2A.4 EFFECTIVE USE OF NWP IN THE FORECAST PROCESS: A NEW COMET DISTANCE LEARNING TRAINING SERIES

Stephen D Jascourt[1], William R Bua[2], and Gregory Byrd[3]
UCAR/COMET
1. Silver Spring, MD 2. Camp Springs, MD 3. Boulder, CO

1. INTRODUCTION

The purpose of this article is to introduce the new COMET NWP distance learning *training series* which is presently comprised of two online courses. Two additional courses are currently at the beginning stage of development and more are planned based on anticipated training needs arising from changes in the operational forecasting environment. This effort was discussed in Bua and Jascourt (2009) when the first two courses were under development and is updated here reflecting what has been published online and an updated view on what will be coming over the next two years.

The Cooperative Program for Operational Meteorology, Education and Training (COMET®) Program 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".

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 NCEP NAM transition from the Eta model to the WRF-NMM model, 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 been focused on particular models and model changes and on new model products. Some of the content has become outdated in details, though many of the principles presented still hold. More importantly, NWP training is needed on integrating the suite of models and products together in the context of the forecast process rather than focusing on specific models or types of products.

Corresponding author address: Corresponding author address: Stephen Jascourt, NWS W/OS-2, Rm. 13110, SSMC-2, 1325 East-West Hwy , Silver Spring, MD 20910

Meanwhile, National Weather Service (NWS) forecasters now create grids of sensible weather forecasts at 5-km or 2.5-km grid spacing and some private sector meteorologists and others create gridded forecast products in a similar manner. 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. A 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. Specific priorities were identified through a survey of 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).

The new course was designed to

- be more immersive in the forecast process
- provide more interactivity
- allow COMET to update old material
- address the new training needs identified in the survey
- modernize the online format of COMET NWP training

Note: The operational orientation of COMET NWP training may provide a useful complement to academic courses, and faculty are encouraged to supplement some of their courses with COMET materials as they see fit. However, we have never suggested that COMET NWP materials should substitute for a rigorous curriculum.

2. WHERE TO FIND THE TRAINING

The direct link to the new training series is http://meted.ucar.edu/dl_courses/nwp

The home page has the objectives and philosophy of the series. The introduction tab contains a description of all of the courses. The Course 1 and Course 2 tabs contain the listing of all lessons within each course and the link to each. Additionally, some of the lessons are complemented with cases which can be run on the AWIPS Weather Event Simulator. These cases are available on DVD from the NWS Warning Decision Training Branch.

3. ORGANIZATION

Course 1: NWP Basics and Background covers the fundamental building blocks of NWP as well as specific tools such as downscaling, bias correction, and high-resolution models. Lessons on emerging future tools may also be inserted into the training series in
Course 1.

Course 2: Using and Adding Value to NWP in the Forecast Process is more immersive in forecast scenarios and covers the steps of using NWP in making a forecast, beginning with identifying the problem(s) of the day and using observations and models to form a conceptual model. The forecast process described and the individual lessons in this course were developed collaboratively with operational NWS forecasters, including Science and Operations Officers.

Course 3: NWP in the Era of Digital Forecast Preparation will address how NWP can be utilized by a human forecaster whose responsibility is to generate digital forecast grids. NWP-based inputs are crucial and selecting which inputs are to be used is one of the roles of the human but not the only role. This course is being developed now in collaboration with our colleagues in NWS forecast offices and NCEP centers and elsewhere. It is anticipated to become available before the end of 2012.

Course 4: Special Topics will address utilizing NWP in forecasting over complex terrain, in coastal and marine environments, forecasting convection, and a variety of other topics. Each topic will have its own lesson. This course is being developed now in collaboration with our colleagues in NWS forecast offices and NCEP centers and elsewhere. It is anticipated to become available before the end of 2012.

Course 5: Emerging Topics will cover new training needs anticipated to arise a few years further into the future.

4. COURSE 1: NWP BASICS AND BACKGROUND

The first section in Course 1 is comprised of lessons on general basics. This is an update of the COMET online distance learning course from around ten years ago. Some of the material is identical and has simply been reformatted as shown in Figure 1 (old) and Figure 2 (new), while some of the material has been consolidated and streamlined. The material in the old course (Fig. 1) on pages numbered without the white spots on the navigation panel on the left was optional and not tested on the post-module quiz. The optional material in the new version (Fig. 2) is denoted by the faded items in the navigation panel on the left. A small amount of new content was also added as part of the update. An example is shown in Figure 3, part of a section on adaptive analysis methods including ensemble Kalman filter (shown), anisotropic covariances, and 4d-var. Each of the pages on these topics illustrates how the analysis is affected.

The second section in Course 1 contains lessons on various forecast tools. These are all recent additions. Presently, the topics available are:

- Bias Correction of NWP Model Data
- Effective Use of High-resolution Models
- Introduction to the North American Ensemble Forecast System (NAEFS)
- Downscaling of NWP Data

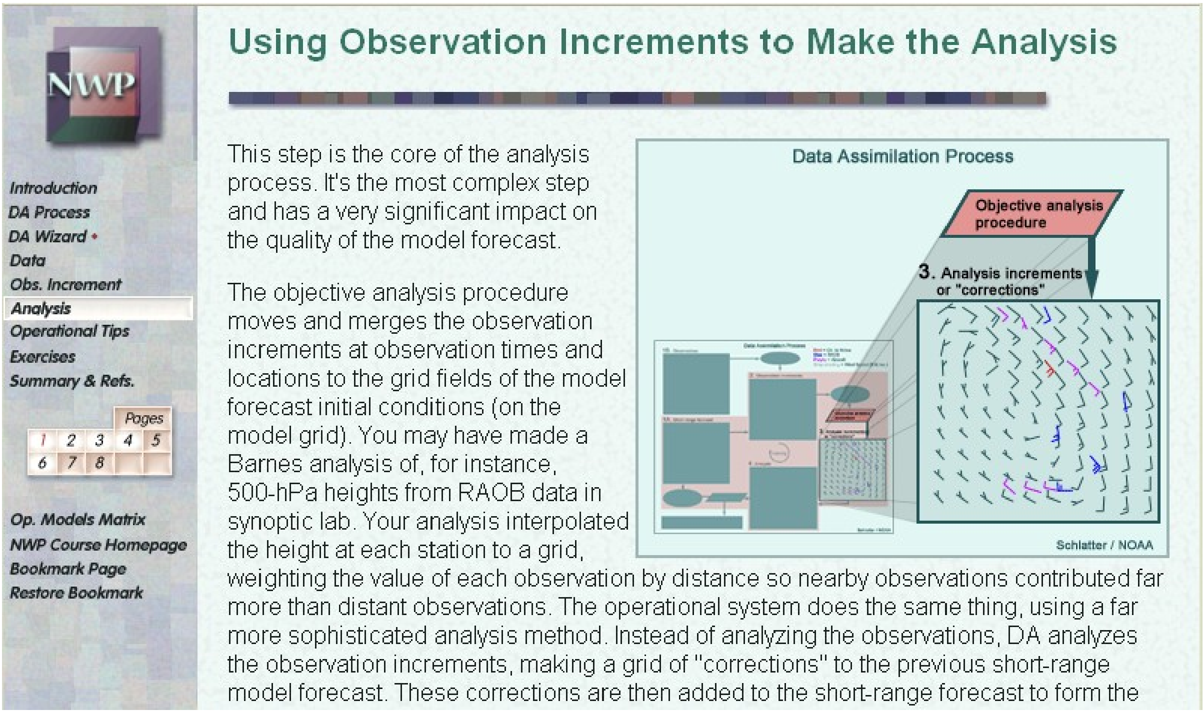

Figure 1. Sample page from the old COMET NWP distance learning course

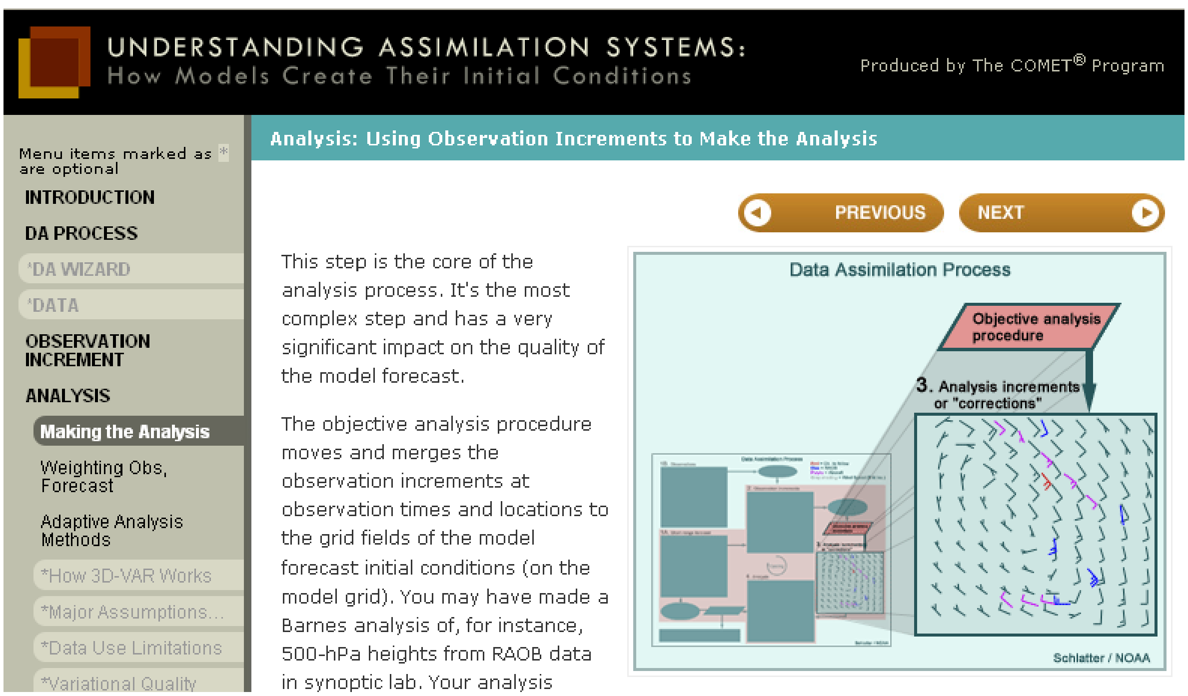

Figure 2. Sample page of the same content as in Fig. 1 but from Course 1 in the new training series

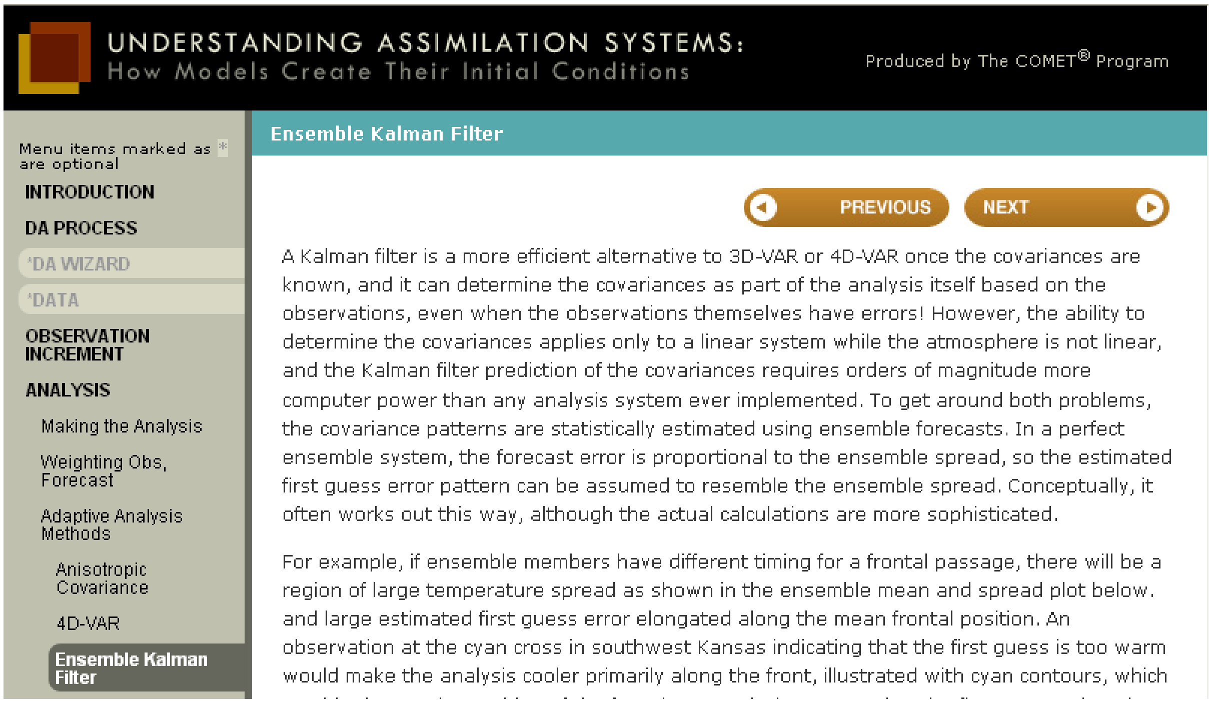

Figure 3. Example of new content on data assimilation in a section on adaptive analysis methods

5. COURSE 2

The emphasis in this course is on how NWP should be used *in the forecast process*. The material in this course is immersed in forecast scenarios and the lessons have accompanying cases the user can run on the AWIPS Weather Event Simulator. There are separate lessons corresponding to each step in the forecast process. Highlights of the lessons are provided below.

The forecast process starts with the lesson “Preparing to Evaluate NWP Models.” This first step involves situational awareness and determining the problem of the day based on current weather and the model forecast scenarios. The page shown in Figure 4 depicts pressure on a model potential vorticity surface overlaid on a water vapor image and discusses evaluating the model initial state and forecast up to the current time. In the left panel, you can see the topics of some of the other pages in this lesson.

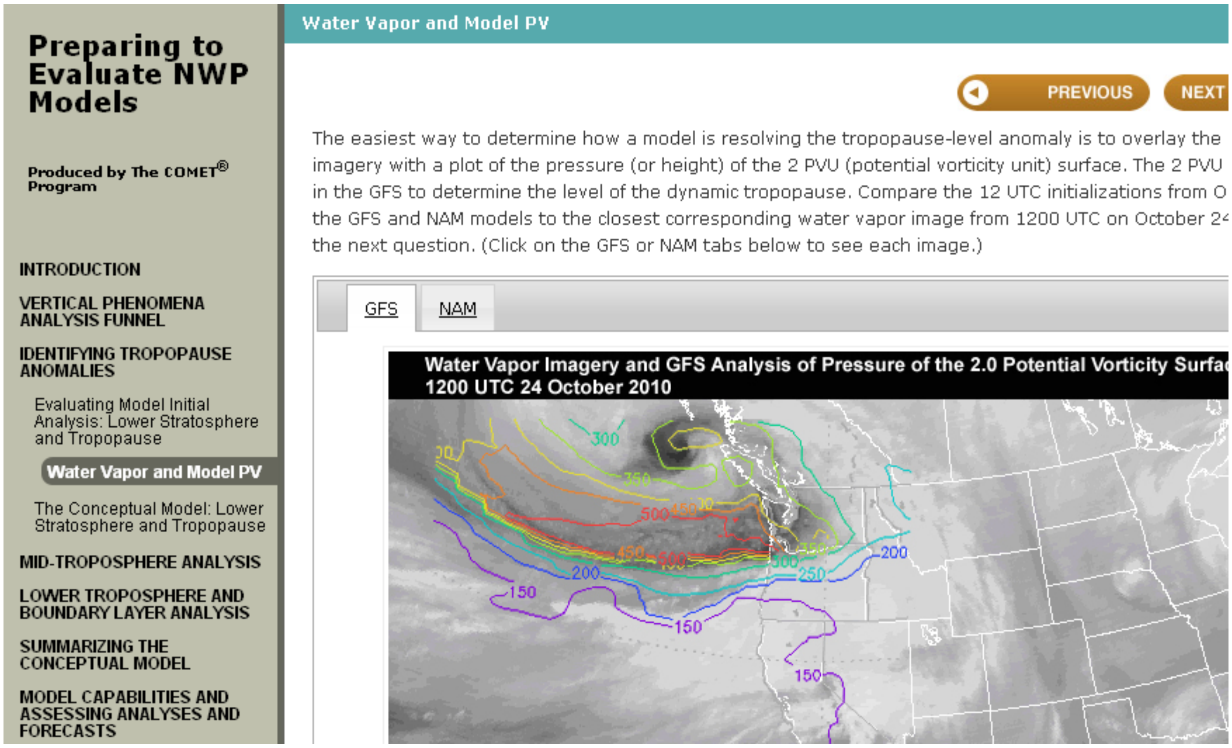

Figure 4. Sample page from Preparing to Evaluate NWP Models

The next lesson is Analysis, Diagnosis, and Short-range Forecast Tools, corresponding to the second step in the forecast process. This discusses diagnosing whether the model solutions are on track and what may be happening which they are missing. For example, after discussing trends in the observed conditions, the black temperature and

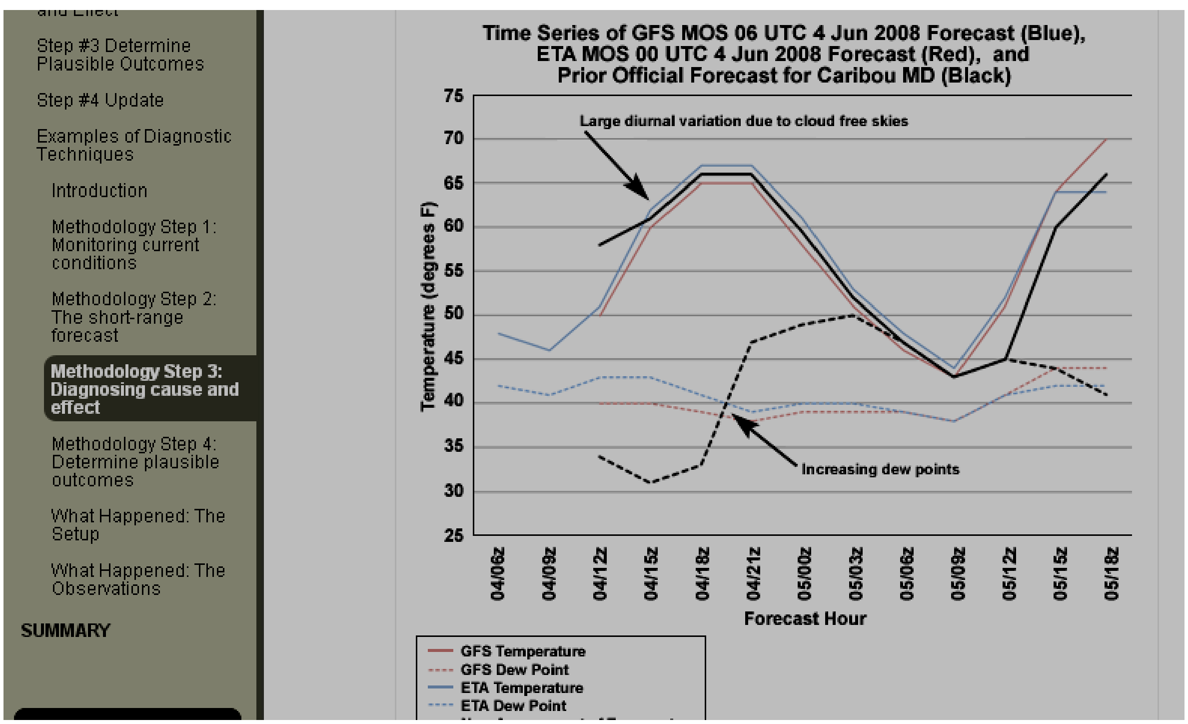

Figure 5. Sample page from Analysis, Diagnosis, and Short-range Forecast Tools

dewpoint curves in Figure 5 show that rising dewpoints may produce saturation and dense fog while numerical guidance shown in the red and blue curves was predicting conditions too dry to even consider a fog threat.

The next three lessons (one of which was still under development as of this writing) address determining which of the possible forecast outcomes are plausible from among the many model and ensemble predictions. The lesson called Determining Plausible Forecast Outcomes runs through this for a couple of different forecast problems. The first

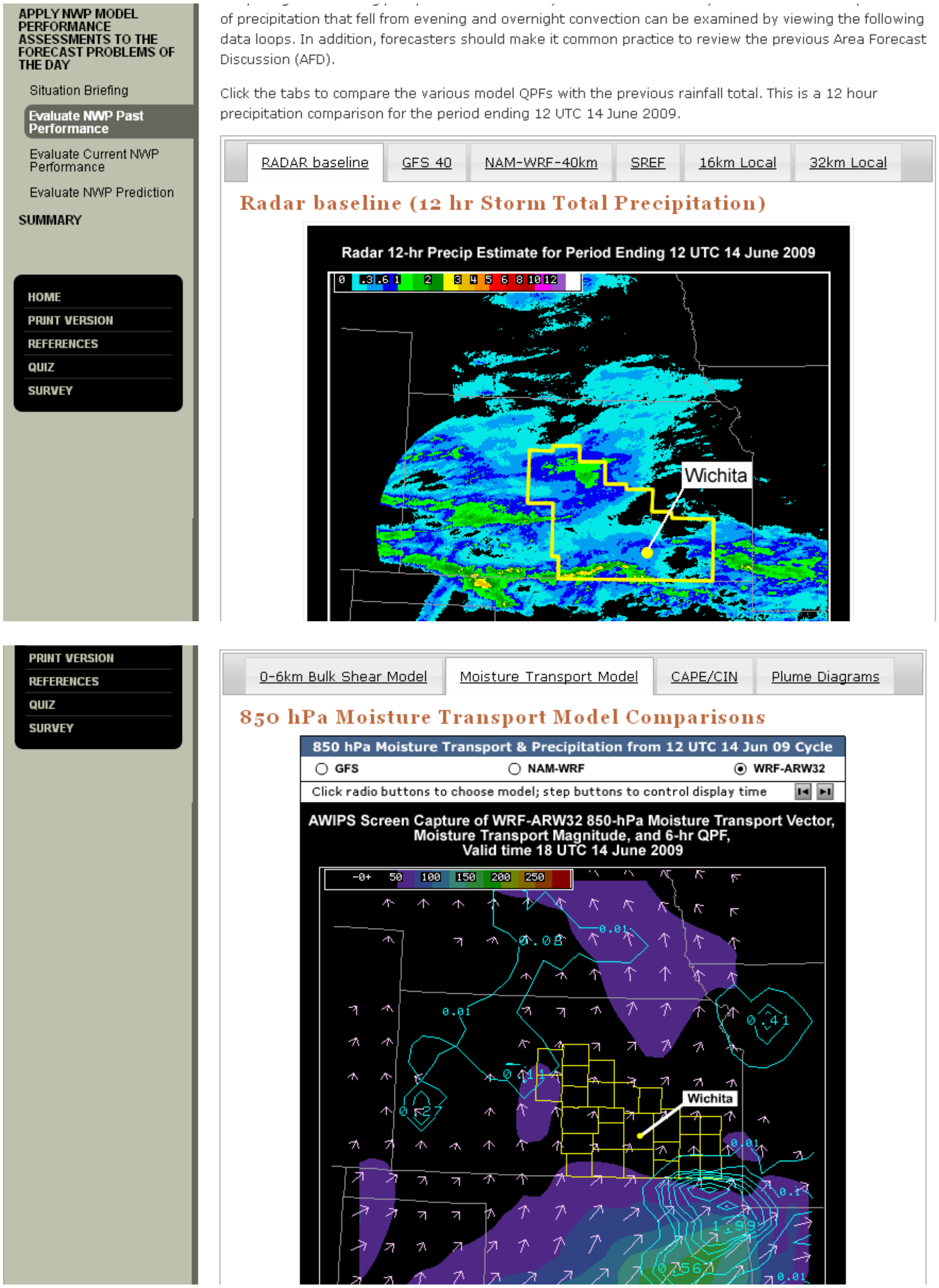

Figure 6. Sample pages from Determining Plausible Forecast Outcomes

image in Figure 6 shows a page on evaluating how the models have handled the situation so far. Other tabs display precipitation over the last 12 hours from the corresponding forecasts from a variety of models and ensembles. The precipitation forecast is then evaluated looking forward in time in the second screen capture. On that page, forecast loops of low-level moisture transport are shown from several models, each selected using the radio button above the data plot.

Also addressing this step in the forecast process is the lesson titled Understanding the Role of Deterministic versus Probabilistic NWP Information. This lesson compares the information from ensembles to that from individual model runs and discusses various ways of viewing ensemble data. On the page shown in Figure 7, there is a question asking the reader what the main forecast problem is based on a plume diagram of QPF color-coded by precipitation type. Many such questions are placed throughout all of the lessons, where the reader is given a little bit of information and learns more by considering the question and reading the feedback discussion.

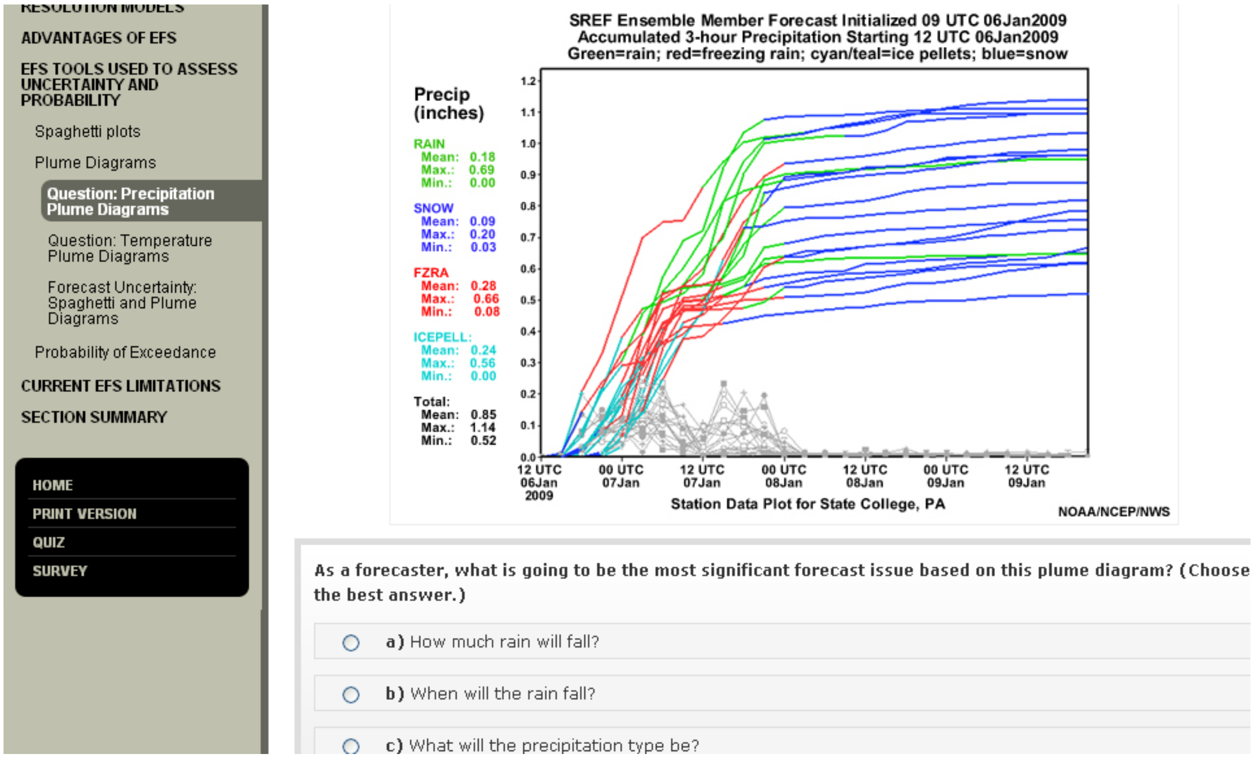

Figure 7. Sample page from Understanding the Role of Deterministic versus Probabilistic NWP Information

Finally, Course 2 culminates in the lesson titled Adding Value to NWP Guidance. This lesson addresses opportunities for the human to improve over automated guidance at each step in the forecast process. Verification is a key aspect of this and the page shown in Figure 8 is an example of bias in model guidance in a persistent weather pattern. Due to continued persistence of the pattern, the forecaster has an opportunity to use this information to improve over this model guidance.

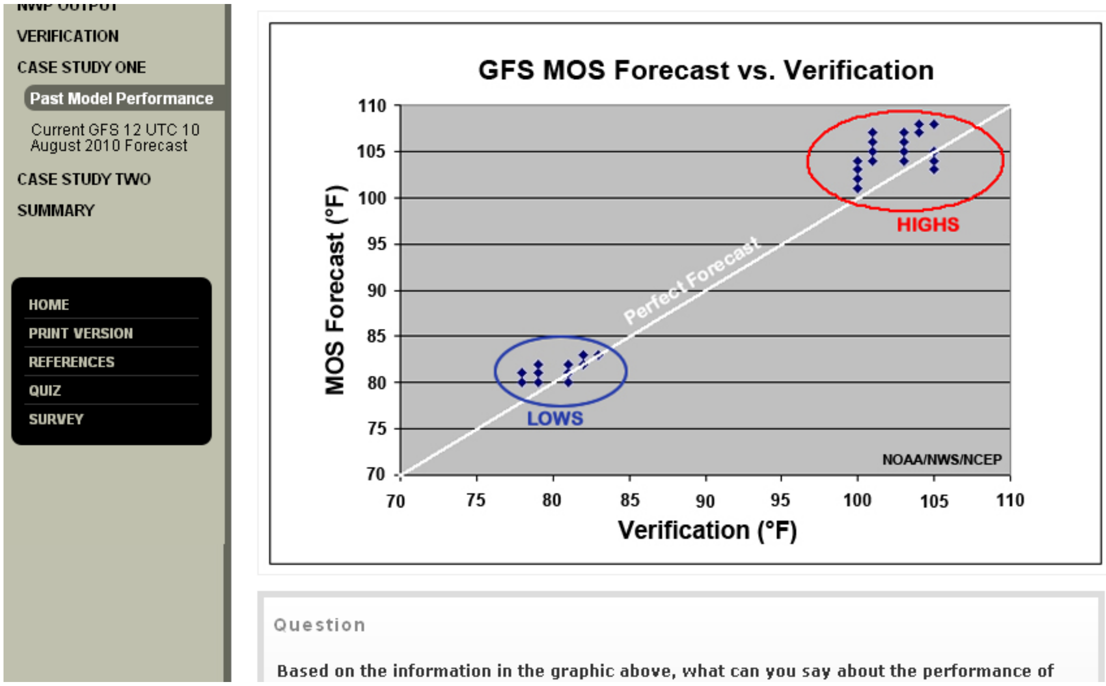

Figure 8. Sample page from Adding Value to NWP Guidance

6. COURSE 3

Course 3 will address how NWP can be put to good use, not blind or automated use, as a forecaster generates gridded products. Topics planned include addressing the time-honored forecast funnel approach to forecasting starting with larger scales and working down to smaller. The difficulty now is that the forecasters are focusing much of their efforts on the small end of the spectrum, while the small scale weather is driven by the larger scale conditions. Other topics include selecting the NWP-based sources for starting points for the grids or when a forecaster should start with the forecast from the previous shift instead of an NWP-based product. Another challenge is forecasting small scales at long lead times. There are some situations when certainty is high enough on the large scale that terrain-driven details, for example, are predictable. Gains made using local models also could be shared more widely and we plan to be working with some forecast offices who have had success.

7. COURSE 4

Course 4 will cover special topics, many of which are geographically limited, but forecasters in any place will find some topics highly pertinent to their challenges. The forecast problem will be presented and a forecast approach will be described using all different types of NWP models and products and observations. The lessons in this course will be immersed in forecast scenarios. Topics planned include convection, complex terrain, coastal environments, predicting excessive rainfall, and arctic environments.

8. COURSE 5

Beyond Courses 3 and 4, we intend to address emerging topics, some of which we can already anticipate. For example, AWIPS will be changing from receiving data pushed over NOAAport to pulling data from servers like NOMADS. Even under current bandwidth limitations, this will greatly increase the variety of NWP data which NWS forecasters will have access to, and they will need some guidance to make the most advantageous selections. Warn-on forecasts, sort of like a long-lead time warning or very detailed watch, will take advantage of high-resolution model forecasts or ensembles. The role of the human in (or over) the loop in the big NextGen aviation project will be crucial to success in what will be largely an automated model-driven system. Future forecasts will be not only for weather but also for various environmental hazards. Meanwhile, NWP data is increasing exponentially and the forecaster needs methods of assessing and making sense of it in real time.

9. ACKNOWLEDGEMENTS

This paper is funded by cooperative agreement #NA17WD2383 from the National Oceanic and Atmospheric Administration (NOAA). The views expressed herein are those of the authors and do not necessarily reflect the views of NOAA or any of its sub-agencies.

10. 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]

----- and -----, 2009: New training course on use of NWP in forecast operations. *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/153222.pdf]

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]