Evaluation of Quantitative Precipitation Forecast of High-Resolution Rapid Refresh Model

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WRF Users Workshop 2017, June 12-16

United States network of Weather Surveillance Radar-1988 Doppler(WSR-88DP)

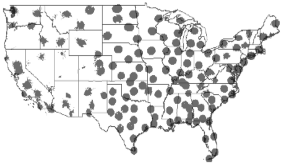


Figure 1: WSR-88DP radar network

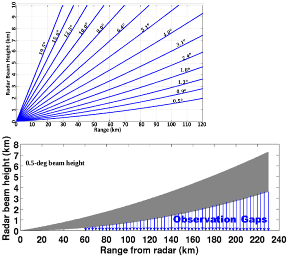


Figure 2: Scan Strategy

WSR-88DP also known as Next-Generation Radar (NEXRAD)

- S band radar (wavelength 10 cm)
- Network spaceing
  230 km in the eastern U.S
  245 km in the western U.S
- Max coverage range is 230 km
- Limitations

  1)Lowest beam(0.5 degree) about 5.4 km above ground level (AGL)

  2)low-level coverage

  3)Limited spatial resolution at long distance

  4)Impede to identify and detect fine-scale weather features due to slow scan rate

Collaborative Adaptive Sensing of the Atmosphere(CASA) Solution: Dense X-band Radar Network

1. Aimed to enhance weather sensing in the lower troposphere (1-3km AGL)
2. CASA introduced Distributed Collaborative Adaptive Sensing(DCAS) to overcome the resolution and coverage limitations.

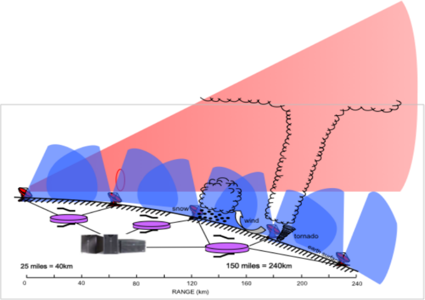


Figure 3: CASA Dense X-band Radar Network

CASA Dallas-Fort Worth (DFW) radar network

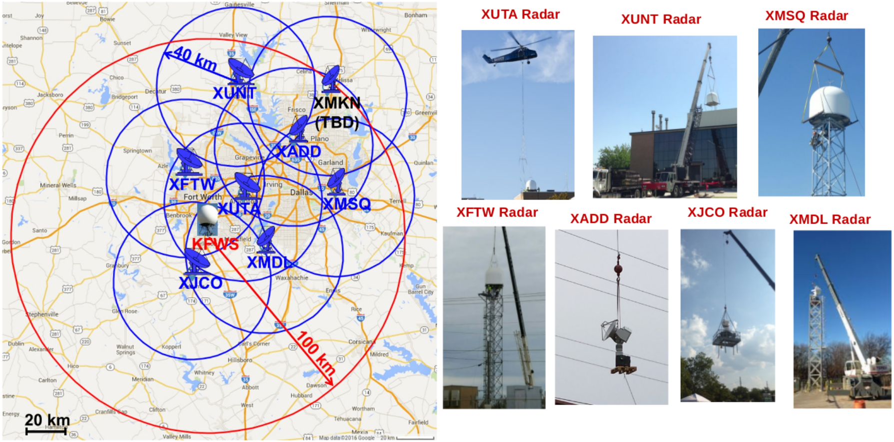


Figure 4: CASA DFW radar network

Specification comparison between CASA X-band Radar ad NEXRAD S-band

Specification Comparison (CASA X-band Radar vs. NEXRAD)		
	DFW Radar	WSR-88DP
Transmitter	Magnetron	Klystron
Peak power	8.0 kw	750 kw
Average power	12 w	300-1300 w
Pulse width	660-1000 ns	1600-4500 ns
Frequency	9.41 GHz (X-band)	2.7-3.0 GHz (S-band)
Antenna size	1.2 m	8.5 m
Antenna gain	41 dB	45.5 dB
beam width	1.8 deg.	0.925 deg.
Range res.	60 m	250 m (super res.)
Scan update	Less than 1 min	5-6 mins

Dataflow architecture of DFW urban radar network

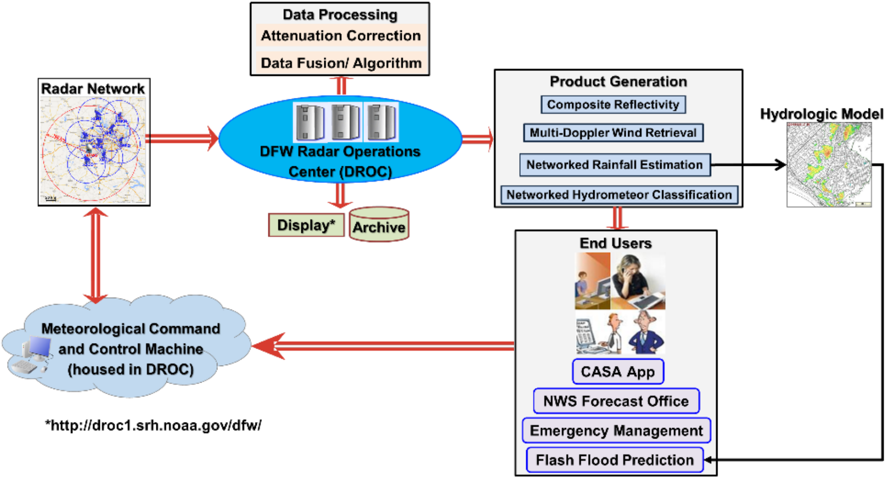
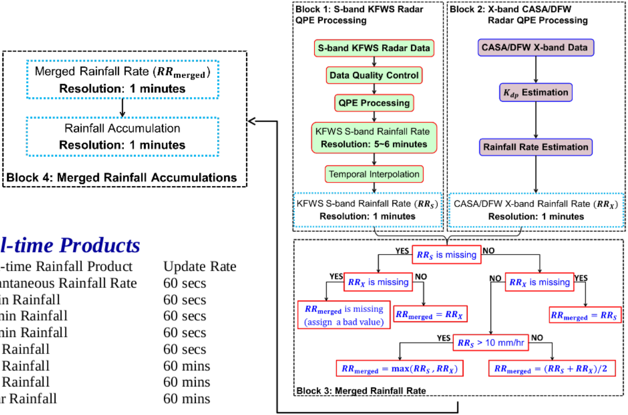


Figure 5: Dataflow architecture of DFW urban radar network

CASA DFW High-Resolution Quantitative Precipitation Estimation System



Real-time Products

Real-time Rainfall Product	Update Rate
Instantaneous Rainfall Rate	60 secs
5-min Rainfall	60 secs
15-min Rainfall	60 secs
30-min Rainfall	60 secs
1-hr Rainfall	60 secs
3-hr Rainfall	60 mins
6-hr Rainfall	60 mins
12-hr Rainfall	60 mins

Figure 6: Estimation system flow chart and products

(Haonan Chen and V. Chandrasekar, 2015)

High-Resolution Rapid Refresh (HRRR) weather model

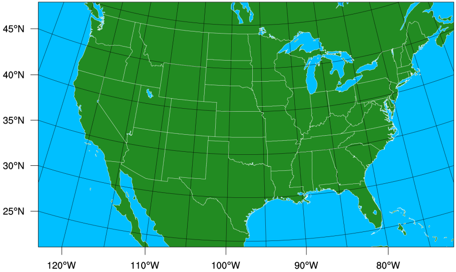


Figure 7: Model domain

Physics parameterization schemes:

Micro physics	Thompson
PBL	Nakanishi and Niino(MYNN2)
Surface layer	Nakanishi and Niino
Land surface	RUC Land Surface Model
Shortwave radiation	RRTMG
Longwave radiation	RRTMG

- The HRRR is a NOAA real-time hourly updated 3-km high resolution weather model.
- Initialized by 3km grids with 3km radar assimilation.
- Radar data is assimilated in every 15 min over a 1-hr period through the Gridpoint Statistical Interpolation (GSI).
- Covers the CONUS domain and initialization from ESRL Rapid Refresh model.
- Forecast duration is 18 hours.
- Current operational version: HRRRv2 from August 2016.

Case study: April 17th 2017 rainfall event over DFW region

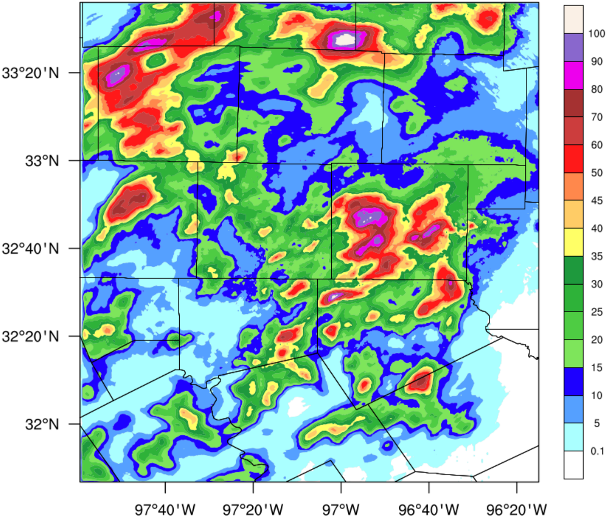


Figure:8 DFW Radar estimated rainfall over 24 hours on April 17th 2017

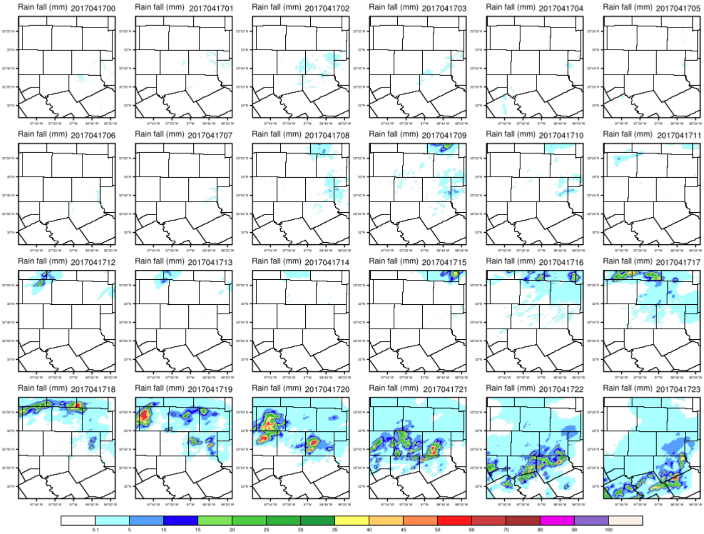


Figure 9: Hourly Rainfall (mm) Map on 17th April 2017 from DFW radar

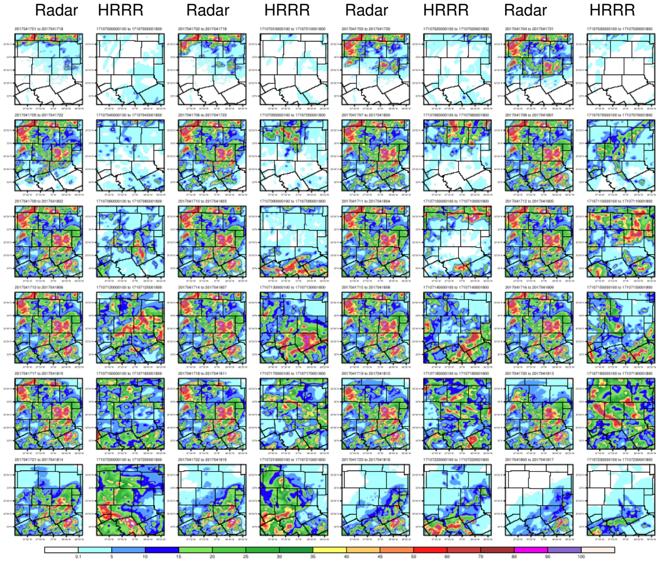


Figure 10: 18 hours accumulation rainfall(mm) from DFW Radar and HRRR model

Model QPF verification

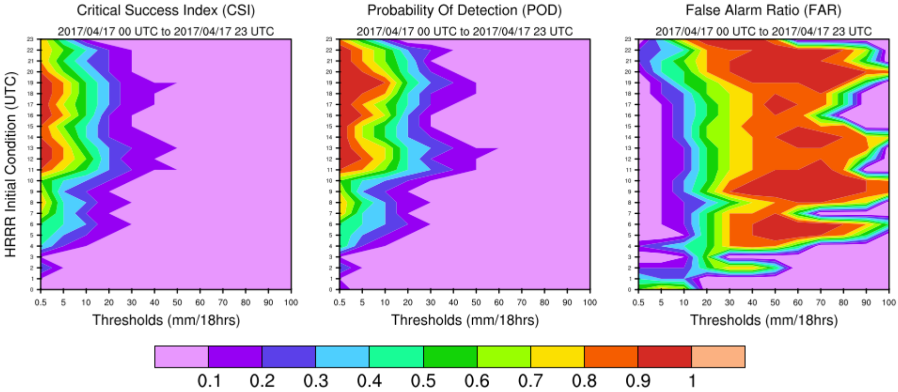


Figure 11: Model precipitation skill scores

Model performance as a function of lead and valid time (April 17, 18 to 23 UTC)

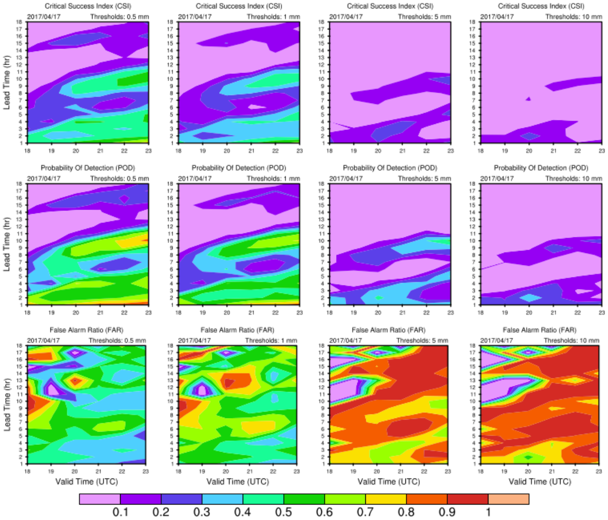


Figure 12: Model precipitation skill scores

Skill scores for 6 hour HRRR forecast (April 17, 17 UTC as Initial condition)

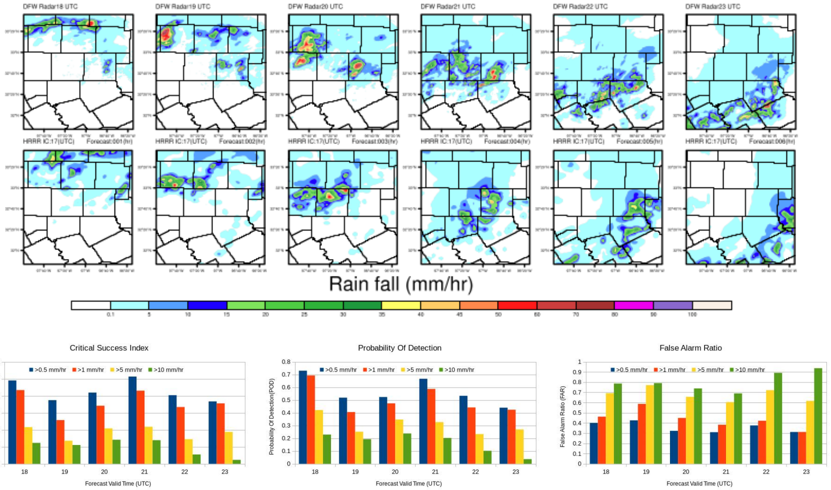


Figure 13: Model precipitation skill scores

Summary and future work

1. The operational HRRRv2 model has good prediction skills in this particular rainfall event.
2. Need to analyze more rain events over DFW region.
3. Use the neighborhood approach to evaluating the model skills.

References

1) Haonan Chen,V. Chandrasekar, “The quantitative precipitation estimation system for DallasâFort Worth (DFW) urban remote sensing network”,Journal of Hydrology,Volume 531, Part 2, December 2015, Pages 259-271.