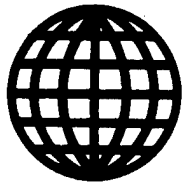


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# **Science & Technology**

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# Science & Technology

## USSR: Earth Sciences

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UDC 551.46.0:629.78

### Gravitational Instability of Main Black Sea Current

18650193b Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol.306 No 2, May 89 (manuscript received 23 Mar 88) pp 466-471

[Article by G. A. Grishin, V. N. Yeremeyev and S. M. Motyzhev, Marine Hydrophysics Institute, Ukrainian Academy of Sciences, Sevastopol]

[Abstract] A six-month satellite and subsatellite experiment was carried out in the Black Sea for investigating circulation of the Main Black Sea Current (MBSC). Experimental monitoring during 1987 was in two stages: in the period of intensification of the MBSC as a result of strengthening of cold northeasterly winds and during the period of intensive river runoff during spring and maximal frequency of recurrence of summer calms. An eddy structure observed during the period 8-15 June is examined in great detail. This was a large-scale eddy pair. The genesis of this formation is attributable to the fact that in the western part of the sea, together with the MBSC, there is a strong alongshore current caused by the runoff of such rivers as the Dnepr and Dnestr. The MBSC passes along the slope separating the shelf and the abyssal zone, whereas the alongshore current is pressed toward the shore. On the Bulgarian shelf both currents evidently merge. In 1987 there was a two-week lag in entry of flood waters into the sea. This inflow was in the form of a "shock wave" in the slope region and the interaction with the MBSC resulted in the eddy formation. Such a phenomenon should be repeated each year in one form or another. The gravitational instability of the MBSC is an element of its seasonal circulation during the period of discharge of flood waters. Figures 3; references 13; references: 7 Russian, 6 Western.

UDC 551.46.06(268.42/43)

### Structure and Variability of Oceanic Parameters in Norwegian Energy- Active Zone

18650207c Moscow METEOROLOGIYA I GIDROLOGIYA in Russian No 8, Aug 89 (manuscript received 10 Oct 88) pp 116-122

[Article by G. V. Alekseyev, candidate of physical and mathematical sciences, Arctic and Antarctic Scientific Research Institute]

[Abstract] This is a review of the principal oceanological results of expeditionary research carried out during implementation of the "Razrezy" ("Sections") program in 1981-1987 and "Poleks-Sever" ("POLEX- North") program (1976-1985) in the Norwegian and Greenland Seas. These surveys yielded an enormous volume of data on the mean multiyear and mean seasonal climatic distributions of oceanological characteristics, substantially refining climatic generalizations made earlier. It was possible to define the principal stable oceanic structures (hydrological

fronts, stationary circulations, deep cores of warm and cold waters) and to ascertain the range of their spatial variability. The regions of maximal variability of oceanological characteristics in different water layers were defined and their relationship to the principal oceanic structures and processes was discovered. It was possible to trace climatic changes in oceanological characteristics in different water layers and to determine the trend in thermal state of water masses at the center of the Norwegian Sea with a minimum in 1983 and with a gradual warming after 1984. Great amounts of information were collected on the state of the ocean and its variability which are being used in evaluating ocean climate and its variability and a system is being developed for predicting the thermohaline structure of waters in the Norwegian and Greenland Seas. The results serve as a basis for organizing monitoring of the thermohaline structure and circulation of waters in polar and subpolar regions for the purpose of long-range prediction of weather and climate. Figures 3; references 29: 28 Russian, 1 Western.

UDC 534.661:551.463.284

### Dependence of Parameters of Interference Modulation of Wide-Band Sound in Shallow Sea on Frequency

18650215a Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 35 No 4, Jul-Aug 89 (manuscript received 3 May 88) pp 685- 688

[Article by V. A. Lazarev, Ye. F. Orlov, V. N. Fokin and G. A. Sharonov, Applied Physics Institute, USSR Academy of Sciences]

[Abstract] The dependence of the coordinates of the extrema of the two-dimensional spectrum of interference modulation of wide-band signals of a concentrated sound source on frequency is examined under the conditions prevailing in a shallow sea. Experimental research on the dynamics of individual extrema of the two-dimensional spectrum with a frequency shift of the integration region was carried out under in situ conditions in a wave guide with a water layer depth 160 m which virtually did not change along the acoustic path. A signal was received by a detector at rest on the bottom in the frequency band 3-60 Hz from a wide-band source moving at a constant depth of 7 m. The experimental data were compared with a model of an ideal wave guide with both rigid and soft bottoms. A much better agreement of the data was obtained in the first case. In a two-layer wave guide the dependence of the coordinates of individual extrema of the two-dimensional spectrum on frequency differs from the similar dependence in an ideal wave guide only in a narrow frequency range near the critical frequencies. The dependence of the coordinates of the extrema of the two-dimensional spectrum of interference modulation on frequency was obtained for two models of a shallow sea. Analytical expressions were derived which can be used in predicting the nature of behavior of the fine interference structure in a shallow sea. Figures 3; references: 5 Russian.

UDC 534.21

**Influence of Local Inertial Inhomogeneity on Sound Radiation by Complex Mechanical Systems***18650215b Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 35 No 4, Jul-Aug 89 (manuscript received 4 May 88) pp 689- 695*

[Article by A. V. Lebedev, Applied Physics Institute, USSR Academy of Sciences]

[Abstract] The determination of the level of sound radiation by complex mechanical systems (CMS), that is, systems with distributed parameters, experiencing oscillations in a compressible medium under the influence of a stipulated force, is a complex self-consistent problem. Solution of this problem by traditional methods involves tedious computations. Small changes in system parameters, such as the introduction of inhomogeneities, can substantially change the mechanical properties of the CMS, making it necessary to carry out such computations in each specific case. This difficult problem is examined with emphasis on the influence of local inhomogeneities on the resonance radiation of CMS. The dependence of the resonance component of radiation in a general case is nonmonotonic. A small inhomogeneity can substantially increase the radiation level and therefore in computing the radiation characteristics of mechanical systems with inhomogeneities even small inhomogeneities can be neglected only with caution. The directivity characteristics of inhomogeneous CMS may differ substantially from similar characteristics for homogeneous systems in a case when the additional radiation resistance caused by an inhomogeneity exceeds the radiation resistance of this same mode for a homogeneous CMS. Moreover, due to the resonance character of reradiation through an inhomogeneity relatively broad regions of increased radiation will be discriminated in the dependence of an inhomogeneous CMS on frequency. Figures 2; references 10: 4 Russian, 6 Western.

UDC 681.883

**Estimation of Coordinates of Point Source Situated at Interface of Two Media***18650215c Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 35 No 4, Jul-Aug 89 (manuscript received 1 Dec 87) pp 696- 702*

[Article by A. N. Lukin, Voronezh State University imeni Leninskiy Komsomol]

[Abstract] The coordinates of a source situated at the interface of two media are estimated. The structure of the reference signal is computed with arbitrary parameters of the direct and reflected waves and the characteristics of the estimate of range and distance to the boundary are estimated with a description of the field in the Fresnel approximation. The time processing of the field of a point source of random oscillations, narrow-band in the spatial-temporal sense and situated at the reflecting boundary, is dependent on the distance between the source and

boundary, dimensions of the receiving antenna, range to the source and wavelength. The accuracy in estimating range to a source situated at a known distance from the reflecting boundary can be improved considerably by allowance for the oscillations reflected from this boundary. The neglecting of the signal reflected from the interface of two media in the algorithm for processing the source field in the case of small Fresnel numbers results in a considerable worsening in estimates of range and distance to the boundary in comparison with the estimates obtained in an optimal procedure. Figures 4; references: 10 Russian.

UDC 551.463

**Acoustic Interference Tomography of Ocean***18650215d Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 35 No 4, Jul-Aug 89 (manuscript received 8 Apr 88) pp 703- 710*

[Article by L. Ya. Lyubavin and A. G. Nechayev, Applied Physics Institute, USSR Academy of Sciences]

[Abstract] Diagnostics of mesoscale inhomogeneities in acoustic tomography of the ocean is based on the possibility of reconstructing the speed of sound field from the measured lag time of pulses of individual modes or rays or using the phase of normal waves passing through the investigated region. Accordingly, the realization of such schemes requires a high accuracy in determining the propagation time (or phase) of a signal and the distance between the source and detector, which imposes rigorous requirements on the parameters of the technical apparatus and conditions for carrying out experiments. A tomography scheme is therefore proposed which makes it possible to reconstruct the mesoscale speed of sound profile from measurements of the interference structure of the sound field of a quasimonochromatic source. Integral equations are derived relating disturbance of sound field intensity and speed of sound fluctuations. An algorithm is outlined which makes it possible to retrieve the speed of sound field in the ocean. The influence of a priori information and the effect of smoothing of the interference structure caused by nonchromaticity of the sound field are also discussed. Figure 1; references 13: 12 Russian, 1 Western.

UDC 534

**Computation of Averaged Distributions of Intensity of Sound Fields in Ocean***18650215f Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 35 No 4, Jul-Aug 89 (manuscript received 27 Jan 88) pp 724-731*

[Article by A. L. Piskarev, Applied Physics Institute, USSR Academy of Sciences]

[Abstract] The ray method is the most important approximate method for computing sound fields in the ocean, but it is encumbered by many shortcomings. These inadequacies are eliminated to a great extent by an approach

proposed by Ye. A. Selin, but some fundamental problems remain unresolved and are therefore discussed in detail in this article. A new trajectory-ray algorithm is proposed for computing the averaged distributions of sound field intensity in a two-dimensional grid formed by a uniform breakdown of the considered part of a wave guide in range and depth in accordance with the stipulated averaging intervals of the pertinent fields. The algorithm is a generalization of the Selin method, is quite universal, quite fast and has an adequate accuracy. The "Delta" program was developed for application of the algorithm and was tested numerically and compared with other programs. The testing revealed its superiority to schemes proposed earlier. Figures 3; references: 10 Russian.

UDC 534.26

#### Some Features of Propagation of Normal Waves in Shallow Sea With Inhomogeneous Elastic Bottom

18650215g Moscow *AKUSTICHESKIY ZHURNAL in Russian Vol 35 No 4, Jul-Aug 89 (manuscript received 30 Mar 88) pp 744-747*

[Article by A. V. Bezrukov, Acoustics Institute imeni N. N. Andreyev, USSR Academy of Sciences]

[Abstract] In studies of the propagation of normal waves in a shallow sea an allowance for the real physical properties of both the fluid and inhomogeneous elastic layer, as well as the underlying homogeneous solid half-space, is of the greatest interest. This article is essentially a continuation of earlier research along these lines (A. V. Bezrukov, et al., *AKUST. ZHURN.*, Vol 33, No 5, pp 805-813, 1987). Emphasis now is on the influence of the layered structure of the wave guide and the parameters of the elastic half-space on the characteristics of normal waves as a function of frequency, relative thickness of the inhomogeneous layers and their simplified models (as applicable to a plane stratified inhomogeneous wave guide). For example, the importance of the parameters of the solid half-space as a function of thickness of the fluid layer was examined. It was found that in the case of adequately great thicknesses of the fluid layer it is the inhomogeneity and structure of the water layer which exerts the main influence on sound field formation. Figures 4; references: 5 Russian.

UDC 534.21

#### Experimental Research on Emissivity of Shells of Revolution With Stiffening Ribs

18650215h Moscow *AKUSTICHESKIY ZHURNAL in Russian Vol 35 No 4, Jul-Aug 89 (manuscript received 5 Jul 88) pp 754-756*

[Article by D. M. Donskoy, A. E. Yekimov and A. V. Lebedev, Applied Physics Institute, USSR Academy of Sciences]

[Abstract] Although there have been theoretical studies, there has never been experimental research on the influence of stiffening ribs on the acoustic characteristics of shells. A

study was made of the dependence of emissivity on frequency for three cylindrical circular steel shells of identical geometry and thickness but with a different set of stiffening ribs: shell No 1 without ribs, shell No 2 with four steel ribs and shell No 3 with 10 steel ribs. The shells, with massive flanges, were tightly sealed and submerged in water to a depth of 1 m. A monopole emitter of the electrodynamic type was situated at the same depth at a distance of 7 m from a vibro-pickup. The stiffening ribs resulted in an increase in shell emissivity. Emission increases greatly in the frequency range in which inter-rib resonances of flexural oscillations appear. This effect was manifested most clearly for shell No 3. For shell No 2 with a great distance between the ribs the increase in emissivity begins from the lower frequencies. Figures 3; references: 6 Russian, 2 Western.

UDC 551.466

#### Intensification of Small-Scale Turbulence by Internal Waves

18650218 Moscow *DOKLADY AKADEMII NAUK SSSR in Russian Vol 307 No 4, Aug 89 (manuscript received 22 Jun 88) pp 979-984*

[Article by P. A. Matusov, L. A. Ostrovskiy and L. Sh. Tsimring, Applied Physics Institute, USSR Academy of Sciences, Gorkiy]

[Abstract] In addition to direct in situ observations of the destruction of short internal waves (IW) on density interlayers, resulting in the formation of turbulent spots, there is indirect evidence of energy transfer from internal waves to turbulence which is unrelated to the collapse of IW. In order to clarify this problem a laboratory experiment was carried out to study the interaction between IW in a two-layer fluid and turbulence generated by an oscillating blade. The experiments were carried out in two stages: measurement of the turbulent energy profile in the absence of an IW with turbulence decreasing from the blade nearly exponentially, which is consistent with the semiempirical theory of turbulence; 2) simultaneous activation of a wave generator of IW and an oscillating blade, making it possible to register the turbulent energy profile. The experiments confirmed the possibility of intensification of the mean level of turbulent energy by the oscillatory field of velocity of IW, which was theoretically predicted earlier. However, it is premature to speak of a total agreement between theory and experimental data. The possibility of a substantial intensification of turbulence (with moderate Reynolds numbers) of an IW supports the hypothesis explaining the universal propagation of turbulent "spots" in the ocean arising during a brief increase in shear velocity in IW, specifically, intensification and maintenance of turbulence by IW without collapse; this process is far more probable than frequent collapse due to a decrease in the Reynolds number to the critical value  $Ri = 1/4$ . In evaluations of in situ situations it must be remembered that the distribution of turbulence regions can be dependent to a considerable degree on the structure of large-scale convective flows. Figures 3; references 8: 4 Russian, 4 Western.

UDC 535.8

**Polarization Structure of Images Formed in Turbulent Atmospheric Channel***18650193a Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 306 No 2, May 89 (manuscript received 22 Feb 88) pp 339-343*

[Article by A. I. Deryugina, V. N. Kurashov and A. I. Mashchenko, Kiev Polytechnic Institute]

[Abstract] One of the methods for adaptive compensation of phase distortions in optical image-forming data systems is based on the polarization characteristics of optical fields reflected by an object. Independent processing of the matched and cross polarization components makes it possible to write an effective algorithm for retrieval of an image distorted by the turbulent atmosphere. However, high-quality retrieval requires that the polarization structure of a spatially modulated optical beam persist during propagation. In this article it is shown that the nonlocal nature of image formation in a randomly inhomogeneous channel results in a considerable depolarization of radiation, which makes it difficult to use compensation methods based on criteria of this type. The role of interference phenomena in formation of the polarization structure of images is fully discussed and illustrated in a number of examples. Diffraction effects in a turbulent image-forming channel may result in a substantial change in the degree of polarization of radiation. However, the depolarizing property of the channel is virtually not manifested in the region of very strong turbulence. This is attributable to the fact that under these conditions the imaging system becomes incoherent. Figures 2; references 5: 4 Russian, 1 Western.

UDC 551.501.816

**Microstructural Variations and Statistical Characteristics of Aerosol Backscattering Indices in Atmospheric Boundary Layer Determined From Multiwave Sounding Data***18650204a Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian Vol 25 No 7, Jul 89 (manuscript received 30 Nov 87) pp 717-722*

[Article by F. P. Osipenko, A. P. Chaykovskiy and V. N. Shcherbakov, Physics Institute, Belorussian Academy of Sciences]

[Abstract] During 1978-1984 systematic research was carried out on the optical and microphysical characteristics of aerosol in the atmospheric boundary layer using remote and contact methods. This article represents a generalization of the collected data with a clarification of the statistics of  $\beta_a(\lambda_i)$  (spectral dependence of aerosol backscattering index) for conditions close to the background in the middle part of the European USSR and gives an analysis of the corresponding transformations of

the microphysical parameters of aerosol. Data were registered by multiwave laser sounding at 7-10 working wavelengths in the range 0.4-0.95  $\mu\text{m}$ , supplemented by surface contact measurements of meteorological parameters in the lower 300-m layer of the atmosphere. The analysis revealed that the parameters of atmospheric boundary layer aerosol are relatively stable. There is a high correlation between the aerosol backscattering index at different wavelengths. The fluctuations of its optical and microphysical parameters for the most part are related to changes in the concentration of particles and to a lesser degree are attributable to microstructural transformations. This gives basis for constructing models of atmospheric optical and microphysical parameters. Figure 1; references: 9 Russian.

UDC 551.521.3

**Optical Diagnostics of Dispersion Media With Multiple Scattering in Small-Angle Approximation***18650204b Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian Vol 25 No 7, Jul 89 (manuscript received 12 Jan 87, after revision 14 Nov 88) pp 723-731*

[Article by N. I. Vagin and V. V. Veretennikov, Atmospheric Optics Institute, Siberian Department, USSR Academy of Sciences]

[Abstract] A method was developed for determining the microstructure of dispersion media based on inversion of the results of measurements of the angular distribution of the intensity of radiation under multiple scattering conditions in a small-angle approximation. The inverse problem is formulated, solution algorithms are presented and the results of numerical simulation are presented. Regularizing algorithms were developed for inversion of a system of two integral equations to which the inverse problem is reduced and their accuracy characteristics are evaluated. The results of inversion of measurements of the angular distribution of intensity are presented and these are compared with data from direct measurements and with results obtained by other optical methods. In the diagnostics of dispersion media the results for the first time make it possible to regard the contribution of multiple scattering as a useful signal component, not as noise. Figures 5; references 11: 9 Russian, 2 Western.

UDC 551.463.5:535.36

**Range of Visual and Television Detection of Object in Scattering Medium***18650204c Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian Vol 25 No 7, Jul 89 (manuscript received 25 Jan 88, after revision 7 Jun 88) pp 732-740*

[Article by I. L. Katsev and E. P. Zege, Physics Institute, Belorussian Academy of Sciences]

[Abstract] In estimating the capabilities of observation systems, including the limiting range of detection of real objects in a scattering medium, it is not sufficient to know the quality characteristics of test objects of a definite shape. Due to the diversity of real objects it is necessary to know the correlation between the characteristics of video systems when observing standard test objects and the quality of perception under real conditions. Such a statistical correlation was described by J. Johnson in 1988 in the example of naval ships. Proceeding along these lines, a model is proposed for detecting test objects in a scattering medium. A system of equations is written whose solution determines the optimal element of spatial integration of the image and the limiting detection range. Solutions are found for cases of solar illumination and when a flash system with the cutoff of backscattering noise is used. Figures 3; references 12: 11 Russian, 1 Western.

UDC 551.463.5

#### **Extinction and Reflection of Radiation by Sea Under Continuous Cloud Cover**

18650204d Moscow *IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian Vol 25 No 7, Jul 89 (manuscript received 15 Feb 88) pp 770-773*

[Article by B. M. Golubitskiy, V. M. Greysukh and I. M. Levin, Oceanology Institute, USSR Academy of Sciences]

[Abstract] An earlier article (B. M. Golubitskiy, et al., *IZV. AN SSSR: FAO*, Vol 16, No 10, pp 1051-1058, 1980) gave simple formulas for the extinction of irradiance, albedo and brightness coefficients of the sea for directed and diffuse illumination. The adequate accuracy of these formulas, derived in a quasisingle approximation, was confirmed by both the Monte Carlo method and by an experiment. This approximation and the Monte Carlo method are now used in computing the extinction of solar radiation by the sea after passing through a horizontally infinite thick cloud layer. Computations of the extinction of irradiance  $T$  and the coefficient of diffuse reflection or albedo of a semi-infinite sea  $R_M$  were made under a continuous cloud cover by the Monte Carlo method for two phase scattering functions and different probabilities of survival of a quantum. The data obtained by the Monte Carlo method and several special formulas revealed that under continuous cloud cover the quasisingle approximation is applicable for computing irradiance only in the upper layers of the sea. However, an empirical formula is derived which remedies this problem. A dependence is derived which describes the results of computation of albedo for a semi-infinite sea under continuous cloud cover conditions for all probabilities of survival of a quantum and for different phase scattering functions. Figures 2; references: 9 Russian.

UDC 551.501.81:551.576:551.577.3

#### **Determining Liquid-Water Content of Clouds and Precipitation Intensity by Passive-Active Radar Methods**

18650207a Moscow *METEOROLOGIYA I GIDROLOGIYA in Russian No 8, Aug 89 (manuscript received 19 Jul 88) pp 38-44*

[Article by N. D. Popova and G. G. Shchukin, doctor of physical and mathematical sciences, Main Geophysical Observatory]

[Abstract] Earlier studies (N. D. Popova, et al., *TRUDY GGO*, No 395, 1977; No 430, 1979) gave an approach to solution of the inverse problem of determining the distribution of liquid-water content and the intensity of precipitation using data from passive and active radars. The basis for this is the dependence of both radar reflectivity and the absorption coefficient on the droplet-size distribution function. On the basis of comparison of the relative contribution of droplets of different parts of the spectrum to radar reflectivity  $q_z$  and liquid-water content  $q_w$ , it was found that the ratio  $q_w/q_z$  changes insignificantly with a change in the droplet-size distribution, which indicates the possibility of using radar reflectivity as a key parameter in estimating the liquid-water content of clouds and precipitation by passive-active radar methods. The use of combined passive-active radar sounding of clouds and precipitation makes it possible, in the case of an identical radar reflectivity, to detect centers with different liquid-water content. This is attributable to the fact that when estimating liquid-water content it is not the "strict" correlation between  $z$  and  $w$  which is used, but a correlation established on the basis of the results of passive-active radar measurements. Figures 3; references: 9 Russian.

UDC 551.510.721:621.039.9:546.42(47+57)

#### **Rate of Removal of Fission Products From Stratosphere as Function of Injection Season**

18650207b Moscow *METEOROLOGIYA I GIDROLOGIYA in Russian No 8, Aug 89 (manuscript received 24 Aug 88) pp 45-49*

[Article by S. G. Malakhov, candidate of physical and mathematical sciences, Tayfun Scientific Production Association]

[Abstract] In contrast to earlier publications, a study was made of the rate of removal of radioactive fission products from the stratosphere as a function of the time of their injection. It represents a generalization of earlier studies based on systematic data on the levels of radioactive pollution over the USSR. The article analyzes the radioactive fallout from thermonuclear shots in China (therefore all data apply to the middle-latitude stratosphere). Emphasis is on two Chinese nuclear shots: December 1968 and June 1967, in the first case close to the spring maximum, in the second case after the spring

maximum. Data are also employed for two French nuclear shots in the southern hemisphere which correspond to the onset of spring. In all cases the concentrations and fallout of  $\text{Sr}^{90}$  were calculated. All data were scaled to an injection of 1 Mcurie. Data for the four cases are summarized in a table. Conclusions are drawn concerning the temporal fallout pattern. These data can be used in predictive estimates of the levels of pollution in the atmospheric surface layer and soils following injection of radioactive fission products or other pollutants, such as from volcanic eruptions, into the stratosphere. Figure 1; references: 15 Russian.

UDC 621.378.325

### Radiation Transfer Equation in Describing Wind Refraction of Partially Coherent Beams

18650213b Tomsk OPTIKA ATMOSPHERY in Russian Vol 2 No 5, May 89 (manuscript received 20 Jan 89) pp 462-468

[Article by V. V. Kolosov and M. F. Kuznetsov, Atmospheric Optics Institute, Siberian Department, USSR Academy of Sciences, Tomsk]

[Abstract] The thermal self-effect of coherent beams in a moving medium is described on the basis of the radiation transfer equation. This problem is solved for a nonlinear medium with wind refraction when the problem does not have axial symmetry. The equation is solved in a near-geometrical optics approximation, which makes it possible to reduce the self-effect problem to solution of a system of ordinary differential equations (special aspects of the mentioned type of approximation are examined). A number of special cases are examined, such as for a homogeneous medium with a constant wind speed directed perpendicular to the direction of beam propagation. The differences in the behavior of the self-effect of coherent and partially coherent beams are discussed. The results of computations of the coherence radius in the beam section are given. The invariance of the coherence coefficient on an arbitrary geometrical ray in the geometrical optics approximation is demonstrated within the framework of the used approach. Figures 4; references: 11 Russian.

UDC 621.378.325

### Numerical Simulation of Coherent Systems in Atmospheric Optics

18650213c Tomsk OPTIKA ATMOSPHERY in Russian Vol 2 No 5, May 89 (manuscript received 15 Dec 88) pp 474-478

[Article by P. A. Konyayev and N. N. Mayer, Atmospheric Optics Institute, Siberian Department, USSR Academy of Sciences, Tomsk]

[Abstract] Existing algorithms and programs for the designing of optical systems are inapplicable for computing adaptive and laser systems for operation in the

atmosphere. This requires use of the equations of wave optics for correct description of diffraction effects in restricted beams; use of the radiation transfer equation is inadequate. Moreover, the medium through which the optical wave is propagated begins to play a role, which dictates incorporation of both a source and receiver in the modeling scheme and in the case of adaptive optics, also mirrors, reflectors and other elements. This necessitated the writing of new, effective algorithms for wave optics. Methodological aspects of simulative computer modeling of optical systems in randomly inhomogeneous media are examined. The statistical tests method is used in evaluating quality of the images obtained in a turbulent atmosphere. The effectiveness of use of a segmented adaptive mirror for corrections of wave front phase distortions is evaluated. Figures 4; references 10: 9 Russian, 1 Western.

UDC 528.044.6

### Research on Spectral-Kinetic Characteristics of Laser-Induced Plant Fluorescence

18650213d Tomsk OPTIKA ATMOSPHERY in Russian Vol 2 No 5, May 89 (manuscript received 1 Aug 88) pp 506-512

[Article by Yu. L. Lukin, V. S. Agishev, A. D. Bernikov and O. S. Mergelyan, Wave Processes Branch Laboratory, General Physics Institute, USSR Academy of Sciences, Andizhan; Physiology Institute, Uzbek Academy of Sciences, Tashkent]

[Abstract] The information content of the spectral-kinetic characteristics of laser-induced fluorescence (LIF) of plants was evaluated, taking into account species composition, age changes and the influence of stress factors (application of defoliants and water shortage). The structure of the laboratory apparatus is described and illustrated. The radiation source was a He-Ne laser. All measurements were made 4 meters from the leaf surface under full laboratory illumination. The kinetics of LIF was registered at 685 and 725 nm. The differentiation method was used in detecting the fine structure of LIF and the choice of significant parts of the LIF was by correlation analysis. The registered spectral-kinetic characteristics make possible early diagnosis of the physiological state of plants under different environmental conditions. This is demonstrated using specific LIF spectra of different plant species, with emphasis on the effect of defoliants and moisture deficit on plant development. Figures 6; references 7: 2 Russian, 5 Western.

UDC 551.50;519.25;510.67

### Methodological Aspects of Prediction of Characteristics of Atmospheric Optical Channel on Basis of Physical-Statistical Approach

18650213e Tomsk OPTIKA ATMOSPHERY in Russian Vol 2 No 5, May 89 (manuscript received 21 Jul 88) pp 513-520

[Article by V. S. Komarov, A. N. Kalinenko and S. A. Mikhaylov, Atmospheric Optics Institute, Siberian Department, USSR Academy of Sciences, Tomsk]

[Abstract] One of the possible approaches to solution of problems in predictive evaluation of the optical state of the atmospheric channel is examined. A block diagram of the statistical analysis and prediction procedures (six steps) is presented and serves as a basis for description of each step. First physical-statistical methods are employed in precomputing the temporal changes in optically active components. Then the collected data are used in computing predictive evaluations of the optical characteristics of the atmospheric channel, which are then used as an information basis for remote sensing systems. The proposed method makes it possible, when the necessary initial information is available on the vertical profiles of atmospheric optically active components, to obtain regional estimates of the state of optical channels in the cloudless atmosphere for different times in advance. This method is used at the Atmospheric Optics Institute in the form of databases and computer programs. The method was tested using a 10-year series of data from aerological and ozonometric stations. The testing revealed an adequate reliability and effectiveness of this approach. Further publications on this subject are planned. Figure 1; references 16: 15 Russian, 1 Western.

UDC 551.576

**Statistical Characteristics of Cloud Cover Morphometric Parameters in Different Mesostructural Formations**

18650213f Tomsk OPTIKA ATMOSPHERY in Russian  
Vol 2 No 5, May 89 (manuscript received 1 Jun 88)  
pp 521-526

[Article by V. D. Tudriy, A. A. Feshchenko, T. Ya. Belousova, A. N. Blinov and V. S. Yatsyk]

[Abstract] Cloud cover photographs taken from "Meteor" satellites in the visible range of the electromagnetic spectrum were used in computing the morphometric parameters of cloud cover with different types of morphostructure during different seasons. The so-called single-threshold method was used in processing the photographs. The statistical characteristics of cloud cover parameters (moments, probability density function, spatial correlation function and spatial spectrum of brightness fluctuations) were computed. It was found that the mean size and standard deviation of the dimensions of cloudy and cloudless sectors vary greatly as a function of the type of mesostructure. With allowance for the interrelationship between cloud cover extent and clearings it was possible to discriminate three classes of cloud cover with different mesostructure. The results obtained in automatic processing of satellite cloud cover photographs are consistent with the results obtained by other methods. Figures 3; references 6: 5 Russian, 1 Western.

UDC 681.7.784

**Influence of Residual Instrument Aberrations on Quality Control of Optical Parts**

18650213g Tomsk OPTIKA ATMOSPHERY in Russian  
Vol 2 No 5, May 89 (manuscript received 9 Nov 88)  
pp 527-531

[Article by I. G. Polovtsev and G. V. Simonova, Optika Special Design Bureau for Scientific Instrument Making, Siberian Department, USSR Academy of Sciences, Tomsk]

[Abstract] Careful monitoring of fabrication quality is an indispensable part of the process of production of optical components. In developing schemes for checking such components great emphasis must be placed on the influence of control instrument aberrations on measurement results. For example, lidar antennas are quite large and are used only under stationary conditions; in checking their optical systems it is necessary to deal with large aperture angles of the wave front, making it essential that residual aberrations be eliminated. The results of an analysis of optical schemes (shadow instruments and interferometers) for checking concave spheres and for eliminating the influence of residual aberrations are presented with diagrams and descriptions of different variants of such instruments. An assessment of their relative merits and shortcomings is presented. Figures 4; references: 6 Russian.

UDC 551.501

**Analytical Expression for Optical Radiation Extinction Coefficient of Polydisperse Ensemble of Platy Crystals**

18650213h Tomsk OPTIKA ATMOSPHERY in Russian  
Vol 2 No 5, May 89 (manuscript received 12 Jan 89)  
pp 532-536

[Article by A. A. Popov and O. V. Shefer, Mariy Polytechnic Institute imeni Gorkiy, Yoshkar-Ola; Atmospheric Optics Institute, Siberian Department, USSR Academy of Sciences, Tomsk]

[Abstract] Modeling of transmission of optical radiation through polydisperse media involves tedious computations of the extinction coefficients. Each such coefficient is an integral whose integrand contains as a cofactor the section of extinction of radiation by a particle of some shape. These characteristics are a result of solution of the wave scattering problem for an individual particle. However, such solutions cannot be obtained for particles of all shapes. For most polydisperse media the extinction coefficient can be determined only numerically. This article gives a model of a polydisperse medium, close to reality, for which the necessary integration is possible in analytical form in the case of a system of platy crystals. A formula is proposed that reveals a neutral behavior of the extinction coefficient in the visible part of the range and its appreciable dependence on wavelength in the IR

range. In comparison with an integral representation, an algebraic formula for the extinction coefficient makes it possible to carry out computations with an error not greater than 2.5%. References 5: 4 Russian, 1 Western.

UDC 535.215

### Statistics of Lidar Signal Photoelectrons

18650213i Tomsk *OPTIKA ATMOSPHERY in Russian*  
Vol 2 No 5, May 89 (manuscript received 12 Dec 88)  
544-545

[Article by V. G. Astafurov, Atmospheric Optics Institute, Siberian Department, USSR Academy of Sciences, Tomsk]

[Abstract] In laser sounding of the atmosphere in most cases conditions are satisfied which make it possible to use asymptotic probability distributions  $P(n)$  of the number of photoelectrons in the time interval  $\Delta t$ , such as the negative-binomial and Poisson distributions. However, the validation of applicability of these distributions and determination of their parameters is accomplished without allowance for fluctuations of the backscattering coefficient for a particular range, transmission coefficient and power of the sounding pulse. This article examines use of asymptotic distributions with allowance for fluctuations of these three parameters. This results in successful description of the unconditional statistical characteristics of photoelectrons applicable to lidars. The results of model computations of the introduced equivalent "degeneration parameter," which takes the fluctuations of these parameters into account, are given. Figure 1; references 3: 2 Russian, 1 Western.

UDC 551.510

### Measurements of Short-Period Variations of Solar Radiation and Ozone Content

18650213j Tomsk *OPTIKA ATMOSPHERY in Russian*  
Vol 2 No 5, May 89 (manuscript received 17 Oct 88)  
pp 549-551

[Article by L. S. Ivlev, O. V. Maksimenko and V. G. Sirota, Physics Scientific Research Institute, Leningrad State University; Arctic and Antarctic Scientific Research Institute; Leningrad Hydrometeorological Institute]

[Abstract] Research on temporal variations of total ozone content and solar radiation intensity requires a high-response, low-inertia and small-sized apparatus making it possible to carry out synchronous automated ozonometric and actinometric measurements. An apparatus meeting these specifications is described (the shortcomings of measuring instruments employed earlier, characterized by an error of 3%, are discussed). The new design ensures thermal stabilization, maintenance of a temperature  $+20^\circ$  within the housing and an automatic operating mode with solar tracking. There is an internal source of reference radiation for maintaining instrument

calibration during measurements. The light filters and radiation detector are rigidly connected, precluding error due to ambiguity in setting the light filters during their changing. The apparatus contains a branching light conductor conducting filtered light and light of the calibrating source to a fixed sector of the photocathode, in the course of instrument adjustment making it possible to select the most sensitive part of the photocathode and to virtually exclude noise due to light scattered within the instrument. The measurement error can thereby be reduced by a factor of 1.5. Figures 3; references 11: 9 Russian, 2 Western.

UDC 538.566:551.511.6

### Effectiveness of Wave Front Corrections for General Slopes and Defocusing

18650214a Tomsk *OPTIKA ATMOSPHERY in Russian*  
Vol 2 No 6, Jun 89 (manuscript received 2 Jan 89)  
pp 563-572

[Article by V. P. Lukin, Atmospheric Optics Institute, Siberian Department, USSR Academy of Sciences, Tomsk]

[Abstract] The possibilities of control of the lowest modes of phase fluctuations of the wave front phenomenon are examined: the general slopes of the wave front and its defocusing. The lowest modes were selected for study because their technical control is simplest. The effectiveness of the simplest correction methods are investigated, as well as the influence of time lag on the quality of correction of random wave front slopes. Specifically, the effectiveness of correction of fluctuations of the angles of arrival and defocusing of the phase of the wave front passing through a layer of a turbulent medium is evaluated. The wave sensor used was an instrument for measuring the distribution moments of field intensity in the lens focal plane. The influence of the variable lag in phase correlation, attributable to the finiteness of the frequency band of the adaptive system as a whole, is analyzed. Figure 1; references 7: 4 Russian, 3 Western.

UDC 535.36

### Extinction of Restricted Optical Beam in Medium With Large Scatterers

18650214b Tomsk *OPTIKA ATMOSPHERY in Russian*  
Vol 2 No 6, Jun 89 (manuscript received 20 Dec 88)  
pp 573-576

[Article by D. S. Bochkov, Atmospheric Optics Institute, Siberian Department, USSR Academy of Sciences, Tomsk]

[Abstract] In many experiments with propagation of a He-Ne laser beam in model scattering media consisting of particles measuring from tens of microns to millimeters it was discovered that the extinction is exponential with an exponent significantly different from the

Bouguer distribution computed from medium microstructure. In order to clarify this phenomenon research was carried out resulting in the derivation of formulas describing extinction of a divergent beam with allowance for multiple scattering in media with a scattering phase function highly elongated forward. The results explain the observed effect. The derived multiple scattering formula is correct on the condition that the energy increment due to scattering from regions adjacent to the beam can be neglected. This is possible in coarsely dispersed media, such as rain. With a decrease in the relative size of the particles the energy exchange between the beam zone and adjacent regions is intensified and there is an increase in the role of the latter in formation of the scattered background in the receiver and at some time this role becomes decisive. With a beam divergence of several minutes or more, characteristic for a He-Ne laser, multiple scattering must be taken into account in all types of precipitation and coarsely dispersed aerosols. Figures 4; references: 8 Russian.

UDC 551.510.42

#### **Parametrization of Optical Characteristics of Polydisperse Aerosol System**

18650214c Tomsk OPTIKA ATMOSPHERE in Russian  
Vol 2 No 6, Jun 89 (manuscript received 12 Dec 88)  
pp 577-583

[Article by I. N. Sokolik, Atmospheric Physics Institute, USSR Academy of Sciences, Moscow]

[Abstract] Problems related to the modeling of the optical characteristics of aerosol are examined for clarifying the influence of microphysics on optical properties, and especially on those optical characteristics which are used in computing radiation transfer in the atmosphere. Since the use of simple analytical solutions of Mie theory is possible only in a limited range of values of microphysical parameters, it was important to obtain simple parametrizations of the optical characteristics of polydisperse aerosol on the basis of the initial parameters of its microstructure. Parametrization formulas were therefore derived for computing  $K_{ext}$ ,  $\omega$  and  $g$  on the basis of microstructure parameters on the assumption of a log-normal particle-size distribution by means of an analysis of direct computations made with application of the Mie theory. The parametrization formulas are given in a series of three tables (for the extinction index, mean cosine of the scattering phase function and single-scattering albedo). These parametrizations can be used in computing the optical properties of aerosol in climate models and in routine interpretation of experimental data on aerosol microphysics. Figure 1; references 14: 8 Russian, 6 Western.

UDC 539.196

#### **Effective Thermalization Time of Ensemble of Dissociating Anharmonic Oscillators**

18650214d Tomsk OPTIKA ATMOSPHERE in Russian  
Vol 2 No 6, Jun 89 (manuscript received 30 Jan 89)  
pp 584-592

[Article by V. Ya. Panchenko and I. M. Sizova, Physics Institute, USSR Academy of Sciences; Scientific Research Center for Industrial Lasers, USSR Academy of Sciences, Moscow]

[Abstract] Formulas are derived for the instantaneous rates of change in translational temperature and the mean number of oscillatory quanta with the relaxation of oscillatory energy of a nonequilibrium excited anharmonic dissociating Morse oscillator under nonisothermal conditions. They represent a generalization of the formula proposed by S. A. Losev, et al., DAN SSSR, Vol 195, No 3, p 585, 1970, and in contrast to the Gordiyets formulas, derived for the time interval greater than  $\tau_{VT}$ , they make it possible to compute the relaxation time in the time interval less than  $\tau_{VT}$ . In the expressions for the instantaneous relaxation rate it is possible to discriminate both their dependence on the distribution function and the degree of excitation and to find corrections for nonisothermality, dissociation and anharmonicity of the process. Numerical computations are used to illustrate the relative contribution of all the mentioned nonlinearity mechanisms. Figures 2; references 9: 5 Russian, 4 Western.

UDC 535.331.34;539.183/184

#### **Magnetization of Atomic Gases in Interaction With Constant Electrical Field and Field of Unpolarized Light Ray**

18650214e Tomsk OPTIKA ATMOSPHERE in Russian  
Vol 2 No 6, Jun 89 (manuscript received 14 Dec 88)  
pp 593-596

[Article by V. S. Smirnov, M. B. Sultanov and A. V. Taychenachev, Tomsk State University imeni V. V. Kuybyshev; Siberian Scientific Research Institute of Metrology, Novosibirsk]

[Abstract] The magnetization of atomic gases during optical pumping by an unpolarized light ray with a quasithermal spectral composition of magnetic sublevels of the ground state, split due to the quadratic Stark effect, was examined. The case of weak static fields (less than  $10^2$  V/cm), when the splitting of the emission (absorption) line can be neglected, was investigated. The dependence of the mean magnetic moment and magnetic field in the medium on the parameters of the optical and static electrical fields, as well as the spatial distribution of the magnetic field, was considered. The limiting magnetic field strength is attained in relatively weak static and optical fields. The discussed qualitative effect

of magnetization of a neutral gas can make an appreciable contribution to variation of the Earth's magnetic field when the atmosphere is irradiated by sunlight. References: 5 Russian.

UDC 535.36

### Explosive Absorption Effect in CO<sub>2</sub> Laser Beam in Atmosphere

18650214f Tomsk OPTIKA ATMOSFERA in Russian Vol 2 No 6, Jun 89 (manuscript received 2 Mar 89) pp 597-604

[Article by V. M. Shmelev, V. I. Zakharov and A. I. Nesterenko, Physical Chemistry Institute, USSR Academy of Sciences, Moscow; Atmospheric Optics Institute, Siberian Department, USSR Academy of Sciences, Tomsk]

[Abstract] The threshold conditions under which the explosive absorption of radiation of a CO<sub>2</sub> laser occurs in the atmosphere were investigated. With such explosive absorption there is a sharp increase in the medium absorption coefficient due to strong self-heating of the atmosphere in the beam channel. The time of development of a thermal explosion are determined and the power losses (change in the absorption coefficient) during the propagation of laser radiation through the atmosphere in a suprathreshold mode are estimated. The studied thermal instability of atmospheric carbon dioxide in the field of resonance radiation results in a substantial (by an order of magnitude) decrease in atmospheric transparency and this should be manifested during propagation of a large-diameter laser beam through the atmosphere. A similar thermal instability mode should be observed under the influence of radiation at 9.4 μm because the level (0200) in CO<sub>2</sub> mixes well with the level (100). A detailed study of explosive absorption of radiation at 10.6 and 9.4 μm by water is of practical importance because water vapor is always present as an admixture in air and its characteristic concentrations considerably exceed the CO<sub>2</sub> concentration. Figures 3; references 22: 21 Russian, 1 Western.

UDC 530.182.551.510.42

### Transparency of Optical Channel in Moist Atmospheric Hazes Under Optical Breakdown Conditions

18650214g Tomsk OPTIKA ATMOSFERA in Russian Vol 2 No 6, Jun 89 (manuscript received 27 Jan 89) pp 609-614

[Article by A. A. Zemlyanov, G. A. Maltseva and V. A. Pogodayev, Atmospheric Optics Institute, USSR Academy of Sciences, Tomsk]

[Abstract] A numerical investigation was made of the propagation of laser radiation at 10.6 μm in moist atmospheric hazes of different chemical composition and for different ranges of meteorological visibility. A

study was made of the possibility of an optimal change in beam radius, radiation focusing angle and steepness of the leading edge of the pulse (with a constant pulse power) for the purpose of increasing propagation channel transparency. It is shown that a change in beam parameters makes it possible to increase channel transparency for dry hazes by 50-70% and for moist hazes by 10-15% due to a worsening of conditions for the formation of plasma cells. The influence of humidity on the process of formation of plasma cells results in a lessening of laser spark length by a factor about 1.2-2. The influence of the chemical composition of absorbing particles on optical channel transparency does not exceed about 10%. Figures 4; references: 7 Russian.

UDC 621.373.826:533.9

### Influence of Temperature Gap on Decrease in Aerosol Optical Breakdown Threshold

18650214h Tomsk OPTIKA ATMOSFERA in Russian Vol 2 No 6, Jun 89 (manuscript received 28 Feb 89) pp 615-620

[Article by V. N. Soshnikov]

[Abstract] There is a clearly expressed decrease in the theoretical threshold intensities of nonstationary optical breakdown for atmospheric aerosols, especially for small aerosol radii (less than 5 μm). Computations are presented showing that there is a gap between electron and gas temperatures which can be attributed to bottlenecks in energy exchange, resulting in a gap between electron and gas temperatures up to several thousand degrees. The decisive role in the balance of energy fluxes and accordingly in the decrease in threshold breakdown intensities is evidently not due to losses in the excitation of oscillations of N<sub>2</sub> and O<sub>2</sub> molecules by electron impact, but instead is attributable to the excitation and deactivation of low-lying metastable states of O and N atoms in completely dissociated high-temperature atmospheric plasma. References 12: 8 Russian, 4 Western.

UDC 535.8:520.2

### Information Content and Limitations of Strehl Criterion

18650214i Tomsk OPTIKA ATMOSFERA in Russian Vol 2 No 6, Jun 89 (manuscript received 12 Jan 89) pp 628-635

[Article by L. A. Pushnoy, Optika Special Design Bureau for Scientific Instrument Making, Siberian Department, USSR Academy of Sciences, Tomsk]

[Abstract] The quality of an optical image is often evaluated using the Strehl criterion. Despite its wide use in optics, there has never been a detailed study of its limitations and the range in which the criterion performs effectively. A study was therefore made to ascertain to what extent the Strehl criterion is sensitive to the type and degree of wave front disturbances, since should the

results be negative the Strehl criterion would be ineffective as a test of the quality of an optical system and it would be necessary to seek other simple characteristics. The Strehl criterion is found by computing the ratio of the maximal intensities of the real scattering function of a point to the ideal intensity. However, for an optical system with an increase in its rms error there is an intensive deviation of energy from the core of the diffraction image to the distant rings, so that the energy remaining at the center is small and the Strehl criterion becomes insensitive to wave front distortions beginning with some distortion limit. The specific conditions under which the Strehl criterion becomes ineffective are defined. As an alternative a quality test is proposed indicating the increase in the size of the scattering circle for a real optical system. Figures 5; references 16: 9 Russian, 7 Western.

UDC 621.391.83

#### Linear Image Retrieval Algorithm

18650214j Tomsk OPTIKA ATMOSPHERE in Russian  
Vol 2 No 6, Jun 89 (manuscript received 10 Jan 89)  
pp 657-664

[Article by V. T. Kalayda, N. V. Molchunov and S. V. Sapozhnikov, Atmospheric Optics Institute, Siberian Department, USSR Academy of Sciences, Tomsk]

[Abstract] In many cases of processing of images obtained by remote sensing of the underlying surface the need arises to eliminate distortions introduced by the atmosphere along the optical radiation path caused by the presence of scattering layers and turbulence. An algorithm is therefore proposed for computing the coefficients of a spatial nonrecursive retrieving filter which effectively corrects this problem. It is based on the representation of the distorting effect of the atmospheric channel on image formation by use of a noncausal four-quadrant recursive filter with linear prediction. The retrieval operation is performed by convolution of the image with a small mask containing the coefficients of the spatial nonrecursive retrieving filter. Two variants of the algorithm are outlined. Figure 1; references: 7 Russian.

UDC 621.383.814

#### Single-Electron Response of Image Amplifier With Multichannel Electron Multiplier Section Energized by Pulsed Power Source

18650214k Tomsk OPTIKA ATMOSPHERE in Russian  
Vol 2 No 6, Jun 89 (manuscript received 7 Feb 89)  
pp 665-668

[Article by N. V. Zamyatin, V. M. Klimkin, G. V. Fedotova and V. A. Chikurov, Atmospheric Optics Institute, Siberian Department, USSR Academy of Sciences, Tomsk]

[Abstract] This article is essentially a continuation of an earlier paper by the authors (OPTIKA ATMOSPHERE, Vol 1, No 3, p 104, 1988). The single-electron characteristics (level of noise scintillations, counting curve, distribution of energies of photoelectron scintillations) of an image amplifier energized by a pulsed power source are described for a microchannel electron multiplier section consisting of two microchannel plates (in the earlier study only a single plate was used, which gave rise to a number of problems). A block diagram of the experimental apparatus is given which serves as a basis for describing the theory and operating principle. A number of recommendations are given for its further improvement (the use of four or more plates, for example, may solve some problems associated with the new two-plate variant). Figures 4; references: 5 Russian.

UDC 537.874.3:551.521.3

#### Estimation of Total Atmospheric Thickness From Refraction Data

18650214l Tomsk OPTIKA ATMOSPHERE in Russian  
Vol 2 No 6, Jun 89 (manuscript received 10 Jan 89)  
pp 671-672

[Article by V. P. Yakubov, N. A. Simakova and M. A. Yerofeyeva, Siberian Physical Technical Institute imeni V. D. Kuznetsov, Tomsk]

[Abstract] The influence of the atmosphere is one of the main factors limiting the potential accuracy of laser and radio communication, sounding, range finding and navigation systems. Modern requirements on the accuracy of range finding are characterized by a value in the centimeter range, whereas refraction corrections may be in the meter-decimeter range. The parameter describing the refraction correction for range is total atmospheric thickness  $H$ . A precise determination of  $H$  requires a knowledge of the dependence of the refractive index on altitude  $n(h)$ . On the basis of further development of the method proposed by V. P. Yakubov, et al. (OPTIKA ATMOSPHERE, Vol 1, No 10, p 48, 1988) formulas are derived for an approximate estimation of total atmospheric thickness and range corrections on the basis of refraction data without retrieval of the vertical dependence  $n(h)$ . The derived formulas and proposed method will be useful in routine correction of the atmospheric influence on the accuracy in determining range to a source of radiation of electromagnetic waves moving beyond the limits of the atmosphere. An example is given showing that the influence of the atmosphere can be reduced by a factor not less than 5 when using data on the Doppler frequency shift or on the value of the angle of refraction without drawing upon meteorological data and without solving the inverse problem of retrieving the dependence of the refractive index on altitude. References 4: 3 Russian, 1 Western.

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