The sensitivity of the oxygen isotopes of sulfate to changes in oxidant concentrations during the preindustrial-industrial transition

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Motivation: Preindustrial $\Delta^{17}O$ of $SO_4^{2-}$ Measurements

Site-A, Greenland

WAIS-Divide, Antarctica

[Alexander et. al., 2004]

[Kunasek et. al., manuscript in prep.]
GEOS-Chem Model Configuration (v8-01-01)

- 1989-1991 GEOS-4 Meteorology, Reduced (30) vertical levels
- 2-year spinup, 3-year run
- NOx-Ox-HC → extract oxidant fields → Offline Aerosol
- RPMARES Aerosol thermodynamic routine

Preindustrial Configuration

- Fossil Fuel & Fertilizer Emissions: OFF
- Biomass Burning Emissions: Scaled to 10% of present-day (1997)
- CO$_2$ = 285 ppm, CH$_4$ = 792 ppm

\[ \Delta^{17}O \text{ of } SO_4^{2-} \]

- $0.0\%$
- $0.9\%$
- $8.8\%$
- $0.0\%$
Change in Global Average Oxidants from Preindustrial

-40%  -20%  0%  20%  40%  60%  80%

Martinerie et al., 1995
Brasseur et al., 1998
Wang and Jacob, 1998
Mickley et al., 1999
Lelieveld and Dentener, 2000
Grenfell et al., 2001
Shindell et al., 2001
Hauglustaine and Brasseur, 2001
Lelieveld et al., 2002
Shindell et al., 2003
Lamarque et al., 2005
Sofen, 2009

OH
O3

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Conclusions

- NH: Metal-catalyzed oxidation is important in the industrial period.
- SH: $\Delta^{17}O$ is insensitive to small changes in oxidants; pH is important.
Future Work

- Sensitivity to pH
  - Dynamic calculation with Isorropia II?
- Biomass burning peak
  - 1900 emissions inventory from Brian Magi, NOAA GFDL (in progress)
- Preindustrial & glacial chemistry/climate simulations
  - with GISS-E and BIOME4 (with Loretta Mickly and others)
- More ice core measurements