S42-08

A census of deep volcanic eruptions in the tropics as observed by Himawari-8

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Volcanic eruptions are significant aviation hazards due to the formation of airborne volcanic ash clouds. Particularly important are eruptions that reach the upper troposphere and stratosphere where ash may be spread more broadly. Climate impacts on longer time frames may appear in more intense eruptions. Satellite platforms in geostationary orbit are a key resource in the detection and monitoring of these events. However, due to the morphology of these clouds many of the traditional methods for detecting volcanic ash, such as the split window brightness temperature difference (BTD), may not return the expected signals and inhibit detectability. Imagers onboard modern geostationary satellite platforms, such as the 16-channel Advanced Himawari Imager, particularly when combined into RGB composite imagery, provide the means to better monitor, and understand these complex clouds and their impacts on the environment.

This work examines the characteristics of multiple deep eruptions in the tropics, defined here as those that interact with the tropical tropopause layer that begins around 14 km altitude. Approximately 20 eruptions in the Himawari-8 field of view that meet this criterion are examined with multiple combinations of satellite imagery, including the Volcanic Ash RGB, the sulphur dioxide (SO_2) RGB, 'True Colour' visible RGB, and standard IR images. Particularly important is the 10.4-12.4 μm BTD, which generally shows a very strong positive signature associated with small ash/ice crystals that dominate these eruptions. The evolution of these systems is examined on a half-hourly basis using the Himawari-8 data. The large number of eruptions studied gives a broad sample that allows for a generalization of the common properties of these systems, their composition, and their evolution. Properties examined include the growth rate and its relationship with the height of the volcanic plume, the evolution of the cloud microphysics and SO_2 signature, and the use of lightning as an indicator of volcanic activity. These analyses provide insight that can be used operationally to improve the diagnosis and detection of these volcanic clouds, provide a basis for better dispersion model initialization, interpretation, and verification of model results, and yield insight into understanding any climate response that may occur.