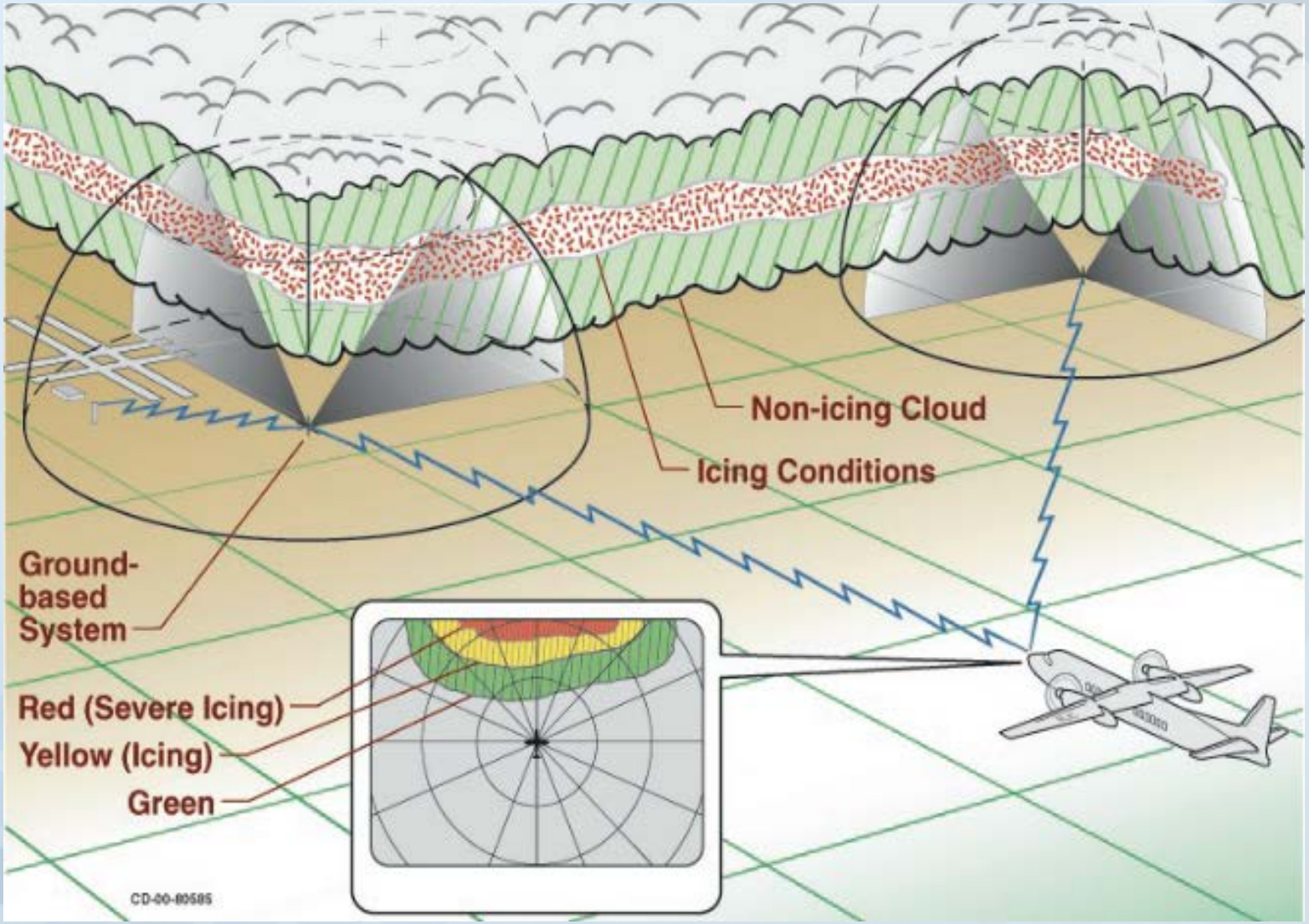
NCAR's 'Radar Icing Algorithm'

David Serke[a], Scott Ellis[b], John Hubbert[b],
David Albo[a], and Marcia Politovich[a]

[a] National Center for Atmospheric Research, Research Applications Laboratory,
3450 Mitchell Lane, Boulder, Colorado 80301, USA

[b] National Center for Atmospheric Research, Earth Observing Laboratory,
3450 Mitchell Lane, Boulder, Colorado 80301, USA

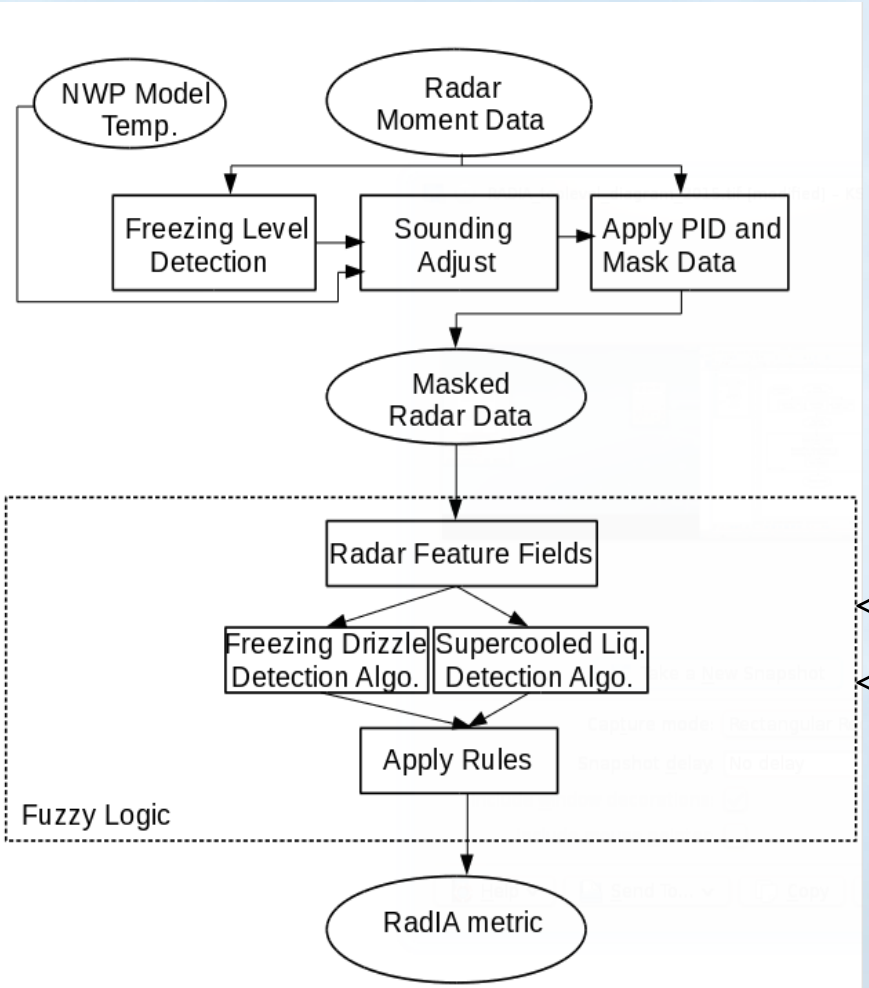
Needed! .... Ground-based IFI detection



Question: IFI detection with Polarized NEXRADs?

- Reflectivity factor ~ D6
  > not promising for direct detection through point moment values

- 'Radar Icing Algorithm' (RadIA, formerly IHL):



< PID: Vivekanandan et al, 1999

< FRZDRZ: Ikeda et al, 2009

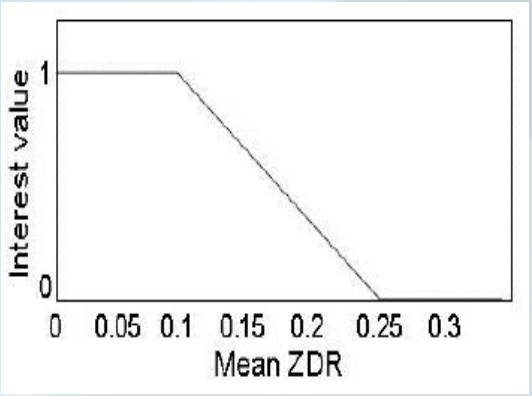
< SLW: Plummer et al, 2010

< IHL Final Report, 2010&2012

RadIA meta-algorithms:

Int_FRZDRZ = (int_meanDBZ + int_sdevDBZ +
int_sdev20DBZ + int_meanTDBZ +
int_sdev20TDBZ) / 5

Int_SLW = (int_meanZDR + int_sdevZDR +
int_meanKDP + int_sdevKDP) / 4



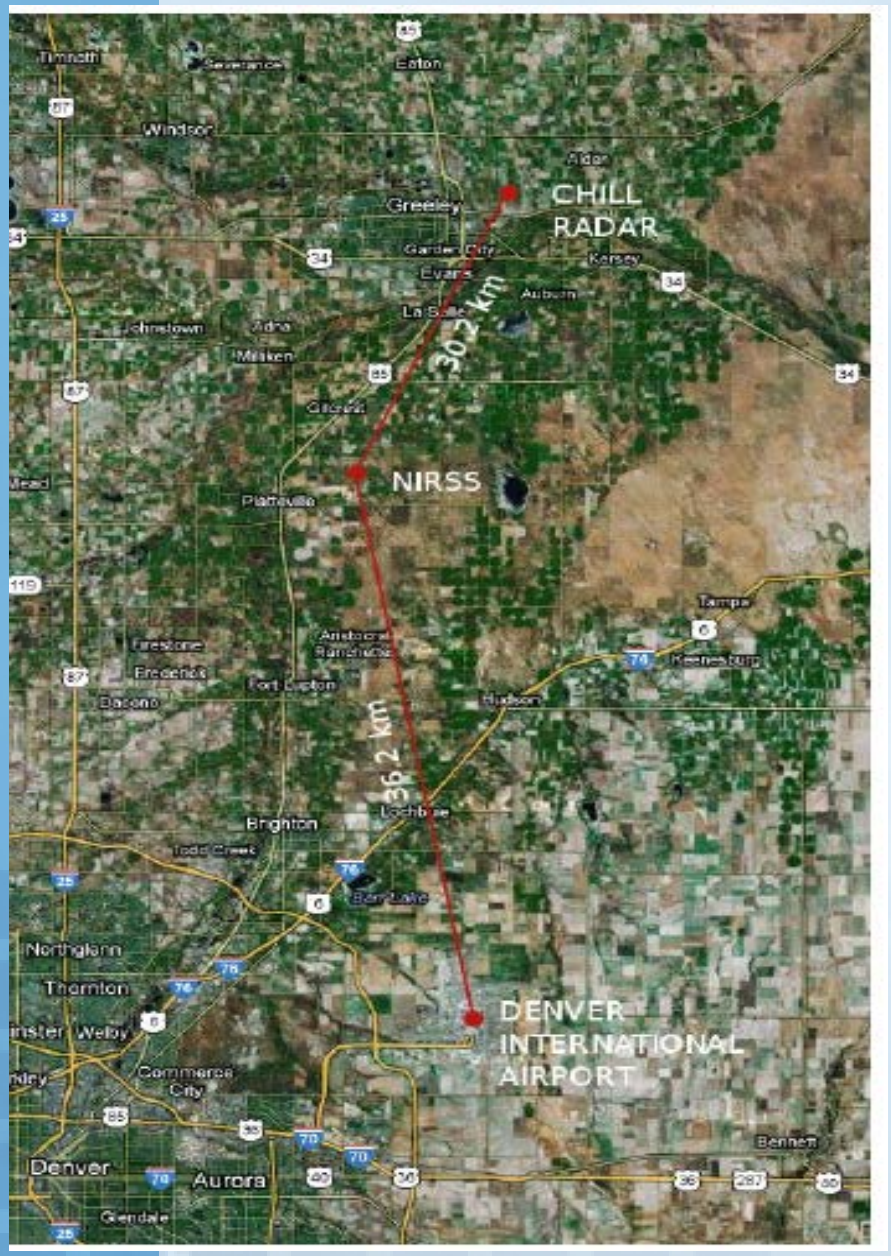
* 'Interest' (int)

determined by fuzzy
logic membership function

RadIA hazard output:

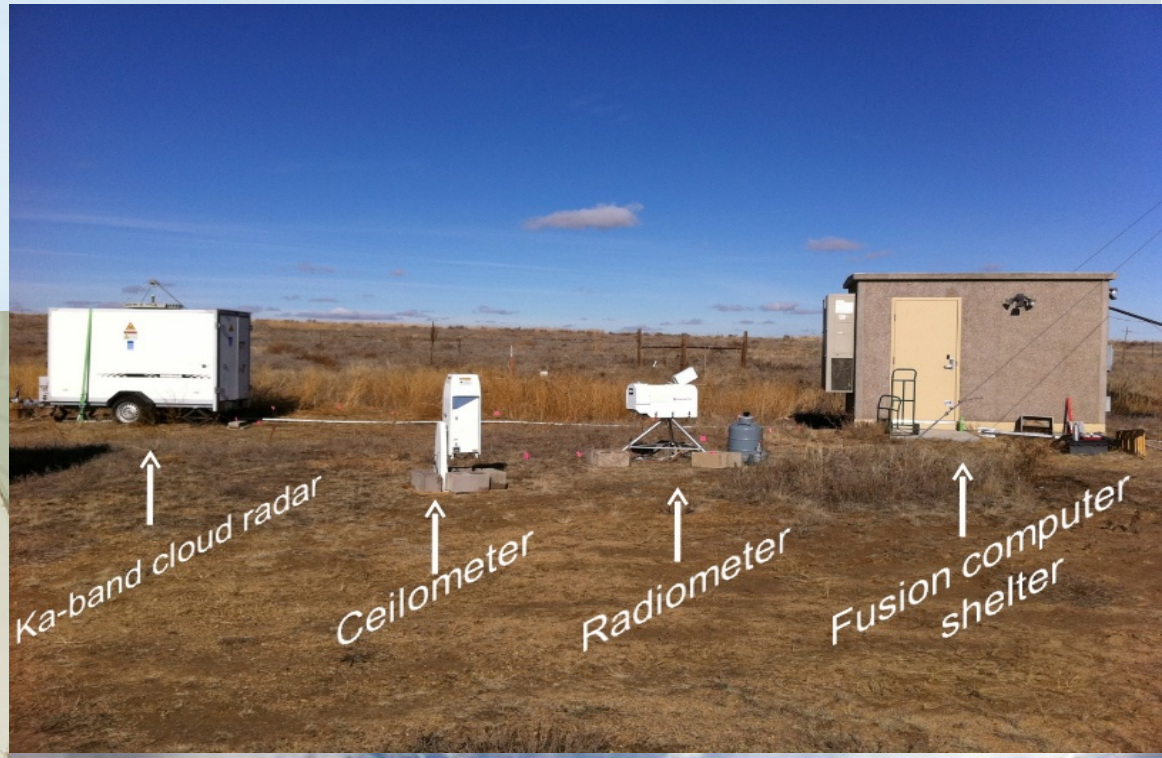
Category	Name	Description	Value	Icing
1	High SLW	SLWA output >0.55	1.0	Yes
2	High FZDZ	MNDDA output >0.70	0.7	Yes
3	Both high	Category 1 and 2 apply	0.8	Yes
4	Both low	SLWA and MNDDA output both <0.45	0.0	No
5	Below SNR	When mean dBZ < -31 dBZ	-0.1	Unknown
6	Both medium	Not categories 1 through 5	0.5	Maybe

2010 Field Campaign



NIRSS & PIREPs provide icing/non-icing case verification for examining dual-polarization radar moments with research S-band radars

2010 Field Campaign: Instrumentation



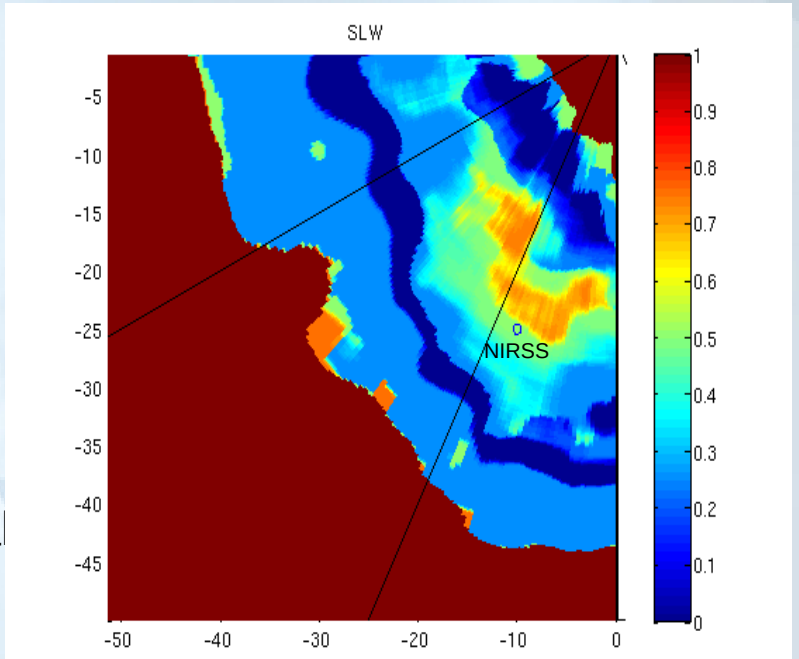
2010 Field Campaign: Results

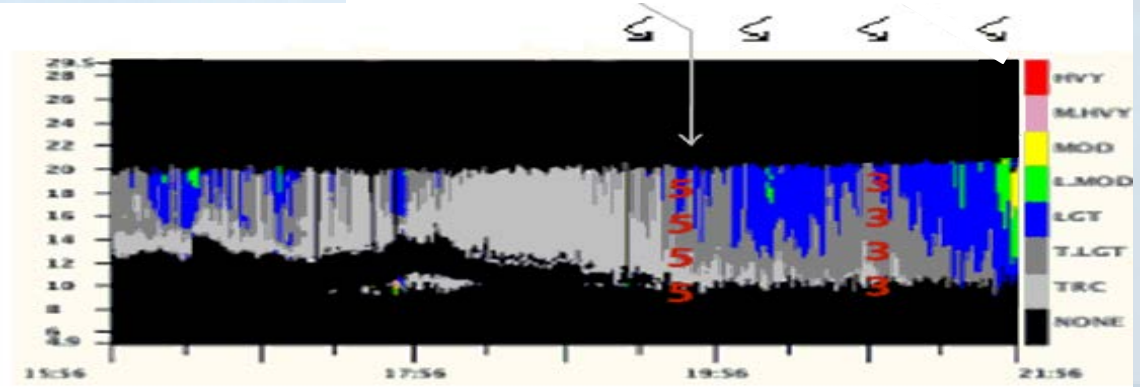
Moment profiles within several kms of NIRSS at times of icing PIREPs had repeatable signatures that could be detected with RadIA (Serke et al., 2011).

Several instances of embedded high ZDR bands not associated with freezing layer observed (as mentioned in Williams et al., 2011).

Needed larger database of cases to continue analysis

Needed to see if RadIA metas would work with (shhh! ...less-than-perfect) operational S-band polarized fields

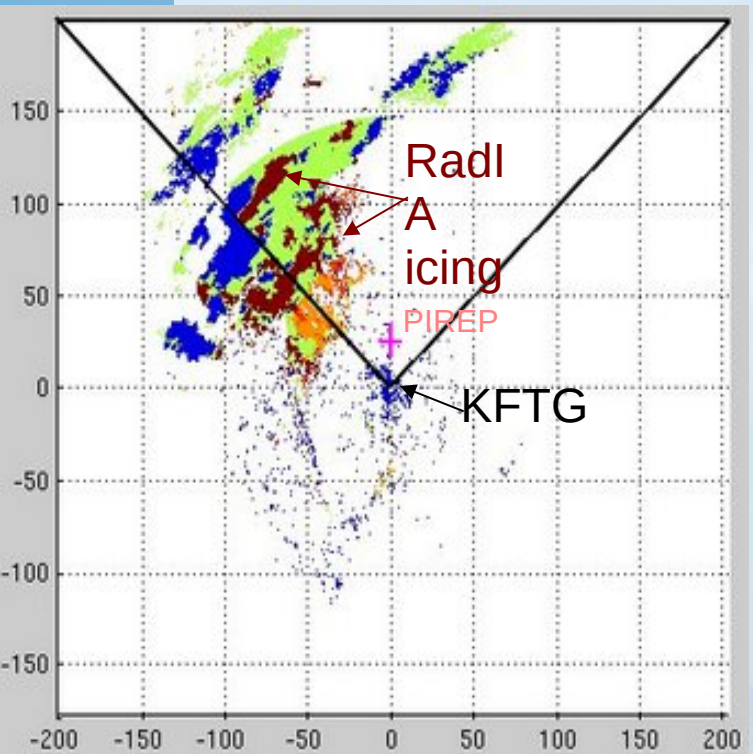




2012-2013 Case Study Period

Collected & analyzed 50 icing and 25 non-icing PIREPs from operational NEXRADs at 8 different cities during different weather scenarios (https://wiki.ucar.edu/display/icinghazardlevel/Home)

Compared DP algorithm to SP plus temperature and reflectivity 'smarts' algo. (Serke et al., 2013)



Weather Scenario	# of MOG PIREPs	matched by algorithm... $IH_{SP\text{-}y}$	IH_{DP}
Dev. low/upslope	25	7	21
shortwave trough	3	1	3
stationary front	0	0	0
ahead warm front	5	3	5
behind cold front	8	5	8
lake effect	8	4	7
hurricane/ext. Trop.	1	0	1
TOTAL CASES	50	20	45
POD_y		0.40	0.90

	# of Null PIREPs	matched by algorithm... $IH_{SP\text{-}y}$	IH_{DP}
TOTAL CASES	25	13	15
POD_n		0.52	0.60

More promising results!
Algorithm's shortcomings better understood

Known RadIA shortcomings

No detection outside radar volume

Misses some homogeneous very small drop cases (below -5 dBZ)

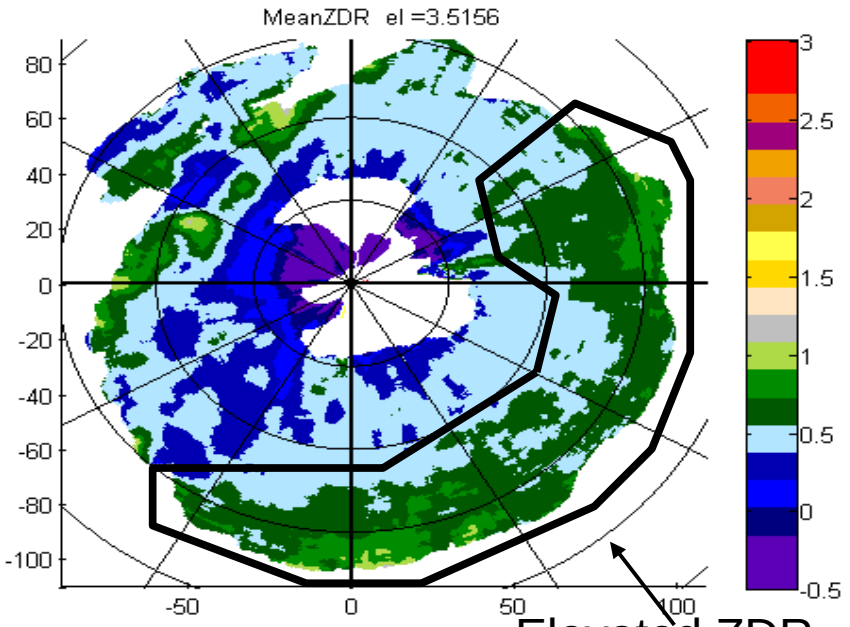
Unknown effect of radar-dependant ZDR bias/drift in NEXRADs

Probable detection capability degradation beyond ~100km due to proximity to useful SNR for polarized moments

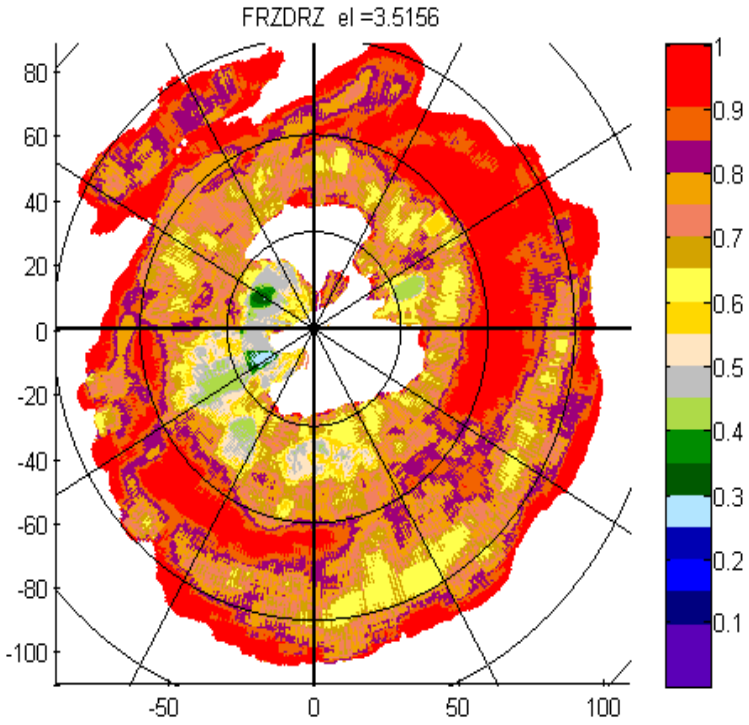
Particle canting effects due to electrification (Hubbert et al., 2010)

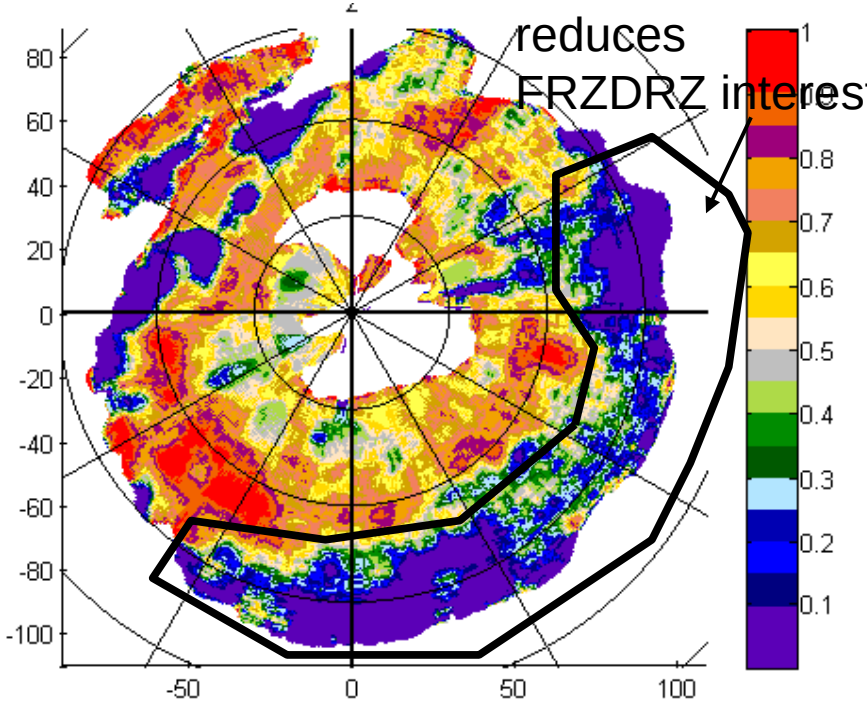
Progress in 2014 (part 1)

- ZDR adjustment to formerly non-polarized 'Freezing Drizzle Algorithm'
- Feb 10, 2012: Known large drop icing case at KCLE

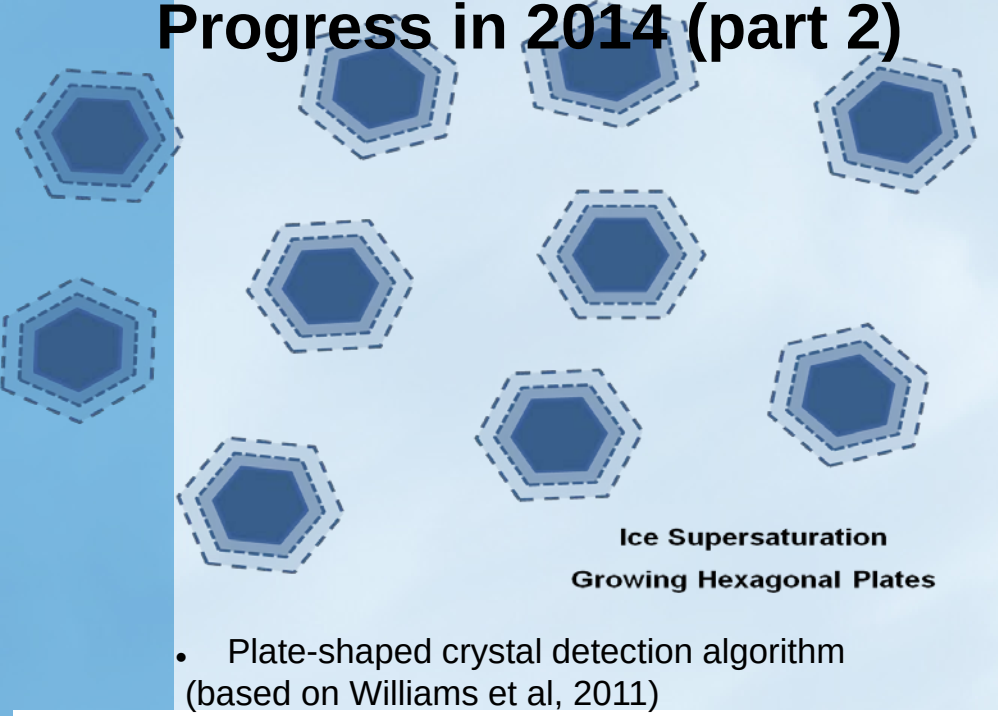


Elevated ZDR reduces FRZDRZ interest

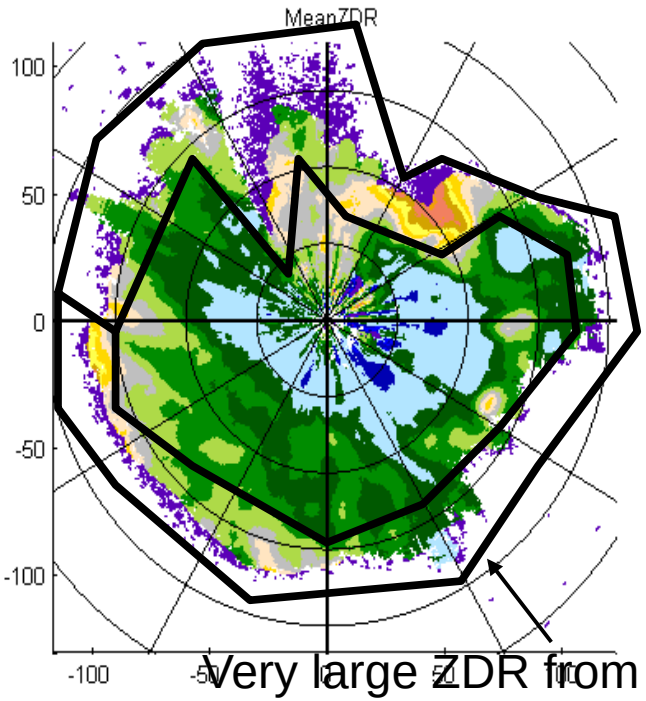




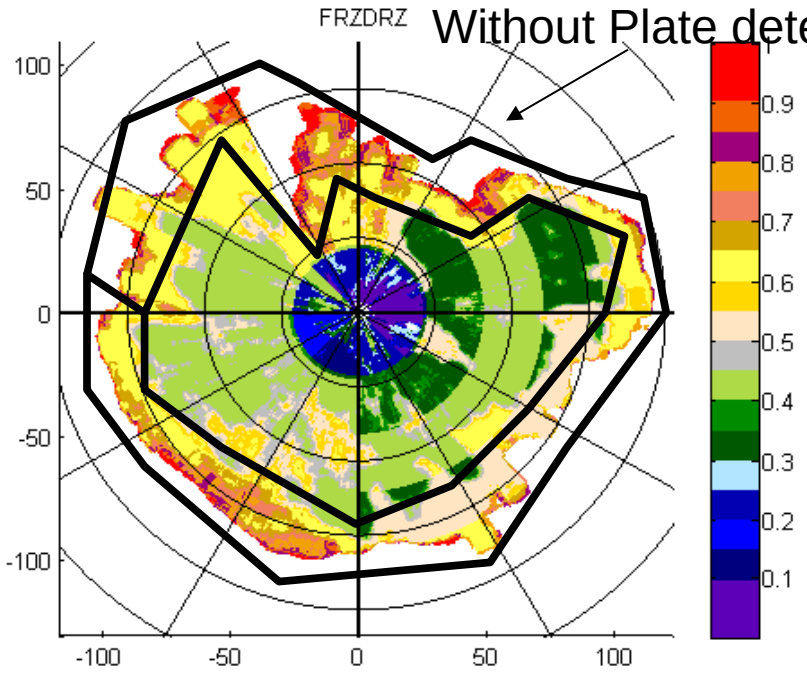
Progress in 2014 (part 2)



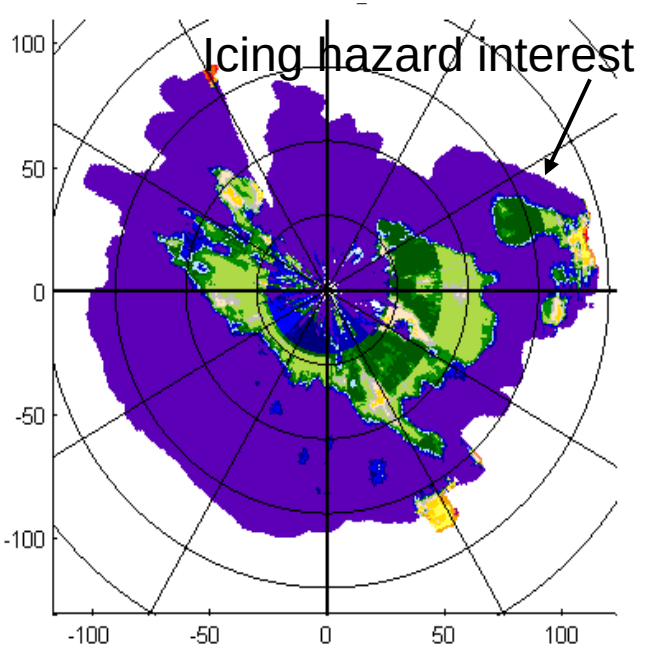
- Plate-shaped crystal detection algorithm (based on Williams et al, 2011)



Very large ZDR from plates



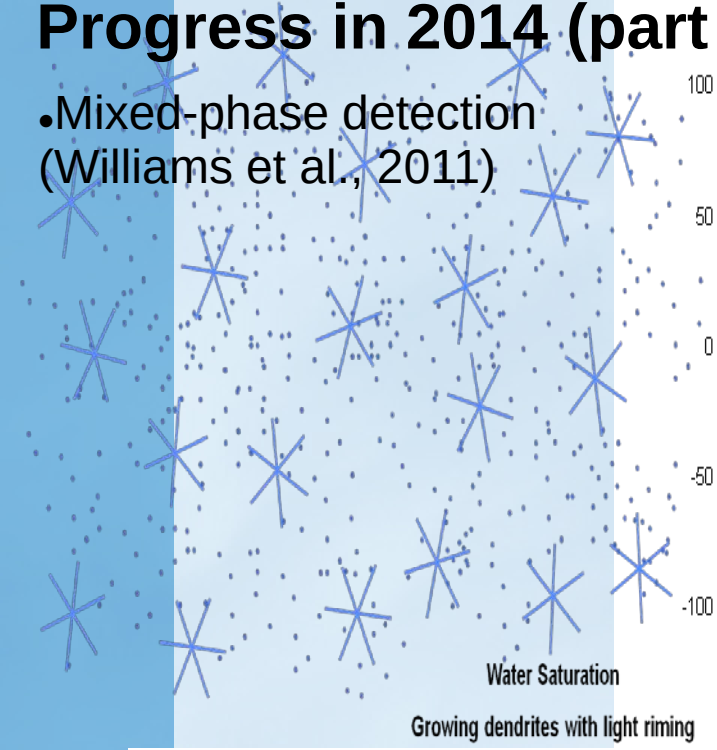
Without Plate detection

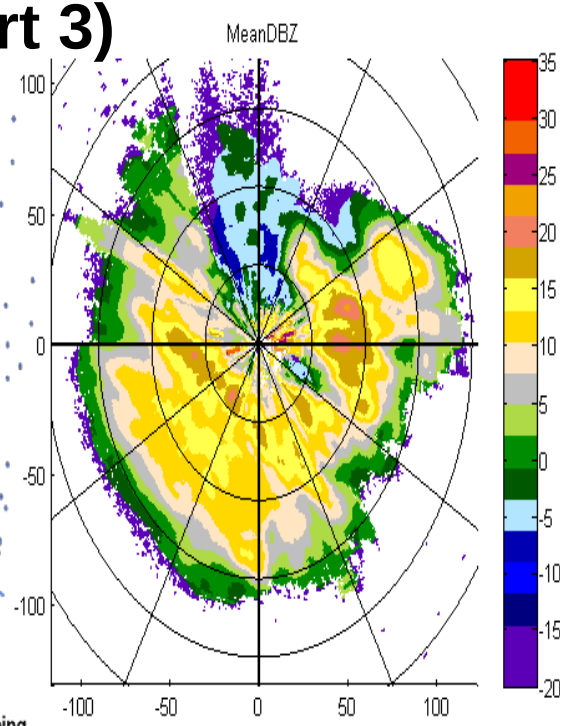


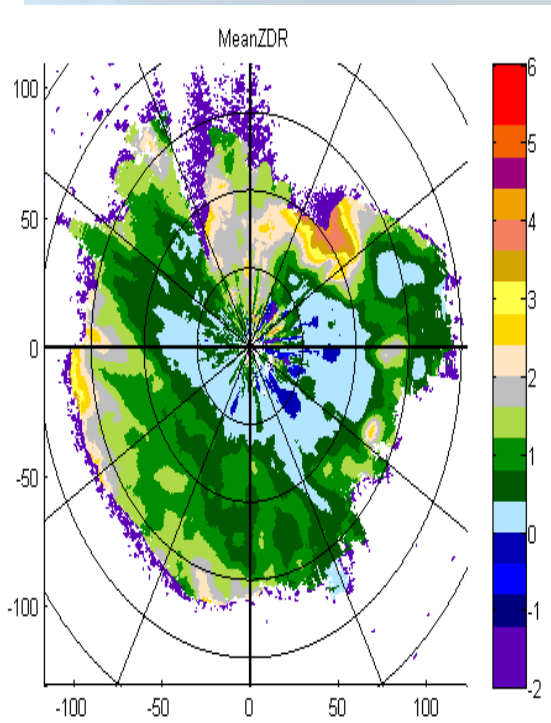
Icing hazard interest reduced

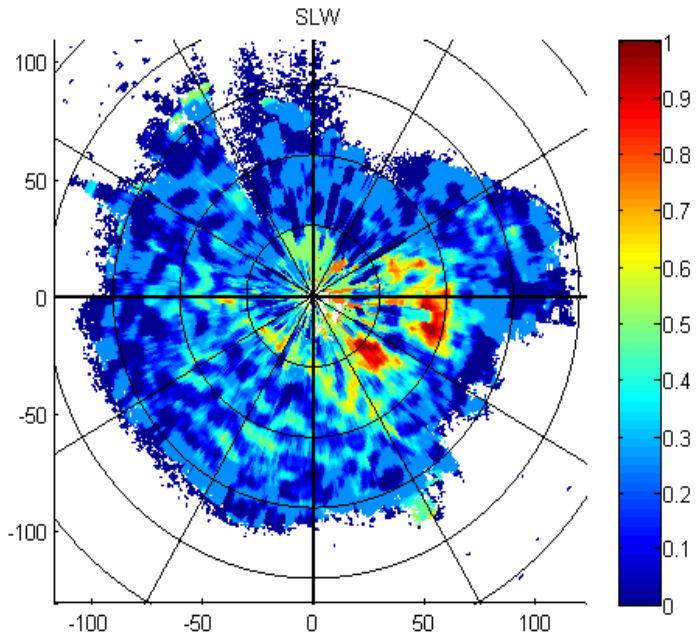
Progress in 2014 (part 3)

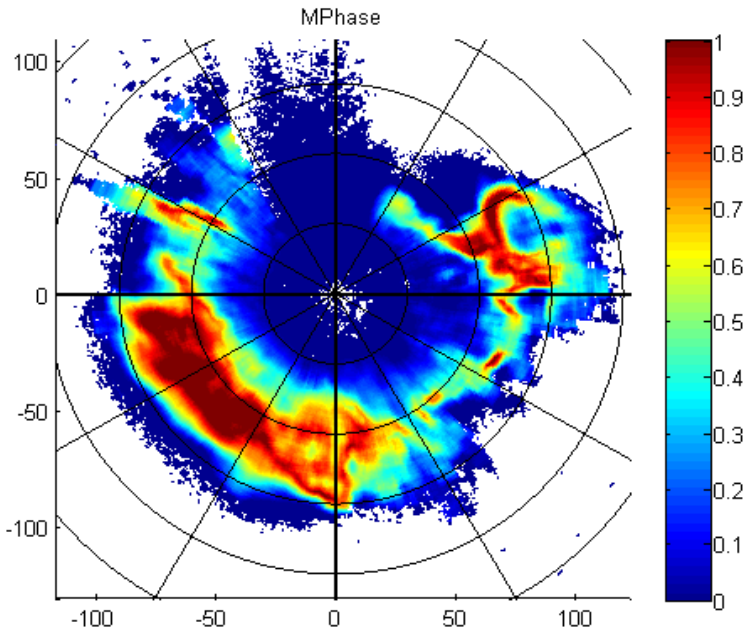
- Mixed-phase detection (Williams et al., 2011)











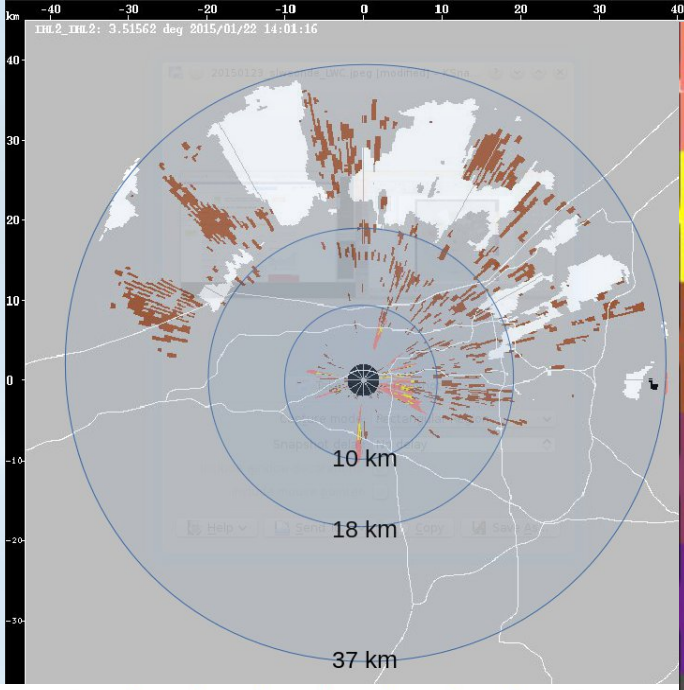
Case: January 22nd, 2015 @ Cleveland

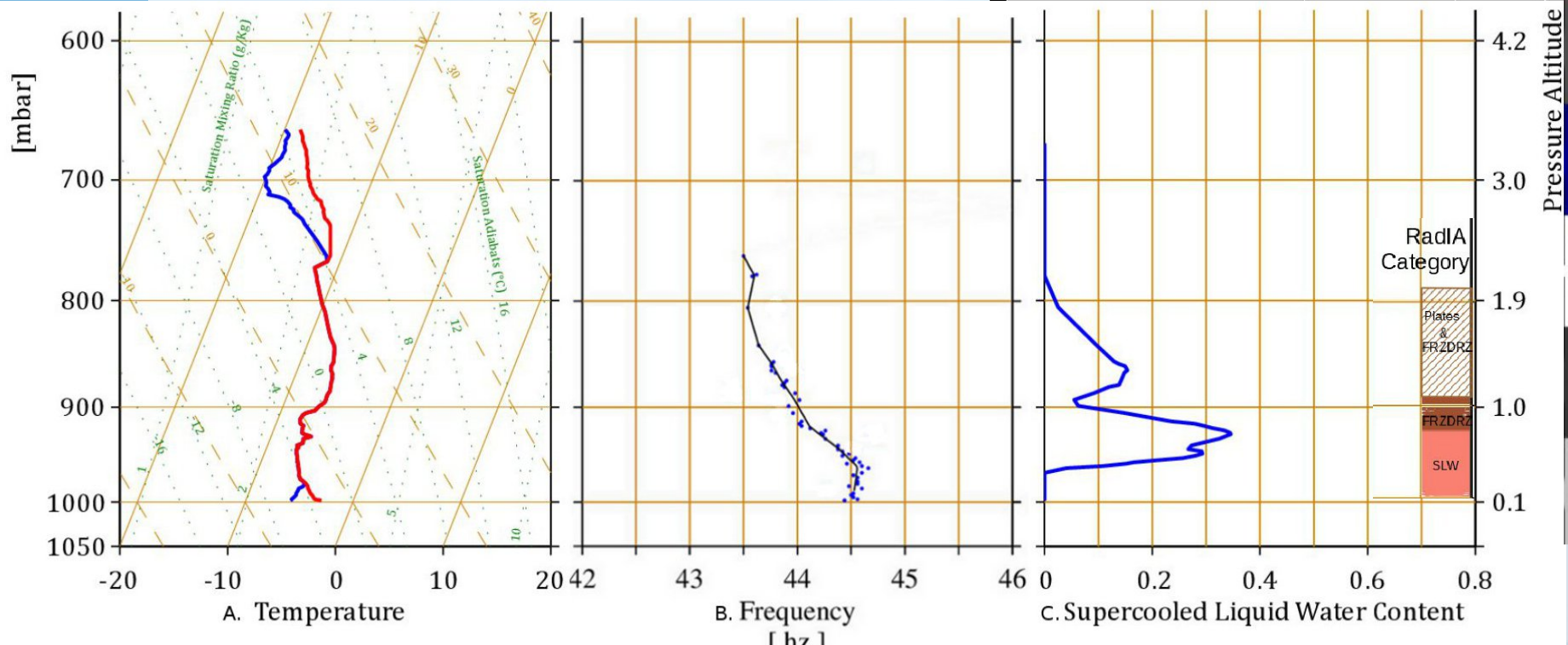
Several moderate PIREPs near CLE

SLW-sonde detects significant SLW from0.3-1.9 km AGL

RadIA detects:
Small drops within 10km (0.9km alt)
Large drops 10-18km (0.9-1.1km alt)
Patchy plates and large drops above

(SAE, 2015)



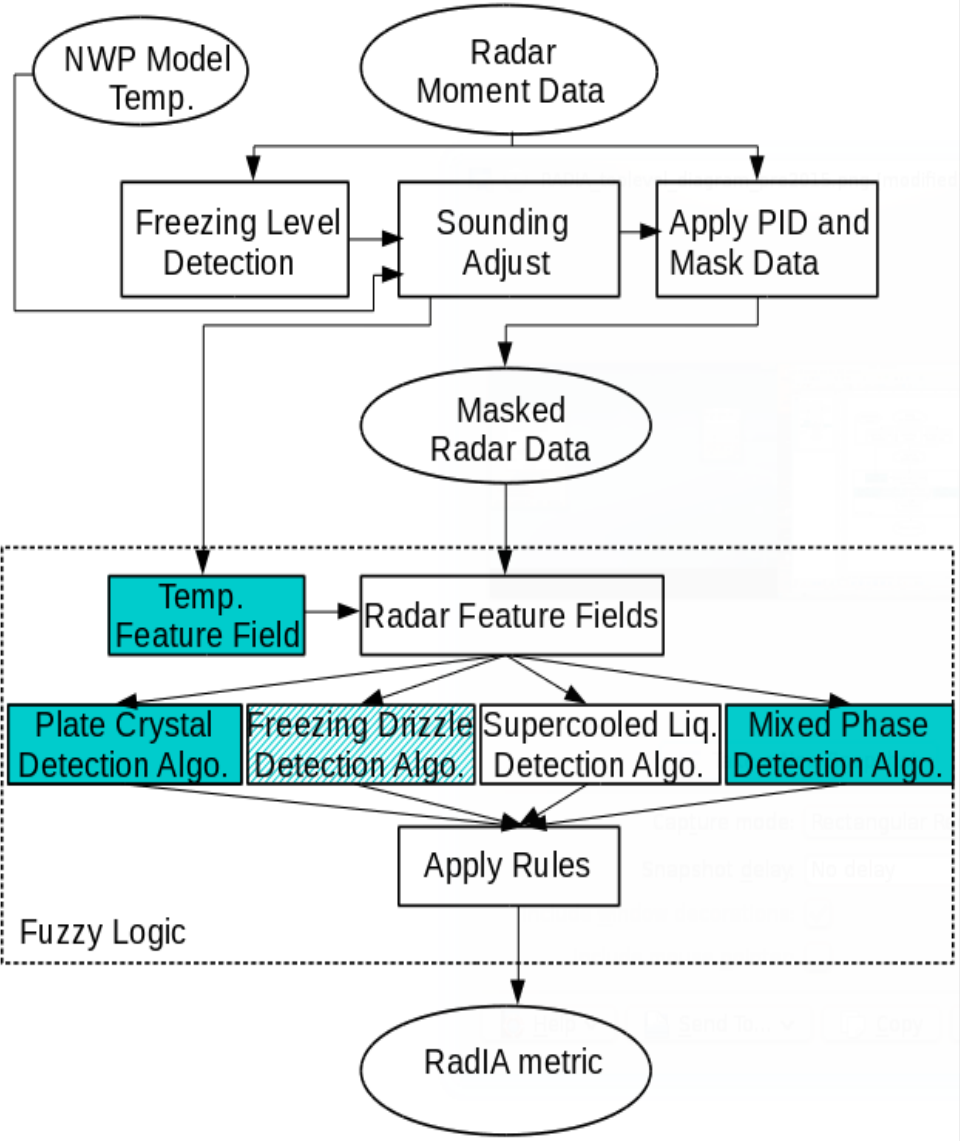


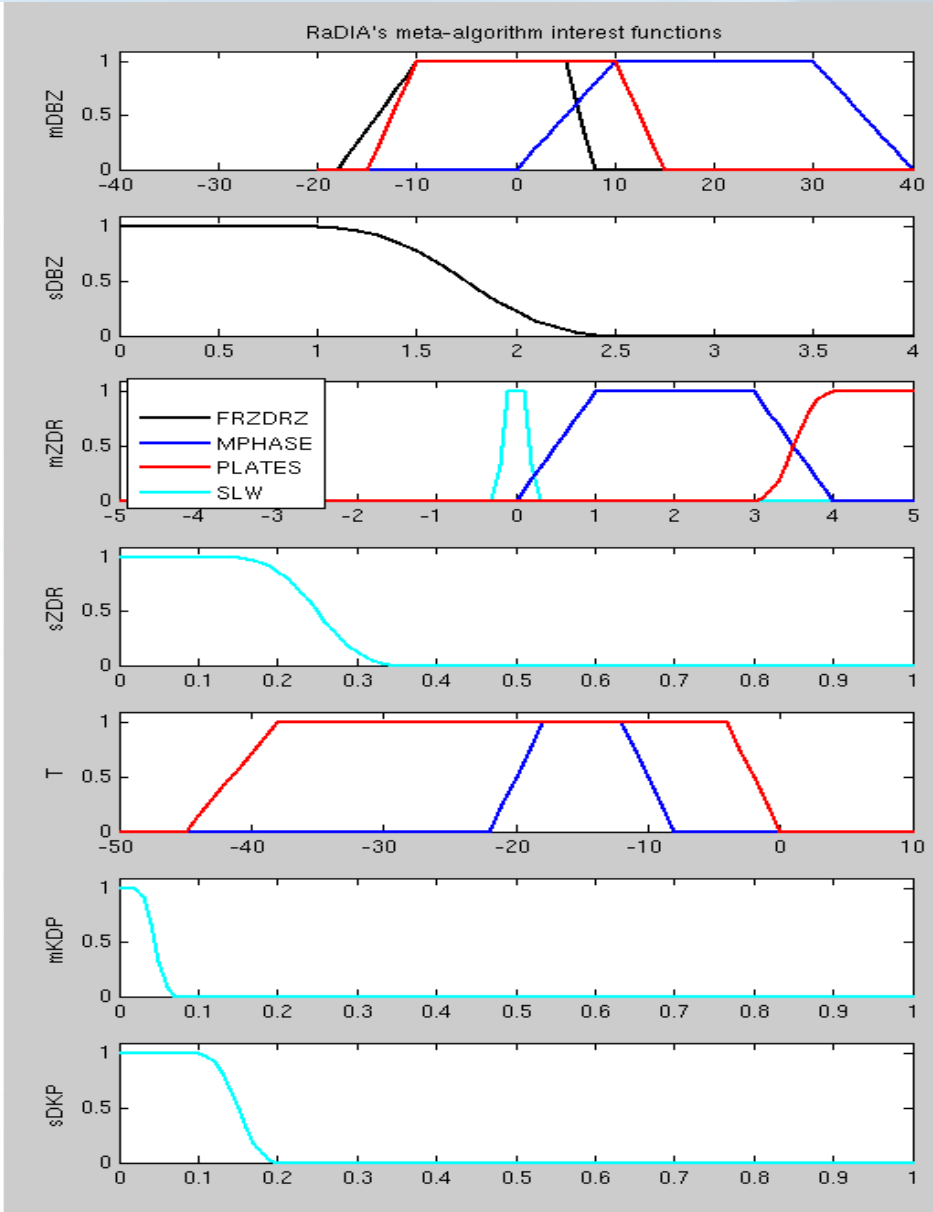
hi SLW
^ hi v
hi FRZ
^ hi v
hi MIX
hi PLA
low all
no sig

Summary of progress in 2014-2015

- Dedicated RadIA server acquired
- Realtime RadIA output for Cleveland now exists with 5 minute resolution

NCAR





2015-2016: RadIA and the NASA Flight Campaign?

- NASA had 60 flight hours available during Jan to March, 2015
- Delayed due to aircraft refitting time schedule issues

Available comparisons to:

- NASA Icing Remote Sensing System
- NCAR's RadIA
- NCAR's CIP/MICRO Algorithm
- up to 50 vibrating wire sonde launches (Serke et al, 2015)
- PIREPs, etc.

- Case imagery and analysis being updated at: https://wiki.ucar.edu/display/TAIWIN/Home+-+TAIWIN

RadIA beyond 2015

- Realtime RadIA for NEXRADs near NSOC test sites
- Ingest satellite fields to assist in cloud-but-no-precip scenarios
- Journal papers on field campaign findings
- Improve the flexibility of RadIA's freezing level detection algo.
- Port RadIA into NSSL's MRMS through NWS's Vlab platform (behold maximized acronyms per line ratio)

RadIA-related references

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Thank you!

Questions or comments?