CoCO2

Prototype system for a Copernicus $CO_2$ service

# D2.1 Prior Emission data 2018 documentation report

Hugo Denier van der Gon and

CoCO2 WP2 team

coco2-project.eu

Co-ordinated by ECMWF

# D2.1 Prior data 2018 documentation report

| | |
|---|---|
| **Dissemination Level**: | Public/ Confidential |
| **Author(s)**: | Hugo Denier van der Gon (TNO) |
| **Date**: | 02/03/2022 |
| **Version**: | 1.0 |
| **Contractual Delivery Date**: | 31/12/2021 |
| **Work Package/ Task**: | WP2/ T2.1 |
| **Document Owner**: | TNO |
| **Contributors**: | JRC, BSC, MPG-Jena, LSCE, CNRS Lab AERO, DLR, Mercator-ocean, TNO |
| **Status**: | Final |

# CoCO2: Prototype system for a Copernicus $CO_2$ service

**Coordination and Support Action (CSA)**
**H2020-IBA-SPACE-CHE2-2019 Copernicus evolution – Research activities in support of a European operational monitoring support capacity for fossil CO2 emissions**

**Project Coordinator:** Dr Richard Engelen (ECMWF)
**Project Start Date:** 01/01/2021
**Project Duration:** 36 months

**Published by the CoCO2 Consortium**

**Contact:**
ECMWF, Shinfield Park, Reading, RG2 9AX,
richard.engelen@ecmwf.int

The CoCO2 project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 958927.

# Table of Contents

# Executive Summary and Introduction

This deliverable report describes the characteristics of the regional and global prior (anthropogenic and biogenic) emissions datasets compiled for the year 2018 in CoCO2 Task 2.1. It gives a brief overview of the resulting products and provides information on data access and contact persons for each product. A default approach for an emission height profile by sector for point sources is also provided in chapter 3.

While the release of this document was delayed until February, the regional and global emissions datasets for 2018 have been made available by the end of 2021 and as such there were no delays in delivering the products.

## Background

The aim of Task 2.1 is to provide state-of-the-art emission data as input for WP3 (Development of global modelling and data assimilation capacity in an MVS), WP4 (Local and regional modelling and data assimilation) and the CO2MVS in general. Data assimilation efforts in WP3 and WP4 require prior information on emissions that is spatially explicit and complete. This implies that both anthropogenic and biogenic fluxes are included, both for a regional (European) domain (WP4) and the global domain (WP3). An important limitation of the current emission inventories is that they are based on data that comes available with a lag of at least 2 years. Therefore, one of the focus points of Task 2.1 is to develop new methodologies and use additional data sources to be able to deliver reliable prior emission data with a shorter lag time. While the first prior emission data will be pertaining to 2018 to best accommodate and fit with the models and satellite data used in WP3 and WP4, a prior emission dataset for 2021 will be delivered in M20 (August 2022) that will rely on new methods to deal with the fact that some of the source data will not yet be available for 2021.

## Scope of this deliverable

### Objectives of this deliverable

The objective is to compile a regional and global emission dataset for 2018 consisting of individual components that modellers can use and that covers all relevant species and sectors, including anthropogenic, biosphere and ocean fluxes. The aim is to base the dataset on a consistent bottom-up approach at regional or global scale to ensure consistency and transparency.

### Work performed in this deliverable

The work for this deliverable has resulted in seven emission products:

- A dataset of regional anthropogenic emissions
- A dataset of global anthropogenic emissions
- A dataset of global biofuel consumption and production fluxes
- A dataset of regional biosphere fluxes
- A dataset of global biosphere fluxes
- A dataset of (global) ocean fluxed

Next to this an introduction to a global land use, land use change, and forestry (LULUCF) dataset for 2018 is provided

### Deviations and counter measures

The main deviation in the workplan was that in the original CoCO2 DoW, Task 2.1 aimed at providing prior datasets for 2016 and 2021. In consultation with all CoCO2 partners it was decided to exchange the year 2016 with 2018, mostly because more satellite observational data will be available for 2018. This creates slightly more work for WP2 but does not ask for any countermeasures.

# 1 Overview of anthropogenic prior emission data for 2018

## 1.1 Regional anthropogenic prior emission datasets of ffCO2 and bioCO2 and co-emitted species for 2018

The regional European emission dataset has been compiled and delivered in December 2021. This work is done in collaboration with and building on CAMS and the CHE and VERIFY projects but introduced several important improvements. Point sources are at exact locations.

This product will also be the basis for the regional zoom version for NW Europe (1/60° x 1/120°) for WP4 (Task 4.4). We expect to deliver this dataset in Q2 2022.

**Table 1: Characteristics of the anthropogenic emissions for greenhouse gases and selected co-emitted species for the European domain for 2018 TNO GHGco v4 regional European emissions for 2018**

| Description | TNO GHGco v4 regional European emissions for 2018 |
|---|---|
| Product family | Anthropogenic emissions |
| Species[2)] | $CO_2$_ff[1], $CO_2$_bf, CO_ff, CO_bf, $NO_x$, $CH_4$, NMVOCs |
| Geographical area | Europe (-30.0°, 60.0°, 30.0°, 72.0°) |
| Vertical coordinate | Surface with emission height profile by sector |
| Vertical coverage | Surface flux, area sources and point sources at exact location |
| Horizontal resolution | 0.1° x 0.05° longitude-latitude |
| Time coverage | 2018 |
| Time resolution | Annual with default temporal profiles for monthly, daily, hourly on request |
| Dissemination mechanism | FTP, Data Server |
| Data format | NetCDF, CSV |
| Dissemination time | December 2021 |

[1)] ff = fossil fuel, bf = biofuel (solid, liquid or gaseous)

[2)] Exact species list to be discussed with CoCO2 model WPs.

The sector classification of the regional emission data is shown in Table 2. The sector coding follows the GNFR system which is an aggregated version of the NFR (Nomenclature For Reporting) used for Gridding the data (GNFR). This system is used for the emission reporting to EMEP and EU by individual countries, and for consistency reasons has also been implemented in the TNO GHGco v4.0 emission inventory. More details on the sector classification can be found at http://www.ceip.at/ms/ceip_home1/ceip_home/reporting_instructions/ .

**Table 2 Source sectors following the GNFR Sector nomenclature and short category name**

| GNFR_Category | GNFR_Category_Name |
|---|---|
| A | A_PublicPower |
| B | B_Industry |
| C | C_OtherStationaryComb |
| D | D_Fugitives |
| E | E_Solvents |
| F | F_RoadTransport |
| G | G_Shipping |
| H | H_Aviation |
| I | I_OffRoad |
| J | J_Waste |
| K | K_AgriLivestock |
| L | L_AgriOther |
| F1 | F_RoadTransport_exhaust_gasoline |
| F2 | F_RoadTransport_exhaust_diesel |
| F3 | F_RoadTransport_exhaust_LPG_gas |
| F4 | F_RoadTransport_non-exhaust |

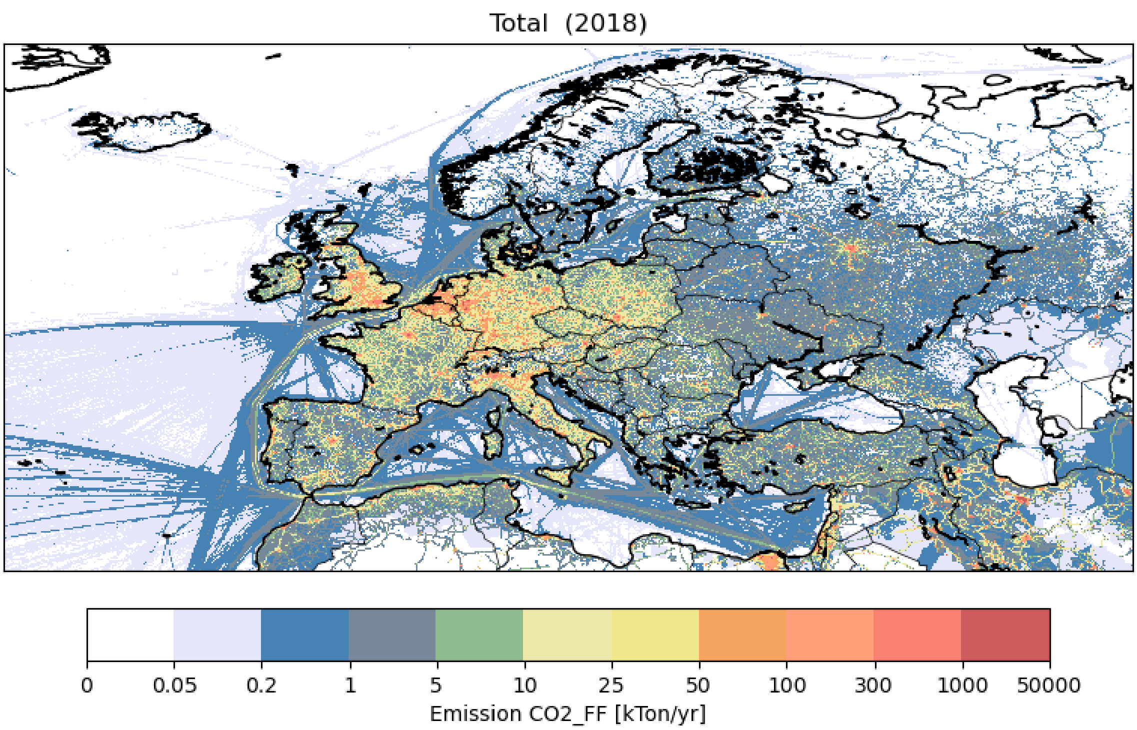


**Figure 1: Example of the $CO_2$ emissions from fossil fuel combustion for 2018 from the TNO_GHGco v4.0 dataset.**

### 1.1.1 Improvements in the regional TNO GHGco_v4 inventory for year 2018

In the CAMS_81 and VERIFY projects, emissions inventories for 2018 had already been compiled and delivered by TNO earlier in 2021. Similar to the TNO GHGco dataset delivered for VERIFY, the inventory dataset for 2018 prepared for CoCO2 places point source emissions at their exact coordinates. Several important improvements have been implemented in this TNO GHGco v4 inventory compared to the previous versions:

- The emissions and spatial allocation of sea shipping and inland shipping have been revised in cooperation with FMI and the CAMS_81 project (Jalkanen and Majamäki, 2021). The emissions and spatial allocation of sea shipping emissions are now based on the latest and improved STEAM model by FMI. For inland shipping, reported emission values are used and only the spatial distribution has been based on the STEAM model.
- Gap filling of public power and heat plant emissions has been completed using fuel-, country- and year-specific emission ratios between $CO_2$ and other pollutants, based on the IIASA GAINS model.
- A significant number of public power and heat plant point source coordinates have been manually checked and improved. Priority has been given to the largest emitters.
- The $CH_4$ emissions value for coal mining and handling in Romania has been replaced by a bottom-up calculated value using detailed coal production statistics and taking into account the type of coal and method of mining, based on work done by TNO in the framework of a project investigating methane emission in the energy sector.
- The spatial distribution of coal mining emissions has been improved. Many mining locations have been added and coordinates have been improved. Mining locations, type of coal produced, mining method and production have been retrieved from recent information provided by Global Coal Mine Tracker (CMT, 2021), supplemented by various other online resources (including those provided by nationally and internationally operating coal mining companies). In total 47 operational open cast mines and 50 operational underground mines have been added. Figure 2 illustrates the new spatially distributed methane emission estimates for coal mining, together with other energy-related fugitive methane sources for Europe (GNFR D).
- The allocation and spatial distribution of gas processing, storage, transmission, and distribution has been improved. based on work done by TNO in the framework of a project investigating methane emission in the energy sector. The gas transmission spatial distribution map has been updated to include known compressor station locations in the aforementioned project and used here in aggregated form. Furthermore, gas storage locations from the GIE database (GIE, 2018) were geocoded to get an approximate location and included in the spatial distribution with their respective share in methane emissions.
- The nitrogen application proxy maps have been reprocessed to improve their spatial accuracy.

In the near future a further discussion can be had on which co-emitted species are most useful for CoCO2 partners. It would for example be possible to expand the co-emitted species list with particulate matter and/or black carbon.


**Figure 2: Illustration of methane emissions from fugitive sources (GNFR D) in the regional inventory for 2018**

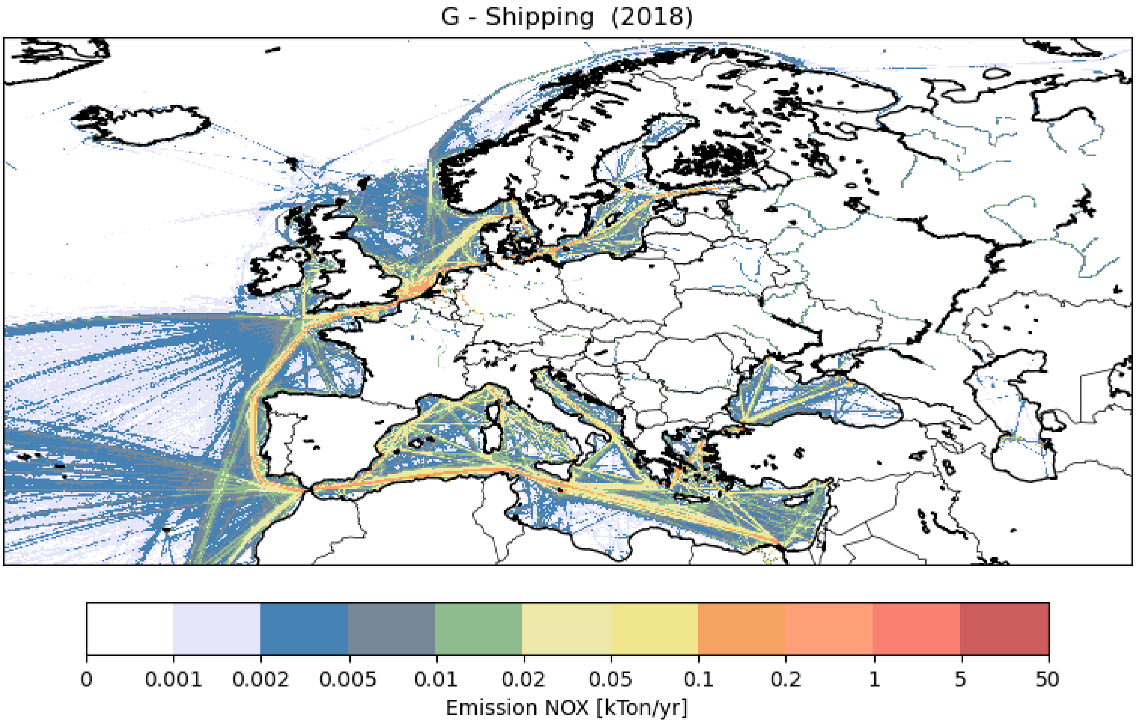


**Figure 3: Improved shipping emissions (NOx, 2018) based on FMI STEAM model (Jalkanen et al., 2009; Jalkanen and Majamäki, 2021)**

Contact persons: hugo.deniervandergon@tno.nl
jeroen.kuenen@tno.nl
stijn.dellaert@tno.nl

## 1.2 Global anthropogenic prior emission datasets of ffCO2 and bioCO2 and co-emitted species for 2018

As part of the work to determine the global anthropogenic prior datasets for ffCO2 and bioCO2, we first focused our work on the emissions in Africa.

In the past few years, we developed a regional inventory for the anthropogenic emissions in Africa called DACCIWA (Keita et al., 2021; https://doi.org/10.5194/essd-13-3691-2021). This original DACCIWA dataset included only atmospheric pollutants and considered only combustion sources.

As part of CoCO2, we developed a second version of African regional emissions inventories which correspond to an extension of the DACCIWA inventory. We worked on the inclusion of the emissions of $CO_2$ and $CH_4$, for combustion and other sources such as fugitive's sources. The DACCIWA dataset, which currently provides emissions up to 2015 has been furthermore extended to 2018.

For this inventory, activity data mainly come from the United Nations Statistics Division (UNSTAT) database (http://data.un.org/Explorer.aspx) and are available for different fuels available by country and by fuel following many subsectors such as residential combustion sources, industry, power plant, traffic, etc. In this work these sectors are lumped following seven main "groups of sectors": ENERGY_S, ENERGY_A, MANUFACTURING, SETTLEMENTS, AVIATION, TRANSPORT and OTHER. The distinction is made between fossil fuel $CO_2$ (CO2ff) and biofuel $CO_2$ (CO2bf) using the IEA definition to identify what belongs to the second category of "biofuel" that generate CO2bf (Biofuels, Biogas, Peat and Solid biomass) and the fraction of fossil carbon for each waste categories and different waste types/materials included in solid waste for open waste burning source.

For $CO_2$ and $CH_4$ emissions factors (EF), we used $CO_2$ EF obtained from field measurement data for the sources studied in Keita et al. (2018) (https://doi.org/10.5194/acp-18-7691-2018) for residential, commercial, road transport and open waste burning; $CO_2$ and $CH_4$ emission factors from Akagi et al. (2011) and Doumbia et al. (2019) were used for charcoal making, solid waste burning and gas flaring. For all other sources, we used default emission factors from IPCC (2006). Figure 4 and 5 show respectively the 2018 CO2ff emissions spatial distribution for 3 sub sectors and sub-sector contribution to CO2ff and CO2bf emissions.

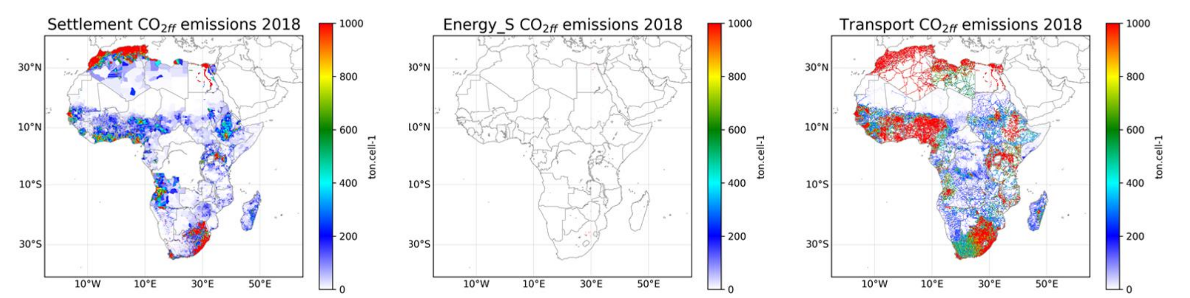


**Figure 4: Spatial distribution of CO2ff emissions for 2018 for Energy_S, Transport and Settlements sources**

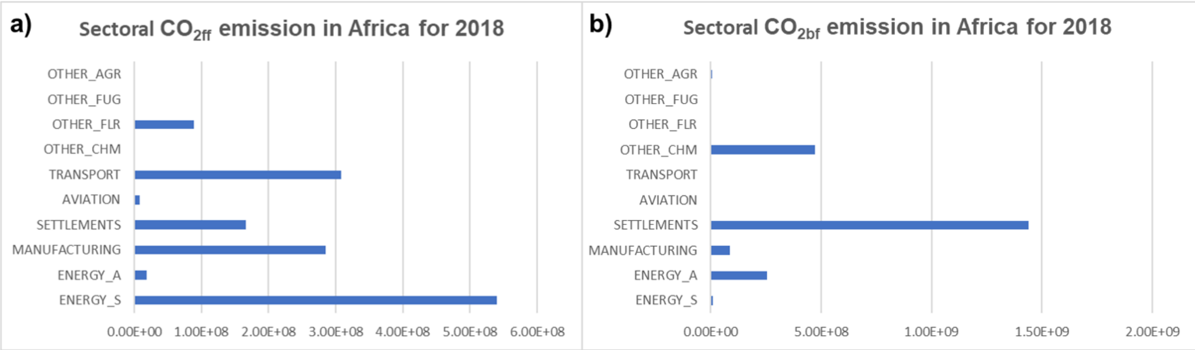


**Figure 5: $CO_2$ emissions (a) fossil $CO_2$ and b) biofuel $CO_2$) in tCO2eq. for the different sector (Energy_S, Energy_A, Manufacturing, Settlements, Domestic aviation, Transport (road, domestique navigation and rail) and Other (charcoal making, flaring, fugitive and agricultural soil).**

Contact persons: Claire.granier@aero.obs-mip.fr
sekou.keita@aero.obs-mip.fr,
antonin.soulie@aero.obs-mip.fr

## 1.3 Global biofuel production and consumption maps

The biofuel production and consumption provide an alternative view on $CO_2$ sources and sinks related to biofuel. It is not to be used directly with the anthropogenic emission and biogenic data sets described in this deliverable report as there will be double counting involved. It is a complementary source of information that will help to inform on the important role of biomass and biofuel in carbon accounting.

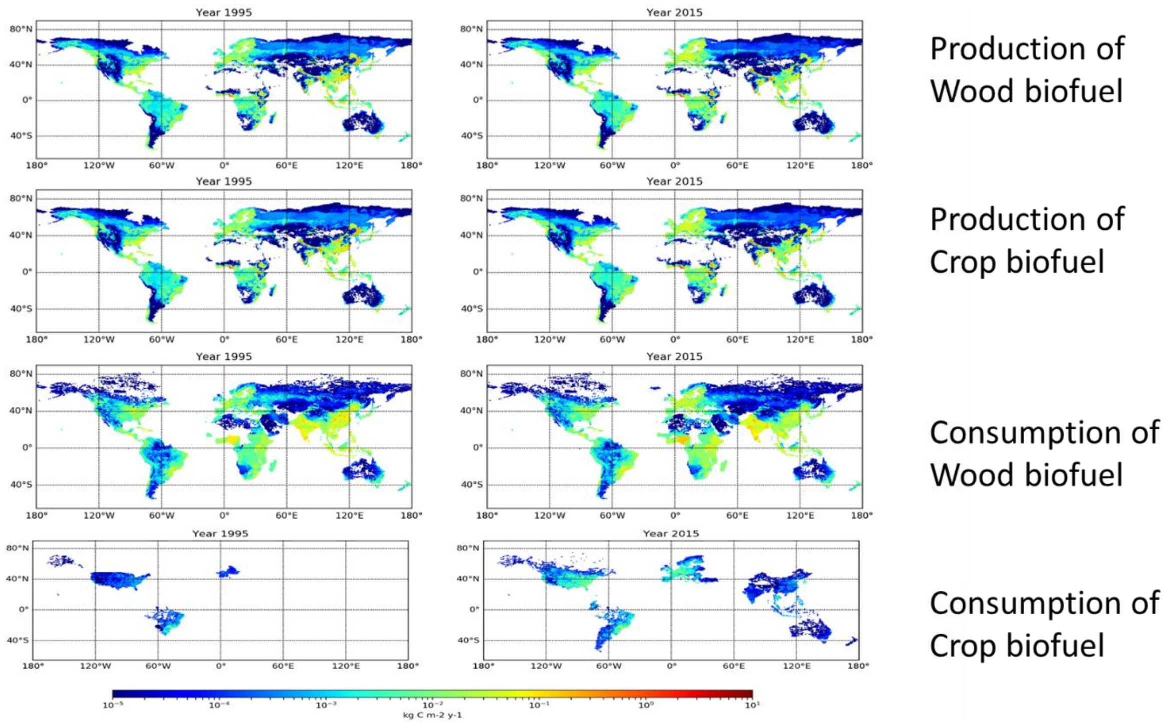


**Figure 6 Preliminary maps of wood biofuel and crop biofuel production and consumption in 1995 and 2015 (source LSCE).**

For trade fluxes, statistics from the Food and Agriculture Organization of the United Nations (FAO) have been analysed with appropriate conversion factors and disaggregated on the 0.08-degree global grid with a series of proxies and activity maps. River fluxes come from a data-driven climatology. Biofuel sinks and sources from crop and wood have been explicitly included, in collaboration with Yilong Wang (Institute of Geographical Sciences and Natural Resources Research, China). To that end, trade statistics from the International Energy Agency (IEA) and spatial distribution maps from Peking University (PKU) have been included in the processing.

The products are 0.08-deg annual maps with the following variables, in gC $m^{-2}$ $yr^{-1}$:

- Surface upward mass flux of carbon from crop use including biofuels
- Surface downward mass flux of carbon from crop growth including biofuels
- Surface upward mass flux of carbon from wood use including biofuels
- Surface downward mass flux of carbon from wood production including biofuels
- Surface upward mass flux of carbon from biofuel crop burning
- Surface downward mass flux of carbon from biofuel crop growth
- Surface upward mass flux of carbon from biofuel wood burning
- Surface downward mass flux of carbon from biofuel wood production
- Terrestrial biospheric carbon that is reactive in the inland water network (counted positive)
- Surface upward mass flux of carbon from rivers, lakes and reservoirs

For further descriptions we refer to Ciais et al. (2022); Deng et al. (2022) and Ciais et al (2007). LSCE will update the data into a v3 in spring 2022 when input data for year 2021 is available.

The latest data can be accessed from:

https://vesg.ipsl.upmc.fr/thredds/fileServer/work/p24cheva/LateralFluxes/lateralfluxes_${yyyy}_v2.nc

with ${yyyy} any year between 1961 and 2020.

Contact persons: philippe.ciais@lsce.ipsl.fr; frederic.chevallier@lsce.ipsl.fr

# 2 Overview of biogenic prior emission data for 2018

## 2.1 Regional biogenic prior emission datasets for 2018

For the European domain, biogenic fluxes at 1-km resolution for GPP and respiration have been prepared based on the diagnostic light-use-efficiency model VPRM (Vegetation Photosynthesis Respiration Model, Mahadevan et al., 2008). This simple model is driven by indices derived from satellite measurements, namely the enhanced vegetation index (EVI) and the land surface water index (LSWI) as well meteorological data.

The remotely sensed indices EVI and LSWI are calculated based on 8-day reflectances measured by MODIS (product MOD09A1, version 6), which are measured at spatial resolutions between 500 m and 1 km. A loess filter is applied to the signals at the pixel scale. Hourly meteorological (2-m temperature and shortwave radiation at the surface) are taken from the ECMWF ERA5 reanalysis data at 0.25° resolution.

The model considers the fractional coverage of seven different land cover classes, currently defined by the landcover map SYNMAP (Jung et al., 2006). Within the project, development is underway to replace this with the regularly updated Copernicus Land Service 100-m land cover map, but this has not been sufficiently tested to include in the initial data release. For each of the landcover types two parameters are fit to match measurements from local flux tower sites from a different year. In this case, the parameters were fit based on a selection of representative European sites for each landcover type using data for the year 2007, retrieved from www.europe-fluxdata.eu. For more information about which sites were used and the parameter values we refer to Gerbig (2021).

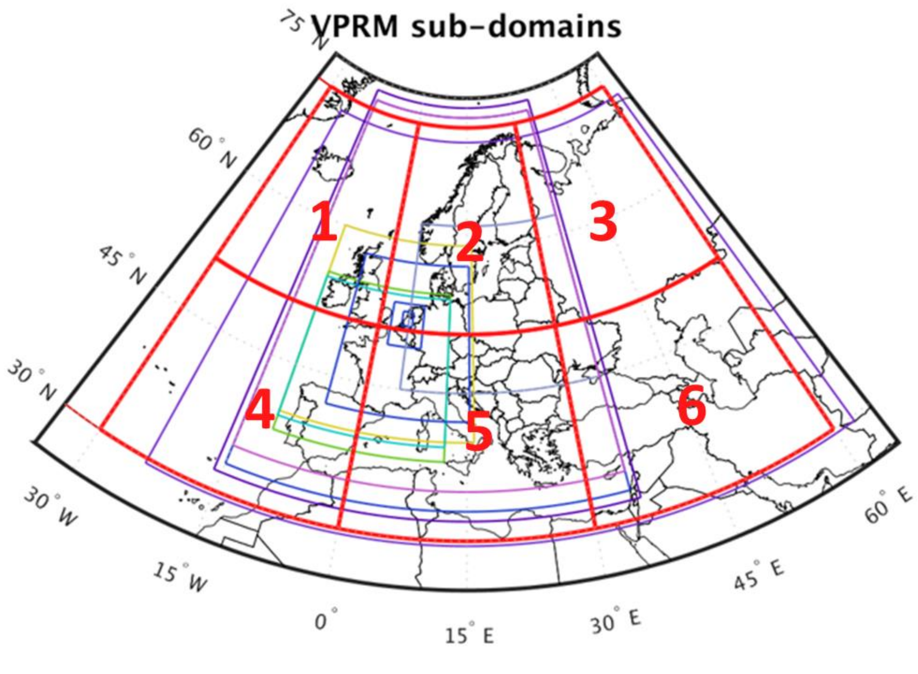


**Figure 5. Europe subdomains (red panels) for the hourly, 1 x 1 km 2018 biogenic fluxes made with the VPRM model.**

Taking into account the different regional modelling domains planned within CoCO2 WP4 it was decided to simulate the full European domain as covered by the TNO regional anthropogenic emissions data. The whole domain is than prepared at the same spatial resolution of ~1 x 1 km (i.e., 1/120° latitude and 1/60° longitude). The data were split in six panels or tiles (see Figure 5) for file handling. One day for one tile is about 850 MB, for the whole domain one day is ~5 GB, one year is ~1.8 TB.

Contact person: Julia.Marshall@dlr.de

## 2.2 Global biogenic prior emission datasets for 2018

Biogenic carbon flux estimates based on integrating in-situ observations and satellite data using machine-learning methods are provided from the Fluxcom approach (Tramontana et al., 2016, Jung et al., 2017, Bodesheim et al., 2018, www.fluxcom.org). In this, statistical relationships between in-situ observations of carbon fluxes and environmental conditions are learned and transferred to global gridded estimates using satellite observations and meteorological data of the same predictors. Data based on an extension of the approach described in Bodesheim et al. 2018 will be provided. Those use eddy-covariance-derived net and gross carbon (using nighttime partitioning after Reichstein et al. 2005 only) fluxes in the FLUXNET La Thuile data set, random forest as a machine learning method and the following predictor variables:

### 2.2.1 Spatial and temporal details:

- mean seasonal cycle of the product of the enhanced vegetation index (EVI) and potential radiation (Rpot)
- mean seasonal cycle of the product of fPAR and daytime land surface temperature (LST)
- minimum of mean seasonal cycle of the normalized difference water index (NDWI)
- amplitude of mean seasonal cycle of band 4 BRDF reflectance
- mean seasonal cycle of nighttime LST
- amplitude of mean seasonal cycle of NDVI
- plant functional type
- amplitude of mean seasonal cycle of water availability index 2

Daily:

- Water availability index 2
- product of global radiation (total solar incoming at the surface) and the mean seasonal cycle of the normalized difference vegetation index (NDVI)
- air temperature

Hourly:

- potential radiation
- derivative of potential radiation
- air temperature
- vapour pressure deficit (VPD)
- global radiation (total solar incomding at the surface)

Remotely sensed data are based on a mean seasonal cycle of measurements by the MODIS instrument collection 5 (Tramontana et al. 2016). One model is trained for all hours of the day. In the forward runs, the differentiation between the hours is achieved through hourly meteorological information, in particular potential radiation and its derivative. Daily and hourly meteorological information is derived from ECMWF ERA5 reanalysis data for the predictions. Potential radiation is calculated based on time of the year, day and location. The inclusion of sub-daily meteorological information affects diurnal cycles compared to the typical shapes based on only daily meteorology. 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/ .

Towards the end of 2021 a complementary product at higher spatial resolution of 0.05deg generated in the newly developed Fluxcom2.0 will be made available.

Contact persons: mjung@bgc-jena.mpg.de; swalth@bgc-jena.mpg.de

## 2.3 Global ocean flux datasets for 2018

A first version of air-sea $CO_2$ fluxes for 2018 at a monthly frequency has been provided to Anna Agusti-Panareda (leader of WP3) as a boundary condition (air-sea interface) of the global CO2MVS prototype. These files come from a multi-year simulation (1992-2019) at 1/4° resolution with the ocean NEMO-PISCES model, but without any data assimilation (neither physical nor biogeochemical observations). This simulation is disseminated on the web portal of the Copernicus Marine Environment Monitoring Service. More information on this product can be found in the Quality Information Document: https://resources.marine.copernicus.eu/?option=com_csw&view=details&product_id=GLOBAL_REANALYSIS_BIO_001_029

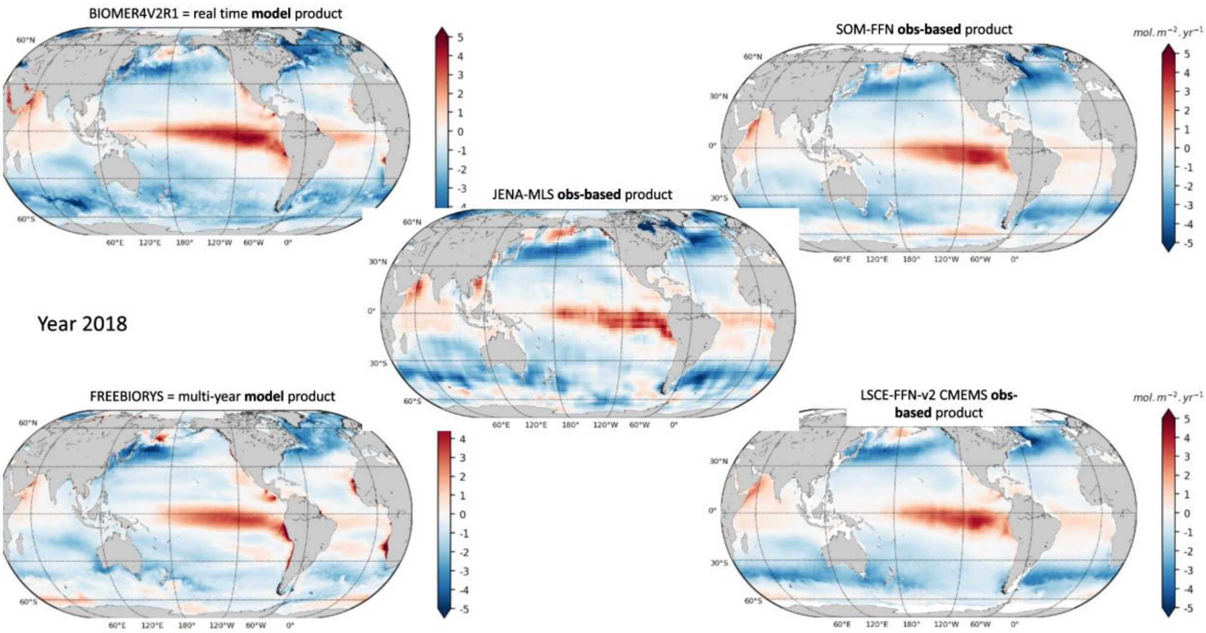


**Figure 6 : Illustration of the comparison for year 2018 between modelled solutions on the left column (above: the real time system with both Ocean colour data assimilation and physical data assimilation; below: the multi-year simulation without any data assimilation) and the observation-based products on the two right columns.**

These $CO_2$ flux fields were previously interpolated from the ORCA tripolar grid toward a regular 1/4° grid.

The assessment of these $CO_2$ fluxes with observation-based products based on SOCAT ocean surface pCO2 database) is on-going. For this comparison, 3 products will be used:

- JENA-MLS (Rödenbeck et al. 2013, 2014): observation-driven ocean mixed-layer scheme
- SOM-FFN (Landschützer et al. 2016): neural network-based data interpolation method
- LSCE-FFN-v2 (QuiD, Denvil-Sommer et al. 2019): on Marine Copernicus web portal (here ): neural network-based data interpolation method

Figure 6 provides an overview of the comparison for year 2018 for the different products. The next step is to develop data assimilation of surface ocean pCO2 maps (and then BGC-Argo database) in our model in order to improve the air-sea $CO_2$ fluxes that are provided to WP3. On top of that, we will test the use of atmospheric pCO2 (annual global mean) from ECMWF to be more consistent between Copernicus $CO_2$ and Copernicus marine services.

Contact person: cperruche@mercator-ocean.fr

## 2.4 LULUCF datasets for 2018

For the global land sink of $CO_2$ JRC compiled a dataset of national GHG Inventories, including Annex I countries reports, non-Annex I NC and BUR and FAOSTAT estimates for some non-Annex I countries. Taking the average for the epochs around 2010 and 2015, the global land sink amounts to only 0.3 GtC $y^{-1}$, which is significantly smaller than inversions estimate. More details and an explanation of the differences are given by Grassi et al. (2021). Bottom-up scientific maps are under development, using the spatial land cover data of ESA-CCI+ and the methodology of IPCC (2006). This product will be finalised in Q1 of 2022 resulting in a more updated version of the LULUCF database used in Grassi et al. 2021 (based on country submissions to UNFCCC). The dataset is strictly speaking not a CoCO2 product but an important resource in the framework of providing a Prior Emission Dataset and is therefore included here. More details will be given in the 2021 PED deliverable in 2022. A paper describing this result is to be submitted in the first half of 2022. The associated datasets will become fully available online upon submission of the manuscript. If urgently needed by CoCO2 partners before this Dr. Giacoma Grassi (JRC) can be contacted and status / availability can be discussed.

Contact person: Giacomo.Grassi@ec.europa.eu

# 3 Emission height profiles by source sector

The following subsections describe the sector-dependent emission height profiles proposed as a first step for the vertical distribution of the regional and global anthropogenic prior emission datasets, respectively.

Individual emission height profiles for specific industrial facilities (i.e., top emitters) could be developed and provided as a next step. Prior to that, interaction with modellers is needed to understand their requirements and identify how the representation of point sources in the proposed case studies can be improved.

## 3.1 Regional

Table 3 summarises the TNO default emission height profiles proposed by GNFR sector. The information is derived from Table 3 in Bieser et al. (2011). The lowest layer over 0-92 m is split into a surface part for 0-20 m and remainder, to better facilitate simulation models that usually have a first layer of this thickness. Surface emissions are then 100% assigned to this 0-20 m layer. The table shows height distributions as fractions (0-1) for the different layers. The header shows the top of the layer in m.

**Table 3 Sector-dependent emission height profiles proposed for regional anthropogenic prior emission datasets**

| GNFR Category | 0-20m | 20-92m | 92-184m | 184-324m | 324-522m | 522-781m | 781-1106m |
|---|---|---|---|---|---|---|---|
| A | 0 | 0 | 0.0025 | 0.51 | 0.453 | 0.0325 | 0.002 |
| B | 0.06 | 0.16 | 0.75 | 0.03 | 0 | 0 | 0 |
| C | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| D | 0.02 | 0.08 | 0.6 | 0.3 | 0 | 0 | 0 |
| E | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| F1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| F2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| F3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| F4 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| G | 0.2 | 0.8 | 0 | 0 | 0 | 0 | 0 |
| H | 0.25 | 0.25 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| I | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| J | 0 | 0.41 | 0.57 | 0.02 | 0 | 0 | 0 |
| K | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| L | 1 | 0 | 0 | 0 | 0 | 0 | 0 |

contact persons: hugo.deniervandergon@tno.nl
jeroen.kuenen@tno.nl

## 3.2 Global

Table 2 summarises the simplified sector-dependent emission height profiles proposed as a first step for the vertical distribution of global anthropogenic emissions. The information is derived from the height profiles proposed for the regional scale (section 3.1). For the sectors not included in the table all emissions should be injected at the surface level.

**Table 2 Sector-dependent emission height profiles proposed for global anthropogenic prior emission datasets**

| Sector | Description | Injection height [m] |
|---|---|---|
| ene | Power generation | 200 - 800 |
| ind | Industrial process | 20 - 300 |
| shp | Shipping | 30 - 100 |
| swd (*) | Solid waste and waste water | 20 - 100 |
| (*) only applicable to emissions mainly related to incineration plants and open burning of waste (i.e. NOx, CO, NMVOC, SO2, PM10, PM2.5, CO2).<br>CH4 and NH3 are mainly diffuse emissions from solid waste disposal sites and water waste treatment plants and should be injected at the surface level | | |

contact person: marc.guevara@bsc.es

# 4 Conclusion

This deliverable report documents the development of a Prior Emission Dataset (PED) for the year 2018. The PED consists of different components that are complementary such as anthropogenic emissions, biogenic land-based fluxes, and ocean fluxes for a) the global scale and b) the regional European scale. The report also provides a brief description and access to two datasets that provide complementary information on lateral carbon fluxes and LULUCF carbon fluxes. In a separate chapter brief information on emission height for the anthropogenic regional and the global data set is provided by source sector.

As indicated, for each product the report provides contact persons for further details and access to the data. As such this document is a guide to the other CoCO2 WPs on what data has been prepared and how to get access to it.

In Year 2 of CoCO2 the 2021 PED will be delivered, and a discussion can be had on whether it is necessary to have all the prepared data stored in a central place and where this should be. The latter is not trivial as the data size of especially the high resolution, hourly biospheric flux data is enormous and cannot be simply hosted on a project sharepoint or equivalent. Discussions are ongoing to see if the ICOS carbon portal can be a solution for this.

# 5 References

Bieser, J., Aulinger, A., Matthias, V., Quante, M., Denier van der Gon, H.A.C.: Vertical emission profiles for Europe based on plume rise calculations, Environmental Pollution, Volume 159, Issue 10, 2011, Pages 2935-2946, doi:10.1016/j.envpol.2011.04.030.

Ciais, P., Bastos, A., Chevallier, F., Lauerwald, R., Poulter, B., Canadell, J. G., Hugelius, G., Jackson, R. B., Jain, A., Jones, M., Kondo, M., Luijkx, I. T., Patra, P. K., Peters, W., Pongratz, J., Petrescu, A. M. R., Piao, S., Qiu, C., Von Randow, C., Regnier, P., Saunois, M., Scholes, R., Shvidenko, A., Tian, H., Yang, H., Wang, X., and Zheng, B.: Definitions and methods to estimate regional land carbon fluxes for the second phase of the REgional Carbon Cycle Assessment and Processes Project (RECCAP-2), Geosci. Model Dev., 15, 1289–1316, https://doi.org/10.5194/gmd-15-1289-2022, 2022.

Ciais, P., P. Bousquet, A. Freibauer, T. Naegler. Horizontal displacement of carbon associated with agriculture and its impacts on atmospheric CO 2. Global Biogeochemical Cycles, American Geophysical Union, 2007, 21 (2), pp.GB2014. ff10.1029/2006gb002741

CMT, 2021, Global Coal Mine Tracker, online database. URL: https://globalenergymonitor.org/projects/global-coal-mine-tracker/

Deng, Z., Ciais, P., Tzompa-Sosa, Z. A., Saunois, M., Qiu, C., Tan, C., Sun, T., Ke, P., Cui, Y., Tanaka, K., Lin, X., Thompson, R. L., Tian, H., Yao, Y., Huang, Y., Lauerwald, R., Jain, A. K., Xu, X., Bastos, A., Sitch, S., Palmer, P. I., Lauvaux, T., d'Aspremont, A., Giron, C., Benoit, A., Poulter, B., Chang, J., Petrescu, A. M. R., Davis, S. J., Liu, Z., Grassi, G., Albergel, C., and Chevallier, F.: Comparing national greenhouse gas budgets reported in UNFCCC inventories against atmospheric inversions, Earth Syst. Sci. Data, accepted, 2022.

Gerbig, C. (2021). Parameters for the Vegetation Photosynthesis and Respiration Model VPRM (Version 1.0). ICOS-ERIC - Carbon Portal. https://doi.org/10.18160/R9X0-BW7T

GIE, 2018, Storage Database. Gas Infrastructure Europe. URL: https://www.gie.eu/index.php/gie-publications/databases/storage-database

Grassi, G., Stehfest, E., Rogelj, J. *et al.* Critical adjustment of land mitigation pathways for assessing countries' climate progress. *Nat. Clim. Chang.* **11,** 425–434 (2021). https://doi.org/10.1038/s41558-021-01033-6

Jalkanen, J.-P.P., brink, A., Kalli, J., Pettersson, H., Kukkonen, J., Stipa, T., Kuukkonen, J., and T. Stipa, Kukkonen, J., Stipa, T., 2009. A modelling system for the exhaust emissions of marine traffic and its application in the Baltic Sea area. Atmos. Chem. Phys. 9, 9209–9223. https://doi.org/10.5194/acp-9-9209-2009

Jalkanen J.-P., E. Majamäki, Improve the ship emissions applying the FMI approach to emission modelling, Deliverable report CAMS81_2020SC1_ D81.2.3.1_Improved ship emissions for 2014-2020, CAMS, 2021

Jung, M., Henkel, K., Herold, M., and Churkina, G.: Exploiting synergies of global land cover products for carbon cycle modeling, Remote Sens. Environ., 101, 534–553, 2006.

Mahadevan, P., Wofsy, S. C., Matross, D. M., Xiao, X., Dunn, A. L., Lin, J. C., Gerbig, C., Munger, J. W., Chow, V. Y., and Gottlieb, E. W. (2008), A satellite-based biosphere parameterization for net ecosystem CO2 exchange: Vegetation Photosynthesis and Respiration Model (VPRM), Global Biogeochem. Cycles, 22, GB2005, doi:10.1029/2006GB002735.

## Document History

| Version | Author(s) | Date | Changes |
|---|---|---|---|
| | Name (Organisation) | dd/mm/yyyy | |
| V0.1 | Hugo Denier van der Gon (TNO) | 28/02/2022 | Compilation of all contributions, harmonization and editing. |
| V1.0 | Hugo Denier van der Gon (TNO) | 02/03/2022 | Processing of review comments, added table of Effort Contribution per Partner |
| | | | |

## Internal Review History

| Internal Reviewers | Date | Comments |
|---|---|---|
| Richard Engelen (ECMWF) | 01/03/2022 | Mostly editorial corrections |
| | | |
| | | |
| | | |
| | | |

## Estimated Effort Contribution per Partner

| Partner | Effort |
|---|---|
| TNO | 5 |
| CNRS-LA | 6.5 |
| DLR | 1 |
| MPG | 1.5 |
| BSC | 0.5 |
| MOi | 6 |
| CEA | |
| JRC | 1 |
| **Total** | **21,5** |