A WRF-based rapid updated cycling forecast system of BMB and its performance during the summer and Olympic Games 2008

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  - Cycling flow chart
  - Data Assimilation
    - BE tuning
    - AWS
    - AMDAR
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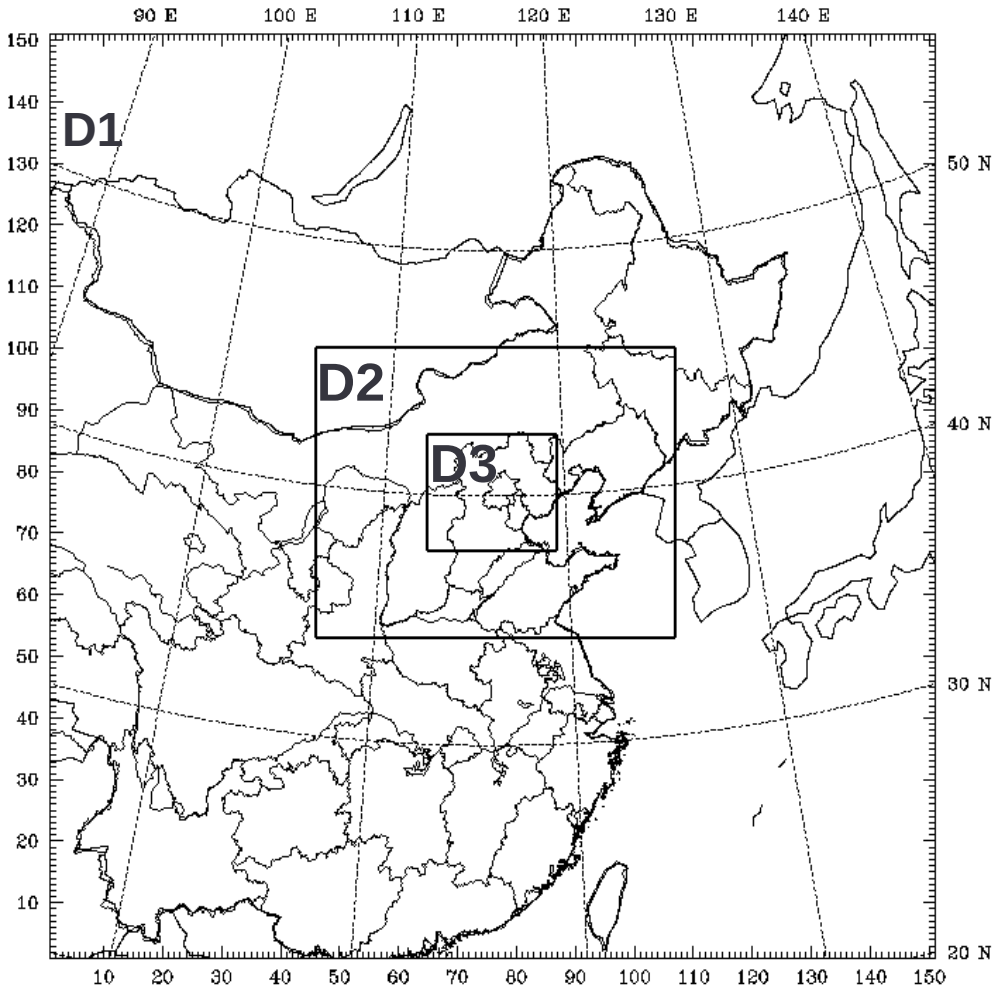
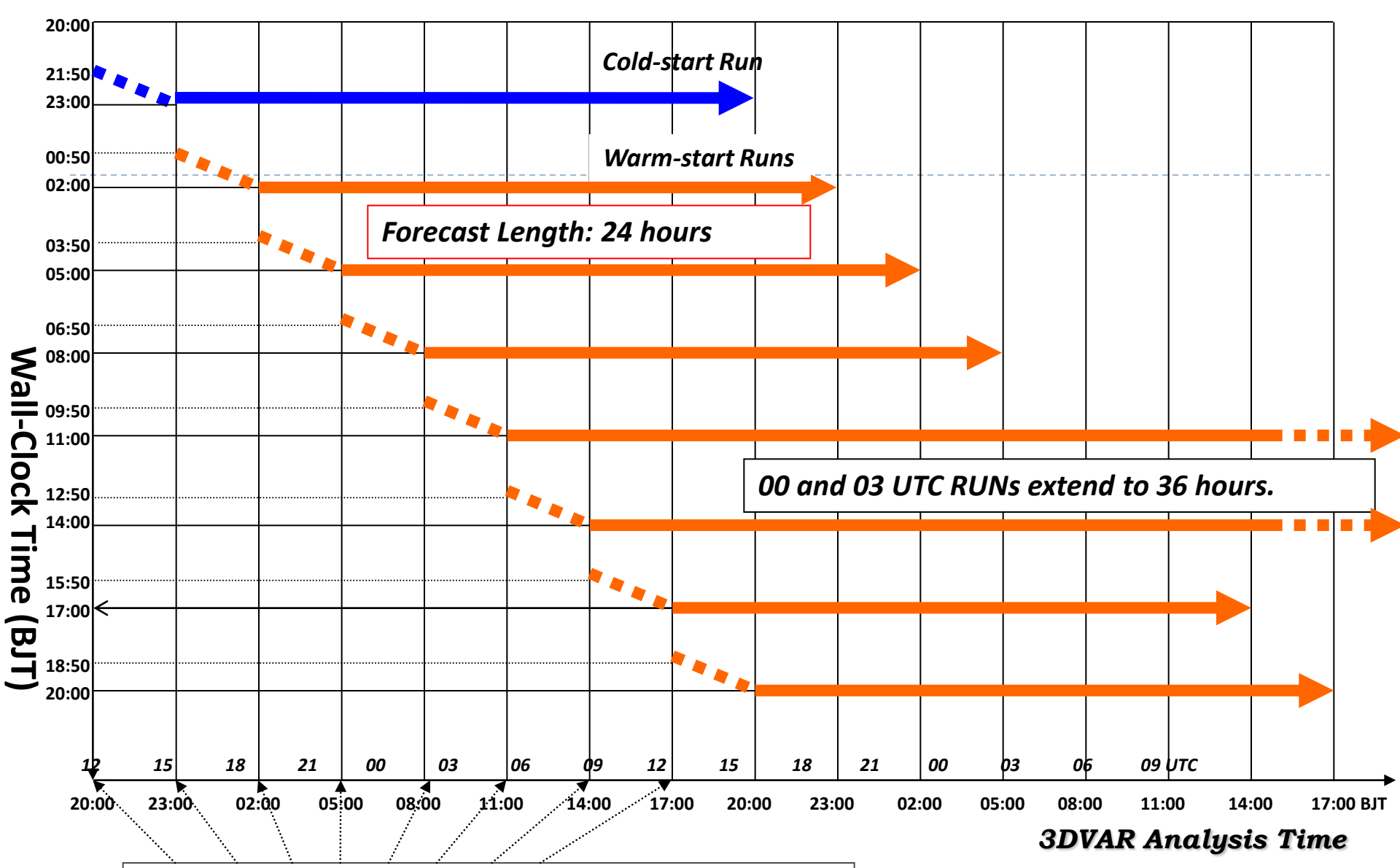
- Performance during summer and the XXIX Olympic Games in 2008
  - Scores
  - CASES

Introduction

Model Domain Configuration



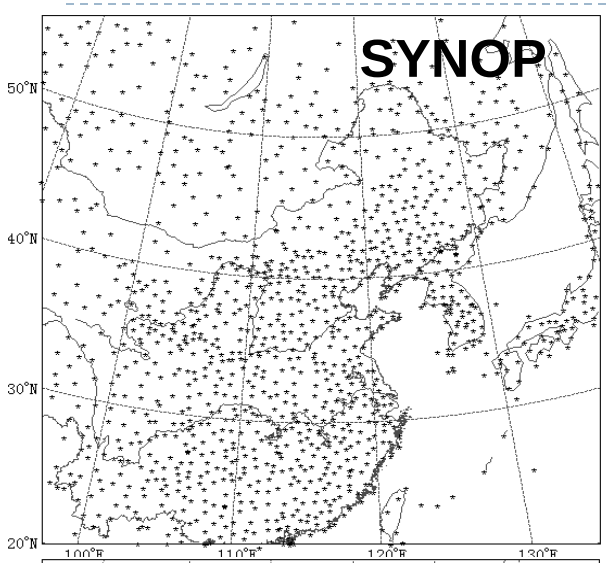
- D1:
  - Grid distance: 27km
  - 151×151×38
- D2:
  - Grid distance: 9km
  - 142×184×38
- D3:
  - Grid distance: 3km
  - 172×199×38

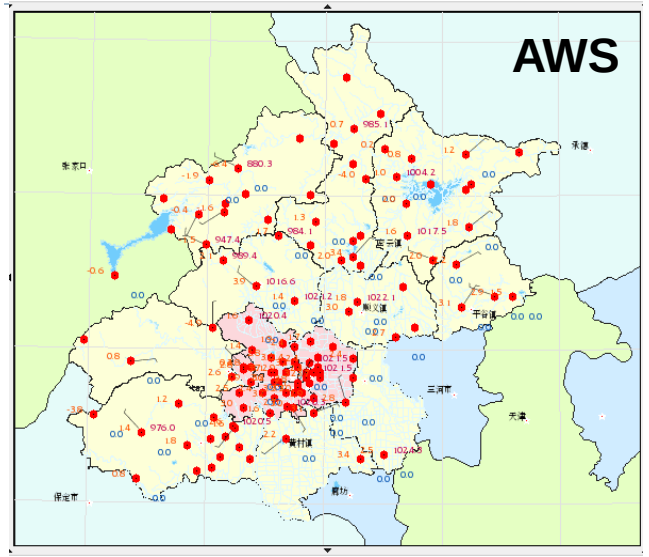


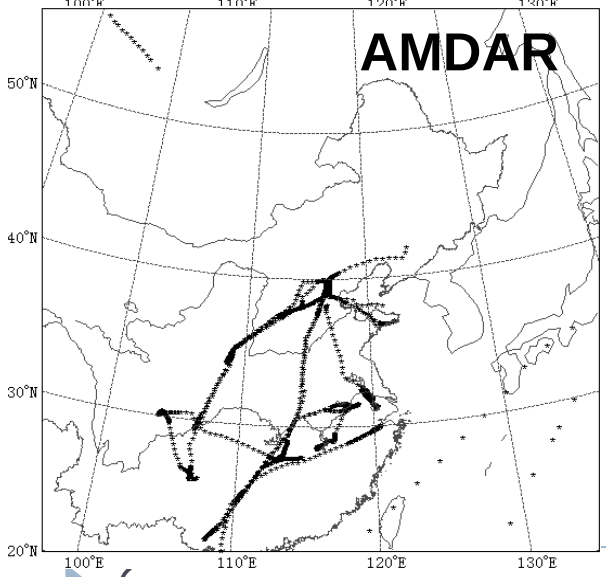
GTS data, including SYNOP, conventional and intensive TEMP, AMDAR, SHIP, BUOY etc.
Local AWS and ground-based GPS precipitable water in Beijing area

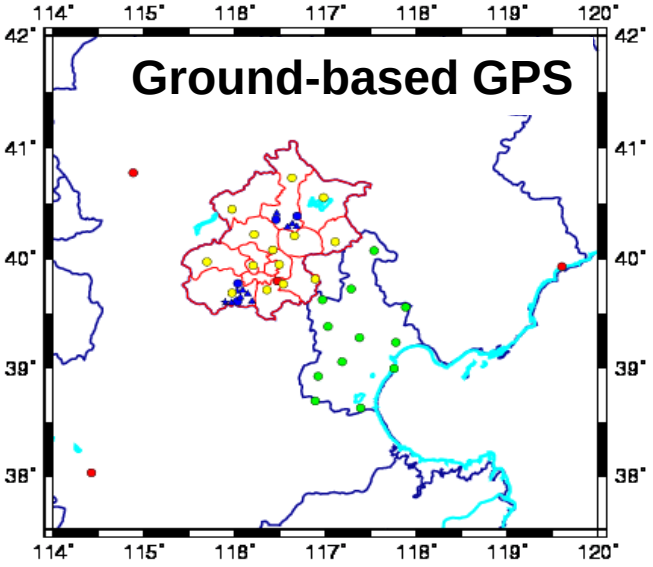
Flow Chart

Data Distribution









BE Tuning

- WRF 27 km BE well tested

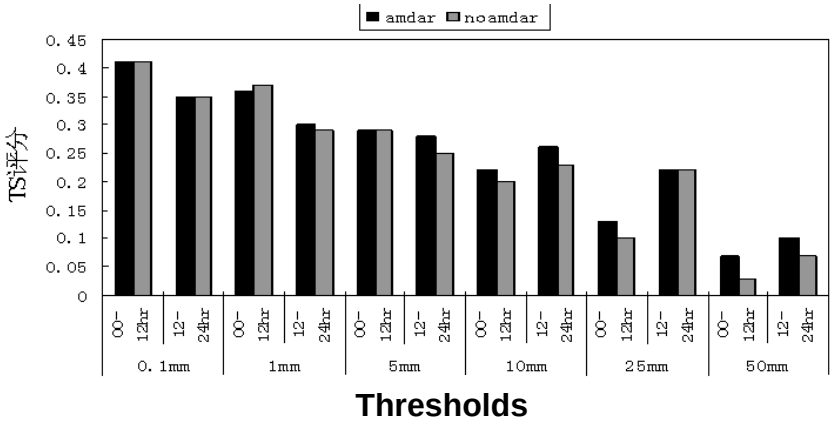
- WRF 9 km BE from interpolating 27 km BE:
  - Interpolate from 27 km BE.
  - Tuning and testing.
  - Can be used to start the 9 km data assimilation work.

- WRF 27 km and 9 km BE recomputed
  - Using SI+ wrfvar (BE interpolation) + WRFv2.1, the pre-operational forecasts in August 2006
  - Single observation experiments
  - AWS+GPS data assimilation experiments

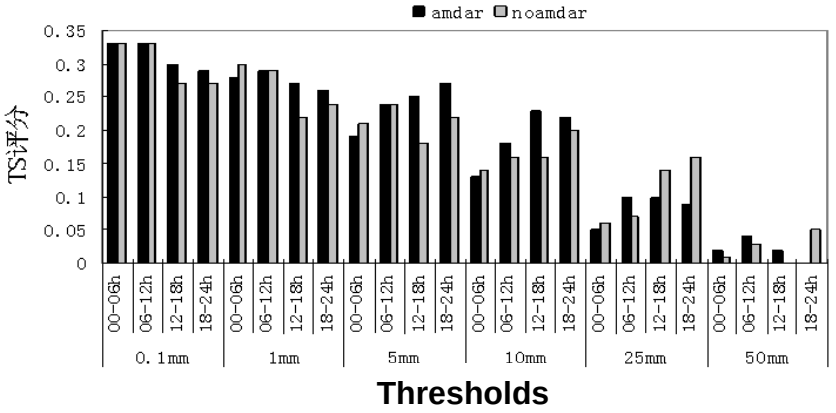
- WRF 3 km BE
  - Apr 2007: Fix the bug of Gen_be software and recalculate BES for 3 domains
  - Apr 2007: Tuning var_scaling=0.5 for 3kmBES

AMDAR data assimilation

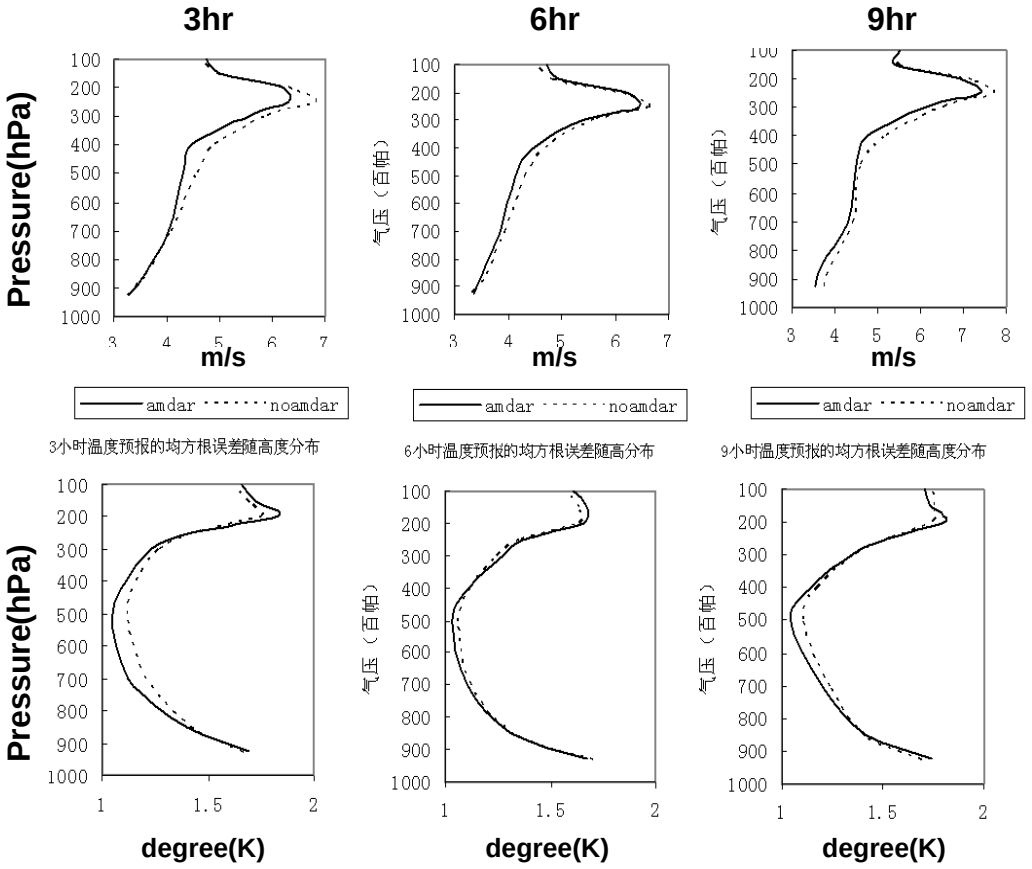
TS scores for 12-hr Accumulated Precipitation



TS scores for 6-hr Accumulated Precipitation

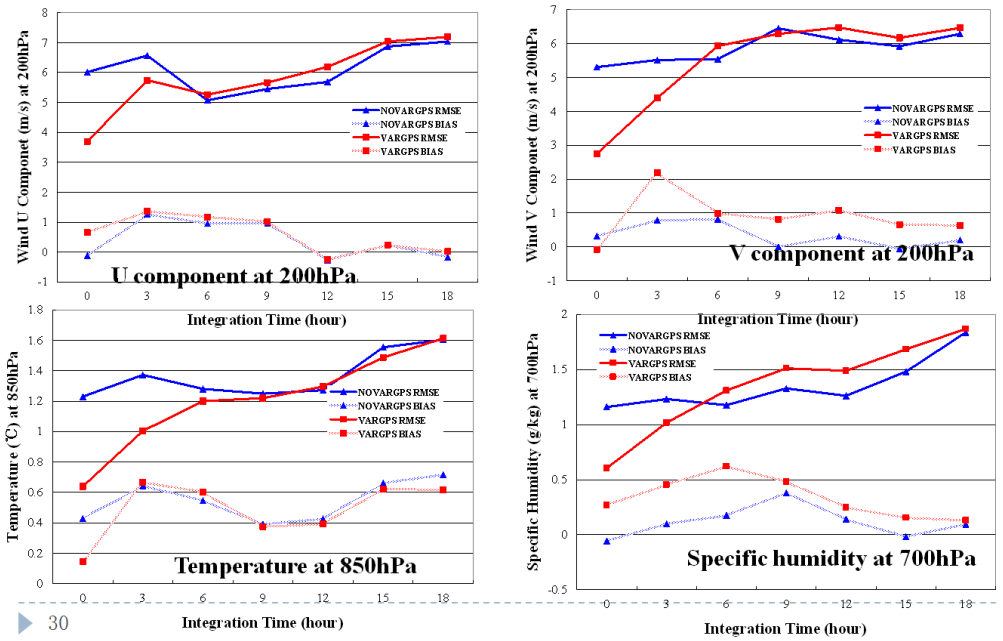


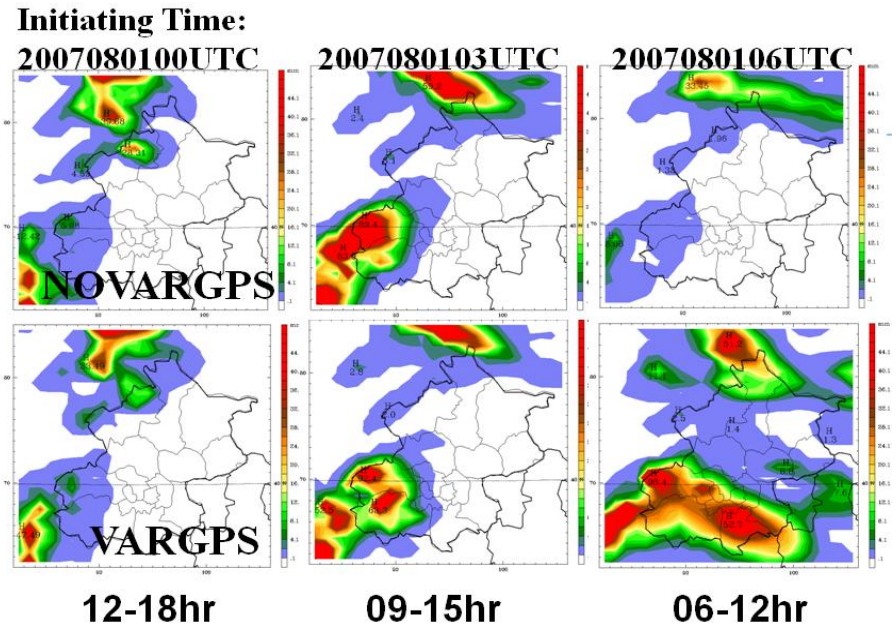
Profiles of RMSE for wind and temperature forecast



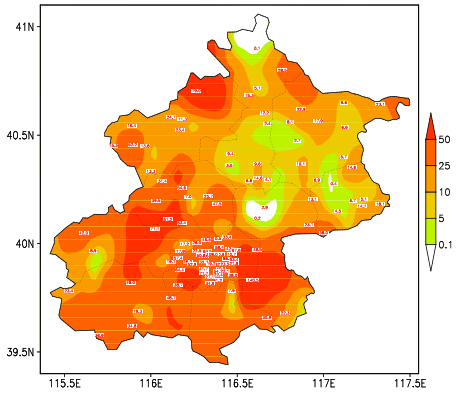
- Positive impact will be brought by assimilation of AMDAR data.
  - Short-term precipitation forecast skill
  - Wind and Temperature forecast qualities

Local ground-based GPS/IPW data assimilation





- Neutral impact over the whole model domain
- Positive impact over the Beijing area!
  - Improved skill for 0-6 hr forecast
  - accumulated assimilation effects of local GPS-IPW observations would help model to create circumstance more favorable to the formation and sustaining of the local convections



6-hr accumulated observed precipitation valid at 2007080112-18UTC

Model Configuration

- WPS(v2.2)+WRFVAR(v2.1)+WRF_ARW(v2.2)

- Physics Package
  - WSM6 Microphysics Scheme;
  - Kain-Fritsch Cumulus Scheme (cu=99) (for both 27 and 9km domains), no cumulus scheme for 3km domain;
  - YSU PBL Scheme;
  - RRTM Longwave Radiation Scheme;
  - Goddard Shortwave Radiation Scheme;
  - Noah land-surface model;

- The cycles run in cold start style at 1200UTC everyday and in warm start style for the rest cycles of the day.

- WRFVAR analysis and WRF forecasts are performed for 27, 9 and 3 km domains independently.

Performance during summer of 2008: SCORES

Performance Evaluation

- Data:
  - 00UTC1 June~21UTC 30 Sep, 2008
  - 3-hr updated interval
  - 3km domain
- Verified against:
  - Precipitation Verification: 171 AWS stations in Beijing area
  - Objective Verification: surface and sounding observations
- BJT (Beijing Time) = UTC + 8hr

Diurnal cycle of the accumulated 3-hr precipitation (mm) during the perio… …ons in Beijing a…

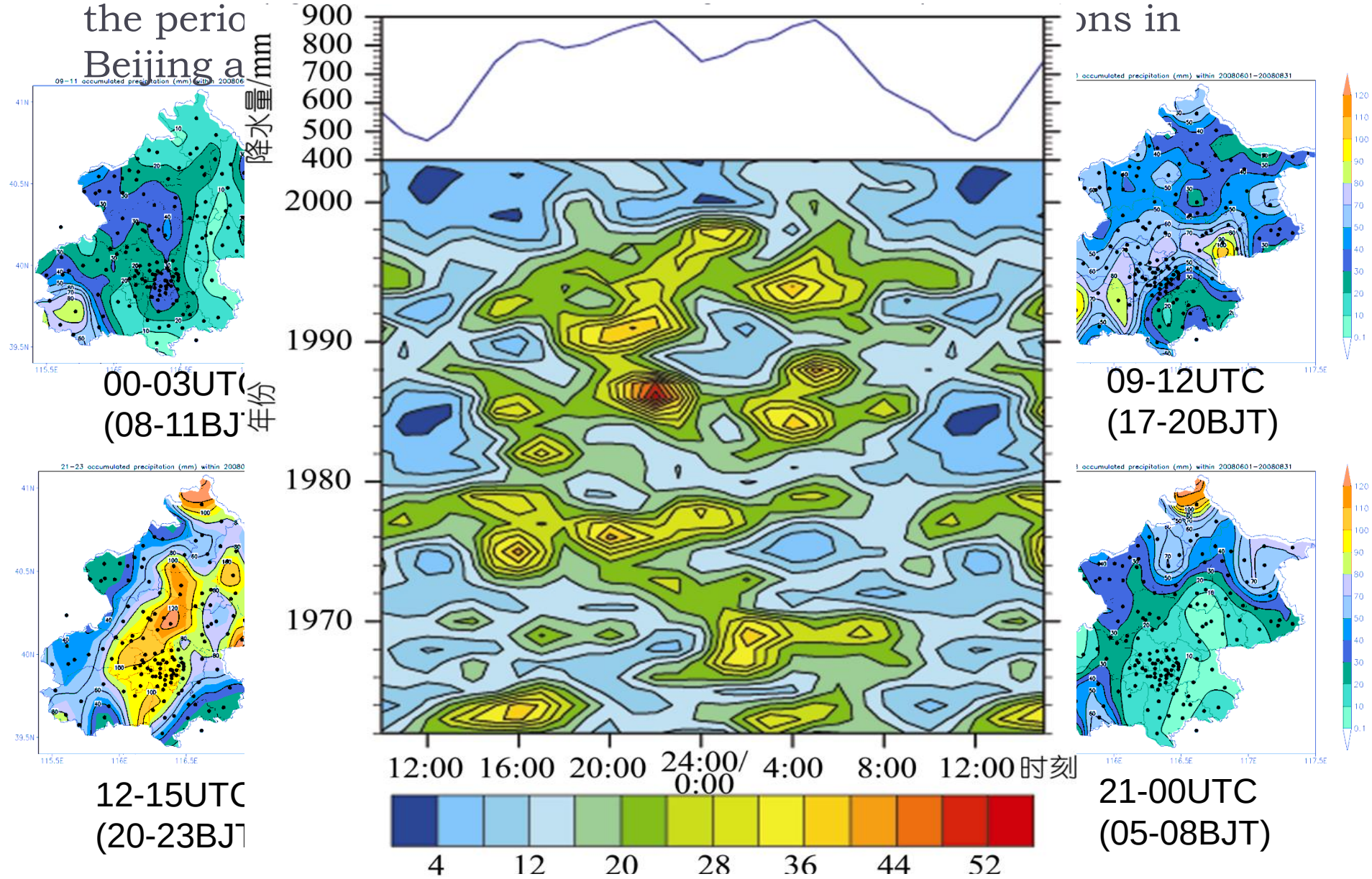
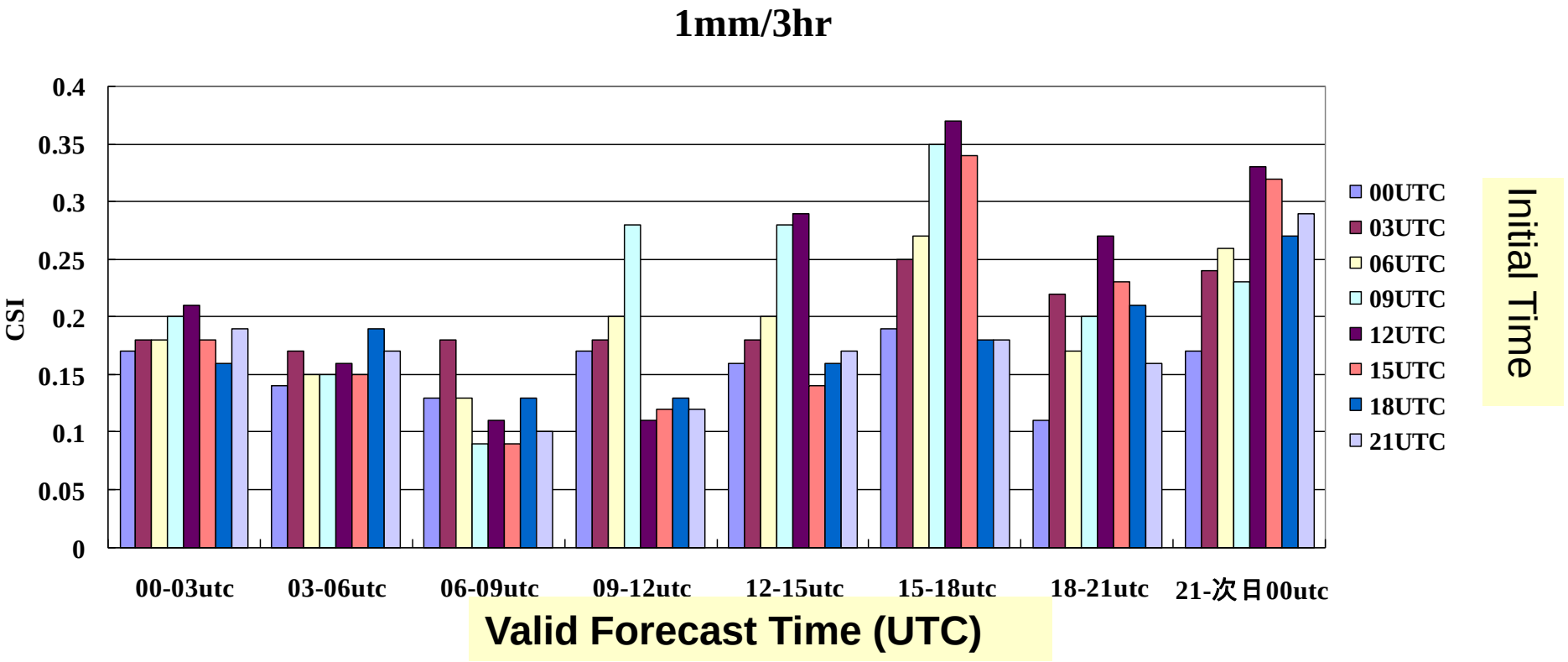


Diagram of the 1-hr accumulated precipitation for 43 years in Beijing (Li, Yu and Wang, 2008)

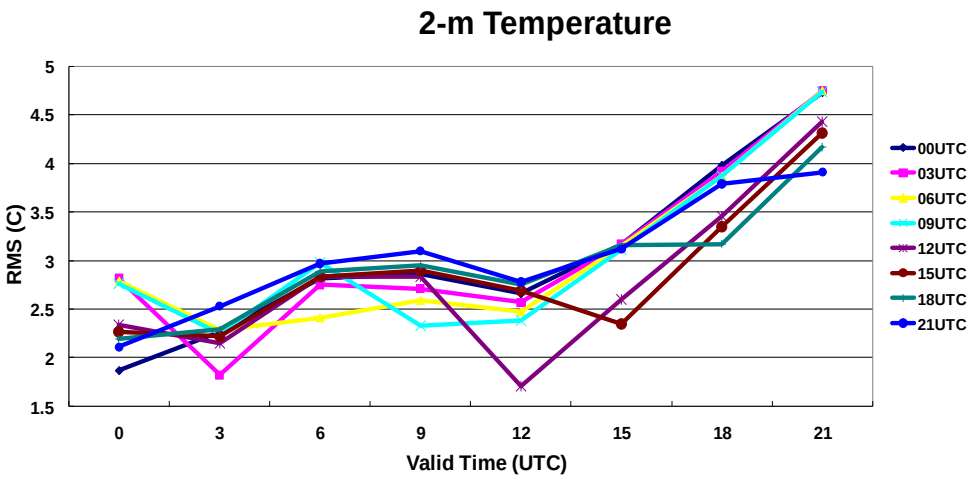
- In each 3-hr period such as 00-03utc, 03-06utc,…,21-00utc, there're 8 comparable forecasts from cycles with different initial time. We have to answer the questions raised from the forecasters:
  - *Which cycle had the best forecast skill for each 3-hr period?*
  - *For each cycle initiating from different time, how about its forecast performance for the diurnal cycle of precipitation in Beijing area?*

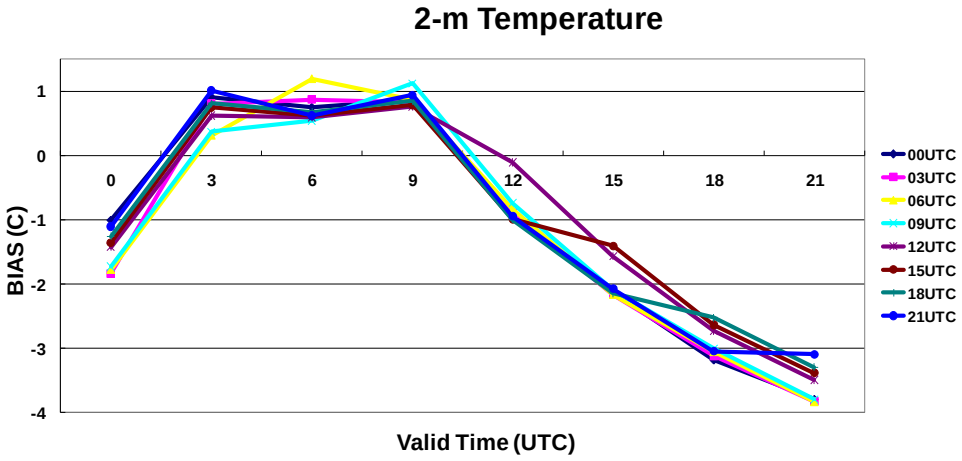
Precipitation Scores



- For the precipitation mostly occurring during late afternoon and nighttime, the runs initiating from 06,09,12,15UTC would have better forecast performance.
- The spin-up problem has been greatly ameliorated by utilizing the rapid updated cycling data assimilation and forecast style.

Objective Verification --- 2-m Temperature



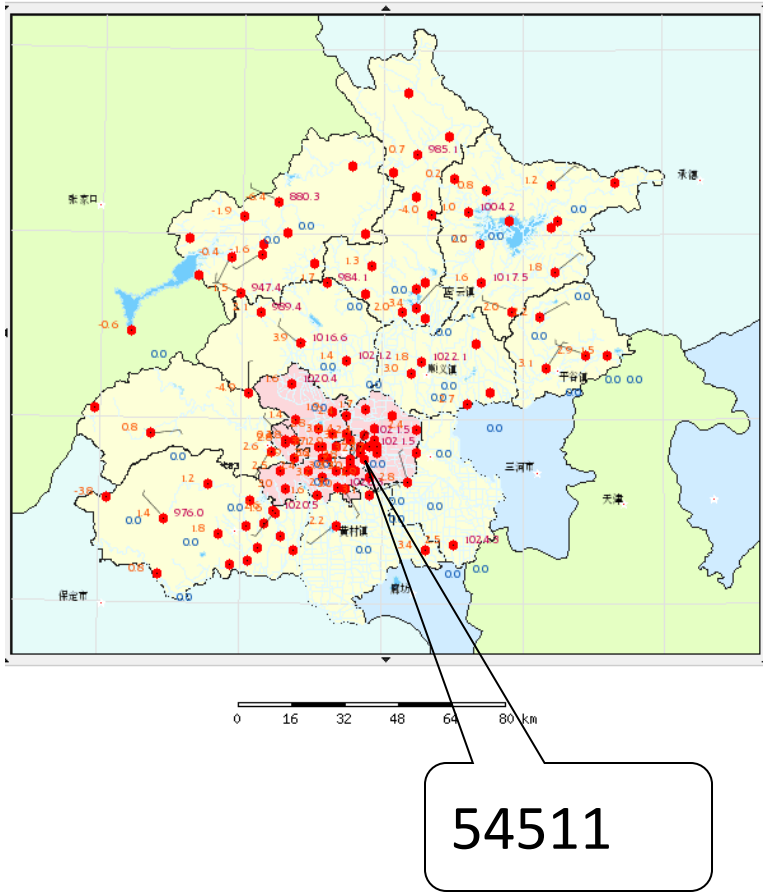


- Significant systematic error for 2-m temperature.
- Analysis did have the best quality.
- Significant distances between analysis and 3-hr forecast of previous cycles.
- Initial conditions with latest observations assimilated would have positive impacts on forecast quality at least during the first 6-hr integrations

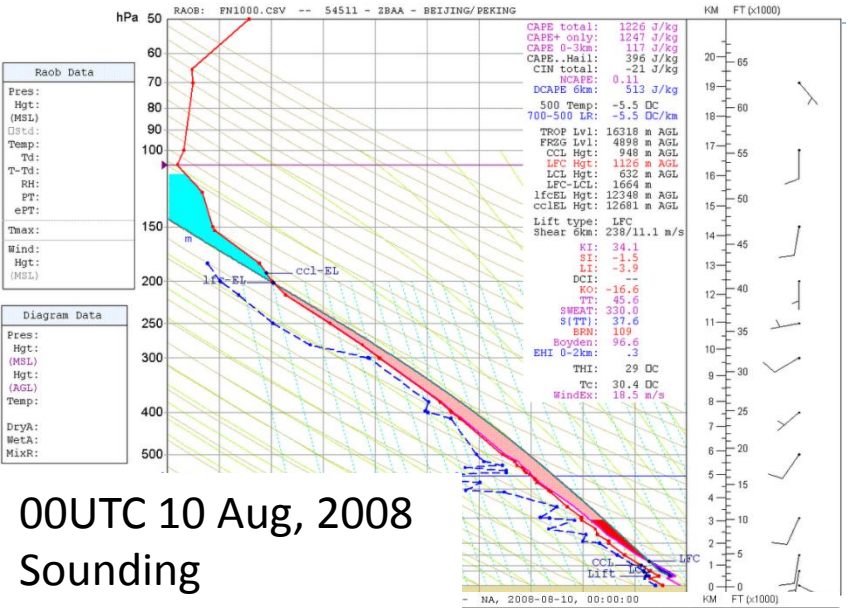
Performance during summer of 2008: CASES

CASE 1 : 10 Aug, 2008

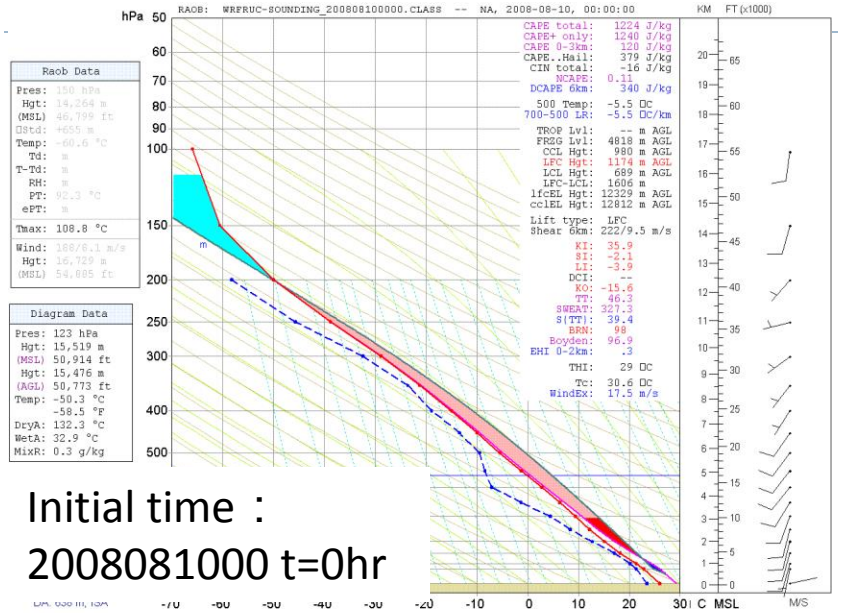
large-scale rain band disrupts afternoon events



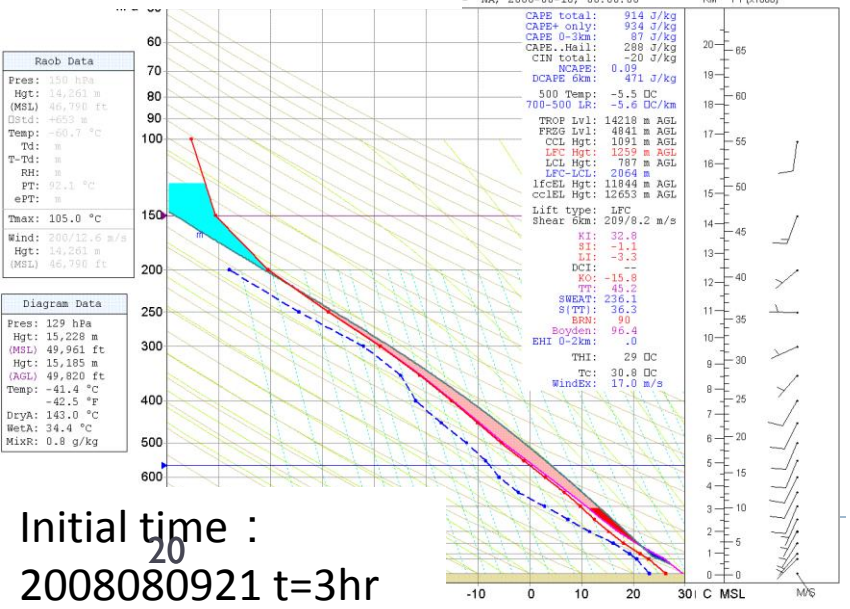
For 2008081000---Good analysis and forecasts



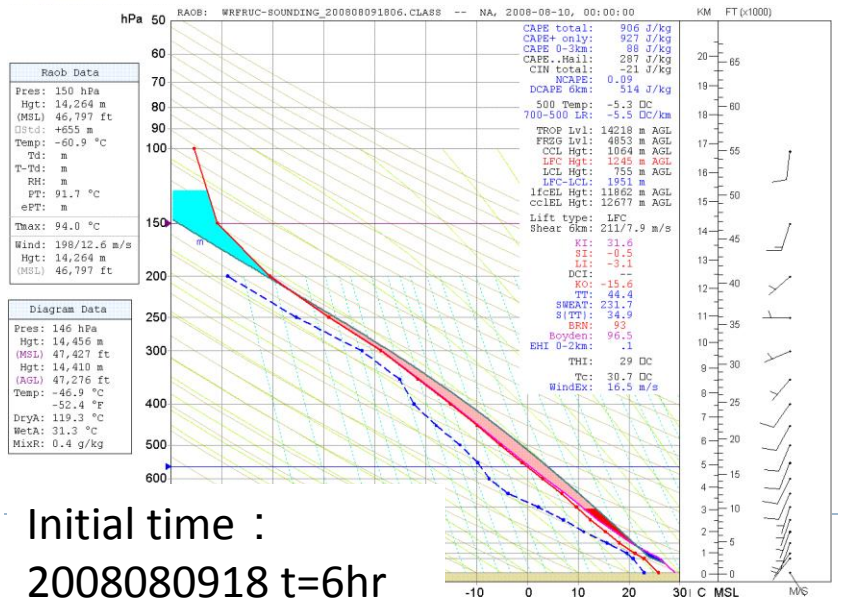
00UTC 10 Aug, 2008 Sounding



Initial time：
2008081000 t=0hr



Initial time：
2008080921 t=3hr

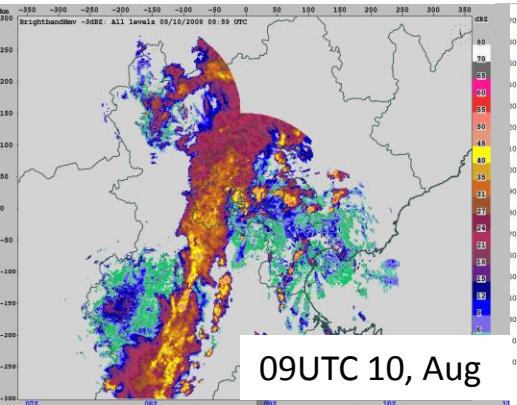


Initial time：
2008080918 t=6hr

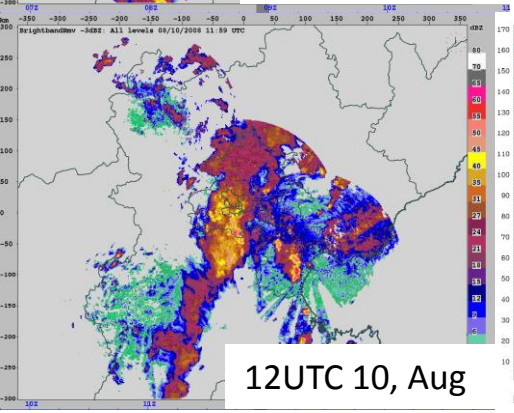
Forecasted dBZ--- is there any potential of blending for this case?

Observed reflectivity

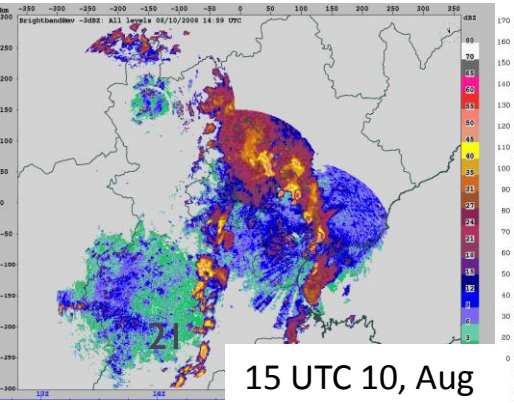
Initial time: 2008080918 **2008080921** **2008081000**



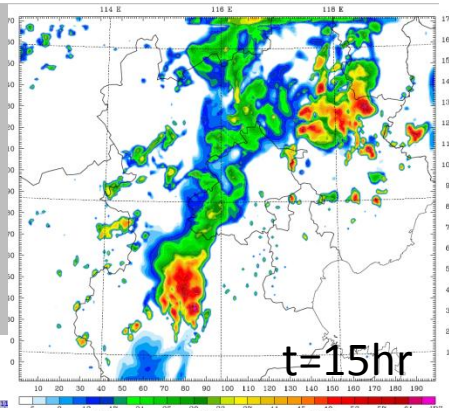
09UTC 10, Aug



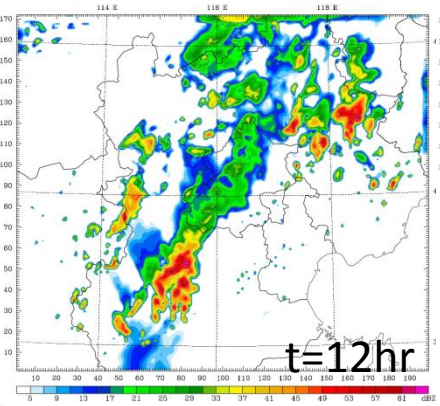
12UTC 10, Aug



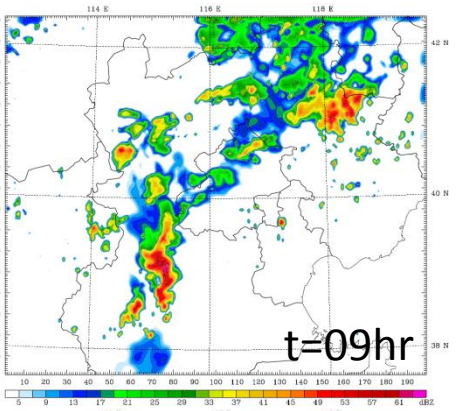
15 UTC 10, Aug



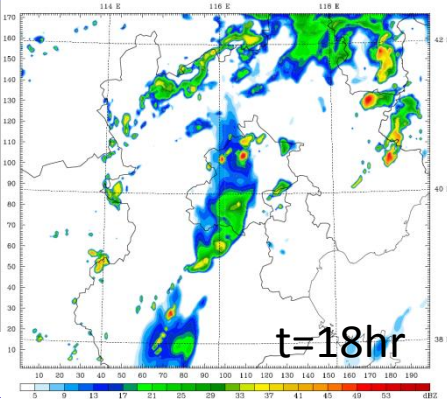
t=15hr



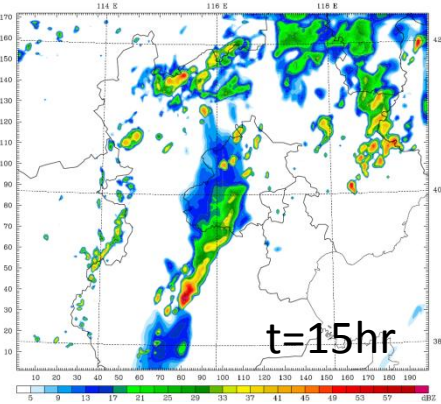
t=12hr



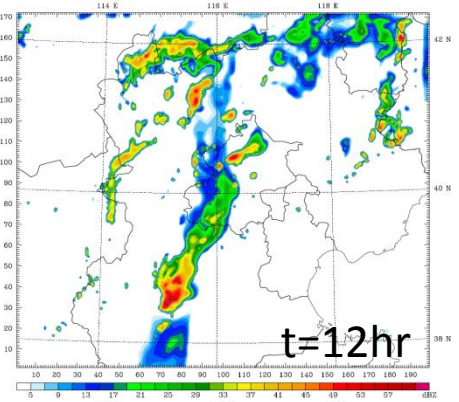
t=09hr



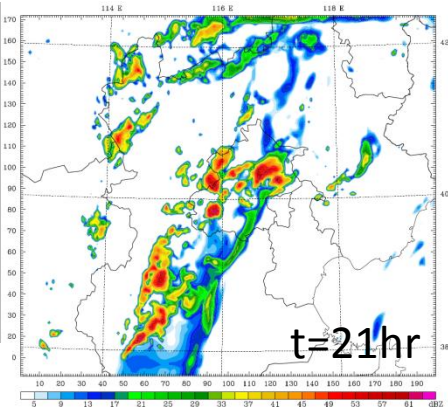
t=18hr



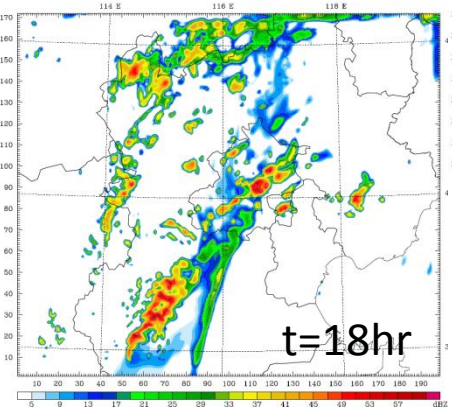
t=15hr



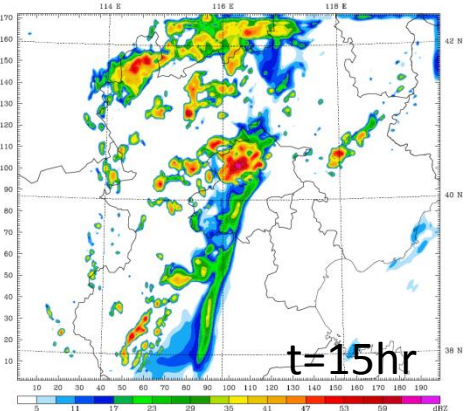
t=12hr



t=21hr



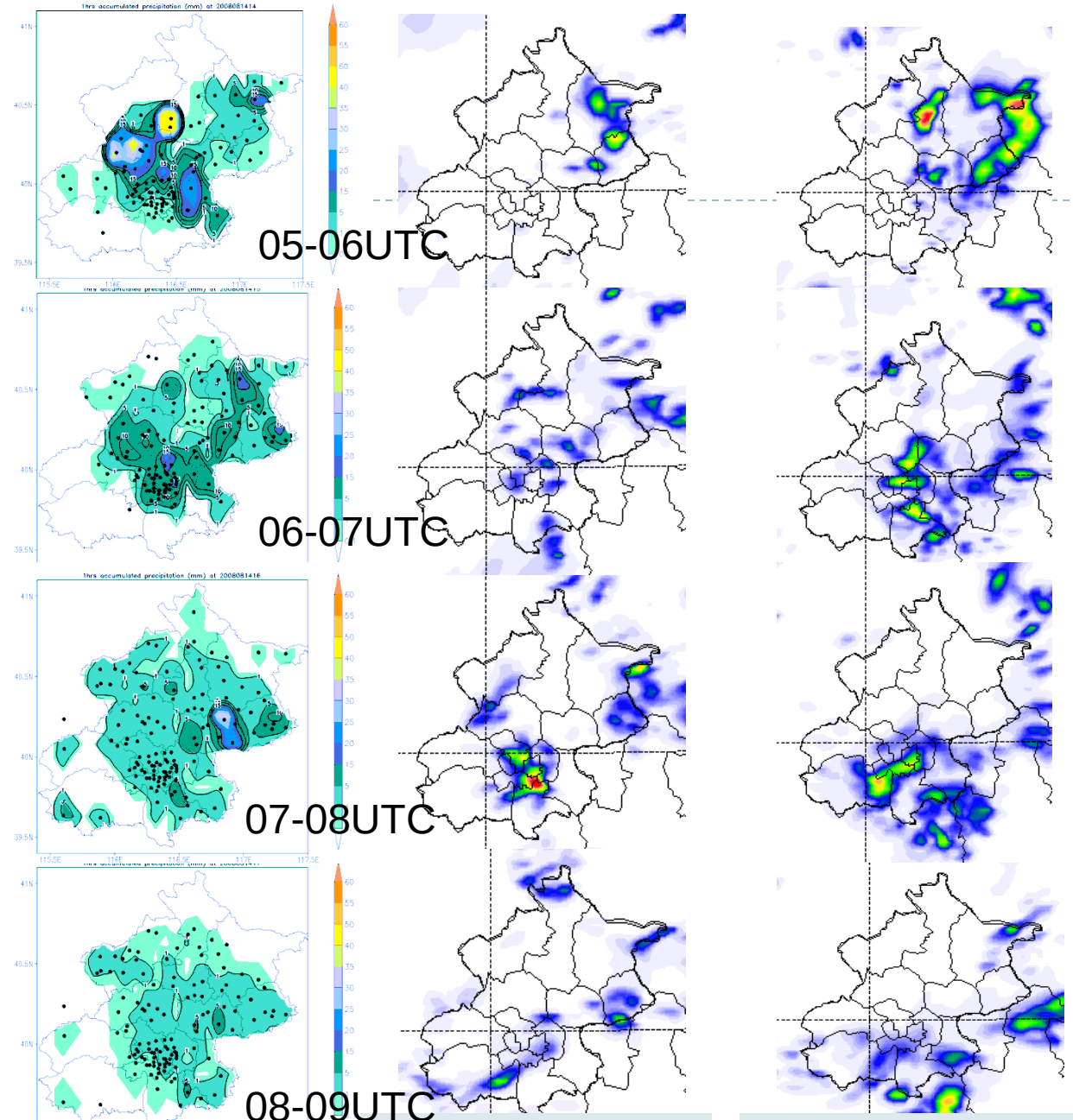
t=18hr



t=15hr

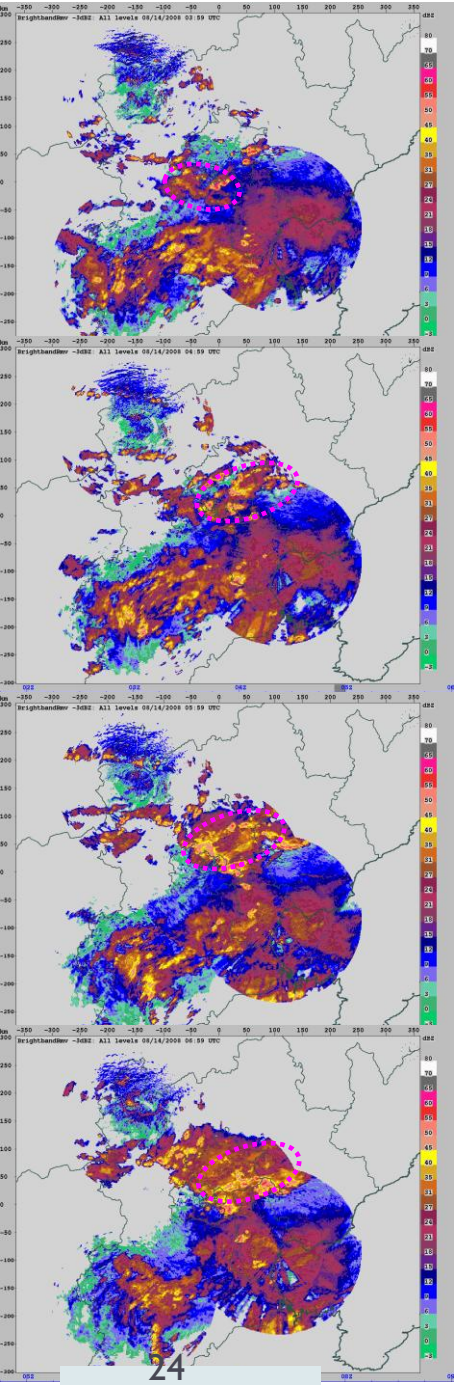
CASE 2 : 14 Aug, 2008

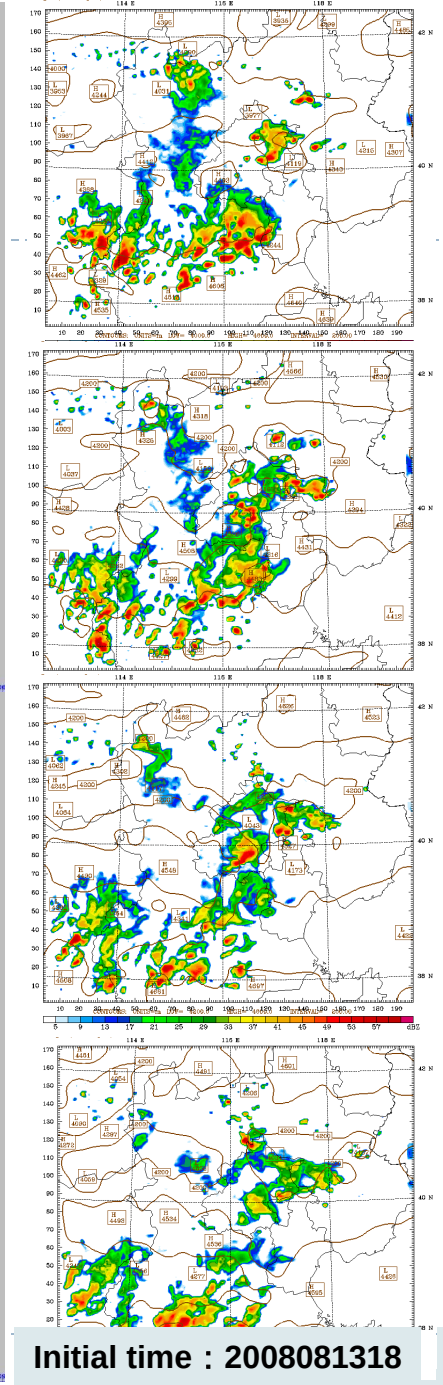
heavy afternoon thunderstorms postpone outdoor events

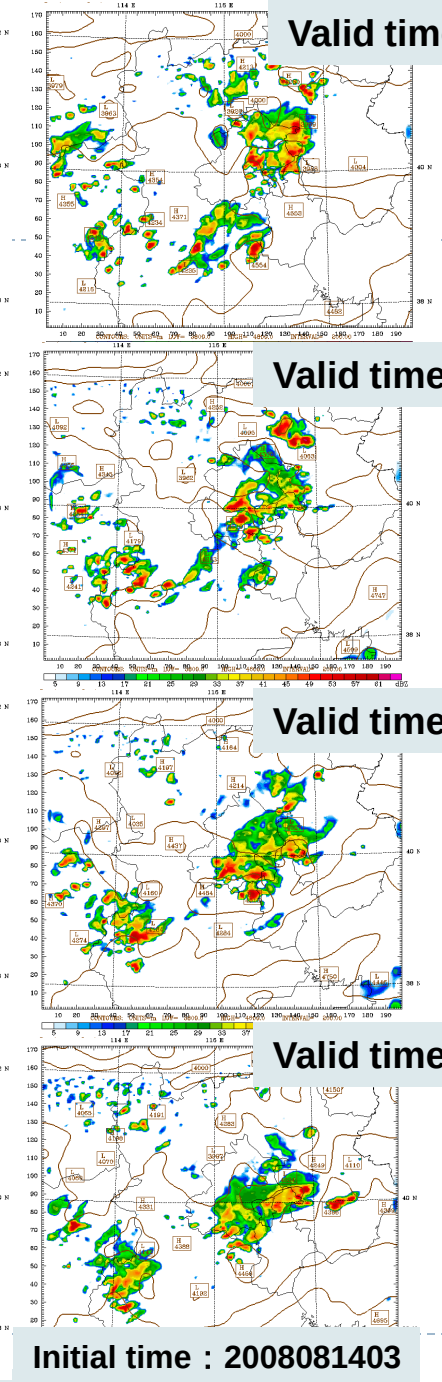


- Several cycles have forecasted the rainfall.
- Locations can't be exactly match with the observed but the occurring time was well forecasted.

Observed **Forecasted Precipitation**







Valid time: 06UTC 14 Aug, 2008

Valid time:07UTC 14 Aug, 2008

Valid time:08UTC 14 Aug, 2008

Valid time:09UTC 14 Aug, 2008

Initial time : 2008081318

Initial time : 2008081403

Observed

Forecasted

Opening and Closing Ceremony

Opening Ceremony– 08 Aug 2008

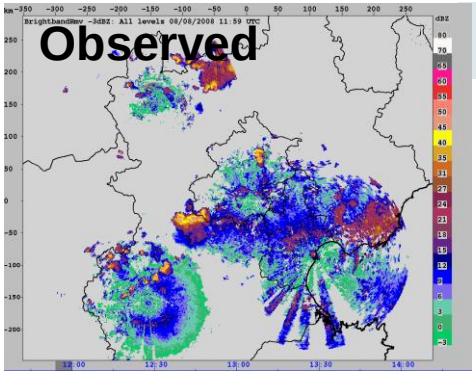
Initiating from 2008080809

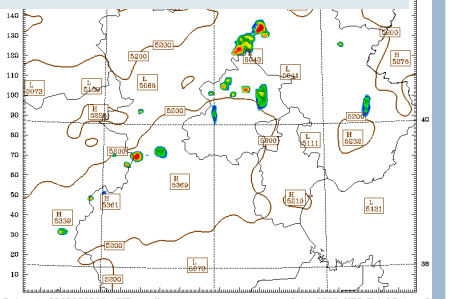
Observed

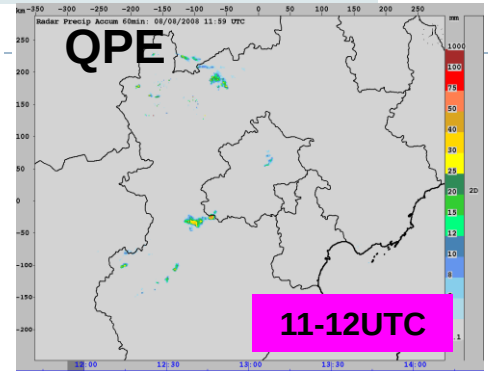
Forecasted dBZ

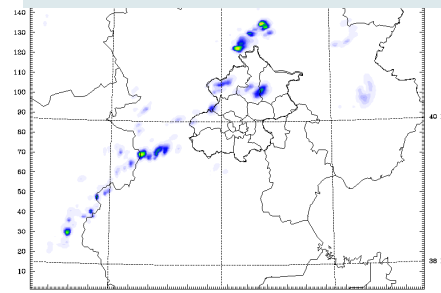
QPE

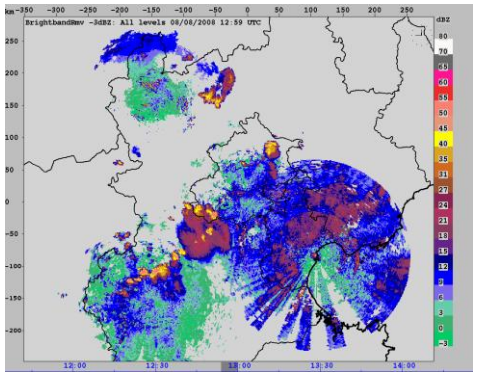
Forecasted Prcp

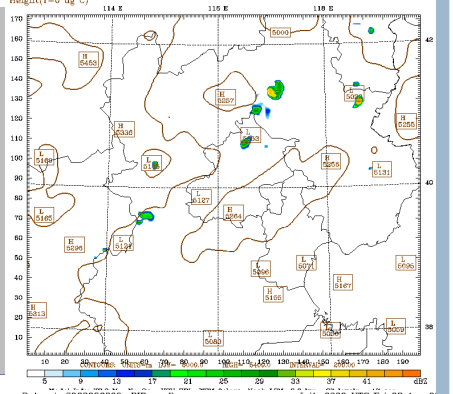


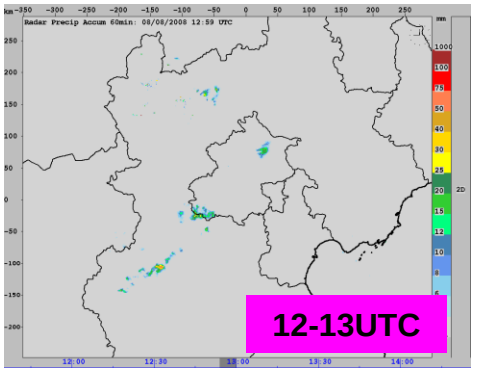


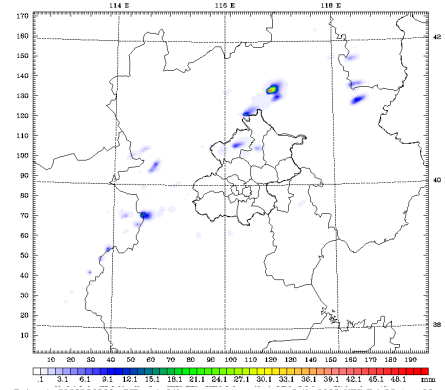


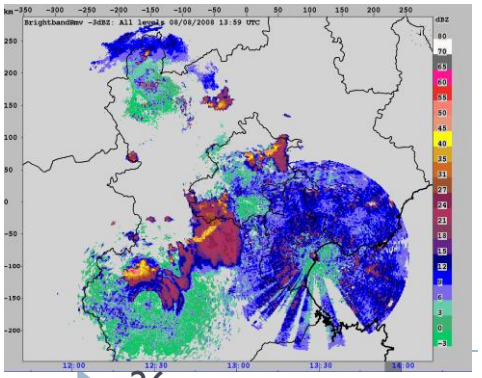


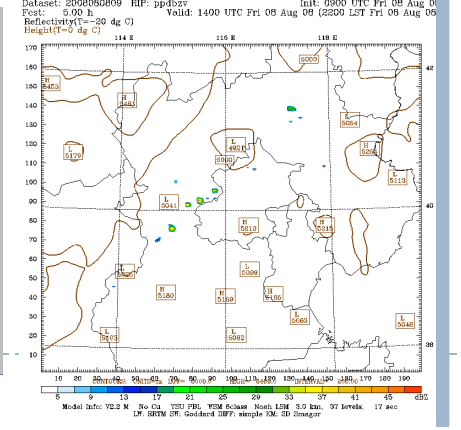


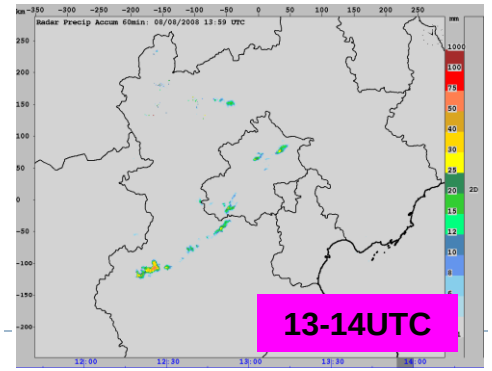


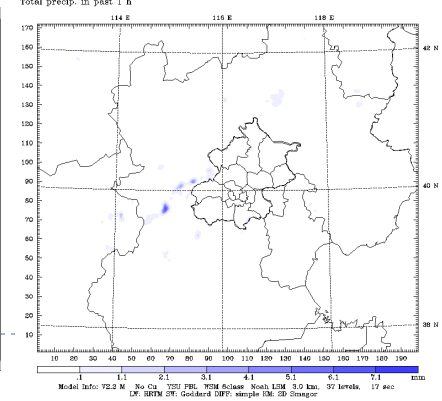






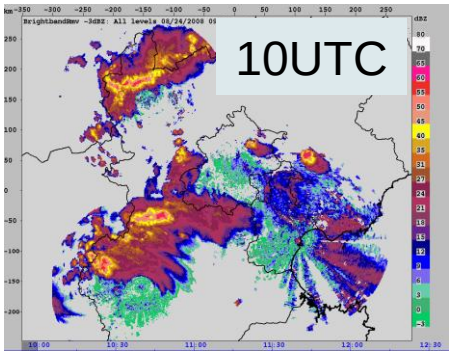


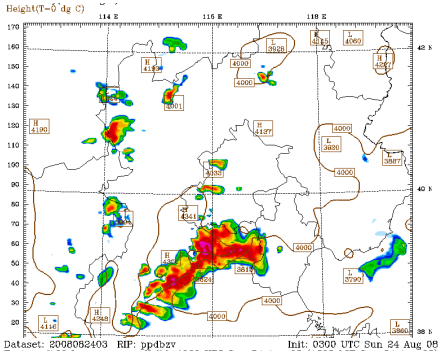


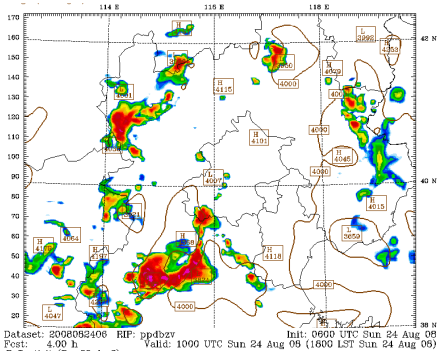


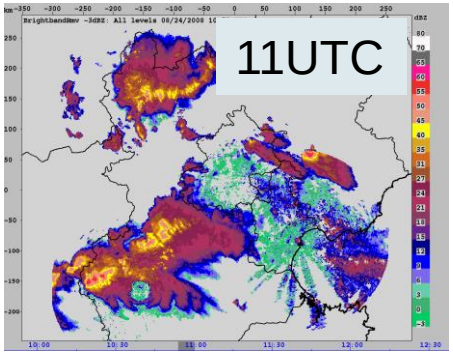
Closing Ceremony– 24 Aug, 2008

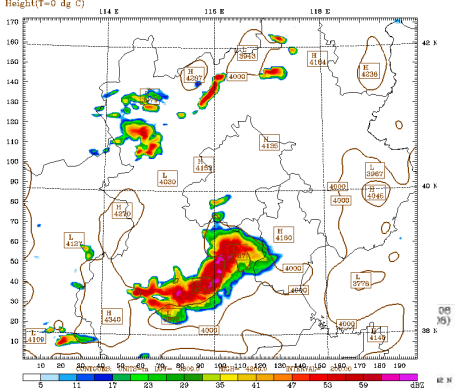
Radar Mosaic Initiating from 2008082403 Initiating from 2008082406

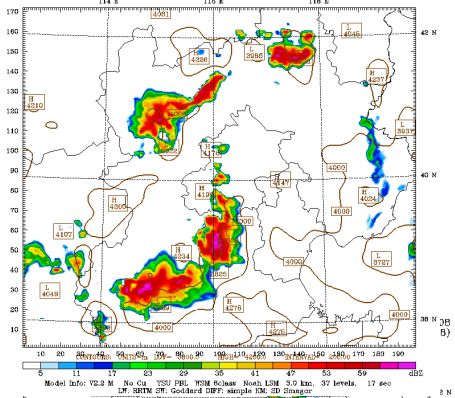


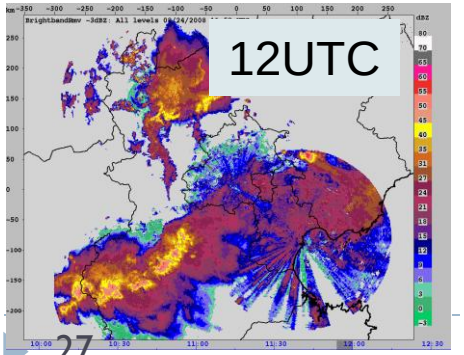


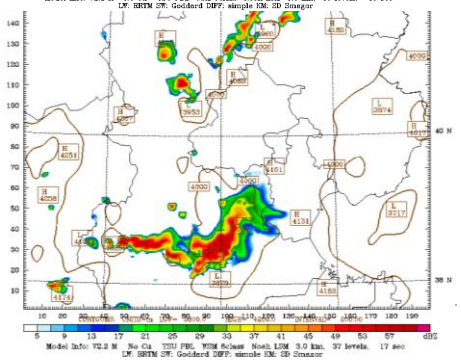


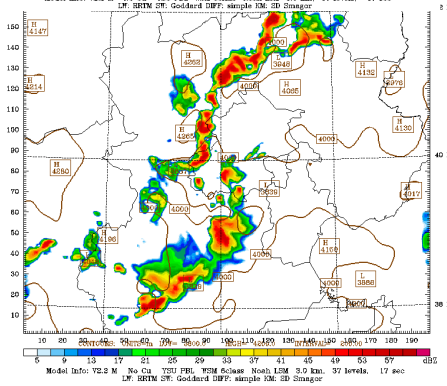












Outside of the Bird-nest at the night of the opening ceremony


Thank you!!