AeroCom III nitrate experiment: current status and concerning issues

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Gunnar Myhre (CICERO)
and AeroCom III nitrate modellers

AeroCom 2014

Review

Three objectives:

(1) address the diversity of nitrate simulations by the AeroCom models and understand the reasons for the intermodel differences,

(2) compare model simulated nitrate with measurements from ground networks, aircraft campaigns, and satellite retrievals,

(3) investigate how nitrate formation changes in different models in response the perturbation of precursor emissions and meteorological conditions.

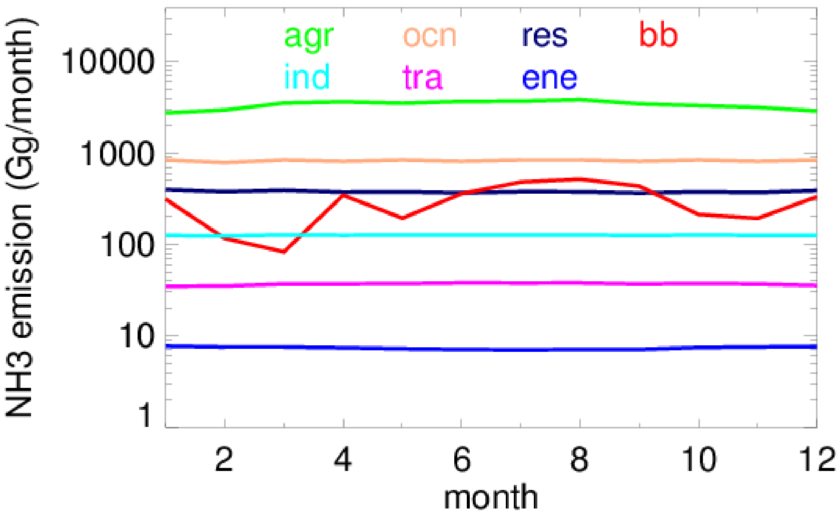
Current Status

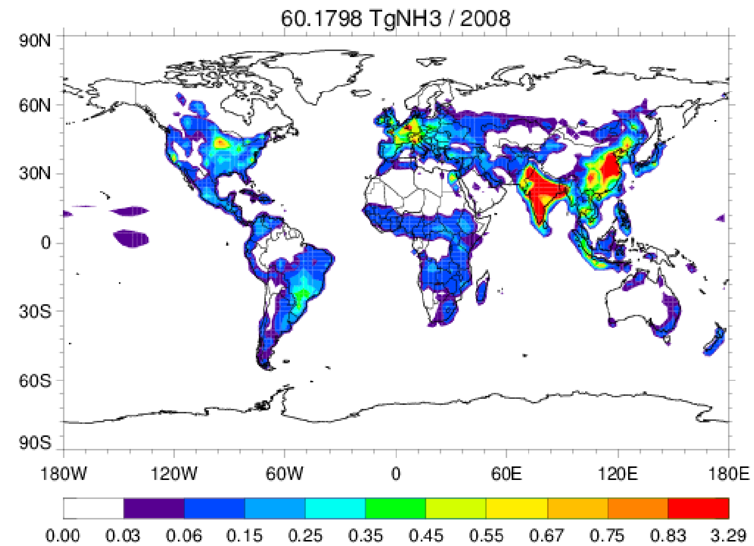
model	PI	Current status
GISS-MATRIX	Susanne Bauer	Will simulate soon
GISS-modelE	Susanne Bauer	Will simulate soon
GMI	Huisheng Bian	Finish Base case run
INCA	Didier Haugluztaine	Finish Base case run
HadGEM3	Steve Rumbold	Finish an initial Base case run
OsloCTM	Gunnar Myhre Ragnhild B. Skeie	Will simulate soon
CHASER/MIROC-ESM	Kengo Sudo Toshihiko Takemura	Finish Base case run
IMPACT	Guangxing Lin Joyce Penner	Need update
NCAR-CAM3.5	Steven J. Ghan Jean-Francois Lamarque	Need update

Setup

Base year: 2008

NH3 emission



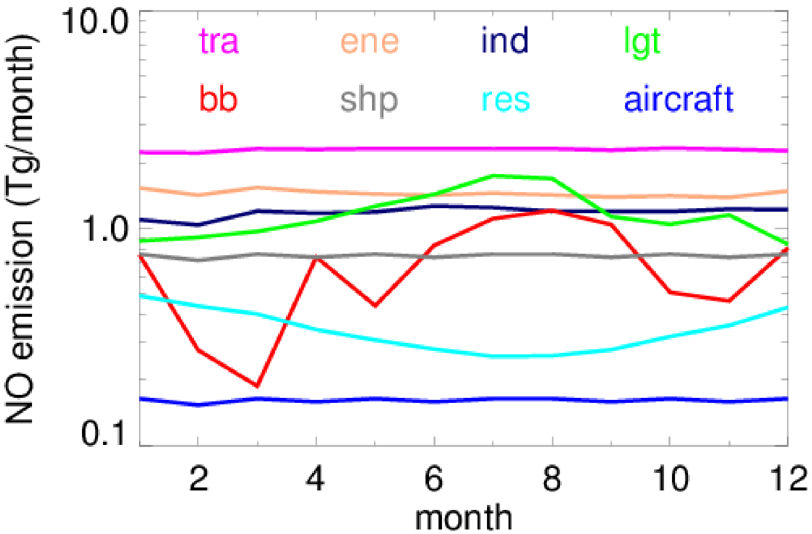


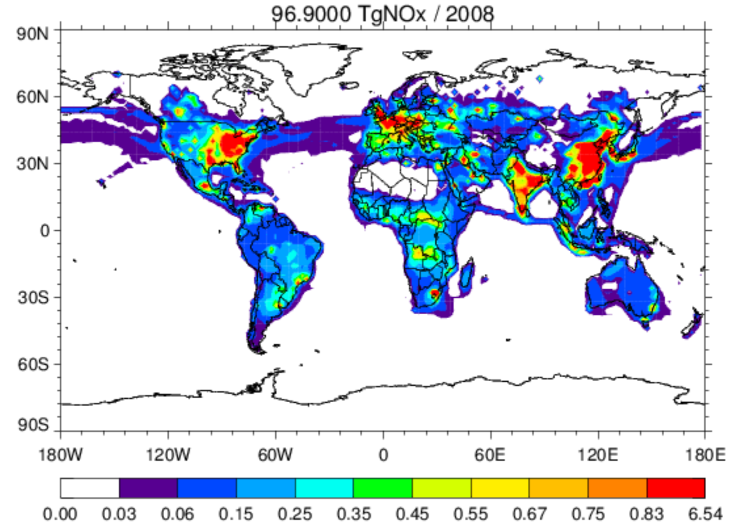
Sectors	Emission (Tg/yr)	Fraction (%)	references
Agriculture	40.41	66.8	HTAP2
Ocean	9.93	16.4	GEIA
Residence	4.54	7.5	HTAP2
Biomass burning	3.58	5.9	GFED3
Industrial	1.51	2.5	HTAP2
Transportation	044	0.7	HTAP2
Energy	0.09	0.1	HTAP2

Setup

Base year: 2008

NO emission



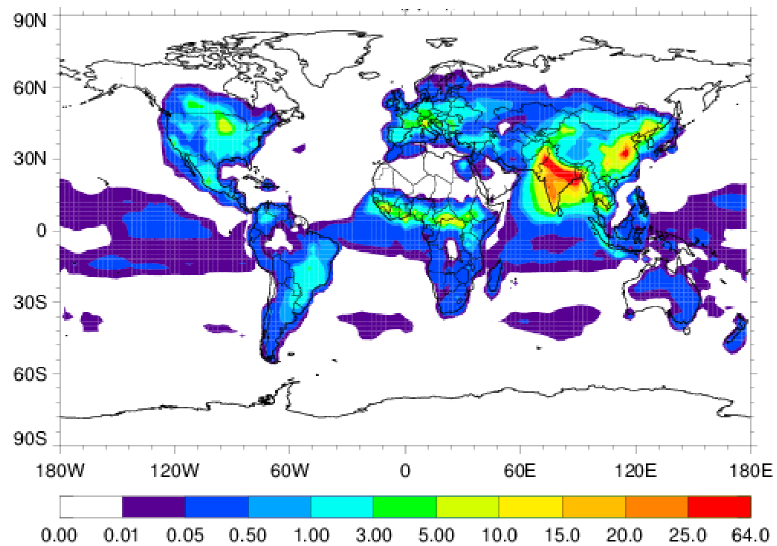


Sectors	Emissions (Tg/yr)	Fraction (%)	References
Transportation	27.68	28.6	HTAP2
Energy	17.40	18.0	HTAP2
Industrial	14.26	14.7	HTAP2
Lightning	14.15	14.6	Online calculation
Ship	8.99	9.3	HTAP2
Biomass burning	8.37	8.6	GFED3
Residence	4.15	4.3	HTAP2
Aircraft	1.94	2.0	HTAP2

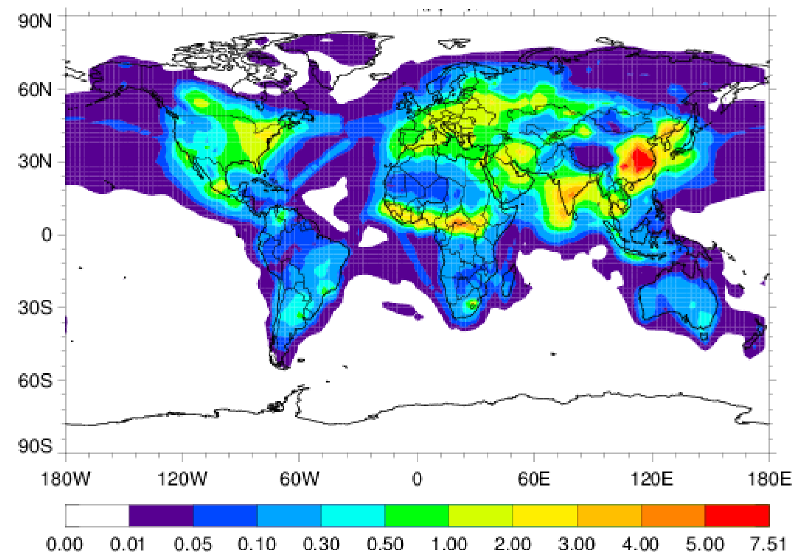
Base experiment

Surface concentration, 2008 January

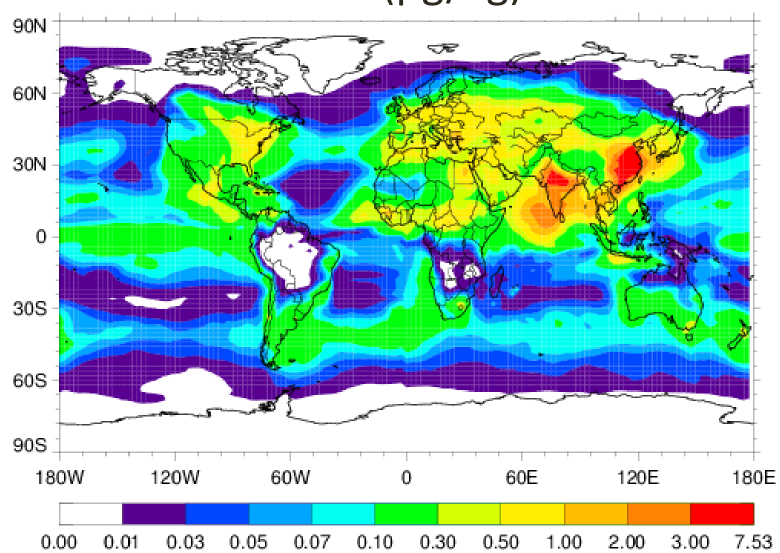
NH3 (ppb)



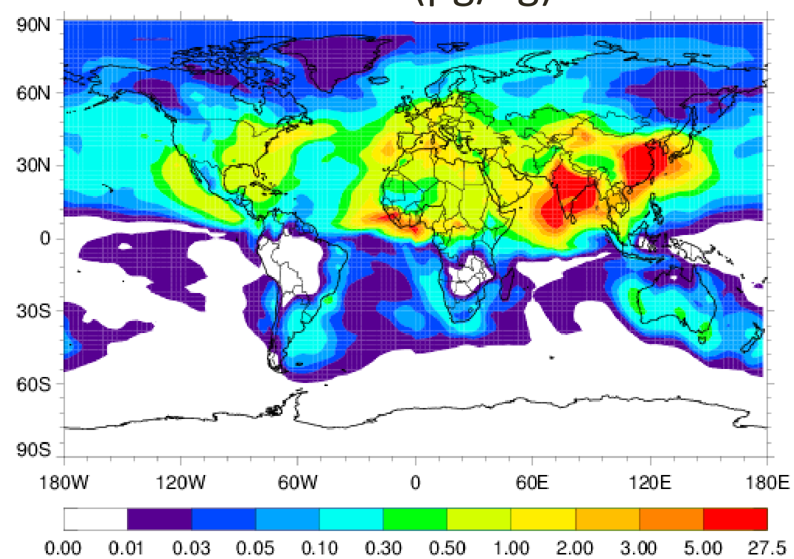
HNO3 (ppb)



NH4 (μg/kg)



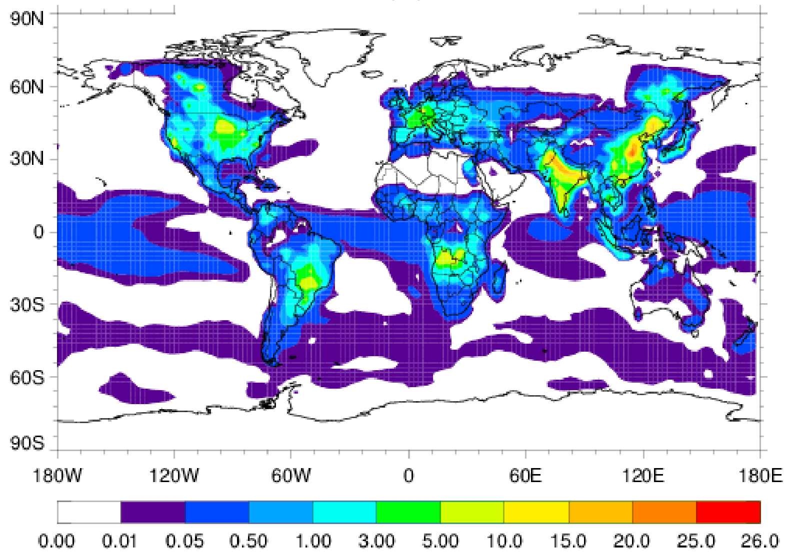
NO3 (μg/kg)



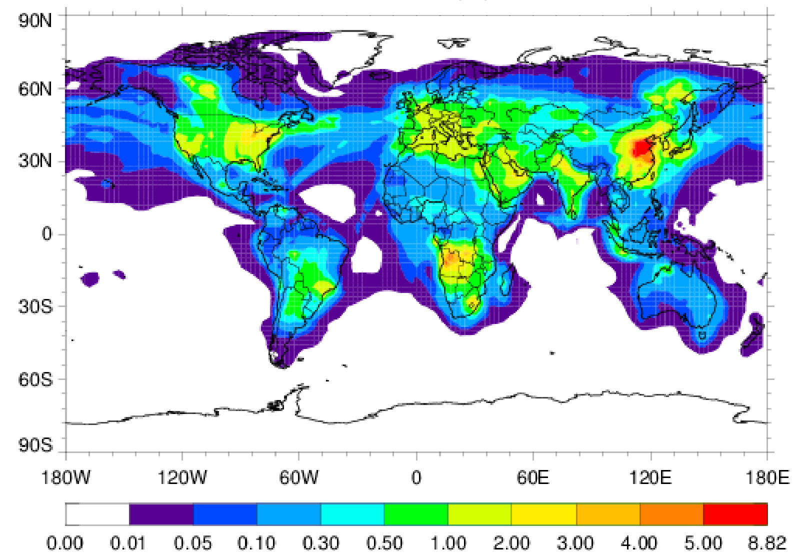
Base experiment

Surface concentration, 2008 July

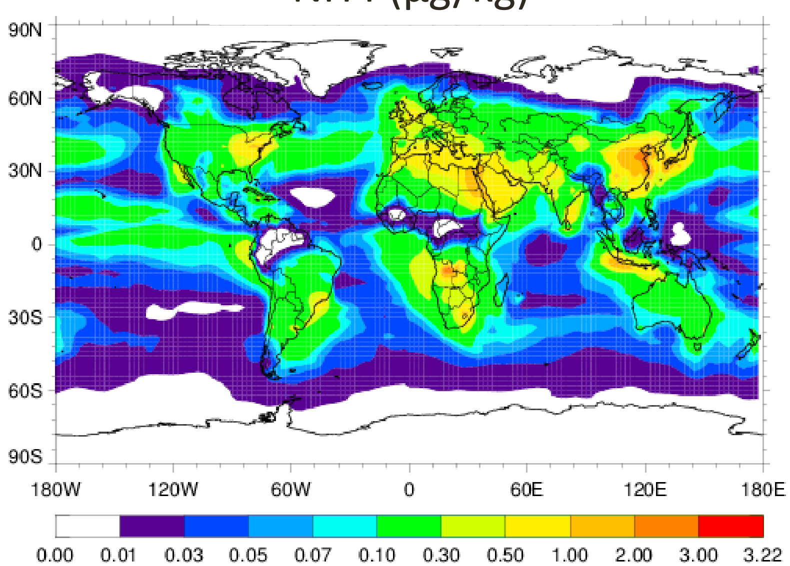
NH3 (ppb)



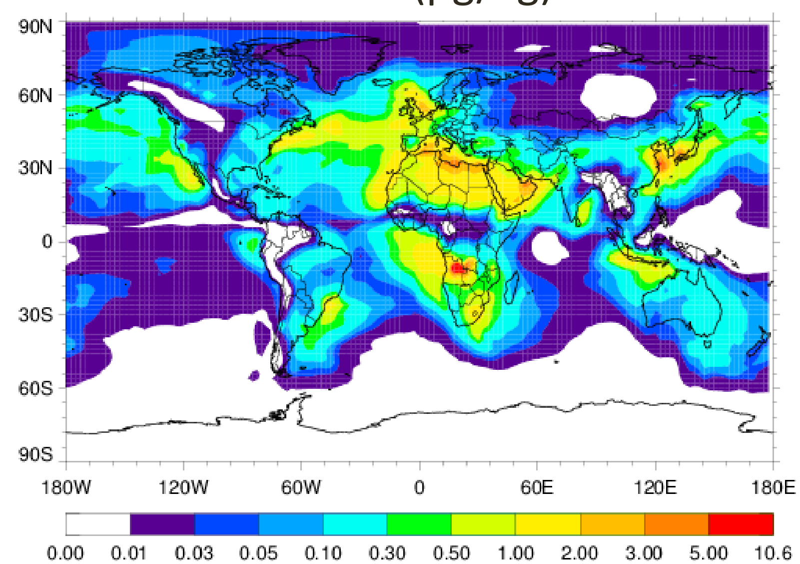
HNO3 (ppb)



NH4 (μg/kg)

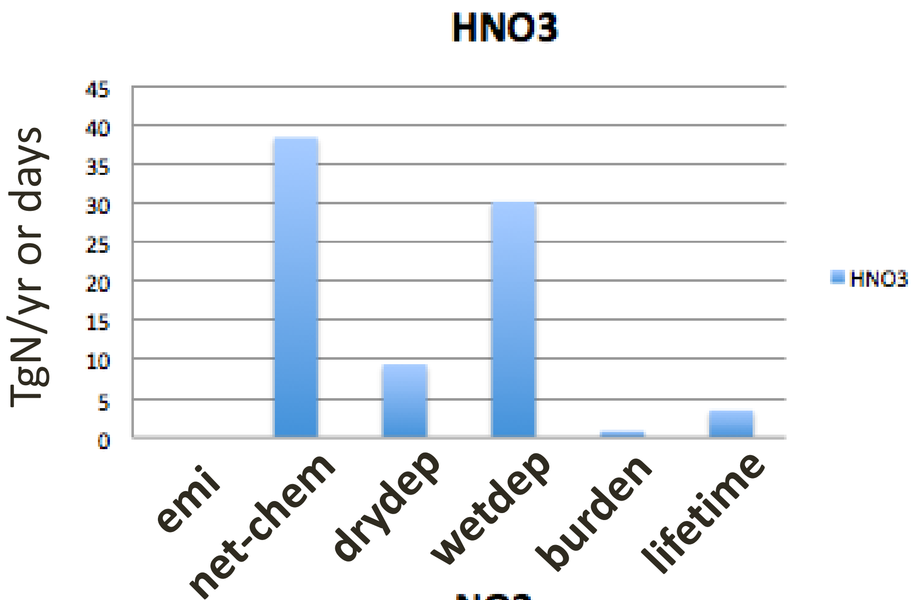


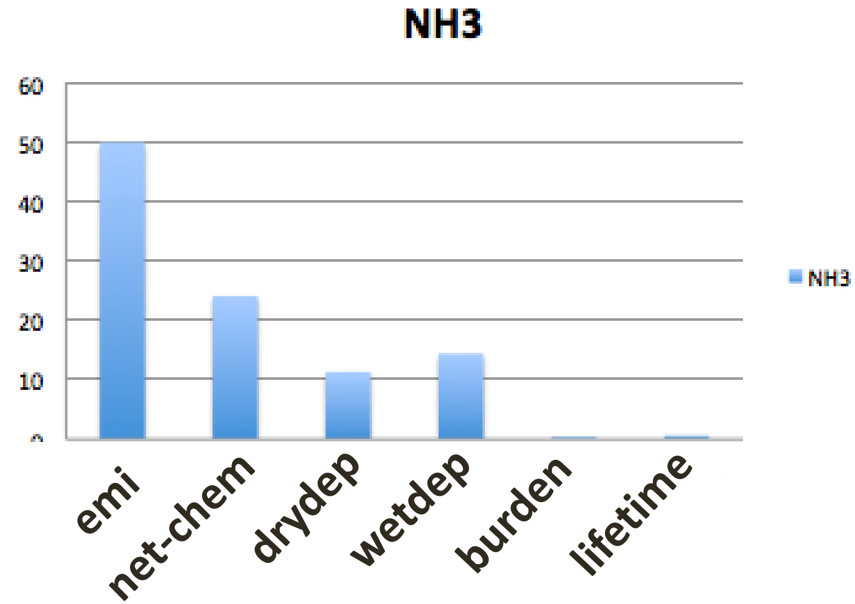
NO3 (μg/kg)

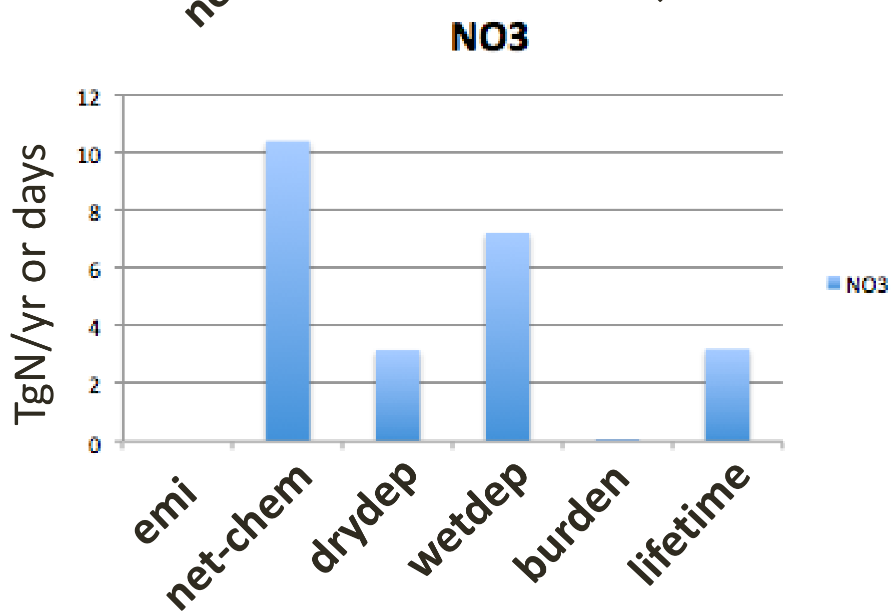


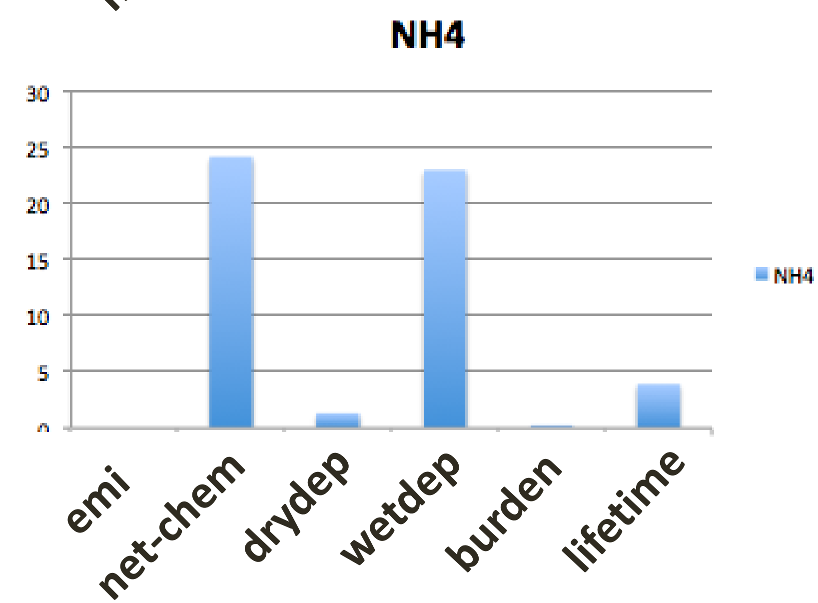
Base experiment

Budget









Base experiment

Detail chemistry budget for HNO3 and NO3

HNO3 (unit: TgN/year)

P-gas	P-aq	L-phot	L-gas	L-aer	L-eqm
55.3	26.9	21.2	12.4	9.9	1.0
Total P		Total L			
82.2		44.9			

NO3 (unit: TgN/year)

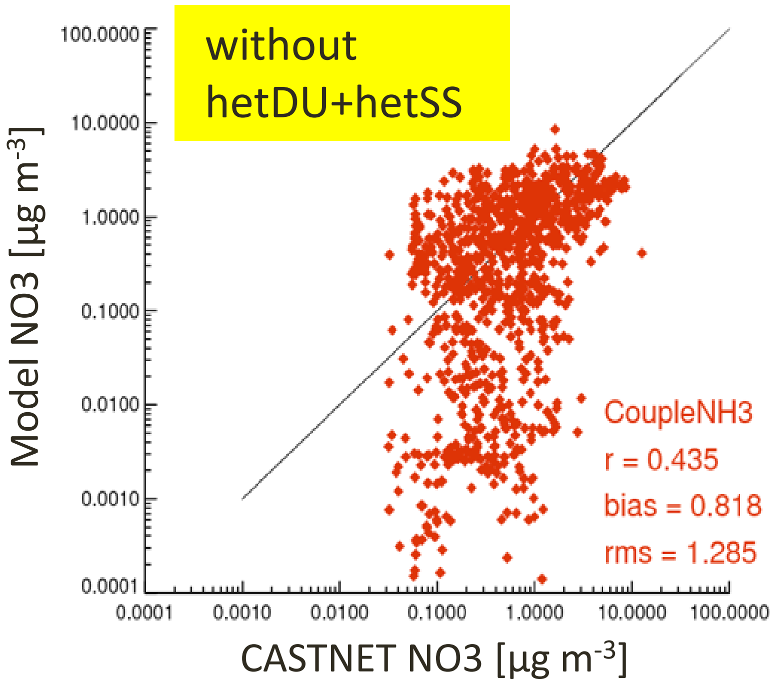
P-eqm	P-aer
1.0	9.9

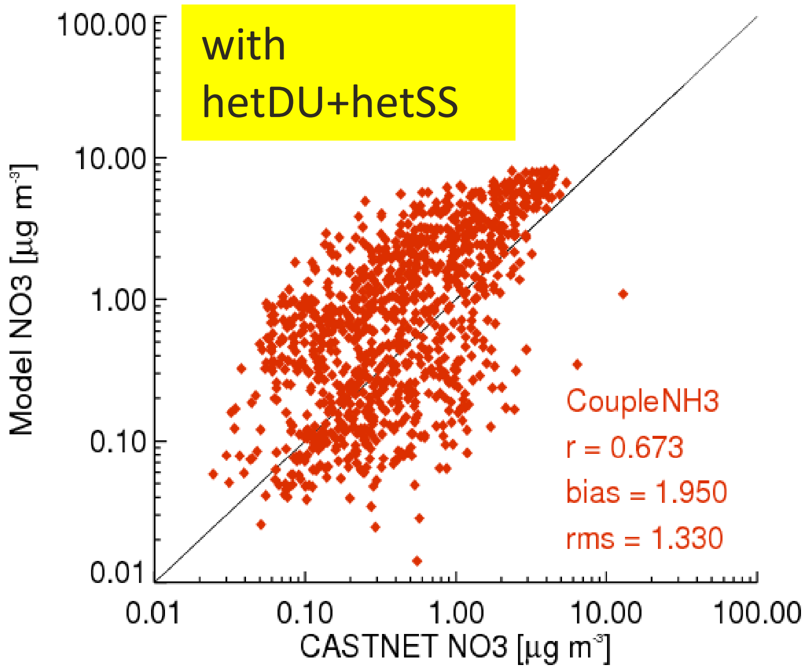
P-fine (D ≤ 1 μm)	P-coarse (D> 1 μm)
4.5	5.9

Base experiment

Importance of dust & ss in NO3 formation

NO3 (TgN/yr)	NH4NO3	dust	Sea sat
GMI	1.0	9.9	
Haugluztaine et al., (2014)	3.2	6.3	4.9

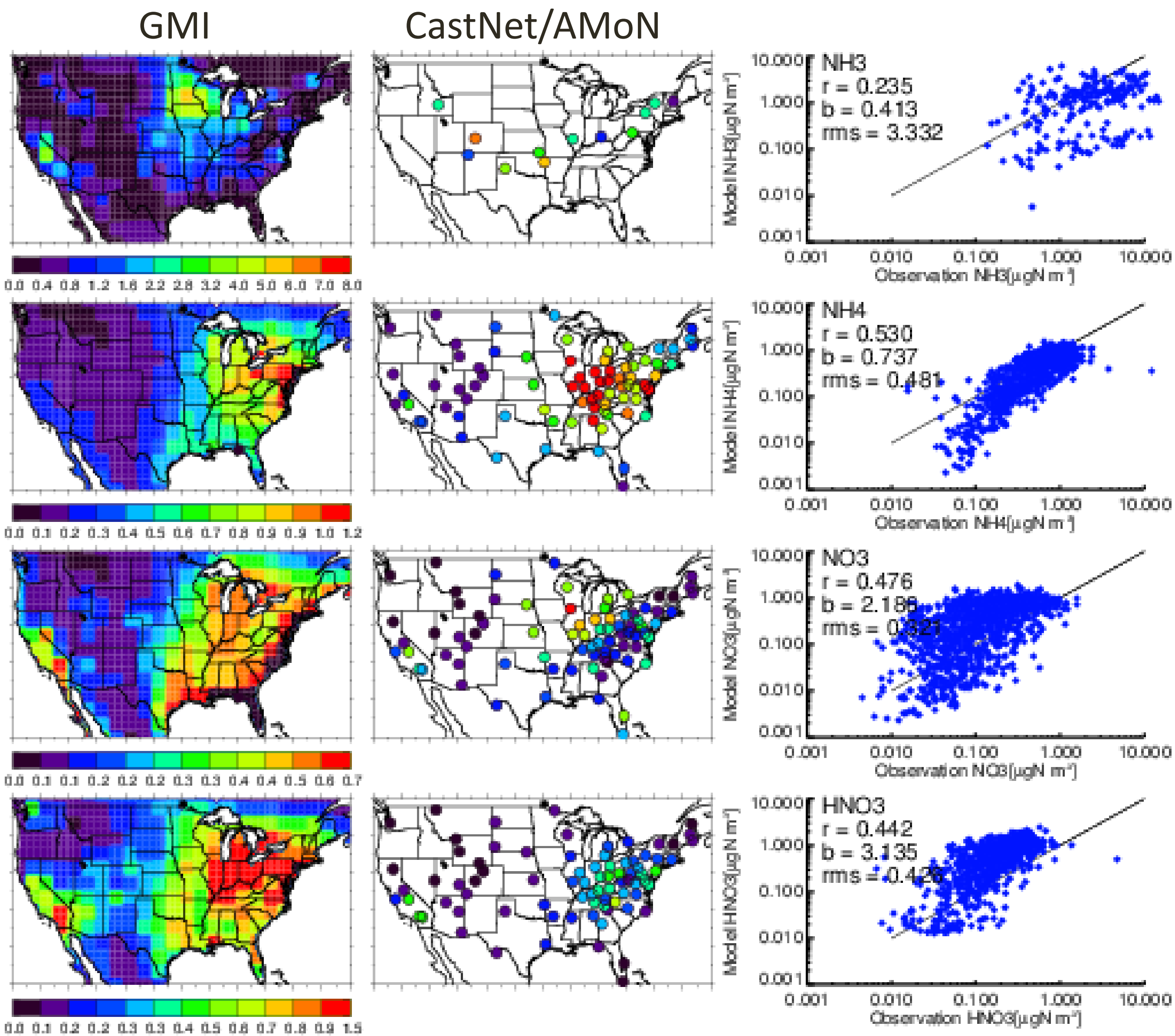




NEED: include the impact of dust and sea salt on nitrate formation

Base experiment

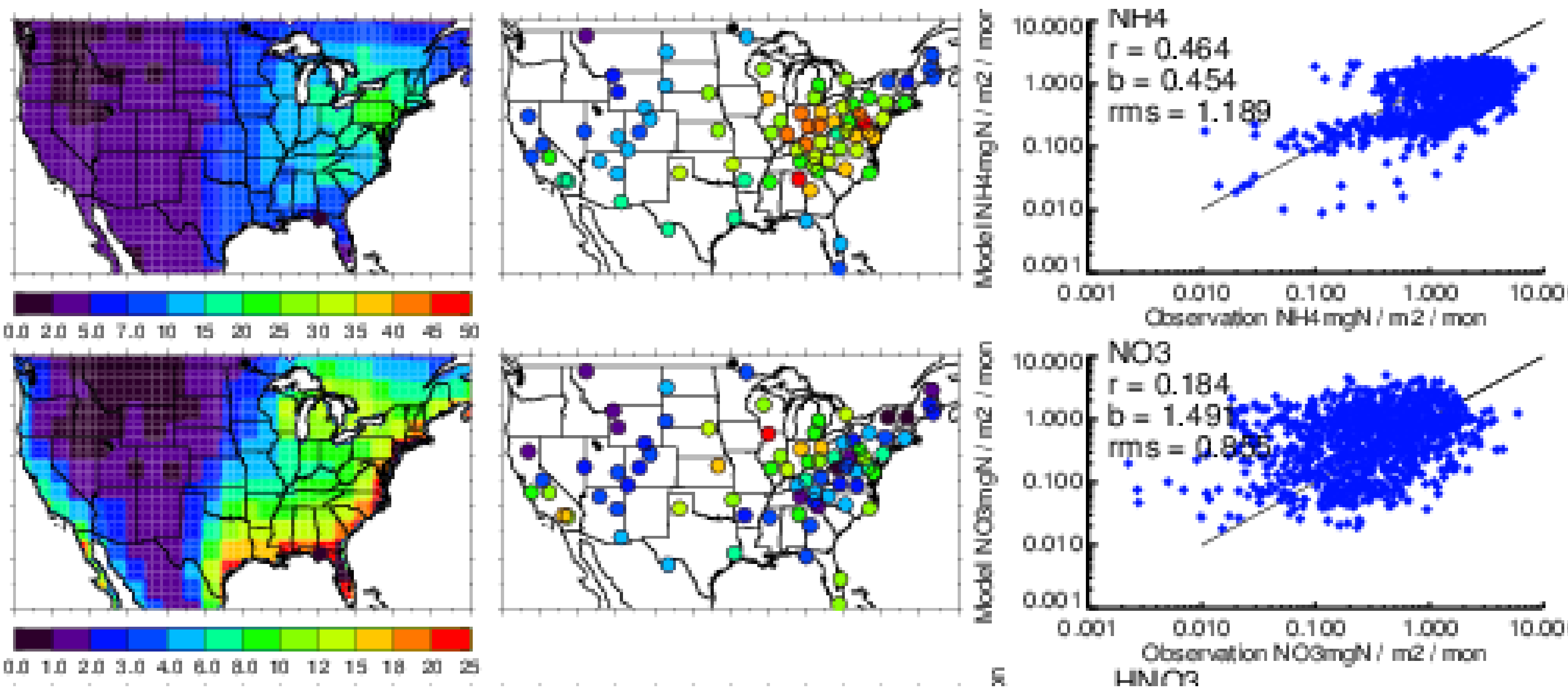
Evaluation: surface concentration



Base experiment

Evaluation: dry deposition

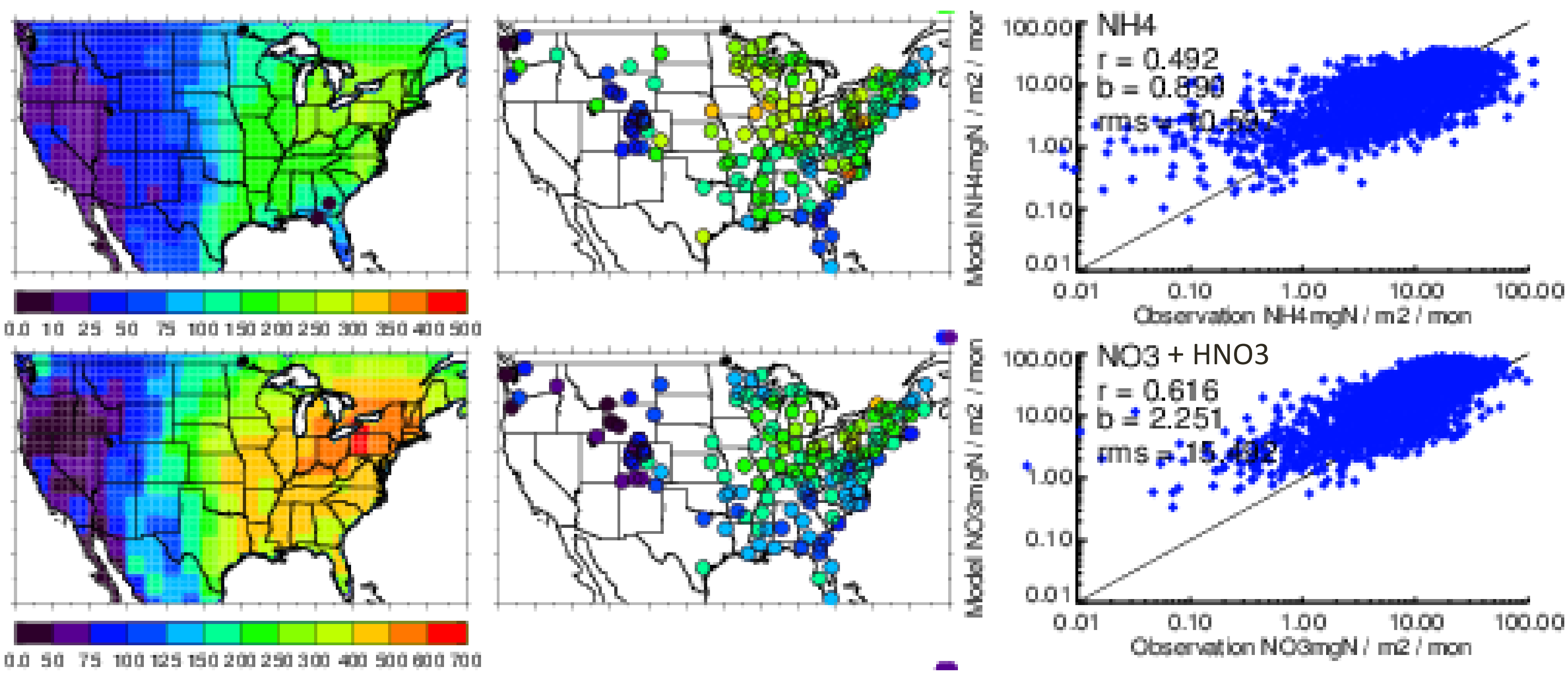
GMI CastNet



Base experiment

Evaluation: wet deposition

GMI　　　　　NADP/NTN



Purturbation experiments

Six perturbation experiments

1: increase anthropogenic NH_3 by 20% (NGLONH3120)

2. Decrease anthropogenic NOX by 20% (NGLONOX)

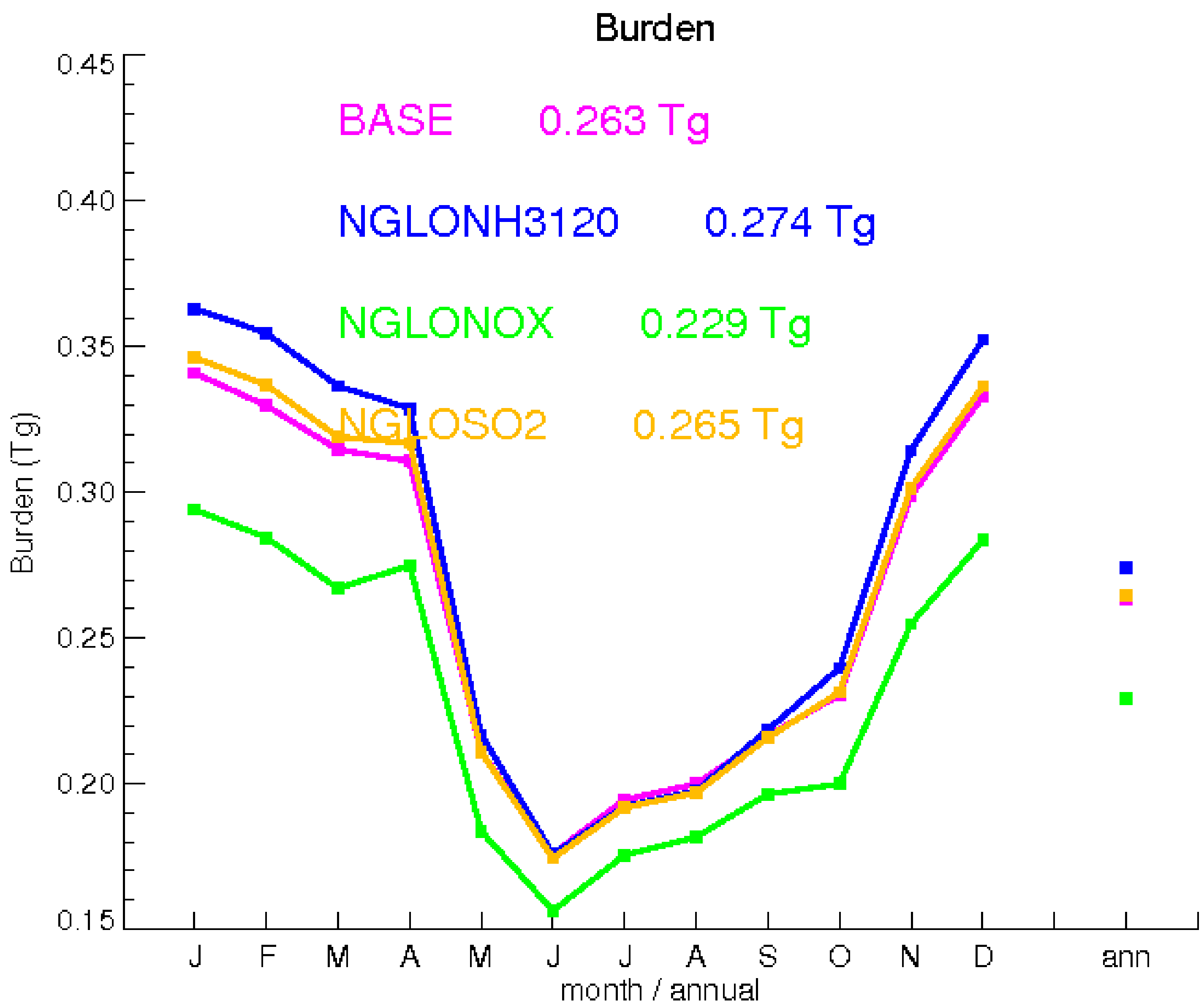
3. Decrease anthropogenic SO_2 by 20% (NGLOSO2)

4. Decrease dust emission by 20% (NGLODUST)

5. Increase T by 1.5K (NGLOTEMPA1P5)

6 Increase RH by RH+(100-RH) x 0.1 (NGLORH110)

Purturbation experiments



Purturbation experiments

Questions asked by modellers

Q1: what's the emission sector for NGLONH3120, NGLONOX, NGLOSO2?

1: Increase **anthropogenic** NH_3 by 20% : **agr, ind, ene, res, tra**

2. Decrease **anthropogenic** NOX by 20% : **aircraft, ind, ene, res, shp, tra**

3. Decrease **anthropogenic** SO_2 by 20% : **aircraft, ind, ene, res, shp, tra**

Q2: What's the impact scope which the change of T and RH should be applied to?

- whole model
- whole chemistry
- only thermodynamics calculation of NH_4-SO_4-NO_3-dust-salt

output

Diagnose for mass budget

- Emission, dry deposition, wet deposition, chemistry prod & loss, surface concentration, loading

Diagnose for chemistry

- Gas phase prod & loss, liquid phase prod & loss, het prod & loss, thermodynamical prod & loss

Diagnose for optical quantities

- AOD and abs at 550nm

(od550pm1no3 & od550pm2p5no3 & od550pm10no3)

Diagnose for radiative effect: only NO3 forcing???

HTAP2-AeroCom3 **CMOR** table is under developed and an updated version was released in Sept, 2014

https://wiki.met.no/aerocom/phase3-experiments

Conclusion

Thanks for all participants!

Base cast study:

- Understand diversity of NO3 simulation between models;
- Investigate reasons for the diversity (traditional processes, relative contribution of ammonia, dust and seasalt);
- Examine fine and coarse NO3;
- Suggest potential improvement

Perturbation study:

- Understand key tracers/fields for NO3 simulation
- Project potential future change

timeline

Aug-Sept, 2014: updated CMOR table and document

Oct 2014: finalize CMOR

1ST half year 2015: finish model simulation, do sanity check

2st half year 2015: analyze results and prepare draft