# Impact of using different prior flux products on NEE estimates derived from the Jena Carboscope regional inversion system

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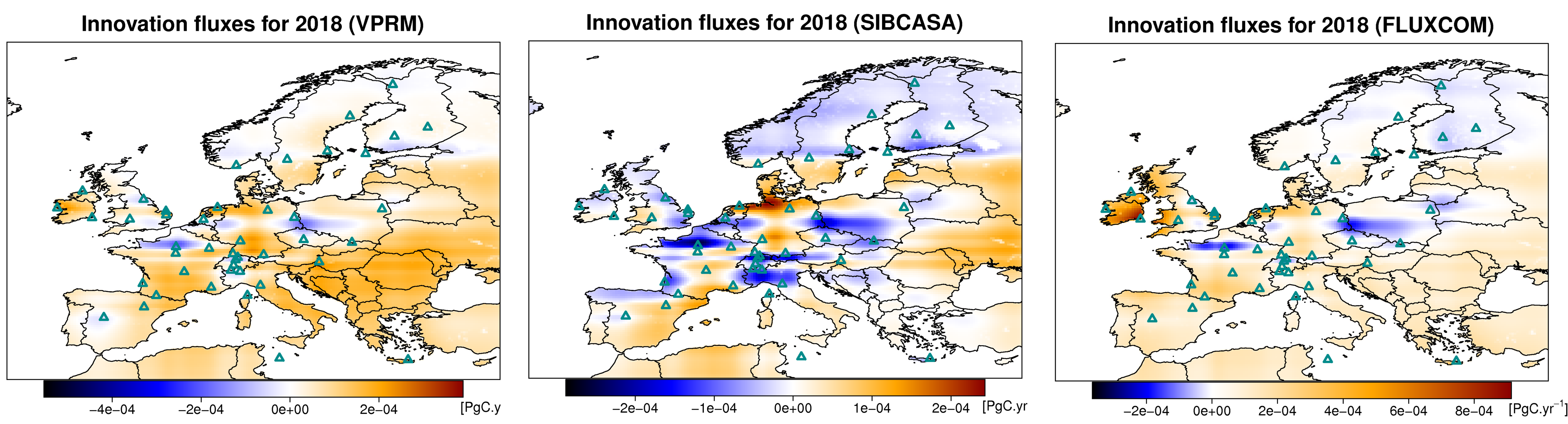
## Introduction

For independent verification of $CO_2$ flux budgets at annual and national scales over Europe, within the research project VERIFY, flux estimates of $CO_2$ have been calculated for the period 2006-2018 using the Jena CarboScope Regional inversion system (CSR). Based on prior knowledge of $CO_2$ fluxes, the NEE is optimized against observational datasets of $CO_2$ dry mole fractions collected through the station network of the Integrated Carbon Observation System (ICOS) across the European domain. To distinguish the impact of using different terrestrial biosphere models on posterior NEE, the Vegetation Photosynthesis and Respiration Model (VPRM), the Simple Biosphere/Carnegie-Ames Standford Approach (SiBCASA), and FLUXCOM model are assimilated in ensemble inversions in the CSR. Moreover, Mikaloff-Fletcher et al. (2007) and Jena CarboScope $pCO_2$-based ocean fluxes are used as various ocean flux models in the ensemble inversions. $CO_2$ national emission inventories are provided from EDGAR_v4.3 and updated based on BP statistics.

Results from the ensemble inversion runs utilizing different terrestrial biosphere models show agreement in the estimated interannual variability (IAV) of NEE, despite a large difference on the prior NEE annual budgets of biosphere models. A much smaller impact is observed when applying different ocean flux models, in particular for regions far inland.

## Results



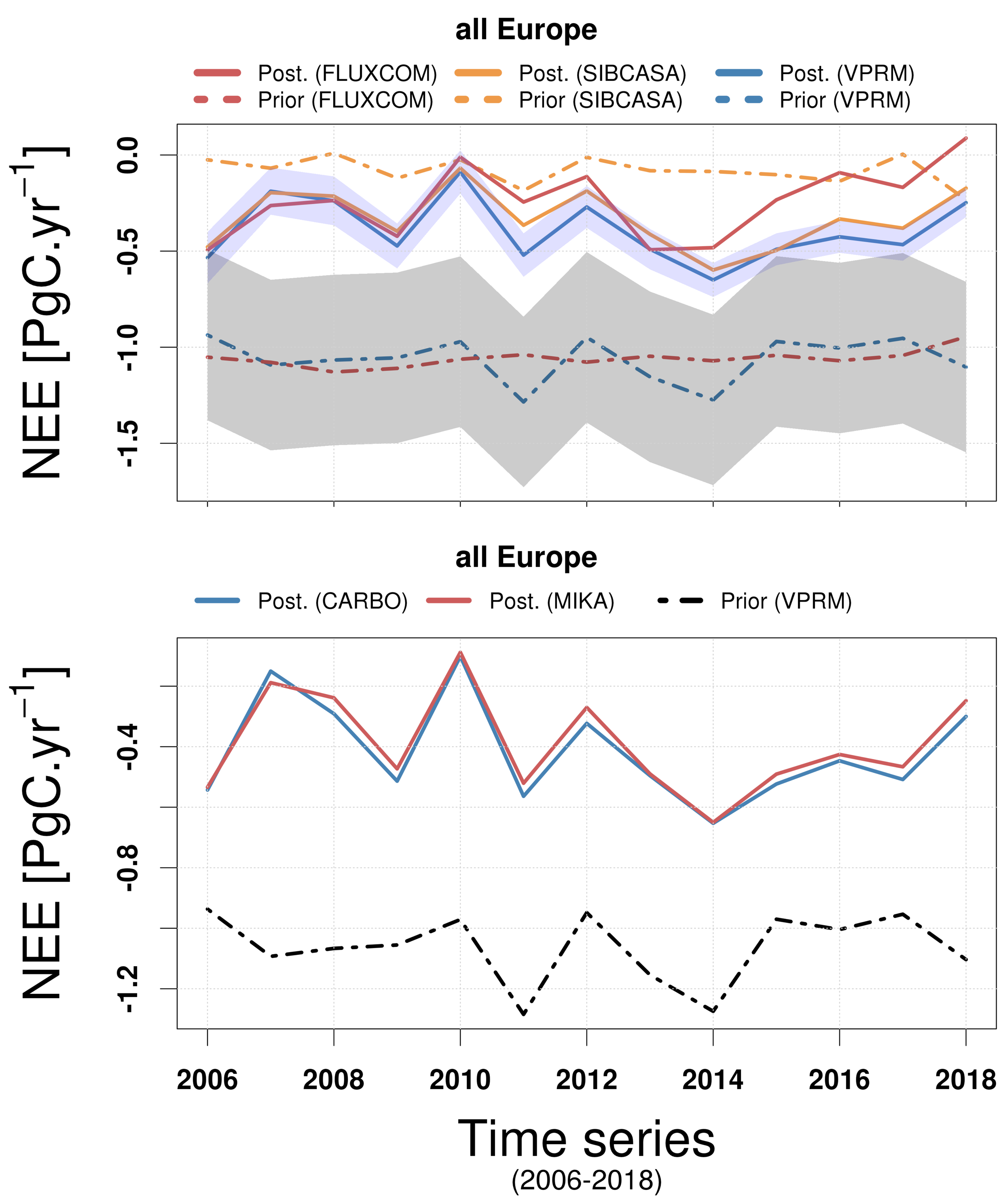
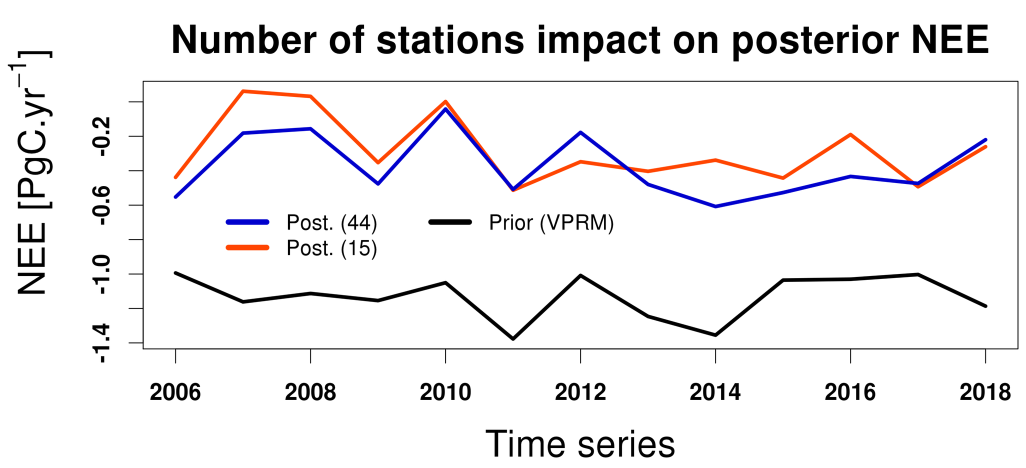




**Figure 1:** Impact of applying various prior flux models of biosphere (above) and ocean (below)

- Innovation of fluxes for 2018 depicted on maps outlines the difference between posterior fluxes and the a-priori calculated from VPRM, SIBCASA, and FLUXCOM models at spatial resolution of 0.5 degree
- IAV of posterior NEE is consistent for all biosphere models despite inconsistency over prior flux models (Figure 1, above); a quite uncertainty reduction realized over the a-posteriori for VPRM (shadow of lines)
- Quite a small impact appears on posterior NEE when using different ocean flux model (Figure 1, below)
- As the main constraint of prior fluxes, observational data have a major impact in estimating posterior fluxes.
- Corresponding figure shows estimated fluxes from two inversion runs assimilating 44 stations (blue line) and 15 stations (red line) across Europe

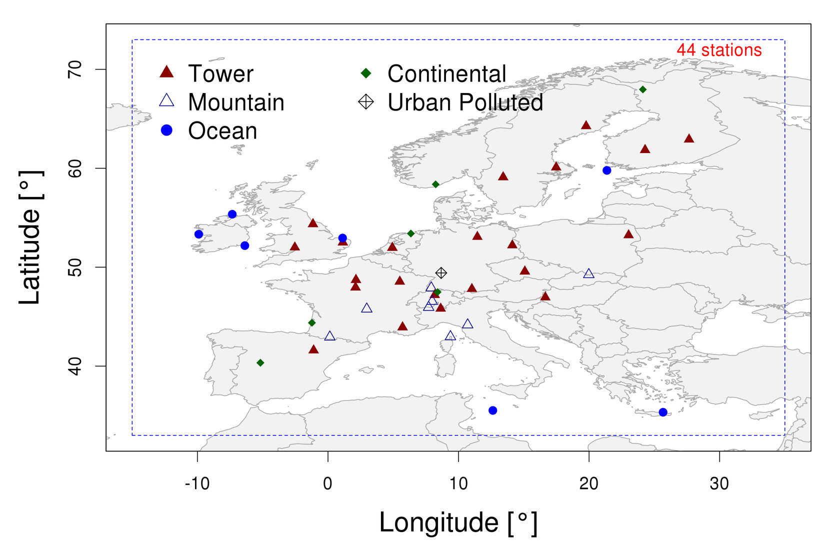


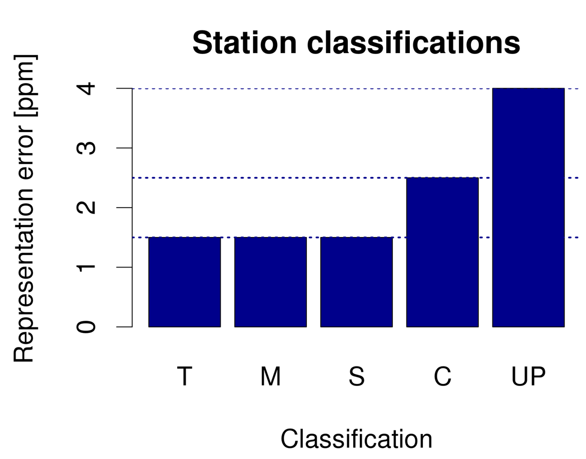

## Observations

### ❐ Station network

Measurements of $CO_2$ dry mole fraction

- 44 stations
- Coverage over the domain of Europe



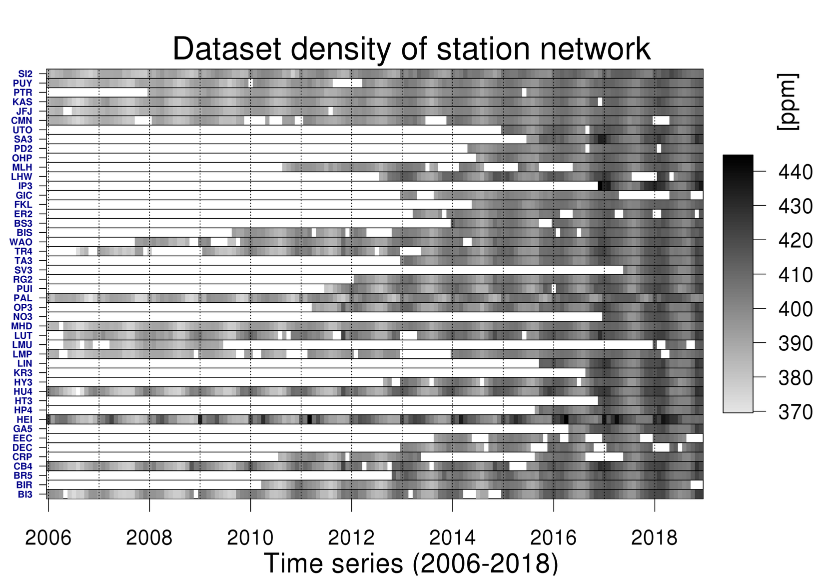

| | |
|---|---|
| T: Tall Tower | M: Mountain |
| S: Ocean | C: Surface |
| UP: Urban Polluted | |

### ❐ Station classifications

The representation uncertainty of atmospheric transport model defined weekly based on station location

### ❐ Data availability

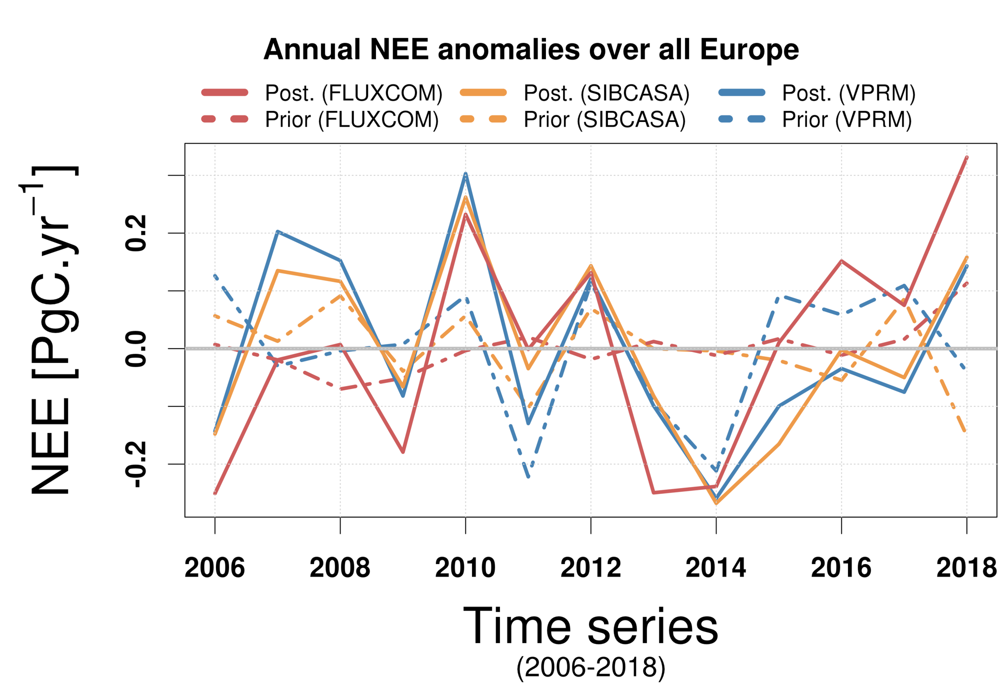
- Measurements from a wide site network being provided by ICOS and pre-ICOS for recent years

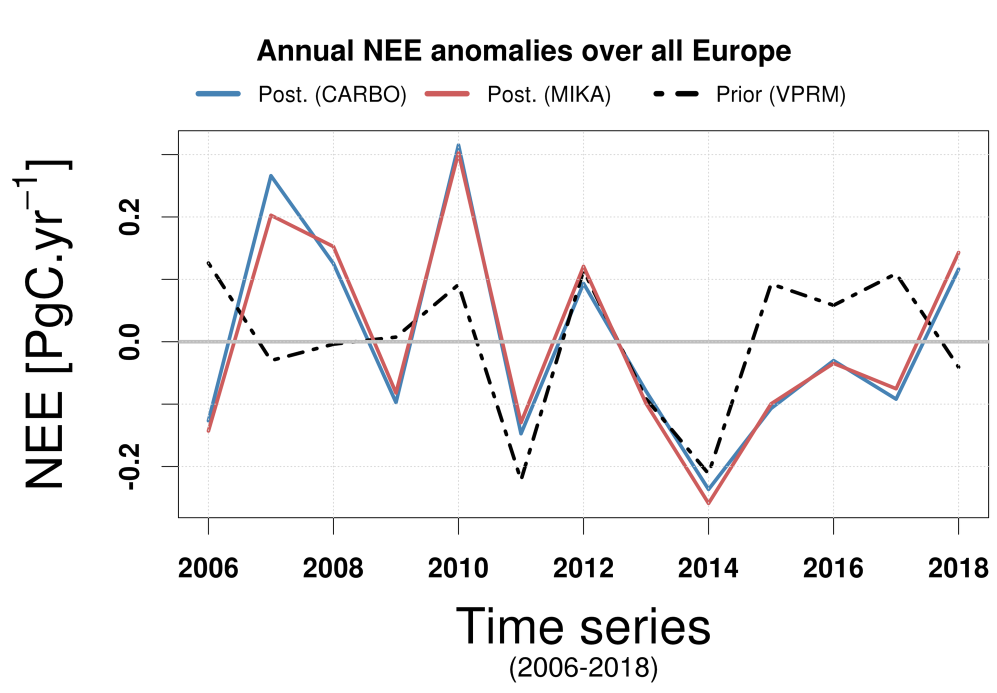



- Continuous and flask observations assimilated at 23:00-04:00 UTC for mountain sites and at 11:00-16:00 for the rest

### ❐ NEE anomalies relative to long-term mean of 2006-2018

- Posterior fluxes of biosphere models show a stronger anomaly signal, likely captured from observations
- In contrast to SIBCASA and FLUXCOM, VPRM has a better representation of IAV
- Using different ocean flux models has a smaller impact on total CO2 estimate over domain-wide in comparison with biosphere models




## Modelling set-up

- Hourly STILT footprints calculated over receptors (stations)
- Prior flux models
  - ✧ Diagnostic biogenic terrestrial models (VBRM, SiBCASA, FLUXCOM)
  - ✧ Ocean flux model (Mikaloff-Fletcher et al. (2007), Jena CarboScope $pCO_2$-based ocean fluxes)
  - ✧ Fossil fuel emission statistics (EDGARv4.3 updated according to BP)
- Lateral Boundary Conditions (LBCs)
  - ✧ Global TM3 model
  - ✧ Two-step scheme inversion
- 100 km spatial correlation length of prior error, hyperbolic decay
- 30 day temporal correlation length of prior error

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