



Royal Netherlands
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and Water Management*

Deriving anthropogenic CO₂ emissions for
combustion by application of the emission-ratio
method to TROPOMI/S5P NO₂ emission data.

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CHE H2020





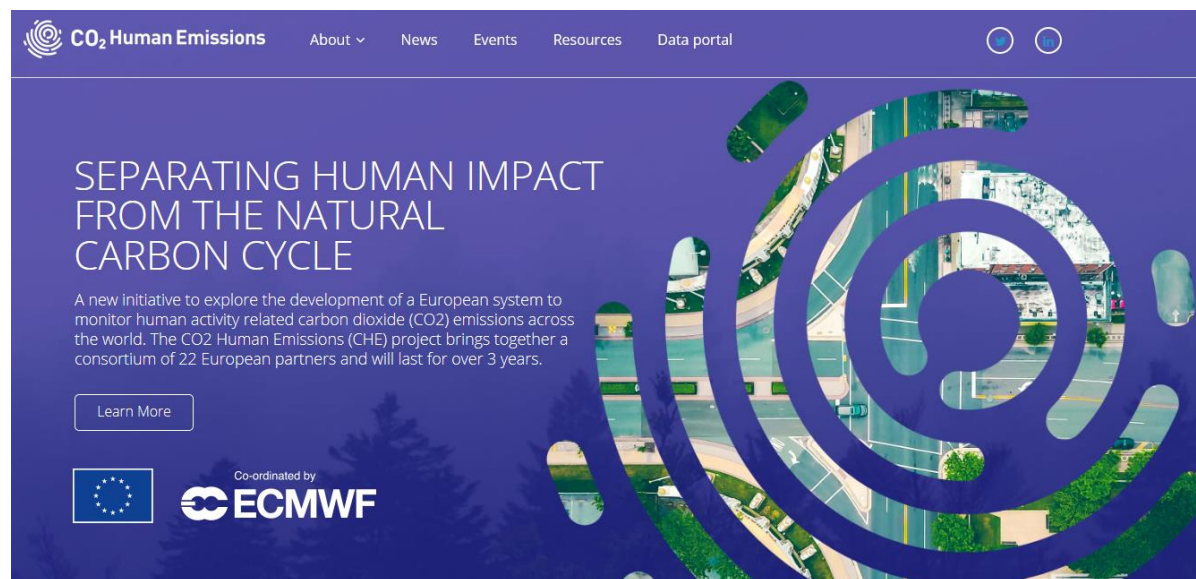
CHE sub - work package

CO₂ emissions based on TROPOMI NO₂ + emission factors (TNO)

$$\text{CO}_2 = \text{NO}_x^{\text{S5P}} \cdot (\text{CO}_2 / \text{NO}_x)^{\text{bottom-up emissions, for example TNO or EDGAR or HTAP}}$$

as a test:

- › Iberian peninsula
- › part of South America



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emission databases

bottom-up emission database TNO (Europe), EDGAR (South America)

- same research group working on EDGAR/HTAP

TROPOMI NO_x emissions using DECSO emission inversion algorithm

- DECSO (Daily Emission estimates Constrained by Satellite Observations)
- TROPOMI NO₂ daily total column data
- 0.125°×0.125° grid
- multiply TROPOMI NO_x emissions with TNO CO₂/NO_x emission ratio

DECSO references

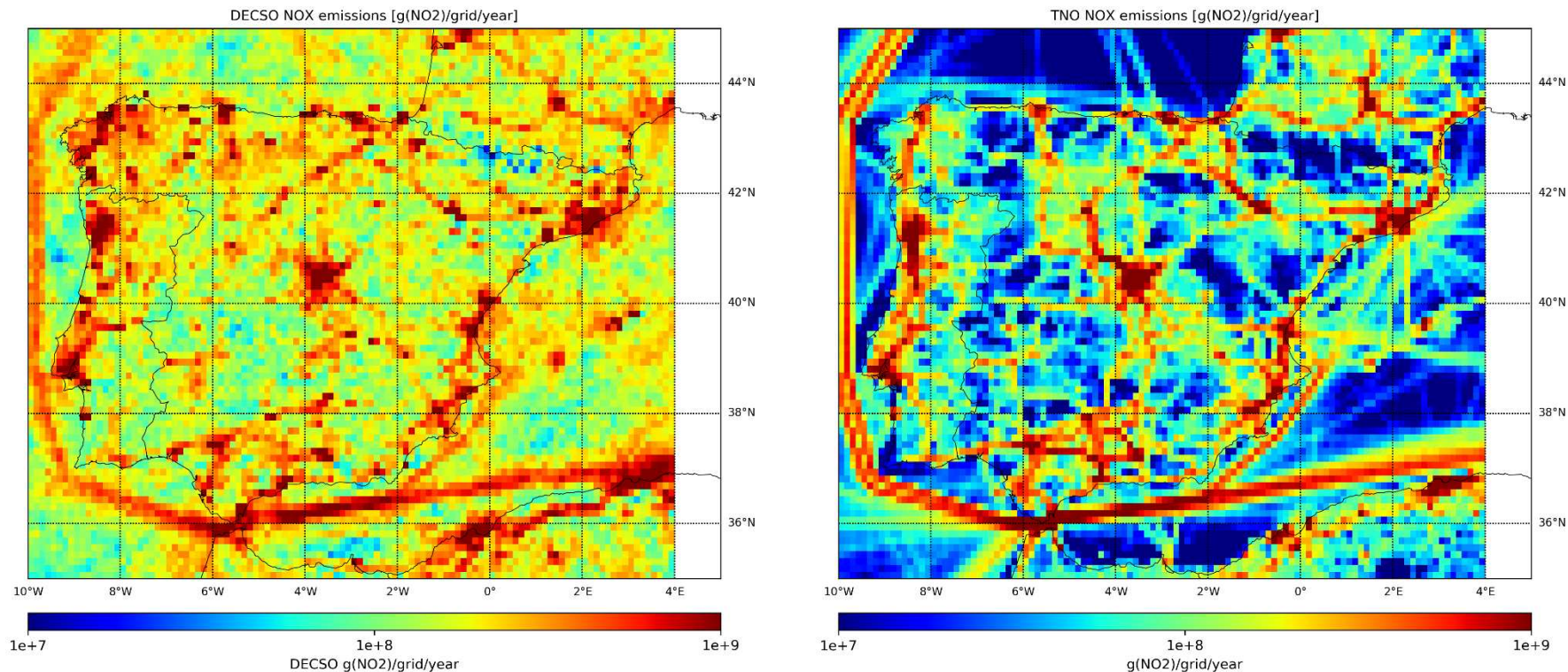
- Mijling and van der A, 2012, doi:10.1029/2012JD017817
- Ding et al., 2017, <https://doi.org/10.5194/amt-10-925-2017>



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TROPOMI DECSO $\leftrightarrow$ TNO bottom-up



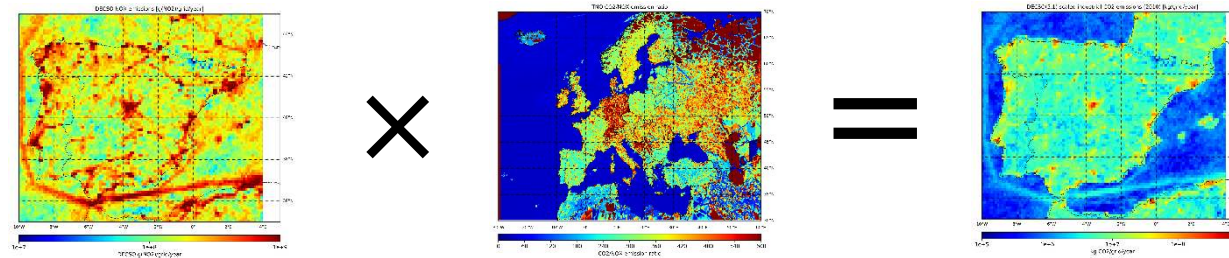
*note the
logarithmic
color scale*

Similar spatial patterns, TROPOMI shows background (biogenic) NO_x emissions not in TNO data

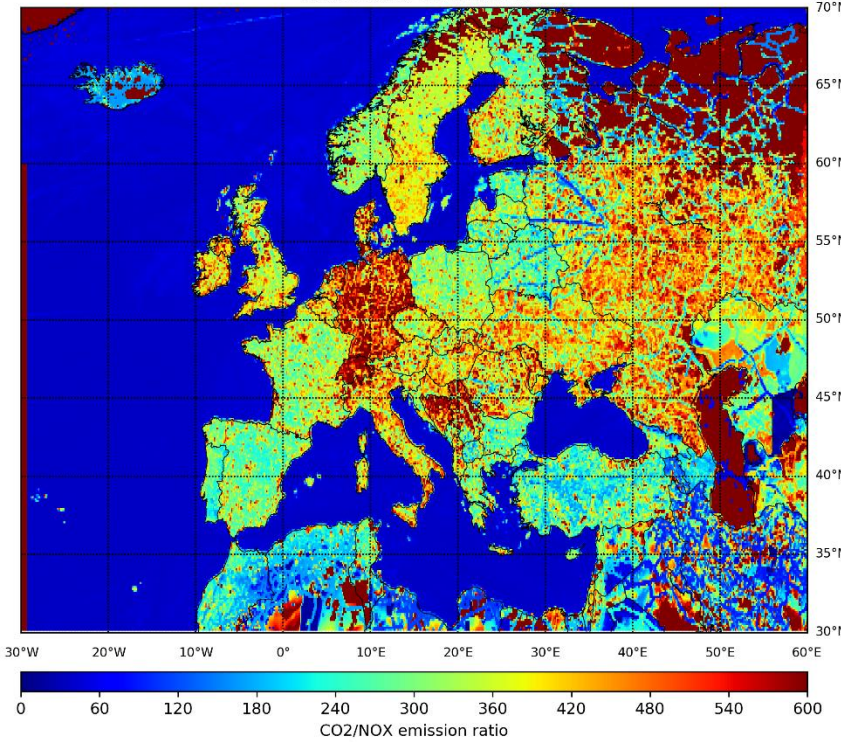


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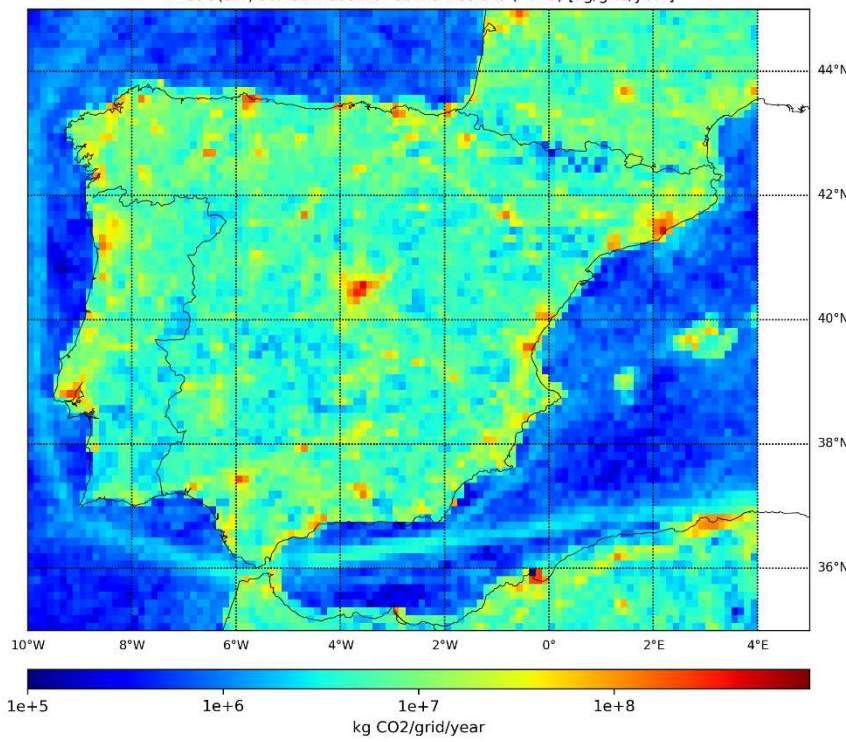
ratio method



TNO CO₂/NO_x emission ratio



DEC50(5.1) scaled industrial CO₂ emissions (2010) [kg/grid/year]



S5P/DECSO
NO_x-based
CO₂ emissions

*note the
logarithmic
color scale*

note: CO₂/NO_x
emission ratios
appear to be
country specific
→ more research

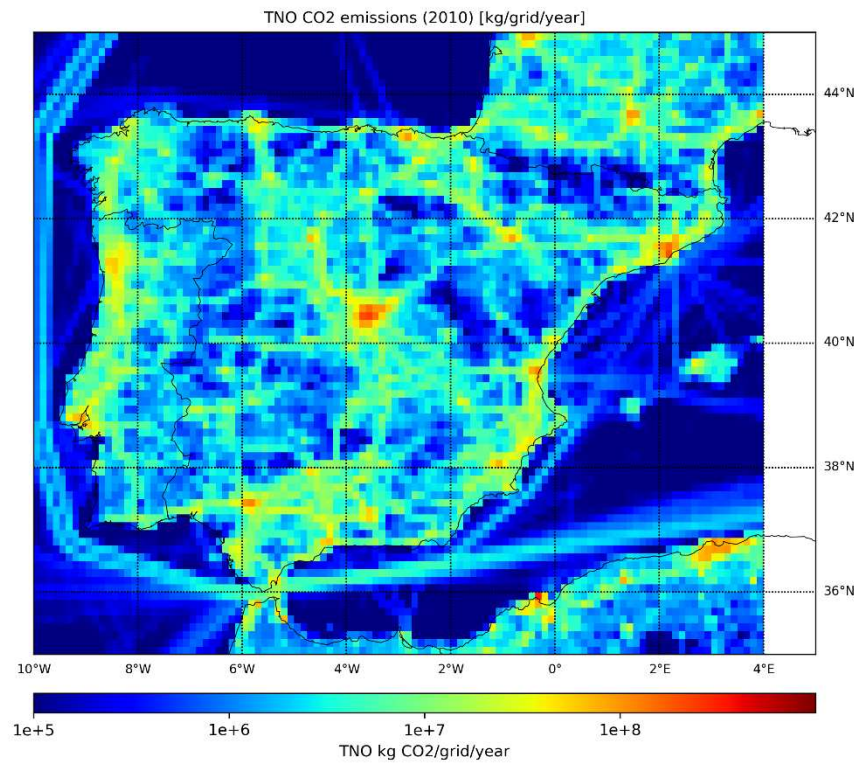


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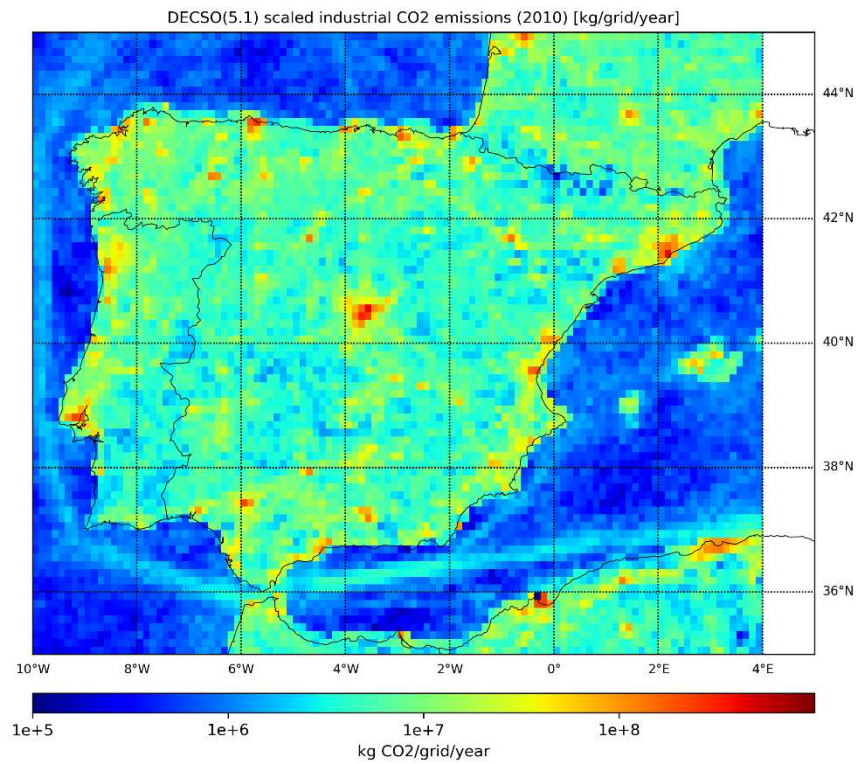


TROPOMI NO₂-based CO₂ emissions

TNO
combustion
CO₂ emissions



S5P
NO_x-based
CO₂ emissions



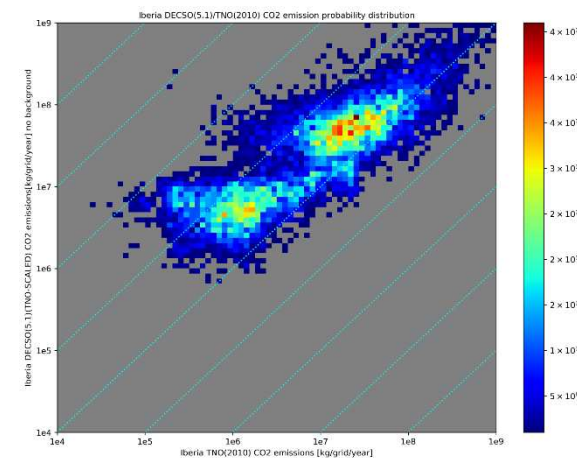
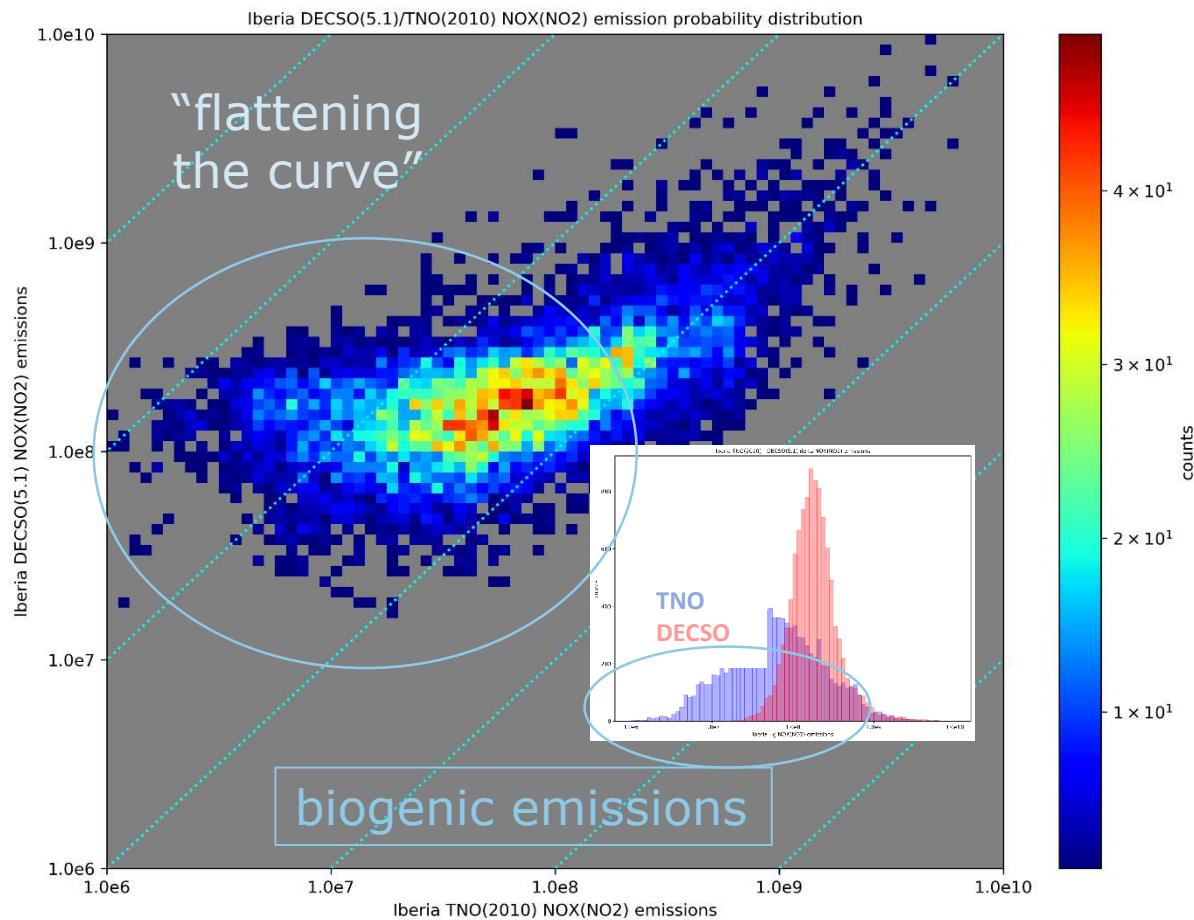
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TROPOMI biogenic NO_x -emissions



biogenic NO_x
translates
into artificial
background
 CO_2 emissions

DECSO NO_x -based CO_2
vs. TNO NO_2 emissions

*note the
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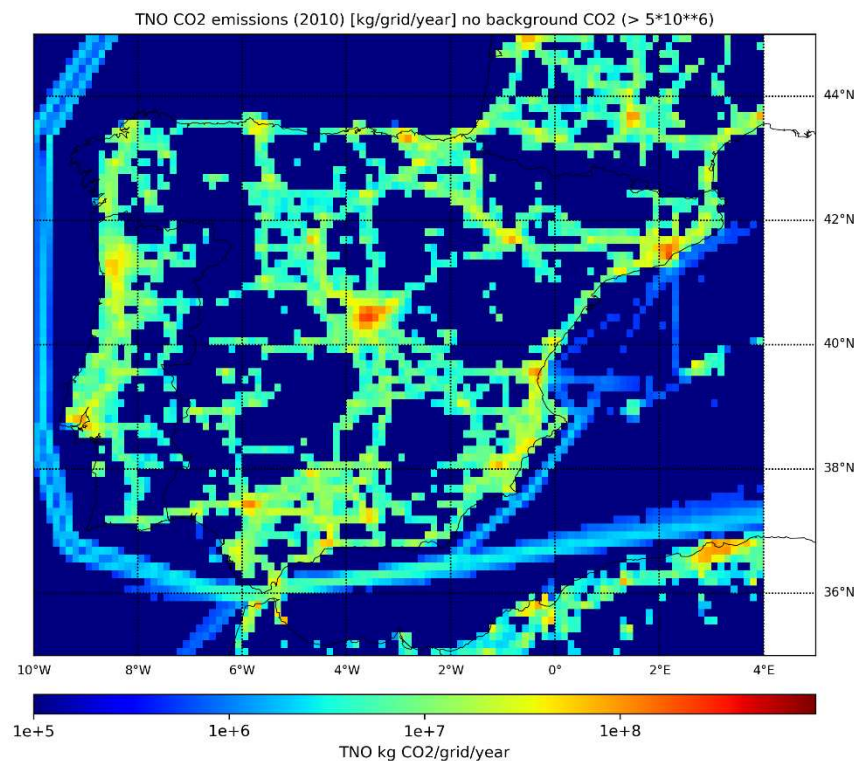


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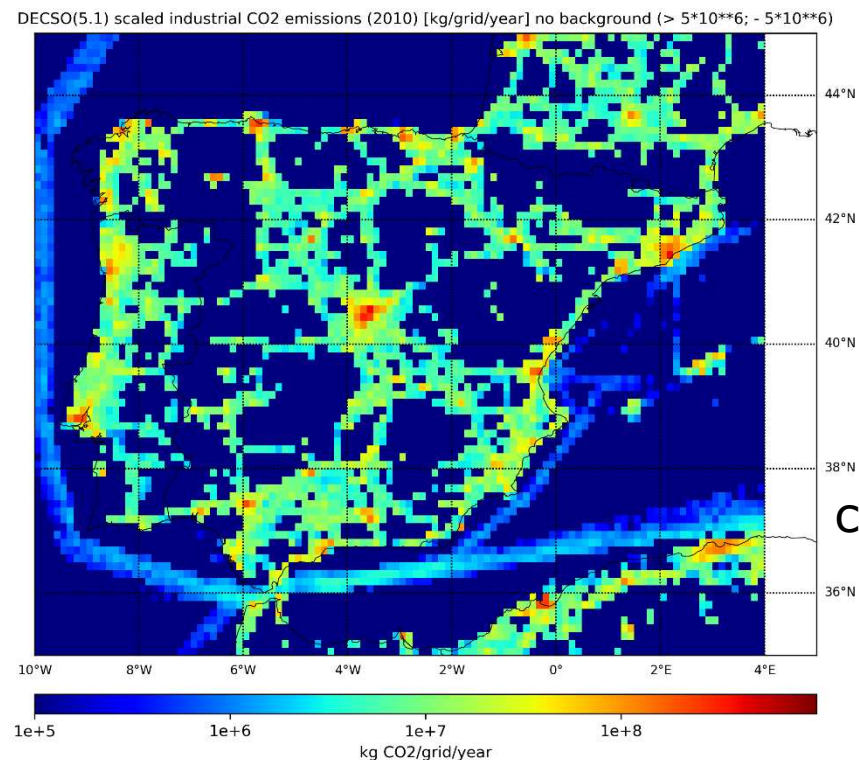


filtering biogenic NO_x emissions

TNO CO_2



S5P/DECSO NO_x -based CO_2



biogenic NO_x
can be filtered
out in several ways.

Here, we simply remove
pixels with hardly any
combustion NO_x according
to the TNO database

*note the
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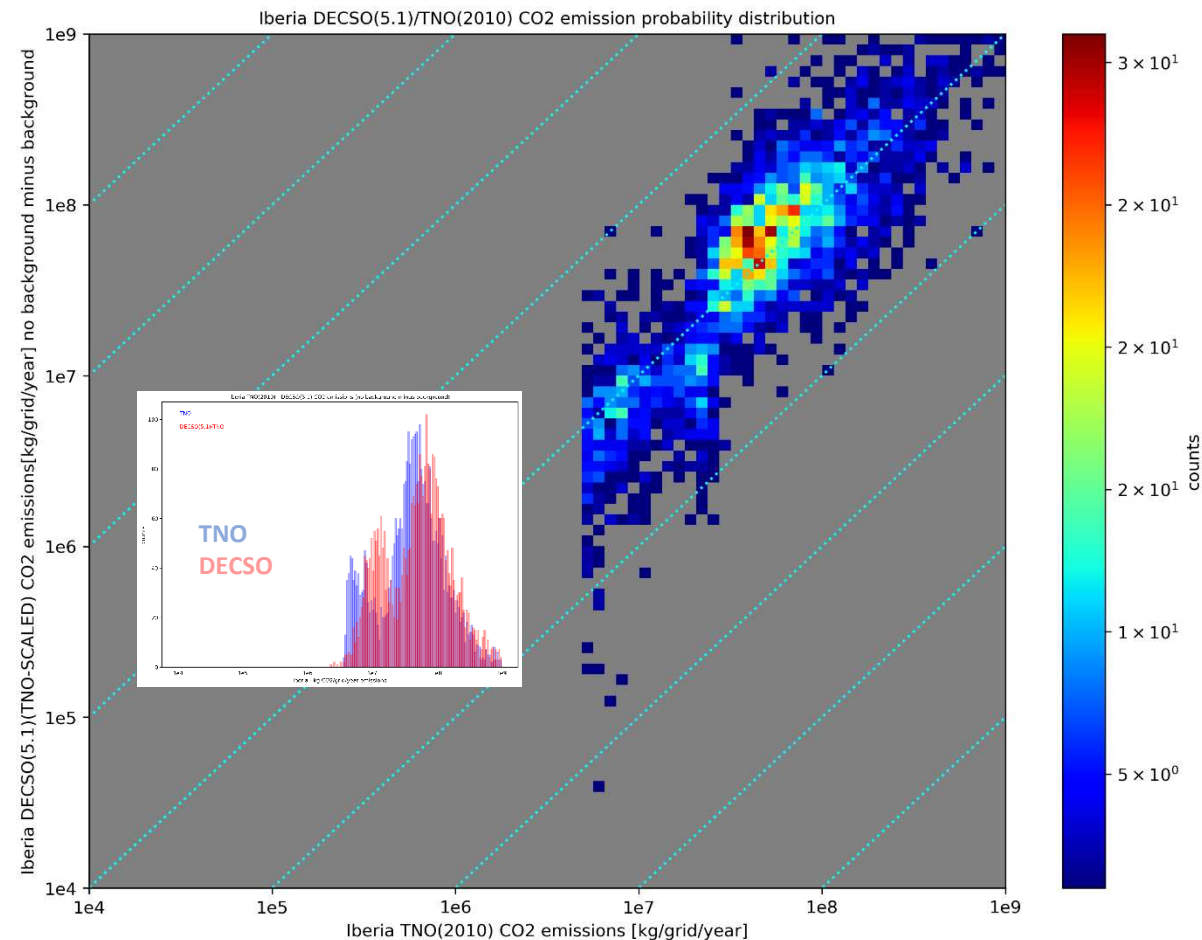


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TROPOMI NO₂-based-CO₂ emissions vs TNO

after “dealing” with
the biogenic emissions
there is a good spatial
correlation between TNO
combustion CO₂ emissions
and S5p NO_x-based
CO₂ emissions



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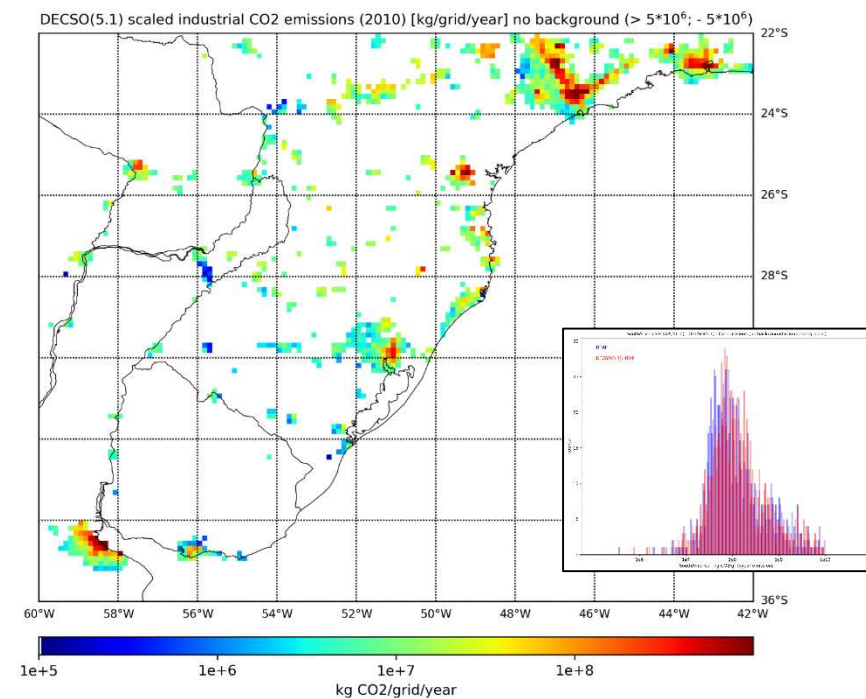
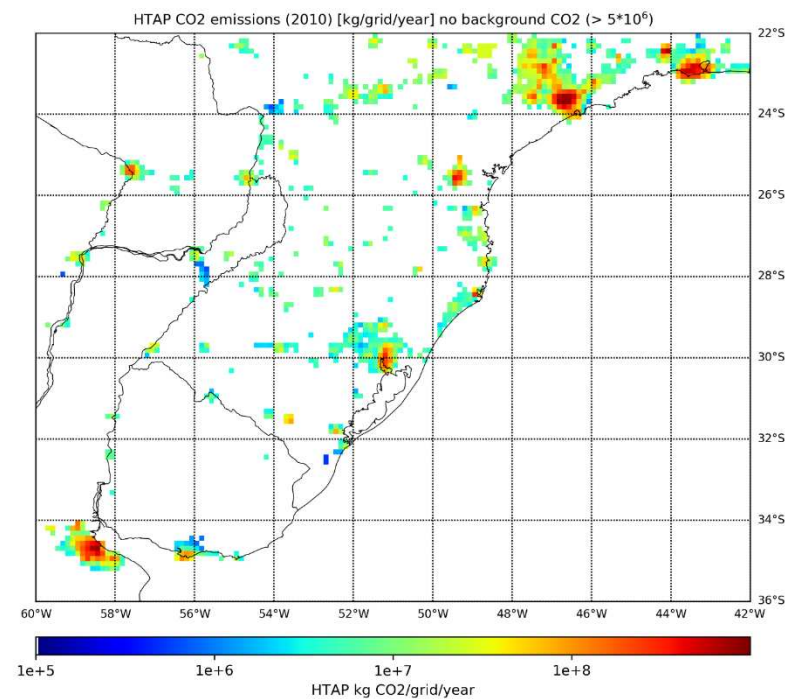


TROPOMI NO₂-based-CO₂ emissions vs. EDGAR

South America
(Paraguay, southern Brasil,
northern tip Argentina,
Uruguay)

EDGAR emission database

Note: 90% of NO_x emissions
here is biogenic



*note the
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conclusions

- realistic industrial CO₂ emissions (Iberia, South America)
- promising, can be used at least as a “sanity check”

Table 1: Total annual CO₂ emissions and NO_x emissions over the Iberian Peninsula.

Emissions Tg/yr	TNO CO ₂	TNO CO ₂	DECSO CO ₂	DECSO CO ₂	DECSO CO ₂
filter	-	TNO NO _x > 10 ⁸ g/grid/yr	-	TNO NO _x > 10 ⁸ g/grid/yr	TNO NO _x > 10 ⁸ g/grid/yr TNO CO ₂ > 5•10 ⁹ g/grid/yr
2010	341.8	290.7	581.7	390.6	372.2
2015	332.1	271.6	637.9	399.8	382.9
Emissions Tg/yr	DECSO NO _x		DECSO NO _x	DECSO NO _x	
filter	-		-	TNO NO _x > 10 ⁸ g/grid/yr	
2010	1.49		2.55	1.41	
2015	1.36		2.55	1.37	

Table 2: Uncertainty analysis on total CO₂ for the Iberian peninsula

Cause of uncertainty	Estimated uncertainty	Possible future improvements
Uncertainty in NO _x emissions	2-3 %	Further research on DECSO
Intercountry ratio differences	10 %	Uniform reporting methods
Time differences in ratio	-2 to 16 % per year	Apply the same year for the ratio and the NO _x emissions
Correction biogenic NO _x emissions	10 %	1) Other correction methods 2) Distinguish biogenic and anthropogenic emissions in DECSO

- important to use bottom up emissions for year of TROPOMI data (currently 2010 or 2015)
- further investigation of uncertainties, errors
- more tests/refinement S5P biogenic NO_x filter
- “weird” spatial patterns CO₂/NO_x emission ratios





conclusions continued ...

- › results strongly depend on quality bottom-up emissions
- › DECSO update: also fit biogenic emissions
- › explore different possibilities for applying ratio method
- › China, Europe & covid-19: how much less CO₂

update: 1 May 2020

important/crucial that NO_x and CO₂ bottom-up emissions have been constructed in a consistent way (consistent emission ratios $\leftarrow \rightarrow$ physically consistent).

using NO_x emissions from one source and CO₂ emission from another source quickly introduces large uncertainties in emission ratios and thus derived CO₂ emissions.



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