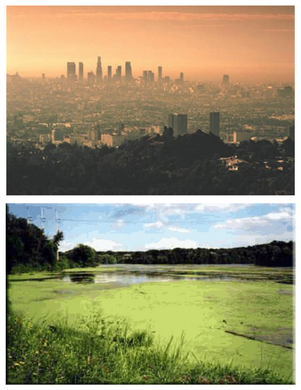
Constraining NH_3 emissions using TES NH_3 observations and surface measurements.

Juliet (Liye) Zhu[1], Daven Henze[1], Jesse Bash[2], Mingzhao Luo[3], Karen Cady-Pereira[4], Robert Pinder[2], Mark Shephard[5], John Walker[2]

1.University of Colorado at Boulder, Mechanical Engineering Department. 2.EPA Research Triangle Park. 3. NASA JPL. 4. AER. 5. Environment Canada

1 Introduction



Why study NH_3 ?

– A substantial fraction of $PM_{2.5}$.

– Health impacts

– Climate change

– Cut visibility

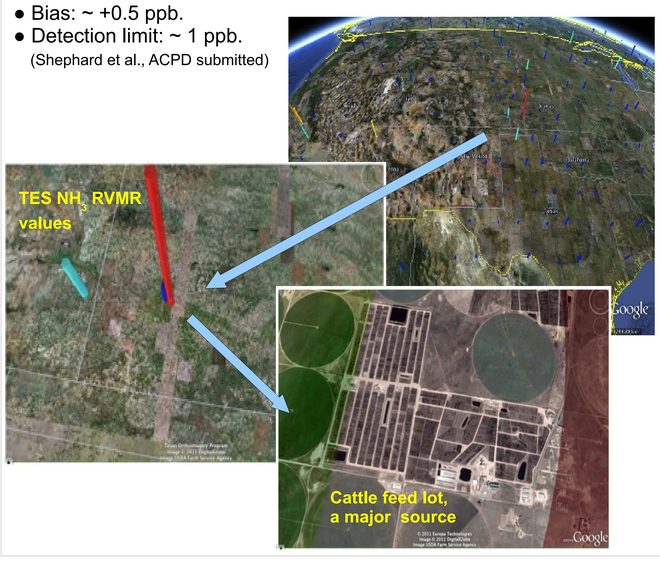
– Deposition (acidification, eutrophication)

2 Objectives and Methods

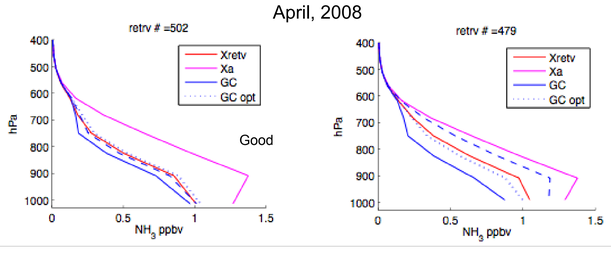
Constrain NH_3 emission using new remote sensing observation (TES NH3 retrievals), NH_3 surface observations (AMoN,LADCO), NH_4^+ wet deposition (NTN) and GEOS-Chem (v8-02-03) adjoint modeling tools.

3 TES: remote sensing of NH_3

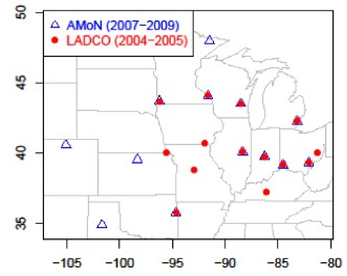
- There are three types of a priori NH_3 profiles from GEOS-Chem:
  - Unpolluted: NH_3 < 1ppbv
  - Moderately Polluted: 1< NH_3 < 5ppbv (below 500 mb)
  - Polluted: NH_3 > 5ppbv (surface)
- TES NH_3 spatial and seasonal trends verified by surface obs. (Pinder et al., 2011)
- Sensitivity to NH_3 peaks at 700~900 hPa.
- Bias: ~ +0.5 ppb.
- Detection limit: ~ 1 ppb. (Shephard et al., ACPD submitted)

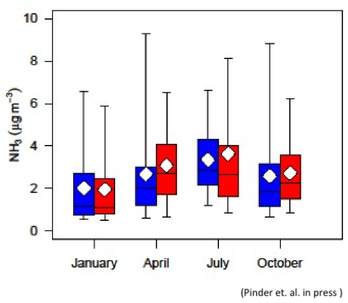


4 Profiles before and after TES assimilation:

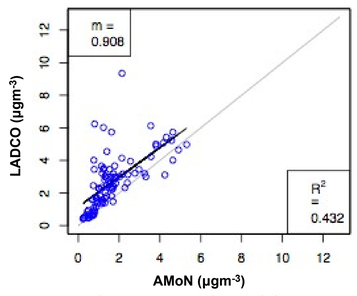


5 AMoN, LADCO: surface obs of NH_3



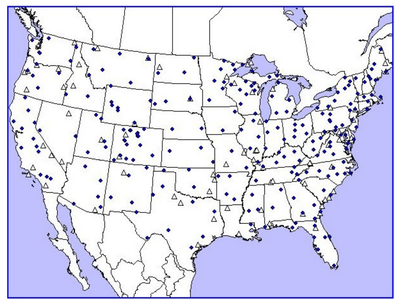


Seasonal ammonia concentrations.



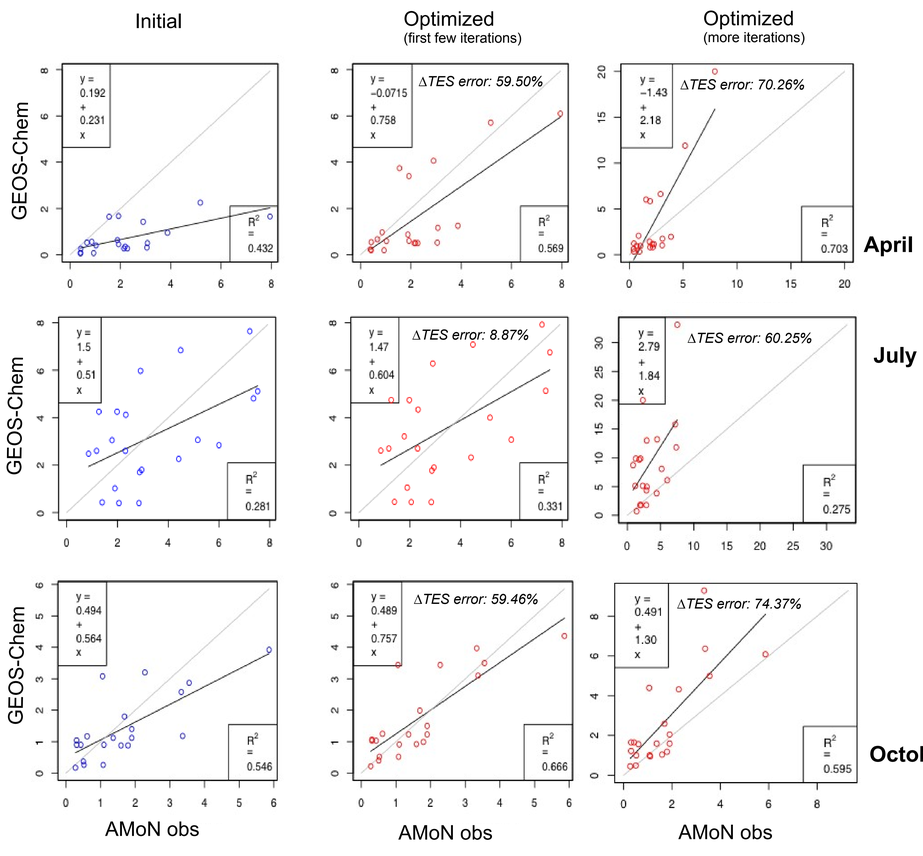
Comparison of LADCO and AMoN for 9 co-locations.

6 NTN/NADP: surface obs of NH_4^+



NTN sites map
* Active sites
Δ Inactive sites

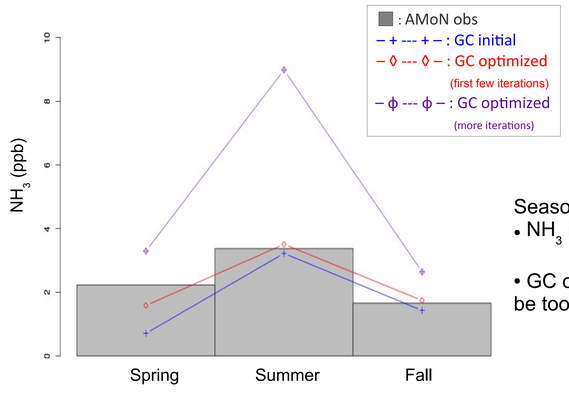
7 Comparison of optimized GEOS-Chem model and AMoN obs: NH_3 (ppb), 2006-2009



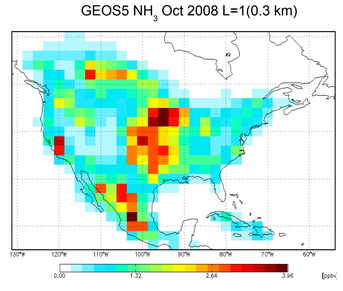
$$\sigma = \ln\left(\frac{emission_{optimized}}{emission_{initial}}\right)$$

- GC NH_3 initially has a low bias compared to AMoN.
- Optimization initially decreases the bias.
- After more iterations, GC NH_3 matches TES better but has a high bias compared to AMoN.

8 Seasonal variance of NH_3 con.

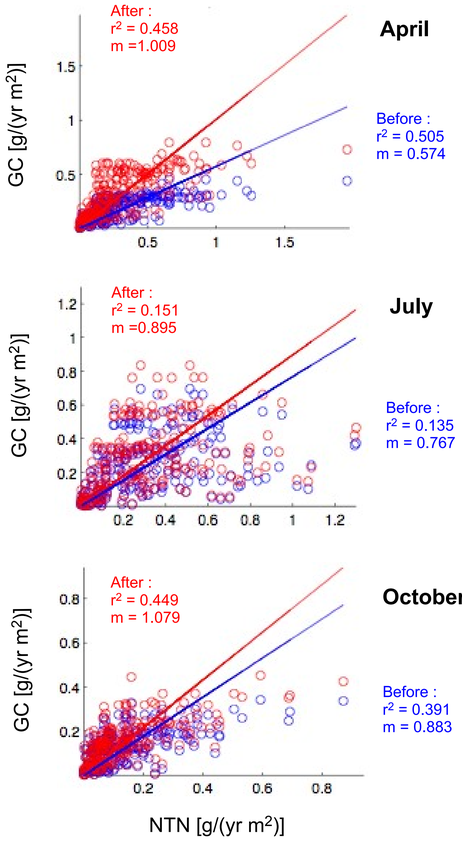


Seasonal variance:
- NH_3 is highest in summer.
- GC optimized values tend to be too high compared to AMoN.



Optimized NH_3 surface concentrations
Grid: 2x2.5

9 Comparison of optimized GEOS-Chem model and NTN wet deposition NH_4^+, 2008



- Generally, wet deposition obs is greater than GC.
- Assimilation of TES NH_3 data reduces the bias with respect to NTN deposition observations.

Reference:

1. Beer, R., M. W. Shephard, S. Kulawik, S. A. Clough, R. A. Eldred, K. W. Bowman, S. P. Sander, B. M. Fisher, V. H. Payne, M. Luo, G. B. Osterman, and J. R. Worden.: First satellite observations of lower tropospheric ammonia and methanol, Geophys. Res. Lett., 35, L09801, doi:10.1029/2008GL033642. 2008
2. Henze, D. K., Hakami, A., and Seinfeld, J. H.: Development of the adjoint of GEOS-Chem, Atmos. Chem. Phys., 7, 2413-2433, 2007.
3. Henze, D. K., Seinfeld, J. H. and Shindell, D. T.: Development of the adjoint of GEOS-Chem, Atmos. Chem. Phys., 9, 5877-2009.
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