In Situ Icing Verification

David J. Smalley

MIT Lincoln Laboratory

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MASSACHUSETTS INSTITUTE OF TECHNOLOGY





- In Situ Icing Mission Objectives
- In Situ Icing Missions

NEXRAD – WSR-88D Next Generation Weather Surveillance Radar



- FAA funds Lincoln Laboratory's NEXRAD Algorithm Enhancements Program since 2001
 - Operational products: storm intensity, echo tops, data quality, wind shear
 - In pipeline: dual pol icing hazards, dual pol hail hazards



Dual Polarization Issues NEXRAD Hydrometeor Classification

HCA Category Relationship to a Single Melting Layer and Icing Potential

Categories		No Echo	Dry Snow	Wet Snow	Ice Crystals	Graupel	Big Drops	Light/Mod Rain	Heavy Rain	Rain and Hail	Ground Clutter/AP	Biological	Unknown
Thresholds		NE	DS	WS	IC	GR	BD	RA	HR	RH	GC	BI	UK
Melting Layer	Above	Unknown	None	None	lcing	lcing	lcing	lcing	lcing	lcing	Unknown	Unknown	Unknown
	Mostly Above	Unknown	None	None	lcing	lcing	lcing	lcing	lcing	lcing	None	Unknown	Unknown
	Within	Unknown	None	None	Unknown	lcing	Conditional	Conditional	Conditional	lcing	None	None	Unknown
	Mostly Below	None	None	None	Unknown	Conditional	None	None	None	None	None	None	None
	Below	None	None	None	None	None	None	None	None	None	None	None	None

HCA Classification Key

Current HCA Category

Not in HCA/Potential in HCA

Below SNR or none selected

Icing Hazard Key					
lcing:	Definitive icing region				
Conditional:	Potential hazard based on fluctuations in freezing level				
None:	No icing				
Unknown:	More research is needed				

Evolution of Melting Layer concepts and HCA classifications necessary to achieve full dual pol benefit



Icing Hazard Levels Product KOKX 02/24/2012 0952 UTC





- Icing Hazard Detection with Dual Pol NEXRAD
- In Situ Icing Mission Objectives
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Need for In Situ Icing Missions





- Verify microphysical conditions: Crystal habit, ground truthing
- Validate classifications: Is HCA correct? Can improvements be made?
- Addresses PIREP negatives: sparse, temporal/spatial uncertainty
- Relate to radar observables





Icing-Related Dual Pol Radar Signatures Five Zones





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DJS 09/20/2013

NRC Convair 580





- Atmospheric state
- Liquid water content
 - Nevzorov, King
- Particle imaging
- Particle sizing
- X-band radar
- W-band radar



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NRC = National Research Council of Canada



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In Situ Verification: KCLE Icing Mission 02/24/2012

Convair position marked by cross



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February 2013 Buffalo Area Icing Missions





In Situ Verification: KBUF Icing Mission 02/19/2013





Regions of mixed phase encountered in vast HCA Dry Snow classification

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In Situ Verification: KBUF Icing Mission 02/26-27/2013



- Cleveland ARTCC issued alert for moderate/severe clear icing
 - Known notable icing hazard region (Supercooled Large Drops)
- Reflectivity to 57 dBZ; Differential reflectivity 2 4 dB
 - Indicative of oblate large drops
- Convair measure temps in single numbers below 0° C
 - Spirals and transects probe region of supercooled drops



In Situ Verification: KBUF Icing Mission 02/26-27/2013



Case needs further study to deal with complex HCA depiction and consider SLD options

IN SITU ICING 15 DJS 09/20/2013 HCA = NEXRAD Hydrometeor Classification Algorithm SLD = Supercooled Large Drops

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02/26/2013 NAX radar with 2DB Particle Probe



7:48 PM pilot reports liquid but does not realize we are in melting we have not seen supercooled water 7:49 PM we want to spiral up but still in descent right now 7:50 pm 7:51 PM t=-1C and seeing large drops! 7:52 PM 7:53 pm we may have lost our connection says Gary 7:54 pm 7:53 PM one more minute of ascent and then will climb back up, says pilot 7:54 pm we can't trust the temperature reading, says Mengistu it is -4C but Alexei sees same drops I do 7:54 PM Alexei is skeptical of supercooled drops 7 56 pm 7:55 PM first time I have seen circles on particle display



In Situ Verification: KBUF Icing Mission 02/28/2013



Classic dry snow / ice crystal / unknown HCA case

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- Dual pol NEXRAD network provides great opportunity for development of a radar-based icing hazard detection product
- Relating radar observables to microphysics and hydrometeor classifications is key for a robust detection product
- Valuable verification and validation provided by the NRC Convair 580 in situ icing missions in four notable events
- Mission results suggest potential to improve and refine hydrometeor classifications that would benefit icing hazard detection