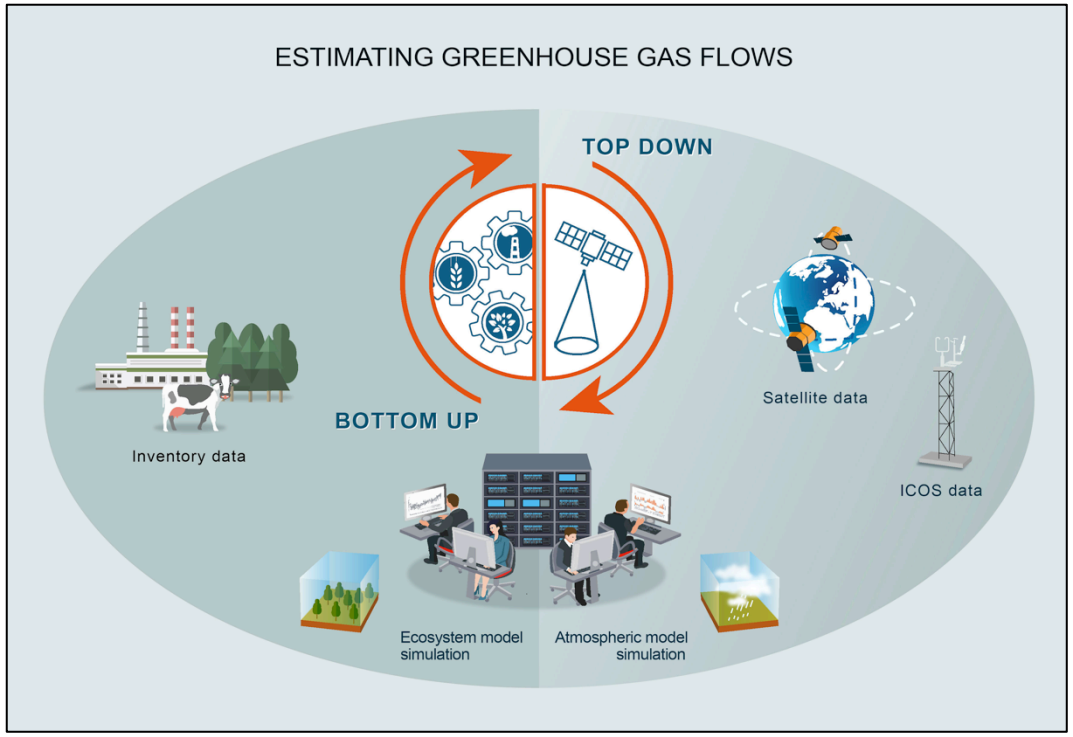
VERIFY:
Observation-based system for monitoring and verification of greenhouse gases

Philippe Peylin (CEA-LSCE) for the VERIFY consortium

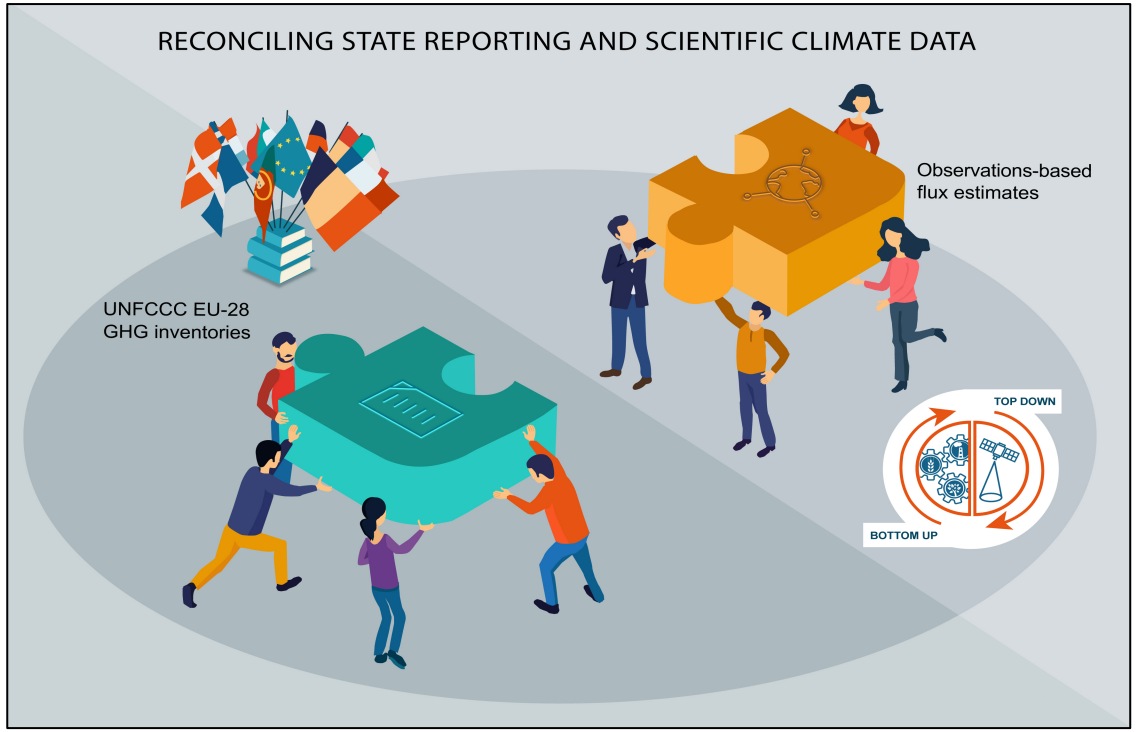
- Consortium of **40 institutes and inventory agencies**
- Period: 4 years (2018 – 2022)

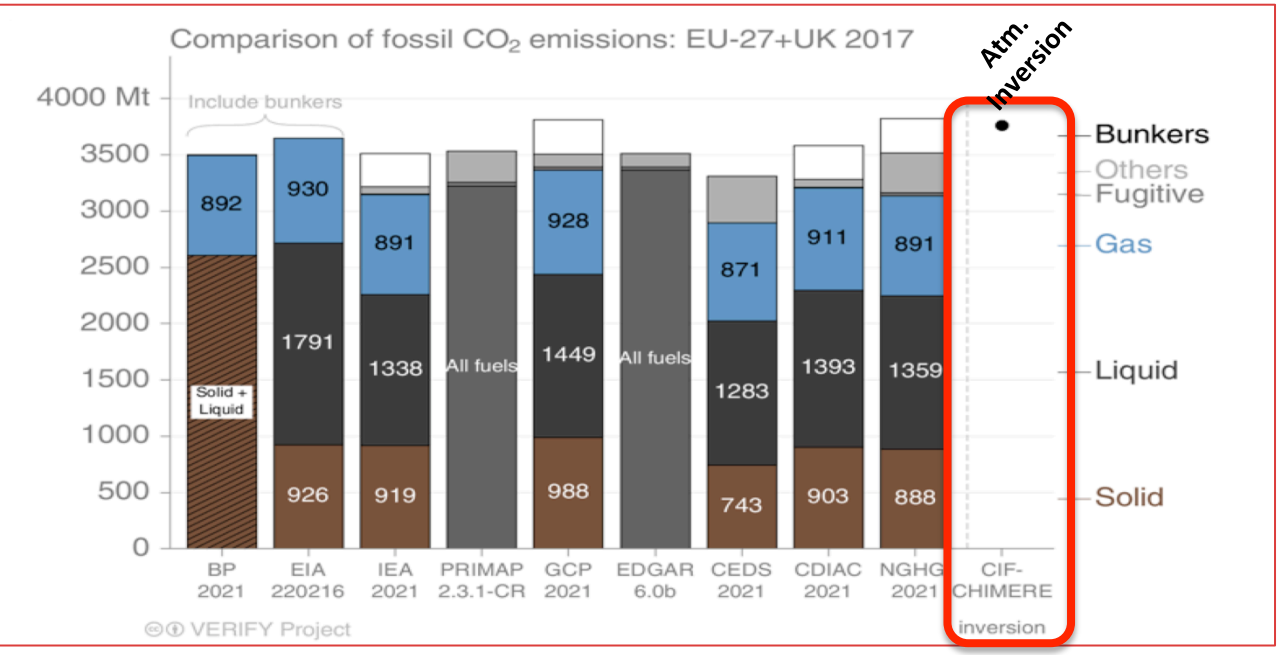
Observation-based system for monitoring and verification of GHG



1) Estimate CO_2 - CH_4 - N_2O GHG fluxes at European country scale from bottom up (models) and top down (inversion) **observation-based approaches**

2) Compare observation-based estimates with the **reported fluxes by each country to UNFCCC on annual basis !**





First synthesis of EU27+UK CO_2 fossil emissions

Fossil CO_2

- Fossil CO_2 emissions from 9 sources *& a first inversion*
- Differences mostly due to different accounting systems
- Inversions are still very uncertain and at their infancy.

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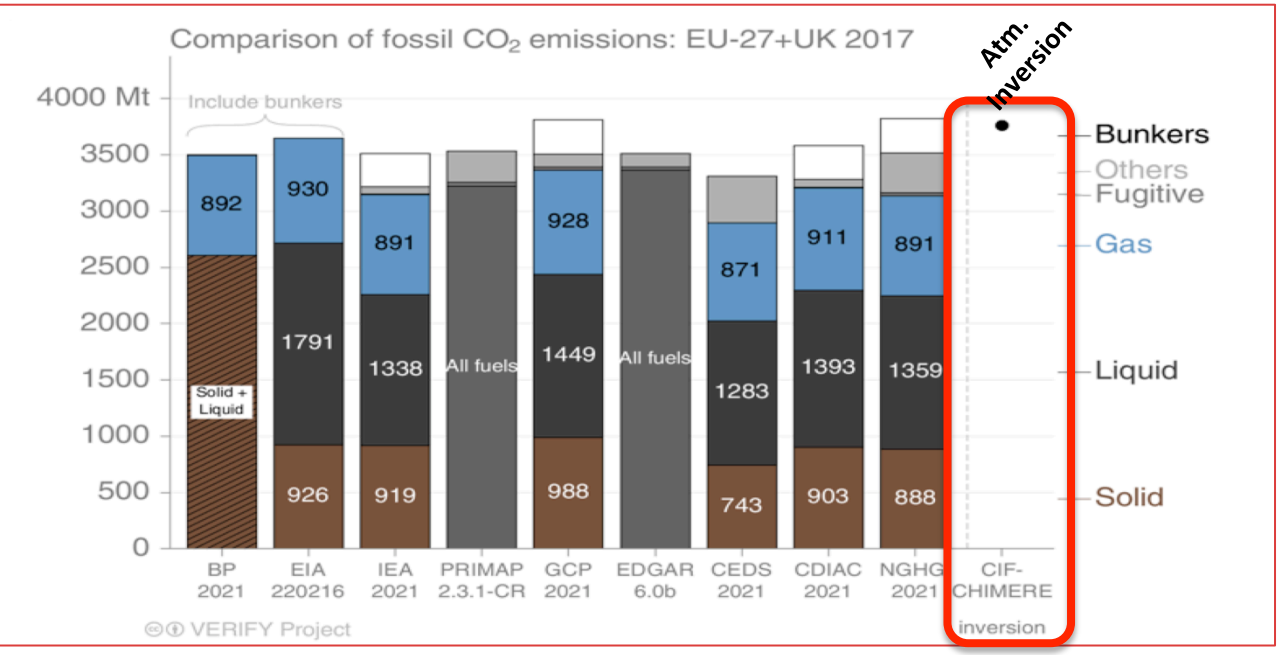

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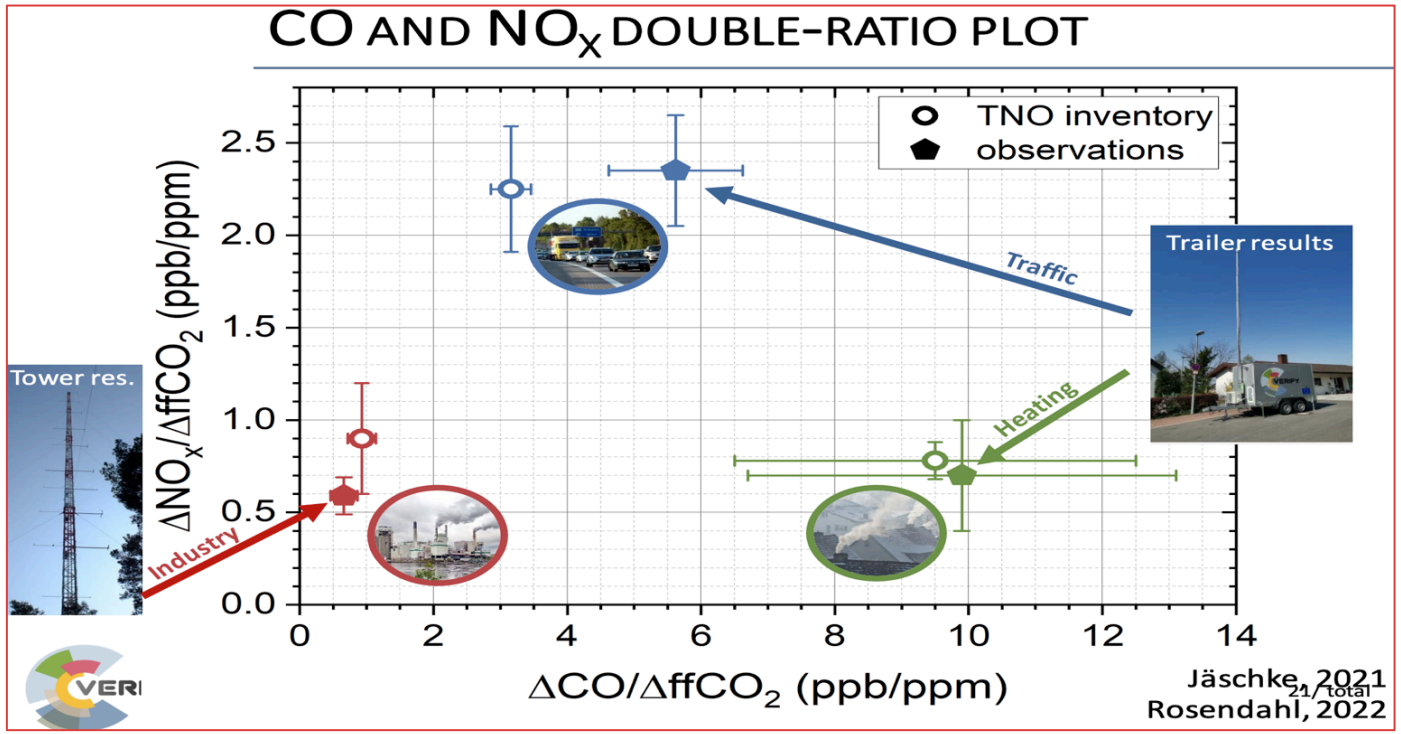
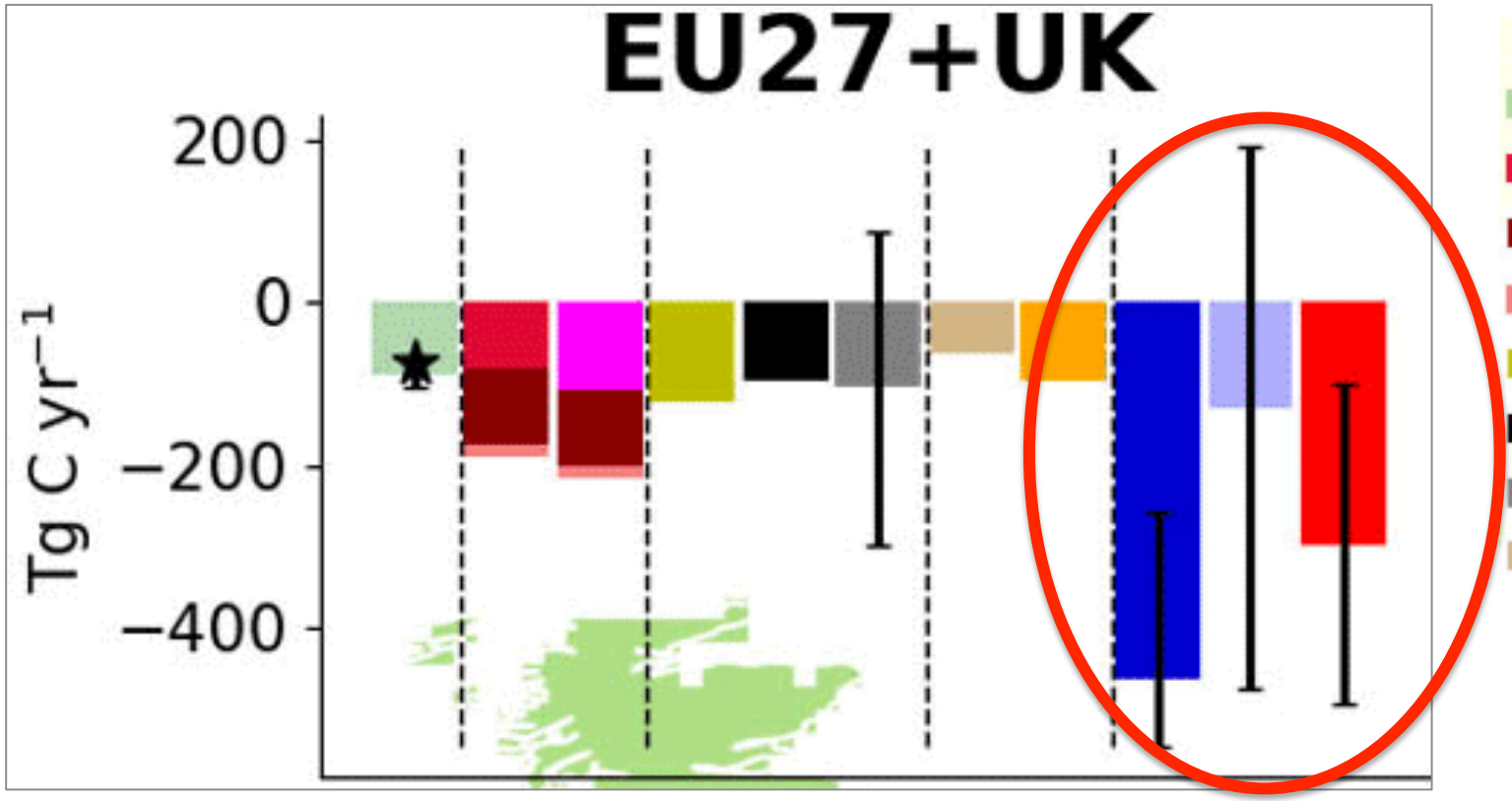


Fossil CO2 inversion

- Based on CO / NOx proxies using prescribed CO2 / Proxy ratios (ex TNO inventory)
- Measured Ratio during 2020 campaign in Rhine valley
  - ➔ Good agreement but small differences may be critical !

Overall CO2 LULUCF fluxes



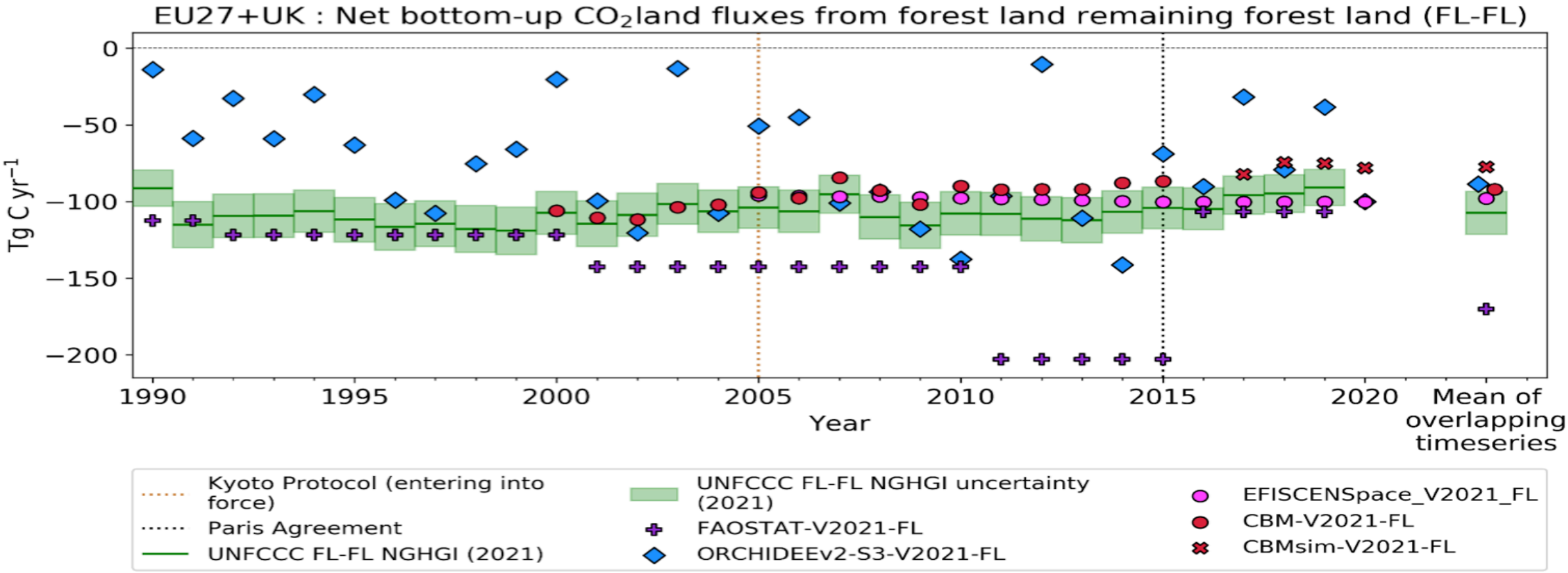
UNFCCC 1990 base year estimate
UNFCCC LULUCF
CBM_FL-FL
ECOSSE_GL-GL
EPIC_CL-CL
FAOSTAT
ORCHIDEE
TRENDY v7 DGVMs
BLUE
EFISCEN_FL-FL
FAOSTAT_FL-FL
CarboScopeReg
EUROCOM
GCP inversions
H&N

UNFCC
Sectorial models
FAOSTAT Process models
Bookkeeping models
Inversions ensembles

➔ Inversions tend to show a larger sink !

Petrescu et al. 2021

CO2 land : forest remaining forest



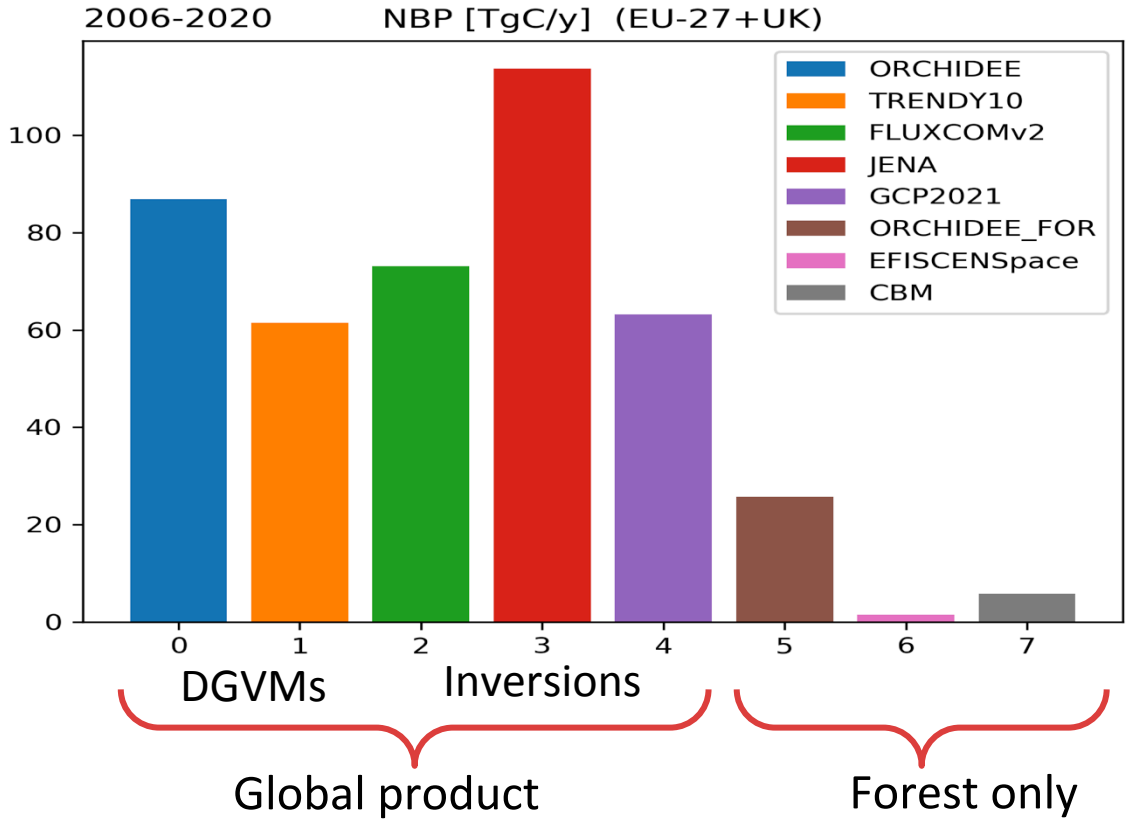
- **Potential effect of forest area differences (CBM vs EFISCEN)**
- **ORCHIDEE high resolution (10 km) has a much larger yearly variability !**

CO2 LULUCF flux variability

➢ **Is the large yearly variability of DGVM models robust ?**

IAV (standard deviation of yearly mean fluxes)

EU 28

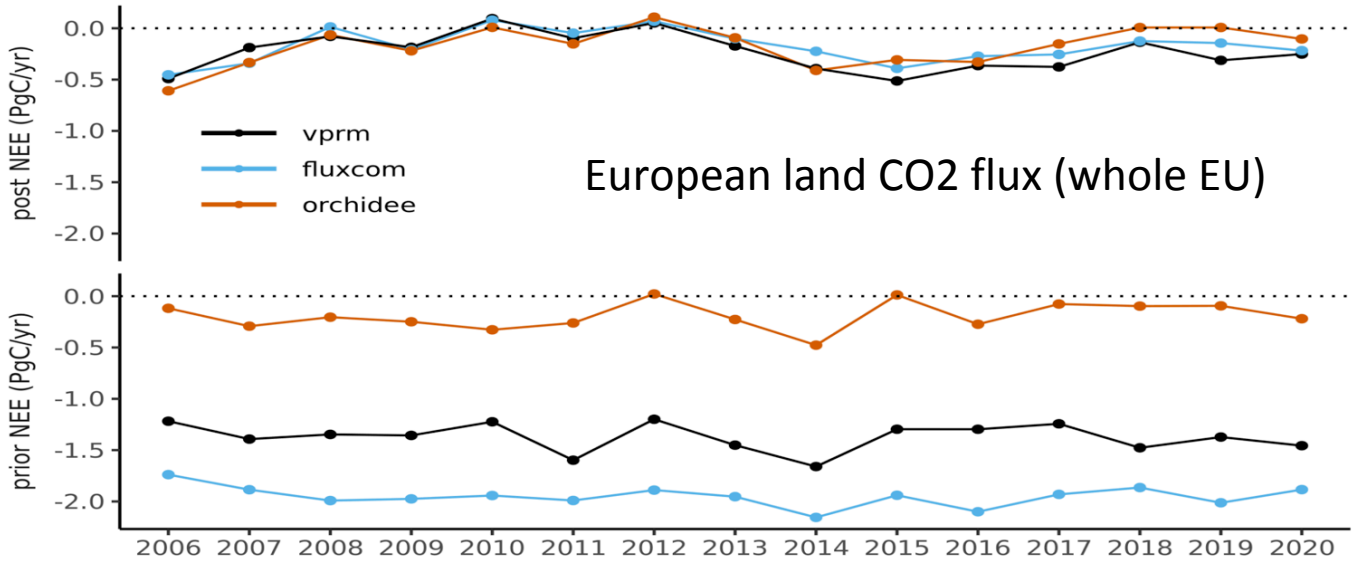


➔ DGVMs and inversions show much larger variability than « forest – data driven models »

➔ Should be taken into account when comparing with UNFCCC reported fluxes ? (important for the Global stocktake)

Regional CO2 land flux inversion

- Very promising results with CarboScopeRegional inverse system
- Robust NEE against different prior fluxes



European land CO2 flux (whole EU)

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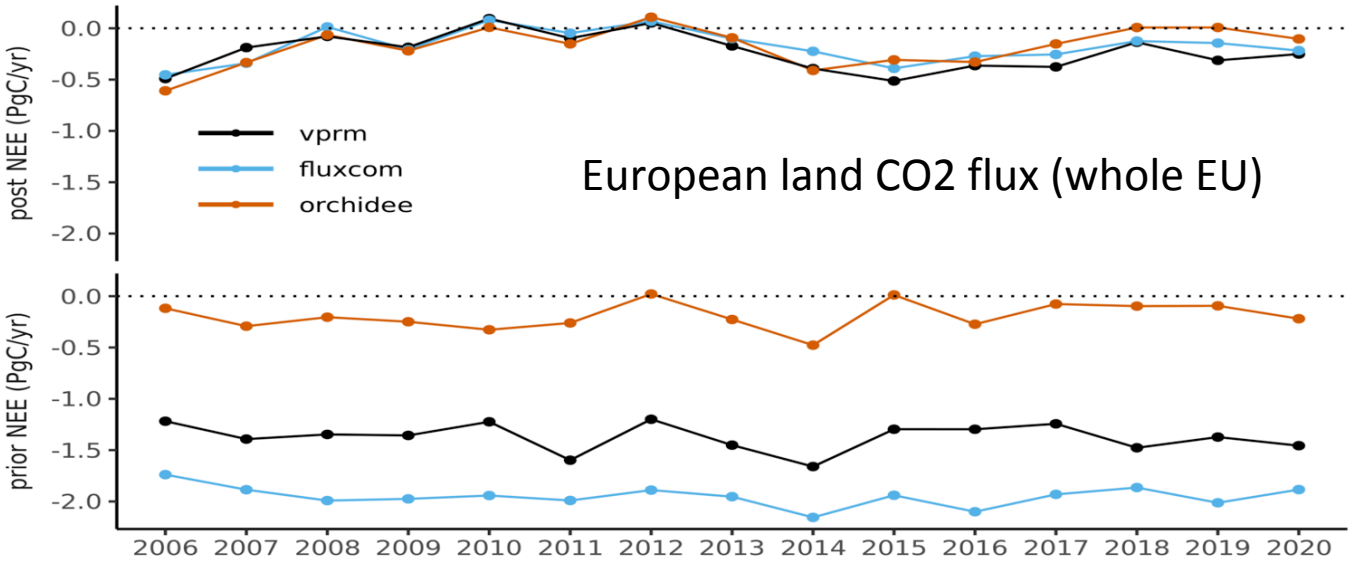
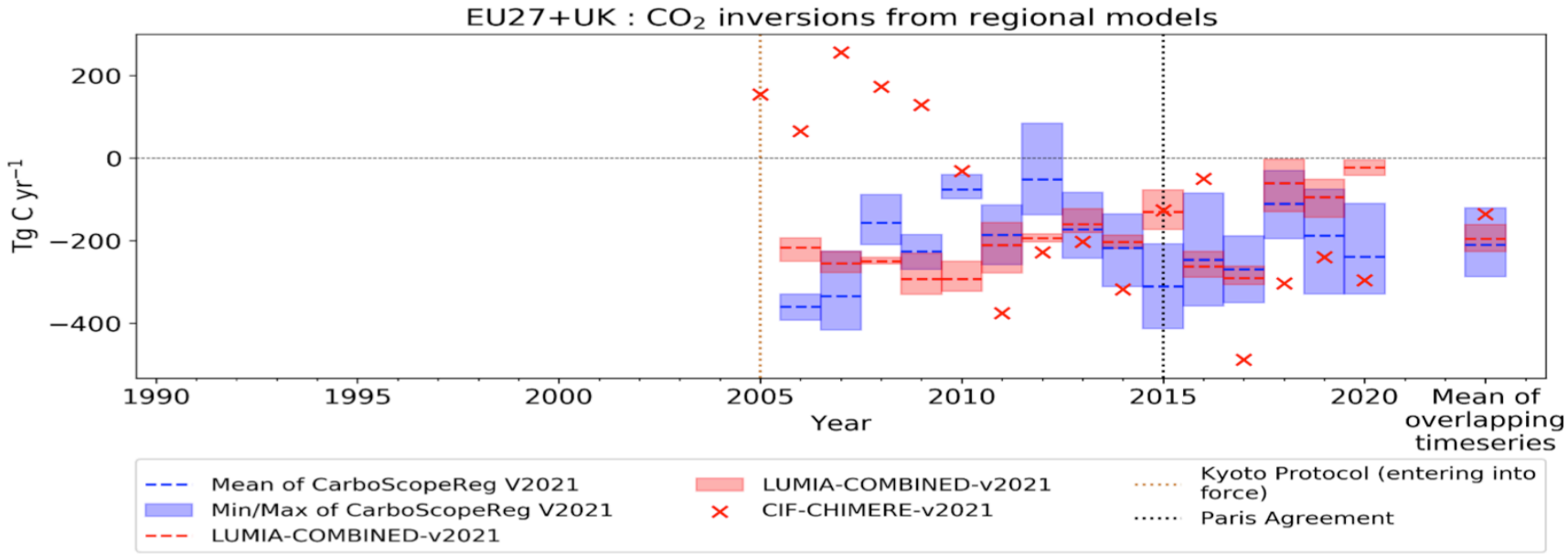
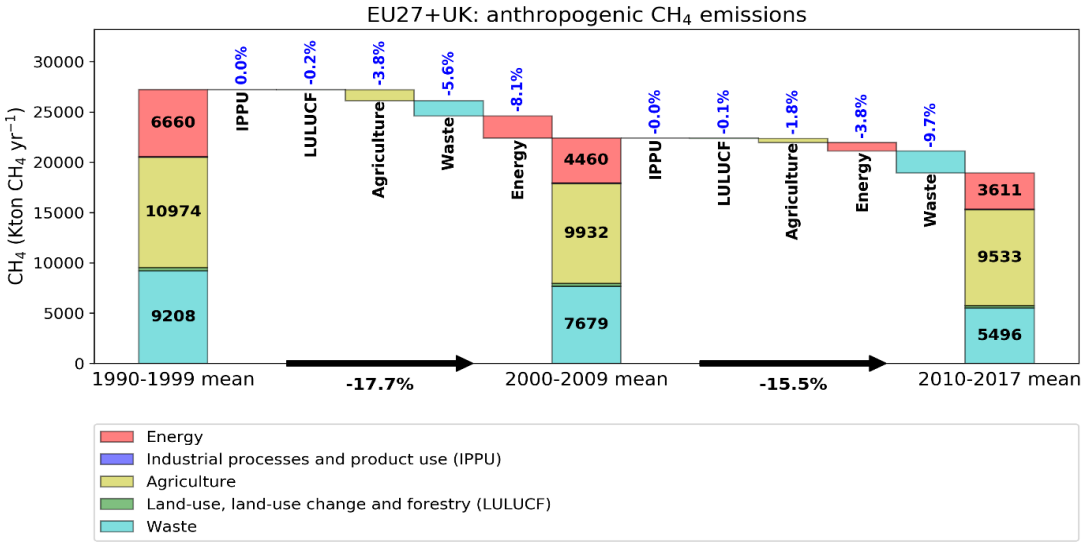


European land CO2 flux (whole EU)

- Comparison with others inversion models (CHIMERE, FLEXPART) show large year to year differences !

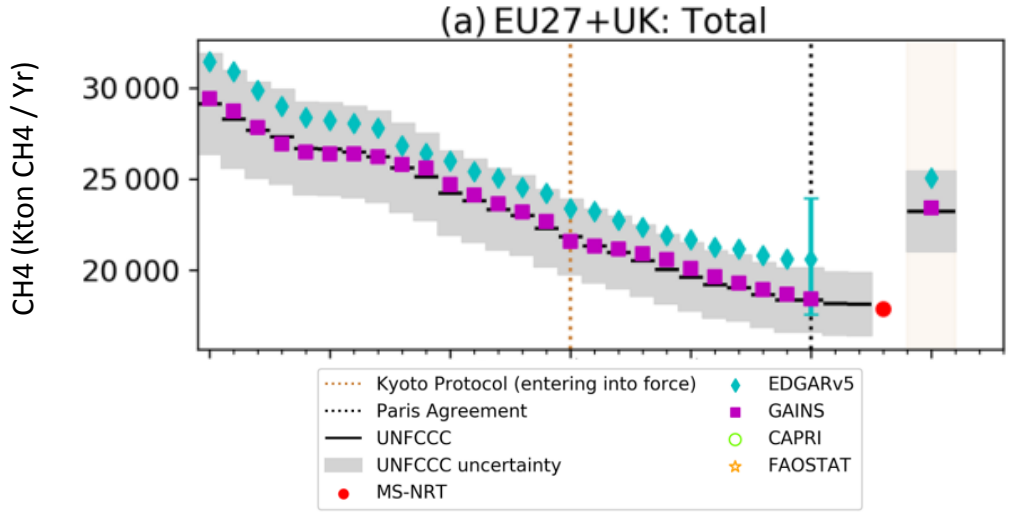


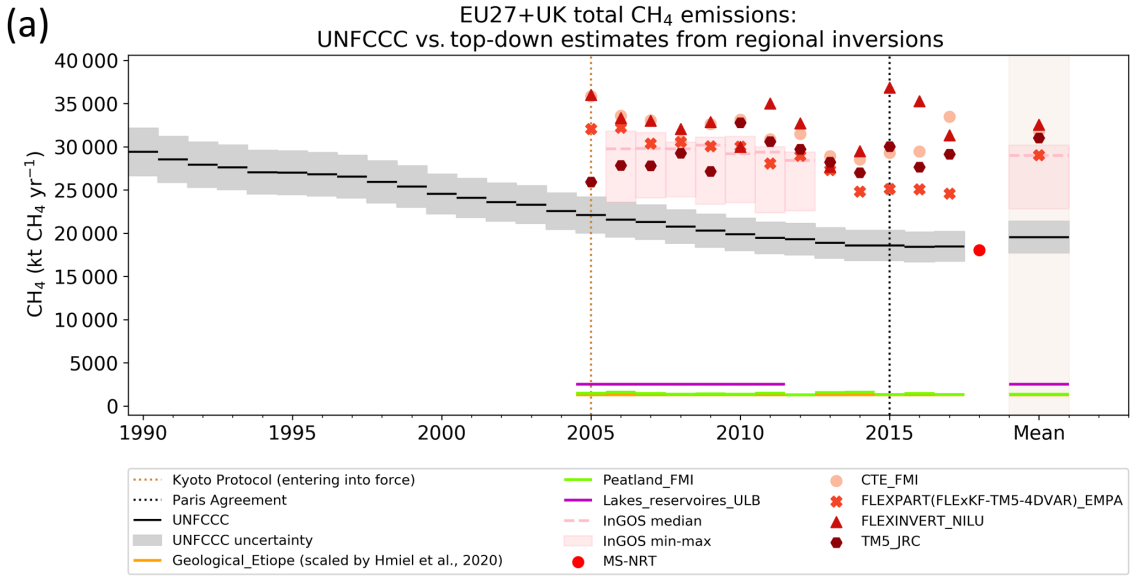
First synthesis of EU27+UK CH_4 anthropogenic fluxes



Contribution of 5 sectors to changes in decadal mean (as reported to UNFCCC)

UNFCCC flux changes compared to bottom up estimates for agriculture and all sectors (excluding LULUCF)

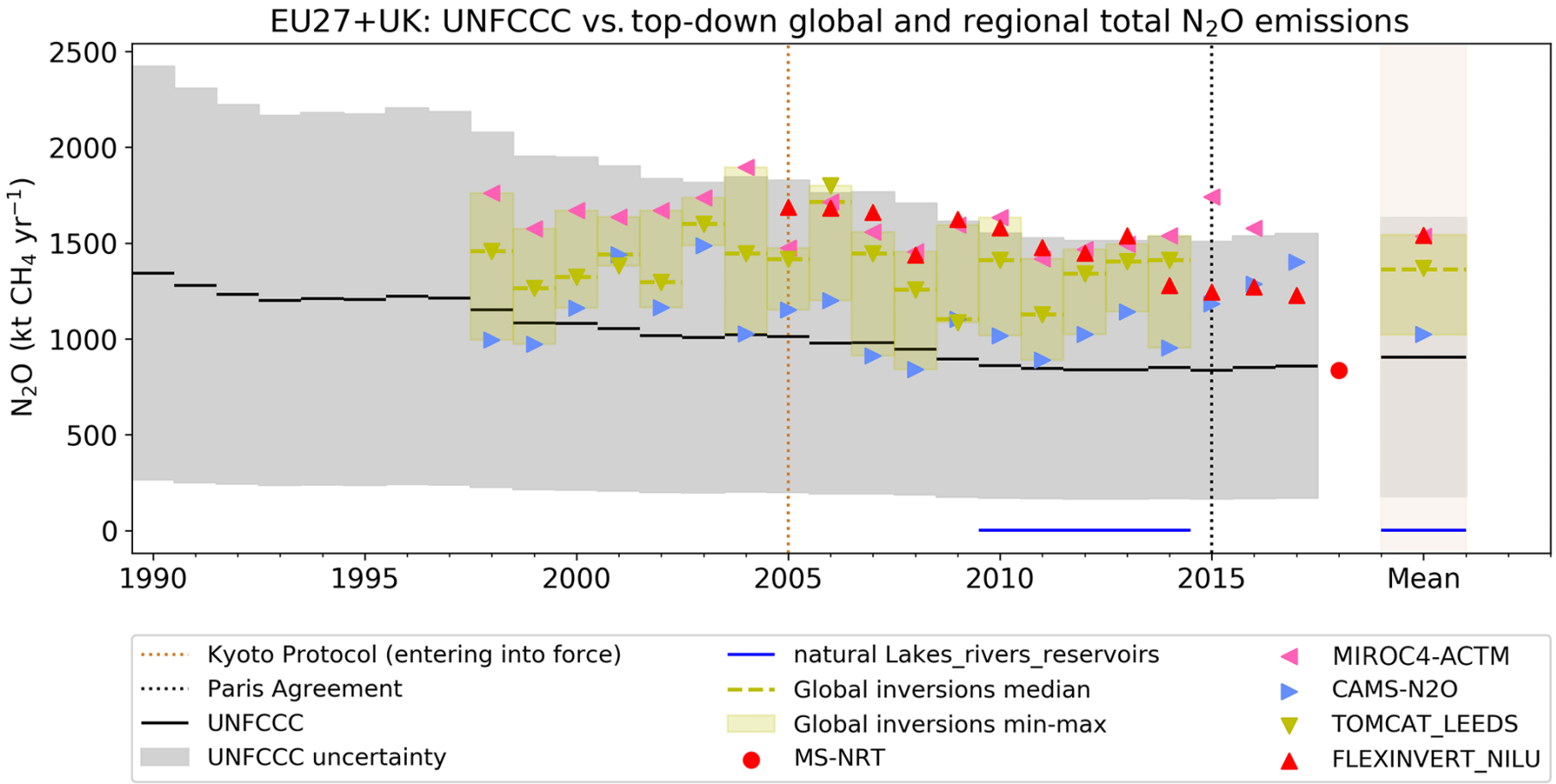




UNFCCC flux changes compared to regional atmospheric CH4 inversions (regional inversions of VERIFY)

Petrescu et al. (ESSD, 2021b)

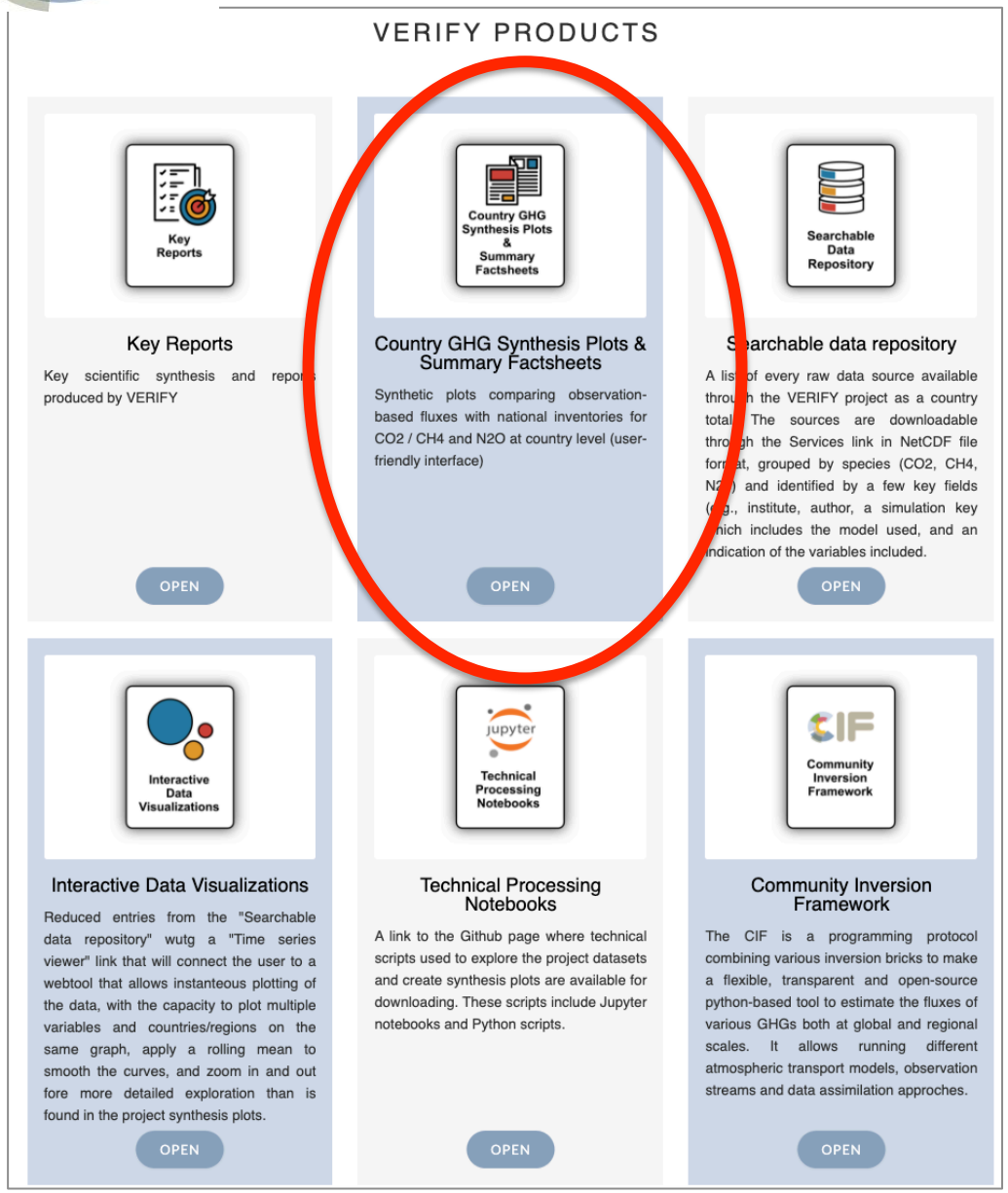
Summary of N20 budget (EU27+UK)



UNFCCC flux changes compared to regional / global atmospheric N2O inversions: Higher emissions from the inversion but within the large UNFCCC uncertainty

Petrescu et al. 2021

Access to all products



From the VERIFY web page:

http://verify.lsce.ipsl.fr/index.php/products

(Free registration)

- Access to all gridded products
- Synthetic plots: GHG time evolution per country, with all estimates
- Key reports and factsheets
- Interactive visualisation tool

Access to all products

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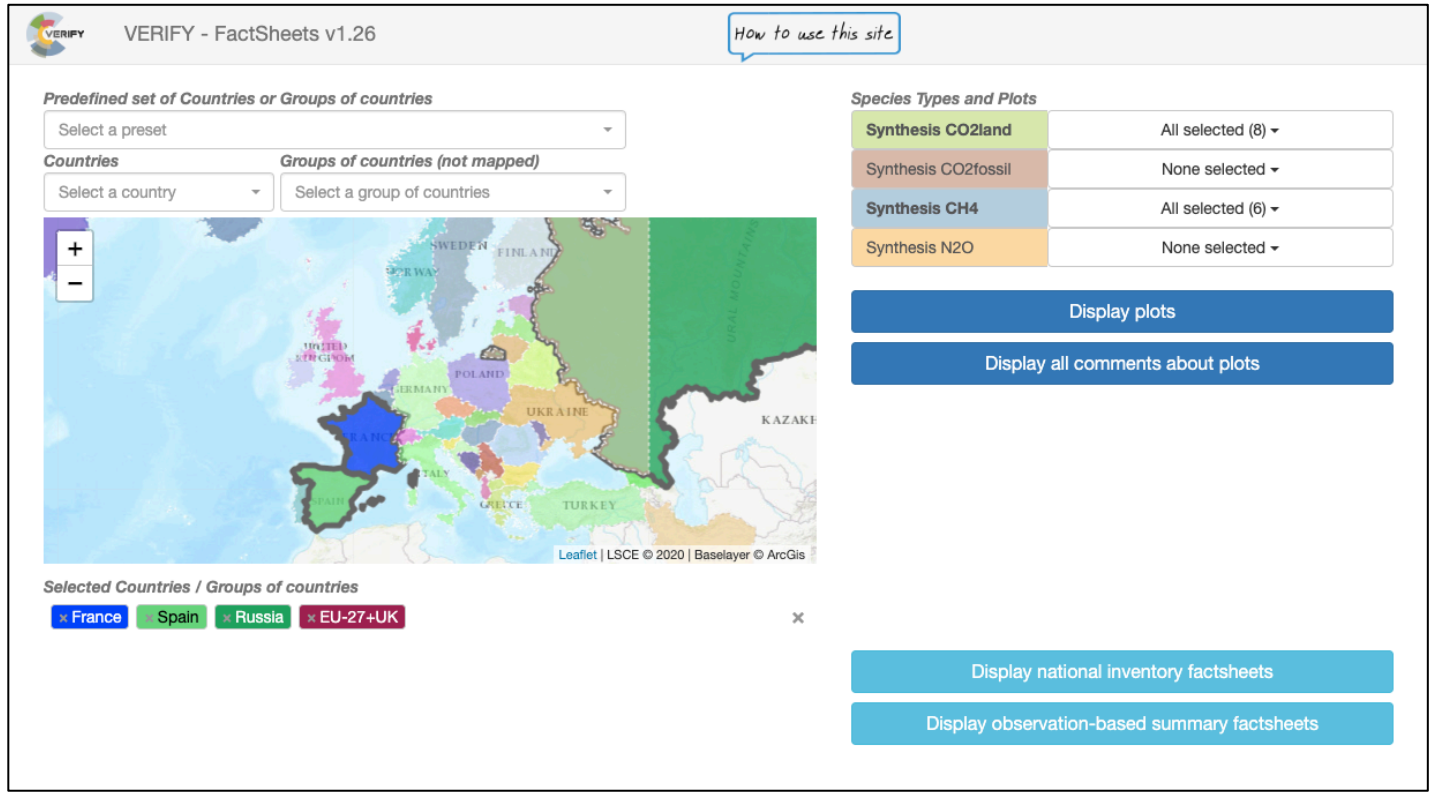
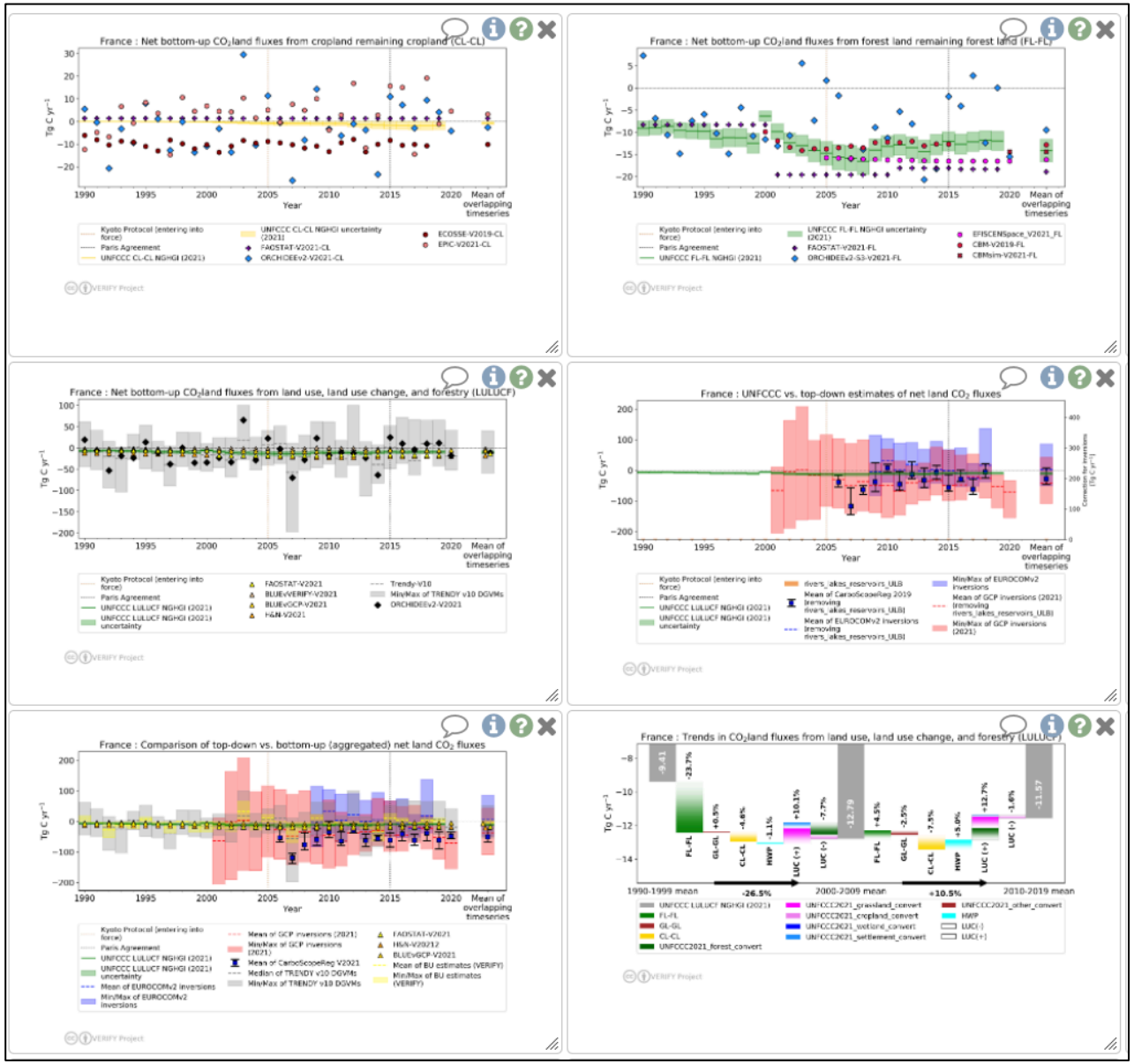
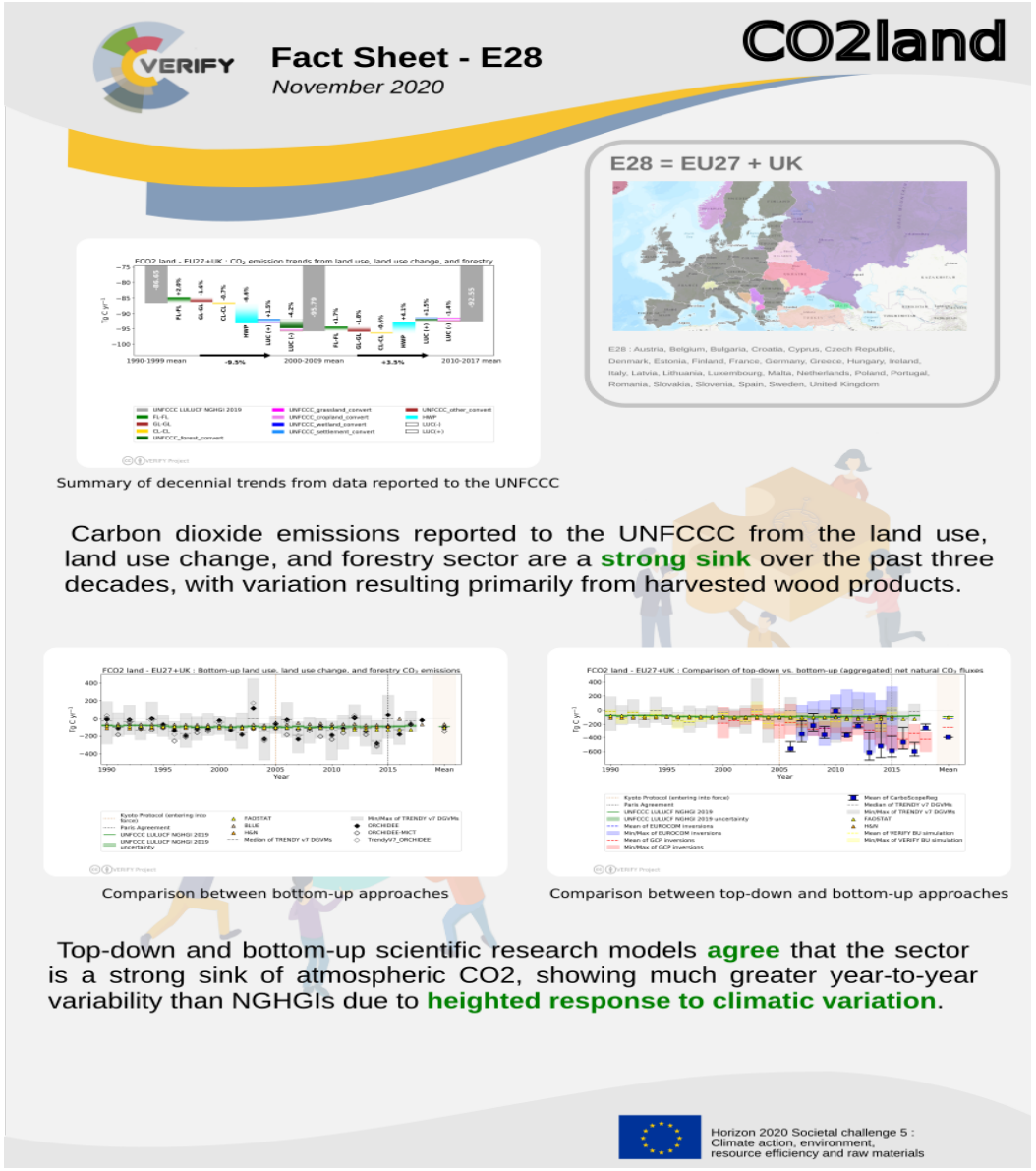


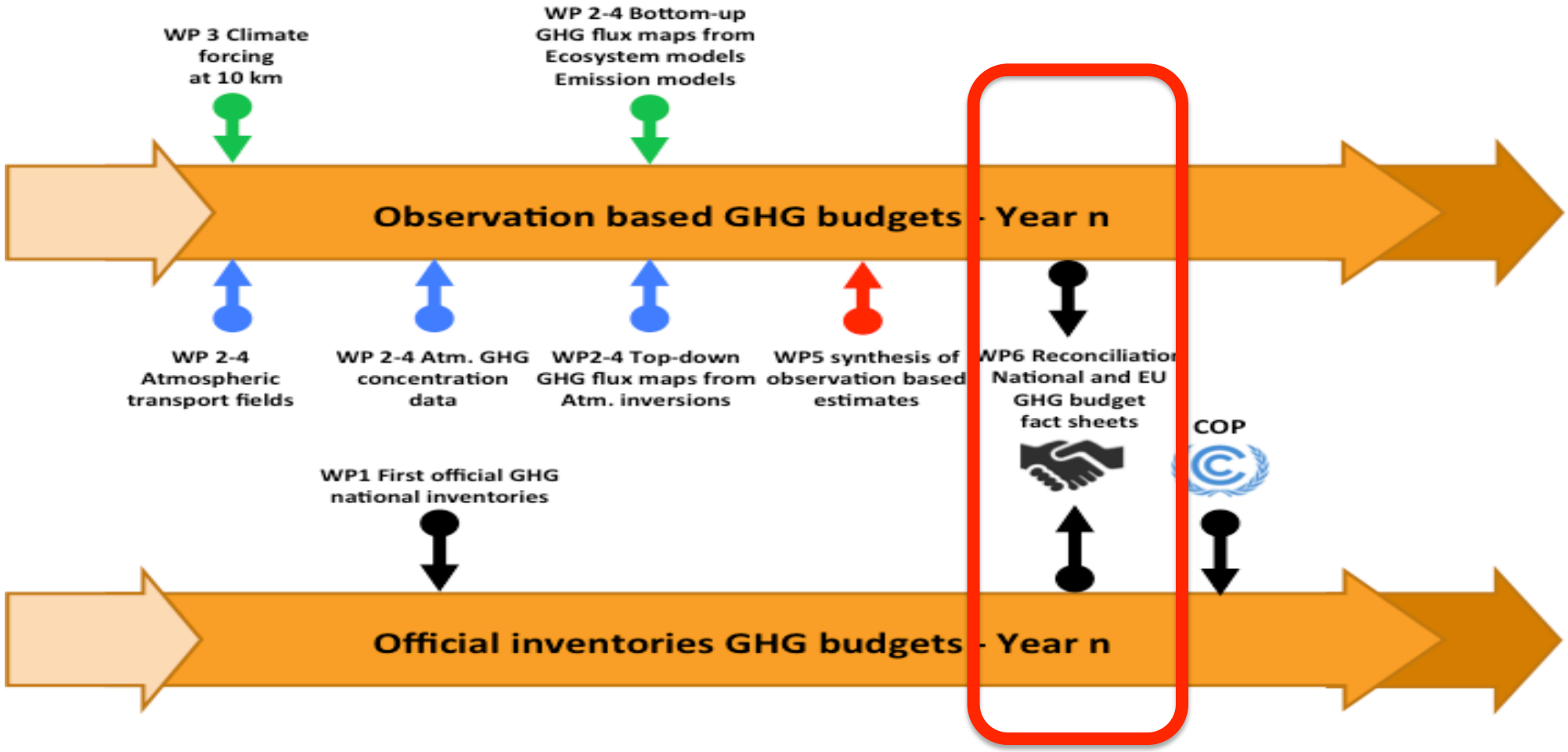
- Selection of countries (groups of) (soon over 160 countries)
- Select GHG type
- Select types of plots
- Display synthesis plots or summary Factsheets

Synthesis plots / Summary factsheets for policy makers





A pre-operational system for yearly GHG estimates



- **<u>Annual updates</u>** of observation-based GHG national budgets and inventories (like GCB)
- Regional changes in GHG budgets and drivers and Uncertainties analysis
- Tracking progress towards EU mitigation targts (Paris Agreement NDCs, stocktake)

Summary – Key messages

- Atmospheric inversions provide substantial information to support Inventory estimates;

  But highly depend on the GHG, region size ; current observation network,…

- CO2fossil: still a huge challenge ahead ! But it will improve with new obs (CO2M, …)
- CO2land: already some important results can be obtained (especially on IAV)
- CH4 & N2O: the most promising given current uncertainties in National Inventories

- Collaboration with National Inventory Agencies is needed / crucial !

  The better the prior flux we get the better the inversion results !