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Reexamining the tropical Atlantic influence on ENSO using perfect model predictability experiments

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The potential influence of the tropical Atlantic on the development of ENSO has received increased attention over recent years. In particular equatorial Atlantic variability (also known as the Atlantic zonal mode or AZM) has been shown to be anticorrelated with ENSO, i.e. cold AZM events in boreal summer (JJA) tend to be followed by El Niño in winter (DJF), and vice versa for warm AZM events. One problem with disentangling the two-way interaction between the equatorial Atlantic and Pacific is that both ENSO and the AZM tend to develop in boreal spring (MAM).

Here we use a set of GCM sensitivity experiments to quantify the strength of the Atlantic-Pacific link. The starting point is a 1000-year free-running control simulation with the GFDL CM 2.1 model. From this control simulation, we pick years in which a cold AZM event in JJA is followed by an El Niño in DJF. These years serve as initial conditions for “perfect model” prediction experiments with 10 ensemble members each. In the control experiments, the predictions evolve freely for 12 months from January 1 of each selected year. In the second set of predictions, SSTs are gradually relaxed to climatology in the tropical Atlantic, so that the cold AZM event is suppressed. In the third set of predictions, we restore the tropical Pacific SSTs to climatology, so that the El Niño event is suppressed.

The results suggest that, on average, the tropical Atlantic SST anomalies increase the strength of El Niño in the following winter by about 10-20%. If, on the other hand, El Niño development is suppressed, the amplitude of the cold AZM event also reduces by a similar amount. The results suggest that, in the context of this GCM, the influence of AZM events on ENSO development is relatively weak but not negligible. The fact that ENSO also influences the AZM in boreal spring highlights the complex two-way interaction between these two modes of variability.