NASA N-Pol data collection in MC3E and….

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November 2011 PMM Science Team meeting

Outline

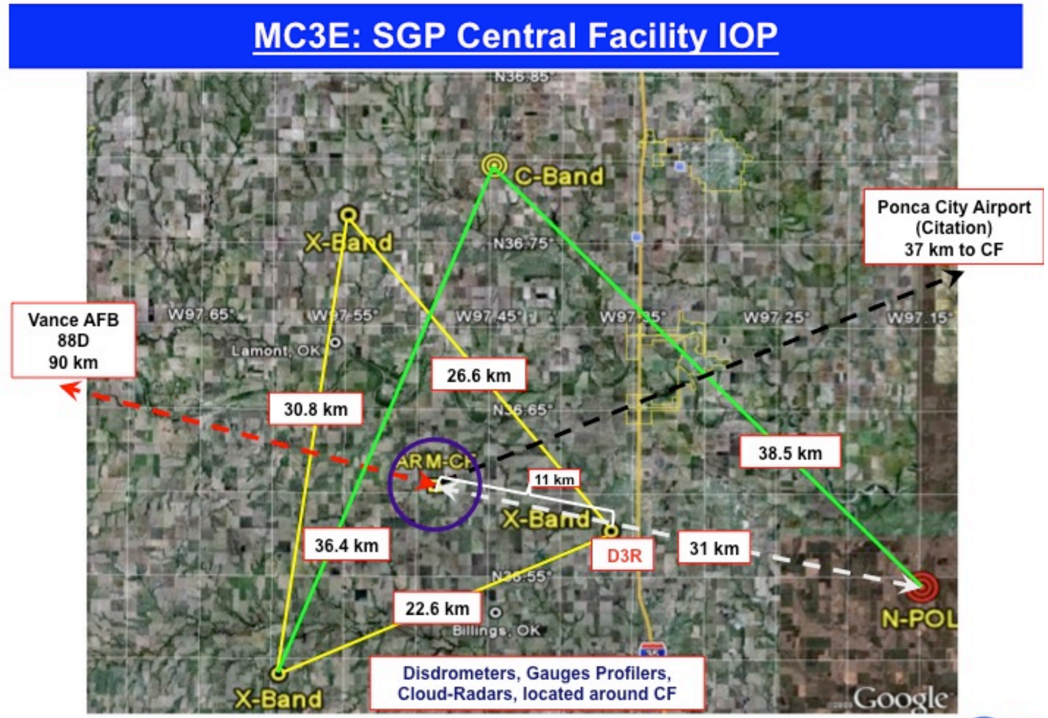
- NASA N-pol radar operation in MC3E
- Data quality based on polarimetric analysis
- Some data examples
- ER-2 overpass of the CSU-CHILL coverage area
- DYNAMO, shipboard operation of NASA/ TOGA radar

Highlights

- N-Pol deployed to north central Oklahoma to support the joint NASA-DOE MC3E project
- Operations went extremely well. N-Pol operated 24/7 from 22 April through 2 June
- Operations were continuous with the exception of a 4 day down period from 19-23 May
- Overall the operation was a success; a rich data set was collected ranging from tornadic supercells to MCSs
- Data to be used for numerical model comparison, algorithm development and validation, and storm kinematic and microphysical studies

MC3E N-Pol Scanning

Five basic scan sequences were used, each for different objectives/scenarios



Waiting for precipitation

Scan 0 – Low-level 360º PPIs, 10 min

No aircraft, precipitation in range

Scan 1 – 5-6 minute 90º or 120º PPI volumes ('near' and 'far' modes); include select RHI sweeps as appropriate

Aircraft, widespread precipitation (emphasis on vertical structure)

Scan 2 – 3 RHIs centered in the D3R radial (~1 min)

Both aircraft fly stacked legs along radial

Aircraft, isolated precipitation (emphasis on vertical structure)

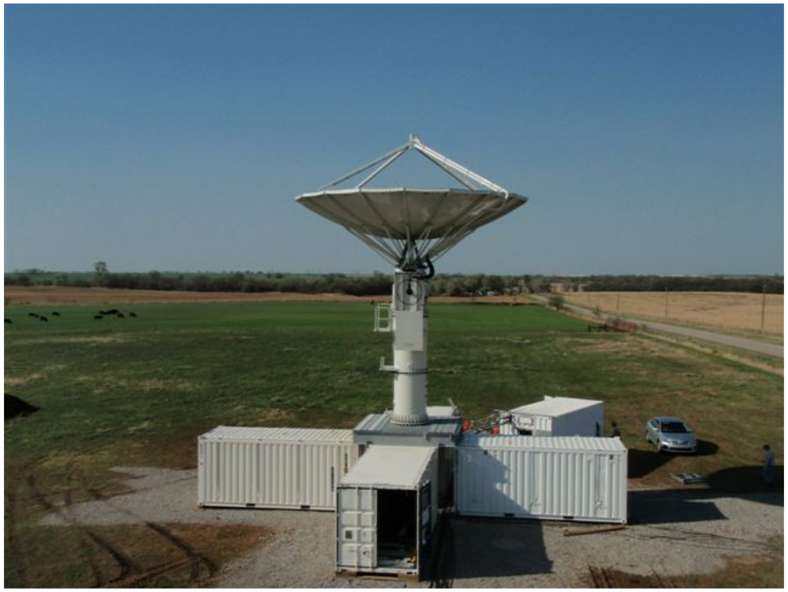
Scan 3 – 6 RHIs following aircraft (~2 min)

ER-2 overflies, Citation penetrates edges

Precipitation over gauge/disdrometer network - DSD variability

Scan 4 – Low-level PPI 90º sector, 1 RHI sweep to 20º, ~ 45 seconds

N-Pol in MC3E sporting its new center-fed parabolic antenna and other upgrades



N-Pol during the checkout period at the CSU-CHILL Facility, October 2011 through early March 2011

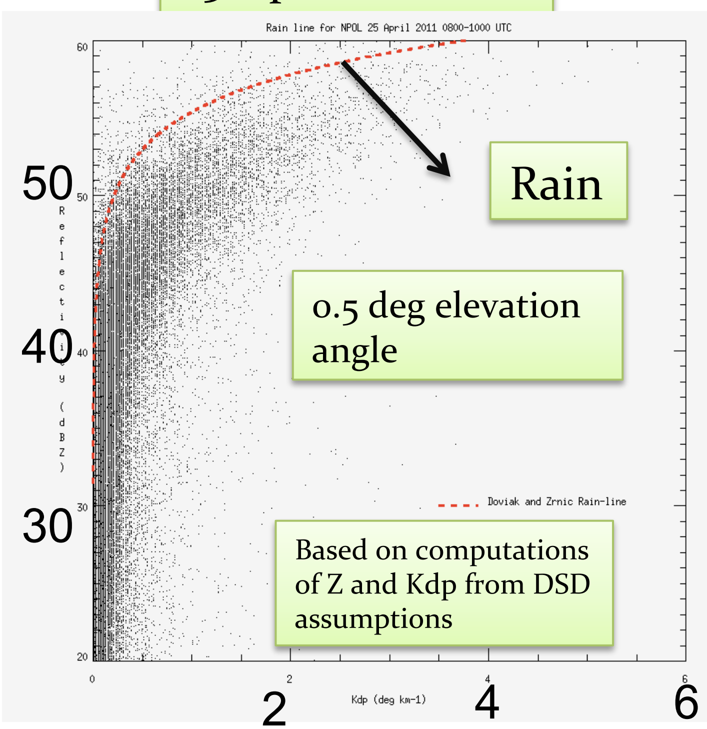
N-Pol quality control….distribution between reflectivity and K_{dp} should be well behaved in rain

$$K_{dp} \propto C\lambda^{-1}\int D^3(1-r)N(D)dD$$

$$Z \propto \int D^6 N(D)dD$$

K_{dp} proportional to mass content and mass-weighted oblateness ratio

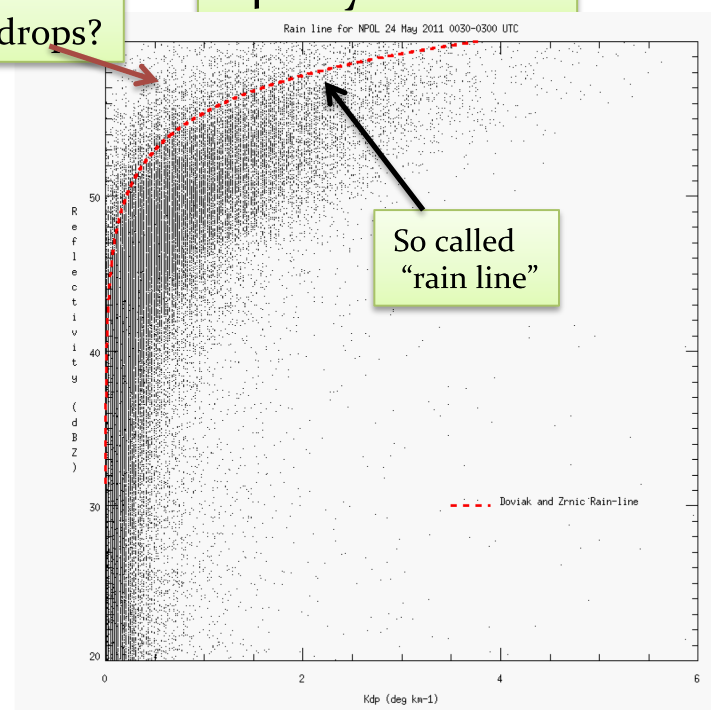
25 April 2011 case



K_{dp} deg/km

Rain/hail mix or large drops?

24 May 2011 case



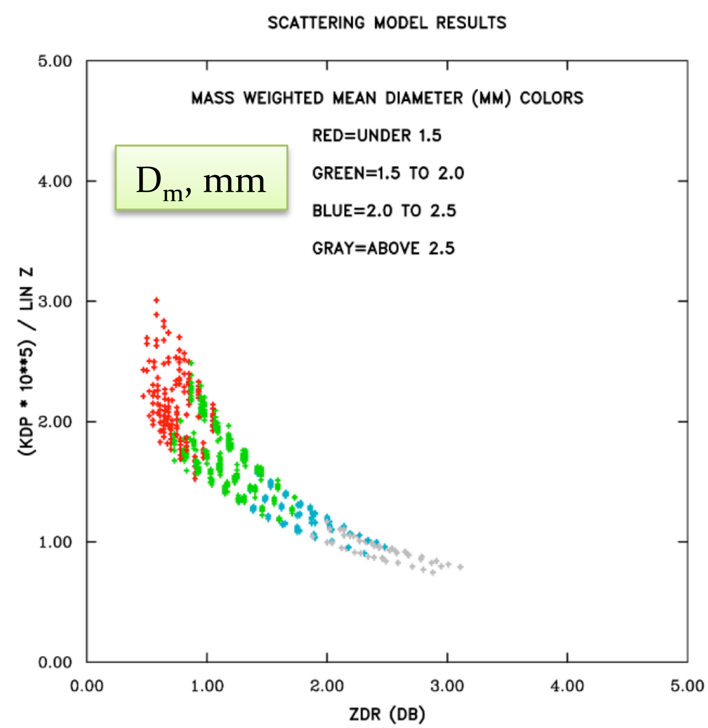
Another look at N-Pol data quality….

Gorgucci et al. (2006, JTECH) showed that a parameter space formed by K_{dp} / Z vs. Z_{dr} was useful for characterizing the shapes of raindrops.

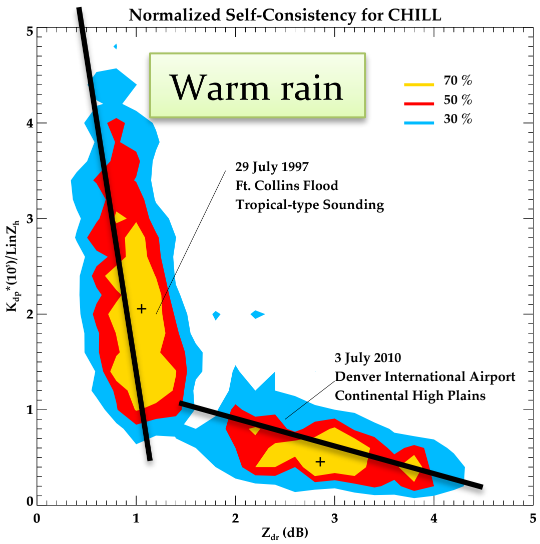
Figure on the right shows results of scattering simulations for various **Gamma DSD's** with mean diameters (D_m) ranging from 1.2 to 3.5 mm. Variations in D_m are evident as well-defined curving paths in K_{dp}/Z vs. Z_{dr} space.

This technique can also be used to distinguish convective rain produced by warm rain environments (high freezing level and active drop coalescence processes, smaller drop sizes) from rain derived from the melting of graupel and hail (larger drop sizes), as distinguished by K_{dp}/ Z and Z_{dr} pairs.

For a given rainfall regime, behavior of K_{dp}/Z and Z_{dr} pairs in actual data can be used to evaluate data quality. N-Pol data were evaluated in this manner.

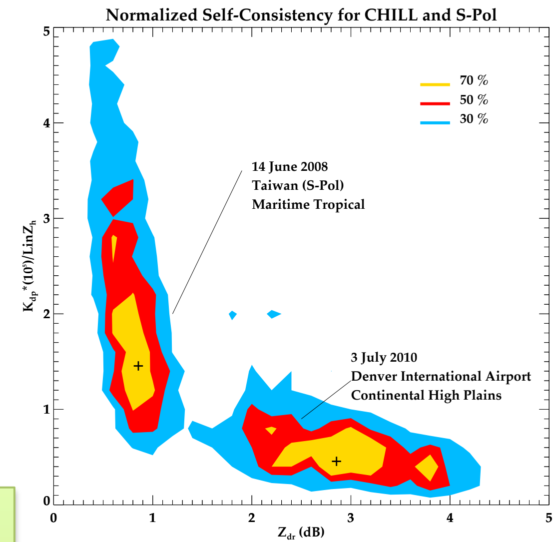


Normalized density of points expressed as a percentage



Colorado and “tropical” events

Ice based

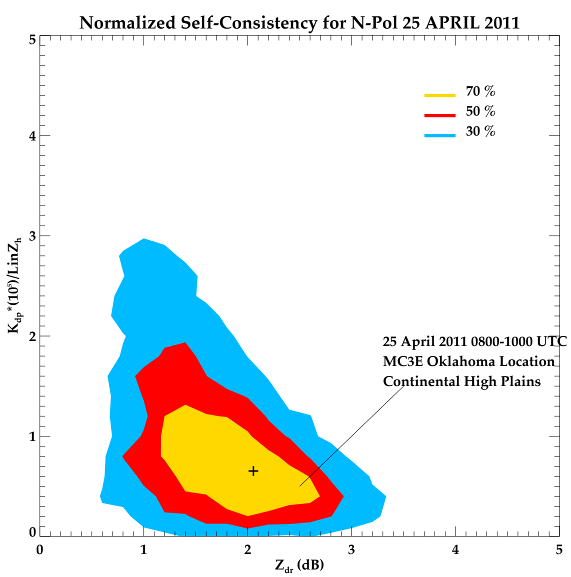


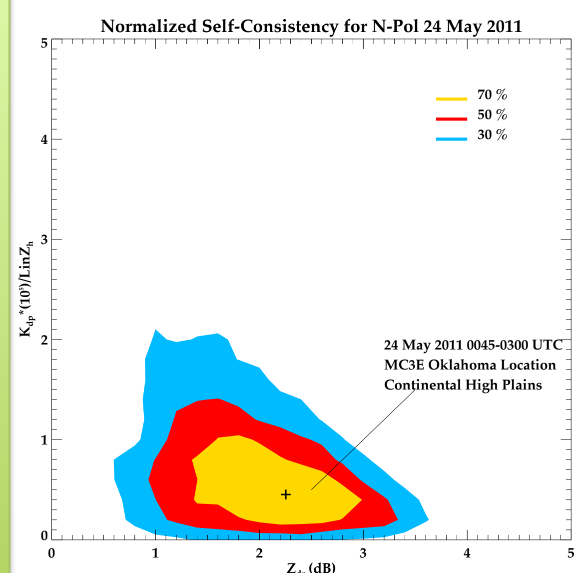
N-Pol in Oklahoma

Results consistent with active coalescence growth and ice-based precipitation.

Resulting from higher moisture contents, higher freezing level, collisional breakup, etc.

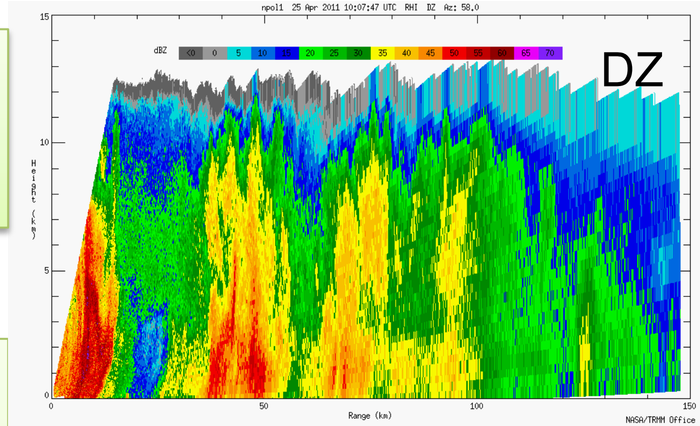
N-Pol data are clearly going to help us better understand DSD variability and the physics leading to the variability.

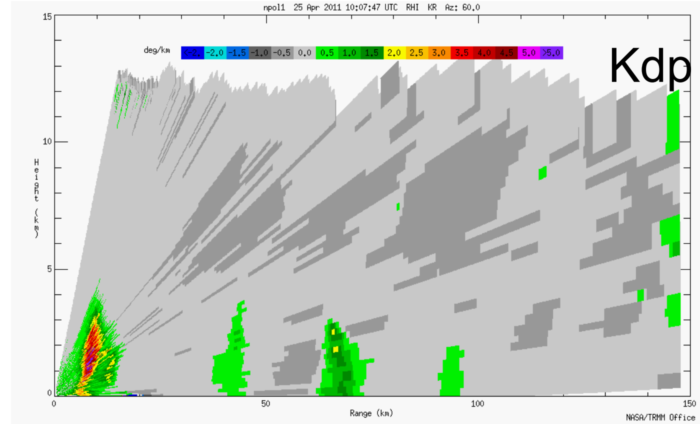


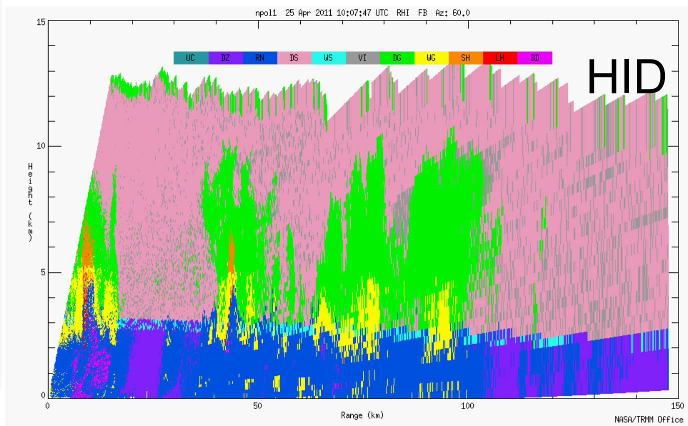


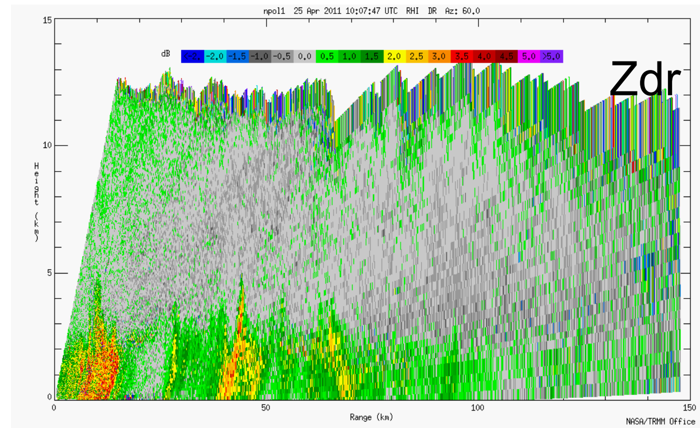
Some data examples

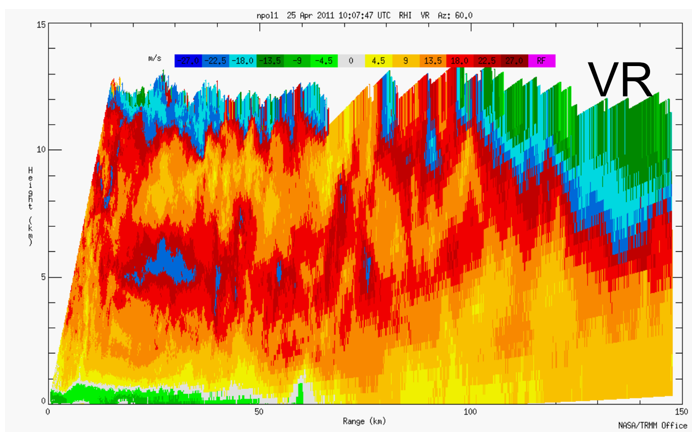
25 April 2011: Multiple Convective Cores

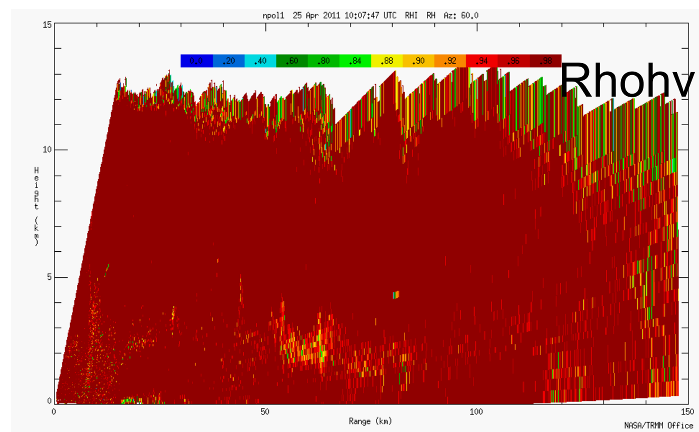






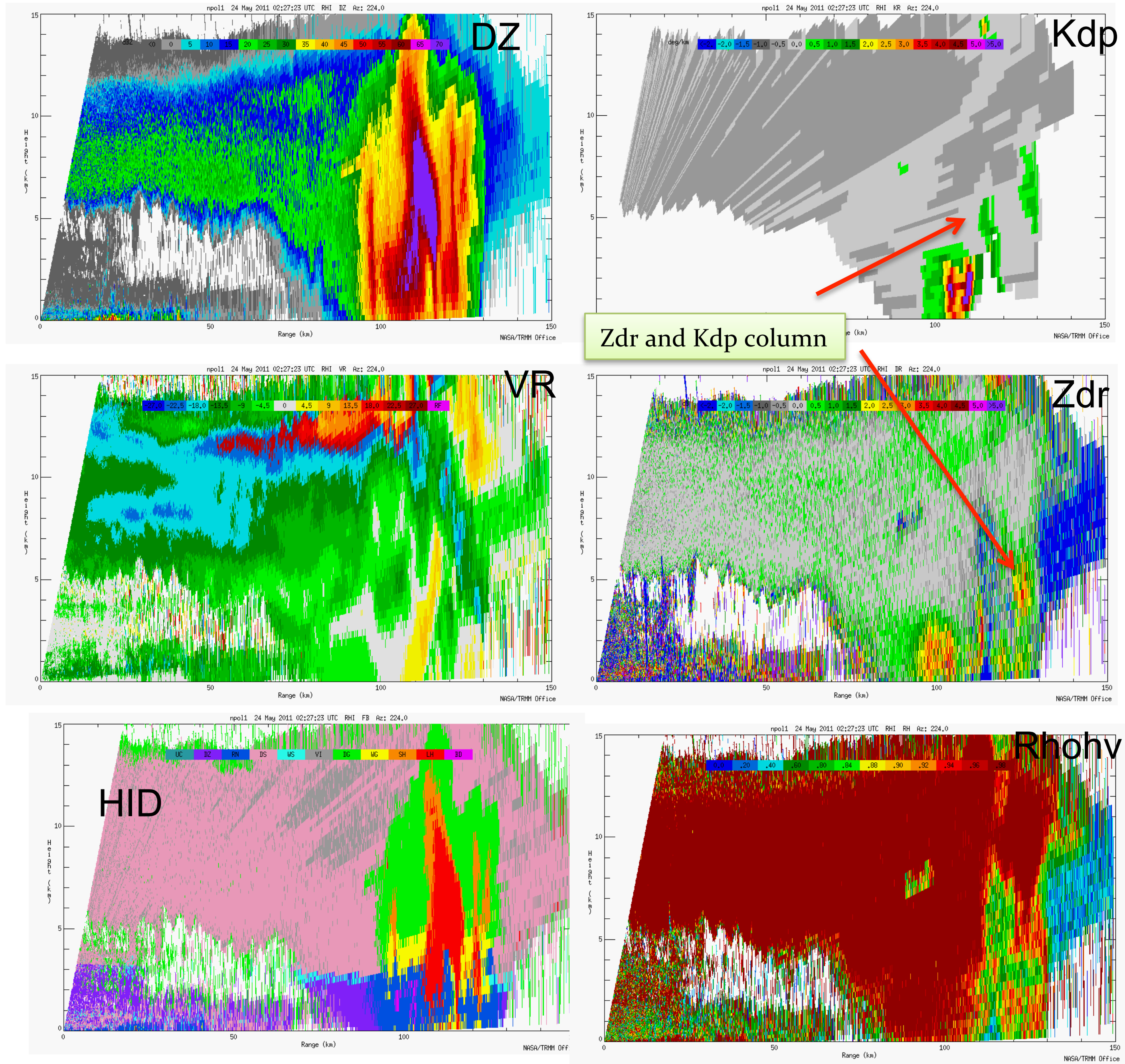






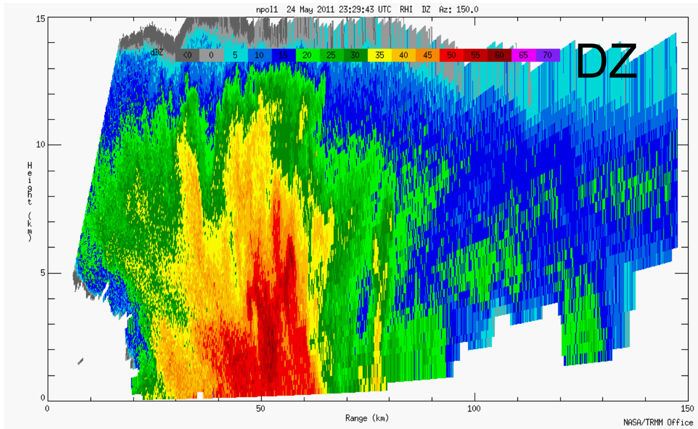
24 May 2011 Severe storm

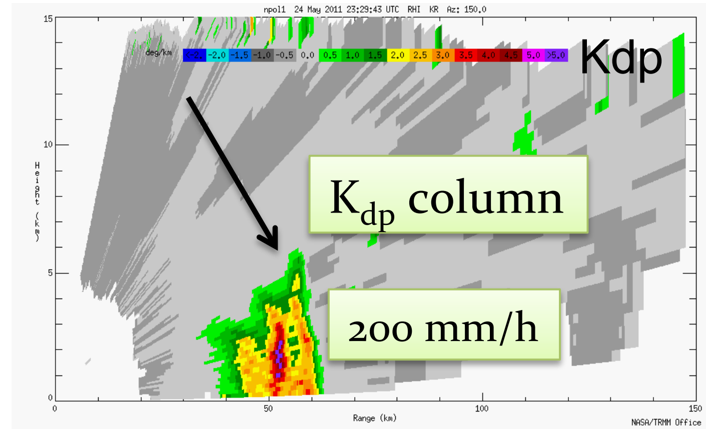
- 70+ dBZ up to 10 km
- Large (+5 º/km) K_{dp} at the surface
- Signature of large hail (in RH and ZDR)
- Strong tilted updraft and divergence aloft
- Data of high quality at significant ranges

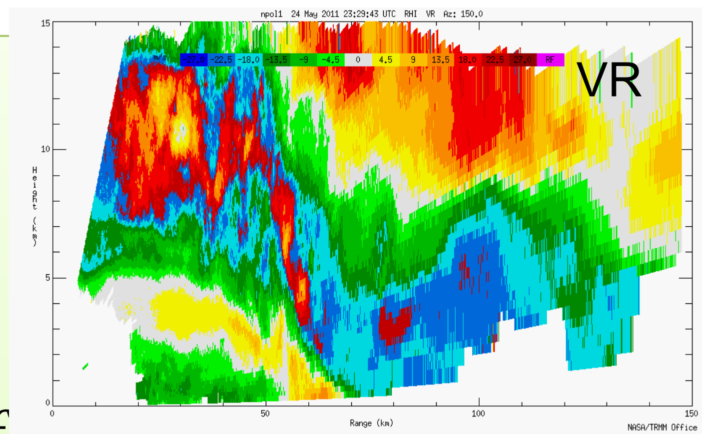


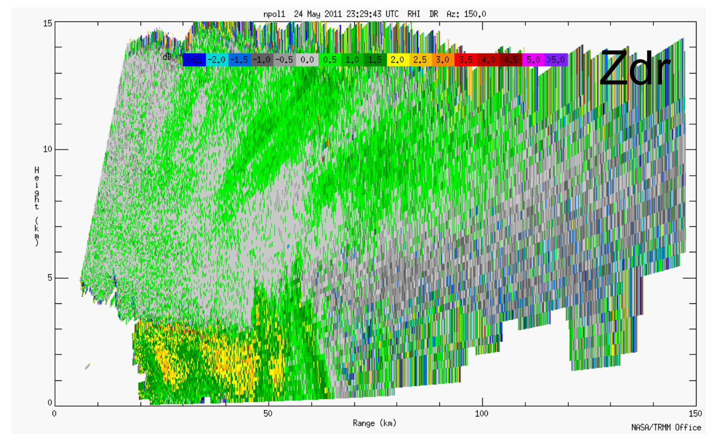
24 May 2011 Strong core

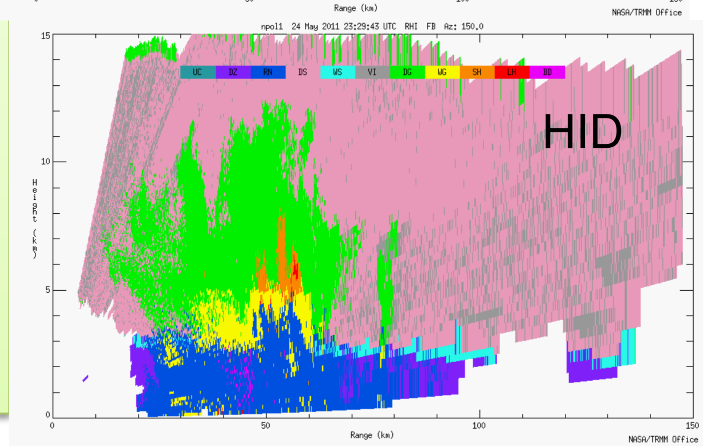
- 50 dBZ up to 8 km
- Large (+5 º/km) K_{dp} in the core
- Large region of wet graupel and small hail
- Strong tilted updraft and divergence aloft

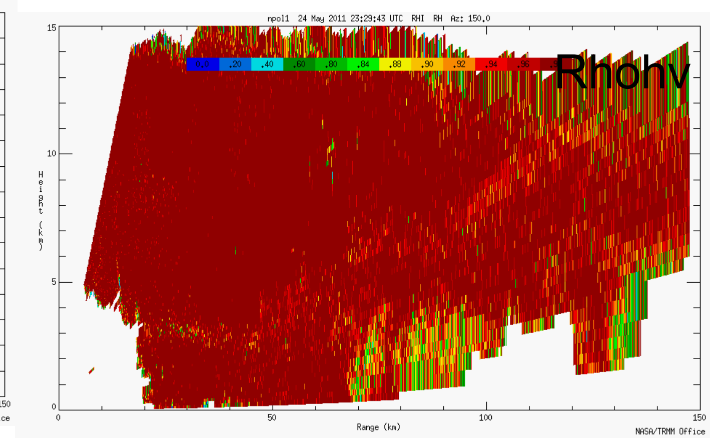




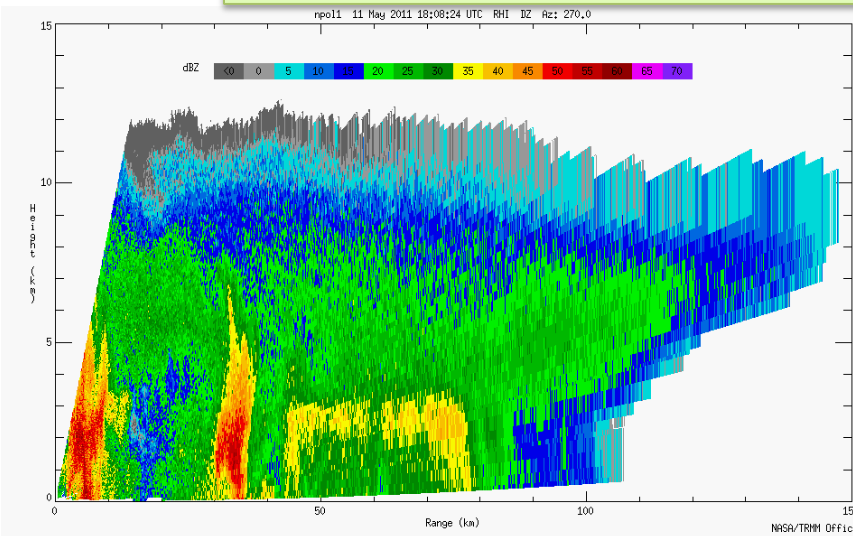


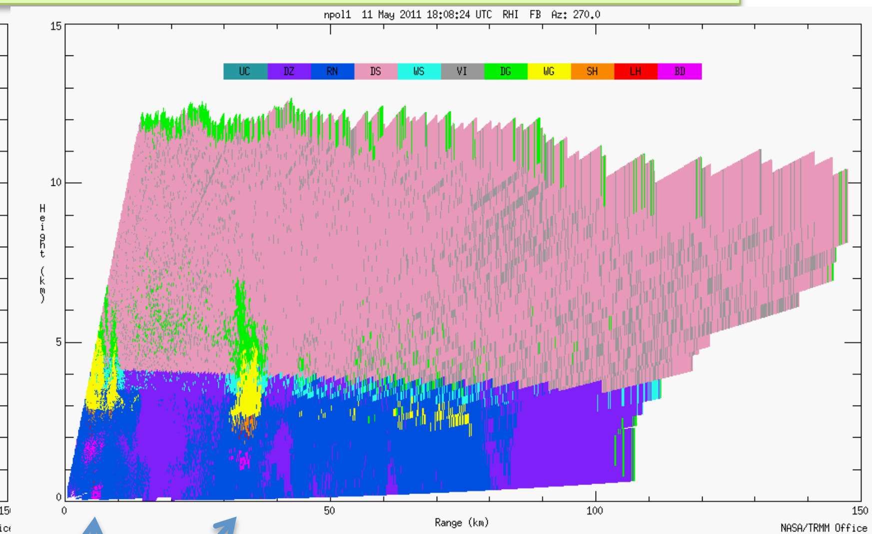


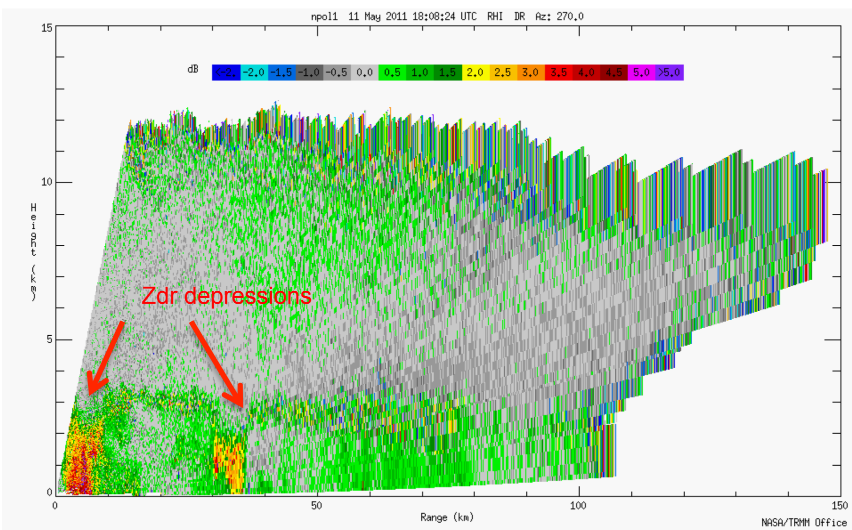




Big Drop example, ~1808 UTC, RHI 270 deg, N-Pol observations







Peak Z_{dr} is 5.75 dB

Big drops, motivated a new classification in the HID algorithm. Melting of hail and graupel, followed by coalescence.

Big drops category: 1.0 < KD < 3.5, rhohv > 0.98, Zdr > 2.5, and 50.0 < DZ < 65

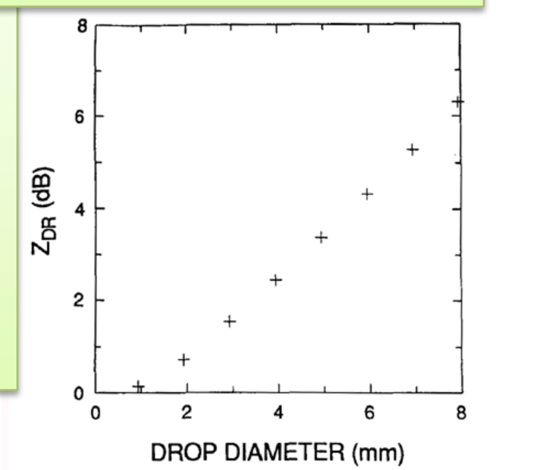
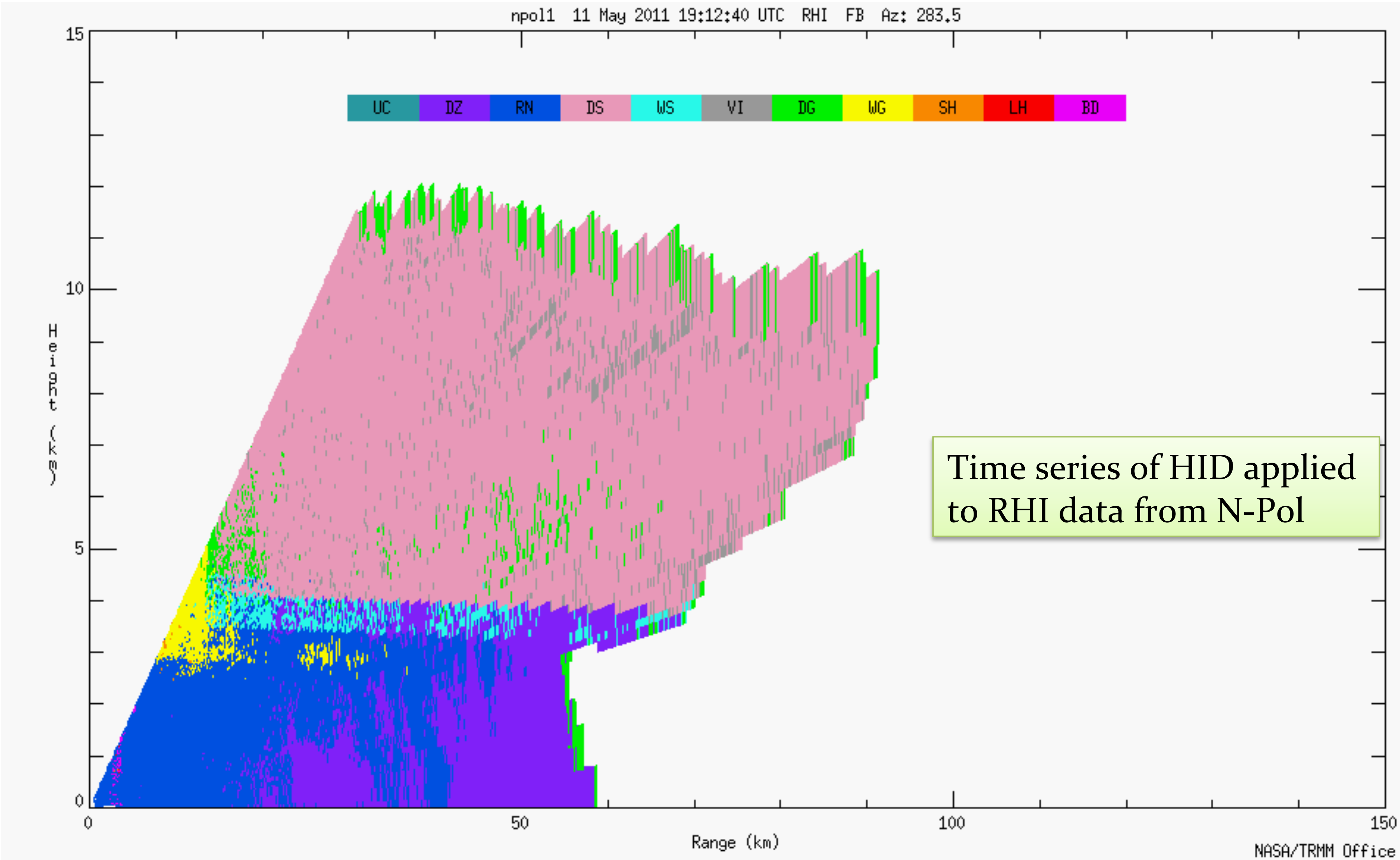
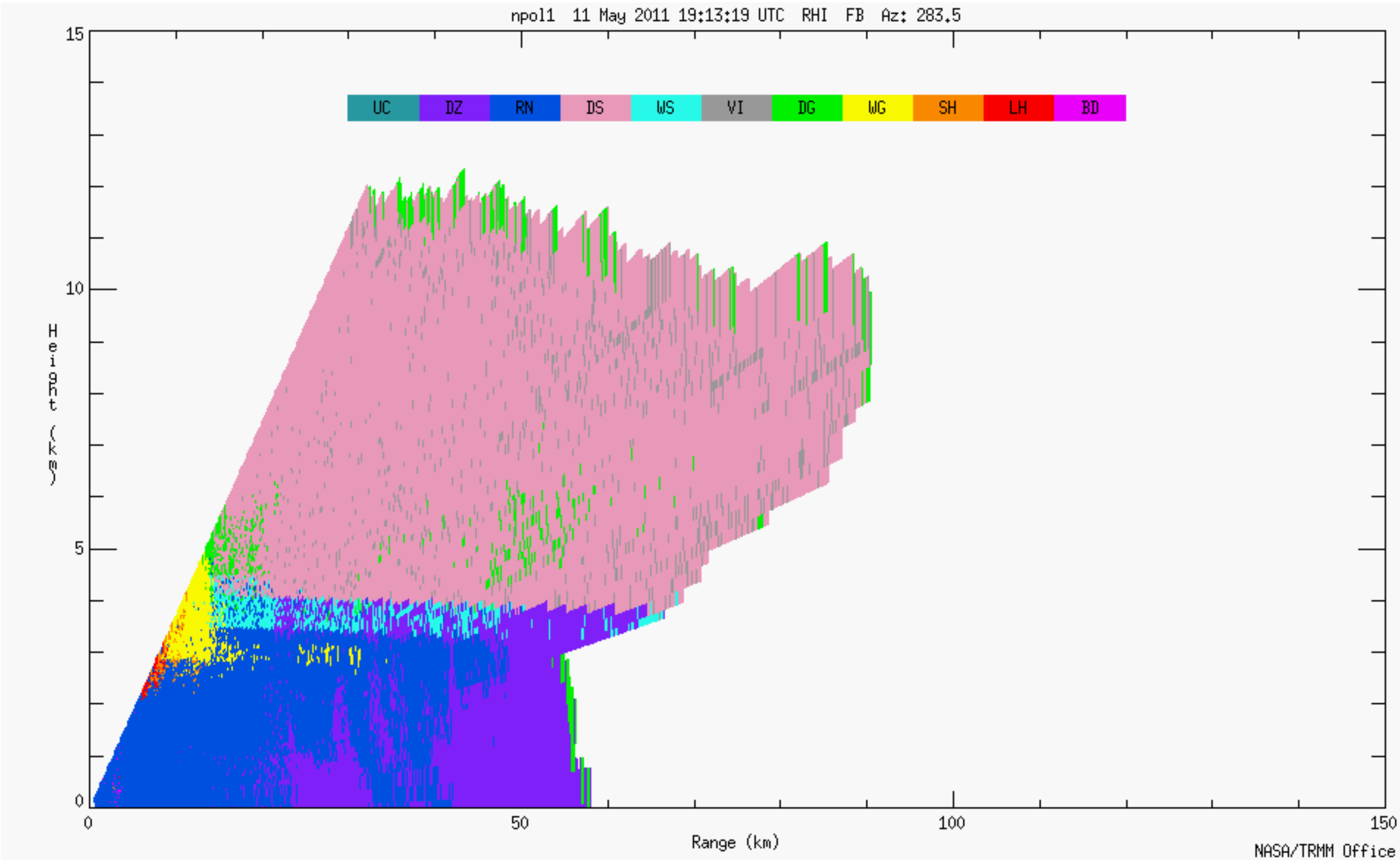


Fig. 1. Calculations of Z_{DR} in decibels as a function of drop diameter for the drop-size shape relationship of Beard and Chuang (1987). Calculations use the scattering theory of Gans (1912).

HID – Fallout of hail melting into big drops 1912-1921, RHI 283.5 deg



Time series of HID applied to RHI data from N-Pol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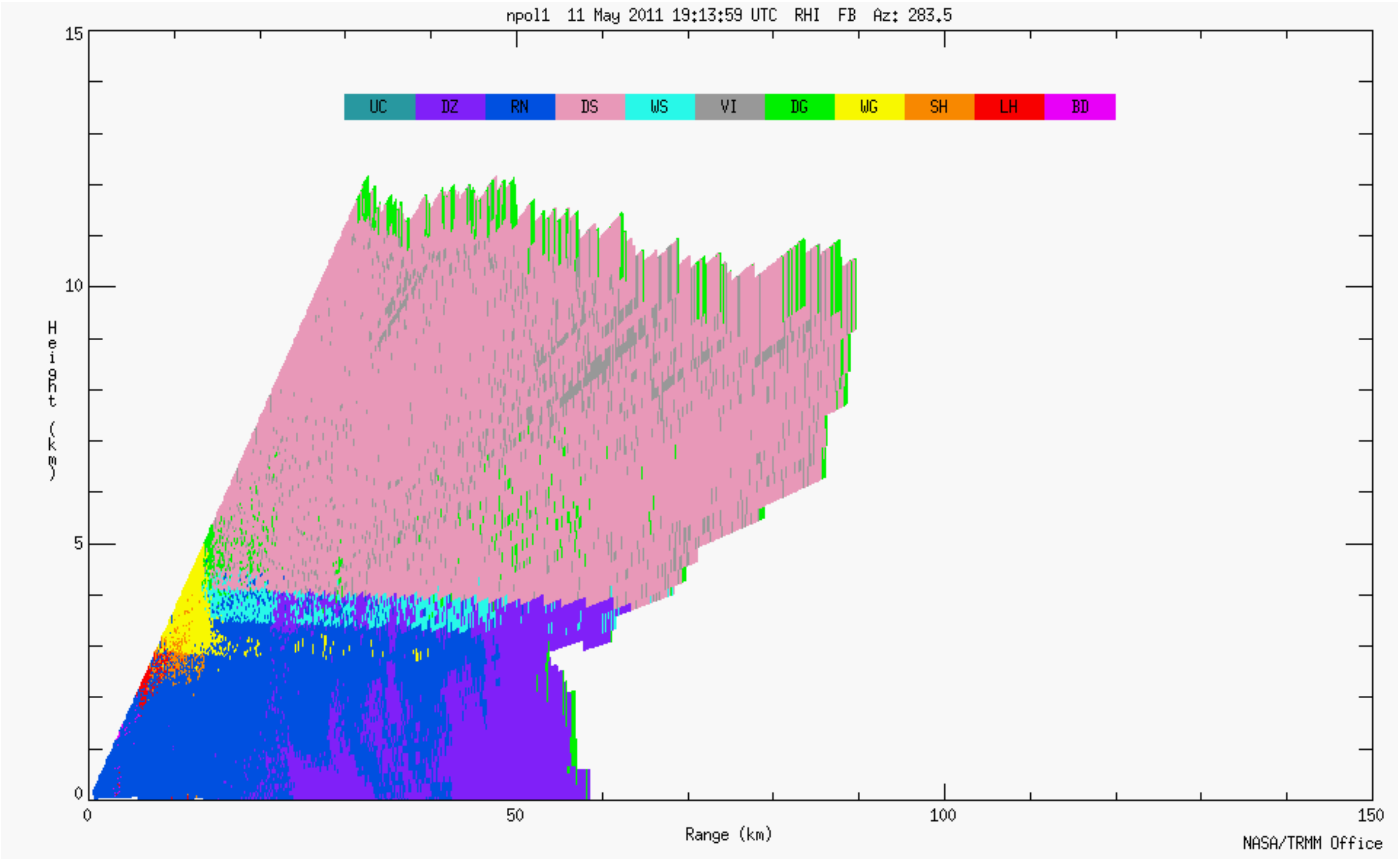
NASA/TRMM Office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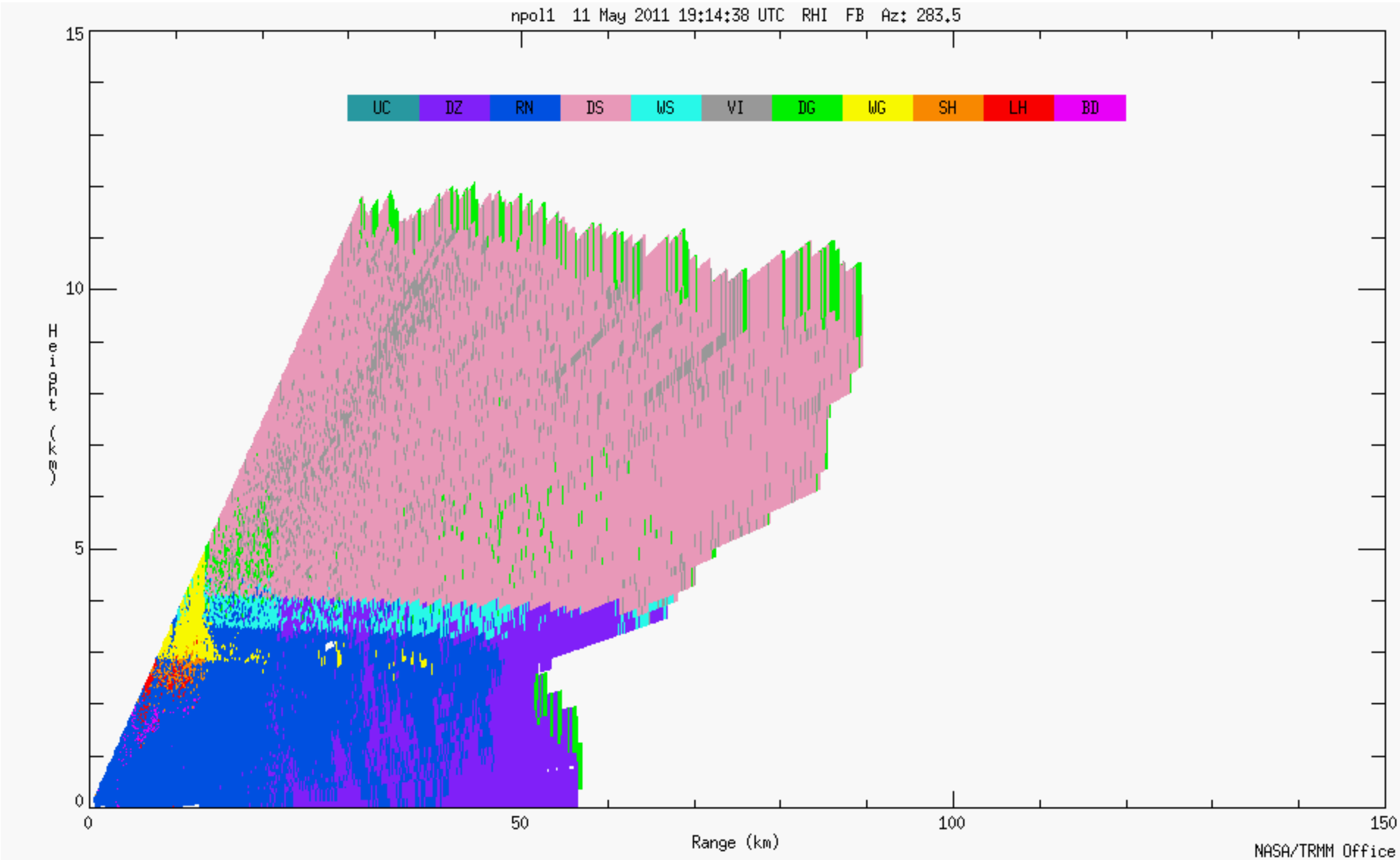
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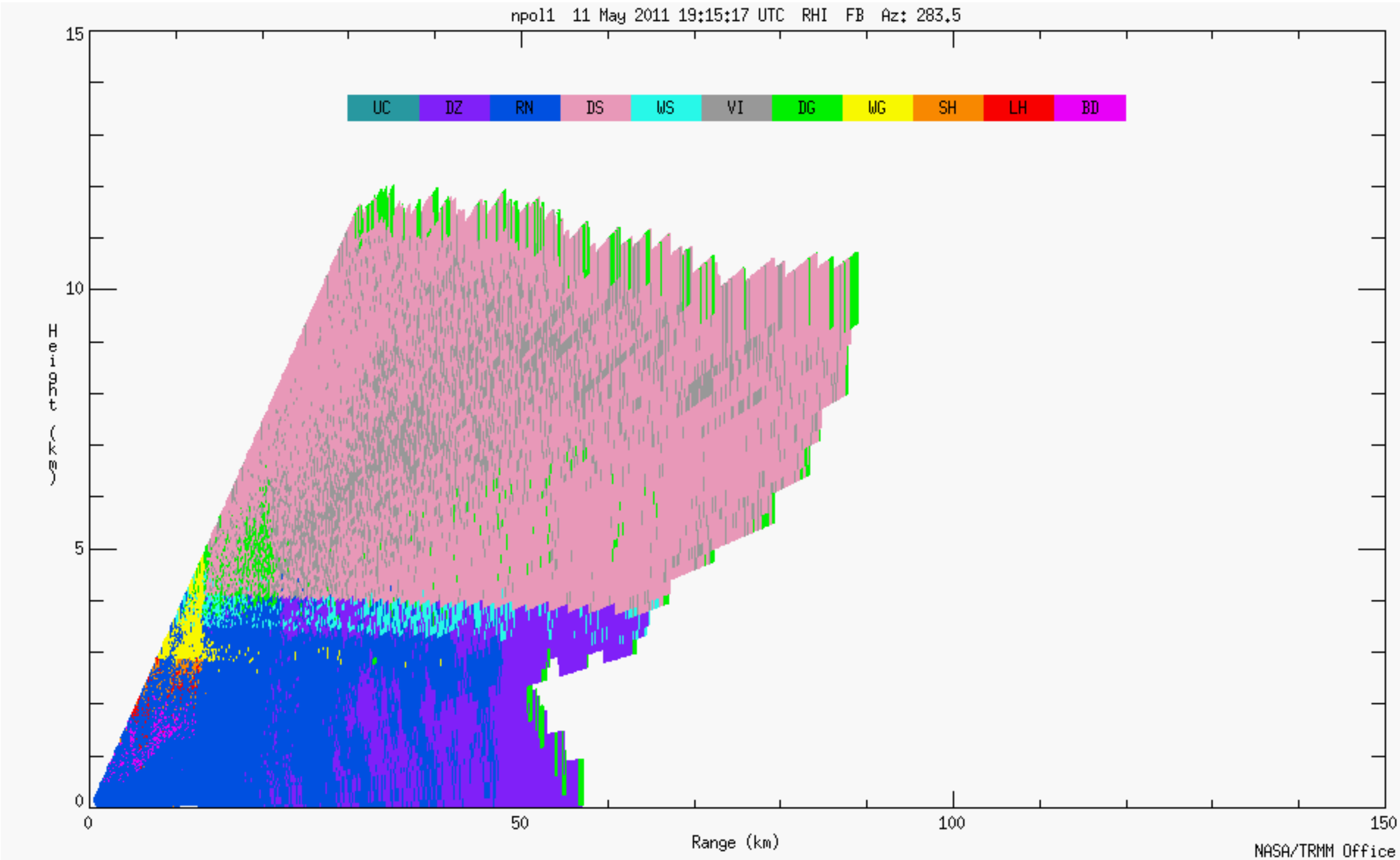
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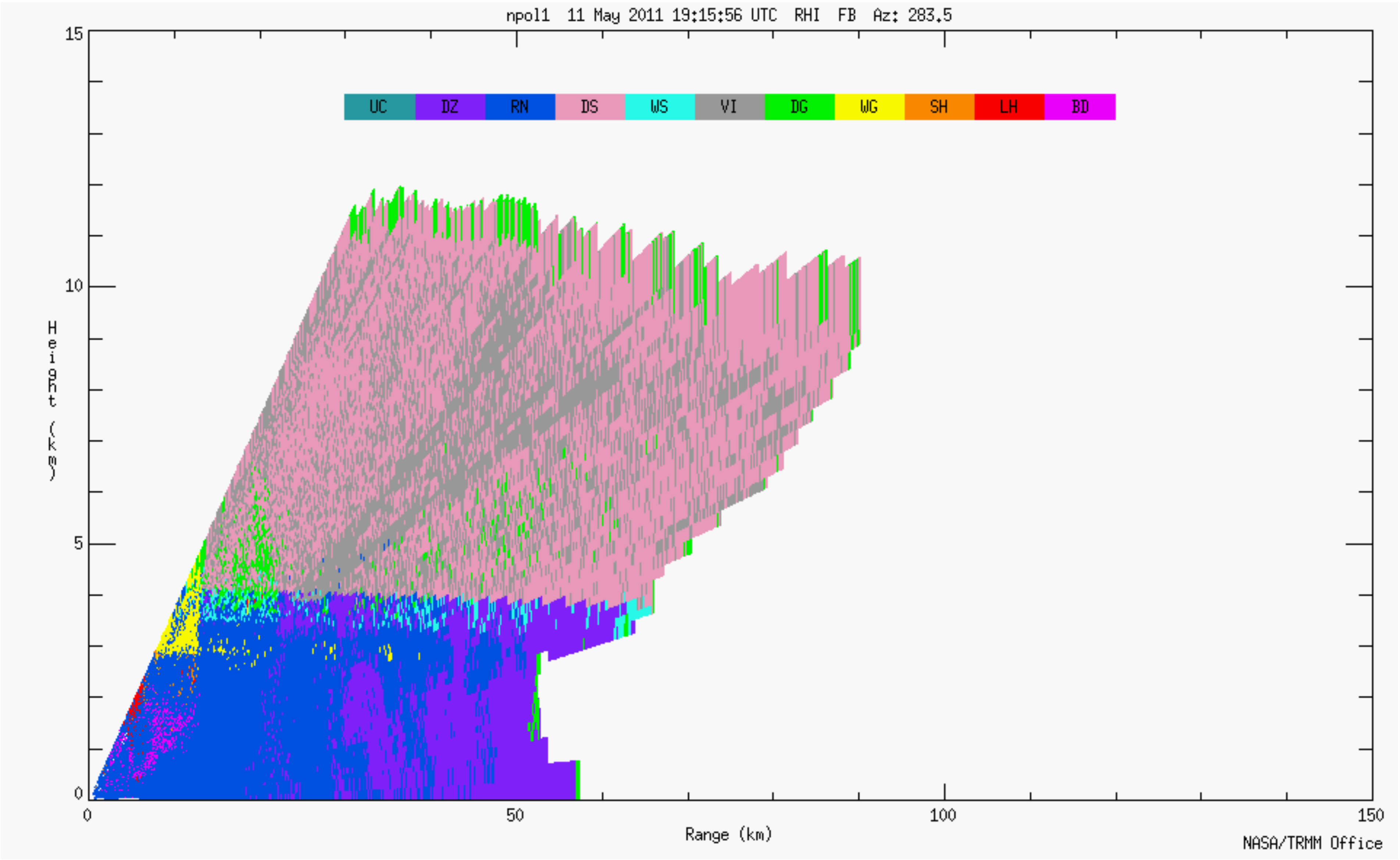
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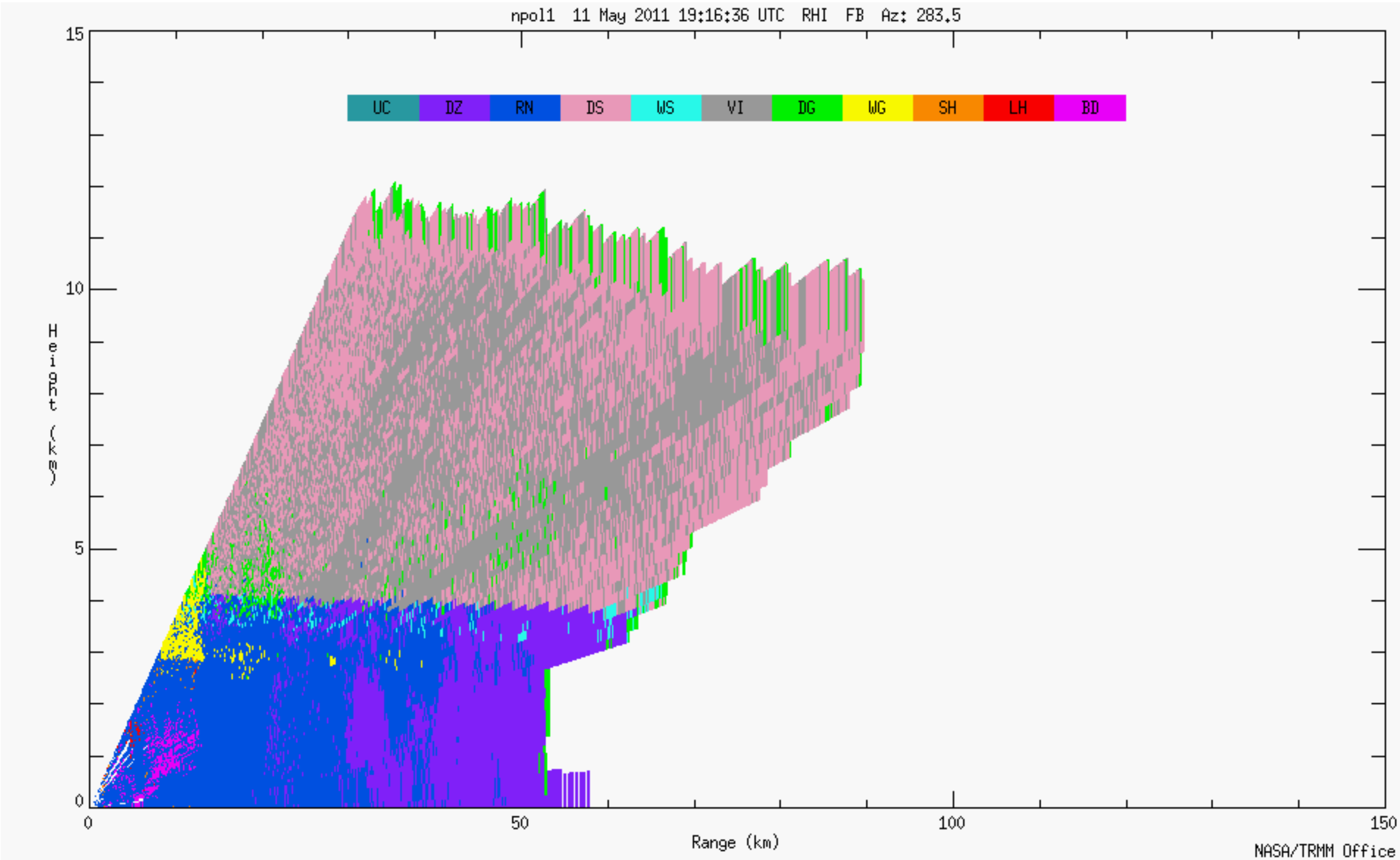
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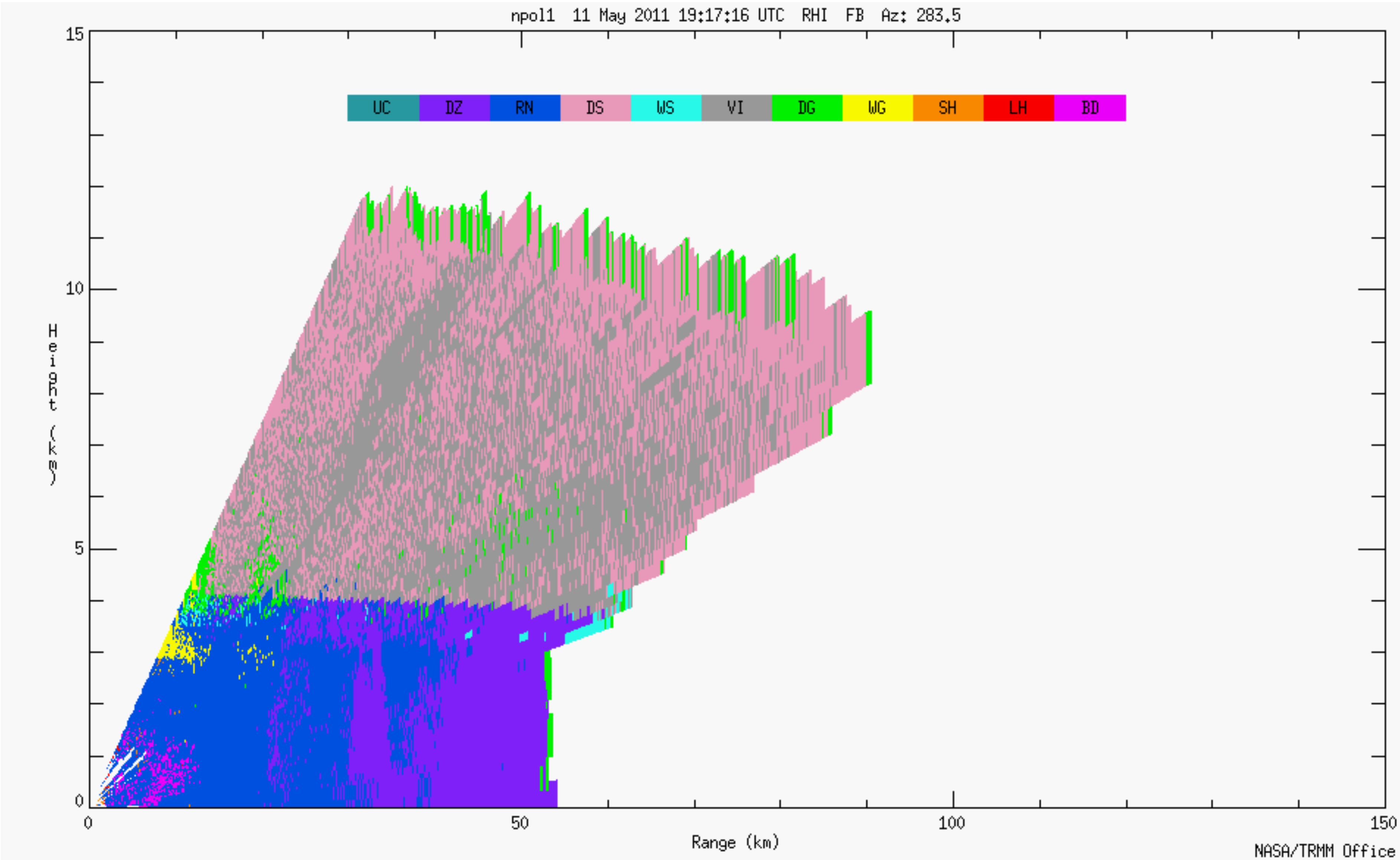
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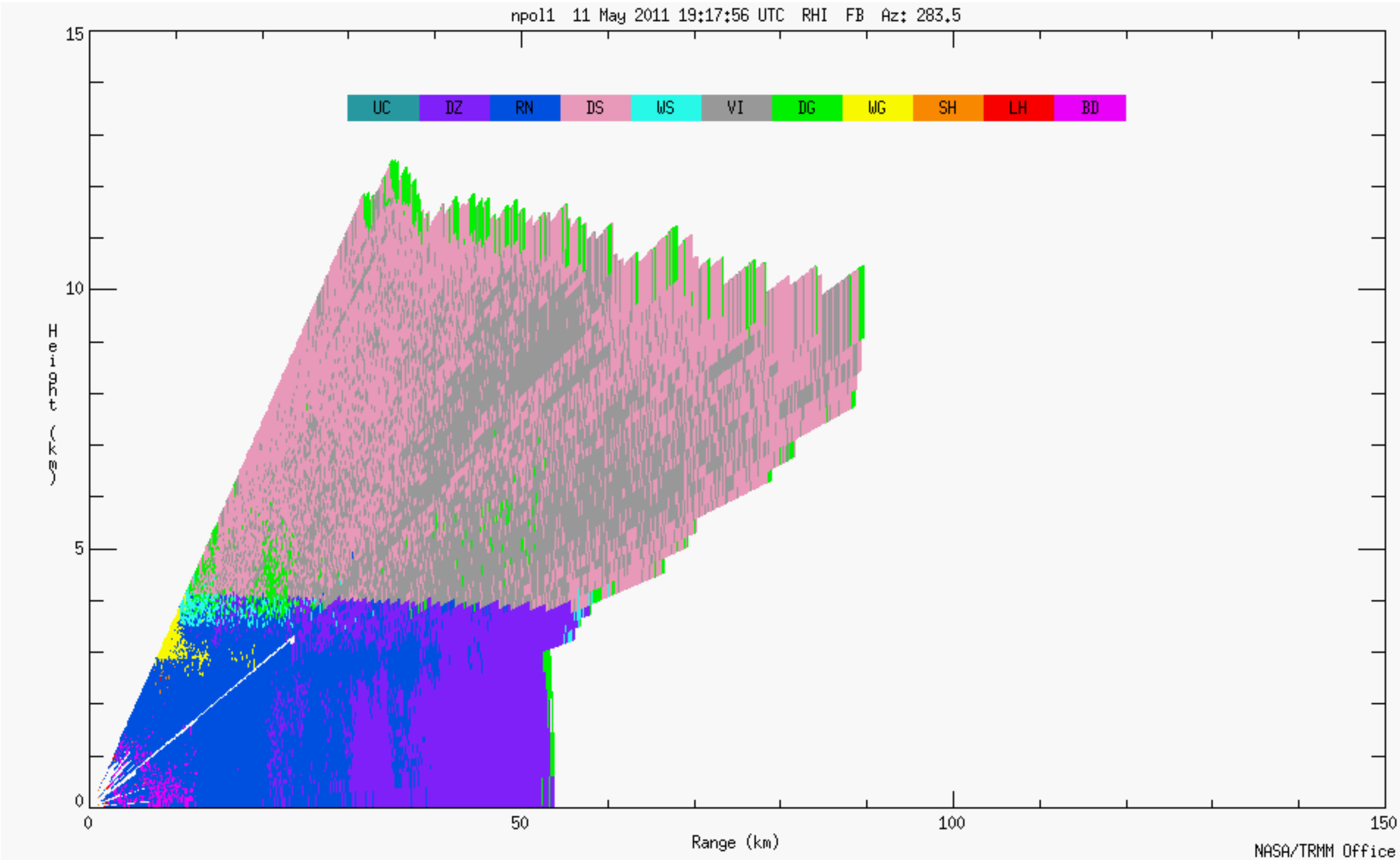
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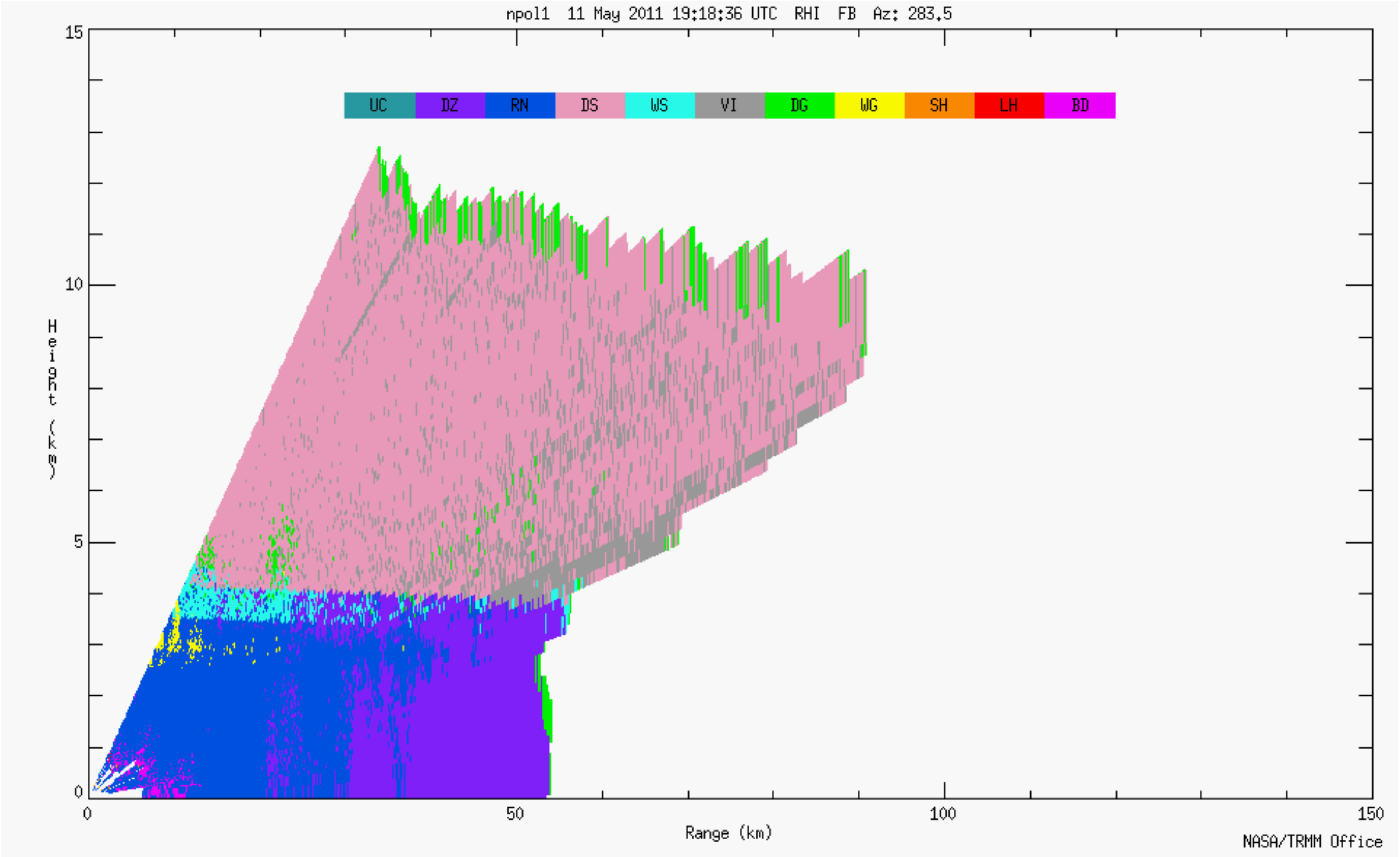
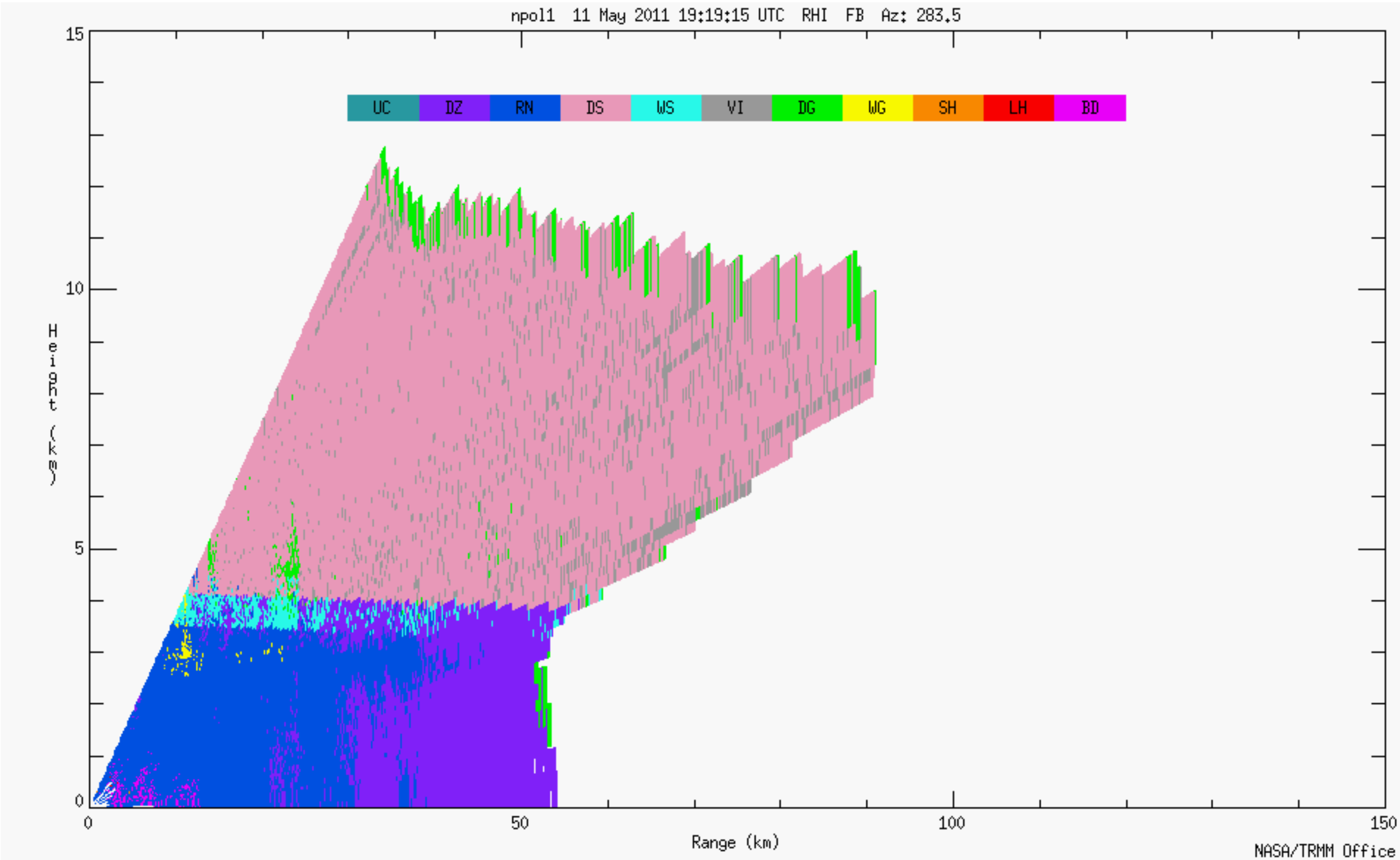
HID – Fallout of hail melting into big drops 1912-1921, RHI 283.5 deg

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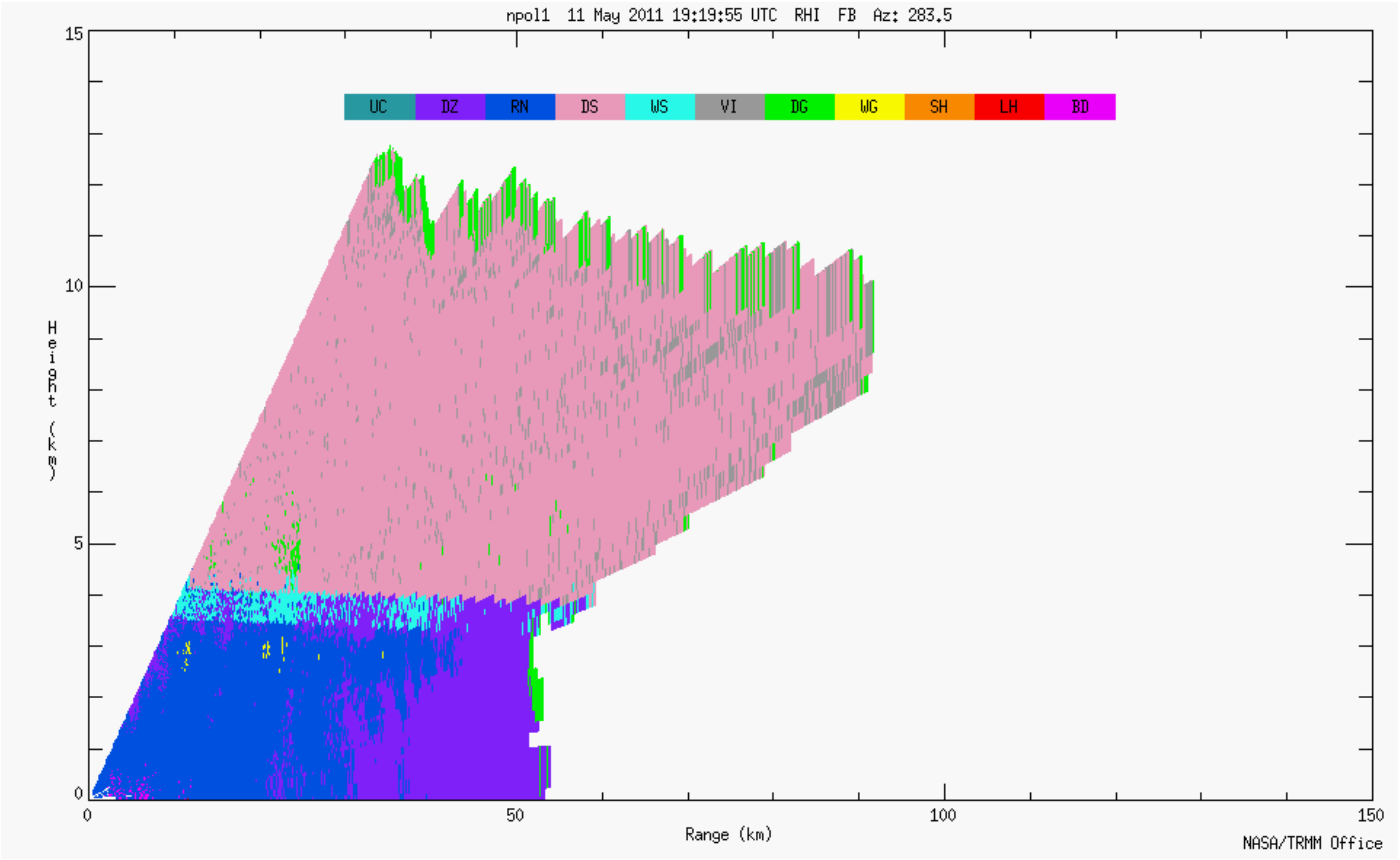
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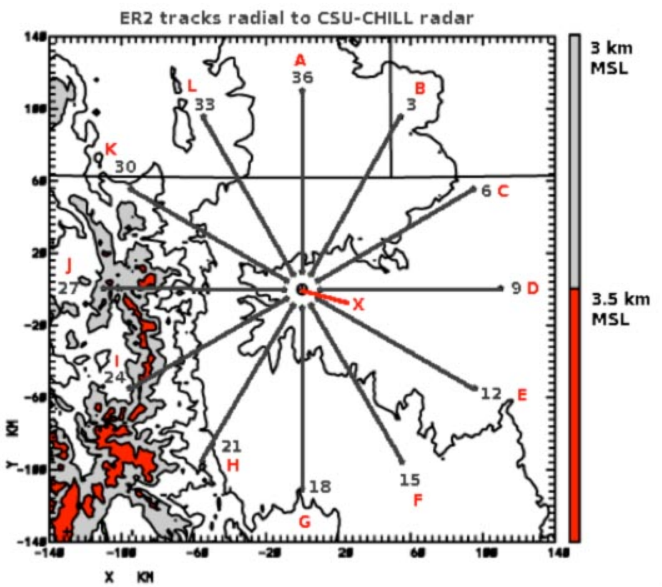
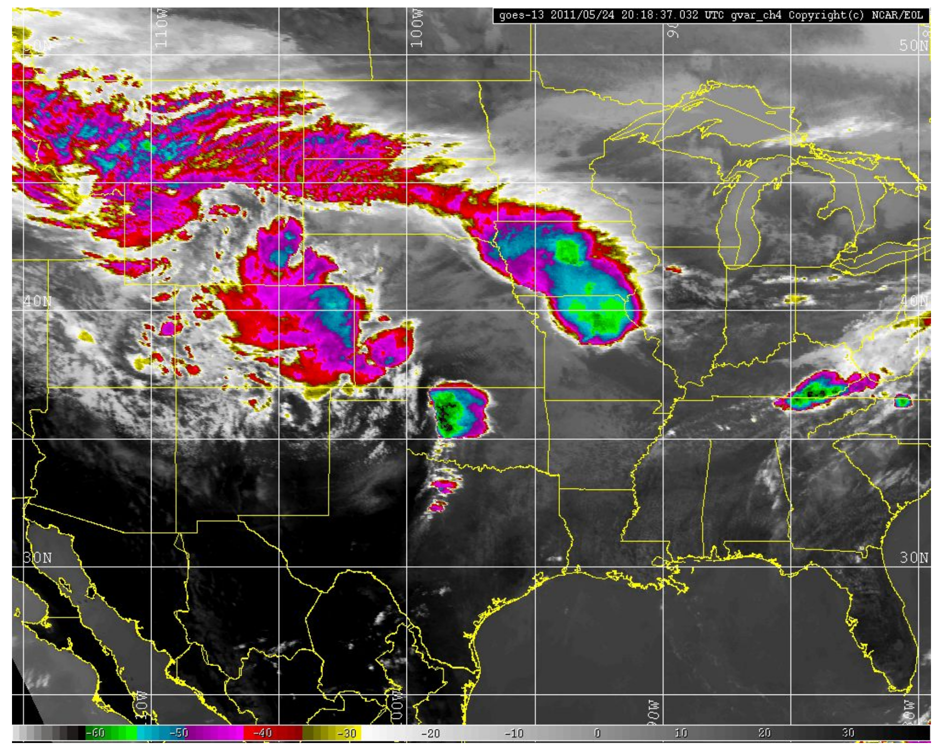


Pre-set radials for ER-2 coordination with CSU-CHILL

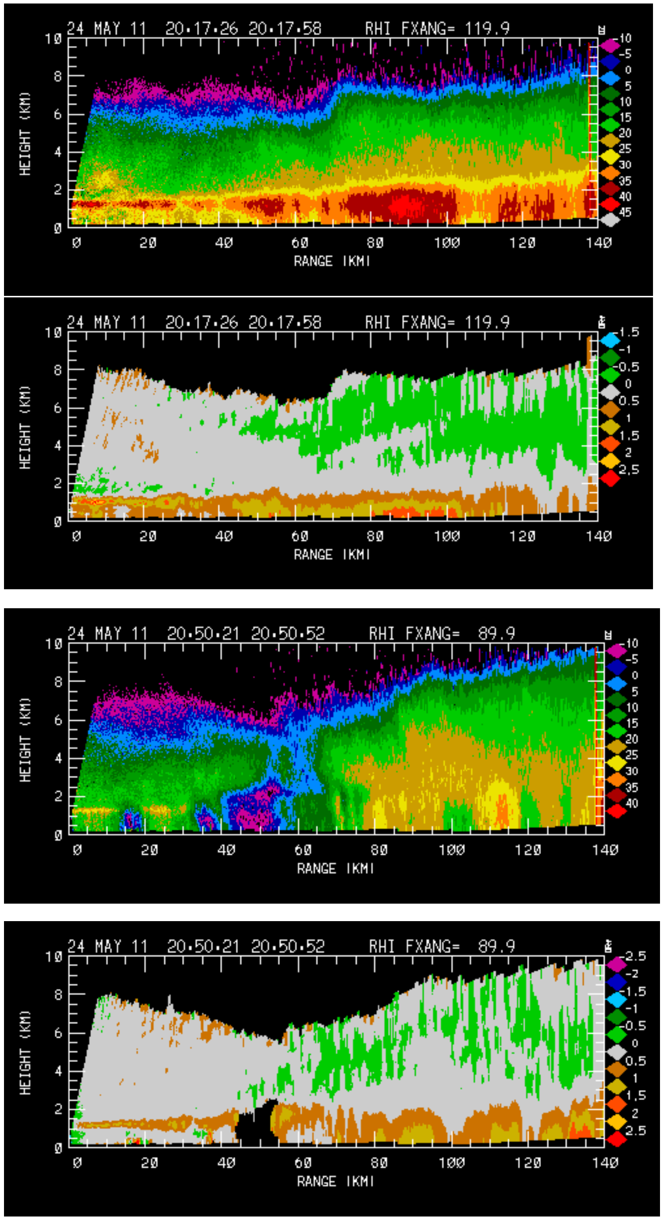


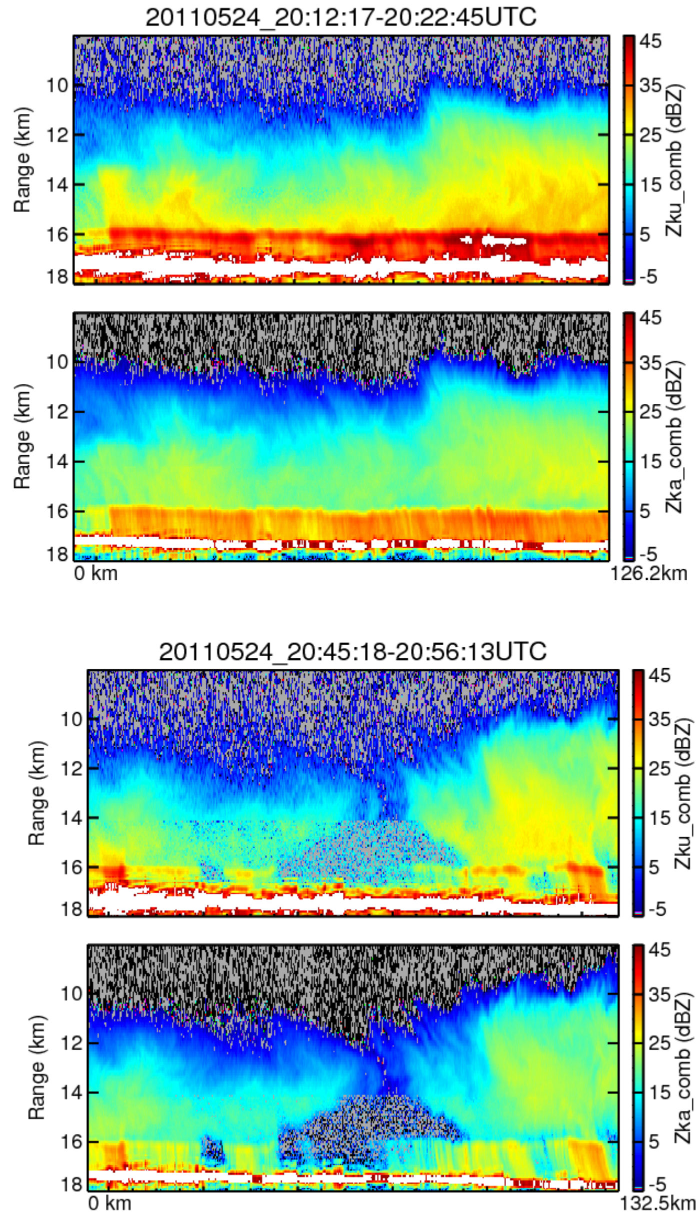
ER-2 passes around CSU-CHILL radar
24 May 2011

Provided opportunity to sample areas with extensive, long lasting melting bright bands

Help with determining algorithm performance in resolving microphysics of the melting region

HIWRAP Coordination with the CSU-CHILL Radar





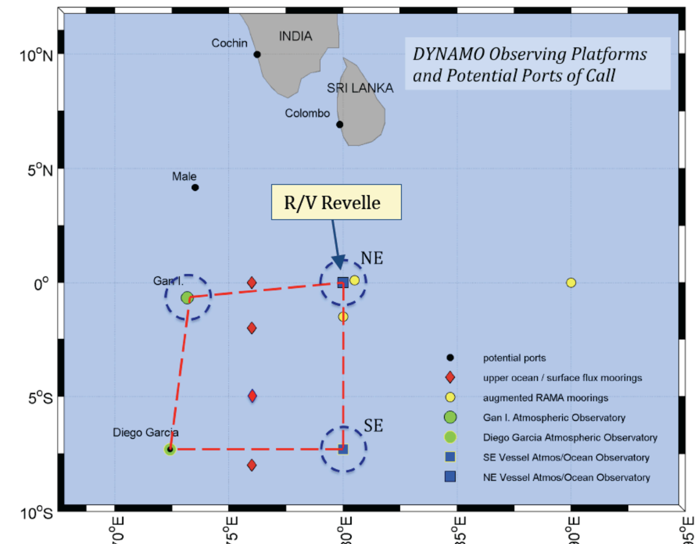
ER-2 data courtesy G. Heymsfield/L. Tian

Higher vertical resolution of HIWRAP compared to CHILL is readily apparent.

Case represents an excellent opportunity for a multi-frequency study of an upslope rain/snow event.

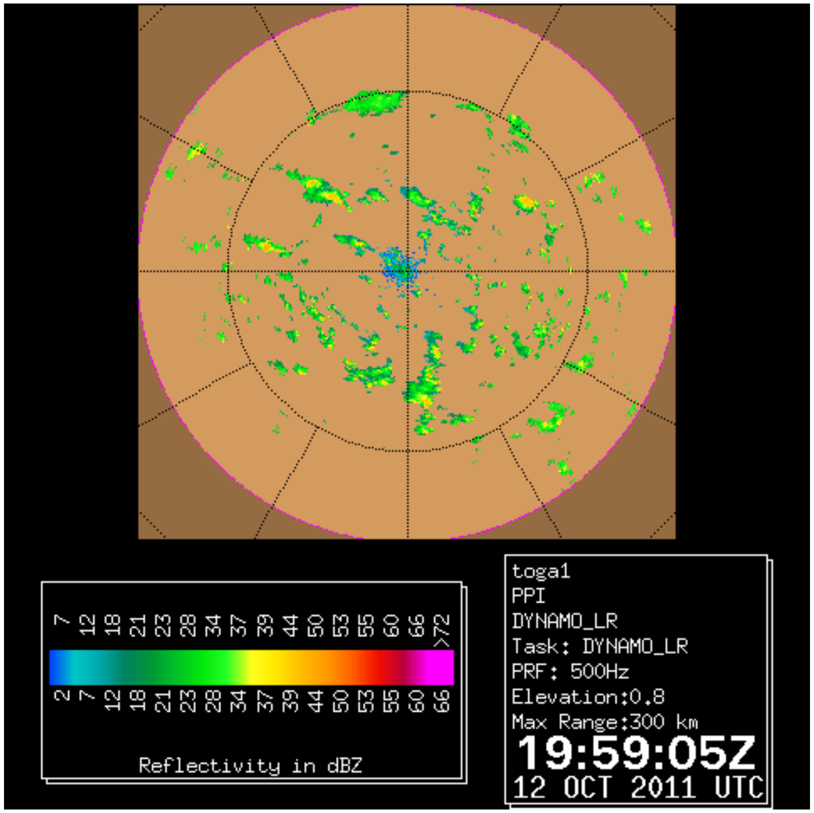
DYNAMO—DYNAmics of the MJO
Shipboard operation of the NASA/TOGA radar

Photo courtesy of T. Lang

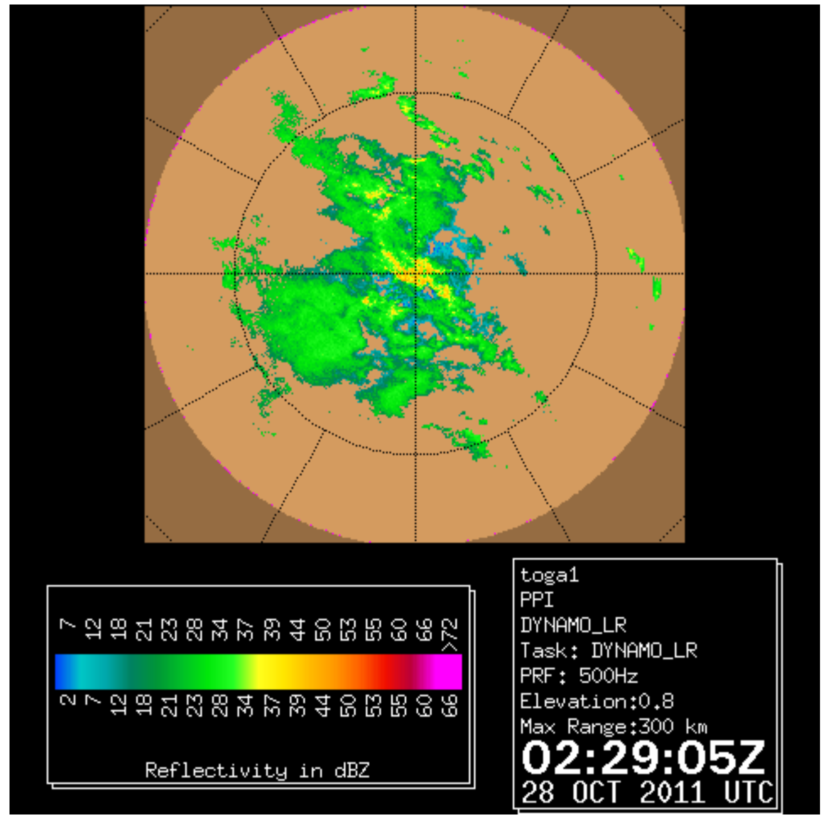


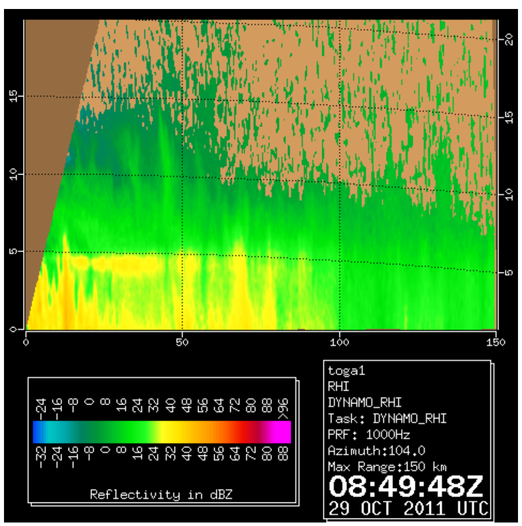
Will be used for MeghaTropiques ground validation

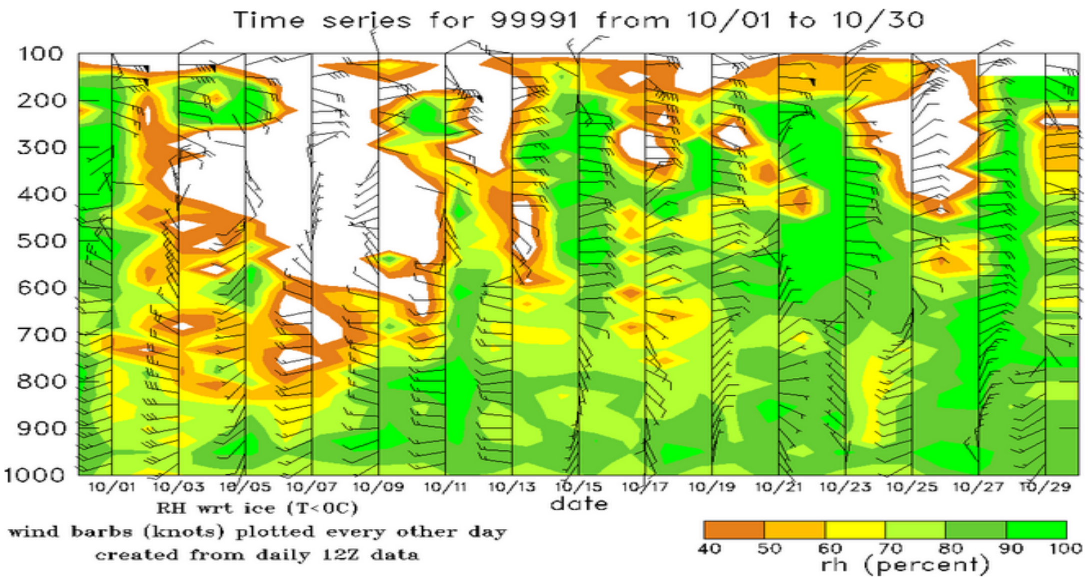
Special thanks to NASA and especially to John Gerlach, Michael Watson, Nathan Gears and Gary King



7.5 inches recorded on the Revelle on 28 October

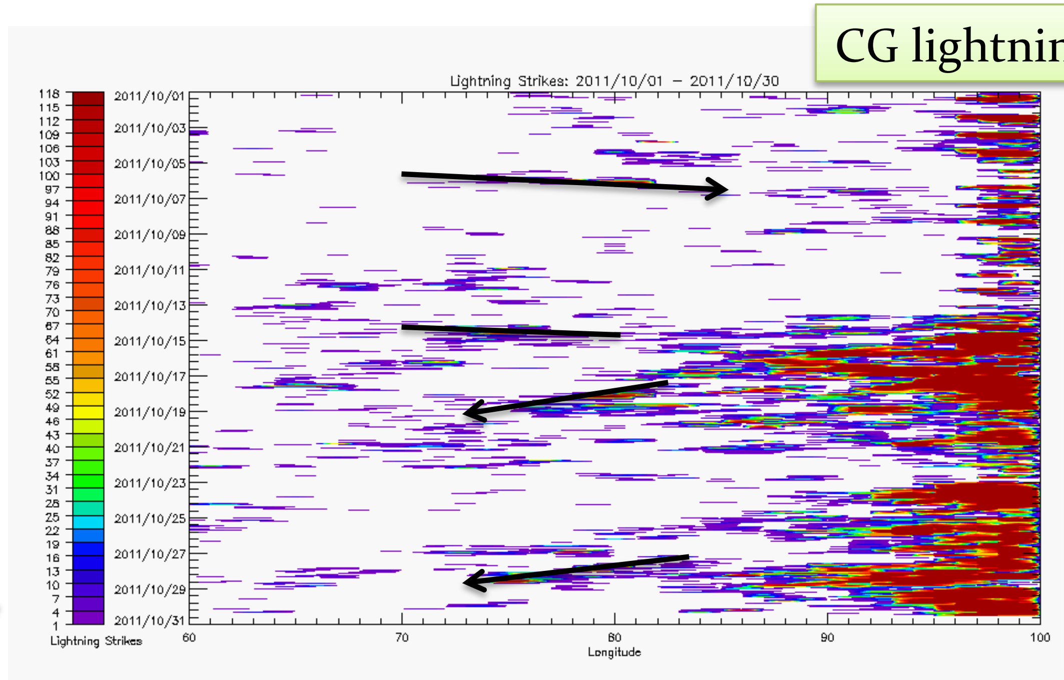






Sounding data courtesy of R. Johnson

CG lightning



Lightning Hovmoller from Vaisala's GLD360 dataset.

Lightning seems to coincide with beginning and end of MJO burst

7.5 inch
24-hour
rainfall