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Estimating the likelihood for Amazonian forest dieback

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Climate change is likely to affect forests in Amazonia, but direction and intensity of change vary widely within the region and between different scenarios from climate models (GCMs). The 24 General Circulation Models (GCMs) evaluated in the 4th Assessment Report of the Intergovernmental Panel on Climate Change (IPCC-AR4) have been assessed with respect to their capability to reproduce present-day climate in the Amazon basin using a Bayesian approach. With this approach, greater weight is assigned to the models that simulate well the annual cycle of rainfall. We then use the resulting weightings to create probability density functions (PDFs) for future forest biomass changes as simulated by the Lund-Potsdam-Jena Dynamic Global Vegetation Model (LPJmL) to estimate the risk of potential Amazon rainforest dieback. Our results show contrasting changes in forest biomass throughout five regions of northern South America: If photosynthetic capacity and water use efficiency is enhanced by CO_2, biomass increases across all five regions. However, if CO_2-fertilisation is assumed to be absent or less important, then substantial dieback occurs in some scenarios and thus, the risk of forest dieback is considerably higher. Particularly affected are regions in the central Amazon basin. The range of potential biomass change arising from the weighting of rainfall patterns is smaller than the uncertainty arising from CO_2-fertilisation effects, which highlights the importance of reducing the uncertainties in the direct effects of CO_2 on tropical ecosystems. Additionally, our results display shifts in forest composition from closed rainforest to more open forest or even shrubland. Our probability-based risk analysis could be used to advise regional forest protection.