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GLOBAL AND REGIONAL METHANE BUDGETS FROM GROUND-BASED AND SPACE-BORN OBSERVATIONS BY CTE-CH_4 ATMOSPHERIC INVERSE MODEL

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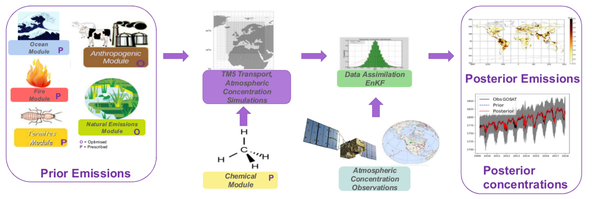
INTRODUCTION

- Atmospheric methane (CH_4) is a greenhouse gas strongly influenced by human activities
- Atmospheric CH_4 has increased in recent years as rapidly as in the end of 20th century
- The cause of the rapid increase and its interannual variability are still under discussion due to lack of flux information and modelling complexity
- In order to obtain further understanding especially on the regional budgets, we present global and regional CH_4 emission estimates from CarbonTracker Europe-CH_4 (CTE-CH_4) atmospheric inverse model[4]

MODELLING

Carbon Tracker Europe – CH4 model

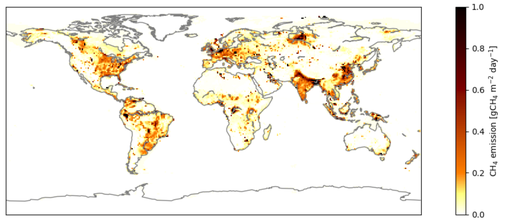


- Grid-based optimization over Europe
  - 1°x1° horizontal resolution (correlation length = 100-500 km)
  - Weekly temporal resolution
- Anthropogenic priors:
  - EDGAR-GCP[2]: annual means, extended to 2017
- Biospheric priors
  - Previous GCP-CH_4 bottom-up estimates[3] averaged over the models, climatological fluxes
- Other priors: GFED v4.2[1] (fire), termites & other microbial sources[3], geological sources[3], ocean[3]
- Assimilated observations
  - **(SURF)** High-precision observations from ground-based stations
  - **(GOSAT)** Dry air total column-averaged CH_4 mole fractions*, retrieval from GOSAT TANSO-FTS[5] (NIES v2.72 retrieval)

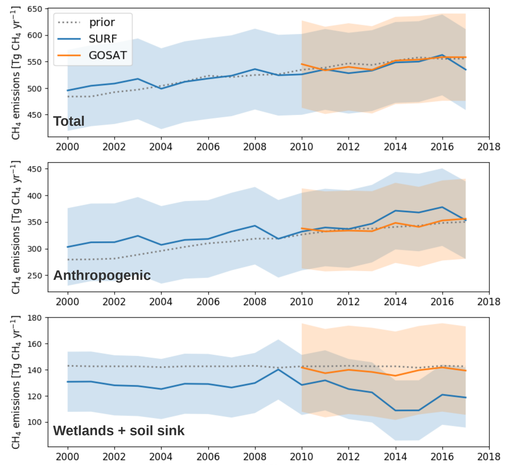
*Average differences in 5° latitudinal mean between surface inversion driven 3D concentrations and retrieved XCH_4 were substracted from XCH_4 data before inversion

GLOBAL CH_4 EMISSIONS

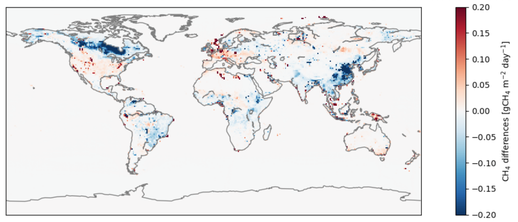
Annual global total CH_4 emissions from SURF inversion



Annual global total CH_4 emissions for 2000-2018.



Annual mean differences between SURF and GOSAT inversions



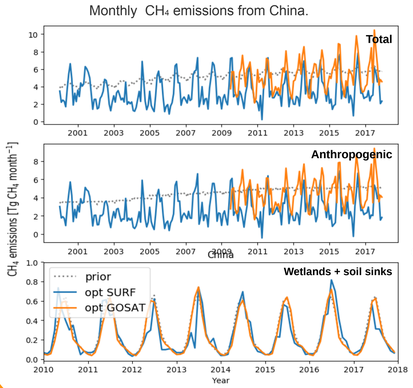
* Positive values indicates higher emission estimates from SURF inversion

*Shaded areas represent uncertainties for posterior estimates

- Global total CH_4 emissions from inversions agree well with each other – also similar to prior
- Changes in global total emissions from inversions are more in agreement with atmospheric CH_4 GR than those from prior
- Surface inversion gives larger anthropogenic emissions and stronger increasing trend in their emissions
- GOSAT inversion gives much higher emissions for wetlands

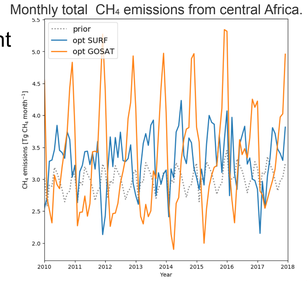
REGIONAL CH_4 EMISSIONS

Monthly CH_4 emissions from China.



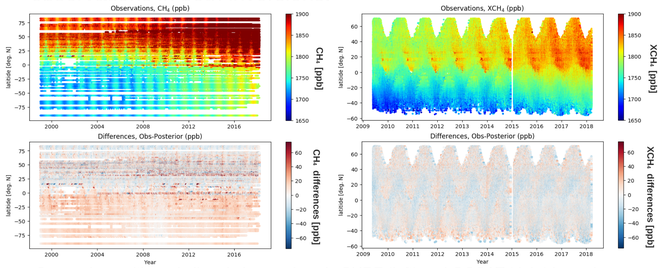
- Large differences between inversions were found in China
- Anthropogenic emissions, especially winter are much higher in GOSAT inversion in China
- Seasonal cycle can be different in the inversions
- Large differences are found especially in the central Africa
- The area has little constraints from surface observations – estimates from GOSAT inversion are more realistic?

Monthly total CH_4 emissions from central Africa.



MODEL EVALUATION

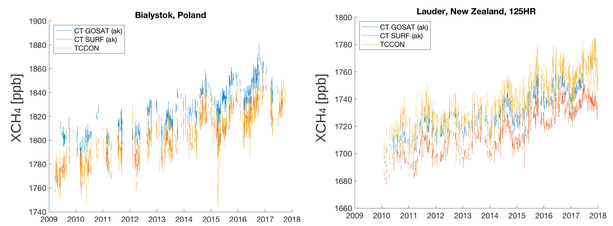
- Posterior concentrations generally agree well with assimilated observations in both inversions.

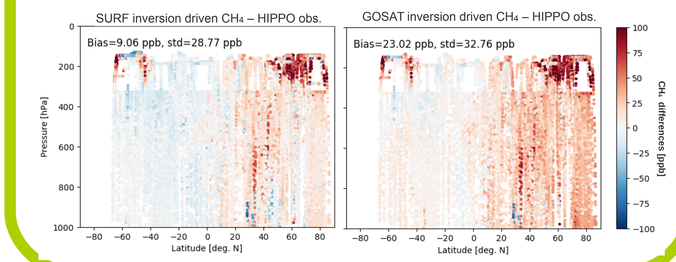


Comparison with assimilated observations in SURF (left) and GOSAT (right) inversions.

*Note that 5° latitudinal mean differences in retrieved XCH_4 and XCH_4 estimated from SURF inversions are subtracted in the top right figure, and the bottom right figure shows comparison to that.

- Comparison with TCCON and HIPPO aircraft observations suggest overestimation of Northern Hemisphere CH_4 emissions when using GOSAT observations
  - Differences in regional emission estimates cannot alone explain the overestimation.
  - Long-range transport possibly play an important role.





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Photography encouraged