

Recent Anthropogenic Increases in Sulfur Dioxide from Asia Have Minimal Impact on Stratospheric Aerosol

R.R. Neely III¹, O.B. Toon², S. Solomon³, J.P. Vernier⁴, C. Alvarez⁵, J.M. English⁶, K.H. Rosenlof⁷, M.J. Mills⁶, C.G. Bardeen⁶, J.S. Daniel⁷ and J.P. Thayer²

¹National Center for Atmospheric Research, Atmospheric Chemistry Division, Boulder, CO 80307; 336-302-4244, E-mail: rneely@ucar.edu

²University of Colorado, Department of Aerospace Engineering Sciences, Boulder, CO 80305

³Massachusetts Institute of Technology, Department of Earth, Atmospheric and Planetary Sciences, Cambridge, MA 02139

⁴NASA Langley Research Center, Hampton, VA 23681

⁵Cooperative Institute for Research in Environmental Sciences, University of Colorado, Boulder, CO 80309

⁶Earth System Research Laboratory, National Center for Atmospheric Research, Boulder, CO 80305

⁷NOAA Earth System Research Laboratory, Boulder, CO 80305

Observations suggest that the optical depth of the stratospheric aerosol layer between 20 and 30 km has increased 4–10% per year since 2000, which is significant for Earth's climate. Contributions to this increase both from moderate volcanic eruptions and from enhanced coal burning in Asia have been suggested. Current observations are insufficient to attribute the contribution of the different sources. Here we use a global climate model coupled to an aerosol microphysical model to partition the contribution of each. We employ model runs that include the increases in anthropogenic sulfur dioxide (SO₂) over Asia and the moderate volcanic explosive injections of SO₂ observed from 2000 to 2010. Comparison of the model results to observations reveals that moderate volcanic eruptions, rather than anthropogenic influences, are the primary source of the observed increases in stratospheric aerosol.

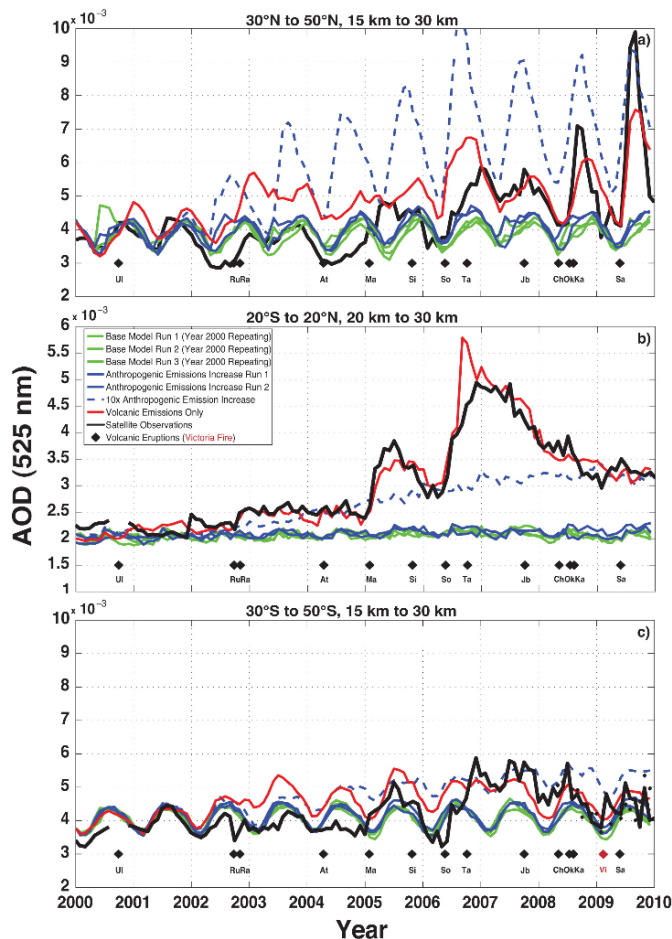


Figure 1. Observed and modeled time series of stratospheric Aerosol Optical Depth (AOD) from three latitude bands. Monthly averaged AOD at 525 nm from a) 30°N to 50°N integrated from 15 km to 30 km, b) 20°S to 20°N integrated from 20 km to 30 km, c) 30°S to 50°S integrated from 15 km to 30 km from satellite observations (black line) from SAGE II (2000 to Aug 2005), GOMOS (Mar 2002 onward) and CALIOP (Apr 2006 onward) and the simulation results. Base-line model runs are in green. Model runs with the increase in anthropogenic emissions from China and India are in blue. The dashed blue line depicts a model run with 10x the actual increase in anthropogenic emissions. The model run with volcanic emissions is in red. The black diamonds and initials along the bottom of the plot represent the volcanic eruptions that were included in the model run. Panel c) also denotes the Victoria Fire in red.