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Enhancing early ENSO prediction: how the South American Monsoon onset connects the South Atlantic Subtropical Dipole and the South Pacific Oscillation

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In recent decades, a growing body of research has highlighted the intricate interplay between the El Niño-Southern Oscillation (ENSO) and various climatic patterns across multiple ocean basins. Several studies have highlighted the significance of the South Atlantic Subtropical Dipole (SASD) and its association with ENSO.

This investigation examines the interaction between SASD and ENSO, focusing on the critical role of the South Pacific High in these dynamics. Our study proposes that the onset of the South American Monsoon (SAM) plays a crucial role in this connection, challenging the traditional perception of land's passive role in tropical interbasin interactions.

We identified two eastern Pacific and two central Pacific ENSO precursors from SAM onset period using ERA5 reanalysis data along with 1200-year CESM2 PI run. Applying partial linear regressions revealed the following patterns: initially, warm Southwestern Tropical Atlantic (SWTA) and basin-wide low pressure in the equatorial and subequatorial Atlantic, evolving into cold Southeastern Tropical Pacific (boreal spring); then, negative South Pacific Oscillation (SPO) during the following boreal summer, culminating in La Niña conditions between 12 and 15 months later (SON and DJF of the following year).

We hypothesize that anomalous upper-level divergent monsoonal circulation acts as a bridge connecting the two ocean basins. Ekman dynamics arguably transfers and amplify atmospheric signals from the SAM and SPO to the equatorial Pacific Ocean.

Random Forest and Support Vector Machines for regression analysis yielded results consistent with those from the linear model; superior skill was noted in La Niña prediction compared to under-predicted El Niño events.

Moving forward, we intend to construct causal networks to disentangle the complex interplays described herein while ensuring independence from other known teleconnections; alternatively, we plan to design appropriate numerical experiments using coupled GCMs.

This study's preliminary results present exciting opportunities to enhance early ENSO prediction

by considering the impact of the South American Monsoon on aligning the variability of the tropical South Atlantic and South Pacific oceans.