PREFACE

The Pacific Northwest is a fruitful location for studies of clouds and precipitation associated with extratropical cyclones and orography. In the 1960s, Carl Krietzberg used serial rawinsondes and a vertically directed radar located in western Washington to study frontal structures. In the 1970s, Hobbs and colleagues reported on studies of airflow, clouds, and precipitation over the Washington Cascade Mountains (the Cascade Project). Later in the same decade, Hobbs and colleagues studied winter storms on the Washington coast (the CYCLES Project), which led to a classification of rainbands in extratropical cyclones and detailed information on cloud structures and precipitation processes in the various types of rainbands. Within the past decade, Mass and colleagues have used observations and model simulations from the COAST Project, as well as daily real-time mesoscale model forecasts, to study fronts and precipitation in the Pacific Northwest, including the effects of orography. Problems were noted with moist parameterizations in the fifth-generation Pennsylvania State University–National Center for Atmospheric Research Mesoscale Model (MM5).

In 2001 a new project was launched called Improvement of Microphysical Parameterization through Observational Verification Experiment (IMPROVE). The main goals of IMPROVE are the following:

1) to obtain comprehensive, quantitative measurements of cloud microphysical variables and corresponding dynamic and thermodynamic measurements for a variety of precipitation events in which numerical models provide a realistic simulation of the larger-scale structures;
2) to analyze the observational data to ascertain the physical processes leading to precipitation;
3) to perform simulations of the observed cases with the MM5, and eventually the Weather Research and Forecast Model (WRF), which include current state-of-the-art bulk microphysical parameterizations (BMP);
4) to compare the model forecasts of clouds and precipitation with the observations, in terms of both physical processes and quantitative parameters;
5) to make cost-effective and generally applicable improvements in the BMP in mesoscale models.

To obtain the data necessary to achieve the goals of IMPROVE, two field projects were carried out in 2001, one off the Pacific coast of Washington State (IMPROVE-1) and the other over the Oregon Cascade Mountains (IMPROVE-2). These field projects employed ground-based and airborne Doppler radars, research aircraft equipped with the latest in situ instrumentation for cloud and precipitation studies, and ground-based precipitation measuring and observing stations. Both field projects yielded a wealth of data for a variety of meteorological conditions: 11 case studies in IMPROVE-1 and 16 in IMPROVE-2.

This special section of the *Journal of the Atmospheric Sciences* comprises 10 papers that describe some of the initial results from IMPROVE. The first two papers are concerned with the synoptic, mesoscale, and cloud structures and the precipitation-producing mechanisms in a frontal system documented in IMPROVE-1. The next four papers are concerned with analytical and modeling studies of a frontal system that passed over the Oregon Cascade Mountains during IMPROVE-2. The seventh paper discussed the evaluation of a cold front studied

in IMPROVE-2. This is followed by a paper that compares orographic precipitation over the Oregon Cascades and the European Alps. The role of turbulence in orographic precipitation is discussed in the next paper. The final paper is concerned with polarimetric radar observations of a double melting layer.

These initial studies have already revealed a number of potential deficiencies in the representation of physical processes in the MM5 and other mesoscale models. Future studies will explore the application of such models to the wide range of meteorological conditions documented in the IMPROVE field studies with the goal of identifying and correcting generic deficiencies.

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