

Nutrient Limitation on Land and its Climatic Significance

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Nutrient limitation on land is well documented and analysed by plant scientists for many decades, but has only been implemented into global land models recently for studying carbon-climate feedback and land-based climate mitigation.

In this talk, I will describe three studies from my group on the climatic significance of nutrient (both nitrogen and phosphorus) limitation. Based on carbon:nitrogen ratios of different carbon pools and the estimated carbon fluxes by 11 earth system models for the fourth assessment (AR4) of the International Panel on Climate Change (IPCC), we found that most models overestimated the land carbon uptake, and underestimated the global warming. The second study used a simple earth system model with the Australian community land model (CABLE) to assess the differences in allowance emissions for achieving two representative concentration pathways (RCP8.5 and RCP2.6) from 2006 to 2100 with or without nutrient limitation on land. We show that nutrient limitations reduce the land carbon uptake and allowable emissions by 69 Pg C (21%) for RCP2.6 and by 250 Pg C (13%) for RCP8.5 by 2100. The third study compared the effectiveness of reforestation in the temperate and boreal regions or deforestation in the subtropical and tropical regions (both are 4 million km² from 2006 to 2100) for climatic mitigation. We find that carbon gain from reforestation in the temperate and boreal regions is much less than the carbon loss from deforestation in the subtropical and tropical regions, because of the stronger nutrient limitation in boreal and temperate regions than in the subtropical and tropical regions. Therefore protecting the existing subtropical and tropical forests is about twice as effective as planting new forests in the temperate and boreal regions for climate mitigation.