

# Preliminary analysis for AeroCom III nitrate experiment

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Gunnar Myhre (CICERO)  
Sudo Kengo (Nagoya Univ/Japan)  
Mian Chin (GODDARD/NASA)  
Michael Shultz (NMI)  
and AeroCom III nitrate modelers

AeroCom 2015

### **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.

# Experiment set up

**Study period:** 2008

**Met field:** model's meteorological data for 2008

**Emission:**

- same for models: 1. anthropogenic ---- HTAP v2 2008 monthly emission  
(for tracers not provided by HTAP v2, use CMIP5RCP8.5,  
linear interpolation between 2005 and 2010).
2. biomass burning ---- GFED3
3. NH<sub>3</sub>: add ocean source based on GEIA

specific for models: NO lightning, DMS, dust, sea salt

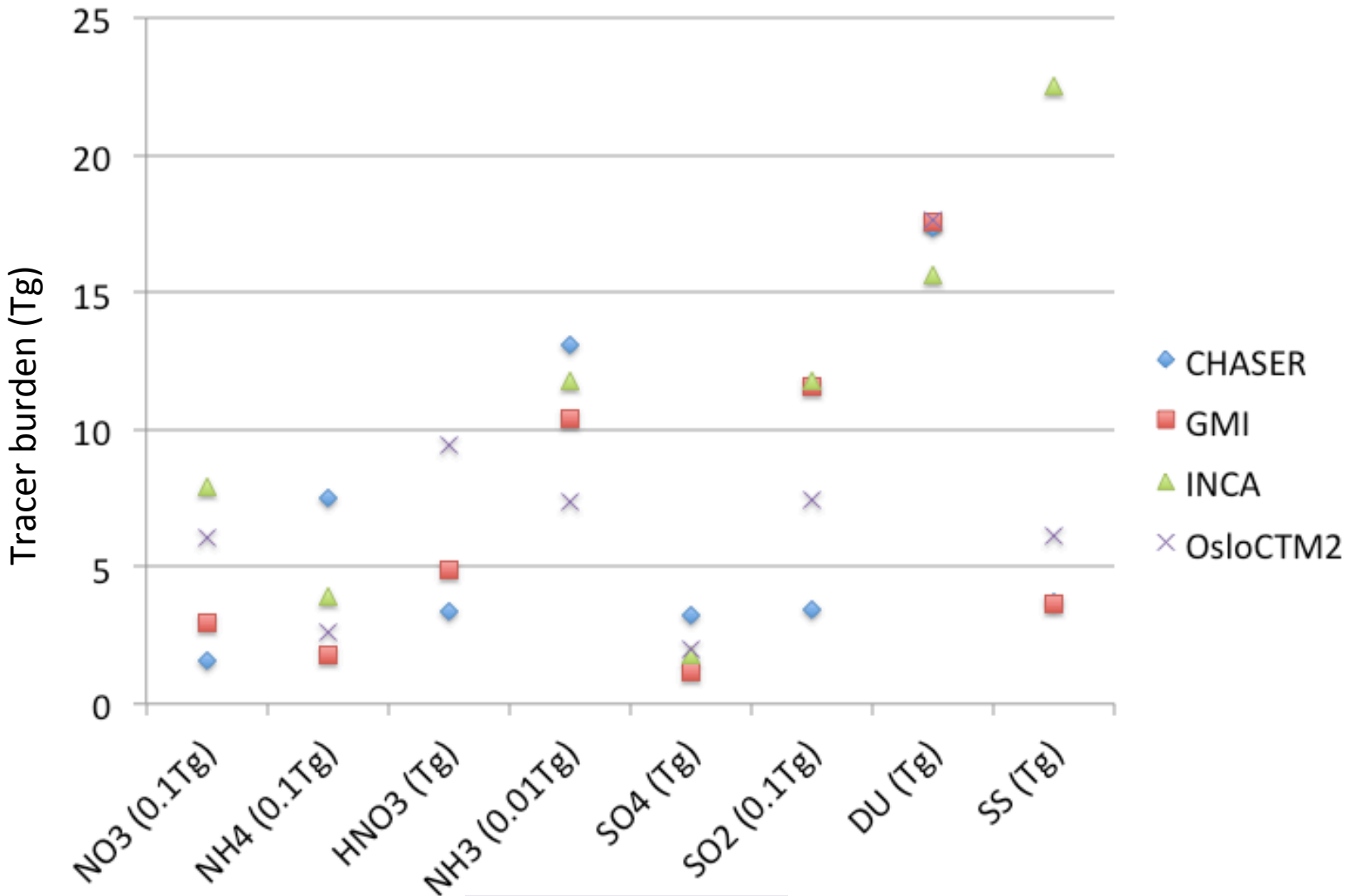
**Observations:**

	observed	USA	Europe	East Asia	ARCTIC	Global
Surface (station)	concentration	Castnet/AMon	EMEP	EANET		
	Dry deposition	Castnet				
	Wet deposition	NDEP NTN		EANET		
Vertical (aircraft)	concentration	ARCTAS-CARB			ARCTAS-A/B ARCPAC	
Global (satellite)	concentration					TAS

## Current Status

model	modeler	Current status
CHASER	Kengo Sudo	submitted
GMI	Huisheng Bian	Submitted
INCA	Didier Haugluztaine	Submitted
OsloCTM2	Gunnar Myhre Ragnhild B. Skeie	Submitted
GISS-MATRIX	Susanne Bauer Kostas Tsigaridis	In post-process
GISS-modeleE	Susanne Bauer Kostas Tsigaridis	In post-process
GEOS-Chem	Daven Henze	Need update
HadGEM3	Steve Rumbold	Need update

### Annual Global Burdens

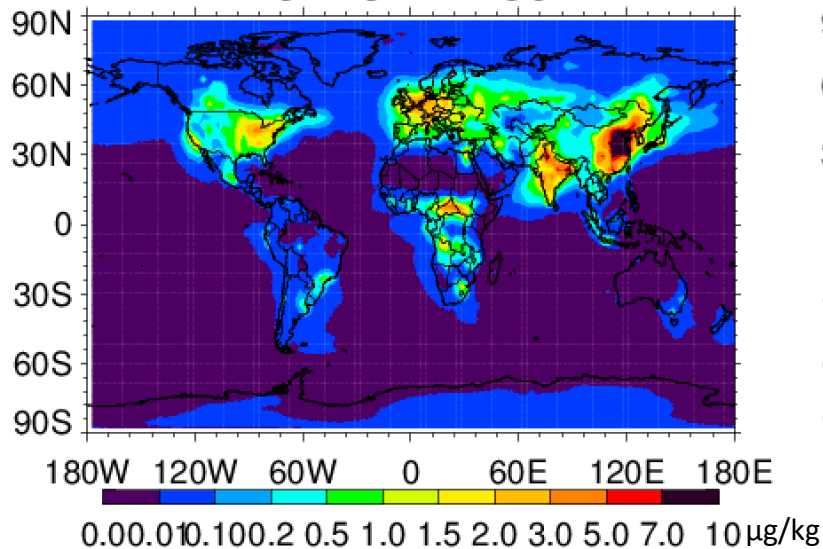


NO3:  $0.46 \pm 0.31$

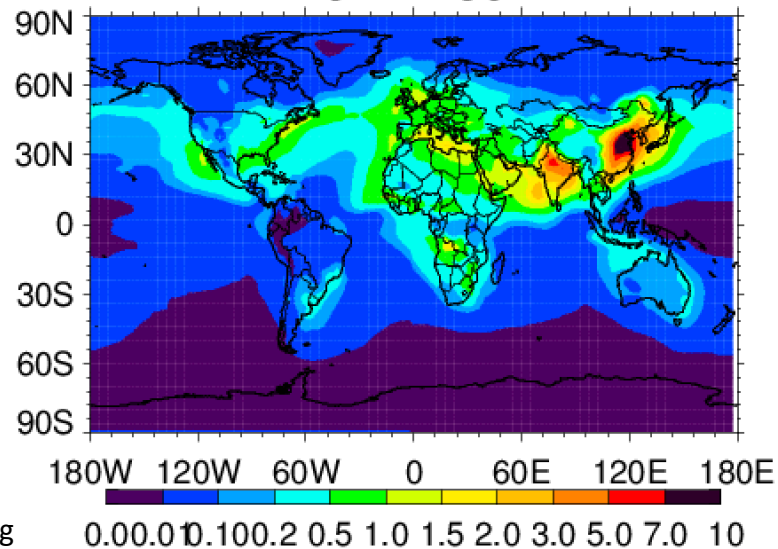
SO4:  $2.05 \pm 1.0$

# NO<sub>3</sub> Surface distributions from 4 AeroCom models

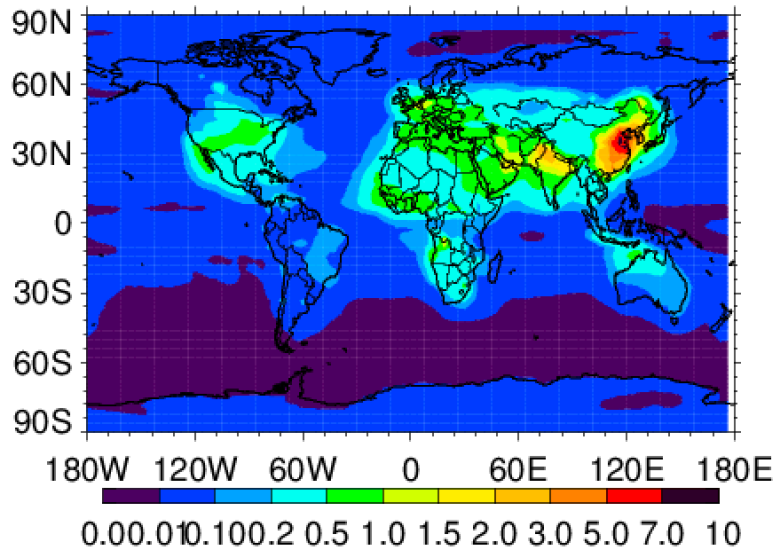
CHASER NO<sub>3</sub>



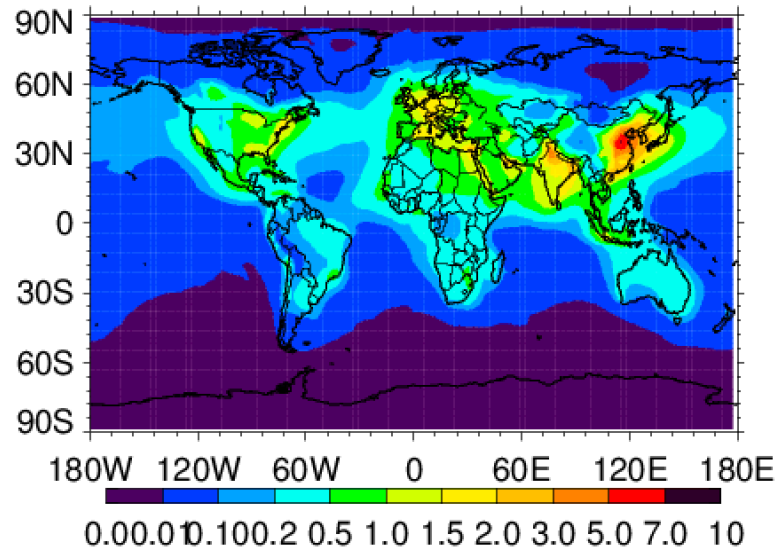
GMI NO<sub>3</sub>



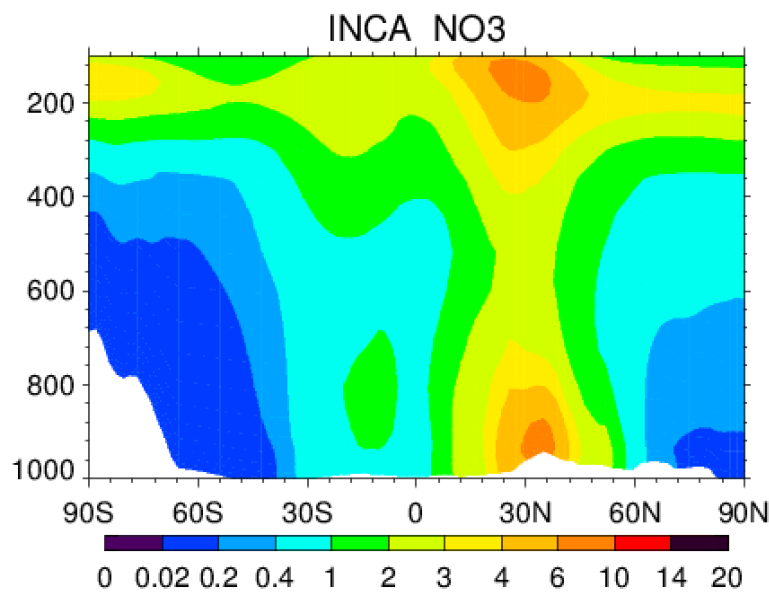
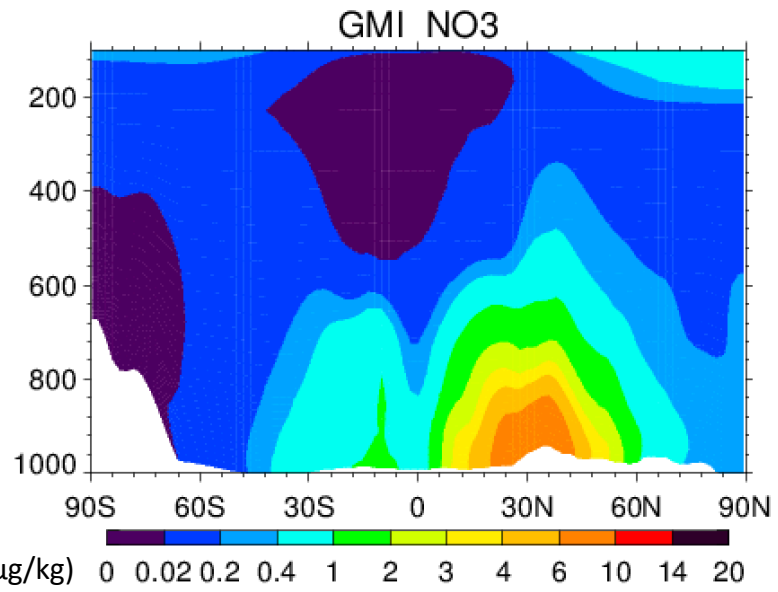
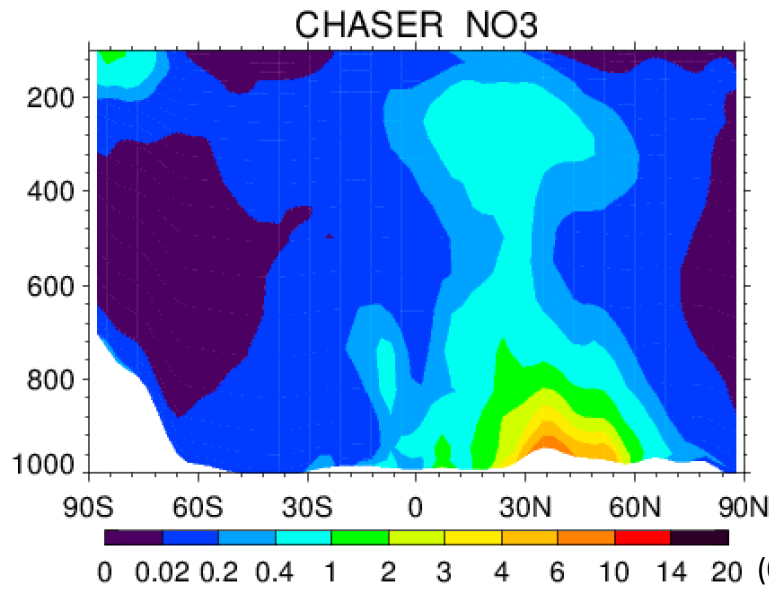
INCA NO<sub>3</sub>



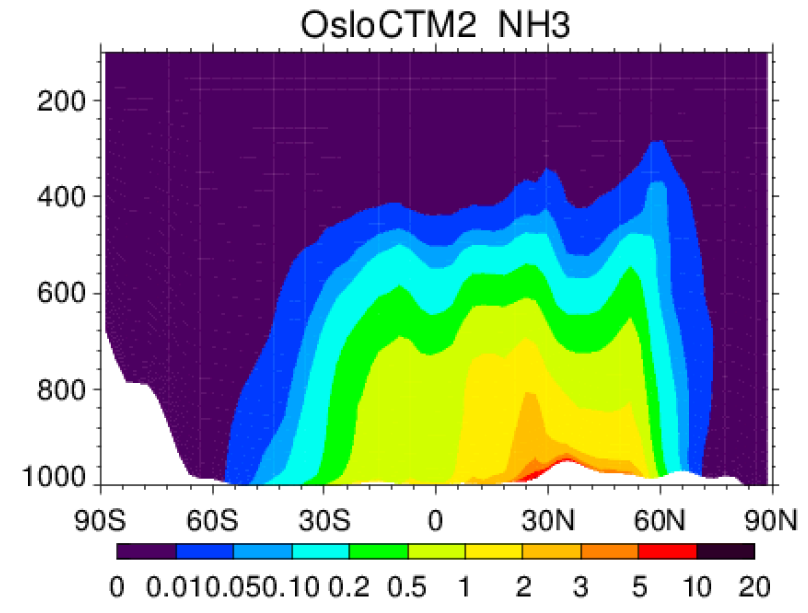
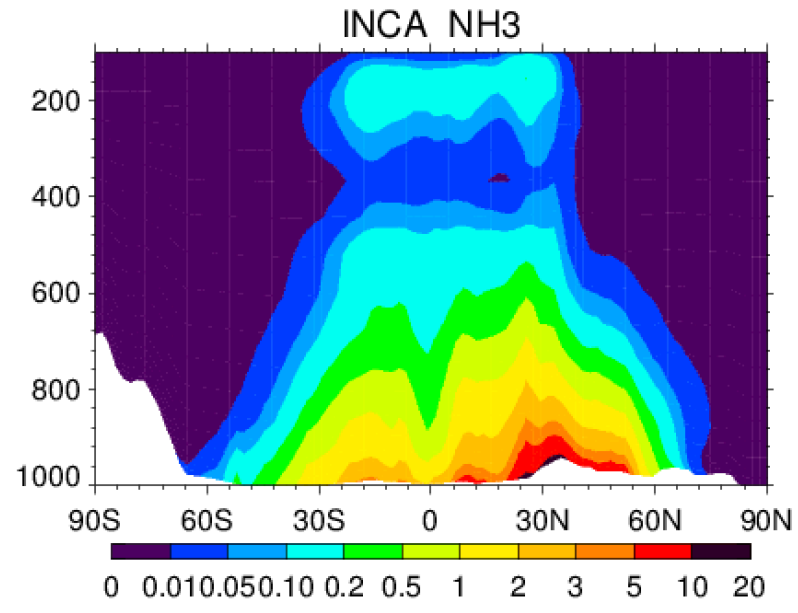
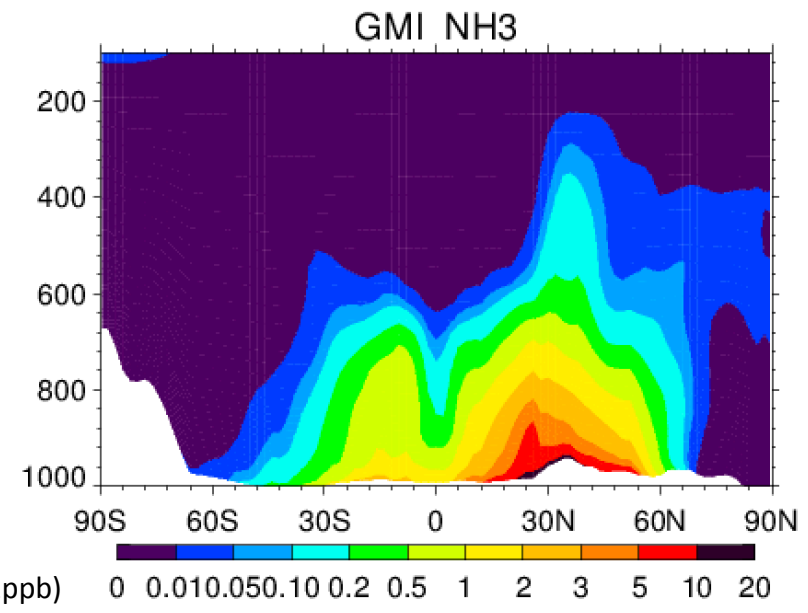
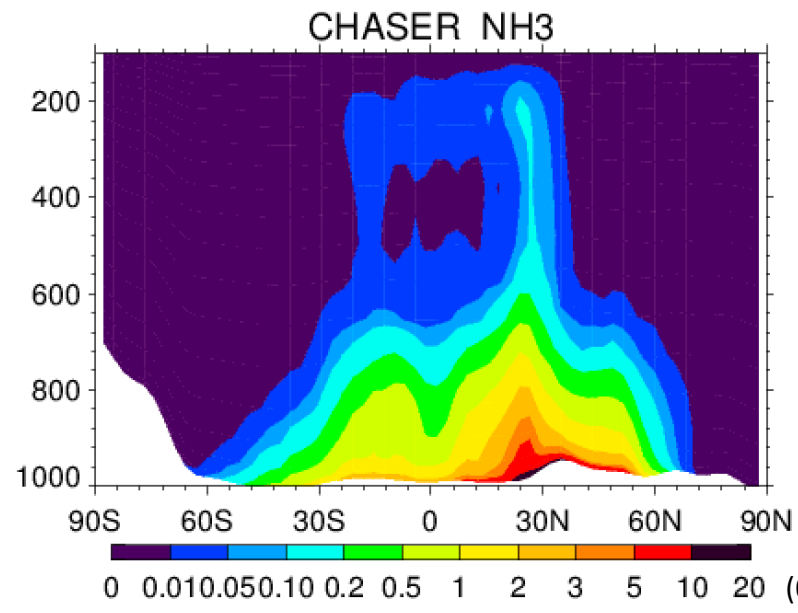
OsloCTM2 NO<sub>3</sub>



# NO3 vertical zonal mean distributions from 4 AeroCom models

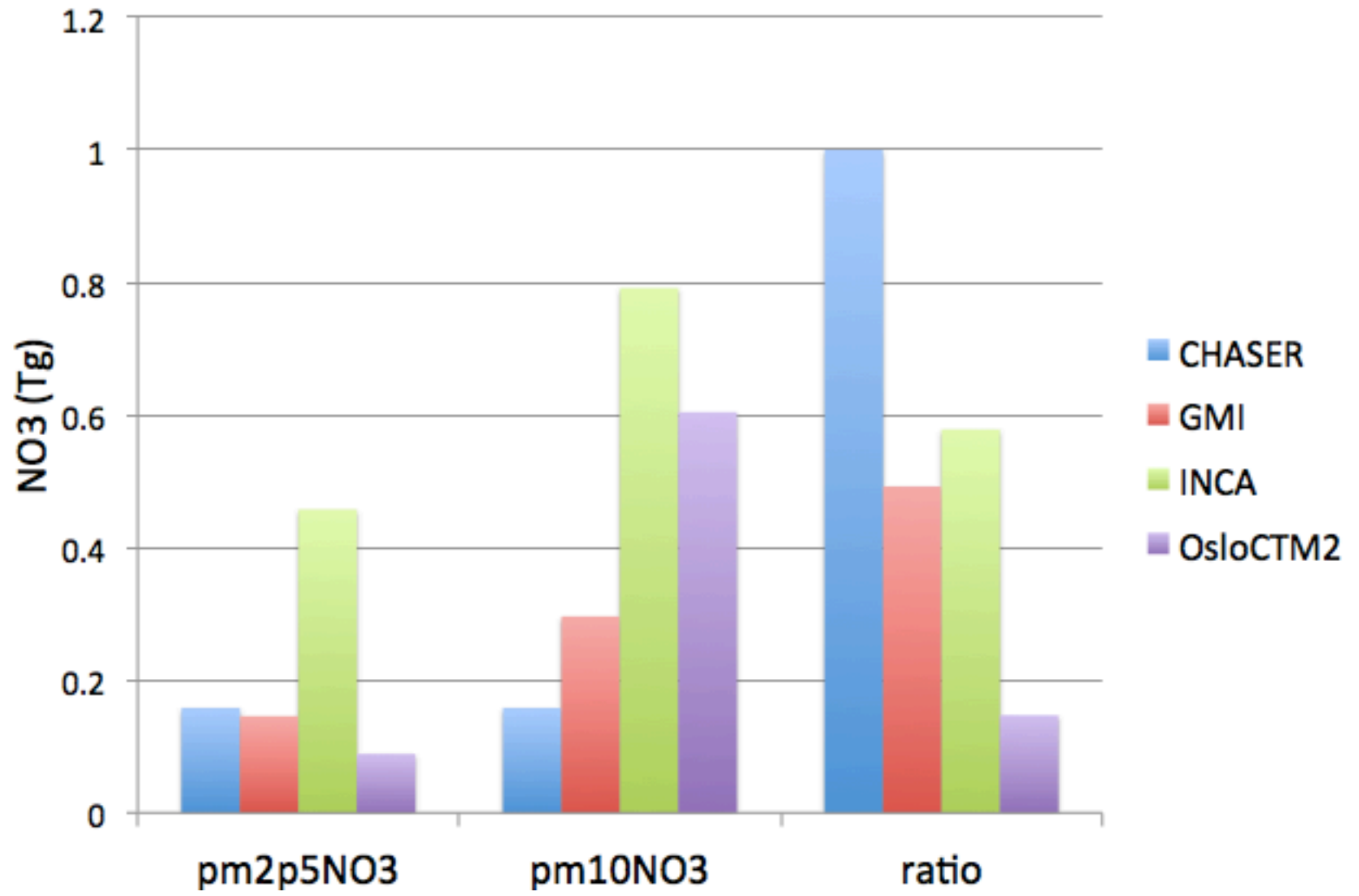


# NH3 vertical zonal mean distributions from 4 AeroCom models



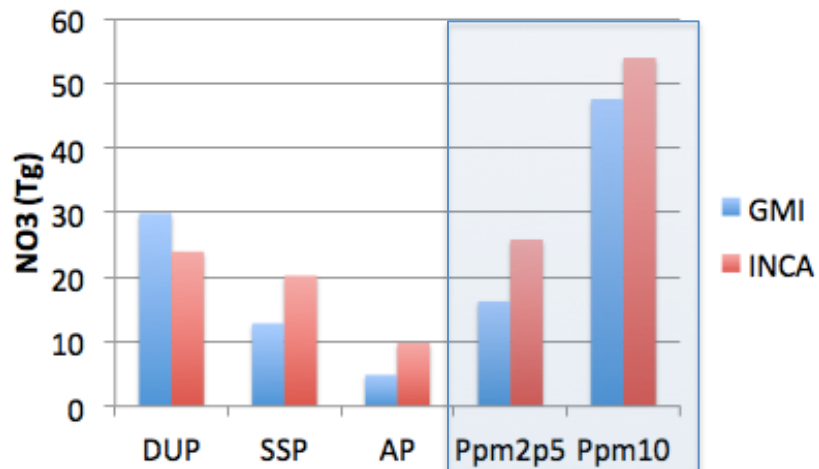


### Global annual fine and coarse mode NO3 and their ratio

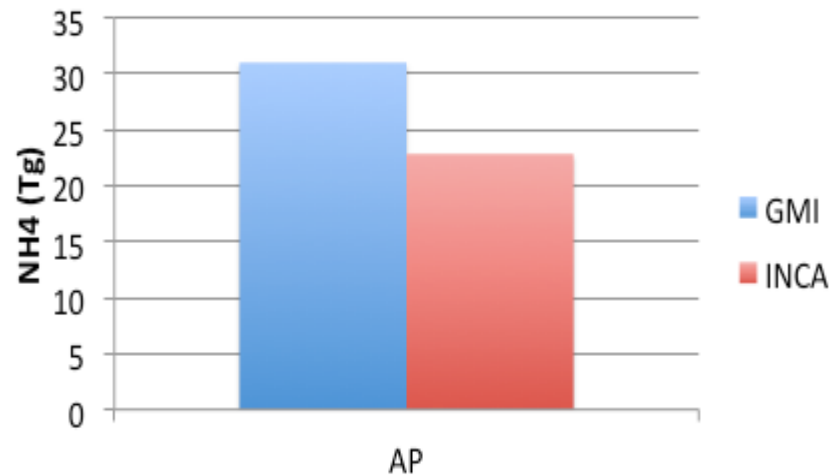


# Chemistry budget of nitrate simulation

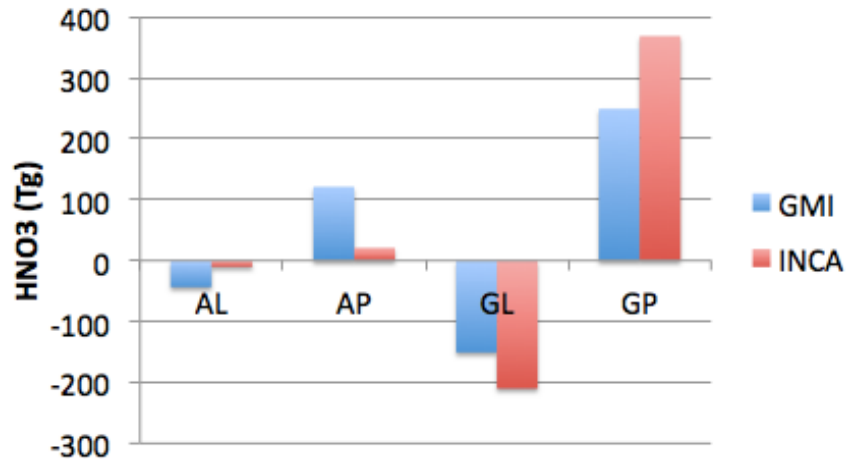
### NO3



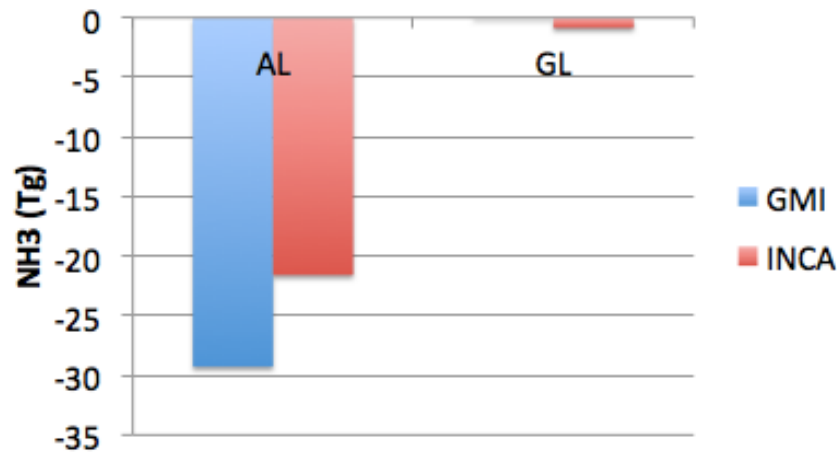
### NH4



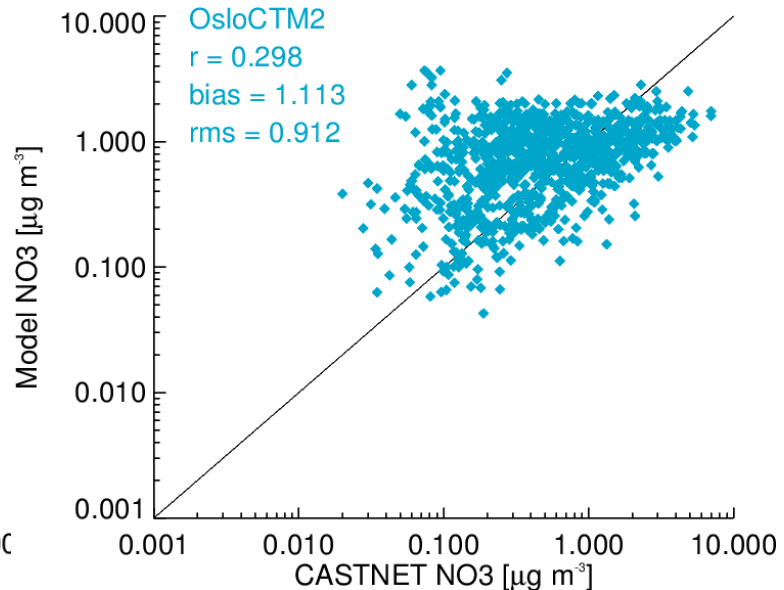
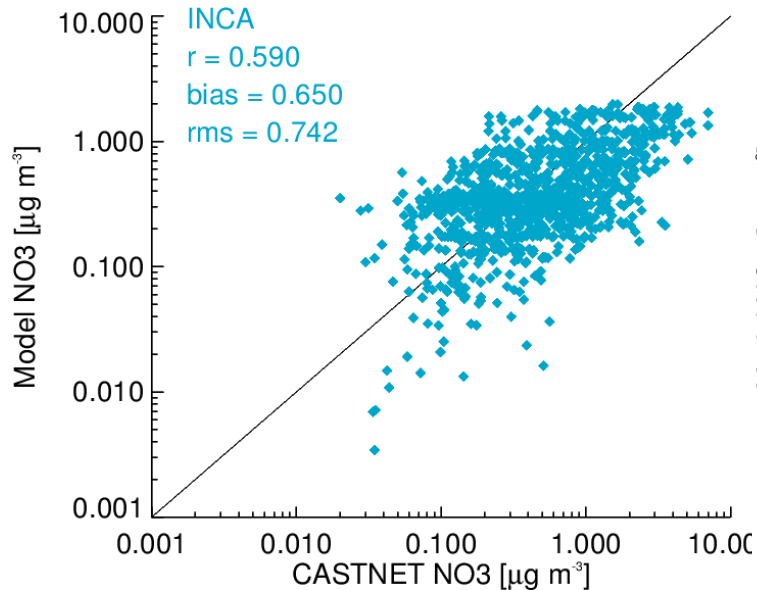
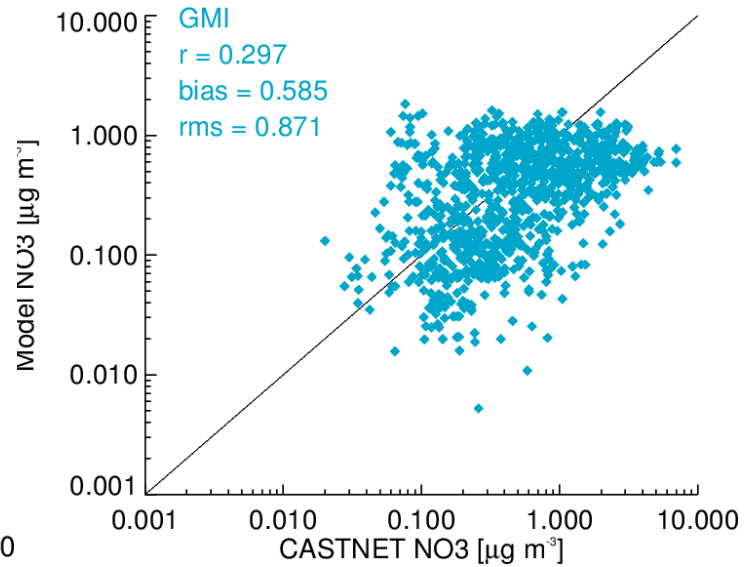
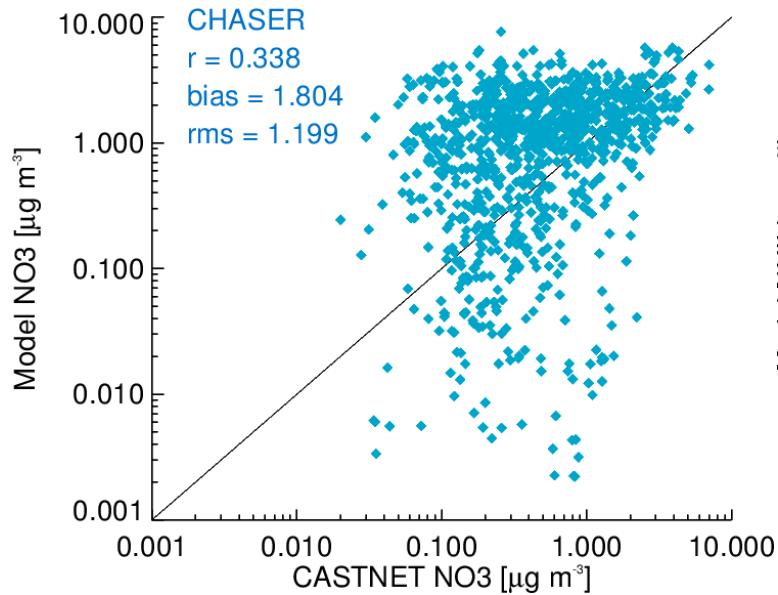
### HNO3



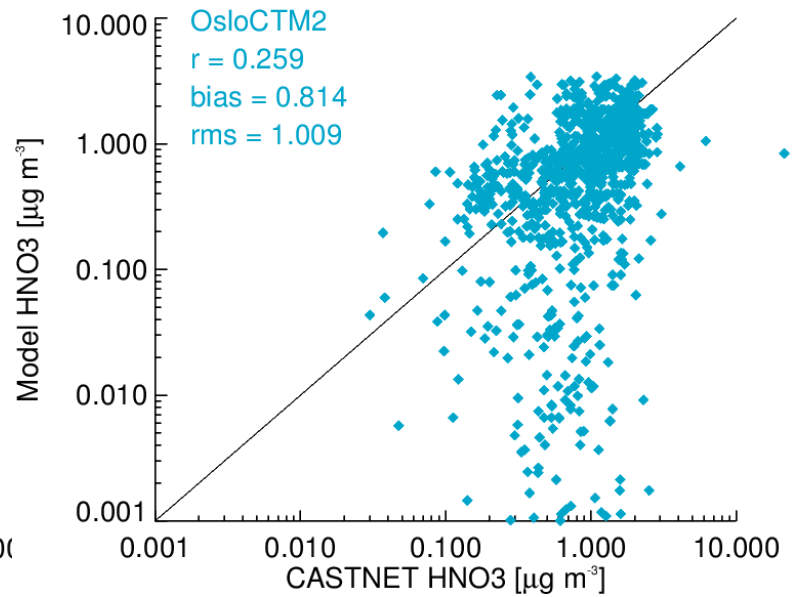
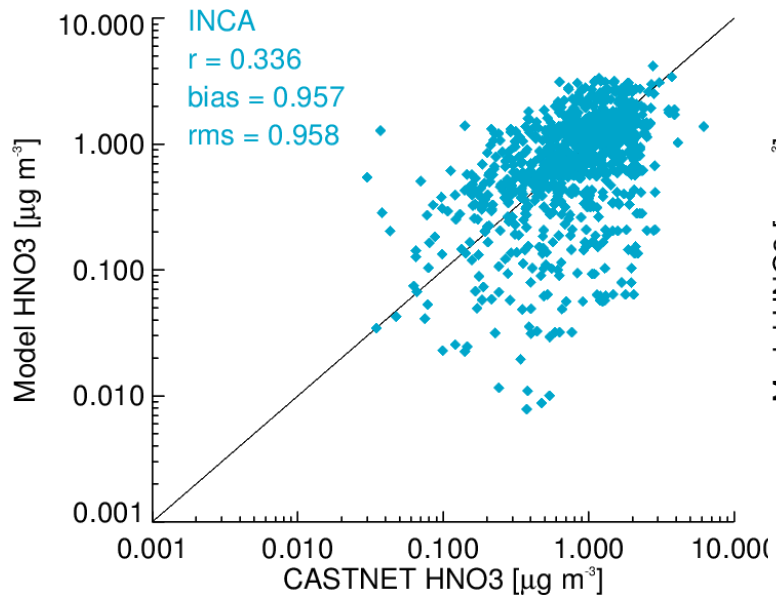
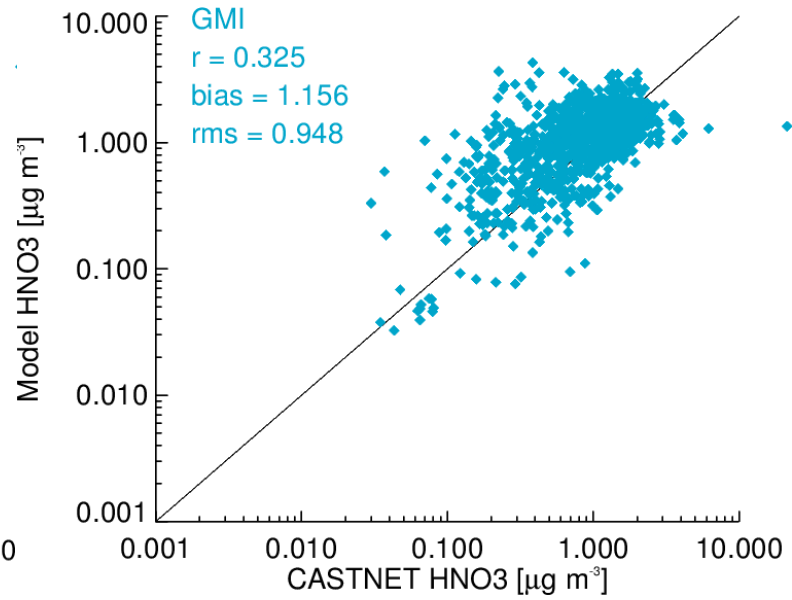
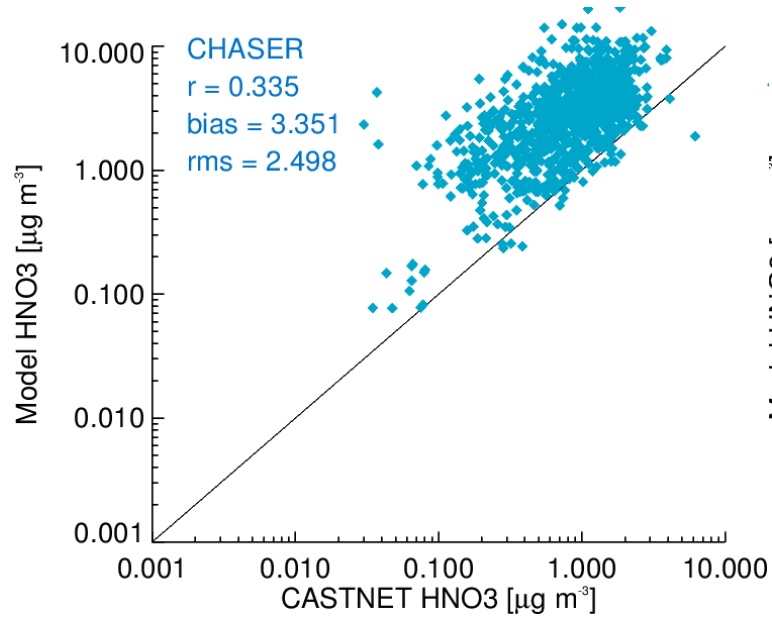
### NH3



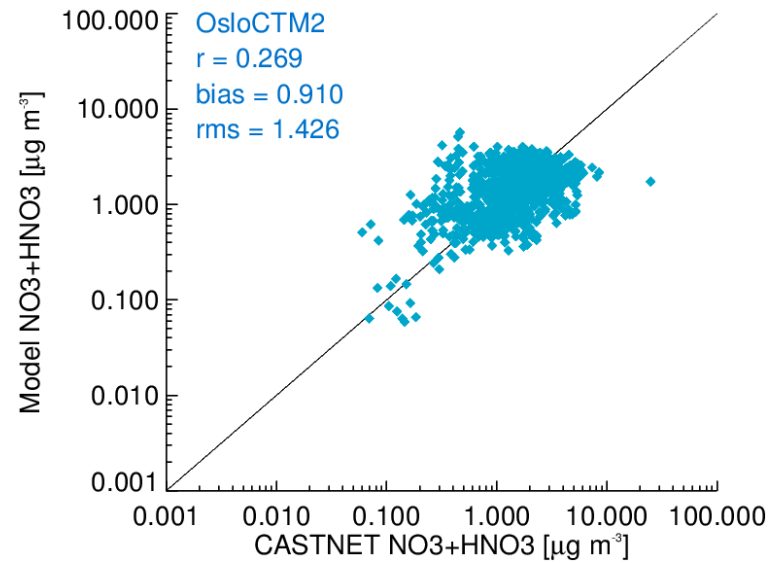
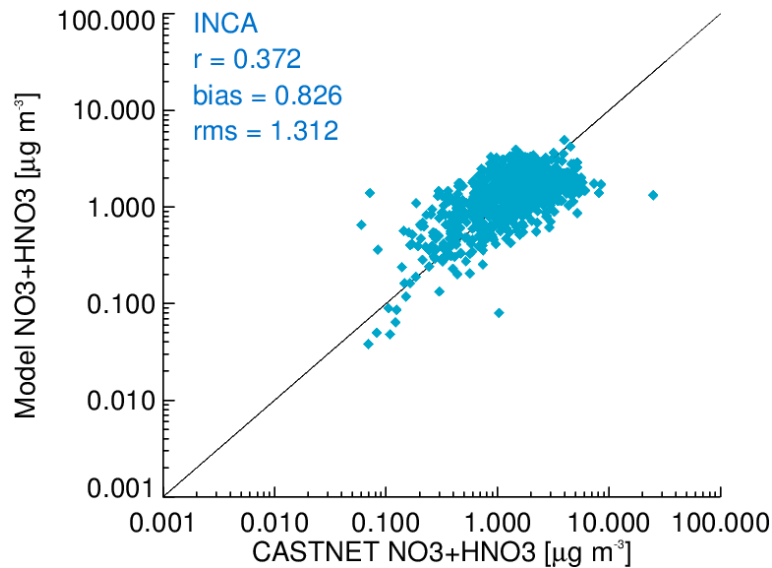
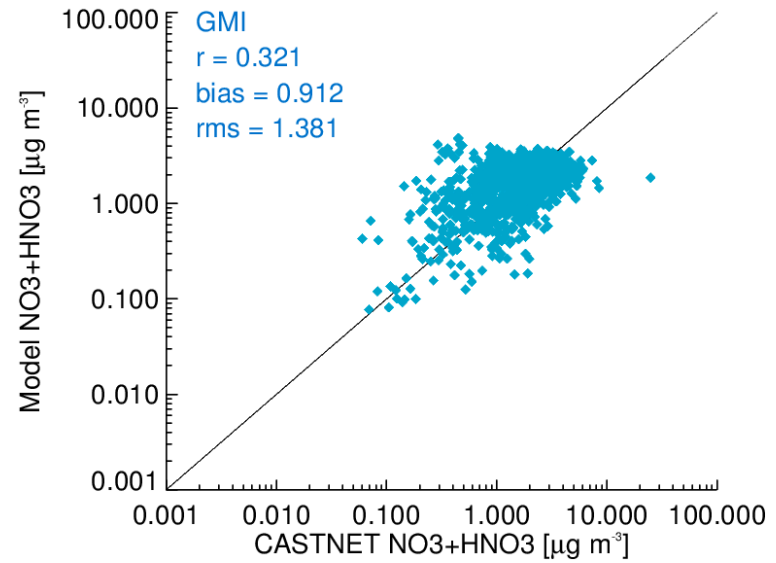
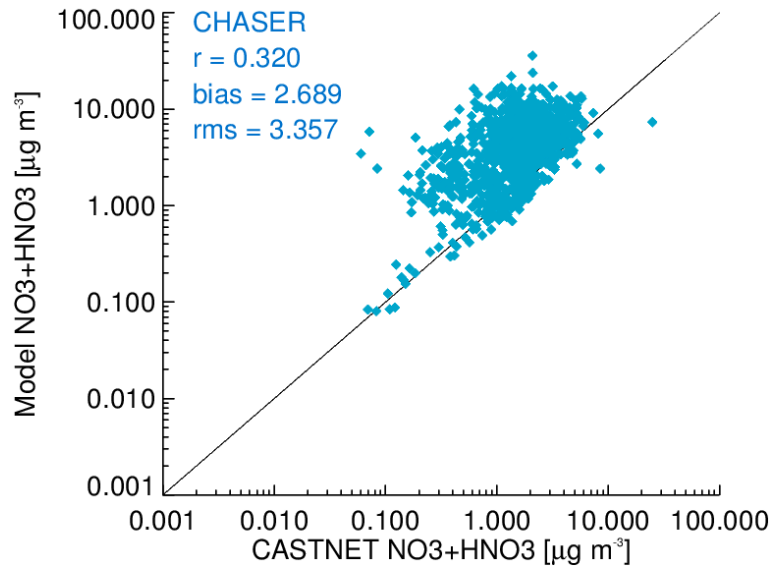
# Surface NO<sub>3</sub> between model and **Castnet** measurement (USA)



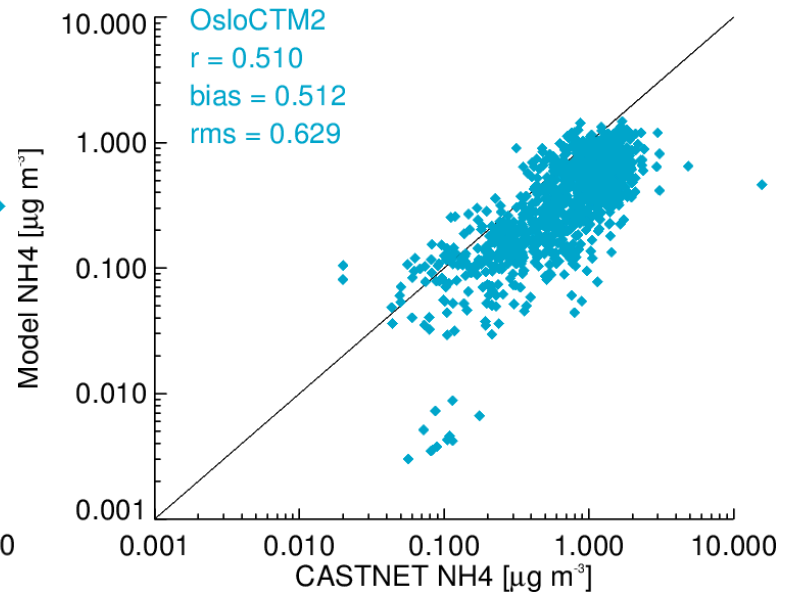
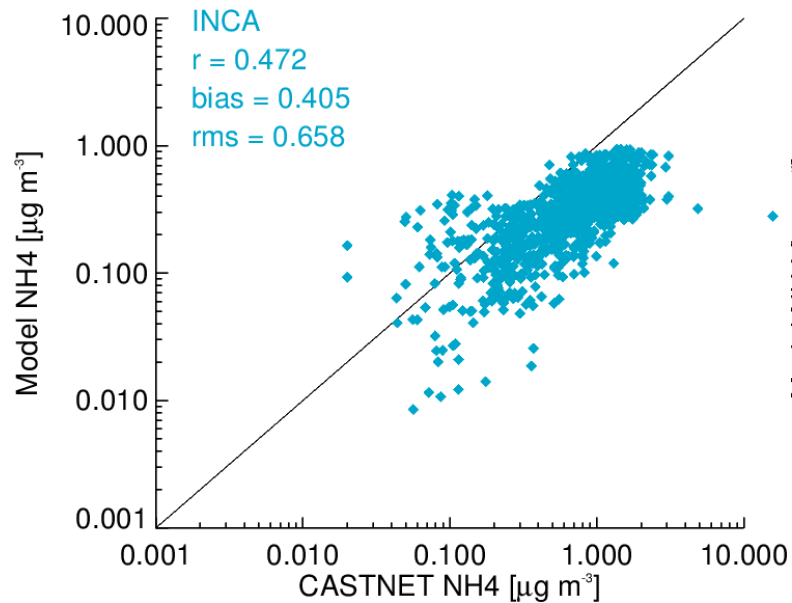
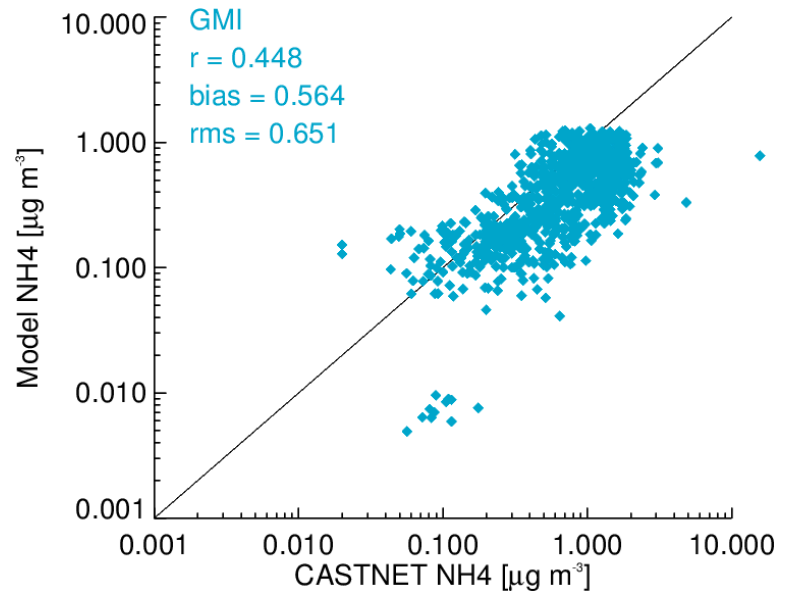
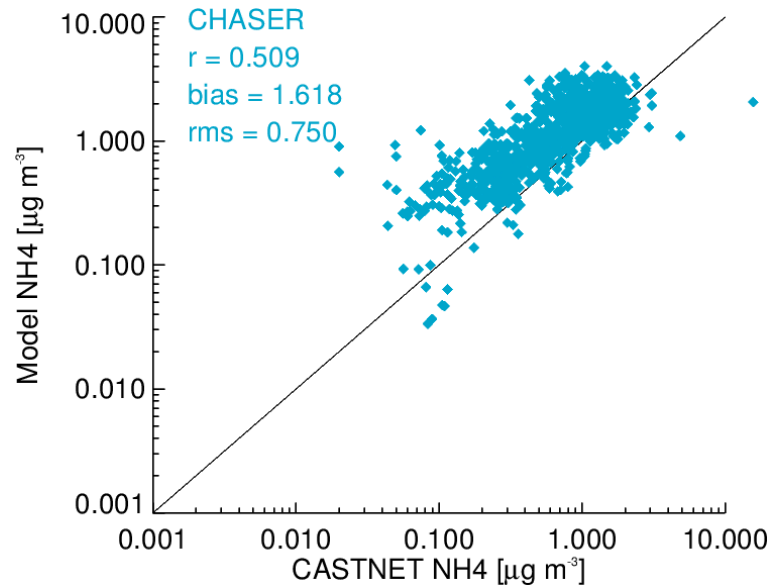
# Surface HNO<sub>3</sub> between model and **Castnet** measurement (USA)



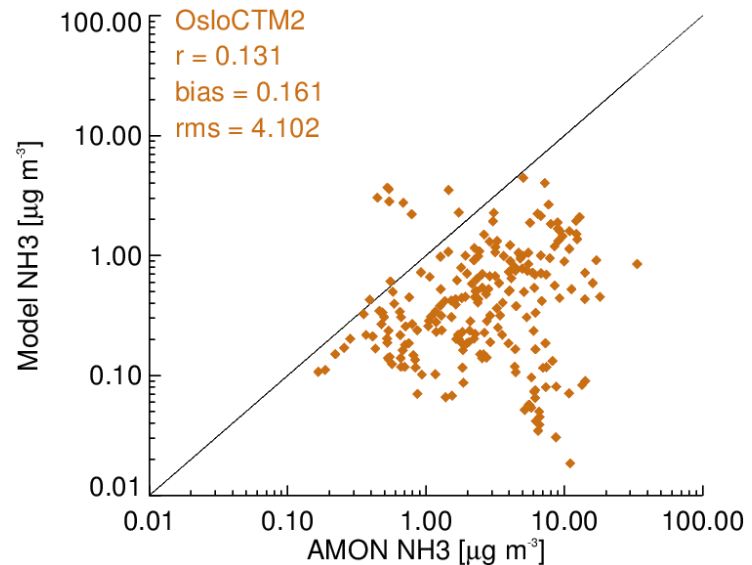
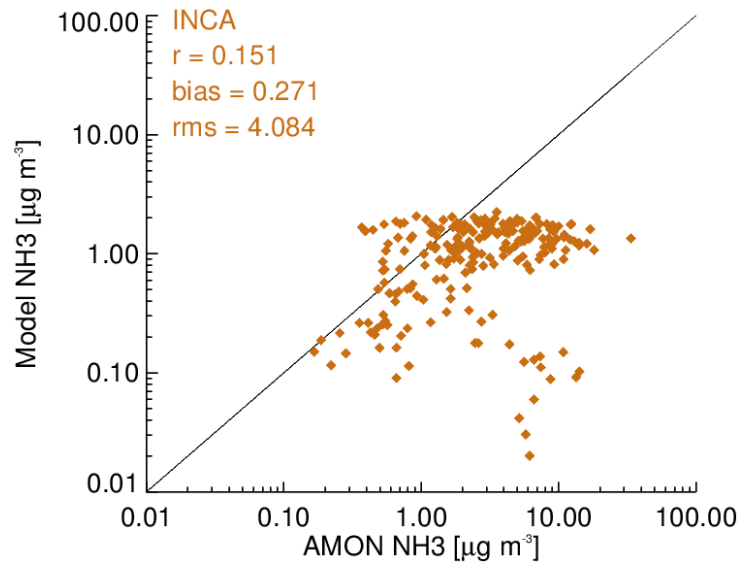
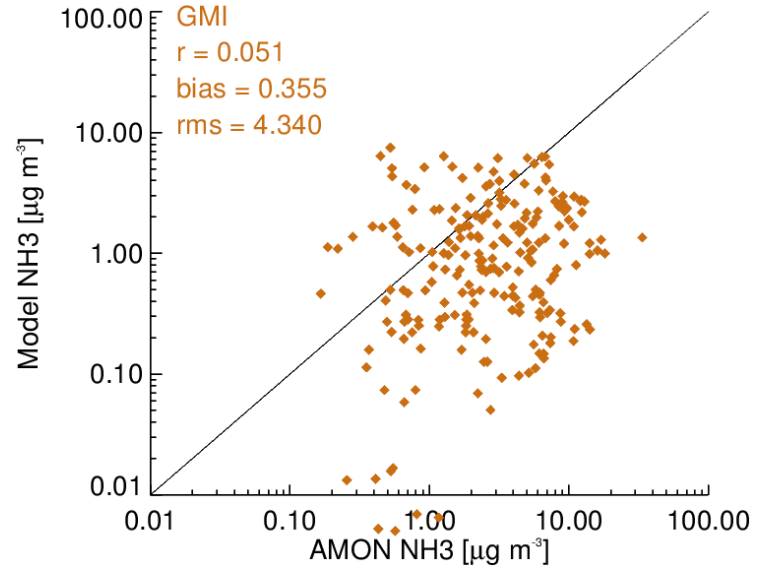
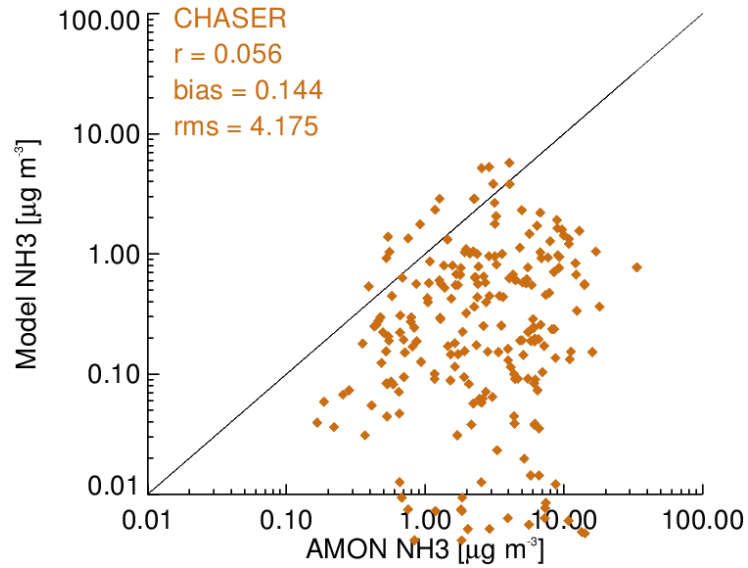
# Surface NO<sub>3</sub>+HNO<sub>3</sub> between model and **Castnet** measurement (USA)



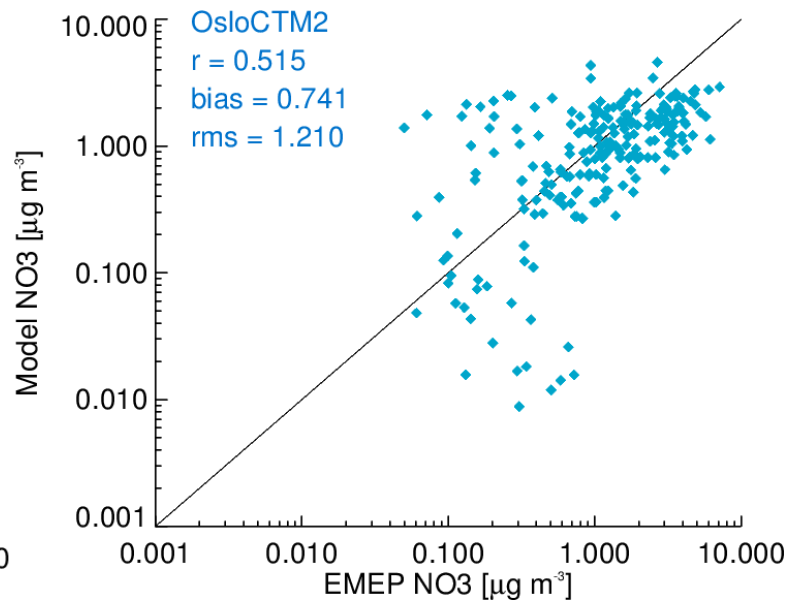
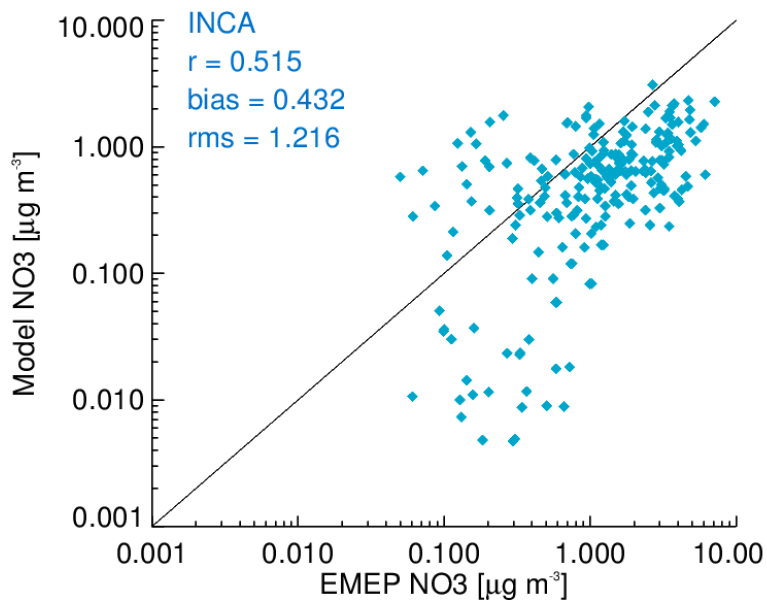
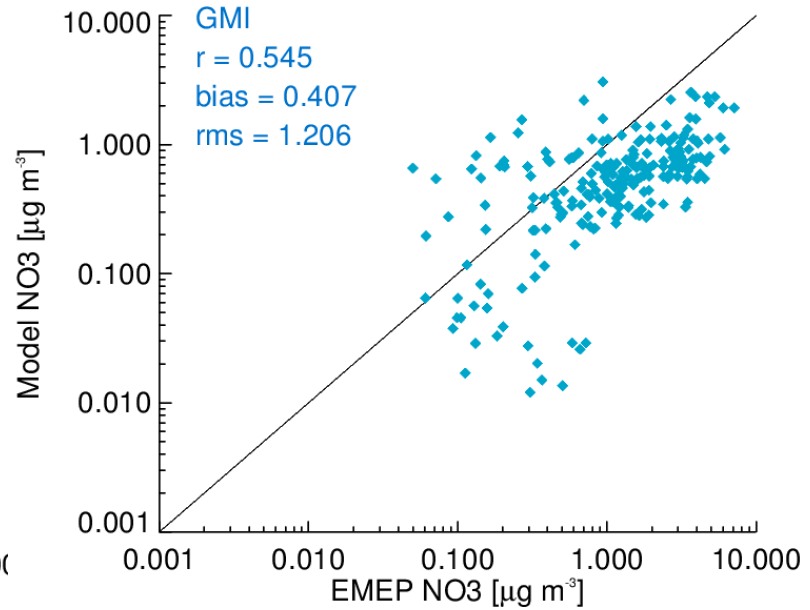
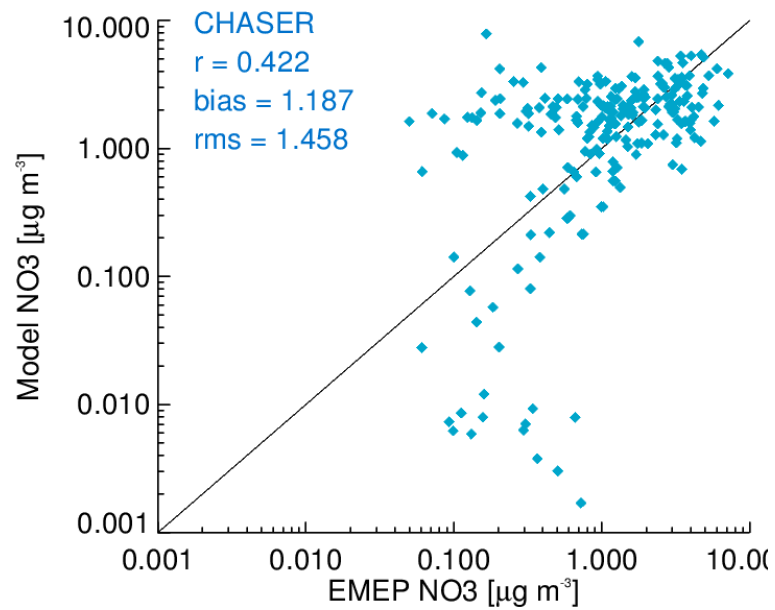
# Surface NH4 between model and **Castnet** measurement (USA)



# Surface NH<sub>3</sub> between model and AMoN measurement (USA)

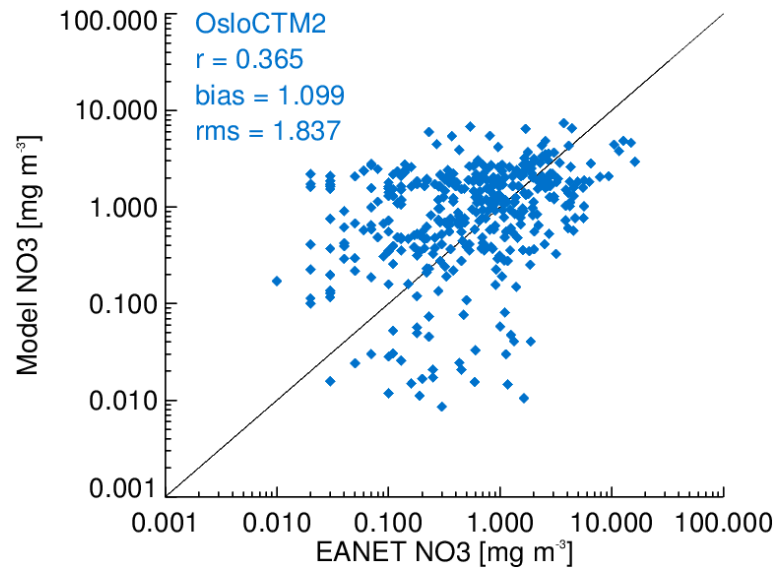
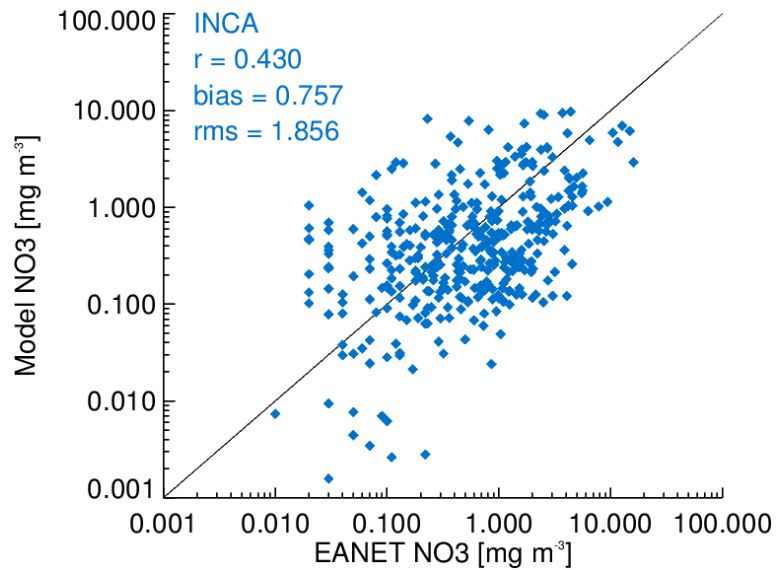
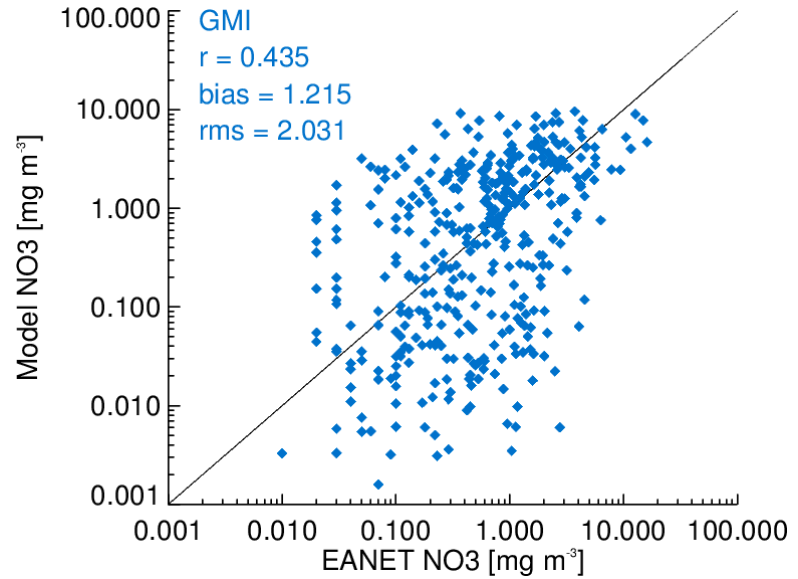
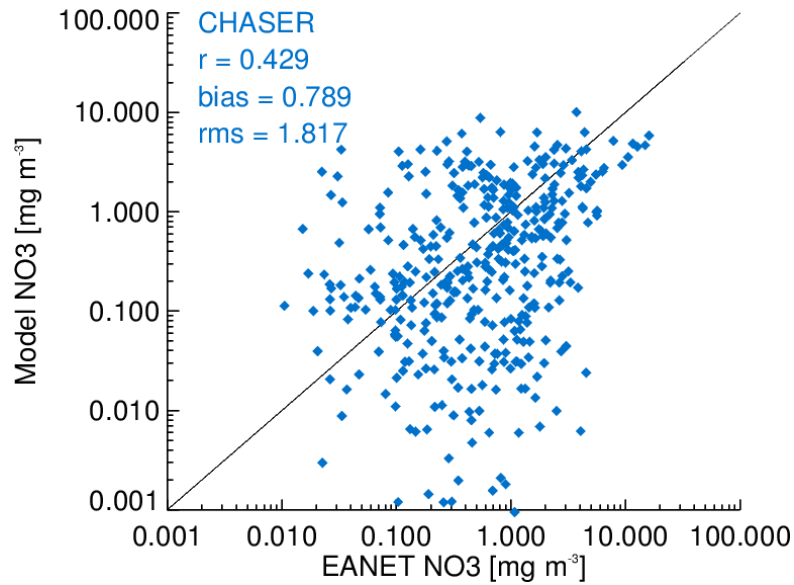


# Surface NO3 between model and EMEP measurement (Europe)

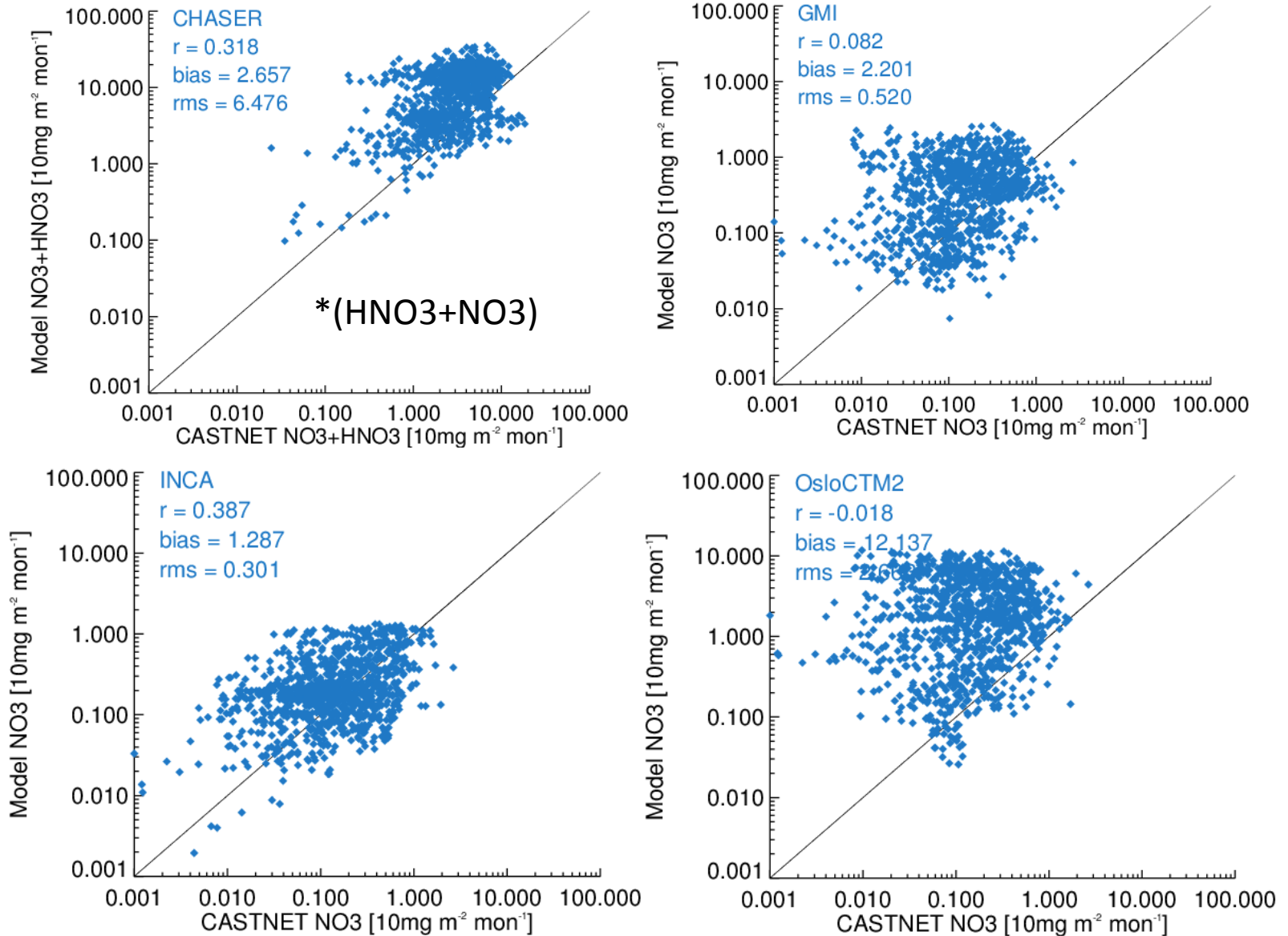




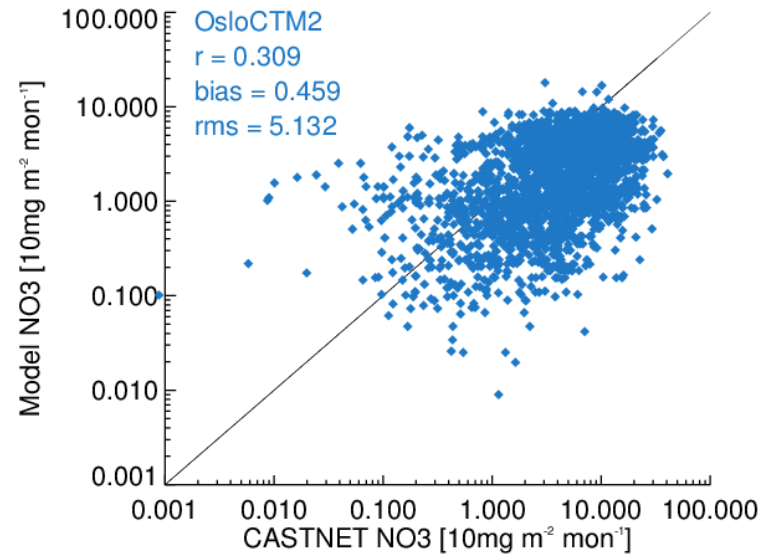
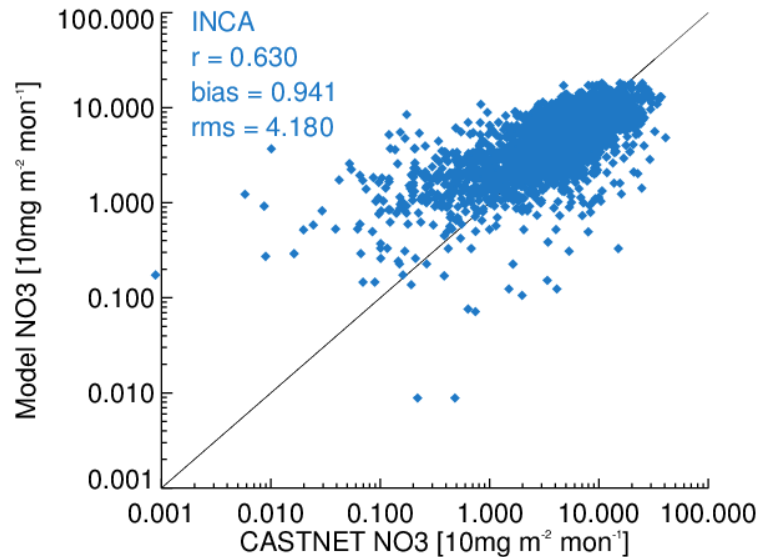
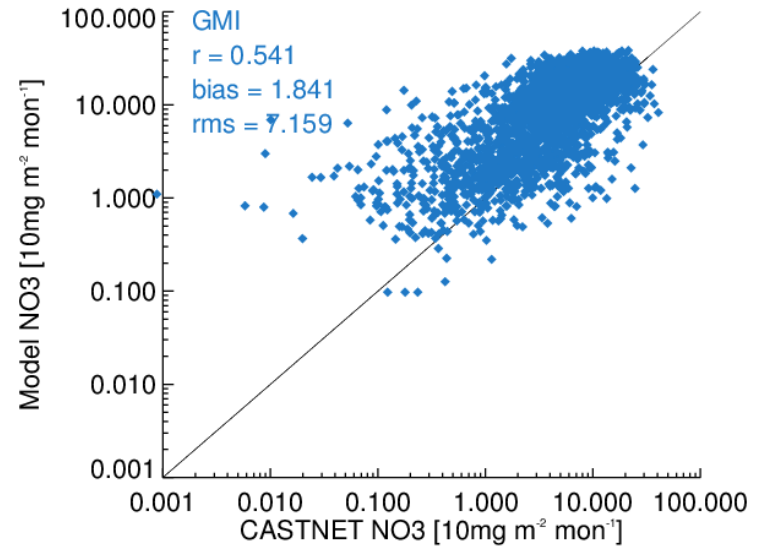
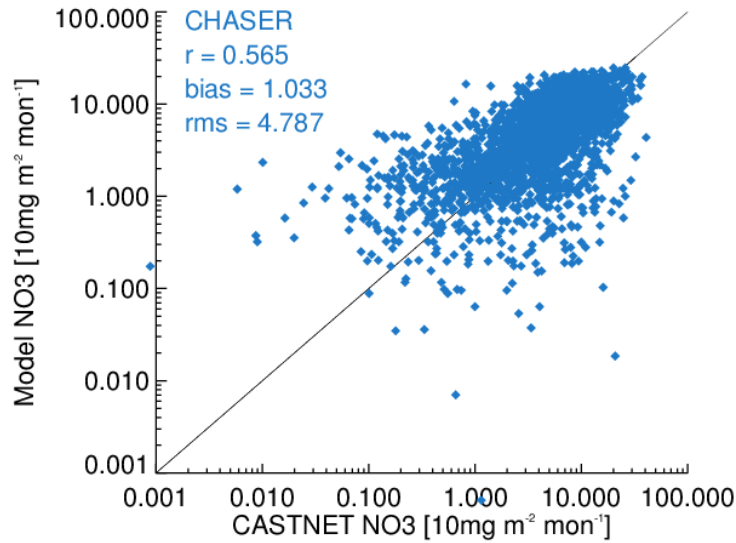
# Surface NO<sub>3</sub> between model and **EANET** measurement (East Asia)



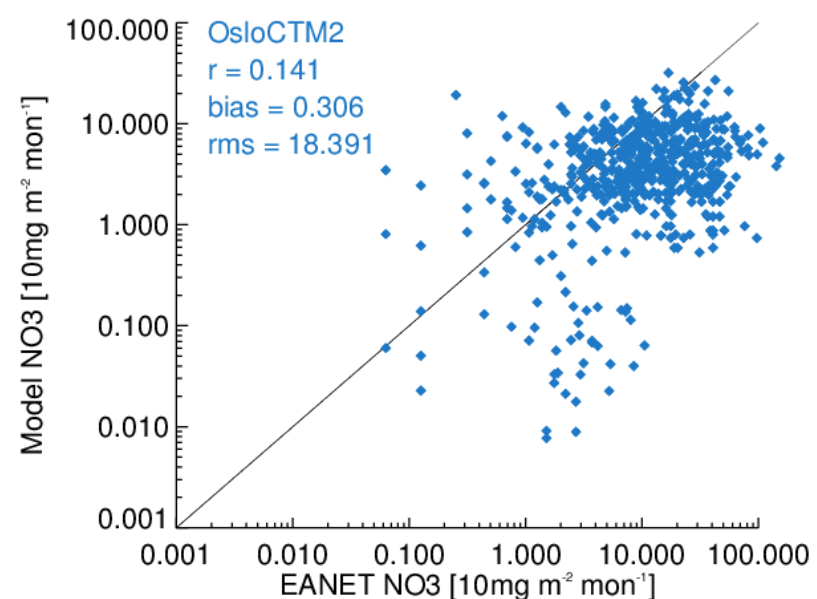
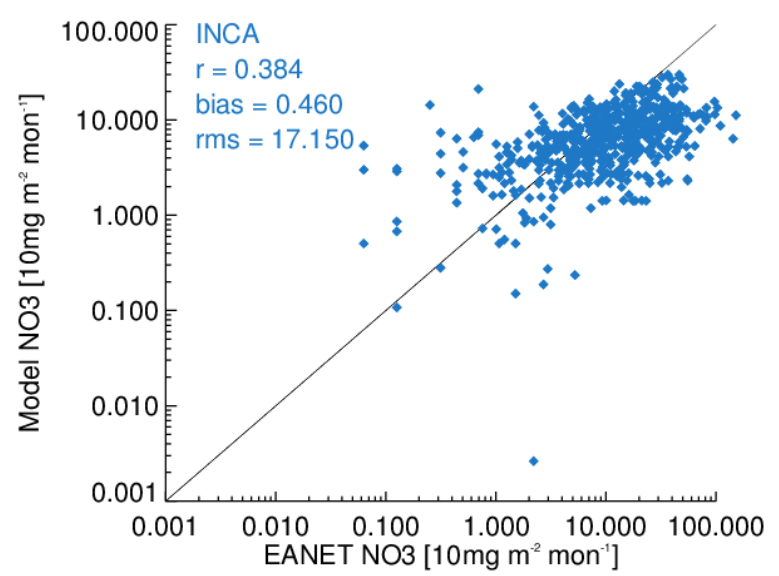
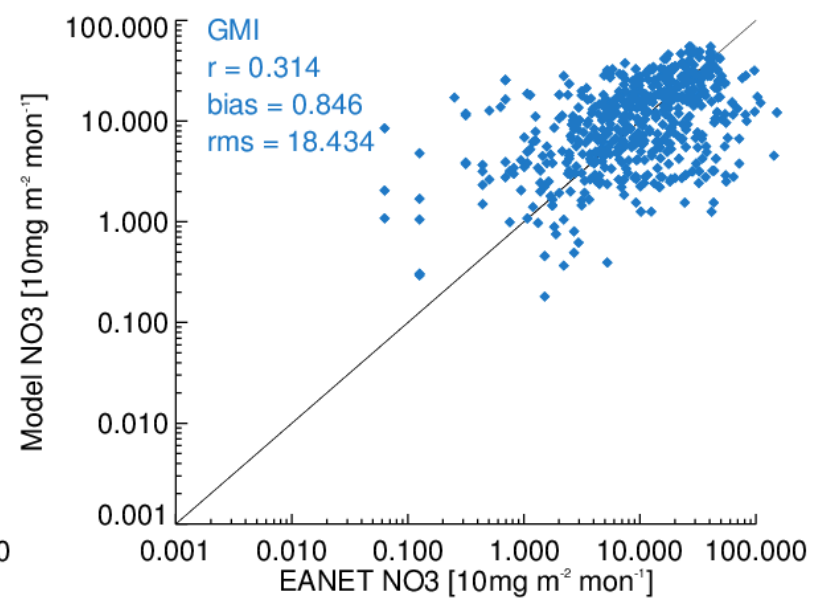
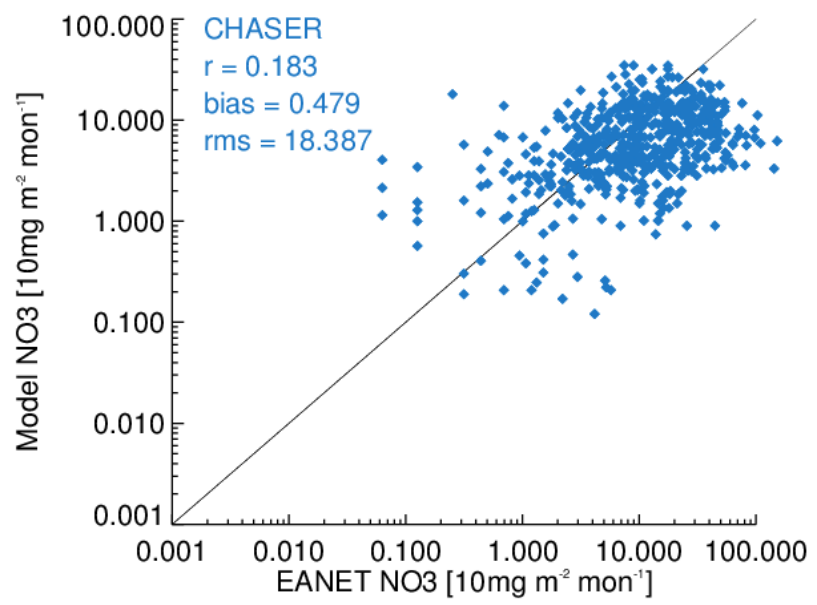
# Dry deposition of NO<sub>3</sub> between model and **Castnet** measurement (USA)



# Wet deposition of NO<sub>3</sub>+HNO<sub>3</sub> between model and **NADP NTN** measurement (USA)

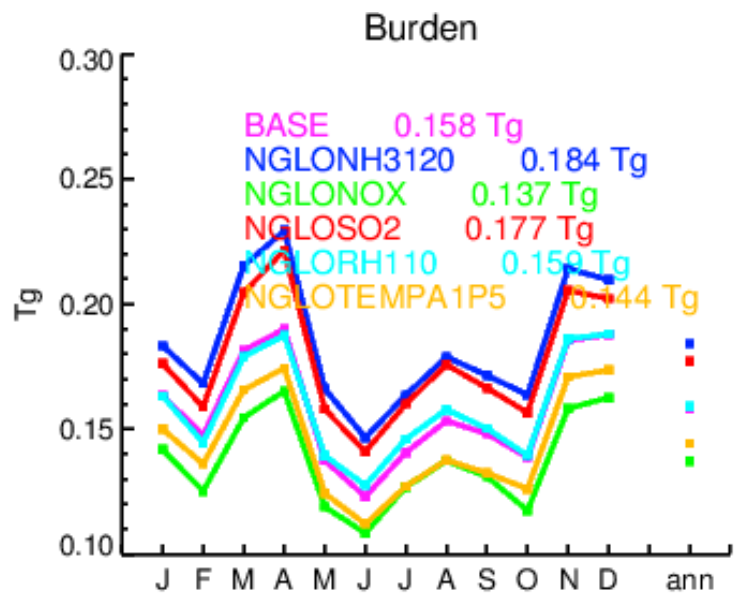


# Wet deposition of HNO<sub>3</sub>+NO<sub>3</sub> between model and EANET measurement (East Asia)

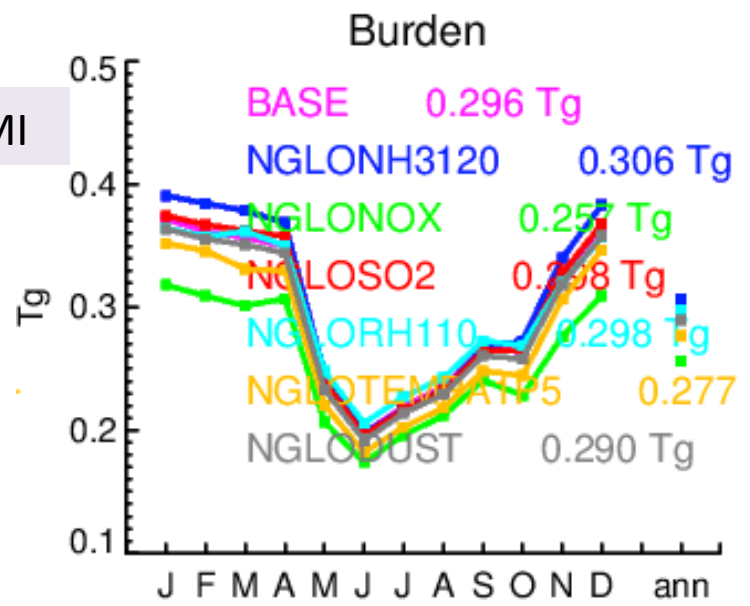


# Global burden of NO3

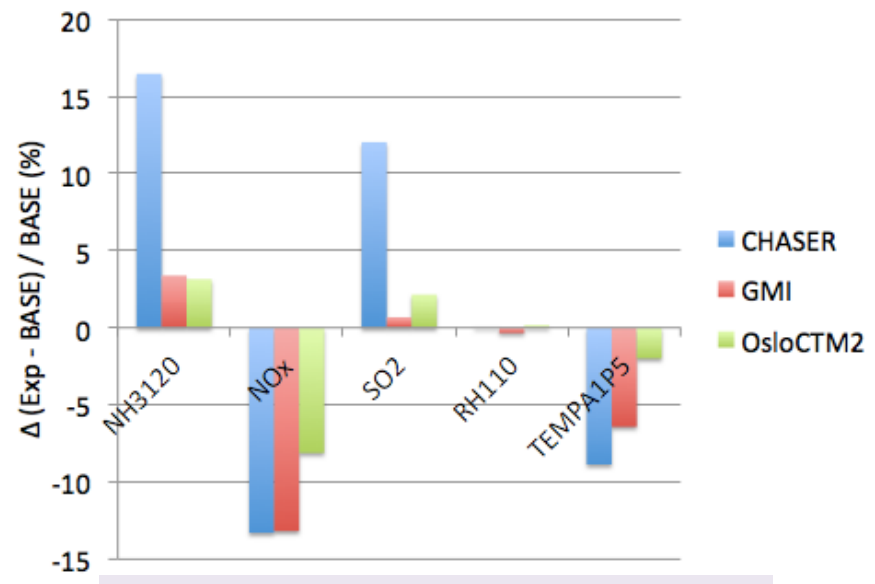
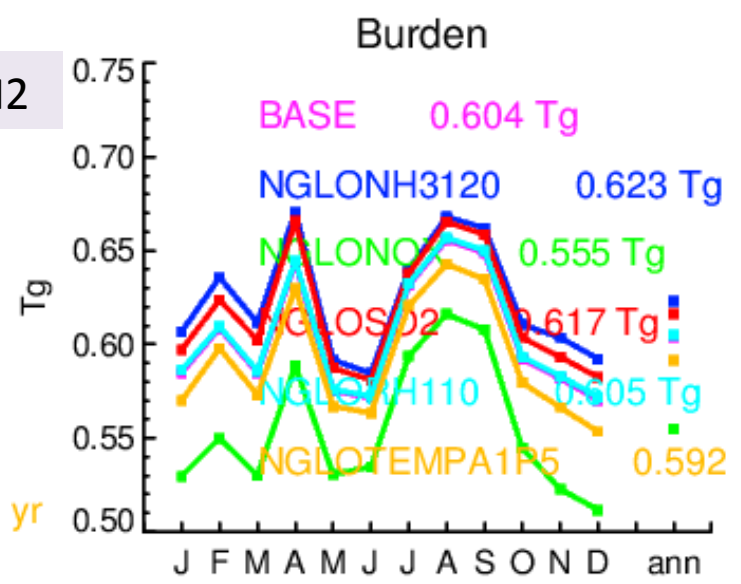
CHASER



GMI



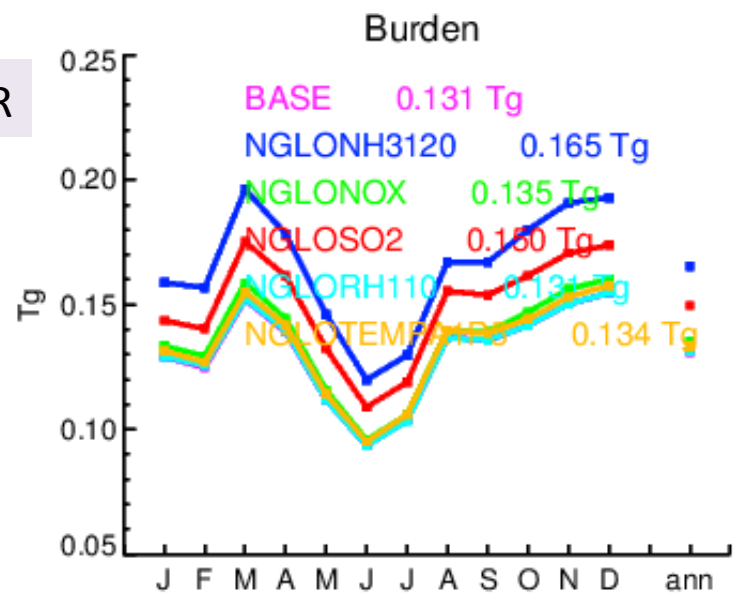
OsloCTM2



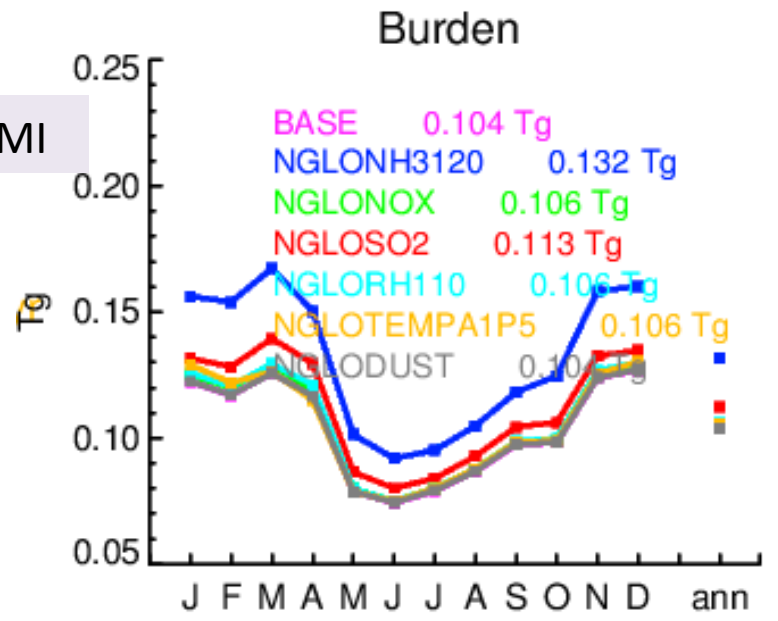
RH110 => RH+(100-RH)x10%

# Global burden of **NH3**

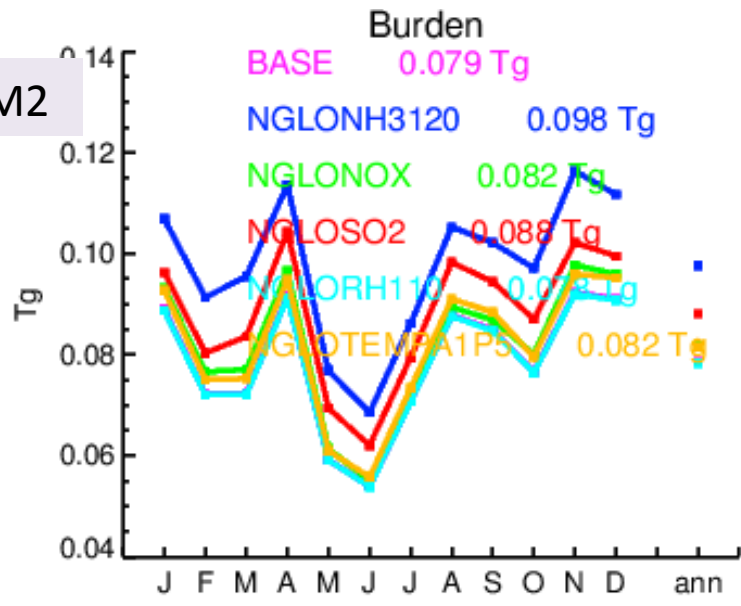
CHASER



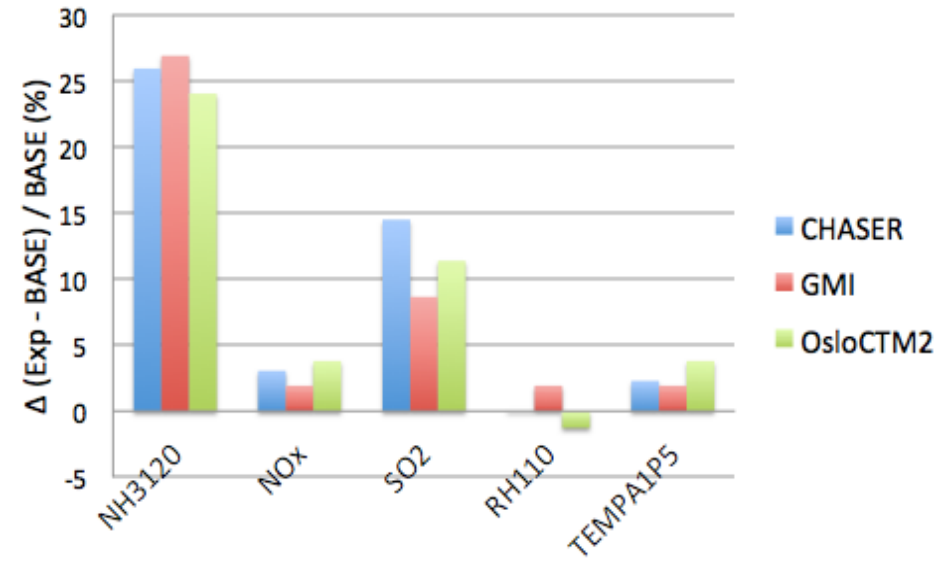
GMI



OsloCTM2



## NH3 (Tg)



### Base case study:

- The diversity of NO<sub>3</sub> simulation is larger than that of SO<sub>4</sub>. The mean global burden of NO<sub>3</sub> is ~1/4 of that of SO<sub>4</sub> in 2008.
- It needs further investigation of the vertical transport, seasonal variation, and ratio of fine and coarse mode NO<sub>3</sub> among models.
- Suggest potential improvements:
  - CHASER: check NH<sub>4</sub> dry/wet deposition, NO<sub>3</sub>/HNO<sub>3</sub> partition
  - GMI: check NO<sub>3</sub> dry deposition
  - OsloCTM2: check NO<sub>3</sub> dry deposition, NO<sub>3</sub>/HNO<sub>3</sub> partition

### Perturbation study:

- The models give same direction but different magnitude of NO<sub>3</sub> in response to proposed perturbations in emission and temperature fields.
- It requires further analysis of NO<sub>3</sub> response in regional basis.

Things on to do list: aerosol water, AOT, forcing

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