Measuring Volcanic Eruption Dynamics with WAMS, a Millimeter-wave Radar and Imager

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Abstract—Millimeter-wave remote sensing technology can significantly improve measurements of volcanic eruptions. Forecasts of drifting volcanic ash for aviation safety would improve with direct measurements of high-altitude volcanic ash, and with better understanding of internal eruption processes. Here we present an update on the development of the WAMS (Water and Ash Millimeter-wave Spectrometer) instrument, a radar/radiometer system to measure water vapor and ash throughout an entire eruption cloud. The radiometer system will measure millimeter-wave water lines (24 GHz, 183 GHz, 220 GHz) to image the water vapor density and temperature inside eruption clouds, improving on existing measurements with infrared cameras that are limited to measuring the outer cloud surface. The radar system will measure the 3D mass distribution of volcanic ash inside eruption plumes and their nearby drifting ash clouds. The wavelength of the 220 GHz radar is optimized to be well matched to typical ash particle sizes, offering better sensitivity than longer wavelength existing weather radar measurements. This proposed mm-wave system would acquire data that no existing instruments can obtain: direct imaging of water vapor path integrated concentration, corresponding water vapor temperature, and 3D radar mapping of ash concentration. The system is built with off the shelf components, except for some millimeter-wave components our team commonly builds for radio astronomy applications.