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A-Train Satellite Observations of Recent Explosive Eruptions in Iceland and Chile

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The past few years have seen remarkable levels of explosive volcanic activity in Iceland and Chile, with four significant eruptions at Chaitén (May 2008), Eyjafjallajökull (April 2010), Grimsvötn (May 2011) and Cordón Caulle (June 2011 - ongoing). The tremendous disruption and economic impact of the Eyjafjallajökull eruption is well known, but each of these events had a significant impact on aviation, sometimes at great distances from the volcano. As of late 2011, volcanic ash from Cordón Caulle was still affecting airports in southern South America, highlighting the potential for extended disruption during long-lived eruptions. Serendipitously, this period of elevated volcanic activity has coincided with an era of unprecedented availability of satellite remote sensing data pertinent to volcanic cloud studies. In particular, NASA's A-Train satellite constellation (including the Aqua, CloudSat, CALIPSO, and Aura satellites) has been flying in formation since 2006, providing synergistic, multi- and hyper-spectral, passive and active observations. Measurements made by A-Train sensors include total column sulfur dioxide (SO_2) by the 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, as 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 ash dispersion modeling, and hence for aviation hazard mitigation. In this presentation we show how A-Train data have improved our understanding of the composition, structure and dynamics of volcanic eruption clouds, using examples from the recent Icelandic and Chilean eruptions. These events span a range of compositions and eruptive styles, including highly silicic, SO_2-poor eruptions (Chaitén and Cordón Caulle), magma-ice interaction (Eyjafjallajökull and Grimsvötn), stratospheric eruption columns (Chaitén, Grimsvötn), and persistent, weak tropospheric plumes (Eyjafjallajökull). In each case, satellite remote sensing played a crucial role in characterizing the eruption, monitoring variations in intensity and tracking the dispersion of volcanic cloud constituents. We also describe plans for advanced SO_2 and ash retrieval algorithms that will exploit the synergy between UV and IR sensors in the A-Train for improved quantification of ash and SO_2 loading by volcanic eruptions.