NCEP’s Role in a National Unified Weather-Climate Modeling Strategy

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Outline

• NRC report on ‘A National Strategy for Advancing Climate Modeling’ – scope, issues, status.
• NCEP CFSv2: A tough act to follow.
• Personal thoughts about NCEP’s role in the future of US unified weather-climate modeling.
A National Strategy for Advancing Climate Modeling
A Study from the National Academy of Sciences
Chris Bretherton, Chair
Edward Dunlea, Study Director

- Overall goals
  - How to improve climate modeling in next 10-20 years
  - Big picture look at whole of US climate modeling
  - Holistic approach

- History
  - Initiated with conversations with Navy, DOE, and Intelligence Community
    - Users of climate models

- Funding
  - DOE, NASA, NSF, NOAA, and Intelligence Community
Committee

- Chris Bretherton (Chair)
  - University of Washington
- V. Balaji
  - Princeton University
- Thomas Delworth
  - NOAA / GFDL
- Robert E. Dickinson
  - University of Texas
- James S. Famiglietti
  - U. of California, Irvine
- James A. Edmonds
  - PNNL (Maryland)
- Inez Fung
  - Univ. of California, Berkeley
- James J. Hack
  - Oak Ridge National Lab
- James W. Hurrell
  - NCAR
- Daniel J. Jacob
  - Harvard University
- James L. Kinter III
  - COLA
- Lai-Yung Ruby Leung
  - PNNL
- Shawn Marshall
  - University of Calgary
- Wieslaw Maslowski
  - Naval Postgraduate School
- Linda Mears
  - NCAR
- Richard B. Rood
  - University of Michigan
- Larry L. Smarr
  - Calit2
Process

- Five meetings throughout 2011.
- April 2011 Community Workshop, NCAR
  - 50 participants, lots of discussion.
- Also Heard from:
  - Sponsoring agencies
    - USGCRP, OSTP/OMB
    - NCAR, GFDL, NCEP, UKMO, ECMWF
  - Climate model users, PCMDI
- March 2012: Report sent out for external review. 13 reviews received late-April 2012; now in response phase.
- Summer 2012: Deliver report

Content of report is confidential until report is released

...but some issues discussed in our meetings were...
1) What do model prediction systems of the future look like?
   - Breadth of earth system modeling
   - Seamless prediction: weather / climate interface, regional/global interface
   - Maintaining an interoperable hierarchy of models
   - Role of regional, global and ‘hybrid’ models
   - Balance between ‘application-driven’ and ‘science-driven’ modeling

2) Evolving computational environment
   - Returning climate modeling to the forefront of supercomputing?
   - Codes must develop extreme parallelism to achieve exascale potential
   - Data explosion – a storage, dissemination, and interpretation challenge
   - Sophisticated, adaptive software engineering
   - Effective collaboration: how to best exploit available human resources

3) User requirements— hardware, software, data analysis, human capital
   - Helping diverse user communities get the most out of model output firehose.
   - Predictability, credibility, and uncertainty quantification.
   - Communicating model uncertainty and how to work with it.
   - Keeping our user communities informed and being responsive to their needs.
   - Role of national operational climate modeling

4) Structural issues
   - Workforce issues in climate model development
   - Fostering collaboration in a multiagency, multi-objective, multi-group environment
   - Value of international model intercomparisons (CMIP, WCRP)
CFSv2: A remarkably skillful climate model … and a tough act to follow

Free-run climatology of CFSv2 beats coupled 2011 GFS in all the above climate metrics, and NCAR model on all but clouds!

In future, try to:
• Bring CFS model improvements back into operational GFS?
• Assess climate impacts of GFS model changes?
Weather forecasts are an excellent testbed for developing the ‘fast physics’ of climate models (as CFSv2 shows).

CFSv2 and GFS are a partly unified modeling effort (new CFS versions rely on GFS development but not vice versa).

A fully unified UKMO-style weather-climate model might facilitate taking GFS and CFS ‘to the next level’.

It could benefit climate-quality data assimilation and U.S. climate research.

It could also entrain both the academic community and collaborations with other U.S. climate modeling centers.

This would require a large national commitment with strong leadership and extensive funding from outside NCEP.

Are NCEP’s operational requirements too tight to allow such an effort?
Useful intermediate stepping stones?

• A systematic project for parallel weather hindcast testing of CFSv2 and other U.S. climate models (using a skillful ‘neutral’ initial condition such as ECMWF) to assess their strengths and weaknesses as weather forecast models.
• A project to develop comprehensive, user-friendly, on-line technical documentation of CFS and GFS.
• Careful analysis of GFS and CFS systematic bias evolution at leads less than one month, and its relation to their climatological biases.
• Evaluation of changes in operational GFS skill as a seasonal climate forecast model before making major model changes.