AeroCom emissions – a brief update

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Atmospheric Chemistry and Physics Discussions

Anthropogenic, biomass burning, and volcanic emissions of black carbon, organic carbon, and SO_2 from 1980 to 2010 for hindcast model experiments

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Goals:

1. Provide choices of emissions for aerosol hindcast experiments, describe methodologies, and analyze emission features.

2. Discuss options of injection heights for biomass burning and volcanic emissions, and biomass burning EFs and aircraft EIs for A2-MAP).

Emissions available for AeroCom Phase II

1a. **A2-MAP-v1** (1980-2007) (formerly A2-HCA0-v1)
Contains land-based anthrop. emissions from D. Streets, aircraft emissions from NASA's AEAP project, ship emissions from V. Eyring, and volcanic emissions.

1b. **A2-MAP-v2** (1980-2005) (formerly A2-HCA0-v2)
Anthropogenic SO2 emissions replaced with emissions from EDGAR 4.1 to fix overestimate in A2-MAP-v1 over Europe.

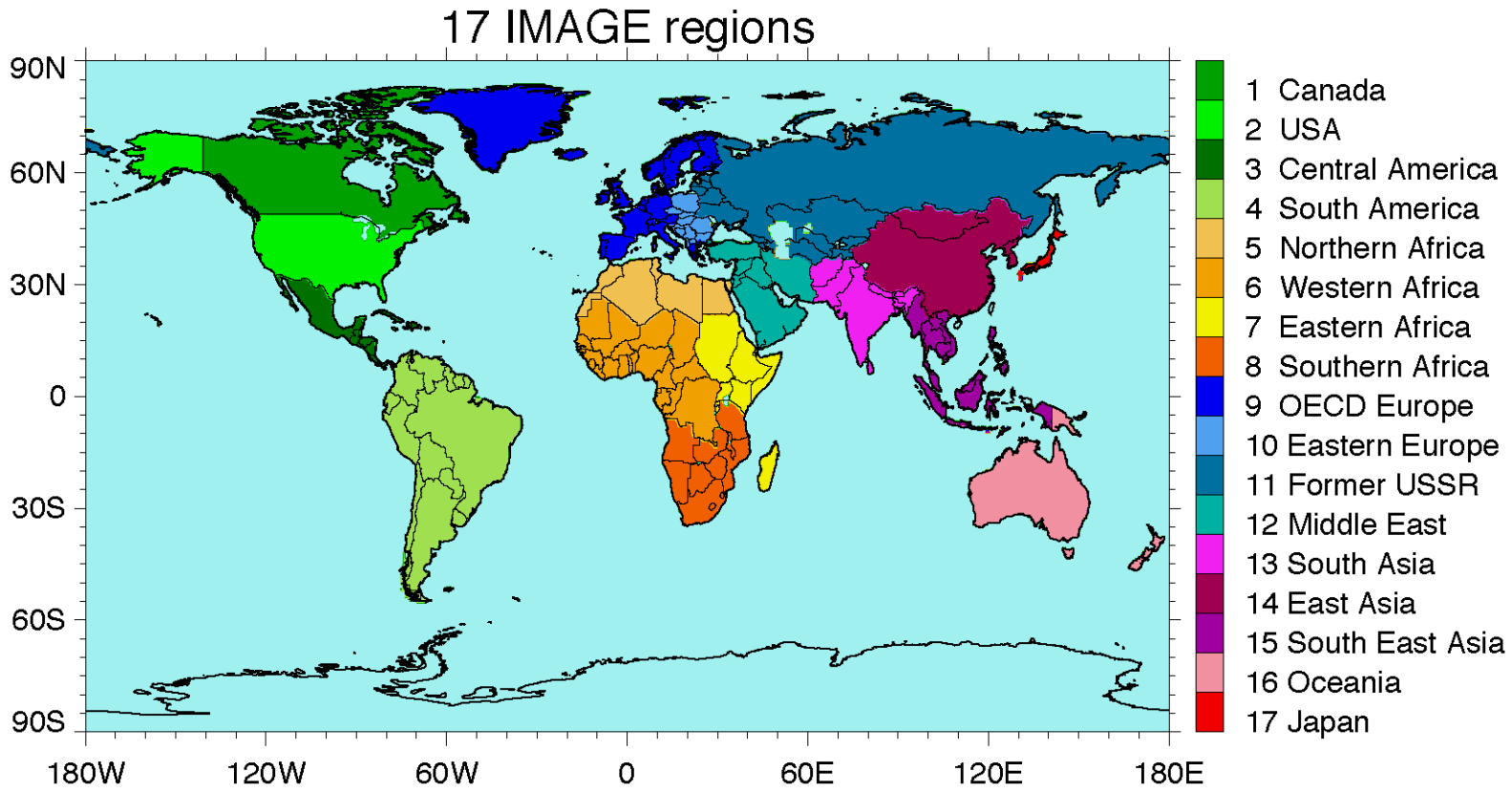
2. **A2-ACCMIP** (1980-2010)
Anthropogenic part derived from ACCMIP (Lamarque et al.) via linear interpolation; years after 2000 derived from RCP8.5.
Biomass burning emissions based on RETRO, GFED-v2 and RCP8.5.

Also available: PI emissions for 1850 (Lamarque et al.) and 1750 (Dentener et al.).

Overview

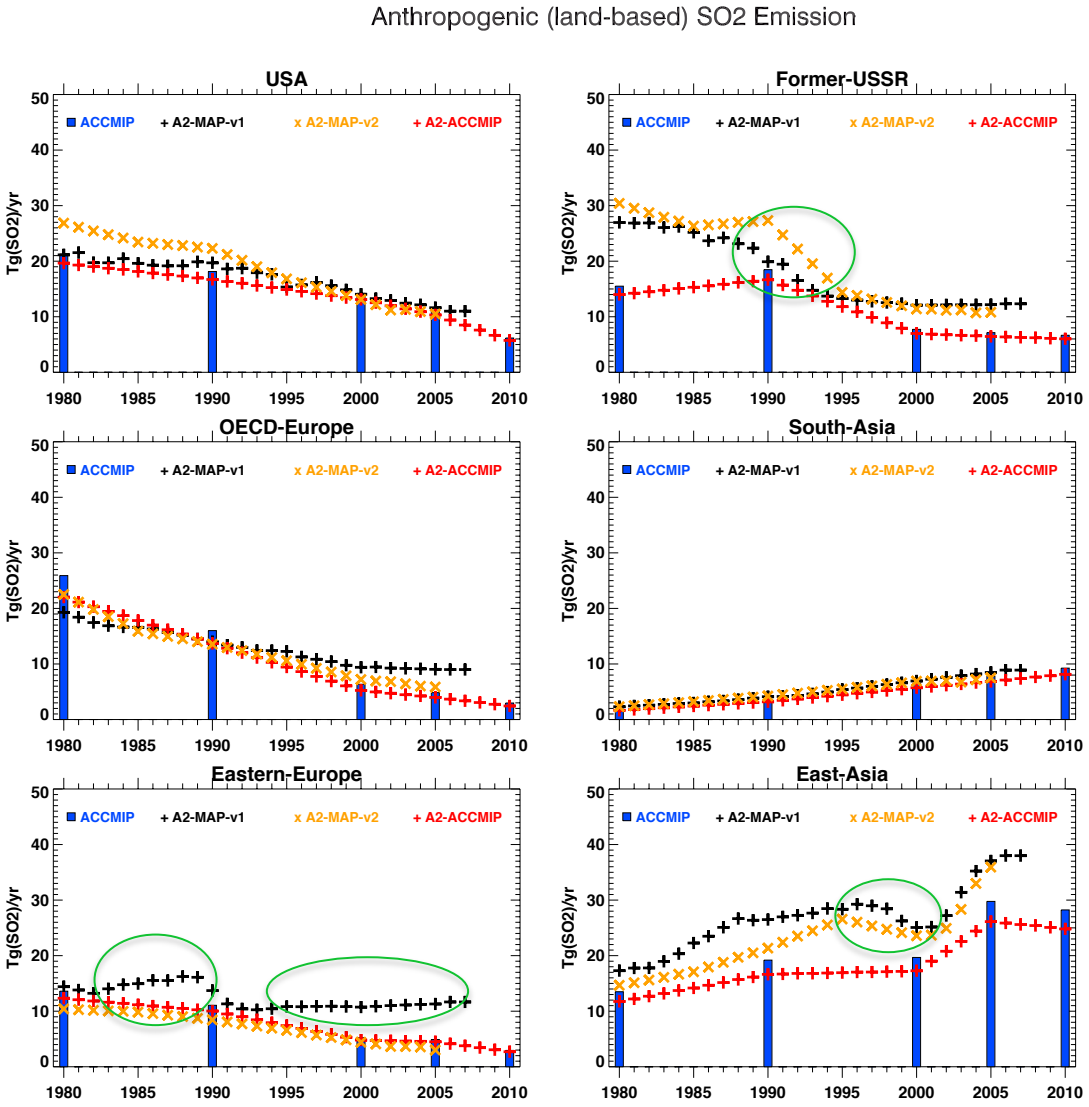
	A2-MAP-v1	A2-MAP-v2	A2-ACCMIP
Spatial Resolution	1x1	1x1	0.5x0.5
Species	BC, OC, SO2	BC, OC, SO2	BC, OC, SO2, NH3, and other species
Sectors	Anthrop. land-based, ships, aircraft, BB, volcanic	Anthrop. land-based, ships, aircraft, BB, volcanic	Anthrop. land-based, ships, aircraft (BC), BB
Temporal Resolution	yearly, monthly (aircraft & BB), daily (volcanoes)	yearly, monthly (aircraft & BB), daily (volcanoes)	yearly, monthly (BB)
Period	1980-2007 (2009 for volcanoes)	1980-2005 (2009 for volcanoes)	1980-2010

Regions for anthropogenic emissions



SO2 land-based emissions

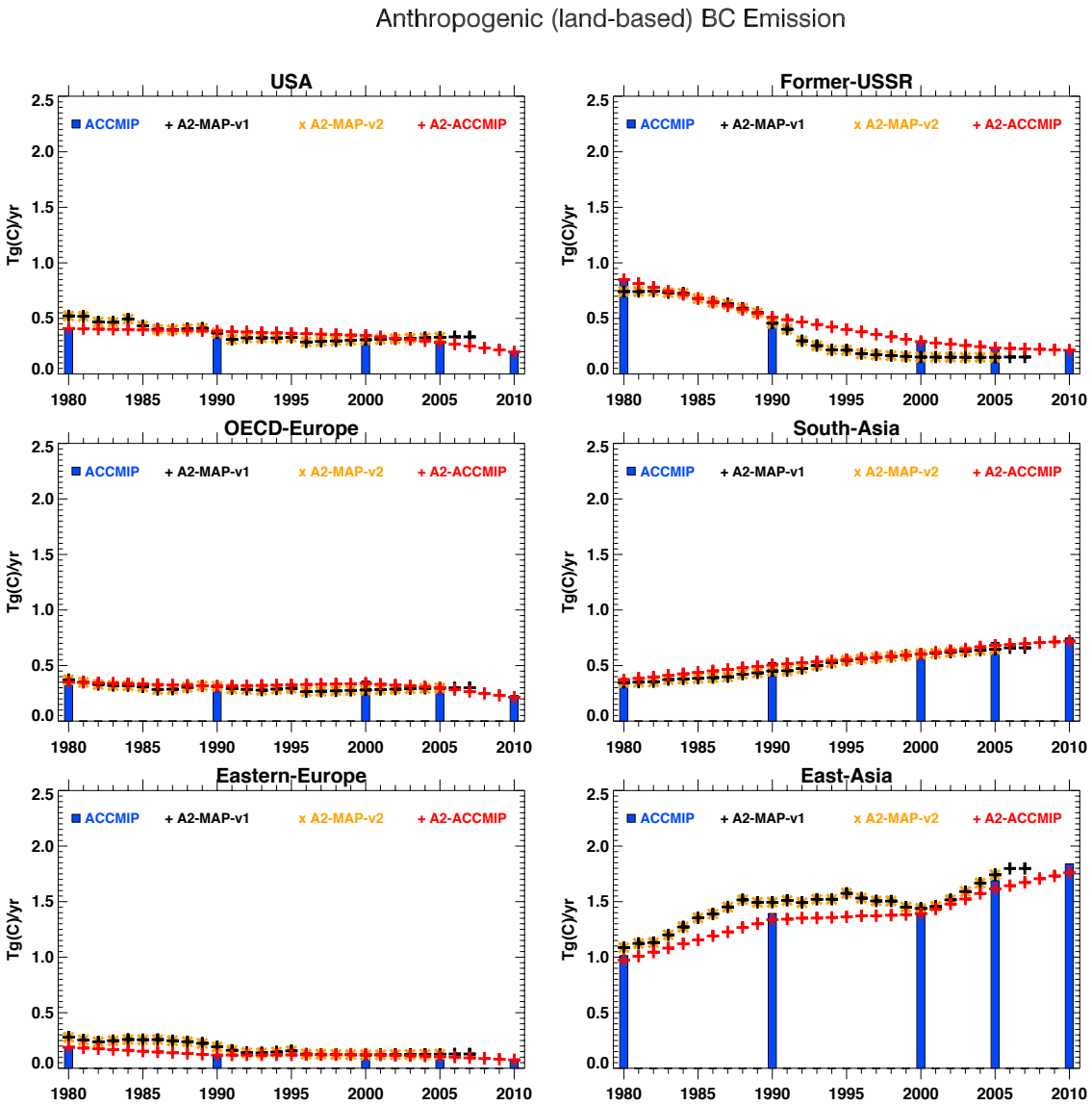
A2-MAP-v1
A2-MAP-v2
A2-ACCMIP



V1 trend probably overestimated;
SO2 reduction measures and breakdown of communism not taken into account

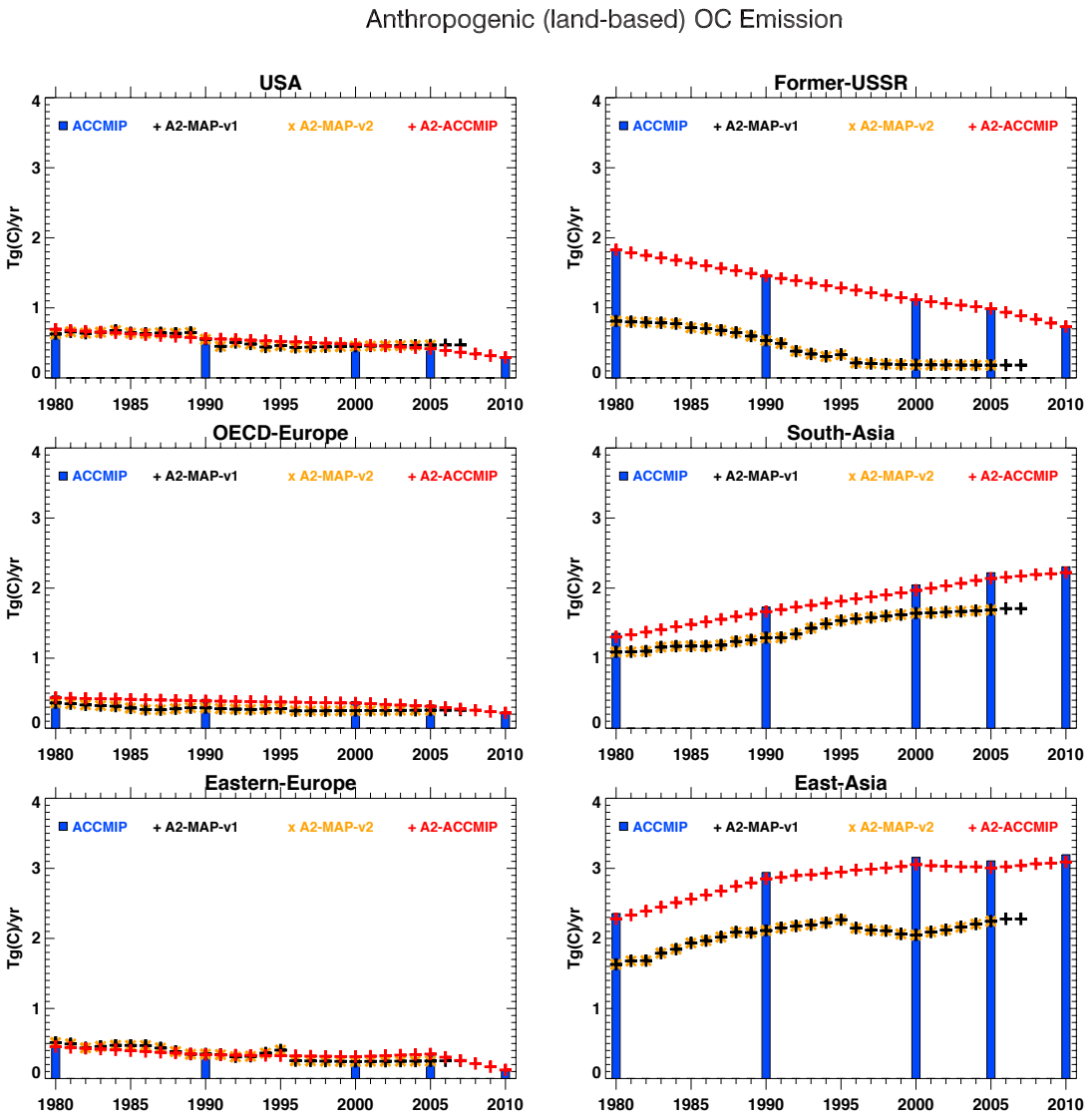
BC Land-based Emissions

Decline in residential fuel use and transport sector from 1995 to 1996 in U.S.

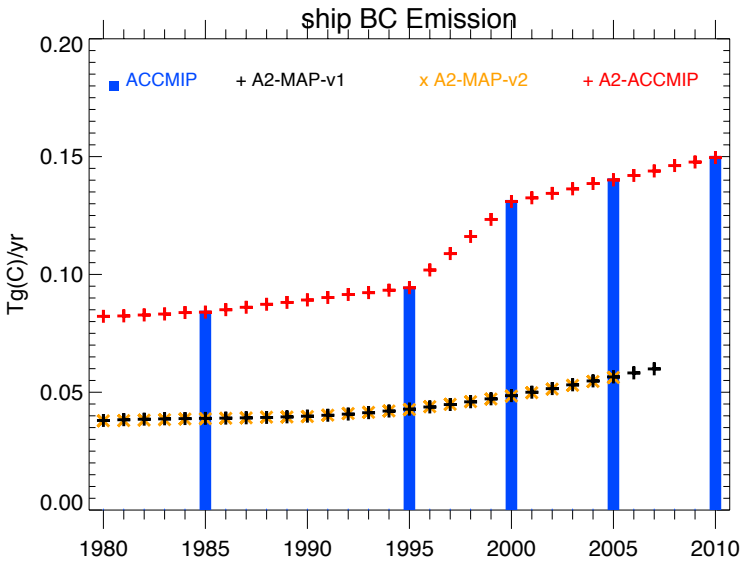


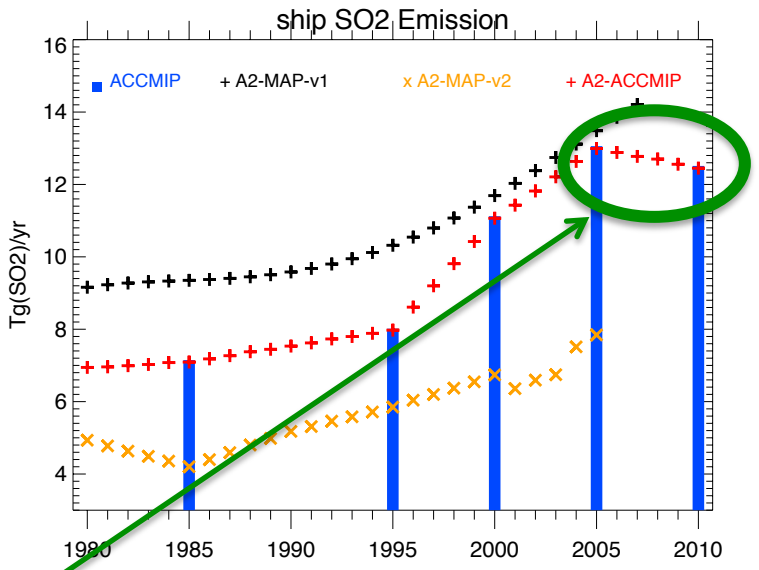
OC land-based emissions

Former USSR and Asia: Similar trends, but larger differences than for BC



Ship emission trends

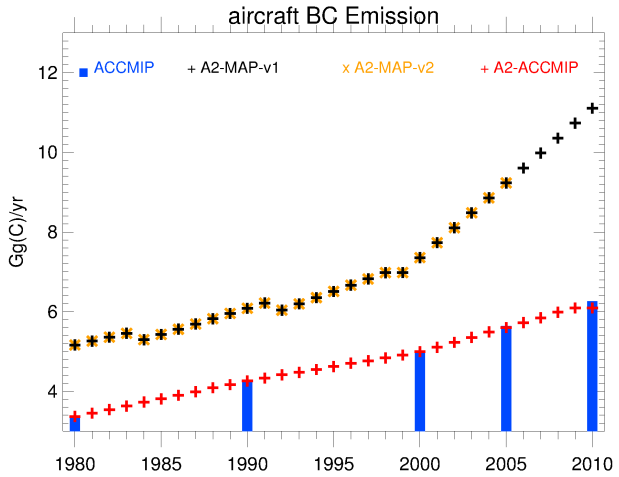




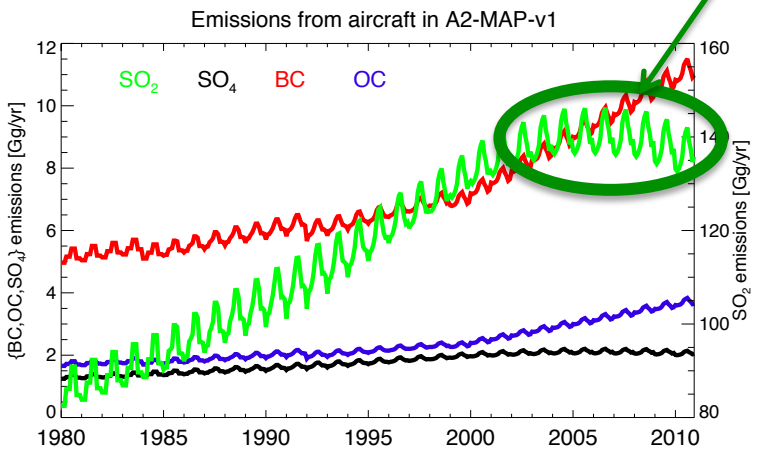
A2-ACCMIP SO_2: decreasing fuel sulfur content after 2005

Large BC difference between A2-MAP-v1 and A2-ACCMIP probably due to different assumptions about BC emission factor

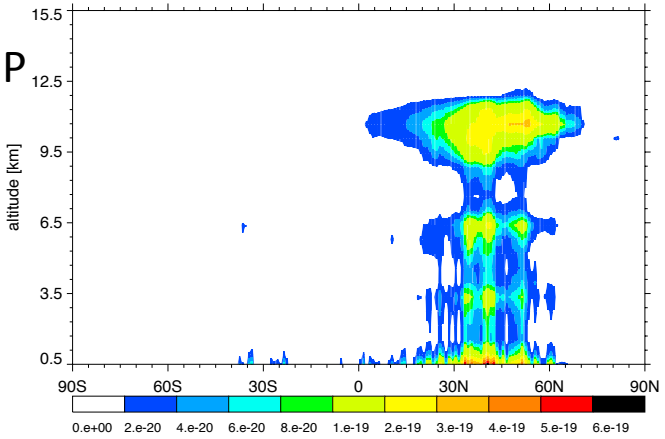
Aircraft Emissions

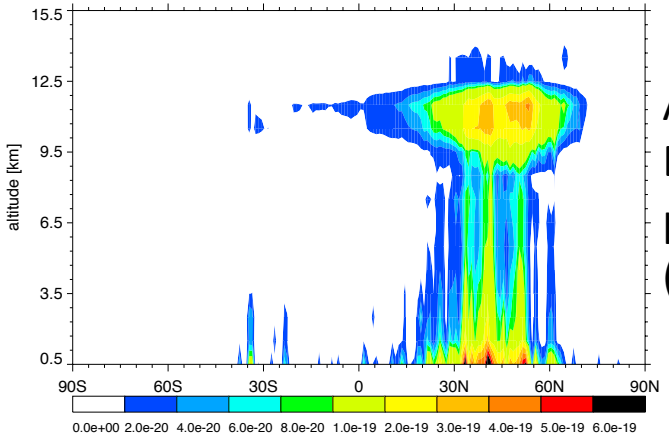


Decreasing fuel sulfur content



A2-ACCMIP BC emis. rates; peak at 10.7 km (1999)

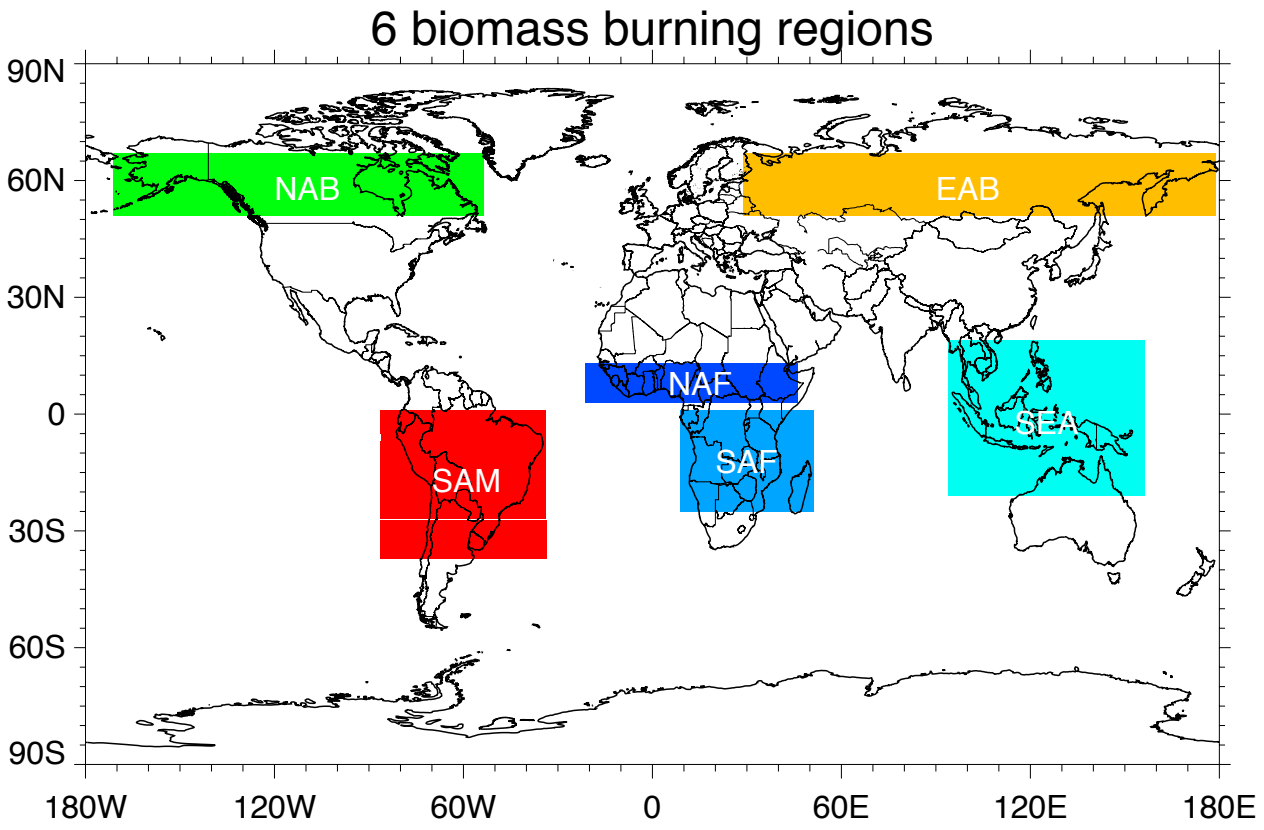




A2-MAP BC emis. rates; peak at 11.6 km (1999)

A2-MAP provides fuel; EI must be applied. A2-ACCMIP provides BC only. Both inventories are based on scenarios after year 2000

Regions for biomass burning emissions



6 regions: 87% of total BB OC

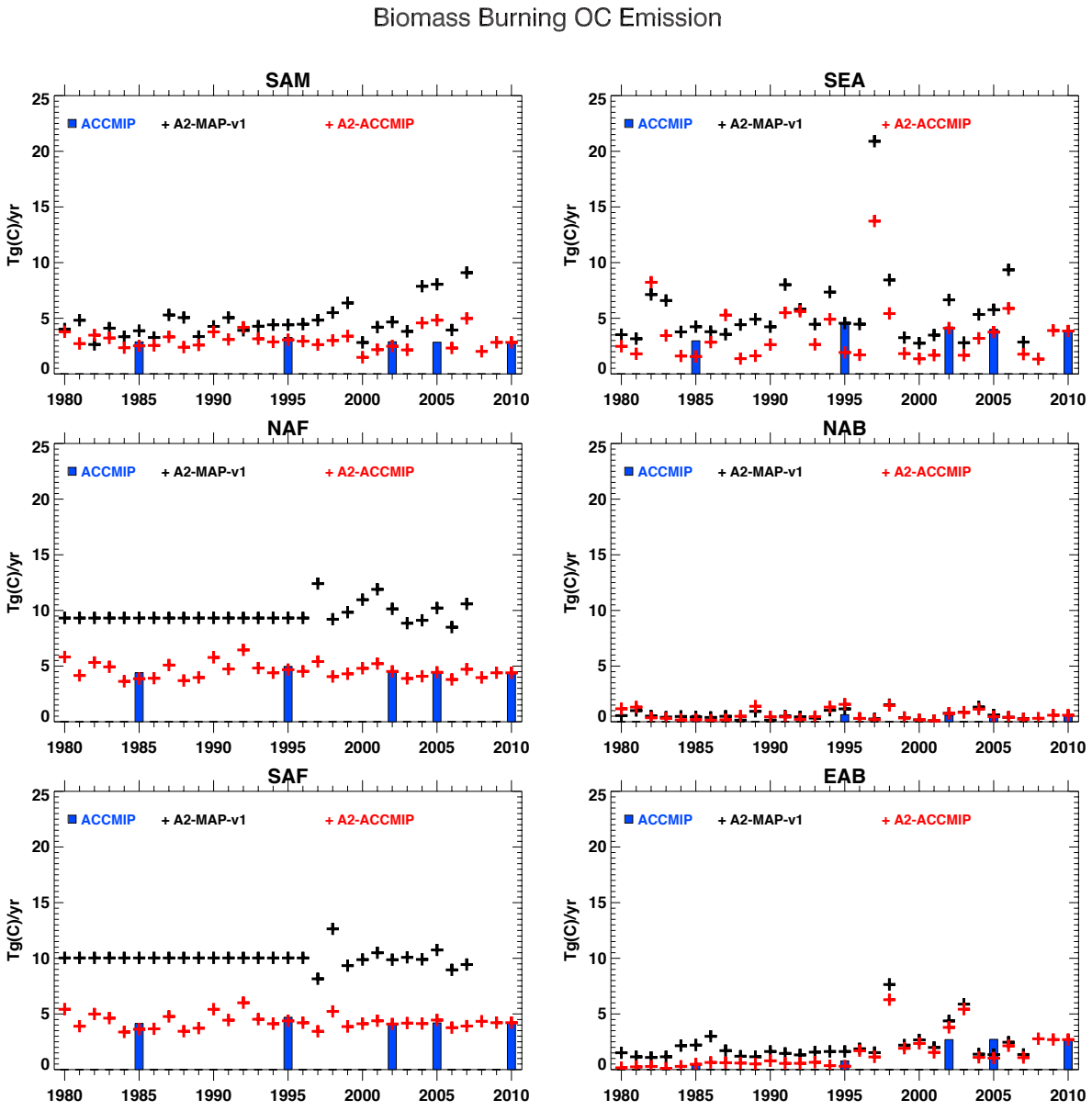
OC Biomass Burning Emissions

Dry Mass identical after 1996.

Applied EF to A2-MAP

EF(A2-MAP) >= EF(A2-ACCMIP), depending on region (~1 to 2.3)

DM differs by up to factor 4 in EAB prior to 1997



Volcanic SO2 Emissions

- Daily SO_2 emissions and plume heights for 1167 volcanoes from 1-1-1979 to 31-12-2009
- Emissions due to explosive and effusive eruptions as well as silent degassing taken into account
- Eruption data including the VEI is from the Smithsonian's Global Volcanism Program (GVP)
- Additional data from TOMS, OMI, and COSPEC measurements, and other estimates in the literature

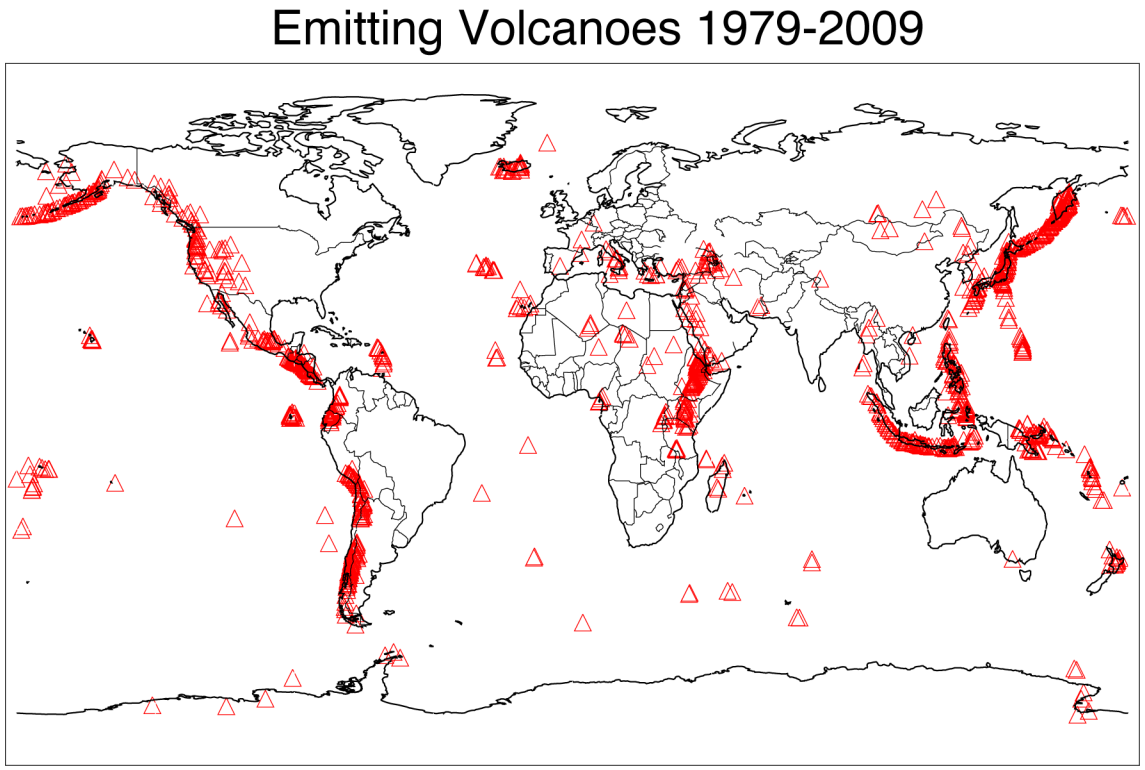
Plume Height Estimation in AeroCom

The plume height default is based on the VEI/height relationship. Data from the weekly or monthly GVP reports has been added over time. Plume heights for major eruptions are from analyses in the literature.

SO2 is evenly distributed over all levels located in the top 1/3 of the column.

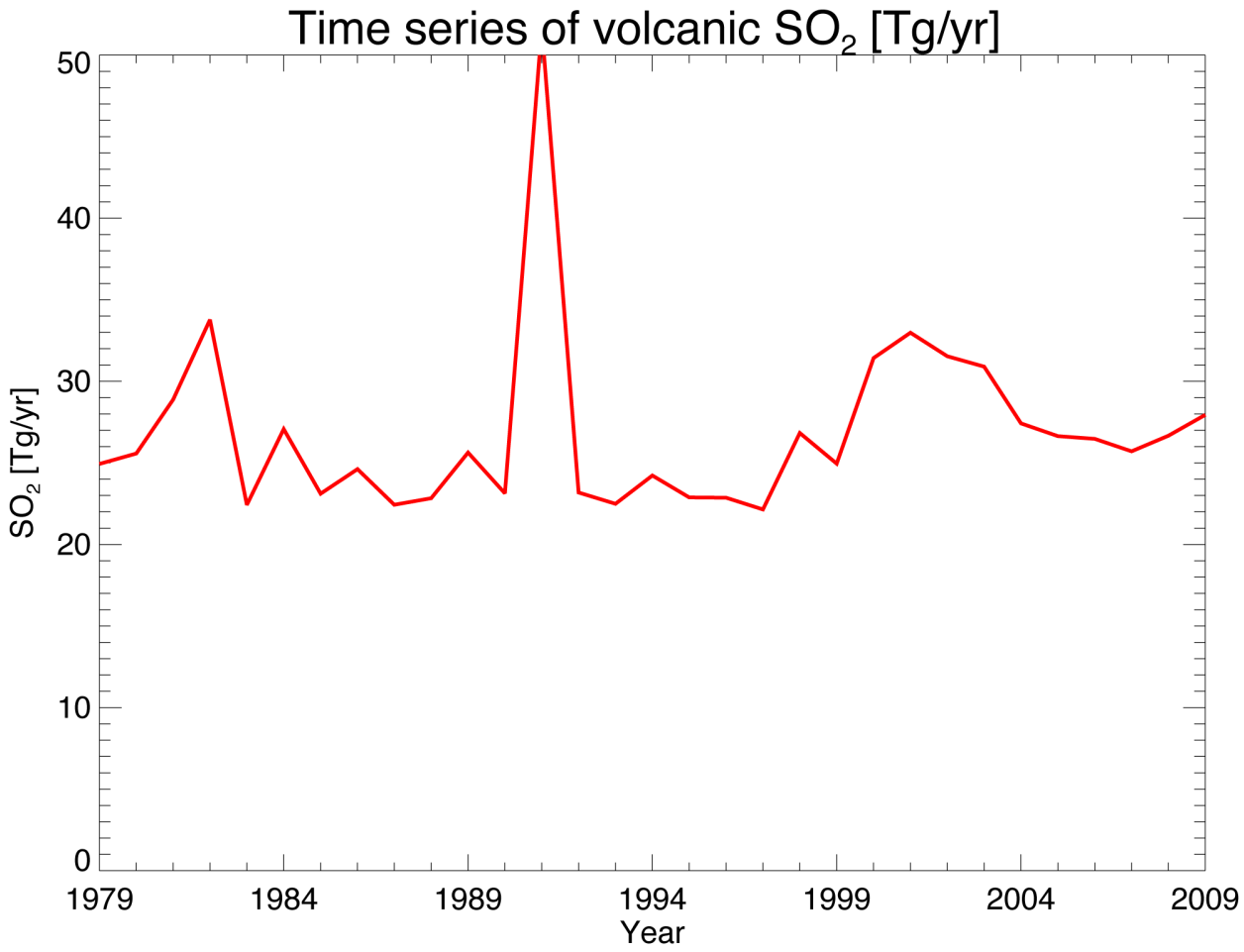
Silently degassing volcanoes emit at the elevation of the volcano. No flank degassing is considered.

Location of Volcanoes



- Mostly located along arcs of subduction zones
  - More frequent, violent and short-lived eruptions
- Fewer hot spot and rift volcanoes
  - Longer lasting eruptions, more effusive, more SO2

Total SO_2 per Year



	Minimum	Maximum	Average	Median
Total SO_2/year	22 Tg	52 Tg	27 Tg	26 Tg

About 11-13 Tg/year from silent degassing included

Global emissions [Tg/a]

		BC	BC	OC	OC	SO2	SO2
		MAPv2	ACCMIP	MAPv2	ACCMIP	MAPv2	ACCMIP
GLB anthrop.	Range	4.6-5.3	4.5-5.2	7.7-8.9	11.0-12.8	104-143	92.6-120
	2005	5.3	5.2	8.9	12.8	113.4	96.7
BB	Range	4.5-7.1	1.8-3.5	36.2-56.4	14.4-33.1	5.4-8.5	2.0-6.6
	2005	5.3	2.6	42.0	21.9	6.3	3.6
Volcanic	Range	---	---	---	---	22.1-51.7	----
	2005	---	---	---	---	26.7	(26.7)
Total	2005	10.6	7.9	51.1	34.8	154.4	140.0

Summary

- Overall, major global anthropogenic emission trends are captured in both inventories. Global differences are lowest for BC (2% in 2005), followed by SO_2 (17%) and OC (43%). Regional differences can be 100% or more, especially for OC (but also BC and SO2) over the former USSR.

- Globally, the largest differences (~100%) occur for BB due to higher emission factors applied to A2-MAP. Large differences (>100%) for dry mass burned prior to 1996 for some regions and years.

- Both inventories constructed from multiple inventories => internal inconsistencies

- Choice of inventory depends on scope of experiment. Differences: inter-annual variation, resolution, period, volcanic emissions, consistency with CMIP5/ACCMIP.