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Merging multiple observational data streams to constrain carbon uptake and water loss in the Amazon basin

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The Amazon River basin contains a substantial amount of carbon stored within terrestrial ecosystems. The unknown fate of this this carbon remains a substantial source of uncertainty in projections of the Earth system. While increasing atmospheric carbon dioxide concentrations could potentially enhance photosynthetic carbon uptake and/or reduce transpiration, increasing vapor pressure deficits have the potential to act with the opposite sign on both of these fluxes. Here, we investigate these competing factors at a process level, using a data assimilation system in which we constrain a parsimonious ecosystem model with observations from river runoff gauging stations, gravimetric water storage anomalies, and solar-induced chlorophyll fluorescence. Our model-data fusion provides us with an observationally consistent reanalysis of 21st-century ecohydrology across 14 Amazon watersheds along side the posterior distribution of key process parameters and emergent ecosystem properties such as water use efficiency (WUE). We find that the response to trends in atmospheric carbon dioxide concentrations and meteorological drivers varies across a hydroclimatic gradient within the Amazon, with implications for how carbon and water cycling could be expected to change subject to future biogeochemical and climatic trends.