Multiple National Laboratory and University Partnership to Develop Dual Polarization Weather Radar Products for the FAA

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Objective

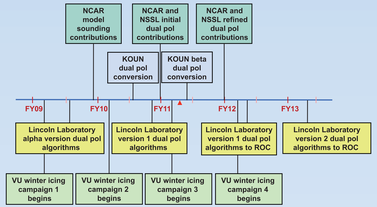
Derive benefit from NEXRAD's dual polarization upgrade to FAA weather systems. The benefit will come from creation of new icing and hail hazard products plus upgrades to existing products. Partnership allows contributions from subject matter experts and early access to dual polarization weather radar data.

Planning and Timelines

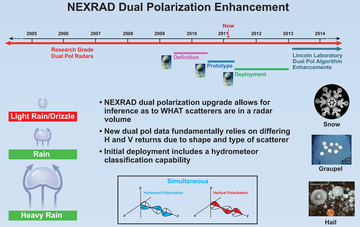
Partnerships Contribute to Development of FAA Dual Pol Algorithm Products

- FAA supports partnership plan with dual pol radar subject matter experts (SMEs) from national laboratories and universities
- Contributions from SMEs to be incorporated into real-time dual pol algorithms in development at Lincoln Laboratory for FAA weather systems
- Proxy data sources being used for early development
  - Valparaiso University's C-band dual pol radar
  - KOUN (Norman, OK) prototype and beta site dual pol data
- Strategies identified to bolster determination of the melting layer altitude and hydrometeor classification
- Incrementally more robust products from increasingly sophisticated algorithms
  - Current Source: NEXRAD Open Radar Product Generator
  - Future Added Source: NextGen Weather Processor

Partner Dual Pol Product Development Timeline



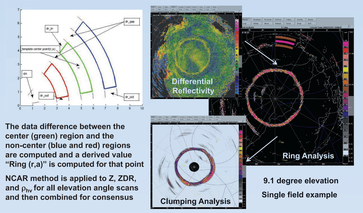
NEXRAD Dual Polarization Enhancement



- NEXRAD dual polarization upgrade allows for inference as to WHAT scatterers are in a radar volume
- New dual pol data fundamentally relies on differing H and V returns due to shape and type of scatterer
- Initial deployment includes a hydrometeor classification capability

Melting Layer Altitude Detection

NCAR Detection of Melting Level Altitude



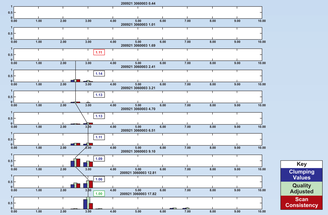
The data difference between the center (green) region and the non-center (blue and red) regions are computed and a derived value "Ring (r,a)" is computed for that point

NCAR method is applied to Z, ZDR, and ρ_{hv} for all elevation angle scans and then combined for consensus

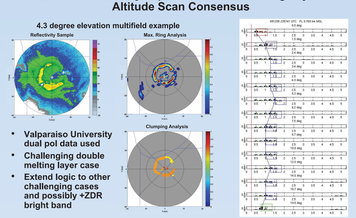
9.1 degree elevation

Single field example

Melting Layer Altitude Scan Consensus



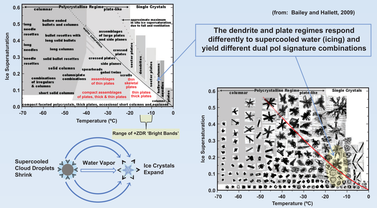
Lincoln Laboratory Implementation of Melting Layer Altitude Scan Consensus



- Valparaiso University dual pol data used
- Challenging double melting layer case
- Extend logic to other challenging cases and possibly +ZDR bright band

Keys to a Robust Icing Product

Discover Supercooled Water in Dual Pol Data



(from: Bailey and Hallett, 2009)

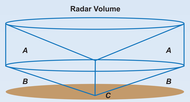
The dendrite and plate regimes respond differently to supercooled water (icing) and yield different dual pol signature combinations

Complete Icing Hazard Coverage

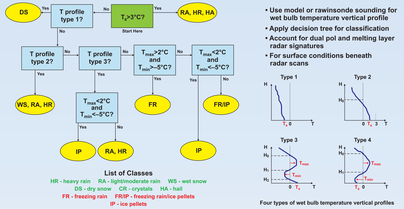
A. Icing hazards within radar volume for en route applications
Supercooled water, ice crystals

B. Icing hazards beneath lowest scan and above surface
Snow, sleet, rain, freezing rain, supercooled water

C. Icing hazards at surface for terminal applications
Snow, sleet, rain, freezing rain



NSSL Decision Tree to Determine Surface Precipitation Types

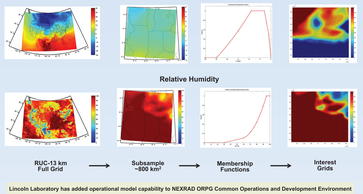


- Use model or rawinsonde sounding for wet bulb temperature vertical profile
- Apply decision tree for classification
- Account for dual pol and melting layer radar signatures
- For surface conditions beneath radar scans

Four types of wet bulb temperature vertical profiles

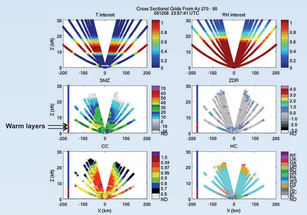
Model Data Support

Transform Model Data to NCAR CIP Interest Products Centered at Valparaiso



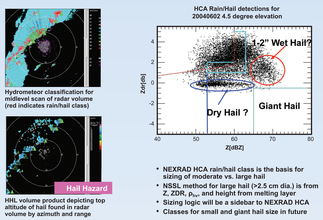
Lincoln Laboratory has added operational model capability to NEXRAD ORPG Common Operations and Development Environment

Applying NCAR CIP Interest Products to Valparaiso Data



Hail Sizing

Lincoln Laboratory Hail Hazard Product Development

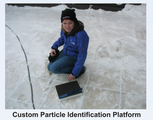


- NEXRAD HCA rain/hail class is the basis for sizing of moderate vs. large hail
- NSSL method for large hail (>2.5 cm dia.) is from Z, ZDR, ρ_{hv}, and height from melting layer
- Sizing logic will be a sidebar to NEXRAD HCA
- Classes for small and giant hail size in future

Winter Weather Field Studies

Valparaiso University's 2010 Winter Weather Verification Campaign

- Dec. 8, 2009 20 UTC – Dec. 9, 2009 01 UTC
- Jan. 7, 2010 20 UTC – 21 UTC
- Jan. 8, 2010 15 UTC – 21 UTC lake effect band
- Jan. 27, 2010 22 UTC

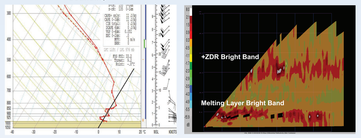


Custom Particle Identification Platform

Targeted Radiosonde Soundings

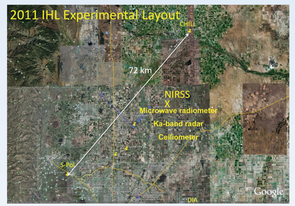
- Feb. 2, 2010 16 UTC – 21 UTC
- Feb. 9, 2010 12 UTC – Feb. 10, 2010 6 UTC; Lincoln Laboratory staff on-site
- Feb. 10, 2010 6 UTC – lake effect band; Lincoln Laboratory staff on-site

Sounding Augments +ZDR Bright Band Interpretation



- +ZDR Bright Band often noted within the ~0° to ~15°C temperature range
- Moderate rime icing PIREPs often associated with the ~0° to ~15°C altitude
- Lincoln Laboratory, NSSL, and NCAR discussing relevance of this feature to the icing hazard
- Plan to integrate +ZDR Bright Band concept into icing hazard product

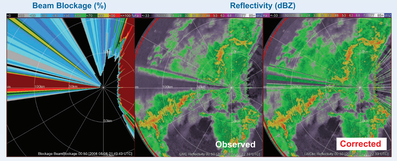
NCAR Winter Weather Verification 2011



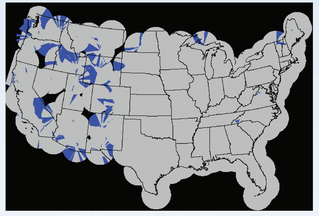
Partial Beam Blockage Mitigation

NSSL Z-Φ_{DP} Method to Adjust Z for Partial Beam Blockage

- Lincoln Laboratory and NSSL found NEXRAD KDP product problematic to mitigate partial beam blockage
- NSSL method uses root Φ_{DP} to recover Z in regions of partial beam blockage
- Method has potential to work in areas of significant (>50%) blockage

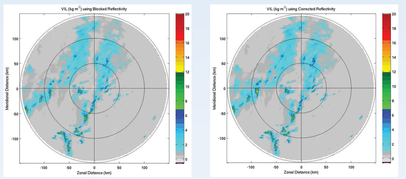


SPOL in Taiwan 20080614 13:22 UTC, 0.5° Elevation Angle Scan



NEXRAD 230 km coverage (gray) with partial blockage (blue)

Applying NSSL Z-Φ_{DP} Method to Compute VIL with Partial Beam Blockage



- Lincoln Laboratory plans to mitigate partial beam blockage effect in the FAA High Resolution VIL algorithm product
- High resolution VIL algorithm will require new inputs for Z, Φ_{DP}, and terrain data
- Alternate approach is to apply method for FAA Data Quality Assurance algorithm

Legend: HCA = Hydrometeor Classification CIP = NCAR's Current Icing Potential Product Z = Reflectivity Φ_{DP} = Differential Phase ρ_{hv} = Correlation Coefficient ZDR = Differential Reflectivity VIL = Vertically Integrated Liquid Water

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