VERIFY: Observation-based system for monitoring and verification of greenhouse gas fluxes

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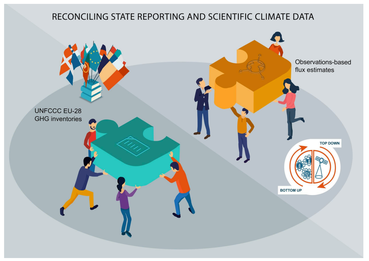
Objectives: A pre-operational system to support national GHG inventories

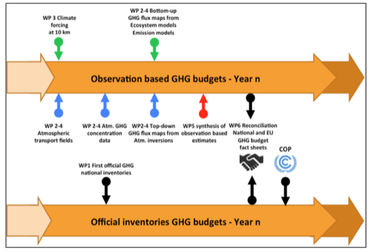
➢ INTEGRATE EFFORTS between the research community, national inventory compilers, operational centers, international organizations.



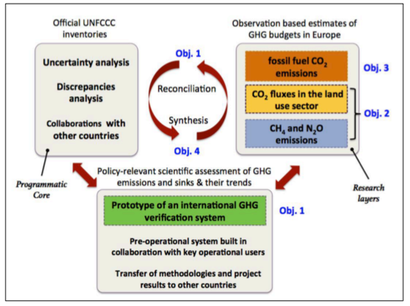
➢ ENHANCE current observation & modeling abilities.

➢ DEVELOP NEW research approaches to monitor anthropogenic GHG fluxes.

➢ PRODUCE annual synthesis of national GHG balance in Europe.



Project structure



Method: Observation-based system to estimate GHG fluxes (for Europe)

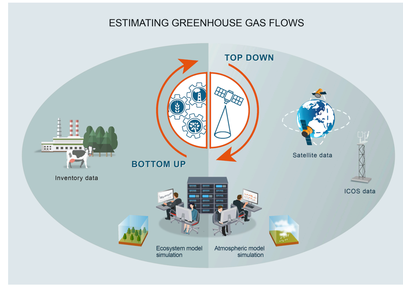
Use of atmospheric & ecosystem measurements (in situ and satellite) with existing modeling systems

➢ Combine complementary approaches including process-based, data-driven, bookkeeping, atmospheric inversions models.

➢ Application with high resolution data over Europe (land cover, meteorology, management, transport)

➢ Apply Data Assimilation to merge information from model and observations

➢ Develop a Community Inversion Framework (CIF)

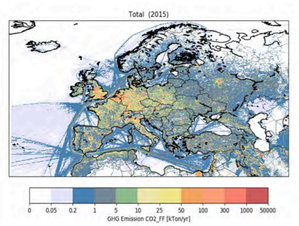


Results: Snapshots of the main results and key messages

CO2 fossil

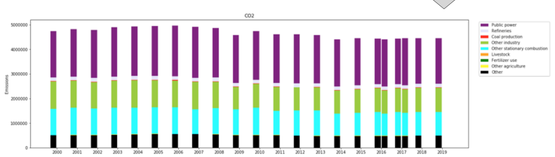
➢ Annual maps of CO_2 fossil fuel emissions at high resolution.

➢ Towards inversion estimates of fossil fuel emissions from atmospheric observations including satellites data .



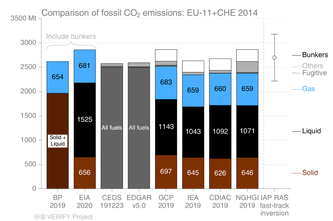
Fossil fuel map at ~6x6 km resolution (also for co-emitted species CO, NOx)

Using emission modelling to complete the timeseries up to the present year as input for inversions
(Note: 2016 and 2017 used for testing)



Time series of CO2 fossil fuel emissions splitted per sectors

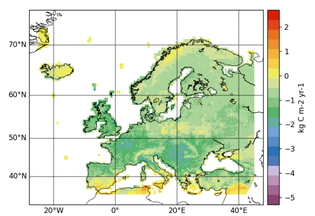
- Fossil CO_2 emissions from 9 sources, including *UNFCCC NGHGI, and a first inversion estimate (IAP RAS).*
- Differences mostly due to different accounting systems
- Understanding is critical for analysis and communication; inversions are still very uncertain and at their infancy.



CO2 land biosphere

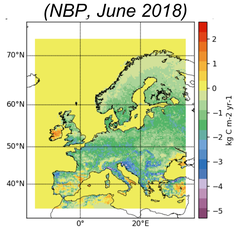
➢ Derive annual land-biosphere CO_2 fluxes: Process-based model at 10 km resolution, statistical bookkeeping and regional inversion ensembles

ORCHIDEE (NBP, June 2018)



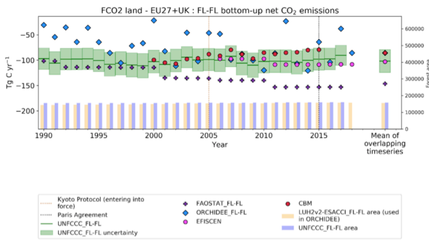
- Inversion shows a generally stronger sink.
- Resolution differences are a key issue between inversions and bottom-up approaches.

Regional inversion (NBP, June 2018)

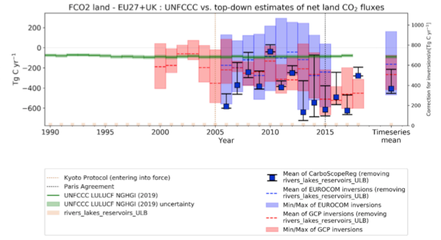


EU27 + UK GHG synthesis

Forest remaining forest (FL - FL) fluxes (UE27+UK)



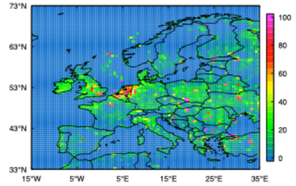
Net land fluxes (EU27+UK)



- Bottom-up models (sector-specific and general ecosystem) vary in terms of interannual variation and agree with National GHG Inventories (NGHGIs) reported to UNFCCC
- Top-down inversions generally indicate stronger sinks compared to NGHGIs, with significant variation between individual members of each ensemble.
- Care must be taken to not apply inversions to too small regions!

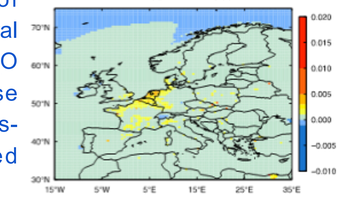
CH4 and N2O

Regional inversion ($mgCH_4/m2/day$)

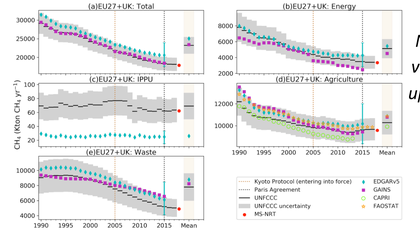


➢ Monthly estimates of anthropogenic & natural sources of CH_4 and N_2O using regional inverse modelling and process- and statistics- based models

Regional inversion ($gN/m2/y$)

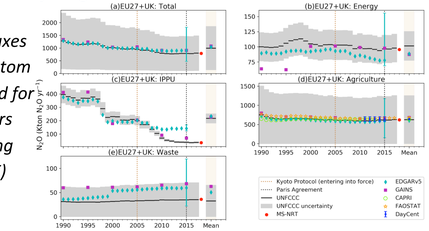


- **CH_4:** Bottom-up estimates larger than UNFCCC NGHGI due to Energy & Waste

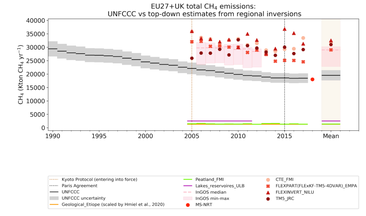


NGHGI fluxes versus bottom up total and for all sectors (excluding LULUCF)

- **N_2O:** Bottom-up estimates in good agreement with NGHGI; but slightly different trends & very large uncertainties.

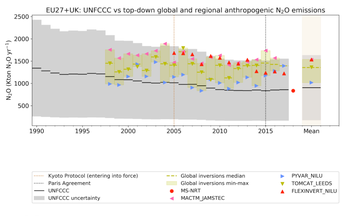


- **CH_4 total** regional inversions larger than total NGHGI emissions, differences due to natural fluxes or underestimation of the anthropogenic fluxes



NGHGI fluxes versus total regional (& global for N_2O) atmospheric inversions

- **N_2O total estimates from** inversions are slightly larger then NGHGI fluxes but within the (very large) uncertainty range.



➢ **Results for all EU countries & groups of countries under: http://webportals.ipsl.jussieu.fr/VERIFY/FactSheets/**