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

**Purpose and Participation in TF HTAP**
**Policy relevant scientific Questions**
**Timeline**
**Overview of model experiments**
**Some results for surface ozone, N-dep, aerosol**
**Concluding remarks**

**http://www.htap.org**

# Purpose and Participation in TF HTAP

- Created in December 2004 by the UNECE Convention on Long-Range Transboundary Air Pollution

- To improve the scientific understanding of intercontinental transport and hemispheric air pollution in the Northern Hemisphere.

- United States and European Community are the Lead Parties.

- TF HTAP is organized under EMEP and engages with the EMEP Centres and other EMEP Task Forces.

- Participation is open to all interested experts.  Countries (inside and outside the ECE region) are encouraged to nominate national focal points.

# Policy-Relevant Science Questions

1. How does hemispheric transport affect air pollution?

2. How much do emissions in one country or region affect air pollution in another country or region?

3. How confident are we of the results and what is our best estimate of the uncertainties?

4. How will changes in emissions in one country or region affect air pollution in another country or region?

5. How may the source-receptor relationships change over the next 20 to 50 years due to changes in emissions?

6. How may the source-receptor relationships change due to climate change?

7. What efforts are needed to develop an integrated system of observation data and models?

# A Path to a 2009 Assessment

| | Focused Workshops *Building Consensus* | TF Meetings *Reviewing Results, Planning* |
|---|---|---|
| 2005 June | | Science Questions, *Brussels* |
| 2006 Jan | New Research | Modeling, *Washington* |
| June | & Report Writing | Hg/POPs, CH$_4$, *Moscow* |
| Oct | | Emissions, *Beijing* |
| 2007 Jan | | Integrated Observations, *Geneva* |
| May-June | | Interim Report to Protocol Review, Climate, *Reading* |
| Oct | | Modeling, *Jülich* |
| 2008 April | | Hg/POPs, *Rome* |
| June | | *U.S.* |
| Oct | | [Tropics, *Asia*] |
| 2009 Feb | | [w/ TF MM, AC&C] |
| June | | ? |
| Oct | Assessment Report | ? |
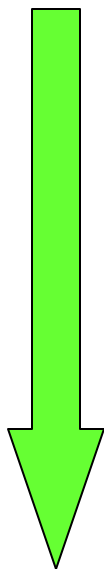
# 2007 Interim Report

- Focus on Ozone and Aerosols
- http://www.htap.org/activities/2007_interim_report/
- Serves as Foundation for 2009 Report
- Includes measurement-and model based analysis

## Major Findings (1)

- Observations from the ground, aircraft, and satellites provide a wealth of evidence that ozone and fine particle concentrations in the UNECE region and throughout the Northern Hemisphere are influenced by intercontinental and hemispheric transport of pollutants."

- "The processes that determine the overall patterns of transport at this scale are relatively well understood and our ability to quantify the magnitude of transport is improving."

# *2007 Interim Report*

**Major Findings (2)**

- "The HTAP model intercomparison has provided the first set of comparable estimates of intercontinental source-receptor relationships from multiple models."

- "For ground-level ozone, there is a hemispheric background concentration of 20-40 ppb that includes a large anthropogenic and intercontinental component. …changes in intercontinental transport can have small, but significant, impacts on surface concentrations."

- "For fine particles, the impact of intercontinental transport on surface air quality is primarily episodic, especially associated with major emission events such as fires or dust storms.  The intercontinental transport of both ozone and fine particles has large impacts on total atmospheric column loadings, which have significant implications for climate change."

# Recommendations

- "Improving our assessment of intercontinental and hemispheric transport will require an integrated approach where the best available knowledge from observations, emissions, and models is combined."

  – Improving the modeling of transport processes using existing and new field campaign data.

  – Improving emissions inventories using local information and inverse modeling.

  – Identifying and explaining long-term trends by filling gaps in the observing system and improving model descriptions.

  – Developing a robust understanding of current source-receptor relationships using multiple modeling techniques and analyses of observations.

  – Estimating future source-receptor relationships under changing emissions and climate.

  – Improving organizational relationships and information management infrastructures to facilitate necessary research and analysis.

# Coordinated model studies

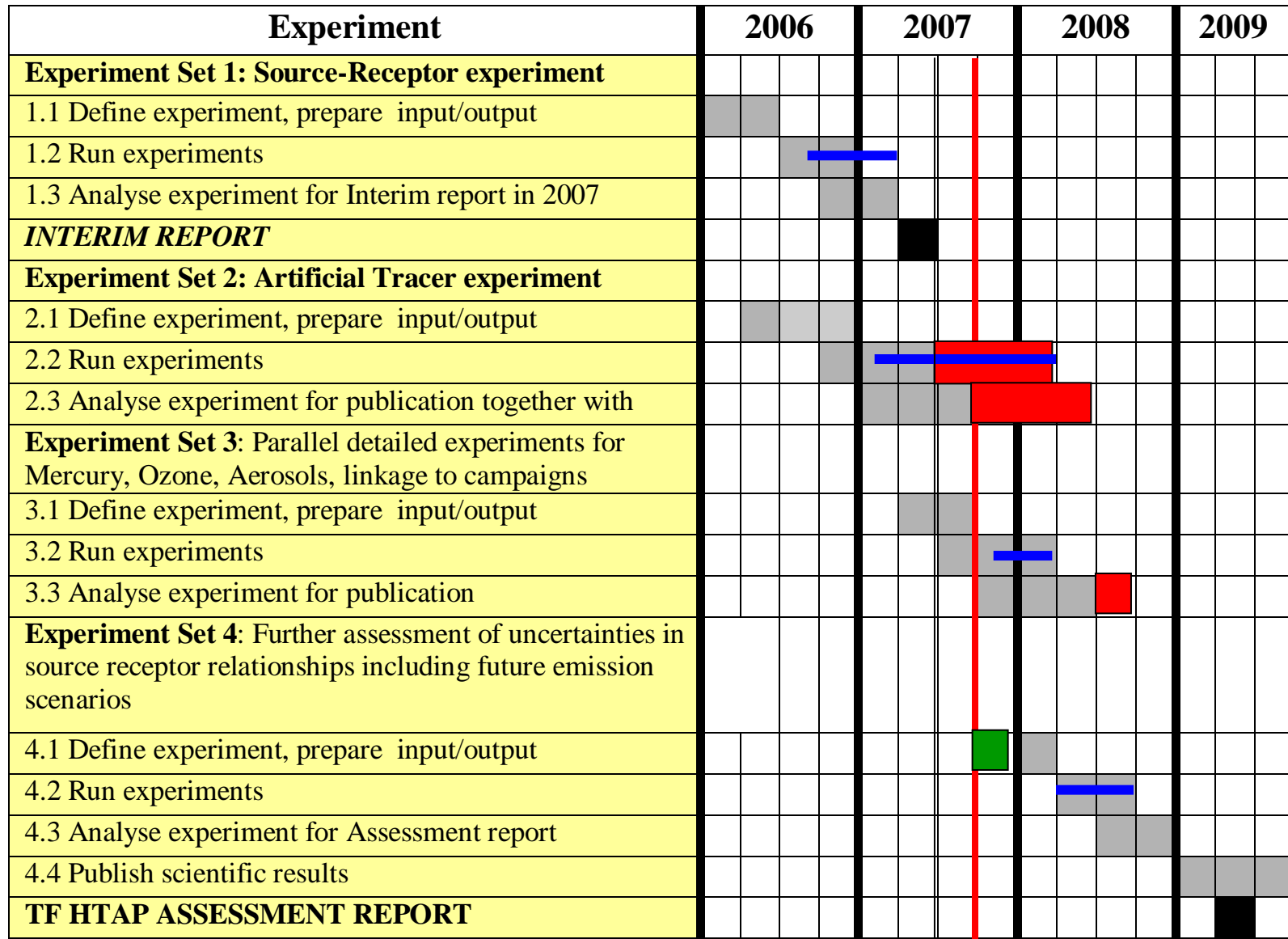| |
|---|
| Exp 1: Source-Receptor Relationship (ca. 25 models) |
| Exp. 2: Artificial tracer experiments |
| Exp. 3: Parallel experiments: Hg, Pops, Climate Change, field campaigns, regional |
| Exp. 4: Narrowing down uncertainties; future SR |

# Timeline for Coordinated Model Studies

| Experiment | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|
| **Experiment Set 1: Source-Receptor experiment** | | | | |
| 1.1 Define experiment, prepare input/output | | | | |
| 1.2 Run experiments | | | | |
| 1.3 Analyse experiment for Interim report in 2007 | | | | |
| *INTERIM REPORT* | | | | |
| **Experiment Set 2: Artificial Tracer experiment** | | | | |
| 2.1 Define experiment, prepare input/output | | | | |
| 2.2 Run experiments | | | | |
| 2.3 Analyse experiment for publication together with | | | | |
| **Experiment Set 3**: Parallel detailed experiments for Mercury, Ozone, Aerosols, linkage to campaigns | | | | |
| 3.1 Define experiment, prepare input/output | | | | |
| 3.2 Run experiments | | | | |
| 3.3 Analyse experiment for publication | | | | |
| **Experiment Set 4**: Further assessment of uncertainties in source receptor relationships including future emission scenarios | | | | |
| 4.1 Define experiment, prepare input/output | | | | |
| 4.2 Run experiments | | | | |
| 4.3 Analyse experiment for Assessment report | | | | |
| 4.4 Publish scientific results | | | | |
| **TF HTAP ASSESSMENT REPORT** | | | | |

**June 2009 is last opportunity for new analysis to be included.**

# Overview of experiment set 1

**Source Receptor Relationships**
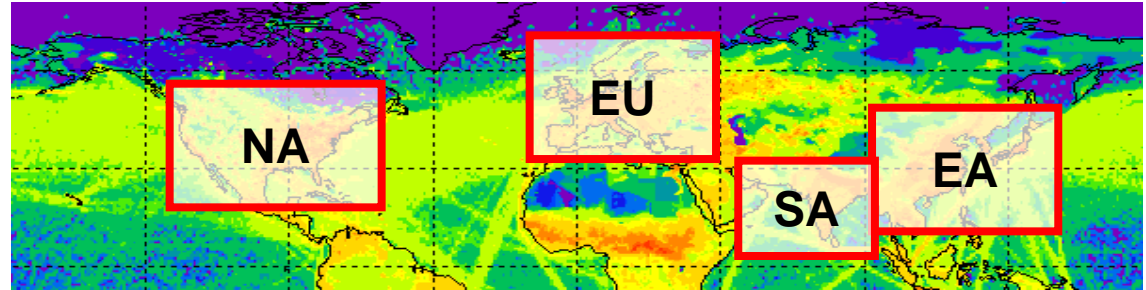


- Importance and uncertainties of hemispheric transport processes for **ozone and its precursors, particulate matter**
- Using **'best' emission inventory and meteorological dataset** for 2001.
- Simulations consist of a reference simulation (2001), and simulations **with anthropogenic emissions decreased in each region by 20 %.**
- The four regions of interest for Source Receptor Relationships are **Europe (EU), North America (NA), East Asia (EA), South Asia (SA)**.
- **>25 models** participated in Experiment 1

# Overview of experiment set 1

www.htap.org
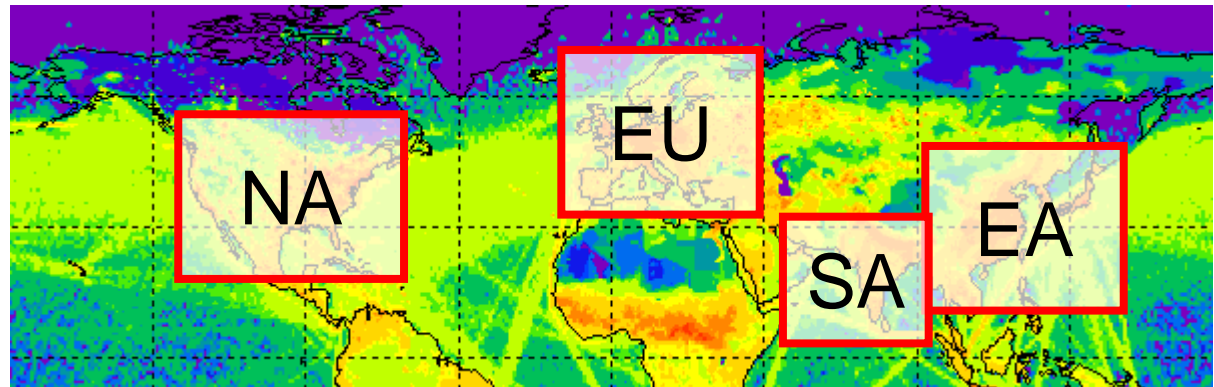


1. SR1 = base case (methane prescribed 1760 ppb)

2. SR2 = global methane reduction by 20% (1408 ppb)

3. 4x SR3 = regional **$NO_x$** anthropogenic emissions reduced by 20%

4. 4x SR4 = regional **NMVOC** anthropogenic emissions reduced by 20%

5. 4x SR5 = regional **CO** anthropogenic emissions reduced by 20%

6. 4x SR6 = regional reduction of **all anthropogenic emissions** by 20%

18 experiments in total (each at least 18 months simulation time)

**Total NOx emissions**

Tg N/year

Legend:
- GEOSCHEM
- MOZART
- STOCHEM
- CAMCHEM
- INCA
- LLNL
- EMEP

**European NMVOC emissions**

Tg/year

EU Tot · EU Ant · EU bio

Legend:
- GEOSChem-v07
- MOZARTGFDL-v2
- STOCHEM-v02
- CAMCHEM-3311m13
- INCA-vSSz
- LLNL-IMPACT-T5a
- EMEP-rv26
- OsloCTM2
- FRSGCUCI-v01
- UM-CAM-v01
- TM5-JRC-cy2-ipcc-v1
- GEMAQ-v1p0
- ULAQ-v02
- STOC-HadAM3-v01
- GISS-PUCCINI-modelE
- GISS-PUCCINI-modelA

**Total NMVOC Emissions**

SH/5 · EU · NA · SA · EA

Legend:
- GCv7
- MOZART
- STOCHEM
- CAMCHEM
- INCA
- LLNL
- Oslo
- FRSGCUCI
- UM CAM
- TM5
- GEMAQv1p0
- ULAQ
- STOC-HadAM3-v01

# Seasonality: Monthly mean surface $O_3$ change in EU from 20% reductions of domestic $NO_x$ emissions



GEOSChem-v07
MOZARTGFDL-v2
CAMCHEM-3311m13
INCA-vSSz
LLNL-IMPACT-T5a
EMEP-rv26
OsloCTM2
FRSGCUCI-v01
UM-CAM-v01
TM5-JRC-cy2-ipcc-v1
MOZECH-v16
GEMAQ-v1p0
ULAQ-v02
MeanValue – – –

EU

[ppb]

J F M A M J J A S O N D
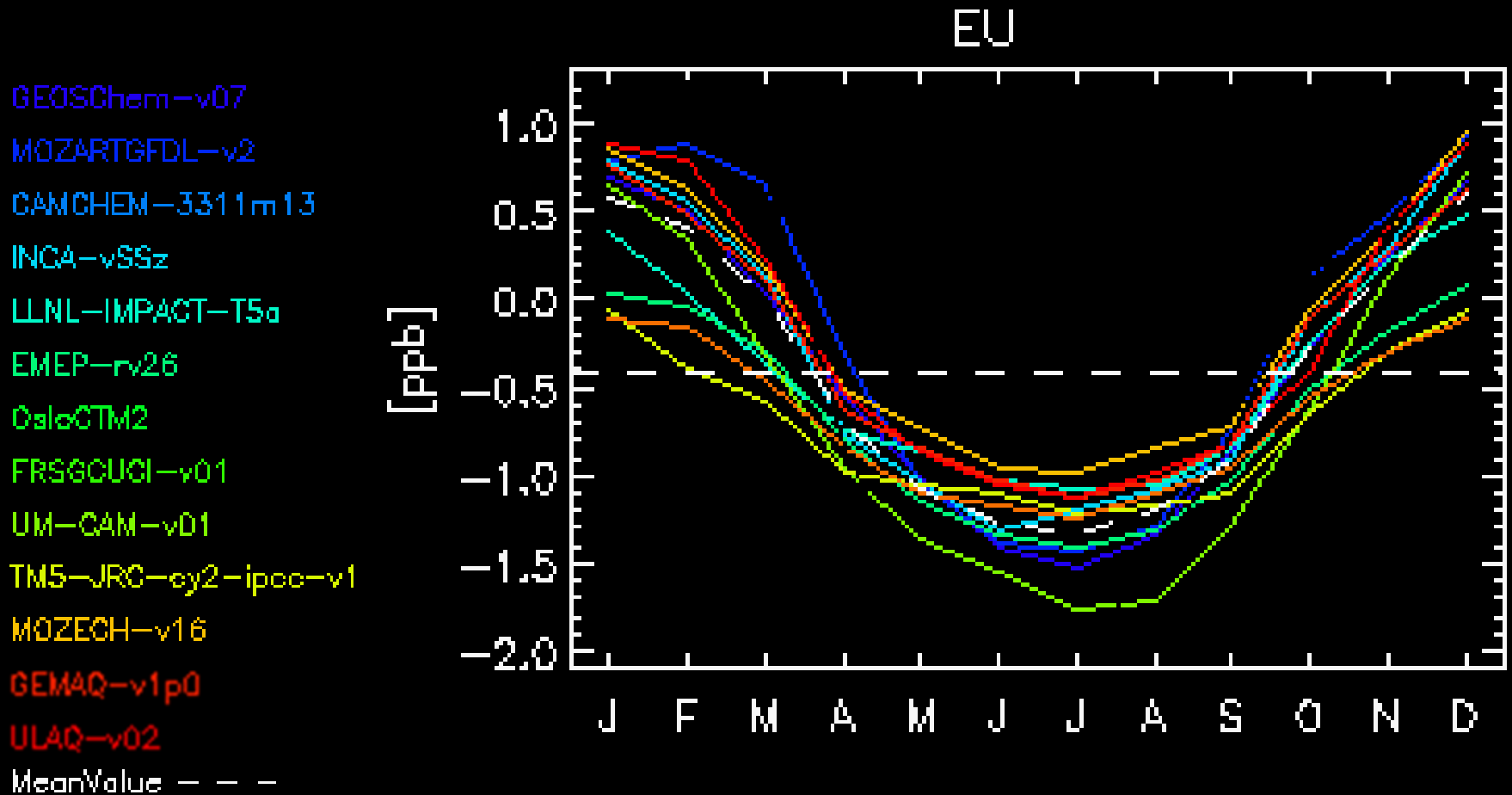
→ **Large seasonality masked by annual mean statistic**

# Intercontinental Ozone SR relationships

Ozone Response [ppbv] in Receptor regions due to 20 % anthropogenic Emission reduction

Fiore et al, in preparation, [2008]
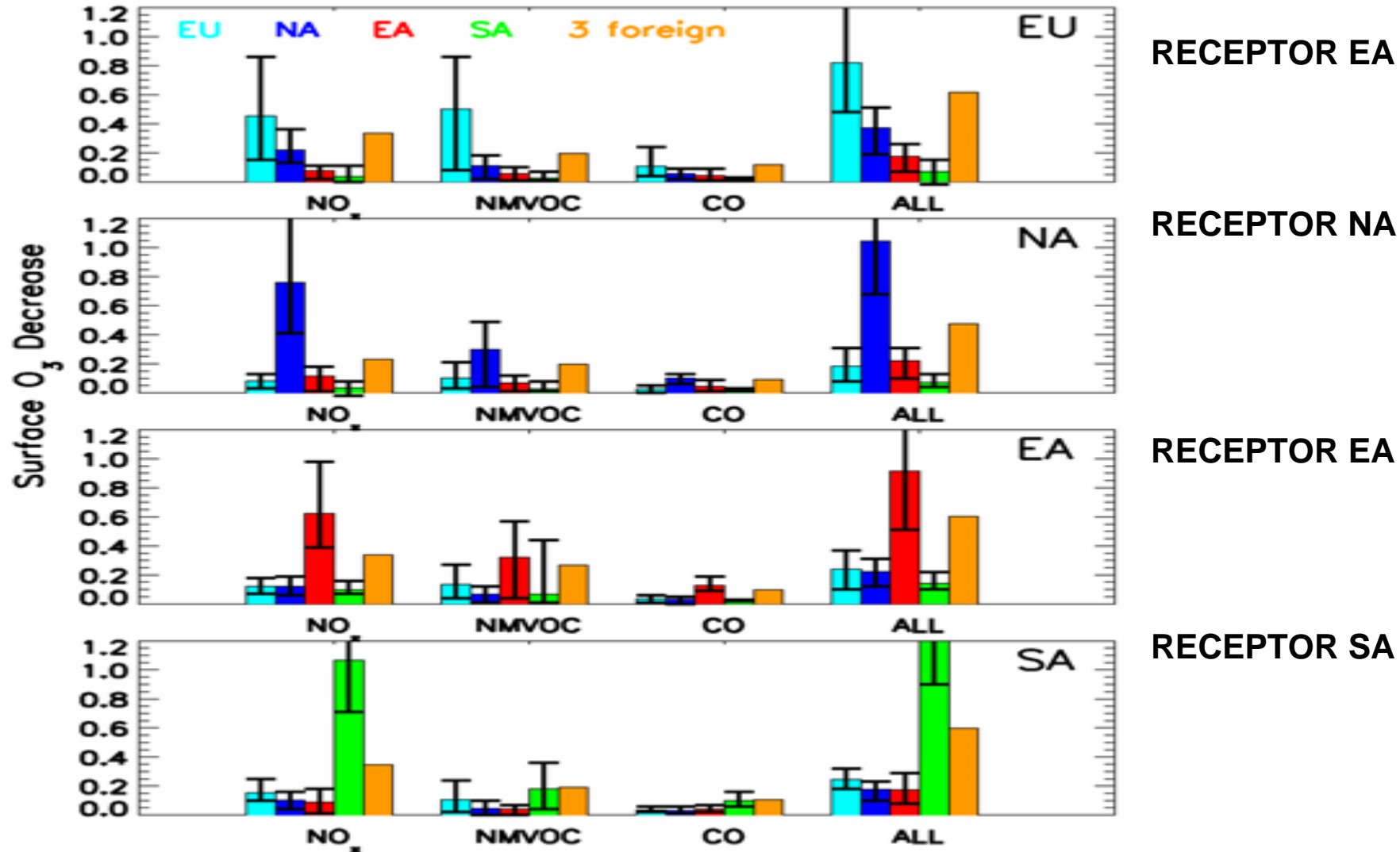
# Annual mean surface O₃ change
## in EU from 20% reductions of domestic NOₓ emissions
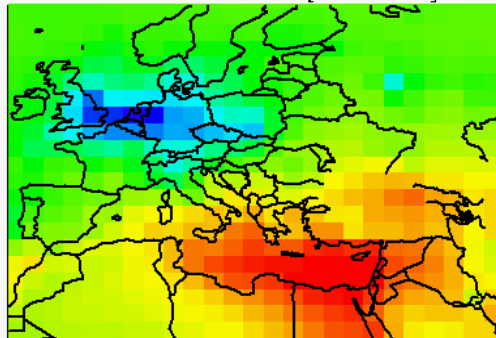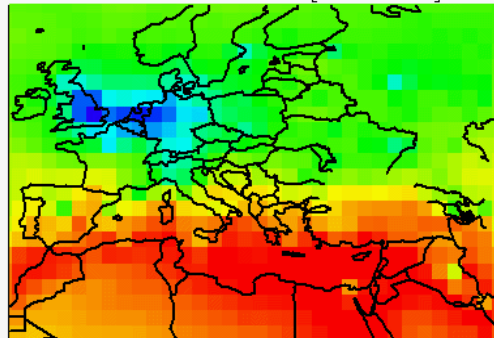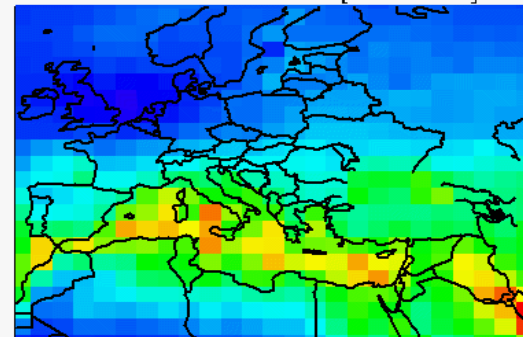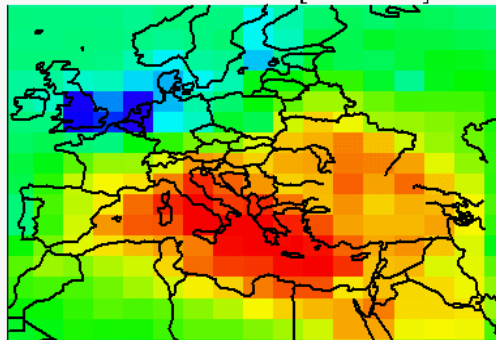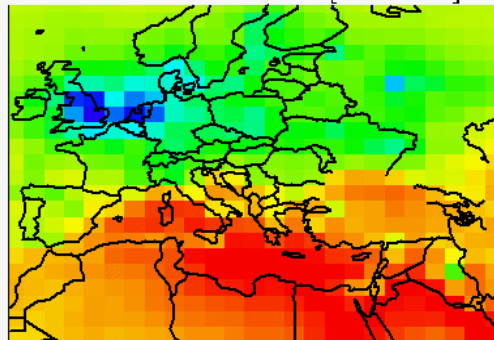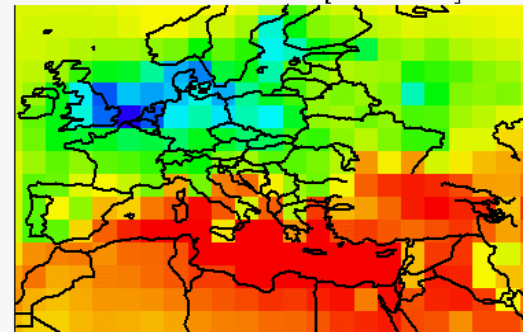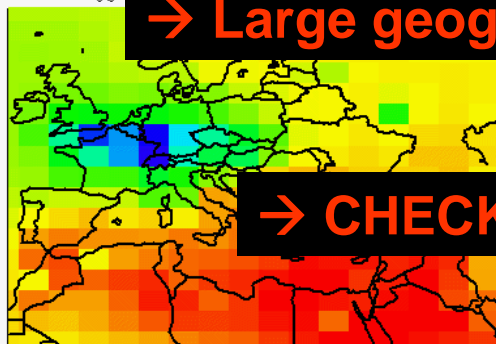


→ **Large geographical variability masked by regional mean statistics**

→ **CHECK YOUR OWN MODEL WITH HEMIT**
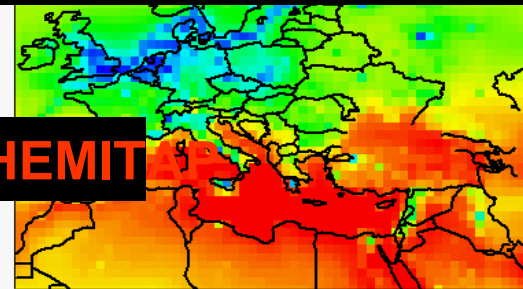
# NOy deposition: Source-Receptor analysis

## Where do NO emissions from East Asia go to?



Impact of NO Emission perturbation in East Asia on NOy deposition in Region

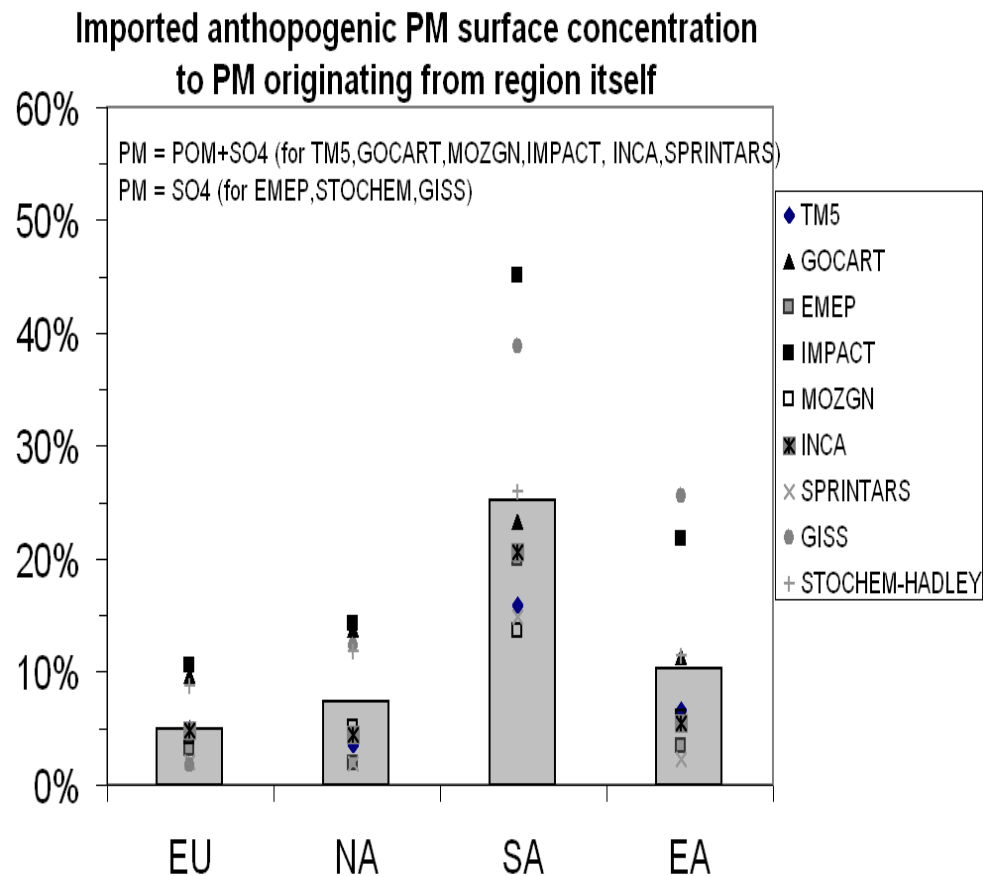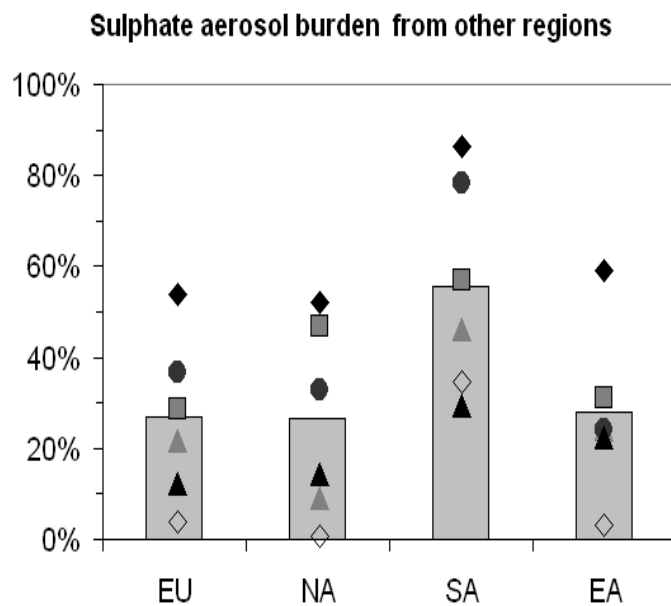| | EU | NA | SA | EA | 70N-90N |
|---|---|---|---|---|---|
| ☐ Mean | 0.005 | 0.014 | 0.012 | 0.868 | 0.001 |
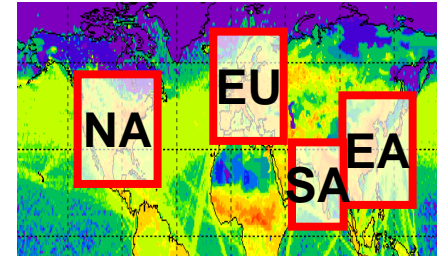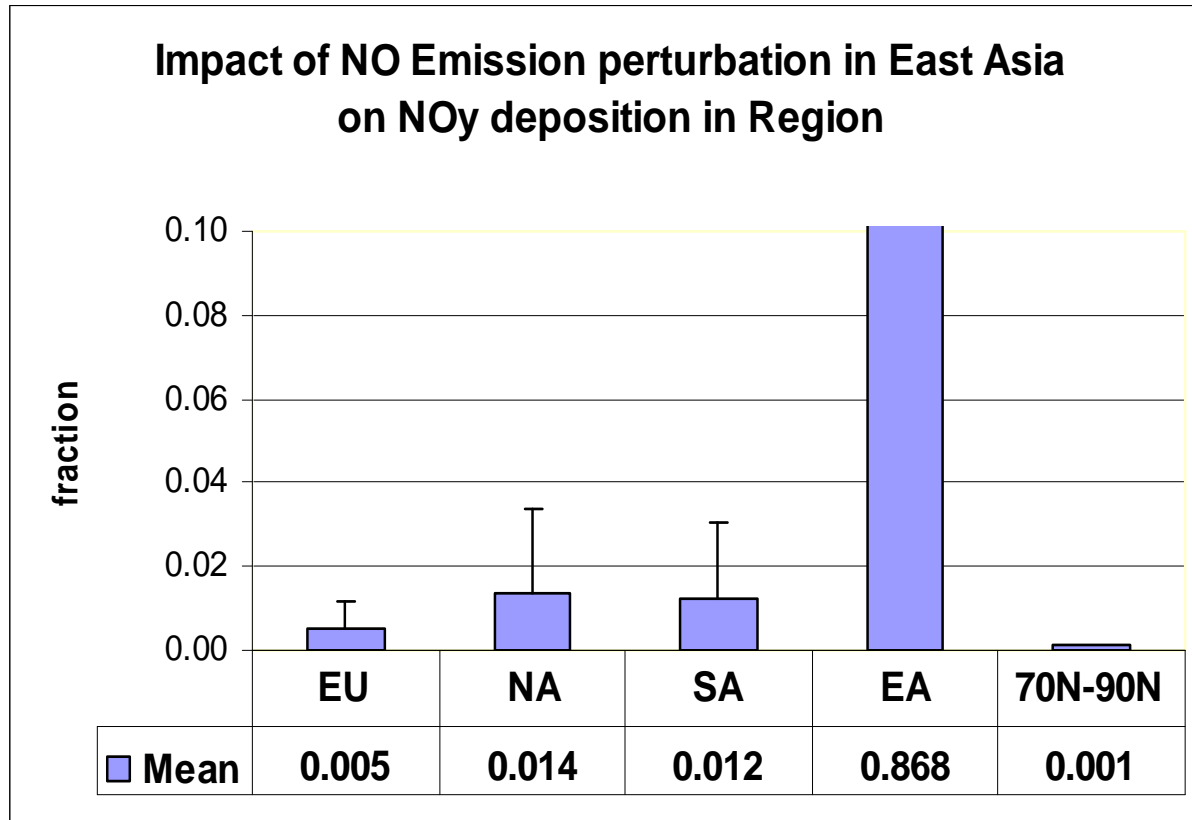
**Elsewhere: 0.101**

Sanderson et al., 2008 in preparation.

# PM receptor analysis



M. Schulz et al, 2008, in preparation

## Concluding remarks

- Perturbation experiments for 4 world regions:
  NOx, CO, VOC, SO2, EC, POM, CO (Hg Pops).

- Model spread in perturbation signal typically factor of 2

- Ozone sensitivities ca. 1.5-2 ppbv to 20% ant. emission reduction in all 4 regions. Methane can play an important role as well (…half of conventional precursors).

- Tracer experiments indicate that BL mixing among models varies between 40% and 80%

- Relatively much attention to interoperability; CF conventions

- How can MICS profit from HTAP and HTAP from MICS?

- EDGAR-HTAP database: includes regional inventories in global framework.