Ku / Ka Sigma-0 analysis

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Ku / Ka Sigma-0 analysis

- Differences between Ku and Ka sigma0
- MLE3 /MLE4 Ka estimations
- Relations Sig0 / SWH / Mispointing / ECMWF Wind
- Ku/Ka AGC and SNR comparisons
- Bloom event observed in Ka (an example)
- Rain Cell observed in Ka (an example)
- Ku/Ka Sig0 on iced regions

AltiKa and Jason-2 data

	AltiKa	Jason-2
Frequency band	Ka	Ku
Cycle(s)	2	178-181
Tracks	1-1002	1-254
Start date	2013-04-18	2013-05-11
End date	2013-05-23	2013-06-04
Time period	35 days	24 days
Geographical selection	Distance to coast >10 km && ABS(Latitude)<66°	

	AltiKa		Jason-2
	MLE-4	**MLE-3**	**MLE-4**
Backscatter coefficient	=SIG0	=10*log10(PUI_MLE3) + KCAL_FACTOR_SIG0	=SIG0
Signal to Noise Ratio	=SNR	=10*log10(PUI_MLE3/THN_MLE3)	=SNR

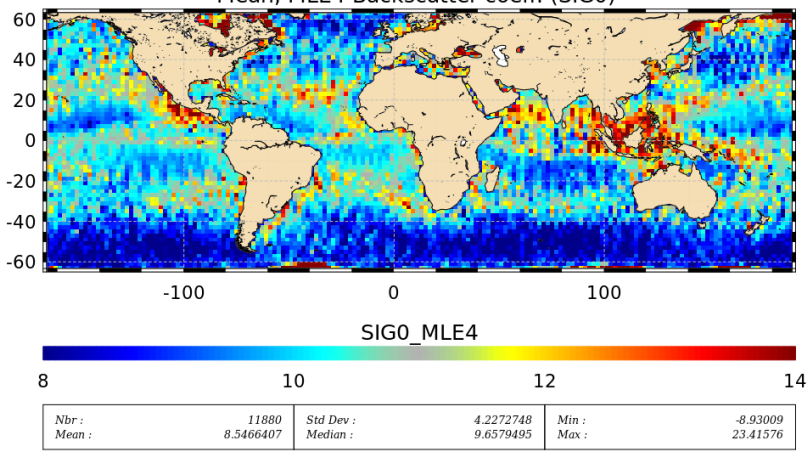
Gridded maps of SIG0, MLE-4

(Ka uncorrected for atmospheric attenuation)

Ka

AltiKa Cycles 2-2

Mean, MLE4 Backscatter coeff. (SIG0)

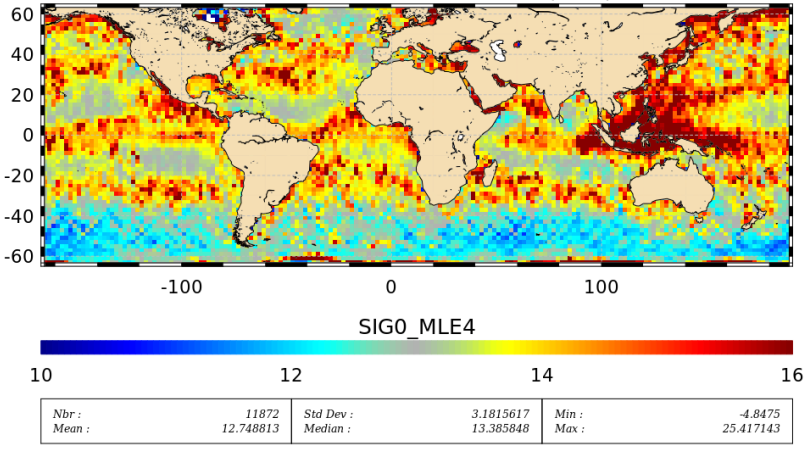


Nbr :	11880	Std Dev :	4.2272748	Min :	-8.93009
Mean :	8.5466407	Median :	9.6579495	Max :	23.41576

Ku

Jason-2 Cycles 178-181

Mean, MLE4 Backscatter coeff. (SIG0)

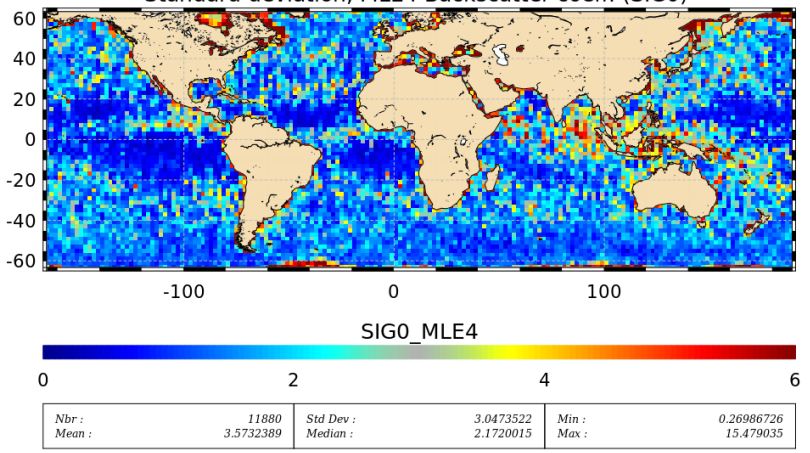


Nbr :	11872	Std Dev :	3.1815617	Min :	-4.8475
Mean :	12.748813	Median :	13.385848	Max :	25.417143

Mean

AltiKa Cycles 2-2

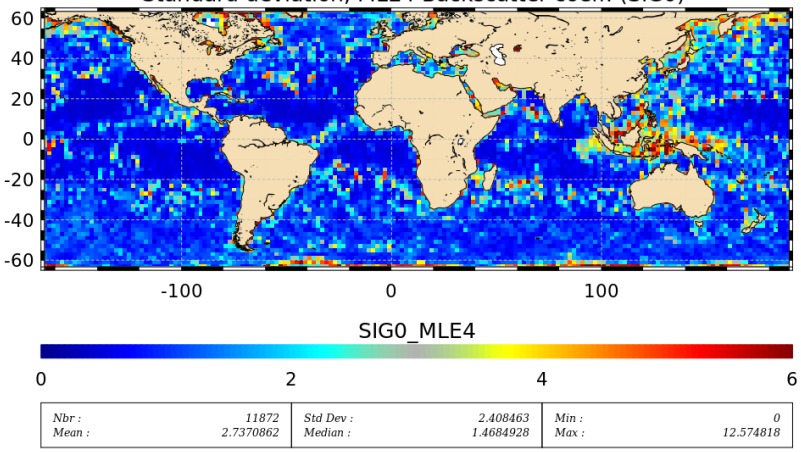
Standard deviation, MLE4 Backscatter coeff. (SIG0)



Nbr :	11880	Std Dev :	3.0473522	Min :	0.26986726
Mean :	3.5732389	Median :	2.1720015	Max :	15.479035

Jason-2 Cycles 178-181

Standard deviation, MLE4 Backscatter coeff. (SIG0)

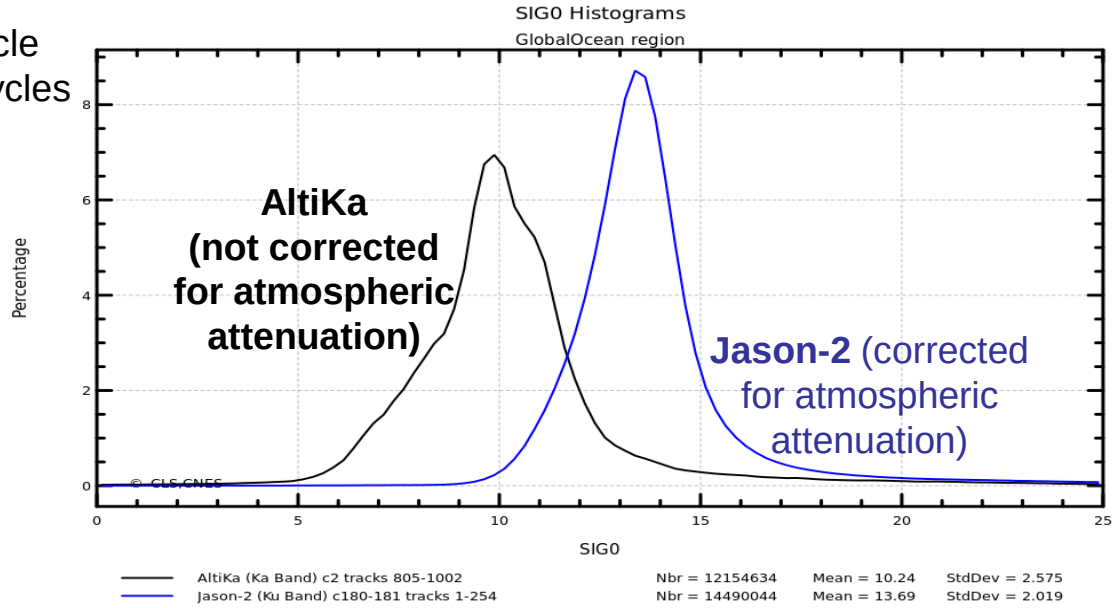


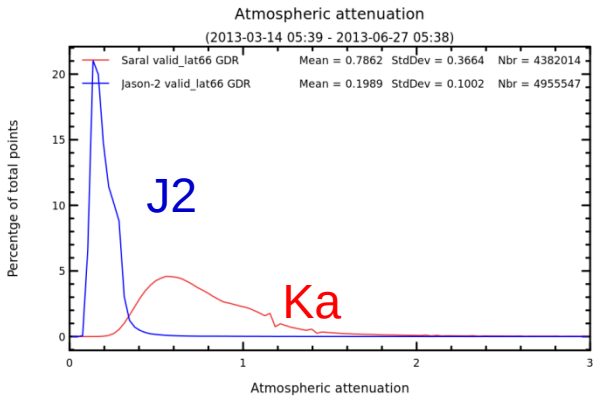
Nbr :	11872	Std Dev :	2.408463	Min :	0
Mean :	2.7370862	Median :	1.4684928	Max :	12.574818

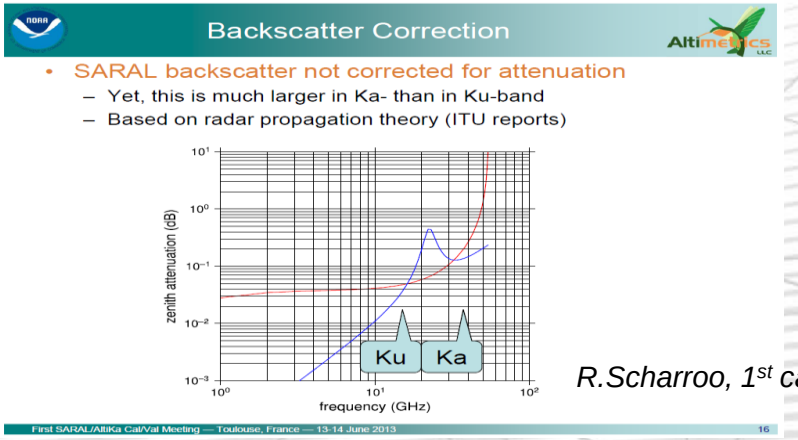
Standard deviation

Histograms of SIG0, MLE-4 (Ka/Ku)

AltiKa 40Hz data : ~200 tracks, 1 cycle
Jason-2 20Hz data : 254 tracks, 2 cycles



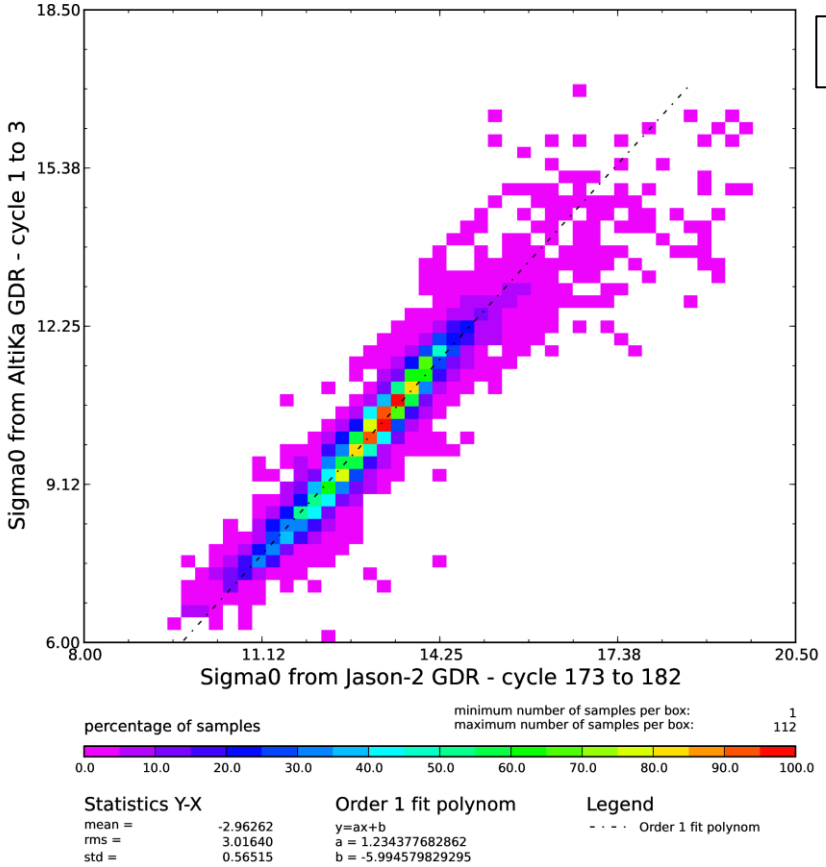




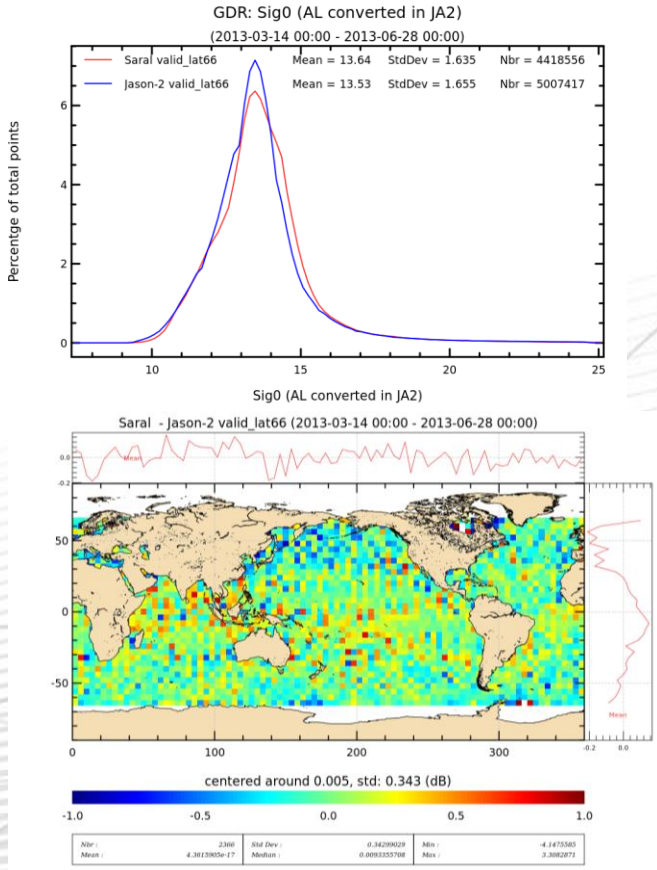
R.Scharroo, 1st calval meeting

GDR SRL/JA2 X-Overs (< 3 Hours)

Scatterplot Sig0 AltiKa = f(Sig0 Jason-2) for X-over < 3h



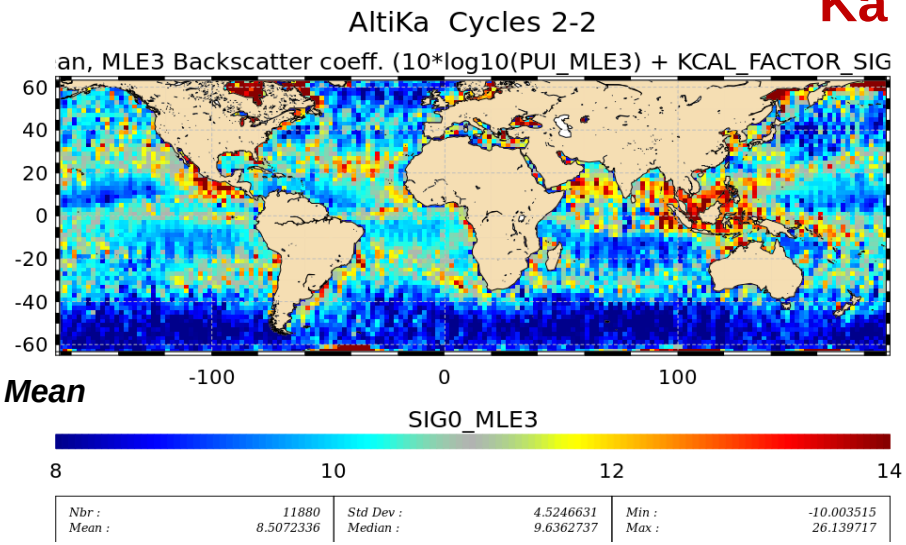
Sig0_JA2=(Sig0_SRL + 5.994579)/1.2343776



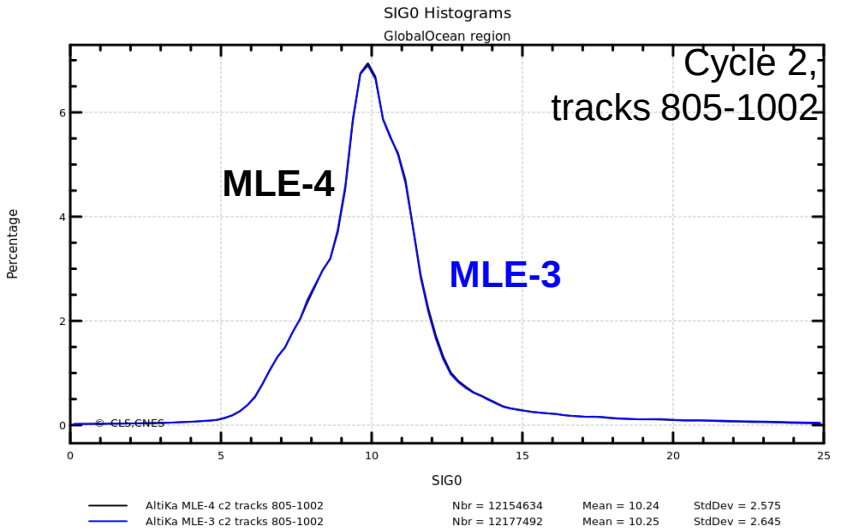
Gridded maps of SIG0, MLE-3

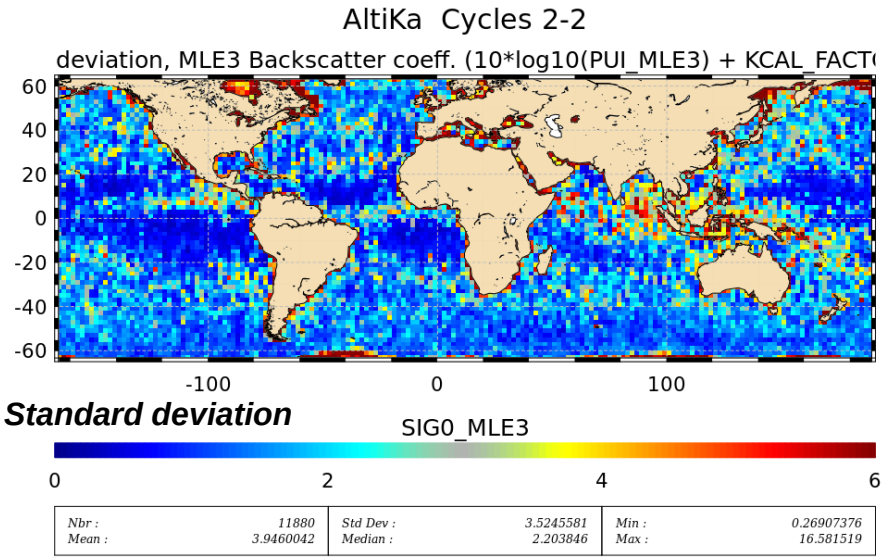
(uncorrected for atmospheric attenuation)

Ka

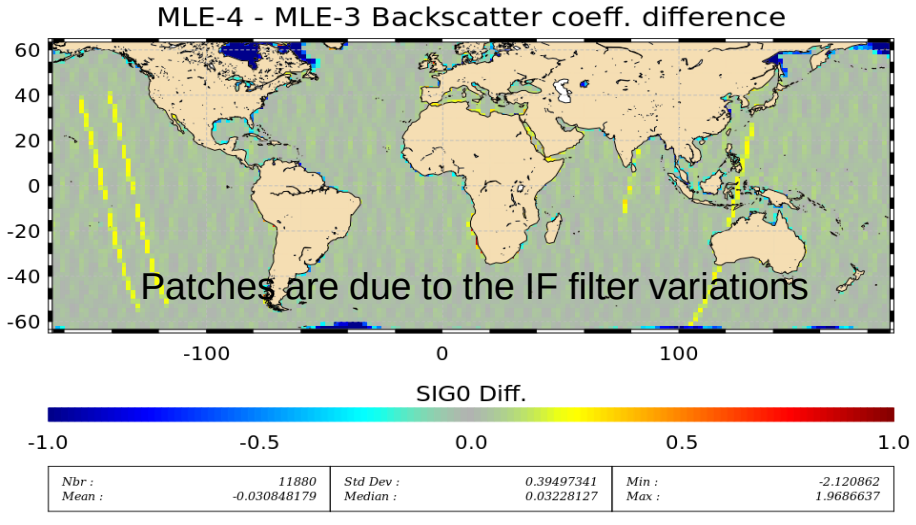


Mean



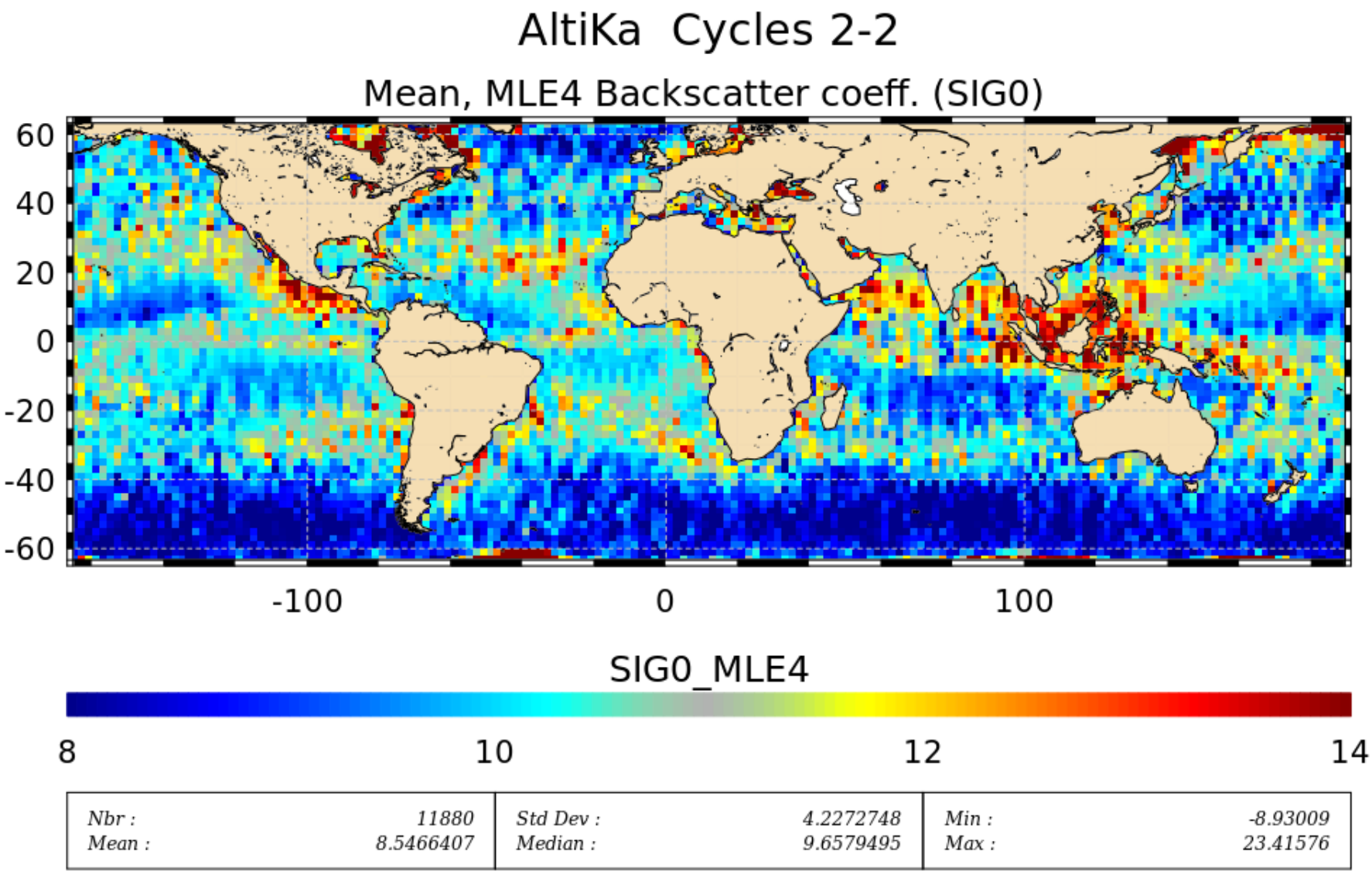


Standard deviation



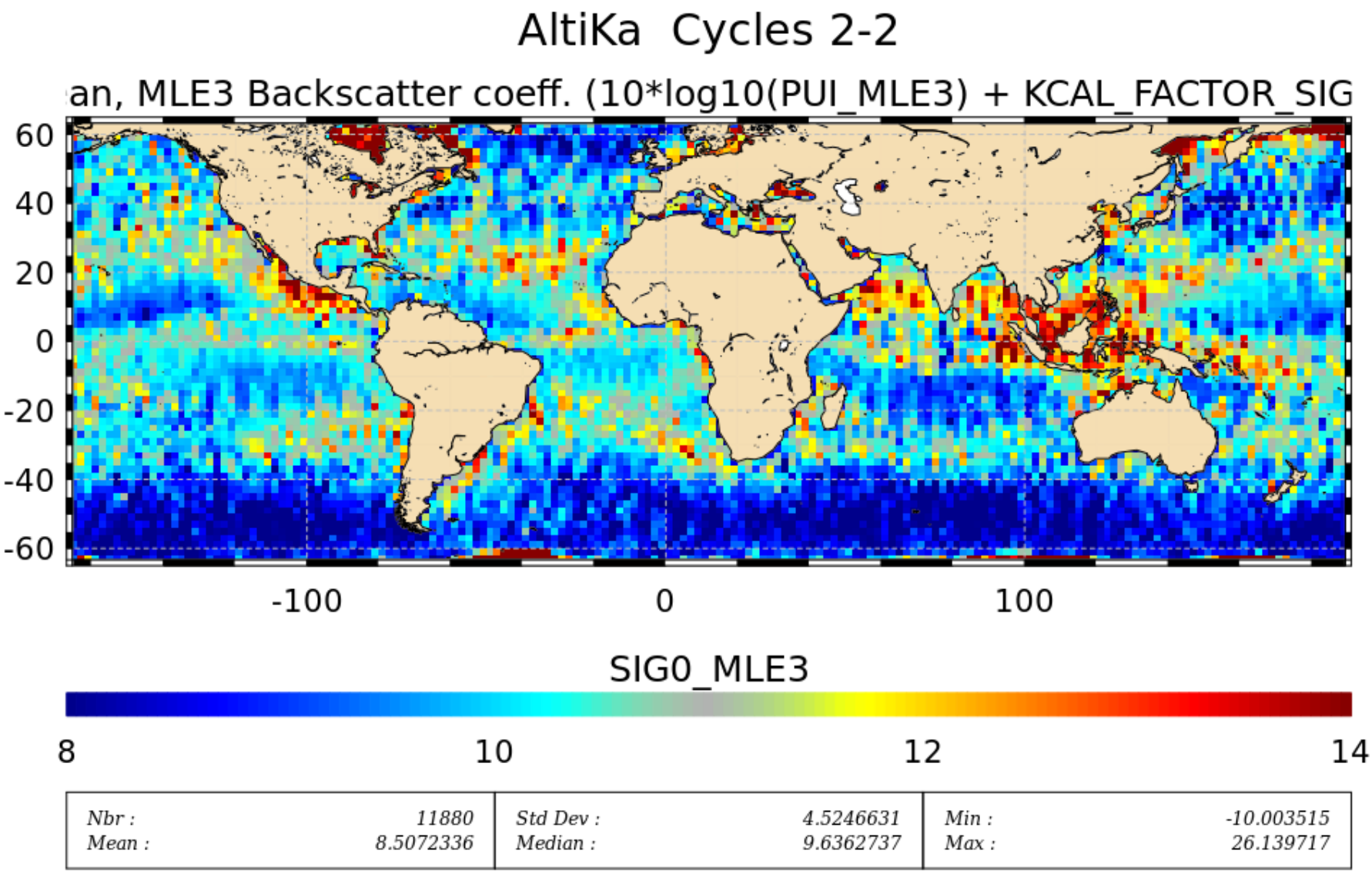
Gridded maps of SIG0, MLE-4

(uncorrected for atmospheric attenuation)



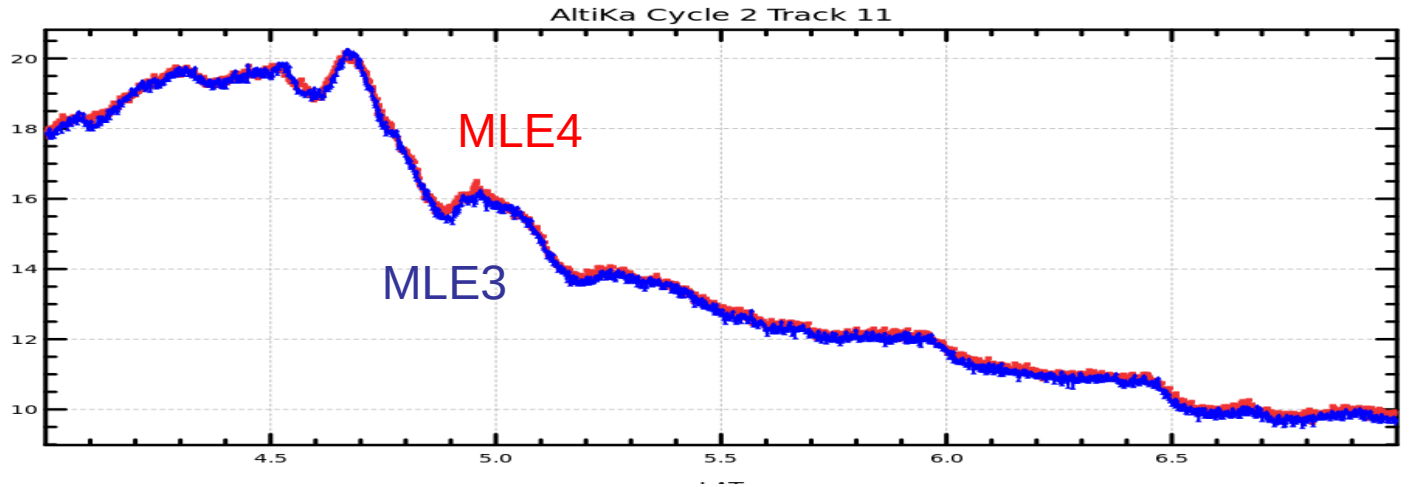
Gridded maps of SIG0, MLE-3

(uncorrected for atmospheric attenuation)

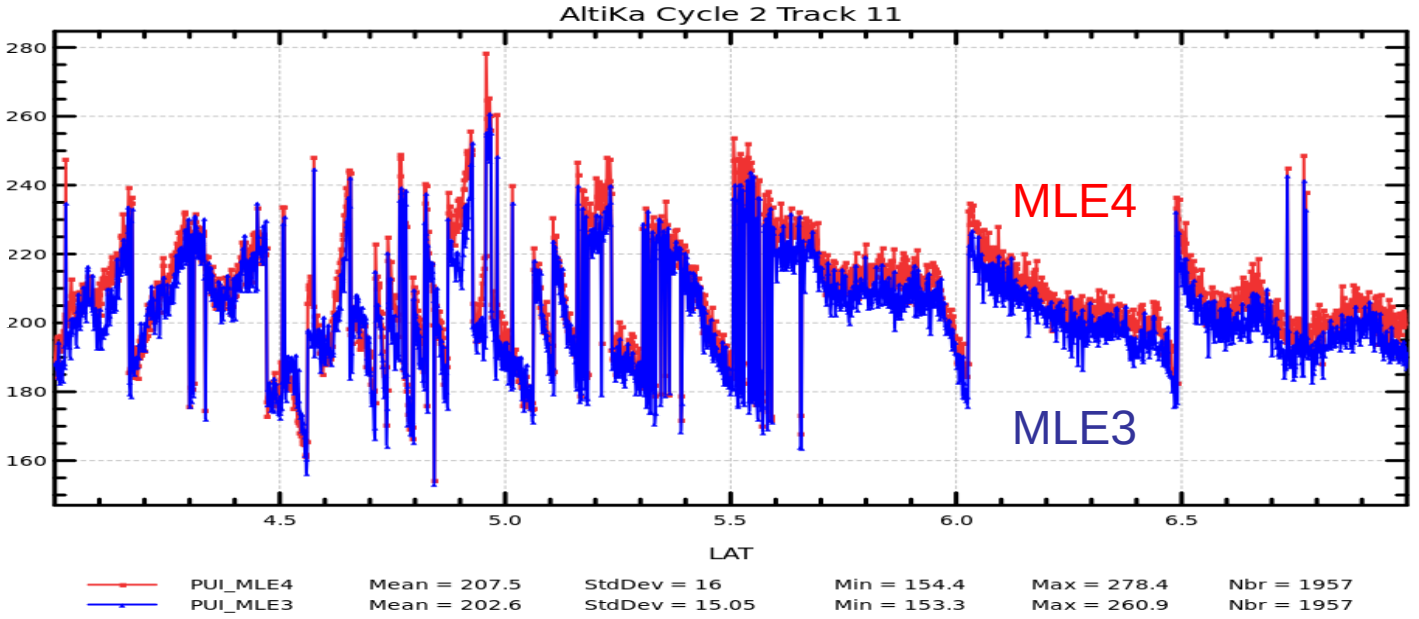


Along track comparison : MLE3.vs.MLE4

σ_0 (dB)

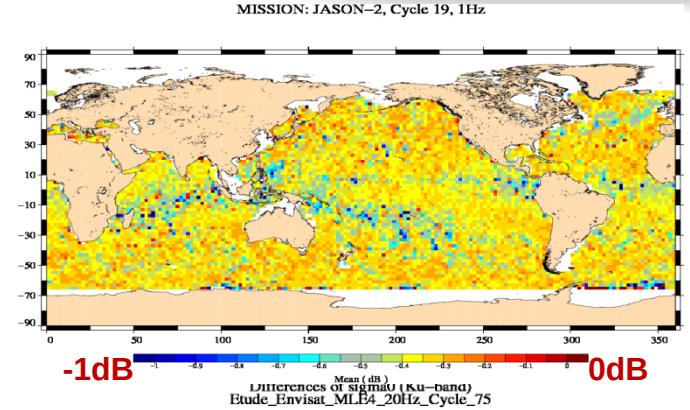


Power (FFT p.u)



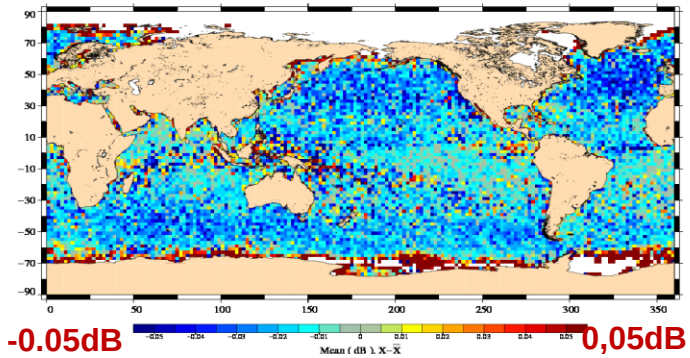
Jason-2 / RA-2 / AltiKa $(\sigma_{0\_MLE4} - \sigma_{0\_MLE3})$

Ku



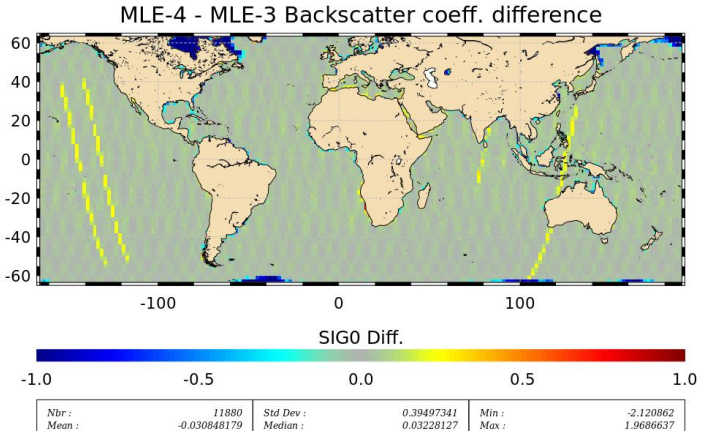
Jason-2 : H=1336 km
WF_Footprint_Radius = 9.56 km

Ku



RA-2 : H= 800 km
WF_Footprint_Radius = 7.6 km

Ka

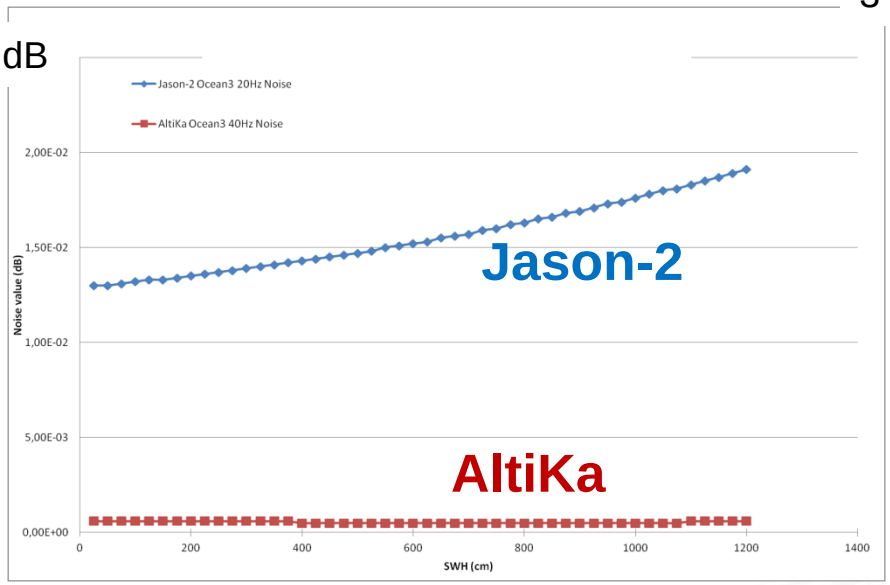


Alti-Ka : H= 800 km
WF_Footprint_Radius = 5.6 km

Ku/Ka Standard Deviation on sig0

Standard deviation on Sigma0 (simulated data)

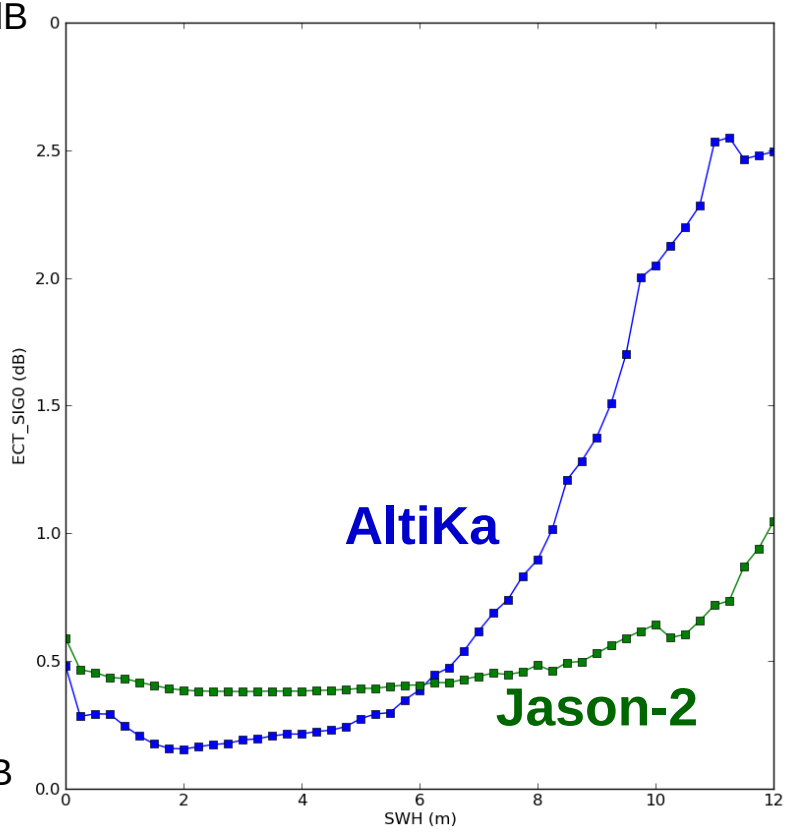
0.025 dB



0 dB

Standard deviation on Sigma0 (real data)

3 dB



0 dB

➔ Quite null dependency with SWH

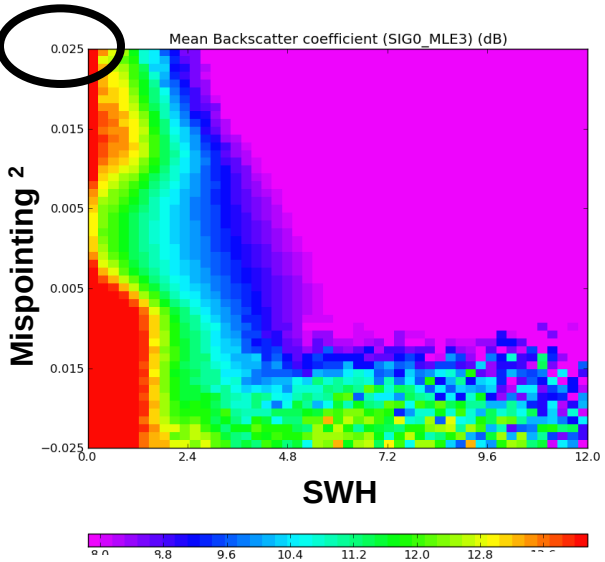
➔ Smaller Std for AltiKa

➔ Strong dependency with SWH (>6m)

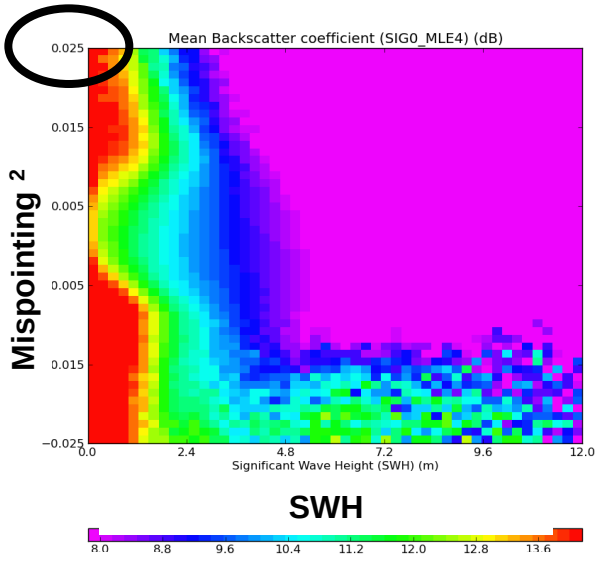
Mean SIG0 = f(SWH, ζ²), MLE-3/4

AltiKa Sig0

MLE3

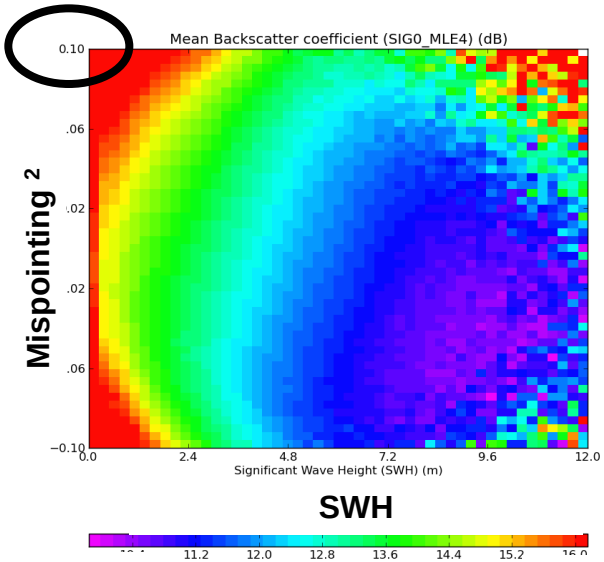


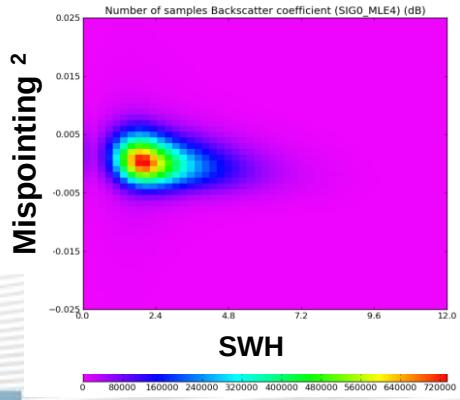
MLE4

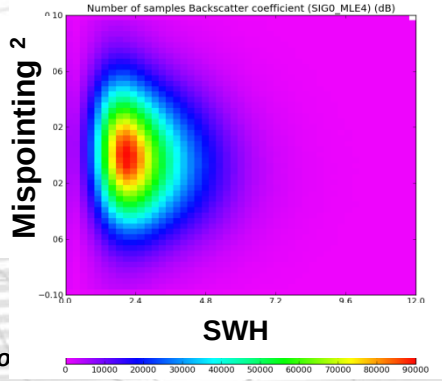


Jason-2 Sig0

MLE4

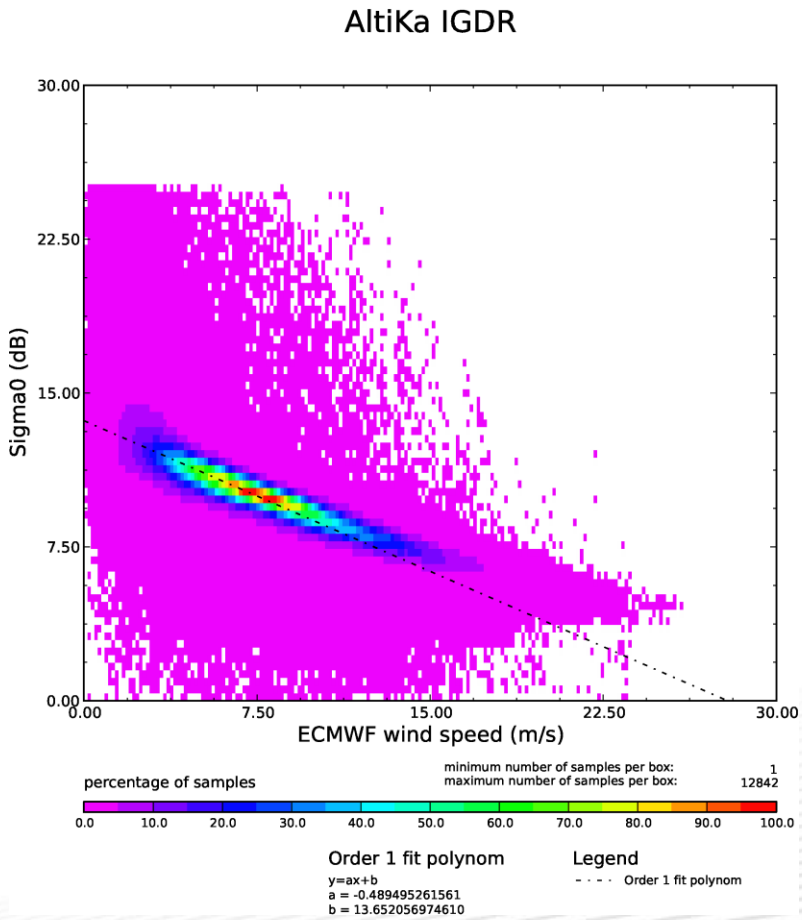




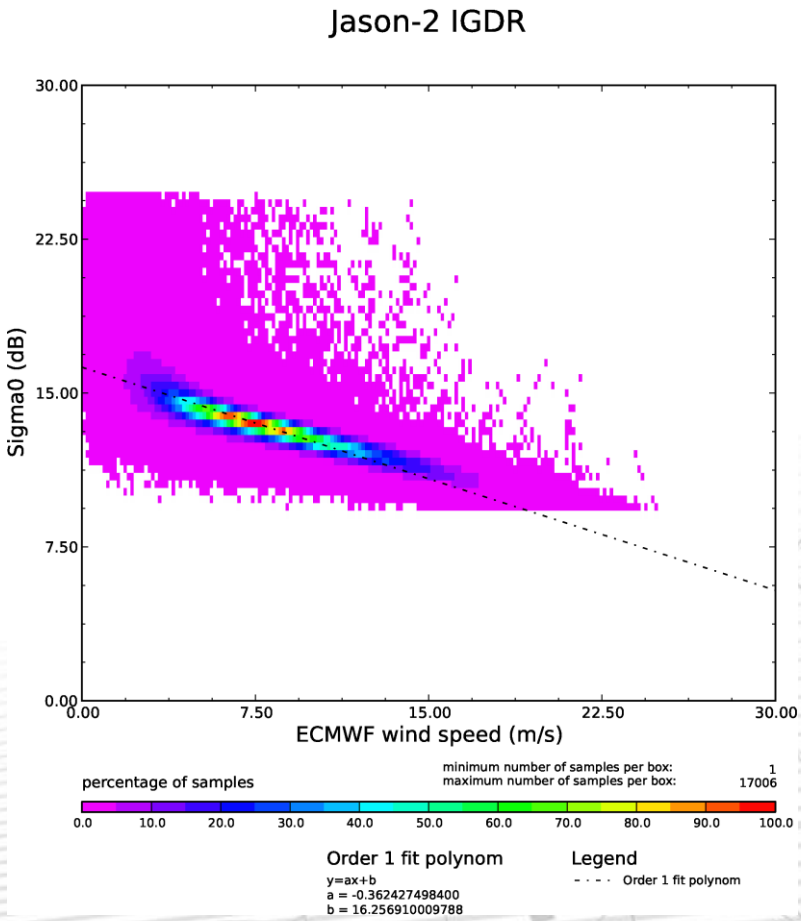


Ku/Ka dispersion Sig0 / ECMWF WS

AltiKa (Ka band)



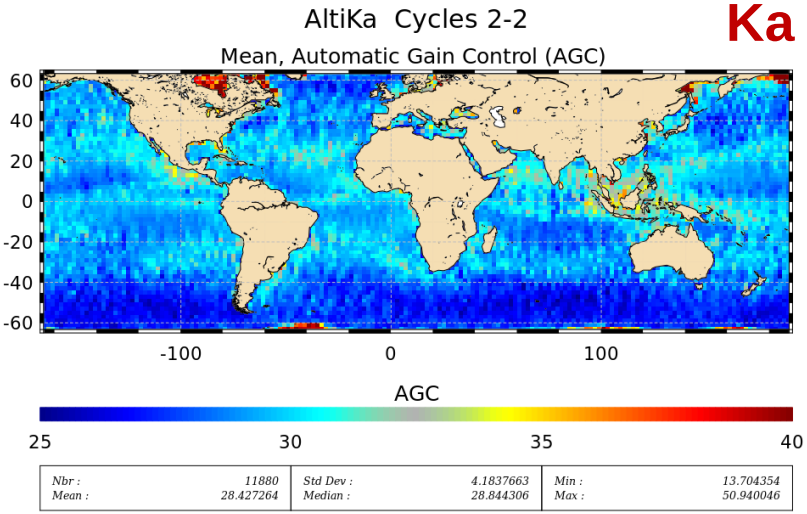
Jason-2 (Ku band)



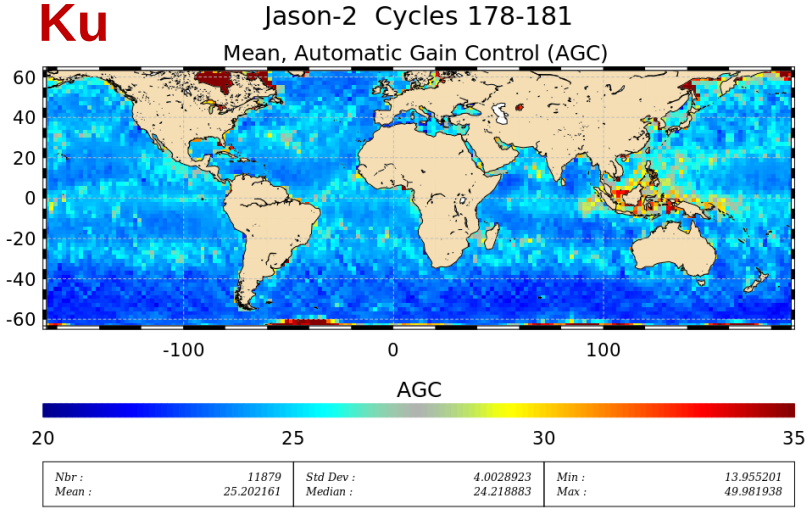
Sigma0 (without att_atmospheric)

Gridded maps of AGC
AltiKa vs. Jason-2

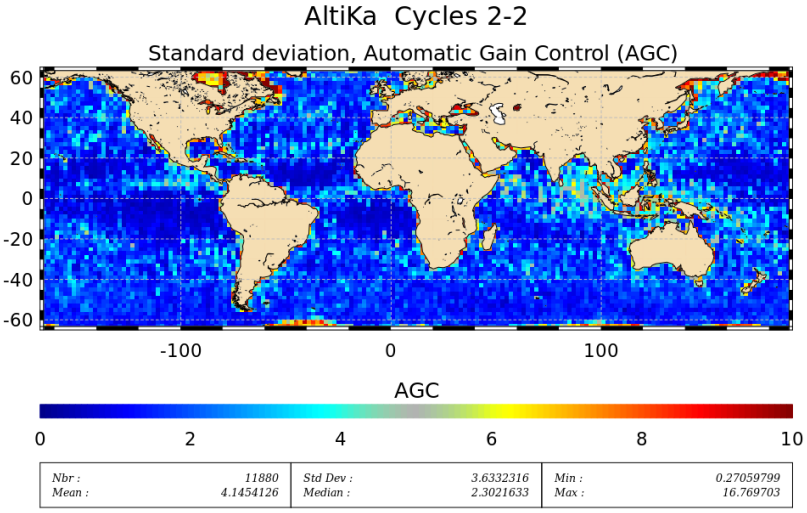
Ka



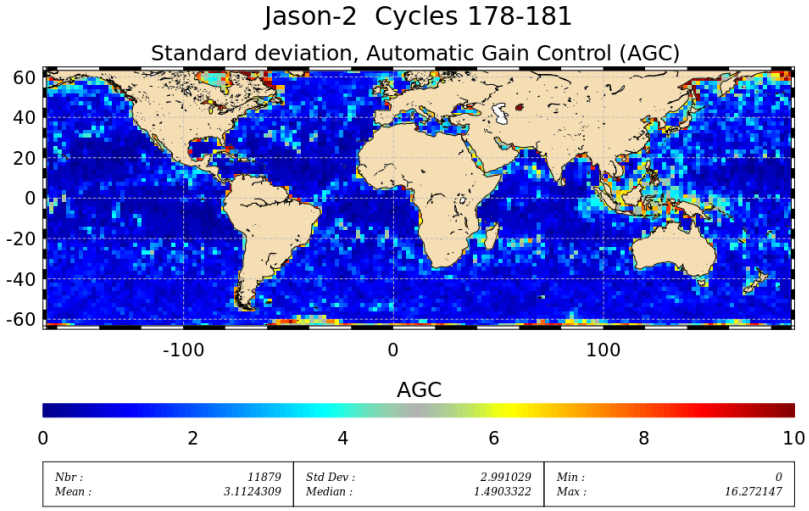
Ku



Mean



Standard deviation



SNR considerations

- Several studies have been made during AltiKa development to assess hypothesis on σ0 and atmospheric attenuations

  σ0 Ka = σ0 Ku [Topex] – 1,5 dB ≈ σ0 Ku [Jason] – 3,5 dB

- Some margins have been considered in the link budget during development : system margin, ageing, mispointing and rain attenuation
- In flight assessment : better SNR than expected
  - Measured AltiKa σ0 : σ0 Ka ≈ σ0 Ku [Jason] – 2,5 dB

    => i.e. 1 dB greater than σ0 hypothesis considered during development
  - The 3,5 dB margins allocated to mispointing, system margin and ageing provide additional capacity to withstand higher rain rates than targeted
  - **Thus, a few data are lost due to atmospheric attenuations**

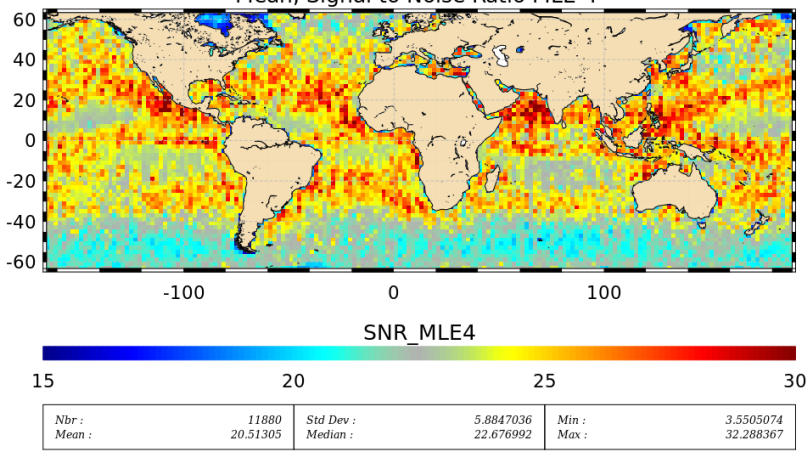
Gridded maps of SNR, MLE-4

AltiKa vs. Jason-2

Ka

AltiKa Cycles 2-2

Mean, Signal to Noise Ratio MLE-4

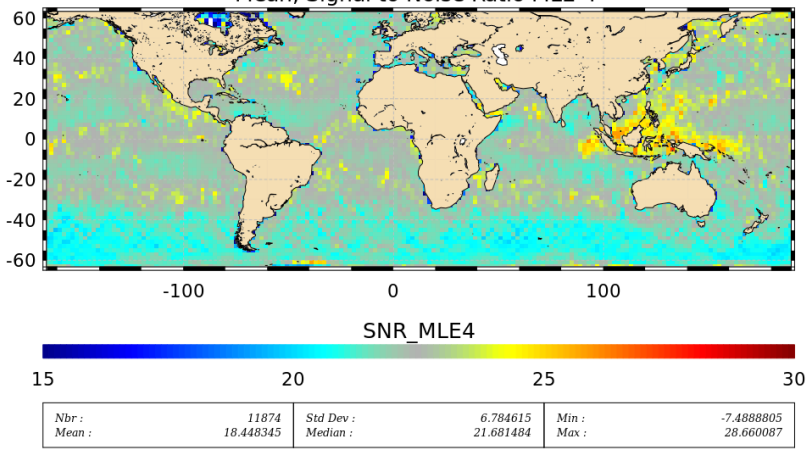


Nbr :	11880	Std Dev :	5.8847036	Min :	3.5505074
Mean :	20.51305	Median :	22.676992	Max :	32.288367

Ku

Jason-2 Cycles 178-181

Mean, Signal to Noise Ratio MLE-4

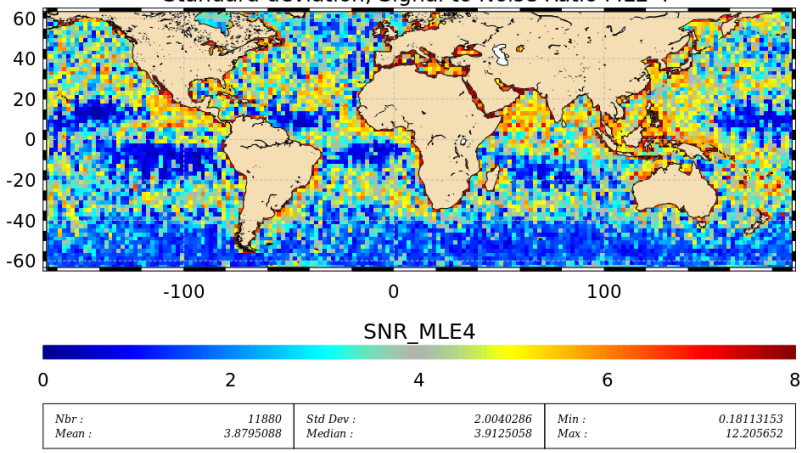


Nbr :	11874	Std Dev :	6.784615	Min :	-7.4888805
Mean :	18.448345	Median :	21.681484	Max :	28.660087

Mean

AltiKa Cycles 2-2

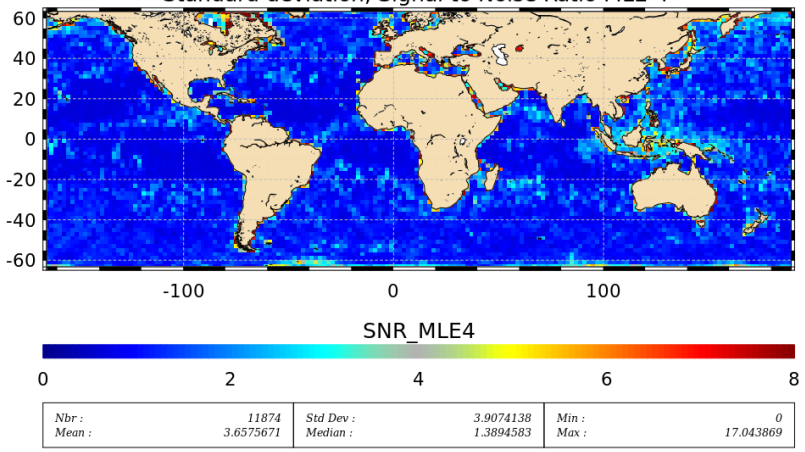
Standard deviation, Signal to Noise Ratio MLE-4



Nbr :	11880	Std Dev :	2.0040286	Min :	0.18113153
Mean :	3.8795088	Median :	3.9125058	Max :	12.205652

Jason-2 Cycles 178-181

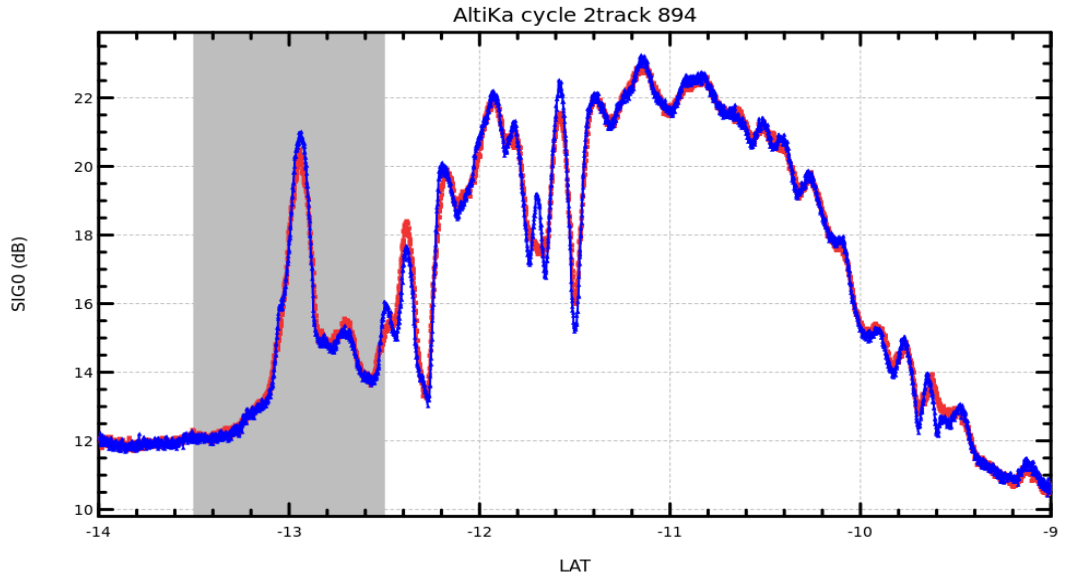
Standard deviation, Signal to Noise Ratio MLE-4

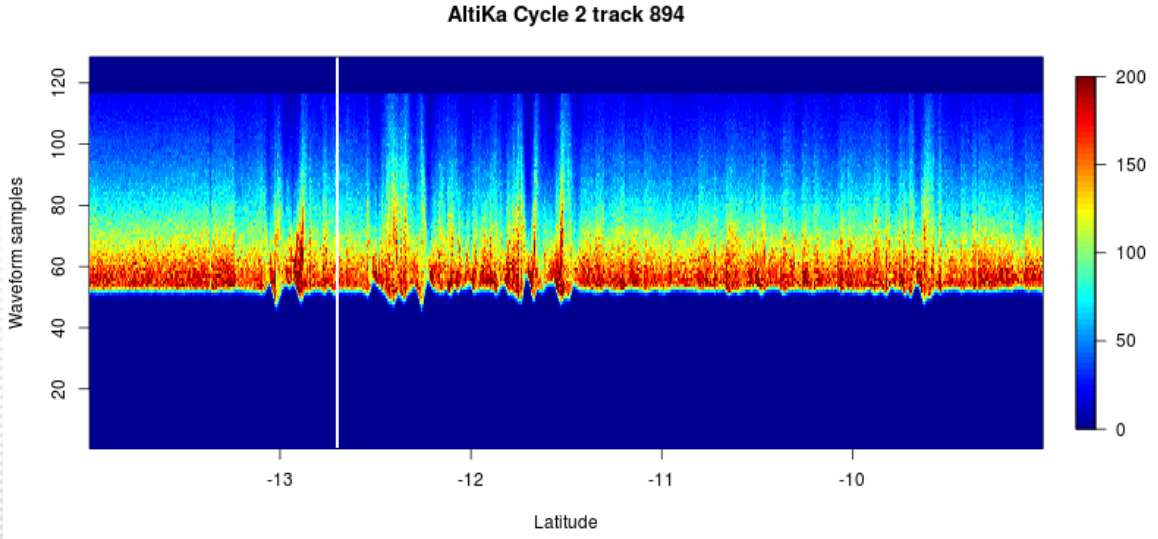


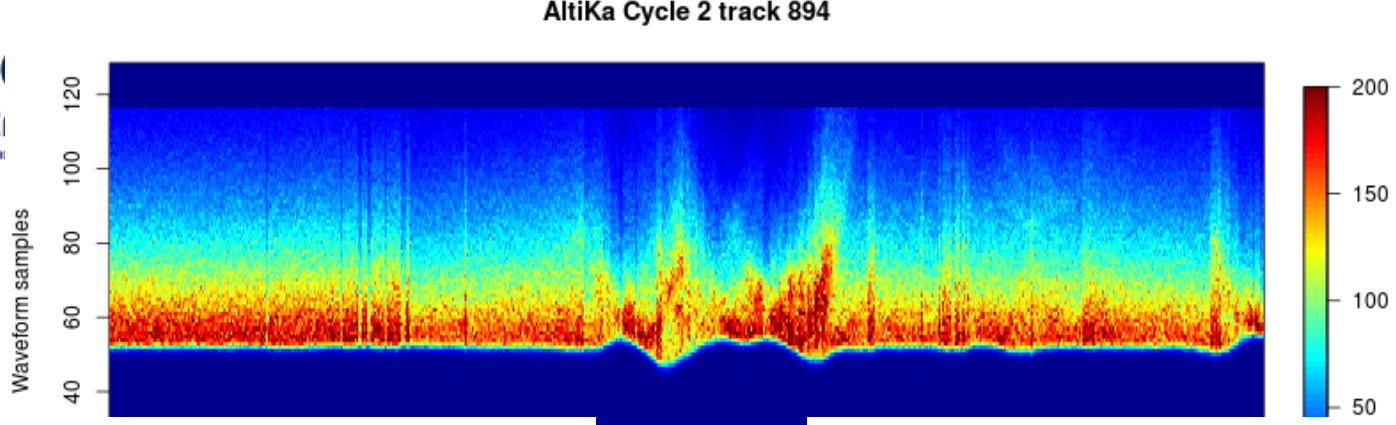
Nbr :	11874	Std Dev :	3.9074138	Min :	0
Mean :	3.6575671	Median :	1.3894583	Max :	17.043869

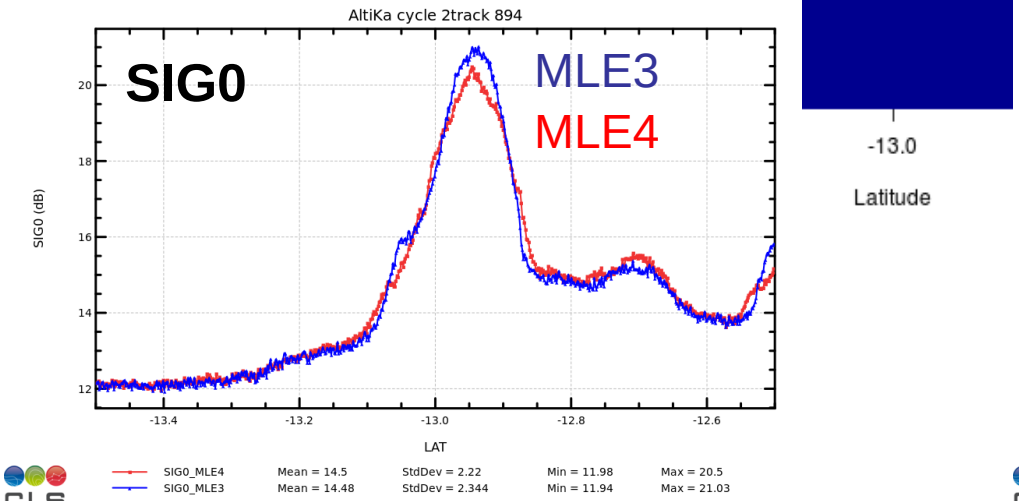
Standard deviation

Along-track examples : Bloom event



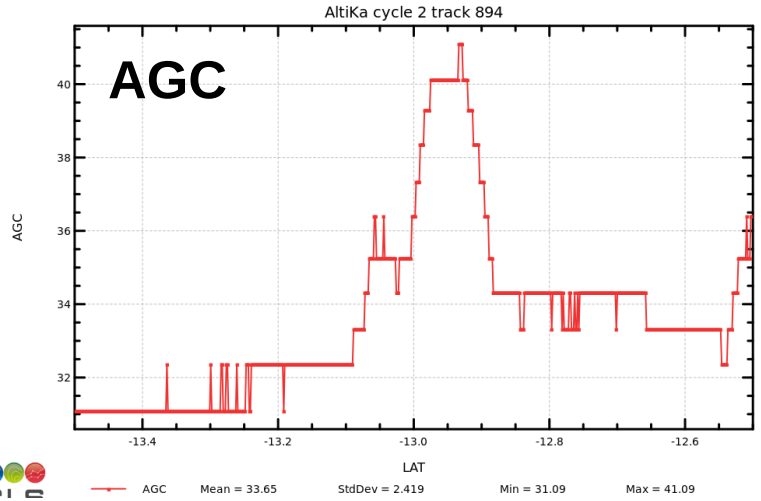


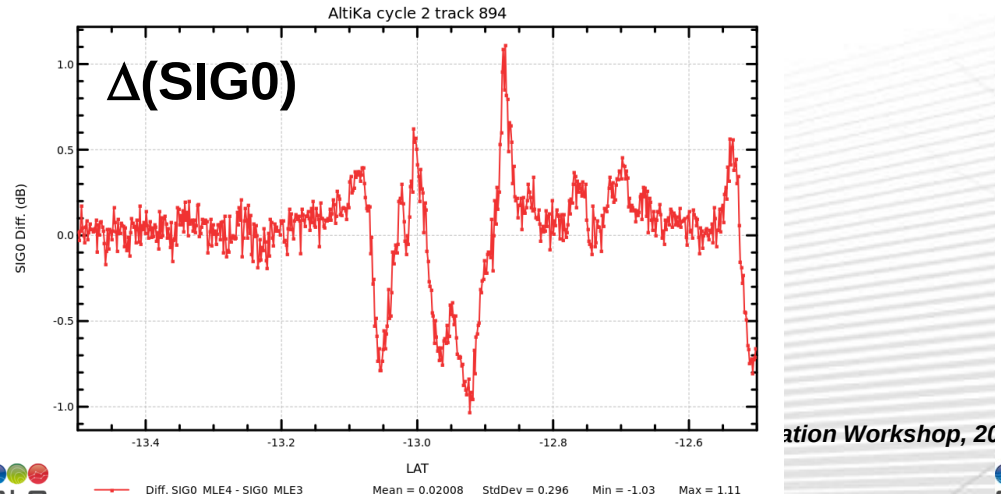


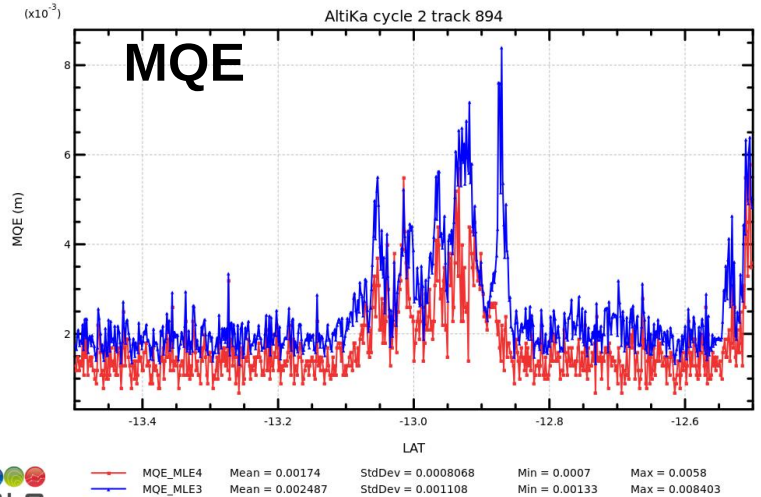


-13.0

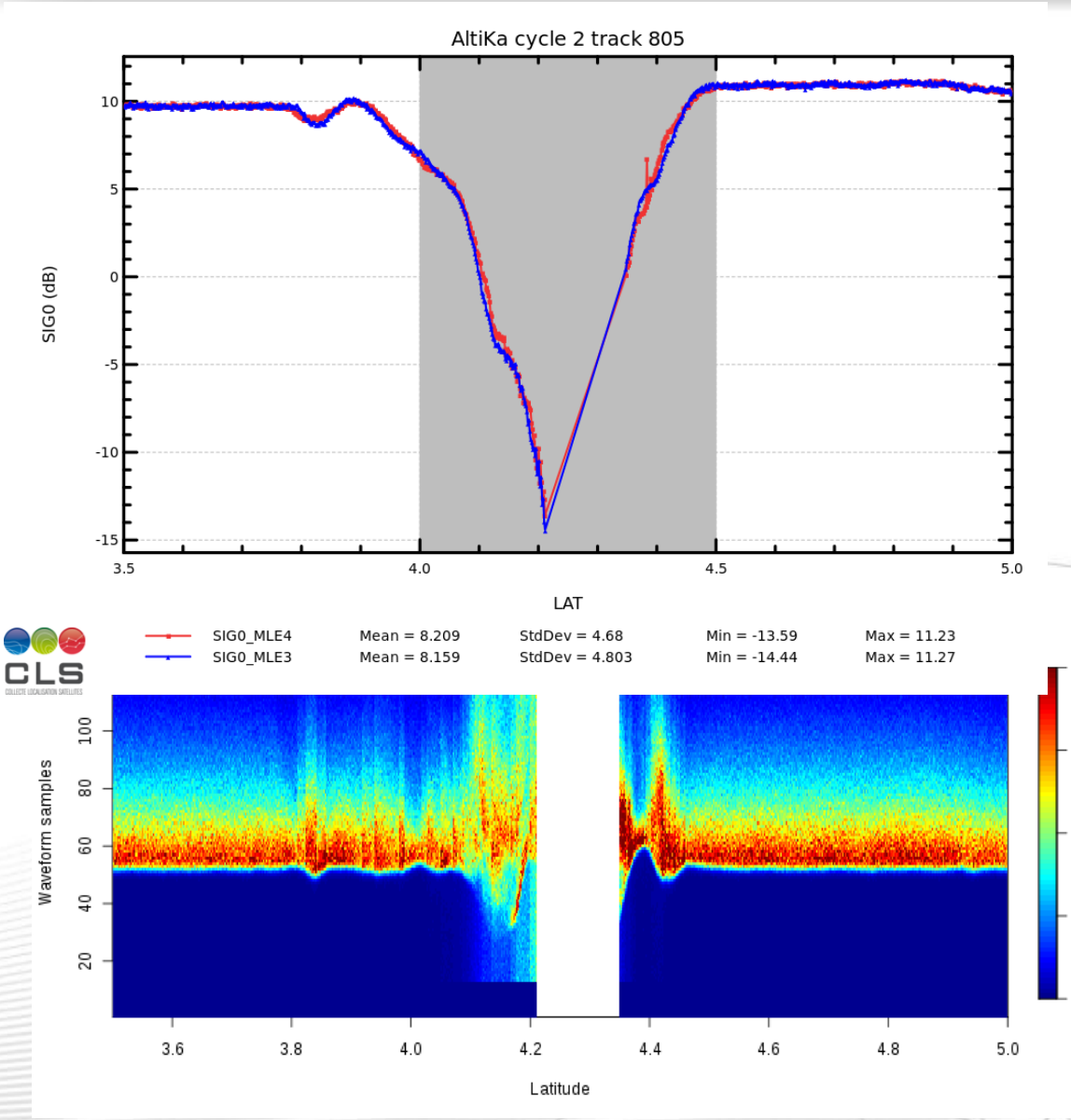
Latitude

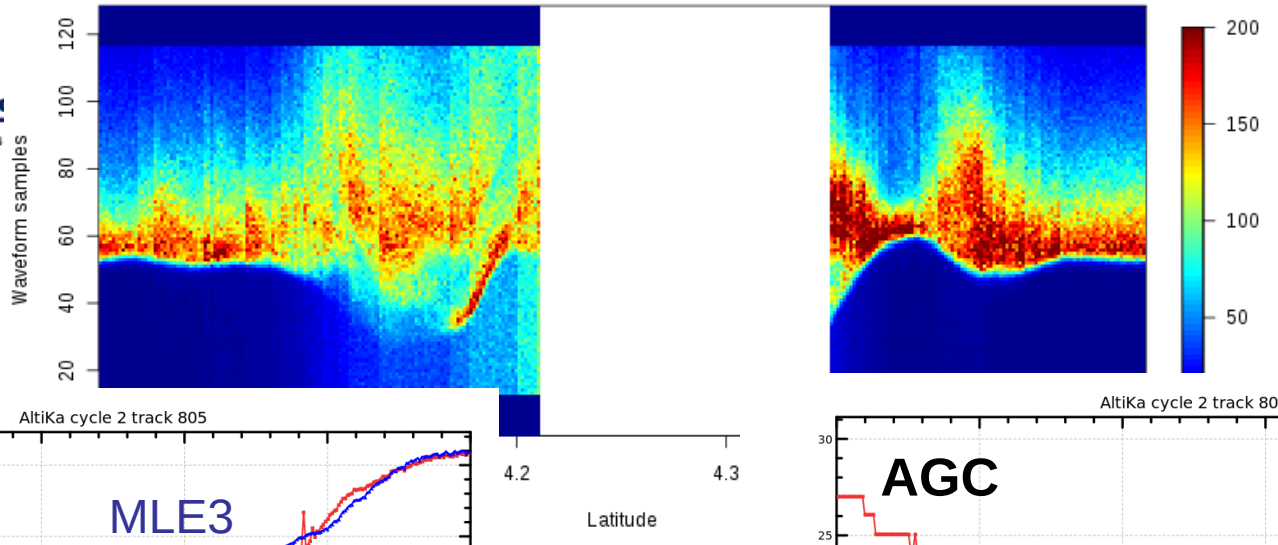


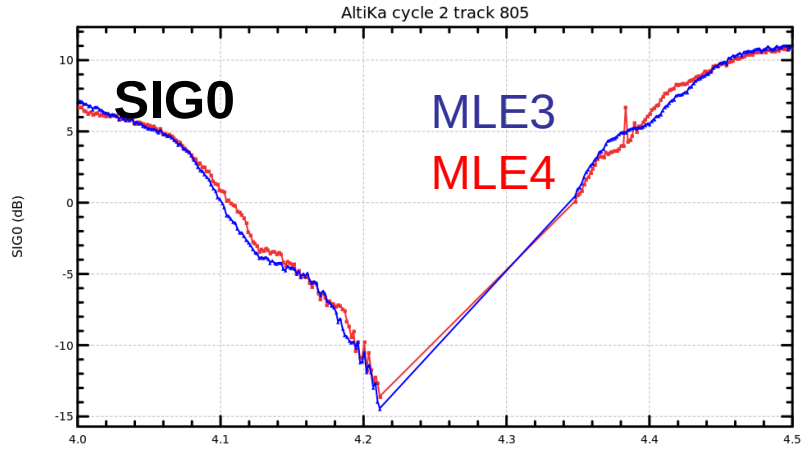


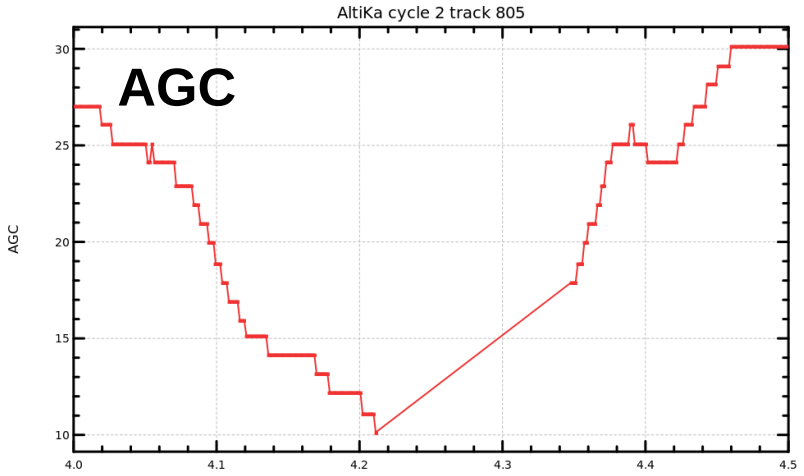


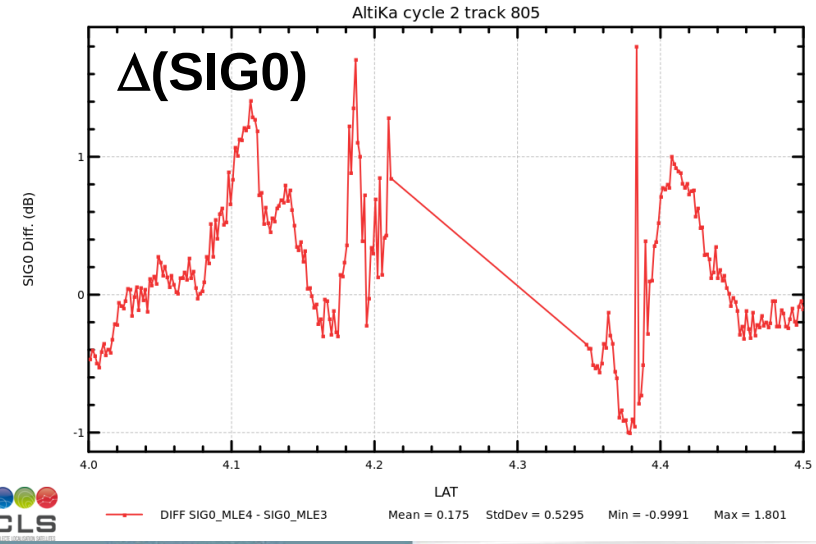
Along-track examples : Rain event

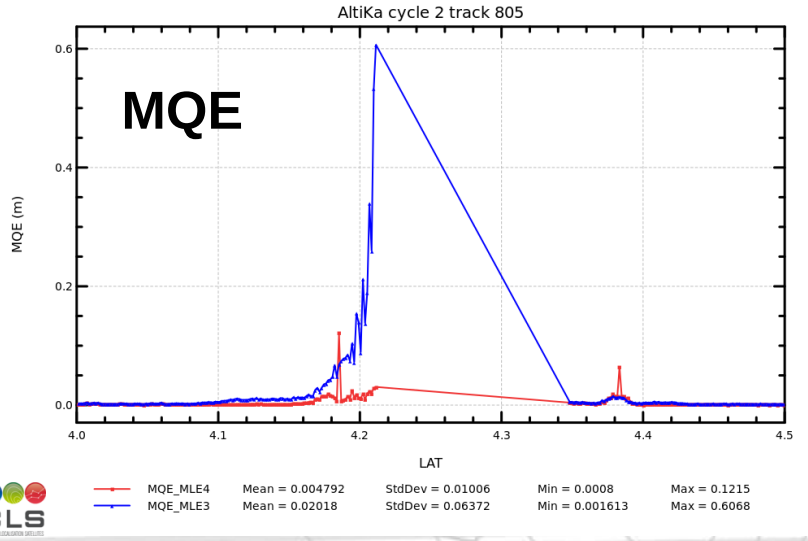



Waveform samples
120
100
80
60
40
20
200
150
100
50
4.2
4.3
Latitude


AltiKa cycle 2 track 805
SIG0
MLE3
MLE4
SIG0 (dB)
10
5
0
-5
-10
-15
4.0
4.1
4.2
4.3
4.4
4.5

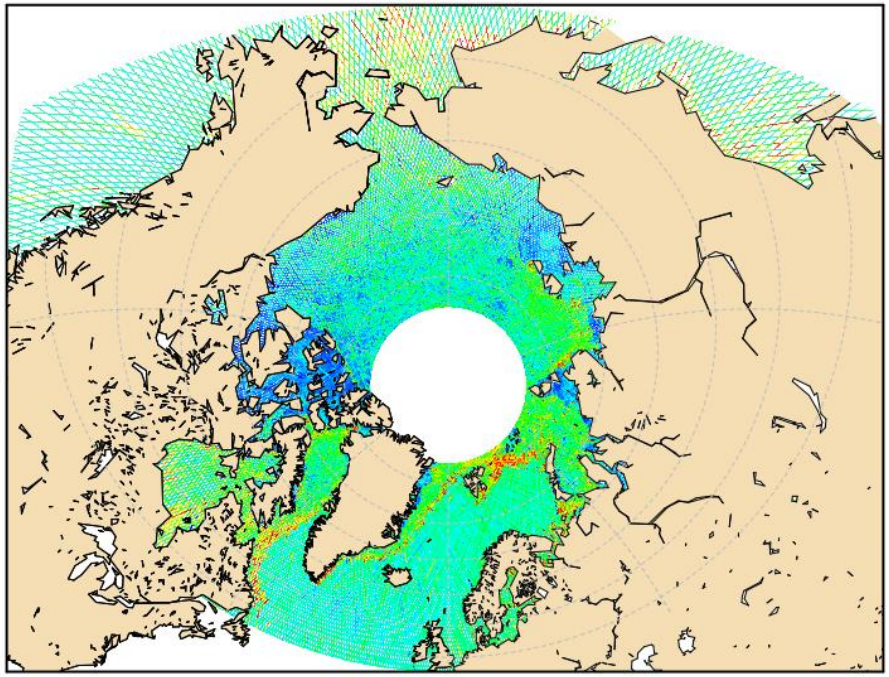

AltiKa cycle 2 track 805
AGC
AGC
30
25
20
15
10
4.0
4.1
4.2
4.3
4.4
4.5


AltiKa cycle 2 track 805
Δ(SIG0)
SIG0 Diff. (dB)
1
0
-1
4.0
4.1
4.2
4.3
4.4
4.5
LAT
DIFF SIG0_MLE4 - SIG0_MLE3
Mean = 0.175
StdDev = 0.5295
Min = -0.9991
Max = 1.801


AltiKa cycle 2 track 805
MQE
MQE (m)
0.6
0.4
0.2
0.0
4.0
4.1
4.2
4.3
4.4
4.5
LAT
MQE_MLE4
Mean = 0.004792
StdDev = 0.01006
Min = 0.0008
Max = 0.1215
MQE_MLE3
Mean = 0.02018
StdDev = 0.06372
Min = 0.001613
Max = 0.6068

Ka/Ku Sigma0 on Ice

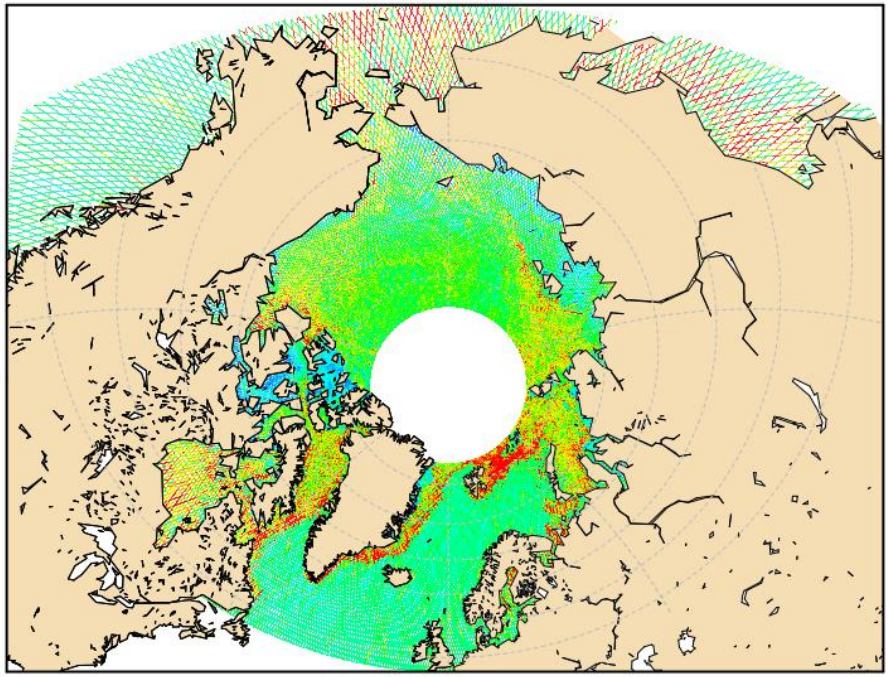
AltiKa cycle 2



Sigma0 (dB)

0 10 20 30

Envisat



Sigma0 (dB)

0 10 20 30

(cycles 88-89 : same period)

Conclusions

- Very good instrumental behavior
- MLE3/MLE4 quite equivalent at such altitude
- In flight SNR, better than expected because of margins in the link budget
- Only a few data are lost due to the atmospheric attenuation

Thank you !

Ka Sigma0 DSP

Backscatter coeff. Power Spectra
AltiKa, MLE-4 vs. MLE-3

ABS(LAT)<60
Distance to coast > 10 km
FLG_DALT == 0
FLG_ITER_SLA == 0