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Improving the Long-Lead Predictability of El Niño Using a Novel Forecasting Scheme Based on a Dynamic Components Model

Desislava Petrova (1), Siem Jan Koopman (4), Joan Ballester (1,3), Markel Garcia (1), Xavier Rodo (1,2)

(1) Catalan Institute of Climate Science, Barcelona, Spain (desislava.petrova@ic3.cat), (4) VU Amsterdam, Amsterdam, Netherlands, (3) California Institute of Technology (Caltech), Pasadena, California, United States, (2) Institució Catalana de Recerca i Estudis Avançats (ICREA), Barcelona, Catalonia, Spain

El Niño Southern Oscillation (ENSO) is a dominant feature of climate variability on inter-annual time scales and predictions for it are issued on a regular basis by a wide array of prediction schemes and climate centres around the world. We have explored a novel method for ENSO forecasting. In the state-of-the-art the advantageous statistical technique of Structural (Unobserved Components) Time Series has not been applied. Therefore, we have developed such a model with regression parameters obtained by a State Space approach. Its distinguishing feature is that observations consist of several unobserved components - trend, seasonality, cycles, disturbance, and explanatory regression covariates. These components are modeled separately and ultimately combined in a single forecasting scheme.

We introduce a new domain of predictor regression variables accounting for the state of the subsurface ocean temperature in the western and central equatorial Pacific as it has been shown by previous studies that subsurface processes and heat accumulation there are fundamental for the genesis of El Niño. An important feature of the scheme is that different regression predictors are used at different lead months, thus capturing the dynamical evolution of the system and rendering more efficient forecasts.

The new model has been tested with the prediction of all warm events that occurred in the period 1980-2015. Retrospective forecasts of these events were successfully made for long lead times of at least two years. Hence, we demonstrate that the theoretical limit of ENSO prediction should be sought much longer than the commonly accepted "Spring Barrier". Our statistical approach is found to exhibit similar skill to the best dynamical forecasting models for ENSO. Thus, the novel way in which the proposed modeling scheme has been structured could also be used for improving other statistical and dynamical prediction systems.