

# Atmospheric and Ocean Optics: Atmospheric Physics

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

This Special Issue aimed to collect current novel papers, presented at the 25th International Conference “Atmospheric and Ocean Optics: Atmospheric Physics”. We invited researchers to contribute original research papers, dealing with all aspects of atmospheric and oceanic optics and atmospheric physics.

The first three papers of the Special Issue are devoted to studies of atmospheric processes in Eastern Siberia (Baikal region) and Kamchatka.

The linkage between atmospheric blocking (blocking frequency, BF) and total monthly July precipitation in the Selenga River Basin, the main tributary of Lake Baikal, for the period 1979–2016 was investigated (O. Antokhina et al. [1]). Based on an empirical orthogonal functions (EOF) analysis, the two dominant modes of precipitation over the Selenga River Basin were extracted. The first EOF mode (EOF 1) is related to precipitation fluctuations mainly in the Mongolian part of Selenga; the second EOF mode (EOF 2)—in the Russian part of Selenga. Based on the two different modes obtained, the total amount of precipitation individually for the Russian and Mongolian part of Selenga was calculated. Correlation analysis has demonstrated that precipitation over the Mongolian part of the Selenga Basin is positively correlated to blocking over Eastern Siberia/Mongolia (80–120° E, ESM-BF). Precipitation over the Russian part of the Selenga Basin is positively correlated to blocking over the Urals-Western Siberia (50–80° E, UWS-BF) and European blocking (0–50° E, E-BF). However, the linkage is not stable, and after the mid-1990s, the obtained positive correlation became insignificant. The analysis has shown that the dominance of E or ESM-blocking in July was the primary driver of the existence of the two precipitation modes over the Selenga River Basin. During 1996–2016, the negative trend of the time coefficients of EOF 1 and 2 for precipitation in Selenga had been observed, which was characterized by a displacement of positive precipitation anomalies outside the basin. At the same time, there was a weakening of the linkage between precipitation in the Selenga Basin and the blocking frequency.

In the paper of O. Khuriganova et al. [2] the measured concentrations of inorganic pollutants, such as ozone (2015–2018), sulfur, and nitrogen oxides (2012–2018) at air monitoring sites in the south of Eastern Siberia were sampled, following the passive sampling method, and analyzed. The spatial inhomogeneity of atmospheric gas concentrations is presented. The ozone concentration is lower in urban areas than those in rural areas and the background level. However, the nitrogen and sulfur oxide concentrations are higher in the atmosphere over the city site. The seasonal dependence of the ozone concentration was determined using its maximum (March–April) and minimum (September–October) levels. The dynamics of the nitrogen and sulfur oxide concentrations indicate that they are at their highest in December–June and their lowest in July–August. A linear regression analysis and a pairwise modification of Student’s t test evaluated the concentrations of



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the air pollutant, sampled and measured using different methods, and they correlate well ( $r = 0.7\text{--}0.9$ ).

The paper of P. Firstov [3] is devoted to the description of observations over atmospheric and electric effects from volcanic eruptions on the Kamchatka peninsula (Russia) and perspectives of their development. To collect information about atmospheric-electric effects accompanying the eruptions of Kamchatka volcanoes, three sensor networks and a VLF radio direction finding station are used. The World Wide Lightning Location Network (WWLLN) provides information on high-current lightning discharges that occur during the development of an eruptive cloud (EC). Variations in the electric field of the atmosphere (AEFEz) during the passage of EC were obtained by a network of electric field mills at the sites for volcanic activity observations. A seismic detector network was used to make a precision reference to the eruptions. Based on the data obtained, a description is given of the dynamics of eruptions of the most active volcanoes in Kamchatka and the Northern Kuril Islands (Shiveluch, Bezymianny, Ebeko). The paper presents a simulation of the response of the atmospheric electric field, which showed that the approximation by the field of distributed charges makes it possible to estimate the volume charges of EC. The fact of a multi-stage volcanic thunderstorm is confirmed.

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

The purpose of paper [4] (S. Dolgii et al.) is to measure the ozone vertical distribution (OVD) in the upper troposphere–stratosphere by a differential absorption lidar (DIAL) at 299/341 nm and 308/353 nm and to compare and analyze the results against satellite data. A lidar complex for measuring the OVD in the altitude range  $\approx(5\text{--}45)$  km has been created. The authors analyzed the results of ozone lidar measurements at wavelengths of 299/341 nm and 308/353 nm in 2018 at the Siberian Lidar Station (SLS) and compared them with satellite (MLS/Aura and IASI/MetOp) measurements of OVD. The retrieved lidar OVD profiles in the upper troposphere–stratosphere in comparison with MLS/Aura and IASI/MetOp profiles, as well as the stitched OVD profile in comparison with the mid-latitude Krueger model, confirm the prospects of using the pairs of ozone sounding wavelengths 299/341 and 308/353 nm.

A differential absorption lidar (DIAL) system designed on the basis of optical parametric oscillators (OPO) with nonlinear  $\text{KTiOAsO}_4$  (KTA) and  $\text{KTiOPO}_4$  (KTP) crystals is described (S. Yakovlev et al. [5]). The crystals allow laser radiation tuning in the infrared (IR) wavelength region. The measurements in the 3.30–3.50  $\mu\text{m}$  spectral range, which includes a strong absorption band of methane, are carried out. Lidar backscattered signals in the spectral band 3.30–3.50  $\mu\text{m}$  have been measured and analyzed along the horizontal path in the atmosphere. Based on the experimental results,  $\text{CH}_4$  concentrations  $\sim 2.085$  ppm along an 800 m surface path are retrieved in the spectral range under study with a spatial resolution of 100 m.

In the paper of M. Panchenko et al. [6], the authors analyzed the main states of “dry” aerosol on the basis of the results of long-term regular measurements in the near-ground layer of the atmosphere near the city of Tomsk in 2000–2017. The following parameters were considered: aerosol number concentration and size distribution function, total and angular scattering coefficients, including the small-angle range  $1.2^\circ$  to  $20^\circ$ , mass concentration and size distribution of absorbing substances (equivalent black carbon), characteristics of the aerosol hygroscopic properties, and spectral aerosol extinction of radiation on an open long path in the wavelength range 0.45 to 3.9  $\mu\text{m}$ . The results showed that most of the seasonal average values of the aerosol parameters analyzed in the paper are statistically significantly different when comparing various characteristic types of scattering and an absorbing atmospheric aerosol. The results of the research indicate that the application of the developed classification of types of aerosol weather for the analyzed optical and microphysical parameters of aerosol particles is quite effective and reasonable.

The last paper of S. Bobrovnikov et al. [7] presents the results of a numerical evaluation of limiting sensitivity of the method for detecting vapors of nitrocompounds in the atmo-

sphere based on one-color laser fragmentation (LF)/laser-induced fluorescence (LIF) of NO fragments via the  $A^2\Sigma^+(v' = 0) \leftarrow X^2\Pi (v'' = 2)$  transition. The calculations were performed using the developed kinetic model of the one-color LF/LIF process under consideration. The calculations take into account the influence of ambient nitrogen dioxide as a limiter of the sensitivity of the method when operating in a real atmosphere. It is shown that if the nitrogen dioxide concentration in the atmosphere does not exceed a value of 10 ppb, the maximum detectable vapor concentrations of nitrobenzene and *o*-nitrotoluene are several ppb. It is also shown that the method of single-frequency one-color excitation usually used for the detection of nitrocompounds does not allow achieving the maximum efficiency of the LF/LIF process.

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