Session: B7 Oral presentation

The reliability of AOGCM decadal predictability properties

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All CMIP5 decadal predictions must be viewed in the context of uncertainties in those predictions resulting from the chaotic nature of the climate system. Because the climate system is chaotic, pairs of forecasts made with a given model from nearly identical initial conditions become more and more different and eventually are as different as random states, at which point the forecasts have no value. It is important that this uncertainty, which is known as the predictability of a system, be quantified so that it can be taken into account when designing, interpreting and evaluating model experiments and when comparing models to each other and to nature. Also, if the predictability properties of a model are different from those of nature then its predictions have greatly reduced value since the reliability of the forecasts cannot be assessed. In this presentation we measure the predictability properties of six AOGCMs from various research centers. By quantifying model-to-model variations in predictability we are able to assess a lower bound on how well this important property is represented by these models. We concentrate on the predictability of upper ocean heat content in the two northern ocean basins, and we use two methods that only require long control runs for estimating predictability limits. One method makes use of analogs and the other uses multivariate linear regression. In contrast to the conventional ensemble technique both methods are able to estimate the average predictability characteristics of very many initial states. When we use relative entropy as a measure of predictability and consider entire basins, we find that on average the effect of initializing a forecast from a specific initial condition can be detected for about a decade, but this limit can vary by as much as a factor of three from one model to another. Furthermore, for a given model, there are variations in predictability of a factor of four at different locations within a basin. The model-to-model variations can be traced to variations in the properties of horizontally propagating disturbances in each model, including prominent modes. Given the large variations in predictability that exist from one model to another, we conclude that a) the predictability characteristics of each model used for decadal predictions must be carefully determined for proper design and interpretation of forecasts, and b) many, and perhaps all, comprehensive AOGCMs misrepresent the limit on forecast certainty imposed by the inherent sensitivity of the climate system to uncertainties in the initial state.