The European Aerosol Budget

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Aerocom meeting, Oslo, june 2005

PHOENICS

EVK2-CT-2001-00098 • http://phoenics.chemistry.uoc.gr

Aerosols are complex ensembles of particles in the atmosphere of varying composition and size. Aerosols compromise human and ecosystem health, influence visibility, ozone and the global radiation budget, modify cloud properties, and are responsible for feedbacks on the hydrological cycle and for climate perturbation.

The European Union has put forward and implemented a number of policies and legislation to improve air quality and reduce anthropogenic climate change. Fundamental questions for this are: "How and how much do aerosols affect climate? What is the contribution of European emissions to this impact? What is the contribution of other countries to aerosols and their climate forcing over Europe?"

The EC FP5 sponsored PHOENICS project aimed at answering these questions, and specifically made a rigorous evaluation of our knowledge of the magnitude and uncertainties of the direct climate effect of multi-component mixed tropospheric aerosol.

This report contains a synthesis and integration of main results from the project's work. The aim is to give a reader a concise overview of the main results which are of relevance to both the research community and policy makers.

PHOENICS was funded by the FP5 Energy, Environment and Sustainable Development programme.

PHOENICS

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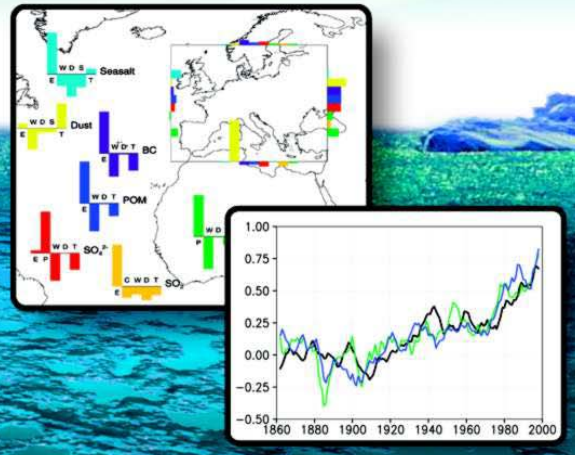
Particles of Human Origin Extinguish Natural solar Irradiance in the Climate System



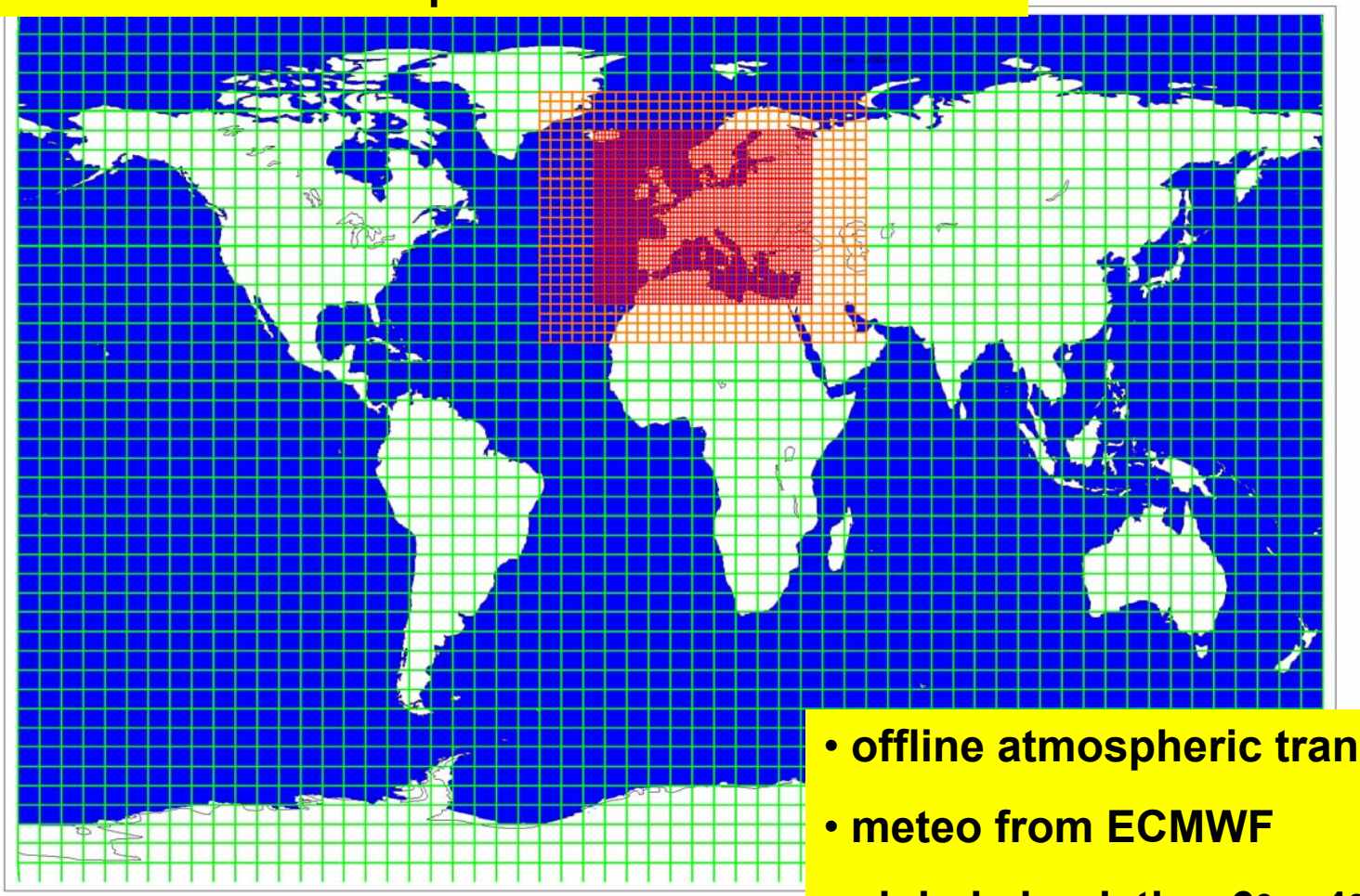
Synthesis and Integration Report

PHOENICS research questions

- Impact European emissions on global aerosol formation
- Impact other world regions on Europe
- Assess major uncertainties in aerosol calculations

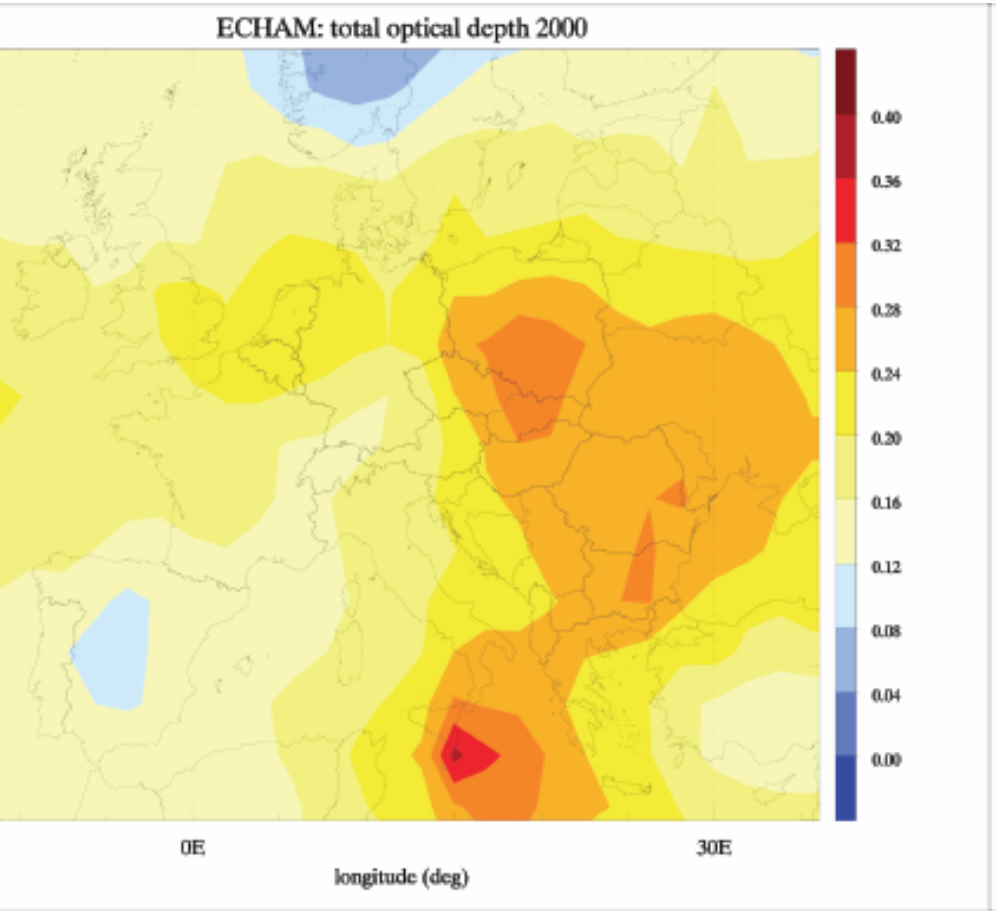
TM5 model

TM5 model – atmospheric zoom model

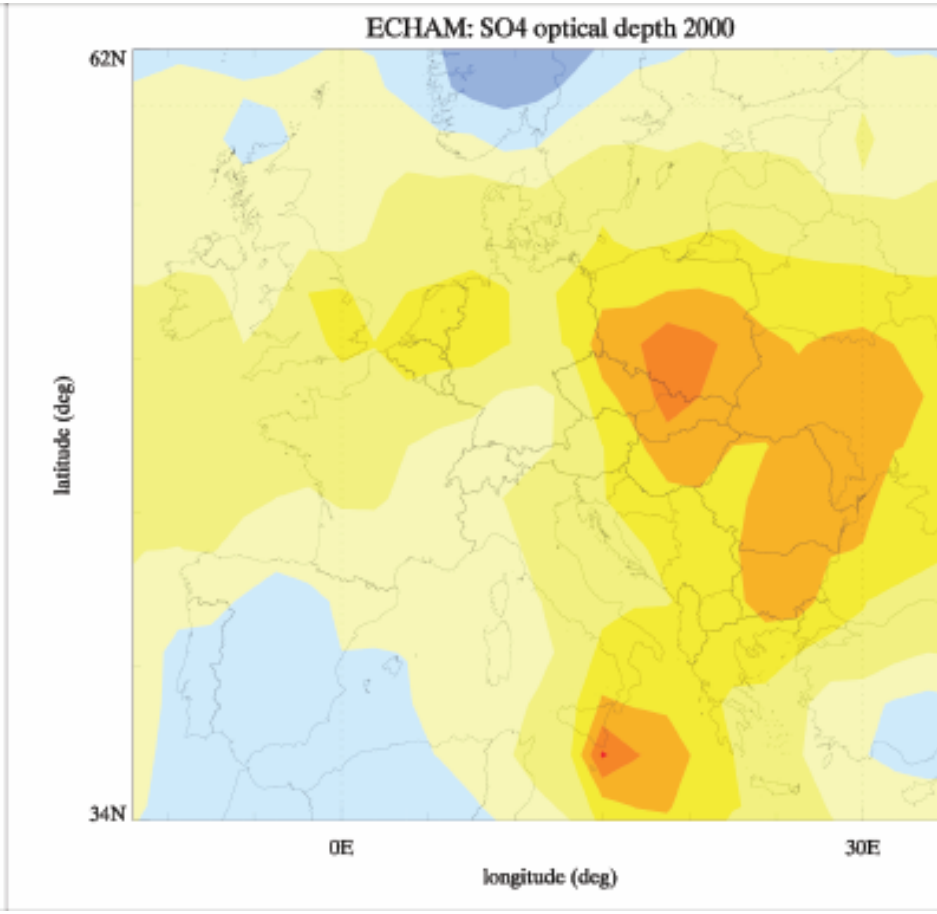


- offline atmospheric transport mode
- meteo from ECMWF
- global simulation 6° x 4°
- zooming 1° x 1° (Europe, …)
- http://www.phys.uu.nl/~tm5/

ECHAM5-HAM (M7)

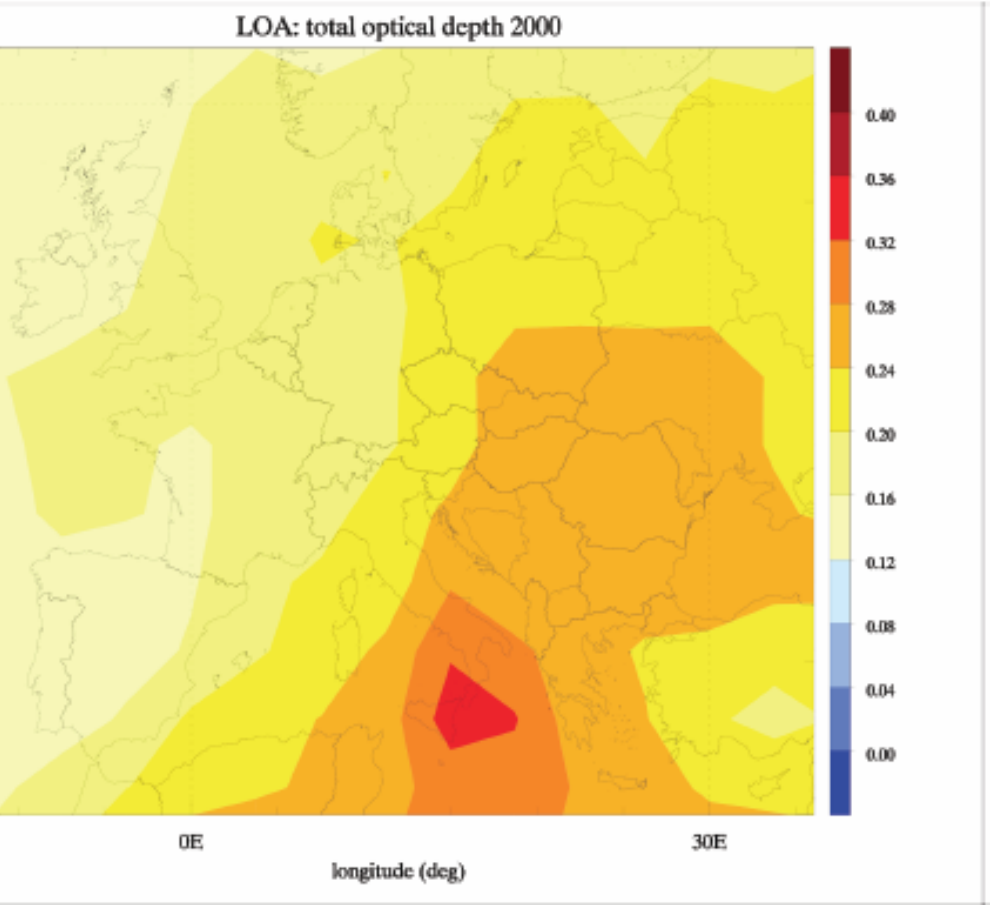


Total AOD 2000

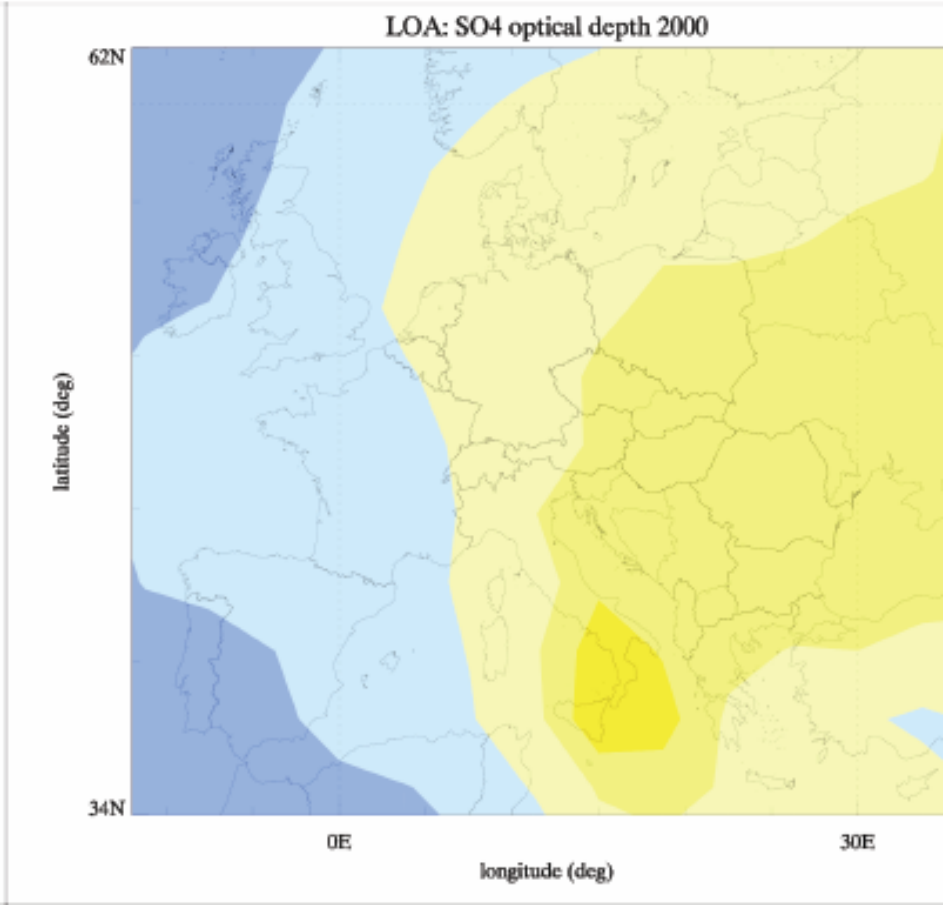


SO4 AOD 2000 + water

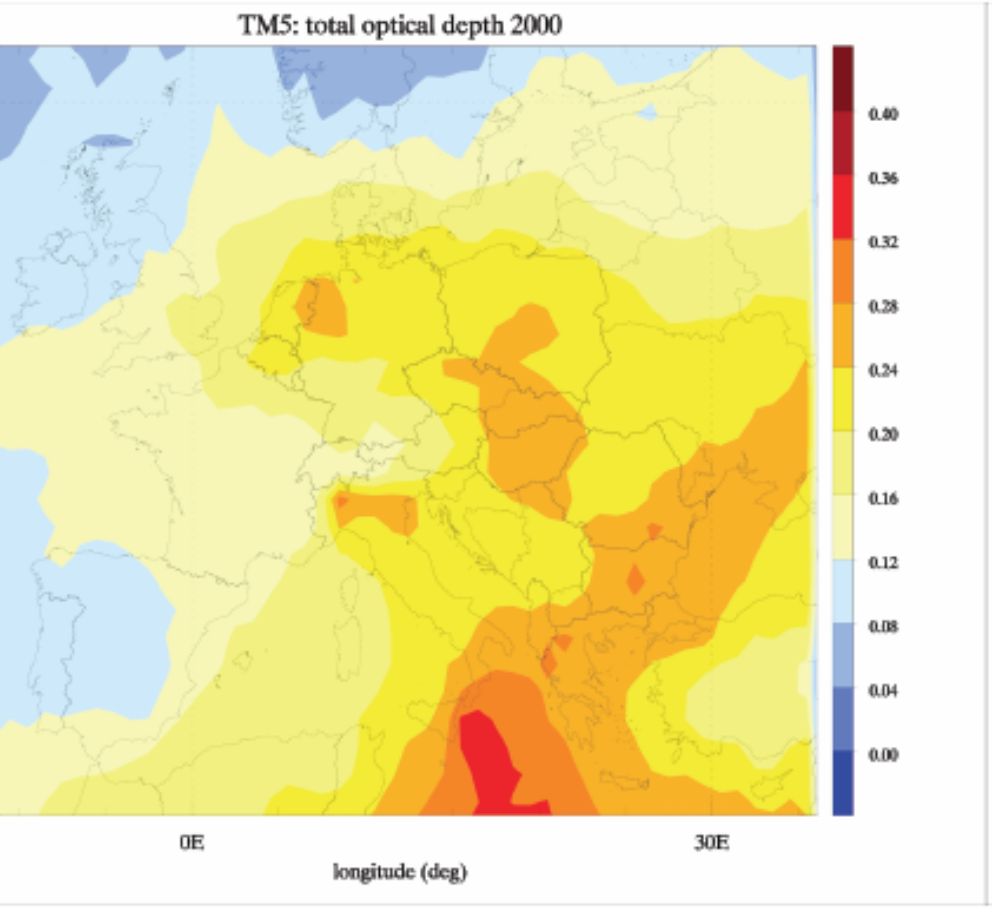
LMDZ-LOA



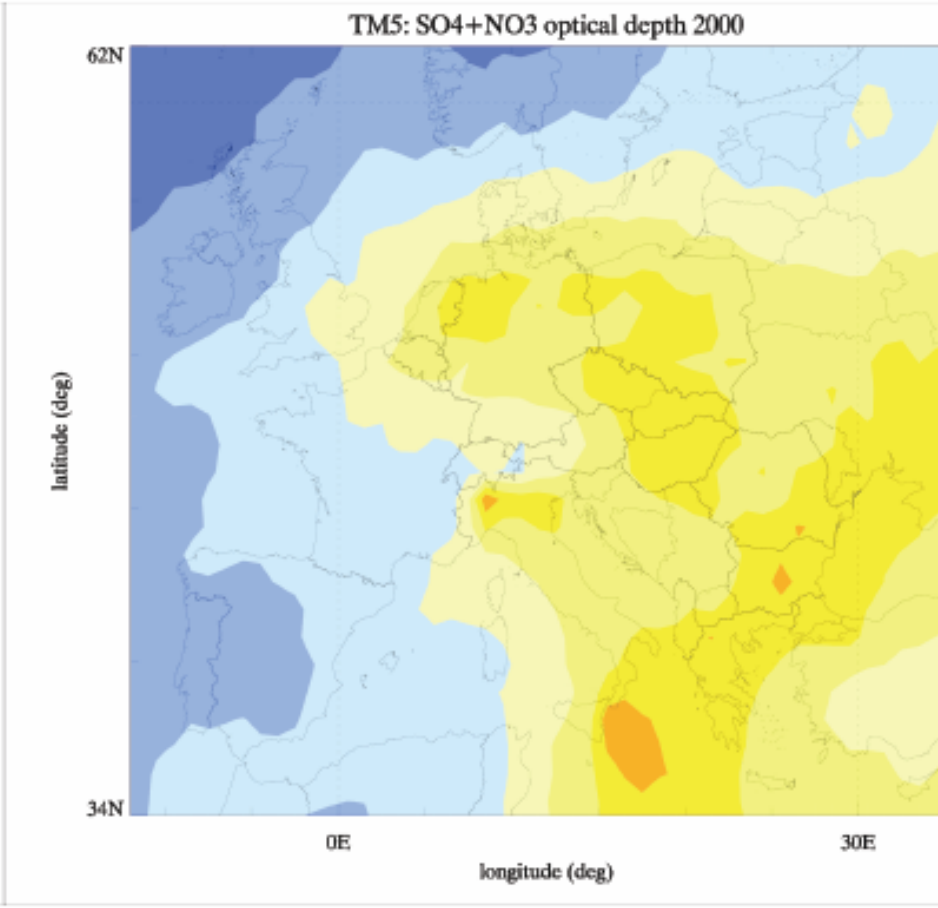
Total AOD 2000



SO4 AOD 2000 + water

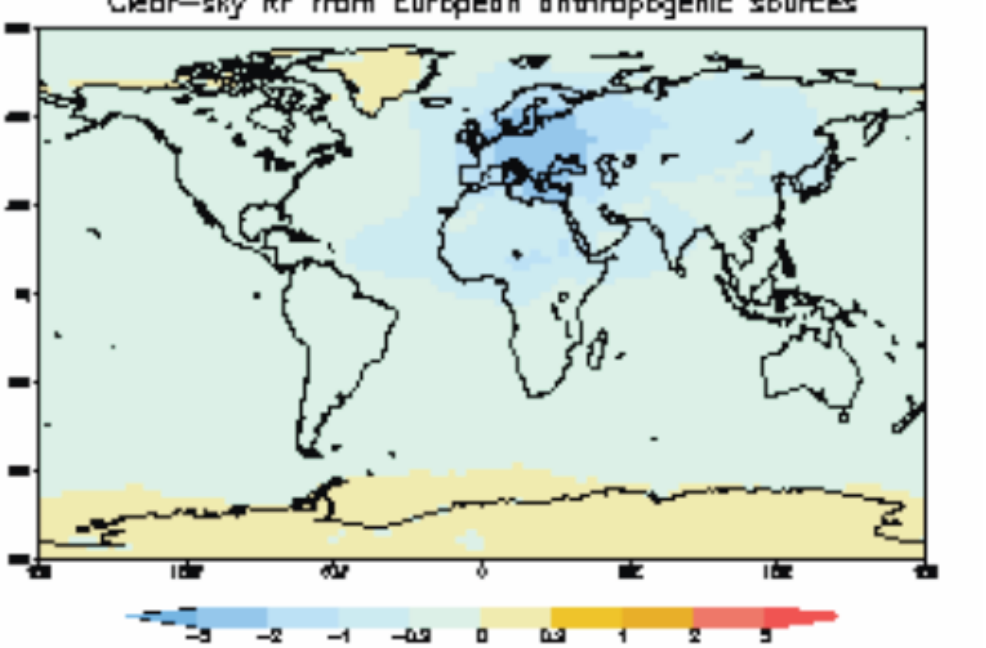


Total AOD 2000

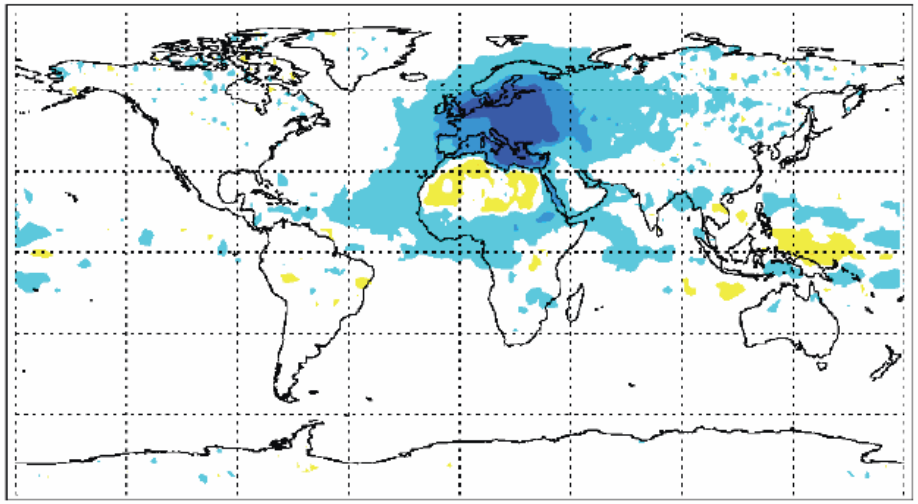


SO4 + NO3 AOD 2000 + water

	Europe to Europe			Europe to ROW		
	LOA	HAM	TM5	LOA	HAM	TM5
All AOD	42%	51%	42%	2.3%	1.3%	1.2%
Inorganic	59%	60%	64%	5.5%	5.5%	4.6%
BC	76%	85%	78%	2.8%	2.0%	2.3%
POM	44%	45%	44%	0.7%	0.5%	0.4%



No Anthropogenic European - Clear Sky



Sulphate	Global (TgS/year)	Europe (GgS/year)
Emission	1.4	232
Chem. Production	48.7	3421
Wet Removal LSP	-43.7	-2102
Wet Removal CP	-5.9	-161
Dry deposition	-0.5	-26
Transport		
		west 280
		east -949
		south -408
		north -290
		total -1366
Mean burden	446 GgS	25 GgS
Lifetime	3.3 days	4.0 days

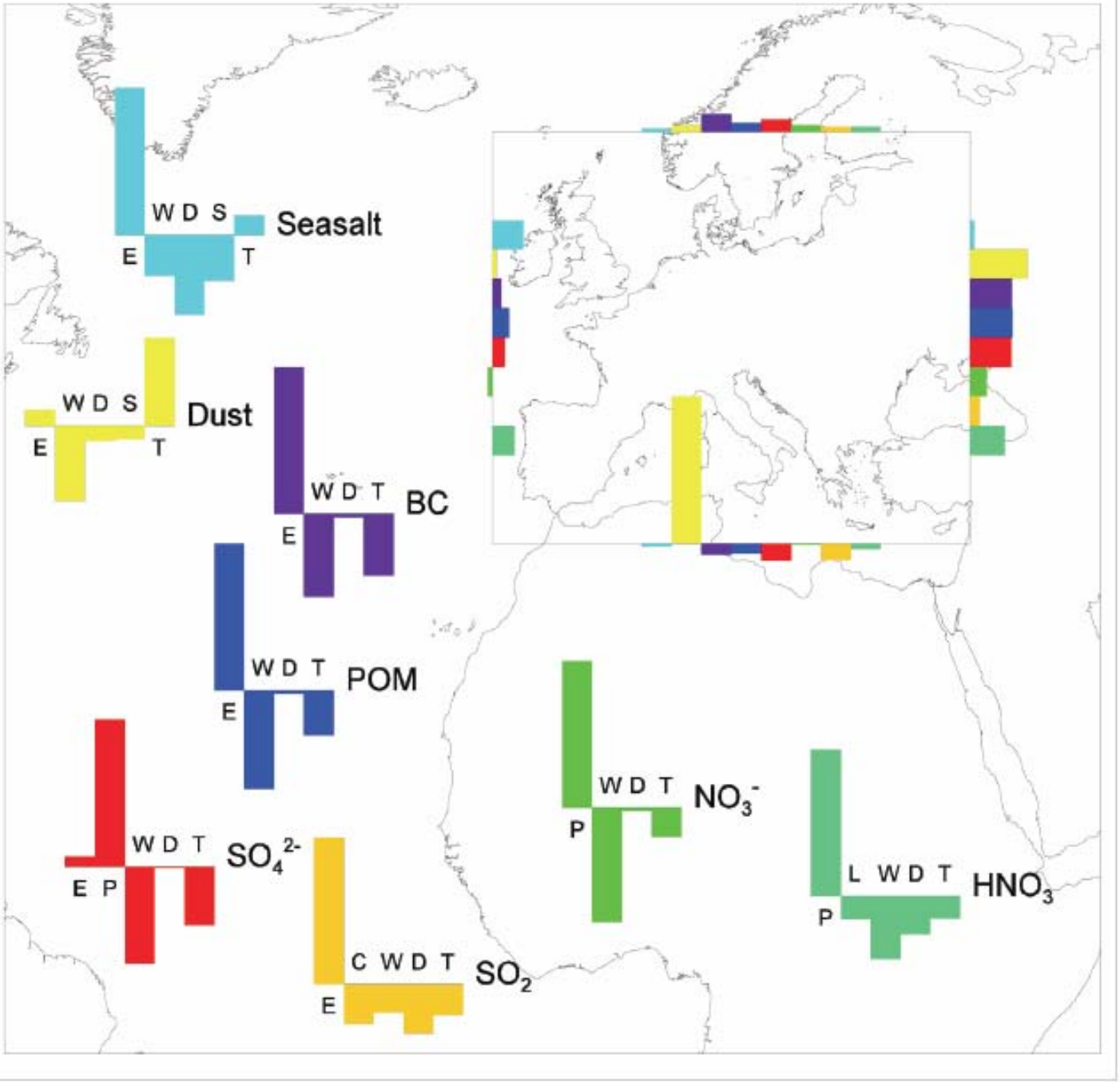
Nitrate	Global (GgN/year)	Europe (GgN/year)
Emission	-	-
Chem. Production	1027	550
Wet Removal LSP	-973	-414
Wet Removal CP	-26	-16
Dry deposition	-28	-11
Transport		
		west -1
		east -6
		south -5
		north -2
		total -1
Mean burden	9.9 GgN	2.75 GgN
Lifetime	3.5 days	2.3 days

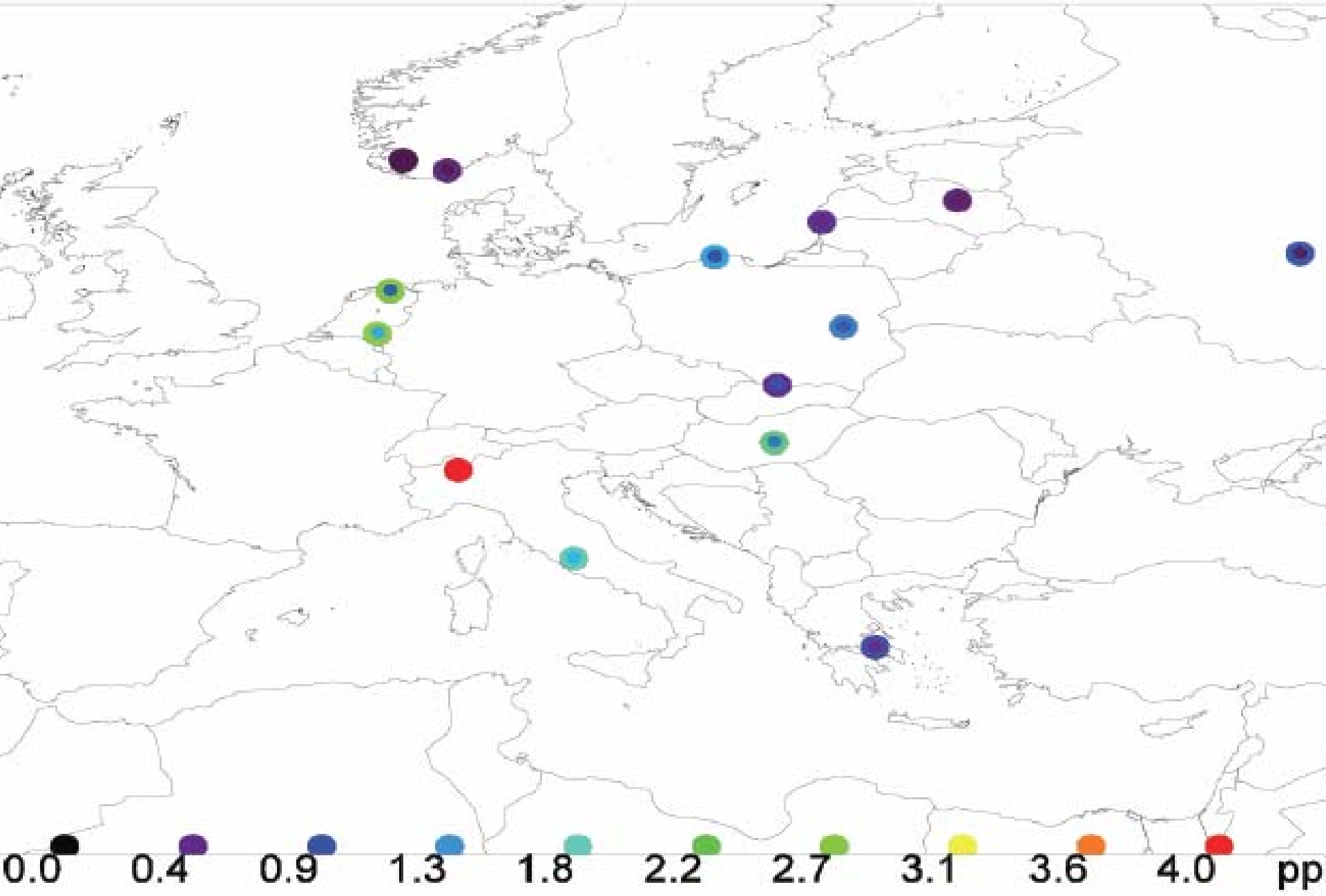
Note: Nitrate formation very resolution dependent

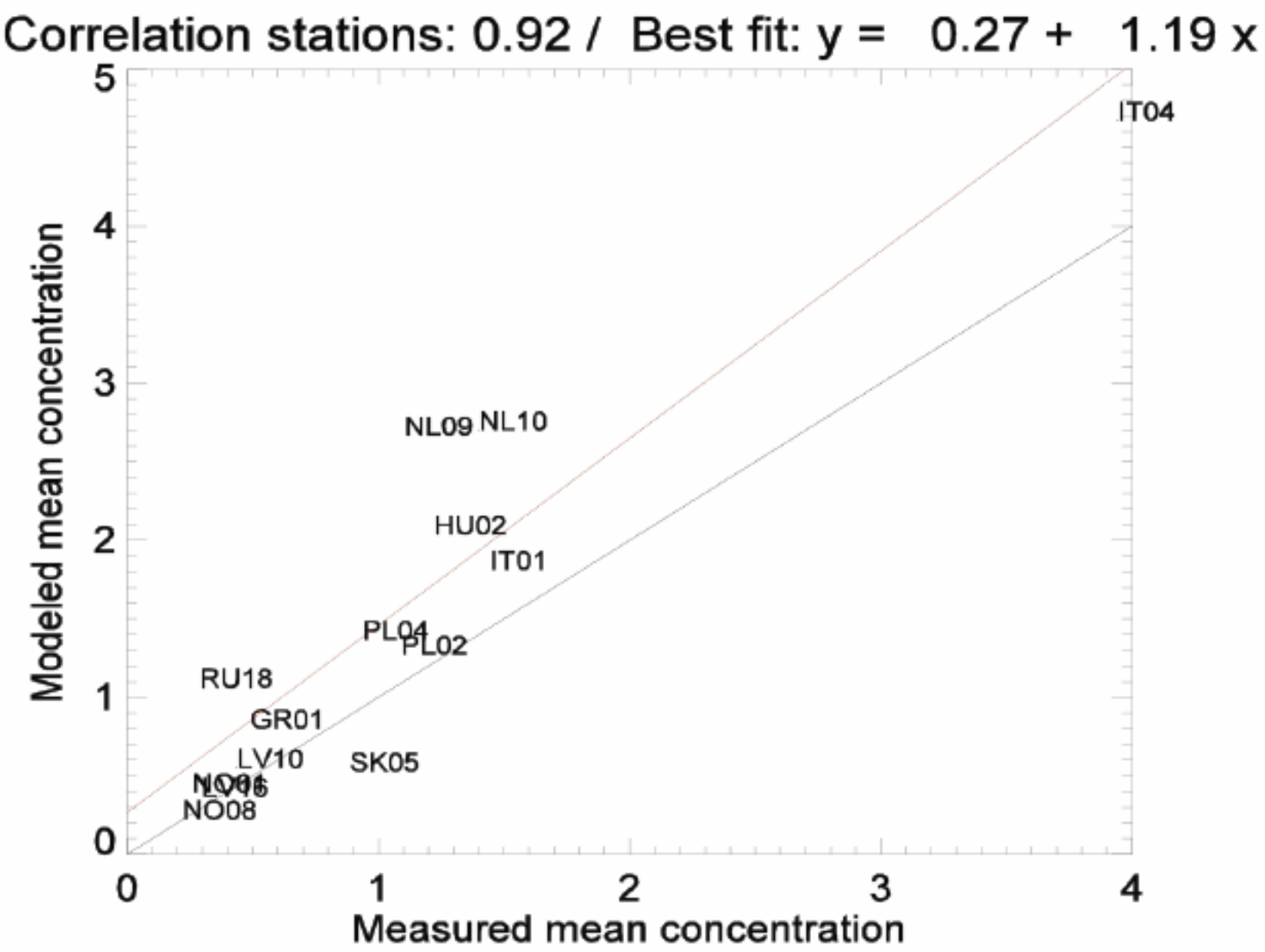
Seasalt	Global (Pg/year)	Europe (Tg/year)
Emission	7.94	87.2
Wet Removal LSP	-1.04	-20.2
Wet Removal CP	-0.29	-4.4
Dry deposition	-4.02	-47.2
Sedimentation	-2.58	-27.2
Transport		
	west	17.9
	east	-2.6
	south	-1.6
	north	-1.9
	total	11.8
Mean burden	6.3 Tg	0.12 Tg
Lifetime	0.29 days	0.45 days

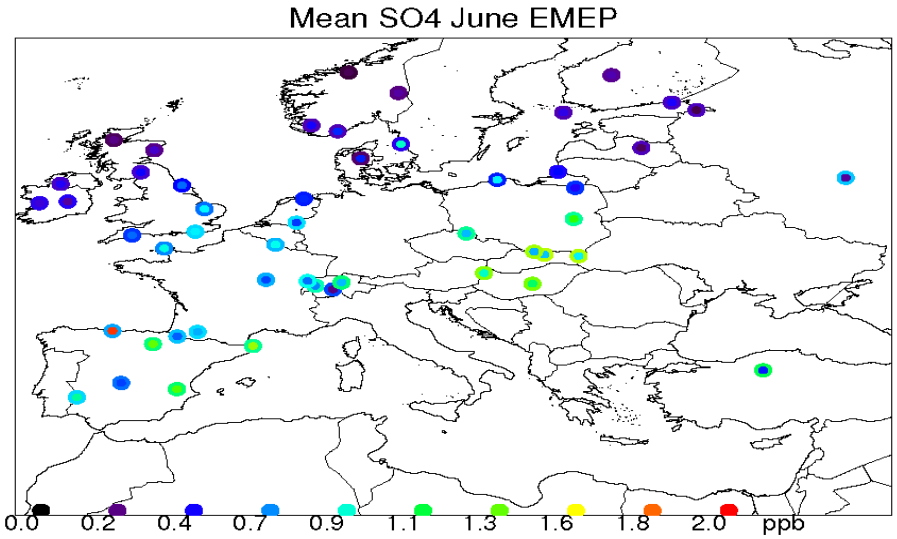
Dust	Global (Tg/year)	Europe (Tg/year)
Emission	1681	3.7
Wet Removal LSP	-256	-16.2
Wet Removal CP	-41	-1.3
Dry deposition	-592	-3.6
Sedimentation	-794	-3.2
Transport		
	west	0.
	east	-1
	south	34
	north	-1
	total	20
Mean burden	9.6 Tg	0.29 Tg
Lifetime	2.2 days	4.4 days

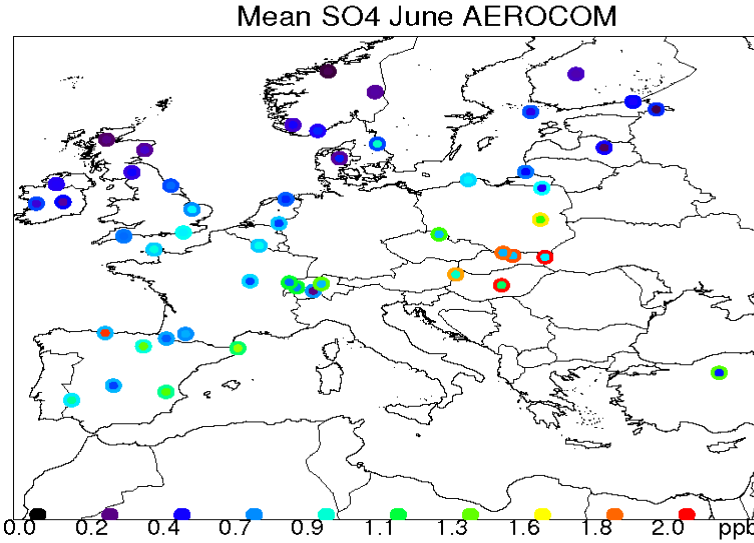
EUROPEAN COMMISSION
DIRECTORATE-GENERAL
Joint Research Centre

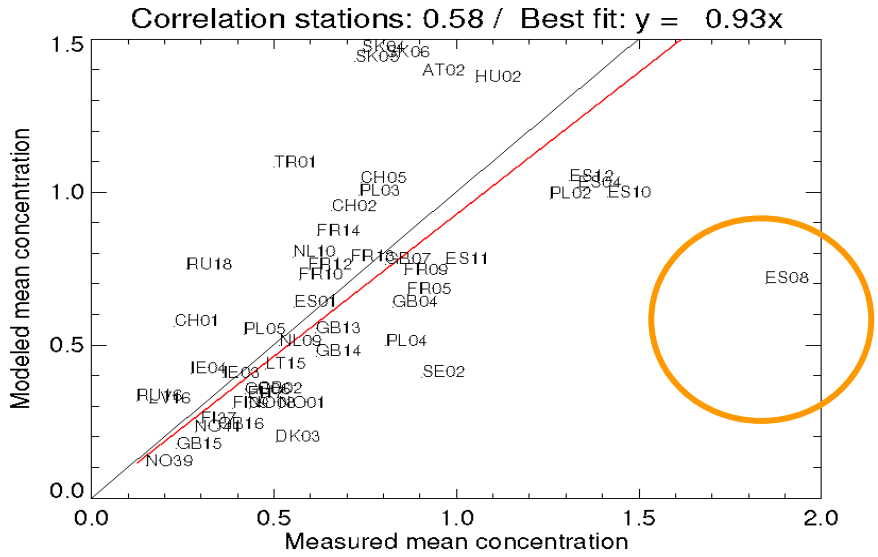


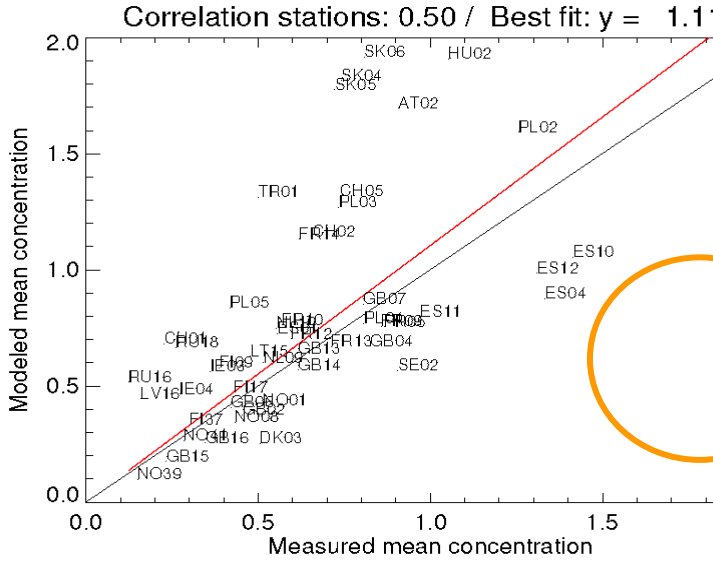

0.0
0.4
0.9
1.3
1.8
2.2
2.7
3.1
3.6
4.0
pp


Correlation stations: 0.92 / Best fit: y = 0.27 + 1.19 x
Modeled mean concentration
Measured mean concentration
0
1
2
3
4
5
IT04
NL09
NL10
HU02
IT01
PL04
PL02
RU18
GR01
LV10
SK05
NO08

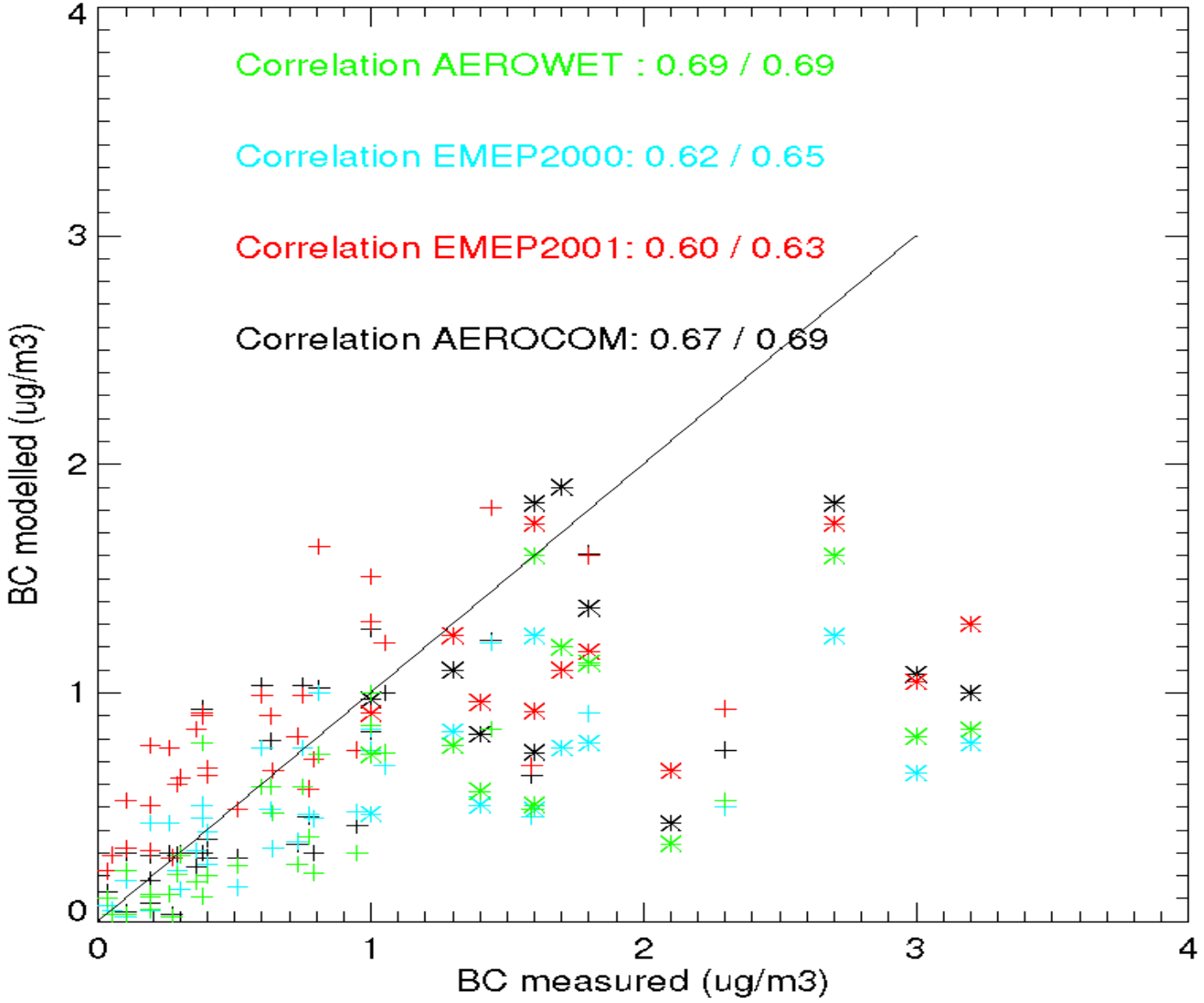


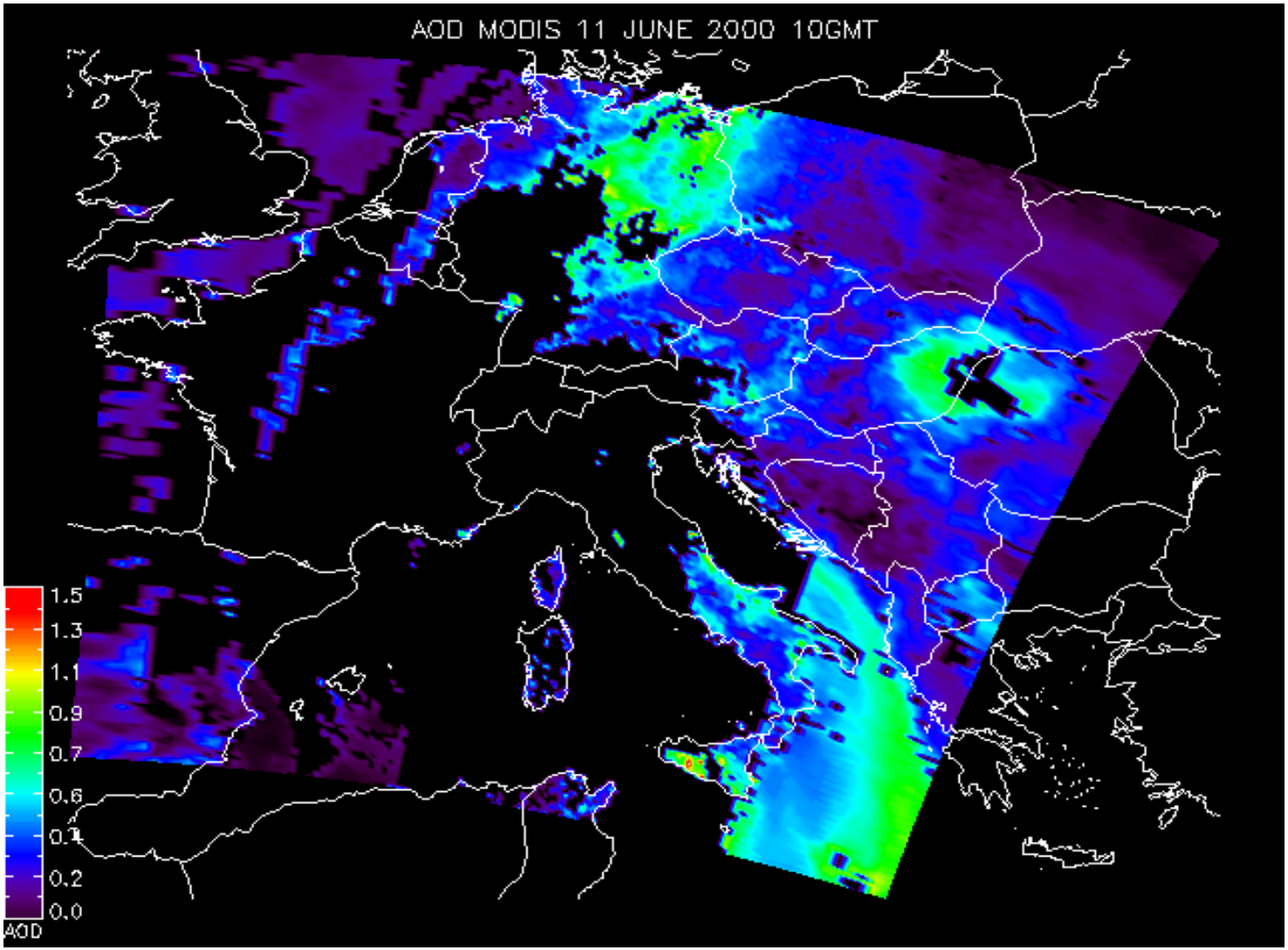




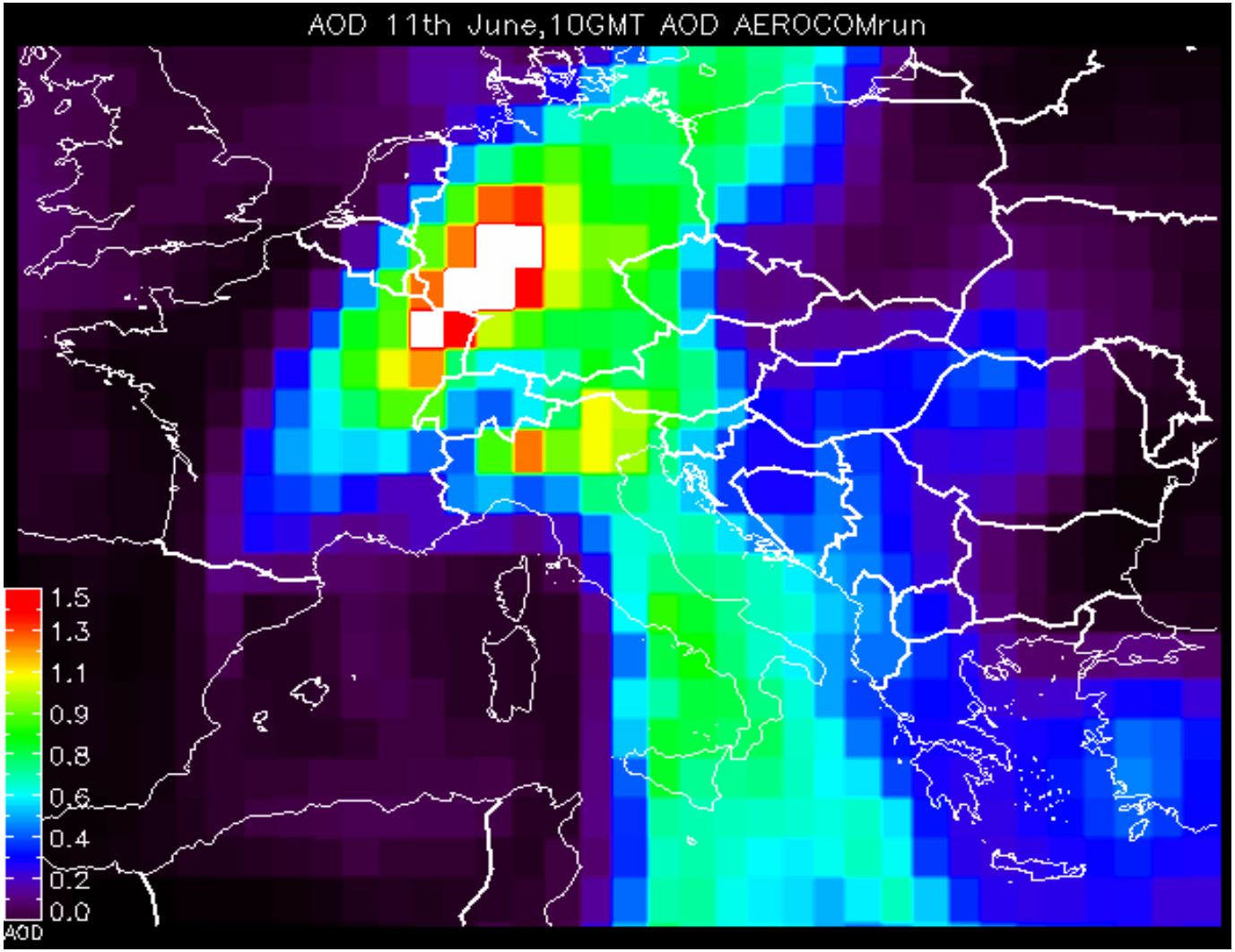


Courtesy: Alex de Meij


Correlation AEROWET : 0.69 / 0.69
Correlation EMEP2000: 0.62 / 0.65
Correlation EMEP2001: 0.60 / 0.63
Correlation AEROCOM: 0.67 / 0.69
BC modelled (ug/m3)
BC measured (ug/m3)
0
1
2
3
4

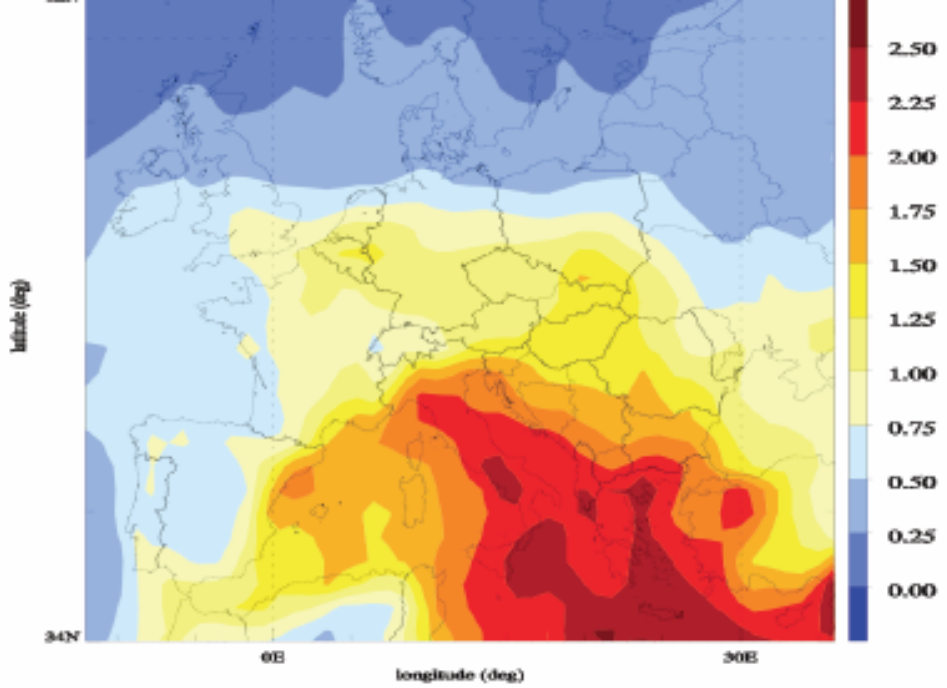

AOD MODIS 11 JUNE 2000 10GMT
1.5
1.3
1.1
0.9
0.7
0.6
0.4
0.2
0.0
AOD

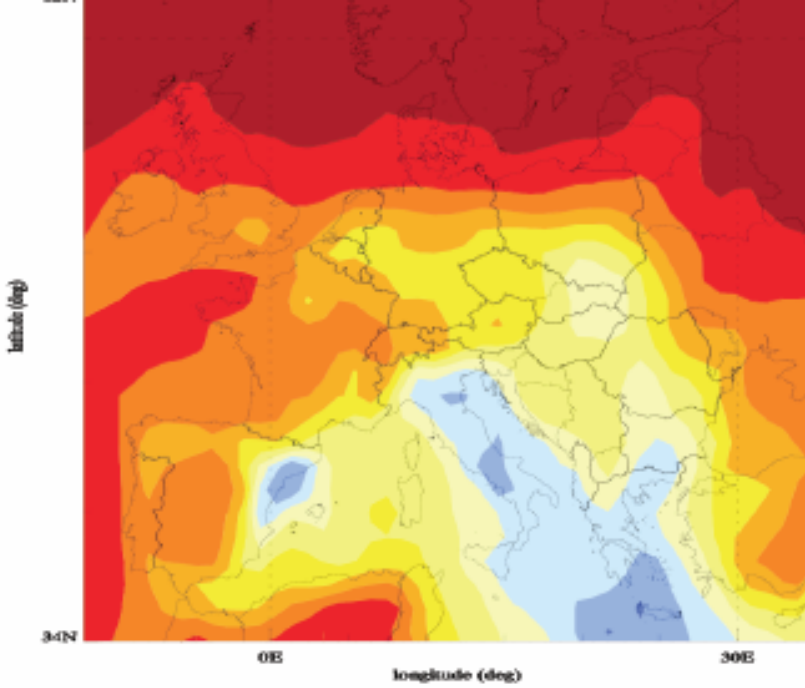
Use of satellite data



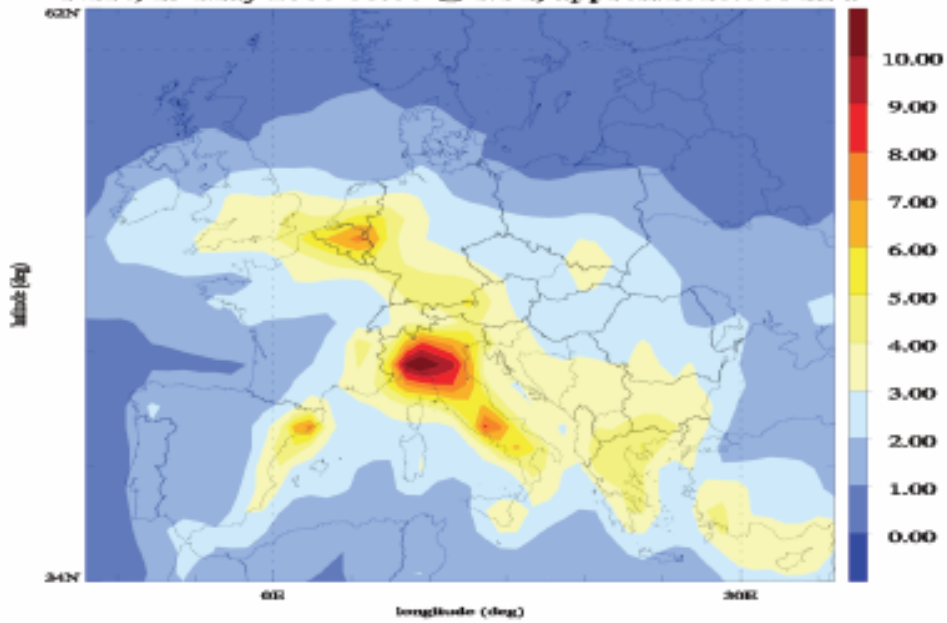
Main Identified uncertainties

- Water uptake
- Wet removal
- Emissions (seasonal variations)
- Resolution dependencies (mainly nitrate formation)

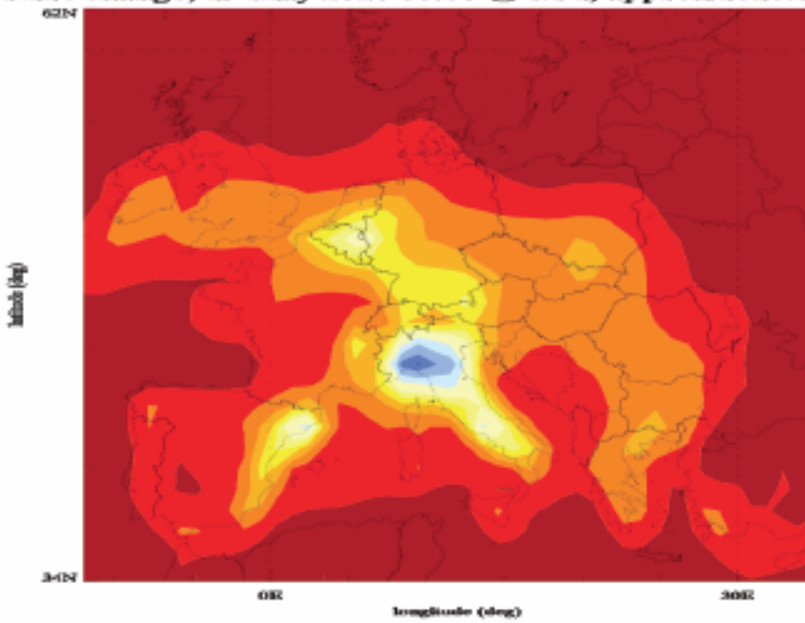


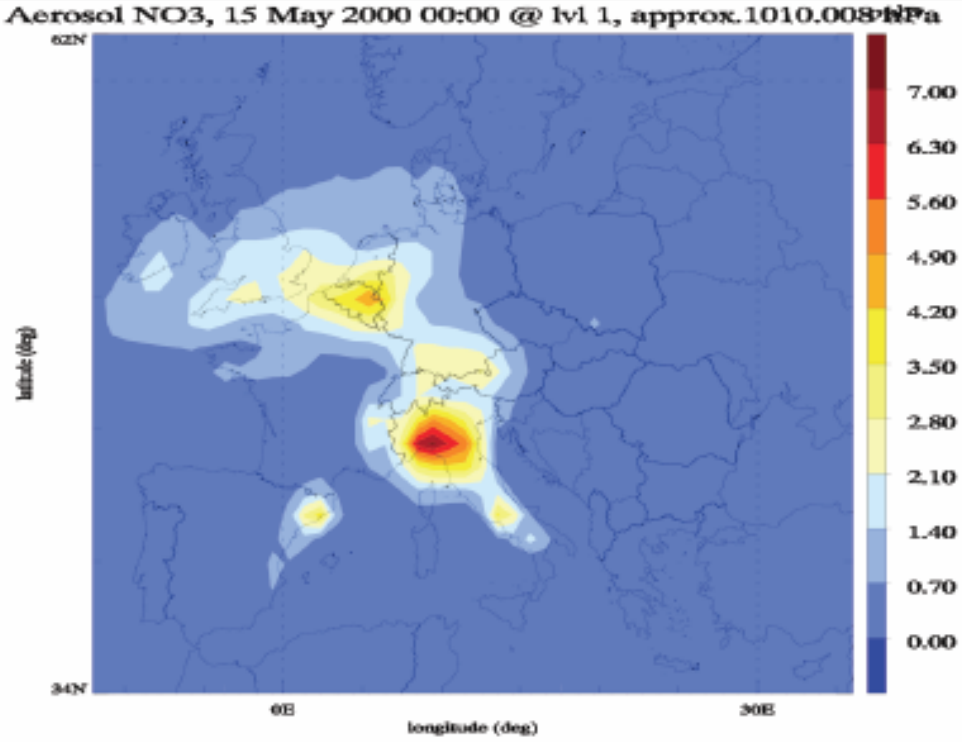


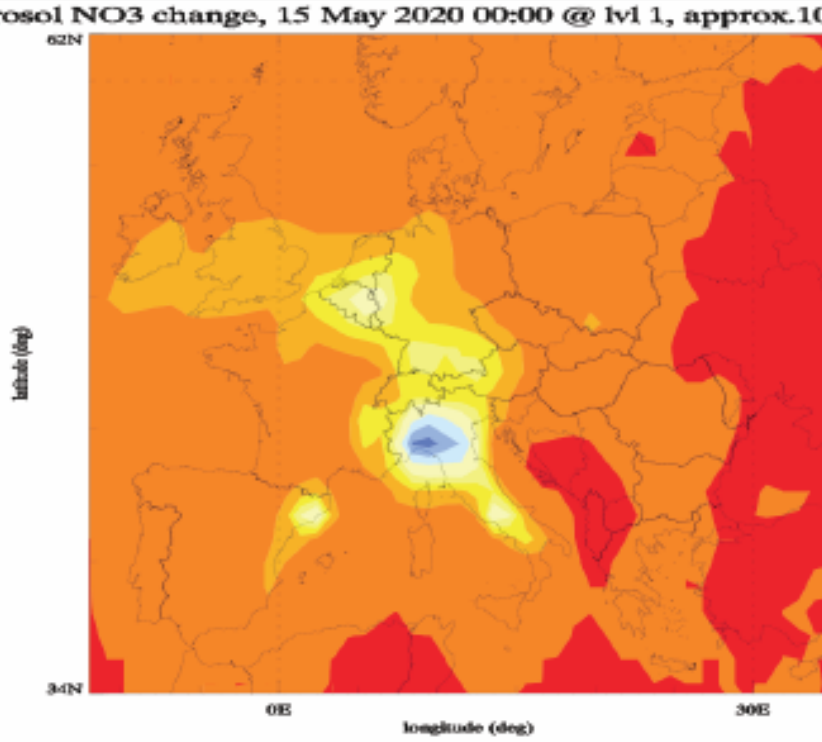
NH4, 15 May 2000 00:00 @ lvl 1, approx.1010.008 hPa ppbv



NH4 change, 15 May 2020 00:00 @ lvl 1, approx.1010.0




Aerosol NO3, 15 May 2000 00:00 @ lvl 1, approx.1010.008 hPa
62N
34N
0E
30E
latitude (deg)
longitude (deg)
7.00
6.30
5.60
4.90
4.20
3.50
2.80
2.10
1.40
0.70
0.00


Aerosol NO3 change, 15 May 2020 00:00 @ lvl 1, approx.10
62N
34N
0E
30E
latitude (deg)
longitude (deg)