DTC Annual Operating Plan – FY 2010

1. Introduction

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 and validation 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. In FY 2010, the National Weather Service (NWS), the Office of Oceanic and Atmospheric Research (OAR), the Air Force Weather Agency (AFWA) and NCAR have collectively provided approximately $5M to support the activities of the DTC. This document provides a description of the tasks that will be carried out by the DTC in FY 2010, without differentiating the funding sources for each specific task. Most tasks are carried out jointly by JNT and GSD staff.

2. DTC Director's Office

The DTC Director's Office provides administrative and management support for all DTC activities. This support includes: (i) managing and coordinating all DTC tasks, (ii) conducting DTC workshops and tutorials, (iii) interacting with DTC partners (e.g., NOAA's National Centers for Environmental Prediction (NCEP) Environmental Modeling Center (EMC), the Mesoscale and Microscale Meteorology (MMM) division of the NCAR Earth System Laboratory (NESL), and AFWA) on collaborative efforts, (iv) creating and maintaining the DTC web site, and (v) providing administrative support for DTC management meetings. In addition to these basic support activities, the DTC Director's Office hosts the DTC Visitor Program. The following DTC staff are affiliated with the DTC Director's Office: Bill Kuo (Director – 0.50 FTE), Louisa Nance (Assistant Director – 0.50 FTE), Pam Johnson (Adminstrative Assistant and web support – 0.50 FTE), Barb Brown (JNT Director – 0.10 FTE), Steve Koch (GSD Director – 0.10 FTE), JNT DTC manager (TBD – 0.25 FTE), GSD DTC manager (TBD – 0.25 FTE), and Naomi Surgi (NCEP Liaison – 1.00 FTE funded directly by NCEP).

Managing and Coordinating DTC Tasks

Due to the distributed nature of the DTC, the coordination and oversight of DTC tasks requires more effort on the part of the management team. On the other hand, the benefits of having a

distributed facility (e.g., ability to maintain stronger connections to a broader intersection of the research community through daily interactions at two institutions rather than one, expanded access to computing resources, etc.) far exceed this slight increase in management overhead. This increase in overhead has also been reduced by establishing a structure where activities are managed in terms of tasks. Each task has an assigned lead responsible for developing the task work plan and ensuring the successful execution of the task. Hence, management's responsibilities are mainly related to coordinating the allocation of resources and staffing at the two nodes, collecting information from the task leads to produce planning and reporting documents, resolving staffing issues when conflicting deadlines arise, identifying commonalities among the tasks that need broader coordination, and longer term planning.

DTC Workshops and Tutorials

The DTC conducts or assists with several workshops and tutorials each year. These events provide venues for strengthening the DTC connection with the broader community. For FY 2010, the DTC will be involved in the annual WRF Users Workshop, DTC Verification Workshop, as well as the bi-annual basic WRF and MET Tutorials. New additions to the tutorial offerings for FY 2010 will be the WRF Tutorial for Hurricanes in February and the Gridpoint Statistical Interpolation (GSI) Data Assimilation (DA) System Tutorial in June. In concert with the WRF Tutorial for Hurricanes, the DTC will be involved in the EMC/MMM/DTC Joint Hurricane Science Workshop, also scheduled for February. And finally, the DTC plans to host a Technical Workshop on Mesoscale Probability Prediction to help define priorities for the DTC mesoscale Ensemble Testbed it will be establishing in FY 2010. More information on these events is provided in the relevant sections below. Management involvement in the planning and conducting of the on-going workshops and tutorials is generally fairly limited because the members of the relevant task team are responsible for these activities. On the other hand, the administrative staff is a critical part of this process.

Interacting with DTC Partners on collaborative efforts

Maintaining a strong connection with the DTC's collaborative partners is critical to the success of the DTC given its role of providing a bridge between the research and operational communities. Since the DTC is not involved in the development of new NWP capabilities and techniques, the DTC needs to maintain a close working relationship with the developers of the packages it is tasked with supporting to the community. The success of community code activities relies on a strong connection with these development groups. Testing and evaluation activities also need to be planned such that their results will be relevant to both the research and operational communities.

DTC Website

The DTC website is an important communications tool for sharing information about the DTC and its accomplishments. Prior to FY 2009, little time was dedicated to maintaining the information on this website other than adding new project pages when necessary. During FY 2009, the DTC website was redesigned to utilize more modern navigation tools and the information displayed on the site is being updated as staff time and resources permit. The DTC is making it a priority to complete this update process during FY 2010 and implement procedures geared toward keeping the information on the site current. Achieving the goal will require participation from all staff members with some direction from management.

DTC Visitor Program

The DTC Visitor Program supports visitors to work with the DTC to test new forecasting and verification techniques, models, model components, and data assimilation approaches for NWP. The goal is to provide the operational weather prediction centers (i.e., 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 technology. It also offers an opportunity for visitors to introduce new NWP and verification techniques into the community codes supported by the DTC that would be of particular interest to the research community. The DTC has strived to release an annual Announcement of Opportunity (AO) for scientists to submit proposals for projects to be funded through this program. The AO provides broad guidance on what types of projects would be of interest to the DTC, as well as a more detailed list of suggested areas. In the past, the funded projects were selected based upon recommendations from a panel consisting of representatives from the Weather Research and Forecasting (WRF) principle partners. Under the DTC Charter, proposals will be reviewed by a selection committee, which may contain members from the DTC Management Board, as well as the DTC Science Advisory Board. The DTC Management Board will provide recommendations on the overall direction and areas of emphasis for this program.

The DTC plans to distribute an AO for the DTC Visitor Program in FY 2010. Before distributing this AO, the DTC has decided to review the structure of the program and make adjustments that will increase the likelihood funded projects will have an impact on the NWP community that is beneficial to the DTC mission. In the past, successful applicants have been offered up to one month of salary compensation, travel and per diem. The visitors were expected to visit the DTC in Boulder, Colorado or one of the operational centers for a total of one month. Remote access to DTC computational resources enabled significant portions of the visitor's project to be conducted from their home institution. While a number of the projects funded under this structure were able to achieve the proposed goals, far more have fallen short of the intended mark. Feedback from the participants indicates that limiting salary compensation to one month is likely the source of this less than desirable success rate. Hence, the DTC plans to double the funding dedicated to supporting visitor projects by submitting a proposal to NSF for additional funding and increasing the NOAA funds set aside for the visitor projects. The DTC also plans to explore the possibility of reserving some of its visitor funds to support extended visits by graduate students working on a project relevant to the DTC mission.

Staffing Needs:

Software Engineers/System Administration – 0.10 FTE (Laurie Carson – 0.05, Terri Eads – 0.05)

3. Support for Community Systems

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 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

Preparations are underway at the DTC for releasing one additional software package to the community in FY 2010:

- 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 MMM.

3.1 *Weather Research and Forecasting (WRF)*

The DTC works in collaboration with MMM to maintain the WRF repository, including running tests on the repository code. Given the growth in the complexity of the WRF code and the number of available configuration options, the DTC and MMM will undertake the following tasks during FY 2010 to ensure appropriate testing procedures are being applied to the repository code: 1) the current weekly regression test will be updated to allow additional NMM configurations to be tested (similar to the current ARW configuration test suite), 2) additional testing will be performed on an as-needed basis (typically 2-3 month time frame) that will exercise longer forecasts, restarts, data assimilation and other capabilities not included in the weekly regression test, and 3) test cases included in both test environments will be reviewed to ensure meaningful cases are being exercised for both ARW and NMM. The additional testing performed by the DTC will include a baseline test for the NMM configuration used for the North American Mesoscale (NAM) model directed at monitoring the timing and quality of the forecasts produced by this configuration.

Major WRF releases occur annually in the March/April timeframe, with the possibility of a minor release (mainly to address bug fixes) later in the year. Prior to any public release, extensive pre-release testing on several platforms using multiple configurations of the code is conducted. Any bug fixes found during internal testing or brought to our attention by community users through wrfhelp correspondence are incorporated back into the WRF repository to ensure they are released with the next version of the code. Assistance is also provided to members of the DTC Visitor Program for inclusion of their new developments into the WRF repository.

The DTC works in collaboration with EMC to provide enhancements and bug fixes to the WRF Post Processor (WPP) code. This package provides the ability of computing a variety of diagnostic fields, as well as interpolating to pressure levels, destaggering grids, and interpolating to specified grids. These grid manipulations produce output that can be used directly by a number of plotting packages and MET. The current publicly available version of WPP is maintained under subversion (SVN) control at NCAR. All future code modifications will be checked into the WPP repository for inclusion in future releases of the code to the user community. Releases of WPP are typically, but not necessarily, concurrent with the annual WRF releases. During FY 2010, work will begin towards transitioning WPP to the Unified Post Processor (UPP) under development at EMC. The UPP, which is capable of post-processing output from a variety of NWP models, will be released to the user community in FY 2011, after it has been implemented operationally at NCEP for use with NCEP's Global Forecast System (GFS) and NAM. A number of groups have expressed an interest in the DTC establishing a

community code repository for the UPP that would allow new capabilities from the community to be added to this operational package. Hence, during FY 2010, the DTC will also undertake discussions with relevant groups geared towards establishing a code management plan for a community version of the UPP. This code management plan will put forth requirements for checking new code into the repository and testing procedures to ensure code integrity. A transition to UPP will also require assembling new documentation.

The DTC supports the WRF Nonhydrostatic Mesoscale Model (WRF-NMM) and WPP code to the community and answers email correspondence related to both the aforementioned codes through wrfhelp. Requests for DTC staff assistance via wrfhelp average about 40-50 inquiries per month. Relevant bug fixes are made available throughout the year on the WRF-NMM Users Page maintained by the DTC.

Several community outreach programs are hosted by MMM and the DTC in Boulder, CO each year, including an annual WRF User's Workshop and bi-annual WRF Tutorials. At the WRF User's Workshop, presentations are given on the use of WRF in both research and operational settings. The WRF Tutorials are an opportunity to teach participants how to run the WRF system (NWP model plus pre- and post-processing software). During these tutorials, participants benefit from lectures given by system experts and one-on-one assistance during the practical sessions. Documentation is available on the web and is updated prior to each tutorial and WRF public release.

Anticipated major accomplishments for FY 2010:

- New major release of WRF
- Bi-annual WRF tutorials
- Establish a code management plan for Community Unified Post Processor

Staffing Needs:

DTC Staff -

<u>Scientists</u> – 0.17 FTE (Jamie Wolff)

<u>Software Engineers</u> – 0.49 FTE (Laurie Carson – 0.10, Chris Harrop – 0.04, SEII – 0.35)

<u>Student Assistant</u> – 0.07 FTE

MMM staff -

<u>Scientists</u> – 0.55 FTE (Wei Wang – 0.25, Cindy Bruyere – 0.20, Jimy Dudhia - 0.10)

<u>Software Engineers</u> – 0.42 FTE (Dave Gill – 0.22, John Michalakes – 0.10, Michael Duda – 0.10)

3.2 WRF for Hurricanes

The DTC, in collaboration with MMM and EMC, plans to release WRF for Hurricanes to the community as part of the next major WRF release. Shortly before the code release, this collaborative effort will sponsor a Joint Hurricane Science Workshop, followed by the first WRF Tutorial for Hurricanes (February 2010). The intent of the two-day workshop, which will be open to all interested parties, is to provide the community with some perspective on the "why" and "how" the hurricane modeling systems that will serve as the basis of the tutorial were developed. The three-day tutorial, which will be limited to 40 participants, will consist of

lectures given by system experts from a variety of institutions and one-on-one assistance with running test cases during the practical sessions.

Once the WRF for Hurricanes capability has been released to the community, user support responsibilities will follow that used for WRF in general: MMM will be responsible for supporting the Advanced Hurricane WRF (AHW) capabilities, whereas the DTC will be responsible for supporting the Hurricane WRF (HWRF) system developed at EMC, which is currently composed of the Princeton Ocean Model (POM), the NCEP coupler, a modified version of the WRF-NMM dynamic core, physics packages for the tropics, and a vortex initialization package. Preparations for supporting WRF for Hurricanes to the community falls into two basic categories: code management and user support resources.

During FY 2010, the DTC and EMC will implement the HWRF Code Management Plan established in FY 2009, which calls for making HWRF a compile-time and run-time configuration of the current WRF software package. The atmospheric component of the operational HWRF is based on WRF version 2 with modifications by EMC, whereas the general WRF repository is currently under development for WRF version 3.2. Hence, achieving this goal requires adding the atmospheric capabilities of the 2009 operational HWRF to the general WRF repository. This work, which began in FY 2009, will be completed during FY 2010. It is important to note that while the WRF version 3.2 HWRF configuration will contain the same basic capabilities of the 2009 operational HWRF, the code will not be an exact match to the operational code due to the extensive evolution of the general WRF repository since WRF version 2 that was used for HWRF development. To keep up with EMC's development cycle, upgrades for the 2010 operational HWRF will also need to be the added to the general WRF repository once skill of the 2009 HWRF capabilities in WRF version 3.2 has been established. And finally, proposed upgrades for the 2011 operational HWRF will need to be added to the WRF repository to allow pre-implementation testing to be based on code from the general WRF repository. Hence, the 2011 operational HWRF will be the first opportunity for the code supported to the community to match that used in operations.

Maintaining the integrity of the overall code base for operations, while allowing the latest development of new capabilities and techniques to be added to the WRF repository, will require a hierarchy of tests to ensure the HWRF configuration is not unintentionally modified when WRF repository changes. These tests will include: a regression test to be run before and after HWRF capabilities are added to the repository, and a monthly comprehensive test to assure forecasts from HWRF configuration of the repository have not been inadvertently modified. Once the HWRF configuration in the WRF repository contains all the features of the current operational HWRF and the appropriate testing framework is in place, the DTC will be ready to work with developers from the research community to add new capabilities and techniques that show promise towards advancing hurricane prediction. Advances that will likely be candidates for checking into the WRF repository in the near future are: a third nest capability for the NMM that would enable high-resolution experiments and a number of physics package developments.

In addition to adding HWRF capabilities to the general WRF repository, code repositories will need to be established for the non-WRF components of the HWRF prediction system: POM, NCEP coupler, Vortex Initialization, and GFDL Vortex Tracker. These repositories will be established during FY 2010, for which their initial state will reflect the 2009 operational HWRF. Upgrades to these packages for the 2010 operational implementation and any new features under

consideration for the 2011 operational implementation will also need to be added to these code repositories to achieve the goal of supporting the operational codes to the community.

A number of user support resources need to be assembled before releasing code to the community. These resources include: scientific documentation, a users' guide, a website for posting information on the package and providing the capability to download the software, and an email helpdesk capability. Additional preparations necessary for the tutorial include: lecture materials, instructions for the practical sessions, and test cases for the student to practice running the model.

Anticipated major accomplishment for FY 2010:

- WRF Tutorial for Hurricanes (February 2010).

- Full support for users of WRF for Hurricanes (code availability, helpdesk, documentation, website).

- Maturity of the HWRF configuration in the general WRF code repository, such that it matches forecast skill of the operational HWRF used in the 2008 and 2009 seasons.

Staffing needs:

DTC Staff -

Scientists – 1.57 FTE (Ligia Bernardet – 0.25, Shaowu Bao – 0.80, Jamie Wolff – 0.02, PSI - 0.50)

Software Engineers – 1.00 FTE (Laurie Carson – 0.05, Christopher Harrop – 0.20, Donald Stark - 0.25, SEII - 0.5)

MMM Staff –

Software Engineers – 0.13 FTE (John Michalakes)

3.3   *Gridpoint Statistical Interpolation (GSI) Data Assimilation System*

For FY 2010, the DTC, in collaboration with EMC, GSD and MMM, will continue to provide support for the Gridpoint Statistical Interpolation (GSI) Data Assimilation (DA) system (coupled with WRF) to the user community and administrate the Boulder Community GSI code repository and code releases. These responsibilities encompass maintaining the code through oversight of the processes for source code modification, source code testing, and repository upkeep, as well as managing the preparation for and issuance of GSI community code releases.

Supporting and managing a community version of the GSI DA system that includes a diverse set of currently unfamiliar capabilities requires continuous coordination of code sharing between the various developers. The Boulder Community GSI Code Management Plan, initiated in FY 2009 will be maintained, updated and enhanced by the GSI developers, as necessary. This plan will be supplemented in terms of providing details on repository maintenance and release oversight. The DTC will work with GSI development groups to provide an administrative structure for the GSI repository, release and development to avoid conflict and duplication of the GSI codes. Based on past discussions with EMC, a GSI Review Committee will be necessary to oversee GSI code development, manage GSI coding and scientific standards, and authorize submitted code meeting these standards into the repository. The DTC will facilitate the formation of such a committee to provide guidance to the GSI support and development.

During FY 2010, the DTC will continue to maintain a Boulder Community GSI repository to store the GSI code under subversion control to accommodate community contributions as well as the operational capability. This repository will continue to be closely linked to the primary GSI repository at EMC, which is consistent with operational system resident at NCEP. The DTC will continue to port EMC GSI code updates to the Boulder repository on a regular basis (e.g., weekly) and work with EMC on code merging plans, with the consideration of more code development expected from Boulder GSI developers in the coming year.

The DTC will continue to work towards development of more sophisticated and generalized utilities, which are necessary to ensure the integrity of the GSI repository. This work will include: 1) enhancing the existing compilation scripts and regression tests, and 2) building utilities to make the GSI system easy to run, including sample run scripts and PrepBUFR converter sample code. Prior to any public release of the GSI code, the DTC will conduct pre-release testing on several platforms using multiple configurations of the code. The DTC works with developers as necessary to incorporate any bug fixes found during internal testing or brought to our attention by community users through GSI helpdesk correspondence back into the GSI repository.

A new version of GSI will be released in spring of 2010 that will include a number of EMC major updates as well as a four dimensional variational (4D-Var) framework. GSI outreach will continue to be an important aspect of this effort. User support will be provided through GSI-help. A three-day GSI tutorial will be held in Boulder in June 2010, for which lectures will be presented by a number of GSI and DA experts. GSI documentation is available on-line and will be updated as new information or issues arise. In addition, the community GSI effort will be publicized at appropriate meetings (e.g., AMS Annual Meeting and WRF Users Workshop).

The DTC will maintain a staff member resident at EMC in Maryland to encourage direct interactions with the developers in Maryland, while also staying closely connected with the developers at GSD and MMM located in Boulder, Colorado. This arrangement has been and will continue to be effective in facilitating the syncing of multiple development efforts and minimize the divergence of the software baselines between Maryland and Boulder.

Anticipated major accomplishments for FY 2010:

- Establish GSI Review Committee
- Conduct first GSI tutorial (June 2010)
- Release GSI community code v2.0 to the community (Spring 2010)

Staffing needs:

Scientists – 1.50 FTE (Xiang-Yu (Hans) Huang - 0.20, Hui Shao - 0.80, Ming Hu - 0.50)

Software Engineers – 0.50 FTE (Don Stark – 0.50)

3.4   Model Evaluation Tools (MET)

It is widely acknowledged in the NWP community that the traditional verification metrics that are applied to assess model skill (such as bias, root-mean-squared error, and mean absolute error) provide a useful but limited view of how well a model is performing. A number of tools (including object-based, scale separation, neighborhood, and field deformation approaches) are under development by the international verification community to cope with this dilemma, and to

provide more meaningful information about the performance of high-resolution models. As the premier, independent, organization responsible for evaluating new NWP techniques, the DTC requires state-of-the-art verification tools. To truly serve as a bridge between research and operations, the DTC needs to make traditional as well as state-of-the-art verification tools available to the NWP community. Hence, the DTC began assembling its Model Evaluation Tools (MET) package in the fall of 2006. This package includes standard verification approaches, as well as a number of more advanced approaches recently developed by the verification community. To maintain truly state-of-the-art verification tools, the DTC must engage the international verification community and continue to add new capabilities to MET.

3.4.1 MET Development

The MET software package is on an annual development/release schedule with the next major release (MET version 3.0) scheduled for spring of 2010. This release will contain several enhancements, as well as new capabilities to verify cloud forecasts and ensembles. Following the release of MET version 3.0, further enhancements to the new cloud and ensemble methods will be implemented. Some of the ensemble method enhancements will stem from utilities developed for the HMT-DTC collaboration. MET development in FY 2010 will also focus on better diagnostic methods for evaluating wind forecasts and the capability to examine forecast statistics through time.

In addition to advancing the core software of MET, the DTC will continue the development of a database and display system for MET output during FY 2010. Components of this database and display system will be applied to various DTC testing and evaluation activities during the development stage. A prototype system will be used for the Hazardous Weather Testbed (HWT) Spring Experiment 2010.

The DTC engages the international verification community in its development planning process through its Verification Advisory Group (VAG) and the annual DTC Verification Workshop. The VAG is a group of verification experts from both sponsoring agencies and the community that provides guidance and vision for MET. In particular, they decide what new verification methods should be incorporated into and thus made available to the modeling and verification communities. The VAG will meet several times during FY 2010. The annual DTC Verification Workshop brings together the MET developers with the verification, modeling, and user communities to discuss issues related verification methods. These discussions will also provide valuable input to the planning process for the 2011 release of MET.

Anticipated major accomplishments for FY 2010:

- Release MET v3.0 to community
- Hold annual DTC Verification Workshop
- Identify five important areas of verification methods research for short-to-mid term planning based on input from VAG, DTC Verification Workshop and general community input

Staffing needs:

Scientists – 0.25 FTE (Tressa Fowler - 0.20, Eric Gilleland- 0.05)

Software Engineers – 0.98 FTE (John Halley Gotway – 0.33, Randy Bullock – 0.30, Paul Oldenburg – 0.35)

3.4.2 MET User Support

Each new release of MET requires tasks that fall under the user support category: pre-release testing and updating the MET User's Guide to include information on new verification methods and tools included in the software. Periodic bug fixes are also made available, as necessary, throughout the year on the MET Users Page. A new SVN code repository was implemented in FY 2009 to streamline the development process and provide consistency with other DTC supported software. Enhancements and additions to the repository will continue through FY 2010.

Other on-going support tasks include providing assistance via the met_help email, bi-annual tutorials held in Boulder, CO, and an instructional session at the WRF Users Workshop. MET help receives about 25 emails each month from users seeking support for the MET software, particularly with compilation issues. User assistance is often provided on the same day. To improve tracking, sharing, and scalability of met_help for the future, the development team will implement the Request Tracker (RT) ticketing system. This implementation will be started in FY 2010. The tutorials teach participants how to run the MET software and understand verification methods. The DTC staff designs and gives all presentations and hands-on sessions. The practical session information from these tutorials is incorporated into the online tutorial as well. Thus, the online tutorial will be enhanced to include the cloud verification procedures and ensemble verification methods.

Anticipated major accomplishments for FY 2010:

- Bi-annual MET tutorials and an instructional session at the WRF Users Workshop
- Updated MET Users Guide and online tutorial
- Timely support via MET help

Staffing needs:

Scientists – 0.30 FTE (Tressa Fowler - 0.20, Tara Jensen - 0.05, Eric Gilleland- 0.05)

Software Engineers – 0.60 FTE (John Halley Gotway – 0.30, Paul Oldenburg – 0.15, Randy Bullock – 0.05, SEII – 0.10)

4. Test and Evaluation

Testing and evaluation undertaken by the developers of new NWP techniques from the research community is generally focused on case studies. Extensive testing and evaluation must be performed to ensure that these new techniques are indeed ready for operational consideration. Testing and evaluation by the DTC generally focuses on extended retrospective time periods. The cases selected for these retrospective tests encapsulate a broad range of weather regimes ranging from null, to weak and strong events. The exact periods chosen vary based on the type of phenomenon that is the focus of the test. Before testing begins, a design document is created in consultation with the developers, relevant area experts, and verification experts, detailing the specifications of the testing to be done. The DTC's evaluation of these retrospective forecasts includes standard verification techniques, as well as new verification techniques when appropriate. All verification statistics also undergo a statistical significance assessment when appropriate.

By conducting carefully controlled, rigorous testing, including the generation of objective verification statistics, the DTC is able to provide the operational community with guidance for

selecting new NWP technologies with potential value for operational implementation. DTC testing also provides the research community with baselines against which the impacts of new techniques can be evaluated. The statistical results may also aid researchers in selecting model configurations to use for their projects.

4.1 WRF

4.1.1 Reference Configurations (RCs)

The WRF model is a state-of-the-art NWP system that is highly configurable and suitable for a broad range of weather applications. With the numerous options available in the WRF end-to-end system, it is extremely difficult to test all possible option combinations. Thus, there is a need within the WRF community for widely publicized verification results from a variety of configurations that have been extensively tested and evaluated by either the DTC or a member of the WRF community in hopes of serving both the research and operational communities.

To fill this need, the DTC will implement the Reference Configuration (RC) concept in FY 2010. A DTC RC refers to a specific configuration from the WRF repository that has been extensively tested, documented, and the baseline data and statistical verification results made available to the community by the DTC. Configurations tested during the early part of FY 2010 (see New Testing Activities below) will be the first designated DTC RCs. Given numerous groups are still using earlier versions of WRF for their research, effort will also be made to designate previously tested configurations (but no later than two previous annual community releases) as DTC RCs in FY 2010 and publish these results to the community as well. The DTC's goal is to designate four RCs per year. The actual number of configurations tested during a given year will depend on the available resources. Previously designated RCs will be considered for retesting following each official annual WRF release. Since RCs are associated with a particular version of the code, retesting will lead to a new RC designation. Retesting provides an assessment to the user community of the code change impacts within the latest version of the code for particular configurations.

The DTC also recognizes extensive data sets are being produced by the WRF user community and these data sets may provide additional resources to leverage. In FY 2010, the DTC will encourage members of the university community to collaborate in the implementation of the Community Contributed Reference Configurations (CCRCs) concept in order to take advantage of these data sets and potentially create a more extensive collection of model verification results across a broader range of forecast applications.

Publicizing both concept definitions is key to making the WRF community aware of the efforts the DTC is undertaking to create a database of baseline results for specific configurations of the WRF model. Presenting information at appropriate scientific conferences and workshops on the first designated DTC RC will help us accomplish this objective. The RC webpage on the DTC website will continue to be updated throughout FY 2010 with the latest results from RC testing.

4.1.2 New Testing and Evaluation Activities

Early in FY 2010, the DTC will undertake an extensive retrospective test for two WRF-ARW configurations directed at assessing the performance of the Quasi-Normal Scale Elimination (QNSE) planetary boundary layer (PBL) and surface layer scheme, which was a new feature in WRF version 3.1. The baseline by which the performance of this scheme will be assessed is AFWA's Operational Configuration. The second configuration will be identical to the baseline

except the QNSE scheme will replace AFWA's current operational PBL and surface layer scheme. A final report will be written and delivered to AFWA detailing the individual performance of each configuration along with a direct comparison of the two configurations. Both configurations will be designated Reference Configurations (RCs) with the results distributed to the user community via the RC webpage on the DTC website. Results will also be presented at appropriate workshops or conferences. Both configurations will be retested following the release of WRF version 3.2 in the spring of 2010 to determine the impact of code upgrades and bug fixes that will be part of that official community release.

The second type of major retrospective test related to WRF that the DTC will undertake during FY 2010 is an evaluation of the precipitation forecasts from the operational North American Mesoscale (NAM) model, which is WRF based, and the Global Forecast System (GFS) model. The primary goal of this activity is to quantify the differences in precipitation forecasts produced by the two modeling systems, which vary significantly in horizontal resolution. In order to better associate precipitation differences with the different horizontal scales of the model itself, more advanced verification techniques, in addition to traditional methods, will be utilized. In particular, object-based verification (e.g. Method for Object-based Diagnostic Evaluation - MODE) and neighborhood verification methods (e.g. Fractional Skill Score - FSS) will be applied. Input for this evaluation system will be the operational NAM and GFS precipitation GRiB files and Stage IV precipitation files. A report summarizing the results of this test will be provided to EMC. This report will also be posted on the DTC website and the results will be presented at relevant upcoming workshops and conferences.

4.1.3   Prior Testing and Evaluation Activities

The DTC has conducted a number of major WRF retrospective tests since its inception in 2003 (i.e., WRF Rapid Refresh Core Test, Extended Core Test and WRF Rapid Refresh Vertical Levels Test). Each of these tests led to refinements in the DTC's methodology and tools for conducting retrospective tests and performing analysis of this type of controlled experiment. The remaining step is to publish results from these prior activities so the DTC can inform the community about its methodology, as well as the results of these controlled tests for earlier versions of the WRF model. When appropriate, configurations from these earlier tests will also be designated DTC RCs, which will require preparing materials to be posted on the DTC website.

Anticipated major accomplishments for FY 2010:

- Implement RC concept for WRF configurations tested during FY 2010 and selected configurations from prior testing activities.

- Reports for the testing activities conducted during FY 2010

- Manuscripts ready for submission for prior testing activities

Staffing needs:

Scientists – 1.58 FTE (Jamie Wolff – 0.68, Louisa Nance – 0.15, Ligia Bernardet – 0.15, Eric Gilleland – 0.10, Betsy Weatherhead – 0.10, ASI – 0.30, PSII – 0.10)

Software Engineers – 0.38 FTE (Laurie Carson – 0.02, John Halley Gotway – 0.12, Paul Oldenburg – 0.15, Christopher Harrop – 0.03, Lara Ziady – 0.06)

Student Assistant – 0.45 FTE

4.2   WRF for hurricanes

In FY 2009, the DTC facilitated, at the request of the Hurricane Forecast Improvement Project (HFIP), the High Resolution Hurricane (HRH) test with the primary goal of evaluating the effect of increasing horizontal resolution within a given model across a variety of storms with different intensity, location and structure. This extensive retrospective tropical cyclone test utilized retrospective forecasts submitted by six modeling groups rather than forecasts generated by DTC staff. The evaluation required assembling a new evaluation system that incorporated existing software provided by GFDL and the National Hurricane Center (NHC), as well as new tools developed by the DTC. The project report for this test was completed at the end of FY 2009. Preparing manuscripts for publication during FY 2010 will be important to communicating the methodology and results to the community.

During FY 2010, the DTC will perform comprehensive tests for HWRF with the objectives of assessing the skill of 1) the operational HWRF configuration in the general WRF repository and 2) alternative HWRF configurations based on promising advances for the 2011 EMC operational implementation and beyond. To assure the results of this testing are relevant to EMC, the DTC will assemble an HWRF testing and evaluation (T&E) infrastructure that will emulate the EMC testing environment. The HRH evaluation system will be an important component of this T&E infrastructure. In addition to using this infrastructure for in-house testing, the infrastructure will be made available to the hurricane community for its own testing of new capabilities and techniques. HFIP participants will likely be the first members of the hurricane community to benefit from this tool because the DTC will setup this infrastructure on the HFIP computing platform. Comprehensive tests of the operational HWRF configuration in the WRF repository will consist of a large number of cases (approximately 150 cases) to verify 2009 and 2010 HWRF configurations from the repository are producing results comparable to operational version. Results of these tests will constitute WRF RCs. Testing of promising new capabilities for operational implementation, which will give careful consideration to code management practices, will include three levels of testing:

- Preliminary T&E of proposed model upgrades, including diagnostics, to determine potential suitability for operations.
- Advanced T&E of proposed model upgrades, to assess cost/benefit ratio for operational implementation.
- Comprehensive T&E leading to recommendations for upgrades to be considered for transition to operational testing.

Most, if not all, of the new capabilities that will be tested by the DTC during FY 2010 and into FY2011, will likely stem from development funded by HFIP.

Anticipated major accomplishment for FY 2010:

- HWRF testing infrastructure on HFIP computing platform.
- HWRF Reference Configurations.
- Report on results from comprehensive HWRF tests.

Staffing needs:

Scientists – 2.30 FTE (Ligia Bernardet - 0.40, Shaowu Bao – 0.20, Louisa Nance – 0.10, PSI - 0.50, PSI - 1.00, Eric Gilleland - 0.10)

Software Engineers – 1.36 FTE (Christopher Harrop – 0.21, Donald Stark 0.15, SEII - 0.50, SEIII – 0.50)

4.3   GSI DA System

During FY 2010, the DTC will complete extended retrospective tests of GSI version 1.0 in applications relevant to AFWA. A report summarizing the test results and recommendations will be provided to AFWA. This report will also be posted on the DTC website so the NWP community will have access to the results. Following the completion of this test, the DTC will undertake testing GSI version 2.0. Prior to conducting the tests, the components of the end-to-end system, which include WPS, GSI, WRF-ARW, and MET, will be updated to their latest version available in the spring of 2010. Utilities to read and display output from GSI, WRF and MET will be developed in collaboration with other DTC tasks to improve the analysis process.

The configuration of the testing for GSI version 2.0 will be based on recommendations from the DTC GSI version 1.0 testing and evaluation report. The reference for GSI version 2.0 testing will be one extensive run of the WRF-ARW (standard no data assimilation or "NODA" run). Additional runs with a variety of WRF-ARW plus GSI configurations will be used to determine the capability and robustness of the ARW+GSI in regional applications, as well as the impact of a variety of data types (i.e., surface, sounding, radiance, and Global Positioning System radio occultation). In addition to these basic tests, a new ARW background error covariance (BE) will be computed from the ARW NODA runs and the impact of this new BE will be evaluated by generating an extensive run using the ARW regional BE once it is properly tuned. This particular testing and evaluation activity will not be completed until FY 2011, at which time reports will be made available to AFWA and the NWP community.

Anticipated major accomplishments for FY 2010:

- Final report summarizing the GSI v1.0 configuration testing and data impact studies.

Staffing Needs:

Scientists: 1.70 FTE (Hui Shao - 0.20, Kathryn Crosby - 1.00, ASII/ASIII-0.50).

5. HMT-DTC Collaboration

The Hydrometeorology Testbed (HMT) has the goal of accelerating the infusion of new technologies, models, and scientific results from the research community into daily forecasting operations of the National Weather Service (NWS) and it's River Forecast Centers (RFCs).   The DTC was selected by the HMT Management Council to explore the potential for a DTC and HMT collaboration in four areas of common interest: forecast verification, evaluation for ensemble forecasting, model physics, and data impact studies. A set of tasks that make use of current capabilities to provide meaningful verification information for HMT applications was undertaken in the first year (FY 2009) of this project. The MET verification package established by the DTC was refined and applied to address the goals for the project. The principal goal is to enhance forecast evaluation capabilities to meet additional DTC and HMT needs, many of which involve the HMT-West winter exercises.

During FY 2010, the DTC will add several new capabilities to the MET package involving ensemble and probabilistic forecast verification that are of high potential value to HMT and to

USWRP, assess the impact of observation choices on ensemble forecast verification, and complete diagnostic descriptions of high-resolution WRF model performance during the HMT-West winter exercise (December 2009 to March 2010) using MET results. These capabilities will be particularly focused on verification of extreme precipitation events, and will build on new MET utilities (installed as part of the 2009 efforts of this project) that allow application of verification methods in domains corresponding to River Forecast Centers. Specific objectives during this period include:

1) *Develop and assess prototype MODE-based spatial verification techniques to verify Eastern Pacific Atmospheric River events in near-real-time*

Generally responsible for cool season West Coast extreme precipitation events, Pacific Atmospheric Rivers (ARs) are eastward-propagating elongated fields of low-level moisture concentrated and propelled by the counter-rotational flow around extratropical cyclones and their associated high-pressure ridge systems. These streams of concentrated water vapor stand out in polar orbiting SSM/I microwave channel vertically-integrated water vapor (IWV) imagery. Current global models are capable of predicting the arrival of an AR several days in advance. It remains important to validate the forecasts of ARs against observations, with the goal of improving forecast quality through quantification of the errors involved, determination of any consistent model biases, and as feedback to the modeling process. Because ARs have characteristic, relatively stable, and continuous shapes they are good candidates for object analysis. The Method for Object-based Diagnostic Evaluation (MODE) tool in the MET package represents a good starting point for application and development of such an effort. GFS global forecasts verified with composite SSM/I and other satellite products will constitute the long-range, large context verification components. At smaller time and space scales in the impact zone of the Western United States coastal mountains, higher-resolution WRF model quantitative precipitation forecasts (QPF) will be verified for individual case study days during heavy rainfall events and for the field period as a whole.

2) *Install and demonstrate a real-time and retrospective QPF verification system based on MET for the HMT-West winter exercise*

For the HMT-West experiments, QPF verification has been among the most vital objectives. For the last several years, the HMT has provided experimental high-resolution hybrid ensemble forecast systems (time-lagged and mixed microphysics members of the ARW and NMM cores of the WRF model) and new observing systems (including GPS sites and movable research radars) in an effort to establish new abilities for timely forecasts within watersheds in this region. To assess the performance of these models in their prediction of precipitation, and to compare with other existing forecast systems, real-time and retrospective verification is needed. The extreme terrain and strongly varying climatic regions within the model domains further require that verification data be closely monitored for accuracy and adaptability, and that a variety of domain selection and scoring be available. The MET package has the ability to meet these needs, with the additional advantage of a strong focus on assessment of scoring uncertainty. For this year's exercise, a real-time QPF verification system based on MET will be installed that will be suitable for later adaptation to other relevant variables. Part of this installation will include web-based interactive displays of verification products.

3) *Addition of new ensemble-based probabilistic techniques to the MET*

Some probabilistic verification procedures are currently available in MET, including the Brier Score and Relative Operating Characteristic (ROC) curves. However, additional scores, such as the rank probability score (RPS) and the cumulative rank probability score (CRPS) would be very helpful. Given much of probabilistic verification is dependent on ensemble forecasts, the ability to compute basic ensemble parameters, such as ensemble mean and spread, will also be added. This new set of utilities will be developed and their use demonstrated for QPF verification during the HMT-West winter exercise. The development of object-based techniques that incorporate spatial verification of ensemble forecasts, a new arena for MET utilities, will also begin in FY 2010.

Anticipated major accomplishments for FY 2010:

- Add the capability to compute new ensemble-based probabilistic methods including the RPS and CRPS to MET for QPF and PQPF verification and apply to HMT-West experimental ensemble forecasts.

- Perform diagnostic experiments to assess the impact of verification dataset choices on verification results.

- Report on initial set of ensemble spatial verification techniques.

Staffing needs:

Scientists: 1.04 FTE (Ed Tollerud – 0.25, Tara Jensen – 0.35, Matt Pocernich - 0.12, Huiling Yuan – 0.10, Tressa Fowler – 0.10, Barb Brown – 0.04, PSII – 0.05, Paul Schultz – 0.03)

Software Engineers: 0.49 FTE (John Halley Gotway – 0.20, Paul Oldenburg – 0.20, Randy Bullock – 0.07, Chris Harrop – 0.02)

6. HWT-DTC Collaboration

The DTC has been asked to participate in the NOAA Hazardous Weather Testbed (HWT) Spring Experiment (SE) 2010. The three general goals of the DTC participation are to: 1) provide objective evaluation of the experimental forecasts; 2) supplement subjective performance assessments by comparing to DTC's objective evaluation; and 3) expose the forecasters and researchers to both new and traditional approaches for evaluating forecasts. A meeting held in September 2009 provided guidance for the DTC-HWT collaboration in 2010. During this meeting, organizing members of the HWT, modeling participants and DTC staff discussed HWT SE objectives in detail.

The FY 2010 objectives for the DTC's participation in the SE 2010 are:

1) Continue to provide a real-time objective evaluation system.

The system developed for SE 2009 will be upgraded for SE 2010 to include improvements and developments stemming from other collaboration projects within the DTC during the off-season. The fields to be evaluated will be determined by HWT once plans are finalized in March 2010. The underlying system for retrieving files, cataloguing the metadata, running MET, and pre-generating graphics will either reside on one of the supercomputers the DTC uses or will be adapted to run efficiently on a Linux workstation. The graphics generated by these processes will be made available through an improved interface on the DTC website.

2) Expand evaluation system to include new ensemble evaluation methods available in MET.

A number of experimental WRF configurations based on both the ARW and NMM dynamic cores and a variety of physic package combinations will be run in real-time for SE 2010. For SE 2009, the DTC provided real-time evaluation for two members of the Center for Analysis and Prediction of Storms (CAPS) Storm Scale Ensemble Forecast (SSEF) and the NOAA High Resolution Rapid Refresh (HRRR) model (3-km ARW).   For SE 2010, the evaluation will be expanded to include the entire 20-member 4-km CAPS SSEF. Time and resources permitting, the DTC will also evaluate several of the other available deterministic models, which include: AFWA 4-km ARW, National Severe Storms Laboratory (NSSL) 4-km ARW, EMC 4-km NMM, and MMM 3-km ARW. Evaluation of the AFWA, NSSL, and EMC contributions would provide model physics comparisons with the CAPS ensemble members, whereas the MMM contribution would provide a model physics comparison with the HRRR forecasts.

3) *Extend the METviewer database and display system to allow interactive detailed investigations for HWT thematic research.*

The MET community, as well as the DTC's testing and evaluation team, have expressed the need for a tool that places MET data in a database and allows the database to be queried interactively to better understand the verification results. This tool, called METviewer, was prototyped for the SE 2009 and will be augmented by other DTC projects during FY 2010 (including MET development, Reference Configuration testing and HMT activities). METview will be generalized for SE 2010 by building upon the capability developed for the HMT nine-member ensemble to include interactive analysis and plotting for all members of an ensemble. The tool will also be enhanced to handle plotting some cloud and aviation related fields. Backward compatibility for MET data generated during SE 2009 will also be included. Finally, the METviewer tool will be installed on an HWT computer to allow for friendly beta-testing by HWT scientists.

4) *Adapt real-time evaluation system for retrospective forecasts and demonstrate the utility using a SE 2009 participating model.*

During the September 2009 DTC-HWT meeting, the participants expressed a clear need to perform retrospective testing and evaluation of participating models. The intended purpose of these tests is to provide tangible feedback to the modelers to help with improving their modeling systems before the next SE. The real-time evaluation system will be adapted to perform evaluation of model grids generated, but not evaluated, during previous SEs. The METviewer tool will be tied into this retrospective system for more in-depth analysis of model performance. The retrospective system will be tested on deterministic contributions from one or two of the SE 2009 participating models (NSSL, EMC, AFWA, and NCAR) or additional CAPS ensemble members. More retrospective evaluation will be performed as resources allow.

5) *Continue Education and Outreach Activities*

To increase the effectiveness of this MET demonstration, a DTC meteorologist or statistician will be onsite at the HWT during each week of the SE 2010. In addition to participating in the actual experiment, DTC staff will perform an analysis of the objective verification data directed at the evaluation objectives identified by the HWT. Results of the objective evaluation will be presented at relevant conferences and workshops.

Anticipated major accomplishments for FY 2010:

- Real-time evaluation of entire CAPS ensemble and several deterministic models during SE 2010 and retrospective evaluation of selected grids from SE 2009.

- METviewer available for thematic research and SE 2011 planning.

- Report on the analysis of the objective verification data from SE 2009 and 2010 and how these results compare with subjective model performance assessments.

Staffing needs:

Scientists: 0.54 FTE (Tara Jensen – 0.25, Jamie Wolff – 0.03, Barb Brown – 0.03, PSII – 0.03, ASI – 0.20)

Software engineers: 0.32 FTE (Paul Oldenburg – 0.15, John Halley Gotway – 0.05, new SE II – 0.10, Lara Ziady – 0.02)

Student Assistant: 0.15 FTE

7. New Areas

7.1 DTC Ensemble Testbed (DET)

As operational centers move towards ensemble-based probabilistic forecasting, it will be important for the DTC to expand its efforts into this area in order to continue to serve as a bridge between research and operations. Hence, the DTC will be investing a substantial portion of its increment in NOAA funding for FY 2010 towards establishing the DTC Ensemble Testbed (DET). The goal of this testbed is to:

- Provide an environment in which extensive testing and evaluation of ensemble-related techniques developed by the NWP community can be conducted such that the results are immediately relevant to the operational centers (e.g., NCEP/EMC and AFWA).

As with all areas the DTC is currently involved in, DET activities will involve maintaining and supporting community codes, as well as conducting extensive testing and evaluation of promising new capabilities and techniques that have been incorporated into these community codes. The community codes the DTC already supports will serve as building blocks for the end-to-end ensemble testing and evaluation system assembled by the DET. To keep the results of DET testing relevant to the operational centers, it will be important to include key components and methodologies from the current operational systems, as well as elements targeted for implementation in the near future. Including elements targeted for operational implementation will ensure the DET ensemble system does not lag behind the operational capabilities, which will allow the DTC to contribute to operational upgrade decision early on. To truly act as a bridge between research and operations, it will also be important to define a process for adding promising new developments from the research community as options to the appropriate component of this ensemble system, including a mechanism that allows the community to provide input. Hence, the DTC plans to engage the WRF ensemble modeling working group (EMWG) in FY 2010 for DET planning activities. The WRF EMWG includes representatives with ensemble expertise from both the research and operational communities, and will provide valuable guidance and advices on the development and operation of DET. In addition, the DTC plans to host a technical workshop (or meeting) on mesoscale probabilistic prediction. This workshop will provide a forum for the community to discuss what testing the DET should

undertake that would provide the most useful information to the research and operational components of the NWP community.

Given the DET testing and evaluation system needs to facilitate testing and evaluation of competing techniques and capabilities for specific components of the ensemble system, the DET infrastructure will be modular. In order to keep the testing and evaluation results of new ensemble capabilities developed by the research community relevant to operational upgrade decisions, the DET modules will need to be configured such that they are able to replicate the algorithms used operationally at NCEP and AFWA. Modules to be included in the infrastructure are:

- *Ensemble configuration*: Defines membership and horizontal/vertical resolution of members, such that different models and/or different configurations of the same model can be included

- *Initial perturbations*: Provides the ability to represent uncertainty in initial conditions based on a variety of techniques.

- *Model perturbations*: Provides the ability to represent model-related uncertainty based on a variety of techniques.

- *Statistical post-processing*: Provides ability to specify techniques for fusing information from ensemble and high resolution control forecasts, climatology, and other sources such as the latest set of observations; Bias correct / calibrate forecast distribution; Statistically downscale information to user relevant variables

- *Product generation*: Provides ability to specify technique for deriving information from the ensemble, generating probabilistic products, providing decision support services, etc

- *Verification*: Provides the ability to specify techniques to be used to evaluate ensemble and derived probabilistic forecasts

To meet the needs of the DTC, which uses multiple computing platforms to perform its testing and evaluation, as well as the needs of the community, portability of the software will also be important. Given NCEP will be moving to the NOAA Environmental Modeling System (NEMS) in the near future, the design of the DET infrastructure will also need to take this software framework into consideration. Hence, the first step in this process will be to document the software design requirements for the DET infrastructure. Once these requirements are defined, available software packages will be reviewed to determine what if any pieces would make sense to incorporate into the modules or general infrastructure. For instance, MET is a community verification package that already includes some ensemble and probabilistic verification capabilities, so it would make sense to focus on expanding MET capabilities by incorporating additional capabilities from the community, rather than starting from scratch. In FY 2010, the DET plans to complete the design for all modules and make significant progress in establishing the first two modules (ensemble configuration and initial perturbation).

Establishing a fully functional end-to-end ensemble testing and evaluation system will take time. And yet, there is an immediate need to make progress toward determining which techniques should be used to upgrade current operational ensemble systems. Hence, the DET also plans to engage ensemble-related testing and evaluation activities associated with other testbeds and programs, such as the HMT, HWT, and HFIP. DET will work with leaders of HMT, HWT and

HFIP to identify ensemble forecast needs for these testbeds, particularly in the area of ensemble methods and performance measures. These interactions will allow DET to develop a stronger connection with these testbeds. The experimental forecasts generated by these groups provide valuable datasets that can be used to perform ensemble evaluations while the DET is in the process of assembling all the components of its testing and evaluation system. During FY 2010, the DET will design formal procedures for testing and evaluation of ensemble techniques and apply these procedures to the evaluation of at least one of these existing datasets.

Anticipated major accomplishments for FY 2010:

- Engage the WRF ensemble modeling working group in DET planning activities, including the organization of a technical workshop/meeting on mesoscale probabilistic prediction.

- Define DET infrastructure requirements, review existing tools and software packages for suitability for incorporation, design ensemble modules, and define priorities for module development.

- Complete basic development of two modules, including preliminary testing to assure functionality and portability.

- Establish formal test and evaluation protocol for DET and demonstrate by applying to an available ensemble data set.

- Written plan developed in collaboration with HMT, HWT, and HFIP describing interactions between DET and other testbeds: How DET will need to be configured so it can support applications in various areas (advice to DET from other testbeds), and what ensemble forecasting and technique development DET will offer for various application areas (DET support of other testbeds). We will focus on the development of such plan for DTC-HMT collaboration for year one, and expand it to other testbeds in future years.

Staffing needs:

Scientists – 1.95 FTE (Barb Brown – 0.10, Tara Jensen – 0.10, PSII – 0.25, PSII – 0.75, PSI – 0.75)

Software Engineers – 1.05 FTE (SEII – 0.25, SEIII- 0.50, SEIII – 0.30)

7.2   NOAA Environmental Modeling System (NEMS)

A fundamental purpose of the DTC is to facilitate operational and research collaborations with the goal of accelerating the transfer of new science and technology from research into operations. To facilitate these collaborations, the DTC provides operational capabilities, as well as state-of-the art developments from the research community to the NWP community through its code management and user support for numerous community code packages. As NCEP and NOAA begin to transition their operations to the NOAA Environmental Modeling System (NEMS), the DTC will need to develop expertise with the NEMS software and the science associated with the NEMS-based models, so it will be prepared to add this new capability to the packages it supports to the research community.

During FY2010, the DTC will begin defining the building blocks necessary to add the NOAA Environmental Modeling System (NEMS) to the suite of NWP code it supports for the NWP community. The DTC will support a NEMS system to the community that includes the

contributed capabilities from all NEMS developers. Supporting and managing a version of the NEMS system that includes a diverse set of currently unfamiliar capabilities will require a plan for coordinating the sharing and development of code between the various developers. During this funding cycle, the DTC will begin work with the developer groups to define a role for the DTC as the focal point for community support. Expertise will be developed within the DTC staff, to participate and assist in the development efforts with the goal of community software in future years. As a starting point for this process, one DTC staff will be assigned to work at EMC in Camp Spring to collaborate with EMC on the development of NMM-B in the NEMS framework. This collaboration will allow DTC staff to gain expertise on the NEMS-NMMB, which will be one of the community systems supported by DTC in the future, while also providing a community perspective to the development process.

In addition to working directly with EMC, the DTC will host a working group meeting to discuss issues and plans for future community software support. Important topics that will need to be addressed in this planning process are: 1) DTC adoption of the NEMS-based software infrastructure for NEMS-based packages, 2) timing milestones to grow sufficient skill sets to support, 3) resource requirements necessary for overlap between WRF- and NEMS-based support to the community and 4) maintaining a connection with the broad research community.

Anticipated major accomplishments for FY10:

- Define DTC NEMS community software goals and timeline
- Develop DTC expertise in NEMS software
- Establish DTC NEMS operations to research (O2R) transition plan

Staffing needs:

Scientists – 0.1 FTE (Jamie Wolff – 0.10)

Software Engineers – 0.75 FTE (SEIII – 0.50, Don Stark – 0.10, Laurie Carson – 0.15)