Assessment of Intraseasonal to Interannual Climate Prediction and Predictability

More accurate forecasts of climate conditions over time periods of weeks to a few years could help people plan agricultural activities, mitigate drought, and manage energy resources, amongst other activities; however, current forecast systems have limited ability on these time-scales. Models for such climate forecasts must take into account complex interactions among the ocean, atmosphere, and land surface. Such processes can be difficult to represent realistically. To improve the quality of forecasts, this report makes recommendations about the development of the tools used in forecasting and about specific research goals for improving understanding of sources of predictability. To improve the accessibility of these forecasts to decision-makers and researchers, this report also suggests best practices to improve how forecasts are made and disseminated.

Best Practices

Operational forecasting centers produce regular forecasts of climate for periods of weeks to years, called intraseasonal to interannual timescales. These centers provide information on drought conditions in the coming seasons or forecasts of the effects of El Niño. This type of information can be useful to both public and private decision-makers, such as farmers, insurance firms, or water resource managers. This report suggests best practices for the procedures and protocols associated with making forecasts, with the goals of increasing transparency and improving forecast quality.

Increase collaboration between operational centers and the research community to encourage the exchange of ideas between the two cultures. For example, operational centers could hold workshops focused on forecast development and grant short-term appointments to visiting researchers.

Enhance transparency by establishing public archives of forecasts, comparisons of past forecasts to actual climate conditions, the measurements used to produce forecasts, and the details of forecasting models. Archives of the inputs, outputs, and tools used in forecasts can help quantify and identify sources of forecast error, assist users as they interpret forecasts to their own needs, and

document how forecasts are made using a variety of climate prediction tools.

Broaden the metrics used to assess forecast quality. No perfect metric exists to convey all the information about a forecast; therefore multiple metrics should be used.

Improving the Building Blocks of Forecast Systems

Intraseasonal to interannual forecast systems are composed of several "building blocks," including observational systems, models, and data assimilation schemes, systems that expand the types of data that can be used for a forecast. The committee recommended improvements to the building blocks that would enhance forecast quality.

Use statistical techniques to complement predictions from models. Statistical techniques, especially non-linear methods, can be used to identify errors in dynamical models, sets of equations that describe the motions of the atmosphere and ocean. Statistical techniques can also be used to translate forecasts to more local scales, which can benefit decision-makers.

Investigate and correct errors in the representation of physical processes in dynamical models. For example, models often fail to represent important processes associated with clouds, which can impact climate on regional and global scales. Sustained

observations of complex climate processes are needed to better diagnose and correct these errors.

Continue exploration of multi-model ensembles, tools that combine predictions from different climate models when making a forecast. Work is needed to develop standards and metrics that could help determine the optimal selection and weighting of ensemble members.

State-of-the-art data assimilation systems should be used by forecast centers, and the types of data used to make forecasts should be expanded.
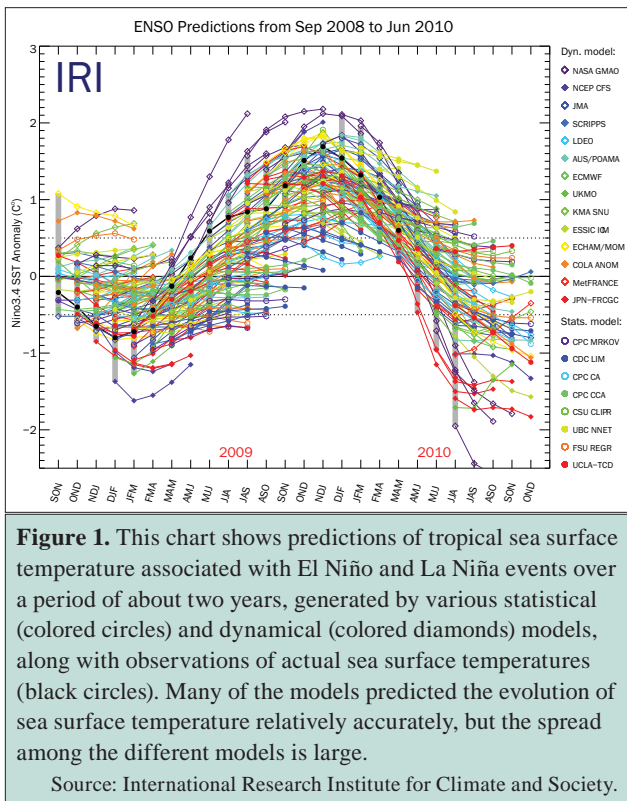
Research Goals for Sources of Predictability

Climate forecasts are based on "sources of predictability," variables or processes in the atmosphere, ocean, or land surface that can influence climate in predictable ways on intraseasonal to interannual timescales. **To better understand key processes that are likely to contribute to improved forecasts, research is needed in several areas,** represented by the questions listed below.

- How could the Madden-Julian Oscillation, a recurrent pattern of tropical rainfall and atmospheric circulation, be used to predict climate on intraseasonal to interannual timescales? How does the Madden-Julian Oscillation interact with other recurrent climate processes, such as El Niño and the Indian monsoon?

- How do interactions between the stratosphere and lower layers of the atmosphere impact climate on intraseasonal to interannual timescales?

- How do interactions between the ocean and the atmosphere, for example the exchange of heat and moisture between the ocean's surface and the atmosphere, impact climate processes? Similarly,

how do conditions on the land surface, such as those associated with soil moisture, influence atmospheric conditions, and vice versa?

- How do forecasts represent unexpected events such as volcanic eruptions or nuclear explosions? These events can alter the composition of the atmosphere with consequences for climate in the weeks, months, and years that follow.

- How should forecast systems incorporate information on long-term changes in the climate system, such as increases in greenhouse gas concentrations or alterations in the types of land cover?

Figure 1. This chart shows predictions of tropical sea surface temperature associated with El Niño and La Niña events over a period of about two years, generated by various statistical (colored circles) and dynamical (colored diamonds) models, along with observations of actual sea surface temperatures (black circles). Many of the models predicted the evolution of sea surface temperature relatively accurately, but the spread among the different models is large.

Source: International Research Institute for Climate and Society.

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