



A global emission inventory for aerosol simulations of the period 1980 - 2005

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Motivation

- Quantify the relation between changes of aerosol loading, emissions, and surface radiation (“global dimming”, “global brightening”)
- Determine impact of intercontinental transport on air quality of other regions
- Support the interpretation of satellite products, etc....
- Long-term global simulations together with observations are a prerequisite for these analyses
- 1980-2005 is of particular interest because:
 - The distribution of industrial emissions was substantially changed
 - Several large volcanic eruptions occurred
 - A plethora of observational data became available

Emissions required by GOCART



Dust: based on topographic source [Ginoux et al. 2001] and modifications from M. Chin for Asia

Sea salt: based on parameterization using the wind speed at 10 m [Gong 1997] and swelling by RH

DMS (oxid. to SO_2): based on observed sea surface concentrations [Kettle et al. 1999]

SOA formation (OC) due to biogenic emissions (Terpene): based on [Guenther et al. 1995]

Black Carbon (BC)

Organic Carbon (OC)

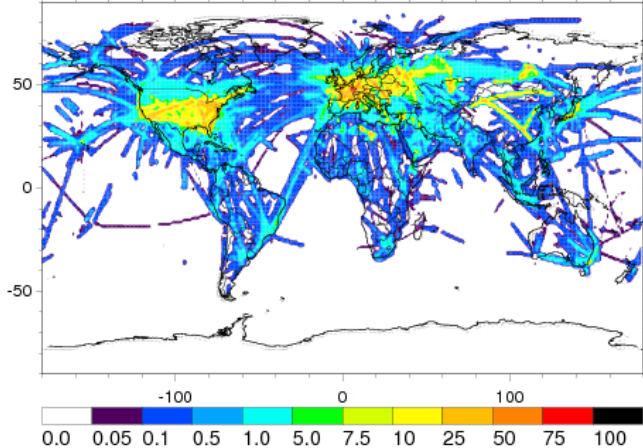
SO_2 (and SO_4)

New time-dependent inventory (yearly, monthly) in $1.0^\circ \times 1.0^\circ$ resolution

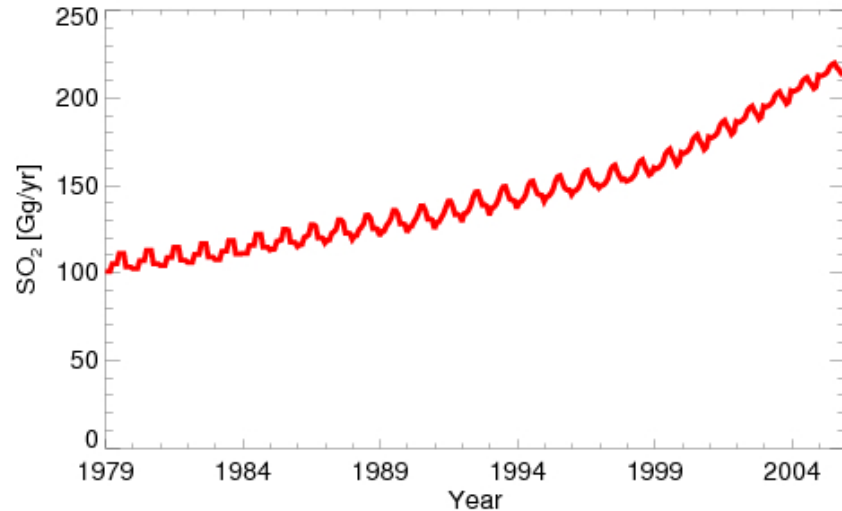
Aircraft emissions



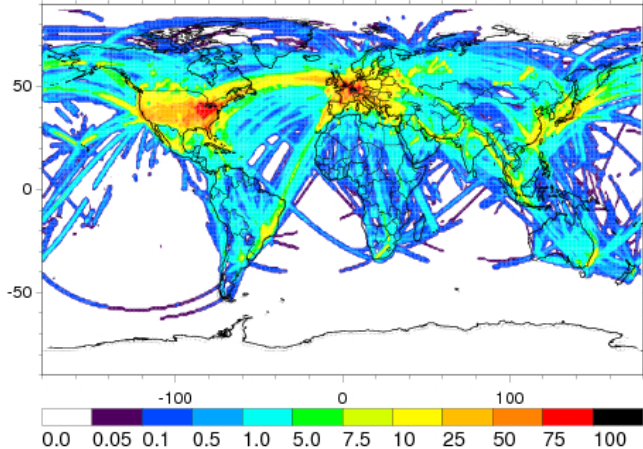
SO₂ from aircraft in July 1980 at 267 hPa (~ 10 km) [kg/d]



Time series of SO₂ emission from aircraft [Gg/yr]



SO₂ from aircraft in July 2005 at 267 hPa (~ 10 km) [kg/d]

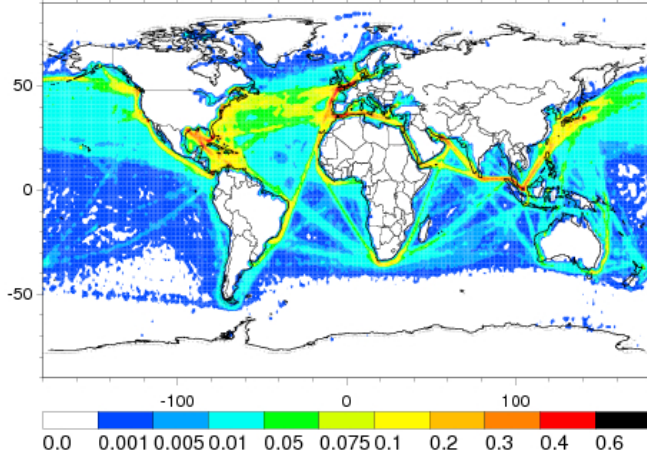


- Based on gridded burnt fuel files from AEAP project for 1976, 1984, 1992, 1999, and a projection for 2015
- Flight pattern is preserved between base years for interpolation
- EI of 1.0 assumed for SO₂ (1g SO₂/kg fuel)

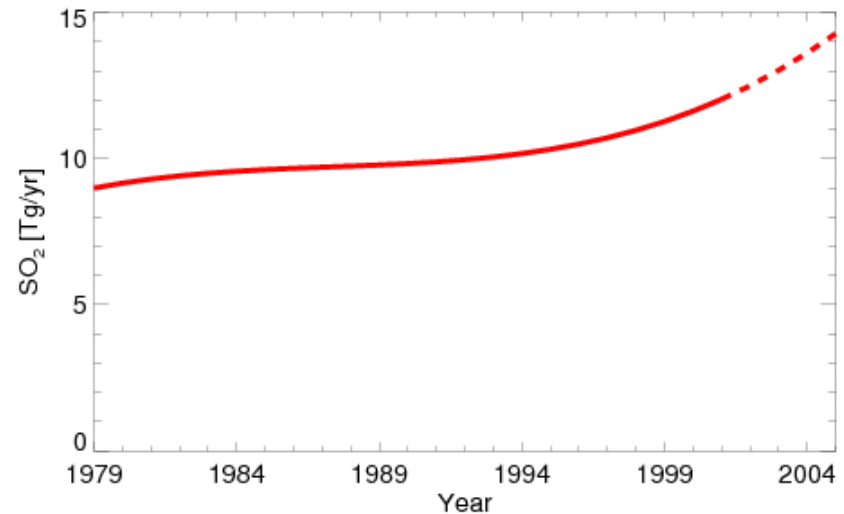
Emissions from international ship traffic



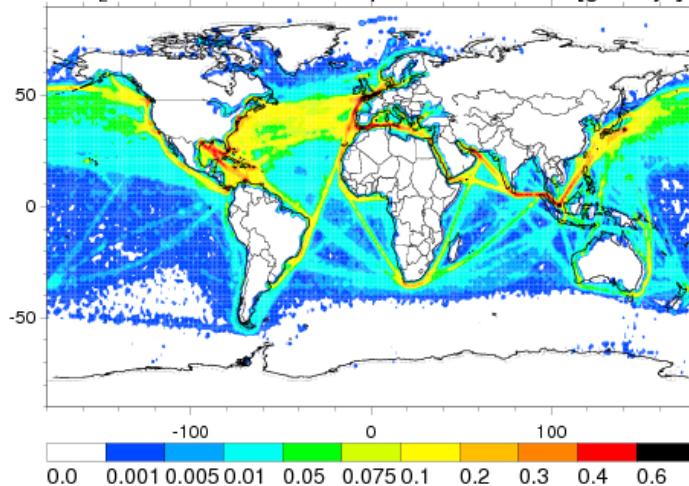
SO₂ from international ship traffic for 1980 [g/m²/yr]



Time series of SO₂ from international ship traffic [Tg/yr]



SO₂ from international ship traffic for 2001 [g/m²/yr]

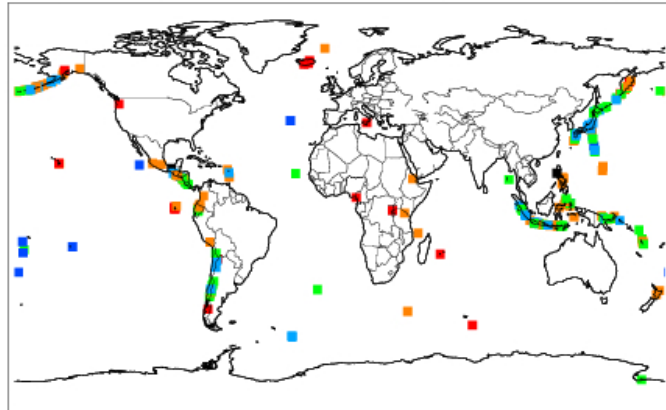


- Based on estimates of total SO₂ and PM emissions of Eyring et al. 2005 for 1970, 1980, 1995, and 2001.
- These numbers were used to scale gridded SO₂ emissions from the EDGAR 32FT2000 database for 2000 (<http://www.mnp.nl/edgar>)

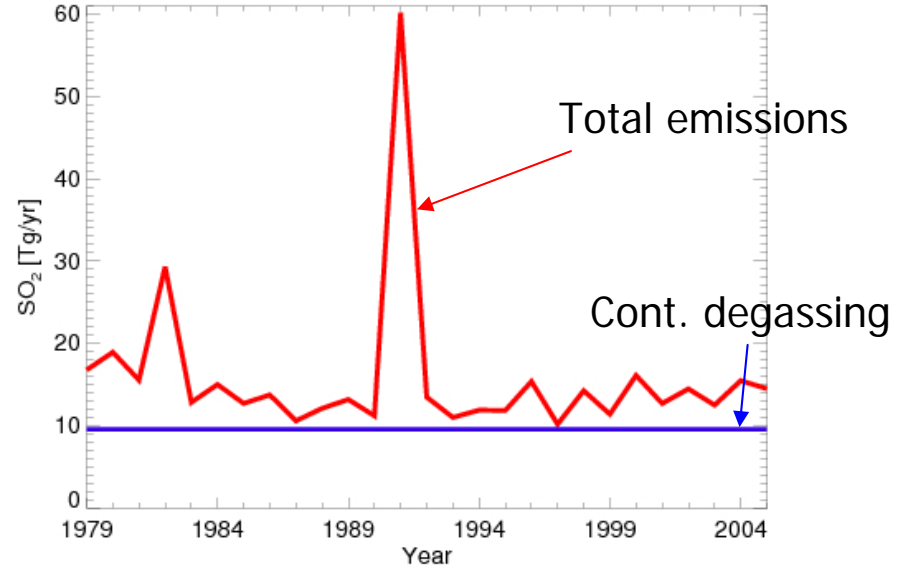
Volcanic emissions



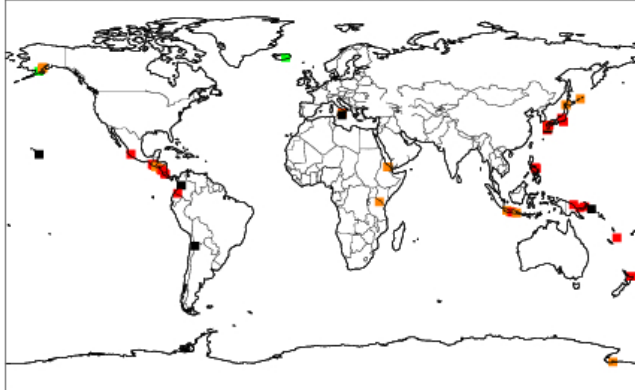
SO₂ from sporadic eruptions during 1979-2005 [Tg]



Time series of SO₂ from volcanic emissions [Tg/yr]



SO₂ from continuously degassing volcanoes during 1979-2005 [Tg]

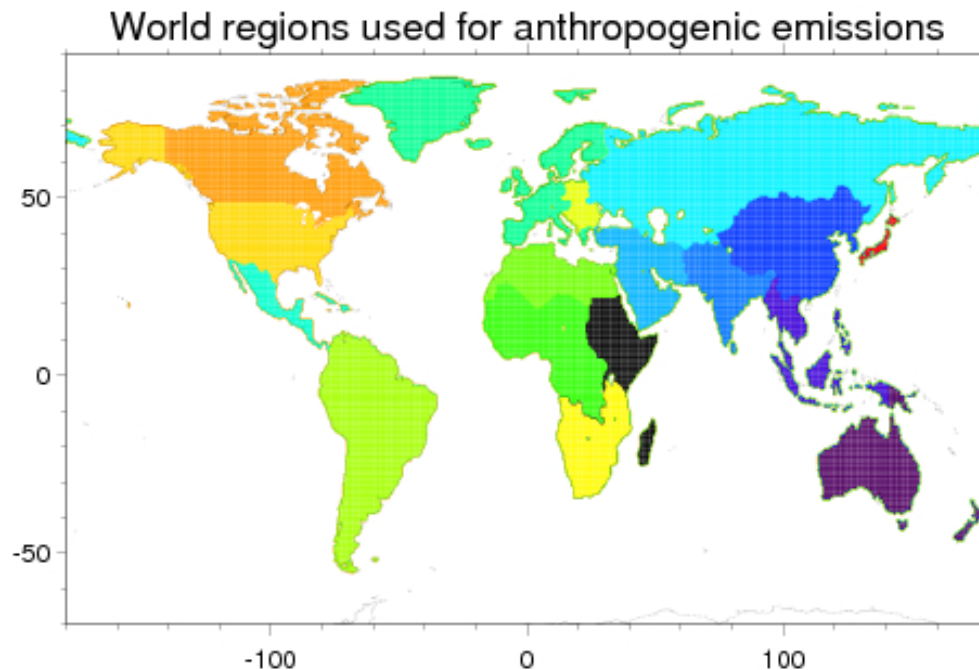


- Sporadic eruptions are based on the Smithsonian Institution's Global Volcanism Program
- Cloud column height is derived from the VEI and SO₂ data is derived from a modified SO₂ index from Halmer et al. 2002
- TOMS SO₂ data is used when available
- Continuously degassing volcanoes are from the climatological GEIA database

Anthropogenic emissions

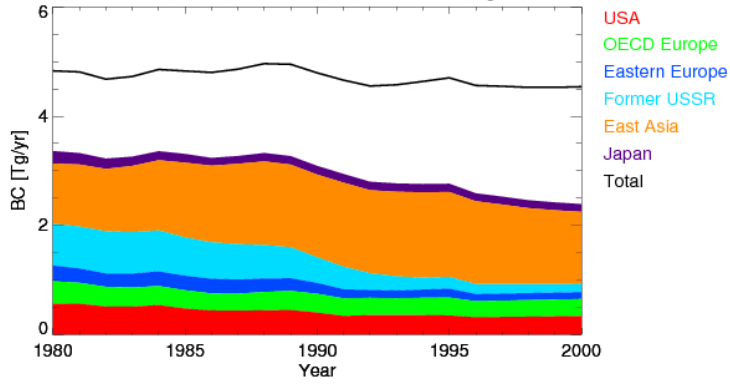
(excluding BB, aircraft and intl. ship traffic)

- Gridded BC and OC emissions for 1996 are based on the Speciated Particulate Emissions Wizard (SPEW) inventory (Bond et al. 2004)
- Gridded SO₂ emissions for 2000 are from the EDGAR 32FT2000 database.
- The gridded files were extended to an annual trend by scaling with regional BC, OC, and SO₂ emission numbers for 17 regions (D. Streets, personal communication)

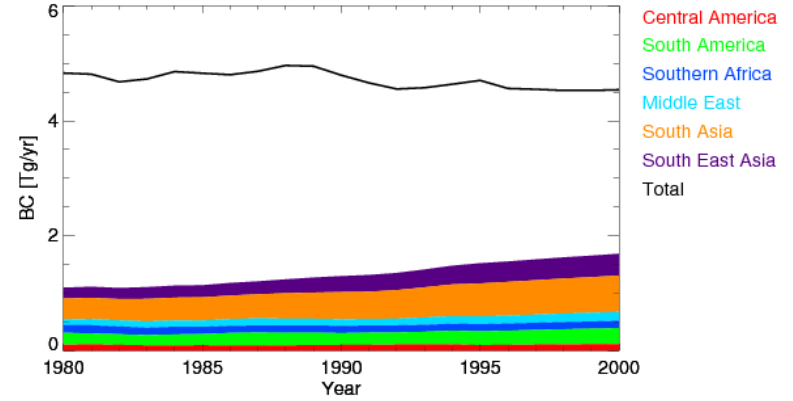


Trends in anthropogenic emissions

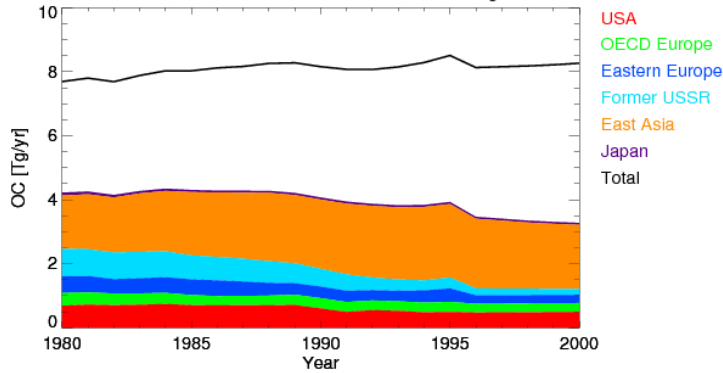
Trends in BC emissions for industrialized regions



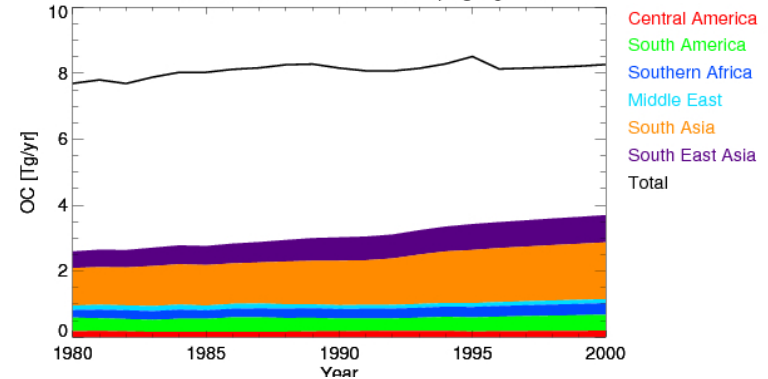
Trends in BC emissions for developing regions



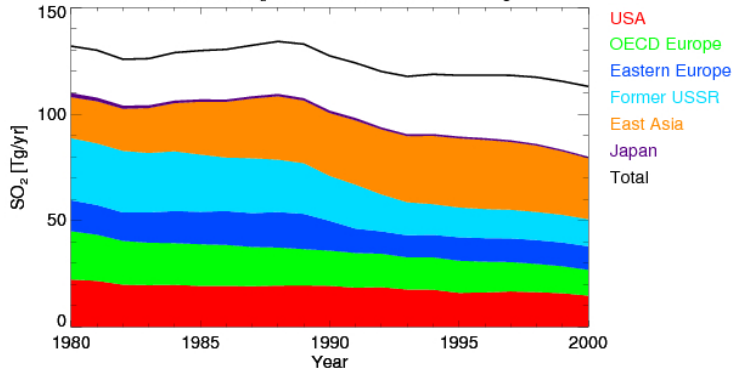
Trends in OC emissions for industrialized regions



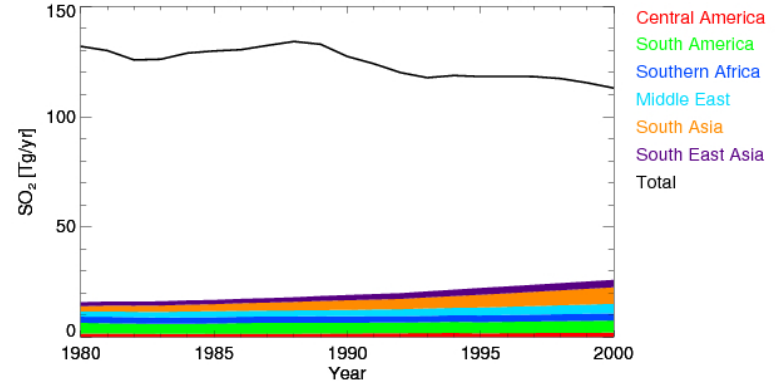
Trends in OC emissions for developing regions



Trends in SO₂ emissions for industrialized regions

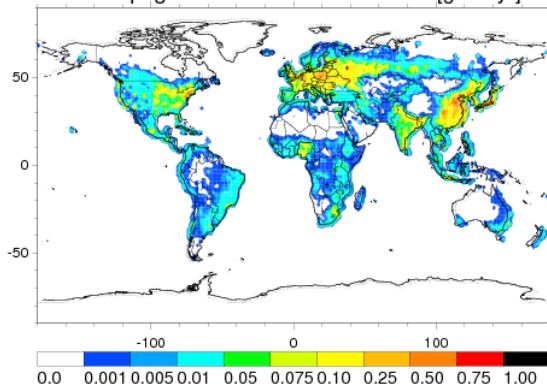


Trends in SO₂ emissions for developing regions

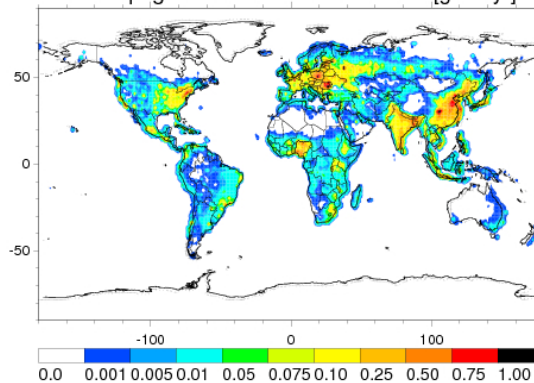


Gridded anthropogenic emissions

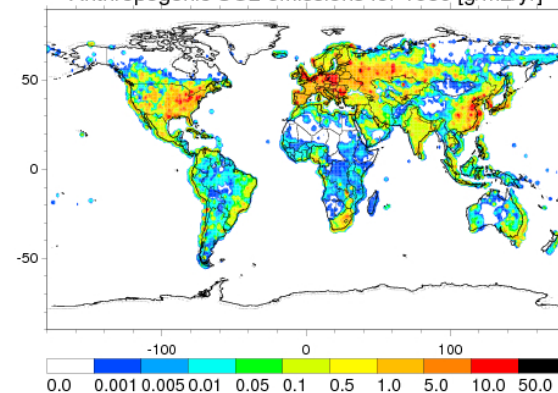
Anthropogenic BC emissions for 1980 [g/m²/yr]



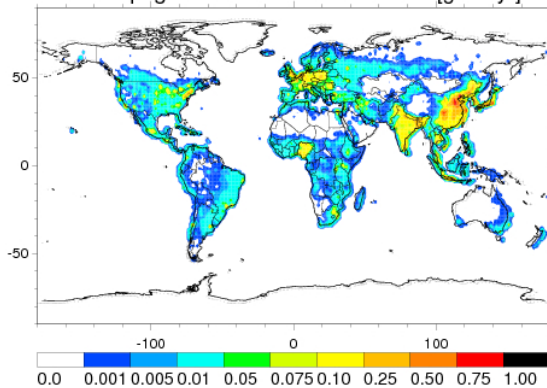
Anthropogenic OC emissions for 1980 [g/m²/yr]



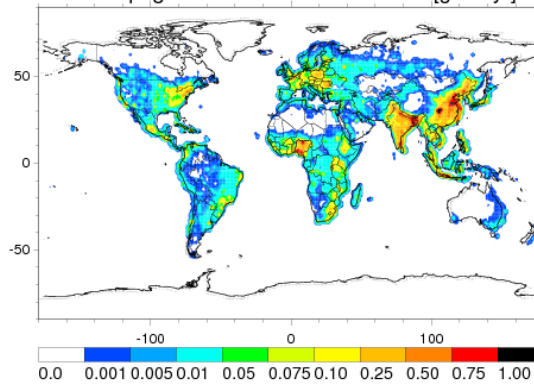
Anthropogenic SO₂ emissions for 1980 [g/m²/yr]



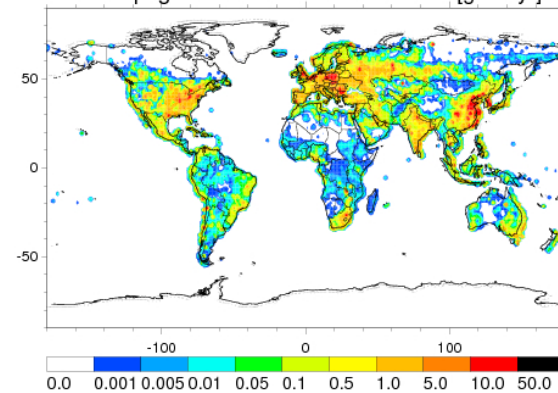
Anthropogenic BC emissions for 2000 [g/m²/yr]



Anthropogenic OC emissions for 2000 [g/m²/yr]



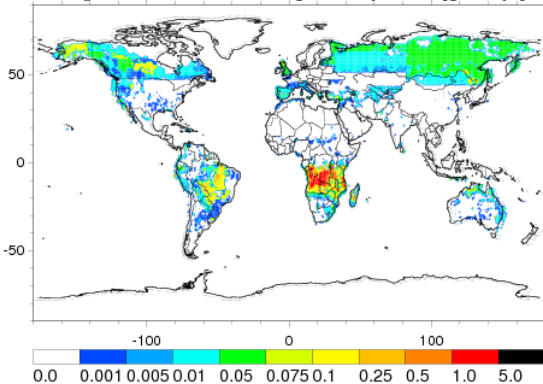
Anthropogenic SO₂ emissions for 2000 [g/m²/yr]



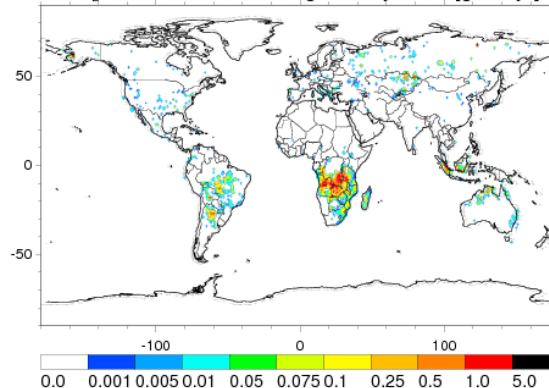
Biomass Burning Emissions



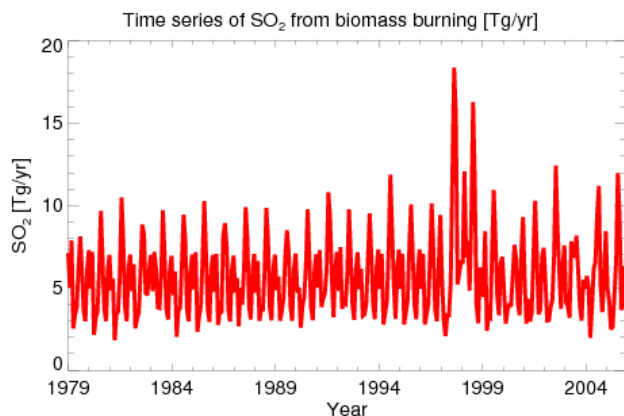
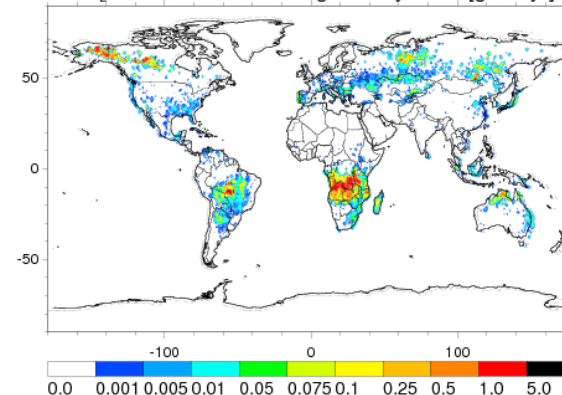
SO₂ from biomass burning for July 1980 [g/m²/yr]



SO₂ from biomass burning for July 1997 [g/m²/yr]



SO₂ from biomass burning for July 2004 [g/m²/yr]

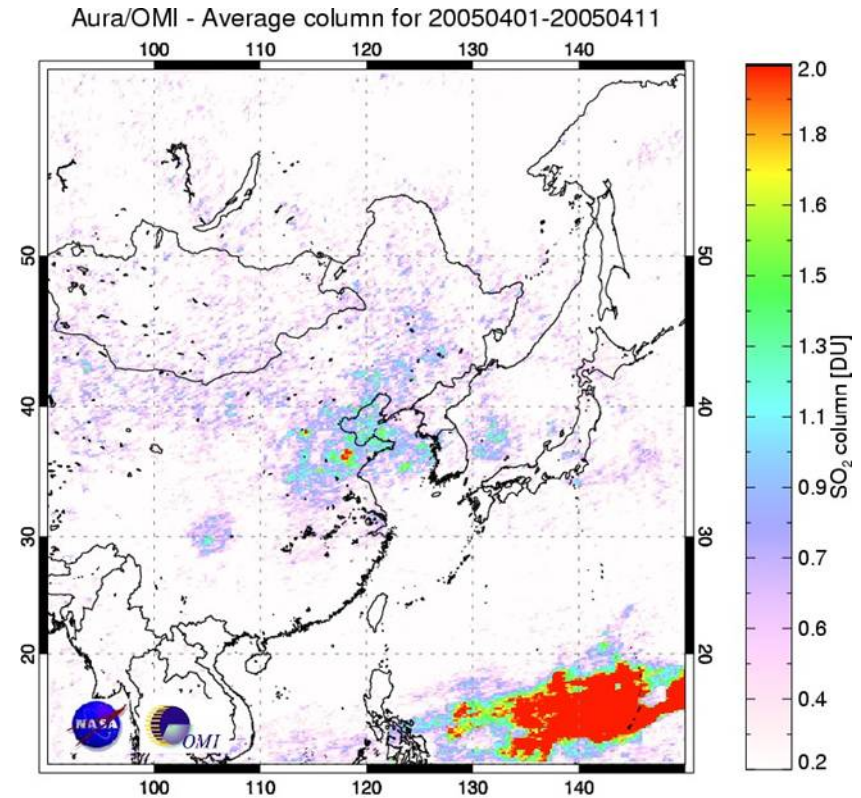
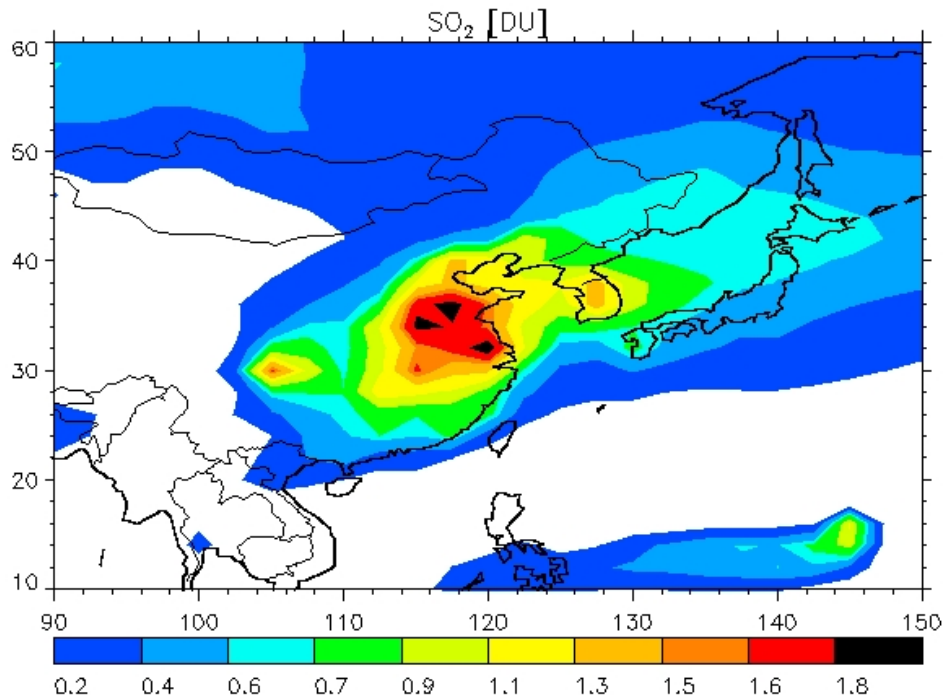


- For 1997-2005, we use the Global Fire Emission Dataset (GFED) version 2
- SO₂, BC, and OC for 1980 – 1996 based on a scaled version of a total dry mass burnt inventory from Duncan et al. 2003
- Adjusting factors determined from overlapping period 1997-2000 by adjusting the Duncan dataset to GFEDv2

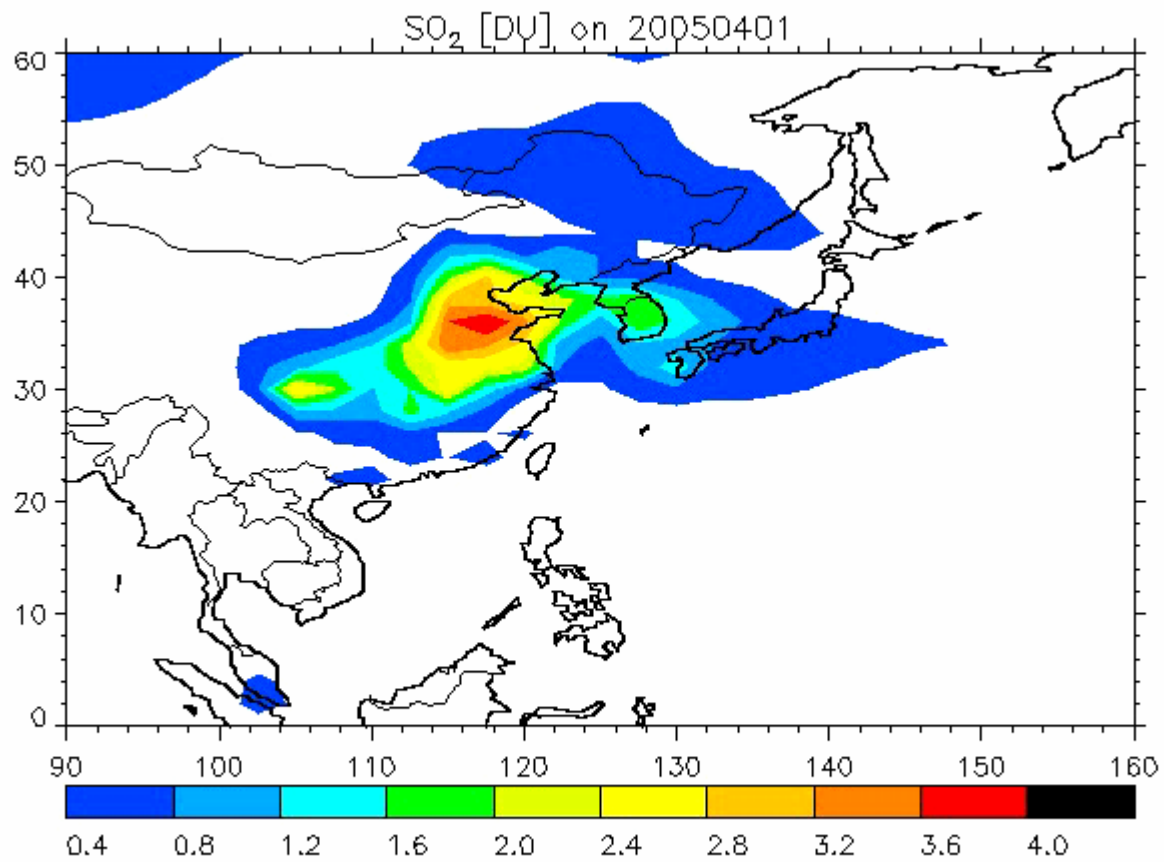
Emission Heights

- Sporadic volcanic eruptions: evenly distributed within top third of the plume height
- Continuous degassing: injected only into the level of the crater (no flank degassing is considered)
- Biomass burning emissions: distributed within boundary layer
- Ship emissions and anthropogenic emissions are currently only injected into the lowest model level

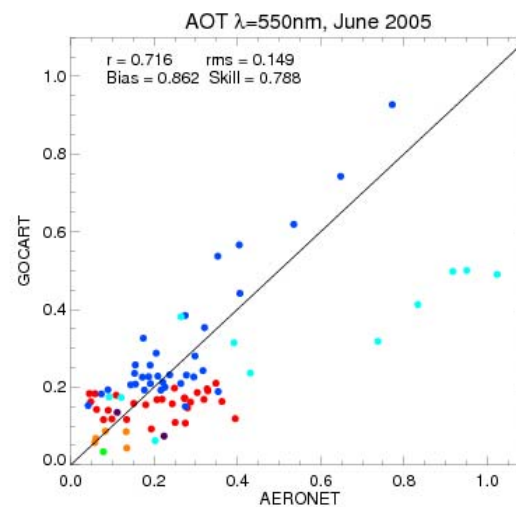
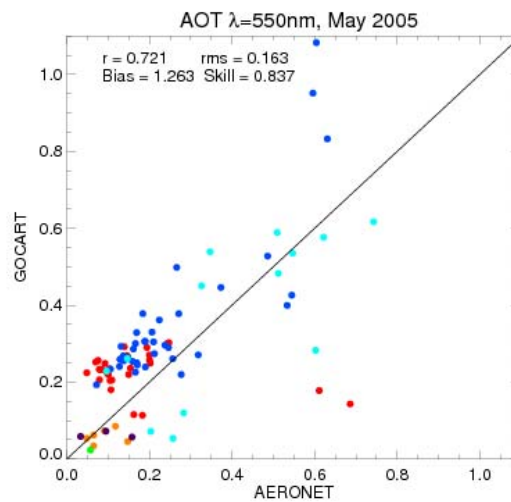
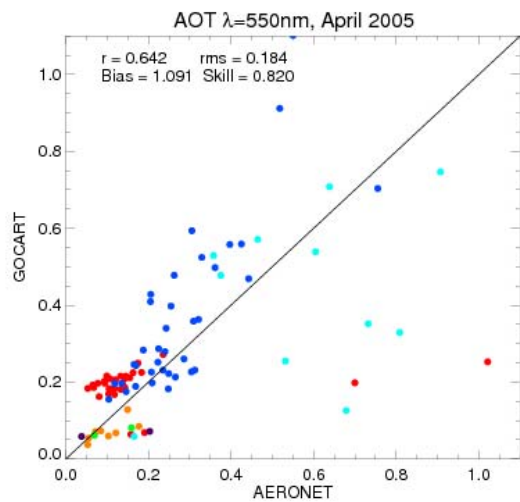
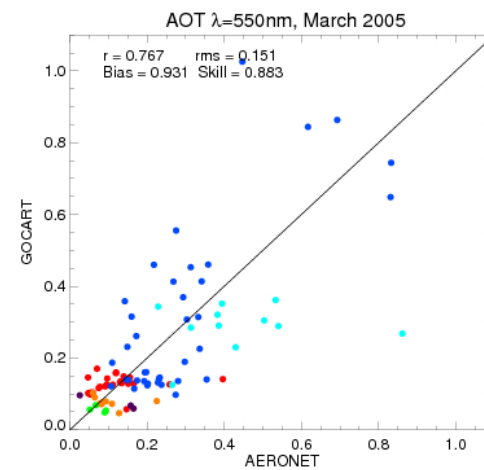
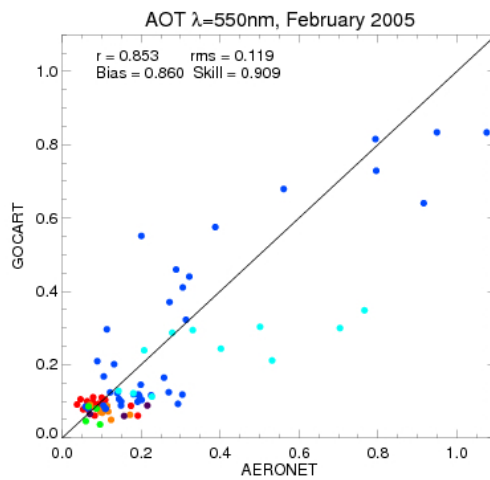
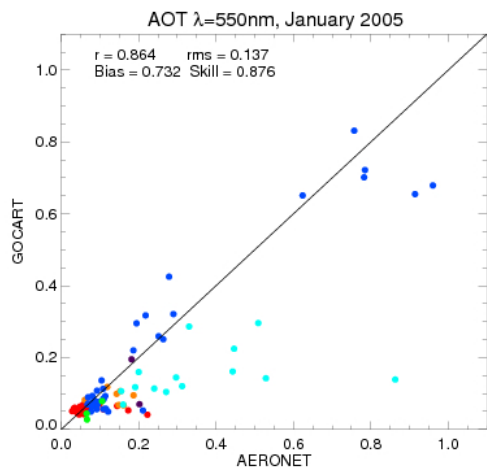
SO₂ from GOCART and Aura/OMI for April 1-11 2005



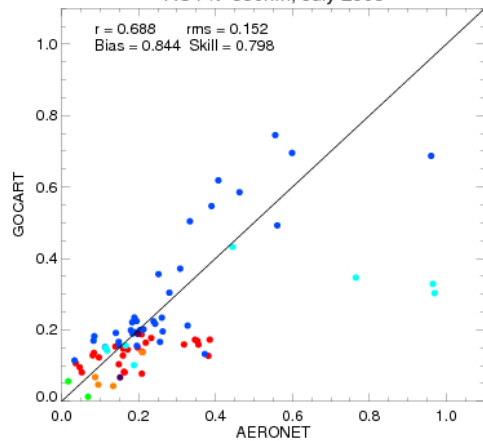
Contact: Simon Carn (scarn@umbc.edu)



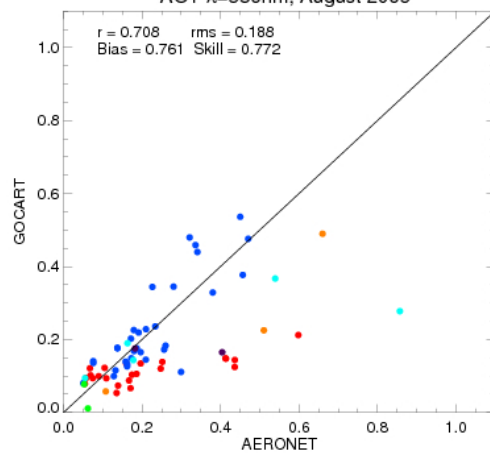
● = Europe/North Africa, ● = South Africa, ● = Asia, ● = North Am., ● = South Am., ● = Austr.



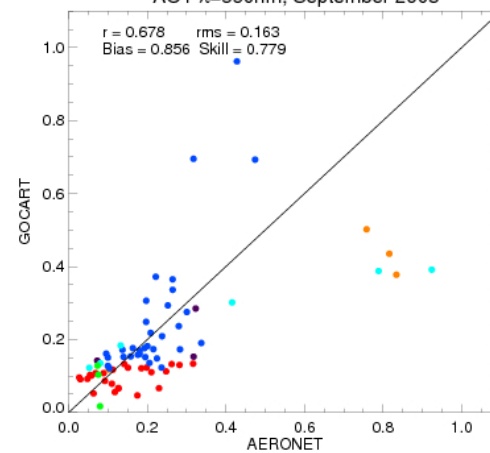
AOT $\lambda=550\text{nm}$, July 2005



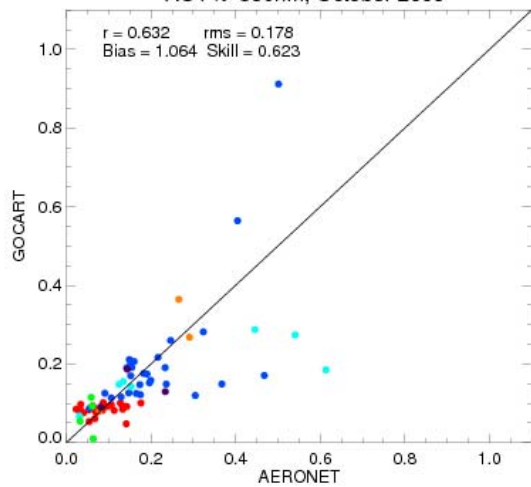
AOT $\lambda=550\text{nm}$, August 2005



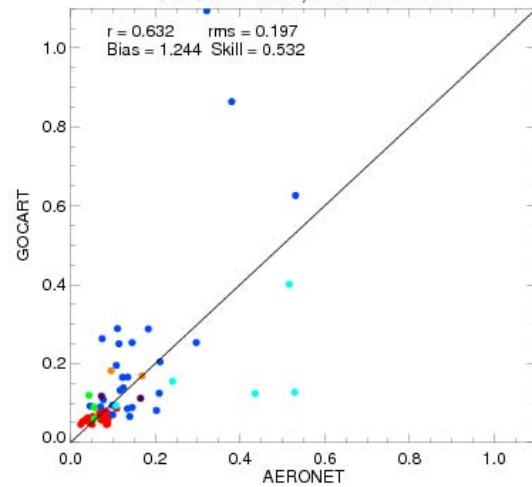
AOT $\lambda=550\text{nm}$, September 2005



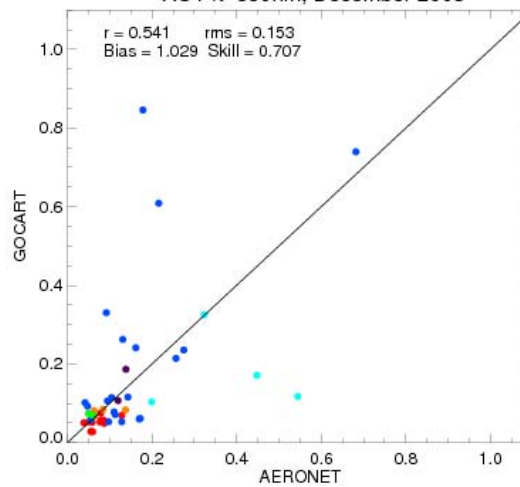
AOT $\lambda=550\text{nm}$, October 2005



AOT $\lambda=550\text{nm}$, November 2005



AOT $\lambda=550\text{nm}$, December 2005



Summary

We compiled an emission inventory in $1^\circ \times 1^\circ$ for BC, OC, and SO_2 , taking into account the following sources:

- International ship traffic, 1980 – 2001 (= > 2005)
- Aircraft, 1980 – 2005
- Other anthropogenic sources, 1980 – 2000 (= > 2005)
- Biomass burning, 1980 – 2005
- Volcanic emissions, 1980 – 2005

Preliminary model results are available for 2000 – 2005 based on these emissions, and the long-term run is ready to be launched ...