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Bi-directional exchange of ammonia above a corn crop canopy: from flux measurements to model parameterizations

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Emissions of ammonia (NH₃) from agriculture have a significant impact on the environment. Its atmospheric transport and subsequent deposition has been shown to alter nutrient-poor ecosystems thereby reducing biodiversity. As the most abundant base in the atmosphere, NH₃ plays a key role in secondary aerosol formation impacting air quality and climate. Due to the lack of long term observations and challenges in performing NH₃ flux measurements, large uncertainties exist in both emission quantification from fertilized crop fields and in the bi-directional exchange of NH₃ with agroecosystems. We measured NH₃ fluxes above a corn field using the eddy covariance technique together with a quantum cascade laser spectroscopy analyzer over two consecutive growing seasons in 2017 and 2018. We found that after initial NH₃ emissions following fertilizer application, periods of both NH₃ emission and deposition with similar flux magnitudes prevailed throughout the growing seasons (ranging approximately between ±300 ng m⁻² s⁻¹), highlighting the importance of the corn crop canopy for regulating the net NH₃ exchange. To evaluate the underlying processes of the NH₃ bi-directional exchange, a two-layer compensation point model was used. Based on the large range of environmental conditions encountered during the extensive flux measurements periods, the validity of different parameterizations could be assessed. In particular, processes regulating stomatal and non-stomatal flux pathways will be discussed.