Running the Integrated Methane Inversion (IMI)

1. Running the IMI walkthrough
   - Downloading the IMI to your local system
   - Documentation
   - Using an IMI instance on the cloud
   - The configuration file

2. Best practices for using the IMI
   - Working with the IMI preview
   - Reducing computational cost
   - Generating an inversion ensemble
   - Evaluating the quality of the inversion

Accessing the IMI

1. On your local cluster
   - Download and run with the IMI Docker container

2. On the AWS cloud
   - Start an IMI instance
   - IMI code is preinstalled, including all dependencies

3. Integral Earth
   - Web based user interface

Comprehensive documentation

Search docs

GETTING STARTED

Quick start guide

IMI configuration file

IMI preview

Tips for minimizing AWS costs

ADVANCED FEATURES

Running the IMI with tmux

The IMI Kalman Filter mode

Integrated Methane Inversion (IMI)

ReadTheDocs passing | Latest Pre-Release imi-2.0.0-beta.4

The Integrated Methane Inversion (IMI) workflow is a cloud-computing tool for quantifying methane emissions by inversion of satellite observations from the TROPOspheric Monitoring Instrument (TROPOMI). It uses GEOS-Chem as forward model for the inversion and infers methane emissions at 25 × 25 km^2 resolution.

Getting Started

- Quick start guide
- IMI configuration file
- IMI preview
- Tips for minimizing AWS costs

Advanced Features

- Running the IMI with tmux
- The IMI Kalman Filter mode
- Setting up Jupyter on EC2

Walks you through:

- Setting up an IMI instance on the cloud
- Running the IMI
- Capabilities and features

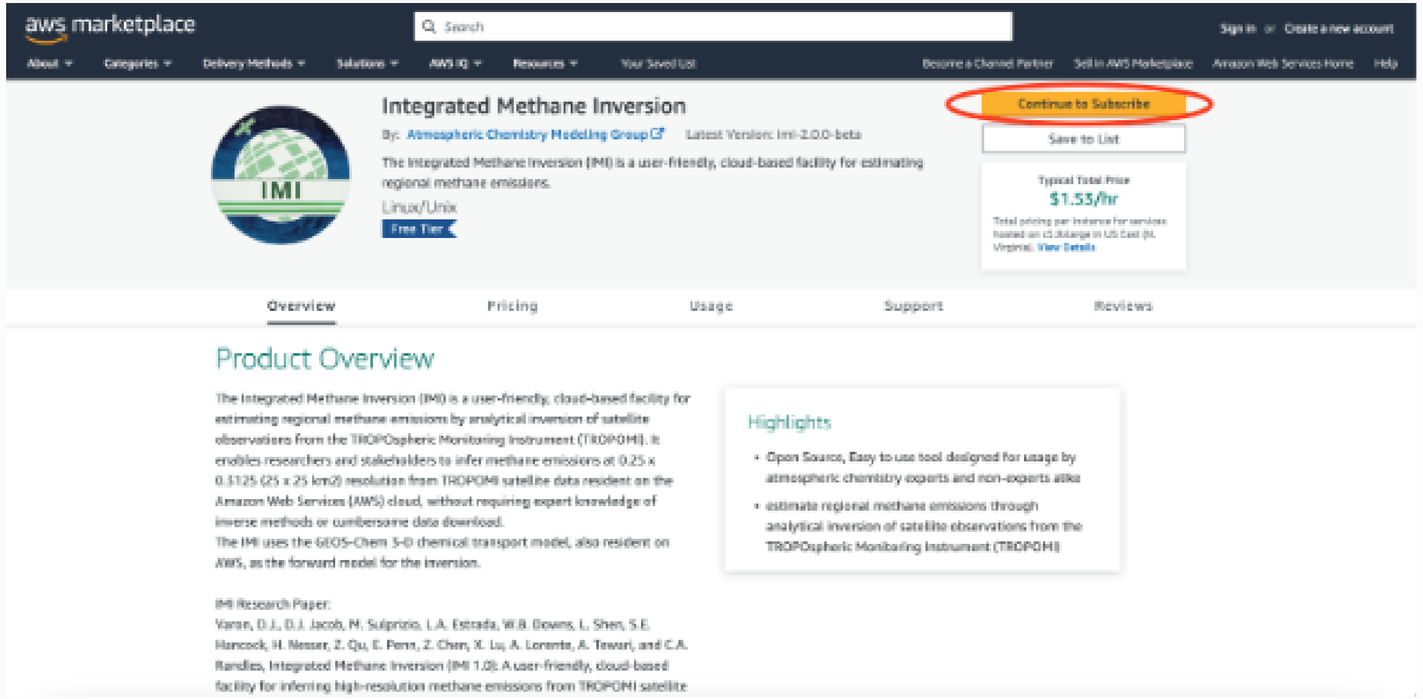
imi.readthedocs.io

Comprehensive documentation

4. Launch an instance with the IMI

Once you've setup S3 permissions on your AWS account, login to the AWS console and go to the AWS Marketplace IMI listing (listed for free). This image contains the latest version of the IMI including all required software dependencies on an Amazon Machine Image (AMI). An AMI fully specifies the software side of your virtual system, including the operating system, software libraries, and default data files.

On the listing page click "Continue to Subscribe".

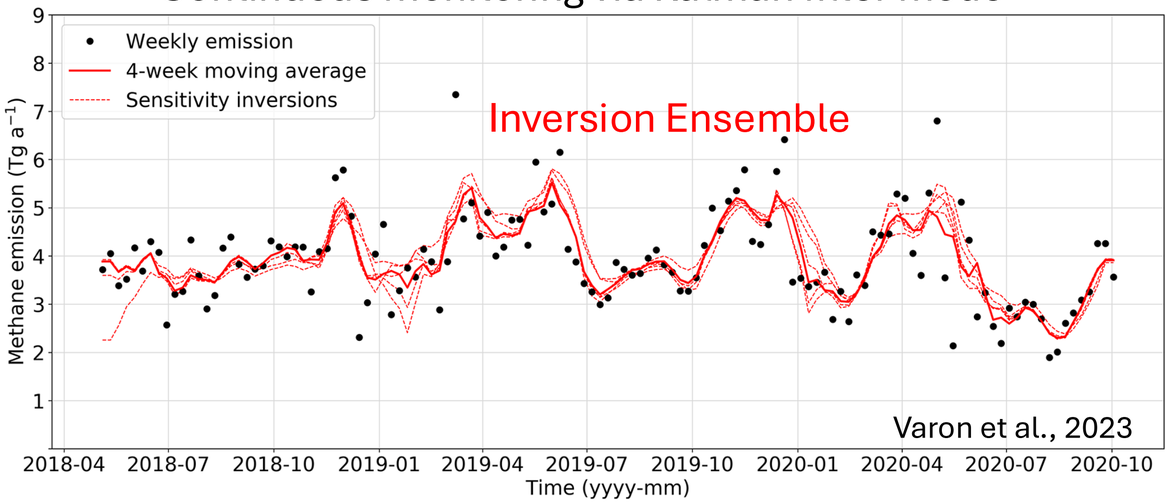


Configuring the IMI

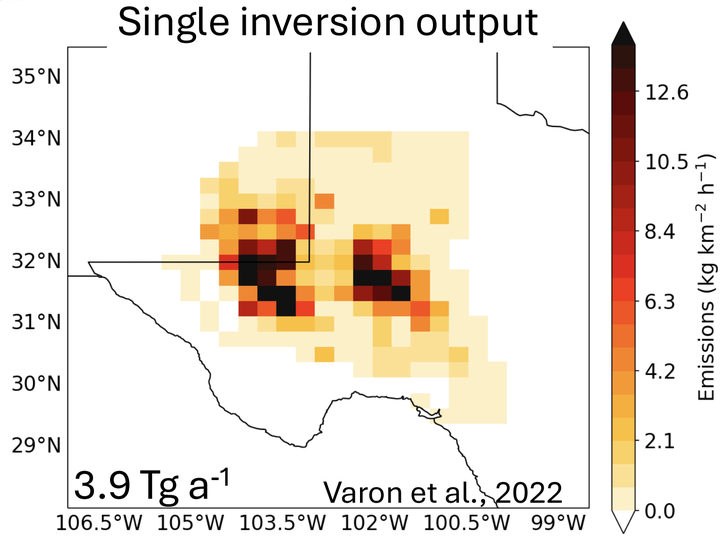
The IMI is designed to flexibly allow users to:

- Customize inversion domain and period
- Select spatial resolution including with smart clustering
- Modify inversion parameters or use defaults
- Swap prior emissions if desired

Continuous monitoring via Kalman filter mode



Single inversion output



Sample IMI configuration file

```
## IMI configuration file
## Documentation @ https://imi.readthedocs.io/en/latest/getting-started/imi-config-file.html

## General
RunName: "IMI_Sample_Inversion"

## Period of interest
StartDate: 20180501
EndDate: 20190101
SpinupMonths: 1

## Use blended TROPOMI+GOSAT data (true)? Or use operational TROPOMI data (false)?
BlendedTROPOMI: false

## Use observations over water? Set to false to filter out water observations
UseWaterObs: false

## Region of interest
##   These lat/lon bounds are only used if CreateAutomaticRectilinearStateVectorFile: true
##   Otherwise lat/lon bounds are determined from StateVectorFile
LonMin: -105
LonMax: -103
LatMin: 31
LatMax: 33

## Kalman filter options
KalmanMode: false
```

Single command to run:

```
$ sbatch run_imi.sh
```

IMI Live Demo

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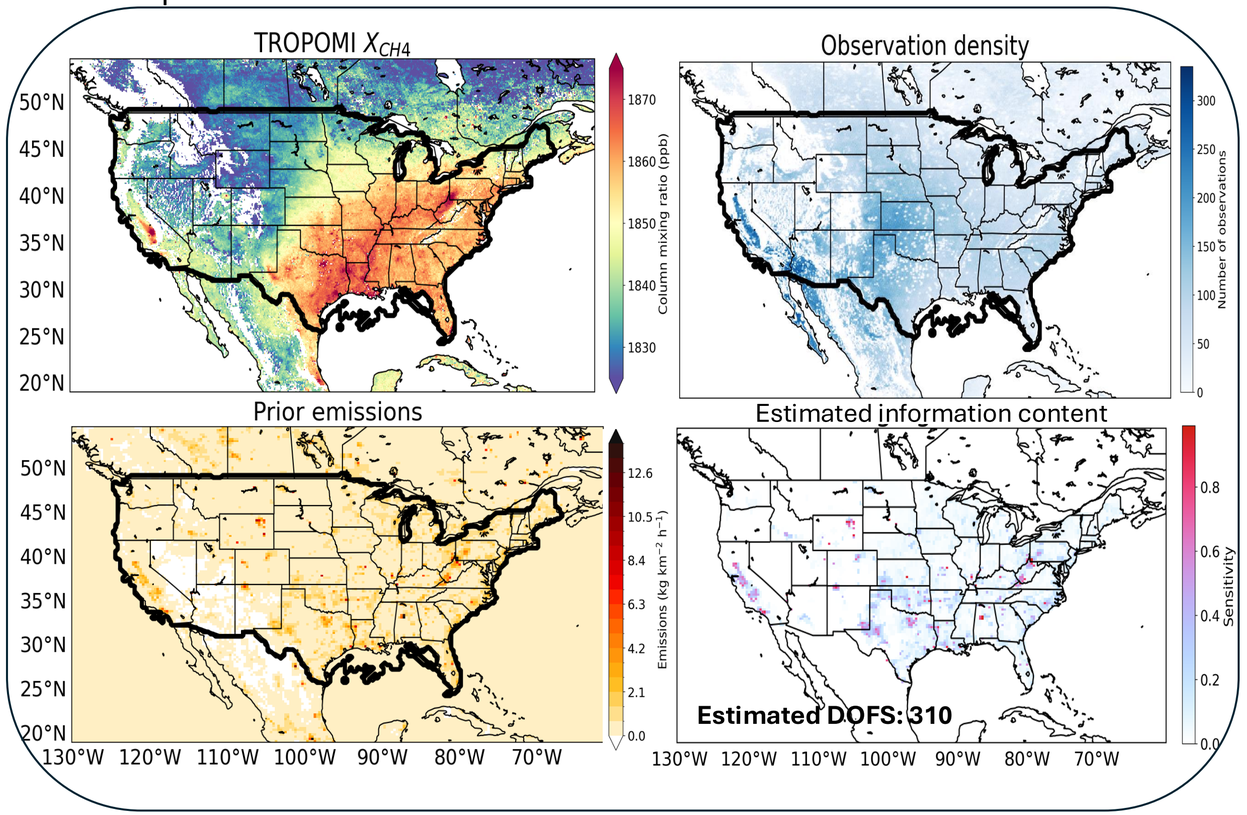
Working with the IMI preview

1. Run the IMI preview

2. Check expected quality of inversion from outputs

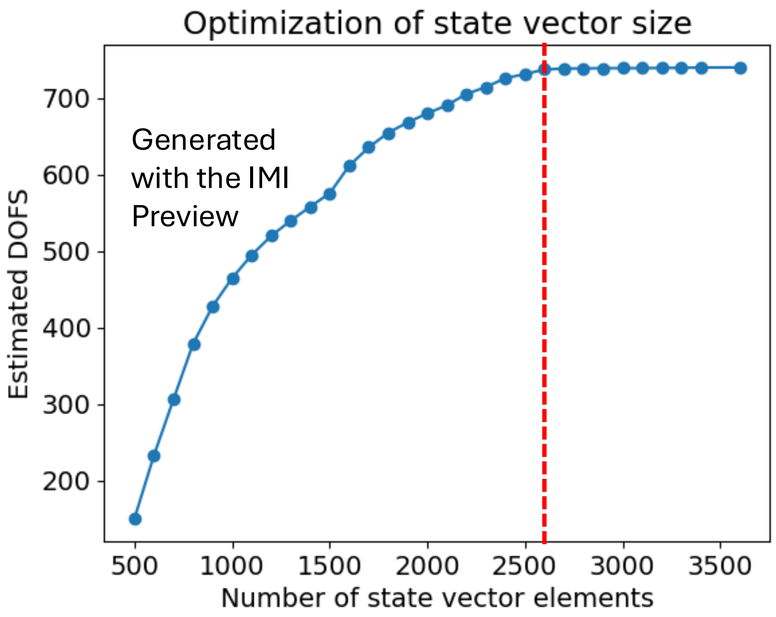


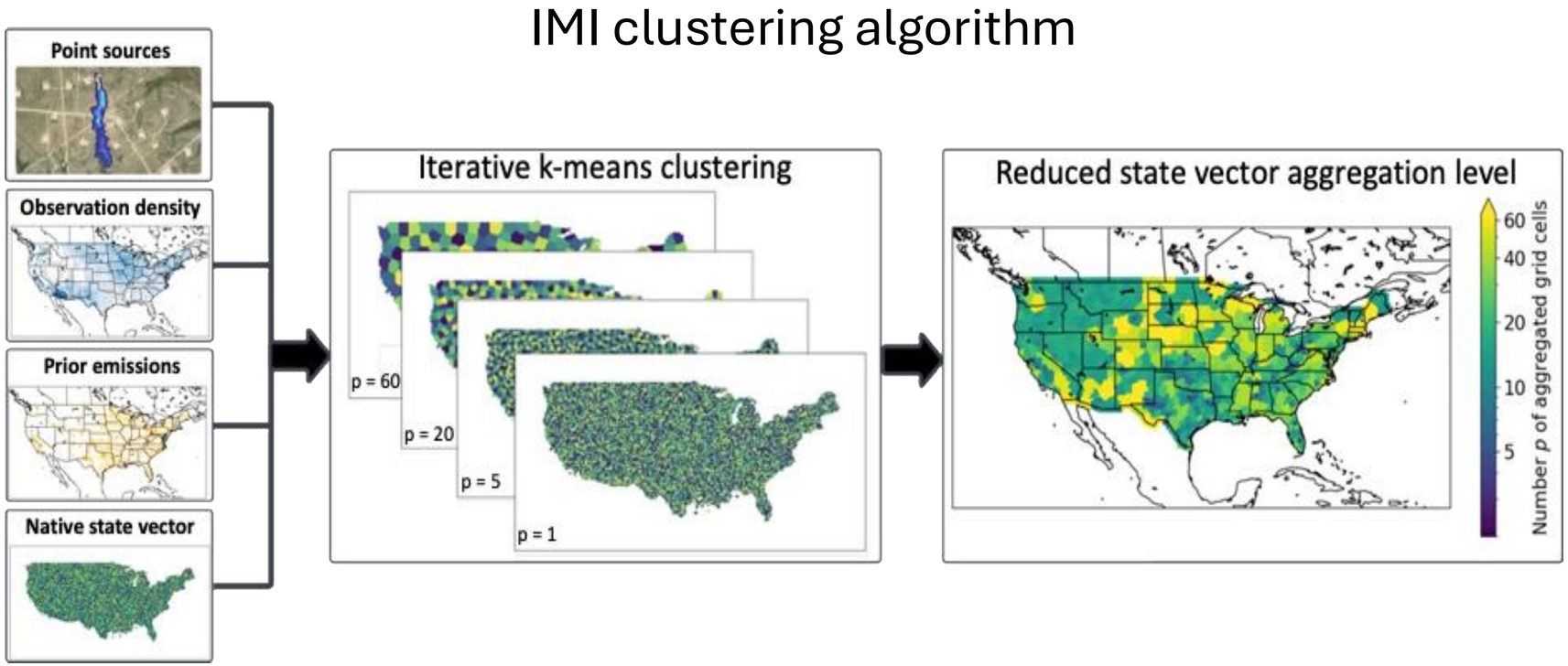
- Proceed with full inversion

- Increase period
- Adjust error estimates
- Change prior inventory

Smart adaptive clustering for reduced computational cost

Goal: reduce state vector size while maintaining high resolution for areas with strong emissions and strong observation density





State Vector

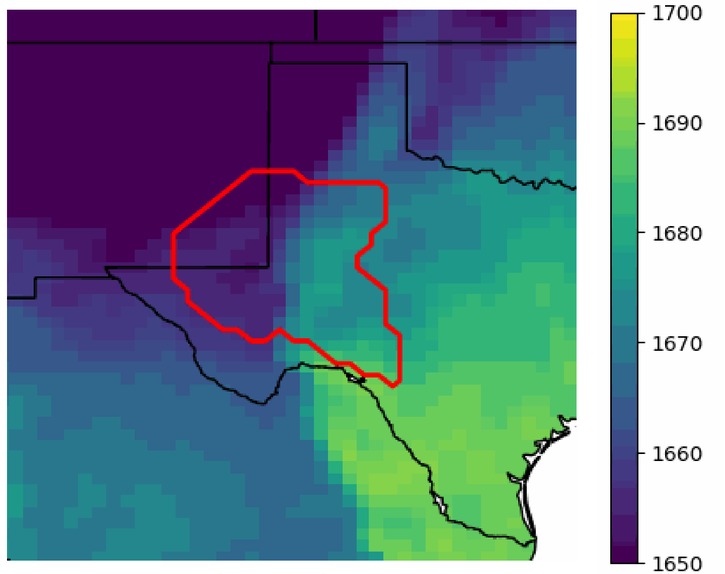
Collection of emission elements to be optimized

Correcting boundary conditions

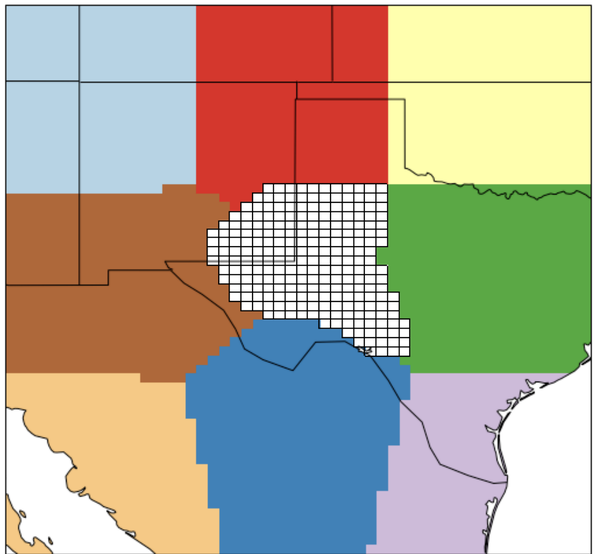
The IMI handles boundary conditions by:

- Using smoothed TROPOMI concentrations at the boundaries
- Optimizing boundary conditions as part of the inversion
- Creating buffer elements to correct outside emissions as part of the inversion

Simulated CH_4

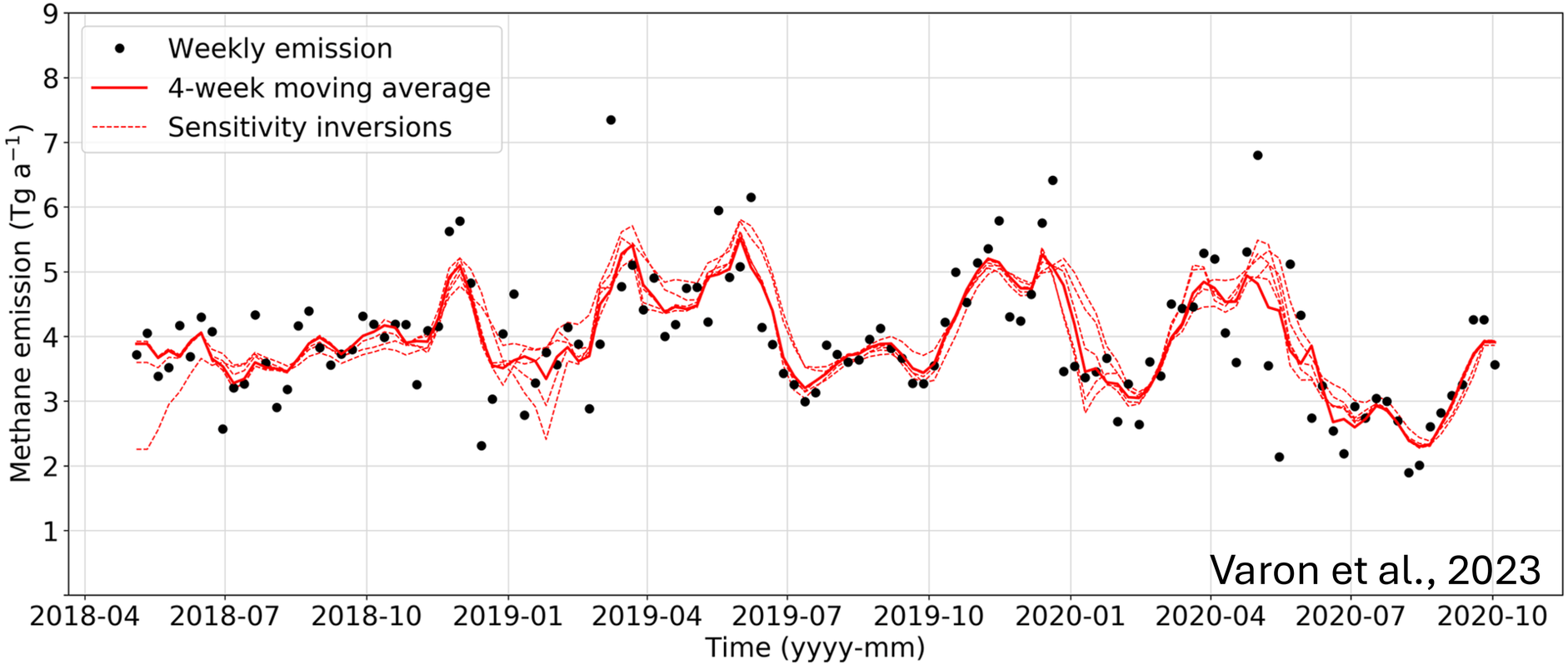


Buffer elements



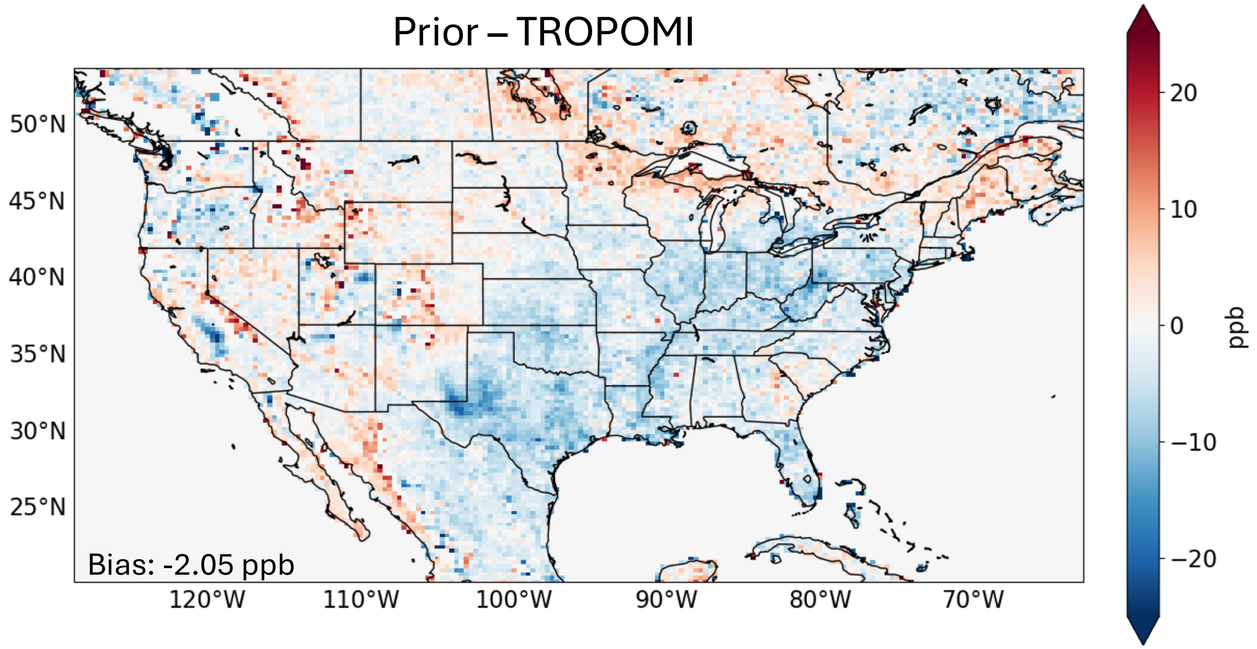
Inversion ensembles for error characterization

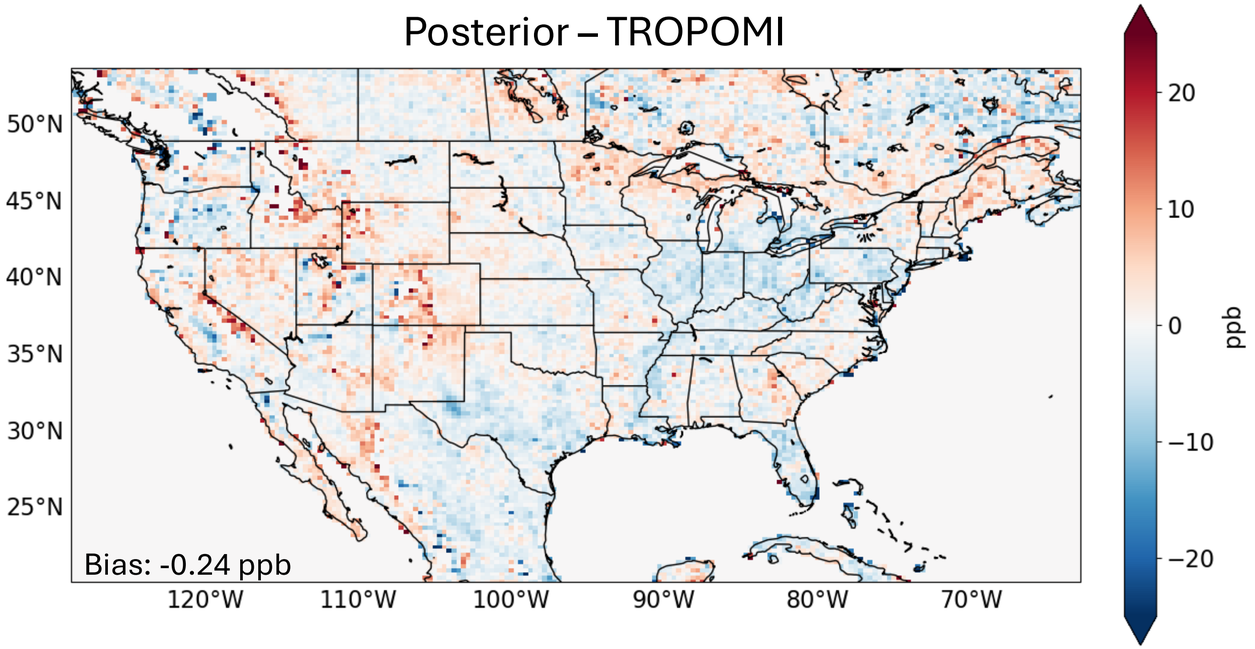
- IMI analytical method allows quick generation of inversion ensemble with little computational cost
  - Vary prior inventories, observation subsets, prior errors, observation errors, regularization parameter, etc.



Evaluating the quality of the inversion

- IMI provides output to compare the simulated atmosphere to observations
- Users can assess the improvement in the fit to the observations
  - Check if bias is reduced effectively





IMI Resources

IMI

IMI Documentation

FAQs

Best Practices

IMI 1.0 Research Paper

IMI 2.0 Research Paper