Barcelona Supercomputing Center
Centro Nacional de Supercomputación

EXCELENCIA SEVERO OCHOA

Impact of dynamical agricultural temporal profiles on NH_3 modelled concentrations

M. Guevara, Tena, C., Jorba, O., Pérez García-Pando, C.

08/10/2021

FAIRMODE Technical Meeting (on-line)

Motivation and objective

- Agricultural practices, including manure management and use of fertilizers, dominate the total amount of European NH_3 emissions (94% according to EMEP/CEIP)
- NH_3 agricultural emissions present large contributions to total $PM_{2.5}$ levels in Europe (e.g., 23% in average according to Thunis et al., 2018)
- Temporal distribution of agricultural emissions when used for AQ modelling typically relies on the use of sector-dependent fixed profiles
- Dynamical parametrizations of NH_3 emissions, which takes into account the effect of meteorology and agricultural practices, have proved to have a significant impact on the modelling of NH_3 concentrations (e.g., Backes et al., 2016)

Objective: To construct a set of gridded temporal profiles for NH_3 emissions that represent the dynamical component of agricultural practices

Dynamic temporal parametrisations

GNFR_K: Livestock emissions

Influence of temperature and wind speed on NH_3 volatilization (Gyldenkærne et al., 2005)

$$T(x,d)^{0.89} * V(x,d)^{0.26}$$

$V(x,d)$ → Ventilation

$T(x,d)$ → Temperature

Calculation as a function of type of process:

- Animal houses with forced ventilation
- Open animal houses
- Manure storages

GNFR_K: Other agricultural emissions (use of fertilizers)

Influence of temperature and wind speed on NH_3 volatilization (Gyldenkærne et al., 2005)

$$e^{0.0223 * \boldsymbol{T_{2m}(x,d)}} * e^{0.0419 * \boldsymbol{W_{10m}(x,d)}}$$

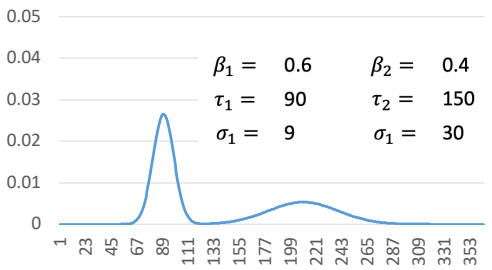
$\boldsymbol{T_{2m}(x,d)}$ → ERA5 dataset

$\boldsymbol{W_{10m}(x,d)}$ → ERA5 dataset

Influence of agricultural practices (i.e. when fertilizers are applied) (*)

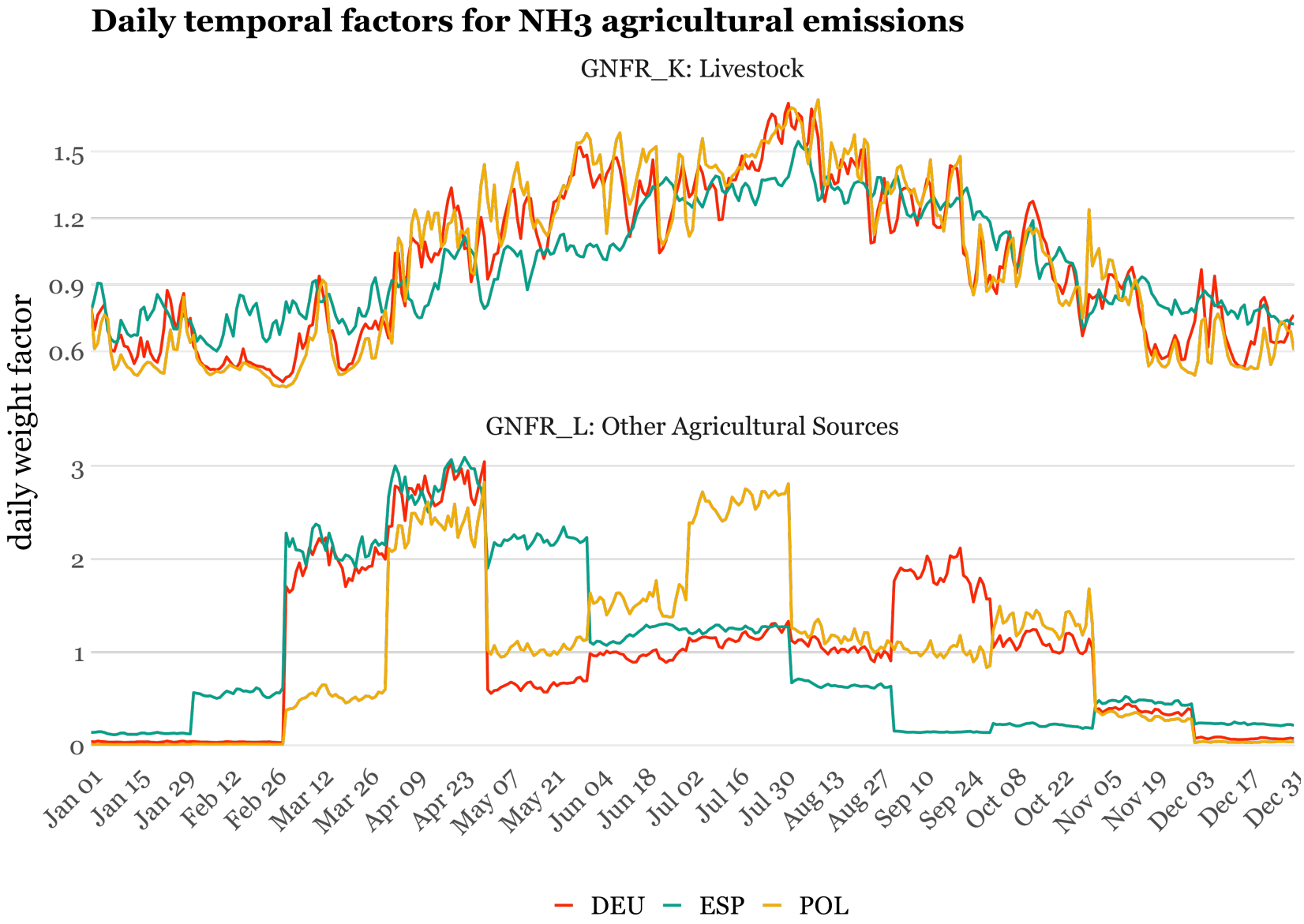
$$\sum_{a=1}^{3} \frac{\beta_{a,c}}{\sigma_{c,a} * \sqrt{2 * \pi}} * e^{\left(\frac{(t-\tau_{c,a})^2}{-2*\sigma_{c,a}^2}\right)}$$

$\beta_{a,c}$ Fraction of fertilizer applied to crop *c* at stage *a* (1:planting, 2:at growth, 3:after harvest)



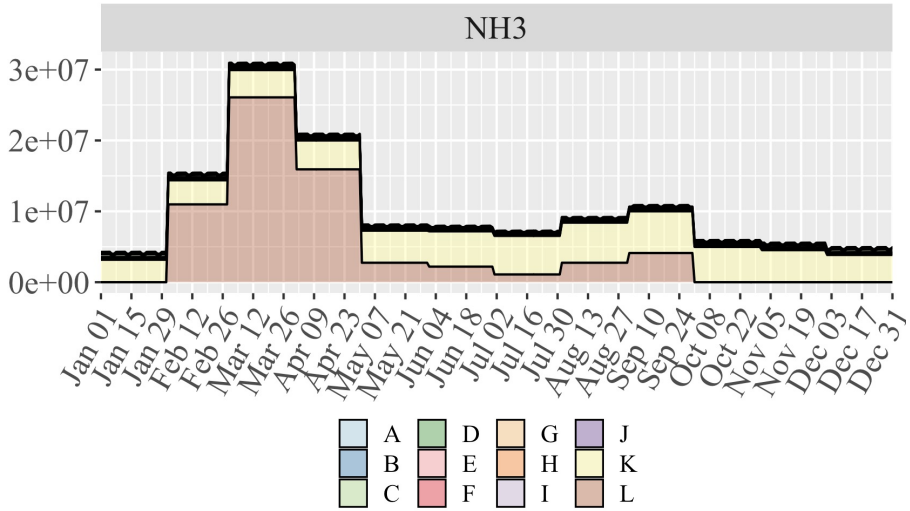
(*) Mosaic of gridded factors derived from the MASAGE inventory (Paulot et al., 2014) + integration of national seasonality reported from multiple studies: Skjoth et al. (2011) (Denmark, Germany), Werner et al. (2015) (Poland) and Backes et al. (2016) (Netherlands, France, Belgium)

Resulting temporal profiles

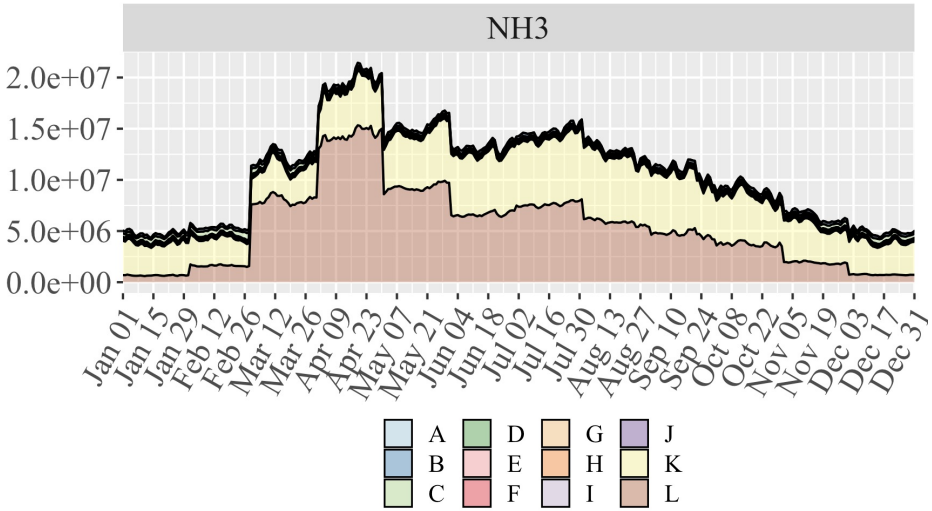


Impact on NH_3 daily emissions

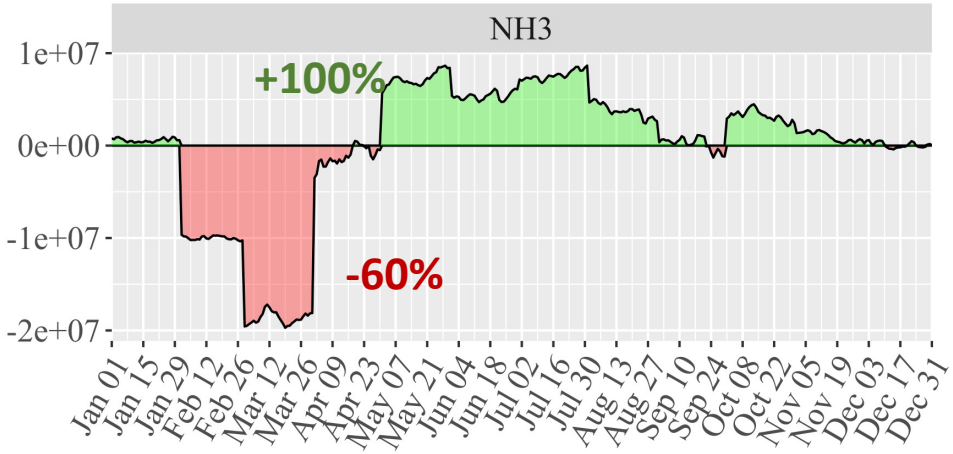
TNO profiles (EU27 plus UK)



CAMS-TEMPO profiles (EU27 plus UK)



Differences (EU27 plus UK)



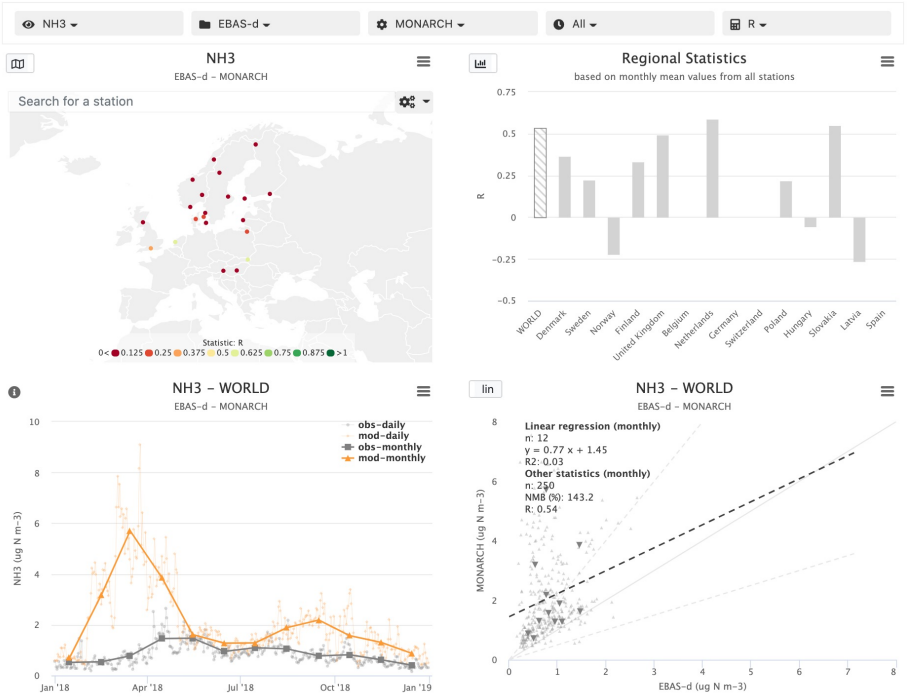
Impact on NH_3 daily concentrations

- **AQ model:** MONARCH (Badia et al., 2017)
- **Year of study:** 2018
- **Emissions:** CAMS-REG-APv4.2 (2017)
- **Observations:** EBAS daily observations

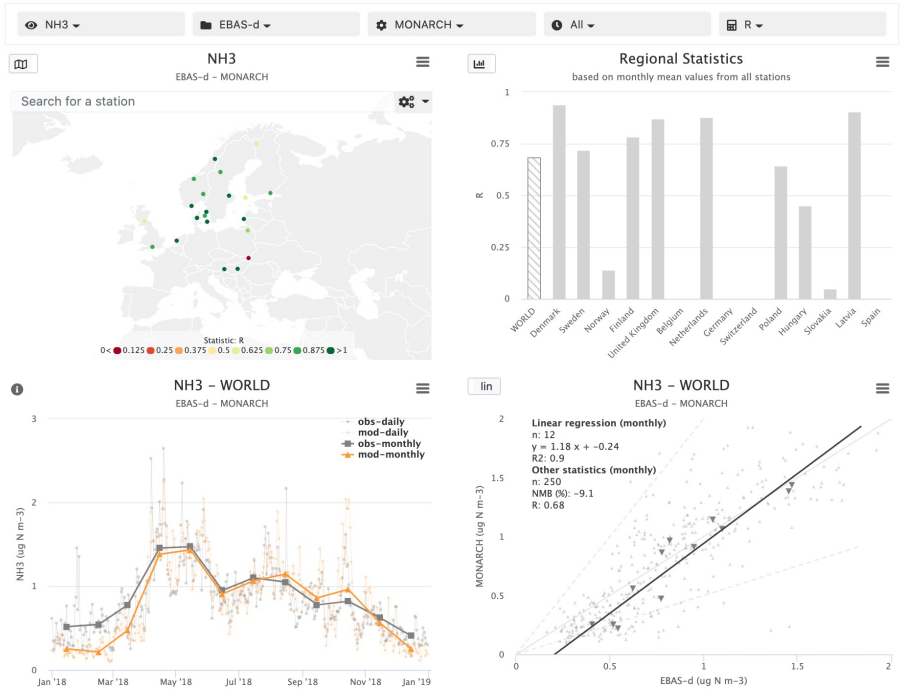
Correlation coefficient (R):

- All stations: 0.54 to 0.68
- Netherlands: from 0.59 to 0.88

TNO profiles



CAMS-TEMPO profiles



Barcelona Supercomputing Center
Centro Nacional de Supercomputación

Atmosphere Monitoring

Results from CAMS_61. Available at [AeroVal platform]

Take home messages

- Dynamical approach used to construct a dataset of daily emission temporal profiles for livestock and fertilizer NH_3 emissions
- General improved agreement in correlation between modelled and measured concentrations of NH_3 when compared to a static approach
- Results obtained with MONARCH cannot be extrapolated to other models (e.g. different chemical and deposition mechanisms affecting the modelled results)
- Constructed profiles not applicable to all pollutants (e.g. CH4 from GNFR_L and GNFR_K are dominated by rice fields and enteric fermentation processes, respectively)
- Resulting temporal profiles reported as part of the CAMS-TEMPO dataset (Guevara et al., 2021, Earth Syst. Sci. Data.)