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Uncertainty of runoff sensitivity to climate change in the Amazon River Basin

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The Amazon River basin is at risk due to climate change effects. Projected alterations in the climate system are expected to affect water supply, lead to losses in biodiversity and to be reflected at a global scale, given the feedbacks in the land-atmosphere system and the complex eco-hydro-climatological dynamics (IPCC, 2014). For this reason, aiming at quantifying the runoff response to changes in climatic conditions in the Amazon is a question that draws the attention of hydrologists, geoscientists and water management agencies. However, uncertainties exist due to the differences in observations and estimations of the water balance components of diverse datasets available in this region, which impact not only runoff estimation but also the water budget closure and, consequently, the quantification of climate change impacts. Budyko's Framework (1984) has been widely used to determine how climatic and catchment characteristics affect the long-term water balance (Koster & Suarez (1999); Arora (2002); Renner et al., (2014); Berghuijs et al., (2017)). We employ the framework of Roderick and Farquhar (2011) to assess the sensitivity of runoff R given changes in climatic factors (precipitation P and potential evaporation Ep) and in catchment properties (n) by estimating sensitivity coefficients that analytically predict which variable (P, Ep or n) will affect R the most. We use this approach using 24 years of data of different sources and products for P, R, E and Ep currently available for 100 catchments within the Amazon River Basin to quantify the uncertainty of the hydrologic response. Results for the entire Amazon show that this basin is more sensitive to changes in Ep than to changes in P, implying that it is more energy limited than water limited. This is expected in humid environments. For example, a 10% increase in P would increase R between 1.7% to 2.7%, depending on the combination of datasets, while a 10% increase in Ep would decrease R between 24% to 27%. However, highly marked differences between sub-catchments of the Amazon River are found, e.g., not all catchments are expected to experience an increase in R given a higher P. Results even show that for some combination of datasets R is expected to increase in a catchment but to decrease with a different combination of datasets, thus leading to the highest uncertainty (>87% in 30 sub-catchments). Finally, some regional patterns are detected. The lowest uncertainty in the sensitivity to P (<6%) due to the different combination of datasets is found in the northwest region, which is the wettest area of the Amazon. In contrast, these sub-catchments show the highest uncertainty in the sensitivity to Ep and n (19-34% and 64-80%, respectively), while in the catchments closer to the Andes uncertainty in Ep is estimated between 10-18%. In addition, high uncertainty is also found for the smallest catchments regardless their location across the basin. Thus, we show that using different combinations of datasets can lead to dissimilar results with implications for the quantification of climate change impacts at the regional scale in the Amazon River basin.