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Using Effusive Volcanic Eruptions to Constrain Aerosol-Cloud-Climate and Precipitation Interactions: The case for in-situ observations

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Aerosol cloud interaction (ACI) from anthropogenic emissions of sulfur are the most significant uncertainty in global climate forcing. Effusive volcanoes are a large natural source of sulfur, that can be used as a natural laboratory to study aerosol cloud interactions. Here we show examples of constrained model and observational comparisons using Kilauea Volcano in Hawaii and the 2014-5 Holuhraun Eruption in Iceland. Kilauea in particular is a uniquely isolated major source of sulfur emissions into an otherwise pristine marine boundary layer, and is thus a unique natural laboratory to study the evolution of sulfur emissions, and the effects of sulfur emissions on clouds. Previous studies have focused on satellite observations to observe changes in cloud drop number and even depth of clouds. Here we illustrate with observation simulation experiments how proposed in-situ observations of aerosols and cloud microphysics could help constrain fundamental aerosol-cloud interaction processes that have eluded previous aircraft campaigns and a plethora of satellite analyses.