COMET Partners Project for Visiting Scientist Support: The Storm Prediction Center/National Severe Storms Laboratory Spring Program Partners Project S04-44693 Final Report

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1. SUMMARY OF PROJECT OBJECTIVES

Each year during the active spring severe weather season, the Storm Prediction Center (SPC), the Cooperative Institute for Mesoscale Meteorological Studies (CIMMS), and the National Severe Storms Laboratory conduct a collaborative, multi-agency experiment designed to explore operationally relevant research and forecasting activities. The 2004 Spring Program was conducted in the SPC/NSSL Science Support Area (SSA) adjacent to the SPC Operations Room from April 19 through June 4, 2004. The primary objective of this year's program was to assess whether WRF configurations that marginally resolve deep convective clouds (i.e., configurations with grid spacing ~ 4 km) can help SPC forecasters make better predictions of severe convective weather. A broader, over-arching goal of annual Spring Programs is to promote interactions and collaboration between operational forecasters and research meteorologists.

2. PROJECT ACCOMPLISHMENTS/FINDINGS

The program had an experimental forecasting component and a model evaluation component. Results from both elements suggested that severe weather forecasters benefit from the high-resolution guidance. For example, when forecasts prepared with and without examination of high-resolution output were evaluated separately using a rating scale from 1 to 10, the former received a higher overall rating for 52% of the forecast periods, and a lower rating only 14% of the time. When the same type of rating procedure was used to evaluate model predictions of convective initiation, evolution, and mode, one of the high-resolution models was rated significantly better than the operational Eta model for convective initiation, evolution, and mode. Widely used objective verification procedures were also applied in evaluating both the human

forecasts and the model output, and these metrics generally substantiated the subjective verification results. Thus, the program provided strong evidence that near-cloud-resolving configurations of the WRF model can provide valuable and unique information for forecasters of severe convective weather, enabling them to make more skillful forecasts on at least some days.

3. BENEFITS AND LESSONS LEARNED: OPERATIONAL PARTNER PERSPECTIVE

Before the start of the program SPC forecasters had little experience with high-resolution forecast models and they were uncertain about the value and potential impact of these models in the operational severe weather forecasting arena. The experiences of the numerous forecasters and research scientists who participated in the experiment and the documented findings indicate that high-resolution WRF models demonstrated remarkable forecast skill on some days. These results strongly suggest that continued development efforts in high-resolution WRF modeling will be beneficial to operational forecasting, and they have clear potential to improve severe weather forecasts.

Forecasters who participated in the program benefited from interactions with both local and visiting scientists. Much of this interaction occurred in one-on-one or small group settings, a forum that was extremely important for developing mutual respect among the participants. The scientific exchange was also enhanced greatly by one-hour seminars that all COMET-supported visiting scientists delivered (see section 5.1). The seminars were well attended by a variety of operational forecasters and research scientists. These were part of a larger training program designed to educate and familiarize SPC forecasters about basic concepts related to high-resolution modeling, as well as other relevant research interests of the visitors.

4. BENEFITS AND LESSONS LEARNED: UNIVERSITY PARTNER PERSPECTIVE

The 2004 Spring Program provided numerous benefits for university participants, both scientifically and academically. It generated valuable and unique feedback to university model developers as they continue to test the WRF model and optimize its performance. This was true even for developers who did not participate directly in the program, as scientific results were disseminated into the community by publications and presentations (see section 5). For those who did participate, however, the reward was much greater. They had a rare opportunity to work where “the rubber hits the road” – where operational forecasters use models to make decisions that directly impact life and property. Through this experience, they came to understand the challenges and constraints that operational forecasters face on a daily basis. This experience will give them the knowledge to design research projects that are more relevant to operational forecasting problems. Furthermore, for those participants who have teaching responsibilities, the program will allow them to introduce “real-world” relevance into the classroom.

The Spring Program provided a particularly valuable opportunity for one undergraduate Meteorology student, Adam French, a rising senior from Valparaiso University. Adam worked at the SPC during the summer under the auspices of the Oak Ridge Institute of Science and Education (ORISE) and he assisted in the evaluation of the Spring Program data. He analyzed daily participant feedback, experimental forecast evaluations, and subjective model verification data collected in real-time during the program. He also assisted in the analysis of the weekly participant survey forms. At the conclusion of his summer experience, he wrote a brief paper summarizing his statistical findings, and presented a seminar as part of the Oklahoma Weather Center summer student program. This experience enabled him to better understand how applied collaborative research activities contribute to advancing forecast improvements, and directly contributed to his decision to apply to graduate schools this semester to continue his own academic research experiences.

5. PUBLICATIONS AND PRESENTATIONS

Bright, D. R., 2004: Examination of several different versions of the WRF model for the prediction of severe convective weather: The SPC/NSSL Spring Program 2004. Presented at the 8th Great Divide Workshop, September 10, 2004, Billing, MT.

Kain, J. S., S. J. Weiss, J. J. Levit, M. E. Baldwin, and D. R. Bright, 2004: Evaluating the utility of WRF as a severe weather forecasting tool. Presented at the First Joint WRF/MM5 User's Workshop, June 22, 2004, Boulder, CO.

Weiss, S. J., J. S. Kain, J. J. Levit, M. E. Baldwin, and D. R. Bright, 2004: Examination of several different versions of the WRF model for the prediction of severe convective weather: The SPC/NSSL Spring Program 2004. *Preprints, 22nd Conference on Severe Local Storms*, Hyannis, MA, Amer. Meteor. Soc., CD-ROM, paper 17.1

Weiss, S. J., J. S. Kain, J. J. Levit, M. E. Baldwin, and D. R. Bright, 2004: Examination of several different versions of the WRF model for the prediction of severe convective weather: The SPC/NSSL Spring Program 2004. Presented at 29th Annual National Weather Association Meeting, October, 21, 2004, Portland, OR.

Weiss, S. J., J. S. Kain, J. J. Levit, M. E. Baldwin, and D. R. Bright, 2004: Examination of near-convection-resolving configurations of the WRF model for the prediction of severe convective weather: The SPC/NSSL Spring Program 2004. To be submitted to *Wea. Forecasting*.

Weiss, S. J. and J. T. Schaefer, 2004: A historical perspective on the role of NWP models in the prediction of severe local storms. Presented at the Symposium on the 50th Anniversary of Operational Numerical Weather Prediction, June 15, 2004, College Park, MD.

5.1. Presentations by COMET-supported visiting scientists

"A decade of exploration of the use of mesoscale models in making convective forecasts. Presented by Prof. Paul Roebber, University of Wisconsin (Milwaukee), May 3, 2004, Norman, OK.

"Application of the Meso-West cooperative networks for environmental analysis and prediction". Presented by Prof. Jim Steenburgh, University of Utah, May 11, 2004, Norman, OK.

"The promise and challenge of explicit convective forecasting with the WRF model". Presented by Dr. Morris Weisman, NCAR, May 17, 2004, Norman, OK.

"Numerical simulation of waterspouts in the Tyrrhenian Sea". Presented by Prof. Greg Tripoli, University of Wisconsin (Madison), May 18, 2004, Norman, OK.

"Comparing methods for the operational estimation of precipitation efficiency". Presented by Prof. Pat Market, University of Missouri (Columbia), May 20, 2004, Norman, OK.

"Use of a modified Ebert-McBride technique to evaluate IHOP QPF as a function of convective system morphology (and other attempts to improve warm season rainfall prediction)". Presented by Prof. Bill Gallus, Iowa State University, May 26, 2004, Norman, OK.

"Mesoscale divergence observations in convecting areas". Presented by Dr. Brian Mapes, CIRES/University of Colorado, June 3, 2004, Norman, OK.

5.2 Presentation by ORISE-supported undergraduate student

"The Effects of High Resolution Model Output on Severe Weather Forecasts as Evaluated in the SPC/NSSL Spring Program 2004". Presented by Adam French, Valparaiso University, July 29, 2004, Norman, OK.

6. SUMMARY OF UNIVERSITY/OPERATIONAL PARTNER INTERACTIONS AND ROLES

This year we took a key step in organizing the Spring Program, forming partnerships with CAPS, EMC, and NCAR. We collaborated with these three institutions to design WRF model configurations that allowed us to examine key scientific issues while producing a range of possible solutions that figured in the forecast-preparation process. The individual institutions controlled realtime initialization and integration of these configurations, while scientists at NSSL/SPC supervised the post-processing, importation, and display of results. Collaboration with these partners culminated with direct participation of many of their representatives in day-to-day operations during the Spring Program.

Spring Program participants included SPC forecasters and support scientists, NSSL/CIMMS researchers, forecasters/SOOs from other NWS offices, research scientists and forecasters from numerous other NOAA agencies, AFWA, NCAR, the Meteorological Service of Canada, the Finnish Meteorological Institute, and a number of academic institutions (Universities of Arizona, Iowa State, Missouri-Columbia, Oklahoma, Utah, Valparaiso, Wisconsin-Madison, Wisconsin-Milwaukee, the Naval Postgraduate School, and SUNY-Albany). Partial travel expenses for visiting scientists from the University of Wisconsin at Milwaukee (Paul Roebber), the University of Utah (Jim Steenburgh), NCAR (Morris Weisman), the University of Missouri at Columbia (Pat Market), University of Wisconsin at Madison (Greg Tripoli), Iowa State (Bill Gallus), and CIRES (Brian Mapes) were provided by the COMET partners grant. We were able to leverage COMET funds to get supplementary travel support from NSSL.

Many benefits of the Spring Program are not immediately obvious. On an individual level, many participants reported that the most rewarding aspect of the program was the unique and lively interaction between forecasters and researchers. Working relationships were forged and mutual respect was earned, perhaps because of the challenging demands that were placed collectively on all participants. Forecasters and researchers alike were required to make a consensus prediction in the face of uncertainty, to critically examine their decisions as verifying data became available (often a humbling experience), and to arrive at a consensus on numerous other subjective assessments. Through this process, forecasters learned to take a more scientific approach to making predictions and researchers learned to appreciate the uncertainty and operational constraints associated with the daily challenges of SPC forecasters. The program “greases the skids” for the transfer of science and technology into forecast operations and it makes participating research scientists better equipped to formulate and conduct operationally relevant research. For those participants who have teaching responsibilities, the program also provides them with the knowledge to bring “real-world” relevance into the classroom. Several external participants in the 2004 Spring Program indicated that their experience in the program would have a direct impact on the content of courses that they teach at major universities. Thus, the influence of the Spring Program is far reaching, touching and uniting the areas of operational forecasting, scientific research, and university instruction.