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

- Preliminary results **-**

Thomas Diehl[1], Mian Chin[2]

With contributions from David Streets, Tami Bond, Lee Siebert, Simon Carn, Nick Krotkov, Bryan Duncan, Steven Baughcum

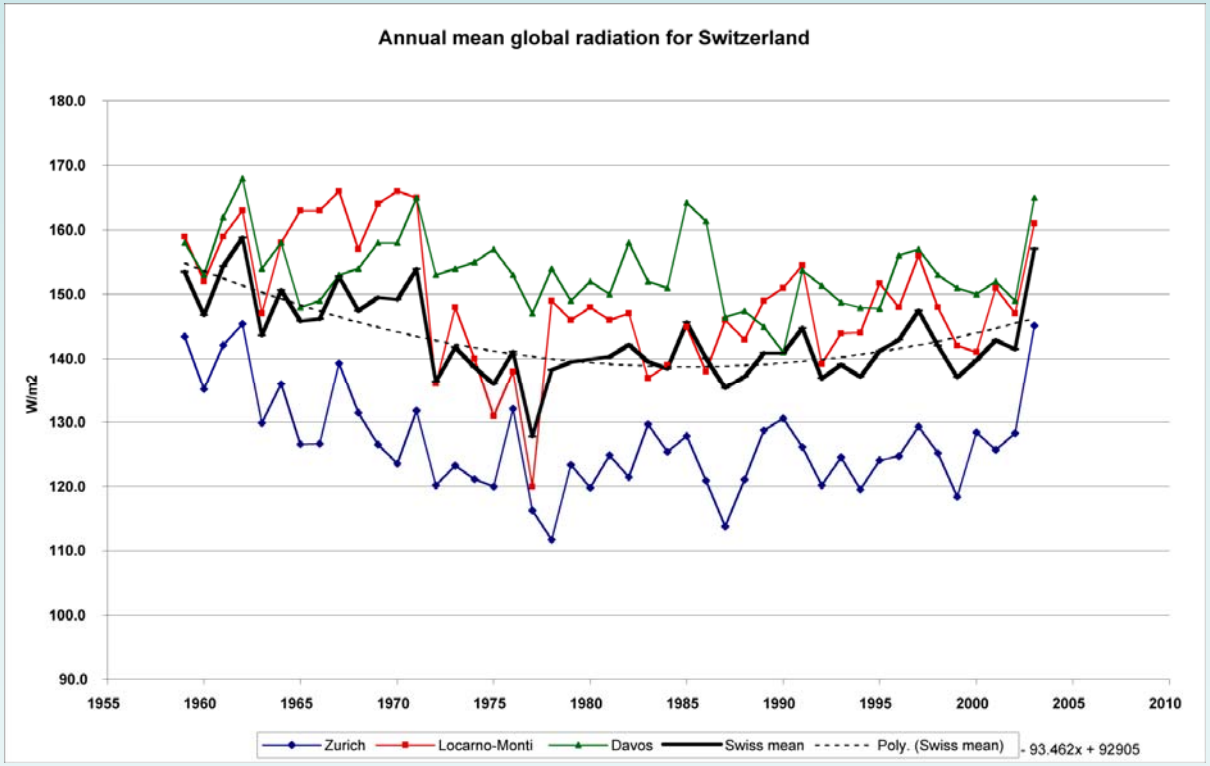
1: University of Maryland, Baltimore County

2: NASA Goddard Space Flight Center

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:

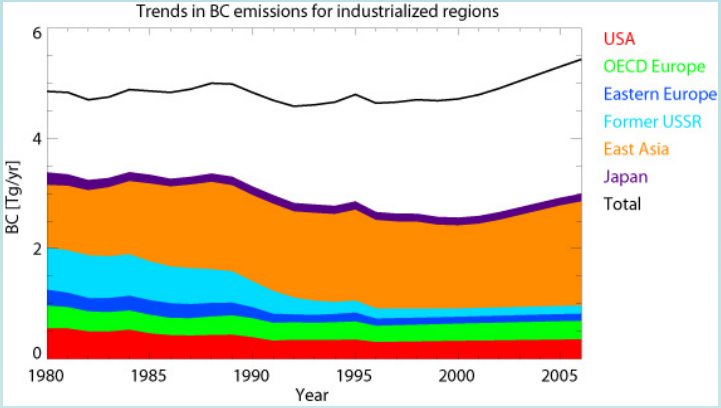
- The Global Fire Emission Dataset (GFED) version 2 for 1997-2007
- From 1980 – 1996, dry mass burned is from a scaled version of an inventory from Bryan Duncan (based on TOMS AI)

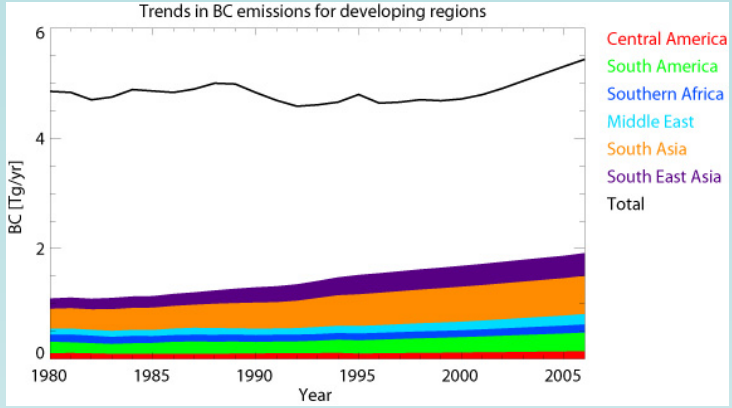
Volcanic emissions are compiled from:

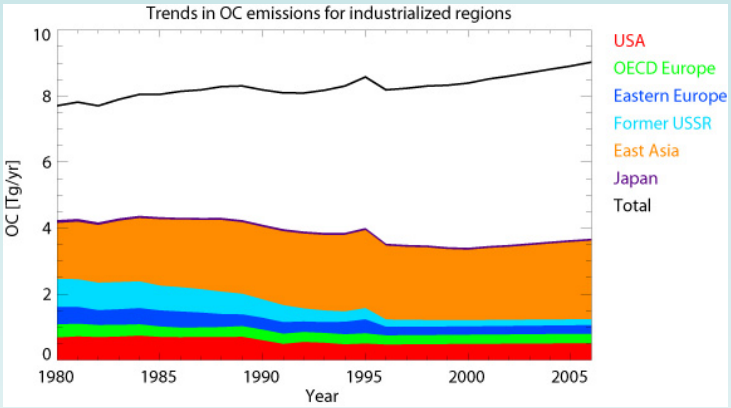
- the Global Volcanism Program
- TOMS (and OMI) SO_2 retrieval
- COSPEC measurements

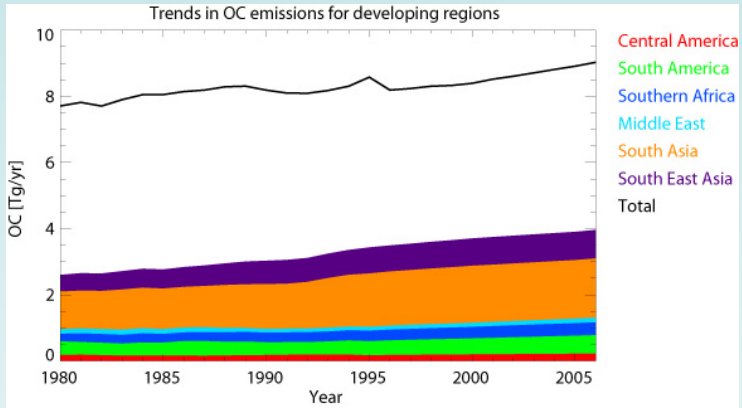
Dust and sea salt emissions are calculated as a function of meteorological data

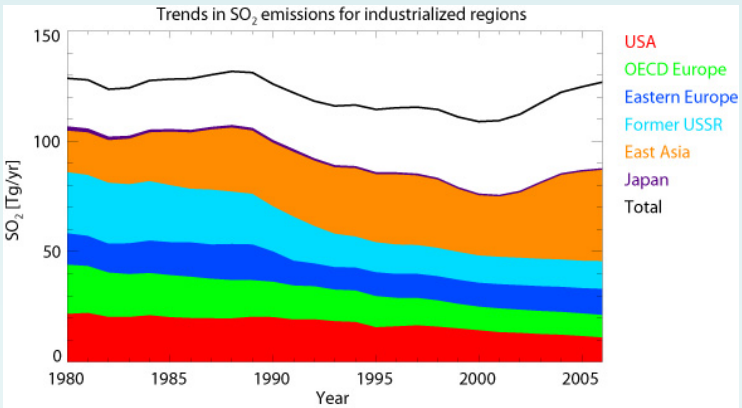
Trends in anthropogenic emissions

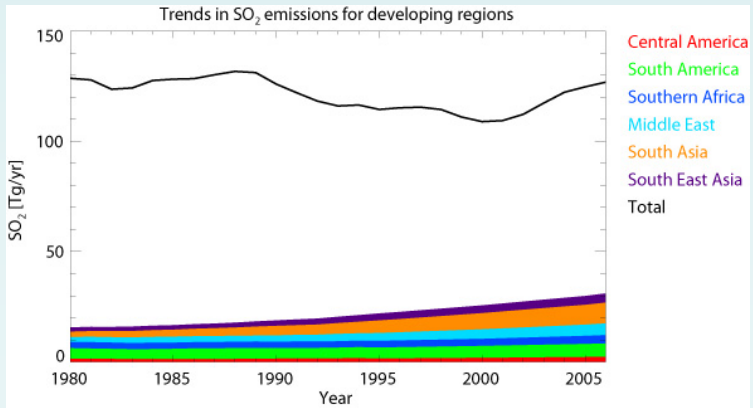






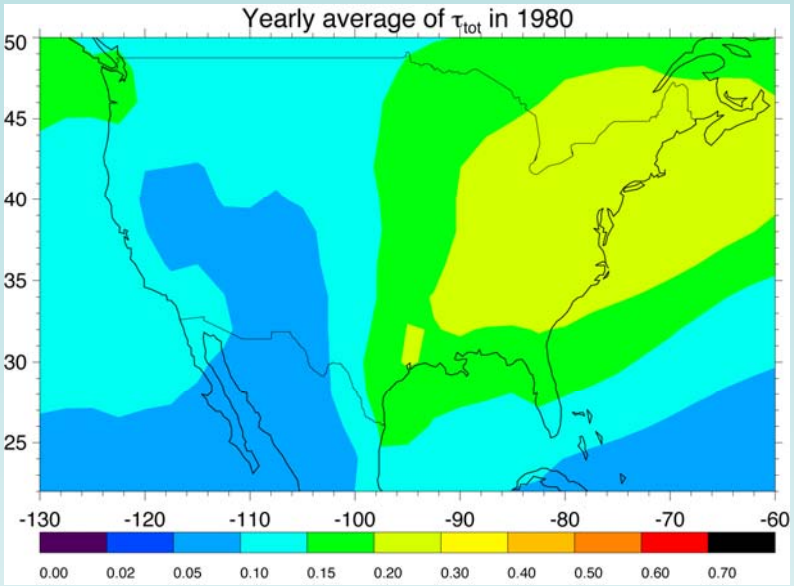


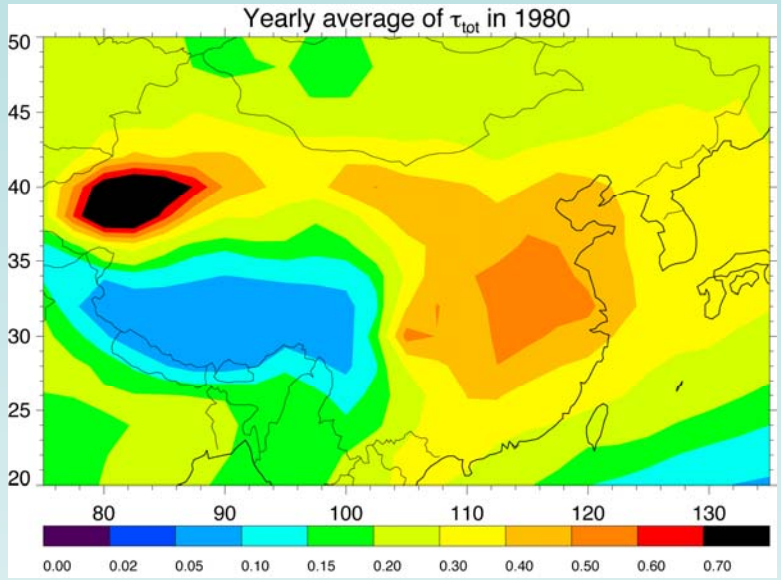




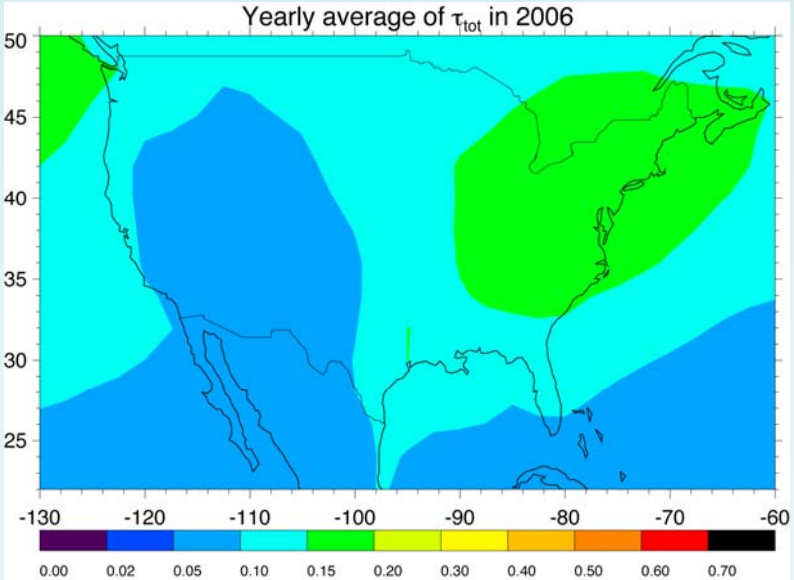
Total Aerosol Optical Depth in 1980 and 2006

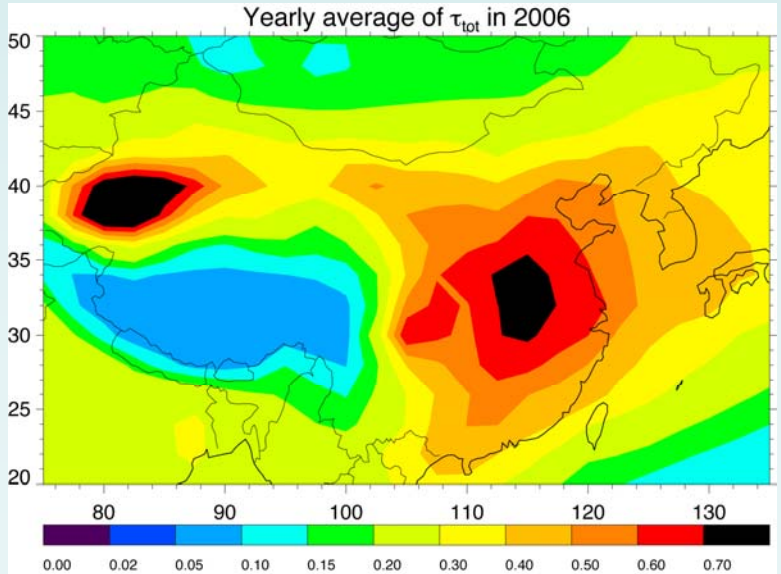
1980



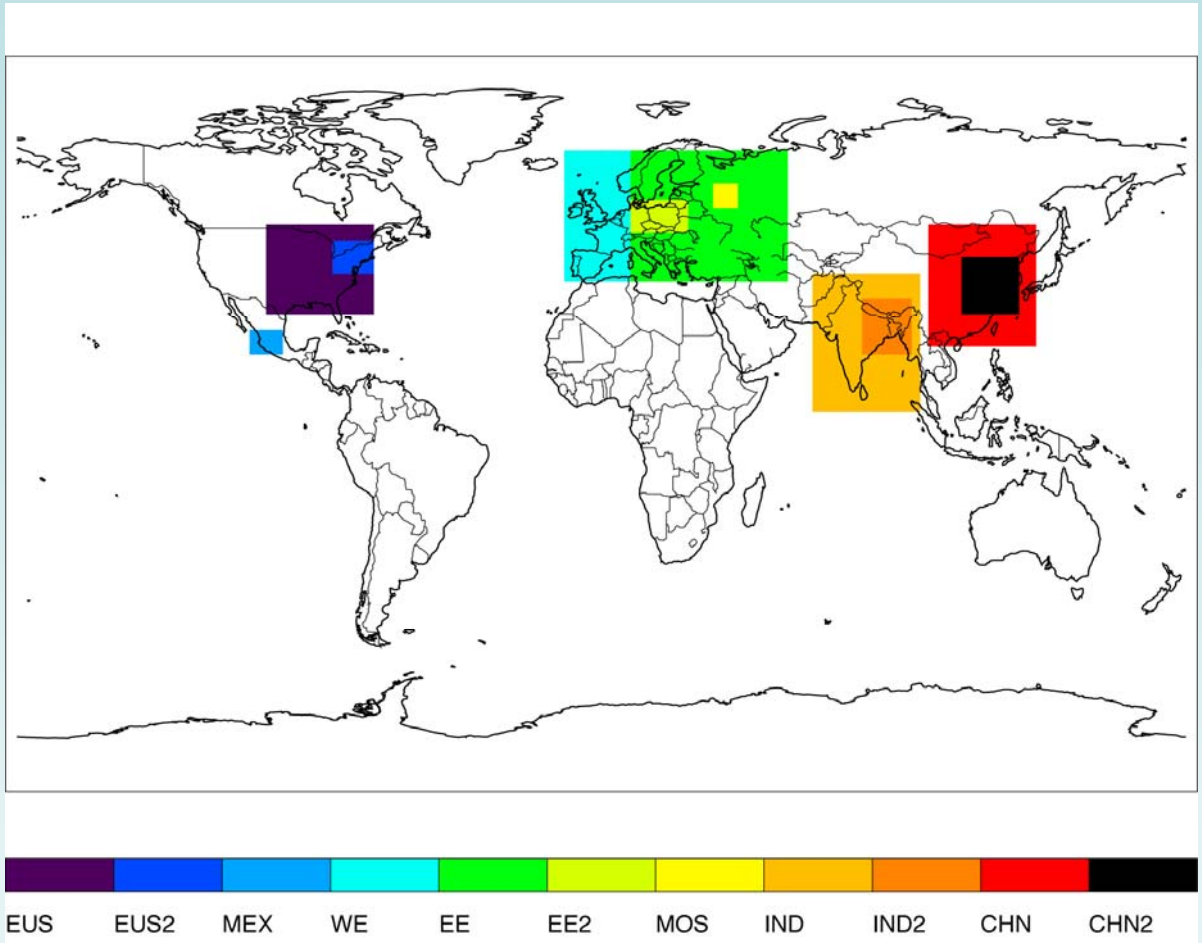


2006

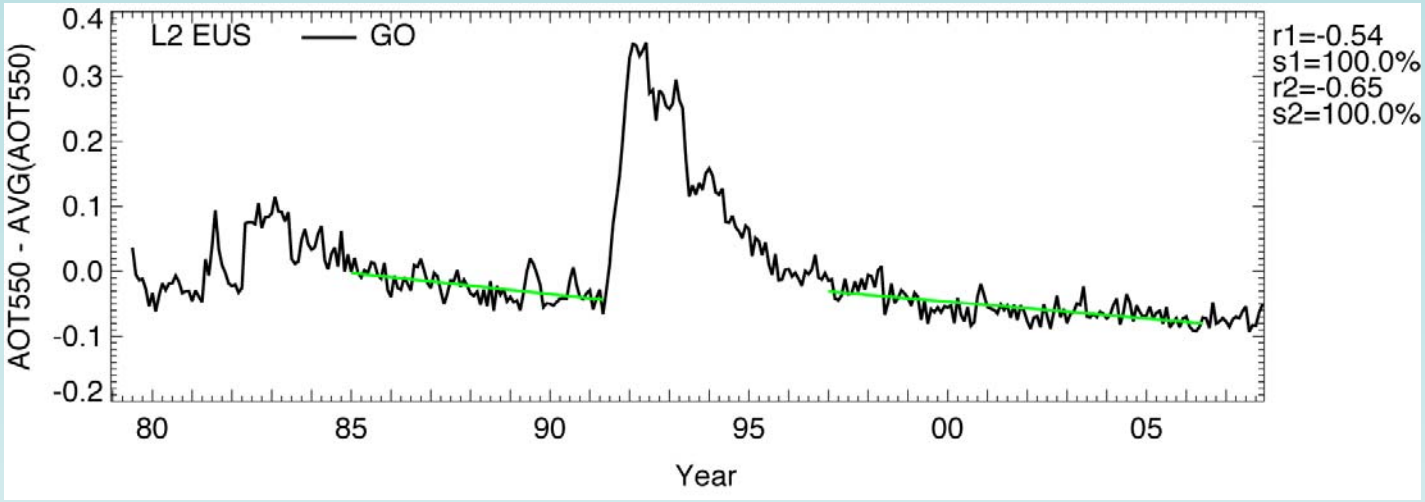


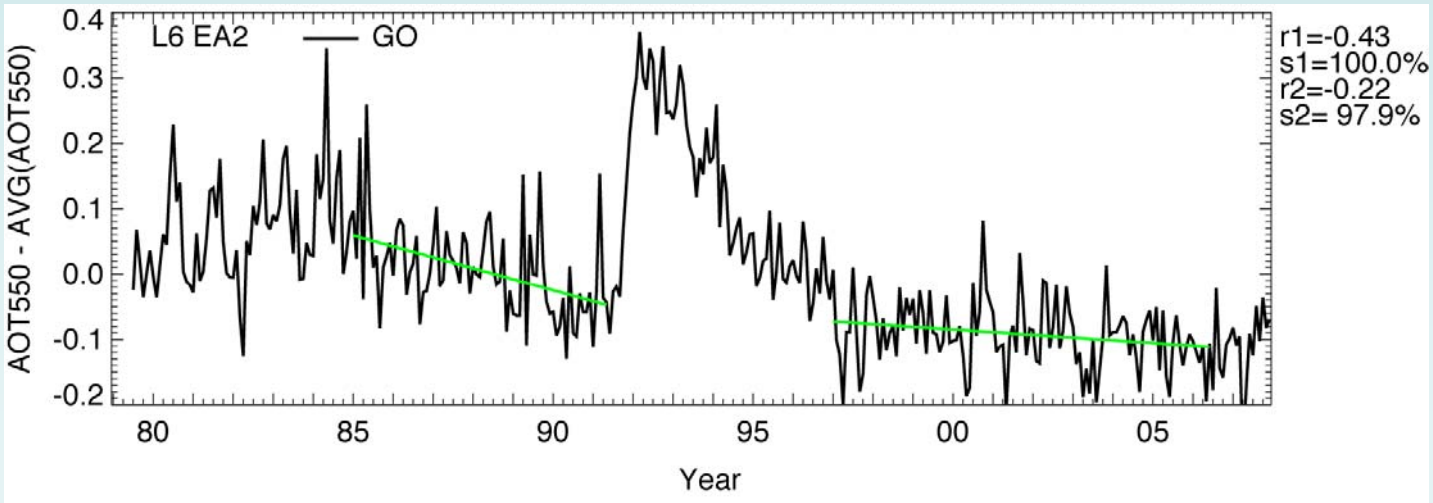


Densely Populated Regions



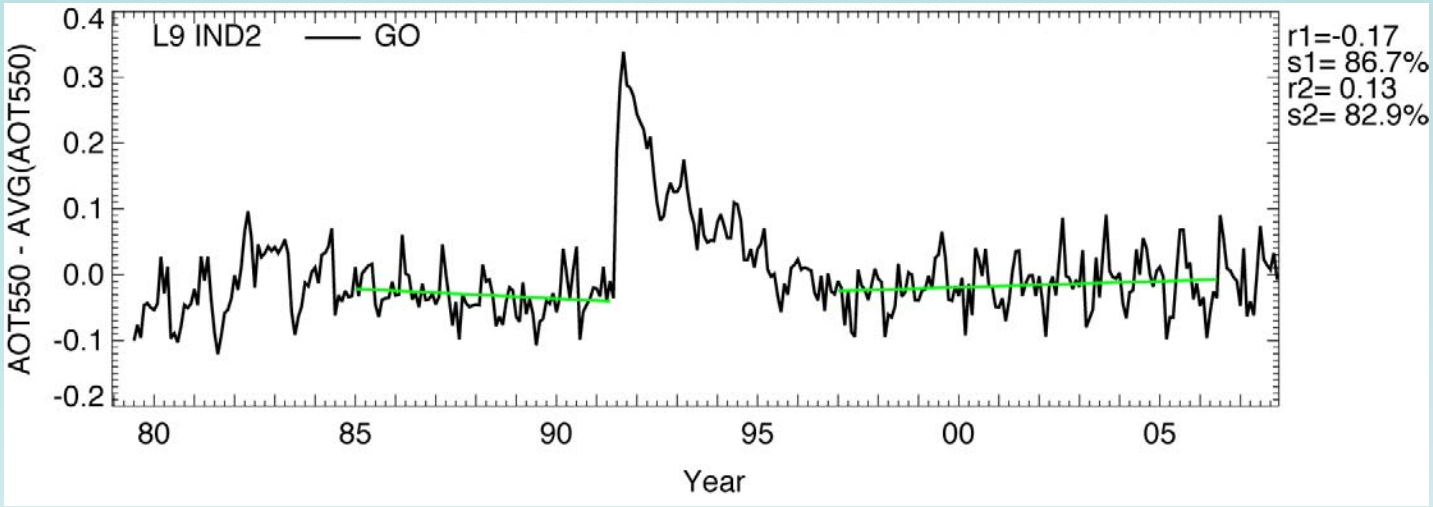
Deseasonalized AOT for GOCART Over Smaller Regions

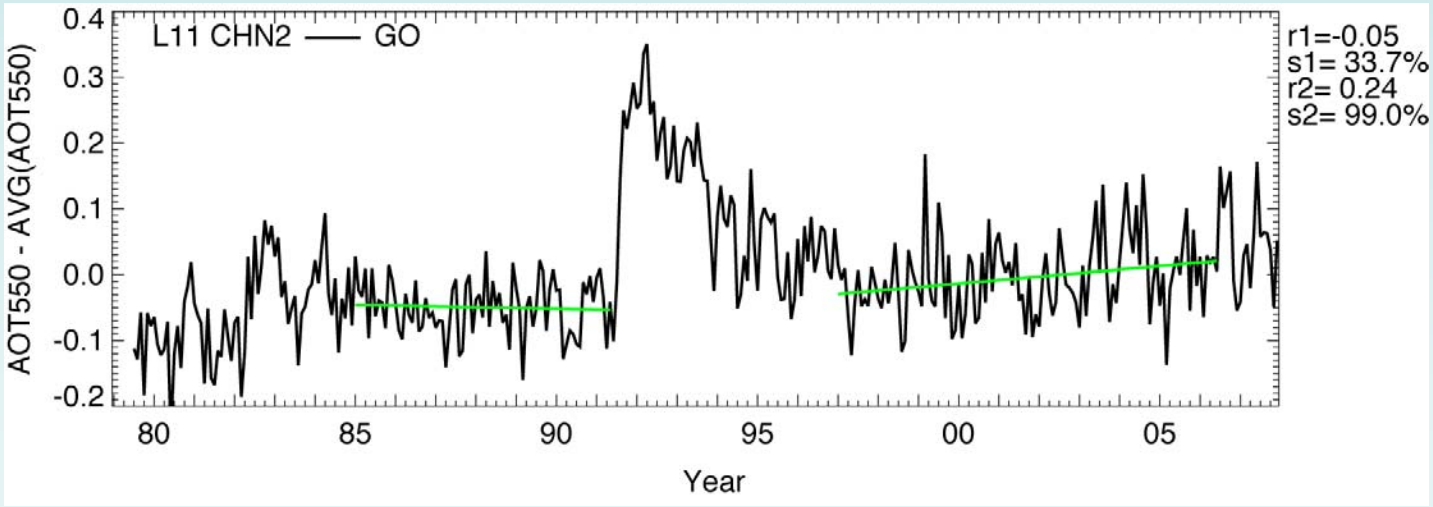




GOCART fit: green
r: correlation coeff.
s: significance

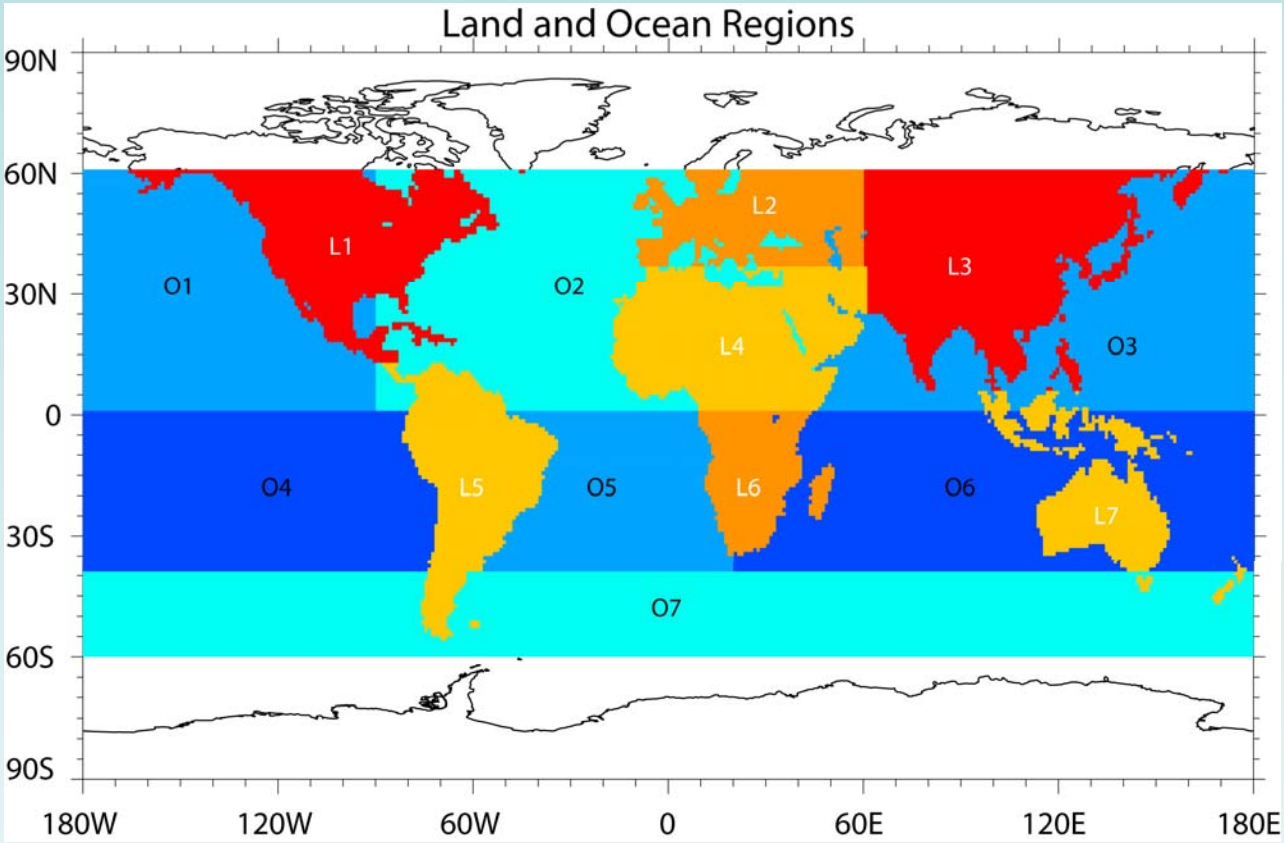
Deseasonalized AOT for GOCART Over Smaller Regions



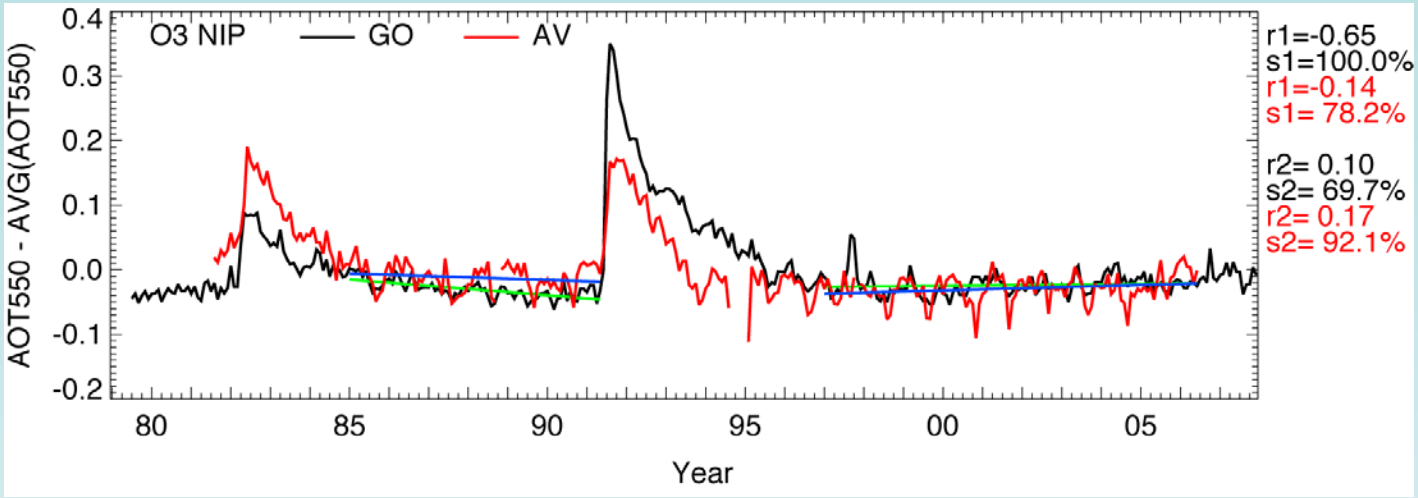


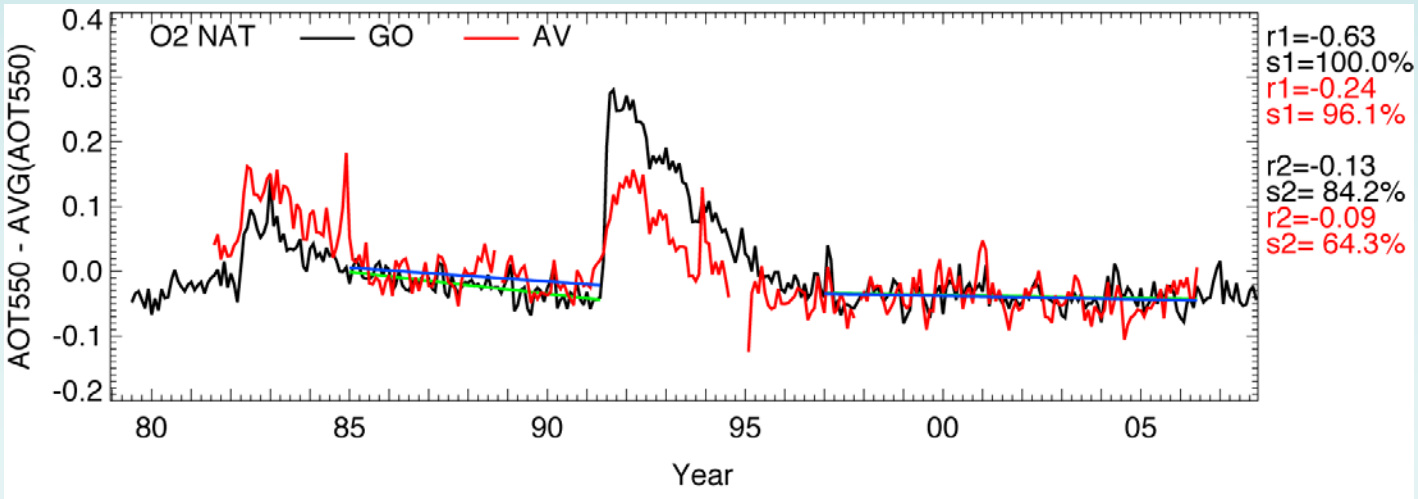
GOCART fit: green
r: correlation coeff.
s: significance

Land and Ocean Regions



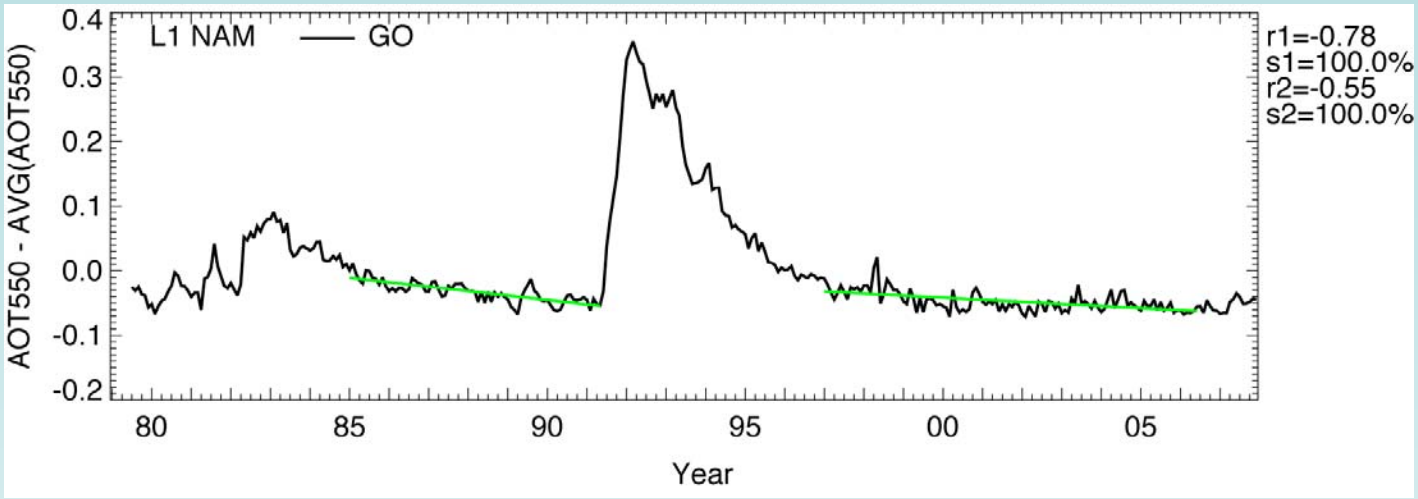
Deseasonalized AOT for AVHRR and GOCART (Ocean)

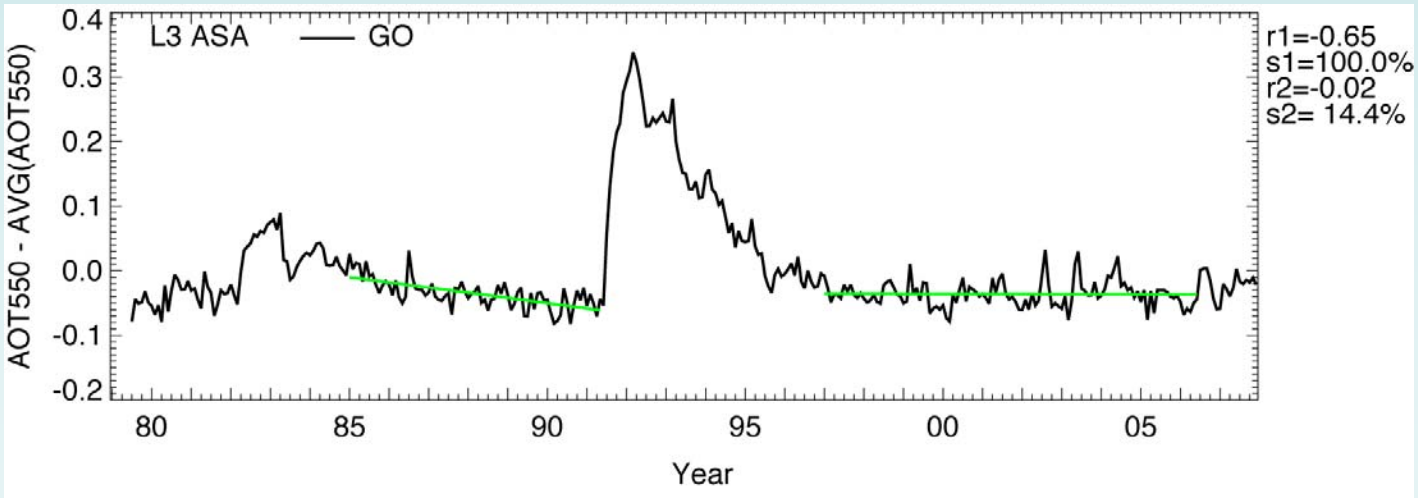




GOCART fit: green
AVHRR fit: blue
r: correlation coeff.
s: significance

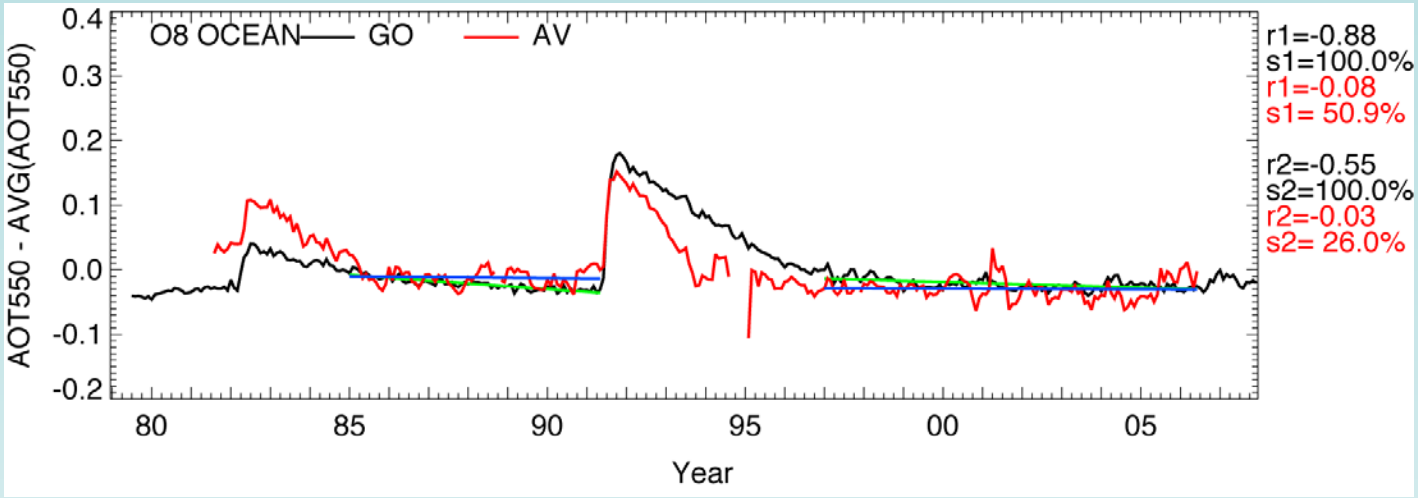
Deseasonalized AOT for GOCART Over Land

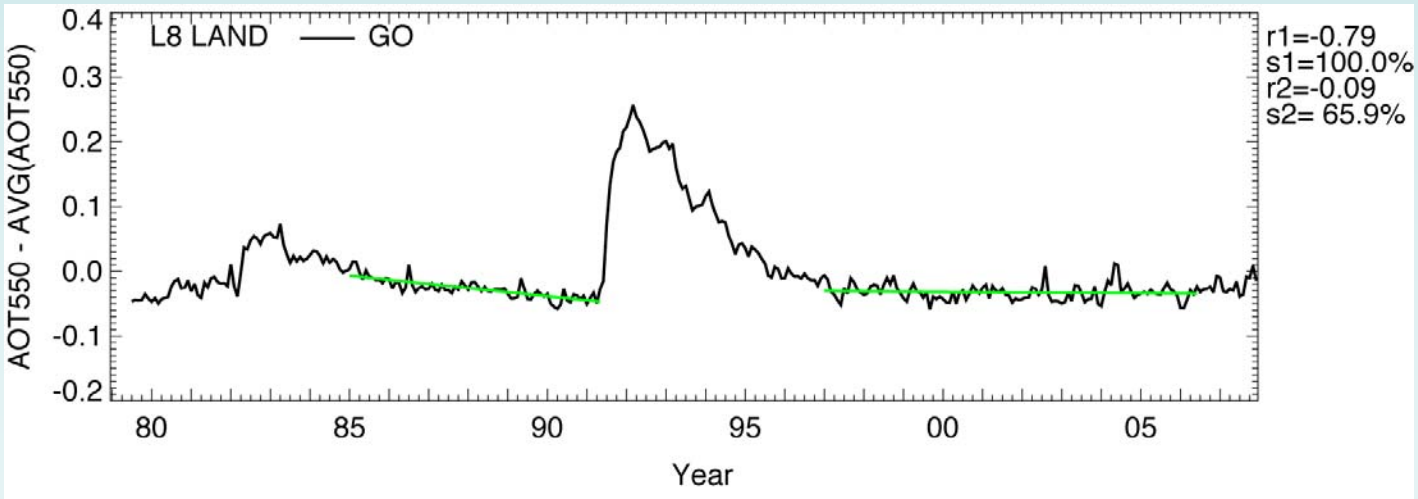




GOCART fit: green
r: correlation coeff.
s: significance

Global Deseasonalized AOT for GOCART





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

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