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A Model-Based Analysis of Nitrogen Deposition: Effects on Forest Carbon Sequestration

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Over the last 150 years nitrogen deposition has increased, especially in the northern hemisphere, mainly due to the use of fossil fuels, deforestation and agricultural practices. Although the impact of this increase on the terrestrial carbon cycle is still uncertain, it is likely that this large perturbation of the global nitrogen cycle will have important effects on carbon cycling, particularly via impacts on forest carbon storage.
In the present work we investigated qualitatively the overall response of forest carbon sequestration to nitrogen deposition, and the relative importance of different mechanisms that bring about this response.
For this purpose we used the G'DAY forest carbon-nitrogen cycling model (Comins and McMurtrie 1993), introducing some new assumptions which focus on the effect of nitrogen deposition. Specifically the new assumptions are: (i) foliar litterfall and specific leaf area (SLA) are functions of leaf nitrogen concentration; (ii) belowground C allocation is a function of net primary production (NPP); (iii) forest canopies can directly take up nitrogen; (iv) management of forests occurs; (v) leaching occurs only for nitrate nitrogen. We investigated the effect of each assumption on net ecosystem production (NEP), with a step increase in nitrogen deposition from a steady state of 0.4 gN m-2 yr-1 to 2 gN m-2 yr-1, and then running the old and new model versions for different nitrogen deposition levels.
Our analysis showed that nitrogen deposition can have a large effect on forest carbon storage at ecosystem level. In particular the effect of the assumptions (ii), (iii) and (iv) seem to be of greater importance, giving rise to a markedly higher level of forest carbon sequestration than in their absence. On the contrary assumptions (i) and (v) seem not to have any particular effect on the NEP simulated. Finally, running the models for different levels of nitrogen deposition showed that estimating forest carbon exchange without taking into nitrogen deposition effects into account can easily lead to an underestimate of the carbon storage capacity of the forest ecosystem.