Contributors to Measurement Errors (Chap. 7)

- *1) Widespread spatial distribution of scatterers (range ambiguities)
- *2) Large velocity distribution (velocity ambiguities)
- *3) Antenna sidelobes
- *4) Antenna motion
- *5) Ground clutter (regular and anomalous propagation)
- *6) Interference from other weather radars (next slide)
- *7) Airborne scatterers (birds, etc.)
- *8) Returns from strong point scatterers
- *9) Solar radiation
- 10) Time window effect
- 11) Receiver noise
- 12) Receiver non-linearity
- 13) Quantization and saturation noise
- 14) Many more contributors that are too numerous to list

INTERFERENCE FROM NEARBY RADARS

Often 1st seen by Operational radar Meteorologists

Skip?

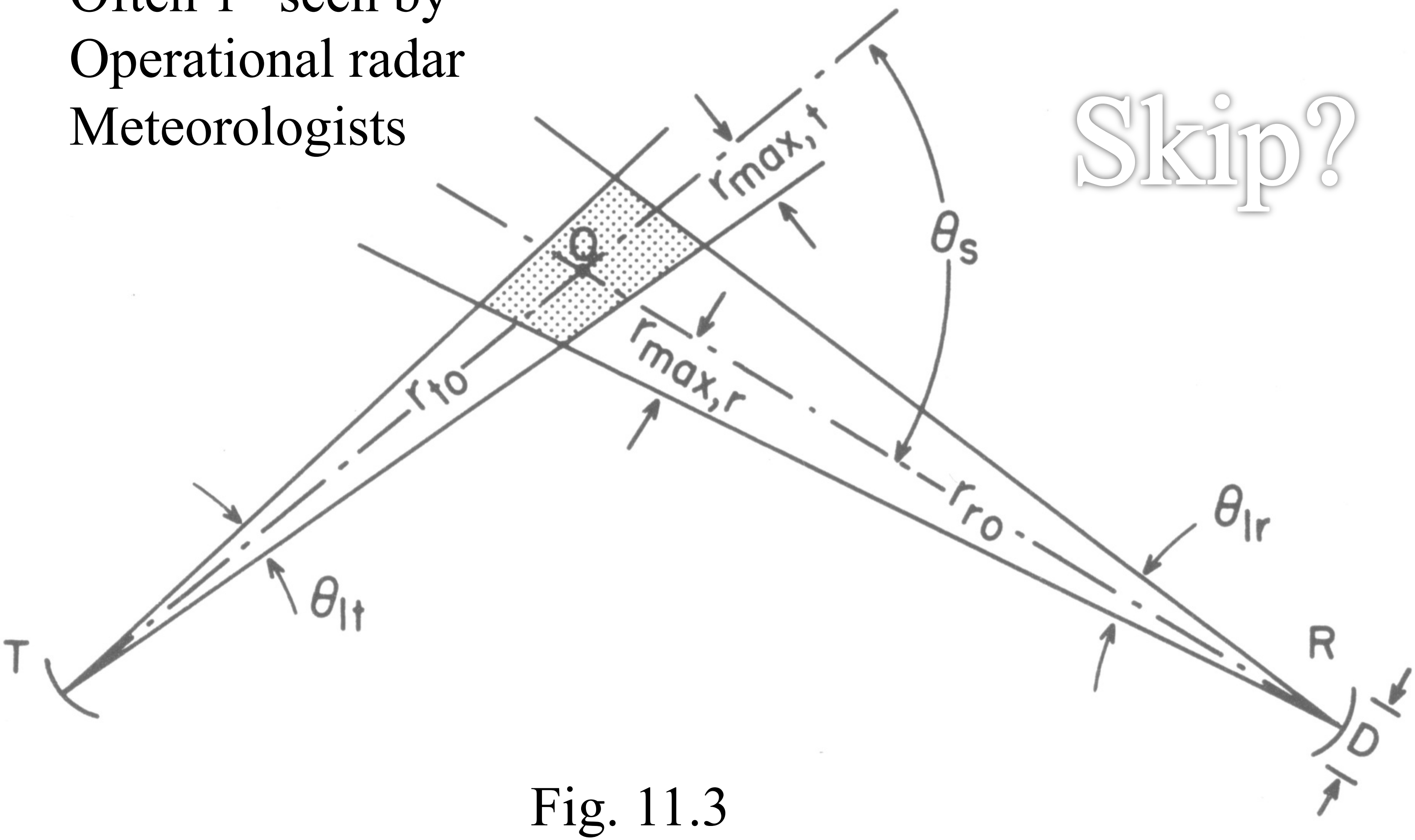
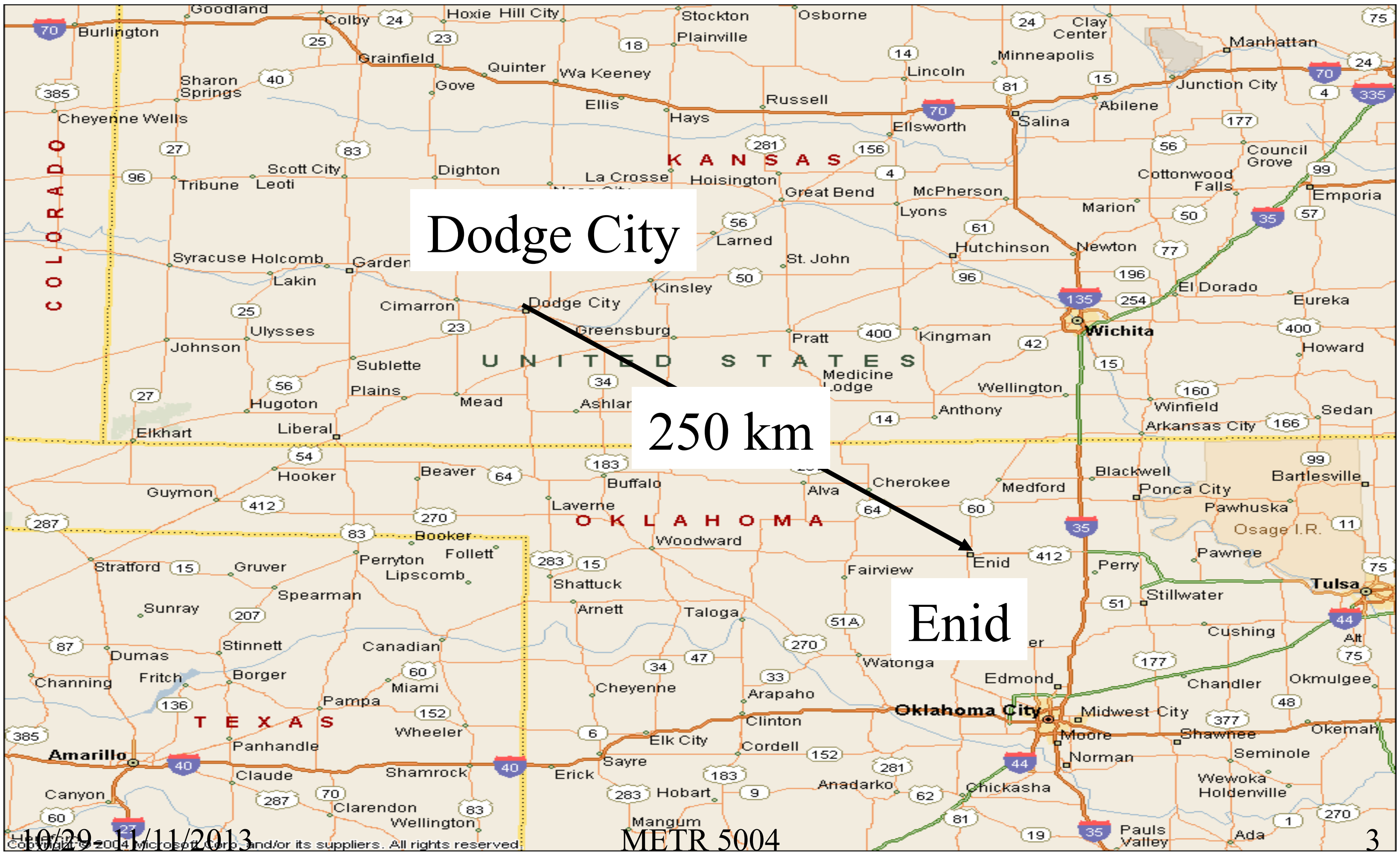
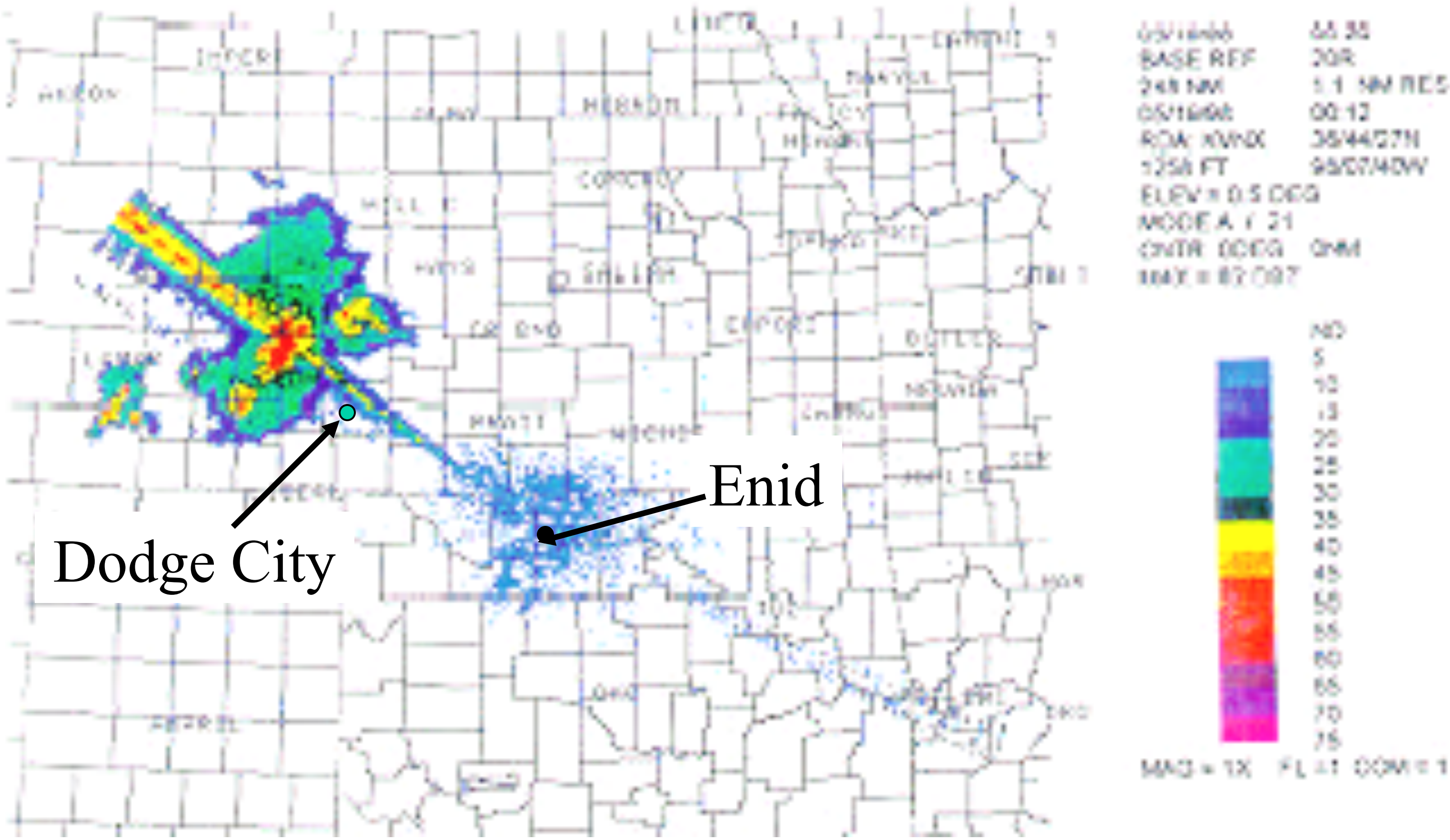


Fig. 11.3

Interference from weather radars at Dodge City,Kansas and Enid, OK

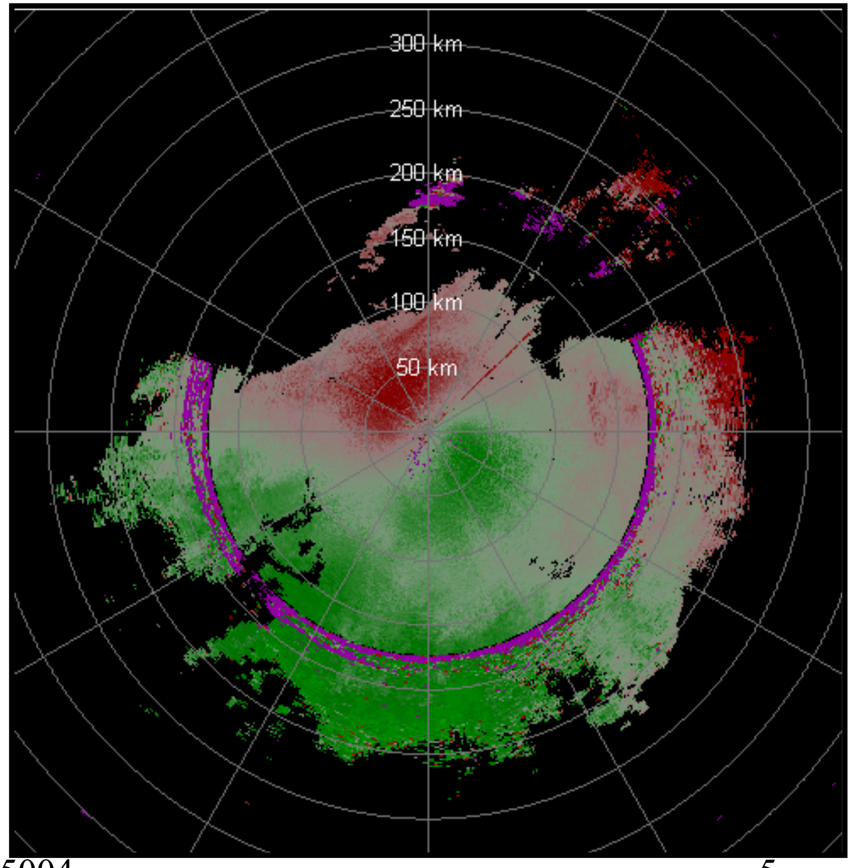


Enid weather radar display. Interference from Dodge City Transmissions



Range and Velocity Ambiguities

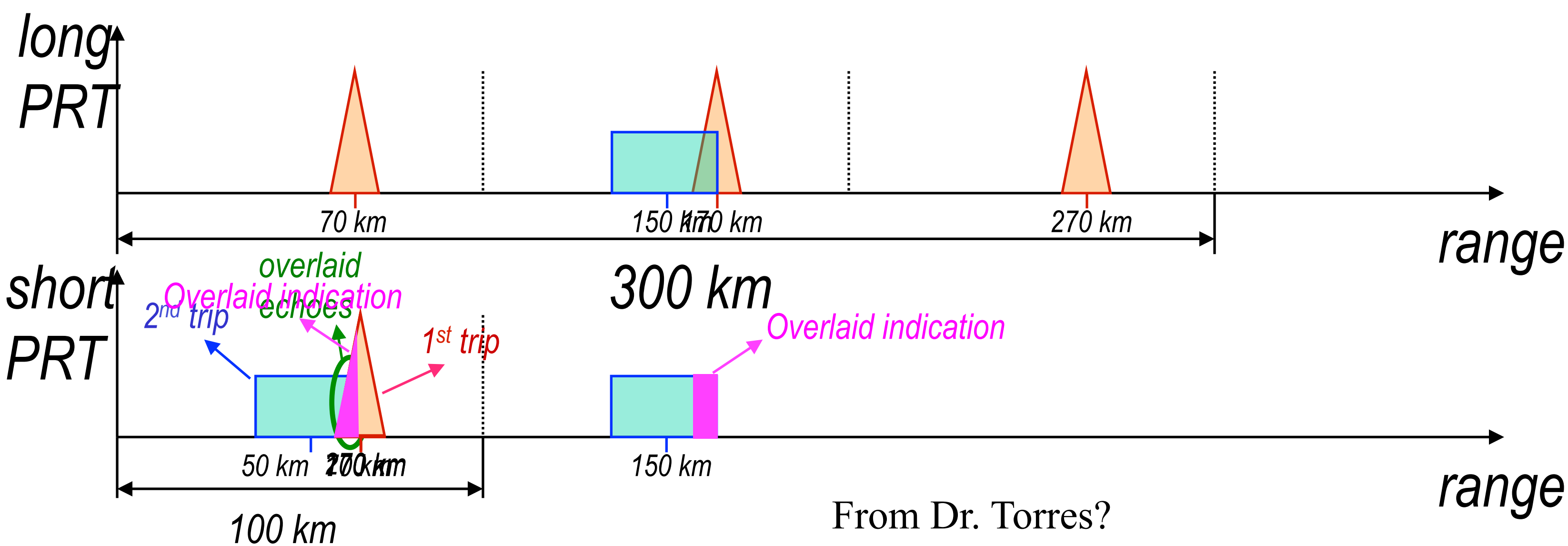
- Short PRTs are needed to maintain signal coherency, to provide acceptable velocity aliasing, & low estimate variance
- Dilemma: $r_a v_a = c\lambda/8$
  - Given λ, we can pick v_a to satisfy our needs. Then, r_a is fixed, and it is usually so small that there can be 2nd and even 3rd trip overlaid echoes.
- Goal: Reduce obscuration from overlaid echoes (a.k.a. "purple haze syndrome")



From Dr. Torres?

Range/Velocity Ambiguity Mitigation in the WSR-88D network

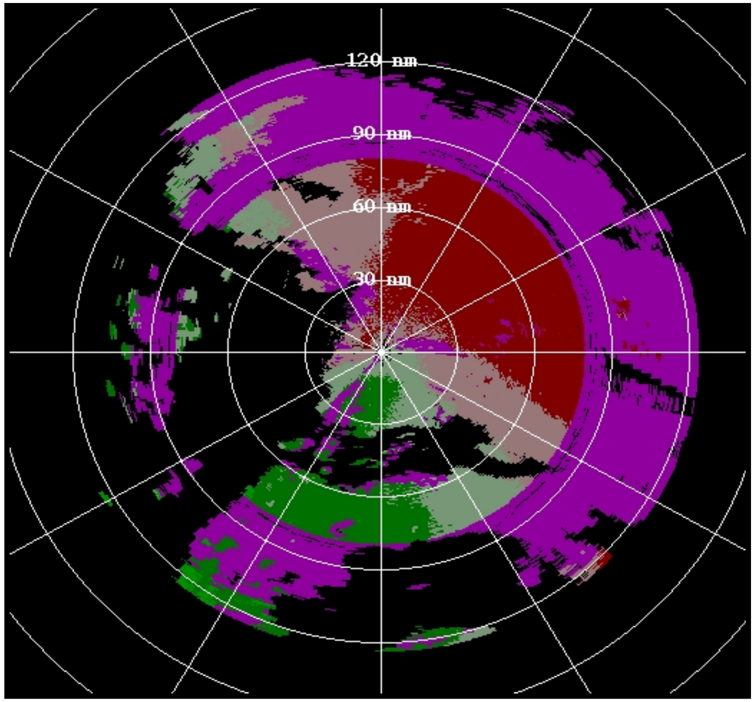
- Long PRTs are used to estimate powers (reflectivity) and short PRTs to estimate velocity
- Long-PRT powers are used to unfold short-PRT velocities
  - Range unambiguous powers from the long PRT tell us where the echoes come from in the short PRT
  - Overlaid echoes with comparable strengths cannot be resolved!



From Dr. Torres?

Performance of range velocity Ambiguity Mitigation in the WSR-88D network

- Velocity field is obscured by range-overlay censoring ("purple haze" syndrome)
- In case of overlaid echoes, only strong-trip velocities are recovered
  - Strong-trip power must exceed weaker-trips powers by ~10 dB
- Velocities from weaker echoes cannot be recovered!



Can we do better?

Mitigation Techniques for range and velocity ambiguities

- 1) To avoid range ambiguities of Z measurements:

  -- Long PRTs
- 2) To mitigate range ambiguities for Doppler measurements:
  – Phase coding (Random)
  – Phase coding (Systematic → WSR-88D)
- 3) To mitigate velocity ambiguities:

  -- Continuity (not a signal processing approach

  -- Staggered PRT (future for WSR-88D); also mitigates range ambiguities

Range Ambiguities

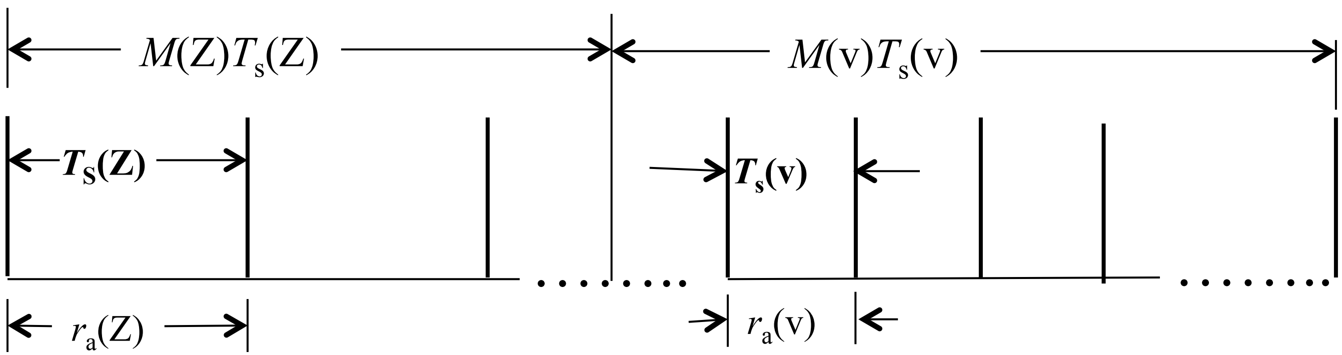
- Simultaneous H,V (SHV mode; used by the WSR-88D)
  - Polarimetric variables $Z_h, Z_v, \rho_{hv}(0)$, and $\varphi_{DP} = \varphi_{hh} - \varphi_{vv}$ are affected in the same manner as reflectivity factors
  - Range ambiguities (i.e., overlaid echoes) **need not appear if** Doppler velocity measurement is not required (only long PRT could be used!)
  - sophisticated mitigation of ambiguities is needed if mean velocity must be estimated along with polarimetric variables

- Alternately transmit H,V (AHV mode)
  - Differential Phase and Doppler velocity are coupled

Range/velocity Ambiguity Mitigation in the WSR-88D network

- Split cut at low elevation angles
  - Collect two scans at the same elevation angle (one using a long PRT and one using a short PRT)
  - The long-PRT scan is used to retrieve unambiguous powers and polarimetric parameters, whereas the short-PRT scan is used to retrieve (range-folded) velocities
  - Good ground clutter suppression but antenna scans twice at the same elevation
- Batch mode at intermediate elevation angles
  - Collect one scan with interlaced batches of short and long PRTs
  - The long-PRT scan is used to retrieve unambiguous powers and the short-PRT scan to retrieve (range-folded) velocities and polarimetric parameters
  - Reduced ground clutter suppression but antenna scans once at each elevation

Batch mode of data collection



T_s(Z) = long PRT, for reflectivity measurements ≈ 2 ms;
T_s(v) = short PRT for Doppler and polarimetric measurements ≈ 0.9 ms
r_a(Z) = Unambiguous range for reflectivity measurements (Z_h) ≈ 300 km
r_a(v) = Unambiguous range for Doppler and Polarimetric measurements ≈ 135 km
M(Z) = number of samples for reflectivity measurements ≈ 6
M(v) = number of samples for Doppler and polarimetric measurements ≈ 36 to 40

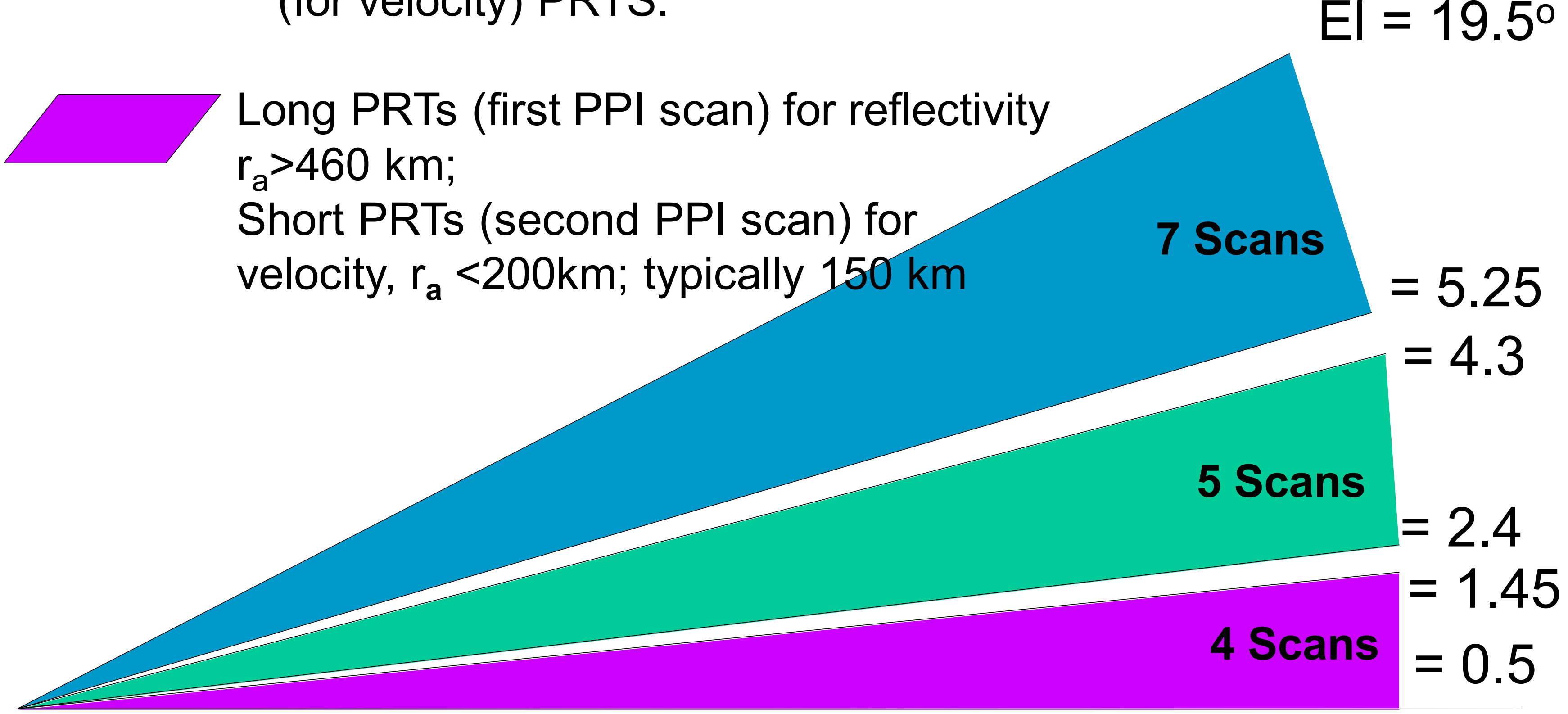
Mitigation of Range Ambiguities (Table 7.1; p.176)

(VCP 11)

Uniform PRTs

Alternate batches of long (for Z) and short (for velocity) PRTS.

Long PRTs (first PPI scan) for reflectivity r_a>460 km;
Short PRTs (second PPI scan) for velocity, r_a <200km; typically 150 km

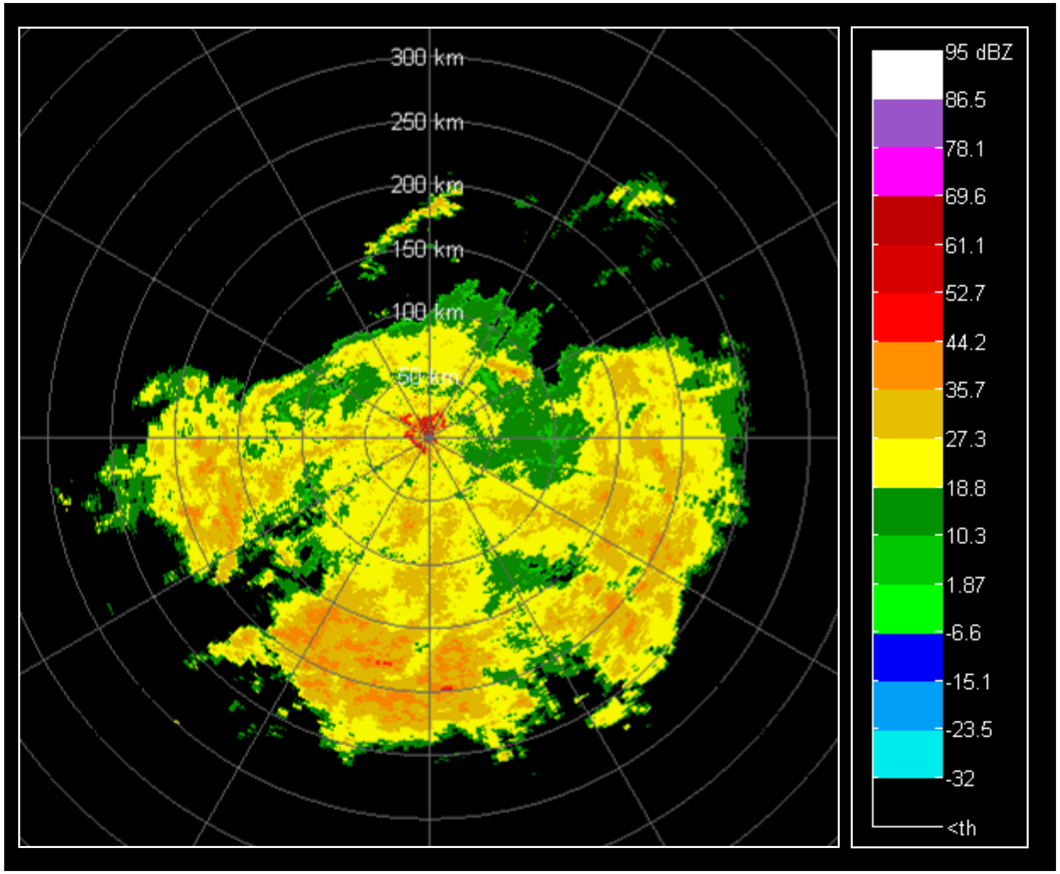


Phase Coding
(First scan long PRT as shown)

10/08/02 15:11 GMT

EL = 0.5 deg

Reflectivity
Long PRT



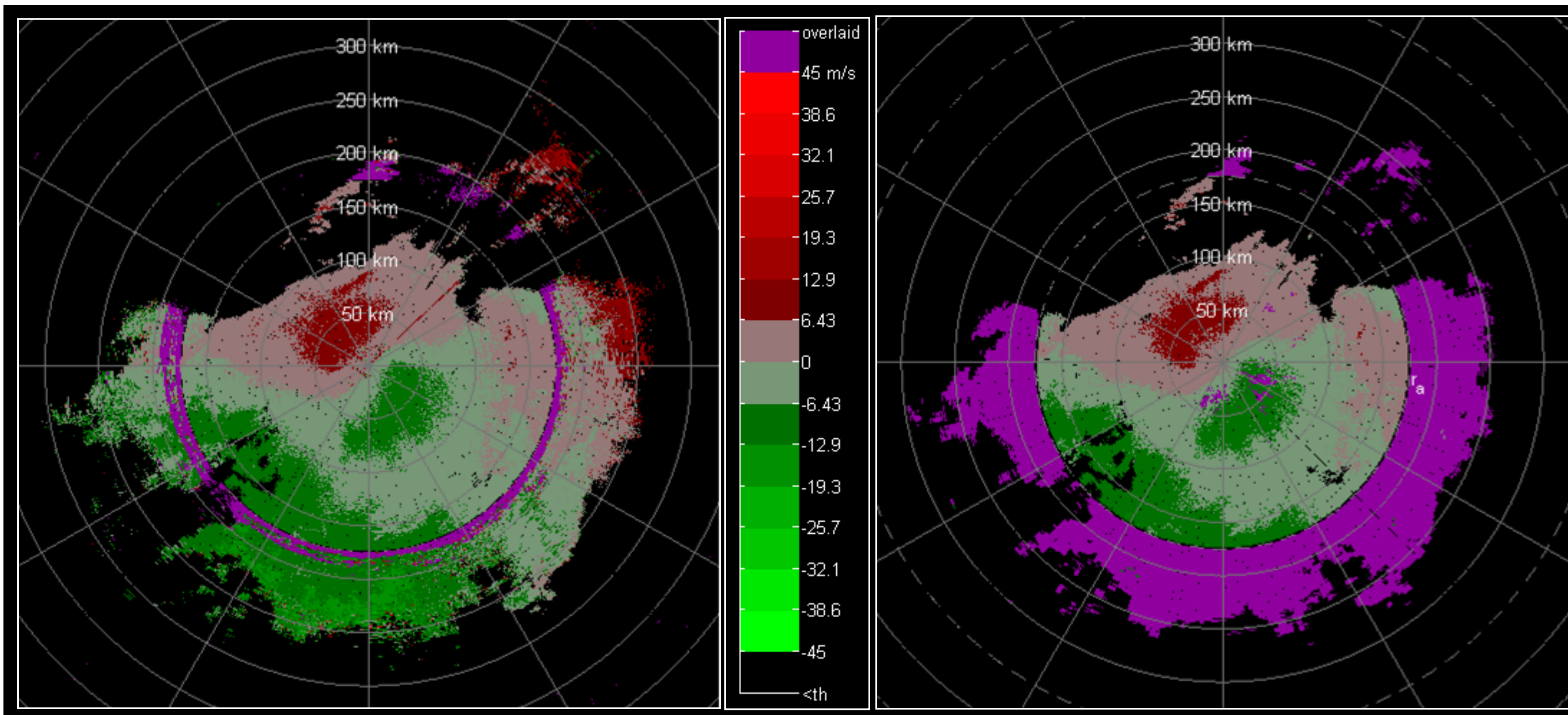
Phase Coding

10/08/02 15:11 GMT

EL = 0.5 deg

Doppler Velocity
Phase coding, medium PRT

Doppler Velocity Processing as on earlier WSR-88Ds



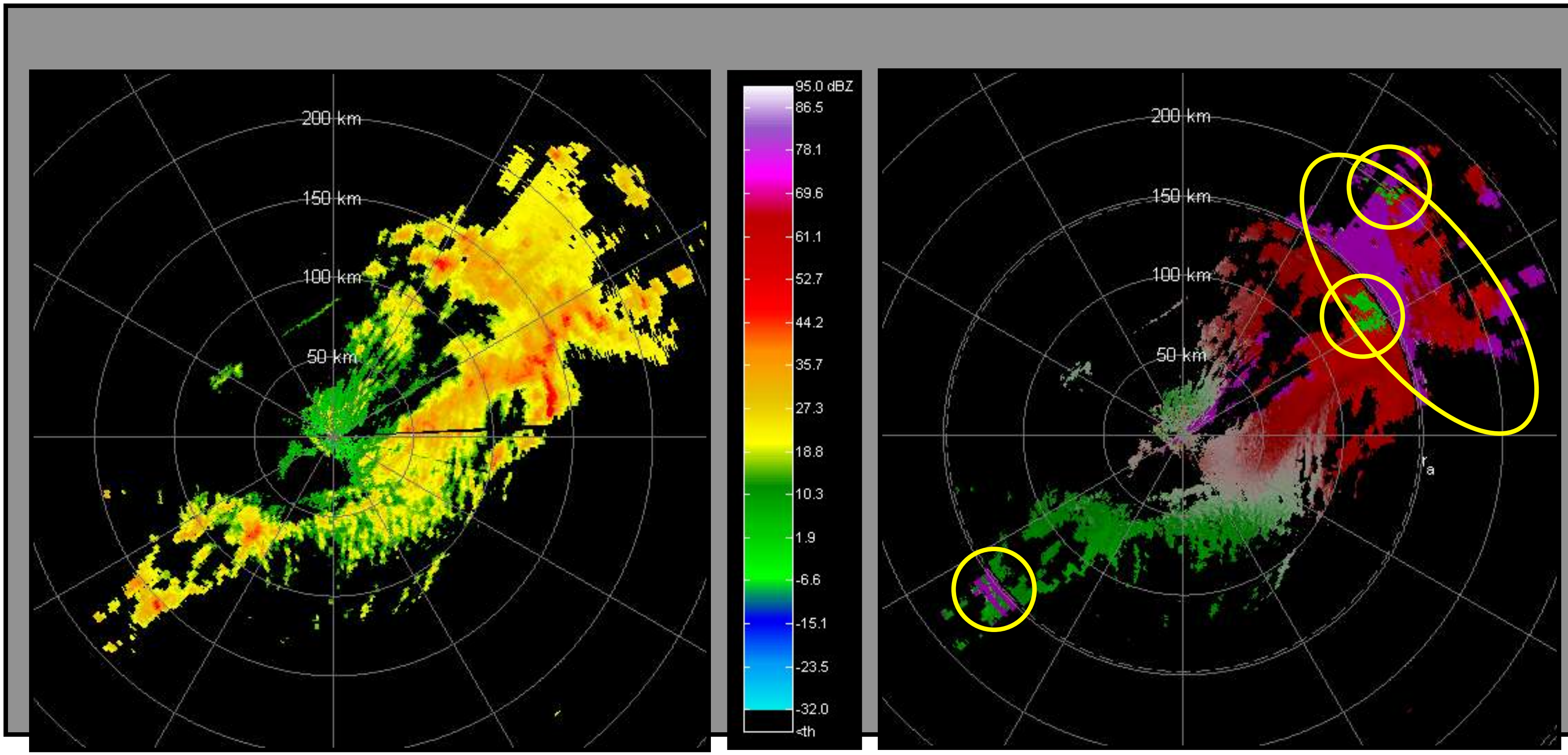
$v_a = 23.7$ m s^{-1}, $r_a = 175$ km

$v_a = 23.7$ m s^{-1}, $r_a = 175$ km

Phase Coding Performance (I)

03/03/04 20:28 GMT

Reflectivity "Split cut" | EL = 0.5° | Legacy Velocity "Split cut"



$v_a = 8.9$ m s^{-1}, $r_a = 466$ km

$v_a = 28.1$ m s^{-1}, $r_a = 148$ km

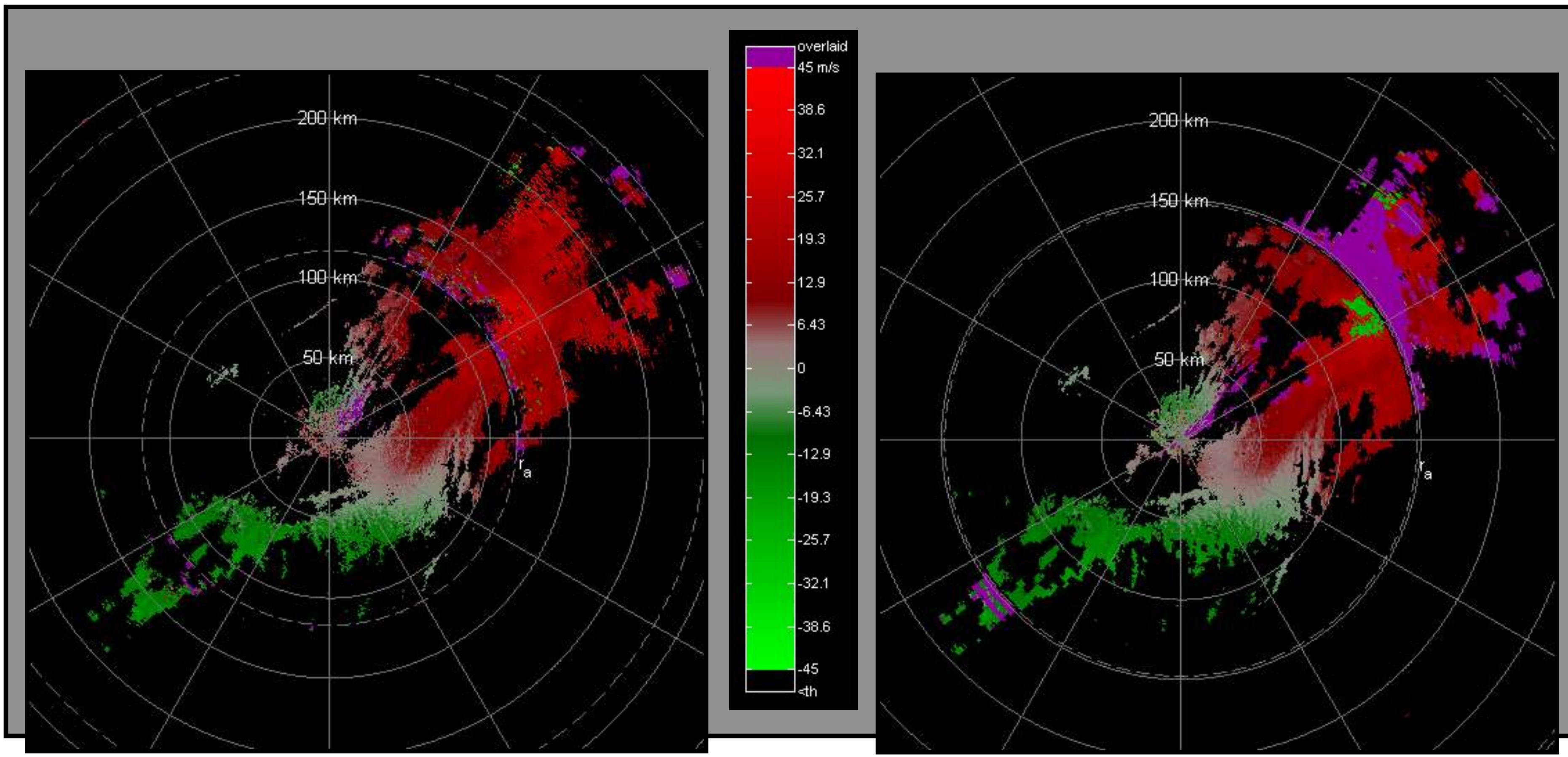
Phase Coding Performance II)

03/03/04 20:28 GMT

SZ-2 Velocity
Short PRT

EL = 0.5°

Legacy Velocity
"Split cut"



$v_a = 35.5$ m s^{-1}, $r_a = 117$ km

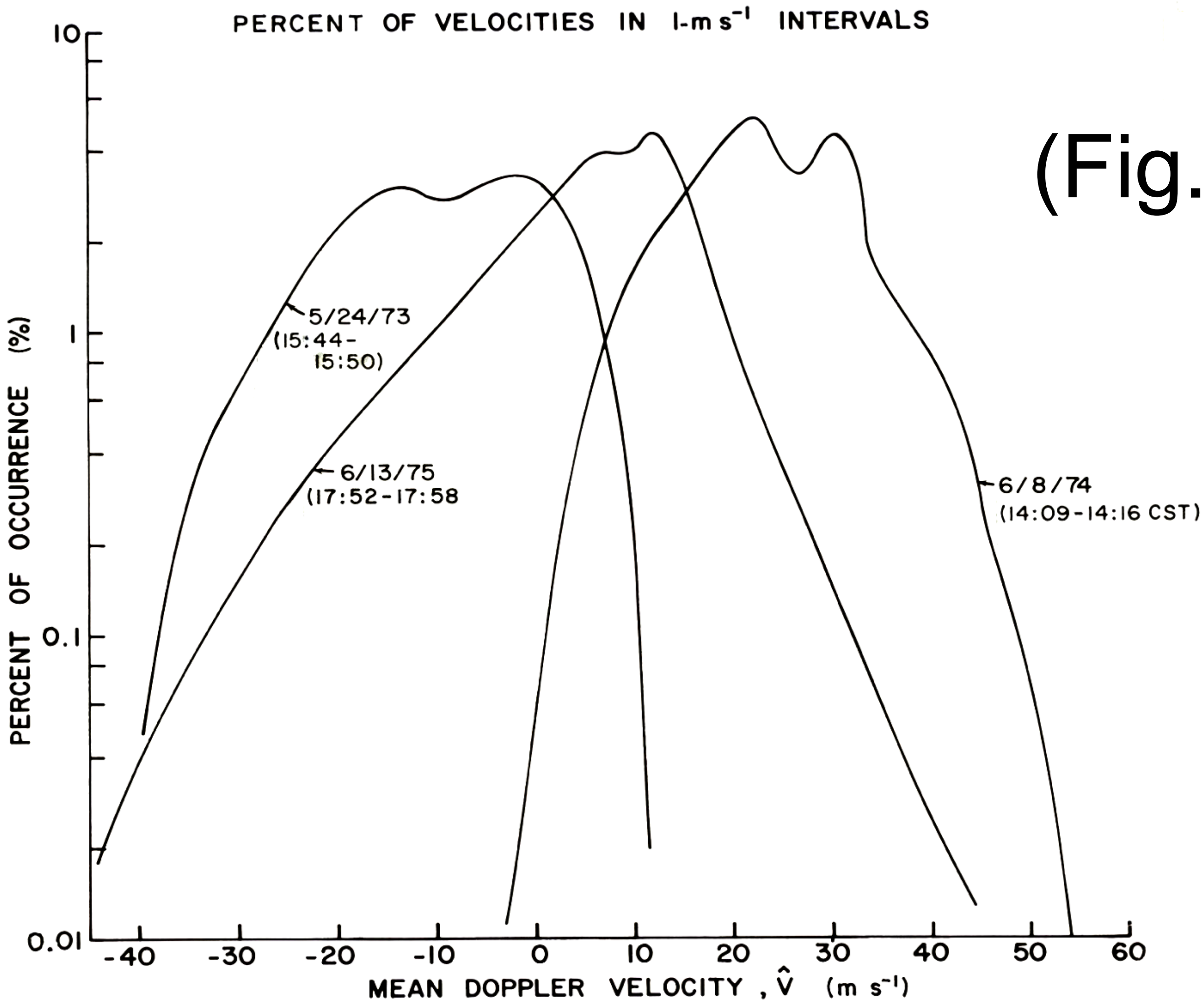
$v_a = 28.1$ m s^{-1}, $r_a = 148$ km

Mitigation of Velocity Aliases

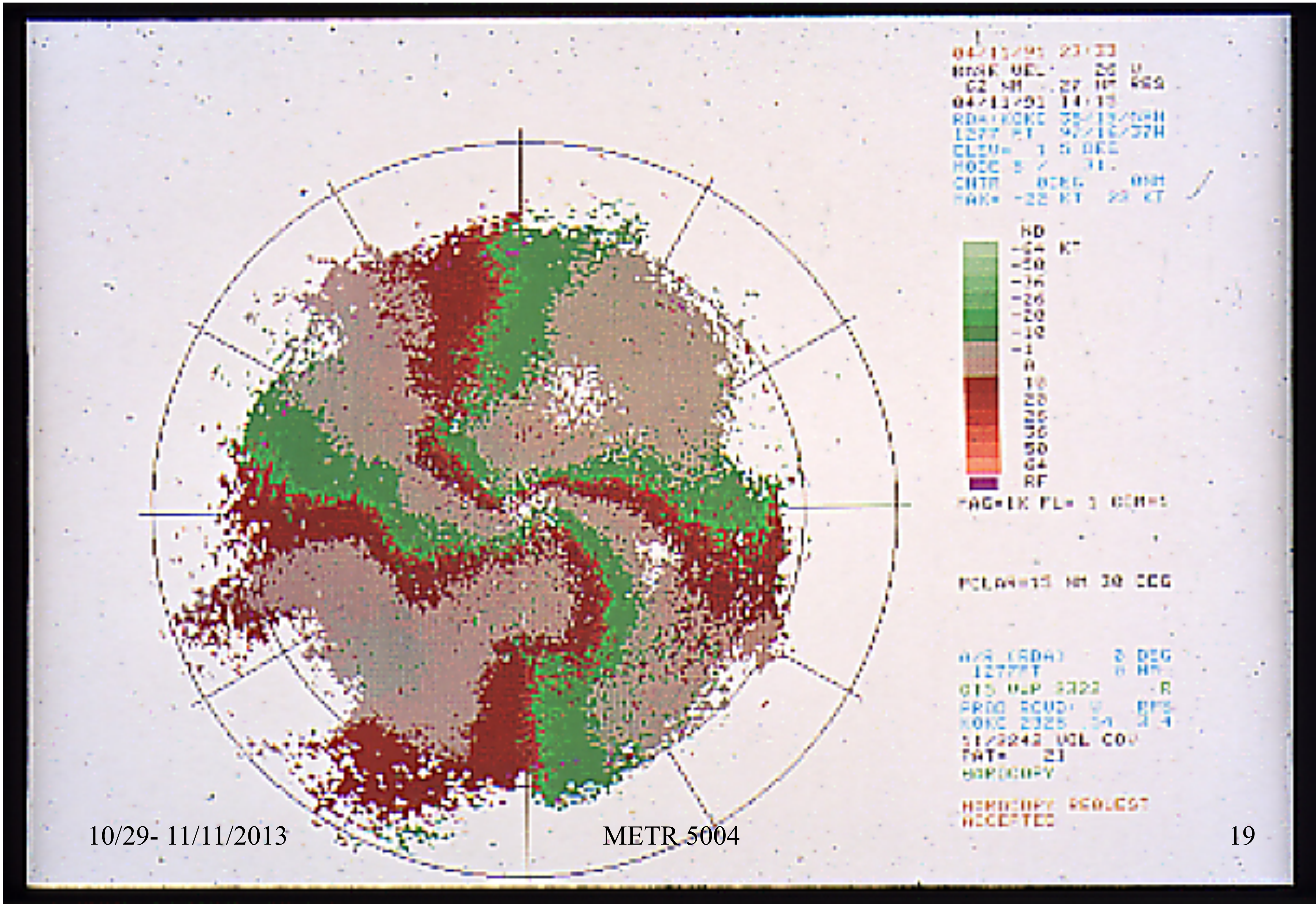
(Based on continuity of the velocity field)

Distributions of Velocities in Tornadic Storms

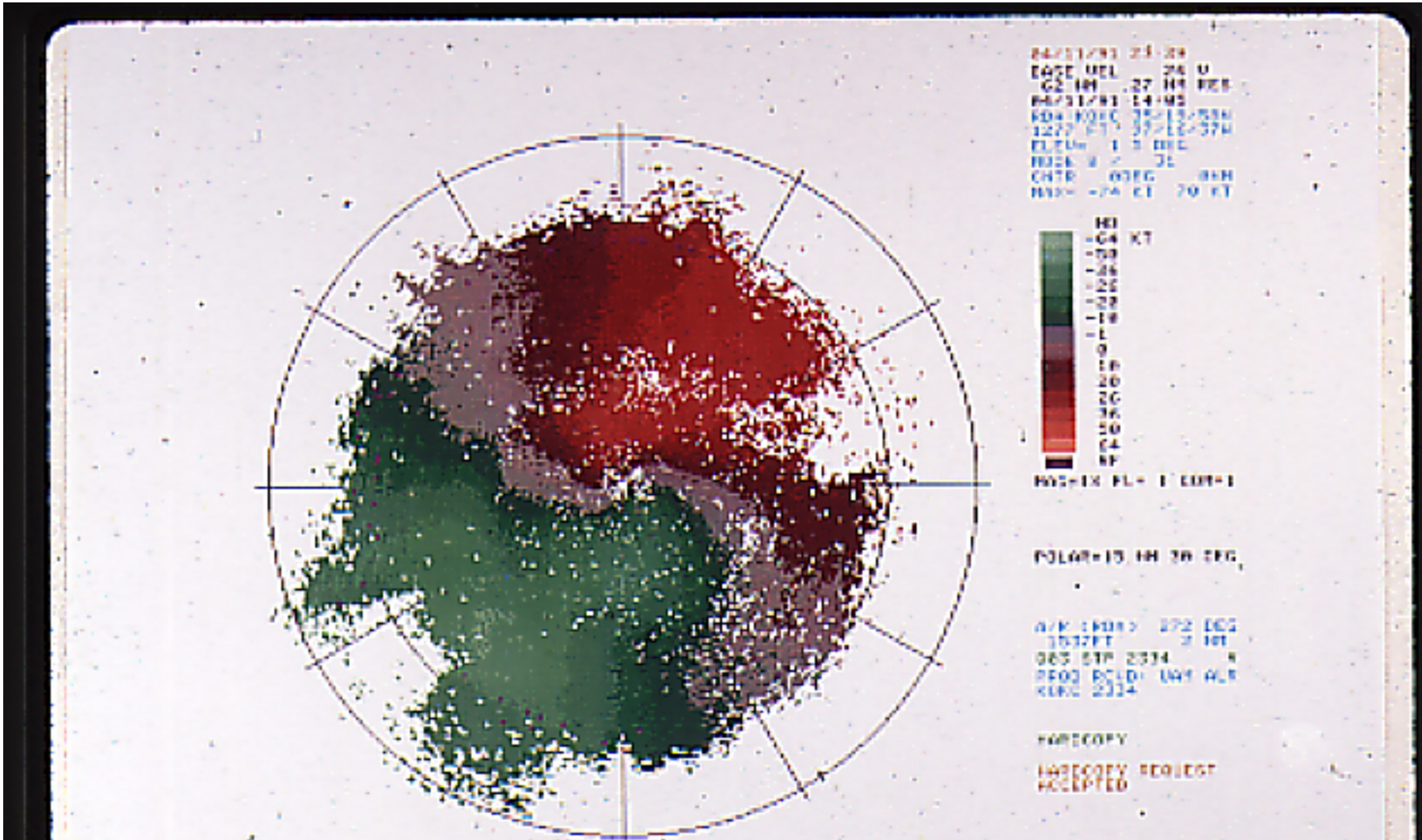
(Fig. 7.4)



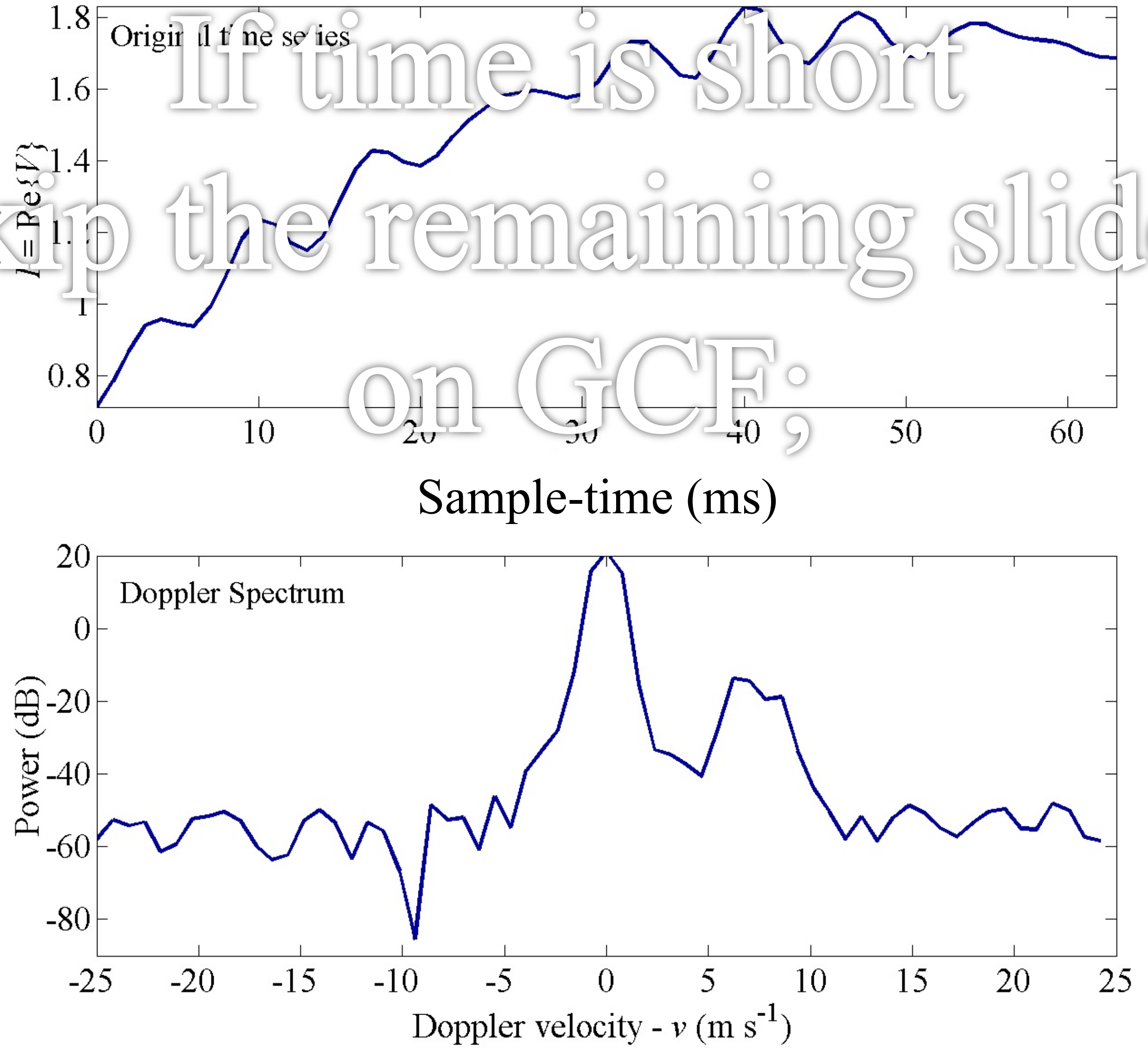
Multiple Doppler Aliases (long PRT)



Velocity Field after Dealiasing
(i.e., spatial continuity had been applied)

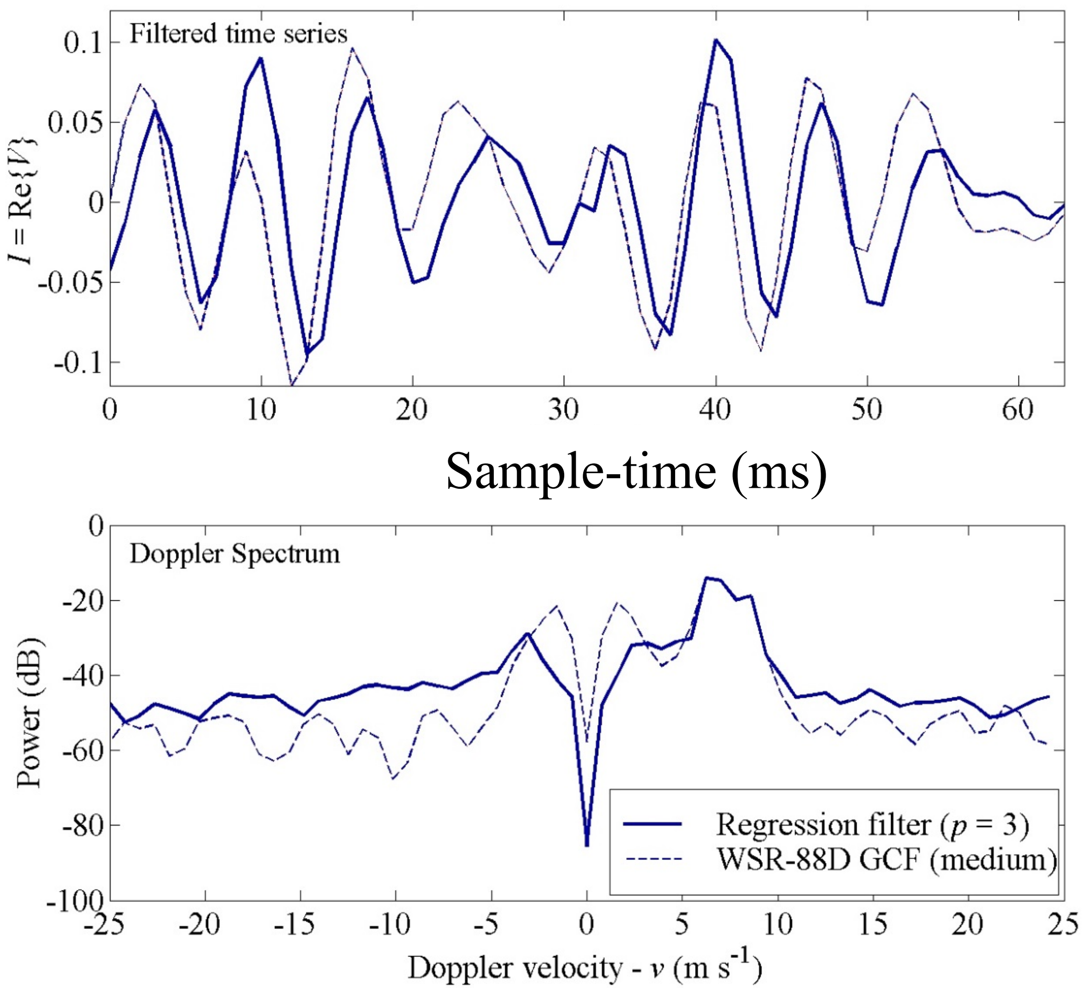


Weather and Ground Signals

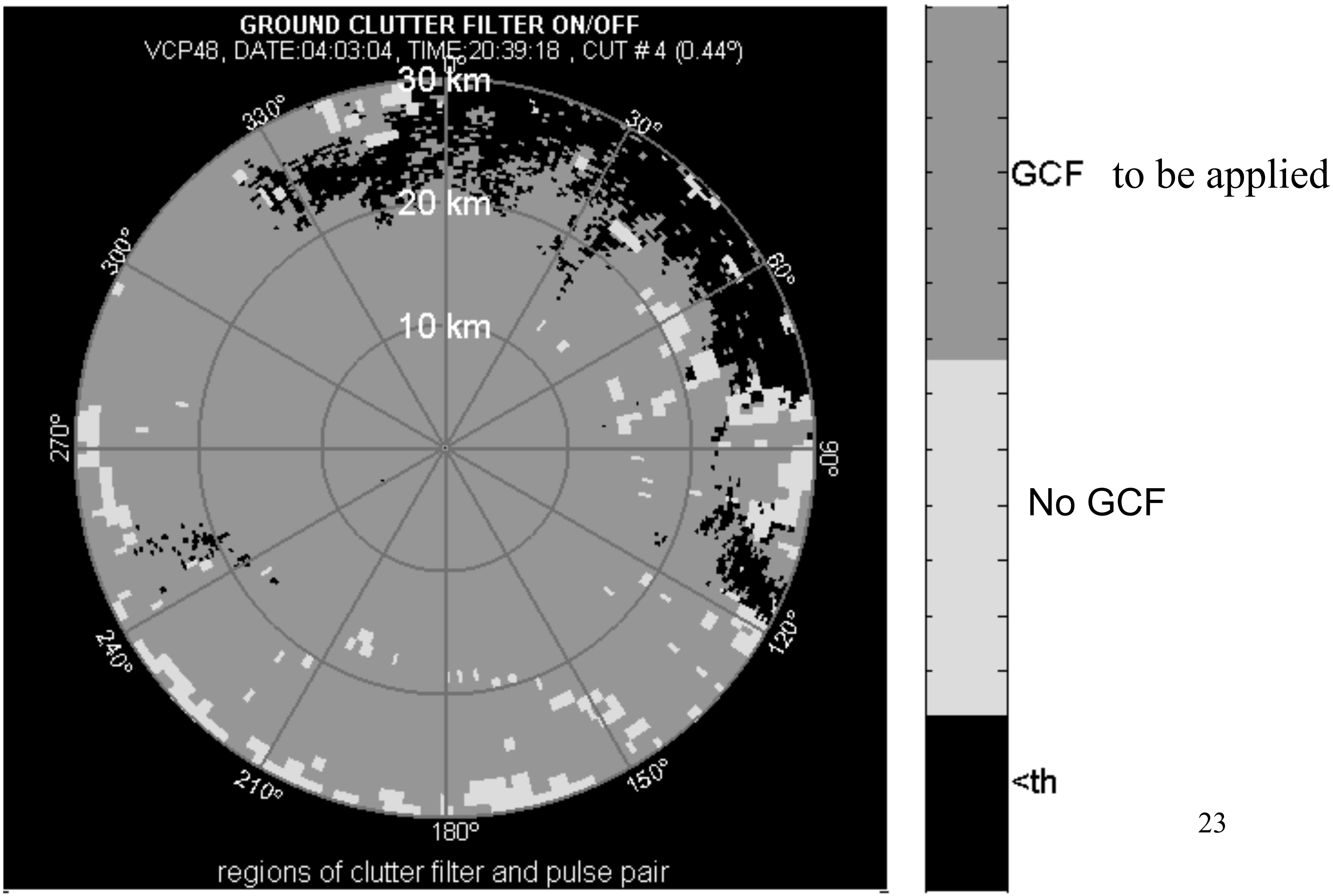


If time is short skip the remaining slides on GCF;

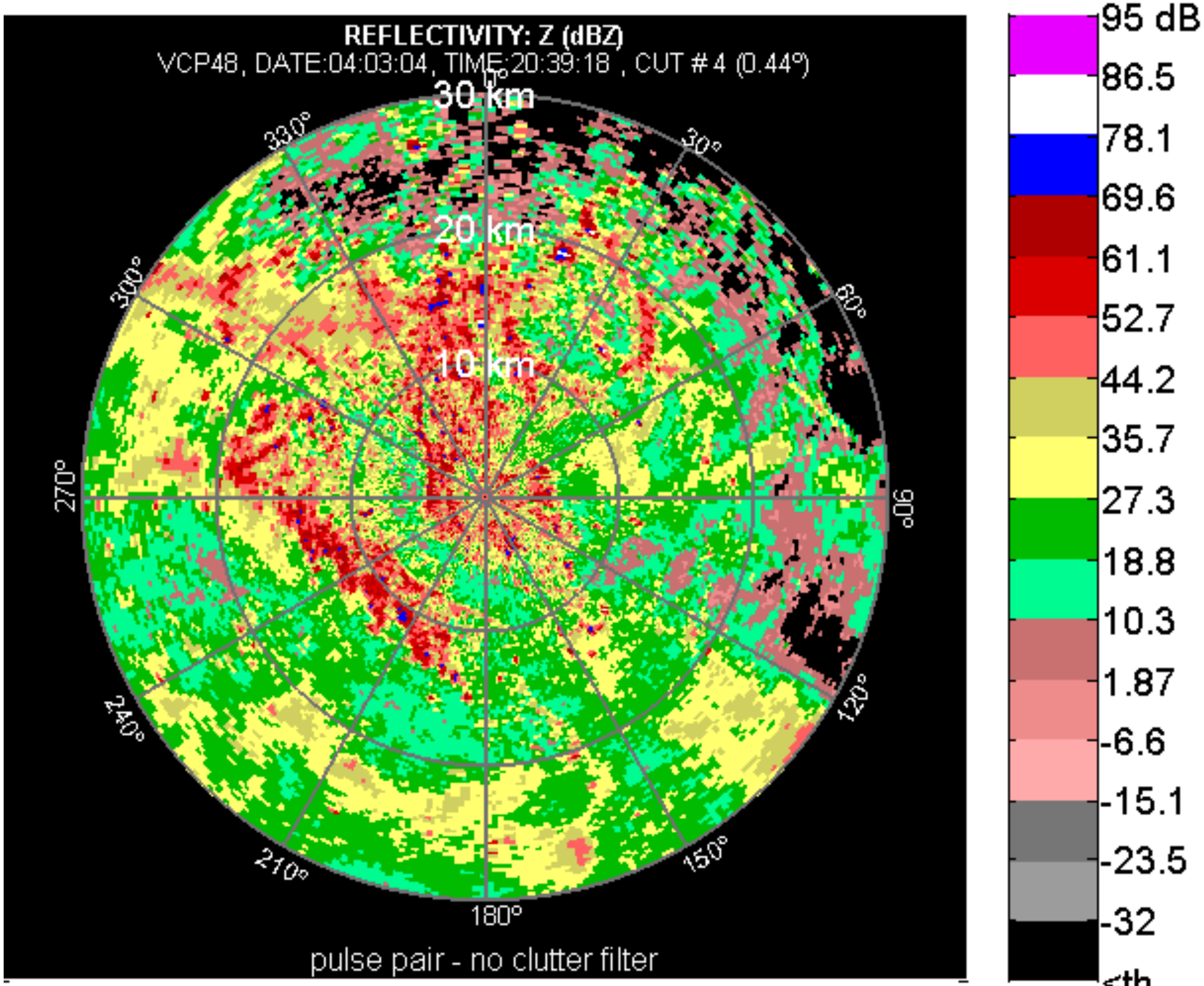
Weather Signal after Clutter Filter



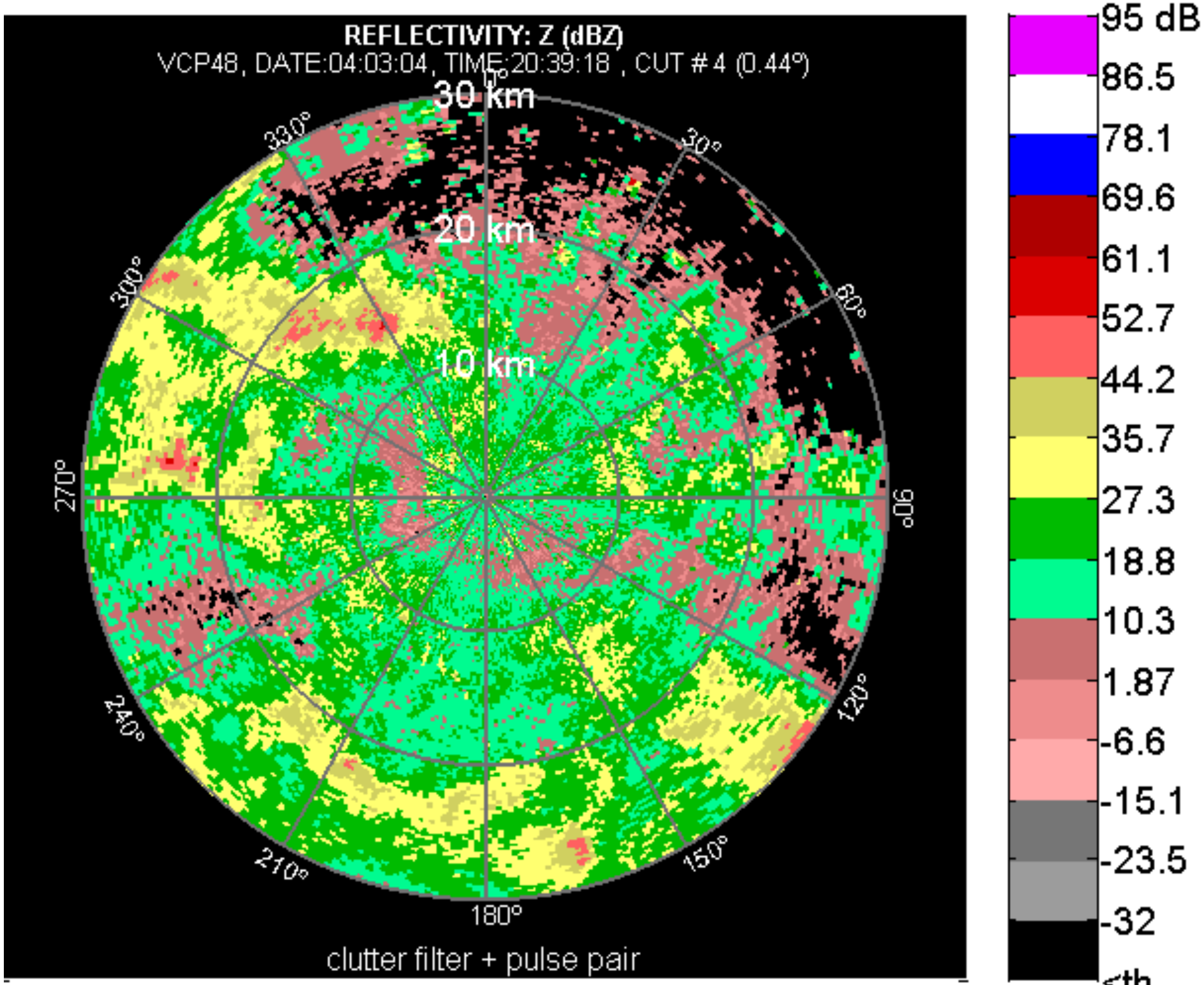
Clutter Filter Map



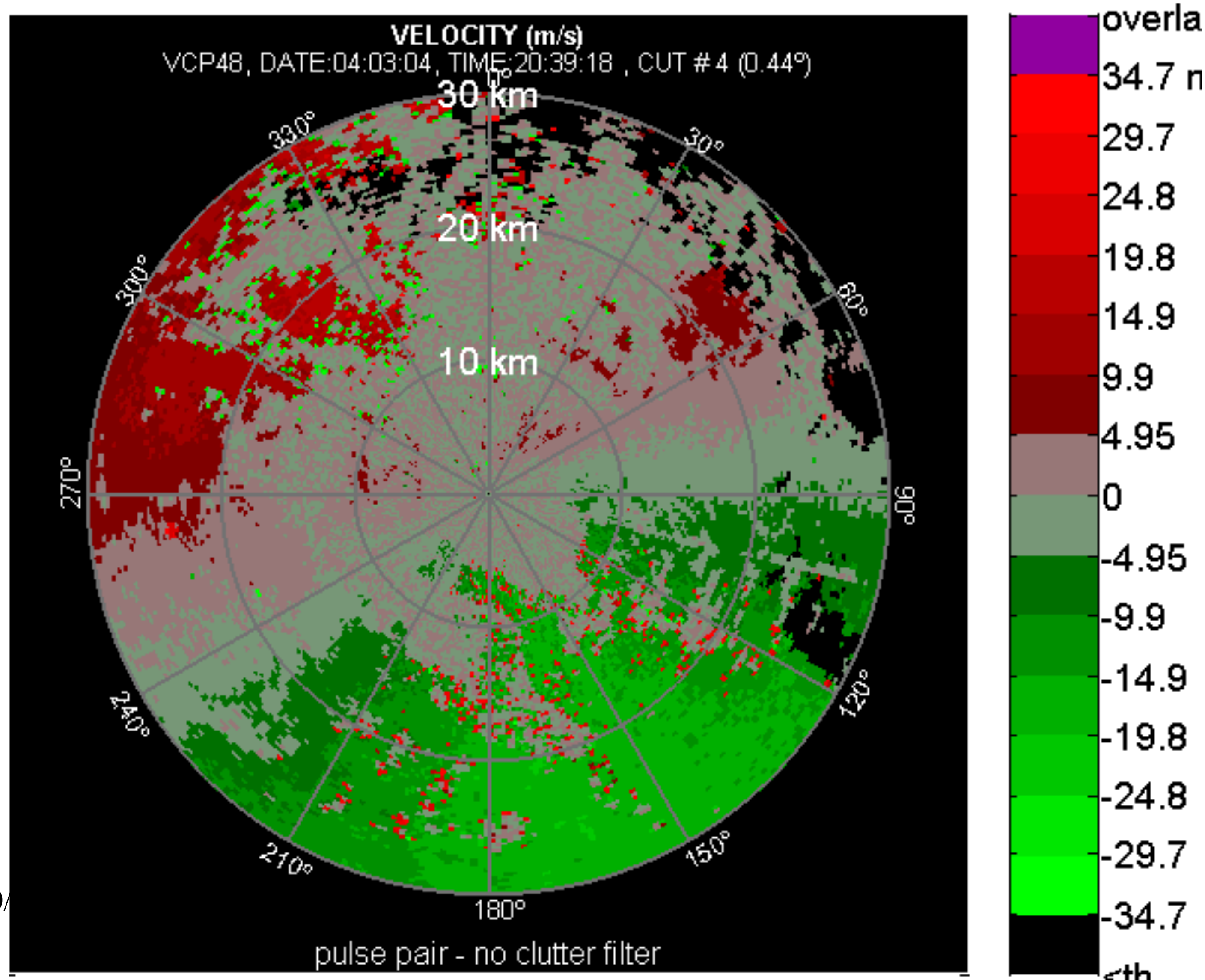
Reflectivity Field no GCF



Reflectivity Field after GCF



Velocity Field no GCF



Velocity Field after GCF