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TROPOMI inversion with CTE-CH4

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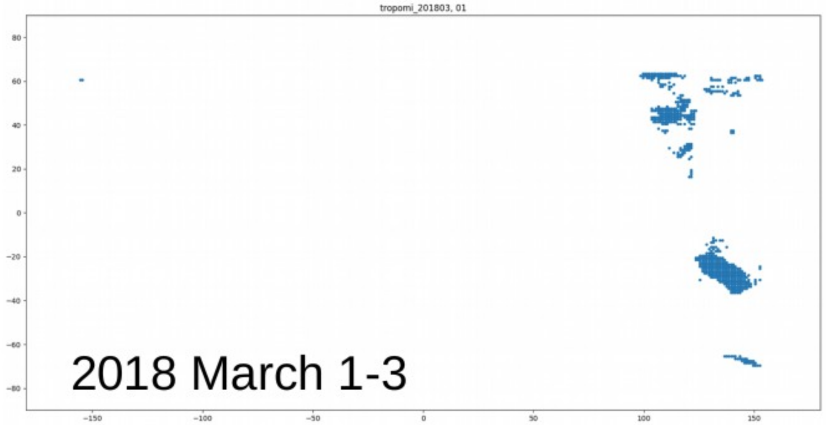
22/11/2019 **TM meeting, remote connection to Wageningen**

$CTE\text{-}CH_4$

- Setup similar to normal $CTE\text{-}CH_4$
  - TM5 with zoom over Europe
  - Grid base optimization over Europe, region-wise elsewhere
  - Optimize biospheric (wetland+sink) and anthropogenic sources, prior uncorrelated
  - Priors as GCP (avg. from Pouter et al., 2017, EDGAR v4.3.2, GFED v4, geological, termite, ocean)
- 3 day optimization with 15 days (3-day x 5) assimilation window
  - Shorter optimization window is used to reduce number of obs. to handle
- Simulation: Nov. 2017 → Dec. 2018

TROPOMI data preprocessing

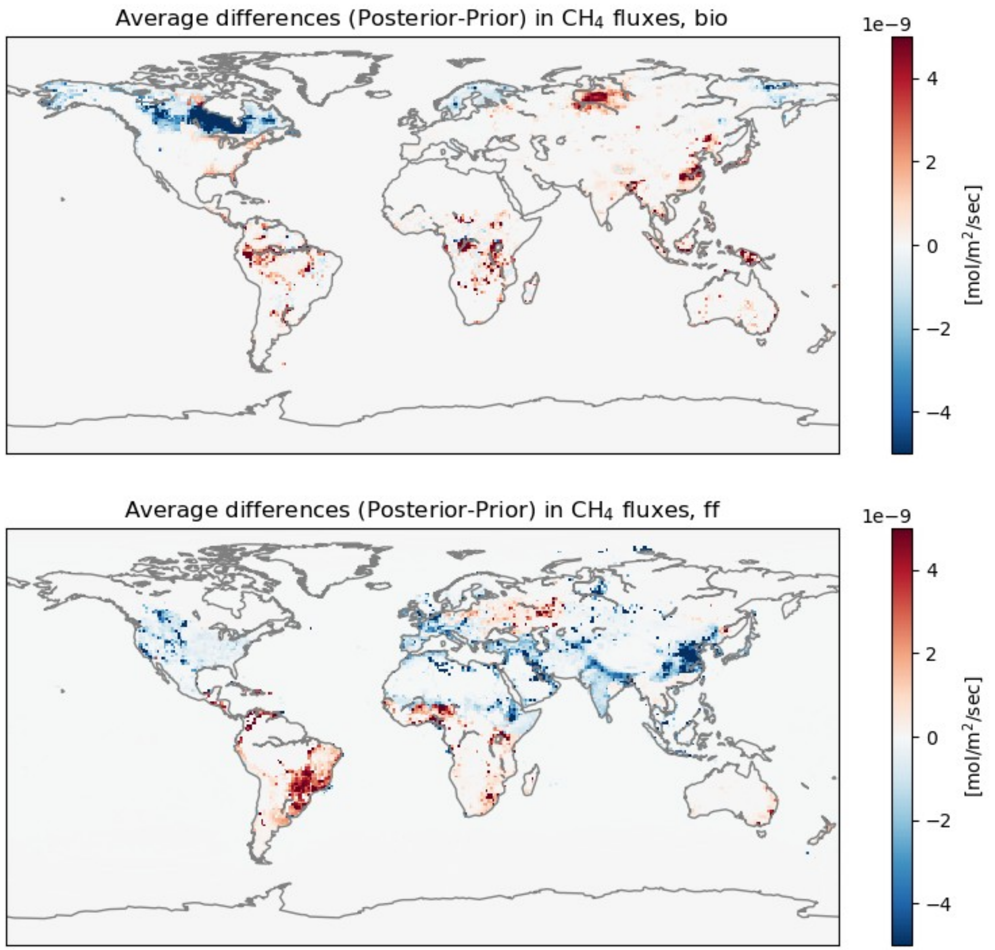
- Data preprocessed by taking 1° x 1° x daily averages
  - 1. Calculate median XCH_4 value of the grid
  - 2. Find a retrieval whose XCH_4 value is the closest value to the median
  - 3. Take the retrieval as the obs. of the grid (applies to all parameters, e.g. AK correction)
- Obs. uncertainty: std from averaging + transport model uncertainty (15 ppb)
  - Min. std = 5 ppb
- AK implemented
- Rejection threshold = twice obs. uncertainty
  - Too large unc. was not good



Results

<u>Global emissions</u> [Tg CH_4 yr^{-1}]

- Total: 556 (prior) → 552 (posterior)
  - GOSAT (560), surface* (550→572)
- Biospheric: 142 → 162
  - GOSAT (157), surface* (147→157)
- Anthropogenic: 350 → 325
  - GOSAT (341), surface* (360→372)



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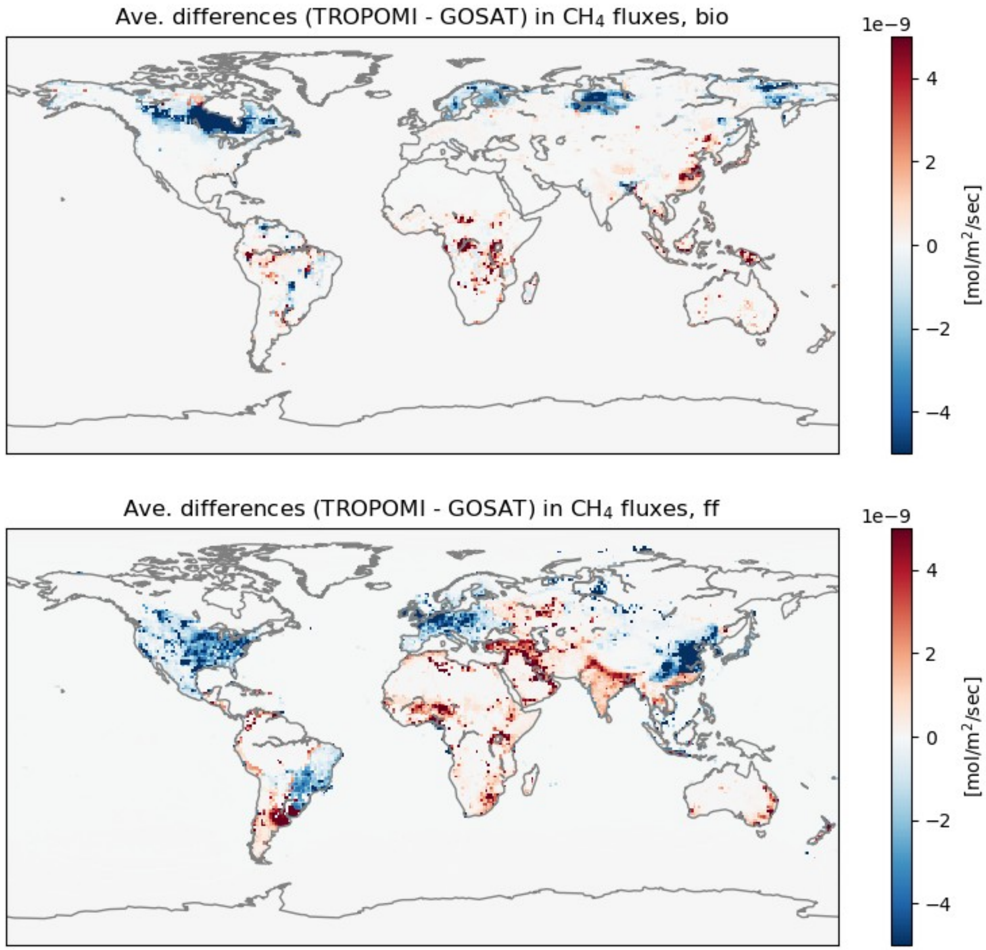
Results

<u>Comparison to GOSAT inversion</u>

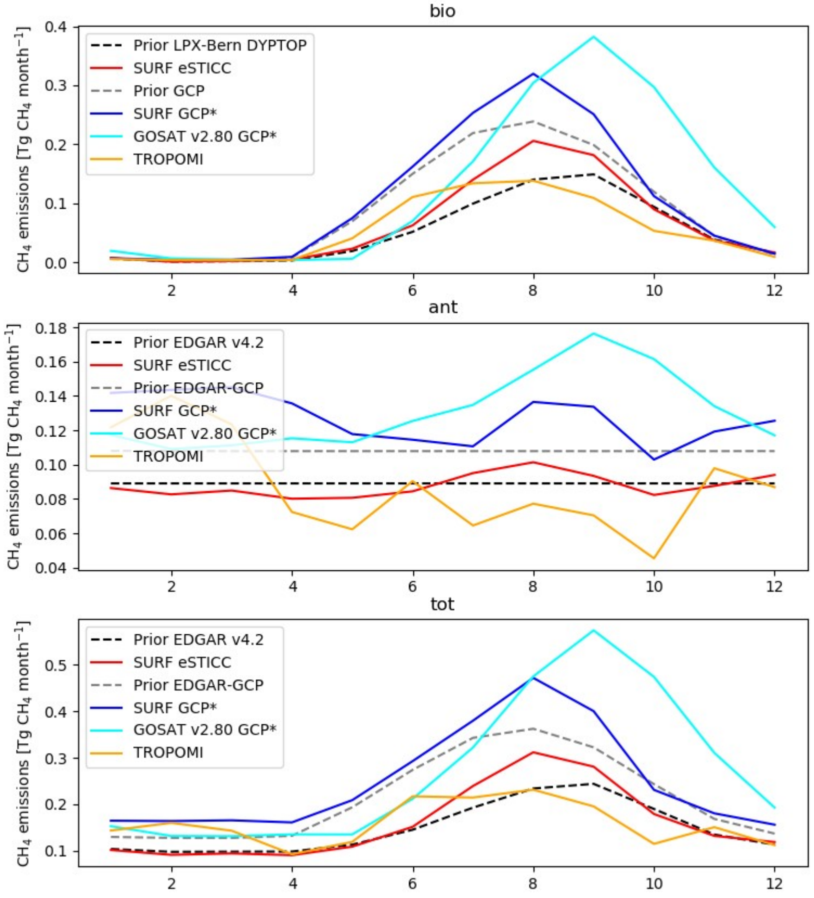
- Biospheric
  - NH: TROPOMI<GOSAT
  - SH: TROPOMI>GOSAT
- Anthropogenic
  - North America, Europe, China: TROPOMI<GOSAT
  - Middle East, Africa, India: TROPOMI>GOSAT

→ Some spatial dependencies



Results

Avg. monthly totals, EU 60°N>



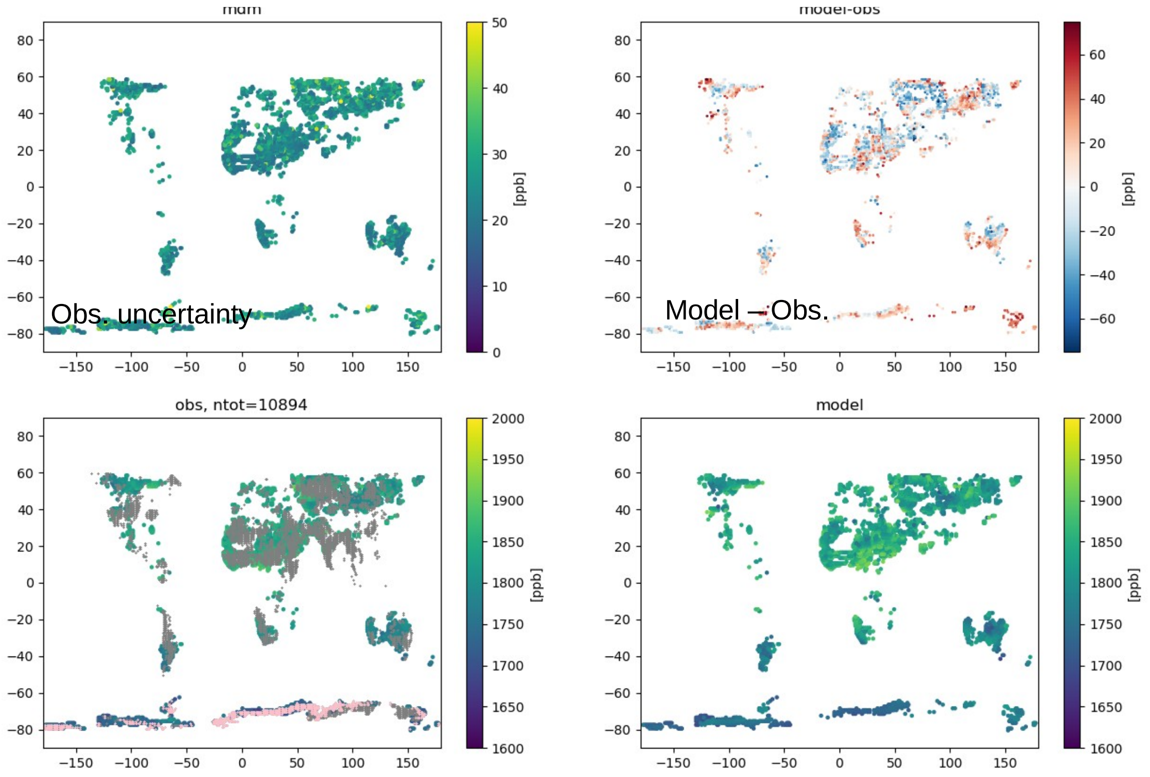
Seasonal cycle for Northern Europe

- TROPOMI inv. give earlier increase in biospheric emissions
  - Maybe due to seasonal bias in the TROPOMI data
- Summer max. in TROPOMI inversion is not as clear as other inversions, but July-August is close to e.g. EC observations
- GOSAT inversion give much later summer maximum and high winter emissions
  - XCH_4 data is "pre-corrected" to match XCH_4 from surface inversion (zonal and monthly means)

Results

- Assimilation rate ~0.5 throughout the year
- Comparison with posterior XCH_4 showed little latitudinal gradient bias
- Over ice: std of XCH_4 values from ensembles were zero
  - Could not be used in optimization

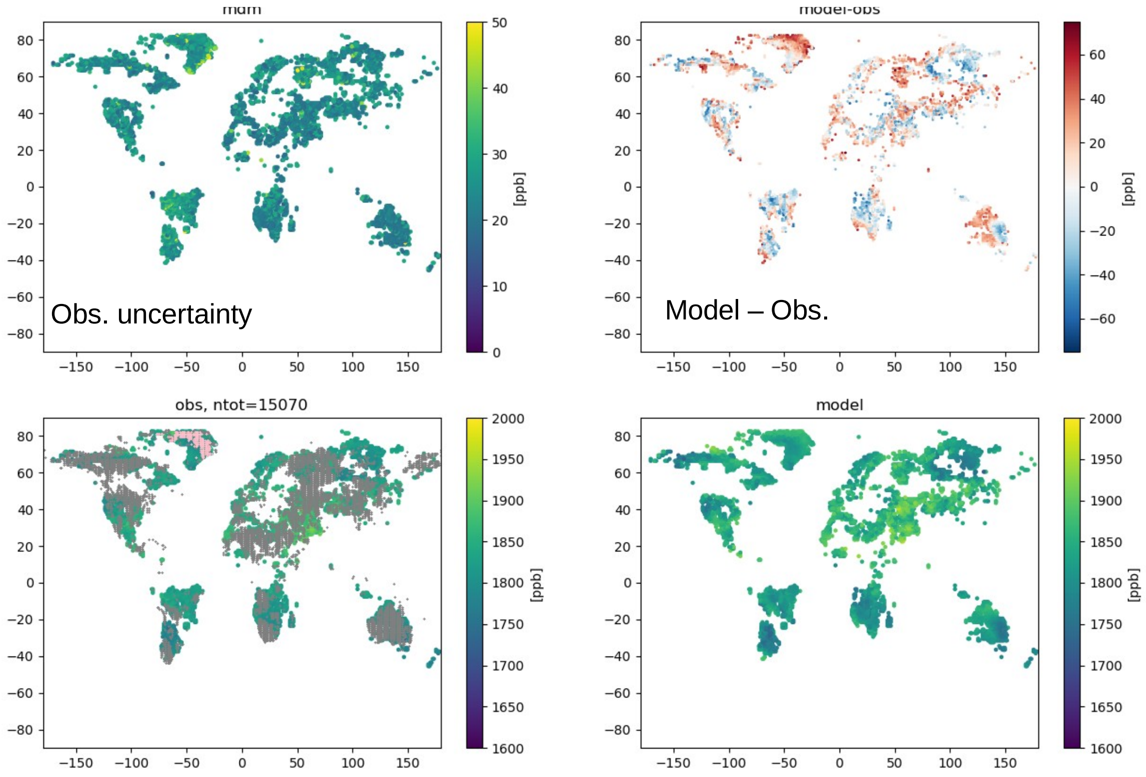
Assimilated data between 20180217 – 20180220,
Assimilation rate=0.42



Results

- Assimilation rate ~0.5 throughout the year
- Comparison with posterior XCH_4 showed little latitudinal gradient bias
- Over ice: std of XCH_4 values from ensembles were zero
  - Could not be used in optimization
- Mountains & desserts, central Russia obs. seem to have problem assimilating
  - Increasing TM5 resolution may help?

Assimilated data between 20180723 – 20180726,
Assimilation rate=0.44



Next step

- Further evaluation of results
  - Posterior surface CH_4, comparison to observations
  - Seasonal cycles
  - HNL autumn and spring (in connection to Maria's project)
- Assimilate surface observations at the same time

- *Increase TM5 resolution – global 1°x1° or 0.5°x0.5°
- *Move to ERA5

*Will be applied to all upcoming CTE-CH_4 runs