COMET TRAINING ON THE USE OF HIGH-RESOLUTION MODELS

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1. INTRODUCTION

Convection-allowing models have been used for research for several decades already, but their use in real-time forecast operations is a more recent development and has become far more widespread over the past few years. For example, some National Weather Service forecast offices have access to 4-km WRF-NMM and 5-km WRF-ARW “high-resolution window” runs which are operationally produced by NCEP, 3-km WRF-ARW hot-start High-Resolution Rapid Refresh (HRRR) runs from NOAA/ESRL which, although not fully operational, are more than around 95% reliably available, and models run locally at the forecast office in real time. The HRRR and high-resolution window runs are also publicly available. Some universities and the private sector are also running high-resolution models in real time.

Forecaster training is needed on how to utilize and interpret the output from high-resolution models run at grid spacings finer than around 5 km and not employing a deep convective parameterization. For example, this topic was identified as a high priority by National Weather Service (NWS) Science and Operations Officers working in forecast offices across the United States and by the NWS Regional Scientific Service Divisions (Jascourt and Bua 2009).

In response to this need, the The Cooperative Program for Operational Meteorology, Education and Training (COMET®) Program developed a web-based training module, Effective Use of High-Resolution Models, available online at http://meted.ucar.edu/nwp/hires . This lesson is also being supplemented by a case available on the AWIPS training machine, the Weather Event Simulator (WES). The WES case is being assembled by the NWS Warning Decision Training Branch and would be available on DVD directly from them. The web module is part of the new COMET NWP Training Series, available online at http://meted.ucar.edu/dl_courses/nwp and described in Bua, Jascourt, and Byrd (2010). COMET has been developing forecaster training on numerical weather prediction 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 will be listed on the MetEd web page at http://meted.ucar.edu under the topic “NWP”.

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The purpose of this article is to make the largest possible audience of interest aware of this new, free, and publicly available training and offer a few highlights from it. The web module takes only around 90 minutes to complete and provides a foundation. In such a limited time, the reader could not possibly be exposed to the full range of related training topics and applications. COMET in collaboration with the NWS is developing additional training which will incorporate high-resolution models as one of the tools used to forecast in various types of challenging situations.

In addition to this training on the use of high-resolution models, a training module on downscaling is also available, at http://meted.ucar.edu/nwp/downscaling . That module compares dynamical downscaling by high-resolution models to physical and statistical downscaling, although the emphasis is more on the latter two.

2. INTERACTIVE LEARNING

The lesson is filled with questions and interactions, conveying some of the information through the feedback explaining the correct choices. In this example, the forecaster can practice identifying some of the various types of storm structures models are capable of simulating.

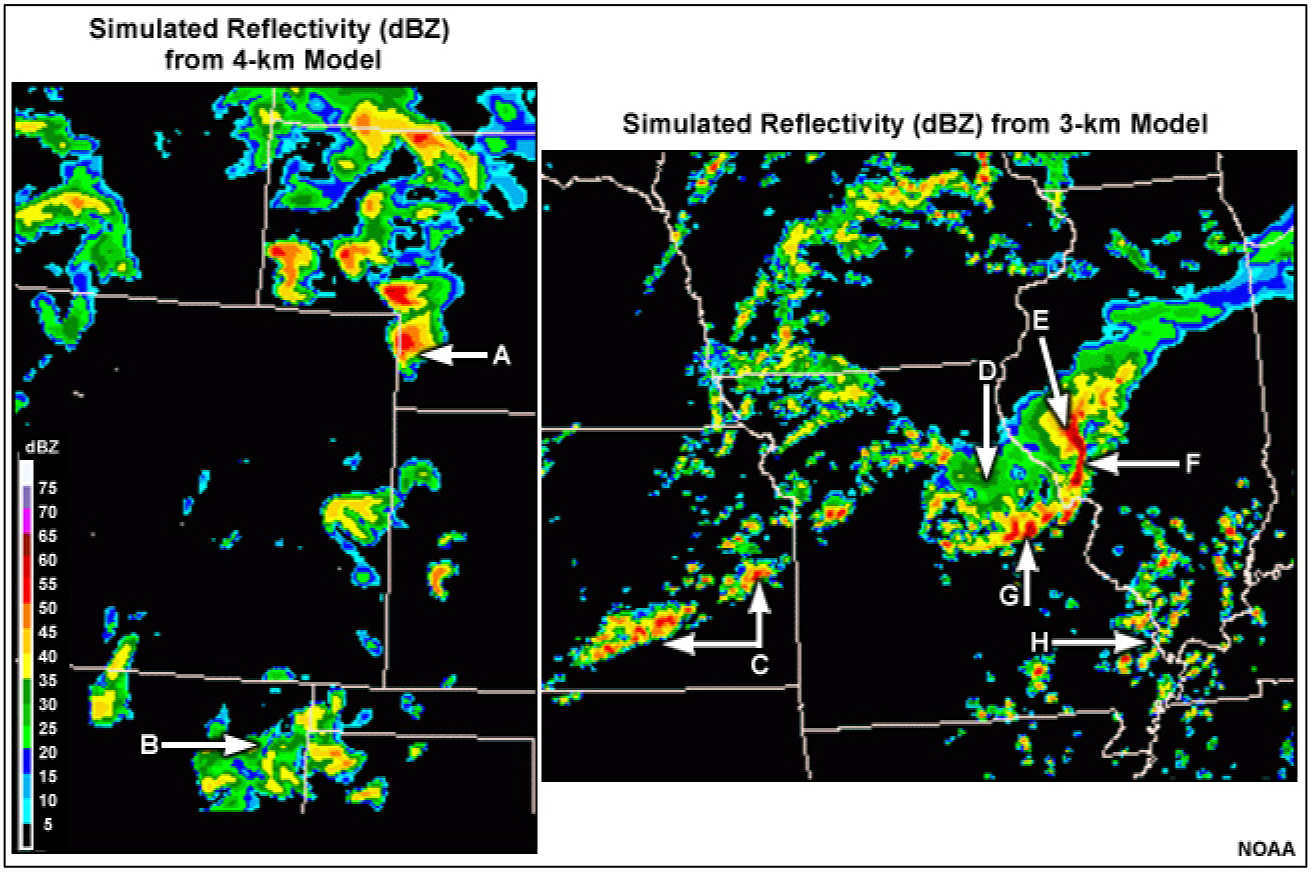


Figure 1. The reader is asked to identify features labeled A through H, selecting from a list.

3. INTERPRETATION

Numerous interpretation issues are raised. For example, is the predicted phenomenon real? It looks realistic, but will it verify? The reader is asked to identify which of the below images (Fig. 2) is a mosaic of observed radar reflectivity. The other three are forecasts. This illustrates not only the realistic-looking nature of the model output but also predictability limitations – all are valid at the same time but have storms in different places. The predictability theme is raised repeatedly and the suggestion is made to interpret the model forecast as an event prediction instead of a point prediction.

Model diagnostics such as updraft helicity are introduced as well as the notion of maximum output over time, such as the maximum wind speed or updraft helicity over the past hour.

The complexity of the model forecast is also presented.

One key issue confronting forecasters is the masking of the synoptic signal by higher-amplitude mesoscale details. A forecast image of 500 hPa absolute vorticity and simulated radar reflectivity from the HRRR are juxtaposed using a slider bar (Fig. 3), allowing the reader to see that the highly textured appearance of vorticity coincides with fine-scale precipitation structure. An explanation is provided.

Another level of complexity is the detailed structure around model convection. Forecast soundings around simulated convection are shown and discussed. Figure 4, a snapshot during the middle of the event, shows cool low levels and dry air aloft behind the storm at KSUS, saturation to the tropopause in the storm at KSTL, and a deep MAUL-topped mixed layer where the model has low-level ascent ahead of the storm at STL. All three soundings in different mesoscale regimes around the storm are predicted to occur within the same metropolitan area. When forecasters examine a model sounding, they need to be able to recognize the processes producing it and realize the large magnitude of mesoscale forecast variability in proximity to model convection. This variability is probably not more than in nature around storms in a similar type of environment.

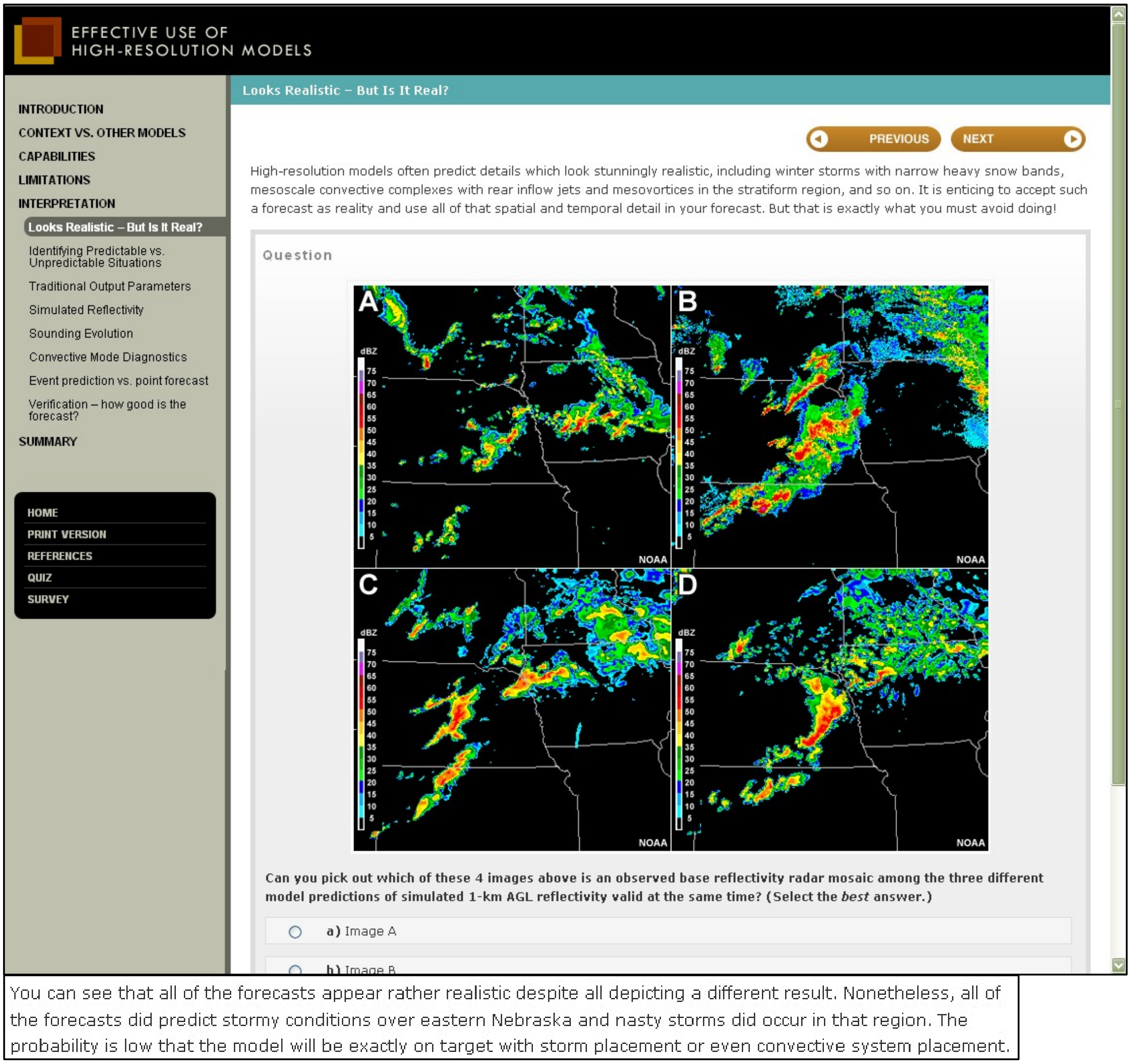
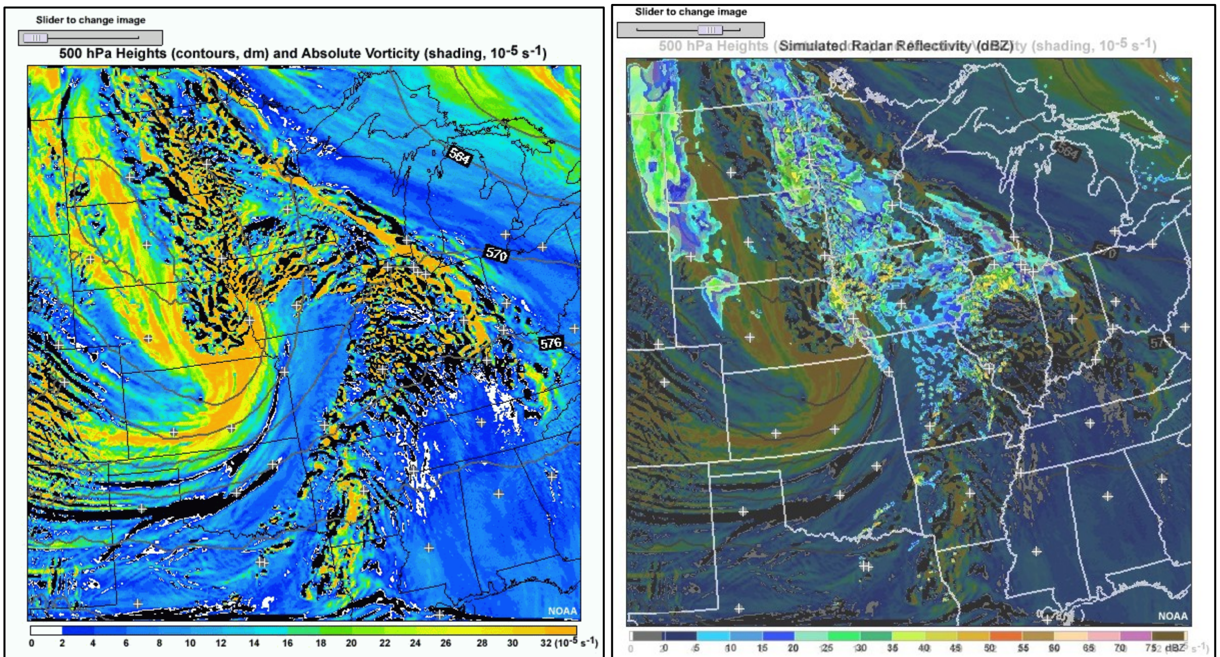


Figure 2. An exercise for the reader to recognize the realistic depiction of the model storm structures as well as the lack of predictability in timing and placement and even size of the structures.



to simulated reflectivity. This highly textured appearance of vorticity where precipitation is predicted is commonly seen because vertical motion pockets in shear flow create vorticity couplets through tilting of horizontal vorticity into the vertical. Conceptually, the textured vorticity pattern results from gradients in vertical parcel displacements, thus the scale of individual maxima or minima corresponds to the fine scale in the pattern of vertical motion in the model.

Figure 3. The slider bar at the top allows the image to fade from 500 hPa absolute vorticity to simulated radar reflectivity, allowing the two to be juxtaposed in one image as shown in the right panel. An exerpt from the explanation is provided below the two panels.

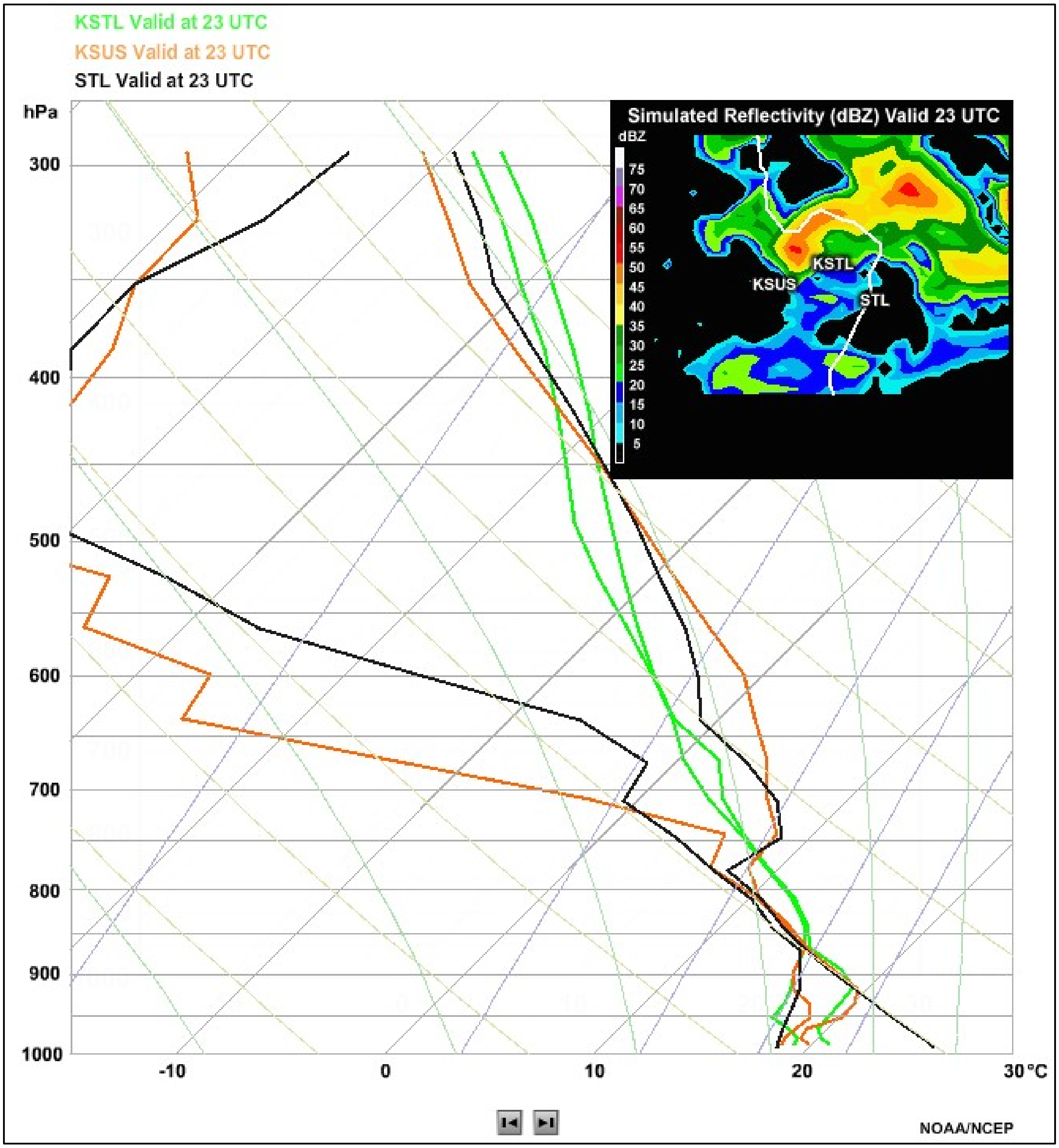


Figure 4. Forecast soundings from the three points indicated in the inset showing simulated reflectivity.

4. OTHER HIGHLIGHTS

The training also covers a variety of key limitations:

- Scales near the grid spacing are not resolved, leading to poor forecasts of details such as flow over complex terrain and convective storm-scale structures for features only a few grid spacings in size.
- The central role of initial and boundary conditions supplied by a coarser-resolution model is emphasized in a case study. The reader examines data and answers questions to progress through the case. Forecasters are urged to independently evaluate the large-scale flow, frontal positions and motion, and so on which are being downscaled in the high-resolution forecast.
- Sensitivity to physics and dynamics is mentioned.
- The spin-up time following a cold start and the short memory of small-scale information from a hot start are both presented using examples of forecasts valid at the same time.

5. ACKNOWLEDGEMENTS

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6. REFERENCES

Bua, W. R. and S. D. Jascourt, 2005: The Numerical Weather Prediction Professional Development Series (NWP PDS). Preprints, *21st Conference on Weather Analysis and Forecasting/17th Conference on Numeric al Weather Prediction, joint with 34th Conference on Broadcast Meteorology,* Washington, D.C., Amer. Meteor. Soc., on CD-ROM. [Available online at http://ams.confex.com/ams/pdfpapers/94546.pdf]

Bua, W. R., S. D. Jascourt, and G. Byrd, 2010: Effective Use of NWP in the Forecast Process: A New COMET distance learning course. *Extended Abstracts, 24th Conference on Weather Analysis and Forecasting/20th Conference on Numerical Weather Prediction*, Seattle, WA., Amer. Meteor. Soc. [Available online at http://ams.confex.com/ams/91Annual/webprogram/Session25203.html]

Jascourt, S. D. and W. R. Bua, 2004: Distance learning methods for numerical weather prediction (NWP) professional development training. *Preprints*, *13th Symposium on Education,* Seattle, WA, Amer. Meteor. Soc., on CD-ROM. [Available online at http://ams.confex.com/ams/pdfpapers/66415.pdf]

----- and -----, 2009: Training on better operational use of numerical weather prediction (NWP) models: Needs assessment survey results. *Extended Abstracts, 23rd Conference on Weather Analysis and Forecasting/19th Conference on Numerical Weather Prediction*, Omaha, NE., Amer. Meteor. Soc. [Available online at http://ams.confex.com/ams/pdfpapers/153224.pdf]