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Satellite observations of lightning-generated NOx in volcanic eruption clouds

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The generation of NO2 by lightning flashes is known to be an important source of NOx in the free troposphere, particularly in the tropics. Although UV-visible satellite observations of lightning-generated NOx (LNOx) in thunderstorms have been previously reported, here we present the first satellite observations of LNOx generated by lightning in volcanic eruption clouds (vLNOx) from the Ozone Monitoring Instrument (OMI) aboard NASA's Aura satellite. To date we have identified vLNOx in operational OMI NO2 measurements (OMNO2) during the high-latitude eruptions of Okmok (Aleutian Is; July 2008), Kasatochi (Aleutian Is; August 2008), Redoubt (Alaska; March 2009) and Grimsvötn (Iceland; May 2011). We have also detected vLNOx associated with eruptions of Ol Doinyo Lengai (Tanzania) in March 2008, which is significant as this volcano produces little SO2 and hence its eruption clouds are otherwise difficult to detect. We use World Wide Lightning Location Network (WWLLN) observations to verify the occurrence of lightning flashes in the volcanic eruption clouds, and a specialized algorithm to calculate accurate vertical columns of LNOx. All the vLNOx anomalies are associated with strong UV Aerosol Index (UVAI) signals due to volcanic ash. Preliminary analysis shows that the maximum vLNOx column detected by OMI decreases linearly with time since eruption, and suggests that the vLNOx signal is transient and can be detected up to ~5-6 hours after an eruption. Detection of vLNOx is hence only possible for eruptions occurring a few hours before the daytime OMI overpass. The observation of vLNOx in volcanic clouds is significant since it implies active convection and plume electrification close to the satellite overpass time, with implications for aviation hazards due to volcanic ash. Although vLNOx is undoubtedly a very minor fraction of global LNOx production, explosive volcanic eruptions may inject NOx into the stratosphere where it has implications for ozone chemistry.