

# Clutter Mitigation Decision (CMD) system Status and Demonstration Studies

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# Motivation

## Mitigation of AP Clutter without weather attenuation

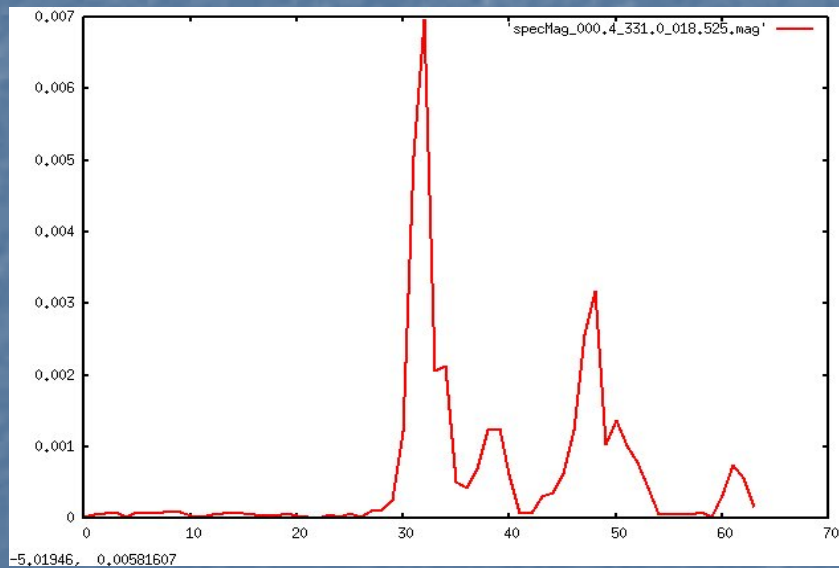
- Currently: Only Detect AP clutter in RPG
  - No “correction” only censoring of data
- Future: New fast radar processors (e.g. RVP8) which make possible:
  - Spectral processing with FFTs, etc
  - Spectral clutter filters instead of time domain filters. Simply calculate the spectrum and “notch out” zero and near zero velocity points

## Real time detection and *correction* of AP clutter

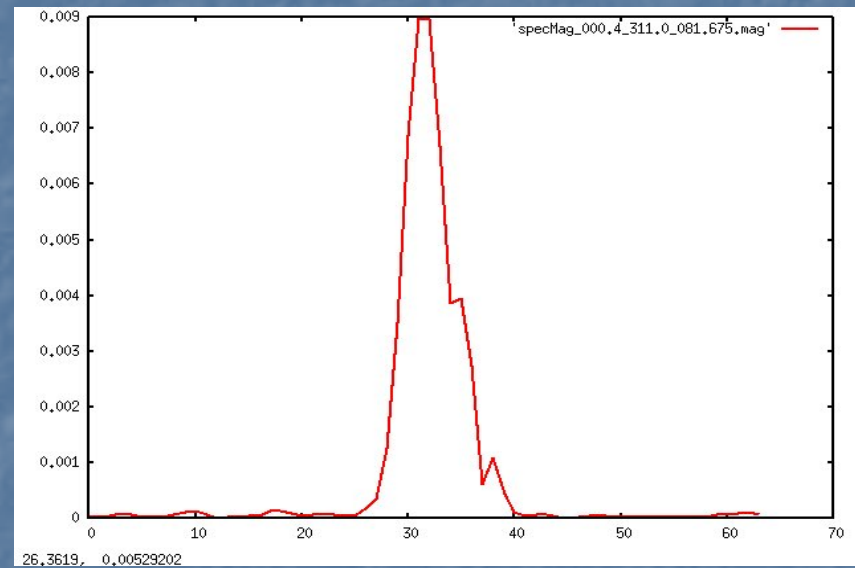


# Clutter and Weather Spectra

Clutter and weather separated



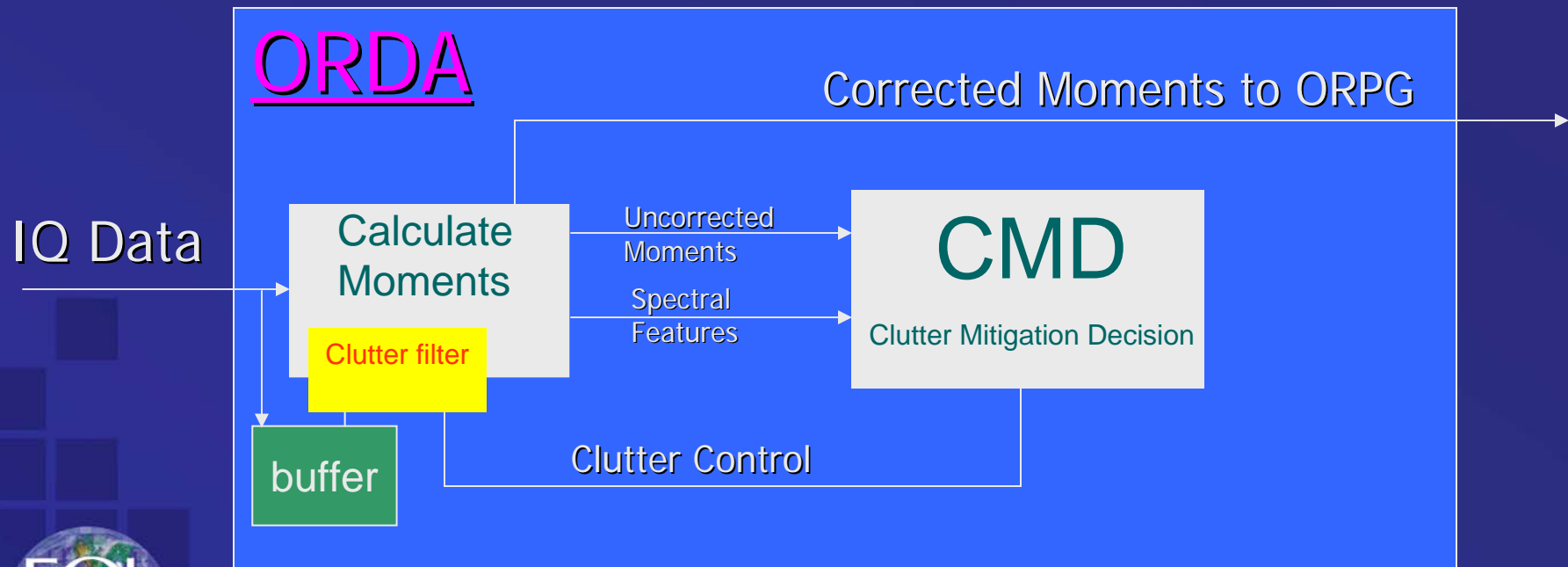
Clutter and and weather not separated



Clutter and narrow width weather are indistinguishable.  
Must use spatial variance parameters to distinguish.

# AP Detection and Correction in ORDA

Objective: Real time AP clutter detection *AND* correction



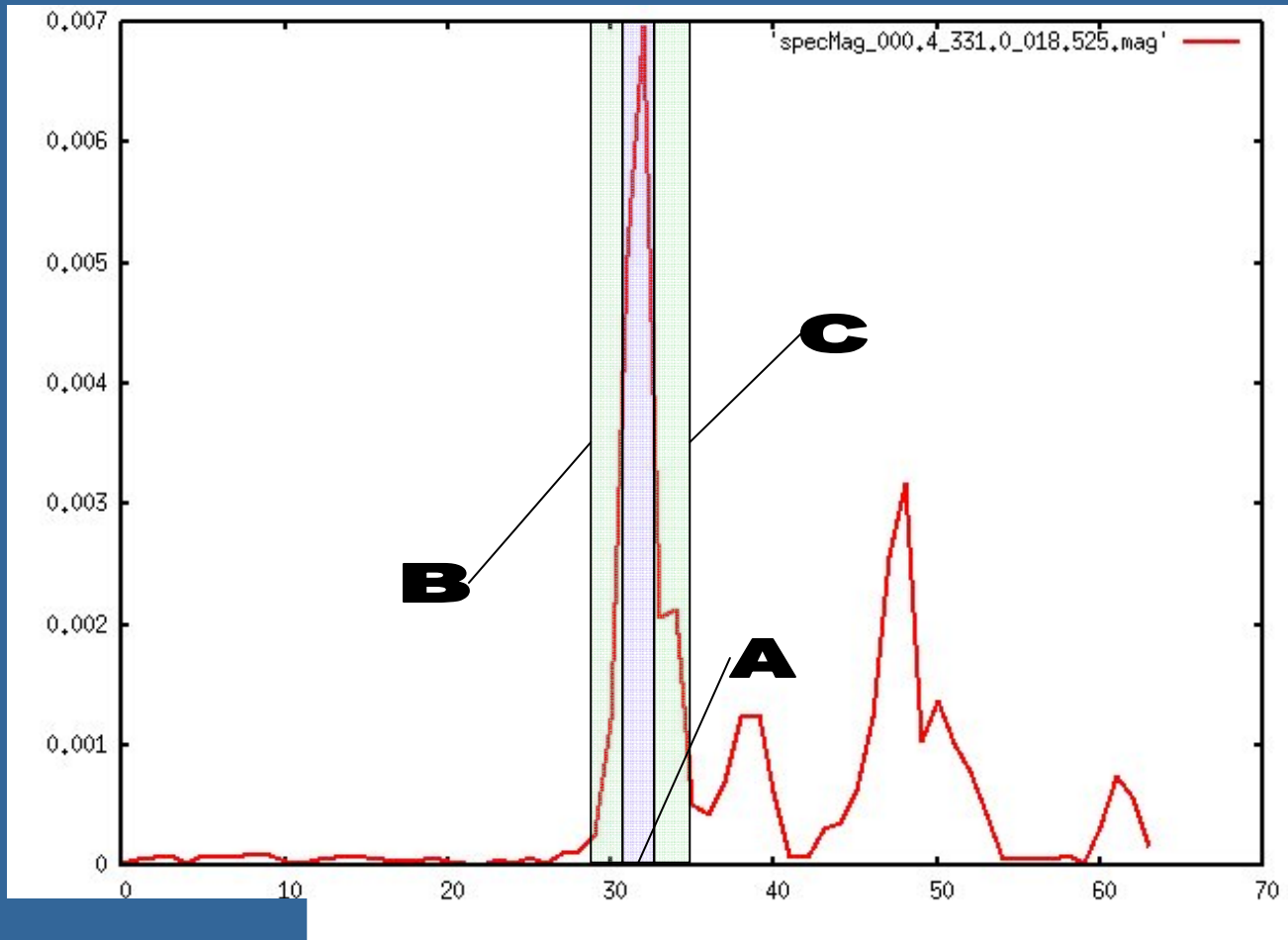
# CMD Input Variables

- Uses the following fields:
- **TDBZ** - DBZ texture: squared change in dBZ from one gate to the next, in range, averaged over the kernel.
- **SPIN** - DBZ 'spin': measure of how frequently the trend in reflectivity along a beam changes with range. Averaged over the kernel.
- **Spectral Domain parameters:**
  - Clutter ratio narrow
  - Clutter ratio wide
  - TDBZ\_0 Texture of power close to 0 m/s (under development)
  - SPIN\_0 SPIN of power close to 0 m/s (under development)
  - NSPA NEXRAD Spectral Processing Algorithm (under development)



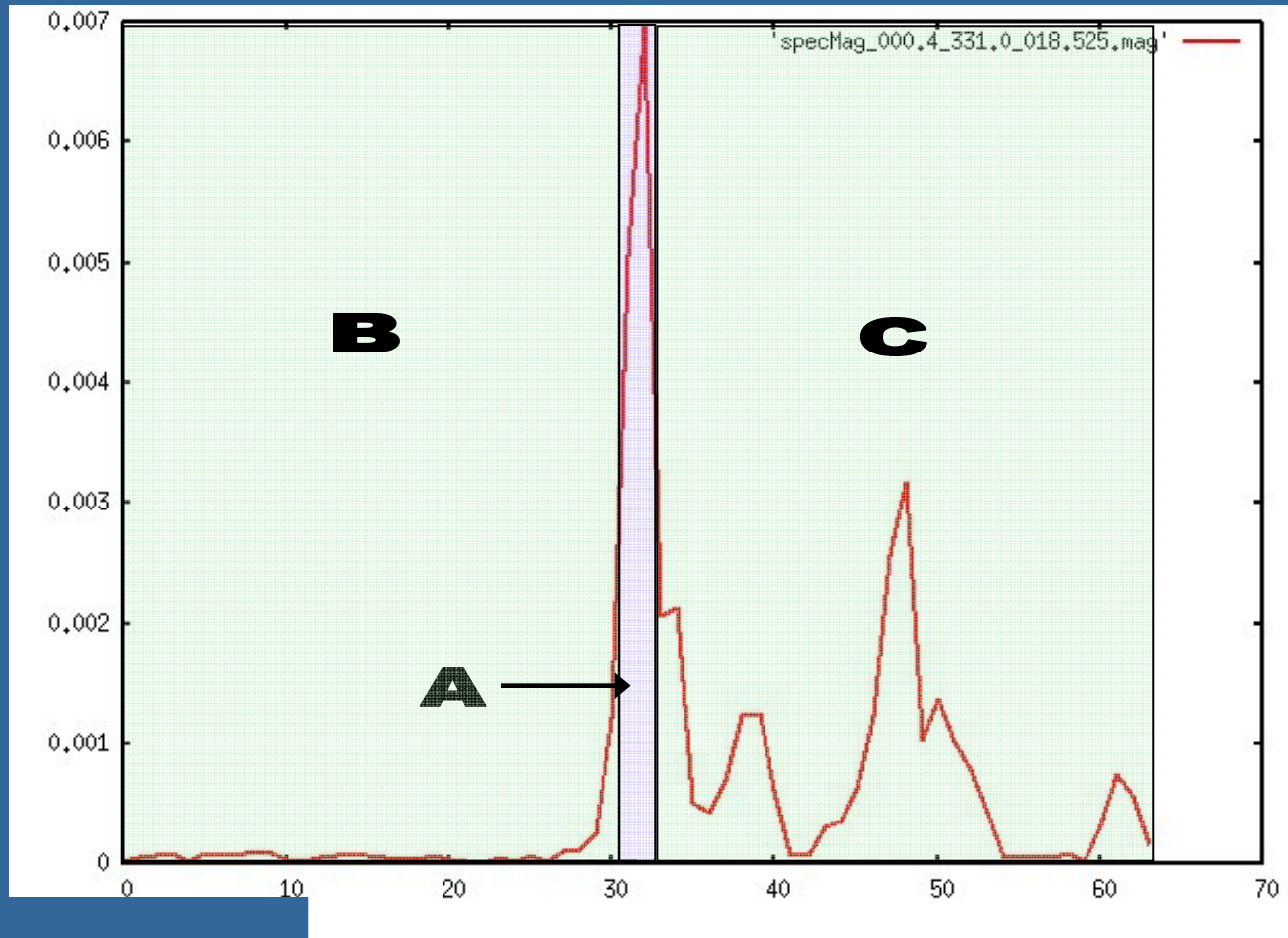
# Definition of Clutter Ratio Narrow

RatioNarrow = Power in A / (Power in B + Power in C), expressed in dB



# Definition of Clutter Ratio Wide

RatioWide = Power in A / (Power in B + Power in C), expressed in dB

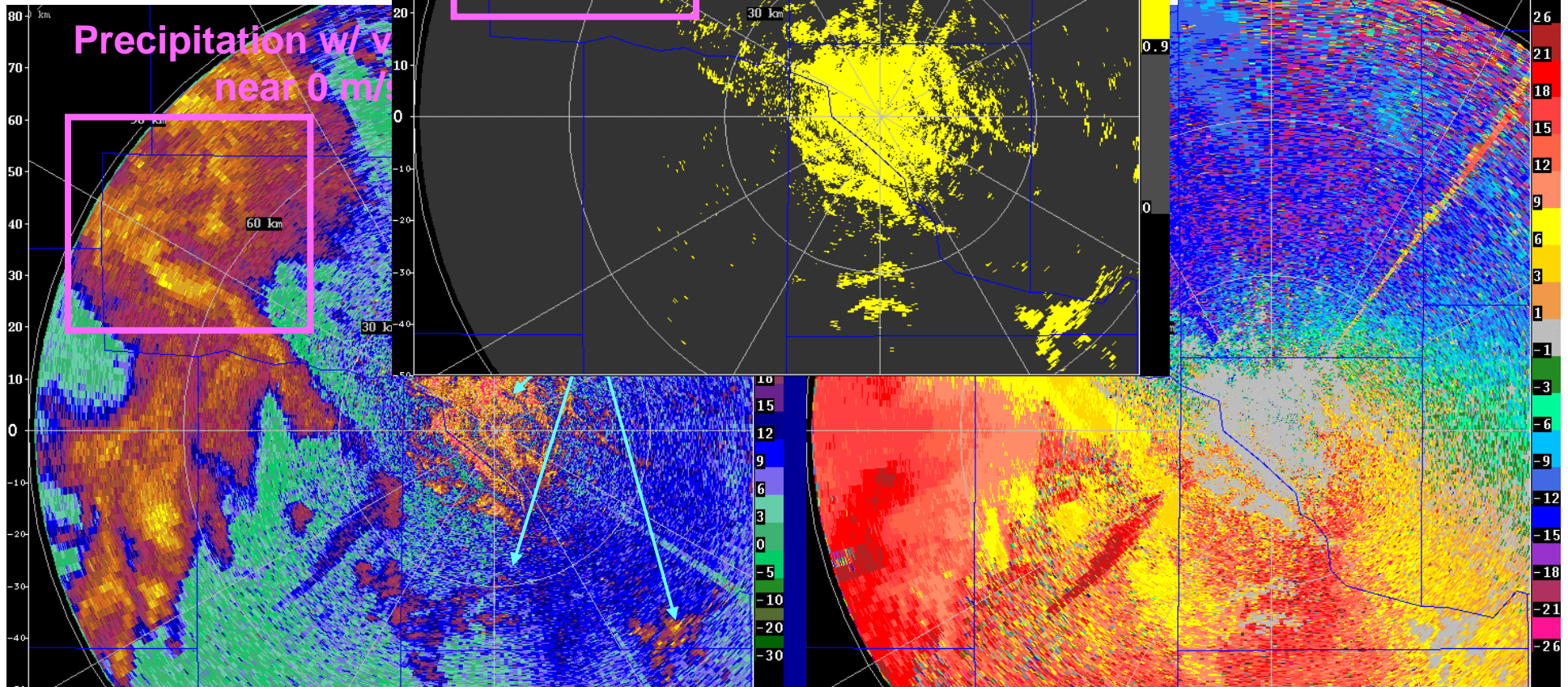


# CMD Methodology and an Example

- CMD will automate C
- Fuzzy logic used
- GMAP applied c
  - Precipitation
- Example: KJIM squa

Clutter Flag determined by CMD

Reflectivity – No GMA

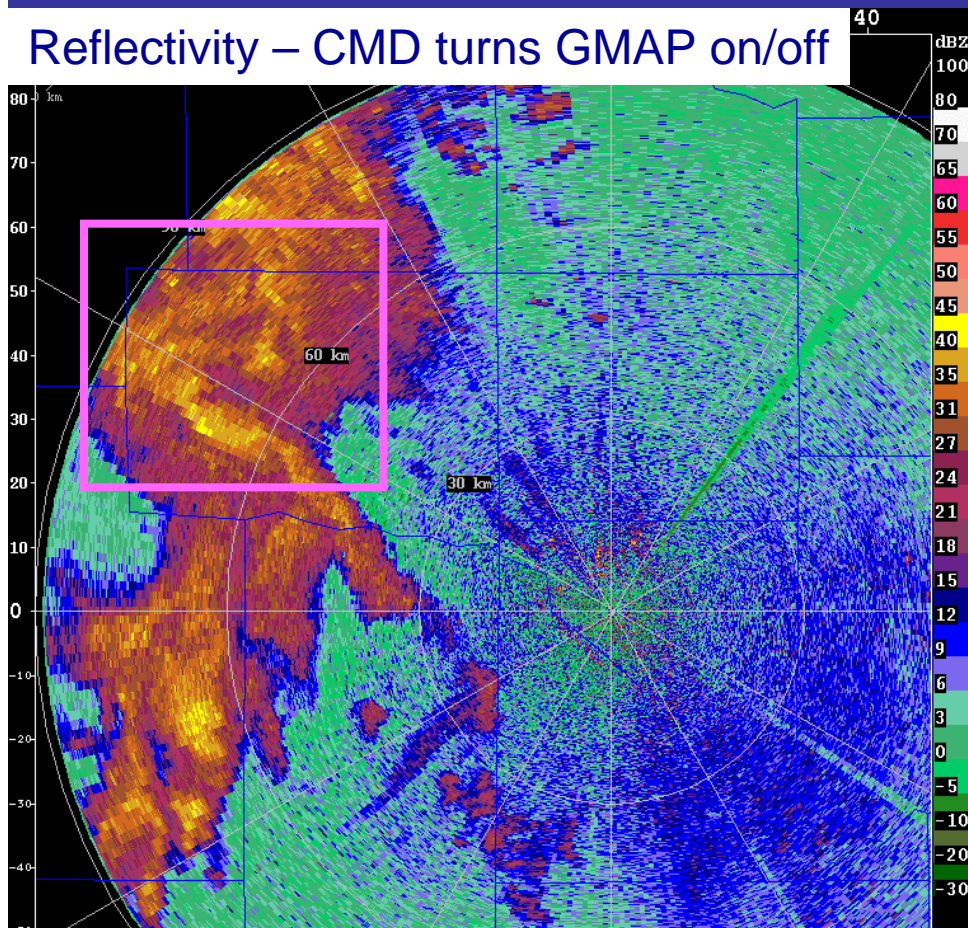




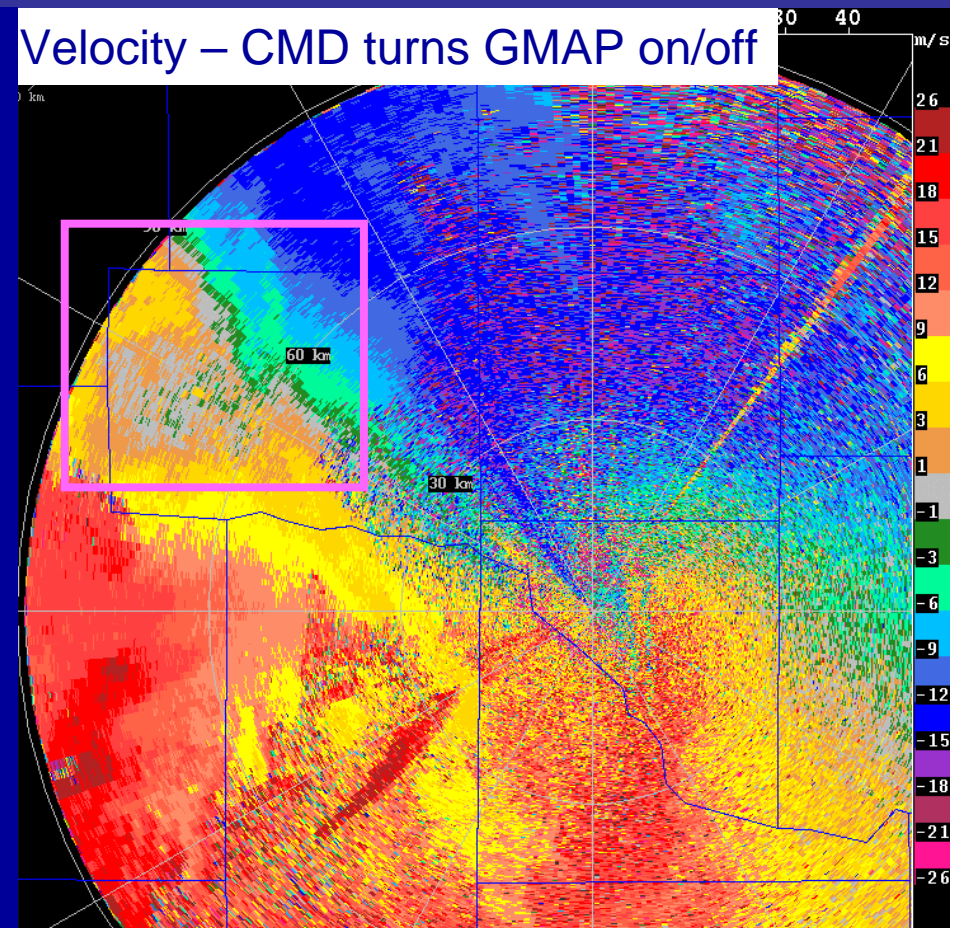
# CMD Specifies Where GMAP is Applied

- Clutter flag specifies GMAP application
- Near-zero precipitation return is not clutter filtered and no bias is introduced
- NP clutter is removed and underlying signal recovered

Reflectivity – CMD turns GMAP on/off



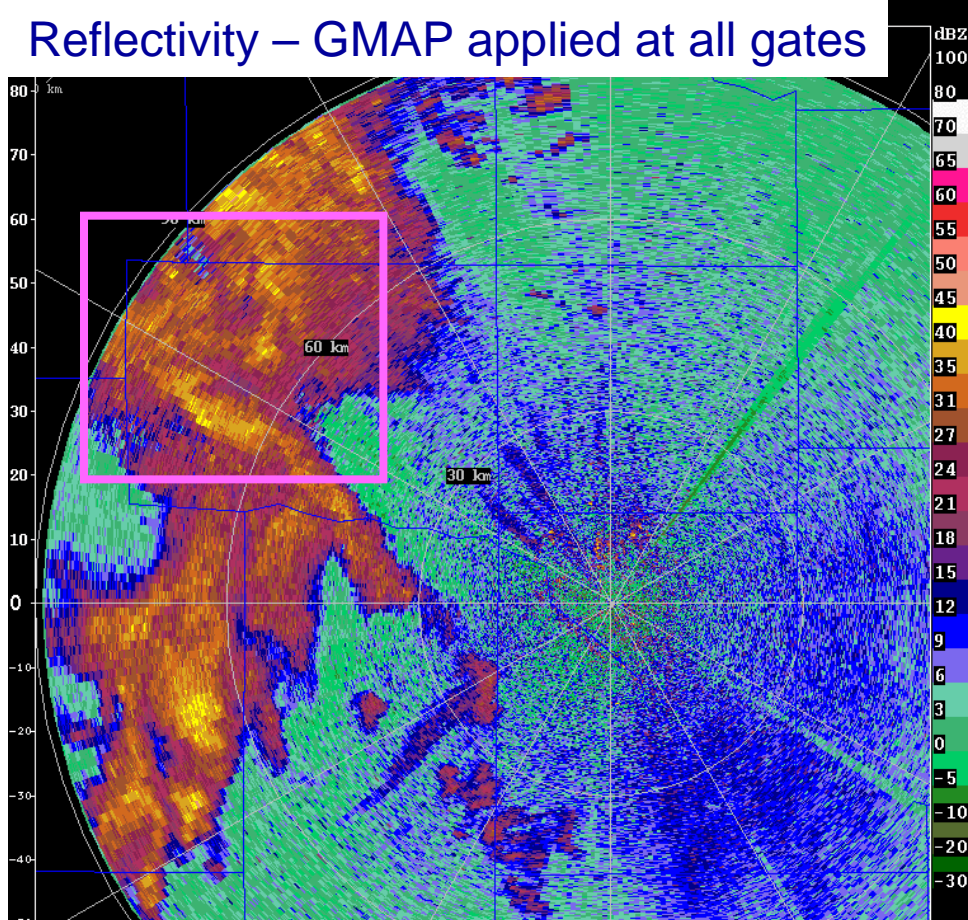
Velocity – CMD turns GMAP on/off



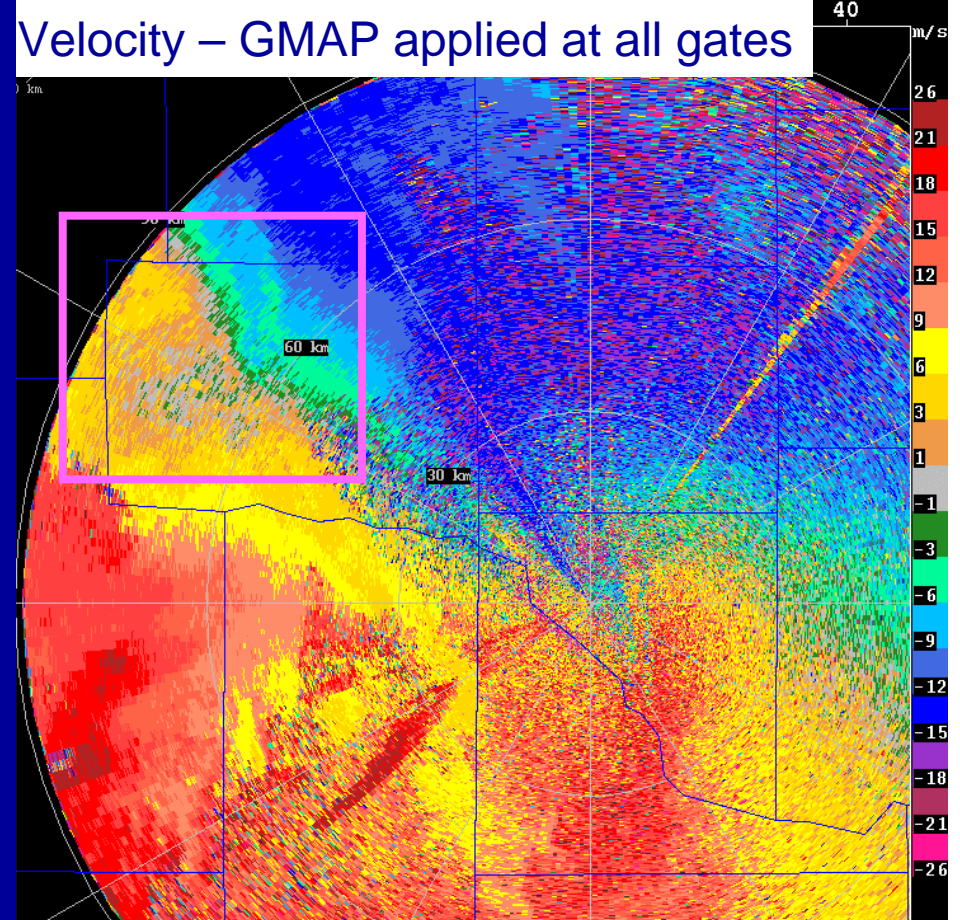
# What if GMAP is Applied Everywhere?

- Example shown for comparison purposes only
  - Shows the bias that is introduced when precipitation is clutter filtered
- CMD will automate the clutter filter application decision and remove the human from this decision loop
  - **Result: improved moment estimates**

Reflectivity – GMAP applied at all gates



Velocity – GMAP applied at all gates



# Clutter with Zero Velocity Precipitation

Colorado Front Range Snow Storm

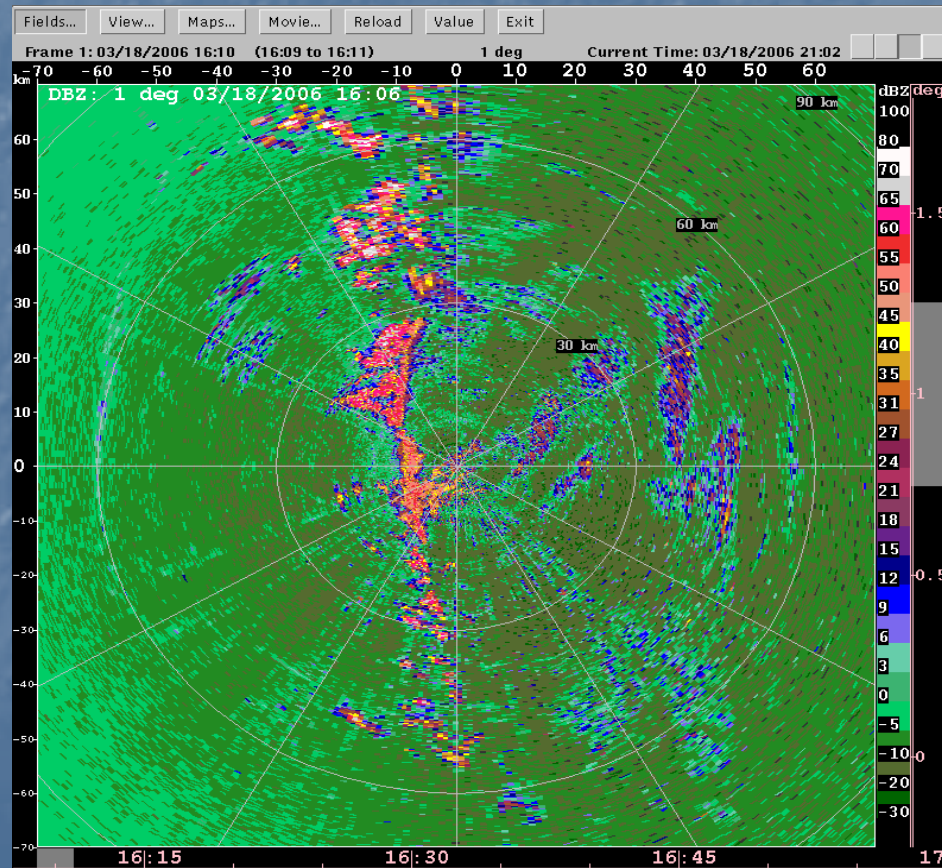
RVP8 in S-Pol

2006/03/08

# S-Pol Clutter Map

elev. 1.0 deg., to 70km range

Mountains to the west of the radar, plains with ridges to the east

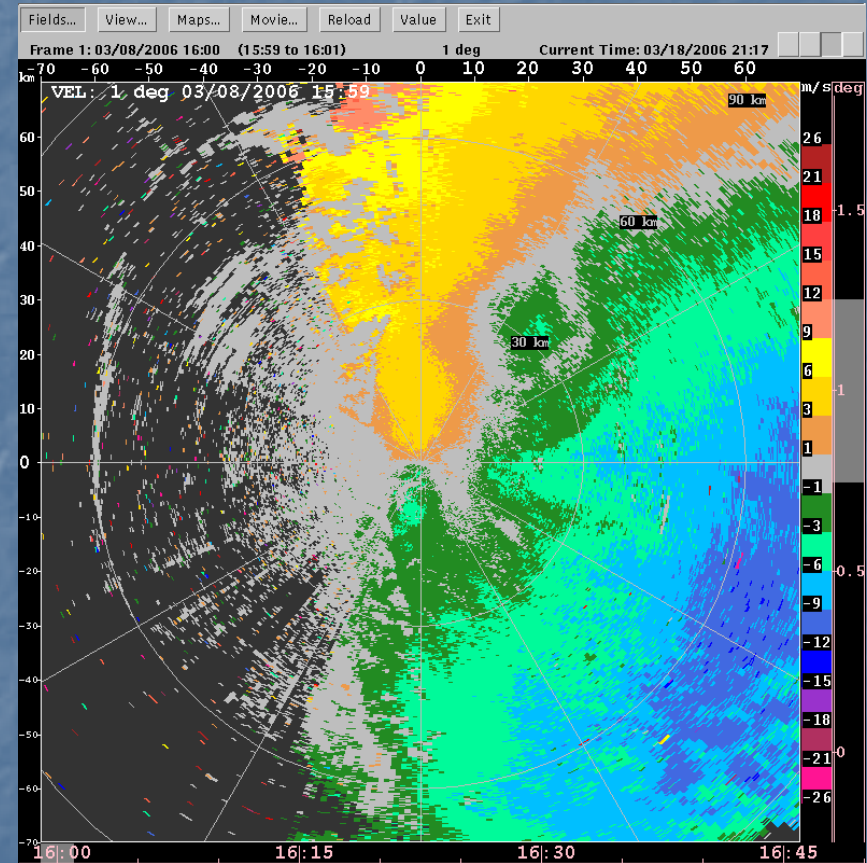
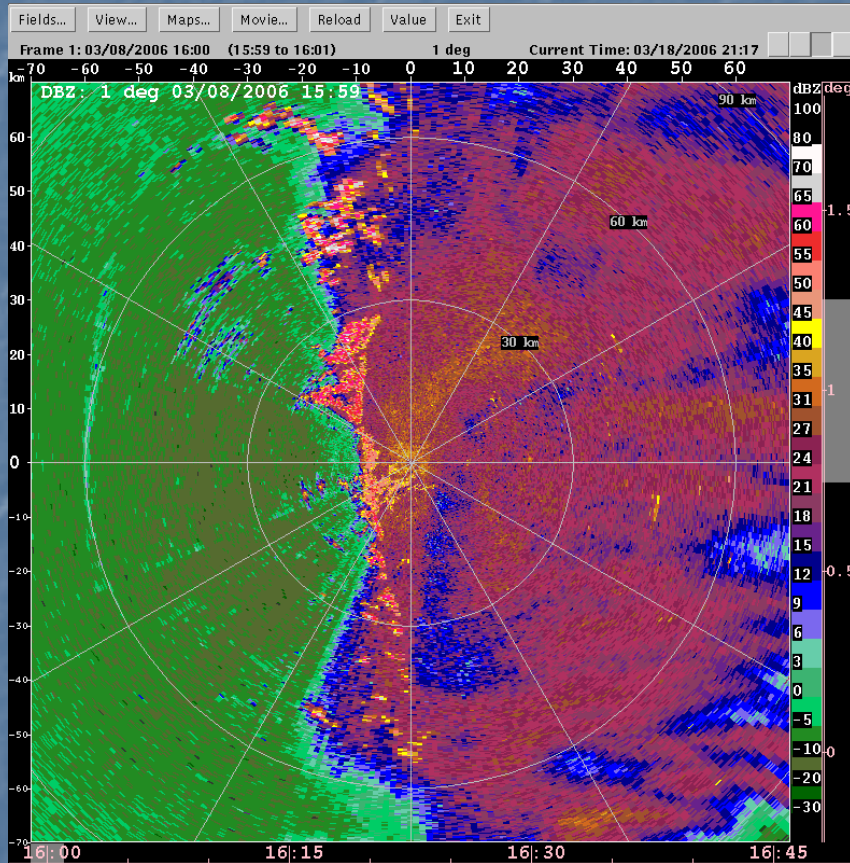


# Snow Example

Reflectivity

Elev. 1.0 deg.

Velocity

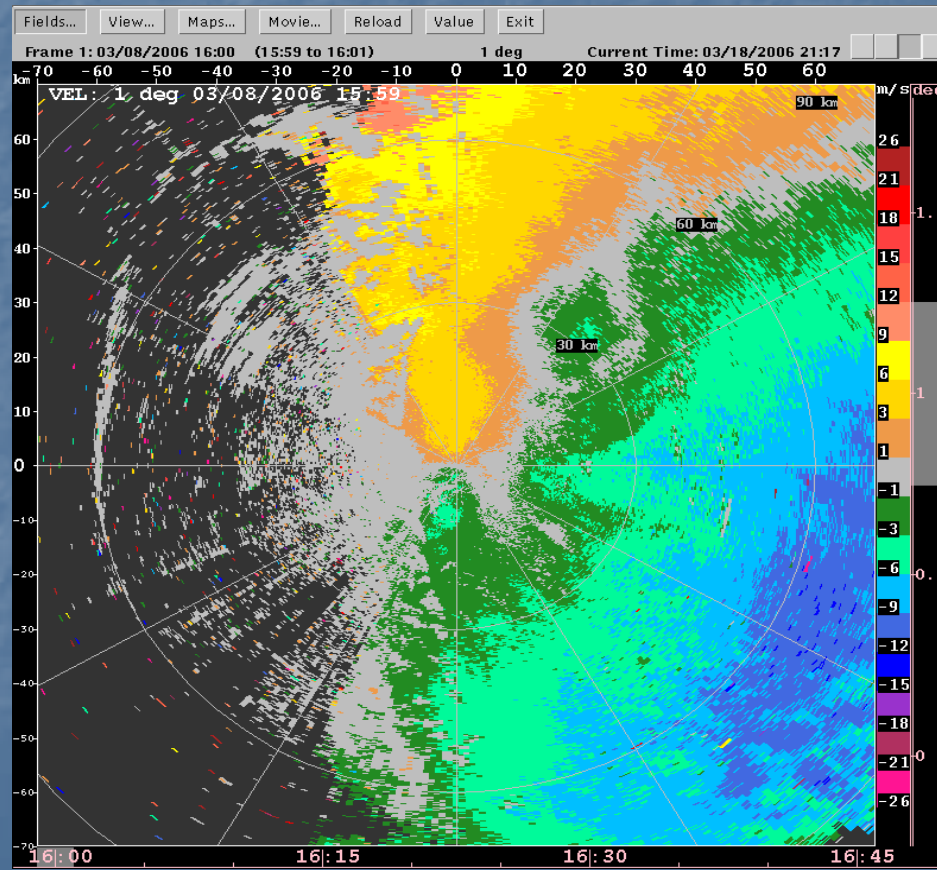


Winds: south-east to north-west.

Temperature at the surface around freezing

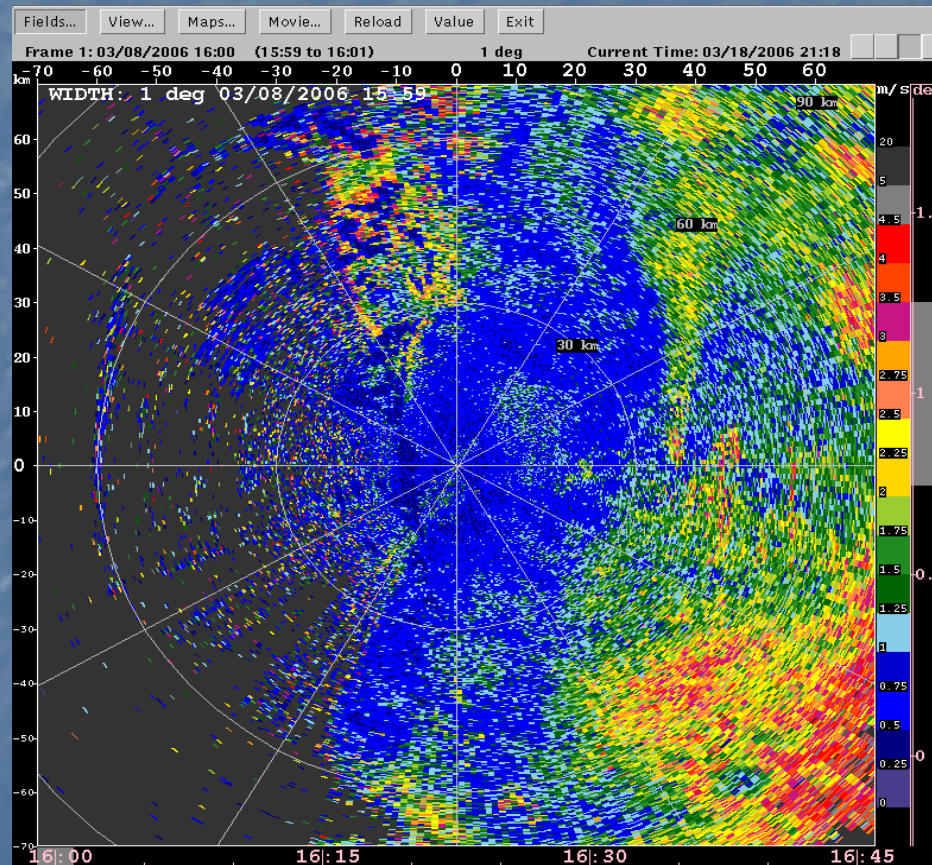
# Velocity field 0-m/s line through weather and clutter

Notice the 0 m/s line through the weather and clutter, making this a difficult case for clutter filtering and clutter identification

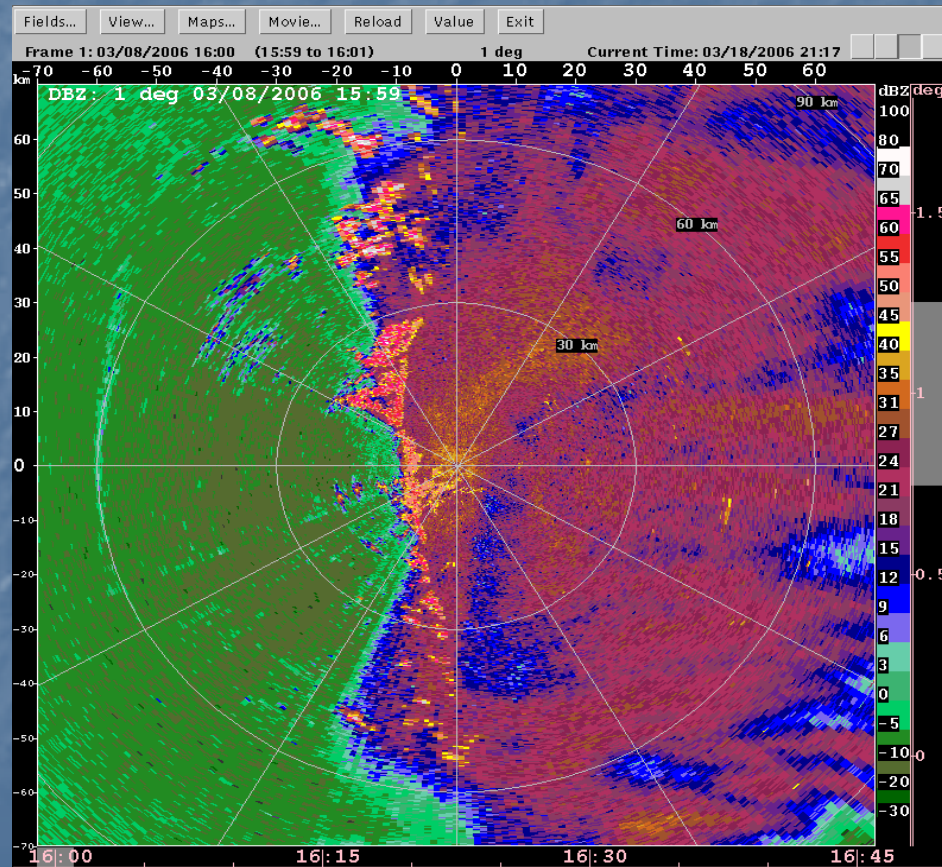


# Spectrum width

Both clutter and weather regions have narrow spectra, making clutter filtering difficult



# Snow band reflectivity again

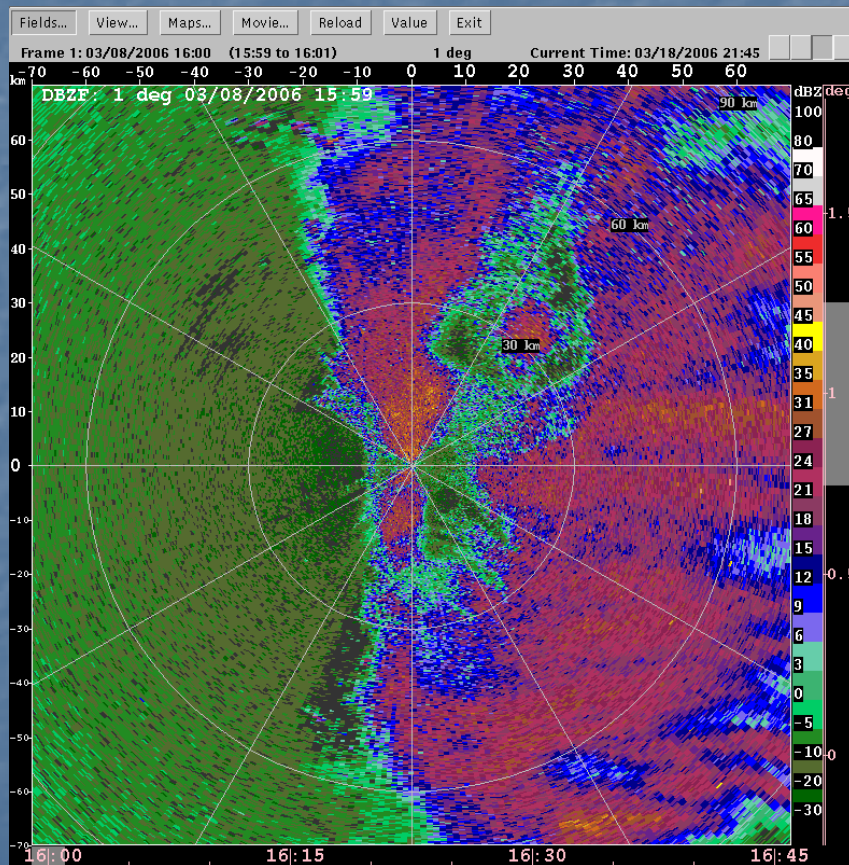




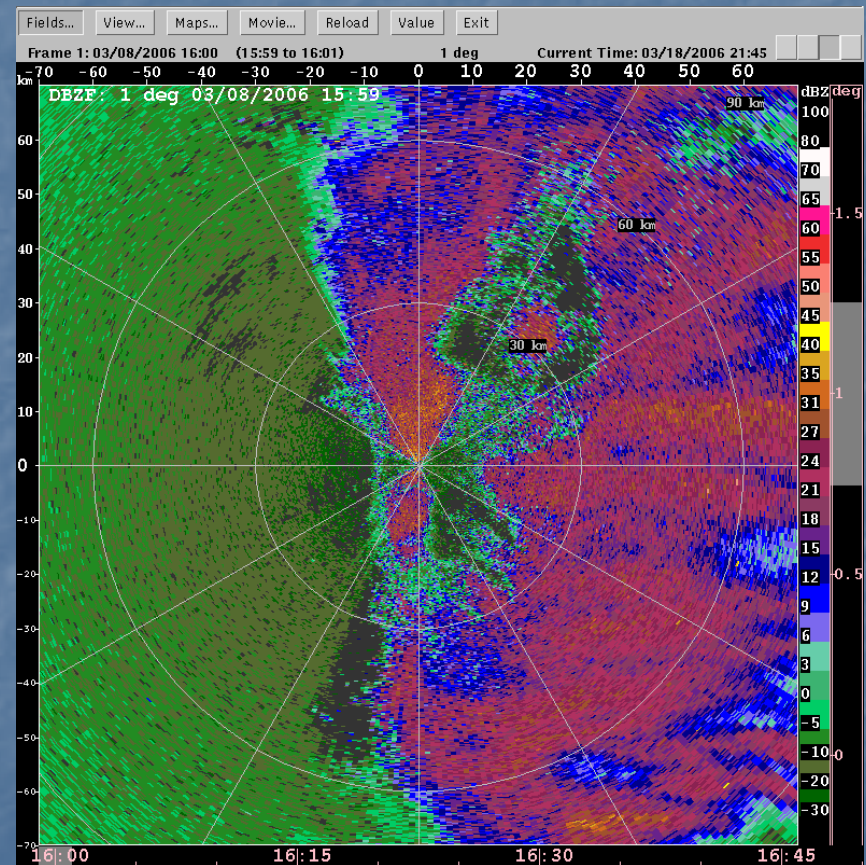
# Notch Filter versus Adaptive Filter

Power is removed from weather echoes.

## Notch

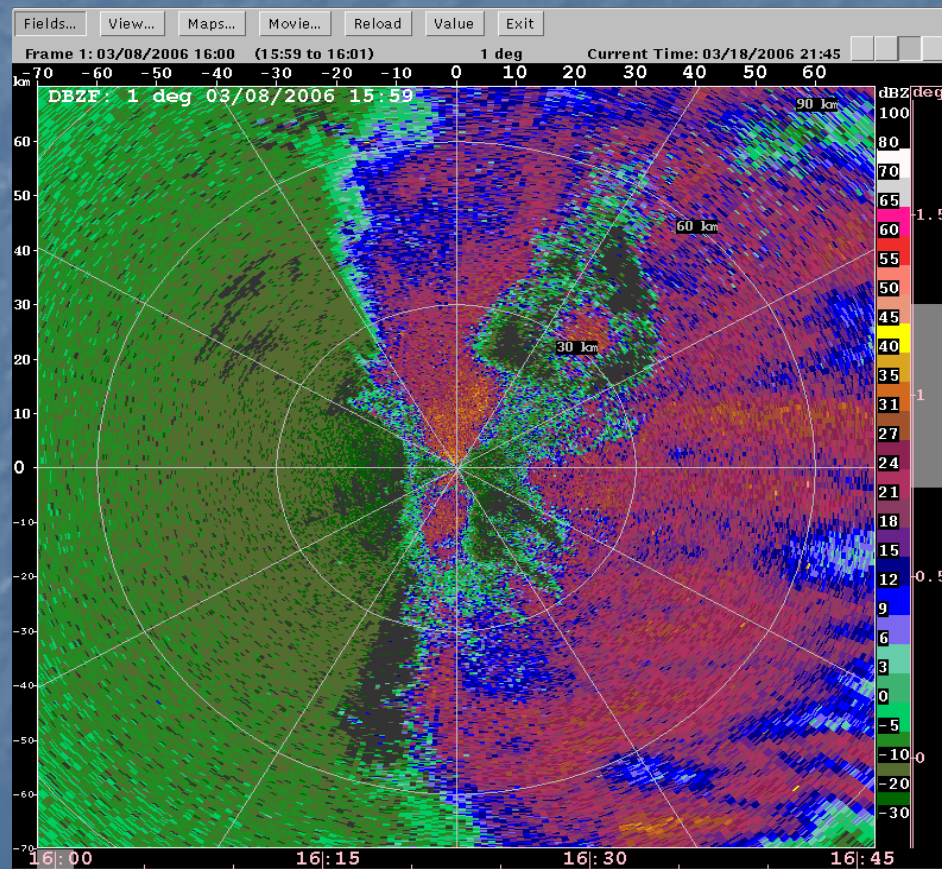


## Adaptive

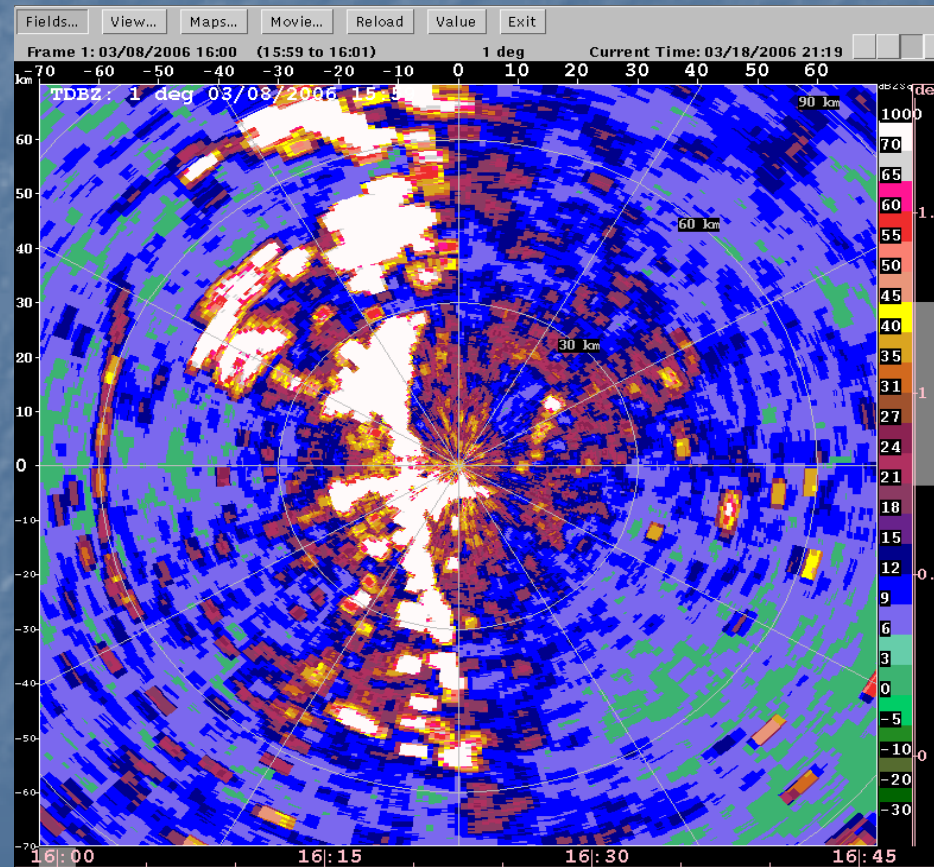


# Applying adaptive filter everywhere

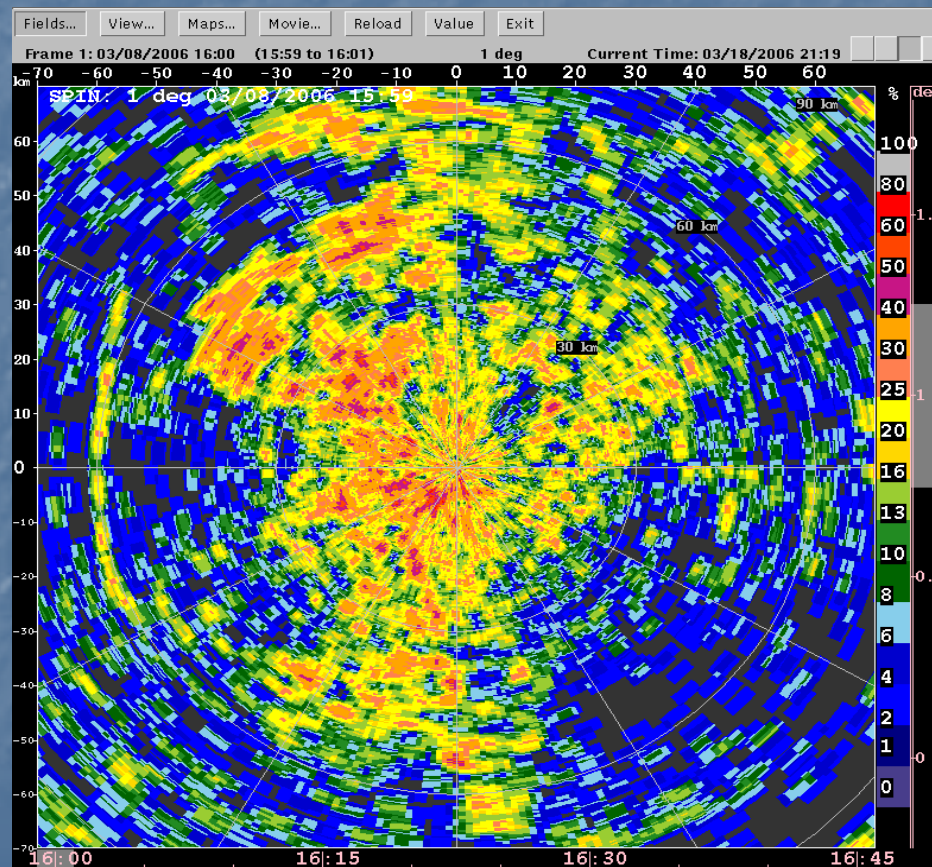
Not much difference from notch in the areas where velocity is close to 0.



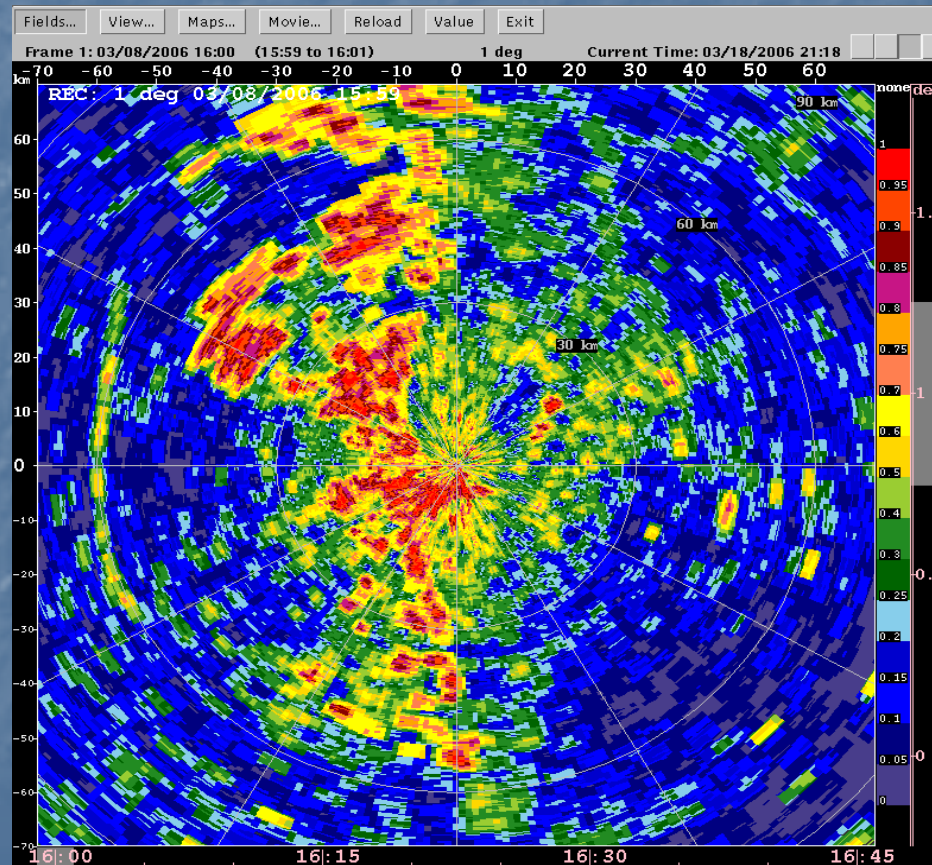
# DBZ texture feature field



# DBZ spin change feature field

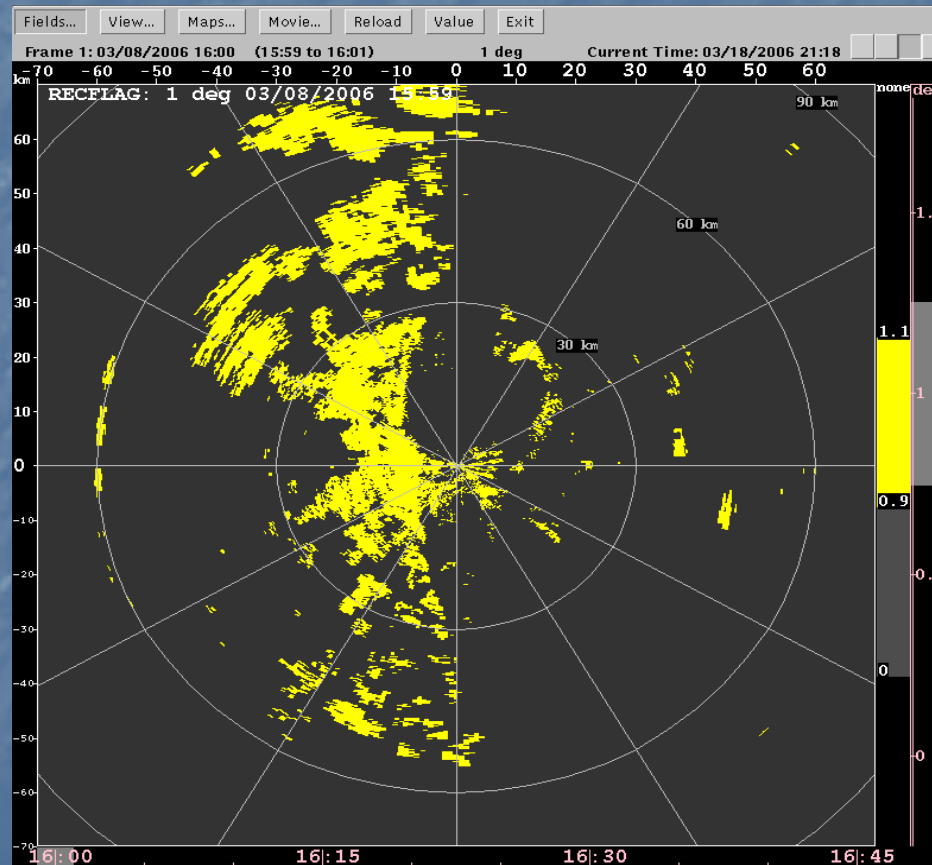


# CMD combined interest field

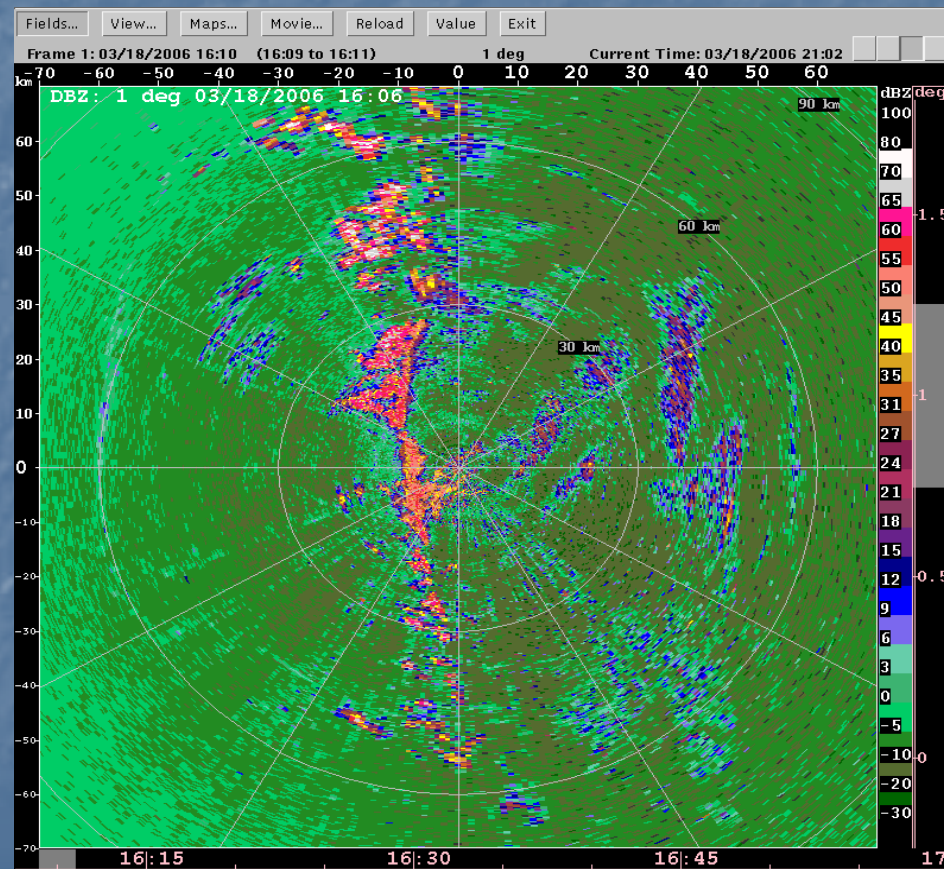


# CMD Clutter Flag Field

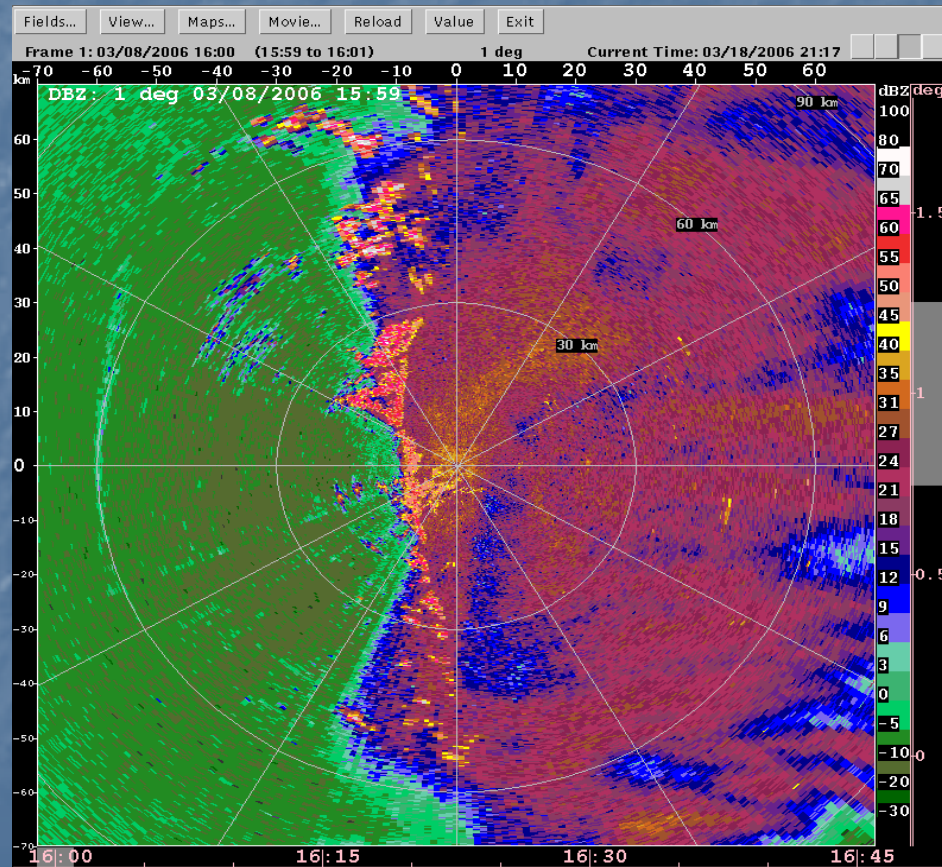
The clutter filter is only applied at the points flagged in this way



# Clutter reflectivity again



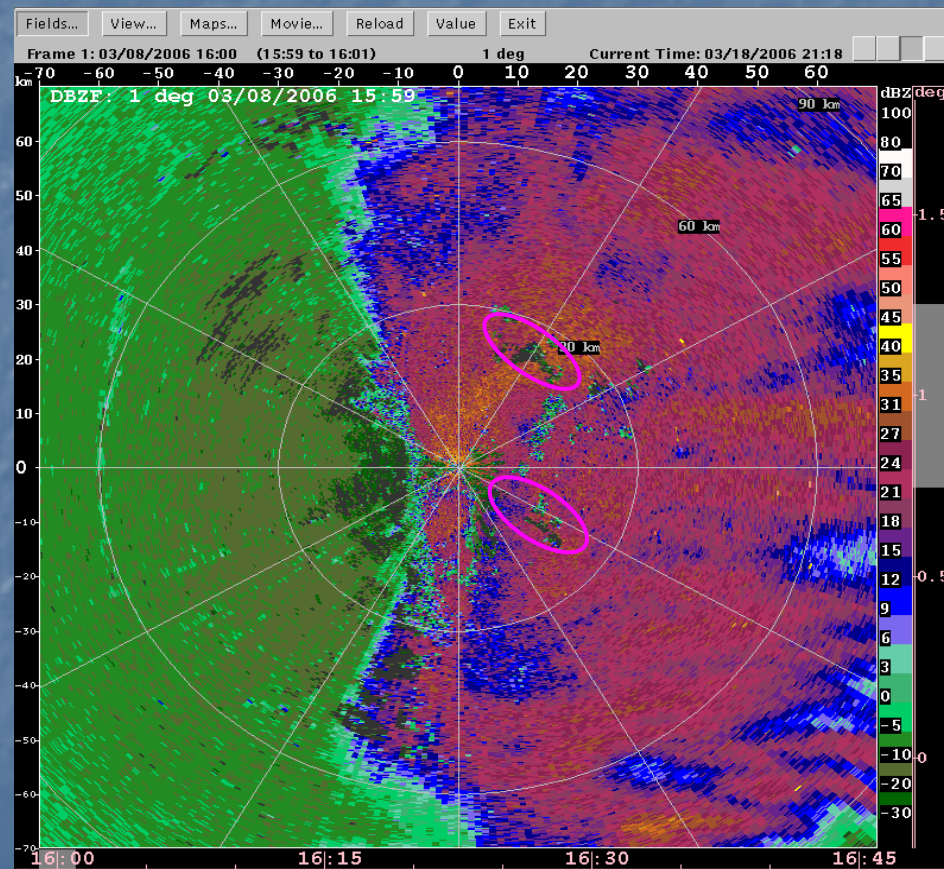
# Reflectivity field again





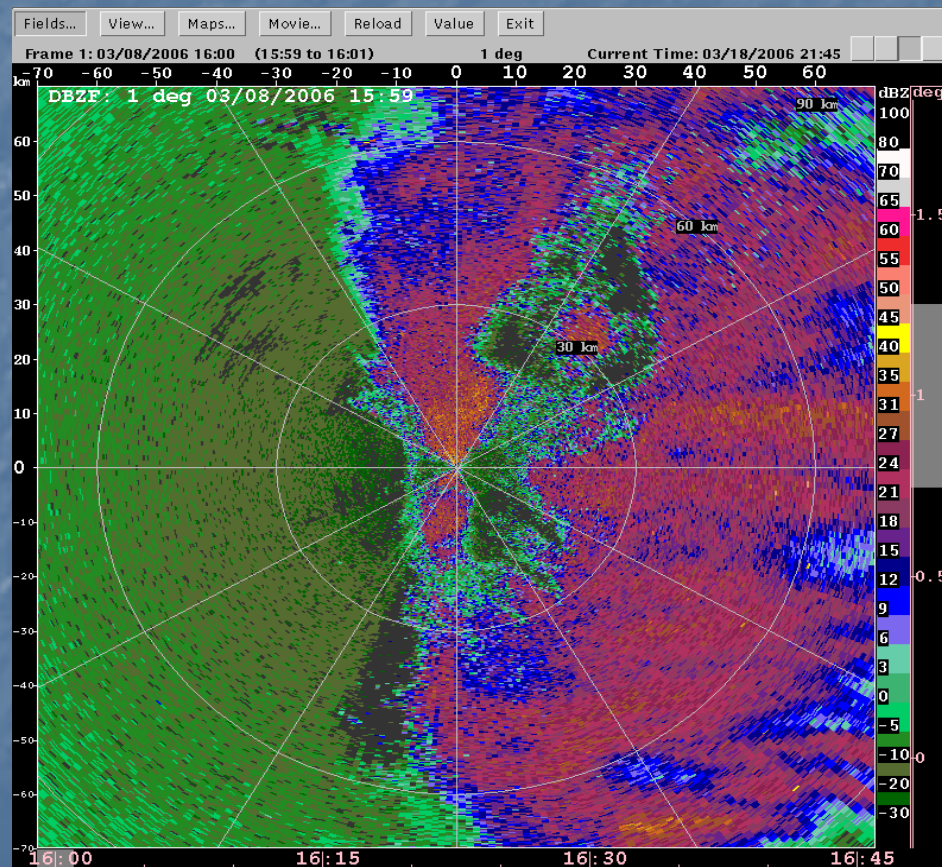
# Filtered reflectivity

Reflectivity after application of adaptive filter at points flagged as having clutter. Some small “problem” regions— still needs investigation.

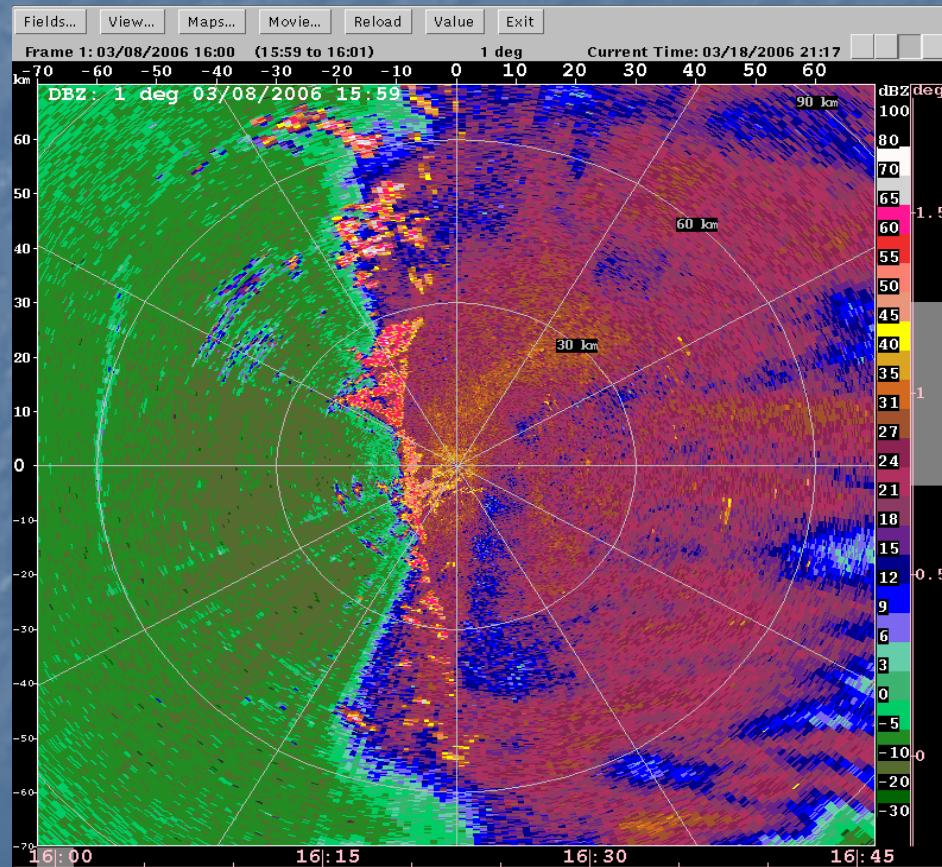


# Applying adaptive filter everywhere

Not much difference from notch in the areas where velocity is close to 0.

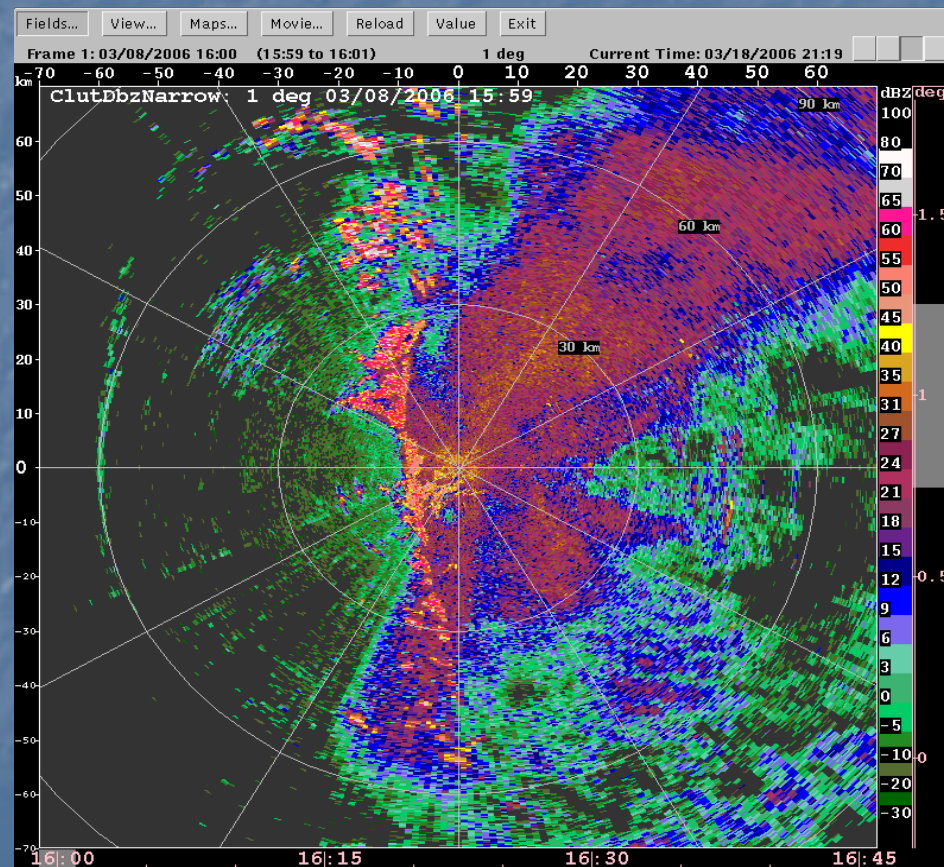


# Reflectivity again



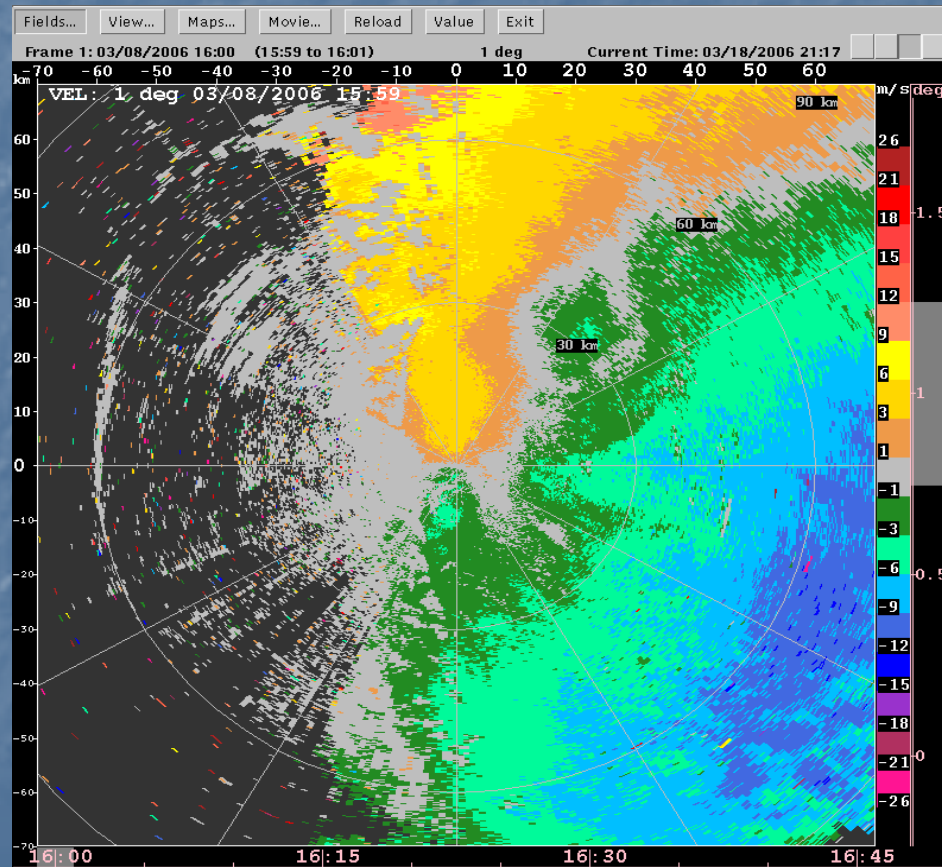
# New Fuzzy Logic Input Variables: Reflectivity close to 0 m/s in spectrum

One idea is to compute the power from only those points close to the 0 m/s line in the spectrum, and then compute texture and spin for that field, instead of from total reflectivity.

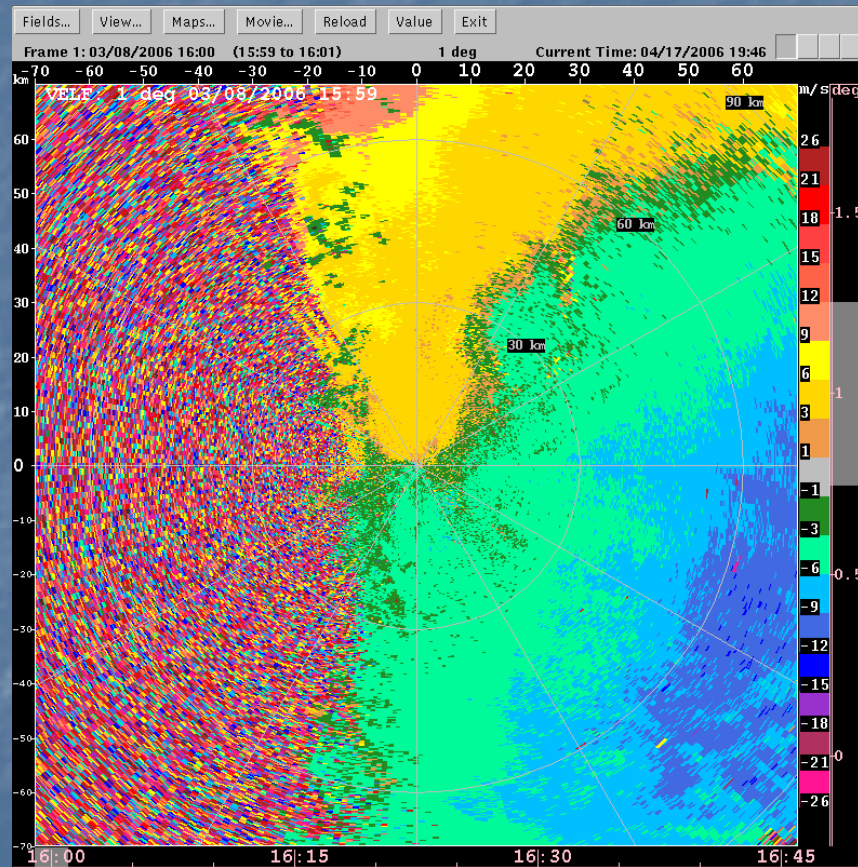


This idea is being tested.

# Velocity again

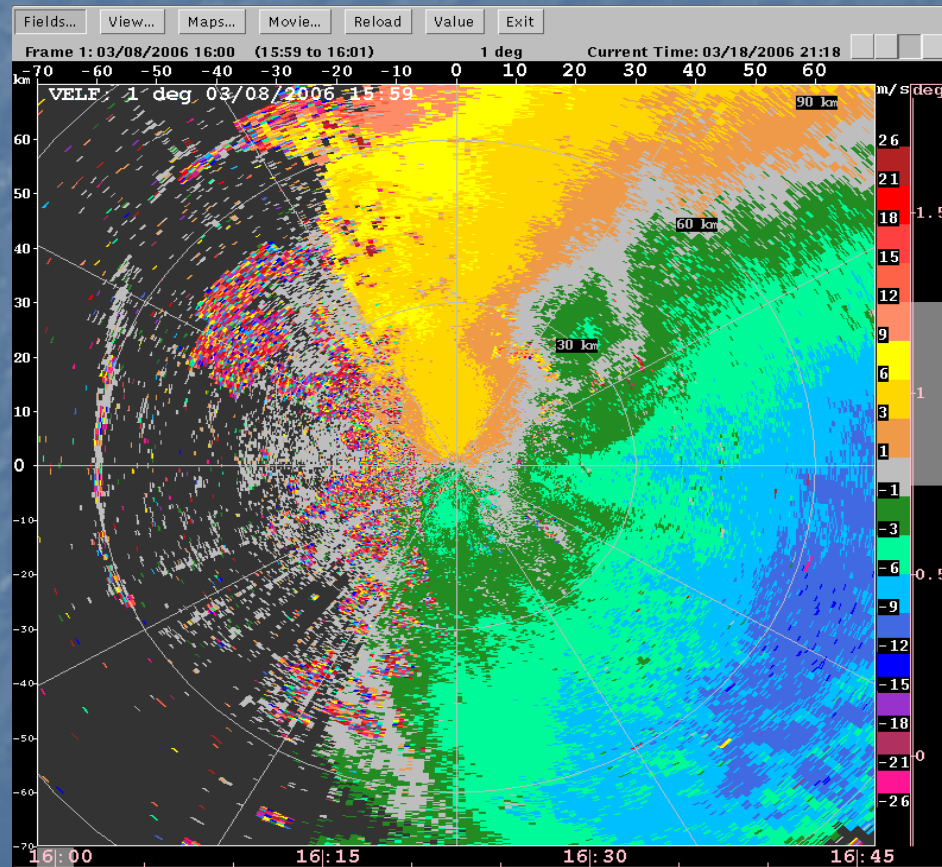


# Velocity after applying clutter filter everywhere



# CMD filtered velocity

Note the preservation of the zero velocity weather data



# Issues / Future work

- Identify “failure” regions and determine cause.
- Adding additional spectral features.
- Gathering and testing of further data sets.

Thank you



# Thank You

See:

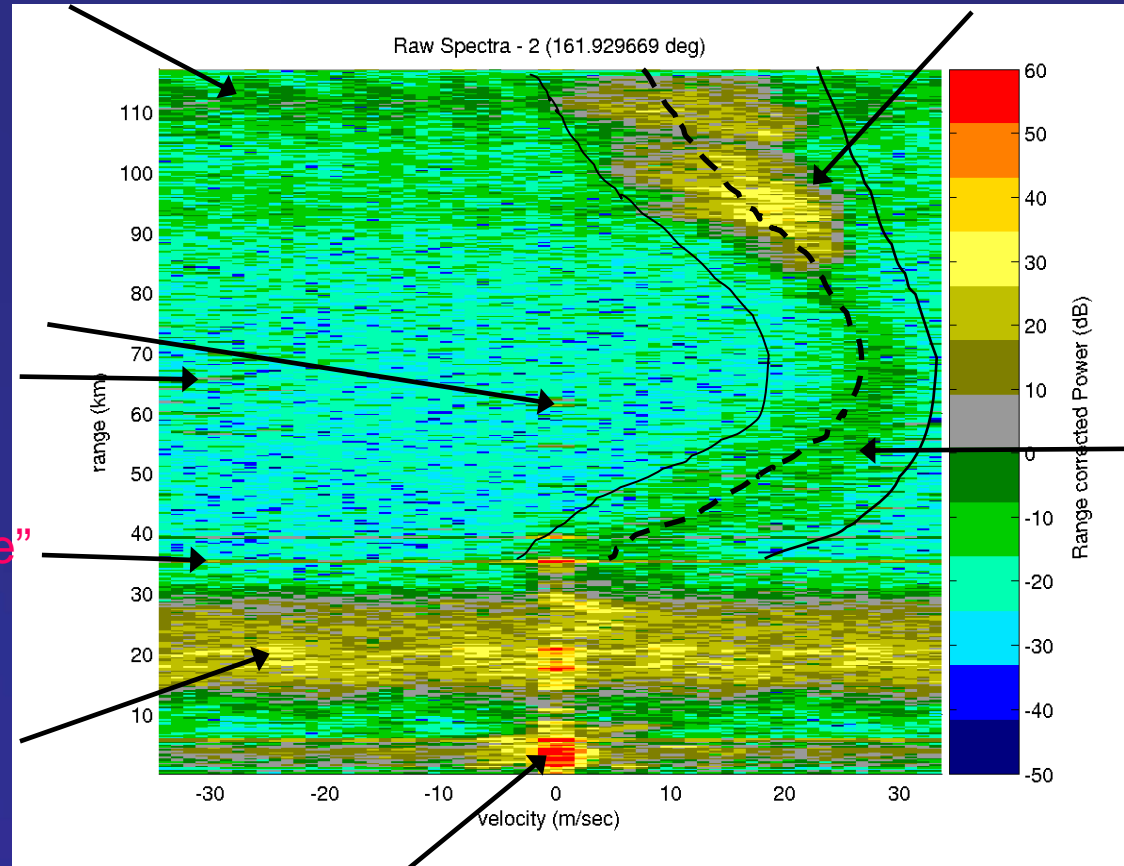
<http://www.atd.ucar.edu/rsf/NEXRAD/index.html>

for publication and presentation  
downloads & further info.

# Spectra versus Range

Second trip

Weather



Point scatterers

“Clear air”

Clutter “leakage”

Third trip

Clutter

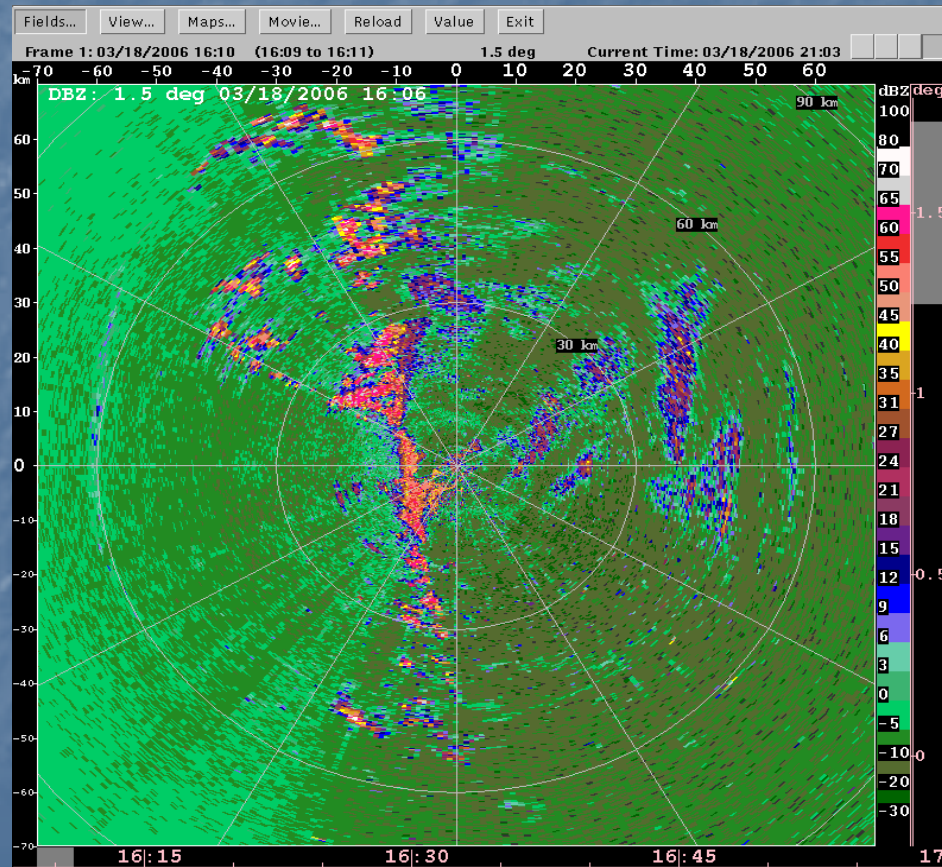


# Example – SPOL AP case

AP case  
2006/03/09

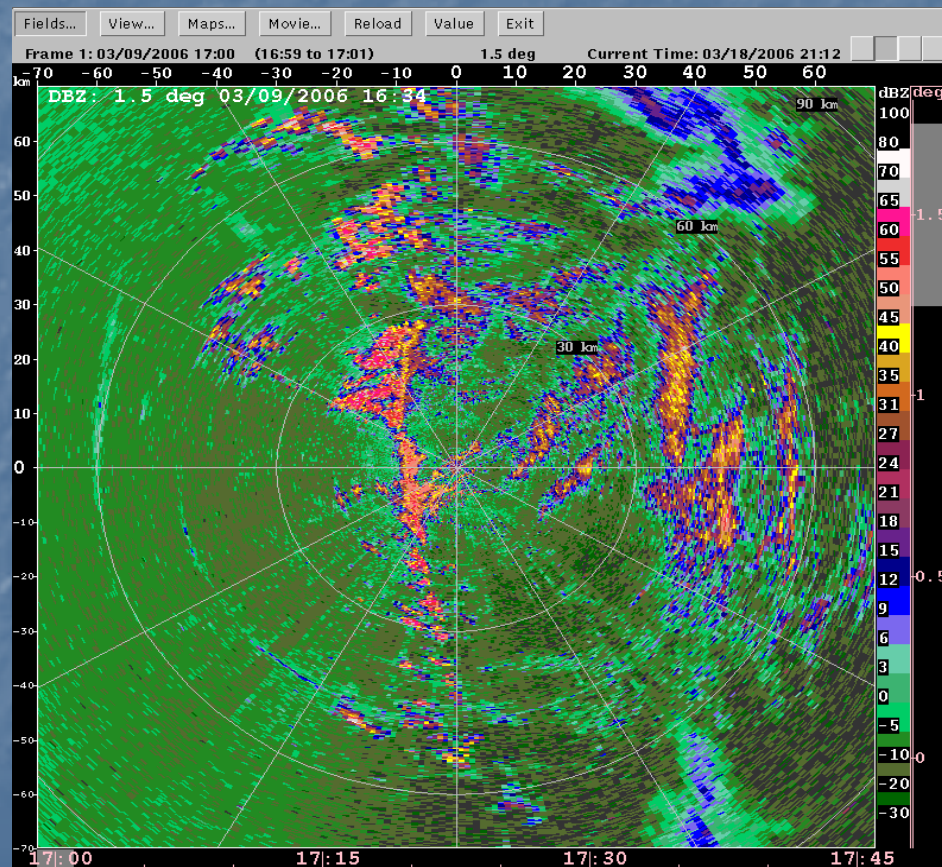
Case of anomalous propagation on the morning after the previous snow storm case.

# Clear-day clutter reflectivity at 1.5 degrees

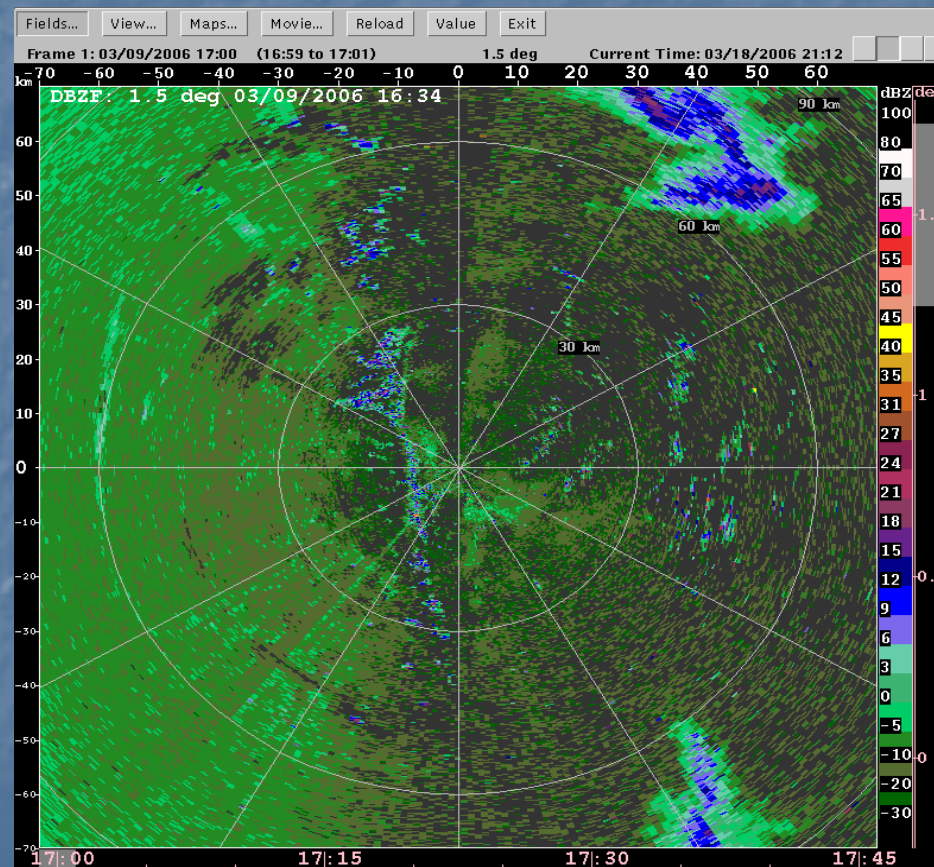


# AP reflectivity at 1.5 degrees

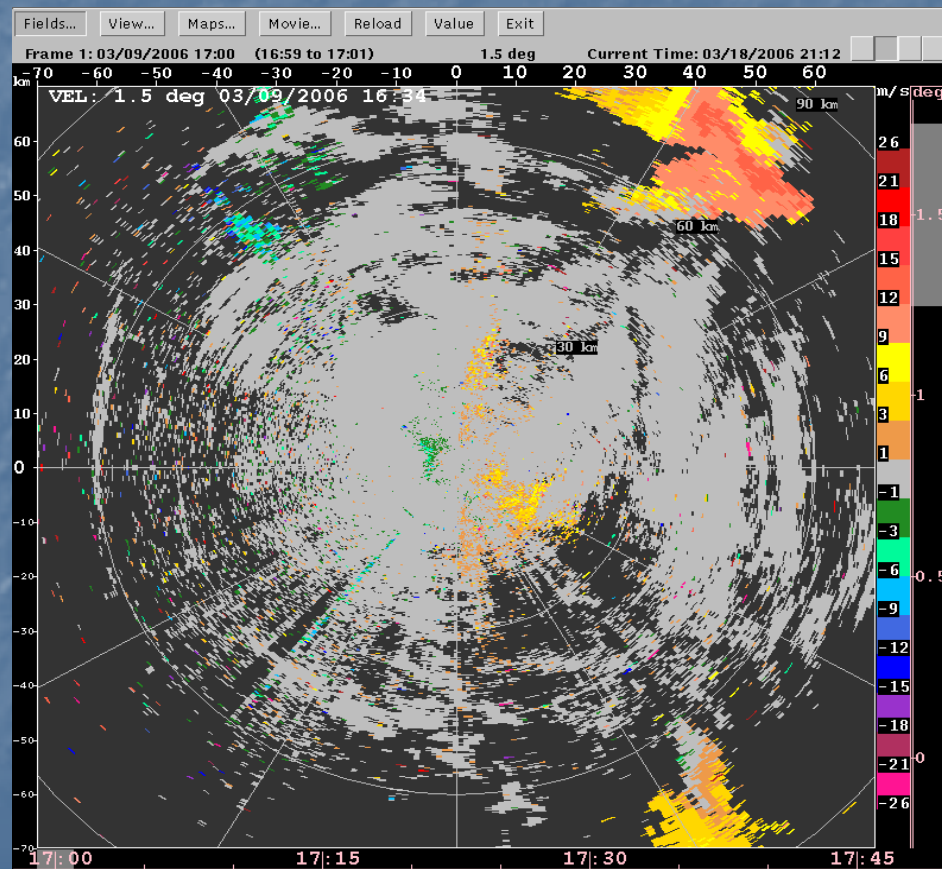
This case has usual NP, plus AP within 60 km and Weather echoes to the NE and SE beyond 60 km.



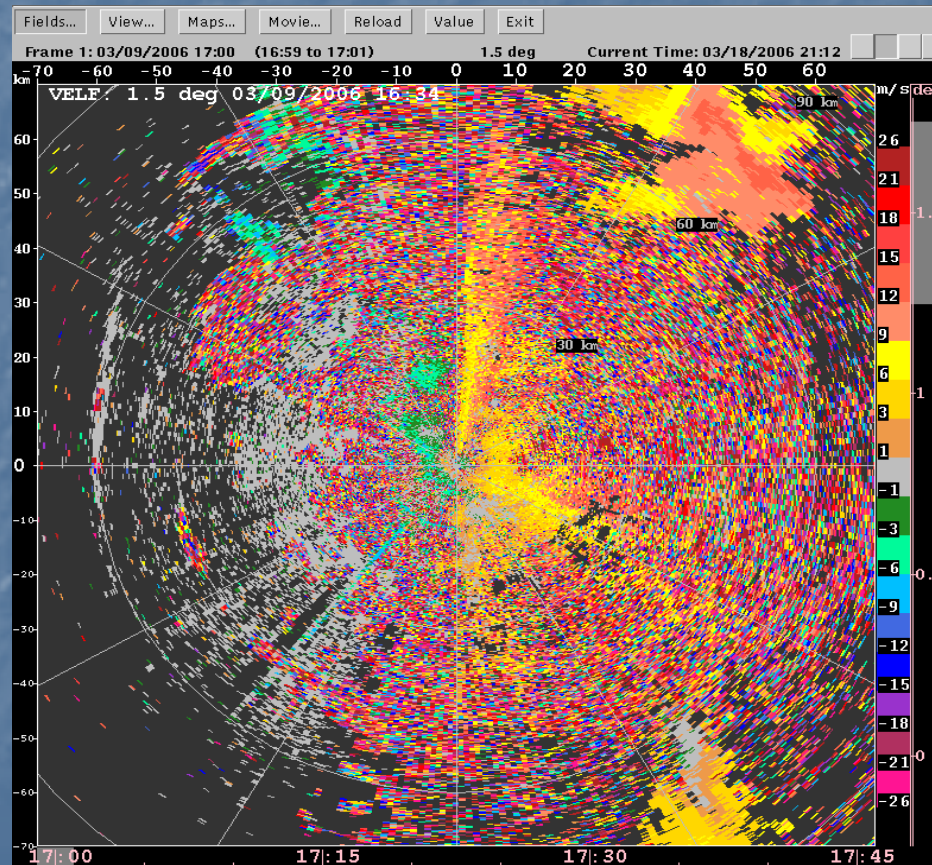
# Filtered reflectivity for AP case



# Radial velocity for AP case



# Filtered radial velocity for AP case





# Example – SPOL Dual-pol case

Dual polarization case  
2006/03/10

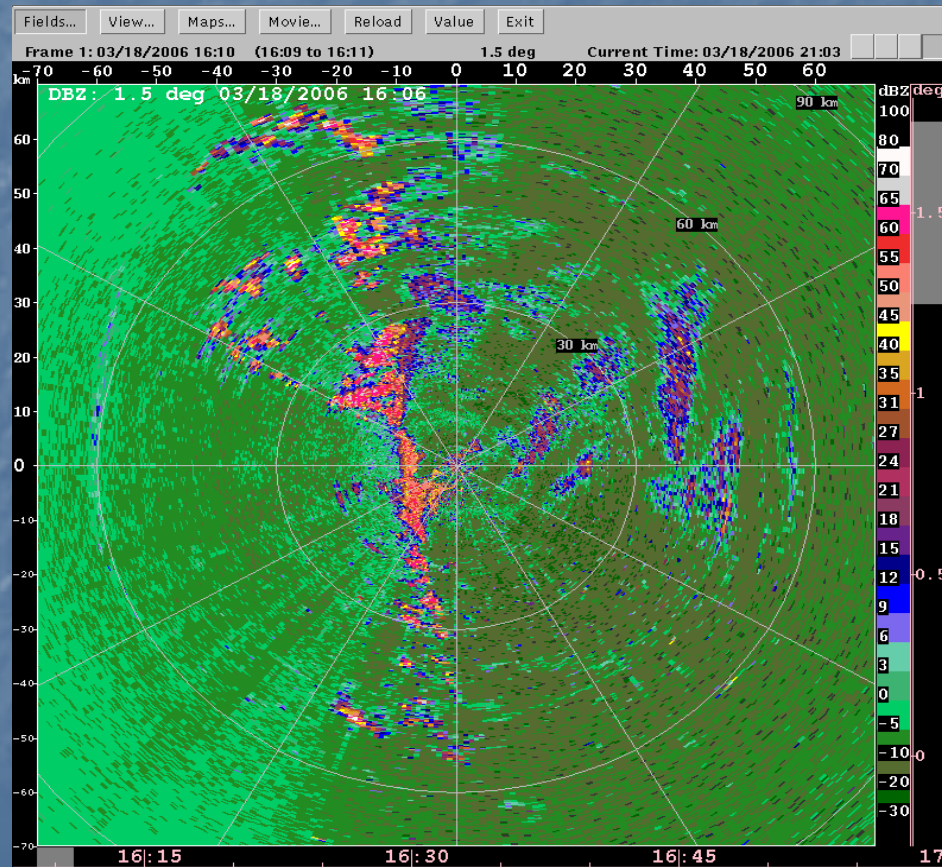
For this case, SPOL was run in alternating pulse mode.

There is weather echo to the north and south of the radar.

Some dual polarization fields are added to the CMD to enhance the accuracy of the clutter detection.

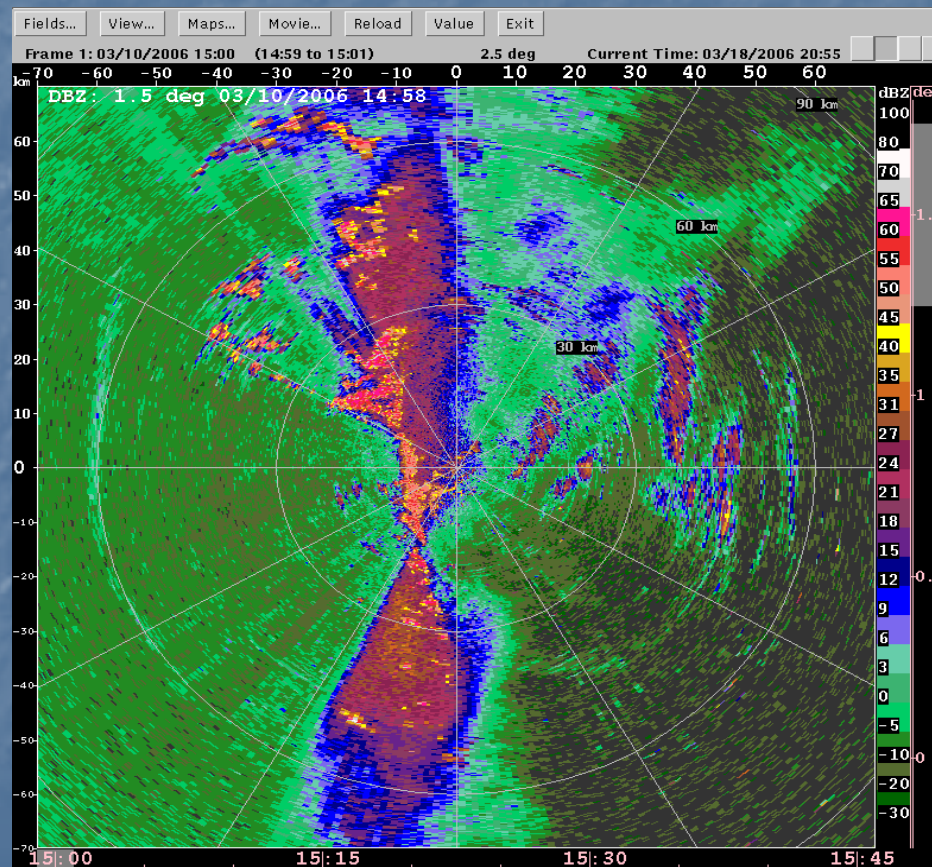
# Clear-day clutter at 1.5 degrees

## again



# Reflectivity field – dual pol case

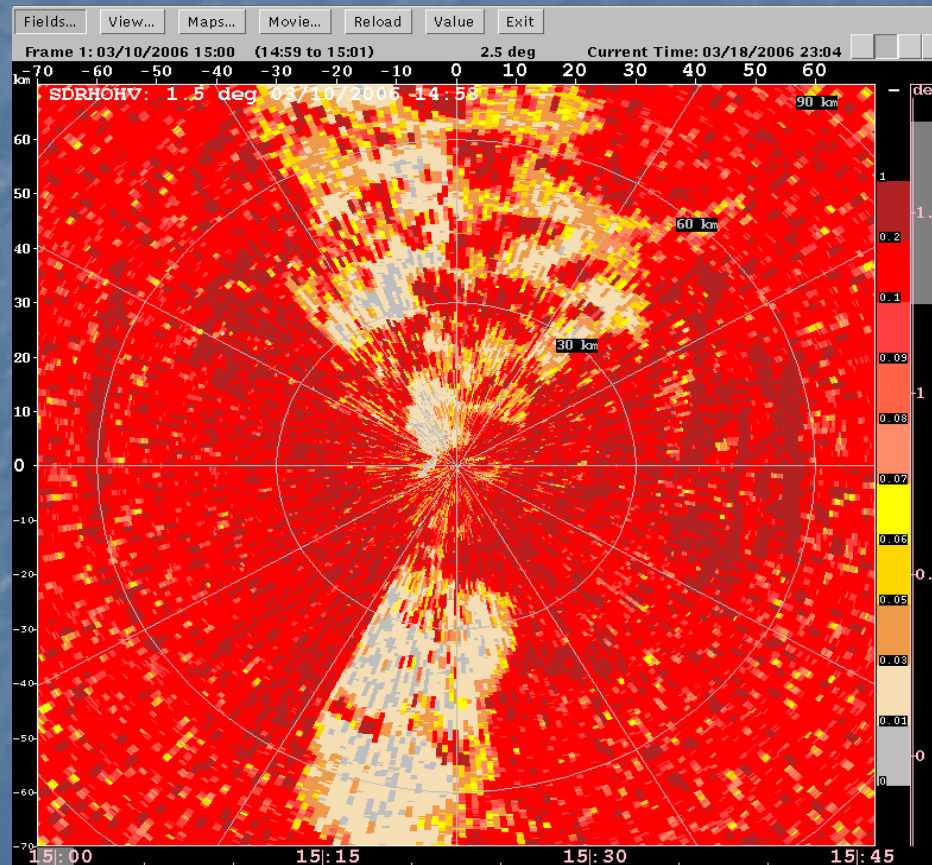
There is clutter to the east of the radar, and weather and clutter combined to the north and south of the radar.



There also appears to be some minor AP mixed with the NP clutter.

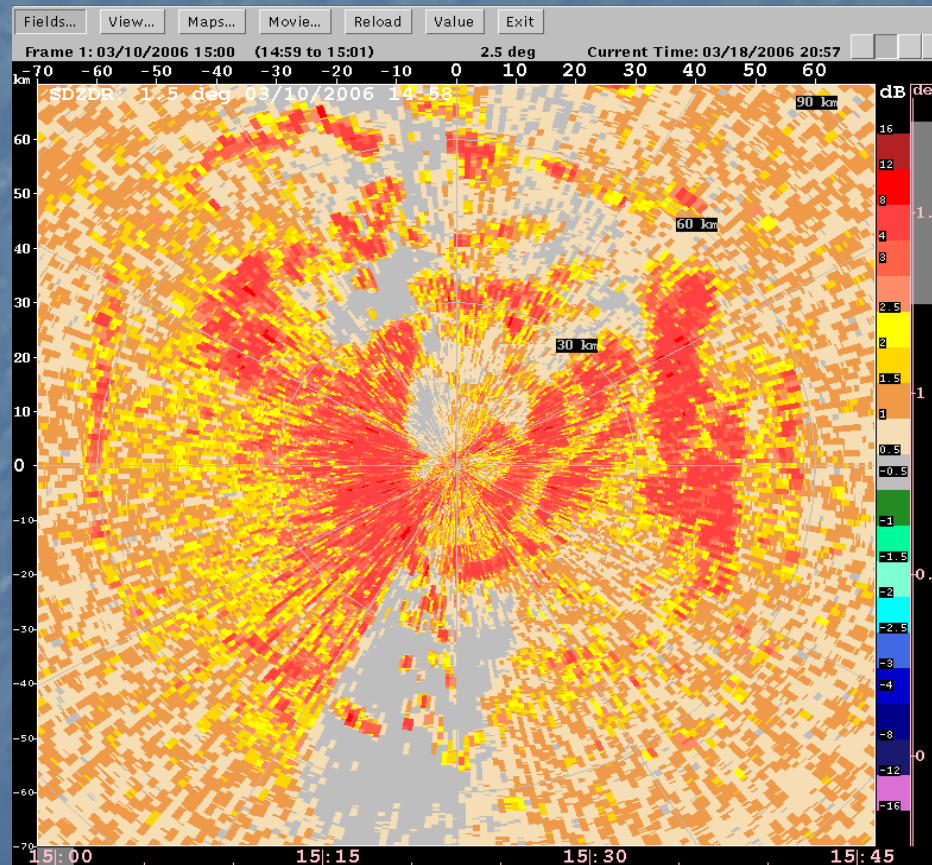
# SDEV of RhoHV feature field

Feature field computed as the standard deviation of RhoHV.  
Lower values (gray) indicate weather echo.



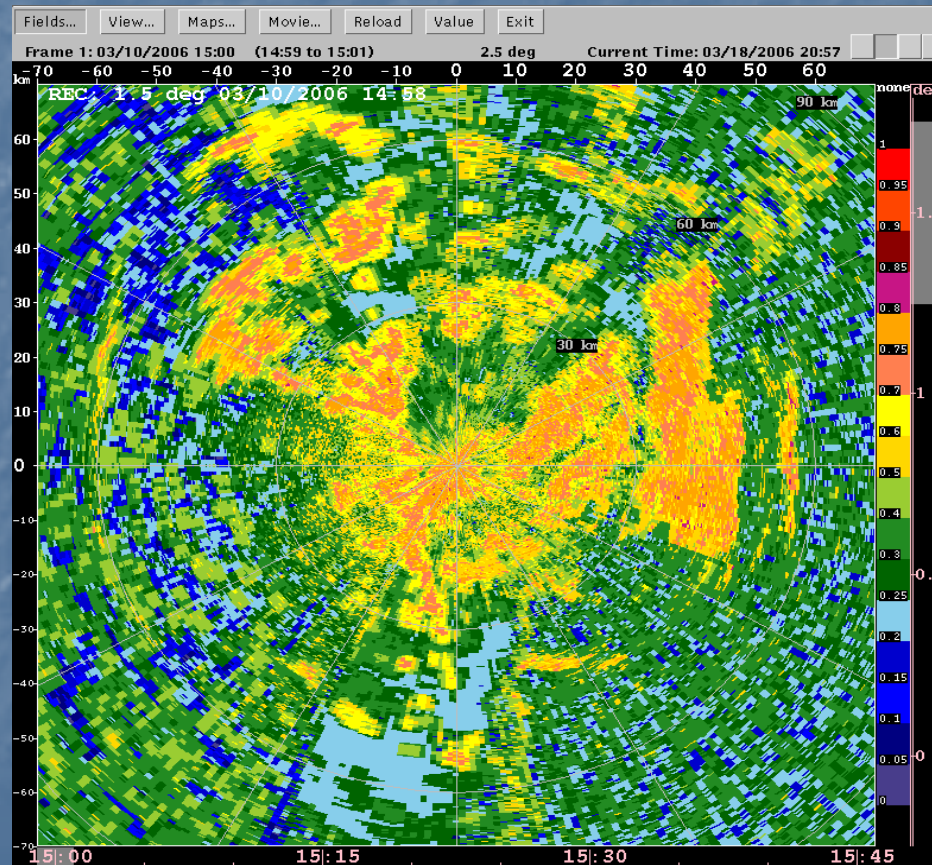
# SDEV of ZDR feature field

Feature field computed as the standard deviation of ZDR.  
Lower values (gray) indicate weather echo.

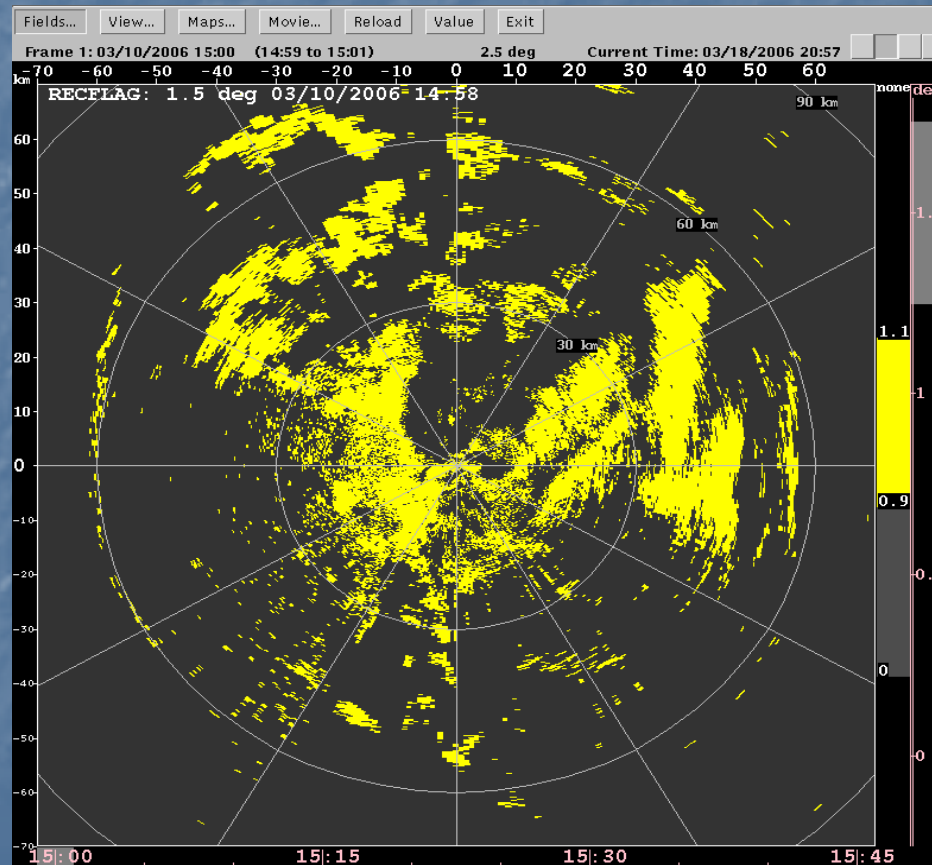


Higher values (reds) suggest clutter regions.

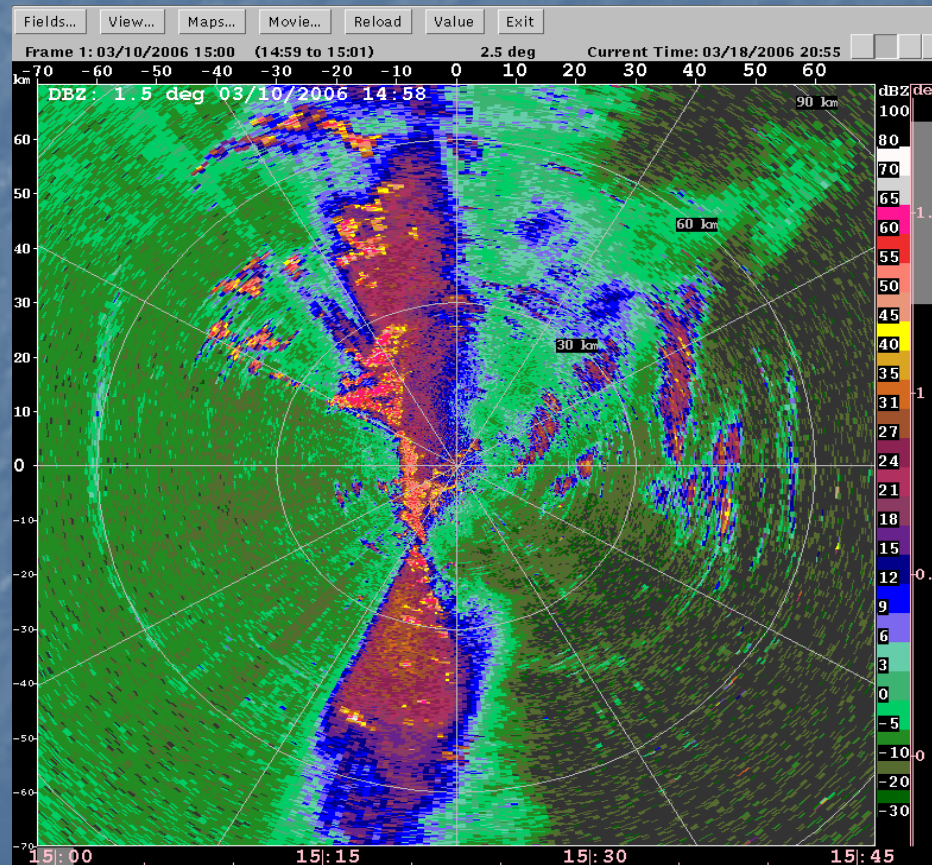
# Dual polarization CMD combined interest field



# Dual polarization CMD clutter decision flag

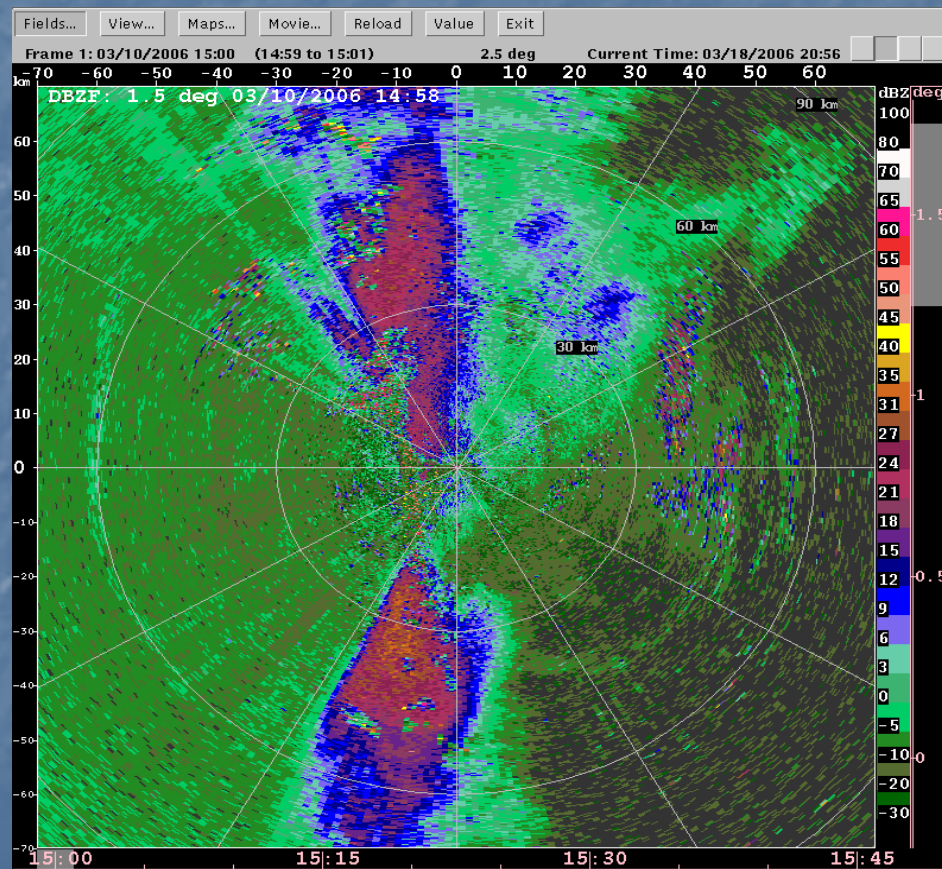


# Unfiltered dual-pol reflectivity again



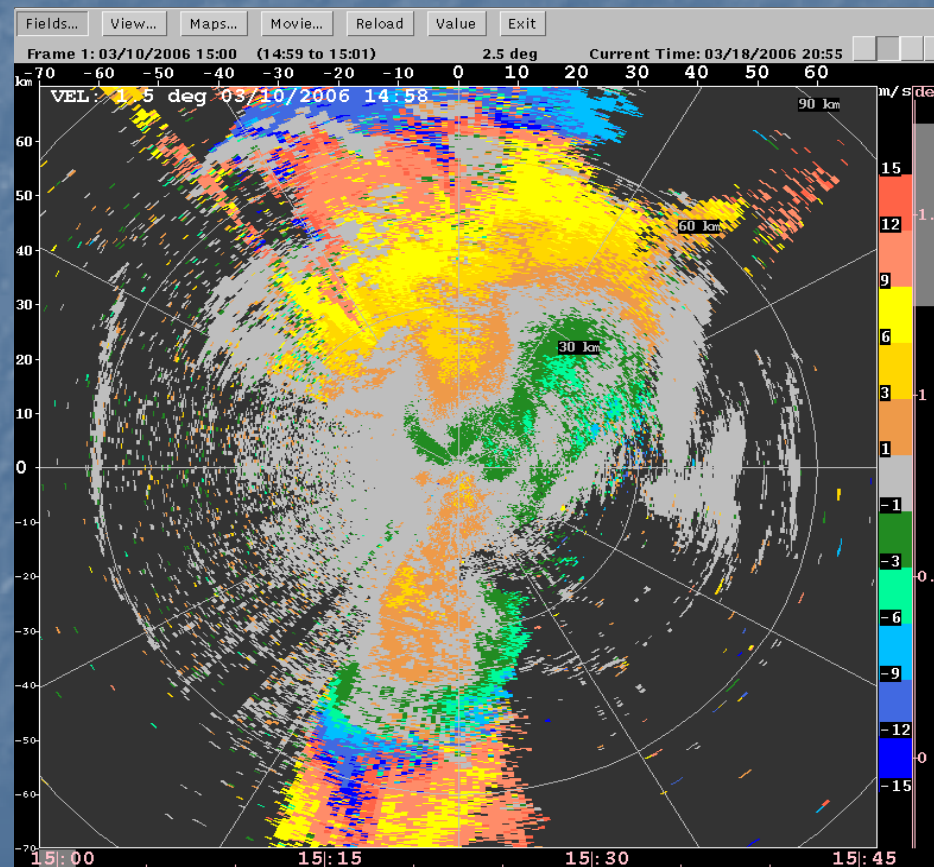


# Filtered dual-pol reflectivity



# Unfiltered dual-pol velocity

Folding is due to creating spectra using every second pulse, so that spectra are not affected by differences in H/V paths. This was done for simplicity, and is only a temporary solution.



This problem would not occur with simultaneous HV transmission.

# Filtered dual-pol velocity

