Performance of the WRF Model for Forecasting and Regional Climate Modeling

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1. Introduction

Last Year, MESO, Inc. integrated the Weather Research and Forecast (WRF) model into its existing forecasting and climate modeling systems. Over the past year, comparisons have been made of the performance of WRF with the Mesoscale Atmospheric Simulation System (MASS) for a variety of regional climatological purposes to include the U.S. Air Force's Advanced Climate Modeling and Simulations system and AWS Truewind windmapping products. This paper will highlight the results of the comparisons.

2. Modeling System

MESO's core mesoscale modeling system is set up so that it can easily integrate other models into the system. It is also designed so it can be easily configured to be either a regional forecasting system or climate modeling system. The system is described by Van Knowe et al. (2005).

Currently, MESO has integrated WRF into two operational modeling systems designed to produce climate statistics. Until the integration of WRF, the mesoscale model component of this modeling system had been the Mesoscale Atmospheric Simulation System (MASS) developed by MESO, Inc. MASS is a mesoscale model which ingests both gridded reanalysis and observational data to provide simulations of the hourly weather for any specified geographical region (Kaplan, et al. 2000). For regional climate purposes, these individual daily simulations are run over a long time-range of multiple months, or even years, and these simulations form the basis for deriving statistical metrics of the underlying climate.

One climate modeling system has been designed to optimize the model output in order to create wind climate statistics, called wind maps, to aid the wind power industry in siting new wind turbines. The other system has been designed for use by the U.S. Air Force to create high resolution regional climate statistics for battle-planning weather scenarios for data sparse regions of the world.

The wind mapping system is produced for AWS TrueWind, a company that specializes in engineering and site selection for the wind industry. WRF has been added as an additional mesoscale model option when producing the wind statistics used to create the wind maps.

MESO also has integrated WRF into the Air Force Combat Climatology Center's (AFCCC) Advanced Climate Modeling and Environmental Simulations program (ACMES) that is used to derive regional climate statistics in areas around the world for which climatology-based observational data is not directly available.

3. Comparison of MASS and WRF Output

An evaluation was performed comparing the climate statistics obtained from WRF with those produced by MASS over two regions: California from 2001-2002 and Korea from 1987-1996. Both regions have complex terrain, coastal

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regions, are relatively rich in observational data, and have been previously examined using MASS. Last year's paper focused on the results from California, this paper will focus on the results of the simulations over Korea.

For these comparisons, the model configurations were set as identically as possible given the inherent differences between the two NWP models. The model domain used for each set of simulations was a 100x80x25 grid with a 40-km grid spacing. The input data for each model was as similar as possible; however, there were differences because of limitations with the current version of WRF. In particular, the input grib data for the WRF model had to be on pressure levels (as opposed to sigma levels) because WRF can only preprocess pressure-level gridded data. Initial conditions for both the MASS and WRF runs were derived from global grid point analysis data from the NCAR/NCEP GDAS Reanalysis project. The same data was used to generate lateral boundary conditions every 6 hours beginning at 0000 UTC.

3.1 Qualitative Spatial Analysis

To quantify the spatial differences between the two models, the average 2 meter surface temperatures were computed during the months of November and December 1996 and 1997. In general, the overall mean thermal patterns were similar between MASS and WRF. As with the California simulations, the WRF model tended to be colder over land than MASS, with this trend being most noted in the regions of higher elevations. Other near surface parameters compared were, dew point (slight dry bias as compared to MASS was noted for WRF) and wind speed (WRF tended to be lower then MASS, but actually a little better in terms of a lower absolute bias when compared to surface observations).

3.2 METAR Station Comparison

A point comparison was made between the WRF and MASS output using five surface observing stations across the Korean Peninsula. At each location, mean climate values of surface pressure, temperature, dew point, and 10 meter wind speeds were derived from the MASS and WRF output. Overall, results of WRF for each period considered were similar. MASS performed better at some stations and WRF better at others.

Results from the first two-month period of November/December 1996-97 are summarized in Table 1.

Stat	**Obs**	**MASS**	**WRF**
Surface P			
Osan	1026.2	1025.1	1021.1
Pusan	1029.7	1030.1	1028.3
Tague (Daegu)	1028.0	1029.5	1027.8
Pyong Yang	1028.1	1029.7	1026.1
Seoul	1028.7	1029.6	1027.1
Temp			
Osan	34.3	34.5	33.2
Pusan	40.1	41.4	39..8
Tague (Daegu)	37.6	38.8	36.4
Pyong Yang	33.3	33.5	32.8
Seoul	34.4	33.8	31.3
Dew Point			
Osan	23.2	23.5	22.2
Pusan	30.1	31.3	29..8
Tague (Daegu)	27.6	28.8	26.3
Pyong Yang	22.2	22.5	22.8
Seoul	23.3	22.8	21.2

Table 1: Comparisons of surface pressure, temperature and dew point between MASS, WRF, and observations for November-December 1996-97.

4. Summary

Results from the comparisons of WRF with MASS were quite encouraging in that similar results were derived with the WRF model, indicating that WRF can be used to obtian quality climate statistics.

5. References

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