Bifrequency radiometer onboard AltiKa mission: issues and way of improving the retrieval

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Radiometers onboard altimetry missions

NASA/CNES/NOAA/Eumetsat missions

Topex-Poseidon/TMR
Jason-1/JMR
Jason-2/AMR

European missions

ERS-1/MWR
ERS-2/MWR
Envisat/MWR
S3/MWR

CNES/ISRO AltiKa

NASA/CNES/NOAA/Eumetsat		European / AltiKa
18 (18.7) GHz	Sea Surface	Altimeter wind $\sigma0$ Ku, $\sigma0$ Ka
21 (23.8) GHz	Water Vapor Content = dh	23.8 GHz
37 (34) GHz	Cloud Liquid Water content	36.5 (37) GHz

Retrieval algorithms for bifrequency radiometers

- ERS 1 & 2 algorithm (Eymard et al, 1996)

  dh= c0 + c1 ln (280. – TB23.8) + c2 ln (280. – TB36.5) + c3 (Ws -7.)

- Envisat & S3 algorithm (Obligis et al, 2006)

  dh= NN (TB23.8, TB36.5, σ0 Ku)

- What about AltiKa ?

  => Formulation of radiometer algorithm similar to the Envisat ones

Inversion algorithm development

Simulated
TB23.8, TB37
Sigma 0 Ku or Ka

Direct model
MEAS=f(geoφ)

Inverse model
geoφ=f(MEAS)

Radiative Transfer model

Neural Net (Weights, Bias)

ECMWF analyses
2D surface: sst, wind
3D profiles:T,P, Wv, Wc

Computation of geoφ parameters

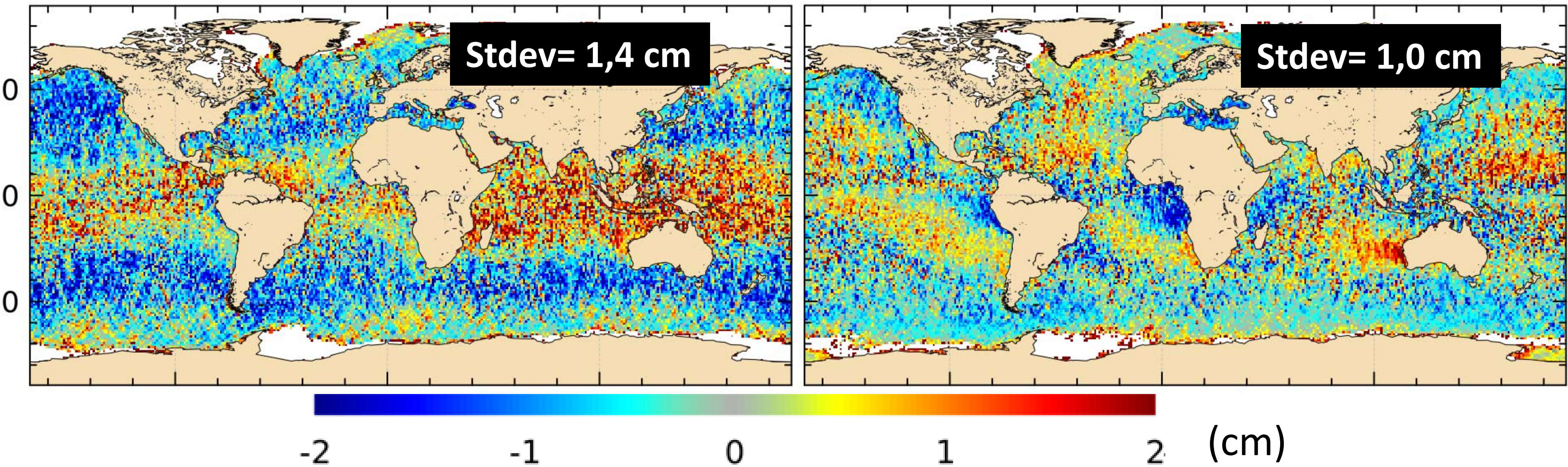
geoφ parameters
column-integrated
dh, Att, Wc, Wv

In-flight results

ECMWF – RADIOMETER dh (cm)

ALTIKA – cycle 1 (P1)

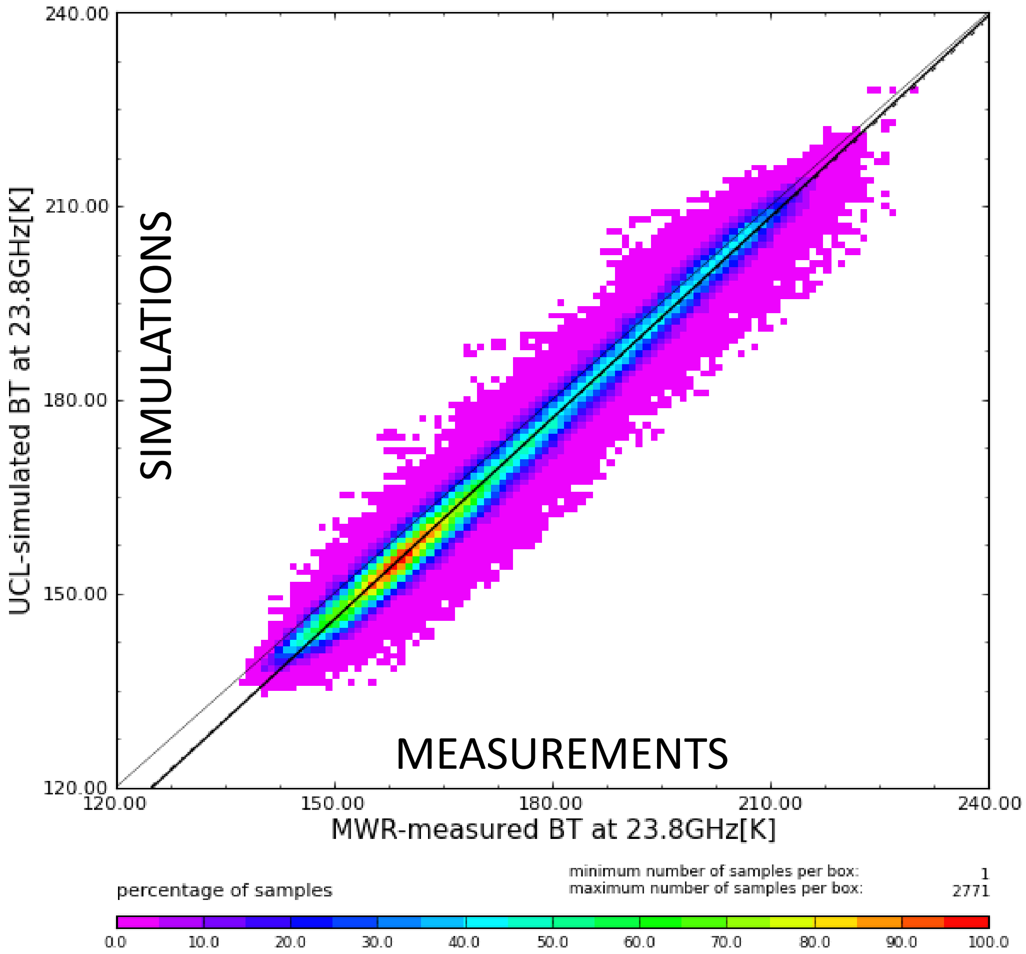
Envisat – cycle 75



- Performances over measurements degraded with respect to the Envisat ones
- Additional analyses are required
- Algorithm formulated over simulations
- Consistency between simulations and measurements ?

Once in-flight: measurements vs simulations

ALTIKA – **Raw 23.8 GHz TBs** – 4 months of collocated data

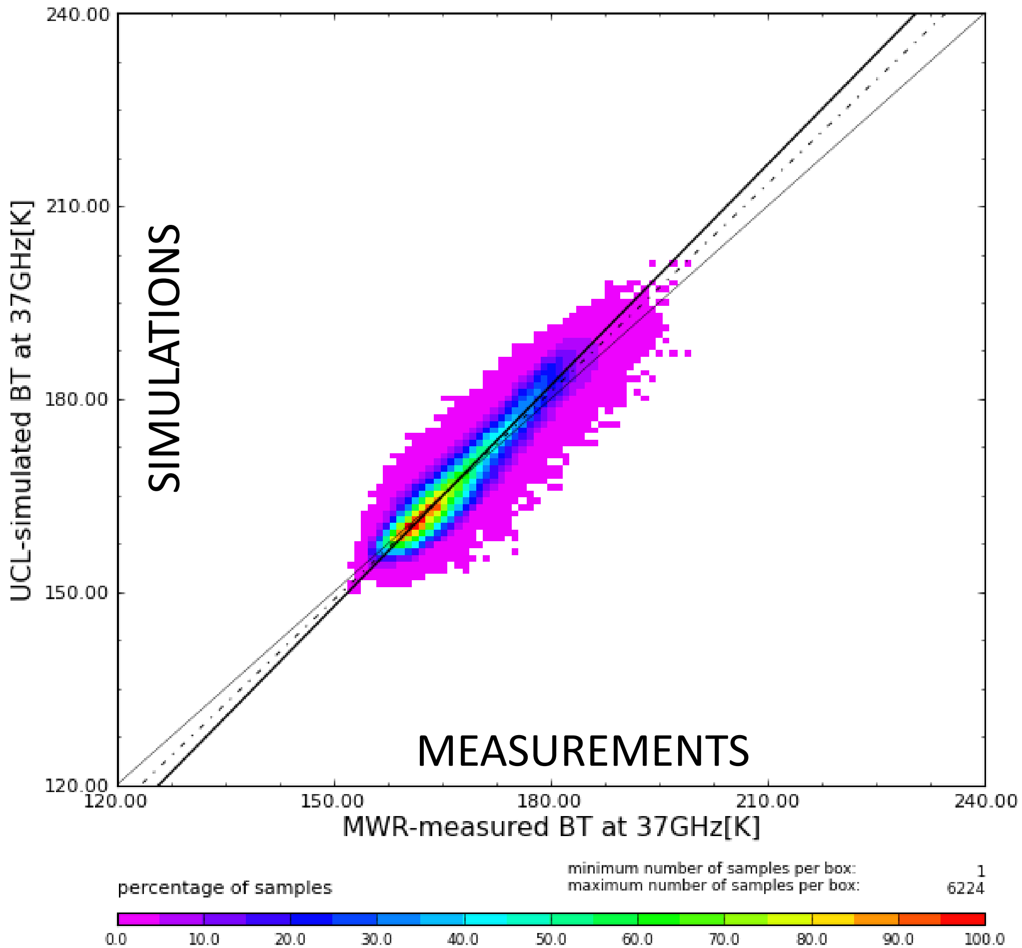


Bias=-3.1 K

Stdev=2.8 K

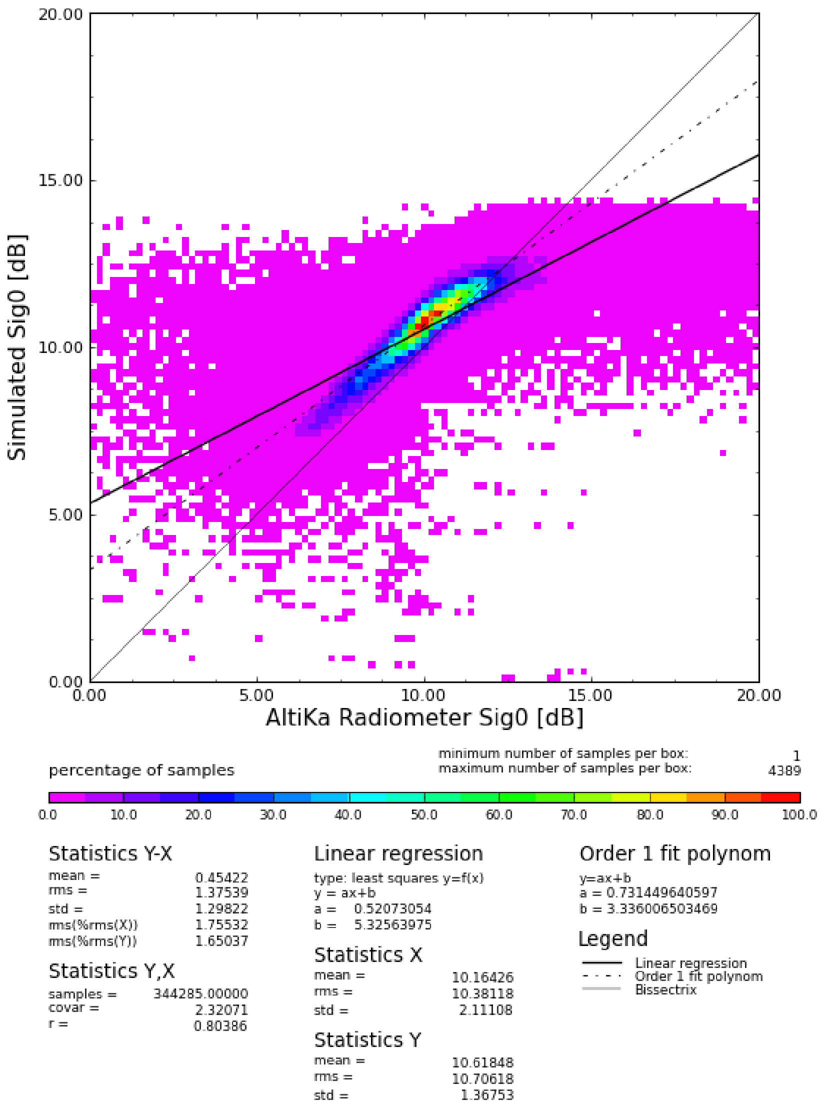
Once in-flight: measurements vs simulations

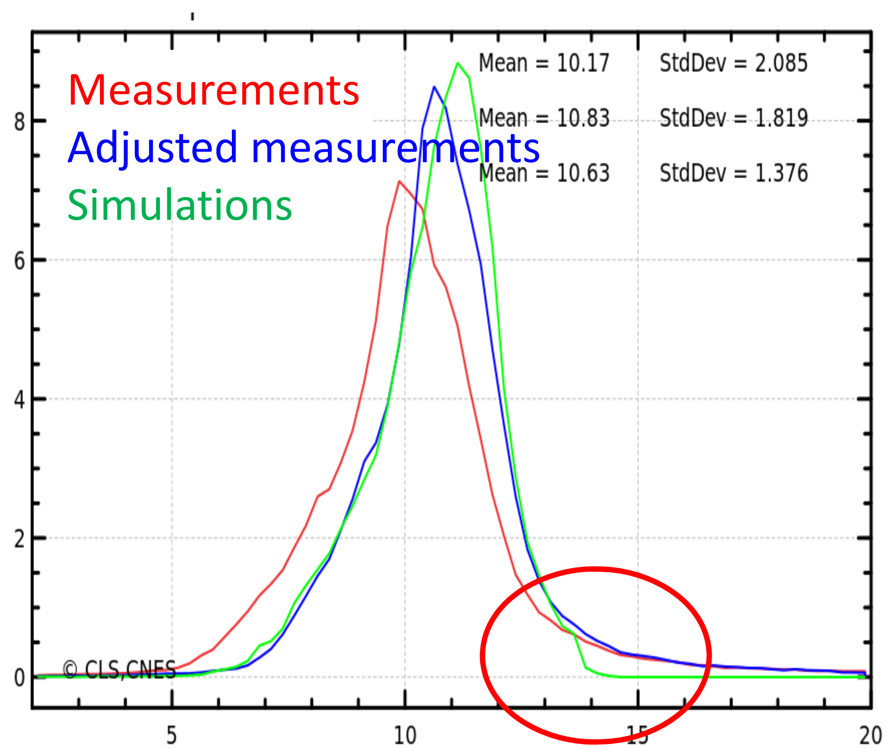
ALTIKA – **Raw 37 GHz TBs** – 4 months of collocated data



Bias=0.3 K
Stdev=3.0 K

Once in-flight: measurements vs simulations





Once in-flight: measurements vs simulations

- For the brightness temperatures, the agreement between measurements and simulations is not perfect but satisfactory, at the level of the one obtained with the Envisat mission

- For sigma0 in Ka band, necessity to better understand the discrepancies (mainly observed for high values = low wind speed)
  - Simulations: What is the ability of our emissivity model to simulate accurately the backscattering coefficient in Ka band for low and high winds ?
  - Measurements: Sigma0 is not a direct measurement of the instrument. What is the accuracy of the estimation, what is the impact of the retracking ?
  - Weak weight of the sigma0 in the retrieval algorithm: How to explain the observed impact on wet tropo correction ?

- **In parallel to these investigations, development of alternative L2 radiometer algorithm**

Alternative retrieval algorithm ?

- ERS 1 & 2 algorithm

  $$dh = c0 + c1 \ln(280. - TB23.8) + c2 \ln(280. - TB36.5) + c3\,(WSalt - 7.)$$

- Envisat algorithm

  $$dh = NN(TB23.8,\ TB36.5,\ \sigma 0\ Ku)$$

- First AltiKa algorithm

  $$dh = NN(TB23.8,\ TB37,\ \sigma 0\ Ka)$$

  Not mature enough

- What about a new AltiKa algorithm ?

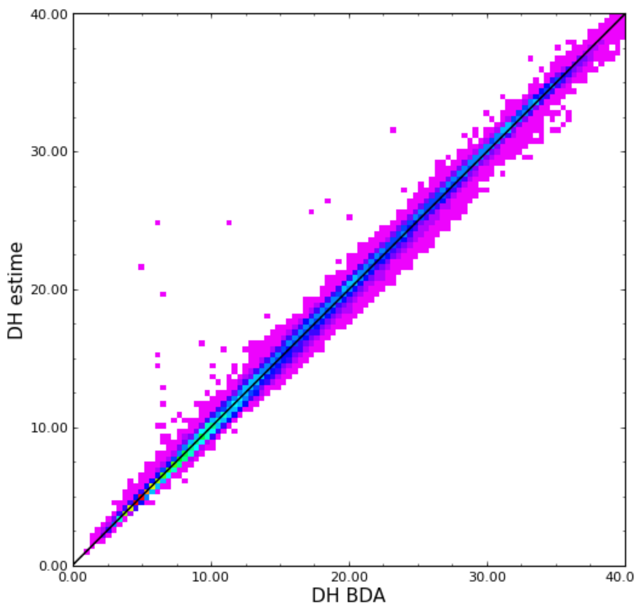
  $$dh = NN(TB23.8,\ TB37,\ WS)$$

Building of the learning database

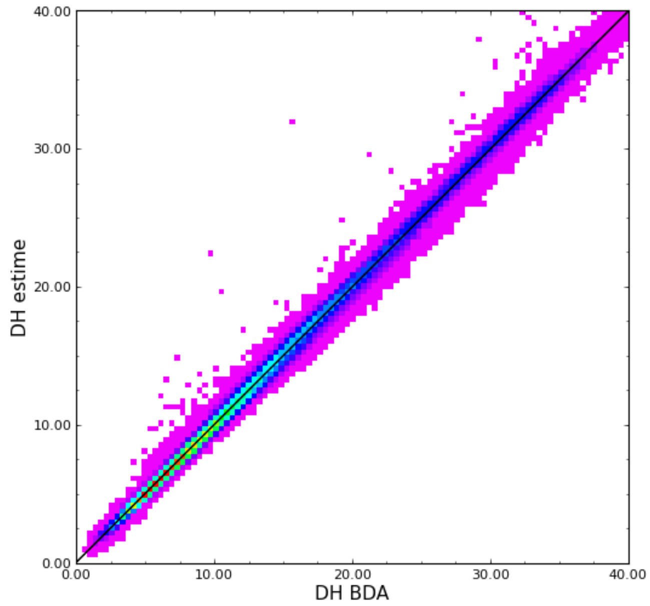
dh=NN(TB23.8, TB37, sigma0Ka) => dh=NN(TB23.8, TB37, Ws)

Performances over simulations

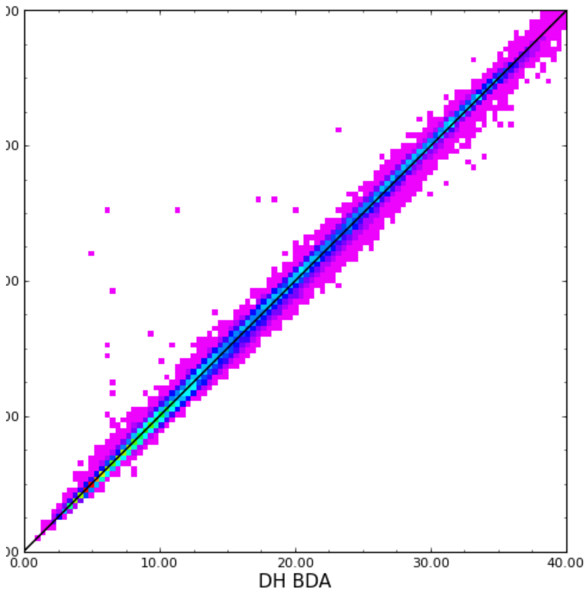
ENV
dh=NN(TB23.8, TB36.5, sigKu)



ALTIKA
dh=NN(TB23.8, TB37, sigKa)



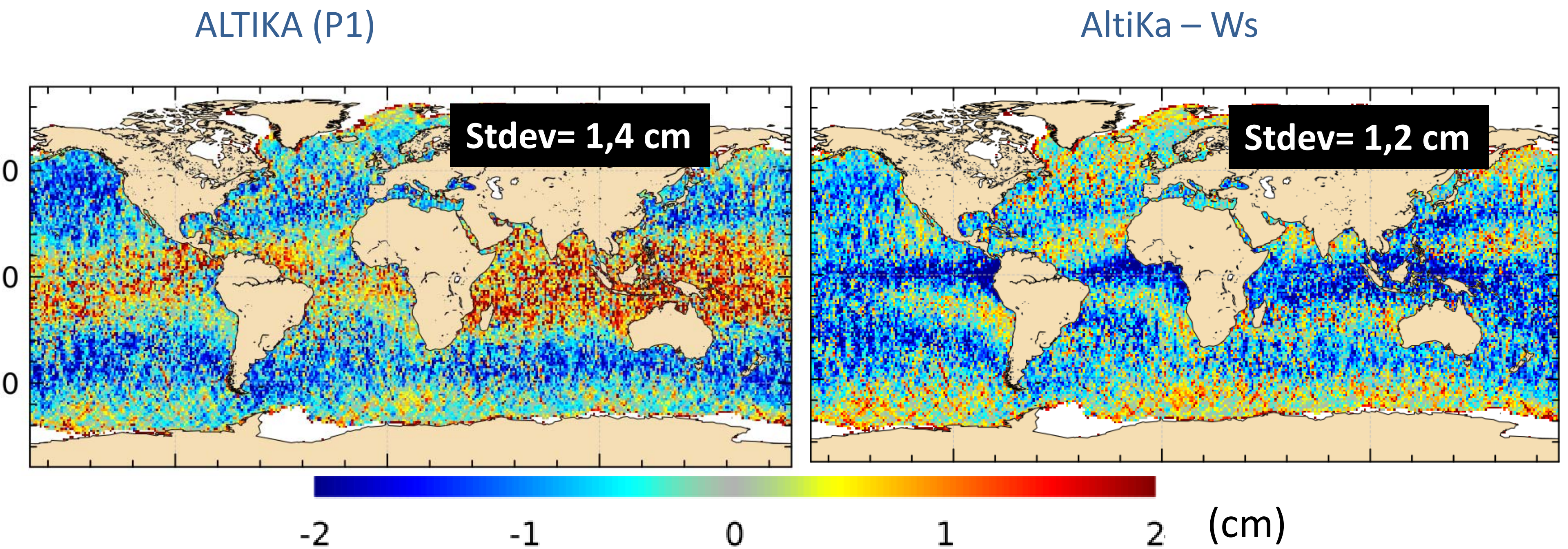
AltiKA
dh=NN(TB23.8, TB37, Ws)



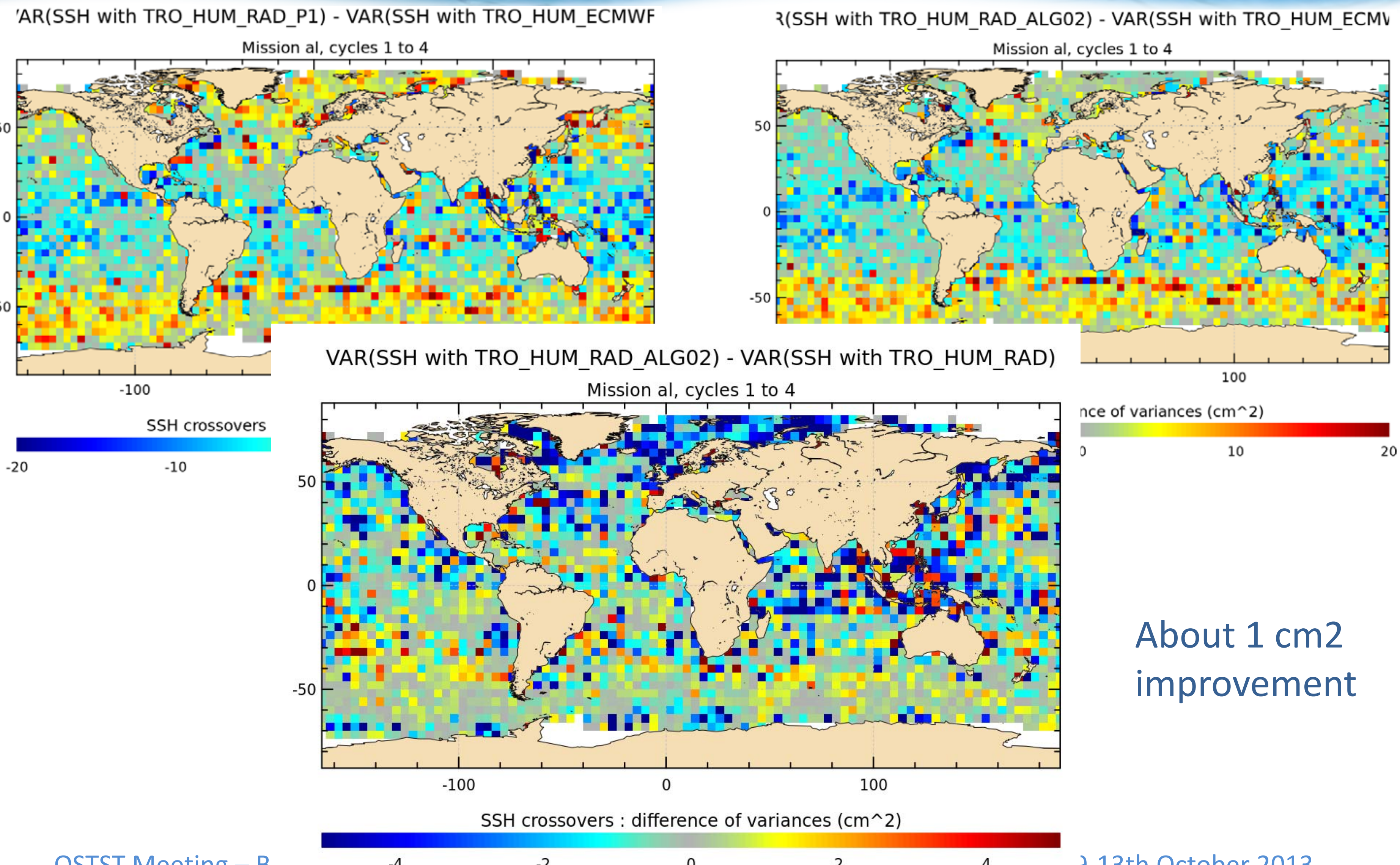
- Over simulations, similar performances
- But over measurements ?
- Algorithm applied with the ECMWF wind speed

Performances over measurements

ECMWF – RADIOMETER dh (cm)



Performances over measurements



About 1 cm2 improvement

Conclusions

- For the Altika mission, at that time, the quality of the radiometer wet tropospheric correction is not at the level of the Envisat one.
- This is mainly due to the fact that the sigma0 in Ka band, used in the retrieval algorithm, is poorly known:
  - No accurate emissivity model to simulate it
  - Quality of the sigma0 altimeter measurement to be assessed (dependency on retracking)
  - Especially in areas of low and high wind speed (inaccuracy of the model, poor representativity in the learning database)
- Development of a new algorithm based on wind speed to overcome these problems
  - Algorithm applied with the ECMWF wind speed
    - ➢ Limitations: poor accuracy, low spatial and temporal resolution
  - But still improvements of the performances

Perspectives

- When available, use of altimeter wind speed instead of ECMWF wind speed in the new algorithm : should significantly improve the performances

- The potential of adding SST as an additional input (See Thao's talk) should be studied

- In parallel, improvements in our knowledge of the interactions between sea surface and electromagnetic waves in Ka band is necessary. This will allow realistic simulations and development of accurate algorithms

- Impact on the other radiometer parameters seems to be minor, but this has to be assessed

Atmospheric attenuation

- Retrieval algorithm similar to the wet tropo one Att_Ka=NN(TB23.8,TB37, sigma0Ka)
- Comparison with Lillibridge-Sharoo model attenuation :
  - After P1 adjustment no more bias between model and radiometer values
  - Model estimation is smoother than MWR one