



Constructing water change spectra in Budyko space to recognize main drivers of change

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Understanding historical changes in the hydroclimate is necessary for adaptation and mitigation of forthcoming global change. However, studies that attempt to separate hydroclimatic change effects of landscape drivers (e.g., changes in land and water use, water storage or water phase) from those of atmospheric climate change have up to date focused mostly on regional scales. Such focus limitation may arise from the complexity of representing multiple existing driver-effect combinations that may prevail among regions at larger scales, continental to global. Here we develop and propose water change spectra of movements and directions of hydroclimatic change in Budyko space, in order to quantify, visualize and separate change drivers and effects on such large scales. We analyze changes during the period 1901–2008 based on available hydroclimatic data for up to 859 hydrological basins across all continents. We further combine such change spectra with a previous independent classification of anthropic biomes to distinguish changes driven by atmospheric climate change and by different types of landscape change. We find that landscape drivers are needed to explain hydroclimatic change in at least 74% of the basins studied and that effects of landscape drivers are mostly opposite to those of atmospheric climate change. Such global changes thus require relevant account and resolution of key landscape drivers, as they cannot be explained or projected based solely on information about direct effects of atmospheric climate change on water in the landscape.