WACCM & CARMA at CU/LASP

- WACCM/CARMA
  - Volcanic clouds (R. Neely)
  - *PSCs (Y. Zhu)
  - *Early earth haze (E. Wolf)
  - *Sulfate nucleation (J. English)

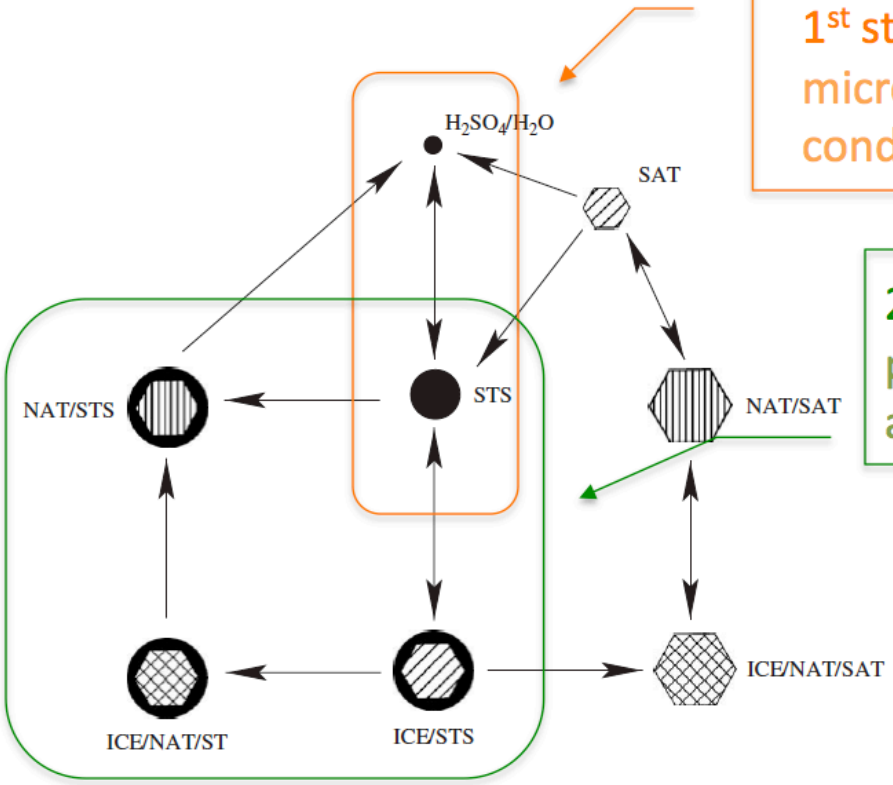
- CAM/CARMA
  - Tropospheric dust (L. Su)
  - Sea salt (T. Fan)
  - Mars (R. Urata)
  - Titan (E. Larson)

Microphysical Modeling of Polar Stratospheric Clouds Using the WACCM/CARMA Model

Yunqian Zhu, Brian Toon

CARMA: condensation, nucleation (freezing), and evaporation

MOZART: simulate the heterogeneous reactions on PSC particles



Initial data: total gc for HNO3 and H2SO4

WACCM: Chemistry process to update gc and pc

CARMA: Conden process to update pc and gc

1st timestep: set up pc

Right now!

1st step: building the STS-PSC microphysics model with condensation/evaporation

2nd step: Add nucleation/freezing processes into the model (i.e. NAT and ice particles) step by step

3rd step: Comparison with MOZART parameterization results; CALIPSO data.

Yunqian Zhu

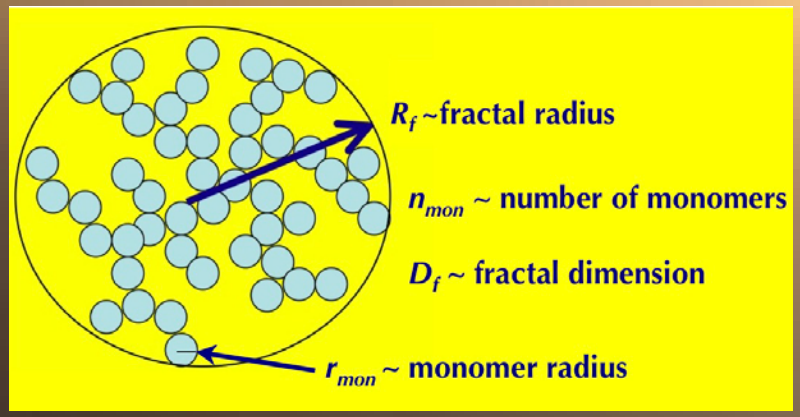
Fractal aggregate hazes provide an ultraviolet shield for early Earth.

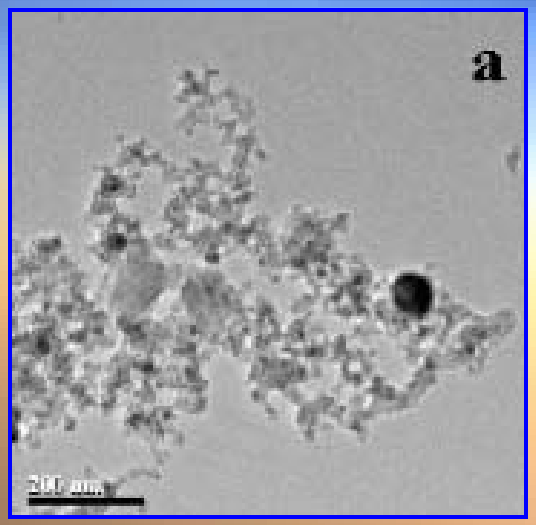
Titan-like photochemical hazes likely enshrouded the Earth during the Archean period (3.8 - 2.5 Ga).

Haze particles form loose aggregate structures that can be modeled using fractal geometry.

$$n_{mon} = \alpha \left(\frac{R_f}{r_{mon}} \right)^{D_f}$$

(Mandlebrot, 1977)





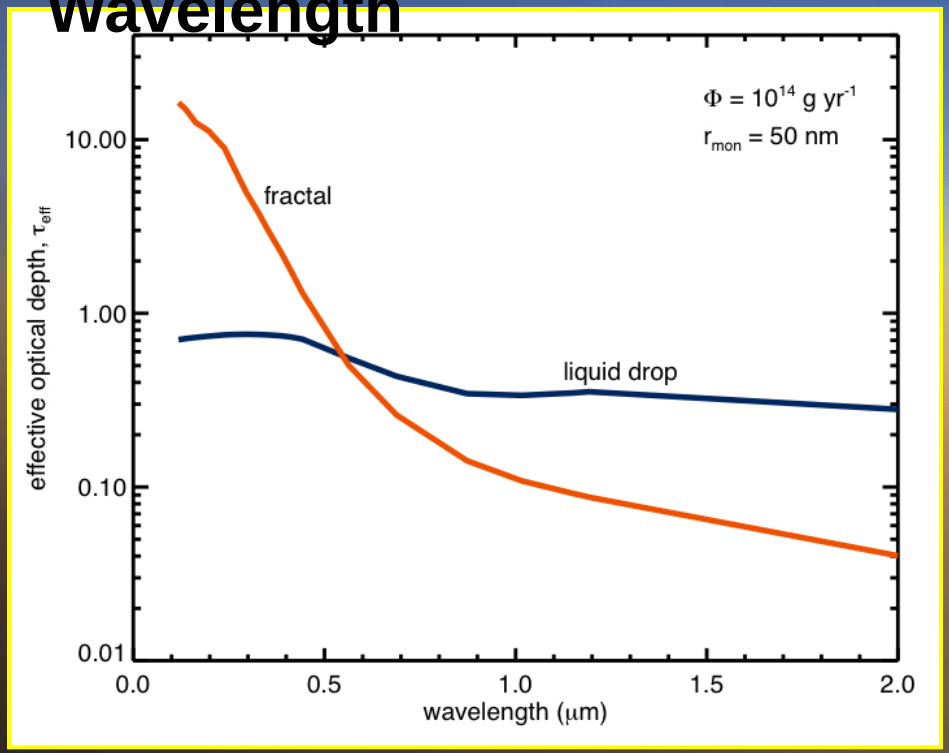
Eric Wolf

Fractal aggregate hazes provide an ultraviolet shield for early Earth.

Hazes Modeled Using WACCM/CARMA*

***modified for fractal aerosols**

Optical Depth vs. Wavelength



(Wolf & Toon, 2010 in press))

Fractal aggregates are strongly absorbing in the UV

Early Earth haze…

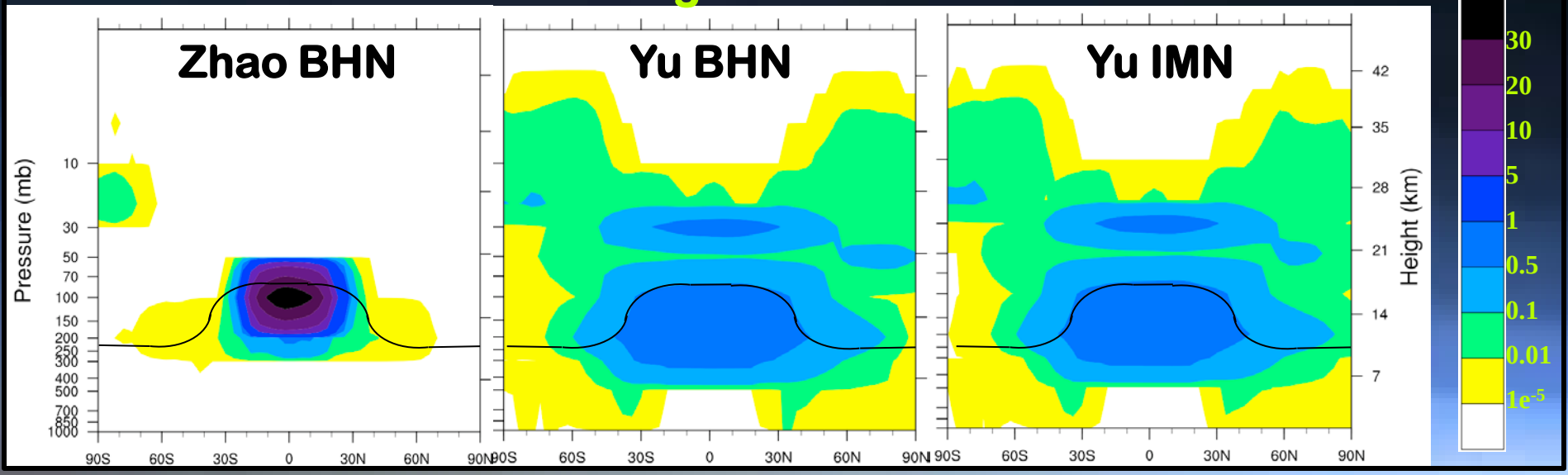
•protects young life from harsh UV of young Sun.

• allows photochemically unstable reduced gases to accumulate (NH_3), warming Earth despite faint young Sun.

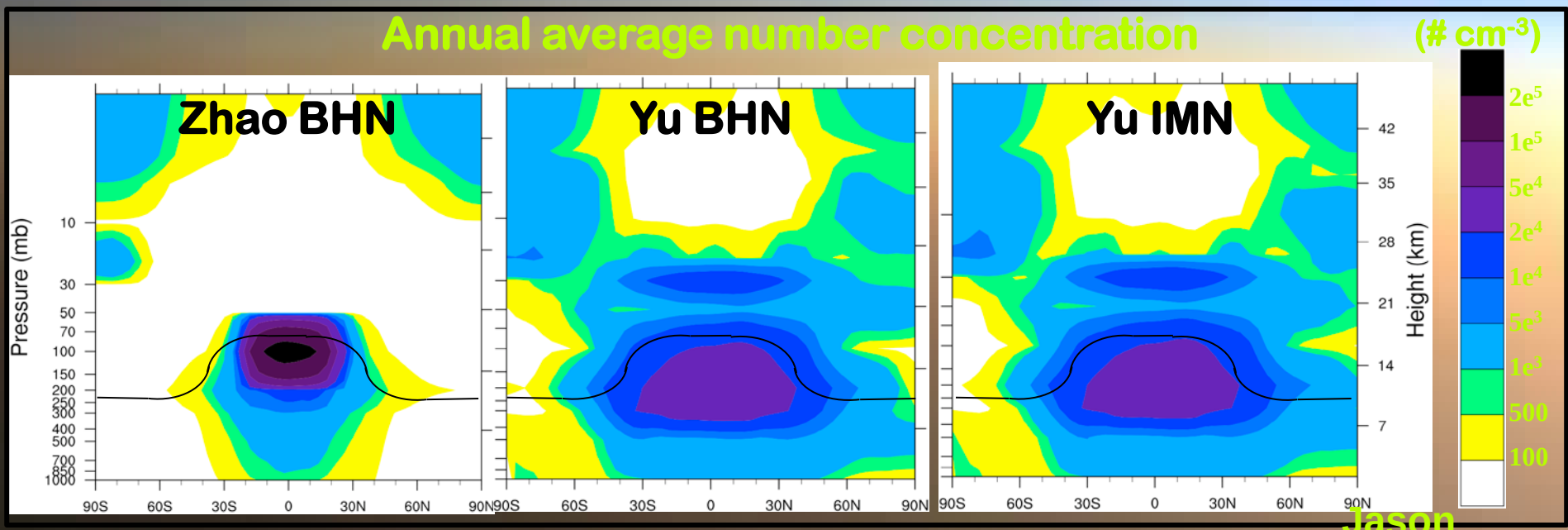
Eric Wolf

Sulfate nucleation differs 100x; ions insignificant

Annual average nucleation rate

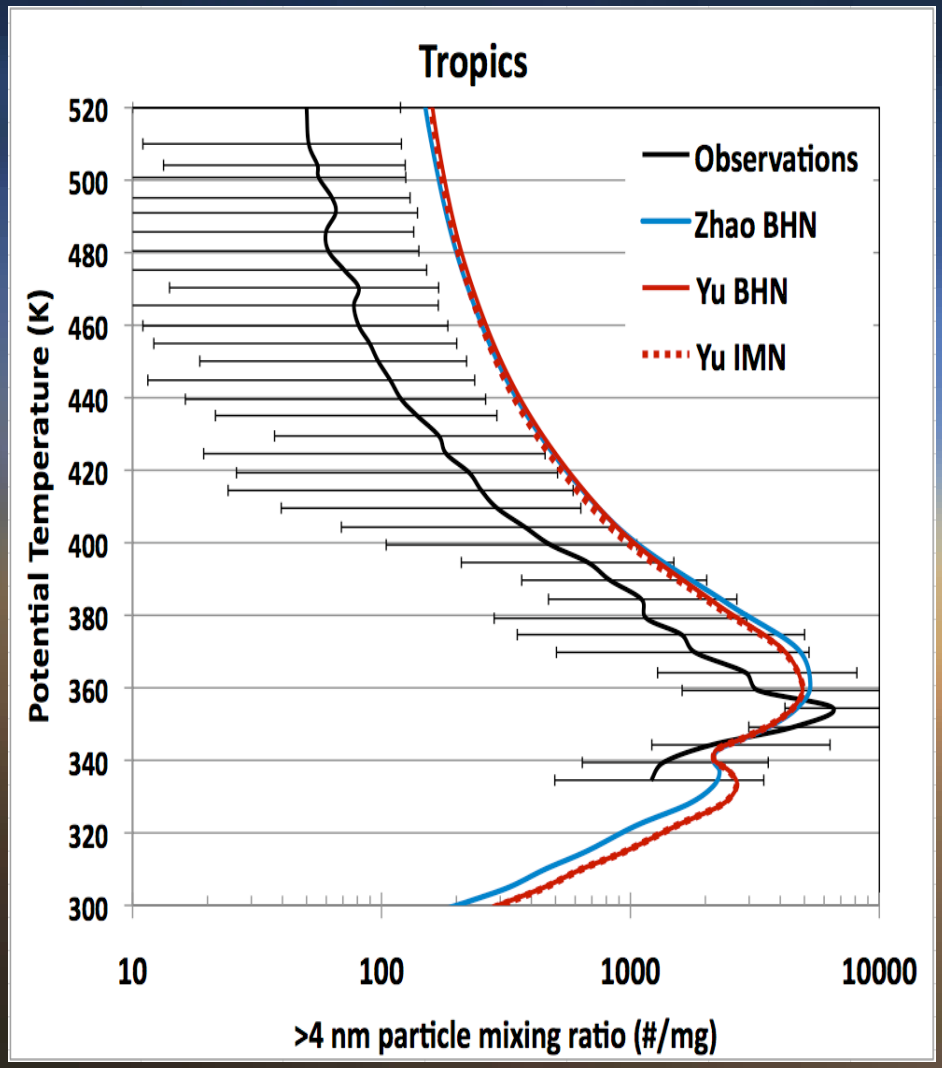


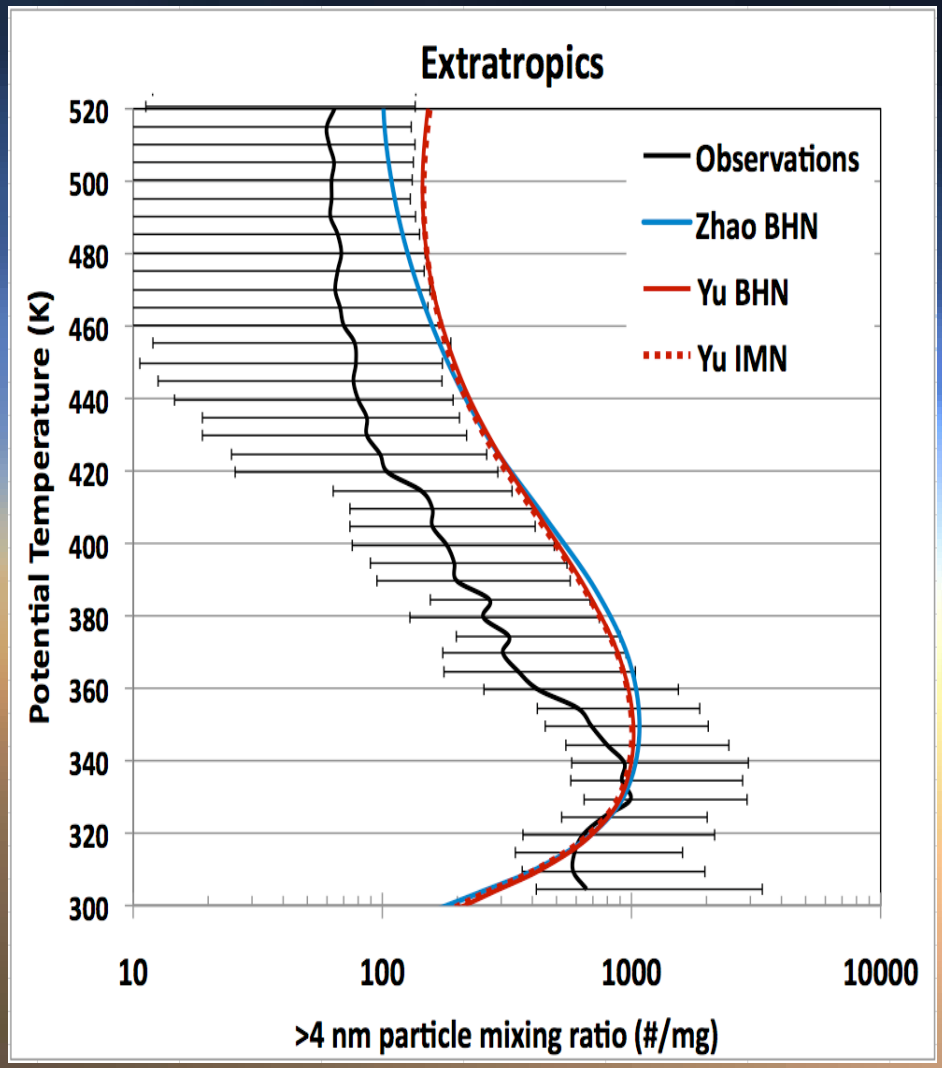
Annual average number concentration



Jason

Peak # compares well to obs in upper troposphere; stratospheric numbers a little high





Assimilation of aircraft obs from 1980's & 1990's *(Brock et. al. 1995)*

Jason English