



Atmosphere Monitoring

# CAMS emissions

*How satellite-based information can be used to strengthen our understanding of emissions*

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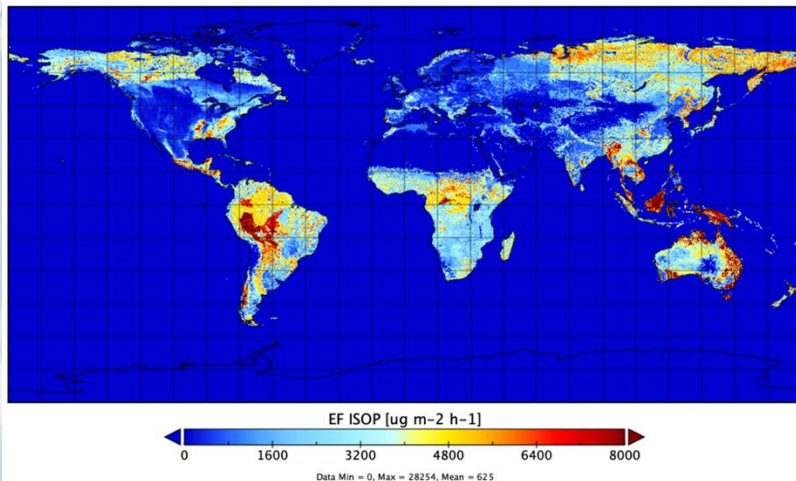


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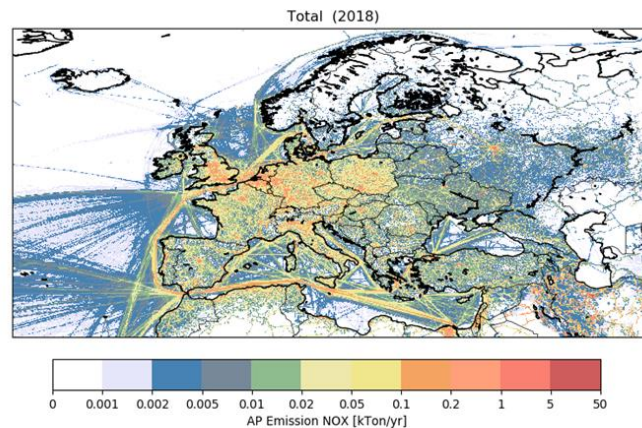
# The CAMS emissions portfolio

CAMS emission products provide state-of-the-art emission information for both anthropogenic and natural sources, as input to the CAMS production systems but also as stand-alone products

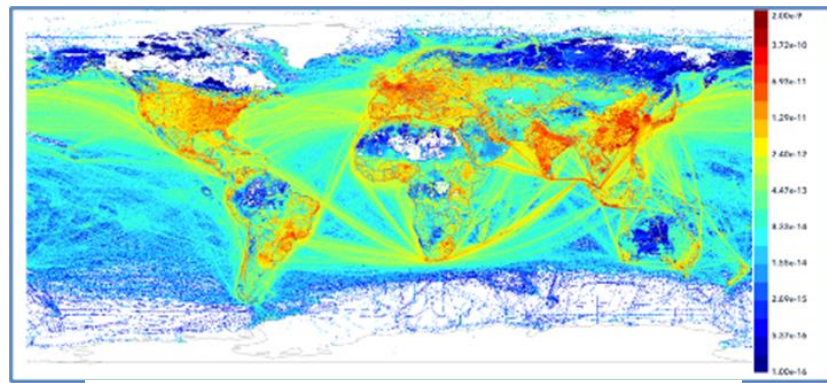
Global EF Isoprene with updates in EU and NA



CAMS-GLOB-BIO-v3.1 Emission potential maps for isoprene



CAMS-REG-v5.1  
NO<sub>x</sub>  
emissions  
2018  
( $\text{kg}/\text{grid cell}$ )  
[Kuenen et al., ESSD \(2022\)](#)



CAMS-GLOB-ANT-v5.2 NO<sub>x</sub> emissions 2021 ( $\text{kg}/\text{m}^2/\text{s}$ )



- Primary goal is to provide state-of-the-art and up-to-date emission information to the CAMS production systems
- But also the datasets are useful input for modelling studies as all datasets are publicly available ([ECCAD](#), [ADS](#))
- Biogenic emissions are based on emission modelling (similar to other CAMS natural emission products)
- Anthropogenic emissions are (largely) based on emission inventories which estimate bottom-up (by using activity data and emission factors) the overall emissions in each country
  - At European scale, based on the same emissions which are submitted by each country
  - At global scale, based on EDGAR inventory extrapolated to present-day
- Different versions of the emission products have been provided over the years, typically with an annual update cycle



# CAMS-REG approach in a nutshell

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Official reported GHG emissions  
(UNFCCC NIR – CRF)

Official reported Air Pollutant  
emissions (EMEP CEIP)

Other emission datasets  
IIASA GAINS & JRC EDGAR

TNO internal estimates  
Bottom-up checks

- Small combustion (wood)
- Non-international shipping
- Agricultural waste burning
- Etc.

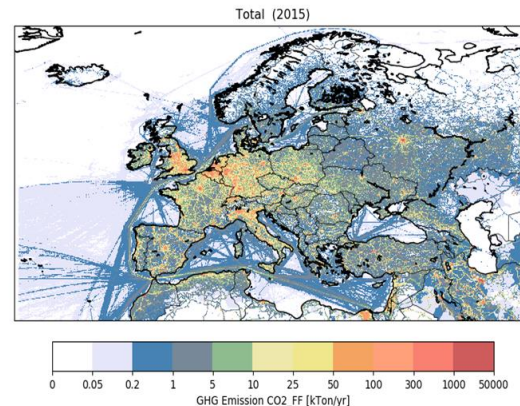
~250 subsectors:  
aggregated CRF/NFR  
with fuel splits

CAMS / TNO  
emissions by  
subsector

Shipping grids  
(FMI)

Spatial proxies

- Population
- Road transport
- Animal densities
- E-PRTR, etc. etc.



Gridded European regional emission  
product (time series)

Annual emission grids accompanied by:

- Annual data broken down to hourly by using temporal profiles
- Speciation profiles for PM/NMVOG

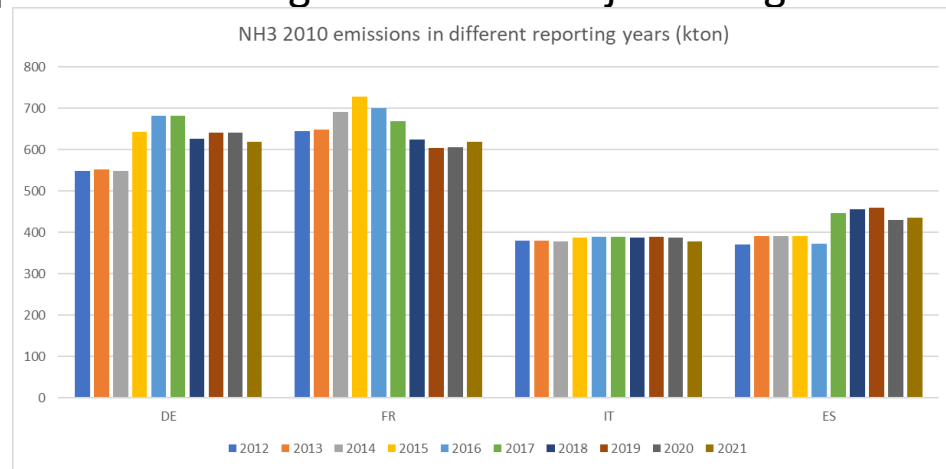
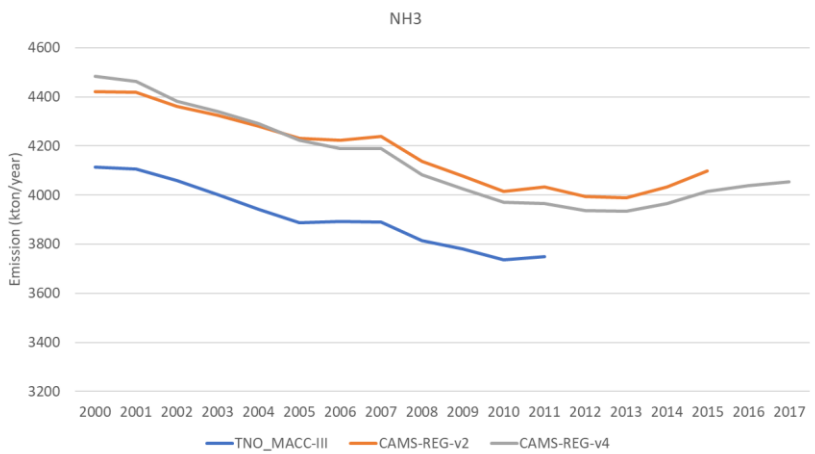
All details in [Kuenen et al., ESSD, 2022](#)





# Comparing different inventories/versions

- All emissions for historical years are recalculated & reported annually by European countries => input for CAMS-REG inventory versions
- Inventories develop because of progressing science and improved methodologies, but it also means emissions may change considerably from one year to the next => important to remember when making comparisons!
- Satellite based emissions can help understanding trends and major changes

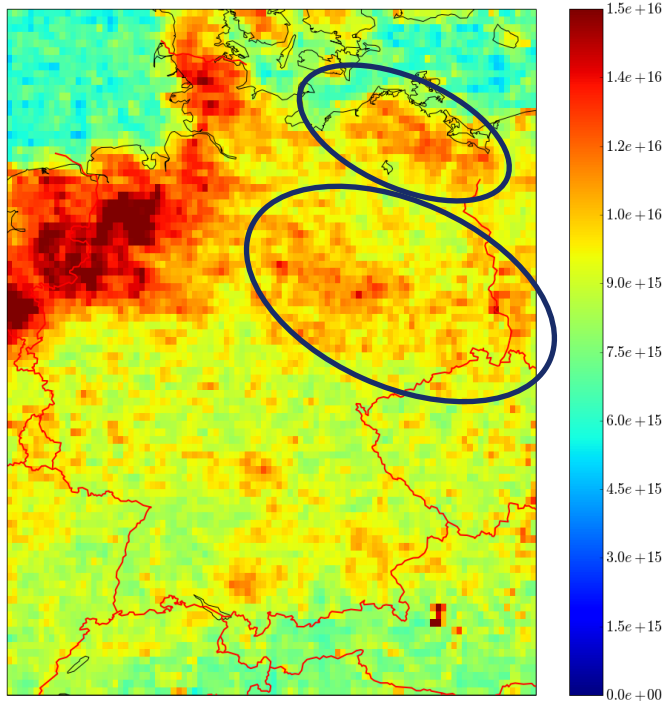




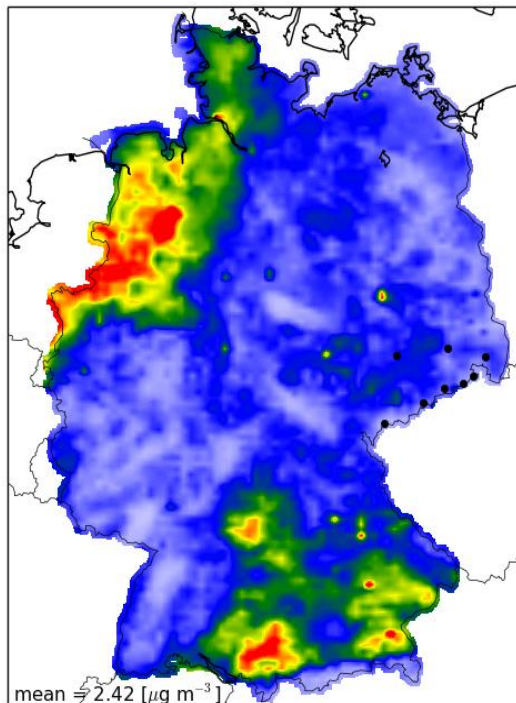
# Verification of spatial distribution

- Satellite data identifies regions in Germany with substantial NH<sub>3</sub> emissions which were not in the emission inventories

Satellite-IASI-NH<sub>3</sub>: 8-year average



Modelled mean surface NH<sub>3</sub>



Emission inventories use proxies e.g. number of farms to distribute country totals

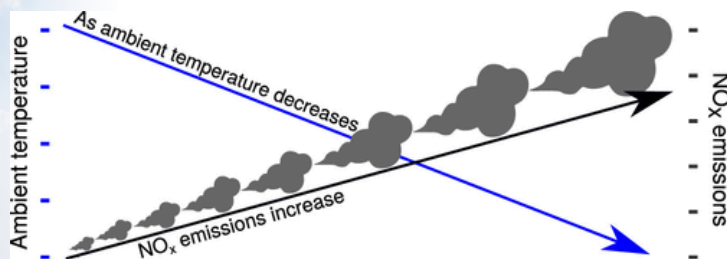
However in eastern Germany part of emissions are missed because the proxy is less suitable (farmers often have larger land areas)

→ Used to improve the emission inventories



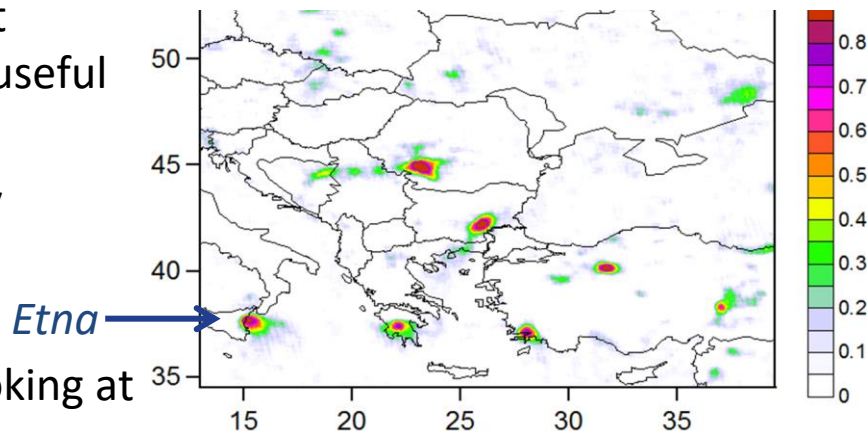
# Added value of satellite data

- Inventories are well-developed for most developed countries – but satellite based emissions are a useful resource for verification
- In other regions, the availability and/or quality of bottom-up inventories is limited
- Many examples in literature looking at e.g. point sources and trends



Grange et al., *Env. Sci. Tech.*, 2019

## Checking point source locations e.g. for SO<sub>2</sub>



Fioletov et al., *ACP*, 2017 <https://doi.org/10.5194/acp-17-12597-2017>

Satellite data can also contribute to a better understanding of seasonal variation of emissions, e.g. temperature dependency of road transport emissions



# Anthropogenic emission inventories

- Emission inventories are a key data source in policy
  - Emission reduction commitments e.g. UNFCCC/Paris Agreement, CLRTAP Gothenburg Protocol, EU NEC Directive
- However, issues may exist as these inventories rely on the availability of high-quality underlying information

<b>“Traditional” emission inventories e.g. CAMS-REG/CAMS-GLOB-ANT</b>	<b>Satellite-based emission inventories</b>
All relevant pollutants are possible	Available for selected pollutants
Only “known” sources but with sector detail	All sources but only total
Not always fully consistent between countries	Consistent across domain
Spatially distributed emissions using proxies and point source (reported) data	Spatial distribution explicit in the observations
Only annual data	Temporal disaggregation (e.g. daily value)





## Conclusions

- Both bottom-up and satellite-based emission inventories have their possibilities and limitations => but together they can do more!
- Emission inventories from individual countries are and will remain a key piece of input in policy processes
- Emissions based on satellite observations are important to identify inconsistencies, which can then be further investigated/improved in the inventories
- Satellite data are useful to validate emission inventories, e.g. regarding point sources, trends, spatial distribution and seasonal pattern
- In regions where emission inventories are scarce or of limited quality, satellite-based estimates can fill the information gap



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Thank you

Thank you for your attention!

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