A Gridded Version of the EPA Greenhouse Gas Inventory

With: D.J. Jacob[1], M.P. Sulprizio[1], A.J. Turner[1], M. Weitz[2], T. Wirth[2], C. Hight[2], M. DeFigueiredo[2], M. Desai[2], R. Schmeltz[2], L. Hockstad[2], A.A. Bloom[3], K. Bowman[3], S. Jeong[4], and M. Fischer[4]

J.D. Maasakkers

(1) Harvard University
(2) U.S. Environmental Protection Agency, Climate Change Division
(3) Jet Propulsion Laboratory/California Institute of Technology
(4) Lawrence Berkeley National Laboratory

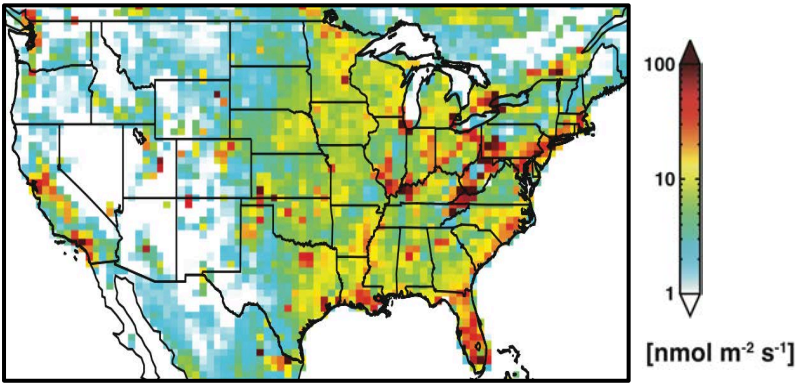
2012 US EPA anthropogenic methane emissions

Available only as national totals

US EPA (2016)

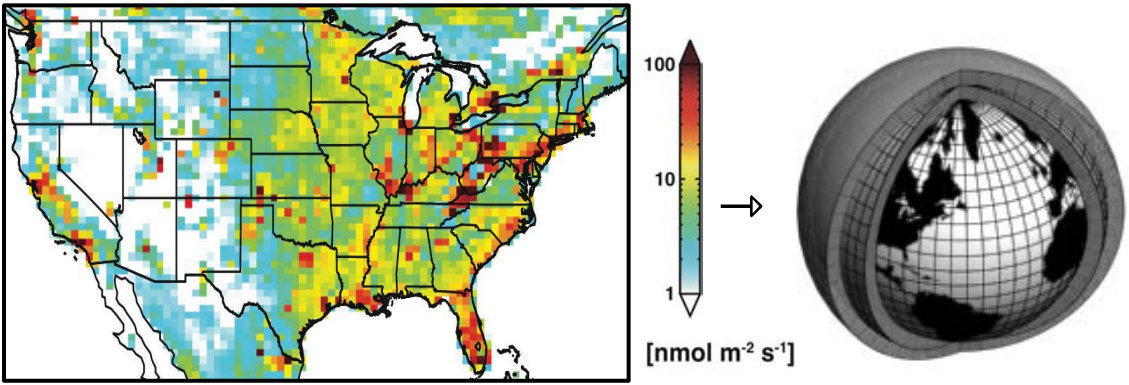
We can estimate emissions based on concentrations

Process based emissions



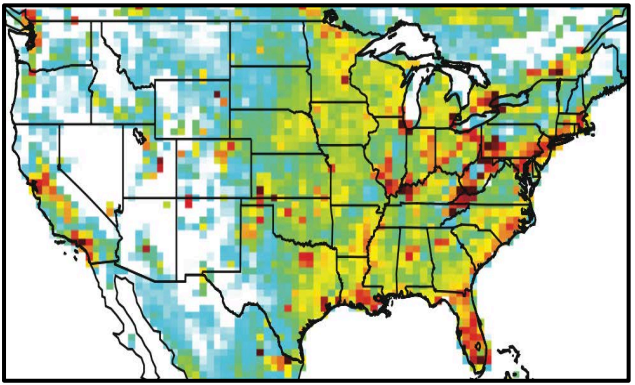
We can estimate emissions based on concentrations

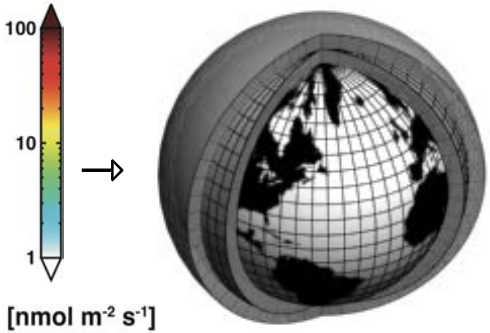
Process based emissions



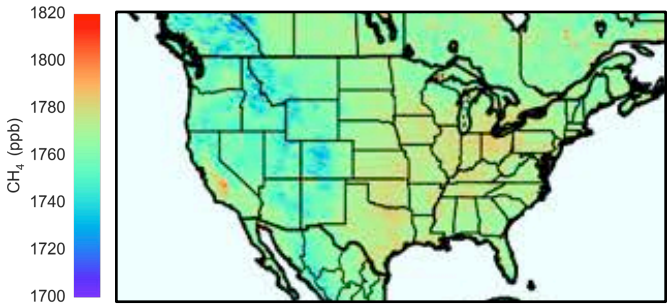
We can estimate emissions based on concentrations

Process based emissions

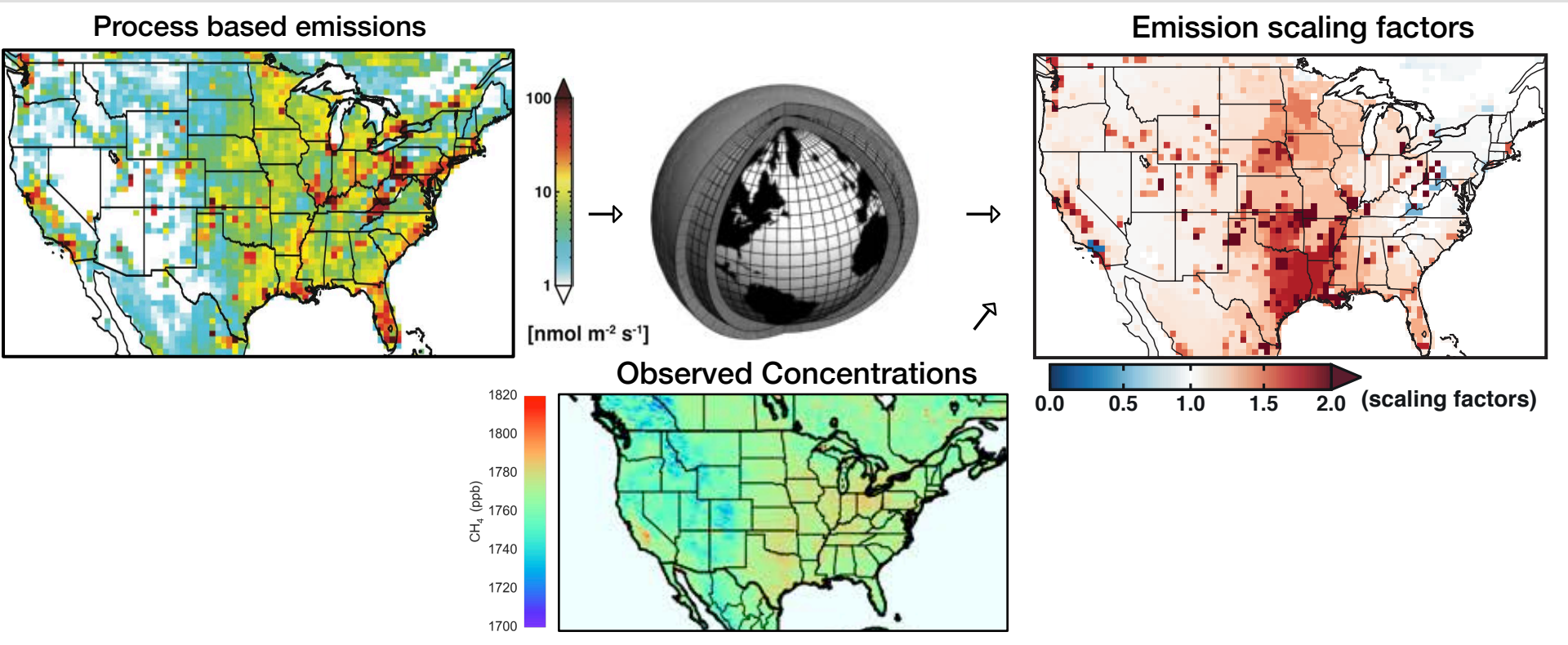




Observed Concentrations

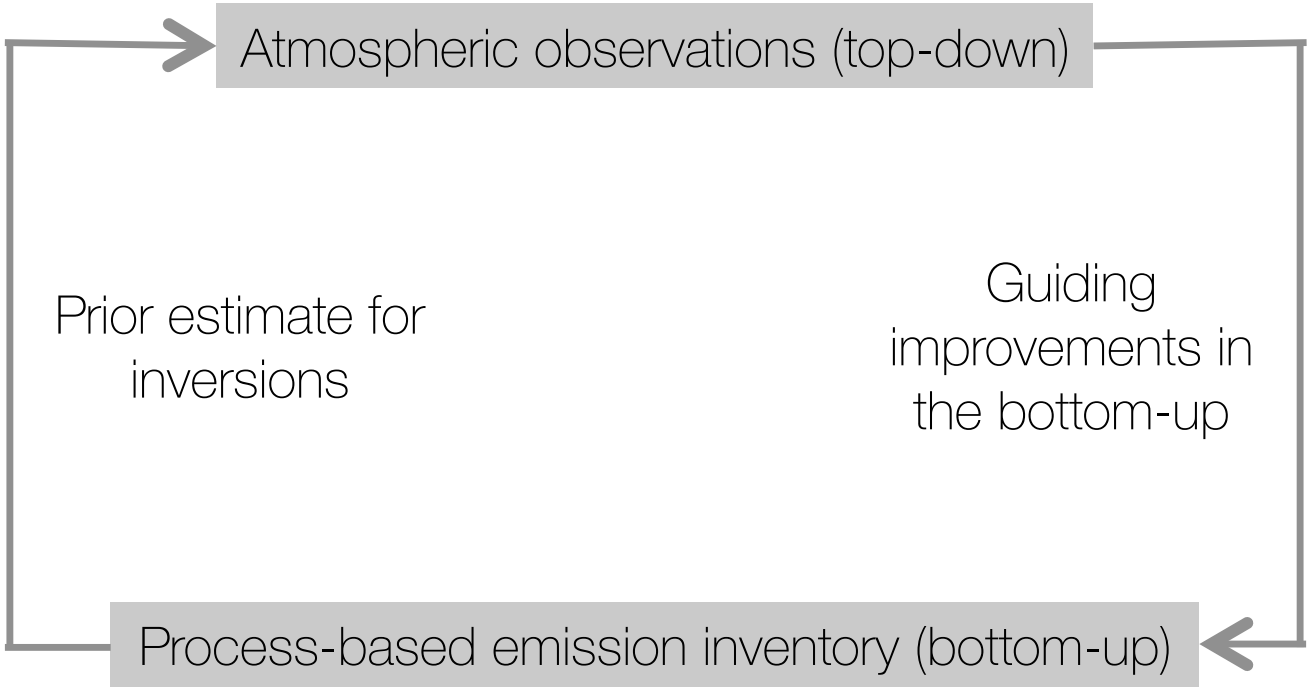


We can estimate emissions based on concentrations



Turner et al. (2015)

The ultimate goal of inverse analyses is to improve bottom-up inventories



An evaluable gridded EPA inventory for 2012

Region-specific EPA emission factors

Spatial allocation on 0.1° x 0.1° grid using national & high resolution datasets with facility-level information from the Greenhouse Gas Reporting Program

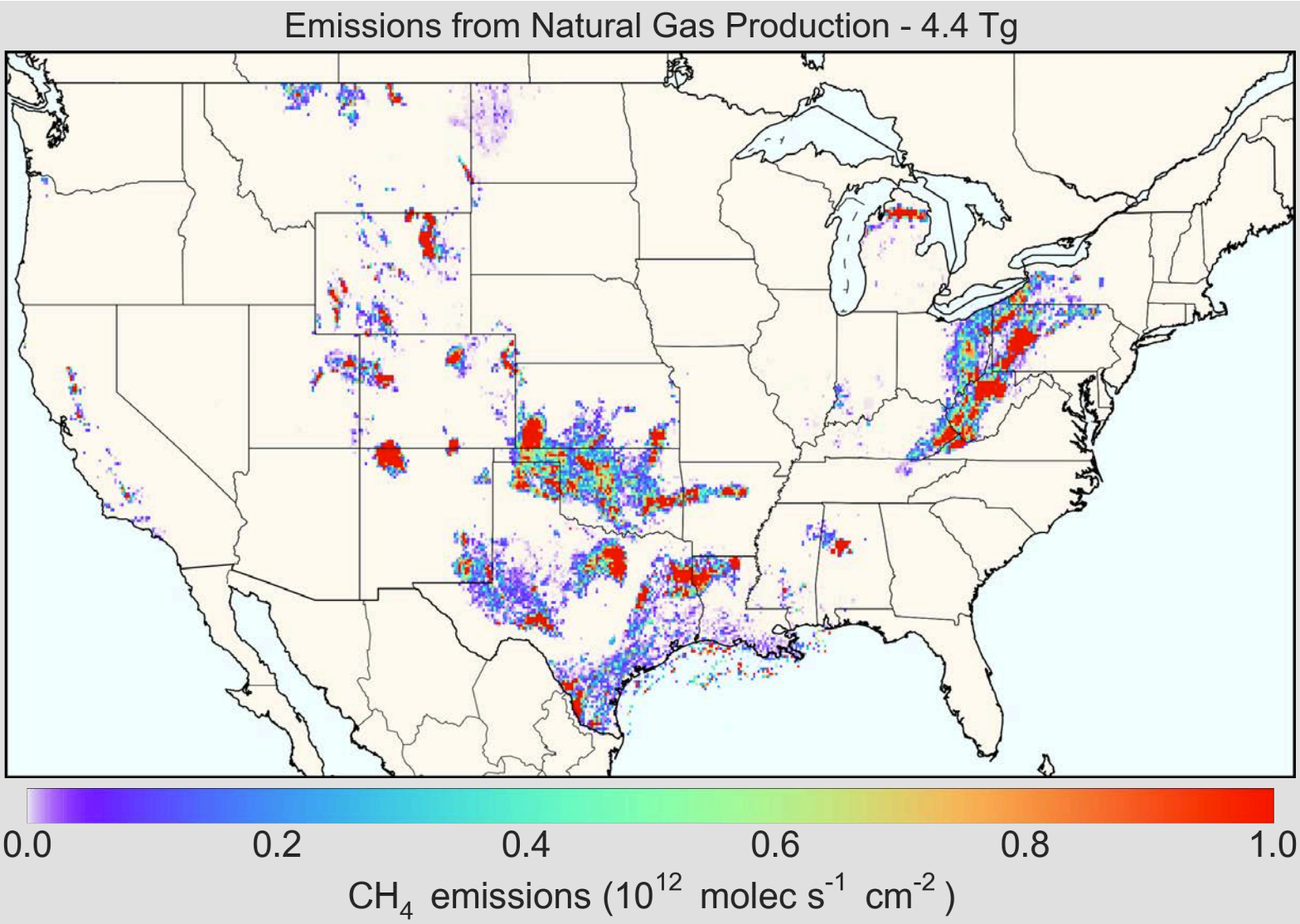
22 layers of data for emissions from different processes

Monthly time resolution

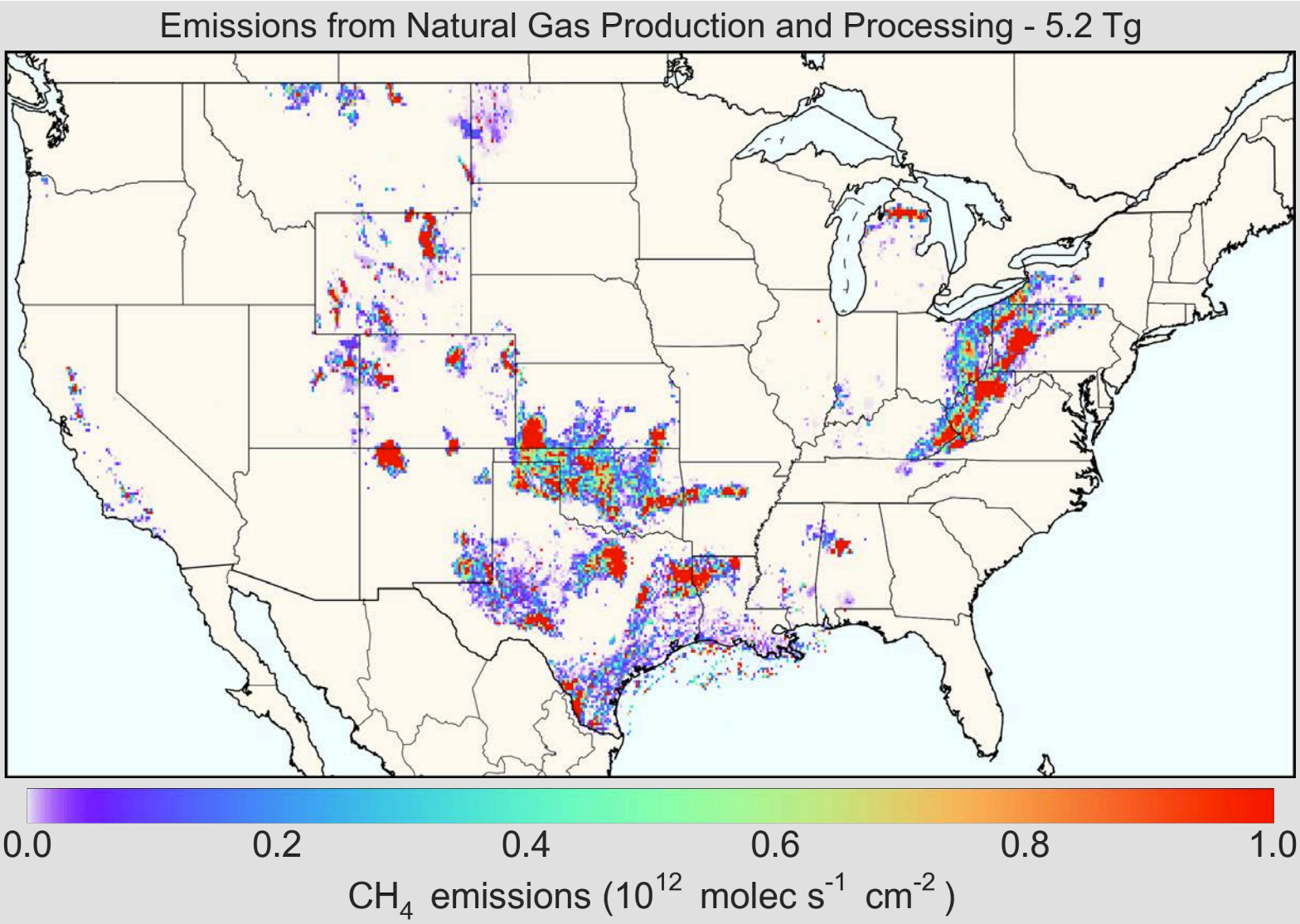
Scale-dependent error characterization


4.4 Tg Production
0.9 Tg Processing
1.1 Tg Transmission
0.5 Tg Distribution
Allocating Natural Gas Emissions

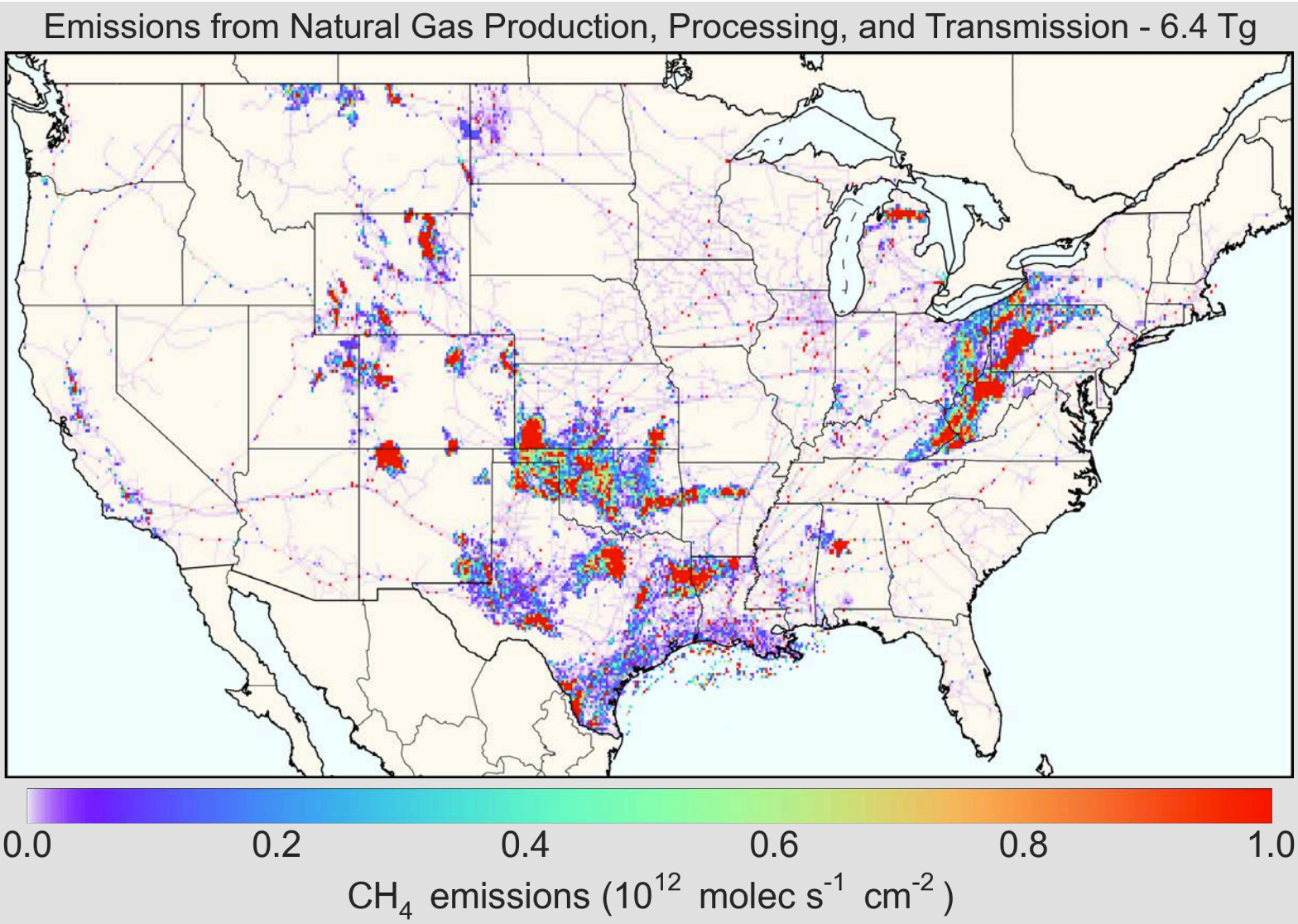
The allocation accounts or nonconventional wells and well completions



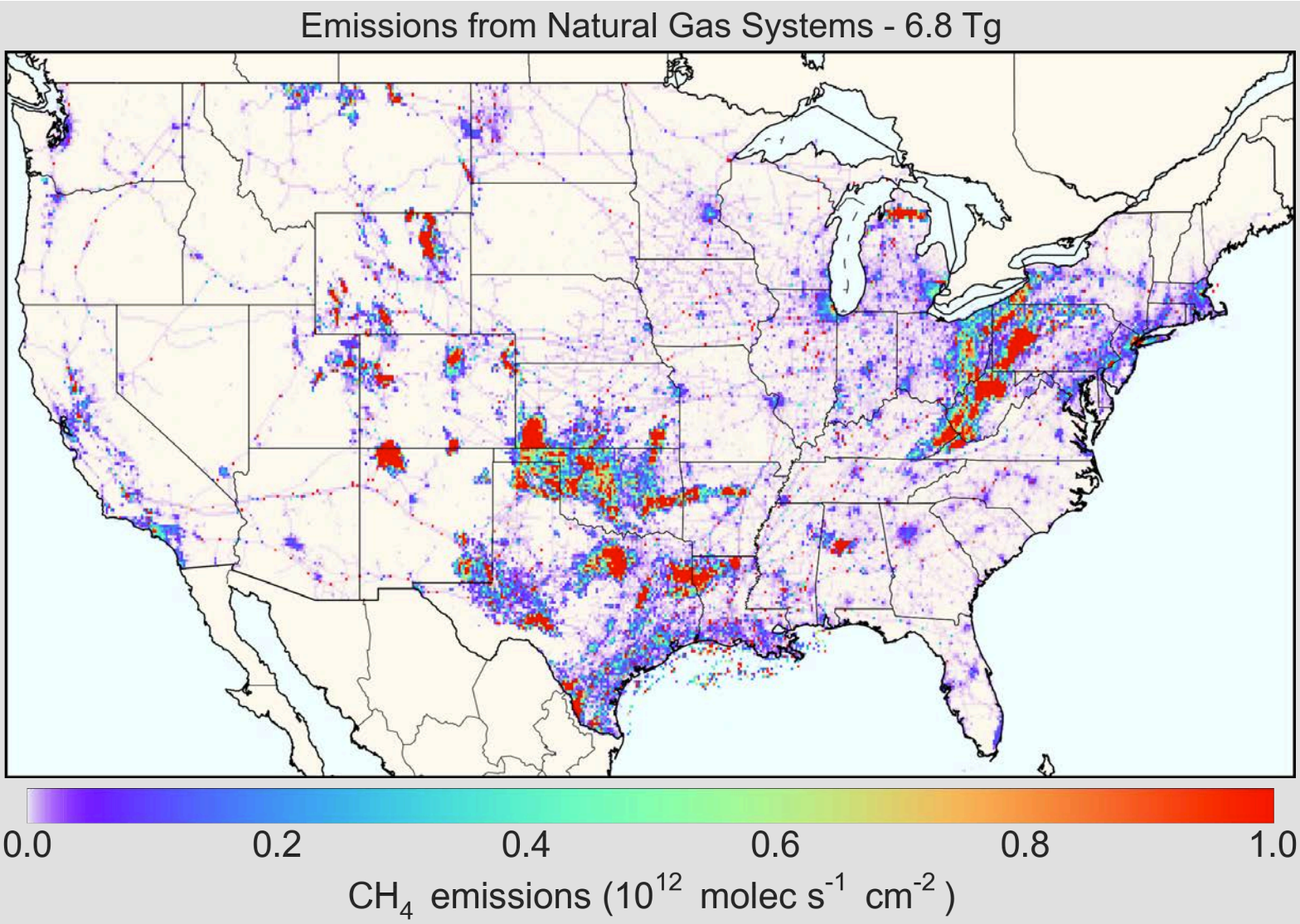
Processing emissions are only allocated to processing plants



Transmission emissions are related to a large set of activity data

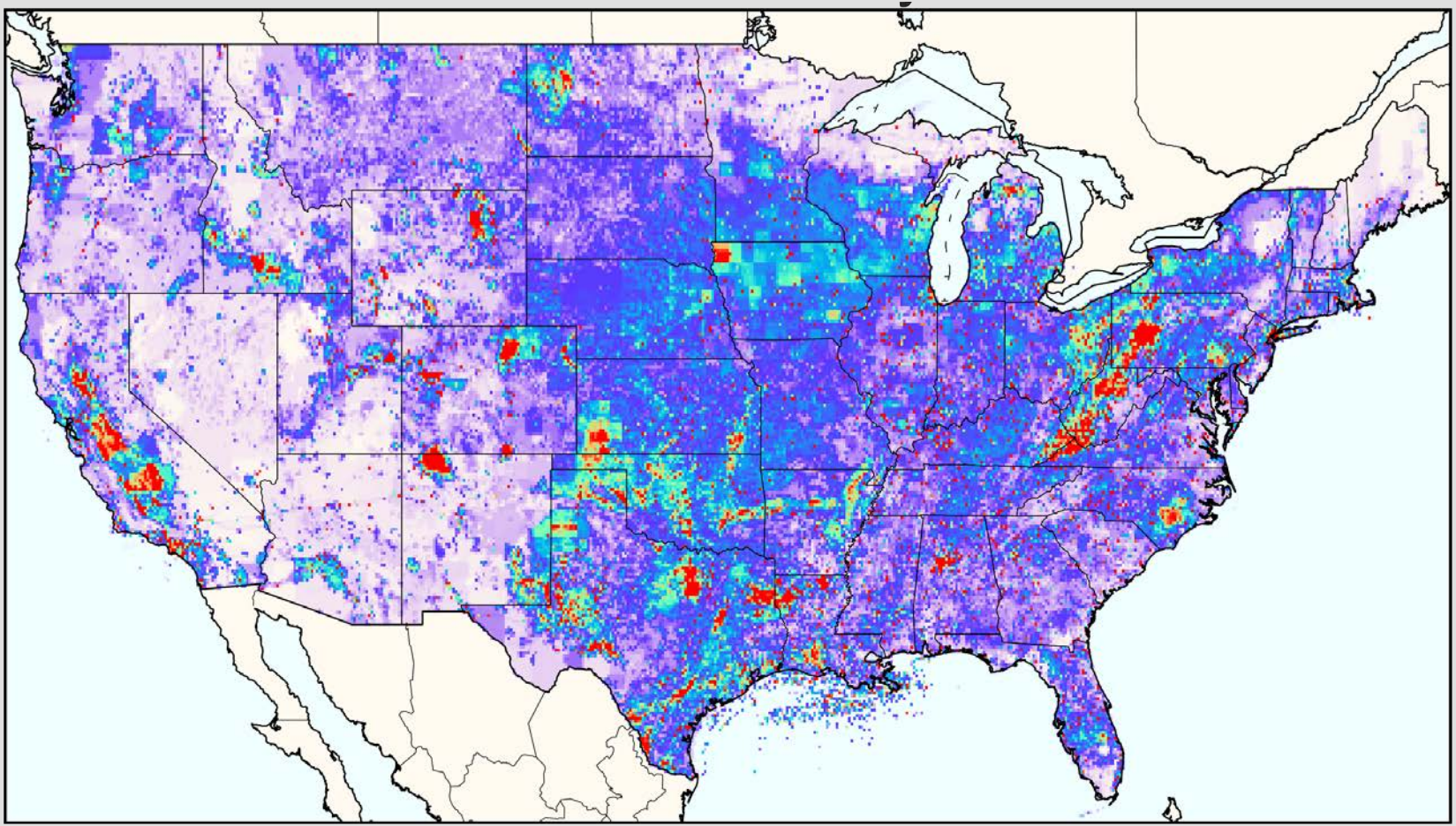


Distribution emissions take into account local differences in infrastructure

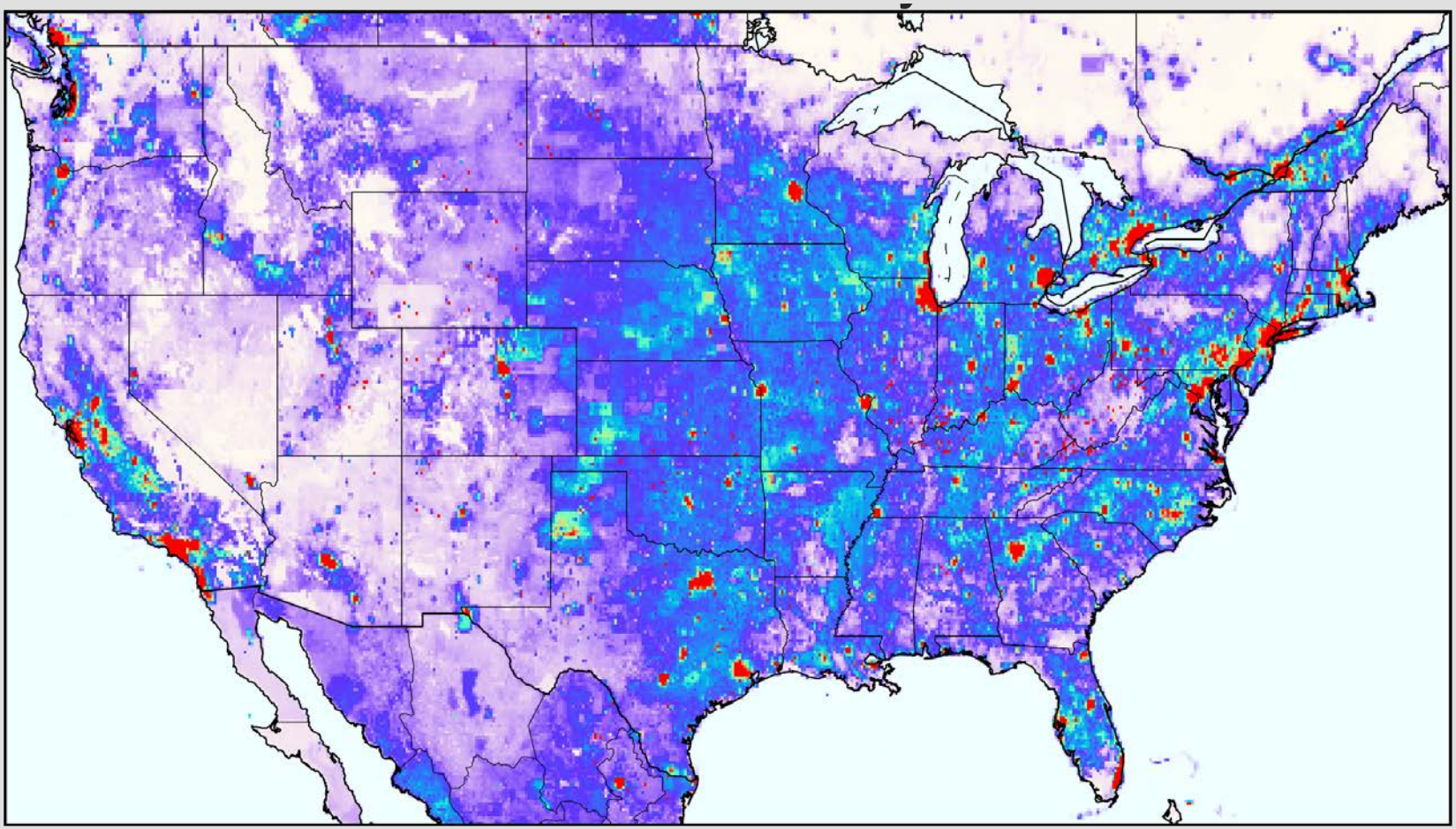


Total emissions

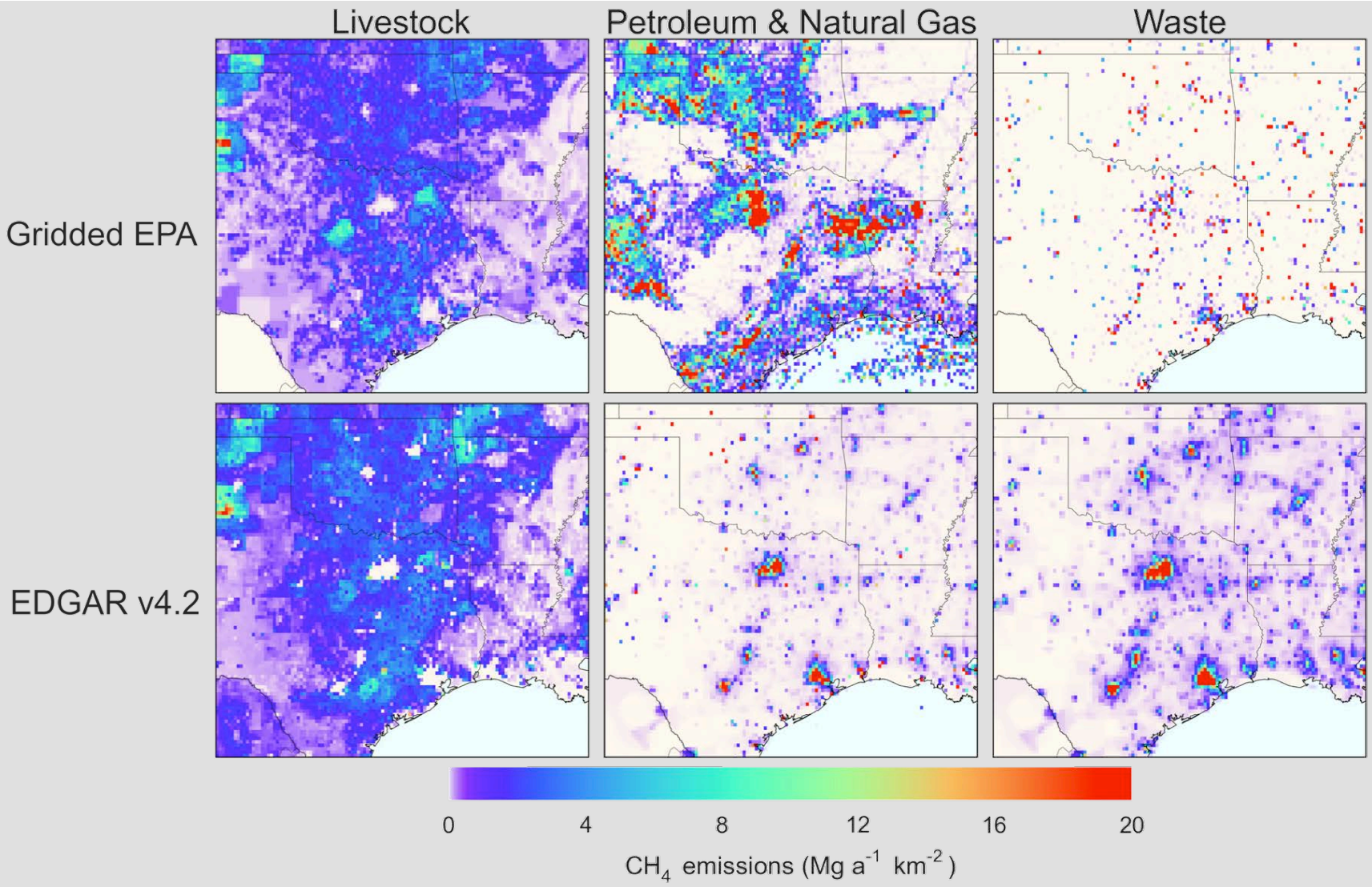
Gridded EPA anthropogenic methane emissions for 2012



EDGAR v4.2 anthropogenic methane emissions for 2008

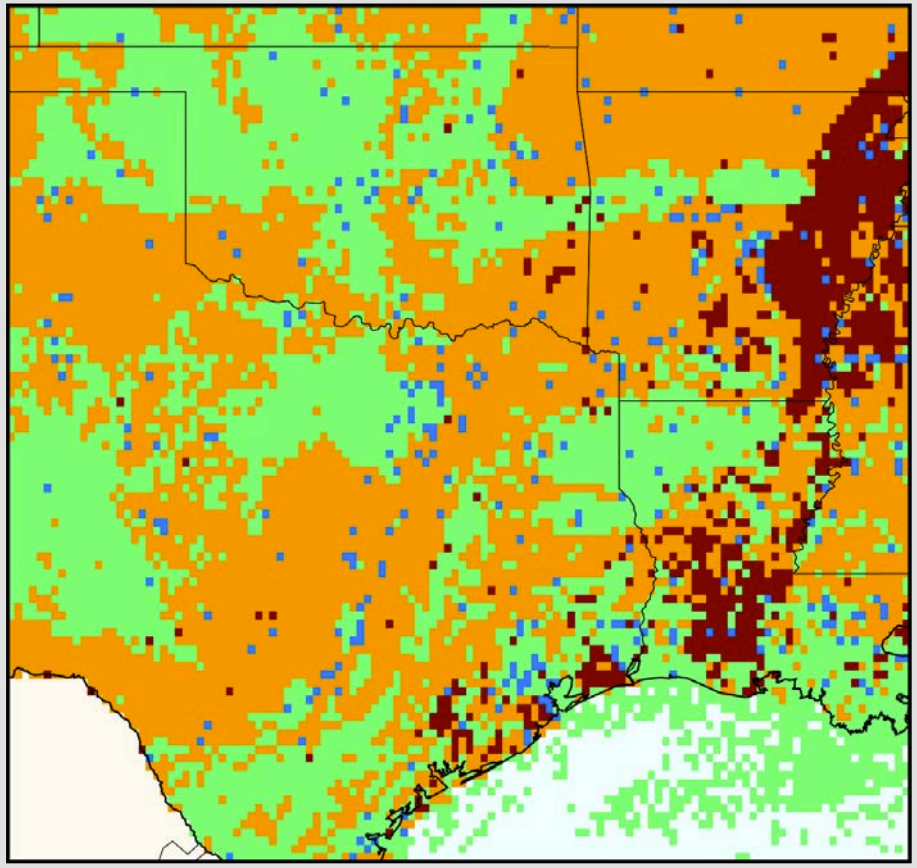


Differences in spatial allocation will impact inversion results

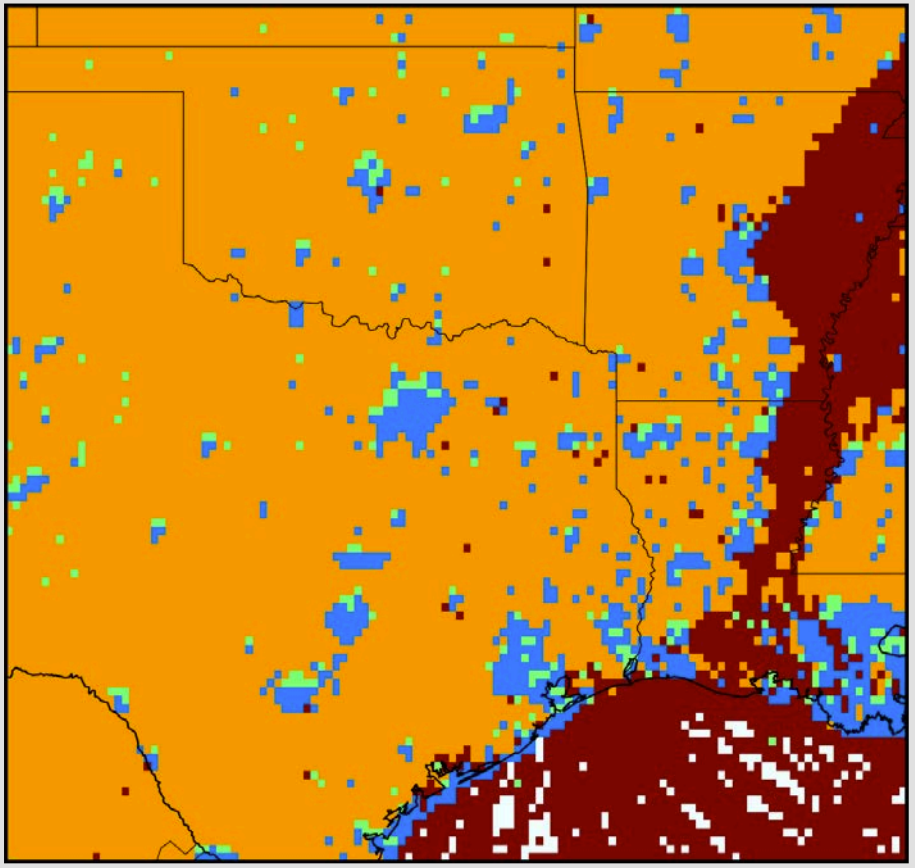


Differences in spatial allocation will impact inversion results

EPA - Dominating Emission Source

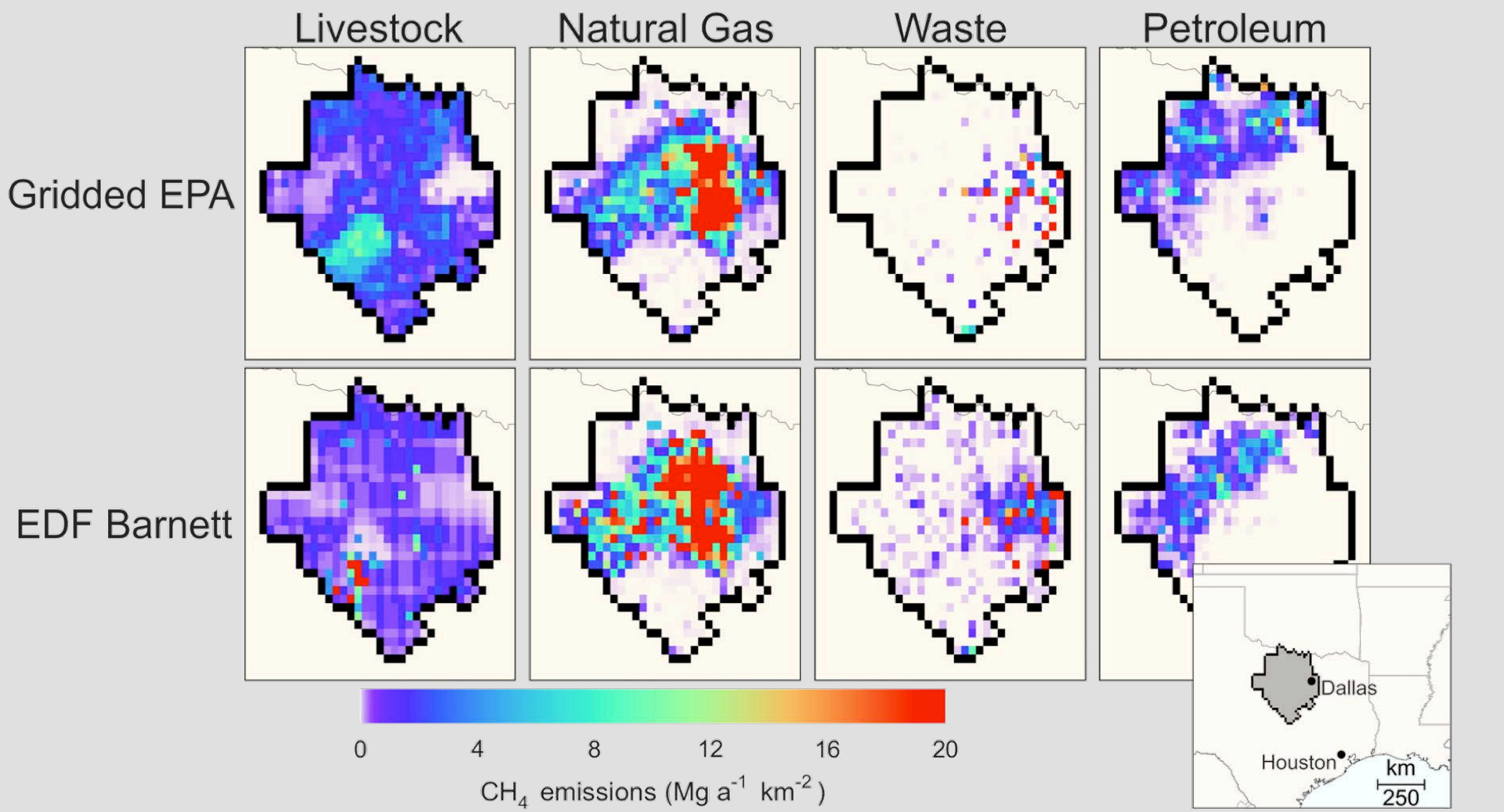


EDGAR - Dominating Emission Source

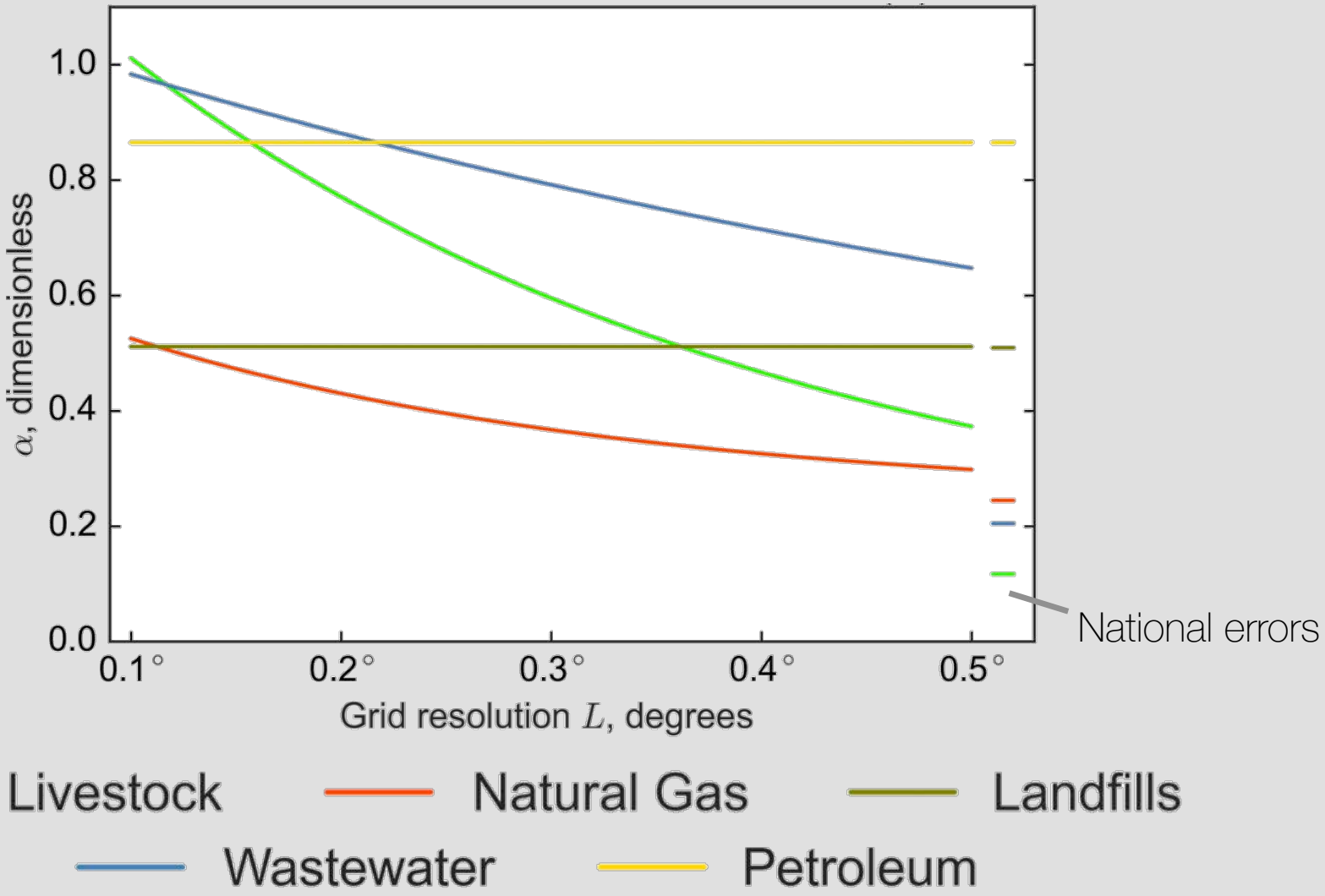


Waste
Oil and Gas
Livestock
Other

We can use the detailed local EDF Barnett Shale inventory to estimate our errors



Estimated errors vary as a function of resolution



Emissions and the paper are available at: epa.gov/ghgemissions/gridded-2012-methane-emissions

Article

pubs.acs.org/est

Environmental Science & Technology

Gridded National Inventory of U.S. Methane Emissions

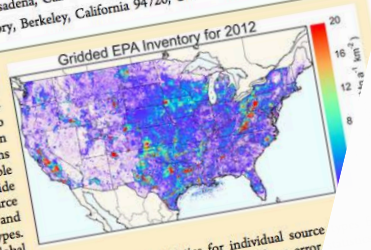
Joannes D. Maasakkers,*[†] Daniel J. Jacob,[†] Melissa P. Sulprizio,[†] Alexander J. Turner,[†] Melissa Weitz,[‡] Tom Wirth,[‡] Cate Hight,[‡] Mark DeFigueiredo,[‡] Mausami Desai,[‡] Rachel Schmeltz,[‡] Leif Hockstad,[‡] Anthony A. Bloom,[¶] Kevin W. Bowman,[¶] Seongeun Jeong,[§] and Marc L. Fischer[§]

[†]School of Engineering and Applied Sciences, Harvard University, Pierce Hall, 29 Oxford Street, Cambridge, Massachusetts 02138, United States

[‡]Climate Change Division, Environmental Protection Agency, Washington, District of Columbia 20460, United States

[¶]Jet Propulsion Laboratory, California Institute of Technology, Pasadena, California 91109, United States

[§]Energy Technologies Area, Lawrence Berkeley National Laboratory, Berkeley, California 94720, United States



ABSTRACT: We present a gridded inventory of US anthropogenic methane emissions with 0.1° × 0.1° spatial resolution, monthly temporal resolution, and detailed scale-dependent error characterization. The inventory is designed to be consistent with the 2016 US Environmental Protection Agency (EPA) Inventory of US Greenhouse Gas Emissions and Sinks (GHGI) for 2012. The EPA inventory is available only as national totals for different source types. We use a wide range of databases at the state, county, local, and point source level to disaggregate the inventory and allocate the spatial and temporal distribution of emissions for individual source types. Results show large differences with the EDGAR v4.2 global gridded inventory commonly used as a priori estimate in inversions of atmospheric methane observations. We derive grid-dependent error statistics for individual source comparison with the Environmental Defense Fund (EDF) regional inventory for Northeast Texas. These error independently verified by comparison with the California Greenhouse Gas Emissions Measurement (CALGEM) emission inventory. Our gridded, time-resolved inventory provides an improved basis for inversion of atmos observations to estimate US methane emissions and interpret the results in terms of the underlying processes

INTRODUCTION

Under the United Nations Framework Convention on Climate Change (UNFCCC), individual countries must report their national anthropogenic greenhouse gas emissions calculated using comparable methods.[1] The Intergovernmental Panel on Climate Change (IPCC)[2] provides three different methods or "tiers" for calculating emissions. All are bottom-up approaches in which emissions from individual source types are generally calculated as the product of activity data and emission factors. Increasing tiers are more detailed and require more country-

inversions of atmospheric methane th
ments in the inventory.

Table 1 gives the GHGI estimate
ology updated in 2016[3] and incl
different source types. Total US an
Tg a^{-1}, including major contribut
(24%), enteric fermentation (23
(9%), manure management
equivalently oil) systems (8%
fire emissions but no other
source of methane is thoug
± 5 Tg A^{-1} in the c
anthropogenic emission
EPA[3] with a consisten
updated information

Greenhouse Gas Emissions

Gridded 2012 Methane Emissions

A team at Harvard University along with EPA and other coauthors developed a gridded inventory of U.S. anthropogenic methane emissions with 0.1° x 0.1° spatial resolution, monthly temporal resolution, and detailed scale-dependent error characterization. The inventory is designed to be consistent with the 2016 U.S. EPA Inventory of U.S. Greenhouse Gas Emissions and Sinks estimates for the year 2012, which presents national totals for different source types. The gridded inventory was developed using a wide range of databases at the state, county, local, and point source level to allocate the spatial and temporal distribution of emissions for individual source types.

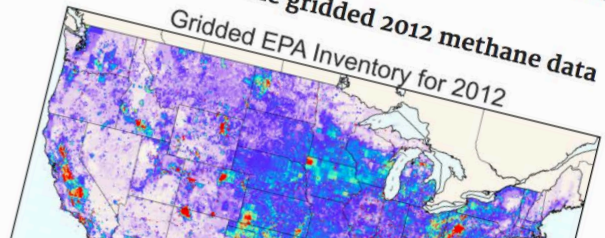
This data can be used by researchers to better compare the national-level inventory with measurement results that may be at other scales. Users of this gridded inventory are asked to cite the original reference (Maasakkers et al., 2016) in their publications. Error estimates are given in that reference.

- Paper: Maasakkers et. al. 2016, A Gridded National Inventory of U.S. Methane Emissions
- Maps based on the gridded 2012 methane data
- Data

Paper: Maasakkers et. al. 2016, A Gridded National Inventory of U.S. Methane Emissions

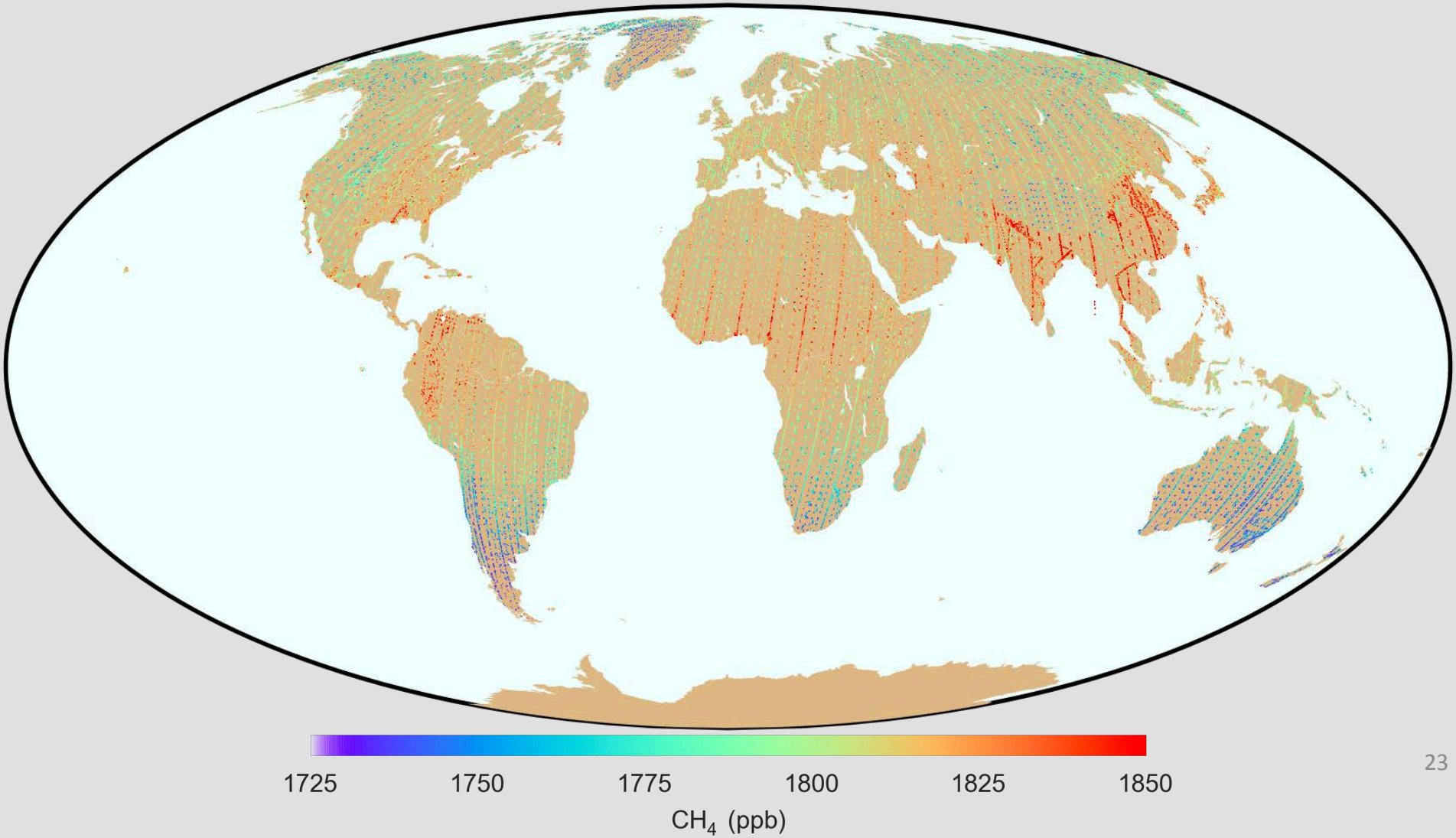
Read the paper EXIT

Maps based on the gridded 2012 methane data




Atmospheric inversions

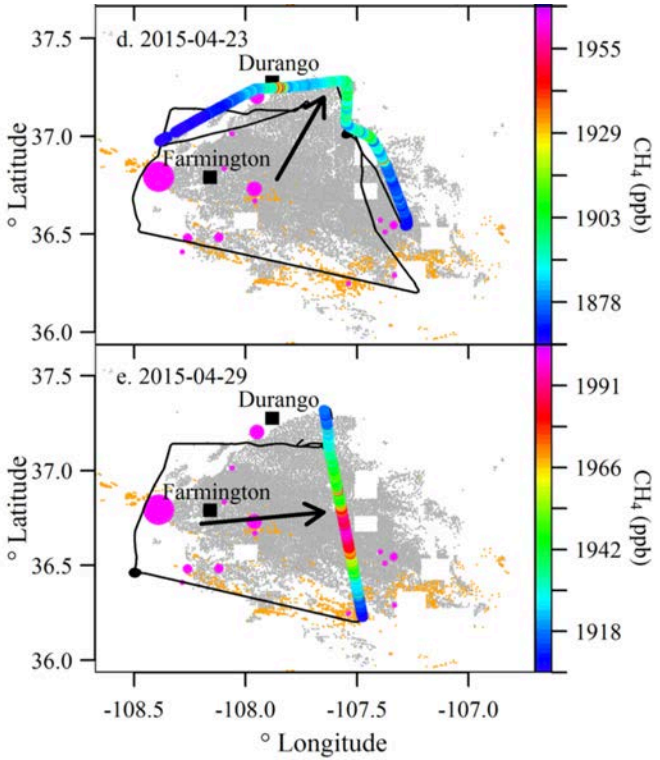
We are finalizing an inversion using GOSAT Methane for 2009 - 2015



Smith et al. find consistency over Four Corners

Emissions estimated from aircraft mass balance at Four Corners are now consistent with Gridded EPA inventory.

No significant decedal change, emissions do not seem to scale with natural gas produced.

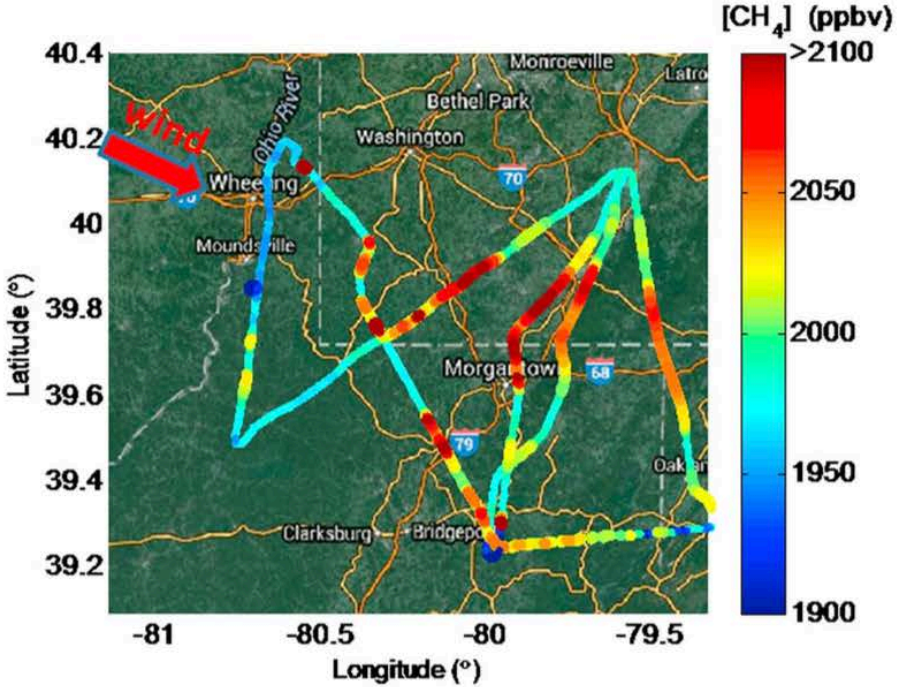


Smith et al. (2017)

Ren et al. find higher oil & gas emissions in the Marcellus

Emissions estimated from aircraft mass balance point at a larger source from oil & gas operations (Comparing 2015 with 2012).

Low ethane emissions may point at a larger coalbed methane.



Ren et al. (2017)

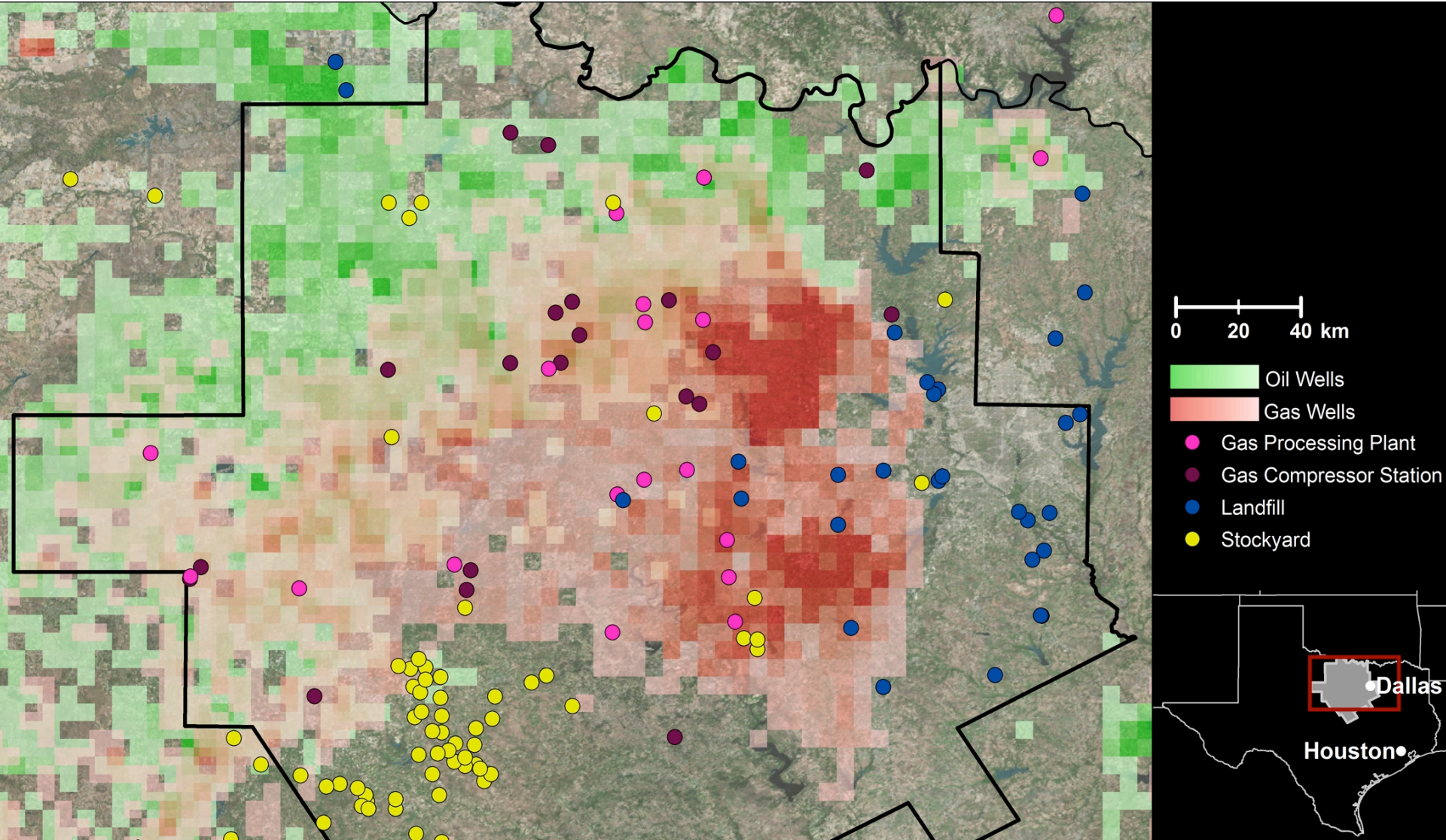
Some other studies

Barkley et al. (2017) use some emissions fields to allow comparison of aircraft data with their local inventory.

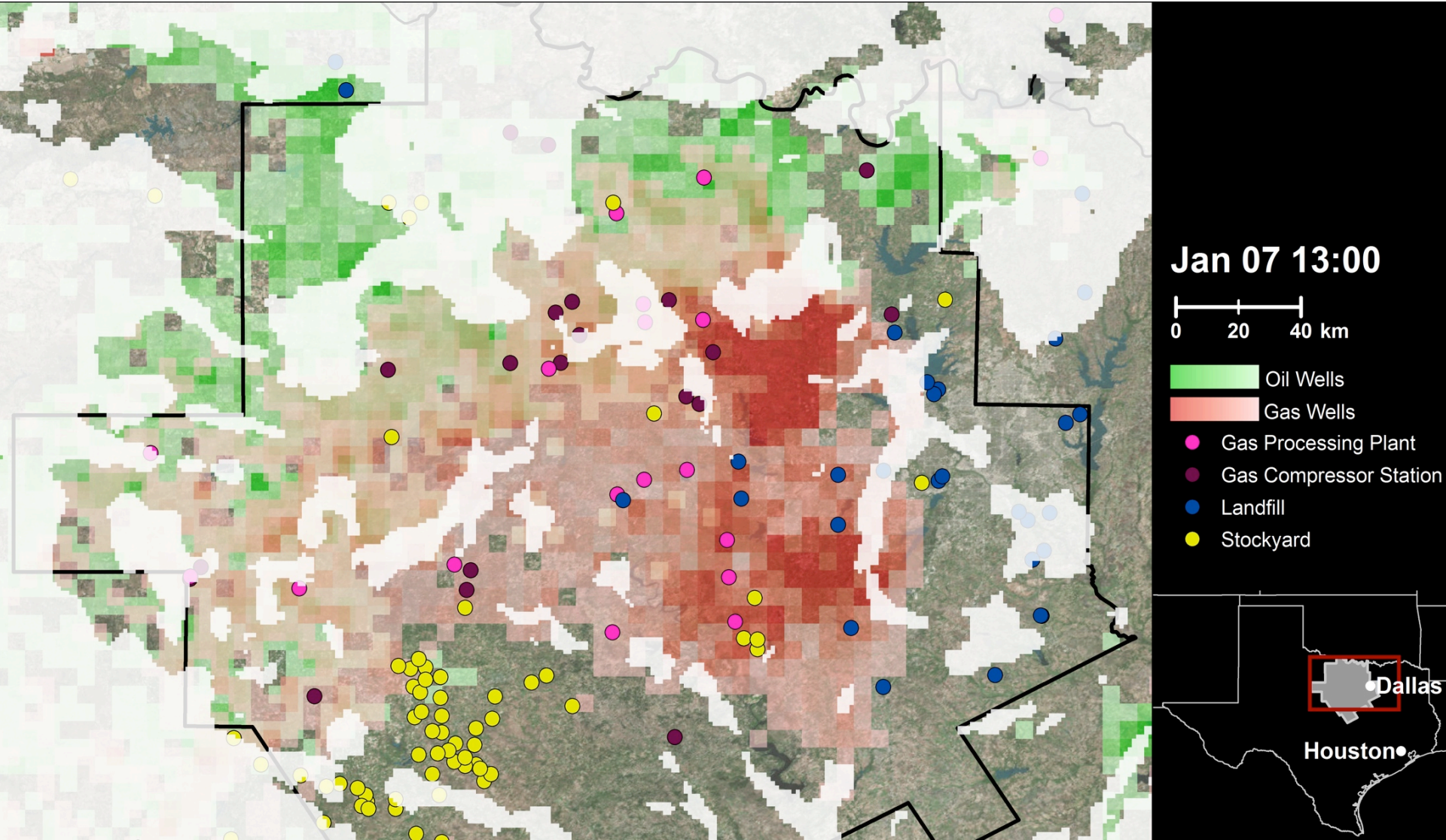
Cui et al. (2017) found consistency with aircraft estimates for the San Joaquin Valley.

Jeong et al. (2017) used the landfill estimate as an independent check on their study of California emissions.

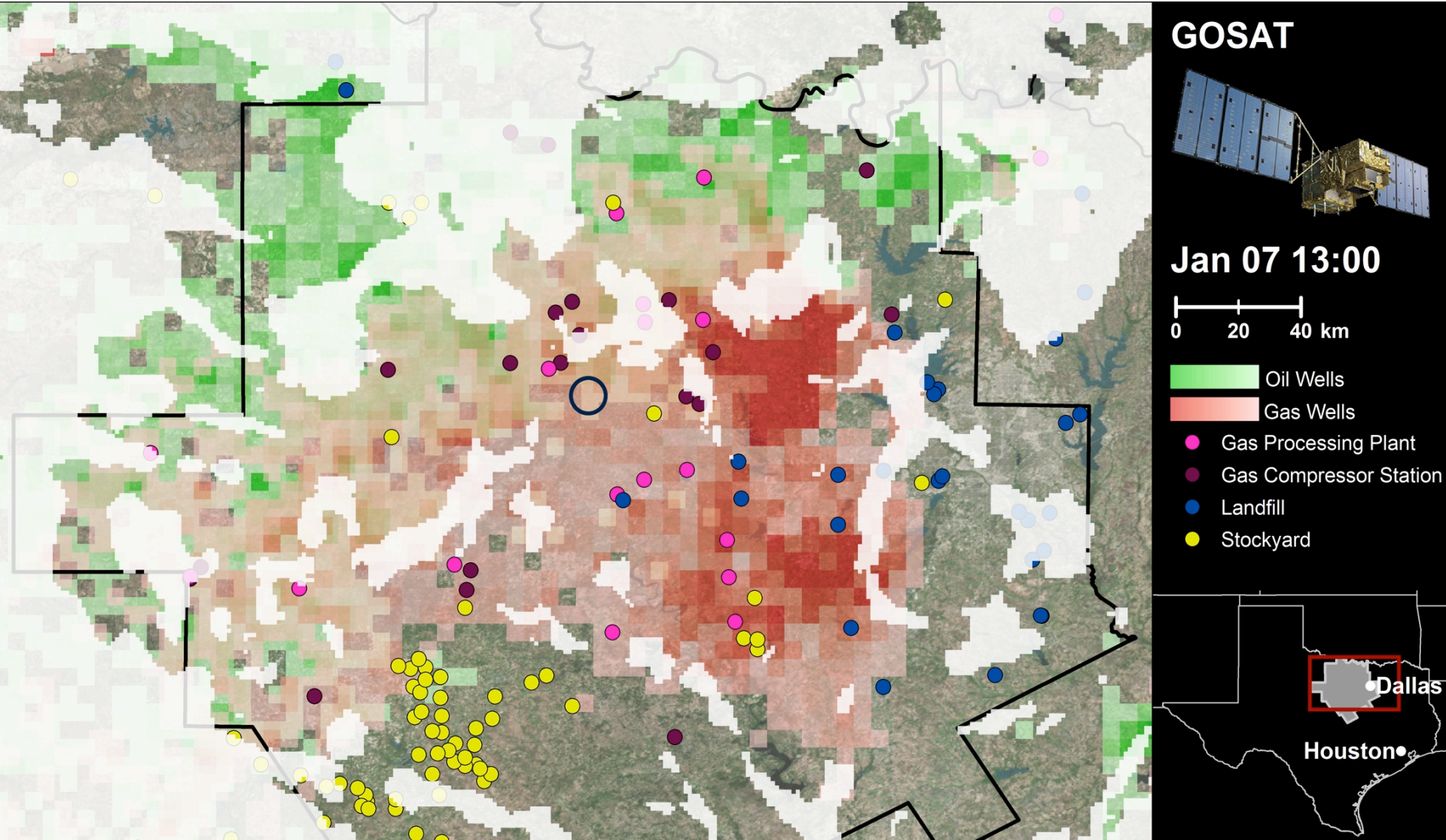
The future for satellite inversions is bright



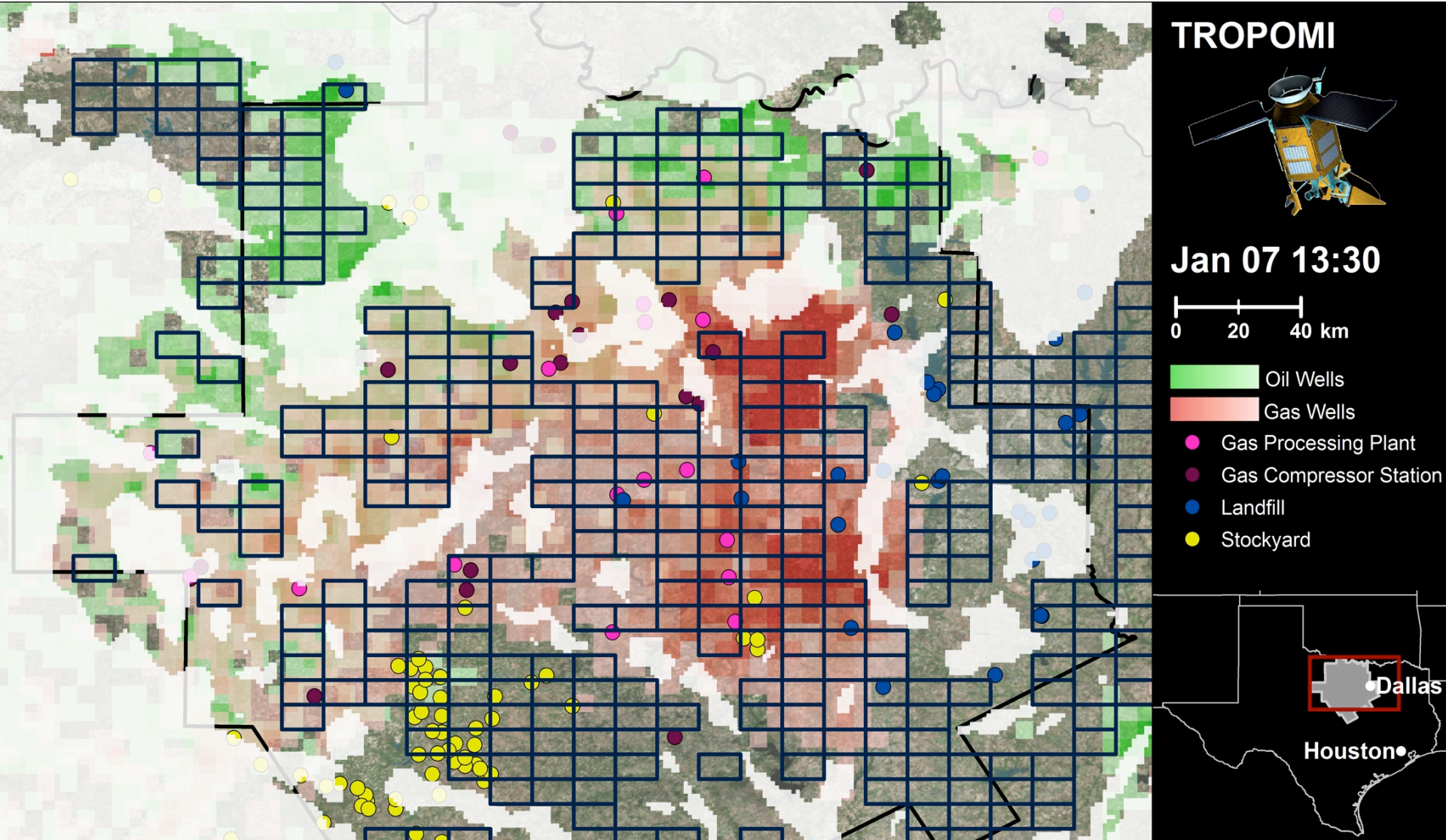
The future for satellite inversions is bright



The future for satellite inversions is bright



The future for satellite inversions is bright



A Gridded Version of the EPA Greenhouse Gas Inventory

With: D.J. Jacob[1], M.P. Sulprizio[1], A.J. Turner[1], M. Weitz[2], T. Wirth[2], C. Hight[2], M. DeFigueiredo[2], M. Desai[2], R. Schmeltz[2], L. Hockstad[2], A.A. Bloom[3], K. Bowman[3], S. Jeong[4], and M. Fischer[4]

J.D. Maasakkers

(1) Harvard University
(2) U.S. Environmental Protection Agency, Climate Change Division
(3) Jet Propulsion Laboratory/California Institute of Technology
(4) Lawrence Berkeley National Laboratory