Minutes

WRF Executive Oversight Board (ExOB)
Meeting 6 (2006-2)
USNO, Washington, DC
28 April 2006

Attendees: Tim Killeen (NCAR), John Lanicci (AFWA), Eric Hartwig (NRL) Robert Winokur (N7C), Louis Uccellini (NCEP), Stanley Benjamin (ESRL), Gloria Kulesa (FAA), Pamela Clark (ARL), Pamela Stephens, Stephan Nelson, Simon Chang , Nelson Seaman, Robert Gall, Mark Surmeier, William Curry, Greg Mandt, Mark Swenson, Steve Payne, Joe Klemp, Dan Pawlak, Dan Eleuterio, Ron Ferek, Fred Toepfer, Dennis Staley.

1. Briefing 1: Meeting Agenda and Objectives

Dr. Seaman (PC) welcomed everyone and explained that the agenda of the ExOB meeting had been tailored to focus on the scope, management, and resourcing of the WRF DTC. Most of the routine briefs were eliminated to ensure adequate time for the primary topic. Formal briefings were limited to the early morning, while late morning and all afternoon were reserved for open discussions on DTC.

The meeting **objective** was to seek a **working consensus** for four areas of DTC organization: **scope, management, staffing** and **resources**. Defining the scope of the DTC is to be approached by identifying services and functions that different sectors of the community consider important and to organize them into a small set of strategic activities. A management structure needs to be defined to provide for DTC operations while meeting agency requirements for resource oversight. A conceptual plan for shared resource commitments is sought that will allow participating agencies to direct their resources toward services and functions for which they have highest priority. As a critical meeting outcome, the PC and DTC Director request that they be assigned the task of preparing and refining a DTC staffing plan consistent with the WRF ExOB's priorities for DTC services and functions, as expressed during the meeting, and a corresponding analysis for minimum resource requirements.

NOTE: The agenda and meeting objectives, plus the rest of the briefings prepared for this meeting fulfill the request in **Action Item 5.2-2006** assigned by the ExOB at its January 2006 meeting, "*The Program Coordinator will plan for an ExOB meeting in April to focus on issues relating to the expansion of the DTC: final scope, resourcing, requirements, and management. The PC will lead an effort to generate key questions for the meeting that will assist the partner agencies in preparing for the meeting (e.g., what opportunities are provided by expanded DTC; what linkages are needed; what nodes are necessary?)*" This action item is now **closed**.

2. Briefing 2: Overview of N7C Mission

Dr. Robert Winokur (N7C) explained that N7C operates the U.S. Naval Observatory (USNO) and is a major sponsor for Naval research. USNO is a working observatory, houses an extensive astronomical and navigational library and is the official residence of the Vice President of the United States. Historically, N7C is the inheritor of programs established in the early 19th century that laid the foundations for much of the nation's modern atmospheric and oceanographic research establishments. Today N7C's oceanography research program has a budget of ~$400M/yr, most of which focuses on "6.4 work" that transitions maturing research for operational deployment to the fleet. It also operates seven oceanographic research vessels. The USNO supports the global positioning system (GPS) and the Master Clock for precision timekeeping.

Dr. Winokur concluded by inviting those present to participate in a tour of the USNO immediately following the ExOB meeting.

3. Briefing 3: Status of WRF Operational Implementations

Two new WRF modeling systems, with fully cycled variational data assimilation systems, are expected to enter operations within the next 2-3 months.

Col. Lanicci gave a briefing summarizing AFWA's progress toward placing the WRF-ARW into operations in summer 2006. The initial implementation will occur in AFWA's classified window domains, with the full operational capability anticipated by late 2007. Recent activity has focused on extensive pre-operational testing of forecast quality, primarily over southwest Asia, using domains with 15-km and 5-km grids. Earlier testing with WRF version 2.0.3.1 had revealed a number of problems, which have been addressed in the more recent release, WRF version 2.1.2. Tests using the latter "out of the box" showed improvements, but some deficiencies remain relative to the incumbent MM5 model as revealed in objective General Operations (GO) index scores. These deficiencies are now being addressed and recent modifications show promise for bringing the WRF-ARW to readiness for its initial operational implementation. Col. Lanicci also reported on AFWA's efforts, along with its partners in DoD and NCEP, to develop global and mesoscale ensembles. He concluded with a short report on the status of the new AFWA building at Offutt AFB, which is now under construction.

Dr. Uccellini followed with a briefing that summarized NCEP's efforts leading to implementation of the WRF-NMM in June 2006 as the replacement for the incumbent Eta model on the North American Mesoscale domain. The briefing emphasized that this is only the latest in a series of WRF implementations that will allow NCEP to consolidate its limited-area operations from running 5 different mesoscale models to using only different configurations of WRF. NCEP is aggressively pursuing its goal of shifting to rely primarily on model ensemble prediction systems that provide probabilistic forecasts with more information about solution uncertainty and greater reliability and accuracy than traditional deterministic approaches. The WRF Common Modeling Infrastructure (CMI) facilitates the paradigm shift to mesoscale ensembles, even though its code presents challenges to operations scientists and engineers who

work with it. Strategically, NCEP plans to rely on the DTC as its most crucial link to the academic community as it seeks solutions to the modeling problems it faces. Dr. Uccellini concluded with a short report on NCEP's new building at U. MD, where construction is scheduled to begin later this spring.

The announcement by FNMOC at the recent COPC meeting that they would not operationally run WRF due to Information Assurance requirements of the Navy was discussed. Dr. Seaman added that FNMOC had interpreted the Navy's IA requirements to preclude acceptance of output datasets generated by WRF model runs at NCEP, not only the WRF code itself. There was no resolution as to how to overcome the issues, but it was recognized that IA issues are important and appropriate security concerns for Navy.

4. Briefing 4: WRF and ESMF Convergence

Dr. Seaman provided an overview of the chief outcomes from the Workshop on WRF-ESMF Convergence held at NCAR on February 9-10, 2006. The primary goals of WRF-ESMF convergence are to minimize the effort to couple WRF with other component models, while maximizing computational performance, versatility, interoperability and system supportability. The 13 selected workshop experts, all of whom are experts in framework development or are advanced users knowledgeable about the design of either WRF or ESMF, were also asked to consider ways that the WRF framework might be streamlined to improve certain of its characteristics that have been identified as problematic for some users. A critical requirement of any strategy for WRF-ESMF convergence is that the end state must allow for a single version control of the WRF science code to maintain WRF as an identifiable community modeling system.

The briefing outlined the key results from the workshop final report. The report provided three short and long term strategies for code convergence, with assessments of the advantages and disadvantages of each. The issue of time required to approach code maturity was explained, with an estimate of 3-5 years for ESMF to mature for the purposes required by the WRF community and another 3-5 years to adapt the WRF framework to ESMF. The changes required in ESMF notably include support for efficient grid nesting, if ESMF is to be considered as a possible substitute for the WRF framework. In the meantime, NCAR/MMM has adapted the WRF framework so that WRF can be coupled as a component model to another model via ESMF.

The report also examined how much complexity versus functionality might be expected as inevitable in a software framework. Finally, the report listed a number of potentially important steps that could be taken to streamline the WRF framework, separate from the question of its convergence toward ESMF. The streamlining process would aim to improve documentation and to simplify codes and user interactions with WRF, while essentially maintaining its range of functionality.

- *Discussion on WRF and ESMF software frameworks*

Dr. Uccellini said that the current WRF common modeling framework (CMI) represents the greatest single challenge to NCEP's use of WRF in operations. He asked what the next steps are for relieving the present distress caused by software frameworks.

Dr. Hartwig voiced concern that WRF needed to address issues of efficiency and complexity of WRF framework vs. ESMF or other frameworks and how best to overcome those issues that are found to exist. He followed up by commending the Program Office for the recent workshop and the report.

Dr. Seaman replied that in the near term, it was probably practical to make use of ESMF to couple WRF with other modeling components, as provided by NCAR. In the meantime, while ESMF continues to mature, interested partner agencies may find it advantageous to continue experimentation with ESMF to provide much needed information that is currently lacking (e.g., learning whether users will need to get deeply embroiled with internal ESMF codes and whether that poses serious obstacles or not). The WRF Program Office POCs would be polled to solicit their views on whether a coordinated plan for investigation of ESMF's current capabilities has advantages. Plans of the WRF CMI developers for implementing various streamlining options discussed at the workshop are not known at present, but will be explored.

- *Outcome*: Recent delivery to the ExOB of the final report from the Technical Workshop on WRF-ESMF Convergence fulfills the requirements of the following ExOB action items:

  Action Item 3.6-2005: *"Analyze the whether the documentation for the WRF software infrastructure is sufficiently detailed and extensive to meet needs of code developers.*"

  Action Item 3.9-2005: *"As soon as possible, prepare for and conduct a planning meeting to develop a technical plan (with options) for merging, or integrating, WRF and ESMF infrastructures and report back to the ExOB.*"

  Action Item 5.1-2006: "*The team charged with conducting the Technical Workshop on WRF-ESMF Convergence (Seaman, Gall, and Clancy) will attempt to extend the length of the workshop to include a second day. Priority should be given to holding it on February 9-10, 2006, if a sufficient number of invitees indicate they can participate at that time.*"

  The three AIs above have been **closed**.

5. Briefing 5: Preliminary Core-Test Results at DTC

Dr. Gall gave a summary of the first phase of numerical experiments being conducted at DTC that are designed to isolate and compare the influences of the WRF dynamical cores on short-term weather forecasts. These tests, using ARW and NMM on CONUS grids of 13 km and 50 layers, are designed to support Rapid Refresh WRF development. For both cores, the Phase 1 tests used RUC initial conditions, NAM lateral boundary conditions, the Noah land surface

model, NCEP NMM physics and domains engineered to have nearly identical size. DTC worked closely with NCAR/MMM and NCEP/EMC to incorporate latest versions of the models and current bugfixes. Calls to physics routines were made at approximately similar time intervals for both models, even though the ARW's time step is over twice as long as NMM's in most runs. Drs. Gall and Benjamin reported that considerable effort was made to establish physics interoperability on a more sustainable basis than had been done in previous WRF T&E projects. All runs were made to +24 h, although most of the preliminary statistical results were shown for +12 h. Additional results appear at: http://ruc.fsl.noaa.gov/wrf/RR/testing/NCEP_verif/

Dr. Gall next presented preliminary Phase 1 results for 30 days of tests during winter 2006. They indicated that solutions using each core are remarkably similar for most variables and at most levels of the atmosphere. RMS errors and biases between the two models are small (e.g., on the order of 0.1-0.2 C for temperature), with one model being slightly better than the other for some variables/levels and the other having a similar small advantage for other variables/levels. Although these tests were not designed primarily to explore questions about computational performance, the ratio of the ARW's total computational time versus that of NMM was reported to be 1.08 in runs for which ARW used Dt = 72 s and NMM used Dt = 30 s.

It was noted that additional tests are underway for the other three seasons. Tests will be repeated for all seasons using similar model configurations, but with RUC-like physics replacing the NCEP physics (Phase 2 testing).

- *Discussion on DTC Core-Test Results*

Dr. Chang asked if there would be future tests of the two models, but with the NCAR physics. Dr. Gall indicated that was not within the scope of the RR WRF development, but that such tests are needed.

Dr. Uccellini agreed that such tests must be done, especially since NCEP plans for its short-range ensemble forecast (SREF) system are based on using both cores and different physics suites. Dr. Seaman noted that the current tests, while very helpful, are only a small part of more extensive testing necessary to adequately identify the influence of the two cores for weather forecasting, either in deterministic or ensemble modeling applications. Tests must be run for longer forecast periods and with finer grid resolutions. Results from such tests will lay a good foundation for further evaluations aimed at understanding how WRF cores and physics can be used most effectively in the construction of better ensemble modeling systems.

6. Briefing 6: Proposal for Discussion: Development Testbed Center

At the suggestion of Mr. Fred Toepfer and Dr. Uccellini, the order of presentation for Briefings 6 and 7 was reversed. To follow the meeting notes in the order of presentations, the reader is directed first to Briefing 7 titled, "WRF Development Test Center: A NOAA Perspective."

Dr. Gall's briefing began by reiterating that the purpose of the DTC is to serve as a bridge between research and operations that facilitates the activities of each. DTC is not a facility for

performing either research or operations, although its activities may at times contain elements of both.

The heart of the brief was a proposal for how the DTC could be reorganized and expanded to provide the scope of functions that the agencies have said are important, while establishing a management structure that ensures adequate accountability to those agencies providing resources to DTC. Starting from the DTC goals established at the January 2006 ExOB meeting, the proposal listed three critical issues facing DTC that the proposal is designed to address: (a) DTC currently is under-staffed to provide the range of services demanded by the community, (b) its current management structure provides insufficient accountability to participating agencies for spending and project results, and (c) its resource profile needs to be commensurate with DTC's scope and required staffing. The proposal to address these issues first introduced a set of 18-20 functions and services, organized into five strategic activities:

- software management,
- community support,
- test and evaluation (T&E) of contributed codes,
- T&E of reference and operational codes, and
- T&E for transition to operations.

A sixth major activity, administration, is necessary but not strategic.

The proposed DTC management plan is designed to provide accountability in three areas: (a) planning, (b) resources, and (c) services provided (including deliverables and reports). Additionally, the management plan proposed that all DTC personnel must be accountable to the Director. The proposal concluded with an outline for a resource plan, suggesting that each agency providing resources to DTC would have part of its funds used for jointly supported activities that are agreed to be necessary for all to share (e.g., administration or code management), while the rest of its funds could be directed into specific strategic activities designated by that agency (e.g., T&E of contributed code or transition of code for operations).

Dr. Gall concluded with a request that the ExOB provide feedback on what it considers its highest priorities among the functions and services DTC has been asked to provide. From that information, a set of alternative plans can be prepared for the ExOB, each giving staff required to provide those high-priority functions and services and an estimate of required resources. The ExOB was also asked to give its assessment of the proposed management plan, whether it is viewed as suitable for further refinement into a consensus DTC plan, or unsuitable and needing extensive redesign.

NOTE: The proposal for DTC management, staffing and resourcing contained in Briefing 6 fulfills ExOB's **Action Item 3.8-2005**, "*Prepare a joint resource plan for the DTC and WRF Program Office, with options, for discussion at the next meeting of the Executive Oversight Board, in August 2005.*" This action item is now **closed,** although plan refinement is being carried forward **(see new Action Item 6.1-2006 below)**.

From here, the reader is directed to the ExOB's discussion of DTC issues in Section 8.

7. Briefing 7: WRF Development Test Center: A NOAA Perspective

Mr. Toepfer began by introducing NOAA's rationale for DTC. NOAA's long-term plans for improving the skill of its numerical predictions heavily depend on WRF and it wide use by the research community. Without DTC the advantages of the WRF program are significantly reduced. DTC provides the key to greater community access to WRF and more efficient harvesting of innovative science and technology emerging from the community. Currently, NOAA invests between $6-8M/yr to improve numerical predictions, but has seen only 2-3% annual improvement in statistical skill scores. By using DTC to tap into the broad research community working with WRF, NOAA aims to accelerate that rate of improvement by a factor of 3. NOAA is ready to commit long-term funding to DTC and substantial computing resources in the form of external grants to researchers to ensure that DTC is prepared to fulfill that role in supporting NOAA's strategic modeling goals.

NOAA's Environmental Modeling Program is working to establish a formal funding line for DTC. However, NOAA considers current DTC organizational structure is inadequate because it provides only loose span of control by the Director over DTC funds and programs. The WRF ExOB needs to define the span of control for DTC management in a way that codifies the role of the Director. NOAA is ready to negotiate and enter into a partnership agreement with its WRF partners to (a) empower a WRF program manager and DTC Director and (b) develop and implement an organized, viable, accountable DTC organization meeting the needs of U.S. operations and research communities.

At the suggestion of Mr. Toepfer and Dr. Uccellini, the order of presentation for Briefings 6 and 7 was reversed. To follow the meeting notes in the order of presentation, the reader is directed next to Briefing 6 titled, "Proposal for Discussion - Development Testbed Center," before proceeding to Section 8.

8-10. ExOB Open Discussion on DTC Scope, Management and Resourcing

- *Discussion on Scope of the DTC*

Dr. Killeen began by asking Dr. Gall for his assessment of whether the DTC Director is currently empowered to manage the Center's activities and responsibilities.

Dr. Gall responded that at the moment the Director's role and authority are not well defined. For example, responsibility for overseeing upgrades of contributed codes to WRF Reference code status are divided between MMM, NCEP and DTC, which leads to confusion. Currently, code is checked into the WRF repository by a variety of individuals without review or assurance they are appropriate for Reference status. Also, there is no actual line of authority of the DTC Director with respect to the other nodes. Coordination activities with the other nodes, particularly with ESRL/GSD, have been on the basis of discussion and mutual agreement, which has worked fairly well.

Dr. Seaman agreed that the interactions between Drs. Gall and Koch (Assoc. DTC Director for ESRL/GSD) have indeed been exceptionally positive. However, without adequately defined management authority, DTC remains at risk if future individuals in these positions are less successful working within a poorly defined structure.

Dr. Uccellini addressed the question of highest priorities for expanding DTC's scope, saying that NCEP's goal is for DTC to assist with model testing and evaluations aimed at developing superior multi-model limited-area ensembles for use in operations. The entire community, including research, needs much help in this area and DTC is a natural focal point for bringing community assets to bear. DTC can provide much needed leadership in a number of ways (ensemble code support, verification systems, computational resources, visiting scientist opportunities, etc.). Meanwhile, in the area of data assimilation, NOAA's Research Council is recommending that NCEP explore ensemble Kalman filters as its next-generation data assimilation approach, rather than 4D-Var.

Dr. Killeen asked if model verification should be a high priority of the DTC.

Dr. Seaman replied, saying that improved verification methods certainly should be a DTC priority. In particular measures of forecast precipitation skill appropriate for the mesoscale are needed. The work being done by Barbara Brown and her colleagues is an example of possible innovations that DTC could make available to the community.

Dr. Steve Nelson posed three questions for consideration to help understand and define DTC:

- Are there critical-path activities needed by the operations sector that it expects to pursue through the DTC?
- Are there critical-path activities needed by the research sector that it expects to happen through DTC?
- Are there critical model test and evaluation activities that the Executive Oversight Board is expecting to pursue through DTC?

Dr. Nelson indicated that if the answers to these questions are yes, then the proposed DTC can be defined as equivalent to what has been termed an "Experimental Forecast Facility (EFF)."

Fred Toepfer replied that various organizations may define an EFF somewhat differently. A center that actually performs critical-path functions for operations (i.e., operational forecasting) might not be affordable. Strictly speaking, NOAA would not consider DTC to be an EFF because it will not include an ongoing operations component. As proposed, DTC is primarily a bridge organization lying between research and operations. Thus, DTC will have a role of assisting and enabling each half of the community to pursue their own critical path goals, but is not primarily designed to pursue such functions itself. DTC can assist NOAA by acquiring and testing promising research codes that NOAA can then apply to achieve its critical goal of improving forecast accuracy. Whether or not the research sector would be able to pursue any of its own critical path activities through DTC is primarily up to NSF.

Dr. Hartwig pointed out that this bridging activity is what NRL-MRY has done for atmospheric modeling since its inception. He had hoped that by pushing to ensure for a distributed DTC at NRL-MRY, it would enable the WRF program to focus effort and resources where needed to make use of existing knowledge and capability for executing this bridging capability. He had hoped that the DTC briefing would provide some information or discussion on how the DTC would focus effort and resources on using existing capability, but all discussion was focused on the Boulder DTC.

Dr. Gall added that this emphasizes why it's important for ExOB to define the range of services it deems most essential for the DTC to provide. That will dictate the cost and then ExOB (or others in their organizations) must determine whether that cost is affordable.

Dr. Uccellini stated that neither the research or operations members of the ExOB are interested in having DTC undertake operational implementation tasks. Those are specific to each operational prediction center in any case.

Dr. Hartwig said NRL/MRY, which has participated in a number of community efforts, is presently leading a community research effort that involves WRF, called T-REX (Terrain-induced Rotor Experiment). He offered to have T-REX and lessons learned from it briefed to the ExOB at the next meeting. The Program Office will take an action item to extend an invitation to prepare the briefing.

Dr. Killeen said that NCAR is interested in pursuing seamless weather-climate predictions that will include global to regional scales. As a collaborator, DTC can provide computational and analytical resources to support this research effort.

Drs. Klemp, Benjamin and Payne added that it's important that DTC be able to provide WRF modeling support for scientists performing cases studies of particularly interesting and challenging events.

Dr. Nelson concluded that, from the descriptions and expectations given by the other participants, the proposed DTC sounds exactly like NSF's understanding of an EFF, where for example, a professor engaged in research can bring an idea and test it extensively with the help of operations-savvy scientists and technicians.

Dr. Killeen, Dr. Gall and Fred Toepfer agreed that these are indeed functions DTC should provide for researchers. In many ways DTC is doing so already, although at a reduced level because of staff and resource limitations. However, DTC is not envisioned as ever becoming as extensive or costly as, say, the original FSL (which also may be considered an EFF) because it will not have to build its own extensive computational infrastructure or develop an operations capability.

Dr. Nelson replied that, as described, DTC sounds like the sort of facility NSF has supported in the past.

Mr. Toepfer said that NOAA's expectation is that NSF potential support [for DTC] would be limited to those functions and services that it supports routinely elsewhere. NSF would not be expected to support other functions aimed toward operational goals.

Dr. Gall added that the DTC proposal presented in the meeting is consistent with Fred Toepfer's comments regarding direction of agency resources toward functions normally supported by those agencies.

Dr. Killeen summarized by saying that NCAR welcomes the NOAA initiative and will be supportive to the extent it is able. NCAR considers the DTC visiting scientist program as particularly important.

ExOB members expressed their intent that the next step should be development within the next few weeks of a set of alternatives for DTC scope of functions, based on the priorities expressed in today's meeting. Cost estimates should be developed for each alternative plan. These alternatives should then be discussed individually with the ExOB members to gather feedback needed to move toward a consensus DTC that meets member requirements for scope, management and affordability. That will form the basis for a separate high-level meeting to codify the DTC plan in the form of a MOA.

11. Action Items from Meeting 6 (2006-2)

Action Item 6.1-2006: Program Coordinator and DTC Director Based on ExOB's discussion of most critical DTC functions and services, the Program Coordinator and DTC Director will **prepare alternative plans for DTC staffing and corresponding resource estimates** to be provided to the ExOB. The PC and DTC Dir. will then call members to **obtain ExOB feedback** on the alternative DTC plans and narrow them toward a consensus plan meeting member requirements for scope, management and affordability.

Action Item 6.2-2006: **Program Coordinator** The PC will poll the POCs of the WRF Program Office to solicit their views on whether a **coordinated plan to investigate ESMF's current capabilities** has advantages. Additionally, the PC will investigate and report on what **plans** the WRF CMI developers have for implementing the **streamlining options** discussed at the Technical Workshop on WRF-ESMF Convergence.

Action Item 6.3-2006: Program Coordinator and NRL Program Office POC The PC will consult with the NRL POC to have a briefing on T-REX and lessons learned prepared for the ExOB and placed on the agenda at its earliest practicable future meeting.

Glossary of Common WRF Acronyms
6 June 2005

AFWA	**A**ir **F**orce **W**eather **A**gency
AIP	**A**greement **I**n **P**rinciple
AO	**A**nnouncement **o**f **O**pportunity
ARL	**A**rmy **R**esearch **L**aboratory
AWRP	FAA's **A**viation **W**eather **R**esearch **P**rogram
BAMEX	**B**ow Echo **A**nd **M**CV **Ex**periment
COAMPS	**C**oupled **O**cean-**A**tmosphere **M**esoscale **P**rediction **S**ystem™
COMET	**C**ooperative Program for **O**perational **M**eteorology, **E**ducation and **T**raining
CONUS	**CON**tinental **U**nited **S**tates
COPC	**C**ommittee for **O**perational **P**rocessing **C**enters
DTC	**D**evelopment **T**estbed **C**enter
DWFE	**D**TC **W**inter **F**orecast **E**xperiment
EFF	**E**xperimental **F**orecast **F**acility
ESMF	**E**arth **S**ystem **M**odeling **F**ramework
ESRL	**E**arth **S**ystem **R**esearch **L**aboratory
ExOB	**E**xecutive **O**versight **B**oard
FSL	**F**orecast **S**ystems **L**aboratory
FTE	**F**ull-**T**ime **E**quivalent
FNMOC	**F**leet **N**umerical **M**eteorology and **O**ceanography **C**enter
GFS	NCEP **G**lobal **F**orecast **S**ystem
GPRA	**G**overnment **P**erformance and **R**esults **A**ct of 1993
GSD	**G**lobal **S**ystems **D**ivision of ESRL, formerly FSL
GSI	**G**ridpoint **S**tatistical **I**nterpolation
JAG/OCM	**J**oint **A**ction **G**roup for **O**perational **C**ommunity **M**odeling
JCSDA	**J**oint **C**enter for **S**atellite **D**ata **A**ssimilation
MCV	**M**esoscale **C**onvective **V**ortex
MOA	**M**emorandum **o**f **A**greement
MMM	NCAR **M**esoscale and **M**icroscale **M**eteorology division
NAM	NCEP's **N**orth **A**merican **M**esoscale domain
NCAR	**N**ational **C**enter for **A**tmospheric **R**esearch
NCEP	**N**ational **C**enter for **E**nvironmental **P**redictions
NCOM	**N**avy **C**oupled **O**cean **M**odel
NOGAPS	**N**avy **O**perational **G**lobal **A**tmospheric **P**rediction **S**ystem
NOAA	**N**ational **O**ceanic and **A**tmospheric **A**dministration
NRL	**N**aval **R**esearch **L**aboratory
NSSL	**N**ational **S**evere **S**torms **L**aboratory
NWS	**N**ational **W**eather **S**ervice
OAR	NOAA/Office of **O**ceanic and **A**tmospheric **R**esearch
OST	NWS/**O**ffice of **S**cience and **T**echnology
OTC	**O**perational **T**estbed **C**enter
PC	**P**rogram **C**oordinator
POP	**P**rinceton **O**cean **P**rediction model

QPF	**Q**uantitative **P**recipitation **F**orecast
RAMS	Colorado State University **R**egional **A**tmospheric **M**odeling **S**ystem
RR	**R**apid **R**efresh version of WRF
RUC	**R**apid **U**pdate **C**ycle
RTVS	**R**eal **T**ime **V**erification **S**ystem
SPC	NCEP **S**torm **P**rediction **C**enter
SREF	**S**hort **R**ange **E**nsemble **F**orecast
TOR	**T**erms **o**f **R**eference
USWRP	**US W**eather **R**esearch **P**rogram
WRF	**W**eather **R**esearch and **F**orecast modeling system and program
WRF-ARW	**WRF A**dvanced **R**esearch **W**RF dynamical core
WJIP	**W**RF **J**oint **I**mplementation **P**lan of COPC
WRF-NMM	**WRF N**onhydrostatic **M**esoscale **M**odel dynamical core
WRF-SI	**WRF S**tandard **I**nitialization