Geophysical Research Abstracts
Vol. 21, EGU2019-6460, 2019
EGU General Assembly 2019

Remote Sensing of Anak Krakatau's Convective Eruption Clouds

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In late December 2018 and early January 2019 Anak Krakatau, in the Sunda straits, Indonesia, underwent a series of explosive eruptions that sent ash and gases high into the atmosphere. The eruptions produced only small amounts of SO_2 gas (<0.03 Tg) and ash but generated an almost continuous convective cloud that was observed by a variety of earth orbiting sensors for ∼5 days. Using high-temporal Himawari-8 retrievals we show that the eruption generated a large plume of SO_2 gas streaming south-westwards at altitudes in excess of 15 km. Stereoscopic SLTSR data are used to determine the height of the high clouds and indicates that these reached the tropopause and possibly the lower stratosphere. We show that there was copious production of ice in the convective cloud and compare the ice signature with non-volcanic convective clouds in the same region. Anak Krakatau's phreatomagmatic eruption sustained a convective column to great heights (15–20 km) using CAPE generated by the vertically integrated buoyancy provided by the temperature differential between the eruptive column and its environment, and energy available through latent heat of condensation. Remote sensing data from the high-resolution Sentinel-2 imager are used to investigate ice microphysics, data from the near real-time SACS system are used to provide a time-series of eruptive events, data from moderate resolution imagers (MODIS/SLSTR/OCLI/Himawari-8) are used to study convective cloud evolution and perform geophysical retrievals. Our study shows the utility of high temporal resolution satellite data for studying energetic convective events. It is the first to combine high-resolution spatial and temporal data, with stereoscopic height estimation (±0.5 km) and moderate resolution retrievals to provide insights into volcanogenic convective cloud microphysics and thermodynamics.