

Results from aerosol model intercomparisons HTAP and plans of AEROCOM

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**Task Force on Hemispheric
Transport of Air Pollution**

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Motivation

Long-range transport events of aerosols :

- arctic haze

- fire aerosols transported in elevated layers

- PM sulfate levels elevated eg in western US

- Dust impact on PM exceedances

- Pollution export

Long range transport of PM

from specific regions of continental scale

has not been compared among models

and is little documented in literature

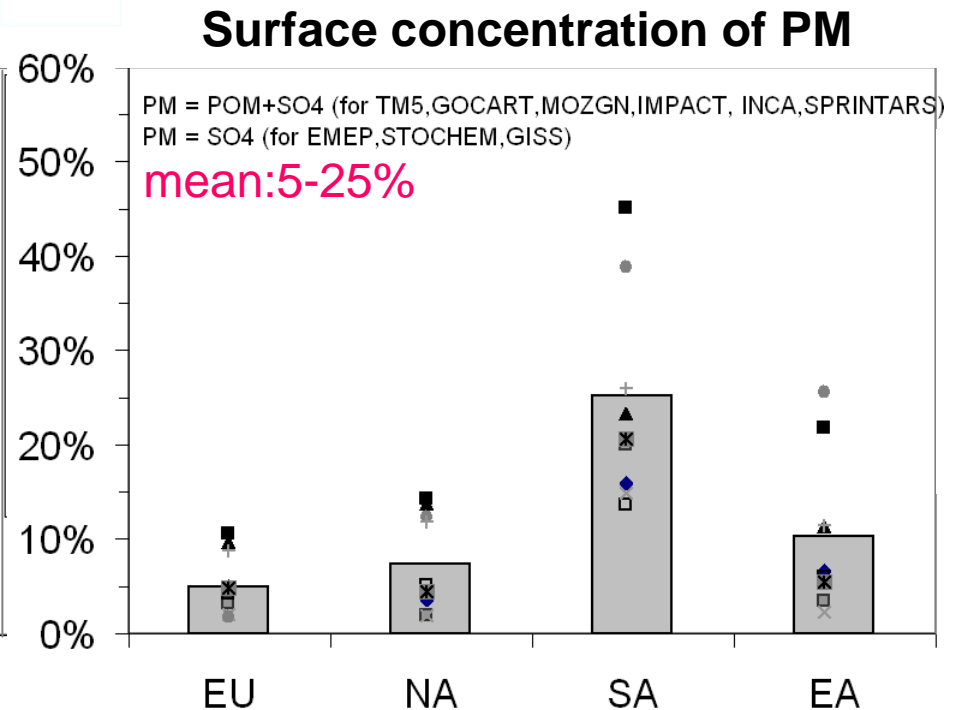
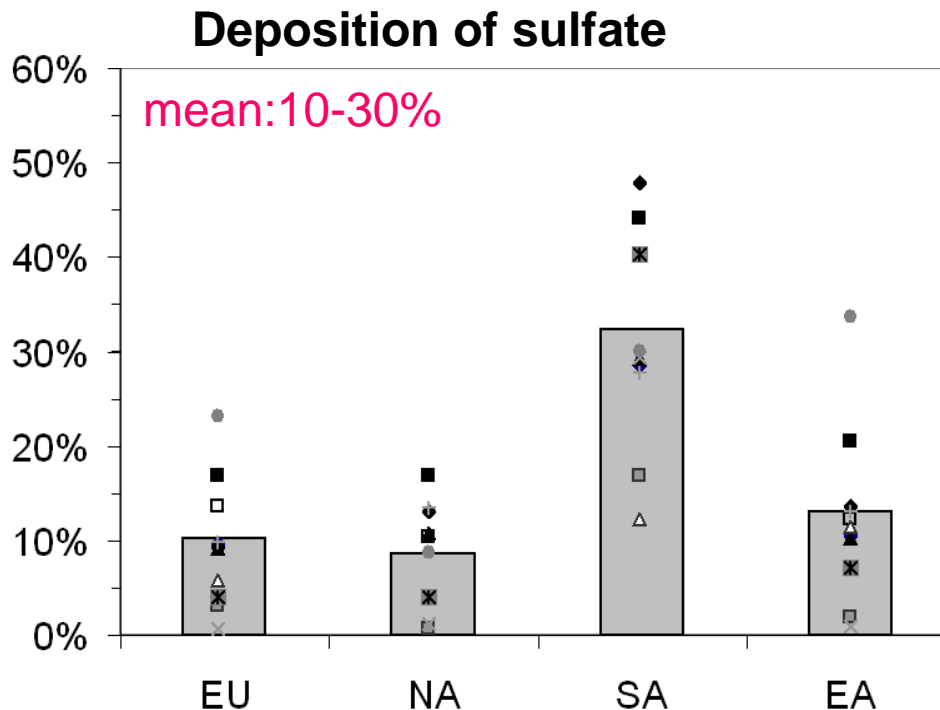
Aerosol models show diversity – ***to be understood***

(see AeroCom publications in ACP 2006, Textor, Kinne, Schulz et al.)

Aerosol simulations from 17 models, 8-11 included in analysis

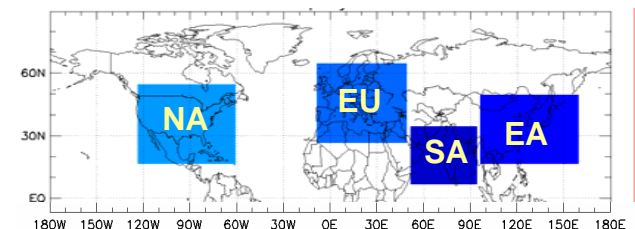
Model/version	Institute
CAMCHEM-3311m13	National Center for Atmospheric Research, Boulder, CO, USA.
ECHAM5-HAMMOZ	LMCA, EPFL, Lausanne, Switzerland
EMEP-rv26	Norwegian Meteorological Institute Oslo, Norway.
GEMAQ-EC	Environment Canada, Canada
GEOSChem-v07	Harvard University, Cambridge, USA
GISS-PUCCINI-modelA	NASA GISS Goddard Institute for Space Studies, New York, USA
GISS-PUCCINI-modelE	NASA GISS Goddard Institute for Space Studies, New York, USA.
GMI-v02a	NASA GSFC (Goddard Space Flight Center), Greenbelt, MD, USA.
GOCART	NASA, USA
INCA-v2MS	IPSL, Paris, France
LLNL-IMPACT-T5a	Lawrence Livermore National Laboratory, Livermore, CA, USA.
MOZARTGFDL-v2	Geophysical Fluid Dynamics Laboratory, Princeton, NJ, USA
OsloCTM2	Oslo University, Norway.
SPRINTARS-v356	RIAM, Kyushu University, Japan
STOCHEM-v02	Hadley Centre, Met Office, UK
TM5-JRC-cy2-ipcc-v1	European Commission, Joint Research Center, Italy
ULAQ	University of L'Aquila, Italy

Response import fractions of the four HTAP regions

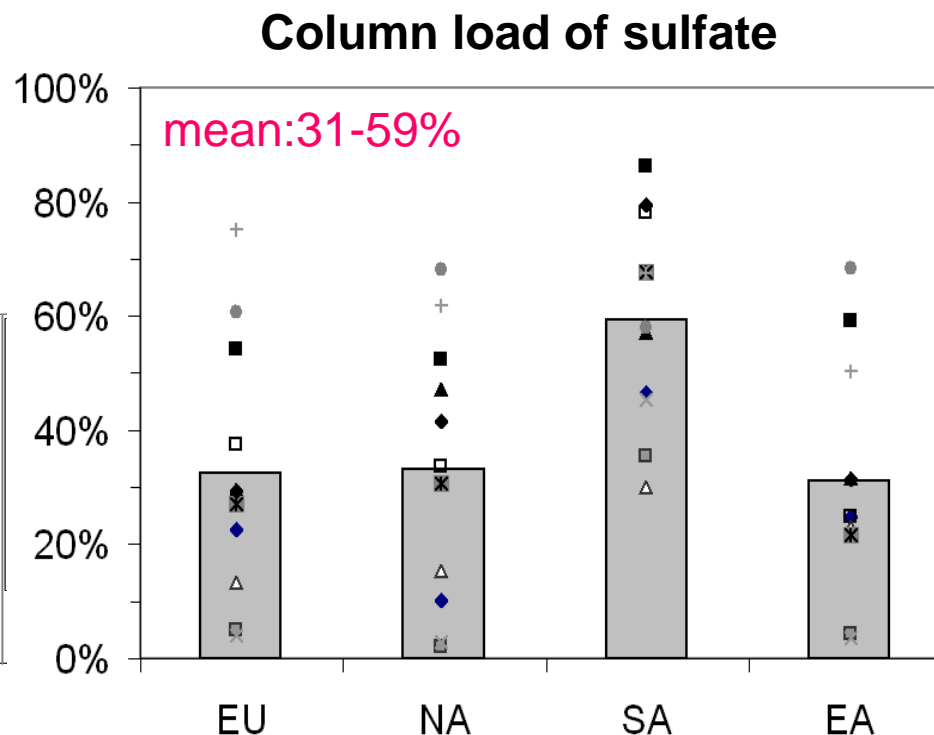
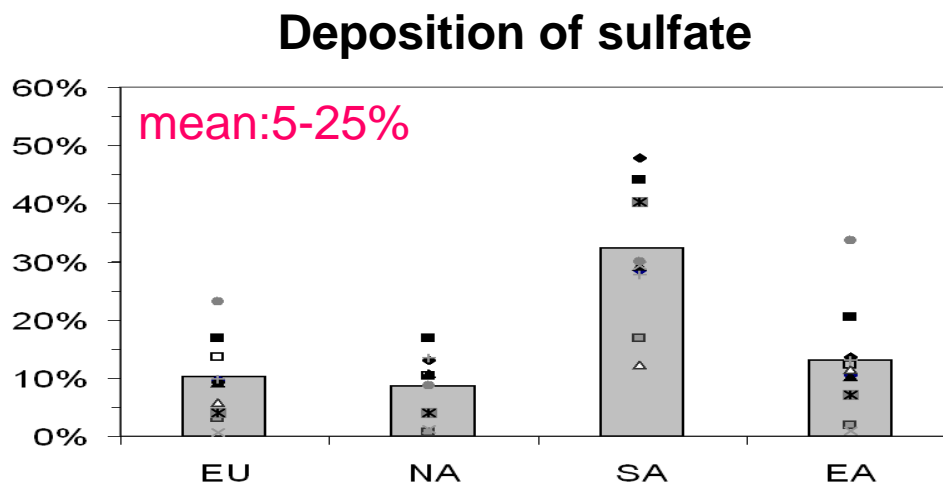


annual means for 2001

- Similar results for deposition and surface concentration
- Highest import for SA

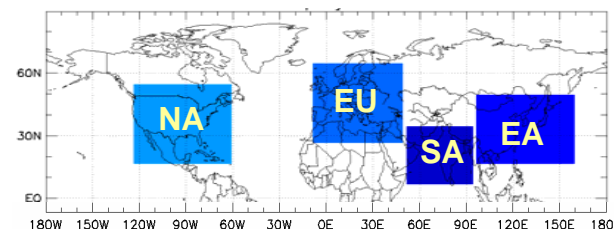


Response import fractions of the four HTAP regions

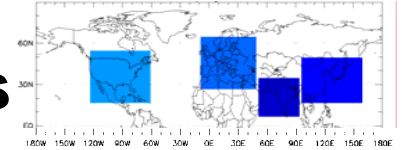


Much higher influence on column load than on surface conc. and deposition

annual means for 2001



Response import fractions [%] to HTAP regions



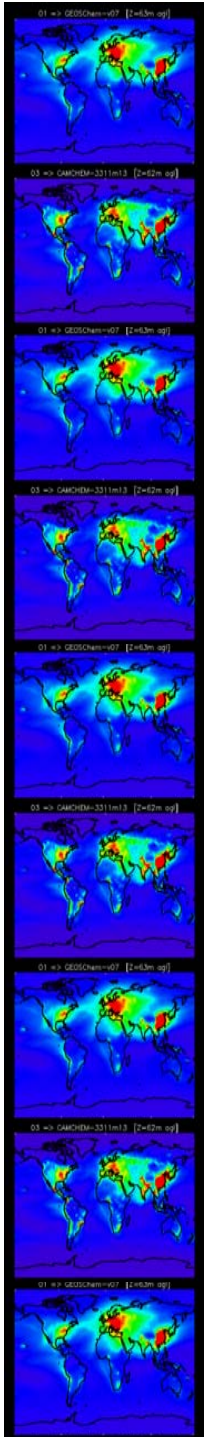
Receptor region:	EU	NA	SA	EA	# models
Surface Concentration response import fraction					
PM	5 (4)	7 (6)	25 (12)	10 (9)	9
Deposition response import fraction					
SO ₄	10 (7)	9 (5)	32 (11)	13 (9)	11
Sulfur (SO ₂ +SO ₄)	3 (2)	3 (3)	19 (8)	5 (3)	11
BC	1 (1)	4 (2)	13 (24)	3 (1)	8
POM	1 (1)	3 (2)	12 (24)	4 (1)	8
Nr	4	3	15	8	10
Column Load response import fraction					
SO ₄	33 (23)	33 (23)	59 (19)	31 (21)	11
BC	21 (14)	32 (23)	19 (3)	17 (5)	7
POM	27 (21)	30 (24)	13 (5)	24 (6)	7

Inter-model standard deviations given in brackets, annual means for 2001

Major Results for PM

annual averages from experiments with
20 % perturbation in the anthropogenic
primary and precursor emissions

- Response import fractions for PM **surface concentration** vary between 5 and 25%.
- Response import fractions for **deposition** varies from 10-30% for sulfate, 1-13% for carbonaceous aerosols, and 2-8% for total reactive nitrogen.
- Much larger influence of intercontinental transport on **column loading**: response import fractions of 31-59% for sulfate, and 13-32% for carbonaceous aerosol.



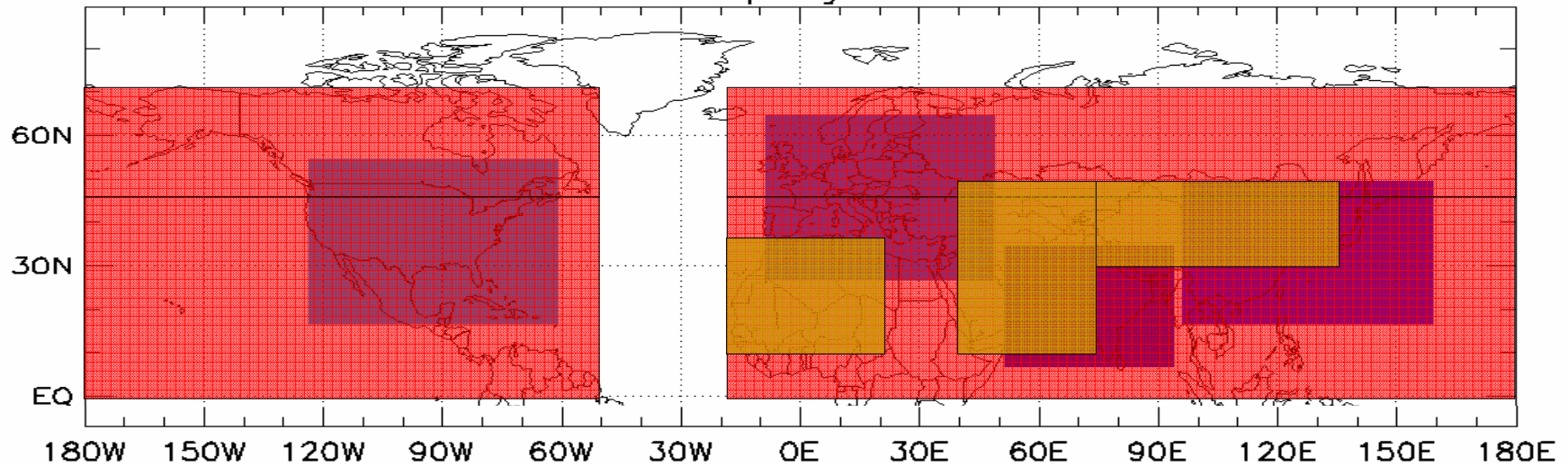
Future modelling studies for PM

11 additional model runs: **4 anthropogenic**, **3 dust**, and **4 biomass burning**

Description	Purpose
Base case simulation for year 2001 with “best estimated” anthropogenic and natural emissions.	Reference/verification
Reducing anthropogenic aerosol emissions by 20% in EA, EU, NA, and SA	Source – receptor relationships
No anthropogenic emissions in 4 HTAP regions	Investigate total effect versus 20%
No dust emissions in 3 dust source regions	Assessing impact of regional dust on air quality & ecosystems
No biomass burning emissions in 4 sectors	Assessing maximum impact of regional and long-range transport of biomass burning aerosol

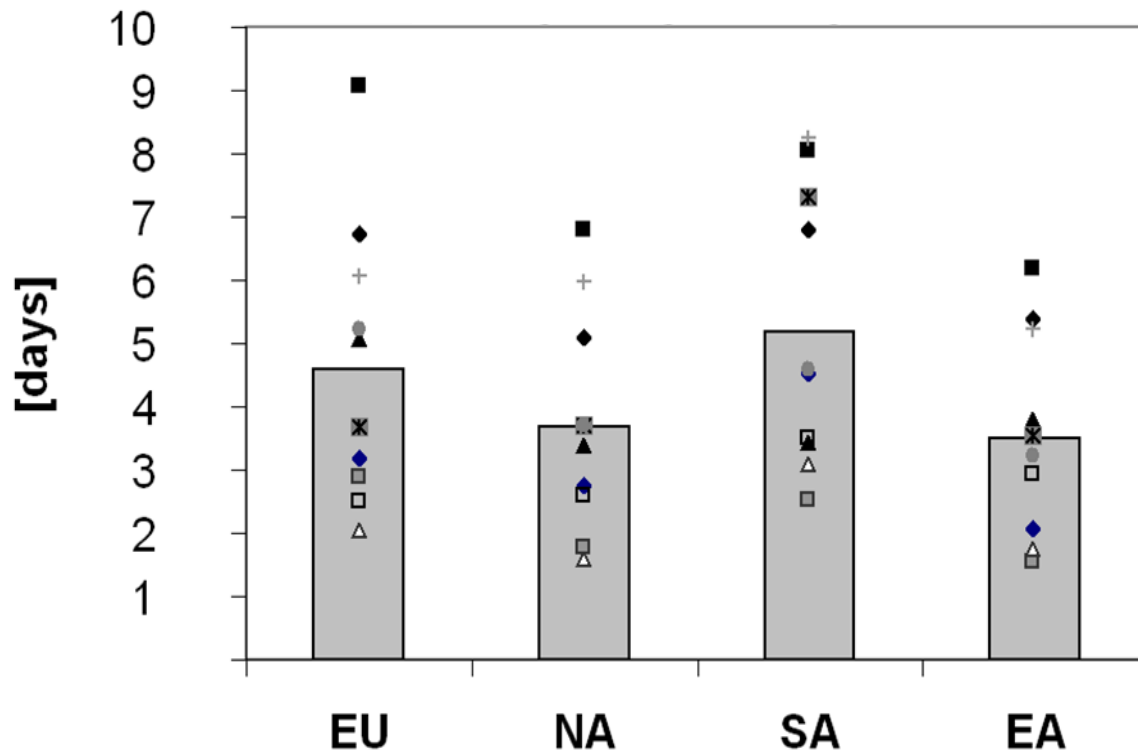
“zero experiments” to assess the maximum impact of long-range transport

Additional HTAP source-receptor regions



Name	Region	Longitude	Latitude
EA	East Asia	95E – 160E	15N – 50N
SA	South Asia	50E – 95E	5N – 35N
EU	Europe + North Africa	10W – 50E	25N – 65N
NA	North America	125W – 60W	15N – 55N
AS	Dust: Asia	75E – 135E	30N – 50N
ME	Dust: Middle East	40E – 75E	10N – 50N
AF	Dust: Africa	20W – 40E	10N – 36N
NE	Fire: Boreal regions in Asia and Europe	20W – 180E	45N – 70N
NW	Fire: Boreal regions in North America	180W – 50W	45N – 70N
SE	Fire: Tropical and mid-lat regions in Asia, Europe, and northern Africa	20W – 180E	0 – 45N
SW	Fire: Tropical and mid-lat regions in North America and South America	180W – 50W	0 – 45N

Residence time τ of anthropogenic sulfur

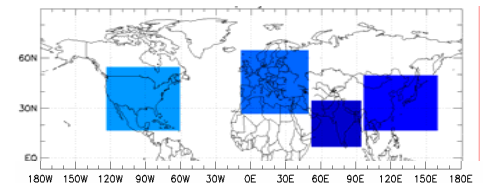


HTAP models

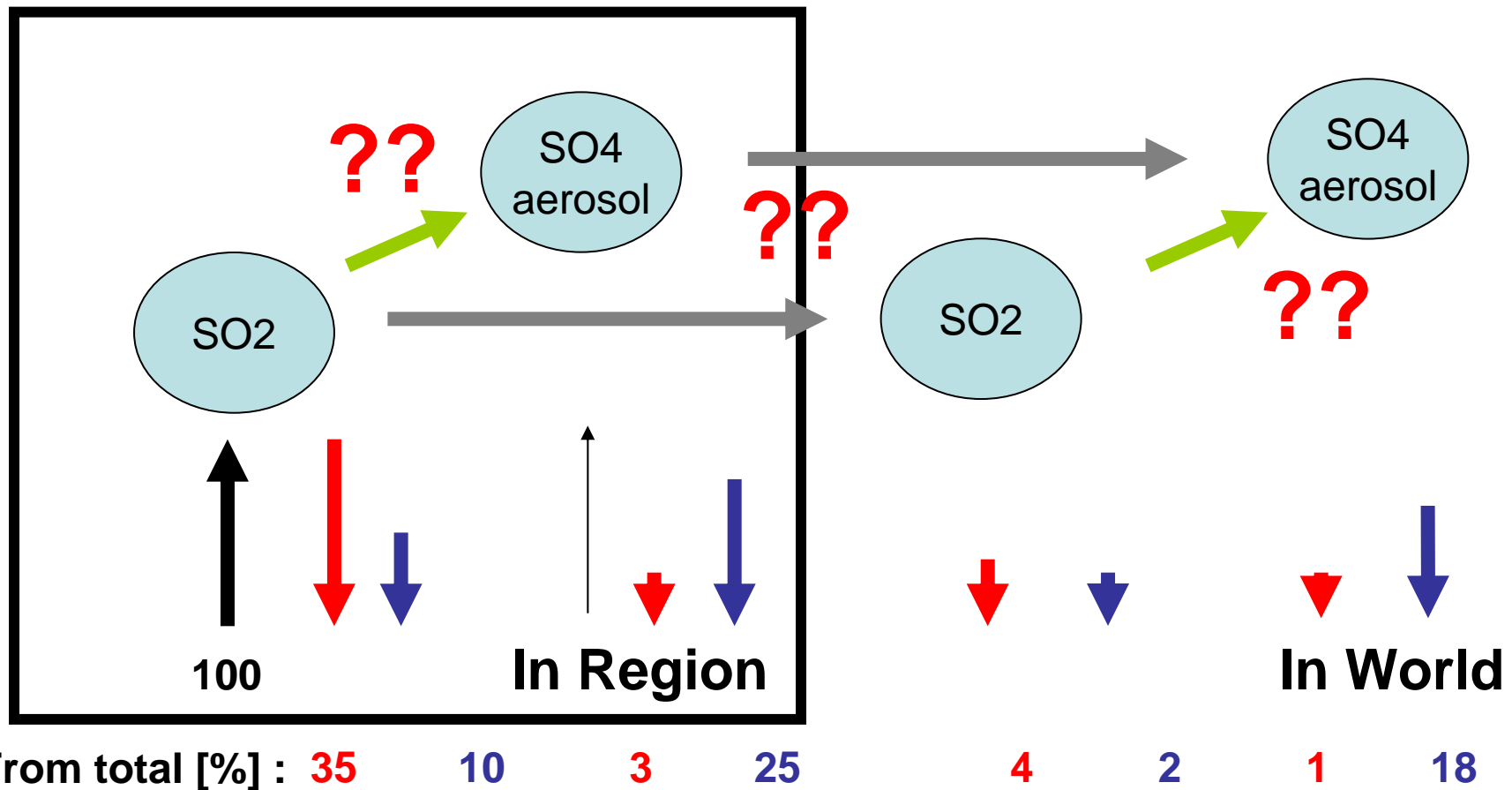
Residence time τ
= Δ load / Δ deposition flux

Δ : Response to
perturbation
of domestic emissions

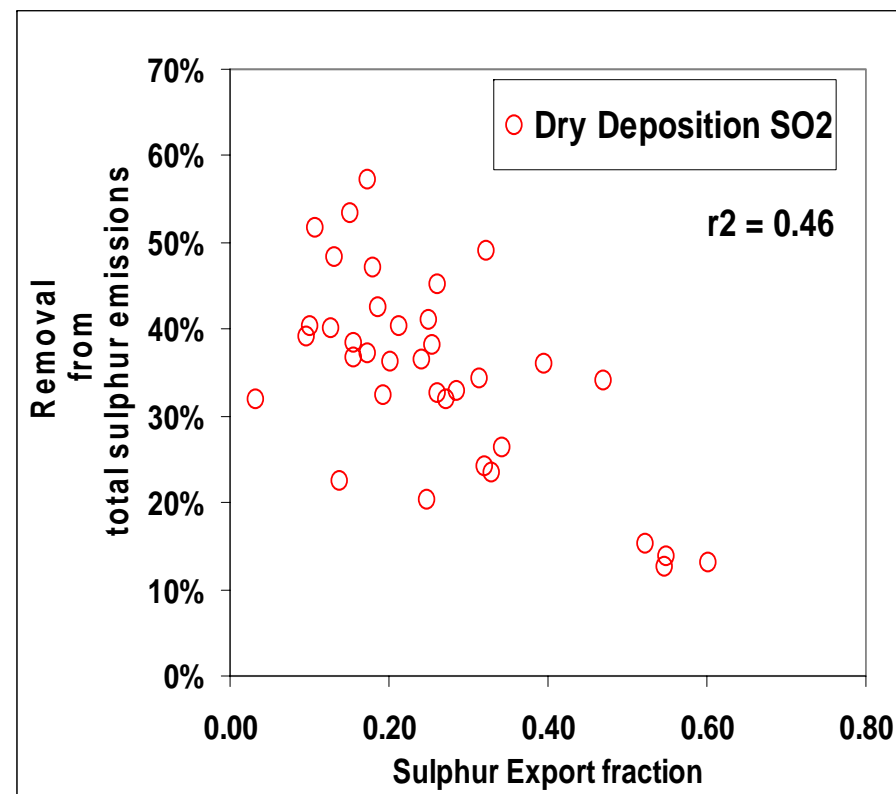
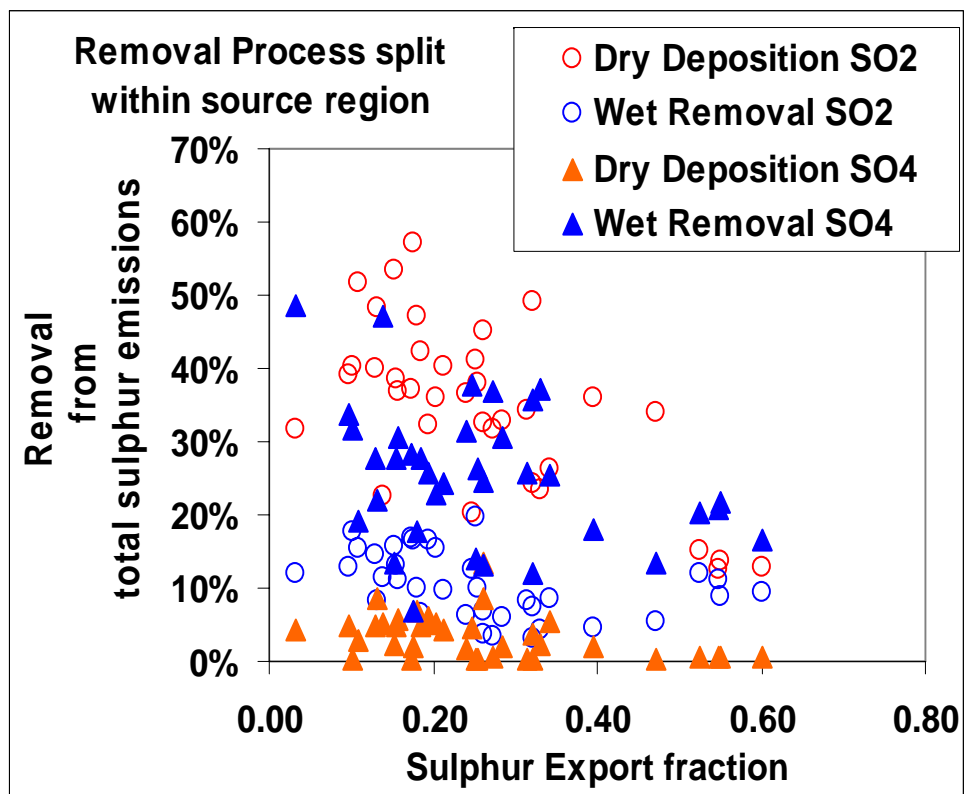
- Large differences in τ (factor 4)
- Models with larger τ show larger export
- Importance of simulated processes

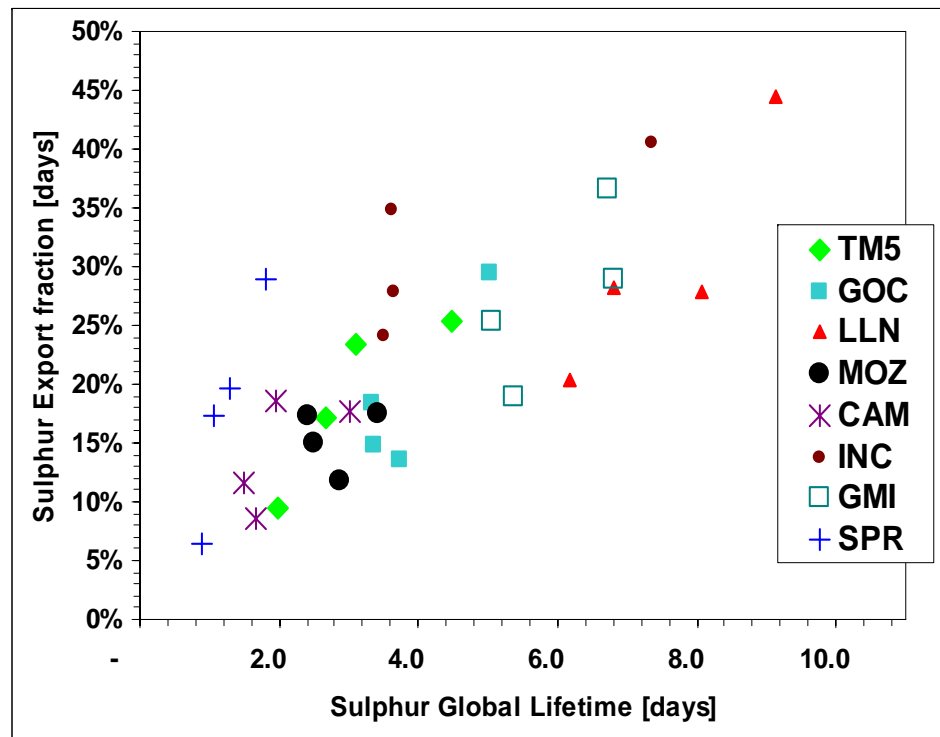
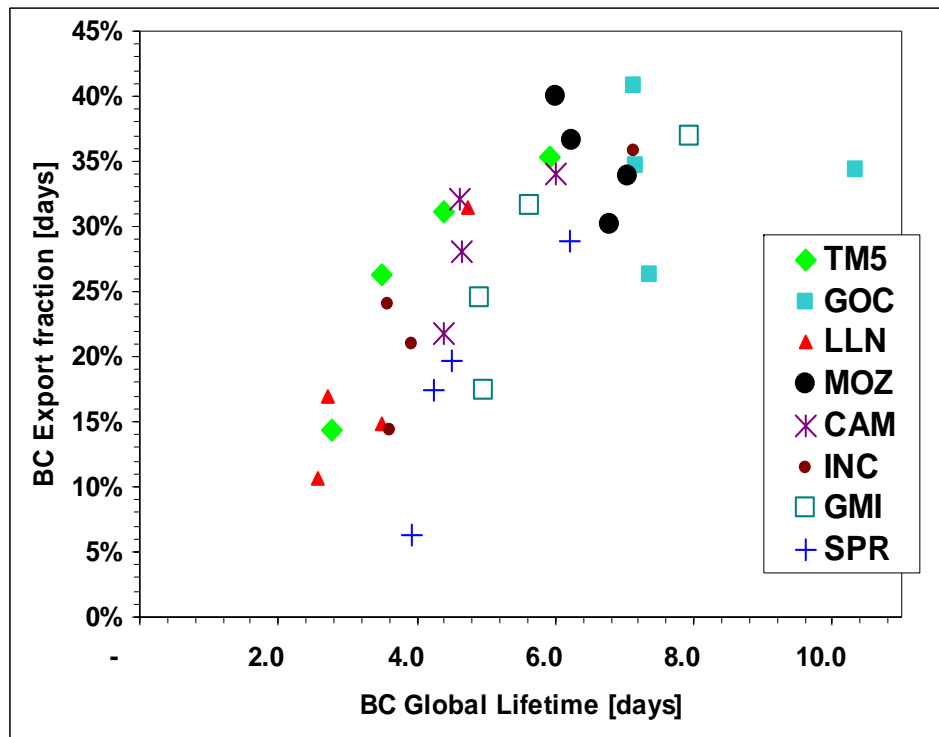


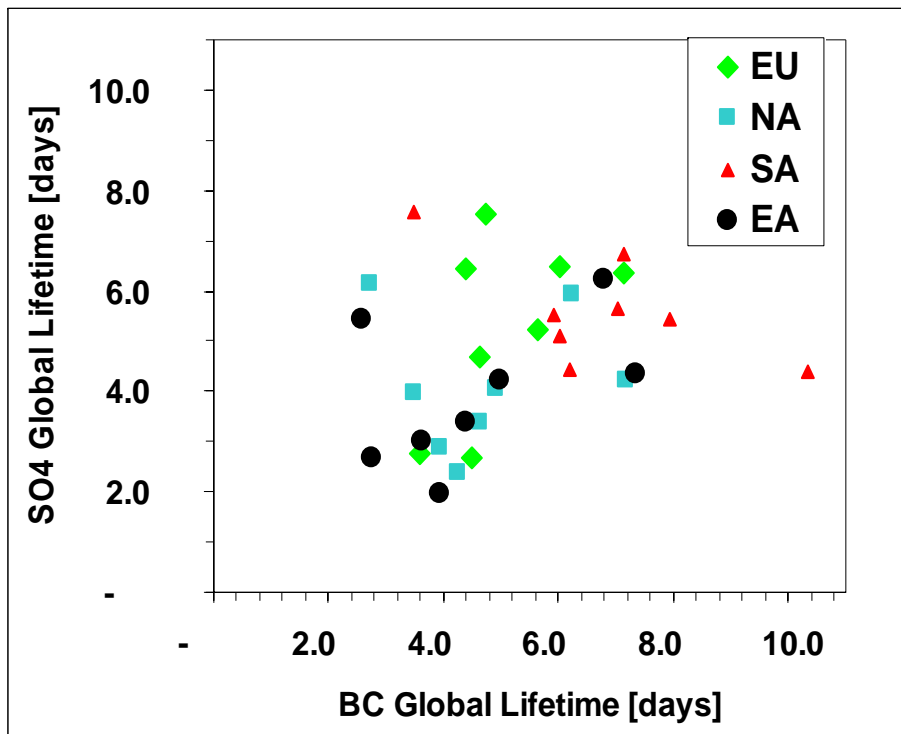
HTAP models sulphur budgeting



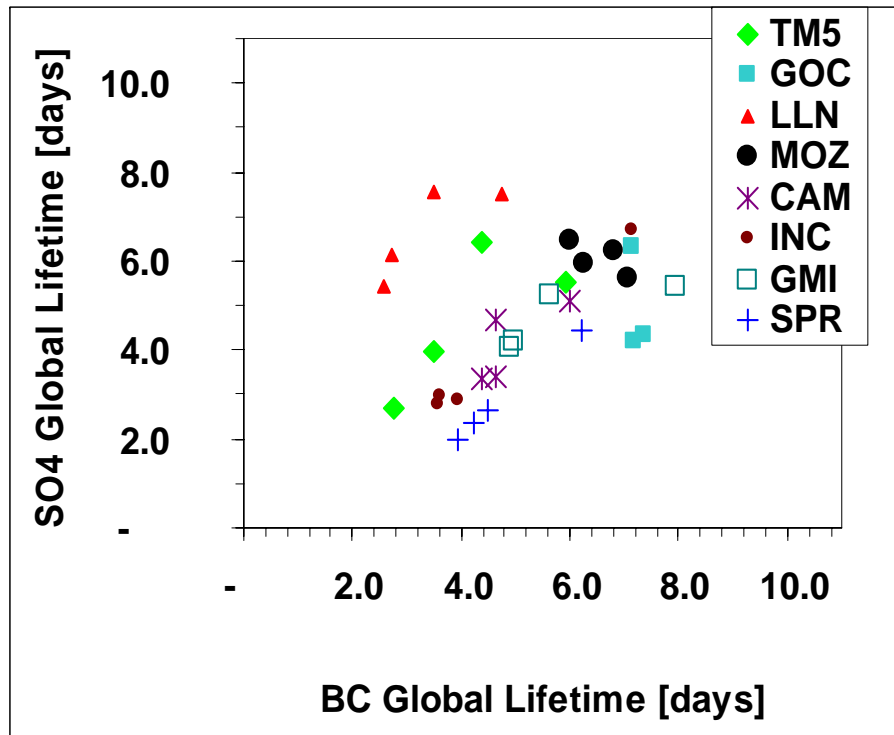
Emission / Chemical production / Dry Deposition / Wet Deposition / Transport



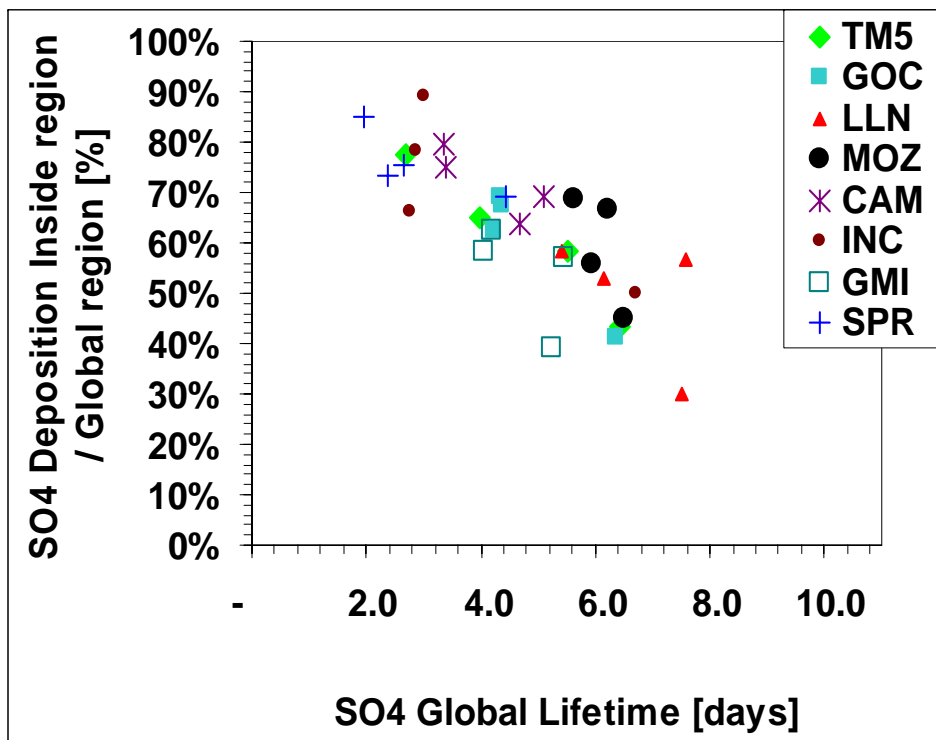
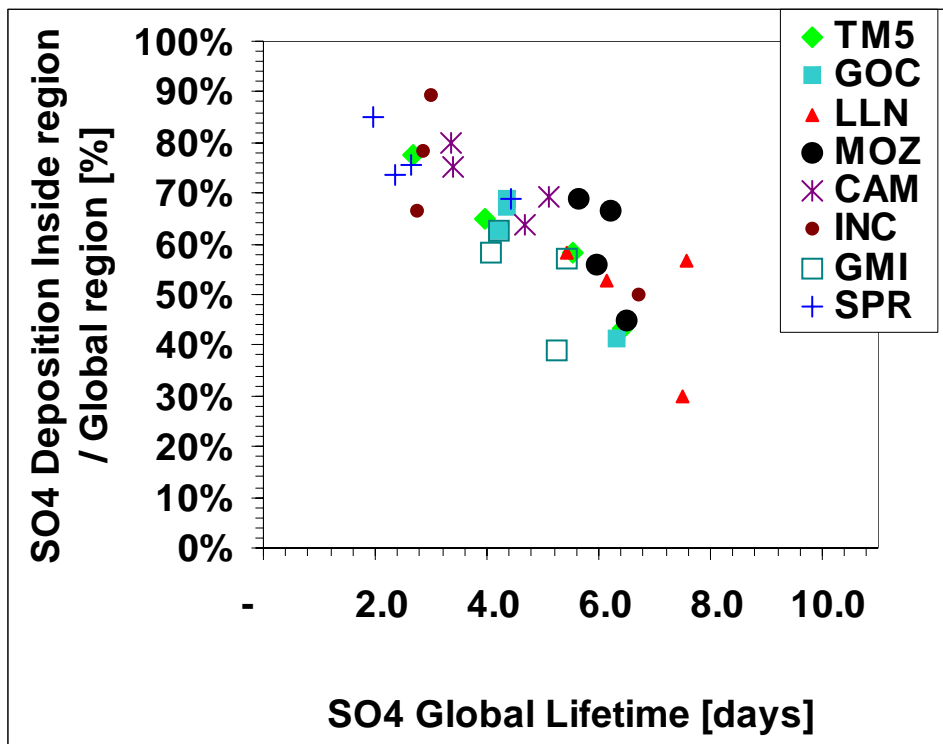


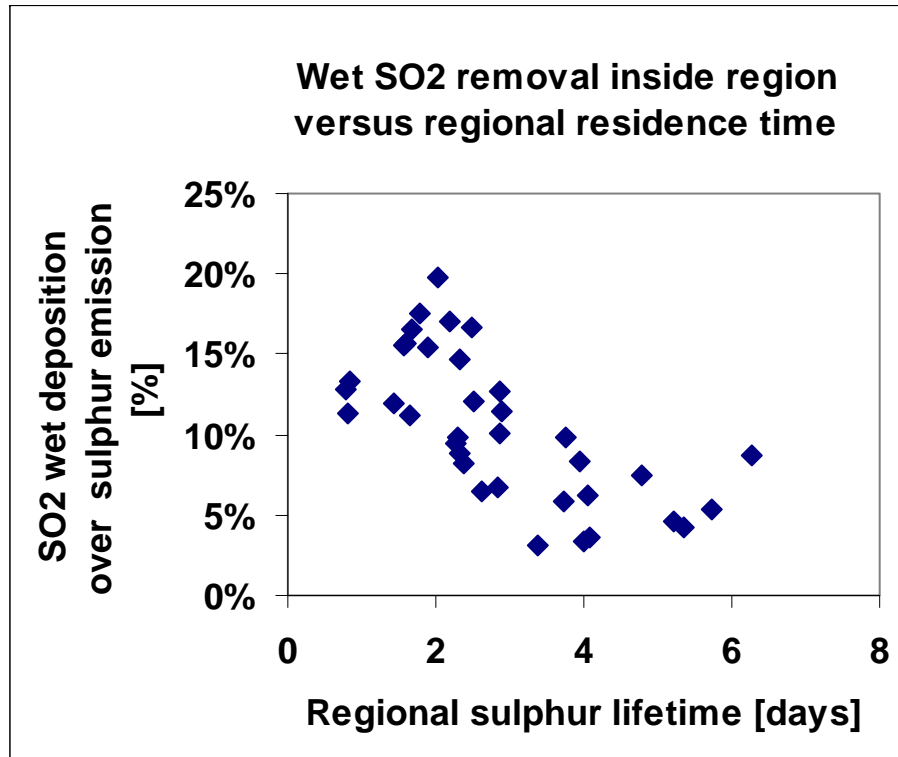
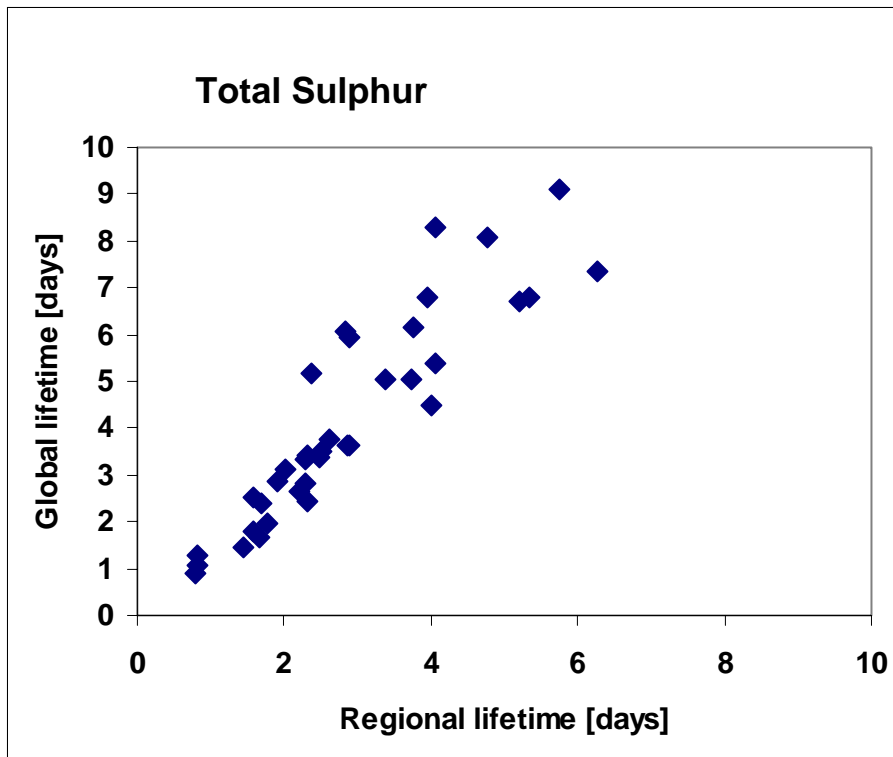


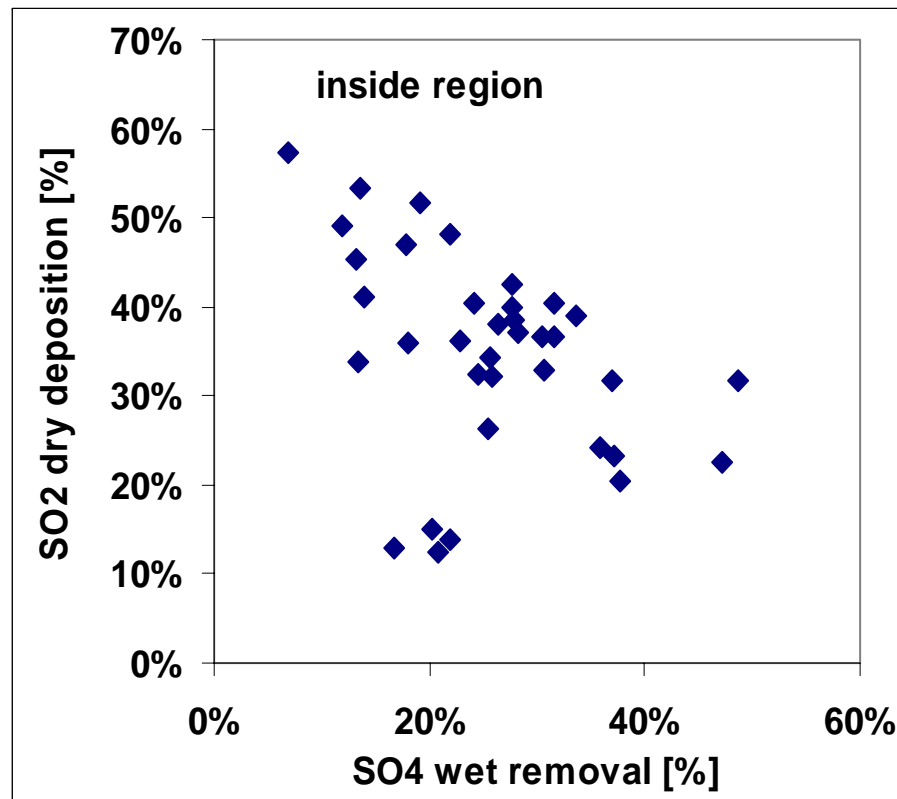
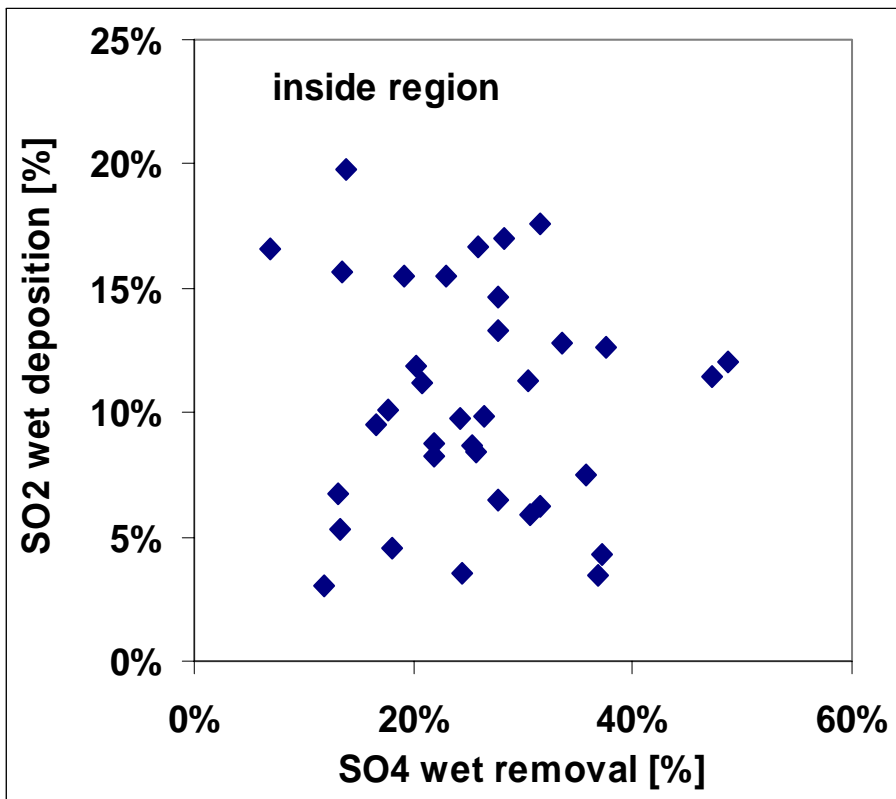
Colored
Per source region



Per model







How to significantly improve the evaluation process of regional and global aerosol models? *The Challenges:*

Communicate between modeling and experimental groups

Establish meaningful process oriented benchmark tests
(representative, scale independent, accuracy, quantitative)

Make them Accessible & Repeatable & Doable

Solve Technical Problems (speed, format, interactivity)

Outreach ... and connect to other international communities

Support by.....EUCAARI-platform - Models

Example data collection for pilot benchmark test

“Aerosol size distribution”:

Include, unify and weight multiple data sources

- Aerosol speciated size distribution from aerosol impactors;
- physical particle sizers: DMA, optical counters, aerodynamic particle sizers;
- satellite estimates of the fine and coarse aerosol fraction (MODIS, POLDER, MISR),
- Size distribution parameters derived from inverting multi-spectral sun photometer measurements (Aeronet)
- Angstrom coefficient measurements (Aeronet).

Functionality of any benchmark test:

Read any model – adapt to data – multiple filters – read error insensitive – weight to area and according to design - reference imbedded – Multiple plots and statistics and scores based on the data – interpolate model fields – published and available

Oct 2006 Virginia Beach AeroCom workshop
Recommendations on AeroCom priorities



- ☺ Consolidate the obs data available
- ☺ Consolidate AeroCom modelled aerosol climatology
- ☺ Extend the observational database to design benchmark tests
- ☺ Allow for better use of AeroCom database (input/output)
- ☺ Establish Working groups to define goals, actions, diagnostics
- ⊘ Better documentation of parameterisations (optical, hygroscopicity, clouds)

Experiments

- ☺ HTAP interhemispheric transport
 - ☺ Calipso related simulation of period July-Sep 2006
 - ⊘ Redo of indirect experiments (follow-up Penner et al. ACP2006)
 - ⊘ Forcing calculation for preindustrial/present in IPCC models
 - ⊘ Reference set of coupled aerosol-climat simulations 1860-2050

Ensure link to other activities:

- ☺ GEWEX, CCSP, Column models, GEIA, HTAP, NARSTO, AC&C, EUCAAR
- ☺ Next meeting 22-26 Oct 2007, with CNES « A-train » meeting, Lille, F



AeroCom

Working group structure

&

coordinating committee

- 1 Emissions
- 2 Use of satellite data for models
- 3 Dust
- 4 Vertical profiles & Removal
- 5 Closure at super sites
- 6 Air quality
- 7 Absorption
- 8 Direct forcing
- 9 Indirect forcing
- 10 Aerosol-climate simulations
- 11 Aerosol Dynamics & Size

Bond
Kinne
Ginoux
Textor
Wilson
Chin
Koch
Myhre
Penner
Schulz
Liu

Ongoing AeroCom wiki discussion =>

<http://wiki.esipfed.org/index.php/AeroCom>

OUTLOOK

Additional diagnostics?

3D sulphate production rates

3D wet deposition of aerosol species

Oxydant changes SR1-SR3-SR6

Comparison to data?

AOD recomposed from regional contributions

PM benchmark test at Western Box Boundaries

PM impact by natural aerosols

Include transport diagnostics

TP1, CO

Model query on process parameterisation

Link with AC&C and AeroCom experiments

PM and organic aerosols analysis