INTRODUCTION

An important role of atmospheric aerosol in the radiation processes in the atmosphere motivates the study of the spatiotemporal variations of the aerosol characteristics. The microcrystalline carbon (black carbon, BC) is the main absorbing component in the atmospheric aerosol and the main contributor to the aerosol absorption in the visible spectral range. As a consequence, the atmospheric aerosol, together with the greenhouse gases, is the main climate forcing agent both on global and regional scales. Of most interest are integrated studies of the dynamics of the aerosol characteristics in the “continent–ocean” transition zones, which are affected by aerosol sources of different origins. An integrated experiment in the “continent–ocean” transition zone to study the variability ranges and specific features of spatiotemporal aerosol variations was performed in spring of 2009. Simultaneously, in two regions, namely, in the coastal zone (on the territory of Ussuriysk Astrophysics Observatory, Far East Branch, Russian Academy of Sciences (Gornotaeznoe) and in the Japan Sea onboard the Nadezhda sailing training vessel (STV), the aerosol and black carbon concentrations in the near-ground (near-water) air layer were measured around-the-clock and aerosol samples were collected for chemical analysis. In that same time period, regular aerosol measurements were performed in the western Siberian region (Tomsk). In this work, we analyze the microphysical characteristics and chemical composition of aerosol in Primorye, and compare them with data of simultaneous springtime and multiyear microphysical measurements in western Siberia (Tomsk).
1. INSTRUMENTATION AND METHOD OF AEROSOL MEASUREMENTS

The aerosol microphysical parameters in Gornoteznoe (GT), in the Ussuriysk region of Primorye (80 km away from the ocean), were measured in the near-ground air layer with the use of an automated mobile aerosol complex (aerosol station) [1–4], which was located on the territory of the Ussuriysk Astrophysics Observatory (http://www.uafo.ru; 43.7° N, 132.2° E; GMT +11.00). The aerosol characteristics were recorded every hour around-the-clock. The angular scattering coefficient of the dry substrate of submicron particles at the angle of 45° was measured with the use of a PhaN-type nephelometer (wavelength of 0.51 μm) with a sensitivity of about 1 Mn–1 sr–1. Data on the angular aerosol scattering coefficient μ (45°) (Mm–1 sr–1) are used to estimate the mass concentration of the submicron aerosol M (μg/m3) = 2.40μ (45°) (with the use of a one-parameter model of atmospheric hazes [5]; for the particle density of 1.5 g/cm3). The mass concentration of black carbon in the composition of aerosol particles Mbc (μg/m3) was measured with the use of an aethalometer, whose principle of operation was analogous to that used by Hansen [6]. The aethalometer implements the method of measuring the diffuse extinction of light by a layer of aerosol particles directly in the process of particle deposition on the aerosol filter. The aethalometer provides measurements of the black carbon mass concentration from 0.1 to 110 μg/m3, with a sensitivity of about 0.1 μg/m3 with the pumping of 20 l of air. A photoelectric particle counter of AZ-5 type was used for coastal measurements of the number concentration N (cm–3) and size distribution of particles in the diameter range of 0.4–10 μm. The aforementioned instruments, the specific features of their calibration, and measurement techniques were previously described in detail [2–4]. Two parameters of near-water aerosol were measured onboard the STV using a GRIMM photoelectric particle counter (model 1.108), which recorded particle number concentration Na in the diameter range of 0.3–20 μm and particle mass concentration M (μg/m3) of particles with sizes d > 0.27 μm.

Simultaneously, at the stationary Aerosol Station of Institute of Atmospheric Optics, Siberian Branch, Russian Academy of Sciences, located in the suburbs of Tomsk (http://aerosol1.iao.ru; 56.46° N, 85.05° E; GMT +7.00), the measurement of aerosol microphysical characteristics, analogous to those mentioned above, were performed. The continuous-mode (since May 1996) measurements at the aerosol station have allowed us to accumulate multiyear measurement time series and estimate mean models of aerosol parameters in the near-ground layer characteristic for the western Siberian region.

The chemical composition of the near-ground and near-water aerosol was studied by the method of collecting the atmospheric air samples on the filters for their subsequent analysis under laboratory conditions. At the GT station, the samples were simultaneously collected on the filters of the aspirator (“funnel,” four filters), and, along the route of the Nadezhda STV, the samples were collected on the filters of the aspirator and impactor (two-cascade filters, for particles larger and smaller than 1 μm) [7]. The time of aerosol accumulation on the filters was 7–10 h, and the air pumping rates were 121 min–1 for the aspirator and 5 l min–1 in the case of pumping through impactor channels. The chemical analysis of the collected samples was performed under laboratory conditions according to the methods described in [8–14]. The concentrations of Na+, K+, Ca2+, Mg2+, NH4+, Cl–, NO3–, HCO3–, and SO42– ions were determined in water extracts from aerosol filters. The concentrations of the gaseous SO2, NO2, HNO3, and NH3 compounds were determined by the calculational method, based on analysis of the corresponding ions.

2. STUDY OF THE MICROPHYSICAL CHARACTERISTICS OF NEAR-GROUND AND NEAR-WATER AEROSOL IN THE REGIONS OF PRIMORYE AND THE SEA OF JAPAN

Time sweeps of the measured integrated aerosol parameters for the GT aerosol station and onboard the Nadezhda for the period from April 5 to May 11 are presented in Fig. 1.

The time scale was divided into two time intervals: interval I, representing the initial stage of measurements at the GT station from April 5 to 13, when the variations of the near-ground aerosol parameters were mainly driven by finely dispersed aerosol generated by smokes from forest fires and vegetation burning and transported to the observation region, and interval II, including cases when the near-ground and near-water aerosol was considerably affected by emissions of the continental aerosol. The statistical data of these parameters for these time intervals are presented in Table 1.

The estimates of the average aerosol concentrations indicate that the near-ground and near-water air layers in the springtime measurement period were characterized by quite high aerosol and black carbon contents. The spread of the smoke aerosol and dust emissions had been affected considerably by passage of atmospheric air masses, mostly due to changes in wind speed and direction. The springtime observation period at both sites was characterized by unstable weather and frequent air mass changes (anticyclones and cyclones). For instance, the synoptic-scale circulation caused strong interdiurnal variations in the time behavior of the black carbon concentration in the coastal zone (see Fig. 1). As an example, for the GT