Department of Meteorology Ph.D. Defense Announcement

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A Systematic Approach to Quantifying the Noise-ENSO Relationship and its Effect on Extreme El Nino Events

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Abstract:

State-dependent noise forcing, where the amplitude of the noise forcing is not independent of the background conditions, has been shown as a potential cause for the El Nino-La Nina amplitude asymmetry. However, the magnitude of the state dependent noise forcing has not been calculated in a manner that is applicable to the current generation of GCMs. Here a method of determining the magnitude of the state-dependence factor of the noise forcing from monthly mean data is determined. This method is shown to be relatively independent of the difference between monthly mean and daily data. The method is then applied to the equatorial zonal windstress, which is a known noise source for ENSO, in a reanalysis product and two coupled GCMs. The windstress in all three cases is shown to have state-dependent noise forcing, with both coupled models overestimating the magnitude of the state dependence. The state-dependent component of the noise forcing is further isolated and shown to be a coupled process between the ocean and the atmosphere. The coupling of the state-dependent noise process acts to increase the low frequency component of the windstress noise forcing of ENSO, which has been shown to be the important component of the noise forcing to excite ENSO in linear models. The methodology is then further applied to a suite of CMIP5 models and emissions scenarios. It is found that most of the models underestimate the state-dependence factor of the equatorial windstress on SST. Further, the models fail to agree on the direction of change of the state-dependence factor due to global warming, although there is a consistent relationship with the zonal equatorial temperature gradient. Finally, the state dependence factor is shown to be important for ENSO skewness and a predictor of the frequency of occurrence of extreme El Nino events. Therefore, it is shown that the magnitude of the state-dependence of the windstress noise forcing on SSTs can be calculated from the data stored in the CMIP5 archives and that the models' inability to accurately simulate this process effects their representation of the El Nino-La Nina magnitude asymmetry.