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Hydroclimatic changes worldwide: distinguishing freshwater change signals of flow regulation and irrigation

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Distinction of the main drivers of hydroclimatic change in the atmosphere and in the landscape is needed to advance our understanding of freshwater system changes in a changing climate and environment in general. This study analyzes worldwide hydroclimatic changes over the period 1900-2009 based on observation data for 99 of the largest hydrological basins across all continents. On land and globally, observed atmospheric changes in temperature and precipitation cannot alone explain corresponding changes in landscape evapotranspiration and runoff. The latter indicate dominant effects of landscape drivers, e.g., changes in land use, water use, water storage, or landscape determinants of water phase transfer. The role of river system fragmentation and flow regulation (FFR) as a global driver of such changes is here investigated based on independent categorization and parameterization of FFR impact in the studied basins. Consistent signals of FFR-driven change are distinguished directly from worldwide observation data, against the background of large change variability among basins and several coexisting drivers of water change for each basin. For strongly FFR-affected basins, these signals include increase in evapotranspiration relative to precipitation and an associated decrease component in long-term average runoff, which are related to both flow regulation and irrigation, and decrease in the coefficient of short-term variation of runoff, which is primarily related to flow regulation. These findings should be used and accounted for in further quantification, modelling and projection of large-scale hydroclimatic changes.