Volcanic activity in the Kuril Islands in 2018: on the basis of satellite and visual data

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Abstract. The data characterizing volcanic activity in the Kuril Islands in 2018 are given on the basis of satellite and visual data. The Ebeko volcano (Paramushir island, the Northern Kuriles) and Sarychev Peak volcano (Matua Island, the Central Kuriles) were active in the Kuril Islands. On Ebeko volcano a weak (to moderate) explosive eruption occurred, it expressed in regular steam and ash-gas emissions (only about 800 with a height from 2 to 5.5 km). Sarychev Peak volcano was characterized by a manifestation of weak (to moderate) explosive activity (during the period from September till October there were at least 10 emissions to a height of 2 to 4.5 km). Due to the relatively low emission height and low ash concentration, the activity of Ebeko and Sarychev Peak volcanoes in 2018 did not pose a serious threat to international air routes, but could complicate the work of local airlines.

Keywords: the Kuril Islands, volcanoes, activity, Ebeko, Sarychev Peak volcano, SVERT.

1. Introduction
In the Kuril Islands there are 36 active volcanoes, the activity of which is monitored by the Sakhalin Volcanic Eruption Response Team (SVERT). The area of responsibility of SVERT covers the territory from Kunashir Island to Onekotan Island inclusively (figure 1). Continuous monitoring of active volcanoes in the region is necessary to ensure the safe living of ~20,000 civilians in Paramushir, Iturup and Kunashir Islands and to reduce the risk for air transport, the air corridors of which are located near the Kuriles.

2. Material and methods
In the practice of daily operational monitoring SVERT uses satellite data of AQUA and TERRA (MODIS), NOAA (AVHRR/POES), supplied by the Laboratory of remote sensing (Sakhalin State University, Yuzhno-Sakhalinsk), as well as resources from the information service VolSatView "Remote monitoring of activity of volcanoes of Kamchatka and Kuriles" developed jointly IVS FEB RAS, IKI RAS, CC FEB RAS and SRC "Planeta" ("Planet") [1, 2]. Since October 2017, a video surveillance camera (figure 1) has been used to monitor the activity of Ebeko volcano in Paramushir Island. In addition, SVERT, if possible, attracts additional information from local residents and tourists who witnessed the manifestations of higher volcanic activity in the Kuril Islands (photo and video materials, descriptive data).

Based on the analysis of the received information, SVERT creates daily information reports, which are sent to all interested organizations (the regional state institution "Office of civil defense, emergency protection and fire safety" of the Sakhalin region, AVO, meteorological centers of Yelizovo and...
Yuzhno-Sakhalinsk airports, Advisory centers for volcanic ash (Volcanic Ash Advisory Center (VAAC)) of the cities of Tokyo, Anchorage, Washington, weather centers of Japan, Canada, etc.).

In 2018 Ebeko volcano (Paramushir Island, the Northern Kuriles) and Sarychev Peak volcano (Matua island, the Central Kuril Islands) were active. Brief data characterizing the manifestations of the activities of these volcanoes in 2018 and connected with them consequences are showed in this report, based on satellite, visual and video surveillance data.

3. Results and discussions

**Ebeko volcano** (absolute height – 1156 m) is located in the northern part of Paramushir Island, 7 km west of the city Severo-Kuril’sk (figure 1). Its edifice is an elongated in the meridional direction stratovolcanic cone, the top of which is crowned by three large craters (South, Middle, North) with a number of lateral explosive craters and funnels of the explosion (total ~10). Historical volcanic eruptions took place in 1793, 1833-1834, 1859, 1934-1935, 1963, 1965, 1967-1971, 1987-1991, 2009, 2010-2011 [3-8].

In 2018, Ebeko volcano continued weak (to moderate) explosive activity, which began in October 2016 [9, 10]. The style of the eruption did not undergo significant changes: weak and moderate steam and ash - gas emissions prevailed throughout the year. Increased activity was observed from late August till early December 2018 (figure 2 a-c). During this period, there was an increase in the number and height of ash explosions; it was recorded ~60 emissions to a height of 4 to 5.5 km a.s.l. (figure 3). The plumes extended mainly in the north-eastern, south-eastern, eastern and northern directions, their length, as a rule, did not exceed an average of 5-10 km. The maximum removal of the ash cloud was observed on August 21st from 02:00 till 06:20 UTC (hereinafter referred to the UTC time (world coordinated time): according to satellite data HIMAWARI-8, its movement was tracked at 278 km in the south-eastern direction (azimuth 125º) with an average speed of 54 km/h.

In just one year, the surveillance camera recorded more than 800 emissions of Ebeko volcano (in the daytime in the absence of clouds and fog) to a height of 2 to 5.5 km a.s.l. (figure 3). It is important to note that some of the explosions were accompanied by ash falls of varying intensity observed in the vicinity of the city Severo-Kurilsk [10].
Figure. 2. Volcanic explosions of Ebeko volcano (according to AXIS surveillance camera) and Sarychev Peak volcano (according to visual observations, photo by S. A. Tatarenkov). Ebeko volcano: (a) 21.08.2018, (b) 14.09.2018, (c) 04.12.2018. Sarychev Peak volcano: (d) 02.09.2018, (e) 17.09.2018
Figure. 3. The height of ash emissions at Ebeko volcano in 2018 (according to the surveillance camera). Average emission heights for each month are taken.

Sarychev Peak volcano (absolute height – 1446 m) is located in the north-western part of Matua Island (figure 1). The volcano is built like a Somme-Vesuvius and consists of a Pleistocene volcano Matua with a summit caldera and a young cone of Sarychev Peak – a typical post-caldera stratovolcano with a summit crater. Volcanic eruptions occurred in 1765±5, 1878-1879, 1923, 1928, 1930, 1946, 1954, 1960, 1976, 2009, 2017 [3, 11-15].

Figure. 4. Ash emission height at Sarychev Peak volcano in September-October 2018 (visual and satellite data). The maximum of emission heights for each day is taken.

In 2018, ordinary weak (to moderate) explosive eruption occurred at Sarychev peak volcano. According to the analysis of satellite image made by KVERT (http://www.kscnet.ru/ivs/kvert/van/index.php?type=1) since May 7, 2018, thermal anomalies have been periodically recorded on the volcano, and on August 11, 2018, a weak ash emission was observed on the volcano. Starting from September 2, 2018, weak thermal anomalies and vapor-gas emissions with ash addition (figure 2 d) were recorded at Sarychev Peak volcano. The first strong emission to a height of 3-4 km a.s.l. occurred on September 12 at 19:03 UTC. The eruptive cloud (observed from 19:10 till
21:00 UTC) spread to the south-east and had a length of 121 km. The average speed of its movement was 81 km/h, and the square of cloud varied from 30 km$^2$ to 47 km$^2$.

Volcanic explosions of similar nature occurred on September 13, 23:40 UTC and September 14, 22:40 UTC. The most powerful event among all explosive episodes occurred on September 17; at 22:10 UTC (figure 2 d): ash emission was observed at a height of 4.5 km a.s.l. The ash cloud moved 255 km to the east-south-east; its average speed was 50 km/h. The maximum square was 128 km$^2$.

In the following days, the intensity of eruptive activity began to decrease: on September 19, 02:10 UTC and September 20, 20:40 UTC the emissions of weak and moderate force were observed to a height of 2 to 2.5 km.

The last ash emission was recorded on October 10, 01:50 UTC. The satellite images of HIMAWARI-8 showed the ash emissions to a height of 2.1 km a.s.l. (according to TOKIO VAAC). In the subsequent time, no signs of activity on the volcano Sarychev Peak were recorded. In total, in the period from September 2 till October 10, 2018 on Sarychev Peak volcano, according to satellite and visual data, at least 10 explosive events were recorded with the rise of the ash-gas column to a height of 2 to 4.5 km a.s.l. (figure 4).

According to the military meteorologist S. A. Tatarenkov, who was in the island from August 26 till September 28, 2018, the explosive activity on the Sarychev peak volcano began on September 2, 19:51 UTC. Visual ash emissions were observed on September 3, 12, 13, 17 (local time), which is confirmed by our satellite observations. Glow over the crater of the volcano in the dark was not observed. Any sound effects (roar, rumble) during the eruption were not felt. At the same time, during the entire period of activity, eyewitnesses noted weak local earthquakes.

4. Conclusions

In 2018, the activity of volcanoes of the Kuril Islands was relatively low. On the Ebeko volcano, weak (to moderate) explosive eruption, expressed as regular steam and ash-gas emissions, took place. In total, more than 800 emissions to a height from 2 to 5.5 km were recorded during the year. Periodically, ash falls were observed in the city Severo-Kuril’sk.

A weak (to moderate) explosive eruption occurred on Sarychev Peak volcano. According to satellite and visual data in the period from September 2 till October 10, 2018, at least 10 explosive events were recorded with the rising of the ash-gas column to a height of 2 to 4.5 km a.s.l. The maximum distance of ash cloud from the volcano was 255 km.

Due to the relatively low emission height and low ash concentration, the activity of Ebeko volcano and Sarychev Peak volcano in 2018 did not pose a serious threat to international air routes, but could complicate the work of local airlines. Visual observation of eyewitnesses for the volcanic activity allowed to detail the picture of the events, traditionally based solely on satellite data.

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