



WP4: Emissions of CH₄ and N₂O

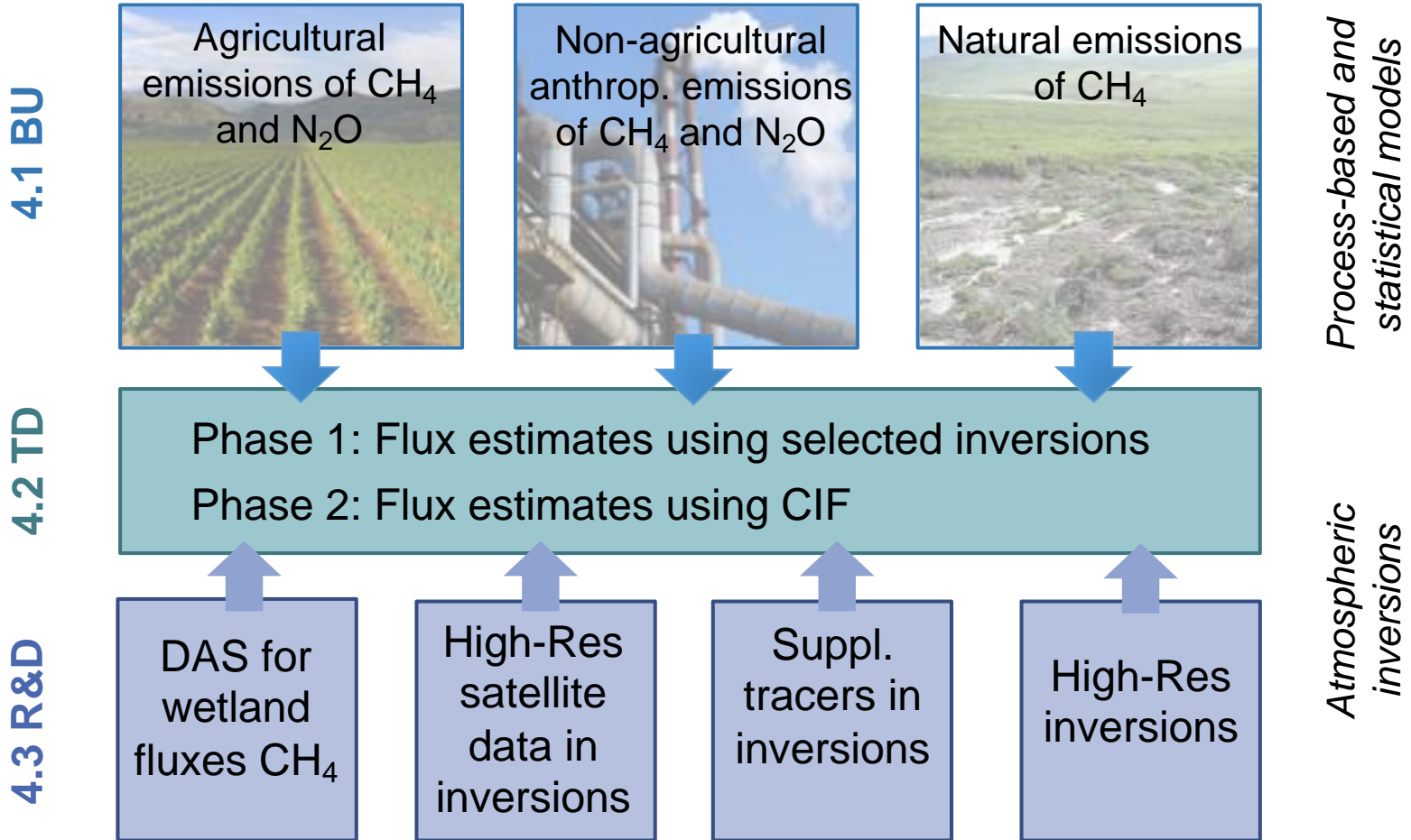
April 28th, 2021

WP4 leader and presenter: Rona Thompson (NILU)



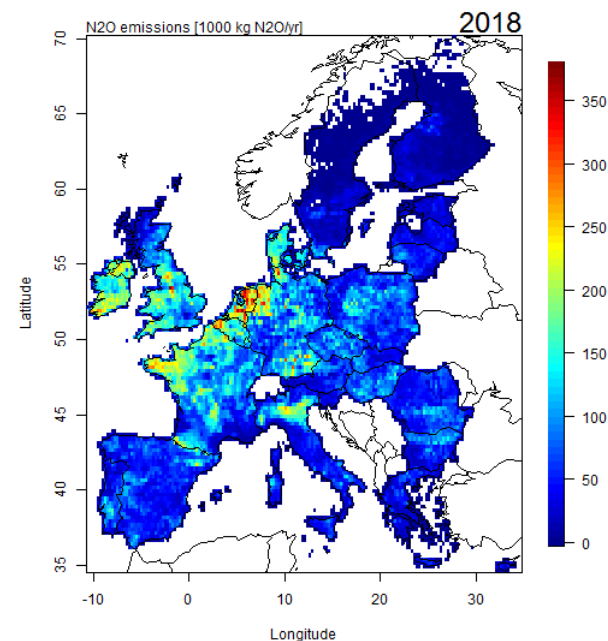
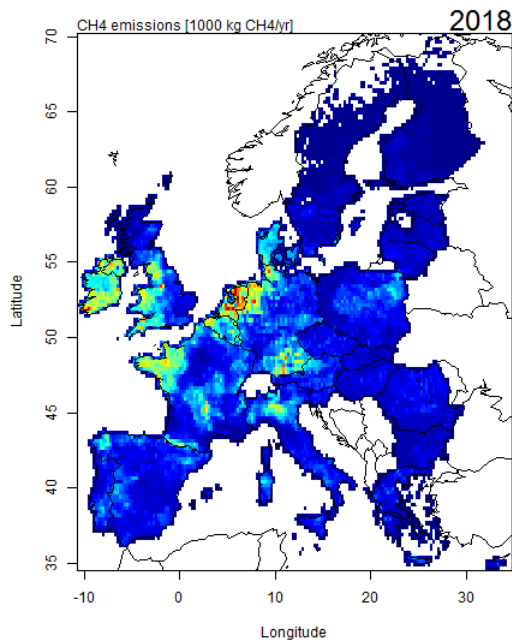
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 776810

OVERVIEW WP4



T4.1.1. Agricultural emissions of CH₄ and N₂O (JRC)

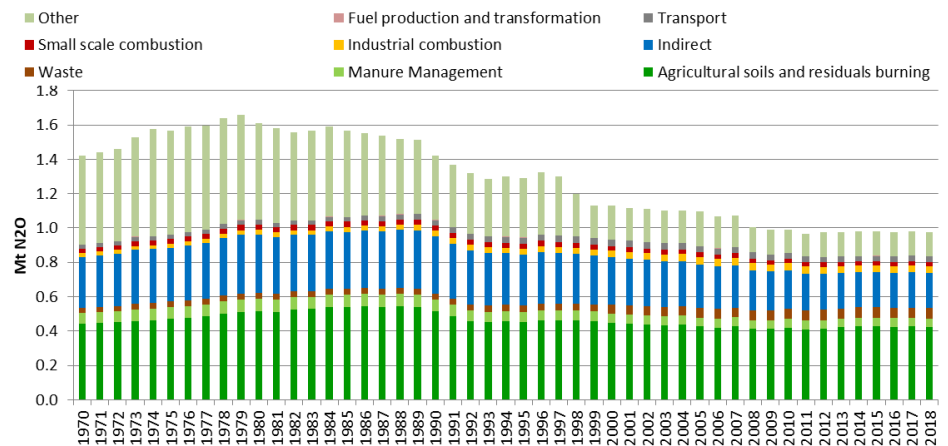
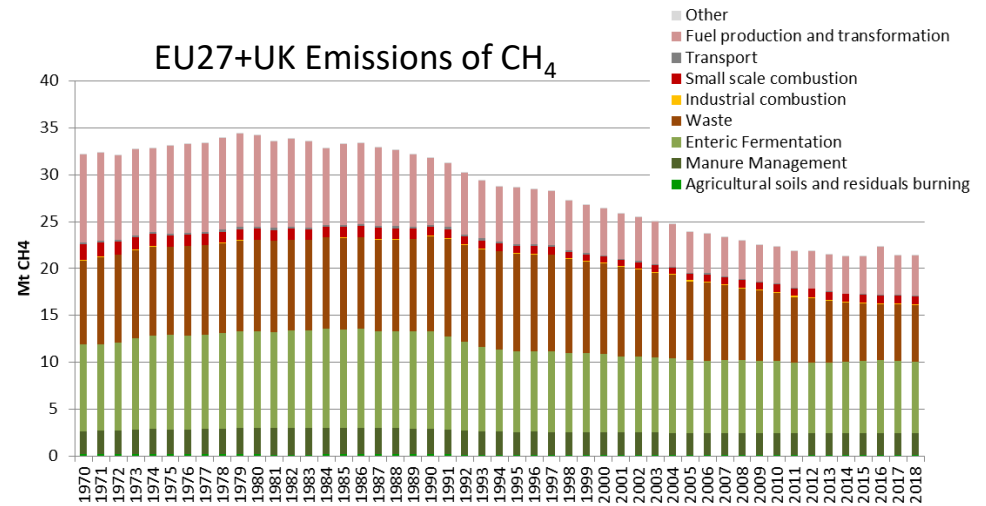
- CAPRI statistical model estimates of agricultural emissions for EU27+UK
- Emissions calculated using IPCC Tier 1 and 2 approaches
- New regional disaggregation using Farm Structure Units (median size 11 km²)
- New use of topography information at high-resolution for limiting activity
- Emissions calculated bi-annually from 2000 to 2018



ACHIEVEMENTS : T4.1 (CONTINUED)

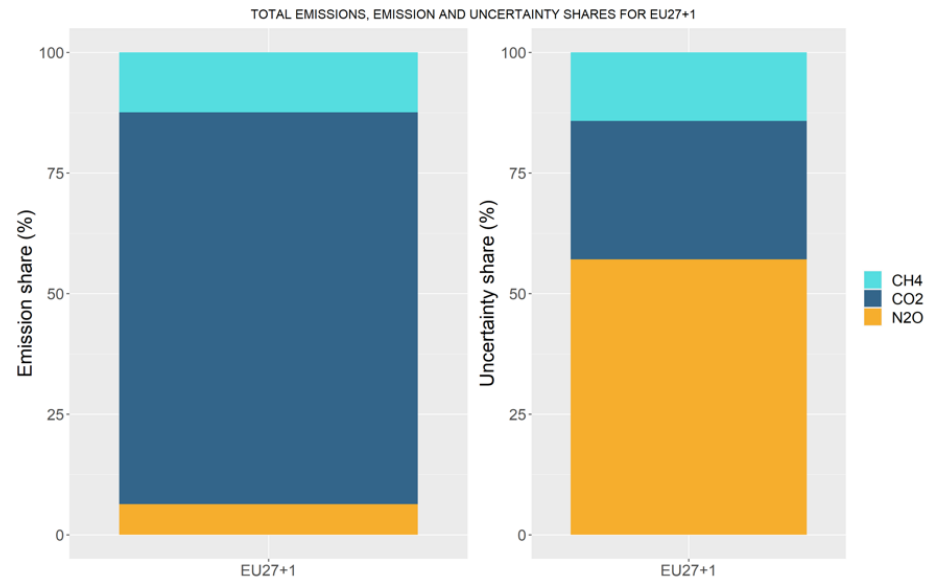
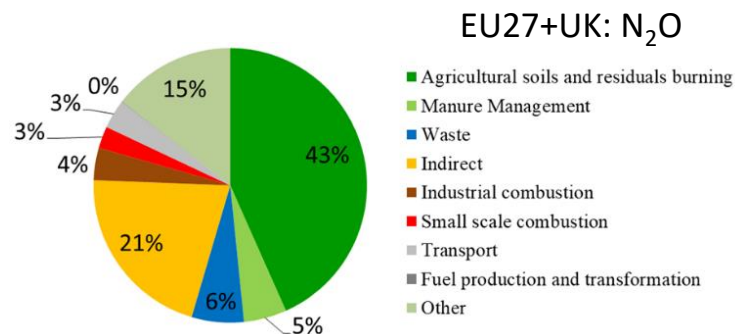
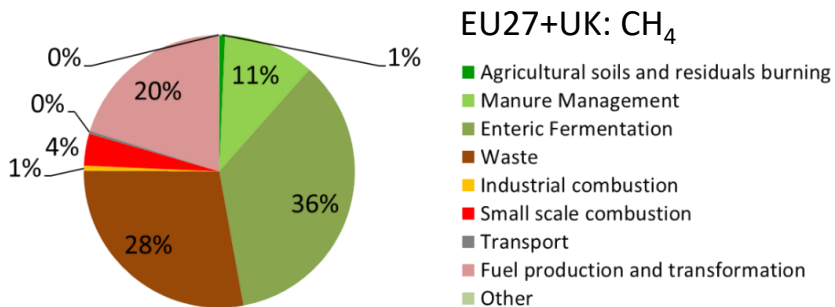
T4.1.2. Anthropogenic emissions of CH₄ and N₂O (JRC)

- Emissions calculated using statistical model EDGAR using IPCC Tier 1 and 2 methods
- Methods applied consistently to all countries globally
- Emissions spatially distributed to 0.1° x 0.1° based on sector-specific proxies
- New monthly disaggregation based on country and sector specific proxies
- EU27+UK emissions of CH₄ decreased by 33% since 1970, agriculture responsible for 48% of emissions
- EU27+UK emissions of N₂O decreased by 31% since 1970, agriculture responsible for 69% of emissions



T4.1.2. Anthropogenic emissions of CH₄ and N₂O (JRC)

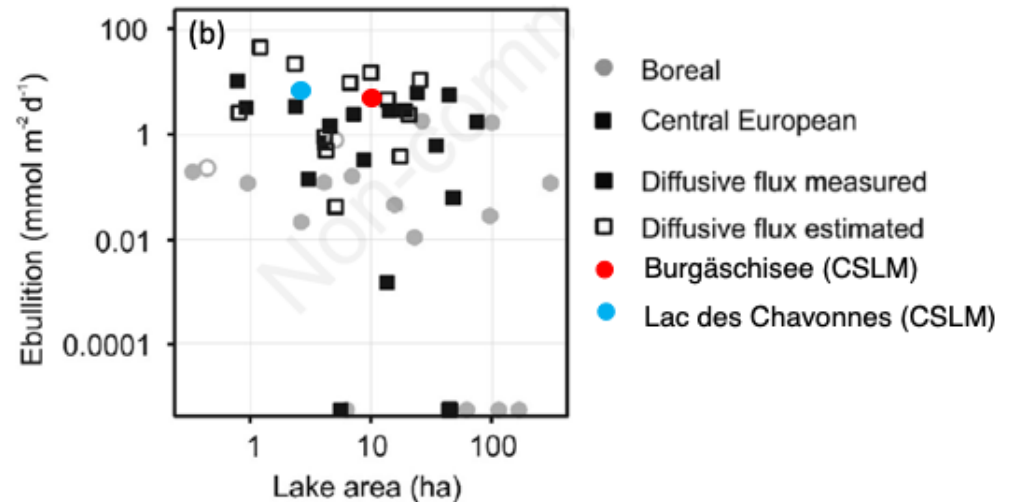
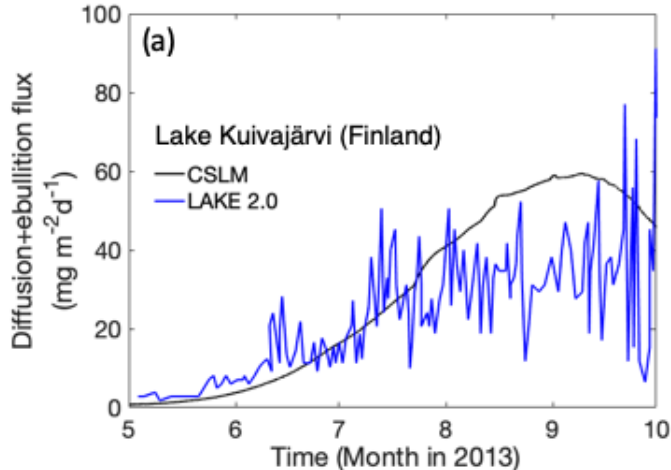
- New emission uncertainties calculated nationally and by sector by propagating uncertainties in activity data and emission factors
- CH₄ and N₂O responsible for 20% of GHG emission (CO₂-equiv) but 80% of the emission uncertainty



Solazzo et al. ACP, 2021

T4.1.3. Natural fluxes of CH₄: Lakes (ULB)

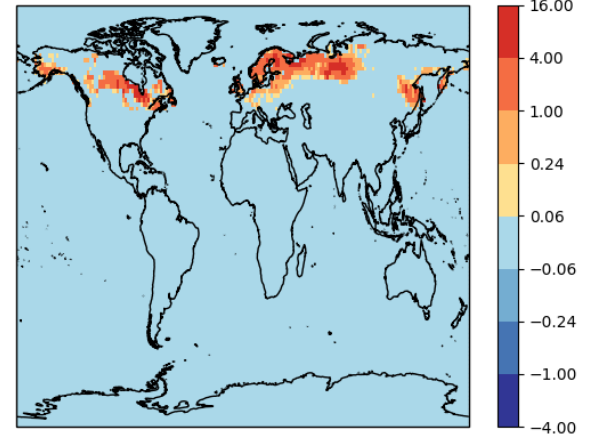
- Developed new process-based model for lake emissions of CH₄
- Model embedded in the physical Canadian Small Lake Model (CSLM)
- Calculates CH₄ concentration in water column and ebullition and diffusion fluxes
- Model evaluated for individual lakes



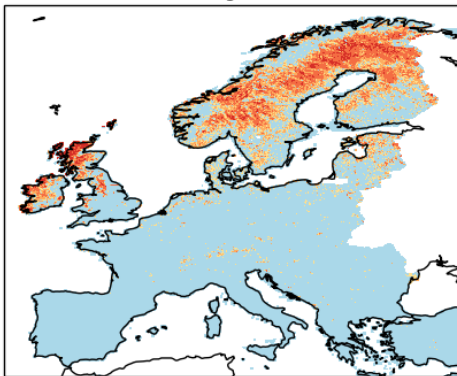
T4.1.3. Natural fluxes of CH₄: Peatlands and mineral soils (FMI)

- Global model simulation of mineral and peat soil fluxes at 1.875° and daily resolution using JSBACH with CRU-JRA2.1 climate data for 2005 to 2019
- European simulations of peat and mineral soil fluxes using the coupled JSBACH-HIMMELI model at daily and 0.1° x 0.1° resolution for 2000 to 2018

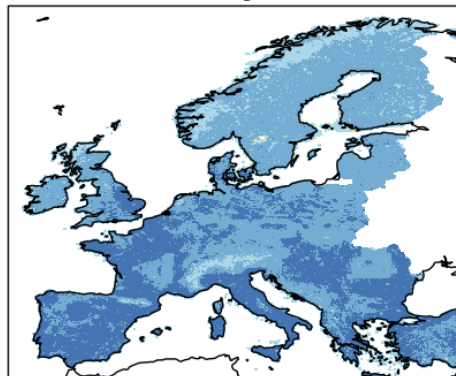
Yearly peatland emissions, g[CH₄]/m²



Peatland flux, (g [CH₄] m⁻² a⁻¹)

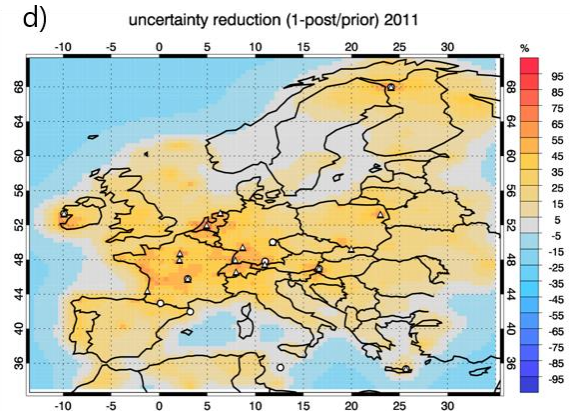
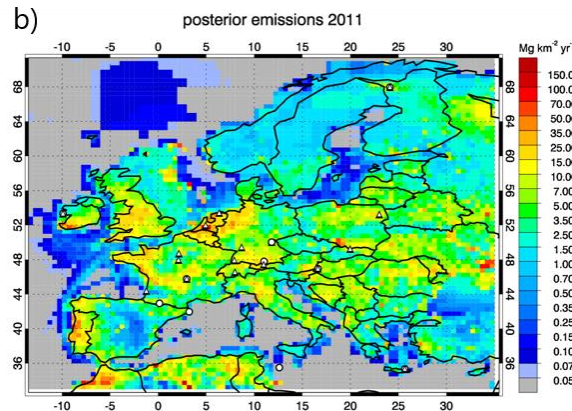
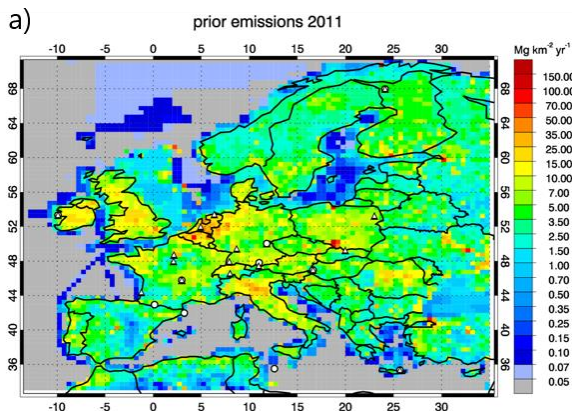
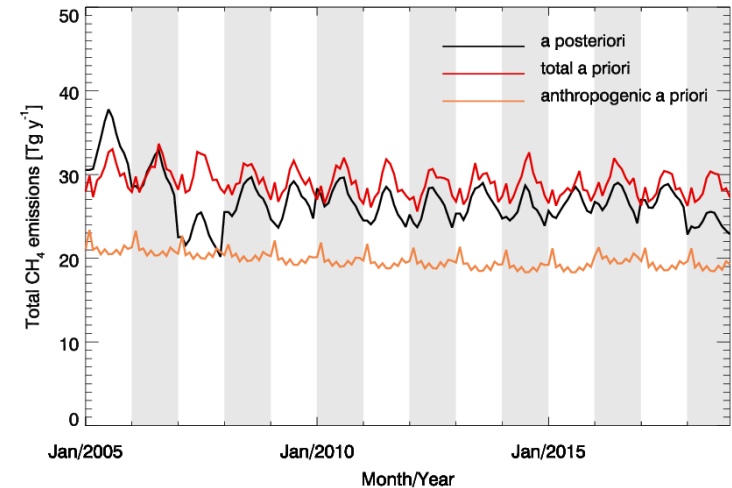


Mineral soil flux, (g [CH₄] m⁻² a⁻¹)



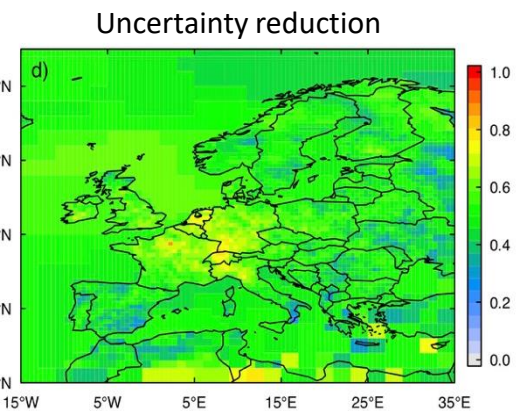
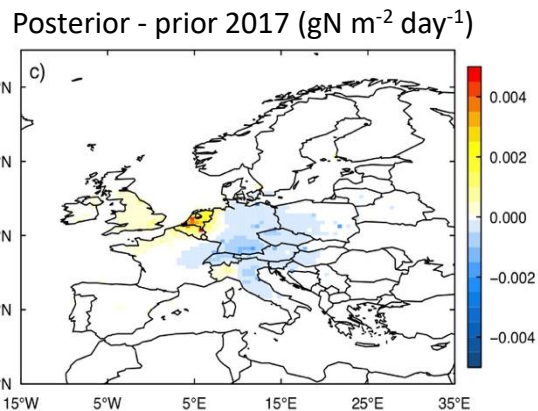
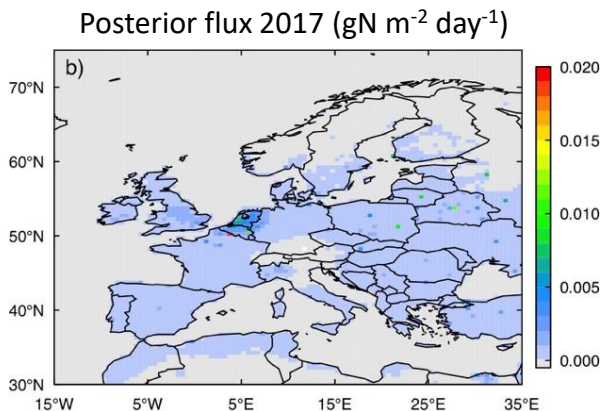
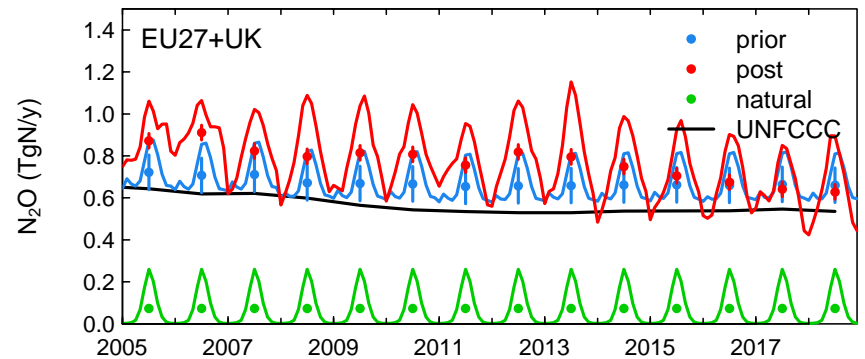
T4.2. Top-down flux estimates of CH₄ (EMPA)

- Atmospheric inversion using FLEXPART-ExKF framework for 2005-2018
- Prior flux estimates for anthropogenic emissions as well as for lakes and peat + mineral soils taken from VERIFY datasets (T4.1)
- Inversion assimilated atmospheric observations at 26 locations in Europe



T4.2. Top-down flux estimates of N₂O (NILU)

- Atmospheric inversion using FLEXINVERT framework for 2005-2018
- Prior flux estimates for anthropogenic emissions taken from VERIFY datasets (T4.1)
- Inversion assimilated atmospheric observations at 18 locations in Europe



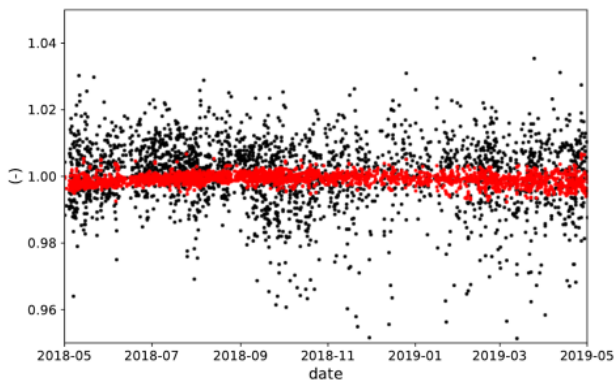


ACHIEVEMENTS : T4.3

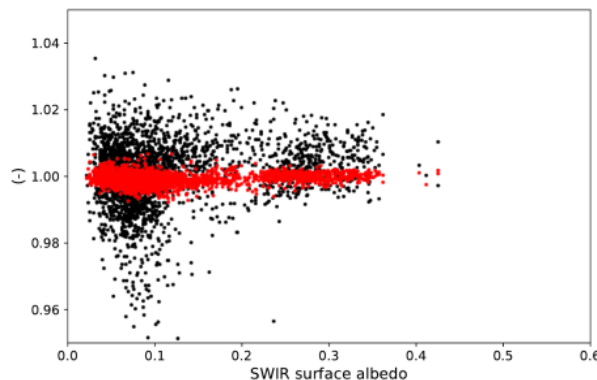
T4.3.1 Error characterization of TROPOMI CH₄ (VUA)

- New TROPOMI instrument on S5P first to use 2.3 micron band thus needs careful error characterization before using in inversions
- TROPOMI column mixing ratios (XCH₄) compared to TCCON global ground-based network for FTIR measurements and to optimized columns of TM5 model (optimized using ground-based measurements in NOAA network)
- Mean difference uncorrected TROPOMI versus TCCON is 0.9 ± 18 ppbv

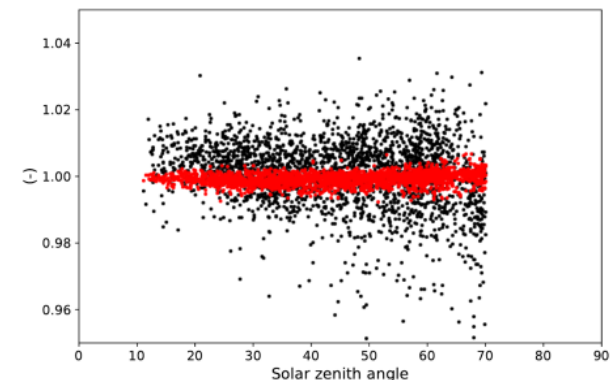
Ratio as function of time



Ratio as function of surface albedo



Ratio as function of solar zenith angle

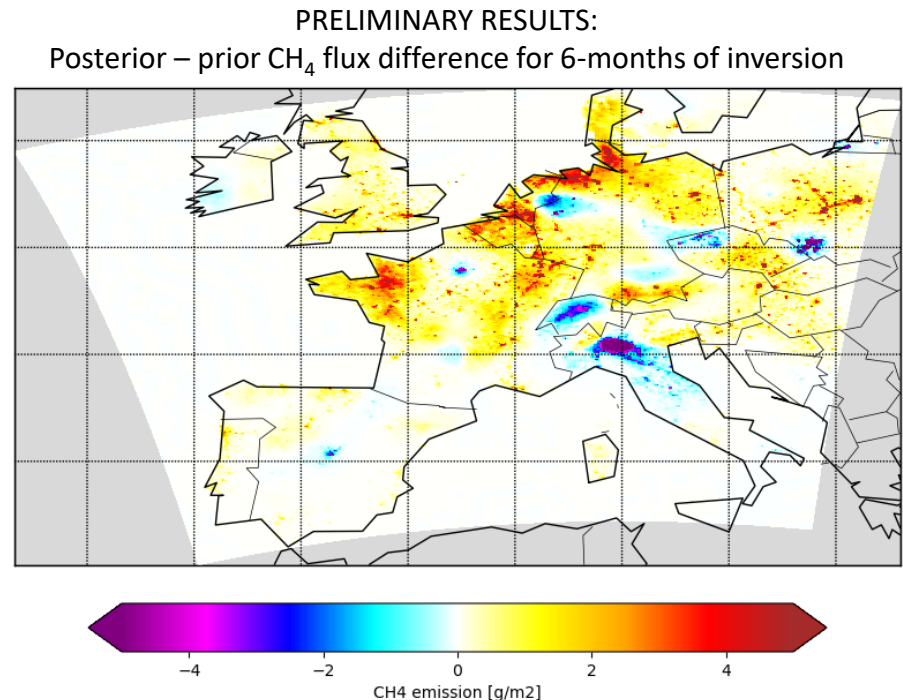


Ratio of XCH₄ from TCCON versus TROPOMI

Ratio of XCH₄ from TM5 as observed by TCCON versus TROPOMI

T4.3.5 Very high-resolution inversions of CH₄ (EMPA)

- New framework developed using the regional Lagrangian model (FLEXPART-COSMO) and a global model (TM5) to provide boundary conditions
- Inversion algorithm used is 4D-VAR
- Inversions run for 2018 at 7 x 7 km over Europe using observations from ICOS
- Includes optimization of inversion parameters (amplitude and correlation scale lengths) of prior and observation covariance matrices using maximum-likelihood approach





WP4 Summary and Conclusions

- Updated BU estimates of CH₄ and N₂O emissions from anthropogenic sources to 2018
- Updated BU estimates of CH₄ from peat and mineral soils to 2018
- Development of process-based model for CH₄ lake emissions
- Updated TD estimates of CH₄ and N₂O fluxes to 2018
- TROPOMI XCH₄ errors characterized for use in inversions
- Development of very high resolution inversions of CH₄ using FLEXPART-COSMO and TM5



Thank you for your attention.



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