



Norwegian  
Meteorological Institute  
met.no

*Overview over products and  
model developments at MSC/W for  
TFMM in support of the revision  
of the Gothenburg protocol*

*Michael Schulz*

Zagreb, TFMM 6 May 2013



- ◆ Model Status and Training Course
- ◆ Model Simulations for Gothenburg Protocol and TSAP
- ◆ Model Data on Recent Trend
- ◆ 10 year Multi Component Trend Evaluation
- ◆ Status Report Plans

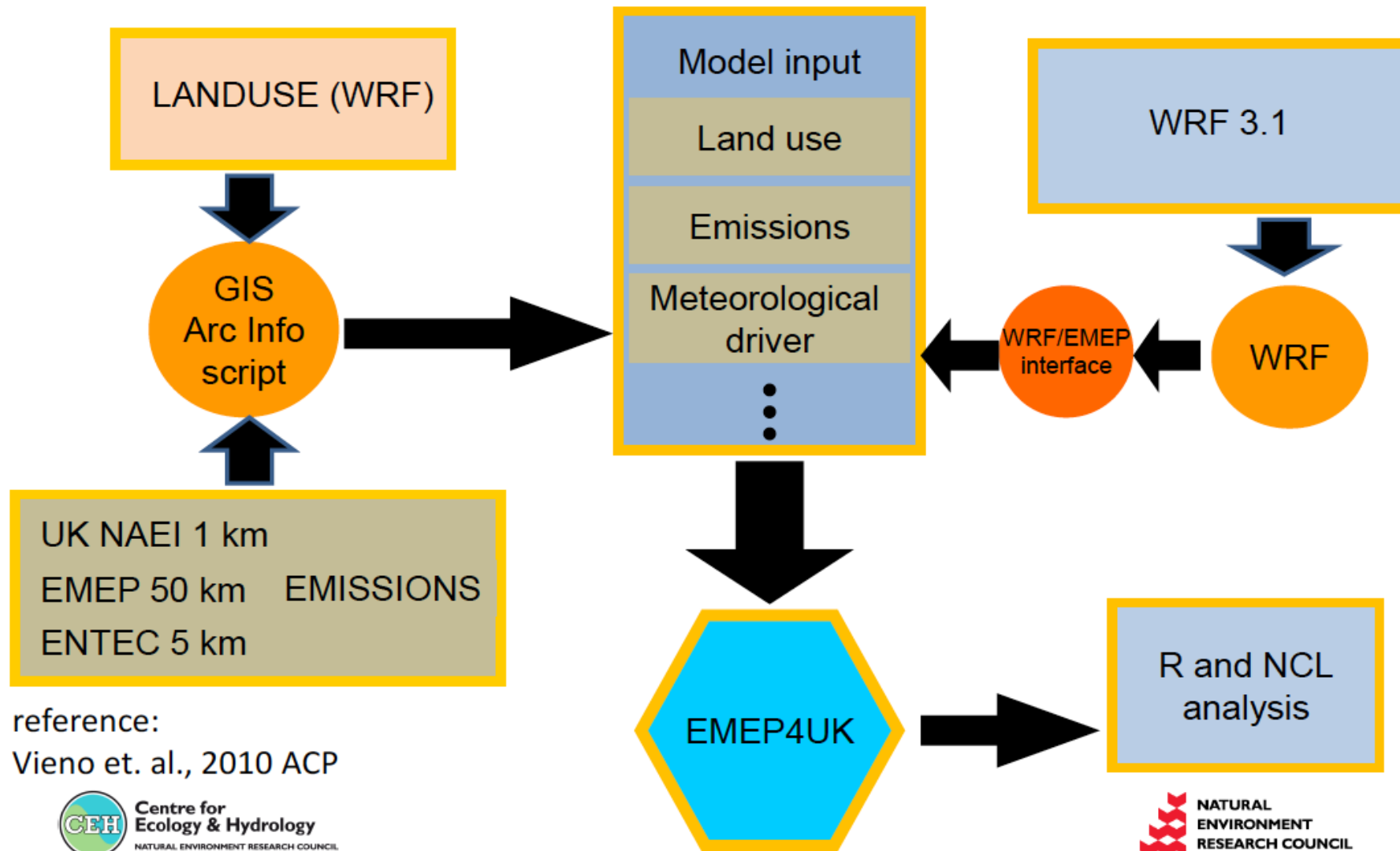


# EMEP MSC-W Model Training Course 24-26 April 2013, Oslo, Norway



- ◆ 25 Participants : UK, Hungary, Belgium, Poland, Norway, Estonia, Croatia, Austria, JRC/Italy  
(no visa or travel permit: Congo, France)
- ◆ Presentations on **A**erosol and **C**hemistry, **E**missions, **C**omputer requirements, **G**rid flexibility, **N**esting, **I**FS Meteorology, **W**RF Coupling, **P**lume rise, **O**utputs&Formats, **P**roducts, **P**lotting tools, **I**T infrastructure at MSCW and **H**ome Exercises
- ◆ Training Course presentations on [https://wiki.met.no/emep/page1/emepmscw\\_opensource](https://wiki.met.no/emep/page1/emepmscw_opensource)

# EMEP-WRF interface



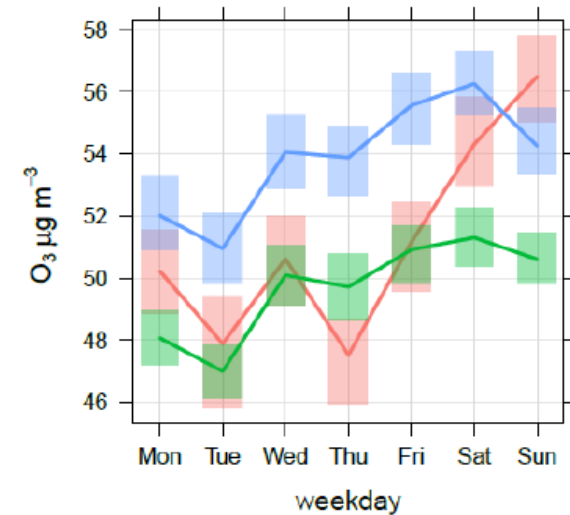
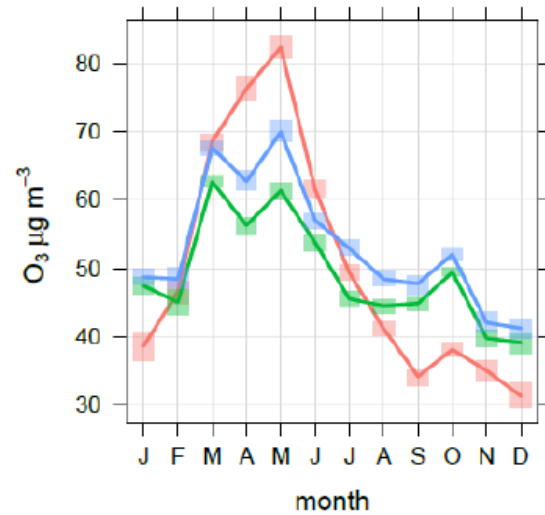
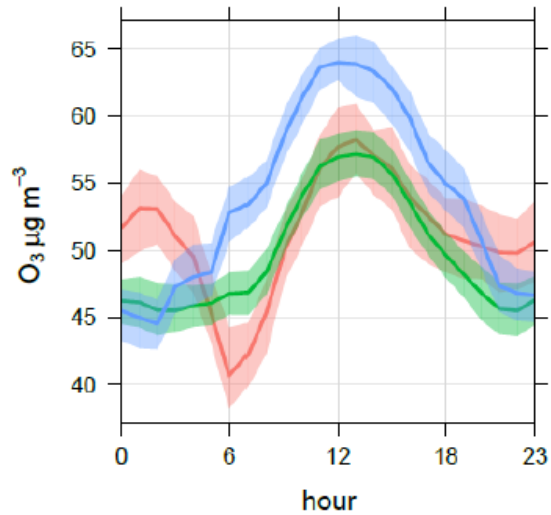
Courtesy Massimo Vienno



# WRF/EMEP evaluation two resolutions Ozone at 90 UK/AURN sites



■ AURN    
 ■ EMEP4UK 1km rv4    
 ■ EMEP4UK 5km rv4



Courtesy Massimo Vieno



## ***EMEP MSC-W Model Training Course summarising ...***



- ◆ EMEP Open source code 2013 rv 4.3, Released April 2013  
[https://wiki.met.no/emep/page1/emepmscw\\_opensource](https://wiki.met.no/emep/page1/emepmscw_opensource)
- ◆ Available MSCW support on documentation, grids, nesting, emissions and ECMWF meteorology clarified
- ◆ WRF offers now a flexible meteo source => Group ?
- ◆ Boundary conditions from standard EMEP simulations could be a future product for national model use
- ◆ User forum, FAQ, email list will be renewed
- ◆ Course should be repeated, probably bi-annually



## *Simulations Overview 2012/13 for GP and TSAP*



- ◆ Gothenburg protocol and Thematic Strategy of Air Pollution revision required at different stages of negotiation EMEP model runs (always asap)
- ◆ Multiple Emission Scenarios from TFIAM and CIAM where tested in combination with base runs
- ◆ Future Source Receptor runs at 14/28/56 km resolution
- ◆ We were glad to have a new super computer at MetNo ...



Short Name	Description	Purpose	receiving EMEP bodies
GP_2005 GP_2020 GP_CLE_2010 GP_CLE_2020 GP_CLE_2030	TNO28 & PS EMEP grids Meteo 2006-2010 UNECE GP emissions = TSAP revision work	Scenario runs Gothenburg Protocol Guidance Document	TFIAM/ CIAM; ICPs
TSAP SR 2020	TNO28 0.5x0.25 Meteo 2006-2010 SR for 55 countries NO <sub>x</sub> ,SO <sub>2</sub> ,NH <sub>3</sub> ,PM,VOC 1400 runs, 5 base runs	TSAP revision GAINS input Scale Dependency	TFIAM/ CIAM
TSAP SR 2020 Fine/coarse grid	TNO14 and TNO 56 Meteo 2009 SR for 55 countries NO <sub>x</sub> ,SO <sub>2</sub> ,NH <sub>3</sub> ,PM,VOC 600 runs, 10 base runs	TSAP revision GAINS input Scale Dependency	TFIAM/ CIAM





Short Name	Description	Purpose	receiving EMEP bodies
TSAP 2020 Ozone boundary conditions	TNO28 0.5x0.25 Meteo 2006-2010 9 ozone perturbations +1.5 to -4 ppb	TSAP revision GAINS input Future Hemispheric Impact	TFIAM/CIAM HTAP
TSAP scenarios Jan 2012	TNO28 0.5x0.25 Meteo 2006 MCE 2020/2030/2050 nonEU 2020/2030/2050 REF 2005/2010/2020/ 2025/2030/2050	TSAP revision	TFIAM/CIAM
TSAP scenarios Sep 2012	TNO28 0.5x0.25 Meteo 2006-2010 MCE 2050 REF 2000/2005/2020	TSAP revision	TFIAM/CIAM
TSAP scenarios March 2013	TNO28 0.5x0.25 Meteo 2006-2010 P12_[A5/COB/MFR]2025 REF 2005	TSAP revision	TFIAM/CIAM

# Critical load exceedance of nutrient nitrogen $\text{Eq ha}^{-1} \text{yr}^{-1}$

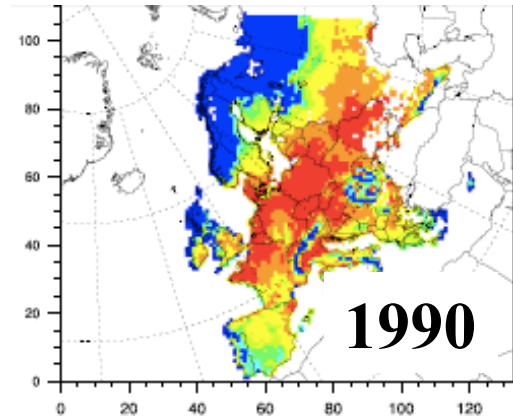


Areas at risk

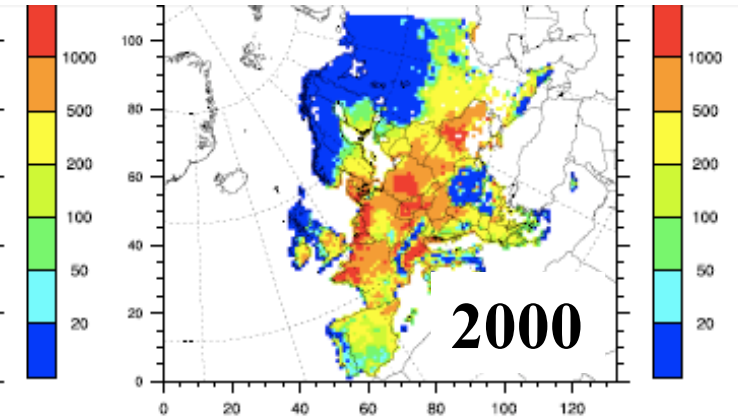
1990 = 63%

2010 = 52%

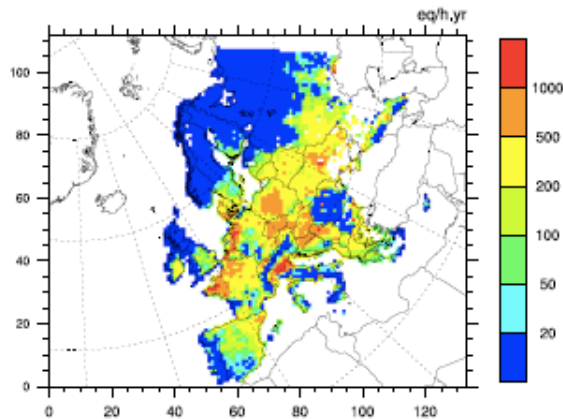
2020 = 37%



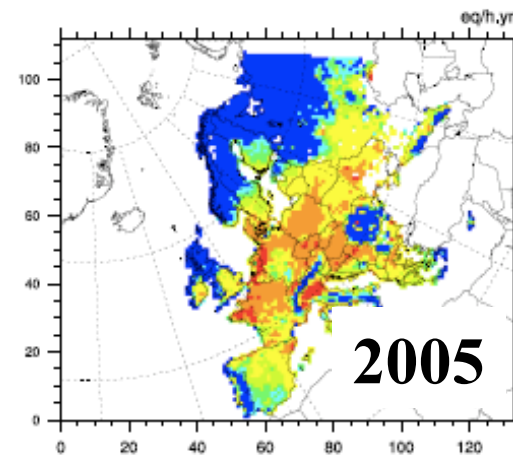
(a) 1990



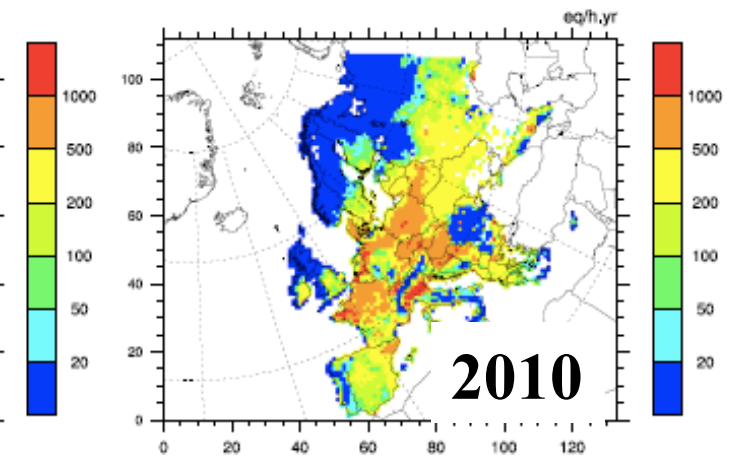
(b) 2000



2020 revised GP



(c) 2005

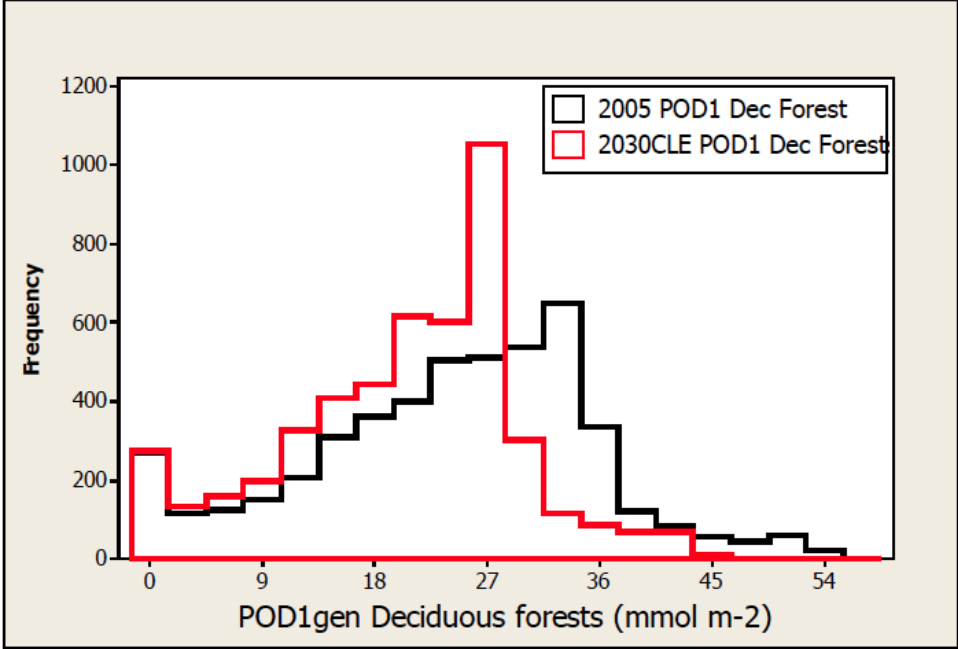


(d) 2010

# Ozone peak and background reductions will lead to significantly less damage



## POD1 for Deciduous forests



	2005	2030CLE	% reduction
mean	24.0	20.3	15.4%
25 <sup>th</sup> centile	16.7	14.4	13.8%
75 <sup>th</sup> centile	32.2	27.0	16.1%

Courtesy G. Mills / D. Simpson

# How to access the EMEP trend runs *emep.int*



MSC-W home

Unified Open Source  
(Wiki)

EMEP/MSC-W  
Models

Downloadable data:

S, N, O<sub>3</sub> and PM data

S, N, O<sub>3</sub> and PM SR  
tables & data

Tools:

EMEP grid

2D trajectory data

Publications:

EMEP/MSC-W  
Reports

S, N, O<sub>3</sub> and PM  
Country reports

Common EMEP  
Status Reports

Peer-review articles  
from MSC-W

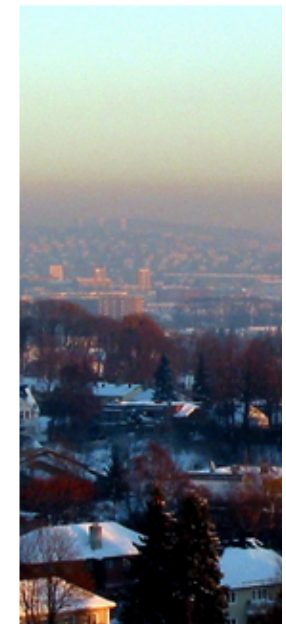
Other:

Model  
development/projects

^ The chemical transport model developed at Meteorological Synthesizing Centre - West (MSC-W) called the EMEP/MSC-W model. The Eulerian model was released as OpenSource code in 2008 and is under continuous development for meeting new tasks within the EMEP programme and other projects.

- [EMEP/MSC-W model Open Source code](#)
- [EMEP/MSC-W model Open Source code v.2011-06](#)
- [The Unified EMEP model Open Source code \(rv3\)](#)
- [The history of the chemical transport models developed at MSC-W](#)
- Downloadable modelresults:
  - [S, N, PM and O<sub>3</sub> air concentrations and depositions](#)  
National totals(html, ASCII) and gridded(ASCII, Graphical map(PNG)) data
  - [Source-receptor relationships](#)  
~~Yearly SR tables country to country, yearly SR country-to-grid data and projected SR country-to-grid data for year 2010~~
- Tools for analysis of model results:
  - [EMEP grid](#)  
Description of coordinates, conversion, areas, country codes
  - [2-D air trajectories](#)  
96h trajectories(ASCII), daily sector values(ASCII) and trajectory crossings(Graphical map(PNG)) data for EMEP stations
- Publications:
  - [EMEP Reports from MSC-W](#)
  - [Country reports: main pollutants, ground level ozone and PM](#)
  - [Common EMEP Status Reports](#)
  - [Peer-review articles from MSC-W](#)
- [Model development/Other projects](#)
- [Staff at EMEP/MSC-W](#)

*Contribution of emission  
in the EMEP domain in  
Note 1/08 Germany)*





# The data selection table



**Countries / Areas**

- ALL
- EU15
- EU25
- EU27
- SHIPS

Type 1 results  
Yearly Reporting

**Years**

- 2010
- 2010 v2012
- 2009
- 2009 v2012
- 2008

**Air Concentrations**

Main Pollutants	PM
SO2	PM10
SO4	PM2.5
NO2	PMcoarse
NH3 + NH4+	Primary PM10
HNO3 + NO3	Primary PM2.5

**Depositions**

**Main Pollutants**

- Dry deposition of oxidized sulphur
- Wet deposition of oxidized sulphur
- Total deposition of oxidized sulphur
- Dry deposition of oxidized nitrogen
- Wet deposition of oxidized nitrogen

**Type and Format**

- National Totals, HTML
- National Totals, HTML
- National Totals, Semicolon-Separated
- Grid (50km x 50km), Semicolon-Separated
- Grid (50km x 50km), Graphic map





# *10 year Multi Component Trend Evaluation*



# Reported Emission Trends 1990-2010

## Can we verify? Falsify?

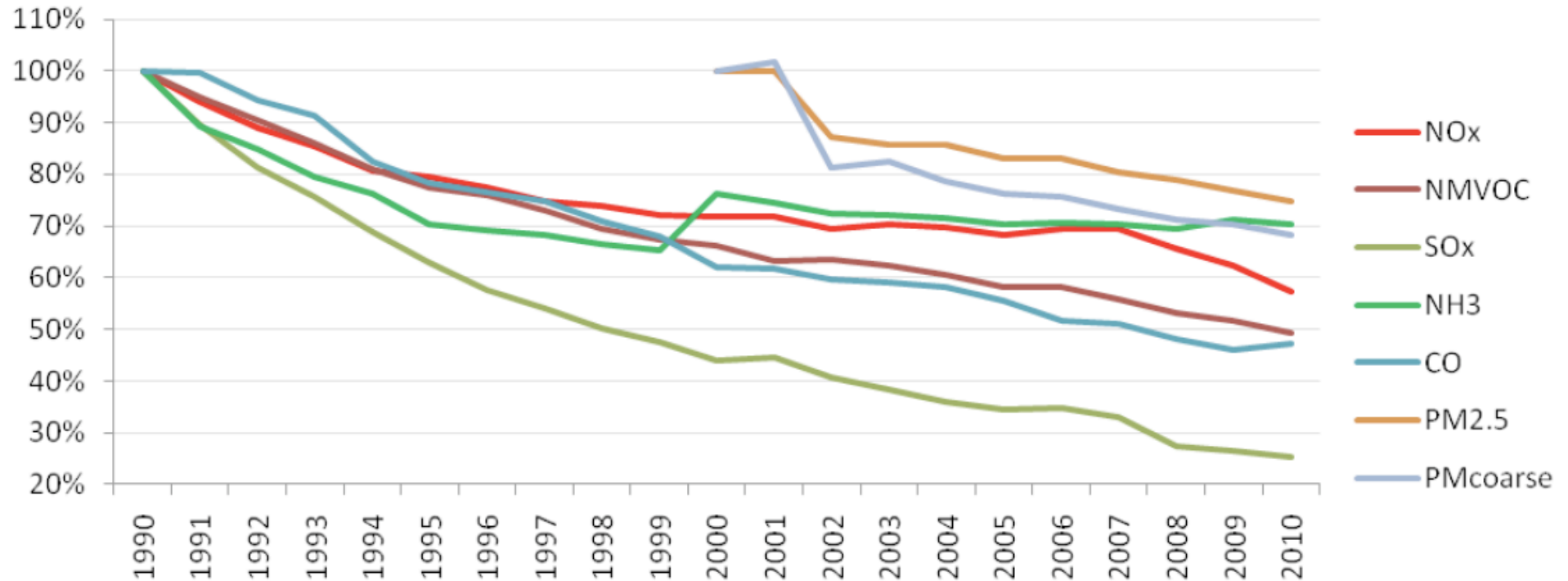


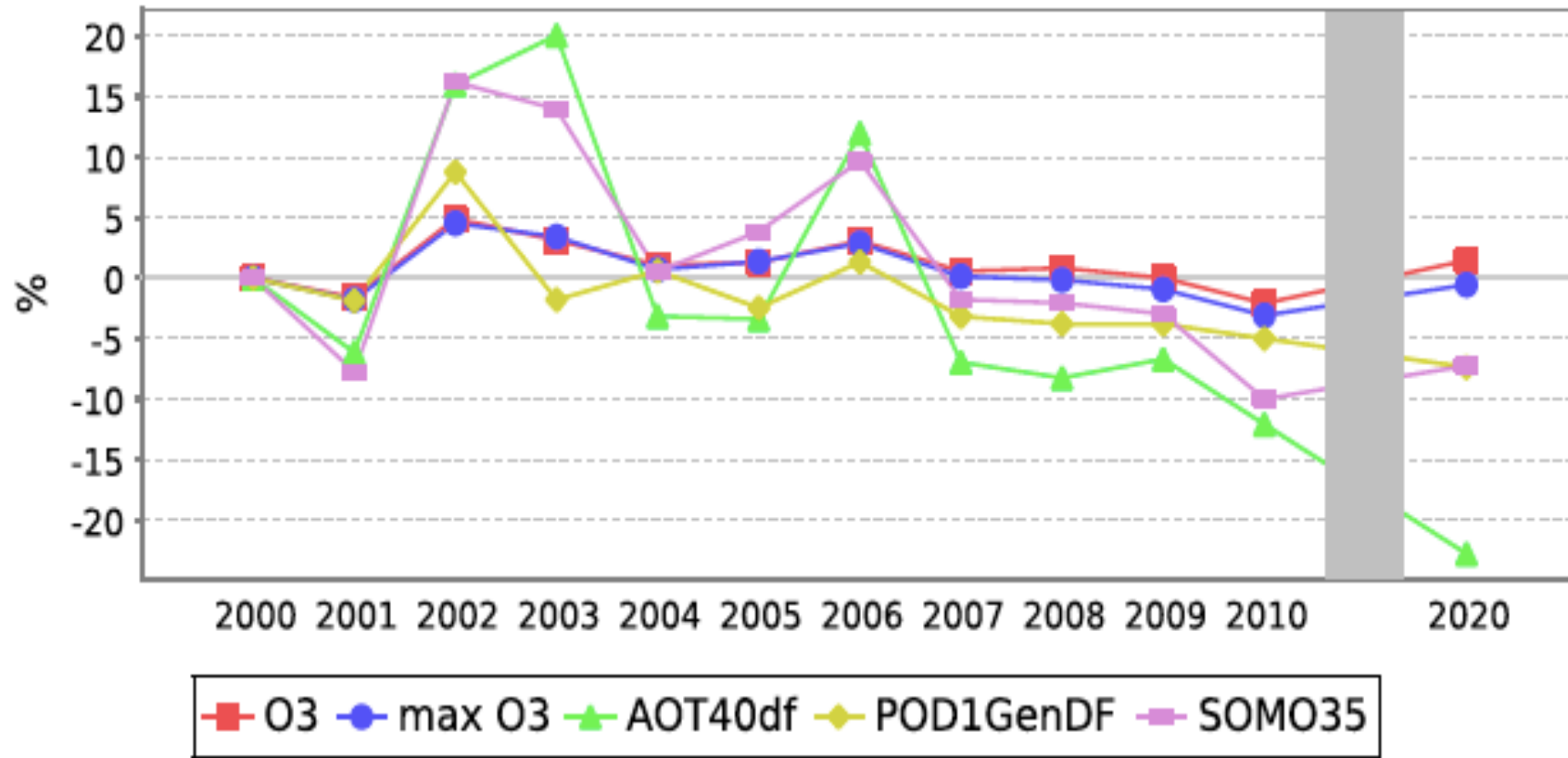
Figure 2.4: Expert estimates of the emission trends [%] in the EMEP area, 1990-2010.

## *10 year Trend Evaluation Ozone*



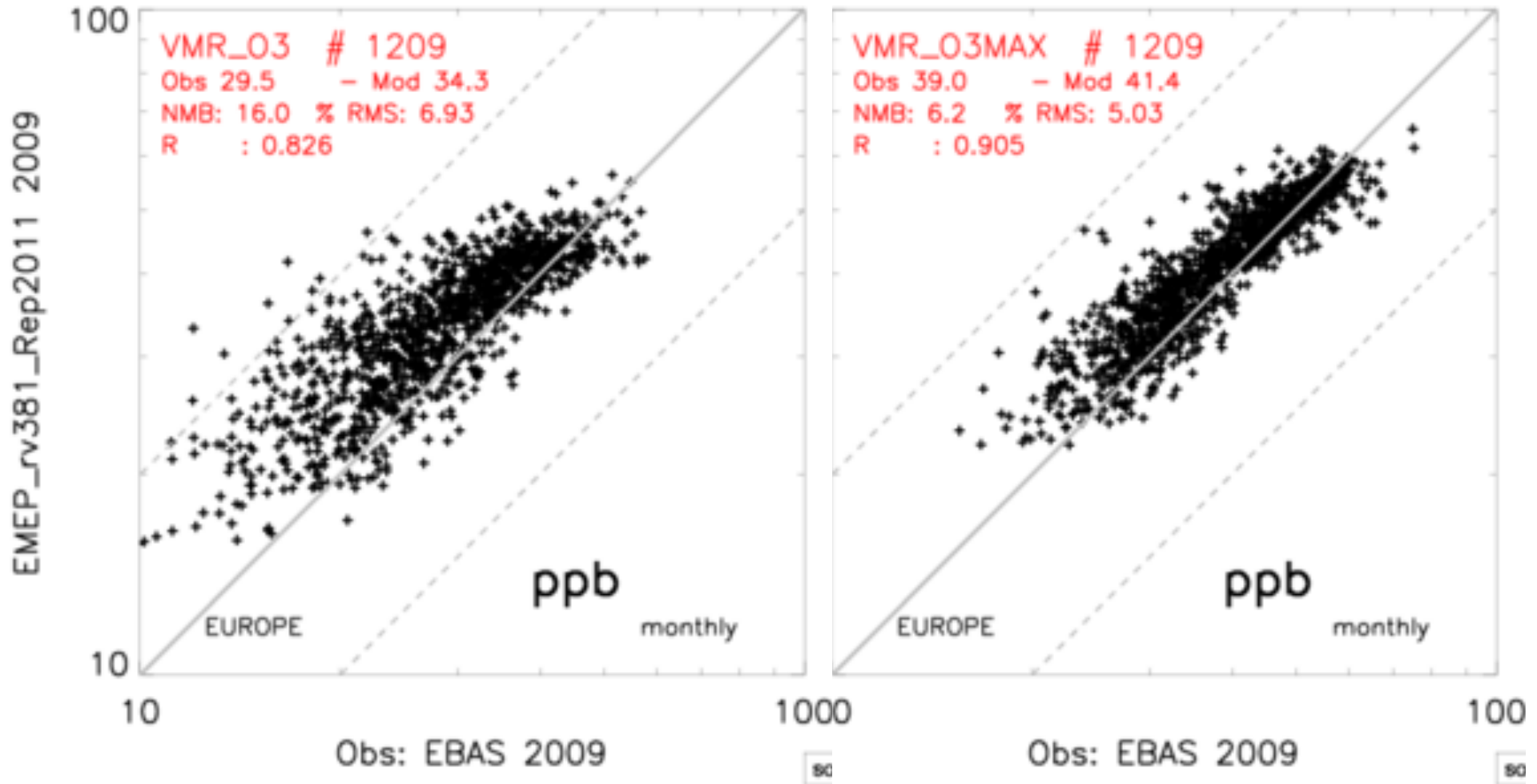
- ◆ What do the model runs show ?
- ◆ Are the peak ozone concentrations better traced ?
- ◆ Where and when are the changes ?  
Due to emissions only....
- ◆ How is the hemispheric transport influencing Europe ?

# Evolution of Ozone indicators EMEP model in EU27



*EU27 country report supplement to EMP status report 2012*

# Evaluation EMEP model mean ozone / daily ozone maximum

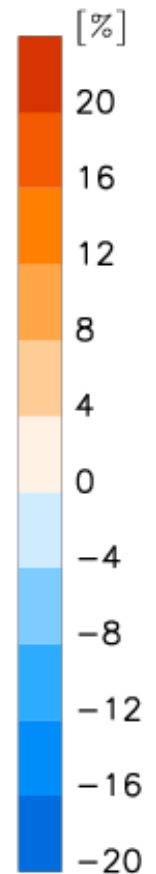
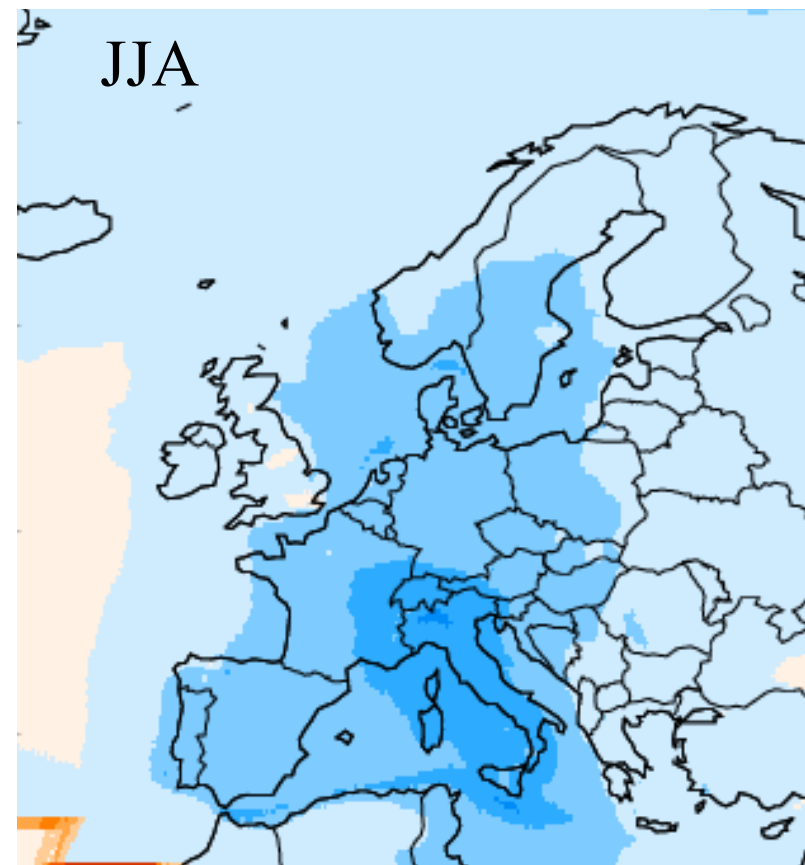
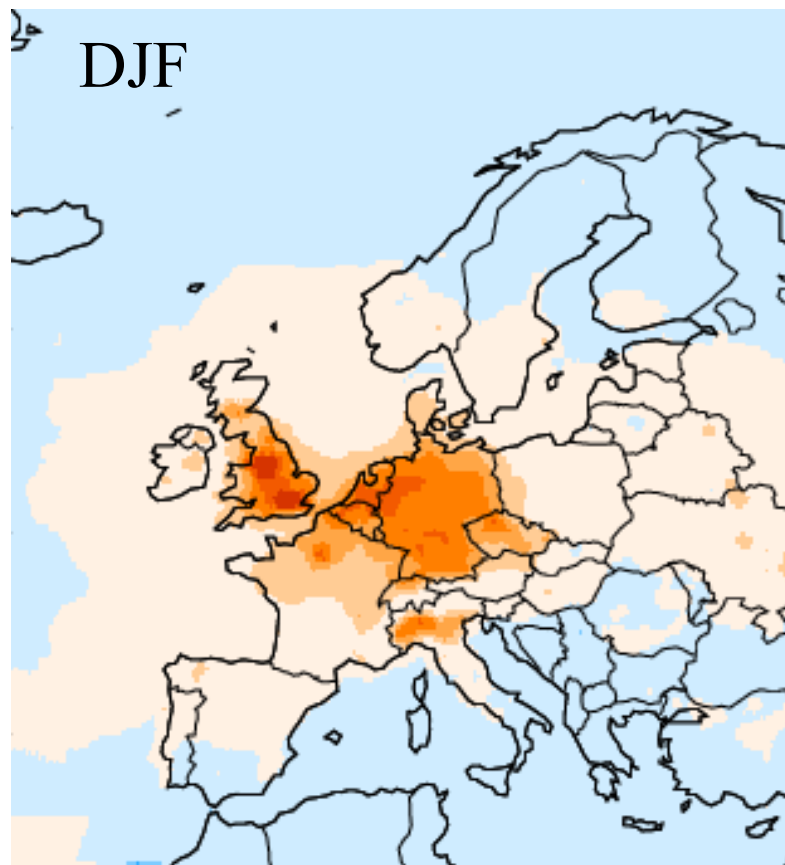




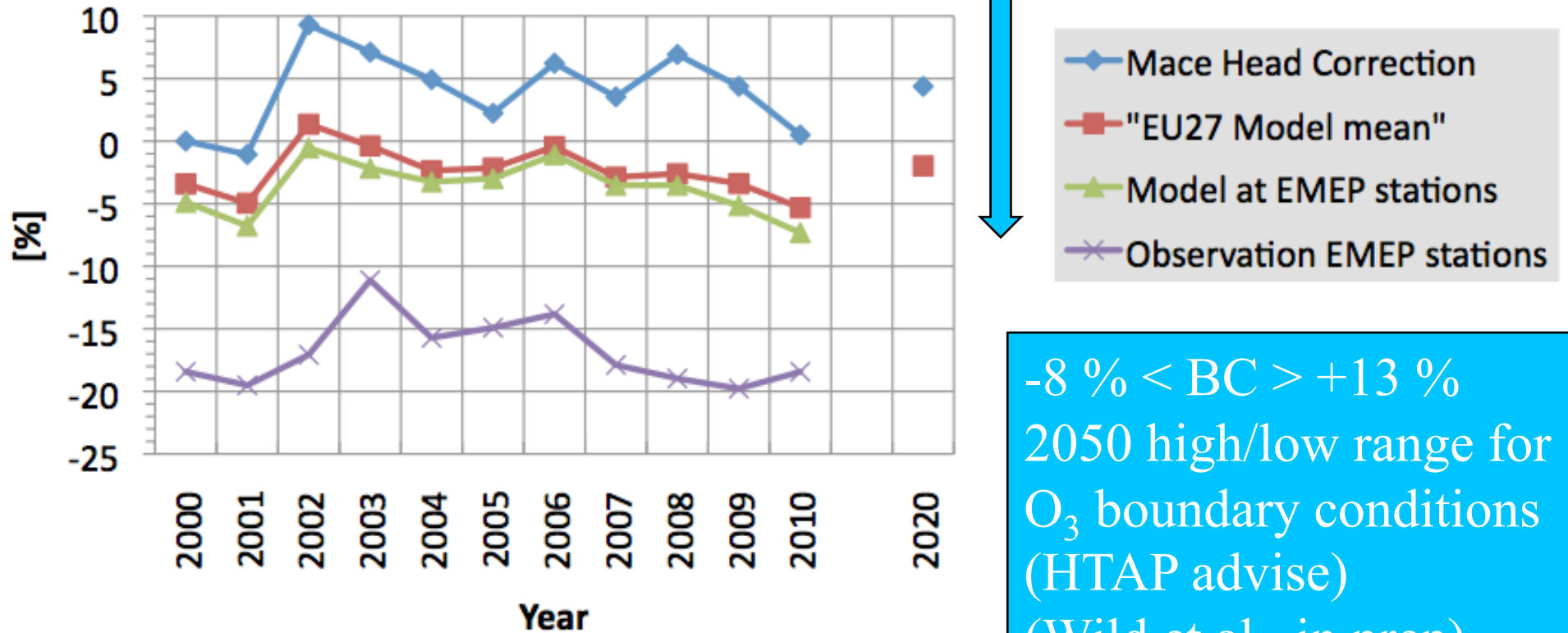
# EMEP MSC-W trend calculations due to emissions only (meteo=2000)



◆ Percentage change in 2010 surface ozone since 2000 [%]



# Surface Ozone Anomaly relative to Mace Head clean sector year 2000



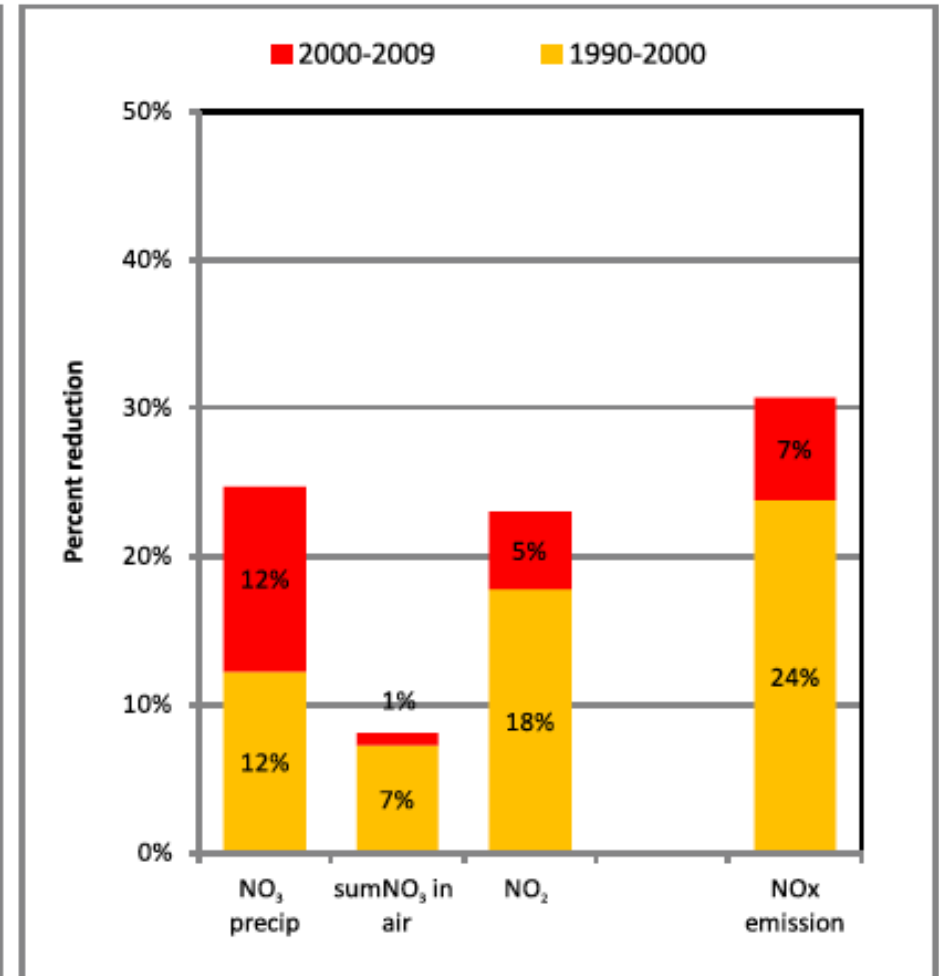
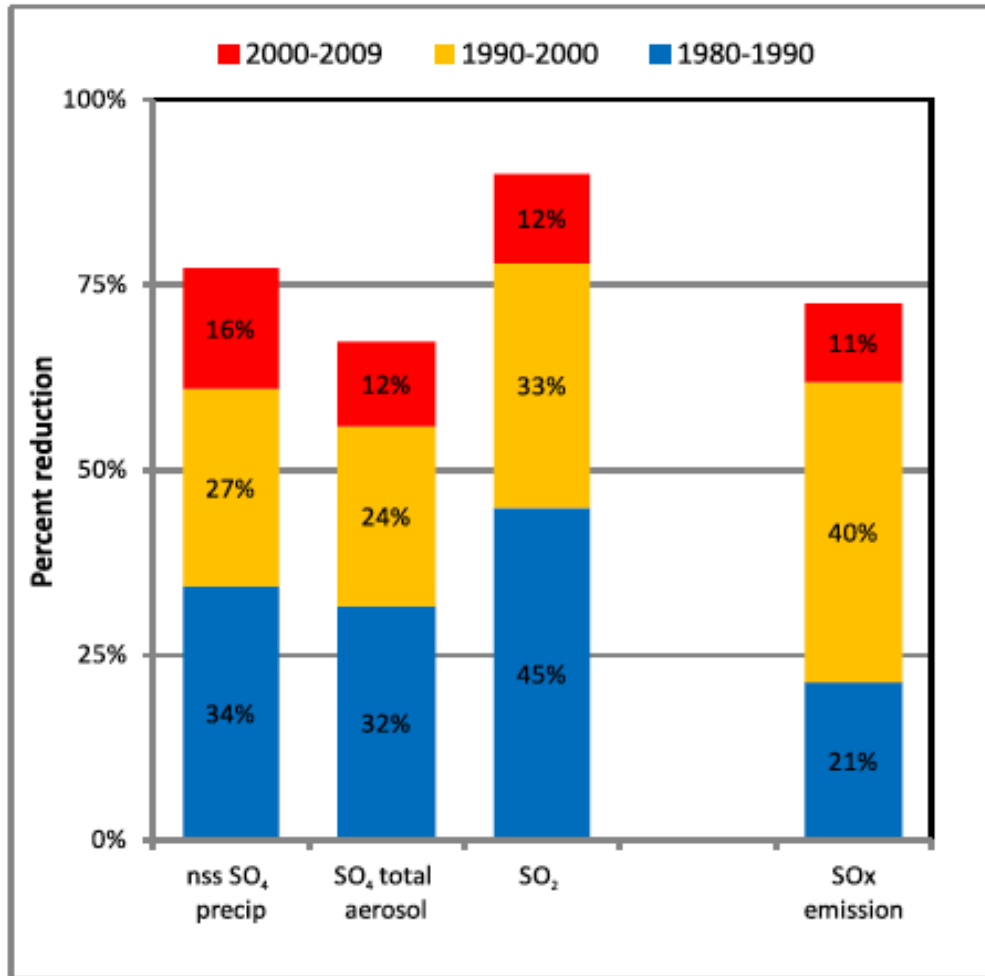
-8 % < BC > +13 %  
 2050 high/low range for  
 O<sub>3</sub> boundary conditions  
 (HTAP advise)  
 (Wild et al., in prep)

## *Hemispheric transport of ozone MSC-W contribution in TF-HTAP*



- ◆ Extensive global & regional model runs
  - ◆ Sensitivity of model ozone to hemispheric transport
  - ◆ Quantification of ozone S/R (global vs regional)
  - ◆ Future scenario runs
- ◆ Provision of boundary conditions to regional models  
North America, Europe, Asia
- ◆ Provision of infrastructure for HTAP-II intercomparison  
Multi-Model storage, web access, quality checks

# Trends N and S Measurements versus Emissions

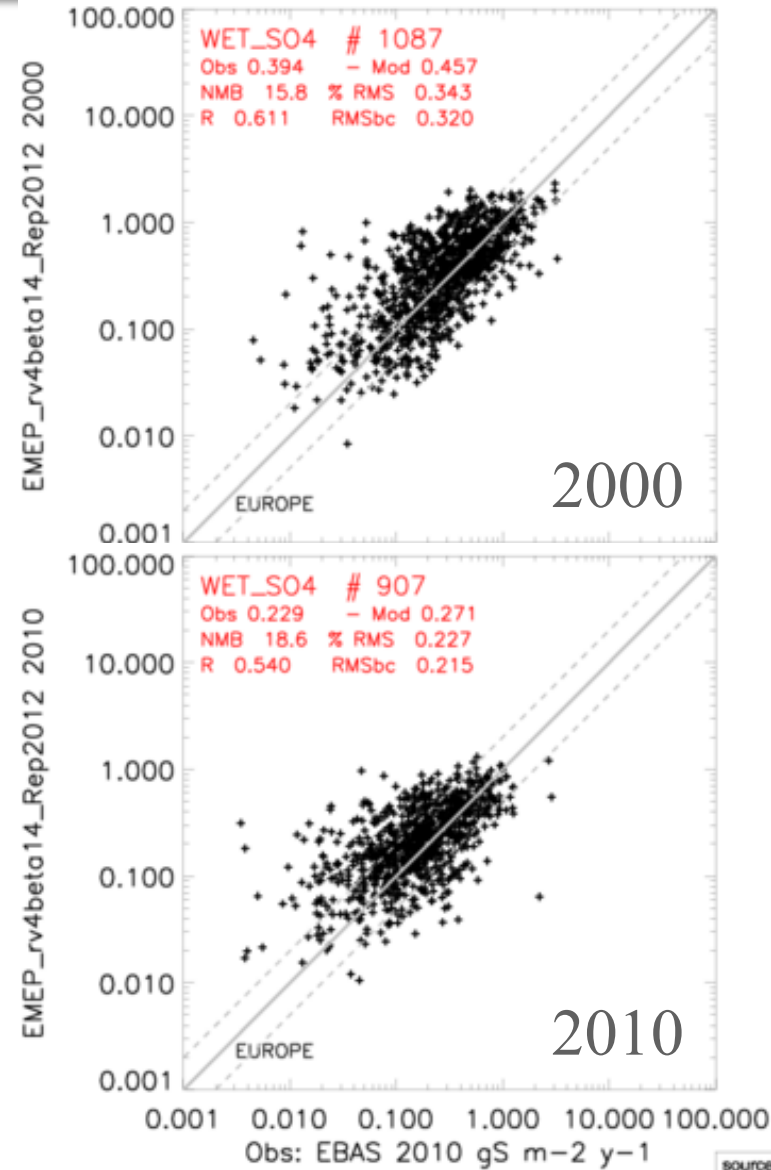
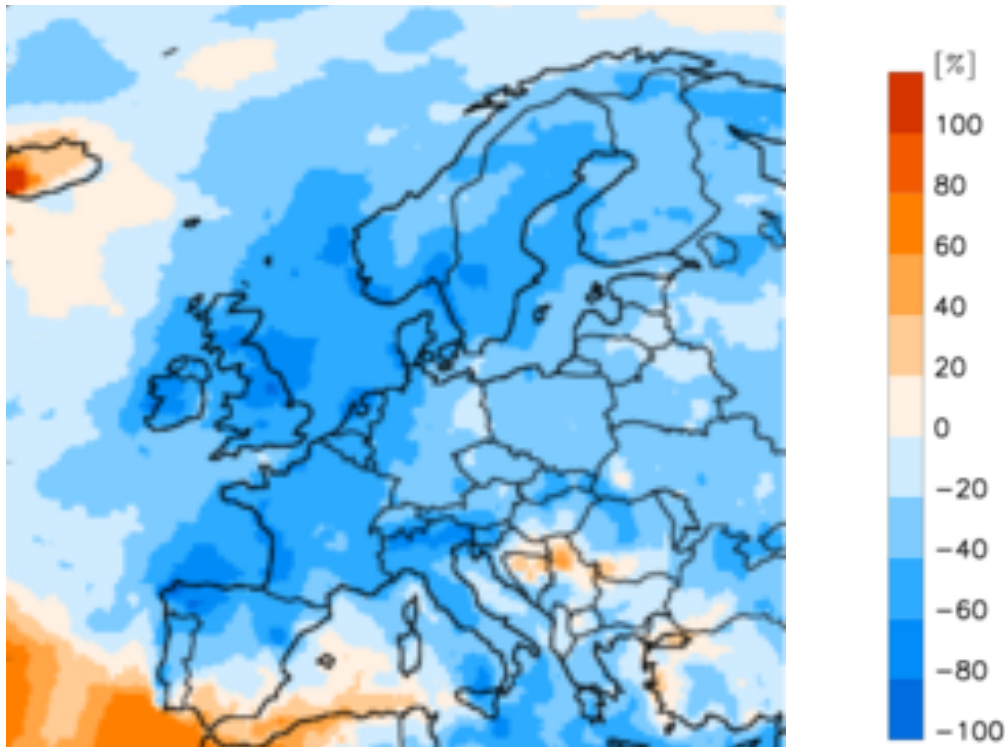


14 sites used for consistent sulfur trends  
All sites used for nitrogen trends

Torseth et al. 2012



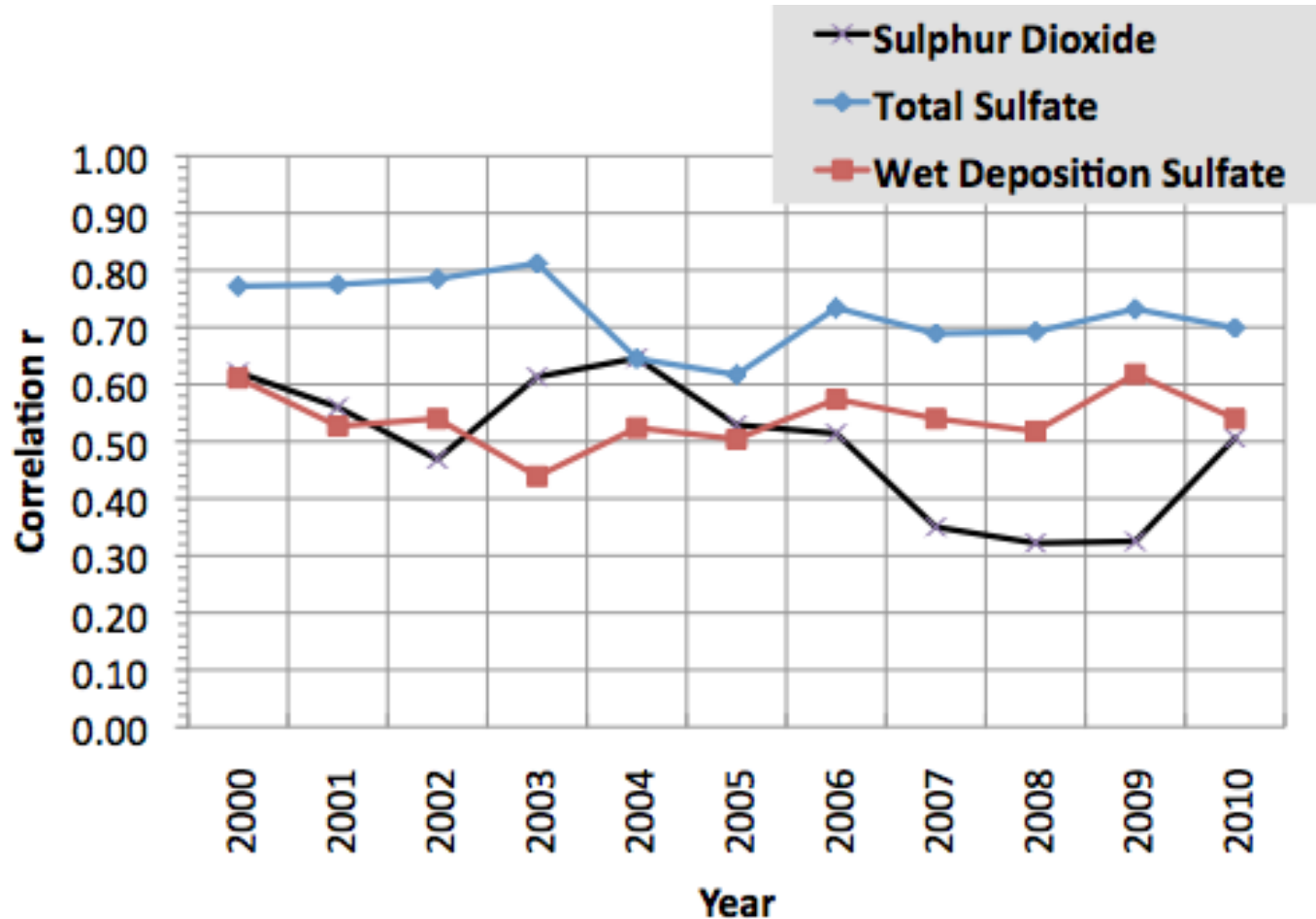
## ◆ Sulfate Wet Deposition 2010 relative to 2000



[http://aerocom.met.no/cgi-bin/aerocom/surfobs\\_annualrs.pl?MODELLIST=EMEPReports](http://aerocom.met.no/cgi-bin/aerocom/surfobs_annualrs.pl?MODELLIST=EMEPReports)

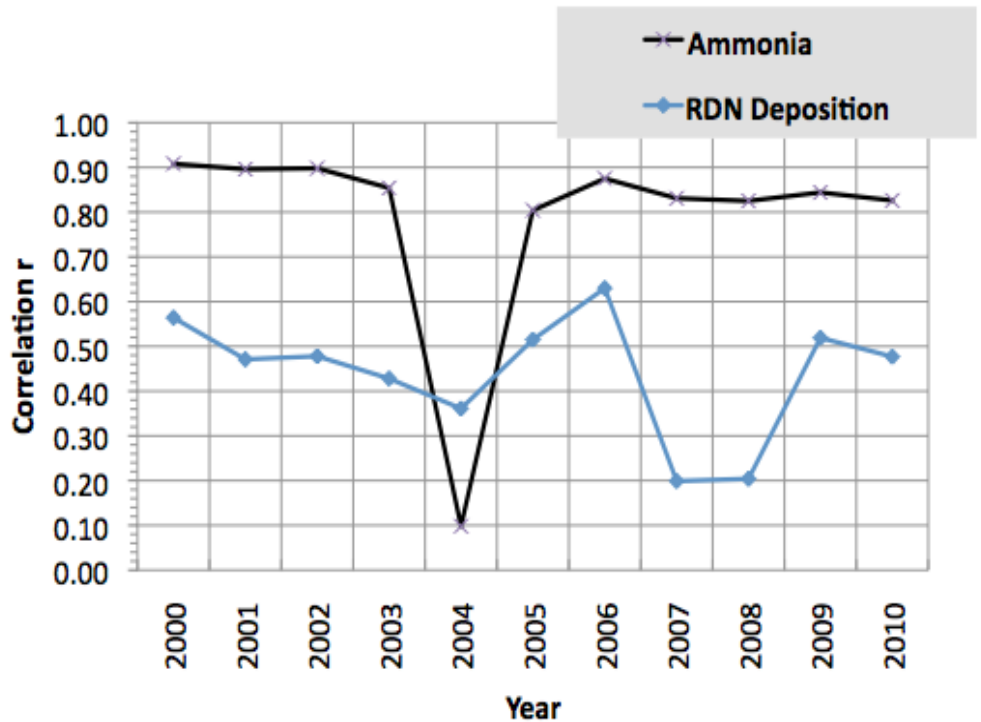
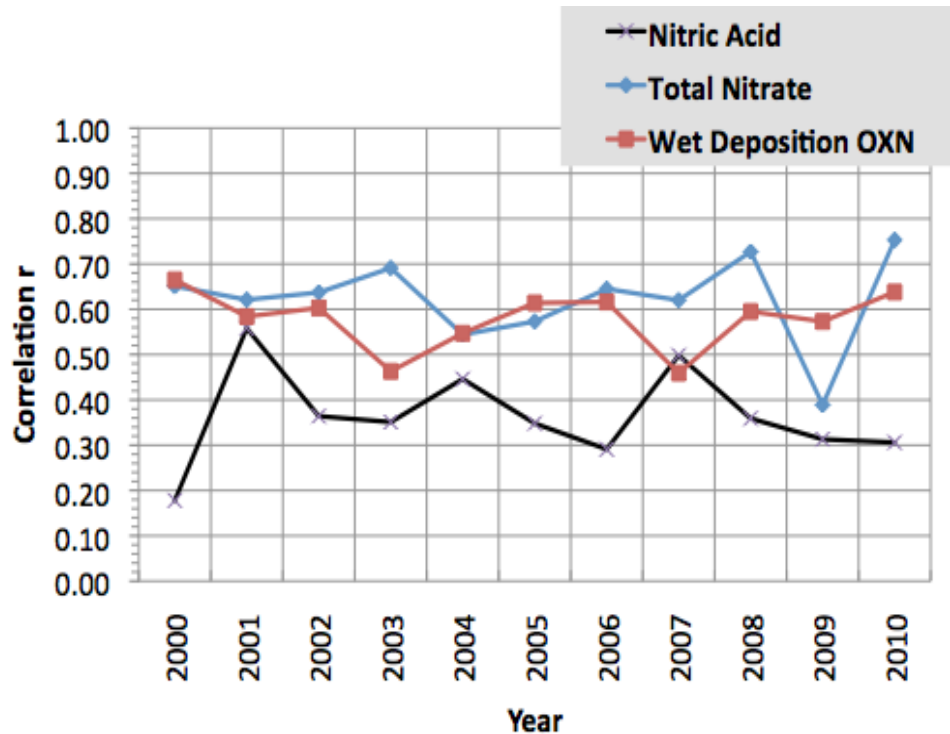


# Model-Data correlation coefficient based on monthly station means



Number of Stations reporting  
 $SO_4 = 59$   
 $SO_4$  Deposition = 87  
 $SO_2 = 72$

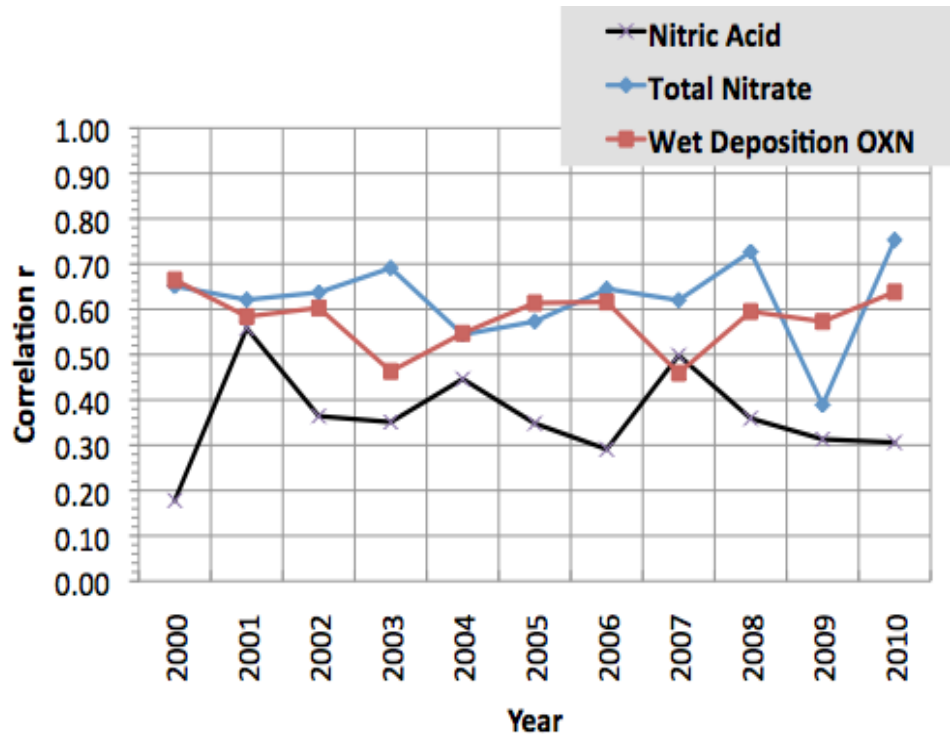
# Model-Data correlation coefficient based on monthly station means



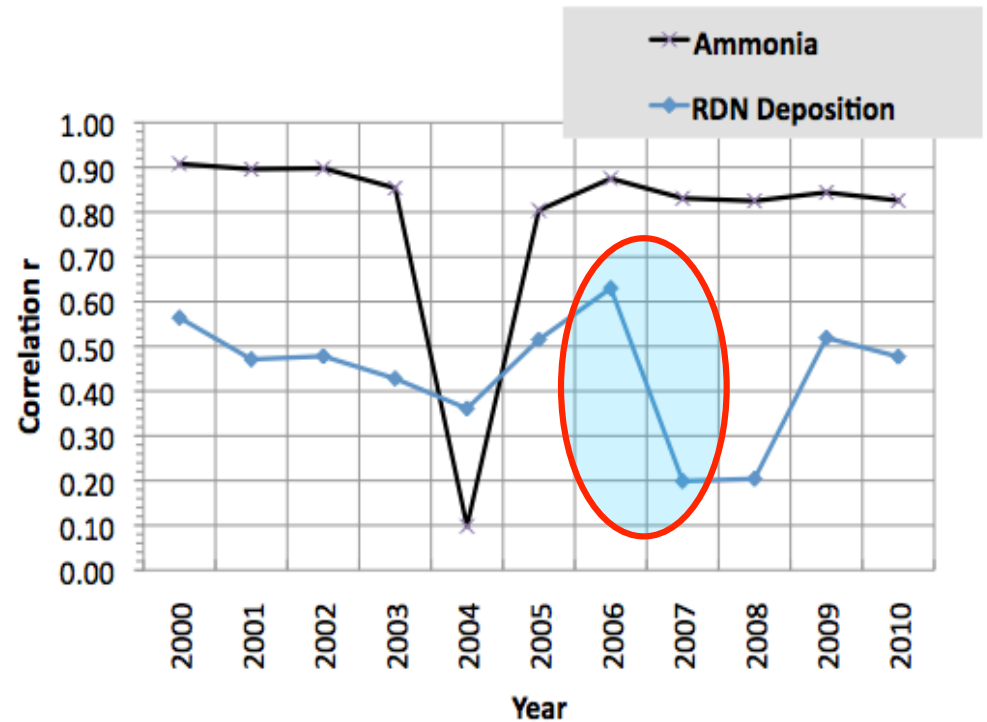
Stations reporting  
**Total Nitrate = 55**  
**OXN deposition = 88**  
 Nitric Acid = 16

Stations reporting  
 Ammonia = 19  
**RDN deposition = 88**

# Model-Data correlation coefficient based on monthly station means

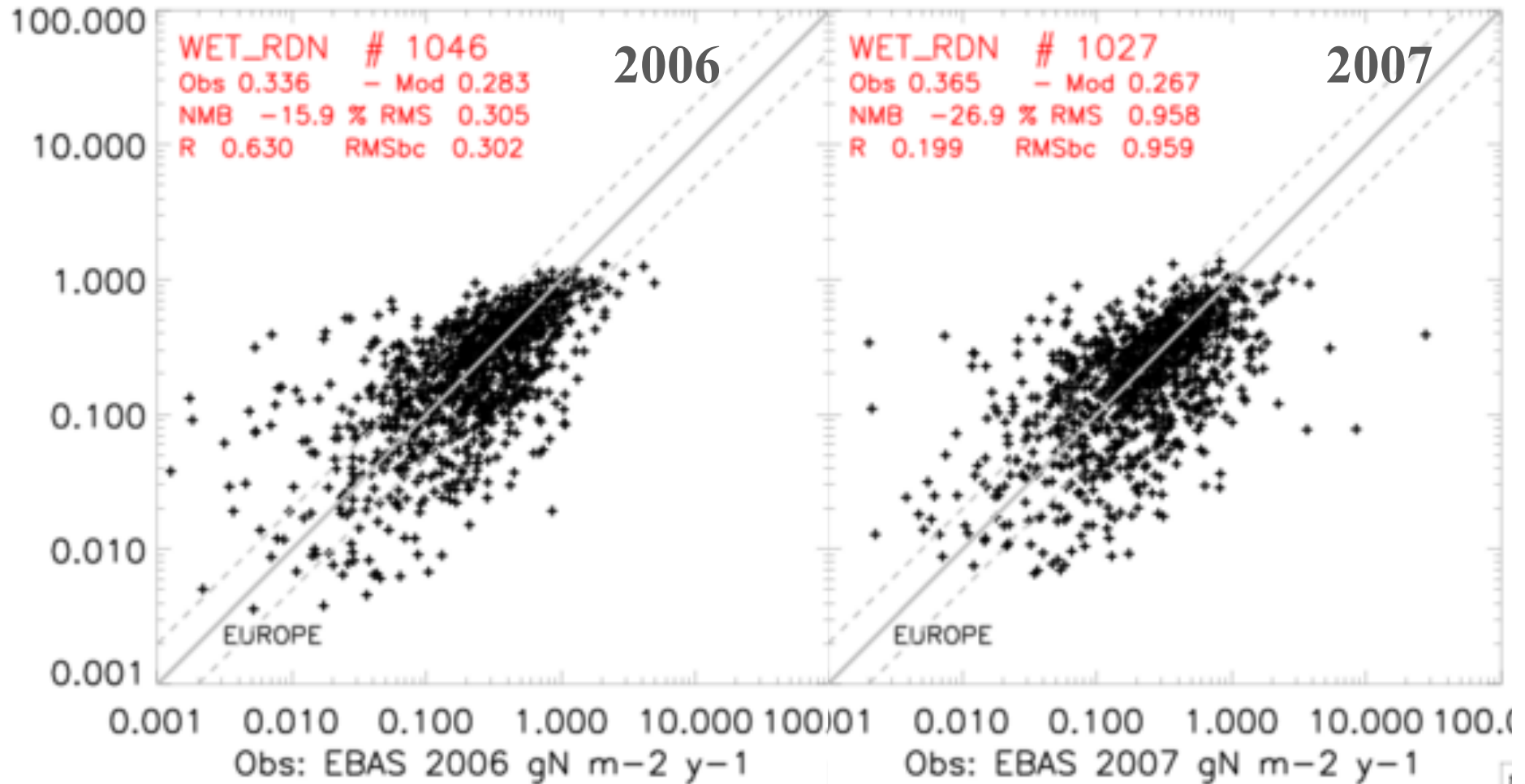


Stations reporting  
**Total Nitrate = 55**  
**OXN deposition = 88**  
 Nitric Acid = 16

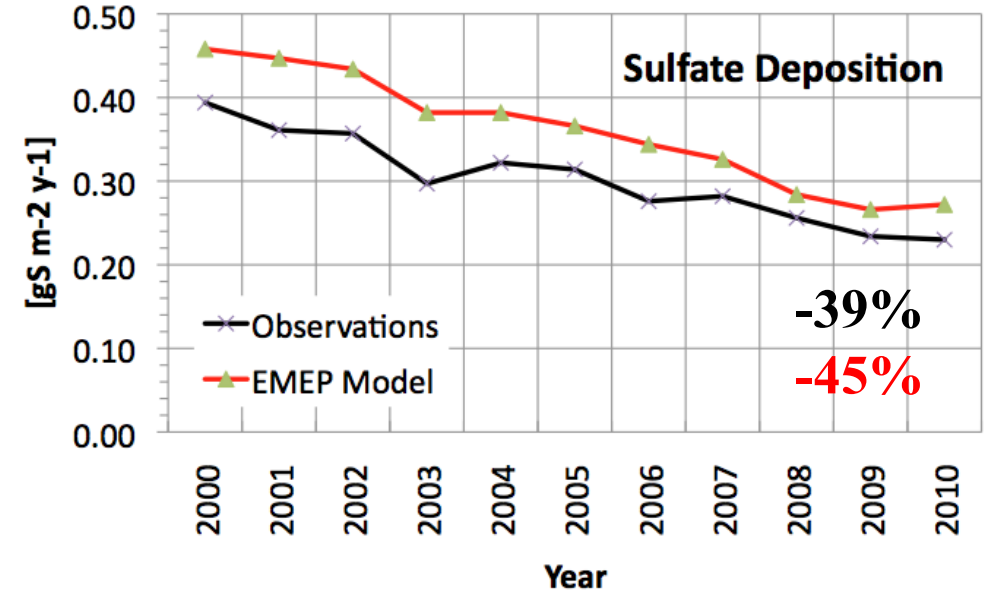
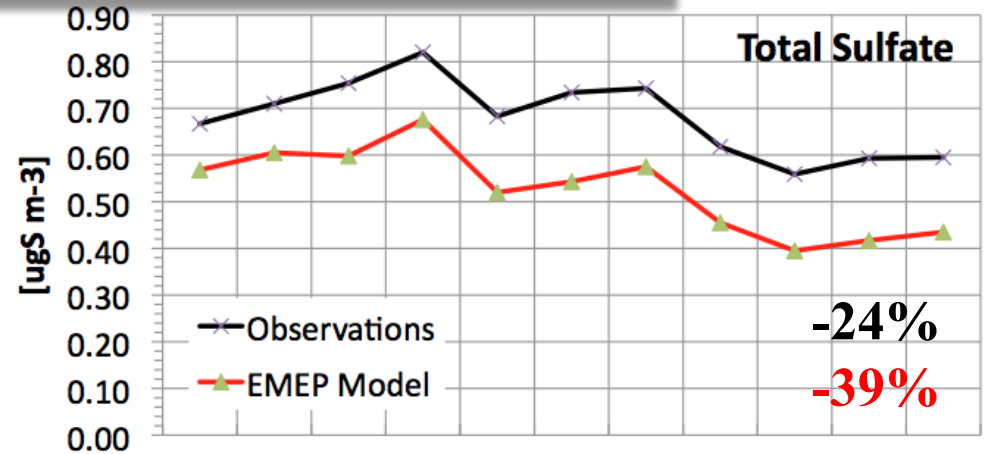
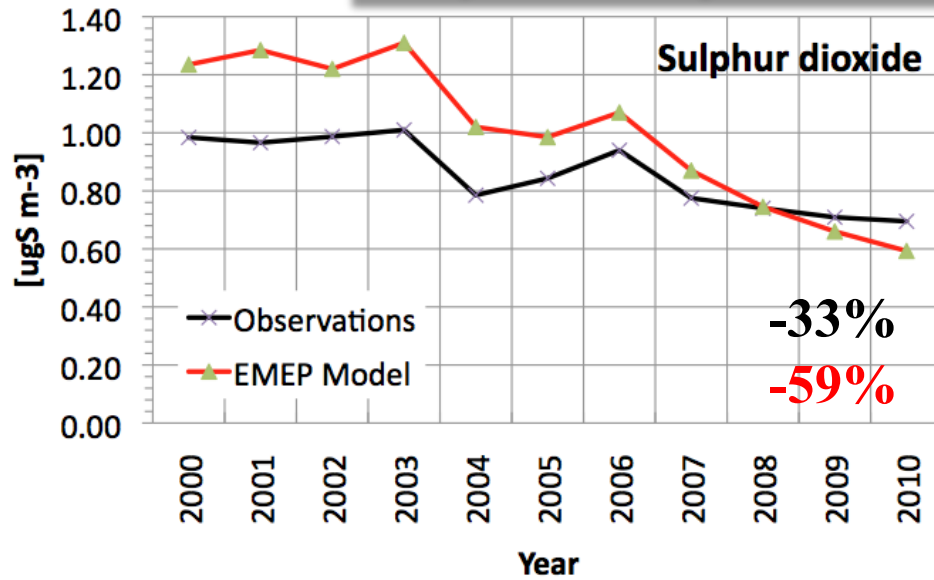


Stations reporting  
 Ammonia = 19  
**RDN deposition = 88**

# Deposition of Reduced Nitrogen “Performance” shift 2006 vs 2007



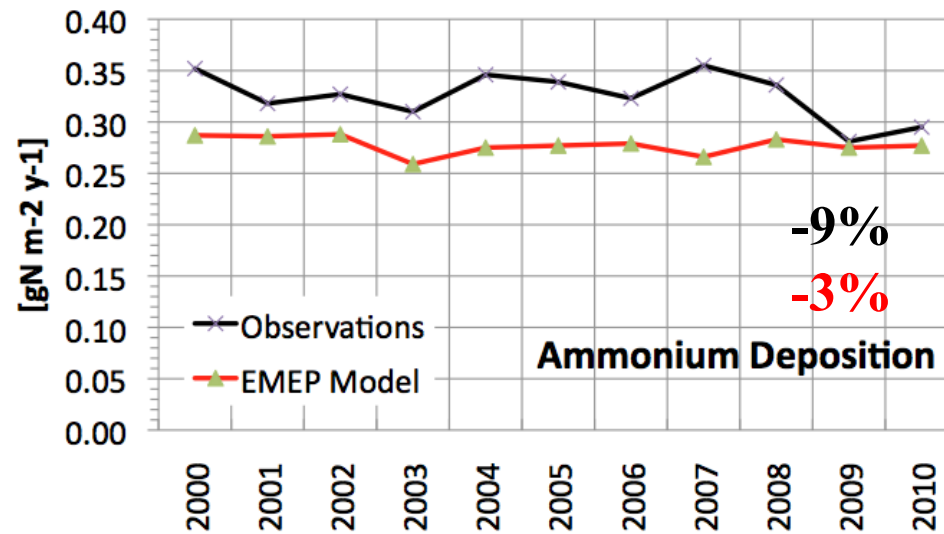
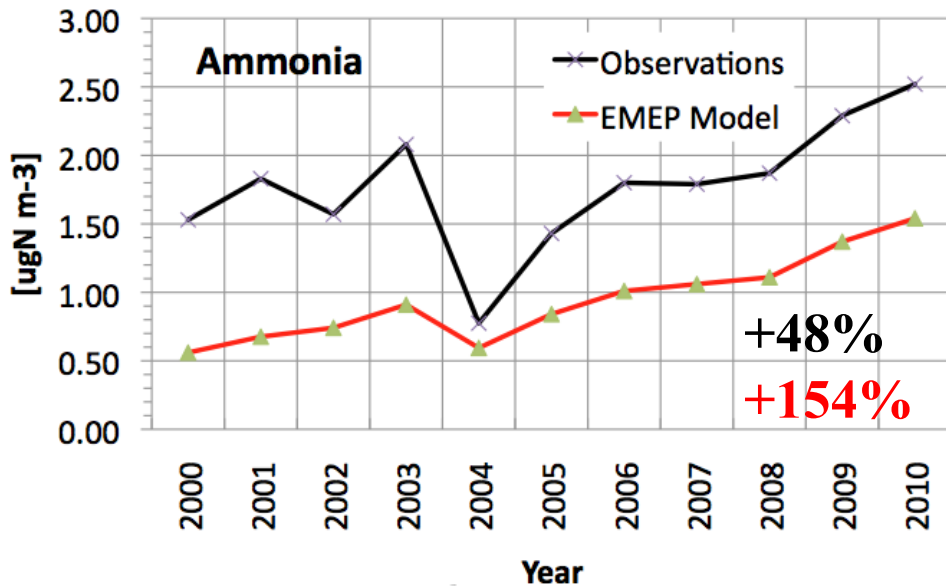
# 10 Year Trend of European Mean Sulfur components



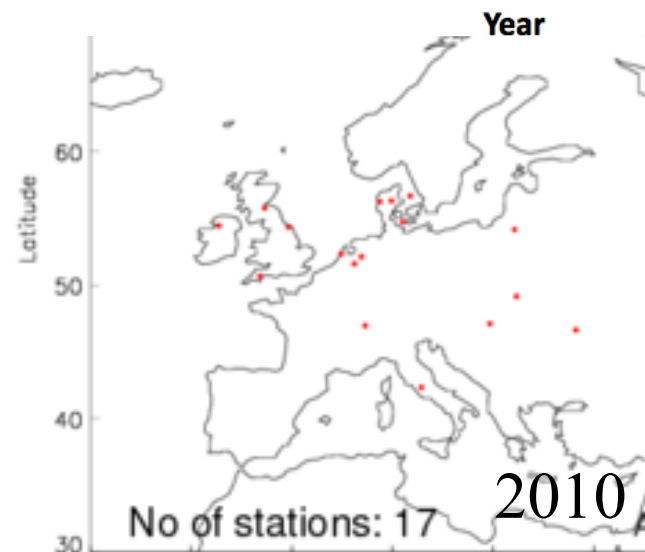
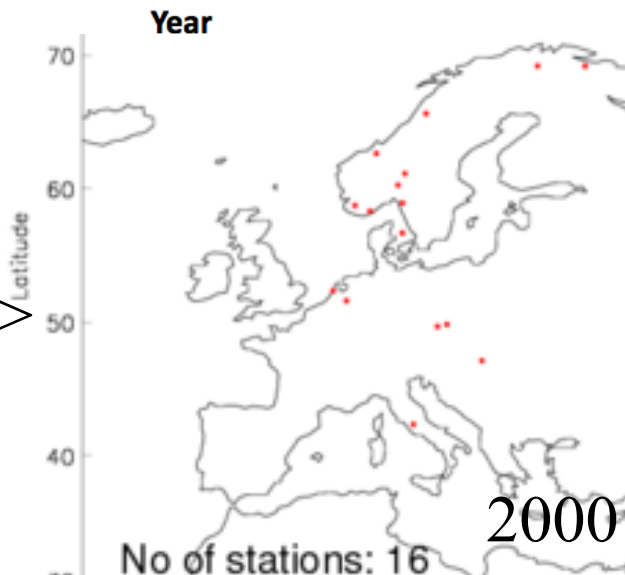
*Trends calculated per decade relative to year 2000*



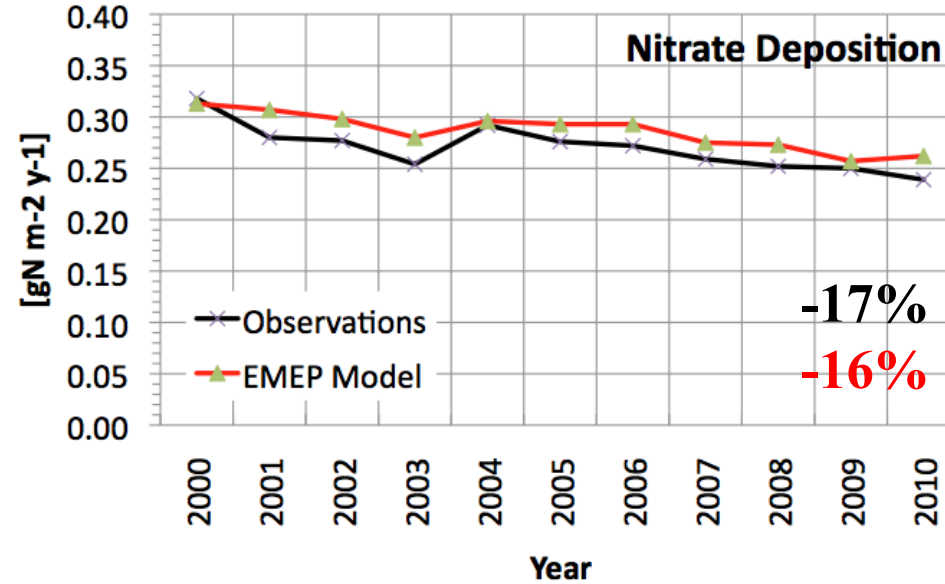
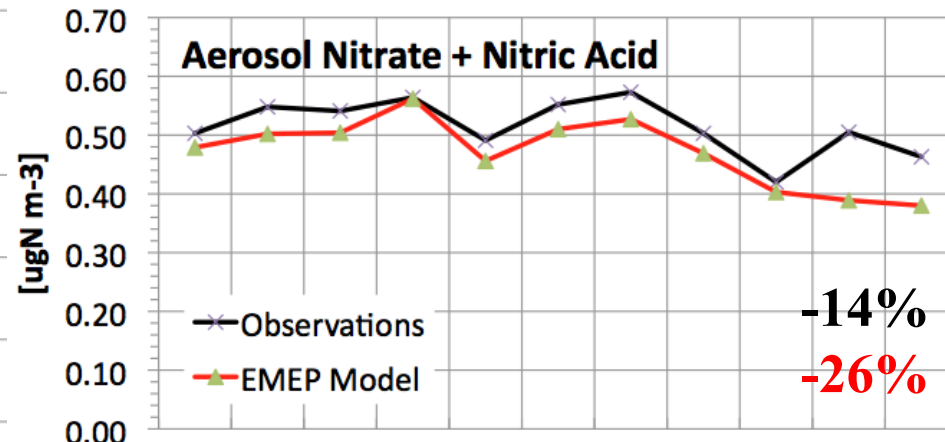
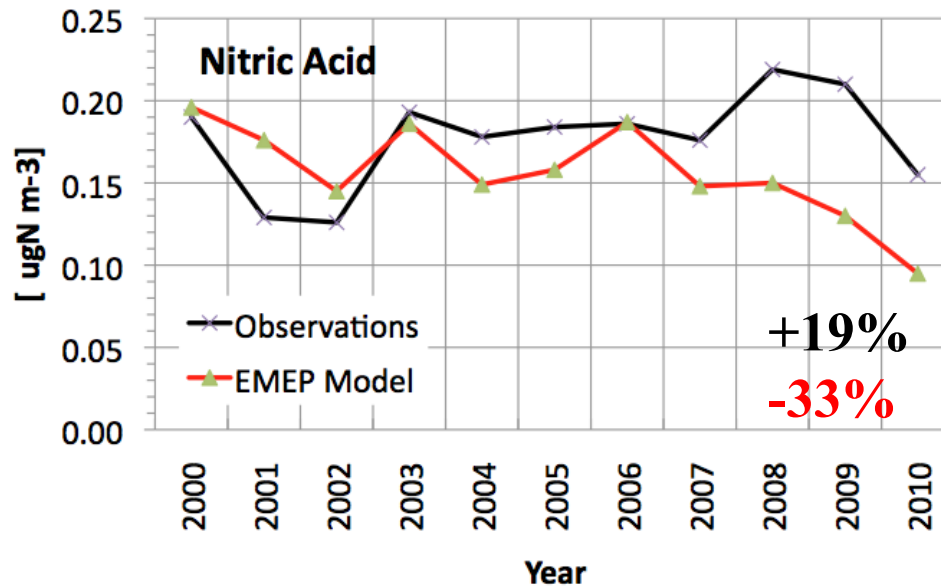
# 10 Year Trend of European Mean Reduced Nitrogen



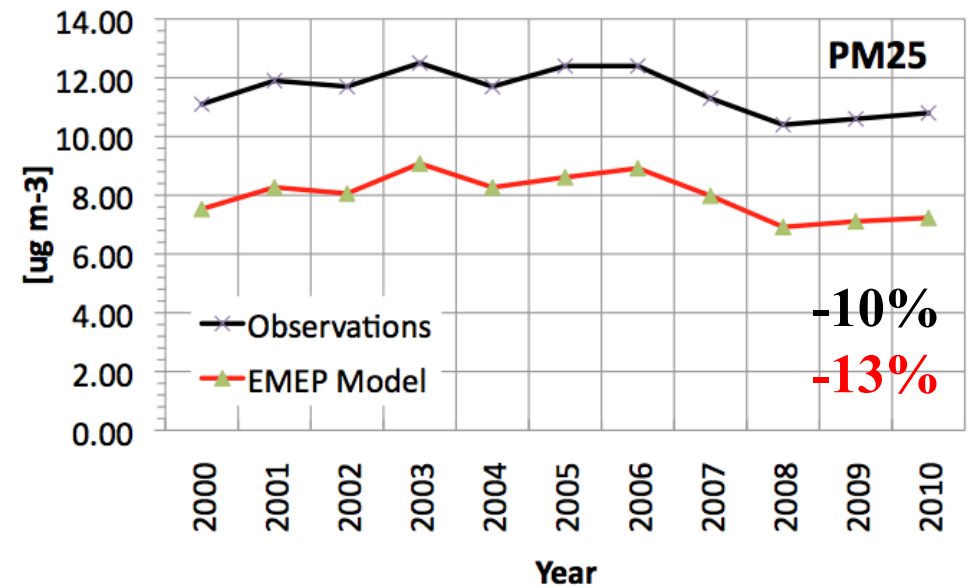
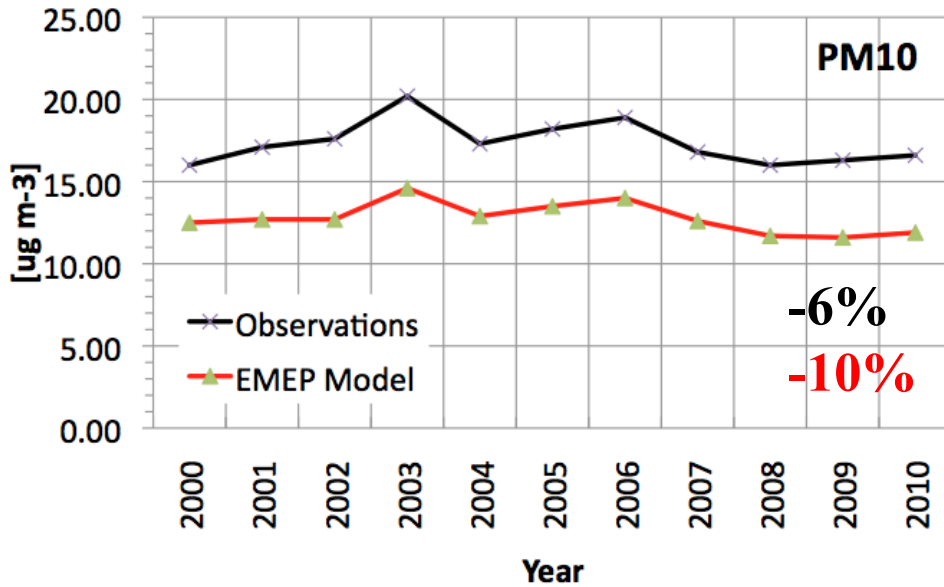
Sites  
Reporting  
Ammonia=>



# 10 Year Trend of European Mean Oxidised Nitrogen



# 10 Year Trend of European Mean Particulate matter



## Summary 10 year trend evaluation



- ◆ Revisit measurement data? Use model to question outliers? Fix data as trend benchmark dataset?
- ◆ Bias rather constant over time for all components!!  
Except maybe  $\text{NH}_3$ , RDN deposits, Nitric Acid => Sampling?
- ◆ Ozone: nighttime values? Hemispheric transport?
- ◆ Sulphate: sea salt correction at more sites; more  $\text{SO}_2$  dry deposition? ship emissions ?
- ◆  $\text{NH}_3$  upward trend, site development involved
- ◆  $\text{NO}_x$  reductions are small from 2000 to 2010 !
- ◆ PM: missing natural dust, OC, agricultural and road dust



## ***Status report 2013 preliminary chapter outline***



- ◆ Status update (new and old grid) and S/R 2011
- ◆ Model development : updates, including WRF/EMEP
- ◆ Impact of grid revision on S/R relationships
  - ◆ Scale Dependency Exercise and S/R on 3 resolutions
  - ◆ Change of loads and trends
- ◆ Trend analysis (1990)-2000-2010
- ◆ Short lived climate forcers understanding
- ◆ Vertical dispersion in EMEP model
- ◆ + TFMM suggestions ??