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Decreasing trends of NH3 over Europe seen from space

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Ammonia (NH_3), the only basic gas in the atmosphere, constitutes one of the most reactive nitrogen species. It mainly originates from agricultural-related activities, with emissions contributing over 80% globally, while locally they can reach as high as 94%. Once it is emitted, it is transported and deposited to water bodies, soil or vegetation and can then lead to eutrophication of water bodies, modulate soil pH and burn vegetation. It also reacts in the atmosphere with the abundant sulfuric and nitric acids forming fine particulate matter (PM2.5), which affect Earth's radiative balance, causes visibility problems, but also affects human health, as it penetrates the human respiratory system. However, despite its significance, ammonia source emissions are poorly constrained due to lack of ground-based measurement. Today, several satellite products have become available mainly from satellite sounders.

In the present study, we use direct comparisons between the CrIS (Cross-track Infrared Sounder) observations and model retrievals using the Least Squares with Adaptive Prior Covariance (LS-APC) algorithm, which reduces the number of tuning parameters in the method significantly using variational Bayes approximation technique. We constrain ammonia emissions over Europe over 2013–2020 and validate the results against ground-based observations from the EMEP (European Monitoring and Evaluation Programme). We find that emissions of ammonia decreased from 5431 Gg in 2013 to 3994 Gg in 2020 (-26%). Regionally, emissions declined by 38% in Central and Eastern Europe, 37% in Western Europe, 8% in Southern Europe and -17% in Northern Europe.