Assimilating Remote Ammonia Observations with a Refined Aerosol Thermodynamics Adjoint

Shannon Capps[1], Daven Henze[2], Karen Cady-Pereira[3], Zhe Jiang[4], Rob Pinder[1], Armistead Russell[5], Athanasios Nenes[5]

[1]US Environmental Protection Agency
[2]University of Colorado, Boulder
[3]Atmospheric and Environmental Research, Inc.
[4]NASA Jet Propulsion Laboratory | Caltech
[5]Georgia Institute of Technology

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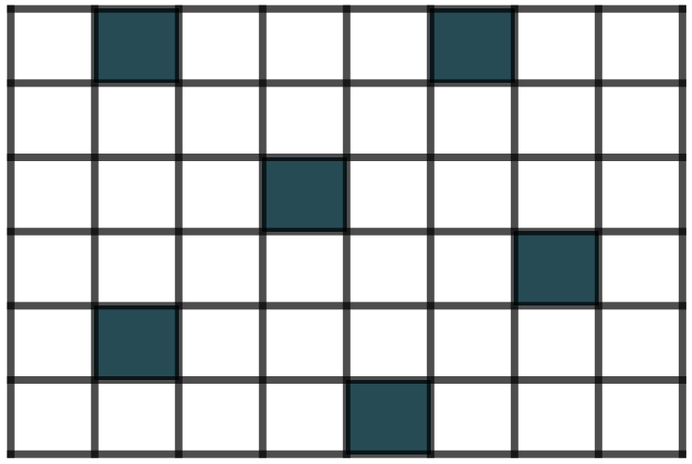
Assimilation Approach

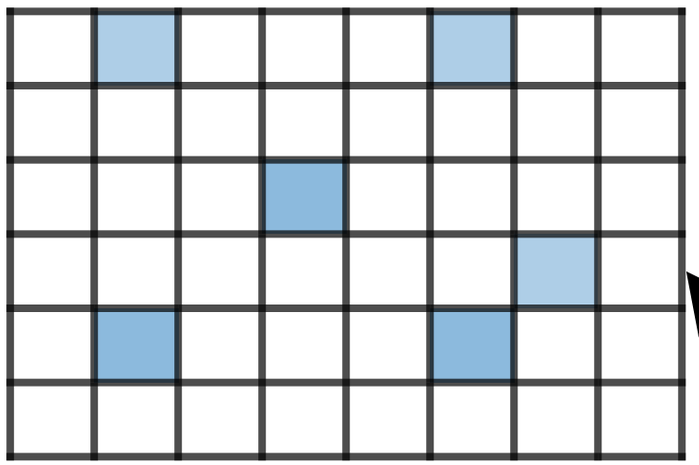
Iteratively minimize *J*

$$\mathcal{J} = \frac{1}{2}\sum_{\mathbf{c}\in\Omega}(H\mathbf{c} - (\mathbf{c}_{obs} - \mathbf{b}))^T \mathbf{S}_{obs}^{-1}(H\mathbf{c} - (\mathbf{c}_{obs} - \mathbf{b})) + \frac{1}{2}\gamma(\boldsymbol{\sigma} - \boldsymbol{\sigma}_a)^T \mathbf{S}_a^{-1}(\boldsymbol{\sigma} - \boldsymbol{\sigma}_a)$$

NH_3 from TES, $\mathbf{c}_{obs}$ - **b**

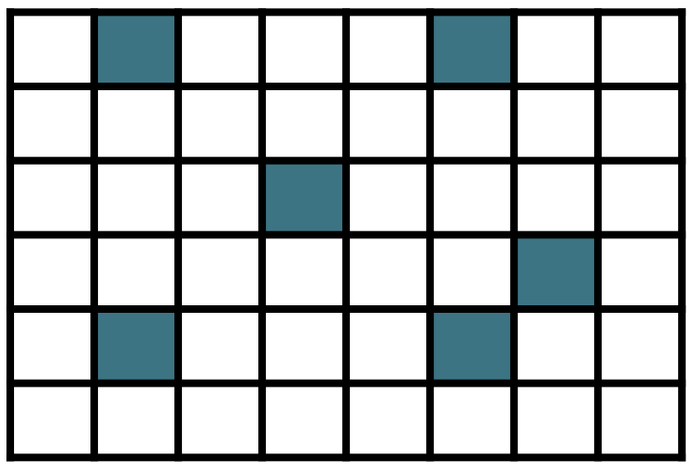


NH_3 from GEOS-Chem, *H***c**

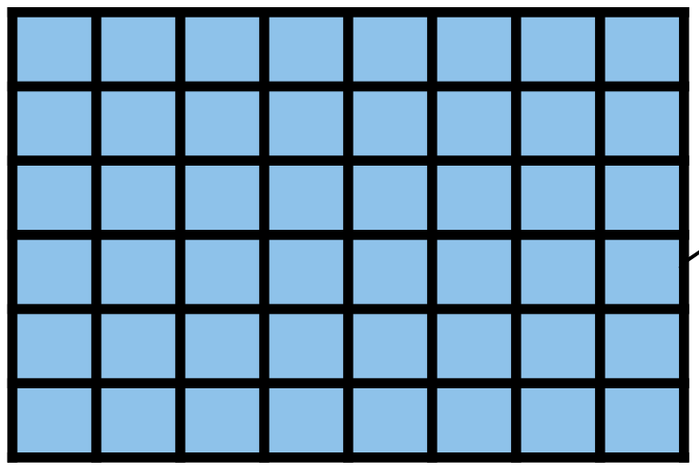


Observation operator, H

Observation error & *a priori* weighted difference, *J*



Modeled concentrations, **c**



Zhu et al., 2013, JGR

Assimilation Approach

GEOS-Chem
North American nested grid 0.5° x 0.66° adjoint
(Zhe Jiang et al.)

TES NH_3 retrievals from special obs & polar orbit
(Lite files from NASA & AER)

Inorganic aerosol thermodynamics ANISORROPIA
(Capps et al., 2012)

Emissions Scaling Factors

∂SO_2

∂NH_3

∂NO_2

NEI2005 currently; aim to use NEI2008
(GCadj v.35)

GEOS-Chem Adjoint

NH_3 from TES

NH_3

∂J

Observation operator, H

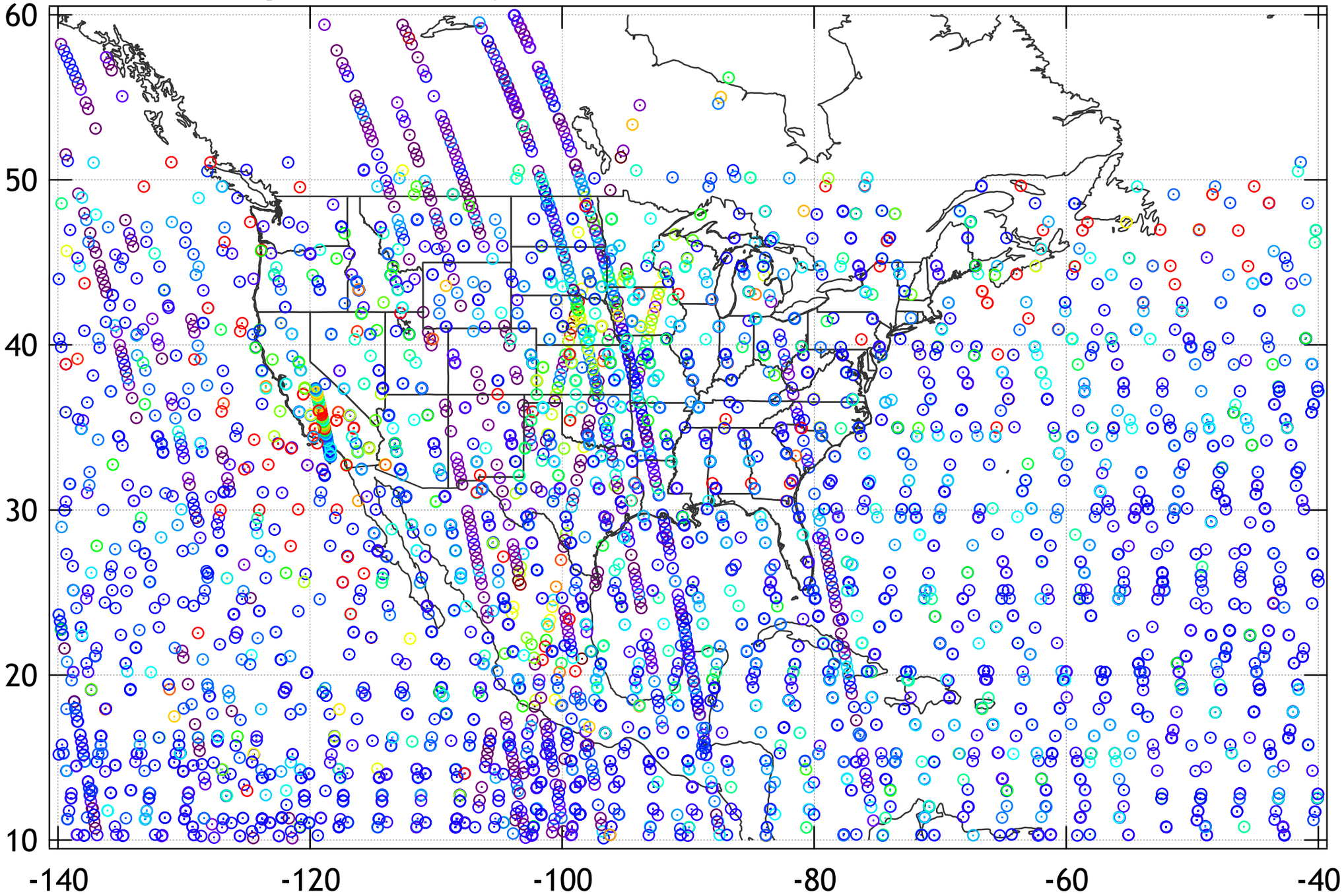
Emissions rates

GEOS-Chem

Modeled concentrations, **c**

TES NH_3 Observations

April - July 2010 | ~28,000 RVMRs



NH_3 Representative Tropospheric Volume Mixing Ratio (ppb)

0 2 4 6 8 10

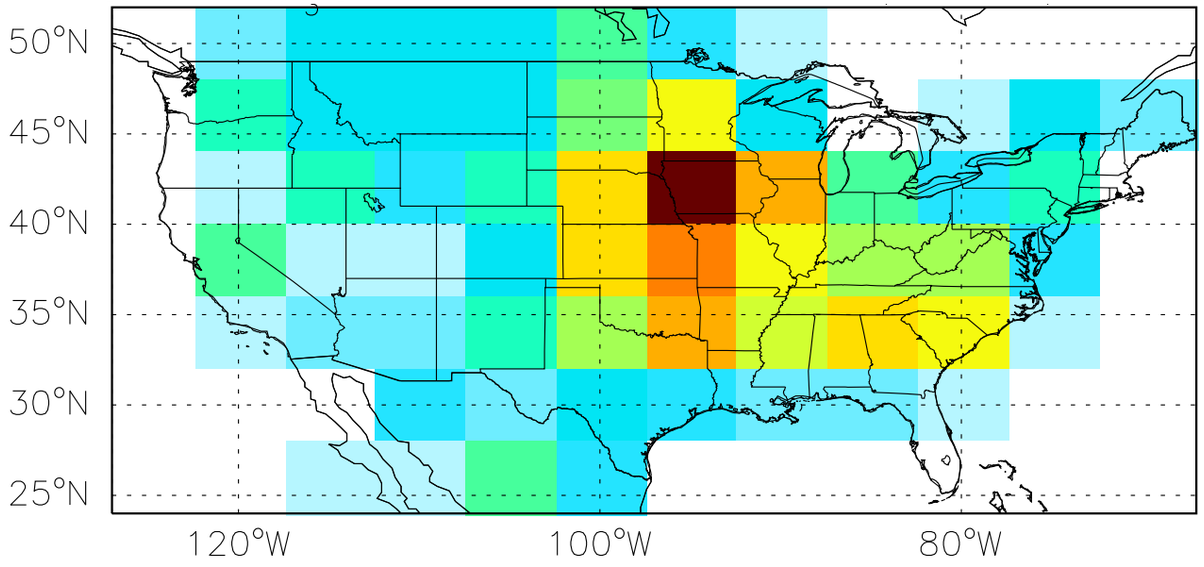
TES Lite Files | tes.jpl.nasa.gov/data/

Refined Aerosol Thermodynamics

August 1-13, 2008

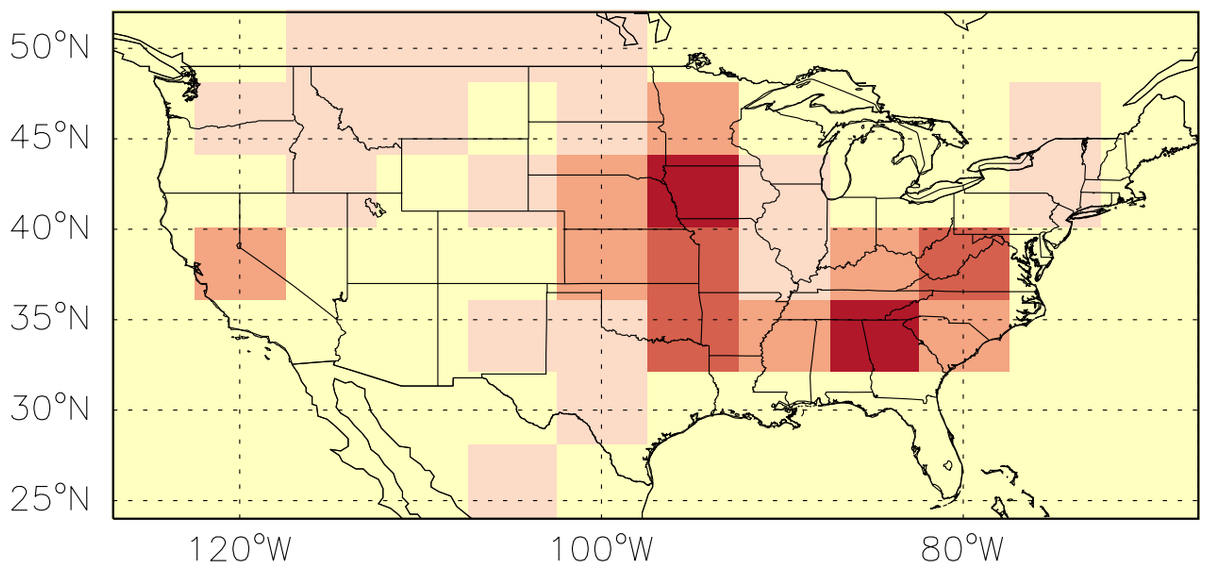
surface NH_3 concentrations

ISORROPIA



0 1.6 3.2 4.8 6.4 8.0 (ppb)

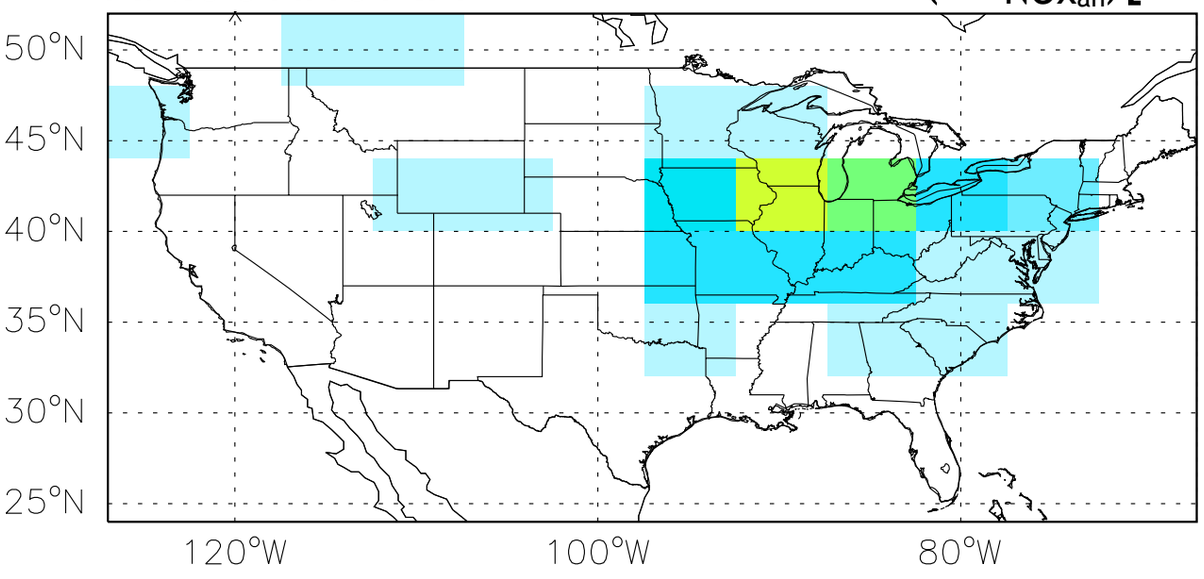
RPMARES - ISORROPIA



-1.5 -0.75 0 0.75 1.5 (ppb)

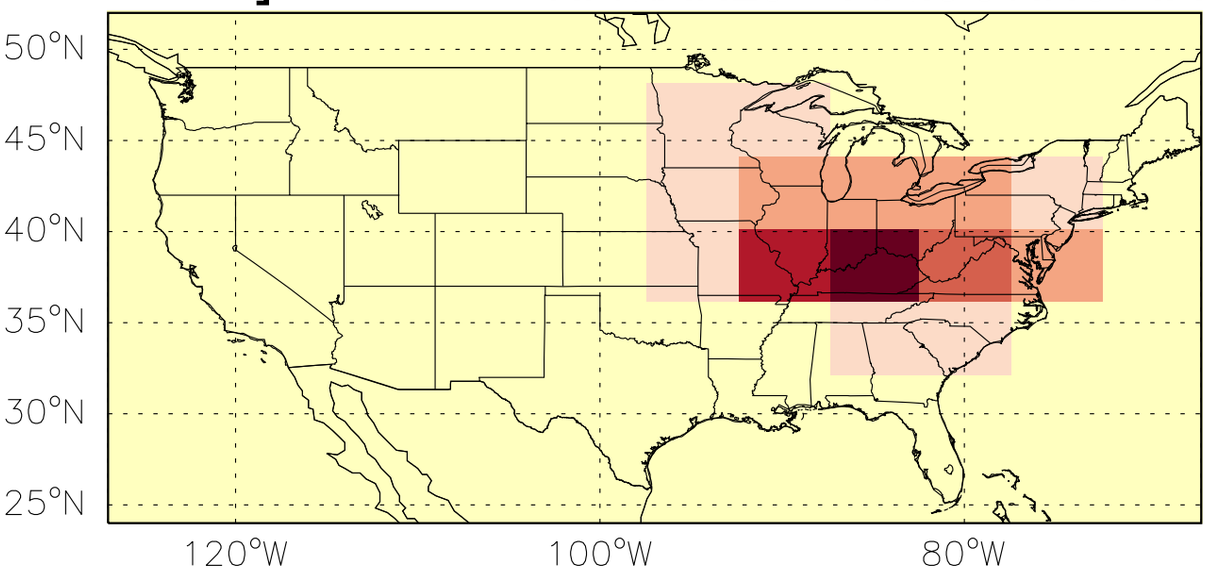
$$\frac{\partial[\text{inorganic aerosol}]}{(\partial\sigma_{NOx_{an}})[\text{inorganic aerosol}]}$$

ANISORROPIA



0 1.4 2.8 4.2 5.6 7.0 x10^{-4} (ppb^{-1})

RPMARES - ANISORROPIA



-7 -3.5 0 3.5 7x10^{-4} (ppb^{-1})

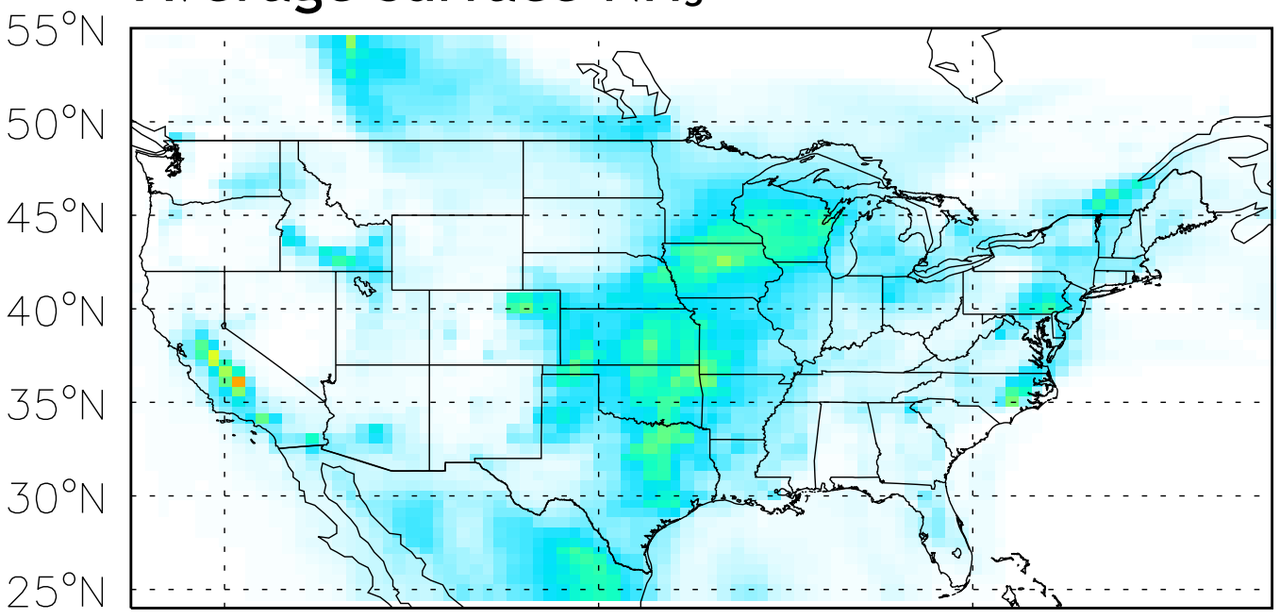
Capps et al., 2012, ACP

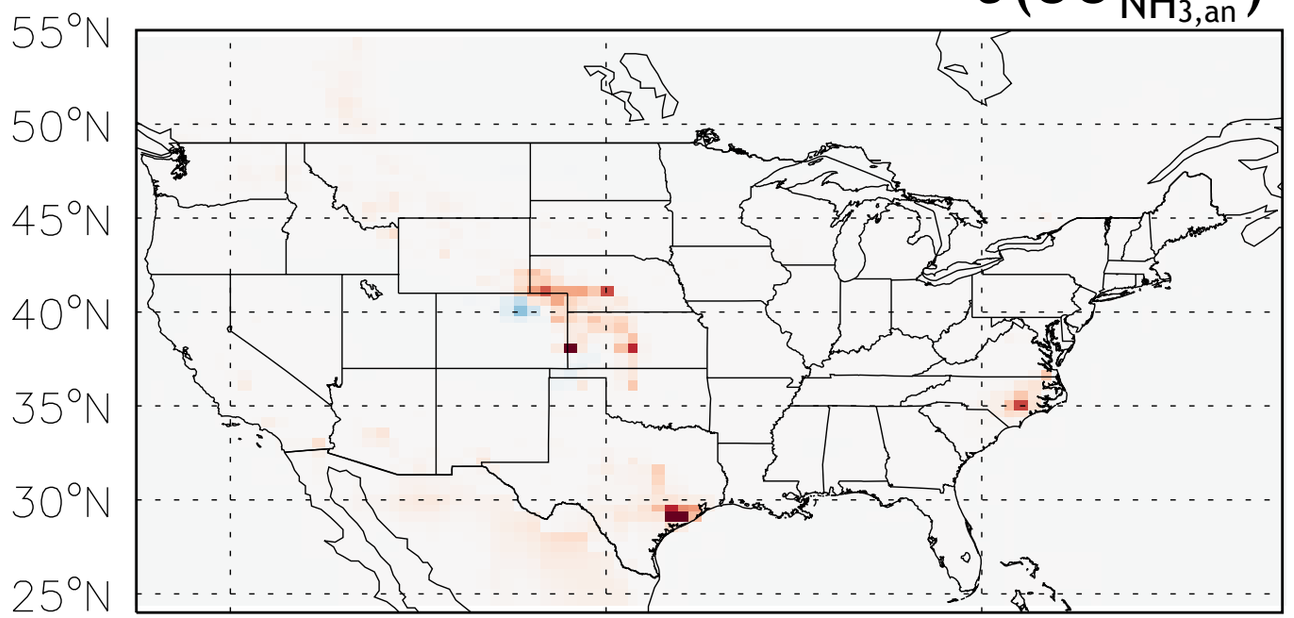
Current Progress in Assimilation

Average surface NH_3

1-3 May 2010

$$\frac{\partial J}{J(\partial \sigma_{NH_3,an})}$$





1-3 Jun 2010