VALUE-ADDED QUANTITATIVE PRECIPITATION FORECASTS

How Valuable is the Forecaster?

BY DAVID REYNOLDS

The Hydrometeorological Prediction Center (HPC), one of six service centers of the National Centers for Environmental Prediction (NCEP), has produced daily quantitative precipitation forecasts (QPFs) for the continental United States since the 1960s. These forecasts have depended heavily on numerical guidance provided by the suite of NCEP operational forecast models. A comprehensive review of the methodology used to produce and verify the HPC's manual forecasts and the use of the threat score is described in Olson et al. (1995). A more recent study (Charba et al. 2003) goes into greater detail as to the best methods to quantify forecast accuracy with regards to quantitative precipitation forecasts.

The purpose of this short note is to relate forecaster improvements made to numerical guidance QPF to the number of years of model development required to reach this same level of accuracy. Such an assessment necessitates looking at the long-term trends in the day-1 manual QPF scores. Figure 1 shows the yearly manual threat score plotted for the day-1 (12- to 36-h forecast) precipitation amount of 1 in. or greater.

Over the 37-yr period that is plotted, there is an improvement of 56% in the threat score using the linear fit to the data. Also plotted on Fig. 1 is the 5-yr running mean. This is shown to see if there is any direct correlation between new model implementations and improvements in accuracy. Key dates worth noting are 1966 [six-level primitive equation (PE)]; 1972 (LFM 1); 1979 (LFM 2); 1985 [nested grid model (NGM)]; and 1993 (Eta). Since 1993, various improvements have been made to the Eta physics package, and the grid size has changed from 80 to 12 km. Similar types of improvements have been made to the global forecast model now called the AVN (most recently changed to the global forecast system). This model currently runs with a spectral resolution of T254. Each of these implementations required a major upgrade to the computer architecture. Based on these dates there appears to be no direct correlation between model upgrades and a change of slope in the 5-yr running mean. What may complicate this relationship is the variability in weather patterns that may lead to more or less predictability, varying over a season or a few years. This variability might in fact mask whatever model improvements there were.

The steady growth in accuracy depicted in Fig. 1 equates to a 1.6% improvement per year. As Olson et al. (1995) pointed out, the increase in forecaster QPF accuracy over the years is more dependent on numerical model guidance than on the number of years of experience by the forecaster. This conclusion seems reasonable since there have been many changes in forecasters over the 36-yr period. Thus, it is appropriate to attribute the slow but steady rise in the manual forecast accuracy to a slow and steady rise in accuracy of the numerical models. This assumption will be fundamental to defining the value added by the forecaster. In fact, any improvement beyond that produced by the models can be defined as the accuracy of the forecasters relative to the accuracy of the models.

Figure 2 shows the percentage improvement of the HPC day-1 1-in. QPF threat score over the operational NCEP global AVN model and the NCEP regional Eta Model for the past 8 yr. During the early to mid-1990s, the percentage improvement was about 30%. From the mid- to late 1990s the percentage improvement fell to about 20%. Olson et al. (1995) showed results from 1988 to 1994 comparing HPC forecasts to the NGM. These results indicated almost a 50% improvement by the forecaster. If one looks just at the calendar year 2001, the percentage

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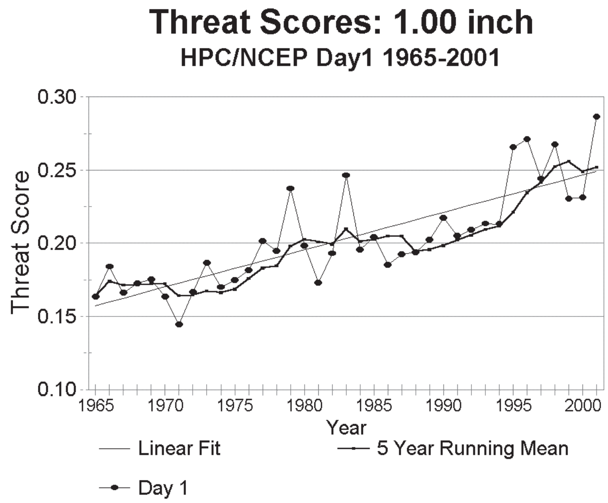

Fig. 1. HPC manual day-1 annual threat scores. Both a linear fit to the data and a 5-yr running mean are annotated. New model implementation dates are also noted.

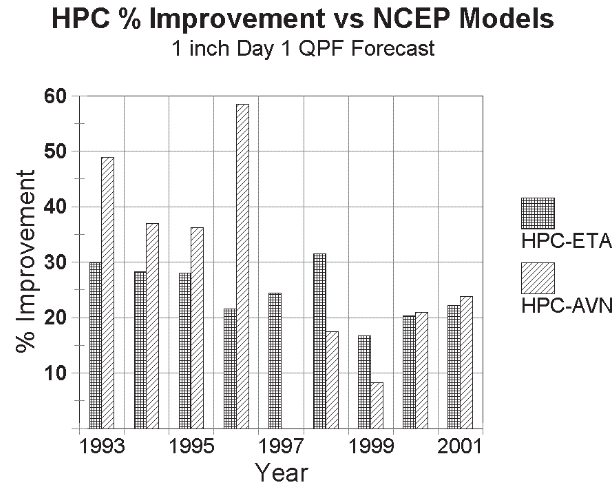

Fig. 2. Forecaster improvement in percent over operational NCEP models for the day-1 1-in. or greater category.

improvement, although greater in the cool season than the warm season, has averaged about 22%, close to the trend of the last 5 yr (see Fig. 3). Olson et al. (1995) described in detail the reasons why forecasters are able to add value to the model guidance; these reasons are still valid today. It would appear, however, that as the models have been improved and the time between model implementations has been reduced from a 5-yr cycle to once or maybe twice per year, the forecasters have a more difficult time tracking model biases and thus, knowing exactly how and when to adjust the QPFs.

The question this note addresses is "How does one associate value with forecaster improvement?" As previously mentioned, the goal is to assess value in terms of the years of model development required to reach the same level of accuracy exhibited by forecasters. Based on the estimated 1.6% improvement per year by the models as shown in Fig. 1, this 22% improvement equates to 14 yr of model development. In other words, by having manual forecasts produced, the public is realizing a 14-yr improvement in the quality of the day-1 QPF over what would be available if only direct numerical guidance were used.

As the National Weather Service continues to modernize and improve its products and services, especially as this relates to the costs associated with these improvements, it is essential to keep in mind the importance of the forecaster (Snellman 1977; Doswell and Brooks 1998). As Doswell and Brooks point out, the benefit of the forecast to the user community must be quantified. This note has quantified benefit, not in terms of direct economic benefit, but in terms of years of improvement by the forecaster. The forecaster must utilize his/her understanding of the physical processes leading to moderate-to-heavy rainfall combined with a thorough understanding of the numerical guidance—both strengths and weaknesses—in order to add a significant amount of accuracy to the QPF. A

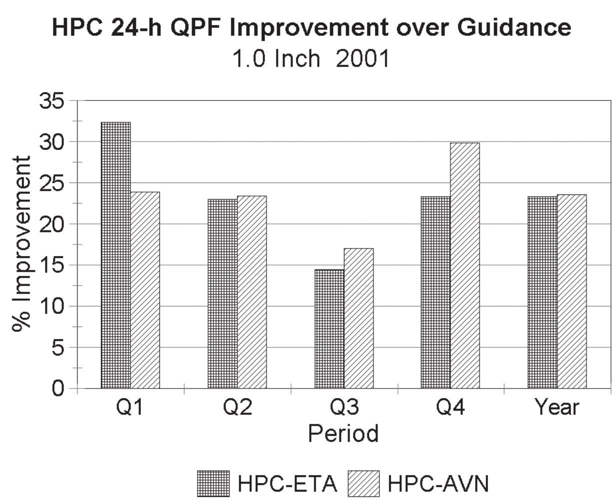

Fig. 3. Calendar year 2001 for percent improvement for the day-1 1-in. or greater category by quarter and for the entire year. Graph shows normal seasonal variation from the cool to warm season.

14-yr improvement in QPF accuracy is a significant benefit; the results presented in this short note would strongly support the continued role of the forecaster in the forecast process.

This conclusion will be severely tested over the next several months. NWS forecasters will begin implementing a new digital forecast process. That is, all routine forecasts will be derived from a manually edited set of grids. These digital forecasts will be set up as a mosaic in a National Digital Forecaster Database (Glahn and Ruth 2003; available online at www.nws.noaa.gov/ndfd/). Verification of these grids against model guidance will be conducted. This will provide additional opportunity to measure the value of the forecaster in the forecast process.

FOR FURTHER READING

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