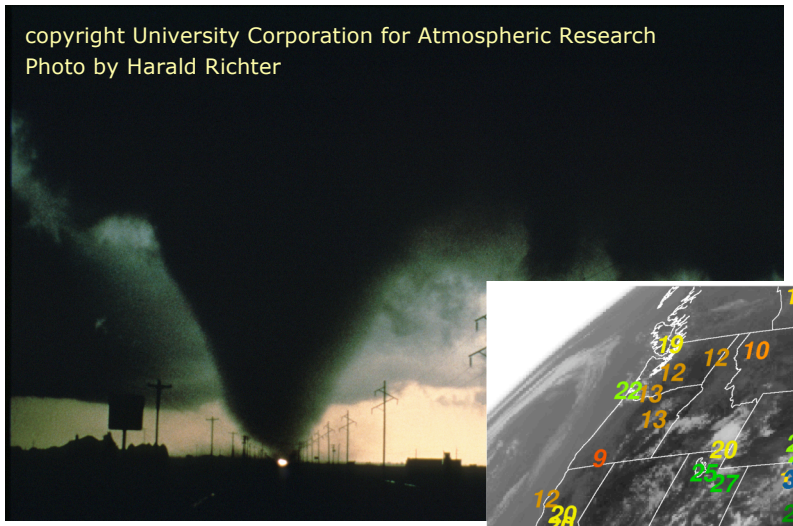
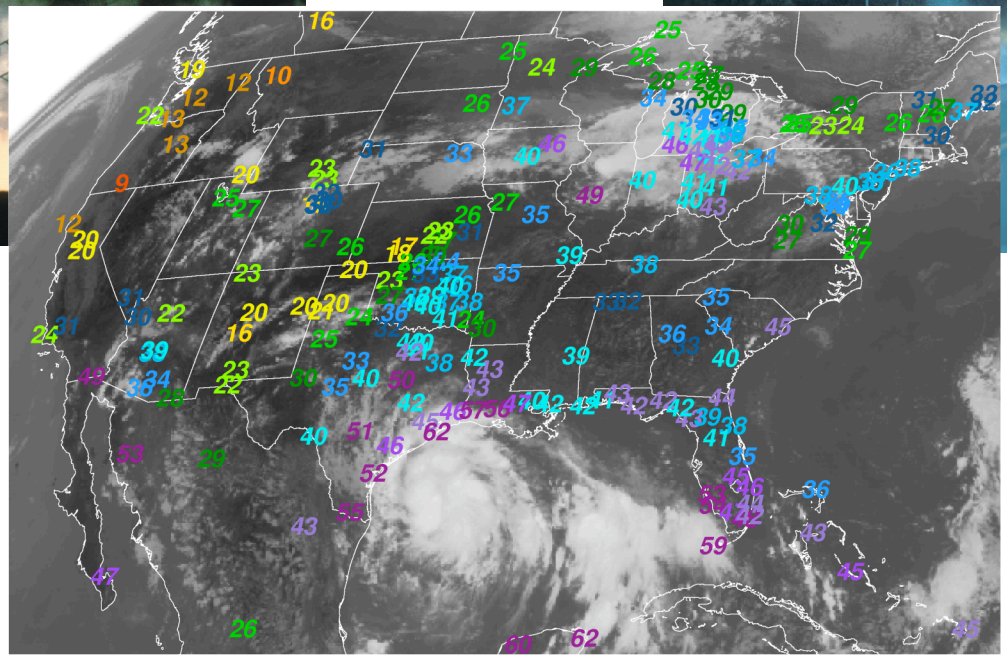
Meteorological Applications Using Continuous Streams of GNSS Data





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GPS PW Estimation Fundamentals

$$N \approx 77.6\left(\frac{p}{T}\right) + 3.73\times10^{5}\left(\frac{e_w}{T^2}\right)$$

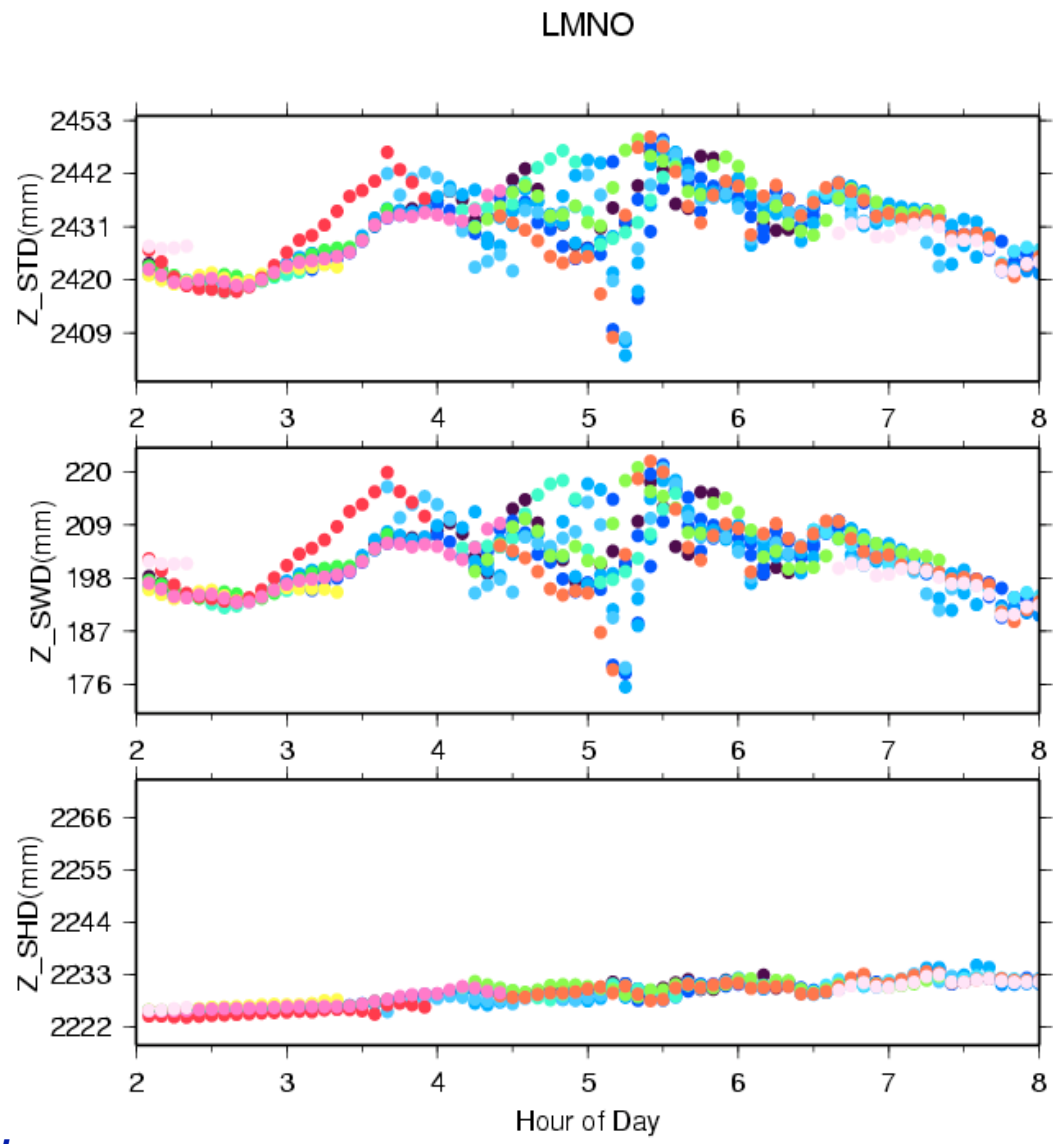
$$\Delta L = 10^{-6}\int_S \left[77.6\left(\frac{P}{T}\right) + 3.73\times10^{5}\left(\frac{e_w}{T^2}\right)\right] ds$$

$$ZTD = ZHD + ZWD = \frac{SHD}{m_h(\theta)} + \frac{SWD}{m_w(\theta)}$$

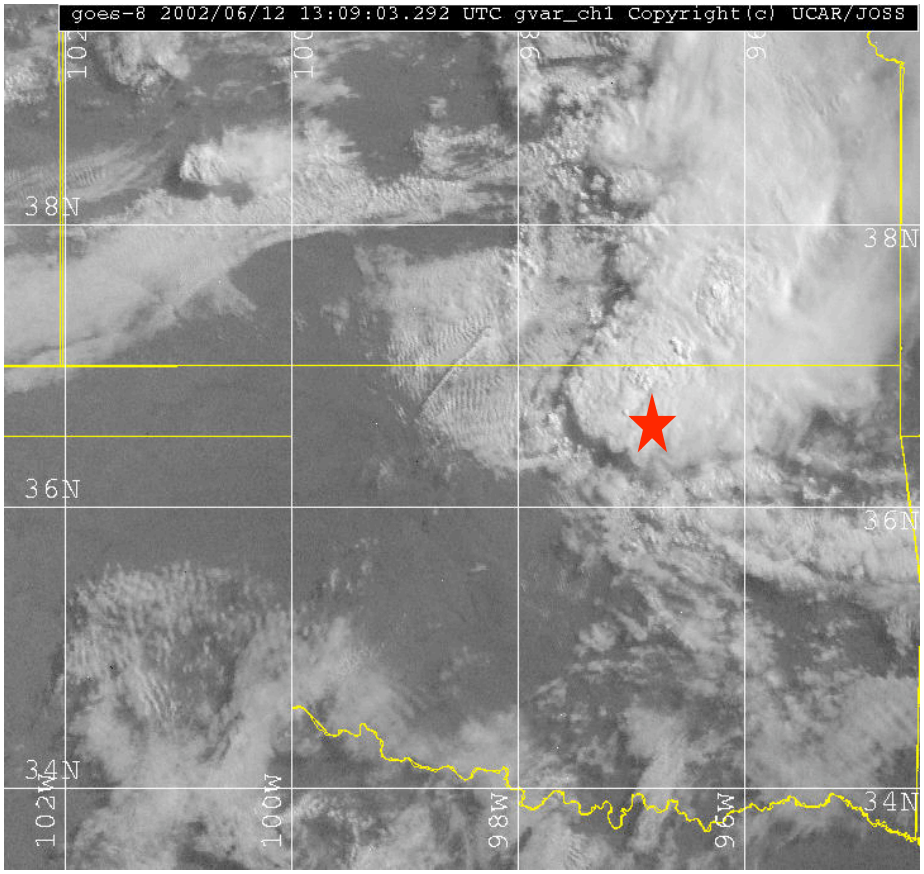
$$PW = \frac{IWV}{\rho} = \Pi \bullet ZWD$$

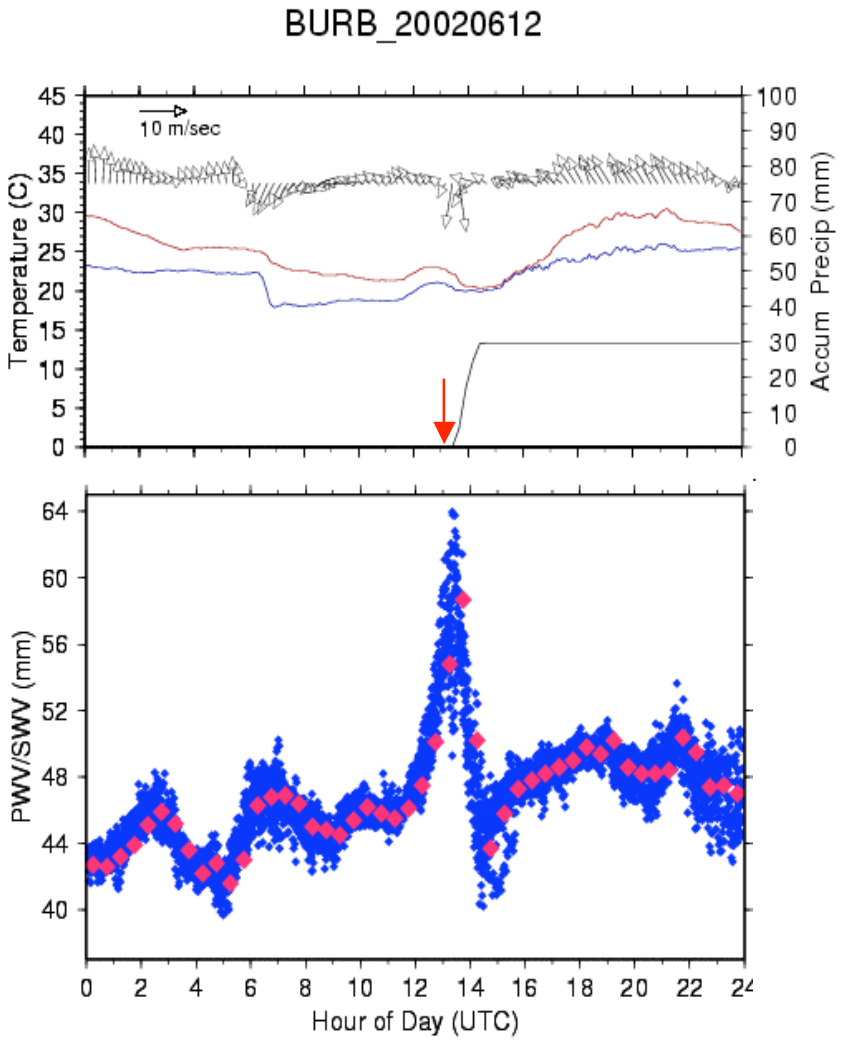
or

$$PW = \frac{1}{\rho} IWV = \frac{1}{\rho}\int \rho_v dz$$

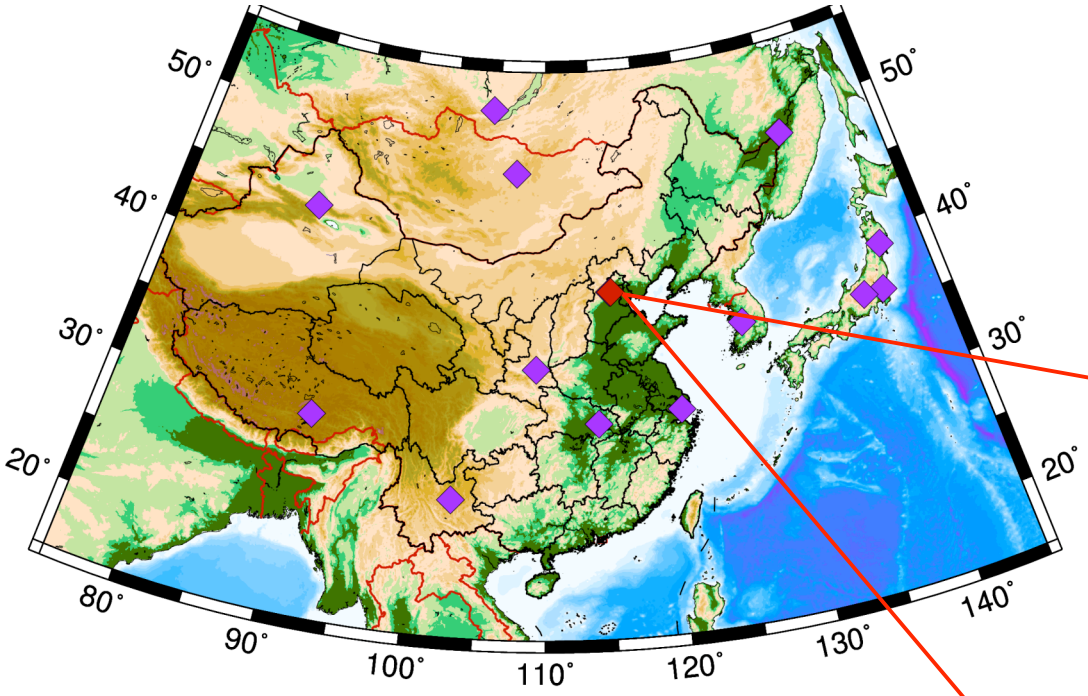


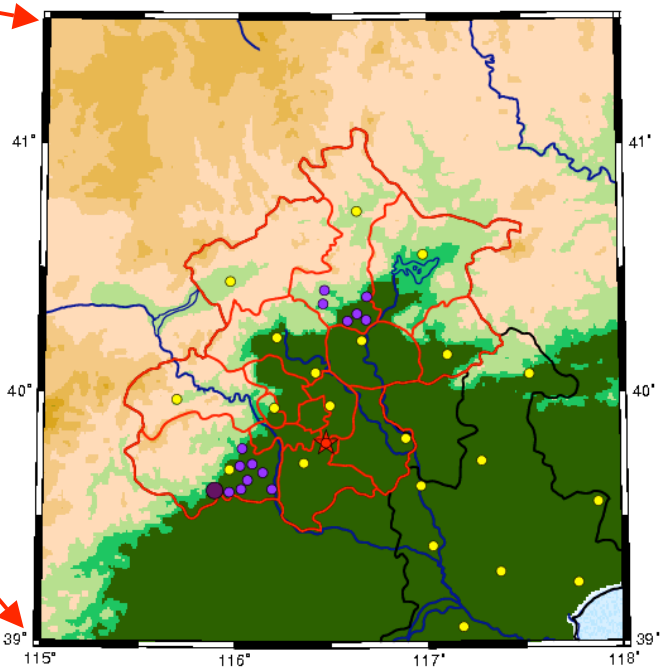
June 12 Surface Met and SW





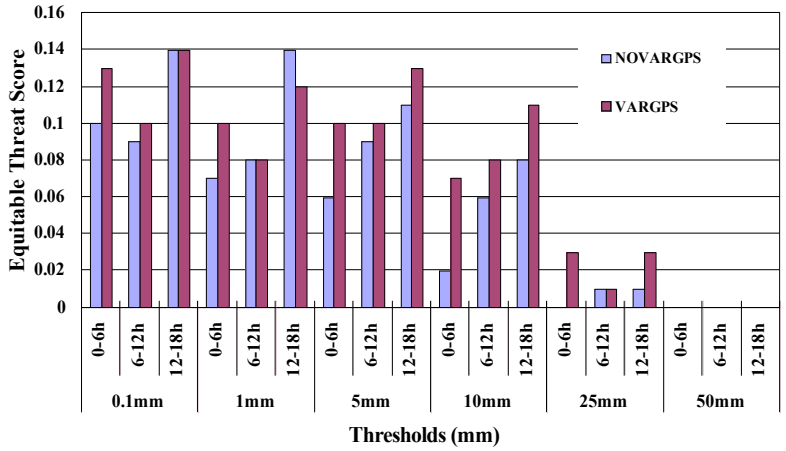
Forecast Demonstration Project Beijing Olympics

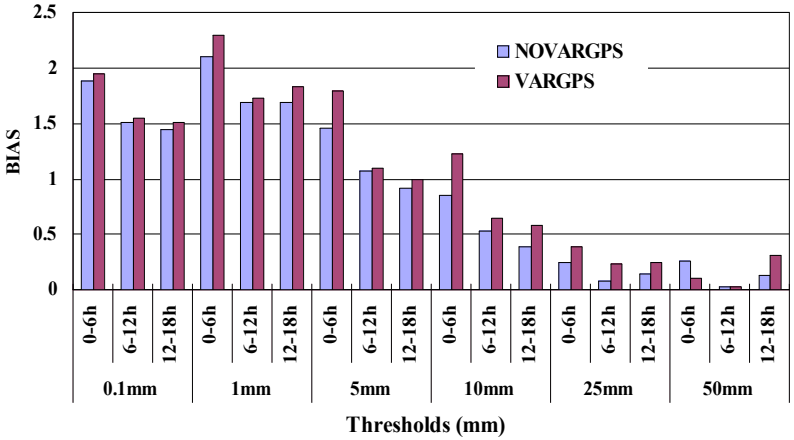


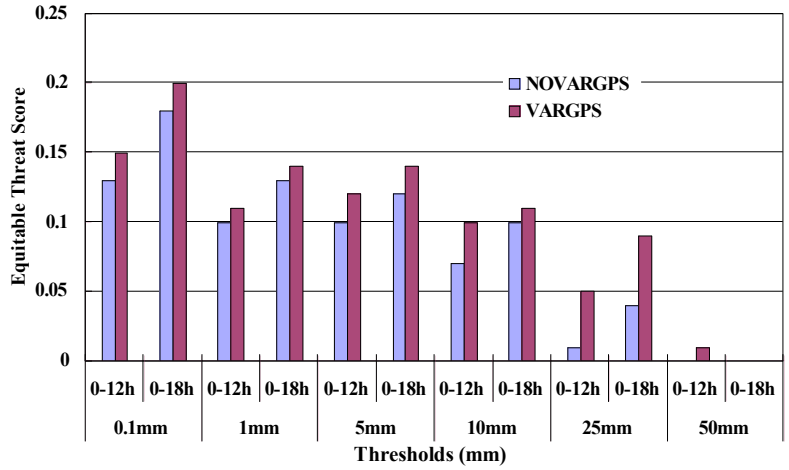


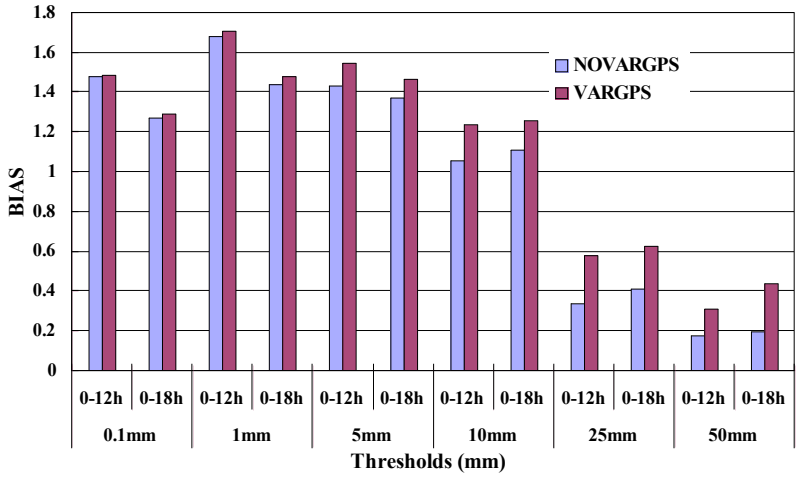
- Beijing Meteorological Bureau (BMB)/Institute for Urban Meteorology (IUM) Collaborators Wang Y. C.,Zhang C. L.,Chu Y.L.
- Observational system will include radiosondes, GPS, microwave radiometers, S-band radar.
- Network will be used to initialize NWP for 2008 Olympic Games.
- Collaborating with UCAR/COSMIC program.

Impact of PW for Beijing Forecasts



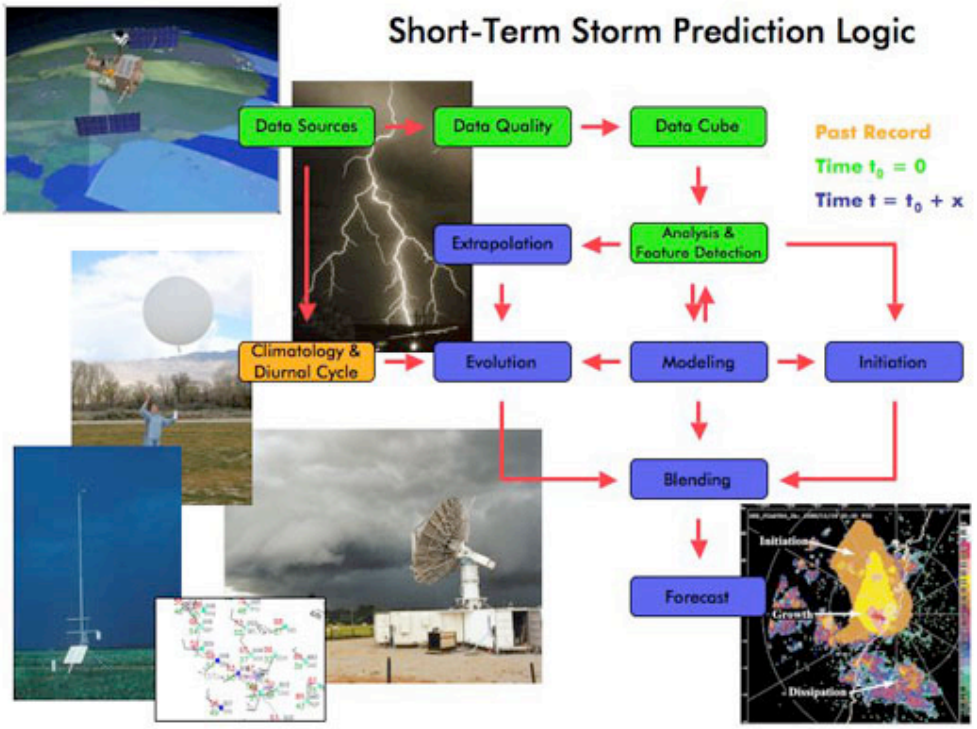






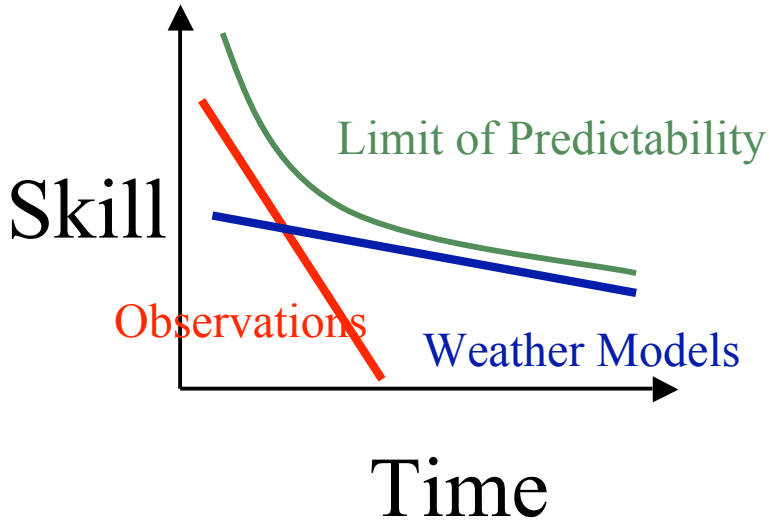
Chen, et al, 2008: "Impact of assimilating GPS-IPW observations into the WRF-based rapid updated cycling system in IUM", WRF Workshop Korea

Nowcasting (0-3hr forecasts)



http://www.ral.ucar.edu

Input Data:
Surface Obs (Temp,press, RH)
Radar (clouds, precipitation)
Satellite (clouds)
Radiosonde (temp,press,humidity)



Simulation of PW as a Nowcasting Tool

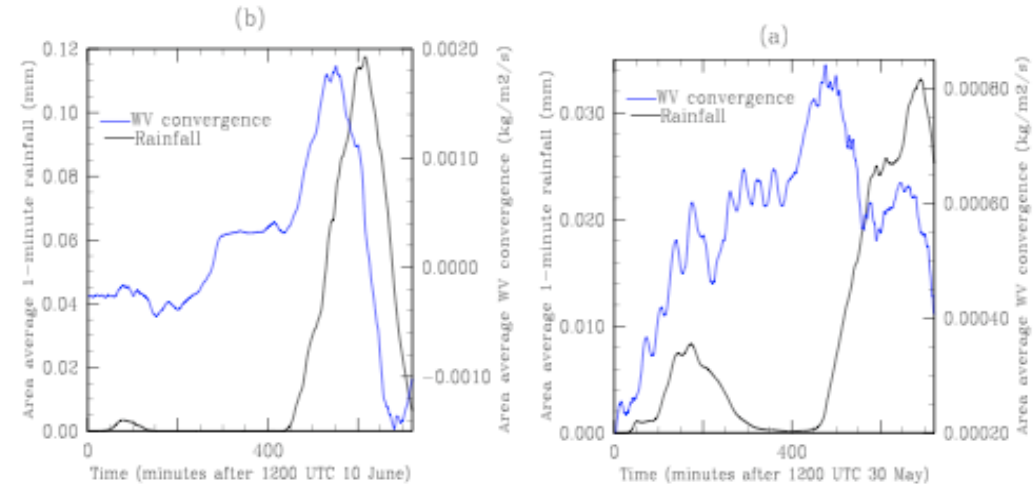


Figure 7: Timeseries of 1-minute rainfall accumulation (mm, black) and low-level water vapor convergence ($kgm^{-2}s^{-1}$, blue) averaged over a 151km square box for (a) case 2 and (b) case 3.

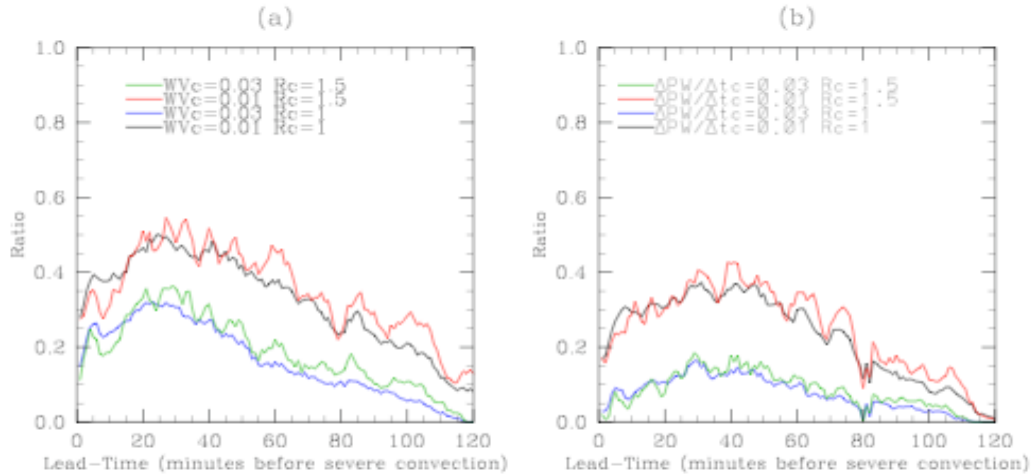
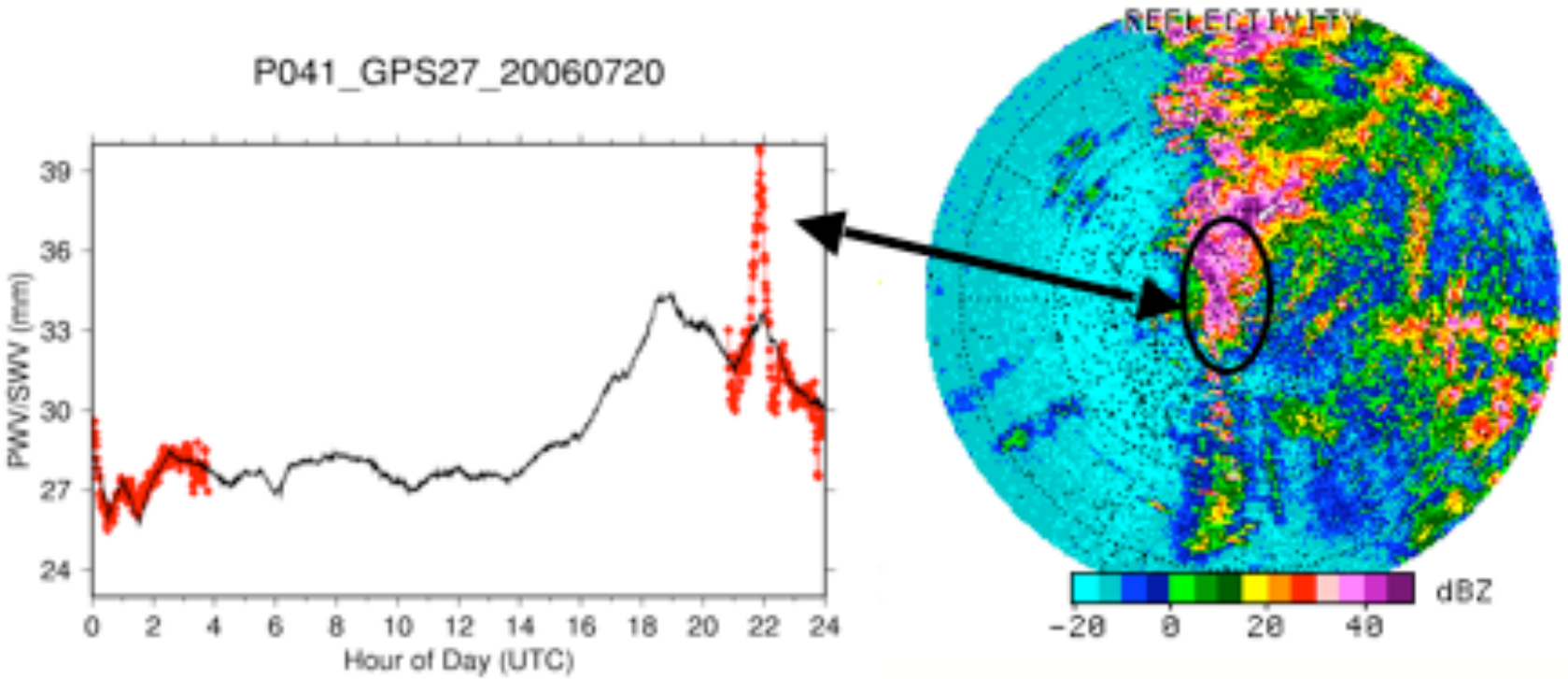


Figure 4: Ratio of the number of grid points exceeding a rainfall threshold to the number of those grid point exceeding (a) a water vapor convergence threshold and (b) a $\Delta PW/\Delta t$ threshold, for different thresholds.

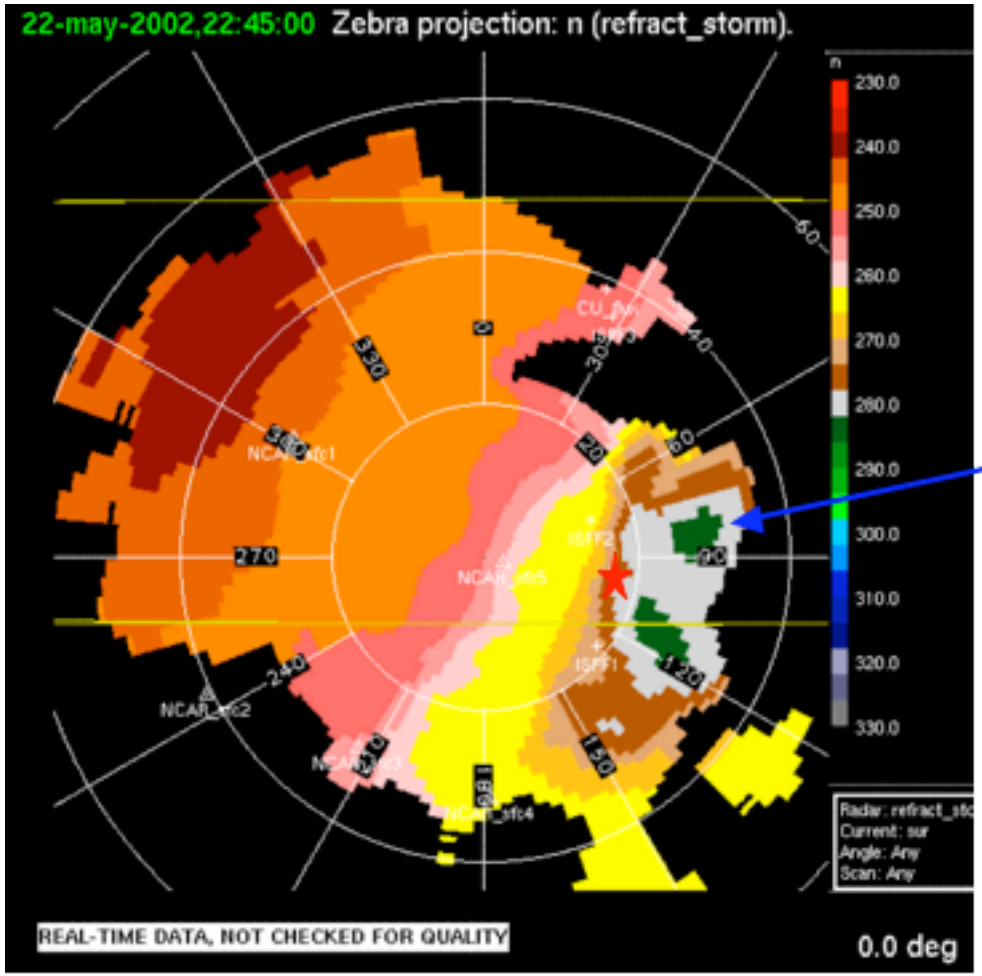
Done, et al, 2005:
"..we conclude that observing instrumentation capable of providing 10 min repeat cycles at a resolution of 10 km would be able to detect significant moisture convergence, and provide useful warning for the possibility of severe convection."

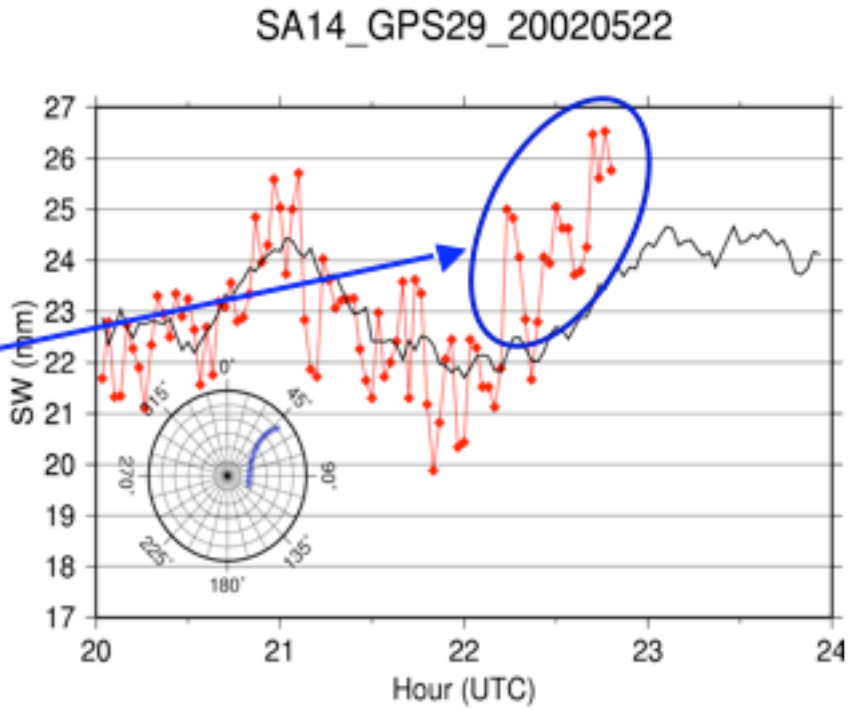
REFRACTT-06



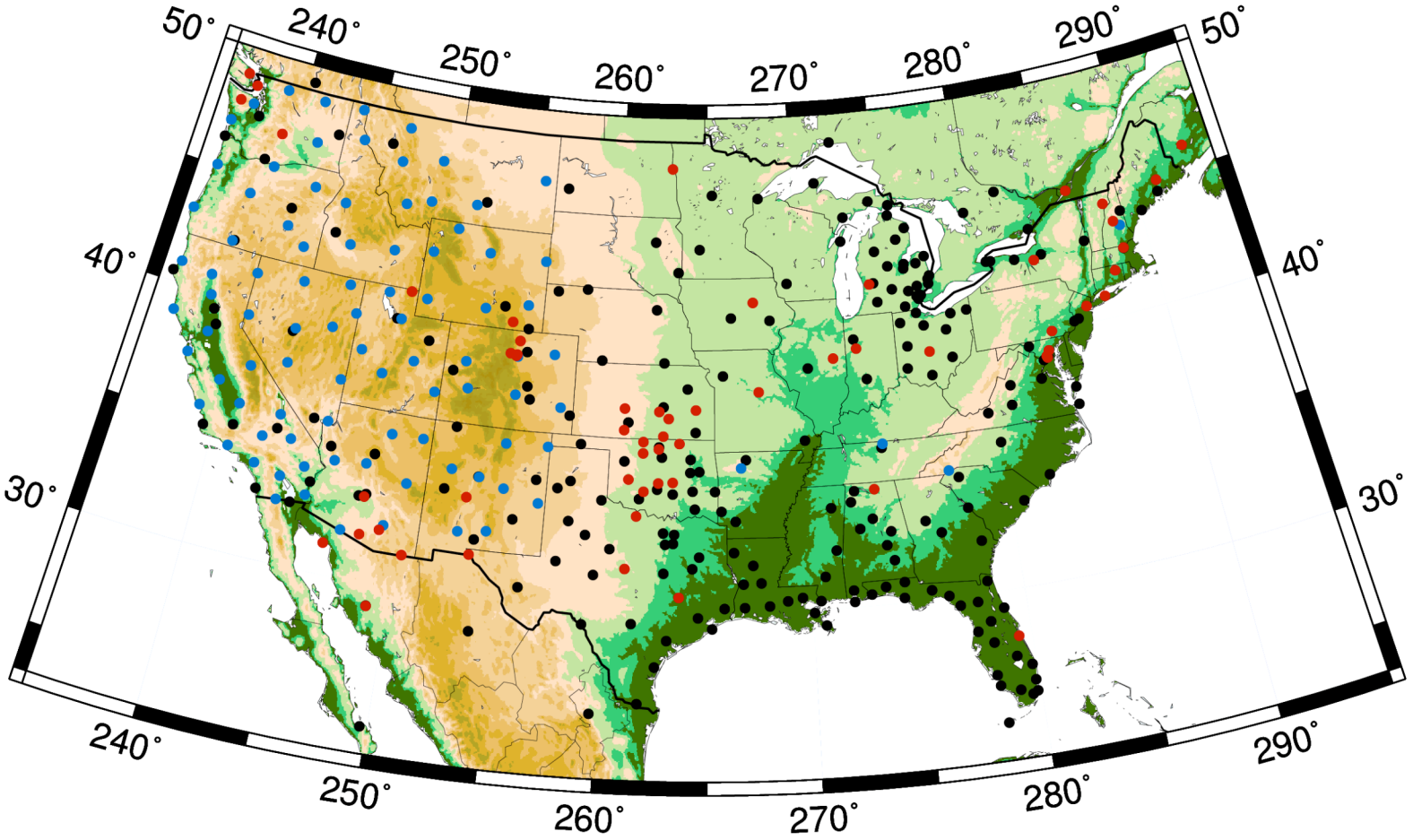
Roberts, et. al. 2008, Bulletin of the American Meteorological Society

Dryline Observations (2245 UTC)



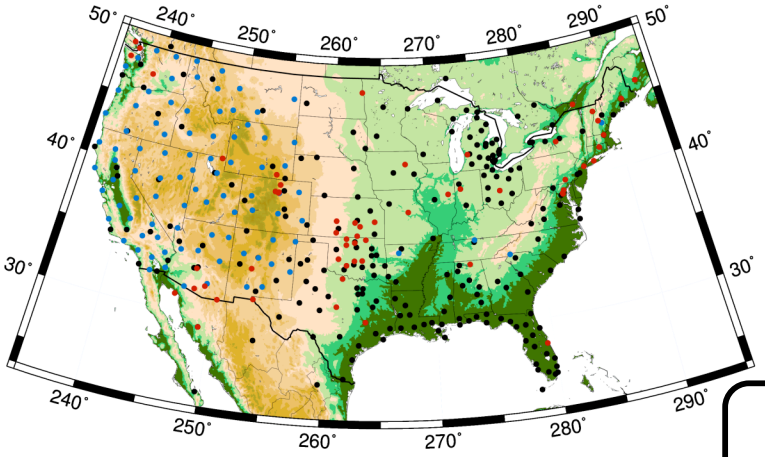


Real-Time Network



Collaborative MRI Proposal between UNAVCO, COSMIC, and Unidata

Real-Time Network



Streaming Data Server

UNAVCO Archive

Realtime Analysis

Other Users

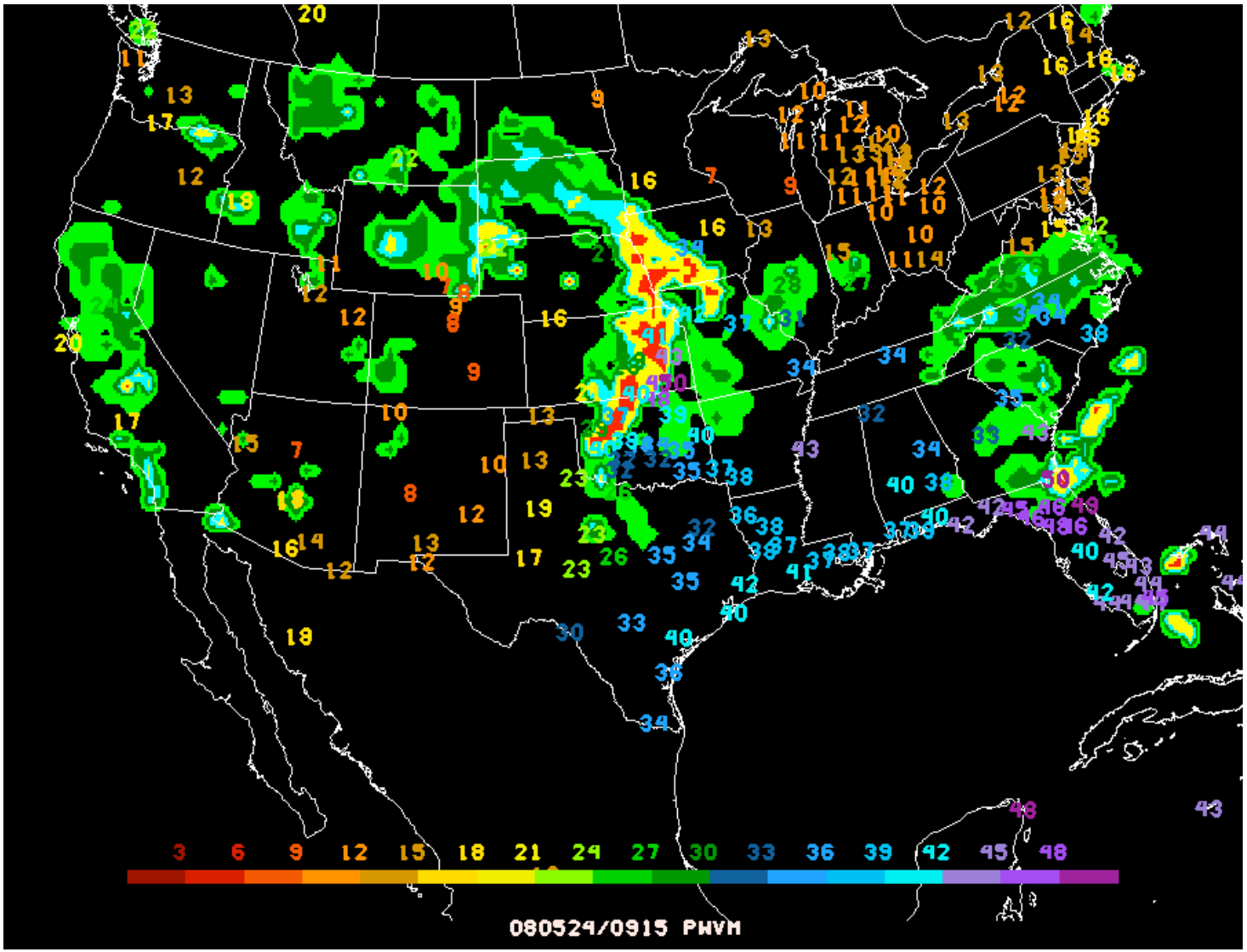
Publish To WWW

Push to Universities

Archive for Case Studies

Blend with Other Data

Blended GPS and Radar Data



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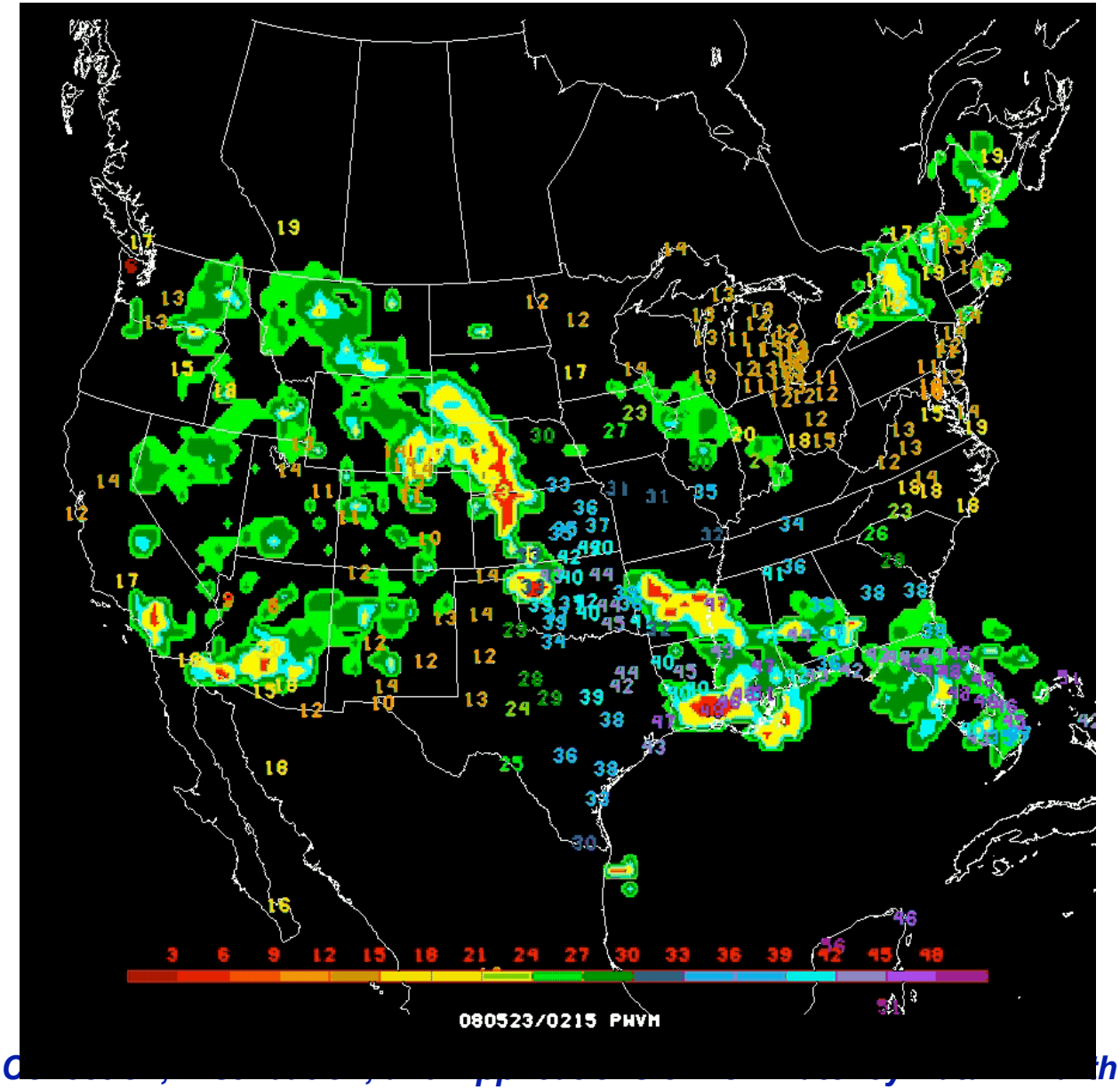
Conclusions

• Ground based GPS estimates of PW are becoming an accepted and important component of the observational systems used by the weather and climate community.

• Preliminary results and simulations indicate that PW can be a useful tool in nowcasting strategies.

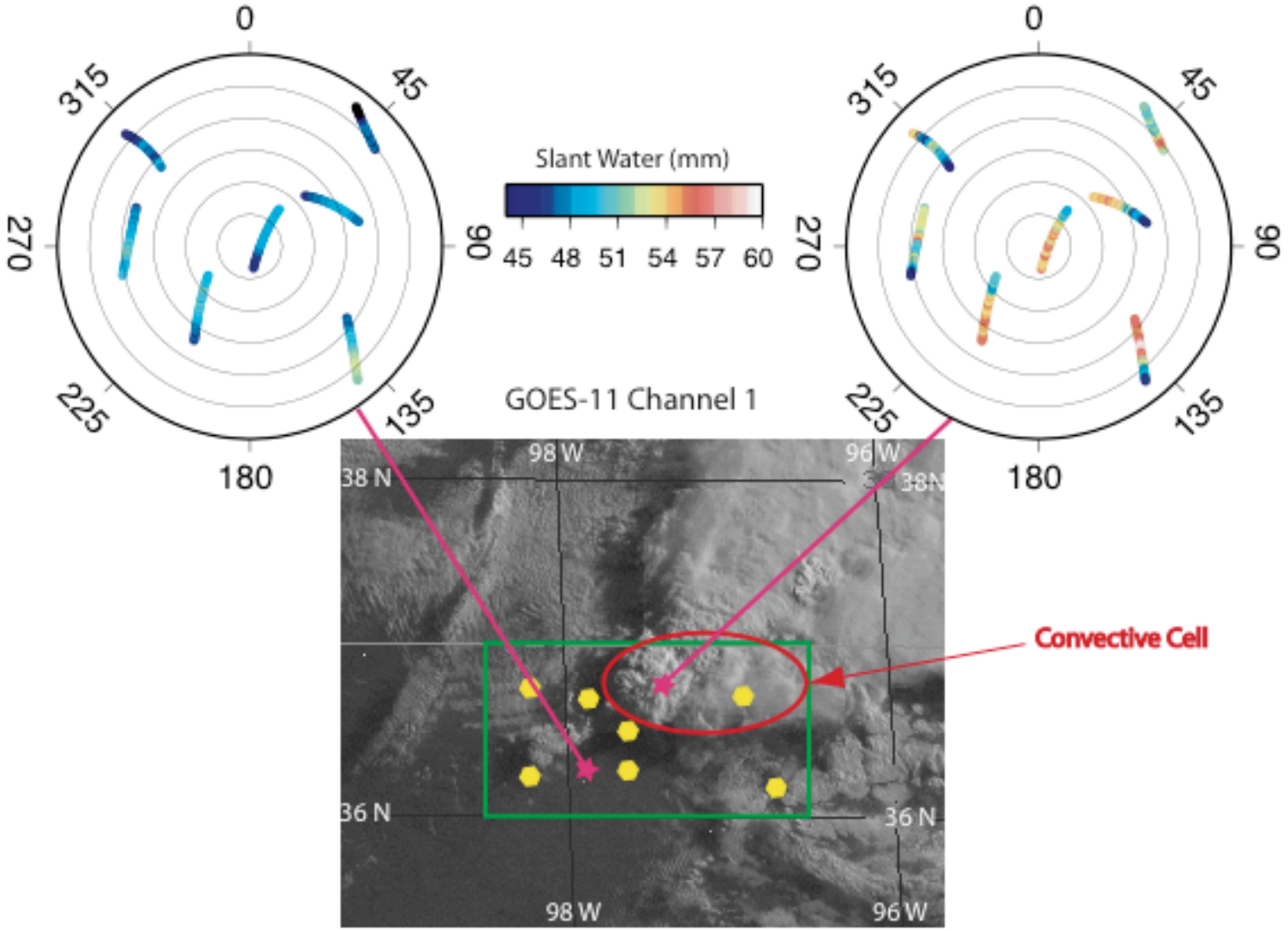
• COSMIC, in collaboration with UNAVCO and Unidata, are exploring methods to created realtime data streams that hold promise for very short term weather prediction.

Animation of Blended GPS and Radar

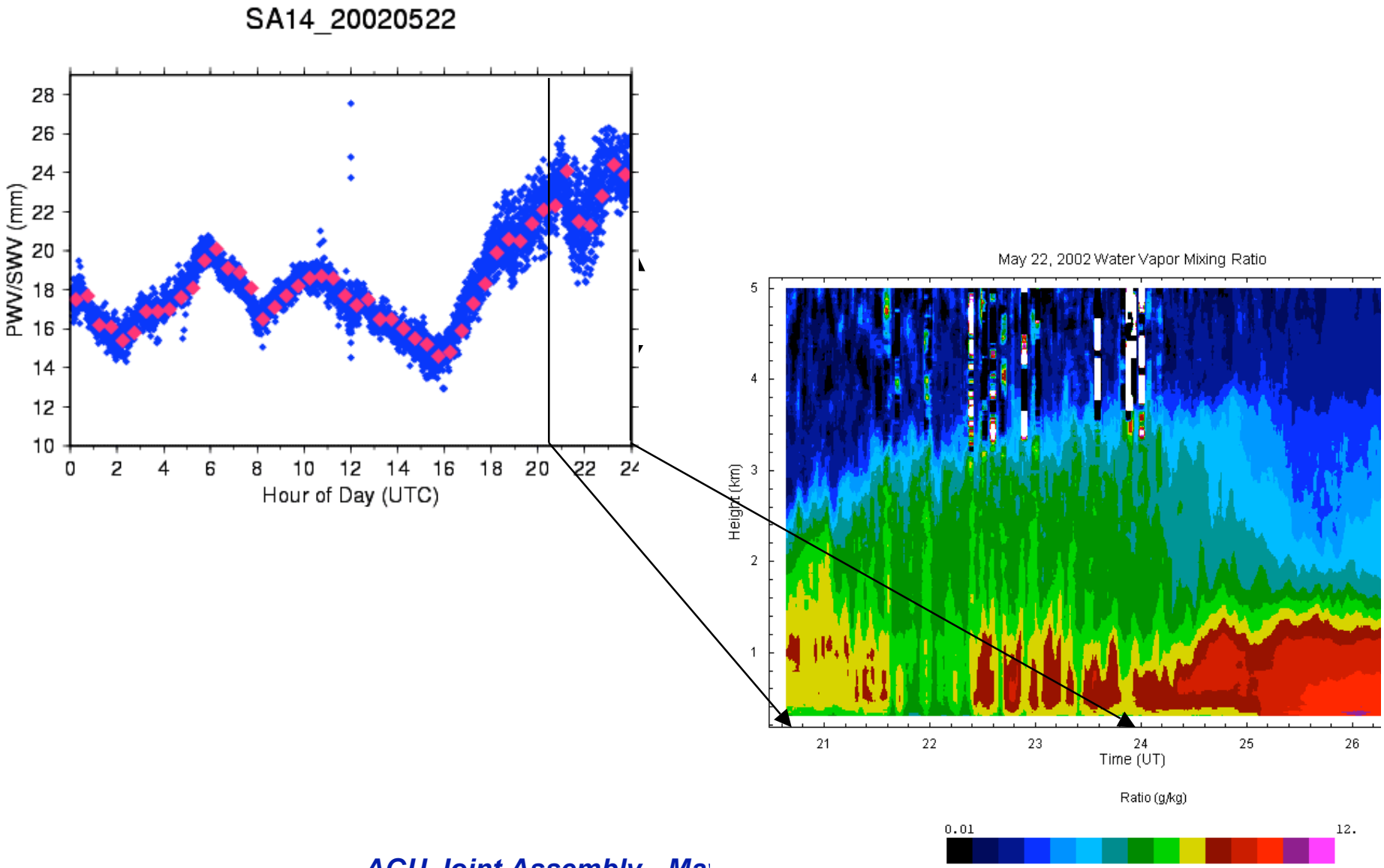


Faster: C… …h Science

SW within Convective System



SW and Lidar Observations at Dry-Line



Dryline Observations (May 22, 2145 UTC)