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# Modelling the reactive nitrogen budget across Germany using LOTOS-EUROS between 2000 and 2013

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Nitrogen deposition causes soil acidification and enhances eutrophication causing biodiversity loss. Currently, a major contribution to N-deposition derives from ammonia. Furthermore, ammonia contributes to the formation of secondary inorganic aerosol, a major contributor to atmospheric particulate matter levels. The aerosol formation provides a means of long range transport of reactive nitrogen as the life time of the aerosols is larger than that of ammonia itself. Despite its central role in these environmental threats, little is known about the ammonia budget. In this study we report on recent modelling study to assess the ammonia and reactive nitrogen budget over Germany for a period of 14 years (2000-2013).

Prior to the long term simulation the process descriptions in the LOTOS-EUROS CTM were updated and a sensitivity simulation was performed showing that the impact of the compensation point for ammonia and the changes in aerosol deposition had the largest impact against earlier studies. Next, sensitivity simulations were performed to assess the impact of newly reported emissions totals (with 30 higher emissions caused by adjusted emission factors for fertilizer spreading), different spatial and temporal emission variability. Long term evaluation showed that the model is well able to reproduce the variability in wet deposition fluxes induced by varying precipitation amounts, but that systematic changes remain. These sensitivity simulations showed that detailing the seasonal emission variability is more important to remove systematic differences than lowering the uncertainty in dry deposition parametrization. Evaluation with the ammonia retrievals of the IASI satellite confirm that the newly reported emission data for fertilizer application have positive impacts on the modelled ammonia distribution. The new emission information confirms an emission area observed by the satellite in the northeast of Germany, which was previously absent from the national scale modelling exercises. This finding is supported by evaluating the model performance against wet deposition data and a compilation of ammonia passive sampler data.

The new model setup was used to reassess the nitrogen deposition and PM formation in Germany between 2000 and 2013. In comparison to previous studies the nitrogen deposition estimates over Germany increased by 25% with considerable variability across the country. Two thrids of the deposition could be attributed to German sources, whereas the rest is of foreign origin. About 70% of the natural ecosystems across Germany receive nitrogen in access of their critical load.