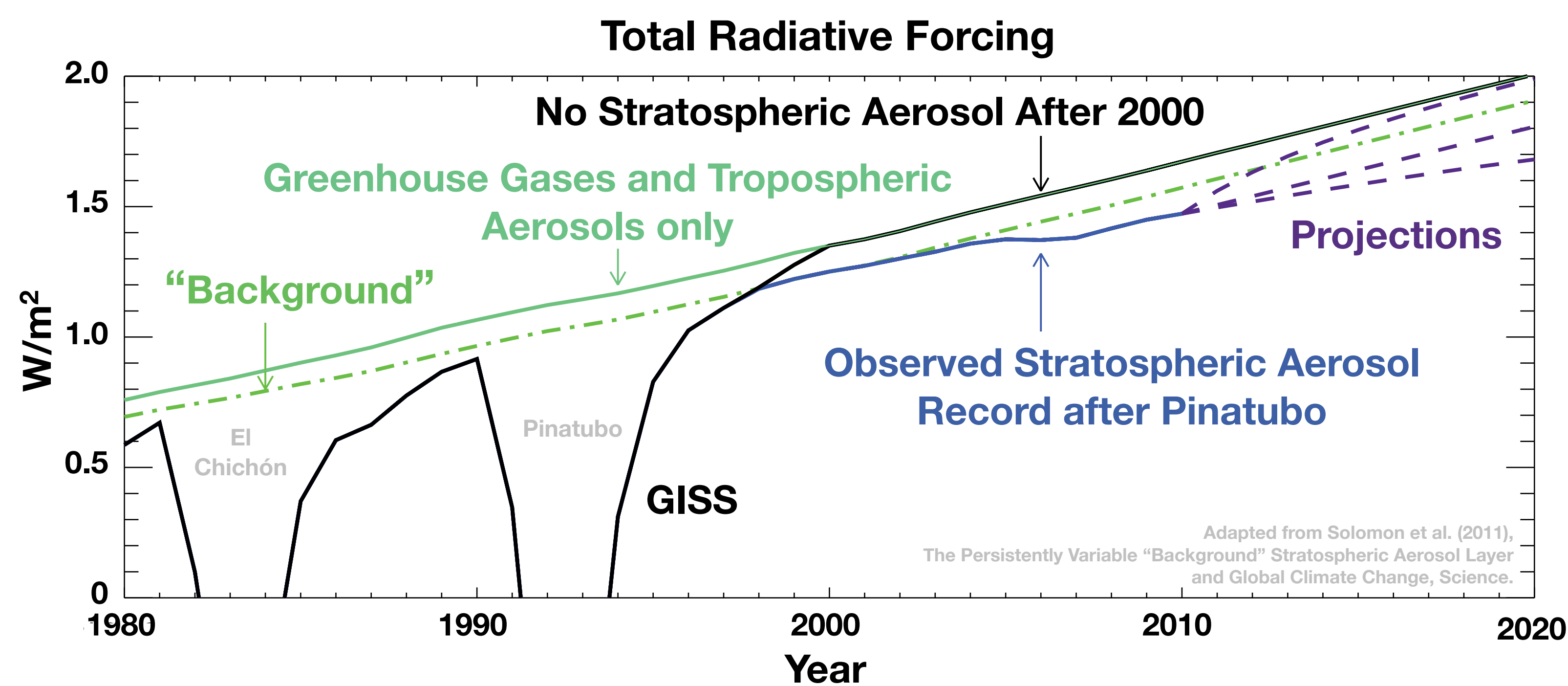


Trends in Stratospheric Aerosol: ANTHROPOGENIC OR VOLCANIC?

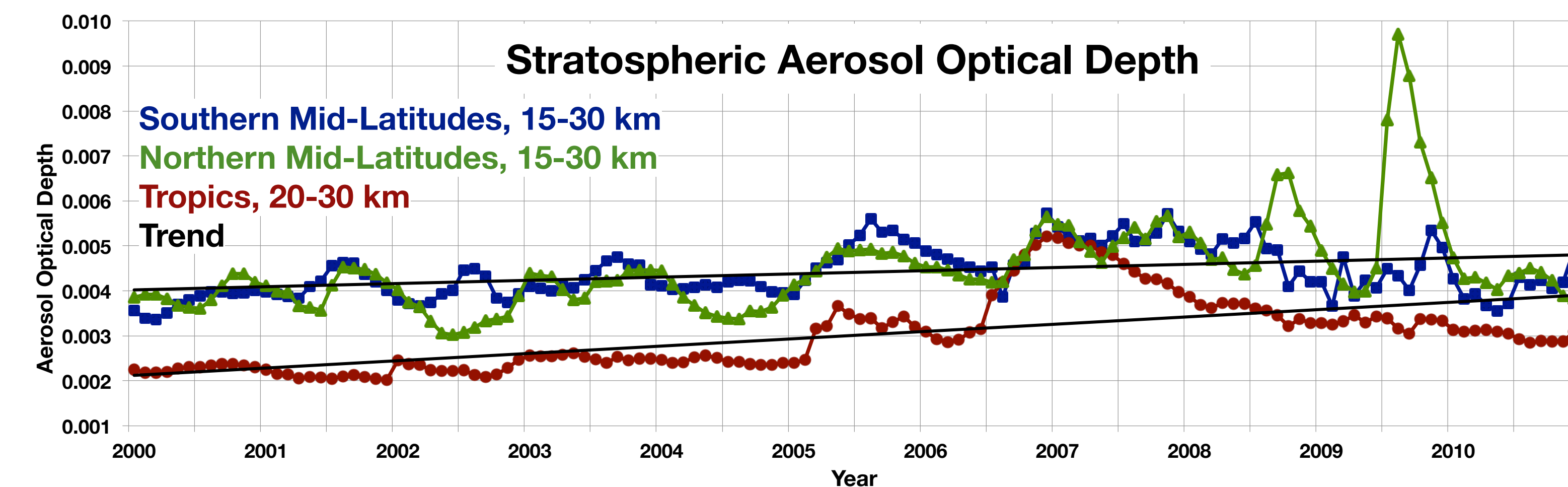
WHY CARE ABOUT STRATOSPHERIC AEROSOL?

- As much as 25% of the radiative forcing driving global climate change from 2000 to 2010 may have been counterbalanced by the increases in stratospheric aerosol loading.
- Stratospheric aerosol impacts heterogeneous chemistry involving catalytic cycles affecting the ozone layer.
- Currently, anthropogenic SO₂ is the dominant source (~80%) of sulfur in Earth's atmosphere.



OBSERVATIONS OF INCREASING AEROSOL

- Satellite and ground observations reveal the variability of the stratospheric aerosol layer from 2000 to 2010.
- Linear fits suggest an increase in aerosol optical depth of 4-7% per year.



WHAT IS CAUSING THE INCREASE IN AEROSOL?

HYPOTHESES

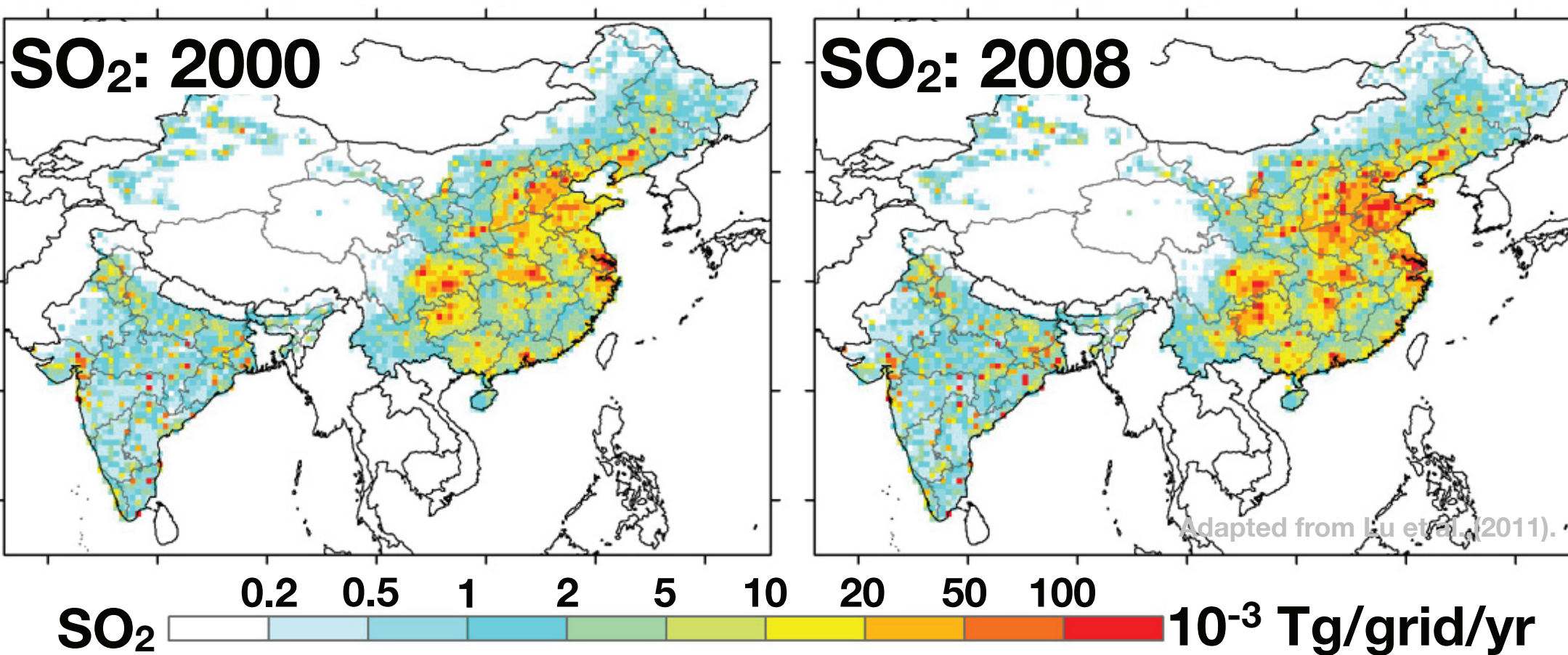
ANTHROPOGENIC

IS LOCAL AIR POLLUTION HAVING A GLOBAL IMPACT?

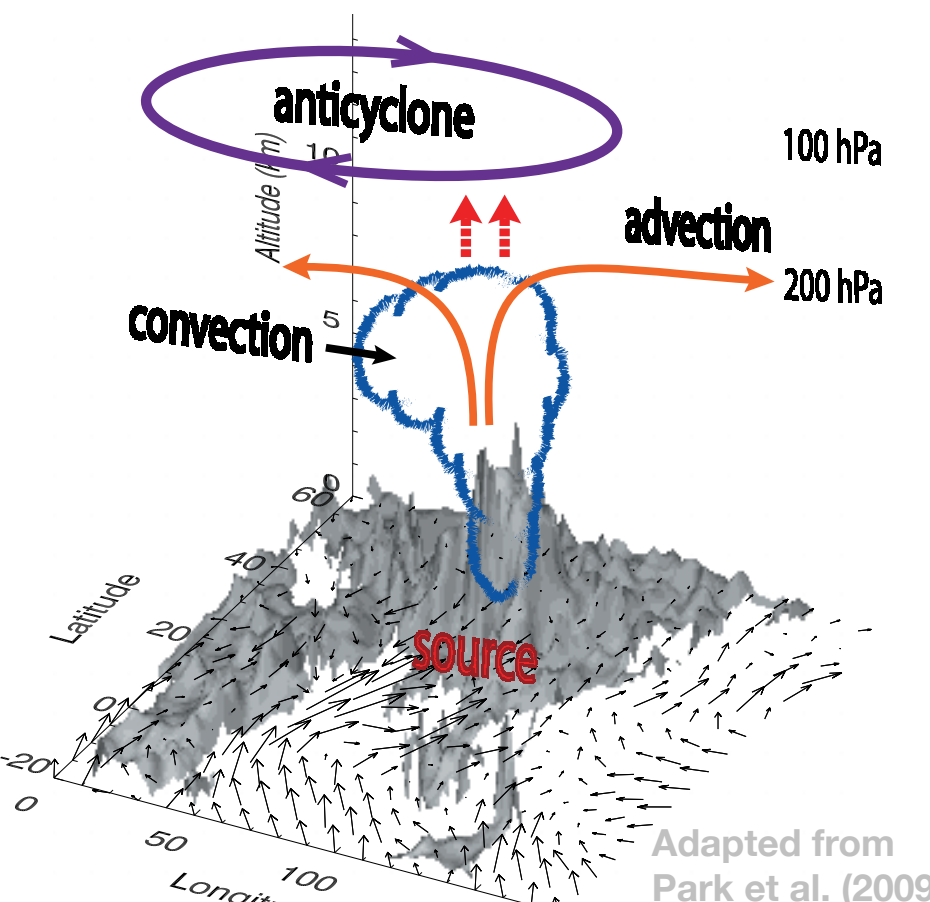
- Chinese and Indian emissions have driven the global emission of SO₂ since 2000.



Distribution of Chinese and Indian SO₂ emissions (Lu et al., 2011).



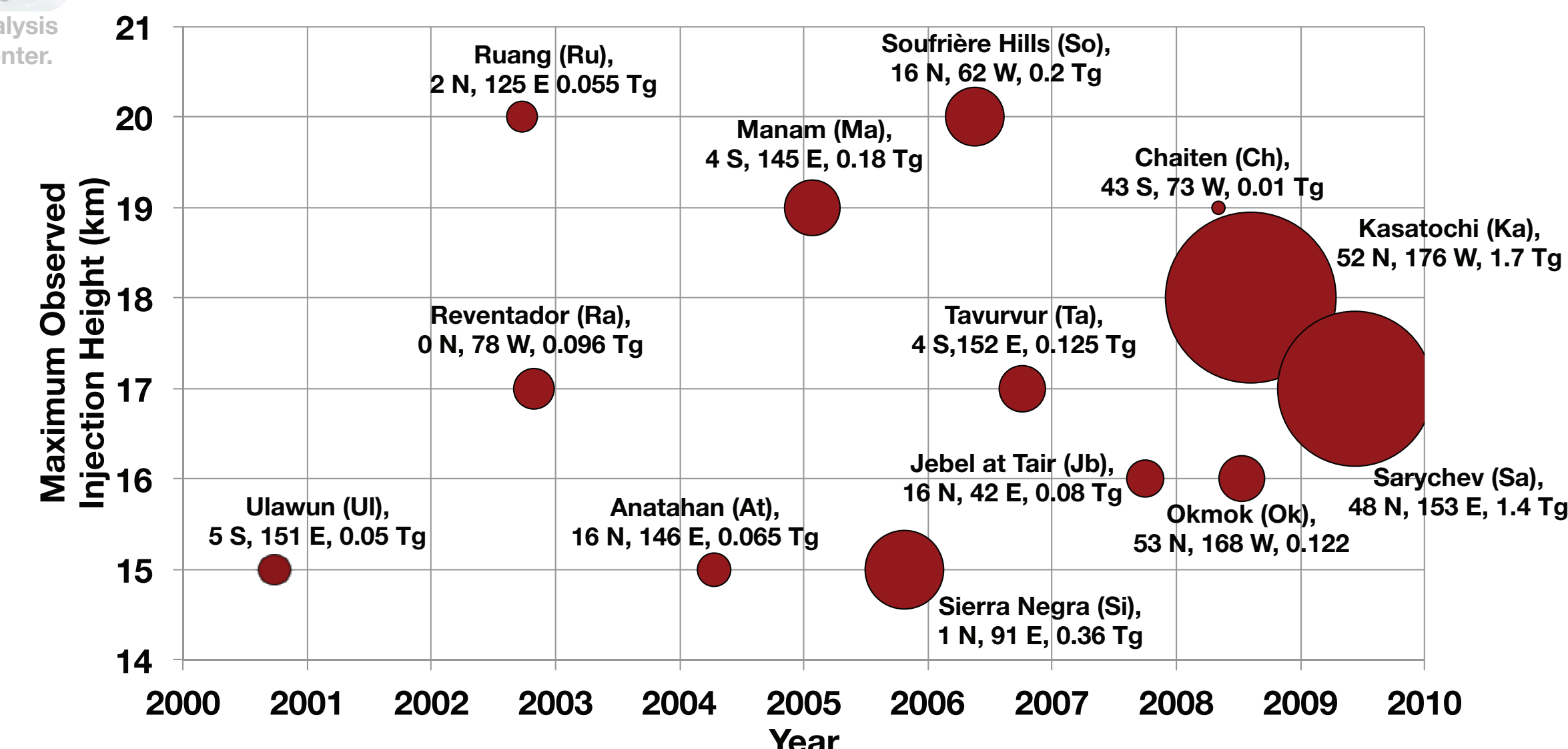
Asian monsoon provides gateway to stratosphere



VOLCANIC

OR, ARE SMALL VOLCANOES, ONCE IGNORED, COINCIDENTALLY CREATING A TREND?

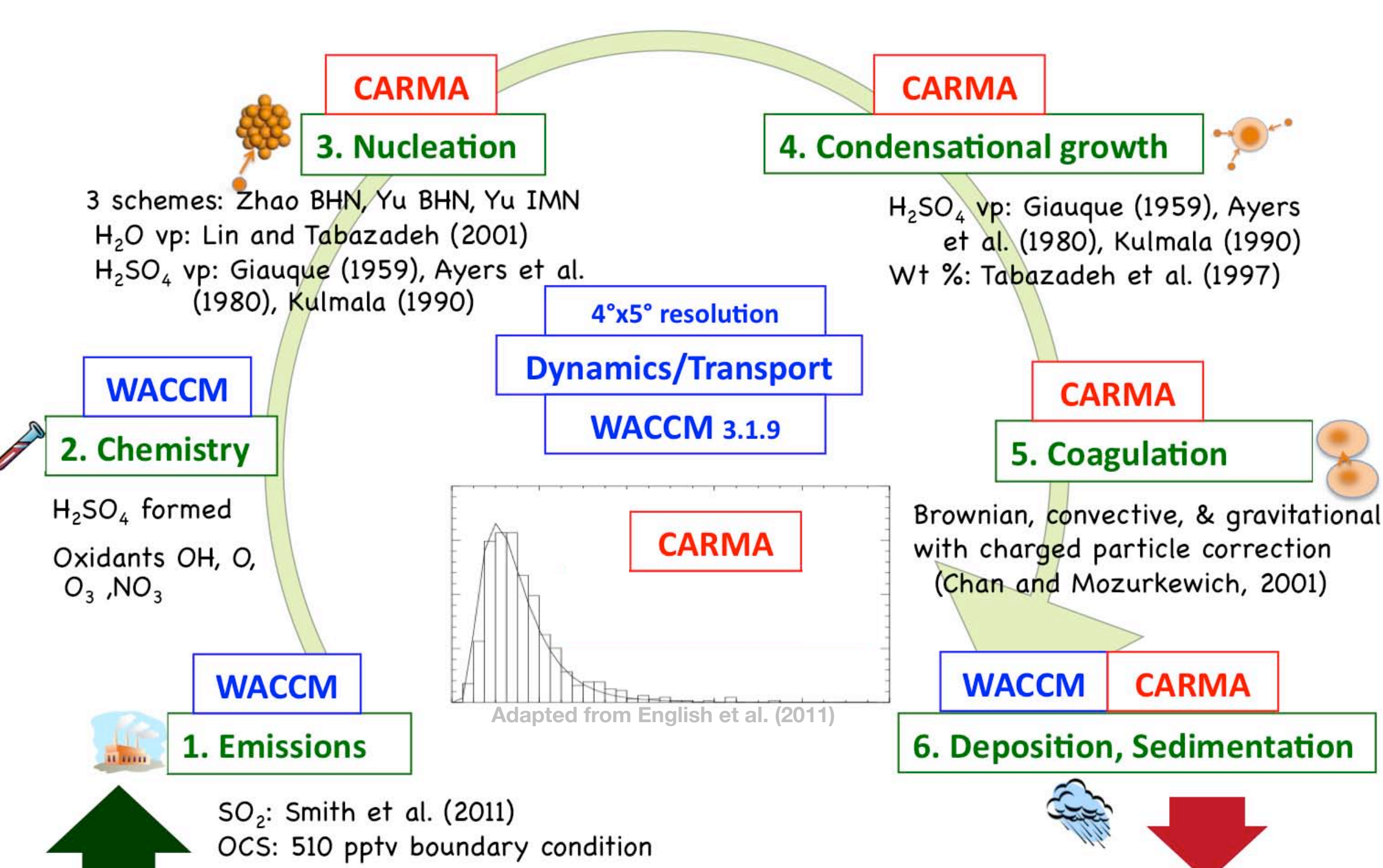
Maximum observed injection height and total column SO₂ of the largest volcanic eruptions form 2000 to 2010.



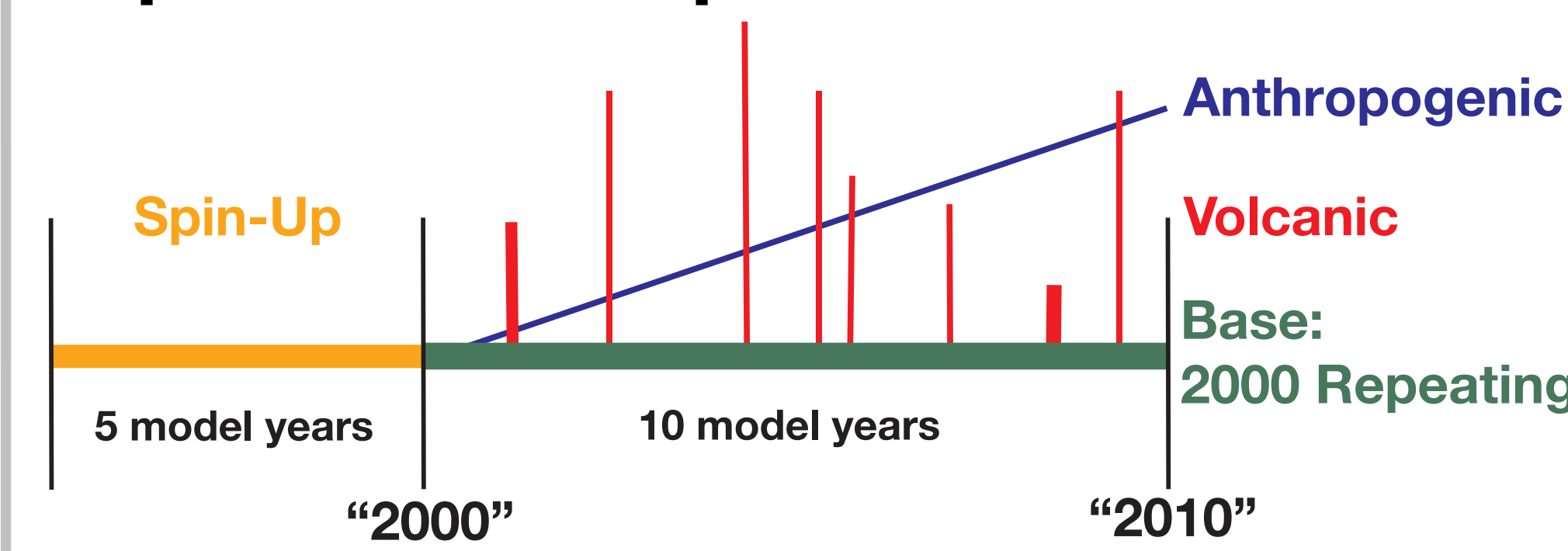
METHOD: MODEL AEROSOL FROM SEPARATE SOURCES AND COMPARE TO OBSERVATIONS

- While a volcanic signal is clear in observations, it is not possible to separate out the anthropogenic influence on the total observed variability.

Model Details:



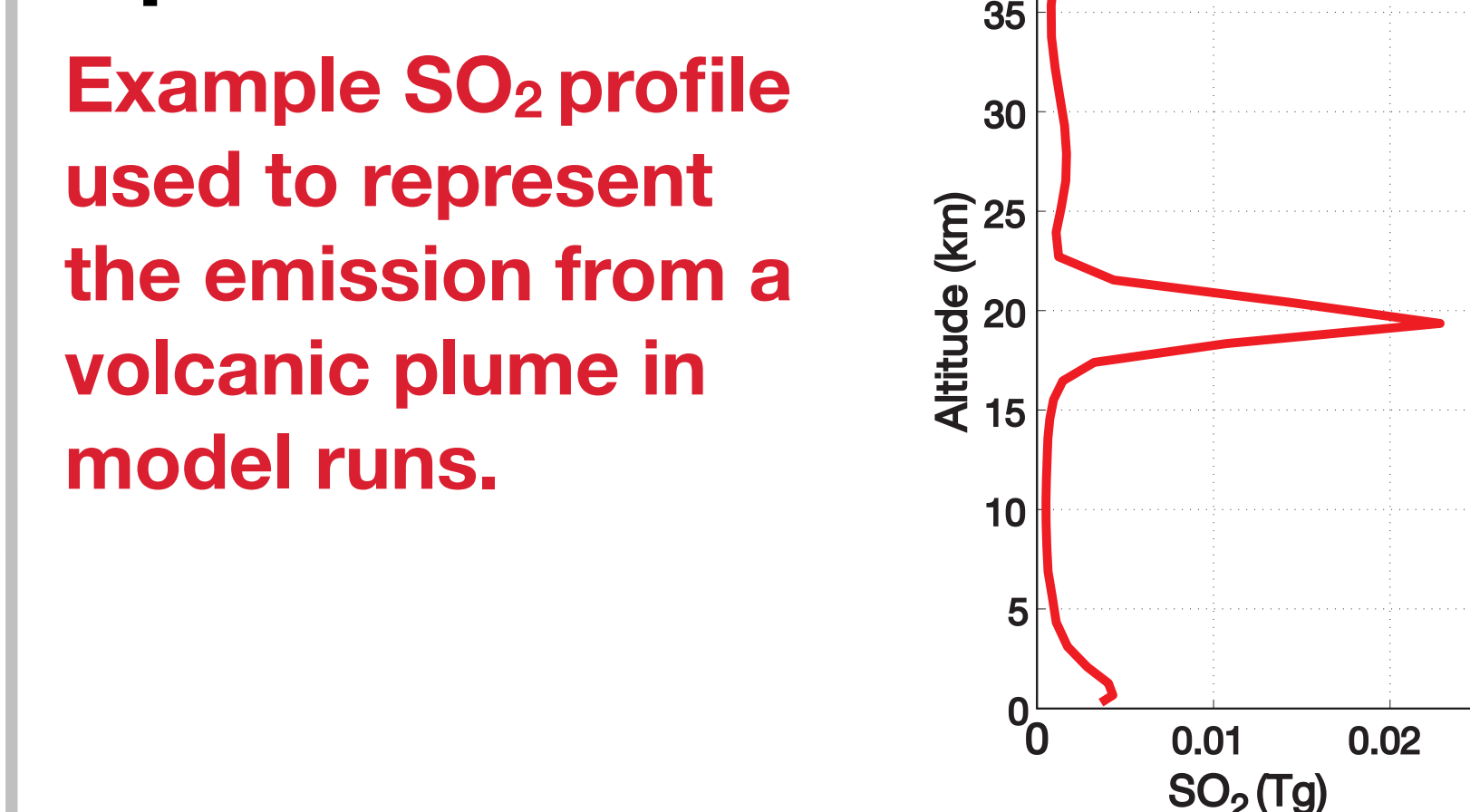
Experiment Setup:



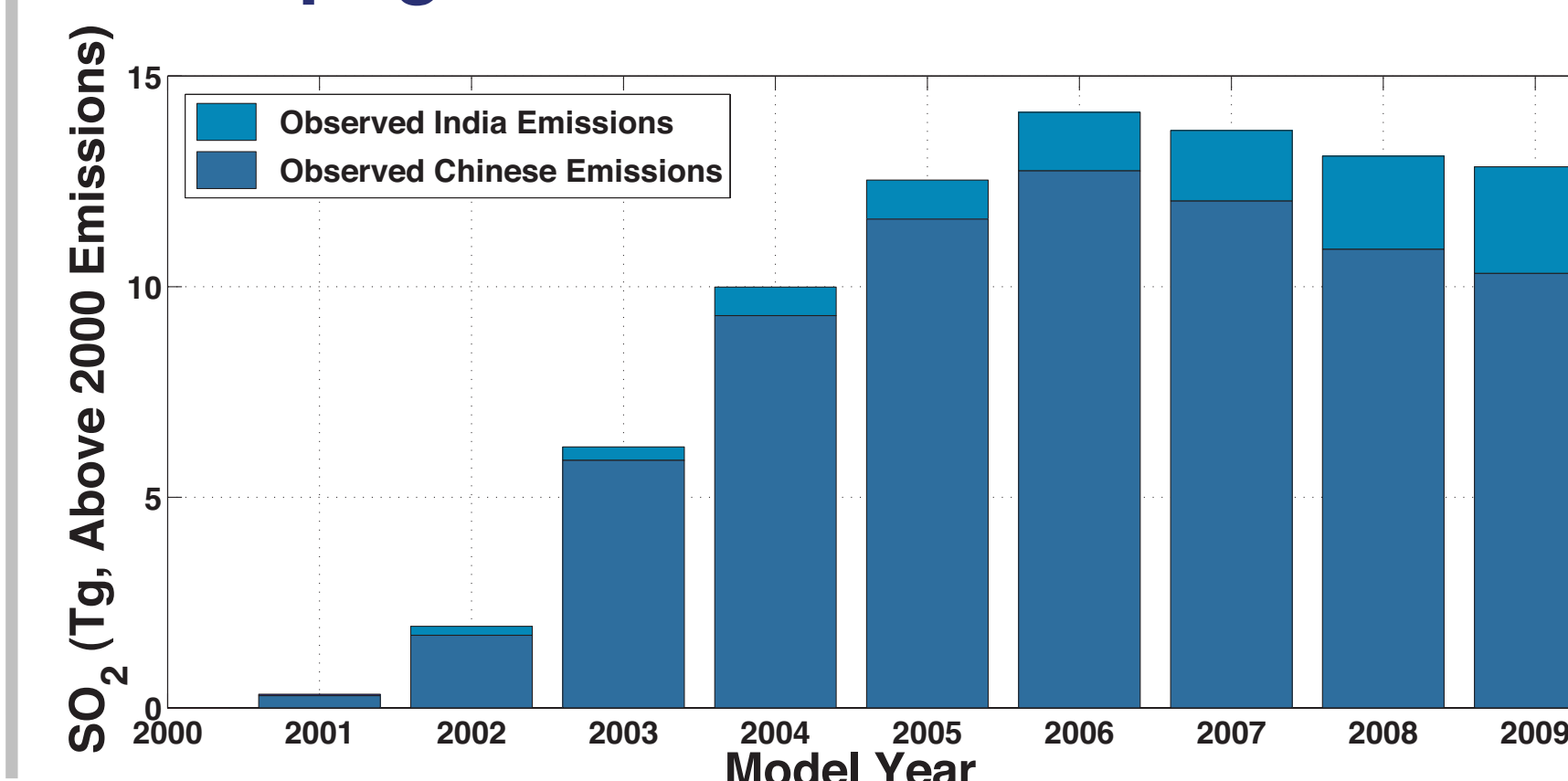
Three model emission scenarios:

- Base: Year 2000 emissions repeated.
- Volcanic: Base model emissions plus the SO₂ plumes from the 13 largest volcanoes from 2000 to 2010.
- Anthropogenic: Base model emissions plus the observed increases in Chinese and Indian emissions.

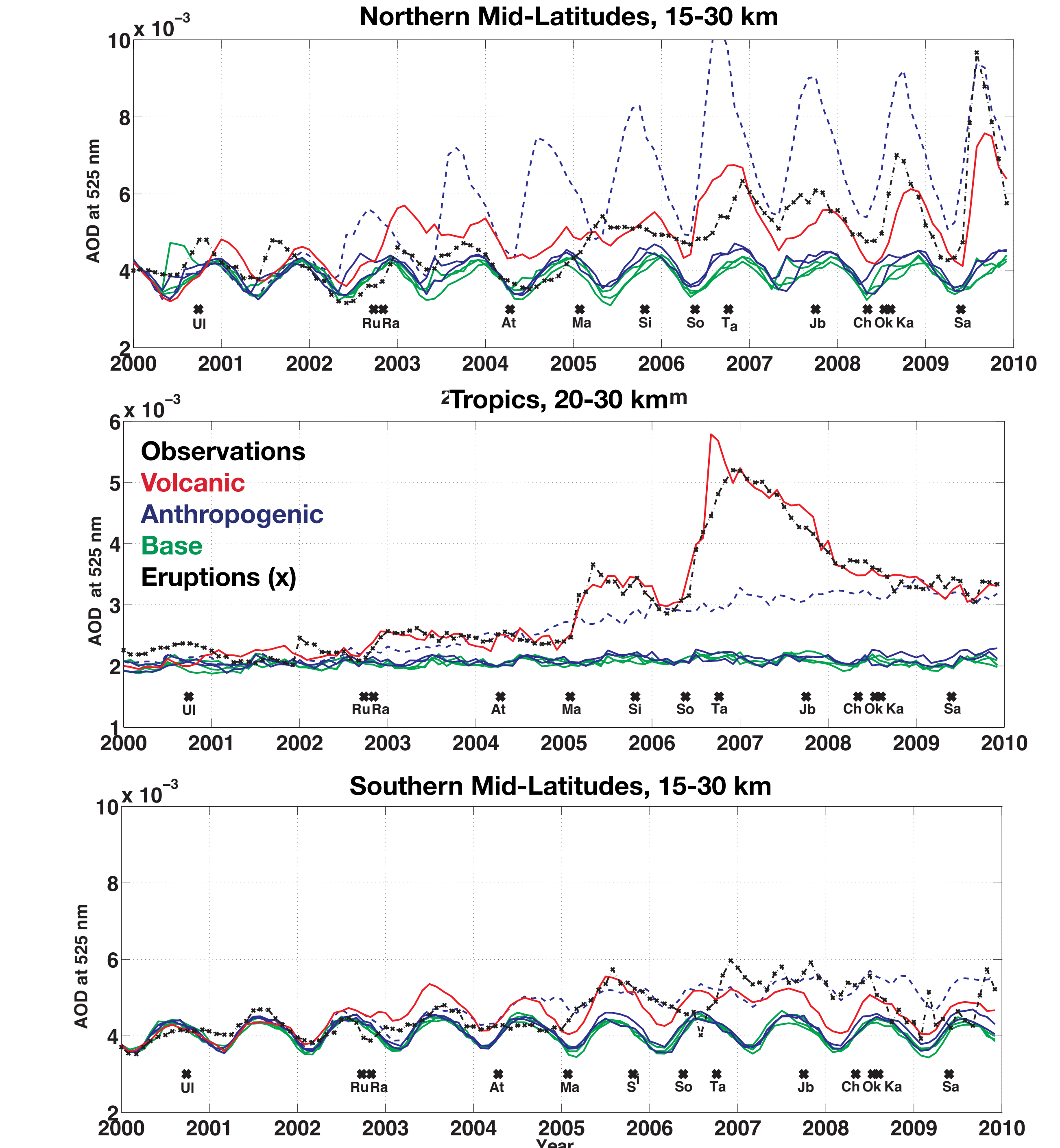
Inputs:



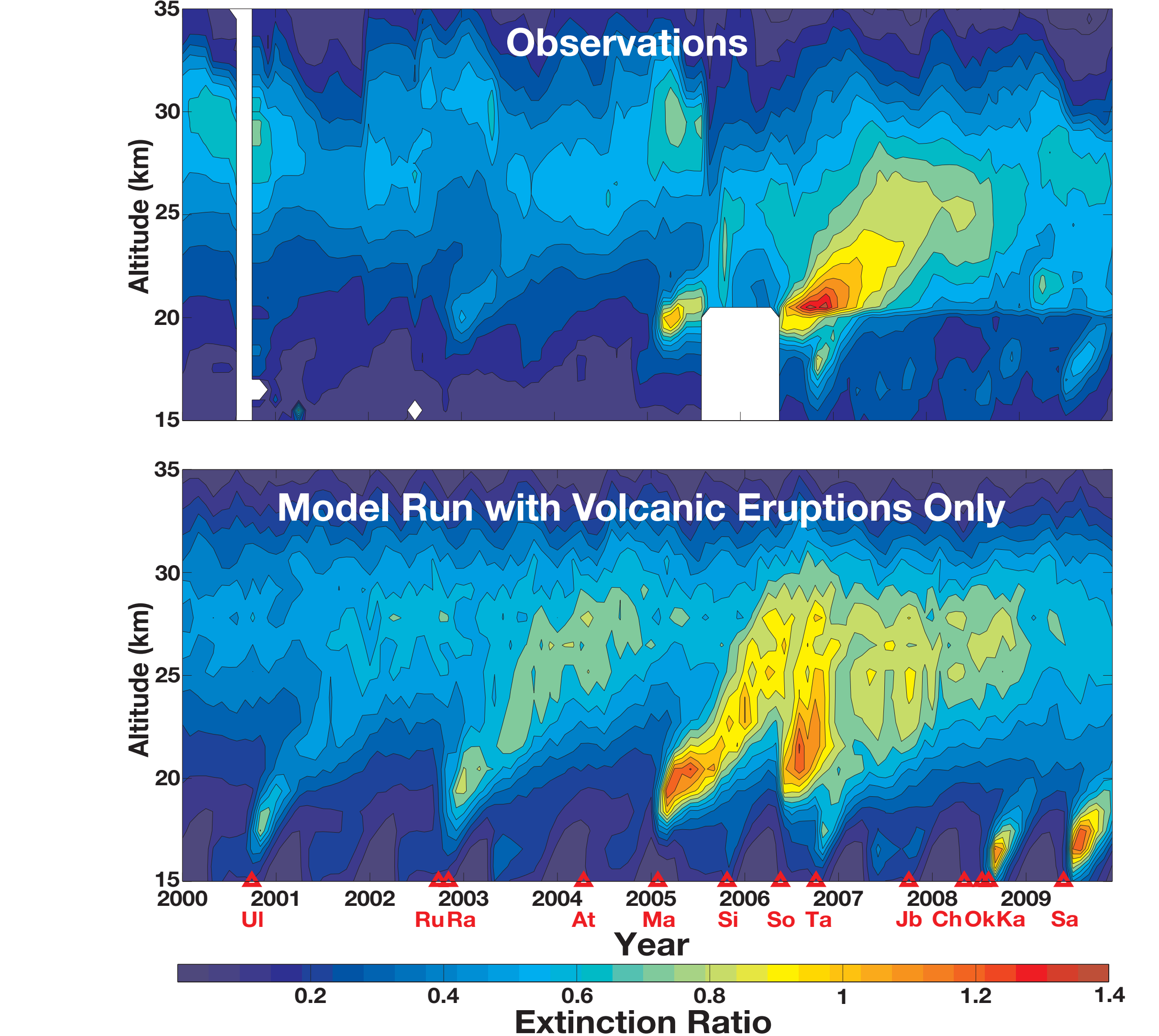
Total annual change in Chinese and Indian SO₂ emissions added to the anthropogenic model runs.



RESULT



Tropical (20 N-20 S) Zonal Monthly Mean



SUMMARY

- Observations suggest stratospheric aerosol has increased 4-7% per year from 20 km to 30 km since 2000, which is significant for Earth's climate.
- Observations alone cannot partition the influence of anthropogenic emission of SO₂ from China and India from moderate volcanoes.
- Here we use a global climate model coupled to an aerosol microphysical model to partition the contribution of each.
- Moderate volcanic eruptions are the primary source of the observed increase in stratospheric aerosol, not Chinese and Indian emissions.