NOAA Climate Test Bed

Jin Huang
CTB Director

**Mission**
To accelerate the transition of scientific advances from the climate research community to improved NOAA climate forecast products and services.

- CTB embraces *the R2O and O2R paradigms*
- CTB emphasizes high profile science activities
  - *Climate model improvements*
  - *Multi-model ensembles*
  - *Climate forecast tools & products*
- Competitive Grants Program
- CTB Seminar Series

*CTB embraces *the R2O and O2R paradigms*

- Joint NCEP-CPO facility @ NCEP
- CTB Science Advisor Board (SAB)
- Established in 2005
- Serves as conduit between the operational, academic and research communities

*CFS – Climate Forecast System*
**Climate Test Bed**

**Currently Funded Projects**

- **FY09**
  - CFS Stratosphere Improvement, Perlwitz, Long, Alpert & Iredell
  - Multi-model Ensemble Reanalysis System (MERS) Using the 4D Kalman Filter, Ide, Kalnay, Miyoshi & Wang
  - A GOES Thermal-based Drought Early Warning Index For NIDIS, Anderson, Mo, Svoboda, Wardlow, Zhan, Mecikalski, Kustas & Brown

- **FY10**
  - Incorporating Scale and Predictability Information in Multi-model Ensemble Climate Predictions, DelSole, Tippett & van den Dool
  - Multi-Model Ensemble Forecast of MJO, Wang & Waliser,
  - Enhancing operational drought monitoring and prediction products through synthesis of N-LDAS and CPPA research results, Wood & Lettenmaeir
  - Improved Extended Range Prediction through a Bayesian Approach Exploiting the Enhanced Predictability Offered by the Madden-Julian Oscillation. Xie, Johnson, L'Heureux, Collins & Gottschalk
  - Seasonal Prediction for Ecosystems and Carbon Cycle Using NCEP/CFS and a Dynamic Vegetation Mode, Zeng, Kalnay & Kumar
  - CPT for Improving the Representation of the Stratocumulus to Cumulus Transition in Climate Models, Bretherton, Mechoso, Park & Teixeira
Climate Test Bed
Past Funded Projects

• FY06
  1. Using Initial tendency errors to reduce systematic errors, identify model errors, and construct stochastic parameterizations (DelSol) (Transition: FY08)
  2. Development of neural network emulations of model physics components for improving the computational performance of the NCEP seasonal climate forecasts (Fox-Rabinovitz) (FY08)
  3. The Ocean Component of the NCEP ENSO CFS (McPhaden/Xue/Behringer) (FY08)

• FY07
  4. System-wide advancement of user-centric climate forecast products (Hartmann/O’Lenic) (FY09)

• FY08
  5. Probabilistic forecasts of extreme events and weather hazards over the United States (Jones/Gottschalck) (FY09)
  6. Enabling the Transition of CPC Products to GIS Format (Doty/Silva/Halpert) (FY09)
  7. Generation and Evaluation of Long-Term Retrospective Forecasts with NCEP Climate Forecast System: Predictability of ENSO and Drought (Cane/Wang/Xue) (FY10)
  8. Multi-Model Ensemble Climate Prediction with CCSM and CFS (Kirtman/van den Dool) (FY10)
  9. Development of an Extended and Long-range Precipitation Prediction System over the Pacific Islands (Annamalai/Kumar) (FY10)
Multi-Model Ensembles

Goal

A multi model ensemble prediction system that leverages the best national and international models for improved predictions on intraseasonal-to-interannual time scales.

CTB Activities

- Consolidation techniques
- Verification
- MME Prediction System
  - MME Forecast of MJO (FY10)
  - MME Prediction with CFS and CCSM
  - National MME Prediction System in planning (NCEP, GFDL, NASA, NCAR) in collaboration with COLA, IRI, ESRL

ENSO Prediction

- MME mean outperforms individual models
Goal
To accelerate evaluation of and improvements to the operational Climate Forecast System (CFS) to enhance its use as a skillful tool in providing NCEP’s climate predictions for users to address today’s problems and plan for tomorrow.

CFS Improvements

- **CFS V1 implemented in 2004**
  - Atmosphere & ocean DA
  - Real time coupled 9-month forecasts
    - 25 years of hindcasts
- **CFS V2 (2011)**
  - CFS Reanalysis & Reforecast (CFSRR) project (completed)
  - Coupled O-A-L-Sea Ice data assimilation 1979-2010
  - Coupled reforecasts initialized from coupled reanalysis, 1981-2010
- **CFS V3 (in planning)**
  - Will engage the external community in planning process

CTB Activities

- **NCEP Climate Process Team (FY10)**
  - to improve CFS cloud representation
  - consists of scientists from NCEP NCAR, NASA, DOE and universities.
- **CFS Stratosphere Improvement (FY09)**
- **Hybrid Data Assimilation and coupled O-A Data Assimilation for Reanalysis (FY09)**

- **Focus areas for CFS Improvements**
  - Dynamics
  - Physics
  - Coupled Data Assimilation (Ocean Atmosphere Land Cryosphere)
## Advancement of Climate Forecast System (CFSv2) Planned for Q2FY11

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Operational (Since 2004)</th>
<th>Jan 2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analysis Resolution</td>
<td>200 km</td>
<td>38 km</td>
</tr>
<tr>
<td>Atmosphere model</td>
<td>1995: 200 km/28 levels&lt;br&gt;Humidity based clouds</td>
<td>100 km/64 levels&lt;br&gt;Variable CO2&lt;br&gt;AER SW &amp; LW radiation&lt;br&gt;Prognostic clouds &amp; liquid water&lt;br&gt;Retuned mountain blocking&lt;br&gt;Convective gravity wave drag</td>
</tr>
<tr>
<td>Ocean model</td>
<td>MOM-3: 60N-65S&lt;br&gt;1/3 x 1 deg.&lt;br&gt;Assim depth 750 m</td>
<td>MOM-4 fully global&lt;br&gt;¼ x ½ deg.&lt;br&gt;Assim depth 4737 m</td>
</tr>
<tr>
<td>Land surface model (LSM) and assimilation</td>
<td>2-level LSM&lt;br&gt;No separate land data assim</td>
<td>4 level Noah model&lt;br&gt;GLDAS driven by obs precip</td>
</tr>
<tr>
<td>Sea ice</td>
<td>Climatology</td>
<td>Daily analysis and Prognostic sea ice</td>
</tr>
<tr>
<td>Coupling</td>
<td>Daily</td>
<td>30 minutes</td>
</tr>
<tr>
<td>Data assimilation</td>
<td>Retrieved soundings, 1995 analysis, uncoupled background</td>
<td>Radiances assimilated, 2008 GSI, coupled background</td>
</tr>
<tr>
<td>Reforecasts</td>
<td>15/month seasonal output</td>
<td>25/month (seasonal)&lt;br&gt;124/month (week 3-6)</td>
</tr>
</tbody>
</table>
Application of T382 CFSv2 for Dynamic Hurricane Seasonal Prediction

- CFS is used operationally (April+) to produce an ensemble of high resolution runs in support of NOAA’s Atlantic and Eastern Pacific Hurricane Seasonal Outlooks.
- CFS is able to reliably capture the net seasonal frequency and intensity of tropical cyclone activity in these basins.
Climate Forecast Tools/Products

**Goal**

To provide reliable climate forecast tools/products that are responsive to the needs of users and incorporate state-of-the-art science and research.

- Relationships with partners
- Delivery of useful products
- Continuous flow of user requirements
- Strong research component

**CTB Activities**

- Forecast Evaluation Tool
- Development of an Extended and Long-range Precipitation Prediction System over the Pacific Islands
- Experimental Drought monitoring and prediction System
- CTB Regional Connection Development is underway
## CTB Seminar Series
Co-hosted by NCEP, NASA, COLA, ESSIC, IRI, ESRL

<table>
<thead>
<tr>
<th>#</th>
<th>Date</th>
<th>Location</th>
<th>Speaker</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>29-Oct</td>
<td>NCEP</td>
<td>Steve Lord/Hua-Lu Pan, NCEP/EMC</td>
<td>CFS - Under the Hood and CFS – Where It’s Going</td>
</tr>
<tr>
<td>2</td>
<td>12-Nov</td>
<td>NCEP</td>
<td>V. Ramaswamy, GFDL</td>
<td>Climate Modeling at GFDL: The Scientific Challenges</td>
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<tr>
<td>3</td>
<td>17-Nov</td>
<td>ESSIC</td>
<td>Ed O’Lenic, NCEP/CPC</td>
<td>An Interactive, Community-Based Web Tool for Evaluating the Skill of CPC Forecasts</td>
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<tr>
<td>4</td>
<td>24-Nov</td>
<td>NCEP</td>
<td>Zhaohua Wu, COLA</td>
<td>Annual cycle and predictability of interannual variability</td>
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<tr>
<td>5</td>
<td>3-Dec</td>
<td>COLA</td>
<td>Eugenia Kalnay, U. of MD</td>
<td>New ideas on Ensemble Kalman Filter</td>
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<tr>
<td>6</td>
<td>10-Dec</td>
<td>NCEP/209</td>
<td>Kathy Pegion, COLA</td>
<td>Subseasonal Variability of Tropical Cyclone Activity</td>
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<tr>
<td>7</td>
<td>21-Jan</td>
<td>COLA</td>
<td>Jae Schemm, NCEP/CPC</td>
<td>Hurricane season prediction experiment with CFS</td>
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<tr>
<td>8</td>
<td>28-Jan</td>
<td>NCEP</td>
<td>J. Shukla, COLA</td>
<td>Seamless weather and climate prediction</td>
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<tr>
<td>9</td>
<td>4-Feb</td>
<td>NCEP</td>
<td>Emilia Jin, COLA/GMU</td>
<td>TBD</td>
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<tr>
<td>10</td>
<td>11-Feb</td>
<td>COLA</td>
<td>Soo-Hyun Yoo, NCEP/CPC</td>
<td>The relationships between Indo-Pacific SSTs and Asian summer Monsoons in the NCEP CFS</td>
</tr>
<tr>
<td>11</td>
<td>25-Feb</td>
<td>NCEP</td>
<td>Renguang Wu, COLA</td>
<td>The relationship of U.S. droughts with SST and soil moisture: Distinguishing the time scale of droughts (with J. Kinter)</td>
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<tr>
<td>12</td>
<td>9-Mar</td>
<td>ESSIC</td>
<td>Viviane Silva, NCEP/CPC</td>
<td>Validation of Reanalysis Daily Precipitation over the Americas</td>
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<tr>
<td>13</td>
<td>25-Mar</td>
<td>NCEP</td>
<td>J. Kinter, COLA</td>
<td>Soil moisture effects on predictions with CCSM</td>
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<tr>
<td>14</td>
<td>8-Apr</td>
<td>COLA</td>
<td>Jin Carton, U. of MD</td>
<td>Ocean reanalyses: prospects for climate studies</td>
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<tr>
<td>15</td>
<td>22-Apr</td>
<td>NCEP</td>
<td>E. Schneider, COLA</td>
<td>Amazon deforestation in CFS</td>
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<tr>
<td>16</td>
<td>29-Apr</td>
<td>NCEP</td>
<td>Rong-Hua Zhang, ESSIC</td>
<td>Effects of freshwater flux (FWF) forcing on interannual climate variability in the tropical Pacific</td>
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<tr>
<td>17</td>
<td>6-May</td>
<td>NCEP</td>
<td>Jiangfeng Wei, COLA</td>
<td>TBD</td>
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<tr>
<td>18</td>
<td>11-May</td>
<td>ESSIC</td>
<td>Huug van den Dool, NCEP/CPC</td>
<td>Methods of Multi-Model Consolidation, with Emphasis on the Recommended Cross Validation Approach</td>
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<tr>
<td>19</td>
<td>27-May</td>
<td>NCEP</td>
<td>Vladimir Krasnopolosky, NCEP and ESSIC</td>
<td>Development of neural network emulations of model radiation for improving the computational performance of the NCEP seasonal climate forecasts</td>
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<tr>
<td>20</td>
<td>3-Jun</td>
<td>NCEP</td>
<td>Li Zhang, COLA</td>
<td>TBD</td>
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<tr>
<td>21</td>
<td>10-Jun</td>
<td>COLA</td>
<td>Kintgse Mo, NCEP/CPC</td>
<td>Monitoring many faces of drought over the United States</td>
</tr>
<tr>
<td>22</td>
<td>24-Jun</td>
<td>NCEP</td>
<td>Sumant Nigam, U. of MD</td>
<td>TBD</td>
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</tbody>
</table>

Speakers from CLIVAR and VAMOS community are welcome
Summary

- Climate Test Bed (CTB) is aimed at accelerating transition of research to operations.

- CTB Research-to-Operation Priorities:
  - Climate model improvement
  - Multi-model ensembles
  - Climate forecast tools & products

- CTB serves as a testing platform to transfer research from science community to NOAA operations
  - Competitive Grants
  - CTB Monthly Seminars

- CTB PIs meeting will be Oct.3-6, 2011 in Fort Worth, TX

Website: http://www.cpc.ncep.noaa.gov/products/products/ctb/