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Surface Temperature Monitoring by Satellite Thermal Infrared Imagery at Mayon Volcano of Philippines, 1988-2019

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Mayon Volcano on eastern Luzon Island is the most active volcano in the Philippines. It is named and renowned as the "perfect cone" for the symmetric conical shape and has recorded eruptions over 50 times in the past 500 years. Geographically the volcano is surrounded by the eight cities and municipalities with 1 million inhabitants. Currently, its activity is daily monitored by on-site observations such as seismometers installed on Mayon's slopes, plus, electronic distance meters (EDMs), precise leveling benchmarks, and portable fly spectrometers. Compared to existing direct on-site measurements, satellite remote sensing is currently assuming an essential role in understanding the whole picture of volcanic processes. The vulnerability to volcanic hazards is high for Mayon given that it is located in an area of high population density on Luzon Island. However, the satellite remote sensing method and dataset have not been integrated into Mayon's hazard mapping and monitoring system, despite abundant open-access satellite dataset archives. Here, we perform multiscale and multitemporal monitoring based on the analysis of a nineteen-year Land Surface Temperature (LST) time series derived from satellite-retrieved thermal infrared imagery. Both Landsat thermal imagery (with 30-meter spatial resolution) and MODIS (Moderate Resolution Imaging Spectroradiometer) LST products (with 1-kilometer spatial resolution) are used for the analysis. The Ensemble Empirical Mode Decomposition (EEMD) is applied as the decomposition tool to decompose oscillatory components of various timescales within the LST time series. The physical interpretation of decomposed LST components at various periods are explored and compared with Mayon's eruption records. Results show that annual-period components of LST tend to lose their regularity following an eruption, and amplitudes of short-period LST components are very responsive to the eruption events. The satellite remote sensing approach provides more insights at larger spatial and temporal scales on this renowned active volcano. This study not only presents the advantages and effectiveness of satellite remote sensing on volcanic monitoring but also provides valuable surface information for exploring the subsurface volcanic structures in Mayon.