# Modeling of inorganic and organic aerosol particles using GEOS Chem

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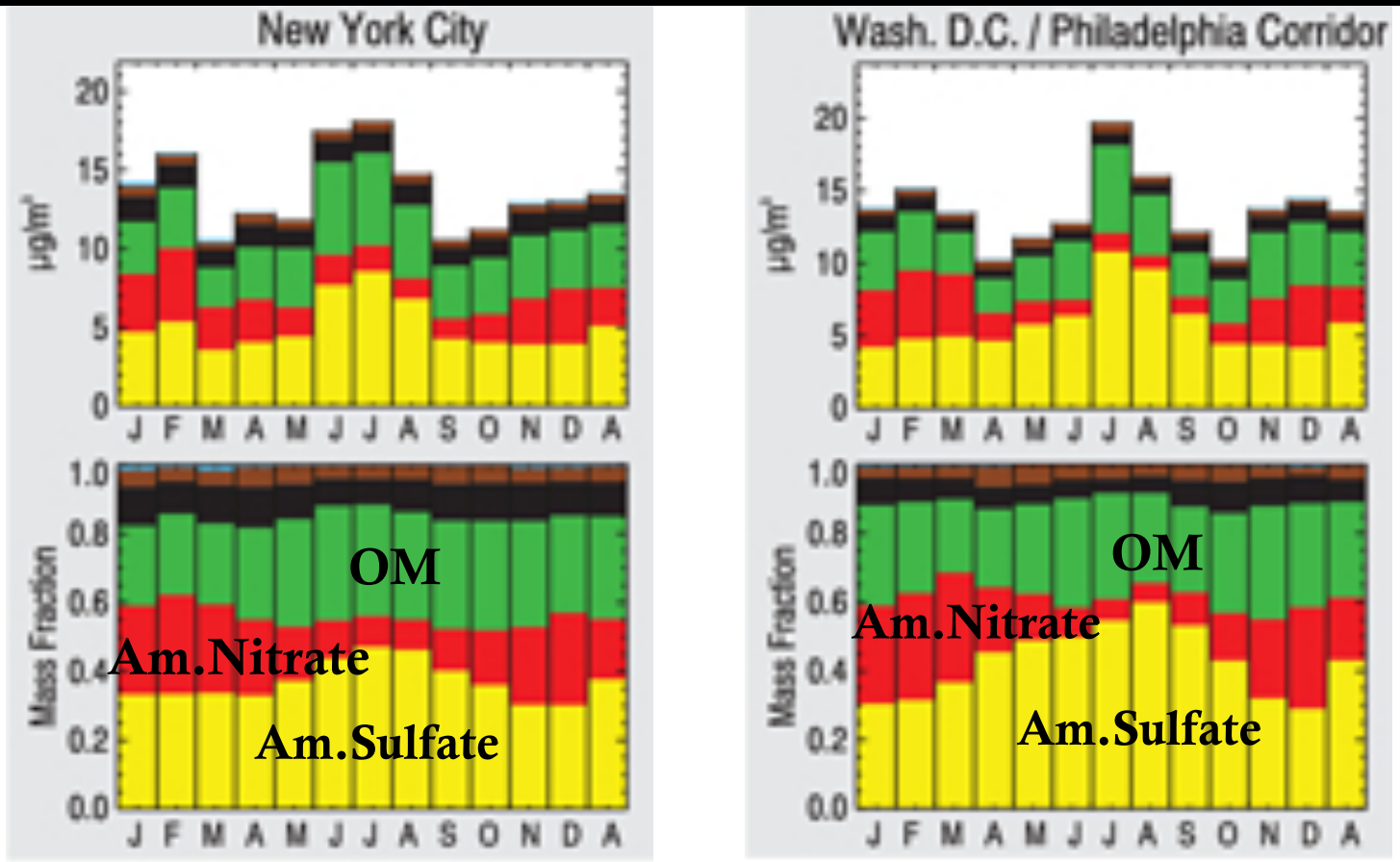
# Motivation

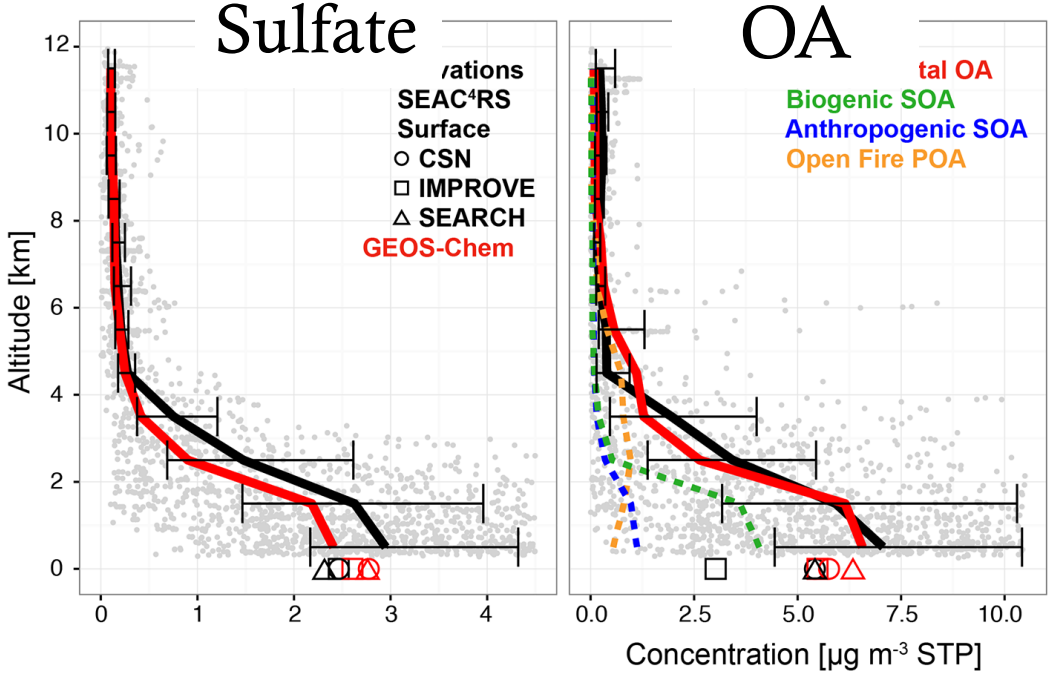



(Hand et al., 2012)

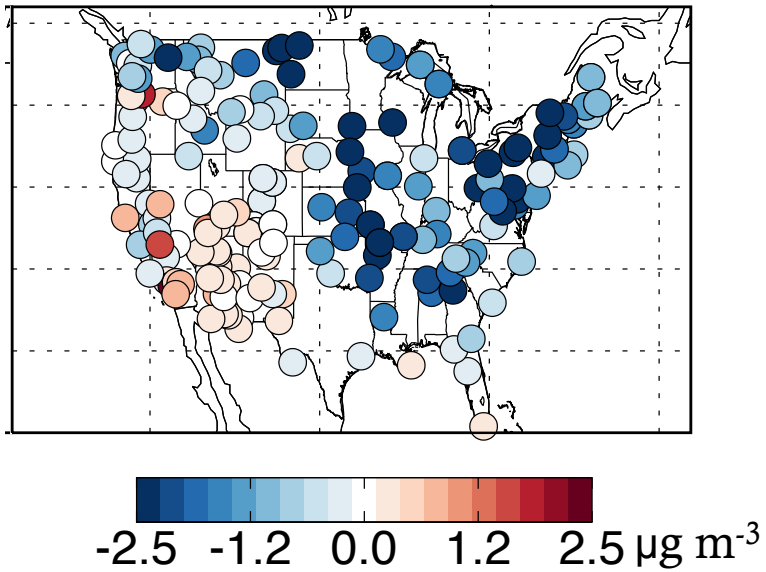
**Goal: Understand the controls on the distribution of aerosols over northeastern US in winter.**

# Comparisons with observations

Vertical profiles during SEAC⁴RS
(Kim et al., 2015)




$pNO_3$ at IMPROVE sites
Obs-Model (DJF)
(Heald et al., 2012)

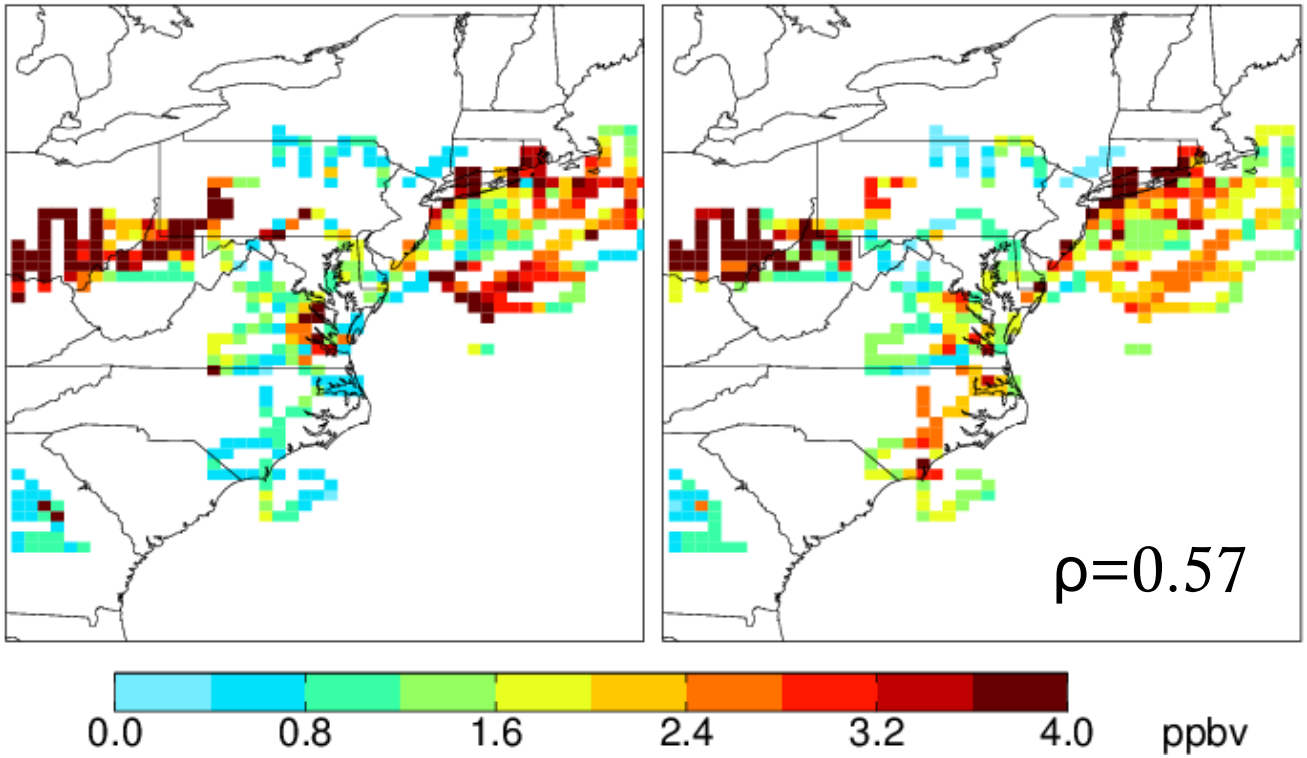



**How well does GEOS Chem simulate wintertime aerosols over northeastern US?**

# Total sulfur below 800m

Observations
1.5 [0.8-3.0] ppbv

GEOS Chem
1.6 [1.2-2.6] ppbv



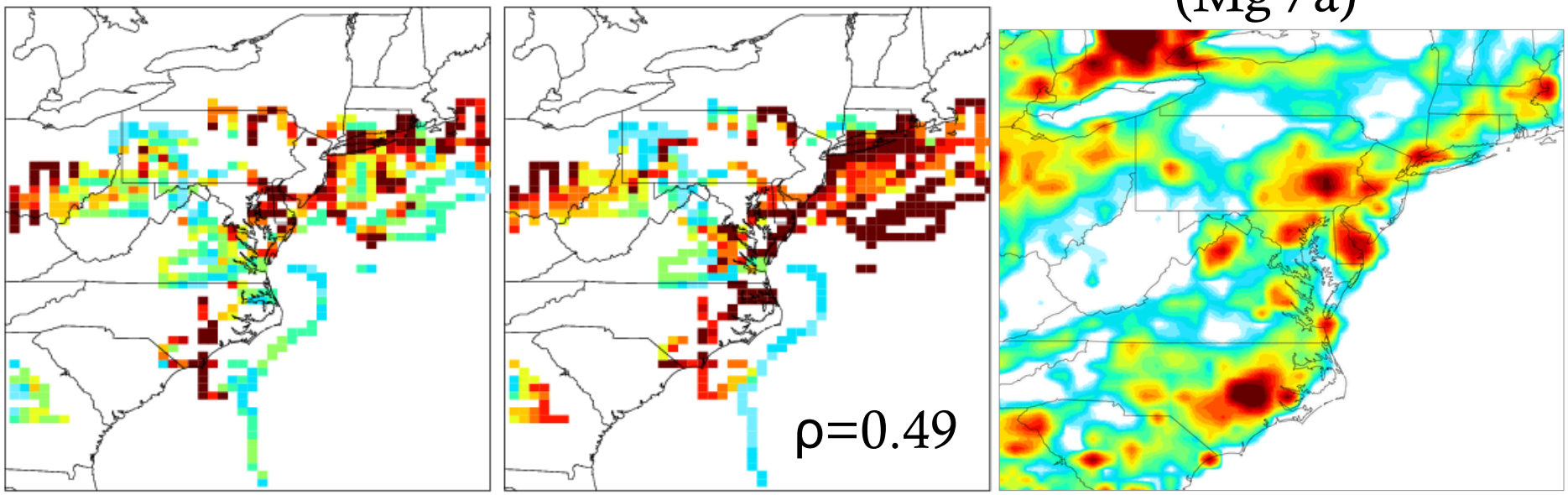

**Modeled $SO_2$ emissions are reasonable**

# Total ammonia below 800m

Observations*
0.92 [0.5-1.5] ppbv

GEOS Chem
1.3 [0.8-1.9] ppbv

$NH_3$ emissions
(Mg /a)

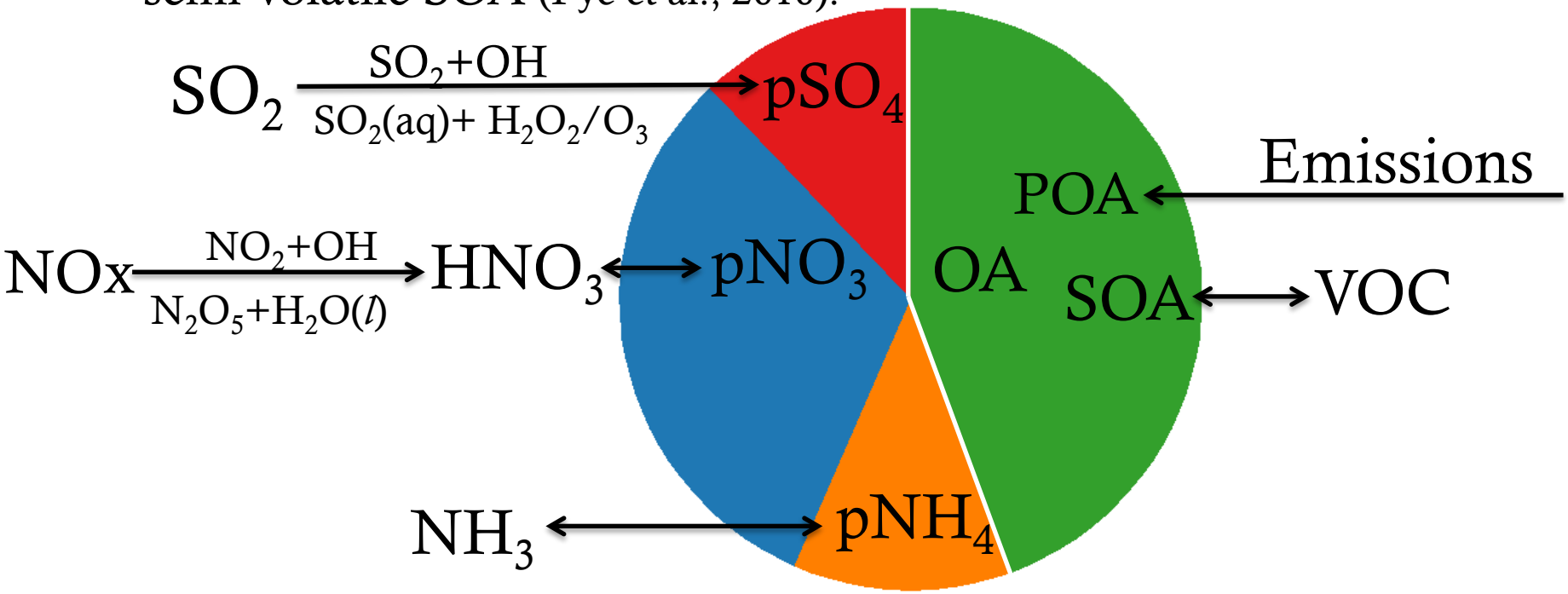



*estimated

**Modeled $NH_3$ emissions are moderately correlated.**

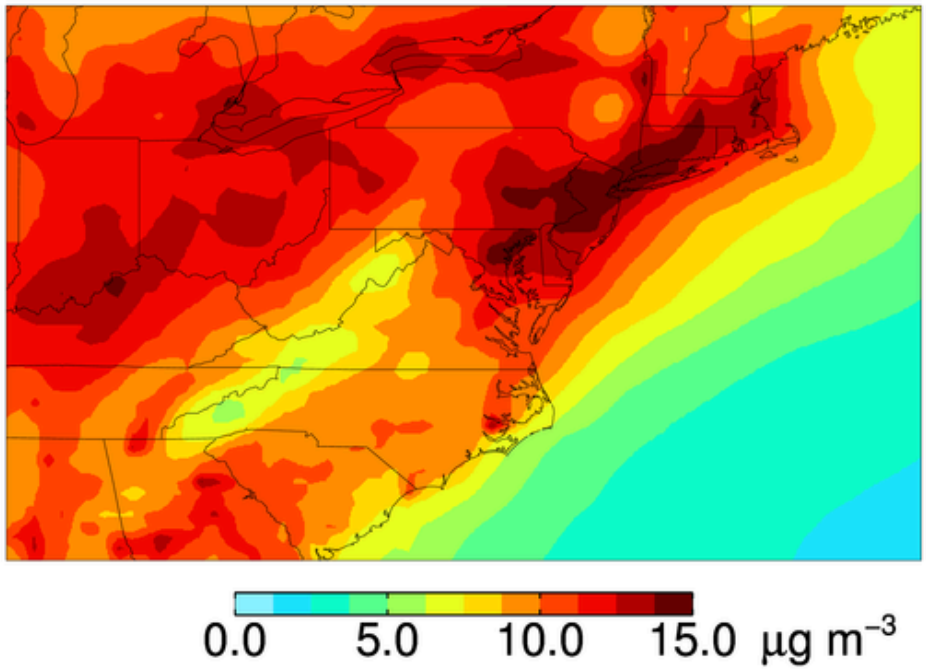
# Overview of the aerosol model

- Bulk SNA and organic aerosols (Park et al., 2003; 2004).
- Separate size-resolved seasalt (Jaeglé et al., 2011) and dust (Fairlie et al., 2007)
- Equilibrium partitioning of SNA: ISORROPIA II (Fountoukis and Nenes, 2007; Pye et al., 2009)
- Nonvolatile primary organic aerosol (POA) (Park et al., 2003) & semi-volatile SOA (Pye et al., 2010).

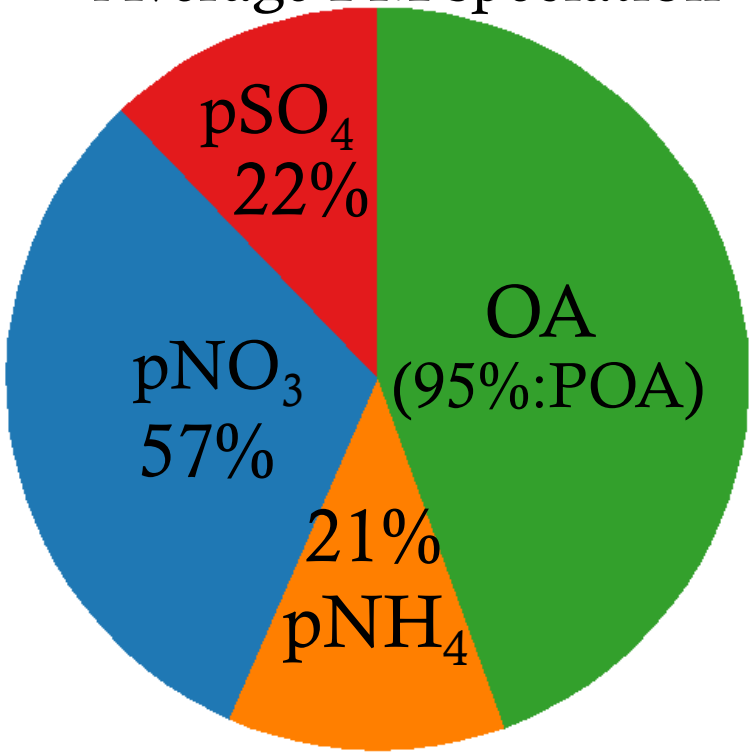


# Modeled PM during WINTER

Mean PM in bottom 1 km



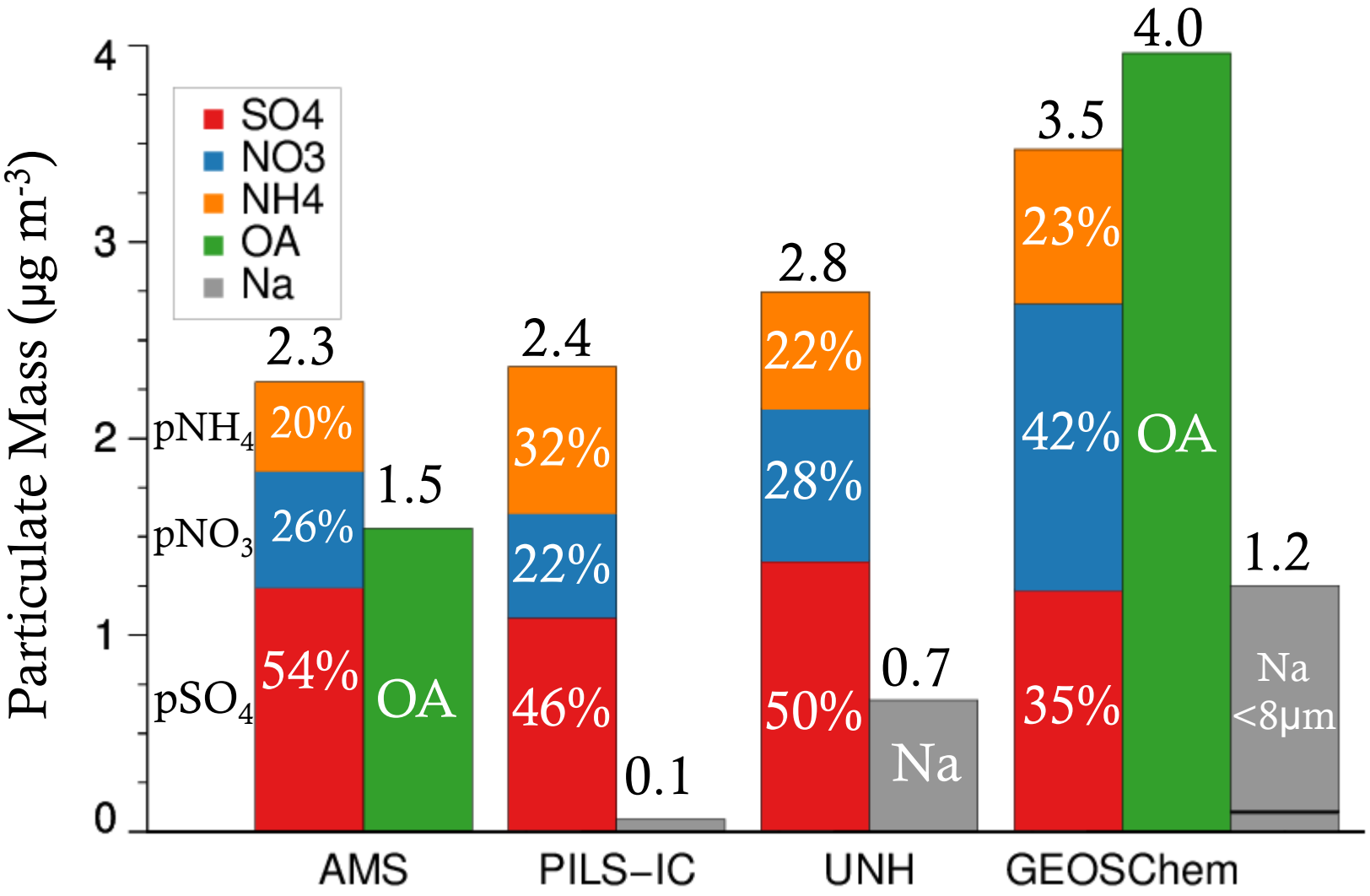

Average PM speciation



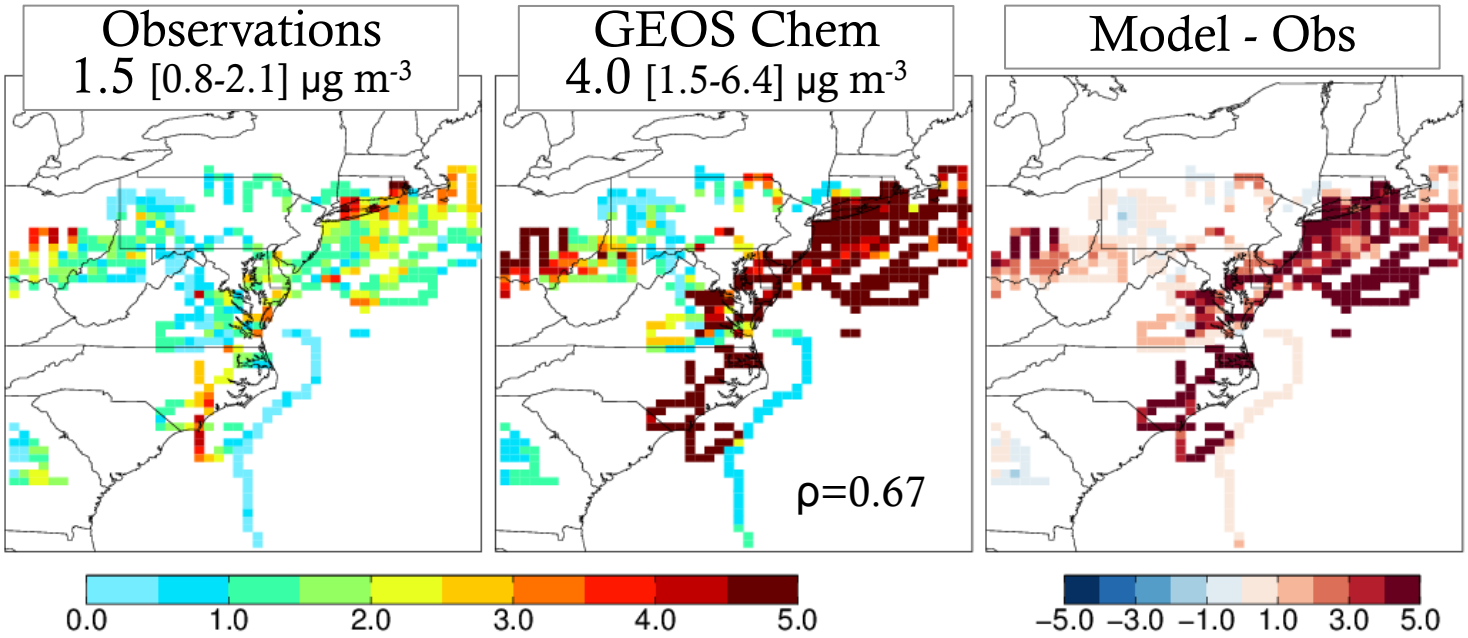

Median SNA
4.9 μg $m^{-3}$

Median OA
3.8 μg $m^{-3}$

# PM concentration below 800m



# Organic aerosol

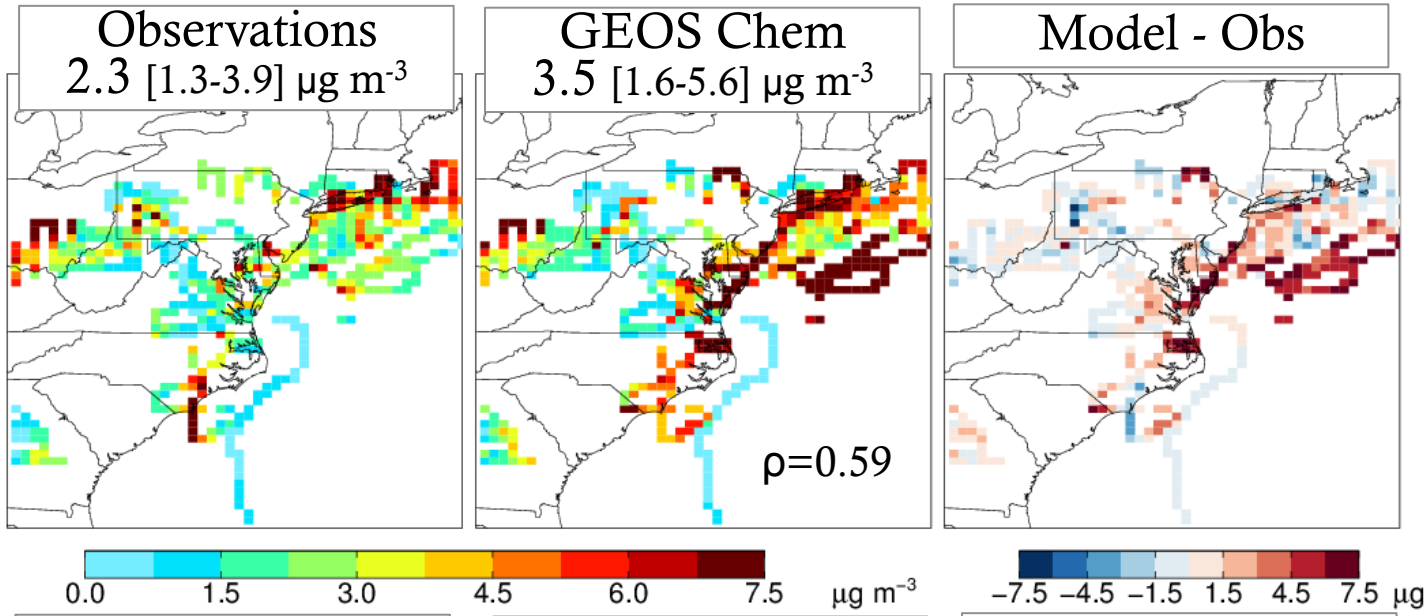



Organic aerosol is a factor of 3 high.

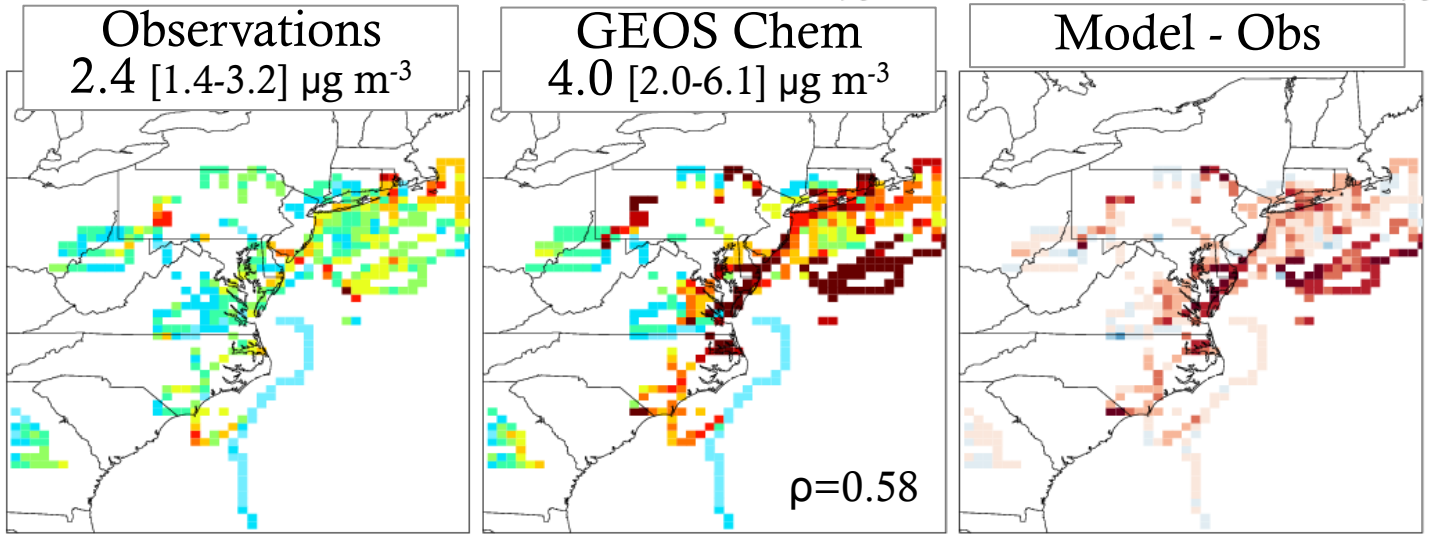
- OM/OC ratio?
- Emissions overestimated?

# SNA distribution (below 800m)

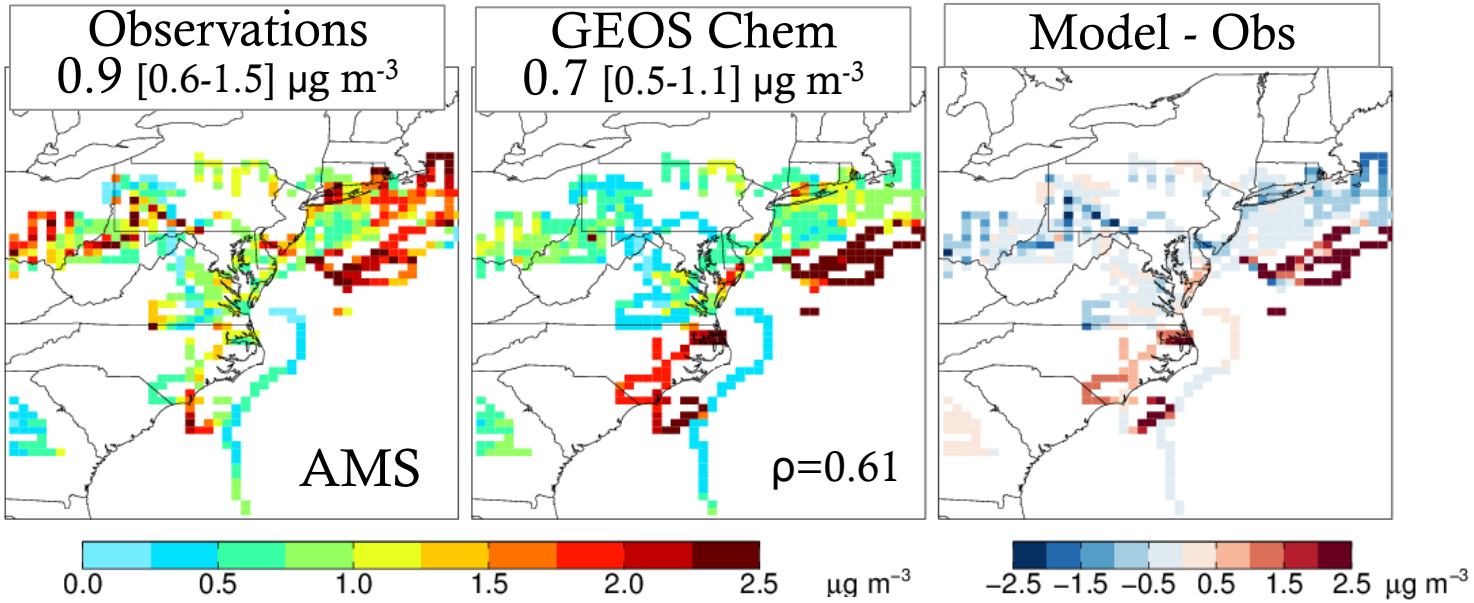
AMS



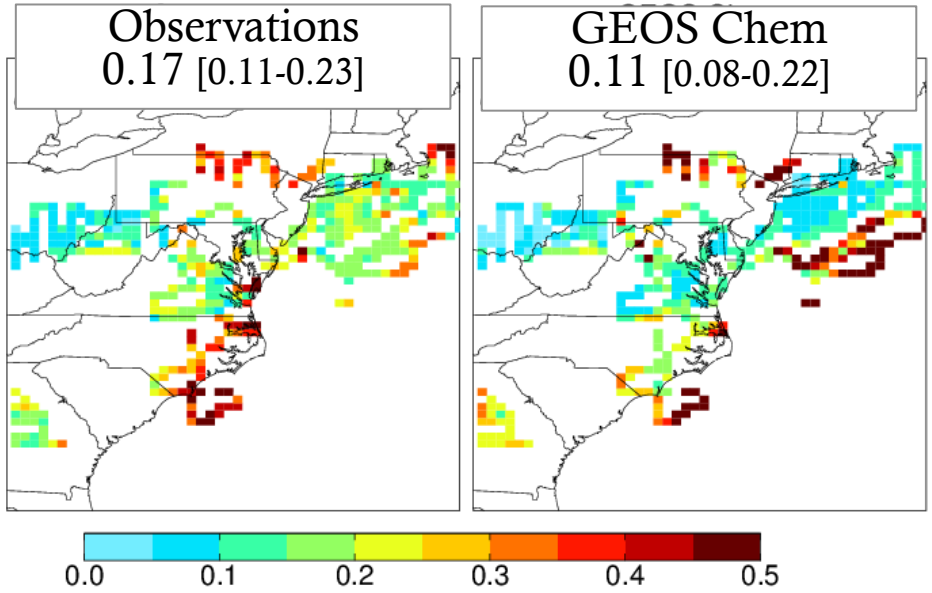

PILS



# $pSO_4$ distribution (below 800m)

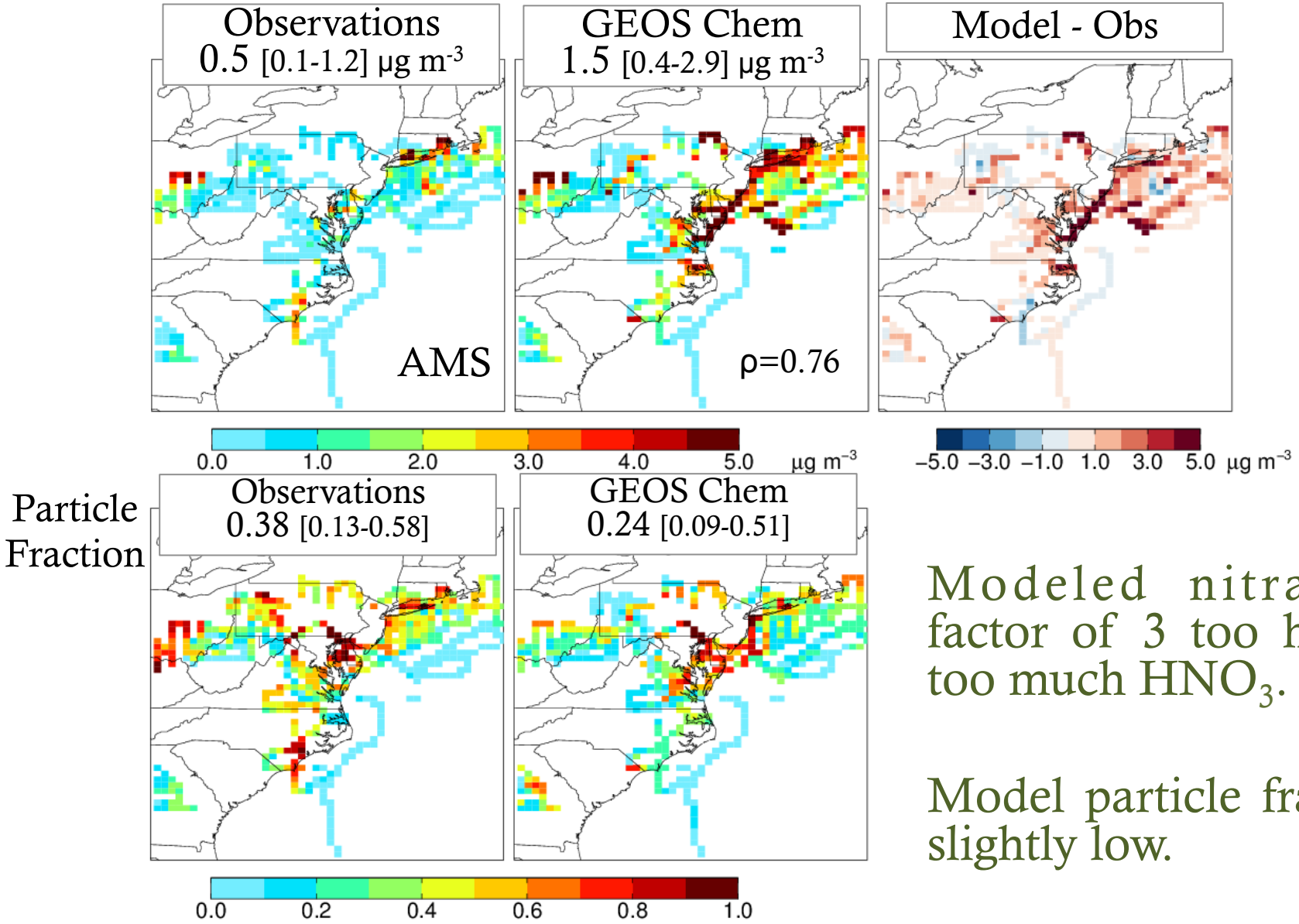



Particle Fraction




Modeled sulfate & particle fractions slightly low.

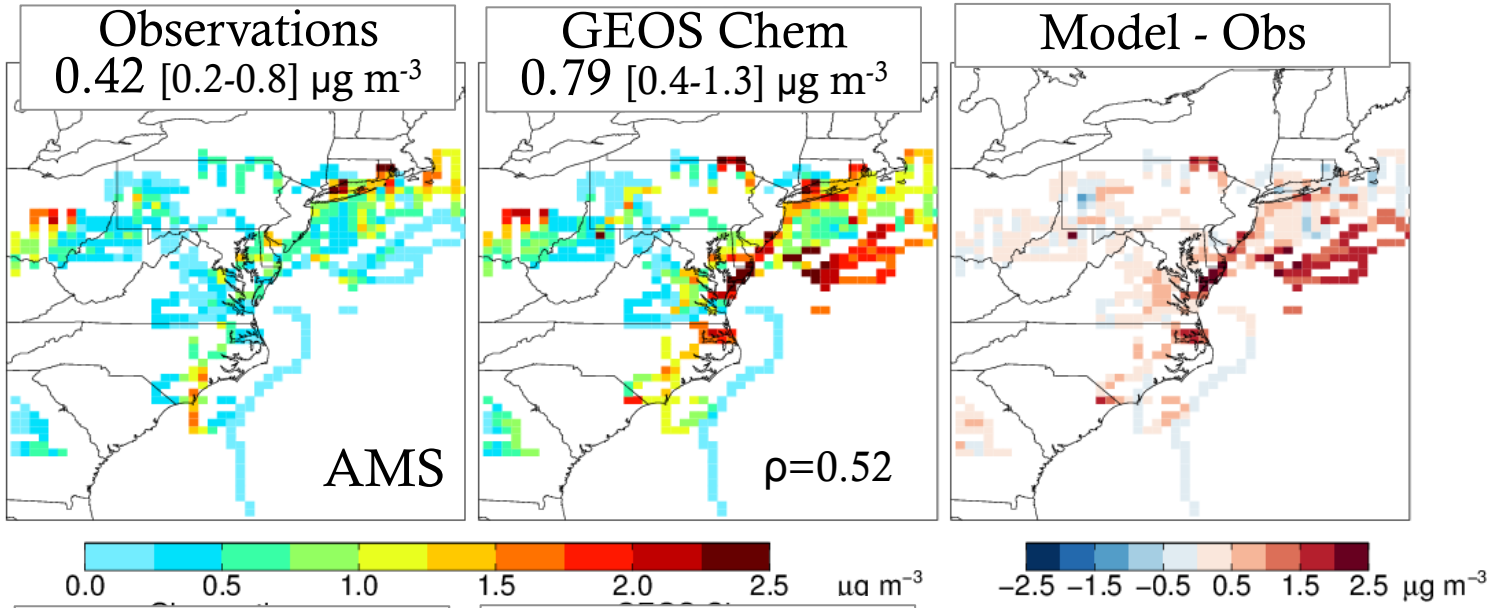
# $pNO_3$ distribution (below 800m)



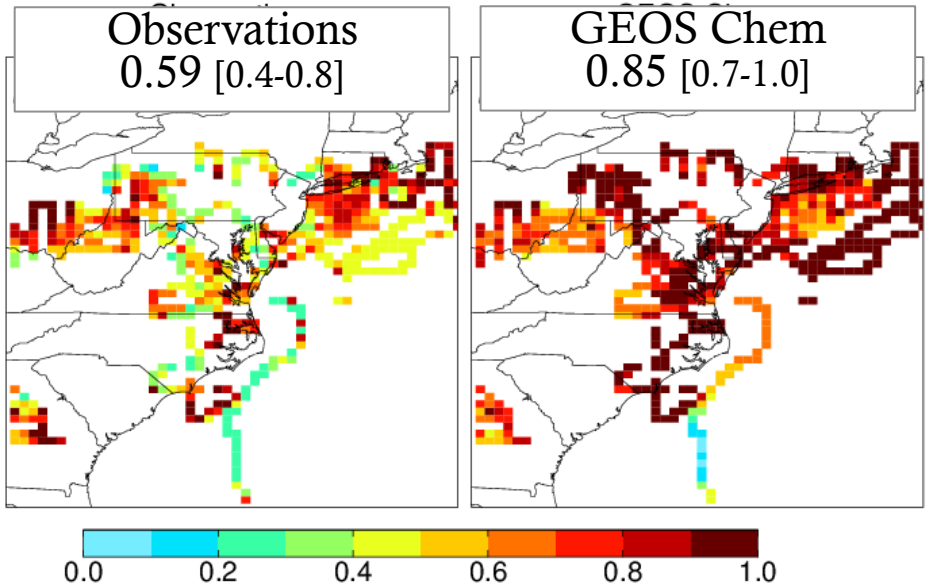

Modeled nitrate a factor of 3 too high – too much $HNO_3$.

Model particle fraction slightly low.

# $pNH_4$ distribution (below 800m)




Particle Fraction

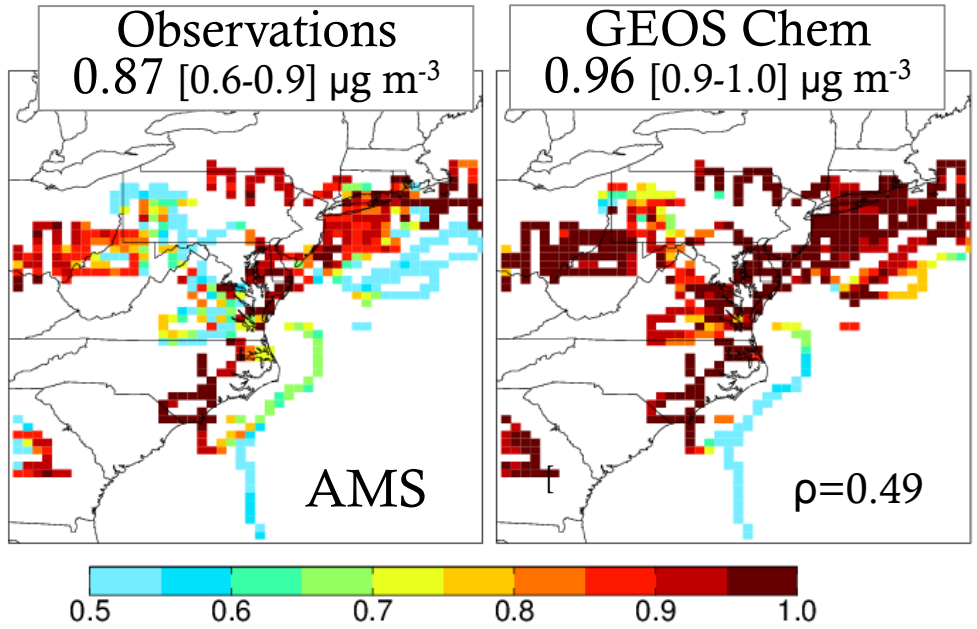


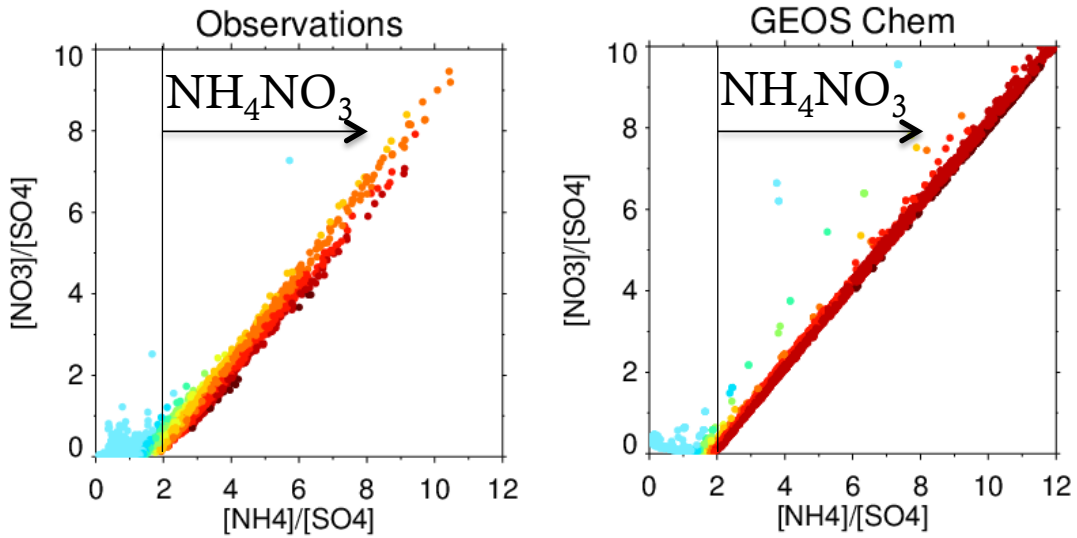

Model ammonium a factor of 2 too high – too much $HNO_3$.

Model particle fraction is too high.

# Aerosol neutralization

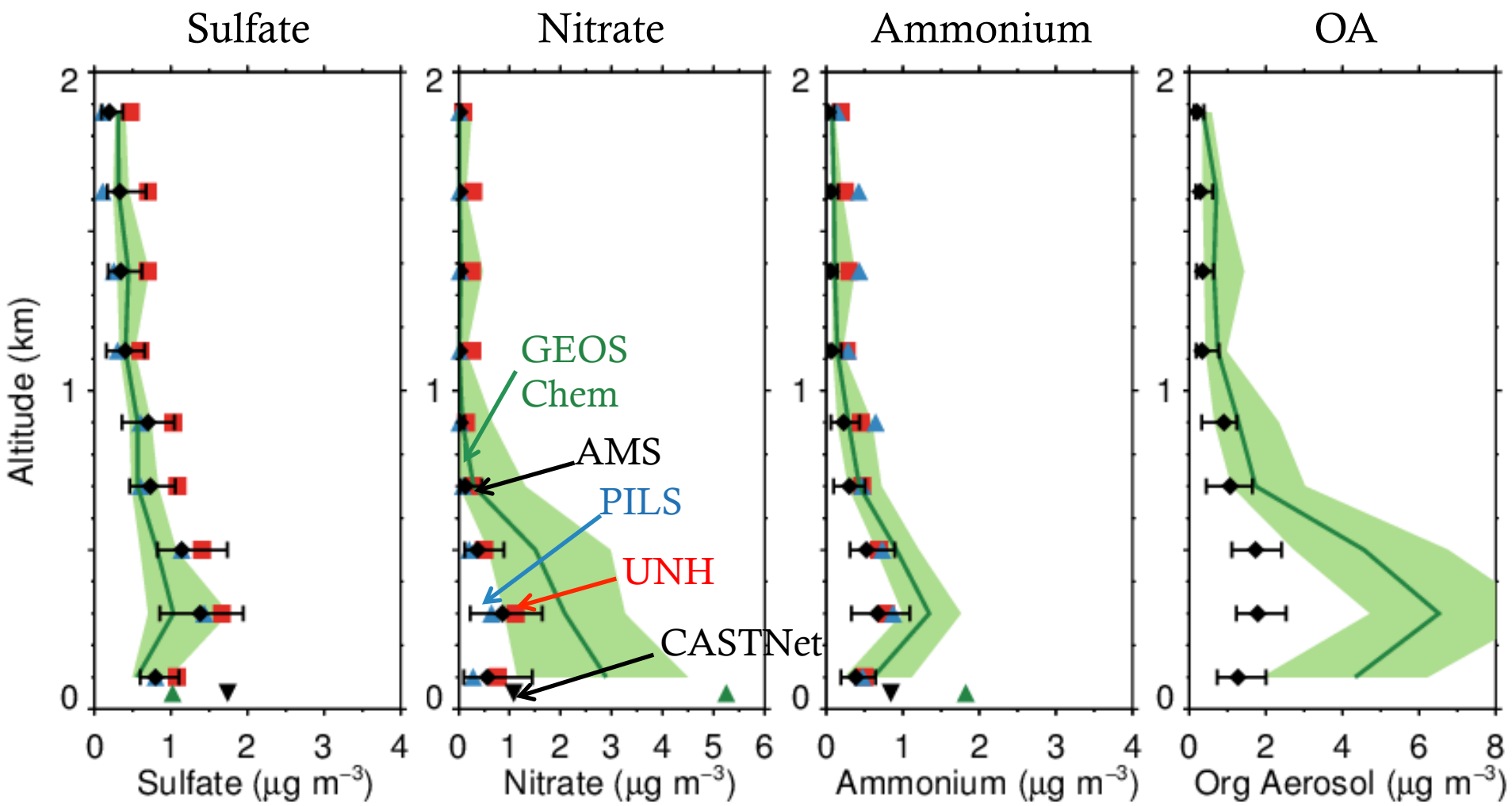
$$\frac{[NH_4]}{2[SO_4]+[NO_3]}$$




Larger fraction of aerosol neutralized in the model.

# Vertical profiles



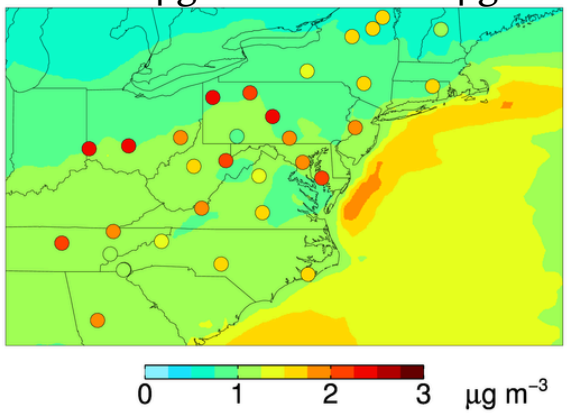
# Next steps

- Determine contributions of $pSO_4$ and $pNO_3$ formation pathways.
- Constrain emissions of OA based on WINTER data.
- Include surface observations from EPA AirData and NADP sites.
- Compare modeled AOD with satellite retrievals.

# CASTNet observations

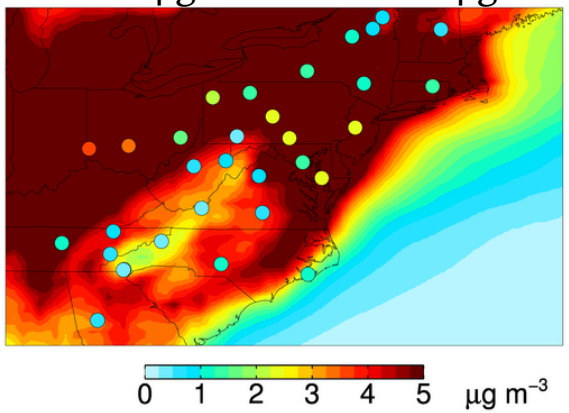
## $pSO_4$

Obs: 1.7μg $m^{-3}$ Model: 1.0μg $m^{-3}$



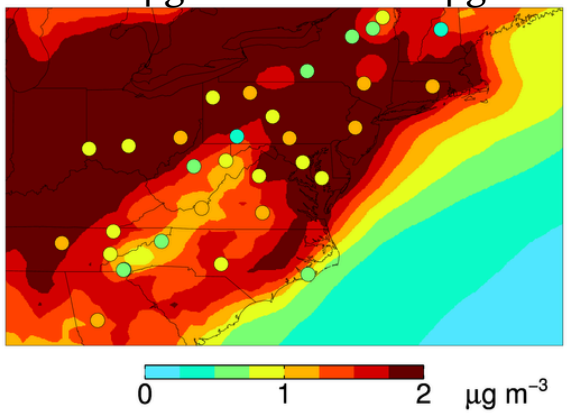

## $pNO_3$

Obs: 1.1μg $m^{-3}$ Model: 5.2μg $m^{-3}$



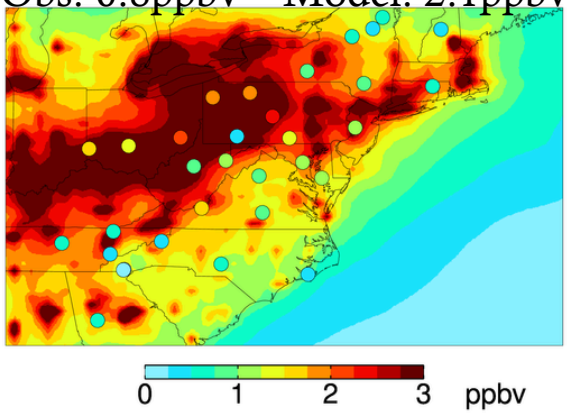

## $pNH_4$

Obs: 0.8μg $m^{-3}$ Model: 1.8μg $m^{-3}$




## $SO_2$

Obs: 0.8ppbv Model: 2.1ppbv




- Modeled $SO_2$ too high, $pSO_4$ too low.
- $pNO_3$, $NH_4$ too high.
- Are PBL heights in the model low?