Gridded Level 3 TROPOMI Methane Data Products

Olga Khaliukova, William Daniels, Lewis Blake, and Dorit Hammerling

Motivation

A request from a collaborator, an economist Dr. Gilbert, to create a gridded data product to be used in the pipeline congestion study in the Permian basin, the largest oil and gas basin in the USA. He found the Satellite Level 2 product challenging to use and could not find an official Level 3 product publicly available.

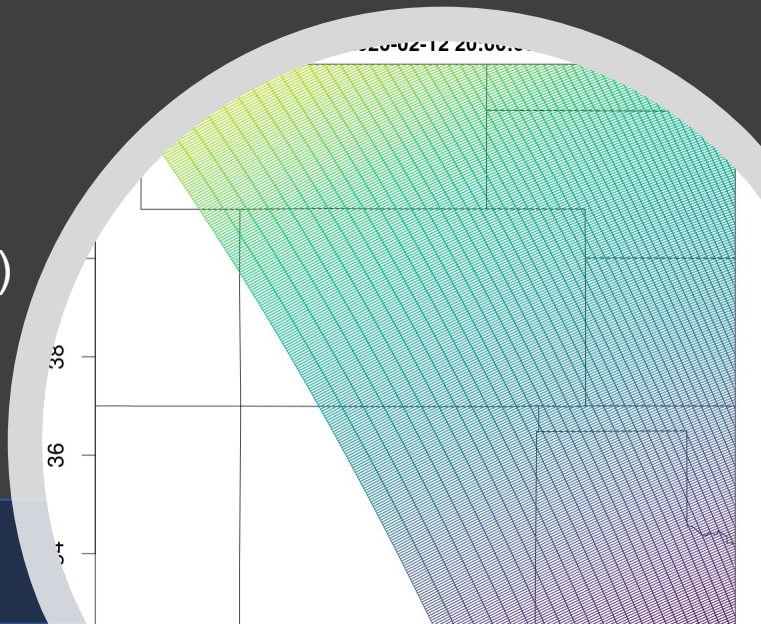
Objective

To promote the use of the methane satellite data, including those outside the climate research domain (e.g., sociology, political sciences, and economics fields), we create gridded 0.5° x 0.5° Level 3 methane products.

The TROPOspheric Monitoring Instrument (TROPOMI)

- Onboard the Copernicus Sentinel-5 Precursor satellite
- Provides a geolocated satellite measurements of methane, formaldehyde, Nitrogen oxides (NO_X), etc.
- 7 x 5.5 km^2 spatial resolution
- Data from April 2018

- **Level 1:**
Geolocated and calibrated spectral radiance and solar irradiance data
- **Level 2:**
Atmospheric data product (e.g., methane)
- **Level 3:**
Gridded product at given spatial and temporal resolution



Two Level 3 Products

Simple averaging

Method:

- Define a grid (e.g., 0.25°x0.25°, 0.5°x0.5°, 1°x1°)
- Choose a time scale (e.g., daily, weekly, monthly)
- Average observations that fall within the selected grid

Advantages:

- Straightforward and quick to compute
- Accuracy increases over larger temporal averages (monthly vs daily)

Disadvantages:

- Ignores spatial and temporal correlation structures
- Poor uncertainty estimates

Spatial modeling

Method:

- Assume underline stochastic field
- Estimate the field's correlation structure
- Predict the underlying field with associated uncertainties

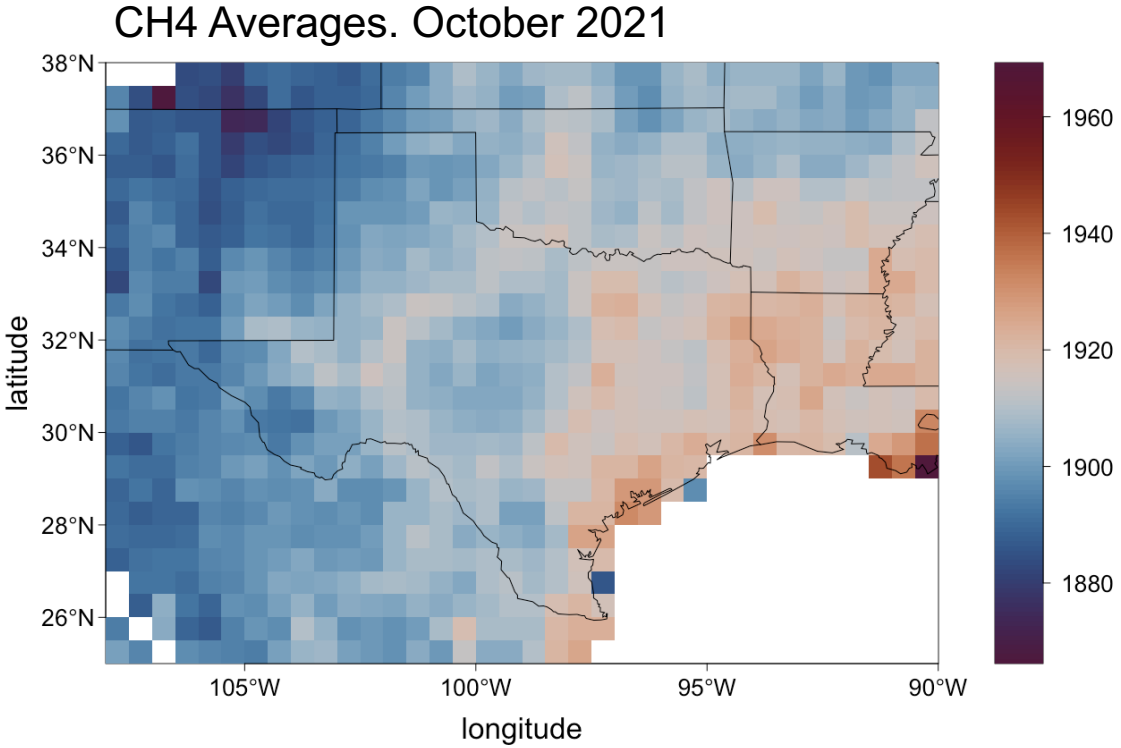
Advantages:

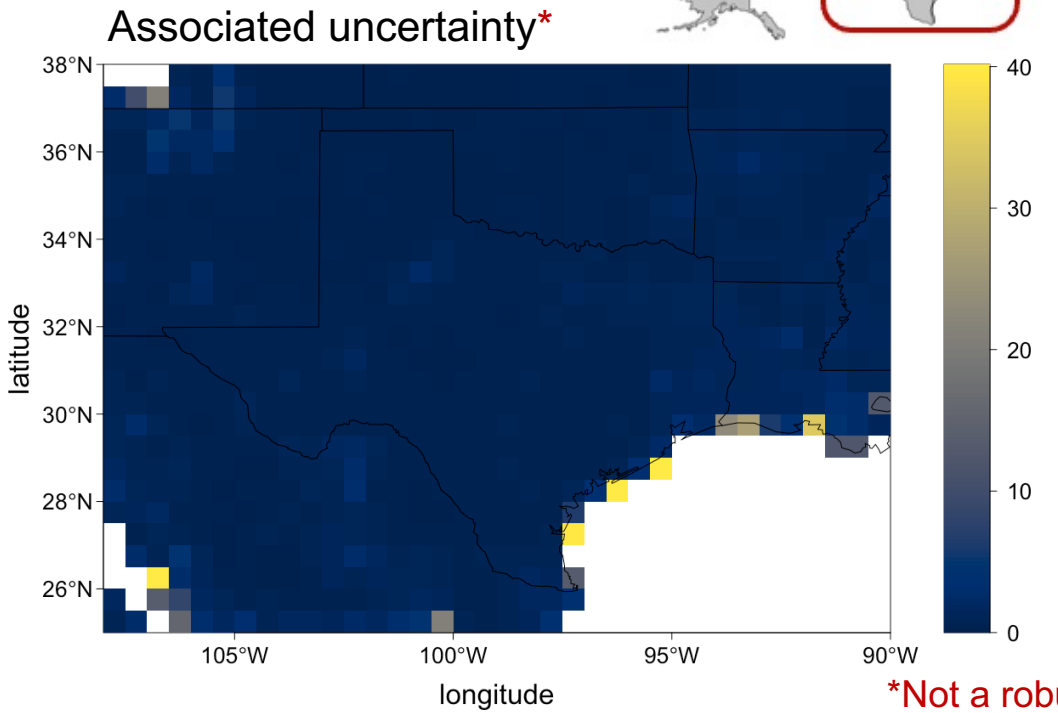
- Can capture fine scale of the spatial structure
- Rigorous uncertainty quantification

Disadvantages:

- Challenging to implement, estimating non-constant correlation parameters is not a simple task
- Can be computationally expensive

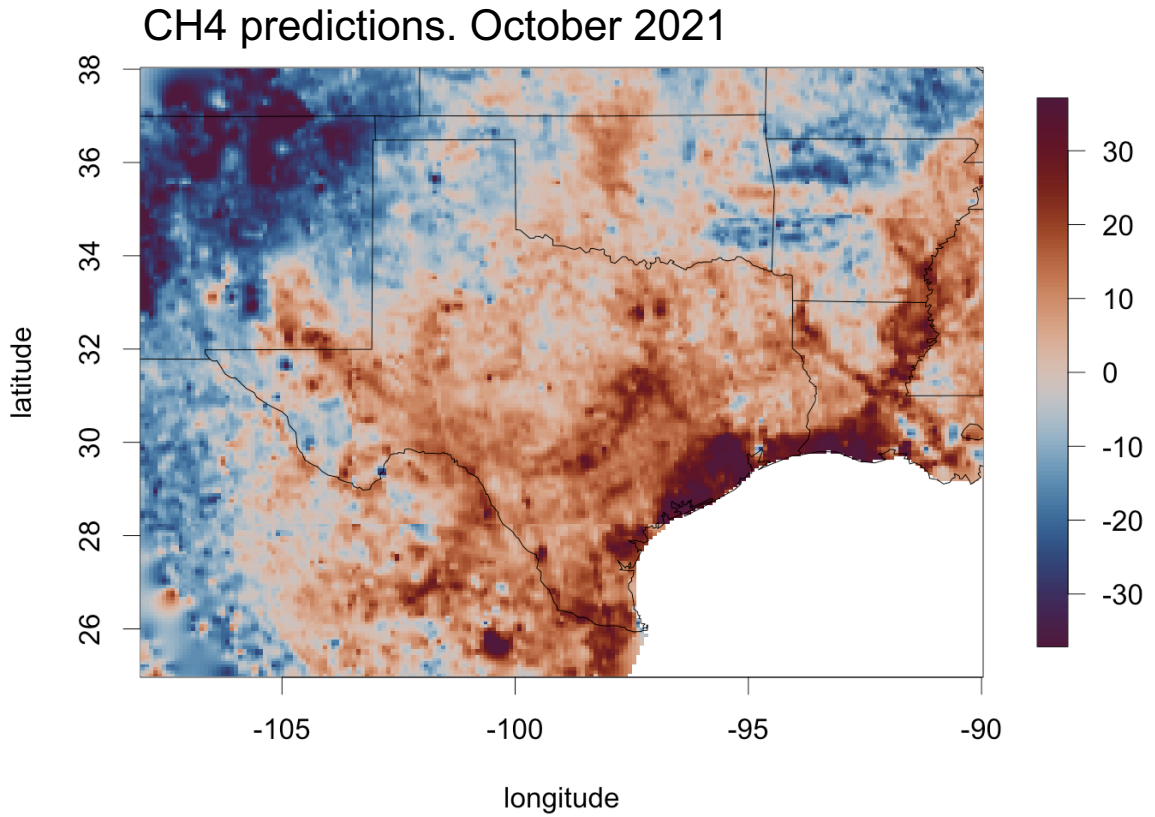
Example of Simple Averaging product

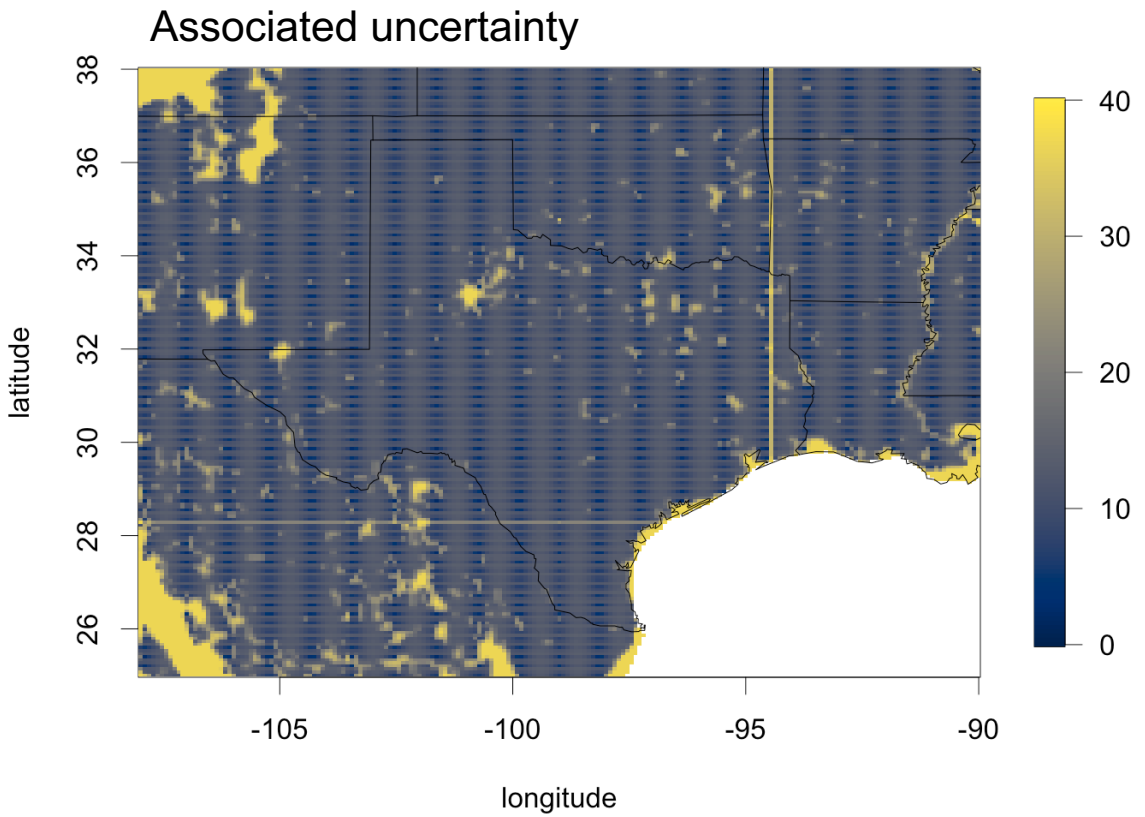




*Not a robust method

Example of Spatial Modeling product



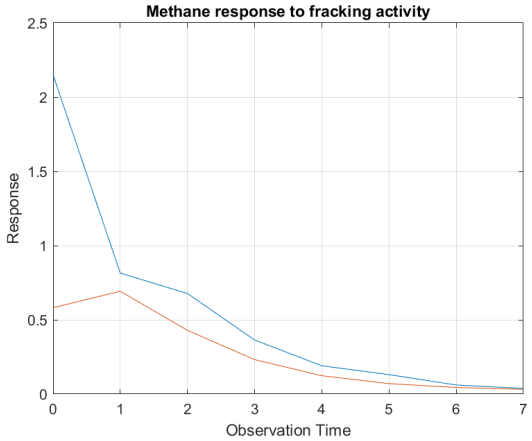


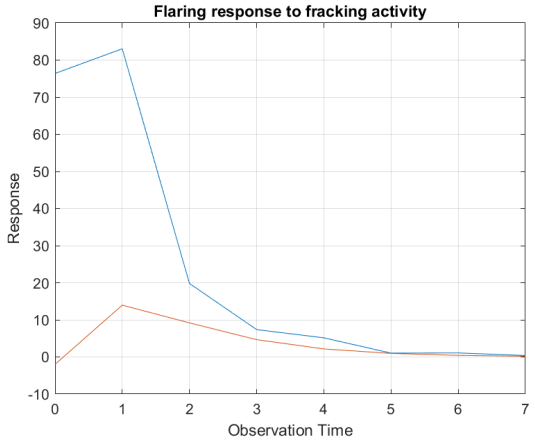
Use-Case Example: Methane, flaring, and pipeline constraints.

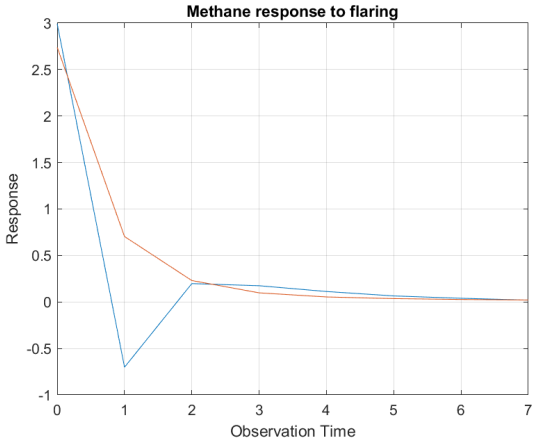
Ben Gilbert, Colorado School of Mines; Mark Agerton, UC Davis; Wesley Blundell, Washington State University

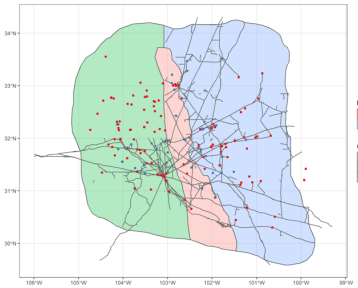
Preliminary estimates of dynamic responses:

- ***Blue:*** *pipeline* ***congested*** *days.* ***Red: uncongested*** *days*
- *Responses over 7 days following a one-time, one std. deviation shock*









Preliminary conclusions:

- Atmospheric **methane and flaring** respond **more** to a fracking/drilling activity shock during **pipeline congested days**
- **Methane** responds to a **flaring** shock **regardless** of pipeline congestion.

Ongoing work:

- Better understand methane/flaring responses to congestion itself.
- Estimate responses to **processing capacity** constraints.

Summary and Future Work

- Simple gridded averaging product is already created and being used by our collaborators
- We are working to refine the spatial modeling product
- We will focus our attention on the differences in the associated uncertainties of the two types of Level 3 gridded products

Thank you!

Olga Khaliukova

okhaliukova@mines.edu