Moving towards a European capacity to monitor anthropogenic / natural CO2 emissions
The CoCO2 and VERIFY European projects

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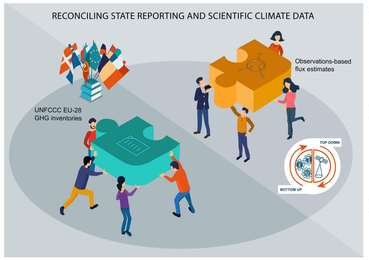
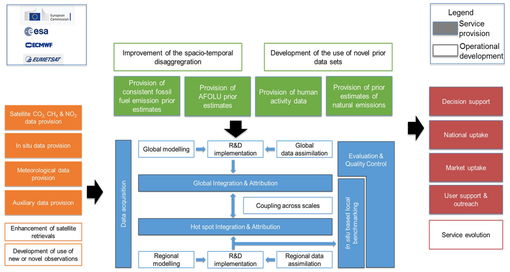
Objectives: An operational system to support national GHG inventories

- INTEGRATE EFFORTS from the research community, national inventory compilers, operational centers, international organizations.



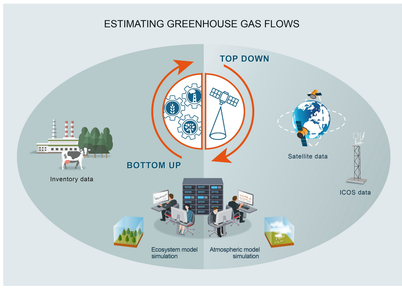
- ENHANCE current observation & modeling abilities.
- DEVELOP NEW research approaches to monitor anthropogenic GHG fluxes.
- PRODUCE annual synthesis of GHG balance in Europe.
- DEVELOP a Copernicus CO_2 Monitoring and Verification Support Capacity (CO2MVS)



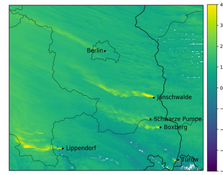
Method: Observation-based system to estimate GHG fluxes

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

- Combine complementary approaches including atmospheric inversions and process-based / data-driven models: global & regional (Europe) applications
- Data Assimilation to merge information from model and observations
- Develop a Community Inversion Framework
- Exploit Anthropogenic Activity Data as demonstrated by carbonmonitor.org



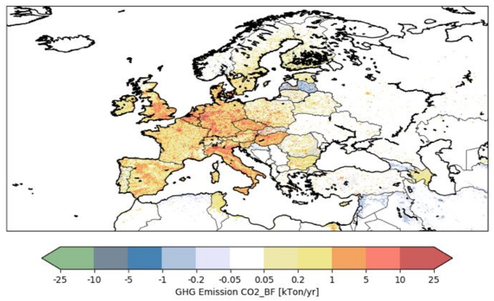
- Develop smart algorithms to estimate emissions from satellite-observed hotspots.



Simulations from ESA SMARTCARB study (EMPA) used for detection/estimation algorithm development.

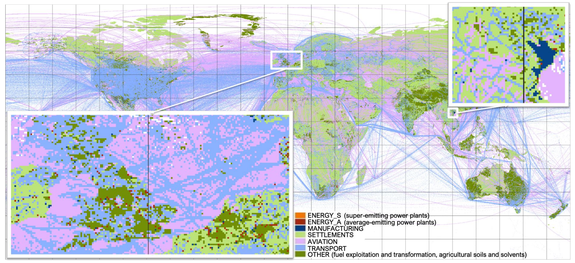
CO2 fossil / biofuel

Change in biofuel emissions from 2005 to 2015



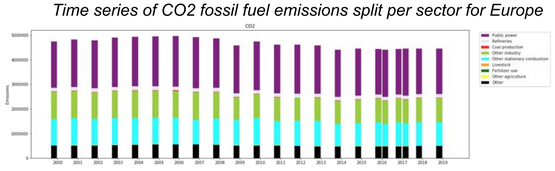
- Large increase in biofuel use in Europe over the past decades.

- Sectoral CO_2 fossil fuel emissions and uncertainties allow attribution from atmospheric inversions. Dominant emissions groups are shown in the figure.

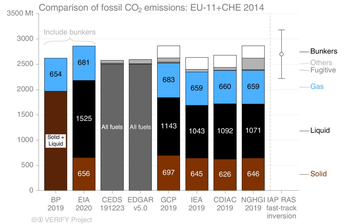


Dominant sector of the CO2 fossil fuel emissions (Choulga et al. 2021) based on EDGAR 4.3.2 global emissions dataset.

Time series of CO2 fossil fuel emissions split per sector for Europe

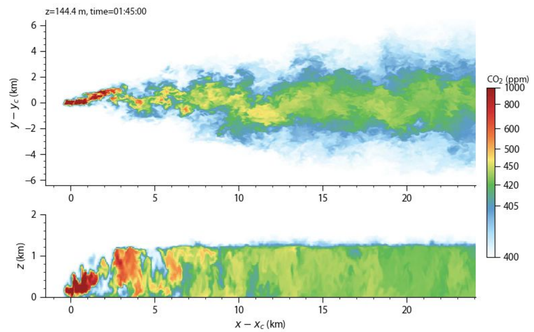


- Fossil CO_2 e
  sources, includ
  NGHGI, and estimate (IAP RAS).
- Differences most different accounting systems: understanding them for further analysis and communication



Inversions are still very uncertain and at their infancy.

- Detailed modelling supports the satellite detection and estimation of emissions from power plants.

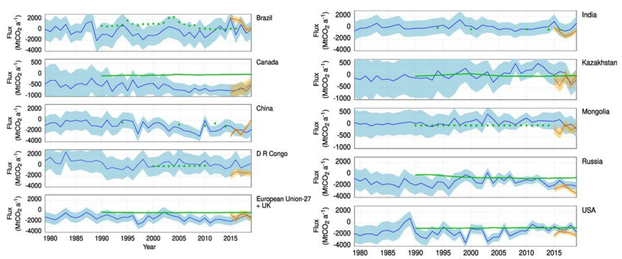


Detailed atmospheric modelling of the behaviour of CO_2 plumes emitted from large power plants. These simulations support a more accurate interpretation of the satellite and in-situ observations of atmospheric CO_2.

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

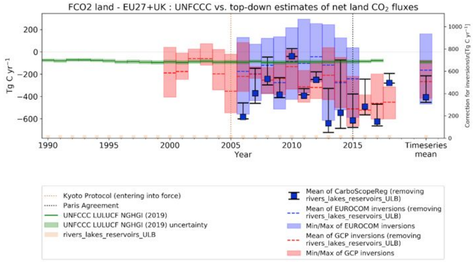
CO2 land biosphere

- **Global**: Inversions (CAMS system) using either in situ surface (blue) or OCO-2 satellite (orange) observations show larger variability compared to National Inventories (green)



Annual CO2 flux from the Agricultural, Forestry and Other Land Use (AFOLU) sector in ten large countries or groups of countries estimated by the 1-σ uncertainty envelope of the two CAMS atmospheric inversions (blue with surface data and orange with satellite-data). Green curve is for the reported fluxes to UNFCCC by all countries. Positive values indicate that the country is a source of CO2 to the atmosphere. Chevallier et al., GRL, 2021.

Net land fluxes (EU27 +UK)



- **Above**: Regional (blue) and global (Red) inversions compared to National Inventories (green) for Europe. **Below**: European synthesis of process-based/statistical models, atmospheric inversions and National Inventories.

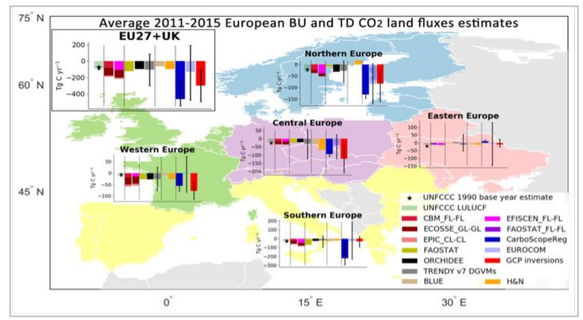
Europe

⇒ Bottom-up models (process-based and data-driven) show large interannual variations but agree with National GHG Inventories (NGHGIs) reported to UNFCCC.

⇒ Top-down inversions generally indicate stronger sinks compared to NGHGIs, with significant variations between individual members of each ensemble.

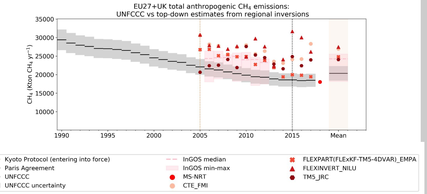
⇒ Care must be taken with inversions for small regions !

(Petrescu et al., ESSD, 2021a)



CH4 anthropogenic

- **CH_4 total** regional inversions (Europe) larger than total NGHGI emissions
- Differences due to underestimated natural fluxes or anthropogenic fluxes *(Petrescu et al. ESSD, 2021b)*



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