

Atmospheric and Ocean Optics: Atmospheric Physics II

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The Atmosphere Special Issue entitled “Atmospheric and Ocean Optics: Atmospheric Physics II” comprises eight original papers.

This Special Issue aimed to collect current novel papers, presented at the 26th International Conference “Atmospheric and Ocean Optics: Atmospheric Physics.” We invited researchers to contribute original research papers, dealing with all aspects of atmospheric and ocean optics and atmospheric physics.

In the first paper of the Special Issue, V. Belov et al. [1] presented an overview of investigations of non-line-of-sight (NLOS) communication carried out in Russia and in collaboration with researchers in Israel. The theories of radiative transfer and linear systems provide the theoretical basis for this joint research, and experimental results demonstrate that maximal ranges for NLOS communication through atmospheric channels can reach hundreds of kilometers in the visible range and tens of kilometers in the ultraviolet (UV) range of the spectrum. NLOS communication was realized for base distances up to 70 km in the visible range at a wavelength of 510.6 nm at night, and up to 1.3 km in the UV range at a wavelength of 255.3 nm in the daytime and at night. The experiments were performed under different meteorological conditions in the atmosphere, which varied during the experiments. Underwater NLOS communication was carried out in a freshwater lake (including under ice) at radiation wavelengths of 510.6 and 450 nm at basic distances of up to 40 m. In the forefront of the experimental investigations carried out in Russia stand the underwater NLOS communication trials, including communication under ice. This communication was realized with sources in the visible range, at wavelengths of 510.6 and 450 nm and at distances up to 40 m. Finally, they predict the range of bistatic underwater communication systems can reach hundreds of meters.

The next three papers in the Special Issue are devoted to numerical modeling and assessment of the impact of changes in meteorological conditions, aerosol, and gas composition of the atmosphere on the current state of climatic conditions.

The paper of A. Starchenko et al. [2] presents the results of calculations of meteorological parameters and parameters that characterize air quality in the city of Tomsk, obtained with the use of mesoscale meteorological and chemical transport models. Changes in the numerically predicted wind velocity fields, temperature, and concentration of major air pollutants were considered in detail for the selected dates when calm, cloudless, dry, and anti-cyclonic weather was observed in Tomsk. The numerical calculation results were compared with the observation data from the Joint Use Center “Atmosphere” of IAO SB RAS. The results of modeling, which were also confirmed by observations, have shown that the most unfavorable meteorological conditions for pollutants’ accumulation are stable. There is neutral stratification of the near-surface air with low ambient air temperatures (−30, −20 °C) and calm winds of various directions. The new modification of the mesoscale photochemical model was developed. The paper shows the possibility of the model to predict the state of the atmosphere above the city, including the heat island and its characteristics



Citation: Romanovskii, O.A.; Matvienko, G.G. Atmospheric and Ocean Optics: Atmospheric Physics II. *Atmosphere* **2021**, *12*, 430. <https://doi.org/10.3390/atmos12040430>

Received: 22 March 2021
Accepted: 23 March 2021
Published: 26 March 2021

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(intensity, horizontal extent, lifetime, differences between urban temperature, suburban temperature, and humidity values, and air circulation).

The emission of dust particles into the atmosphere during rock mass breaking by blasting in ore mining open-pits is one of the factors that determine the ground-level air pollution in the vicinity of pits. The data on dust concentration in the cloud, which is extremely difficult to obtain experimentally for large-scale explosions, is required to calculate the dust dispersion in the wind stream. The authors of the paper [3] developed a Eulerian model to simulate the initial stage of dust cloud formation and rising, and a Navier–Stokes model to simulate thermal rising and mixing with the ambient air. The first model is used to describe the dust cloud formation after a 500 t TNT (Trinitrotoluene equivalent) explosion. The second model based on the Large Eddy Simulation (LES) method is used to predict the height of cloud rising, its mass, and the evolution of dust particles size distribution for explosions of 1–1000 t TNT. It was found that the value of the turbulent eddy viscosity coefficient (Smagorinsky coefficient) depends on both the charge mass and the spatial resolution (grid cell size). The values of the Smagorinsky coefficient were found for charges with a mass of 1–1000 t using a specific grid.

Using the two-box energy balance model (EBM), Sergei Soldatenko [4] explored the climate system response to radiative forcing generated by variations in the concentrations of stratospheric aerosols and estimate the effect of uncertainties in radiative feedbacks on changes in global mean surface temperature anomaly used as an indicator of the response of the climate system to external radiative perturbations. Radiative forcing generated by stratospheric sulfate aerosols from the second-largest volcanic eruption in the 20th century, the Mount Pinatubo eruption in June 1991, was chosen for this research. The global mean surface temperature response to a specified change in radiative forcing is estimated as a convolution of the derived impulse response function corresponding to EBM with a function that describes the temporal change in radiative forcing. The influence of radiative feedback uncertainties on changes in the global mean surface temperature is estimated using several “versions” of the EBM. Changes in the global mean surface temperature caused by stratospheric aerosol forcing are found to be highly sensitive not only to radiative feedbacks but also to climate system inertia defined by the effective heat capacity of the atmosphere–land–ocean mixed layer system, as well as to deep-ocean heat uptake. The results obtained have direct implications for a better understanding of how uncertainties in climate feedbacks, climate system inertia, and deep-ocean heat uptake affect climate change modeling.

In the next three papers, a comparative analysis of measurements of atmospheric parameters by various methods of remote and contact sensing is carried out.

Meteorological and atmospheric-electrical observations in the Geophysical Observatory of the Institute of Monitoring of Climatic and Ecological Systems are presented in the paper of V. Kalchikhin et al. [5]. Precipitation data are used to identify periods of heavy rainfall ≥ 5 mm/h. Information of weather stations and satellites is used to separate the heavy rainfall events by synoptic conditions such as thunderstorms and showers of frontal or internal air masses. Authors find that rains associated with the frontal *Cb* clouds produce more abrupt changes in negative electrical conductivity in comparison with the *Cb* clouds in internal air masses. The significant increase in negative electrical conductivity (more than two times vs. normal values) occurs typically during the passage of frontal *Cb* and heavy rain with droplet size greater than 4 mm.

The purpose of the work [6] was to study the influence of temperature correction on ozone vertical distribution (OVD) in the upper troposphere–stratosphere in the altitude range $\sim(5\text{--}45)$ km, using differential absorption lidar (DIAL), operating at the sensing wavelengths 299/341 nm and 308/353 nm. We analyze the results of lidar measurements, obtained using meteorological data from MLS/Aura and IASI/MetOp satellites and temperature model, at the wavelengths of 299/341 nm and 308/353 nm in 2018 at Siberian Lidar Station (SLS) of the Institute of Atmospheric Optics, Siberian Branch, Russian Academy of Sciences. To estimate how the temperature correction of absorption cross-sections influences

the OVD retrieval from lidar measurements, the authors calculated the deviations of the difference between two profiles, retrieved using satellite- and model-based temperatures.

Experimental field observations are needed to improve the understanding of the surface-atmosphere interaction and atmospheric boundary layer (ABL) physics and develop corresponding model parameterizations. Information on the ABL wind profiles is essential for the interpretation of other observations. In paper [7], authors consider the experience of using two low-cost methods for wind profiling, which may be easily applied in field studies with modest demands on logistical opportunities, available infrastructure, and budget. The first one is a classical and well-known method of pilot balloon sounding, i.e., when the balloon is treated as a Lagrangian particle and tracked by theodolite observations of angular coordinates. The second one is based on a vertical sounding with a popular and relatively cheap mass-market quadcopter DJI Phantom 4 Pro and utilizes its built-in opportunity to restore the wind vector from quadcopter tilt angles. Both methods demonstrated reasonable agreement and applicability even in harsh weather conditions and complex terrain. The advantages and shortcomings of these methods, as well as practical recommendations for their use are discussed. For the drone-based wind estimation, the importance of calibration by comparison to high-quality wind observations is shown.

The mobile aerosol Raman polarizing lidar LOSA-A2 designed at V.E. Zuev Institute of Atmospheric Optics SB RAS is presented in the paper of S. Nasonov et al. [8]. Its main technical specifications are given. The lidar carries out sounding of the atmosphere of a Nd:YAG laser at two wavelengths, 1064 nm and 532 nm. An optical selection of lidar signals at these wavelengths is performed by two identical telescopes with diameters of 120 mm and a focal length of 500 mm. In the visible channel, the signal is divided into two orthogonal polarized components, and a Raman signal at a wavelength of 607 nm is separated. The lidar was tested in aircraft and ship research expeditions. Results of the study of spatial aerosol distribution over the Baikal with the use of LOSA-A2 lidar received during ship-based research expeditions are described. The first in situ tests of the lidar were carried out in an aircraft expedition in the north of Western Siberia.

Author Contributions: Conceptualization, O.A.R. and G.G.M.; writing—original draft preparation, O.A.R. and G.G.M.; writing—review and editing, O.A.R. and G.G.M.; supervision, G.G.M.; project administration, O.A.R.; funding acquisition, O.A.R. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by the Ministry of Science and Higher Education of the Russian Federation (V.E. Zuev Institute of Atmospheric Optics of Siberian Branch of the Russian Academy of Sciences).

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Acknowledgments: The editors would like to thank the authors for their contributions, the reviewers for their comments and the editorial office for the support in publishing this issue.

Conflicts of Interest: The authors declare no conflict of interest.

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