JP1.3 REGIONAL SCALE MODELING FOR THE 2002 OLYMPIC WINTER GAMES

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1. INTRODUCTION

In February 2002, the Olympic Winter Games will be held in the Salt Lake City (SLC) metropolitan area and the nearby Wasatch Mountains. With over 100,000 spectators and athletes attending and competing daily at various venues, accurate weather forecasts are critical for public safety and games logistics. The NOAA-CIRP real-time MM5 modeling system will be a key component of the forecasting system implemented for the games.

With advances in microprocessor speed and distributed-memory parallel computing, the computer hardware necessary is extremely low-cost. The prototype system, used from September 2000 to May 2001, ran on eight 700 Mhz AMD nodes of the University of Utah Center for High Performance Computing Beowulf-class PC cluster for a total hardware cost of $10,000. Expansion of the modeling system is also inexpensive and can be accomplished by purchasing low-cost personal computers.

2. MODEL DESCRIPTION

The NOAA-CIRP real-time modeling system is based on the Penn State/NCAR MM5 Version 3 (Grell et al. 1995), a non-hydrostatic finite-difference atmospheric model employing a terrain-following sigma coordinate. Since July 1998, the model has been run with a 36-km grid spacing outer nest covering the western United States and eastern Pacific, and a 2-way interactive nested grid at 12-km grid spacing covering Utah and parts of adjacent states (Fig. 1). The model is run with 27 vertical levels. Model parameterizations include a microphysical scheme that allows for simple ice-phase processes below 0 ˚C (Dudhia 1989), a radiation parameterization allowing for long- and short-wave interactions with the atmosphere, clouds, precipitation, and surface (Dudhia 1989), the Kain-Fritsch cumulus parameterization (Kain and Fritsch 1993), and the MRF planetary boundary layer scheme (Hong and Pan 1996).

Initial and lateral boundary conditions for the modeling system are provided by the NCEP Eta Model. These 36-h forecasts require 82 minutes to integrate on the PC cluster. Forecasts and post-processing are typically completed by 0430 (1630) UTC for the 0000 (1200) UTC initialization. An additional NCEP Aviation-model-initialized version has also been run since late winter 2001. Forecasters feel this version adds important mesoscale detail when they determine that the Aviation model is the large-scale "model of the day" rather than the Eta.

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3. MODEL PRODUCTS AND AVAILABILITY

After the model integration is completed, 3-d hourly model output is ingested into the National Weather Service (NWS) AWIPS system and used by meteorologists at the SLC and Elko forecast offices, as well as by the 2002 Winter Olympics Venue Forecast Team through a software package called FX-NET, which is similar to AWIPS. Forecasters at the SLC forecast office and Olympic Venue Forecasters have had up to two winter seasons, including the pre-Olympic test period of winter 2000-2001, to gain familiarity with the model and it's strengths and biases.

Forecasts are also available to the public via the Internet (www.met.utah.edu/jimsteen/mm5). Products include time-height sections, soundings, station time-series, various horizontal plots, GEMPAK grid files, and model-output-statistics (MOS) time-series (Siffert et al. 2001; Fig. 2). Sites for MOS time-series include selected major regional cities and all outdoor Olympic venue sites for the 2002 Winter Games (winter season only). This hourly MM5 MOS guidance is the only objective site-specific forecast product available at many of these locations, and was found to be helpful by many Olympic forecasters during the pre-Olympic test period.

4. EVALUATION DURING IPEX FIELD PROGRAM

The Intermountain Precipitation Experiment (IPEX) was held near SLC during February 2000 to improve the understanding of orographic and lake-effect precipitation, to evaluate model performance, to improve radar estimates of quantitative precipitation, and to study electric fields in winter storms. As part of the IPEX project, the performance of precipitation forecasts by the NOAA-CIRP real-time MM5 was studied (Cheng 2001). It was

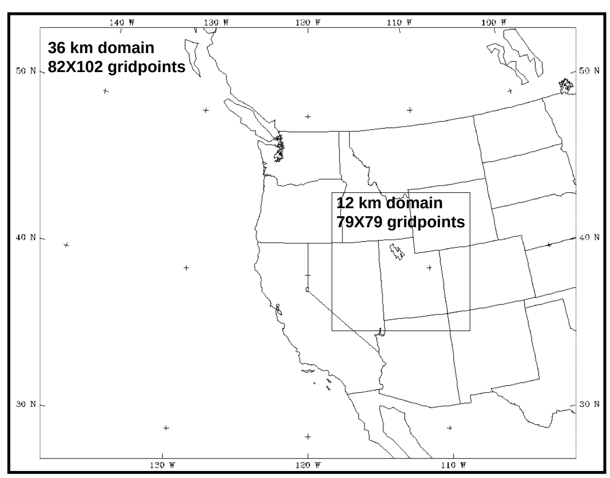

Fig. 1 Domains of NOAA-CIRP Real-time MM5

found that the MM5 often outperformed the Eta and Aviation models over regions of higher terrain, primarily due to better terrain resolution of these features. However, in locations with fine scale terrain features not resolved by the MM5, forecasts performed badly in many cases. An objective technique based upon the Students-t test for the difference of two means was used to contrast the observed vs. MM5 precipitation in selected NWS northern Utah zones. A summary of the results (Table 1) shows that the MM5 provided skillful forecasts in most zones much of the time, however, the Wasatch Mountain Valleys zone had a bias toward too much precipitation due to a lack of terrain resolution. The model error statistics in the Great Salt Lake Desert and Mountains zone were inconclusive because most observations were located in mountains, although most of the region is lowland desert.

5. FUTURE IMPROVEMENTS

Despite the relatively small grid spacing of the modeling system (12 km), many aspects of the topography of the intermountain west remain unresolved. To better predict major weather events such as lake-effect snow, orographic snowstorms, and downslope windstorms, an inner nest at 4-km grid spacing will be added in spring 2001, utilizing an additional 16 1.3 Ghz AMD processors. MOS will continue to be provided from the 12-km domain until a sufficiently large data set is developed at 4 km that MOS can be developed from the high resolution nest.

The dense network of over 2300 surface observation stations in the mountain west included in the MesoWest (Horel et al. 2000) will also be incorporated into MM5 during spring 2001 using the ARPS Data Assimilation System (ADAS). This will insure that high resolution mesoscale information is incorporated into the MM5 initial analysis, and will also allow testing of the importance of assimilation of mesoscale surface information in a mesoscale model forecast.

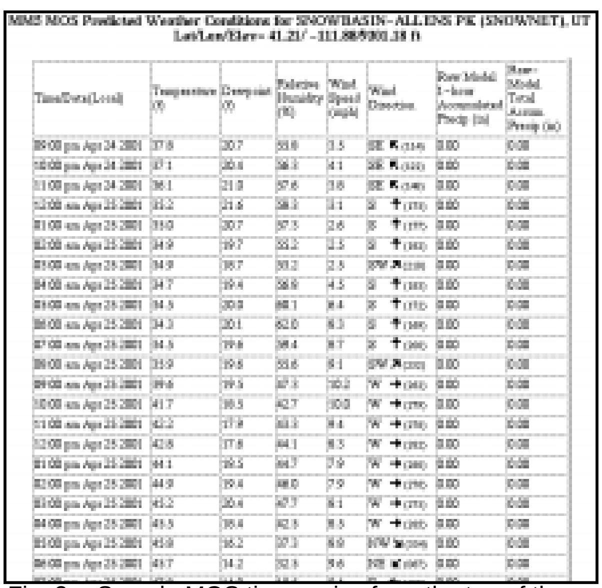

Fig. 2 Sample MOS time-series from the top of the Olympic Men's Downhill.

6. REFERENCES

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Table 1 Summary of MM5 precipitation performance for northern Utah zones for 23 forecasts during IPEX. Performance during precipitation events in columns 2-4. Column 5 presents the number of forecasts where the model produced precipitation when none was observed and the number of days with no observed precipitation (i.e. false alarm rate). Mean bias and observed precipitation in columns 6 and 7. Adapted from Cheng (2001).

Zone	Under Forecast	Skillful	Over Forecast	False Alarms/ No Obs. Precip	Mean Bias (mm)	Mean Observed Precip (mm)
Wasatch Front[a]	4	7	5	2/7	0.2	2.6
Wasatch Mountains[b]	1	9	6	2/7	1.2	5.3
GSL Desert and Mts	6	5	3	3/9	-1.4	3.1
SL and Tooele Valley	4	8	3	2/8	-0.3	2.6
N Wasatch Front	3	6	5	2/9	0.3	3.0
S Wasatch Front	1	10	5	2/7	0.6	2.6
N Wasatch Mts	5	9	2	1/7	-1.2	6.6
S Wasatch Mts	3	8	5	2/7	1.1	6.4
Wasatch Mtn Valleys	0	5	10	2/8	4.8	2.6

a. Includes SL and Tooele Valley, N Wasatch Front, and S Wasatch Front.
b. Includes N Wasatch Mts, S Wasatch Mts, and Wasatch Mtn Valleys.