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Using seasonal hindcasts to understand El Niño mechanisms in climate models

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Seasonal forecasts (and more specifically « hindcasts » of the last decades) can provide a powerful test for understanding the development of bias in IPCC-class CGCMs. The classical analysis of ENSO in IPCC-type integrations (either basic statistics or more advanced evaluation of feedbacks) usually concentrates on the long (at least multi-decadal) time series statistics needed to compute robust signals. Yet, this strategy cannot fully explain how the model's errors (in the mean state but also in the feedbacks) were generated in the first place. This is an issue as the initial model errors result in a balance (a new mean state and annual cycle) that then becomes difficult to link to particular model deficiencies (such as arising from model parameterizations). Hence there is a need for an experimental framework which would focus on the initial adjustment of these models. Such a framework can be provided by the seasonal forecast approach. For example, if a forecast is launched before an observed El Niño event and the model fails to reproduce the event, a careful analysis might show that the surface heat flux damping feedbacks were too strong in the model to allow the event to develop, or if the event has a too weak amplitude, that the wind response to the SST anomaly was too confined near the equator or that the ocean dissipation was too strong to sustain intra-seasonal signals. This strategy has already shown a clear potential using 50 years of 4 yearly 7-months long hindcasts using five CGCMs of the European project ENSEMBLES (Vannière et al. in preparation). Using leadtime-dependent seasonal cycles, we analyse the chronological sequence of errors development in the models. The evolution of coupled feedbacks during the simulations which can be responsible for SST anomalies errors is also assessed. The different adjustment time scales (days, weeks, months) away from observations point to different physical mechanisms responsible for model errors.