CESM/CARMA studies in the CU Toon Aerosol Research Group

Pengfei Yu, Brian Toon, Jason English, Mike Mills, Chuck Bardeen, Christopher Maloney, Eric Wolf, Alex Lanzano
Some features:

- **Sulfur Chemistry (WACCM, Mike Mills), Heterogeneous Chemistry**
- **SOA Chemistry (4-Bin VBS), Coupled with MG Water Cloud, Coupled with RRTMG**
- Including Marine organics, biological organics
CESM/CARMA reproduces Rim Fire smoke and its radiative impact in 2013

Yu et al., 2016, JGR, under review
CESM/CARMA reproduce Stratospheric AOD from Mauna Loa Lidar

Data from Dr. John E. Barnes
Sulfur Geoengineering in the Upper Troposphere versus the Lower Stratosphere

Jason M. English (CIRES/NOAA), Owen Brian Toon (CU/LASP), Pengfei Yu (CIRES/NOAA), Mike Mills (NCAR), Chuck Bardeen (NCAR)

1. Sulfur lifting costs to 13 km are 3-20 times cheaper than to 20 km

2. How much less effective is geoengineering at 13 km? How does ozone destruction change?

3. We plan to use CESM1.2.2/CARMA at 60 levels, with GW tuning, strat sulfur chemistry, het chem, cloud-aerosol-radiation, and sectional aerosols [this model at 56 levels became available in March]
CAM5/CARMA simulated ice concentration and mass distribution are within ATTREX 3 observation mission average error bars.
Comparisons with CALIPSO-GOCCP shows simulations under predicting global high cloud fraction coverage between 0.1 and 0.4
Habitable zone planets around cool stars are tidally locked. The same side of the planet always faces the star. Planetary rotation rates become slow (many Earth days). The Rossby radius of deformation exceeds the planet radius. There are profound effects on dynamics, convection, clouds, and climate!
Using WACCM to study Exoplanets
Alex Lanzano

combines WACCM4, slab-ocean, present day Earth continents and oceans.
tidally locked planet.
Using WACCM/MOZART chemistry.

Asymmetric O₃ Distribution:
**Night side O₃**

![Night side O₃ graph](image)

**Day side O₃**

![Day side O₃ graph](image)
MarsCAM - CARMA used to reproduce high altitude water ice clouds

V. Hartwick, O.B. Toon

Addition of micrometeorites to MarsCAM generates clouds at high altitudes

- High altitude ice clouds above 30km are regularly observed but are difficult to reproduce in simulations
- Clouds nucleate on micrometeoroid material on Earth