



Koninklijk Nederlands
Meteorologisch Instituut
Ministerie van Infrastructuur en Waterstaat

NO_x emissions derived from Sentinel-5P observations

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SEEDS
Sentinel EO-based Emission
and Deposition Service



AMEO



IMPALA



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DECSO

Daily Emissions Constrained by Satellite Observations

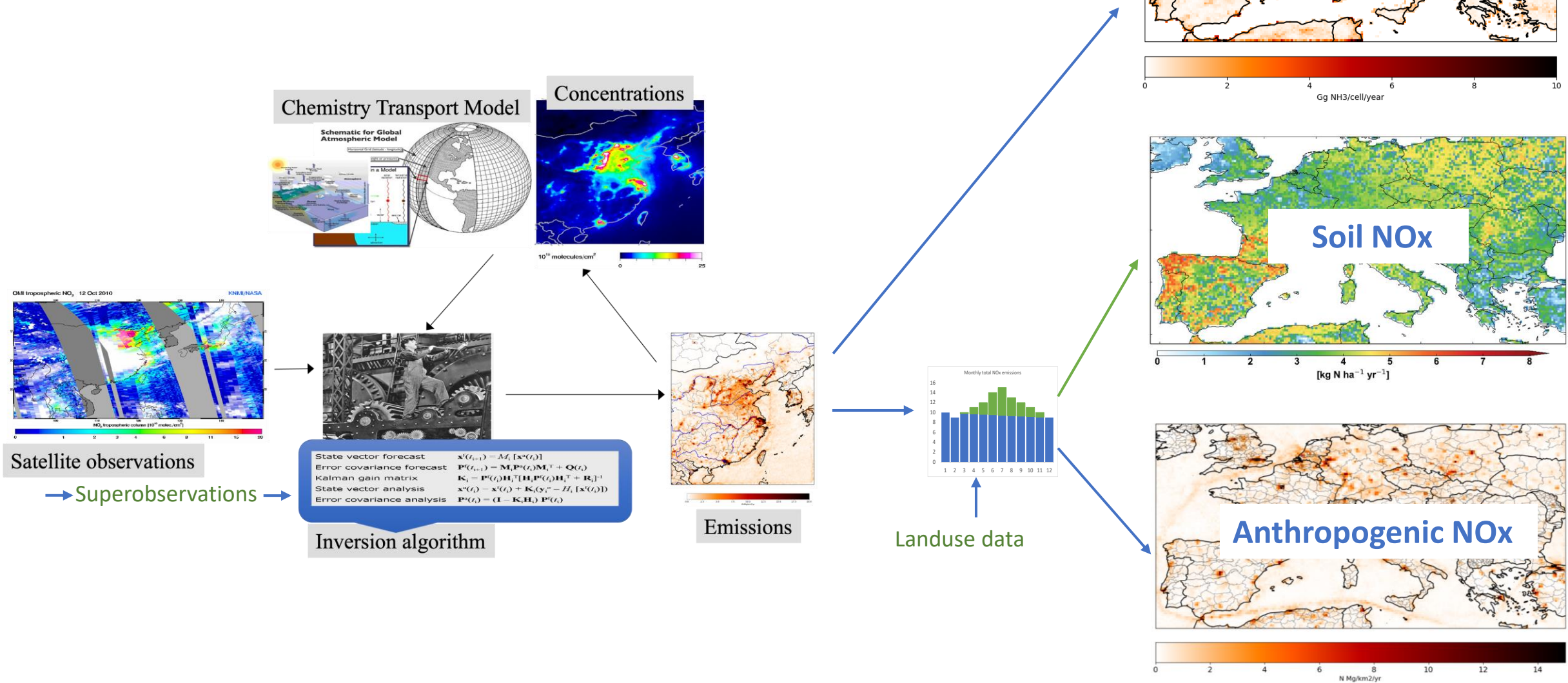
Characteristics:

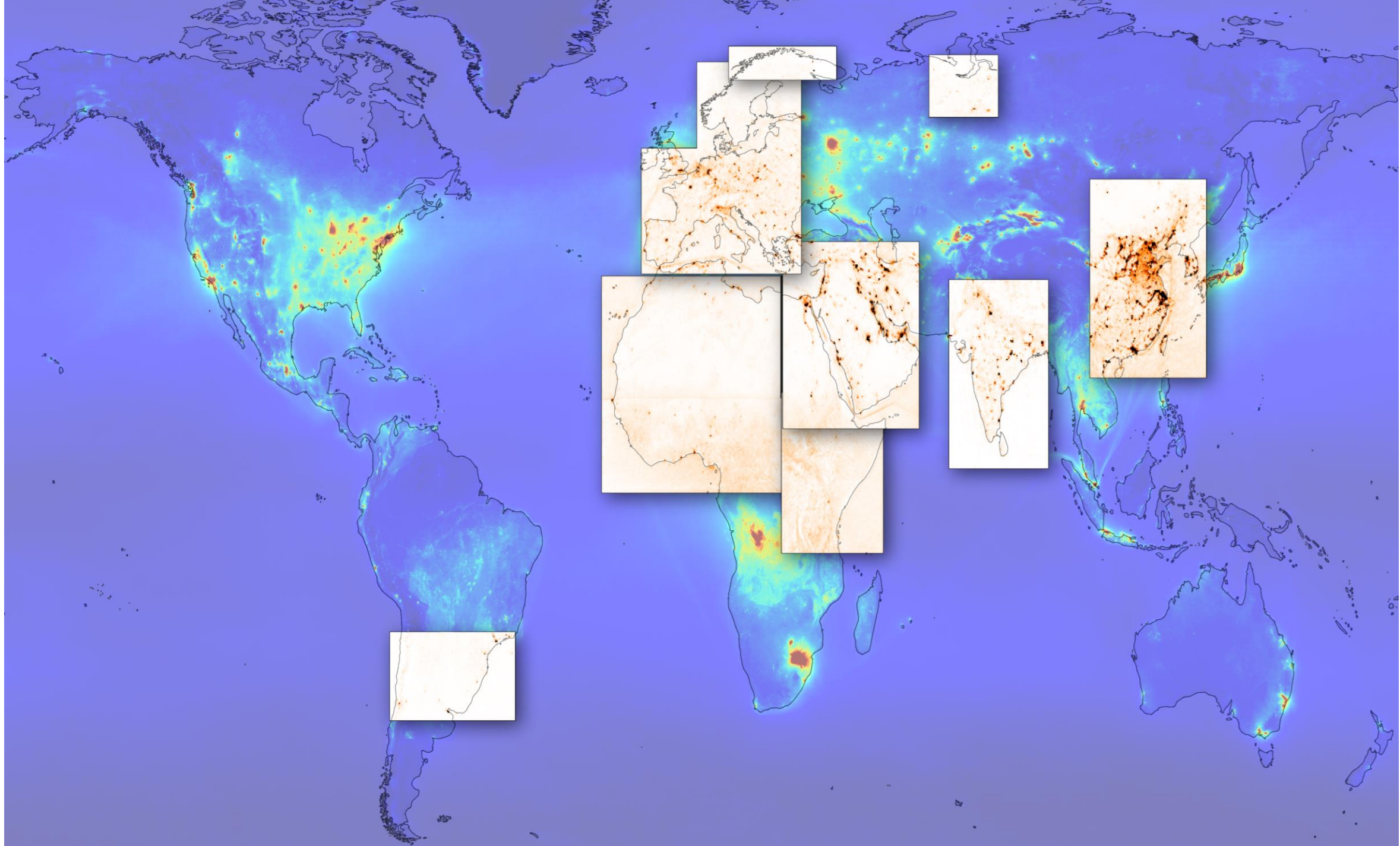
- It is fast: one model run per assimilation step of 1 day
- No *a priori* information: unknown sources become visible.
- Model: CHIMERE v2020r3
- Observations: TROPOMI NO₂ (v2.4), CRIS NH₃
- Includes error estimate (about 25% for individual grid cells)
- Used for daily/monthly **NO_x and NH₃ emissions**
- Resolution is 0.2°x0.2°, or 0.05°x0.05° for a smaller domain



SEEDS
Sentinel EO-based Emission
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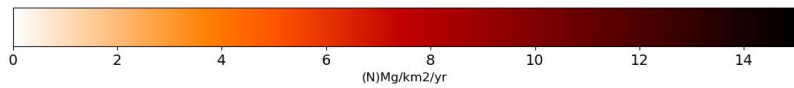
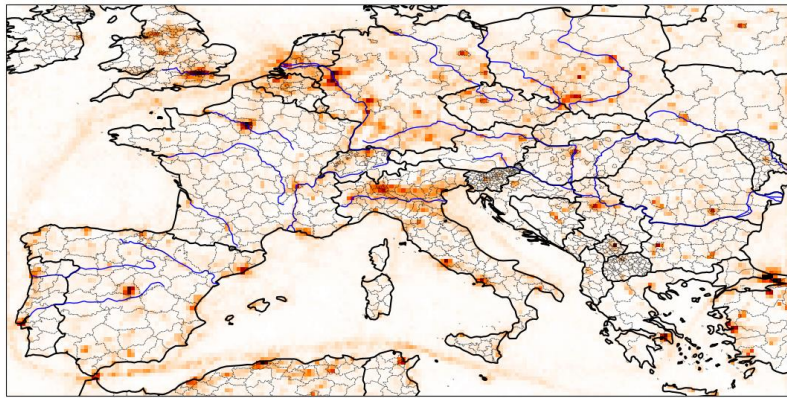
DECSO (Daily Emission estimates Constrained by Satellite Observation)



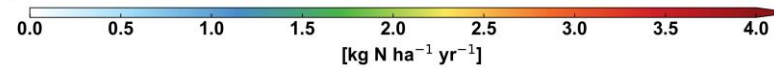
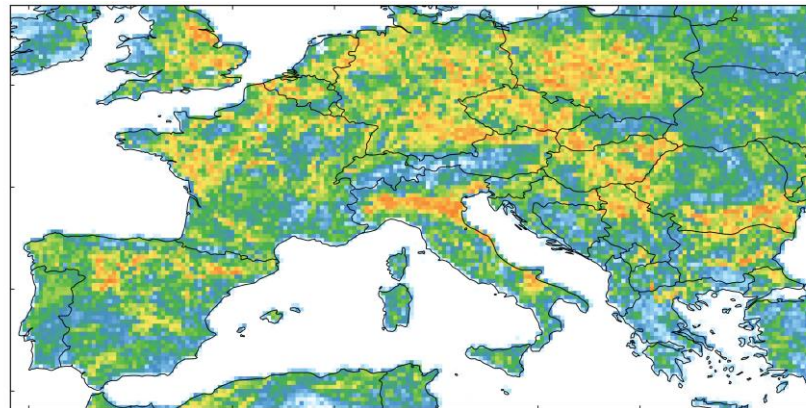
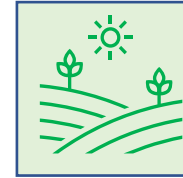


Derived NO_x and NH_3 emissions from TROPOMI observations using DECSO

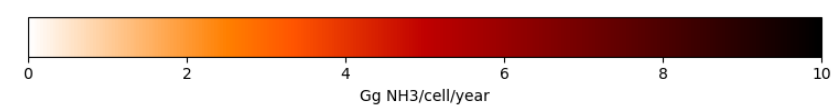
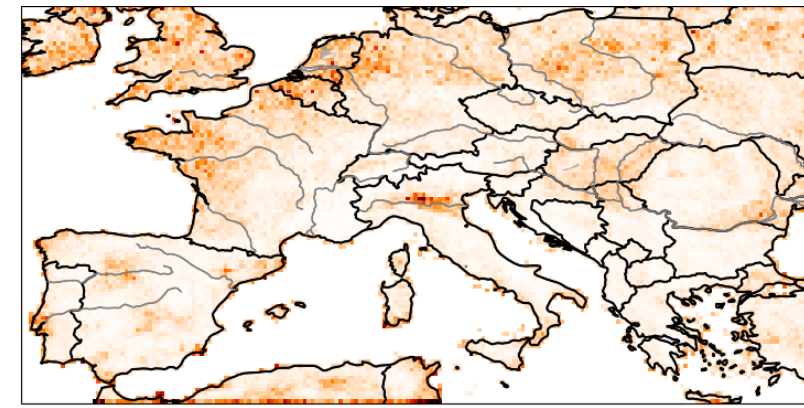
Anthropogenic NO_x



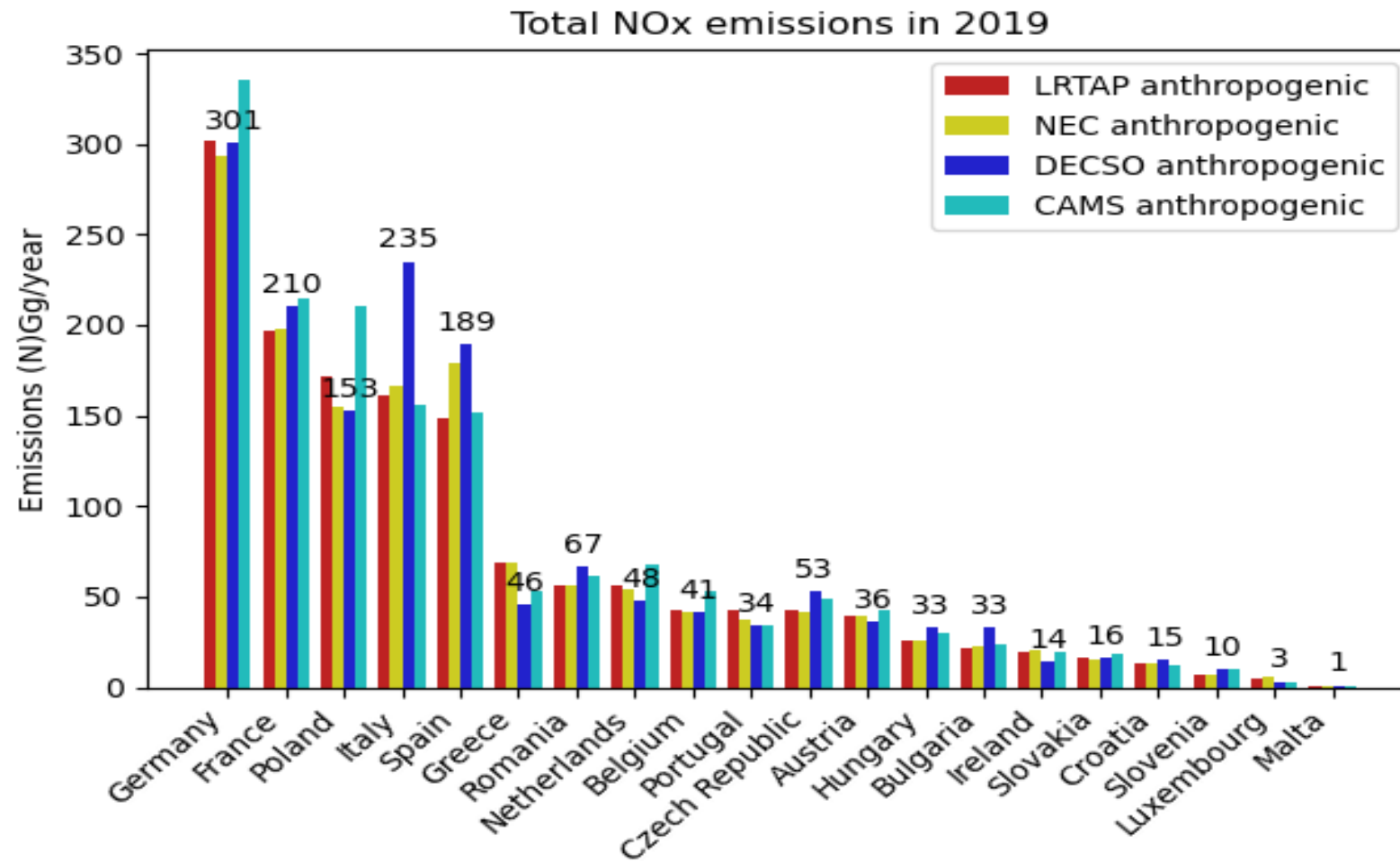
Soil NO_x



NH_3

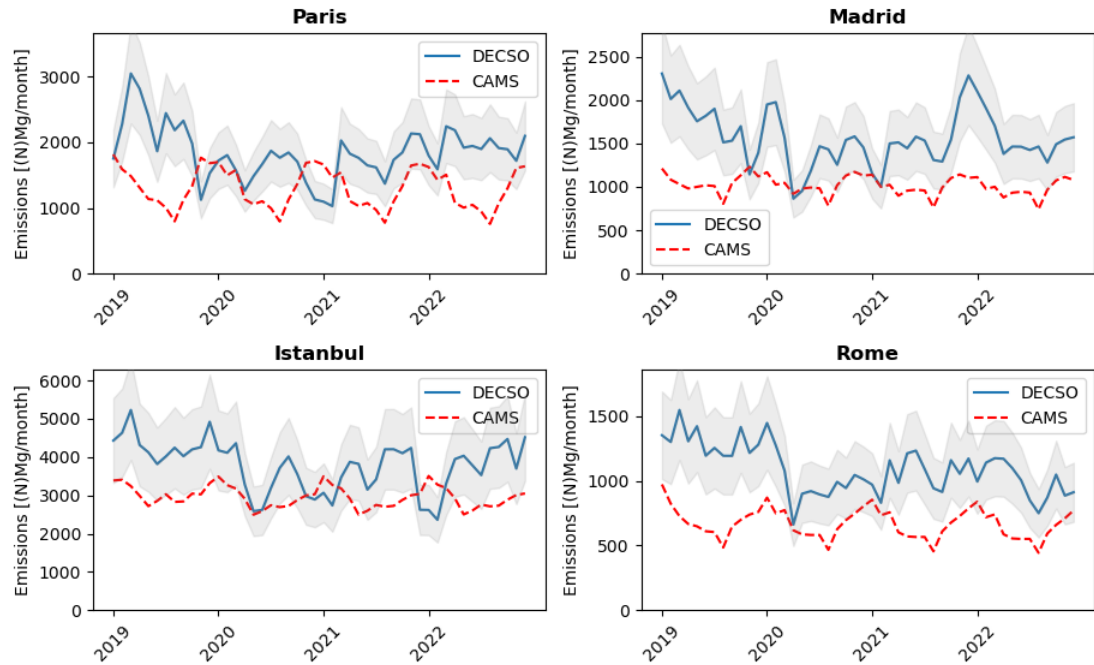


Country totals of European NO_x emissions (2019)

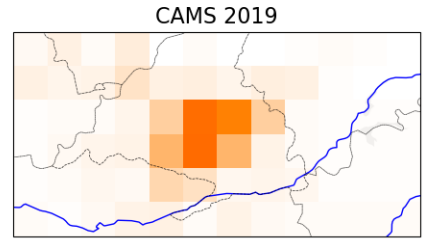
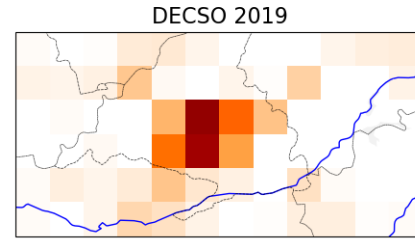


Annual NO_x emissions

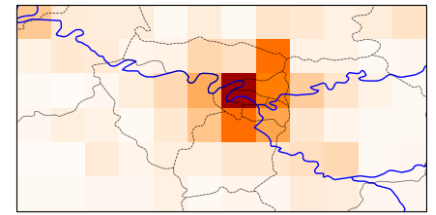
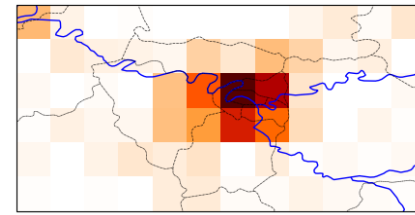
DECSO compared to
CAMS-REG-AP
for some big cities (2019)



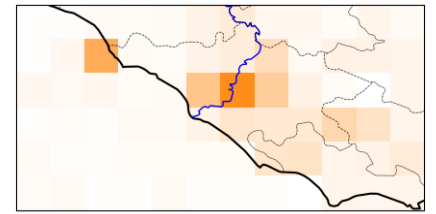
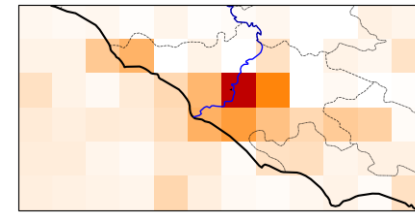
Madrid



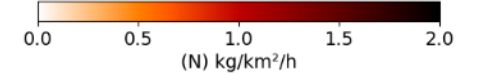
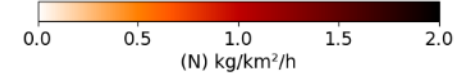
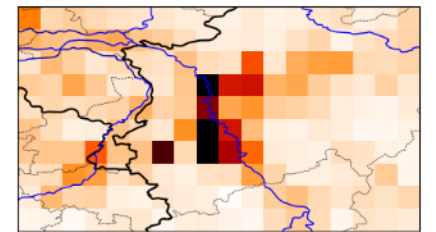
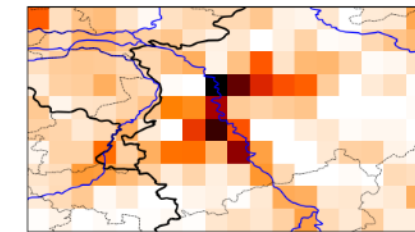
Paris



Rome



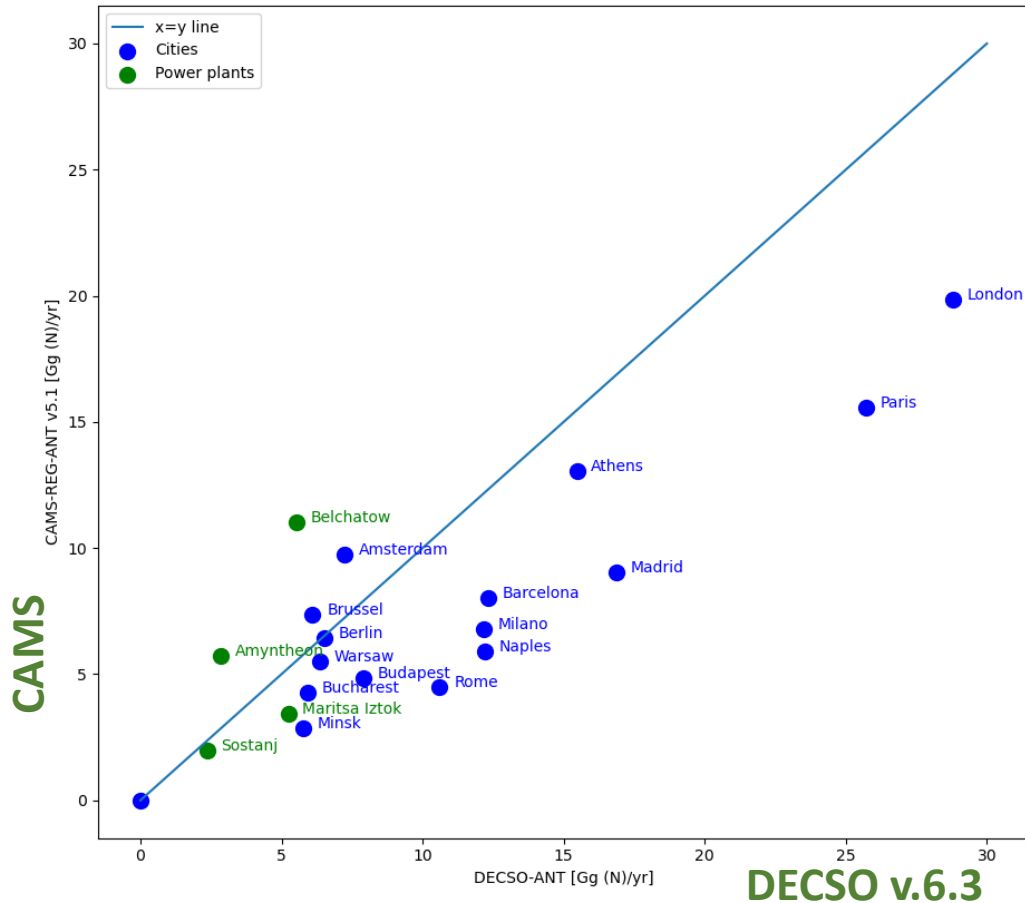
Ruhr area



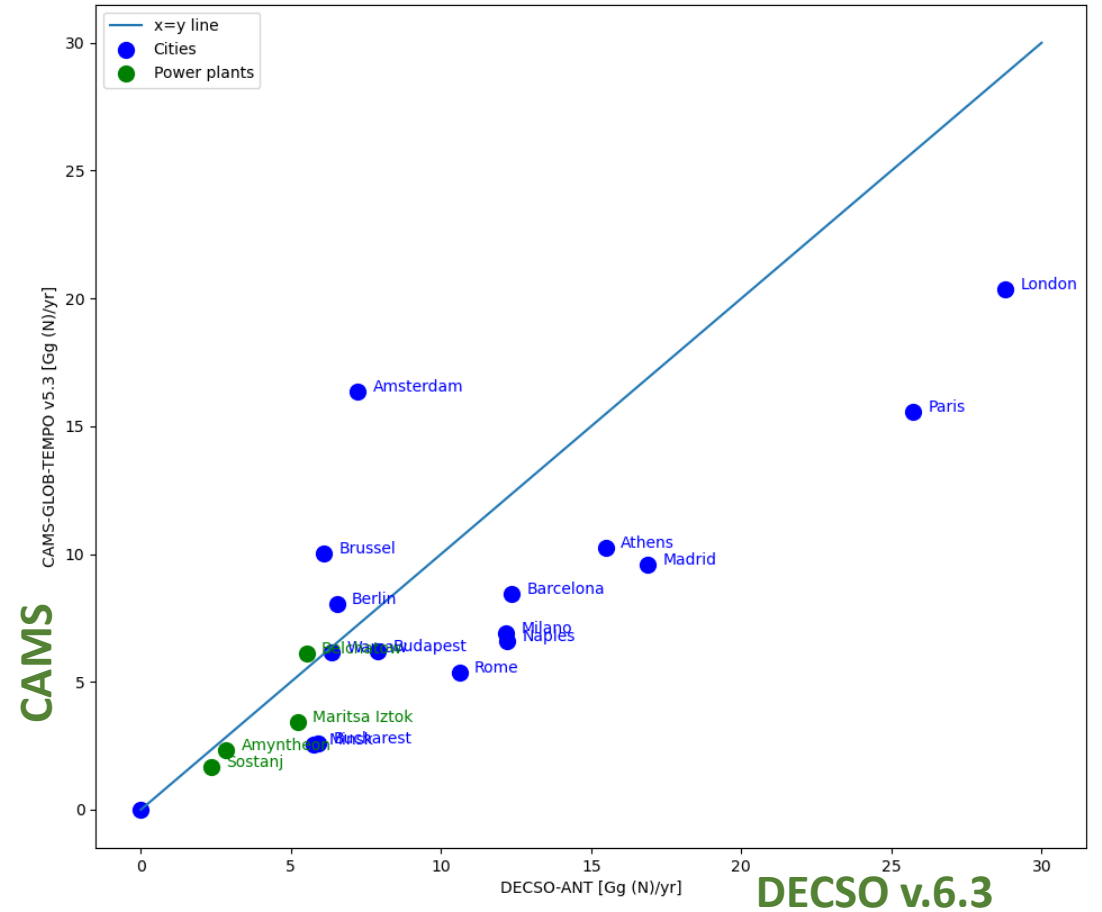
Comparison for European big emitters (NO_x)

- **DECSO** v6.3: anthropogenic NO_x
- **CAMS**: CAMS-REG-AP v5.1, CAMS-GLOB-TEMPO v5.3

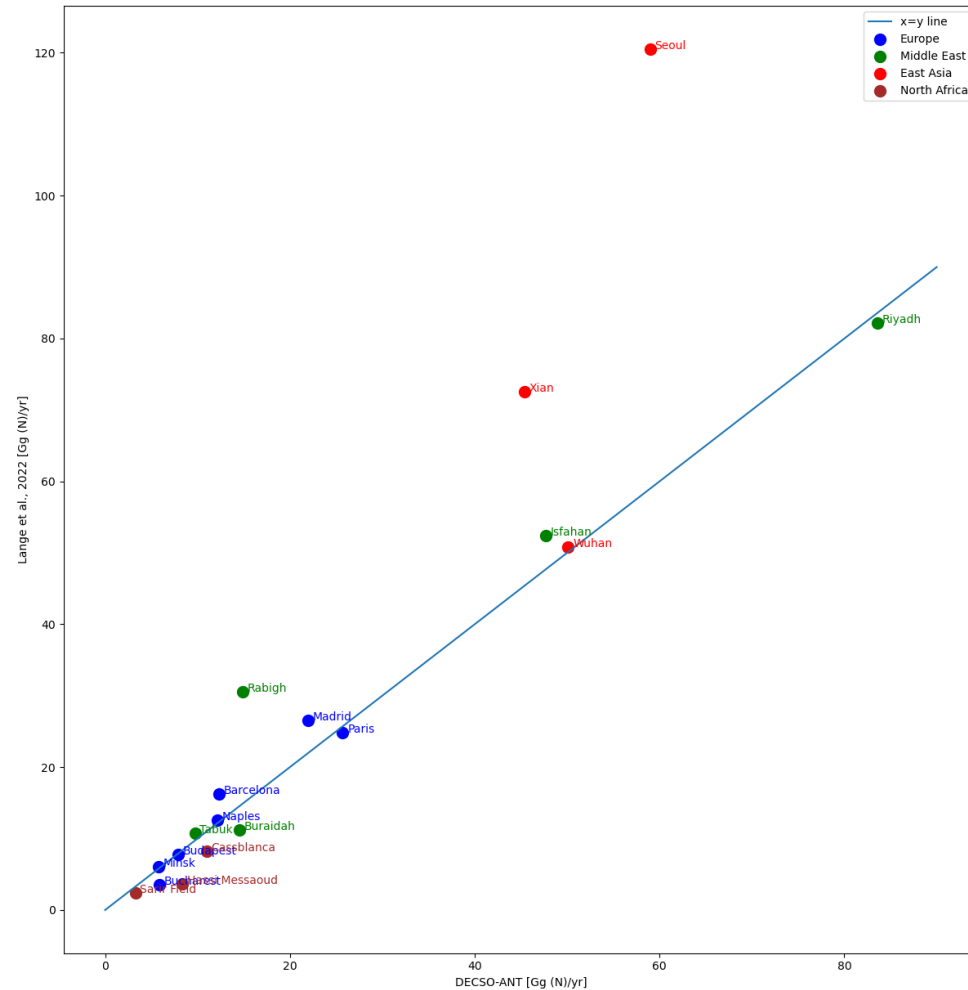
CAMS-REG-AP v5.1



CAMS-GLOB-TEMPO v5.3

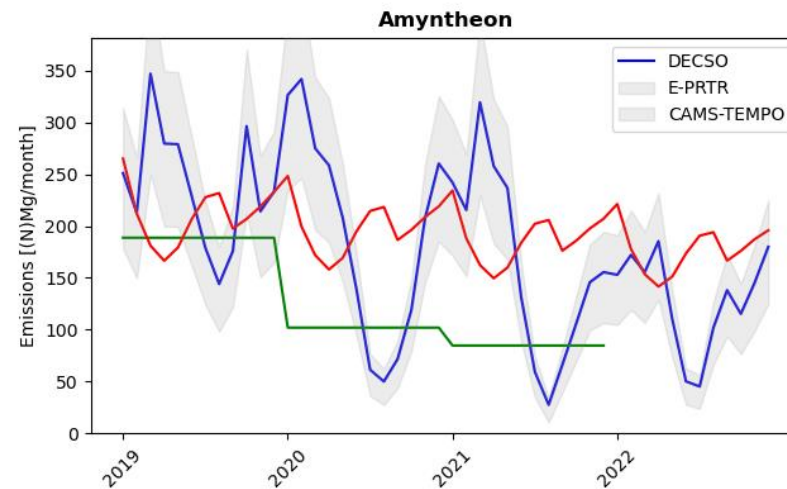
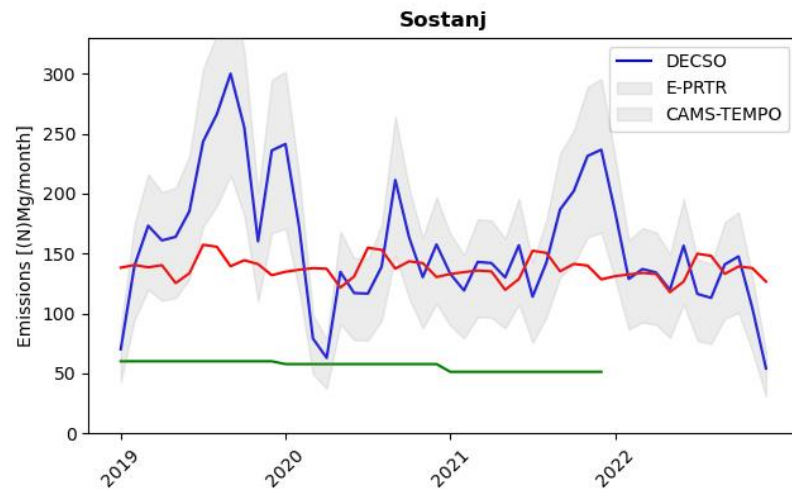
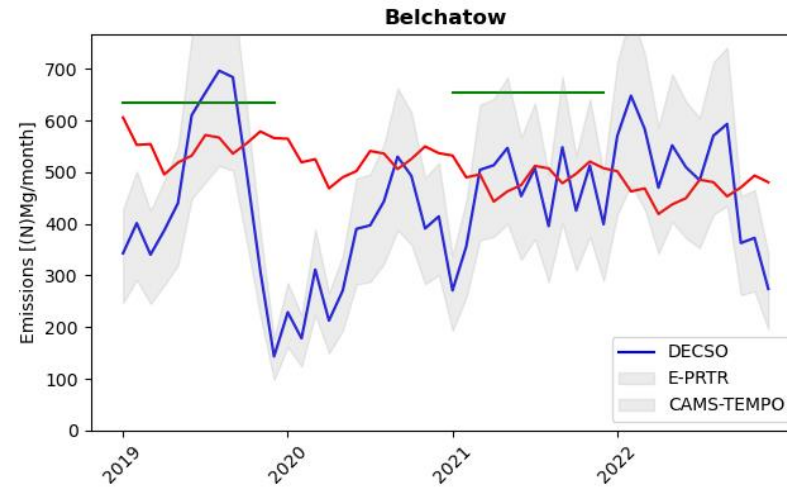
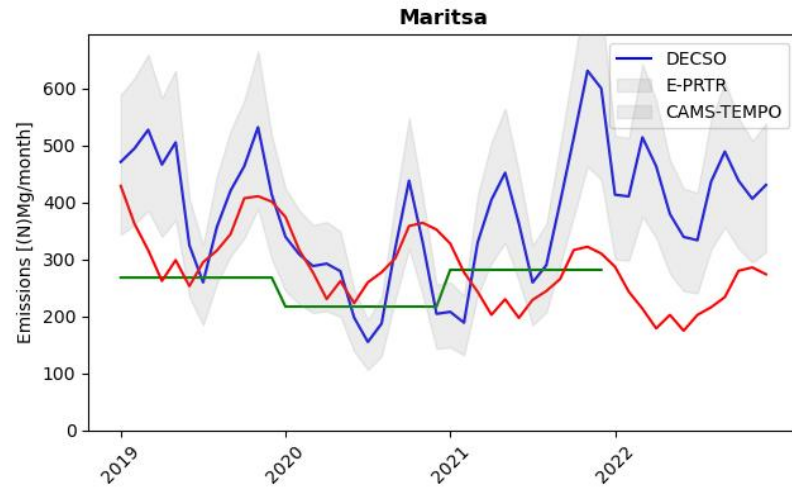


Comparison with independent emission estimates using TROPOMI

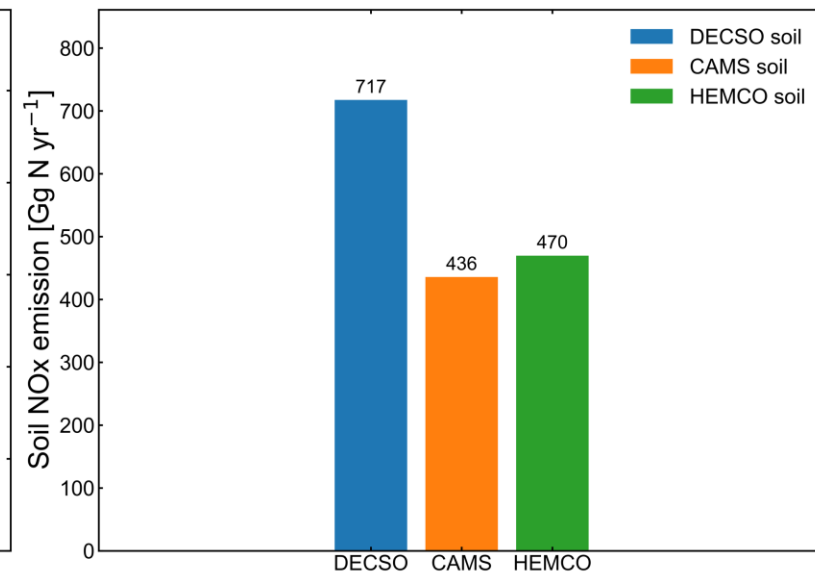
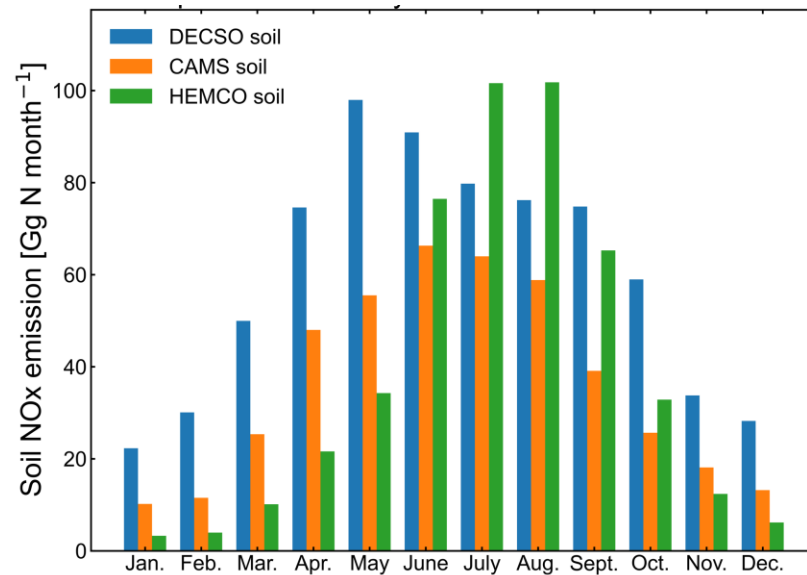
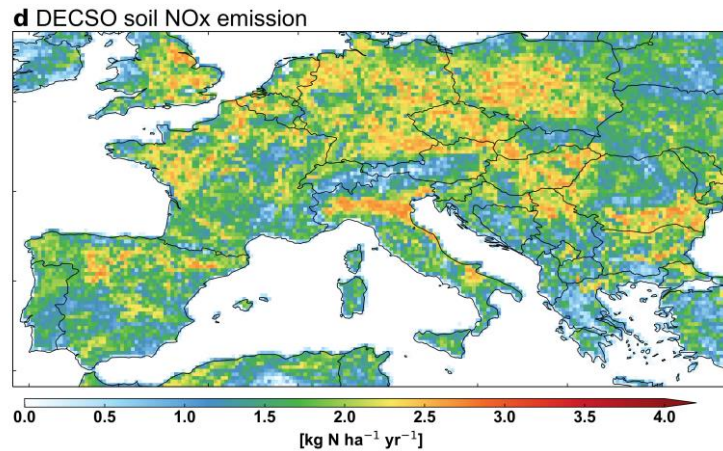


Similar results as the study of Lange et al. (2022), who are using a plume-fitting method applied to the TROPOMI observations.

Large thermal power plants (2019-2022)



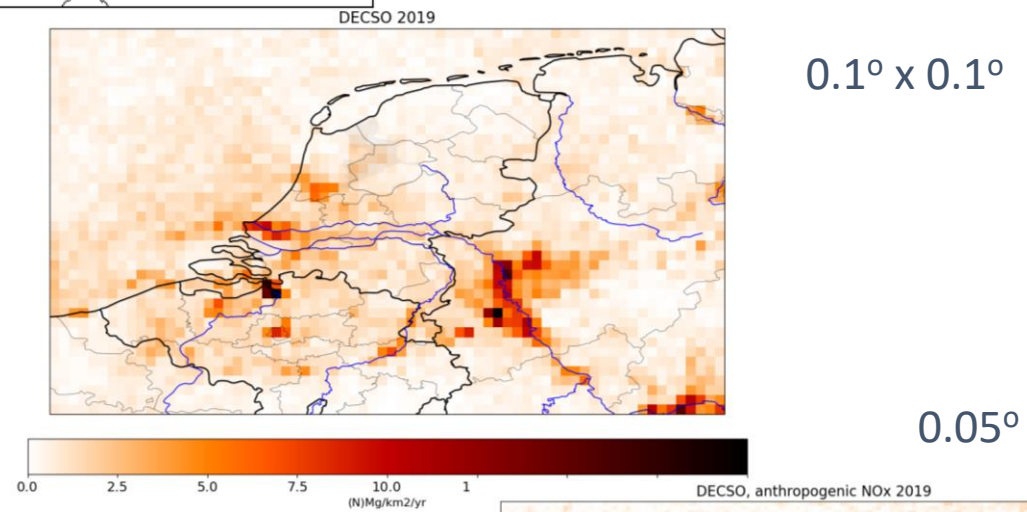
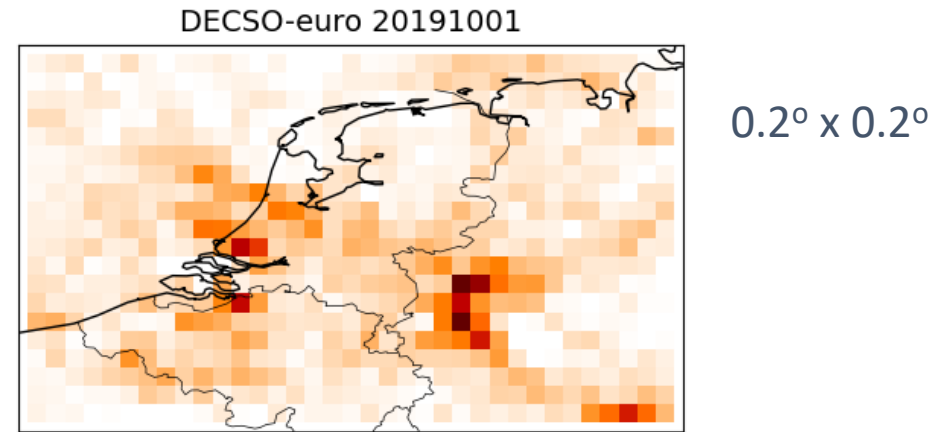
Soil NO emissions derived for Europe compared to CAMS and HEMCO (for 2019)



Going to higher resolutions for DECSO

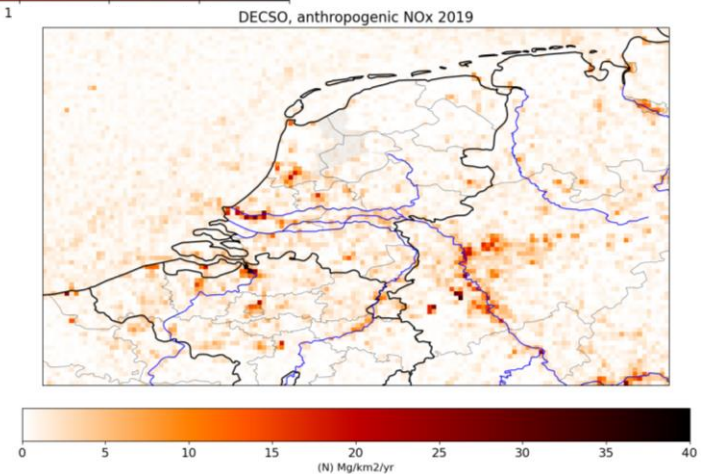
Available with DECSO:

- Europe at $0.2^\circ \times 0.2^\circ$ (2019-2023)
- Netherlands at $0.1^\circ \times 0.1^\circ$ (2019-2023)
- Netherlands at $0.05^\circ \times 0.05^\circ$ (2019)

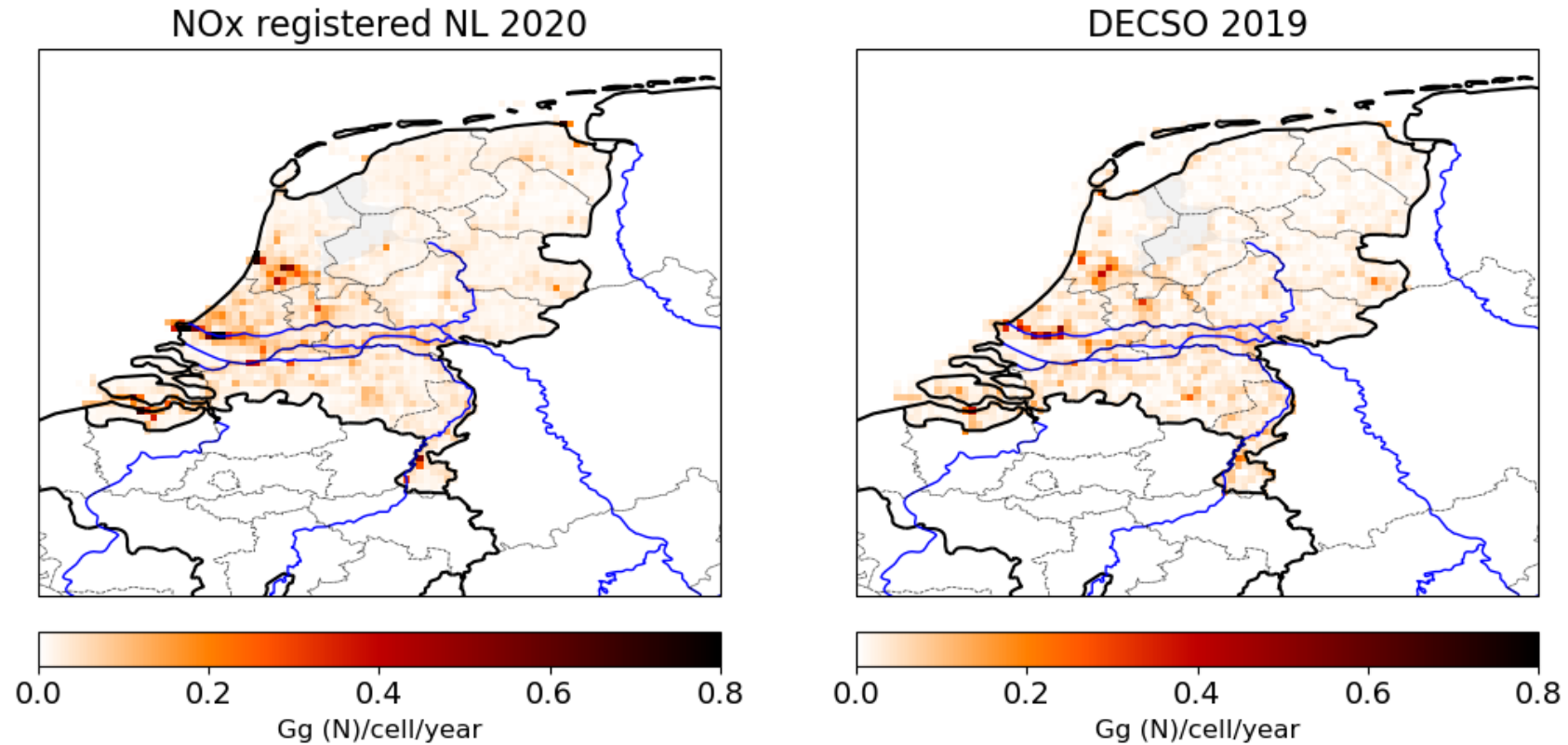


0.05° x 0.05°

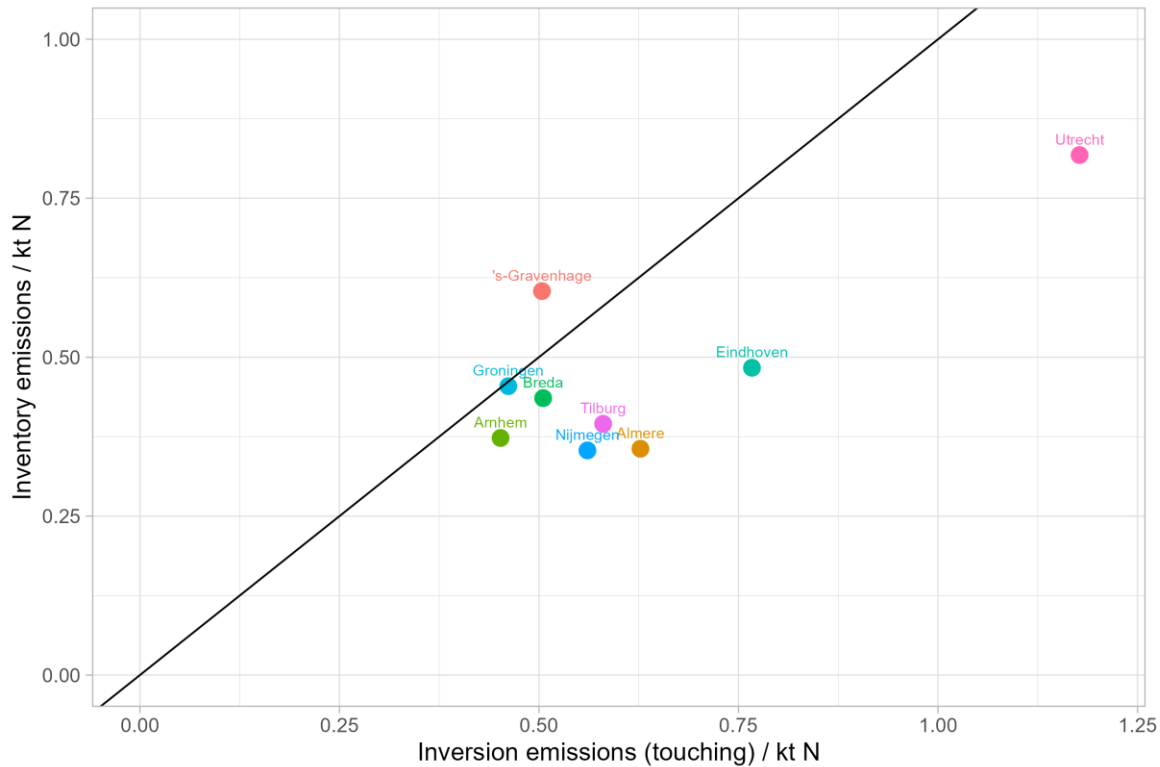
Note that the time and legend are different in these figures



Comparison of DECSO with official registered emissions (of RIVM) in the Netherlands

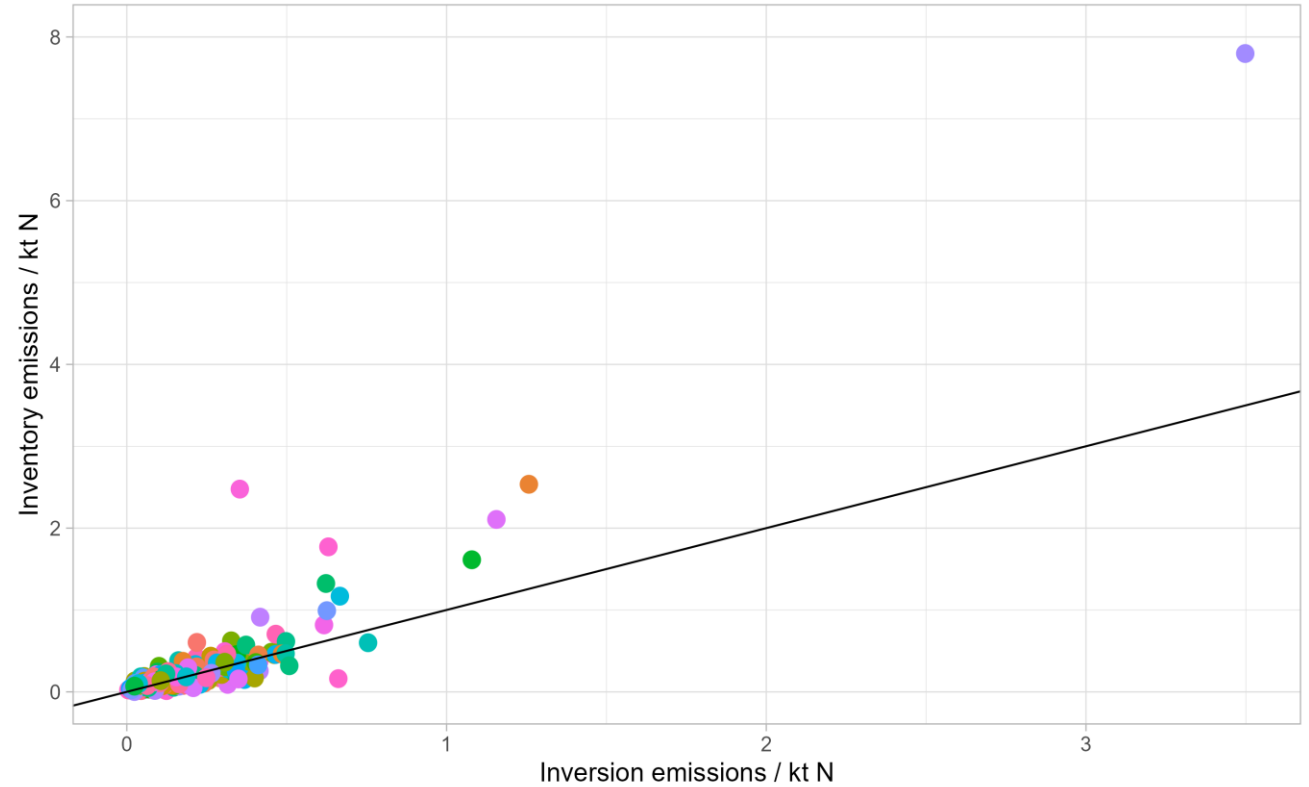


Comparison with official registered emissions in the Netherlands (preliminary results)



- Comparison of emissions from Dutch provincial capitals between DECISO (x-axis) and Dutch Emission Registration (y-axis) (city pop.: 180-360 thousand)

courtesy Hannes Witt (RIVM)



- Comparison at county level (Dutch "gemeente") between DECISO (x-axis) and Dutch Emission Registration (y-axis)

courtesy Hannes Witt (RIVM)



Summary

- DECSO version 6.3/6.4 includes error estimates and a split into biogenic and anthropogenic sector.
- DECSO provides independent satellite observation-based emissions of industrial and city-scale local emissions. No a priori information is used.
- NO_x emissions can be derived on a spatial resolution of 0.05° x 0.05° (± 5km).
- Intercomparisons with CAMS emissions shows for NO_x that:
 - Country total emissions of CAMS and DECSO are within 10%
 - City and soil emissions are systematic higher than CAMS
 - Results of industrial sources are inconclusive (due to limited number of isolated industrial point sources)