SEEDS
Sentinel EO-based Emission and Deposition Service

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Ammonia (NH_3) emissions

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cnrs
isardSAT
lobelia.

Emission estimation method:

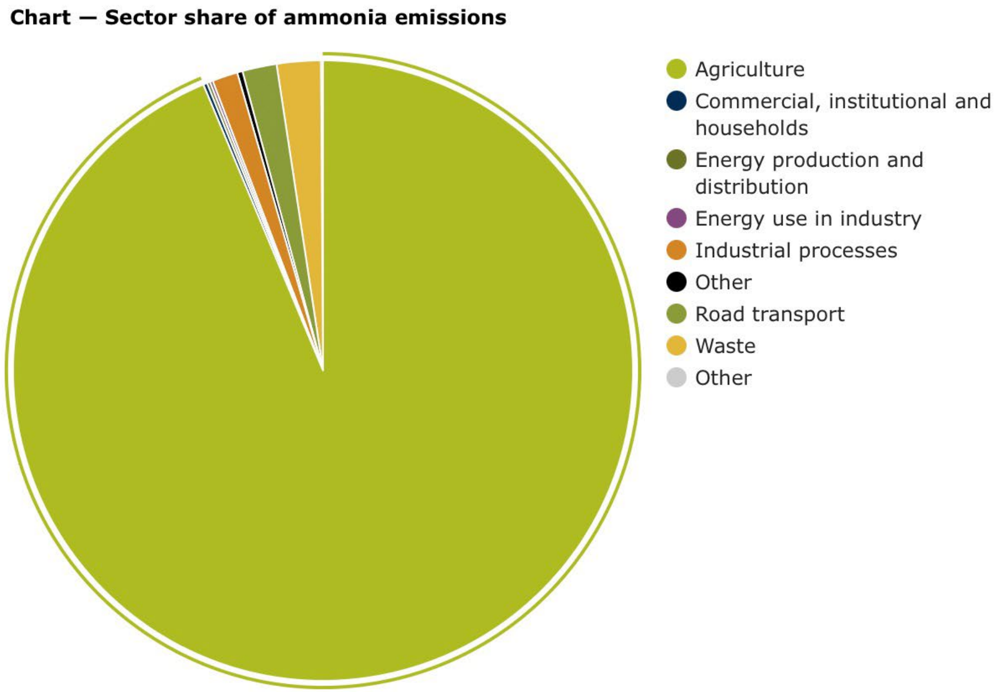
Inversion technique using satellite observations and a chemical transport model:

DECSO (see presentation from Ronald van der A)

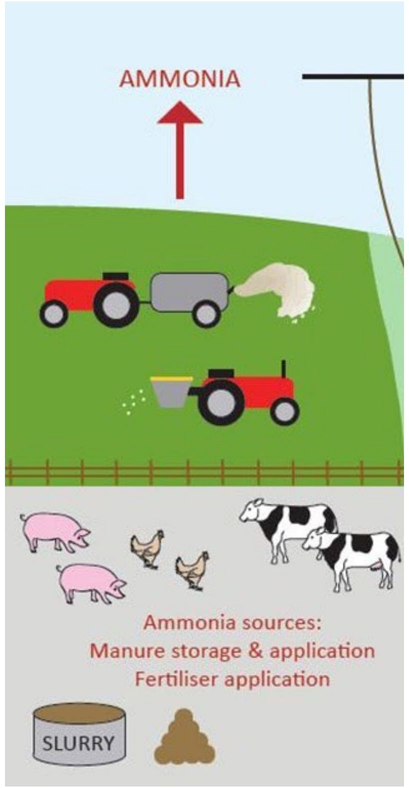
Products:

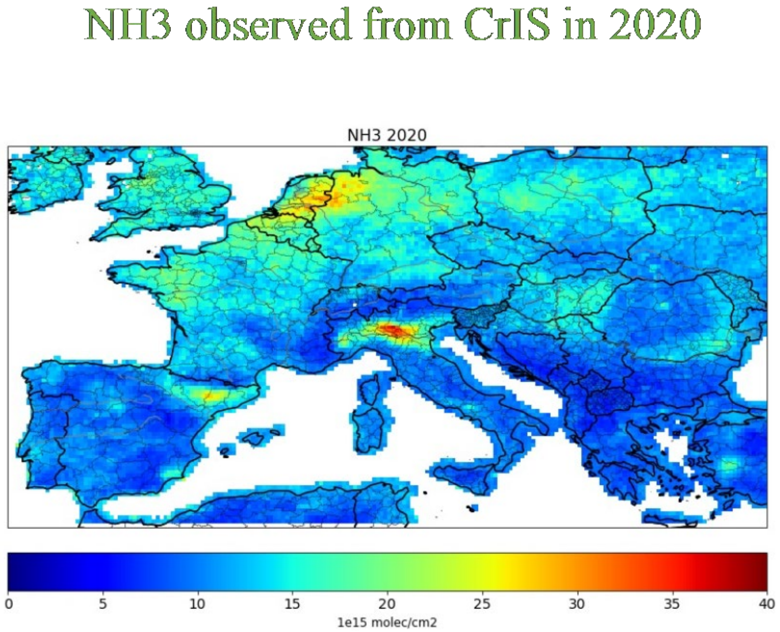
NH_3 emissions from CRIS

Ammonia (NH3)

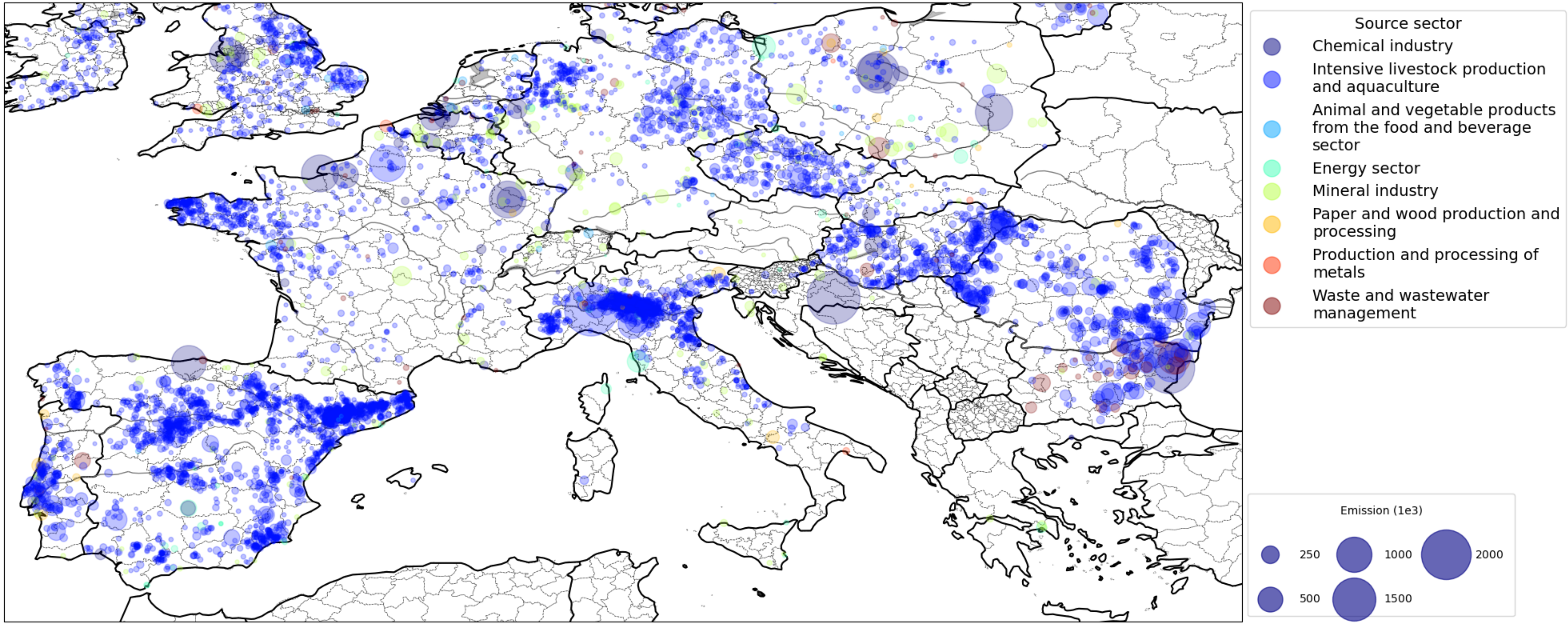


The contribution made by different sectors to emissions of ammonia in 2011. (Figure from European Environment Agency)





Ammonia sources from the European Pollutant Release and Transfer Register (E-PRTR)



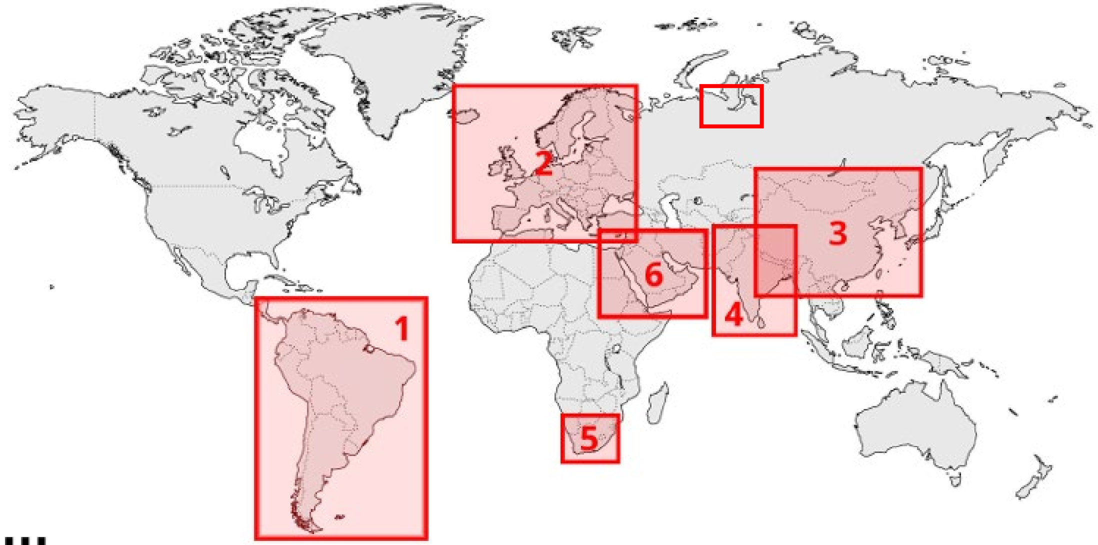
DECSO Daily Emissions Constrained by Satellite Observations

- It is fast: one model run per assimilation step of 1 day
- No *a priori* information needed: unknown sources will become visible.
- Full error estimation of new emission inventory
- Used for daily NO_x and NH_3 emissions

State vector forecast	$\mathbf{x}^f(t_{i+1}) = M_i[\mathbf{x}^a(t_i)]$
Error covariance forecast	$\mathbf{P}^f(t_{i+1}) = \mathbf{M}_i\mathbf{P}^a(t_i)\mathbf{M}_i^T + \mathbf{Q}(t_i)$
Kalman gain matrix	$\mathbf{K}_i = \mathbf{P}^f(t_i)\mathbf{H}_i^T[\mathbf{H}_i\mathbf{P}^f(t_i)\mathbf{H}_i^T + \mathbf{R}_i]^{-1}$
State vector analysis	$\mathbf{x}^a(t_i) = \mathbf{x}^f(t_i) + \mathbf{K}_i(\mathbf{y}_i^o - H_i[\mathbf{x}^f(t_i)])$
Error covariance analysis	$\mathbf{P}^a(t_i) = (\mathbf{I} - \mathbf{K}_i\mathbf{H}_i)\,\mathbf{P}^f(t_i)$

- DECSO v6.1
- Model: CHIMERE 2020 r3
- Observations:
  - CrIS NH3 (provided by Mark Shephard*)

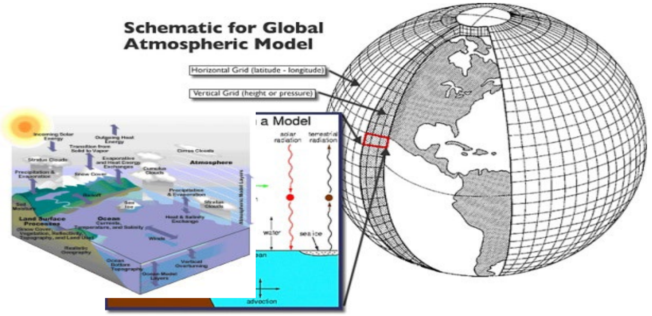
*Environment and Climate Change Canada



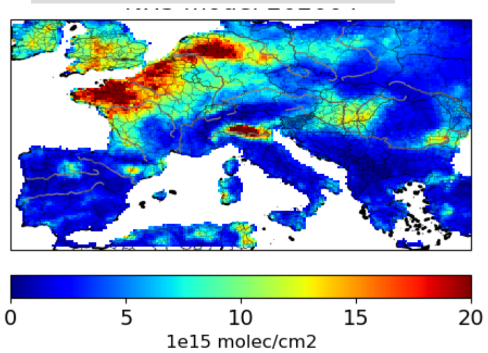
DECSO (Daily Emission estimates Constrained by Satellite Observation)

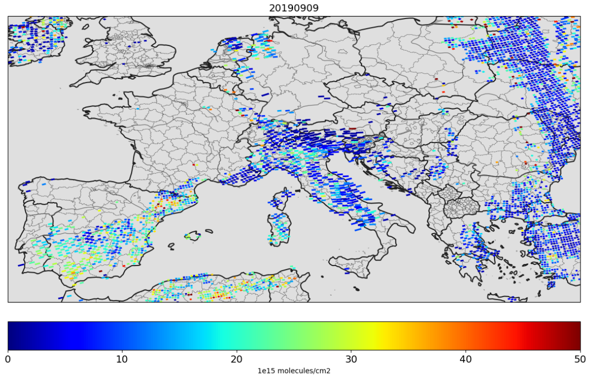
Full inversion of satellite observations

Chemistry Transport Model

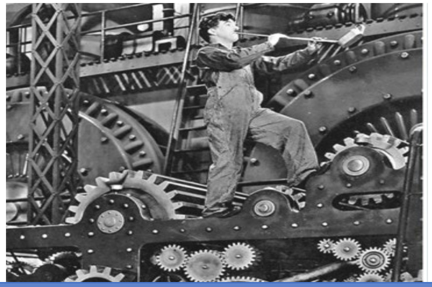


Concentrations





Satellite observations



State vector forecast	$\mathbf{x}^f(t_{i+1}) = M_i\,[\mathbf{x}^a(t_i)]$
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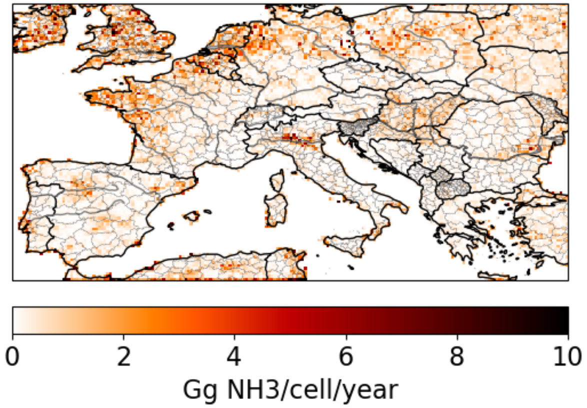
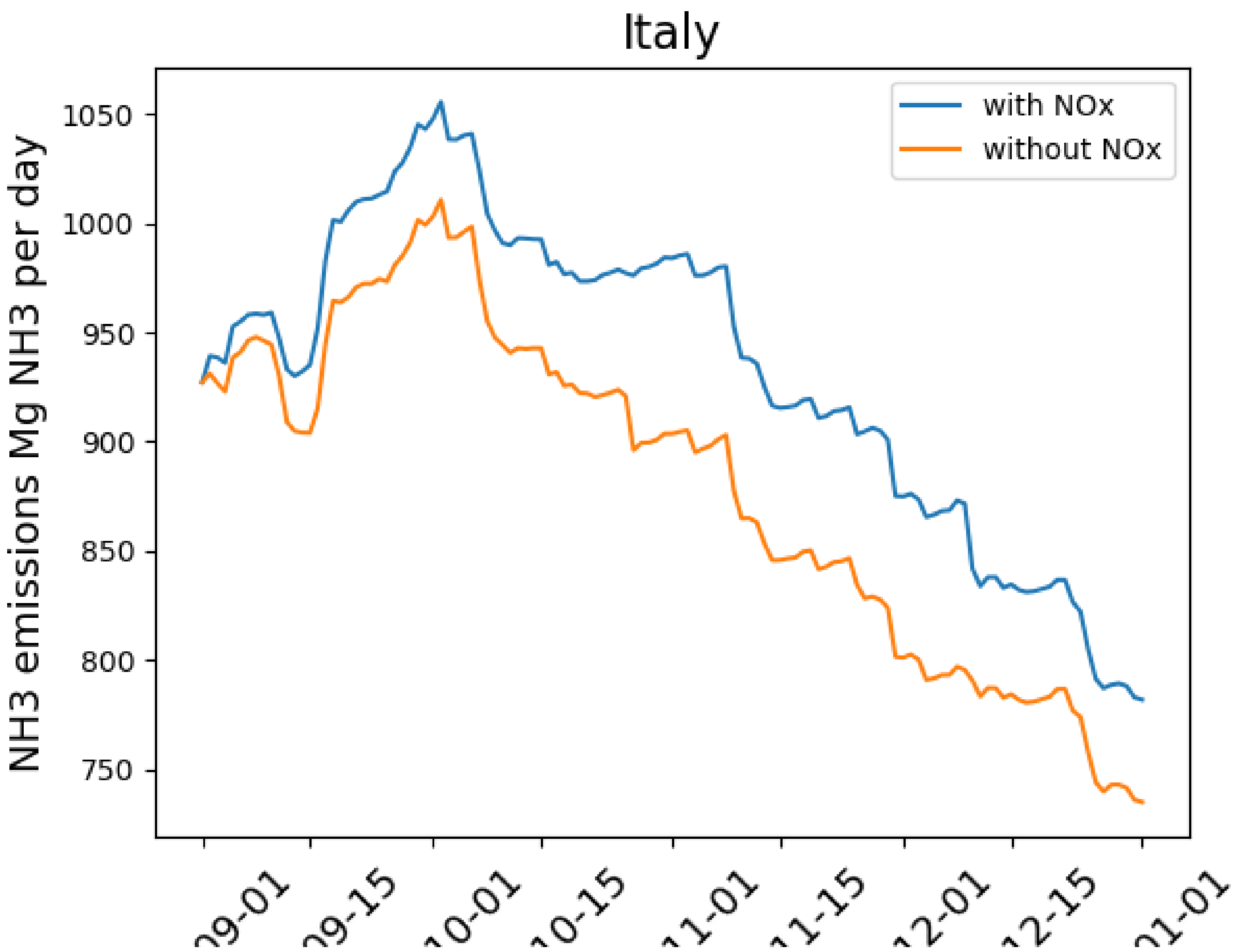
Inversion algorithm



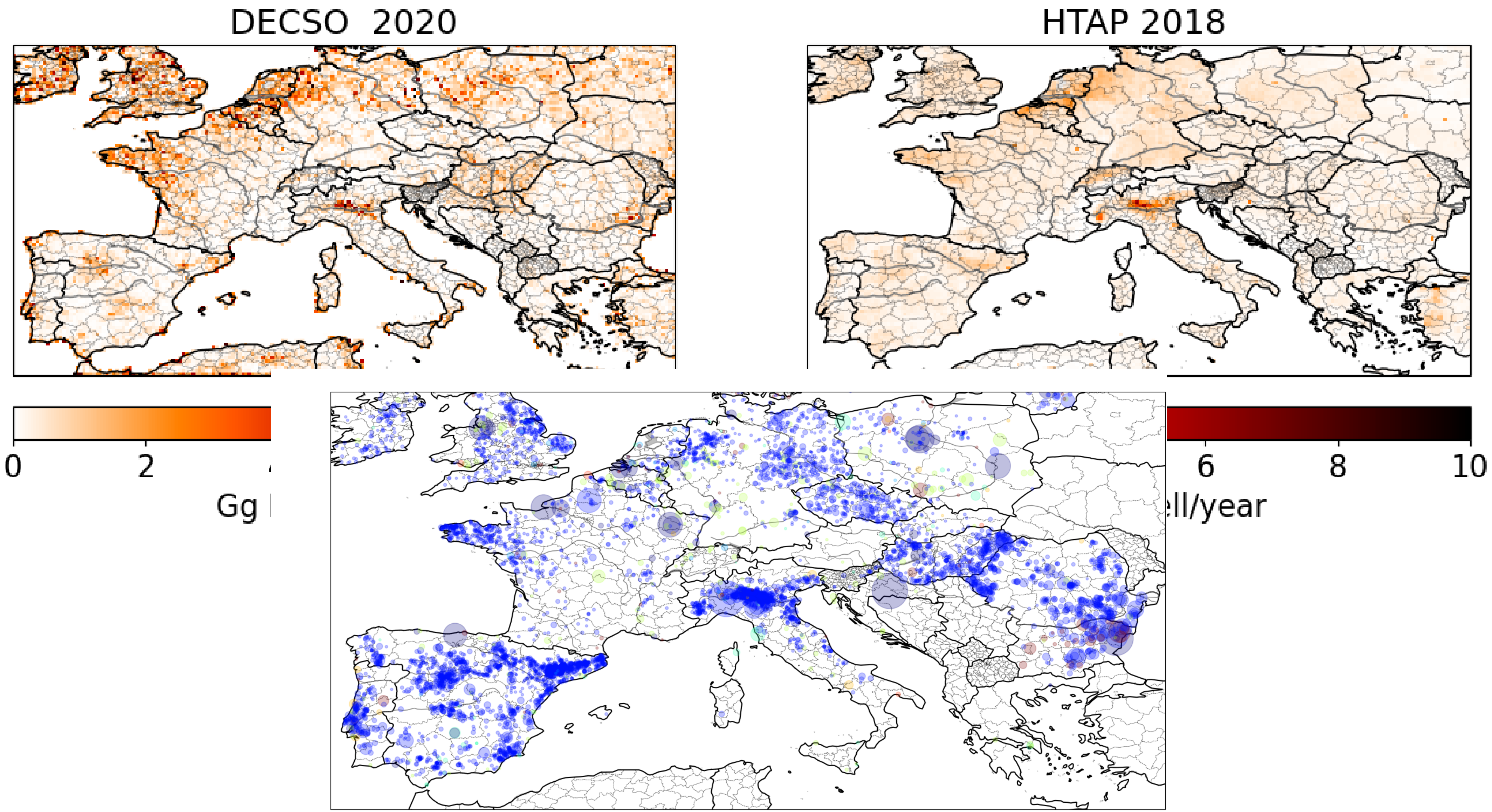
Emissions

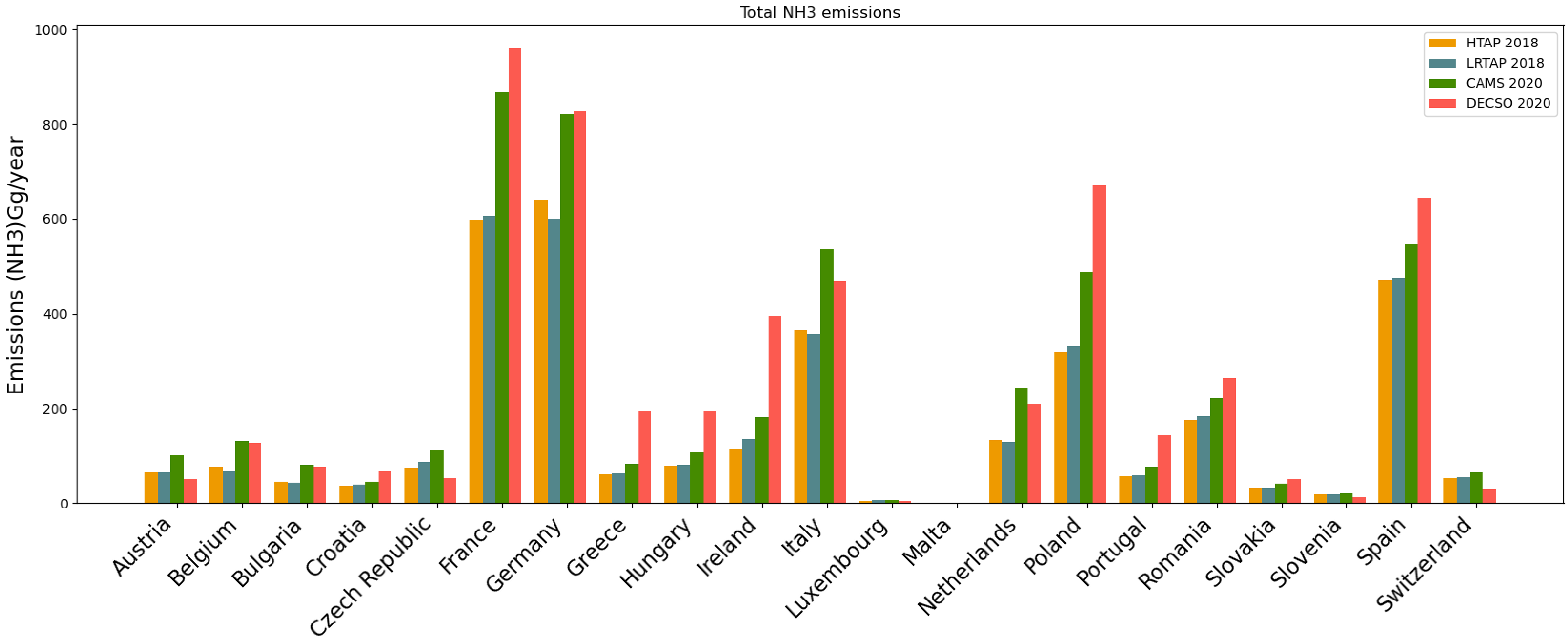
NH_3 emission estimates

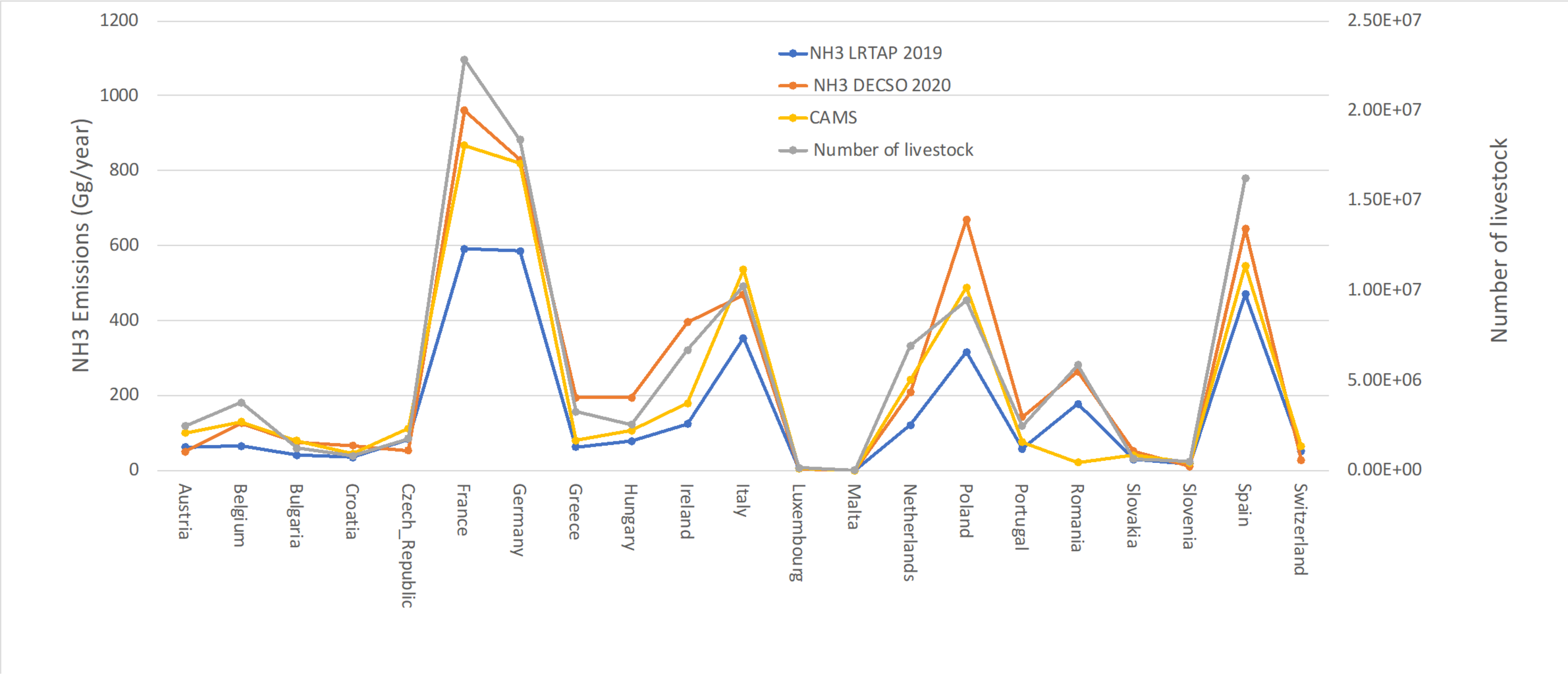


NOx emissions updated daily using TROPOMI

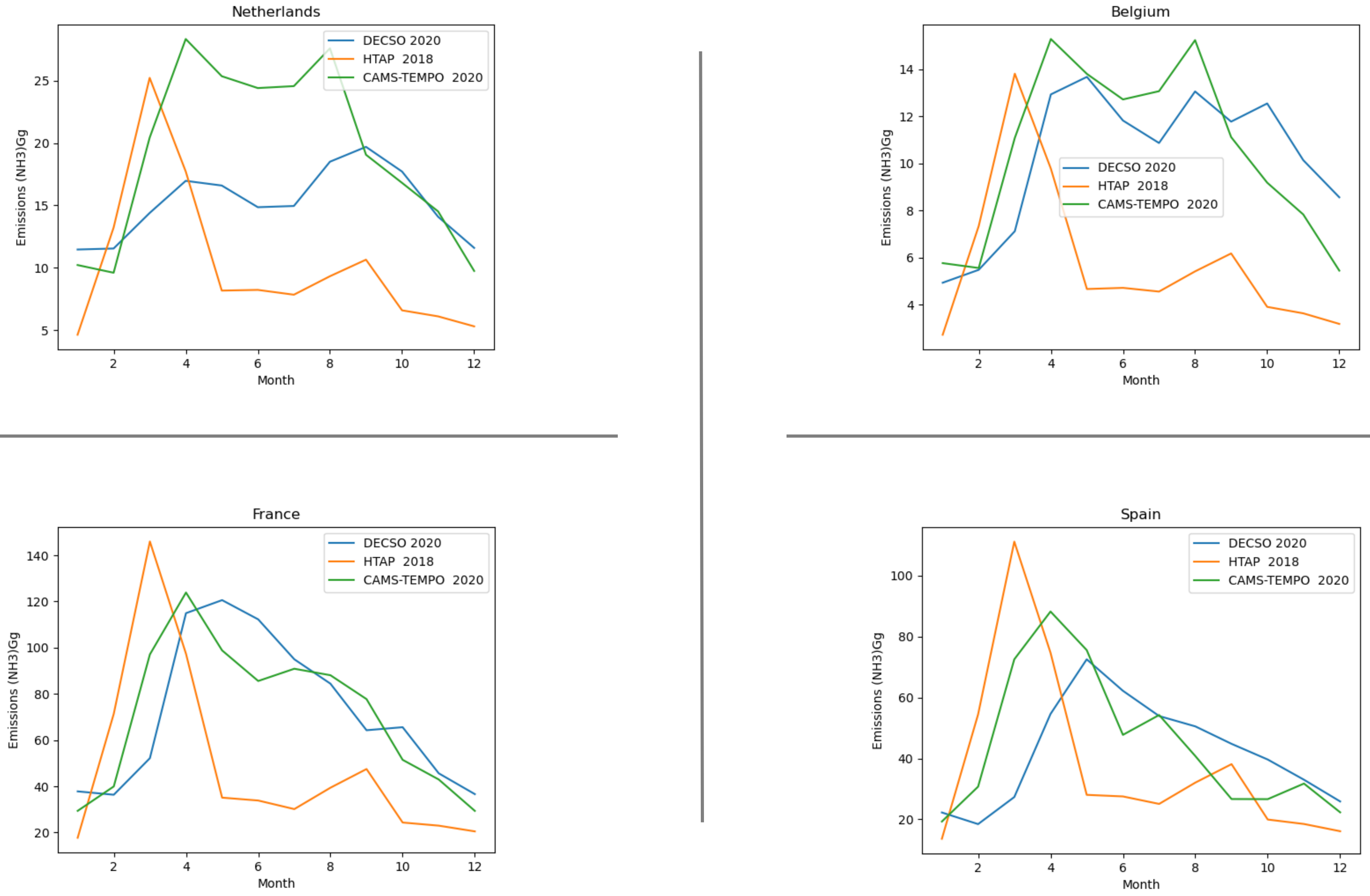
NOx emissions from bottom-up inventory (no daily updates)

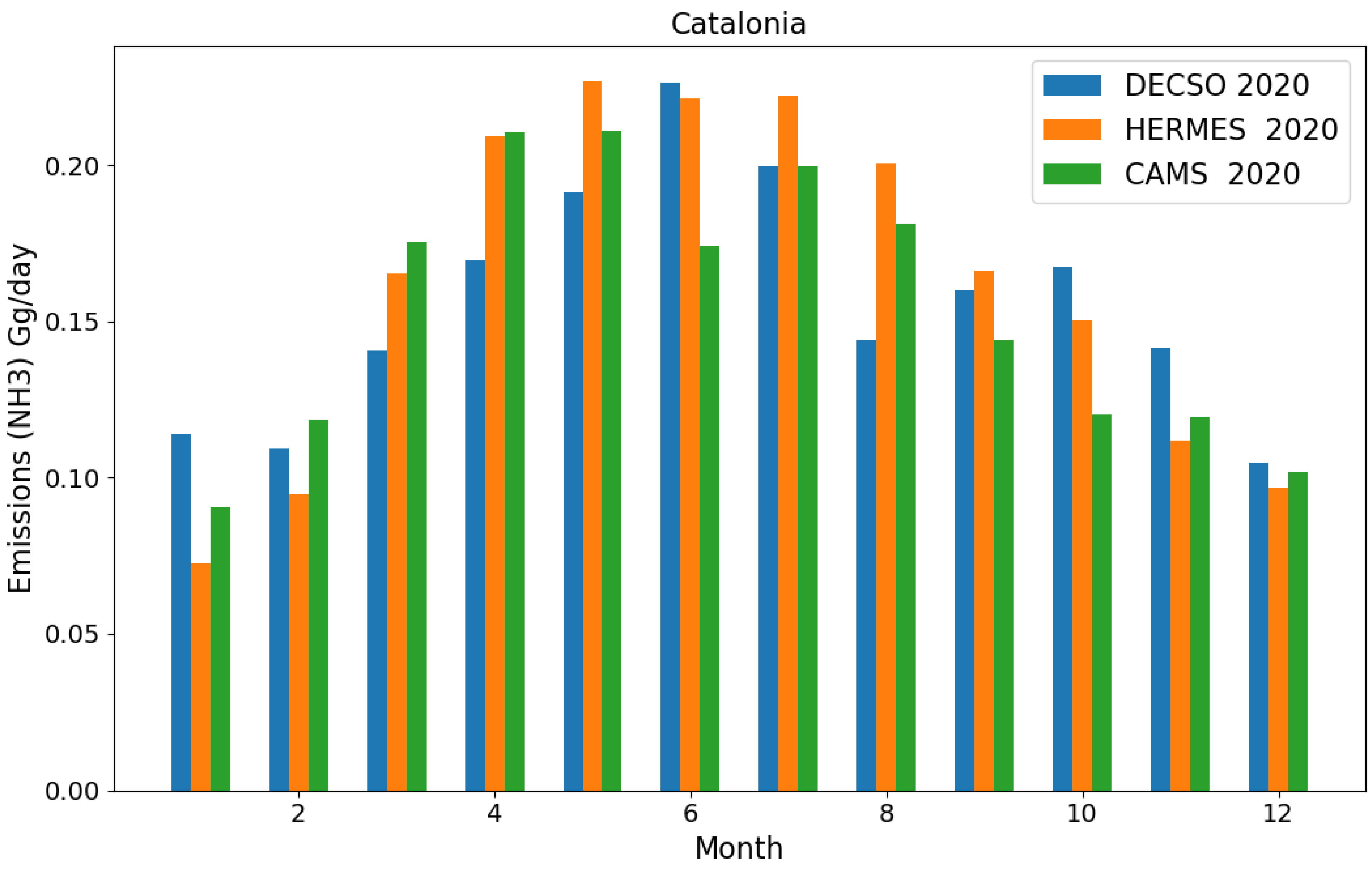

DECSO 2020
HTAP 2018
0
2
6
8
10
ell/year


Total NH3 emissions
Emissions (NH3)Gg/year
0
200
400
600
800
1000
HTAP 2018
LRTAP 2018
CAMS 2020
DECSO 2020
Austria
Belgium
Bulgaria
Croatia
Czech Republic
France
Germany
Greece
Hungary
Ireland
Italy
Luxembourg
Malta
Netherlands
Poland
Portugal
Romania
Slovakia
Slovenia
Spain
Switzerland



NH3 LRTAP 2019
NH3 DECSO 2020
CAMS
Number of livestock
NH3 Emissions (Gg/year)
Number of livestock
1200
1000
800
600
400
200
0
2.50E+07
2.00E+07
1.50E+07
1.00E+07
5.00E+06
0.00E+00
Austria
Belgium
Bulgaria
Croatia
Czech_Republic
France
Germany
Greece
Hungary
Ireland
Italy
Luxembourg
Malta
Netherlands
Poland
Portugal
Romania
Slovakia
Slovenia
Spain
Switzerland

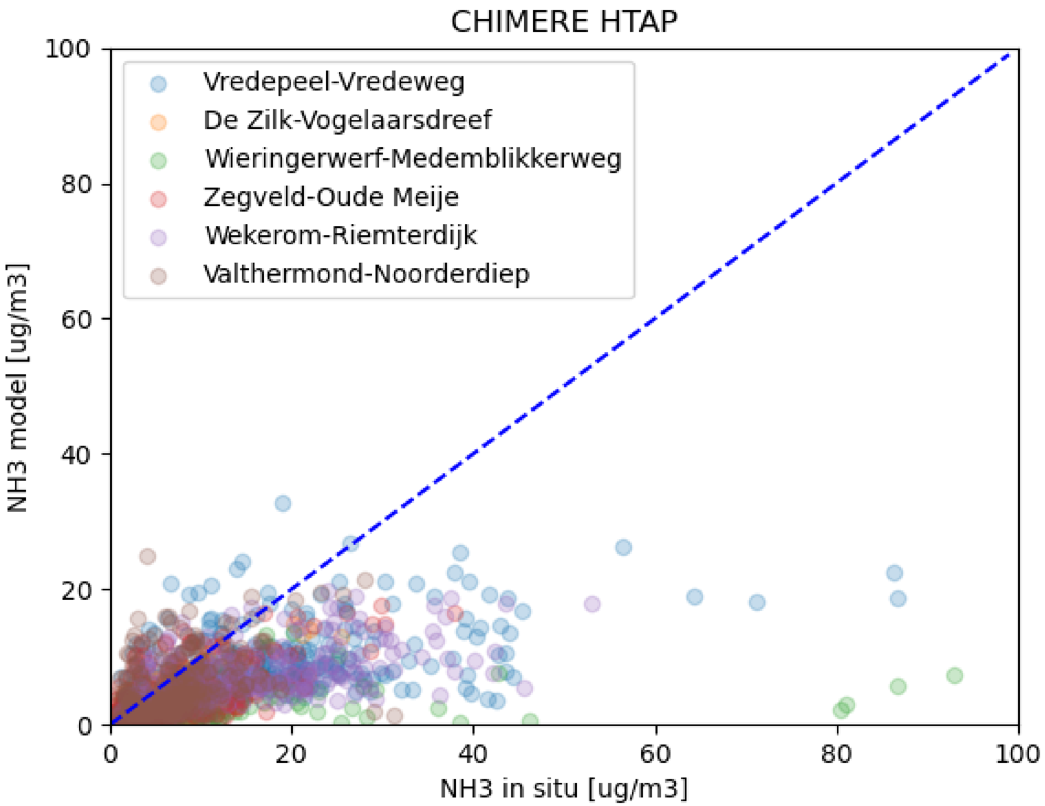

Netherlands
DECSO 2020
HTAP 2018
CAMS-TEMPO 2020
Emissions (NH3)Gg
Month
Belgium
DECSO 2020
HTAP 2018
CAMS-TEMPO 2020
Emissions (NH3)Gg
Month
France
DECSO 2020
HTAP 2018
CAMS-TEMPO 2020
Emissions (NH3)Gg
Month
Spain
DECSO 2020
HTAP 2018
CAMS-TEMPO 2020
Emissions (NH3)Gg
Month

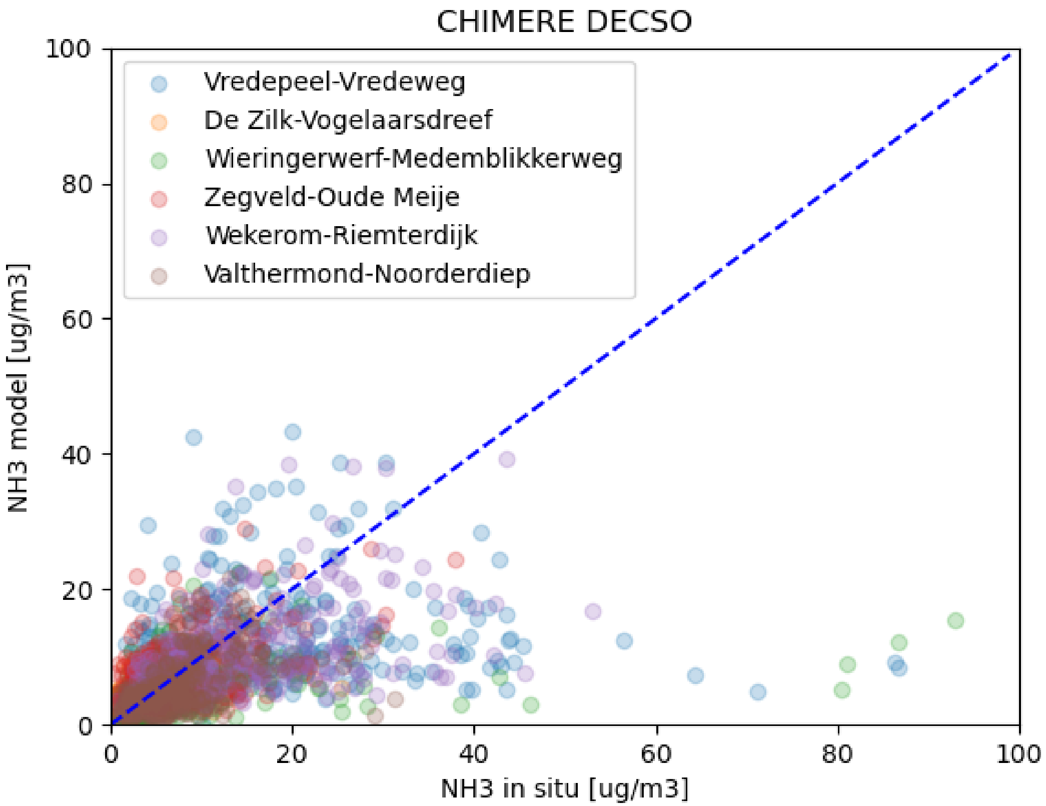


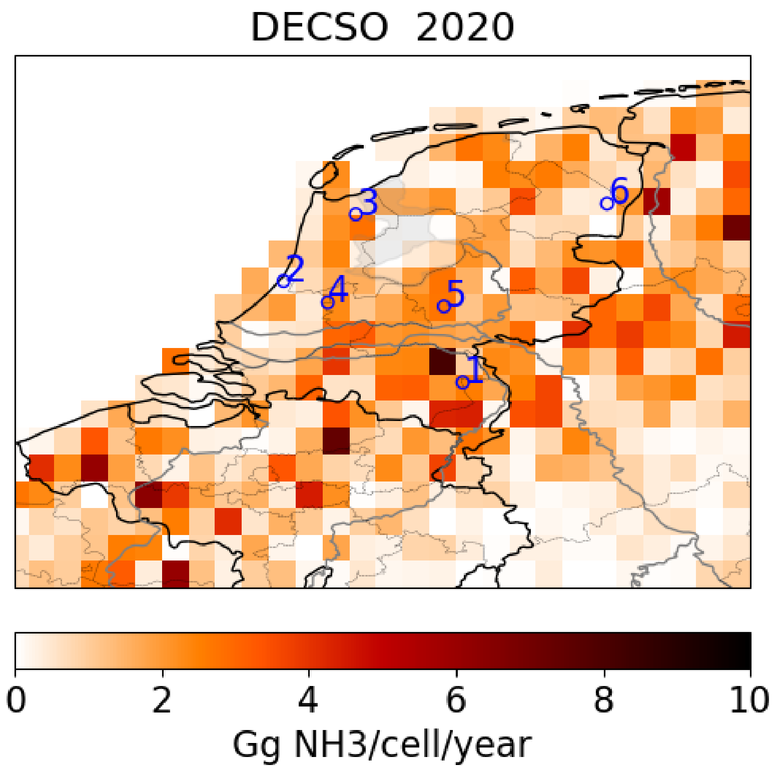
Catalonia
DECSO 2020
HERMES 2020
CAMS 2020
Emissions (NH3) Gg/day
0.00
0.05
0.10
0.15
0.20
2
4
6
8
10
12
Month

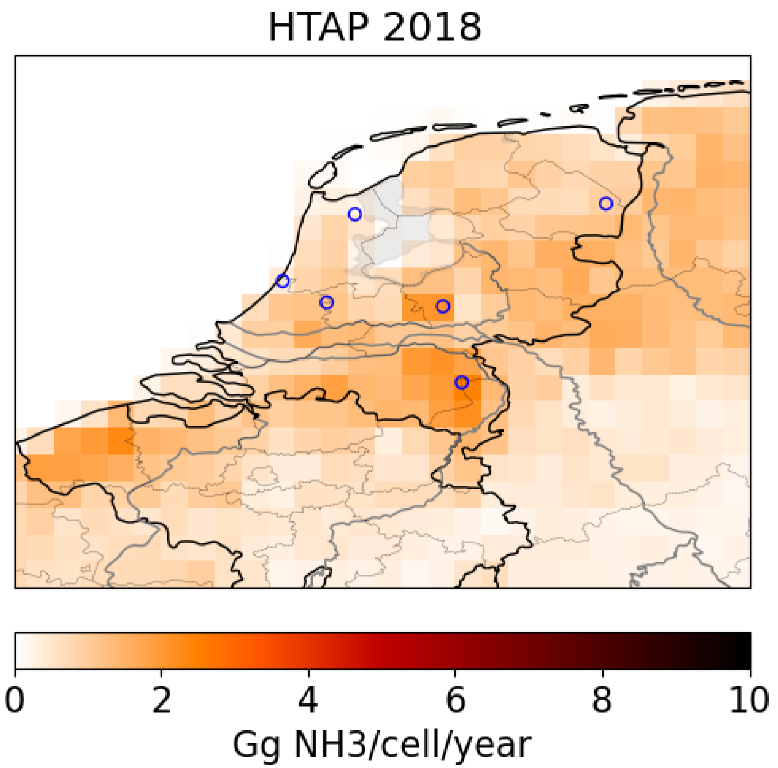
Model simulations vs In-situ measurements

CHIMERE model simulations
Emissions: HTAP vs DECSO

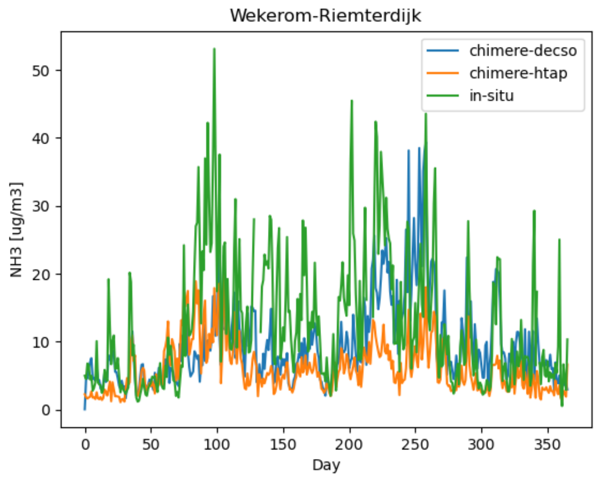


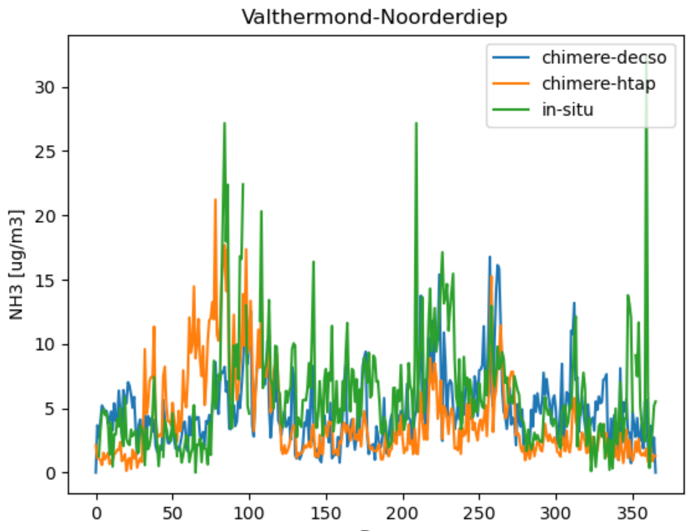


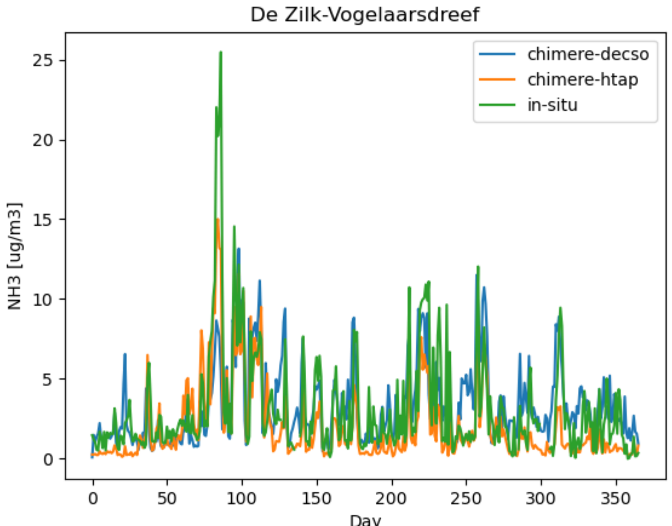


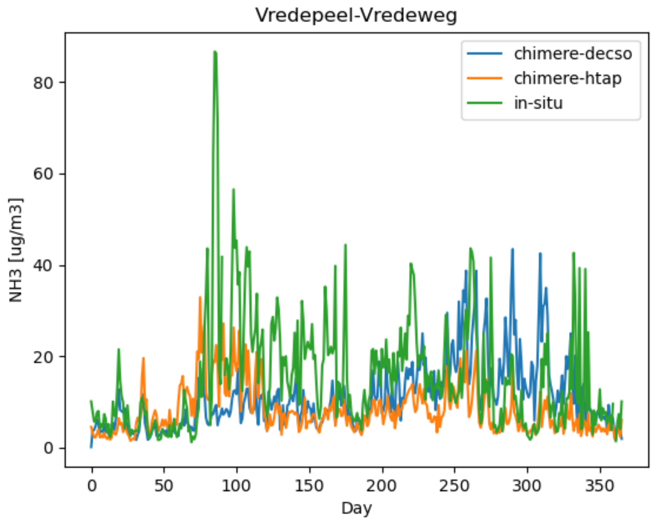


1 Vredepeel-Vredeweg
2 De Zilk-Vogelaarsdreef
3 Wieringerwerf-Medemblikkerweg
4 Zegveld-Oude Meije
5 Wekerom-Riemterdijk
6 Valthermond-Noorderdiep

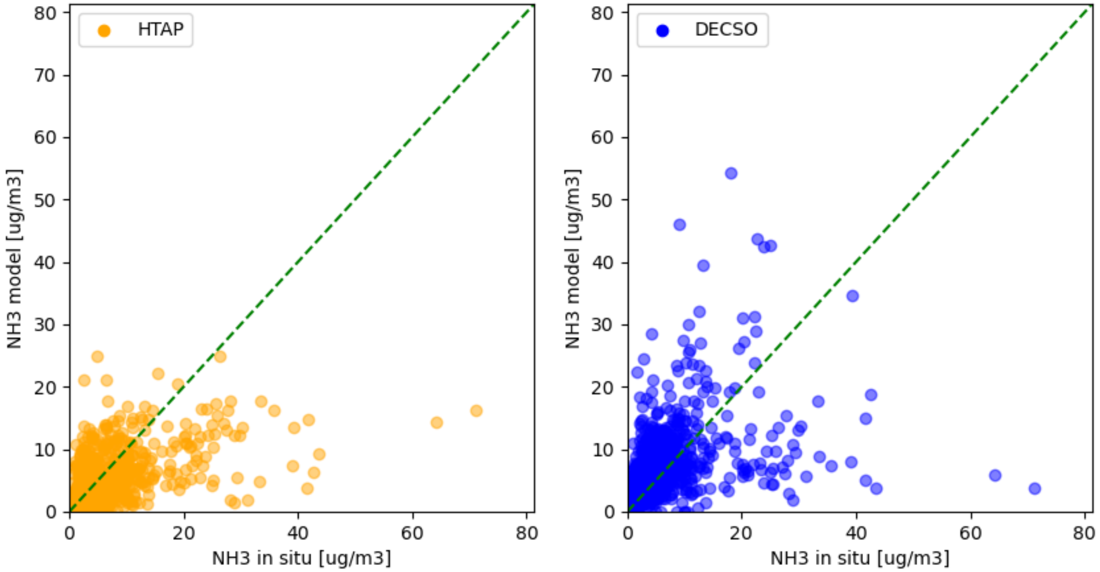




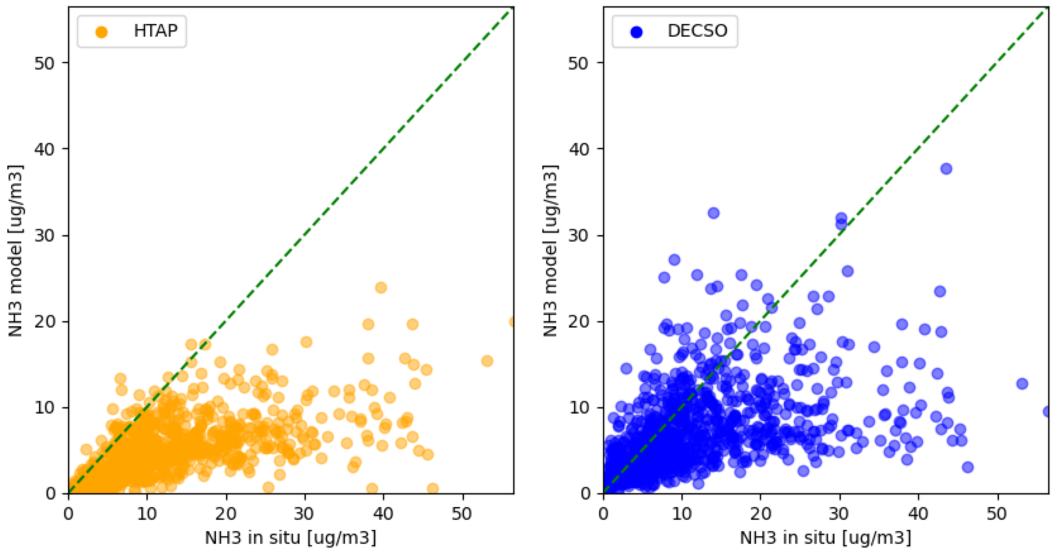


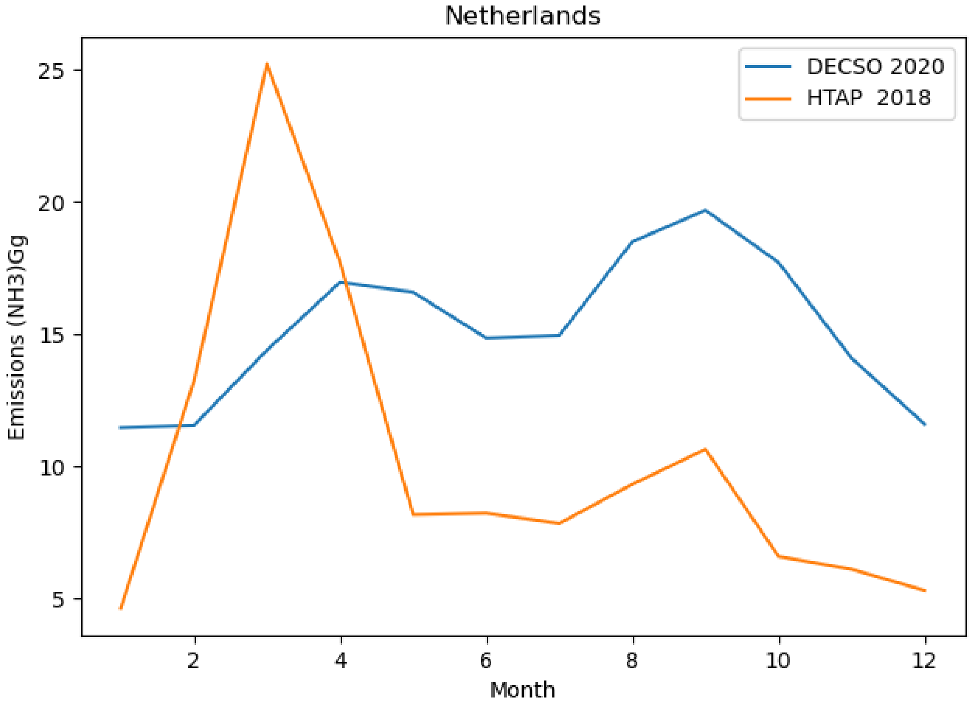


Winter months



Summer months





Conclusions

- The NH_3 emissions from DECSO are comparable with bottom-up emissions/ reported NH_3 emissions for country totals.
- The spatial distribution of NH_3 emissions from DECSO is reasonable. The regions with high NH_3 emissions are well detected.
- The seasonality of NH_3 emissions is different among bottom-up inventories. The results of DECSO are among the variation.
- The comparison with in-situ observations shows that model simulations using DECSO-NH3 with in-situ observations beter captured the seasonal changes of NH_3 than using HTAP.

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Thank you!
Questions?

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