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What affects precipitation partitioning on interannual to interdecadal timescale?

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Abstract: One of the fundamentals of hydrological research is the functional dependence of streamflow on precipitation. On the annual timescale, this dependency can be formalised as the annual precipitation-streamflow relationship which represents water balance partitioning across dry, average, and wet conditions. While the relationship itself is expected to hold under stationary conditions, earlier work demonstrated that this relationship can consistently change under non-stationarity conditions such as vegetation changes or pronounced climatic shifts. Apart from the general shape, there is also year-to-year variability around the relationship which depends on factors other than annual rainfall. Examples of such factors may include annual potential evapotranspiration (i.e. evaporative demand) or within-year rainfall distribution (e.g. presence of extreme rainfall events and seasonality of a given year). Here we investigate the deviations from the historic rainfall-runoff relationship on the interannual to interdecadal timescales and identify the associated factors. We use climate, vegetation, and storage time series from 155 catchments in Victoria, Australia and machine learning techniques to understand what affects the shape of the precipitation-streamflow relationship and the deviations from it. Our results indicate that (1) the shape of the relationship changes across the aridity gradient both spatially and temporarily on the interdecadal timescale, and (2) interannual changes in catchment storage can play a dominant role in the precipitation partitioning on the interannual timescale in some catchments. This has major implications for hydrological predictions and water resources management under future climate non-stationarity and uncertainty.

Keywords: *Streamflow, drought, climate variability, rainfall-runoff relationship, catchment hydrology*