JP4.5 TRAINING ON BETTER OPERATIONAL USE OF NUMERICAL WEATHER PREDICTION (NWP) MODELS: NEEDS ASSESSMENT SURVEY RESULTS

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1. INTRODUCTION

The Cooperative Program for Operational Meteorology, Education and Training (COMET®) Program has been developing forecaster training on numerical weather prediction (NWP) for ten years (e.g., see Bua and Jascourt (2005), Jascourt and Bua (2004) and references therein). COMET training on NWP is free and available online. Most items are listed on the MetEd web page at http://meted.ucar.edu under the topic "NWP".

In recent years, the COMET Operational Model Matrix at http://meted.ucar.edu/nwp/pcu2 and other COMET training, such as webcasts (see http://meted.ucar.edu then select NWP from the topics menu) and VISITView teletraining (see http://rammb.cira.colostate.edu/visit/topic_nwp.html) on the ensemble forecast systems and on the National Centers for Environmental Predication (NCEP) North American Mesoscale Model (NAM) transition from Eta to the Weather and Research Forecast (WRF) – Nonhydrostatic Mesoscale Model (NMM), among others, helped translate model changes into the context of the field forecaster, facilitating better use of the models.

However, most of this training has focused on particular models, model changes, and new model products. Some of the details on general NWP have become outdated, though many of the principles presented still hold. More importantly, NWP training is needed to integrate the suite of models and products together in the context of the forecast process, rather than focusing on specific models or types of products.

Meanwhile, National Weather Service (NWS) forecasters now create grids of sensible weather forecasts at 5-km or 2.5-km grid spacing. The application of NWP products has been correspondingly extended from conceiving of the forecast to using a grid editor to create the forecast, but our training has until now considered the former to be the endpoint. Good scientific practice would not allow the mechanics of the gridded forecast process to drive how model data are utilized in creating a forecast. Nonetheless, training must extend through the creation of the end product in order to optimize the use of NWP in the final forecast.

These factors led NWS to prioritize development of a new forecast training course on the effective use of NWP in the forecast process. A needs assessment survey was conducted to identify more precisely what the course should contain. This article focuses on the needs assessment survey. Our companion article (Bua and Jascourt, 2009), focuses on the new course itself.

2. PURPOSE OF NEEDS ASSESSMENT SURVEY

We needed to determine the NWS NWP training needs before we could develop the new course. The needs assessment survey was designed with this purpose in mind Additionally, more resources were necessary to complete the new course in a timely manner. To solicit such resources, the survey also asked if respondents:

1. Had developed any material to address the cited need, and
2. Whether they would be willing and able to contribute that material or develop new material for the new course.

3. CONDUCTING THE SURVEY

Survey questions prepared by the COMET NWP Team were modeled after the needs assessment

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survey conducted by the NWS Warning Decision Training Branch (WDTB) for the development of their Advanced Warning Operations Course – Winter Track (Winter AWOC; see http://www.wdtb.noaa.gov/courses/winterawoc/index.html for course description and links to webcast lessons). The survey and results were programmed online by Michael T. Smith at NWS Headquarters. Surveys were entered through a NWS password-protected site which uniquely identified each respondent, enabling the system to allow the user to save preliminary responses and edit them further at a later time, while not allowing more than one response per person. However, the results database did not provide respondent's identifying information, allowing respondents to remain anonymous if they wished.

A request for people to respond to the survey was posted on an email list distributed to NWS Science and Operations Officers (SOOs) and meteorologists in the Scientific Services Division (SSD) at each of the NWS regional headquarters. Each NWS forecast office has a SOO, who is responsible for training of forecasters in that office (among the many responsibilities of the SOO). Some recipients passed the information along to line forecasters.

Responses were grouped by question automatically by the software. The COMET NWP team further parsed the results manually to identify common topics or threads.

4. RESULTS

There were 42 responses analyzed, 27 from self-identified WFOs indicated in white on the map in Figure 1, 11 anonymous, two from the NCEP Hydrometeorological Prediction Center, and one each from a Southern Region forecast office and the Western Region SSD. No respondents who identified themselves were from NWS operations in Alaska, Hawaii, Guam, or Puerto Rico. Two later responses were consistent with the first 42, thus, not changing this analysis.

A brief summary of the responses is given here.

4.1 Question 1: What aspects of using models and model guidance products in the operational forecast process need improvement in your office (or region)? Please explain if necessary.

Many needs for improvement were identified. Responses were voluminous and widely varied. Most fell into these categories:

Ensemble/probabilistic

- "Effective use", "know how to make good use", etc. - SREF, GEFS, NAEFS
- Data digestion – how to quickly assess, better AWIPS access, better display
- Assessing uncertainty and probabilistic forecasting (e.g., POP)

MOS – how use in forecast process, ensemble MOS, gridded MOS

High-resolution models (say $\Delta x < 5$ km)

- Use in forecast process, differences from meso/synoptic scale models
- Interpretation, simulated reflectivity, convective mode
- Local initialization (1 response)

Basic NCEP operational models

- Strengths, weaknesses, keeping up with changes, convection
- Model bias – too fast/slow, p-type, regime-based errors, etc.
- Comparisons – which is best for a particular phenomenon/scenario
- Interpretation – believability, predictability

QPF – singled out among forecast parameters

Forecast process

- Gridded forecast generation
- Observations – pay attention, check model initializations, everything starts with obs
- Where can human add value, what to focus on, how good is "good enough"
- Verification
- Model comparisons, "model of the day" (or not), how to determine which to use
- Warn-on forecast (1 response)

Aviation – especially ceiling and visibility grids (1 response)

AWIPS-related and diagnostics

- Diagnostics (q-vectors, frontogenesis, etc.), what useful, how best utilize
- GFE downscaling vs. model-resolvable features, downscaling, GFE

Organization of information – concise, one-stop shopping

Some identified needs could met by existing COMET NWP training materials; thus one factor in improving effectiveness of training is improving awareness of what is already available.

4.2 What aspects of using models and model guidance products in the operational forecast process are not in much need of improvement in your office (or region)? Please explain if necessary.

Few items were identified as not needing improvement. Only 2/3 of respondents answered this question, and of those, almost 1/3 (9 of 28) said they are not sure or that no aspects are not in need of improvement. The remaining responses mostly mentioned large-scale features, "knobology", and decoding text bulletins. Several respondents specifically said that forecasters do not spend much time on the large-scale atmospheric flow.

4.3 Prioritize the following topics of instruction from 1 to 8 (with 1 being the highest) in terms of a perceived need for training over the next 2 to 3 years. Please check the box in the right column next to those topics that are particularly urgent.

The eight topics listed clustered into four considered urgent by 21% or more of respondents and four considered urgent by 7% or fewer. The four most urgent were, in priority order, using NWP to assess forecast uncertainty, using NWP at the meso-α to county scales, using NWP at the scale of the grids created as final human forecast products (currently 5 km grid spacing at some offices, 2.5 km at other offices), and probabilistic NWP. Topics not considered urgent were using NWP at the synoptic to meso-α scale, model data sources and characteristics including post-processing, formulating the forecast problem as a testable hypothesis using available models runs, and using NWP at the global to continental scale. Some respondents (43%) did not select any topics as urgent. A small fraction of respondents suggested other topics.

4.4 Briefly describe up to 3 potential new instructional topics that would be useful in your office or region for improving operational use of NWP.

This question allowed respondents to elaborate about specific topics they would find helpful for training forecasters in their location or region. Most of the topics fell into these categories:

Ensemble/probabilistic (most popular topic area, wide variety of focus areas)

- Probabilistic forecast products, conveying uncertainty to users
- Anomalies, extreme events
- COMAP topics (2008)
- Ensemble clusters, ensemble probabilities, new probabilistic tools

Initial condition assessment, data assimilation – general, practical exercises

High-resolution models (say $\Delta x < 5$ km)

- Interpreting, making sense of output
- When is it better/worse than coarser resolution models

Forecast methods/techniques – QPF, downscaling, identifying when models deficient

Model architecture

- Keeping up with changes
- Boundary layer
- Complex terrain

4.5 What innovative tools (software applications, forecasting techniques, etc.) are used in your office (or region) for model evaluation and assessment during the forecast process?

This question gathered information about methods and applications used at one forecast office which could be used at many others. Ten responses explicitly said "none", while 27 responses mentioned items such as:

- Web pages for viewing ensemble or probabilistic model output
- Using the BOIverify tool to compile a gridded verification history (assuming some selected gridded analysis for verification) by model or by individual forecaster and to display maps of spatially varying biases of that composite.

4.6 Is there a local training module, such as a WES case, that would potentially provide good training on best practices in the use of NWP? If so, please provide a brief description and let us know if you would consider allowing us to adapt it for a national audience.

This question asked for existing cases which could be modified for COMET training instead of developing similar materials from scratch. Eleven respondents indicated they do have cases, of which nine were specific while two did not indicate the topic or nature of their case. Respondents with local cases are geographically and topographically diverse, covering a rich tapestry of forecast challenges.

4.7 Have you or someone in your office developed, or, is interested in developing, a training module on NWP best practices? If so, please provide a brief description and let us know if you would consider allowing us to adapt it for a national audience.

This question directly solicited contributors to the new COMET NWP course. Nine respondents offered, though one was anonymous and one was interested but without a specific topic. Some topics turned out not to be among the high priority items or for other reasons are being deferred, and one was substantially redundant with existing COMET training though tailored for the respondent's forecast area.

4.8 Do you think the forecast funnel approach (evaluating largest to smallest scales) is the best approach in the NWS operational environment? Are there other approaches we should consider? If so, please provide a brief description.

In sending out the survey, we drafted a strawman proposal of the new course, organized along the lines of the forecast funnel (Snellman 1977). This question was to get feedback on whether, regardless of specific topics included, it makes sense to structure a course on application of NWP following the forecast funnel from larger scales to smaller scales. Most respondents (35 of 42) answered this question, around 1/3 (11) of whom gave an unqualified endorsement of the forecast funnel. .Almost all others gave more nuanced support, recommending focus on local, smaller-scale aspects of the forecast.

5. CONCLUSION

NWP training is still vitally needed in forecast offices *in the context of the forecast process.* Training needs group into four categories

1. Forecast process (including "pay attention to observations, analyze/think!")
2. Core model topics (bias, diagnostics, what's in the model, etc.)
3. Uncertainty/probabilistic (focusing heavily on use of ensembles)
4. Local-scale forecasting for NDFD (high-resolution models, downscaling, etc.)

We successfully Identified possible contributors with existing materials or interest in developing such materials. Several are now working with us to develop the new course. We needed to find others in addition, but some of those identified through the survey were crucial to starting course development and provided the critical mass to attract the others we needed.

The proposed course on effective use of NWP was redesigned based on survey responses (and

subsequently further redesigned together with SOOs contributing to the course).

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