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Horizon 2020 Societal challenge 5:
Climate action, environment, resource
efficiency and raw materials

VERIFY

Observation-based system for monitoring and verification of greenhouse gases

GA number 776810, RIA

Deliverable number (relative in WP)	**D2.1**
Deliverable name:	First high resolution emission data 2005-2015
WP / WP number:	WP2
Delivery due date:	Month 12 (January 2019)
Actual date of submission:	Month 13 (15/02/2019)
Dissemination level:	Public
Lead beneficiary:	TNO
Responsible	TNO
Contributor(s):	TNO
Internal reviewer:	/

1. Changes with respect to the DoA.

The data was delivered on time via email to the coordinator CEA/LSCE, on 1st February 2019. But the report couldn't be prepared on time. On 7th February 2019, the coordinator asked the Project Officer for a two weeks delay – the PO agreed.

2. Dissemination and uptake

(Who will/could use this deliverable, within the project or outside the project?)

The TNO GHGco high resolution emission inventory will be used in Tasks 2.3 and 2.4 of VERIFY, and WP6 of the CHE project.

3. Short Summary of results (<250 words)

The TNO GHGco emission inventory was compiled for WP2. It is a high resolution (~6 x 6km over central Europe) gridded inventory which provides a consistent 11-year timeseries (2005-2015) and includes anthropogenic emissions of CO2 (fossil fuel and biofuel separately), and the co-emitted species CO (fossil fuel and biofuel separately), NOx, CH4 and NMVOC.

4. Evidence of accomplishment

(report, manuscript, web-link, other)

The TNO GHGco v.1.1 high resolution emission inventory has been made available via the FTP server to VERIFY partners. Several tables and figures in this deliverable show the results in detail.

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Version	Date	Description	Author (Organisation)
V0	08/02/2019	Writing	Stijn Dellaert (TNO), Jeroen Kuenen (TNO), Hugo Denier van der Gon (TNO), Sander Jonkers (TNO), Antoon Visschedijk (TNO)
V2	15/02/2019	Formatting/Delivery on the Participant Portal	Sonia Firion (CEA/LSCE)

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1. Introduction

High resolution gridded emission inventories have significant added value for modelling at the regional/local level, allowing larger concentration gradients due to emission being averaged over a smaller area. The local influence of relatively small but diffuse emission sources becomes better visible at higher resolutions and is crucial for the verification of emission inventories using in-situ or satellite observations. Especially when comparing modelled concentrations with local atmospheric measurements, emission data that is more accurately distributed in space and time allows for more reliable analysis.

This deliverable describes the compilation of the emission inventory data and the compilation of the high resolution spatial distribution proxy maps that were used to create the gridded emission inventory. Furthermore, some results of the high resolution gridded inventory will be shown.

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2. Compilation of TNO GHGco emission inventory v1.1

This chapter describes the first version of the TNO greenhouse gas and co-emitted species emission database (GHGco) at the resolution of 0.1° x 0.05° (~ 6 km x 6 km) for the years 2005 – 2015. The dataset covers the entire European domain for the GHGs: CO_2 (distinguishing between fossil fuel CO_2 and biofuel CO_2), methane (CH_4) and key co-emitted species that may be used as tracers: CO (also distinguishing between fossil and biofuel), nitrogen oxides (NO_x) and non-methane volatile organic compounds (NMVOC). This chapter describes briefly the methodology followed and presents the resulting emission inventory for the European domain.
The most important characteristics of the emission inventory are shown in Table 1. The spatial domain of the inventory is shown in Figure 1. A first version v1.0 was released to VERIFY WP2 partners in October 2018 (M9). This version is the starting point for the modelling studies. Also a specific zoom area has been defined where the gridding is performed at much higher resolution (~ 1 km x 1 km). This zoom version will cover the VERIFY WP2 case study region in the Rhine valley. During preparation of the 1 km x 1km emissions, some errors and inconsistencies in the initial preliminary delivery were found. This has resulted in a version v1.1 where these issues are resolved, which has been released the 1st of February 2019.

Table 1: Characteristics of the TNO GHGco v.1.1 high resolution emission inventory

TNO GHGco v.1.1 high resolution emission inventory	
Greenhouse gases	CO_2_ff, CO_2_bf, CH_4 (all anthropogenic)
Co-emitted species	CO_ff, CO_bf, NOx, NMVOC
Resolution	1/10° x 1/20° (longitude latitude, ~ 6x6 km over central Europe)
Period covered	2005 – 2015 (annual emissions)
Domain	30° W – 60° E 30° N – 72°N
Sector aggregation	GNFR (A to L), with GNFR F (Road Transport) split in F1 to F4 (total 15 sectors)
Emission unit	kg/year/gridcell or point source (both in CSV and NetCDF files)
Countries	42 countries + 13 sea regions Note: Emissions for other countries within the domain are added based on EDGAR v4.3.2

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Figure 1: Spatial domain of the high resolution (~6x6 km) emission inventory

2.1. Methodology for European anthropogenic emissions 2005-2015.

The methodology that was used for developing the TNO GHG and co-emitted species regional emissions is shown in Figure 2. The development of this inventory is a shared activity with the H2020 CO_2 Human Emissions project (CHE). The methodology is a further development and refinement of the method used for the earlier TNO_MACC, MACC-II and MACC-III emission inventories (Kuenen et al., 2014). The method starts from the reported emissions by European countries to UNFCCC (United Nations Framework Convention on Climate Change) for greenhouse gases and to EMEP/CEIP (European Monitoring and Evaluation Programme/ Centre on Emission Inventories and Projections) for air pollutants. The emissions have been aggregated to ~250 different combinations of sectors and fuels. Because of the different level of detail in reporting between air pollutants and greenhouse gases, in specific cases aggregation and/or disaggregation was needed to harmonize the sectors between all pollutants and countries.

The reported data have been checked for gaps, errors and inconsistencies and form the basis for the TNO_GHGco emission inventory for 2005 – 2015 to be used in the H2020 VERIFY project. Where needed, reported data were replaced or completed using other emission data from the GAINS model[1], EDGAR inventory (Crippa et al., 2016) or internal TNO estimates. Expert judgement was used to make choices on which data source to use in the final inventory. Emissions from sea shipping is added based on results from the STEAM model (Jalkanen et al, 2016) using AIS data as prepared for the Copernicus Atmospheric Monitoring service (CAMS). Inland shipping emissions are replaced with an own TNO estimate since the reporting of shipping emissions across countries is not consistent enough. The resulting emission data set is then checked in detail with regard to its absolute values and trends.

[1] http://www.iiasa.ac.at/web/home/research/researchPrograms/air/GAINS.html

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Thereafter, a consistent spatial distribution methodology is applied for the European domain (Figure 1) where each emission source gets a specific proxy assigned which defines the way emissions are to be spatially distributed over the country. For point sources, information was collected on the location of power plants, large industrial installations, oil and gas production sites, airports and waste treatment locations (e.g. landfills). For area sources, proxies are collected that are thought to best represent the spatial variability of each specific emission source (Table 2). Automated scripts have been developed to calculate the spatially distributed emissions, which are subsequently aggregated from the most detailed level to the GNFR level (see Table 2 for GNFR codes) for the gridded output files in order to limit the total amount of data.

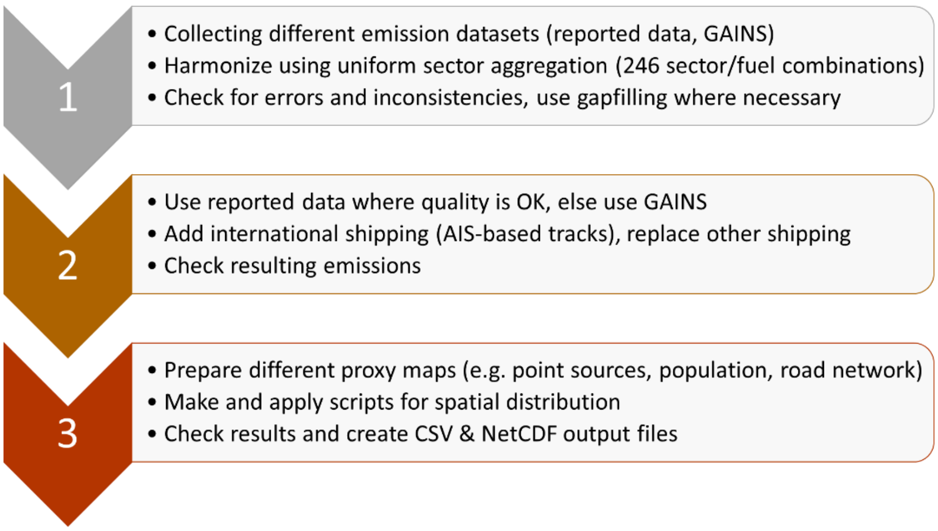

Figure 2. Methodology for developing the anthropogenic global emissions.

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Table 2. Proxy variables that represent spatial variability of the emission sources.

GNFR	Source	Key proxies used
A	Public power	Power plant point sources (from E-PRTR and CARMA databases), CORINE land cover industrial area
B	Industry	Industrial point sources (from E-PRTR and TNO database), CORINE land cover industrial area
C	Other stationary combustion	Population (total/rural/urban), wood use (for biomass combustion)
D	Fugitives	Point sources (oil and gas production sites, coal mines, refineries) and diffuse sources (high pressure gas transmission lines & population density)
E	Solvents	Population density, CORINE land cover industrial area (for industrial solvent use)
F	Road transport	Open street map & Open transport map derived road networks
G	Shipping	AIS based shipping tracks & port locations
H	Aviation	Airport locations
I	Off road	Population density, rail network, inland waterways, CORINE land cover industrial area (for industrial applications)
J	Waste	Waste water treatment and large incinerators point sources, population (total/rural)
K	Agriculture livestock	Gridded livestock (FAO)
L	Agriculture other	Arable land & mixed (CORINE)

2.1.1. Updates and improvements compared to the earlier TNO emissions data

The main features (and improvements compared to earlier TNO_MACC inventories) of this dataset are:

- A horizontal resolution of 0.1° x 0.05° (lon x lat) to align with other emission inventories such as EDGAR and EMEP, which have a resolution of 0.1° x 0.1° (lon x lat). The resolution is around 30% higher compared to earlier TNO emission inventories (such as the TNO_MACC inventories) which were at 0.125° x 0.0625° (~7x7 km).
- The sector classification in the emission grids has been updated from SNAP to GNFR (See Table 3). GNFR is an aggregated version of the NFR which is used by individual country emission reporting to EMEP and European Union, therefore it has also been implemented in the TNO_GHGco emission inventory. More details on the sector classification can be found in Table 3 and http://www.ceip.at/ms/ceip_home1/ceip_home/reporting_instructions/ .
- Along with the updated grid definition used, the allocation and identification of countries has been updated in accordance with the current countries and borders. Compared to the

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TNO_MACC emission inventories, ISO3 code YUG (consisting of Serbia and Montenegro) has been replaced by individual codes for Serbia, Montenegro and Kosovo.

- EDGAR data have been used for gapfilling for those countries that are part of the domain, but not part of UNECE Europe (in North Africa and the Middle East). This implies that all anthropogenic releases within the domain are now covered in this dataset. The emissions and distribution are based on EDGAR v4.3.2 for all substances, covering years 2000-2012. From 2012 onwards, these emissions are assumed constant since no EDGAR data were readily available at the time when this emission inventory was created.

Table 3. GNFR Sector explanation and link to SNAP nomenclature previously used in TNO-MACC emission inventories.

GNFR_Category	GNFR_Category_Name	Link to SNAP
A	A_PublicPower	SNAP 1, only power and heat plants
B	B_Industry	SNAP 1 (non-power and heat plants) + SNAP 34 (or SNAP 3+4)
C	C_OtherStationaryComb	SNAP 2
D	D_Fugitives	SNAP 5
E	E_Solvents	SNAP 6
F	F_RoadTransport	SNAP 7
G	G_Shipping	SNAP 8, only shipping (all types)
H	H_Aviation	SNAP 8, only aviation
I	I_OffRoad	SNAP 8, non-shipping and non-aviation
J	J_Waste	SNAP 9
K	K_AgriLivestock	SNAP 10, livestock only
L	L_AgriOther	SNAP 10, non-livestock only
F1	F_RoadTransport_exhaust_gasoline	SNAP 71
F2	F_RoadTransport_exhaust_diesel	SNAP 72
F3	F_RoadTransport_exhaust_LPG_gas	SNAP 73
F4	F_RoadTransport_non-exhaust	SNAP 74 + SNAP 75 [Note that SNAP 74 has only NMVOC and SNAP 75 has only PM emissions]

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2.1.2. Key features of the spatial distribution

Two types of spatial distribution are used, point sources and area sources (grid cells).

Point sources

Power plants & industrial facilities

For power plants, the locations and characteristics of each large power plant in Europe have been collected from the combination of various datasets:

- E-PRTR (European Pollutant and Transfer Register[2])
- CARMA database (Carbon Monitoring for Action[3])
- Reporting of EU Member States to the Large Combustion Plants Directive (LCPD) and Industrial Emissions Directive (IED)
- Platts-WEPP (World Electric Power Plants database[4], version December 2015)

These datasets have been linked together to obtain a full overview of the power plants and to identify gaps and errors, which have been corrected and gapfilled to the extent possible.
For industrial point sources, the E-PRTR emission dataset has been used for EU(28), and the TNO industrial point source database has been used for other European countries. To the extent possible, gaps and errors in the emission reporting have been corrected and gapfilled. The following point source categories are distinguished:

- Mineral oil and gas refineries
- Coal mining
- Primary iron and steel incl. coke
- Other iron and steel
- Non-ferrous metals (incl. aluminium)
- Non-metallic minerals
- Chemical industry
- Paper and pulp production
- Other industry
- Waste incineration
- Landfills
- Other waste disposal

Note that the emissions for both power plants and industrial sources are used in an absolute instead of a relative way. In the earlier TNO_MACC inventories, the point source data was used only to distribute national total emissions for the relevant sector in a relative sense. In this inventory, the exact emissions as recorded in the E-PRTR are used. Remaining emissions are

[2] http://prtr.ec.europa.eu/
[3] http://carma.org/
[4] https://www.platts.com/products/world-electric-power-plants-database

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distributed using industrial area land cover classification from CORINE. Only in case the sum of point source emissions exceeds the national total for that sector, the point source emissions within that sector are all scaled down to not exceed the national total for the respective sector.
During the compilation of point source emissions it became clear that reporting is incomplete for various reasons. For example, the emission of the co-emitted species e.g. NOx may be below the reporting threshold. However, if a point source emits CO_2 it will also emit NOx. Therefore, for all point sources where CO_2 emissions were reported, missing NOx emissions have been estimated, for example based on the ratio between these substances in other reporting years. In some cases, emissions have not been reported during 1 or a few years of the 2005-2015 time series. These cases were not investigated on an individual basis but were gapfilled using transparent rules for improving the consistency of the total dataset.

Airports
For airports, a new distribution map has been created based on Eurostat statistics on the passenger and freight flights by airport for each individual year. The main advantage of this update is that yearly specific maps can be created, reflecting the opening and closure of airports during the time series, as well as growth in air traffic in specific airports.

Waste water treatment plants
The annual throughput of each treatment plant in the EEA Waterbase UWWTP dataset[5] was used as proxy for this emission source.

TNO point source dataset
For industry outside the EU(28) no E-PRTR emission data is available and use has been made of the TNO point source data, which covers the whole of UNECE Europe. This database records location and capacity of major point source types, including oil and gas production, oil refineries, iron and steel production, non-ferrous metals, cement and major petrochemical production sites. It has been compiled earlier by TNO during 1985 to 2015 and has been subject to continuous updating and maintenance. Various industrial directories have been used to compile the TNO point source database (see e.g. Kuenen et al., 2014).

Area sources

Population density
For population density, the default distribution for many sectors when no specific information is available, three versions of the Landscan population map (https://web.ornl.gov/sci/landscan/) for the years 2005, 2010 and 2015, respectively, have been used. Urban and rural population maps have been created from the population density map by comparing the population density in each cell, with > 250 inhabitants/km^2 categorized as urban and =< 250 inhabitants as rural.

[5] https://www.eea.europa.eu/data-and-maps/data/waterbase-uwwtd-urban-waste-water-treatment-directive-5

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Road transport

The emission from road transport is estimated bottom-up by the product of traffic intensity and emission factors. For the traffic data, we used Open Transport Map (OTM) and -where no OTM data is available - Open Street Map (OSM). Both datasets specify road geometries per road type (e.g. motorway or urban). For many road sections, OTM provides traffic intensities as well. For all road sections where no road data is available, a regression function was applied, which gives a relation between traffic emission and population density (from Landscan). The vehicle emission factors where specified per road type, vehicle type and country. These emission factors resulted from the weighted sum of the fleet composition (Copert/Emisia, 2018[6]) and emission factors per fuel type, technology and capacity (Samaras, 2012).

International and inland shipping

For international and inland shipping, the distribution is based on AIS data and developed by FMI using their STEAM model (Jalkanen et al., 2016). The STEAM emissions are distinguished in sea- and inland shipping, by application of a land-sea mask. We labelled all sea emission as international shipping. In addition to this, a selection of the inland shipping was labelled international too. This was the emission over the Rotterdam, Antwerp and London harbour area, the Western Scheldt, the North-East sea canal and Elbe river. The remainder of the inland emission was further processed as is.

The current shipping distribution is based on a consistent AIS-based map for the year 2016, which is used as the best approximation for 2015. For earlier years, scaling factors have been developed for the shipping emissions to estimate emissions for the years prior to 2015 by sea, taking into account the implementation of environmental control measures in different sea regions.

Livestock

The FAO livestock density maps[7] were used as proxy for livestock emissions. There are separate maps to distribute emissions from cattle, sheep, chicken, goats and pigs.

Industrial areas, arable lands and rice fields

These three spatial distribution maps were created by adapting the 2012 version of the CORINE land cover database[8] to determine the share of each grid cell that is used for each of these functions.

Wood use

For residential wood combustion TNO has developed a dedicated distribution map (see e.g. Kuenen et al., 2014). This map is based on the premise that fuel wood is often sourced locally and that the presence and use of wood combustion appliances is not uniform across various types of houses (e.g. free standing single family vs. high rise apartments). Based on population density classes a wood demand function is assumed, which is overlaid by a wood supply function that is

[6] https://www.emisia.com/utilities/copert-data/
[7] http://www.fao.org/livestock-systems/global-distributions/en/
[8] https://land.copernicus.eu/pan-european/corine-land-cover/clc-2012

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based on sustainable local wood production rates. As a result in more densely populated areas wood use is often limited by supply while in other regions it is limited by demand.

Gas pipelines

The locations of high pressure natural gas transmission pipelines has been taken from Remme et al. (2008). Leakage emissions are distributed uniformly across pipeline locations.

Rail

Railway location and traffic intensities have been taken from the Transtools model (JRC, 2008).

2.1.3. Emission profiles

In addition to the grid files, the following additional information is also provided:

- Temporal profiles: default time profiles are provided per GNFR sector code (consisting of a variation between months, between days of the week and hours in the day).
- Effective emission height: a default effective height is provided per GNFR sector code.
- NMVOC split: a split of NMVOC into components that may be used by modellers.

2.2. Results: the TNO_GHGco_v1.1 emission inventory

Figure 3 shows the contribution of the different sectors (GNFR categories) for each species. For both fossil CO_2 (CO_2_FF) and CO_2 from biofuels (CO_2 _BF), power plants (A), industry (B) and small combustion (C) are the main responsible sectors. For fossil fuel CO_2, road transport accounts for ~25% while for biofuels this is only around 5%. The largest contributor to European CO_2 emissions from biofuel combustion is small combustion (C) with a contribution around 40%. For CO, fossil fuel emissions are dominated by industry (B) and road transport exhaust emissions using gasoline (F1), with smaller contributions from small combustion (C) and the off-road sector (I). CO emissions from biofuel combustion are dominated by small combustion (C) with an additional contribution from non-livestock agriculture (L), which represents the burning of agricultural wastes.

As for the other species, CH_4 is dominated by agriculture (K and L) and waste (J), together representing 80% of the emissions. For NMVOC, the use of solvents (E) is the dominant source while for NO_x road transport using diesel (F2) is the most important source, with other important contributions from power plants (A) and industry (B).

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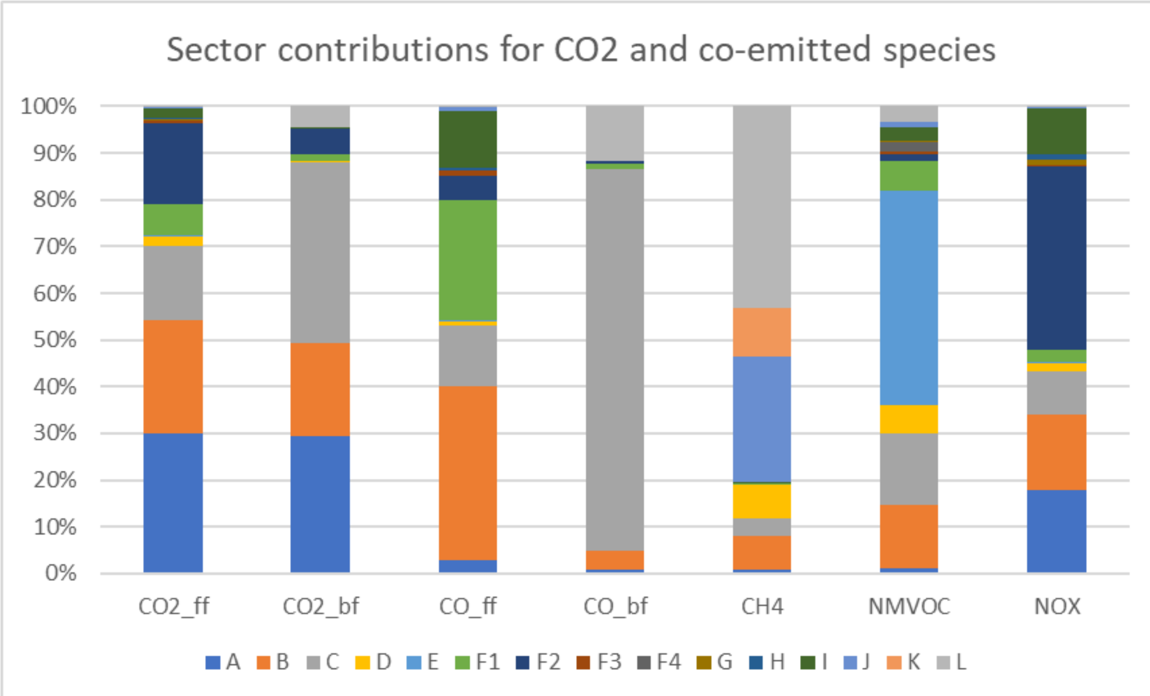

Figure 3. Contribution of the different sectors (GNFR categories, see Table 3) to emission for each species in 2015.

The inventory contains the gridded emission data with annual emission amounts for the time series 2005 – 2015 for the species listed in Table 1. Below, a series of figures show the resulting gridded emission maps for several sectors and substances. Figure 4 shows distributed 2015 emissions for fossil CO_2 from diesel road transport and for biofuel CO_2 from small combustion installations in 2015. Figure 5, Figure 6 and Figure 7 visualize the difference in local emission levels between 2005 and 2015 in the inventory.

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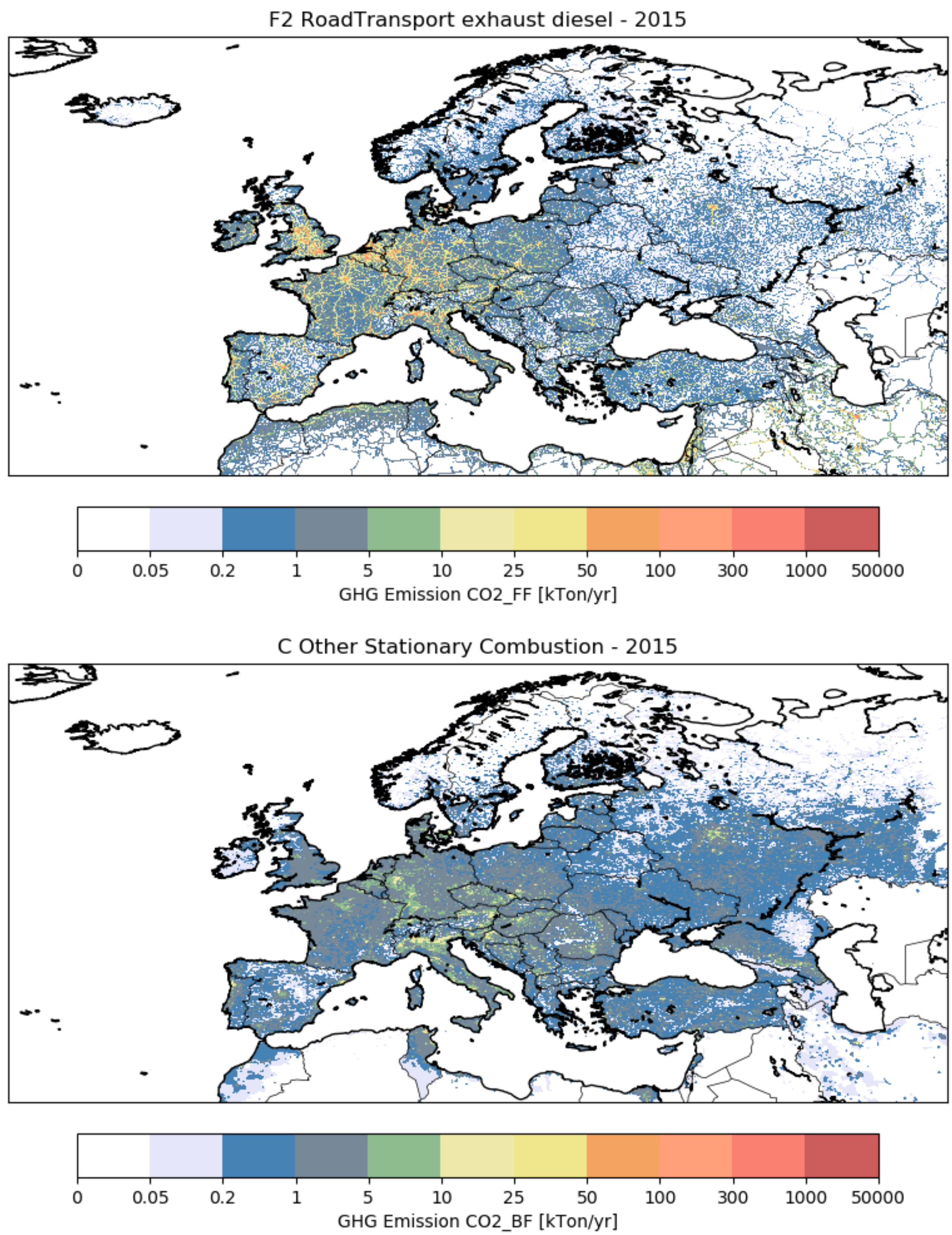

Figure 4. Examples of distributed emissions in TNO_GHGco_v1.1 emission inventory in 2015; fossil CO_2 from diesel road transport (top) and biofuel CO_2 from other stationary combustion (bottom) (unit: Gg/year/grid cell).

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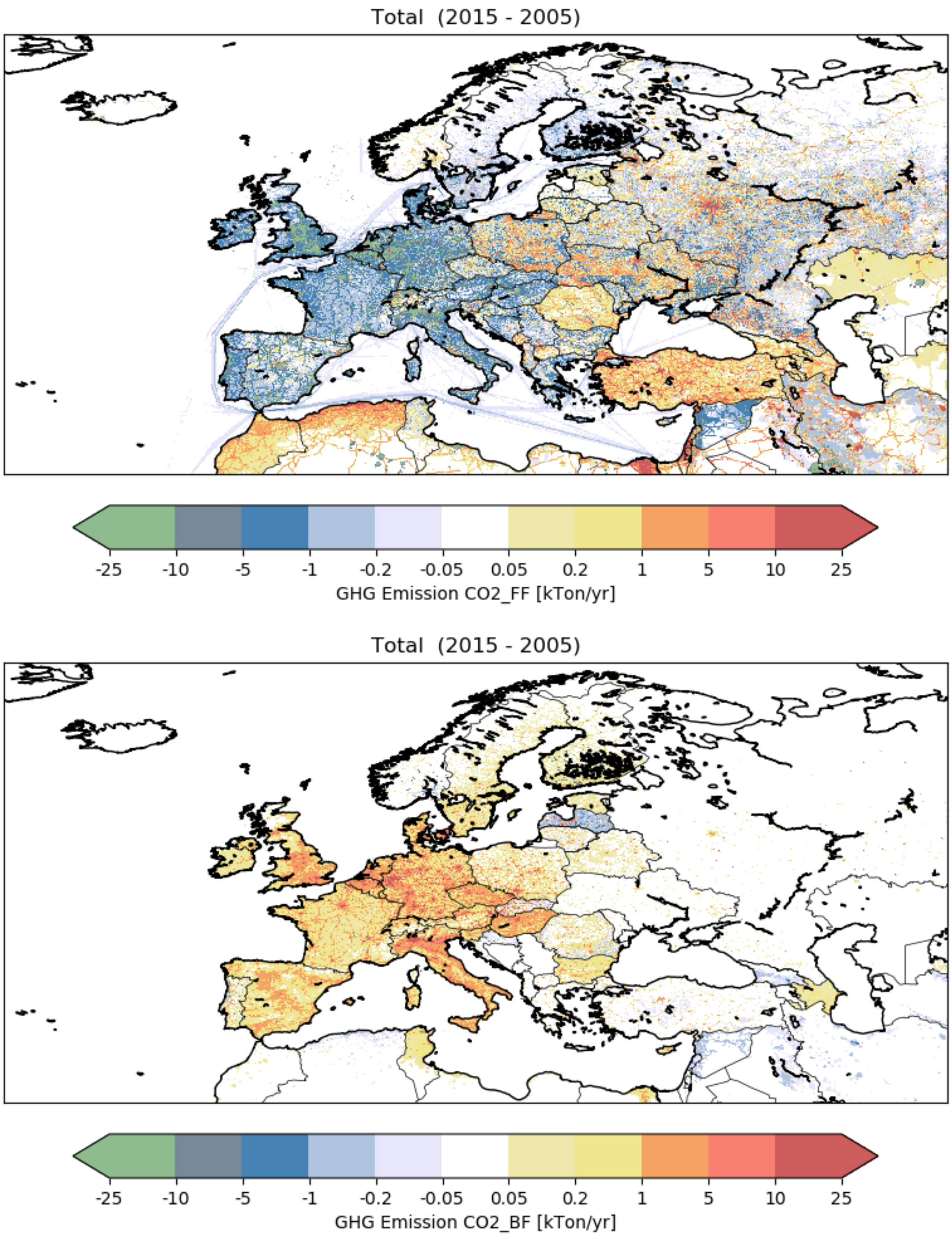

Figure 5: Maps showing the difference in emission levels between 2005 and 2015 for CO_2 from fossil fuels (top) and CO_2 from biofuel combustion (bottom) for all sectors

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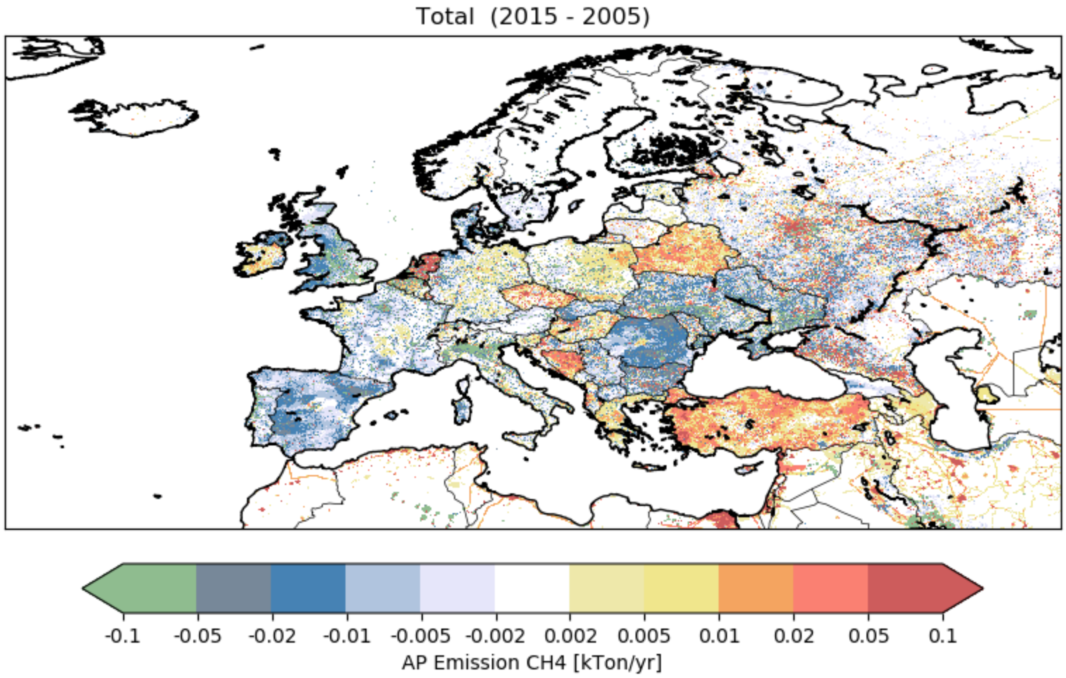

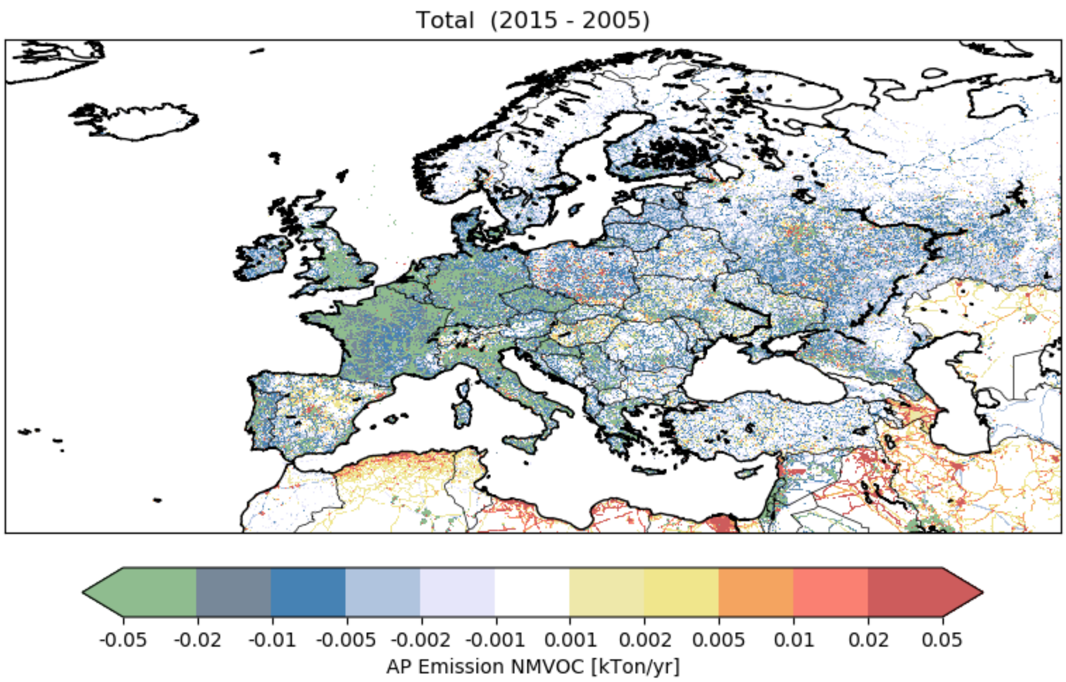

Figure 6: Maps showing the difference in emission levels between 2005 and 2015 for CH_4 (top) and NMVOC (bottom) for all sectors

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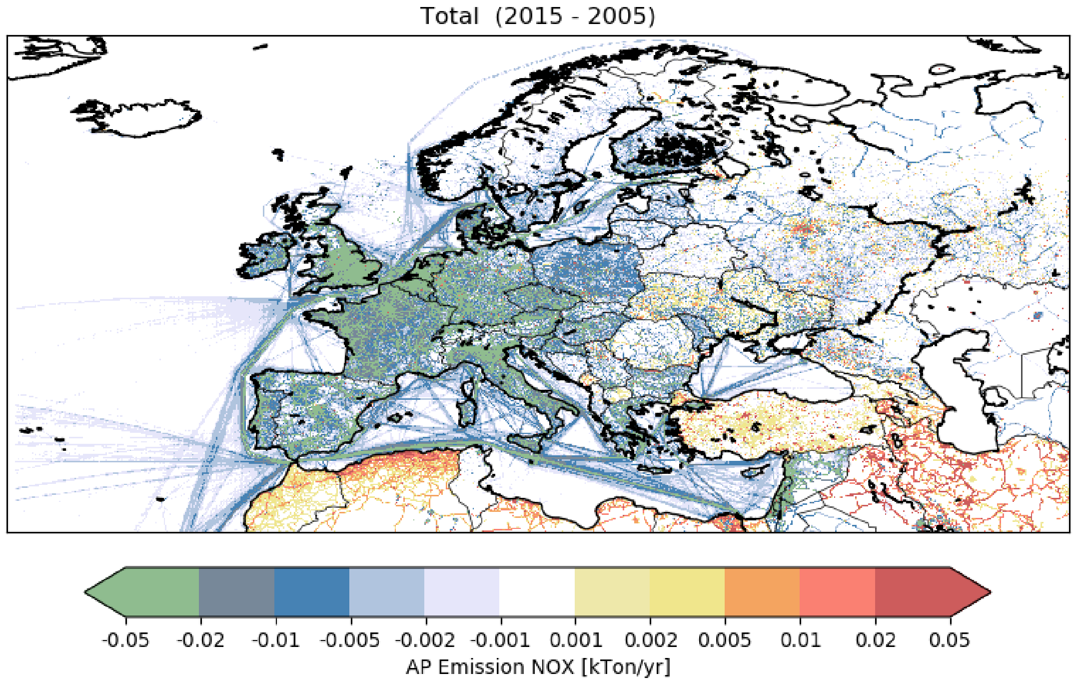

Figure 7: Map showing the difference in emission levels between 2005 and 2015 for NOx for all sectors

The figures above show that for most substances there are significant differences in local emissions between 2005 and 2015. In North West Europe the emissions for many substances have decreased over time, with the notable exception of CO_2 from biofuel combustion (see Figure 8). For methane, there is a mixed result, with large increases for some areas and sectors (e.g. agriculture in the Netherlands) and moderate reductions in many areas for waste.

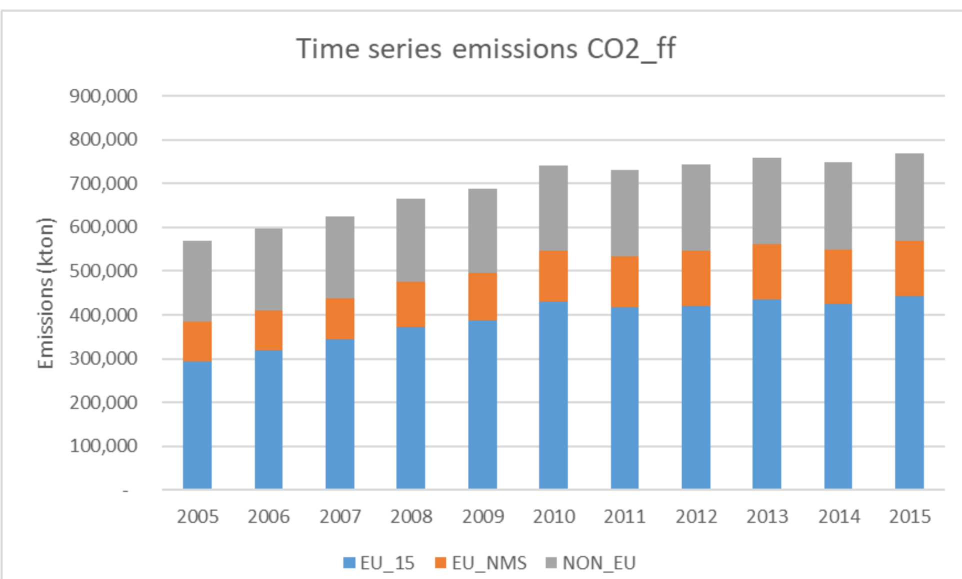

Figure 8: CO_2 emissions from fossil fuel combustion in all sectors for the EU-15 countries (+NOR & CHE), the new member states and the non-EU countries

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2.3. Evaluation and follow-up

This new dataset is a major step since the release of the TNO_MACC-III data and includes a number of additional recent years as well as an improved resolution and a number of methodological improvements, as explained in this report. At this moment, the product is being evaluated partly in combination with European modelling teams among others in the H2020 VERIFY and CHE projects. This evaluation has already led to a version v1.1 being prepared, which was released early 2019. This updated dataset contains a number of bug fixes and correction of errors that were identified when the teams performing the simulations started working with them. In addition, a high resolution version of the emission inventory (at 1/60° x 1/120° resolution, roughly equivalent to 1 km x 1 km) is prepared for a specific zoom region in Europe as envisaged in the VERIFY project WP2. This high resolution version has been released in January 2019 and will be described elsewhere.

2.4. Access to the data

An FTP is provided to the modelling teams in VERIFY WP2 to download the data. At a later stage we will upload the data on the VERIFY website.

3. References

Crippa, M., G. Janssens-Maenhout, F. Dentener, D. Guizzardi, K. Sindelarova, M. Muntean, R. Van Dingenen, and C. Granier (2016). Forty years of improvements in European air quality: the role of EU policy–industry interplay, ATMOSPHERIC CHEMISTRY AND PHYSICS Discuss., 16, 3825-3841, 2016, www.atmos-chem-phys.net/16/3825/2016/ doi:10.5194/acp-16-3825-2016

Jalkanen, J.-P., L. Johansson, and J. Kukkonen (2016). "A comprehensive inventory of ship traffic exhaust emissions in the European sea areas in 2011", Atmos. Chem. Phys., 16 (2016) 71-84, doi:10.5194/acp-16-71-2016, http://www.atmos-chem-phys.net/16/71/2016/acp-16-71-2016.pdf

Joint Research Centre (JRC) (2005). TRANSTOOLS, Tools for transport forecasting and scenario testing, Version 1, http://energy.jrc.ec.europa.eu/transtools/index.html (last access: 1 December 2008), 2005.

Kuenen, J. J. P., Visschedijk, A. J. H., Jozwicka, M., and Denier van der Gon, H. A. C. (2014). TNO-MACC_II emission inventory; a multi-year (2003–2009) consistent high-resolution European emission inventory for air quality modelling, Atmos. Chem. Phys., 14, 10963-10976, https://doi.org/10.5194/acp-14-10963-2014, 2014

VERIFY is a research project funded by the European Commission under the H2020 program. Grant Agreement number 776810.

Remme, U., Blesl, M., & Fahl, U. (2008). Future European gas supply in the resource triangle of the Former Soviet Union, the Middle East and Northern Africa. Energy Policy, 36(5), 1622-1641.

Samaras, Z., Ntziachristos, L., Gkatzoflias, D. Kouridis, C. (2009). COPERT: A European Road Transport Emission Inventory Model, 4th International ICSC Symposium on Information Technologies in Environmental Engineering, May, 28-29, Thessaloniki, Greece.

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