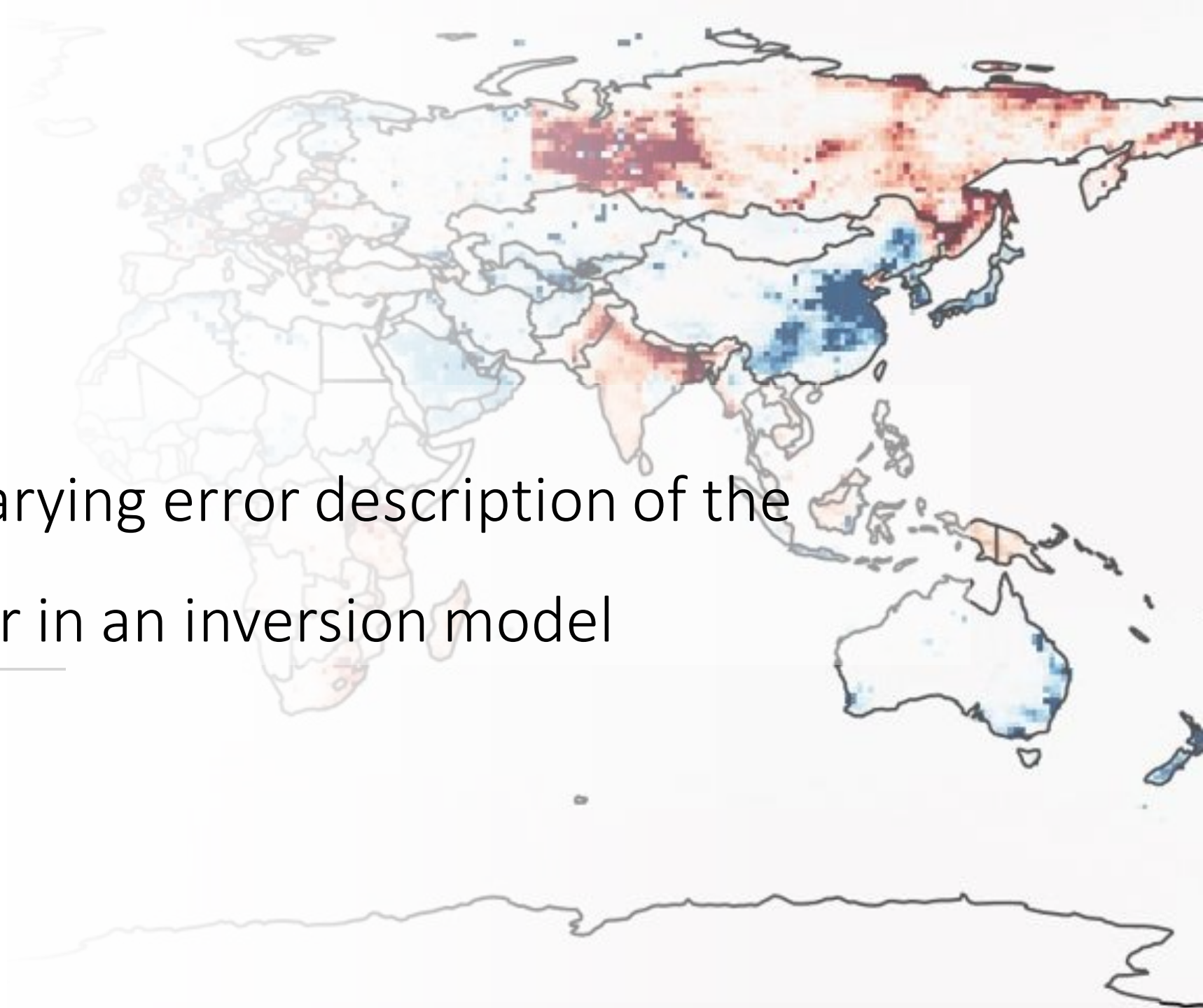
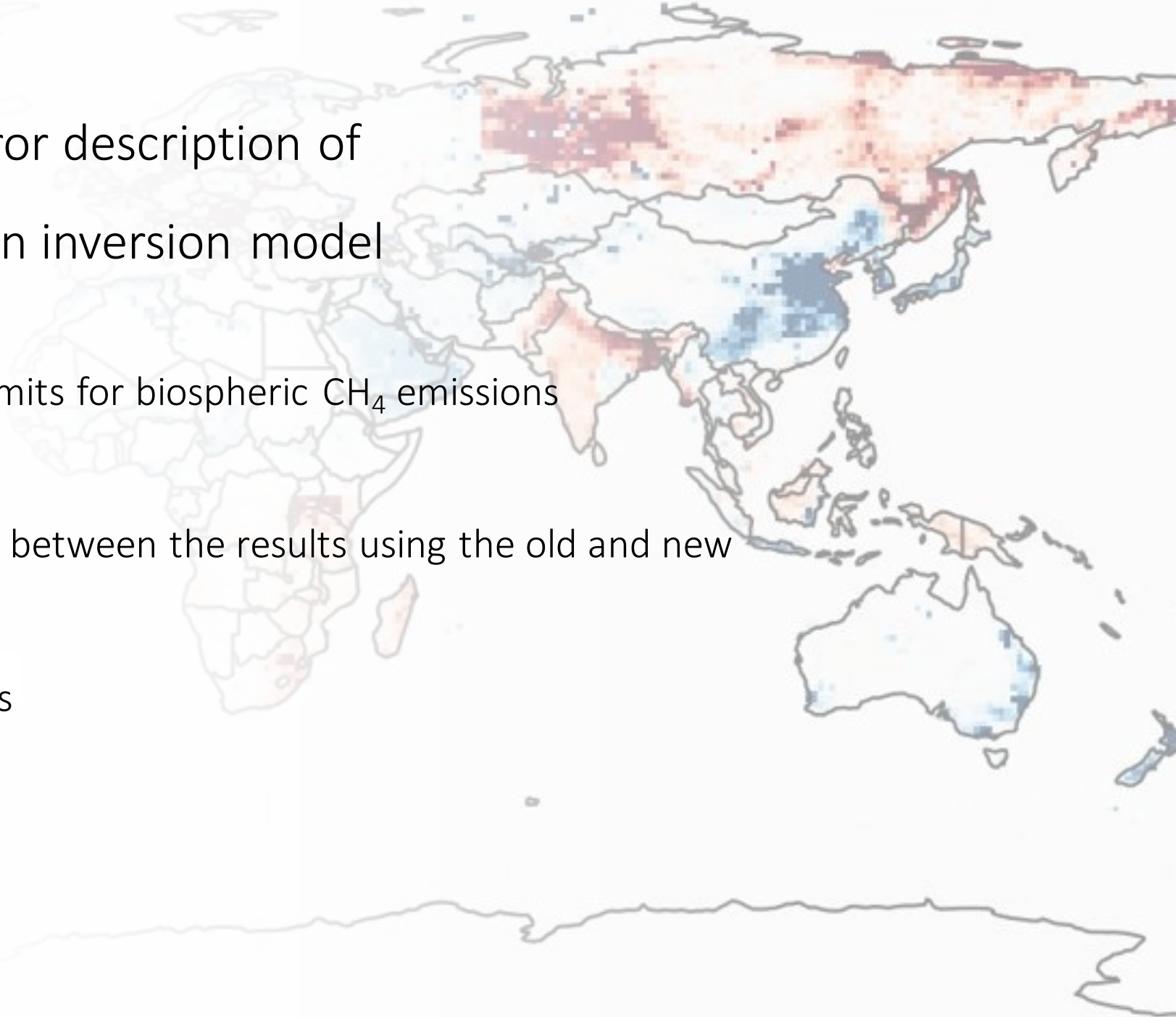


Use of a monthly varying error description of the biospheric CH_4 prior in an inversion model

Maria Tenkanen, Aki Tsuruta and Tuula Aalto

2023/10/16 *34th International TM5 Meeting*

Use of a monthly varying error description of the biospheric CH_4 prior in an inversion model



- Defining new uncertainty limits for biospheric CH_4 emissions
- Inversion setup
- Flux estimates: comparison between the results using the old and new uncertainty limits
- Comparison to observations

The old way

- 80% of the used biospheric prior

  -> smaller fluxes have smaller assigned uncertainty

  -> uncertainties of biospheric and anthropogenic fluxes in the same area are dependend on their (relative) magnitude

The new way

- Based on the process models used in the Global Carbon Project (Saunois et al. 2020)
  - Prognostic (models used their own internal approach to estimate wetland area and dynamics)
- Monthly averages 2010-2017 -> monthly uncertainties

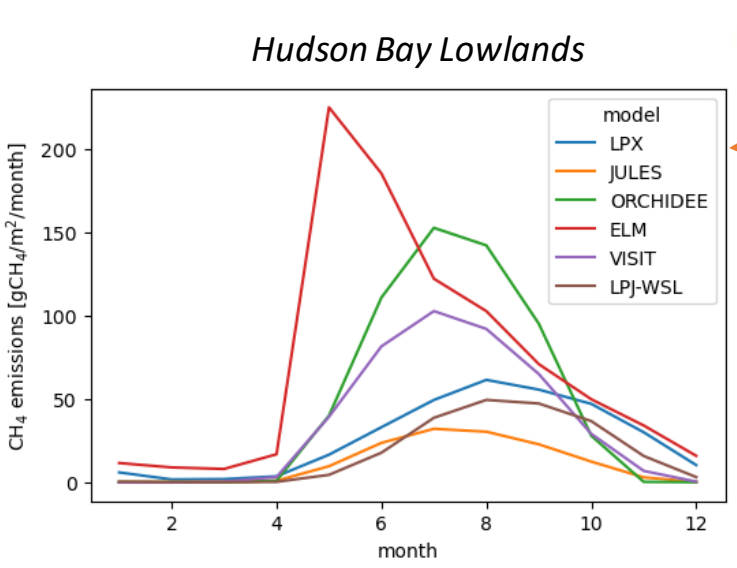
GCP process models

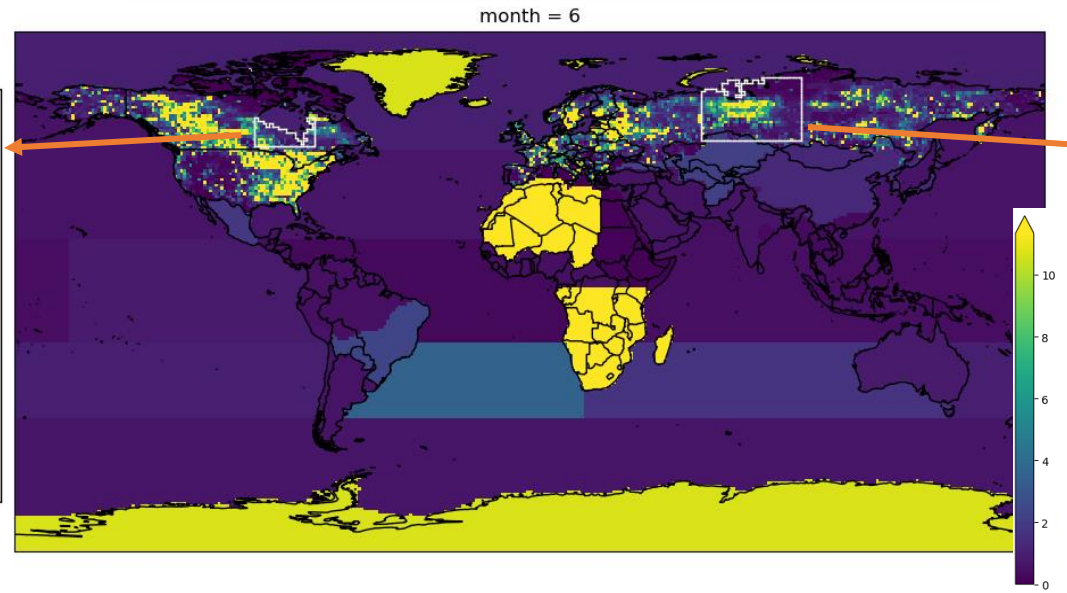
Large spread in the process model estimates

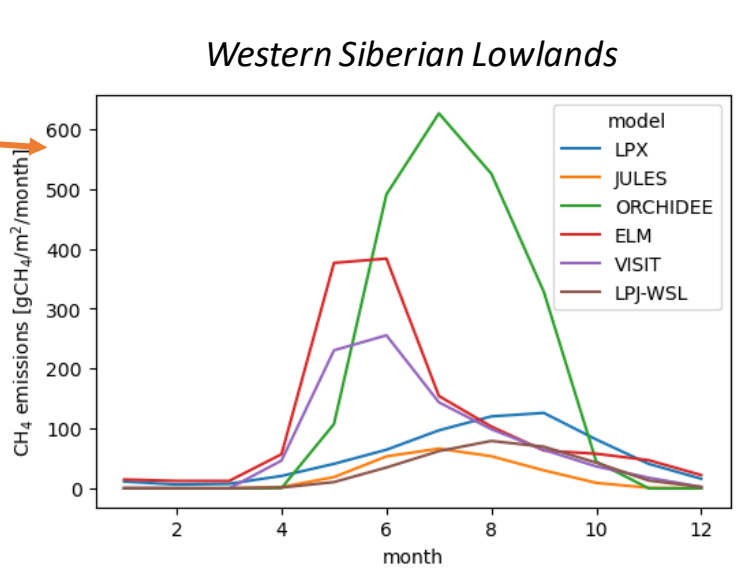
-> range of the lowest and highest 25% divided by the prior

-> max uncertainty 500% and min uncertainty 10% of the prior

$quantile_{75}$(Process model) - $quantile_{25}$(Process model)
Bio prior





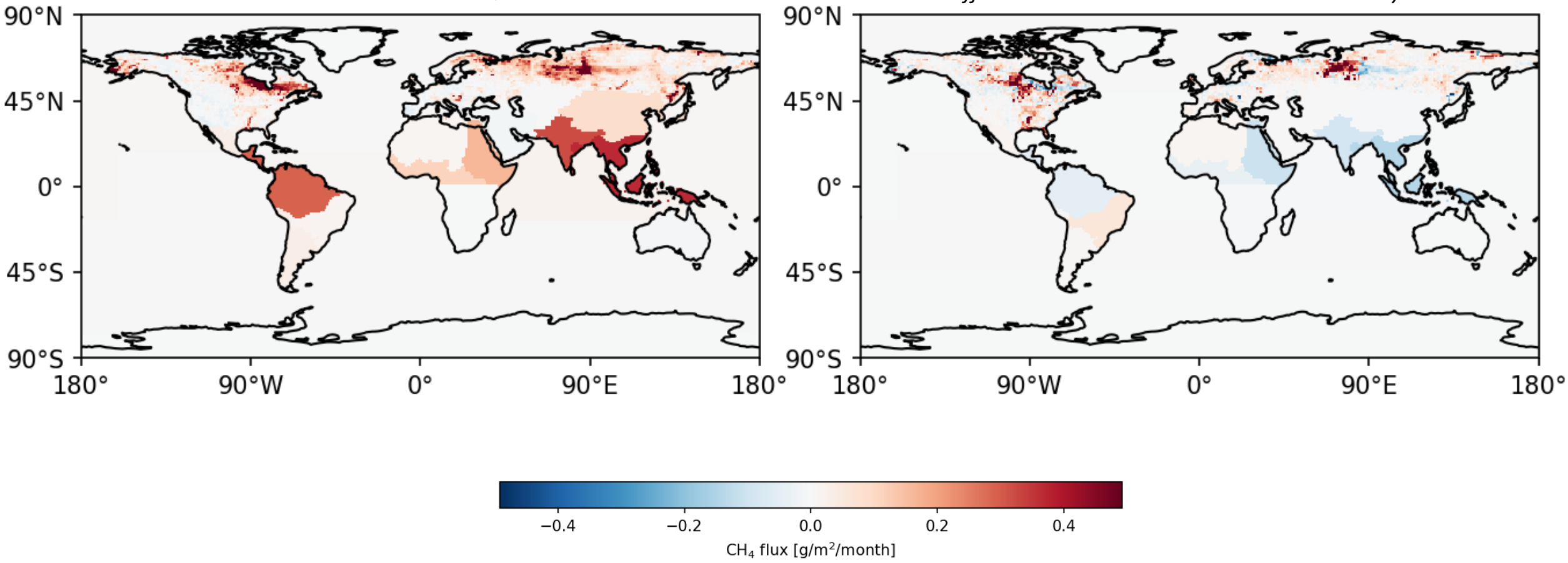


Differences between the old and new uncertainties: July

- Uncertainty estimate reduced in some regions and increased in other regions

LPX-Bern DYPTOP (bio prior)

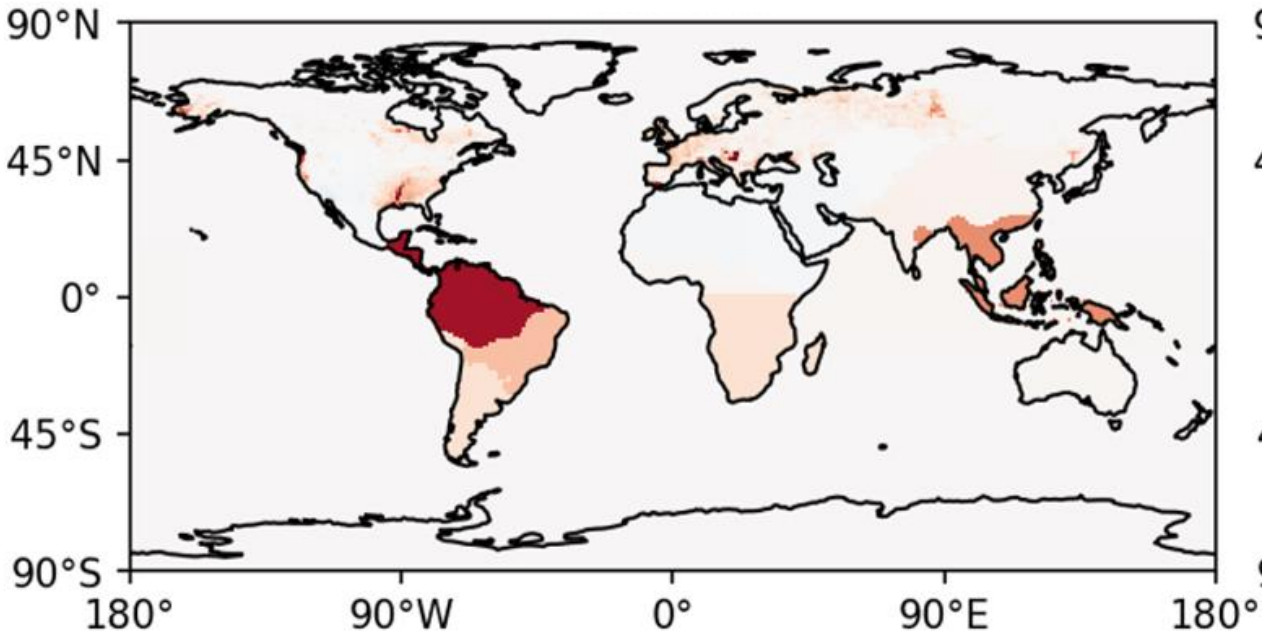
Difference between the new and old uncertainty limits



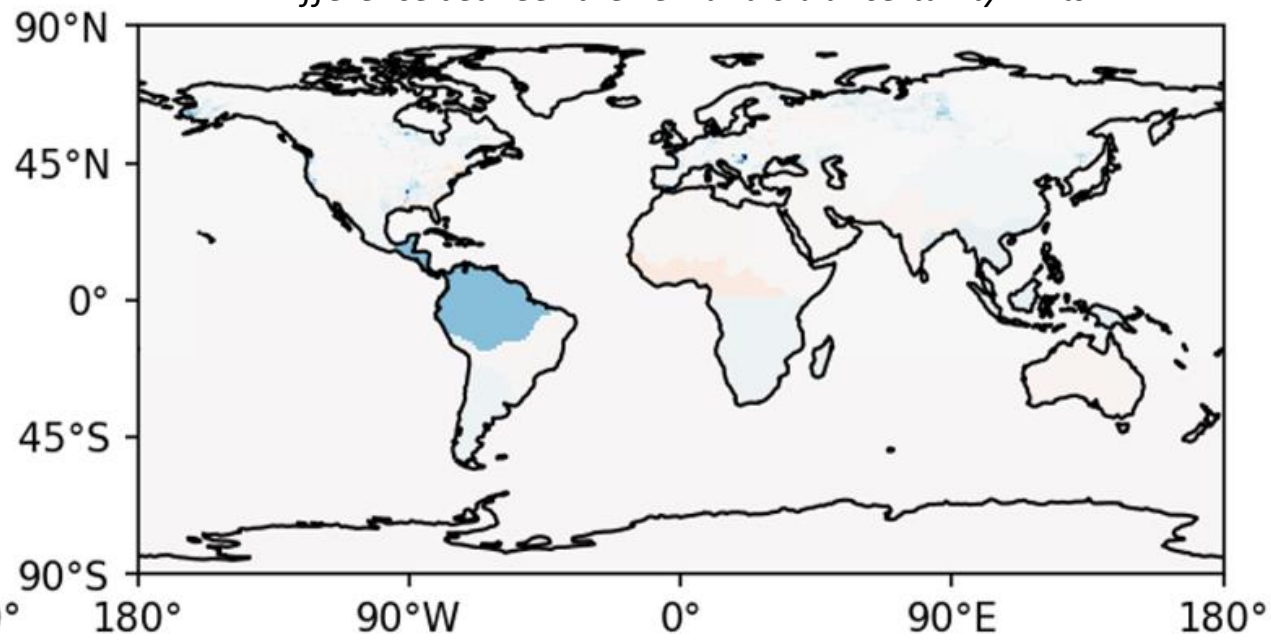
Differences between the old and new uncertainties: January

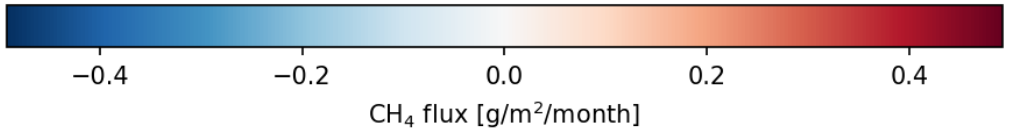
- Norhtern high latitude (our focus area): wintertime uncertainty estimate smaller

LPX-Bern DYPTOP (bio prior)



Difference between the new and old uncertainty limits





Inversion model setup CarbonTracker Europe – CH_4

Priors

- Anthropogenic: EDGAR v6
- Biospheric: LPX-Bern DYPTOP
- Others: GFED v4.1s (fire), Saunois et al. (2020) (termites), Weber et al. (2019) (ocean)

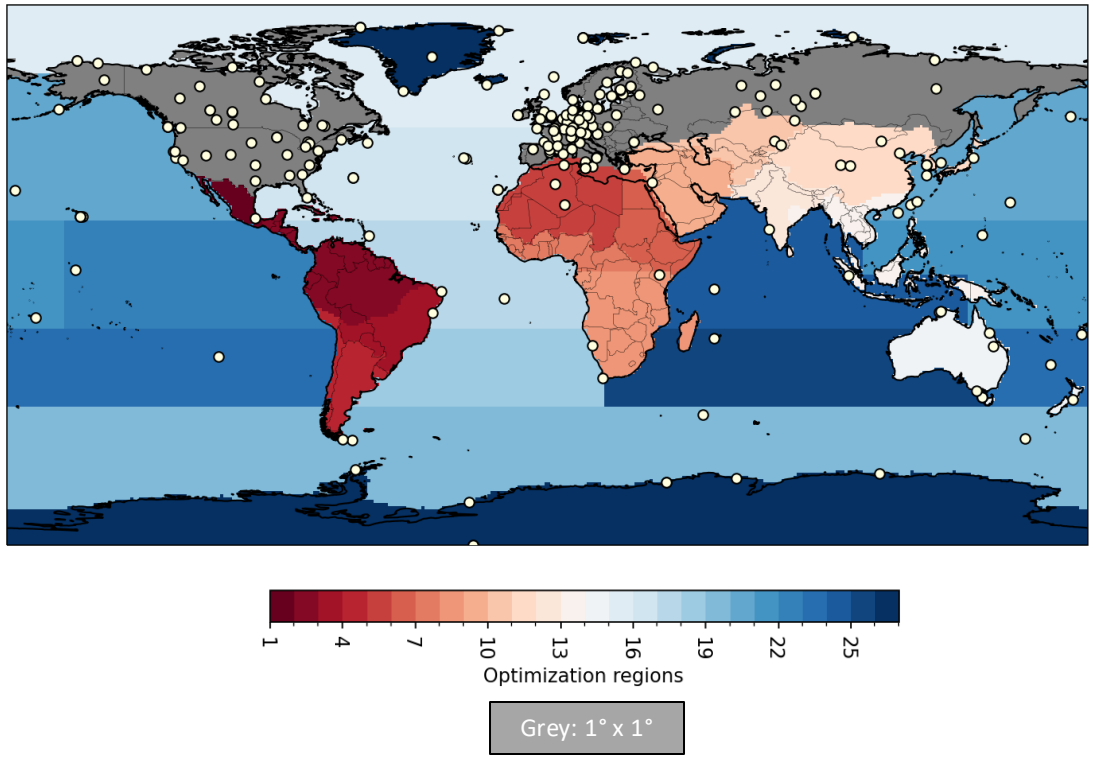
Optimization

- Biospheric (wetlands + soil sink) and anthropogenic emissions are optimized simultaneously
- Assimilated observations: surface measurements
- 1° x 1° resolution (with some spatial correlation) in Canada, USA, Europe and Russia. Elsewhere by region-wise.
- 7-day temporal resolution
- Ensemble Kalman Filter, 500 memebers
- 2010-2021

TM5

- Constrained by ERA5 meteorology (3-hourly)
- Horizontal resolutions: 6° x 4° (glb) + 1° x 1° (eun)
- Vertical levels: 25

Optimization regions and in situ sites



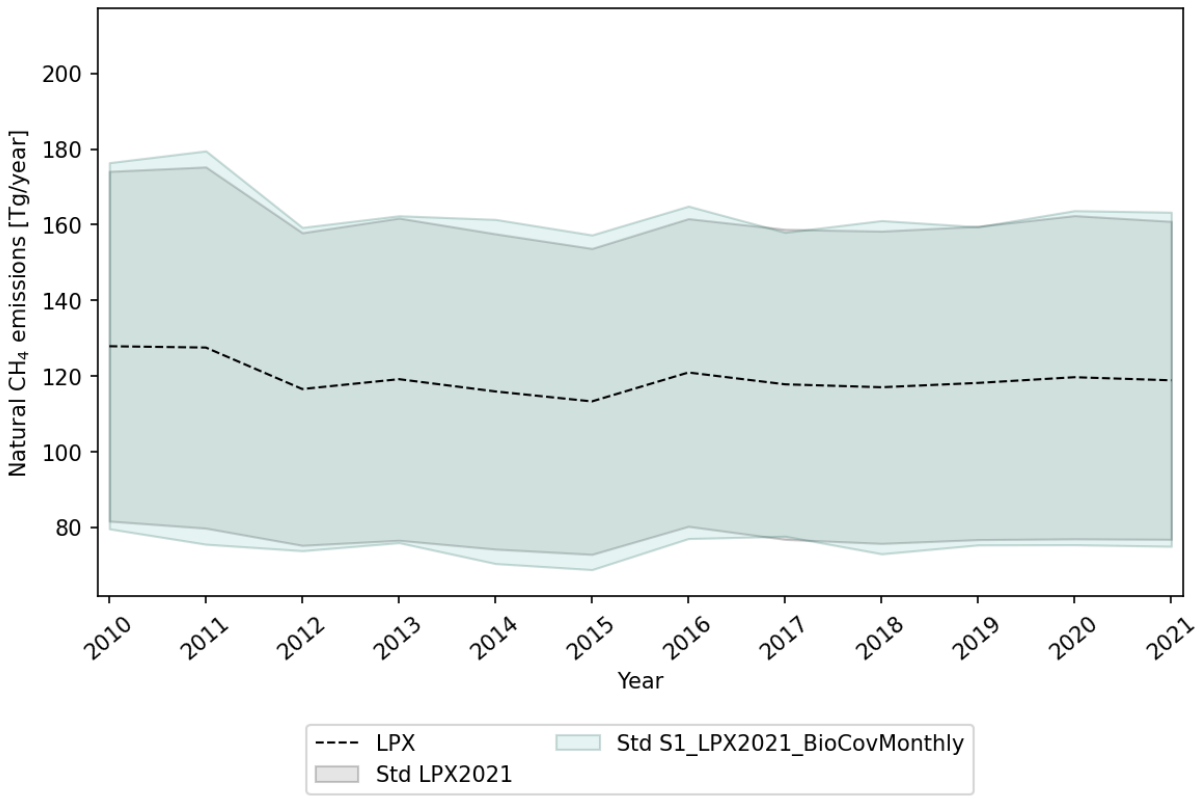
Time series figures

- Annual values 2010-2021
- Mainly biospheric
- Prior with --, posteriors with —
- Old in black, new in blueish

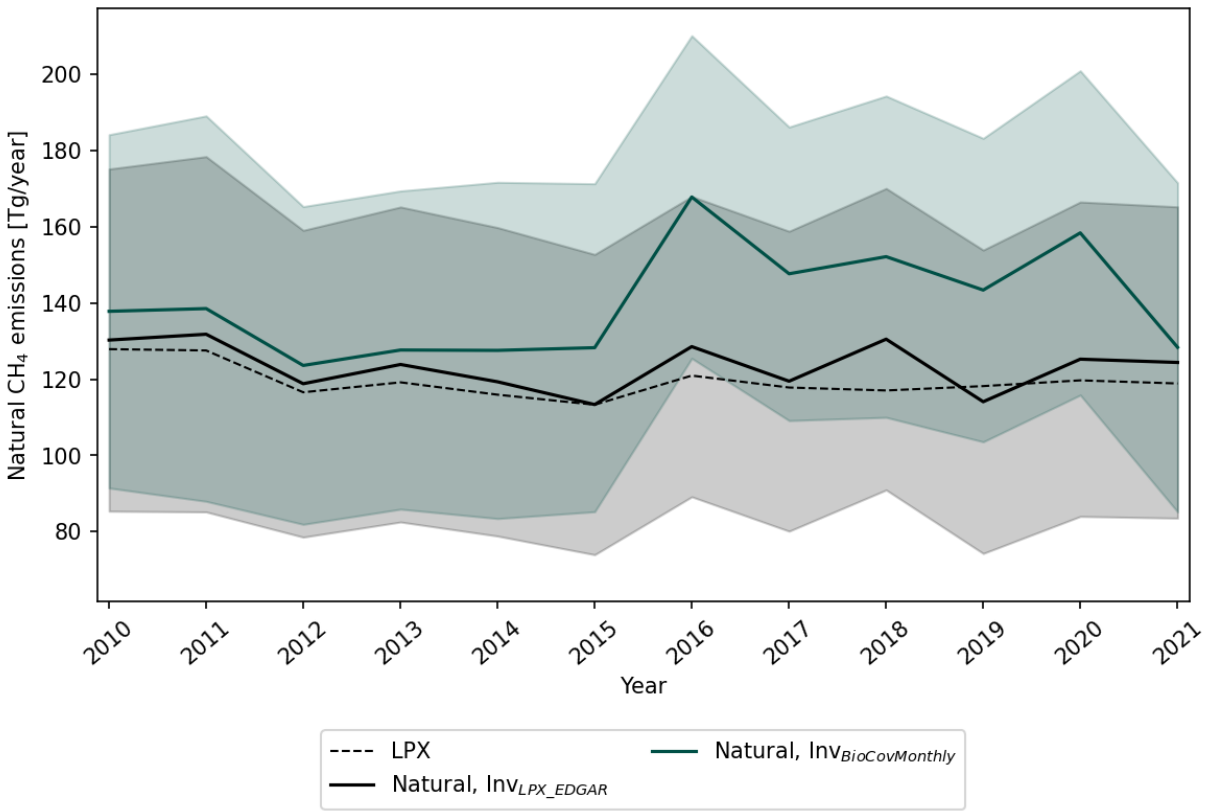
Bio uncertainty remained at the same level

Increase in bio emissions from 2016 onwards -> decrease in anthropogenic emissions

Priors



Posteriors

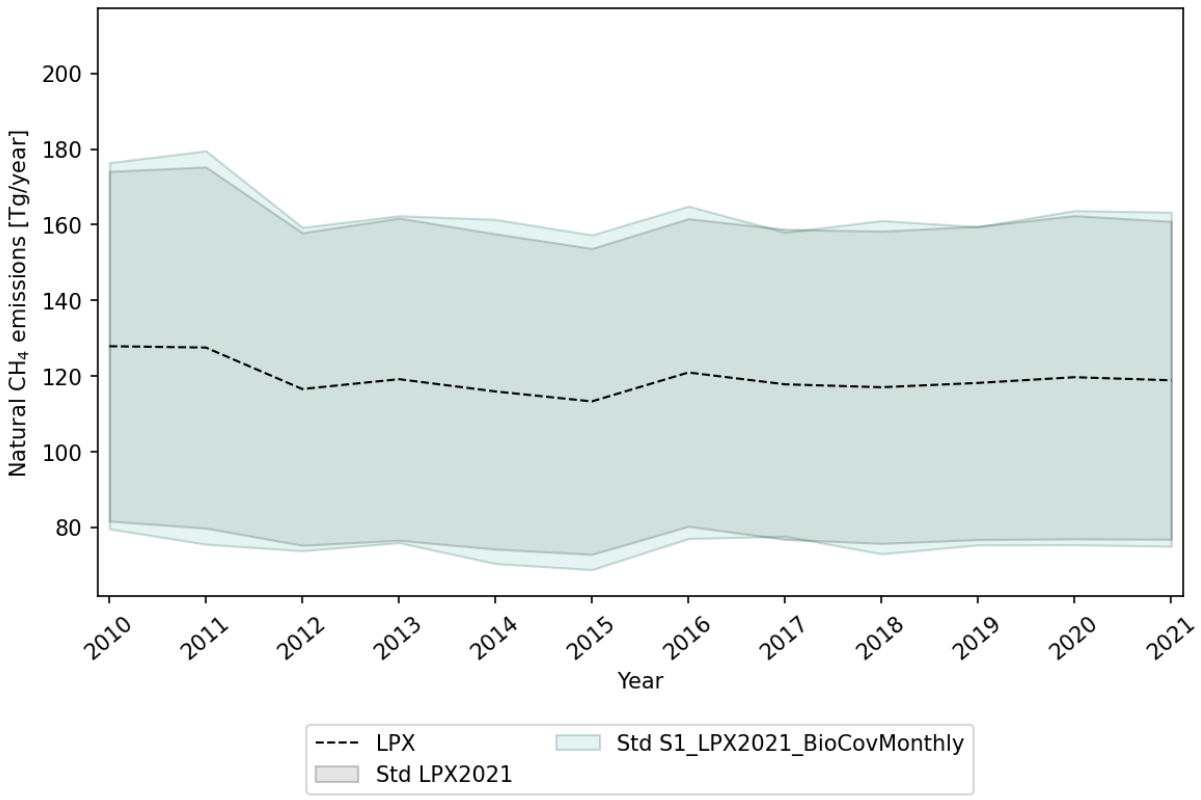


Global CH_4 emissions

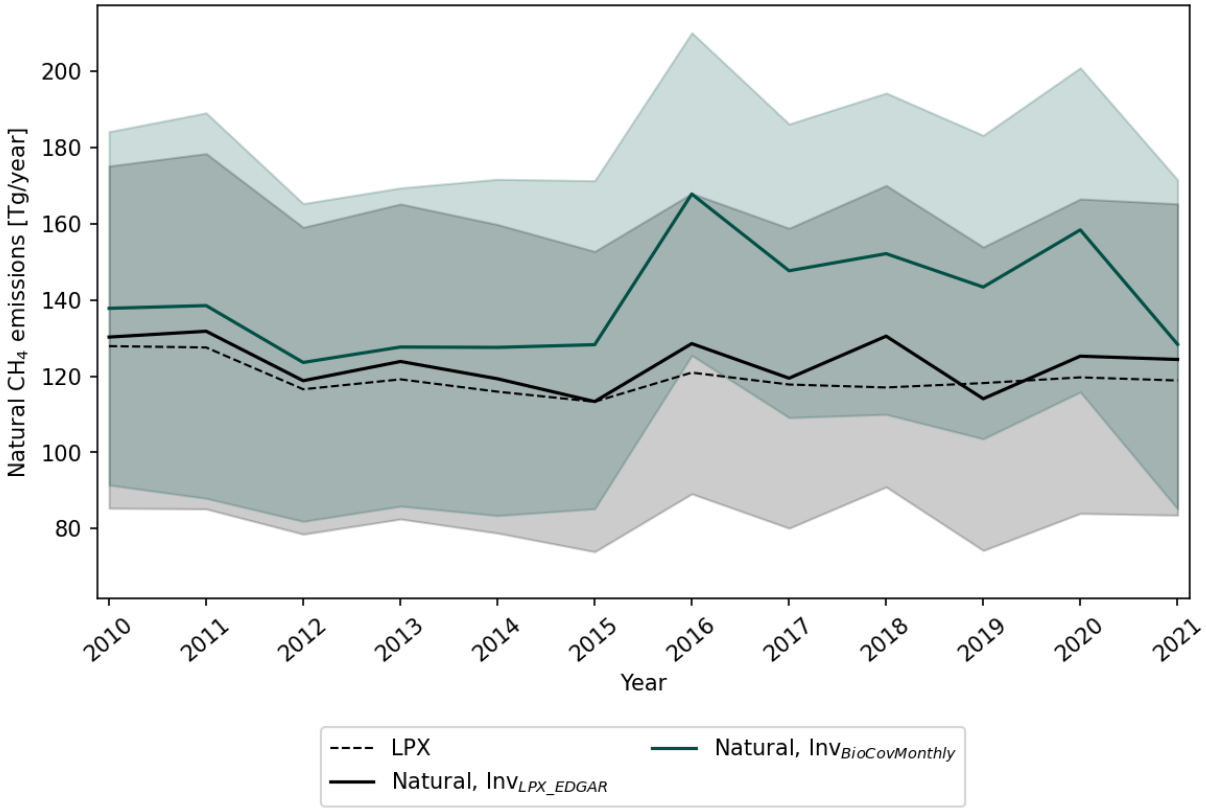
Bio uncertainty remained at the same level

Increase in bio emissions from 2016 onwards -> decrease in anthropogenic emissions

Priors



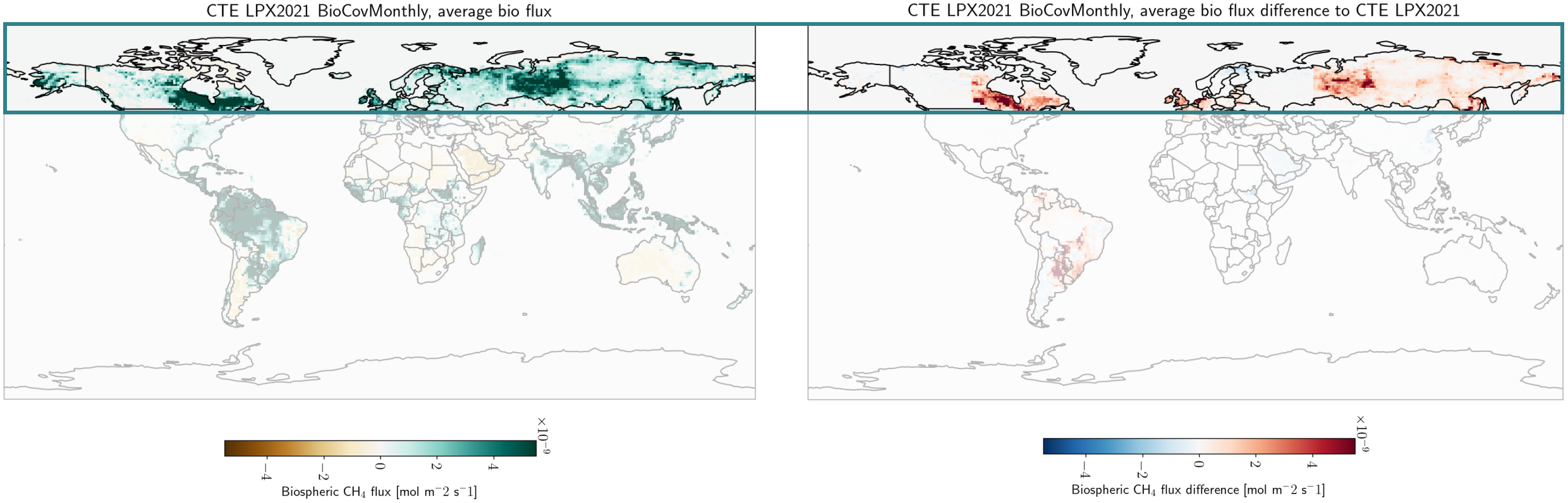
Posteriors



Global CH_4 emissions

Bio uncertainty remained at the same level

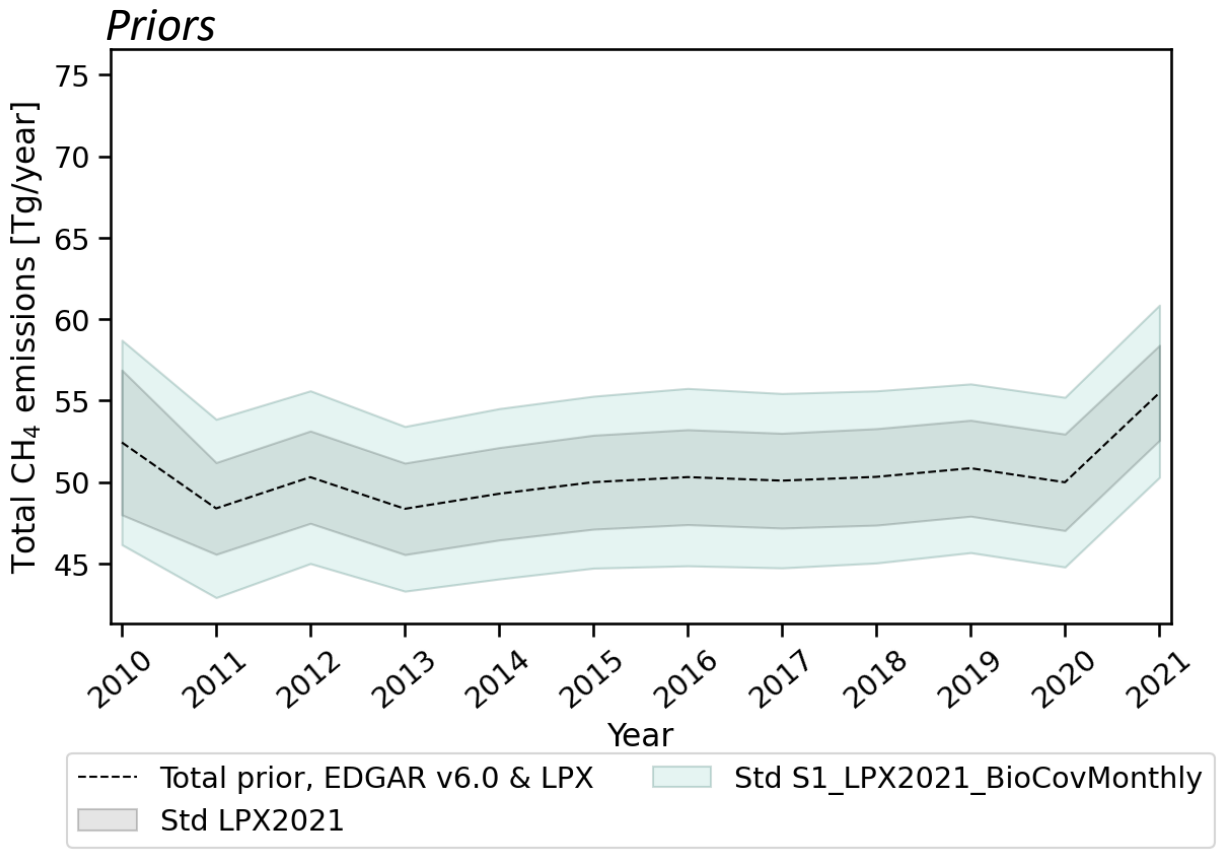
Increase in bio emissions from 2016 onwards -> decrease in anthropogenic emissions

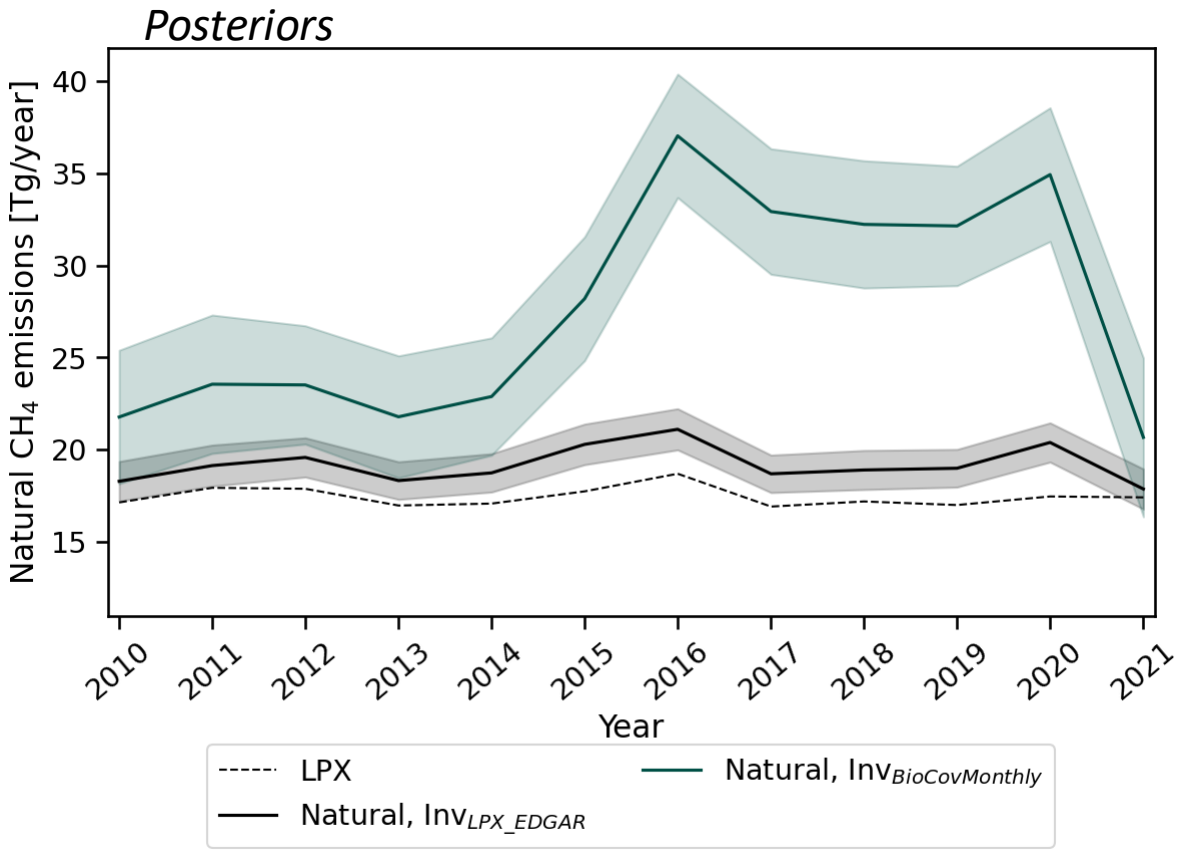


Northern high latitudes CH_4 emissions

Bio uncertainty ~4 times higher than old unc

Large increase in posterior bio CH_4 emissions from 2016 onwards



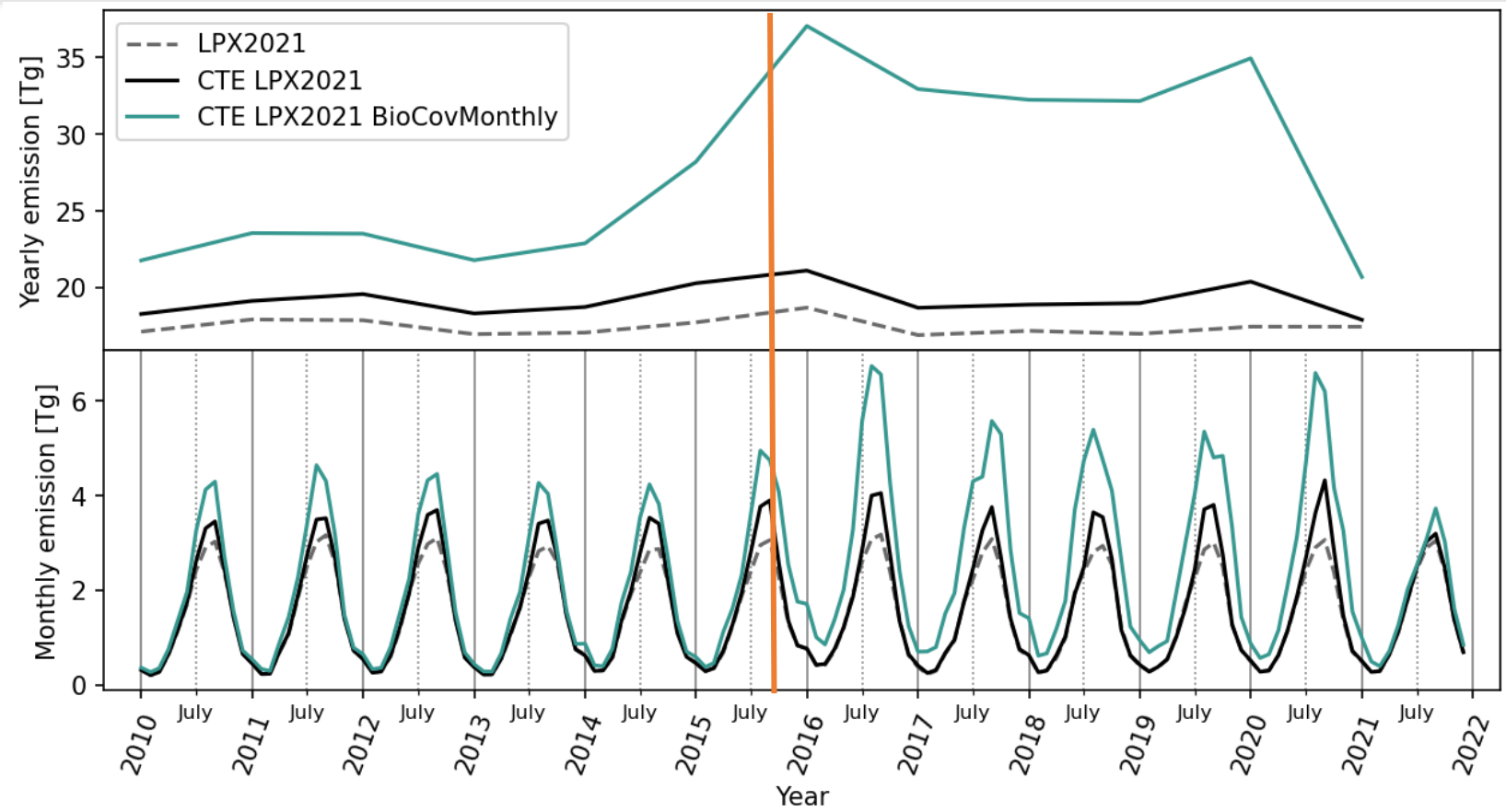


Northern high latitudes CH_4 emissions

Bio uncertainty ~4 times higher than old unc

Large increase in posterior bio CH_4 emissions from 2016 onwards

Increase not only in summer but also in winter



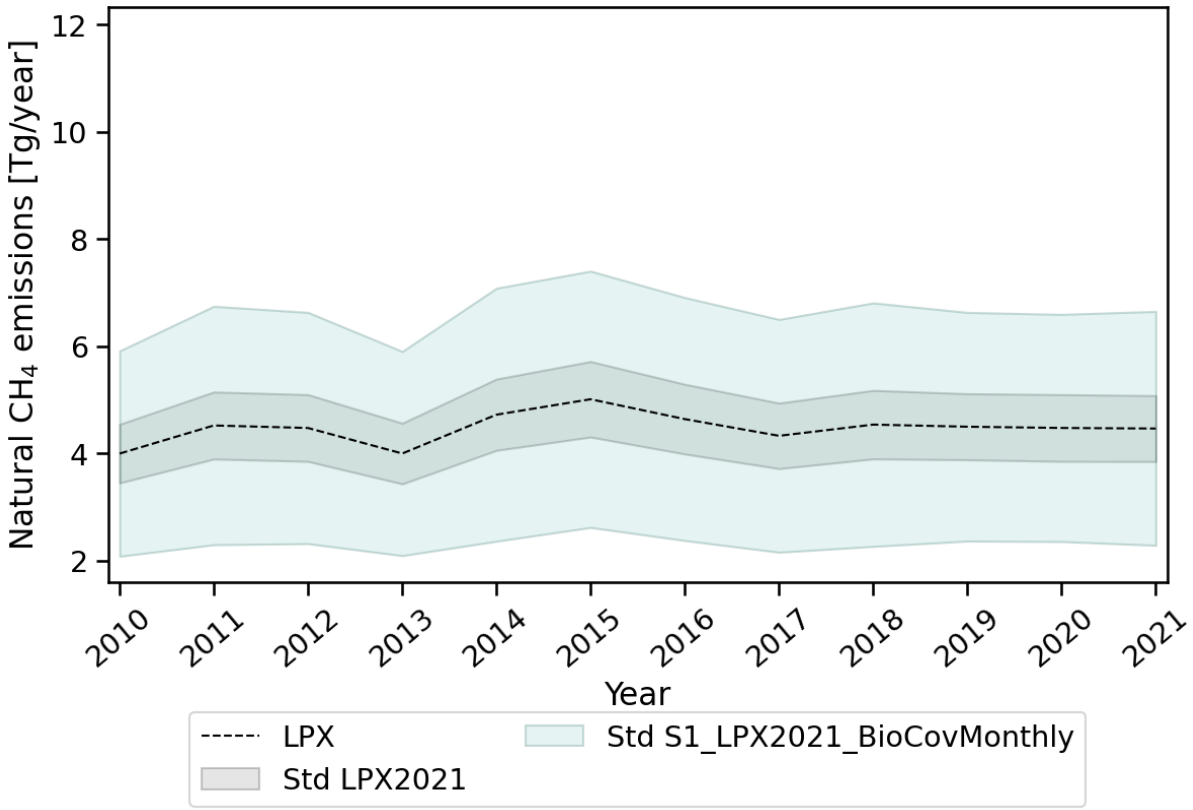
Western Siberian Lowlands CH_4 emissions

Bio uncertainty over 3 times higher than old unc

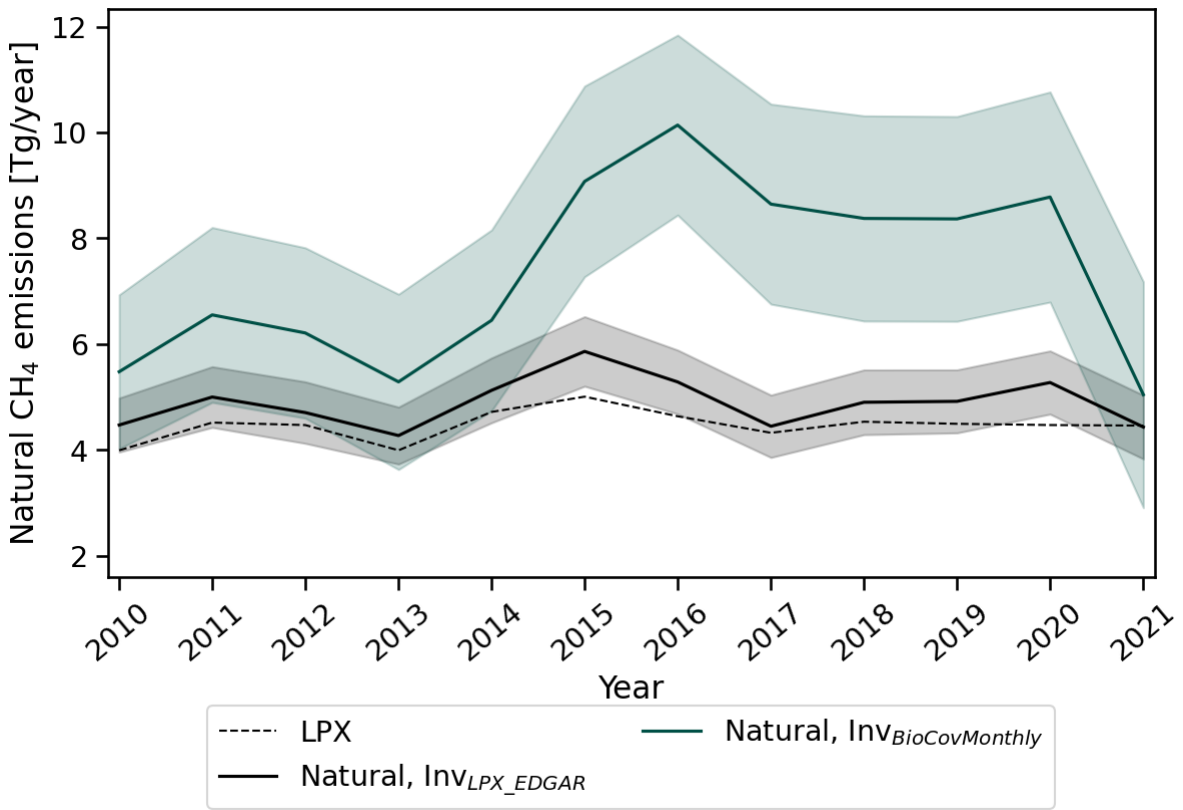
Large increase in posterior bio CH_4 emissions from 2015 onwards

Smaller decrease in anthropogenic posterior emissions than the increase in biospheric

Priors



Posteriors



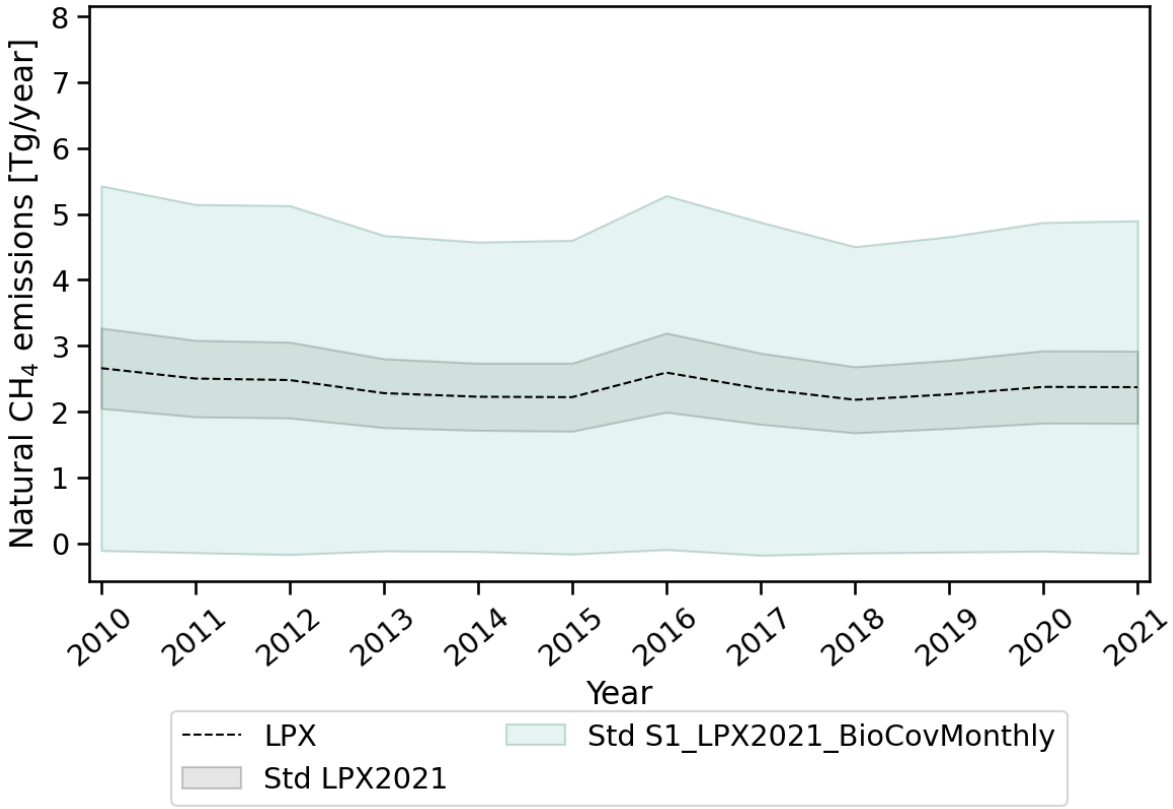
Hudson Bay Lowlands CH_4 emissions

Bio uncertainty over 4 times higher than old unc

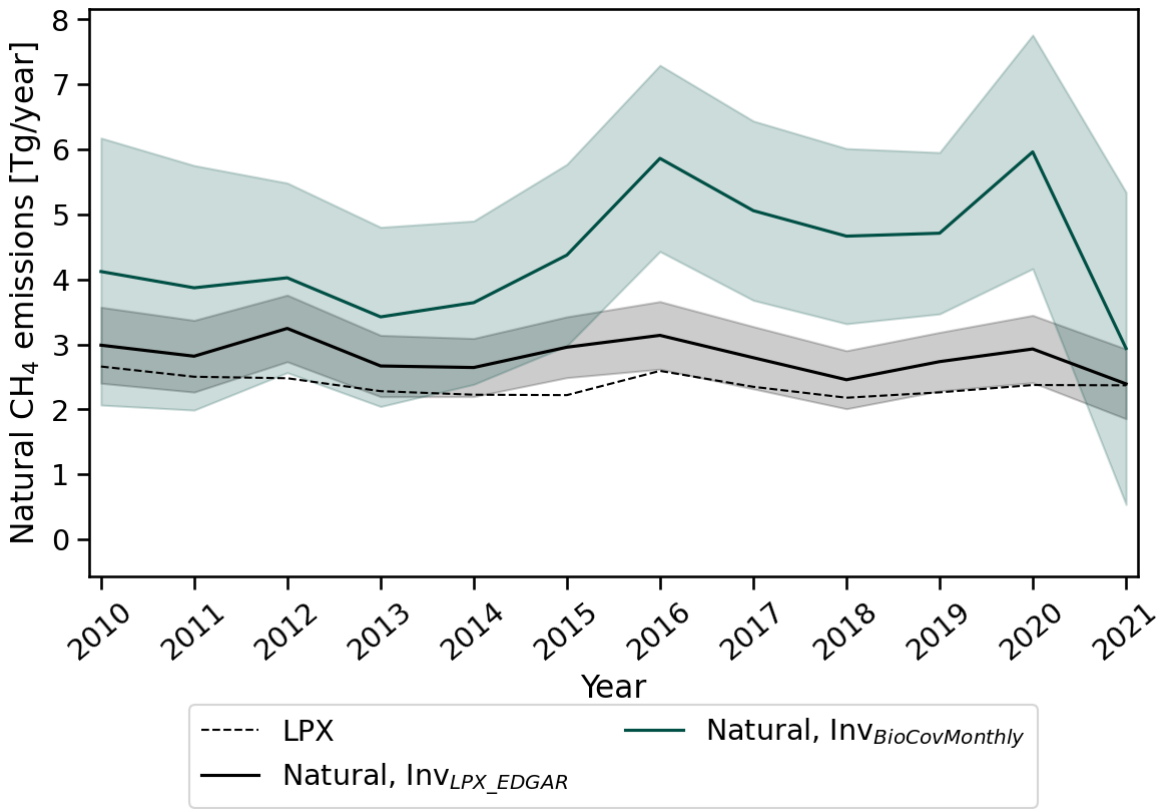
Large increase in posterior bio CH_4 emissions from 2016 onwards

Negligible anthropogenic emissions

Priors



Posteriors

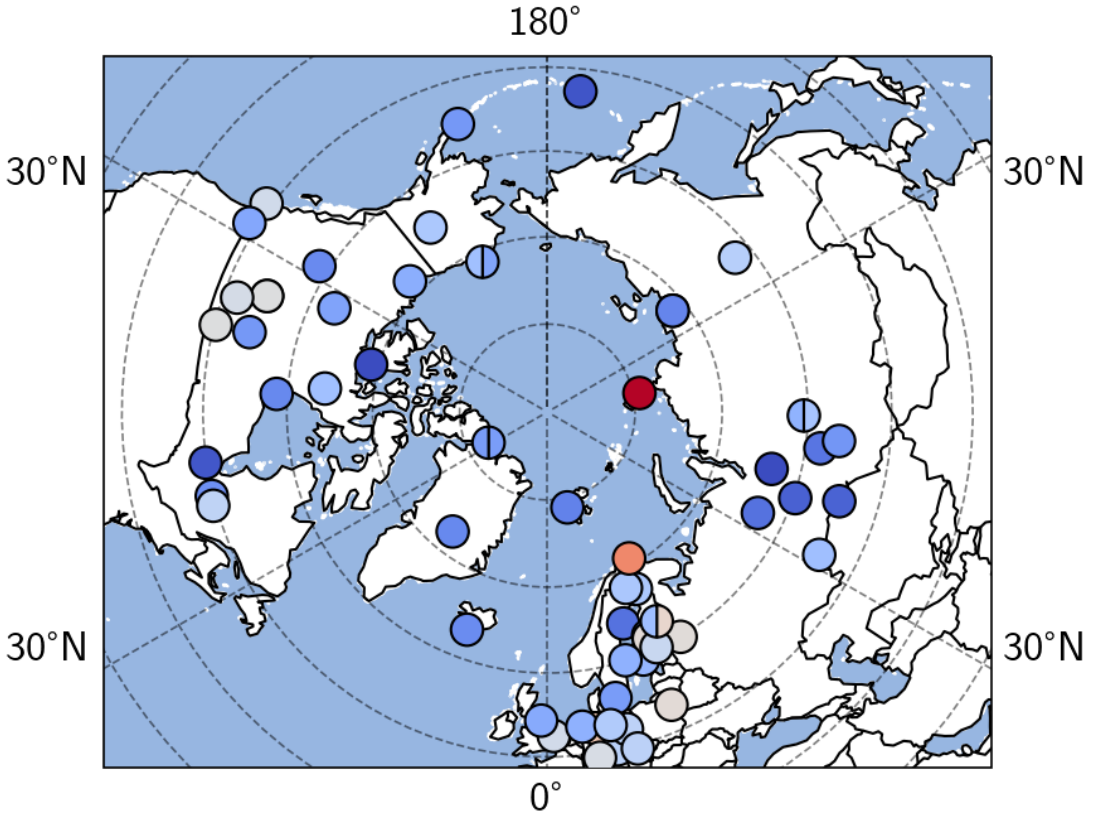


Comparison to assimilated mole fraction measurements

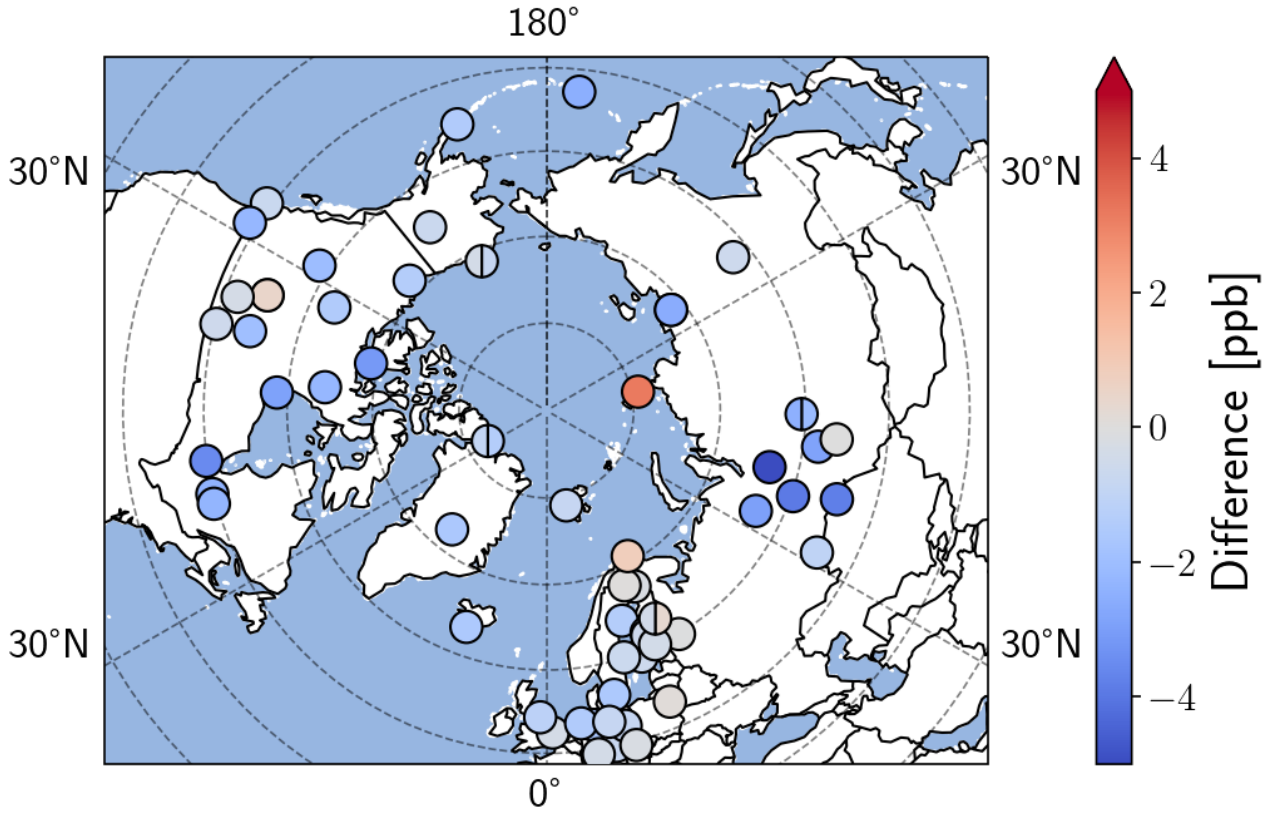
Smaller bias and RMSE compared to the assimilated measurements when using the new uncertainty estimates

With new method: larger uncertainties -> more trust in measurements

Bias differences (new vs old)



RMSE differences (new vs old)



Main points

Process model

- Their estimates have a large range

New uncertainty limits

- Sometimes smaller but mainly larger than the old way to define (80%)

Emission estimates

- Globally emissions remained the same
- Different emission distributions spatially and between biospheric and anthropogenic emissions categories

To do and questions to ask

TM5 resolution

- Too coarse? Grid lines showing?
- -> TM5-MP?

2016 ->

- What caused the large increase in the posterior emissions in norhtern high latitudes?

Fire emissions

- In 2021, GFED showed extremely large CH4 emissions in norhtern high latitudes, which had clear effect on posterior emissions
- GFED v5 should be out soon

Something else?

- What would be the interesting questions to ask?