P1.44 DISTANCE LEARNING METHODS FOR NUMERICAL WEATHER PREDICTION (NWP) PROFESSIONAL DEVELOPMENT TRAINING

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1. INTRODUCTION

Several years ago, the National Weather Service (NWS) identified as a high priority improvement of operational forecaster understanding of numerical weather prediction (NWP) models and consequent improved use of their guidance. However, budgetary constraints have prevented development of a classroom-training program for forecasters. Therefore, the Cooperative Program on Operational Meteorology, Training, and Education (COMET) Program, in coordination with NWS, has developed a distance-learning program on NWP.

Training on the complex topic of numerical models

- needs to be focused on operational application of science concepts
- needs to be compartmentalized to fit into the short time windows which forecasters have available
- needs to enable forecasters to keep up with the science and forecast impact of changes to the models.

The distance-learning program designed to meet these needs includes components:

- Completed a few years ago,
- Still under development,
- Updated to remain current with the changing NWP model suite,
- Ongoing in the form of interactions with forecasters, and
- That are new in response to new training needs.

The program continues to evolve as COMET's experience in distance learning instruction increases and new instructional technologies become available. The major components and media used are the focus of this paper and are discussed below. Web page locations for these components are given as they are cited in the text. Figures showing examples of different instructional methods are referenced in the text.

All of these distance learning materials are designed for professional development training. They are not as thorough and rigorous as an academic class and not intended to substitute for university courses, but much of the material may be well-suited for supplementing academic instruction and all of it is freely available.

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2. MODES OF TRAINING

Seven different modes of training are used now:

1. Web-based modules containing background information on generic aspects of NWP modeling relevant to operational forecasters, parts of which form a distance learning course
2. Web-based reference information specific to individual models
3. Web-based case examples applying concepts found in the first two to forecast problems
4. GFS and Eta/NMM newsgroups for direct interchange with forecasters and others
5. Audio-visual webcasts of lectures with lecture notes and animated graphics
6. Teletraining which can be taken interactively live or individually on a PC or over the web
7. Resource materials such as PowerPoint presentations

A current list of products available can be found on the COMET MetEd home page by selecting "NWP" under the "Topics" menu, sending you to http://meted.ucar.edu/topics_nwp.php. A portion of this listing is shown in Figure 1.

In order to facilitate organizing the extensive materials in training modes 1 and 2 above and allow for easy quick look-up of concepts or model details, a ready-reference page for "one-stop shopping" serves as the centerpiece of NWP training. This page, called the Operational Models Matrix, is located at http://meted.ucar.edu/nwp/pcu2/index.htm and is shown in Figure 2 with annotations added to explain the different kinds of links.

2.1 Concepts In NWP

These web pages, with extensive COMET-quality graphics and many questions with feedback to the student, present general background material as a framework for understanding NWP models. Figure 3 shows an example web page, along with annotation of its special features. On the left is a menu allowing the student to navigate through the module materials. Modules include Model Structure and Dynamics, Model Physics: Precipitation and Clouds, Model Physics: Radiative Processes, Derived Products, and Model Processes (such as Data Assimilation).

The web page chosen for Figure 3 shows an example of interactivity, through posing of a question to the student. These questions appear either at the end of a section of material to reinforce what has been taught, or at the beginning of the section to introduce a topic. When the student is finished, s/he clicks a button to indicate s/he

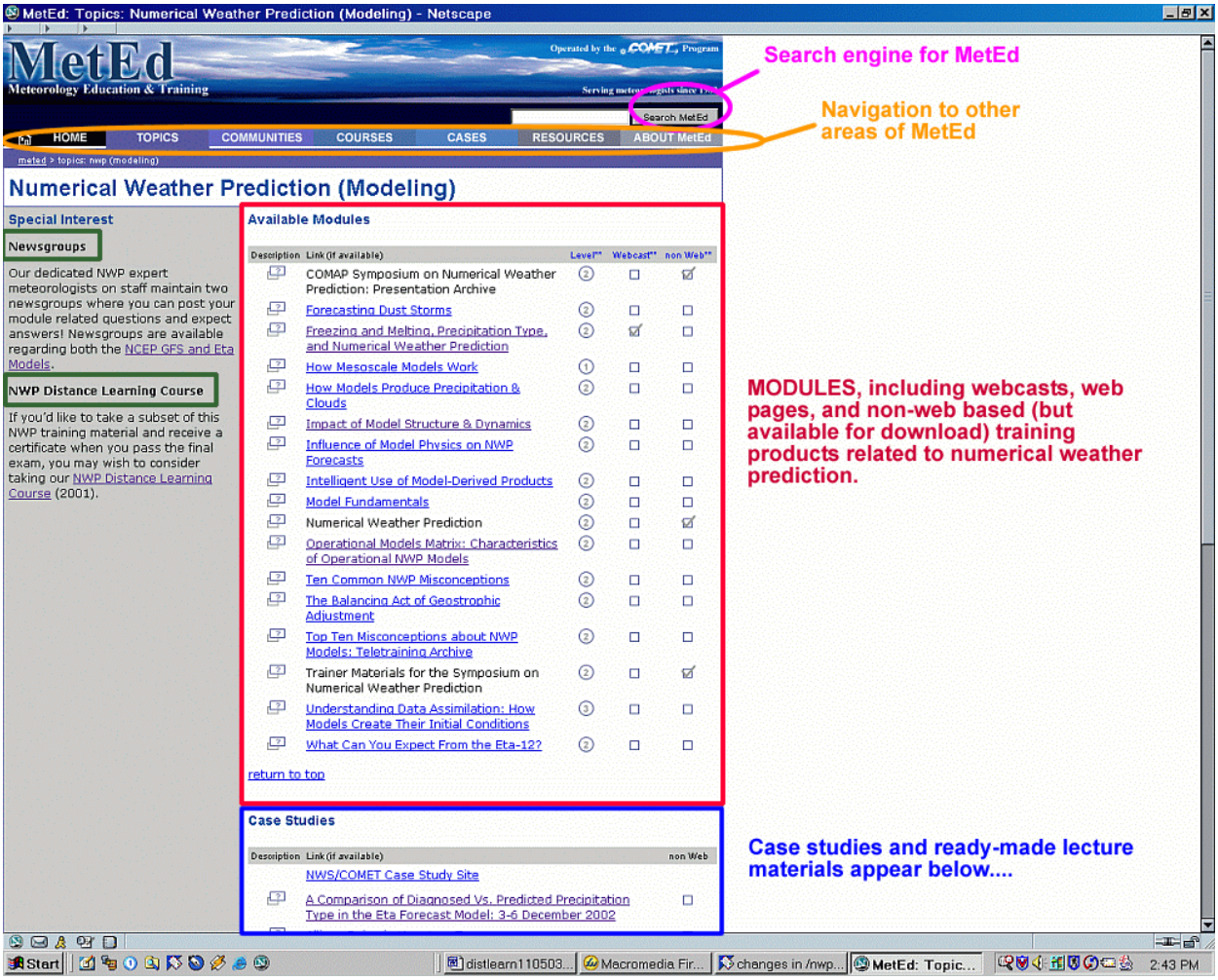

Figure 1: NWP home page on the MetEd web site.

is ready for feedback, after which they may either attempt the question again or view a discussion of the answers.

An NWP distance-learning (DL) course, which can be found at http://meted.ucar.edu/nwp/course/index.htm, draws from these pages and includes an online examination. Some NWS regions have mandated that the online course and examination be taken as part of Weather Forecast Office (WFO) staff training. This effort has been spearheaded by NWS Western Region, where 348 staff members have taken and completed the NWP DL course.

The concepts pages require a major development effort involving teamwork among COMET meteorologists, instructional designers, artists, and web/computer experts, and are not intended to need much revision. New components such as the use of ensembles in probabilistic forecasting are being added as new directions in NWP reach the field forecast offices.

2.2 Current Operational Model Characteristics

These web pages are intended to serve as a quick reference guide on the major operational NWP models. Less development effort goes into these pages at any one time and they tend to be less interactive, but the pages are revised as frequently as needed to remain current with changes to the NWP models.

An example for the National Centers for Environmental Prediction (NCEP) global forecast system (GFS) model is shown in Figure 4. The page shows a schematic of the convective scheme used by the GFS (Simplified Arakawa-Schubert, or SAS). Included in the description are:

- Processes simulated and their treatment in the scheme
- Potential interactions with related parameterization schemes (for example, the grid-scale precipitation scheme)
- Effect on the resolved-scale forecast variables

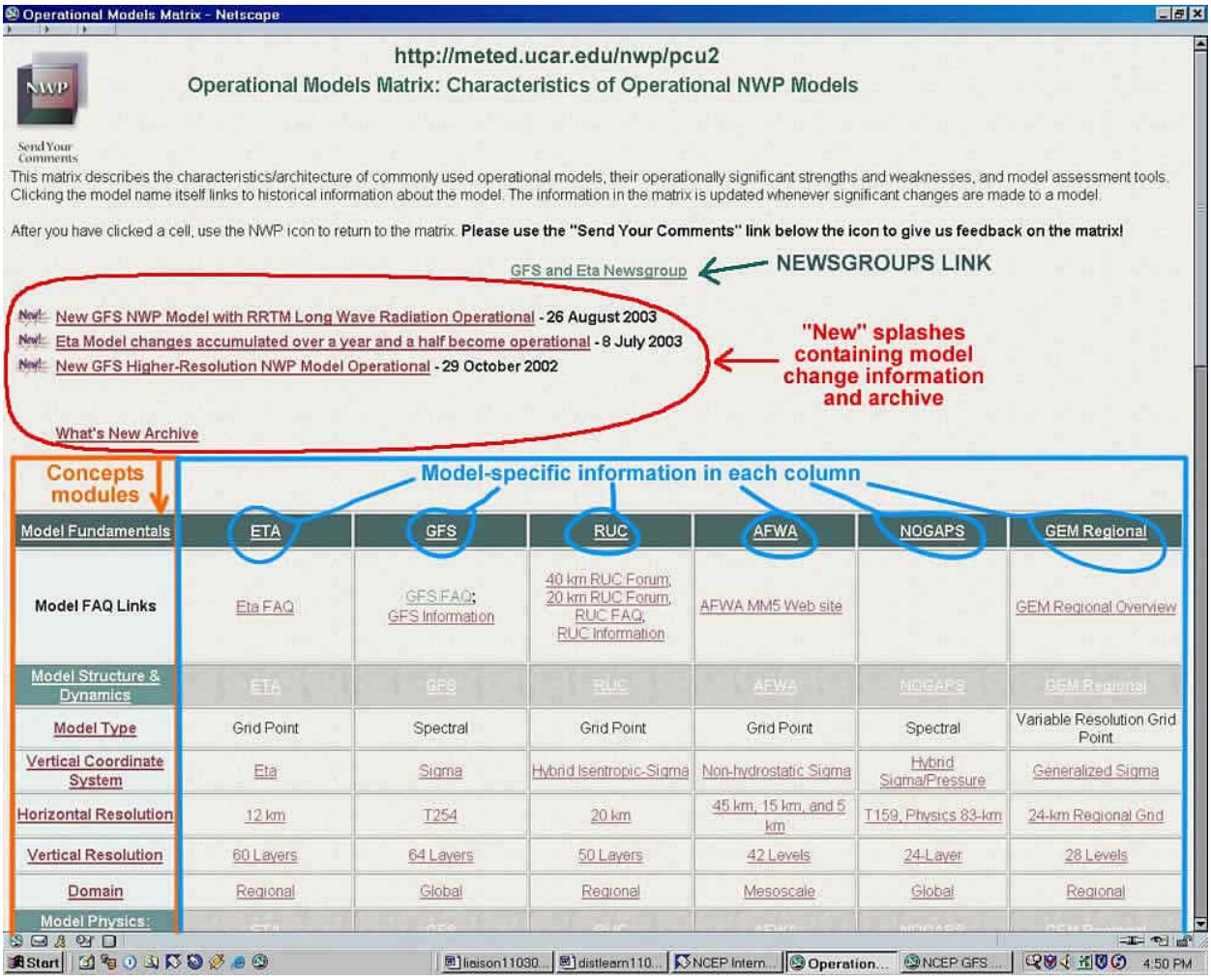

Figure 2: The NWP Operational Models Matrix, with annotation explaining links to web pages and other special features.

When a model upgrade is implemented, a "new" splash page is provided at the top of the matrix page as shown in Figure 2. These summarize changes anticipated in model performance characteristics that will result from the model upgrades.

2.3 Applications of NWP concepts through case examples

Often, a concept or key point or characteristic of model forecasts can be best explained through a case example, and cases are helpful in linking information to its use in forecast applications. Further, critical thinking is essential to the forecast process. These web pages illustrate a particular model behavior or NWP concept, are designed to be completed in short sessions (typically 30-60 minutes). Most are designed to promote critical thinking about model interpretation or forecast problems. The case examples do not delve into the levels of rigor or completeness appropriate for documenting cases for refereed journal articles; instead, they are intended to focus on one or a few key points. The latest list of published cases can be found on the NWP cases web page (http://meted.ucar.edu/nwp/pcu3/cases). New cases are added periodically as they are brought up by NWS operational forecasters, or are noted by COMET staff charged with developing NWP training.

An example case web page is shown in Figure 5. The case illustrates issues with the NCEP precipitation type algorithm, and presents the explicitly predicted fraction of frozen precipitation type output from the Eta model microphysics parameterization as an additional tool for winter precipitation type forecasting.

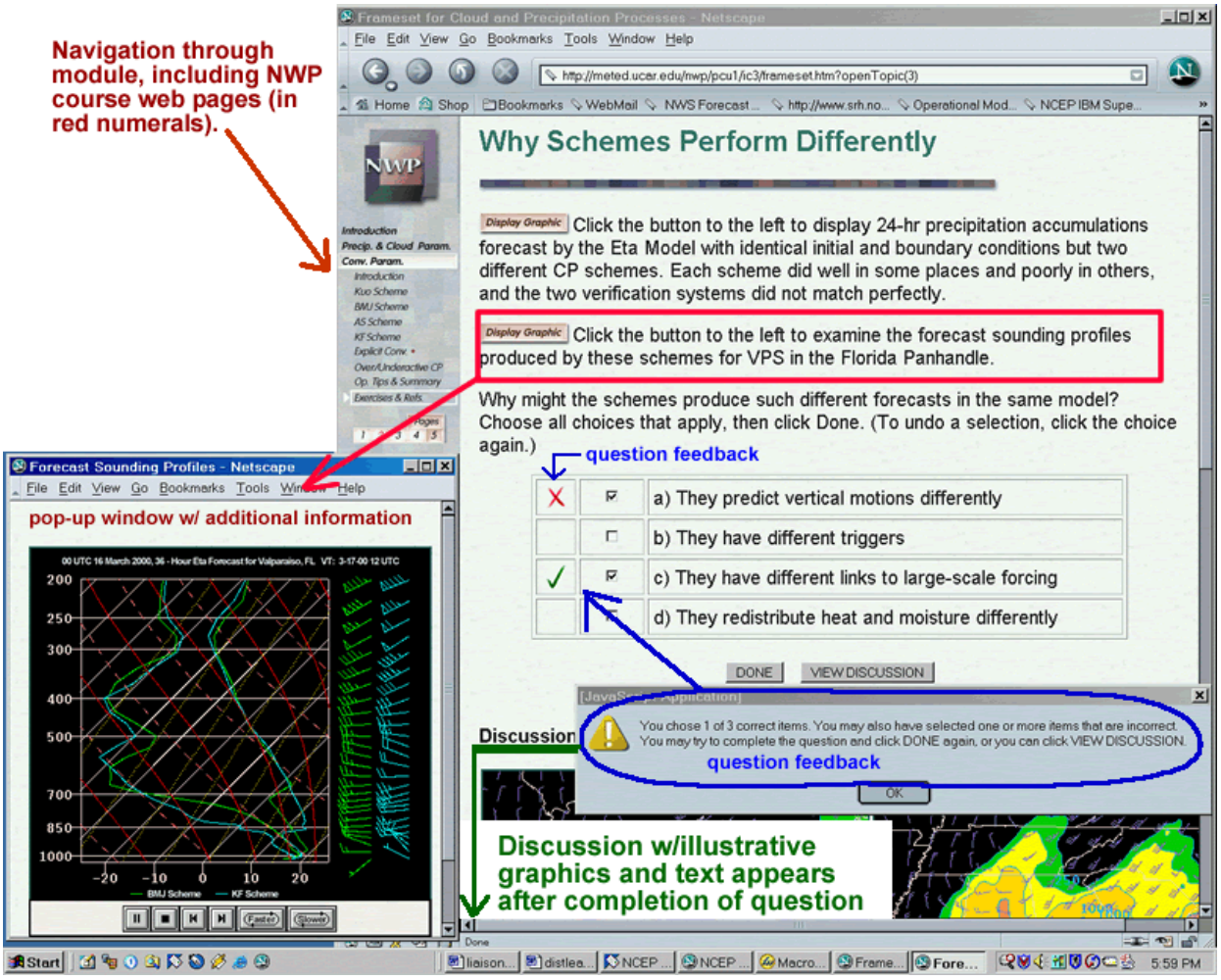

Figure 3: A sample interactive/feedback question from general NWP section on convective parameterization.

2.4 GFS and Eta newsgroups

The newsgroups serve as a public forum so that everyone may see the questions and answers. Often a model problem or model-related forecast issue identified at one forecast office is of interest to other forecast offices, unlike when one person submits a question to NCEP and is given an excellent answer only seen by that one person and the few others s/he may cc on the email.

The newsgroups operate like e-mail and allow more direct two-way interaction tailored to the concerns and needs of the forecasters. They are usually low-maintenance but require quick response to be effective. Topics cover, but are not limited to:

- Evaluation of experimental runs during parallel testing of model upgrades
- Impacts of model changes
- Workings of model parameterizations and data assimilation
- Cases (usually today or in the past week at the time of posting) when the model is doing something unphysical or unrealistic
- Cases (usually very recent at the time of posting) when the model performed outstandingly

There have been several exchanges forecasters found particularly valuable, but the widespread use of this information is hampered by limited participation despite considerable publicity efforts by COMET and an article in *NWS Focus*. Forecast offices are busy places and most have not developed any system for monitoring the newsgroups despite the low volume of messages.

A link to web-based instructions on how to gain access to the model newsgroups can be found at the top of the Operational Model Matrix page or directly at http://meted.ucar.edu/nwp/newsgroups/index.htm.

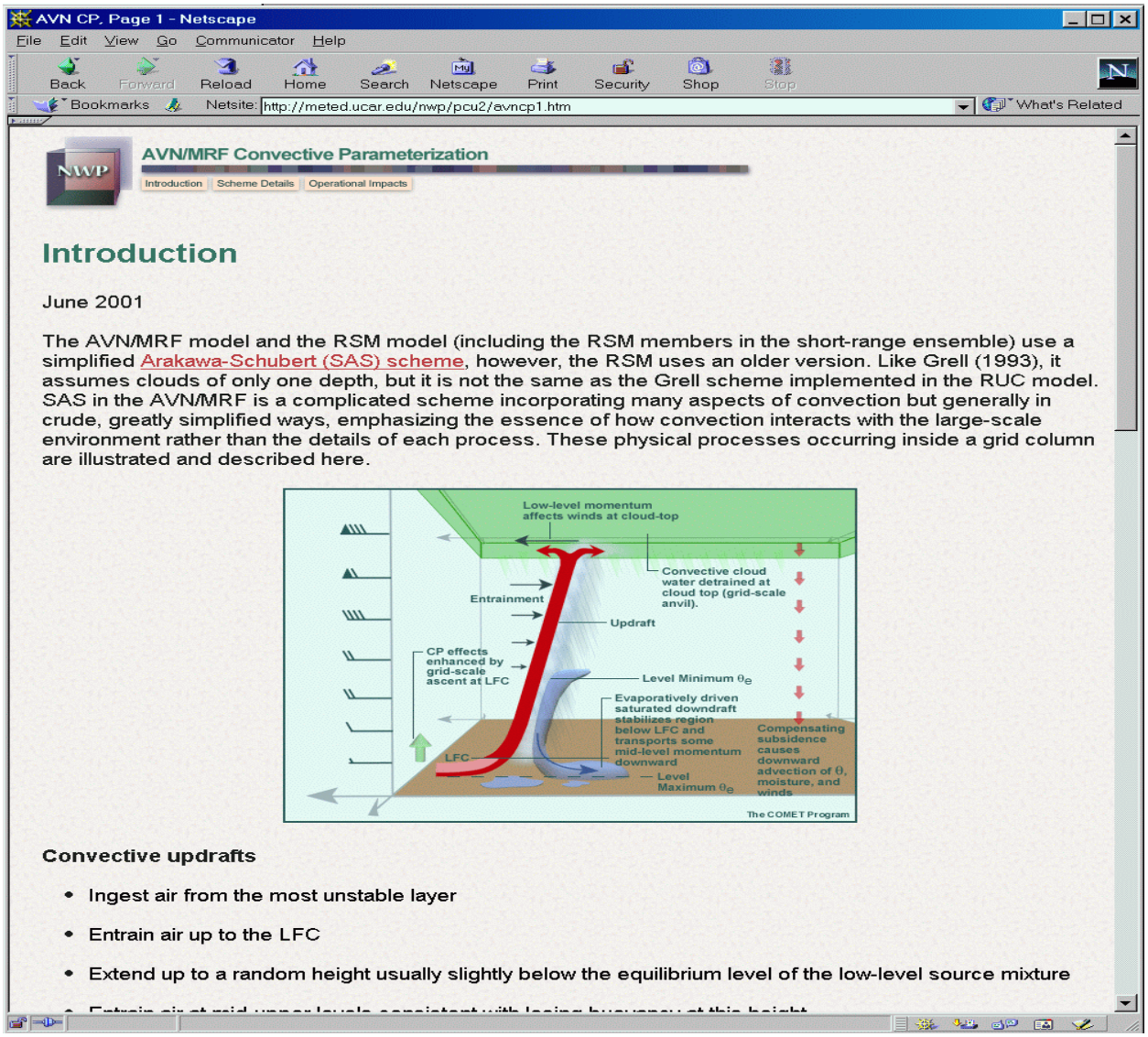

Figure 4: Example of web-based NWP model-specific page from GFS convective parameterization page.

2.5 Webcasts

COMET NWP Training also comes in the form of "webcasts", which can be found on the MetEd NWP training web page (see section 2 above for link). Webcasts are a combination of narration and web-based training using audio and graphic animation. They are generally based on a lecture given in the COMET classroom, with lecture notes and drawings enhanced, animated, and annotated by COMET working with the lecturer. The result is a multimedia combination of web-based graphics, explanatory text, and narration by a subject-matter expert.

Figure 6 shows an example webcast as it appears in Netscape 7.1, on the topic of the parameterization (or lack of same) of freezing and melting of falling precipitation in NWP models. Note that the webcast can be downloaded for local office use. The webcast can be started from any item in the section menu, or played in its entirety.

2.6 Teletraining

Various topics as needed are taught via VISITview teletraining. Information and download sites for VISITview software can be found at the University of Wisconsin's Space Science and Engineering Center (SSEC) website (http://www.ssec.wisc.edu/visitview/). The teletraining medium allows live interaction with trainees in several forecast offices simultaneously during scheduled sessions, as well as individual self-paced instruction on the student's own PC from files downloaded from one of several sites supporting

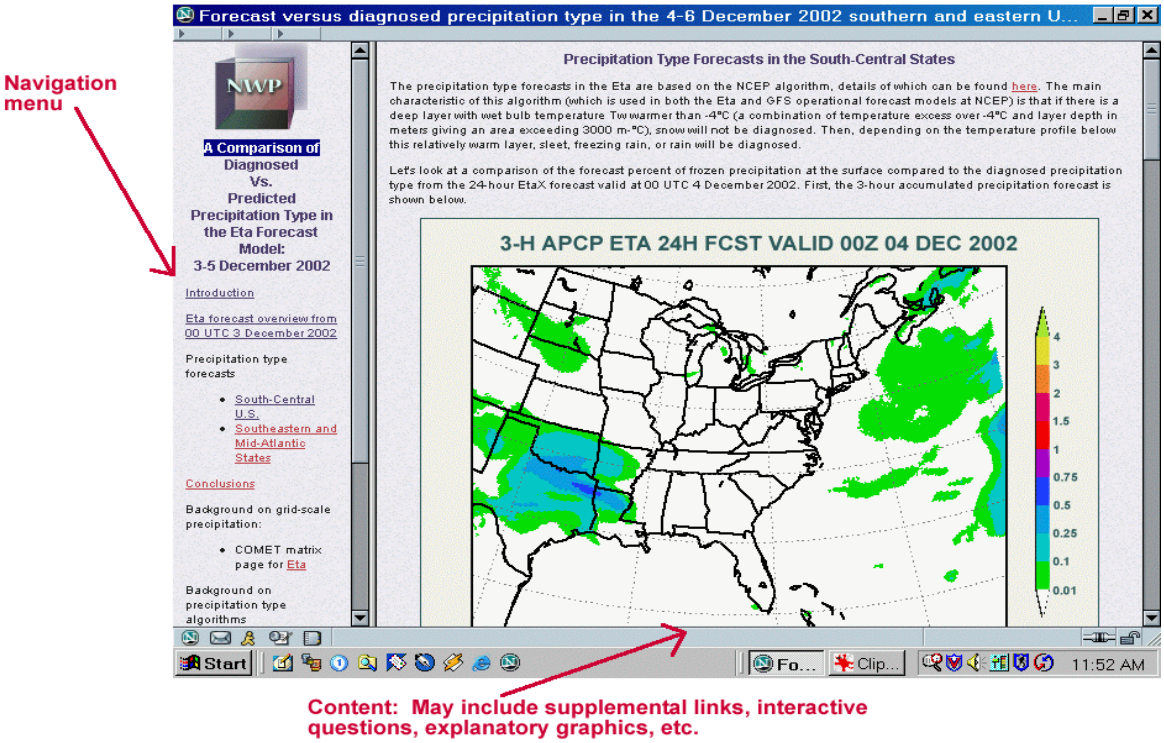

Figure 5: Example of case page on diagnosed versus predicted precipitation type in the NCEP Eta model.

VISITView. Both still and animated graphics are supported in VISITView.

One of the big advantages to teletraining is that multiple offices can participate in live interaction with any participant able to draw on the screen seen by everyone and enter discussion heard by everyone. Each office downloads the appropriate executable file from one of the VISITView sites, signs up for a scheduled teletraining through the SSEC site, and establishes a link to the presentation site through the Internet. Concurrent verbal communication between the instructor and students at various WFOs is established through dialing into a telephone conference.

Figure 7 illustrates one of the special features of the VISITView teletraining: the ability to mark up images by moving a pointer with the computer mouse. In this case from the teletraining session "What's New With the Eta-12?" a skew-T has been presented to illustrate differences between diagnosed and a new prognostic precipitation type variable. Important features in the skew-T, such as the 0°C isotherm, the prognostic precipitation type variable value, and the diagnosed precipitation type using the NCEP precipitation type algorithm can be highlighted by either the instructor or the students.

2.7 PowerPoint presentations

PowerPoint presentations on use of the NCEP NWP models for winter weather forecasting were developed for the two most recent winters. These included information about recent and anticipated upcoming model changes and their forecast impact in specific kinds of situations as well as model problems not addressed by those changes. Science and Operations Officers used it for in-house forecaster training at their forecast offices and found it highly valuable. An example page is shown in Figure 8, describing a model change affecting low-level temperatures and stability in arctic boundary layers. Presentations given at workshop lectures can also serve as additional resources without requiring the development work of creating a webcast.

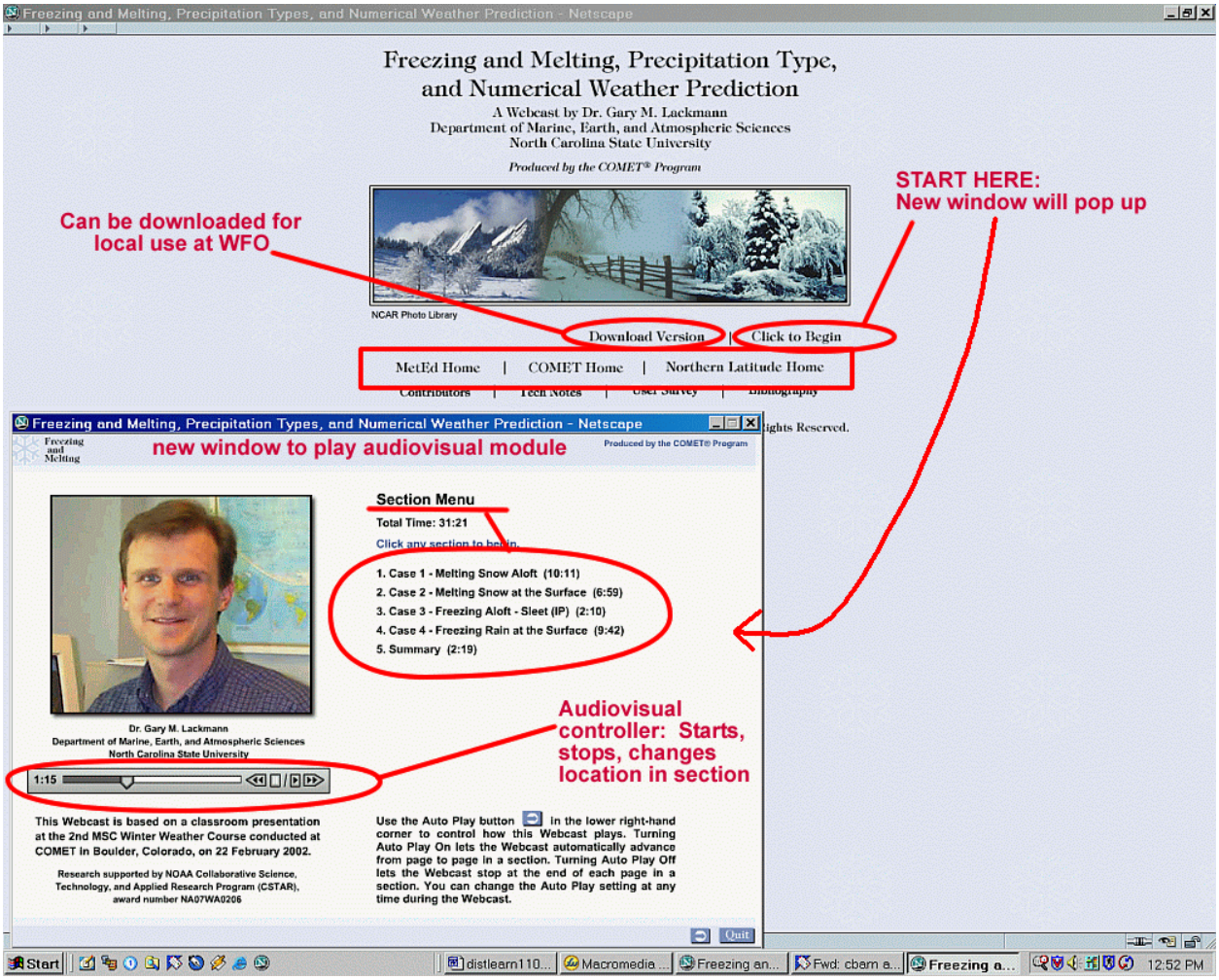

Figure 6: Example of a webcast interface. The webcast is on deficiencies in how NWP models parameterize freezing and melting of forecast precipitation.

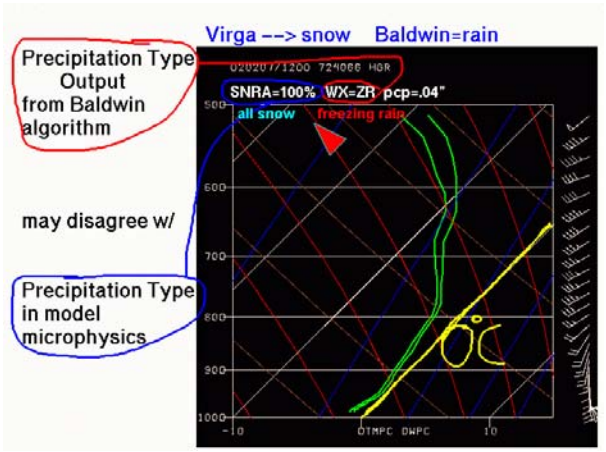

Figure 7: An example of the special features available for distance learning from a VISITview teletraining session. Here, the instructor and the students can mark up the images such as with the hand-drawn annotations/highlights illustrated here.

3. CONCLUSIONS

We have shown a number of different DL methods for NWP training provided by COMET for use in training operational forecasters at NWS WFOs. These training methods are relatively easy to create and inexpensive to use, compared to direct classroom instruction methods, which involve high transportation and lodging costs. Clearly, face-to-face interaction with significant dedicated blocks of time for training is more desirable. However, the DL materials developed have the advantage of being portable, usable in any office, home, classroom, or remote environment with a personal computer, and portions are being translated for use with training programs in developing countries.

The DL training incorporates interactivity with the students to help reinforce what is learned as much as

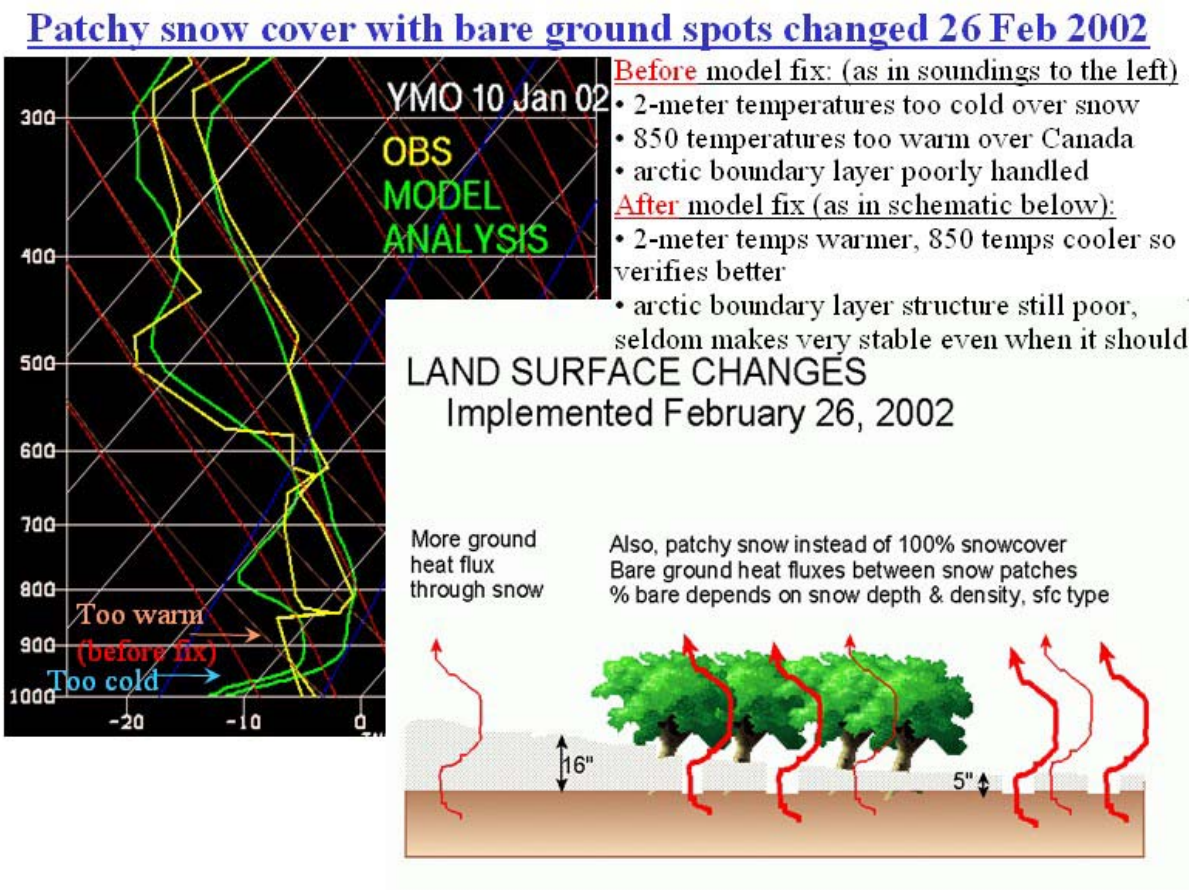

Figure 8. Slide from winter weather PowerPoint presentation explaining a model change affecting handling of arctic boundary layers

possible. Interactivity is accomplished through questions and feedback, verbal communication with the students, and drawing in the case of teletraining.

Content of the NWP DL material is uniquely suited for conveying NWP concepts for forecast application, including both background material and current information about the workings of the models. Much of the content is organized for easy access through the Operational Models Matrix and all of it is modularized for use in small discrete sections. Taken together, the COMET NWP DL training presented is a comprehensive and inexpensive way to meet professional development training goals with NWS WFOs and serve the broader meteorology community.

4. ACKNOWLEDGEMENTS

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5. REFERENCES

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