16.2 THE FIRST MSC/COMET MOUNTAIN WEATHER COURSE

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1. INTRODUCTION

Field research in mountain meteorology continues to provide valuable data for scientific analyses and publications. It is estimated that since the end of the MAP field project in 1999, the Mesoscale Alpine Programme has spawned close to 200 scientific publications (Volkert, 2005). For the operational meteorological community, the challenge has been transferring this wealth of knowledge to the forecast environment so that theoretical concepts can be applied to forecasting the weather in complex terrain.

Building upon a cooperative arrangement between the Meteorological Service of Canada (MSC) and the Cooperative Program for Operational Meteorology, Education and Training (COMET), a residence course on mountain weather was developed in 2005. This inaugural one-week course on mountain meteorology was held in the COMET classroom March 20-24, 2006. The objectives of this course were primarily two-fold: to provide operational forecasters exposure to current research and theory from experts in the field of mountain meteorology, and to provide training for forecasters involved in the upcoming 2010 Winter Olympics in Vancouver, Canada.

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2. THE NEED FOR FORECASTER TRAINING

There is no one size-fits-all approach to training meteorologists; classroom settings may work for some but fail for others. In an environment of fiscal restraint, it behooves us to find efficient ways of training, which apply to the largest possible audience. A survey of operational meteorologists was recently conducted to gauge the level of training in the weather centres across the MSC and parts of the National Weather Service (NWS) in the United States.

Forecaster's impression on the level of training was generally favorable. Close to 60% of respondents rated the level of training in their weather centre as good or excellent.

What is considered the most effective means of training? Table 1 provides a summary of responses to various modes of training.

Training Mode	1	2	3	4	5	AVG
Double-banking with experts	57	30	9	4	0	1.6
Weather Event simulators	39	39	22	0	0	1.8
Forecaster exchanges	29	49	20	2	0	2.0
Local workshops	16	64	14	6	0	2.1
Training courses (residency)	21	50	24	5	0	2.1
On-line modules	10	51	33	6	0	2.4
University courses	10	17	50	24	0	2.9
Conferences	6	24	46	22	2	2.9
Post-graduate work	3	14	54	24	5	3.2
Reading journal papers	0	17	48	29	6	3.3

Table 1. Rating of the effectiveness of various modes of training. Values are percent of respondents for each category. Rating is from 1 (most effective) to 5 (least effective).

The results show that "Double-banking with experts" (i.e., working alongside an experienced forecaster) was considered the most effective mode of training. Reading journal papers was considered to be the least effective mode. Residence courses ranked a bit better than the middle of the pack.

Doswell and Lemon (1981) reviewed the state of forecaster training and highlighted the need for greater interaction between research meteorologists and forecasters. "We have seen that both forecasting and basic research have made substantial gains when a mutual understanding has existed between forecasters and researchers". This gap was noted even earlier:

> *Bergeron [1959] concluded that the lack of contact between theory and empiricism is the major factor blocking progress [in meteorology].*

Have things changed since 1981? One of the survey questions asked respondents to identify the most important gaps between research activities and operations. By far, the most frequent response was a lack of communication between researchers and operational forecasters.

In an effort to improve training and bridge the gap between meteorological research and weather operations, COMET was formed in 1989. COMET has attempted to do this through research partnerships that include both operational and University representatives, residence courses that train both operational forecasters and scientific trainers, and distance learning modules that attempt to advance the levels of scientific understanding of forecasters in an efficient and flexible manner.

A cooperative arrangement established in 2001 between Canada and the US (COMET) led to the development of the Winter Weather Course, for example, and a series of Web-based modules and case studies under the heading "Northern Latitude Meteorology" (Fig. 1).

In 2002, a Summer School on Mountain Meteorology was created in Italy (http://www.unitn.it/ricerca/dottorati_form_av/estiva/index.htm) to address needs of (mostly) students and young researchers. While an important step in presenting advances in mountain meteorology, this course was not tailored toward the operational meteorologist. The need for an internationally-based residence course on mountain meteorology and the associated operational problems has

existed for several decades. While advances in training on synoptic- and meso-β scale forecast issues (fronts, jet streaks, conditional symmetric instability, isentropic analyses, microphysics, conveyor belts, trowals, etc.) have been commonplace material in recent residence courses and distance learning materials at COMET, the treatment of terrain-induced dynamic and thermodynamic factors that can dominate a cool-season scenario, and are intricately related to the basic synoptic and mesoscale features of weather systems over, for example, the western US and Canada, has been limited until now (one example is shown in Fig. 2). The Mountain Weather Course (MWC) brings in the leading national University and operational experts to describe and demonstrate these processes. These expert educators are effectively transferring their special knowledge reservoirs directly to the forecasters in this setting.

The forecaster survey indicated that respondents did not believe that workshops lead by subject matter experts were the most effective way of learning new material. From the context of bringing research and operations closer together this might seem troubling. What was not asked was whether respondents had taken such training. An important component of the MWC is the integration of theory given by Subject Matter Expert (SME) presentations with case studies. Furthermore, direct interaction (both during classroom time and afterwards) amongst forecasters and between forecasters and SMEs has proven invaluable for training success during the ~15 years of COMET's residence program.

3. THE MOUNTAIN WEATHER COURSE

An event such as the Winter Olympics offers a unique challenge for meteorologists to provide high temporal and spatial resolution forecasts in complex terrain. The demands put on the forecaster require not only a good knowledge of the local area, but a sound understanding of theoretical meteorology in mountainous terrain; this is important in order to provide the best possible forecasts. The MWC was designed to establish a solid theoretical foundation for forecasters. Presenters included several from US universities as well as experts from MSC and the NWS. The course was made up of a series of lectures and laboratory sessions led by operational experts. All of the lectures contained extensive descriptions of case studies in order to complement the theoretical material presented.

Quantitative Precipitation Forecasting is a critical aspect for events such as the Winter Olympics. Brian Colle and Bob Banta made presentations dealing with orography and precipitation. Results from the MAP field campaign comprised a major part of these talks. The conceptual model put forth by Medina and Houze (2003) for orographic precipitation under blocked versus slightly unstable air was presented (Fig. 3). This reinforced basic understanding for some and was a revelation for other forecasters: the importance of upstream stability on orographic precipitation.

Cloud microphysics is a key element in understanding cool-season weather systems in complex terrain that have a major impact on daily commuting, recreational, and aviation-related activities. Mark Stoelinga

presented a theoretical overview of Cloud Microphysics followed by some of the research done in the Pacific Northwest. Ethan Greene and Mike Meyers discussed the microphysical role of snow density, avalanche dynamics, and storm dynamics.

An extensive laboratory session analyzed the 1-2 Nov. 2004 case over British Columbia, which contained major operational challenges related to quantitative precipitation forecasting (QPF) and precipitation type. Also, the Olympic forecasting experience in Salt Lake City UT, 2002, provided an excellent background for several lectures over-viewing that effort, and detailing what was learned from the major forecasting effort associated with those events. Tom Potter, John Horel and Dave Whiteman presented this and other portions of the course. More topics included Thermally Driven and Dynamically Driven Flows; NWP & Forecasting Orographic Precipitation; Remote Sensing and Observational Uncertainty.

A second course is scheduled for December 2006 at COMET.

4. REFERENCES

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5. ACKNOWLEDGEMENTS

Thanks to MSC colleagues Tim Bullock, Gilles Simard, Pat King, Jaymie Gadal, Kitty Wilkes for soliciting responses to the training survey.

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

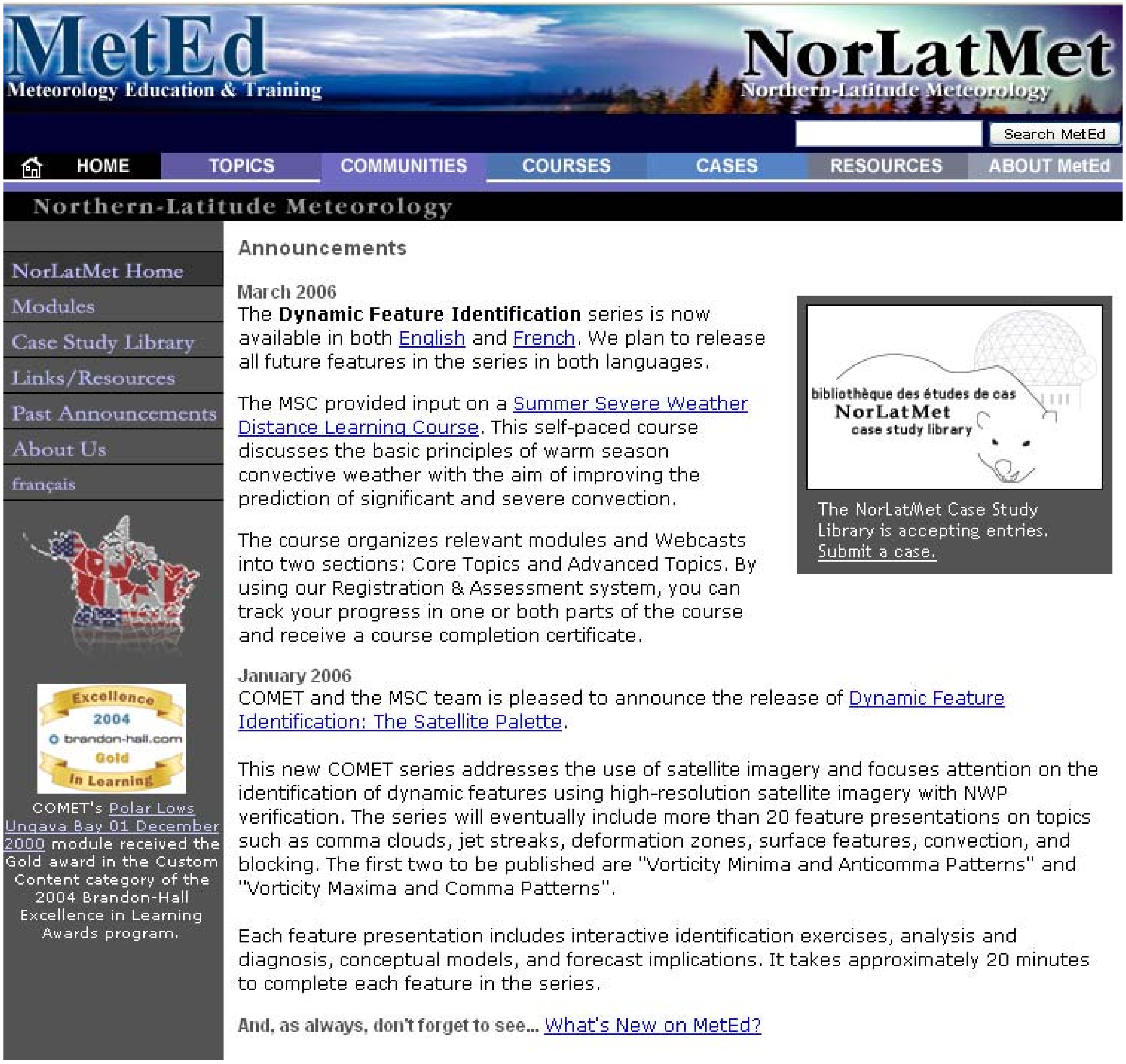

Figure 1. COMET’s Northern Latitude Meteorology home page.

Figure 2. COMET learning module for Barrier Jet Forecasting. One of the prerequisite readings for students in the Mountain Weather Course.

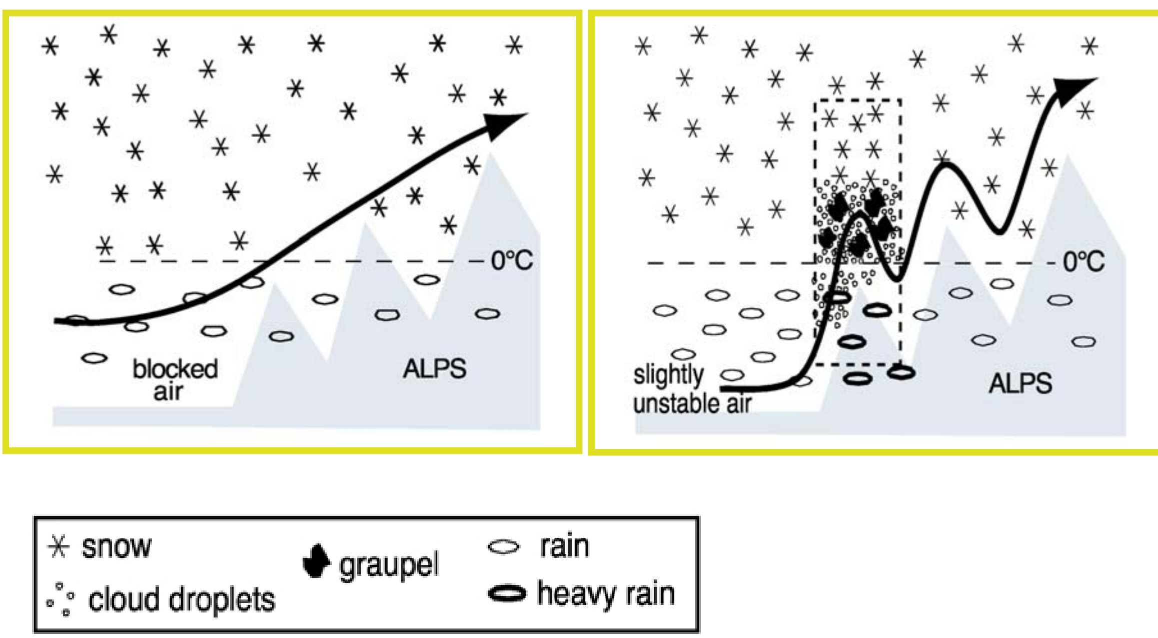

Figure 3. Conceptual model (Medina and Houze, 2003) of orographic precipitation mechanisms active in stable blocked and unstable unblocked flows.