

# The Impact of the High Temporal Resolution GOES/GOES-R Moisture Information on Severe Weather Systems in Regional NWP model

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## Motivation

The precipitation forecast of local storms and other severe weather is very sensitive to the initial conditions (or the analysis atmospheric fields). Both the observed moisture information and the background fields directly affect the initial conditions through data assimilation, and then further affect the precipitation forecast. With high temporal and spatial resolution, GOES-R's humidity information can improve regional/storm scale data assimilation. The different background fields with different spatial resolution are compared using the regional numerical weather prediction (NWP) model. The impacts of layer precipitable water (LPW) from GOES Sounder with different background fields on simulations of the accumulated precipitation of 2012 CONUS derecho are assessed using WRF-ARW / GSI systems. The capability of 3D- and 4D-Var system is studied on assimilating total precipitable water (TPW) for tornado rainfall.

Our study focused on the following questions:

- How to use the LPW data in the assimilation system and NWP model?
- How do the background fields affect the LPW assimilation?
- What is the impact of the LPW data in regional NWP model, especially for the precipitation forecasts?

## Data and Experiment Design

### Data

- Conventional Data (GTS)
- Layer Precipitable Water (LPW) based on the GOES-R Advanced Baseline Imager (ABI) LAP algorithm.
- Three layers of LPW: sigma level values (0.3-0.7, 0.7-0.9, and 0.9-1)
- Background data from NCEP FNL (BG: GFS)
- Background data from ECMWF operational (BG: ECMWF)
- Background data from NCEP NAM (BG: NAM)

Analysis	NCEP GFS	ECMWF	NCEP NAM
Resolution	0.5 degree	0.1406 degree	12 km
Top level	10 hPa	1 hPa	50 hPa

### Models

- Data Assimilation: the Community Gridpoint Statistical Interpolation (GSI V3.1).
- A forward operator for LPW and the related module has been implemented in GSI V3.1 system.
- Regional Forecast Model: Advanced Research WRF (ARW) V3.6.1

### Experimental Design

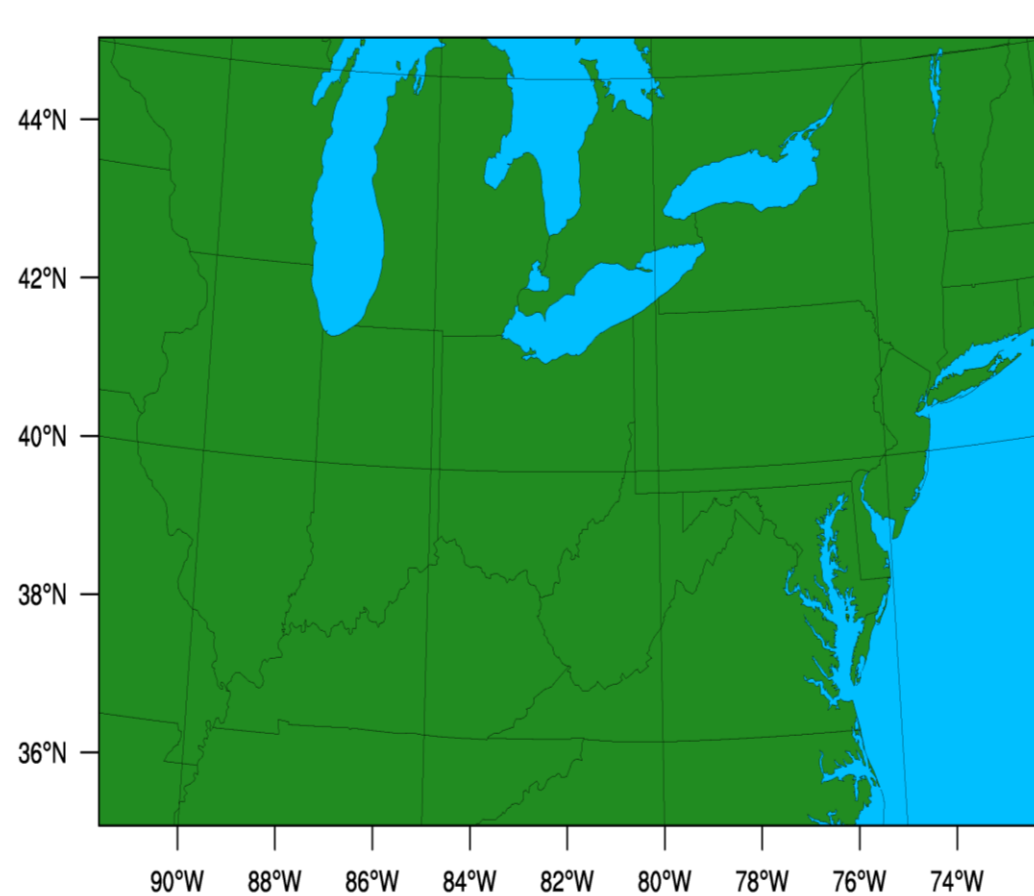


Fig. 1 The model domain

- Spin-up: 2012-6-29 06z to 12z
- Assimilation: 2012-6-29 12z
- Forecast: 2012-6-29 12z to 2012-6-30 12z
- Horizontal: 4 km
- Vertical: 52 levels, from surface to 10 hpa

- GTS+LPW (BG: GFS)
- GTS+LPW (BG: ECMEF)
- GTS+LPW (BG: NAM)

## Forecast Verification Scores

Table 1: Contingency table used in verification statistics for dichotomous (et. Yes/No) forecasts and observations.

Forecast	Observation		
	Yes	No	
Yes	Hits (YY)	False Alarms (YN)	YY + YN
No	Misses (NY)	Correct rejections (NN)	NY + NN
	YY + NY	YN + NN	<b>Total = YY + YN + NY + NN</b>

### • Equitable Threat Score (ETS)

$ETS = (Hits - Hits\ random) / (Hits + Misses + False\ Alarms - Hits\ random)$   
 $Hits\ random = (Hits + False\ Alarms) (Hits + Misses) / Total$   
 Range: -1/3 to 1; 0 indicates no skill, and 1 indicates perfect score.

## Part I: Results

### 6-hour forecast precipitation 2012-06-29 18z to 30 00z

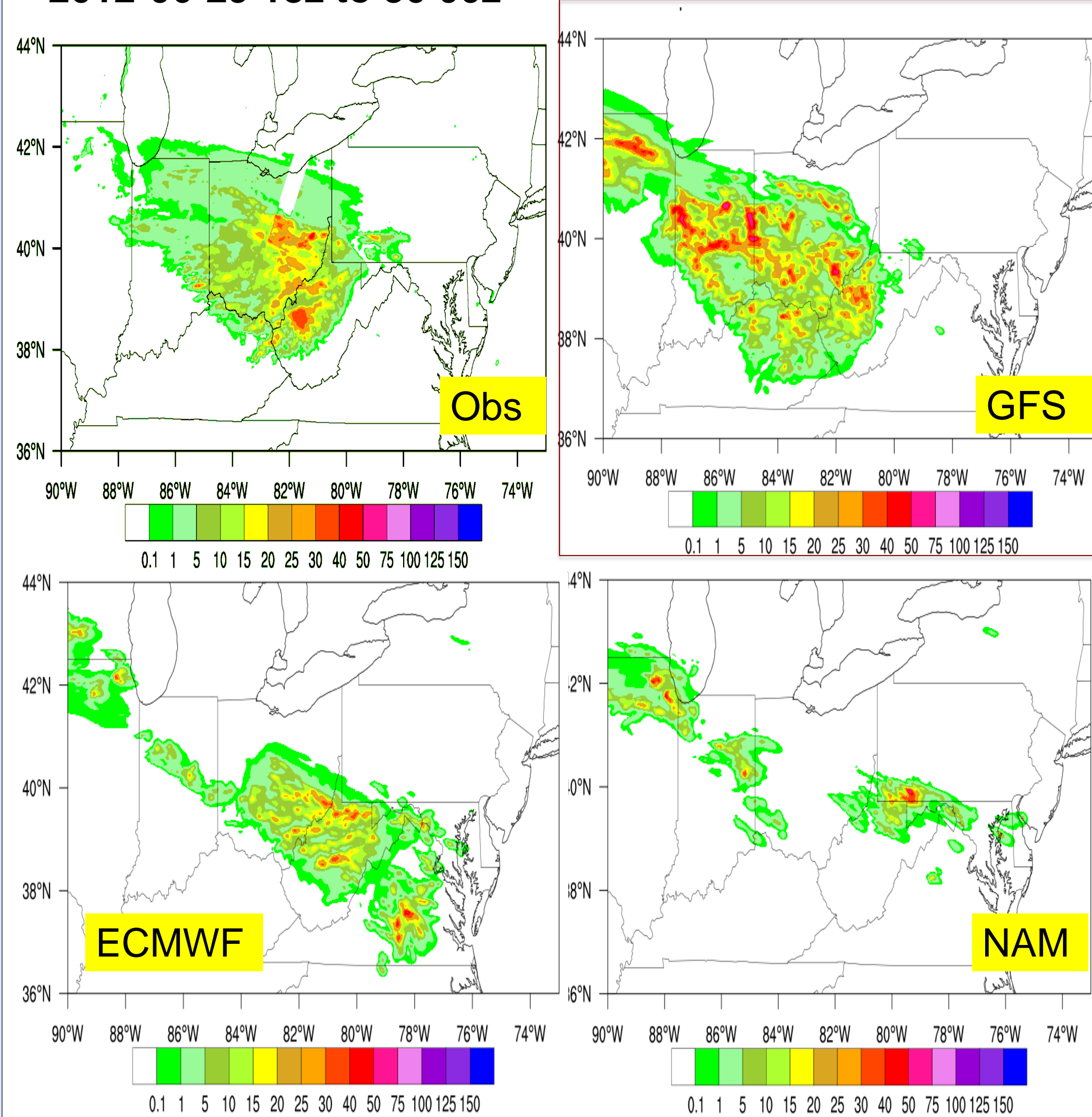


Fig 2. The 6-h accumulated precipitation of observations (Obs), NCEP GFS analysis as background, ECMWF analysis as background and NAM analysis as background from 2012-06-29 18z to 30 00z

### Assimilation of LPW data

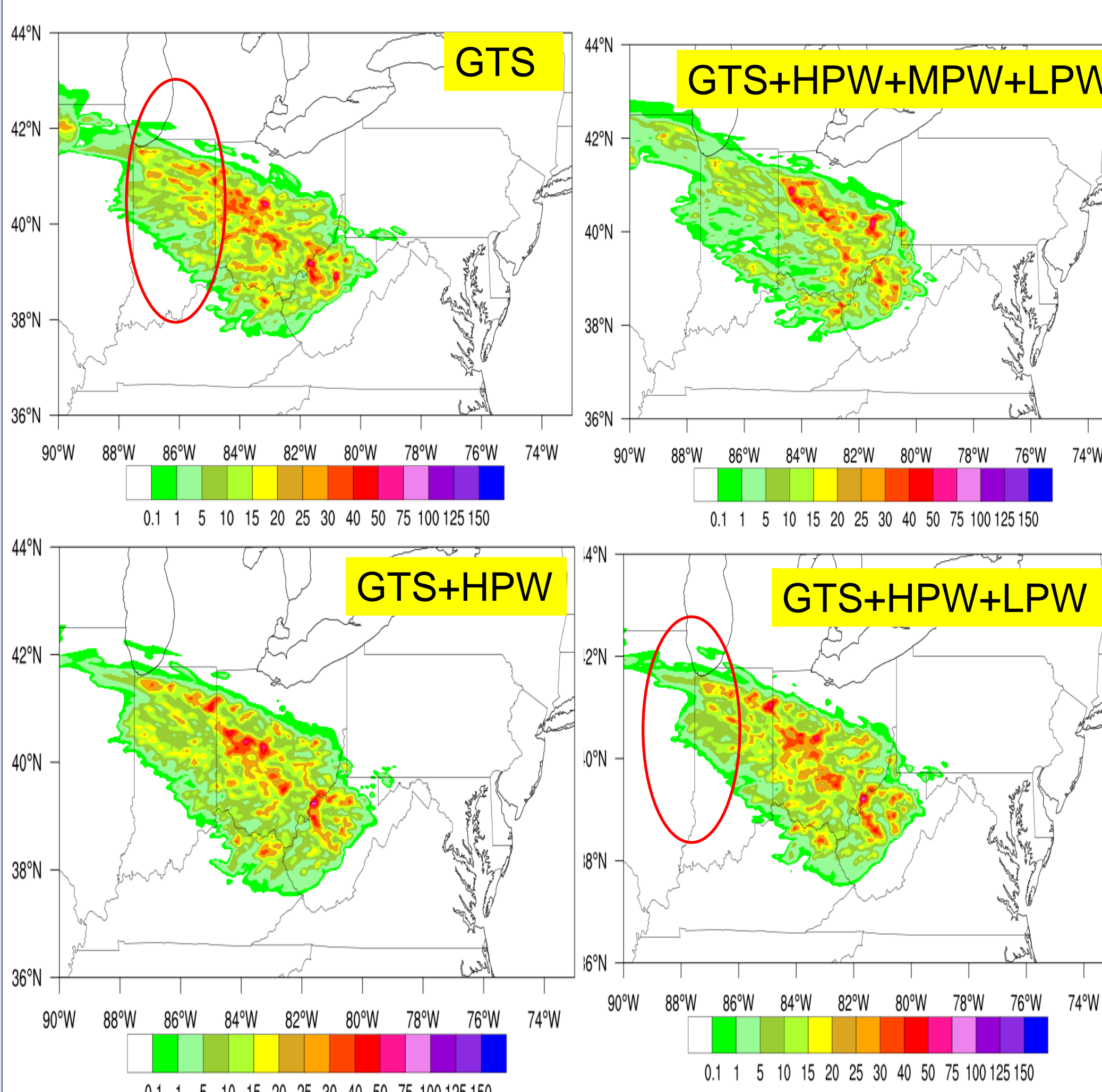


Fig 3. The 6-h accumulated precipitation of assimilation of GTS, GTS+HighPW+MidPW+LowPW, GTS+HighPW and GTS+HighPW+LowPW from 2012-06-29 18z to 30 00z

## ETS of precipitation with assimilation GTS, High PW, Mid PW and Low PW 2012-06-30 00z to 30 06z

### 2012-6-29 18z to 30 00z

ETS scores	0.1 mm	1 mm	5 mm	10 mm
GTS	0.5393	0.4978	0.4243	0.2330
GTS+LPW(H)	0.5639	0.5403	0.4447	0.2315
GTS+LPW(M)	0.4881	0.4137	0.3066	0.1770
GTS+LPW(L)	0.5446	0.5093	0.4312	0.2364
GTS+LPW(HM)	0.5578	0.5386	0.4486	0.2412
GTS+LPW(ML)	0.5335	0.4925	0.4274	0.2309
GTS+LPW(HL)	0.5800	0.5644	0.4510	0.2302
GTS+LPW(HML)	0.5434	0.4854	0.4171	0.2958

Table II: The ETS scores for precipitation. Red: the ETS score is higher than GTS only. The high PW and low PW together give us the highest ETS scores.

## Part II: Results

### Comparison of the precipitation forecasts between GSI-3Dvar and GSI-DRP4DVar system

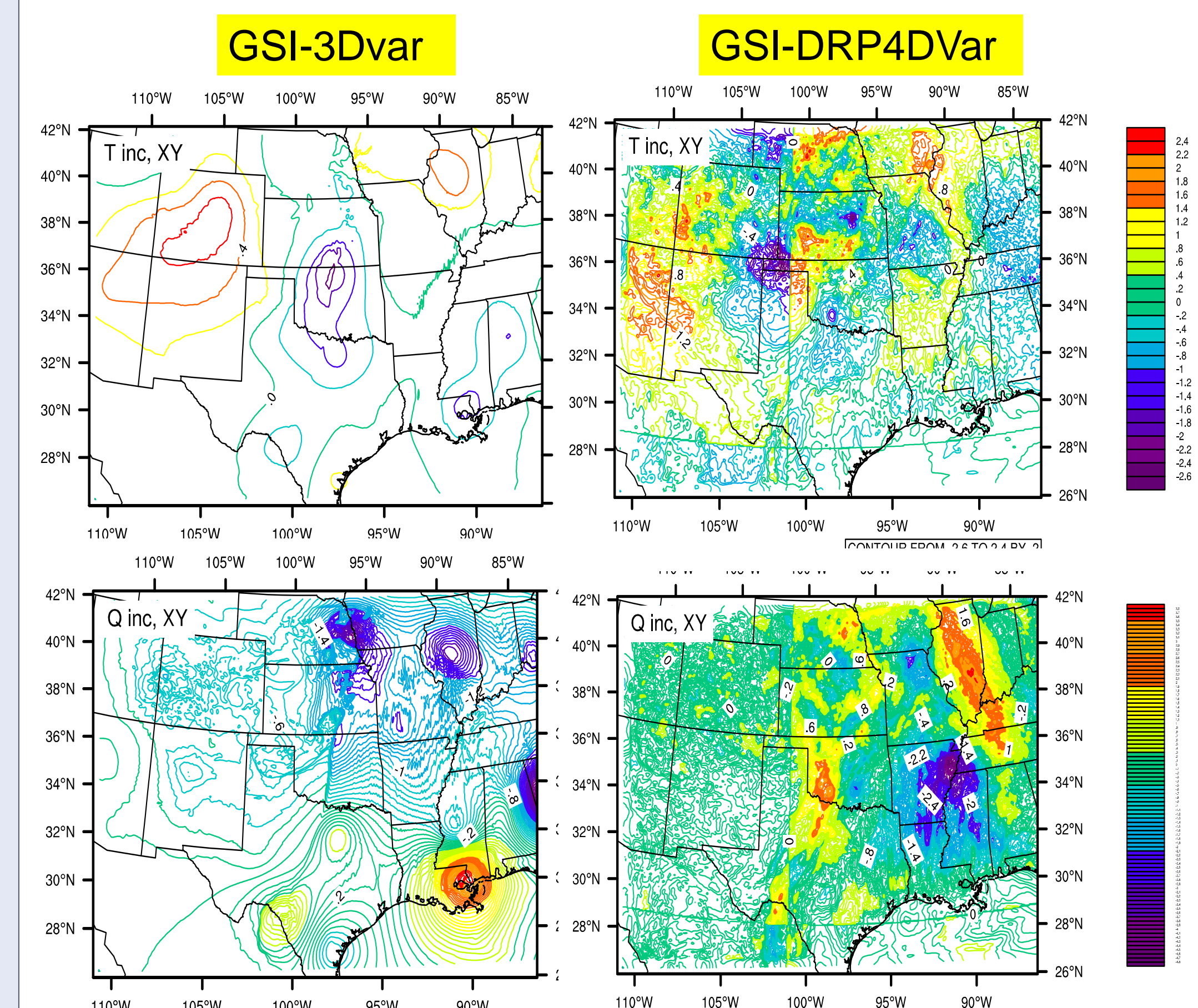


Fig 4. The temperature increment and moisture increment of assimilation of TPW data using GSI-3Dvar and GSI-DRP4DVar system

## Summary and Future work

- The LPW from GOES Sounder data could be assimilated in GSI V3.1 successfully. The LPW affects the precipitation through changing the moisture profiles in the analysis fields.
- The precipitation is sensitive to the background fields. Through comparison of background from NCEP GFS, ECMWF and NCEP NAM, it shows that NCEP GFS provides best precipitation forecasts. Therefore, the background fields for assimilation of LPW data are based on NCEP GFS analysis fields.
- The three layers PW data (High PW, Mid PW and Low Pw) are assimilated separately. The assimilation of PW data affect the analysis fields and then further influence the precipitation.
- The ETS scores of precipitation could reflect the performance of precipitation forecasting compared with observations. It is shown that the combination of high PW and low PW together could provide best precipitation forecasts.
- The comparison of GSI-3Dvar and GSI-DRP4Dvar shows that the temperature and moisture increments are larger with GSI-DRP4Dvar.

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