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Exploring hydroclimatic change disparity via the Budyko framework

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Climate change and human activity are likely to alter the hydrological cycle of catchments. Understanding how climate, vegetation, humans and hydrology interact and feedback to the atmosphere is key for accurate projections of future fresh water resources. In this study we focus on Sweden where significant changes in climate and increasing human activity have co-occurred during the past 50 years.

For this study we have analyzed 280 river discharge and over 400 meteorological records covering the past 50 years (1960-2010) distributed across Sweden. We related catchment runoff coefficients and change trends thereof to land-surface characteristics. With these relationships we were able to create average and change trend maps for runoff and evapotranspiration across Sweden. We summarized all this information using the Budyko framework. The Budyko plot, with the evaporative index (actual evapotranspiration / precipitation) on the y-axis and the dryness index (potential evapotranspiration / precipitation) on the x-axis, characterizes hydrological cycles as a function of climate. Using our change trend maps, we created change trajectories in Budyko space. A striking result is that we see that almost all landscapes in Sweden move closer to the theoretical limits in the Budyko framework, meaning that they have become more efficient in their water and energy use during the last 50 years (a smaller fraction of available energy and water is converted into heat and runoff). Because this finding is accompanied by a general increase in precipitation it signals acceleration of the hydrological cycle.

Furthermore, our analysis revealed three distinct regions: the mountains, the forests, and areas with agriculture. Each region responded markedly different to recent climate and anthropogenic changes. In our presentation we will discuss possible mechanisms explaining this behavior and discuss the implications of our findings for future water cycles.