THE VOLSATVIEW INFORMATION SYSTEM FOR MONITORING AND STUDY KAMCHATKAN AND NORTHERN KURILES VOLCANOES

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The volcanoes of Kamchatka and Northern Kurile Islands are the most active in the world. Annually, from 3 to 8 volcanoes produce eruptions, during which the explosions eject ash to 10-15 km above sea level, and ash clouds spread thousands of kilometers from volcanoes. Strenuous volcanic activity could cause ash falls in towns and settlements, destruction of forests and communications. Ash clouds and plumes pose a serious threat to the modern jet aviation (Gordeev, Girina, 2014).

Scientists of Kamchatka Volcanic Eruption Response Team (KVERT) have conduct daily monitoring of Kamchatka (since 1993) and Northern Kuriles (since 2003) volcanoes to mitigate volcanic hazards to airline operations and population. Since 2014, satellite monitoring of volcanoes is carried out by KVERT scientists using the VolSatView (http://volcanoes.smislab.ru) information system (IS) (Girina et al., 2017c).

The VolSatView (Remote monitoring of active volcanoes of Kamchatka and the Kuril Islands) was created in 2011 by scientists from Space Research Institute (SRI) of Russian Academy of Sciences (RAS), Institute of Volcanology and Seismology (IVS) of Far East Branch (FEB) RAS, Computing Center (CC) of FEB RAS and Far East Planeta Center of Space Hydrometeorology Research, and the IS continues to developing. The system utilize all the available satellite data, weather and video observations to ensure continues monitoring and study of volcanic activity in Kamchatka and the Kurile Islands. Architecture of the VolSatView IS was developed for the work with distributed information resources and computation systems that are used for the acquisition, processing, storage, analysis, and visualization of various instrumental and scientific data (Fig. 1) (Efremov et al., 2012; Gordeev et al., 2016; Kashnitskiy et al., 2015, 2016; Loupian et al., 2014, 2015a, 2015b; Proshin et al., 2016; Tolpin et al., 2011).

The system has a broad set of tools for handling both observational series and cartographic information; several special tools and technologies under development in the system to deal with problems that arise during the monitoring and study of volcanic activity, for example: tools for the analysis of temperature fields, enabling instantaneous inspection of temperature values (in Celsius or Kelvin scales) at any point of an image; tools that can be used to identify ash clouds and plumes, to analyze their time series, to enter them in a database with automatic calculation of the area of the ash plume or cloud, to visualize ash plumes and clouds for specified or all volcanoes for a definite period of time (Efremov et al., 2012; Gordeev et al., 2016). Special emphasis is placed on tools that can be used to perform a joint analysis of information from different satellite systems, on the sources of observation, and on the results of their analysis. Thus, for example, the system can be used to synthesize different data acquired at different times to detect changes in the area of a volcano. As well, one can look at information on ash plumes as observed on satellite images, along with results from numerical simulation for the propagation of these plumes. In addition, the VolSatView has the ability to use data from the satellite Himawari-8 for creation of animated images of explosive events that clearly illustrate short duration of powerful explosive eruptions and long-term existence of ash clouds in the atmosphere, which represent a real danger to air transport (Girina et al., 2017a, 2017b).

A retrospective analysis of volcanic activity in VolSatView incorporate all of the parameters of the activity. These include temporal variations in the temperature and sizes of thermal anomalies in the areas of active vents in order to detect eruption precursors; the fact of thermal anomalies being confined to definite features like lava domes, lava flows, pyroclastic flows, slides of lava domes or active volcanoes, and so on; the zonality of temperature distributions within an anomaly for assessing the size of an imminent or ongoing eruption of the volcano.

The VolSatView IS has technologies for real-time handling of data from different ISs, e.g., information from KVERT IS and VOKKIA IS in the IVS FEB RAS Geoportal, and the Signal AIS (CC FEB RAS), and others. As an example, one can have access, while operating from the VolSatView, video

observations of Sheveluch, Klyuchevskoy, Gorely, Avachinsky and other volcanoes; information on the Aviation Color Code for each of the Kamchatkan and Northern Kuriles volcanoes; results of simulating the paths of ash plume propagation from volcanoes: one can simultaneously visualize the information on the ash plumes that are observed on satellite images and the results of numerical simulation for the propagation of these plumes; etc (Efremov et al., 2012; Gordeev et al., 2016; Sorokin et al., 2016).

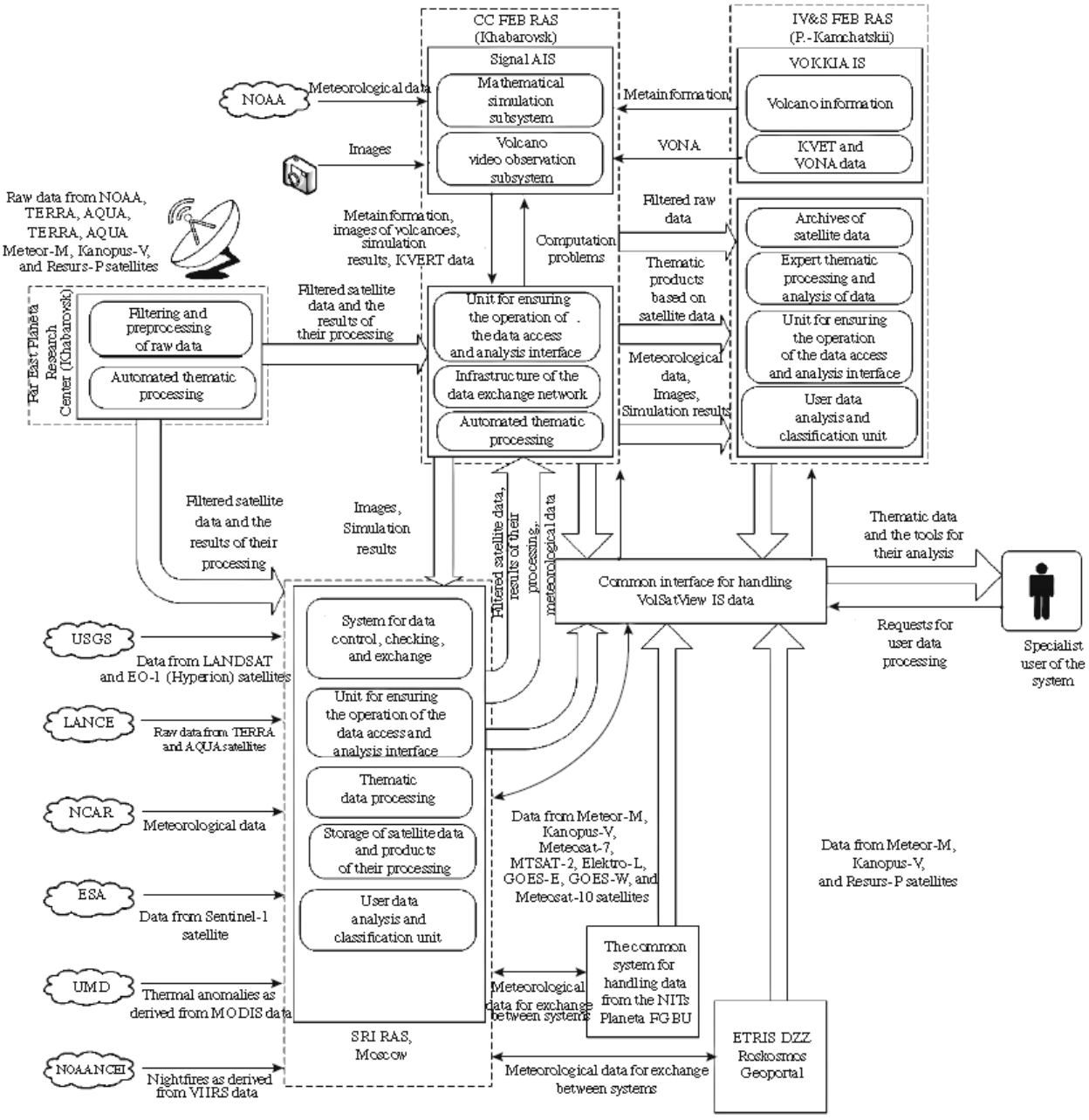

Fig. 1 VolSatView IS: architecture and data streams.

The work with significant amounts of data coming into the VolSatView IS has organize with the help of distributed computing resources of the Far East Center Planeta Research Center, the Shared Facility Center "SRI-Monitoring" (SRI RAS) (Loupian et al., 2015b) and the Data Center of the FEB RAS (CC FEB RAS).

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