1. MODEL DEVELOPMENT AND ENHANCEMENT RESEARCH TEAM (#5) TECHNICAL DIRECTION (ESRL) FY 2009

General Instructions:

1. A detailed quarterly Progress Report will be submitted by the 15th of October 2008 and January, April, and July 2009 describing efforts performed in support of all Advanced Weather Radar Techniques Research Team (MDERT) tasked activities. A high level Monthly Progress Report will be submitted by the 15th of November and December 2008 and February, March, May, June, August, and September 2009 summarizing MDERT efforts towards goals and milestones, and include its financial status report.

Quarterly Progress Reports must contain efforts **by activity** presented as follows:

a. Current Efforts (quarter just completed)
b. Planned Efforts (for next reporting period)
c. Problems/Issues/Schedule Changes Encountered or Anticipated
d. Interface with other organizations (other than Core RT member organizations)
e. Summary of funding status, planned versus actual expenditures

Monthly Progress Reports must contain a high level summary (about one page in length) of **overall MDERT activities** presented as follows:

a. Current Efforts (month just completed)
b. Planned Efforts (for next reporting period)
c. Problems/Issues/Schedule Changes Encountered or Anticipated

2. The MDERT Plan must be updated and delivered to the Program Manager to include activity planning for the seven year period from FY 2010 through FY 2016 **no later** than April 1, 2009.

3. Program Overview Meetings (POMs) will be conducted per the agenda to be supplied by the Program Office prior to the scheduled review.

4. All deliverables, technical reports, documentation to industry, press releases, and briefings must be reviewed and approved by the Program Manager (PM), or designee, **prior** to **External** distribution. Approval must be received from the PM or designee **prior to** exhibiting at conferences, symposiums, etc. The following statement shall be included in all research papers, journal articles, documents, announcements, etc.:

> *"This research is in response to requirements and funding by the Federal Aviation Administration (FAA). The views expressed are those of the authors and do not necessarily represent the official policy or position of the FAA."*

5. In tasks specifically stating "as authorized by the Program Office", authorization must be received in writing from the Program Manager, or designee.

6. The MDERT must not contact any FAA regional, headquarters, or air traffic control facility, in writing or orally, without first notifying the Program Office for approval.

7. Copies of all monthly and quarterly Progress Reports, technical papers, etc., must be submitted electronically to awrp@avmet.com

8. Costs not to exceed $1,735,000 must be expended in performance of the specific tasks of

this Technical Direction.

9. Any funding identified as contingent funding may be funded if the indicated conditions are reached; as with all funding decisions, contingencies will be subject to Program Office consideration reflecting evolving priorities.

10. Although it is intended that funding allocated per fiscal year be expended within that specific fiscal year, consideration will be taken for tasks not completed due to unforeseen circumstances. Upon receipt of written notification from the Program Office, funding for uncompleted tasks will be carried over to the next fiscal year.

11. The MDERT must notify the FAA CO and their respective COTR, via e-mail, whenever a lab individually have reason to believe that the costs they expect to incur in the next 60 days, when added to all costs previously incurred in FY09, will exceed 80 percent of the amount allocated to them for MDERT tasking. ESRL must also indicate whether exceeding the 80 percent level is a positive or negative variance based on their budget plan.

12. All travel must be approved in writing in advance by the COTR.

FY09 Specific Tasking for MDERT (ESRL, NCEP, NCAR, NSSL)

09.5.1 Infrastructure Support Related to Operational Running of the non-WRF Rapid Update Cycle System in NCEP Operations ($65K to NCEP; $120K to ESRL)

This task assures the reliable and timely running of the RUC modeling system in the NCEP Operational Suite and providing output grids state-of-the-atmosphere (SAV) and aviation hazard products (AHP) to aviation users. RUC together with NAM constitute the principal guidance tools for aviation users that are supported by the AWRP and feed into the Aviation Digital Data Service (ADDS) at the Aviation Weather Center as well. NCEP/EMC performs all tasks necessary for transitioning RUC changes (fixes/upgrades) submitted by ESRL to NCEP Central Operations (NCO) for implementation into NCEP's Production Suite (a.k.a. Operations). This includes code compilation/debugging/optimization, scripting, and testing. Testing includes both real-time parallel testing as well as retrospective parallel testing. Parallel test results will be verified and summarized for briefing to NCEP management.

09.5.1.1 Maintain hourly RUC runs and provide grids of SAV and AHP guidance products.

09.5.1.2 Provide vendors with gridded model data via Family of Services and the FAA Bulk Weather Data Telecommunications Gateway.

09.5.1.3 Provide full grids from RUC runs on NCEP and NWS/OPS servers.

09.5.1.4 Maintain access to model verification data.
09.5.1.5 Working with NCEP/NCO and NCEP/EMC, complete the design, compilation, debugging, test runs and parallel testing of RUC codes on new CCS computer. (Joint NCEP and ESRL tasks)

09.5.1E1 (on-going) Perform ingest, quality control and preparation of both existing and new observations in support of the operational RUC runs. (Joint NCEP and ESRL task)

09.5.1E2 (on-going) Perform configuration management for RUC, including thorough documentation, and respond promptly to any code malfunctions or performance issues. (Joint NCEP and ESRL task)

09.5.1E3 (on-going) Monitor RUC performance, respond to any problems detected by ESRL, NCEP, or any RUC users, diagnose cause, develop solution to RUC software, test changes and coordinate with NCO on implementation. (Joint NCEP and ESRL task)

09.5.17 Infrastructure support for operational running of WRF-based modeling system in North American Mesoscale and HiResWindow at NCEP ($95K to NCEP)

This task has a high priority to assure uninterrupted running of the models, continued availability of model datasets at highest resolution and smooth incorporation of

incremental enhancements to the systems (configuration management). This operational WRF infrastructure support covers NAM and HiResWindow.

09.5.17.1 Maintain four-per-day North American Mesoscale runs and provide SAV and AHP guidance. (NCEP Task)

09.5.17.2 Maintain four-per-day HiResWindow runs and provide SAV and AHP guidance. (NCEP Task)

09.5.17.3 Provide vendors with gridded model data via Family of Services and the FAA Bulk Weather Data Telecommunications Gateway. (NCEP Task)

09.5.17.4 Provide full grids from NAM, and HiResWindow on NCEP and NWS/OPS servers. Maintain access to model verification data. (NCEP Task)

09.5.17.5 Working with NCO, complete the design, compilation, debugging, test runs and parallel testing of RR, NAM and HiResWindow (and SREF) codes on new CCS computer. (NCEP Task)

09.5.17E1 (on-going) Perform ingest, quality control and preparation of both existing and new observations in support of the operational WRF runs. (NCEP Task)

09.5.17E2 (on-going) As requested by other RTs, incorporate new AHP calculations into Operational WRF Model post-processor and product generator. (NCEP Task)

09.5.4 Develop, test, and implement the Rapid Refresh ($35K to NCEP, $170K to ESRL; $40K to NCAR)

The effort in FY 2009 for the Rapid Refresh will focus on extensive testing at NCEP and ESRL of the Rapid Refresh (RR) replacing the RUC assimilation/model system. The transition from the RUC to the RR will be evolutionary, not revolutionary, by using model physics and assimilation techniques in the RR similar to those in the RUC that have proven beneficial to aviation weather forecasting.

09.5.4.1 Ongoing evaluation of performance of real-time and retrospective runs of RR system for SAVs, AHPs. (Joint ESRL and NCEP task)

09.5.4.2 Nov ’08: Continue to solicit input from Inflight Icing, Turbulence, National Ceiling/Visibility, and Convective Weather RTs and NWS forecasters in Alaska and Puerto Rico on performance of pre-implementation Rapid Refresh. Arrange to have ESRL RR grids available to examine and solicit feedback on RR performance. (Joint ESRL and NCEP task)

9.5.4.3 May ’09: Updated report on status of tactical planning for making RR-WRF ARW model code for 2012 in compliance with Earth System Modeling Framework (ESMF) in agreement with the Sept 2007 Rapid Refresh MOU between NCEP and ESRL. (Joint ESRL, NCEP, and NCAR task)

09.5.4.4 Sep ’09: Complete pre-JIF evaluation of Rapid Refresh in accordance with NCEP pre-implementation checklist for major implementations. Respond to evaluation questions, present information on Rapid Refresh pre-implementation testing and evaluation results in various forums, as required. (Joint ESRL and NCEP task)

09.5.4.6 Sep ’09: Pending EMC, and NCEP Center initial recommendations, Job Implementation Forms (JIFs) are filed to submit Rapid Refresh software to NCO. (Joint ESRL and NCEP task)

09.5.4E1 Dec ’08: Report on Rapid Refresh testing at annual NCEP Production Suite Review meeting. (ESRL task)
09.5.4E2 Sep ’09: Complete documentation (in Technical Procedures Bulletin-like document) of Rapid Refresh system. (Joint ESRL and NCEP task)
09.5.4E3 Sep ’09: Pending EMC, and NCEP Center initial recommendations, Job Implementation Forms (JIFs) are filed to submit Rapid Refresh software to NCO. (Joint ESRL and NCEP task)

09.5.5 Develop, test, and implement improvements to the operational 3DVARs for Rapid Refresh and North American Mesoscale runs ($120K to NCEP, $170K to ESRL; $40K to OU)

The Gridpoint Statistical Interpolation (GSI) package is currently used for the North American Model (NAM) and has been selected for use with the Rapid Refresh (scheduled to replace the RUC in 2010). This task provides the necessary continued development for the 3DVAR-based GSI analysis capability, the critical analysis component of data assimilation, for implementation and improvement in both the Rapid Refresh and North American Mesoscale components of the NCEP operational run suite. In FY 2009, ESRL and NCEP will continue development of the GSI assimilation system. The major objective for ESRL in FY09 will be to finalize adaptations of RUC-specific analysis components to the GSI framework to create a Rapid-Refresh specific GSI suitable for use with 1-h cycling with surface and other observation types. Specific RUC capabilities include 1) cloud/hydrometeor analysis for stratiform clouds and parameterized convective clouds including use of METAR cloud/weather/visibility information and NESDIS cloud top pressure data (see also task 5.15), 2) use of surface observations including specification of appropriate horizontal and vertical correlation length scales, and 3) appropriate balancing for the RR mesoscale 1-h cycling application yielding forecast improvement down to 1-h lead time.

09.5.5.1 Dec ’08: Report on testing of 2DVAR GSI assimilation of high spatial and temporal mesonet surface data using analysis grids with 5-km or finer resolution. (Joint ESRL and NCEP task)

09.5.5.2 Dec ’08: Establish hourly cycled NAM assimilation system on NOAA R&D computer at NCEP (machine called “haze”) using GSI and WRF-NMM to be adapted to ARW-based RR by ESRL. (NCEP task)

09.5.5.3 Jan ’09: Testing of and refinement to the radial velocity analysis component of

GSI for Repid Refresh configuration, together with the cloud analysis. (Joint ESRL and OU task)

09.5.5.4 9 Feb ’09: Report on preliminary statistical evaluation of Rapid Refresh forecasts initialized with the GSI, including examination of upper-level winds, surface fields, and precipitation. (ESRL task)

09.5.5.5 Jul ’09: Based on case-study testing and refinement of the research quality code, deliver result in an ‘experimental’ code for an upgrade package (e.g. strong constraint, improved satellite channel bias correction, improved use of WSR-88D radial wind and/or satellite radiances and/or retuned covariances to the GSI for FY2009 change package to the NAM. **(**NCEP task)

09.5.5E1 Mar ’09: Subject to NCEP Director approval implement upgrades (e.g., partial cycling, TAMDAR) to GSI used in NAM/NDAS. (NCEP task)

09.5.5E2 Sep ’09: Pending EMC, and NCEP Center initial recommendations, Job Implementation Forms (JIFs) are filed to submit GSI code as part of Rapid Refresh software to NCO. (Joint ESRL and NCEP task)

09.5.5E3 Sep ’09: Finalize enhancement package for radial velocity data analysis to begin testing at ESRL toward future implementation for Rapid Refresh. (Joint ESRL and NSSL task)

09.5.8 Improve physics in the WRF model, especially that bearing on prediction of aircraft icing ($60K to NCAR; $60K to ESRL)

The activities at NCEP will be toward improving the physics and their nonlinear interactions with dynamics, particularly at higher resolution, as more of the details of mesoscale circulations are explicitly resolved. In FY2009, the possibility of explicitly advecting each hydrometeor category will be examined in explicit, high-resolution (4-5 km) runs where no parameterized convection is called, together with evaluating new microphysics packages now available in the WRF NMM. In FY2009, this will become an area of active development as EMC prepares to run the NAM as a nested model in FY2010, where the inner nests will be run at sufficiently high resolution, 4 km, to eliminate the need for using parameterized convection.

09.5.8.1 Jul ’09: Complete systematic ESRL evaluation of physics performance in ESRL 1-hour RR cycles for initial RR implementation. (ESRL task)

09.5.8.3 Jul ’09: Report on research and testing on addition of the new explicit aerosol variable(s) in initiating cloud water and ice. Computer storage and run time considerations will be considered as a constraint on the development. (NCAR task)

09.5.8.5 Dec ’09: Report on FY07-funded ESRL-NCAR RR retrospective testing of the impact of different thickness of vertical model layers close to the surface and, as appropriate, other physics. (Joint NCAR and ESRL task)

09.5.8.6 Aug ’09: Begin to explore possibilities for enhancing treatment of sea ice and

tundra (including spring-time pooling) in Rapid Refresh domain toward FY11 Rapid Refresh upgrade. (ESRL task)

09.5.8E1 Sep ’09: Pending EMC, and NCEP Center initial recommendations, Job Implementation Forms (JIFs) are filed to submit upgraded WRF model physics code as part of Rapid Refresh software to NCO. (Joint ESRL and NCEP task**)**

09.5.8E2 Sep ’09: Provide an improved microphysics scheme to ESRL for evaluation toward FY11 Rapid Refresh upgrade. (NCAR)

09.5.8E3 Aug ’09: Complete physics improvement for icing, C&V, turbulence and convective forecasts. (NCAR)

09.5.15 Develop improved methods of cloud and moisture analysis for use in the WRF Modeling System ($65K to OU; $60K to ESRL)

Aviation needs for improved cloud/hydrometeor assimilation are for three different cloud situations:

- Stratiform cloud
- Convective cloud at parameterized scale (~10-13km)
- Convective cloud at explicit scale (<4 km)

Under this task, efforts will focus on improving the first two cloud situations, stratiform cloud and parameterized convection, and related moisture assimilation issues. The 3rd task on this list (radar assimilation at explicit 3-km scale will be focused on in 09.5.19.

09.5.15.2 Jan ’09: Continue testing and evaluation of the generalized cloud/hydrometeor assimilation (including GOES cloud-top data and METAR cloud/visibility/weather data) within a cycled GSI on the full Rapid Refresh domain. (Joint ESRL and OU task)

09.5.15.3 Jan ’09: Develop and evaluate performance of diabatic digital filter initialization (DDFI) in the 13-km RR WRF model including assimilation of radar reflectivity data. (ESRL task)

09.5.15.4 Mar ’09: Further refine the generalized cloud analysis for the target RR resolution, model physics scheme and use of additional data. Perform forecast test evaluations to document the impact of the cloud analysis refinements. (Joint ESRL and NSSL task)

09.5.15.6 Mar ’09: Include radar reflectivity-based latent heating within diabatic digital filter initialization (DDFI) in the RR WRF model. (ESRL task)

09.5.15E1 Sep ’09: Complete testing of GSI generalized cloud analysis for Rapid Refresh and deliver code to NCEP as part of Rapid Refresh package delivered to EMC, pending availability of NCEP testing capability. **(**ESRL task)

09.5.6 Develop, test, and evaluate the performance of the nonhydrostatic WRF modeling system ($25K to NCAR)

09.5.6.3 Sep ’09: Maintain and further develop WRF Post-processing system including necessary RR capabilities and updates to all documentation, in response to community requirements.

09.5.6.4 Jun ’09: Develop a WRF Users’ Workshop and a WRF tutorial for the user community. (NCAR task)

09.5.6.5 Sep ’09: Incorporate physics improvements from the WRF user community, ESRL and NCEP into the WRF software infrastructure for use in the Rapid Refresh model. Perform code testing to permit implementation into WRF repository. In collaboration with ESRL, assist in the evaluation of those physics schemes for the RR that may be tested using the ARW. (NCAR task)

09.5.6E1 Jun ’09: Deliver a WRF Users’ Workshop and a WRF tutorial for the user community. (NCAR task)

09.5.6E2 Sep ’09: Incorporate physics improvements from the user community, ESRL, and NCEP into the WRF software infrastructure for use in the Rapid Refresh model. Perform code testing to permit implementation into WRF repository. In collaboration with ESRL, assist in the evaluation of those physics schemes for the RR that may be tested using the ARW. (NCAR task)

09.5.24 Test WRF Rapid Refresh model at 3-km resolution toward High-Resolution Rapid Refresh Task ($190K to ESRL; $20K to NCAR)

The key task will be to conduct a summer 2009 convection forecast exercise with other AWRP RTs (Convective Weather, in particular) in which the HRRR plays a dominant role. This will build on the HRRR forecasting experiments conducted in 2008, including real-time HRRR forecasts from ESRL and extensive experiments by ESRL,NSSL, and NCAR to improve data assimilation and modeling configurations. The 2009 HRRR summer exercise will be initialized from the radar-enhanced Rapid Refresh run at ESRL instead of the radar-enhanced RUC used in 2008.

09.5.24.1 Feb ’09: Design the assimilation/modeling configuration for the HRRR during the 2009 summer convection forecasting (CoSPA) exercise. (Joint ESRL, NCAR, NSSL, and MIT task)

09.5.24.2 Aug ’09: Evaluate techniques for convection-permitting (e.g.,3-km) forecasting by the ARW core in the HRRR configuration. In collaboration with ESRL, perform and evaluate convection-permitting forecasts on test cases using radar-enhanced RUC or Rapid Refresh (13-km) grids from ESRL for initial condition fields to identify strengths and weaknesses of HRRR-ARW forecasts. This will include a 2009 analysis on evolution of convective storm mode during first 1-3 hours of model transition from effective resolution 13-km to actual 3-km resolution. Perform fully-explicit tests and evaluate short-term forecast results. Submit summary of results and collaborate with other groups on consolidated summary of results from 2009 HRRR exercise and research results. (NCAR task)

09.5.24.3 Sep ’09: Collaborate on analysis of convection-permitting tests using HRRR cases. Draft and deliver summary of results. (Joint ESRL and NCAR task)

09.5.24.4 Sep ’09: Complete 2009 HRRR summer exercise using modeling and assimilation modifications determined in 2008 exercise. Collaborate on analysis of HRRR tests and deliver summary of results. (Joint ESRL and NCAR task)

09.5.24E1 Aug ’09: Submit report on evaluation of HRRR-ARW forecasts. (NCAR task)

09.5.24E2 Aug ’09: Complete FY09 test with Northeast Corridor U.S. domain with 3-km High-Resolution Rapid Refresh running every 1 h. (ESRL task)

- Conduct real-time summer 2009 HRRR forecasts using 3-km WRF initialized with radar-enhanced Rapid Refresh over Northeast US Corridor domain
- Coordinate with other AWRP users and other collaborators
- Provide project management
- Lead writing of report on summer 2009 HRRR experiments

09.5.24E3 Sep ’09: Collaborate with ESRL on analysis of 2009 results. Draft and deliver summary of results. Evaluate techniques for convection-resolving (e.g., 3-km) forecasting by the Rapid Refresh (ARW core). Perform and evaluate HRRR convection-resolving forecasts on test cases using Rapid Refresh grids from ESRL to identify strengths and weakness of model at high resolution. Perform 2009 experiments to re-evaluate effects of transition from 13-km parameterized convection to 3-km resolved convection in 0-3h forecasts and in lateral boundary conditions from the RUC or Rapid Refresh using the Grell-Devenyi parameterization. (NCAR task)

09.5.19 Develop ability to assimilate WSR-88D radial velocity and reflectivity data through GSI and Rapid Refresh toward High-Resolution Rapid Refresh ($100K to ESRL, $75K to OU; $40K to NCAR)

This task will include development for convective cloud assimilation for explicit horizontal scales using radar reflectivity data.

09.5.19.1 Oct ’08: Select initial case studies from summer 2008 for 3-km HRRR data assimilation case studies. (Joint ESRL, NCEP, and NCAR task)

09.5.19.2 Aug ’09: Run case studies from early 2009 using 3-km HRRR on GSD jet computer using different RR-based initial conditions. (Joint ESRL and NCAR task)

- Radar-DFI enhanced RR
- Radar-DFI RR using unsmoothed latent heating
- Test of 3-km radar-enhanced diabatic digital filter initialization (DDFI)

09.5.19.3 Sep ’09: Complete new 3-km GSI data assimilation experiments toward improved assimilation of radial wind. (OU task)

09.5.19.4 Sep ’09: Develop and test improved DFI assimilation of radar reflectivity at 3-km using observation-based specification of latent heating within WRF-DFI developed by ESRL and NCAR in FY08. (ESRL task)

09.5.19E1 Sep ’09: Complete improved version of 13km/3km radar assimilation techniques for demonstration in FY09 exercises. (Joint ESRL, NCEP, and NCAR task)

09.5.20 Examine Utility of ensembles for conveying probability and confidence to aviation users ($85K to NCEP; $100k to ESRL)

Develop ensemble-based probabilistic products for aviation users. Efforts will focus to improve the Short-Range Ensemble Forecast (SREF) system at NCEP with its annual upgrade and continued development of both grid-based and site-specific SREF products for aviation interests in accord with recommendations and suggestions by AWC, the AWRP RTs and NWS’ Alaska and Pacific Aviation Weather Units.

09.5.20.1 Jan ’09: Complete ‘research quality’ version of upgrade to SREF (e.g. higher resolution, more WRF members and more physics diversity) for consideration in November 2010 SREF upgrade package. (NCEP task)

09.5.20.2 Feb ’09: Visit AWC to conduct continued training and education on SREF applications, receive feedback on existing guidance, and to acquire new requirements. (NCEP task)

09.5.20.3 Apr ‘09: Develops and delivers a new fog algorithm used in the SREF product for aviation. (NCEP task)

09.5.20.4 Aug ’09: Based on case-study testing and refinement of the research-quality code, deliver the upgrade SREF codes to NCO for November 2010 SREF upgrade package. (NCEP task)

09.5.20.5 Mar ’09: Develop a preliminary procedure appropriate for aviation users from Very Short-Range Ensemble Forecast (VSREF) system using high-resolution RR and NAM existing runs. (Joint ESRL and NCEP task)

09.5.20.6 Jul ’09: Further calibrate probabilities and potential echo-top (improve statistical reliability) ensemble cumulus information. (Joint ESRL and NCEP task)

09.5.20E1 Aug ’09: Demonstrate products from experimental VSREF probabilistic forecasts updated hourly. (Joint ESRL and NCEP task)

FY09 MDERT FUNDS ALLOCATION

Task #	Task Description	NCAR	NCEP	ESRL	OU	Total
09.5.1	Infrastructure support for operational running of the RUC at NCEP		65	120		185
09.5.17	Infrastructure support for running WRF RR, NAM, and HRW models		95			95
09.5.4	Develop, test, and implement the Rapid Refresh configuration of the WRF model (WRF-RR)	40	35	170		245
09.5.5	Develop, test, and implement improvements to the operational 3DVAR for Rapid Refresh and NAM		120	170	40	330
09.5.8	Improve physics in the WRF model, especially including those that affect aircraft icing	60		60		120
09.5.15	Develop improved methods for analyzing clouds and water substance for use in the WRF modeling system			60	65	125
09.5.6	Develop, test, and evaluate the performance of the nonhydrostatic WRF modeling system	25				25
09.5.24	Test WRF Rapid Refresh model at 3-km resolution toward High-Resolution Rapid Refresh (HRRR)	20		190		210
09.5.19	Develop ability to assimilate WSR-88D radial velocity and reflectivity data into the WRF modeling system	40		100	75	215
09.5.20	Examine utility of ensembles for conveying probability and confidence to aviation users		85	100		185
09.5.9	Assimilate turbulence observations (EDR data) directly into the WRF model					0
09.5.23	Develop advanced numerical models for aviation					0
09.5.21	Develop, test, and implement advanced 4DDA capability for the WRF model					0
09.5.11	Develop adjoints for physical processes in the WRF model					0
		185	**400**	**970**	**180**	**1735**