Abstracting ENSO Spatial Patterns' Impact on Atlantic Tropical Cyclone Seasonal Frequency

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The warming and cooling patterns along the near equatorial Pacific Ocean, known as the El-Niño Southern Oscillation (ENSO), has been linked to impact Atlantic tropical cyclone activity on interannual time scales [5, 2, 3, 4, 6]. The dominating theory is that the deep convection associated with ENSO affects the large scale conditions over the Atlantic through vertical wind shear [**?**] or tropospheric warming [7]. However, the indices used to abstract such phenomena, commonly known as NINO indices, do not try to capture such pathways and instead simply monitor the SST anomalies of static regions in Pacific. Additionally, there have been an increasing number of reports on recent changes in ENSO warming patterns [1, 8], which has lead to low empirical relationship between NINO indices and Atlantic TCs on interannual time scales.

Instead of monitoring static regions in the Pacific, we propose to adopt an index that is more representative of the physical pathway that warming in the Pacific would impact the large scale conditions over the Atlantic, and subsequently TC activity. Our new index, S-ENSO, focuses on the spatial distribution of warming in the Pacific and its impact on deep convection. The index a linear combination (multivariate linear regression) of:

1. The longitude of the warmest $10°$ by $40°$ region in the Pacific (using SST anomalies)
2. The mean surface pressure of the region identified in (1)
3. The mean OLR of the region identified in (1)
4. The longitude of the $10°$ by $40°$ region with the lowest surface pressure in the Pacific
5. The longitudinal distance between the warmest and coldest $10°$ by $40°$ region in the Pacific

The first three elements of the index are selected to capture the impact of deep convection from SST warming. The fourth item is a proxy to identify the location of tropical cylones (typhoons) in the Pacific. The idea is that on an interannual scale low pressure systems such as TCs tend to organize along well defined tracks. Therefore identifying regions with low pressure is analogous to monitoring TC activity in the Pacific which has been weakly linked to TC activity in the Atlantic [**?**]. Finally, the last component was designed to better capture the evolving ENSO phenomenon by tracking the location warm and cold regions of the Pacific. When the cold region is to the west of the warm one it is more likely that El-Nino event is occurring. When the cold region is to the east, it is a La-Nina. We build S-ENSO by running a L1-regularized regression model on the 5 predictors and Aug-Oct TC counts.

S-ENSO explains 60% of the interannual variability in Atlantic TC counts, a near double improvement over traditional NINO indices. When analyzed further we found that the 0.82 linear correlation coefficient is significant at the 99% interval using rigorous randomization tests to address the small sample size and the data's auto-correlated nature.

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