A-Train satellite observations of young volcanic eruption clouds

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NASA's A-Train satellite constellation (including the Aqua, CloudSat, CALIPSO, and Aura satellites) has been flying in formation since 2006, providing unprecedented synergistic observations of numerous volcanic eruption clouds in various stages of development. Measurements made by A-Train sensors include total column SO_2 by the ultraviolet (UV) Ozone Monitoring Instrument (OMI) on Aura, upper tropospheric and stratospheric (UTLS) SO_2 column by the Atmospheric Infrared Sounder (AIRS) on Aqua and Microwave Limb Sounder (MLS) on Aura, ash mass loading from AIRS and the Moderate resolution Imaging Spectroradiometer (MODIS) on Aqua, UTLS HCl columns and ice water content (IWC) from MLS, aerosol vertical profiles from the Cloud-Aerosol Lidar with Orthogonal Polarization (CALIOP) instrument aboard CALIPSO, and hydrometeor profiles from the Cloud Profiling Radar (CPR) on CloudSat. The active vertical profiling capability of CALIPSO, CloudSat and MLS sychronized with synoptic passive sensing of trace gases and aerosols by OMI, AIRS and MODIS provides a unique perspective on the structure and composition of volcanic clouds. A-Train observations during the first hours of atmospheric residence are particularly valuable, since in-situ sampling of fresh eruption clouds is highly challenging, and yet the fallout, segregation and stratification of material in this period determines the concentration and altitude of constituents that remain to be advected downwind. This represents the eruption 'source term' essential for dispersion modeling, and hence for aviation hazard mitigation. In this presentation we focus on A-Train data collected during eruptions of Redoubt (March 2009), Eyjafjallajökull (April 2010) and Grimsvötn (May 2011), supplemented with high-temporal resolution SEVIRI measurements of ash mass loading in the Eyjafjallajökull plume. The A-Train data provide unique evidence for ash aggregation or hydrometeor-enhanced ash loss in the Redoubt and Eyjafjalljökull plumes, perhaps enhanced by the prevailing meteorological conditions in the latter case. We also present results from a UV ash retrieval algorithm that provides new constraints on ash mass loading in volcanic plumes, to complement commonly used IR retrieval techniques. Although of limited operational use due to data latency issues, the A-Train observations provide unique insights into the complex evolution of volcanic plumes after eruption.