Supplement of Aerosol Research, 3, 155–174, 2025
https://doi.org/10.5194/ar-3-155-2025-supplement

AEROSOL Research
Open Access

Supplement of

Unchanged $PM_{2.5}$ levels over Europe during COVID-19 were buffered by ammonia

Nikolaos Evangeliou et al.

Correspondence to: Nikolaos Evangeliou (nikolaos.evangeliou@nilu.no)

Supplementary Figures

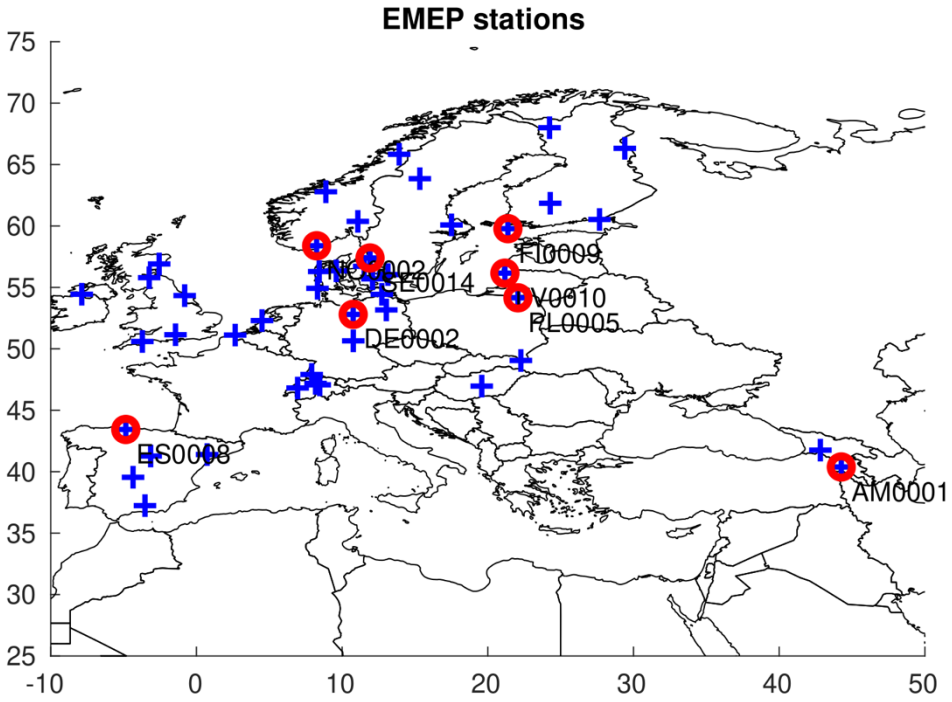

Figure S 1. The EMEP stations (https://emep.int/mscw/) providing weekly or bi-weekly ground-based observations of ammonia. The highlighted stations were selected to show timeseries of the comparison of prior and posterior ammonia against observations.

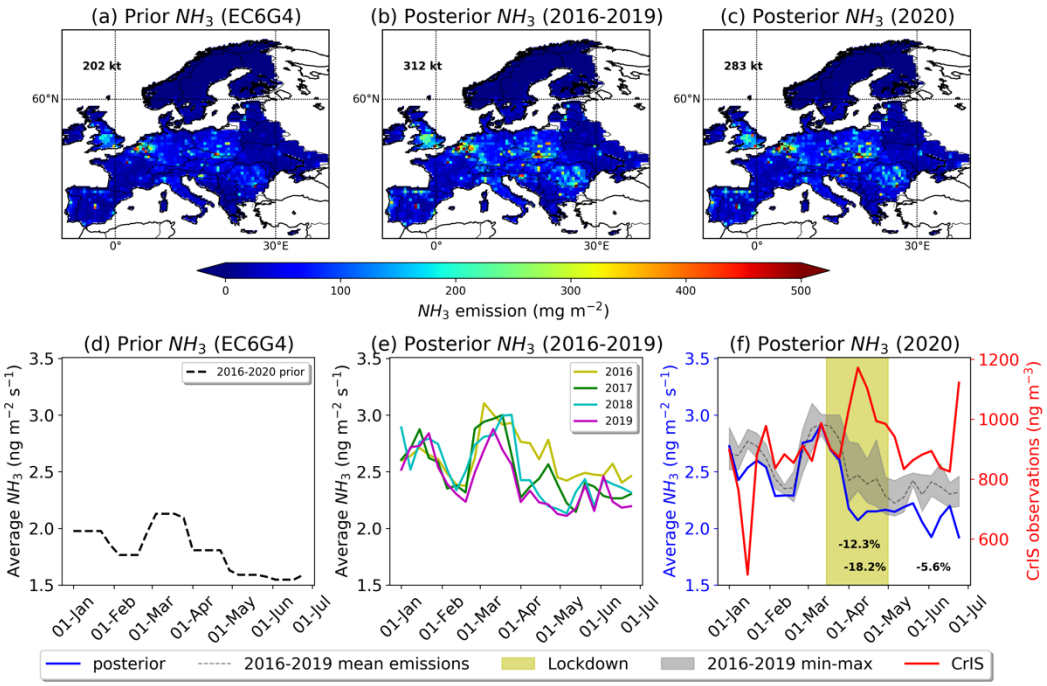

Figure S 2. (a) Total a priori emissions of ammonia over Europe for the inversion period (January – June) using EC6G4 as the prior. The total emitted amount is equal to 202 kt. (b) Total a posteriori emissions of ammonia over Europe for the reference period (January – June). The emissions are an average of respective inversions for years 2016 – 2019 and amount 312 kt. (c) Total posterior emissions of ammonia over Europe for January – June 2020 (283 kt). (d). Timeseries of weekly-average prior emissions of ammonia over Europe (January to June) from EC6G4. (e) Timeseries of weekly-average posterior emissions of ammonia over Europe for years 2016–2019 (January to June). (f) Timeseries of weekly-average posterior emissions of ammonia over Europe in 2020 (January – June). Ammonia emissions during the 2020 lockdown as compared to the same period the years before dropped -12.3%. Changes in ammonia emissions during the 2020 lockdown as compared to the period before lockdown were -18.2% and rebounded after the end of the lockdown (-5.6%).

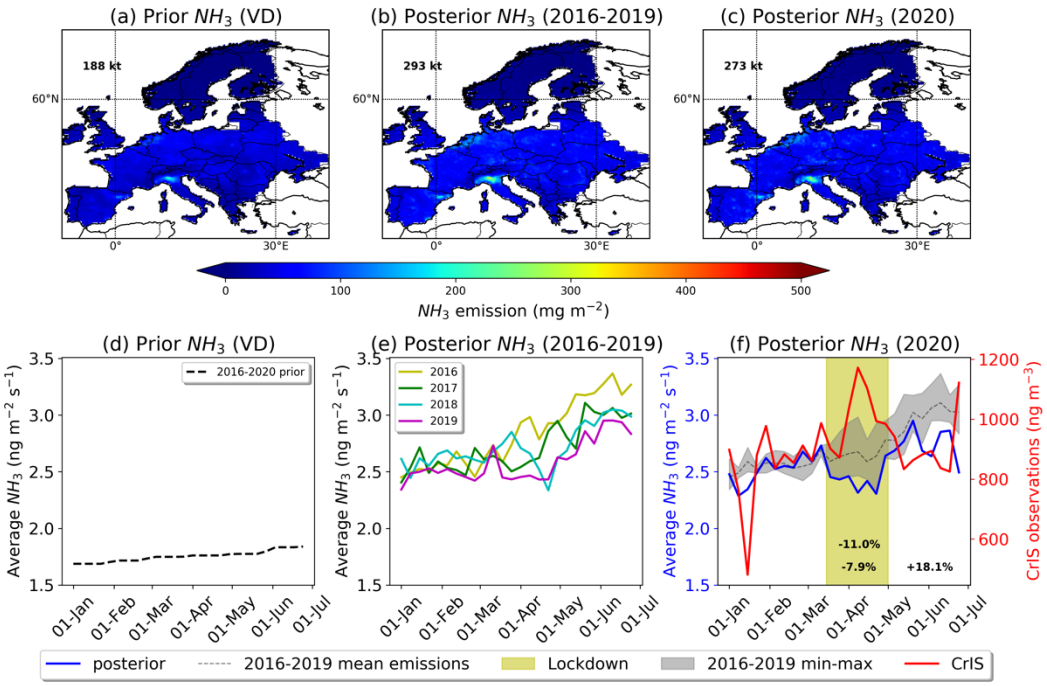

Figure S 3. (a) Total a priori emissions of ammonia over Europe for the inversion period (January – June) using VD as the prior. The total emitted amount is equal to 188 kt. (b) Total a posteriori emissions of ammonia over Europe for the reference period (January – June). The emissions are an average of respective inversions for years 2016 – 2019 and amount 293 kt. (c) Total posterior emissions of ammonia over Europe for January – June 2020 (273 kt). (d). Timeseries of weekly-average prior emissions of ammonia over Europe (January to June) from VD. (e) Timeseries of weekly-average posterior emissions of ammonia over Europe for years 2016–2019 (January to June). (f) Timeseries of weekly-average posterior emissions of ammonia over Europe in 2020 (January – June). Ammonia emissions during the 2020 lockdown as compared to the same period the years before dropped by -11.0%. Changes in ammonia emissions during the 2020 lockdown as compared to the period before lockdown were -7.9% and rebounded after the end of the lockdown (+18.1%).

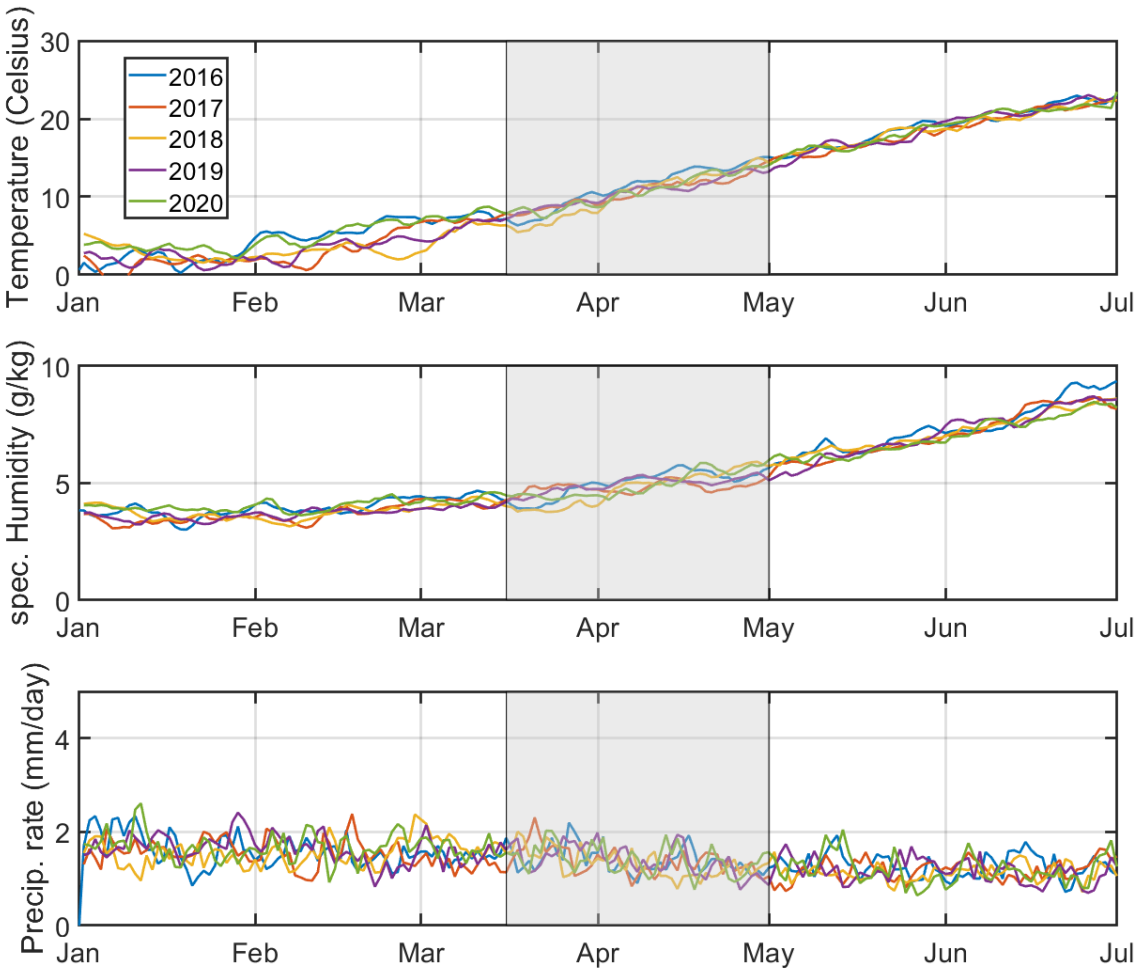

Figure S 4. Average surface temperature, specific humidity and precipitation over Europe from January to June for the years 2016-2020 from ECMWF ERA5 (Hersbach et al., 2020). Temperature, humidity and precipitation are not significantly different than any of the previous years and cannot justify more volatilisation of ammonia. This is an additional evidence that the impact from meteorology did not drive ammonia or PM2.5 formation.

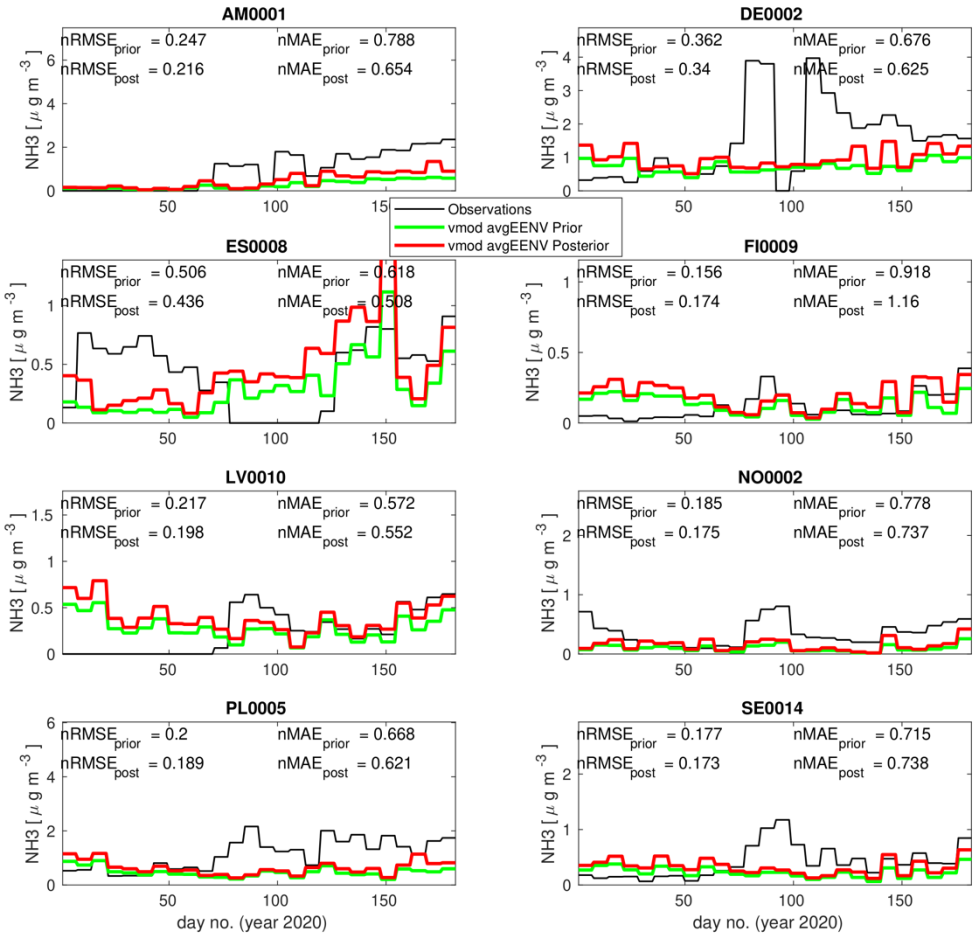

Figure S 5. Timeseries of prior and posterior ammonia against observations from eight EMEP sites. In most cases better statistics were obtained with respect to RMSEs and MAEs.

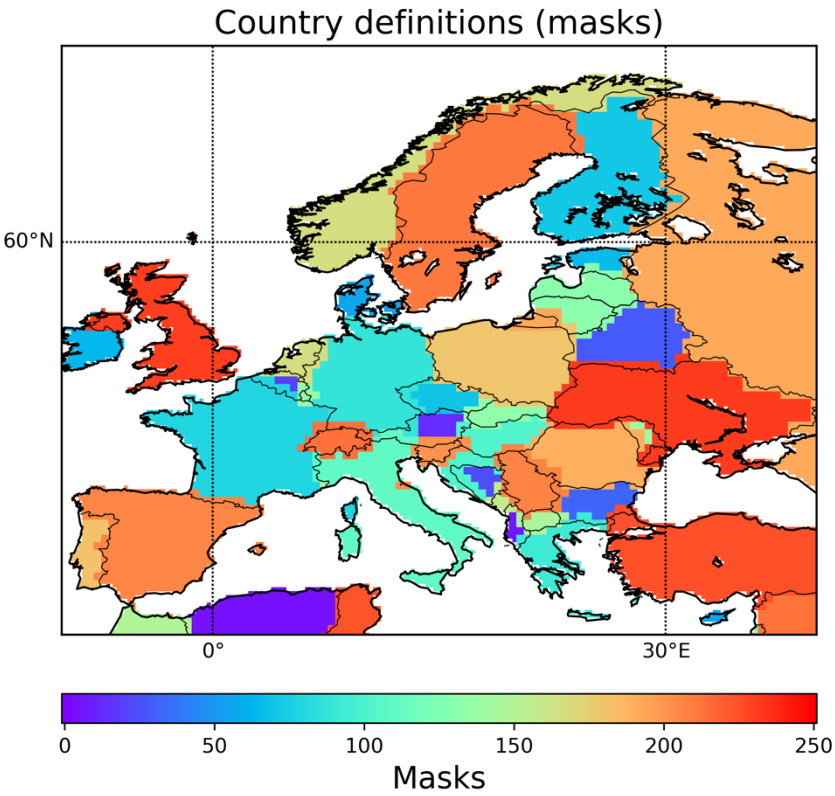

Figure S 6. Country masks used to calculate emissions of ammonia over different European countries, namely Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, United Kingdom, Albania, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Czechia, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Republic of Moldova, Romania, Slovakia, Slovenia, North Macedonia, Ukraine, Serbia (Russian Federation was excluded from the study).

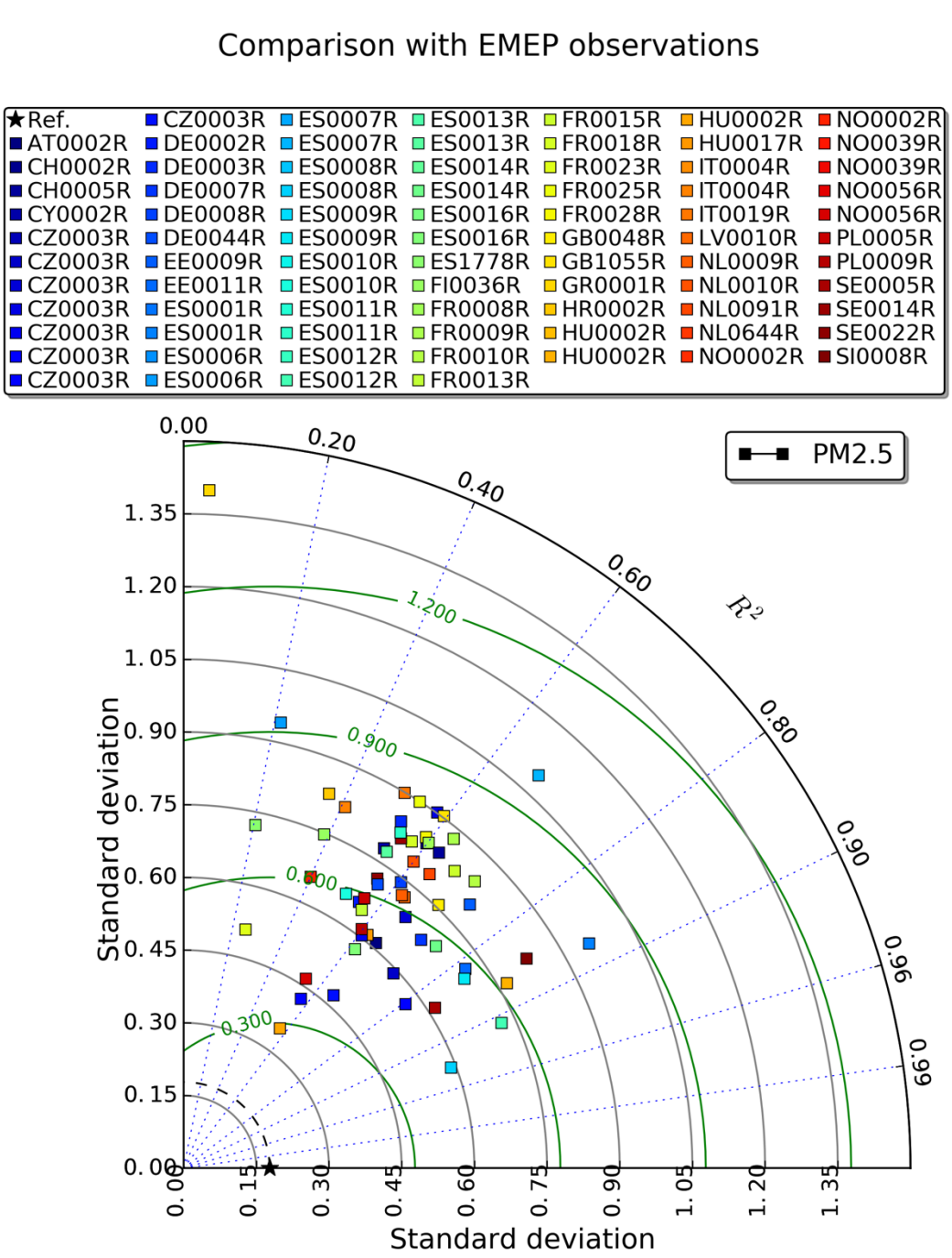

Figure S 7. Modelled concentrations of PM2.5 against ground-based observations from EMEP stations (79 sites) for January to June 2020 presented in a Taylor diagram. The diagram shows the Pearson's correlation coefficient (gauging similarity in pattern between the modelled and observed concentrations) that is related to the azimuthal angle (blue contours); the standard deviation of modelled concentrations of ammonia is proportional to the radial distance from the origin (black contours) and the centered normalized RMSE of modelled concentrations is proportional to the distance from the reference standard deviation (green contours).

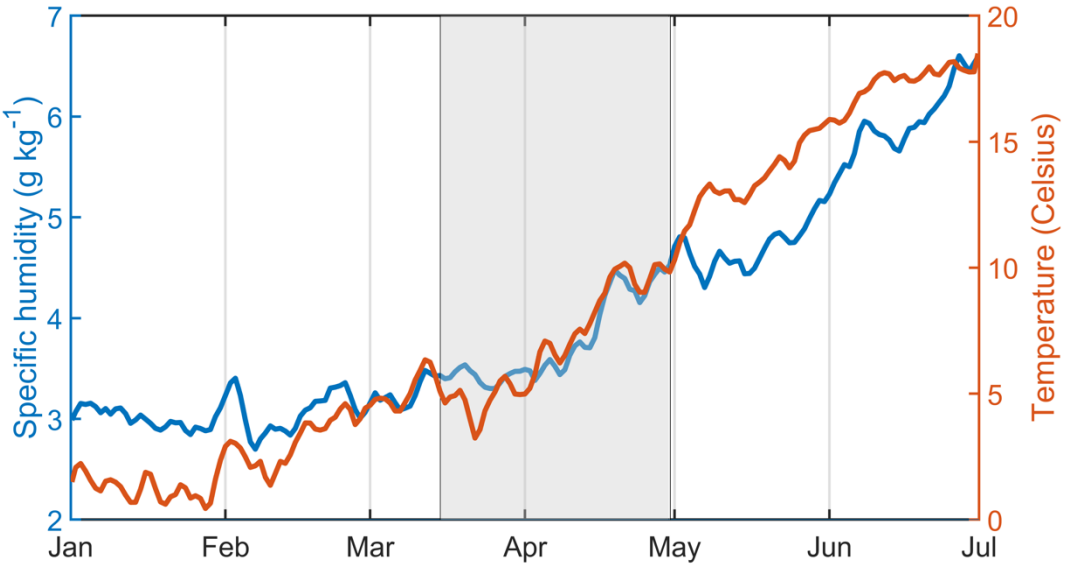

Figure S 8. Temperature (red) and specific humidity (blue) spatially averaged over Europe and vertically averaged up to 32 km (795 mbars) from ERA5 (Hersbach et al., 2020) for January – June 2020. The lockdown period is shaded in grey.