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Partitioning of inter-annual variability in the terrestrial water cycle

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The variability of terrestrial water cycle, i.e., precipitation (P), evapotranspiration (E), runoff (Q) and water storage change (ΔS) is the key to understand the hydro-climate extremes. However, a comprehensive assessment for the partitioning of inter-annual variability in P into E, Q and ΔS is still not available. In this study, we adopt the recently released global monthly hydrologic product known as the Climate Data Record (CDR) to conduct an initial investigation of variance partitioning of global P into the variances (covariances) of (between) E, Q, ΔS. We also examined the long-term mean and inter-annual variability in P, E, Q and ΔS, and further related the variability to aridity and evaluated the empirical theory of Koster and Suarez. The empirical Koster and Suarez framework was found to overestimate σ_E/σ_P and underestimate σ_Q/σ_P. The biases of the empirical framework are shown to be caused by ignoring the variability in ΔS and the covariances between E, Q, ΔS, particularly in semi-arid/humid environments. We also find a great divergence of variance partitioning under extremely hot and cold conditions. That divergence implies significant importance of global warming in changing the variability of global water cycle.