



Global volcanic aerosol properties derived from emissions, 1990-2015, using CESM1(WACCM)

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Accurate representation of global stratospheric aerosols from volcanic and non-volcanic sulfur emissions is key to understanding the cooling effects and ozone-losses that may be linked to volcanic activity. Attribution of climate variability to volcanic activity is of particular interest in relation to the post-2000 slowing in the rate of global average temperature increases. We have compiled a database of volcanic SO₂ emissions and plume altitudes for eruptions from 1990 to 2015, and developed a new prognostic capability for simulating stratospheric sulfate aerosols in the Community Earth System Model (CESM). We combined these with other non-volcanic emissions of sulfur sources to reconstruct global aerosol properties from 1990 to 2015.

Our calculations show remarkable agreement with ground-based lidar observations of stratospheric aerosol optical depth (SAOD), and with in situ measurements of stratospheric aerosol surface area density (SAD). These properties are key parameters in calculating the radiative and chemical effects of stratospheric aerosols. Our SAOD calculations represent a clear improvement over available satellite-based analyses, which generally ignore aerosol extinction below 15 km, a region that can contain the vast majority of stratospheric aerosol extinction at mid- and high-latitudes. Our SAD calculations greatly improve on that provided for the Chemistry-Climate Model Initiative, which misses about 60% of the SAD measured in situ on average during both volcanically active and volcanically quiescent periods.

The stark differences in SAOD and SAD compared to other data sets will have significant effects on calculations of the radiative forcing of climate and global stratospheric chemistry over the period 2005-2015. In light of these results, the impact of volcanic aerosols in reducing the rate of global average temperature increases since the year 2000 should be revisited. We have made our calculated aerosol properties from January 1990 to November 2015 available for public download.