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TAKING THE PULSE OF OUR PLANET FROM SPACE

NH_3 emissions derived from CrIS observations over Europe

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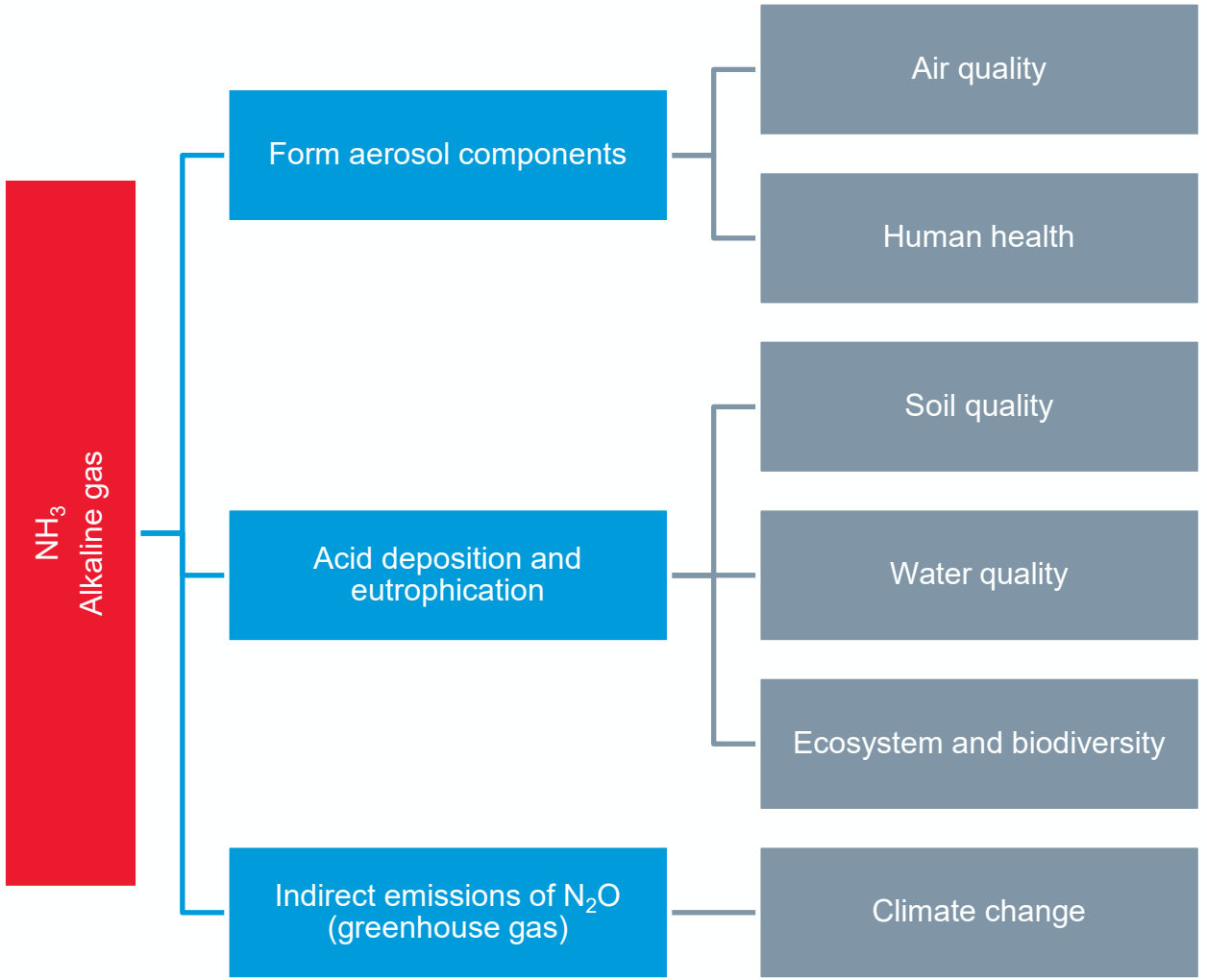
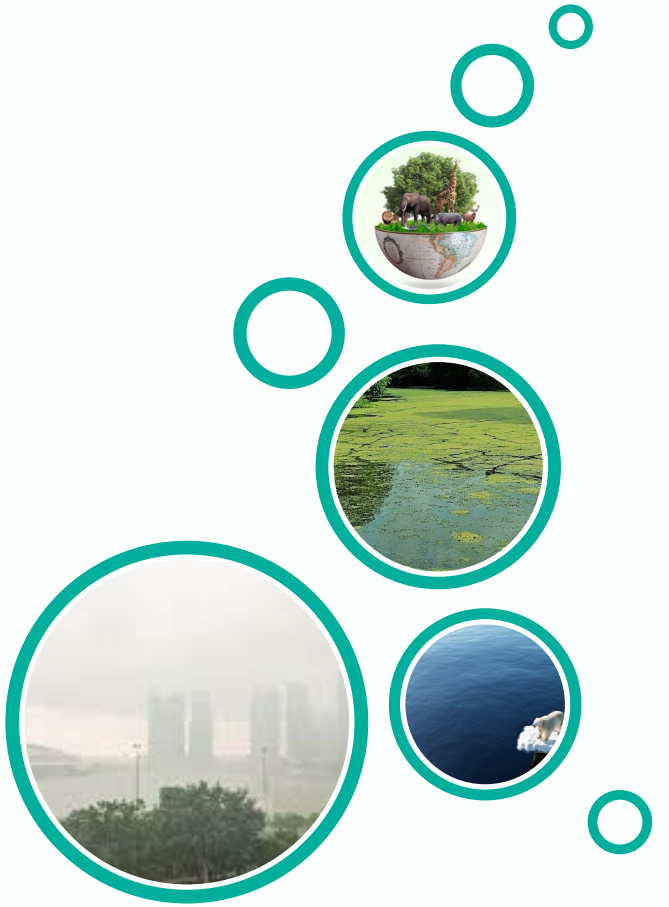
Outline

- Why are we interested in NH_3 emissions?
- Why do we want to estimate NH_3 from satellite observations?
- Can we derive NH_3 emissions from satellite observations? How?
- Can we get good results?
- What shall we do next?

Why are we interested in NH_3 emissions?





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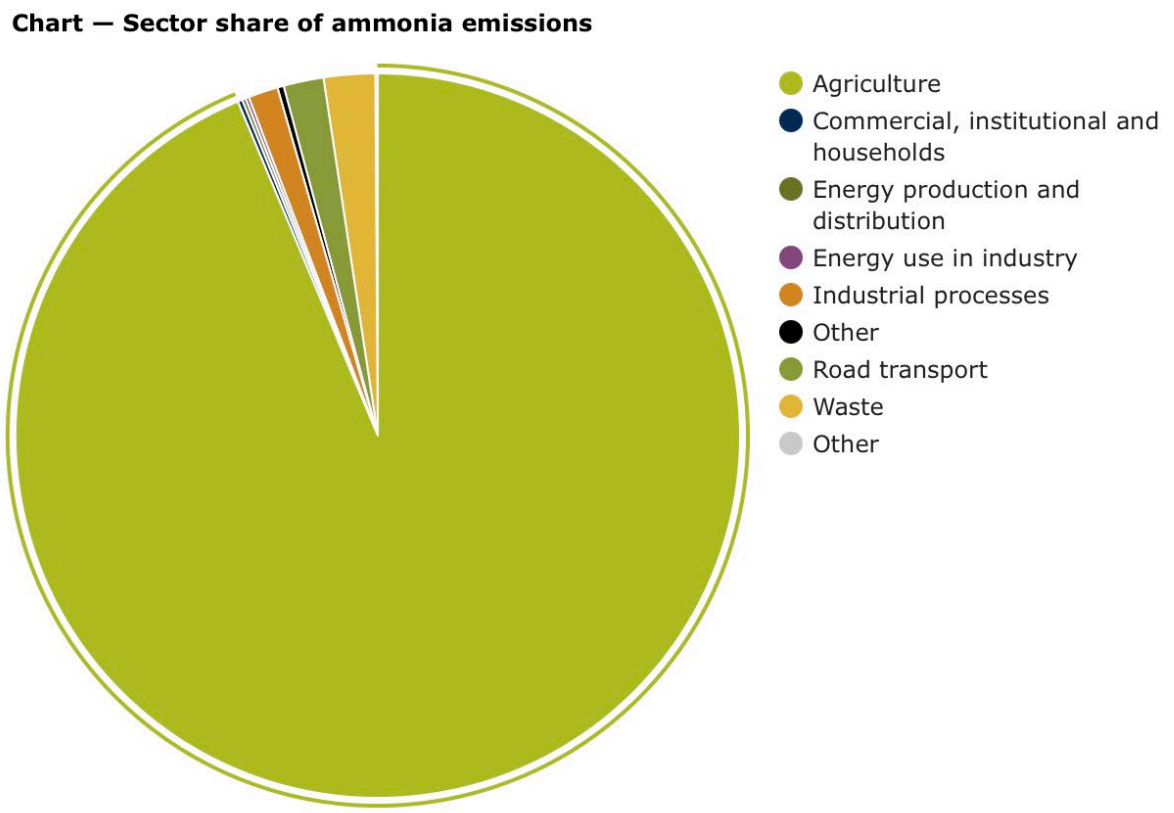
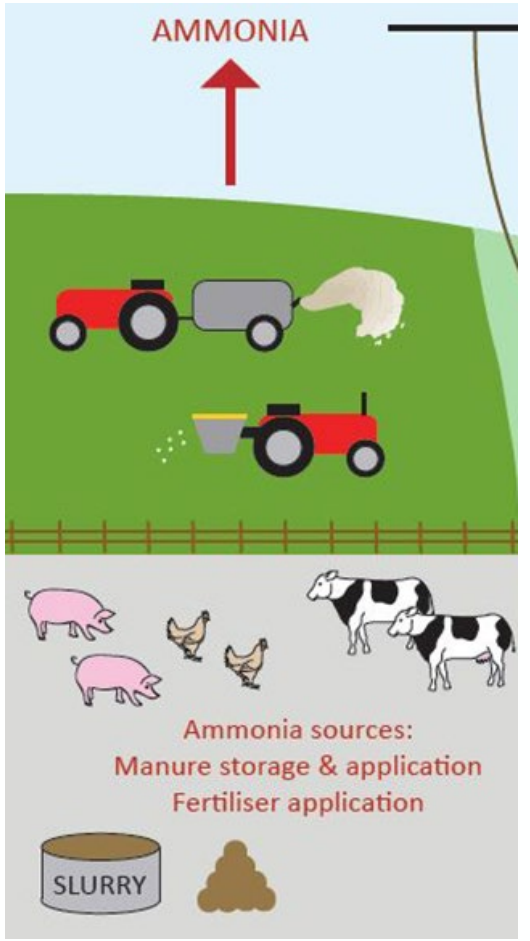
NH_3 Emission Sources



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



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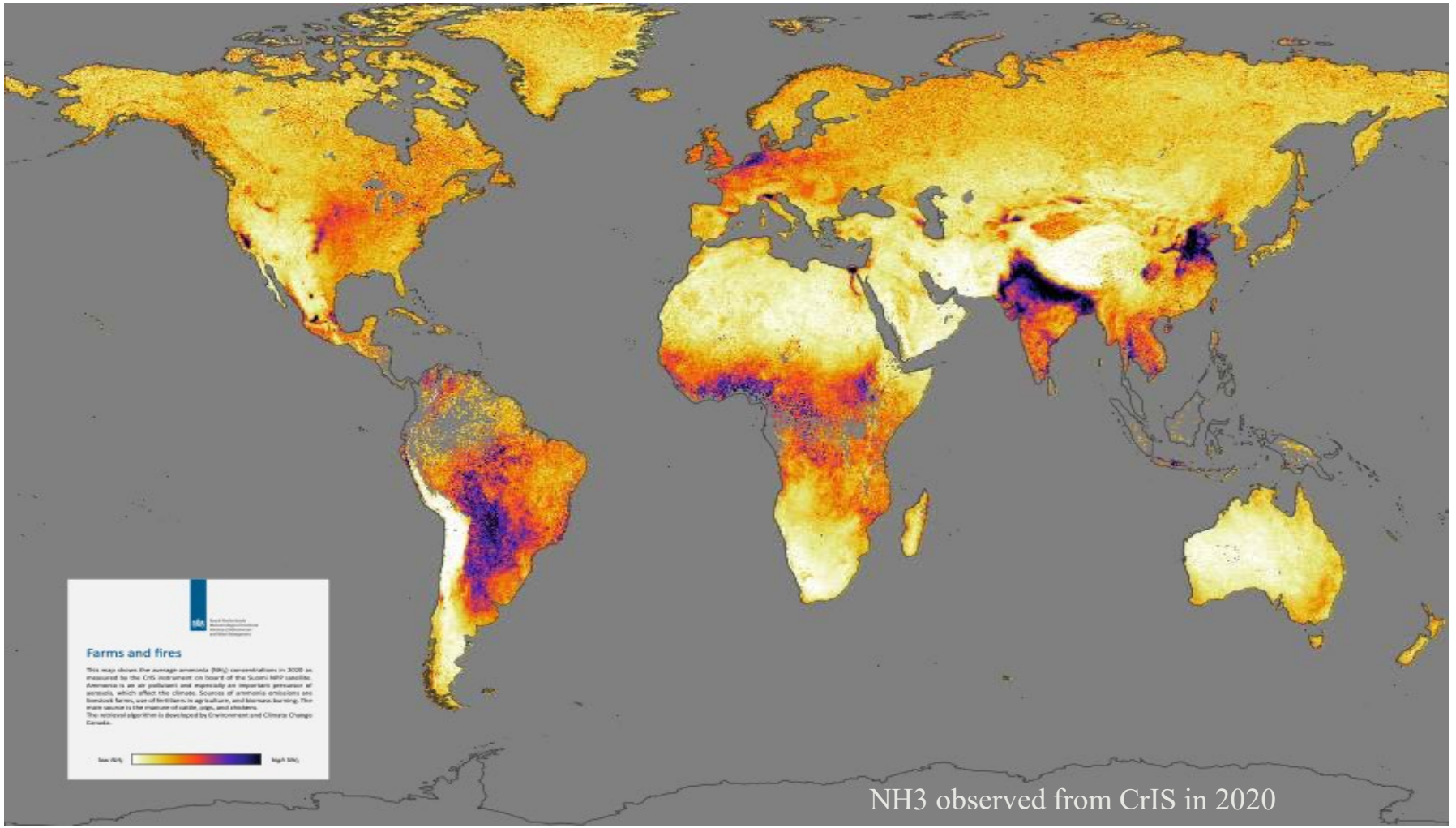
Why do we want to estimate NH_3 from satellite observations?

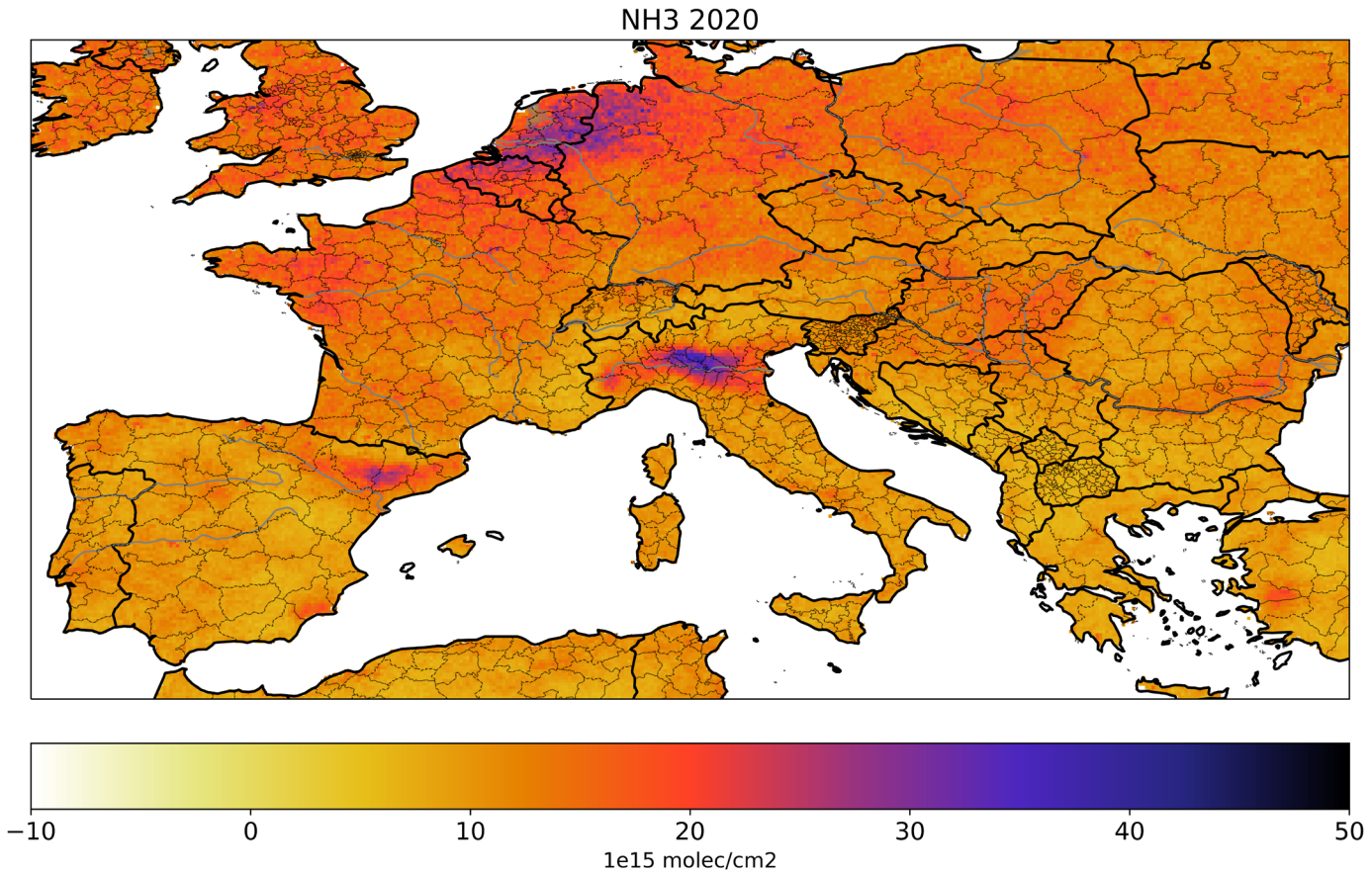
- Limited groud-based measurements
- High uncertainties in bottom-up emission inventories (uncertain emission factors)

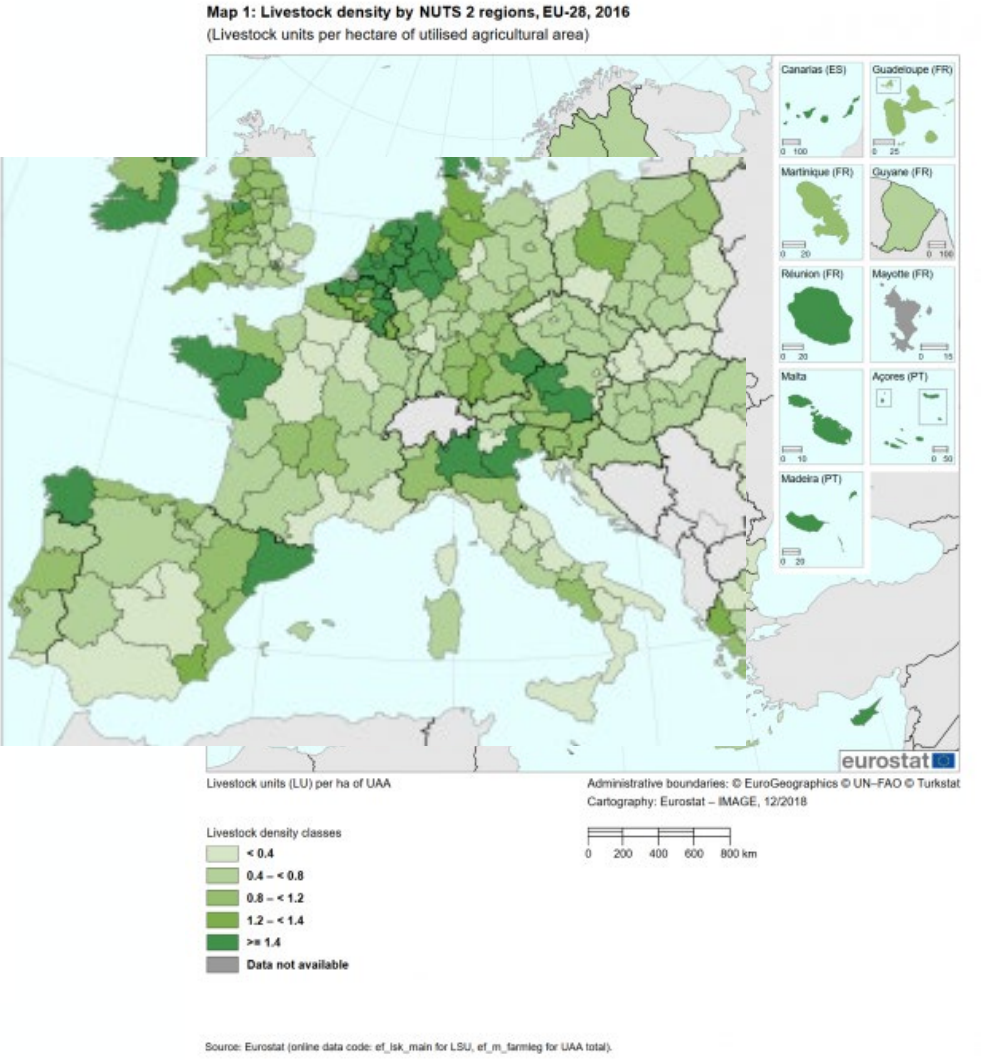
➢ We expect to improve the spatial and temporal distribution of NH_3 emissions.



NH3 observed from CrIS in 2020

NH_3 observations over Europe

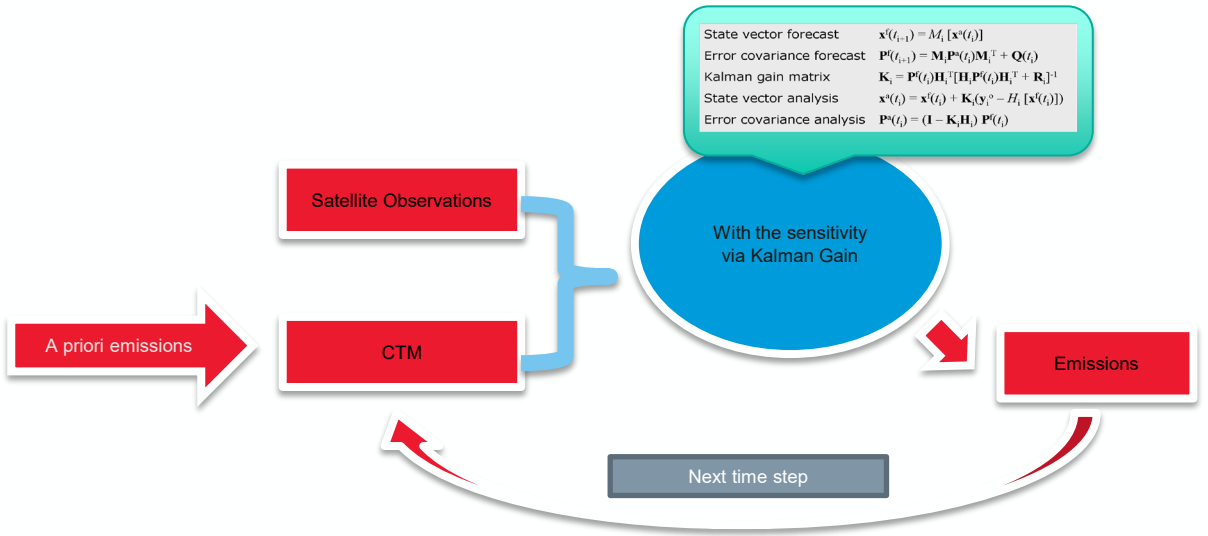


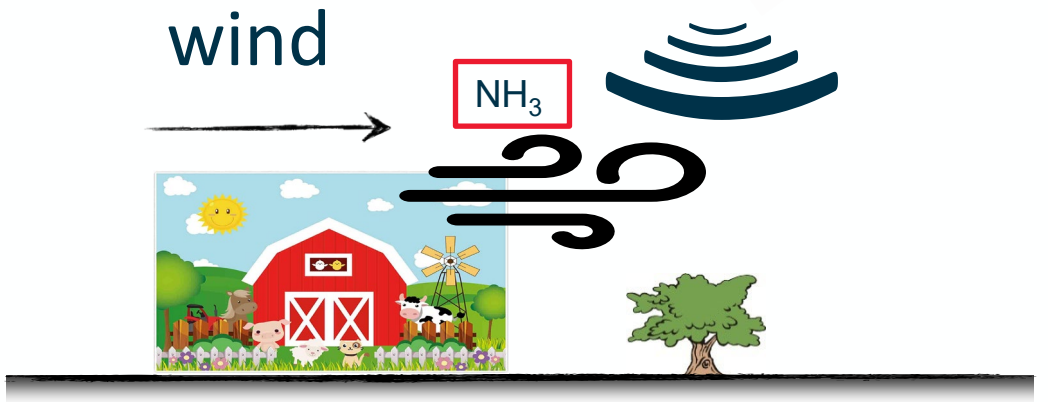


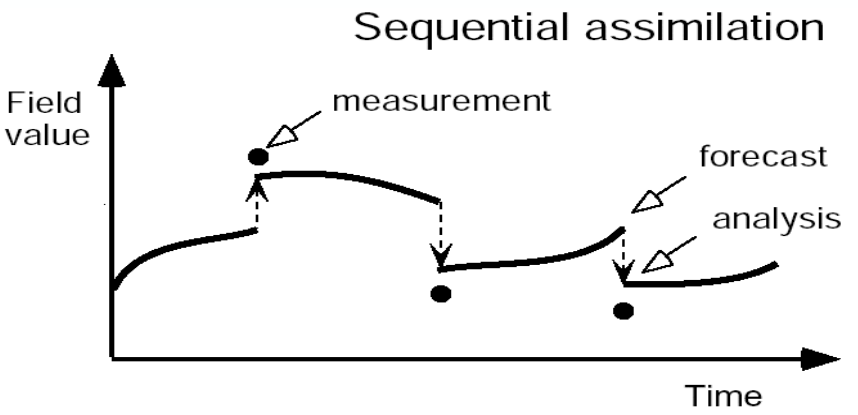
How can we derive NH_3 emissions from satellite observations?

DECSO (Daily Emissions Constrained from Satellite Observations) **algorithm**

- CrIS satellite observations
- Model (CHIMERE 2013, CHIMERE 2020)
- Kalman filter







- Key part: the sensitivity of the observed NH_3 column concentration on the NH_3 emissions in the CTM

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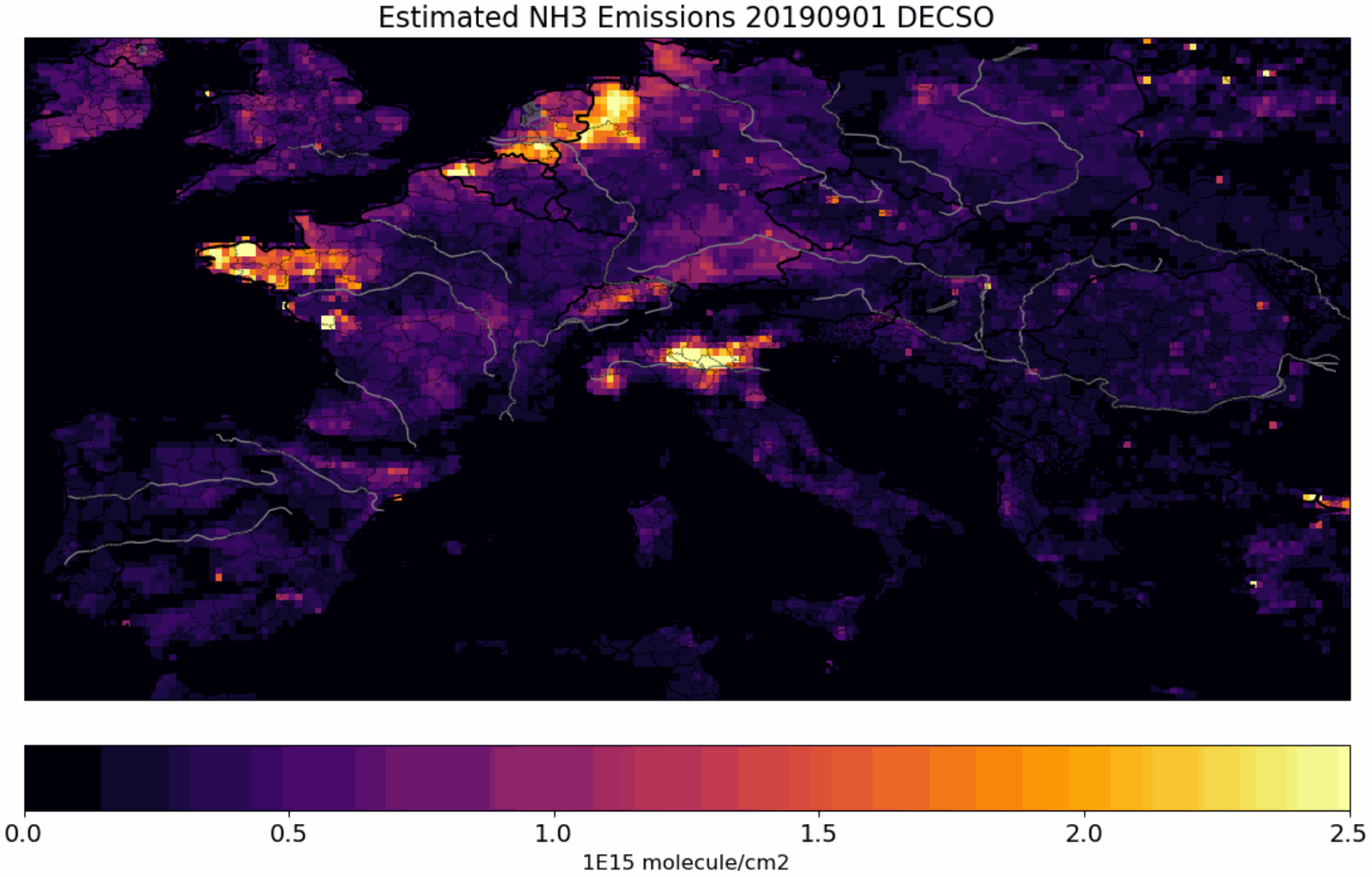
Estimated NH3 Emissions 20190901 DECSO
0.0
0.5
1.0
1.5
2.0
2.5
1E15 molecule/cm2

CrIS observations

- On Suomi National Polar-orbiting Partnership (SNPP) satellite
- Launched in Oct. 2011
- Overpass time 01:30 and 13:30 local time
- Resolution: 14 km resolution at Nadir
- Different versions of Retrieval data from Environment and Climate Change Canada
- Time period Sep. 2019 to Dec. 2020

Data filtering criteria

- Data quality flag >= 5
- Observations over land
- Observations during daytime (13:30)
- No cloudy pixels
- (only the data version above 1.6 has the cloud flag)

CHIMERE Models
version 2013 and version 2020

- Domain: Europe
- Horizontal resolution (0.2^o x 0.2^o)
- Vertical resolutison: 8 layers up to 500 hpa.
- Meteorological input ECMWF
- Initial emission inventory: HTAP 2010

- Implement CrIS NH_3 data
- Construct Model Observations: applying averaging kernel to the model results
- Study the observation errors and the error covariances in DECSO
- Estimate NH_3 emissions

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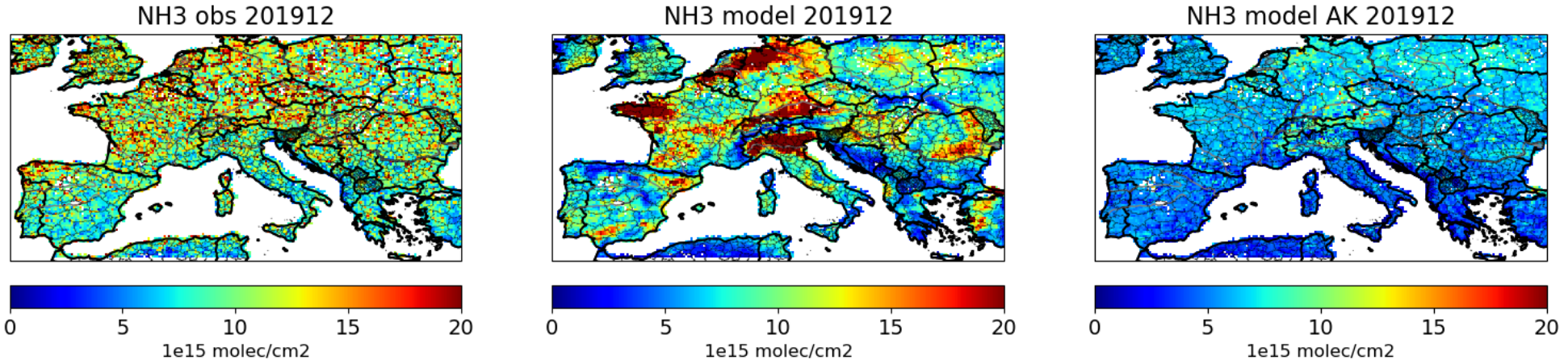
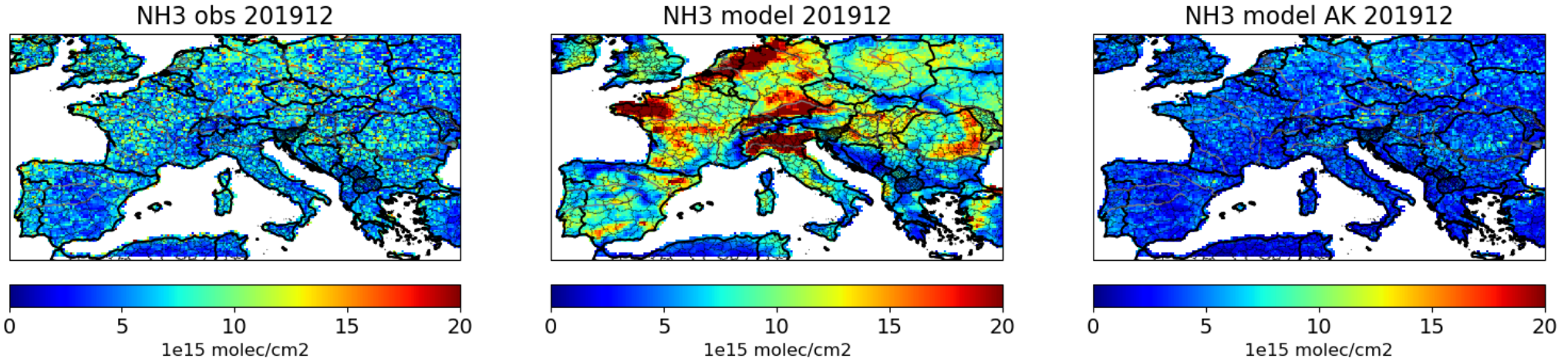
Retrieval data v1.5+ CHIMERE V2013: Observations have positive bias especially in winter



Retrieval data v1.6 + CHIMERE V2013



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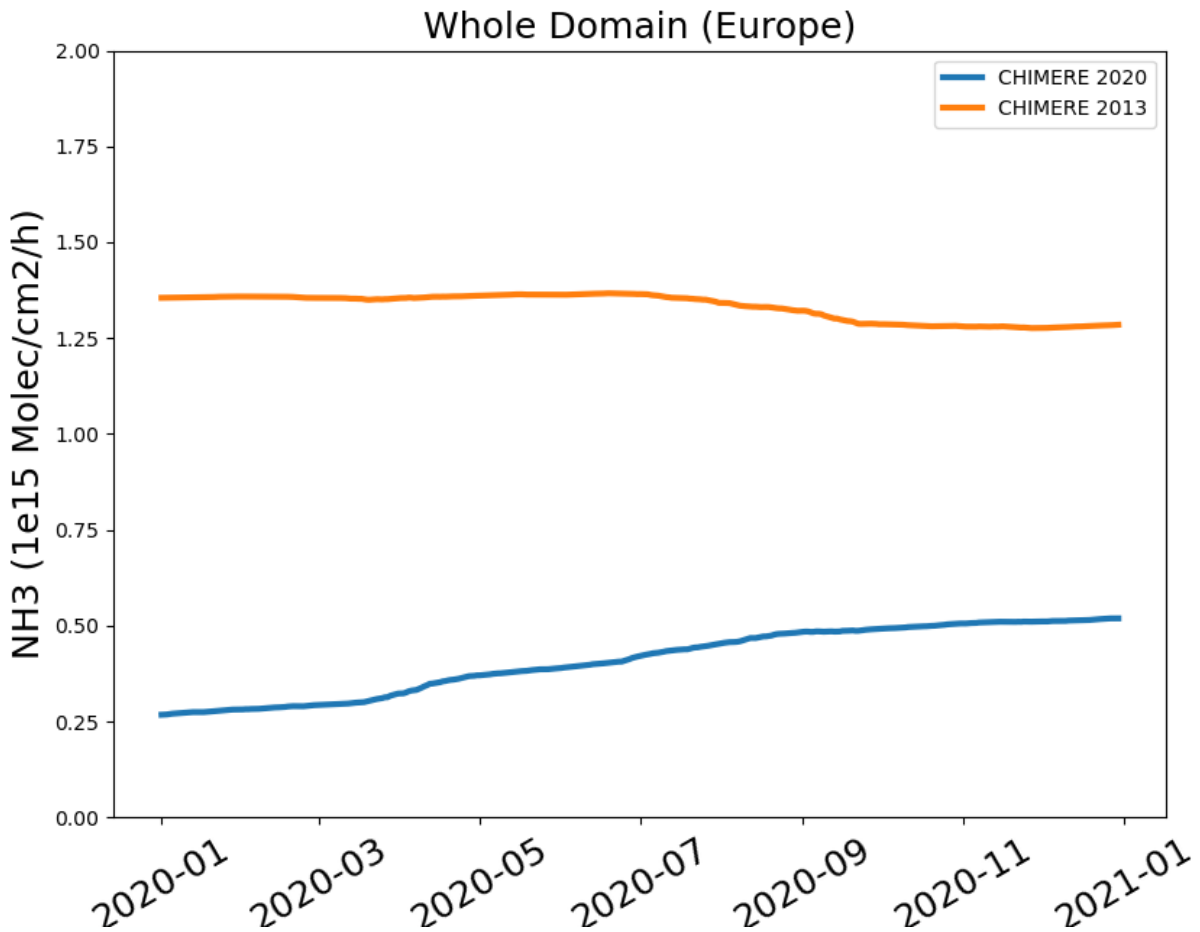
Derived emissions: CHIMERE 2013 vs CHIMERE 2020



- CHIMERE 2013: Emission updates stay at a level which is 6 times higher than HTAP 2010
- CHIMERE 2020: Emissions are 2 times higher than HTAP 2010

Can we get good results?

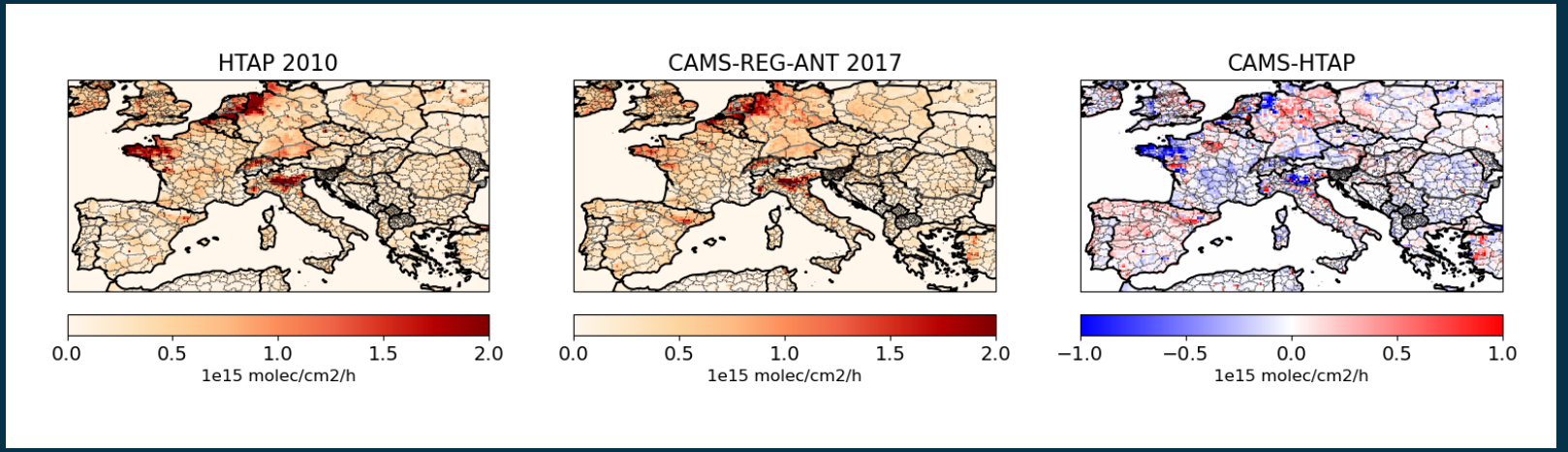
Answer: Yes and No

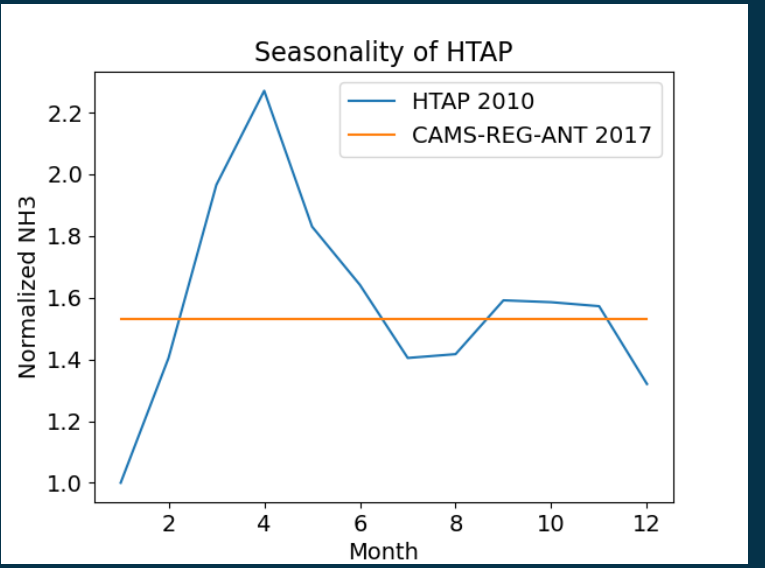
Yes: If the observation data are good and the performance of the model is also good.

Otherwise NO.

What shall we do next?

- Use CHIMERE 2020 in DECSO
- Validate derived emissions:
  - Run CHIMERE with different emission inventories and compare with in-situ observations.
  - Compare emissions with other emission inventories.
  - For example:





SEEDS

Sentinel EO-based Emission and Deposition Service

Funded by the European Union

Thank you for your attention!

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