Improved ENSO predictability in coupled climate simulations with stochastic parameterizations

Judith Berner[1], Hannah Christensen[1,2], and Prashant Sardeshmukh[3]

[1] *National Center for Atmospheric Research, Boulder, USA*

[2] *University of Oxford, Oxford, UK*

[3] *Cooperative Institute for Research In Environmental Sciences, Boulder, USA*

This study investigates the mechanisms by which short-timescale perturbations to atmospheric processes can affect El Niño-Southern Oscillation (ENSO) in climate models. To this end a control simulation of NCAR's Community Climate System Model is compared to a simulation in which the model's atmospheric diabatic tendencies are perturbed every time step using a Stochastically Perturbed Parameterized Tendencies (SPPT) scheme. The SPPT simulation compares better with 20th-century reanalysis in having lower inter-annual sea surface temperature (SST) variability and more irregular transitions between El Niño and La Niña states.

Reduced-order linear inverse models (LIMs) derived from the 1-month lag covariances of selected tropical variables yield good representations of tropical interannual variability in the two simulations. In particular, the basic features of ENSO are captured by the LIM's least-damped oscillatory eigenmode. The impact of SPPT is consistent with perturbations to the frequency of this eigenmode, causing a noise-induced stabilization, which explains the decrease in damping timescale and the broadening of the SST spectrum (that is, greater ENSO irregularity).

Although the improvement in ENSO shown here was achieved through stochastic physics parameterizations, it is possible that similar improvements could be realized through changes in deterministic parameterizations or higher numerical resolution. It is suggested LIMs could provide useful insight into model sensitivities, uncertainties, and biases also in those cases.

Key words: Interannual predictability, tropical variability, stochastic parameterization, linear inverse models