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Ways to contribute to climate modelling, scenarios and downscaling

Submissions from relevant organizations

Addendum

1. In addition to the four submissions contained in document FCCC/SBSTA/2007/MISC.24, one further submission has been received on 1 November 2007.

2. In accordance with the procedure for miscellaneous documents, this submission is attached and reproduced* in the language in which it was received and without formal editing.

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SUBMISSION FROM THE INTERNATIONAL RESEARCH INSTITUTE FOR CLIMATE AND SOCIETY

Climate modeling and downscaling activities at IRI for climate risk management applications

1. Introduction

Reliable seasonal climate information can help countries plan for adverse and beneficial climate events, allocate resources, and achieve development goals. Scientific advances in *seasonal forecasting* are creating opportunities to improve climate risk management - of drought for example - especially in tropical countries where seasonal forecasts are most accurate and societal needs greatest.

The International Research Institute for Climate and Society (IRI) was established in a collaborative agreement between the US National Oceanographic and Atmospheric Administration (NOAA) and Columbia University, New York. IRI's mission is to enhance society's capability to understand, anticipate and manage the impacts of seasonal climate fluctuations in order to improve human welfare and the environment, especially in developing countries.

Although climate modeling and forecasting at IRI is focussed at the seasonal time scale, it is now increasingly recognized that a powerful approach toward adapting to climate changing is through developing approaches and capacity to deal with year-to-year climate fluctuations. In addition, many of the modeling approaches in dealing with uncertainty and regional specificity have parallels in the climate-change arena (Greene et al. 2006) .

2. The IRI Operational forecast system

Since IRI's first global climate forecasts in 1997, seasonal forecasts of precipitation and temperature have been issued routinely - quarterly from 1997 to 2001, and monthly thereafter. Probabilistic El Niño/Southern Oscillation (ENSO) forecasts were introduced in 2002. The IRI's operational forecasts are presently based on a two-tier prediction system, beginning with sea surface temperature (SST) predictions synthesized from several sources (Mason et al., 1999) and climate predictions based on roughly 100 ensemble forecasts spanning seven atmospheric general circulation models (AGCMs) from different institutions (Goddard et al., 2003; http://iri.columbia.edu). Evolving predictions of SST are used in all tropical ocean basins, based on a multi-model combination of coupled ocean-atmosphere GCMs and a statistical forecast model over the tropical Pacific, and statistical forecasts over the tropical Indian and Atlantic oceans. Two-tier systems have the potential to enhance forecast skill through statistical interventions that correct model biases.

3. Reduction of uncertainties through multi-model ensembles

Statistical methods are used extensively in constructing IRI's forecasts, in order to reduce uncertainties and increase regional specificity by combining information from multiple sources (models, data) within rigorous probabilistic formalisms (eg Shongwe et al. 2006). An ensemble approach is used to generate probabilistic forecasts, employing ensembles of predictions from multiple models. Two multi-model combination methods are used at IRI in order to reduce the uncertainties inherent in the forecasts; one is Bayesian (Rajagopalan et al., 2002, Robertson et al., 2004), and the other is a canonical variate technique (Mason and Mimmack 2002). Both methods estimate an optimum weighting of the individual AGCM predictions for a given season and location, based on the past performance of seasonal simulations. This procedure improves the forecast reliability.

4. Regional specificity: Downscaling and tailoring of forecasts to sectoral applications

To be useful aids to real-world decision making, climate forecasts must have regional specificity be expressed or "tailored" in terms of the variables relevant to the decision maker in diverse contexts. IRI performs downscaling and tailoring of seasonal forecasts using both statistical and dynamical approaches with the goal of maximum applicability in specific contexts.

a. Statistical methods

Atmospheric general circulation models are unable to resolve all spatial and temporal scales, and imperfect parameterizations of unresolved processes lead to errors. Statistical correction methods can compensate for model deficiencies by filling in details of large-scale teleconnection patterns observed in nature but inaccurately or incompletely represented by models. Multivariate regression-based "MOS" correction identifies model patterns related to observed patterns of temperature and precipitation using retrospective forecasts, and then replaces model patterns with observed ones. These corrections are usually applied on a regional basis, and are used extensively by IRI and its partners to produce seasonal forecasts with greater reliability and regional specificity, and to tailor forecasts to risk-management relevant quantities, such as reservoir inflow, malaria incidence and crop yields (Hansen et al. 2004, Korecha and Barnston 2007, Landman and Goddard 2005, Tippett et al. 2003, 2005).

Seasonal-average forecasts are often of limited use to decision makers, where risk management in agriculture, for example, may require information on aspects such as the onset of the rainy season, or the probability of rainfall occurrence, long dry spells or rainfall extremes within the growing season. Recent work suggests that rainfall frequency is more seasonally predictable than the seasonal total of rainfall in tropical regions (Moron et al. 2006). Probabilistic models of "weather within climate" with daily resolution based on stochastic weather generators, hidden Markov models, and K-nearest neighbors approaches are used to express GCM-based seasonal forecasts in terms of ensembles of stochastic daily weather sequences that can then be used to drive models of crop growth and yield (Hansen and Ines 2005, Ines and Hansen and 2006, Robertson et al 2004b, 2006, 2007). Other aspects include probabilistic prediction of tropical cyclone activity (Camargo et al 2005, 2007a,b).

b. Nested regional models

Nested regional models are used at IRI to enable higher spatial resolution, flexibility for regional climate research, and for tailored predictions. These models are implemented for specific project regions, with spatial grids of 10's of kilometers; they provide much finer-scale detail than global GCMs which typically run with resolutions of hundreds of kilometers (Camargo and Sun 2007 , Herceg et al 2006, Qian and Zebiak 2003, Rauscher et al. 2006, Seth et al. 2007, Sun et al. 2005, 2006, 2007). Nested regional models also play an important role in regional capacity building.

5. Availability of models and forecasts

The IRI Data Library http://iridl.ldeo.columbia.edu/ contains a full archive of IRI's operational forecasts back to 1997, as well as extensive retrospective forecast runs by each of the component models (eg DeWitt 2005, Li and Goddard 2005). The IRI Data Library is a powerful and freely accessible online data repository and analysis tool that allows a user to view, manipulate, and download over 400 climate-related data sets through a standard web browser.

The IRI Data Library also freely provides a number of dynamic maps and data products that combine geophysical and socio-economic data. These are used by various local and global institutions to manage evolving climate risk conditions. Currently the IRI is hosting maps for the management of malaria conditions, dessert locust/food security crises, there are also evolving map rooms (eg Grover-Kopec et al.

2006) for the management of meningitis epidemics and other climate related threats – these can be found at http://iridl.ldeo.columbia.edu/maproom/.

Statistical tools including the "Climate Predictability Tool" (CPT) package for MOS applications are freely available through the IRI web page (http://iri.columbia.edu).

6. Application, usage and uptake

a. Routine seasonal forecasts, issued monthly

Each month IRI issues probabilistic forecasts for seasonal precipitation and temperature covering 4 overlapping seasons of the coming 6 months (e.g., FMA, MAM, AMJ, MJJ from January). The probabilities are given for tercile categories (i.e., above-, near-, and below-normal) as well as seasonal extremes (<15%-ile and >85%-ile) at a horizontal resolution of 2.5º for precipitation and 2º for temperature. The ensemble predictions from a set of atmospheric GCMs, forced with a common set of boundary conditions, provide the primary input to these forecasts.

In order to improve the usefulness of forecasts to real-world decision making, IRI is engaged in the development of more sophisticated metrics for forecast verification (Mason and Graham 2002, Mason 2004, Mason et al. 2007).

b. Regional demonstrations in sectoral applications

IRI is engaged in a series of demonstration projects where specific climate-related problems are addressed with partners and stakeholders, seeking to transition research and development into operation within relevant institutions. These projects seek ways in which seasonal climate forecasts can be best used to enhance management of climate risk that leads to enhanced climate-related outcomes in real world settings. Tailored seasonal climate forecasts for improved decision making in agriculture, water resources and public health represents major ways in which climate models are used at IRI (Brown and Rogers 2006, Brown et al. 2006, Ceccato et al. 2007, Hansen 2002, 2004, 2005, Hansen and Sivakumar 2006, Hansen et al. 2004, Lall and DeSouza Filho 2004, Osgood et al. 2007, Thomson et al 2004, 2005, 2006, Zubair et al 2005, Zubair and Chandimala 2006,)

7. Capacity building

Converting knowledge gained into training and education products which are then communicated in person and in electronic media offers a significant opportunity for transfer of learning across multiple scales. IRI is committed to both expanding the basis for learning about climate risks and introducing concepts into planning that can help reduce vulnerability to them. Such learning is integrated throughout the institute's project activities as IRI seeks to train and build capacity in stakeholder institutions. In addition, IRI continues to participate in education and training venues, including those that both train professionals about climate influence and that enable others to become trainers. IRI is committed to disseminating and sharing learning materials to enable the widest possible uptake. These materials include curricula, training modules, training courses, workshops, academic program graduates, and visiting scientist/scholar programs.

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