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FOR LONG-RANGE FORECASTING

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PROCEDURES FOR EXCHANGE OF LRF FORECASTS INCLUDING DEFINING PRODUCTS

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Summary and purpose of document

This document examines the dynamic climate forecast process used at the IRI, which consists of first predicting the global SSTs (using a mixture of dynamical and statistical models) and then using the predicted SSTs to force several atmospheric GCMs. The combined results of the GCMs is used to formulate the forecasts of seasonal global temperature and precipitation.

Action proposed

The Team is invited to make its recommendations taking into account the proposals submitted in this document.

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1. INTRODUCTION

In addition to significant observational advancements such as satellite-derived precipitation estimates, the global reanalysis datasets and the TOGA-TAO array in the equatorial Pacific Ocean, our physical understanding of, and ability to predict, ENSO episodes and their global climate impacts has gradually increased throughout the 1980s, 1990s and early 21st century. Dynamical predictive models were developed in the 1980s, led by the Lamont-Doherty simple coupled model by Cane and Zebiak. Statistical models have also played an important role, which has continued to the present. However, their growth and demonstrated effectiveness may have reached a relative plateau compared with the more persistent development and performance increases of dynamical models, whose increased usage has been made possible by the emergence of larger, more powerful computers. The effects upon climate of anomalies of sea surface temperature other than those related to ENSO, particularly in tropical oceans other than the central and eastern Pacific, are also becoming better understood.

2. OPERATIONAL INFRASTRUCTURE FOR THE PRODUCTION OF LRF AT IRI

The climate forecast operation at the IRI is largely based on dynamical models of the ocean and the atmosphere. The process begins by producing a forecast of the global sea surface temperature anomaly, and then using the forecast SSTs as surface boundary conditions to force several atmospheric GCMs (AGCMs). This two-tiered approach is necessary, due to inadequacies in physical parameterizations that cause a fully coupled forecast system to lose its accuracy early in the forecast process. The SSTs are forecast using different models for different portions of the global oceans. For the tropical Pacific, the NCEP coupled ocean-atmosphere model is used. For the Indian Ocean and the tropical Atlantic, a statistical method (canonical correlation analysis) is used. In the extratropics, damped persistence of the anomaly of the most recently observed month serves as the forecast. The AGCMs used in the second part of the IRI's forecast operation, as of November 2001, are as follows:

Model	Where Model Was Developed	Where Model Is Run Monthly
CCM 3.2	NCAR, Boulder, CO., U.S.	IRI, Palisades, NY, U.S.
NCEP MRF9	NCEP, Washington, DC, U.S.	QDNR, Queensland, Austral.
ECHAM 3.6	Max Planck Inst., Hamburg, Germany	IRI, Palisades, NY, U.S.
ECHAM 4.5	Max Planck Inst., Hamburg, Germany	IRI, Palisades, NY, U.S.
NSIPP	NASA/GSFC, Greenbelt, MD, U.S.	NASA/GSFC, Greenbelt MD
COLA	COLA, Calverton, MD, U.S.	COLA, Calverton, MD, U.S.

In addition to the approximately 10 ensemble runs produced from each of the six AGCMs using forecast SST as the lower boundary condition, several of them are also run with persisted SST for the first (shortest lead) forecast season. Two multi-model ensembling processes are applied to the results of the participating models, resulting in forecasts for 3-month mean temperature and total precipitation for the upcoming six months, given as four overlapping 3-month periods. The two multi-model ensemble results are combined with equal weights, and the forecasters then modify the final forecast in view of uncertainties in the SST forecasts or other

factors that may be ignored in the objective process. Additionally, an analog method is used during ENSO episodes, and the results are allowed to contribute to some extent when the objective results appear to have neglected an important analog-based empirical relationship.

The IRI's forecasts are issued in terms of the probabilities that the temperature or precipitation will be in each of three climatologically equal categories: below, near, and above normal. The definitions of the categories are based on the observations for the location and season over the 30-year base period of 1969-1998, using surface data of Mark New from the Climate Research Division of the University of East Anglia, UK. This data is considered to be the best choice for global coverage and quality, and is developed 2 to 3 years behind real-time; hence the "odd" 30-year base period used by the IRI. The forecasts are issued at the spatial resolution used by most of the AGCMs, which is T42, or about 2.8 degrees latitude and longitude. Each T42 "square" is assigned probabilities for being in each of the three categories. These probabilities are rounded to be multiples of 5%, such as 45%, 30%, 25% for being below, near, and above normal, respectively. An exception is the climatology forecast (denoted by "C" on the forecast maps), in which each category is forecast to have a 33.3% probability.

The global SST forecasts that are used as the basis for the AGCM forecasts for the atmosphere are also posted by the IRI. Implicit in these are forecasts for the ENSO, as well as for the other tropical oceans.

3.   REQUIREMENTS FOR THE PRODUCTION AND EXCHANGE OF LRF PRODUCTS

Because the skill of seasonal forecasts is known to vary greatly by season and location (depending on the signal-to-noise characteristics), the expected skill accompanying any climate forecast must be provided as well as the forecast itself. Forecast skill may be evaluated by using hindcast techniques over an extended period, with cross-validation such that the data for the year being forecast is withheld from the exercise. Acceptable verification measures are measures such as the temporal correlation, the root-mean-square-error, spatial anomaly correlation, the rank probability skill score, the relative operating characteristics (ROC), or certain others. For scores that are not inherently normalized (such as the root-mean-square-error), relevant normalizing constants such as the standard deviation of the forecasts and the observations must accompany the scores. It would be desirable to narrow the verification protocol to just several scores, with their definitions, to facilitate intercomparisons.

4.   EXPERIMENTAL EXCHANGE OF LONG-RANGE FORECASTS AND REPORT OF RESULTS

LRFs, and their constituent tools, should be verified using one or more of the agreed-upon verification measures and the verification scores should be posted for the users. The verification measures should be comparable among forecasts and tools to make possible intercomparisons and to facilitate the generation of weights for multi-forecast ensembles. Scores of recent forecasts should be made available as soon as verification data can be obtained. In some cases a preliminary score may be assigned, as for example on the basis of the rapidly available CAMS observations, and then changed later when a more clean-up version of the observations becomes available. A running summary of the mean verification score for a recent operational period, e.g. the last 3 years, should be maintained so that users can see how skillful some actual forecasts have been, as opposed to the somewhat more theoretical hindcast simulations over the longer period.

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