Recent anthropogenic increases in SO_2 from Asia have minimal impact on stratospheric aerosol

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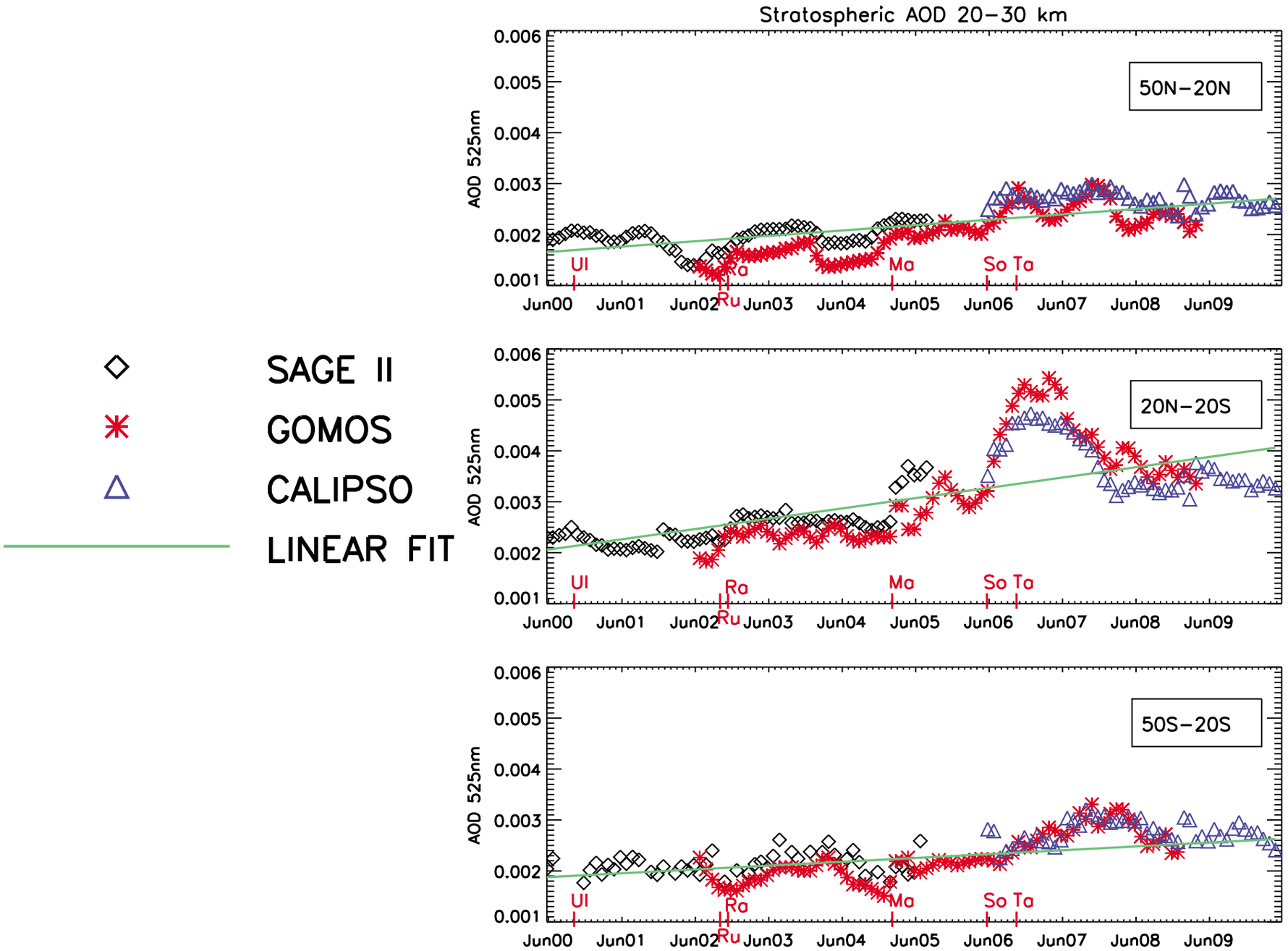
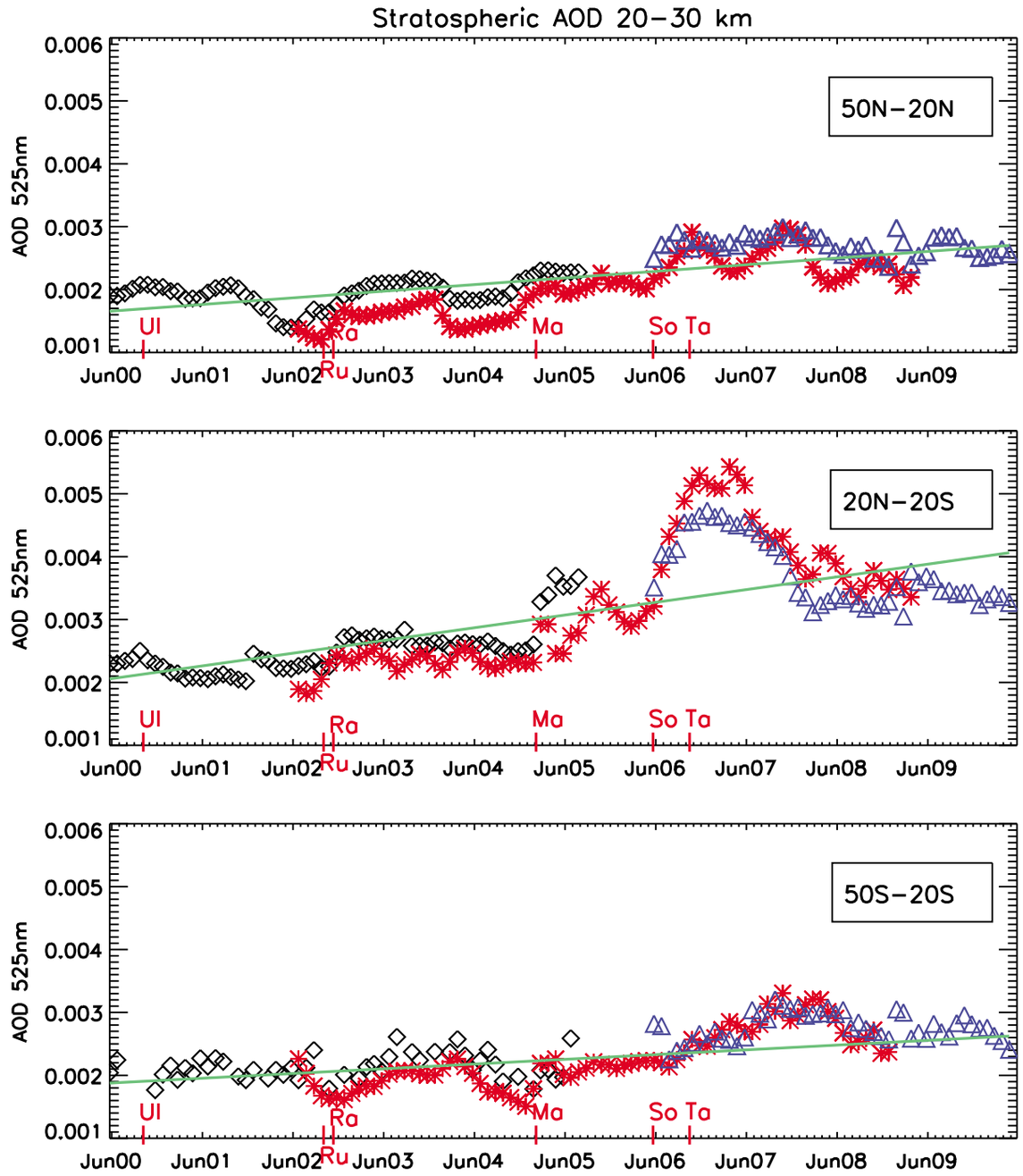
Adapted from Neely, R. R., III et al. (2013), Recent anthropogenic increases in SO_2 from Asia have minimal impact on stratospheric aerosol, Geophys. Res. Lett, doi:10.1002/grl.50263.

Variability In Global Stratospheric Aerosol



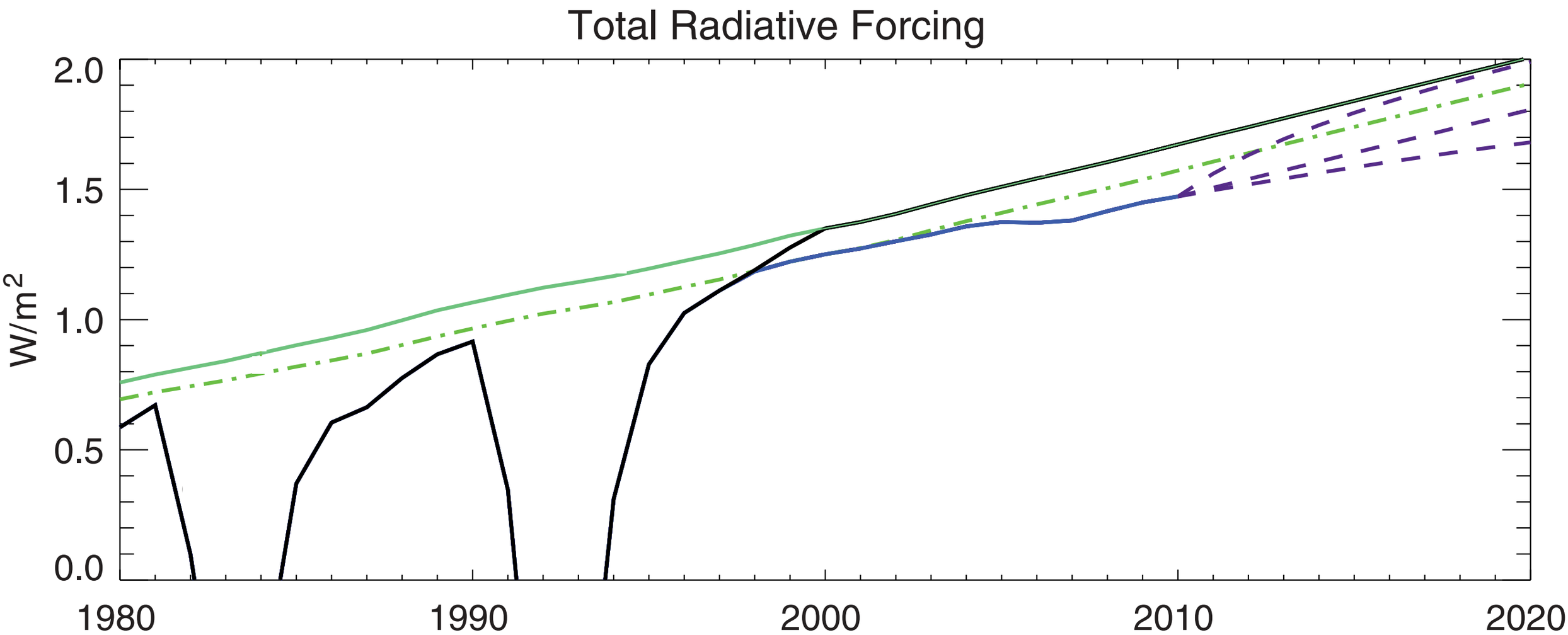
Adapted from Vernier, J. P. et al. Major influence of tropical volcanic eruptions on the stratospheric aerosol layer during the last decade. Geophys. Res. Lett 38, L12807– (2011).

Does it matter? What is causing it?



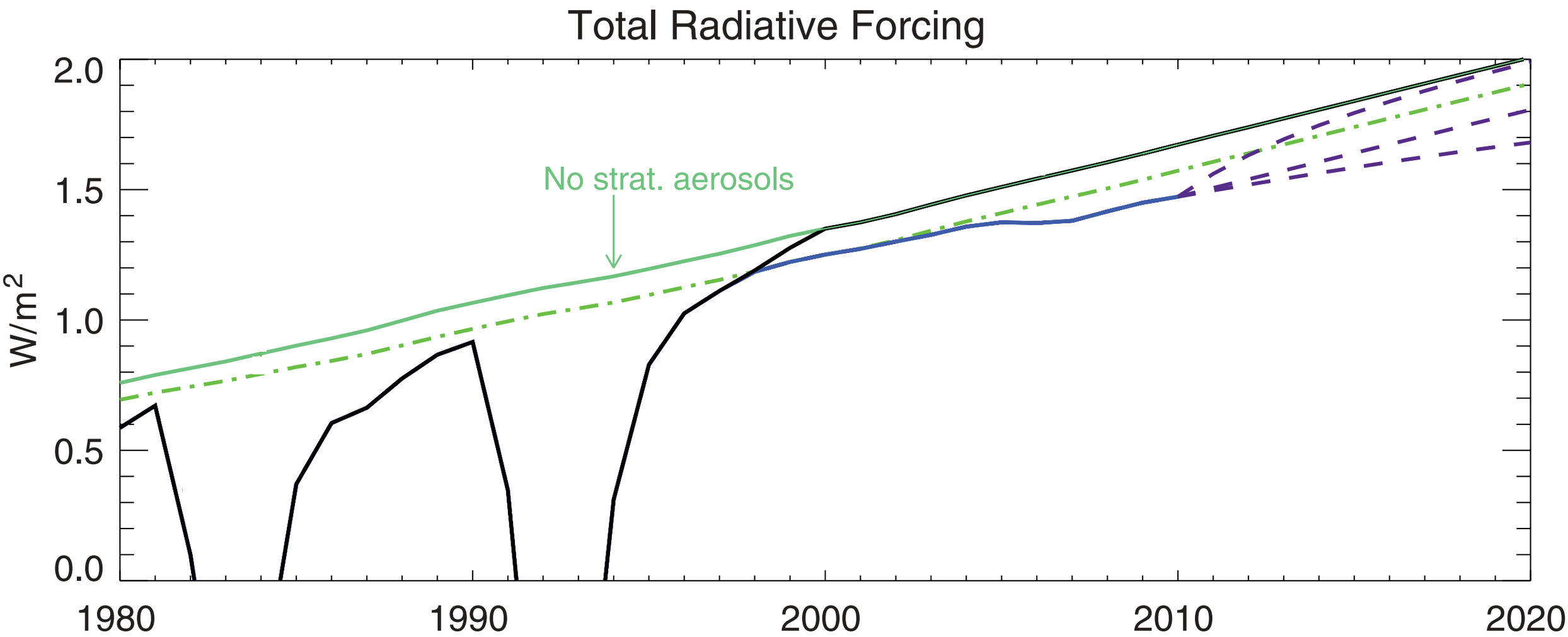
Adapted from Vernier, J. P. et al. Major influence of tropical volcanic eruptions on the stratospheric aerosol layer during the last decade. Geophys. Res. Lett 38, L12807– (2011).

Do small changes in stratospheric aerosol impact climate?



Adapted from Solomon et al. (2011), The Persistently Variable “Background” Stratospheric Aerosol Layer and Global Climate Change, *Science*.

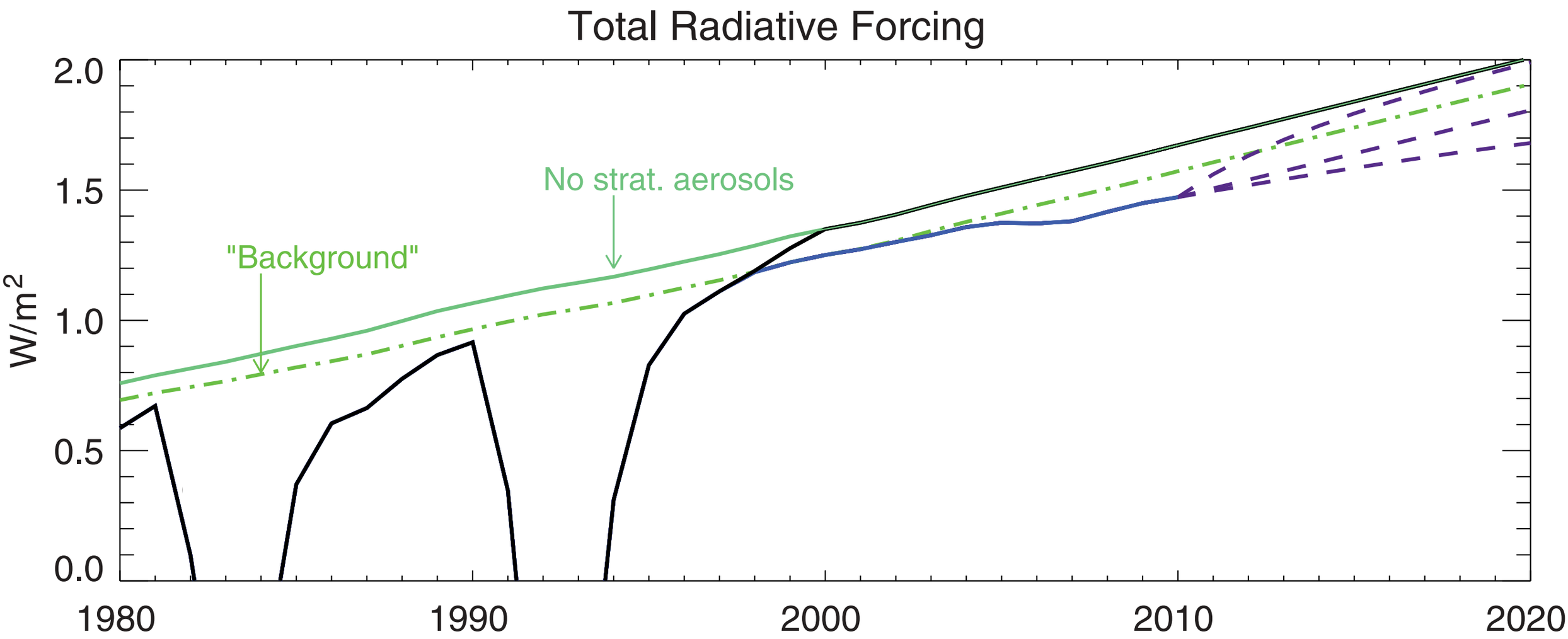
Variability in stratospheric aerosol impacts global radiative forcing



Greenhouse gas forcing increased continuously throughout period.

Adapted from Solomon et al. (2011), The Persistently Variable "Background" Stratospheric Aerosol Layer and Global Climate Change, *Science*.

Variability in stratospheric aerosol impacts global radiative forcing



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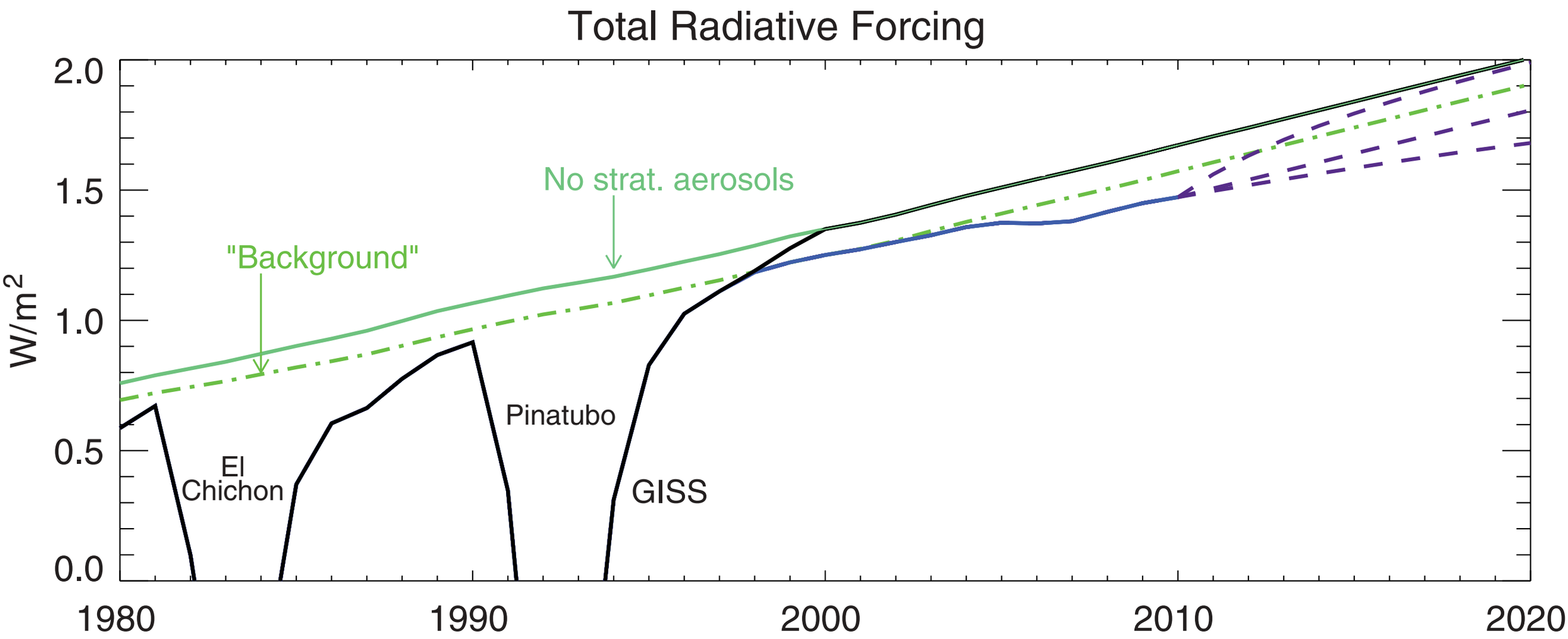
Variability in stratospheric aerosol impacts global radiative forcing



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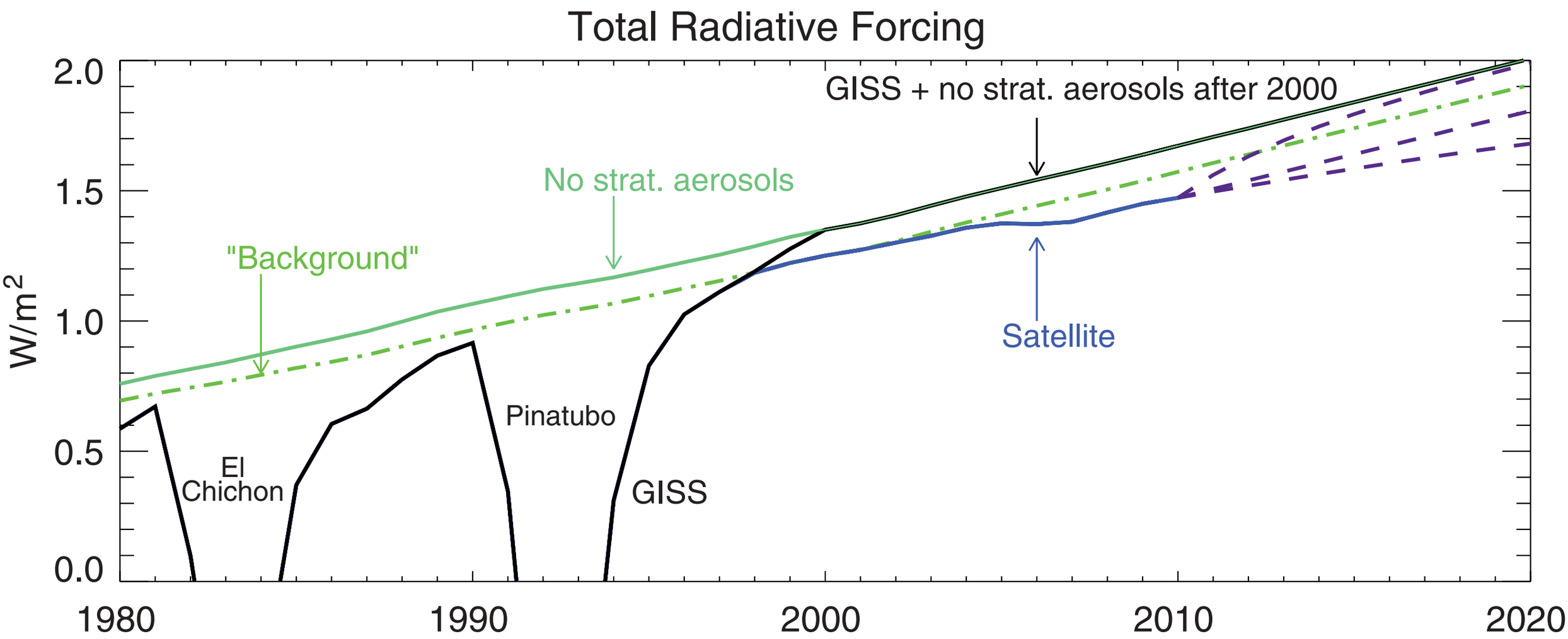
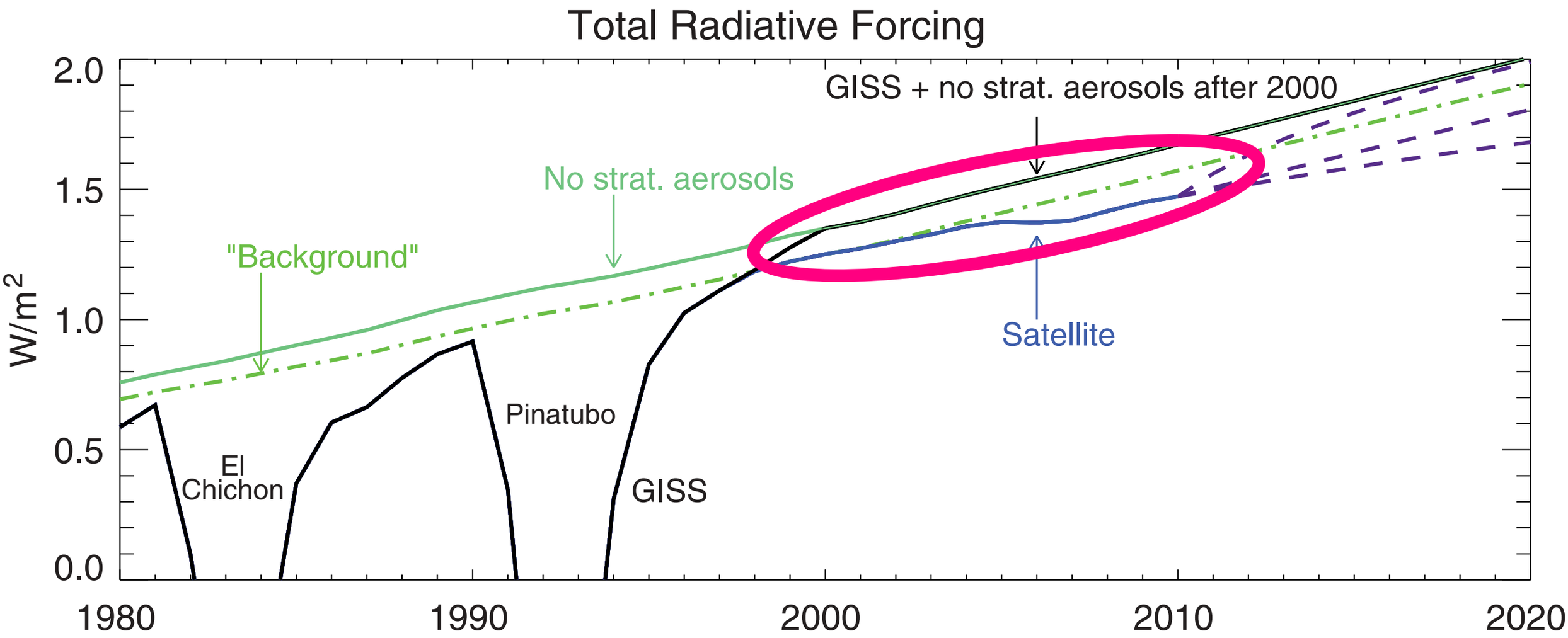
Variability in stratospheric aerosol impacts global radiative forcing



Greenhouse gas forcing increased continuously throughout period.
Stratospheric aerosol only slowed increase by ~0.2W/m^2

Adapted from Solomon et al. (2011), The Persistently Variable "Background" Stratospheric Aerosol Layer and Global Climate Change, *Science*.

Variability in stratospheric aerosol impacts global radiative forcing



What is driving the variability after 2000?

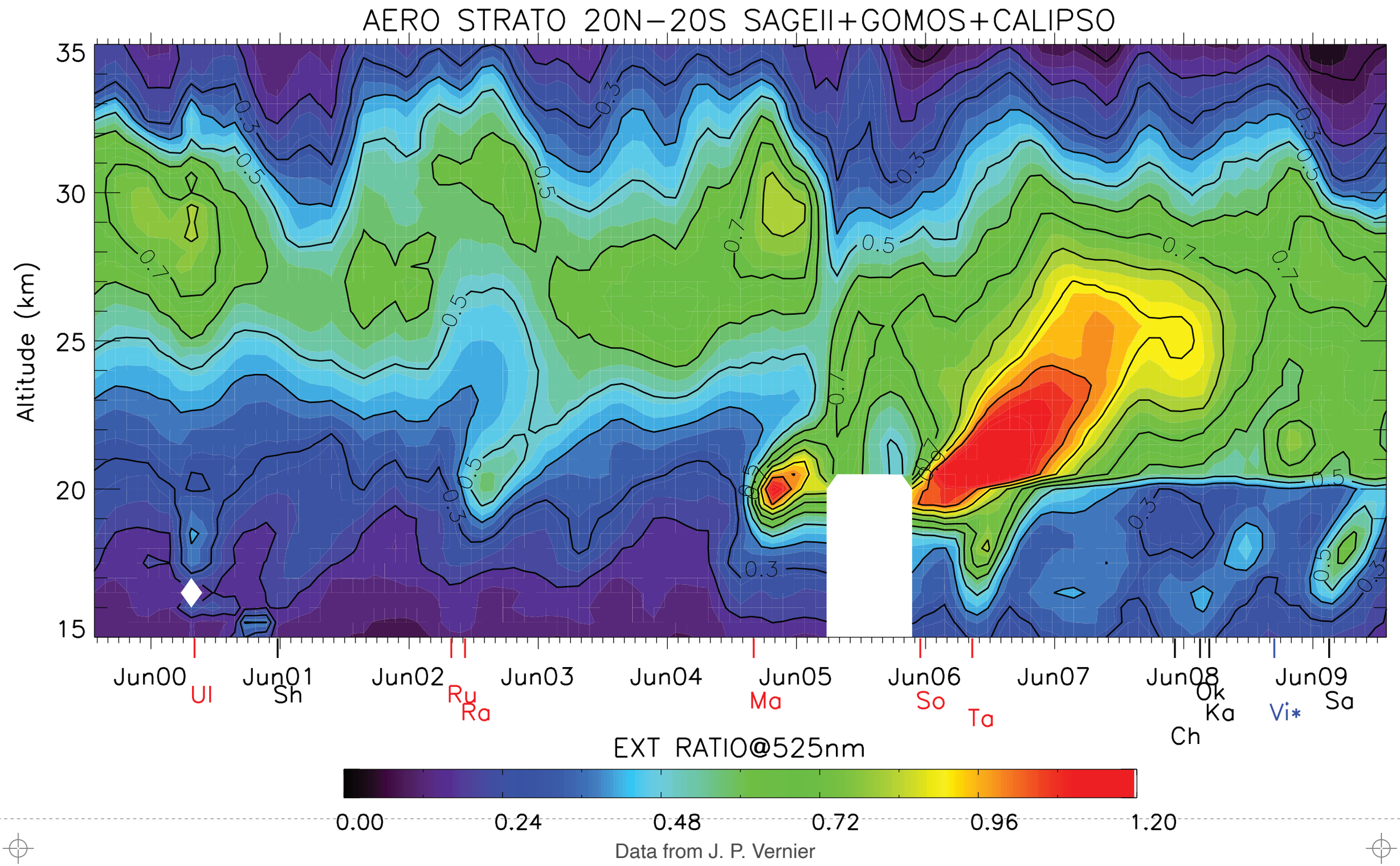
Adapted from Solomon et al. (2011), The Persistently Variable "Background" Stratospheric Aerosol Layer and Global Climate Change, *Science*.

Two Possible Sources

- **Increase in Asian Anthropogenic emissions (Hofmann et al. 2009)**

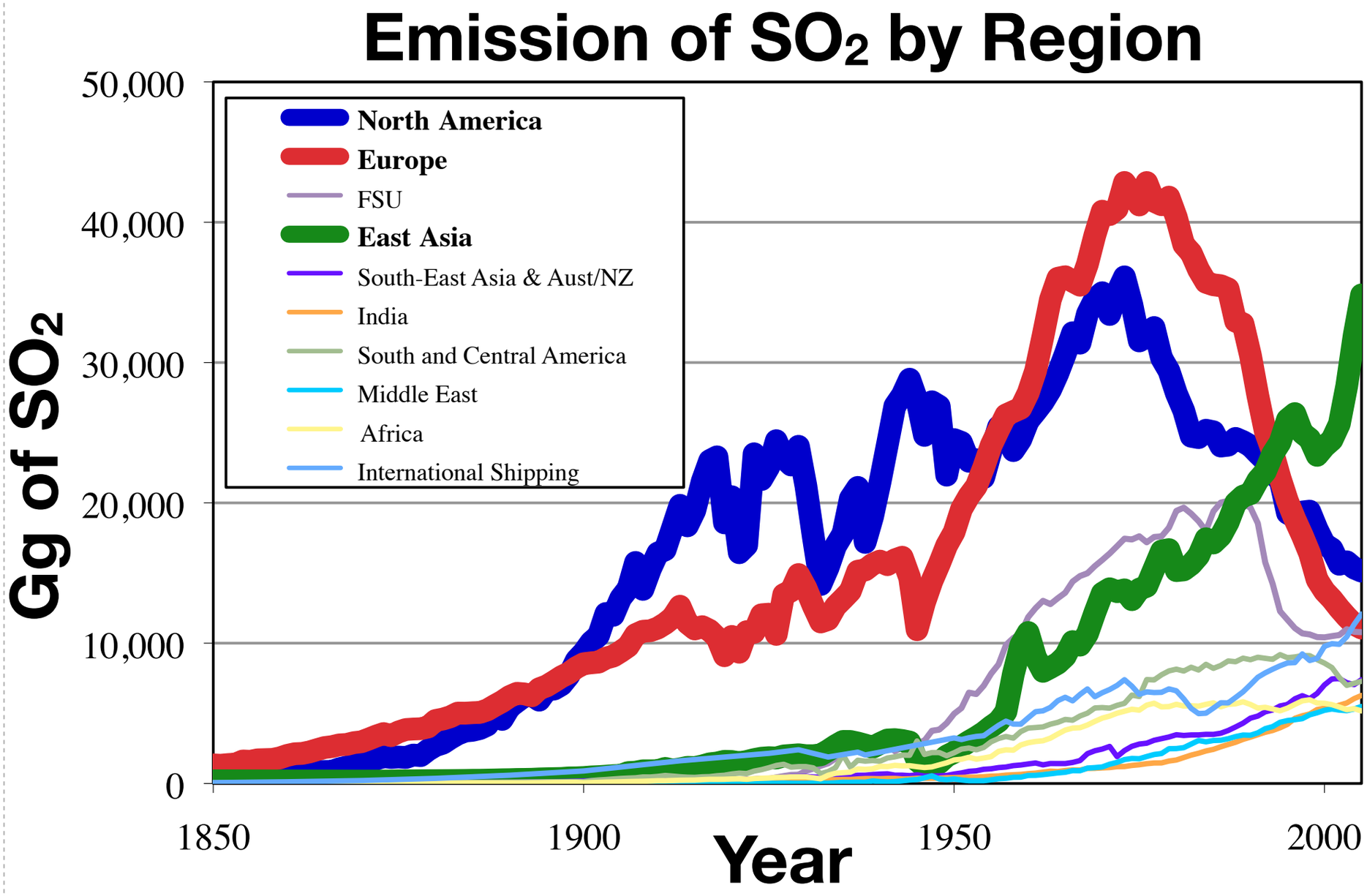
- **Moderate episodic volcanic injections (Vernier et al. 2011)**

Satellite Observations Reveal Volcanic Influence



Data from J. P. Vernier

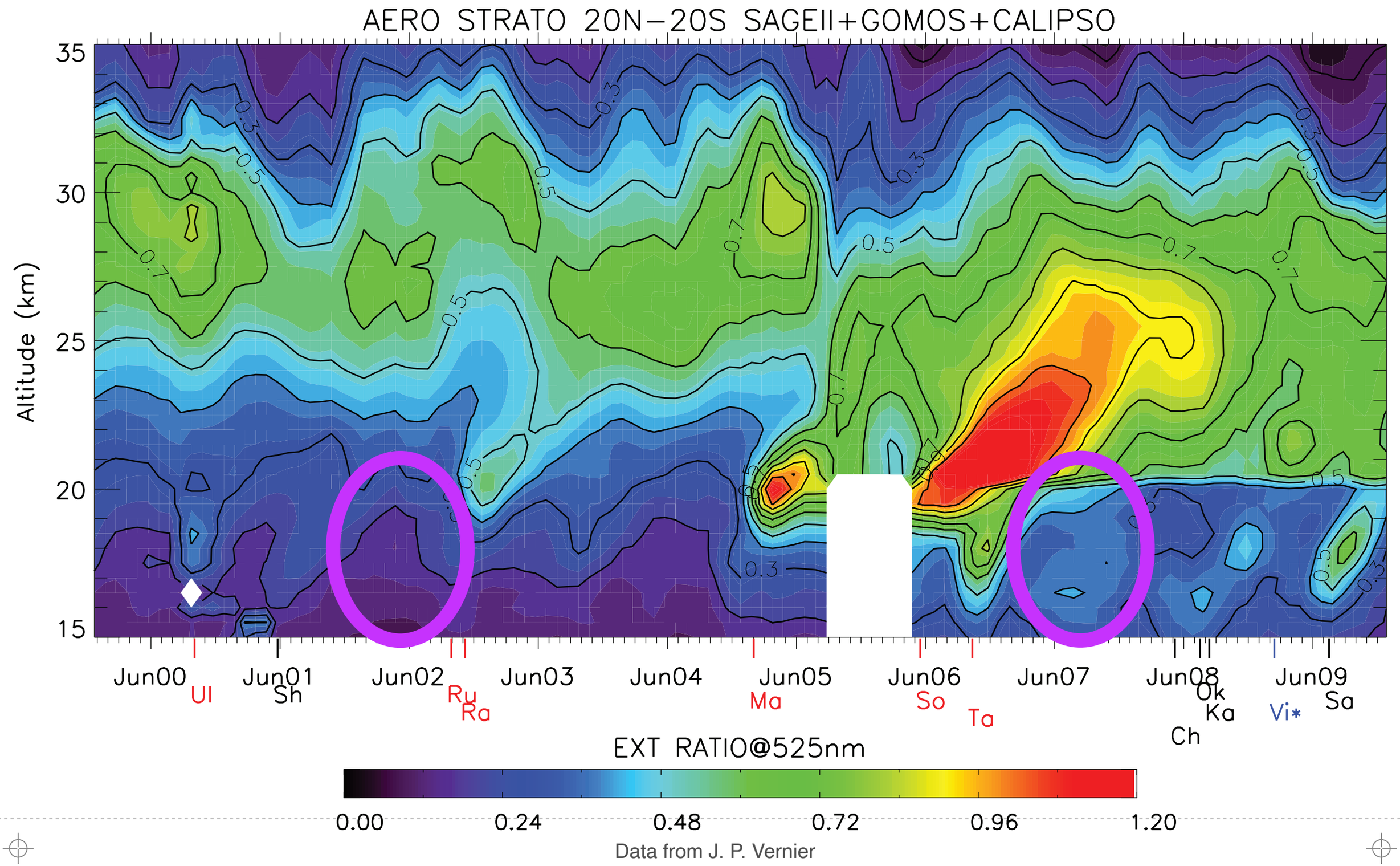
Asian SO_2 Emissions



Shift from Europe and North America to East Asia

Adapted from Smith et al. (2011), Anthropogenic sulfur dioxide emissions: 1850–2005, Atmos. Chem. Phys, 11(3), 1101–1116, doi:10.5194/acp-11-1101-2011.

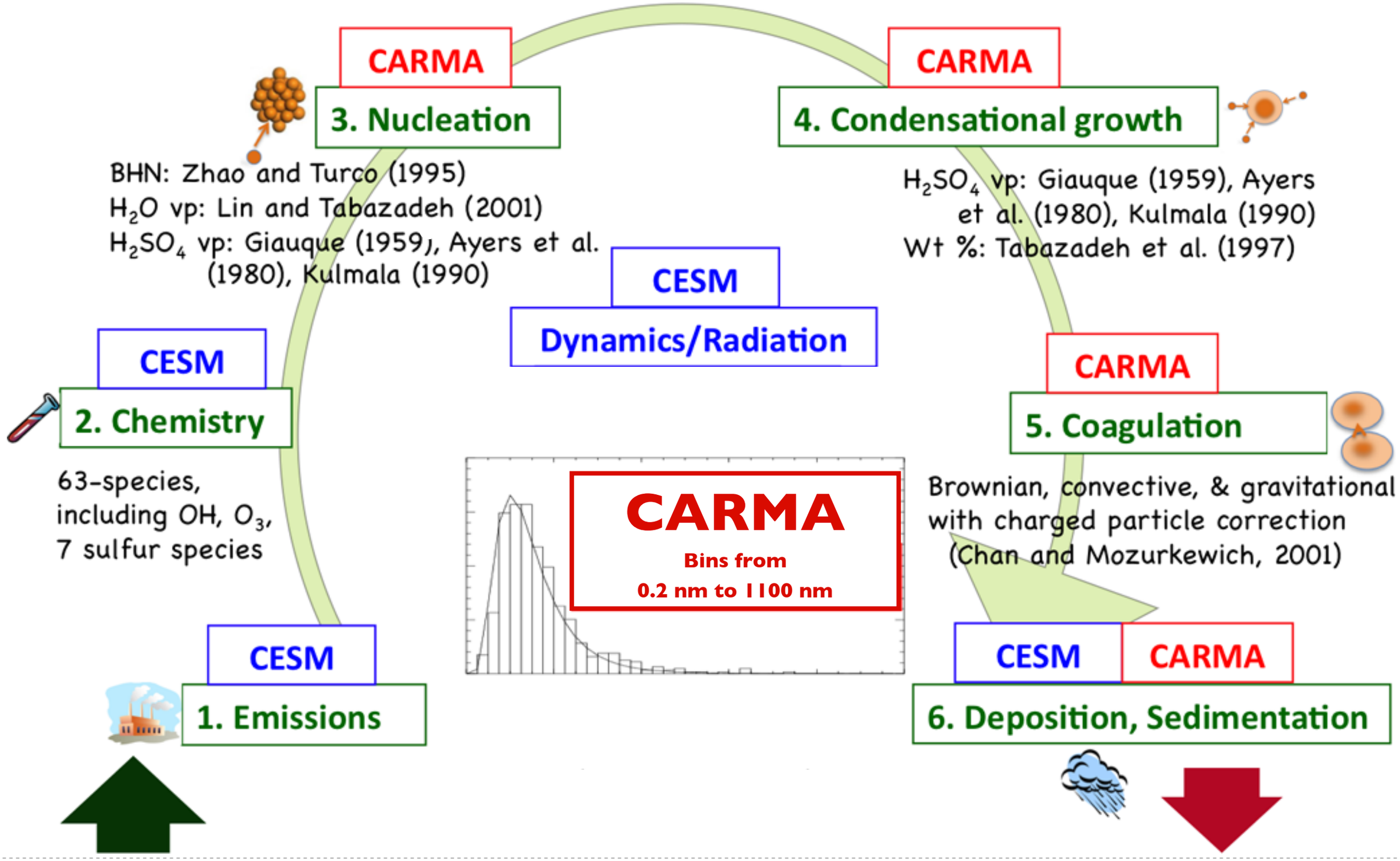
Current observations cannot partition the observed variability to sources



The Model:

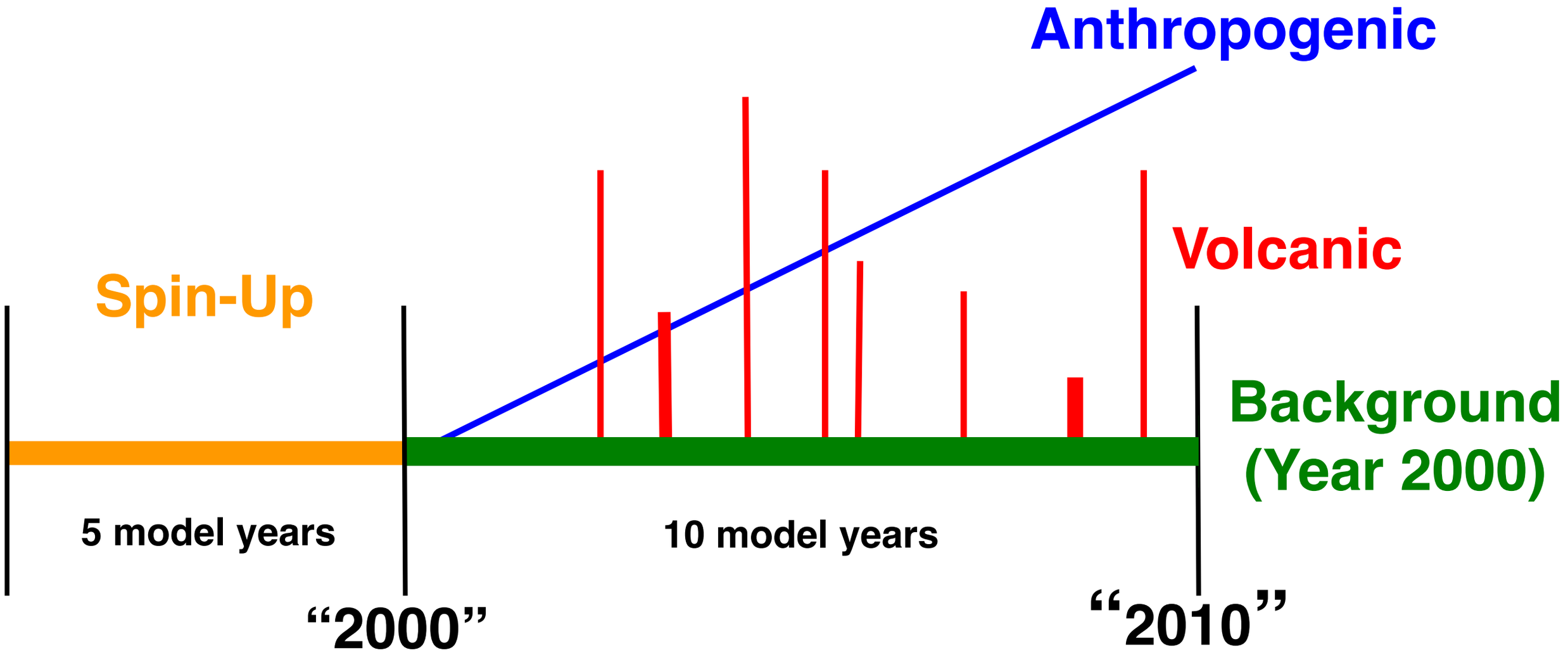
Sulfates: Meteoritic Smoke, Pure Sulfates, Mixed Sulfates

Non-Sulfates: Primary Organics (POA), Secondary Organics (SOA), Black Carbon (BC), Wind Blown Dust, Sea Salt



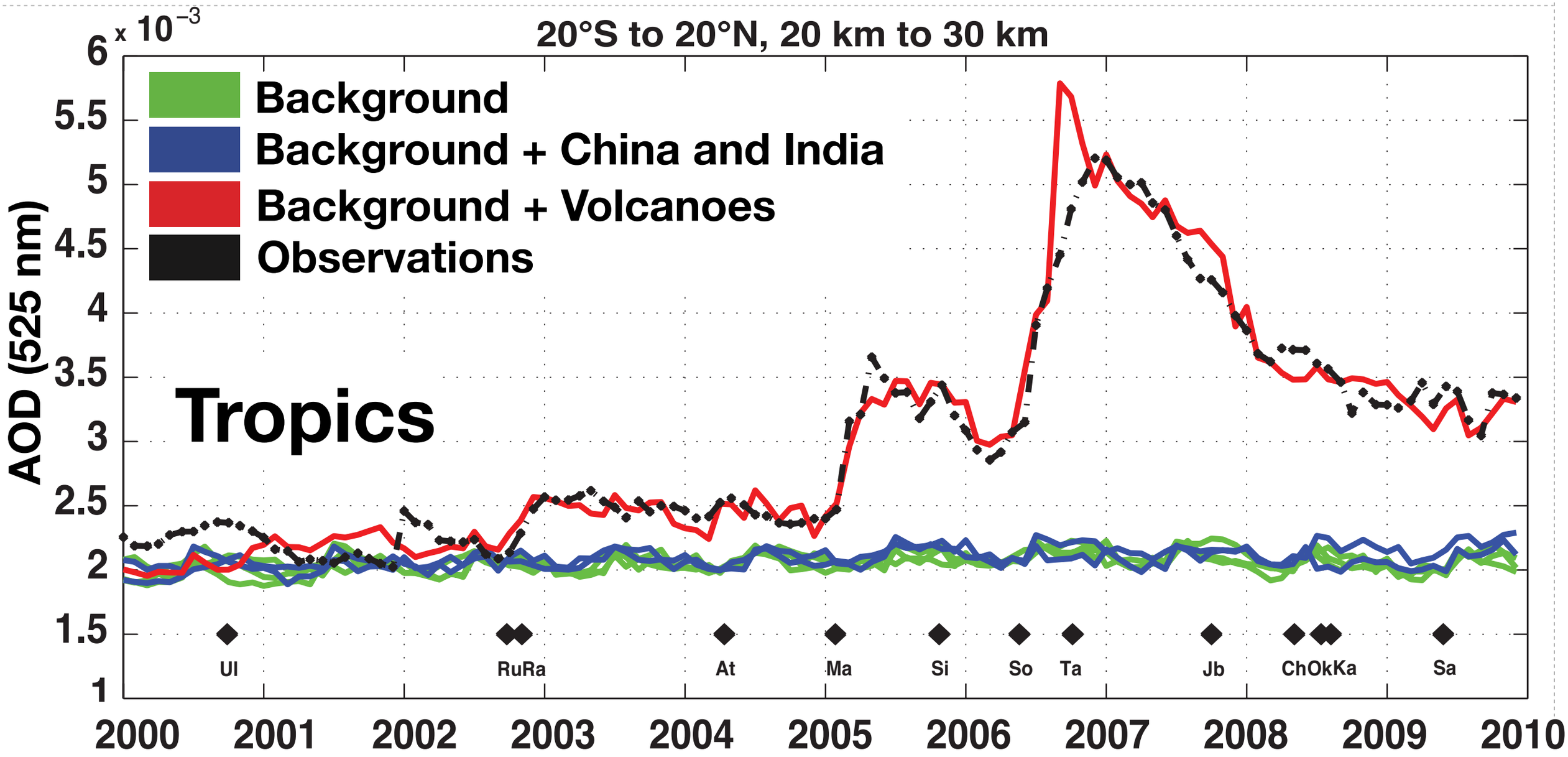
Adapted from J. English

Model Experiment Setup: SO_2 Schemes



Model: CESM1(WACCM) coupled to CARMA (bin microphysical model)

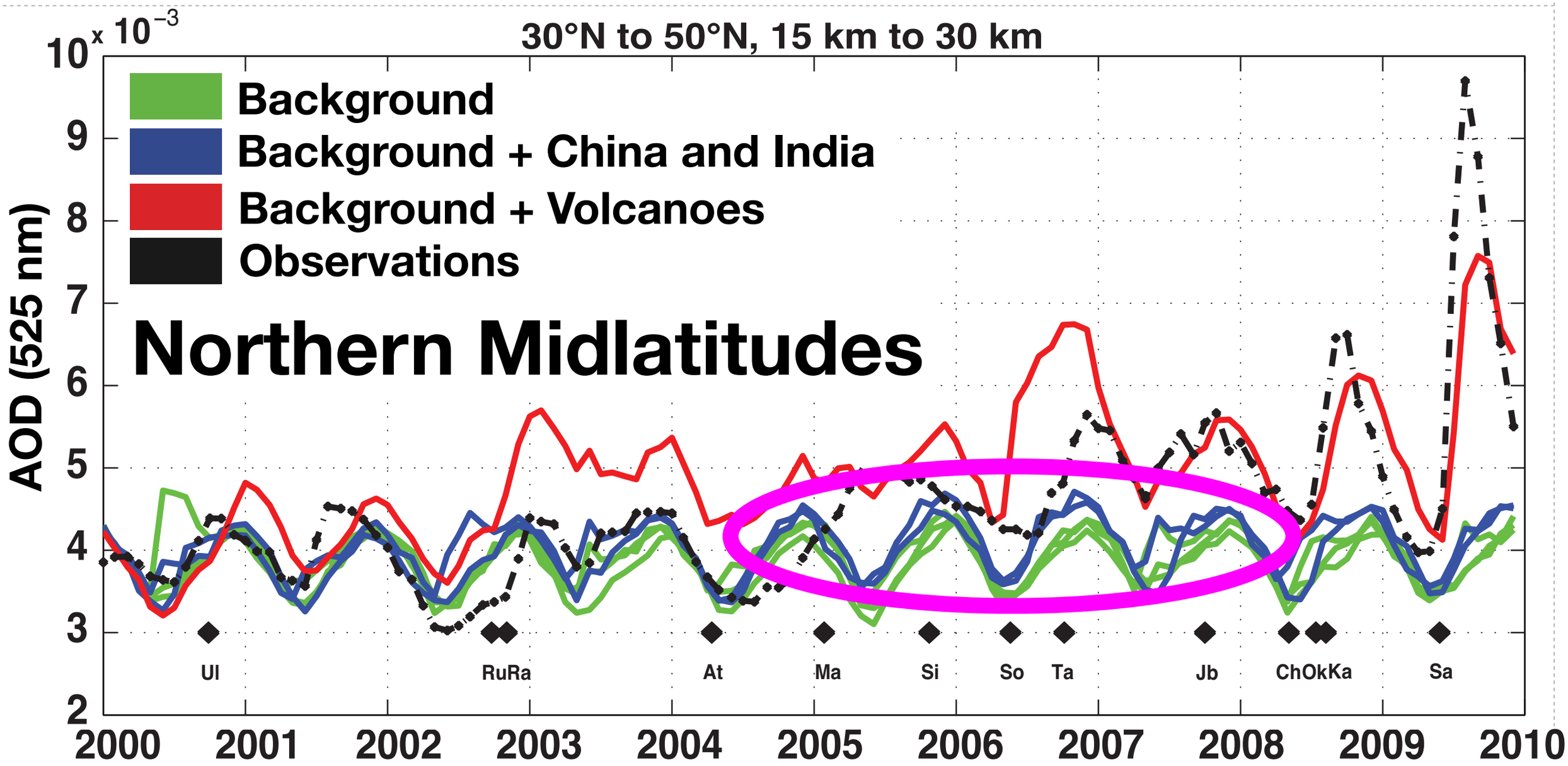
Volcanoes drive stratospheric aerosol variability



Recent variability in stratospheric aerosol is mostly due to volcanic eruptions but...

Adapted from Neely, R. R., III et al. (2013), Recent anthropogenic increases in SO2 from Asia have minimal impact on stratospheric aerosol, Geophys. Res. Lett, doi:10.1002/grl.50263.

Anthropogenic emissions may have some influence



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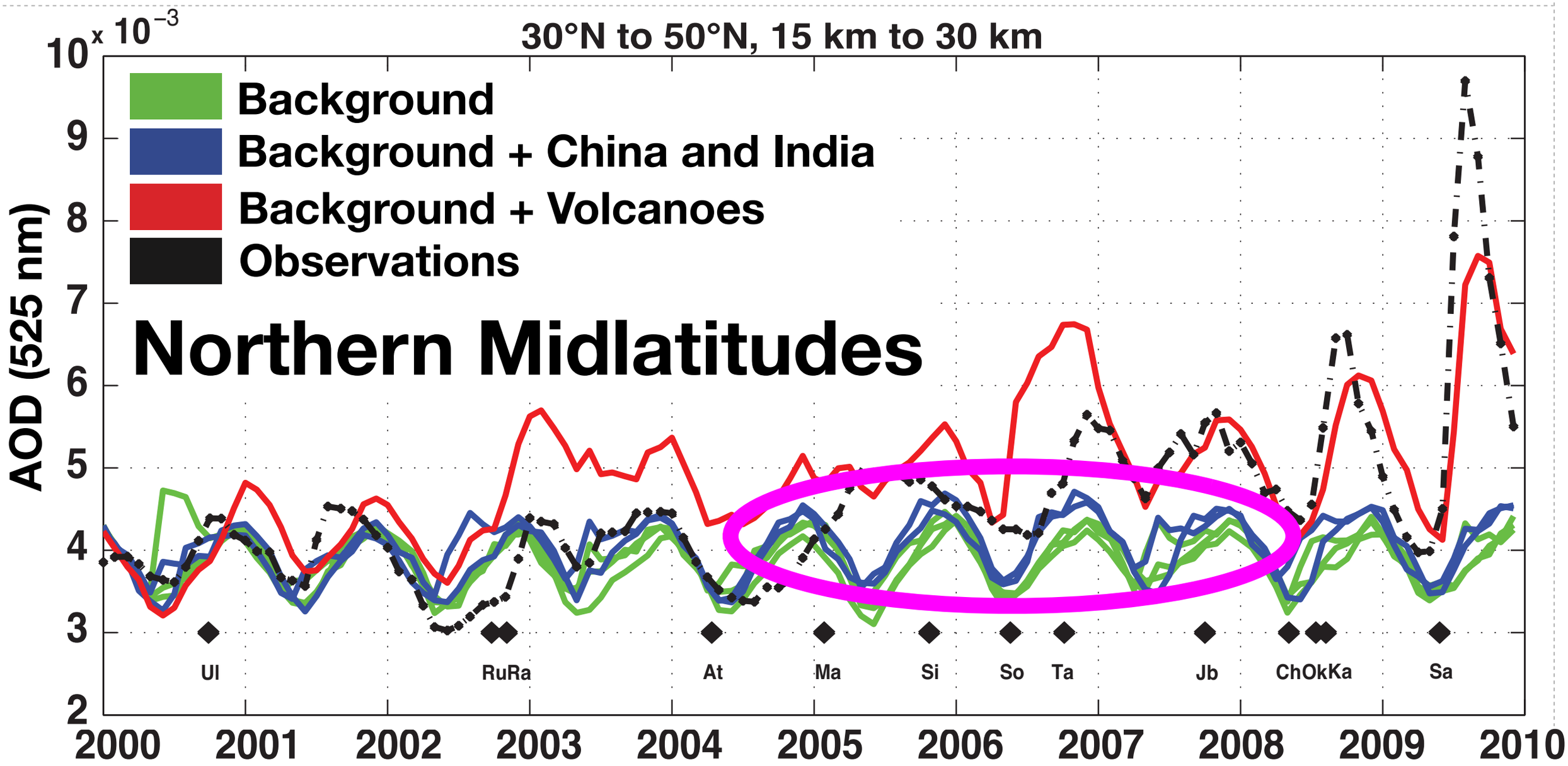
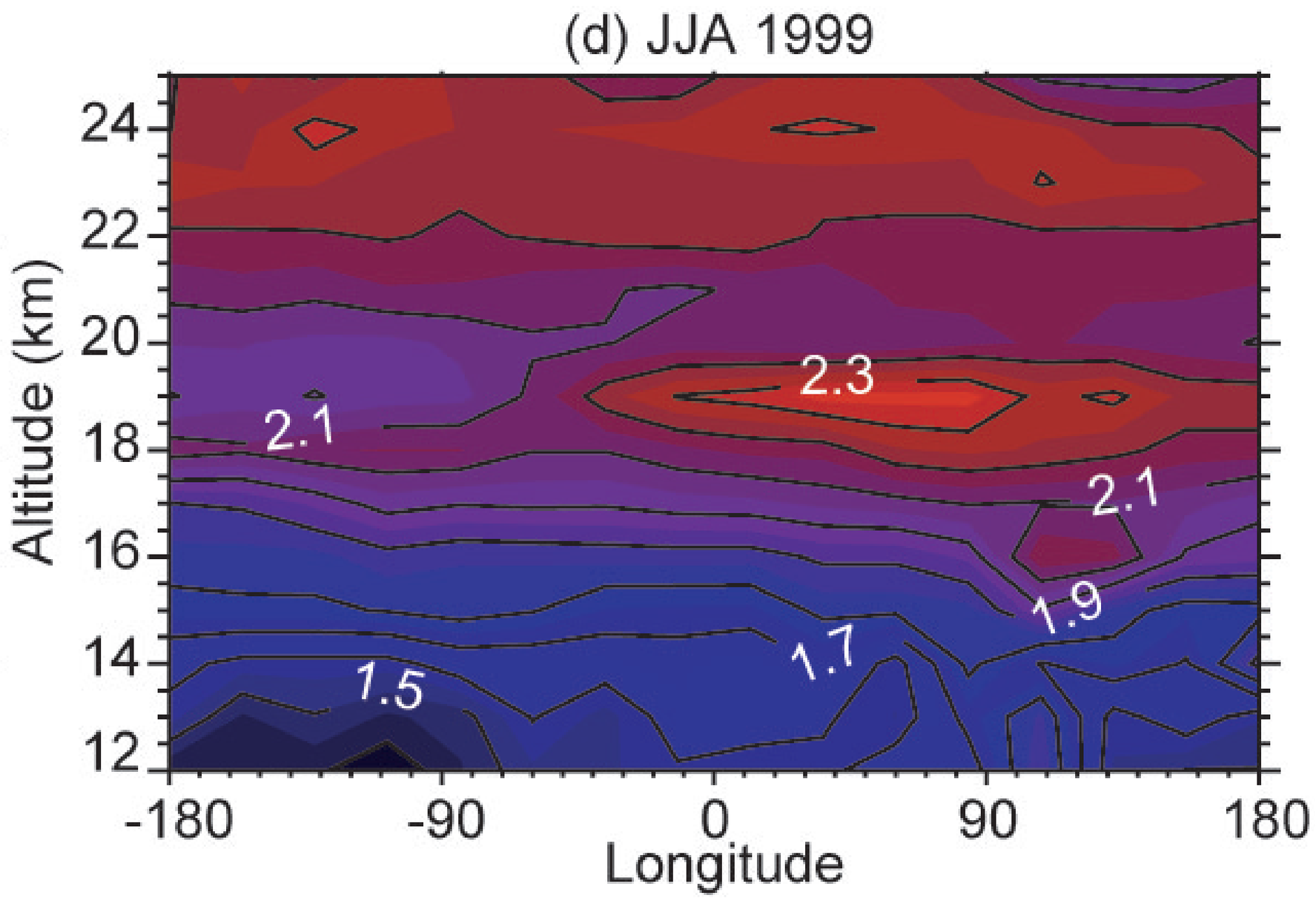


What mechanism leads to this possible enhancement?

Anthropogenic Influence: The Asian Tropical Aerosol Layer (ATAL)

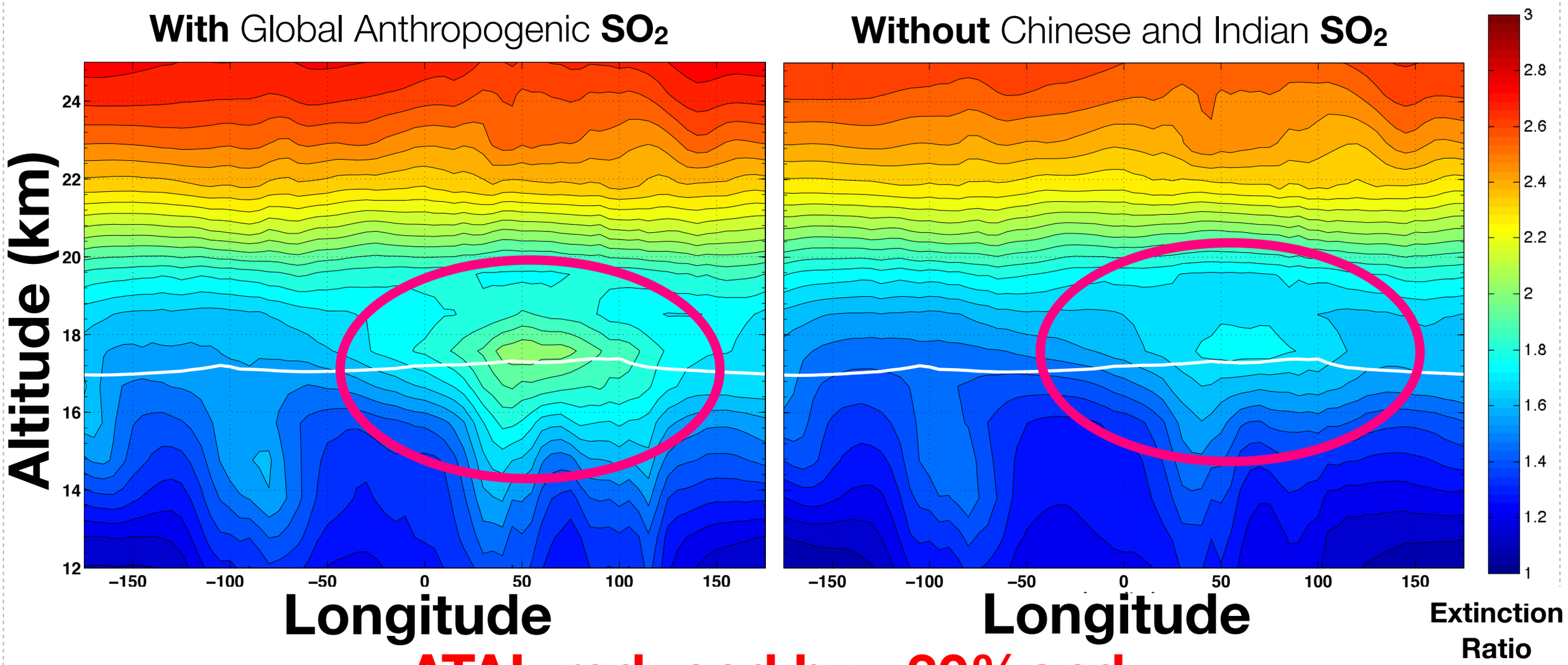
Median 1020 nm Extinction Ratio Observed by SAGE II from 15N to 45N, June thru August



Plot adapted from Thomason, L. W. and Vernier, J.-P.: Improved SAGE II cloud/aerosol categorization and observations of the asian tropopause aerosol layer: 1989–2005, Atmos. Chem. Phys. Discuss., 12, 27521-27554, doi:10.5194/acpd-12-27521-2012, 2012.

Asian Anthropogenic Influence on the ATAL

Modeled Mean 1020 nm Extinction Ratio from 14ºN to 46ºN, June-August

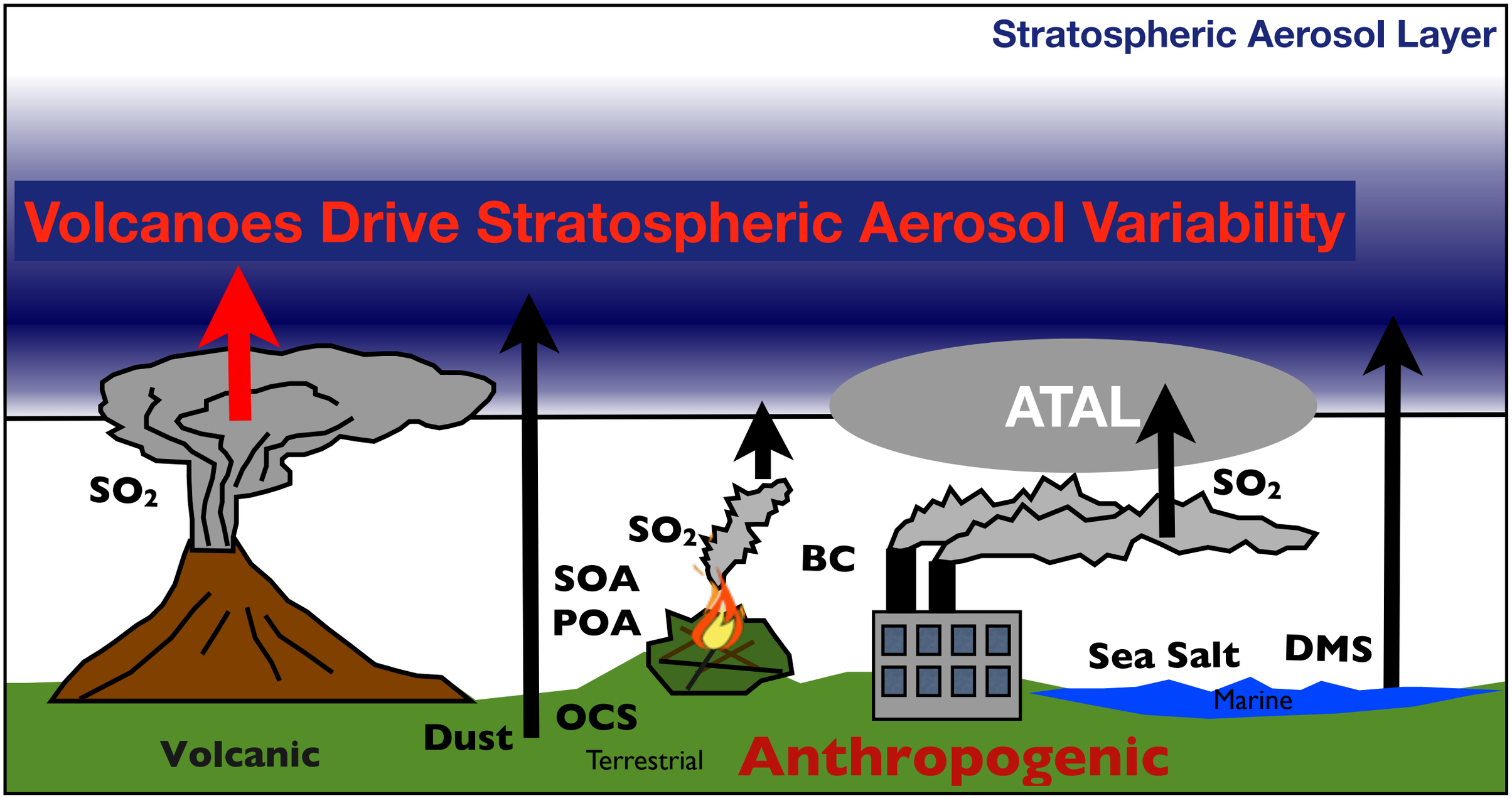


ATAL reduced by ~30%and

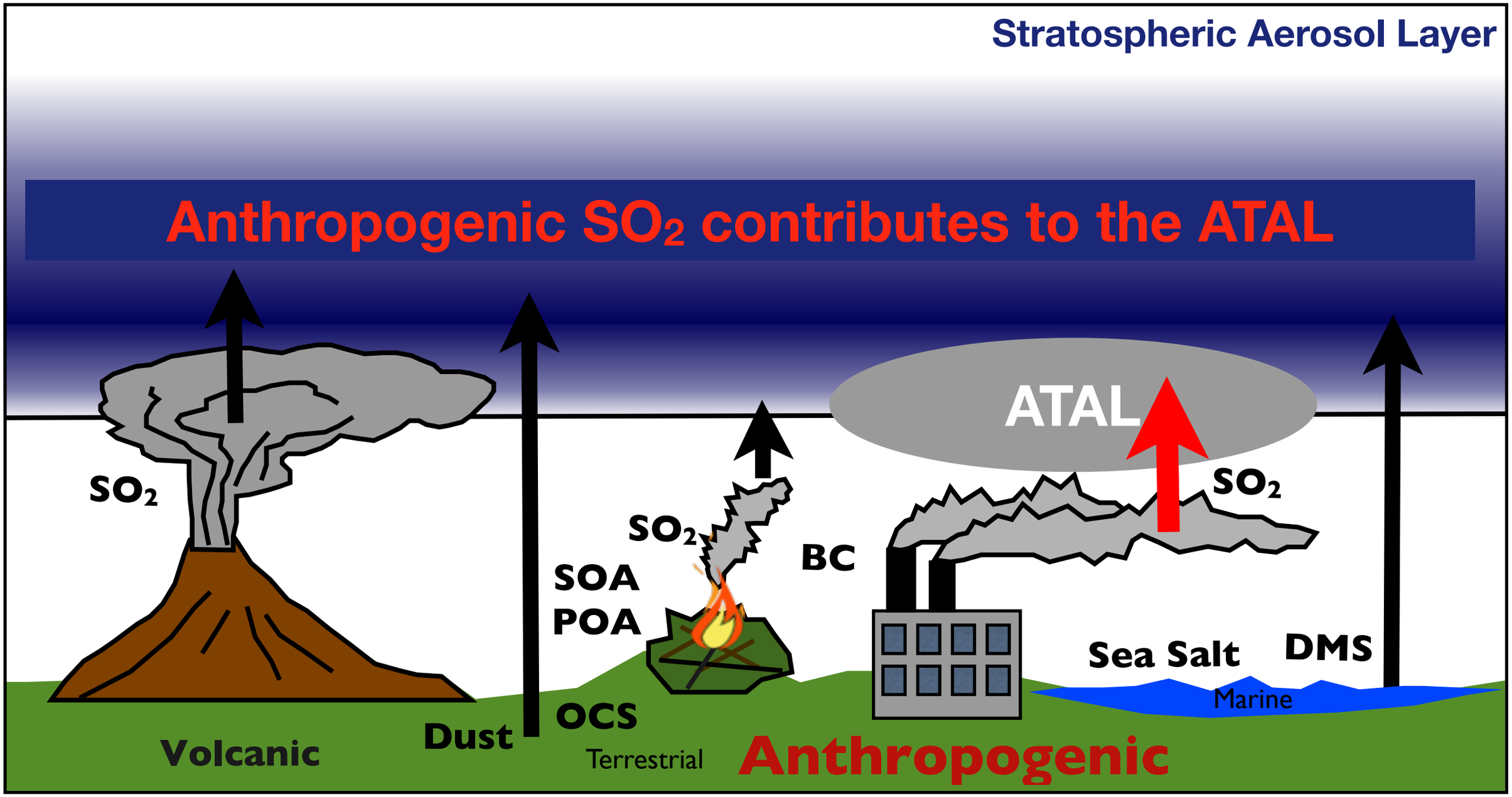
“Background” Layer is similar

Adapted from: Neely et al., (2014), Regional Contributions of Anthropogenic SO2 Emissions to the Asian Tropopause Aerosol Layer, JGR; Accepted.

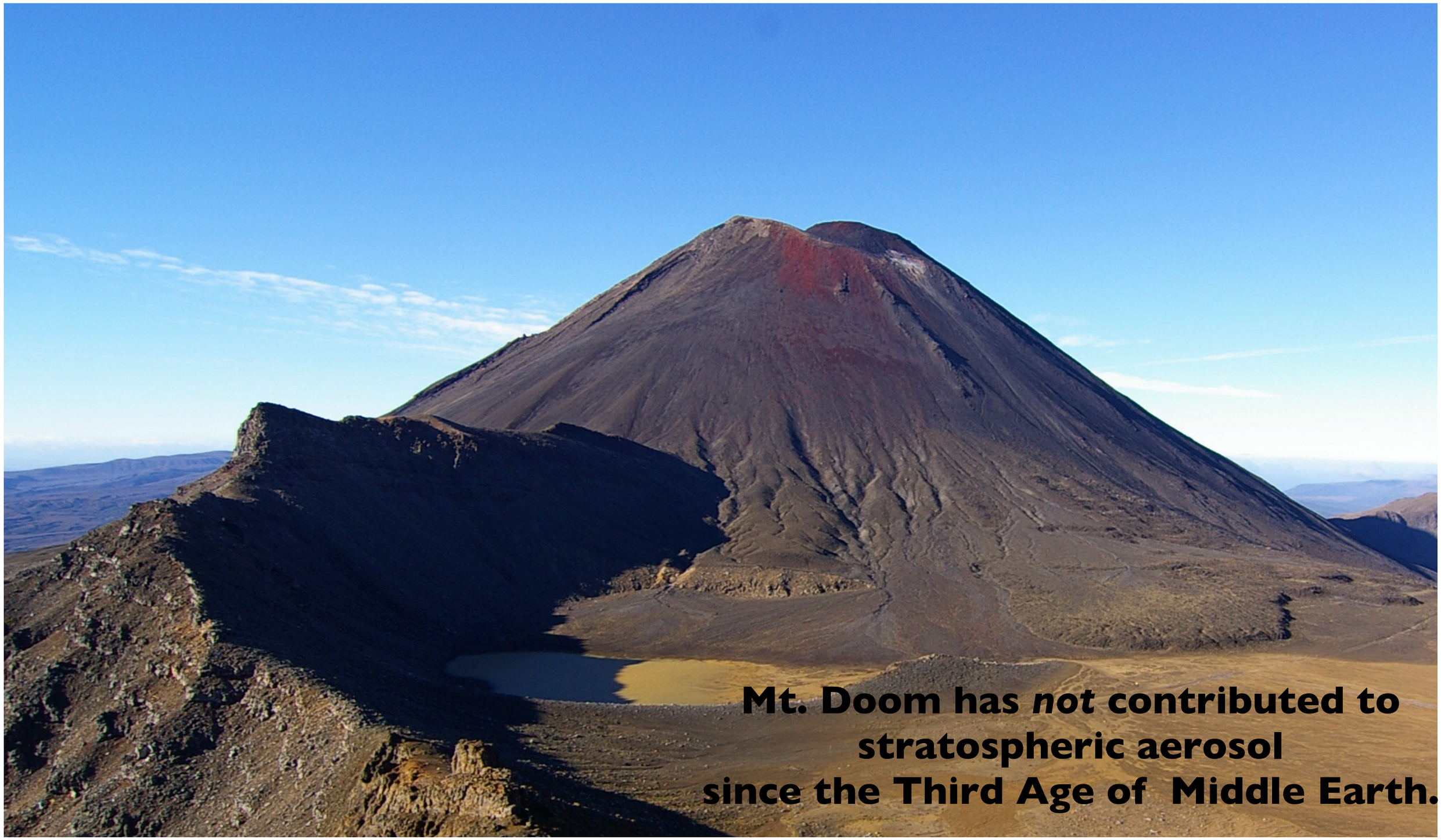
Conclusions



Conclusions



Questions?


Mt. Doom has *not* contributed to
stratospheric aerosol
since the Third Age of Middle Earth.