Final Report for COMET Partners Project

University:
University of Wisconsin at Milwaukee

Name of University Researcher Preparing Report:
Professor Paul J. Roebber

NWS Office:
Wilmington, OH (KILN)

Name of NWS Researcher Preparing Report:
John T. DiStefano

Partners or Cooperative Project:
A Method to Improve Minimum Temperature Forecasts

UCAR Award No.:
S05-53805

Date:
October 4, 2006

SECTION 1: SUMMARY OF PROJECT OBJECTIVES

Accurate forecasts of minimum temperature are important in a variety of contexts including: heating and cooling (energy sector), agriculture, heat stress (warm season), wind chill (cold season), aviation safety, and precipitation type. As part of the modernization of the National Weather Service, emphasis is being placed on digital gridded forecast output. As a subset of this overall output, gridded temperature forecasts are required with a minimum horizontal resolution of 5 km at time intervals of 3-hours (6-hours) out to three (seven) days. Utilization of these forecast grids by external users continues to increase.

Despite the relevance of and requirements for such forecasts, providing accurate minimum temperature forecasts can be a major challenge, particularly during the cool season, when certain variables have greater influence in the forecast process than during the warm season. Although MOS is often an important element in the forecast process that has helped to reduce minimum temperature forecast errors, further insight into problematic forecasts is required to improve accuracy. In particular, the MOS technique is a multiple linear regression approach. Although this is a suitable approach for a variety of forecast parameters including temperature in many situations, further advances are possible using sophisticated nonlinear techniques such as neural networks. The objective of this work was to study in detail the physics of minimum temperature forecast busts and to apply modern data analysis tools to such forecasts to improve overall forecast performance.

SECTION 2: PROJECT ACCOMPLISHMENTS AND FINDINGS

A database consisting of observed and forecast minimum temperatures and attendant meteorological measures was constructed for southwest Ohio (CVG, DAY, CMH). Forecast bust events were highlighted for special study regarding the physics, while the overall dataset was used to construct improved minimum temperature forecast guidance.

A 1D atmospheric boundary layer model was applied to two "dewpoint crash" events in the period of record to understand the mechanisms driving the steep temperature falls and the forecast sensitivities in these events. A logistic regression procedure was developed to identify forecast situations in which large forecast errors could be expected. A neural network was trained and tested that reduced forecast errors across the range of forecast situations.

A technical report was written and provided to NWS-KILN that documents the procedures and findings of the study. On-site training of forecasters is planned, in conjunction with implementation of the logistic regression/neural network tools at KILN.

Two refereed publications are planned. The first, to be submitted to *Mon. Wea. Rev.*, details the results of the dewpoint crash studies. The second, to be submitted to *Wea. Forecasting* details the logistic regression/neural network tool and will follow closely along the lines of the technical report.

SECTION 3: BENEFITS AND LESSONS LEARNED: OPERATIONS

NWS Wilmington forecasters are anticipating the introduction of a developed tool/technique that will assist in improved minimum temperature forecasts. The work to date has established the tool – what remains is to implement it. However, since we have not yet introduced this technique into NWS operations, benefits and lessons learned can not adequately be addressed.

In looking ahead to the tool's implementation, it is envisioned that operational evaluation will commence immediately. Forecasters will be trained on proper use of the tool, and briefed on the resultant findings of this study. Expected benefits are for increased forecaster awareness concerning those instances that would alert of potential improvements to minimum temperature forecasts. These improvements will have the greatest impact when normal numerical weather guidance has the largest errors.

SECTION 4: BENEFITS AND LESSONS LEARNED: UNIVERSITY

One major benefit of this interaction has been the ability to involve three undergraduate students in research. Two of the three have subsequently graduated: one is pursing a doctorate at the University of Stockholm, while the other is currently a masters student at UW-Milwaukee under the University PI's direction. The third student is completing her undergraduate work at UW-Milwaukee and intends to continue on for graduate studies.

A second major benefit is our now increased understanding of the minimum temperature forecast problem. Several key forecast biases have been revealed and with the development of the forecast tool, will be addressed in future forecasting. All of these results will be disseminated in subsequent publications.

SECTION 5: PUBLICATIONS AND PRESENTATIONS

A talk based on this work was presented in the poster session of the CMOS meeting in Toronto, Canada in May 2006. A technical report was produced, and two refereed publications, as described above, are in the writing stages.

SECTION 6: SUMMARY OF UNIVERSITY/OPERATIONAL INTERACTIONS

The interactions between University and Operational personnel were effective and productive, within the very real constraints of time (on both sides) and funding (on the university side). We intend to continue interactions outside of the grant, in order to complete implementation efforts. The funding limitations have been handled by leveraging this activity with other sources. The funds from this grant allowed the University PI to hire three part-time undergraduates. He was able to bring two of these students along on a conference trip, to gain experience at presenting their work in a scientific forum – funding for this trip was provided out of other sources.