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P36 COMPARISON OF CONVECTION-ALLOWING WRF FORECASTS INITIALIZED FROM GFS AND ECMWF FOR A SEVERE STORM IN SOUTHERN CHINA

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1. INTRODUCTION

Convective storms accompanied with heavy precipitation, hail and damaging winds occur frequently in summer season in Southern China. To improve the accuracy of very short-term (0-12h) forecasts of such severe weather events, a realtime hourly updated storm-scale forecasting system based on the WRF-ARW modeling system and the ARPS 3DVAR/Cloud Analysis module (Kong, et al., 2008, 2009, 2010) has been developed collaboratively by the Center for Analysis and Prediction of Storms (CAPS) in the University of Oklahoma, Shenzhen Meteorological Bureau (SZMB) of China, and the Shenzhen Institute of Advanced Technology (SIAT), Chinese Academy of Sciences. The forecasting system, called Hourly Assimilation and Prediction System, or HAPS, is featured by assimilating reflectivity and radial wind from local WSR-98 radars every hour in realtime. During the first phase of developing the forecast system in early 2010, 0.5 deg GFS data was used to initialize the WRF-ARW model, over a smaller domain covering Guangdong province, and overestimation of precipitation were found in many cases. To provide more realistic synoptic settings for the storm-scale forecasts, ECMWF data was considered during the second phase. The present paper is a comparative study using 0.5 deg GFS and fine-resolution ECMWF data for a severe storm case occurred on April 17, 2011 in Southern China that caused heavy property damages and several fatalities.

2. MODEL SETUP

The forecast system consists of an outer domain with 12-km horizontal grid spacing and a one-way nested high-resolution domain at 4-km grid spacing, defined on a Lambert conformal projection. The outer domain that coves southern China region produces 48 h forecasts every 12 h (initiated at 00 and 12 UTC) as background and lateral boundary condition (LBC) for the inner 4-km grid storm-scale forecasts. The 4-km grid, with hourly radar data assimilation, produces 12 h forecasts starting at the top of every hour. Fig. 1 shows the model domains.

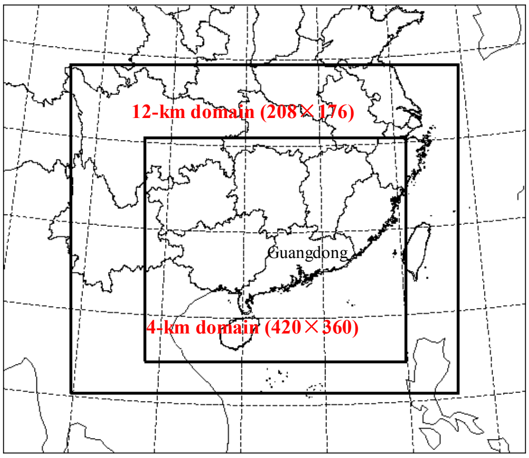

Fig. 1 Model domain coverage. The outer thick rectangular box represents the 12-km domain and the inner thick box is the 4-km domain.

WRF-ARW V3.2.1 was used in the case study.

3. STORM CASE

The heavy storm event affected most of Guangdong Province (marked in Fig. 1) primarily during 0100 and 0830 UTC on Apr 17, 2011, with hail and heavy rain observed at around 0500 UTC. Thus, the model initiation time was 1200 UTC on Apr 16, 2011 for the outer 12-km grid domain to produce background and LBCs. The 4-km resolution storm-scale forecasts was initiated at every hour starting at 0000 UTC on Apr 17, 2011 until 0900 UTC.

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4. RESULTS

4.1 Comparison of GFS and ECMWF

The synoptic settings for the storm event were characterized by an upper level trough and wind shear. Comparison of upper level and lower level fields, mean sea level pressure and moisture from model analysis as well as observations suggested that both GFS and ECMWF could reflect the main airstream and precipitation regions.

Focus was on the accuracy of 1-, 3-, and 6-h accumulated precipitation forecasts from the 4-km domain.

Fig. 2 shows the 6 h accumulated precipitation during 0000 and 0600 UTC on Apr 17 from both observations and simulations. From Fig. 2(a), there was one main precipitation region in central Guangdong Province, with the maximum value of around 56 mm. Fig. 2(b) shows that the model forecast using GFS data as background failed to produce the intense precipitation as observed in central Guangdong. In contrast, the forecast using background from ECMWF data (Fig. 2(c)) produced heavy rainfall in right region, though more extensive and intensive compared to the observation.

The 3 h accumulated precipitation also suggested that forecasts using ECMWF data are better than those with GFS data in simulating precipitation distribution (figures not shown).

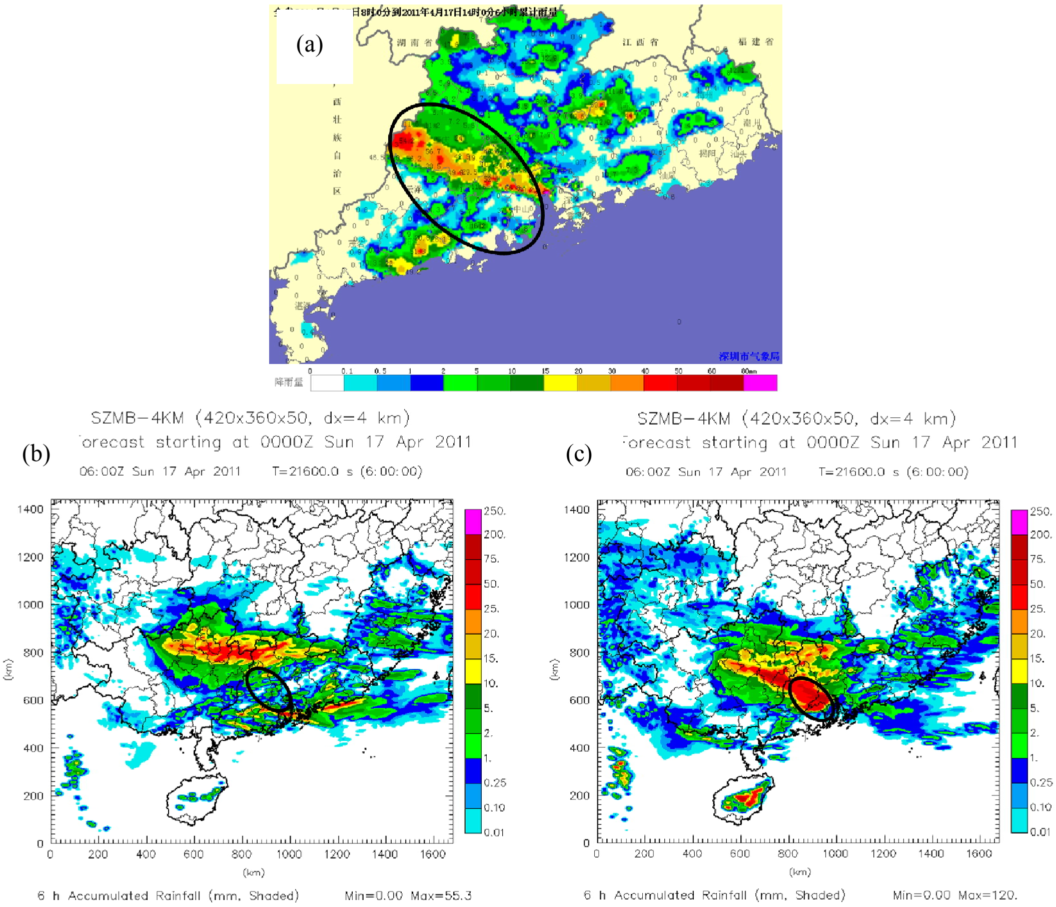

Fig. 2 6-h accumulated precipitation during 0000 and 0600 UTC, 17 April 2011: (a) Observation; (b) driven from GFS data; (c) driven from ECMWF data. The primary precipitation region is marked by a thick oval-shaped line.

Impact of model start time on precipitation area coverage and maximum values were also examined. The start times of the 4-km forecasts are from 0000 UTC to 0900 UTC on Apr 17. Fig. 3 shows the 1-h accumulated precipitation during 0600 and 0700 UTC with two different initiation times, 00 and 04 UTC.

Fig. 3(a) suggests that for the southern part of Guangdong Province, accumulated precipitation was primarily between 10 and 30 mm, with maximum values of over 50 mm. In comparison, forecast using GFS initialized at 0000 UTC (Fig. 3(b)) apparently failed to get the observed precipitation distribution for this period, while forecast using ECMWF, in Fig. 3(c), shows much better agreement with the observation. Fig. 3(d) and 3(e) indicate that forecasts using both GFS and ECMWF data were improved with later initiation at 0400 UTC, with the one driven by ECMWF still performing better than that by GFS in capturing those scattered precipitation centers.

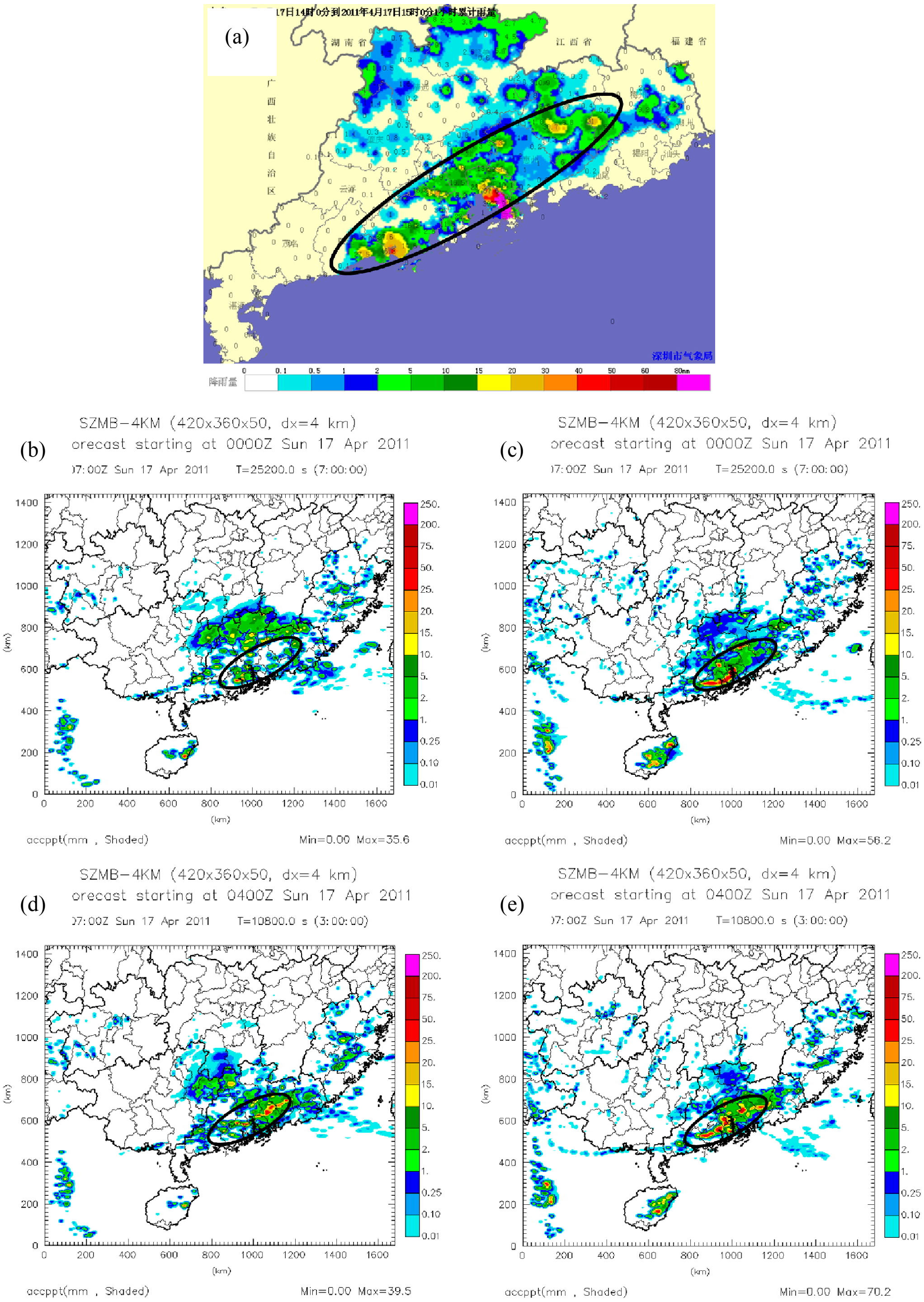

Fig. 3 1 h accumulated precipitation during 0600 and 0700 UTC: (a) Observation; (b) with GFS initialized at 0000 UTC; (c)with ECMWF initialized at 0000 UTC; (d) with GFS initialized at 0400 UTC; (e) with ECMWF initialized at 0400 UTC. The primary precipitation region is marked by a thick oval-shaped line.

4.2 Sensitivity experiments with different microphysics

Sensitivity experiments were performed to study the impacts of physics options, including PBL and microphysics on the QPF. Fig. 4 shows the 1-h accumulated precipitation during 0600 and 0700 UTC initialized at 00 UTC with ECMWF data using different microphysics schemes. It shows that difference indeed exists among those microphysics schemes in terms of QPF distribution, especially the area of maximum values. Quantitative evaluation will be performed to further study the impact.

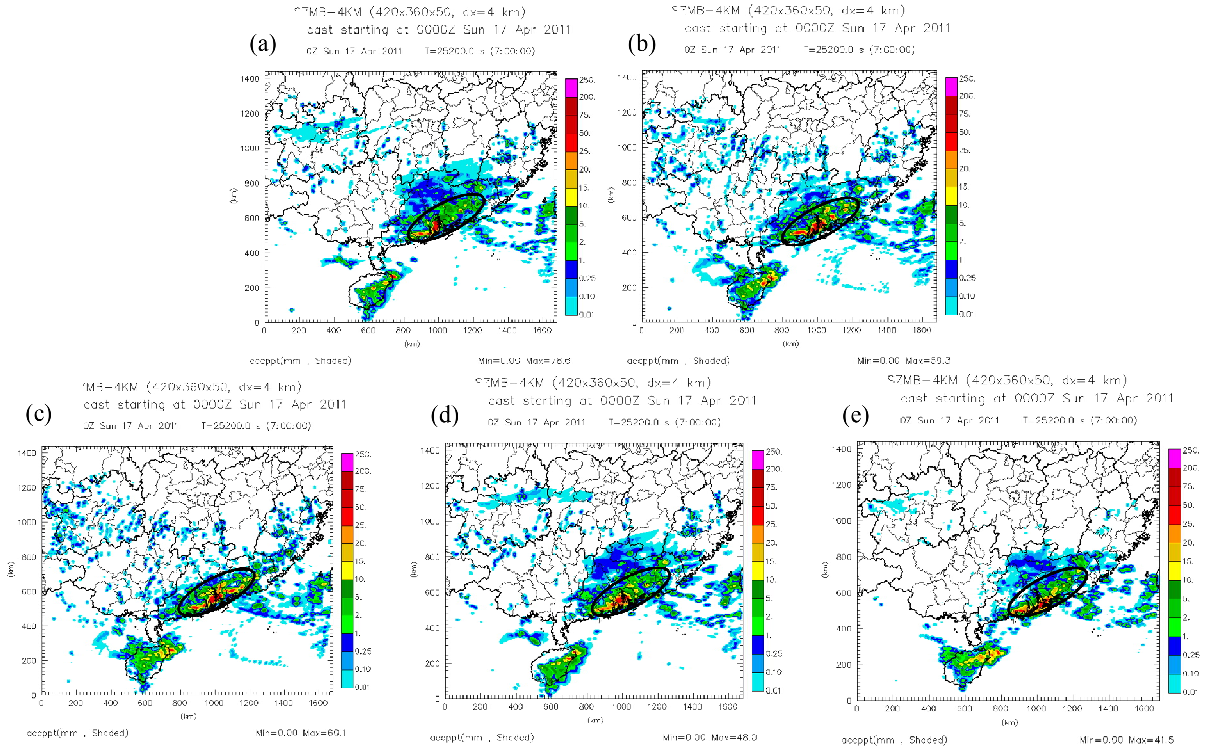

Fig. 4 1-h accumulated precipitation during 0600 and 0700 UTC: (a)Thompson; (b)WSM6; (c)WDM6; (d) Morrison; (e)Milbrandt-Yau. The primary precipitation region is marked by a thick oval-shaped line.

5. SUMMARY

For 6-h accumulated precipitation, forecast using ECMWF background is better than that using GFS in terms of precipitation coverage. For 1-h accumulated precipitation, ECMWF is better in predicting precipitation center location, but overestimating to some degree. More case studies are needed to compare GFS and ECMWF data in synoptical setting. Future work will also be focused on adding analysis of non-radar observation data, such as AWS data.

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