Ground-based activities and notional studies in support of GPM and beyond

Alessandro Battaglia
Frederic Tridon, Pavlos Kollias and the Bonn radar group

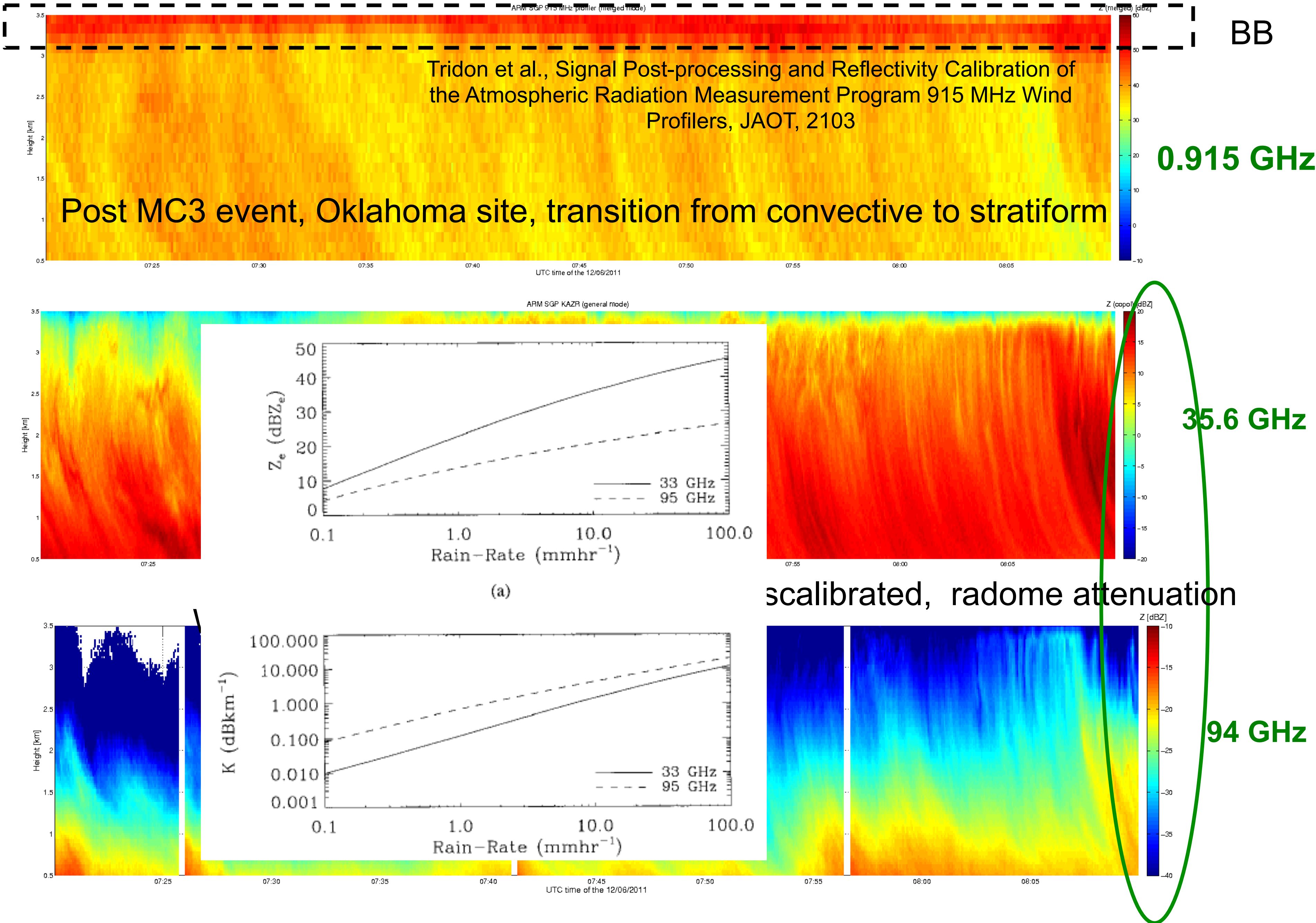
Outline

- Triple frequency rain gamma DSD retrievals at ARM sites (work in progress, UK- NERC PERICLES project)

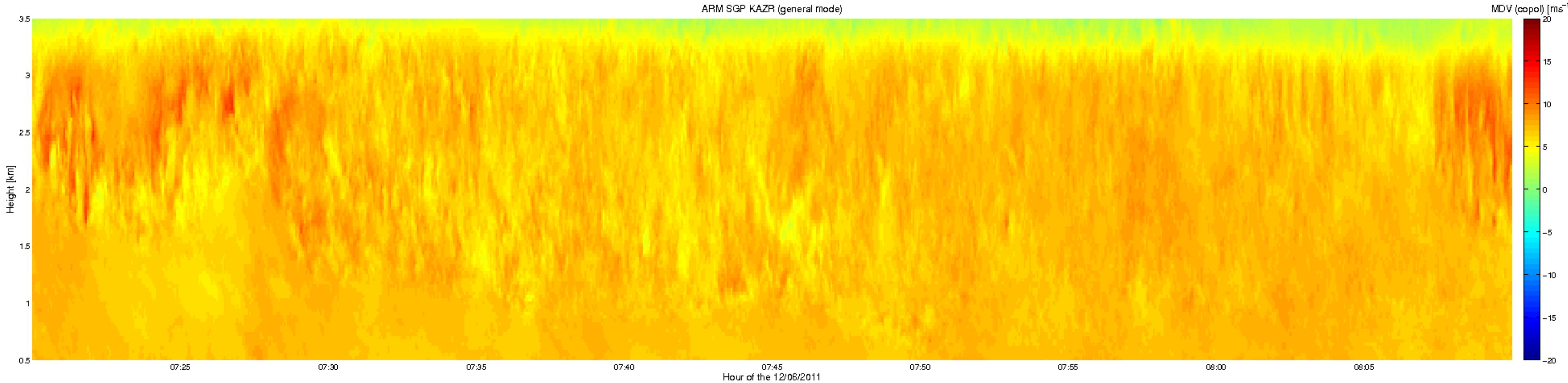
- Opportunities in collaboration with Germany in the Geoverbung test bed (proposal in nuce, open for ideas)

- Notional studies for GPM and future multi-frequency (Doppler) missions (covered by Simone)

Premise: continuous triple frequency Doppler rain observations



K_a observed Doppler velocity and width



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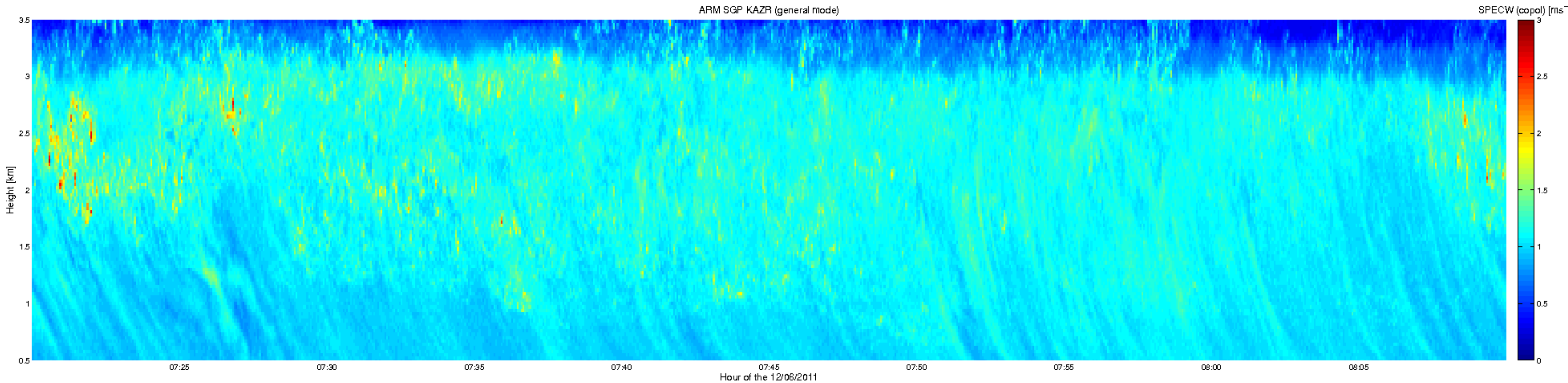
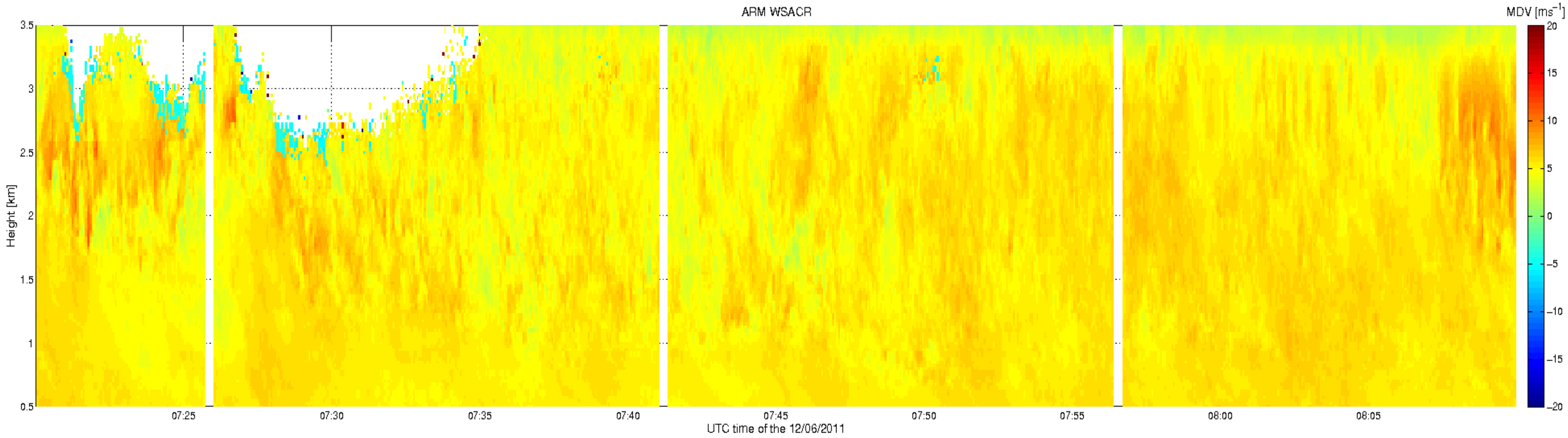
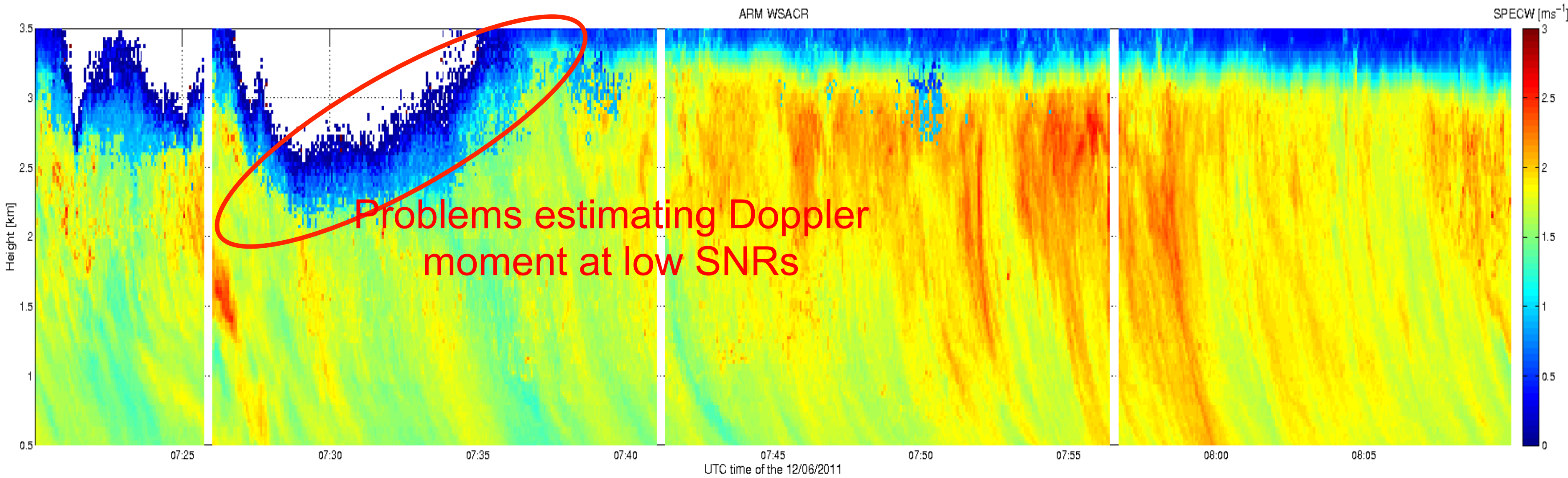


W-observed Doppler velocity and width





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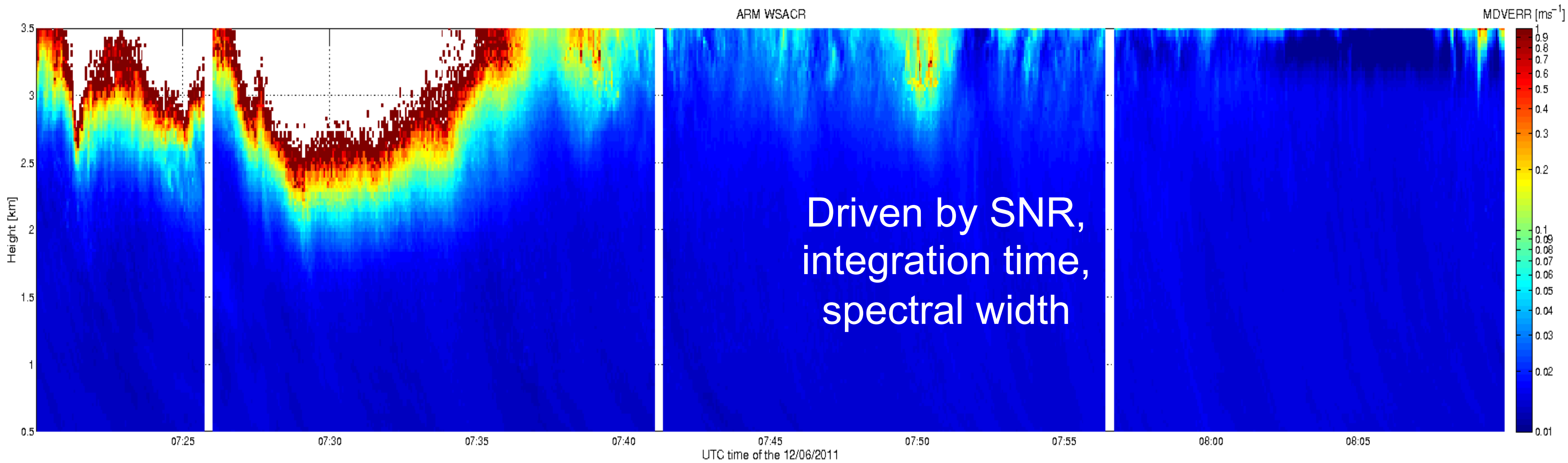

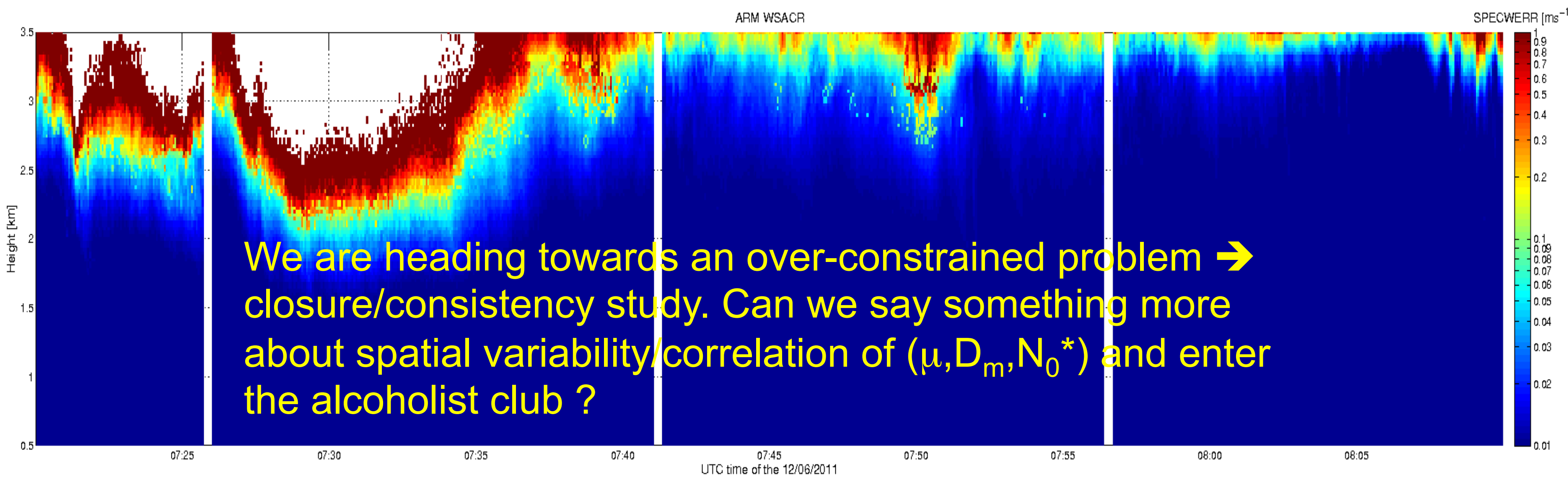

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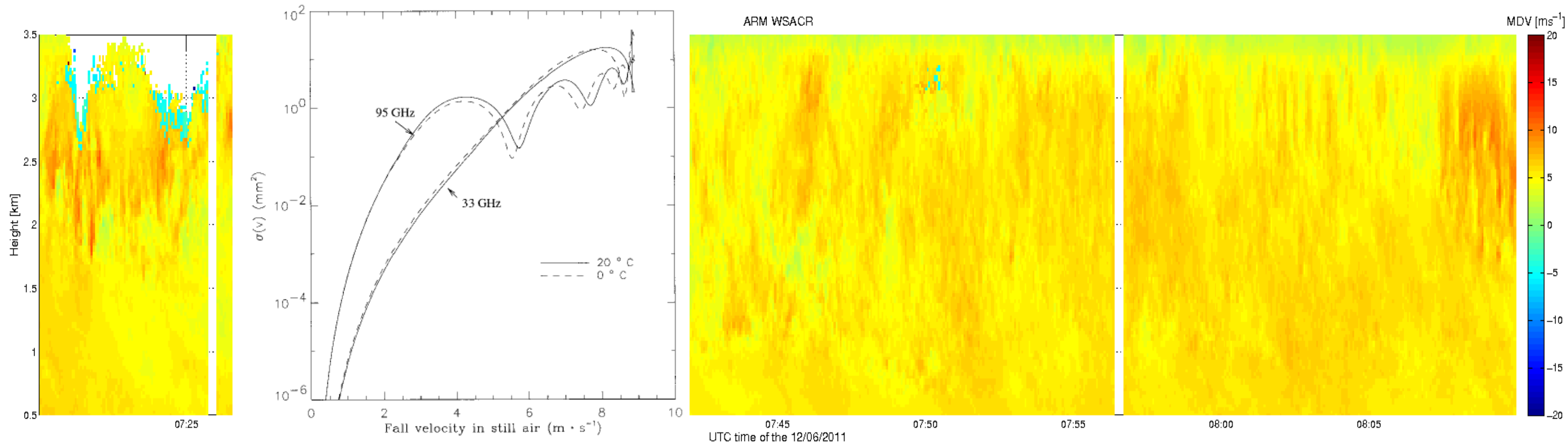
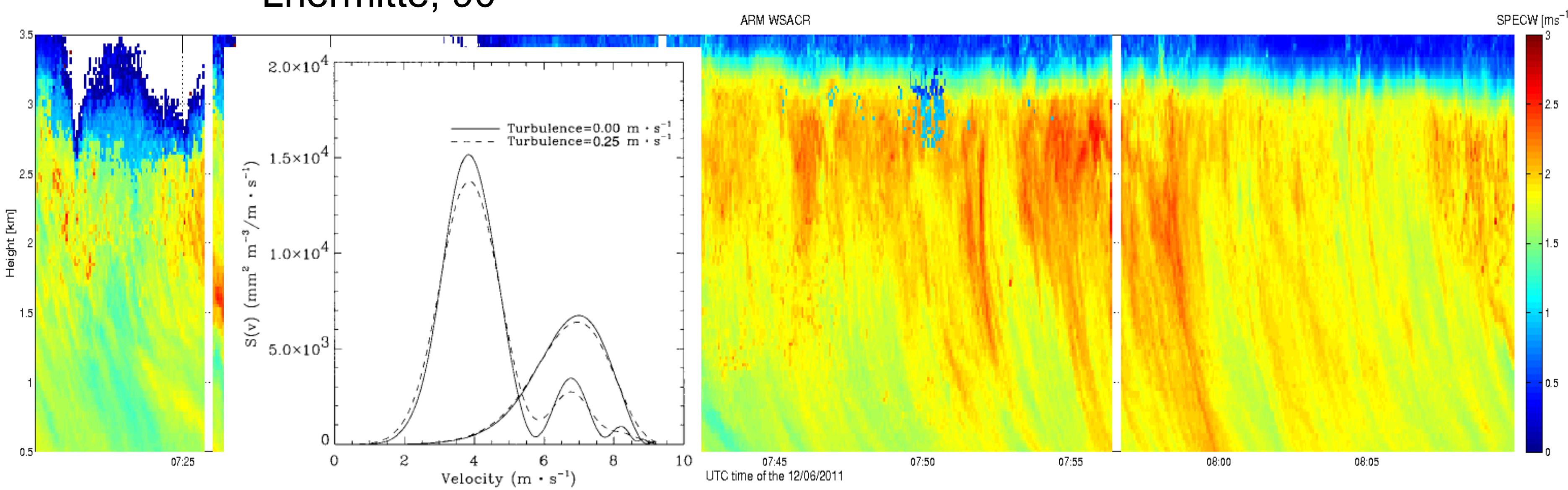
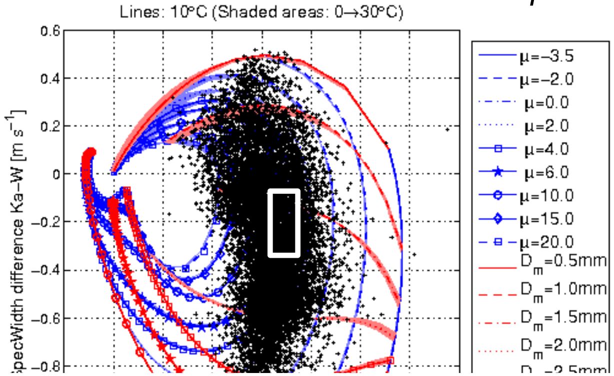


Lhermitte, 90



Step1=Shape of DSD from Δv_D and $\Delta\sigma_D$

Not spectral based like in Firda, 98



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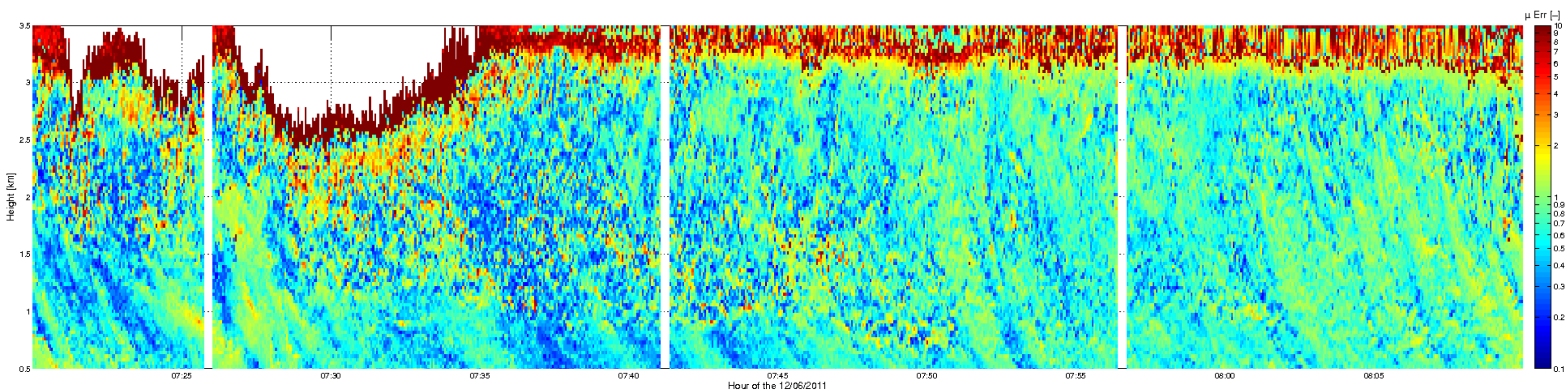
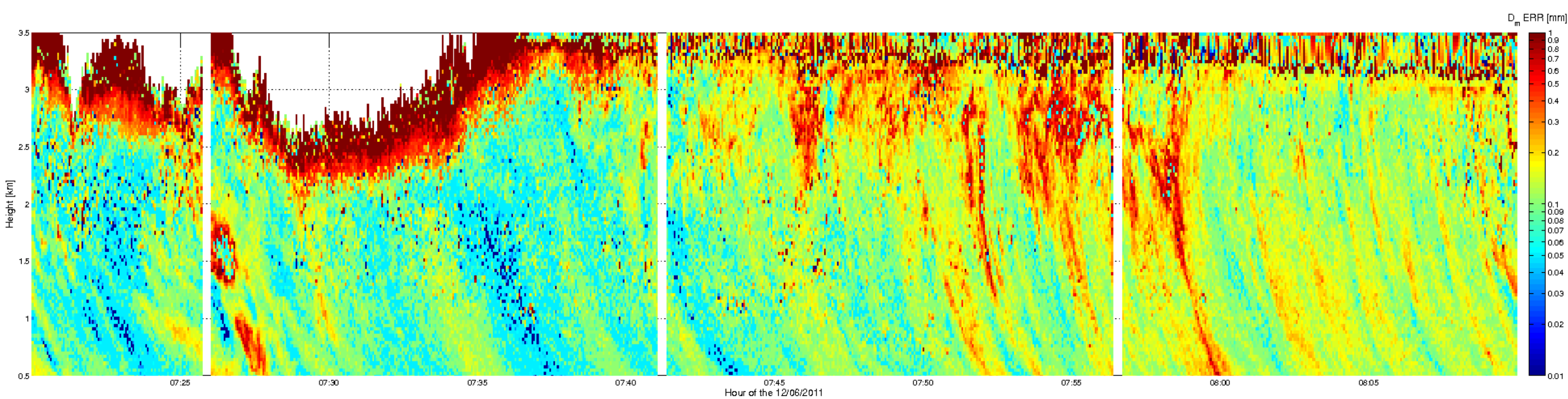
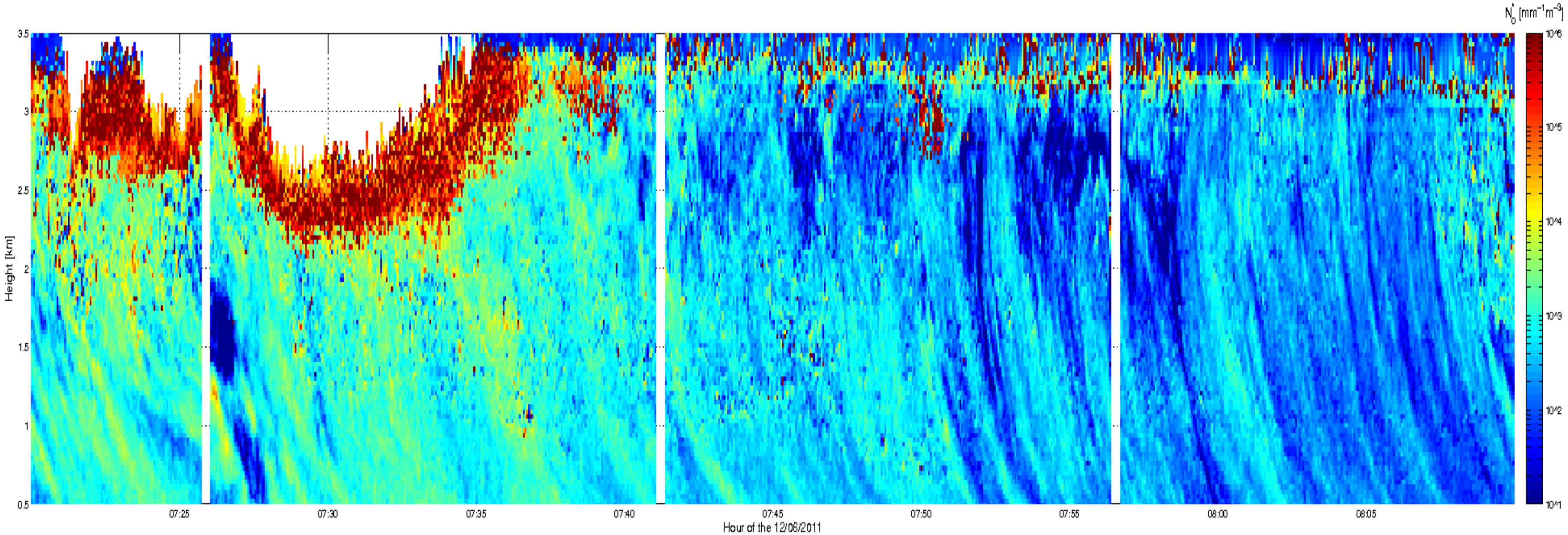
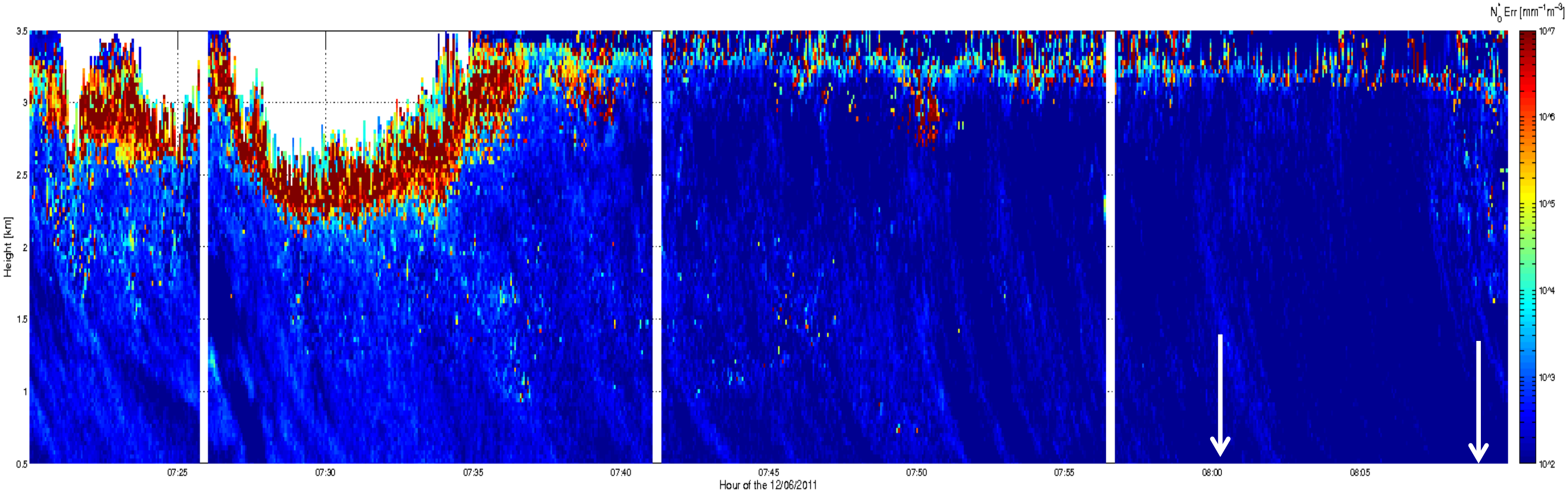
Error of retrieved parameters based on measurement noise uncertainties





Step2=N_0* from calibrated Z_{UHF}

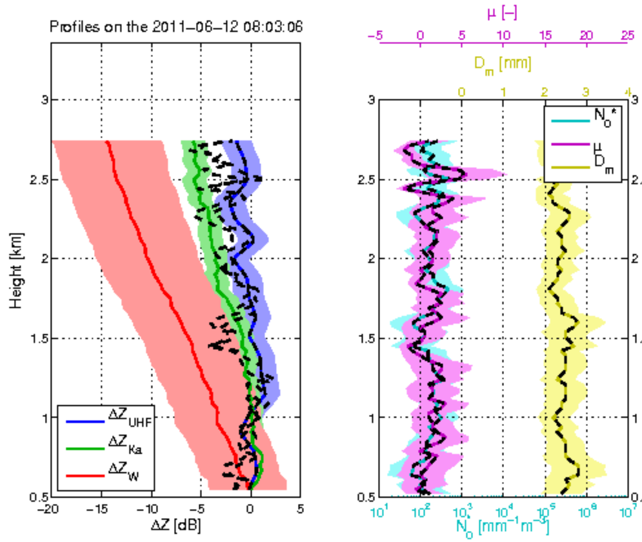


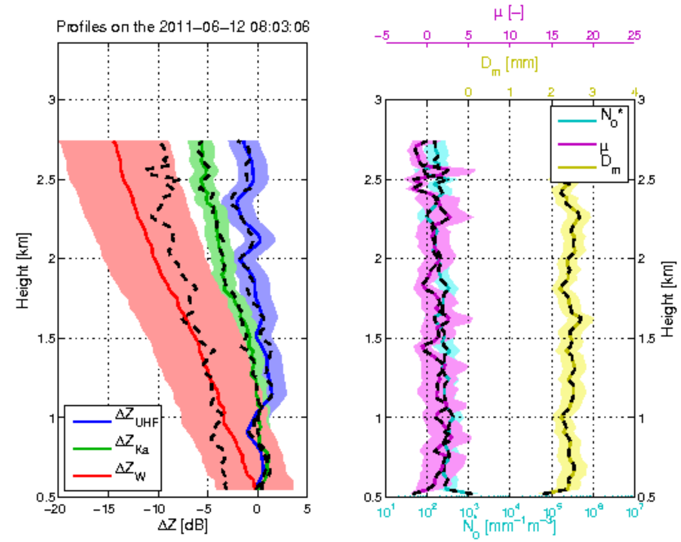


Step3= optimal estimation based on ΔZ respect to lower gate

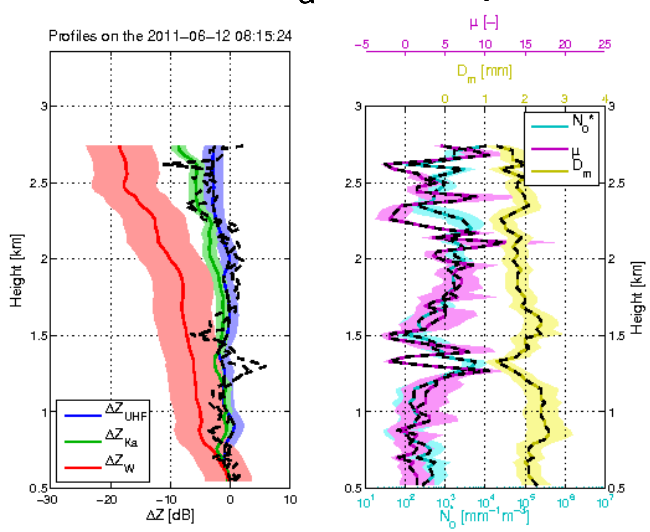
Initial guess

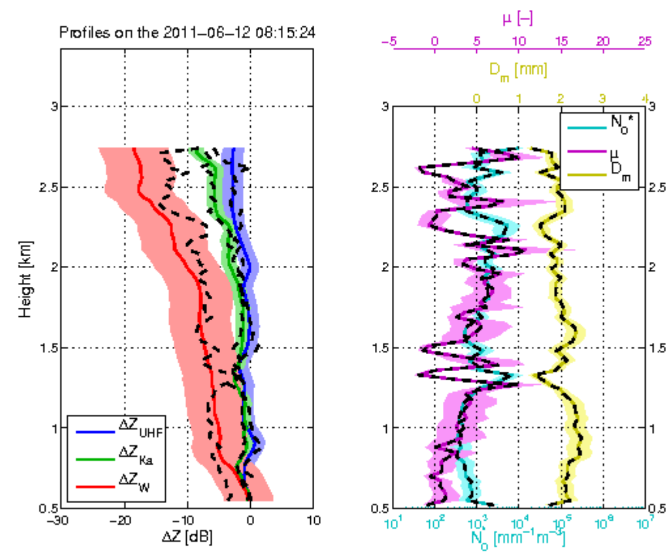
After convergence



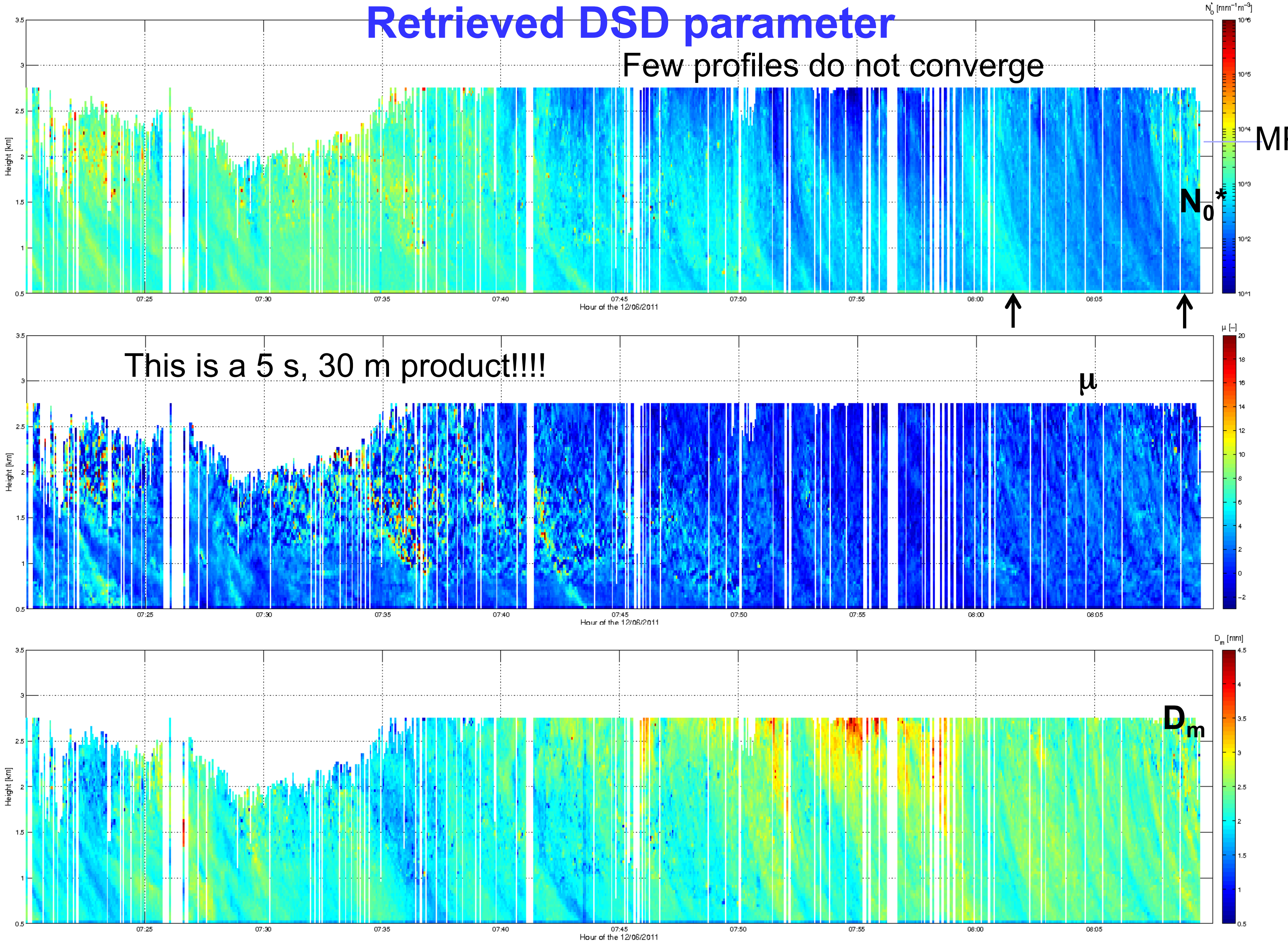


Total disagreement with K_a and W profiles

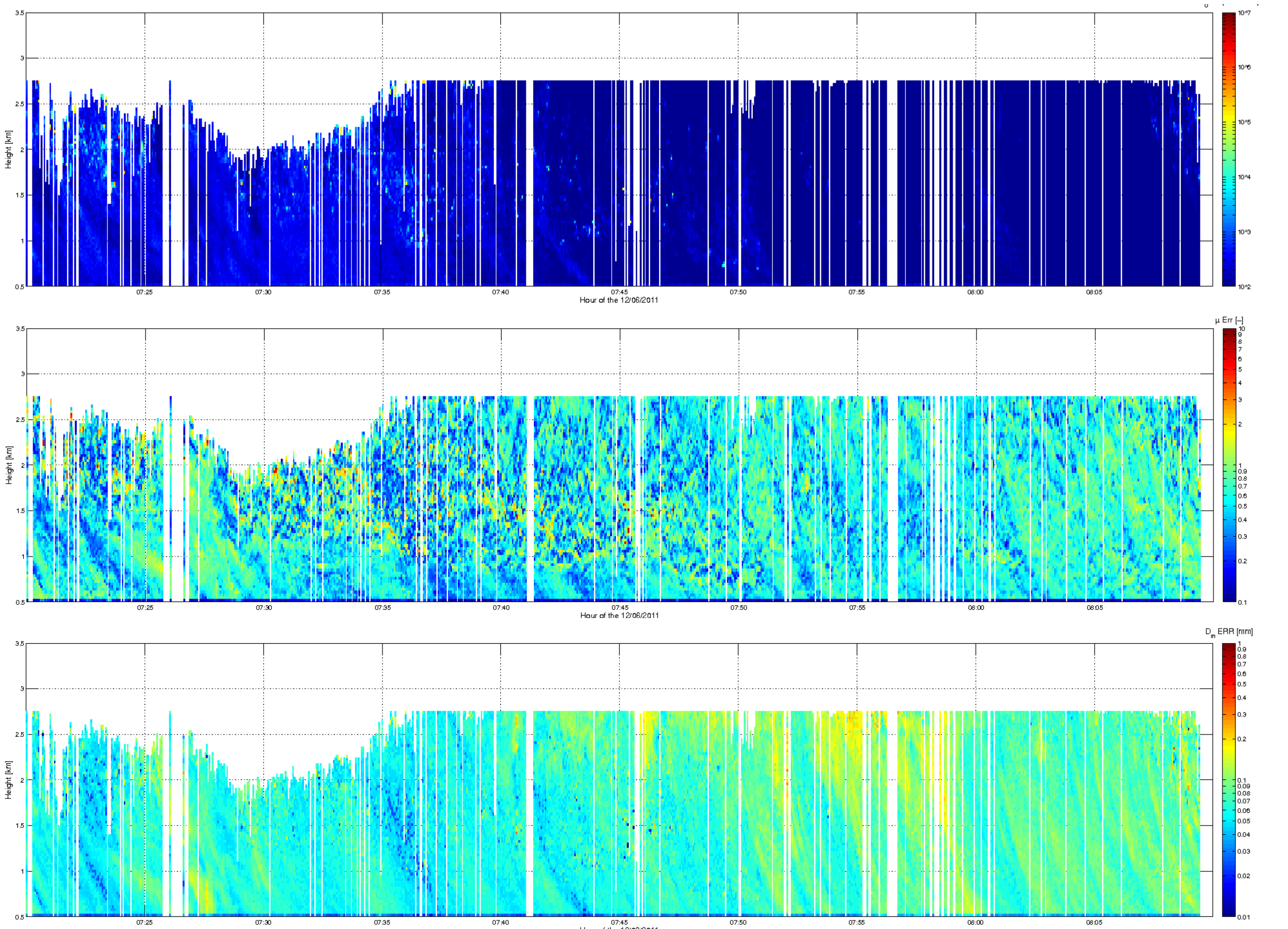




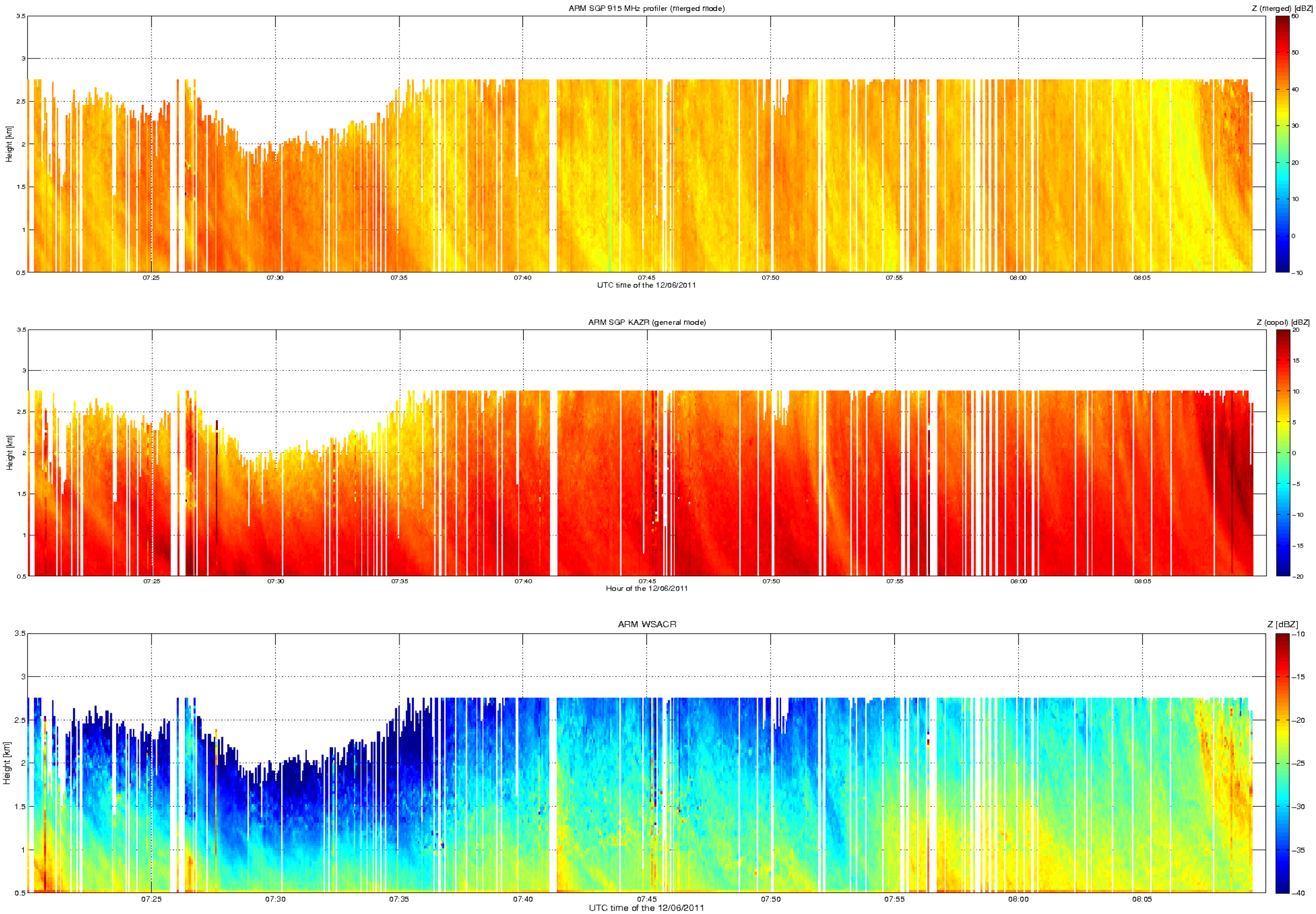
Retrieved DSD parameter



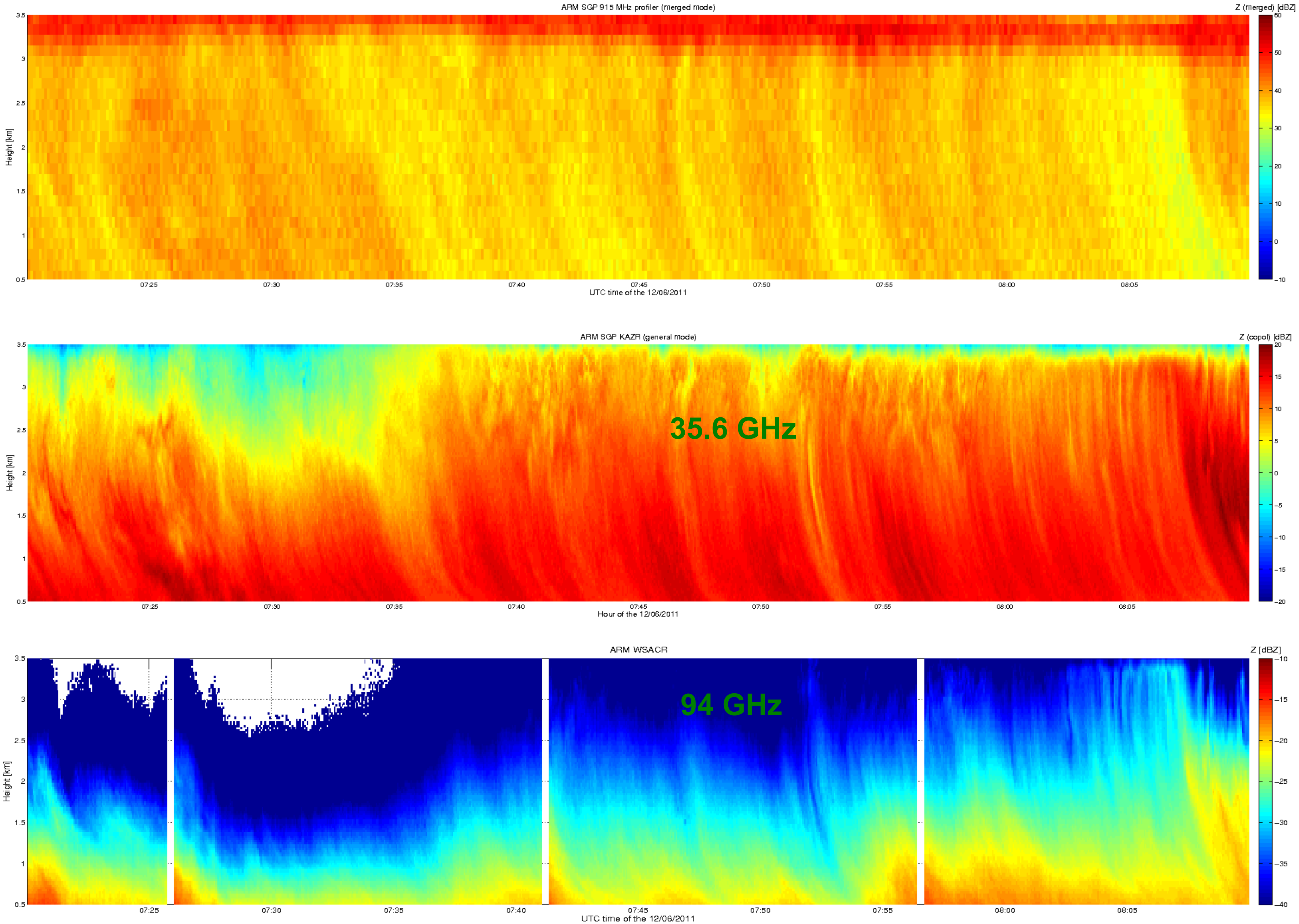
N_0^*, μ, D_m errors from optimal estimation



Forward reflectivities of retrieved fields



Observed radar reflectivities



Preliminary conclusions and roadmap

- First results are encouraging: convergence is reached for most of the profiles ➔ there is physical consistency between triple frequency Doppler measurements at very high temporal and spatial resolution. More tests needed!

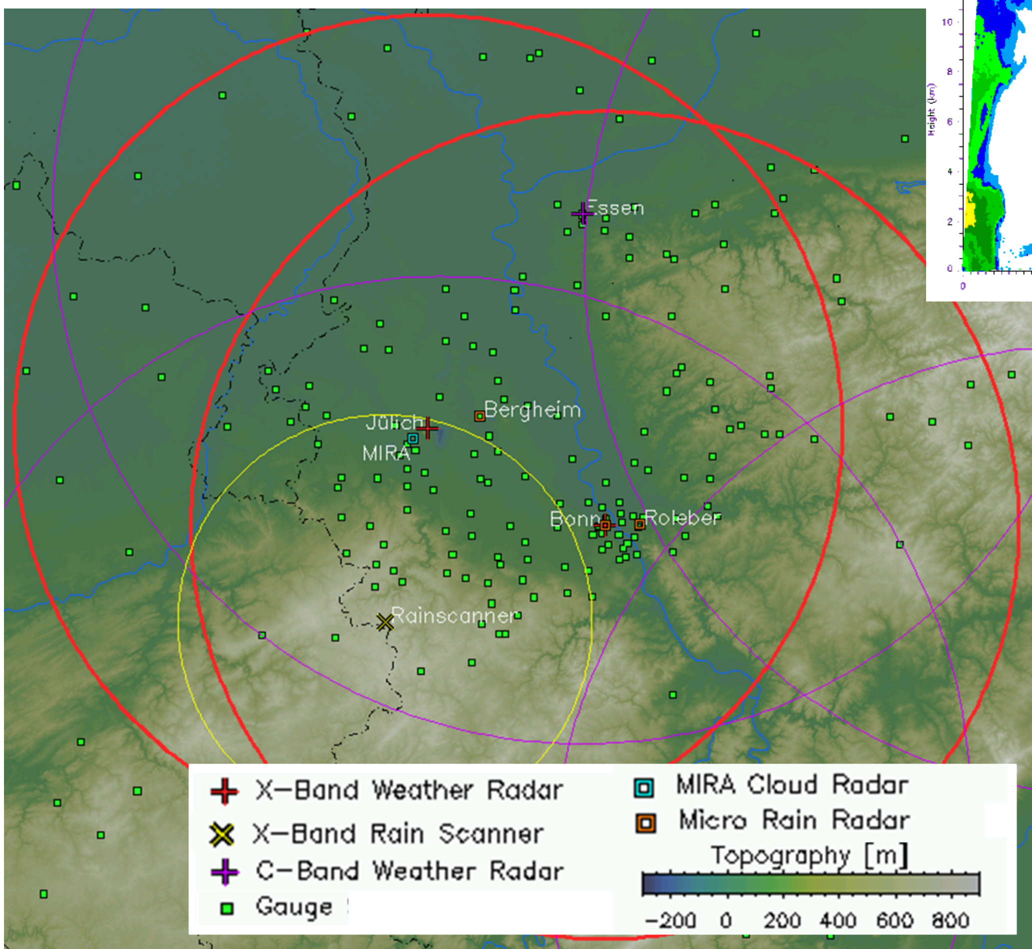
- **Generalization of optimal estimation step**
  1) adaptive two/three wavelength algorithm, thus extending the rain rate range (K_a and UHF continuously operated in vertical mode)
  2) all observables (without adding too many variables in the cauldron).

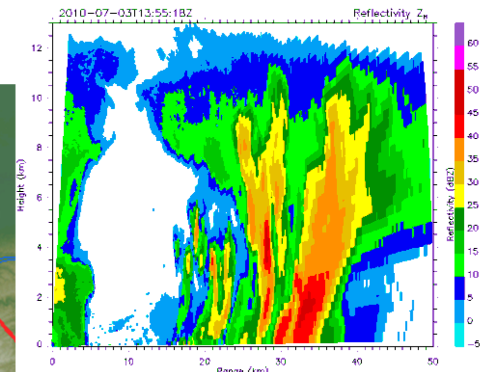
- Better **assessment of errors in Δv_D and $\Delta \sigma_D$** , e.g. including errors due to mismatched volumes (scanning vs vertically point Ka).

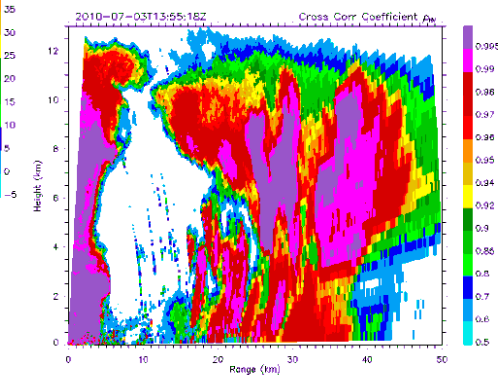
- **Cross-validation with other techniques** (W-band only, S-band profiler, ground).

- Vertical correlation of DSD parameters for retrieval developers and modellers (rain processes).

The Polarimetric Weather Research Radars within the Bonn Test Bed







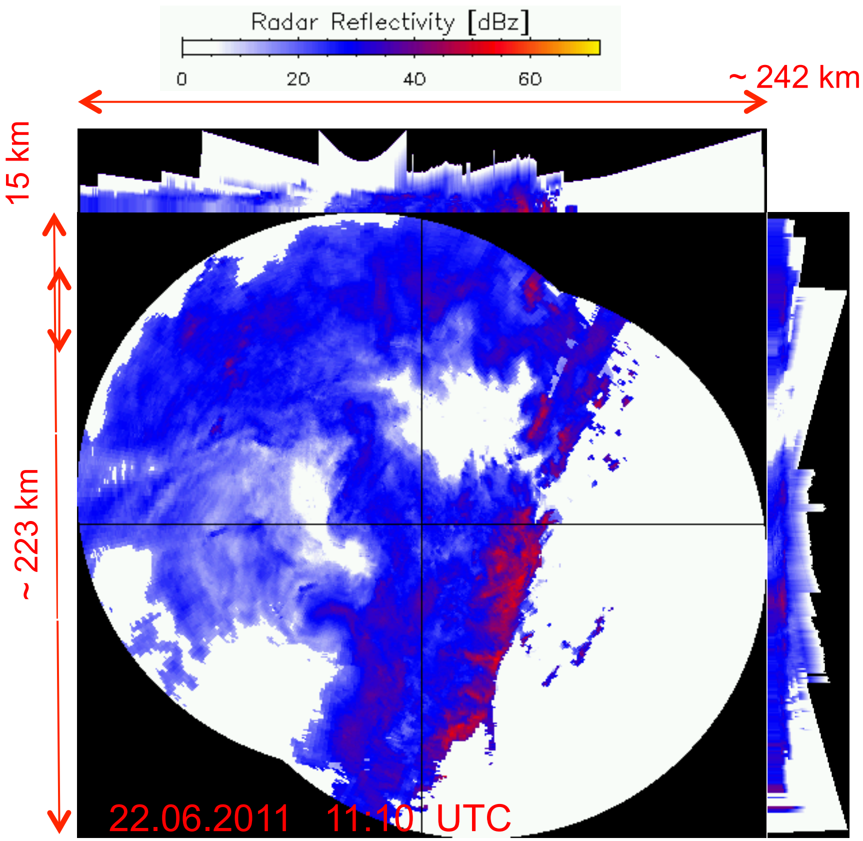
DWD network is currenlty being upgraded to polarisation diversity.

DWD also switched over to a 5min scan strategy.

The idea is to include adjacent polarimetric C-band radars from DWD as soon as available and extent the spatial coverage of the local 3D composite

Bonn area: high-resolved 3D-composite

- 500m * 500m * 250m spatial resolution
- 5 minutes temporal resolution



X-Band radar data (Bonn, Jülich)

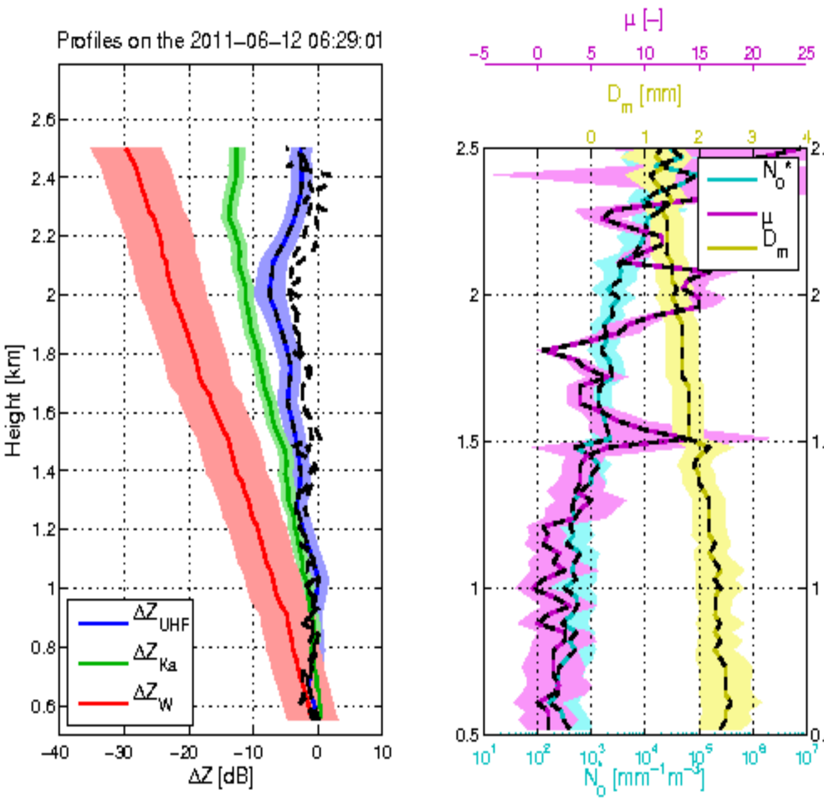
- Based on 13 PPIs of both radars
- Polarimetric C-band radars will be included as soon as available
- Variables: Z, Z_{DR}, K_{DP}, Rho_{HV}, RR
- Corrected for
  - Attenuation
  - Partial beam blockage
  - non-meteorological signals
  - Advection within the 5min interval

MSG- and LINET-data

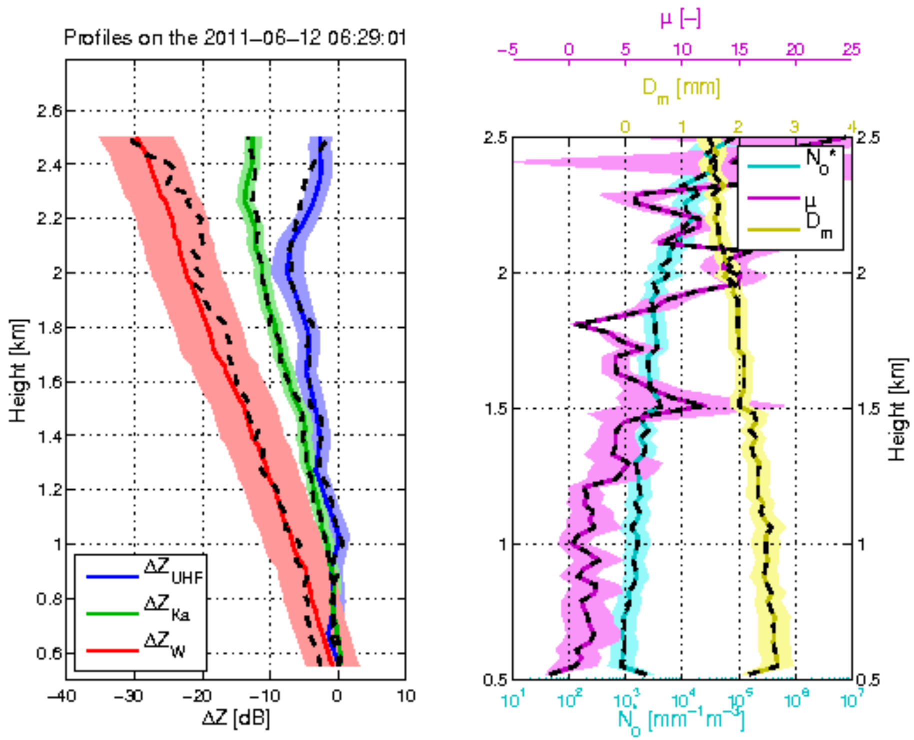
1) Evaluation of quality of PMW rain retrieval over the test-bed as a function of precipitation regime (surface/atmosphere thermodynamic state, vertical cloud structure), sensor, NUBF;
2) Critical assessment of the G-PROF Bayesian database (sub-segmentation/creation of regional specific database). Identification of critical regional knobs.

Questions?

Initial guess



After convergence



Germany: 2D-composite from DWD radar network

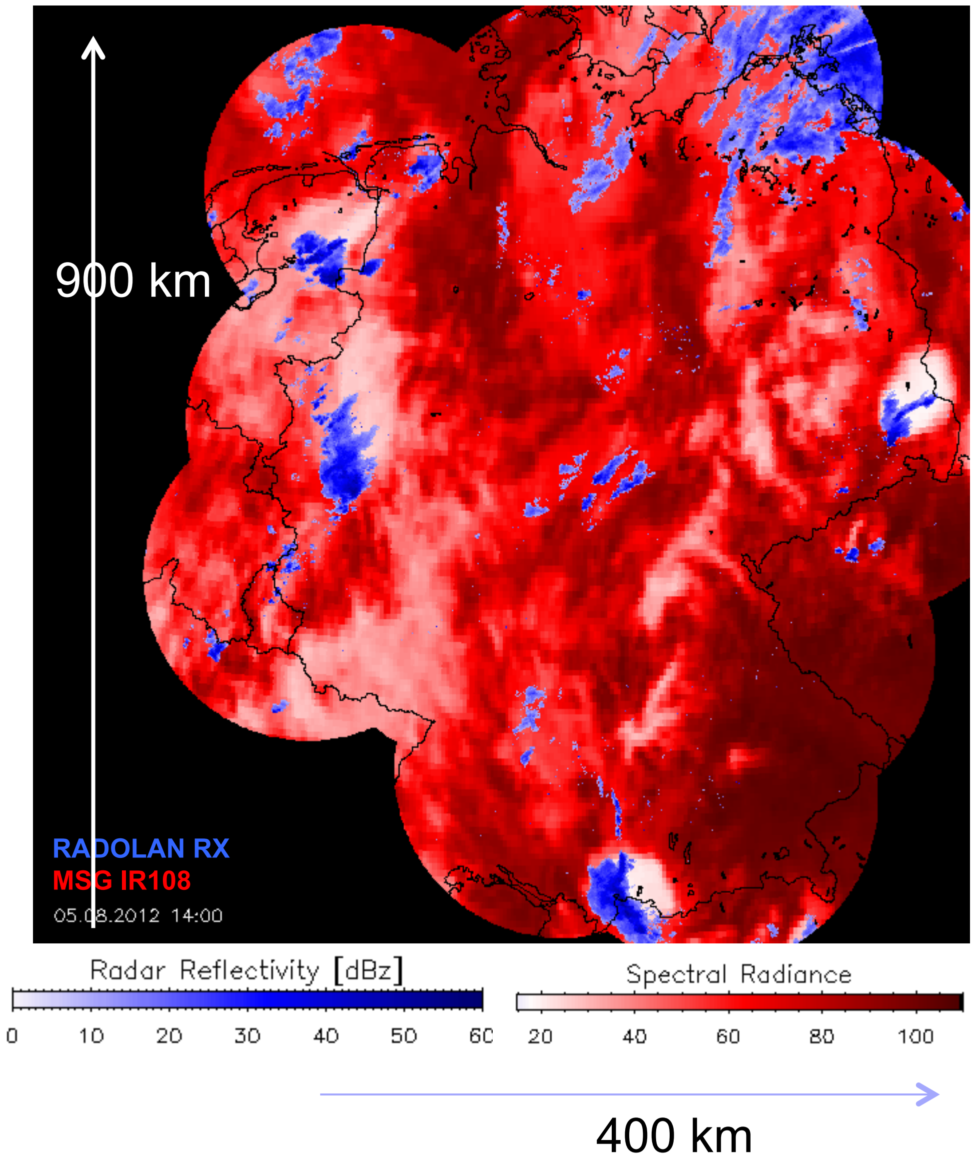
- 1000 m horizontal resolution
- 5 minutes temporal resolution

RADAR: RX product

METEOSAT SEVIRI:

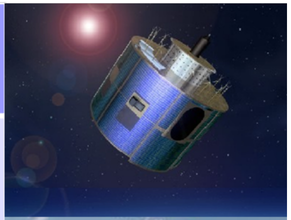
- 12 spectral channels (Vis/IR)
- CMSAF and NWCSAF products: cloud phase, optical depth, cloud effective radius, cloud water path, cloud mask, cloud top height, cloud type

LINET: flash rate



3D and 2D composites

Source	Dimensions/ Resolutions	Areal Coverage	Parameters
METEOSAT SEVIRI	2D/ H 1 km	Germany	12 VIS/IR Channels, CTH, CT, CMA, CWP, R_{EFF}, COT, CPH
Geoverbund X-Band Radars	3D/ H500m, V250m	Bonn/Jülich Area	Z_H, Z_{DR}, K_{DP}, RHO_{HV}, RR, Z_{MIN}, Weight (HMC, LWC, U, V)
DWD C-Band Radars	2D (3D)/ H1km (V250m)	Germany	Z_H (Z_{DR}, K_{DP}, RHO_{HV}, RR, Z_{MIN}, Weight, HMC, LWC, U, V)
LINET Lightning Network	2D (3D)/ H 1 km	Germany	Total Lightning, (+/- charge)



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,

JOYCE: Jülich ObservatorY for Cloud Evolution

- Scanning 35 GHz cloud radar MIRA[1]
- Scanning 14 channel microwave radiometer[2] with IR pyrometer[3]
- Scanning Doppler wind lidar[4]
- Atm. emitted radiance interferometer[5]
- Total Sky Imager TSI[6]
- Laser ceilometer CT25K[7]
- Micro Rain Radar[8], sodar[9]
- Max-DOAS[10]
- Radiation sensors[11]
- 120 m meteorological mast[12] including eddy covariance station

Next May-June first field camapign

ADMIRARI will also be operated at Juelich

Main Observation Strategy for Active-Passive Sensors at JOYCE

Foreseen observations:
RHI at the same Azimuth,
With time resolution of 5 min.

X-band dual-pol

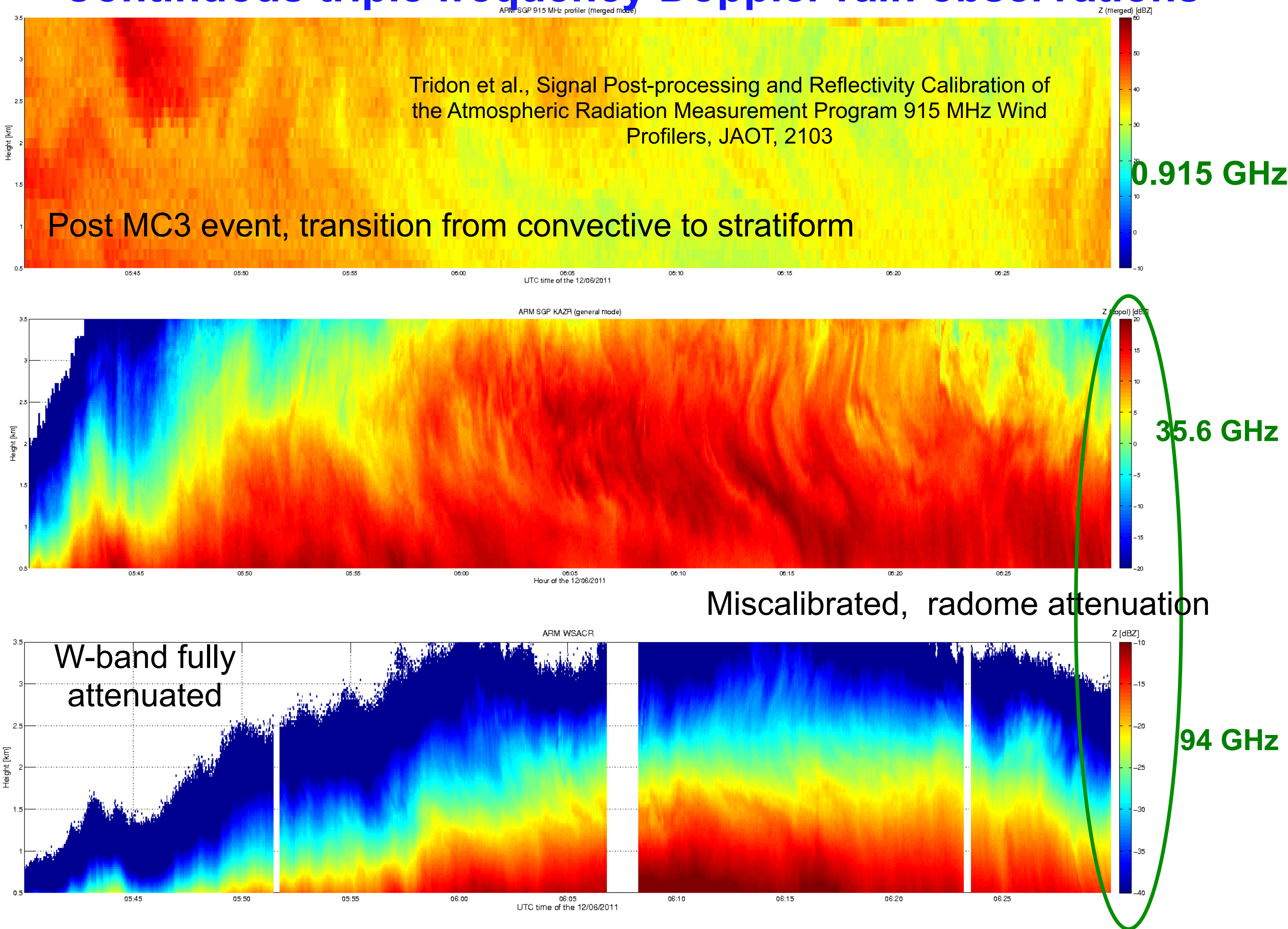
MIRA, Ka cloud RADAR

3 meters

ADMIRARI

~ 4 km

Continuous triple frequency Doppler rain observations



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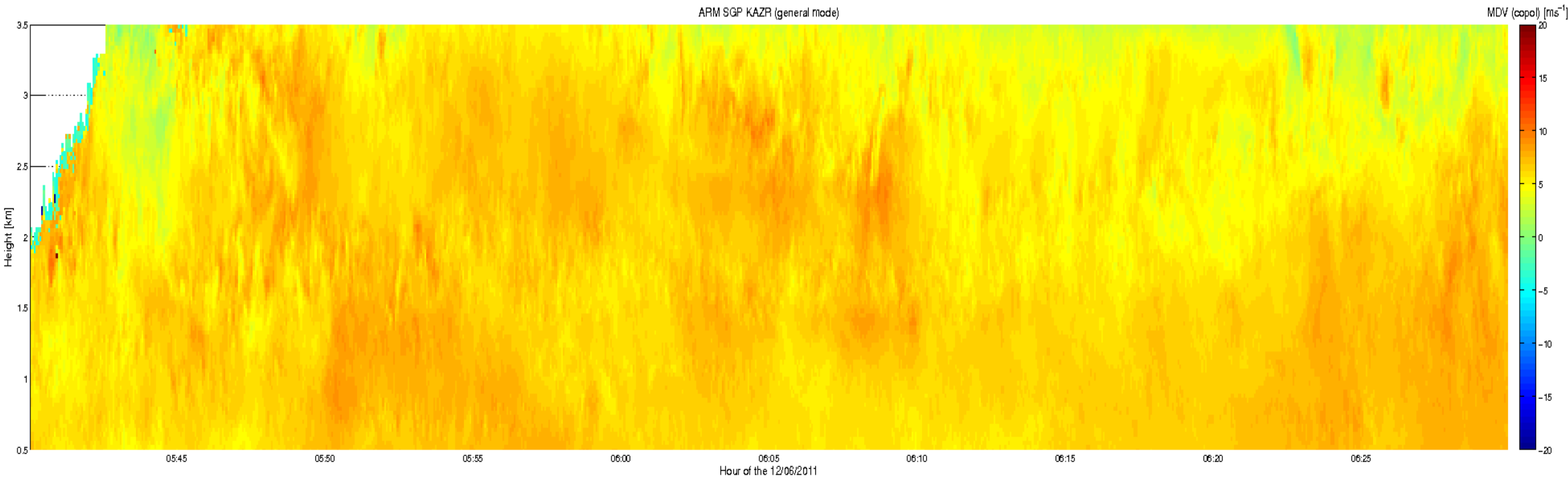

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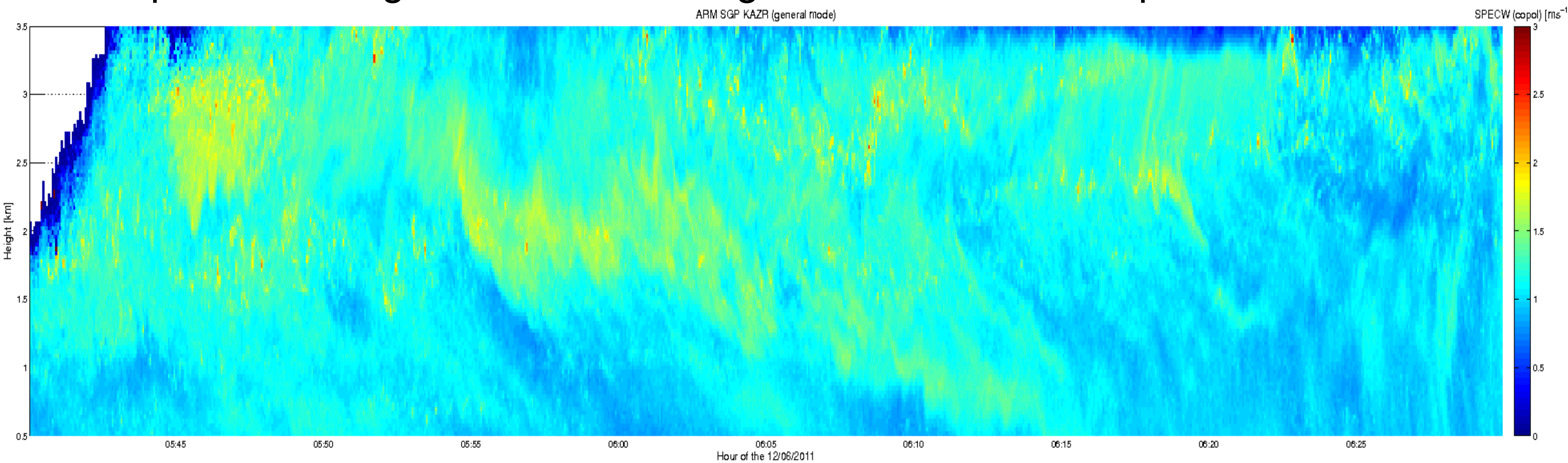

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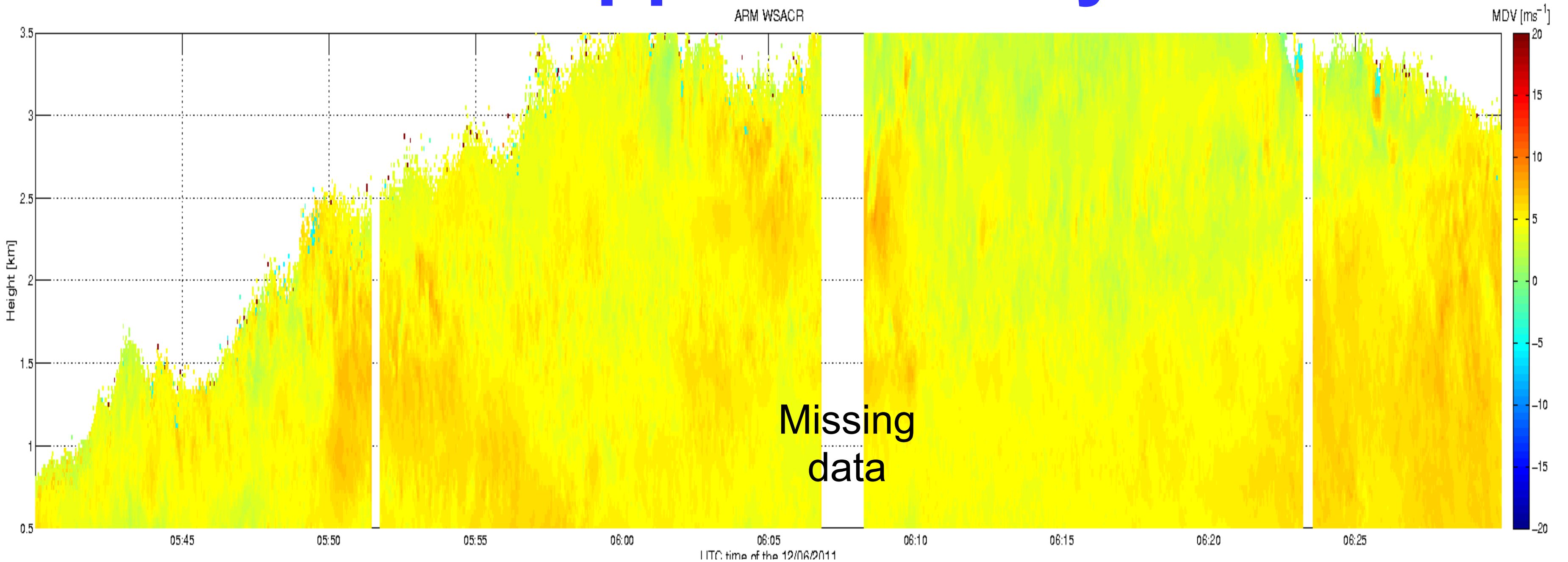

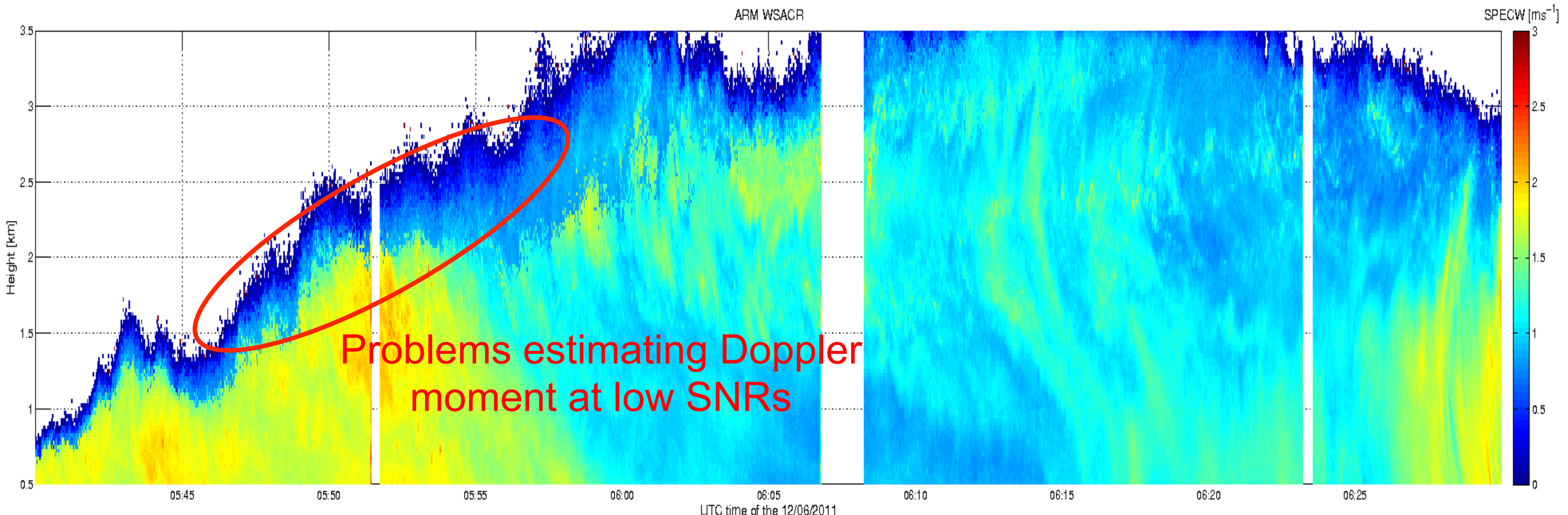

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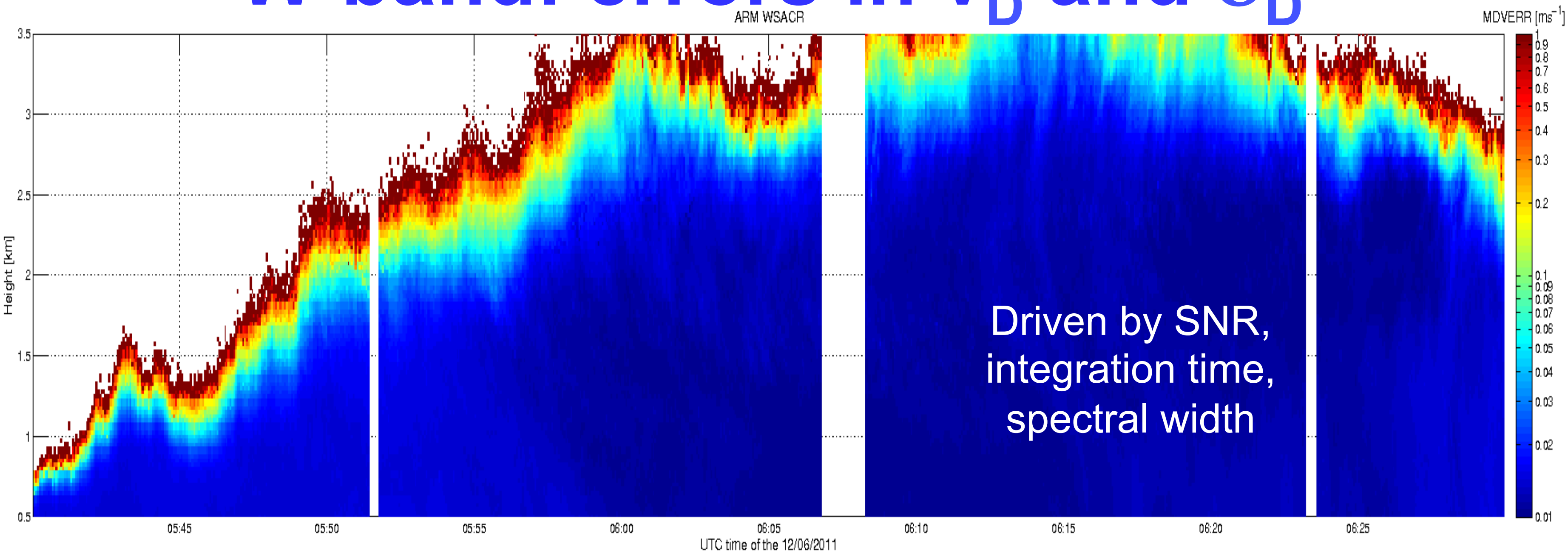
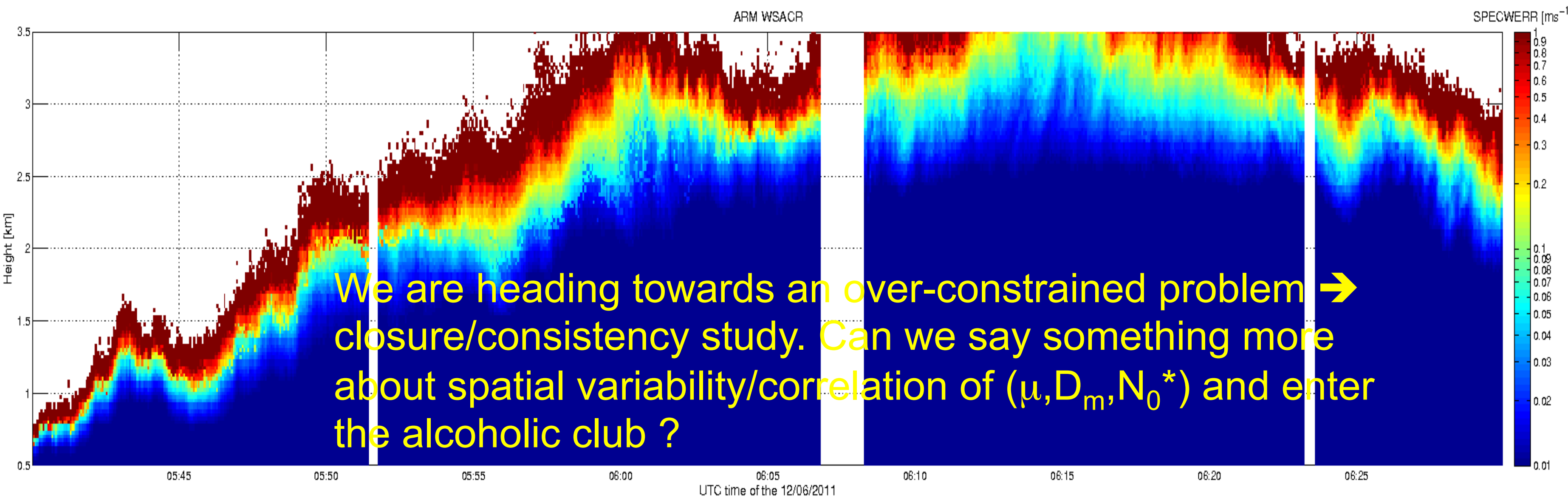


Driven by SNR, integration time, spectral width



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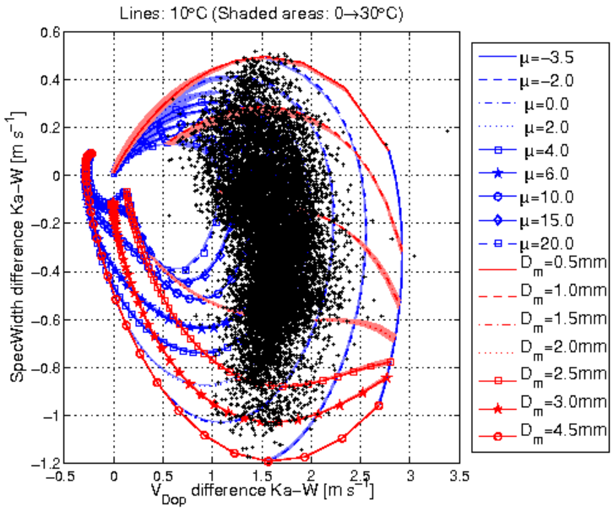

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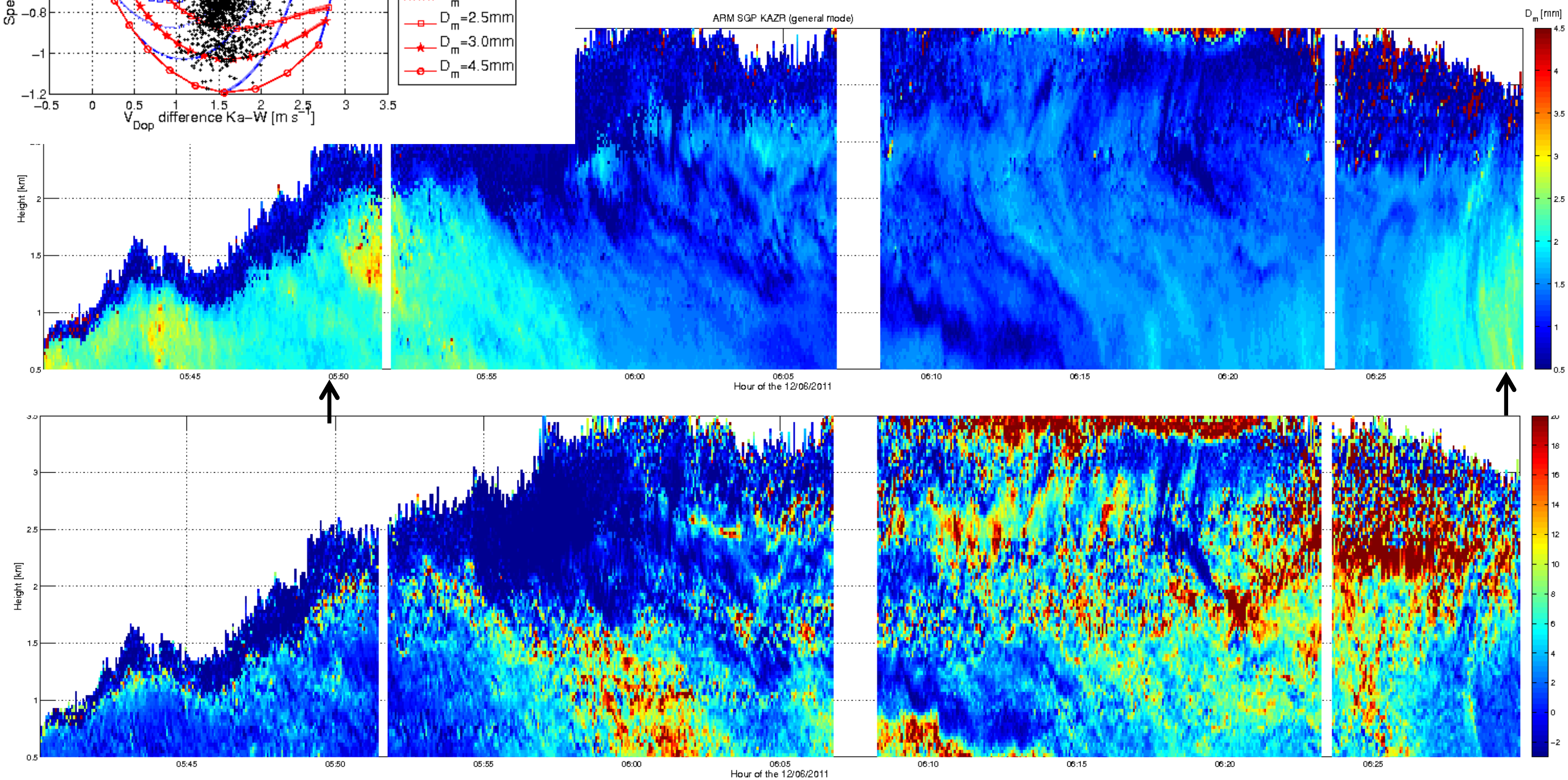

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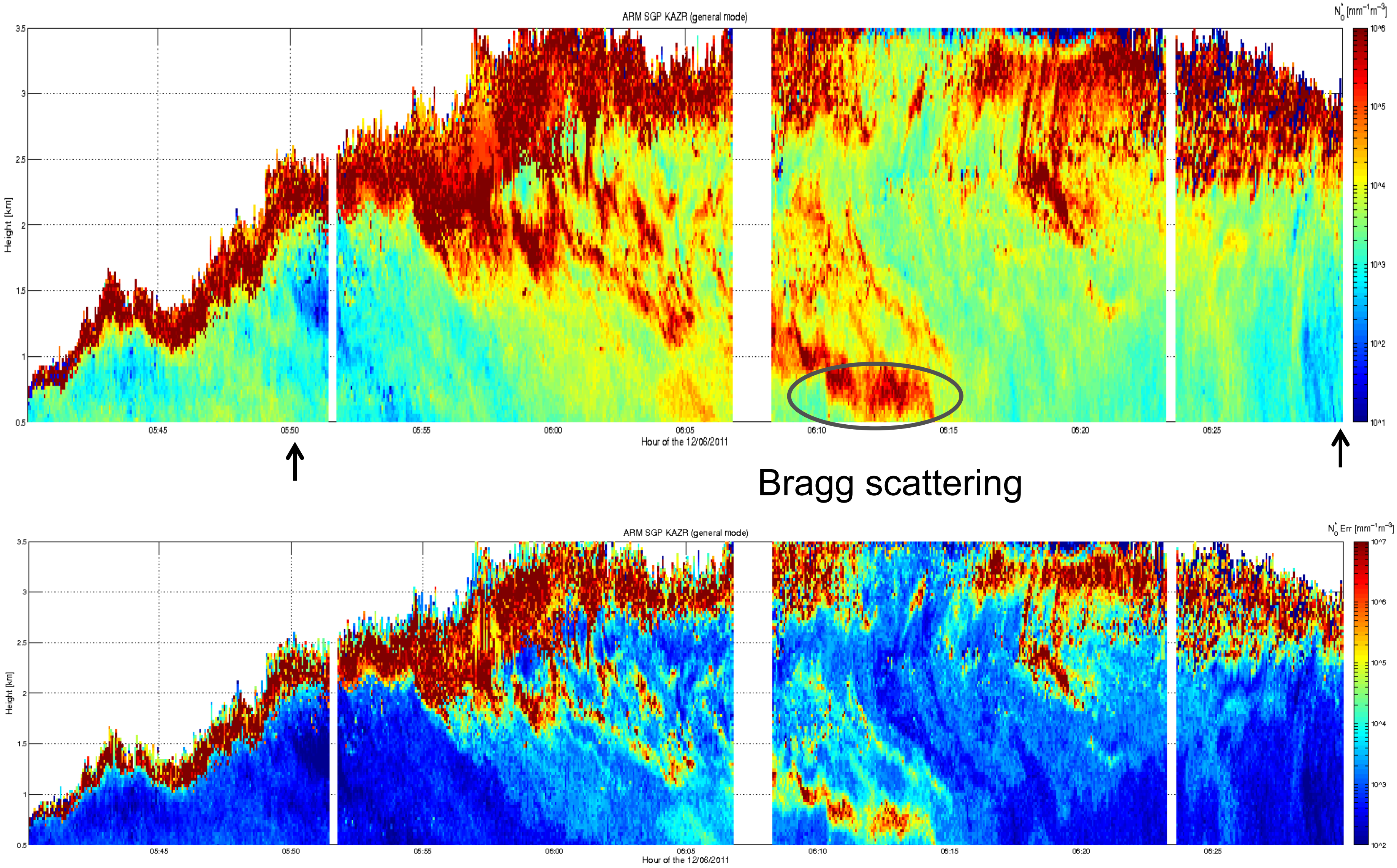

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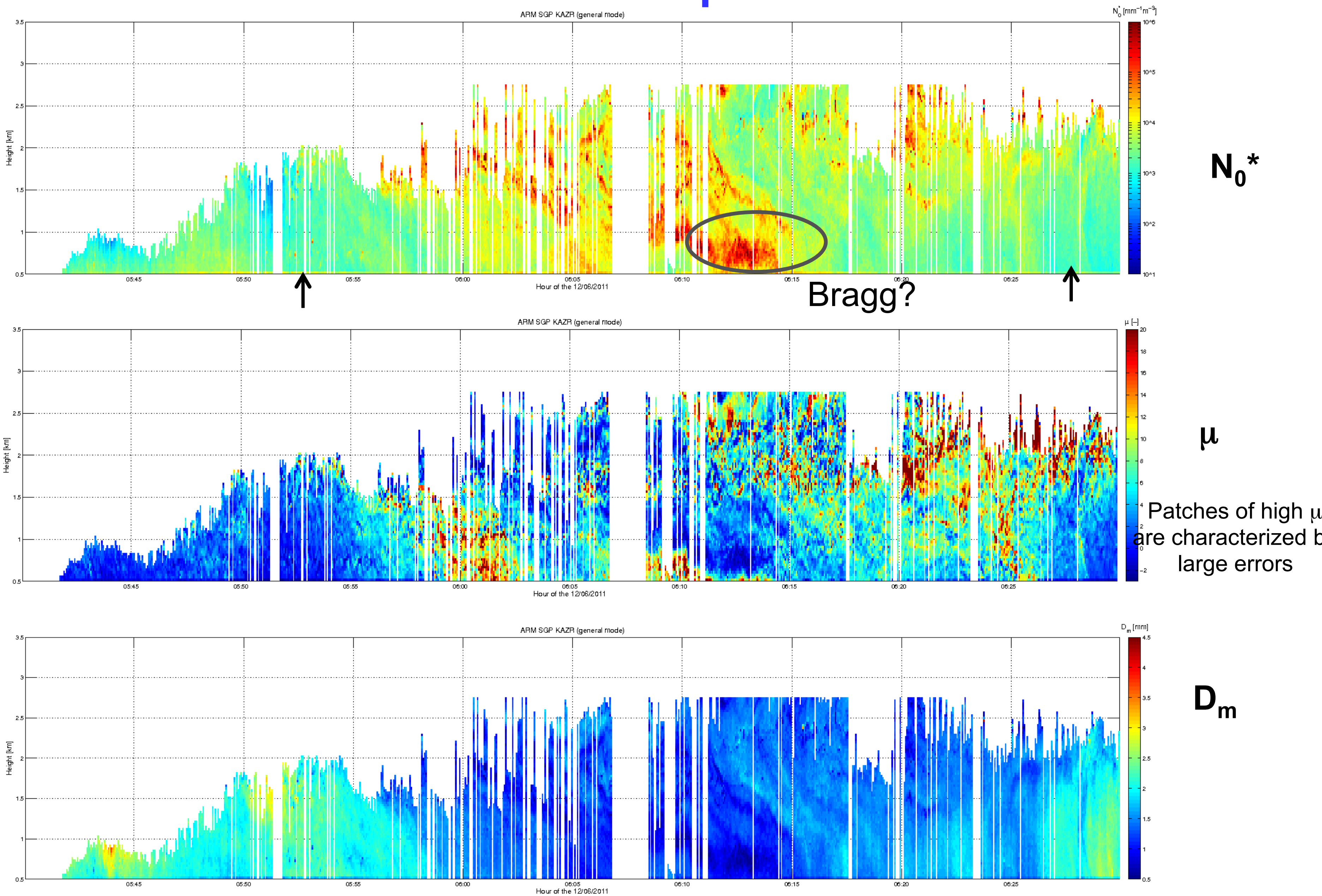

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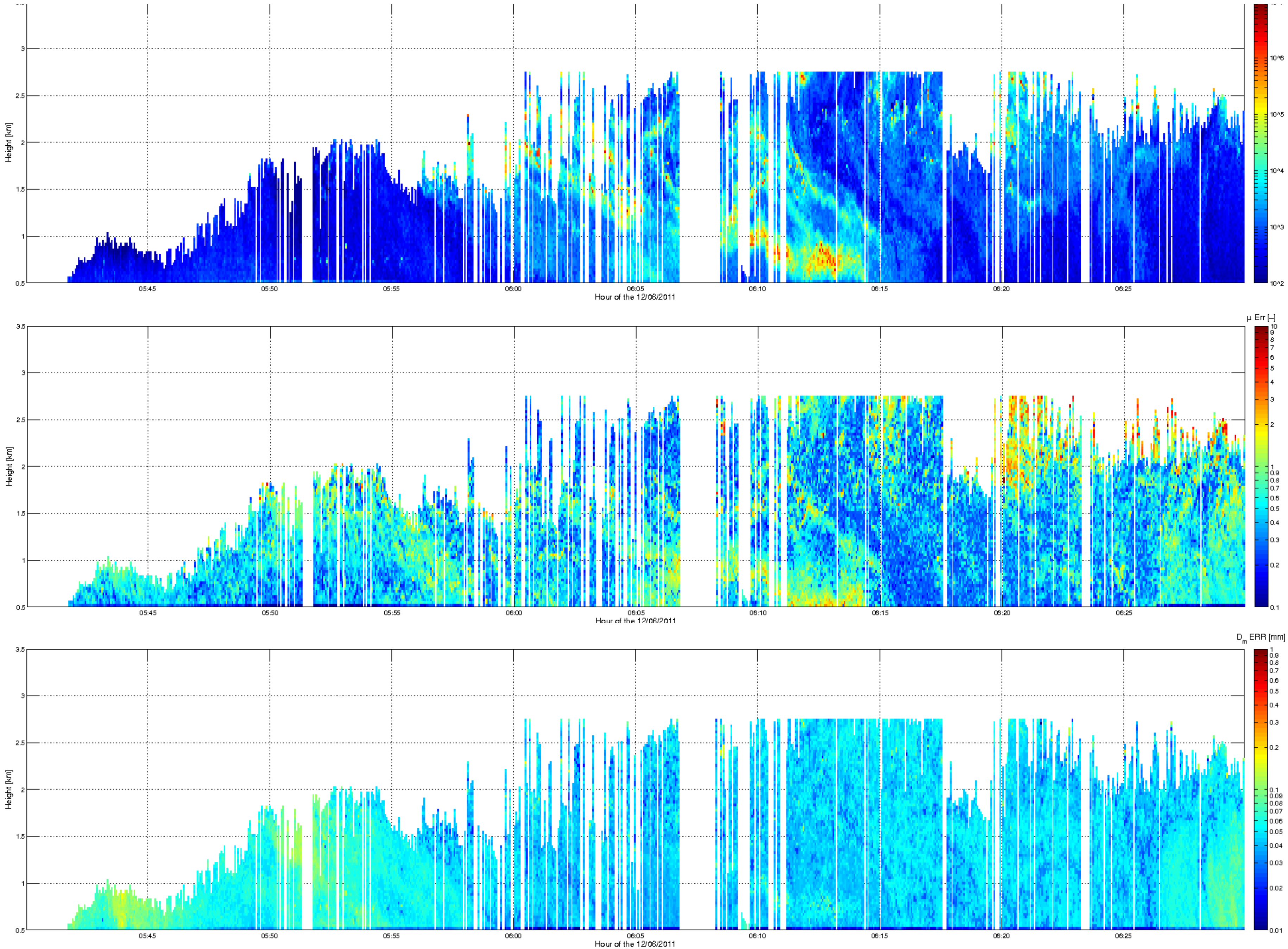

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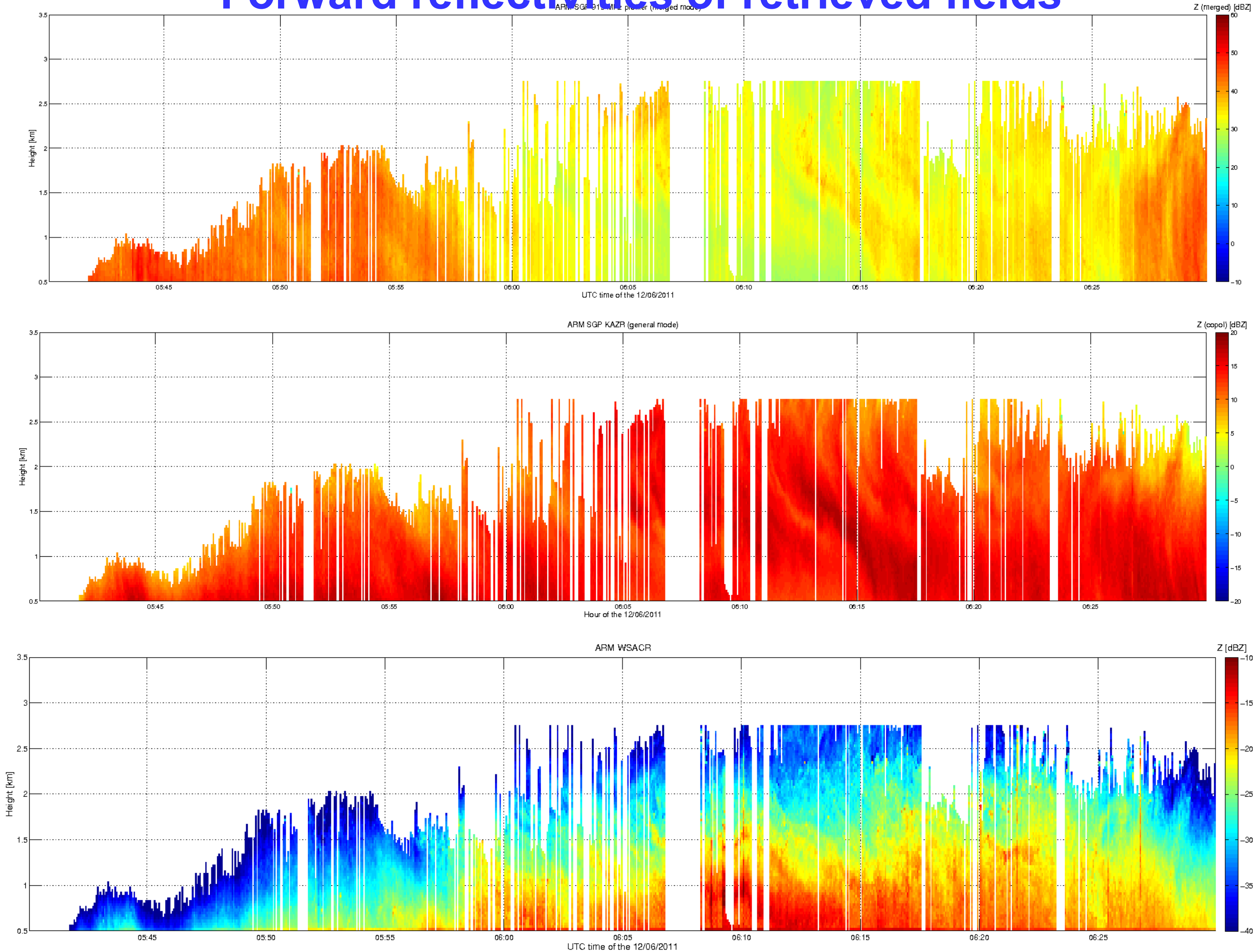

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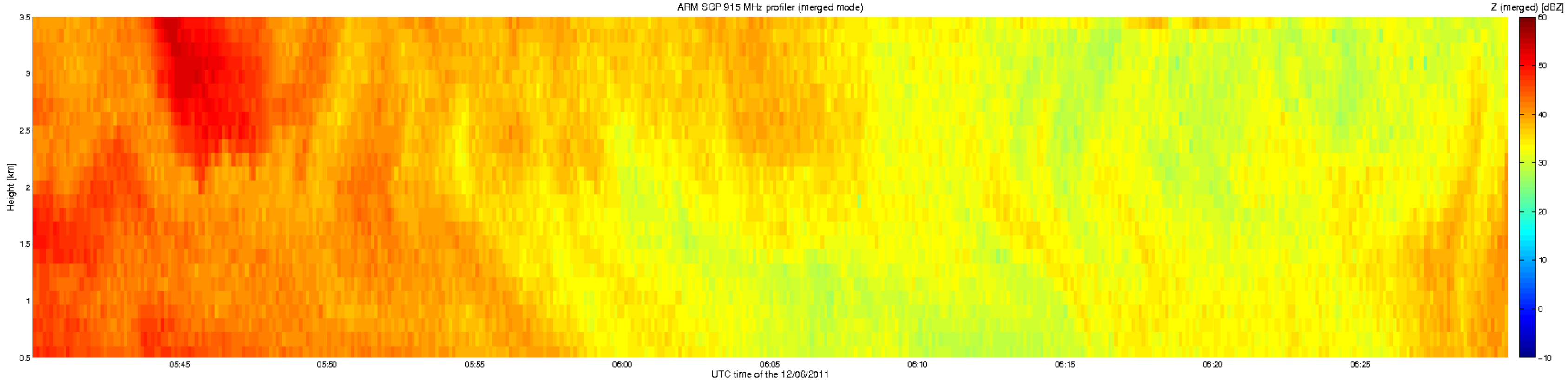
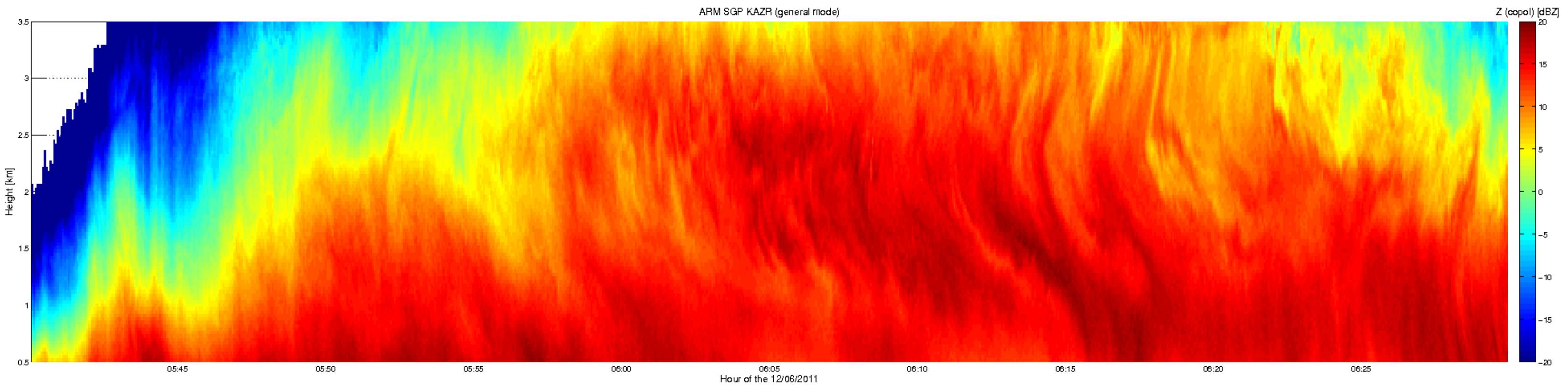
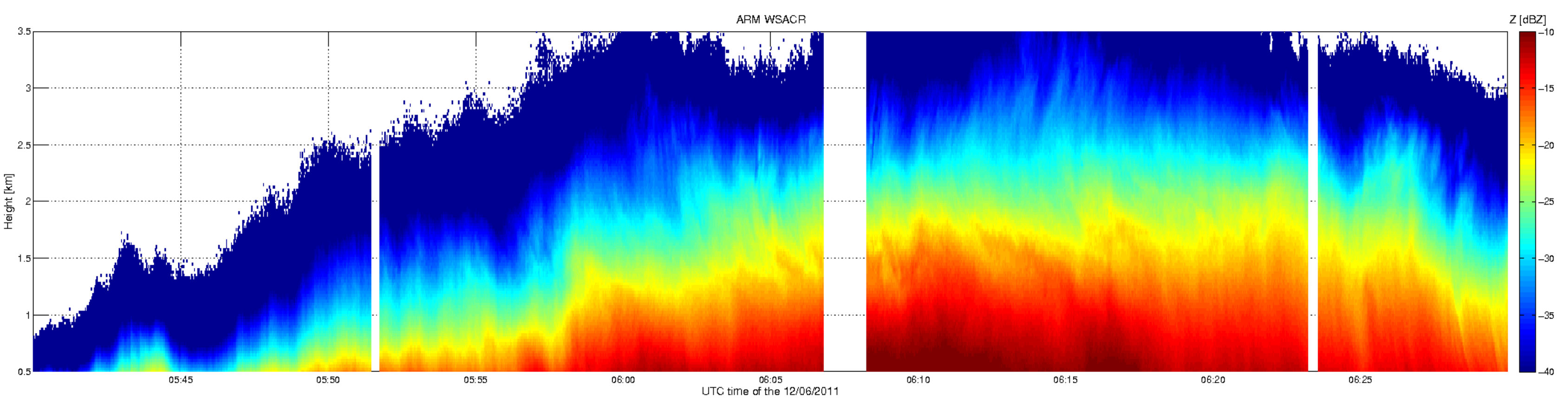


1 GHz



35.6 GHz



94 GHz