Volcanic Precursors Retrieval By The Synergy Of Space-Borne Sensors And Ground Instrumentations

Mohd Nadzri Md Reba* and Amirul Zamani Rosli

Institute of Geospatial Science and Technology (INSTeG),
Universiti Teknologi Malaysia, 81310 Johor Bahru, Johor, MALAYSIA
Phone: +607-5530760, Email: nadzri@utm.my
**Corresponding author*

Abstract: The 400-year long dormant Mount Sinabong, Sumatra, Indonesia finally exhibited massive eruption after several days of rumbling and ejected powerful bursts. It was reported that the eruption has affected a total economic loss of about USD 4 millions and interrupted few air traffics and airport operations for several days. It is therefore critical to monitor evolution of the eruption and by determining precursory parameters would help one to predict the distribution of volcanic clouds so as to minimize the total hazardous impact. Basically, volcano shows some pre-eruptive indications prior to the summit in which continuous emission of ash and small plumes is evident. Remote sensing demonstrates great advantages to synoptically measure the volcanic ash and small plumes based on their optical, chemical and physical properties. Ground instrumentation provides continuous and actual measurement of all properties at local scale. Space-based sensors onboard the A-train satellites; Ozone Monitoring Instrument (OMI), Moderate Resolution Imaging Spectroradiometer (MODIS) and Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO), are used to collect high-resolution three-dimensional images of volcanic tracers. This paper highlights advantages of the synergy between space-based sensors and ground instrumentations to determine the optical, chemical and physical properties of Mount Sinabung precursory evident based on measurements taken in Peninsular Malaysia. Aerosol optical thickness (AOD), attenuated backscatter and extinction are the optical properties while the physical properties are particulate matter of 10 (PM10). Chemical properties estimates are sulphur dioxide (SO2) and nitrogen dioxide (NO2). Ground measurement retrieves most of the variants from 50 distributed meteorological stations in respect to the time of A-train satellites overpass. MODIS and CALIPSO measure the optical and physical properties while OMI observes the chemical one. Linear optimization is applied by defining the mean square error between ground and remote sensing measurements at certain statistical error thresholds (e.g., 1-sigma, 2-sigma and 3-sigma of Gaussian distribution). This paper aims to estimate optical, physical and chemical properties as the volcanic precursors from the synergy of both instruments by using the linear approximation error. This paper also highlights the major challenge which is to correlate the satellite-footprint measurement (MODIS and OMI) with the point-based ground measurement and addresses the point-spread function (PSF) approximation as a solution. There is a good agreement between satellite and in-situ measurements particularly for satellite data with less cloud cover, low anthropogenic effects and high data availability. This study found that series of provisional ash trajectories and plume movements towards the western Peninsular Malaysia are present. This paper ultimately demonstrates the significance of collaboration between ground- and space-based measurements to map volcanic precursory parameters which would improve early warning system practicalibility.

Keywords: Volcano, Optical, Chemical, Physical, Mount Sinabong