The Jason Rain-Flag Revisited

John Lillibridge - NOAA Laboratory for Satellite Altimetry
Jean Tournadre - IFREMER

Instrument Processing: Corrections
01-NOV-2016 @ 14:45

Jason Rain Flag Background

- Rain flag algorithm dates back to Topex:

  Tournadre J. and J.C. Morland, 1997: *The effect of rain on TOPEX/POSEIDON altimeter data: A new rain flag on Ku- and C-band backscatter coefficients*. IEEE Geo. Remote Sens., 35, 1117-1135.

- Algorithm steps:
  - Initialization:

    Set rain flag if rad_surf_type > 0 (non-ocean) OR bad σ^0_{ku} quality
  - Computation:

    IF

    Attenuation of σ^0_{ku} relative to σ^0_c > threshold

    AND

    Cloud_Liquid_Water (CLW) > 0.2 kg/m^2

    THEN

    Set rain flag

Preliminary Rain Flag Issues for Jason-3

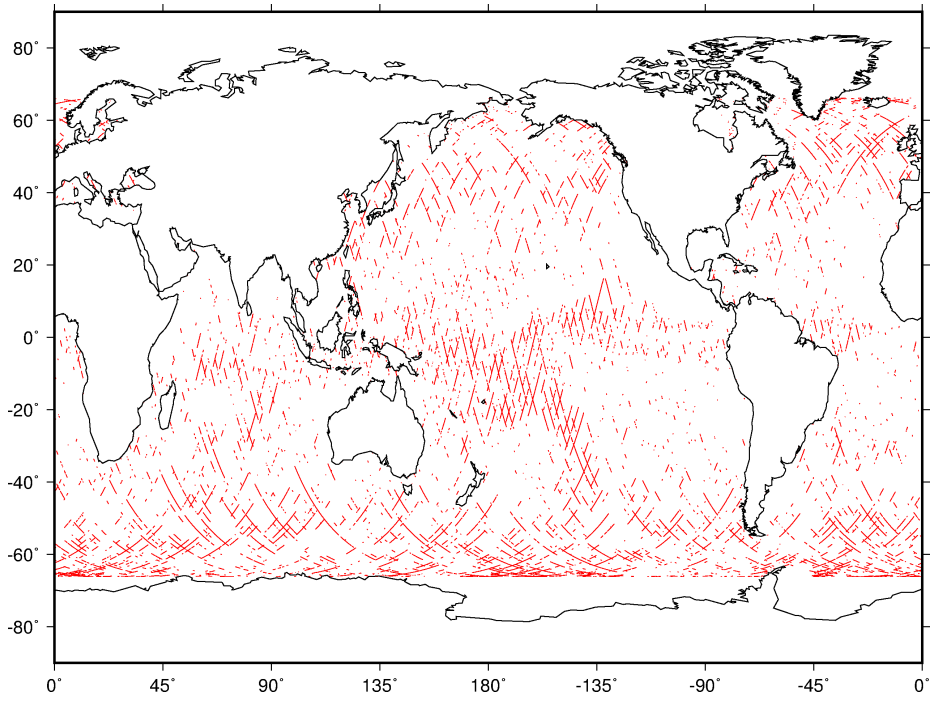
1. Rain flag seemed to be based only on CLW?

2. There are biases between expected values from lookup table (LUT) vs. measured values of σ^0

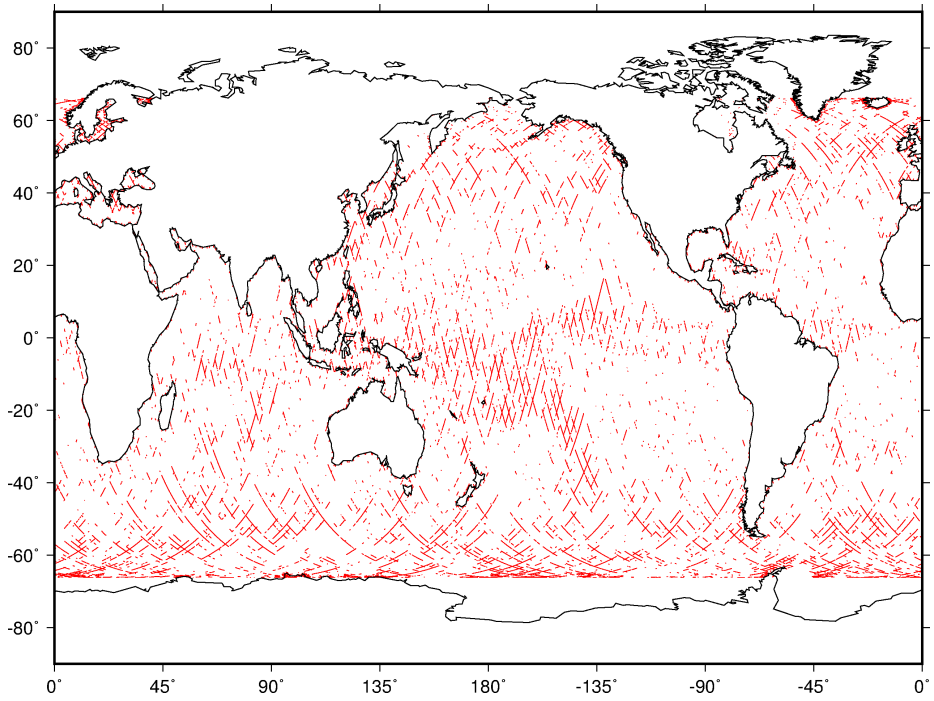
3. The rain flag is set when rad_surf_type > 0 (coastal zones) & qual_alt_1hz_ku > 0

Rain Flag Issue #1 - No Attenuation check?

Jason-3 OGDRs: 2016/02/12-22



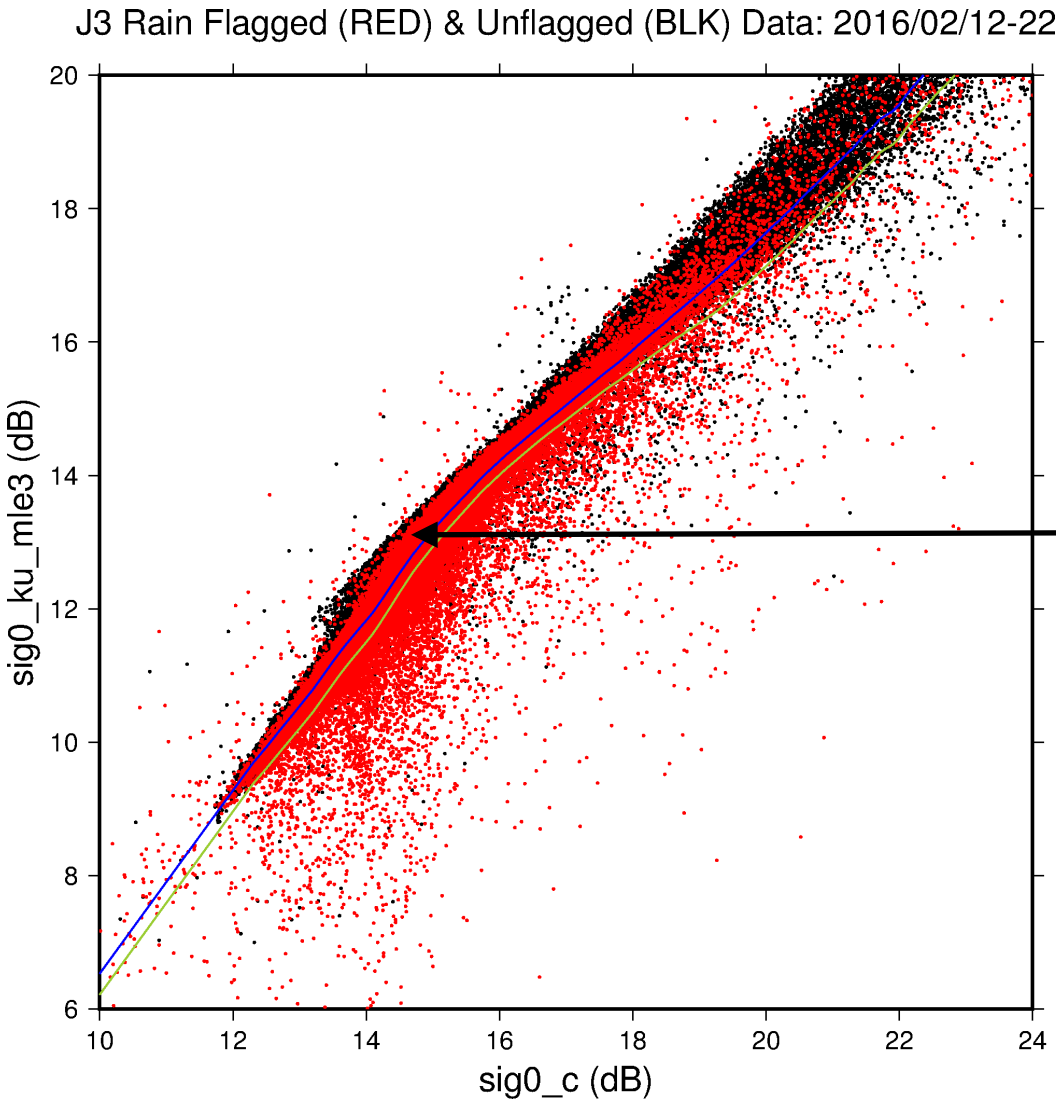
CLW > 0.2 kg/m^2



Preliminary Rain Flag

Current Altimeter Rain Flag appears to be based solely on Cloud Liquid Water

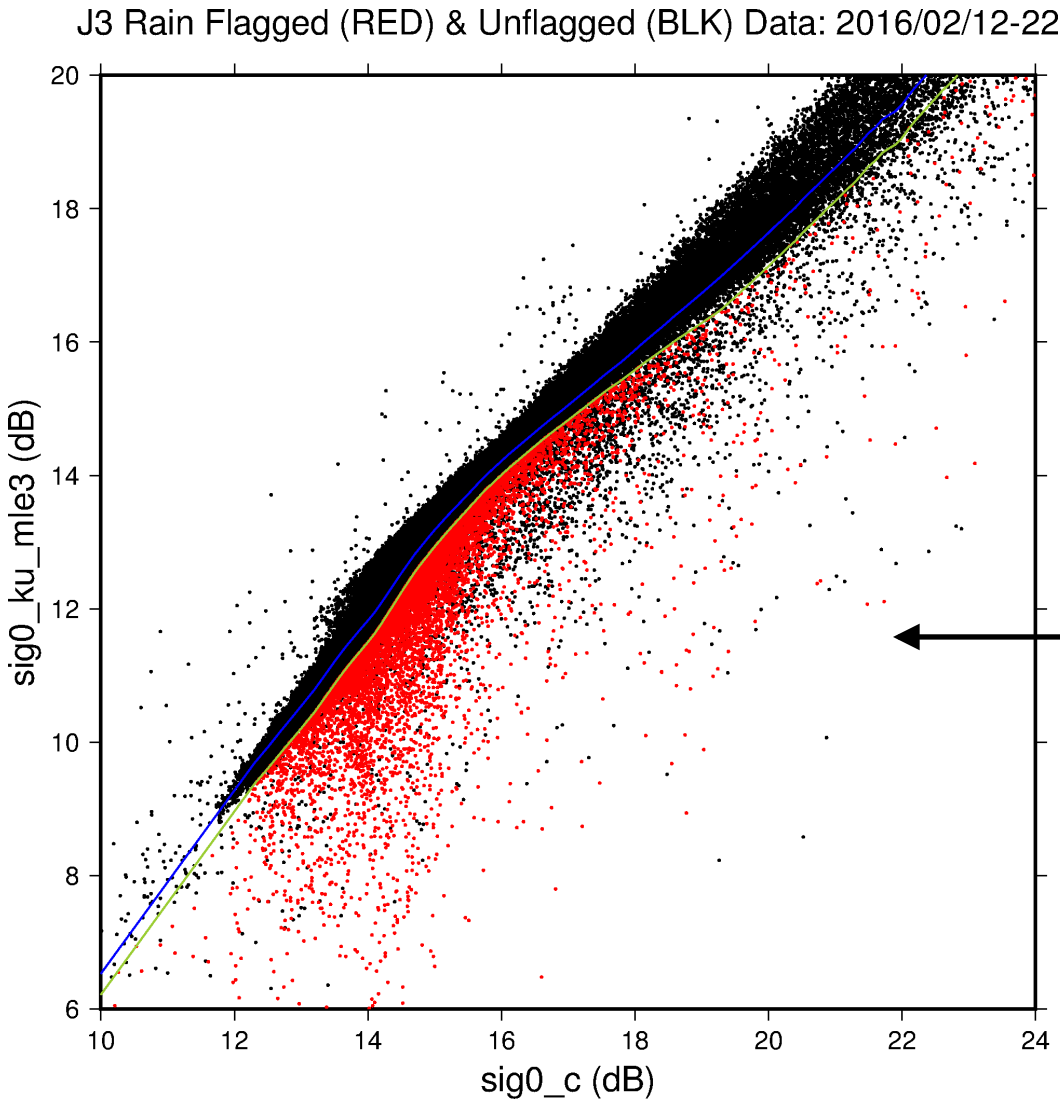
Rain Flag Issue #1 – Preliminary Rain Flag



Black Dots:	Rain Flag = 0
Red Dots:	Rain Flag = 1
Blue Line:	Mean-$\sigma^0_{Ku}(\sigma^0_C)$
Green Line:	Attenuation Cutoff

Flagged points above green line indicate that attenuation criteria is NOT being honored.

Rain Flag Issue #1 – Corrected Rain Flag

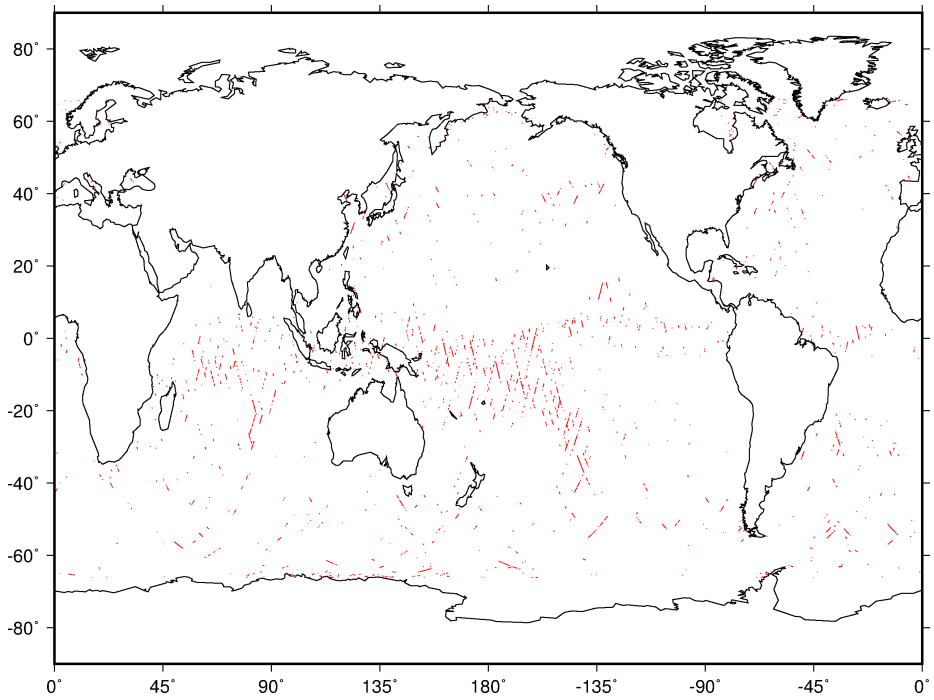


Black Dots:	Rain Flag = 0
Red Dots:	Rain Flag = 1
Blue Line:	Mean-$\sigma^0_{Ku}(\sigma^0_C)$
Green Line:	Attenuation Cutoff

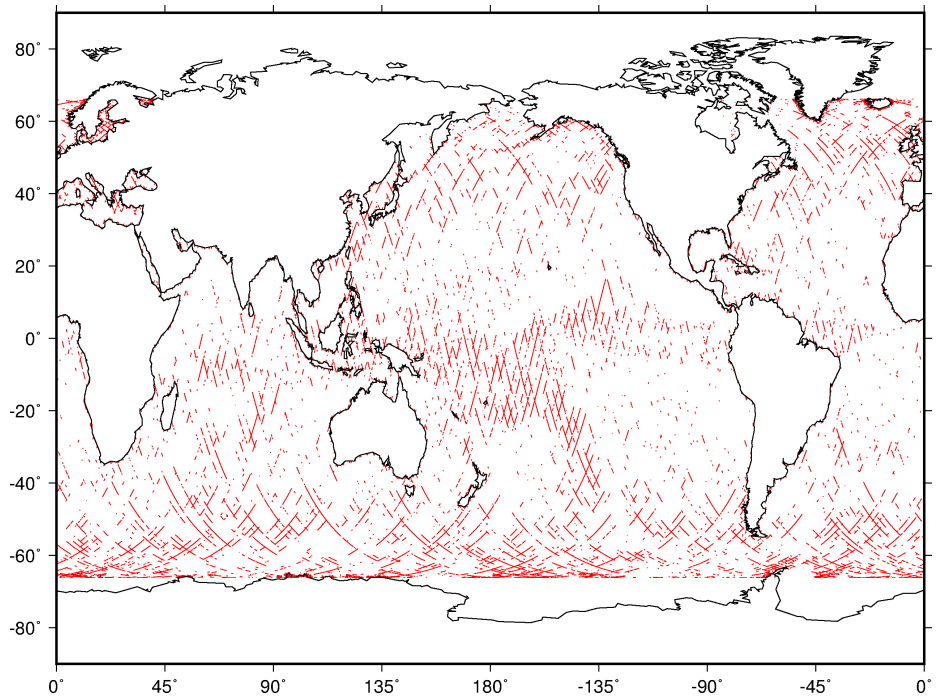
Unflagged (black) points where CLW < 0.2 kg/m^2 even though attenuation is below threshold.

Rain Flag Issue #1 - Attenuation

Jason-3 OGDRs: 2016/02/12-22



Corrected Rain Flag



Preliminary Rain Flag

Corrected Rain Flag more reasonable & similar to Radiometer Rain Flag

Rain Flag Issue #2 – σ^0 Biases

1. $\sigma^0_{ku\_mle3}$ bias of -0.36 dB (J2 - J3)

2. σ^0_c & $\sigma^0_{ku\_mle3}$ biases between LUT & measurements

3. Radiometer attenuation correction <u>subtracted</u> from σ^0

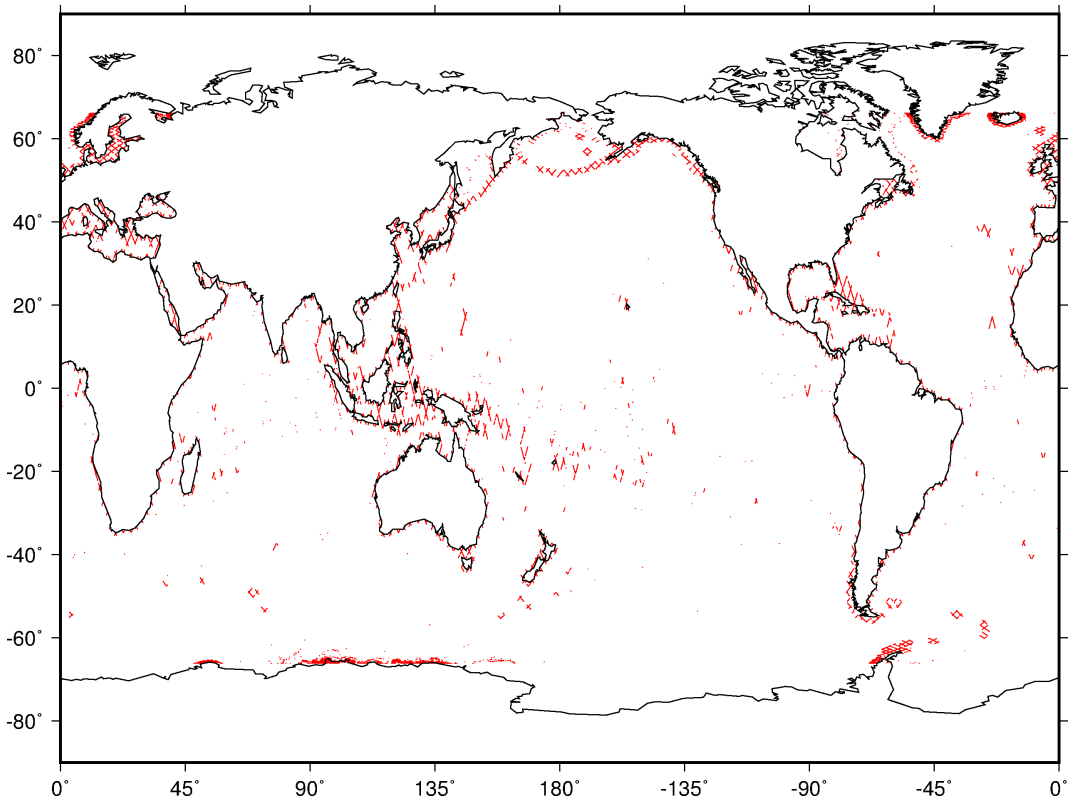
4. Previous plots had 0.6 dB <u>added</u> to J3 $\sigma^0_{ku\_mle3}$

Rain Flag Issue #3 – Coastal Rain Flagging

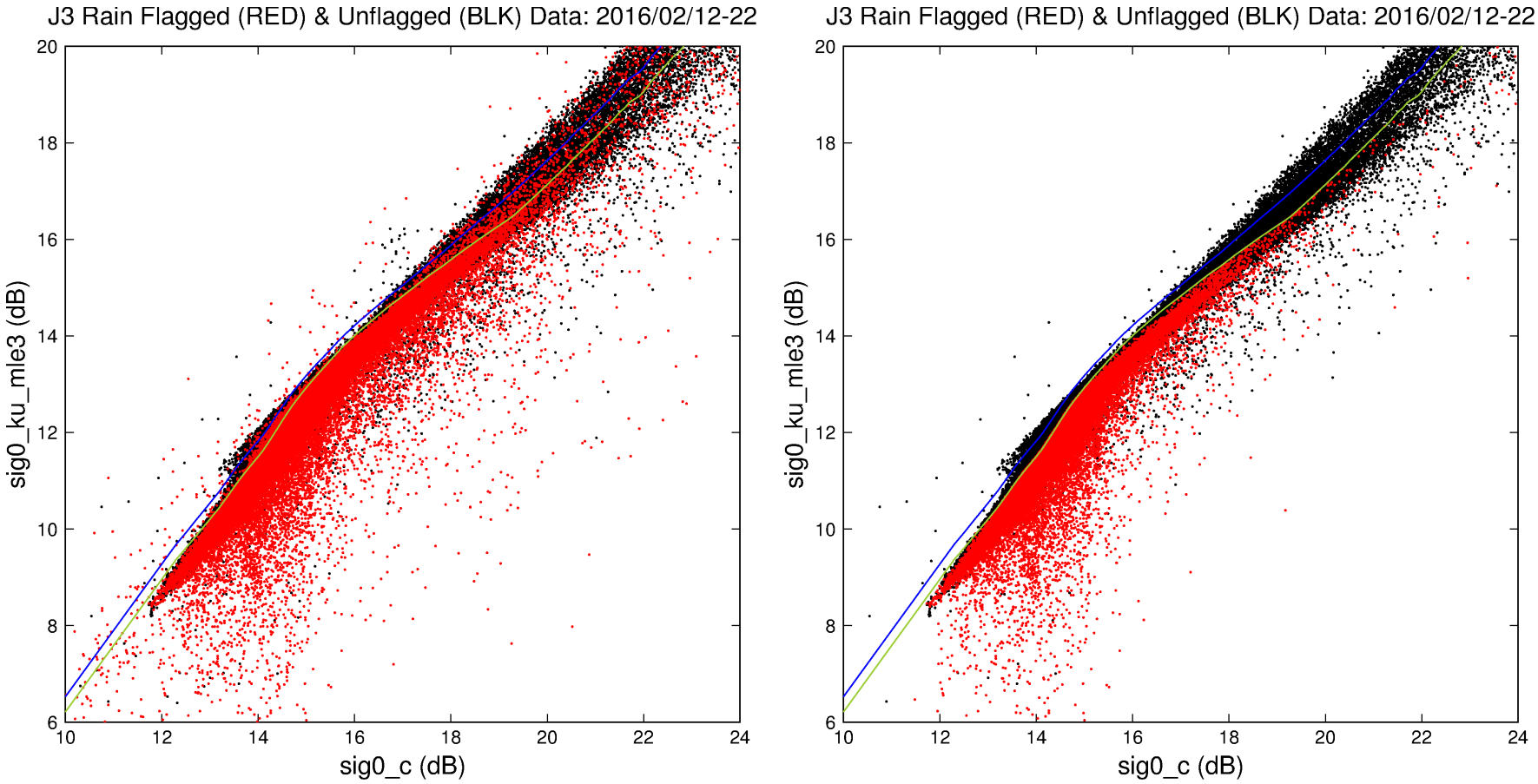
Algorithm initialization flags coastal areas:

IF {
Flag_Valid_σ^0_{Ku} is set to "valid"
AND
Qual_Interp_Rad_To_Alt is NOT set to "fail"
AND
Rad_Surface_Type = 0 ("ocean") }
THEN
The rain flag is initialized to 0 = "no rain"
ELSE
The rain flag is initialized to 1 = "rain"

Jason-3 OGDRs: Rad_Surface_Type > 0

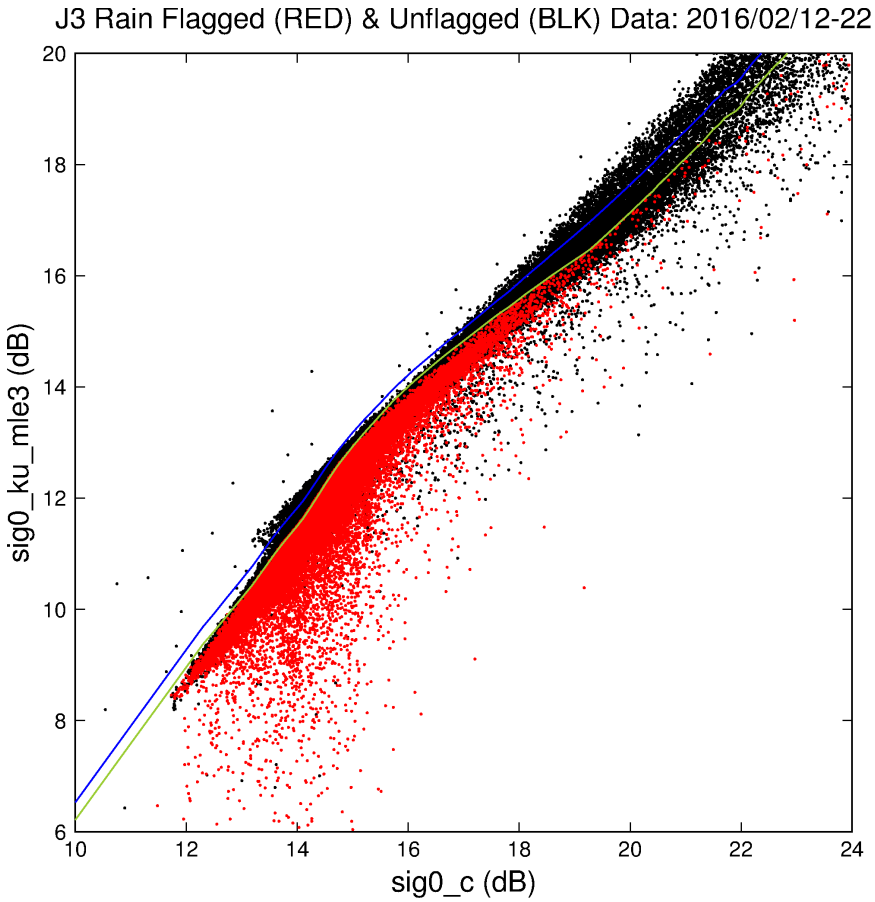


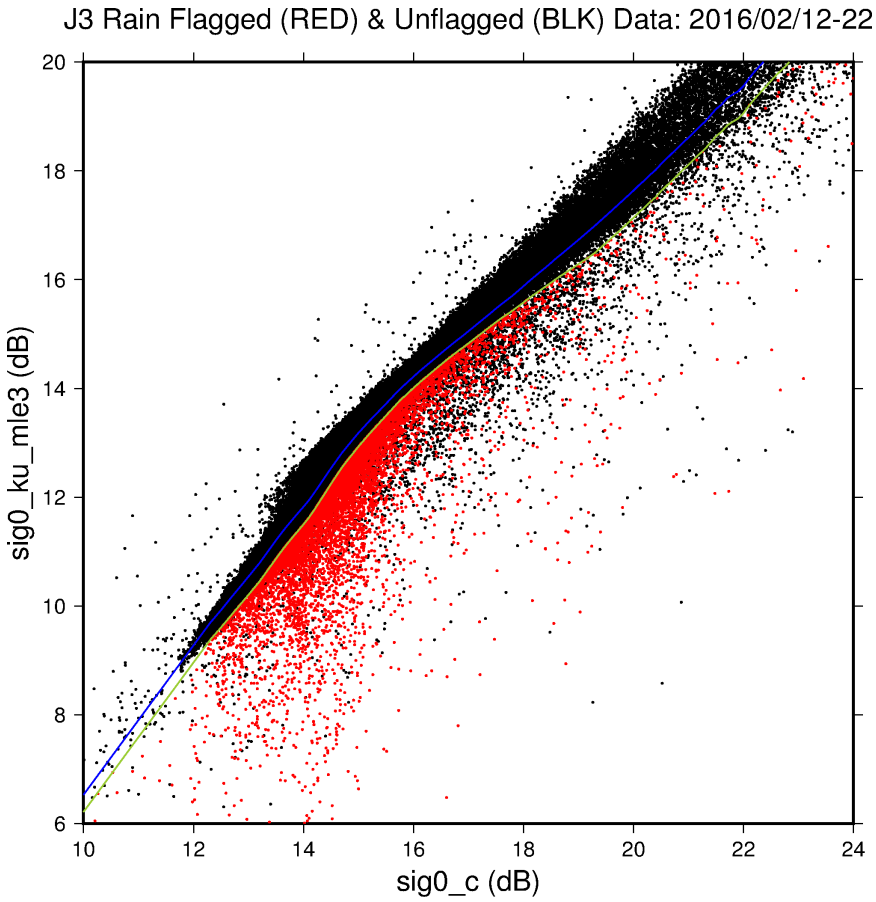
Resolution of Issue #1 (No Attenuation): Due to Issue #3! (Rad_Surface_Type > 0)



Left: Rain Flag; Right: Rain Flag *when* rad_surf_type=0

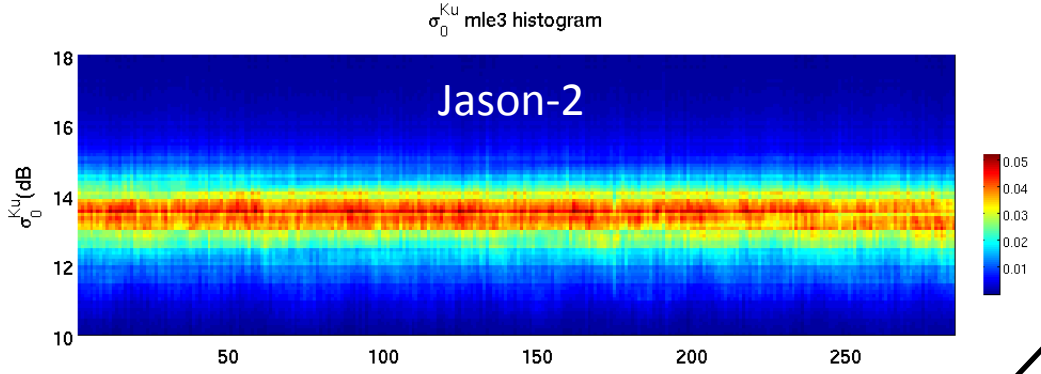
Resolution of Issue #2: Excessive J3 Flagging

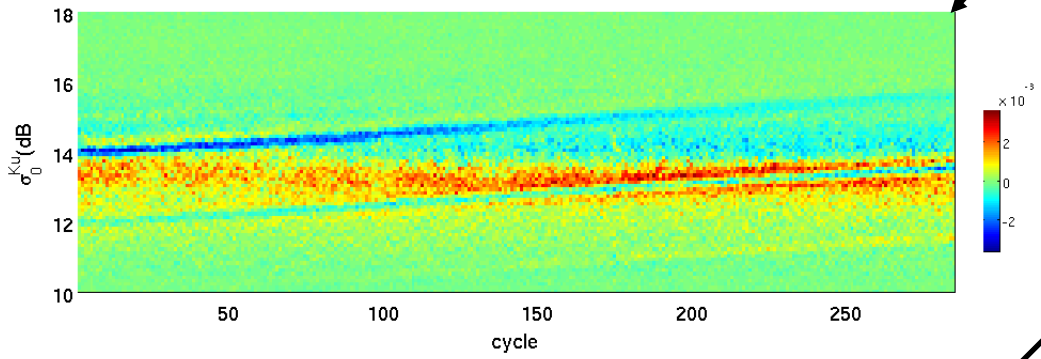




Left: Preliminary Rain Flag; Right: With +0.6 σ^0_{ku3} bias applied

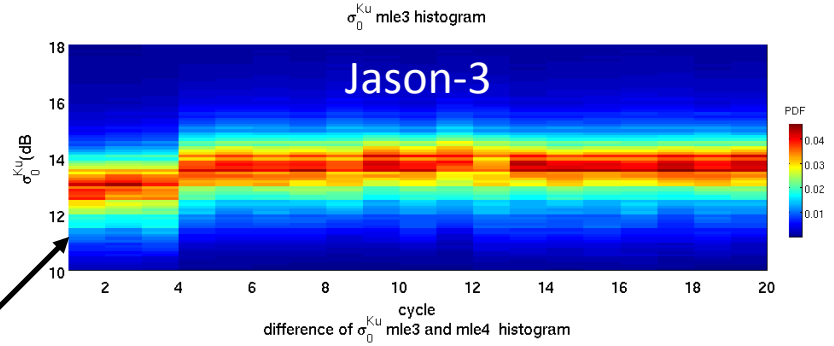
History of Jason-2 & Jason-3 Backscatter

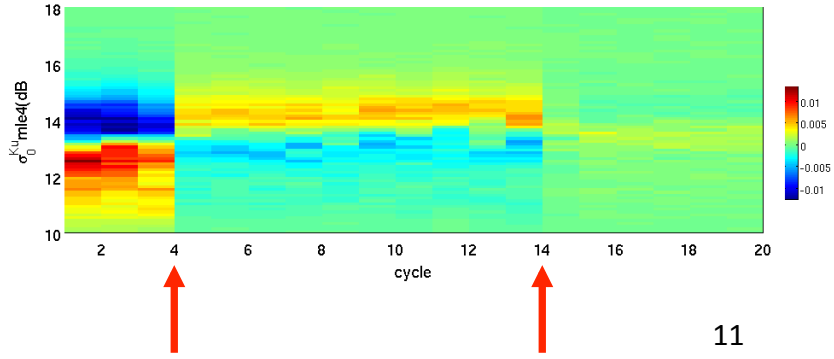




PDF of σ^0 Ku MLE3 vs. MLE4: J2 cycle 1-285

The differences between Ku MLE3 and MLE4 show straight lines for which we have no good explanation - AGC steps?



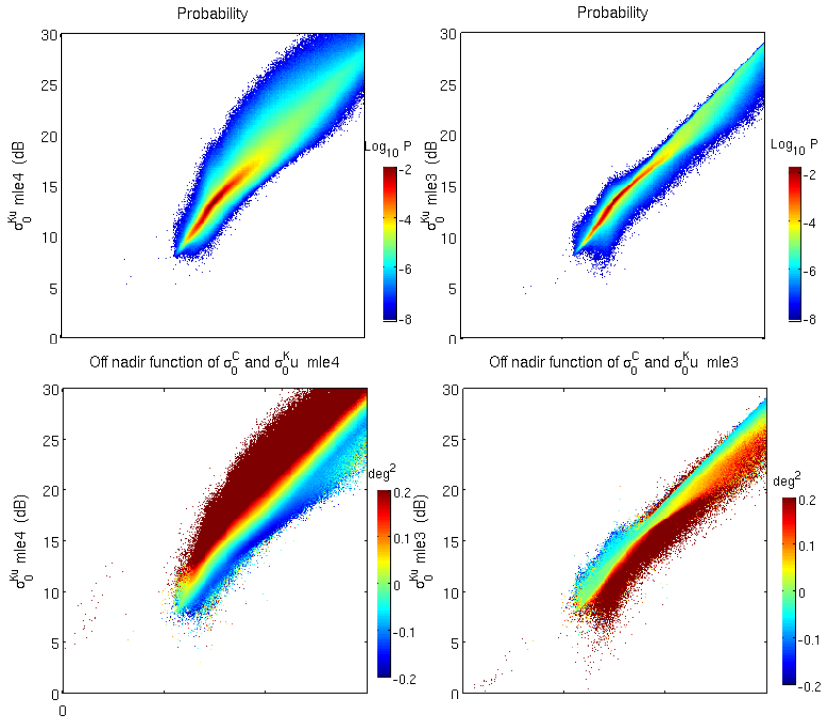


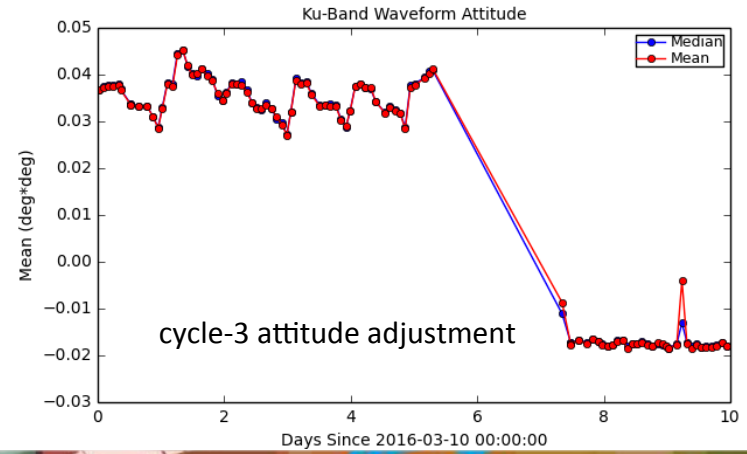
J3 STR + attitude adjustment & GPS OBSW Patch
O/I/GDR: cycle-3 pass-233, 2016-03-17 @ 07:47

Patch-7 version "T" > "d": over-ocean AGC Cal-2
IGDR: cycle-14 pass-043, 2016-06-26 @ 23:30
OGDR: cycle-18 pass-137, 2016-08-09 @ 08:09

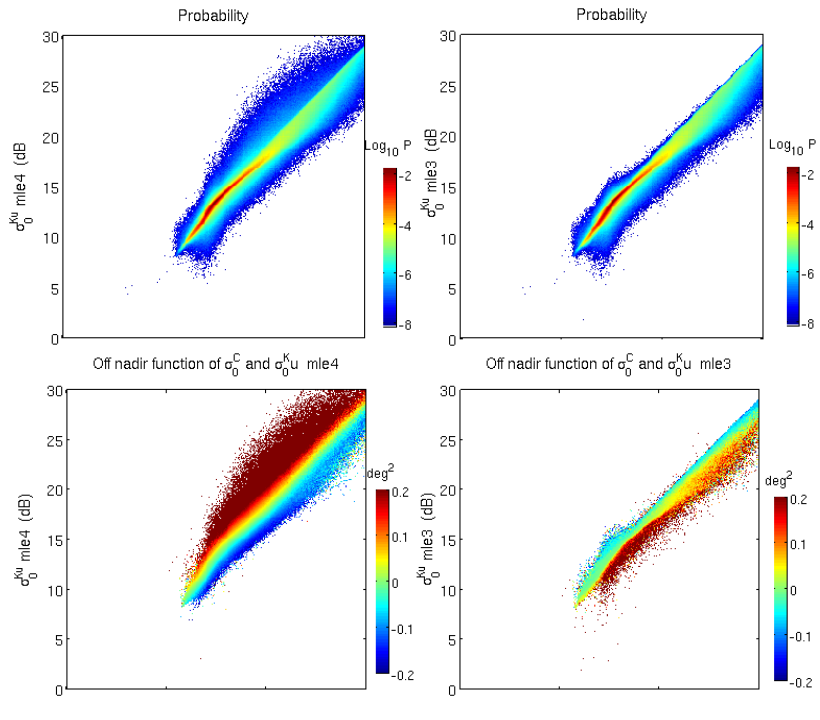
Correlation between σ^0 & attitude

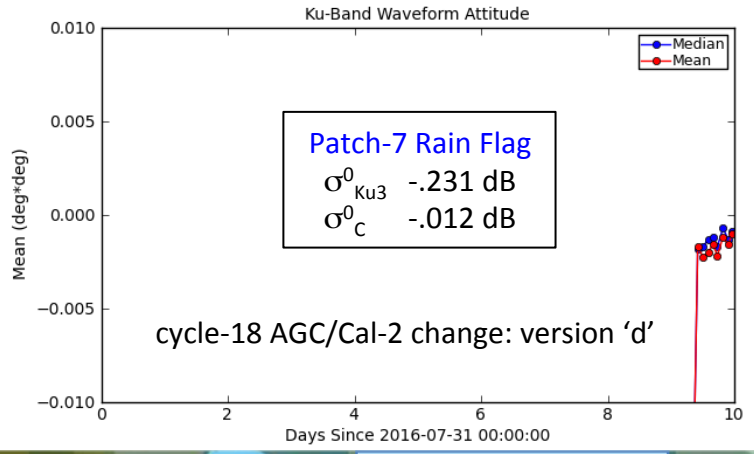
Jason-2



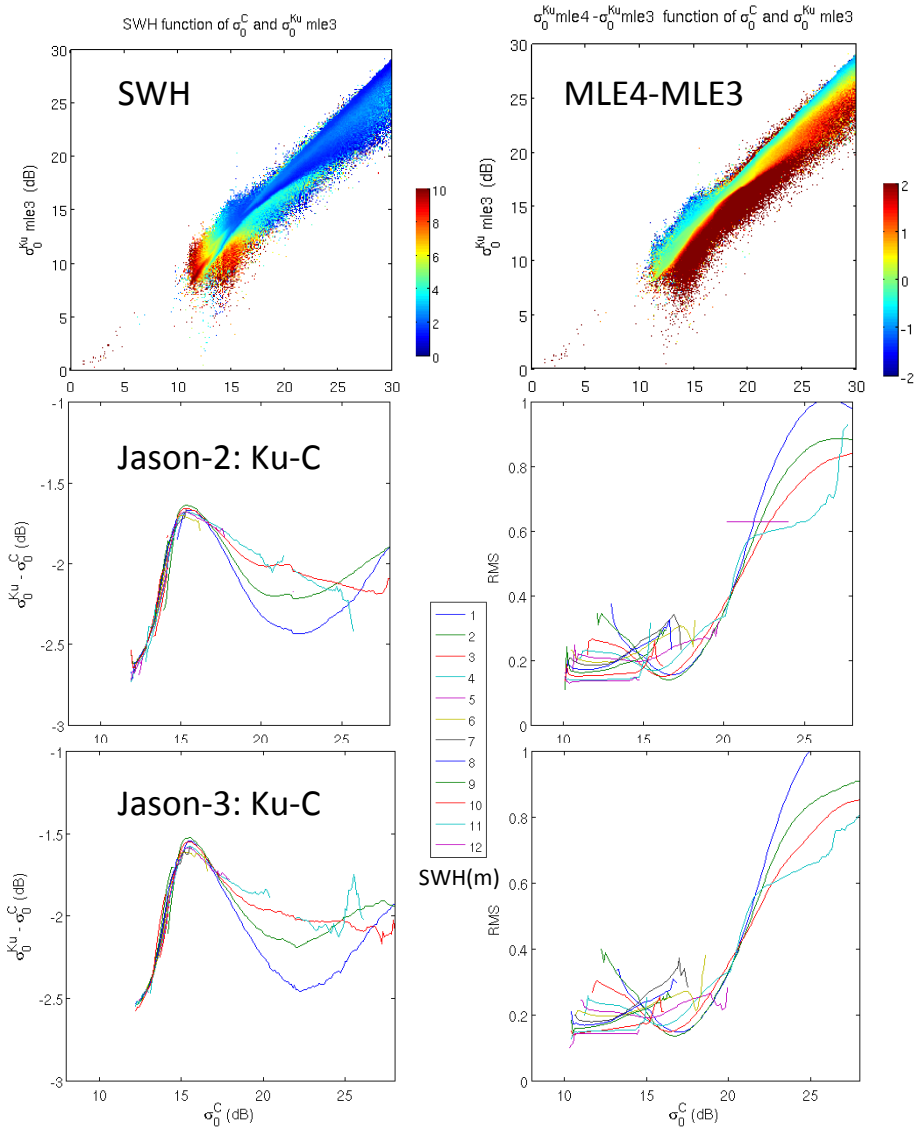


Jason-3





SWH Dependence



Significant wave height has a strong impact on the relation between Ku and C band σ^0 as shown in the distribution as function of Ku MLE3 and C-band σ^0.

The difference between MLE3 and MLE4 σ^0 Ku is as expected from the distribution of off-nadir angles. For 90% of the samples the difference is of the order of some tenth of dB.

Mean relation and RMS as a function of SWH: The relation is shifted to lower σ^0 for higher SWH.

Improved Rain Flagging: SWH & time dependence

- Three rain flag calculations have been tested using MLE3 σ^0.
- The samples are flagged if the departure from the relationship is larger than MIN(1.8 RMS, 0.45 dB) AND if the liquid water content is > 0.02 (to insure the presence of liquid water).
- Ku/C band relationship as a function of SWH (0-12m) computed for each cycle [TOP].
- Ku/C band relationship computed for each cycle [MIDDLE].
- One relationship is used for all cycles (cycle-1; similar to a prelaunch definition of the relationship) [BOTTOM]
- The use of SWH better defines the relationship and clearly decreases the number of flagged samples in the tropics.
- Using only one relationship clearly increases the number of flagged sample,s especially in the tropics and at high latitudes.
- There is still a problem with the ice flag on the IGDR…