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MESOSCALE STOCHASTIC - DYNAMIC WEATHER PREDICTION FOR THE 2002 WINTER OLYMPIC GAMES

Andrew J. Siffert*, Daryl J. Onton, W. James Steenburgh
NOAA Cooperative Institute for Regional Prediction and Department of Meteorology
University Of Utah
Salt Lake City, UT

1. INTRODUCTION

During 8-24 February 2002, an estimated 1.5 million people will converge on Salt Lake City for the Winter Olympics. Approximately 3,500 of the best athletes in the world will compete at venues in and around the Wasatch Mountains. With as many as 100,000 spectators and athletes attending events each day at five outdoor venues, accurate weather forecast are critical. Over the past several years observational networks and numerical modeling capabilities have been developed to aid forecasting for the Winter Olympics and the Western Region of the National Weather Service. Statistical techniques combining the high-density MesoWest surface observation network (www.met.utah.edu/mesowest) and the University of Utah real-time MM5 modeling system (www.met.utah.edu/jimsteen/mm5) have been developed to provide site-specific forecasts for the Olympic venues and other weather sensitive locations.

2. DATA AND METHODS

Traditional MOS relates observed weather elements (predictands) to model forecast variables (predictors) using stepwise multivariate linear regression. For forecast support during the 2002 Winter Olympics, MM5 MOS equations are being developed for observing points at outdoor Olympic venues and other weather-critical locations. Predictands are temperature, dew point, relative humidity, wind speed, and wind direction. Predictors include forecast variables from the inner nest of the University of Utah real-time MM5, which features a grid spacing of 12 km. Equations are being developed for each forecast run (0000 and 1200 UTC) at 3-h increments from forecast hours 3 through 36. Due to the high temporal resolution required for Olympic forecasts, the 3-h MOS equations are interpolated to provide hourly guidance for the Olympic forecast team.

Results in this paper are based on prototype equations developed for Olympic test events that were held during winter 2000-2001. These equations were developed from observations and model forecasts from three months (December, January, and February) during winter 1998-1999 and 1999-2000, were based on a limited number of potential model variables, and did not use observed or geoclimatic predictors.

Corresponding author address: Andrew J. Siffert, Dept. of Meteorology, University of Utah, 135 South 1460 East, Room 819, Salt Lake City, UT 84112;
e-mail: asiffert@met.utah.edu

3. RESULTS

Figures 1-3 present the mean absolute errors (MAE) for NGM MOS at Salt Lake City (SLC) and MM5 MOS at SLC and other selected verification sites for the period from 1 December 2000 – 28 February 2001. Figure 4 shows the percentage of forecasts in which the predicted wind direction was within thirty degrees of observed. The verification sites include SLC (1288 m) and Wasatch Mountain State Park (WMP 1713 m), which are located in valleys, DVE, a mid-mountain site at Deer Valley ski area (2235 m), and SBW, which is located on a ridge at Snowbasin ski area (2670 m). MM5 MOS temperature forecasts were generally more accurate for higher elevation stations. The lower accuracy of MM5 MOS at SLC and WMP was due primarily to large errors that occurred during a prolonged inversion event from 26 December 2000 to 11 January 2001. The large MM5 MOS errors at SLC during the inversion can be seen in Fig. 5. Removing the inversion period decreases the MAE for MM5 MOS by .71 °C for the season. This illustrates that MM5 MOS does not perform well at low-elevation stations during prolonged inversion events. Figure 2 shows that higher relative humidity MAEs were observed at higher elevation stations. Figure 3 shows WMP and DVE have lower wind speed MAEs, although this could be due to the fact that wind speeds are typically lower at these locations. The probability of detection that wind direction was forecasted within 30 degrees was similar at all four sites.

MM5 MOS was used by forecasters at pre-Olympic test events during winter of 2000 - 2001. MOS output was accessed via the Internet, which allowed Olympic forecasters easy access to the product. Many of the forecasters found the site-specific forecasts provided by MM5 MOS very helpful. The positive performance of the prototype MM5 MOS shows that it is possible to create MOS guidance from mesoscale model output that substantially improves the raw model forecast (not shown) and is useful for point-specific forecasts on small spatial scales in complex terrain. The MM5 MOS products also provide forecast guidance where NGM MOS and AVN MOS are not available.

4. FUTURE PLANS

Future plans are to develop new equations this summer that utilize observations from winter 2000-2001 as well as data from the months of November, March, and April. These equations will also use more model variables and observations as predictors. These changes should improve the skill of MM5 MOS. The development of MM5 MOS for the five outdoor Olympic venues and other weather critical locations will hopefully prove to be beneficial for the Olympic forecast team, provide a legacy forecast product for use after the Winter Games, make Olympic events more enjoyable for the estimated 1.5 million spectators coming to Utah in February 2002.

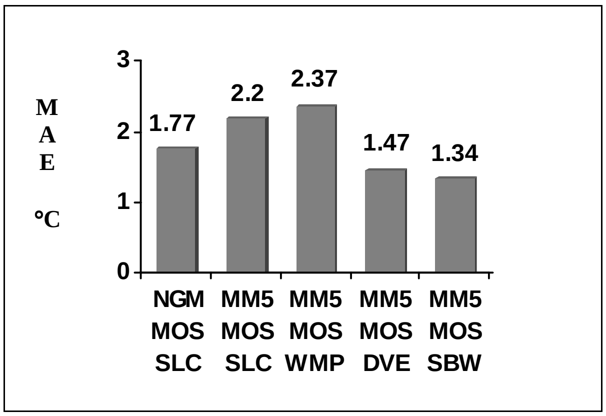

Figure 1. Mean absolute errors for temperature (°C), for NGM MOS (SLC only), and MM5 MOS at Salt Lake City (SLC), Wasatch Mountain State Park (WMP), Deer Valley (DVE), and Snowbasin (SBW).

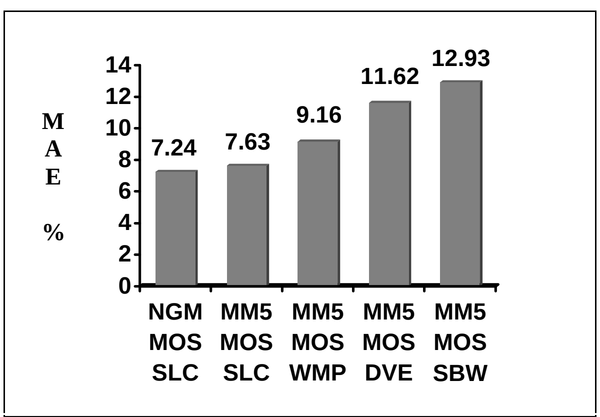

Figure 2. Mean absolute errors for relative humidity (%), for NGM MOS (SLC only), and MM5 MOS at Salt Lake City (SLC), Wasatch Mountain State Park (WMP), Deer Valley (DVE), and Snowbasin (SBW).

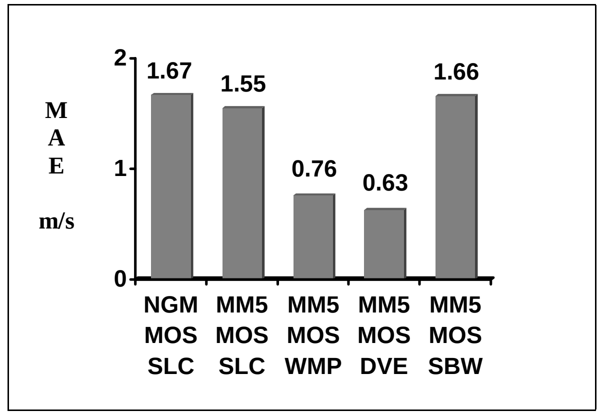

Figure. 3. Mean absolute errors for wind speed (m/s), for NGM MOS (SLC only), and MM5 MOS at Salt Lake City (SLC), Wastch Mountain State Park (WMP), Deer Valley (DVE), and Snowbasin (SBW).

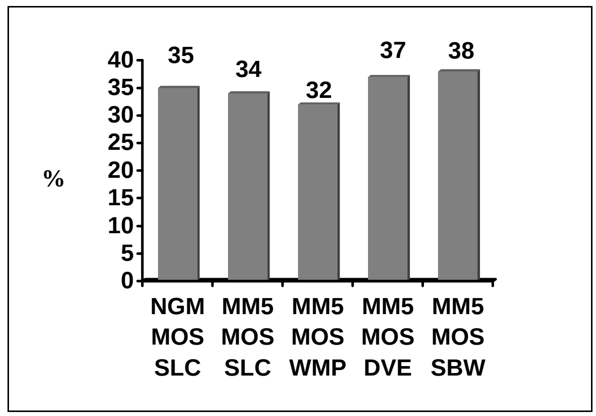

Figure. 4. Probability of detection (%) of wind direction within 30 degrees.

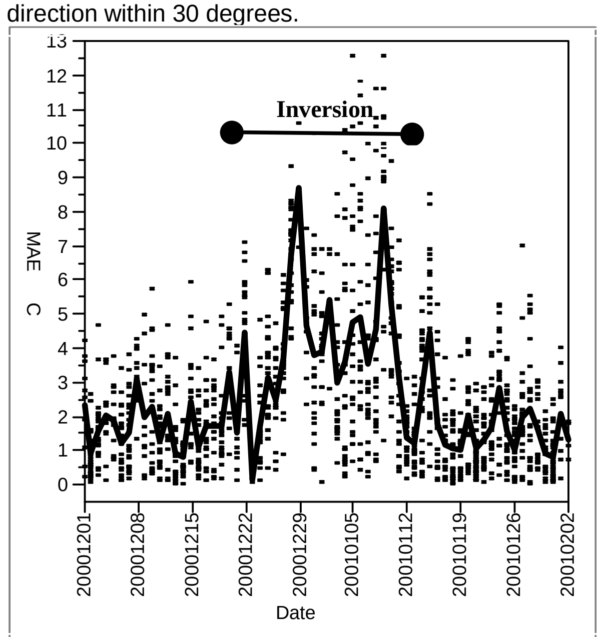

Figure 5. Average daily (graphed) and hourly (dots) MM5 MOS temperature error (°C) from 21December 2000 to 31 January 2001.