

Supplementary Material S1. Volcanic activity and Siberian wildfires in study season

1. Volcanic activity

Before the end of August 2016, the Northern Hemisphere was affected by natural emissions of trace elements from the eruptions of forty-one volcanoes. Thirty of them had also erupted in previous years, even monthly, while eleven started in the year of sampling. Most eruptions took place in areas like Indonesia and the Philippines, Hawaii, and the Pacific Ocean, Mexico, and Central America or South America, Mediterranean and Western Asia, Japan. Among these, five volcanoes from Kamchatka and Mainland, and two from the Kuri Island erupted in previous years [55]. Considering earlier eruptions of most of the volcanoes, the long distance from the Arctic, and the dynamic character of the atmosphere, it can be assumed that their contribution in summer rainfall chemistry was highly dispersed. Attention should be paid only to volcanoes erupting in July and August in close vicinity to the Arctic, such as Sheveluch and Klyuchevskoy volcanoes in the region of Kamchatka, as well as newly erupting in 2016 Pavlof and Cleveland volcanoes in Alaska. Sheveluch and Klyuchevskoy volcano eruptions were recorded throughout the summer season [55]. They emitted gaseous steam and ash plumes over the last weeks of July and all of August at a height between 2.5 and 5 km a.s.l. [56]. The Cleveland volcano eruptions stopped at the beginning of June [57]. The eruptions of Pavlof, however, stopped just by the end of July [58]. During the Pavlof volcano eruption on July 28th (23:00 UTC), emission of steam and ash plume to a height of 3.6 km above sea level (a.s.l.) was observed, while on July 31st, minor ash and steam emissions as high as 2.4 km a.s.l. were recorded [59].

2. Siberian wildfire activity and polluted air transport

Summer, especially July and August, are considered the season of wildfires in the Northern Hemisphere due to the abnormally hot and dry weather resulting from climate change

[24,42–44]. In summer 2016, areas of the Russian Federation damaged by wildfires were estimated for up to 6.34 mln ha. It triggered the emission of specific C (5.86 t/ha) and greenhouse gasses such as CO_2 (136 mln t), CO (2.21 mln t), CH_4 (595 k t), N_2O (4.09 t), NO_x (148 k t), and direct pyrogenic carbon emission (37.2 MtC) [60]. Wildfires in NE Siberia started on July 1st and reached their maximum between July 15th and 25th [43,44]. Due to atmospheric circulation, the polluted air masses moved to central Europe, where they caused a maximum concentration of black carbon (BC) mass in the air (approximately 400 ng/m³) on July 29th. In the second half of July, the BC plume mostly spread in the atmosphere layer at a height of a 2 km also over NE Eurasia, and later the Arctic [49]. As a result of the Arctic front position during summer, lower altitude air masses over the Norwegian Arctic were less polluted than in winter, and strongly polluted Eurasian air masses were able to reach Svalbard from higher altitudes in summer [1].