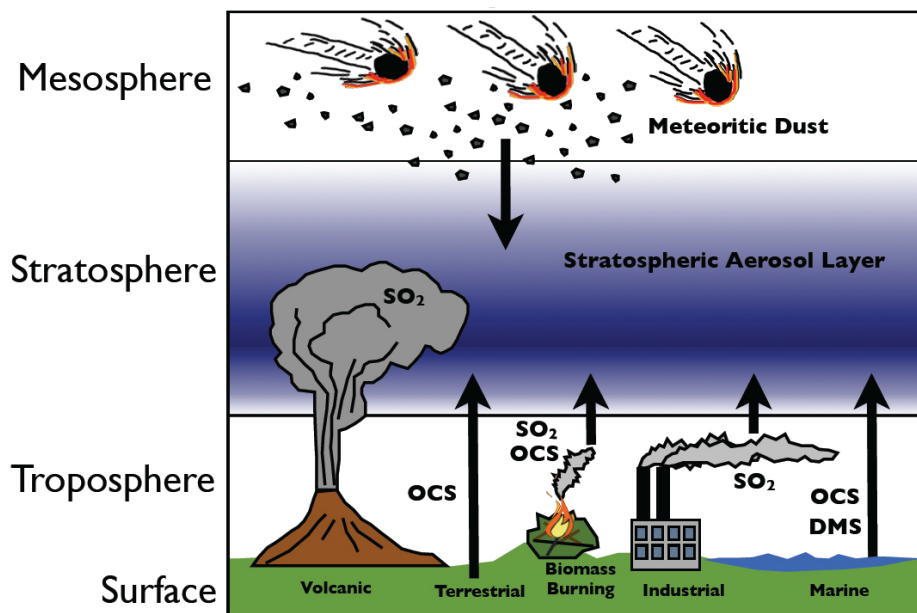


- Aerosols in the stratosphere are chemically and radiatively important for climate.
- Significant short term and long term variability has been observed, resulting in observed changes in surface temperature and stratospheric ozone.



CSD research has examined

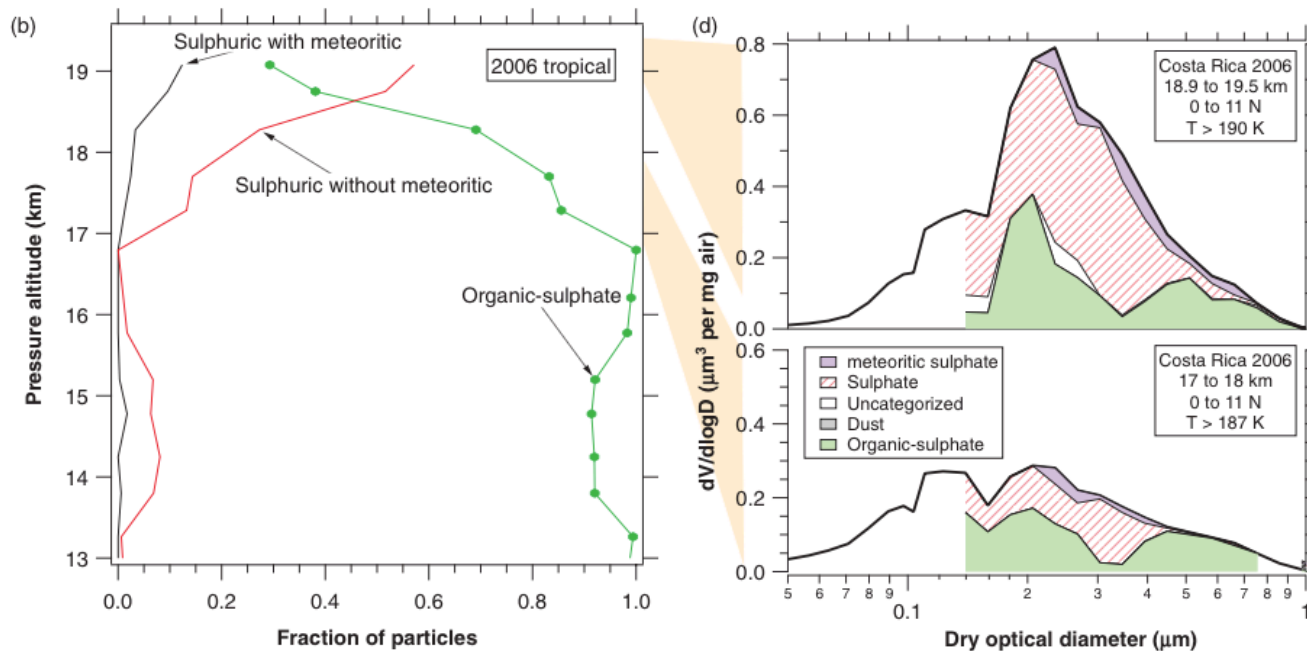
- Aerosol compositions and sources
- Anthropogenic impact on stratospheric aerosol trends
- Radiative forcing due to stratospheric aerosols

Stratospheric Aerosol Composition

Observations of the chemical composition of stratospheric aerosol particles

D. M. Murphy,^{a*} K. D. Froyd,^{a,b} J. P. Schwarz^{a,b} and J. C. Wilson^c

Q.J.R.M.S. 2014, DOI: 10.1002/qj2213



➤ Measurements using the PALMS instrument provide the most complete chemical speciation of lower stratospheric aerosols to date.

Composition and Source? **Primarily Sulfate Formed in the Stratosphere**

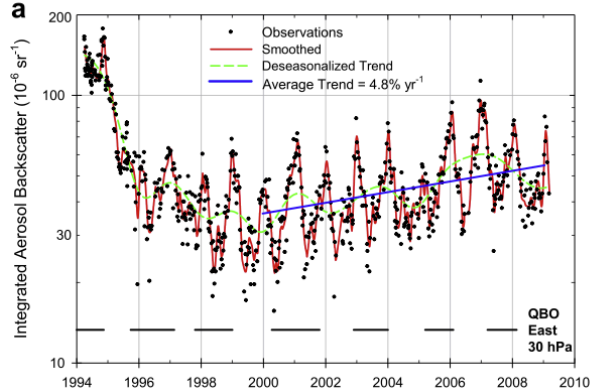
Stratospheric Aerosol Variability

Increase in background stratospheric aerosol observed with lidar at Mauna Loa Observatory and Boulder, Colorado

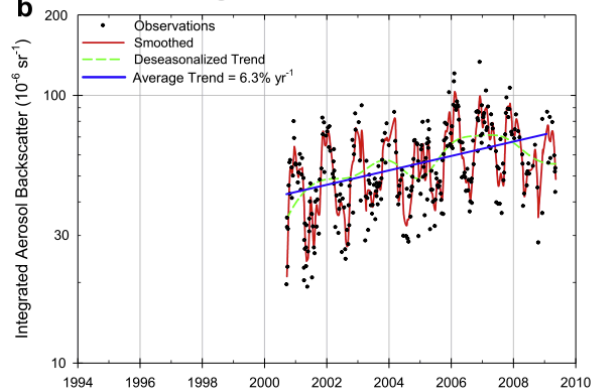
David Hofmann,^{1,2} John Barnes,^{1,3} Michael O'Neill,^{1,2} Michael Trudeau,^{1,2} and Ryan Neely^{1,2}

Geophys. Res. Lett. 2009

Mauna Loa Observatory Integrated Lidar backscatter 20-25 km



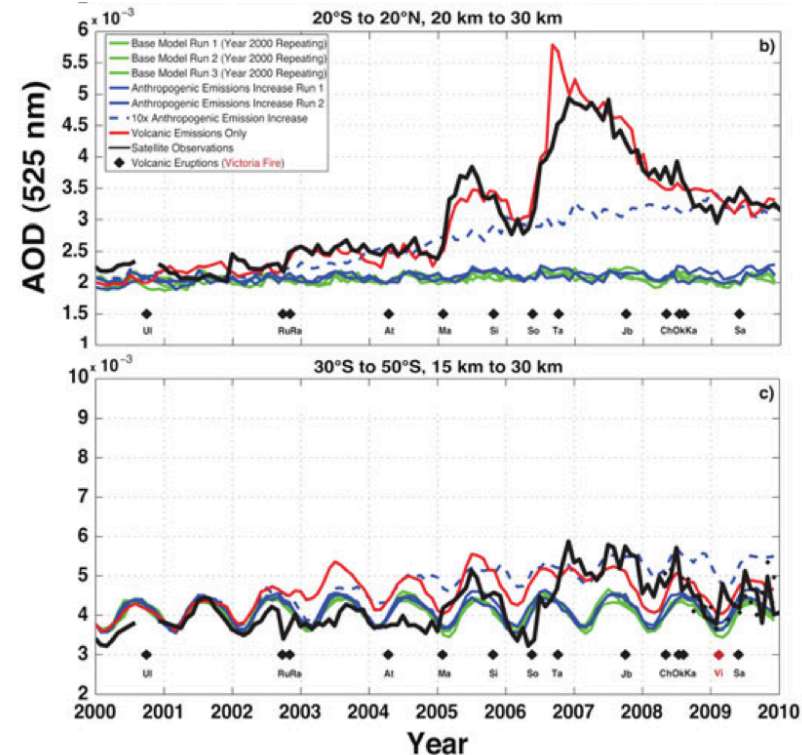
Boulder Integrated Lidar Backscatter 20-25 km



Recent anthropogenic increases in SO₂ from Asia have minimal impact on stratospheric aerosol

R. R. Neely III,^{1,2,3} O. B. Toon,^{1,4} S. Solomon,⁵ J.-P. Vernier,^{6,7} C. Alvarez,^{2,3} J. M. English,⁸ K. H. Rosenlof,² M. J. Mills,⁸ C. G. Bardeen,⁸ J. S. Daniel,² and J. P. Thayer⁹

Geophys. Res. Lett. 2013



➤ Aerosol microphysical/GCM modeling demonstrated that trends in stratospheric aerosol can be mostly explained by small volcanic eruptions.

Anthropogenic? **Not The Primary Factor**

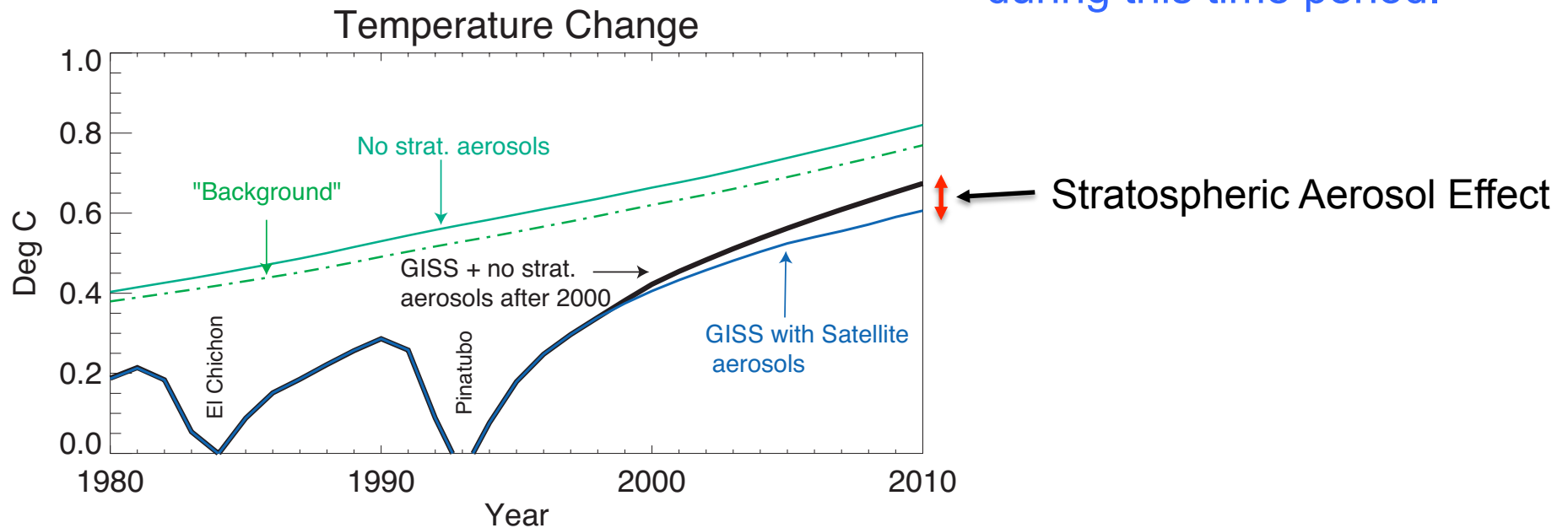
Stratospheric Aerosol Radiative Forcing

The Persistently Variable "Background" Stratospheric Aerosol Layer and Global Climate Change

S. Solomon,^{1,2*} J. S. Daniel,¹ R. R. Neely III,^{1,2,5,6} J.-P. Vernier,^{3,4} E. G. Dutton,⁵ L. W. Thomason³

Science 2011

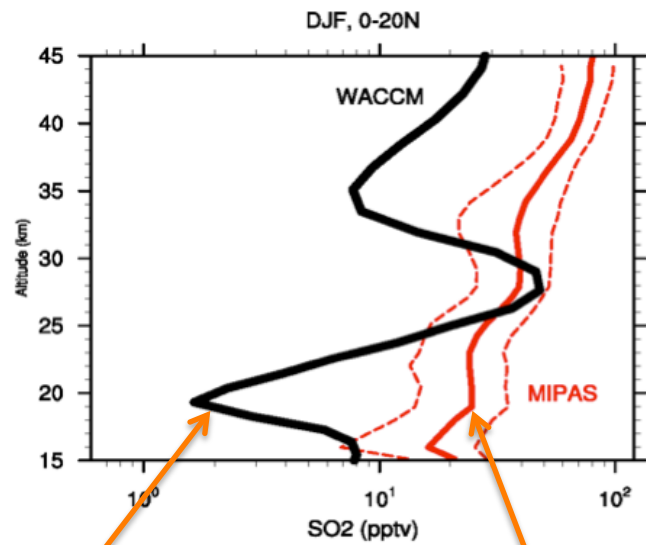
- Climate modeling showed that increases in stratospheric aerosol from 2000 counteract ~ 25% of the warming from CO₂ during this time period.



Aerosol Contribution to 2000 – 2010 Global Warming Hiatus?

~**25% effect**

Ongoing Stratospheric Aerosol and SO₂ Research



Model

Satellite Measurement

Open issues that would benefit from in-situ measurements:

- Chemistry and microphysics of stratospheric sulfur cycling
- Spatial distribution of volcanic SO₂
- Aerosol size distribution as a function of SO₂ input

Answers needed to evaluate climate intervention strategies.

➤ Current CSD development of new in-situ laser induced fluorescence sensor for < 10 ppt SO₂. Field test planned for fall 2015.

