CMD Deployment
TAC Meeting, November 2009
Rich Ice

• Review Implementation Design for Build 11.0
• Summarize Beta Test Results
  – Missed Detections
  – Resulting Build 11.1 Changes
• Build 11.1 Deployment
• On-going Field Performance Monitoring
  – CMD Performing Well in Most Cases
  – False Detections Associated with Low Mean Velocity
    Returns
  – Performance Examples
• Future Work
CMD Algorithm - NCAR

• Algorithm Feature and Fuzzy Logic Interest Fields
  – Clutter Phase Alignment (CPA)
  – Reflectivity Texture (single radial, 9 gates)
  – SPIN (single radial change of sign of texture gradient – 11 gates)

• Includes Data Quality Functions
  – Signal to Noise Ratio Threshold (currently 0 dB)
  – Fill in Filter (recommended 3 gates maximum)
  – Median Filter (recommended 3 gates for smoothing CPA)

• For algorithm design and performance details:
A Few Details

\[ CPA = \frac{\sqrt{\left( \sum_{i=0}^{m} I_i \right)^2 + \left( \sum_{i=0}^{m} Q_i \right)^2}}{\sum_{i=0}^{m} \sqrt{I_i^2 + Q_i^2}} \]

Hubbert et al. JTECH 2009b
CMD Implementation Design Features

• CMD Clutter Flags generated in RVP8
  – first Surveillance cut of each split cut segment (lower 2 of 5)
  – Super resolution: 0.5 degrees by 0.25 km

• CMD Parameters set by special configuration file

• Bypass Map to be same as baseline (1 deg by 1 km resolution)

• Surveillance Reflectivity filtered bins selected in near real time
  – Initially done on 0.5 degree by 1 km basis
  – Build 11.1 changed to Bypass Map application (more later)

• Doppler data filtered by normal application of bypass map

• Operator control – CMD enable/disable – can add zones

• Bypass map for each segment sent to RPG and in Level 2 data
  – Updated each volume
  – Associated with previous volume scan

• CMD Status indicator on HCI and in GSM
Beta Tests – Spring – Summer 2009

• Build 11.0 Beta Test – March 31 – May 14, 2009
  – Sites: Dodge City, Columbus AFB, Yuma, Tucson, South Kuai, Albuquerque, Sacramento

• Issue with missed detections seen initially at Tucson (KEMX)
  – Addressed in Build 11.1 Release with bypass map change

• Build 11.1 Beta Test – June 16 – July 21, 2009
  – Sites: Tucson, Albuquerque, Dodge City, Phoenix, Sacramento, Yuma

• Build 11.1 Deployment: July 27, 2009
Missed Detection Bin
Spectral Characteristics

CPA = 0.1299
Build 11.0 Design (Super Resolution):

CMD Flags: 0.5 by 0.25 km

Surveillance Filtering: 0.5 by 1 km

Doppler Filtering: “Grown” Bypass Map
Build 11.1 Design
(Super Resolution):

CMD Flags: 0.5 by 0.25 km

Surveillance Filtering: Bypass Map

Doppler Filtering: Bypass Map
Good Results with Build 11.1

KEMX Replay Data
Deployment Monitoring

• CMD Active over most of the network

• Some ROC Hotline Calls
  – Some not CMD related
  – Several related to false detections in zero mean velocity regions

• CMD reveals AP clutter can change greatly over short time periods

• Examples follow
KCRI 6/23/2009
12:43Z

Widespread AP
KCRI 6/23/2009
12:49Z

AP Gone?
Reflectivity 155505Z
Wind Turbines! Did CMD detect?

Ruthton, Minnesota
CMD KFDR 9/12/2009 False Detections Static Bypass Map
Engineering Investigated Parameter Changes to Reduce False Alarms

KCRI 7/27/2009
Conclusions From Engineering Tests

- Can reduce false detections slightly with longer Median Filter
- Results in Missed Detections
- Increasing SNR merely reduces number of bins CMD runs on
- Current parameters are optimal

9/16/2009 KCRI

SNR 6 MF 5 Gates
An Interesting Case: Topeka Kansas

August 10, 2009
Topeka KS 8/10/2009
AP Event Developing

17:51:50
Topeka KS 8/10/2009
AP Event Developing

18:00:05
Topeka KS 8/10/2009
AP Event Developing

18:09:18
Topeka KS 8/10/2009
Frontal Passage Near Radar
Later in the Event

20:05:37
Topeka KS 8/10/2009
Frontal Passage Near Radar
Later in the Event
20:14:52
Topeka KS 8/10/2009
Frontal Passage Near Radar
Later in the Event

20:28:41
Wrap-Up

- CMD Working well, but could be improved
- Improve CPA Computation for phase varying clutter targets (NCAR)
- Improve In-Fill Filter (NCAR)
- Add Polarimetric Variables (have algorithm description)
- Clutter Filter Performance Improvements:
  - Adaptive windowing
  - Narrow expected clutter spectrum width (GMAP seed value)
  - Reduce aggressiveness of clutter residue censoring
- Look at alternative filtering methods
Future Work:
NCAR’s Improved CPA Calculation

- Divide the time series into 8 parts.
- Compute the CPA factors for each part.
- Compute CPA using some fraction of the parts which yield a maximum value.
- The leads to higher values of CPA and a generally smoother result.
- The membership function for CPA must be adjusted to account for the higher values.
The existing CMD flag in-fill filter

- The filter ‘fills in’ gates for which the flag is not set, if there are flagged gates on either side.
- The filter is designed to fill in gaps of the type shown above.
- Specifically, it will fill in the gaps of the following type:
  - 1 un-flagged gate between adjacent flagged gates
  - 2 un-flagged gates with at least 2 flagged gates on either side
  - 3 un-flagged gates with at least 3 flagged gates on either side
Proposed new CMD flag in-fill filter

- One each side of the gate in question, construct a computational kernel with weights decreasing with distance from the gate.

- In the forward direction, sum up the weights for gates which have the flag set (e.g. marked \( \ast \) = \( \frac{1}{2} + \frac{1}{5} + \frac{1}{6} = 0.76 \))

- In the reverse direction, sum up the weights for gates which have the flag set (e.g. marked \( \ast \) = \( \frac{1}{2} + \frac{1}{4} = 0.75 \))

- IF forward_weight >= 0.7 AND reverse_weight >= 0.7 THEN set CMD_flag at center gate to TRUE

- IF not, set CMD_flag at center gate to FALSE
NCAR’s Improved In-Fill Filter