

Stratospheric Aerosol Geoengineering :What do we need to know?

Owen Brian Toon

Department of Atmospheric and Oceanic Sciences

University of Colorado

Boulder



What sorts of things do we need to know

Chemistry

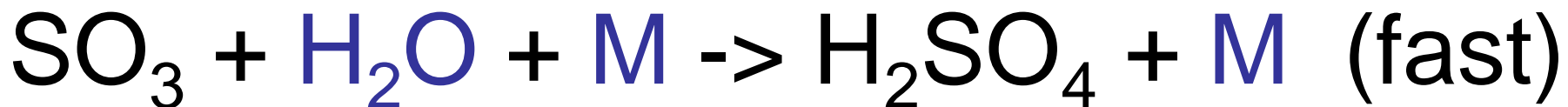
Microphysics

Optical properties

Atmospheric response

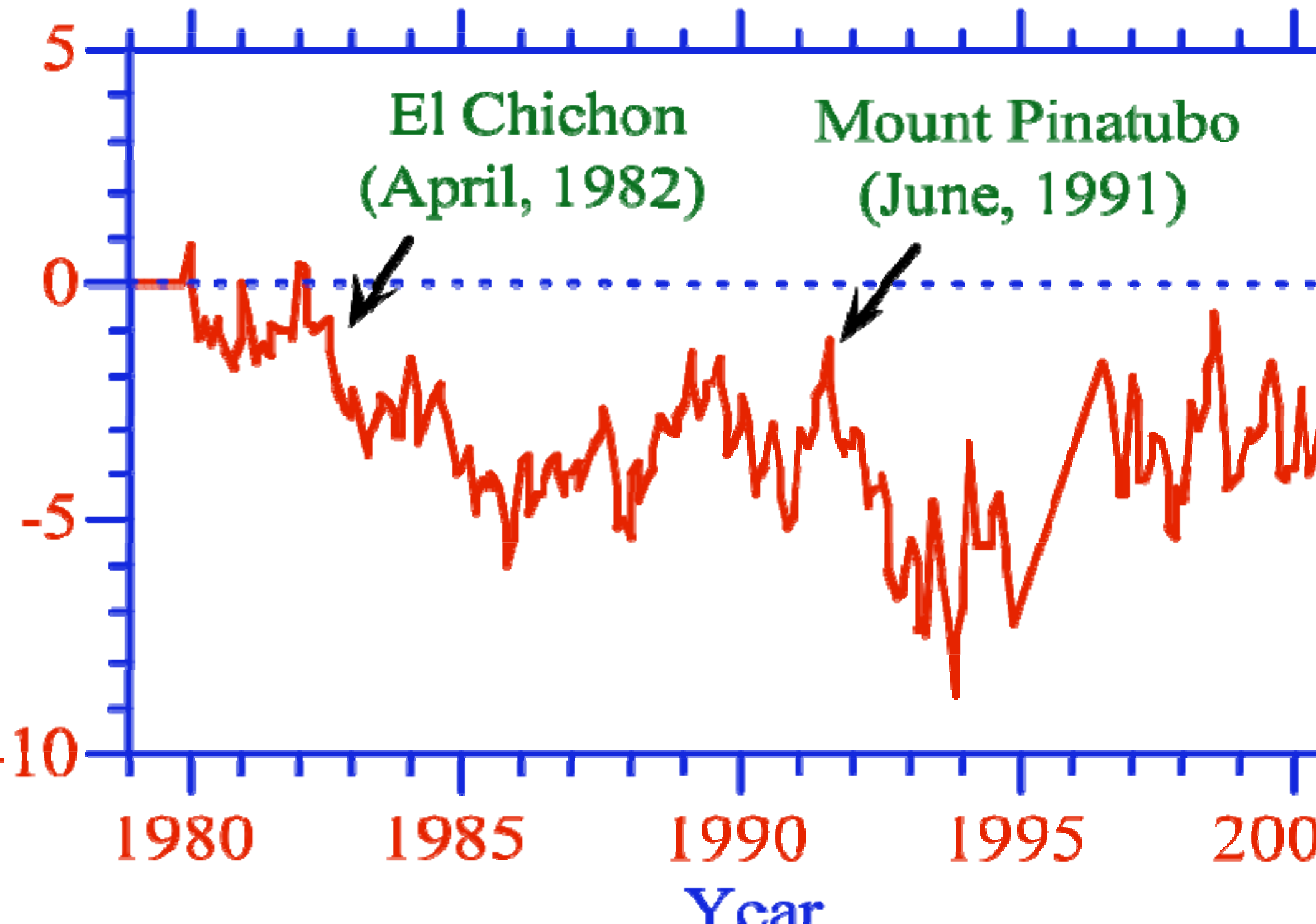
in situ

(measured in ambient stratosphere=blue)

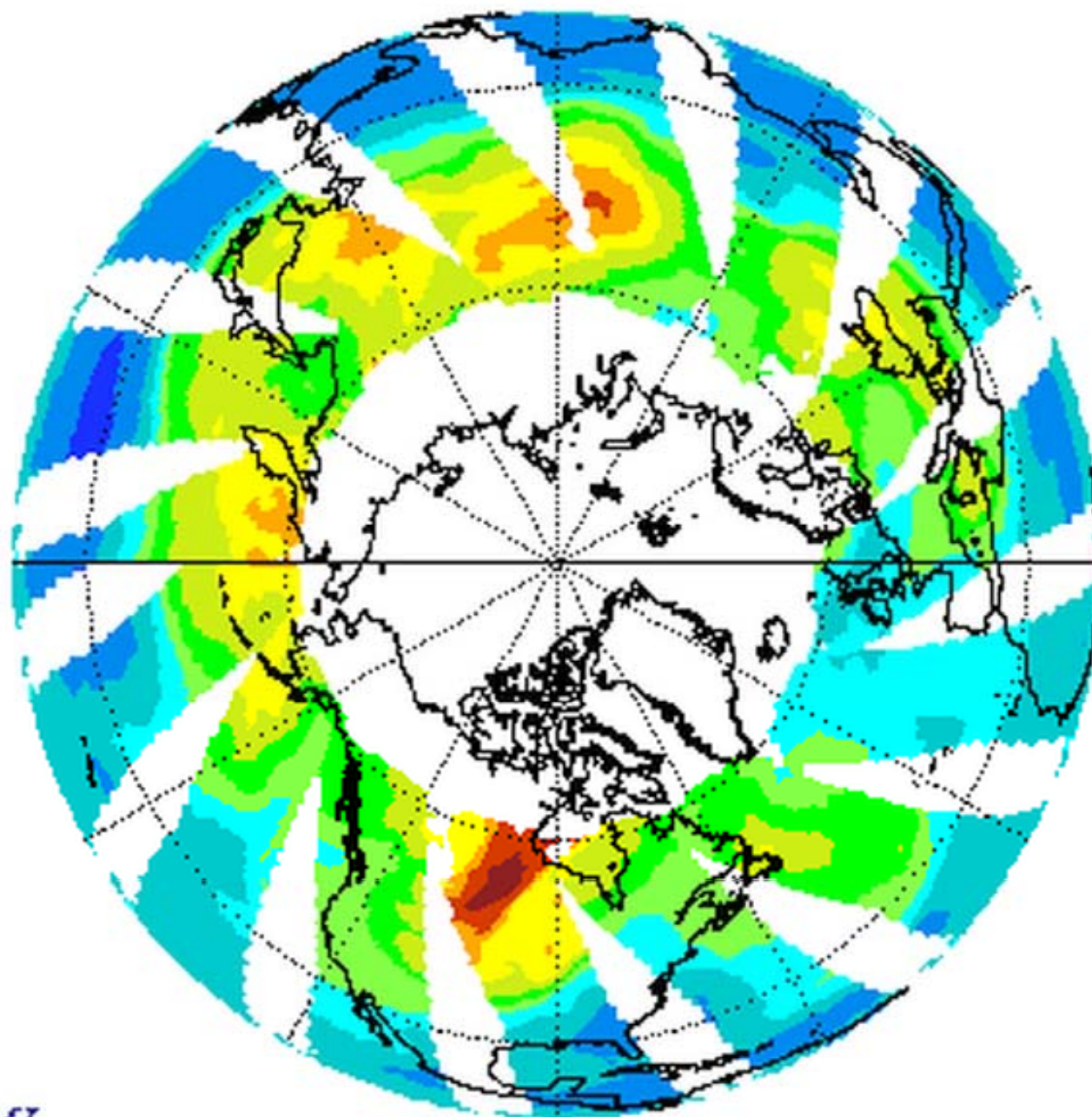


Simplest chemistry shown
really about 20 reactions

Ozone From 1979-2001



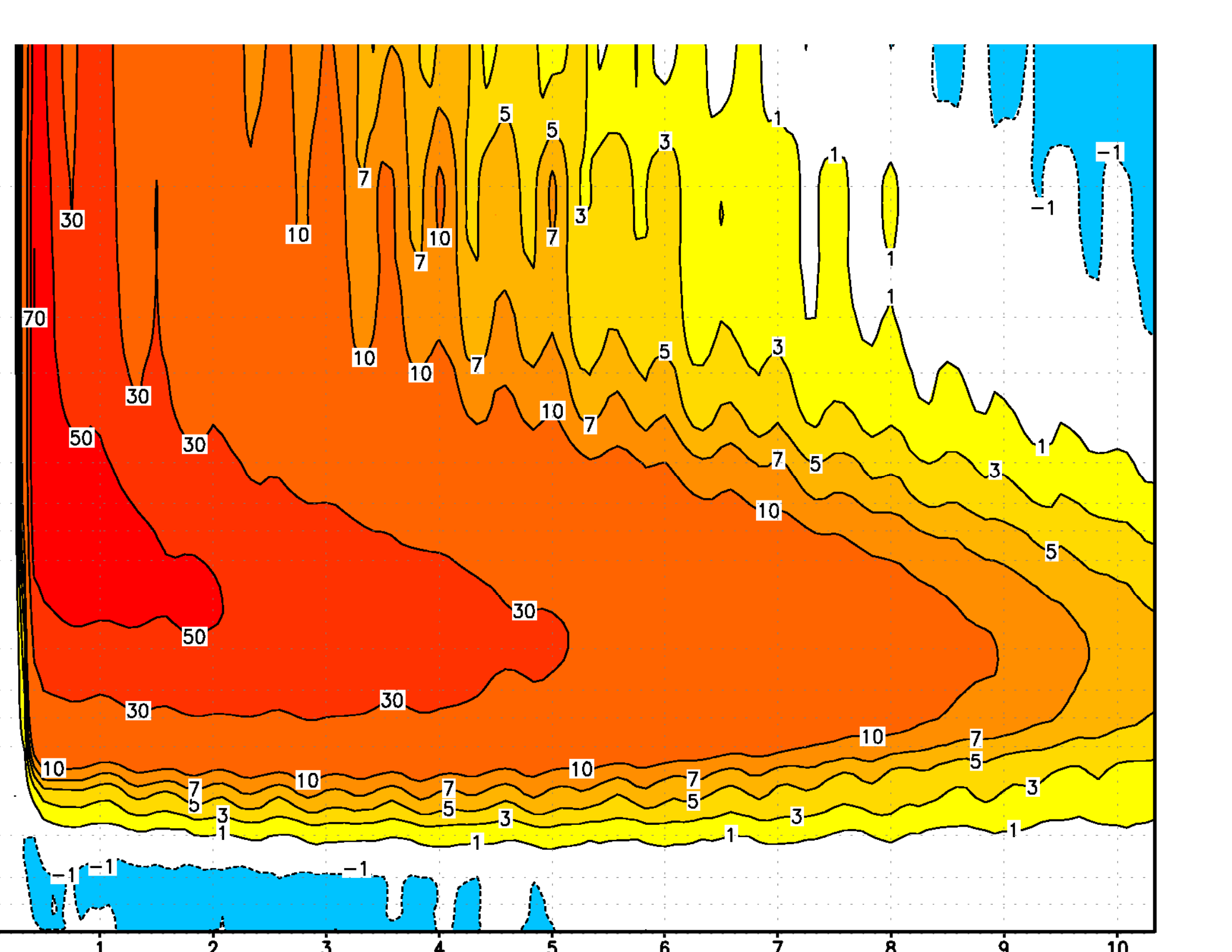
OMI Total Ozone for Jan 1, 2011



NASA-KNMI

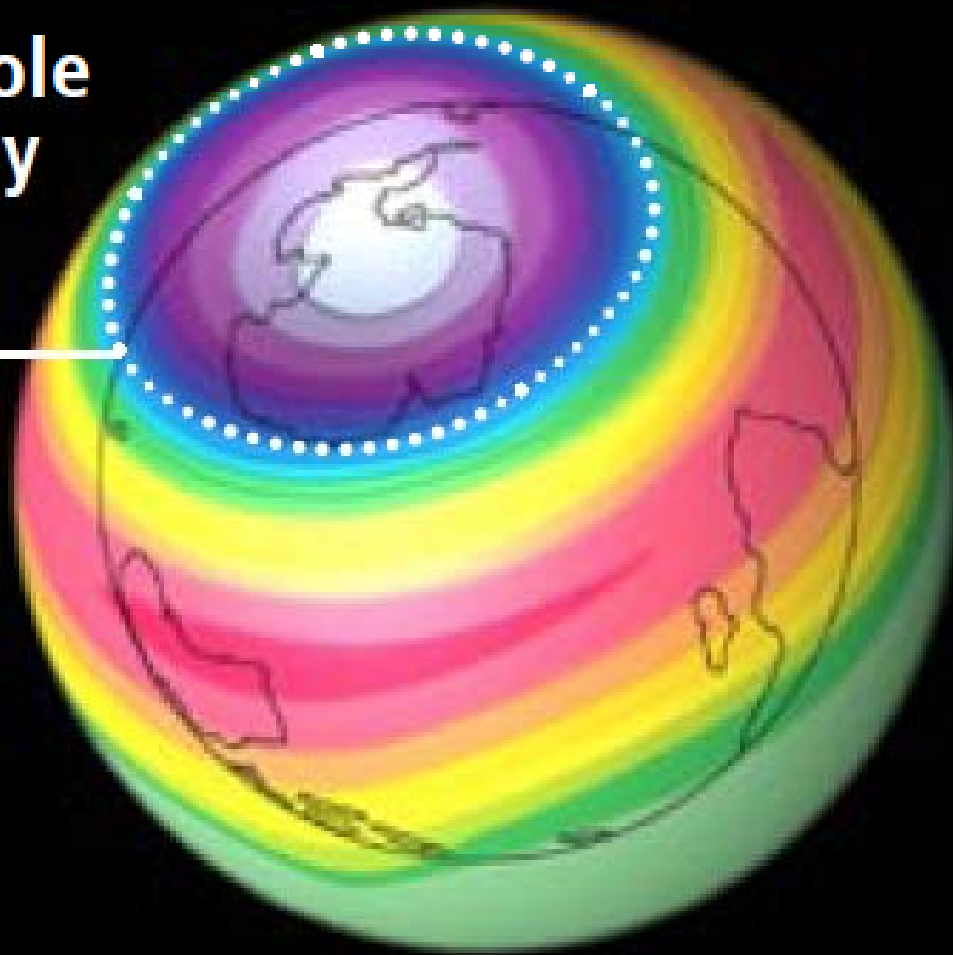
GSFC



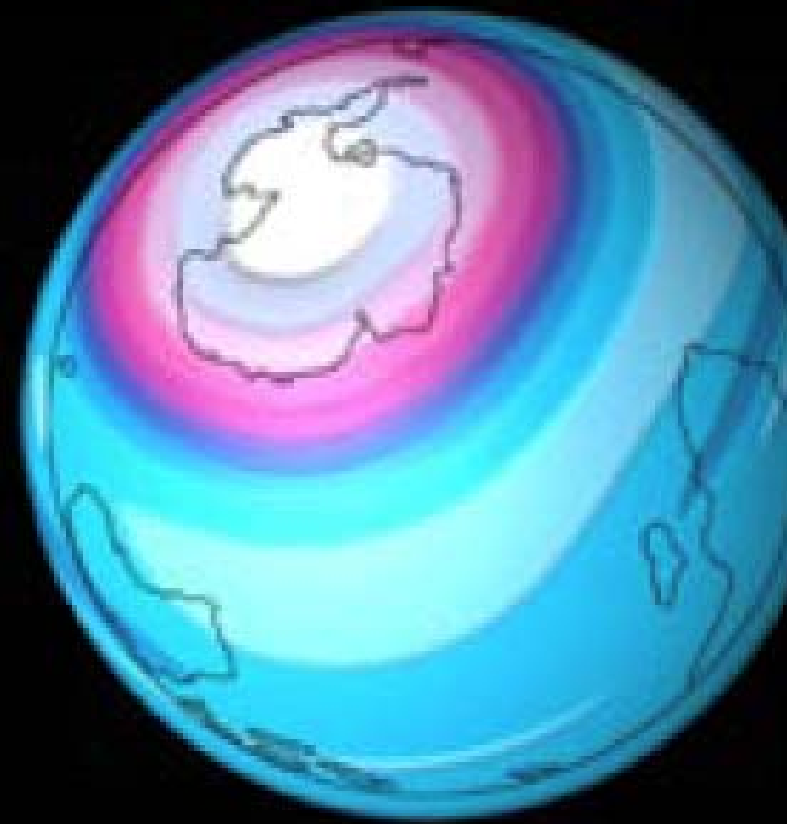


TYPICAL OZONE DISTRIBUTION (October 2008)

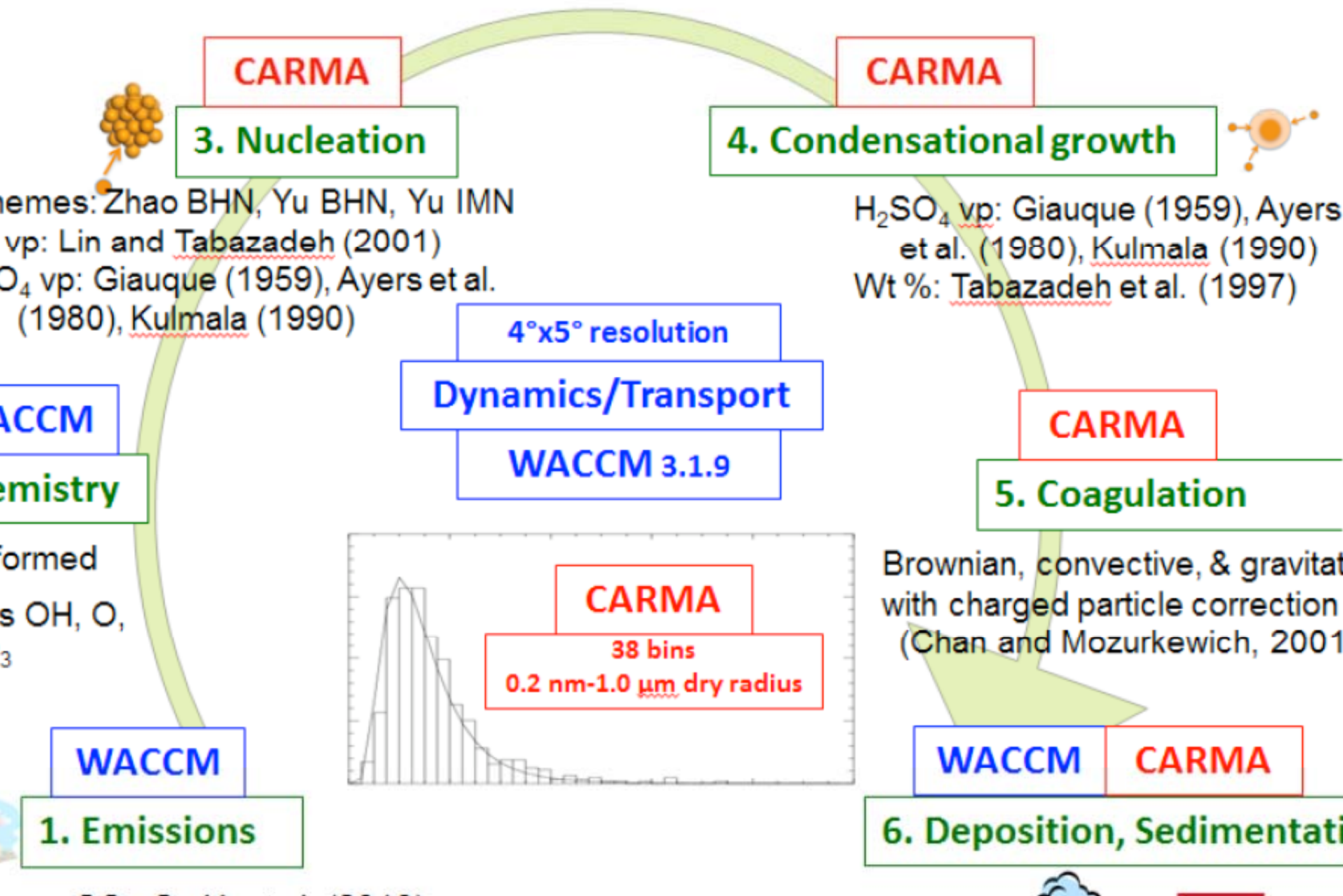
Ozone hole
boundary
(220 Du)



OZONE 17 MONTHS AFTER SOOT INJECTION



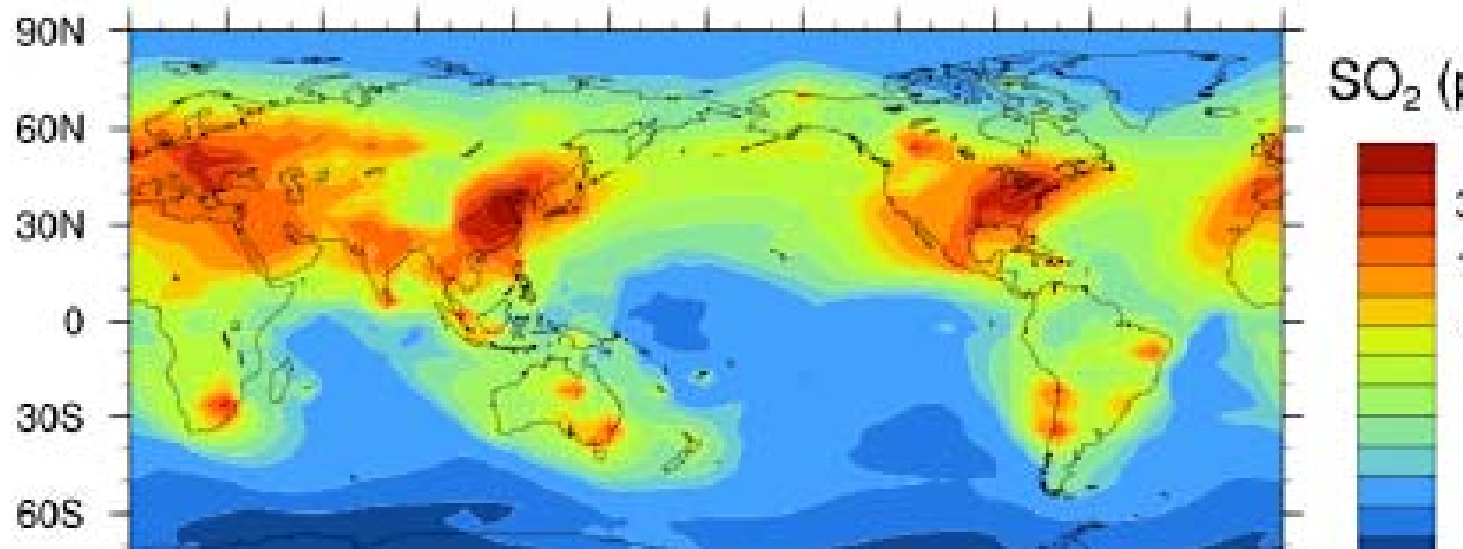
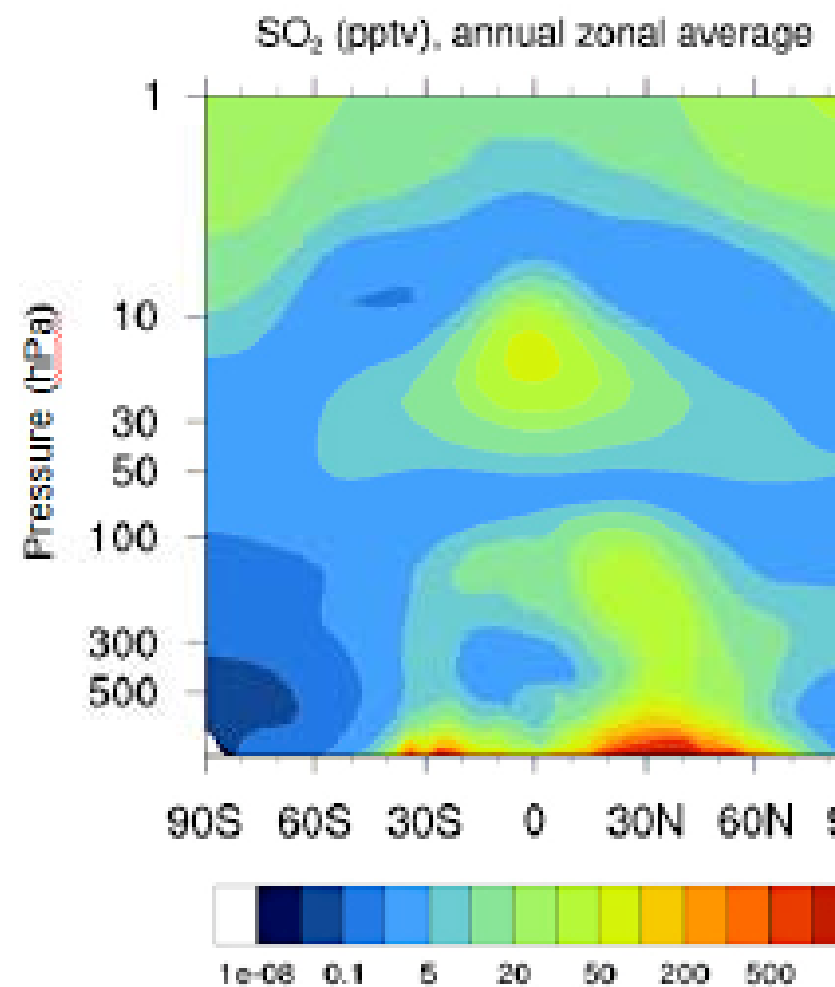
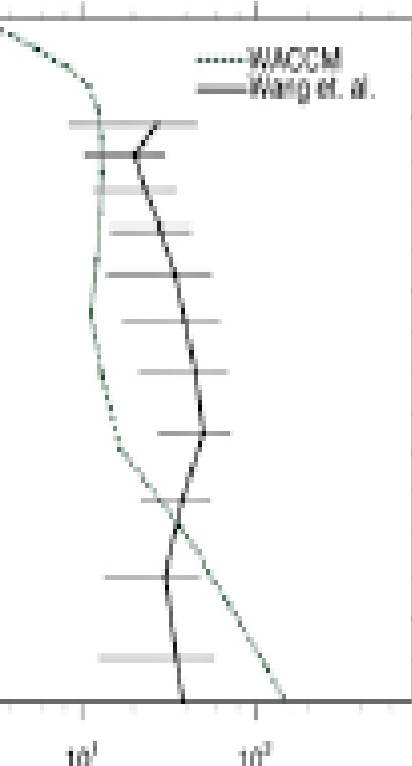
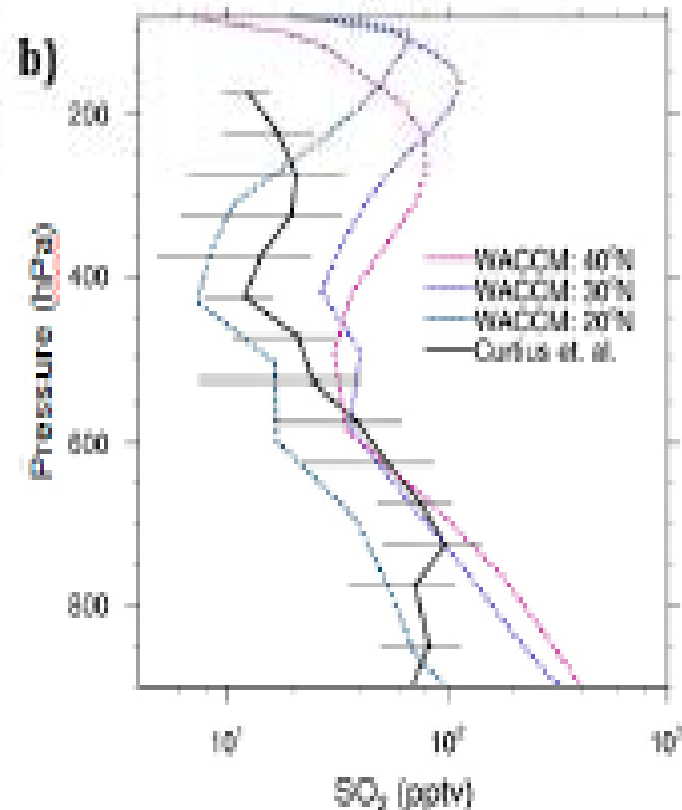
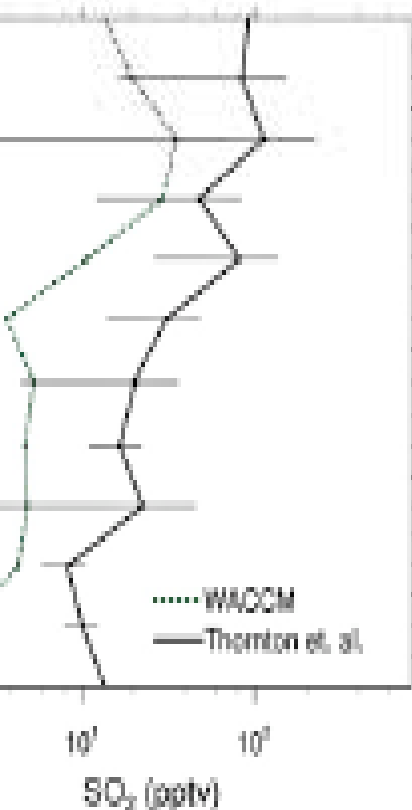
WACCM/CARMA Model

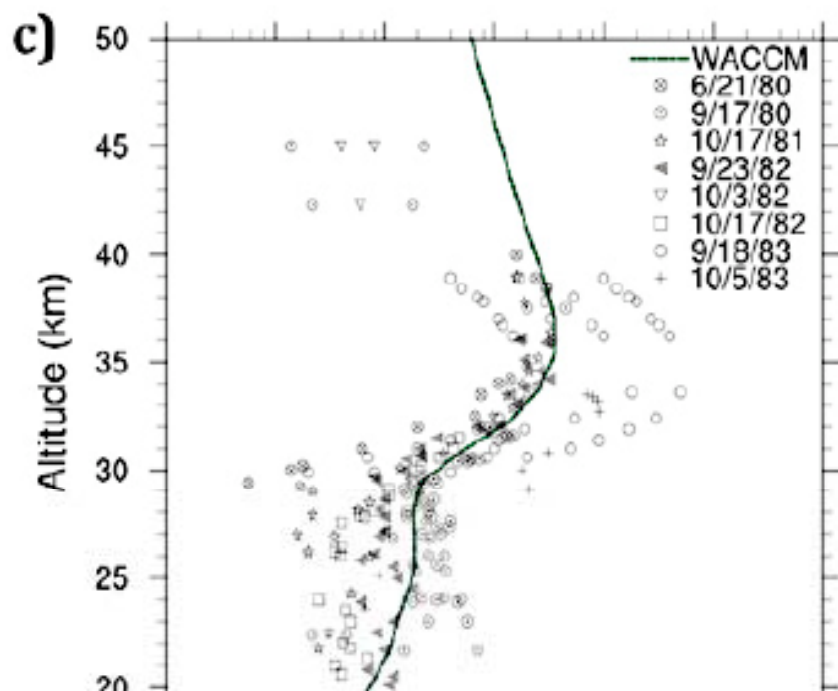
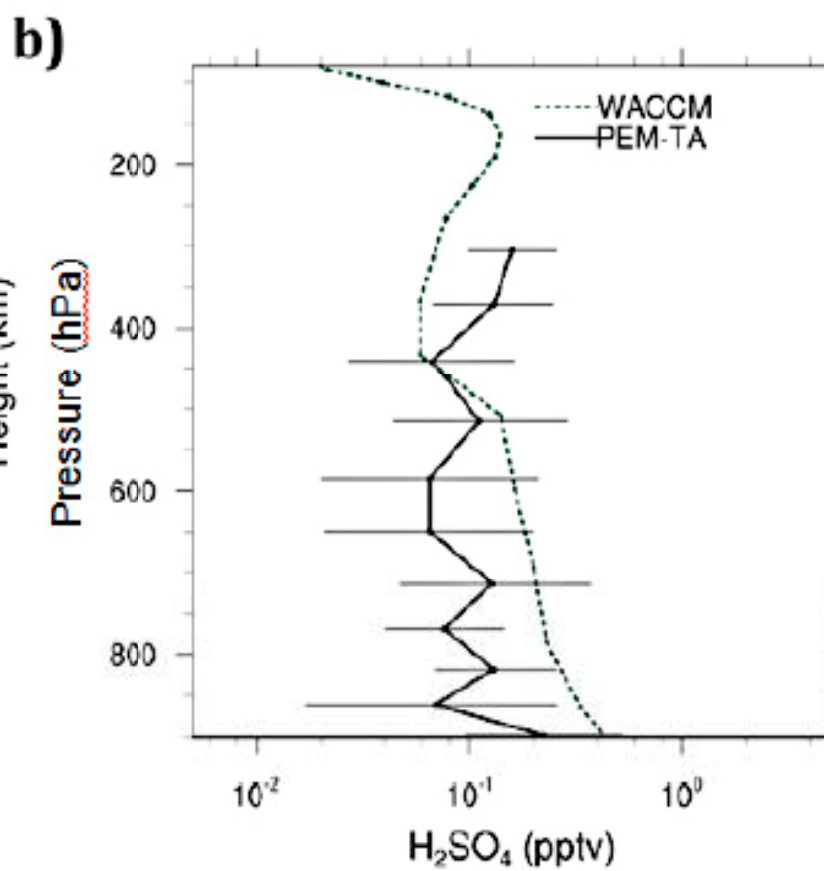
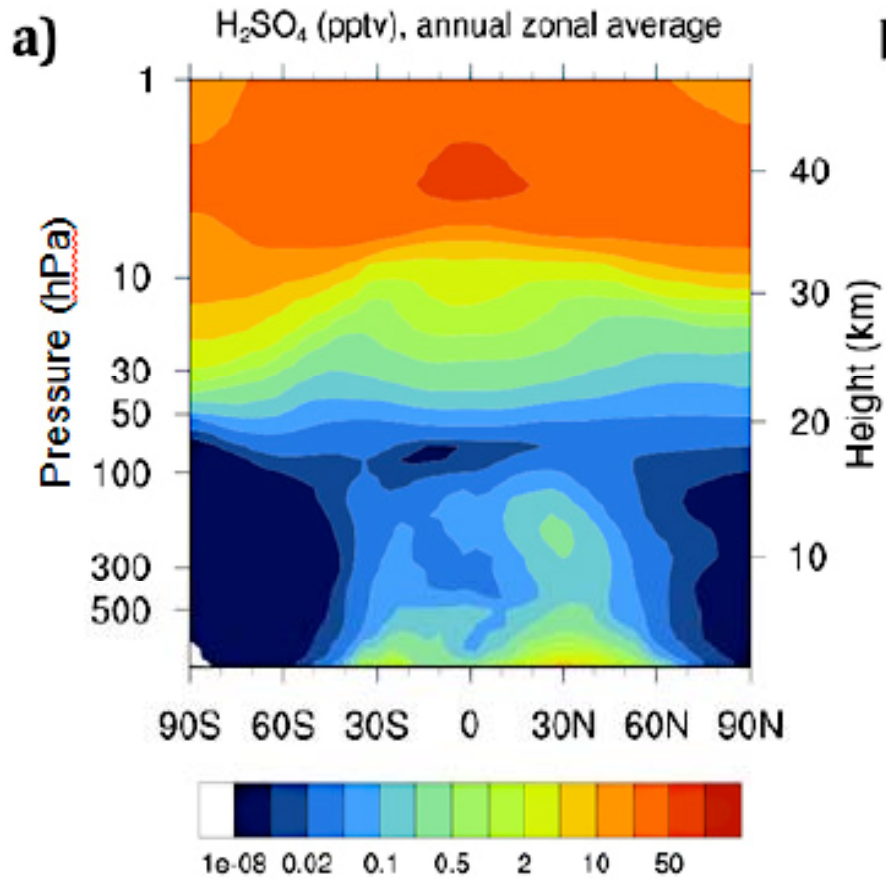


Creation-theories are poor and constraining data are sparse. May not be too important.

Coagulation-theory is well developed. However, Van der Waal's forces may matter.

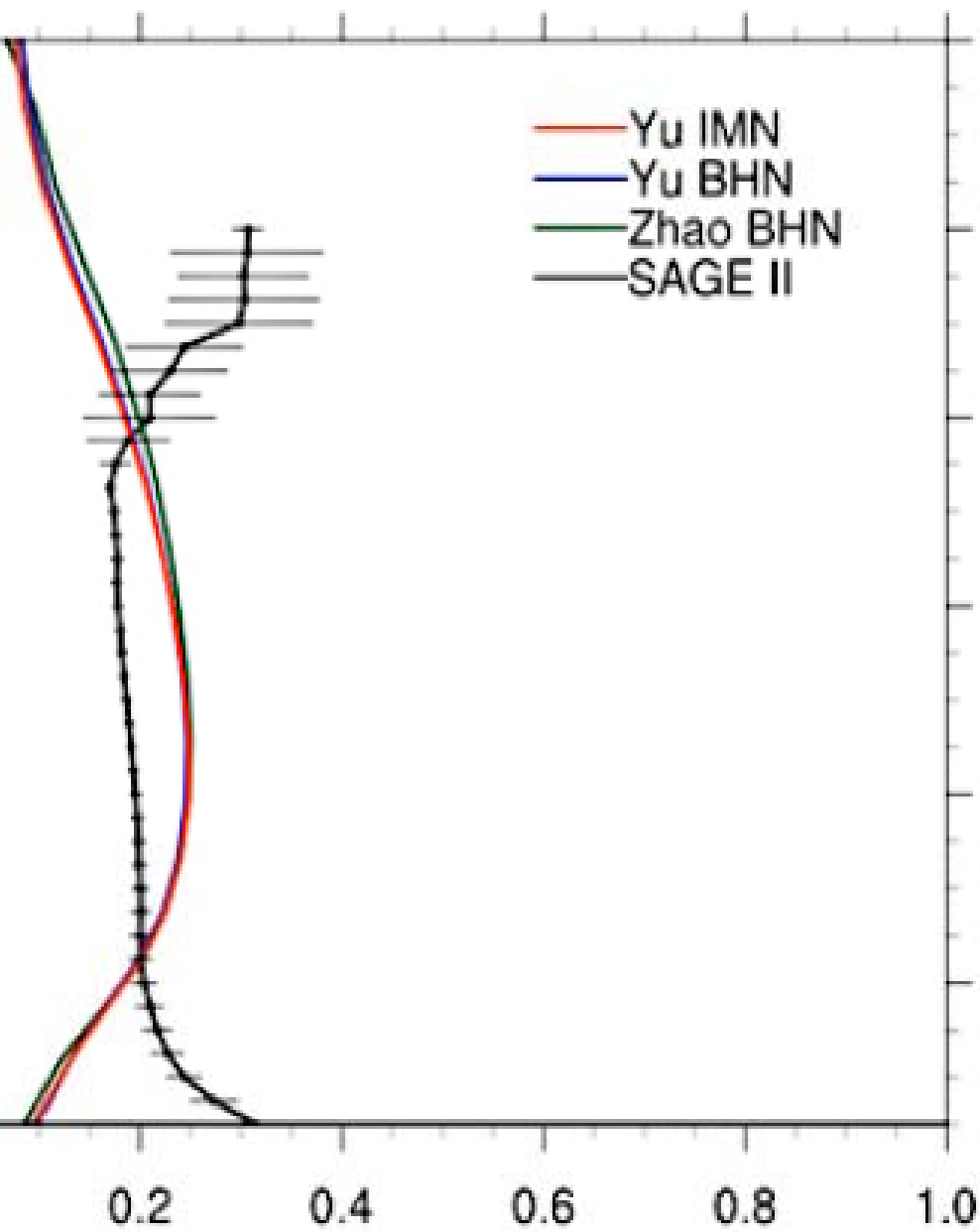
Condensational growth-vapor pressures not measured at ambient temperatures, sticking coefficient not known, effects of supercooling/freezing unknown.



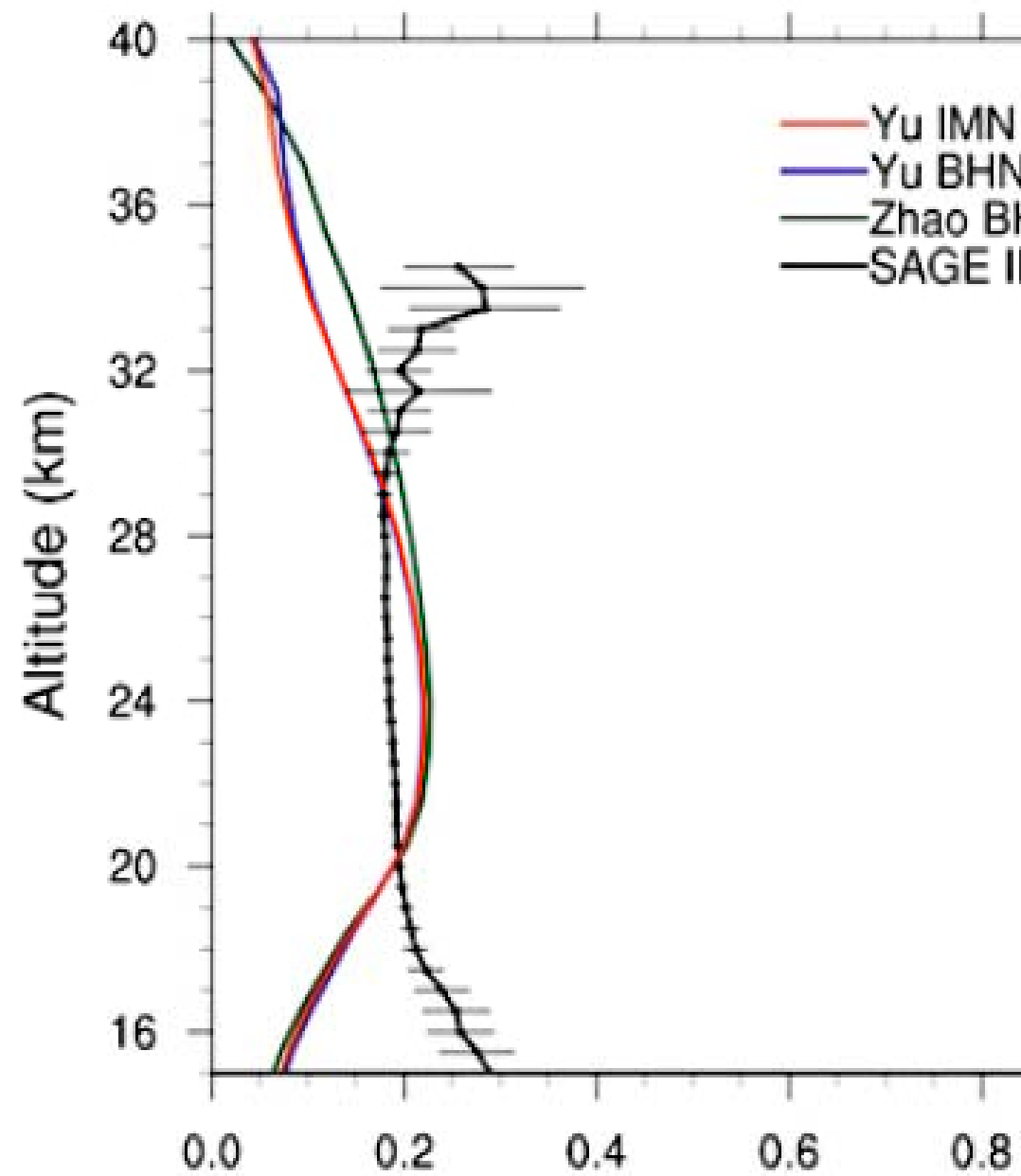


Effective Radius

Latitude -15 to 15

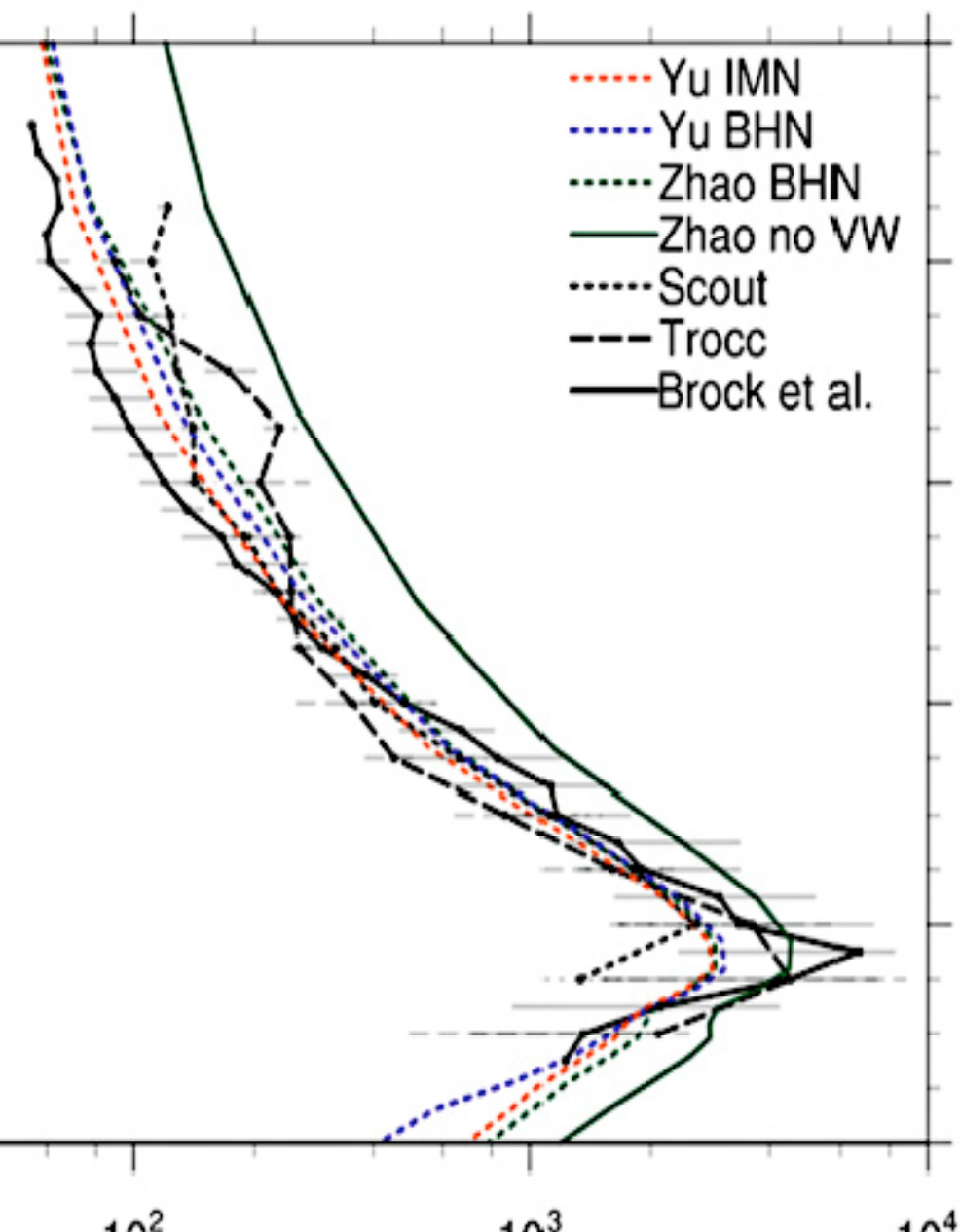


Latitude 15 to 30



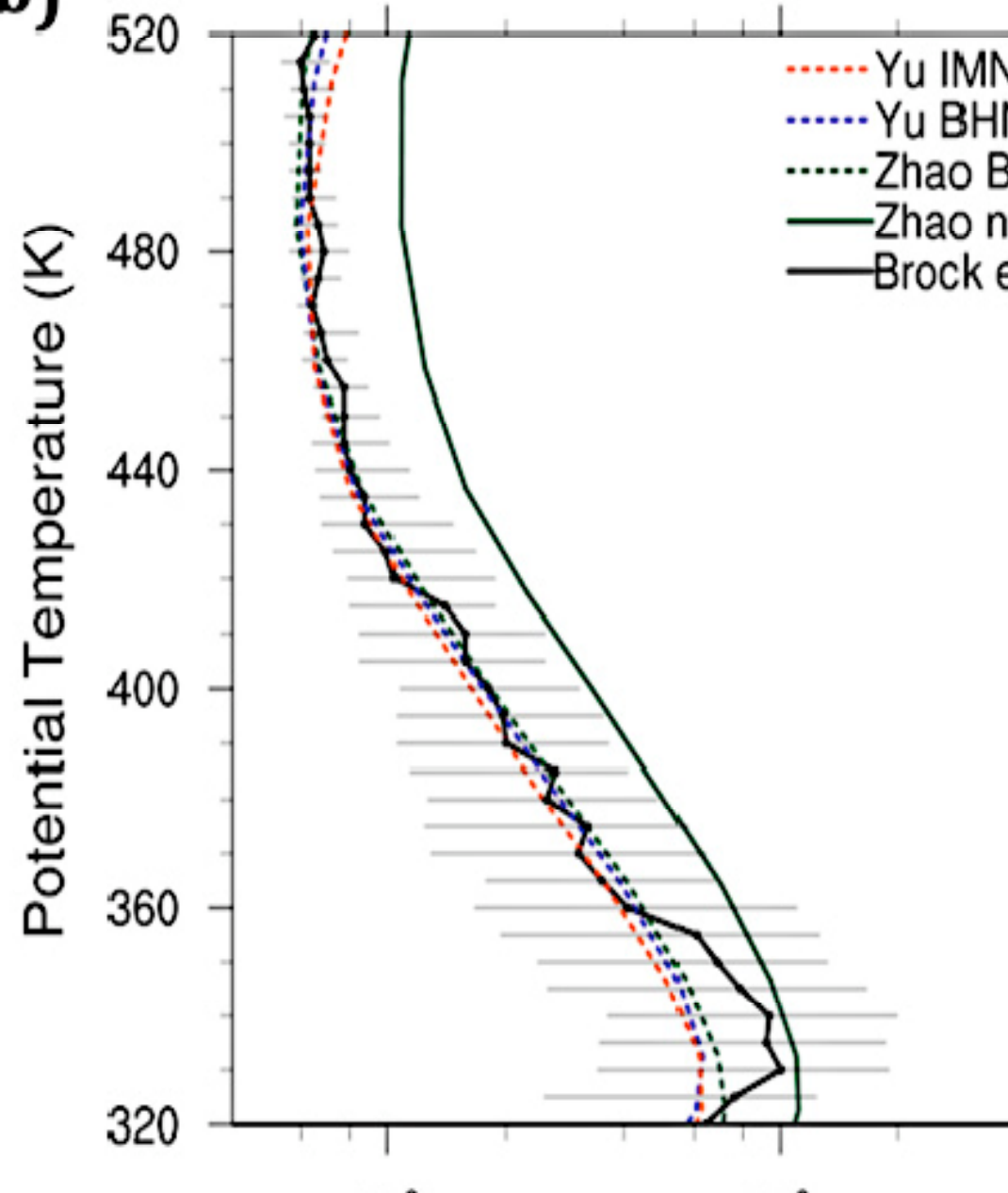
Concentration

Tropics



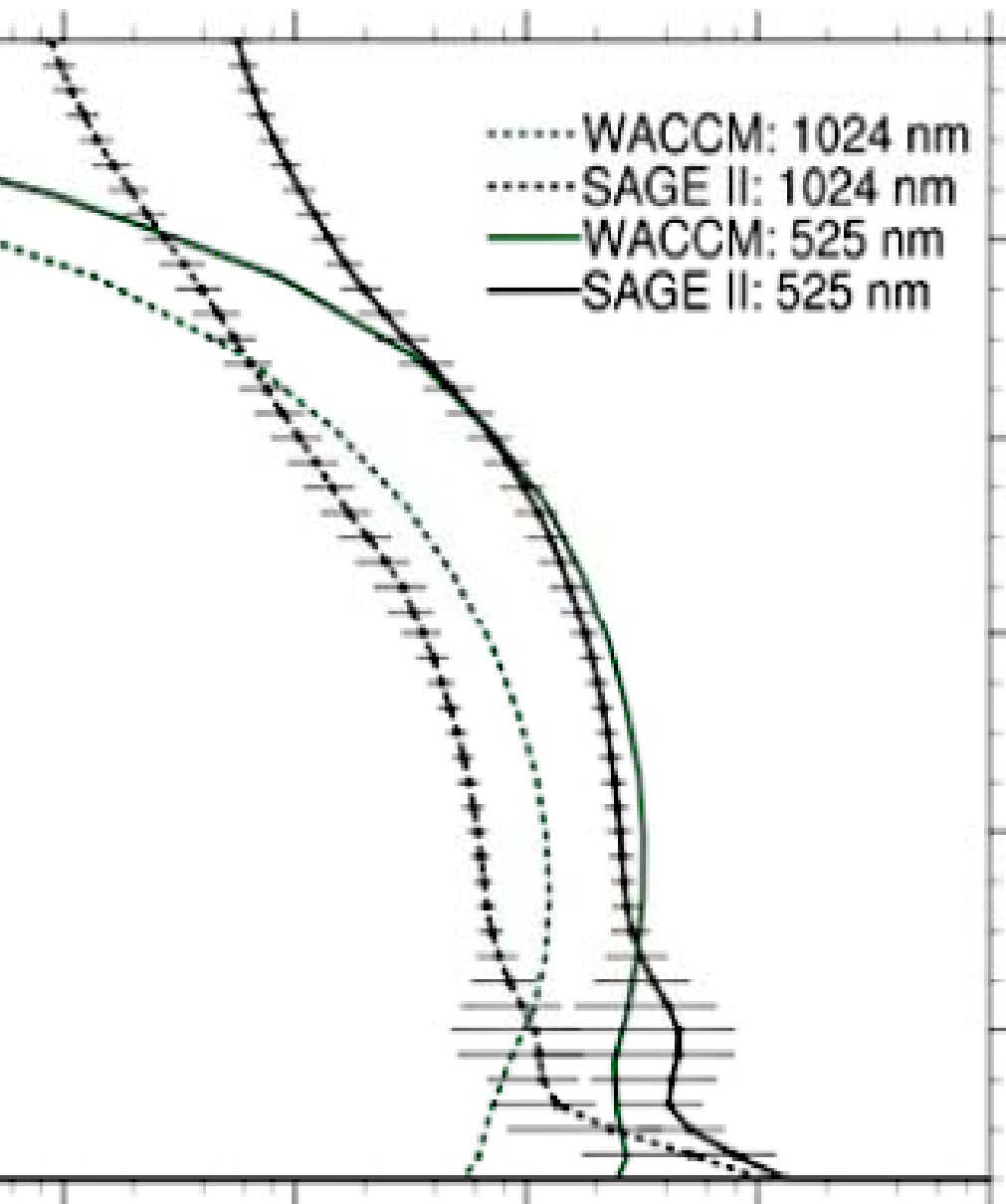
b)

Extratropics

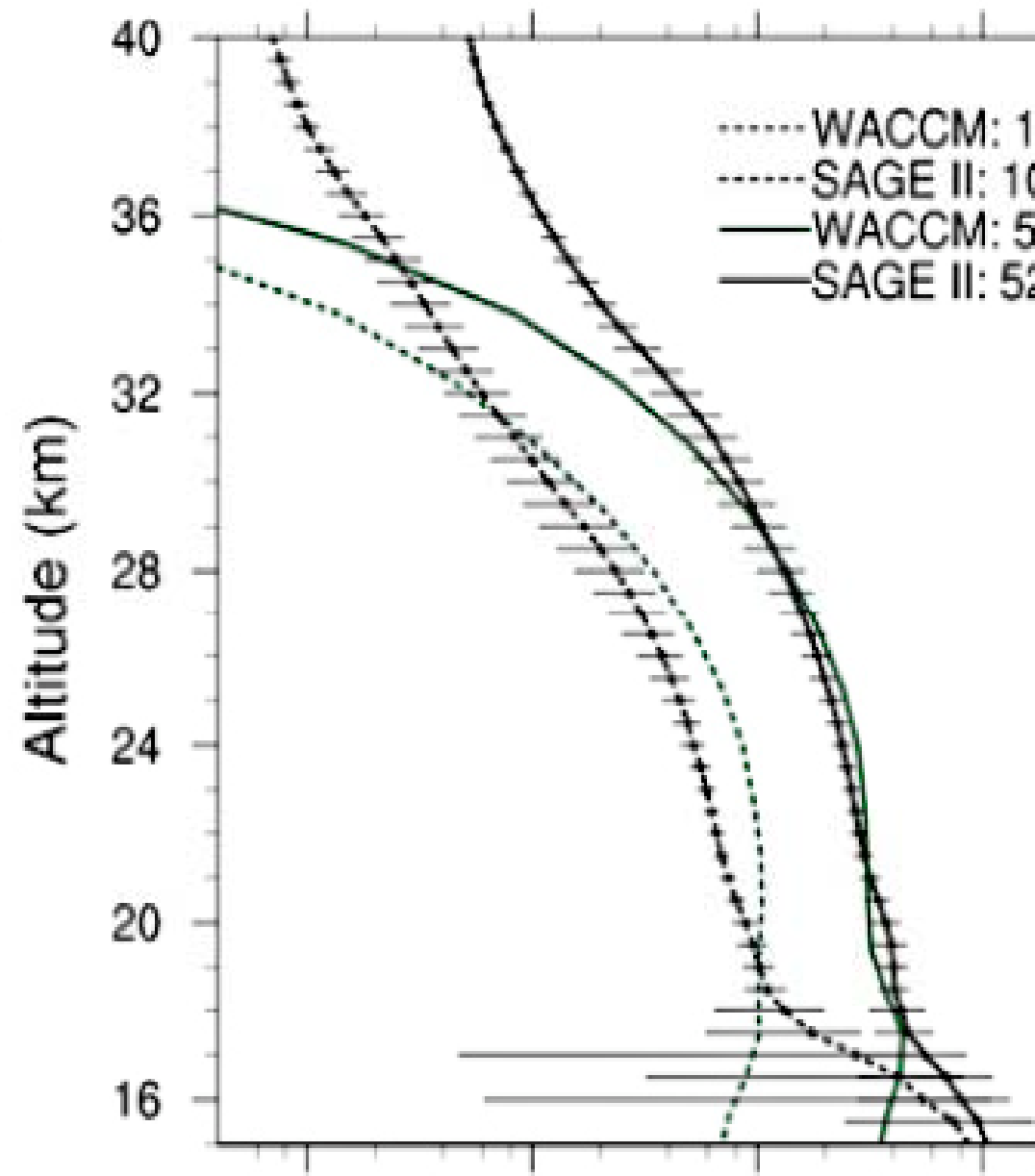


Properties

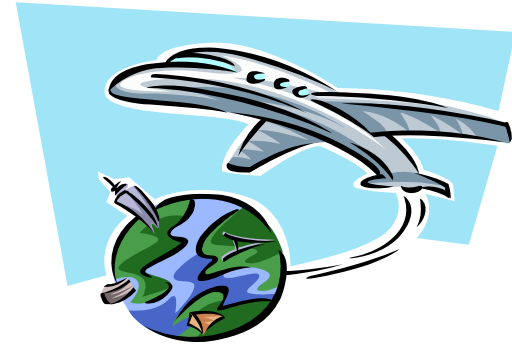
Latitude -15 to 15



Latitude 15 to 30



* Investigate ways to inject sulfur into the stratosphere-



explore microphysics to constrain particle sizes

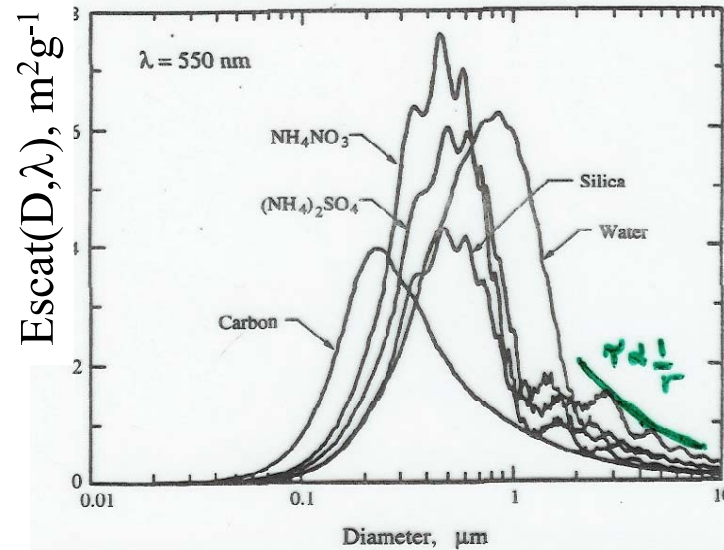
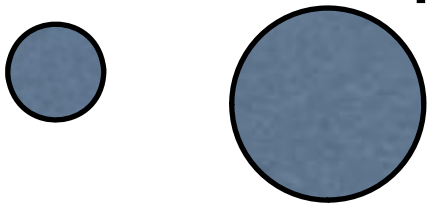


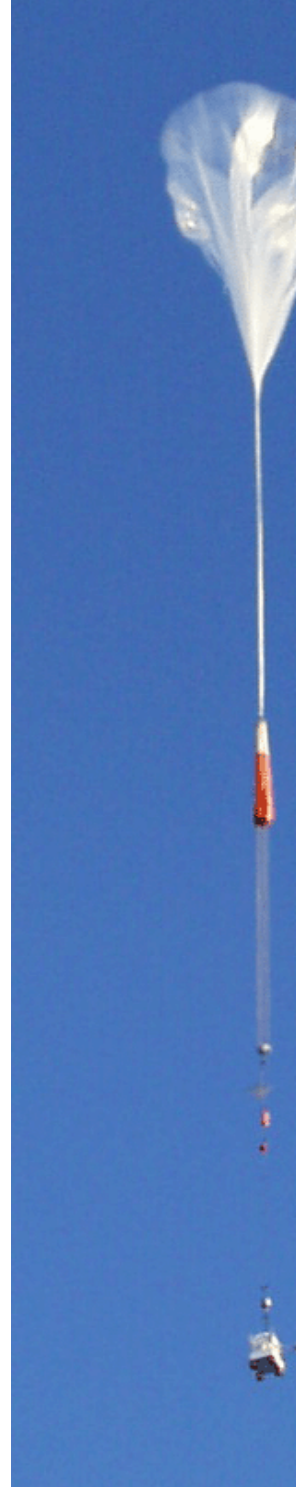
FIGURE 22.7 Mass scattering efficiencies of homogeneous spheres of $(\text{NH}_4)_2\text{SO}_4$, NH_4NO_3 , carbon, H_2O , and silica at $\lambda = 550 \text{ nm}$.

Check for unintended consequences





Balloon



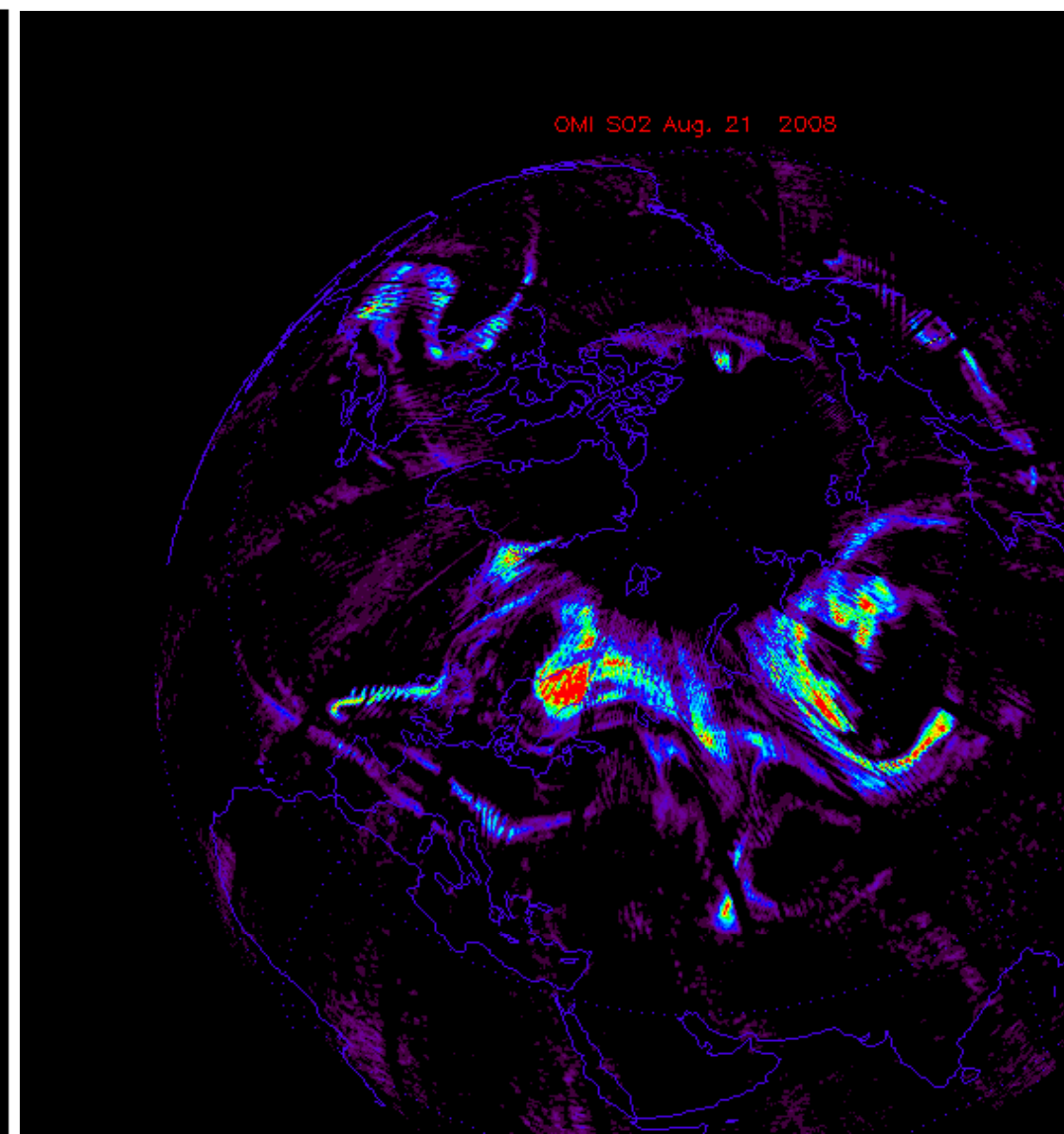
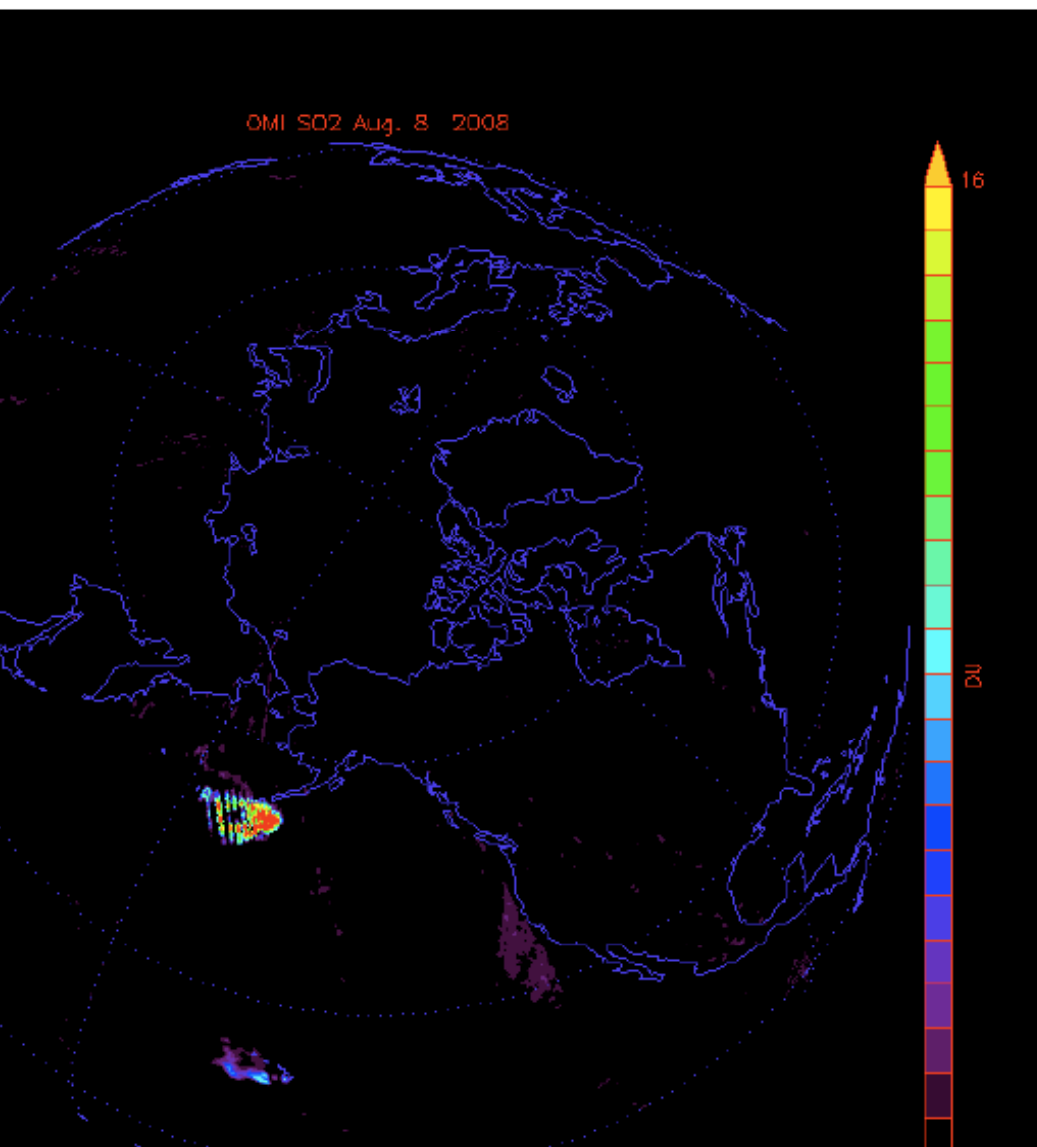
C-8



Platforms used in Solve to study ozone loss and recovery

Volcanic eruptions will provide opportunities to study
injections.

Volcanic SO₂ cloud Aug 8 and Aug 21,



Summary

We need field missions dedicated to confirming we understand stratospheric sulfur chemistry and microphysics as well impact of sulfate aerosols on ozone. Some chemical instrument development needed

It would be a bad idea to put light absorbing particles into the stratosphere, significant ozone loss could occur.