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Combining multi-sensor infrared satellite and laboratory measurements to estimate the lava discharge rate of 2018 Kilauea Volcano, Hawai'i eruption

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Kīlauea Volcano, Hawai'i, is one of the world's most active volcanoes. From 1983 to 2018 the magmatic system was in near continuous eruptions. This eruption ended on 30 April 2018 when the deflation of Kīlauea caldera began and a dike intrusion from the Middle East Rift Zone of Kīlauea Volcano downrift towards the Lower East Rift Zone (LERZ) was observed in seismic data. On 3 May 2018, the first of final 24 eruptive fissures opened at the LERZ. This was the beginning of the largest effusive event of the last two centuries at the LERZ. Here, we present Time-Averaged Discharge Rate (TADR) and lava eruption volume estimations based on a joint analysis of multi-sensor infrared (IR) Visible Infrared Imaging Radiometer Suite (VIIRS) and Moderate Resolution Imaging Spectroradiometer (MODIS) satellite Earth observation data together with laboratory viscosity measurements to investigate this large eruption event at the LERZ. First, the TADR measurements were performed independently for each sensor data to cross-check the results against each other. Second, a joint timeseries of the VIIRS and MODIS TADR estimates was created to obtain more frequent measurements. This joint analysis of VIIRS and MODIS data resulted in an erupted lava volume of 0.924 ± 0.462 km³. Independent measurements based on airborne Synthetic Aperture Radar Interferometry (InSAR) and LIDAR topography changes are within the range of the IR data-based estimates of the erupted lava volume. The 2018 LERZ eruption could be differentiated into four main phases based on major element compositions of the eruptive products. The VIIRS and MODIS-based TADR estimation showed a relatively low Mean Output Rate (MOR) of 2.82 ± 1.41 m³/s during early Phase I. MOR then almost doubled to 4.94 ± 2.47 m³/s in late Phase I. A strong increase of MOR to 64.97 ± 32.48 m³/s occurred during Phase II. In Phase III, MOR again doubled to 137.67 ± 68.83 m³/s. This strong increase of the MOR during the different phases of the 2018 LERZ eruption agrees well with the evolution of the lava from low-temperature, highly differentiated sluggish 'a'ā lava flows in the beginning to high-temperature mafic more fluid pāhoehoe lava from Phase II onwards, as observed in the field by the USGS.