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NEXRAD TAC SUMMARY MEETING MINUTES:

- NEXRAD TAC was convened on the 8th and 9th of March, 2011, in Stephenson Research and Technology Center on the University of Oklahoma campus
    - This TAC had a total of 21 briefings. The first day was totally devoted to the latest on the Dual Pol (DP) program as well as the ongoing support efforts to this program. The second day's topics were varied, ranging from MIT Lincoln Lab's DP initiatives, to the Low Elevation Angle Test for the coming Grey's Harbor Washington Radar, to Spectrum Challenges for the WSR-88D. A list of the topics can be found in Appendix A (the final agenda) and a short summary for each talk can be found in Appendix B (TAC Briefing Summaries).
- There was one scheduled ***decisional brief*** which is discussed below:
  Clutter Environment Analysis using Adaptive Processing (CLEAN AP)
    - *A summary of the CLEAN AP briefing can be found in appendix B. The TAC Executive Session notes on the CLEAN AP technique can be found in the TAC Executive Sessions notes below.*

- **TAC Executive Sessions:** Executive sessions were convened on both the 8th and 9th. On the 8th, the TAC convened to discuss the Decision Brief for CLEAN AP; a short synopsis is included below:

  CLEAN-AP
    - TAC members believed questions raised during the question/answer session after the brief can be resolved.
    - The next phase for this initiative is to port the algorithm into a NEXRAD environment to conduct an engineering evaluation to see how it would work with the rest of the WSR-88D system
    - Once the engineering evaluation is complete, the algorithm could be targeted for a software build.
    - The TAC members agreed to move forward with conducting an engineering evaluation on CLEAN AP.

  NEXRAD Product Improvement Program:
    - Greg Cate, the DP Program Manager, provided an update on the DP Beta Test and Deployment Schedule as well as an update on the funding situation for NEXRAD Product Improvement (NPI) program.
    - The NPI funding situation remains at risk for this critical program…..in particular, NPI funds pay for the transition of promising research into NEXRAD operations. NPI funds currently pay for verification and validation work being conducted on the DP Quantitative Precipitation Estimate Algorithm by staff members from the Office of Hydrological Development (OHD) and Office of Science and Technology (OST) System Engineering Center (SEC).
    - The problem is the current Federal Budget environment makes it very difficult for organizations to get funding. Nonetheless, new algorithm verification and validation work, as well as Product Improvements for a new radar technology, are absolutely critical part of any upgrade program.

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- Any new acquisition involving a complex technology will not be 100% at the start as technical challenges will always need to be resolved. It is more critical than ever to ensure funding remains to resolve DP's challenges as well as fully utilize its capabilities.
- The TAC consensus was an appropriate letter should be written, to the proper agency point of contact, endorsing the criticality of NPI funding.

TAC Consultation for Non-NEXRAD Projects:

- Mr. Vogt spoke to TAC members during the Executive Session about his concept of a Service Life Extension Plan for the WSR-88D. Related to this, Mr. Vogt believes there may be a few areas in the WSR-88Ds strategic direction, as suggested by the TAC in 2003, that may need to be re-visited and perhaps updated.
- Dr. Snow noted that a copy of the previous strategic direction guidance should be passed to TAC members to review if key areas need to be updated.

TAC Consultation for Non-NEXRAD Projects:

- Mr. Vogt was invited to sit in on the TAC Executive Session. Mr. Vogt brought up the case of the Air Force asking for consultation and assistance on a tactical radar system for deployed meteorologists.
- Mr. Vogt asked whether it would be appropriate for the TAC to provide consultation for non-NEXRAD projects that are important to any of the three tri-agency members
- TAC members agreed to evaluate non-NEXRAD projects on a case-by-case basis, as long as it is determined the project could benefit from the expertise of the TAC members.

Private Sector and Non-Government Organizations use of NEXRAD data:

- Some TAC members have learned that NEXRAD data is used by a variety of private sectors and non-governmental organizations, i.e. some railroad companies and the Red Cross use NEXRAD data for their purposes
- TAC members noted that this type of information should be used when appealing to NOAA or NWS, or even Congress for funding.
- As the private sector begin to use NEXRAD data more, it would be very instructive to invite some selected private sector meteorologists to learn how they use NEXRAD data; perhaps a future TAC meeting should have half a day devoted to this topic.

Spectrum Challenges for theWSR-88D:

- A briefing provided by Lynn Allman (ROC Engineer) highlighted the interference challenges the WSR-88D is facing from wireless technology.
- Additionally, Mr. Allman reported on the Federal Government's request to the NEXRAD program to justify its usage of radars in the 'S' frequency band.
    - Government would reserve the 'S' band for enhanced communications
    - Forecaster impacts on losing 'S' Frequency Band radars would be:
        - Decreased range for monitoring showers and thunderstorms

- Attenuation of radar energy via showers and thunderstorms much higher, hence the range forecasters can monitor dangerous weather is significantly decreased
- Attenuation of shorter frequency bands would mean the loss of critical severe weather structure information within the storms themselves
- If 'C' Band radars to replace 'S' Band, would likely need much more to equal coverage of current network, hence a high implementation and Operations/Maintenance cost.
- The overall effect is believed that moving to a shorter frequency band will substantially degrade forecaster warning and forecasting operational performance

- John Snow mentioned that the original frequency band assignments were made immediately following World War II, and that the assignments were for specific reasons. He advocated initiating a study through the Academy of Sciences into what should be the proper frequency band assignments not only for the U.S. but for the world in general, e.g. instead of one country unilaterally changing frequency bands, have a formal study that could be appealed to for maintaining worldwide, standardized frequency band assignments.
- Additionally, other members mentioned it would be important to get the right agencies e.g. NOAA, NWS, FCC, etc, to come to the table to discuss the issue to ensure all the right parties understand the impacts. TAC members suggested using the Office of the Federal Coordinator of Meteorology (OFCM) to get the stakeholder agencies in a forum to discuss the challenges.
- TAC members decided to pursue writing a letter to the chair of the PMC (Mark Paese, NWS Operations) to advocate for the OFCM to initiate discussion of the NEXRAD Spectrum challenge with key agencies

ACTION ITEMS AND MISCELLANEOUS COMMENTS:

Action Items that arose either from the open or the executive session:

ACTION ITEM: The TAC consensus was an appropriate letter should be written, to the proper agency point of contact, endorsing the criticality of NPI funding.

- Lt Col Cocks will work with Mr. Vogt and Dr. Snow to draft a letter

ACTION ITEM: TAC members want to write a letter to the PMC Chairman, Mr. Mark Paese (NWS, Operations) to advocate for the OFCM to initiate discussion of the NEXRAD Spectrum Challenge with the key government agencies.

- Lt Col Cocks will work with Dr. Snow and Mr. Vogt to draft a letter

ACTION ITEM: Provide to TAC members a copy of the WSR-88D Strategic Direction as previously suggested by the TAC in 2003. Members should review it for areas that may need to be updated.

- Lt Col Cocks will send to TAC members a copy of the current WSR-88D Strategic Direction as suggested by the TAC in 2003.

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COMMENT: The TAC remains concerned about the DP Upgrade requirement for ZDR to be accurate to 0.1 dB to ensure the best DP QPE performance. The TAC supports ROC efforts of testing out the Cross Polarization technique to gauge the accuracy of ZDR and improve its accuracy.

COMMENT: The TAC believes it is important, for customer service and budget reasons, to learn more about how Private Industry uses NEXRAD data. The proposal is during the Spring TAC 2012 that half a day be devoted to hearing briefings from Private Industry on how they use NEXRAD data.

NEXT TAC MEETING:

Next TAC will be held in late October/early November at Phoenix AZ with Seattle, Washington a back up site.

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APPENDIX A: FINAL AGENDA

Spring 2011 TAC Agenda

Location: Stephenson Bldg, across the street from Natnl. Weather Center, Norman, OK
***Tuesday, March 08, 2011*,**

0800: TAC Executive Session (TAC members only)
- Assignments for briefing write-ups

0815: Convene Open Session with introductions and opening remarks.
- John Snow, TAC Chairman

0820: WSR-88D PROGRAM OVERVIEW UPDATE [ROC, Rich Vogt, 30 Minutes]

0850 Clutter Environment Analysis using Adaptive Processing (Clean AP) [S. Torres, D Warde, 45 min] ***DECISION BRIEF***

DUAL POLARIZATION PROJECT UPDATE

0935 Beta Test Update & Deployment Schedule (OS&T, G. Cate, 30 min)

1005 BREAK (10 min)

1015 Dual Pol Data Quality Update (ROC APPs, B. Lee, 30 min)

1045 ZDR Calibration (ROC Eng, D. Saxion, 30 min)

1115 DP QPE Verification & Validation (OHD, M. Fresch, 45 min)

1200-1315: LUNCH WITHIN NWC

DUAL POLARIZATION PROJECT UPDATE, CONT.

1315 Dual Pol Operational Assessment (ROC APPs, S. Cocks, 30 min)

1345 Non-Uniform Beam Filling, Attenuation & their Affects on Dual Pol Data (NSSL, A. Ryzhkov, 30 min)

1415 BREAK (15 min)

1430 DP QPE Algorithm Improvement Initiatives (NSSL, A. Ryzhkov, 30 min)

1500 Dual Pol and CMD (ROC Engr, O. Boydsten, NCAR, John Hubbert, 40 Min)

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1540 Staggered PRT Status Update [ROC Engr, D. Saxion, 5 Minutes]

1545-1645 Executive Session: adjourn for discussion on Decision Brief with TAC Members only

Wednesday, Mar 09, 2011

DUAL POLARIZATION PROJECT UPDATE, CONT.

0815 MIT Lincoln Lab Dual Polarization Work w/WSR-88D applications (D. Smalley, 1 hr)

0915 BREAK (10 min)

OTHER INFORMATIONAL BRIEFS

0925 2-D Velocity De-Aliasing Algorithm [ROC Apps, D. Zittel, 15 minutes]

0940 Lower Elevation Angle Test for new Washington State WSR-88D (ROC Apps, J. Schultz, 35 min)

1015 Multi-Lag processing to Improve Dual Pol Radar Data Quality (ARRC, G. Zhang, 30 min)

1045 Wind Turbine Clutter Mitigation Research (ARRC, Dr. B. Palmer, 30 min)

1115 Status on Implementation of Hybrid Spectrum Width Estimator (ROC Engr, J. Krause, 30 min)

1145-1300: LUNCH WITHIN NWC

1300 Status of AVSET Field Test: Decision Brief Follow-up (Roc Engr, J. Chrisman, 15 min)

1315: Spectrum Challenges for WSR-88D and all S-Band Radars (ROC Engr, L. Allmon, 30 min)

1345: MPAR Update (NSSL, D. Forsythe, 30 min)

1415: Meso-cyclone Detection via Linear Least Squares Derivative Methodology (NSSL, K. Elmore, 30 min)

1445 Executive Session: TAC Members only

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APPENDIX B: SUMMARIES OF TAC BRIEFINGS

DAY 1 Briefings:

WSR-88D PROGRAM OVERVIEW UPDATE

In this information brief, Mr. Vogt, Director of the Radar Operations Center, gave an overview of the Radar Operations Center's four priorities for the NEXRAD system: keep operations systems running, sustain baseline operational radar system capabilities, improve radar system reliability and integrate new capabilities, and support the NEXRAD Product Improvement (NPI) program. Each of these priorities brings unique challenges that must be addressed. For example, the rise of wind turbine clutter has become an on-going issue for sustaining baseline capabilities.

A major concern is the recent reallocation of all the funding that supported the NPI program to the dual-polarization upgrade. This has potential long term impacts as this reallocation would eliminate most efforts aimed at improving the radar system's reliability and the integration of new capabilities.

Mr. Vogt closed with some comments regarding possible scenarios for the future of the NEXRAD radar. Which of these scenarios ultimately plays out depends in large part on the rate at which phased array radar technology become available at an affordable price. These scenarios provide a starting point for the TAC's own strategic planning effort.

The TAC agreed to write a letter to the relevant parties about the need to adequate fund the NPI program.

Clutter Environment Analysis using Adaptive Processing (Clean AP *DECISION BRIEF*

CLEAN-AP has the potential for reducing data loss due to clutter filtering. It also has the potential for being a better filtering approach for integrating the Staggered Pulse Repetition Time (SPRT) mitigation technique as CLEAN-AP does not have the PRT ratio restrictions of the SACHI filter currently under consideration. CLEAN AP combines the clutter detection and clutter removal processes and thus can replace the current techniques using the Clutter Mitigation Decision (CMD) and Gaussian Model Adaptive Processing (GMAP) methods.

CLEAN-AP uses a Lag-1 autocorrelation spectral density process which takes advantage of the different effects that data windowing has on clutter and weather signals. This process also preserves phase information in the spectral analysis. The OU/CIMMS and NSSL team provided some performance information of CLEAN-AP operating on WSR-88D data, which was collected with a scanning antenna. The decision before the TAC was whether the ROC should proceed with engineering evaluation of CLEAN-AP for potential replacement of the existing CMD and GMAP combination and for consideration as a clutter filter for the Staggered Pulse Repetition Time (SPRT) range velocity ambiguity mitigation technique.

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CLEAN-AP integrates clutter analysis with mitigation. The TAC asked for more science details at the November 2009 meeting and requested performance analysis using WSR-88D data. OU/CIMMS and NSSL team members accomplished both tasks and presented data at a Fall 2010 Data Quality Technical Interchange Meeting (DQ TIM) as part of the ROC, NSSL and NCAR Joint Memorandum of Understanding for Data Quality Improvement Services. The NSSL team also delivered an Annual Report in December 2010 that provides more detail on the algorithm and performance analysis.

Currently clutter detection and mitigation (filtering) are done by separate signal processing components and the amount of mitigation is fixed by GMAP and the use of a Blackman window only. This sometimes results in excessive loss of data, especially in the zero isodop regions. CMD also can produce false detections on the zero isodop along with some missed detections. CLEAN AP may reduce some of these effects.

CLEAN-AP provides a compromise between detection and filtering, is integrated, and can work with as few as 8 samples. The algorithm uses only spectral processing, so there is no circular convolution bias. Phase information is preserved and used in the clutter detection algorithm. CLEAN-AP is compatible with all present capabilities and planned enhancements.

Summary of the CLEAN AP algorithm:

The algorithm selects an appropriate data window, identifies appropriate clutter components to remove, then restores weather components as needed. The clutter detection uses a Lag 1 Autocorrelation Spectral Density (ASD) designated S1. Note that the ASD is the Power Spectral Density (PSD) for linear phase. The magnitude of S1 is the power spectrum. Ground clutter and weather phases are linear for ideal cases of infinite samples (no windowing needed). However, with a data window, leakage forces all phases to zero. The key to the algorithm is that the phase "leakage", or phase distortion, due to the data window is different for clutter and weather signals.

The algorithm first estimates the Clutter to Noise Ratio (CNR) then selects an appropriate data window, computes the ASD, identifies the clutter components using spectral leakage phase distortion, removes the clutter components, and then reconstructs any lost portions of the weather signal using linear interpolation.

Use of the data window is the key as CLEAN-AP uses 4 windows versus the one for GMAP. A lower CNR means the algorithm selects a less aggressive window. The method incorporates a clutter model, with a single parameter to tune for conditions similar to the GMAP seed width. CLEAN AP gradually transitions the notch width for up to 80 dB Clutter to Signal Ratio (CSR).

CLEAN AP requires less processing than GMAP. CLEAN AP is an all bins approach, meaning it examines all radar data bins for potential clutter. There is no need for an associated clutter bypass map. CLEAN-AP's full performance must be compared with real data due to CMD and GMAP interaction.

Dave Warde then presented the actual WSR-88D data results, a performance comparison of CLEAN AP vs. GMAP. Mr. Warde showed Doppler mode only data in the briefing. His focus was on a "high" suppression case since the other original requirements were overcome by events

with the use of GMAP. CLEAN AP exhibits a maximum suppression of 80 dB versus GMAPs maximum suppression of 60 dB. Additionally, there is less bias and variance for CLEAN AP.

The velocity vs. spectrum width vs. bias plot was significant. Dave did note that both meet requirements in the usable velocity range. At a CSR OF 50 dB, GMAP has a slight bias in the -10 to 10 m/sec velocity range.

Dave then showed 2009 Tucson beta test data and noted that CMD did not detect some weak ground clutter. He then showed a KCRI zero isodop case with a region of real clutter. CLEAN AP was less aggressive meaning there were fewer "holes" in the data due to false detections.

CLEAN-AP is better for SPRT because it will work with any general PRT ratio. This can be a big advantage as it removes the current operational Volume Control Pattern (VCP) design restriction due to the use of the SACHI filter.

Jim Evans expressed a desire to see simulations based on a point target not centered on the window. This may uncover issues similar to the previously observed hot spot issues with CMD. His concern is related to generation of false echo tops. The ensuing discussion also pointed out that CLEAN-AP will do nothing to remove moving vehicles or sea clutter.

Rich Ice asked about the hybrid spectrum width estimator. Both Dave and Sebastian replied that the algorithm can be programmed to can get any lag estimate needed and thus can be used with the hybrid estimator.

Mike Istok asked about dual polarization clutter filtering. The team responded that the same paradigm as baseline dual polarization filtering will be applicable. That is that the horizontal channel will determine the appropriate components of the spectrum to be removed for both.

Beta Test Update & Deployment Schedule:

L3 Communications, Baron Services and ESSCO are responsible for modifying RDA for Dual Polarization (DP) capabilities. In December of 2010, the Technical Manuals were not ready to support the DP deployment and the contractor didn't pass the maintenance demonstration. This resulted in a six month delay in Beta Test. Due to the slip, some of the Beta sites were changed; the resulting change meant that instead of starting Beta Test at Wichita, KS in January 2011, the tests would begin at Phoenix, AZ in late June/early July 2011. Additionally due to the schedule changes Chicago, IL was replaced by Pittsburg, PA as a Beta Site. Beta Test Readiness Review is scheduled for 24 May, 2011.

As part of some risk reduction efforts, the contractor has modified the Vance AFB, OK WSR-88D radar to validate reliability and stability over an extended period. It also allows the government to develop an unambiguous method to validate whether L3's calibration meets contract specifications. As a result of the risk reduction effort, Vance AFB will replace Fort Polk, LA as a Beta site. An additional risk reduction effort undertaken by the contractor was to reconfigure the ROC's pedestal test radar. This provides a method for validating that L3 is

meeting maintenance specifications and frees the KOUN prototype radar for refining calibration techniques.

Production deployment is slated to begin in the 4th quarter of FY11 with the government and L3 developing a flexible schedule to work with field sites.

DOC directed no NPI funding be spent on Program Management and Science Improvement in FY10 and FY 11. The funding was directed to implementing Dual Polarization. NOAA/NWS management is assessing alternatives……the NWS CFO is committed to fund NPI at a minimum level…..nonetheless, NPI funding continues at risk.

DP Data Quality Update

Bob Lee provided an overview of all of the major events that have taken place since the last TAC in the area of DP data quality. From the last TAC (November, 2009), one of the primary technical challenges for the DP program was to understand why KOUN's data was 6 to 8 dB less sensitive than the ROCs test-bed radar, KCRI. What had been expected was for the KOUN DP prototype to be ~3-4 dB less than KCRI due to the splitting of power (radar design) and the power loss from the DP hardware. A Subject Matter Expert (SME) panel reviewed the problem in late December, 2009 and concluded that a DP associated sensitivity loss of 4 dB would likely have minimal impact on field forecasters. However, if the sensitivity loss due to the DP upgrade turns out to be greater than 4 dB then an operational assessment of the DP data using field forecasters would likely be needed.

In January/February the DP contractor re-designed the receiver which improved KOUN's dynamic range and sensitivity. A further SME panel held in March 2010 confirmed that the sensitivity had improved. Additionally, ROC engineers were able to clearly explain the 5 to 5.5 dB sensitivity difference between KOUN and KCRI. As KOUN (2.7 GHz) and KCRI (2.95 GHz) have different frequencies, they will also exhibit different sensitivity for a given weather phenomenon. The ROC analysis indicated that a 1.5 dB sensitivity difference would be due to the different frequencies alone. The remaining 3.5 to 4 dB difference between the two radars is hardware due to the DP upgrade. Therefore, a 3.5 to 4 dB sensitivity loss could be expected for any radar that is upgraded to DP.

A number of issues surfaced but were resolved during last Spring into the Fall. However, at present is the continue investigation into the accuracy of ZDR. During the Fall of 2010, quantitative and qualitative analysis indicated ZDR was approximately too high. Additional contractor hardware and software adjustments were made which made ZDR much more stable, less inaccurate, but now about 0.4 to 0.5 dB too low. The stability and increased ZDR accuracy makes ZDR useful for data interpretation. However, the Quantitative Precipitation Estimate algorithm requires much more accurate ZDR values (errors within 0.1 dB). Therefore, Data Quality work continues on understanding cause to this technical challenge.

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ZDR Calibration

Darcy Saxion provided an informational briefing to TAC members on Differential Reflectivity (ZDR) Calibration. Calibration of ZDR is one of three calibrations that will be done on the dual-pol WSR88D, the other two being Reflectivity and Initial System Differential Phase. The contractual requirement is to calibrate ZDR within 0.1dB, meaning the difference between the expected ZDR value for known precipitation types and the ZDR displayed by the system must be less than 0.1 dB.

An overview of the calibration path was presented, including discussion of the overall calculation: ZDR of the system is 2 times the ZDR of the antenna, plus the ZDR of the transmit path, plus the ZDR of the receive path. ZDR from the transmit path is taken from an initial snapshot, then monitored and adjusted during performance checks (usually every 8 hours). ZDR from the receive path is taken from an initial snapshot, and monitored on retrace (after every VCP). ZDR of the antenna is calculated during the sun scan.

Mrs. Saxion discussed the two challenging aspects of ZDR calibration: 1) finding the initial ZDR, and 2) compensating for instrument drift during operation of the system.

Progress has been made regarding the stabilization of ZDR during system operation (i.e. the 2nd piece of ZDR calibration, above) Results of a software tool developed by Steve Smith, which captures and displays ZDR calculated during performance checks, were shown. Good improvement in stabilization has been shown, thanks to the corrections/changes to the system being made by the contractor. An overview of these changes that have been made were presented, including: a) Relocation of the GFE delay line (moved from shelter to the AME) and replacement of bad cable on the horizontal channel, b) replacement of coax cables with heliax cables for all ZDR calibration paths, c) other physical adjustments/modifications to QN adapters, brackets on LNAs, modification of ladder bar, and stabilizing RF connections. As a result of the above modifications and changes, the variations in ZDR error are within the requirement of less than 0.1 dB change, from VCP to VCP.

Challenges associated with finding the initial ZDR (i.e. the 1st piece of the ZDR calibration, above) remain. As shown by earlier briefings, the overall initial ZDR of the system appears to be too low by about 0.5 dB. The contractor continues to investigate, and use of KVNX as an early test site may be helpful. It is thought that comparison of KOUN results with KVNX results may reveal whether the problem is a process issue, or "an inherent lack of accuracy in microwave metrology, which may not meet requirements".

ZDR calibration continues to be a risk to the program. Three mitigation strategies were briefed to the TAC. 1) NCAR's Cross-polarization Power Technique is actively being worked by the ROC and L-3/Baron, and testing will continue at KOUN and KVNX. Results of this technique may be promising, as NCAR has been able to show that this technique provides equivalent results as vertical pointing (as previously briefed to the TAC in 2007). 2) An OHD methodology to dynamically correct for ZDR values in the RPG also exists, but has not been formally tested. 3) Training forecasters to make manual adjustments to ZDR via adaptation is also a possibility, albeit one of last resort.

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Dual Pol QPE Verification & Validation

Mr. Mark Fresch (NWS/OHD) presented a validation of the Dual Pol Quantitative Precipitation Estimation (DP QPE) algorithm. Since last spring (May 2010), evaluation efforts have uncovered three particular issues regarding overall algorithm performance on the KOUN radar. For each of these, NSSL has provided an initial fix, upon which OHD has been involved in the subsequent implementation and validation thereof. Mr. Fresch noted that since the Zdr calibration problem was discovered, it became necessary to apply a static Zdr bias correction (for past KOUN cases; computed independently for each case) in order to perform the validation work in a timely manner.

The first issue concerns the underestimation problem for the DP QPE rate equation for rain, R(Z,Zdr), especially for tropical rainfall events. In short, more weight was applied to Zdr with the intent to reduce the underestimation during tropical-type events without changing estimations during continental-type events. New adaptable parameters for R(Z,Zdr) were put forth and a comparison of non-zero estimates from DP QPE to gauges was made for storm totals associated with nine cases (4 tropical; 5 continental). The comparison was performed twice for each case, once with the old parameters and then again with the new ones. Results showed that the new parameters reduced bias, with improvements to the mean field bias and fractional bias. Although the underestimation problem still exists somewhat with tropical rainfall, early consensus is to accept the new parameters. However, additional comparisons will need to be made after the Zdr calibration problem is fixed.

The second issue is focused on the immaturity of the DP QPE logic which handles partial beam blockage (PBB) situations resulting in the ineffective use of hydro-classes. This occurs even when the percent blockage is very small. The logic has since gained an apparent measure of maturity that is supported by limited validation results. The old PBB logic didn't utilize the full set of hydro-classes when the beam was blocked one-half percent of more, but the new logic maintains the hydro-class rates for blockages less than 20 percent. Using KOUN data, a comparison was made for non-zero DP QPE output to gauges for storm totals and hourly time increments. Since KOUN suffers very little from beam blockage, the new PBB logic was evaluated to ensure that DP QPE performance was at least the same (if not better) than that with the old logic. Preliminary validation showed this to be true. However, once Dual Pol radar data becomes available from WSR-88Ds located in complex terrain, a more comprehensive validation will need to be performed.

The third issue is also related to underestimation, but as it relates to non-uniform beam filling/attenuation situations. Here, validation is currently underway on multiple algorithms that have intended to mitigate the matter. These include fixes related to Dual Pol Preprocessing, the Quality Index Algorithm and Hydro-Classification Algorithm, and DP QPE within radials flagged for attenuation. The Dual Pol Preprocessor has been coded to flag attenuated radials by counting bins within the radial that meet certain conservative criteria (e.g., Range > 45km; Z = 30 to 50 dBZ; $|V| > 1$ m/s; RHOhv < 0.7). If the bin count is greater than 10, then it is considered attenuated and an SNR of 0.5 dB is used to distinguish weather from non-weather. More so, the Quality Index Algorithm now uses a new rule set where if RHOhv is less than 0.8 and Z is coincidently less than 25 dBZ, then RHOhv's contribution to the quality index is

eliminated. A new rule has also been applied to the Hydro-Classification Algorithm where Biota is no longer allowed for bins with Z greater than 35 dBZ. Mr. Fresch then presented an example of severe attenuation from KOUN on 19 May 2010. In vicinity of the attenuated area of this example, additional reflectivity was added to the convective weather echo (in the area of detected attenuation) which made significant changes to all of the hydro-class and rainfall rate products. Where attenuation was properly detected, most of the incorrect biological classifications were removed. Incorrect classifications still persisted within attenuation areas that were not detected. More testing and optimization is needed.

Dual Pol Operational Assessment

The ROC led an operational assessment to gain forecaster feedback on the utility of dual polarization variables for warning and forecasting operations. The team concluded that dual polarization was useful for winter weather operations, flash flood warnings, and convective weather. Dual polarization does not provide information that could cause forecasters to issue tornadoes with more lead time…..but… polarimetric debris cloud signatures can be useful for confirming that a tornado is on the ground. The team also concluded that the 4 dB sensitivity loss from the DP upgrade would not present any significant operational impact.

Details of Briefing and Discussion

The ROC Applications Branch led a 17 to 19 August, 2011 exercise to assess the potential of dual polarization data for forecasts and warnings. A total of 20 forecasters from across the US participated. The products used were not in final state, and limited to data collected in Oklahoma. The work emphasized that Dual Polarization performance may vary by region.

This was a three day task. Some preliminary training was provided to the participants prior to their arrival at the assessment. Participants also took a pre-assessment survey of the effectiveness of the WSR-88D. The DOD members were not in their usual environment, i.e. there was not an OPUP, but each had an AWIPS expert to guide them through the assessment. Dr. Snow asked how the team members selected. Lt Col Cocks answered that they were selected by the regions. After participants were provided on site additional Dual Pol training, the group reviewed four data cases, each in a key warning and forecasting operations area (e.g. Winter Weather, Flash Flood, Severe Convection, and Tornado Operations). One of the cases reviewed that had "ugly" data with it, chiefly from attenuation and non-uniform beam filling effects. This case was included to ensure forecasters saw some of the areas where Dual Pol was still being adjusted. The case evaluations were held for two days. On the third day, the expected Dual Pol sensitivity loss was discussed with potential sensitivity losses simulated for radars across the U.S. Finally, forecasters rated the effectiveness of the WSR-88D based upon what they learned about DP, its capabilities and how they believe it could enhance their operations. The National Weather Service Warning Decision Training Branch (WDTB), ROC and National Severe Storms Laboratory provided experts to provide instruction and to answer forecaster questions.

Here is a high level summary of results: Cases better served with dual polarization: severe convective, flash flood, winter weather (big increase with the score from 5.5 to 8.0). Cases about the same with dual polarization: tornadoes.

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Participants classified comments as positive, negative, or neutral. An example of a positive winter case was improved location of melting layer and identification of precipitation type. Summary: 76% pos 21% neutral 3% (1) neg.

The ability to delineate heavy rain with differential phase was a positive feature for flash flood warnings. The ability to see updrafts was also an advantage for using during severe convective operations. For tornadoes, Dual Pol can provide the ability to confirm the presence of a damaging tornado within 60 miles of radar using debris signatures. This does not add value in lead time, but does for situational awareness. There was a comment about some loss of data in velocity noted in detecting wind shears.

For the sensitivity loss demonstration, the base moment sensitivity was reduced artificially by 4 dB. Steve showed a mesocyclone example where pertinent features of the super cell are preserved. There was also an example of a warm front being visible even in the reduced data. Jim Evans noted loss of some data, Jessica Shultz, a former forecaster from the Dallas/Fort Worth and Springfield WFOs replied that from her perspective there was no operational impact.

The team identified the top three benefits for dual polarization: flash flood warnings, severe weather interrogation i.e. hail location and updrafts, and the ability to identify precipitation types in winter weather. The following are challenges for the Dual Polarization program: training, integrating dual polarization into operations, and workload concerns. Some key research area are: improve QPE, discern severe hail.

LtCol Cocks presented some back up slides with more data. Terry Schuur asked about ZDR "arc" and helicity. These were not part of the ops assessment because they only had KOUN events available. Jim Wilson asked if any clear air convergence features could be lost from the Dual Pol sensitivity loss. Dusan Zrnic then talked about potential enhancements to sensitivity, including coherency based threshold adjustments and the use of auto covariance processing for combining the velocities in the H and V channels which could possibly improve sensitivity by 1.5 dB. Jami Boettcher mentioned that WDTB would be in the future sponsoring a Storm of the Week to share Dual Pol data with forecasters and gradually develop forecaster familiarity with the data.

LtCol Cocks presented one more example of a Georgia super cell showing no loss of significant data in a mesocyclone, and an example from Jackson MS. One example of a dry line had some loss, but it was not significant. Outflows were still visible in the example, in other examples snow bands still had detail.

Sebastian Torres pointed out that the sensitivity loss simulation did not account for increased variance from lower SNR. Jim Evans was concerned about loss of wind field data for dual Doppler, and felt bringing back sensitivity is a high priority. Wind fields are critical for runway configuration and aircraft separation with changing wind fields (wake vortex). Don Burgess suggested Jim duplicate the sensitivity reduction. John Snow wanted the group to think through how to present and analyze this, and possibly bring back sensitivity in a couple of cases. Dave Zittel pointed out a fleet wide difference in sensitivity exists now due to variations in wavelength with subsequent differences in antenna gain. Jim Evans mentioned further use for velocity data

is in an expanding research and development area.

Non-Uniform Beam Filling, Attenuation & their Affects on Dual Pol Data

In this information brief, Mr. Alexander Ryzhkov, OU CIMMS assigned to the NOAA National Severe Storms Laboratory, provided a review of the negative impacts of non-uniform/partial beam filling on the data fields generated by dual-pol radar. He began with an illustrative example, which he then analyzed in detail to reveal what was happening in the storm to produce the observed results. The fundamental question is "why does the cross-correlation values drop?". Ryzhkov went on to present an elegant theoretical argument (basics published 2007) showing how a gradient of differential phase affects the magnitude of cross-correlation coefficient. Based on this analysis, he then proposed a way of "fixing the problem" in the processing of the received signal by identifying and correcting the contaminated data points. Ryzhkov concluded with the statement "Extensive testing of the suggested software patch demonstrated that it is sufficiently robust and can be recommended for operational implementation."

As this was not a decision brief, the TAC did not take action on this recommendation, but did express interest in learning more about the effectiveness of the technique and the costs associated with its implementation.

DP QPE Algorithm Improvement Initiatives

The briefing focus was on causes and possible solutions to persistent underestimation of precipitation by the dual pol QPE algorithm. Currently, QPE estimates precipitation using Z,Zdr in pure rain and Kdp in areas of rain/hail mix. Data quality issues (Zdr bias; rates censored by low CC from NBF; CC overcorrected for noise) and algorithm deficiencies (optimized for continental rain type; zero rates for ground clutter and biological classifications) are causing estimation errors. Possible algorithm improvements include: a) more aggressive use of Zdr combined with Z or Kdp (e.g., R(Kdp,Zdr) > 40dBZ, R(Z,Zdr) < 40dBZ)), but would be more prone to Zdr errors; b) normalized concentration of raindrops (Nw) which has no direct dependence on Zdr. Another reason for underestimation of tropical precipitation is the rapid decrease of precipitation rate with height which might require implementation of vertical profile of rate based on the reflectivity profile. Additional testing is required to establish if the suggested change to QPE does not adversely affect the quality of continental rain estimates. The Nw technique shows promise and needs to be explored. Questions/discussion items included: a) if 0.1 dB Zdr bias calibration is not achieved, then might consider adjusting Zdr based on statistics of well behaved targets (e.g., dry aggregated snow, low-reflectivity rain); b) Lincoln Lab has Test Spheres they used with the Valparaiso radar and offered to assist in the calibration validation efforts.

1500 Dual Pol and CMD

Summary

The Build 13.0 version of CMD will be quite different than the baseline delivered by Build 11.0. Reasons for this include issues with the internal architecture of the software due to dual polarization, and a need to improve CMD performance. NCAR presented data showing improved performance with the use of a new Clutter Phase Alignment technique and some

miscellaneous data quality adjustments. These, combined with the incorporation of two dual polarization variable inputs, improve the performance of CMD.

Details of Briefing and Discussion

Olen Boydstun explained why Build 13 CMD is different from Build 11 CMD, that is, the dual polarization variable generation is not compatible with build 11 CMD architecture. This is because both filtered and unfiltered dual pol variables are not available for "sorting" at the RCP 8. Also, the Build 11.0 “map growing” process designed to handle missed detections is not satisfactory as there is a large penalty for a false alarm. The ROC has documented issues with false alarms and at least one WFO has requested improvement.

The recommended approach to addressing the above issues is to implement recent NCAR recommendations for handling non uniform spectra with odd point targets, including a new in fill filter which will help in eliminating hot spots, and to implement dual polarization variable inputs along with a new speckle filter to improve detection performance and reduce false alarms.

One benefit is that by moving all detection and filter application to the signal processor, there is no extra cost to engage CMD on all scans.

John Hubbert briefed details on the algorithm. He showed several double peaked clutter spectra, which are hard to detect. He also briefed the modified in fill and spike (speckle) filter. He showed KMEX (Tucson) clutter spectra with a null at zero, a sharp null in power time series, and a sharp phase transition. He then posed a question about what type of target causes a low CPA value?

The answer is that two dominant point targets with a 180 degree phase difference can do this. He presented simulated time series from this model. These targets are somewhat rare, but KEMX has a lot of these.

So the question remains, how to identify these targets? The approach is to identify spectra with the above features. This is done by dividing the spectra into parts and use weighted average of CPA. Dr. Hubbert showed scatterplots of the results of using the baseline and the new CPA design for KEMX and KFTG (Denver) data. NCAR has also modified the fuzzy logic membership function for CPA.

John showed a stratiform rain case with narrow spectrum widths and a defined zero isodop. The CPAs did not increase significantly in the zero with new method. Also, there are fewer false alarms in the zero. He then showed KEMX data for both the old and the new infill filter. Results show missed detections reduced to nearly zero. The algorithm for the in fill filter looks in the forward and reverse direction at the CMD values that are weighted.

For the speckle filter, one or two CMD points are considered after which the filter uses a higher CMD value threshold. New thresholds are given for 1, 2 and 3 flags. For the dual polarization variables, the algorithm uses the same fuzzy logic engine. The added variables are a standard deviation of ZDR and standard deviation of PHIDP. The Spol and CP2 research radars have been using these for years.

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Scott Ellis did histograms of SD ZDR in pure weather and clutter, at various CSRs. John showed mean ZDR bias for -8 to -10 CSR. He then showed simulated ZDR bias vs. clutter ZDR for various CSRs. This research yielded the membership functions.

He presented an example of KOUN data from November of 2010. This showed how the dual polarization variables hit on the clutter but not on the weather for this example, a squall line. John also had a second example with AP. John also presented an S-pol example in clear air with not much zero isodop loss.

John concluded that the use of dual polarization variables for CMD yields a 4 to 5 dB improvement in clutter detection performance. The 50% detection point is moved to lower CSRs. The new algorithm is ready for implementation and the algorithm description (AEL) has been delivered to ROC. John then had one more example using CP2, which is now operating in Australia.

Dave Warde had a question on weights since CPA has less than a third of the role now in the fuzzy logic engine. He asked about an adjustment since now it has a lower role, or weight. Do the DP variables do the job for missed detections? John has not looked at the specific two point spectra. Steve Cocks asked if Dr. Hubbert had looked into the potential of DP for filtering out moving targets. Jim Evans replied that CMD is not what you need for moving clutter since the filter won't help. He said that if you have super resolution available, just throw out the bad data.

Dusan Zrnic asked: have you considered oversampling and the role of CMD? He said you may be able to pick up one of those trucks. Mike Istok asked if CMD going to be applied just on normal resolution basis. Olen replied that it will be based on super resolution.

Mike Dixon commented that the fuzzy logic weights changed for the texture and spin feature fields, but CPA stayed the same. Dave Warde again asked the question regarding whether with use of a lower weight CPA, can CMD still detect the hot spots. This was deemed to be an appropriate off line discussion topic.

Staggered PRT Status Update

Darcy Saxion gave a short status update on the Staggered PRT (SPRT) project. The SPRT project was to be implemented in three phases; the first two phases, RPV8 SPRT transmission /data collection and non-operational implementation, are complete but the third phase, implementing the SACHI clutter filter and test for operational use, is not complete. The reason is the time effort being devoted to the Dual Pol upgrade project.

Some significant developments are:

1) Due to a Dual Pol batch cut processing anomaly, one to two initial high PRF pulses must be dropped for good CC values. The impacts on the SPRT algorithm is unknown and should be investigated.

2) NSSL has developed CLEAN AP. Currently, there are Volume Control Pattern design restrictions due the use of the SACHI filter. However, CLEAN AP would not need to use a SACHI filter and the removal of this restriction may be better to test the SPRT algorithm.

Finally, SPRT is targeted for build 14.0.

DAY 2 Briefings:

MIT Lincoln Lab Dual Polarization Work with WSR-88D Applications

David Smalley provided an informational briefing to TAC members on the efforts of MIT/LL to develop new aviation products, which are of particular interest to the FAA. These new NEXRAD products are expected to directly benefit 5 FAA weather systems: ITWS, WARP, CoSPA, CIWS, and RAPT. Mr. Smalley cited MIT/LL's recent history of involvement with new NEXRAD products including HRVIL, HREET, DQA and MIGFA.

Three new NEXRAD products are in development by MIT/LL: 1) Microburst Detection (AMDA), 2) Layered Icing Hazards (IHL), and 3) Layered Hail Hazards (HHL). Two of the products, IHL and HHL, are being developed in partnership with the FAA, Valparaiso University, NCAR, and NSSL. Both IHL and HHL depend upon the successful implementation of Dual Pol.

Discussing AMDA, Mr. Smalley reviewed the motivation for building microburst detection capability into the NEXRAD, which is the significant number of airports which could receive wind-shear coverage where there is no coverage, currently, or improved complementary wind-shear coverage (if a TDWR or WSP is already located there). The NEXRAD AMDA is based on the AMDA concept used by MIT/LL with the FAA's WSP, and also the LIDAR, thereby leveraging code which has already been developed. Some of the inherent challenges of NEXRAD AMDA were enumerated; siting of the radars and infrequent surface scans. Also, there will be no predictive component to the NEXRAD AMDA, as currently exists on some FAA weather systems. The results of a microburst comparison study (microburst in Norman on 8/21/10 @ 23:48UTC) were presented. Both NEXRAD AMDA and TDWR detected the microburst.

Discussing the new dual-pol products, Mr Smalley presented a timeline for development of IHL and HHL. MIT/LL and the FAA plan to make a readiness decision in 2011, and MIT/LL plans to hand off version 1 of the algorithms to the ROC in 2012. Version 2 of IHL and HHL are tentatively planned for 2013.

Extensive technical details regarding the challenges involved with implementing the new IHL and HHL algorithms were presented. Progress is being made, thanks to the hard work of all the organizations in the partnership.

2-D Velocity De-Aliasing Algorithm

Two-Dimensional Velocity Dealiasing Algorithm uses a least-squares approach to dealias velocity discontinuities simultaneously on a full velocity field. It also develops its own wind

profile and doesn't use the RPG's Environmental Wind Table. It also develops a coarse (sub-sampled) global solution and then resolves discontinuities in smaller regions and assigns more weight to velocity differences near ±2* Nyquist Velocity (V_N)

The key changes to the 2 dimensional velocity dealiasing algorithm (VDEAL) since the November 2009 Technical Advisory Committee meeting include:

- First and last radials are connected azimuthally, improving background wind field estimate (GOOD FOR vcp 31)
- Velocity differences with low spectrum width values are given greater weight than those with high spectrum width values
- Velocity values from side-lobe contamination are temporarily removed during dealiasing
- Regions connected by a narrow bridge of data are dealiased separately

Test results, as seen by comparing analysis from both NSSL and the ROC, showed that 2-D Velocity Dealiasing outperformed the legacy routine, especially so for cases involving tropical cyclones. A field test is planned for the summer & fall 2011 in order to coincide with the hurricane season. Field test site participants will be given the option to toggle a switch between the base line Velocity Dealiasing Algorithm and the new 2-D algorithm. The goal is to get at least two sites with mountains, two in the interior of the U.S. and four or more from the coast. The goals for the field test include:

- Obtain field experience with VDEAL at new sites under a broad range of meteorological conditions
- Obtain feedback from operational users
- Determine if VDEAL can replace the VDA for most VCPs or simply be an option

The following is the tentative Field Test Schedule:

- December 2010/January 2011 obtain approval to conduct field test
- February to May 2011
  - Assemble test team
  - Formulate test plans/evaluation criteria
  - Solicit participation from field sites
- June 1 to December 1, 2011 – conduct field test and begin data evaluation
- December 2011 to March 2012 – conclude data evaluation, write final report, make recommendation
- If successful, determine when to deploy to the field

Lower Elevation Angle Test for new Washington State WSR-88D

A high level presentation on the installation of the new NEXRAD radar at Langley Hill, WA was given by ROC personnel. What is unique about this NEXRAD is that a one year test will be performed where an additional two scans at the same angle will be done below 0.5 degrees in

order to test the usefulness of improving coverage of the marine layer and precipitation estimates at longer ranges.

There were numerous questions from the TAC and discussions among members:

1. Several members questioned the use of 0.0 degrees scanning since ½ the power intersects the ground. It was noted that several prior studies have shown that 0.2 to 0.3 degrees is the optimal lowest angle for a 1.0 degree beam width. The ROC indicated that only the range of 0.5 to 0.0 degrees was given in the test documents and that experimentation will determine for that site what the optimal angle is.

2. Other concerns were expressed by the FAA over the gap between products. The VCPs that have more than a 2 minute gap will time out of the WARP mosaicking system. Fortunately, only the clear air VCPs exceed the 2 minute gap. The FAA is exploring whether to initially use the new radar or wait until the test is over.

3. Several items were clarified by ROC personnel:
    a. Although there are new VCP numbers assigned they are only used for control
    b. Any product generated for distribution will still have the current VCP numbering suite used not the new ones.
    c. The base data (level-2) will have the new VCP number recorded in its header and the raw data below 0.5 degrees will be included.
    d. The products generated for external users will not include any data below 0.5 degrees

4. The test configuration is designed to produce products using below 0.5 degrees for the local WFO at Seattle so that the forecaster can observe and evaluate them on a special AWIPS clone. The operational AWIPS will only receive the standard suite of products just as the external world will. However, it was not clear if the baseline suite of algorithms will run on the level-2 data stream containing below 0.5 degree data.

5. Once the test is completed in one year, the ROC did not have any firm plans of what will happen then. What we heard was:
    a. It could run a longer period than one year
    b. The test could terminate at one year and the special VCPs removed
    c. The optimal scanning below 0.5 degrees could be added into operational VCPs. To do so would require more justification since AWIPS require a change to its baseline to accommodate the new scanning angles. Also the standard algorithms may require rework to operate at the lower angle and would require extensive testing to demonstrate their performance.

Multi-Lag processing to Improve Dual Pol Radar Data Quality

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Summary

Dr. G. Zhang briefed on an approach that uses Autocorrelation beyond Lag 1 for estimating dual polarization variables. This approach, which is analogous to the use of multi lag correlations for the Hybrid Spectrum Width Estimator, has potential for reducing biases in ZDR and RHO HV due to poor noise measurements and subsequent noise adjustments.

Details of Briefing and Discussion

This technique improves estimation of base and dual pol parameters in the presence of noise. Dr. Zhang presented the performance of multi lag estimators with simulations and the University of Oklahoma Prime (OU') C Band radar data. His focus was on RHOHV and ZDR. Details on auto correlation and cross correlation techniques are found in the Doviak and Zrnic (1993). The issue is with noise estimates, as in practice, one cannot typically obtain correct noise power through direct measurements. RHOHV and ZDR are most biased by noise, resulting in errors in ZDR and reduced values of RHOHV. Dr. Zhang pointed out that Dr. Melnikov proposed a lag 1 estimator previously (2004/2006).

The literature on multi lag estimators includes Cao 2010, Lei 2011, and Zhang 2004. The idea is to exclude lag 1 to avoid noise power contamination. He showed a Gaussian fitting function with two parameters. One question that arises is: are his spectrum width estimate results similar to the NCAR Hybrid Spectrum Width Estimator?

Dr. Zhang showed simulated "truth" data from the NWP ARPS model, which generated time series data (Xue 2000, Cheong 2008 JTECH).

Simulation results include ZDR reduced bias in low SNR, and the instance of RHOHV low values are reduced. For real data, the number of lags practical depends on the nature of the weather signal. His approach uses adaptive fitting to determine available lags, minimizing the cost function. Dr. Zhang showed an example of reduced errors in a case of wide spectrum width in noise contamination. The correlation coefficient increased for low SNR. He also showed SNR estimates from lag 0, lag 1, and multi lag. This data was for C Band and we should expect better performance with S band.

Jim Evans asked a question on slide 4. He wanted to know why it is hard to estimate noise. The answer regards background noise from the antenna. Darcy Saxion explained how the WSR-88D system measures noise. Dusan Zrnic noted that NSSL is working on a radial to radial noise estimator and it is presently on the MPAR. The group addressed the Gaussian fit aspect since about 25 percent of weather is not Gaussian. The group asked about looking at the spectral domain to avoid the Gaussian issue. Alexander Rhyzkov pointed out that the issue of loss of sensitivity is even more reason to improve processing. At even good SNRs of 20 - 25 dB, the system can have issues. The persistent issue of overestimation of high correlation is due to bad noise estimation. He asked about how much sensitivity can be gained with this technique. The answer depends on dwell time and weather characteristics. A general observation is that this will yield usable RHOHV down to 1 dB SNR. Dusan Zrnic thinks we can get close to 10 dB improvement. Valery Melnikov commented that RHOHV is highly biased from KOUN historically, and he is concerned with this use of multi lag. Dr. Snow suggested further discussion in a smaller group.

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Wind Turbine Clutter Mitigation Research

The briefing reviewed recent progress on approaches to detect and mitigate data corruption from wind turbine clutter (WTC). Three approaches were described: a) detection based on temporal evolution in the level II data, b) laboratory measurements with mitigation based on template matching, c) range-Doppler spectral mitigation based on continuity of signals in range. The level II detection approach derives temporal texture fields using reflectivity, velocity, spectrum width, and CMD flag data from 6-10 low elevation scans and uses a fuzzy logic inference system (FIS) to compute the likelihood the data bin is WTC. Generalized FIS membership functions were re-tuned and improvements were presented. False detections are expected to be further reduced if membership functions are optimized to specific sites. The FIS could easily be extended to dual-pol data when available. The laboratory mitigation approach relies on creating a library of WTC spectra templates in the absence of weather. Then, the library is searched to find the best match with observed spectra, the WTC spectra template is removed, so that only the weather signal remains. For the range-Doppler spectrum approach, two techniques were described. In the first, each spectral pixel is classified as WTC only, Noise only, or weather (with or w/o WTC) and then moments are estimated using only weather pixels. The classification leverages the characteristic of sharp discontinuities at the edges of WTC corruption; however the back edges are often less sharp due to multi-path echoes. In the second technique, a sorting process is used on the range-Doppler spectrum of corrupted data to remove moment outliers. Then, a polynomial is fit to the remaining data to obtain a range-dependent "weather window" which is used to remove spectral outliers and then moments are re-estimated using the remaining data. Strong gradients in some weather signals will be a challenge which might be addressed by adjusting the order of the polynomial or increasing the window of spectrum width. Another challenge will be the low number of samples used by the WSR-88D for low elevation surveillance scans. This last technique was reported to have a lot of promise for the WSR-88D, but much work remains. No works has been done yet with dual polarization data, but expect it would improve algorithm performance.

Status on Implementation of Hybrid Spectrum Width Estimator

Jane Krause presented the current status of implementation for the Hybrid Spectrum Width Estimator (HSWE) algorithm. This is a method, employing multiple lag auto correlation estimators, developed by NCAR. In the November 2009 meeting, the NEXRAD Technical Advisory Committee endorsed the estimator's science principles and recommended implementation. The WSR-88D Software Recommendation Evaluation Committee targeted the HWSE for deployment in Build 13.0.

The following is the current status:

- *The NCAR team developed this hybrid approach under the ROC's Data Quality Memorandum of Understanding.*
- *NCAR has delivered a final algorithm description.*
- *NCAR has provided sample MATLAB and C versions of prototype code.*

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- *ROC software engineering has implemented the HSWE in an engineering version of the operational code.*
- *The ROC software playback process has been updated for the HSWE.*
- *Playback and analysis of selected data cases is underway.*
- *The ROC presented initial qualitative results, absent clutter filtering, for one case.*
- *Results of the ROC software playback process compare favorably with NCAR results for this single case.*

The ROC plans to produce additional data sets and conduct quantitative analysis. The project is on track to meet the Build 13.0 schedule. There was a brief discussion of the effects of system noise measurement errors on spectrum width estimates. The HSWE is more immune to these errors since it is designed to avoid use of the R0/R1 estimator, which is dependent on proper noise correction, when the signal to noise ratio is low.

Status of AVSET Field Test: Decision Brief Follow-Up

Mr. Joe Chrisman (ROC/ENG) provided a follow-up presentation for the Decision Brief relative to the Automated Volume Scan Evaluation and Termination (AVSET) application. As requested by the TAC, the AVSET is being field tested at ten select radar sites at corresponding NWS offices. Evaluations are being conducted in context of NWS/WFO operations, AFWA/OW operations, and FAA/ARTCC operations. Originally scheduled for July 2010 through January 2011, the test period was pushed back five months and is now in effect through May 2011.

The objectives of the field test are centered upon supporting forecast and warning operations. This is accomplished through the provision of faster volume scan updates by only sampling those elevations containing relevant meteorological data. With AVSET turned on, enhancements to the current scan strategy (for precipitation mode VCPs only) prompt the radar to sample the lowest levels as often as possible while smartly forsaking the oversampling of data void elevations at higher levels. All the while, AVSET remains sensitive to the overall dynamic convective situation at all azimuths, ranges, and elevations. AVSET can be especially helpful in situations when echoes of interest are at greater ranges in tandem with the absence of deep convection closer to the radar itself. During the test period, AVSET will not adversely impact the operation of the WSR-88D. More so, the AVSET-produced volume scans which have varying completion durations must not adversely impact forecast and warning operations or user data processing and display systems.

During the early weeks of the field test, winter weather inhibited the use of AVSET at many of the sites. Yet, preliminary survey results were collected from a few WFOs and showed that AVSET yielded no particular adverse effects when executed and furnished refreshed data every 3-4 minutes. WFO Melbourne (KMLB) forecasters stated that they routinely run AVSET while in precipitation mode and indicated its positive contributions during several warning decision-making events. The most notable of these events occurred on 25 January 2011. While in VCP212, AVSET reliably provided critical low-level data associated with severe convective storms impacting Lake County (located at the far northwest reaches of WFO Melbourne's area of responsibility). With data refreshing at an average rate of every 204 seconds (as compared to every 272 seconds), the WFO was able to issue a timely Severe Thunderstorm Warning with 50-

minute lead-time. The towns of Groveland and Mascotte (in south Lake County) received appreciable damage from what was later determined to be a 70 mph punch of wind. As the event unfolded and storms moved closer to the radar, echoes at higher elevations were not overlooked. Without glitch, the radar ran flawlessly for many successive hours in VCP212 with AVSET turned on.

After Mr. Chrisman's presentation, TAC members noted that to ensure testing was being conducted as thoroughly as possible users should be informed whenever AVSET was invoked. Notification is accomplished through the issuance of a Free Text Message whenever AVSET is turned on or turned off (while in precipitation mode). Associated users are at liberty to request a change in AVSET operations status at any time.

Pending successful results from the comprehensive field test, a request will be made to the SREC to approve AVSET for operational use in Build 13.

Spectrum Challenges for WSR-88D and all S-Band Radars

Electronic Interference to the WSR-88D has been growing particularly from FAA S-band radars (ASR-11) and now a commercial vendor (WiMAX). There is a real fear that the Federal Communication Commission will sell S-Band frequencies in the government spectrum to private companies as a money making endeavor. John Chou (Sp?) of Lincoln Labs mentioned that the TDWR's at C-band are facing the same problem.

The TAC considers this a very serious problem and is considering ways to bring together the frequency coordination groups FCC, NTIA and IRAC to discuss the seriousness of causing interference with weather radars.

MPAR Update

In this information brief, Mr. Douglas Forsyth, Chief, Radar Research & Development Division at the NOAA National Severe Storms Laboratory, provide a review of recent developments and current status of the effort to develop a multi-function surveillance radar using phased array technology. He covered recent developments in both radar engineering (e.g., contractor modifications to real time controller) and radar hydrometeorology (e.g., continuing analysis of National Weather Radar Testbed data from observations of opportunity and working on results from PARISE). Doug described the current three goals for the MPAR program: determine challenges and risks for MPAR; determine path forward that will minimize risk; and implement risk reduction strategies. Four areas of concern were also described: dual polarization on a flat panel phased-array; multi-frequency operations; overall cost of a PAR radar; development of a concept of operations to gain advantage from the rapid, flexible scanning possible with a PAR radar. All four are the subject of active research at NSSL. Doug closed with a graphic showing a path forward, viewing MPAR with its rapid updates as the key to "warn on forecast" operations.

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Meso-cyclone Detection via Linear Squares Derivative Methodology

The stated goal was to develop a more accurate mesocyclone detection algorithm than the present operational one called MDA. MDA produces many false alarms and thus is not used much by the forecasters. The algorithm Kim Elmore reported on uses a linear least square derivative technology and is called LLSD, and was reported on at a previous TAC meeting. Kim presented comparisons between the legacy MSD algorithm and LLSD. A total of 4 cases have been compared. The LLSD algorithm had approximately ¼ the number of detection as MDA. Kim noted that because of funding limitations there has not been any "truthing" by humans of mesocyclone detections; thus it is not possible to compare the accuracy of LLSD to MDA. Cursory examination of Kim's figures suggests that MDA has too many false alarms and LLSA too few detections.