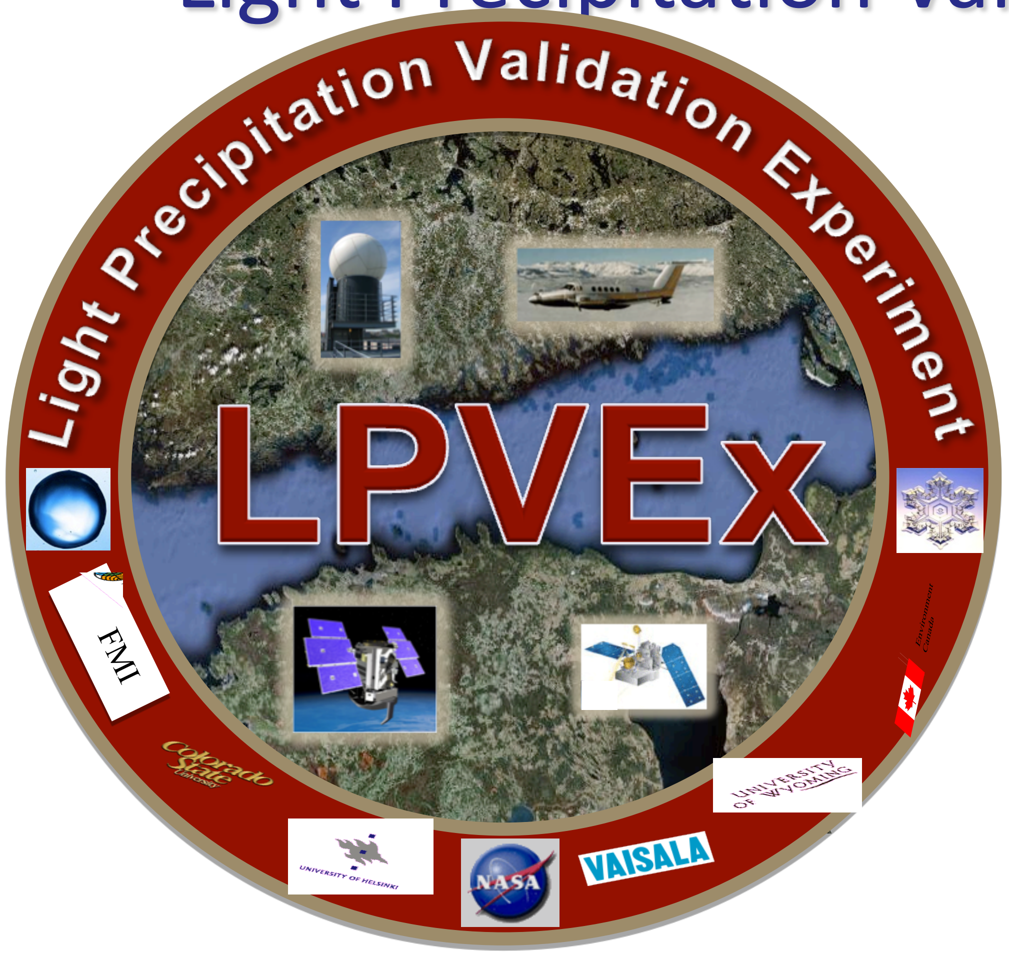
Light Precipitation Validation Experiment



Helsinki, Finland

IOP: Sept 15 – Oct 20, 2010
EOP: Oct 21, 2010 – Jan 15, 2011

Presented by
V.Chandrasekar
On behalf of the LPVEX leadership team

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Light Precipitation Validation Experiment

Dmitri Moisseev
Univ. of Helsinki

"Kumpula OPS"

L. Baldini,V. Bringi, L. Carey, Chandra, B. Dolan, D. Hudak, C. Kidd, J. Koskinen, S. Lim, S. Rutledge, A. Tokay

Tristan L'Ecuyer
Univ of Wisconsin

impossible without

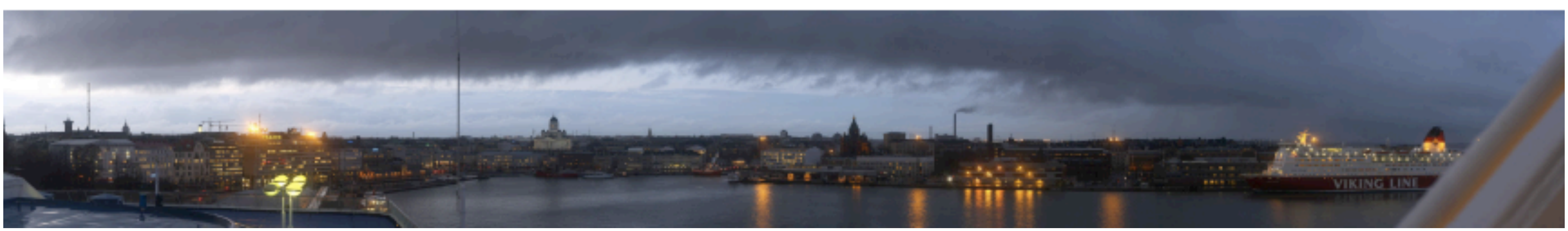
"Uniform Whiskey"

T. Drew, J. French, A. Heymsfield, M. Lebsock, L Oolman, B. Wadsworth, N. Wood

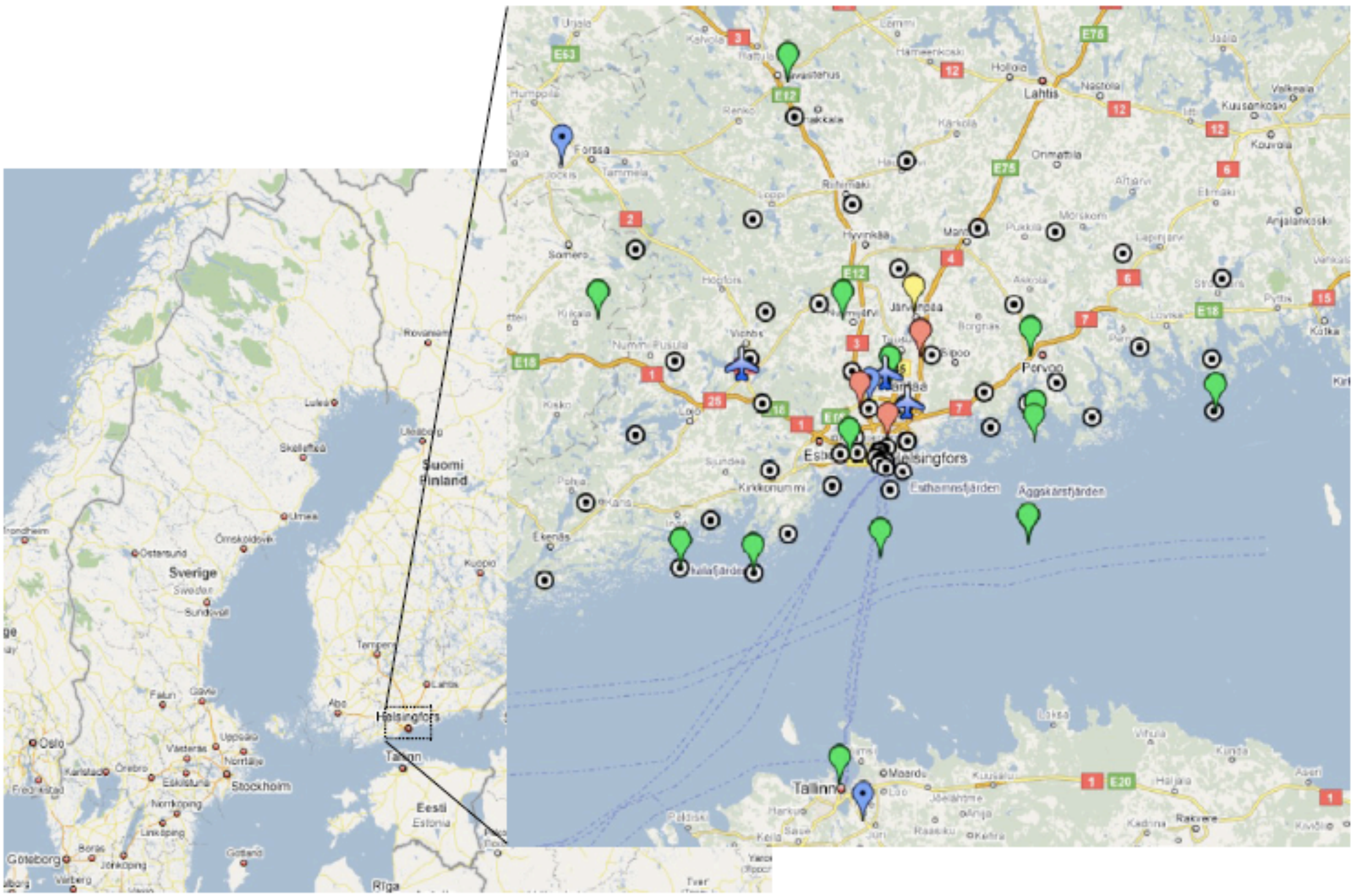
Walt Petersen
NASA-GSFC/WFF

Field

A. Aarva, P. Bishor, A.-M- Harri, P. Gatlin, M. Kurri, L. Latva, T. Lauri, J. Leinonen, M. Leskinen, T. Posio, J. Poutiainen, P. Rodriguez, M. Wingo



Operations area – Helsinki Testbed



LPVEx operations area

3 instrumented ground sites

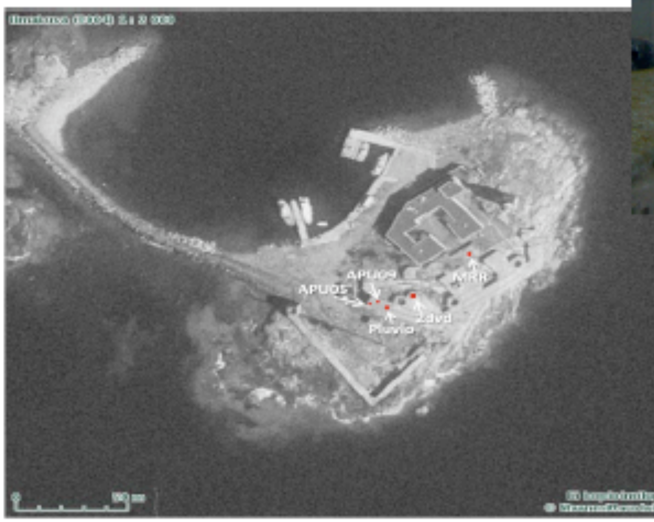
+ instrumentation on RV Aranda

3 Dual-pol C-band radars

1 Doppler C-band radar

HTB instrumentation

Harmaja – island site



1x 2D – video disdrometer
2x OTT Parsivel disdrometer
1x METEK MicroRain Radar
1x OTT Pluvio2
1x FMI AWS

Emäsalo – coastal site

1x 2D – video disdrometer
2x OTT Parsivel disdrometer
1x METEK Micro Rain Radar
1x OTT Pluvio
1x POSS
1x Passive Microwave Radiometer ADMIRARI
1x FMI AWS

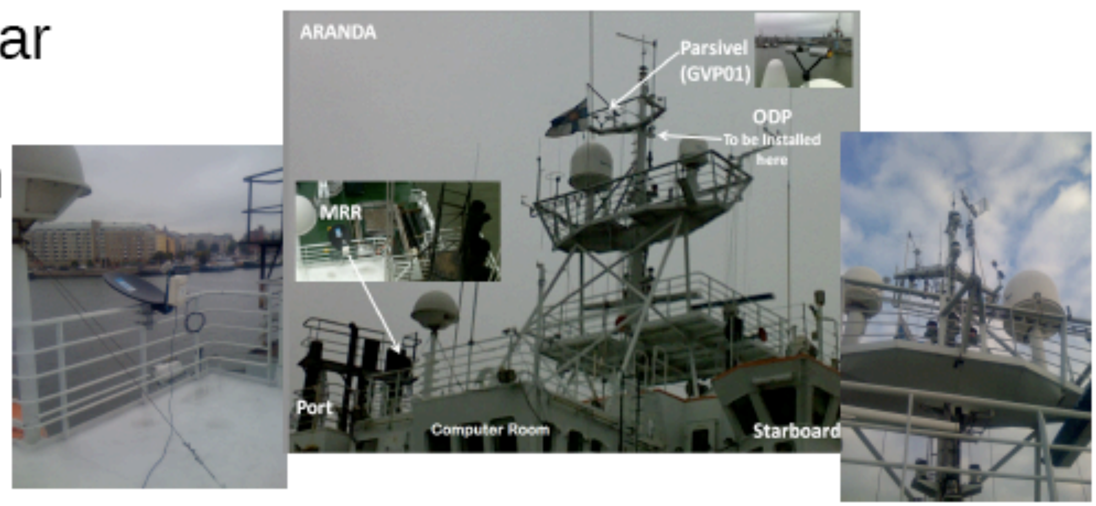
Järvenpää – inland site

1x 2D – video disdrometer
2x OTT Parsivel disdrometer
1x METEK Micro Rain Radar
1x OTT Pluvio2
1x C-band Doppler radar
1x Particle Video Imager

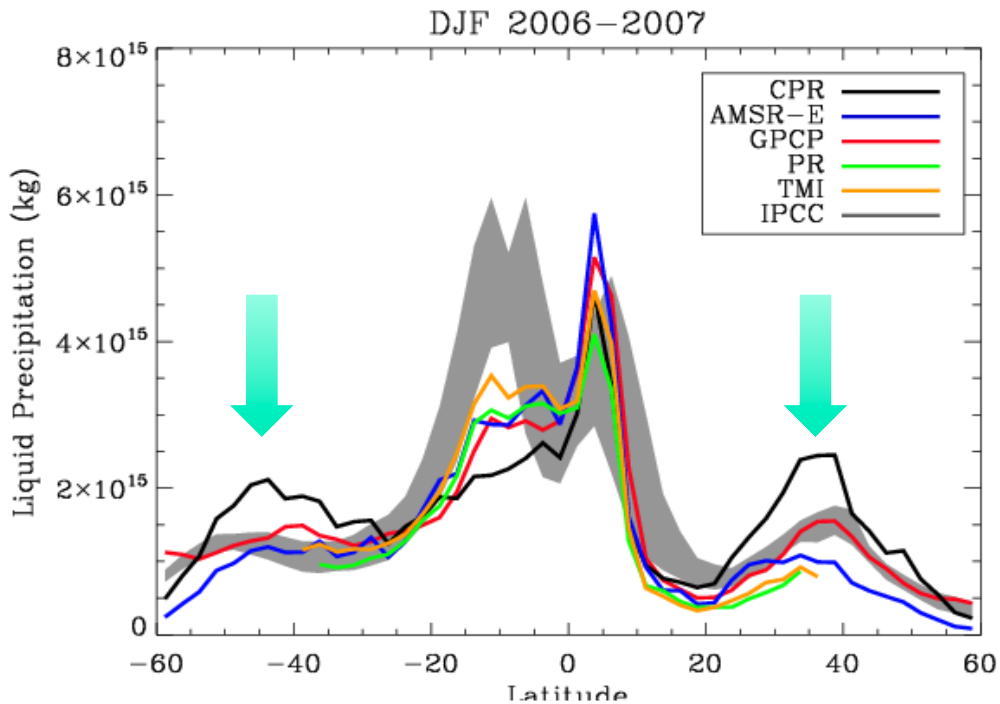
RV Aranda

Cruises:
14.9 – 19.9 Good precip. data, no aircraft overflights
20.9 – 24.9 Good precip. obs., KA spiral
27.9 – 3.10 No precipitation
19.10 -21.10 Good precip, KA overflight and spiral

1x OTT Parsivel disdrometer
1x METEK MicroRain Radar
1x Eigenbrodt ODM 470 disdrometer + precipitation detector
1x FMI AWS



Motivation



- All satellite rainfall products are subject to large uncertainties in shallow freezing level environments

- Significant disagreement among satellite products as to how much light rain falls globally and especially at higher latitudes where accumulation differences are ~40%

-

Overarching Objectives

- Characterize the ability of CloudSat, GPM, and PMW sensors to detect light rainfall and evaluate their estimates of rainfall intensity in high latitude environments with shallow freezing levels.
- Augment the currently limited database of liquid and ice microphysics information in higher latitude light precipitation regimes within the context of developing and improving global satellite precipitation products.

Specific Science Questions

- Can we improve methods of distinguishing cloud, drizzle, and rainfall by establishing rainfall probabilities in terms of Zs, PIAs, and T_Bs?

- What is the characteristic vertical structure of shallow high latitude precipitation events?

- How do any of these findings depend on other meteorological parameters such as cloud morphology, humidity, temperature, and aerosol?

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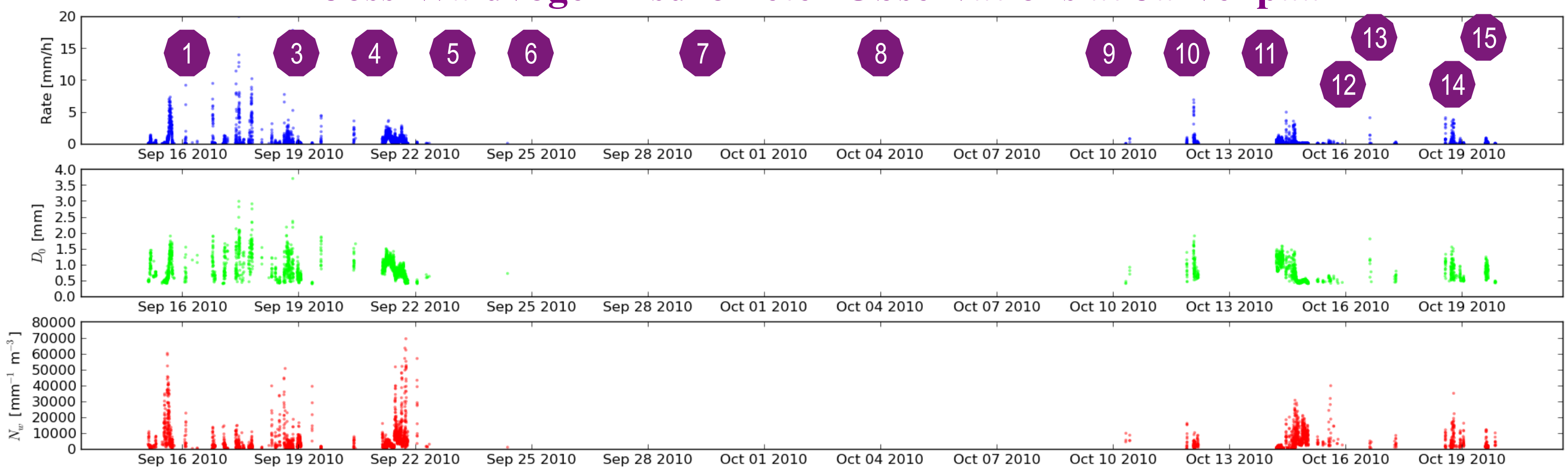
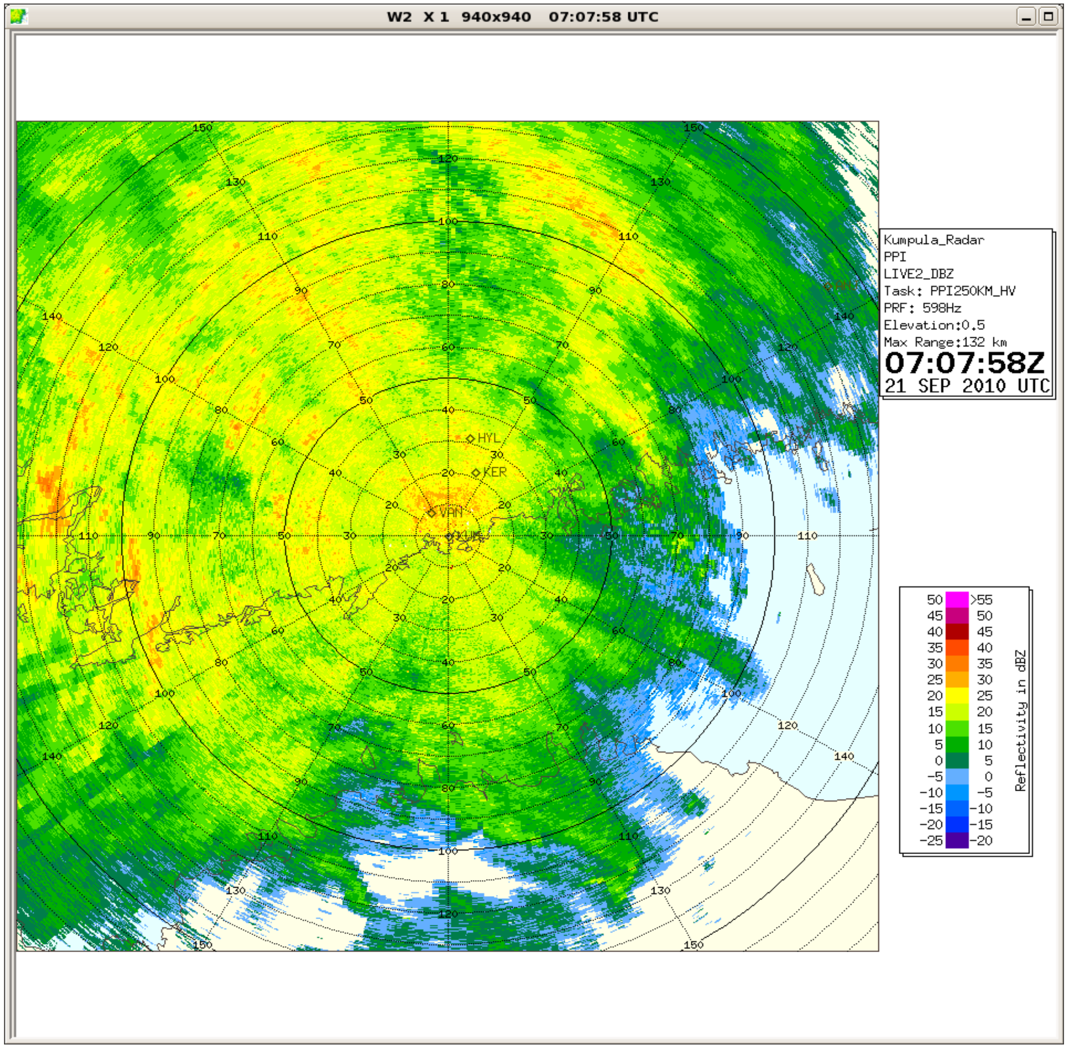
IOP "Golden days": Widespread Rainfall

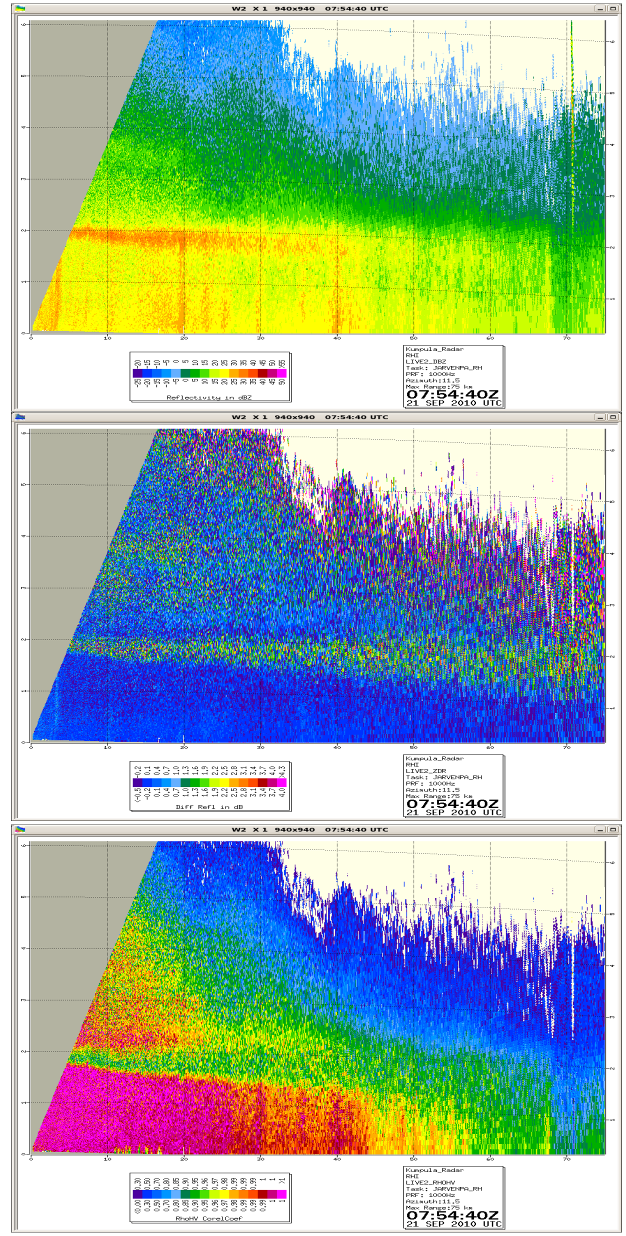
Joss-Waldvogel Disdrometer Observations at Järvenpää



Target Cases	Description	Ground	Aircraft	Ship	Satellite
Sept. 21	Widespread light rain; FL~3 km	X	X	X	X
Oct. 20	Widespread light rain; FL~1 km	X	X		
Oct. 19	Aircraft-only sampling of melting level microphysics		X		
Oct. 14	Widespread rain/snow mix; no aircraft probe data	X			
Oct. 17	Isolated light convective and stratiform rain/snow mix	X	X		X
Oct. 12	Snow north and east of Helsinki	X	X		X
Sept. 25	Convective rainfall initiation, drizzle, rain, graupel	X	X	X	X
Oct. 10	Isolated shallow mixed precip. east of Helsinki	X	X		
Oct. 16	Patchy light frozen precipitation; super-cooled water	X	X		
Sept. 29/Oct. 4	Clear-air flights to observe ocean surface return		X	X	

September 21, 2010





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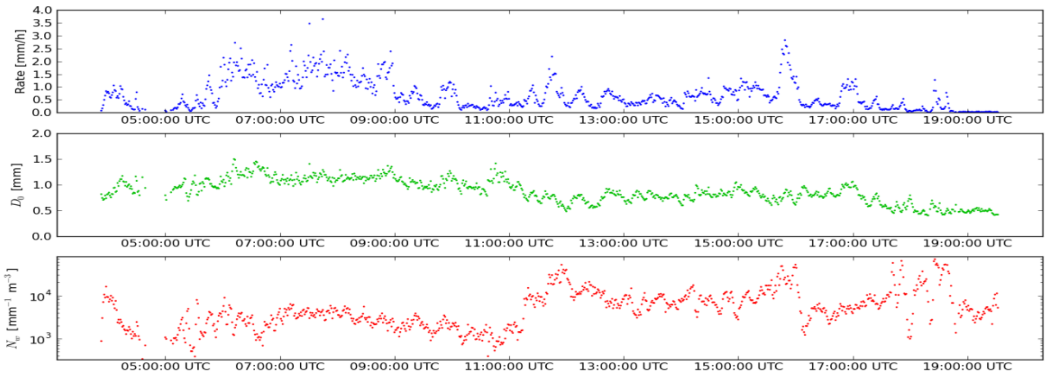
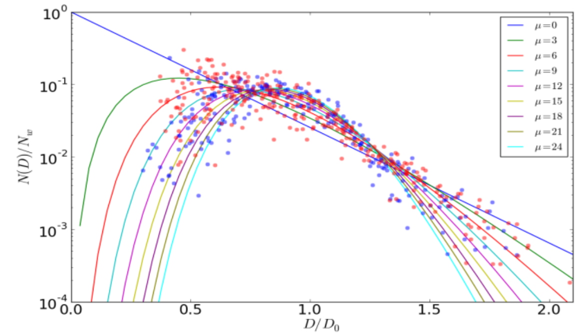
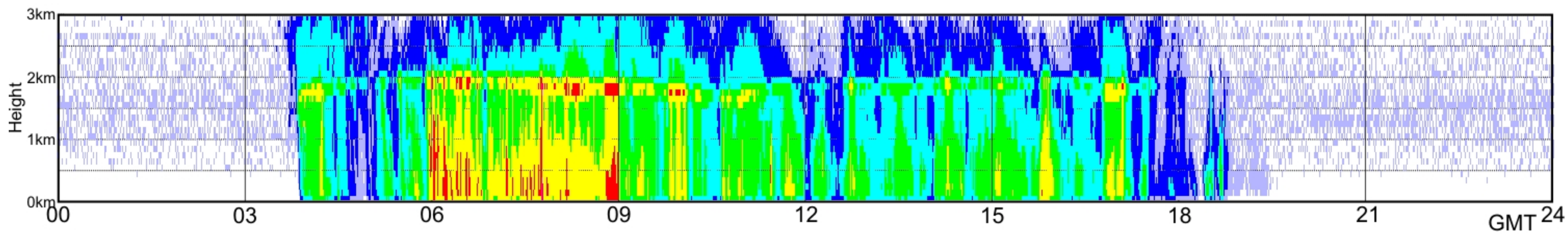
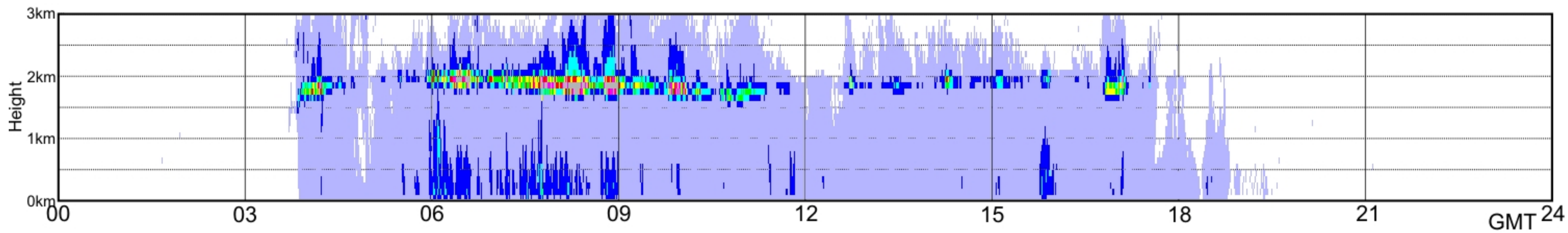
September 21, 2010 - Järvenpää









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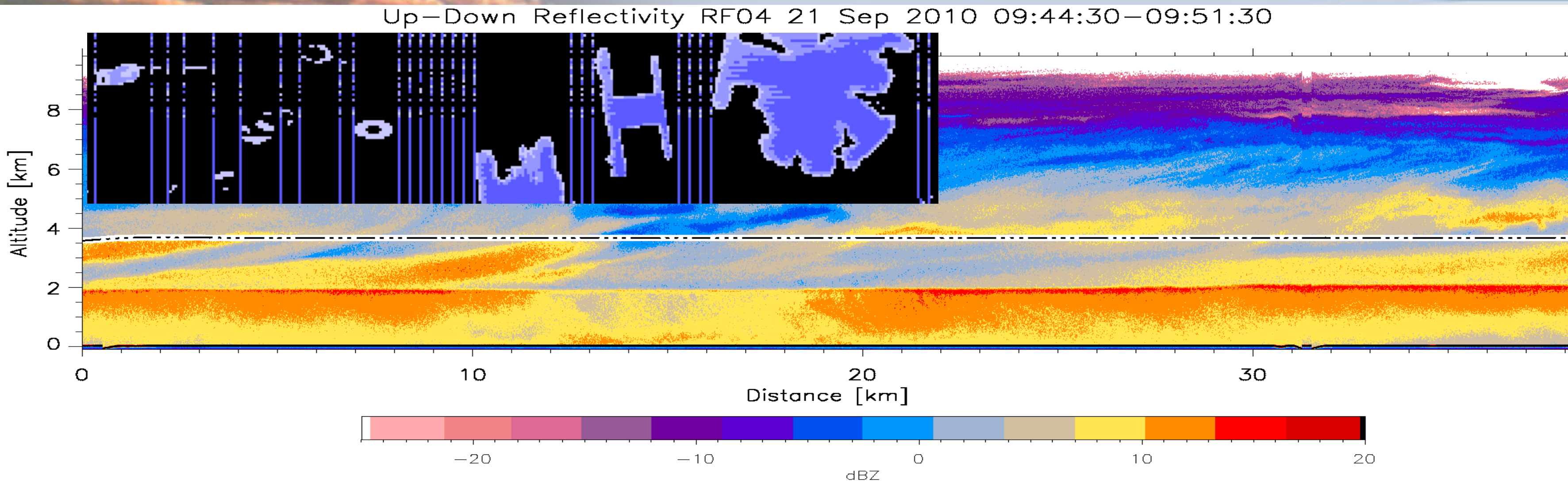
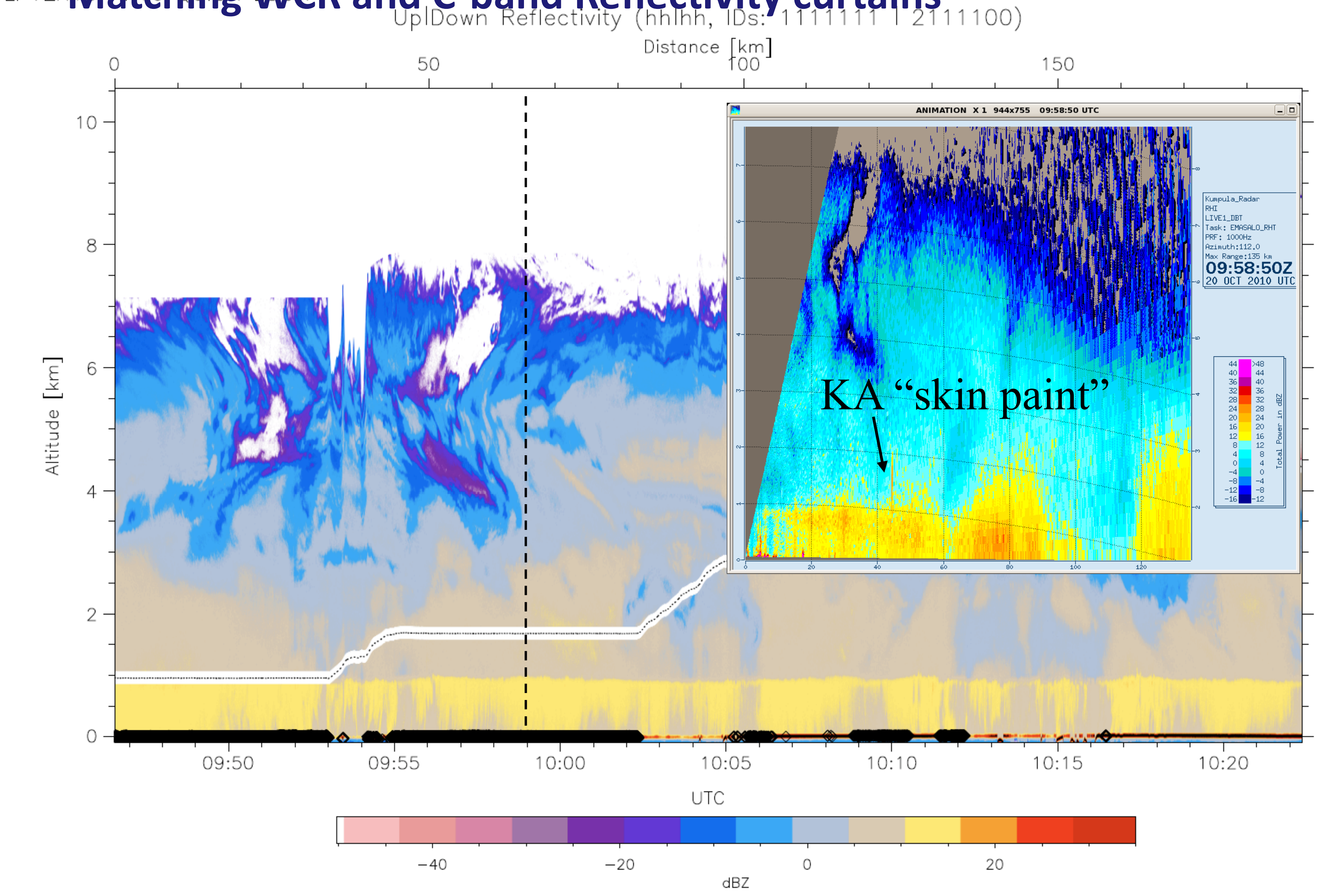
ATMOSPHERIC SCIENCE
King Air Research (n2uw)


Up−Down Reflectivity RF04 21 Sep 2010 09:44:30−09:51:30
Altitude [km]
Distance [km]
dBZ

T ~ -6.5 C;

Matching WCR and C-band Reflectivity curtains



Melting layer modeling

Yokoyama *et al.* *1984, 1985*
- Meneghini and Liao 1996, 2000,
- Liao and Meneghini 2005
- Liao *et al.* *2008, 2009*

Dissanayake and McEwan, 1978
- Hardaker *et. al* 1995
- Bauer *et al.* *2000*
- Olson *et al.* *2003*

Klaassen, 1988
- Klaassen, 1990
- Russchenberg and Ligthart, 1996

Szyrmer and Zawadzki, 1999
- Fabry and Szyrmer, 1999
- Zawadzki *et al.* 2005
- Heyrad *et al.* 2008
- Battaglia, 2003

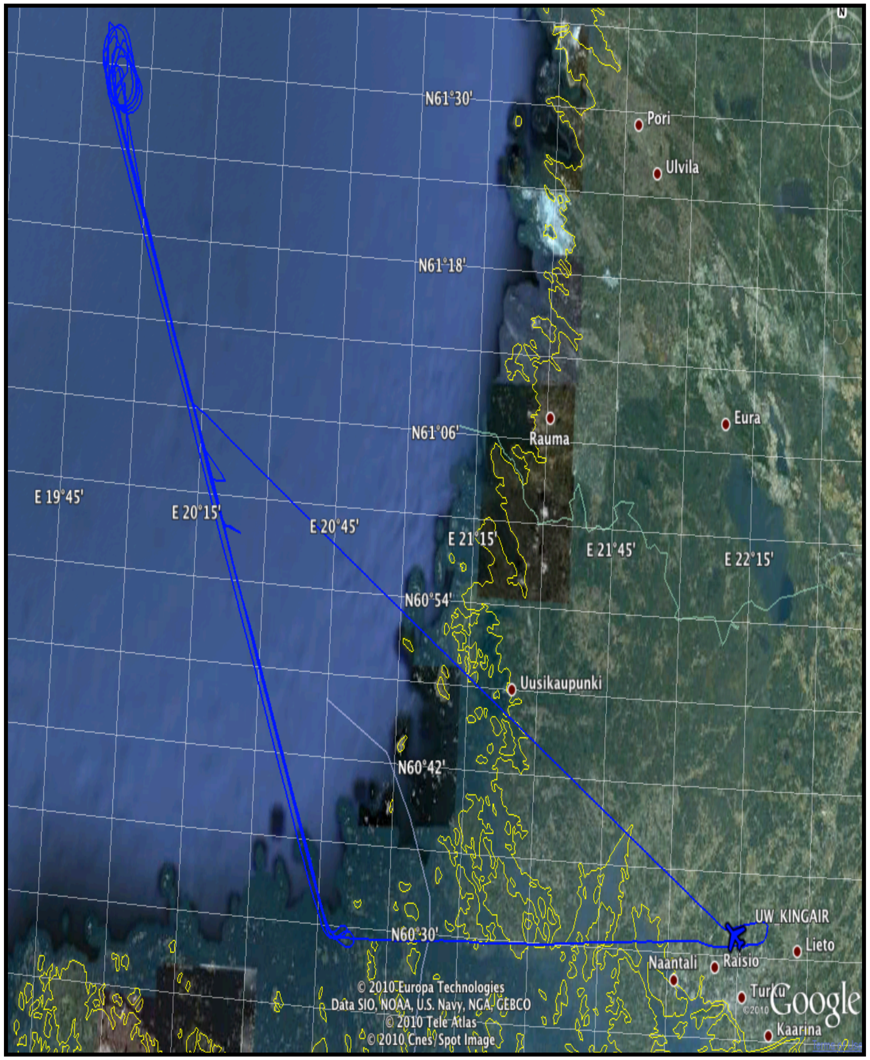
Russchenberg and Ligthart, 1996
- de Wolf *et al.* 1990
- Skaropoulos and Russchenberg, 2003

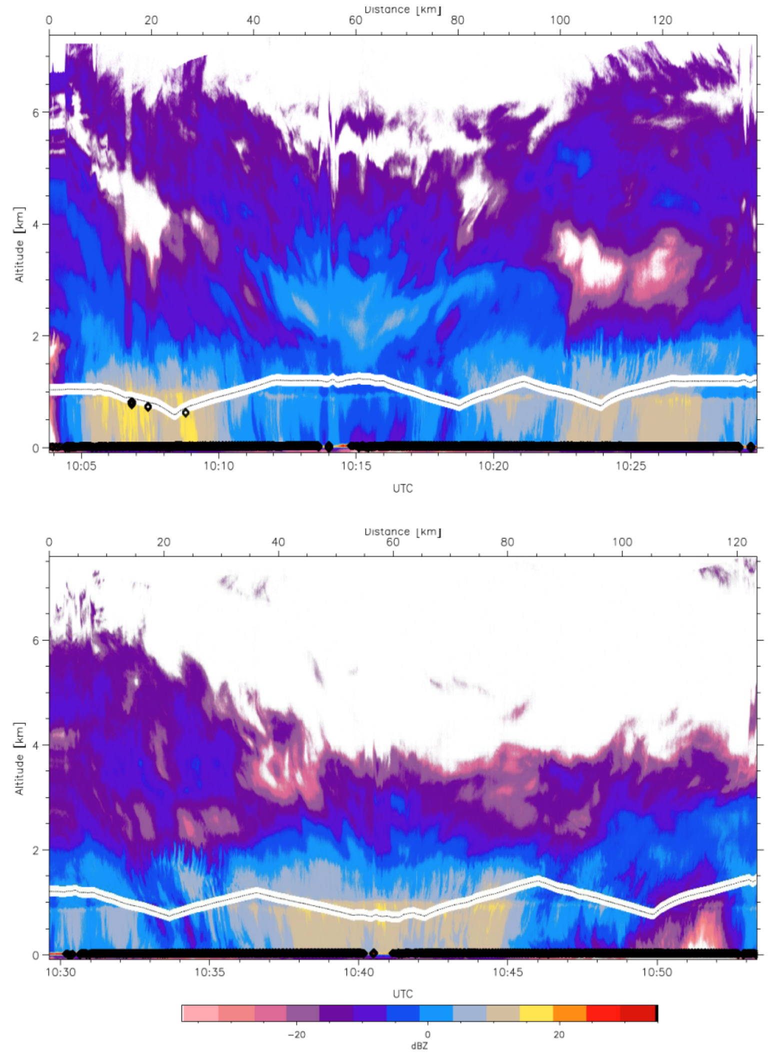
Mitra *et al.* 1990
- Matrosov 2008
- Russchenberg and Ligthart, 1996
- Bauer *et al.* *2000*
- Olson *et al.* *2003*

There are many ML models available

How do we test their assumptions, both microphysical and scattering?

October 19: Extensive melting-layer sampling





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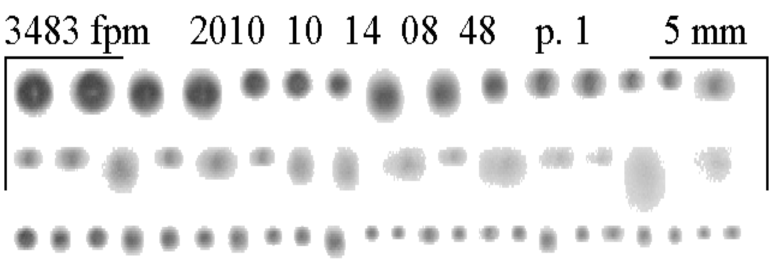
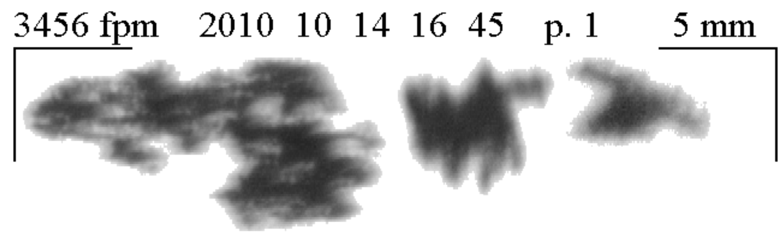
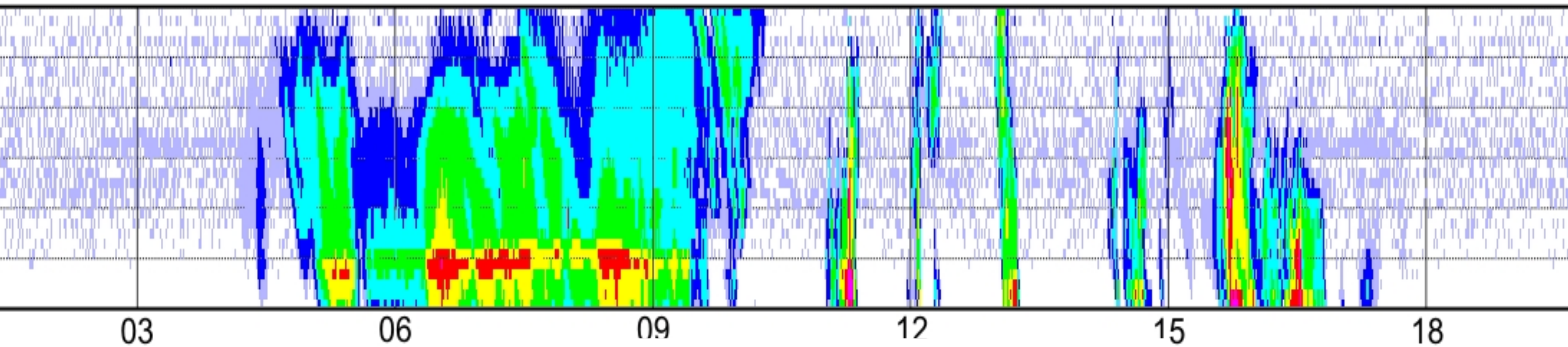
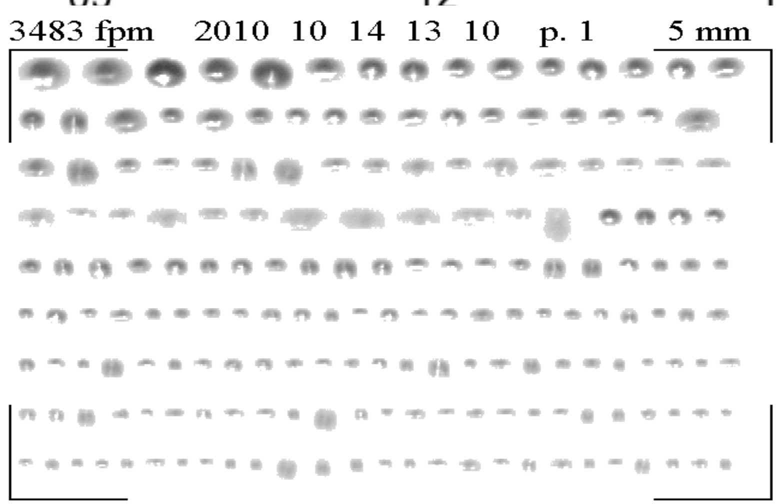
Järvenpää observations; rain-snow transition









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EOP “Golden days”: Dry and melting snow

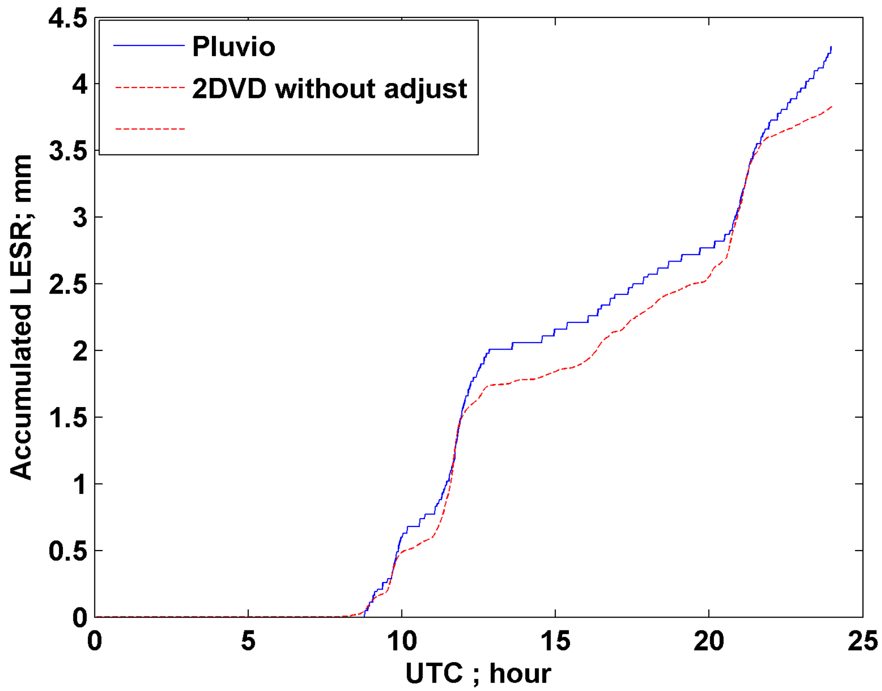
Target cases	Description
Dec. 30, 2010	Large-scale snowfall. Freezing drizzle observed on the ground. Low wind (-6 C)
Jan 6, 2011	Large-scale snow fall, low winds. Temp -6 to -2 C.
Jan 7, 2011	Large-scale snow fall, low winds.
Jan 8, 2011	Large-scale snow fall, low winds.
Jan 9, 2011	Snow-to-rain transition.
Nov 18, 2010	Large-scale snowfall, 15 mm LWE. Strong winds. Temperature around 0C
Nov 9, 2010	Snow- Rain transition after 1120 UTC, LA after 18 UTC. Rain after 23 UTC
Nov 15, 2011	Rain/Melting Snow (+5 C), large (5 mm) raindrops and partially melted particles
Dec 7, 2010	Precipitation area from SW was over Helsinki in the evening. The strongest snowfall was near the Finnish coastline.

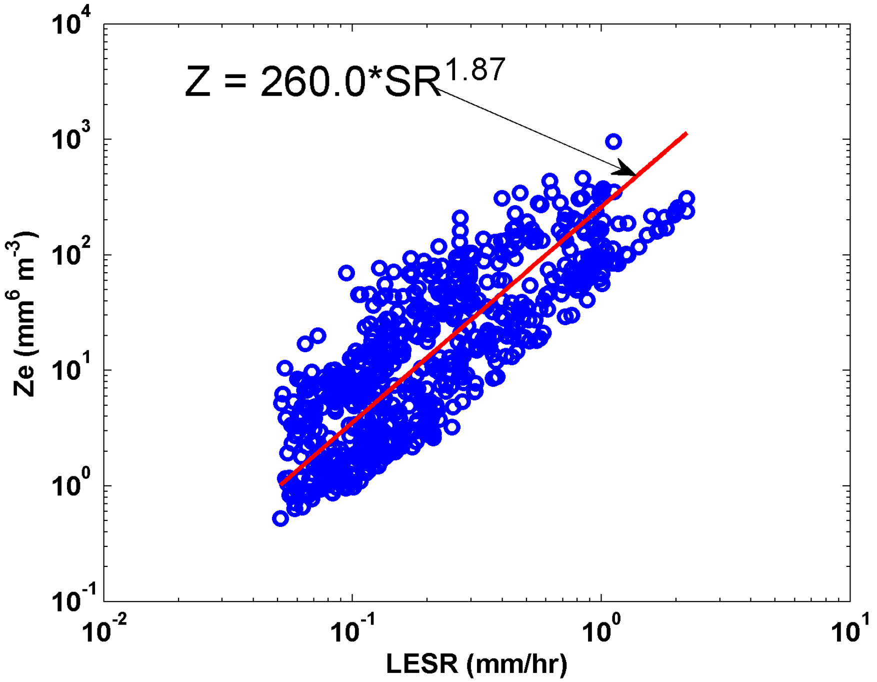
The winter season 2010-2011 was one of the snowiest in the last decade, 14 snow days in November and 25 snow days in December. Large variety of snowfall events, shallow events (< 1 km), reports of super cooled drizzle, well defined ice particle habits on the ground.

Variability Z(SR) relation as retrieved from 2D-video observations

Date	Wind	Temp	Accumulation	Z (SR)
30 Dec 2010	0-3 m/s	- 10 to 8 C	4 mm	Z = 260.00*SR^1.87
06 Jan 2011	1-6 m/s	- 6 C	1.5 mm	Z = 201.75*SR^1.4833
07 Jan 2011	2 m/s	- 6 to -2 C	3.5 mm	Z = 189.05*SR^1.8434
08 Jan 2011	2 -4 m/s	- 2 C	2.5 mm	Z = 273.01*SR^1.7988

Dec 30, 2010 - 2DVD analysis (Bringi and Huang)





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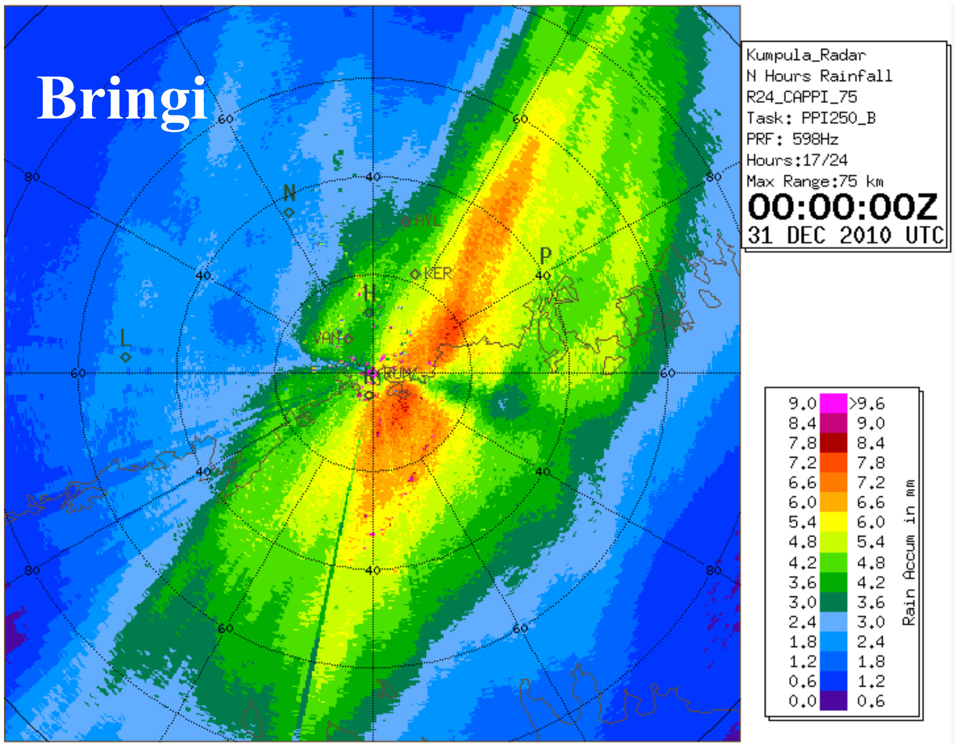
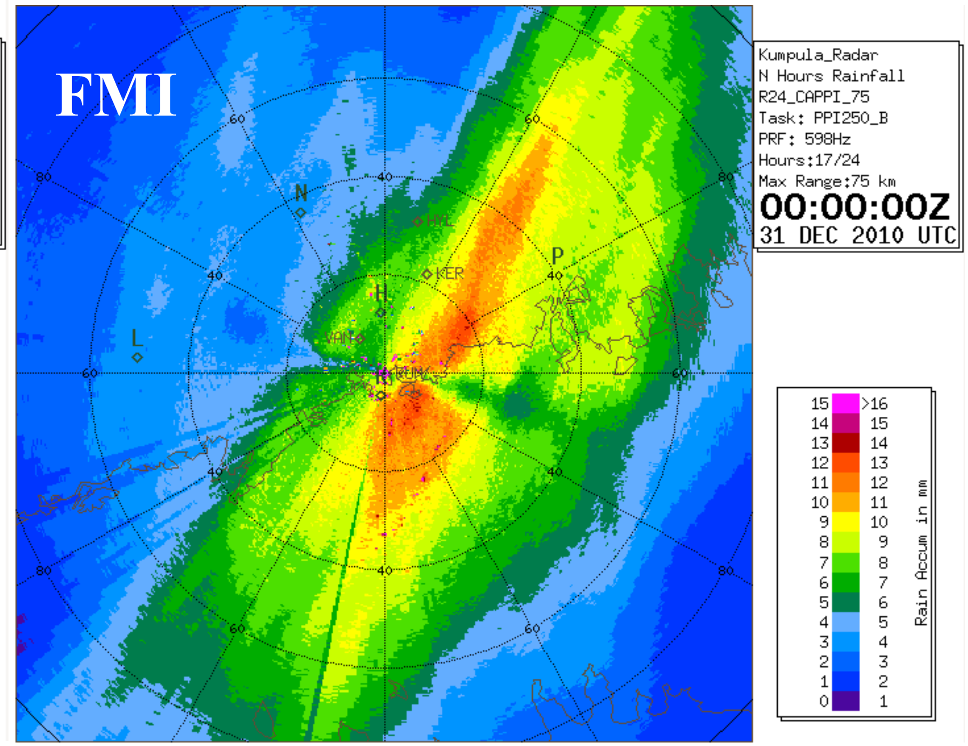
Radar accumulations



Z = 260.00*SR^1.87



Z = 100.00*SR^2

Comparison to 7 AWS station measurements shows a good agreement with 2DVD based relation, and overestimation of the FMI standard relation (note the difference in the limits of the color-scale)

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LPVEx Data Analysis Working Group Meeting
October 13 -14, 2011

The general consensus is that the LPVEx datasets can impact both the *a priori* model databases and associated scattering tables that lie at the root of the CloudSat and GPM precipitation algorithms

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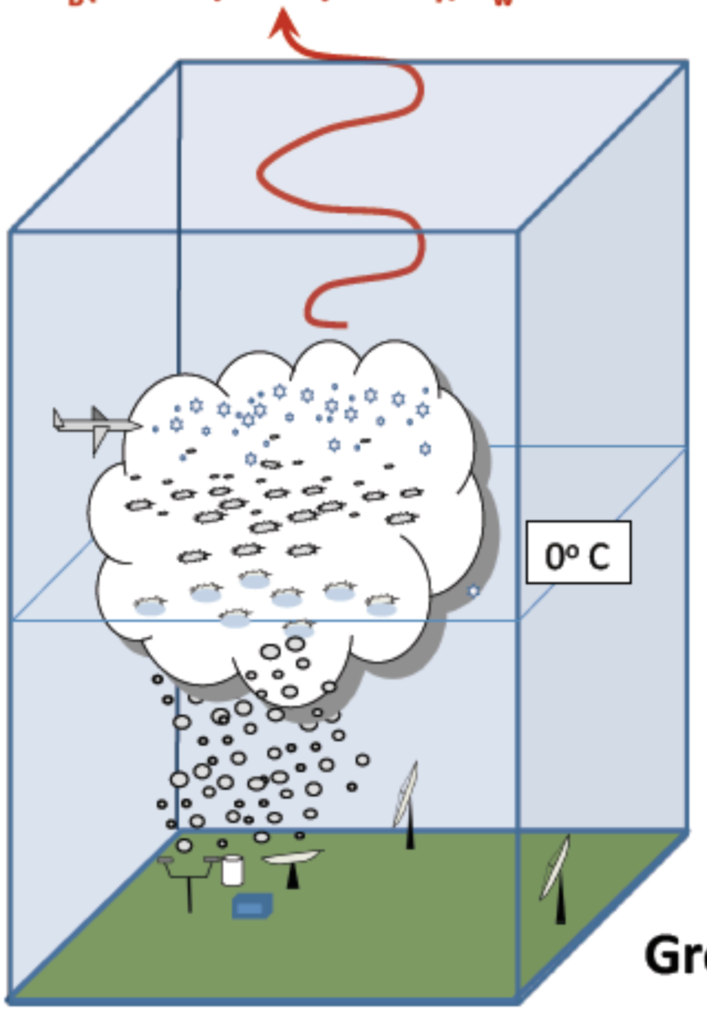
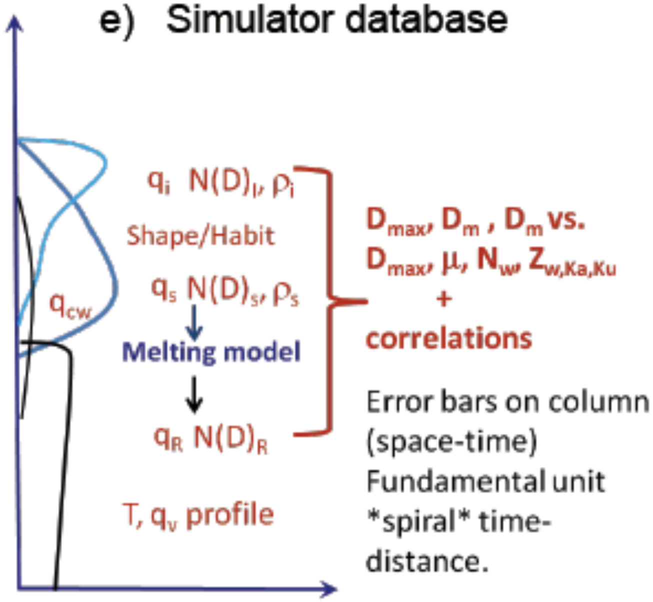
LPVEX Data Meeting (October 13-14, 2011)

- Data QC completing(ed)
- Formal release Dec. 2011

Focus: "golden days" (start with 9/21 and 10/20), move to 10/14 mixed phase, snow cases

a) Ice characteristics
b) Melting layer physics – which melting layer models work and when?
c) Reconstruction of W, Ka, Ku bands from C/K(MRR) bands
d) DSD/PSD parameters and correlation properties
e) Simulator database





Ground to space: "Building" the Column

Identified specific evaluation topics

1. Identifying the microphysical processes above, within, and beneath ML
2. Examining how well these characteristics are reproduced by CRMs and in Bayesian databases
3. Determining how much DSD or snow shape information is present in polarimetric C-band radar observations?
4. Assess scattering models, by comparing simulations to satellite overpasses
5. Using the forward and downward views of the WCR to evaluate attenuation models through the melting layer
6. Simulating Ka/Ku-band observations based on collocated W- and C-band reflectivity curtains
7. Assess rainfall and snowfall detection thresholds for the DPR
8. Use ground-based rainfall and DSD measurements in combination with satellite overpasses to quantify precipitation detection for satellite intruments
9. Examine clear sky returns from ocean as a function of wind speed to test CloudSat PIA estimates

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