Grand Challenge 1: Provision of skillful future climate information on regional scales (includes decadal and polar predictability)

Gerald Meehl and Paco Doblas-Reyes
(with input from Adam Scaife)

Barrier 1: Less decadal predictive skill over the Pacific compared to the Atlantic

There are a number of indicators that show, for the CMIP5 hindcasts, less predictive skill over the Pacific Ocean than the Atlantic (and particularly the North Atlantic).

Defining question: What are the mechanisms and processes that lead to increased decadal prediction skill over the North Atlantic compared to the Pacific, and does this relative skill difference relate to external forcing from aerosols over the Atlantic playing more of a role than purely internally generated variability over the Pacific?

Barrier 2: Less decadal predictive skill for precipitation than temperature

Due to a variety of factors, temperature is more predictable than precipitation, with precipitation over land being particularly problematic

Defining question: What is required to improve decadal predictive skill of precipitation over land?

Barrier 3: It is still unclear what the best initialization strategy yields the best predictions

Modeling groups have tried various initialization methods, with some results showing predictions from hindcast-type initializations schemes sometimes outperforming predictions from full coupled initializations. This may be that the simpler initialization methods produce initial states closer to their systematic error state with consequent smaller bias adjustments, thus reducing possible negative effects from larger bias adjustments required by initial states closer to observations

Defining question: What is the best initialization strategy that would produce the most skillful decadal predictions

Barrier 4: Bias adjustment remains a major factor in decadal predictions, and all groups do it somewhat differently

Bias adjustments are required due to systematic errors in the models that produce rapid drifts from the initialized state to the model systematic error state. These bias adjustments are sometimes larger than the predicted signals, but will be required until model systematic errors can be reduced. Trend adjustment is often not performed as part of bias adjustment.

Defining question: What is the most effective bias adjustment strategy that would produce the most skillful decadal climate predictions?

Barrier 5: The concept of "near term" climate prediction typically extends to roughly 30 years, but the focus of most decadal climate prediction studies until now has been on the next decade.

There is the need for near term climate information that extends beyond one decade to extend out to several decades.

Defining question: Is there any skill in 30 year initialized predictions over and above uninitialized free-running climate model simulations?

Barrier 6: Need for model development

Both systematic error and drift are a major limiting factor for the realization of predictability estimates with current forecast systems. Climate prediction should join forces with other aspects of climate research to properly fund improvements in ESMs, making the most of the current observations and increased computing power.

Defining question: What are the priorities for climate prediction to make progress in model improvement?

Barrier 7: Need for large samples to obtain robust forecast quality estimates

Although the analysis of an increasing number of case studies is shedding light into some relevant aspects of climate prediction, robust forecast quality estimates can only be obtained with sufficiently large samples. This means that both larger ensembles (beyond the current 5-to-10 typical ensemble size) and frequent start dates over long periods that properly sample the observed variability are necessary. When taking into account that decadal prediction deals with long (at least 10 years) simulations, the computing power required is substantially larger than for any other climate research problem. Appropriate computing resources should be made available, especially as the tendency for increased model resolution continues.

Defining question: How to best interact with HPC managers and providers to explain the decadal prediction needs?

Barrier 8: Relevance of decadal prediction for climate services

In the wake of the current development of climate services in the framework of the GFCS, the utility of decadal predictions should be illustrated. A large amount of work is required in this front to overcome the lack of experience in downscaling, calibrating (as mentioned in Barrier 4), and combining decadal predictions to provide useful climate information for the relevant time scales. Users will have to be trained on the relevance and limitations of this sort of forecasts. The use of empirical predictions and user-oriented verification might be especially important for this topic.

Defining question: What strategy to follow to best interact with potential users of decadal predictions?

Barrier 9: Limited skill over land regions

Barrier 10: Very limited skill for extratropical atmospheric circulation