High resolution inversion of methane emissions in North America using satellite and aircraft observations

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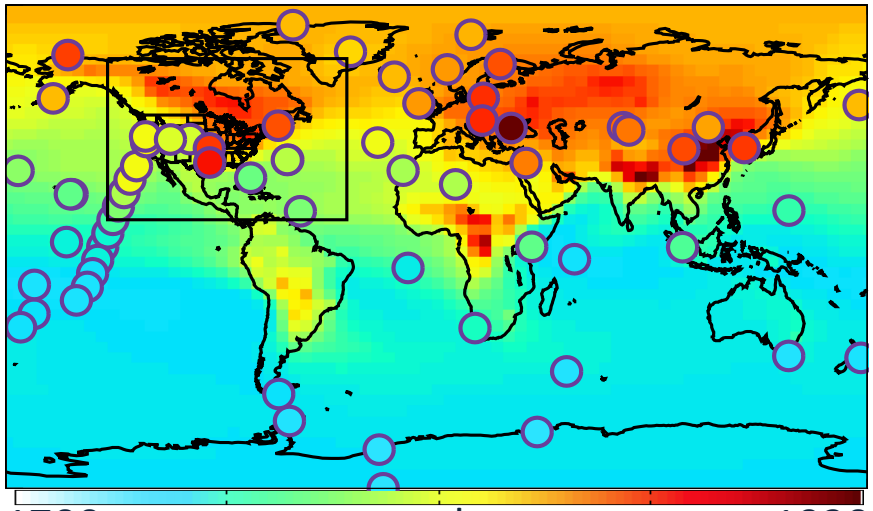
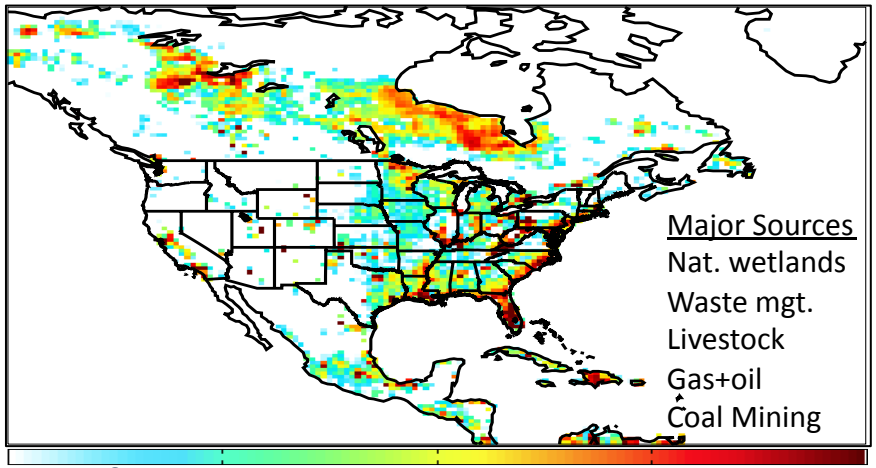
North America methane: observations by satellite and aircraft

GEOS-Chem and NOAA GMD JJA 2004



1700 ppb 1920

GEOS-Chem emissions JJA 2004

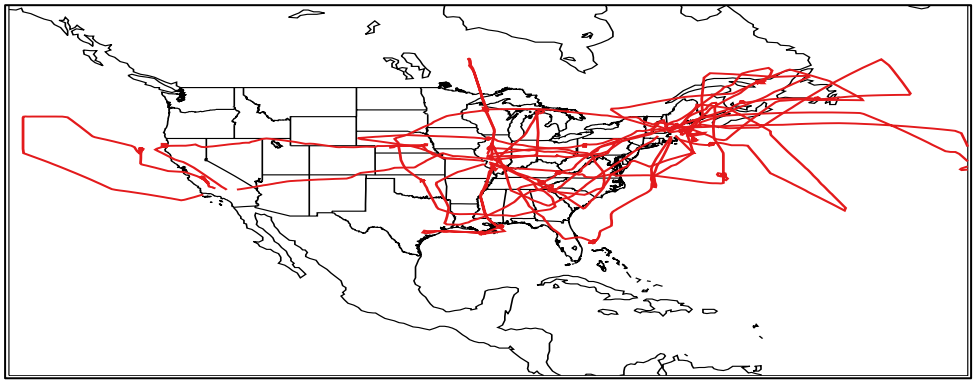


$2 \cdot 10^6$ kg $2 \cdot 10^7$

Study Period 1 JJA 2004

Satellite: SCIAMACHY Aircraft: INTEX-A

INTEX-A Fligthpaths



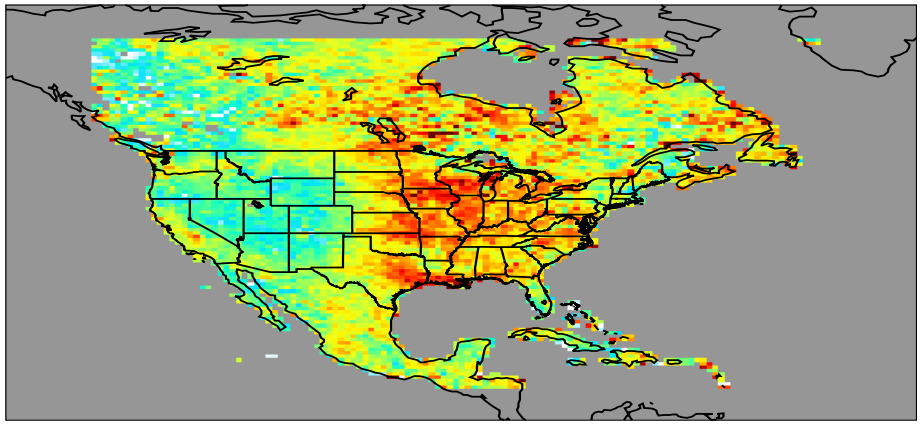
Study Period 2 AMJ 2010

Satellite: GOSAT, TES Aircraft: CalNex

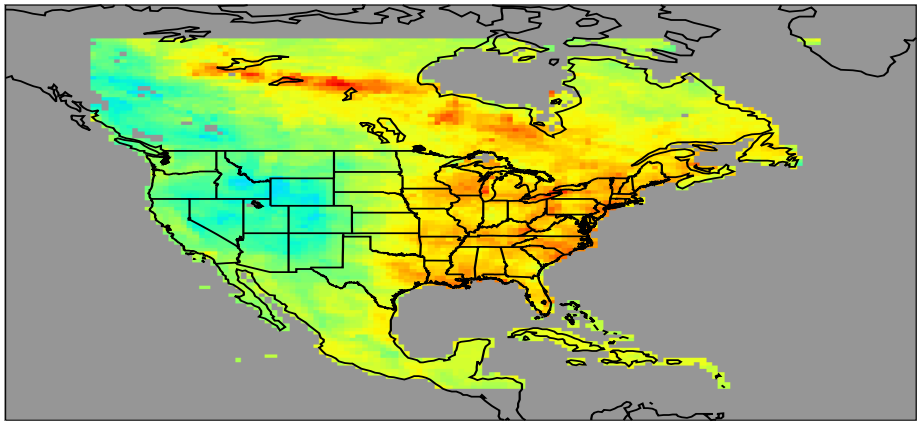
CalNex Fligthpaths

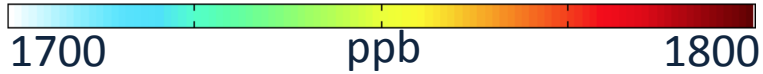
Model vs. SCIAMACHY: A priori
INTEX-A period 1 July – 14 August 2004

SCIA XCH_4 # Observations = 38741

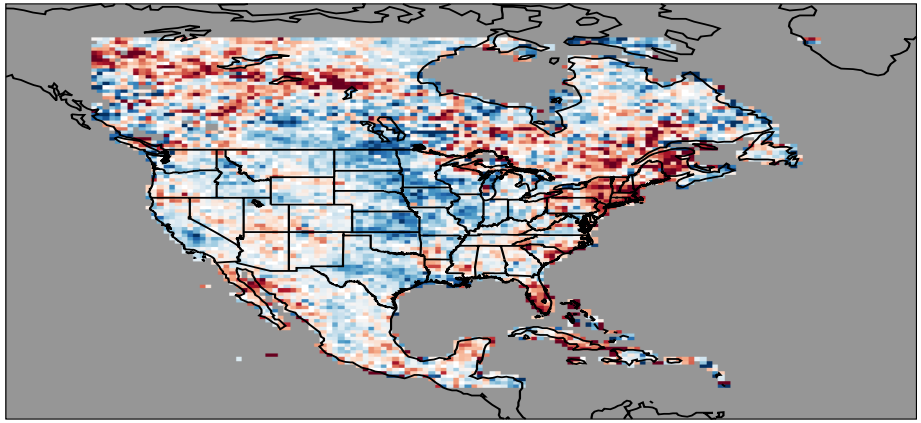


Model XCH_4

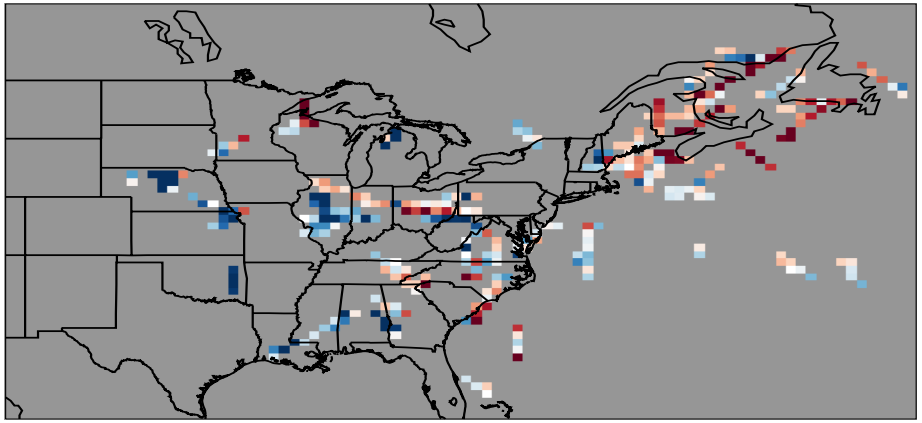




Model – SCIA XCH_4



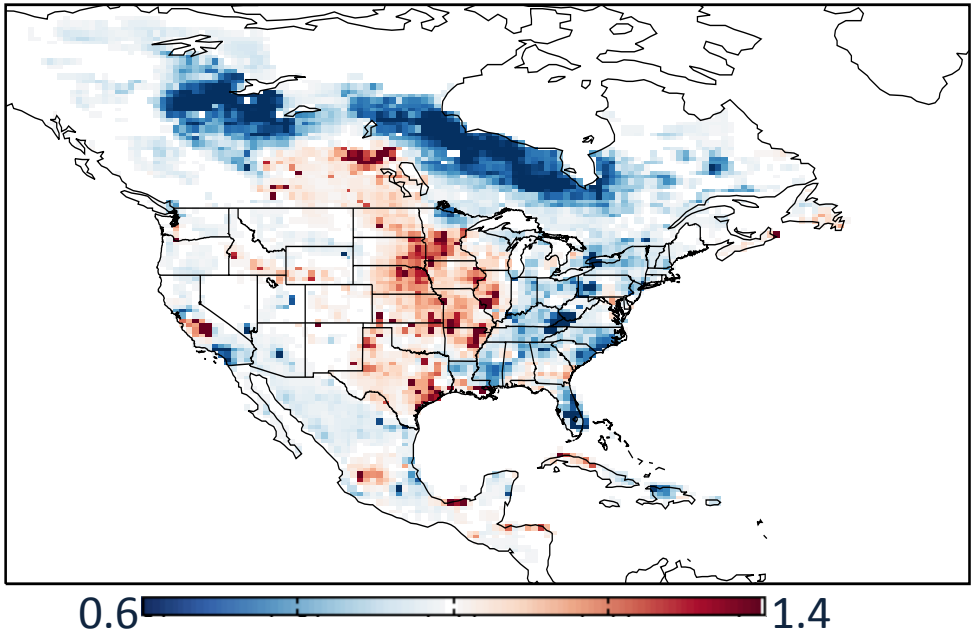
Model – INTEX-A boundary layer CH_4



Consistent model – obs differences suggest corrections achievable through inverse modeling.

Nested Adjoint Inversion – Results and information content of inversion

Optimized Emission Scaling Factors



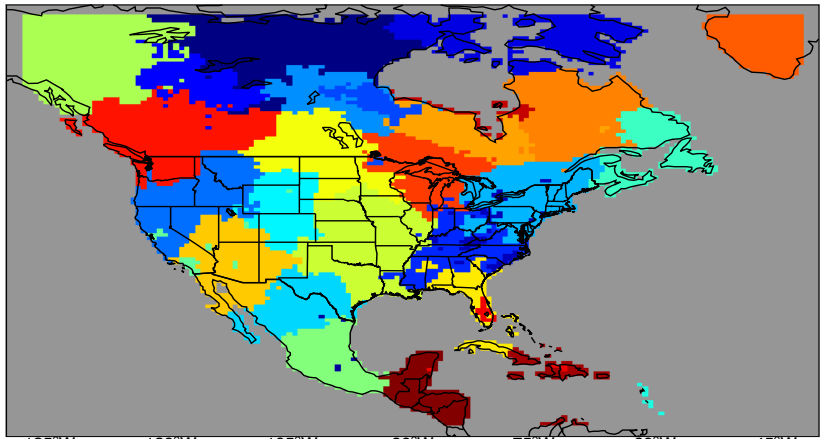
Prior emissions:

- too low: gas + oil, livestock
- too high: natural wetlands, coal mining

Model – obs differences persist. Causes:

- A priori too strong
- Obs inconsistent with model

Emission Scaling Clusters



Expected Behavior

Low spatial res.
Aggregation error

Fine spatial res.
Not enough info

How to reduce dimensionality without a priori info is unsolved problem in adjoint inversions.
We introduce a method based on a priori model-obs and clustering of model grid cells.

Adjoint inversion of California methane emissions using CalNex, GOSAT, and TES data

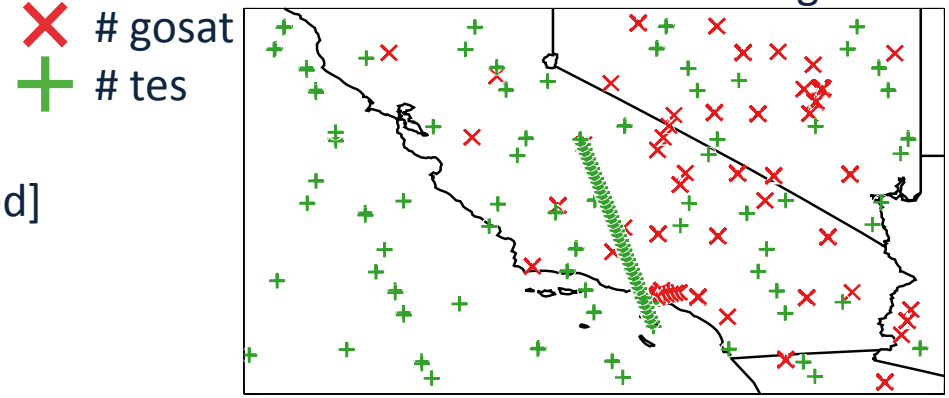
CalNex Mission

- 27 April – 22 June 2010
- Vertical profiles across CA

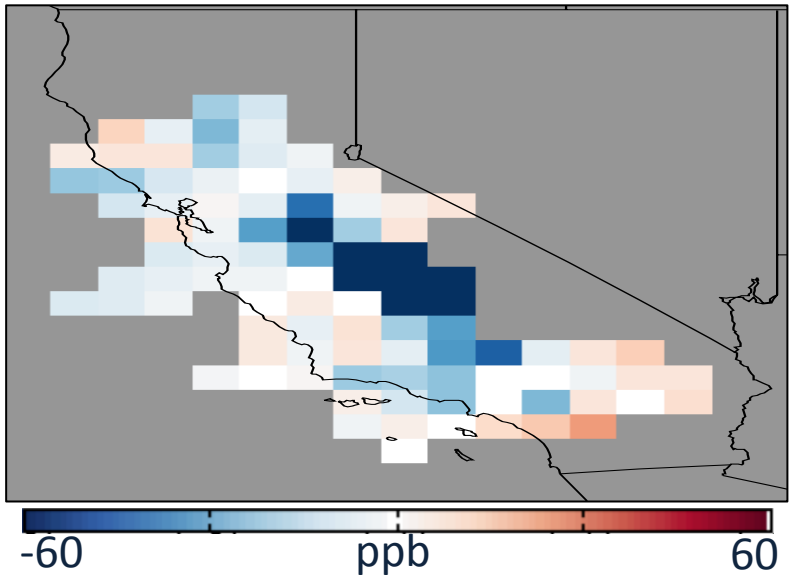
Previous inversion [Santoni et al., submitted]

- Lagrangian back-trajectories
- 2x underestimate of sources

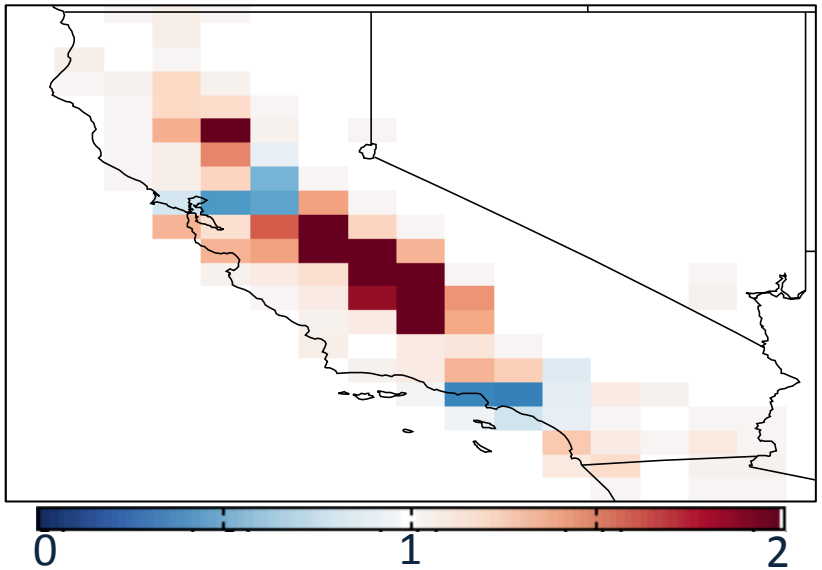
Location of GOSAT and TES during CalNex



GEOS-Chem – CalNex Methane [ppb]



Optimized Emission Scaling (adjoint)



Test lagrangian vs. Euelerian analytical and adjoint inversion framework.

Evaluate utility of remote observations for constraining CA sources.