

The 25 ANNIVERSARY KAMCHATKAN VOLCANIC ERUPTION RESPONSE TEAM**Girina O.A., Gordeev E.I., Melnikov D.V., Manevich A.G., Nuzhdaev A.A., Romanova I.M.***Institute of Volcanology and Seismology FEB RAS, Petropavlovsk-Kamchatsky, Russia*

Strong explosive eruption of volcanoes is the most dangerous for aircraft because in a few hours or days in the atmosphere and the stratosphere can produce about several cubic kilometers of volcanic ash and aerosols (Gordeev, Girina, 2014; Igarashi et al., 2017). Ash clouds and plumes, depending on the power of the eruption, the strength and wind speed, can travel thousands of kilometers from the volcano for several days, remaining hazardous to aircraft, as the melting temperature of small particles of ash below the operating temperature of jet engines.

There are 30 active volcanoes in the Kamchatka and 6 in the Northern Kuriles, explosive eruptions of 3-8 volcanoes occur here every year. For example, in the 21st century (for 17 years) there were 55 eruptions lasting from several hours to three years of 12 volcanoes (Sheveluch, Klyuchevskoy, Bezymianny, Tolbachik, Kizimen, Karymsky, Zhupanovsky, Avachinsky, Koryaksky, Gorely, Mutnovsky, Kambalny) (<http://www.kscnet.ru/ivs/kvert/>). In addition, up to 25 strong explosive events occur each year on Kamchatka volcanoes, at which ash ascend to 10-15 km above sea level (Girina et al., 2017). Annual Kamchatkan strong explosive eruptions with ash emissions by 8-15 km above sea level represent a real threat to modern jet aviation.

The Kamchatkan Volcanic Eruption Response Team (KVERT) was established in 1993 by the Institute of Volcanic Geology and Geochemistry (IVGG) of the Far East Branch of the Russian Academy of Sciences (FEB RAS) in close cooperation with the Kamchatkan Branch of Geophysical Surveys (KBGS) of RAS and the joint efforts of the Alaska Volcanic Observatory (AVO), the US Geological Survey (USGS), the Geophysical Institute at the University of Alaska Fairbanks (GI-UAF) and the Alaska Department of Geological and Geophysical Services (ADGGS). Since 2004, KVERT is part of the Institute of Volcanology and Seismology (IVS) of FEB RAS, while retaining all duties and responsibilities vis-à-vis the airlines of the Pacific region (Girina, 2012; Girina et al., 2017; Gordeev, Girina, 2014). Since 2010, IVS FEB RAS has the authority for discharge obligations as the Volcano Observatory of the Russian Federation. Namely, on behalf of IVS, KVERT is responsible for providing information on volcanic activity to international air navigation services for the airspace users (Girina, 2012). The goal of KVERT is to reduce the risk of aircraft encounters with volcanic ash clouds in the North Pacific region through timely detection of volcanic unrest, tracking of ash clouds, and prompt notification of airline authorities and others about volcanic ash hazards.

Since 1993, KVERT conduct a daily visual and video (since 2000) monitoring of Klyuchevskoy, Sheveluch, Bezymianny, Kizimen, Koryaksky, Avachinsky, Mutnovsky and Gorely volcanoes; and since 2002, a daily satellite monitoring of Kamchatkan and Northern Kuriles volcanoes (Girina et al., 2017). Since 2011, experts from IVS FEB RAS, Space Research Institute RAS, Computing Center FEB RAS and the Far Eastern Planeta Research Center have created and operate the information system "Monitoring of Volcanoes Activity in Kamchatka and the Kuriles" (VolSatView; <http://volcanoes.smislab.ru>) that uses all available satellite data (operative and long-term archive data), weather and on-ground observations, the results of computational modeling of ash clouds and plumes trajectories to ensure continues monitoring and study of volcanic activity in Kamchatka and the Kuriles (Gordeev et al., 2016; Sorokin et al., 2016).

In 2014-2015, scientists of the Computing Center (CC) of FEB RAS and KVERT created a subsystem for modeling the propagation of ash clouds and plumes during explosive eruptions of volcanoes (using the PuffUAF model, NOAA meteorological data and software tools of the AIS "Signal") (Sorokin et al., 2016). Since 2016, the animated results of simulation of ash clouds trajectories based on VONA/KVERT data, placed on the background of the air routes scheme in the Northwest Pacific region, are published on the KVERT website (Fig. 1).

In 2013-2018, KVERT participated in the ICAO training of interaction between aviation and meteorological services in the Far Eastern region of Russia when KVERT scientists declared the danger of spreading ash plumes during the eruptions of Kamchatka volcanoes (Gordeev, Girina, 2014).

KVERT collects all possible volcanologic information, assigns the Aviation Color Code to volcanoes and send Volcano Observatory Notices for Aviation (VONAs) by email to Airport Meteorological Center (AMC) at Elizovo Airport; the Volcanic Ash Advisory Centers (VAACs): Tokyo, Anchorage, Washington, Montreal, and Darwin; aviation services, and scientists located throughout the North Pacific region. VONAs and KVERT Releases are posting on the web-site KVERT (<http://www.kscnet.ru/ivs/kvert/>) (Fig. 2), and data from VONAs – on the database of information system KVERT.

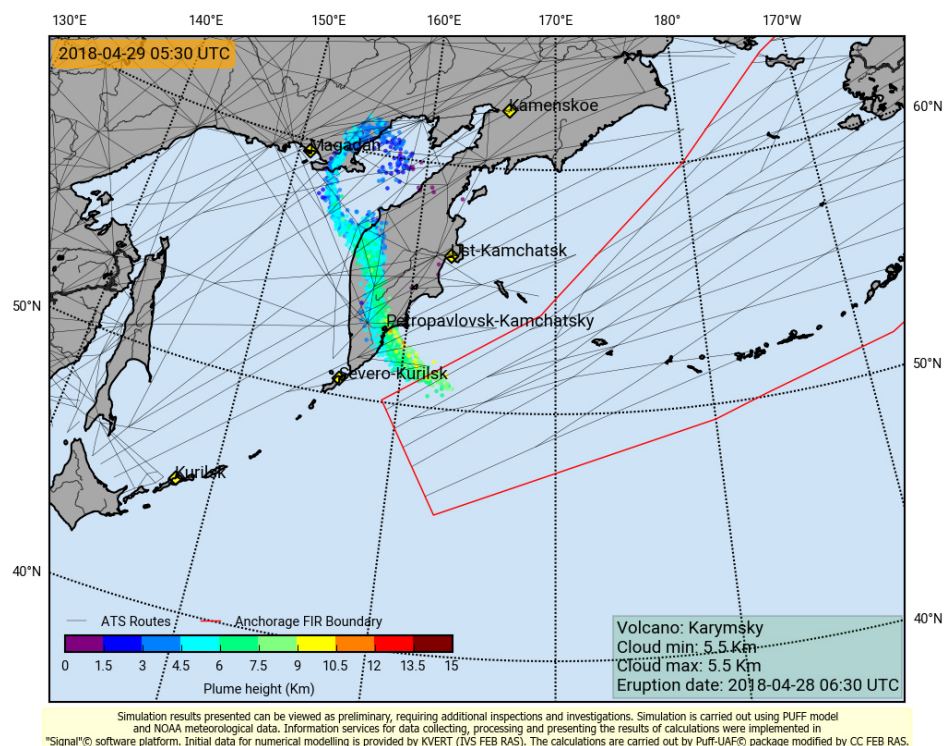


Fig. 1. Results of simulation for the ash plume propagation from Karymsky volcano on April 28, 2018 using the PUFF model at the Signal AIS, CC FEB RAS.

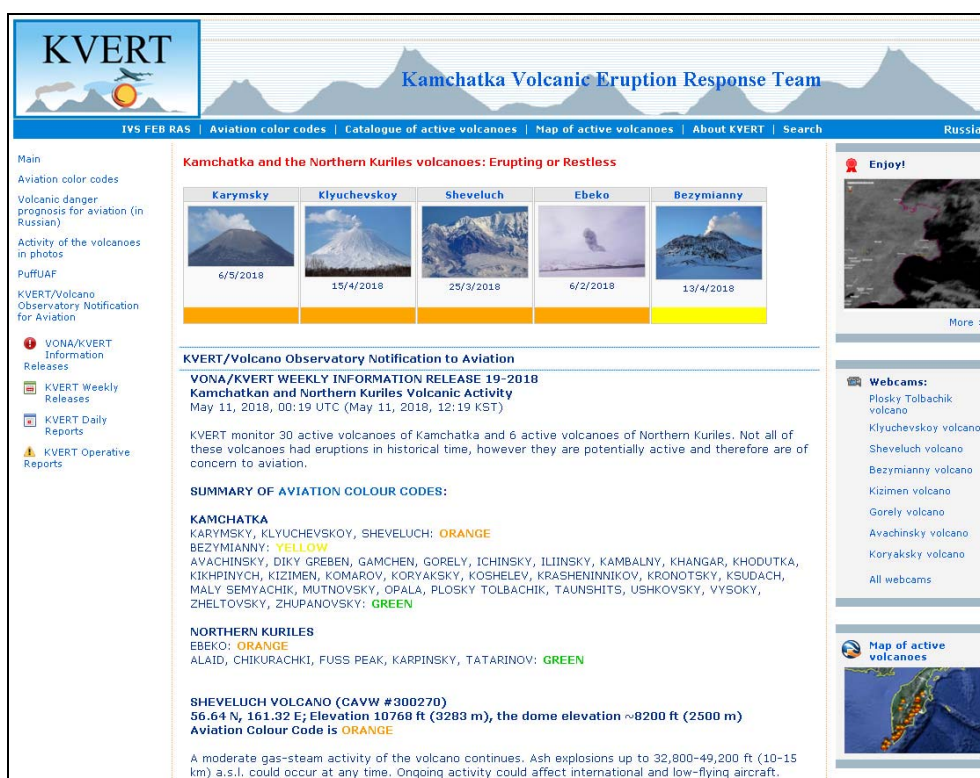


Fig. 2. KVERT-web-site (<http://www.kscnet.ru/ivs/kvert>)

To assess the situation in the area of a specific active volcano in Kamchatka and the Kuril Islands, the prognosis of its activity and danger for air flights for the near future (days, weeks) is very important. A multifaceted analysis of the available published information on the activity of volcanoes, as well as the data obtained by KVERT during the 25-year daily monitoring of volcanic activity, makes it possible to reliably estimate the degree of danger of each volcano for aviation and the population of the peninsula.

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