NO_x and CO inversions based on NO_2 and CO satellite data & derivation of $FFCO_2$ emissions in Europe

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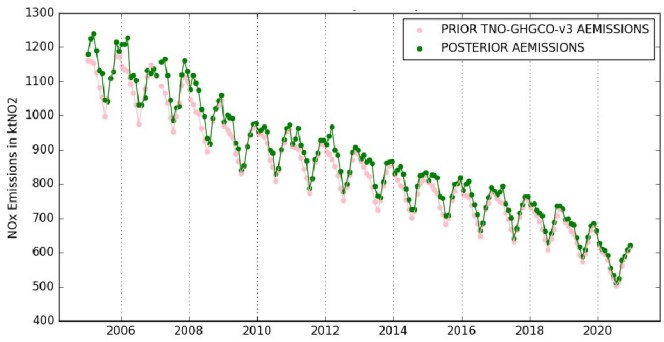
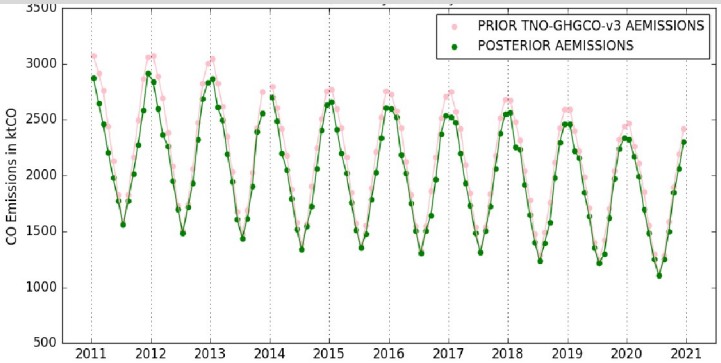
July,13st : 14:00-16:00 JST

1 Inversion for European NO_x or CO emissions at 0.5° resolution



Monthly prior and posterior estimates of the NO_x anthropogenic emissions from 2005 to 2020 over continental land (in $ktNO_2$)

- The posterior NO_x emissions are slightly changed compared to the prior ones during winter mainly because of a lack of observations
- The inversion **mainly applies positive increments to the prior anthropogenic emissions in spring and in summer**



Monthly prior and posterior estimates of CO anthropogenic emissions from 2011 to 2020 over continental land (in ktCO)

- The inversion **mainly applies negative increments to the prior anthropogenic emissions in winter**

See Fortems-Cheiney et al. 2021, GMD

2 Conversion into FFCO2 emissions

Comparison between
- the sectoral maps of NO_x / CO anthropogenic emissions from TNO-GHGco-v3
vs.
- the maps of total NO_x / CO anthropogenic emissions from the inversion
→for each month and country

Sectors = energy, industry, Residential, road transport and "others" (the rest of the sectors)

Simple analytical inversion scheme

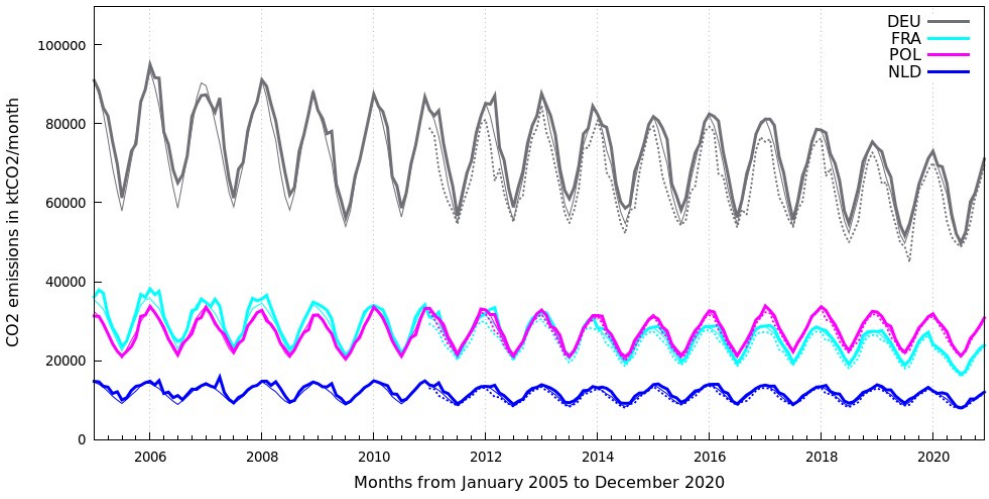
Optimal scaling of the sectoral maps NO_x or CO anthropogenic emissions from TNO-GHGco-v3 for each month and country

NO_x-to-$FFCO_2$ or CO-to-FFCO2 **sectoral emission ratios** from TNO-GHGco-v3 **per month and country**

FFCO2 sectoral emissions

See VERIFY D2.12 and D2.13

3 Monthly budget of sectoral $FFCO_2$ emissions per country



Thin line = $FFCO_2$ prior emissions
Bold line=from the NO_x inversions
Dashed line = from the CO inversions

- **Inversion based estimates close to the inventory: general consistency between the inventory and the observations**
- **However, significant residual biases between the simulation and the data, due to**
  →the large nominal errors associated to satellite retrieval
  →the non-linearity of the chemistry
- **Lack of data in winter esp. for Northern countries**
- **$FFCO_2$ emission estimates from NO_x and CO inversions present contradictory information regarding the sign of the corrections to be applied to the inventory:**
  →highlighting the weight of uncertainties in emission ratios or biases in the observations ?

Perspectives:
- **characterize the uncertainties in the estimates**
- **account for the uncertainties in the CO/$FFCO_2$ and NO_x/$FFCO_2$ anthropogenic emission ratios**
- **synthetize the information from the different species**
- **co-assimilate CO_2 data (controlling the CO2 NEE together with the anthropogenic emissions)**

See VERIFY D2.12 and D2.13