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Exploring the missing processes contributing to the Amazon phosphorus budget.

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The Amazon Basin is one of the World's largest organic carbon reservoir. Like in many other ecosystems, its productivity is constrained by the availability of nutrients. Due to the humid climate and slow tectonic uplift, soils are strongly weathered and poor in nutrients (in particular phosphorus, P). For this reason the productivity of the Amazon rainforest is hypothesized to be limited by the availability of P and therefore to strongly depend on atmospheric inputs of this essential nutrient, e.g., deposition of dust from the Sahara.

Despite the hypothesized strong P limitation, the Amazon rainforest is a highly productive and diverse ecosystem. Moreover, recent studies have shown that the atmospheric input of phosphorus is smaller than the atmospheric export. These lines of evidence raise the question about which unidentified biogeochemical processes provide phosphorus to the Amazon rainforest.

In this study, we use a simple dynamical model considering the major components of the phosphorus cycle, such as tectonic uplift, atmospheric input, weathering, occlusion and uptake by plants. We parameterized the model for Amazonia and conducted a set of sensitivity experiments to variables for which no parameters could be determined based on current knowledge. The sensitivity experiments include scenarios about P redistribution within Amazonia through anthropogenic fires as well as the effects of the ecosystem's ability of phosphorus recycling.

Our sensitivity experiments show that the redistribution of P due to anthropogenic fires cannot sustain the long-term productivity and carbon storage of the rainforest. Furthermore, our model simulations suggest that the ecosystem internal P recycling is an important mechanism to sustain Amazonia productivity. Alterations of this ecosystem function, e.g., a loss of biodiversity, may therefore affect Amazon productivity and carbon storage. Although our model is minimalist and our scenarios of contributing processes are perhaps not yet complete, our model allows synthesizing multiple processes contributing to the Amazonia P budget. Thus, it may serve as a tool generating quantitative predictions and hypotheses, which may stimulate further exploration of Amazonian phosphorus dynamics.