*Supplement of*

# Decreasing trends of ammonia emissions over Europe seen from remote sensing and inverse modelling

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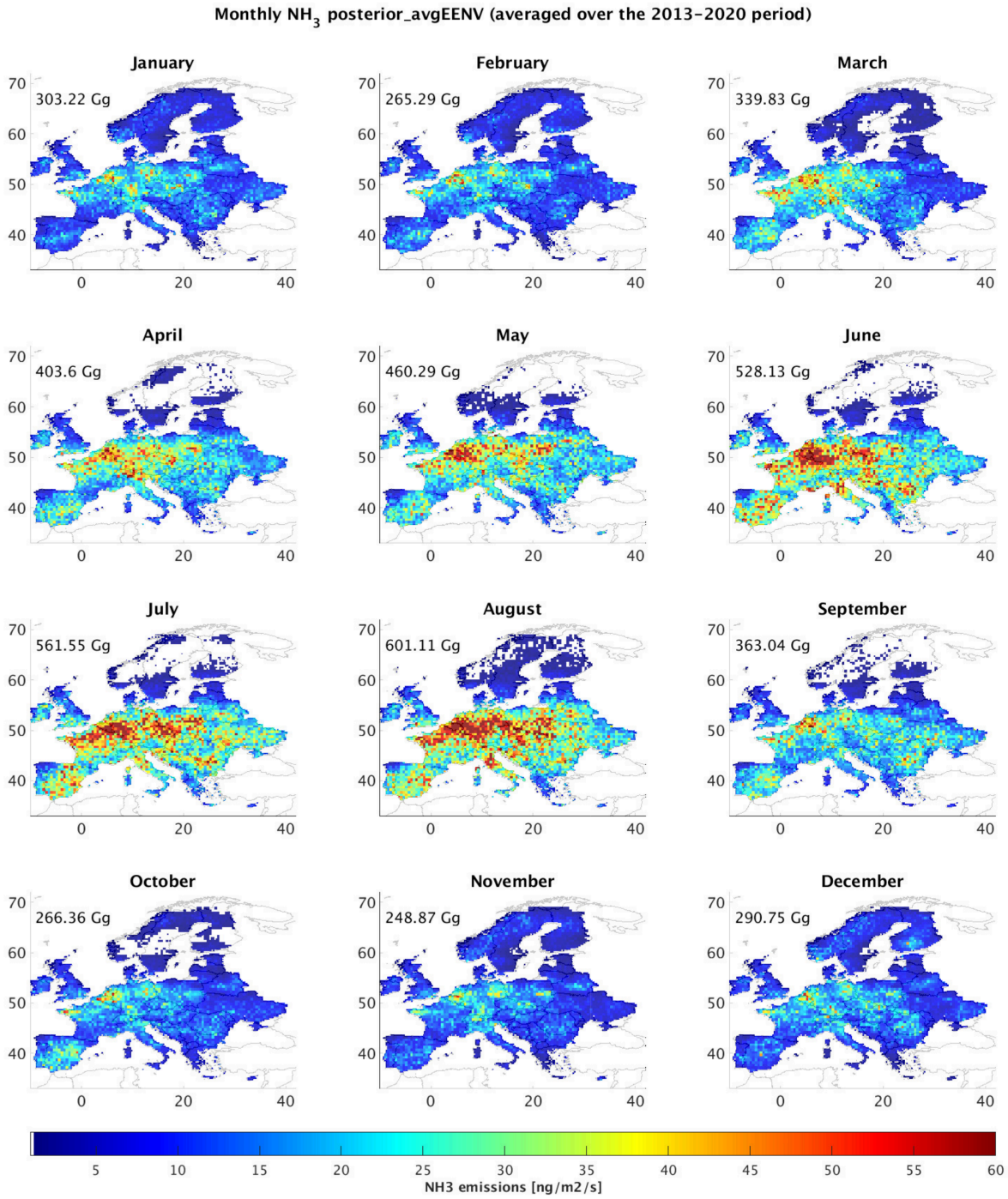
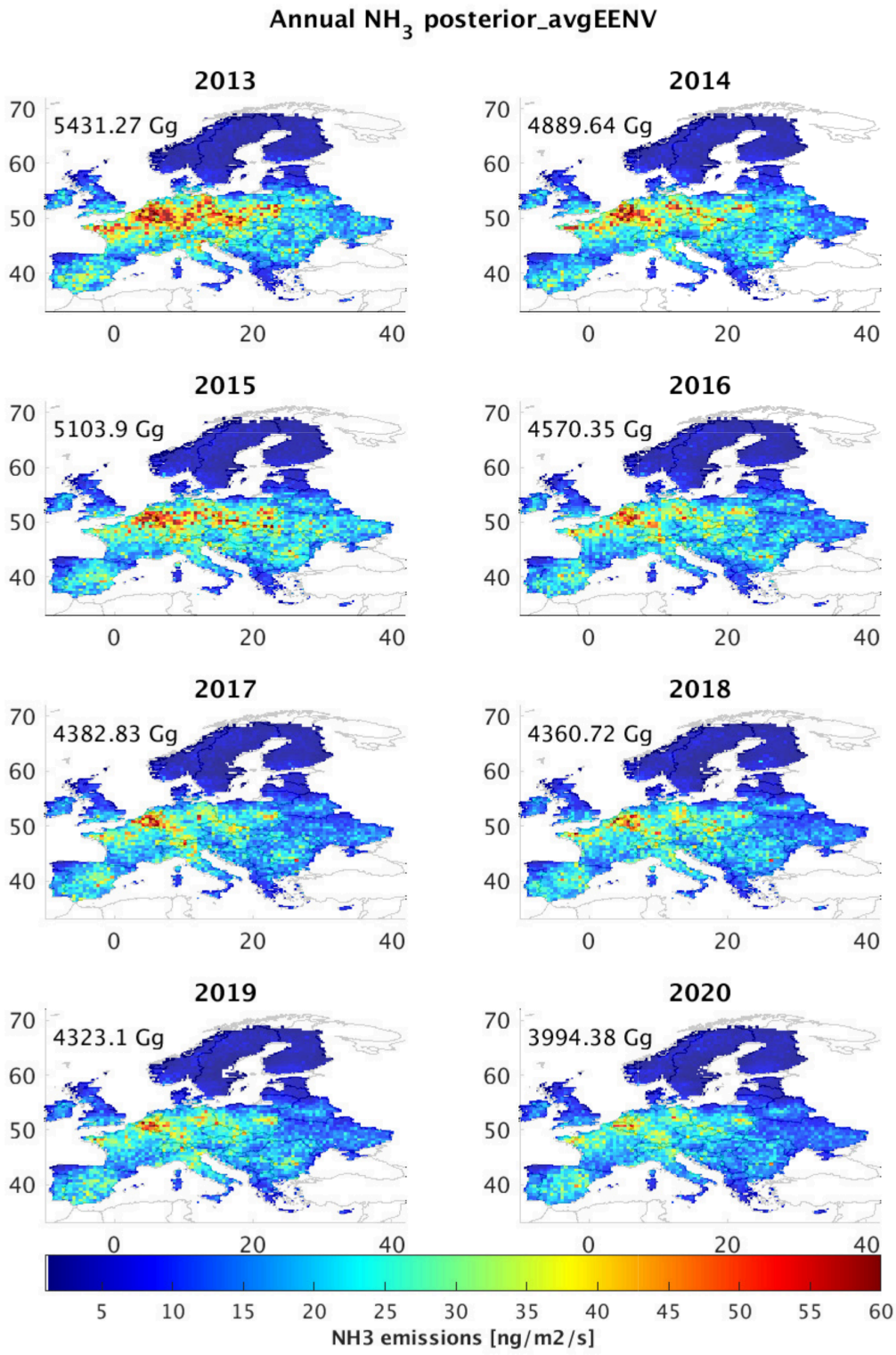
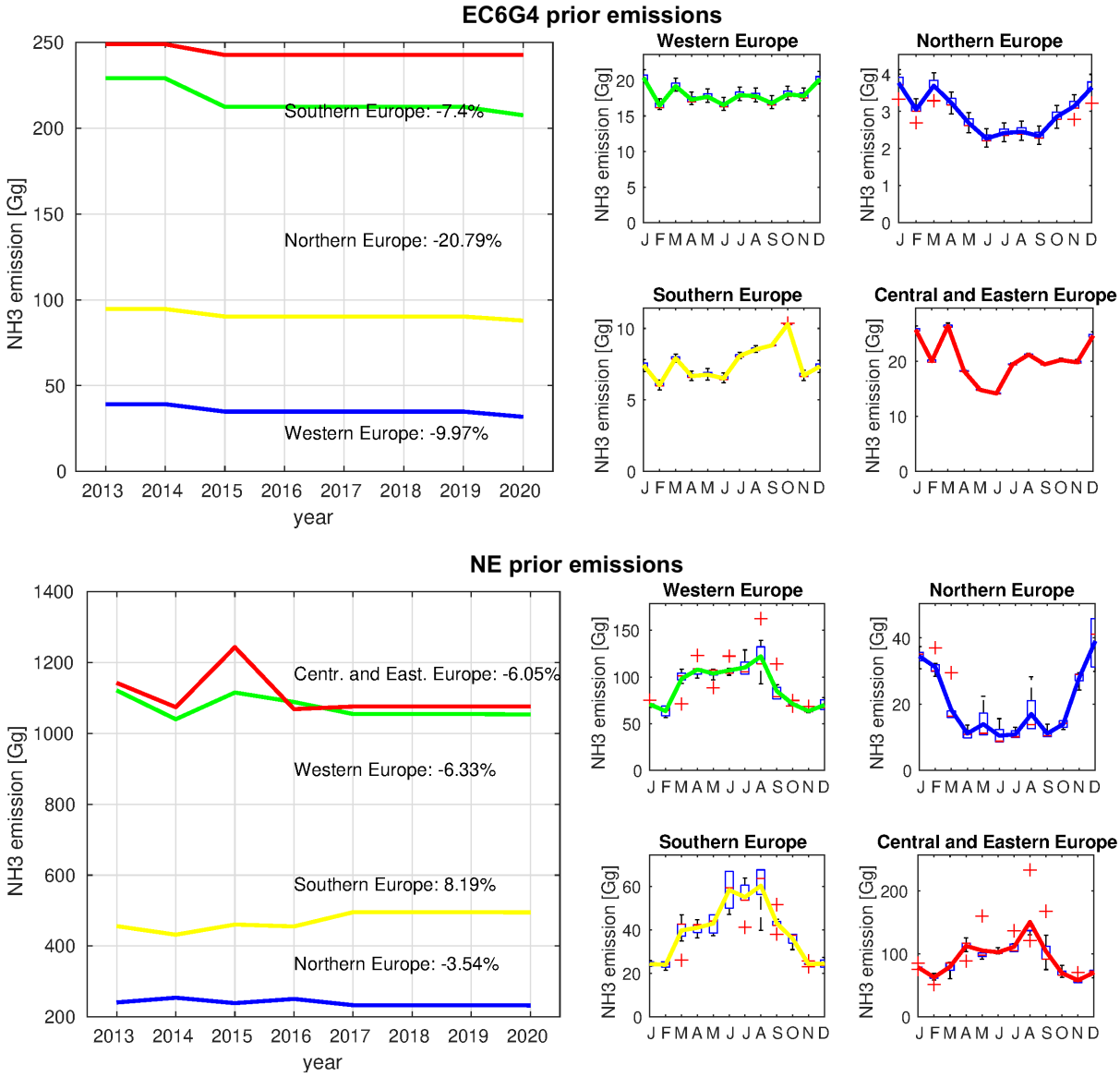
## SUPPLEMENTARY FIGURES



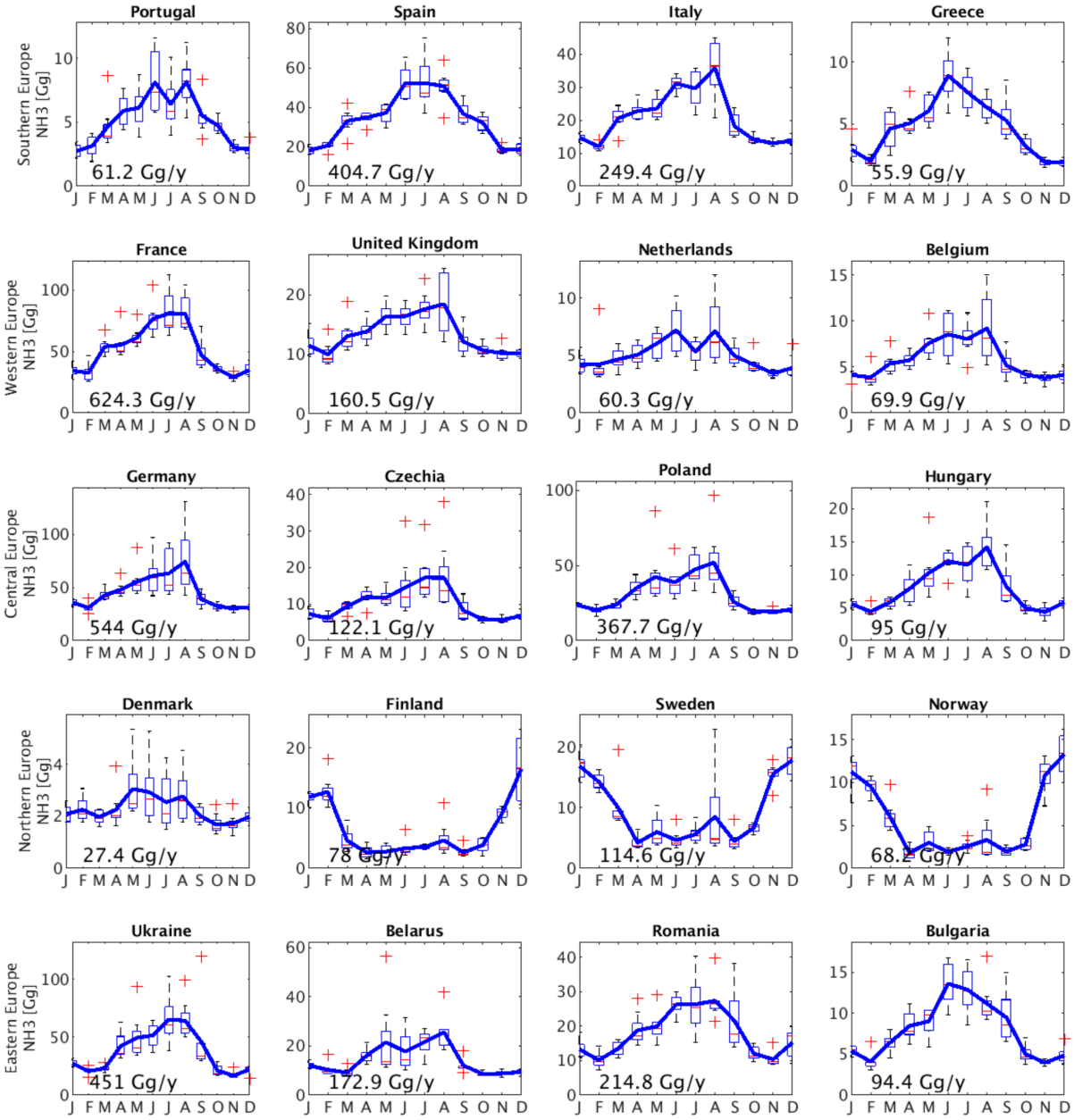

**Supplementary Figure S 1.** Spatial distribution of monthly posterior emissions of ammonia over Europe averaged over the eight-year period (2013–2020). Ammonia increases gradually from spring (March) when the fertilization period starts in Europe and peaks in August due to temperature dependent volatilization. After summer, when fertilization is forbidden, it rapidly declines with a minimum in November.



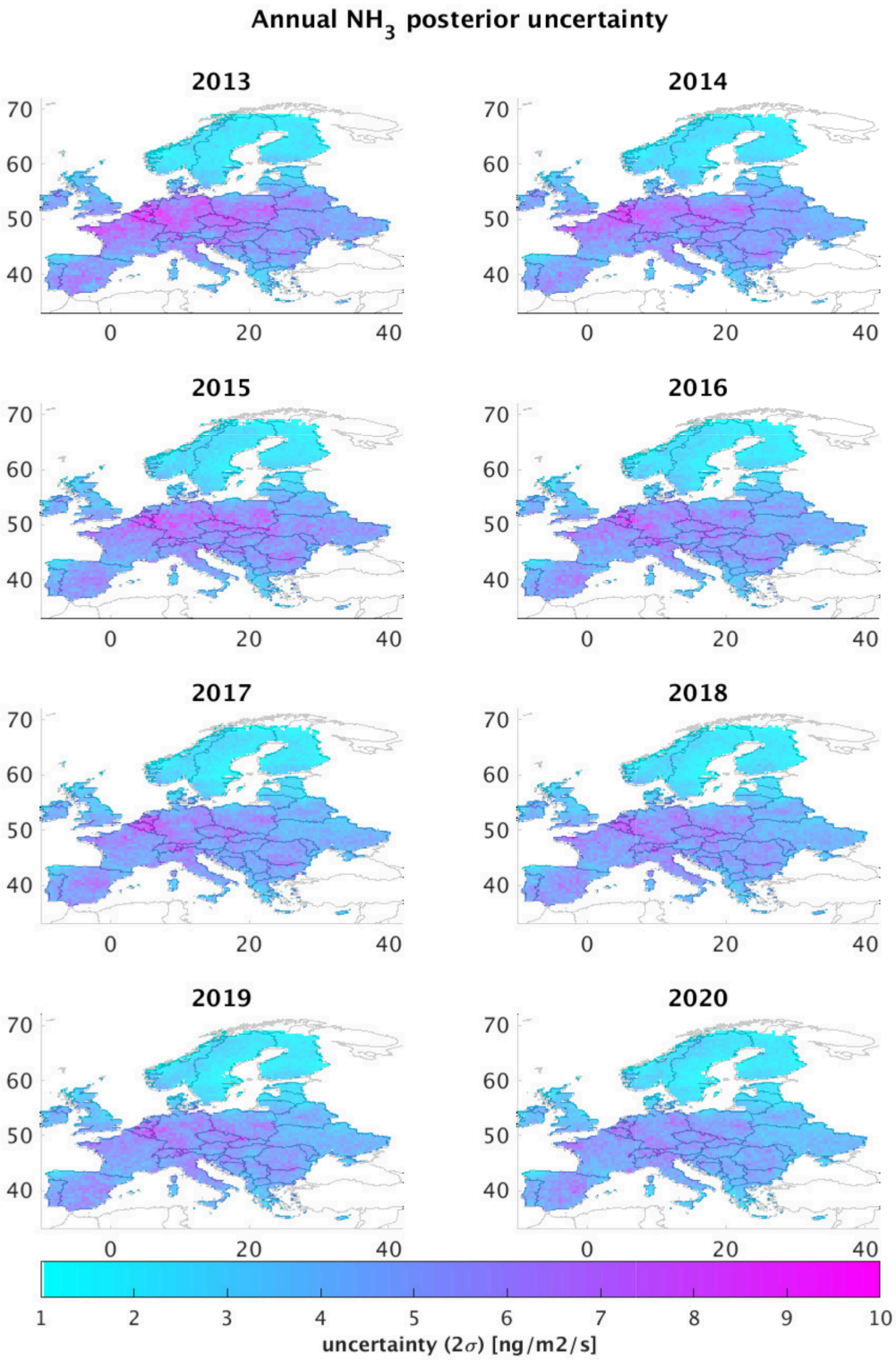

**Supplementary Figure S 2.** Spatial distribution of annual posterior emissions of ammonia over Europe during 2013–2020. Except for a small increase in 2015, emissions of ammonia decreased from 5431 Gg in 2013 to 3994 Gg in 2020.



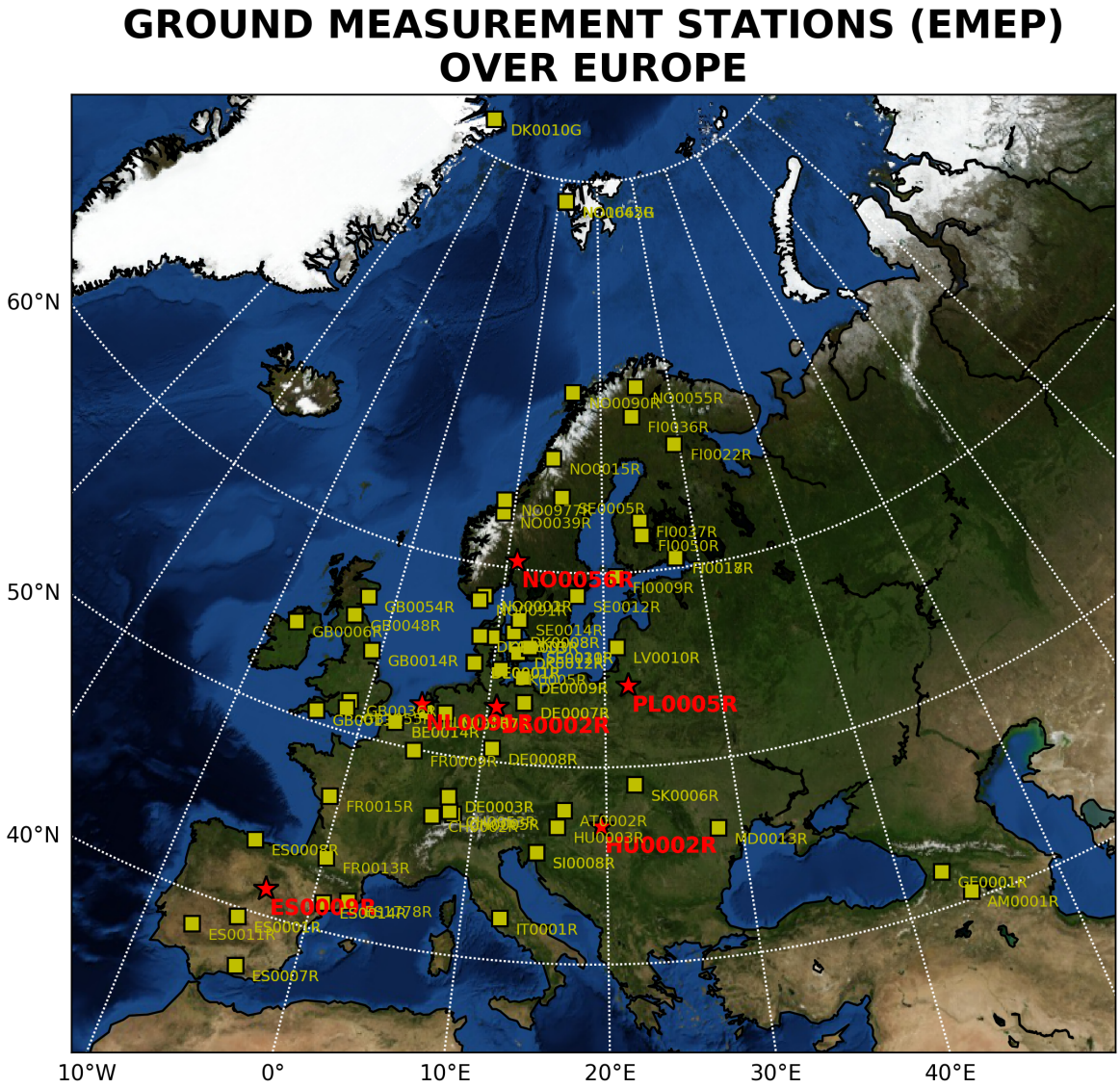

**Supplementary Figure S 3.** Left: Annual prior (EC6G4 and NE) emissions of ammonia in Southern (yellow), Western (green), Northern (blue), and Central and Eastern (red) Europe. Right: Monthly average prior (EC6G4 and NE) emissions of ammonia accompanied by box plots, where the red line indicates the median, the bottom and top edges of the box indicate the 25th and 75th percentiles, respectively, and the whiskers extend to the most extreme data points (not considered outliers), which are represented using red crosses.



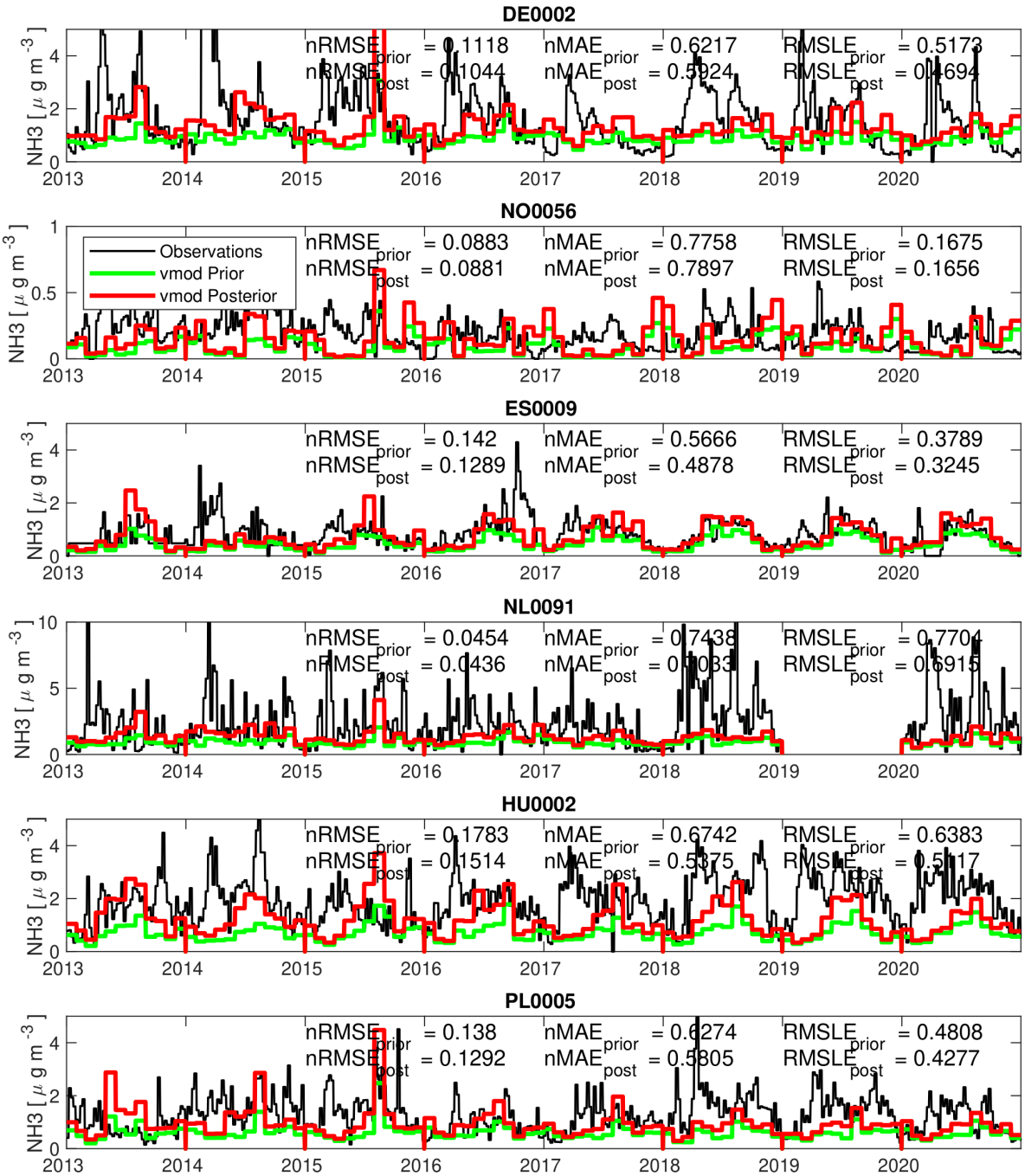

**Supplementary Figure S 4.** Monthly average posterior emissions of ammonia accompanied by box plots, where the red line indicates the median, the bottom and top edges of the box indicate the 25$^{th}$ and 75$^{th}$ percentiles, respectively, and the whiskers extend to the most extreme data points (not considered outliers), which are represented using red crosses.




**Supplementary Figure S 5.** Absolute uncertainty of posterior emissions of ammonia calculated as 2 σ for each year of the study period 2013–2020.




**Supplementary Figure S 6.** The EMEP (European Monitoring and Evaluation Programme, https://emep.int/mscw/) network, which consists of 53 stations over Europe. For each station we used a total of 2829 observations in our comparison that were averaged to the temporal resolution of our modelled concentrations (daily). The six stations highlighted with red color are random stations, for which a timeseries comparison was performed for $v^{mod}$ using prior and posterior emissions against ground-based ammonia (see Supplementary Figure S 7).




**Supplementary Figure S 7.** Timeseries of prior (green) and posterior (red) modelled surface ammonia concentrations over the whole study period (2013–2020) against ground-based observations from six EMEP stations (DE0002 in Germany, NO0056 in South Norway, ES0009 in Spain, NL0091 in the Netherlands, HU0002 in Hungary and PL0005 in Poland). For ease of visualization of the modelled and measured concentration and for smaller computational time, we averaged observations every week and modelled concentrations every month.