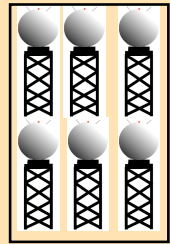


Q2 Description, Results, and Plans

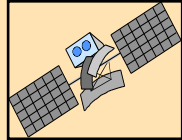
Jian Zhang
Hydrometeorology



Q2 System Overview Flowchart



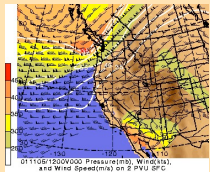
Radar



Satellite



Rain Gauge



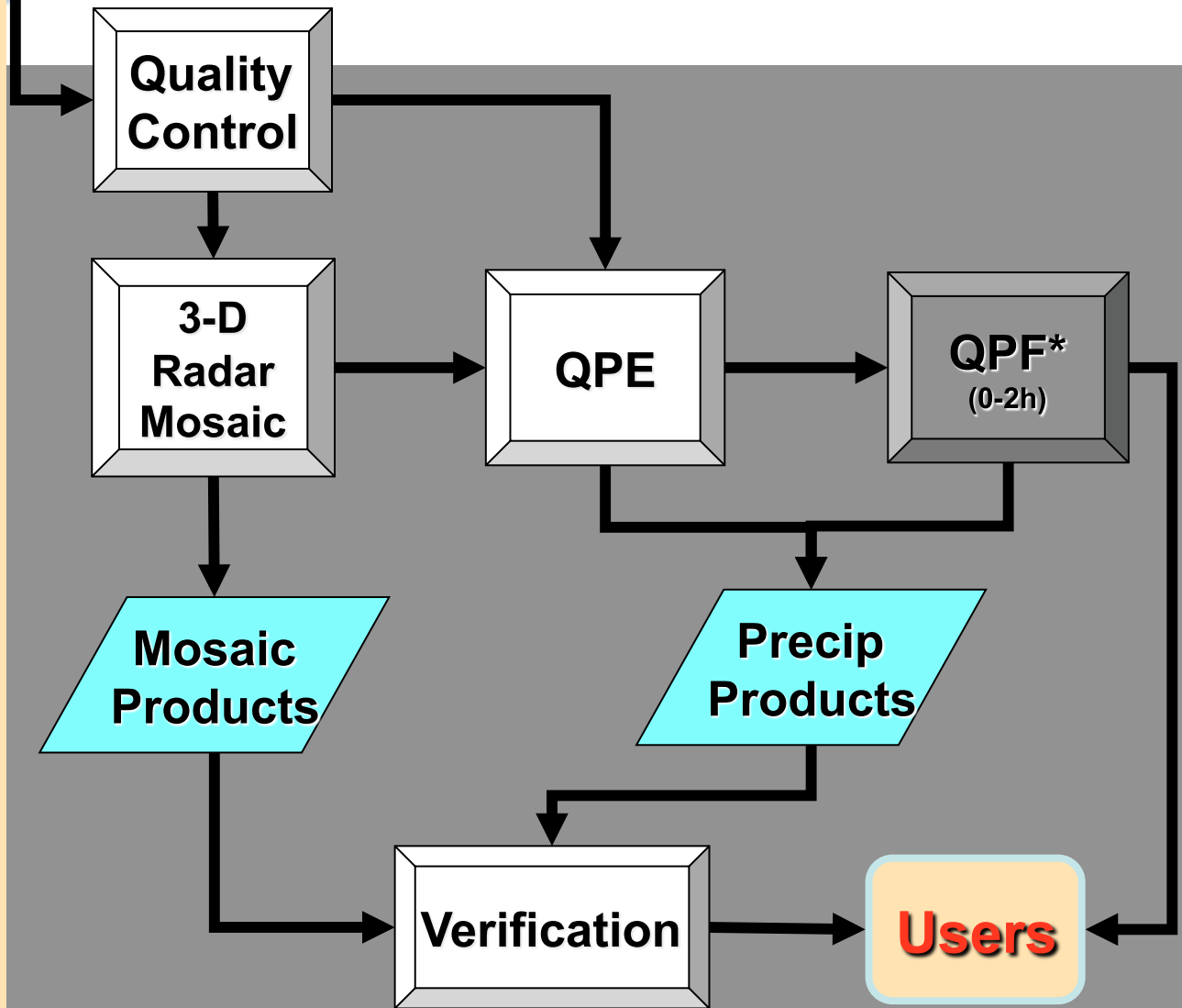
Model



Sfc Obs & Sounding



Lightning

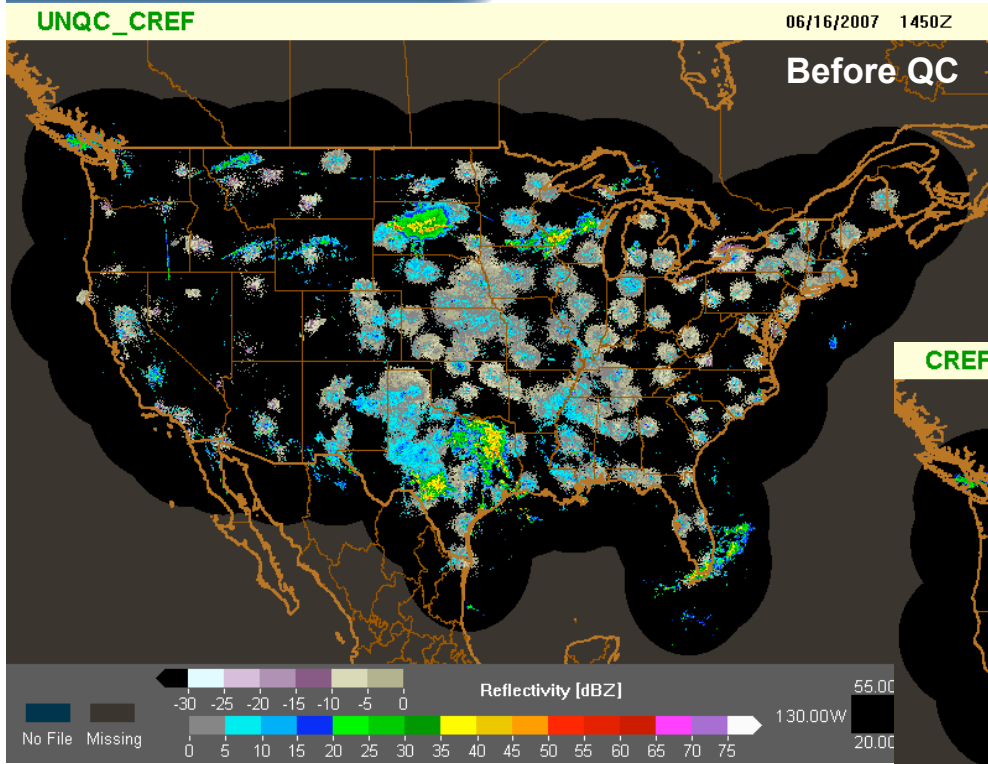




Q2 Components

- ✦ Reflectivity quality control (QC) (*Lakshmanan et al. 2007, JTECH; Gourley et al. 2007, JTECH*)
- ✦ 3-D reflectivity mosaic (*Zhang et al. 2005, JTECH; Langston et al. 2007, JTECH; Yang et al. 2009, AAS*)
- ✦ Precipitation classification (*Xu et al. 2008, J. Hydromet; Zhang et al. 2008, JTECH*)
 - ✦ Stratiform, Convective, Hail, Tropical Rain, and Snow
- ✦ Adaptive Z (reflectivity) - R (rainfall rate) relationships (*Xu et al. 2008, J. Hydromet*)
- ✦ Seamless hybrid scan reflectivity (HSR) mosaic
- ✦ Local gauge bias correction (*in preparation*)
- ✦ Vertical profile of reflectivity (VPR) correction for bright band (*Zhang et al. 2008, JTECH*)
- ✦ Non-standard blockage mitigation (*Chang et al. 2009, JTECH*)
- ✦ Multi-sensor quantitative precipitation estimation (QPE) uncertainties

Automated Reflectivity Quality Control

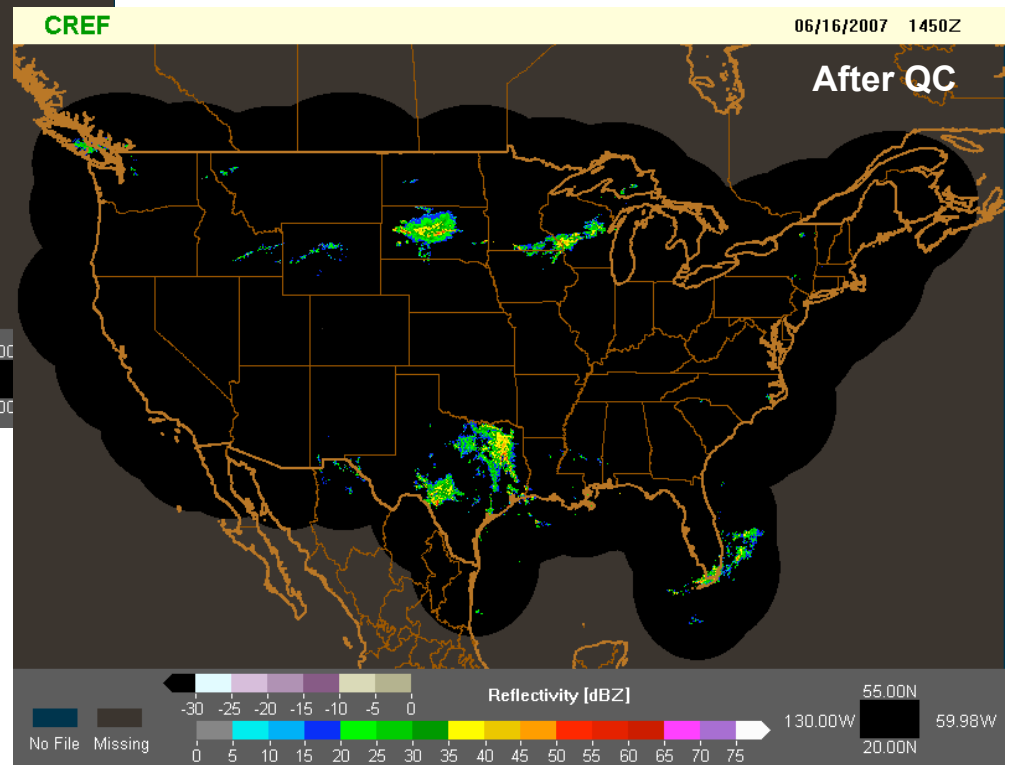


Objective: to remove non-precipitation echoes.

Performance: >95%

Remaining challenges: nocturnal AP + migrating birds.

Future: dual-pol hydrometeor/scatterer classification



Publications:

Lakshmanan, V., A. Fritz, T. Smith, K. Hondl, and G. J. Stumpf, 2007: An automated technique to quality control radar reflectivity data. *J. Appl. Meteor.*, **46**, 288–305.

Gourley, J.J., P. Tabary, and J. Parent-du-Chatelet, 2007: A fuzzy logic algorithm for the separation of precipitating from non-precipitating echoes using polarimetric radar observations. *J. Atmo. and Ocean. Tech.*, **24**, 1439-1451.

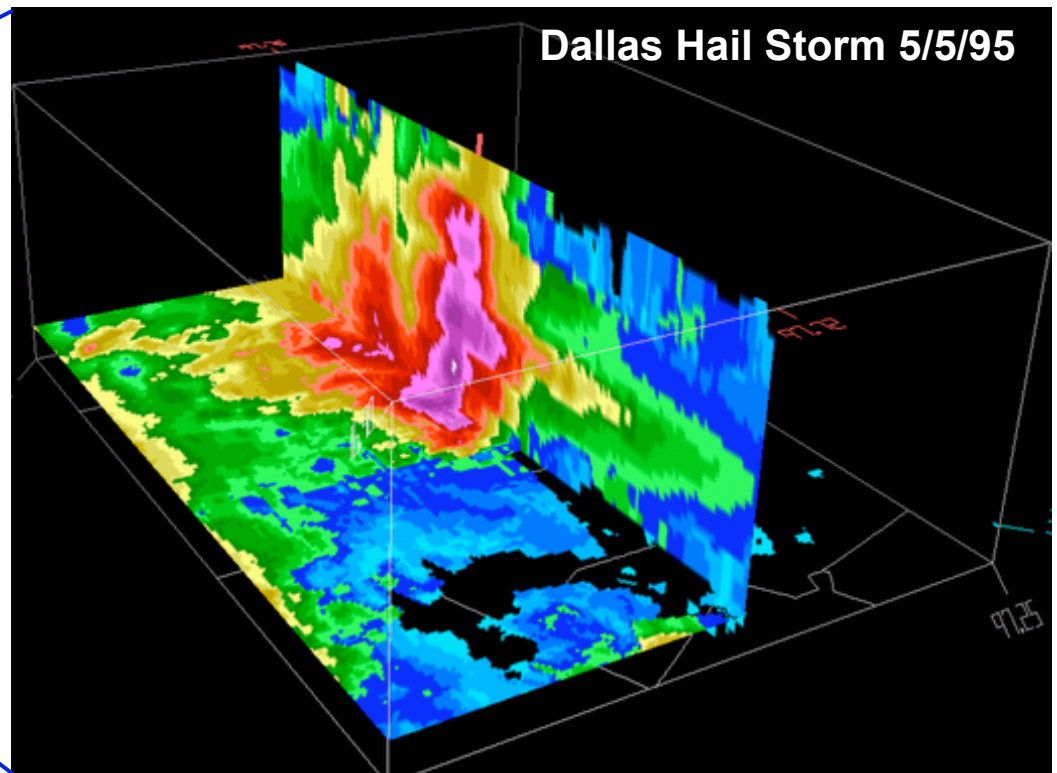
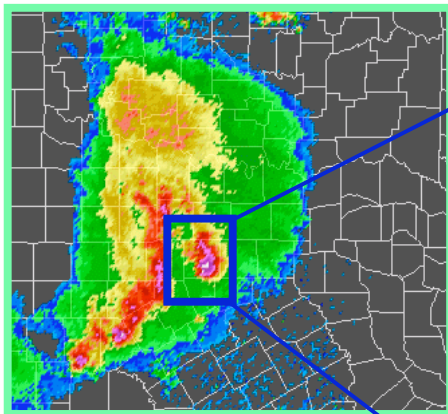
3-D Reflectivity Mosaic

Objective: depict high-resolution 3-D storm structure

Performance: transferred to operations at NCEP and improved short term precipitation forecast;
part of the FAA's "Weather Cube"

Remaining challenges: low vertical resolution

Future: Phase Array Radar will provide better vertical resolution

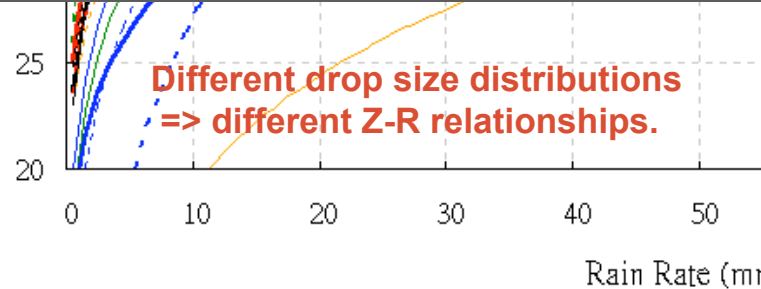
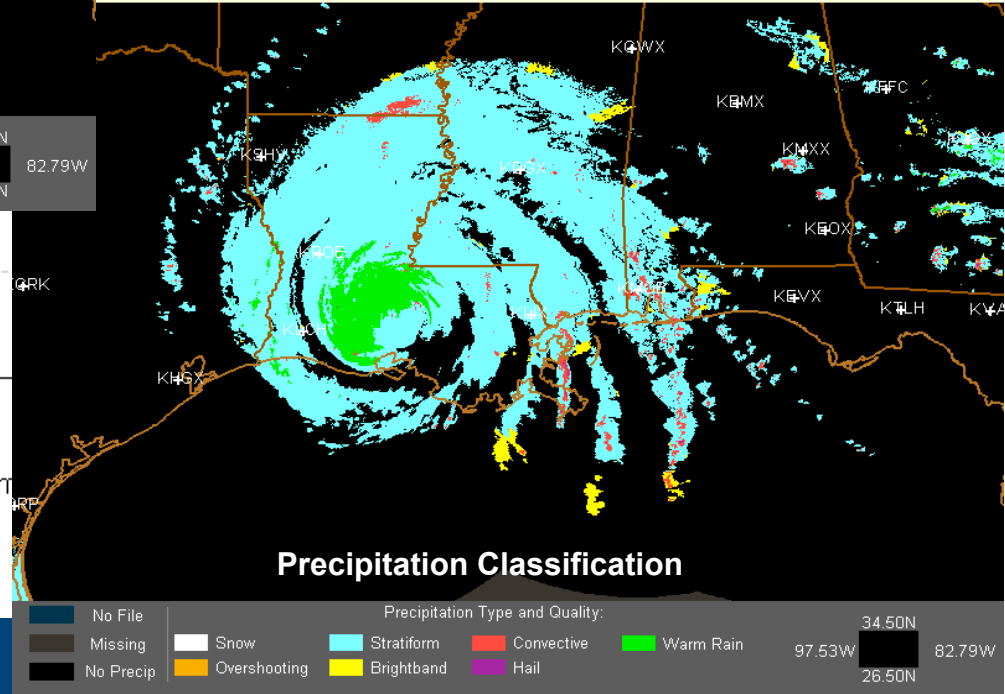
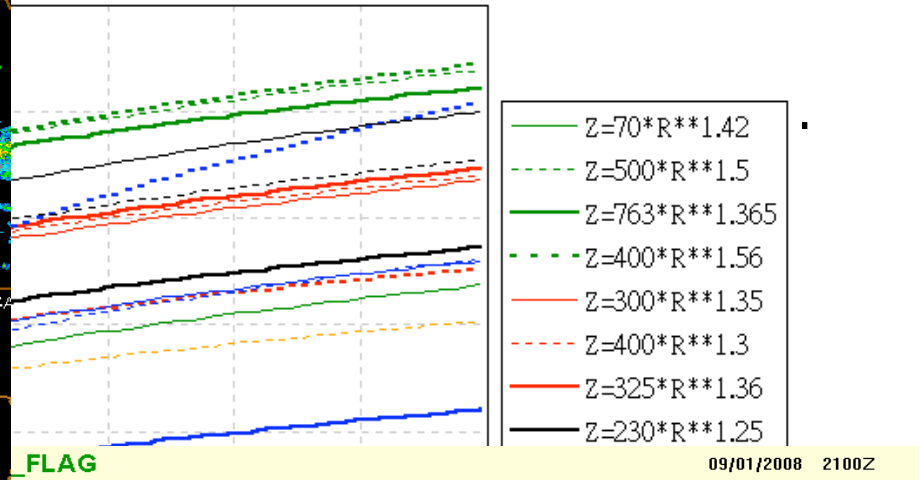
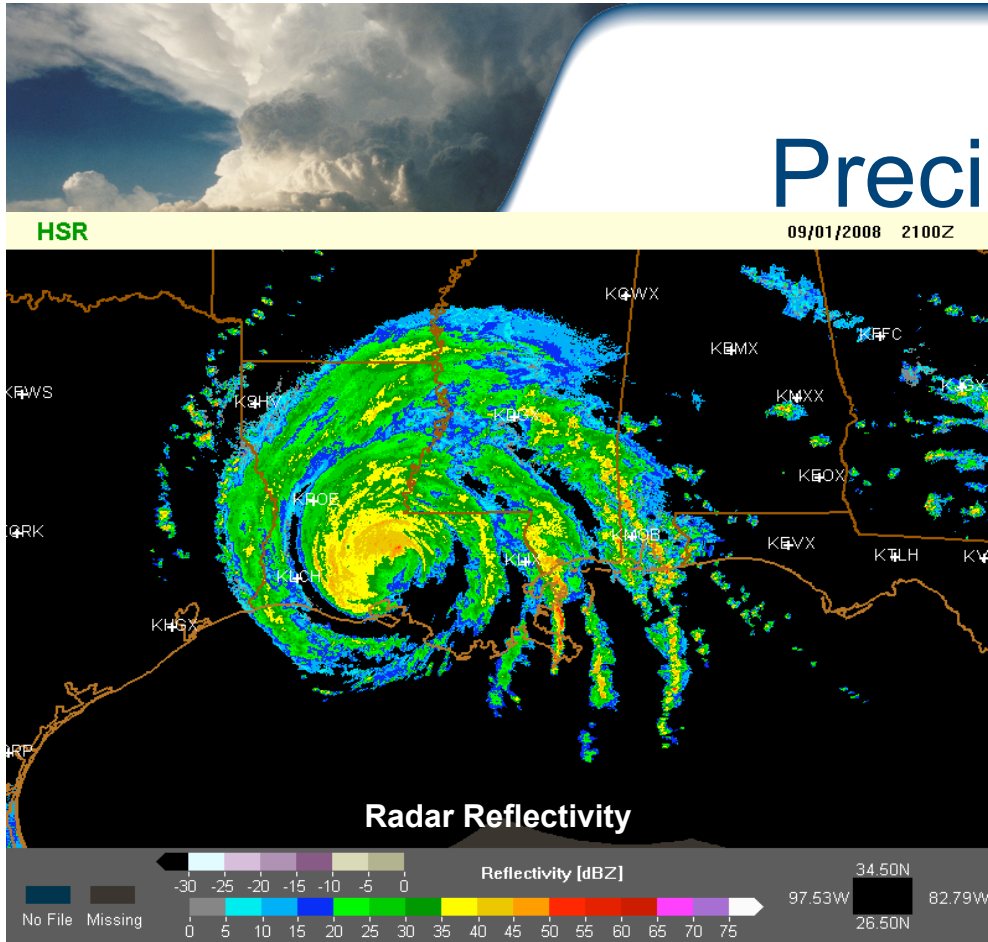


Publications:

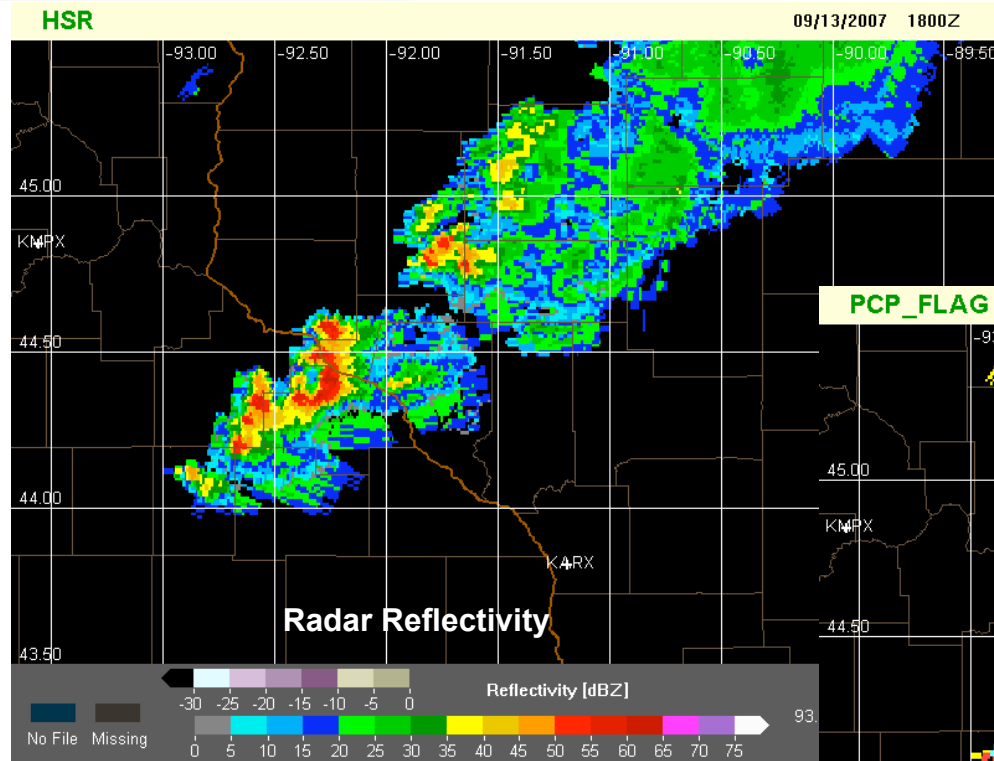
Zhang, J., K. Howard, and J.J. Gourley, 2005: Constructing three-dimensional multiple radar reflectivity mosaics: examples of convective storms and stratiform rain echoes. *J. Atmos. Ocean. Tech.*, **22**, 30-42.

Langston, C., J. Zhang, and K. Howard, 2007: Four-dimensional dynamic radar mosaic. *J. Atmos. Ocean. Tech.*, **24**, 776-790.

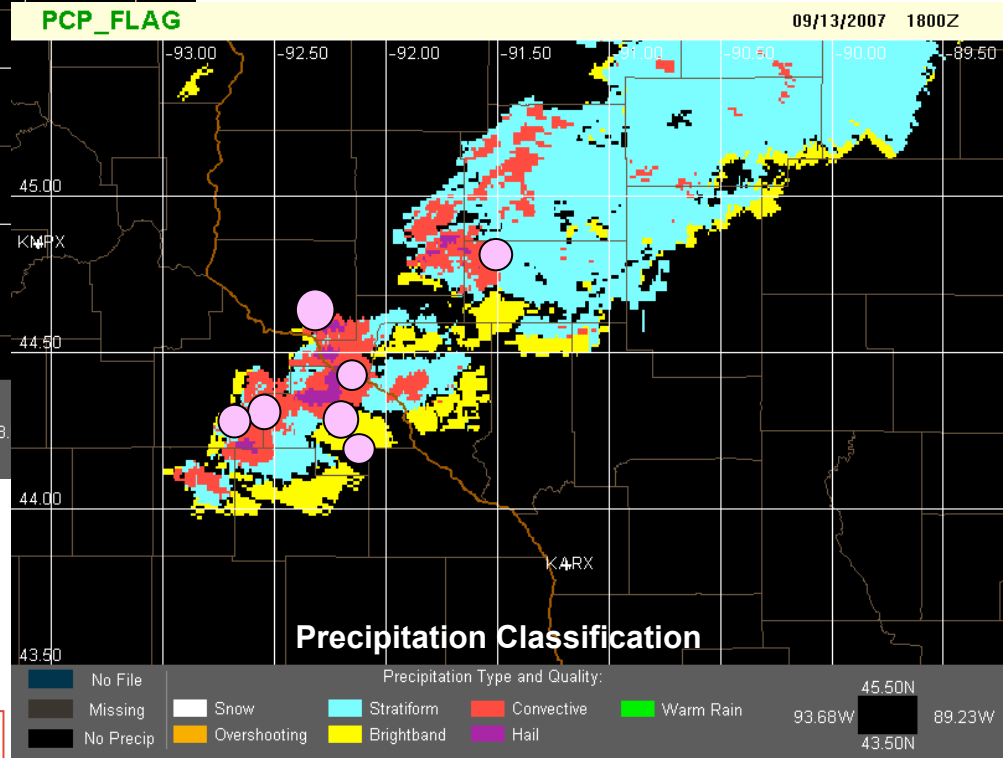
Radar QPE Precipitation Classification



Convective/Stratiform/Hail



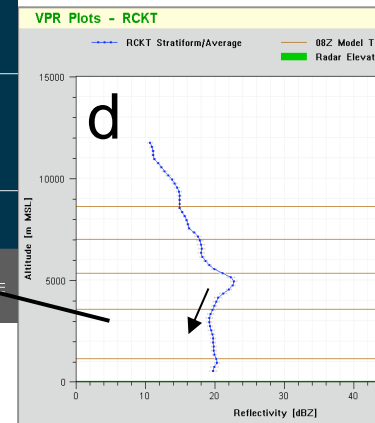
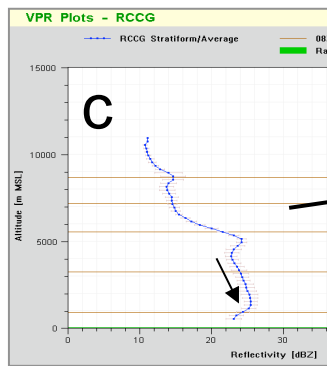
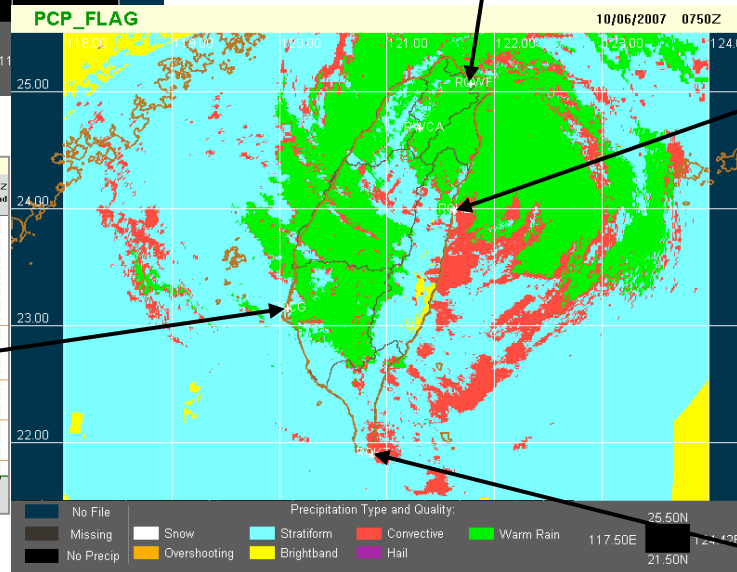
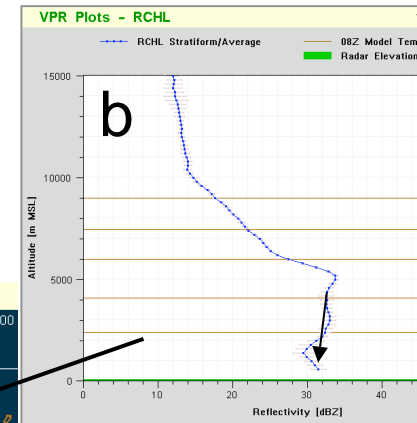
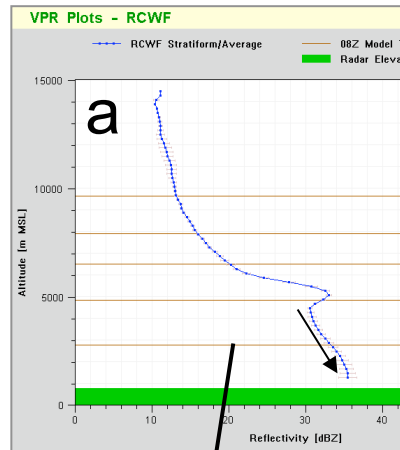
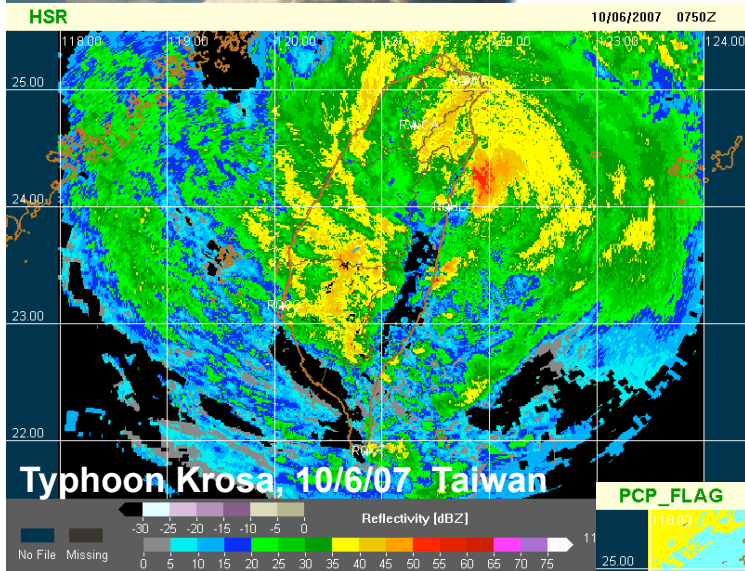
Need more surface validation data
 => Severe Hazards Analysis & Verification
 Experiment (SHAVE) project



Publications:

Zhang, J., C. Langston, and K. Howard, 2008: Bright Band Identification Based On Vertical Profiles of Reflectivity from the WSR-88D. *J. Atmos. Ocean. Tech.* 25, 1859-1872.

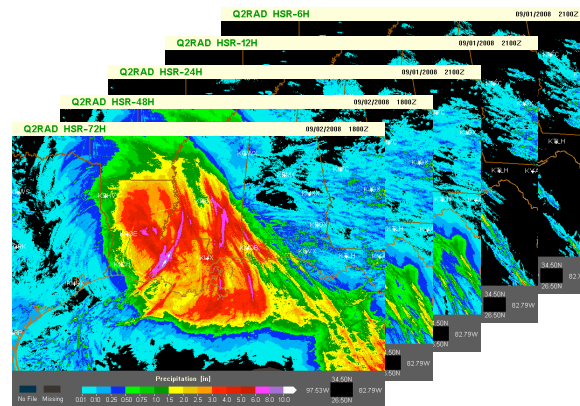
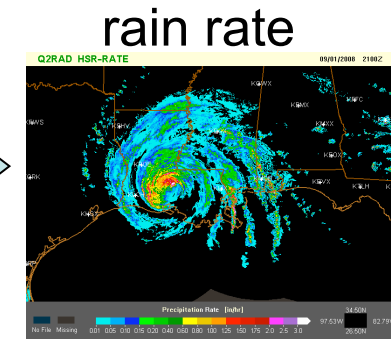
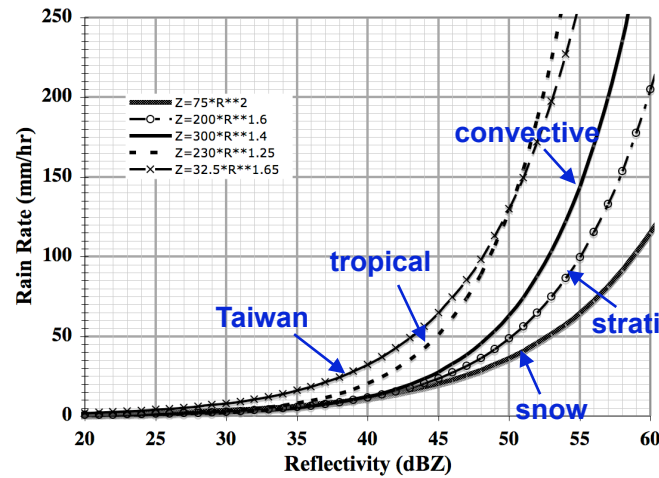
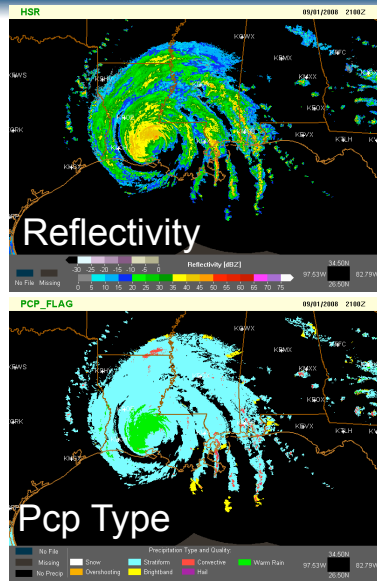
Tropical Rain Identification



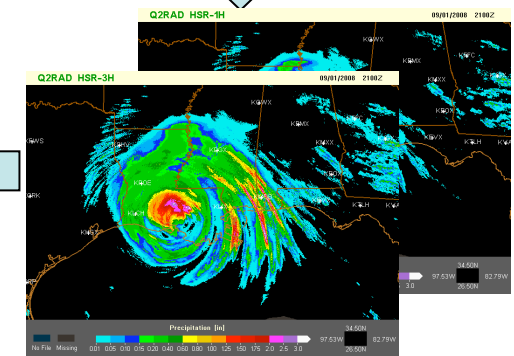
Publications:

Xu, X., K. Howard, and J. Zhang, 2008: An automated radar technique for the identification of tropical precipitation. *J. Hydrometeorology*, **9**, 885-902.

Adaptive Reflectivity-Rainfall (Z-R) Relationships



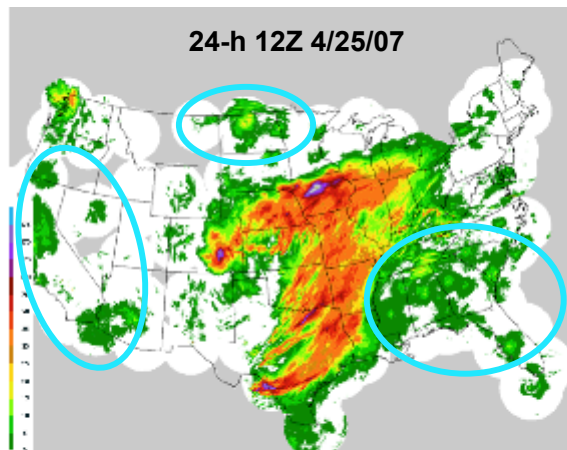
6- to 72-h acc
(updated hourly)



1- and 3-h acc
updated every 5-min

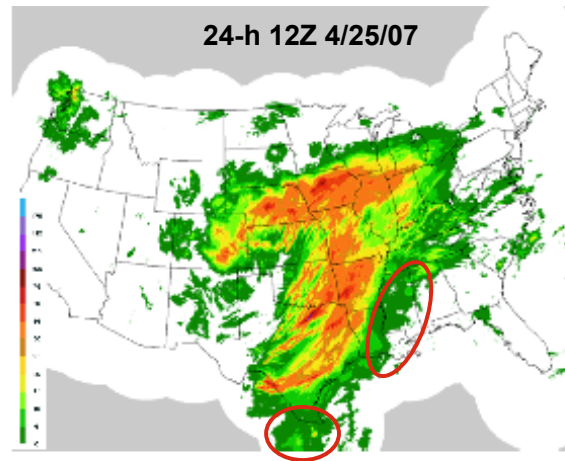
Q2 Performance: Quality Control and Adaptive Z-R

Stage II
(operational)



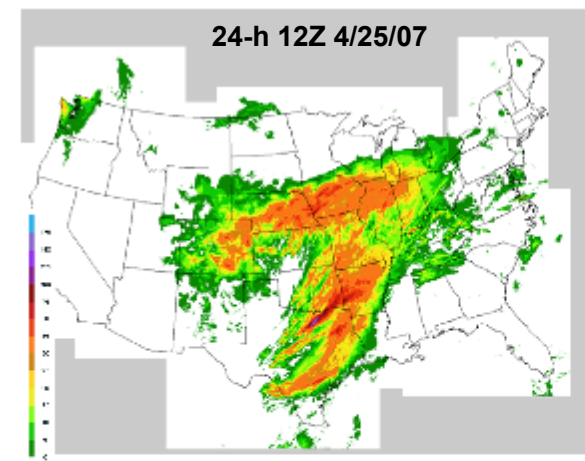
Radar-only, automated

Q2
(research)



Radar & model, automated

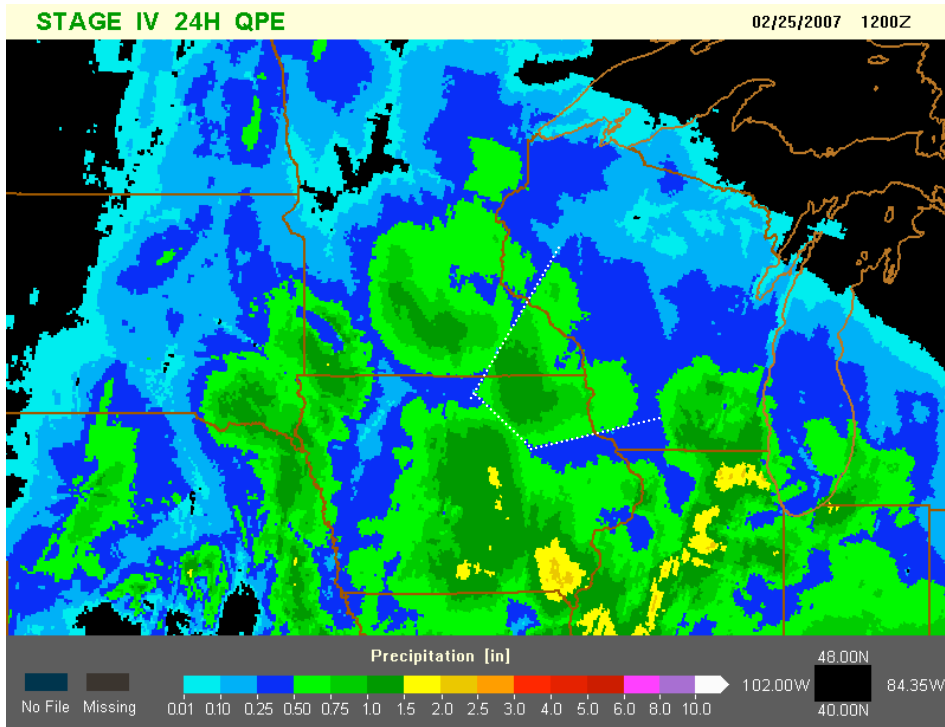
Stage IV
(operational)



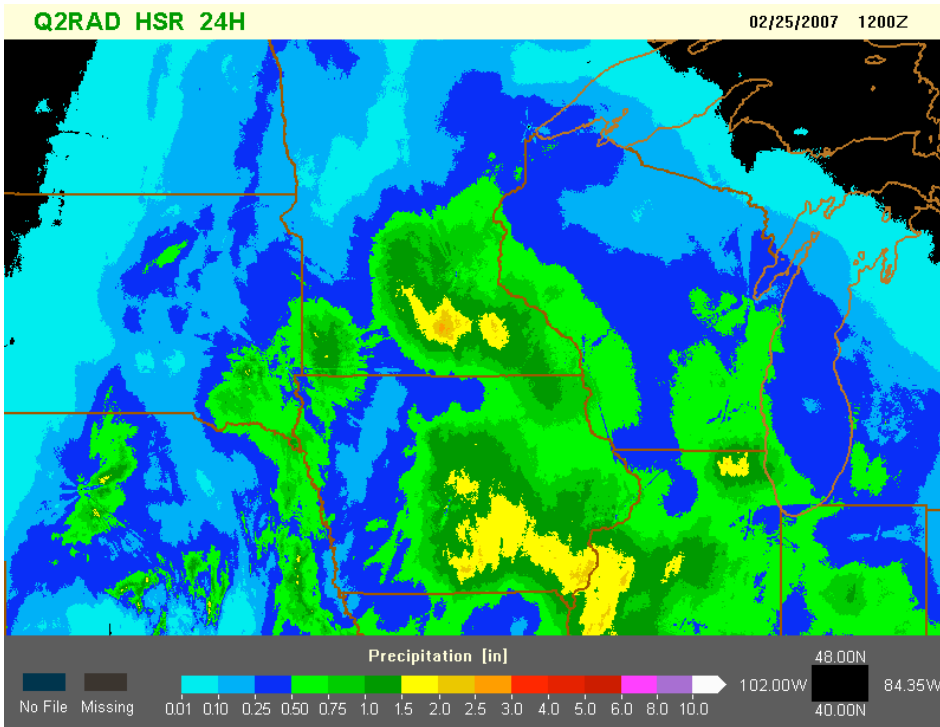
Radar, satellite, and gauge
Human intervention



Q2 Performance: Seamless Mosaic



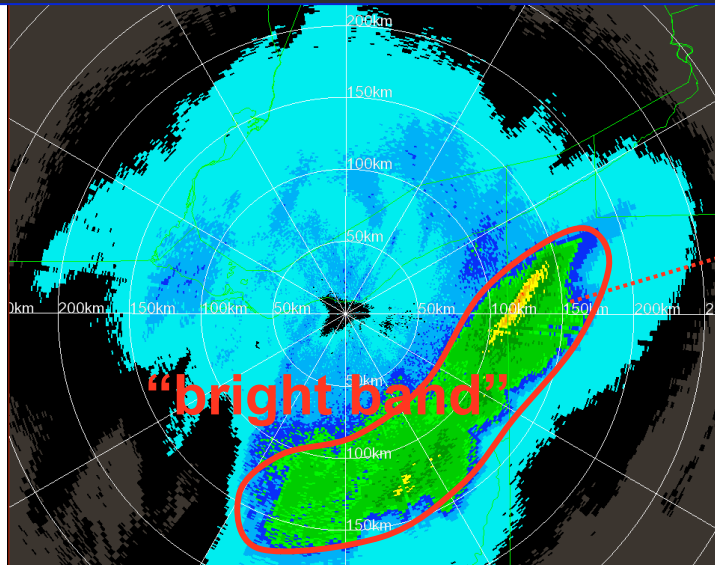
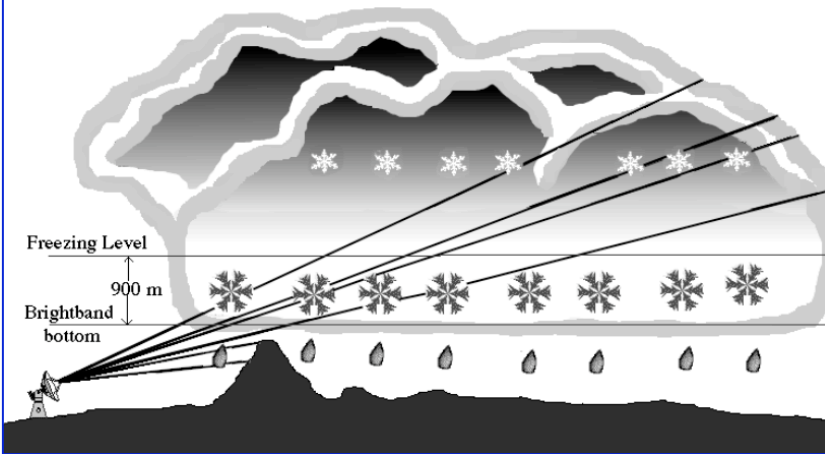
Stage IV



Q2

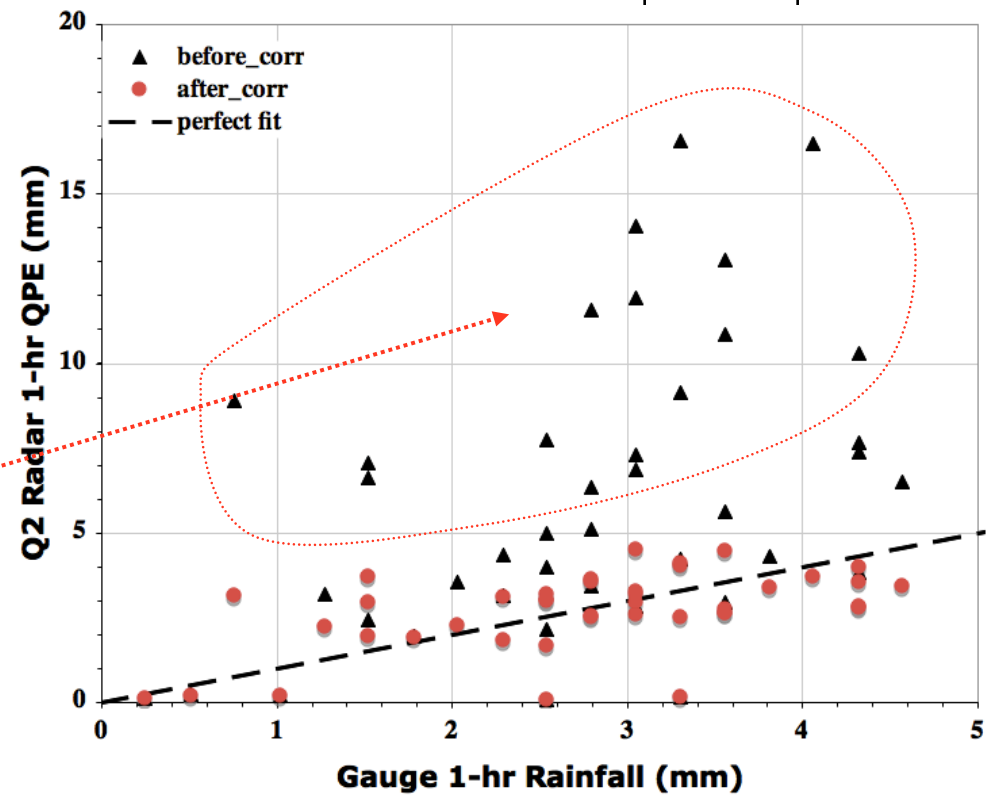
Correction for Non-Uniform Vertical Profiles of Reflectivity

Bright Band (Melting Layer) Schematic



KCLE 1-h rainfall ending 10Z 11/15/08

| | before | after |
|----------|--------|-------|
| Bias | 2.21 | 0.98 |
| RMSE(mm) | 5.15 | 1.09 |





Future Directions

- ✦ Fully integration of **dual-pol** radar QPE techniques
- ✦ Evaluations (in collaboration with NWS/OHD, National Climate Data Center, University of Oklahoma, and NCAR)
- ✦ Continued R&D on
 - ✦ Blockage mitigation
 - ✦ Non-uniform vertical profile of reflectivity correction
 - ✦ Local gauge bias correction
 - ✦ Multi-sensor (radar, model, gauge, satellite) blended QPE
- ✦ Continued collaboration with NOAA/HydroMet Testbed
 - ✦ Integrate gap-filling radars
 - ✦ Refine snow line delineation
- ✦ Continued collaboration with hydro modeling (Coastal & Inland Flooding Observation and Warning Project -- CI-FLOW)



Summary

- ✓ Q2 is a **real-time** system that produces **national** QPE products with **high- spatial and temporal resolution**.
- ✓ Q2 is a testbed that facilitates rapid **science-to-operations** transfer for hydro-meteorological applications.
- ✓ Q2 has been serving many **users** in government agencies, universities, and private sector.
- ✓ Q2 will continue R&D for advanced **multi-sensor** QPE.

Questions?