Poster Session 6
Applications of Climate Information and Improved Climate Services

Scientific Prospects for Weather to Climate Prediction and Services

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INTRODUCTION

The NWS Mission for Science & Technology Infusion is an agency-wide collaborative effort among planning, operations and services, with support by strategic community partners. A prominent focus is to enhance the connection between weather and climate for the advancement and provision of integrated services. This presentation highlights recent progress and challenges in three key development areas: 1) unified modeling, 2) seamless prediction, and 3) integrated services.

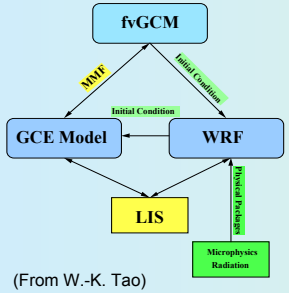
Acknowledgements. This poster is based on presentations for NOAA CTB Joint Seminar Series, 9th JCSDA Workshop, 9th CPAS Workshop, 5th Ensemble User Workshop, NCEP/EMC Seminars and COLA Seminars in 2011.

1. UNIFIED MODELING

- Modeling of weather and climate fluctuations and their interactions with the Earth system are integral to the simulation/prediction problem. A unified modeling approach can be used to address common processes in both classes of models, such that the progress in short-range weather forecasts will translate into improvements in long-range climate predictions and vice-versa.

NASA/Goddard multi-scale modeling system with unified physics

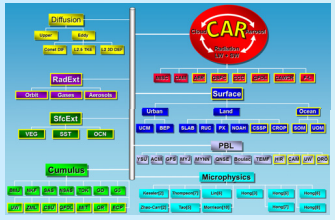
The system shown on the right consists of (1) the Goddard Cumulus Ensemble model (GCE), a cloud-resolving model, (2) the NASA unified Weather Research and Forecasting Model (WRF), a regional-scale model, and (3) the coupled fvGCM-GCE, the GCE coupled to a general circulation model. The same cloud microphysical processes, long- and short-wave radiative transfer and land-surface processes are applied in all of the models to study explicit cloud-radiation and cloud-surface interactive processes. Additionally, WRF has been enhanced by the addition of several of the GCE model's physical packages (*i.e.*, microphysical scheme and short and long-wave radiative transfer processes).



(From W.-K. Tao)

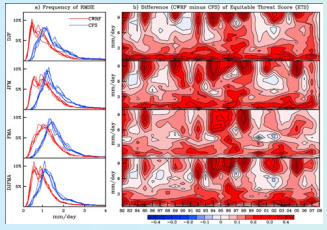
UMD/ESSIC CFS-CWRF nested system with optimized physics

The Climate extension of the Weather Research and Forecasting model (CWRF) inherits all WRF functionalities for NWP while enhancing the capability to predict climate.



The CWRF incorporates a grand set of alternative physics schemes and uses an optimized physics (geographically dependent) ensemble approach to improve weather forecasts and climate prediction along with reliable uncertainty estimates.

The figure on the right shows a) Spatial frequency distributions of root mean square errors (mm/day) predicted by the CFS and downscaled by the CWRF and b) CWRF minus CFS differences in the equitable threat score (ETS) for seasonal mean precipitation over North America.



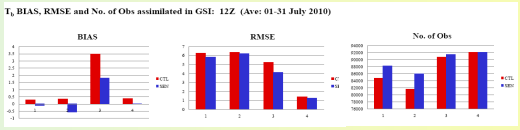
(From X.-Z. Liang)

2. SEAMLESS PREDICTION

- The seamless prediction concept emphasizes the importance of scale interactions and puts the stress on the weakest link of the prediction chain. In forecast practice, reducing biases and better representing uncertainties are the common foci of both weather and climate predictions for improvement. Enhanced cooperation and exchange of experiences between the two communities would accelerate progress for both.

Progress in satellite data assimilation - Land surface data improvement

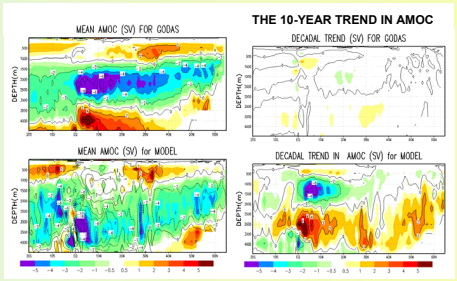
The amount of satellite data assimilated over land in the Gridpoint Statistical Interpolation (GSI) was found to be far less than over ocean. The figure at right shows a reduction of errors in simulated brightness temperature and an increase in the number of observations (NOAA-18 AMSU-A) assimilated in GSI, especially over forest regions, by using new roughness lengths formulations in the Global Forecast System (GFS) and updated microwave land emissivity model in Community Radiative Transfer Model (CRTM).



(From W. Zheng)

Challenges of decadal simulation for CFS

The Climate Forecast System (CFS) simulation of Atlantic Meridional Overturning Circulation (AMOC) is weak and its 10-year trend is larger than that in the GODAS assimilation. Since the AMOC is related to the Atlantic Multidecadal Oscillation, which can modulate ENSO activity, it has become a focus in CFS development to improve ENSO prediction.



(From S. Nadiga and J. Wang)

Shared focus areas with weather ensemble forecast development community

Ensemble configuration and ensemble forecast

- Ensemble initializations
- Multi-model, multi-physics and stochastic physics for ensemble perturbation
- True coupled initialization

Statistical post-processing

- Lead-time dependent systematic errors
- Non-stationarity of real climate and changes of model-error statistics
- Relating model variables to sensible weather
- Choice of proxy of truth - error variance and ensemble of analyses to represent uncertainty

Issues to consider

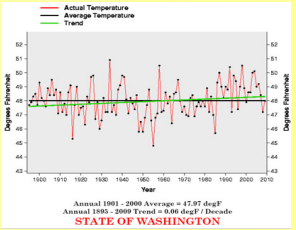
- Forecast of joint probability, *e.g.* "What is joint probability of heavy precipitation and strong winds?"
- Better ways to make members (representativeness vs. ensemble size and resolution), not only for simple statistics but also for higher order statistical moments
- Resolution change in mid-run
- Resource allocation for real-time fore- vs. hind-casts

(From 5th Ensemble User Workshop Breakout Sessions Report)

3. INTEGRATED SERVICES

- Regional services need reliable climate predictions integrated with weather and water information as long term adaptation is inseparable from near term decisions.

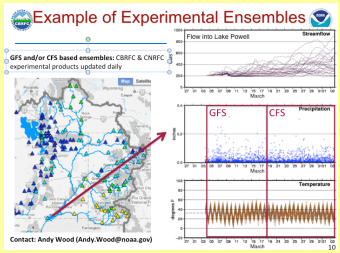
The figure at right shows that short-term variability becomes more significant compared to the long-term trends at smaller spatial scales. This informaiton is critical when attributing anthropogenic causes to local climate variations.



(From E. Sarachik)

Water supply forecasting for the Colorado

To meet stakeholder demands for climate information, the Colorado Basin River Forecast Center (CBRFC) supported by collaborative research with academic partners has launched a seasonal to year-two streamflow forecast intercomparison effort that has the most impact on Colorado River management. CBRFC has also implemented an ensemble forecast technique developed at the NWS Office of Hydrologic Development to create a streamflow forecast ensemble based on GFS and CFS output. It is a centerpiece of the nascent NWS Hydrologic Ensemble Forecast Service. The figure at right shows an example of this ensemble forecast for Lake Powell inflow in an experimental mode in 2010.



(From K. Werner)

Climate Change Impact Assessments for International Market Systems (CLIMARK) project

With broader spatial perspective and greater incorporation of temporal dynamics, new researches in climate impact assessment employed complex integrated models, which contained system components and included feedbacks. A conceptual framework for a dynamic and statistical hybrid modeling system was developed by the CLIMARK project to make industry-wide assessments for market systems with multiple production regions. Its application to assess the impact of climate change on the tart cherry international market demonstrated impressive improvement.

(From J. Winkler)

Questions and concerns from local users

1. What reliable decision-support tools could be designed and deployed at current skill levels and uncertainty of climate predictions?
2. How well could climate projections predict local trends for the next 10 – 20 years? How could best practices be developed for use of projections in decision making and preparation for change?

Regional climate service advancement is awaiting significant research progresses.

(From 9th CPAS Workshop Summary)