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River-discharge variability and trends in southeastern Central Andes since 1940

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The southern Central Andes in NW Argentina comprise small to medium drainage basins (10^2-10^4 km^2) particularly sensitive to climate variability. In this area and in contrast to larger drainage basins such as the Amazon or La Plata rivers, floodplains or groundwater reservoirs either do not exist or are small. This reduces their dampening effect on discharge variability. Previous studies highlighted a rapid discharge increase up to 40% in seven years in the southern Central Andes during the 1970s, inferred to have been associated with the global 1976-77 climate shift. To better understand the processes that drive variations in river discharge in this region, we analyze discharge variability on different timescales, relying on four time series of monthly discharge between 1940 and 2015. Since river discharge in this complex mountain environment results in a pronounced non-stationary and non-linear character, we apply the Hilbert-Huang Transform (HHT) to evaluate non-stationary oscillatory modes of variability and trends.

An Ensemble Empirical Mode Decomposition (EEMD) analysis revealed that discharge variability in this region can be decomposed in four quasi-periodic, statistically significant oscillatory modes, associated with timescales varying from 1 to ∼20y. In addition, statistically significant long-term trends show increasing discharge during the period between 1940 and 2015, documenting an intensification of the hydrological cycle during this period. Furthermore, time-dependent intrinsic correlation (TDIC) analysis shows that discharge variability is most likely linked to the phases of the Pacific Decadal Oscillation (PDO) at multi-decadal timescales (∼20y) and, to a lesser degree, to the Tropical South Atlantic SST anomaly (TSA) variability at shorter timescales (∼2–5y). Finally, our results suggest that the rapid discharge increased occurred during the 1970s coincides with the periodic enhancement of discharge mainly linked to the rise of the PDO oscillation from the negative to the positive phase in superposition with the long-term increasing trend, further modulated by TSA variability.