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# Disentangling biophysical controls of total reactive nitrogen exchange above a mixed forest using artificial neural networks

Undine Zöll, Antje Maria Lucas-Moffat, Pascal Wintjen, and Christian Brümmer
Thünen Institute of Climate-Smart Agriculture, Braunschweig, Germany (undine.zoell@thuenen.de)

Continuous high-resolution measurements of the net exchange of reactive nitrogen compounds between biosphere and atmosphere conducted above remote surfaces with low nitrogen input are still rare. These information, however, are required for benchmarking inferential dry deposition models. In this study, we measured concentration and fluxes of the sum of all airborne reactive nitrogen species ($\Sigma N_r$) above a forest recovering from a bark beetle outbreak in the early 1990ies located in the Bavarian Forest National Park in the southeast of Germany. We used the TRANC (Total Reactive Atmospheric Nitrogen Converter; Marx et al., 2012) to convert $\Sigma N_r$, including ammonia, aerosol ammonium and nitrate, nitric acid, nitrous acid and nitrogen oxides to nitric oxide (NO). NO was measured at high temporal resolution (10 Hz) by a chemiluminescence detector (CLD). Together with an ultrasonic anemometer and miscellaneous instruments - like temperature and humidity probes, leaf wetness sensors and additional anemometers - the system was mounted on a tower at a height of 30 m. By using the Eddy-Covariance (EC) approach the exchange between biosphere and atmosphere for every half-hour could be determined. A subset from a two-year, still on-going campaign was used. During the chosen period from July to September 2016 the concentrations ranged from 2.8 to 12.5 ppb. The median $\Sigma N_r$ half-hourly flux was -13 ng m$^{-2}$ s$^{-1}$ showing most of the time a distinct diurnal cycle. Usually night time fluxes were around 0 and midday values showed highest deposition, meaning negative fluxes. Correlations of the total reactive nitrogen exchange with potential driving factors were characterized using the methodology based on artificial neural networks presented in Moffat et al. (2010). Main climatic drivers were global radiation, humidity, and temperature. The correlations with the concentrations of reactive nitrogen and ammonia were similarly high. A coupling between total reactive nitrogen and net $CO_2$ ecosystem exchange (NEE) was observed with their diurnal patterns strongly linked through radiation. Our study presents a first step towards a better understanding of short-term linkages between $CO_2$ and $\Sigma N_r$ fluxes above an unmanaged forest ecosystem.