Improving the understanding of nitrogen processes by combining field observations and dynamic ecosystem modelling

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1. Background and Objectives

Nitrogen and carbon processes in forest ecosystems are important for several environmental issues. However, scientific knowledge of these highly complex interactions is still limited. By combining empirical data with dynamic models, an increased understanding of these processes could be achieved which would reduce uncertainties in projections of future effects caused by e.g. changes in climate, atmospheric nitrogen deposition and forest management strategies.

In this project, we have combined dynamic ecosystem modelling with empirical data from field sites in Southern Sweden, with the overall objective to increase the understanding of nitrogen processes and cycling in forest ecosystems. One detailed focus has been to investigate the risk of nitrogen leaching from planted forests, which is a risk that needs to be better understood, e.g. when considering an increased use of artificial fertilization in forests for increasing carbon uptake and biomass productivity (wood and biofuel).

2. Materials and Methods

Empirical field data was provided by the Swedish Throughfall Monitoring Network (SWETHRO) (Pihl Karlsson et al., 2011). These data from forest sites includes monthly open field deposition and throughfall measurements, and soil solution data measured three times per year (representing before, during and after the growing season).

The modelling was performed with ForSAFE (Wallman et al., 2005), a dynamic ecosystem model handling dynamics and feedbacks between different processes. The ForSAFE model uses algorithms integrating processes of tree growth, decomposition, weathering, hydrology and ground vegetation.

For simulations for the 21st century, we utilized atmospheric deposition scenarios provided from the MATCH model (see e.g. Engardt and Langner, 2013), with climate data from global climate models. The ForSAFE model was applied with site-specific setups (based on empirical observational data from SWETHRO), and simulations were performed with different MATCH deposition scenarios.

3. Results and Discussion

Two sites in southern Sweden situated only a few kilometres apart, show highly different characteristics regarding observed soil water chemistry. One site shows very low N concentrations in soil water, while the other shows rather high concentrations. Applying the ForSAFE model, preliminary results indicate that differences in the soil chemistry between

the two investigated sites might explain at least part of the observed difference in nitrogen concentrations.

Further detailed investigations are ongoing, including applying different scenarios of forest management, climate and atmospheric deposition. Additionally, initial analyses suggest that the modelled results are affected by uncertainties related to past land management as well as uncertainties in climate and deposition input data.

4. Conclusions

We show that a combination of field site observations and dynamic ecosystem modelling can enhance the understanding of the processes regulating the nitrogen processes and cycling in forest ecosystems, and by so also result in improving dynamic models. This could reduce uncertainties in future projections, and be important when evaluating positive and negative effects of nitrogen fertilization or other forest management strategies. Furthermore, these results could be a useful contribution for the environmental protection work related to key environmental issues such as climate change, carbon sequestration, eutrophication and acidification.

References

Engardt M and Langner J 2013. Simulations of future sulphur and nitrogen deposition over Europe using meteorological data from three regional climate projections. Tellus 65B, 20348.

Pihl Karlsson G, Akselsson C, Hellsten S, Karlsson PE 2011. Reduced European emissions of S and N – Effects on air concentrations, deposition and soil water chemistry in Swedish forests. Environmental Pollution 159, 3571-3582.

Wallman P, Svensson MGE, Sverdrup H and Belyazid S 2005. ForSAFE - an integrated process-oriented forest model for long-term sustainability assessments. Forest Ecology and Management 207, 19-36.

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