Analysis of the Multi-Decadal Variability of Aerosols Based on a GOCART Hindcast and Observations

- Preliminary results -

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Motivation

- Long-term surface radiation measurements indicate a period of decreasing solar radiation reaching the surface from the 1950s to about 1985, followed by a period of increasing solar radiation.

- A.k.a. “global dimming” and “global brightening”
Goals

Combine model experiments and long-term records of satellite data to investigate the following questions:

- To what degree do changes (trends) in the anthropogenic emissions translate into changes (trends) in the aerosol load, optical depth and radiation fluxes?
- What is the spatial scale of this influence? (global, regional, local, …)

GOCART simulation of aerosol loads and optical depths from 1979 – 2007 (preliminary results)
Emission inventories

**Anthropogenic** emissions are based on:
- Gridded BC and OC emissions for 1996 from Tami Bond
- Gridded SO$_2$ emissions for 2000 from the EDGAR 32FT2000 database
- Annual trends for 17 regions and 1980 – 2006 from David Streets
- Ship emissions are from Veronica Eyring
- 3-d aircraft emissions are from the AEAP project (Steven Baughcum)

**Biomass burning** emissions (as dry mass burned) are from:
- From 1980 – 1996, dry mass burned is from a scaled version of an inventory from Bryan Duncan (based on TOMS AI)

**Volcanic emissions** are compiled from:
- the Global Volcanism Program
- TOMS (and OMI) SO$_2$ retrieval
- COSPEC measurements

**Dust and sea salt emissions** are calculated as a function of meteorological data
Trends in anthropogenic emissions

Trends in BC emissions for industrialized regions

Trends in OC emissions for industrialized regions

Trends in SO₂ emissions for industrialized regions

Trends in BC emissions for developing regions

Trends in OC emissions for developing regions

Trends in SO₂ emissions for developing regions
Total Aerosol Optical Depth in 1980 and 2006

Yearly average of $\tau_{\text{tot}}$ in 1980

Yearly average of $\tau_{\text{tot}}$ in 2006
Densely Populated Regions
Deseasonalized AOT for GOCART Over Smaller Regions

GOCART fit: green
r: correlation coeff.
s: significance
Deseasonalized AOT for GOCART Over Smaller Regions

GOCART fit: green
r: correlation coeff.
s: significance
Land and Ocean Regions
Deseasonalized AOT for AVHRR and GOCART (Ocean)

GOCART fit: green
AVHRR fit: blue
r: correlation coeff.
s: significance
Deseasonalized AOT for GOCART Over Land

GOCART fit: green
r: correlation coeff.
s: significance
Global Deseasonalized AOT for GOCART

O8 OCEAN — GO — AV

Year

AOT550 - AVG(AOT550)

80  85  90  95  00  05

r1= -0.88
s1= 100.0%

r2= -0.55
s2= 100.0%

GOCART fit: green
r: correlation coeff.
s: significance

L8 LAND — GO

Year

AOT550 - AVG(AOT550)

80  85  90  95  00  05

r1= -0.79
s1= 100.0%

r2= -0.09
s2= 65.9%
Preliminary conclusions and outlook

Preliminary conclusions:

- Most pronounced aot-trends located over highly populated areas
- Trends decrease when looking at larger regions
- Long decay time of signal from cataclysmic volcanic events might mask anthropogenic signal in GOCART

Outlook:

- Compute time series of radiative fluxes
- Analyze correlation between emissions, aerosol atmospheric burden, aot, and radiative fluxes
- Compare results with TOMS satellite data record, GEBA, and other observations