衛星赤外画像によるリアルタイム火山観測システムの改良とラング火山2015年噴火における検討
Improvement of the realtime volcano observation system based on the satellite infrared imagery and its application to the case of the 2015 Mt Raung eruption

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We are monitoring active volcanoes in east Asia using MODIS and MTSAT images. From 2015 through 2017, Japanese new optical satellites, Himawari-8/AHI and GCOM-C/SGLI start operation, which are next generation instruments of the ones we are currently using for monitoring. We plan to replace the MODIS-based realtime thermal monitoring system to a combination system consisting of Himawari-8/AHI and GCOM-C/SGLI. Further, for more precise non-realtime analysis, we also plan to use high-resolution images, in linkage with these two realtime datasets - combined analysis. The new type of Himawari, carrying the AHI sensor, can be used for thermal analysis, because of the improved resolution to be 2km. Also, its ultra-high frequency observation, every 10 minutes, will be particularly useful for thermal analysis of eruption sequences, which can change in a short period. We recently developed a prototype of realtime monitoring system based on Himawari-8/AHI. SGLI onboard GCOM-C is a moderate resolution sensor having resolution of 250m in the 1.6um and 11um channels. The satellite is being launched at the end of 2016 by JAXA. SGLI can be applied for more precise realtime monitoring than MODIS having resolution of 1 km, such as observing enlargement process of lava flows. Here, in non-realtime analysis, high-resolution images are used for specifying topographic change or type and distribution of erupted materials relating to the on-going eruptive process, which cannot be identified by the medium to coarse resolution images. In order to examine effectiveness of the combined analysis based on the three different datasets, we analyzed the 2015 eruption of Raung, as a test case.
Mt Raung, one of the most active volcanoes in Indonesia, is located in the easternmost of Java, Indonesia and has a large conical edifice with altitude of 3320 m. It has a summit caldera of 2km in diameter approximately 300 m in depth, of which topography is similar to the of Miyakejima formed in 2000. In June, 2015, the volcano erupted and lava continued to effuse in the summit caldera from the pyroclastic cone at the center of the floor. Analysis of high-resolution images (Landsat, SPOT, WV and GE) showed that the effused lava enlarged gradually and covered the entire areas of the caldera floor by the middle of July. At the same time, the accumulated lava bed increased in thickness. The total volume of effused lava and the average effusion rate were estimated to be 5.3×10^7 m^3 and 1.1×10^6 m^3/day, respectively. We also analyzed Himawari-8/AHI images between 1st of June to 31st of August. The time series variations of thermal anomaly (1.6 um, 2.3 um, 3.9 um) showed that there were two pulses in the activity - Pulse I and II, which were divined by a low activity period at the end of July. Through examining the short term variations, we found that the eruption started at 4:30 on 20th of June (UTC) and ceased on 7th of August. Reactivation of the activity, i.e., start of Pulse II, occurred at 21:10 on 1st of August. The activity level was nearly constant through the majority of the period, which can be considered as a characteristic of the effusive eruption involving Strombolian lava fountaining. Several hours ahead of the onset of Pulse II, a small thermal pulse was observed. This can be a precursor to reactivation of the activity. In substitution for SGLI images, NPOSS/VIIRS images (resolution 380m) were analyzed to observe enlargement process of the lava bed on the caldera floor. We could recognize increase in the size of high-temperature areas at the summit on the 11 um images of VIIRS in the period from

late June to early July. This is probably showing enlargement of the lava bed on the caldera floor. This result suggests that we can monitor detailed eruptive phenomena by using SGLI images in realtime. Also, the combined analysis proposed here is considered as a useful method for exploring eruption sequence.

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