University: Arctic Region Supercomputing Center, University of Alaska Fairbanks

Name of University Researcher Preparing Report: Don Morton and Greg Newby

NWS Office: Missoula and Fairbanks WFO's

Name of NWS Researcher Preparing Report: Eugene Petrescu and Eric Stevens

Partners or Cooperative Project: Partners

Project Title: A Study of WRF Performance in High-Resolution NWP of Topography-Influenced Weather Events in Alaska and Montana

UCAR Award No.: S07-62784

Date: 28 August 2007

SECTION 1: PROJECT OBJECTIVES AND ACCOMPLISHMENTS

1.1 *(To be completed by academic and forecaster partners)* Summarize progress on COMET-funded work during the last six months of the project.

- Primary objective for the first six months was to hire two student interns for the Arctic Region Supercomputing Center's Summer Research Challenge program. These students were to learn how to utilize the NCAR Command Language (NCL) for preparing visuals that would enable meteorologists to critically evaluate the performance of the Weather Research and Forecasting (WRF) model in their forecast areas. Additionally, they would learn how to use the ARSC supercomputing systems for running WRF.
- Two students from The University of Montana's Department of Computer Science were hired for the ten-week ARSC program. Both were well-known by Morton, were very interested in the project and in Alaska, and had gained some initial experience in Python scripting prior to the internship. One student had finished his junior year and the other has finished his first year of graduate school. The graduate student's salary, funded by COMET, was supplemented by ARSC.
- During the first two weeks of the summer program, Morton prepared and delivered three hours of hands-on NCL tutorials for the funded interns plus other interested people. He also prepared and delivered a three-hour hands-on tutorial for running WRF on ARSC computers. During these two weeks in Fairbanks there were a number of planning and orientation meetings with Newby, Stevens, Atkinson, Mesquita, Petrescu (via teleconference) and the two interns.
- For the remaining eight weeks of the internship the two students worked under the guidance of their mentors, including the NWS personnel, Stevens and Petrescu on site and through teleconferences. There was a steep learning curve for all, but in the end run both students delivered products and prototypes of products that will be used for evaluating model results. The most visible of these products include the model vs. raobs sounding graphics, available at

http://weather.arsc.edu/~hagedal/soundings/ and the WRF vs. FNL model comparison graphics, available at http://weather.arsc.edu/Testing/james/FNL/comparisons/

- A second, 1.5 day WRF Tutorial was delivered at ARSC by Morton in early July. At this point, the students were settling into the modeling environment and felt like this helped put things into perspective.
- The undergraduate student will continue with this work at U. Montana during the 2007-2008 academic year, supported by funding from ARSC.
- Gene Petrescu visited ARSC and WFO Fairbanks for a week in early July, learning about the unique problems in the Fairbanks forecasting area, while learning how to use the ARSC facilities in the context of weather modeling applications (both Gene Petrescu and Eric Stevens participated in the second WRF Tutorial).
- In early July, NWS personnel from both Missoula and Fairbanks, along with Morton and one of the students visited the weather group at the Cold Regions Test Center at Fort Greely in Delta Junction, Alaska to learn about their mesoscale modeling and monitoring accomplishments and issues. See http://140.32.128.6/4dwx/index.jsp for information on this group.
- Eric Stevens visited Petrescu and Morton at WFO Missoula for two days in early August to familiarize himself with issues local to the Missoula forecasting area, to learn about the Boise Verify system, and to discuss the remaining stages of this project.

1.2 Describe the division of labor between the academic and forecaster partners (i.e., which tasks each partner is responsible for).

- Frankly, this has been mostly a team project with very little "division" of labor. The students have put a lot of effort into the graphics products under the guidance of both academic and NWS mentors. NWS mentors have been connected with the project, providing advice when needed and/or requested.

SECTION 2: RELATED ACCOMPLISHMENTS

2.1 *(To be completed by academic partner)* Please summarize any other work conducted by the University, which was a result of the COMET Outreach Program collaboration, but was not directly funded by it (for example, seminars at NWS office if these were not part of the original proposal).

- The production of graphical products with NCL, and the necessary participation by academic mentors has added much expertise to other WRF modeling projects that Morton is involved in, including a characterization of the Beaufort Sea meteorology, funded by Minerals Management Service.
- These graphical products have also been used to greatly enhance the web presence of ARSC's weather web resources at http://weather.arsc.edu/. This includes the automated productions of animated GIFs and an enhanced web viewer for real-time model output. Additionally, graphics produced through this project have gone into the creation of overlays (available in real-time) for Google Earth.

2.2. *(To be completed by forecaster partner)* Please summarize any other work conducted by the NWS, which was a result of your collaboration with the university but was not directly funded by it (for example, seminars given by NWS forecasters at the university).

- With the Missoula WRF, locally know as the Northern Rockies Mesoscale Model (NRMM), running operationally, systematic verification of modeled surface fields has been ongoing using the Boise Verify software within the Graphical Forecast Editor (GFE). Locally generated gridded analysis fields using the MatchObsAll software are being used to compare against the model forecasts. Information regarding particular weather patterns or output fields that the NRMM is modeling successfully is being passed along to the forecasters. While areas where the NRMM is performing poorly are being noted as items of additional investigation.
- At this point in time the Real Time Mesoscale Analysis (RTMA) does not appear to be mature enough to capture many of the mesoscale details important in the Missoula forecast area and was not used for verification. We hope to utilize the RTMA in the future as a basis for verification.
- A number of case study model runs have been completed for the Missoula forecast area during a few significant inversion events in an attempt to determine factors that are leading to a failure of the WRF to capture the details of the events adequately.
- Stevens provided the two students with a briefing in June on the role of fine-resolution numerical weather prediction local modeling in northern Alaska, with particular emphasis on the capabilities of fine-resolution models in areas of complex terrain.

SECTION 3: SUMMARY OF BENEFITS

3.1 *(To be completed by academic partner)* Please list the benefits to the University resulting from the collaboration (new understanding of forecasting problems, exposure of students to operational forecasting, access to new observing systems, changes in course offerings, use of NWS personnel as a resource, etc.).

- Involvement in this project, particularly in the context of frequent association with the NWS partners, has provided the University researchers (two are computer scientists) and students with a greatly enhanced understanding of the issues faced by the Missoula and Fairbanks Forecast Offices. NWS participants have helped the students understand the workings of a typical forecast office and how a regional weather model like WRF fits in to it all.

3.2 *(To be completed by forecaster partner)* Please list the benefits to the NWS office resulting thus far from the collaboration (promising new forecasting technique, heightened interest in research in the office, better understanding of new observing systems, potential new hires, use of university personnel as resource, etc.). Please be as specific as possible, particularly in regard to any improvements in forecasting operations resulting from this project (see examples).

- The Missoula WRF, or NRMM, has been quite valuable in providing additional forecast guidance during the current summer season. The NRMM appears to be superior over all other models in forecasting the location and timing of convection. Our forecasters are using the model forecasts of convection directly in considering regions of potential convective activity. In addition, forecasters have incorporated images produced from NRMM output of regions of convection directly in briefings for our non-NWS fire weather customers. Also, wind fields from the NRMM are being directly within the Graphical Forecast Editor (GFE) to produce wind forecasts in the Missoula CWA. Given the higher resolution of the NRMM compared with other model guidance, the winds fields appear superior to other guidance avialable.
- Don Morton has been an invaluable resource in developing a stable software environment for the NRMM to run operationally. There have been very few occasions where the model had failed to run successfully.
- The ability to use the ARSC computing facilities to perform case study and model sensitivity runs greatly reduces the time required to do the same task using local office resources. This provides a good platform to determine WRF failures and weaknesses and implement improvements to the WRF.
- Two runs of the WRF model are produced daily at ARSC and ingested into the AWIPS at WFO Fairbanks. This ArscWRF output is used by forecasters in AWIPS' D2D application.

SECTION 4: PRESENTATIONS AND PUBLICATIONS

4.1. *(To be completed by academic and forecaster partners)* Please provide complete citations using the AMS bibliographic format for each thesis, dissertation, publication or presentation prepared as part of this COMET Outreach project.

- An abstract has been submitted to the Great Divide Weather Workshop, held in Great Falls, Montana, 02-04 October 2007
    - The Northern Rockies Mesoscale Model (NRMM)

      Don Morton, Arctic Region Supercomputing Center and University of

Montana
Eugene Petrescu, Missoula Weather Forecast Office

The Missoula WFO has been running a localized numerical weather model in one form or another for almost three years, providing high-resolution coverage of the Missoula CWA and surrounding regions. Over the past year the model output has been incorporated into AWIPS and is available for scrutiny by forecasters. Locally referred to as the Northern Rockies Mesoscale Model (NRMM), this product is comprised of three nested domains, with the innermost domain provding 4km resolution over the Missoula CWA.

NRMM is considered "experimental" - it has provided surprisingly good guidance in summertime convective activity, but exhibits several worrisome issues, most notably in its reluctance to capture the inversions so prevelant in the Missoula area. This presentation will discuss the successes and problems of NRMM, focusing on case studies from Summer 2007.

- A similar study for the Alaska Region is being planned for submission to the National Weather Association Online Digest
- Additional publications are being discussed.

SECTION 5: SUMMARY OF PROBLEMS ENCOUNTERED

5.1 *(To be completed by academic partner)* Please describe problems encountered on the University side in the last six months and their resolution, if any.

- Although the students accomplished a lot during their 10-week internships, as with many projects they didn't get as far as we had planned. The learning curves they encountered were steeper than anticipated. We had hoped that in the last half of the summer they would be able to start running some case studies themselves, but time never allowed for this. However, with ARSC's generous funding of one of these students during the 2007-2008 academic year, we anticipate being able to have a student pursue some of the case study work we have planned.
- Since the students were based in Alaska all summer with easy access to all of the Alaska weather modeling resources, most of the work was performed on Alaska domains. The weather modeling resources available to the Missoula FO are more difficult to work with – they don't have the large storage or network capacities that ARSC makes available in Alaska and, due to NOAA Internet access restrictions, any work done with the Missoula weather modeling system needs to be done on-site at the Missoula FO out at the Missoula International Airport. The work done by the students has been well documented and is very portable, so we don't anticipate major problems in the implementation of some of these graphical comparison packages at Missoula, but the logistics make it somewhat of a challenge.

5.2 *(To be completed by forecaster partner)* Please describe problems encountered on the NWS side in the last six months and their resolution, if any.

- Maximum benefit of the ArscWRF model has yet to be realized at WFO Fairbanks. While the model is available to forecasters via the AWIPS/D2D, the ArscWRF has not been available within the Graphical Forecast Editor (GFE), and no systematic objective verification of the ArscWRF has been performed. To remedy this shortcoming, the Boise Verify software was installed at WFO Fairbanks in late August. It is also expected that routine ingesting of ArscWRF grids into the GFE will be accomplished by late September or October.