Announcement of Opportunity

With the Developmental Testbed Center

The Developmental Testbed Center (DTC) offers visitor appointments for the year beginning October 1, 2010 for proposals received by August 1, 2010. The DTC Visitor Program supports visitors to work with the DTC to test new forecasting and verification techniques, models and model components for numerical weather prediction (NWP). The goal is to provide the operational weather prediction centers (e.g., NCEP and AFWA) with options for near-term advances in operational weather forecasting, and to provide researchers with NWP codes that represent the latest advances in the technology. This program also offers an opportunity for visitors to introduce new techniques into the DTC Community Codes that would be of particular interest to the research community. For 2010, the DTC is offering two types of visitor projects: 1) projects undertaken by the Principal Investigator (PI), and 2) projects undertaken by a graduate student under direction of the PI. Successful applicants for the first type of project will be offered up to two months of salary compensation, and travel and per diem. The two months can be distributed over several weeks during a one-year period. Visitors are expected to visit the DTC in Boulder, Colorado and/or one of the operational centers. Access to DTC computational resources will enable significant portions of the visitor's project to be conducted from their home institution. Successful applicants for the second type of project will be offered up to one year of temporary living per diem stipend and travel expenses for the graduate student to work with the DTC in Boulder, Colorado, and travel and per diem for up to two two-week visits to the DTC by the project PI.

1.0 The Developmental Testbed Center (DTC)

The Development Testbed Center (DTC) is a distributed facility with components residing in the Joint Numerical Testbed (JNT) of the National Center for Atmospheric Research's (NCAR) Research Application Laboratory (RAL) and the Global Systems Division (GSD) of the National Oceanic and Atmospheric Administration's (NOAA) Earth Systems Research Laboratory (ESRL). The objectives of DTC are to: (i) advance science research by providing the research community an environment that is functionally similar to that used in operations to test and evaluate the components of the NWP systems supported by the DTC, without interfering with actual day-to-day operations and providing that community with state-of-the-art numerical weather prediction (NWP) systems; (ii) reduce the average time required to implement promising codes emerging from the research community by performing the early steps of testing to demonstrate the potential of new science and technologies for possible use in operations; (iii) sustain scientific interoperability of the community modeling system; (iv) manage and support the common baseline of end-to-end community software to users, including dynamic cores, physics and data assimilation codes, pre- and post-processors and codes that support ensemble forecasting systems; and (v) establish, maintain and support a community statistical verification system for use by the broad NWP community. The fundamental purpose of the DTC is to serve as a coordinating mechanism that acts as a bridge between research and operations thereby facilitating the activities of both in pursuit of their own objectives.

2.0 DTC Community Codes

Community code is a free and shared resource with distributed development and centralized support. Ongoing development of community codes is maintained under version control with periodic public releases that include the latest in developments of new capabilities and techniques. To serve as a bridge between operations and research, the current operational capabilities must be part of these community code systems. The DTC currently supports, in collaboration with the respective developers, the following software packages to the community:

- Weather Research and Forecasting (WRF) – NWP model + pre- and post-processors
- Model Evaluation Tools (MET) – Verification package
- Gridpoint Statistical Interpolation (GSI) Data Assimilation System
- WRF for Hurricanes (coupled atmosphere and ocean system)

With the exception of MET, the DTC does not contribute to the development of these software packages. Rather, the DTC contributes to the software management and user support for these community codes. The main developers of these packages are affiliated with EMC, GSD, and NCAR/NESL/MMM. Through its Visitor Program, the DTC supports the addition of new capabilities to these Community Codes, as well as tests of the various components of these Community Codes.

3.0 How to Respond to this Announcement

A list of potential topics of interest to the DTC is outlined in section 4.0. These topics are general and intended as suggestions for the type of projects we will consider. Proposals for participation in the visitor program should provide details on the specific work the visitor would conduct with the DTC. Past DTC Visitors are welcome to submit proposals for new projects or projects that build on past work. All proposals will be subjected to the same review process (see description below). The submitted material should include the following:

- Project description including a title (up to 3 pages)
- Curriculum Vitae (1-2 pages)
- For budgeting purposes, include the following information:

  Projects undertaken by the PI:

  1. Salary
  2. Number, location and duration of each planned visit

  Projects undertaken by a graduate student:

  1. Duration of graduate student visit to DTC
  2. Number and duration of PI's visit to DTC

As noted above, it is expected that the visitor will spend two months resident (up to twelve months for graduate student project) at the DTC, an operational center or a combination of time at the DTC and an operational center. The total duration of the

project can continue for one year. It is expected that the visitor will be able to continue the work from his or her own institution using DTC computational resources.

Proposals in response to this announcement should be sent by August 1, 2010 to

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4.0 Possible Visitor Projects with the DTC

This general announcement is for an opportunity to work with the DTC to test existing NWP-based systems in order to assess/identify deficiencies, evaluate new NWP technology that shows promise of improving NWP within the next five years, or provide the DTC with promising new technology for research applications in accordance with chartered focus areas. Potential topics include: testing new physics parameterization components, optimizing physics packages, investigating the interaction between physics schemes, assessing tropical vs. extra-tropical vs. polar strengths and weaknesses within each dynamic core, optimizing coupling mechanisms, investigating alternative verification approaches, investigating data assimilation techniques (including variational, ensemble-based, and hybrid approaches) and observation impacts, as well as investigating the impact of resolution.

Specific suggested topics (not in order of priority) that would receive special consideration include:

1. Physics parameterizations
    a. Hurricanes: Projects leading to improved and/or expanded physics options available in the WRF software infrastructure to address the hurricane prediction problem are encouraged. Improvements to physics suitable for high resolution (grid spacing $\leq$ 3 km), including air-sea transfer physics in high wind conditions, representation of convection, cloud physics, and radiation are of particular interest.
    b. Boundary layer: New Planetary Boundary Layer (PBL) schemes currently being tested by the community are welcome additions to the WRF system. A potential project would be to add a new PBL scheme to the WRF physics options, and test and compare this scheme with existing schemes both in idealized one-dimensional cases, and in full NWP-type simulations. This general topic area also includes the need for new surface layer schemes for high-resolution regional models. One area in need of special attention is shallow convection forced by sensible heat flux at the surface. Testing could be extended to seasonal statistical evaluations using DTC datasets.
    c. Physics interactions: The interactions between the physics schemes in mesoscale models needs to be carefully investigated. In particular, a better understanding of

the mutual feedbacks between radiation and cloud microphysics and the interplay between radiation, cloud microphysics, and parameterized convection is needed.

   d. Land-Surface Model (LSM): The Noah LSM, one of the LSMs currently available in WRF, is hard-wired to four vertical computational soil layers. A potential project would be to generalize this scheme to make the number of soil layers adjustable. A project exploring the effect of near-surface resolution on the Noah physics parameterizations (e.g., bare soil evaporation) is also of interest. New LSM options are also welcome additions either as a physics option within the WRF infrastructure or as an external terrestrial model available to WRF through a two-way interactive coupling mechanism.

2. Verification: A variety of projects focused on advanced verification methods are of interest. Some examples include the following:

   a. Investigate verification approaches that are more appropriate for providing model diagnostics than many traditional approaches – that is, approaches that provide information about particular attributes of model error that can lead to a diagnosis of needed improvements in the model. For instance, a project that applies MET to the operational model development and verification/assessment process with the intent to demonstrate and document the value of alternate verification techniques over those commonly used is of interest.

   b. Investigate verification approaches that allow incorporation of observational uncertainty into model evaluations, and are able to express this uncertainty in the resulting verification measures. Demonstrate how this information can be separated from other sources of uncertainty (e.g., sampling variations) associated with estimates of verification measures.

   c. Apply new spatial verification methods for evaluation of ensemble forecasts.

   d. Investigate and demonstrate methods for using a variety of non-standard datasets (e.g., satellite) for verification

   e. Investigate verification approaches to evaluate forecasts across time.

   f. Recent field studies offer an abundance of data that can be used to diagnose strengths and weaknesses of NWP techniques. Organization of data from these field studies into modules to test certain physical parameterizations for the atmosphere, land surface models or other model system components could serve as a visitor project.

3. Short-range mesoscale ensemble prediction: The DTC is in the process of establishing the DTC Ensemble Testbed (DET). The central piece of the DET is a modular system that will facilitate testing and evaluation of competing techniques and capabilities for specific components of the ensemble system. This system will consist of six modules: ensemble configuration, initial perturbations, model perturbations, statistical post-processing (e.g., methodologies for ensemble calibration), product generation, and verification. The DTC would welcome visitors who are interested in contributing a technique or techniques to one of these modules. Evaluation of cloud-scale/mesoscale experimental forecasts conducted during Hazardous Weather Testbed

Spring Experiment over the past few years that would contribute to the design and development of DET would also be of interest.

4. Sensitivity to terrain:
    a. How much smoothing is "necessary" for the underlying terrain in the WRF cores? The answer to this question will depend on the inherent model smoothing and so may be core dependant. A project addressing this question would provide valuable guidance to both the operational and research communities.
    b. Experiments investigating WRF model sensitivity to terrain treatments, such as form drag and mountain blocking, are also of interest.
    c. The development and testing of different numerical approaches for treating the vertical propagation of wave energy and damping of reflective gravity waves from the model's top boundary are encouraged.
5. Sensitivity to model configuration: A project evaluating sensitivities to a variety of aspects of the WRF model configuration would be of interest. For example, projects could address the effect of vertical and/or horizontal resolution or physics parameterizations on model forecast accuracy. Projects that lead to Community-Contributed Reference Configurations (CCRCs) are encouraged. More information on the DTC's Reference Configuration (RC) concept can be found at: http://www.dtcenter.org/config/
6. A project evaluating the tropical, extra-tropical, and polar sensitivities of current or proposed new physics capabilities directed at recommending optimal latitudinally-dependent configurations or physics parameterization adjustment(s) would be of interest.
7. Nesting: What is the value-added of including two-way interactive nesting verses one way nesting verses nestdown? These tests should include both WRF cores using standard verification scores for all nests especially the coarsest parental nest to see if there is positive feedback to the larger scales.
8. Tropical Cyclone Initialization: The initial intensity and structure of a tropical cyclone (TC) plays a critical role in the skill of numerical guidance systems. A robust and feasible initialization methodology to obtain dynamic and thermodynamic balance for TCs remains a great challenge for TC numerical prediction system. New methods or improving existing capabilities in the WRF for Hurricanes initialization procedures to assimilate satellite data and airborne Doppler radar, SFMR, flight-level winds and dropsonde observations in the hurricane core region for initialization of the hurricane vortex are topic areas of interest.
9. Data assimilation: Projects are encouraged that focus on ingesting new data types into the GSI data assimilation system. The visitor would have an opportunity to work with specialists at NCEP EMC and NCO, as well as the operational data ingest processes. The visitor would have the opportunity to be exposed to NCEP communications, data formatting, operational tanking, dumping and monitoring data increments in developmental GDAS parallel runs at NCEP. If successful, the new data will be considered for operational implementation.

10. Model Framework - User-selectable coupling mechanism: Design, improve, or optimize a coupling mechanism to allow for two-way interaction of either WRF cores with an external terrestrial, space, or ocean model that is available at compile time and selectable via namelists options at run time.

5.0 Proposal Evaluation Process

The proposals submitted in response to this announcement will be subject to both external and internal review. The external review will be conducted by the DTC Science Advisory Board (SAB), which consists of scientists from government labs, operational centers, and academic institutions. The DTC Management Board will make the final recommendations to the DTC Director based on the review by the DTC SAB.