters on the averaging area has been established. Generalized log normal and other functions are used to parameterize cloud amount distribution. Approximation errors are evaluated. A principal difference in the cloud amount distribution curve type is accounted for in the case of averaging observations over small observation areas for which **U**-shaped distribution curves are characteristic vs averaging over large areas for which cupola-shaped distribution curves are characteristic with the density probability maximum close to mean values. Because surface-based observations can only cover a small area, it becomes clear why **U**-shaped cloud amount distributions prevail.

Matveyev, Yu. L., L. T. Matveyev, and **S. A. Soldatenko**. 1986. Global cloud field. Leningrad, Gidrometeoizdat. 279 pp.

Statistical analysis was performed as well as parameterization and modeling of the global cloud field on the basis of the Earth cloud cover satellite observations in 1966-1980. Means, standards, skewness, and curtosis of cloud amounts are given for various time intervals and different areas (including averaging for the Earth as a whole, latitudinal belts, hemispheres, water and land, each continent, and the ocean). Distribution density is constructed and discussed as well as cloud amount correlation and spectral cloud amount functions. Annual variations and geographical characteristics of cloud distribution are investigated. It is shown that the character of atmospheric motions (dynamics) is closely connected with thermal inhomogeneity and advection (horizontal baroclinicity) and plays a decisive role in the formation and evolution of the cloud field.

Matveyev, Yu. L. 1982. The parameterization and dependence of cloud amount distribution functions on the averaging area. Basic Problems of Meteorological Support of Civil Aviation. Leningrad. pp. 122-127.

Visible satellite cloud imagery was used to construct cloud amount distribution functions. The dependence of the functions and other cloud statistical characteristics on the averaging area is established. Cloud amount distribution is approximated with the help of the log-normal function.

Matveyev, Yu. L. Space structure of the global cloud field. Proc. Main Geophys. Observ. 460:38-43.

The results of statistical analysis of the global cloud field are discussed on the basis of satellite

observations for 1971-1975. Cloud amount correlation coefficients for different latitudes and longitudes were obtained that allow one to judge about pressure and thermal formations related to cloud field formation.

Matviyenko, G. G., I. N. Kolev, and **O. P. Parvanov**. 1988. Lidar measurements of cloud velocity. Atmos. Opt. 1(8):97-104.

The efficiency of geometrical location schemes with long and short ranges between two scattering volumes, as applied to remote measurements of cloud field velocity, is compared on the basis of theoretical analysis of correlation functions of signals of aerosol lidar with two sounding tracks. As a result of field lidar measurements that use different geometrical schemes, it is shown that correlation lidars with a larger range between scattering volumes are characterized by higher accuracy. As for their efficiency, it is lower than that of lidars with a short range.

Mazin, I. P., and **A. Ch. Khrisshan** (eds.). 1989. Clouds and the Cloudy Atmosphere. Leningrad, Gidrometeoizdat. 647 pp.

This book is the world's first reference manual on clouds. It contains basic information on the macrostructure of cloud cover and on the microstructure of clouds, including general physical and statistical regularities of the atmosphere and atmospheric aerosols; cloud thermodynamics; their amount; recurrence; phase state; water content in the crystal phase; particulate matter, etc. It also contains information on optical, electrical, and radiative properties and radar characteristics of clouds. The book briefly summarizes global data on fog and precipitation.

Mazin, I. P., and **A. N. Nevzorov**. 1987. On the microstructure of ice crystal clouds. Problems of Cloud Physics: Weather Modification. Leningrad. pp. 37-49.

Results of experimental research on high-level cloud microstructure, carried out at the Central Aerological Observatory during the 1980s are reviewed. It is shown that the particle size spectrum can be represented as a superposition of three terms, each of which describes its own size spectrum range, and that high dispersion fraction (**$a < 20$ μm**) is not always present in clouds and can sometimes consist of droplets only. The possible role of various mechanisms in crystal formation is discussed, including that of spontaneous freezing of droplets at temperatures below -40° C.

Mazin, I. P., and **S. M. Shmeter**. 1983. Clouds, Cloud Structure, and Physics of Formation. Leningrad. Gidrometeoizdat. 279 pp.

The results of theoretical and experimental studies carried out in the USSR and abroad are presented. A description of the physical structure of different cloud types cloud is given, including information on the distribution of different thermodynamic and microphysical parameters in clouds. Along with the description of microphysical and macrophysical structure of clouds and cloud systems, emphasis is

placed on their mesoscale structure and, in particular, those characteristics that affect the process of precipitation formation. Mechanisms of cloud element (droplets and crystals) formation and enlargement are considered as well as the kinetic processes in clouds.

Mikulinsky, I. A., and **K. S. Shifrin**. 1989. Small-angle light scattering by cirrus cloud particles. Radiation Properties of Cirrus Clouds. Moscow, pp. 65-72.

An ensemble method of calculating small-angle scattering on the system of randomly shaped large particles was developed. The method is not designed for calculations of scattering for each individual particle. Its application for calculating small-angle scattering on cirrus cloud particles is shown, and a typical example characterizing the physics of the process is considered. It is shown that the particle nonsphericity deforms the "average" disc small-angle indicatrix. The average intensity curve stretches forward such that the average values of full-flux scattered radiation directed at the cone with a small opening increase. The nonsphericity also results in the appearance of noise in the angular behavior of scattering intensity. Indicatrix maxima decrease, whereas minima increase. Indicatrix extreme values shift towards smaller scattering angles.

Milenky, M. N., V. I. Kozintsev, B. A. Konstantinov, and **G. N. Baldenkov**. 1986. On the possibility of using multiple scattering for measuring cloud height. Proc. Inst. App. Geophys. U.S.S.R. State Comm. Hydrometeorol. and Environ. Prot. 67:129-135.

The results of parameter calculations for single and multiple scattering of a short optical impulse by cloud aerosols are given. A method of measuring cloud base height that uses a multiple scattering signal is suggested. Advantages of the method compared with the conventional methods used for measuring cloud base height are shown, one of which is the higher values of cloud boundary contrast under conditions of subcloud haze and broken clouds. The possibility of using this method for cloud base measurements with minor modifications of series equipment is shown.

Mirvis, V. M., and **I. P. Guseva**. 1986. Cloudiness over the North Atlantic from satellite and surface-based data. Proc. Main Geophys. Obs. 505:29-42.

Cloud amount monthly averages for nine years (1966-1974) for the North Atlantic Ocean Weather Stations land-based and satellite data were compared. Discrepancy values for individual stations for various months were obtained. Interannual variability characteristics of monthly cloud amount averages and time trend are estimated separately on the basis of Weather Station data for 1953-1974 and satellite observations for 1966-1983. It is shown that the satellite cloud data are characterized by a high positive trend in the southeast North Atlantic and a negative trend in the northwest.

Morachevsky, V. G., N. A. Dubrovich, and **A. N. Potanin**. 1984. Surface electric properties of nuclei as an important parameter determining the development of processes in clouds. Interinst. Coll. Res. Papers Leningrad Hydrometeorol. Inst. 84:156-164.

Specific properties of water molecular interaction with the surface of condensation nuclei, resulting in varying condensation activity ions of different sign and varying ice forming activity of differently charged surfaces, are considered. Results of computations and experiments support the importance of taking these properties into account.

Morozova, L. I. 1988. Character and nature of cloud anomalies over broken lithosphere discontinuities. Central Type Microstructures in Siberia and the Far East. pp. 120-135.

Causes for linearly shaped anomaly formations in the cloud cover structure over discontinuities are analyzed. Examples of relationships between the crust structural inhomogeneities and cloud cover anomalies are given.

Nazirov, Z. N., and **L. S. Rasulova**. 1988. Cloud phase structure in the Kashka Darya basin from radar and aircraft data. Proc. Cen. Asian Reg. Sci. Res. Inst. Goskomgidromet. 126(207):33-38.

Space-time variability of cloud system phase structure was investigated on the basis of radar and aircraft data. The frequency of occurrence of cloud thickness with different phase states is determined as well as the ratio of areas with crystal, mixed, and liquid droplet phases. Echo signal depolarization values, which are used for locating different phase structure zones in the cloud, are made more specific on the basis of aircraft research.

Nezval, Ye. I., and **N. Ye. Chubarova**. 1989. Spectral distribution of solar radiation in the 290-560 nm range with continuous upper-air clouds. Radiation Properties of Cirrus. Moscow. pp. 148-152.

Some peculiarities of upper-level cloud effect on the spectral distribution of radiation in the 290-560 nm range are described. The analysis of the spectral distribution of total and diffuse radiation with clouds and cloud-free sky show that the average effect of clouds on the incoming total and diffuse radiation is comparable with the effect of a highly turbid atmosphere. Upper-level clouds significantly affect the diffuse radiation spectrum, whereas the relative spectrum of total radiation changes insignificantly.

Nickolayeva, S. I., and **N. N. Romanova**. 1986. Cloud systems in maximum wind zones. Proc. Cen. Asian Sci. Res. Inst. Goskomgidromet 122(203):37-38.

Results of analyzing cloud system distributions in maximum wind zones with differently oriented jet streams are given. The possibility of using satellite information for locating the jet stream axis is estimated.

Nosar, S. V., and **M. V. Buikov**. 1989. Cloud data analysis using the Lagrangian model of cloud.

Mathematical Modelling of Atmospheric Convection and Modification of Convective Clouds. Proc. Second All-Union Symp. Dolgoprudny, 26-29 May 1986, Moscow. pp. 83-91.

Cloud and precipitation data, obtained at the experimental site of the Ukrainian Scientific Research Hydrometeorological Institute, are analyzed with a view toward testing the empirical material, theoretical conclusions, and relationship between cloud amount and cloud and atmosphere parameters drawn on the basis of ideas about sorting out hydrometeors in a given motion field in the cloud. The Lagrangian cloud model is used for computing convection parameters. One hundred twelve clouds were used for analysis. Radiosonde results for two sites (Krivoy Rog and Zhovtnevoye) were used. Data analysis confirms (1) the theoretical conclusions that if the value of one of the dimensionless parameters is less than a zero, there is no precipitation and (2) the existence of a relationship between the parameter and precipitation amount.

Pavlova, L. N. 1989. Propagation of short light pulses in clouds. Proc. Inst. Exper. Meteorol. Goskomgidromet. 49:82-92.

A short review is given of theoretical and experimental results of studying the passage and reflection of short light pulses in media (clouds of large optical depth). The main effects observed when short light pulses propagate in clouds, apart from their decreasing energy, is their space, angle, and time broadening, which in turn results in space and time disturbance of irradiation coherence. Studying the effect of medium characteristics on these processes is of practical value for the development of optical systems for signaling, location, and communication systems.

Polezhayev, A. A. 1988. Sensitivity of a convective cloud and precipitation model to microphysical processes parameterization methods. Proc. Hydrometcent. U.S.S.R. 298:85-97.

A brief description is given of different microphysics parameterization procedures combined into four independent models of cloud and precipitation formation to be used for local weather forecasting. Ice-formation processes in the atmosphere are taken into account with a different degree of completeness. Numerical experiments are analyzed using five sets of World Meteorological Organization-recommended real, original data sets containing information on mesoscale convective processes over the US, Canada, and the Tropical Atlantic. The calculation results are compared with aircraft and radar observation data. Conclusions are drawn on the quality of various cloud and precipitation parameterization algorithms. One of the versions (Model L) is suggested for incorporation in the local forecasting model.

Popova, N. D., and **G. G. Shchukin**. 1987. Determining water content of convective clouds on the basis of primary/secondary radiolocation. Proc. Main Geophys. Obs. 508:91-96.

To evaluate convective cloud water content, the correlation $\mathbf{z\text{-}Aw^{a}}$ is used where the parameters **A** and **a** are determined from the results of primary/secondary radar sounding.

Prokopyeva, I. P., and **V. G. Tokarev**. 1989. A computerized method of forecasting air mass and frontal cloud system motion. Abstracts of Reports of the Third All-Union Conference on the Statistical Interpretation of Hydrodynamical Forecasts. Nalchik, 25-30 September. 1989. Moscow. p. 22.

A computerized method was suggested that makes it possible to use hydrodynamic forecast data to calculate air mass and front motion as well as cloud systems connected with them for 24-48 h over any area. The technique is based on the hypothesis of the conservation of all major characteristics of synoptic situation during 24 h. Image recognition theory was used in mathematical processing. The method was tested on actual data (18 cases for 18 areas of Siberia). Synoptic map data were used to calculate frontal motions, and satellite data were used to calculate cloud system motions. The reliability of forecasting synoptic front movement was 95%, whereas the reliability of forecasting cloud system movement was 86.8%.

Remenson, V. A., and **L. G. Shuster**. 1989. On space summarization of climatic data on cloud amount for solving problems of remote sounding of the natural environment. Interinst. Coll. Res. Pap. Leningrad Hydrometeorol. Inst. 102:123-130.

Environmental remote sounding systems require the availability of data on clouds. Constructing different cloud distribution models for the USSR area is performed on the basis of climatological data summarization. Statistical characteristics of clouds and USSR regionalization as far as cloud pattern is concerned are given in the paper based on the Manual on the USSR. Climate and results of 6-h observations of the reference station network. Besides cloud variability, characteristics data on the average and continuous duration of various gradation clouds as well as on the probability of transition of one gradation cloud to another in different time intervals were obtained for uniform cloud regions.

Sarkisyan, V. O. 1986. On calculating rain intensity for the Yerevan area. Hydrometeorol. Res. Armenia. Moscow. 2:52-57.

A formula of computed rain intensity was first developed, and the values of its parameters for different durations for the Yerevan area were obtained on the basis of specially processed readings of an automatic rain gauge.

Shalaveyus, S. S. and **R. V. Leskauskas**. 1984. Studying convective clouds using chemical tracers. Phys. Atmos. Vilnius 9:15-35

This is a review of research papers published over the period 1961-1980. During this period about 140 experiments were staged in which over 18 different chemical elements were used. The list of published experiments is given, along with data on tracers, ground rain gauge sites, and engineering support of the experiments. Definitions of parameters that characterized the experiments, and the goals and results obtained are also discussed. Shortcomings in the technique and the interpretation of results are shown.

Sherstyukov, B. G., and **R. H. Reitenbach**. 1990. Vertical profiles of atmospheric temperature and humidity under different cloudiness and circulation conditions. Proc. All-Union Res. Inst. Hydrometeorol. Inf. World Data Cent. 153:70-82.

Vertical climatic air temperature and humidity profiles for the surface to 30-km layer under different total cloud amount conditions were obtained for several USSR stations, taking into account diurna and annual variations of meteorological parameters. Variance analysis was performed and the cloudiness contribution to the total air temperature variance at different levels above the earth was estimated. Conditions were specified under which air temperature is significantly affected by clouds.

An integrated comparative analysis of the role of the total and lower cloud amounts and synoptic conditions in the formation of vertical profiles of meteorological parameters in the troposphere and lower stratosphere was carried out for the Moscow station. It is shown that clouds have a pronounced effect on temperature profiles (10% contribution to total variance) in the surface and boundary layer atmosphere at any time of the day in winter and in the daytime in summer. This being the case, the contribution of cloudiness conditions to the surface temperature variance for most of the USSR stations amounts to 20-50% in winter and 10-30% in the daytime in summer. The effect of clouds decreases with height.

Cloud amount is connected with the synoptic situation; however, the circulation pattern and radiative processes controlled by clouds affect thermal conditions differently. Alternating cyclonic and anticyclonic conditions account for 10-16% of the air temperature variance in Moscow in the 1-8 km and 12-14 km layers, whereas variations in the cloud amount affect only the subcloud layer temperature, with a maximum effect at the earth's surface. Low cloudiness conditions in wintertime in Moscow account for 35% of the temperature variance and 37% of the air humidity variance at the surface, whereas total cloudiness conditions account for 23% of the temperature variance and 21% of the humidity variance.

Shishkin, N. S. 1981. On water content calculation in convective clouds over large areas. Proc. Main Geophys. Obs. 439:11-16.

Water content of convective clouds over large areas with unstable stratification of the atmosphere can be determined from the convective energy potential of the atmosphere, which is obtained by the slice method.

Shneidman, V. A., G. V. Khomenko, and **I. E. Tereshchenko**. 1989. Modelling large-scale fields of vertical motion and clouds from FGGE data. Mathematical Modelling of Atmospheric Convection and Modification of Convective Clouds: Proc. Second All-Union Symposium. Dolgoprudny, 26-29 May 1986. Moscow, pp. 92-98.

A mathematical model of large-scale vertical motion fields was constructed on the basis of a closed set of hydrodynamical equations, including the vorticity, divergence, and heat influx equations. Special emphasis is placed on the heat influx parameterization technique, on which basis an algorithm was formulated and a program for calculating vertical friction motions was developed. The spatial distribution of clouds as a function of synoptic situations and distribution of vertical motion fields was analyzed. Calculated and actual cloud fields were compared, and guidance was developed for estimating cloud amount.

Shuster, L. G. 1985. Assessing the probability of continuous cloud fields completely covering long stretches of land surface. Meteorological Forecasts Leningrad. pp. 90-97.

The probability that frontal cloud fields and individual convective clouds cover rectilinear stretches of Earth's surface in different areas of the Northern Hemisphere is estimated on the basis of spherical approximation of cloud fields and individual convective clouds and the known frequency of occurrence (empirical probability) of characteristic sizes of strata and nimbus zones.

Shuster, L. G. 1983. The choice of distribution law for approximating the total cloud amount. Interinst. Collect. Res. Pap. Leningrad Hydrometeorol. Inst. 82:119-126.

The possibility of using the first-type beta-distribution, the Johnson distribution family S_A and S_B and the first-type Pearson distribution for approximating the total cloud amount is considered. The general approach to choosing the distribution law for any random value is described, and recommendations are given for its use with reference to clouds. The possibility of using a simple function to transform a *U*-type cloud amount distribution to a distribution close to normal is shown.

Skhirtladze, G. I. 1986. On the variability of microstructure parameters in the cumulus cloud field. Problems of Cloud Physics. Leningrad. pp. 225-228.

Estimates of the variability of various cumulus microstructure parameters (water content, mean droplet radius and concentration, droplet size spectrum, and spectrum relative variance) were made on the basis of cloud droplet spectrum measurement data made by an on-board aircraft photoelectric counter. Measurements were made discretely, every second in the range $0.6 < r < 15$ µm, with the sample space averaging scale of about 30 m. Variability of parameters for different cloud types were estimated for three cases: samples with maximum recorded water content of the cloud, those averaged over the cloud updraft region, and those averaged over the whole cloud. Water content and concentration averaged over the whole of the horizontal extent of the cloud are most variable (32 and 24%, respectively). The variability of parameters averaged over the updraft in the cloud is essentially lower (23 and 6%, respectively), whereas the parameter values are close to maxima. This is an indication of similar conditions of cloud droplet formation within updrafts of different clouds.

Smirnov, V. I. 1987. Microstructure of clouds and precipitation. Results of Science and Technology. VINITI. Meteorol. Climatol. 15:1-193.

Results of field and laboratory measurements, the analytical theory, and numerical modeling of the microstructure of clouds and precipitation published over the period 1983-1985 are given, including: the relationship between cloud droplet and crystal size spectra and nucleus parameters; spectrum formation of droplet and ice particles and the multiplication of the latter; and particle transfer in turbulent cloud medium. An attempt is made to systematize the problems relating to microphysics of clouds and precipitation. After abstracting a large number of papers on the topic, conclusions are drawn on the status of and prospects for solving major problems. Quite significant new data on droplet spectra are obtained. A new-type spectrum of ice particles was identified, which was approximated by two exponents. Kinetic equations describing condensation droplet distribution with respect to activity and cloud exchange with the environment were used to explain the observed cloud droplet spectra. The theory of nucleus wetting in the subcloud layer is made more specific, and the bipower spectra are identified. The relationship between nucleus power spectra and cloud droplets is analyzed on the basis of statistics, and the conclusion about the main role of condensation in the range of tens of micrometers is discussed.

Significant steps were made in developing the theory of power spectra. There appears to be hope of deciphering a precipitation exponential spectrum by taking into account the differences in particle ages. Progress has been made in investigating the morphology of ice particles and their growth rate by condensation and coagulation. The conclusions of Hullet-Mossop were confirmed with respect to the effect of an ice-particle multiplication mechanism at temperatures from -4 to -8C° . At lower temperatures, tips of dendrites can be broken off. Accumulation of young ice particles at cloud tops was observed. The boundaries of the Smolukovsky theory are expanded in terms of coagulation theory of clouds; this approach will probably result in doing away with the paradox of mass nonconservation known from earlier papers and negate the conclusion about the formation of superparticle fractions. There are indications of a significantly higher intensity of turbulent coagulation than predicted by theory.

The theory of precipitation particle transfer was developed that revealed quasi-one-dimensional infinite and cyclic trajectories. The theory of convective diffusion was reviewed, taking into account the arbitrary relation of regular velocities u to pulsation velocities v. The diffusion coefficient depends on regular velocities and can change the sign. With u v, the accumulation of particles is possible. Complicated kinetic equations of condensation and coagulation are solved by numerical methods. New numerical cloud models are constructed taking into account the microphysical processes. Problems of relationship between microphysical and dynamic processes are discussed as well as the relationship of the precipitation spectrum type and the precipitation forming process type. The role of analytical and numerical methods in answering questions about the microphysics of clouds is considered. Conclusions are drawn about the style of publications nowadays.

Stepanenko, V. D., Yu. A. Dovgalyuk, Ye. V. Orenburgskaya, Ye. V. Rozhkova, and **V. Ya. Khairullina**. 1987. On the use of radar observation data for estimating cloud resources (on the example of the Leningrad area). Radar Meteorology: Materials of Methodological Center of Socialist Countries. On Radar Meteorol. 1:121-129.

A technique is described for using convective cloud surface and radar observation data to evaluate cloud and precipitation conditions over the expected weather modification area. Quantitative indices of cloud resources (water storage, number of days with convective clouds, averages of radioecho top height, and cloud thickness) are given for the Leningrad area.

Taran, I. V. 1987. The calculation of precipitation amount formed in the boundary layer in cold season.

Proc. Hydrometeorol. Cen. U.S.S.R. 288:101-105.

Three methods of computing vertical motions were used to compare the accuracy of forecasting subinversion precipitation amount. The most accurate forecast of precipitation amount (81% accuracy) for the cases under consideration was obtained with a method specially developed for the atmospheric boundary layer. This method's accuracy was 4-6% higher than that achieved with the other two methods of vertical motion calculation.

Tereshchenko, I. E. ,and **V. A. Shneidman**. 1989. The use of cloud fields in evaluating and forecasting vertical motions in the lower troposphere. Abstracts of Reports of the Third All-Union Conference on Statistical Interpretation of Hydrodynamics of Forecasts. Nalchik, 25-30 September 1989. pp. 16-17.

A technique for calculating friction and ordered vertical motions (VM) in the lower troposphere is offered that uses the parameterization of boundary-layer effects. Analytical expressions have been obtained relating space distribution of tangential turbulent stress components and geostrophic wind, stratification parameters, and baroclinicity and roughness distribution. Results of computing VM in the lower troposphere are given for four natural synoptic periods on the basis of diagnostic and prognostic information. VM fields are compared with cloud fields from surface-based observations and satellite cloud fields. Good agreement is noted between areas of ascending friction motions and low-level cloud areas.

Titov, G. A., and **T. B. Zhuravlyova**. 1988. Recovery of broken cloud albedo from satellite observation data. Earth Res. Space 6:20-26.

The possibility of reconstructing average albedo for broken clouds on the basis of satellite observation data is considered. The effects of optical and geometrical parameters of clouds (cumulus, strata, and those reflecting according to the Lambert Law) on the accuracy of determining average albedo are analyzed.

Tochilkina, T. A. 1989. IR-radiometer data based research of cirrus clouds. Radiation Properties of Cirrus Clouds. Moscow. pp. 108-112.

IR-radiometer measurements of cirrus emissivity for May 1986-87 are summarized. The highest percentage of clouds are those with a emissivity of 0.1-0.2, which agrees with the results of other papers. No water fraction was found in cirrus clouds in which ice storage ranges from 5-100 g/m^2.

Toroyan, G. R., and **V. I. Khvorostyanov**. 1987. Modelling of orographic clouds taking into account droplet and crystal phase microstructure. Proc. Cent. Aerol. Obs. 163:71-92.

A two-dimensional, nonstationary model of orographic clouds was developed that calculates microstructure by solving kinetic equations for droplet- and crystal-size spectra jointly, with equations describing flow over a mountain. Two-dimensional fields of the stream function and vertical and horizontal velocities of flow over a mountain obstacle are calculated. Various parameterizations of the obstacle, fields of evolution of water and ice content, crystal and droplet concentration are used to investigate initial temperature and humidity. It is shown that the mesostructure and microstructure of clouds largely depend on the wave-type character of flow around an obstacle.

Toroyan, G. R. 1986. On the effect of obstacle size, temperature and humidity on meso- and microstructure of orographic clouds. Proc. Acad. Sci. Armenia Earth Sci. 39(4):69-74.

A numerical model of cloud formation in the course of its flowing over a mountain ridge was suggested in earlier papers by the author co-authored by V. I. Khvorostyanov (Proc. Cent. Aerol. Obs. 169:105-116 and 164:78-86). The model is used here for analyzing the dependence of cloud parameters on the obstacle size and some meteorological parameters. In the basic version, the temperature and humidity at the earth surface are assumed to be 23K and 0.65%, respectively, and the radius of the semicylinder simulating the ridge is assumed to be 0.8 km. The stream function and vertical velocity fields are given. Velocity disturbances have a wave-like character. The maximum vertical velocity at an altitude of 1 km at a distance of 2 km from the mountain center is 2.3 m s^{-1}. Over a 2-h period, a complicated cloud system is evolves: continuous clouds before they flow over the ridge, a cap over the ridge, and rolling clouds with gaps between them beyond the ridge. Single-layered or multilayered clouds are formed, depending on the initial humidity profile. Characteristic values for maximum and minimum vertical velocities (on the order of meters per second); condensation beginning time (5 to 105 s); droplet and crystal concentration; and water and ice content in **Sc-Ac** on the windward side, in the cloud cap, in the lee rolling clouds, and in midlevel clouds are given for five versions of mountain parameterization. A case of seeding midlevel and high-level clouds with crystals is cited.

Tsankova-Ilkova, D. S. 1989. Numerical experiments on forecasting cloud field using models. Interinst. Coll. Res. Pap. Leningrad Hydrometeorol. Inst. 102:58-63.

Results are presented of numerical experiments on background and mesoscale forecasting of cloud fields in which a model based on a set of hydrodynamic equations written in the **P-** system of polar stereographic coordinates is used. Finite-difference approximation of equations on a grid with a 300-km horizontal resolution and six vertical levels (1000-200 hPa) for initialization of the background forecast model was used for initializing the numerical model. The numerical model had a 30-km horizontal resolution and nine vertical levels. The system of time integration is explicit. The time step for the background forecast was 12 min and for the mesoscale forecast, 1 min. Central differences were used for space discretization. First GARP Global Experiment data for May 14, 1979, were used as initial data. Numerical experiments showed that the numerical cloud forecasting scheme makes it possible to more accurately forecast space characteristics of cloud fields (extent, lamination, and amount).

Tudry, V. D., and **F. I. Shakirova**. 1989. On the statistical characteristics of cloud top heights in different synoptic systems. Circulation of the Atmosphere and Climate Fluctuations. Kazan. pp. 111-116.

Statistical characteristics of cloud top height (**H_{ct}**) in different synoptic systems are computed for the area Sredneye Povolzhye (the Middle Reaches of the Volga). Two basic groups of systems and their parts were identified, each of which is characterized by about the same features of the distribution density of **H_{ct}**.

Tudry, V. D., A. A. Feshchenko, T. Ya. Belousova, A. N. Blinov, and **V. S. Yatsik**. 1989. Statistical characteristics of morphometric parameters of clouds in various meso-structure formations. Opt. Atmos. 2(5):521-526.

Satellite (METEOR) VIS cloud imagery was used to calculate the morphometric parameters of various types of mesostructure clouds for different seasons. A one-threshold identification test was used to identify clouds. Three classes of clouds with different mesostructures were identified, taking into account the relationship of cloud and clearance dimensions. Small cloud banks, chains, grains, domes, and open cells were classified as the first class. Clearance change range in this class is essentially larger than that of cloud change. In the second class, which includes wide banks and clusters of cumulonimbus clouds, the areas of cloud covered portions are somewhat smaller than those of clearances. In the third, class which includes closed cells of cumulonimbus clouds and fragments of cloud macrostrips, cloud covered areas are much larger than clearances. In the latter case there is a linear dependence of clearance size on the cloud size. It is shown that the distribution of cloud and clearance sizes in various types of mesostructure formation is close to an i-type distribution (which corresponds to gamma distribution with the variation coefficient higher than 1).

Tudry, V. D. 1988. On the regional climatic model of clouds as applied to problems of operating opto-electronic systems. Atmos. Opt. 1(9):87-89.

The structure of a synoptic-climatic model of clouds is given. It is a comprehensive cloud model created from data on synoptic objects at different stages of their development in a region.

Vasiliev, V. A., and **Yu. L. Matveyev**. 1984. On the time structure of the zonal cloudiness field. Proc. Main Geophys. Obs. 485:135-145.

The statistical structure of large-scale cloud fields is considered. Satellite data of the METEOR series were used as a basis for the cloud cover study. Correlation functions and two-dimensional diagrams of cloud fields as a function of time are used as basic characteristics of statistical time structure. The specific features of cloudiness time structure as a function of latitude are also studied. The contribution of time variations of various scales to the total variance of the cloud field is determined.

Volkovitsky, O. A., L. N. Pavlova, and **A. G. Petrushin**. 1984. Optical properties of ice crystal clouds. Gidrometeoizdat. 198 p. (illustrated).

The book contains the following chapters: (1) Ice crystal and mixed clouds; (2) Light diffusion by non-spherical particles; (3) Optical characteristics of elementary volume; and (4) Radiation propagation in an ice crystal cloud.

Volosyuk, A. I., and **A. V. Zinchenko**. 1989. Application of numerical experiment design methods to constructing the dependence of widespread precipitation on cloud parameters. Proc. Main Geophys. Obs. 525:97-103.

The quasi-empirical dependencies between precipitation intensity and cloudiness characteristics are constructed on the basis of numerical experiments with the cloud formation model. An optimum scheme compiled in accordance with the experiment design theory was used to stage the experiments. The dependencies have the form of polynomials of powers of values chosen as determining factors. A minimum set of parameters of a cloudy atmosphere (surface temperature, average water content of the cloud, and vertical cloud thickness) were used as such factors in the example under consideration.

Voloshchuk, V. M., and **Yu. S. Sedunov**. 1986. On some problems of microphysics of atmospheric clouds. Problems of Cloud Physics. Leningrad. pp. 16-25.

Results of atmospheric cloud microphysics research organized by L. M. Levin and carried with his active participation at the Institute of Experimental Meteorology are briefly reviewed. Basic points of stochastic condensation theory in turbulent atmosphere are analyzed in detail.

Vorobyov, V. I. 1989. Estimating the contribution of stratus clouds to the average total cloud amount over the Northern Hemisphere. Interinst. Coll. Res. Pap. Leningrad Hydrometeorol. Inst. 102:131-140.

The contribution (in percent) of stratus (St) to the average total cloud amount (ATCA) by seasons is studied. The research is carried out based on the Northern Hemisphere (0-70° N) nephanalysis maps for 1967-71. Clouds basically occurring as a result of vertical turbulent water vapor transfer and its condensation are referred to as St. On nephanalysis maps, such clouds are commonly defined as stratiform or cirriform, which also covers their combination with cumuliform. Two branches of interseasonal increase in the percentage of St in ATCA and two branches of decrease were revealed in the annual variations over the ocean. The area of St contribution increase is maximum (30% of the area) in winter and minimum (8-9%) in transitional seasons. The seasonal fields of St contribution to ATCA have rather a high degree of similarity. Transitional period fields are most similar with respect to their structure.

Vorobyov, V. I. 1985. Interseasonal variability of the Northern Hemisphere total cloud amount zonal characteristics (from satellite meteorological data). Interinst. Coll. Res. Pap. Leningrad Hydrometeorol. Inst. 90:18-24.

The interseasonal variability of the Northern Hemisphere cloud cover is analyzed on the basis of analyzing mean total cloud amount data averaged over 10 latitude zones and the frequency of occurrence

of cloud types. Data are given on the areas occupied by positive interseasonal variations of the mean total cloud amount in different latitudinal zones.

Vorobyov, V. I. 1985. Seasonal characteristics of cloud type distribution in the Northern Hemisphere on the basis of satellite data. Investigation of Meso- and Macroscale Processes in the Atmosphere and Application of Statistical Methods in Meteorology. Proc. of the All-Union Symp., Alma-Ata, 20-23 October 1981. Moscow. pp. 95-103.

Seasonal characteristics of the convective and nonconvective cloud distribution in summer and winter in the Northern Hemisphere are considered. The results of comparing zonally averaged cloud amount over different latitudinal zones on the basis of space-based and surface-based data are given, as well as results of zonal harmonic analysis of seasonal distributions of the average total cloud amount and the frequency of occurrence of convective and nonconvective clouds.

Vorobyov, V. I., and **V. S. Fadeyev**. 1981. Characteristics of the Northern Hemisphere cloud cover from meteorological satellite data. Leningrad. Gidrometeoizdat. 172 pp.

Results of studying the cloud pattern over the Northern Hemisphere (with the exception of subpolar region) obtained on the basis of nephanalysis maps for 5 years are presented in the monograph. Results include: the distribution of average cloud amount; the frequency of occurrence of three gradations of the total cloud amount, and average amount and recurrence of five groups of different cloud genera and clear sky. Results are presented in relation to the main types of the Northern Hemisphere atmospheric circulation according to Vangengeim-Girs. All the results are represented in the form of maps and tables. The book contains a review of the state of the art of research in cloud distribution. On the basis of new data obtained some applied problems are considered, such as the possibility of joint use of satellite and land-based observations and approximation of cloud amount distribution.

Woolfson, A. N. 1988. On the sufficiency conditions of strata stability with respect to finite amplitude disturbances. Proc. Hydrometeorol. Sci. Res. Cent. U.S.S.R. 298:97-110.

Conditions for convective cloud formation within stratiform clouds are considered on the basis of methods used in the nonlinear hydrodynamical stability theory. The mathematical solution of the problem is based on the analogy between the phenomenon of "sunk" convection and the classical convection in the fluid layer that is heated from below. Necessary and sufficient conditions for sunk convection occurrence and of convective cloud system dissipation are formulated in terms of the critical Rayleigh number. It is shown that strata of small vertical thickness (to 1000 m) are globally stable with respect to arbitrary finite-amplitude disturbances. Hence, sunk convection in them is not possible in principle. It is to be expected that strata modification will not be highly efficient under conditions of global stability.

Woolfson, A. N. 1982. A numerical model of non-precipitating convective cloud development. Proc.

Hydrometeorol. Sci. Res. Cent. U.S.S.R. 249:50-61.

An algorithm is briefly described for the numerical solution of the deep-convection one-dimensional equation involving water phase transitions using the Lacks-Bendroff divergence finite-difference scheme. A numerical experiment is described that models the development, mature, and decay stages of a nonprecipitating convective cloud. It is shown that, even during the cloud development stage, the vertical impulse remained positive, condensation energy monotonically decreased, and the relationship of the cloud area to the area of dry downgoing air monotonically decreased. During the cloud decay phase, its net vertical impulse remained negative, the condensation energy monotonically increased, and the relation of the cloud area to the area of downgoing dry air monotonically decreased. The mature cloud phase rather accurately corresponds to the cloud zero net vertical impulse, to the minimum of condensation energy, and to the maximum of the relation of the cloud area to the area of descending dry air.

Woolfson, A. N. 1981. Energy method and its application to the conditions of the development of convective clouds. Proc. Hydrometeorol. Sci. Res. Cent. U.S.S.R. 238:49-63

The modified energy method is used (developed by Richardson, Prandtl, and Taylor), in which turbulent heat and momentum fluxes are expressed with the help of the semi-empirical turbulence theory. When convective clouds develop in a motionless saturated layer of ideal atmosphere enclosed in hard walls, pulse motion kinetic energy increases only when the cloud air temperature is higher than that of the surrounding air. For the problem under consideration, the energy method is shown to be equivalent to the slice method. The energy method, unlike the slice method, leads one to conclude that energy dissipation, permanent wind shear, and large-scale divergence inhibit the development of convective clouds.

Yegorov, B. N., and **I. I. Ivanova**. 1986. Investigating statistical characteristics of clouds from the North Atlantic Ocean Weather Station data. Proc. Main Geophys. Obs. 488:51-58.

Monthly averages of the total and low cloud amounts were obtained on the basis of data for five North Atlantic Ocean weather stations for the period 1953-1982. Their time, space, and interannual variability is considered. The relationship between the total cloud amount and the low cloud amount is considered. An estimate of the space autocorrelation function of monthly mean cloud amount over the North Atlantic is given.

Zabolotskaya, T. N., S. A. Krochak, and **Yu. S. Rudko**. 1987. Water content and phase state of different cloud types. Proc. Ukrainian Region. Sci. Res. Inst. Goskomgidromet. 221:50-58

Data from clouds of differing water content and phase states were obtained from aircraft soundings over the Ukrainian station network over the period 1950-64 and over the Experimental Meteorological Site of the Ukrainian Hydrometeorological Scientific Research Institute from 1960-82. The results are presented for various temperatures, cloud thicknesses, and seasons.

Zhelnin, A. A. 1989. On the determination of deep convection in the atmosphere. Modification of Atmospheric Processes in Moldavia. Kishinev. pp. 87-95.

It was found that different types of convection in the atmosphere, such as chaotic and regular and shallow and deep, are usually a manifestation of regular mesoscale cellular convection that is observed in the cloud field over the ocean. Because cumulonimbus clouds, as a manifestation of deep convection, are formed in areas of mesoscale open-cell ascending motions, there is a possibility of deterministic forecasting of **Cb** location several hours in advance, the limit of **Cb** predictability being the lifetime of a mesoscale cell.

Zhuravlyova, V. A. 1989. Surface measurements of radiating power and some other parameters of cirrus. Radiation Properties of Cirrus. Moscow. pp. 112-130.

Lidar and radiometer methods were used to study optical, radiative, and some physical properties of cirrus clouds in September 1981. The emissivity was measured. It ranged from 0.1-0.75 , the average being 0.3. Power spectra of space inhomogeneities for cirrus brightness were obtained. The average value of ice storage was determined to be 5-30 g/m^2 and ice content to be 0.005-0.03 g/m^3 on the basis of cloud ice content relationship with its radiating power for a high-mountain area in Kirghizia. The temperature dependence of ice storage on the cloud temperature was found, and vertical profiles of ice content within the cloud were plotted. The results were compared with those of other studies.

Zinchenko, A. V. 1988. Comparison of calculations of convective cloud models and with observed data from Global Atmospheric Tropical Experiment 261st day. Mathematical Modelling of Atmospheric Convection and Modification of Convective Clouds. Proc. Main Geophys. Obs. 517:55-63.

A comparative analysis of computation results using two numerical models of convective clouds (a model used by Canadian researchers and one developed in MGO) was undertaken. WMO convective cloud observation data were used for comparison with theoretical results. Satisfactory agreement between model results and observed data is shown.