University of Macau

Abstract

Weather Simulation in Macao Using the Weather Research and Forecasting (WRF) Model

by Lou Mei Meng

Thesis Supervisor: Prof. K.M. Mok

Department of Civil and Environmental Engineering

Numerical Weather Prediction plays a very important role in weather forecasting. Different weather forecasting models have been running in different weather forecasting centers. The Macao Meteorological and Geophysical Bureau (SMG) has been running the MM5 for assisting daily weather forecast since 1999. As further development on MM5 is ceased, a new forecasting model is sought for replacement. The Weather Research and Forecasting Model (WRF) developed by the collaboration of many research and government organizations in the US is considered.

To examine how WRF performs in Macao, it was first installed and setup locally. It was then used to simulate the weather patterns of one year (from August of 2006 to July of 2007). Different weather parameters such as temperature, relative humidity, mean sea level pressure, wind direction and wind speed were extracted from the model results to compare with the data observed at the Taipa Granda Station. It was found that, the daily maximum temperature is underestimated (except in September 2006 and March 2007), but the difference is not significant. This could be due to the initial conditions set for the model did not correspond to the actual situations well. The simulation of relative humidity is generally overestimated; the difference is around 5%. It was observed that when the WRF simulating hour reached 06UTC, the error could be as large as 25%. The simulation of mean sea level pressure is relative stable and well. The initial condition of wind speed is about

8 km/hr larger than the observation value, which leads the simulation of wind speed to a larger error. The simulation result of wind direction showed that the accuracy situation of initial condition is similar to the running output from the model, they are around 60%.

In addition to performing simulations for the normal days, five cases of severe weather during the summer and winter seasons were studied in details for further investigation. Remote sensing images such as Fengyun-2C satellite images and rain rate Radar images from Hong Kong Observatory were used to gain better understanding of the situation. In the summer of 2007, there were two rainstorms warnings issued on the 20 of May and 10 of June, respectively while one typhoon signal (0706 Pabuk) was hoisted in August. For rainstorm cases, they are qualitative and quantitative verified by pattern analysis and station precipitation comparison. Basically the intensive rain rate areas were found over south China region from the WRF results are consistent with the concurrent satellite images. For the simulation of tropical cyclone, the low pressure area is forecasted in the nearby region. In the winter, cases of two cold surges which led to temperature drop in Macao occurred in December 2006 and January 2007 were simulated and analyzed. The pressure distribution from the WRF qualitatively shows very good similarity. The trend of temperature drop also shows very good result. In general, the forecast from WRF could be used as a reference of forecasting. Large errors on temperature and relative humidity were found when time reached 06UTC. The forecast of cold surges is good. It could be seen not only by the pressure gradient, but also by the temperature drop.