WS6-2016-048

Shot-term Heavy Rain Forecast of Typhoon Fitow (2013) using GSI with Radar Radial Wind Assimilation

Min SUN[1] , Ming HU[2]

1. Shanghai Central Meteorological Observatory, Shanghai Meteorological Service, Shanghai 200030, China
2. Cooperative Institute for Research in Environmental Sciences (CIRES), University of Colorado, Boulder, Colorado, USA

Introduction

- **The Gridpoint Statistical Interpolation (GSI) is a state-of-art analysis system, and has been adopted in various operational systems in USA. A few studies have been conducted to investigate the assimilation of the radar radial wind and its impact on the NWP forecast in a preoperational framework (Montmerle and Faccani, 2009; Simonin et al., 2014). The aim of this study is to assess the impact of assimilating radar radial wind data on short-term forecast by using GSI 3DVAR system and WRF ARW model. In order to explore the impact of radar radial wind data assimilation, a comparison between experiments with and without radar radial wind data is carried out. And a continuous 12-minute cycling 3D-Var is also carried out.**

Case and Experimental Design

- **Typhoon Fitow (2013) was the strongest typhoon to make landfall in Mainland China during October since 1949 (Fig.1). It struck China at Fuding in Fujian province, with a landfall pressure of 955hPa. It quickly weakened over land, dissipating on October 7th. But the residual cloud system in conjunction with cold air caused the maximum of 115 mm rainfall within 24 hours from October 8th to 9th in the east coast of Shanghai. At the same time, there is another typhoon Danas, it not only influences the track of typhoon Fitow but also does some contribution to the heavy rain.**
- **In this study, a 3km forecast is conducted. The number of horizontal grid points of the domain is 400╳400, covering most part of East China. In the vertical, there are 35 sigma levels. The model top is at 10hPa. The forecast is initiated at 0000 UTC 8th October 2013 and runs for 6 hours to 0006 UTC 8th October 2013. The radial wind observations from the two radars in Shanghai are assimilated. The black triangles in Fig.2 indicate the locations of the two radars in Shanghai.**
- **The control experiment is without any data assimilation (CNTL) and the sensitive one assimilates the radar radial wind observations at the initiation time using GSI 3DVAR assimilation system (ASS_RADIAL).**

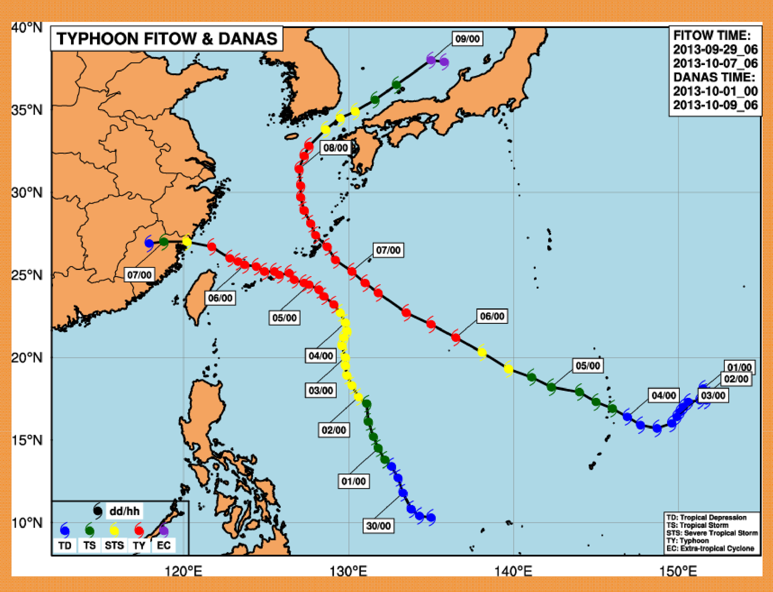

Fig. 1 Best track of typhoon Fitow and Danas

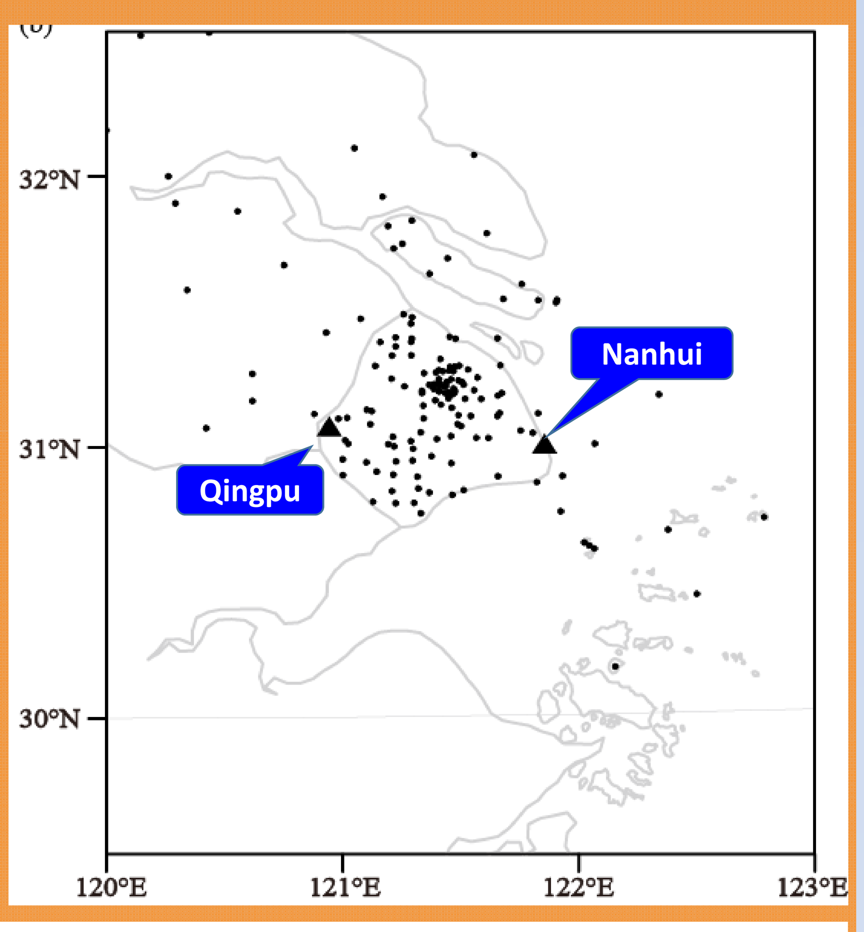

Fig. 2 Locations of auto-stations (dots) and radar sites(triangles)

Analysis Results

- **According to the 1h accumulated rainfall from observation network (distribution shown in Fig.2), there are two maximum rainfall centers in Shanghai (circles in Fig. 3a). Wind increments indicate that obvious wind convergences appear in the same heavy rain location at 925, 850 and 700hPa (circles in Fig.3b-d).**

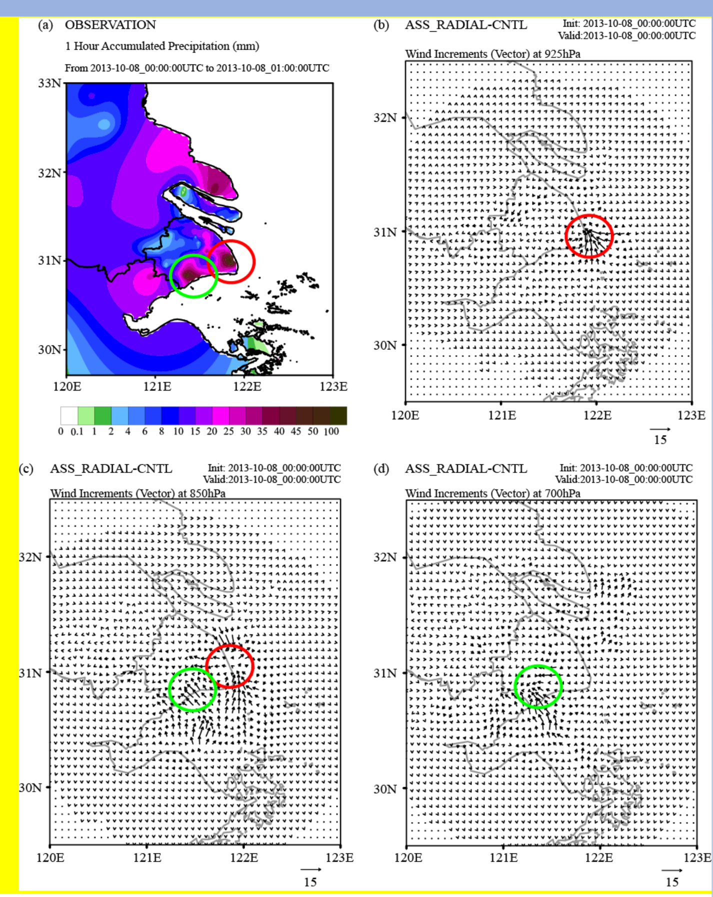

Fig. 3 Observation precipitation and wind increments

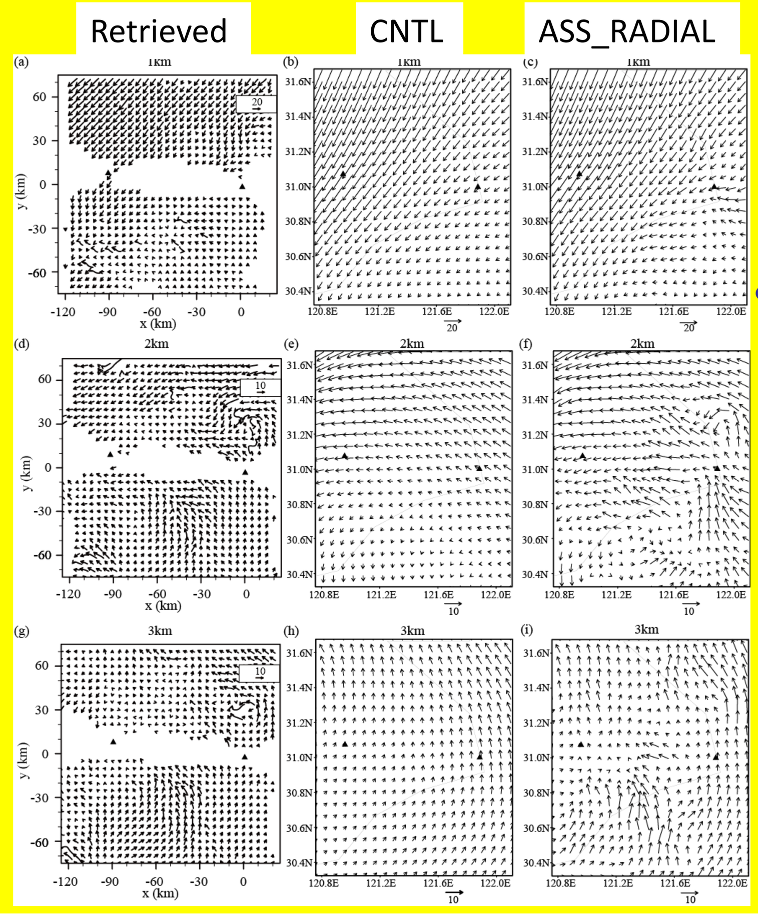

Fig. 4 Dual-Doppler radar retrieved wind fields and wind fields from CNTL and ASS_RADIAL experiments.

- **The wind fields retrieved by the dual-Doppler radar data are shown in the first column of Fig. 4 at the levels of 1, 2 and 3km, respectively. The wind field distribution of CNTL reflects large-scale characteristics and the distribution of wind is smoother (second column in Fig. 4). While ASS_RADIAL presents local features and is closer to the retrieved wind fields (third column in Fig.4)**

Short-term Forecasting Results

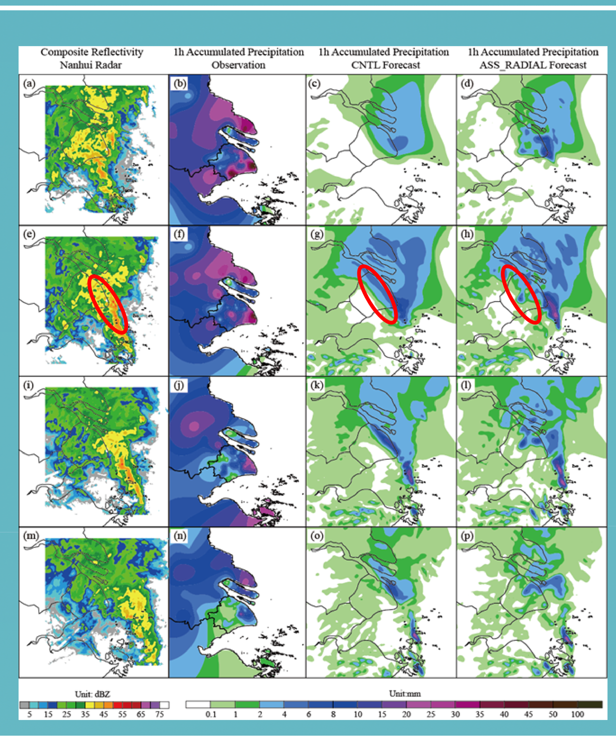

Fig. 5 The composite reflectivity and accumulated precipitation

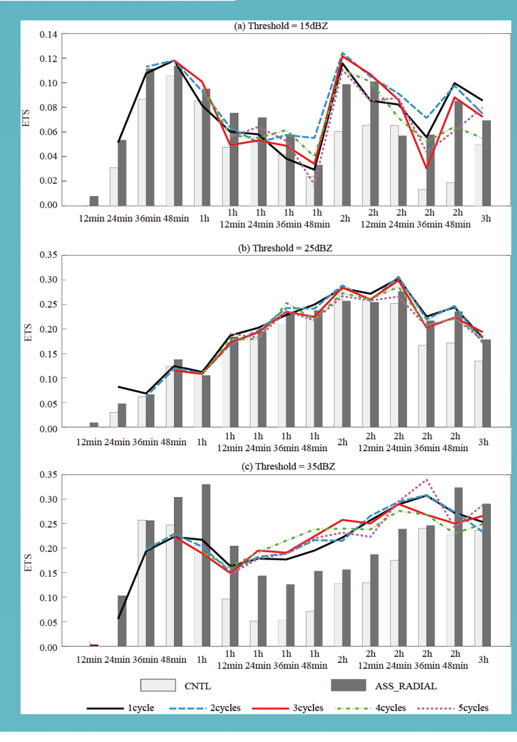

Fig. 6 ETS for composite reflectivity

- **The observed radar composite reflectivity pattern (Fig.5e) shows a quasi-north-south belt rainband along the east side of Hangzhou Bay and ASS_RADIAL catches the character of the quasi-north-south belt rainband. The maximum rainfall increases from 9.8mm/hr in CNTL to 23.7mm/hr in ASS_RADIAL.**
- **Most of ETS for ASS_RADIAL are higher than those of CNTL, especially within the higher threshold (histogram in Fig.6). The higher ETS of ASS_RADIAL suggests that the radar radial wind data assimilation using GSI is beneficial to short-term forecast.**
- **The ETS of different rapid update cycles show that it does improve the reflectivity forecast at the threshold of 35dBZ from 84 to 156 minutes, but it doesn't always improve the results, especially in the first one hour, when it needs time to adjust all the fields to achieve the balance.**

Conclusions

- **When using GSI to assimilate radar radial wind data, the horizontal influence scale should be tuned to small values (the horizontal influence scale ~ 30km).**
- **Assimilating radar radial wind observations can produce reasonable wind analyses and reflect more local information.**
- **The rainfall forecasts within the first 3 hours initialized from radar radial wind assimilation are better than those without any data assimilation when verified against the AWS observed rainfall and radar reflectivity observation.**
- **Rapid update cycle of assimilating radar radial winds can't always improve the results, especially in the first one hour, because it needs time to adjust all the fields to achieve the balance.**