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# Regional Impacts of the El Niño-Southern Oscillation on Hydrologically Excited Length-of-Day Variations: A Cross-Correlation Approach

The El Niño–Southern Oscillation (ENSO) is a major driver of interannual climate variability, influencing terrestrial water storage (TWS) via global atmospheric teleconnections. ENSO-driven climate anomalies modify continental water mass distributions and subsequently alter Earth's angular momentum, thereby inducing measurable variations in the Length-of-Day (LoD) and polar motion.

In this study, we revisit the regional relationship between ENSO-induced TWS anomalies and the axial component of the hydrological angular momentum (HAM), which reflects variations in Earth's rotation and results in changes in the LoD. Therefore, we utilize four largely independent datasets, including TWS observations from the GRACE/-FO satellite missions; reconstructed TWS from GTWS MLrec that utilized machine-learning techniques; and numerically simulated TWS from two hydrological models (LISFLOOD XR0 and LSDM). Using a lagged cross-correlation method, we identify regions with significant and temporally coherent ENSO responses and quantify their contributions to variations in the LoD applying a basin-based empirical orthogonal function (EOF) decomposition.

Our results demonstrate a robust ENSO imprint on LoD across all datasets, with the Amazon basin emerging as the dominant contributor. LISFLOOD XR0 provides the most consistent representation, while LSDM exhibits artificial variability due to changes in atmospheric forcing, and GTWS MLrec shows damped variability inherent to its statistical reconstruction. GRACE/GRACE-FO confirms the large-scale ENSO signal but is limited by its relatively short data record.

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