

Advanced datasets to diagnose higher-order features embedded in expected GPM measurements and their impact on retrieval algorithms



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① Higher order effects

- Complex particle shape and scattering

(A. Heymsfield, G. Liu, M. Kulie, G. Skofronick Jackson, L. Bliven, B. Johnson, etc...
made the point quite clearly already)

- **NUBF** (some in Poster 215, Tanelli et al. SPIE 2012)
- Multiple Scattering
- Surface Clutter & scattering

② Tools

Multiple Scattering (MS): postulations and conjectures?



We now have sufficient experimental evidence and modeling capabilities to prove that Multiple Scattering WILL impact DPR measurements.

Please hold the fire until the next slide.

How often will it happen?

Ka: frequently in deep mature and aging convection, rarely elsewhere;
Ku: rarely (only in large-hail-bearing convection)

What impact can it have on retrievals?

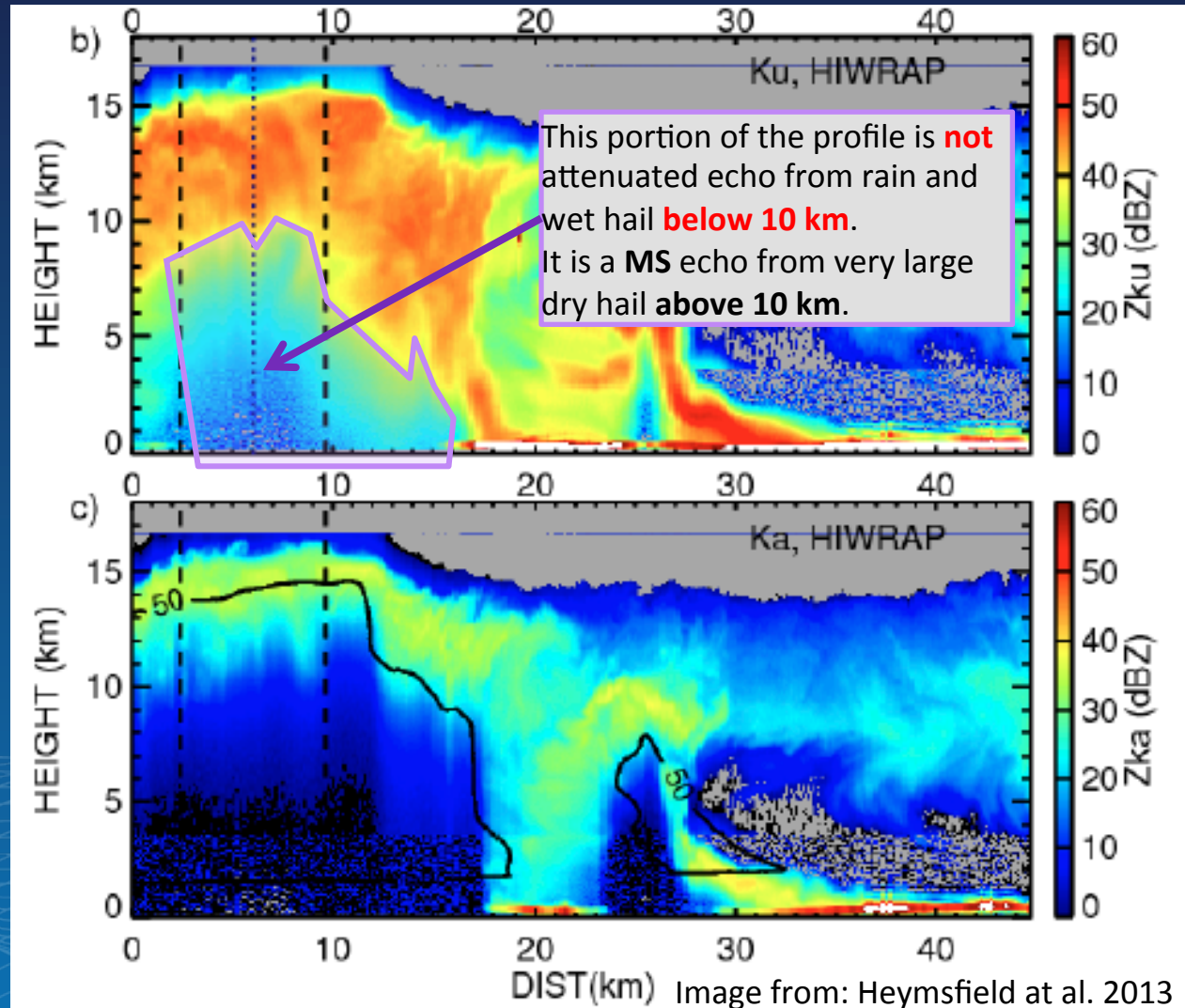
From minor biases to catastrophic

Can we detect it?

Most definitely yes when it is strong, less and less so as it weakens

Can we mitigate it? Possibly.

Can we actually use to our advantage? Sometimes.



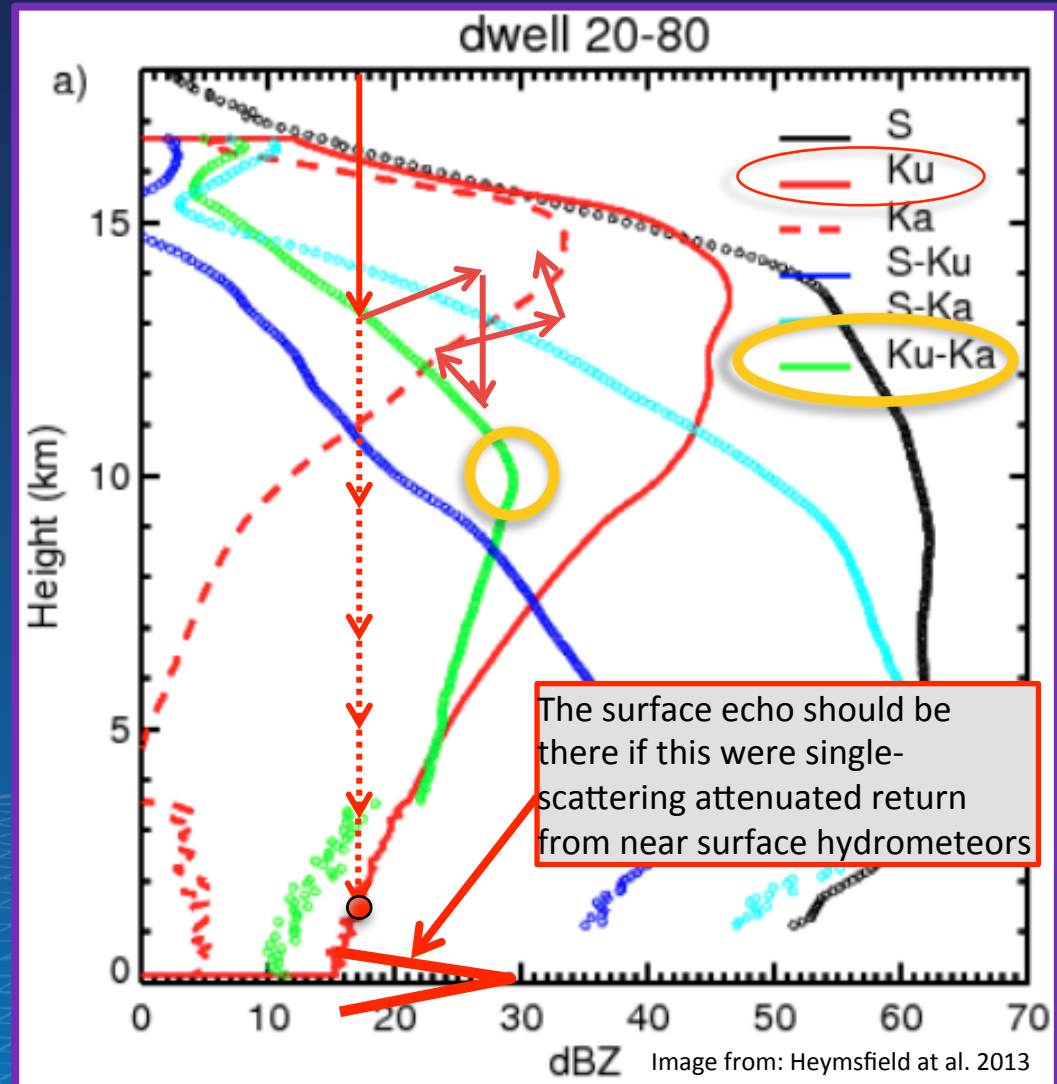
Multiple Scattering:

1) What is it? 2) How can we tell?



1) When the pulse emitted by the radar encounters a region with **significant attenuation** (e.g., > 1 dB/Km) **AND large albedo** (e.g., > 0.5) most of its energy is scattered in all directions and further interacts with surrounding particles. The path length resulting from the multiple events can be erroneously interpreted under the single scattering assumption as the echo of a target further away from the radar. Note to self: remember to click now.

2) Where is the surface return? How can there be an attenuated echo from rain at 0 m above the surface...but no surface? At Ku and Ka band the surface echo persists longer than the near surface rain because it is stronger to start with. Note to self: remember to click now.

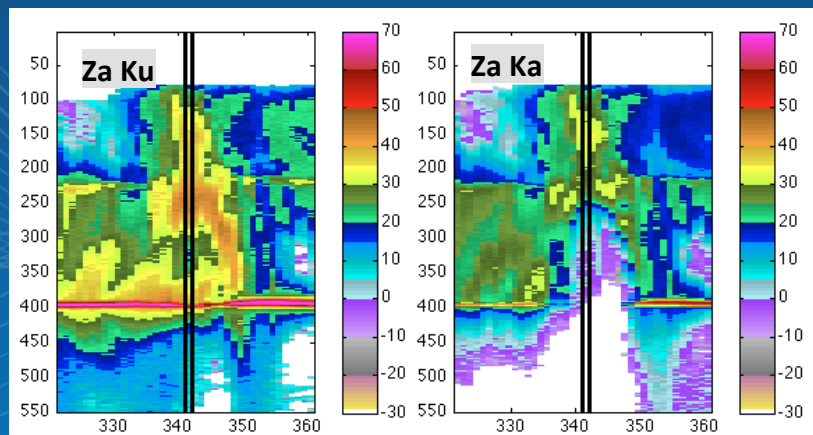
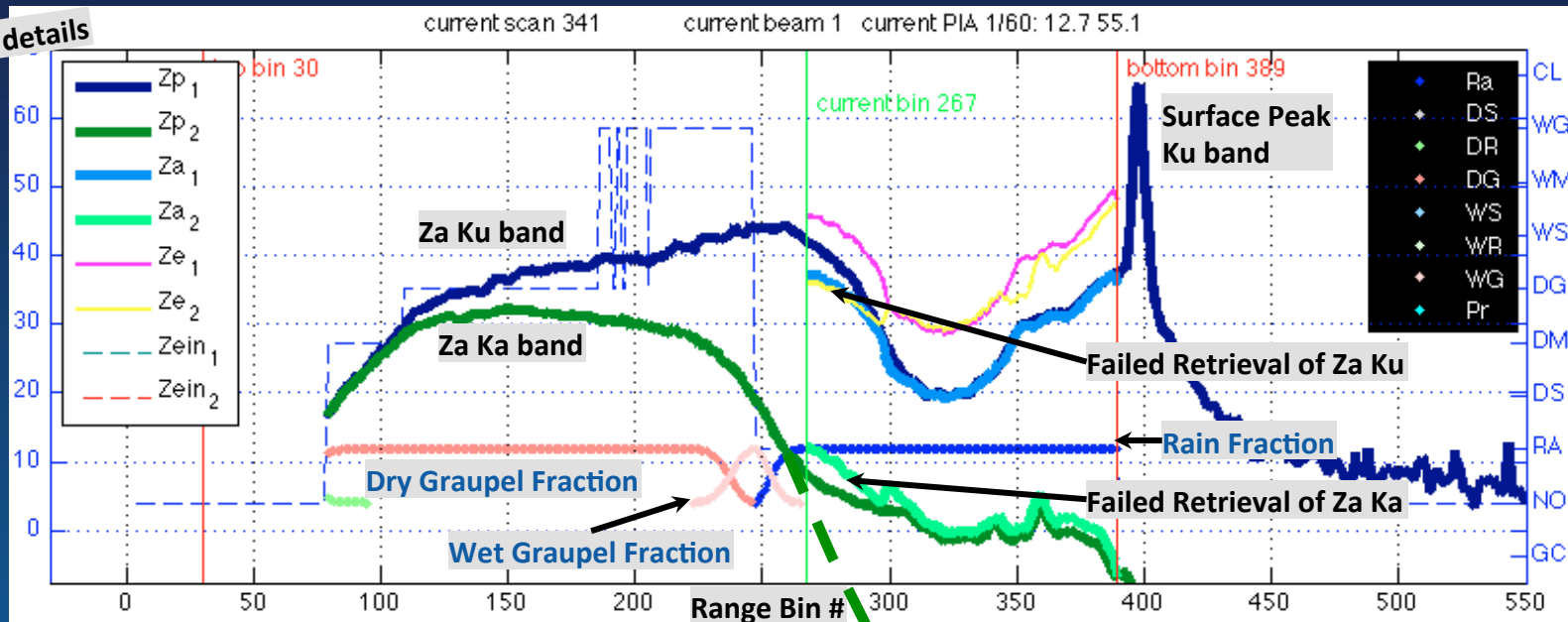


Multiple Scattering:

Large hail is not necessary to generate MS at Ka, graupel can do



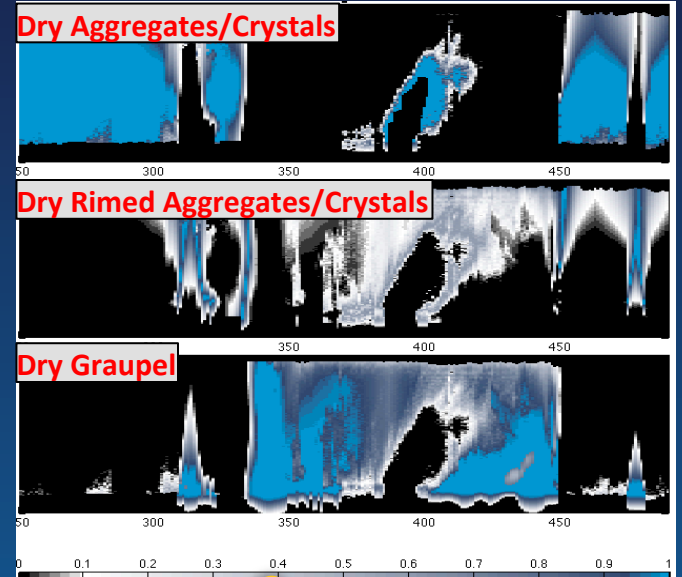
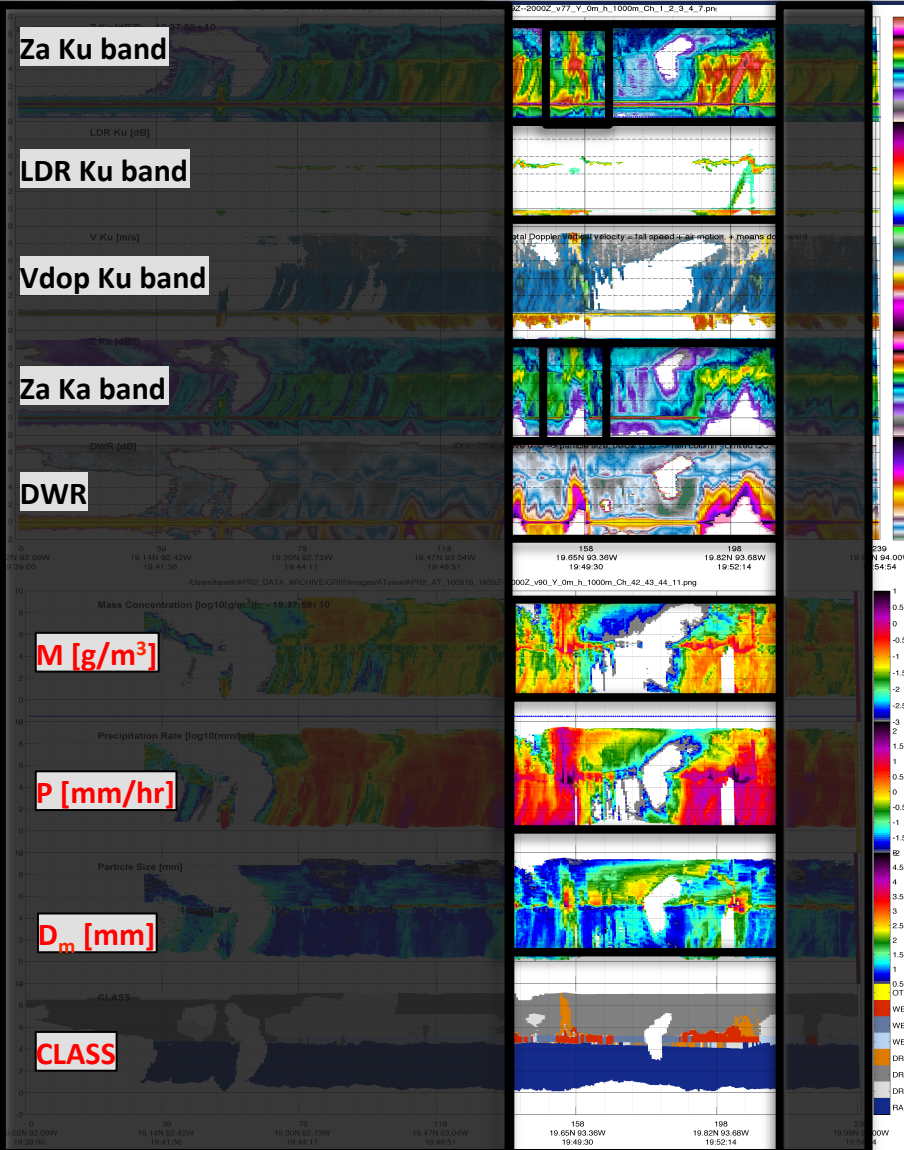
Poster 215 for details



Where the Ka-band Surface Peak, and the single scattering precipitation echo could possibly be (just a guess)

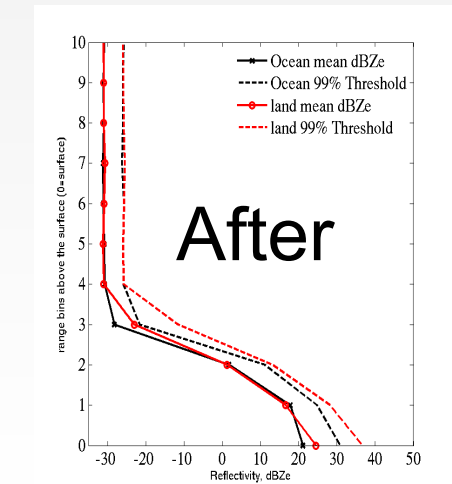
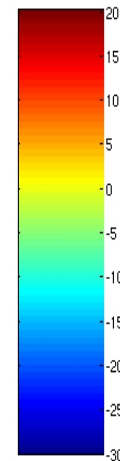
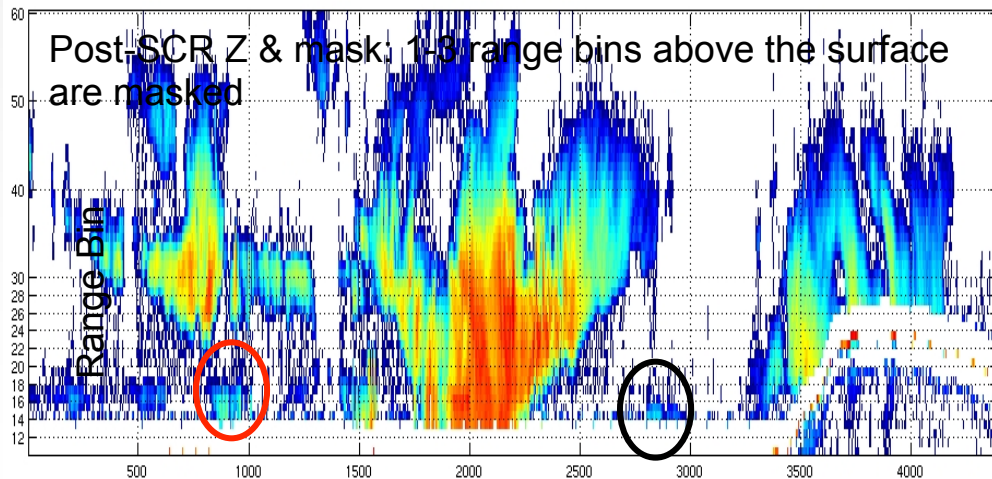
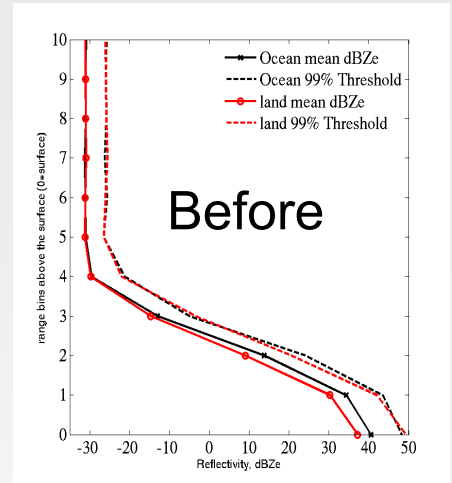
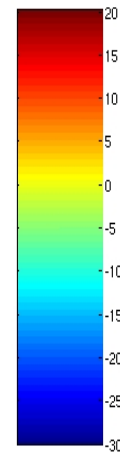
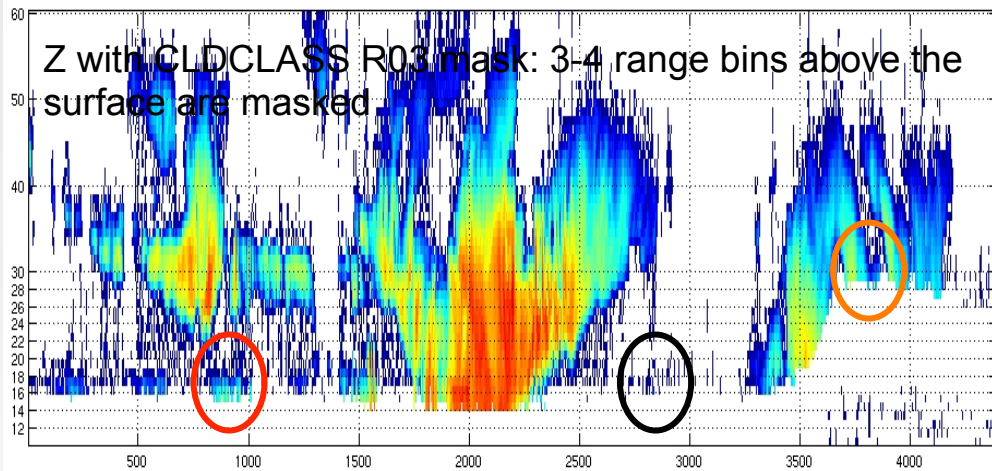
Multiple Scattering:

HB-style **retrievals** in the ice phase can tell us when to expect it



Surface Clutter:

Limited rejection of ground clutter

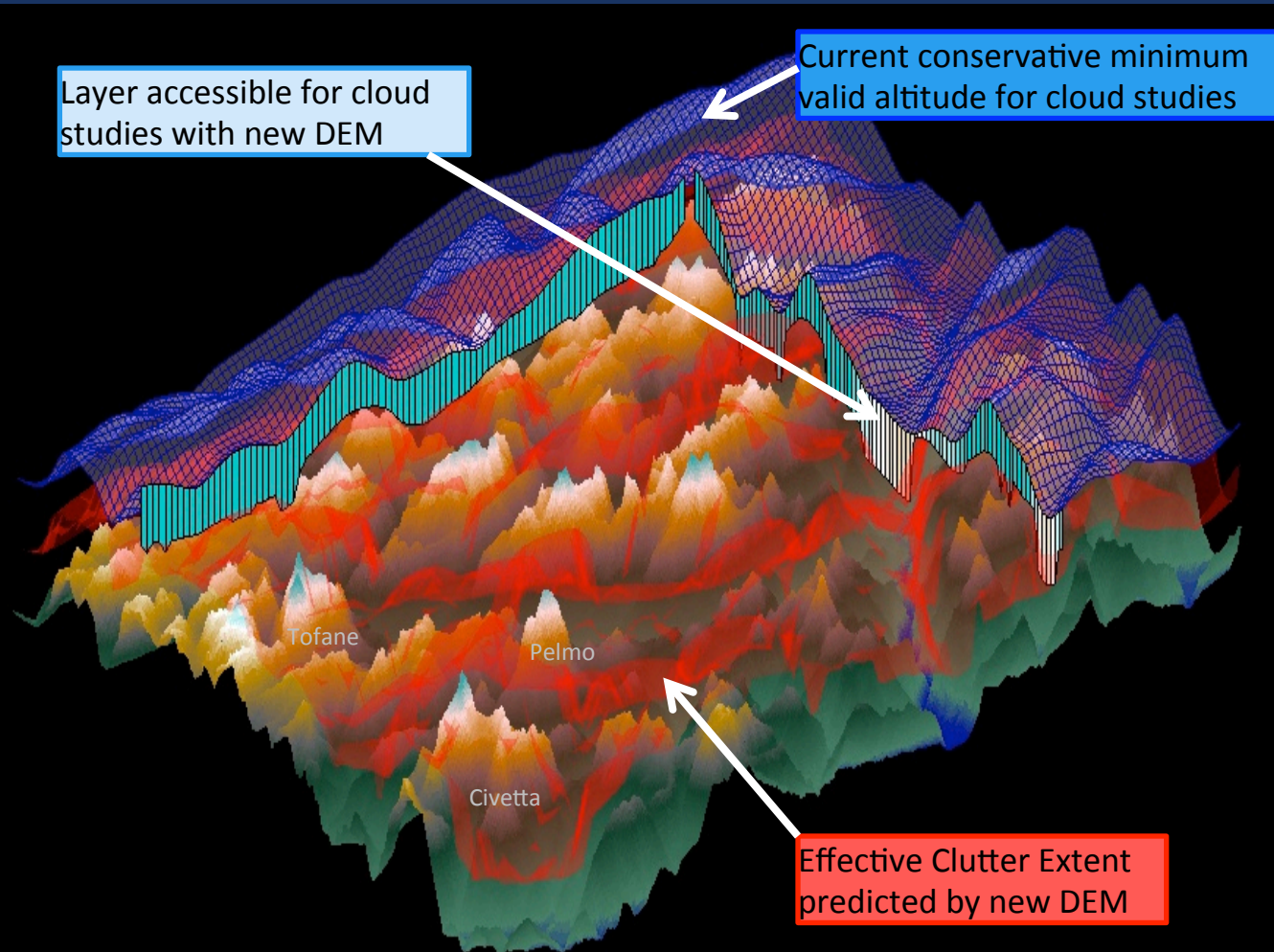
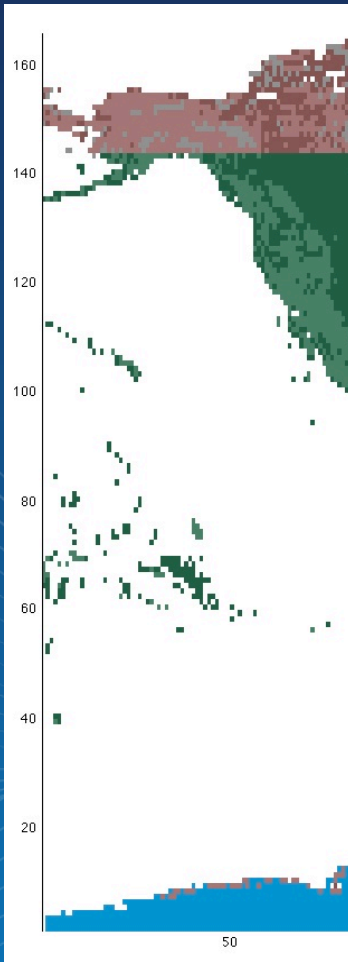


Surface Clutter

Over orography



In order to minimize the # of range bins close to the surface, and to have a chance at simulating appropriate surface scattering and emission, a good quality DEM & 3-D simulation is necessary.

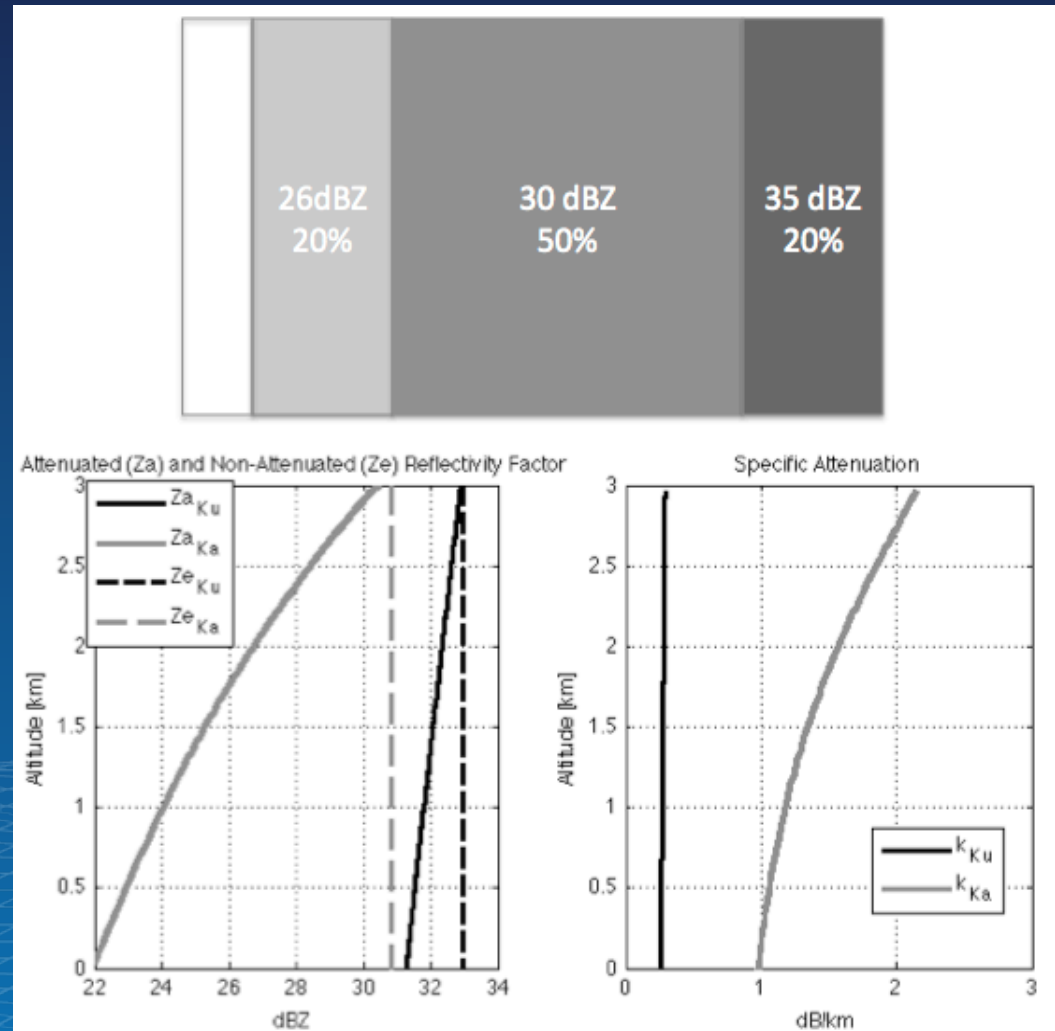


Non-Uniform Beam Filling Impact

The 'column model'

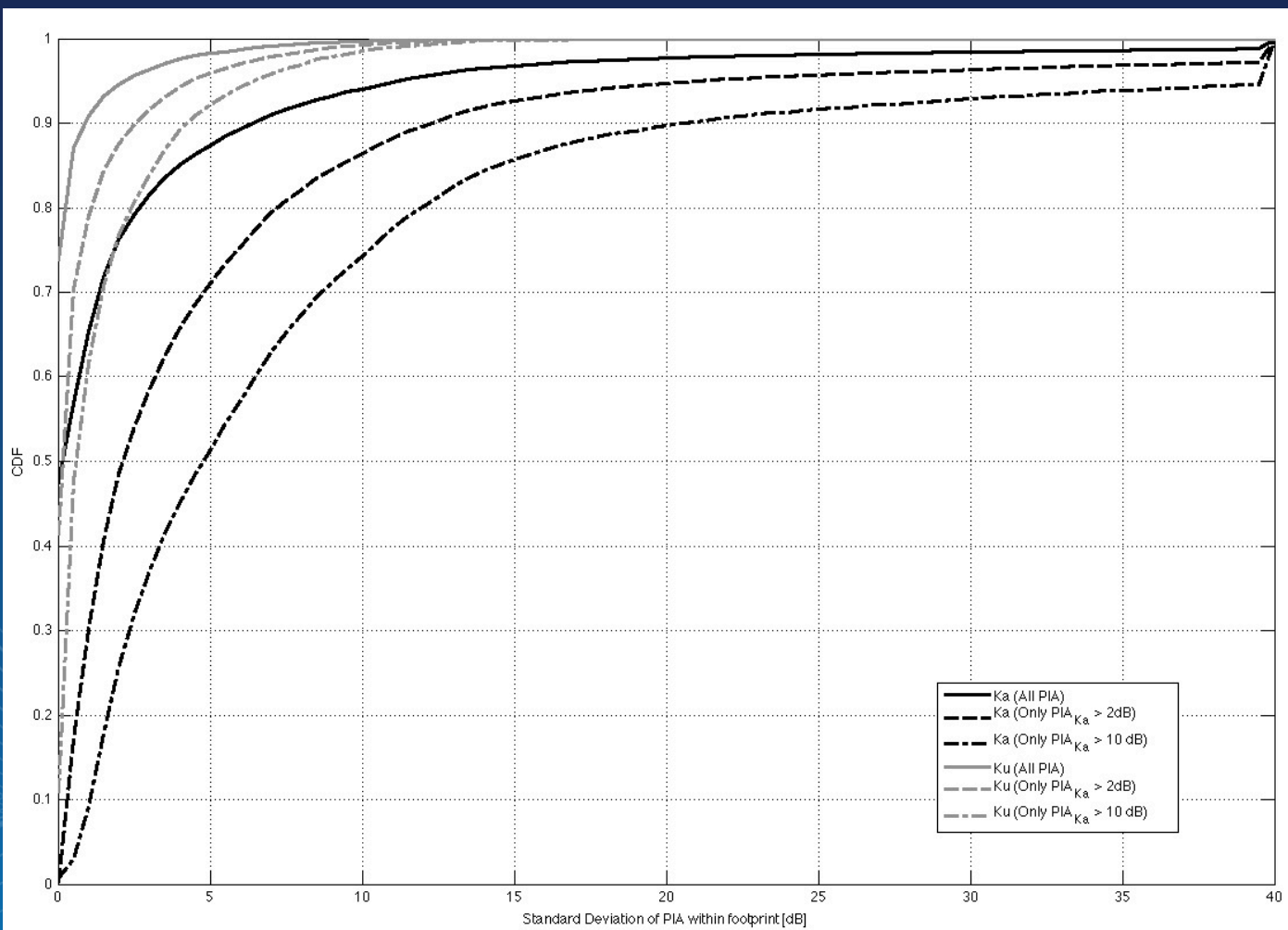
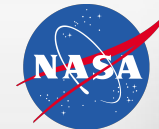


- Non-Uniform Beam Filling = inhomogeneity in the field of reflectivity across the radar beam
- Column Model = the pattern of NUBF is completely correlated along range
- This model was adopted since the first studies (e.g., Nakamura et al. 1991) and is well suited to explain the nature of the problem.
- The higher the specific attenuation the stringer the impact of NUBF → higher frequencies are more affected.



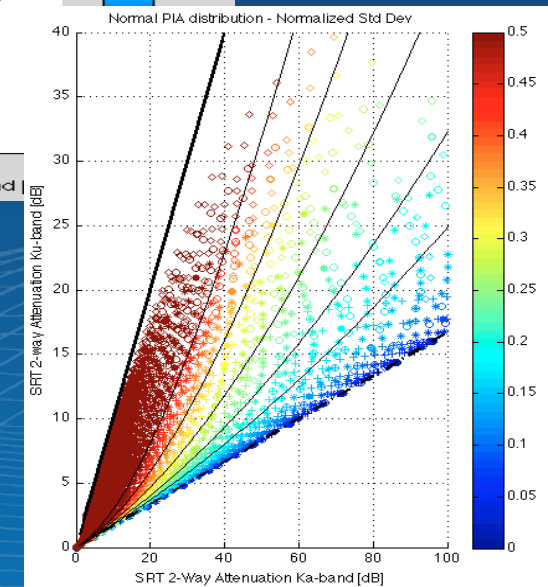
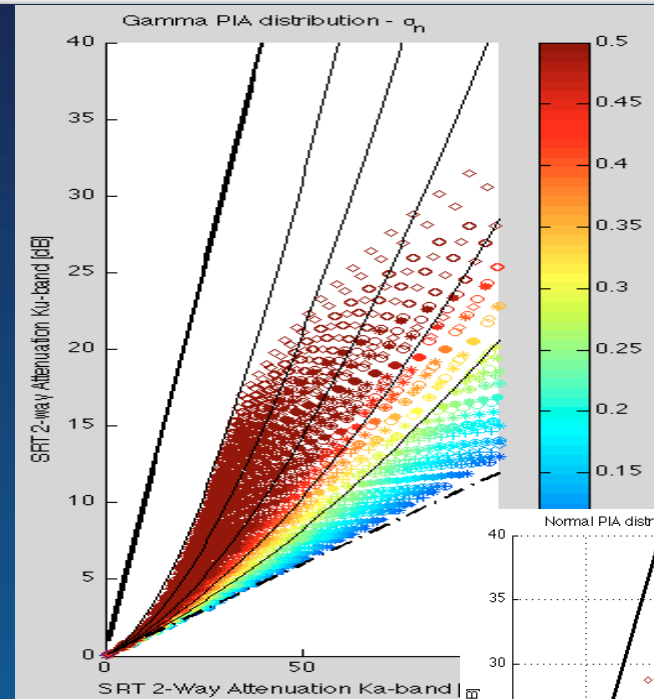
Experimental Evidence

Probability of occurrence from the GRIP APR-2 dataset



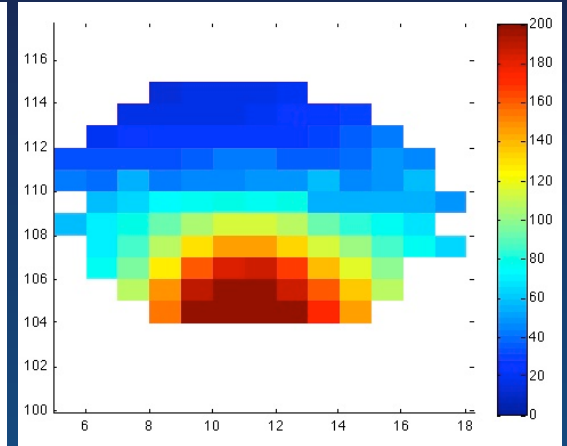
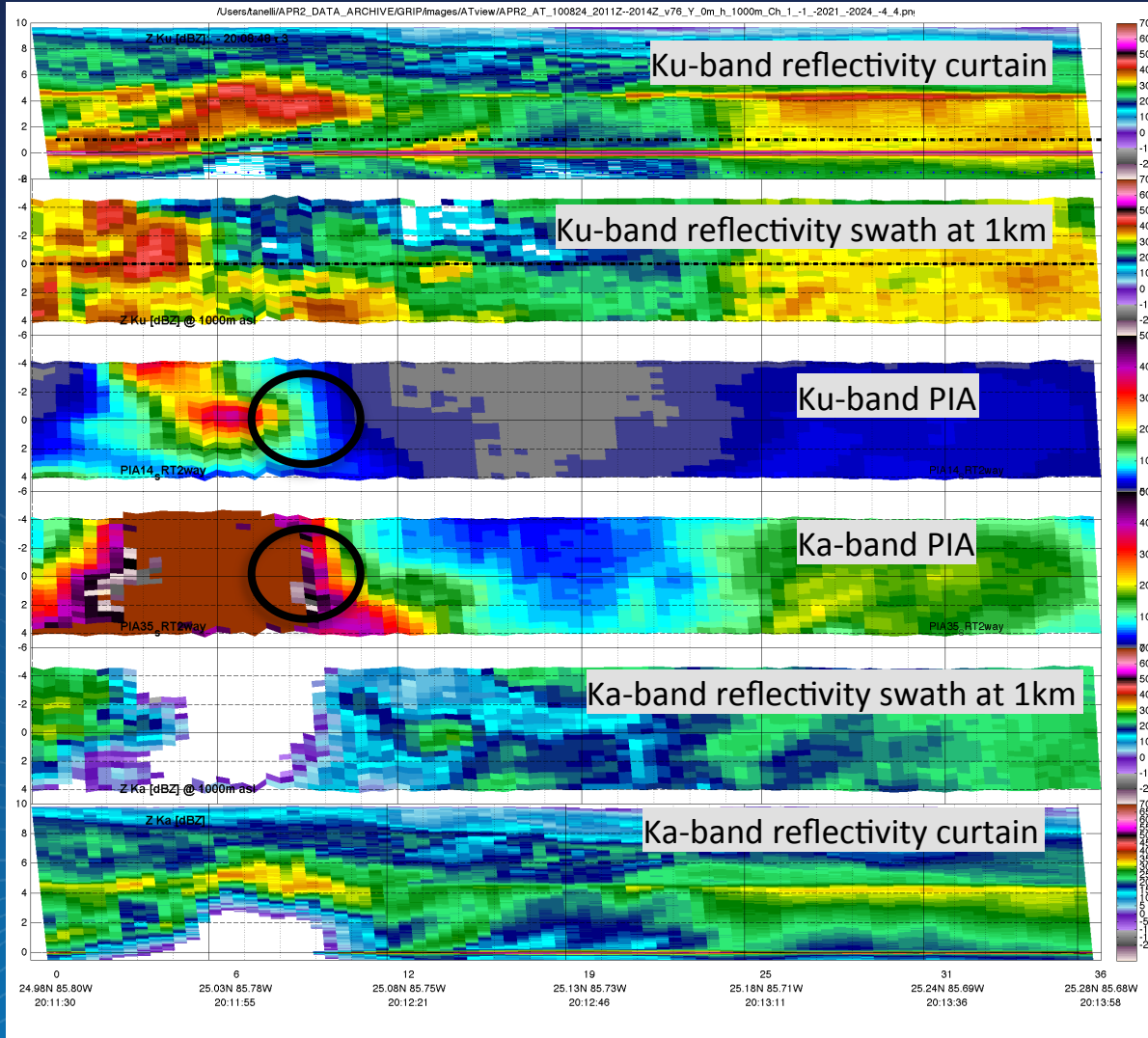


- In the TRMM operational algorithm two shapes have been considered (Iguchi et al. '00, '09):
 - Gamma
 - Log Normal
- The corresponding correction terms have been shown to be comparable.
- They enable elegant analytical solutions.
- How well do these classical monomodal distributions capture the actual distribution of PIA within a 5 km FOV?
- A 'Delta-clear + Gaussian-Rain' simple model is also explored in this paper.

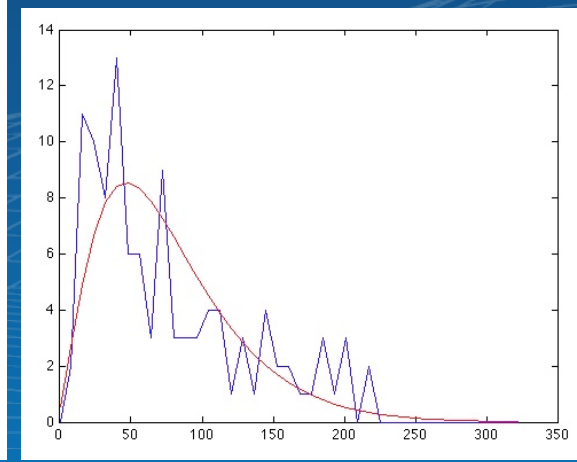


Experimental Evidence

Example of Non Uniform FOV (Embedded Convection)



$\sigma_n > 0.15$
Good fit with Gamma

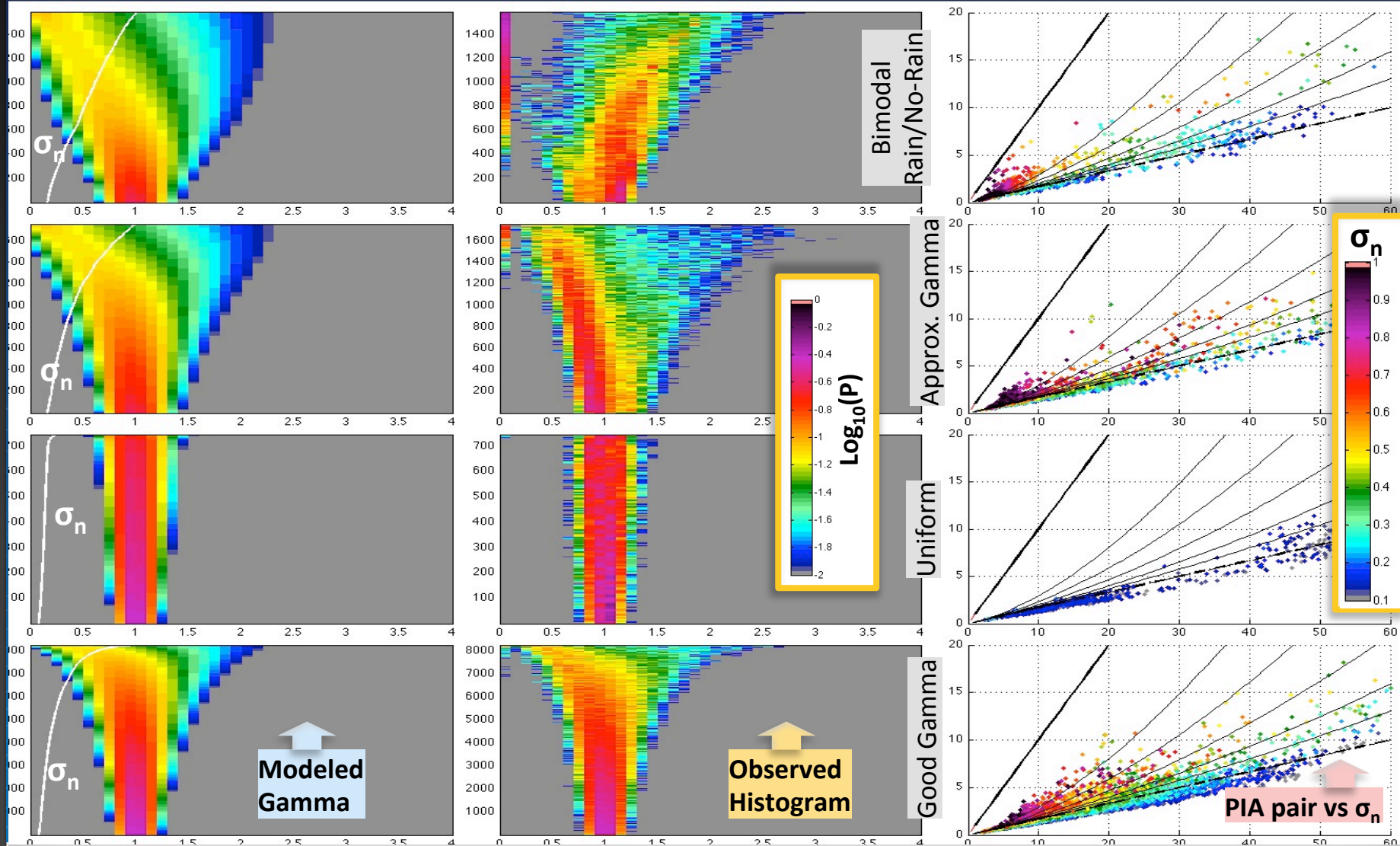


Experimental Evidence

PDF of nomalized PIA within one 5km (GPM) FOV (2)



There is almost never a trimodal distribution, but the no-rain/rain bimodal represents a large fraction of NUBF

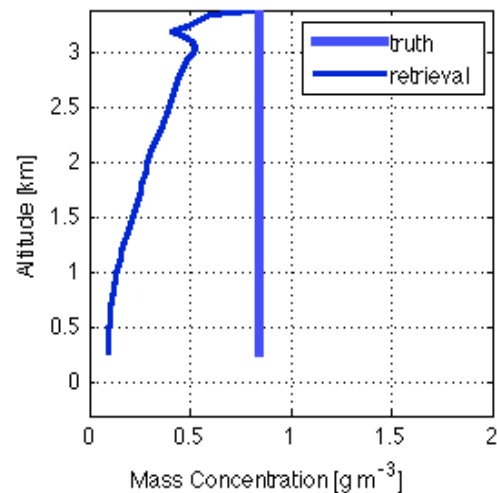
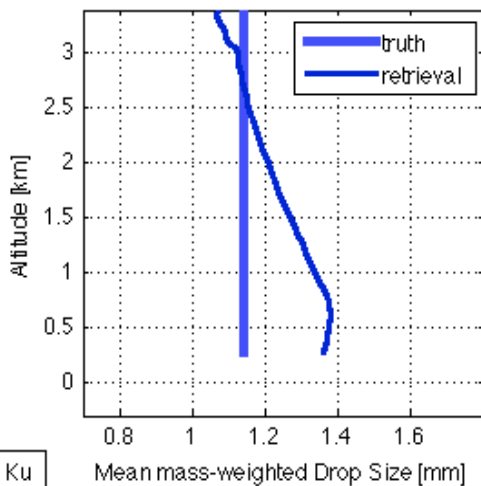
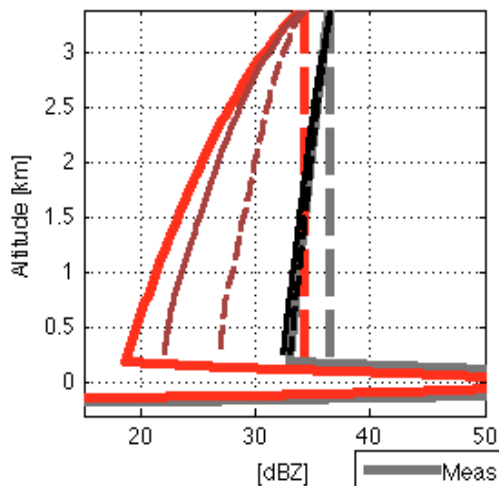


Correction and Retrievals

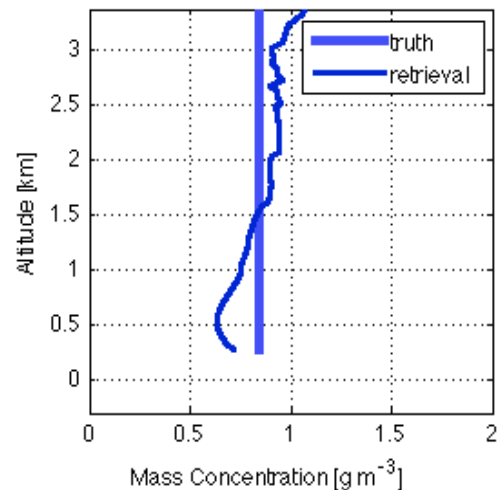
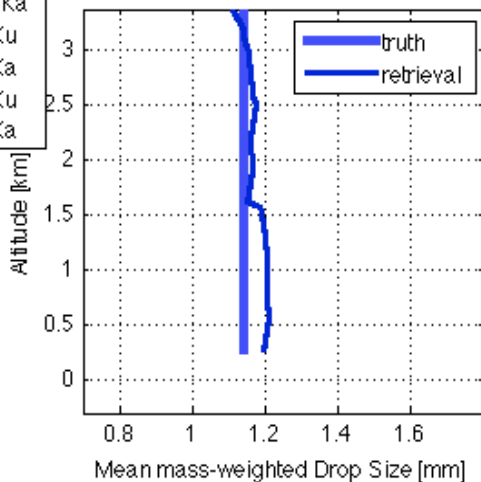
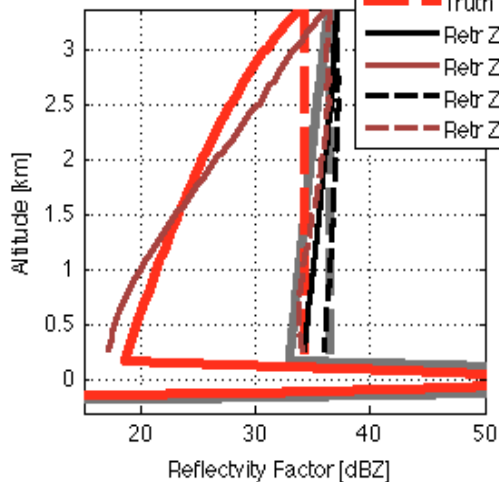
Simulated Column-NUBF profiles & Full Bayesian Retrievals: with and without NUBF correction



Without NUBF correction



With NUBF correction



NEOS³ User Interface



Main user control panel (aka: login page)



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NEOS³ NASA EARTH OBSERVING SYSTEM SIMULATOR SUITE

Job History for tanelli

Show 10 entries

Search:

ID	Name	Modified	Stage	Started						
***-106	[Untitled]	15 Oct 2012, 01:40 PM	ISM	N/A						
***-107	EastUS - GOCART - ACE Active	13 Oct 2012, 08:16 AM	Completed	16 Oct 2012, 11:14 AM						
***-108	Rita - DPR - DOMUS2	11 Oct 2012, 08:32 AM	Completed	12 Oct 2012, 05:41 PM						
***-109	EastUS - GOCART - ACE Quick1D	11 Oct 2012, 05:55 AM	ISM	N/A						
G-102	[Untitled]	12 Oct 2012, 03:36 PM	Completed	12 Oct 2012, 03:39 PM						
G-105	[Untitled]	16 Oct 2012, 10:59 AM	ISM	N/A						

Showing 1 to 6 of 6 entries



Each user has his/her own job list.

(3) Check status

(1) Edit the Job Descriptor file

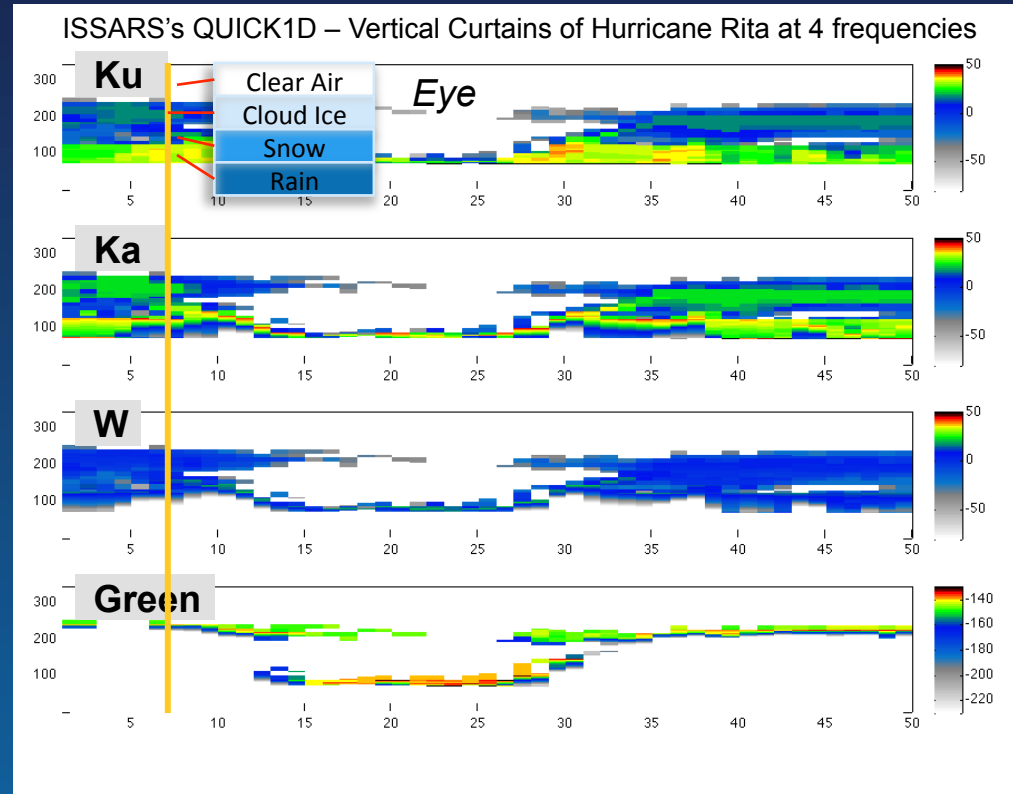
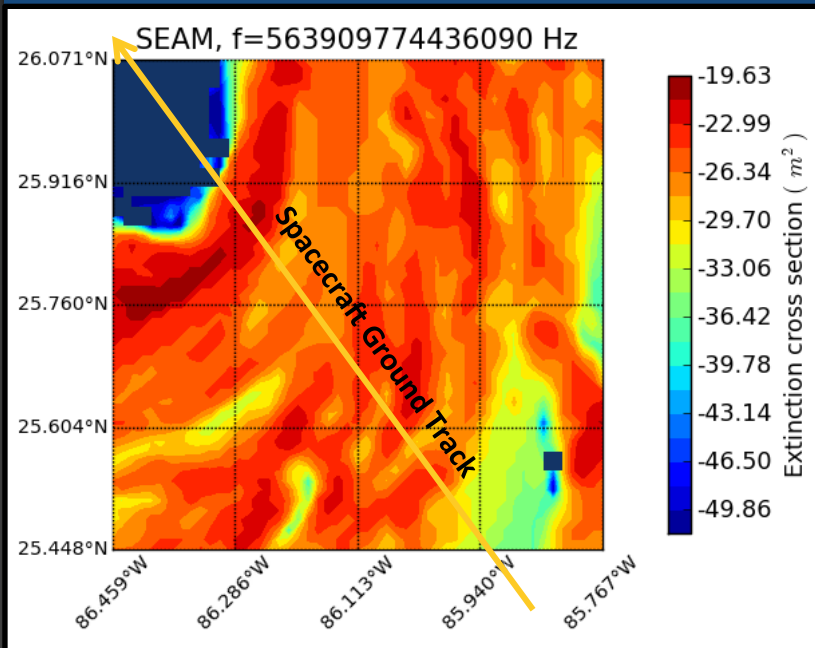
(2) Submit when ready

New job

Advanced Active Instrument Simulators from the 'standard' radar/lidar equation...



Single scattering files are generated
by the SEAM stage

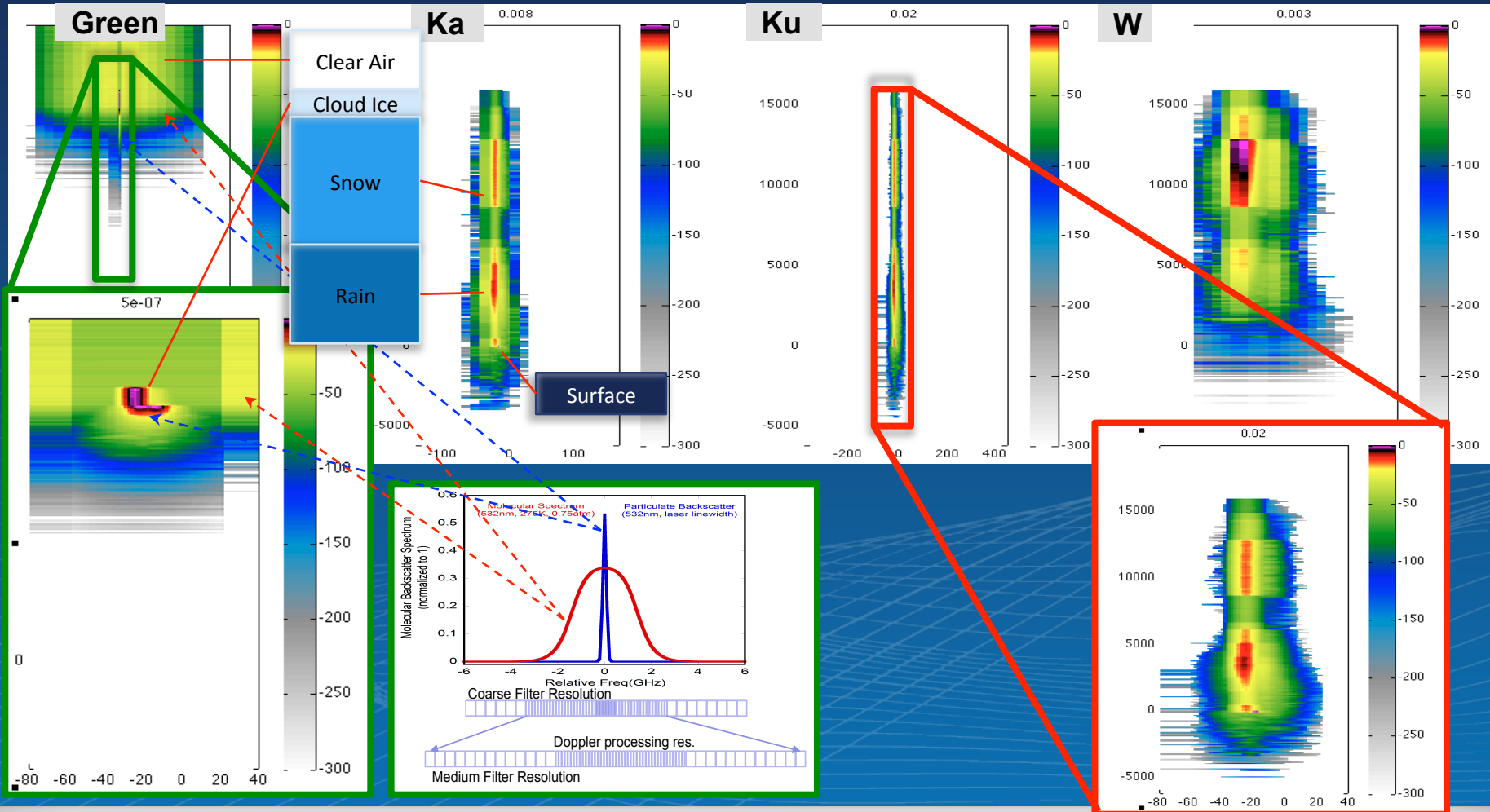


The fastest and simplest Time-Dependent
RTM can produce simulated profiles of
attenuated backscattering which are
sufficient for certain types of research,
but for other.

... to the Doppler Multiple Scattering Radar/HSRL simulator



Developed to capture the spectral signatures of all orders of trajectories. It reproduces the Doppler signatures necessary to test the effectiveness of the **HSRL** concept and of **Doppler radar** measurements



Processing Stage 2: SEAM

Scattering, Emission and Absorption Modules



SEAMs GUI

ISSARS MY TALK MY PREFERENCES MY WATCHLIST MY CONTRIBUTIONS LOG OUT

Main Page page [discussion](#) [edit](#) [history](#) [move](#) [watch](#)

- Main Page
- Topics: Plug-in**
- Plug-in architecture
- Building a plug-in
- Switch file
- Function pointers
- Mixed language programming
- Topics: Others**
- Database
- Directory structure
- Naming convention
- Job descriptor file
- Subkind ID
- Topics: GEI**
- Introduction
- Geophysics
- Electromagnetics
- Instruments
- Topics: IRM**
- Input Reconditioning Module
- Atmospheric Model Output
- Surface Model Output
- Topics: SEAMs**
- Introduction
- LookUp Table

LUT Manager

Main page

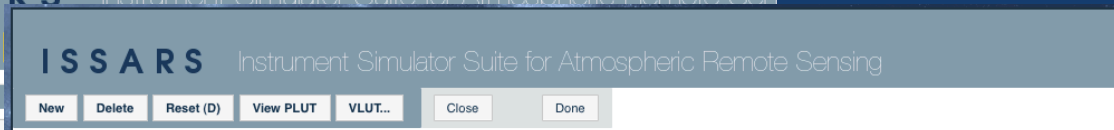


New Delete

Query results

Frequency (Hz)
89000000000
91000000000
91000000000
92000000000

New-LUT dialog box



Query results

Frequency (Hz)	Subkind	Medium Properties	Single Scattering Properties	Status
10650000000	Ziad's Graupel	Maxwell-Garnett (Spherical): Water in (Air in Ice)	Mie	
10650000000	Ziad's Graupel	Maxwell-Garnett (Spherical): Water in (Air in Ice)	Lorentz-Mie	
13400000000	Ziad's Graupel	Maxwell-Garnett (Spherical): Water in (Air in Ice)	Lorentz-Mie	
13400000000	Short Column	Maxwell-Garnett (Spherical): Water in (Air in Ice)	Mie	
13400000000	Block Column	Maxwell-Garnett (Spherical): Water in (Air in Ice)	Mie	
13400000000	Long Column	Maxwell-Garnett (Spherical): Water in (Air in Ice)	Mie	
13400000000	Block Column	Maxwell-Garnett (Spherical): Water in (Air in Ice)	T-matrix	
13400000000	Short Column	Maxwell-Garnett (Spherical): Water in (Air in Ice)	T-matrix	

Table properties

Status: Ready

Testing Frequency

f_{upper} 13.5 GHz

f_{lower} 13.3 GHz

Scattering Parameters (Z_{ij})

Form Discrete angles (uniform 2-D)

N_θ 5

N_φ 4

Temperature (T)

T_{min} -180 C

T_{stop} -40,-30

N_T 1,1,1,1

Spacing lin

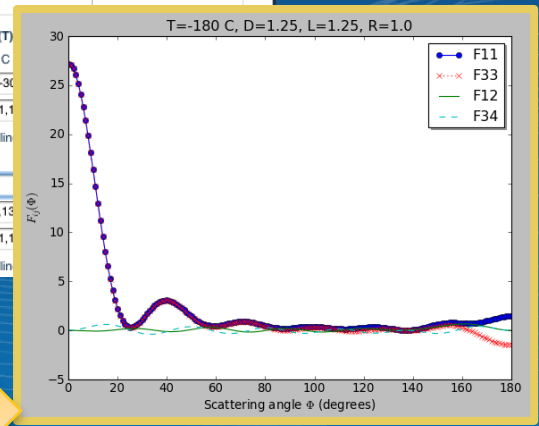
Diameter (D)

D_{min} 66

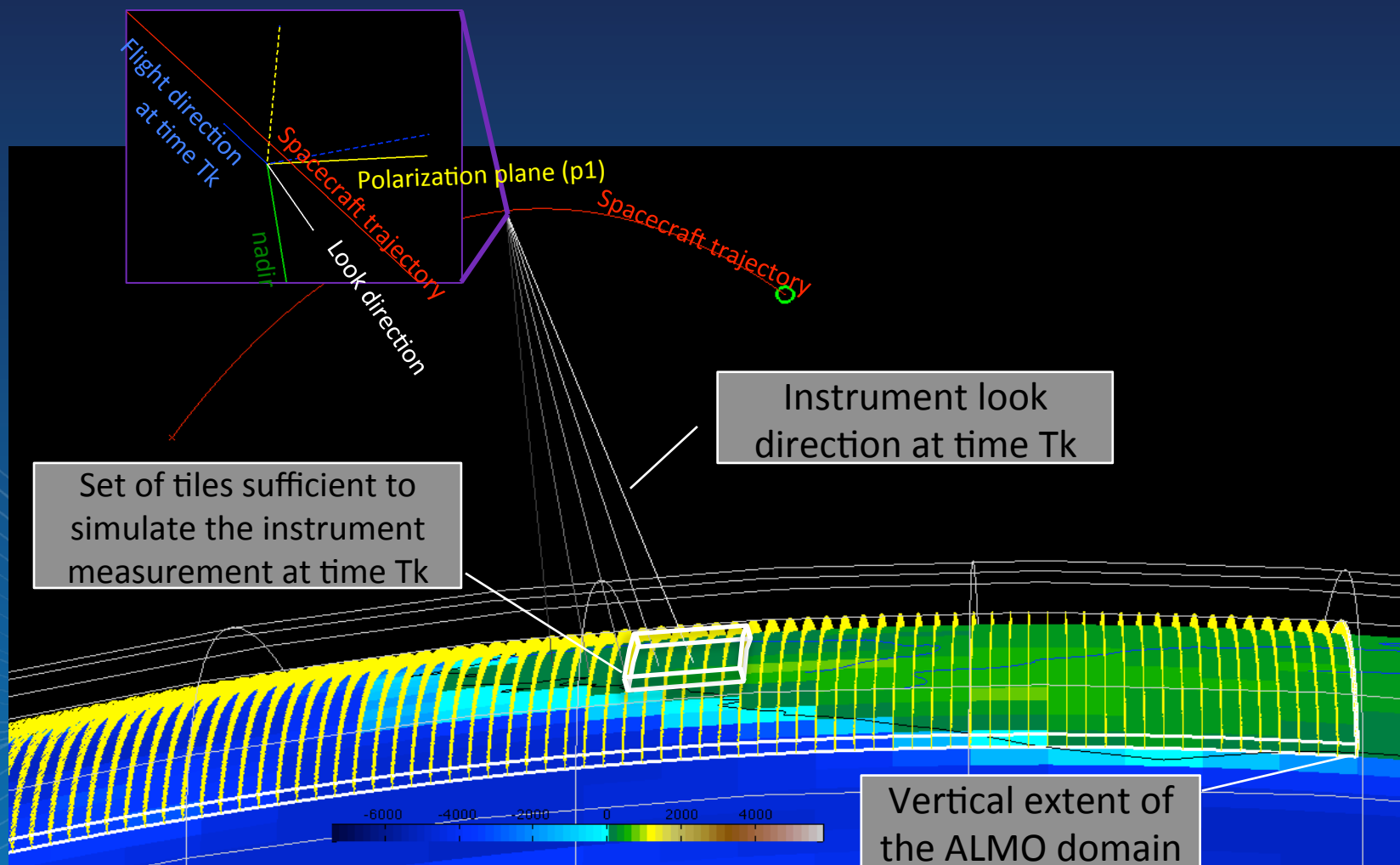
D_{stop} 100,13

N_D 1,1,1,1

Spacing lin



The key: the decoupling of the stages determines the geometry



Simulated Radar and Radiometer



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TC-IDEAS

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The current time is Tue, 19 Mar 2013 19:51:49 GMT

Observation Data

August 2010

Su	M	T	W	Th	F	S
01	02	03	04	05	06	07
08	09	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

37GHZ
 37GHZ
 37VGHZ
 85GHZ
 85VGHZ
 Rain
 TRMM PR
 CloudSat
 CALIPSO
 MLS
 AOT-MODIS

Nadir

Model Data

August 2010

Su	M	T	W	Th	F	S
01	02	03	04	05	06	07
08	09	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

MODEL DATA
Pressure Level: 850
Forecast Time: 000

GFS
 ECMWF
 UKMET
 NOGAPS

SENSOR SIMULATION
Forecast Time: 00

GFS
 HWRF
 10H GHz
 10V GHz
 19H GHz
 19V GHz
 37H GHz
 37V GHz
 85H GHz
 85V GHz

100 10 GHz (K) 250

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