European CH_4 flux distributions estimated from CTE-CH_4 atmospheric inversion assimilating TROPOMI XCH_4 data

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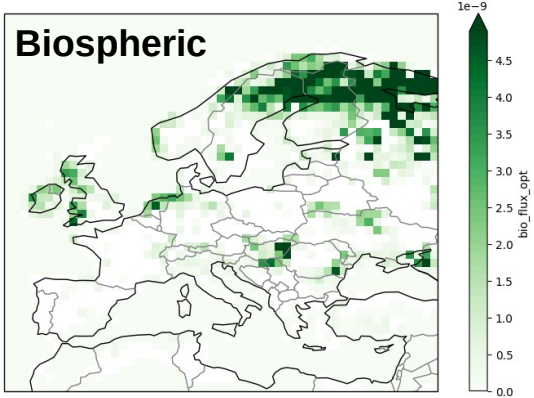
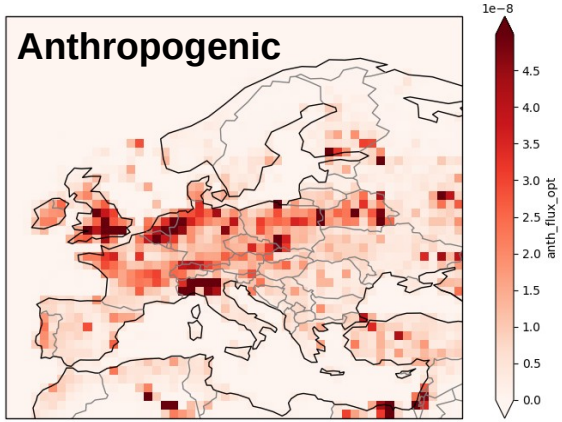
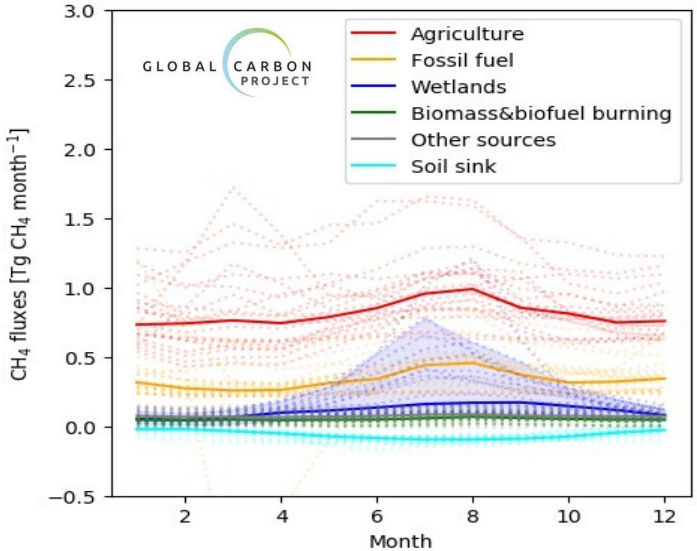
Examine spatial distribution of European CH_4 flux for biospheric (wetlands) and anthropogenic sources.







Seasonal cycle is mostly driven by biospheric sources, but high uncertainty remains.

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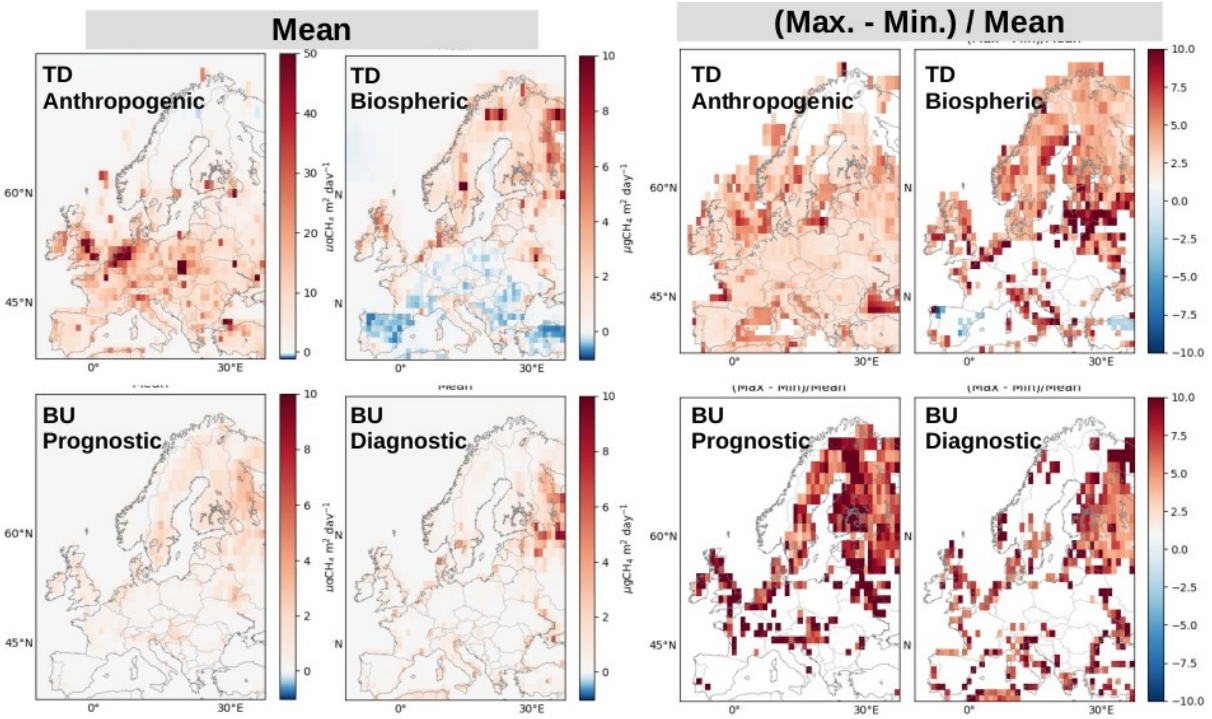
→ Will satellite XCH_4 bring additional information?

European CH_4 flux spatial distributions also vary a lot among GCP models

- High anthropogenic emissions in cities, agricultural areas → high in central Europe
  - – TD estimates do not vary so significantly between models
- Biospheric emissions are high in northern and north-east Europe
  - – Locations of hot spots vary much between TD, BU-Prognostic and BU-Diagnostic
  - – Range in estimates is significantly higher than that of anthropogenic emissions

Mean and range of CH_4 emission estimates over Europe, 2005-2017 average



*Mean of model ensembles is calculated from 2005-2017 monthly data.
*Min. and Max. are minimum and maximum of model ensembles.

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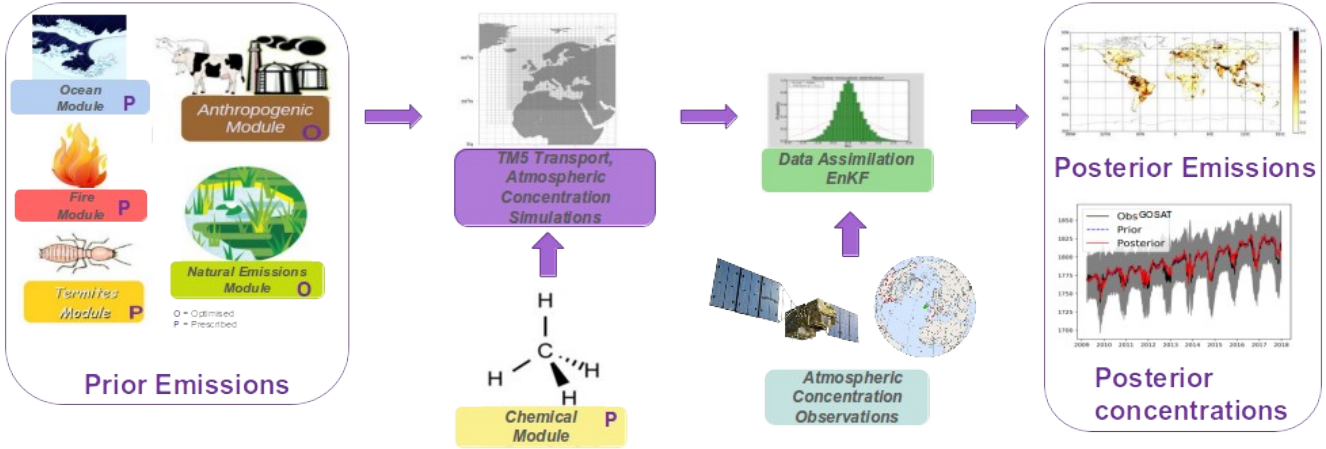
GLOBAL CARBON PROJECT

CarbonTracker Europe-CH_4 (CTE-CH_4) atmospheric inverse model

Model setup

- Grid-based optimization over Europe on **1° x 1° – 6° x 4°** (latitude x longitude) resolution with spatial correlation of 100-500 km
- Optimize anthropogenic and biospheric (wetlands + soil sink) fluxes
- Assimilate surface CH_4 observations mainly from ICOS and NOAA stations
- Assimilate XCH_4 from S5P TROPOMI
  - Operational product provided by SRON (OPER)
  - Research product provided by Univ. Bremen (WFMD)



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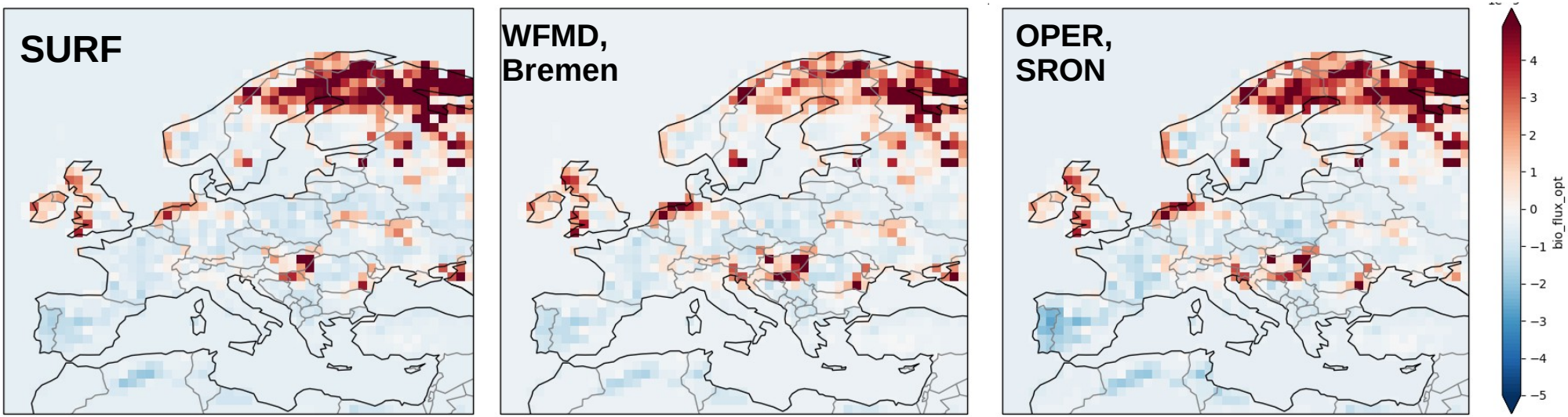
European CH_4 flux distributions estimated from CTE-CH_4

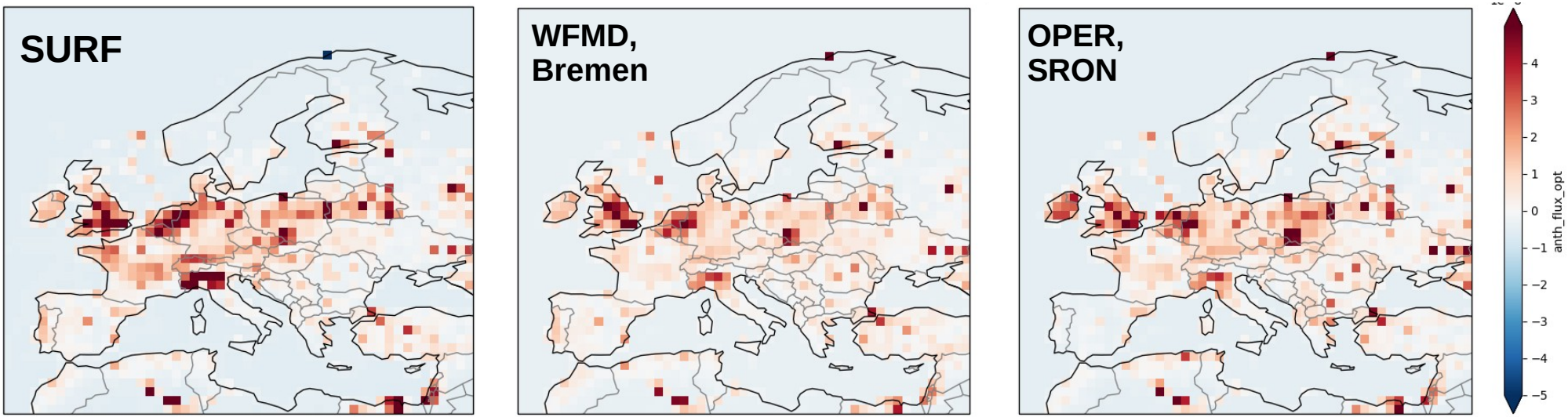
Spatial anomaly of biospheric (wetlands + soil sinks) fluxes, July 2018



- High biospheric emissions in Northern EU, but least pronounced in WFMD inversion
- Enhancement in biospheric emission hot spots from satellite inversions, such as in southern Sweden, Benelux and northeast Italy.

European CH_4 flux distributions estimated from CTE-CH_4

Spatial anomaly of anthropogenic fluxes, July 2018

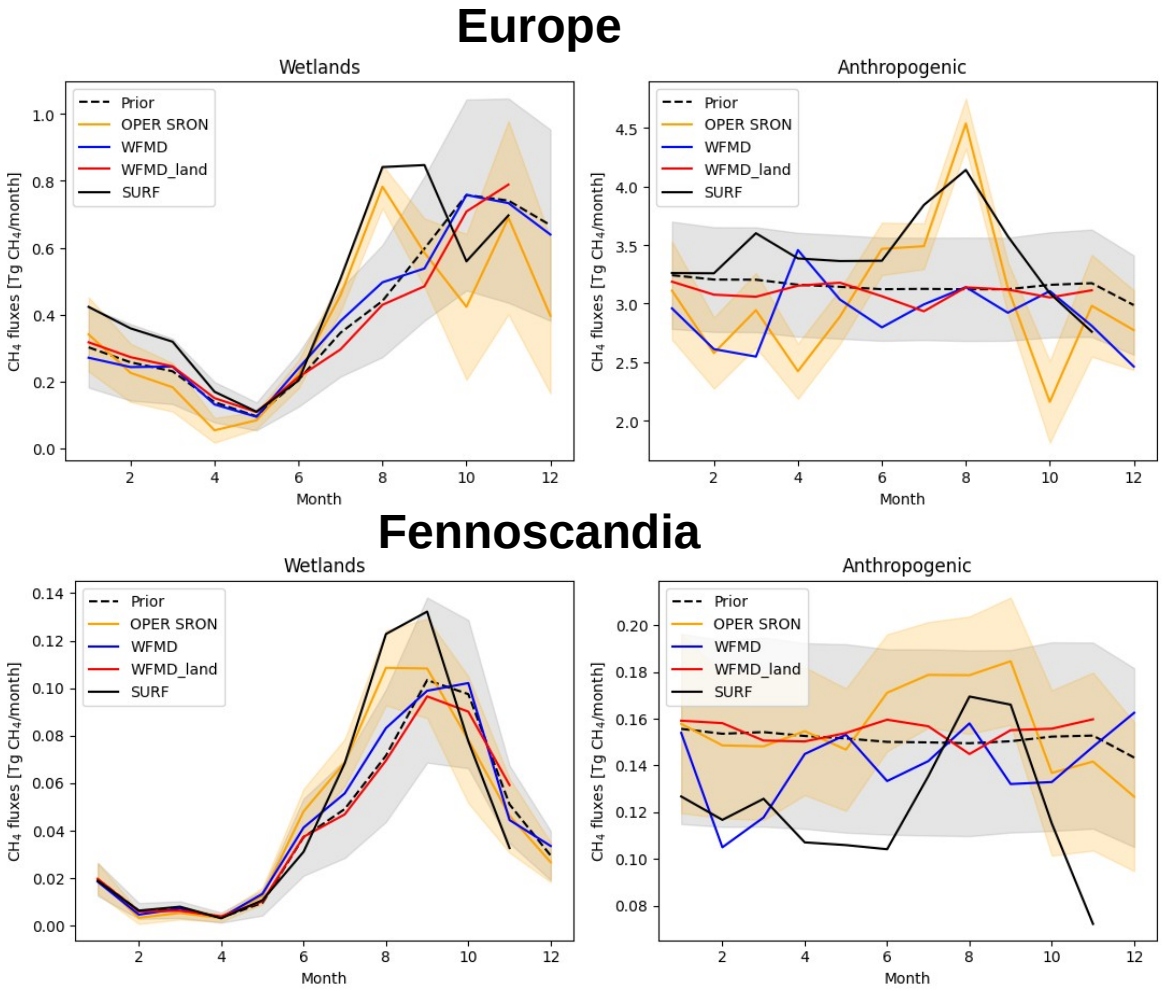


- Anthropogenic emissions from SURF inversion are much more pronounced in Benelux, Germany, northern Italy
- Hot spots are most distinct/clear in WFMD inversion. Others have more small “regional” enhancements.

European CH_4 flux distributions estimated from CTE-CH_4

Monthly budgets, 2018

- Biospheric (wetland) fluxes
  - – OPER and SURF estimates earlier summer maximum of
  - – Both in EU and Fennoscandia only
  - – Timing of seasonal mimum agree among inversions
- Anthropogenic emissions
  - – OPER and SURF show clear maximum in August → associated with correlation structure?
- Uncertainty in satellite inversion corresponds well to the number of available data
  - – low unc. in summer, high in winter



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