Mining large climate model datasets to make actionable multi-year initialized sea surface temperature forecasts

Authors: Hui Ding, Matthew Newman, Michael Alexander, Andrew Wittenberg

Seasonal to interannual forecasts made by coupled general circulation models (CGCMs) undergo strong climate drift and initialization shock, driving the model state away from its long-term attractor. Here we explore initializing directly on a model's own attractor, using an analog approach in which model states close to the observed initial state are drawn from a library obtained from prior uninitialized CGCM simulations. The subsequent evolution of those model-analogs yields an ensemble forecast, without additional model integration.

This technique is applied to four CGCMs from the multi-model ensemble used operationally by NCEP through selecting from prior long control runs those model states whose monthly SST and SSH anomalies best resemble the observations at initialization time. Hindcasts are then made for leads of 1-36 months during 1961-2017. Notably, the model-analog hindcasts of the tropical Pacific SST and precipitation at leads of 1-12 months display comparable deterministic and probabilistic skill to traditionally assimilation-initialized CGCM hindcasts when applied to the same model. Furthermore, the model-analog hindcasts also display skillful SST hindcasts for leads of 13-24 months (Year 2).

This study suggests that with little additional effort, sufficiently realistic and long CGCM simulations may offer skillful seasonal to interannual forecasts of global SST anomalies, even without sophisticated data assimilation or additional ensemble forecast integrations. The model-analog method could provide a baseline for forecast skill when developing future models and forecast systems.