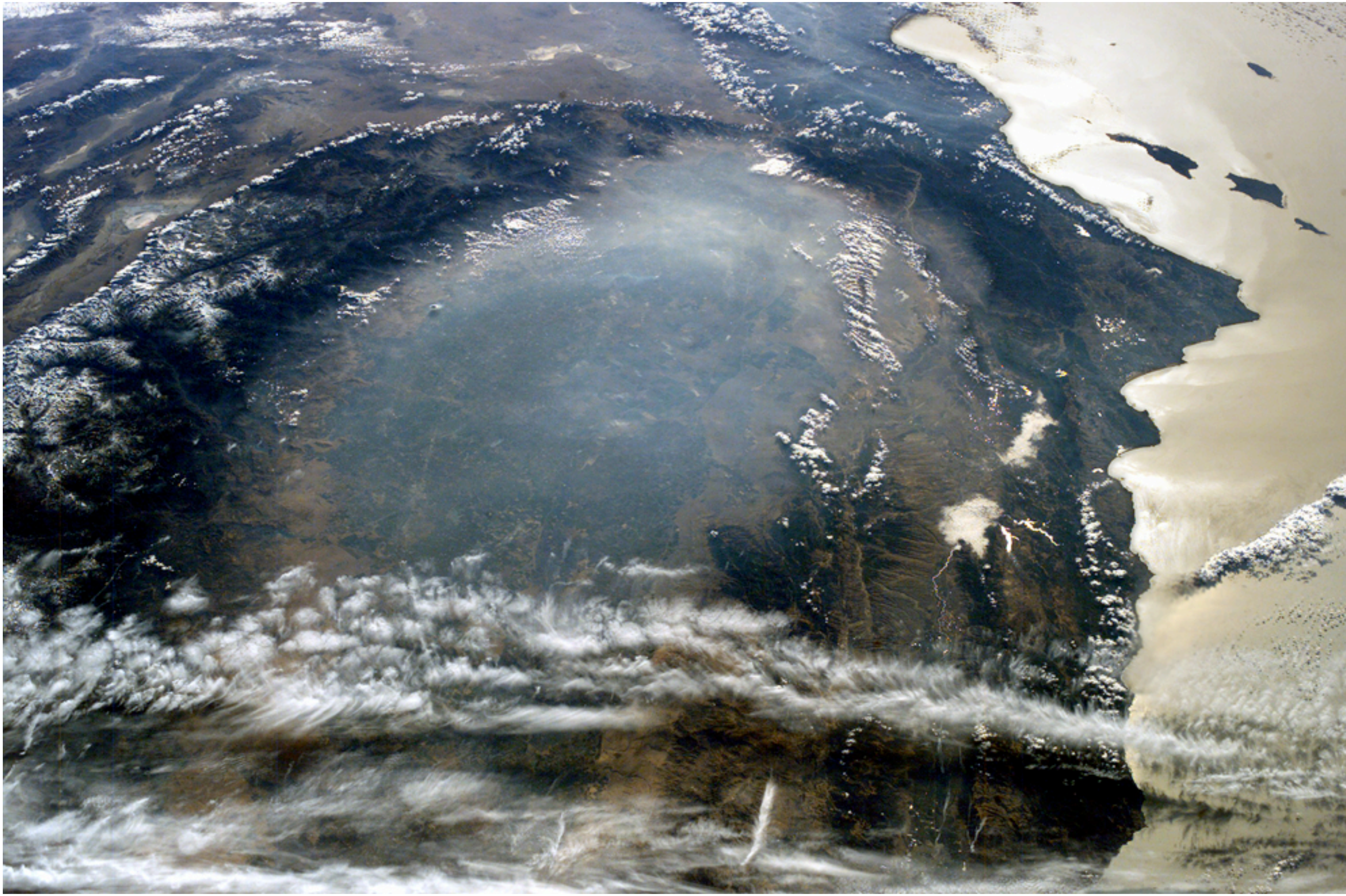
Refining Ammonia Emissions Estimates with Observations during CalNex

Shannon Capps[1], Daven Henze[2],
Armistead Russell[1], Athanasios Nenes[1]

[1]Georgia Institute of Technology, Atlanta, GA
[2]University of Colorado, Boulder, CO

NASA Graduate Student Research Fellowship
additional NASA funding



Central Valley of California

Image courtesy of the Image Science & Analysis Laboratory, NASA Johnson Space Center ISS008-E-05095 http://eol.jsc.nasa.gov

Unique Conditions

Topography conducive to trapping air

Favorable ***meteorology*** for farming

Abundant agricultural ***activity***

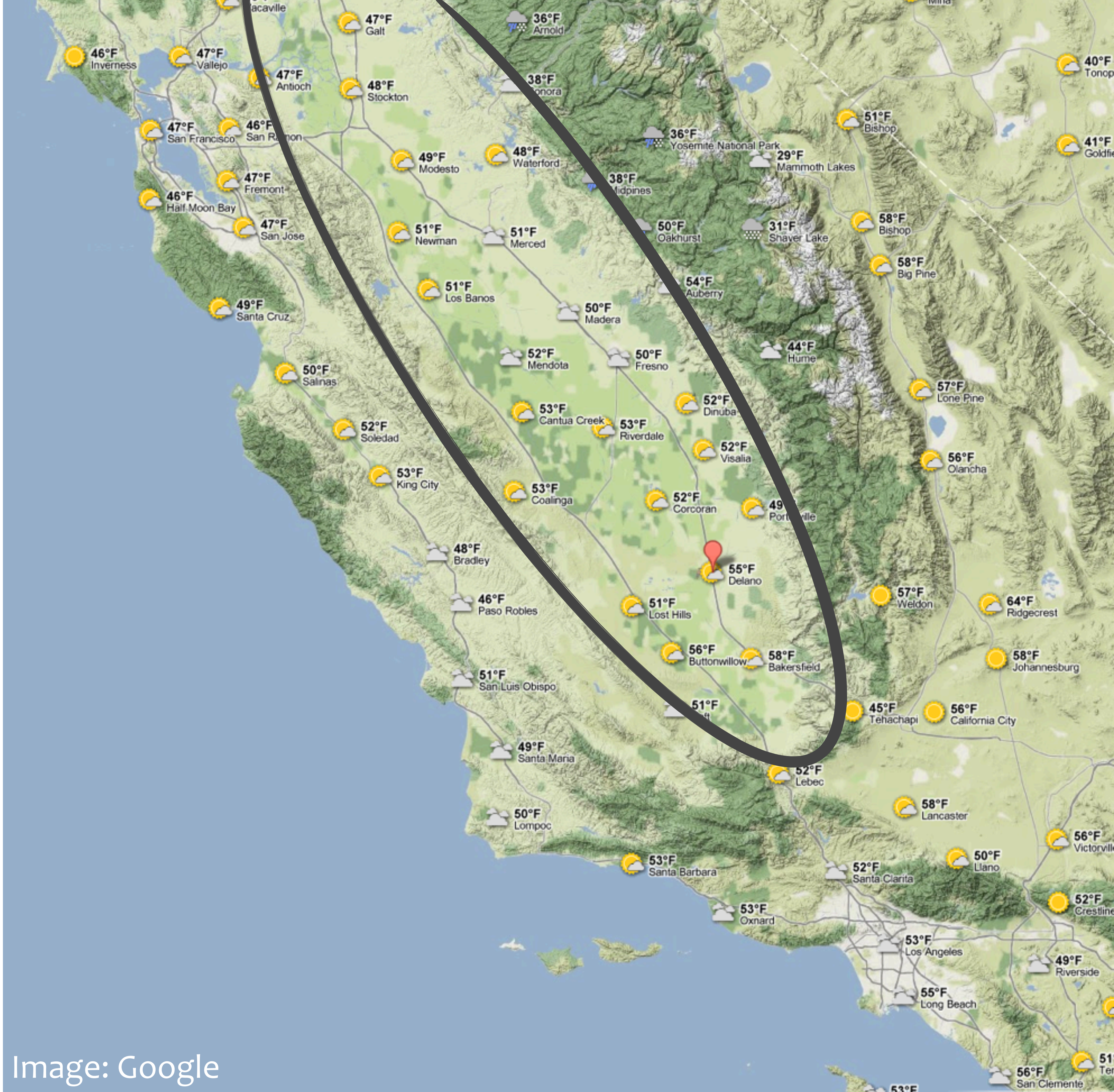


Image: Google

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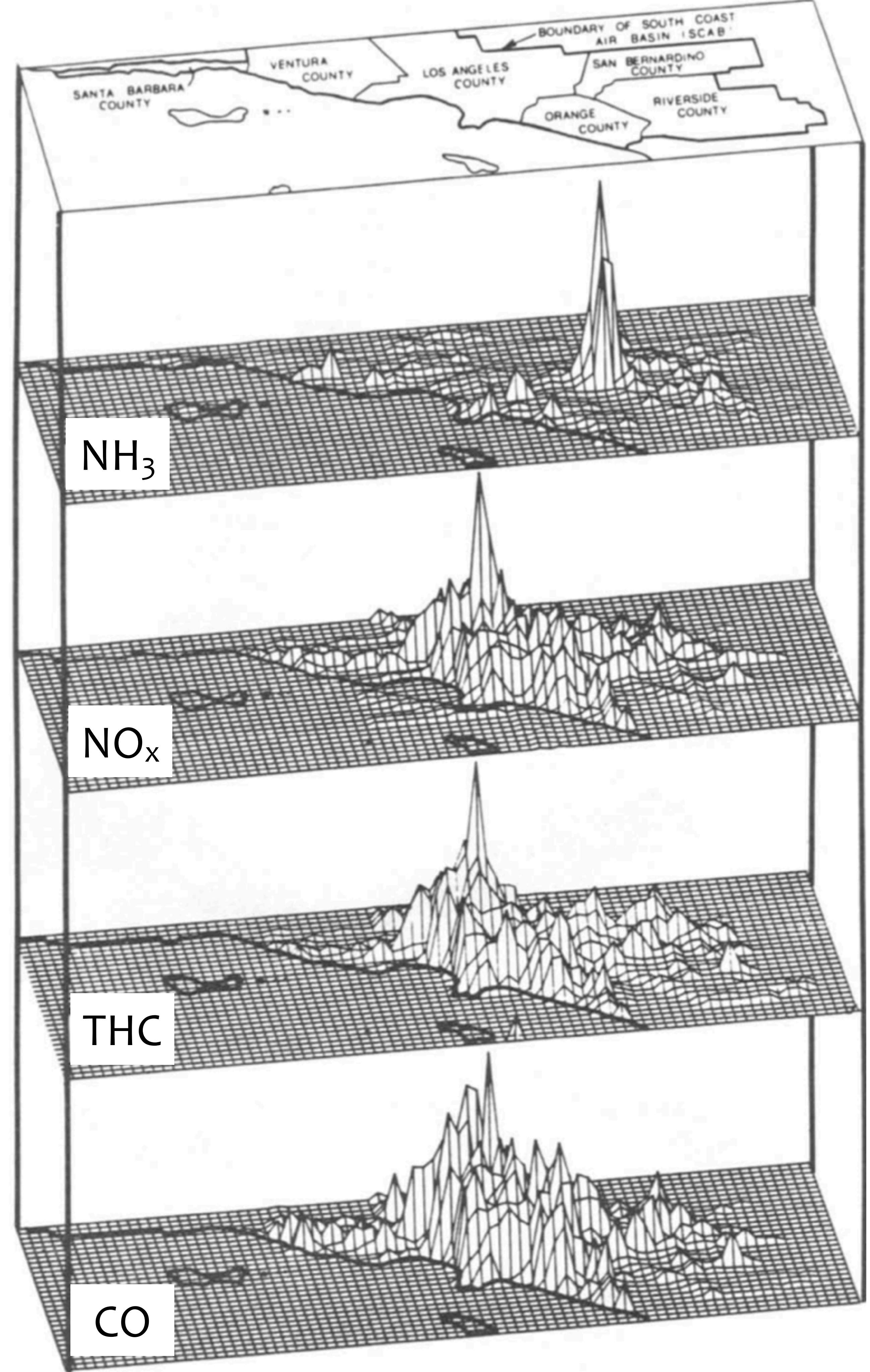
Previous Work

Investigating ammonium nitrate sources & controls in the ***South Coast Air Basin***



Russell & Cass, 1986

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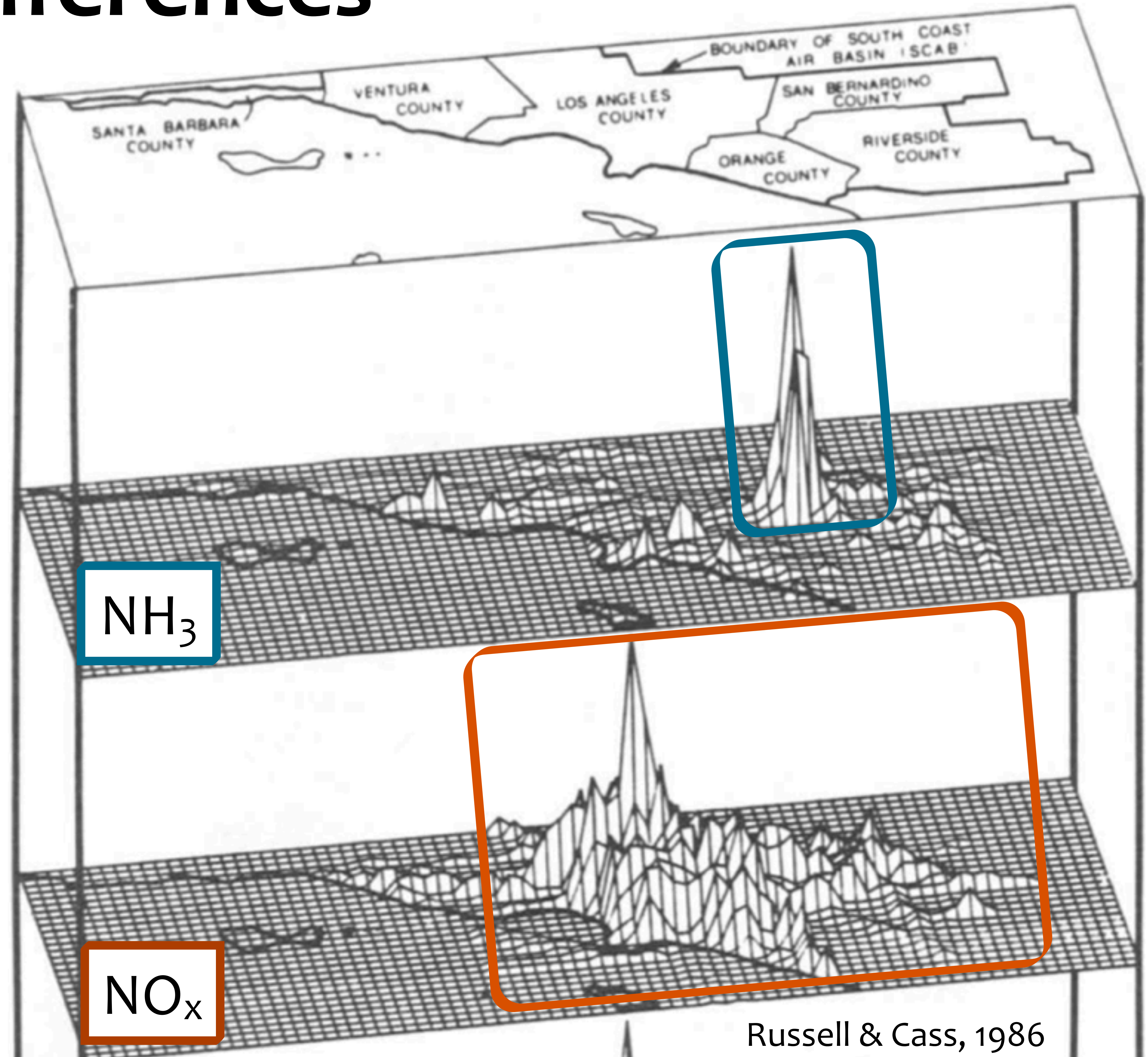
Clear Differences



Russell & Cass, 1986

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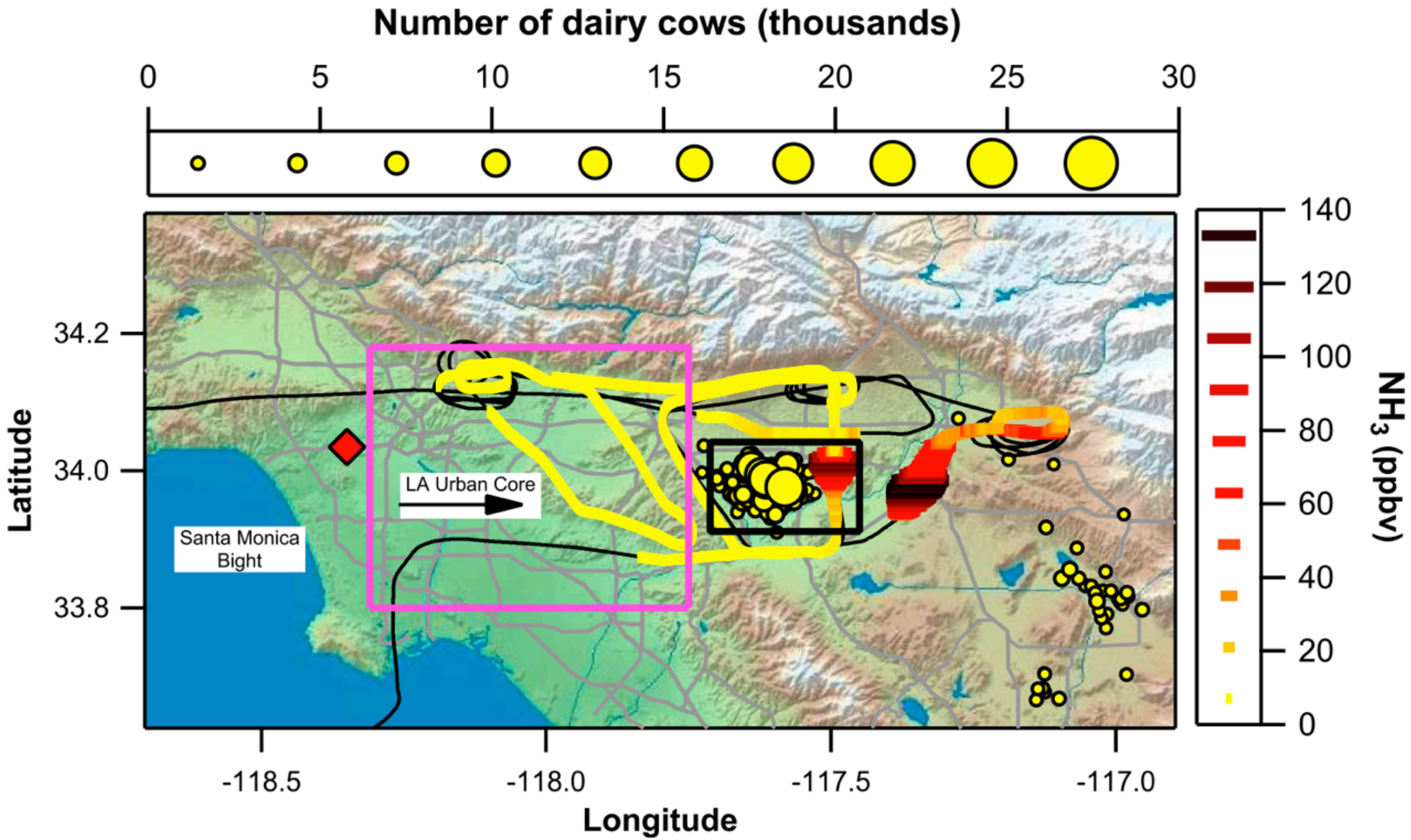
Recent Investigations



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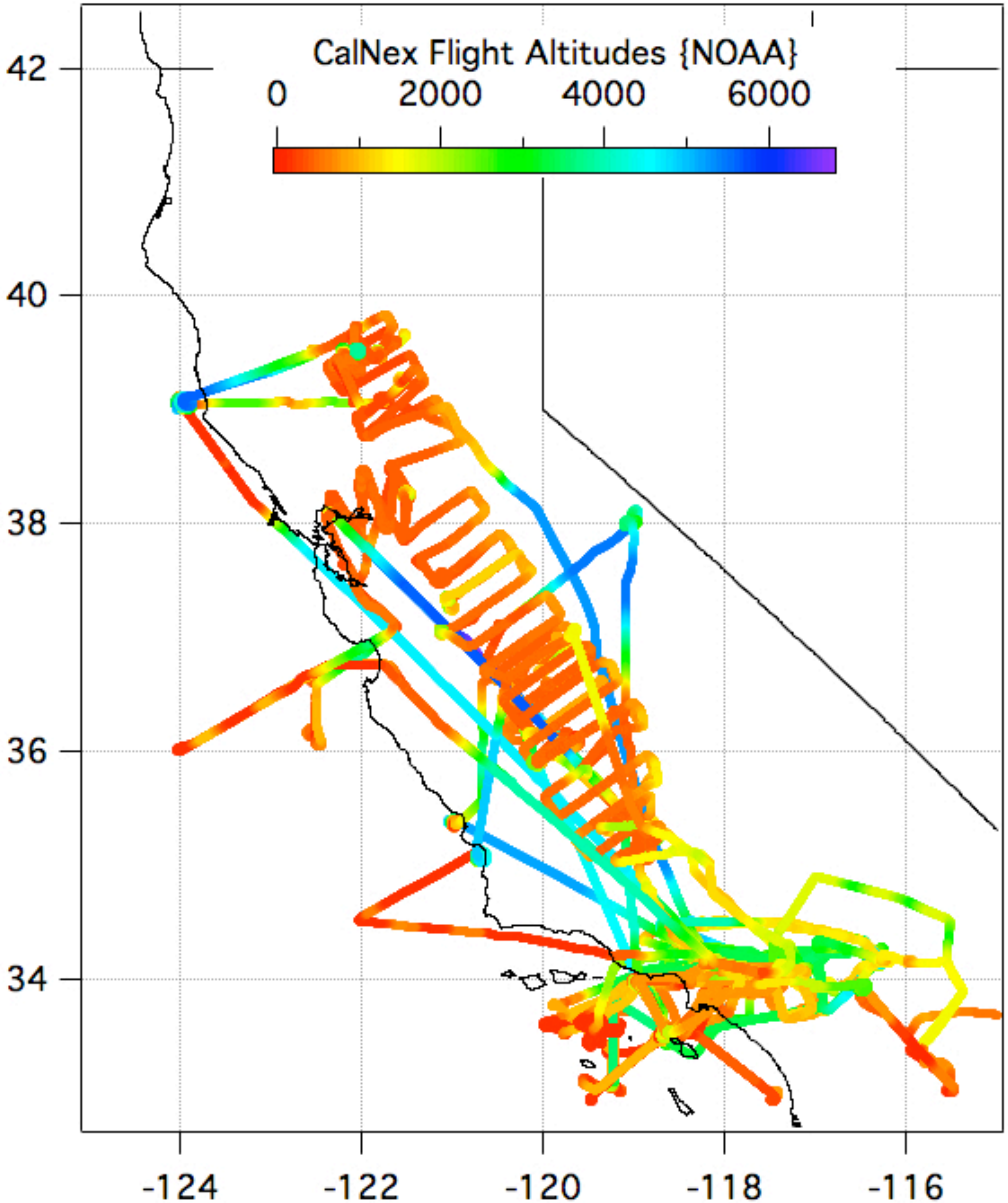
Nowak et al., 2012 (GRL)

CalNex 2010



May - June

NOAA . CIRES

Georgia Tech

vacuum ultraviolet fluorescence instrument: **CO**

chemical ionization mass spectrometry: **NH_3, HNO_3**

compact time of flight aerosol mass spectrometer: **NH_4^+, NO_3^-**

Nowak et al., 2012 (GRL)

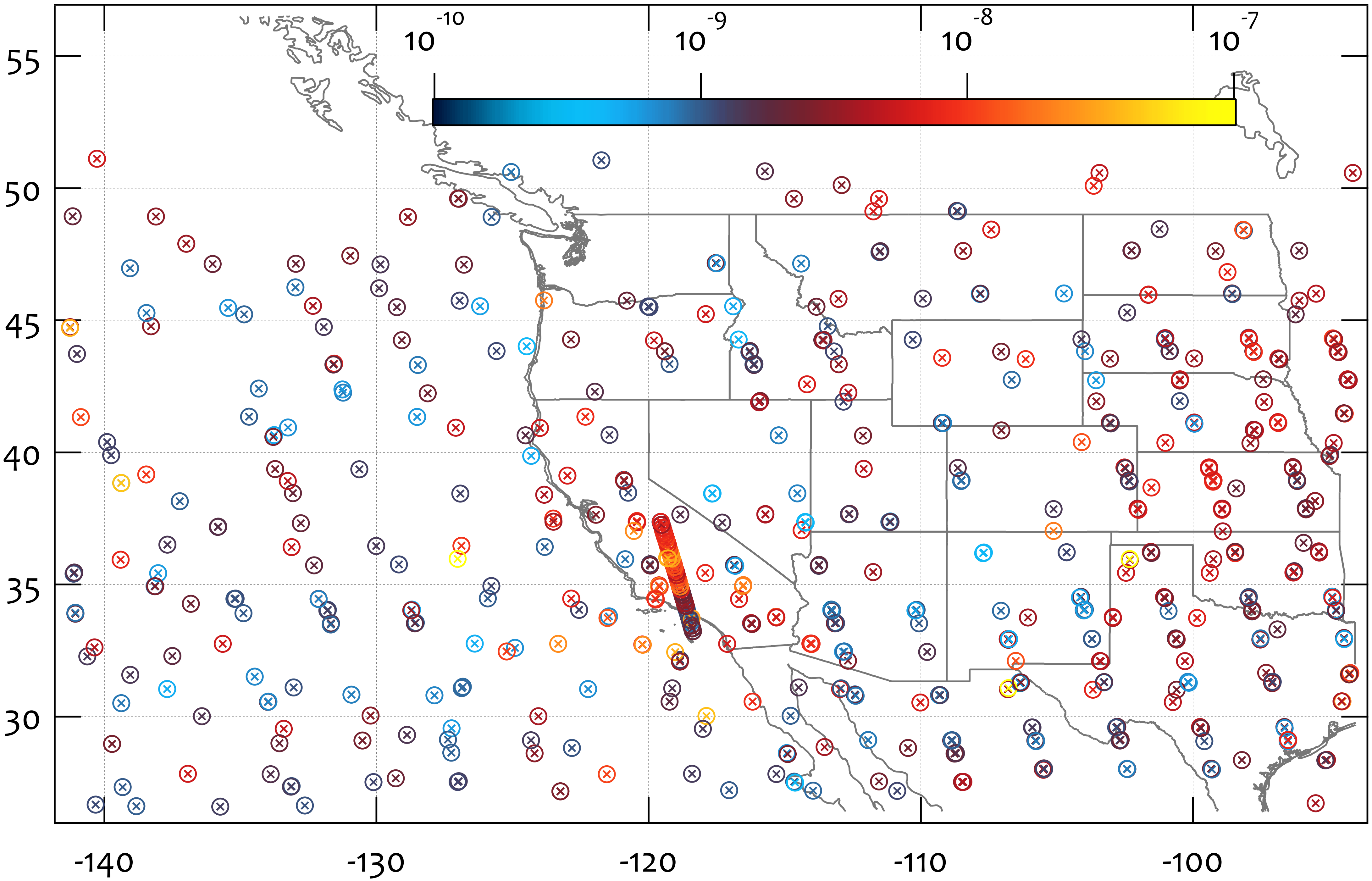
CalNex 2010

March - July

NASA + AER, Inc.

Tropospheric Emissions Spectrometer (TES)

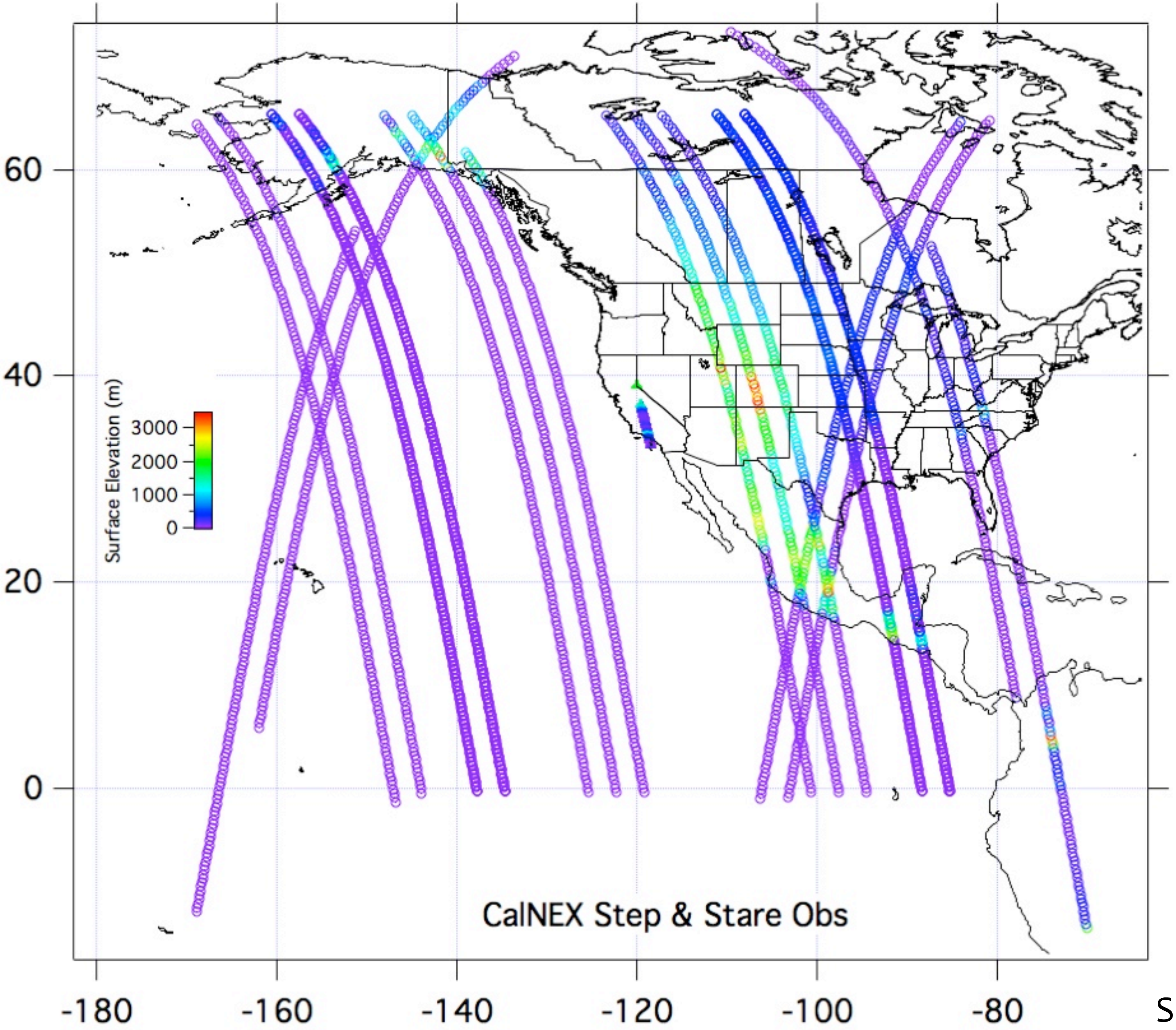
NH_3 tropospheric representative volume mixing ratio (RVMR)



K. Cary-Pereira; Shephard et al., 2011 (ACP)

TES Special Observations

March - July



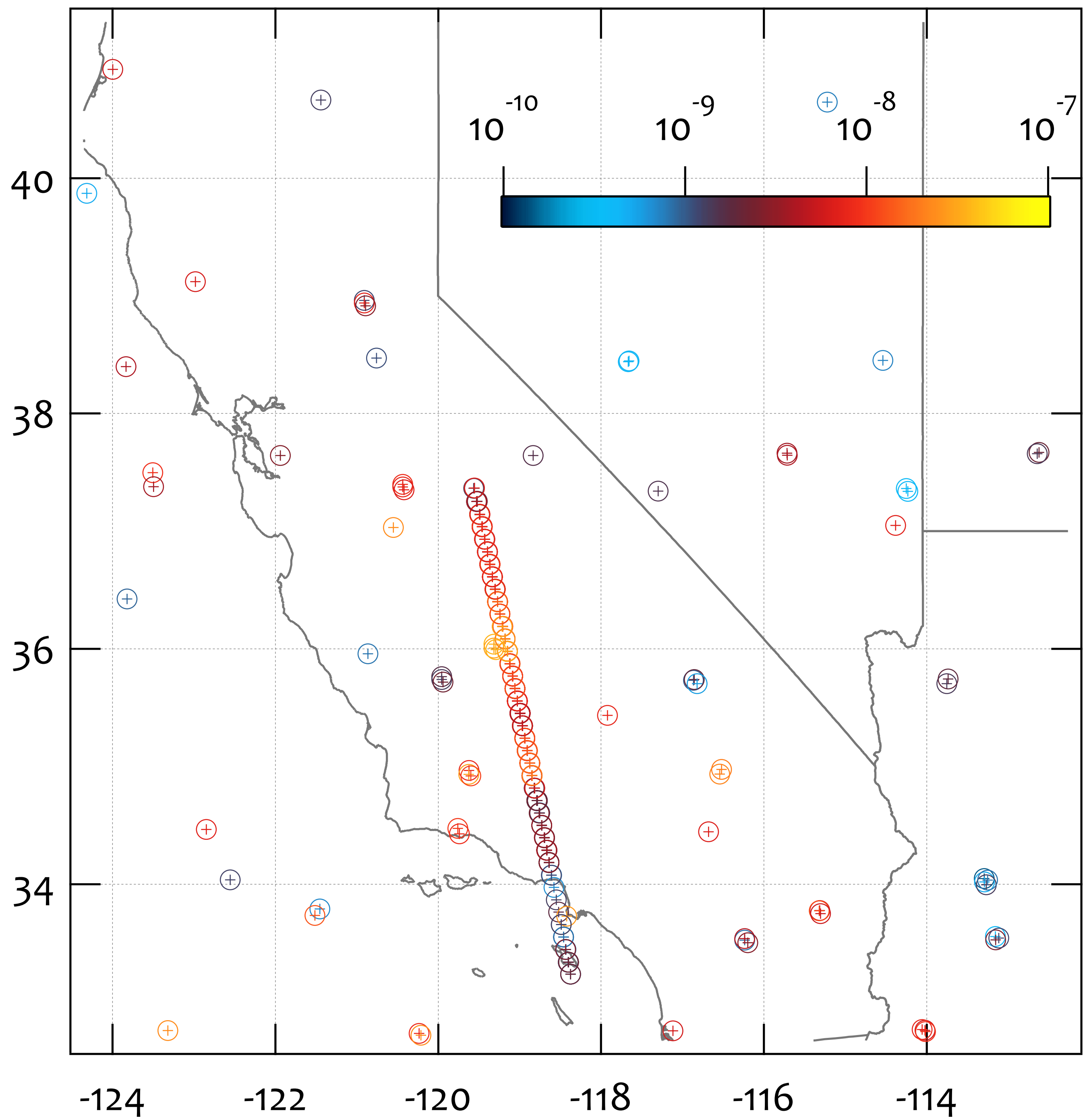
K. Cary-Pereira;
Shephard et al., 2011 (ACP)

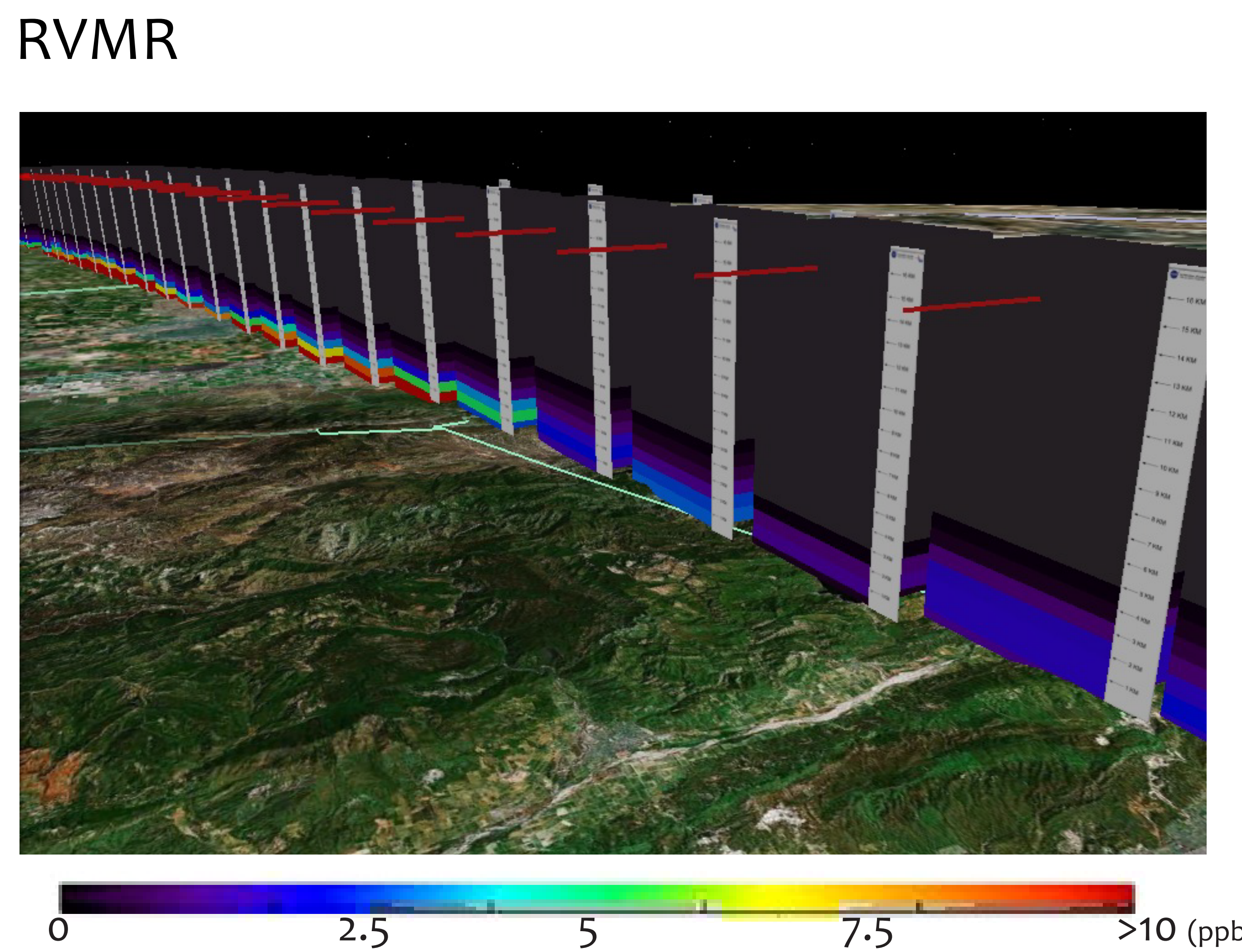
TES Special Observations

May - June

NASA

AER, Inc.





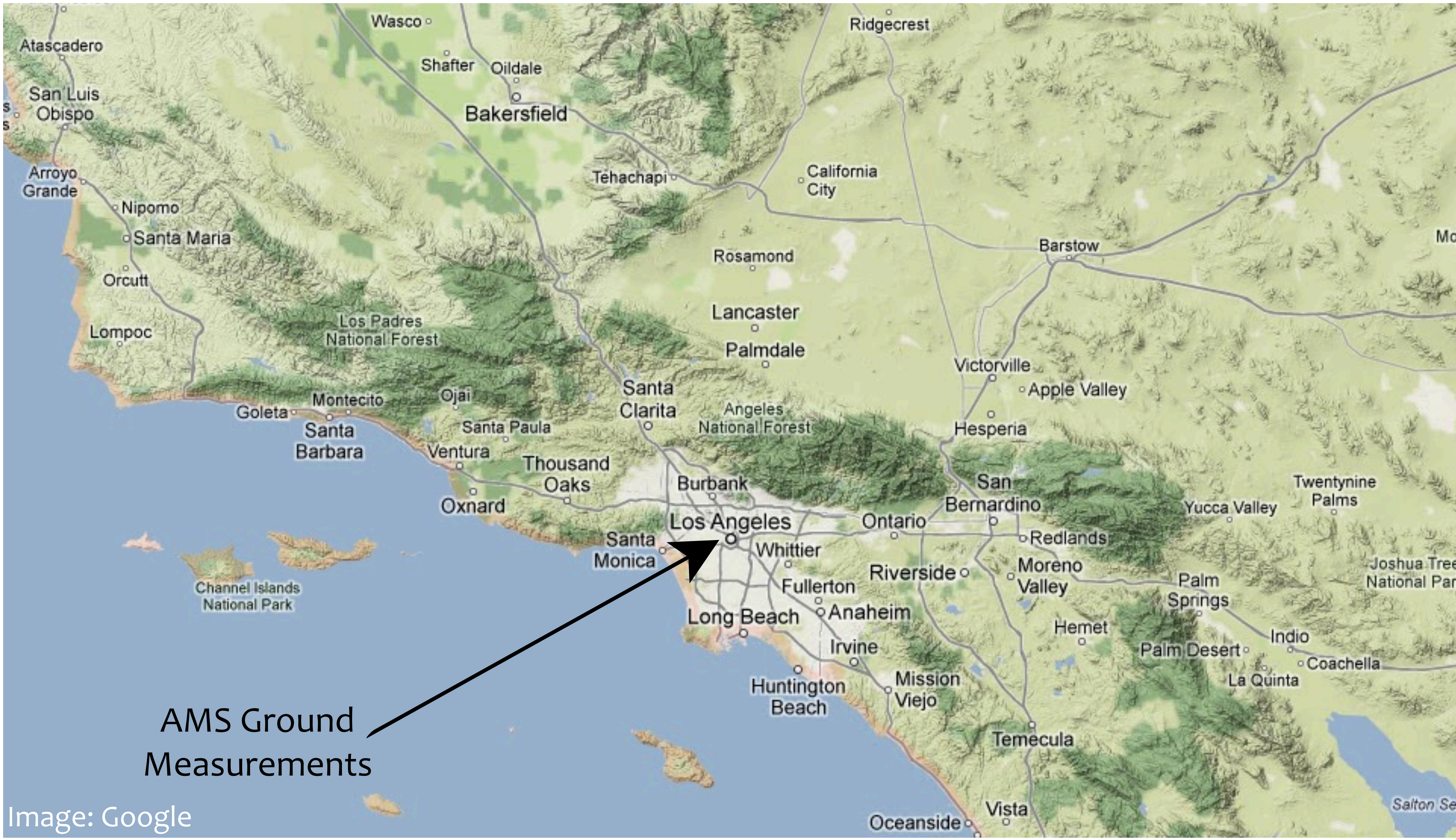
K. Cary-Pereira; Shephard et al., 2011 (ACP)

CalNex 2010

May - June

NSF

CalTech & Univ. of Colorado



CalNex 2010

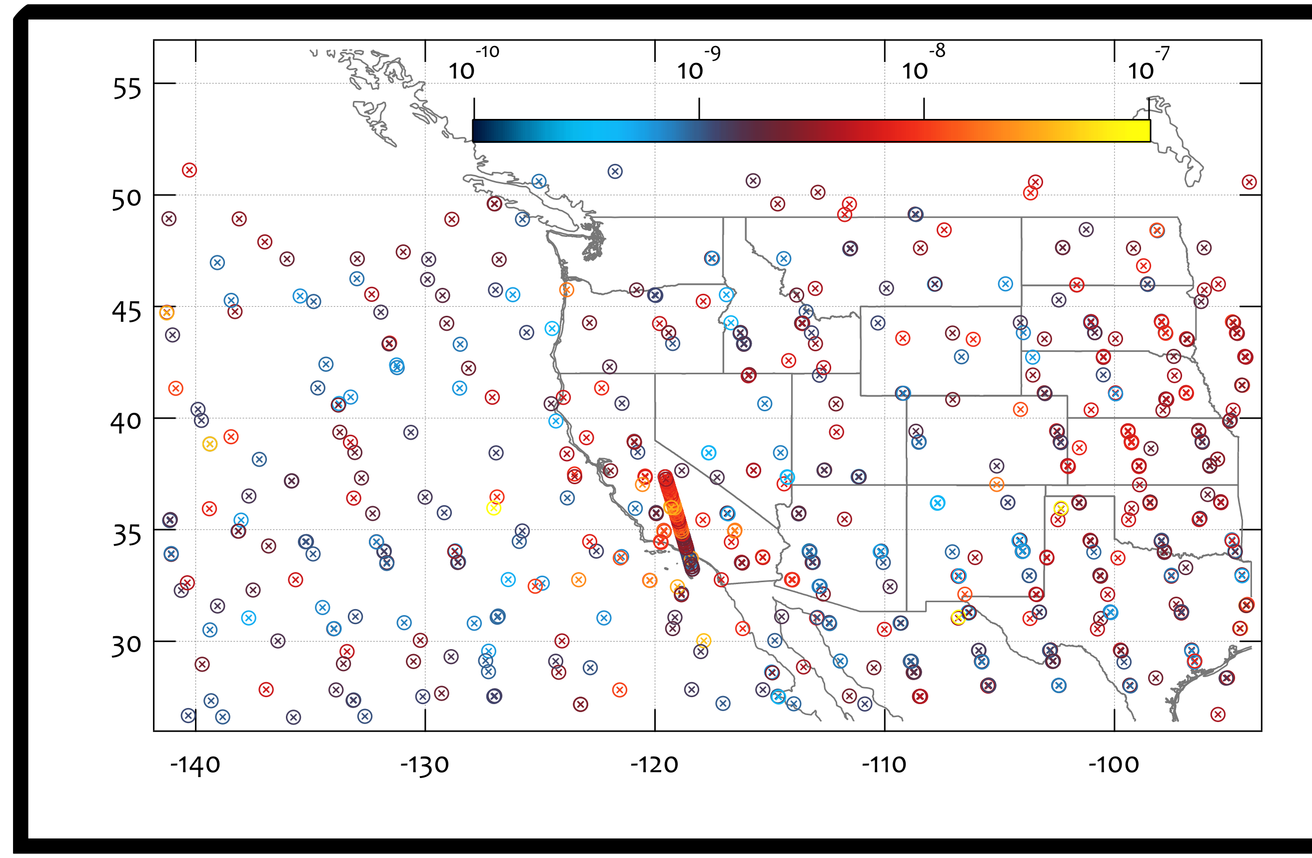
May - June

NSF, NASA, NOAA

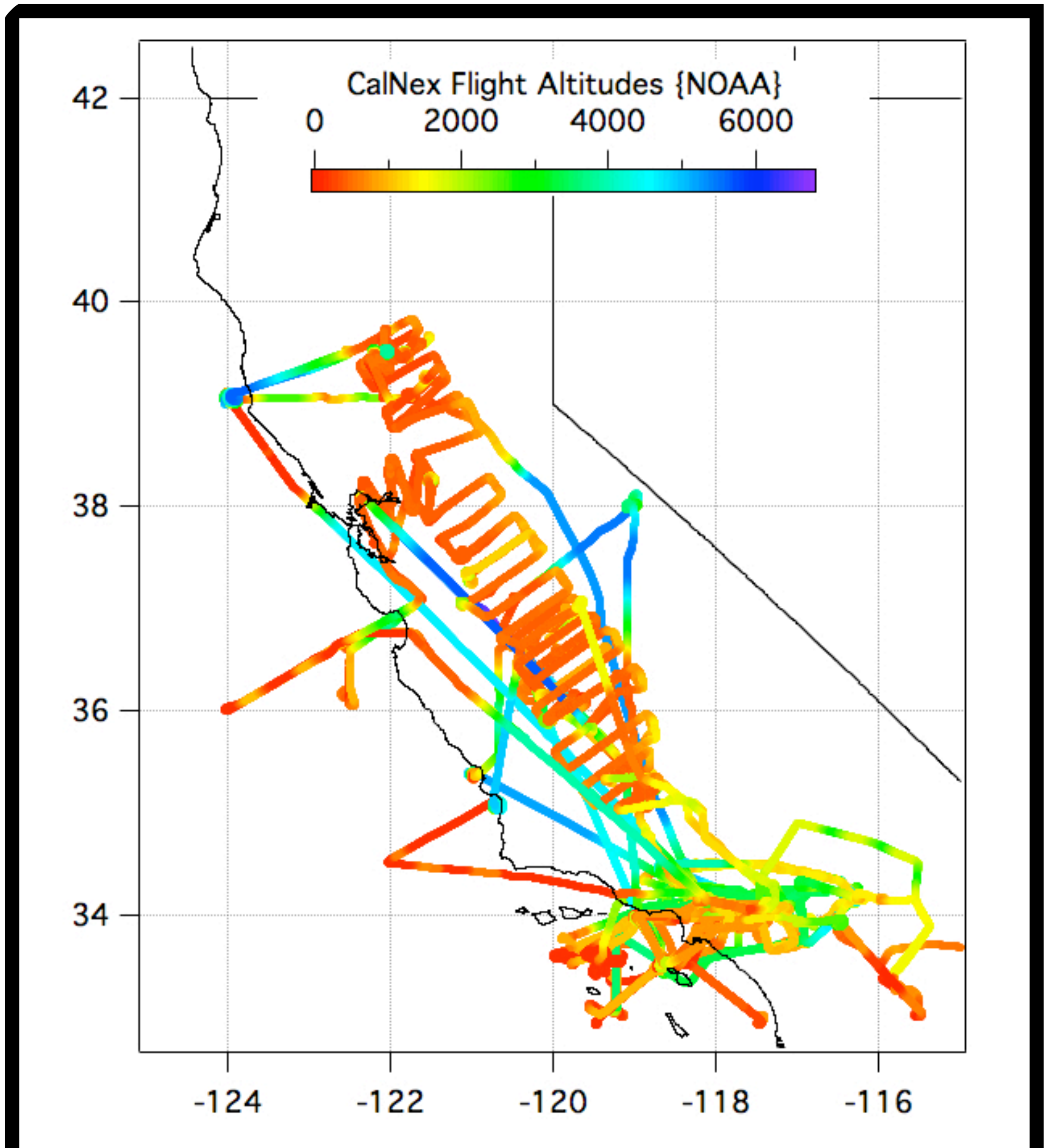
Georgia Tech + CalTech

Univ. of Colorado + AER, Inc.

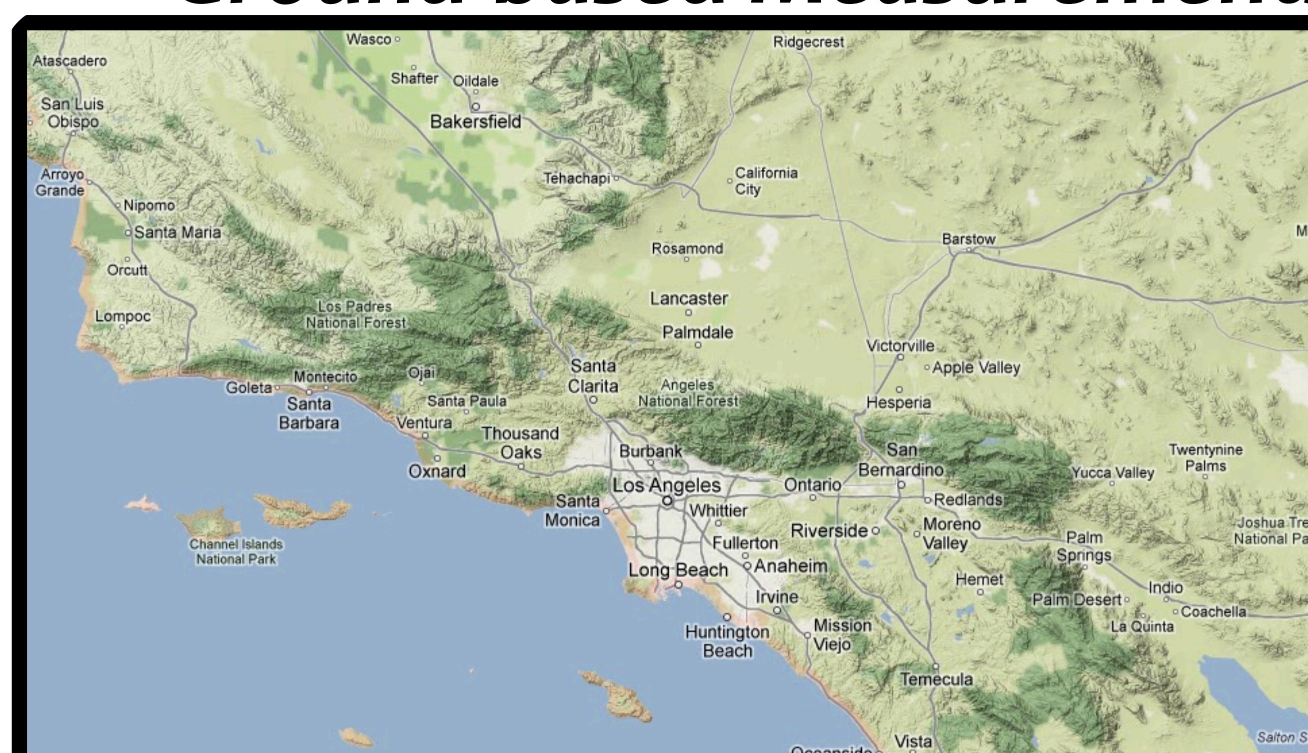
Satellite Observations



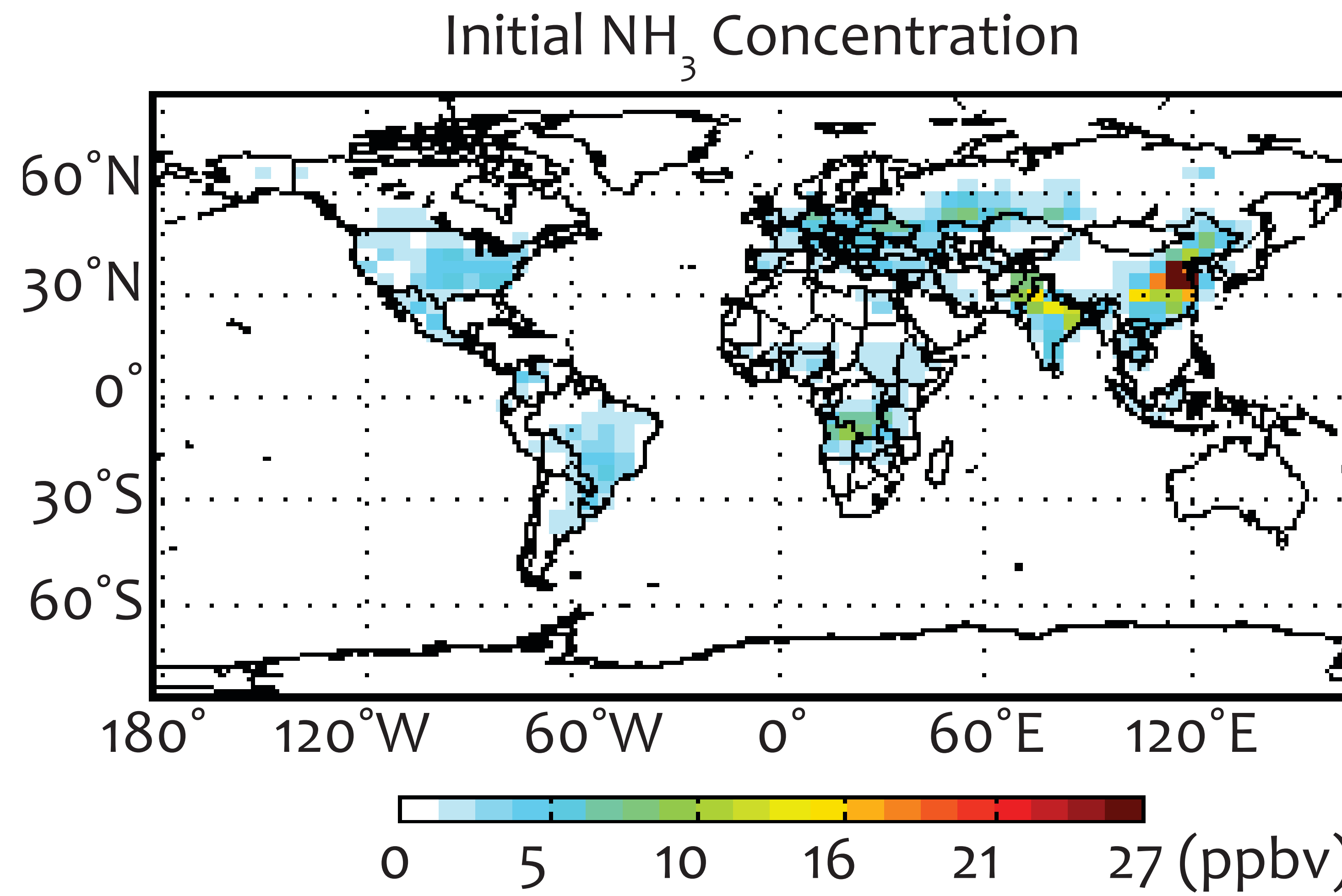
Airborne Measurements

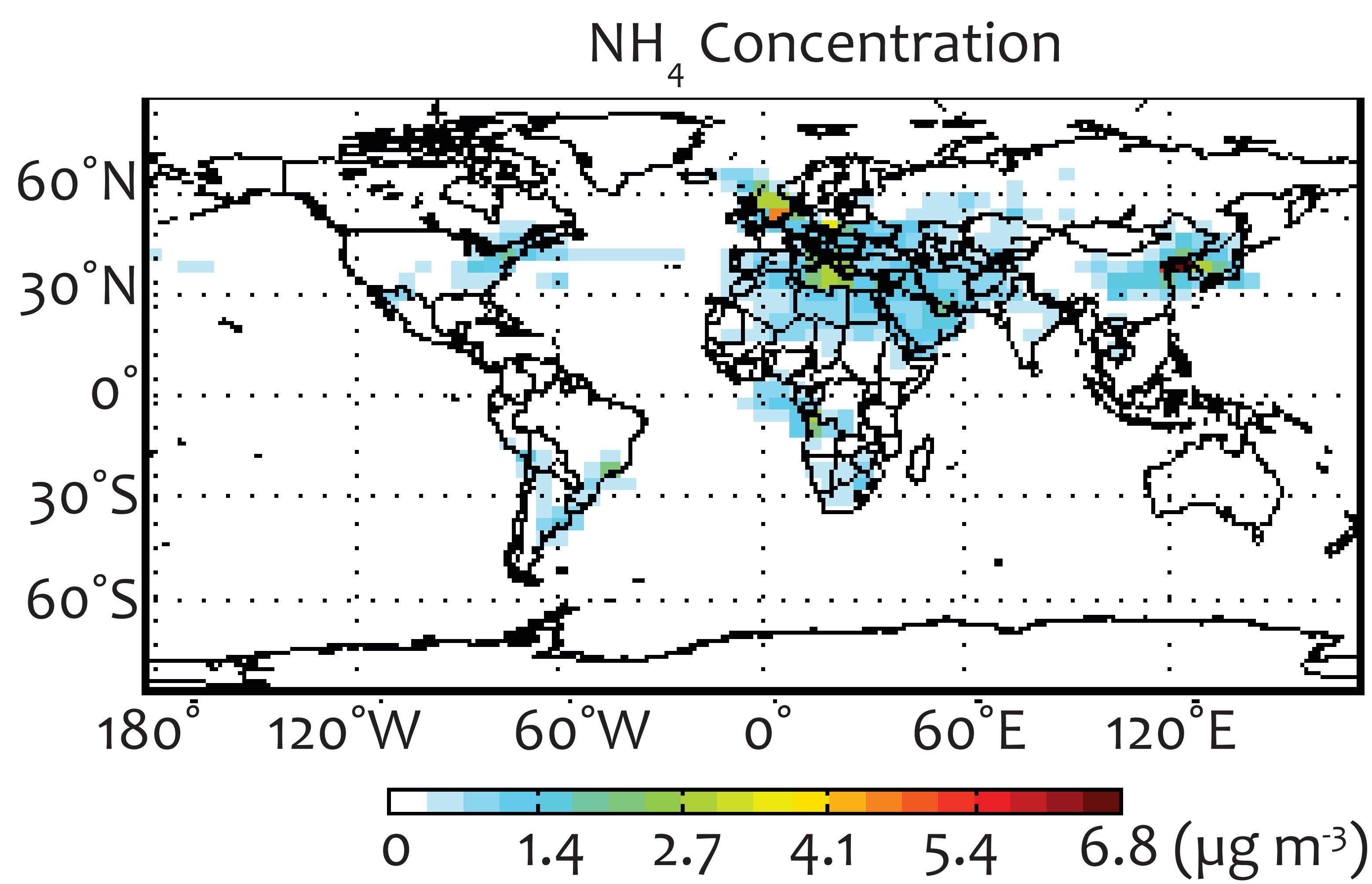


Ground-based Measurements



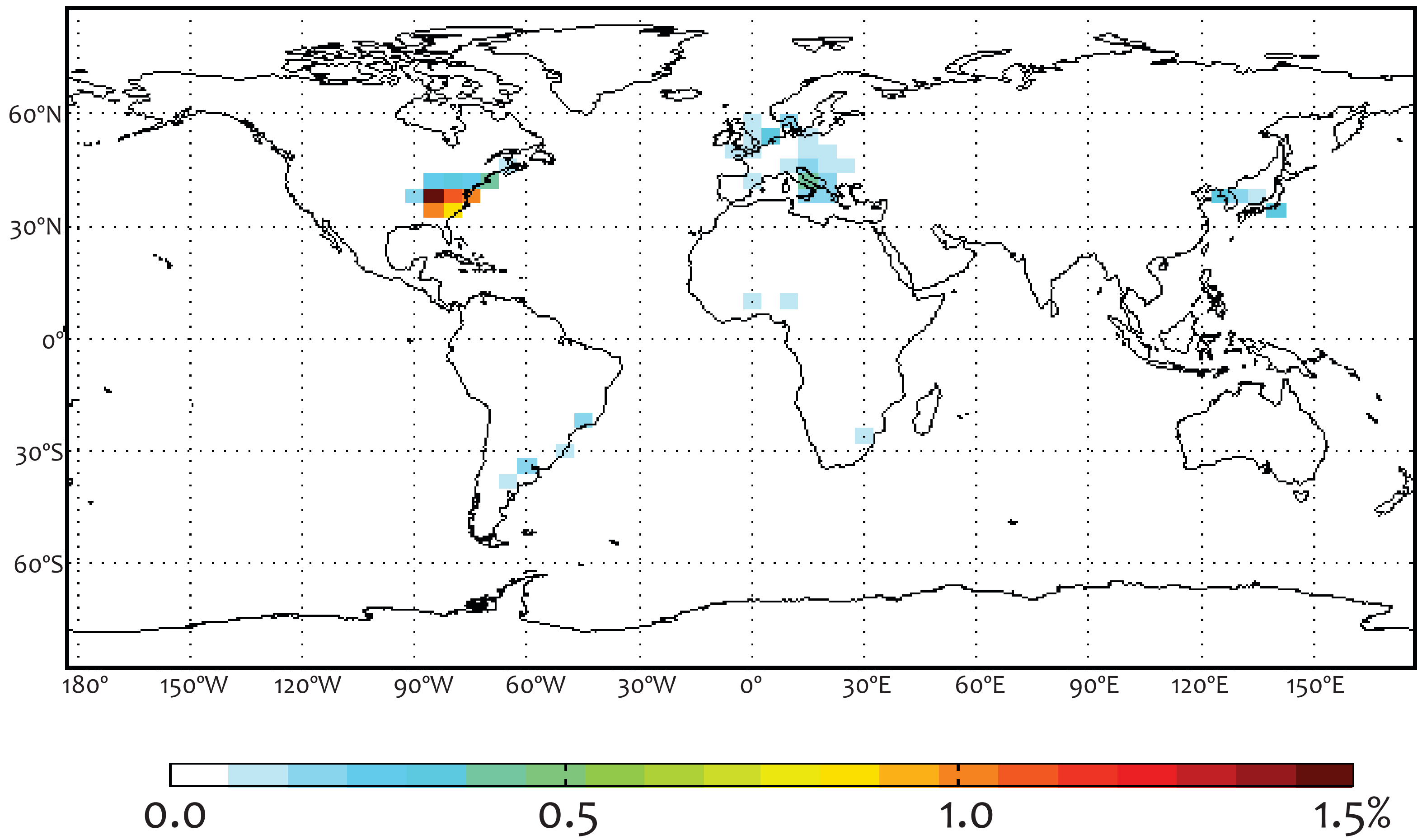
GEOS-Chem Adjoint





GEOS-Chem Adjoint

$$\frac{\partial[\mathit{Nitrate}]_{glob}}{\partial(\mathit{NH}_{3,an}\,\mathit{Emissions})}\;\frac{(\mathit{NH}_{3,an}\,\mathit{Emissions})}{[\mathit{Nitrate}]_{glob}}$$



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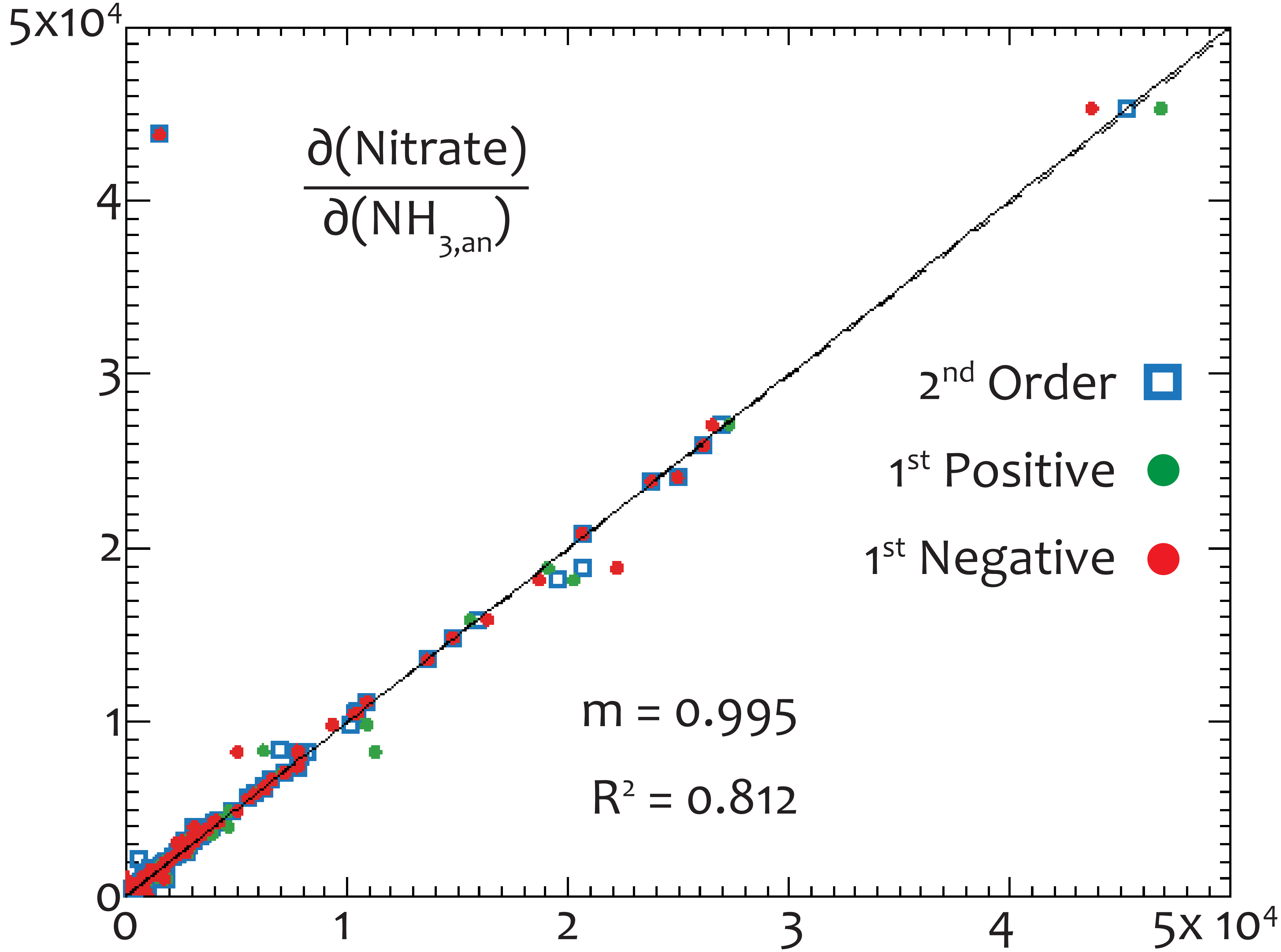
Henze et al., ACP (2007)

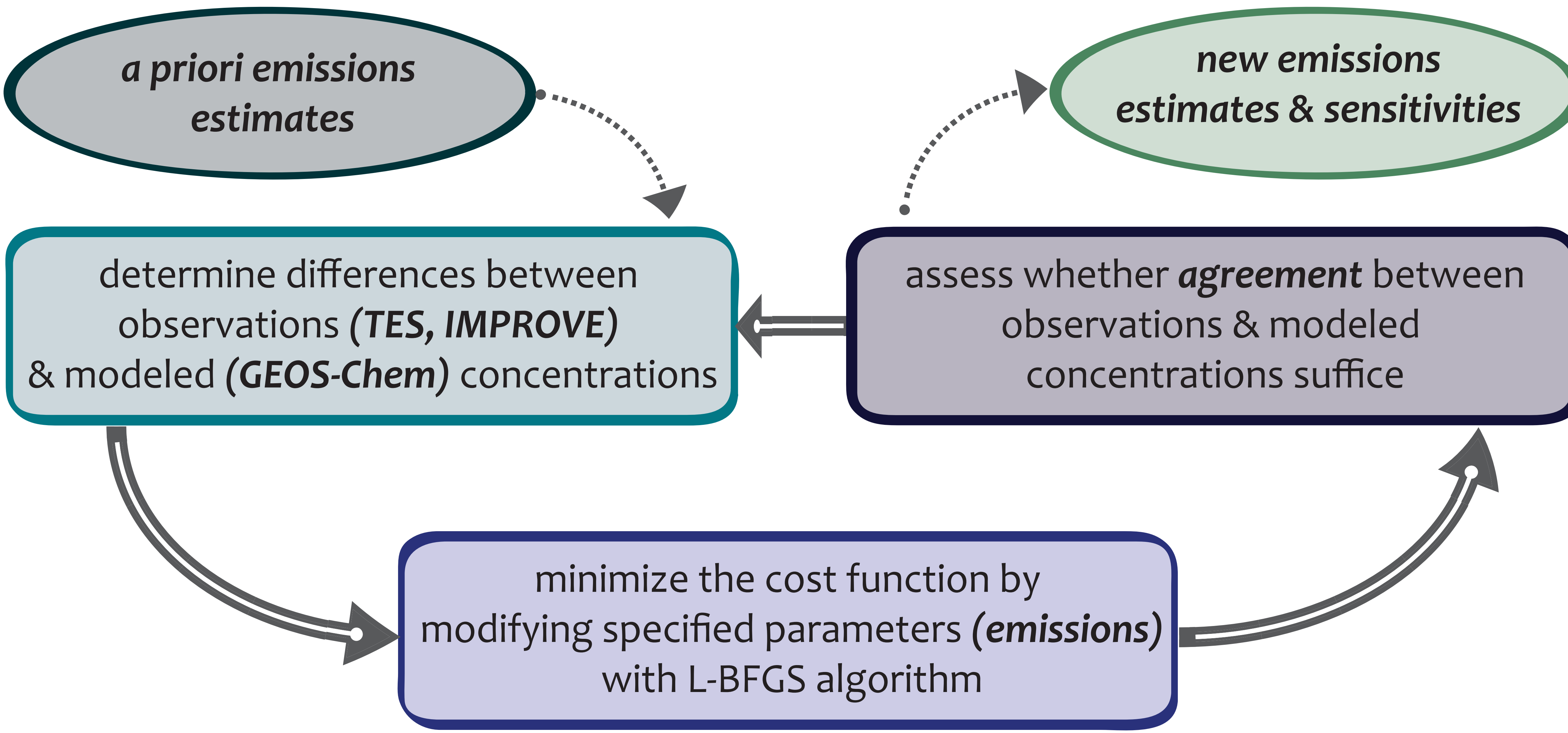
GEOS-Chem Adjoint + ANISORROPIA

Checking Functionality



GEOS-Chem Adjoint

Assimilation Approach



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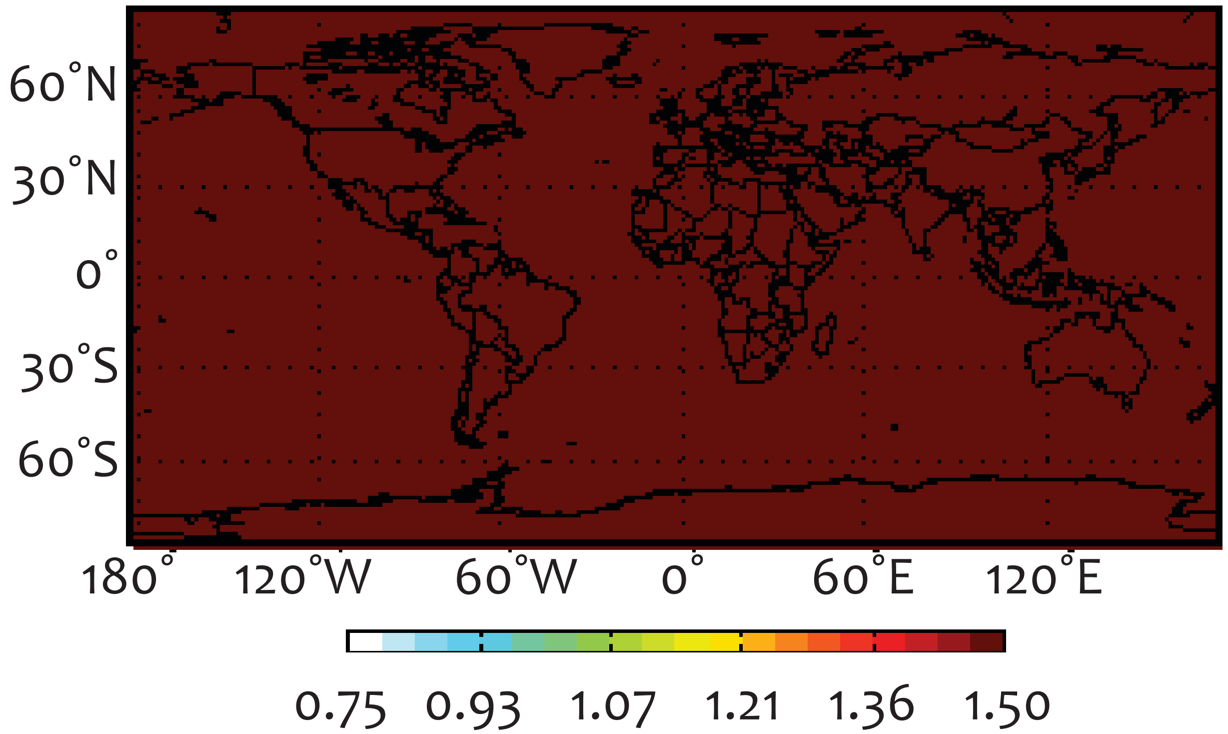
GEOS-Chem Adjoint

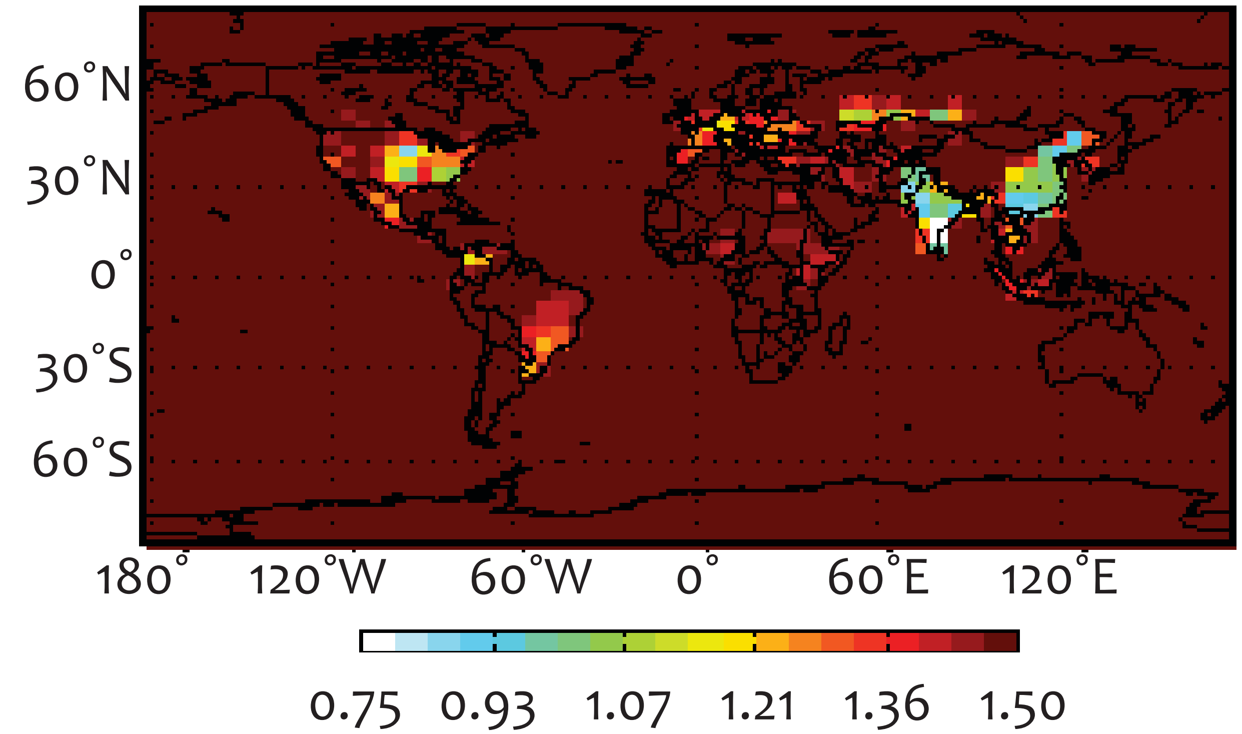
Initial Value

Anthropogenic NH_3 Emission Scaling Factor

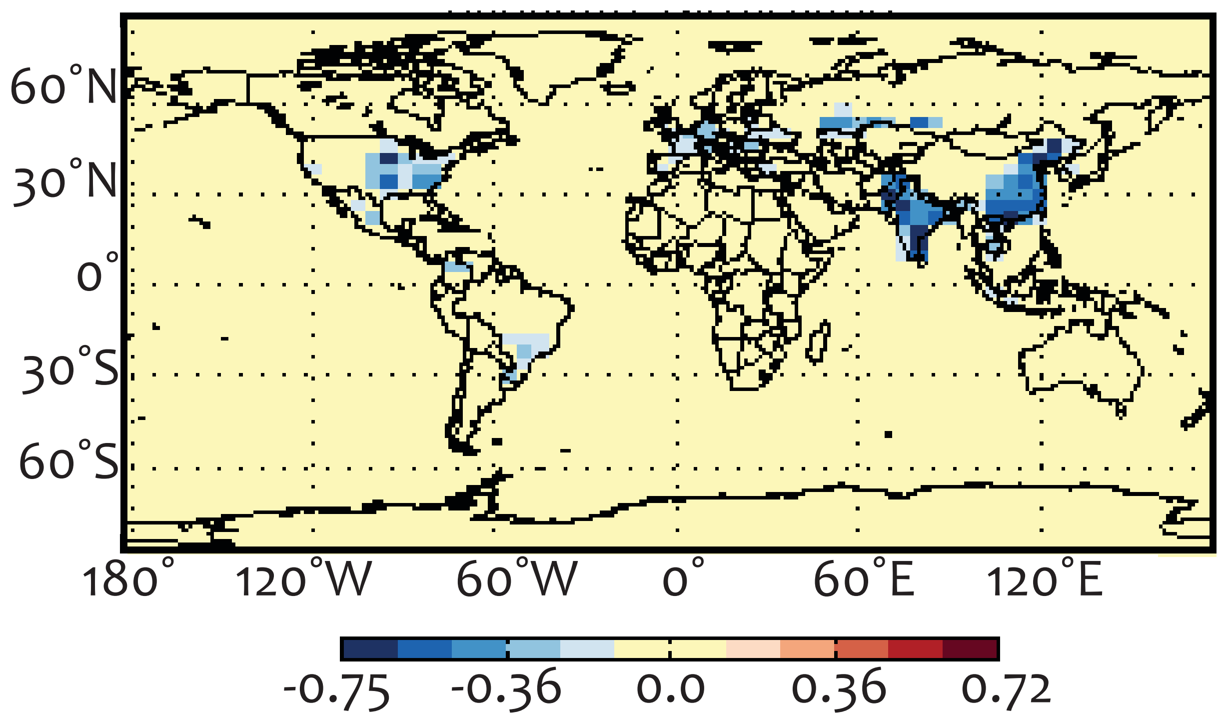


After 10 Iterations

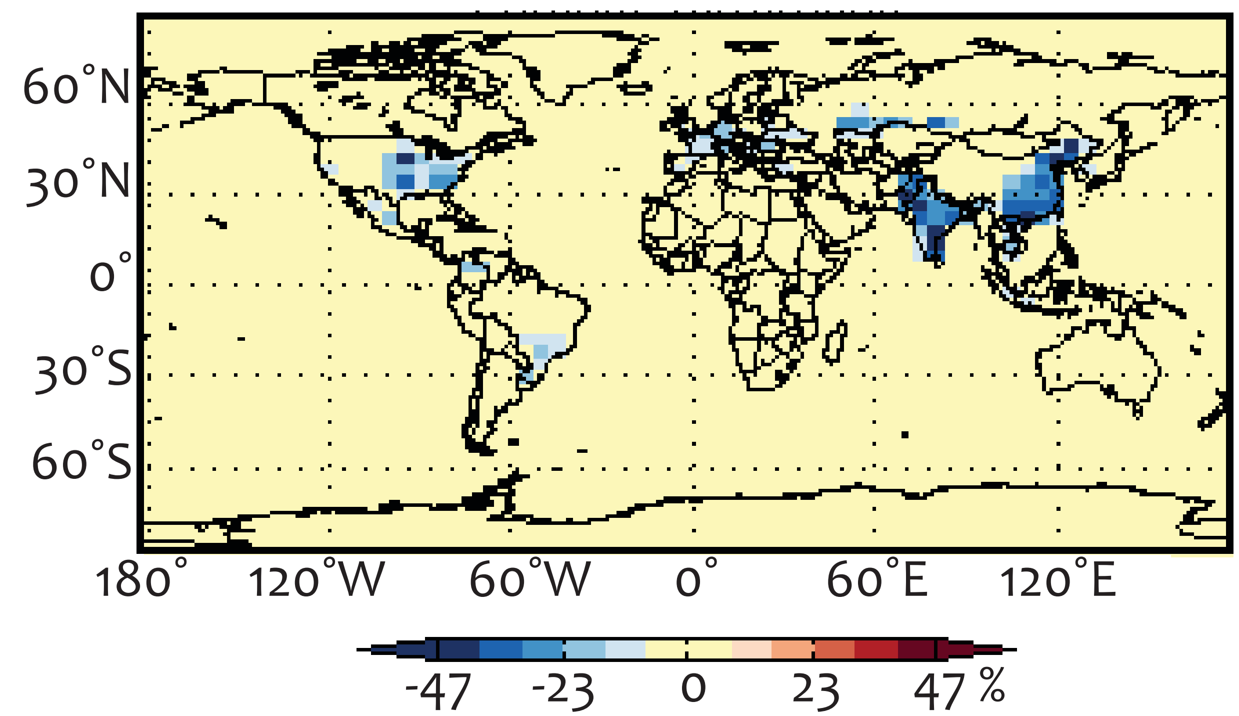
Anthropogenic NH_3 Emission Scaling Factor



Absolute Difference in Factor



Percent Difference in Factor



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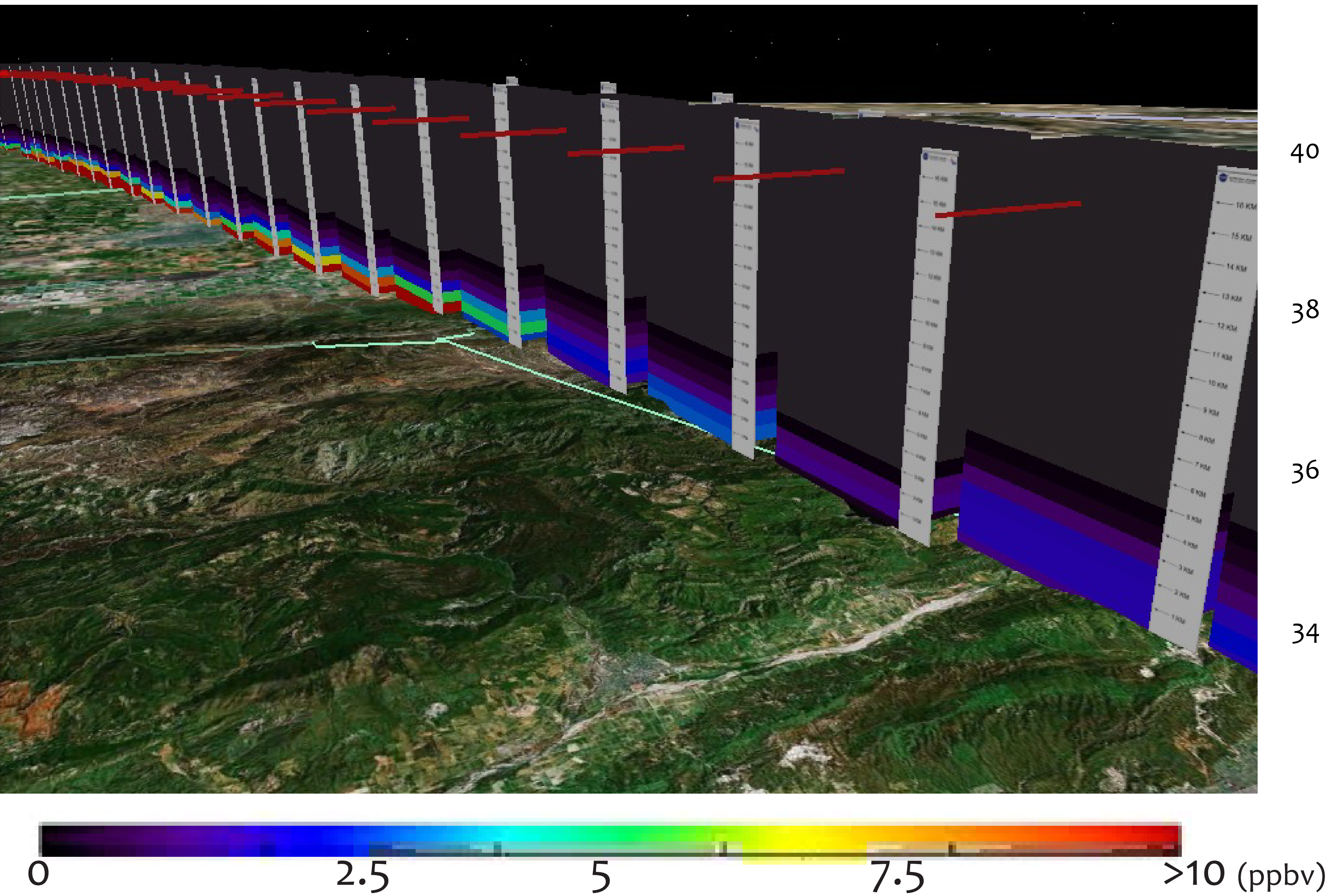
Next Steps

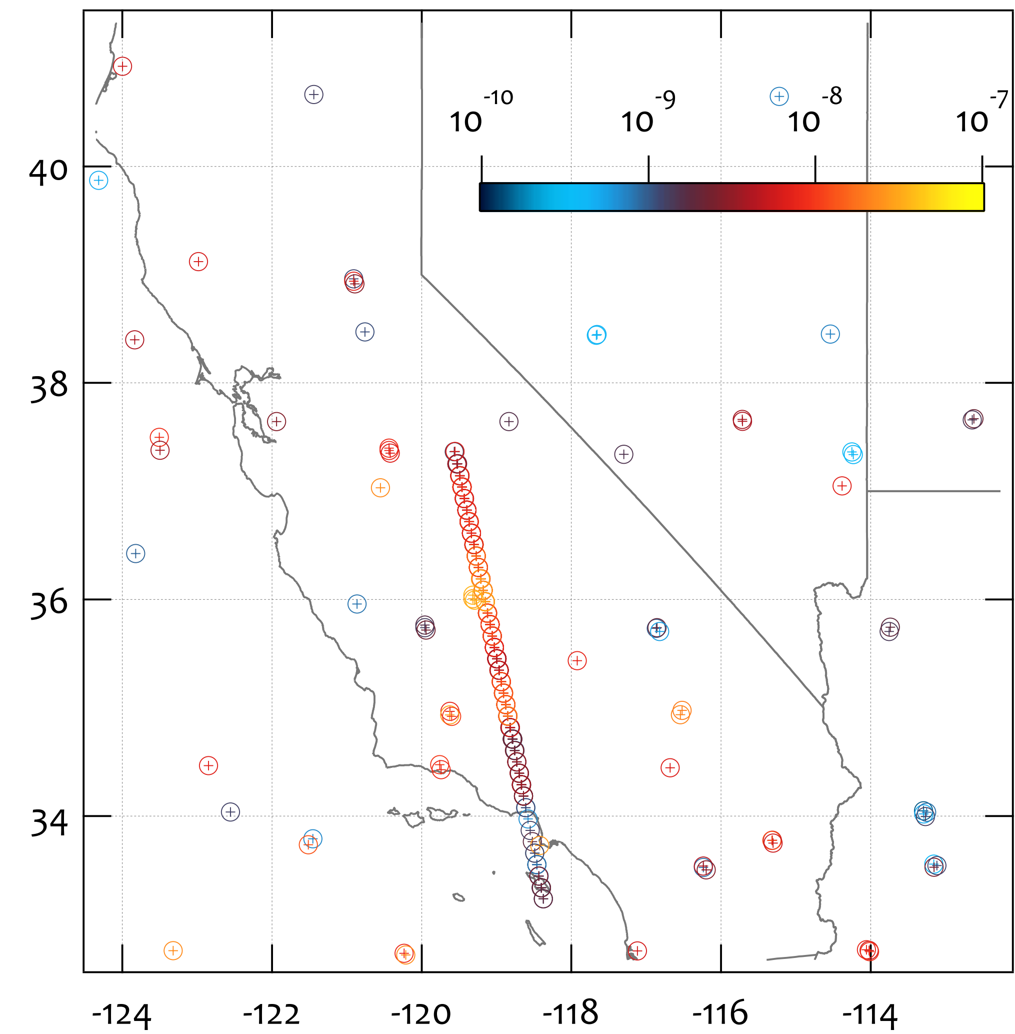
- Complete integration of TES observation operator
- Perform assimilation of TES observations to adjust emissions rates over continental U.S.
- Evaluate new modeled concentrations against in situ observations

Satellite Observations

Tropospheric Emissions Spectrometer

NH_3 Retrieval





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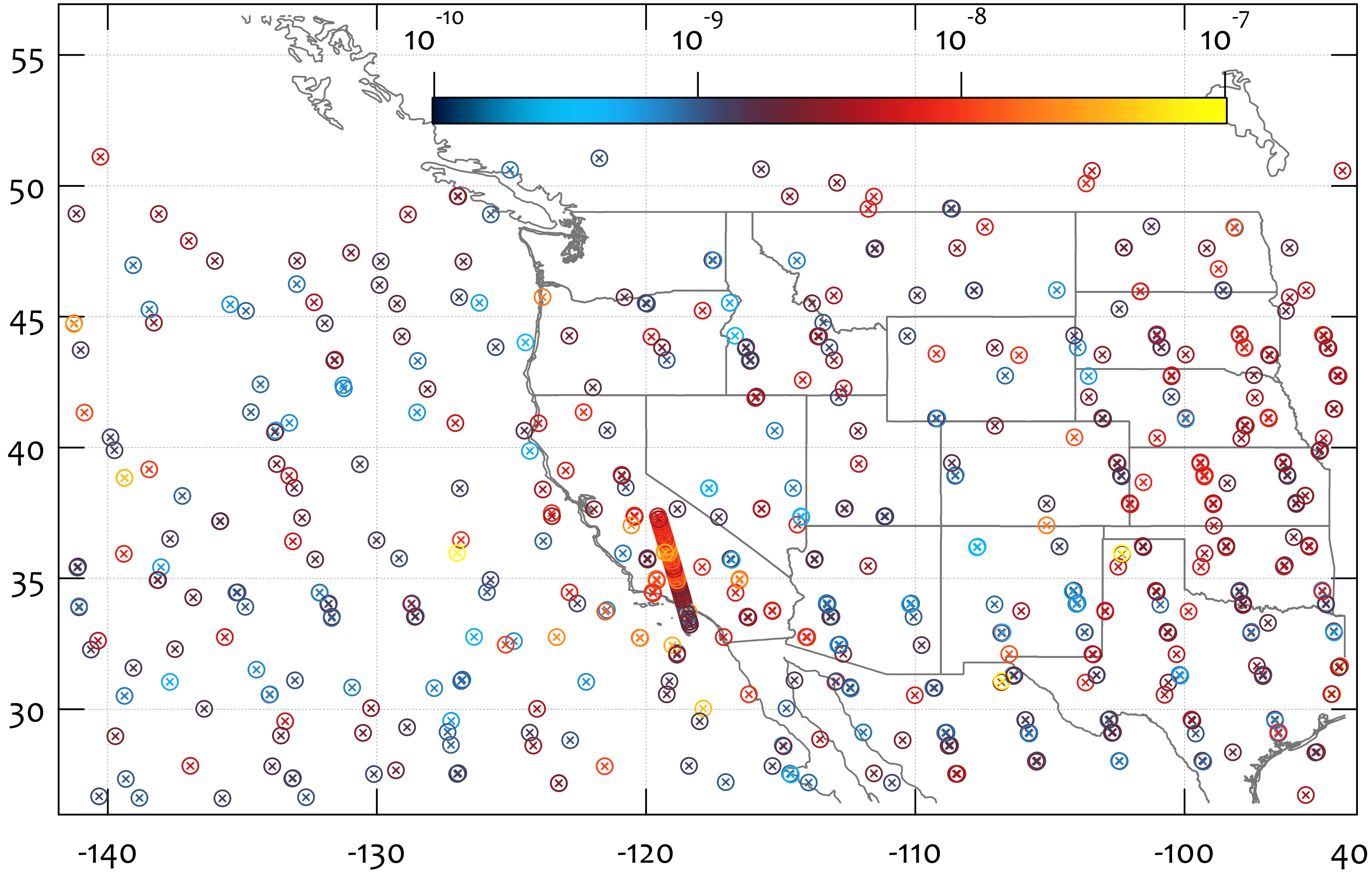
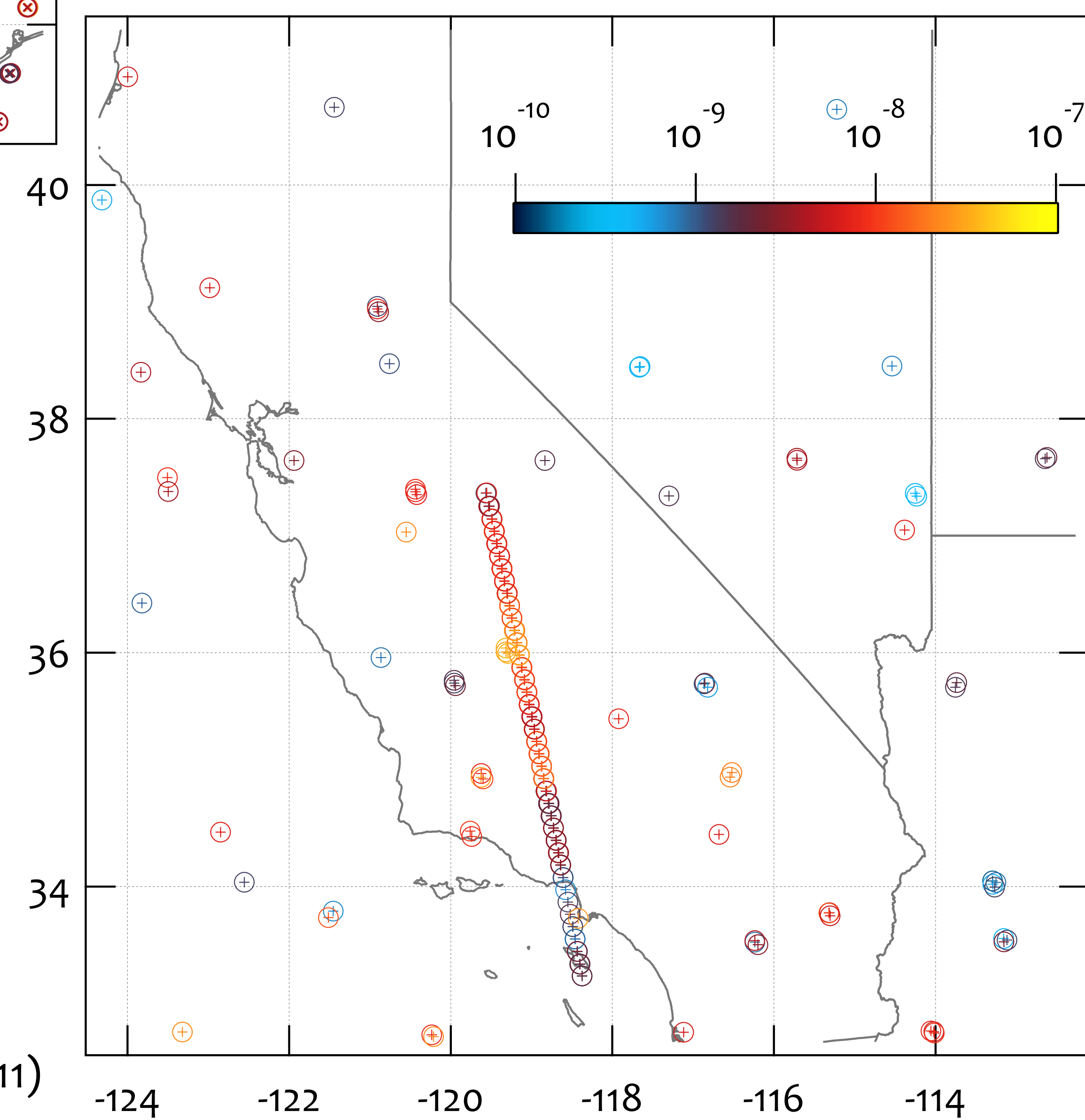


Satellite Observations



Tropospheric Emissions Spectrometer

NH_3 Retrieval

Global Swaths

Transects over Bakersfield

{ CalNex Step & Stare }

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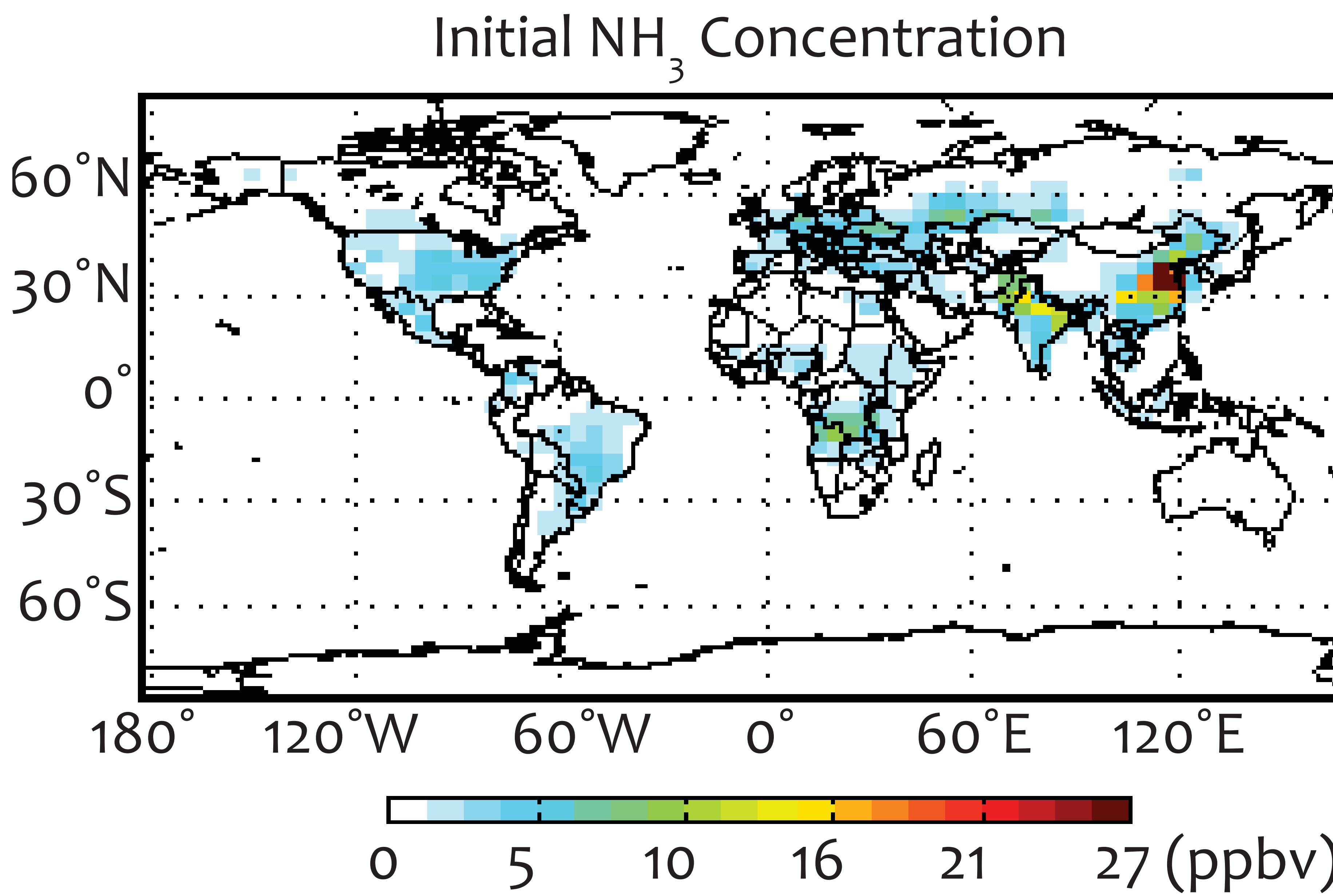
Shepard et al., ACP (2011)

GEOS-Chem Adjoint



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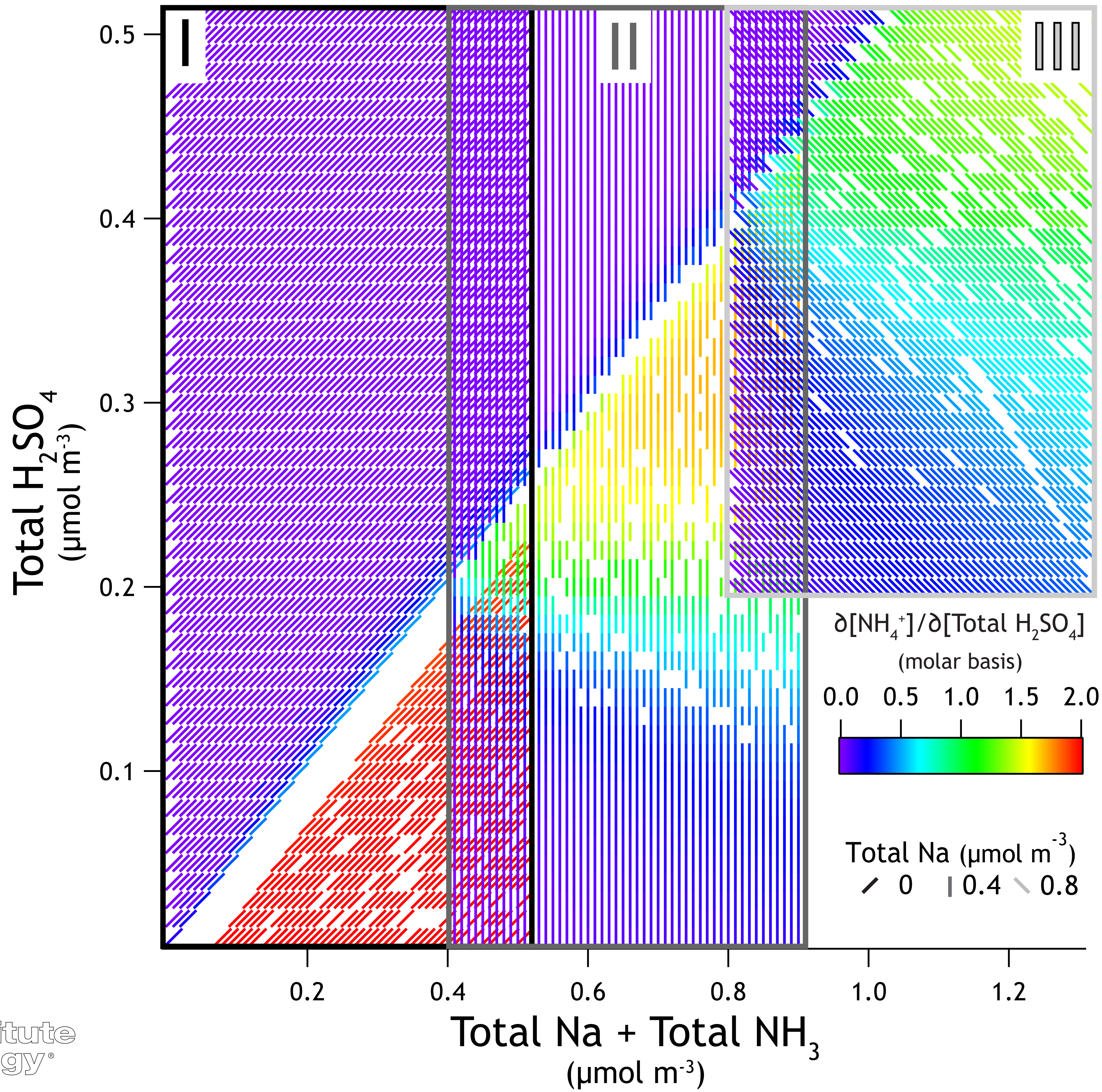
Henze et al., ACP (2007)

GEOS-Chem Adjoint + ANISORROPIA



Capps et al., ACP (2012)

GEOS-Chem v. TES NH_3

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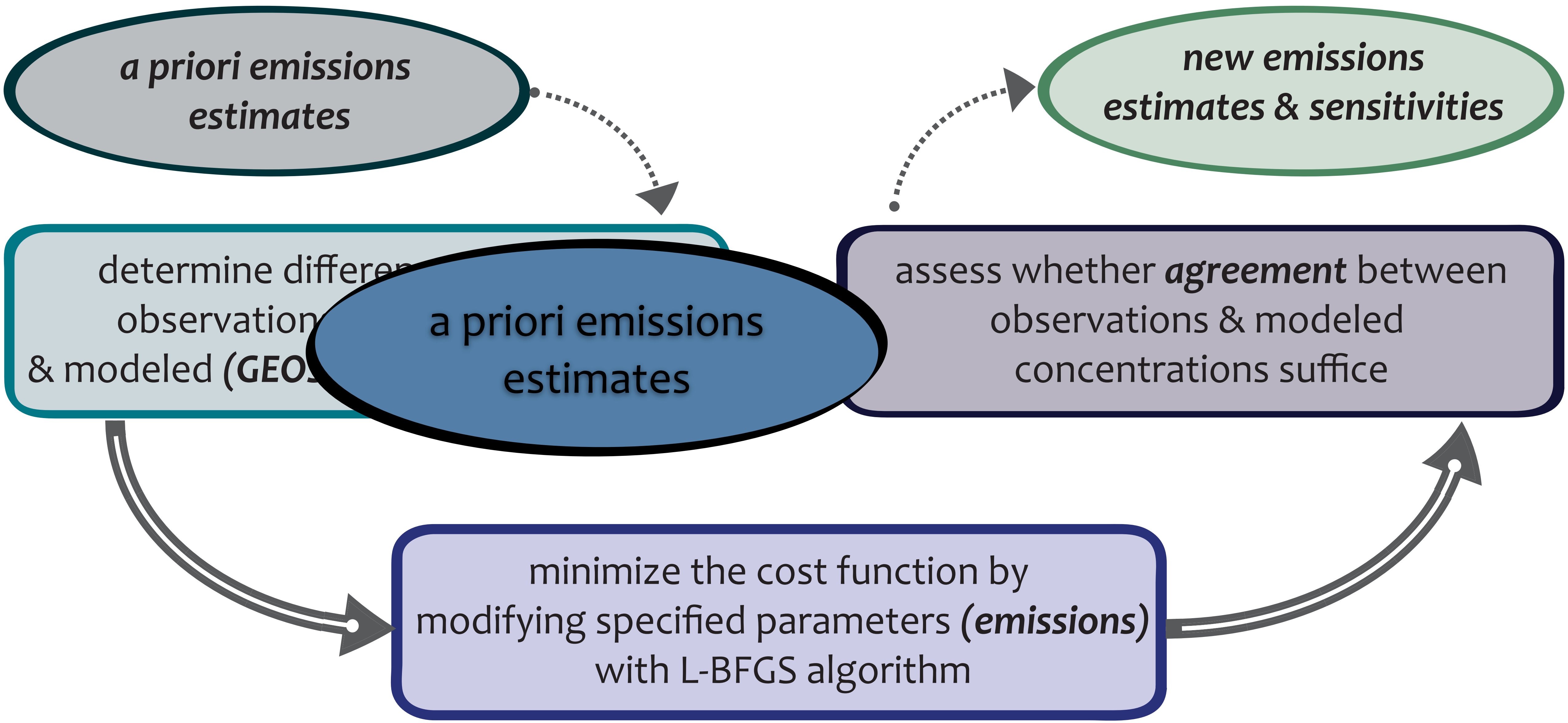
GEOS-Chem v. TES NH_3

Next Steps

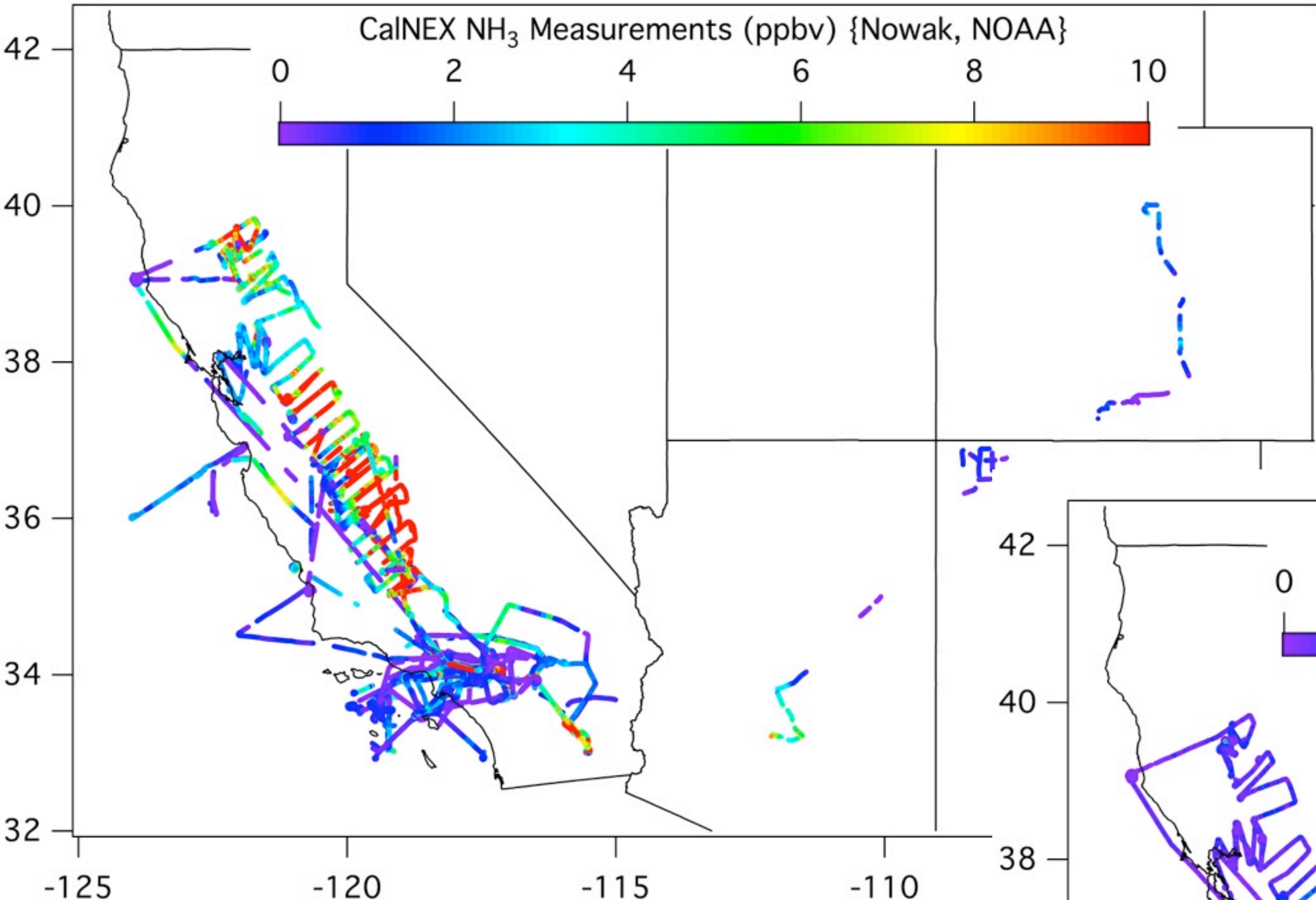


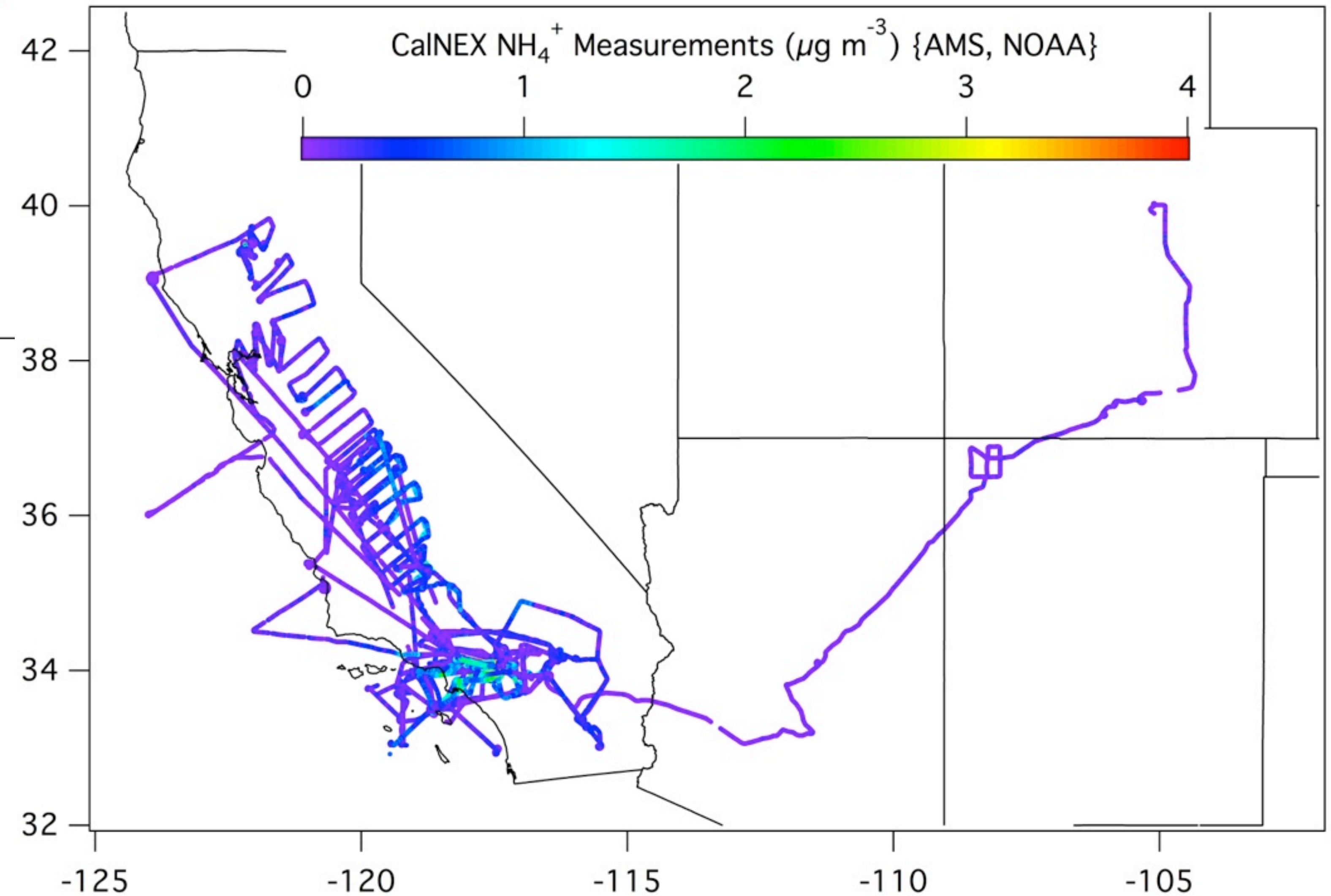
a priori emissions estimates
new emissions estimates & sensitivities
determine differen
observation
& modeled (GEOS
a priori emissions estimates
assess whether agreement between observations & modeled concentrations suffice
minimize the cost function by modifying specified parameters (emissions) with L-BFGS algorithm

California Nexus

Research at the Nexus of Air Quality and Climate Change

(NOAA, NASA, CalTech, Georgia Tech, CIRES)





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