Investigation of nitrate simulations from AeroCom multi-models constrained by various measurements

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AeroCom 2013

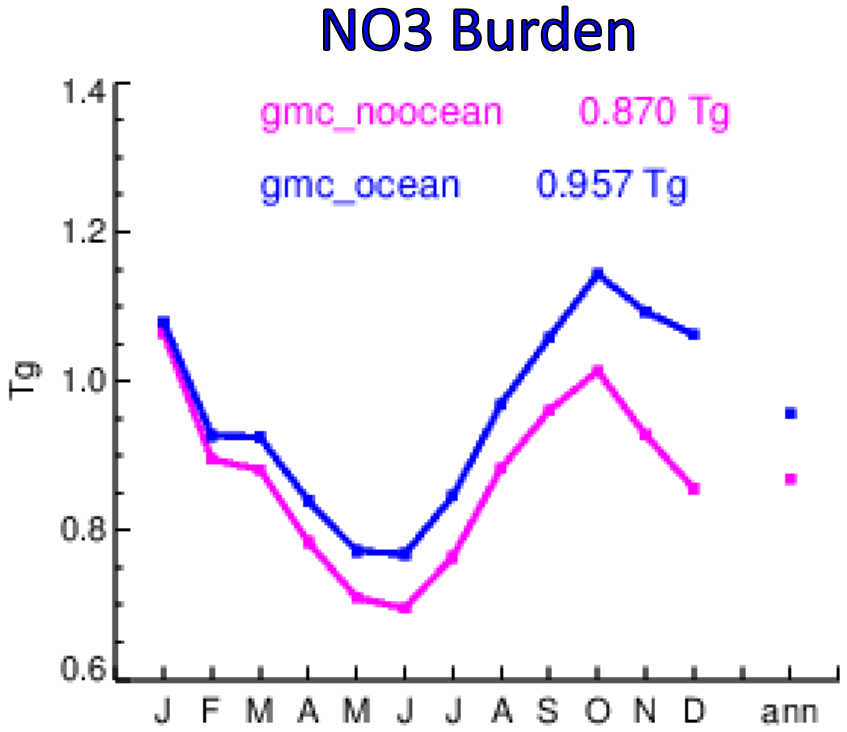
Motivation

- Address the diversity of the nitrate simulation by the AeroCom multi-models and diagnose the driving process for the diversity;
- Explore the uncertainty of the model nitrate simulations constrained against various measurements from ground station networks, aircraft campaigns, and satellite retrievals.

Experiment set up

Study period: 2008
Met field: use or nudge meteorological data for 2008
Emission:
same for models: 1. anthropogenic ---- HTAP v2 2008 monthly emission
(for tracers not provided by HTAP v2, use CMIP5 RCP8.5,
linear interpolation between 2005 and 2010).
2. biomass burning ---- GFED3
3. NH3: add ocean source based on GEIA
specific for models: NO lightning, DMS
Observations
Output
Timetable

The impact of NH3 ocean emission

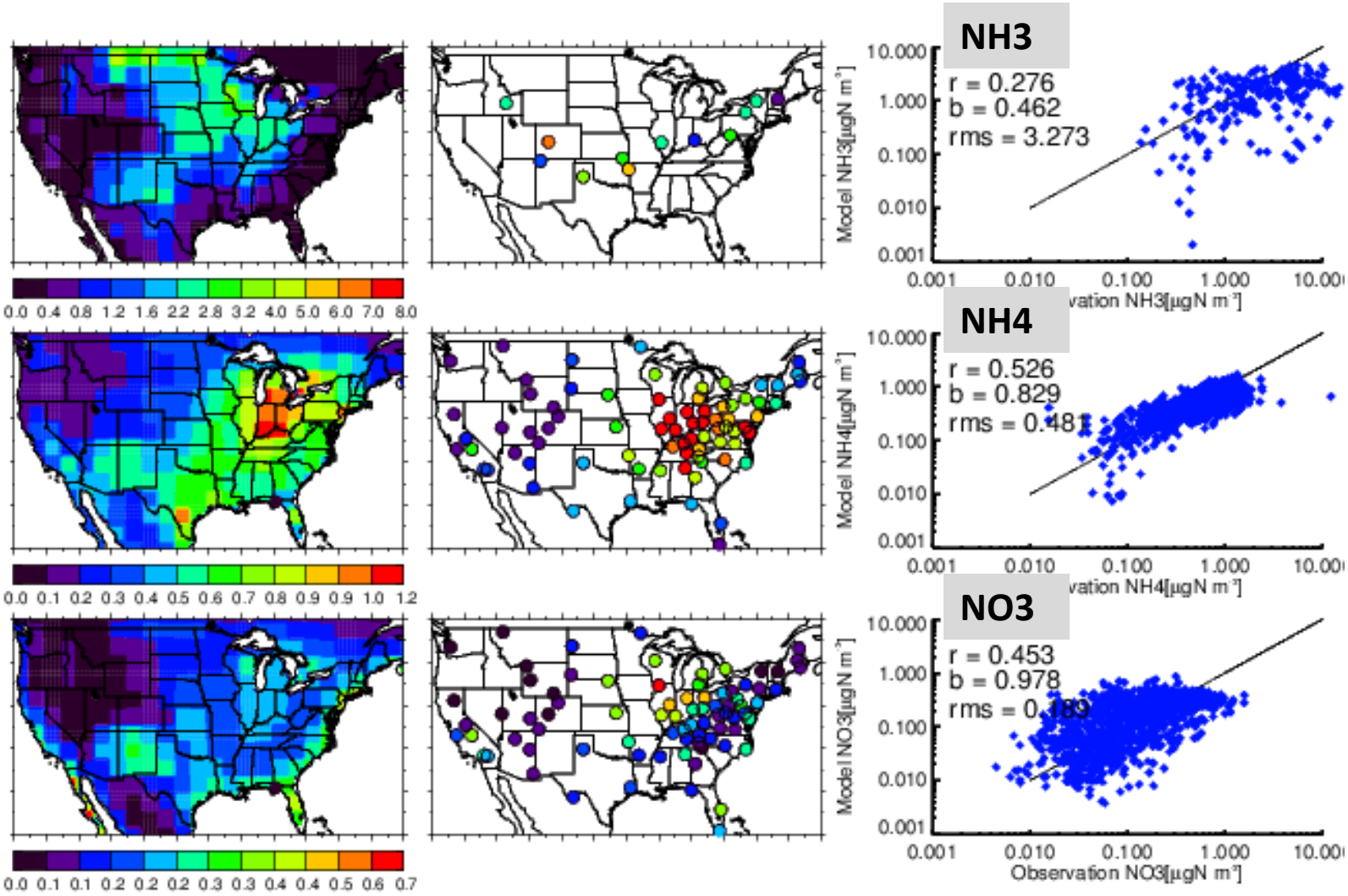


NH3 ocean emission accounts for ~15% total NH3 emission

Spin up ???

All model results from GMI simulation

Observation: surface concentration over US

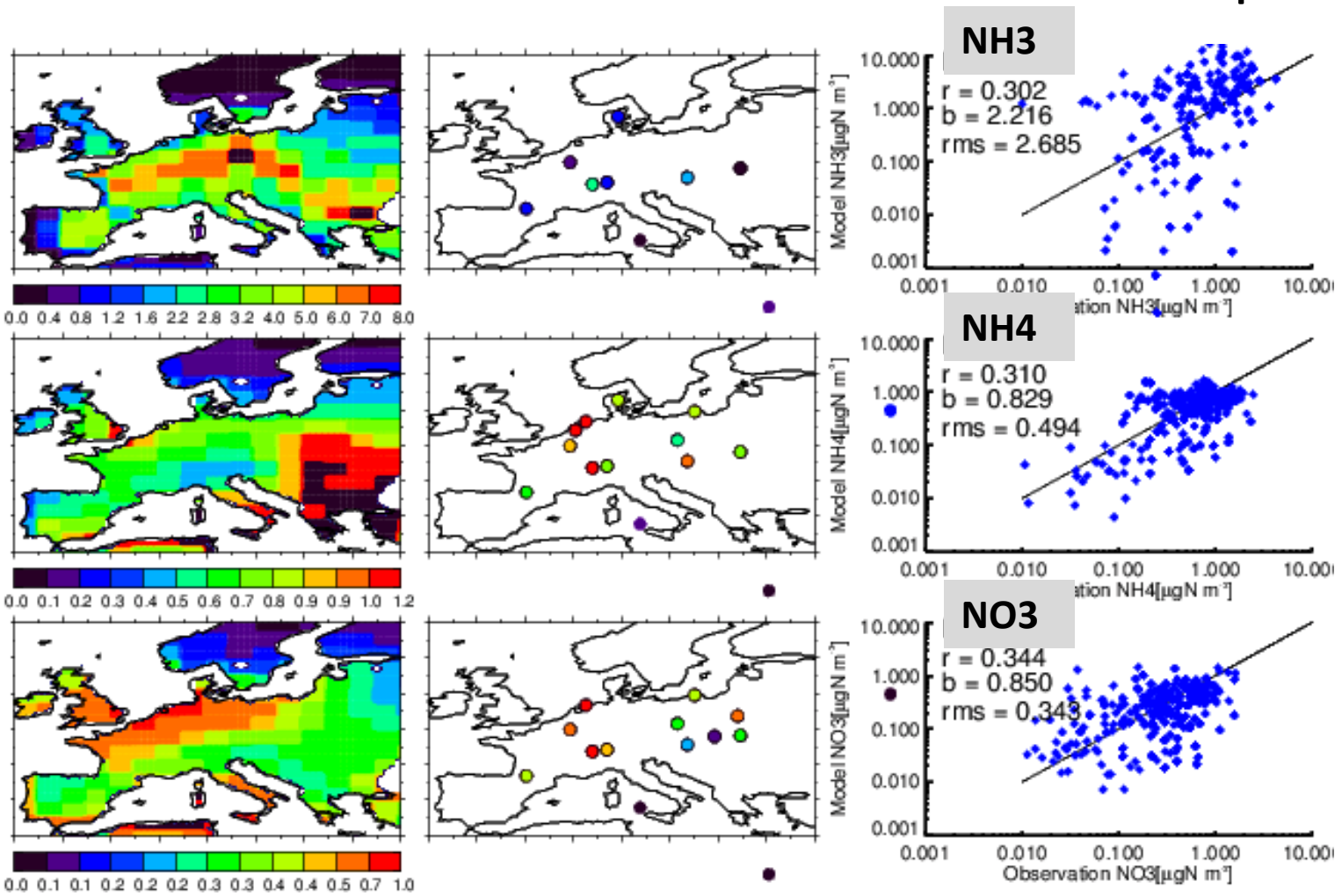


CastNet: NH4, NO3, HNO3, SO2, SO4

AMoN: NH3

IMPROVE: NO3, SO4 (fine mode)

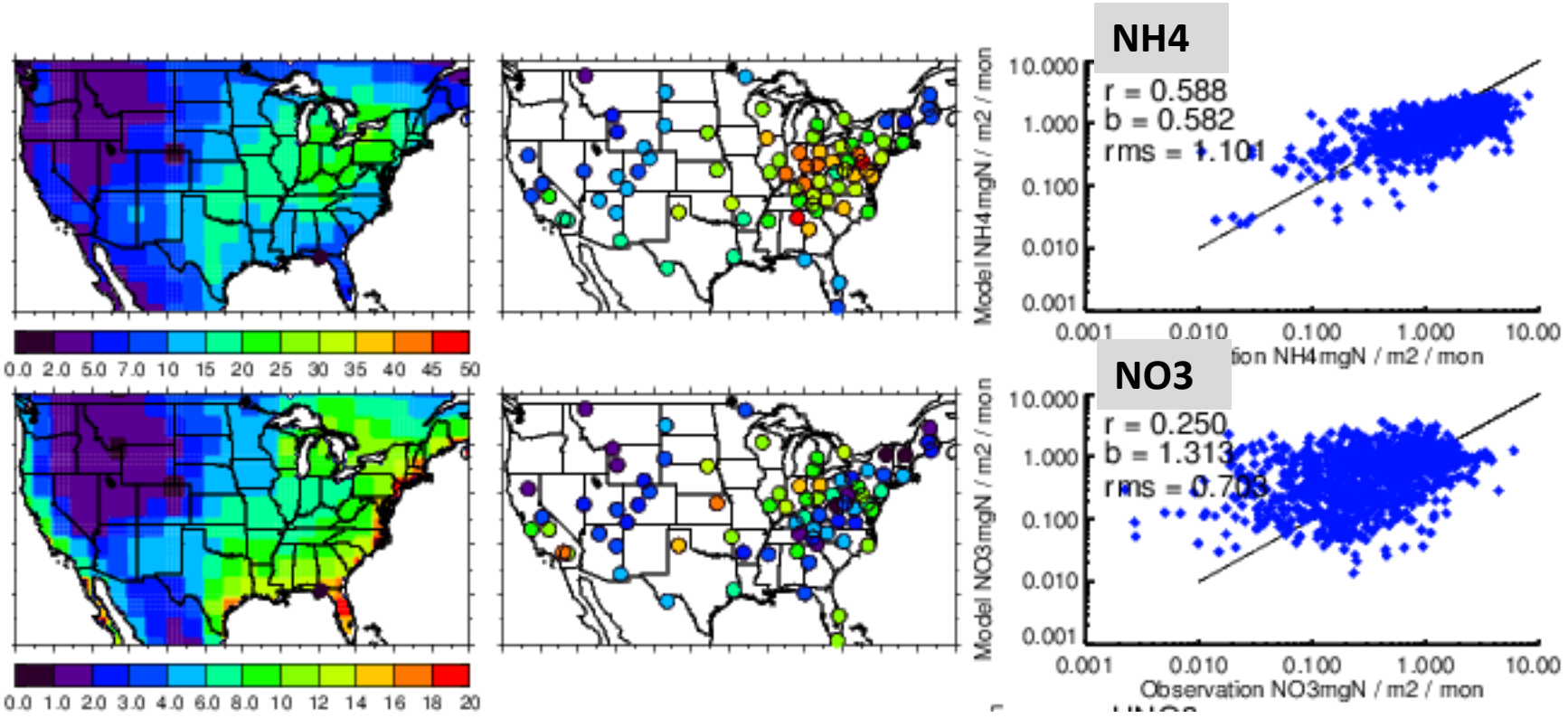
Observation: surface concentration over Europe



EMEP: NH4, NO3, SO4, NH3, HNO3, SO2

NitroEurope: NH4, NO3, SO4, NH3, HNO3, SO2

Observation: dry dep



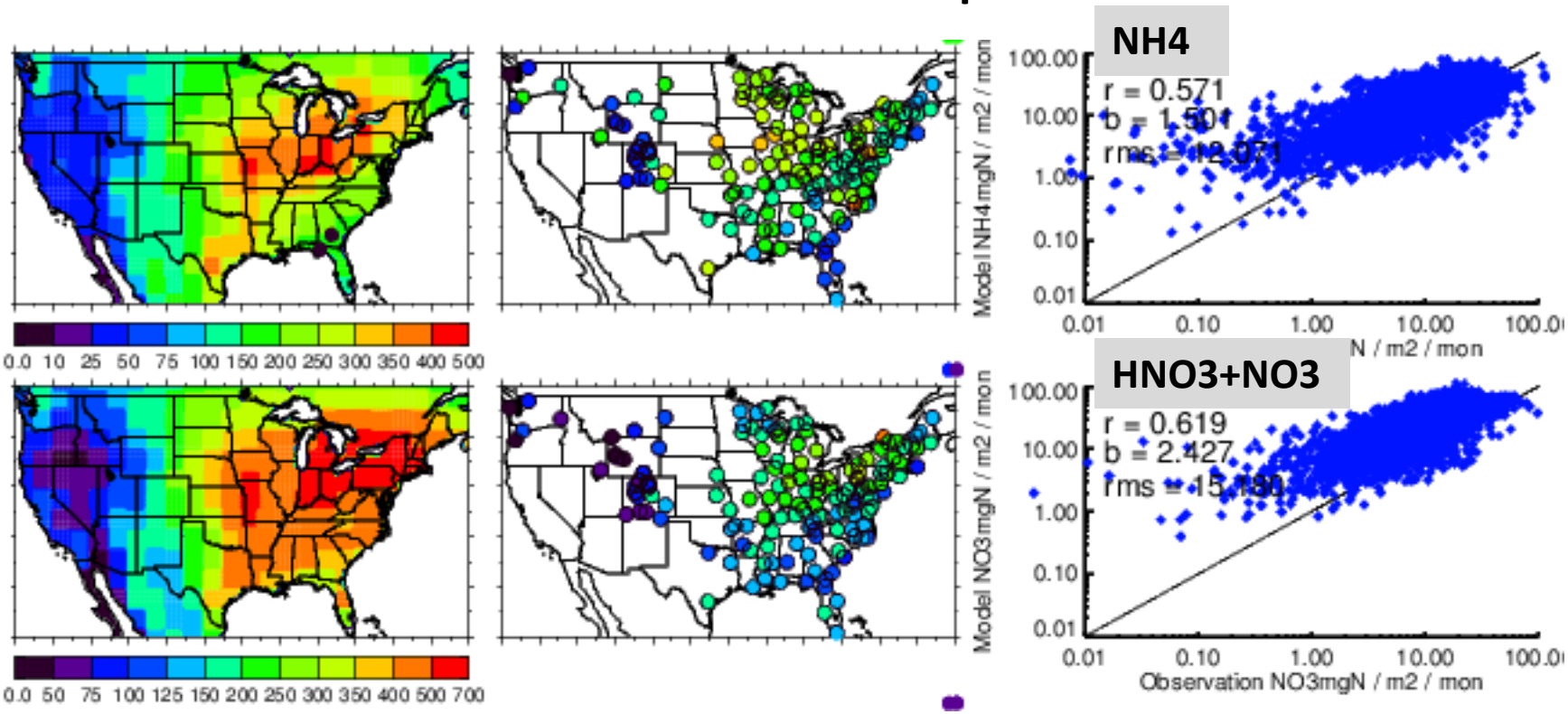
Over USA

CastNet: NH4, NO3, SO4, HNO3, SO2

Over Europe

NitroEurope: NH4, NO3

Observation: wet deposition



Over USA

NADP/NTN: NH4, NO3+HNO3, SO4

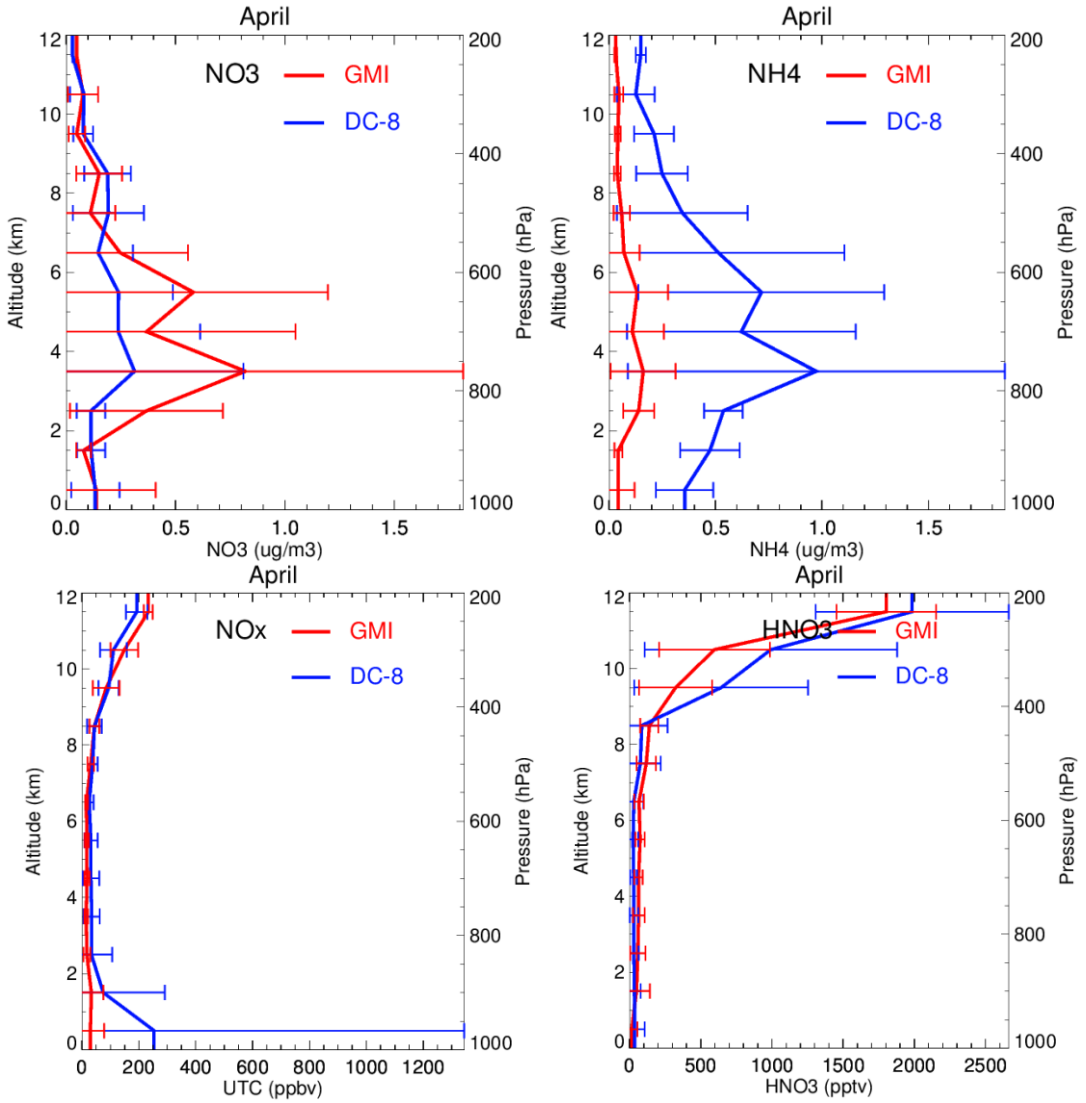
Over Europe

EMEP: NH4, NO3, SO4

NitroEurope: NH4, NO3

Observation: aircraft campaign

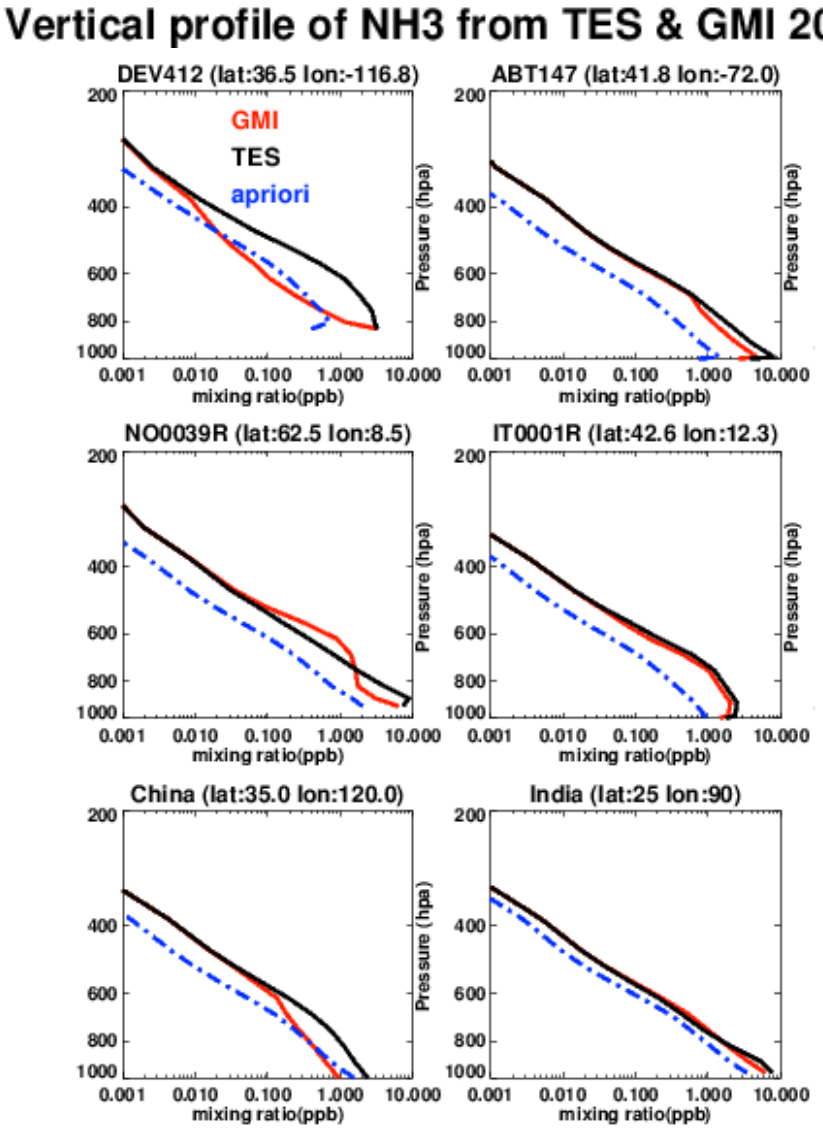
ARCTAS-A

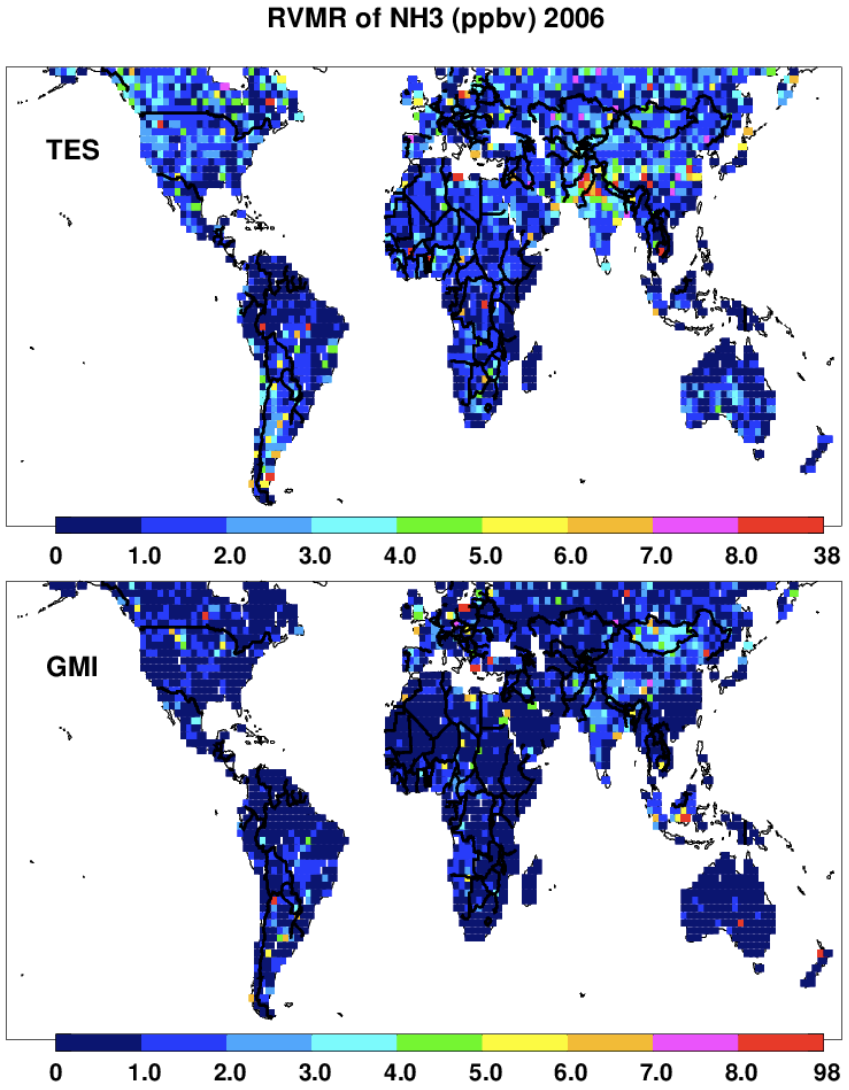


ARCTAS-A
ARCTAS-CARB
ARCTAS-B
ARCPAC
POLARCAT-GRACE
POLARCAT-France
START08/PreHIPPO
(NO, Noy)
YAK-AEROSIB

Any others?

Observation: TES on AURA





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Perturbation experiments

Investigate how the formation of nitrate changes in different models in response to more emissions of NH3, less emissions of NOx and SOx and higher temperature

Do globally

1. Increase NH3 emission by 20%
2. Decrease NOx emission by 20%
3. Decrease SOx emission by 20%
4. Increase T by 1.5 K

Model Output
(for evaluation and budget analysis)

2-D monthly fields	
Emission	NOx, NH3, SO2, SO4, DMS
2-D daily fields	
Meteorology	Precipitation
Dry Deposition, Wet Deposition, Surface Concentration, Load	NH3, NH4, NOx, HNO3, N2O5, NO3 (nitrate), PAN, NOy (including nitrate), SO2, DMS, SO4
Optical field	AOD (nitrate)
3-D monthly fields	
Meteorology	Temperature, Specific Humidity, Air Mass, Pressure
Chemistry prod/loss	Nitrate, SO4 (gas), SO4 (aqu)
3-D daily fields	
Concentration	NH3, NH4, NO, NO2, HNO3, N2O5, NO3 (nitrate), PAN, SO2, SO4

Note: if could, please provide nitrate concentration and dry and wet depositions in fine mode and coarse mode separately.

Discussion

1. Spin up
2. Observations over Asia and other regions: ship-based campaign ICEALOT, baseline stations, etc
3. Others …

Timeline

09.2013 – discuss and refine the experiment plan at the AeroCom meeting

01.2014 – finalize the experiment plan

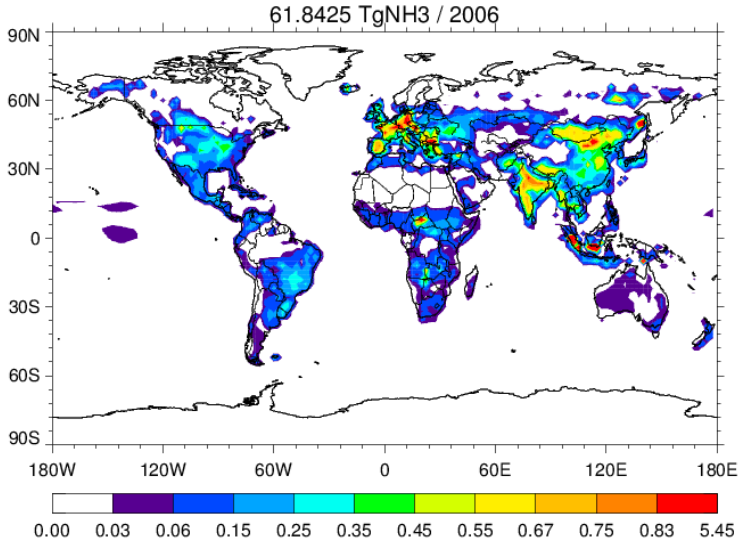
06.2014 - submit model results to AeroCom server

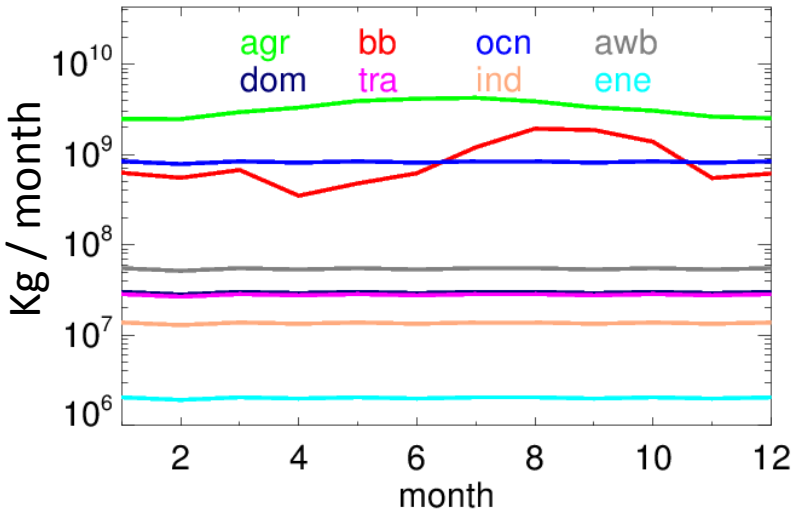
09.2014 – preliminary results for the annual AeroCom meeting

02.2014 – Final deadline for the nitrate experiment

05.2015 – Submission of manuscript

NH3 Emission in 2006





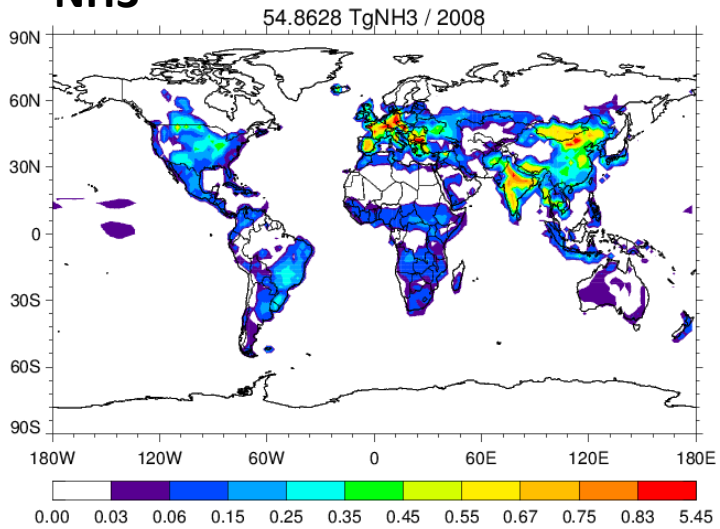
Sections	Emission (Tg/yr)	Fraction (%)
agriculture	39.53	63.9
Biomass burning	10.86	17.6
Ocean	9.93	16.1
Agriculture waste burning	0.65	1.1
domestic	0.36	0.6
transportation	0.34	0.5
industrial	0.16	0.3
energy	0.02	0.03
total	61.84	

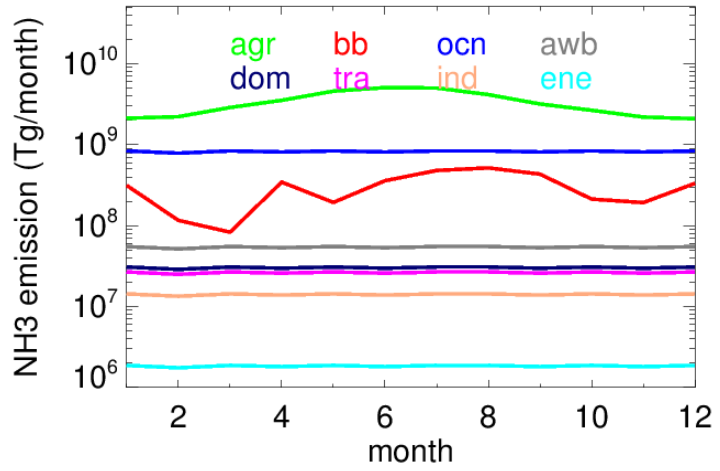
CMIP5 for all except

← **GEIA** for ocean

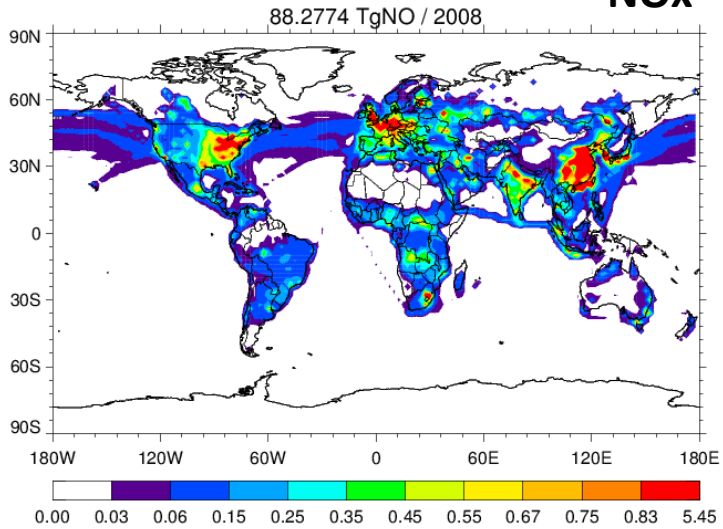
emissions

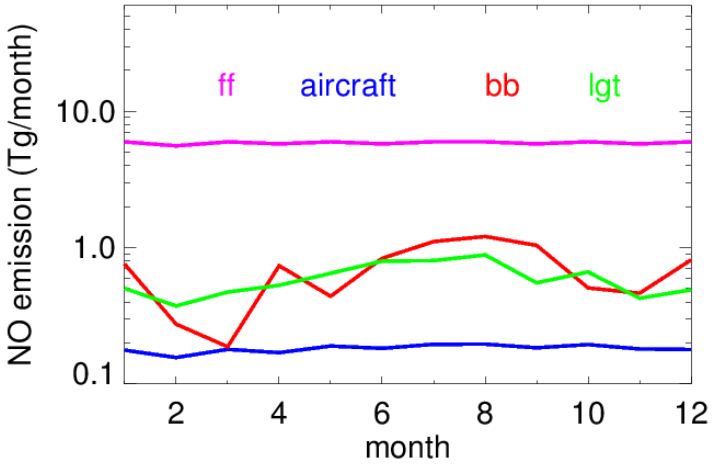
NH3





NOx

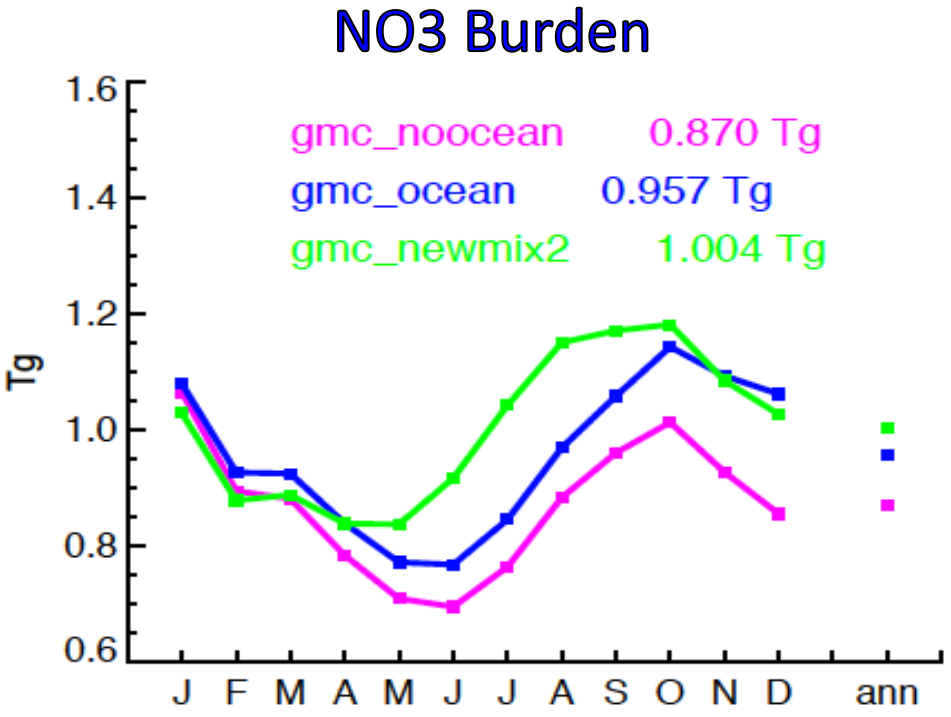




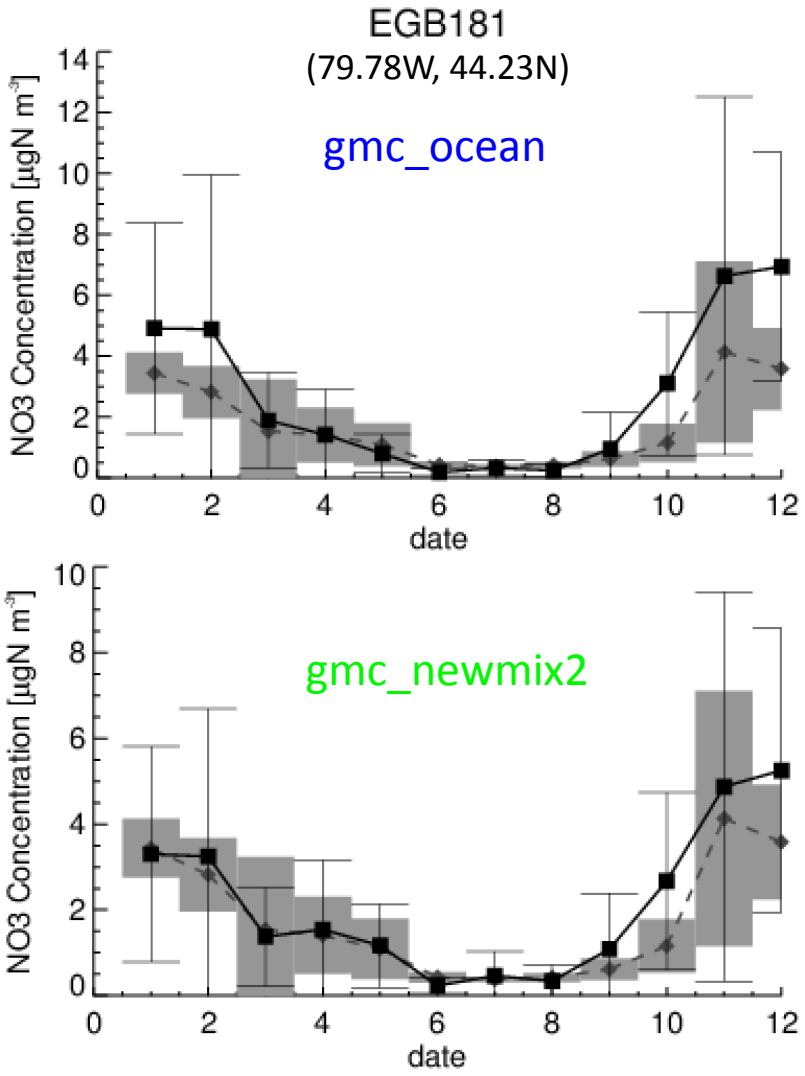
Two modifications on NH3 emission:

1. Add ocean NH3 emission
2. Impose seasonality on NH3 anthropogenic emission

The impact of NH3 ocean emission and seasonal change of NH3 agriculture emission



Spin up ???

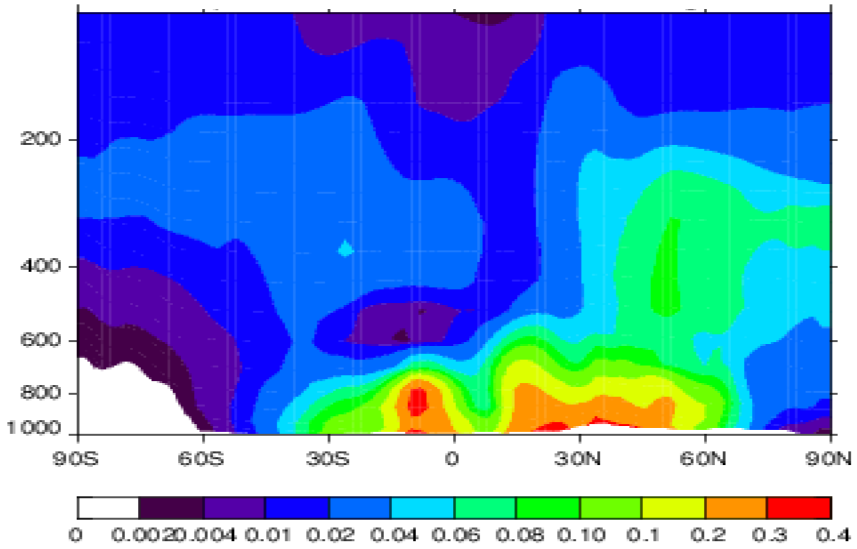


GMI give examples of model simulations

Global vertical distribution of nitrate

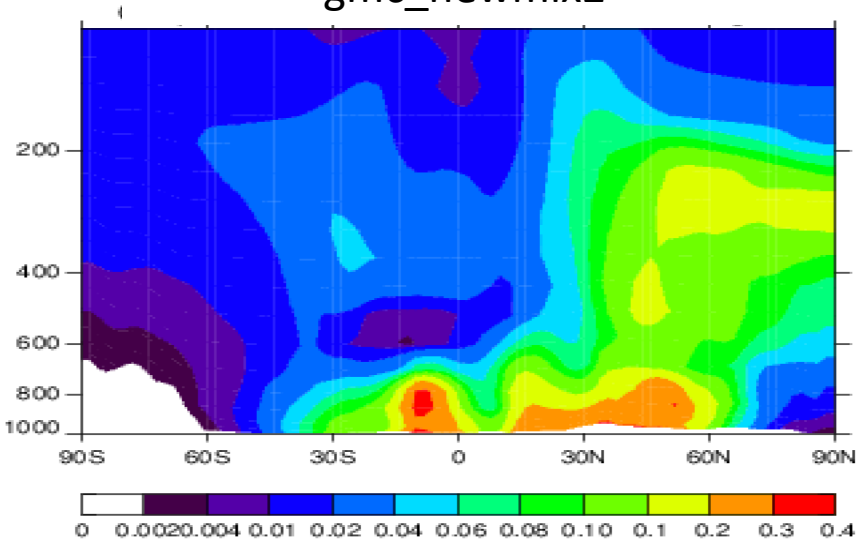
July

gmc_ocean



No seasonal change in NH3 anthropogenic emission

gmc_newmix2



imposed seasonal change in NH3 anthropogenic emission