Airborne Studies of High Wind and Rain Effects Using IWRAP

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OVWST Meeting

July 5-7, 2006

Salt Lake City, Utah

Outline

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Objectives: High Wind and Rain Effects

validate and refine space-based wind retrievals

- Effect of rain at Ku- and C-bands
- Prevalence and spatial variability of extreme winds
- Add to database of Ku- and C-band NRCS measurements

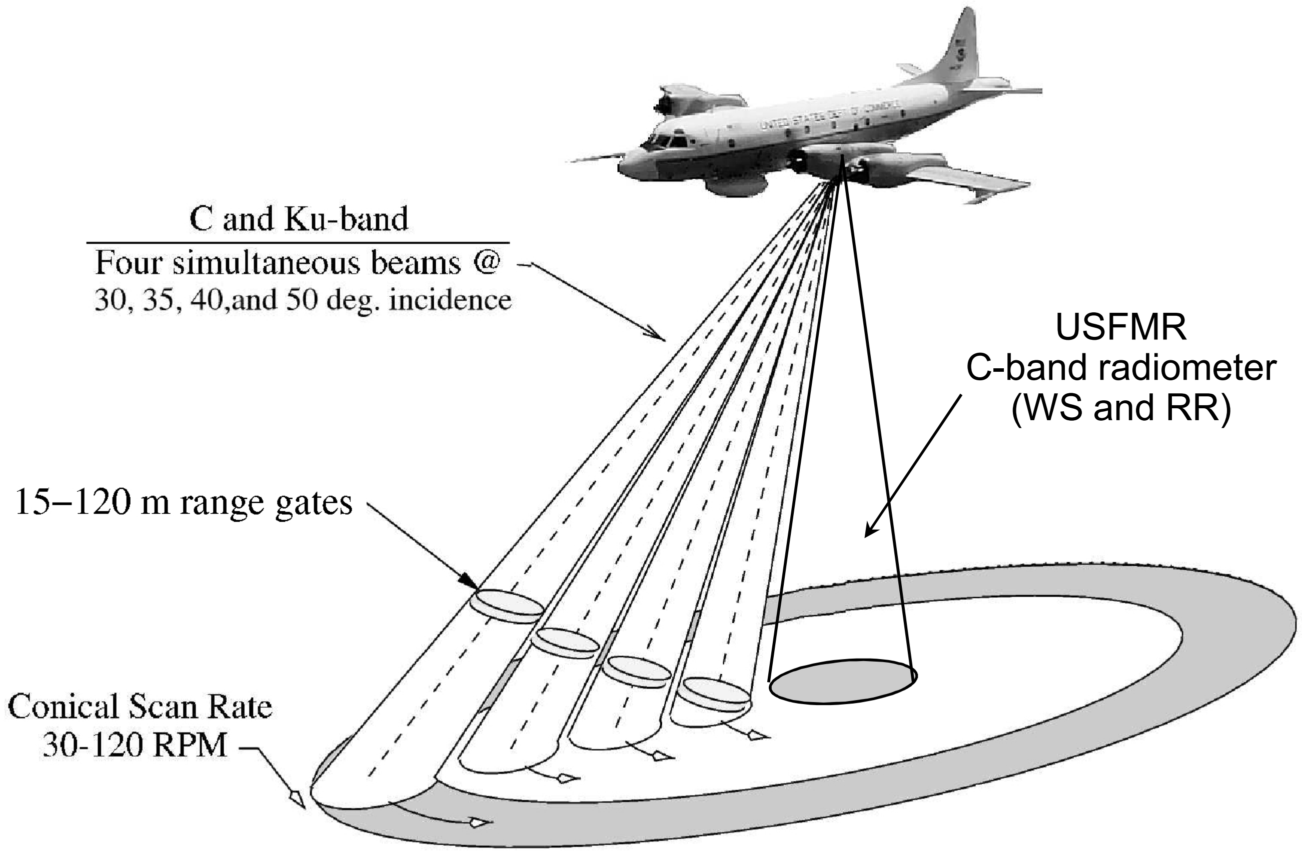
Relevant Science Questions

- During what conditions can the effect of rain be ignored or compensated for?
- How does C-band differ from Ku-band?
- Does rain masquerade as high/extreme winds?
- What is the effect of spatial variability of extreme winds?
- What is prevalence of extreme winds outside of hurricanes?

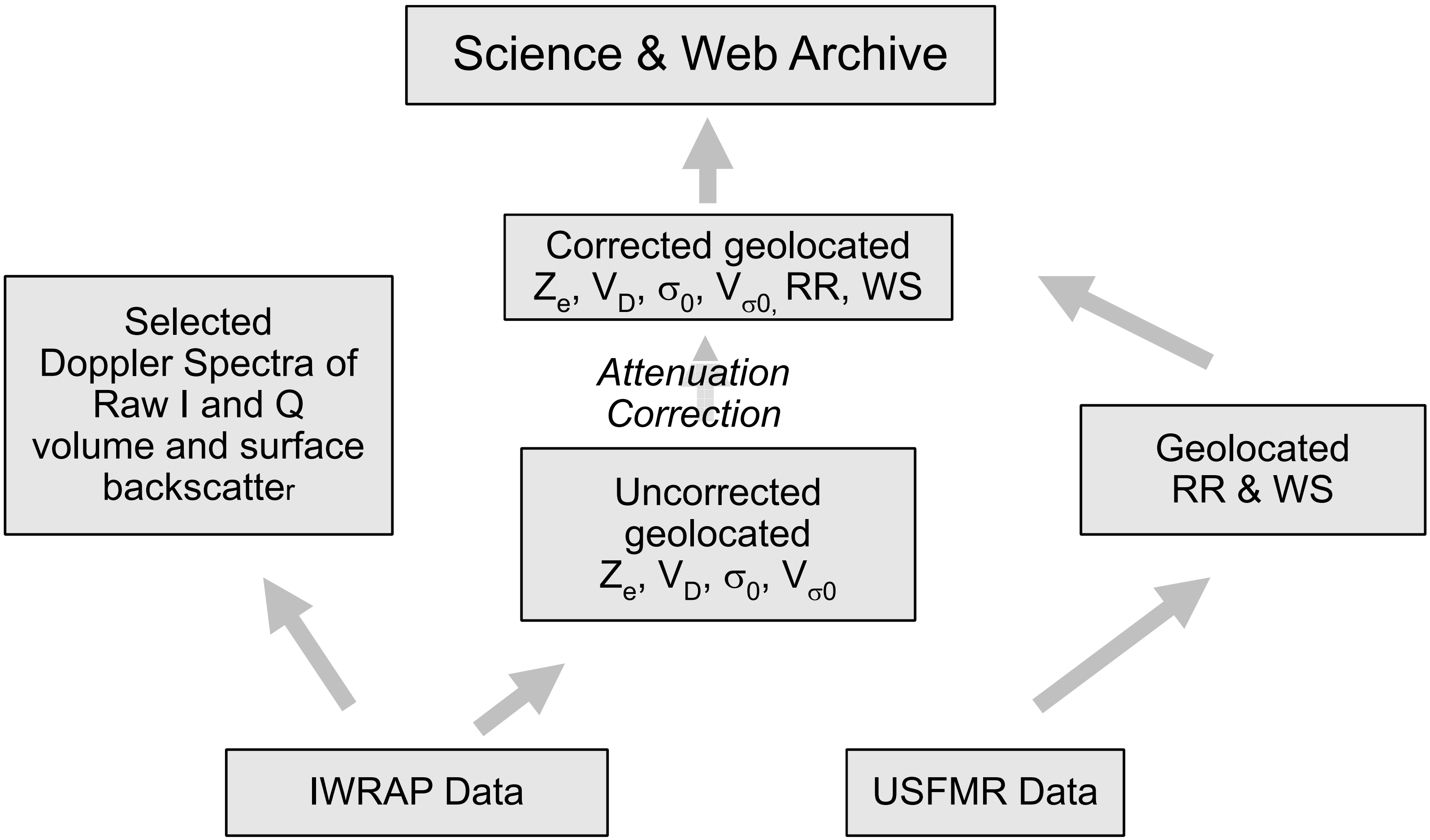
Methodology

- Airborne measurements using IWRAP and USFMR (next three years)
  - 2 hurricane seasons, 1 winter, involvement in International Polar Year
  - **Improvements**: increased Ku-band sensitivity, dual-polarization antenna, flights to address wind intensity and variabilities outside of TCs.
- Continuing analysis of past IWRAP and USFMR data:
  - 4 hurricane season (2002, 2003, 2004, 2005)
  - 3 winter experiments at midlatitudes (2003, 2005, 2006)

Imaging Wind and Rain Airborne Profiler (IWRAP)



Processing & Analysis



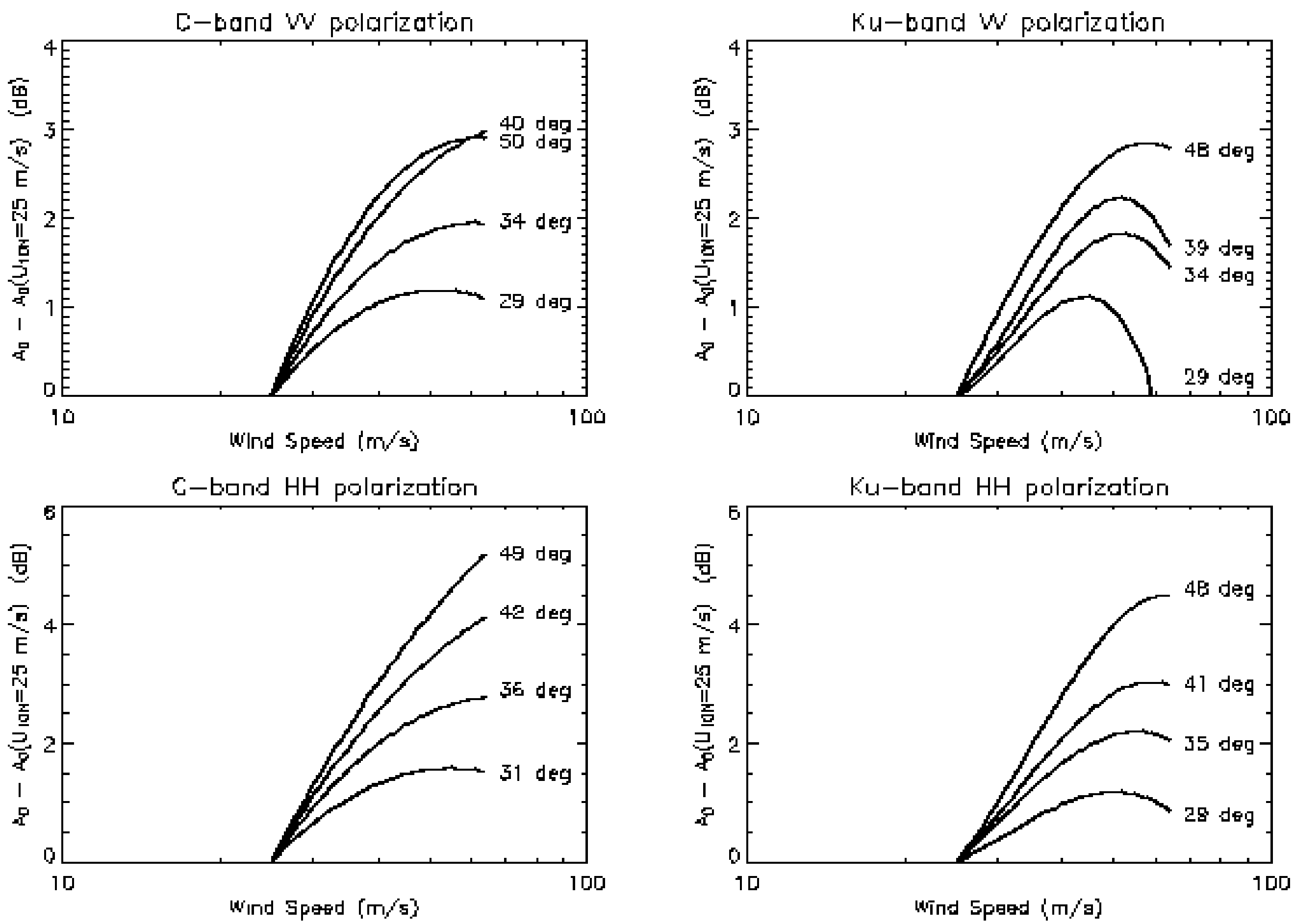
Analysis: Rain Effects

1) Ku- and C-band data will be ***attenuation-corrected*** using a dual-frequency technique (e.g. Mardiana et al., 2004) and binned in 1 km along track bins.
2) The first three harmonics, A0, A1, and A2 will be fit to the data, wind vectors will be estimated and the direction will be compared surface direction estimated from flight level winds.
3) The data will be stratified based on USFMR wind speed and rain rate.
4) 1-3 will be carried out for NRCS not corrected for attenuation and compared which quantifies the effect of attenuation.
5) 1-3 will be carried out for beam-integrated NRCS which is analogous to QuikSCAT NRCS. This will be compared to 1 & 4 which quantifies the effect of scattering and attenuation.

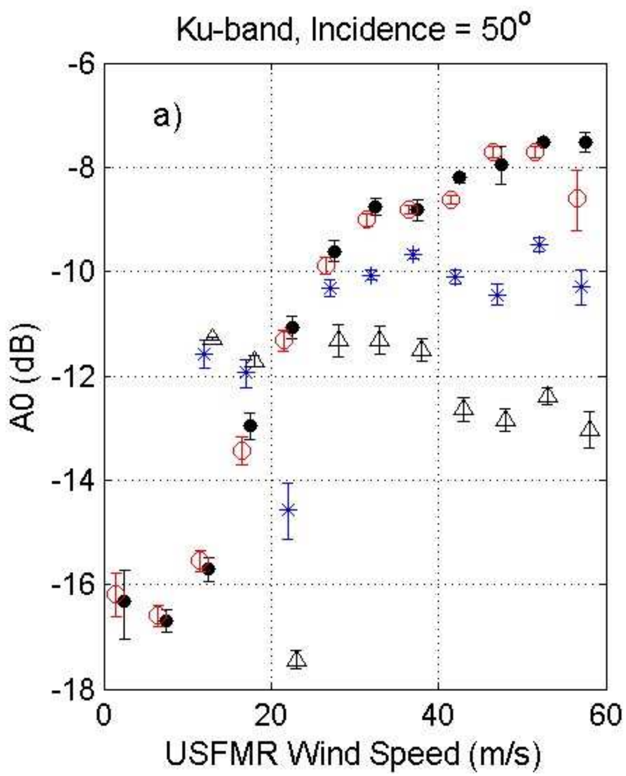
Analysis: High Winds

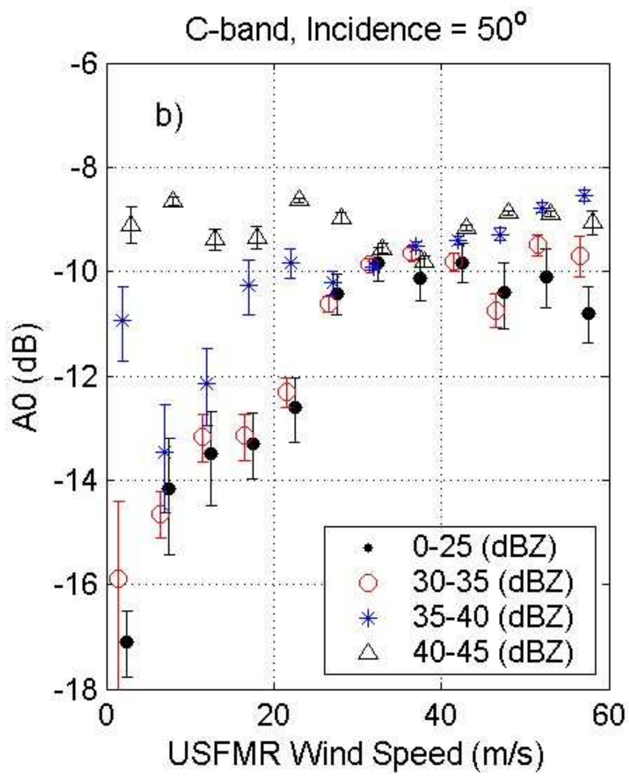
1) During rain-free conditions, periods and locations of extreme wind conditions will be identified using USFMR. Spatial variability will be quantified.
2) In the absence of rain, NRCS measurements will be binned over the width of IWRAP's swath for successively larger along track distances.
3) Wind vectors will be calculated for these varying bins and they will be compared for the same total area.
4) During rain 1-3 will be carried out for attenuation-corrected and beam-integrated NRCS measurements. In addition rain variability will also be quantified.

Prior High Wind Results

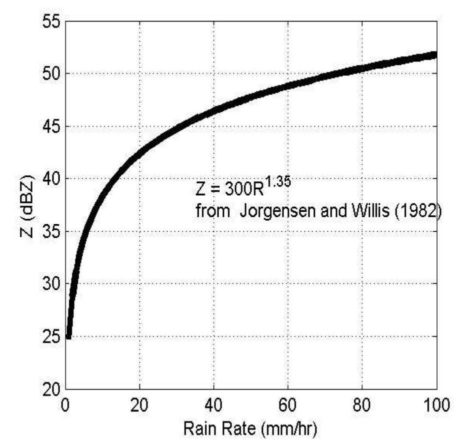


Rain Effect Results





Z measured at
z ~ 1.2 km



Anticipated Results

- Geolocated, attenuation-corrected vector surface winds, as well as Z and Doppler velocities
- The effect of rain on Ku- and C-band scatterometry
- The prevalence of extreme winds outside hurricanes.

Timeline

- Year 1:
  - Perform instrument upgrades increasing Ku-band sensitivity
  - Install and deploy:
    - hurricane season 2006
    - midlatitude flights 2007
  - Process raw hurricane 2005 and winter 2006 data
  - Data Archive
  - Development of new data acquisition system in preparation for hurricane season 2007

Year 1: IWRAP Ku-Band system upgrade:

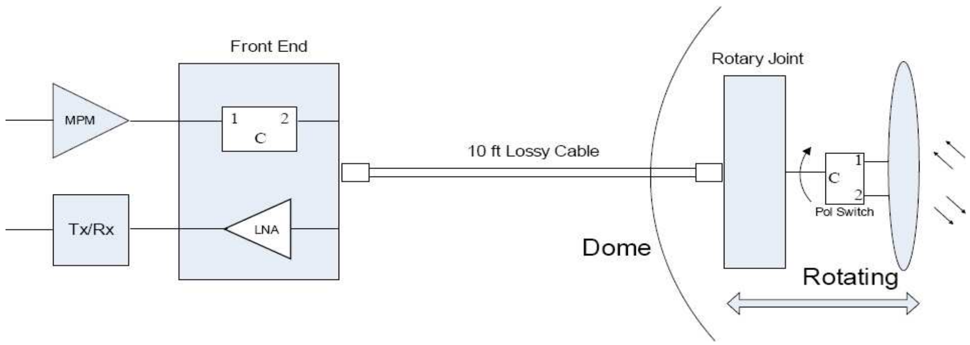


Fig.1: Front-End setup (Before)

Parameters	Before	After
Vendor	Miteq	Miteq
Gain [dB]	48.0	49.4
Pout 1dB [dBm]	22.25	13.5
Noise Figure [dB]	4.08	1.14

Table 1: LNA comparison

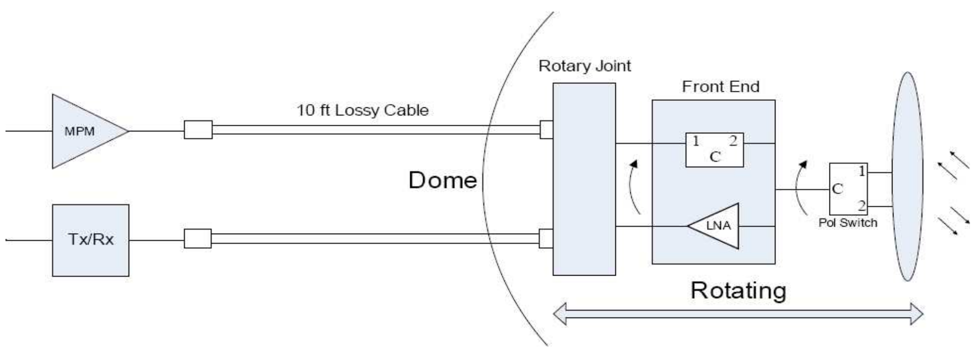


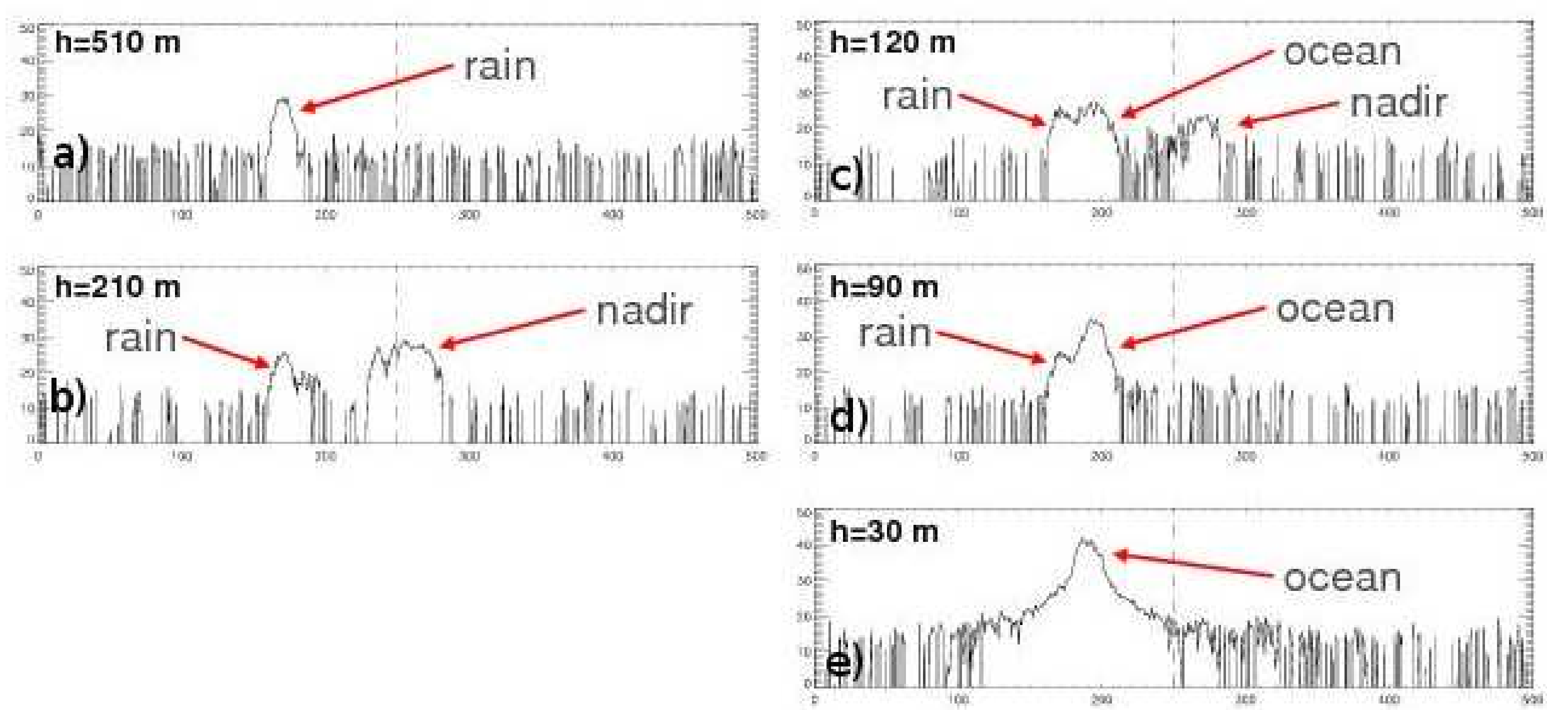
Fig. 2: Front-End setup (after)

Parameters	Before	After
Vendor	Ball	MicroAnt
Frequency [GHz]	13.6+/- 0.680	13.24, 13.6
Gain [dB]	24	32, 29
Cross Pol Isolation [dB]	-15	-25
Side Lobe Level [dB]	-18	-25
Scan angle [deg]	20 to 50	20, 40
Polarization	H and V	H and V

Table 2: Antenna Comparison

Future: Raw Data & Spectral Processing

Profile of spectra measured and processed by NOAA/NESDIS



Future: Raw Data & Spectral Processing

- Analysis of raw data collected by NOAA/NESDIS. The obstacle is it is Terabytes of data.
- Algorithm development for real-time radar processing of multimodal spectra.
- Implementation of algorithm in FPGA or in processing code for next generation IWRAP DAQ

Year 1: Archive