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Modelling the effects of stoichiometric constraints on global ecosystem responses to global change

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The first generation of coupled carbon-cycle climate models (C4-models), as also used widely for CMIP5, suggests a strong terrestrial carbon-climate interaction, effectively accelerating the rate of anthropogenic climate change. This effect is compensated for by an even stronger carbon-concentration interaction due to the CO_2-fertilisation of vegetation that leads to enhanced terrestrial carbon sequestration and thereby slows the rate of anthropogenic climate change. The often made criticism that these models ignore the consequences of ecosystem stoichiometry for ecosystem dynamics has sparked the development of a second generation of C4-models that account for nitrogen, and in some cases also phosphorous dynamics. The first global studies of these new models generally show a substantially smaller carbon-concentration interaction, and also a reduced (if not inversed) carbon-climate interaction that when combined lead to a larger rate of anthropogenic climate change than predicted by the first-generation C4-models.

Here, I will discuss the key assumptions made in global carbon-nitrogen (-phosphorous) cycle models for estimating the effects of ecosystem stoichiometry (and its flexibility) on ecosystem responses, and potential data sources for constraining global stoichiometric models. I will further explore the consequences of these assumptions to step-wise (as observable from ecosystem manipulation experiments) and transient (as occurring in reality) perturbations of the nitrogen-carbon cycle induced by climate change, enhanced atmospheric N deposition and elevated atmospheric CO_2 abundance. Based on these examples I will draw out the uncertainty in global carbon-cycle climate system interactions due to uncertainty in representing the effects of ecosystem stoichiometry on land carbon cycling.