The role of testbeds in NOAA for transitioning NWP research to operations

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Acknowledgements
Bill Kuo
Jamie Wolff
Sid Boukabara
Several operational NWP suites

NOAA has several NWP suites that need ongoing improvement, including…

- **Global**
  - Global Forecast System (GFS)
  - Global Ensemble Forecast System (GEFS)

- **Regional (subset)**
  - North American Mesoscale (NAM)
  - Rapid Update (RAP)
  - Short Range Ensemble Forecast (SREF) System
  - Hurricane Weather Research and Forecasting (HWRF) model
Testbeds for model improvement

- Testbeds are one of NOAA strategies to improve NWP
- Facilities in which NOAA and the community
  - plan,
  - develop,
  - and test new concepts and tools.

From Dabberdt et al., 2005
## Examples of NOAA Testbeds

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<td>Aviation Weather Testbed</td>
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<td>Developmental Testbed Center (regional Numerical Weather Prediction)</td>
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<td>Hazardous Weather Testbed</td>
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<td>Hydrometeorology Testbed (extreme precipitation, QPE, QPF, hydrology)</td>
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<td>Joint Center for Satellite Data Assimilation</td>
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<td>Joint Hurricane Testbed</td>
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For more information, visit [http://www.testbeds.noaa.gov](http://www.testbeds.noaa.gov)
Highlights from JCSDA

- **Inclusion of OSCAT scatterometer 10-m winds** in the Gridpoint Statistical Interpolator (GSI)
  - GSI is the data assimilation system used operationally at NCEP
  - Initial results neutral to positive
  - Now system is ready for further tuning

- **1st Joint DTC-JCSDA GSI tutorial and workshop**

Participants in 2013 Summer GSI Tutorial and Workshop, organized jointly by DTC, NWS/NCEP, NESDIS/STAR and JCSDA in the NCWCP building, in College Park, MD. August 5-8, 2013. Courtesy of Hui Shao. UCAR/DTC.
Highlights from HMT

- Flash Flood & Intense Rainfall Experiment (July 2013)
- 26 forecasters, researchers and model developers brought together to explore challenges in short term QPF and flood
- Several operational and research models used

12-h mean QPF valid 7/18 00

Q: Does NAM-X, HRRR, NSSL, and/or HRW provide better guidance than NAM-nest?
Developmental Testbed Center
DTC activities

- **O2R** transition: operational NWP systems are made available and supported to the research community
- **Interaction** between research & operations
  - organization of community workshops on important topics of interest to the NWP community
  - DTC Visitor Program
- **R2O** transition: NWP innovations are tested and evaluated
  - Work with both 1-2 year implementations and next-generation systems
  - Neutral position in order to provide unbiased assessment
  - Comprehensive testing for a broad range of weather regimes
  - Evaluation based on extensive objective verification statistics
- DTC is jointly sponsored by NOAA, Air Force, NSF, & NCAR
Mesoscale Model Evaluation Testbed

- Facilitates testing of new innovations by community
  - DTC provides model input and observations for case studies
  - Community tests their own innovations
  - Allows for quick comparisons against published baseline results
  - Provides a common framework for testing
  - Allows for direct comparisons among community results
- Promising capabilities nominated for extensive T&E performed by DTC
- Established data sets for nine cases
  - Open solicitation for more cases

http://www.dtcenter.org/eval/meso_mod/mmet/
DTC Highlight: Hurricane WRF

- HWRF provides guidance to the National Hurricane Center (NHC) for the North Atlantic and Eastern North Pacific basins
- Regional model 27/9/3 km
- HWRF has 8 components, many used in other applications
- Developmental Testbed Center works in
  - Support code to community
  - Code management
  - Testing and evaluation (R2O)

Operational forecasts
http://www.emc.ncep.noaa.gov/gc_wmb/vxt/
Developmental Testbed Center support

www.dtcenter.org/HurrWRF/users

Code downloads, datasets, documentation, online tutorial, helpdesk

500 registered users

Yearly releases corresponding to operational model of the year

Stable, tested code

Benchmarks available

Current release: HWRF v3.5a (2013 operational)

Next tutorial: January 14-16, 2014 in College Park, MD USA
Code management supports T&E

- **2010**
  - Initial unification code
  - community = NWS

- **2011-onwards**
  - Code Management for maintaining unification

- **Planning**
  - HWRF Dev Committee
  - Consistency Checks
  - Constant integration

- **Public release**
  - Comm trunk
  - Main HWRF development branch
  - Individual developments and T&E

- **Operational Implementation**
  - July 2013
  - HWRF public release August 2013
    - Fully documented and supported

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Example of collaborative testing

- Coupled HWRF tests (2007 and 2010) indicated POM-TC over-cooling
- To minimize over-cooling, atmos fluxes to POM-TC were reduced 25%
- NOAA Research (2012): POM-TC under-cools
  - Change due to higher resolution and updated physics in atmos model
- Hypothesis (University RI): flux reduction in HWRF not necessary (and should be eliminated as it is mostly non-physical)
- Comprehensive DTC by test: 2012 HWRF with and without flux reduction. Cases: entire 2012 season
- Diagnostics by DTC and NOAA Hurricane Research Division

Buoy passage 9/4 12Z

Katia (from Cione and Uhlhorn)
Atlantic track and intensity

Track ME: HD12 and HDFL very similar
Int MAE: HDFL SS better at 3 lead times
Int bias: HDFL lowers intensity and helps overintensification at long lead times
Pacific impact is much smaller (POM-TC 1D)

Positive results led to implementation in the 2013 operational HWRF model
DTC challenges and opportunities - I

- Code unification and management
  - Operational codes grow organically and are rarely re-designed
  - Variety of expectations regarding software development
  - Best software practices overlooked in fast development phases
  - Software modularity is often lost
  - Periodically, we should rewrite parts of system
  - However, funding for software engineering is scarce

- Seeking solutions to facilitate code management and modularity

I am very interested in learning from this community
DTC challenges and opportunities - II

- Business model for interacting with the research community

- Academic community would like to easily
  - Be able to run an operational system in any computational platform
  - Reproduce previous operational and research runs
  - Access variety of datasets: input, verification, other models runs

- Involves code management, databases, data service, scripting, user interfaces, documentation, training etc.

- Might involve rewriting some code in modular way

I am very interested in learning from this community, including OOPS and PrepIFS