Announcement of Opportunity

with the WRF Developmental Testbed Center

The WRF Developmental Testbed Center (DTC) offers up to five visitor appointments for the year beginning June 1, 2005. Initial consideration will be given to proposals received by April 1, 2005. The DTC Visitor Program supports visitors to work with the DTC to test new techniques, models and model components for numerical weather prediction. The goal is to provide the operational weather prediction centers, NCEP, AFWA and FNMOC with options for near term advances in operational weather forecasting. Successful applicants will be offered up to one month of salary compensation, travel and per diem. The visitors are expected to visit with the DTC in Boulder, Colorado or Monterey, California for at least one month. Access to DTC computational resources will enable significant portions of the visitor's project to be conducted from their home institution.

1.0 The WRF Developmental Testbed Center (DTC)

The Weather Research and Forecasting (WRF) modeling program includes plans for the rapid and direct transfer of new research results into the operational numerical weather prediction (NWP) process of the National Weather Service (NWS) and other operational NWP centers. The WRF effort embodies the concept of the operational and research communities working jointly toward development of next generation NWP capabilities that will allow, as new techniques are developed in the research community, the most promising results to be rapidly and efficiently transferred to operations.

The DTC is a facility where the operational and research communities will work closely together in developing and testing the next generation numerical forecast systems. In the development process, researchers will be invited to work within the DTC with Center personnel and with members of the operational community to demonstrate the promise of new techniques in NWP. In the testing process, improvements in forecast accuracy of new modeling and data assimilation systems will be demonstrated prior to consideration for final testing within the operational centers. In addition, members of both the operational and research community will be able to evaluate the current operational models through retrospective analysis and diagnosis of their strengths and weaknesses. A key objective of the DTC is to offer to the research community an environment that is *functionally similar* to that used in operations to test and evaluate new NWP methods, without interfering with actual day-to-day operations of the operational centers.

The DTC is a distributed facility including components in Boulder, Colorado and at the Naval Research Laboratory in Monterey, California; the component in Boulder is referred to as the Boulder DTC and the component in Monterey, California is referred to as the NRL DTC. In addition, the Boulder DTC is composed of components at NOAA/FSL (FSL DTC) and NCAR (NCAR DTC). The visitor could be associated with any of the three components; those visiting Boulder would be primarily located at NCAR but would interact with DTC personnel at both NCAR and FSL. In addition, since a goal of the DTC is to transition research into operations, a visitor to the DTC could also be associated with any of the operational centers such as EMC at NCEP.

2.0 The WRF Code system

The WRF code systems will consist of three formal levels: Contributed Code, Reference Code, and Operational Code.

2.1 Contributed Code

Contributed Code will be the most informal class of code in the WRF system. The main requirements for inclusion in this category are that the code is compliant with the WRF coding infrastructure and that the technique addresses a potential operational weather forecast need. The codes authors will maintain these codes but the DTC will maintain lists of the contributed code. Visitors to the DTC could conduct tests to determine if a component of the contributed code should be elevated to reference code status.

2.2 Reference Code

This set of code will be the heart of the WRF system. Reference Code will consist of carefully selected tested codes that have the potential of elevation to operational status. This code will be fully maintained by the DTC and will be made available to the community. Users of the DTC will work primarily with the reference code.

The Reference Code will contain multiple cores, physics options, data assimilation and verification systems that may form the basis of the next generation of operational systems. Currently the Reference Code consists of two dynamical cores; the Non-Hydrostatic Mesoscale Model (NMM) and the Advanced Research WRF (ARW). There are two complete physics packages, one from NCEP that was designed to work with the NMM core and one from NCAR that is part of the ARW core. Each of these packages can be interchanged between the cores as can components of the packages. As other components of the reference code are added such as an additional core or an alternative or upgraded physics package, visitors would be encouraged to work with those components in addition to the components noted above.

2.3 Operational Codes

The Operational Codes are the fully hardened, fully tested codes that are being run operationally at the various operational centers. This level of code will be maintained by the Operational Testbed Centers (OTC) at the operational centers but made available to the community through the DTC. These Operational codes are a subset of the Reference code and, as such, are also candidates for Researchers' attention at the DTC. A goal of producing incremental upgrades to address weaknesses in existing Operational components will be viewed as a valid topic for DTC applicants.

3.0 How to Respond to this Announcement

In section 4.0, possible projects that are of interest to the DTC are outlined. These are general and proposals for participation in the visitor program should provide details on the specific work that the visitor would conduct with the DTC. This proposal should be described in a document no longer than 5 pages. The submitted material should include a summary of the project of no more than one page, a CV of no more than 2 pages, and a budget for no more than one month of salary for the PI and travel costs. As noted above, it is expected that the visitor will spend at least one month resident at one of the distributed DTC sites and that 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 to

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4.0 Possible Visitor Projects with the WRF DTC

This is a general announcement of an opportunity to work with the WRF DTC to test existing WRF-based NWP systems in order to assess where they are deficient, and new NWP technology that shows promise of improving numerical weather prediction within the next five years. This could include testing new physics parameterization components, optimizing physics packages, comparing dynamic cores, data assimilation systems, as well as the impact of resolution and the tradeoff of an ensemble verses a deterministic approach.

The DTC has outlined an annual plan that includes objectives that go beyond what the current DTC staff can accomplish. It is expected that DTC visitors will address some of these projects. Thus projects proposed by visitors that fall into any of the areas listed below will be given priority.

4.1 Physics Package Evaluation

A question that needs to be addressed in a systematic fashion is to determine the smallest resolution where convective parameterization needs to be called. Generally, as the resolution is increased at grid spacings below 10km, the model will call the convective parameterization routines less and less frequently as more of the convective processes become resolved. One way to identify this resolution would be to keep track of the calls to the parameterization and note if there is a resolution where this frequency falls off rapidly. A related secondary question would be, can the parameterization be left on regardless of the resolution and is there an advantage? This project would require a systematic exploration of scales where convection parameterization becomes of secondary importance including model configuration, and regional and seasonal dependencies.

A second project would be to carefully determine the configuration of the physics package for particular resolutions and for a particular WRF core to optimize various statistics used to verify the utility of the model as a forecasting tool. This project would also entail examining the influence of various model physical parameterization schemes on the ability to properly represent mesoscale circulation systems, as determined by comparison with the available observations.

4.2 Systematic evaluation of threshold model configuration for explicit convective systems

There is considerable evidence that when the model resolution is set at "cloud resolving scales", which is perhaps around 5 km (see the discussion under "physics package evaluation"), the development and evolution of convective systems is much more realistic, which can provide forecasters with useful information on forecasting convection out to at least 48 hours. This has been established for the summer. The experiment referred to as DWFE in section 4.5 is intended to determine whether there is a similar advantage in winter. The question is what is the minimum configuration of a model that would allow cloud-resolving resolutions to be run within existing or planned computing resources of the U.S. operational centers and major research laboratories within the next five years?

It would first be necessary to determine the grid spacing where the resolution becomes cloud resolving and then model run times can be adjusted by limiting the number of levels, the physics parameterizations used and the frequency of calls to the physics routines. The goal would then be to find a combination that retains a minimum skill for the NWP forecasts and minimizes the run time. Answers could be seasonally and regionally dependant, so a thorough search of such of the options will be required to optimize the design of an "affordable" cloud resolving forecast system.

The answers to this question are likely to transfer from the limited area models where cloud-resolving forecasts are currently possible to global models. It is likely that cloud resolving global models will be possible within several years, at least for lead times of a couple of days. How soon this can happen may depend on the answers to the questions noted above.

4.3 Verification Development

Verification of mesoscale predictions including precipitation has long been recognized as particularly challenging. Traditional skill scores like the Equitable Threat Score do not reflect the type of information available in high-resolution forecasts of precipitation that can be useful in forecasting. For this area of investigation, the DTC would encourage visitors to look at new verification options and use the data from DWFE for evaluation of the schemes. Emphasis would be on object oriented approaches or other proposals.

4.4 Evaluation of Rapid Refresh options

One of the main applications for the WRF is in the Rapid Refresh application, which will replace the current RUC.   There are a few outstanding issues in design of the WRF-RR, all of wide interest to the WRF community.

- Inter-comparison of ARW and NMM forecasts using RUC initial conditions. This specific task would require a preliminary report by October 2005.

- Testing of different mixed-phase cloud microphysics options, including Ferrier and Lin schemes and updated Reisner (matching at least Dec04 version in RUC model from NCAR/RAP).

- Testing of different cumulus parameterizations, including Grell/Devenyi scheme.

- Testing of NOAH and RUC land-surface models, both available as options in WRF V2.

To ensure that results are most compatible for the Rapid Refresh evaluation, it would be important to use RUC initial conditions, especially due to its treatment of cloud initialization and use of surface observations, and hourly assimilation. FSL and RAP/MMM scientists knowledgeable about relevant model issues would work with the visitor on these areas.

4.5 DTC Winter Forecast Experiment Evaluation (DWFE)

The 2004-5 DTC Winter Forecast Experiment will run for approximately four months and the forecasts will be archived for at least one year. The DTC would encourage university investigators to take advantage of this data set for case studies of winter systems with an emphasis on the forecast value of the high resolution. Other studies could look at the relative skill of the two models being run (NMM and ARW) and for development of verification methods (see above).

5.0 Proposal Evaluation Process

The proposals that result from this announcement are subject to both external and internal review. The external review would be conducted by the DTC Advisory Board, which consists of atmospheric scientists from government labs, operational centers, and academic institutions. The DTC Director in consultation with the DTC Executive Committee will make the final selections based on the review by the Advisory Board.