Co-ordinated by ECMWF

CoCO2
Prototype system for a Copernicus CO_2 service

WP2 PRIOR DATA
YR 1 REPORTING TO GENERAL ASSEMBLY

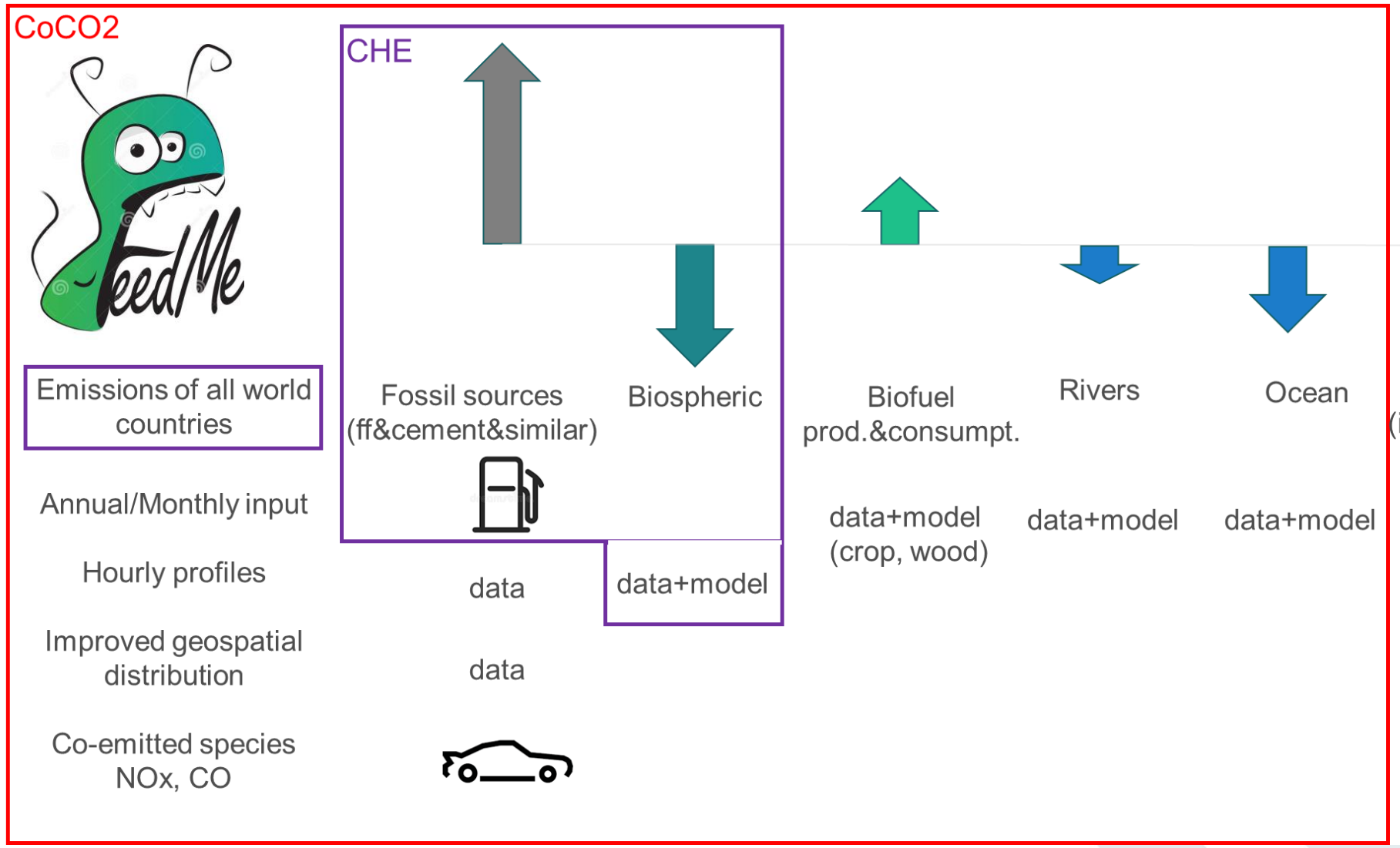
16 November 2021

Hugo Denier van der Gon and Greet Janssens-Maenhout

WP2 includes 48 colleagues from TNO, JRC, BSC, MPG-Jena, LSCE, Lab AERO, AGH, ICOS, LundU, UEdinburgh, Cyl, iLab, ECMWF, DWD, Cicero, DLR, Mercator-ocean, VU-A'dam

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 958927.

WP2: Challenging «holistic» extension of source coverage for CoCO2



WP2 Priors Task overview

- ***T2.1 Regional and global emission datasets (M1-36)***

  (**TNO**, BSC, Cyl, CNRS-LA, MPG, MOi, ECMWF, CEA, CICERO)

- ***T2.2 A mosaic of regional and global emission grid maps for CO_2, CH_4 and co-emitted species (NOx, CO) for 2015 or 2016 (M1-24)***

  (**JRC**, BSC, CNRS-LA, TNO)

- ***T2.3 Improvement of temporal and spatial profiles (M1-24)***

  (**BSC**, TNO, Cyl)

- ***T2.4 Development of emission models (M6-M30)***

  (**ULUND**, ilab, TNO)

- ***T2.5 Prior uncertainties and error correlations (M9-M30)***

  (**ECMWF/ JRC / TNO**, ULund)

T2.1 MS1.1 Prior data 2018 document

Contributors:
JRC, BSC, MPG-Jena, LSCE, CNRS Lab AERO, DLR, Mercator-ocean, TNO

Published in July –good impression of what to expect end of M12.
Feedback from other WPs very welcome!

Report avaible on Confluence WP2 project space.

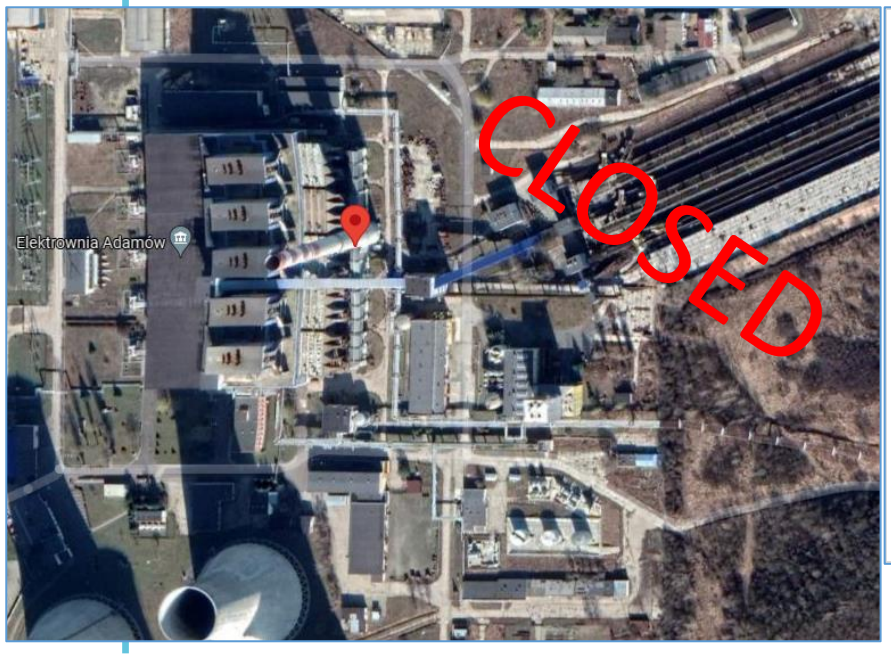
https://confluence.ecmwf.int/download/attachments/212435849/CoCO2-MS1.1%20Prior%20data%202018%20document_202107_v2.pdf?version=1&modificationDate=1637014189325&api=v2

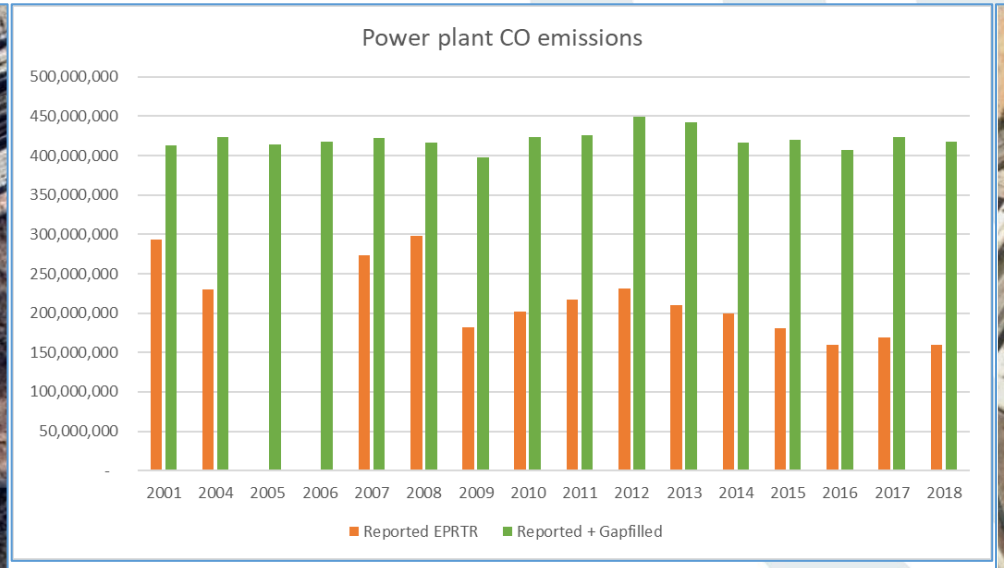
- In December (M12) deliver the yr 2018 prior dataset
- Future plan for all in T2.1 -> prepare yr 2021 dataset

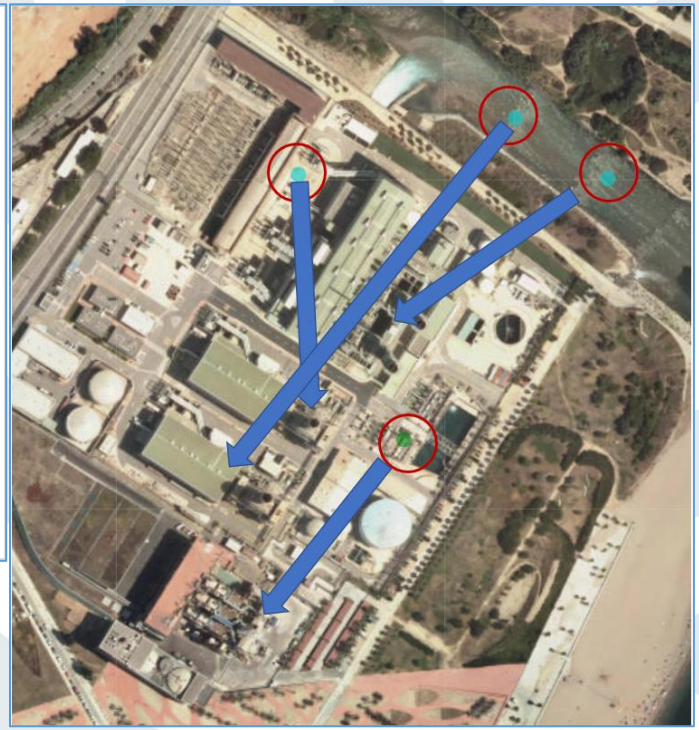
T2.1 Improvements in progress for D1.1 2018 regional inventory (TNO)

- Removed decommissioned coal-fired power plants from the dataset for 2018
- Check and improvement of point source coordinates (~10% of coordinates checked/corrected, priority on larger sources)
- **Complete gap-filling of CO2 emission and co-emitted species** for power plants using country-, year- and fuel-specific pollutant ratio's

(Note this work also feeds into Task 2.3)

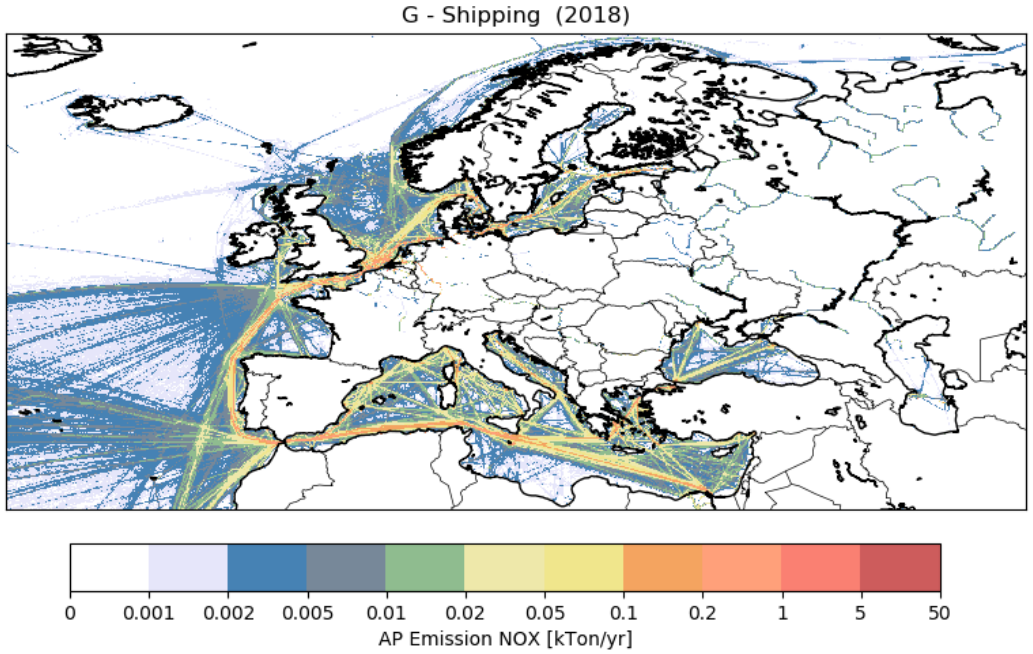






T2.1 Improvements in progress for D1.1 2018 regional inventory

- Update of shipping emissions based on FMI STEAM model output. (in collab FMI / CAMS-81; new version consistent at regional and global scale)
- Update of coal mining CH4 emissions and spatial distribution (underground and surface mines)

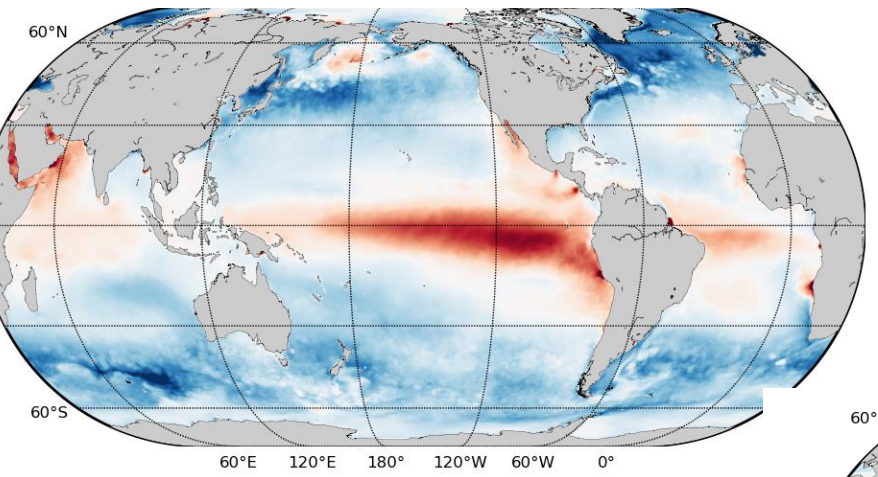


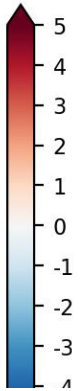
Task 2.1.b: Develop and provide global biosphere and ocean fluxes: Mercator-Ocean contribution

- First version 2018 delivered to WP3 for testing (see also later)
- *See WP2 MS 1.1 document for contacts & details*

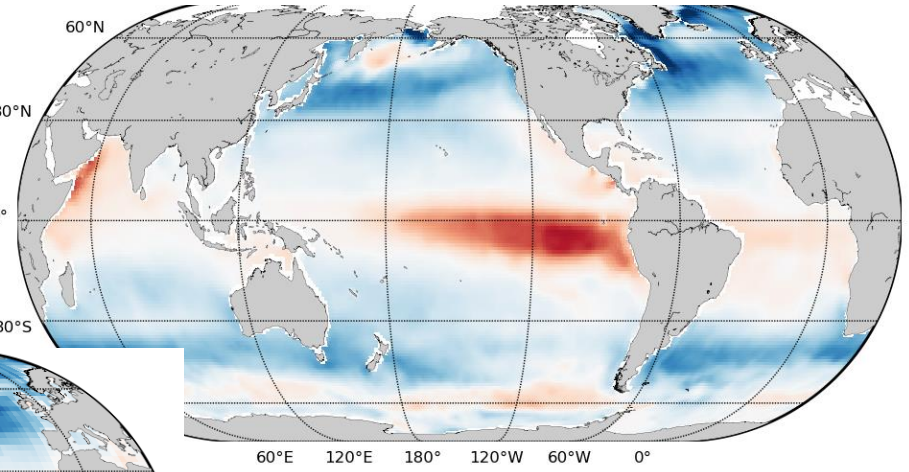
Intercomparison of marine Copernicus model CO2 flux with observation-based products

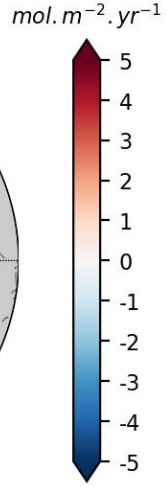
BIOMER4V2R1 = real time **model** product



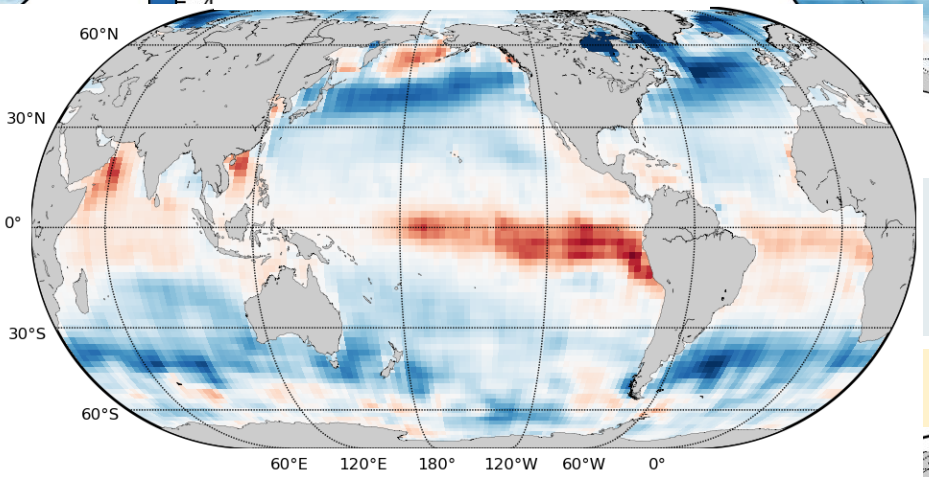


Landschützer **obs-based** product



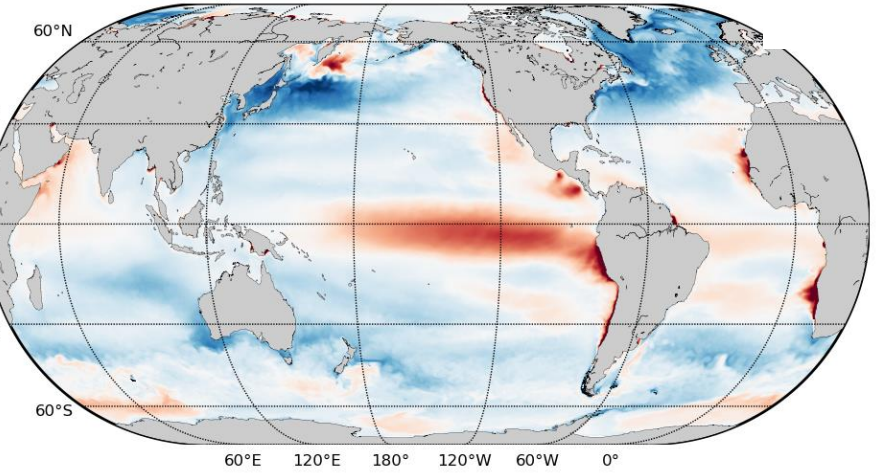


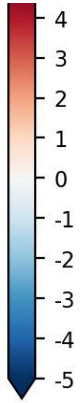
JENA-MLS **obs-based** product



Year 2018

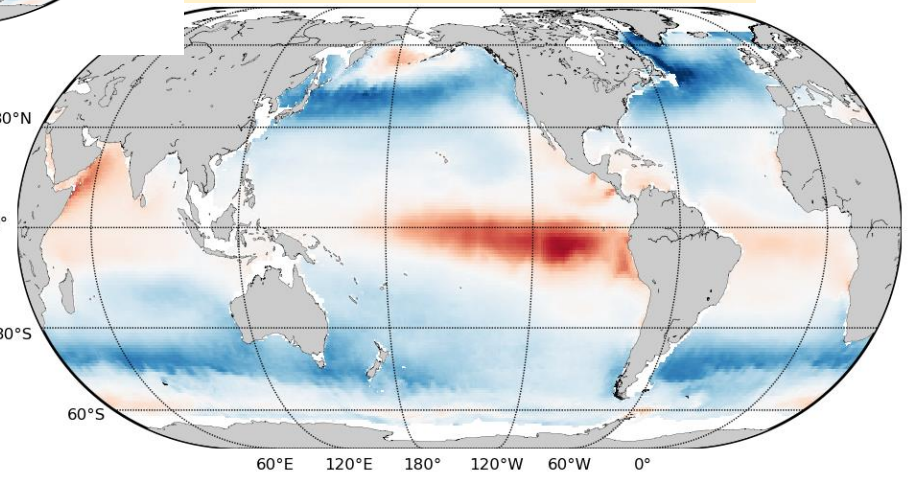
FREEBIORYS = multi-year **model** product

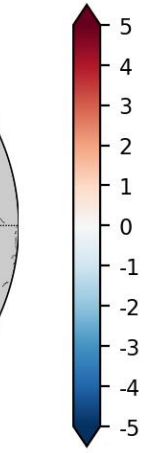




CoCO2

CMEMS **obs-based** product



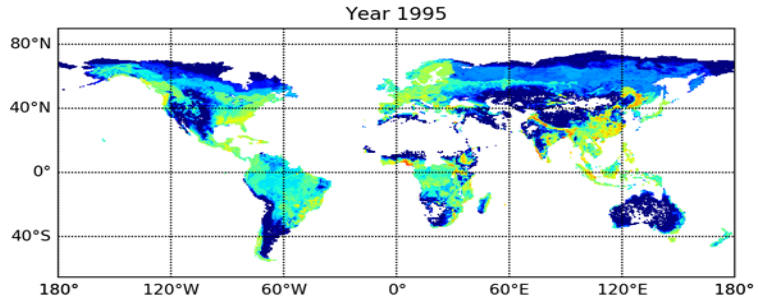


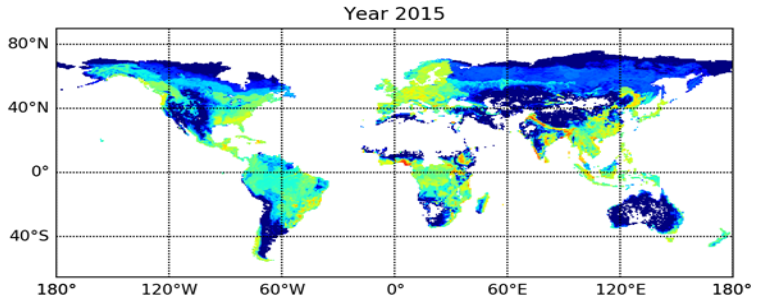
Task 2.1.b: Develop and provide global biosphere and ocean fluxes: Mercator-Ocean contribution

Regarding plans for next year:

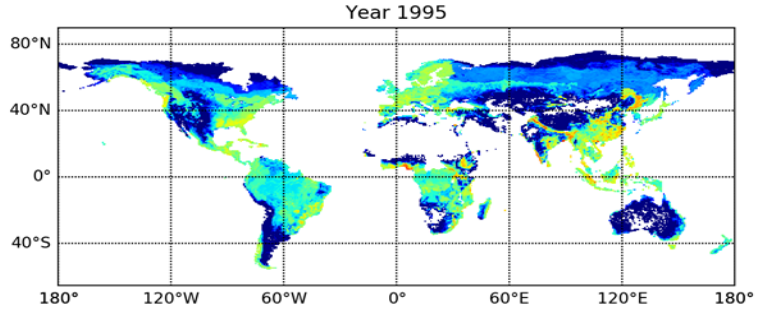
- Continue to compare our modelling product of ocean fluxes with available observation-based products
- Develop the assimilation of pCO2 observation-based maps in our model
- Deliver year 2021

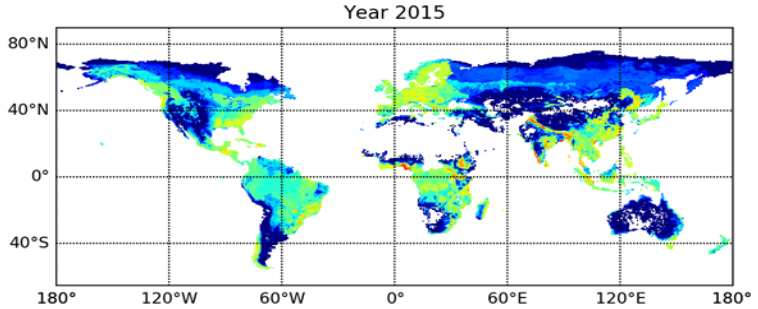
T 2.1: biofuel maps



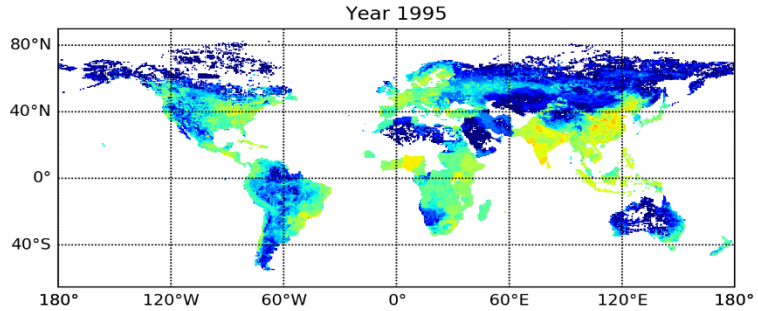


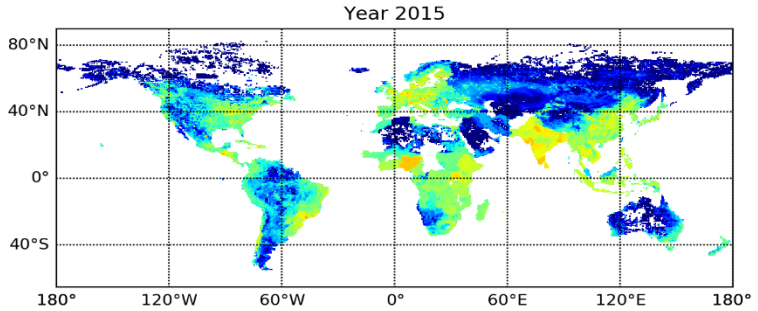
Production of Wood biofuel



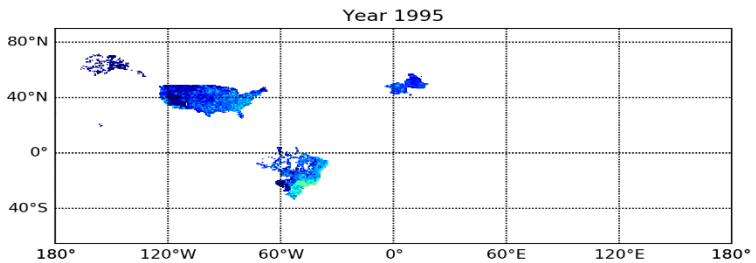


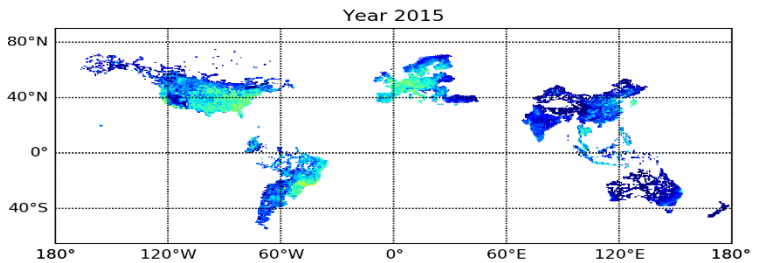
Production of Crop biofuel



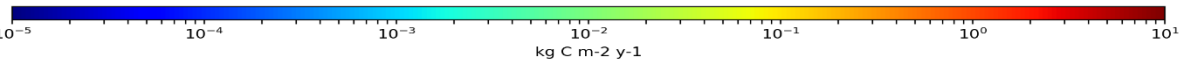


Consumption of Wood biofuel

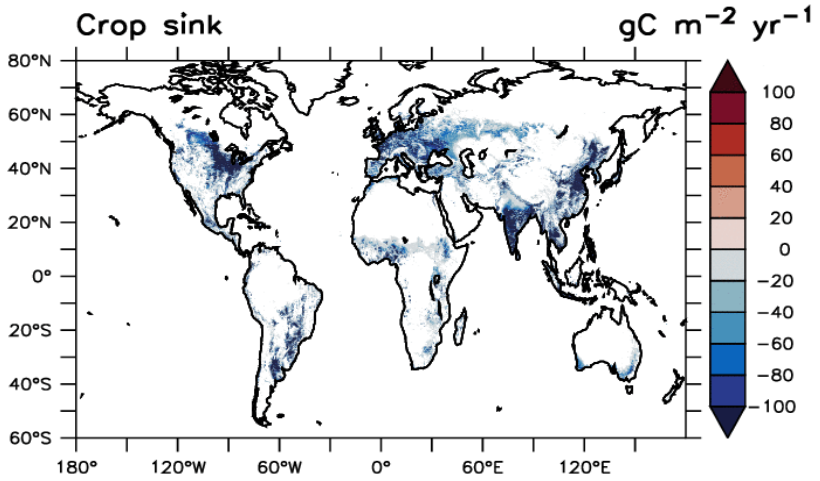


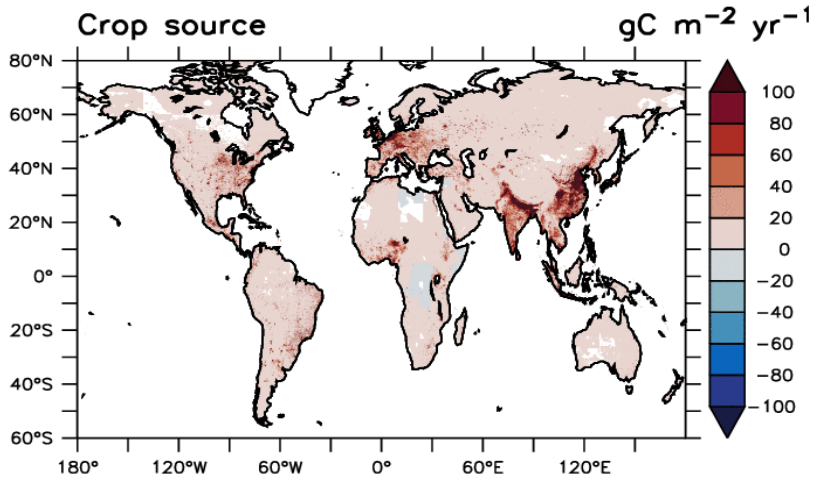


Consumption of Crop biofuel



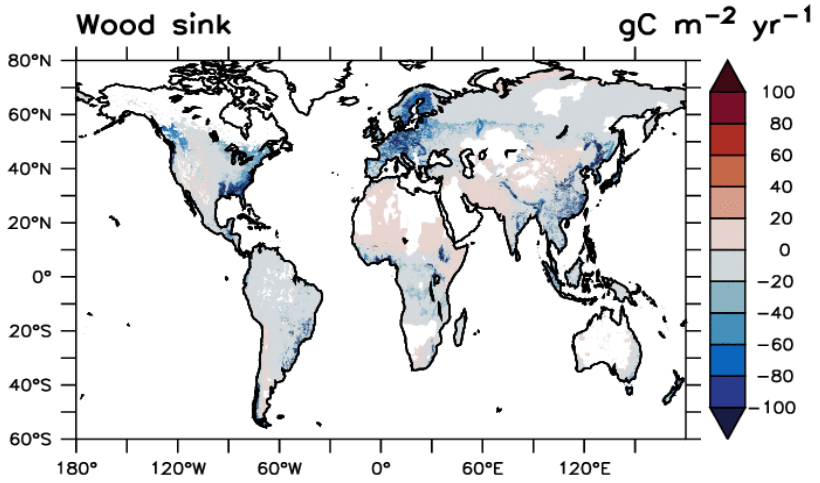
Task 2.1 – biofuel CO2 (courtesy: F. Chevalier, P. Ciais)

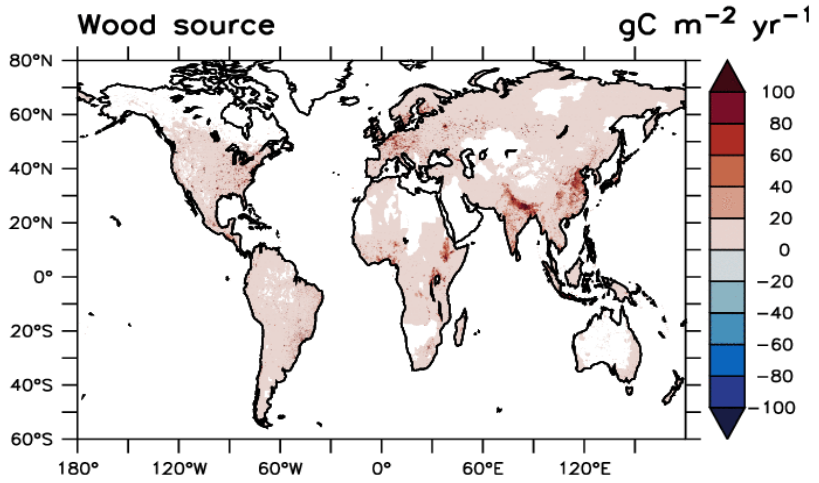




Annual for 1961-2019, 0.08° × 0.08°

Extended from Deng, Ciais et al., ESSDD, 2021





T 2.1B: Regional biosphere modelling links to other Tasks/WPs

- VPRM is being used to create 1-km hourly fluxes over “Europe”
- As foreseen in proposal:

Julia Marshall (DLR) will take action on biogenic fluxes to reach out to other WPs

- For 2018 by M12
- For 2021 by M20

See WP2 MS 1.1 document for contacts & details

T2.1B Global biogenic prior emission datasets for 2018 (MPI Jena)

See the T2.1 Milestone document for a brief description and contact details

Global biogenic prior emission dataset is available

The product comes at a spatial resolution of 0.5deg every hour and can be downloaded from

ftp://ftp.bgc-jena.mpg.de/pub/outgoing/swalth/CoCO2_WP2/

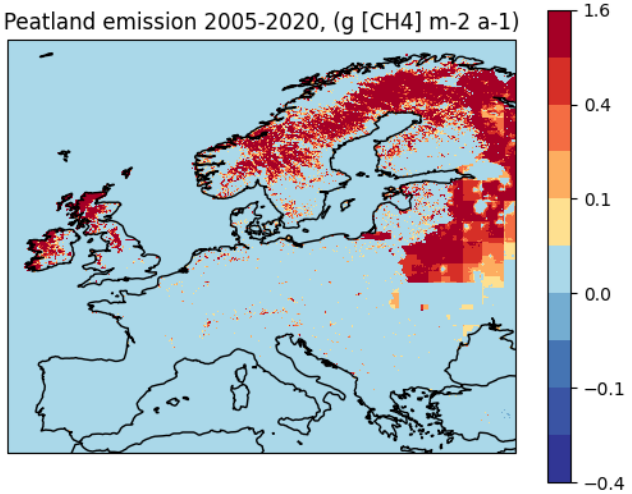
New work! From Martin Jung:

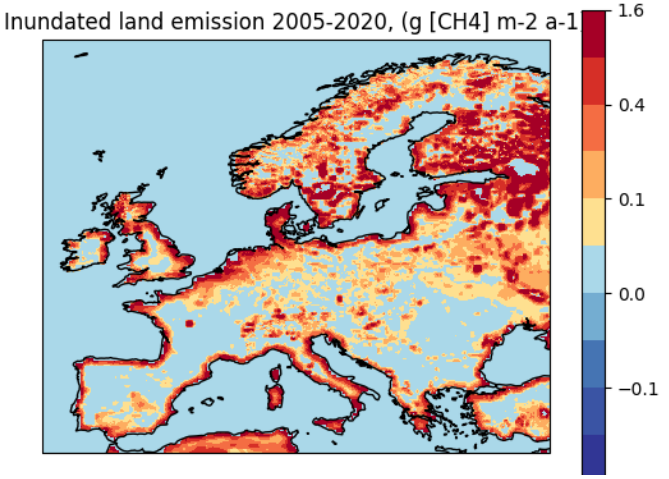
- Brand new global run of biogenic CO2 (NEE) at 0.05° and hourly resolution (~4TB compressed netcdf files).
- A first shot and beta version but we have data in case someone needs and it shows we have a new running system eventually!.
- **Plan for next year is evaluation, consolidation, and running until 2021.**

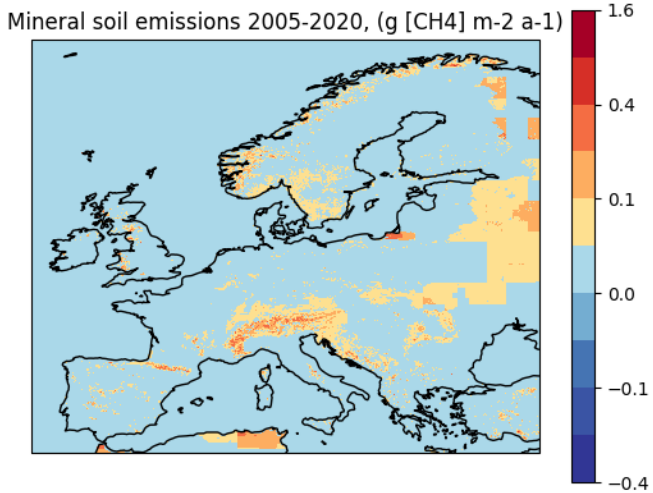
Terrestrial natural BU CH4 fluxes (WP6 Tiina Markkanen, Tuula Aalto, FMI)

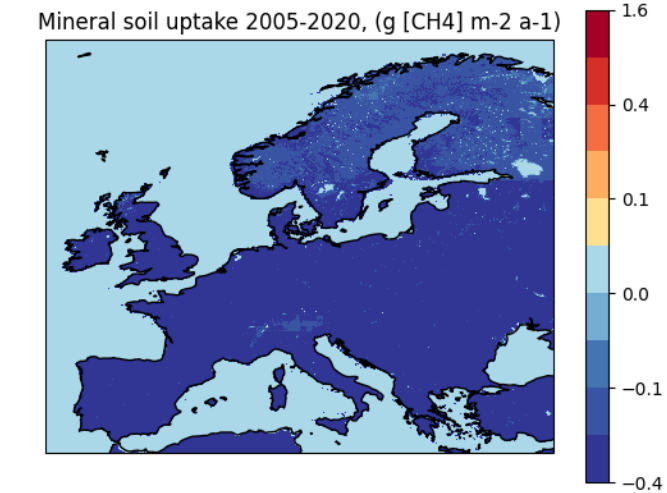
- European set-up in resolution of 0.1º

Spatial distributions

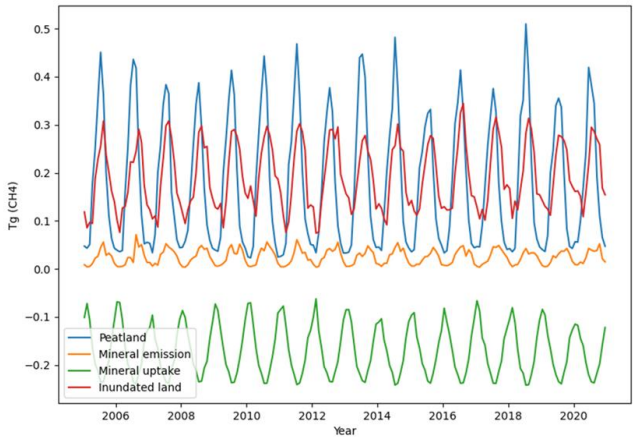






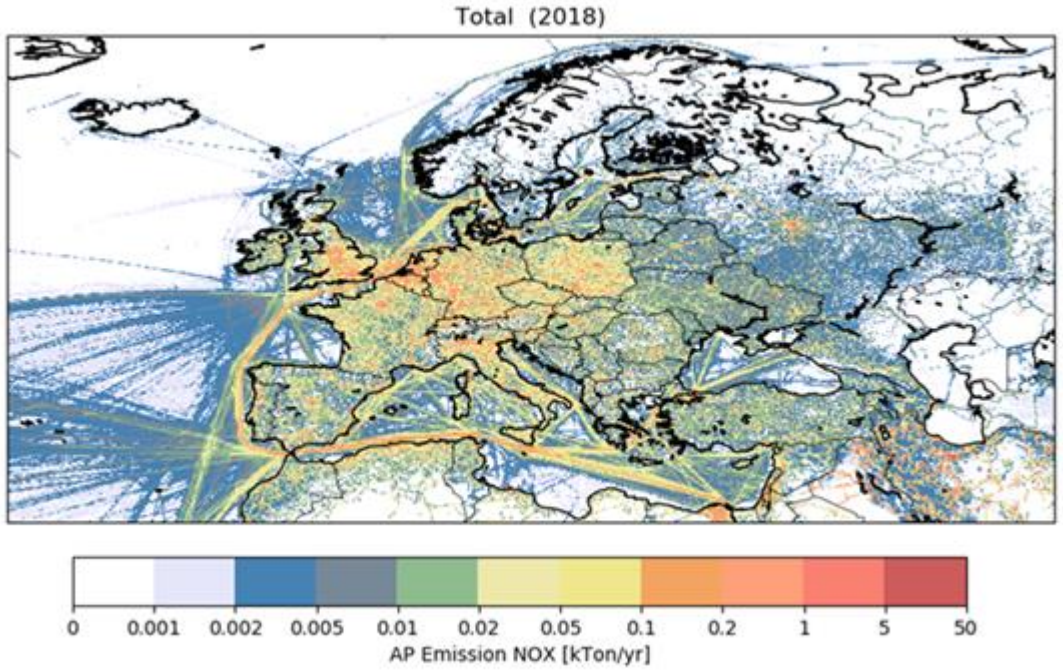


Monthly totals of component terms

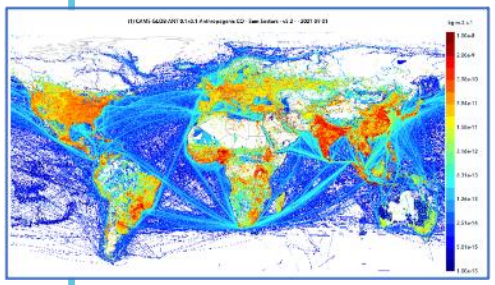
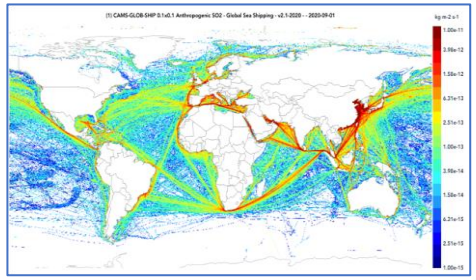
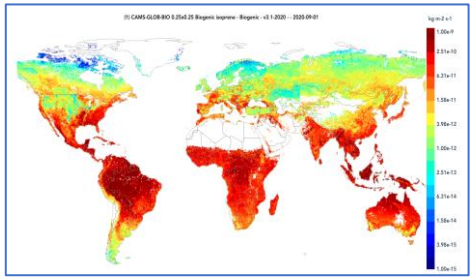
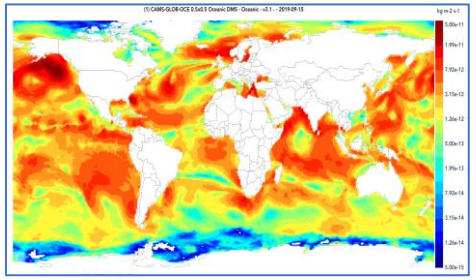
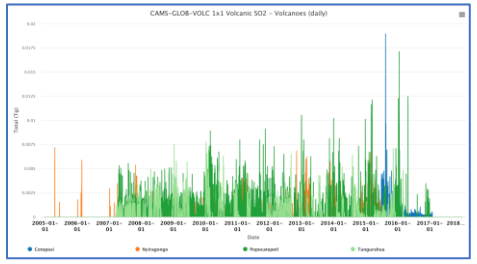


T2.2 Mosaic emission data set - JRC

WP2 – T2.2 Mosaic for CO2ff and CO2bf (7 sectors, 2015-2018)



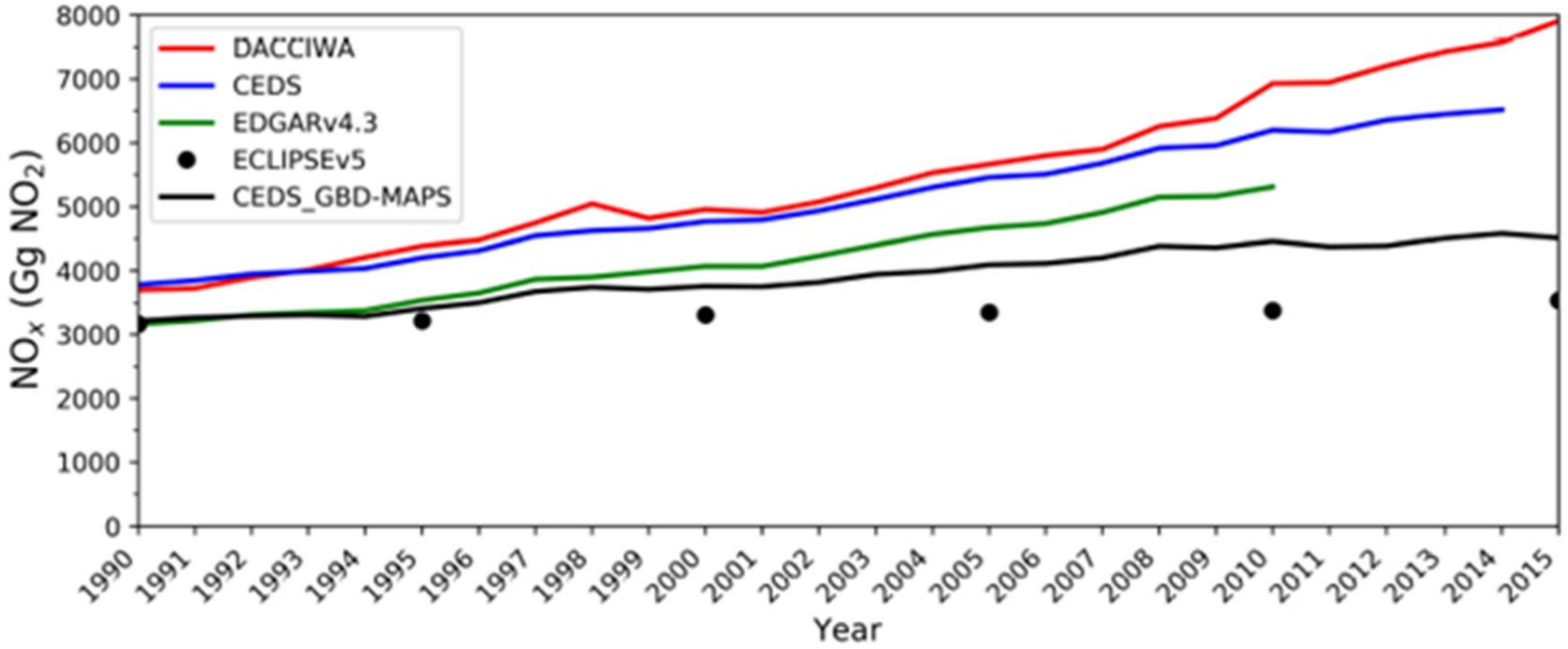
Region	Contact person	Reply received
North America	Kevin Gurney	x
Central America	Beatric Cardenaz	
South America	Nicolas Huneeus, Gomez	x
Europe	Peter W.H.G. Coenen	x
Africa	Sekou Keita	x
Middle East	Jos Lelieveld	
Russia	Nina Uvarova	
China	Zhu Liu	x
India	Armit Garg	
Korea	Jung-Hun Woo	
Japan	Junichi Kurokawa	
Australia	Peter Julian Rayner	

Global emissions of Copernicus Atmospheric Monitoring Service

Extension of the Dacciwa African emissions inventory to CO_2 and CH_4

Sekou KEITA et al, Laboratoire d'Aérologie CNRS, Toulouse

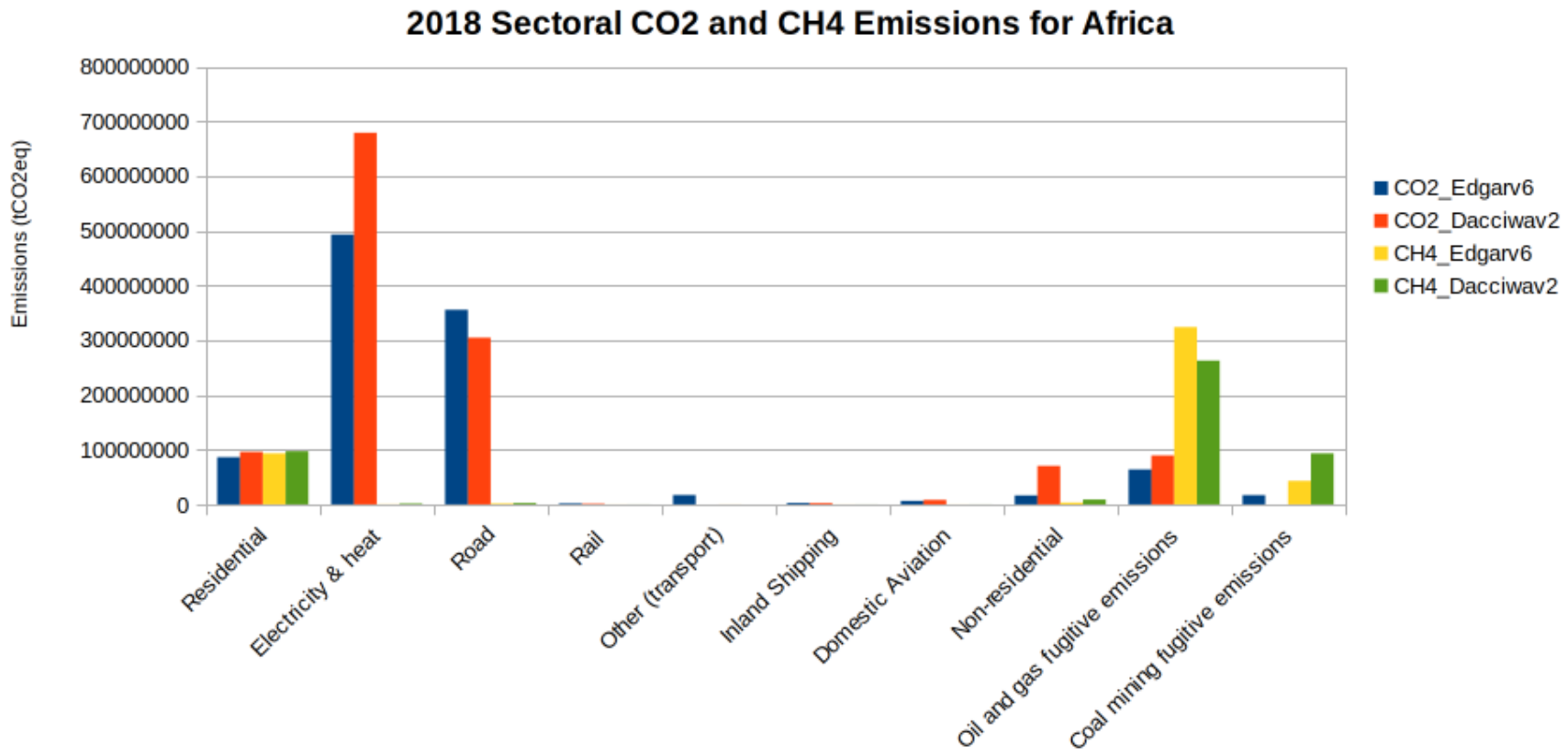


- Contribution to WP2 of CoCO2, Task 1.2: A mosaic of regional and global emission grid maps for CO2, CH4 and co-emitted species (NOx, CO)

- **CoCO2 discussions → focus first on year 2018**

Global Mosaic: T2.2 Mosaic – CNRS – first results

Comparison of CO_2 and CH_4 emissions for DACCIWAv2 and Edgarv6 inventories per sectors



- Electricity & Heat sectors show the largest differences
- At country level this difference comes mainly from South Africa

Note CH4 emissions on Y-axis in CO2 eq

Global Mosaic: T2.2 Mosaic – CNRS

Next step for coming months:

- **South America :** Discuss with colleagues involved in the PAPILA EU project, who completed a 1st version on an emission dataset (https://essd.copernicus.org/preprints/essd-2021-208/)
  → to include CO_2 and CH_4 in this inventory that focus on reactive gases (CO, NOx, NMVOCs, NH_3 and SO_2) from anthropogenic sources for the period 2014–2016.

- **China**: Plan to analyse and extend to 2018 the MEIC inventory for China (2008 – 2017) and REAS (1950 - 2015) which includes all Asia

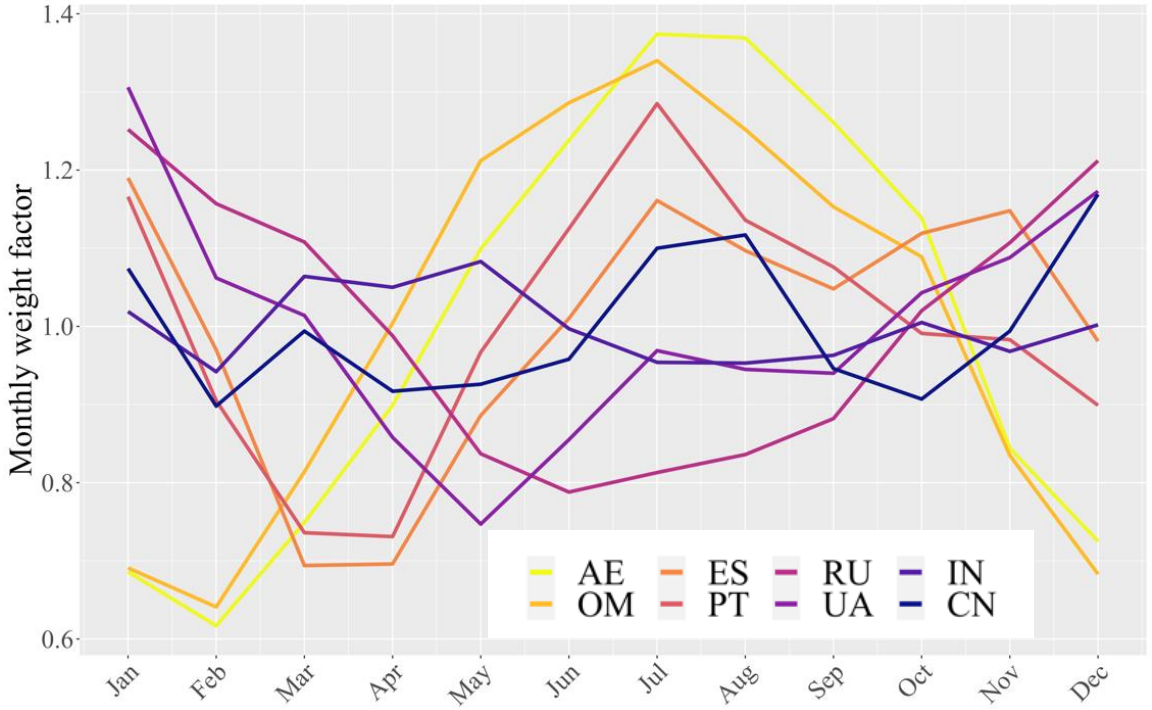
T 2.3: Improvement of temporal & spatial profiles (lead BSC)

T2.3.a Temporal profiles

Produced updated global temporal profiles for energy/manufacturing industries, road transport, residential/commercial combustion and agriculture in collaboration with CAMS:

- Country-dependent / grid cell dependent profiles to account for the effect of meteorology and different climatological conditions and sociodemographic patterns

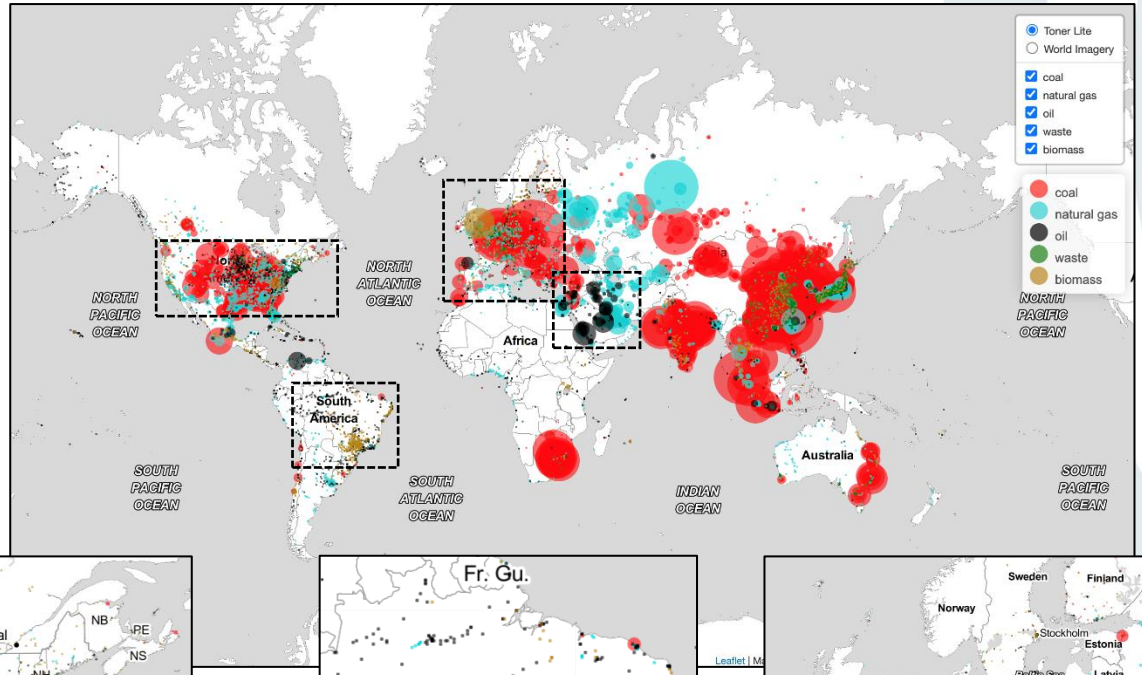
CO_2 monthly factors for power industry

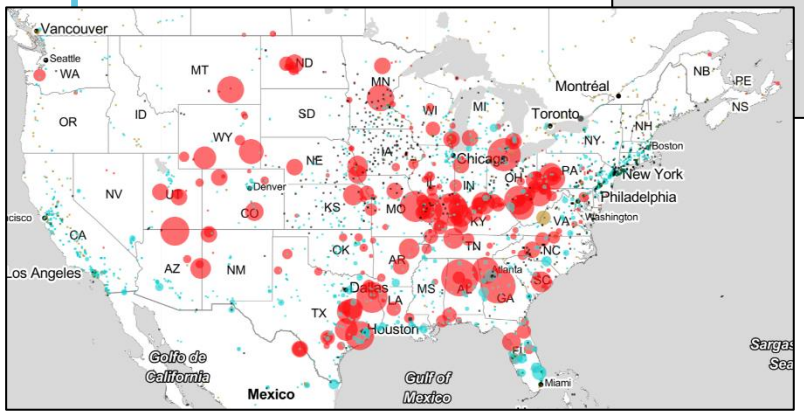


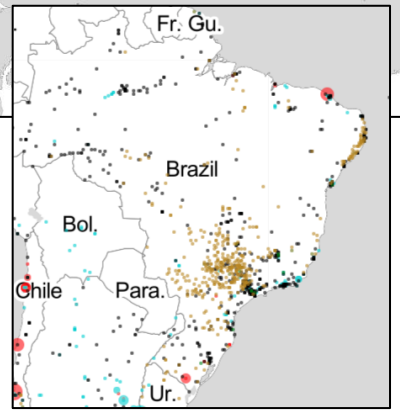
- AE (United Arab Emirate) and OM (Oman) --> Peak occurring during summer due to increase of energy demand for space cooling
- ES (spain) and PT (Portugal) --> Two peaks, one in winter and one in summer, coinciding with increase of energy demand for space heating and space cooling, respectively
- RU (Russia) and UK (Ukraine) --> Peak occurring during winter due to increase of energy demand for space heating
- India (IN) and China (CN) --> Profiles much flatter, energy demand more constant

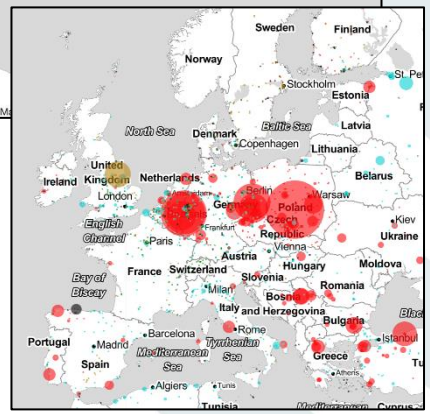
T2.3.b Improvement of spatial representation

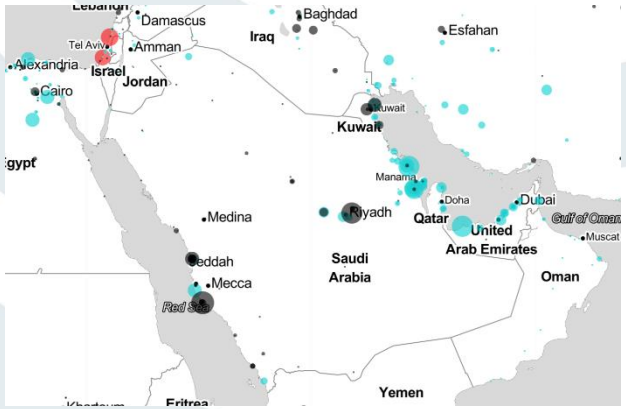
- Development of the CoCO2 global power plant emission database (coal, natural gas, oil, biomass & waste)
- Estimation of 2018 annual emissions for CO_2 + co-emitted species (i.e., NO_x, SO_2, CO, CH_4) per facility
  - **EU28 + Norway + Switzerland + Serbia**: TNO database - based on E-PRTR
  - **Rest of the world**: Mosaic of WRI, GEM, eGRID, IndustryAbout, Openinframaps + IEA statistics











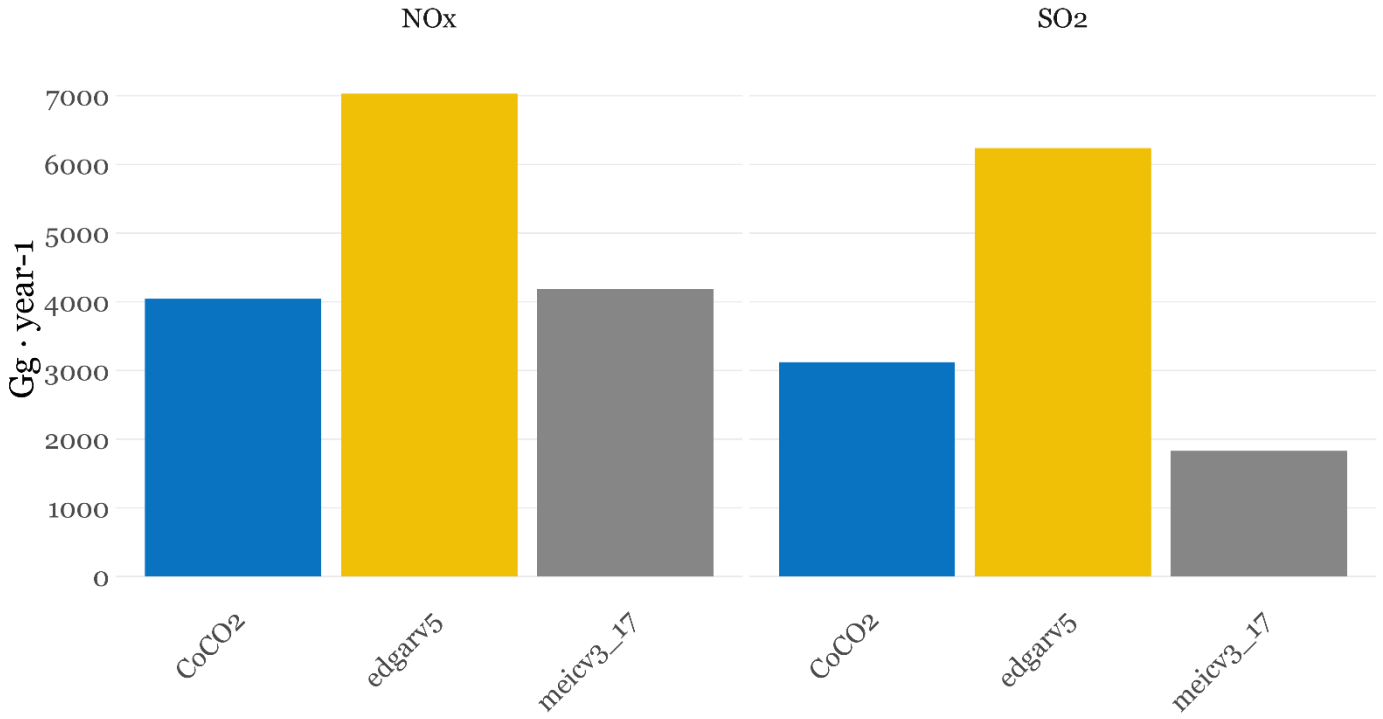
T2.3.b Improvement of spatial representation

Comparison of estimated emissions against other inventories:

- Existing gridded inventories: EDGARv5, MEICv3
- Plant-level emission inventories for India (CEA)

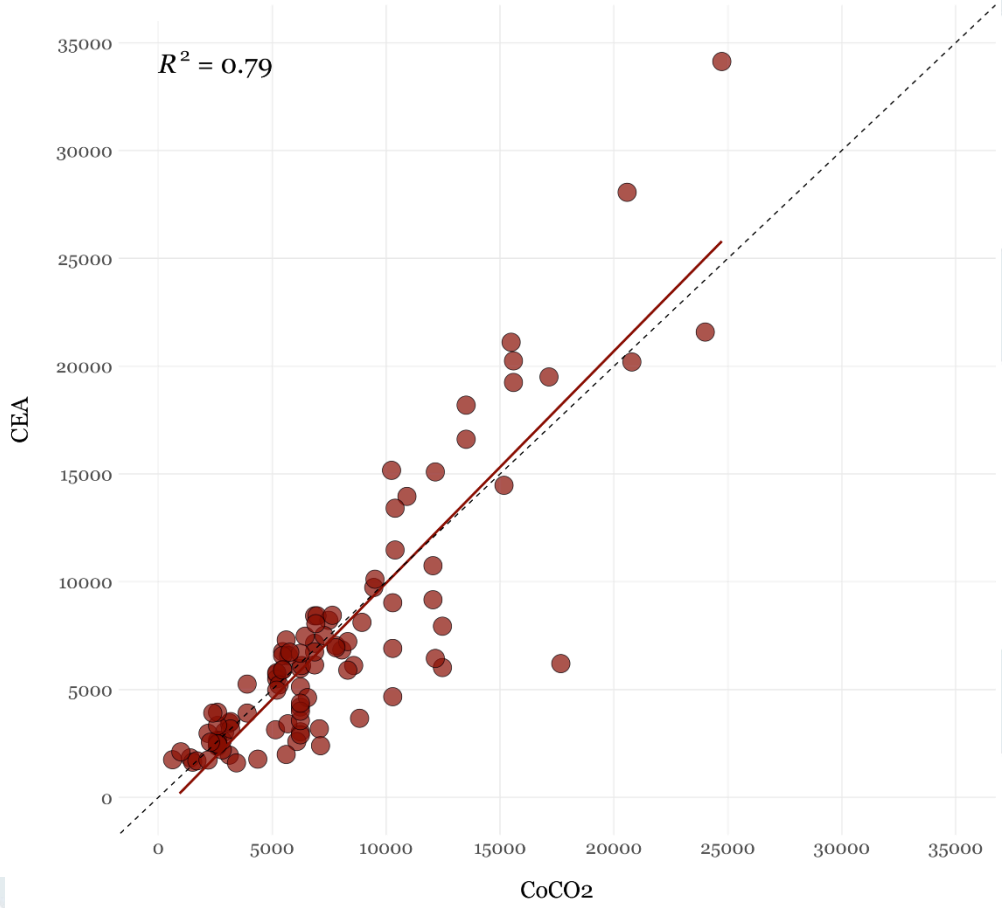
Comparison Between CoCO2-2018, EDGARv5-2015 and MEICv3-2017

China



Comparison between plant-level CO2 emissions

India



T2.3 Future plans

Task 2.3:

- Temporal profiles: Development of country- and day-of-the-week dependent diurnal profiles for road transport + review of profiles based on feedback received from WP3
- Spatial representation: Compute and assign specific temporal and vertical distribution profiles per power plant, giving priority to those that are part of WP4 case studies
- **Preparing deliverable D2.3** - **Documentation of new temporal and spatial profiles including a global point source database (M24)**

During CoCO2 we need close(r) interaction with the modellers.

- *What makes a difference?*
- *Is the effort justified or jump to the next problem?*

Task 2.4 Development of FF emission models (ULUND, iLab, TNO)

- 2.4a Develop global fossil fuel emission model for data assimilation purposes
- 2.4b Develop regional fossil fuel emission model for data assimilation purposes

Work in this task has started in summer and regular meetings between Task partners are scheduled

- We **specified the sectoral FF emissions model for global and regional scales**. For this, the required input data sets have been identified, first data sets were collected and first elements of model formulations were explored.
- Plans for the next year are to gather the remaining input data, continue to derive appropriate parameterisations for the sectoral emissions model components and implement these, together with tangant and adjoint versions in the FFDAS.
- The model will be first run and tested for 2018 and later for 2021.

T2.5 Prior uncertainties and error correlations

Task lead by ECMWF (Margarita Choulga) & TNO (Ingrid Super)

Discussion started what are priorities regarding uncertainty calculations (list of questions, priorities)

Pragmatic approach: To avoid getting overloaded we need to set priorities related to:

- *Which species to focus on*
- *Which sectors should get most attention*
- *Which type of uncertainties*

We start at the top of the list and work down as long as time/budget permits

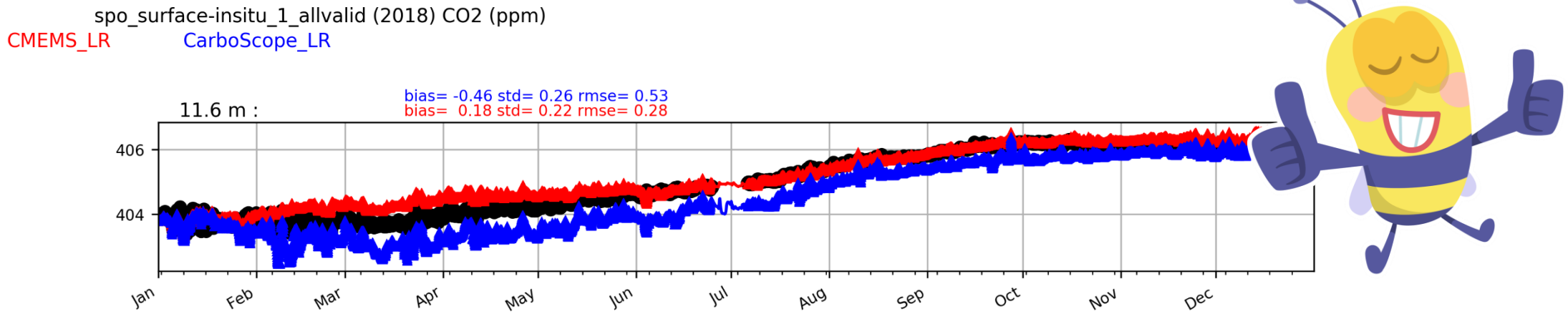
Sub tasks defined that once agreed can be executed.

Current thoughts are to work in layers to be as consistent as possible when we compute global and regional uncertainties. For example start from Sector annual uncertainty and then to add complexity in layers on top.

Good news! The CHE uncertainty paper is under last proofreads before publication – Long process, important basis for T2.5

Ambition to establish (more) direct links at “work floor level” in the next year between WP2 prior development teams and users in CoCO2

E-mail exchange WP2 (Coralie Perruche, Mercator-ocean) and the CoCO2 WP3 user (Anna Agusti-Panareda, ECMWF)



Hi Coralie, 4/10/2021

Please find attached the updated plot of CO2 time series at south pole which shows very encouraging results. The Jena Carboscope fluxes seem to cause a decrease in CO2 from January to March (not present in observations), while in the experiment with CMEMS fluxes we see no increase in January and a small increase in February and March which fits better the observed atmospheric CO2 variability.

Regarding your question on operational implementation, it means that the dataset should be updated regularly. We know it will not be possible to have the fluxes in NRT but it would be good to have the flux data as fast as possible for the NRT analysis and forecast, considering the constraints of NRT availability of observations. To start with we can use the fluxes from the previous year assuming ocean fluxes vary slowly over time. Do you think that would be a good assumption?

Best wishes, Anna

Challenges…..

- Difficult to not have ANY physical meetings (less travelling is good, none is not good) -> these teams do not all know each other.
- WP2 needs a new co-lead in 2022.