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Spatial pattern of nitrogen deposition flux over Czech forests: a novel approach accounting for unmeasured nitrogen species

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Nitrogen plays an important role in the biogeochemistry of forests as an essential plant nutrient and indispensable substance for many reactions in living cell. Most temperate forests are N-limited (Townsend, 1999), and increased nitrogen deposition results in many negative environmental effects, such as eutrofication, acidification, and loss of biodiversity (Bobbink et al., 2010). The nitrogen biogeochemical cycle is still poorly understood (Fowler et al., 2014). In studies addressing the association between atmospheric deposition and its impacts on ecosystems, a reliable estimation of N deposition is a key factor of successful approach of this issue. The quantification of real deposition of nitrogen is a complicated task, however, due to several reasons: only some constituents are regularly measured, and throughfall is not a relevant proxy for estimation of the total deposition due to complicated interchange of nitrogen between forest canopy, understory, and atmosphere.
There are studies estimating the total nitrogen deposition at one particular site, on the other hand, there are studies estimating the total nitrogen deposition over a larger domain, such as e.g. Europe. The studies for a middle scale, like one country, are practically lacking with few exceptions (Fowler et al., 2005). The advantage of such a country-scale approach is that measured constituents might be mapped in detail, which enhances also spatial accuracy and reliability.
The ambient air quality monitoring in the Czech Republic is paid an appreciable attention (Hůnová, 2001) due to the fact, that in the recent past its territory belonged to the most polluted parts of Europe. The time trends and spatial patterns of atmospheric deposition were published (Hůnová et al. 2014). It is obvious, however, that nitrogen deposition is substantially underestimated, particularly due not fully accounted for dry and occult deposition.
We present an advanced approach for estimation of spatial pattern of atmospheric nitrogen deposition flux over the Czech forests collating all available data and model results. The aim of the presented study is to provide an improved, more reliable and more realistic estimate of spatial pattern of nitrogen deposition flux over one country. This has so far been based standardly on measurements of ambient N/NO_x concentrations as dry deposition proxy, and N/NH4+ and N/NO_3- as wet deposition proxy. For estimate of unmeasured species contributing to dry deposition, we used an Eulerian photochemical dispersion model CAMx, the Comprehensive Air Quality Model with extensions (ESSS, 2011), coupled with a high resolution regional numeric weather prediction model Aladin (Vlček, Corbet, 2011). Contribution of fog was estimated using a geostatistical data driven model.
Final maps accounting for unmeasured species clearly indicate, that so far used approach results in substantial underestimation of nitrogen deposition flux. Substitution of unmeasured nitrogen species by modeled values seems to be a plausible way for approximation of total nitrogen deposition, and getting more realistic spatial pattern as input for further studies of likely nitrogen impacts on ecosystems.

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