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An empirical model of decadal ENSO variability

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This study assesses potential predictability of decadal variations in the El Niño/Southern Oscillation (ENSO) characteristics by constructing and performing simulations using an empirical nonlinear model of the Niño-3 index. The model employs decomposition of global sea-surface temperature (SST) anomalies into the modes that maximize the ratio of interdecadal-to-subdecadal SST variance to define external predictors called the canonical variates. When the whole available SST time series is so processed, the leading canonical variate (CV-1) is found to be well correlated with the area-averaged SST and exhibit a non-uniform warming trend, while the next two (CV-2 and CV-3) describe secular variability arguably associated with the Atlantic Multidecadal Oscillation (AMO). The corresponding Niño-3 model that uses either all three (CVs 1–3) or only AMO-related (CVs 2 and 3) predictors captures well the observed autocorrelation function, probability density function, and the seasonal dependence of the ENSO, as well as the observed interdecadal modulations of fall/wintertime ENSO variance, the latter being anti-correlated with the AMO. The model predicts a net reduction in ENSO activity by the year 2020. Retroactive ENSO-frequency forecasts possess a useful skill at decadal lead times. The skill is limited chiefly by the lack of predictability of the canonical variates, so that improvements to decadal ENSO forecasts require alternative definitions of the external predictors; the latter may need to be based on simulations of dynamical models, rather than to be computed in a purely statistical fashion as in the present paper. These findings thus argue that decadal modulations of ENSO variability are predictable subject to our ability to forecast AMO-type climate modes.