One year of Kamchatka volcanoes live observation with VIIRS Nightfire

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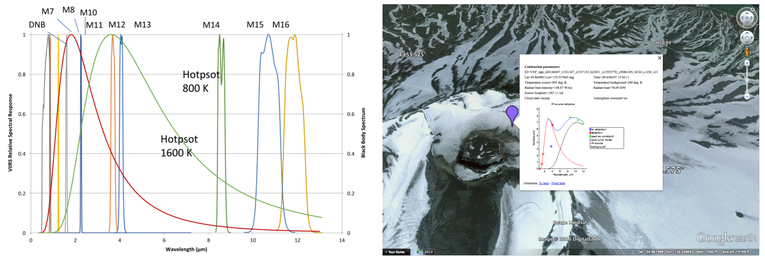
Nightfire: Subpixel Hotspot Temperature, Size and Radiant Heat

Nightfire algorithm have been developed to play along with a Suomi-NPP polar satellite multispectral radiometer VIIRS with the main goal to detect gas flares related to the upstream and downstream production of oil and natural gas at night. Simultaneously using of nighttime data in SWIR, MWIR, and LWIR sensor bands the algorithm is able to estimate the hotspot temperature, size and radiant heat. Planck curve is fit using a simplex algorithm to match the radiances with temperature and size for sum of a subpixel hot source and background.



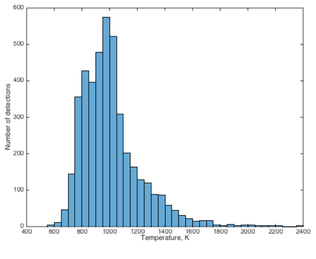
Detection of Alaid volcano eruption, Kuril islands, April 7, 2016

One Year of Near Real-time Monitoring at the Direct Receiving Station

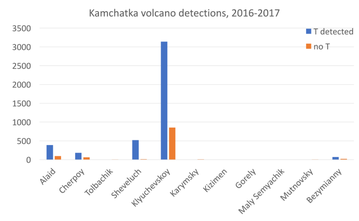
On the April of 2016 Nightifire algorithm have been deployed at IVS RAS receiving station. Within a year after installation it has withstood long power outages, satellite data processing and Nightfire software updates. Throughout the one-year run about 6 Gigabytes of processed data with more than 400000 of hotspots have been gathered.

All the data and WMS layers are freely available at:

http://geoportal.kscnet.ru/nightfire http://geoportal.kscnet.ru/viewer.php



Temperatures distribution for the years 2016-2017. (Temperatures are calculated by the brightest pixel in M10 channel)

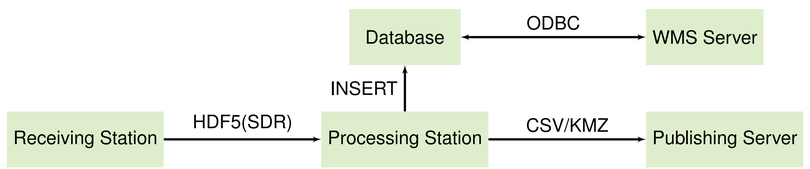


Number of detections with temperature identified and unidentified for each volcano for the years 2016-2017

Service Architecture Overview

The Nightifre service consists of Pipelinine Runner responsible for monitoring of new SDR file arrivals and the Nightfire algorithm itself with the both of them wraped around with a Docker container. The service is organized in such a way that it could be isolated from the data source directory with readonly acces, making sure all the receiving station data stays intact. The supplimentary utilities provide PostgreSQL database ingestion and WMS integration functionality. Overall processing workflow at the test station includes:

- Demultiplexing and geolocation of multispectral satellite images into HDF5 files
- Hotspot detection with Nightfire into CSV files
- Spatio-temporal database PostgreSQL ingest from the CSV files
- Presentation of the hotspot detections on a GIS map layer



Nightfire service dataflow

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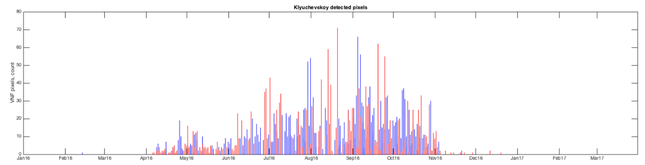
Klyuchevskoy Strombolian Eruption

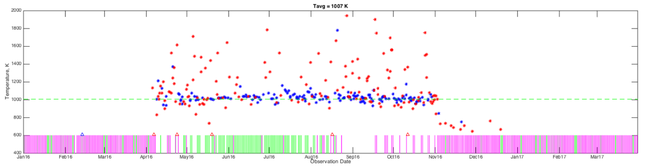
Klyuchevskoy strombolian eruption started on April the 3rd of 2016, intensive activity was observed in the crater. Between 23rd and 24th of April peritoneal part of the volcano had fractionally collapsed. Lava flows had been effused from the rupture up until November the 4th of 2016 when eruption stopped.

4 July 2016

22 September 2016

Lava flows on the slopes of Klyuchevskoy volcano

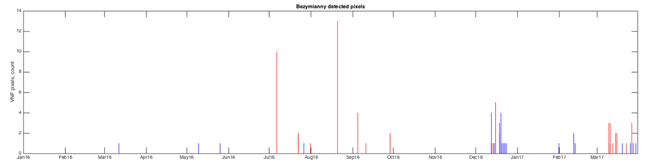


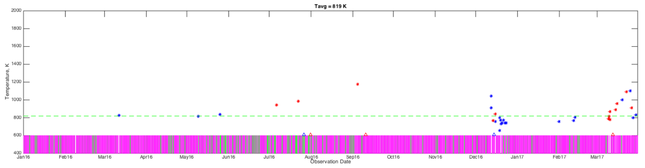


Klyuchevskoy VIIRS detections history

Bezymianny Activity

Throughout the whole 2016 year a weak thermal anomaly has been registered. In the early December it itensified seemingly because of lava extrusion.

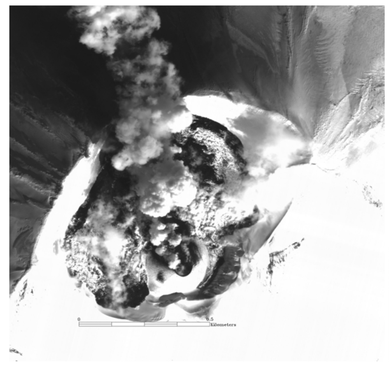




Bezymianny VIIRS detections history

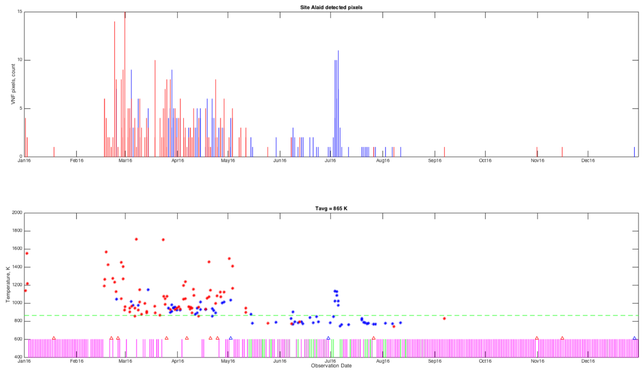
Alaid Eruption

The Alaid volcano eruption began on October 1st of 2015 and continues until August of 2016. The eruption was accompanied by explosive events and lava filling the volcano crater. By the end of the eruption, volcanos crater (about 100 meters in depth) was entirely filled with lava. On top of the lava cork had grown a cinder cone out of which moderate explosive events were coming. In the April of 2016 a short (about 300 meters in length) lava flow effused on the south-west slope.



22 March 2016 Resurs-P GEOTONE Satellite photo. The crater filled with lava cork with the cinder cone on the top, explosive discharges could be seen coming from it.

28 April 2016 Alaid crater filled with lava cork with the cinder cone grown on top of it. Lava flows by the south-west slope.



Alaid VIIRS detections history

Available for Onsight Installation

Our team is happy to announce that we are now ready to share the service with interested parties. It is delivered in the form of a Docker (x64) container suitable for deployment on various flavors of Linux and Windows. Please contact the team members for details and/or help.

Related Research

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- Elvidge, C.D.; Zhizhin, M.; Hsu, F.-C.; Baugh, K.E. VIIRS Nightfire: Satellite Pyrometry at Night. Remote Sensing, 2013, 5, 4423-4449. DOI: 10.3390/rs5094423 http://www.mdpi.com/2072-4292/5/9/4423
- Blackett, M. (2015). An initial comparison of the thermal anomaly detection products of MODIS and VIIRS in their observation of Indonesian volcanic activity. Remote Sensing of Environment, 171, 7582
- Girina O.A., Manevich A.G., Melnikov D.V., Nuzhdaev A.A., Demyanchuk Y.V. (2017) Kamchatkas and North Kuril islands volcanoes activity in 2016 by KVERT DATA, Materials of XX regional scientific conference "Volcanism and related processes", dedicated to volcanologists day, 30-31 March 2017, Petropavlovsk-Kamchatsky: IVS FEB RAS. P. 7-10.