

Humidity Mapping and High-Impact Weather Prediction

presentation to

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R. Ware^{1,2,3}, R. Anthes⁴, L. Cucurull⁹, M. Eilts⁵, I. Gultepe⁶, M. Jackson⁷,
K. Kelleher⁹, S. Koch⁸, A. MacDonald⁹, R. Marshall¹⁰, M. Murakami¹¹,
M. Rajeevan¹², R. Serafin², Y. Xie⁹, J. Zhang¹³

¹Radiometrics; ²National Center for Atmospheric Research;
 ³Cooperative Institute for Research in Environmental Sciences;
 ⁴University Corporation for Atmospheric Research; ⁵Weather Decision Technologies;
 ⁶Environment Canada; ⁷Trimble Navigation; ⁸National Severe Storms Laboratory;
 ⁹Earth Systems Research Laboratory; ¹⁰Earth Networks; ¹¹Japan Meteorological Research Institute;
 ¹²India Institute of Tropical Meteorology; ¹³China MetStar Radar Company



Early Stage Convection

- Humidity convergence during early stage convection is visible via microwave
- Local lightning prediction several hours in advance based on microwave radiometer observations
- Convective storm prediction can be extended to regional scales using combined GNSS slant delay and radiometer observations



Severe Storm Precursor

- A severe thunderstorm killed 22 and left millions without power for five days in Washington, DC.
- Forecast indices derived from a local thermodynamic profiler showed extremely unstable conditions and risk of high winds hours in advance.



Thermodynamic observations of a severe thunderstorm that killed 22 and caused 5-day power outage in Washington, D.C.



High Impact Local Weather Warnings >2-hr in Advance

- "...ground-based MWR observations can be used effectively to predict the occurrence of thunderstorms at least 2 h in advance."
 (Madhulatha et al, JGR, 2013)
- High Impact Local Weather includes: Fog, Lightning, Hail, Rain, Gust Fronts, Turbulence, Wind Shear, Icing



Lightning prediction more than 2 hours in advance derived from radiometer measurements (<u>Madhulatha et al, JGR, 2013</u>)

- Hazardous
 Weather Testbed
- Boundary Layer Network radiometers (3)
- Ft. Worth WMO radiosonde
- Tornado reports 3 April 2014



Sigma Soundings

- Radiometer and gridded analysis
 1DVAR combination
- High accuracy continuously updated thermodynamic and wind soundings
- Full suite of forecast index time series
- Automated high-impact local weather alerts

THE NATIONAL WEATHER SERVICE IN FORT WORTH HAS ISSUED A
* TORNADO WARNING FOR... CENTRAL DENTON COUNTY IN NORTH CENTRAL TEXAS...
* UNTIL 630 PM CDT 3 April 2014

* AT 547 PM CDT... STORM SPOTTERS AND DOPPLER RADAR OBSERVED A DEVELOPING TORNADO 3 MILES SOUTHWEST OF KRUM... MOVING EAST AT 20 MPH.

* THE TORNADO WILL BE NEAR... **DENTON** AROUND 605 PM CDT... CORINTH AROUND 615 PM CDT... SHADY SHORES AND **LAKE DALLAS** AROUND 620 PM CDT... OAK POINT AROUND 625 PM CDT... KRUGERVILLE... CROSS ROADS AND LAKEWOOD VILLAGE AROUND 630 PM CDT...





Sigma Sounding 3 hours prior to Denton Tornado



Public (a) and private (b) GNSS stations and private radiometer stations (X) within 250 km of Dallas-Ft. Worth.





GNSS slant delay gradients at Denton and Dallas, 6 Apr 2015



Thermodynamic variability at Flower Mound, 6 Apr 2015



Thermodynamics during stable conditions at Flower Mound



Final Comments

- Early stage convection is visible via microwave before it is seen by eye or radar
- Radiometer and GNSS provide crucial humidity data for high-impact local weather prediction
- Existing GNSS networks can provide valuable humidity field information for improved weather modeling and forecasting