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Predictability in coupled versus forced GCM experiments

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For predictability experiments with general circulation models (GCMs) not only fully coupled ensembles are adopted, but also forced ensembles, where e.g. the sea surface temperature (SST) from observational data drives the atmospheric model. The focus of this investigation is, how the predictability of forced and fully coupled GCM ensembles are related to each other.

From a conceptual non-linear model of atmosphere and ocean, that we analysed in the fully coupled and in the forced version [1], we considered the effect of module coupling on the overall dynamical uncertainty. In this study we identified phase space as well as time-series features with respect to which a forced model set-up qualitatively differs from its fully coupled counterpart. We now analyse a fully coupled and a SST-forced ensemble from the ECHAM-3 model with respect to the identified fundamental differences in view of predictability. As in the conceptual model we find that the forced set-up displays artificial predictive skill (so-called locking), where all trajectories lock on the one master trajectory. We apply a two-way analysis of variance (ANOVA) to identify the mechanism for locking and conclude that the locking can indeed be traced back to the forced model set-up.

References

[1] B. Knopf, H. Held and Hans-Joachim Schellnhuber. Forced versus Coupled Dynamics in Earth System Modelling and Prediction *Nonlinear Processes in Geophysics*, 12: 311-320, 2005.