IMPACT OF CLOUD AND RAIN EVENTS ON SARAL/ALTIKA MEASUREMENTS

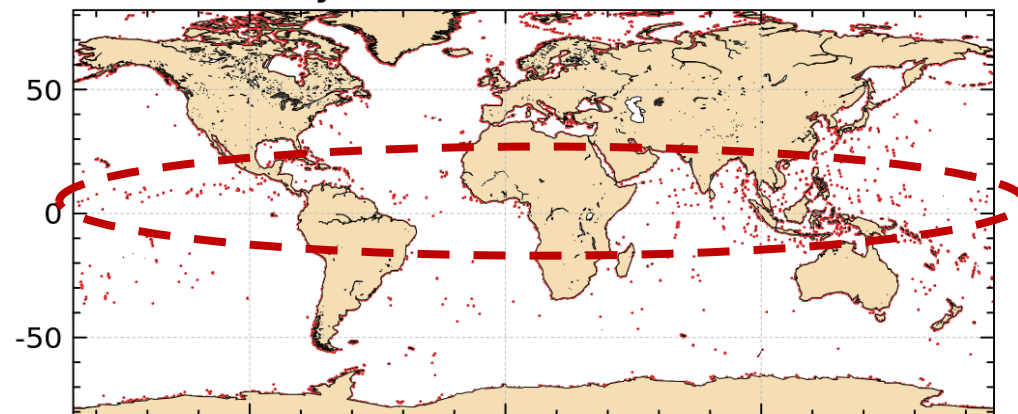JC. Poisson, B. Picard, P. Thibaut, M. Simeon, D. Hoang
N. Steunou, N. Picot

Summary

1. AltiKa characteristics

1. Impact of rain events on AltiKa Waveforms

2. AltiKa data collocation with SSMI and WindSat rain rate measurements

3. Towards a radiometer rain rate products for AltiKa

4. Impact of rain rate on AltiKa altimeter geophysical estimates

5. Detection of AltiKa measurements impacted by rain

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SARAL

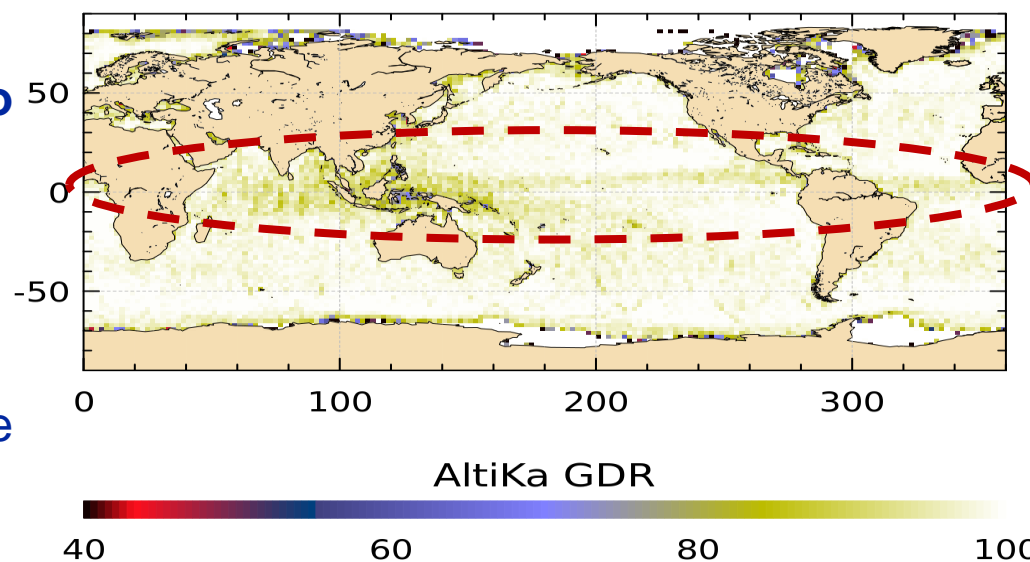SALP

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AltiKa characteristics

- AltiKa is a mono frequency altimeter, operating in Ka-band which is strongly affected by the presence of atmospheric water.

- The altimeter acquires data **96 % of the time** (all surfaces combined)

- **Rate of data lost** due to rain **over ocean** is lower than anticipated **< 0.1%** thanks **to margins into the link budget.**

- **The % of edited data on thresholds** (as mentioned in the handbook products) is more important in low latitudes mainly due to rain cells
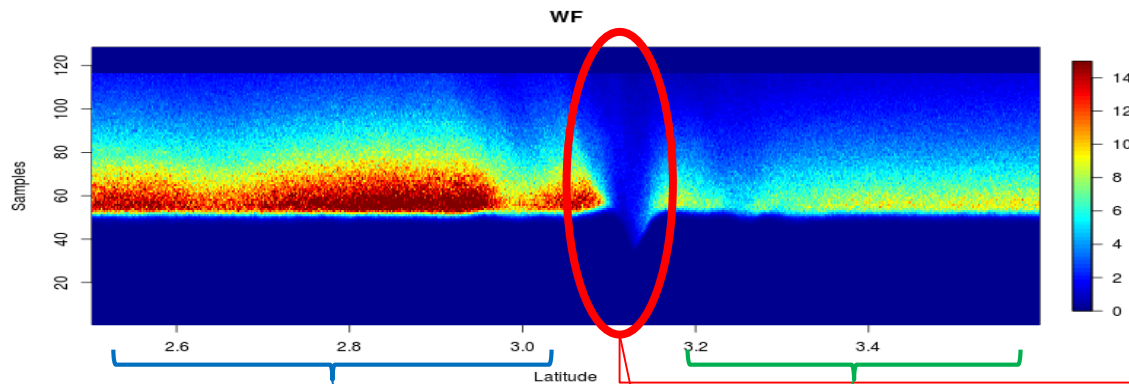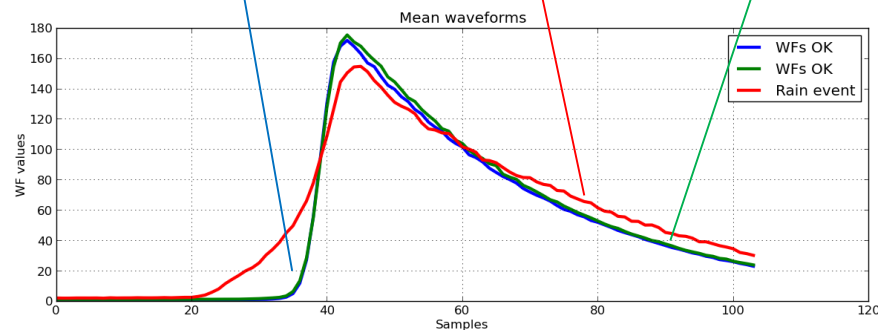
Cycle 3 Pass 0001-1002

% of data valid on thresholds

AltiKa GDR

40   60   80   100

AltiKa verification meeting : India 22-24 April 2014

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Impact of rain on AltiKa waveforms

Rain event induce strong attenuation of the waveforms
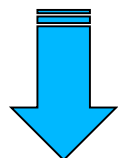
But also fast temporal variations of the shape of echoes
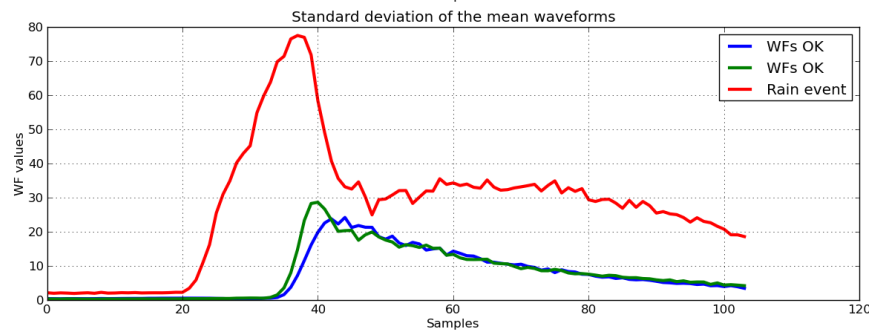
➔ All geophysical estimates are impacted

Collocation with SSMI and WindSat rain rate measurements

SSMI F16

SSMI F17

WINDSAT

Get Rain Rate for AltiKa from external sources
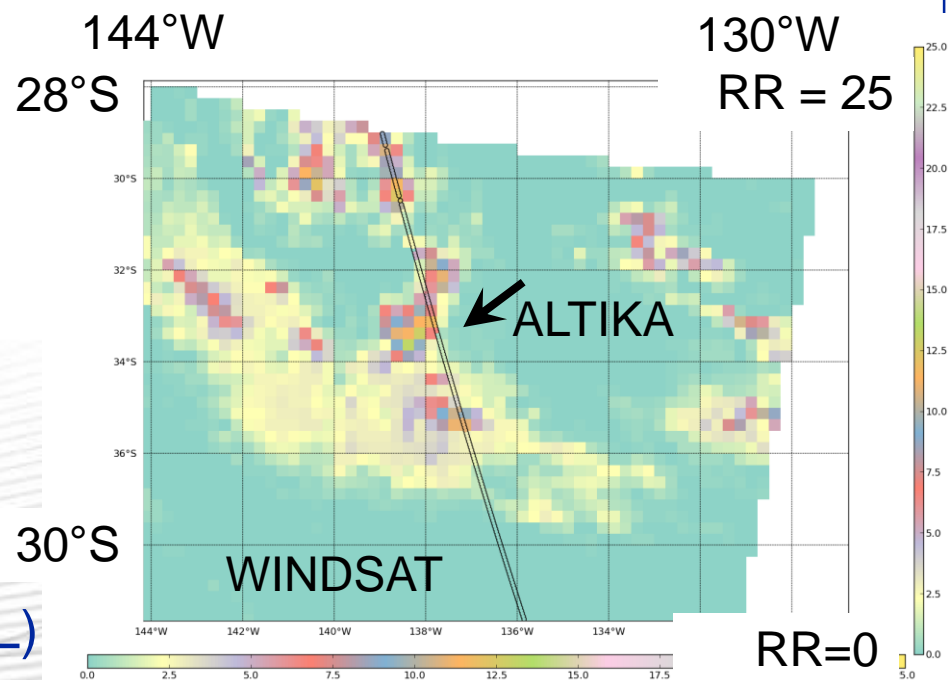
orbit swath 0.25° gridded product

⬇

get closest RR
(wrt to AL position)

⬇

select smallest $\Delta t = abs(t\_RR - t\_AL)$
(among the external sources)

144°W
28°S

130°W
RR = 25

ALTIKA

30°S
WINDSAT

RR=0

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Towards a radiometer rain rate product for AltiKa

- Rain for AltiKa combined :

  - **RR [mm/hr]**
    - ➔ ~ 80 % of AL measurement are covered
    - ➔ including 10% of RR > 0

  - **Confidence Flag** (based on LWC and TB@37)
    - ➔ ~ 70% of RR > 0 are considered effective rain events

- **Δt** = abs(t_RR – t_AL)
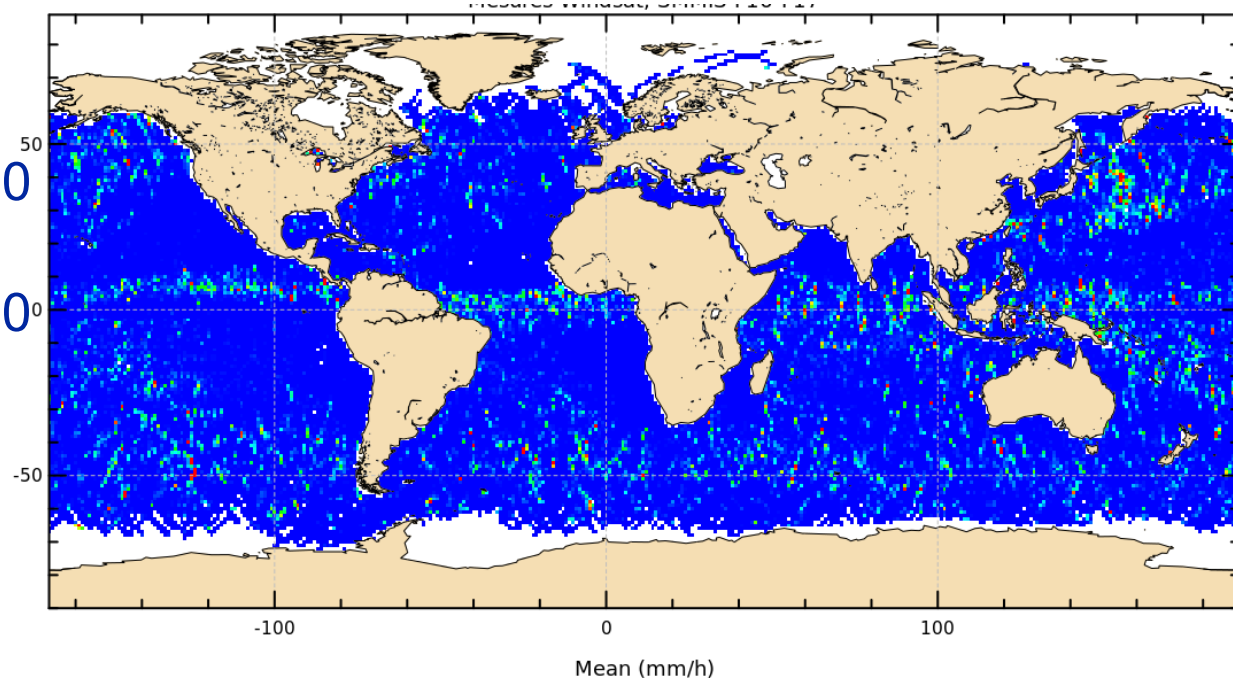 - ➔ ~ 80% of "true" RR > 0
    with Δt < 60 min
  - ➔ ~ 10% of "true" RR > 0
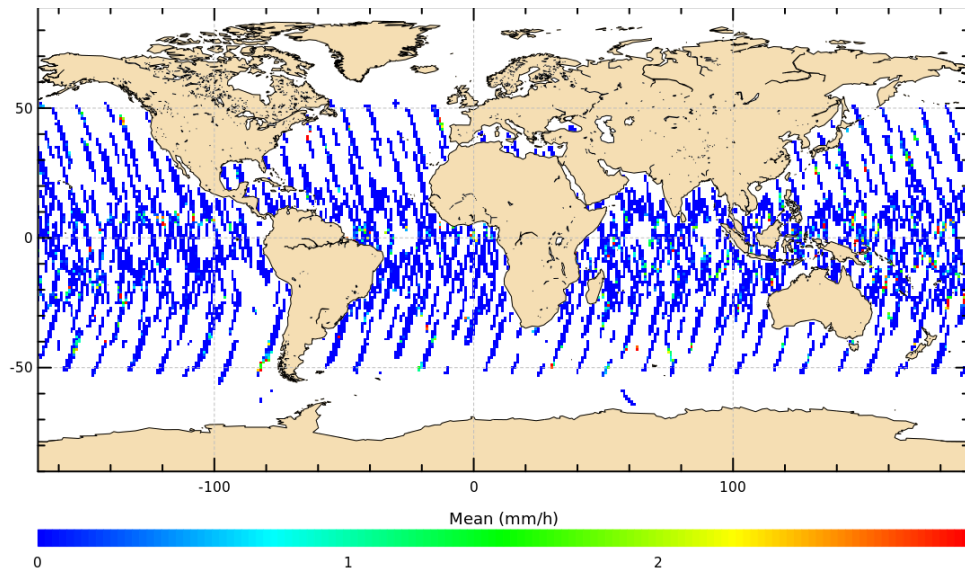   with Δt < 10 min

➔ will be used
as a learning dataset
for an integrated product

Mean (mm/h)

Impact of rain rate on AltiKa geophysical estimates

- As rain cells can appear, move and disappear very quickly, we select collocated data with a $\Delta t < 5 \min$ to look at the impact of the rain rate on the geophysical parameters estimated from AltiKa waveforms
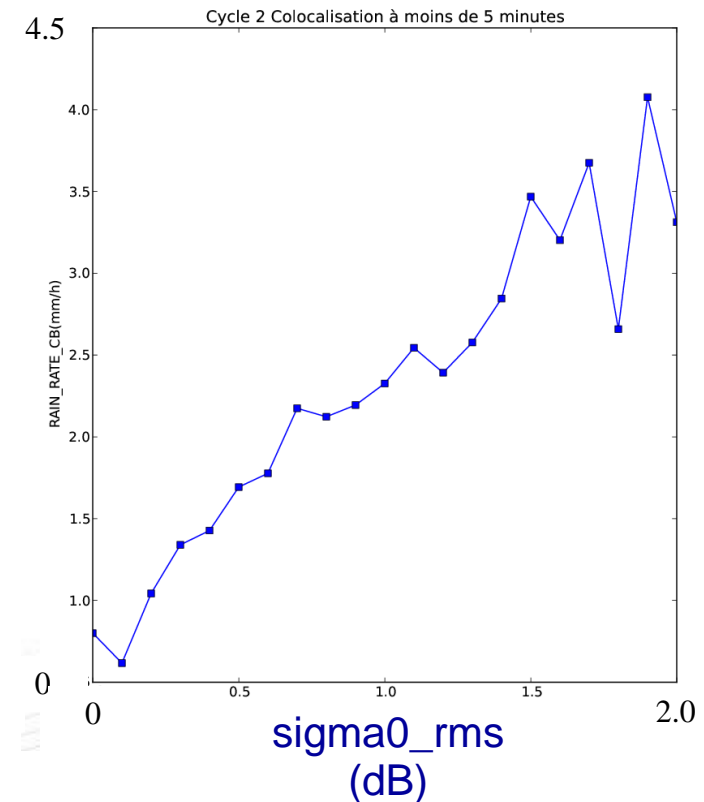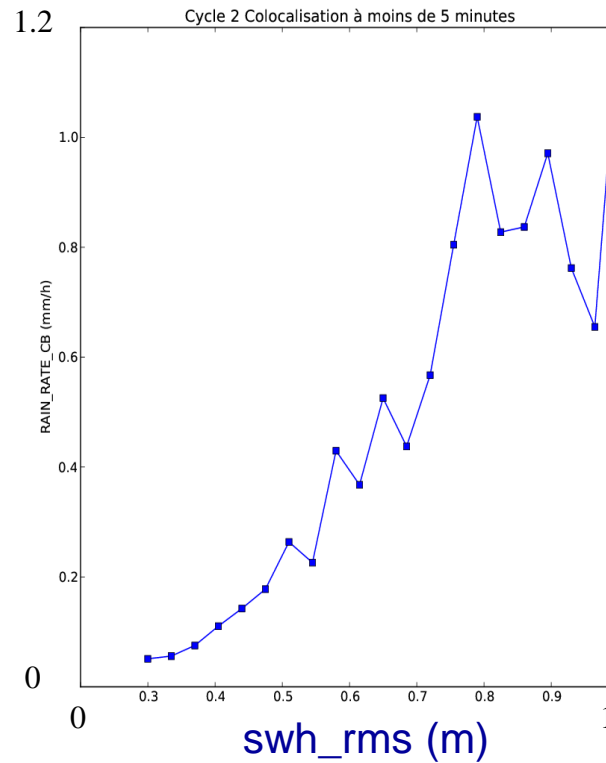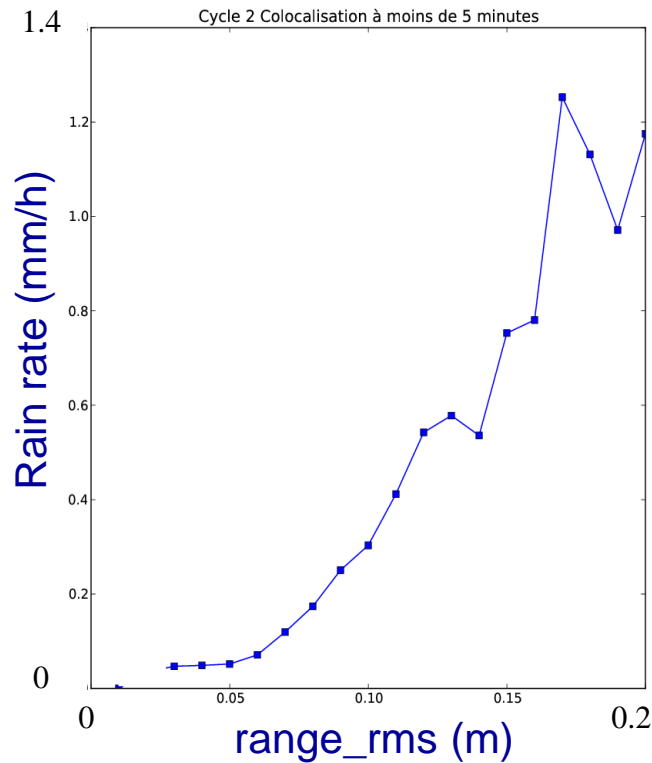
Collocated rain rate measurements for $\Delta t < 5 \min$

Distribution of rain rates for $\Delta t < 5 \min$

RAIN_RATE_3CB   Nbr = 8098 Mean = 0.6867 StdDev = 0.7159 Min = 0.1 Max = 3
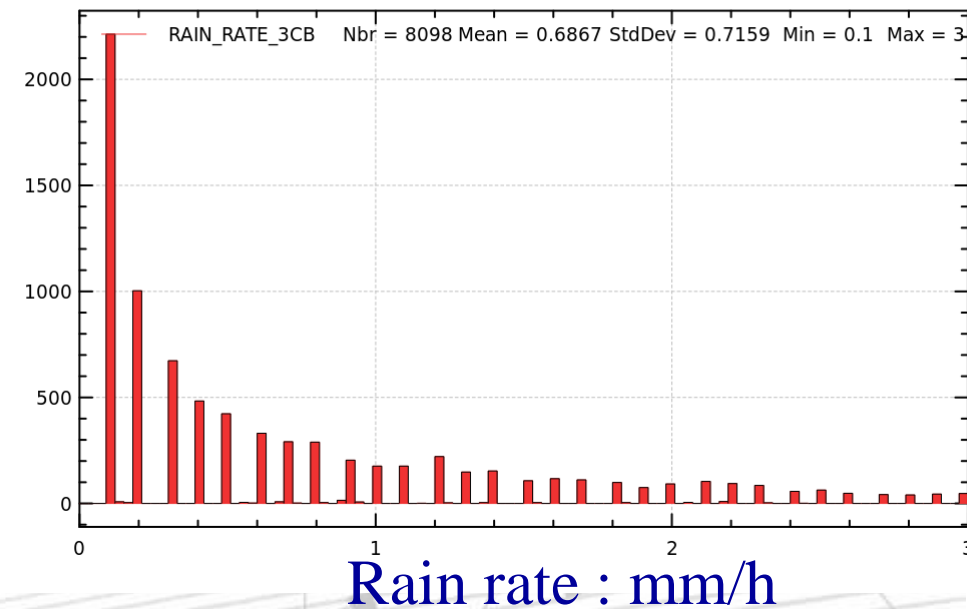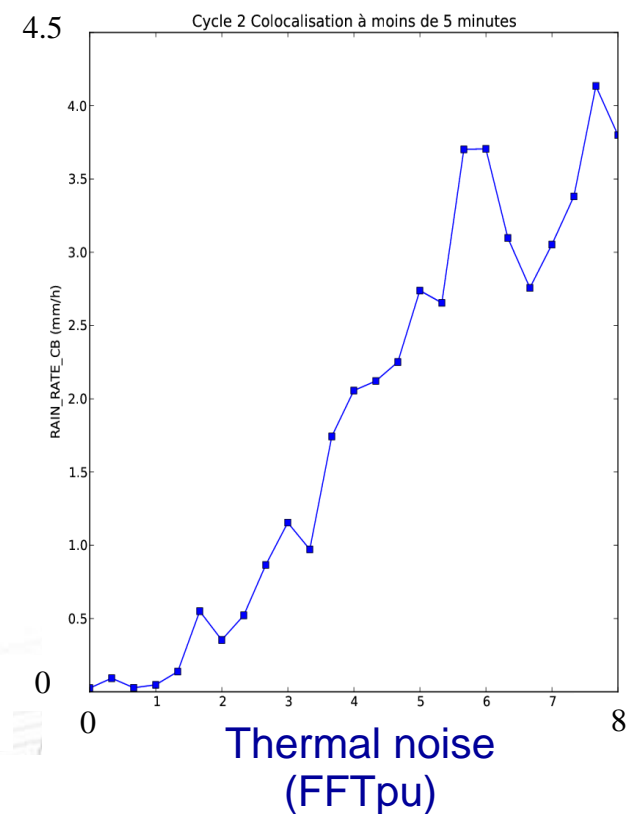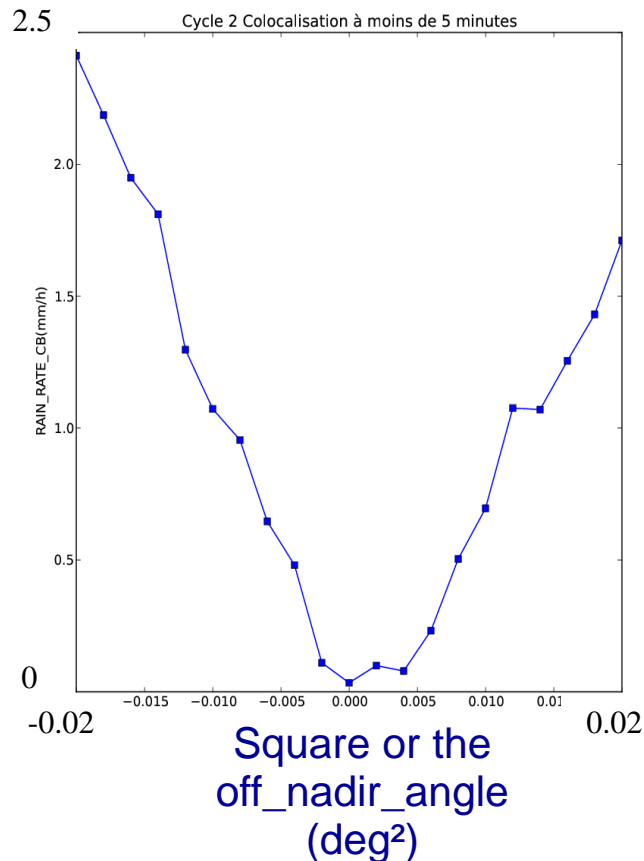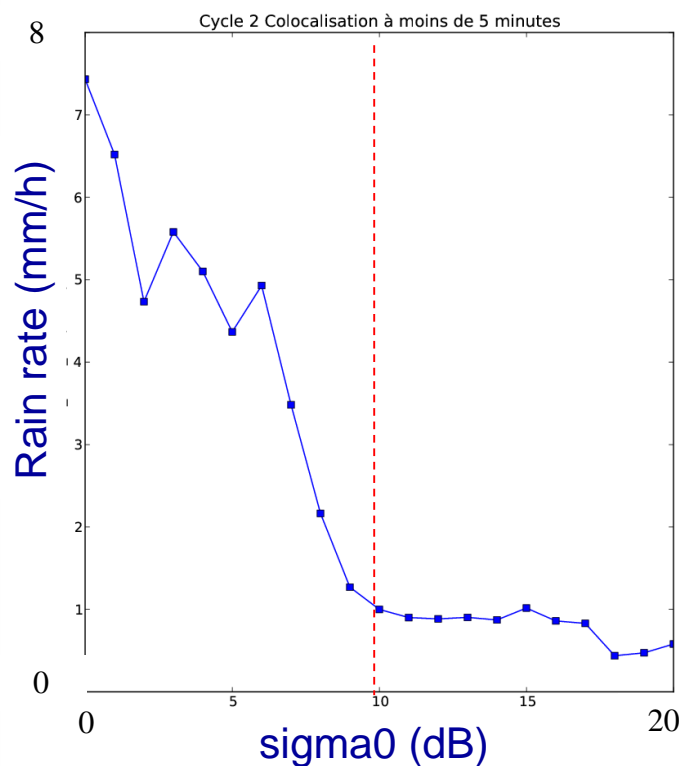
Rain rate : mm/h

- As expected, most rain events are weak (less than 3 mm/h)

Impact of rain rate on AltiKa geophysical estimates

- Rain cells strongly increase the noise on range, swh and sigma0.
- The impact of rain rates is more important on the sigma0
- Relation between rain rate and range_rms/swh_rms is not linear

Impact of rain rate on AltiKa geophysical estimates

- As expected : strong attenuation of the sigma0
- Strong impact on the **square of the off_nadir_angle** and the **thermal noise**
  - ➔ the high sensitivity of those 2 parameters can be exploited

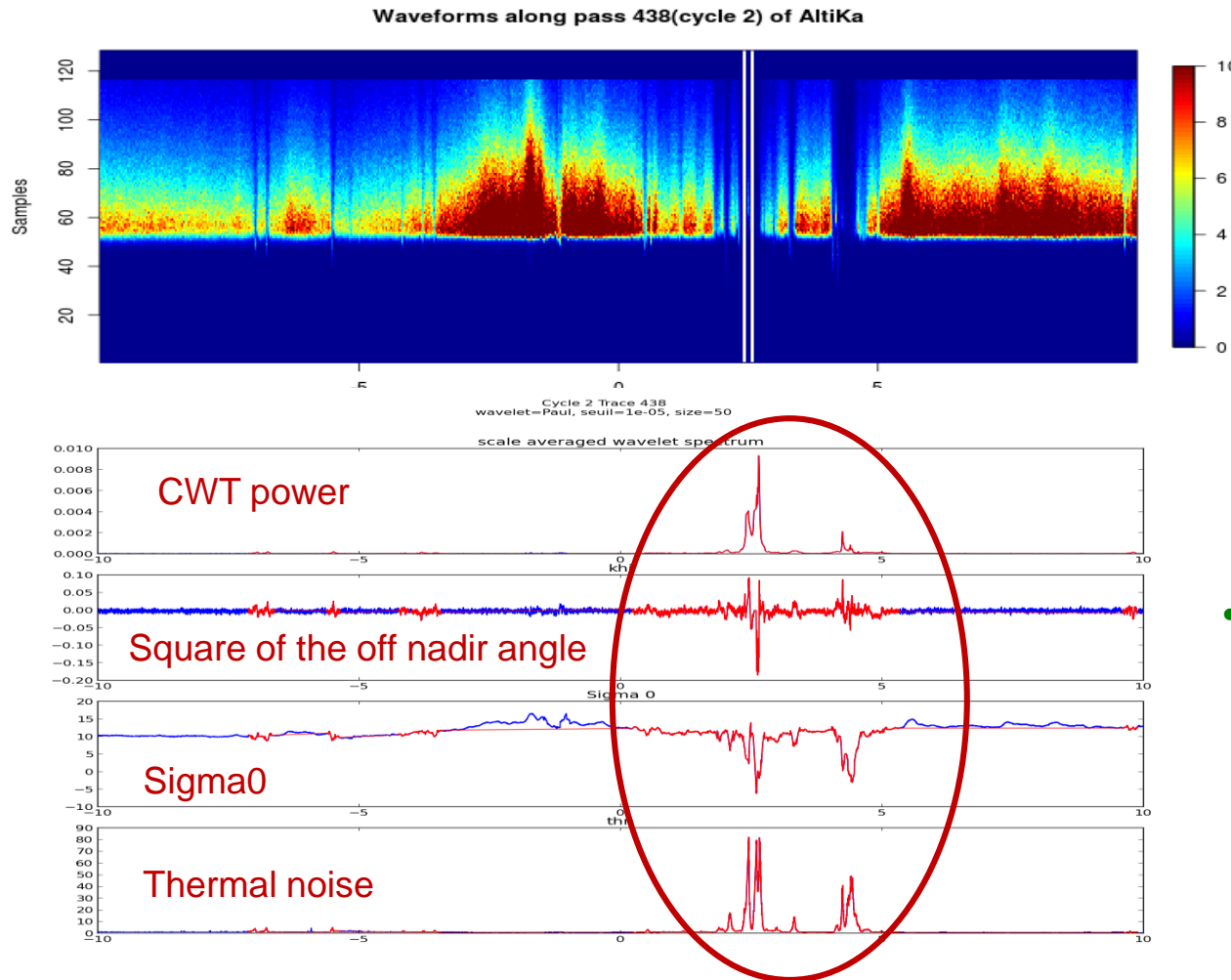# Detection of measurements impacted by rain : Matching Pursuit

- The Matching Pursuit algorithm was developed by J. Tournadre to detect quick and strong temporal variations of the slope of the waveform trailing edge

- Combined with the 1Hz radiometer liquid water content, it can be a good processing to identify altimeter measurements impacted by rain at 1Hz

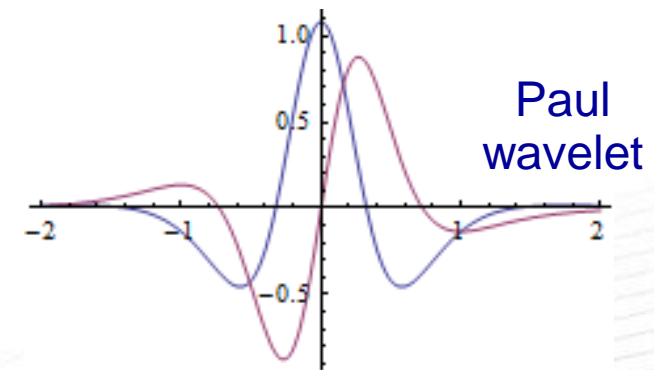- Since patch 2, this flag (available in AltiKa GDR products) provides good detection

Mean (%)
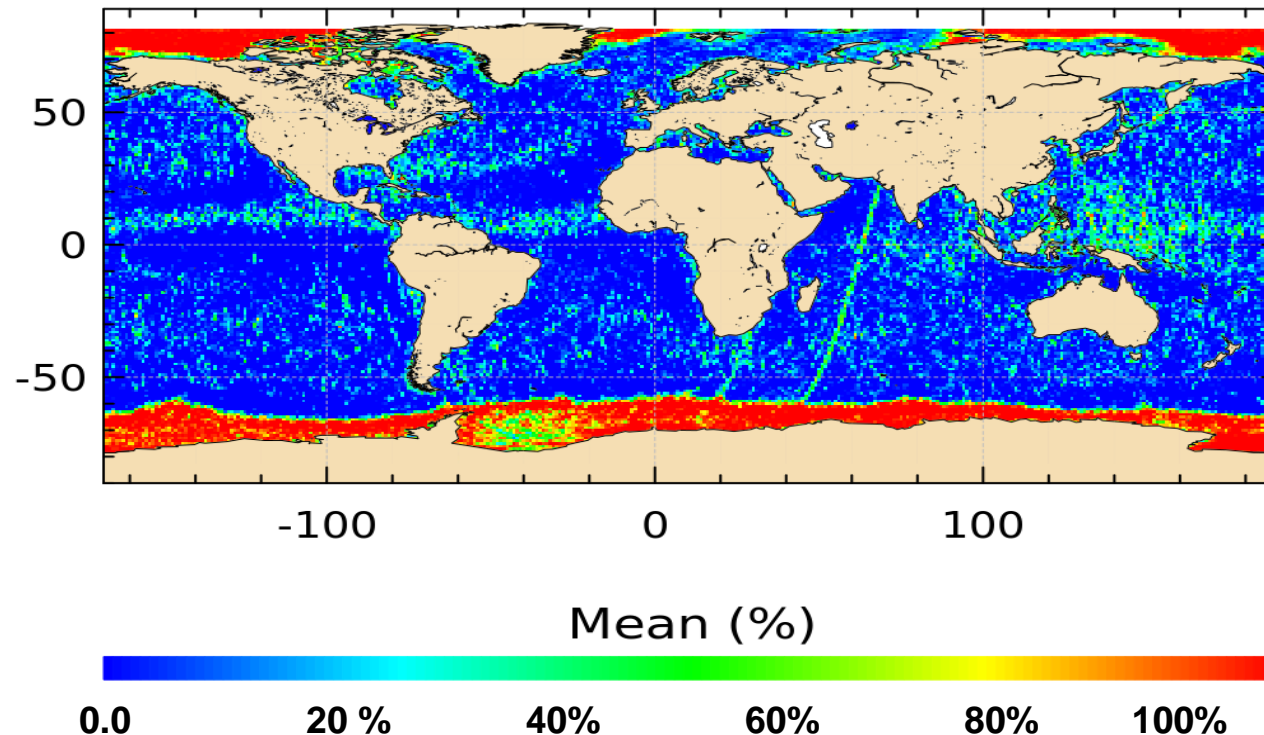
~ 10% of data are identified on ocean between lat +/- 50°

Detection of measurements impacted by rain : CWT

- Another relevant detection method consists in computing a Continuous Wavelet Transform on the square of the off nadir angle derived from the waveform.

Waveforms along pass 438(cycle 2) of AltiKa

$$W_n(s) = \sum_{n'=0}^{N-1} x_{n'} \psi^* \left(\frac{(n'-n)\delta t}{s} \right)$$

Paul wavelet

Cycle 2 Trace 438
wavelet=Paul, seuil=1e-05, size=50

scale averaged wavelet spectrum

CWT power

Square of the off nadir angle

Sigma0

Thermal noise

- Combined with the thermal noise level, the CWT is a powerful processing to identify geophysical phenomena on altimeter measurements like rain events
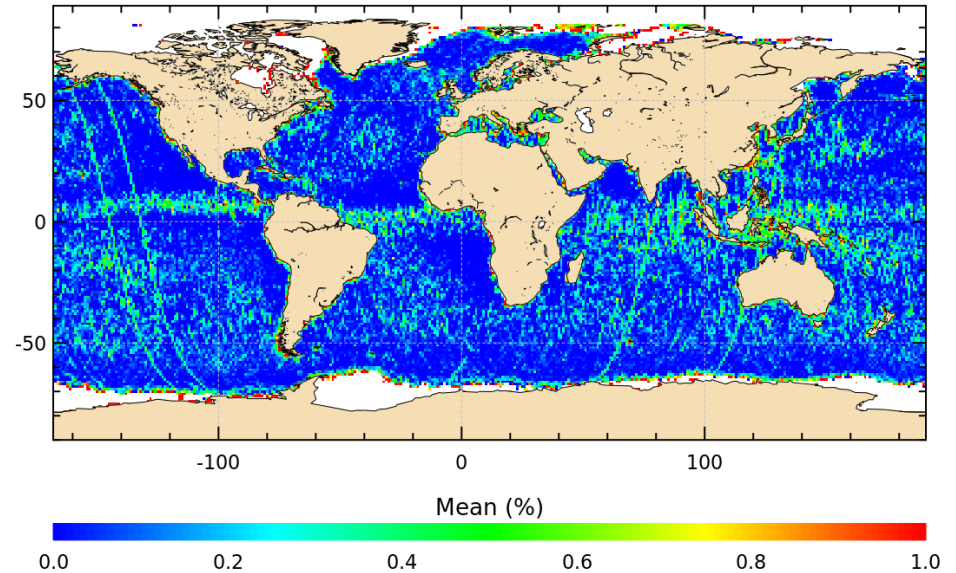
Continuous Wavelet Transform

- The combination of CWT and threshold on thermal noise identifies ~ 10% of 40Hz data
- SSMI and WindSat measurements provides ~ 9.6 % of rain rates > 0
  → Good agreement between measurements and the CWT detection

% of SSMI and WindSAT measurements with rain rate > 0
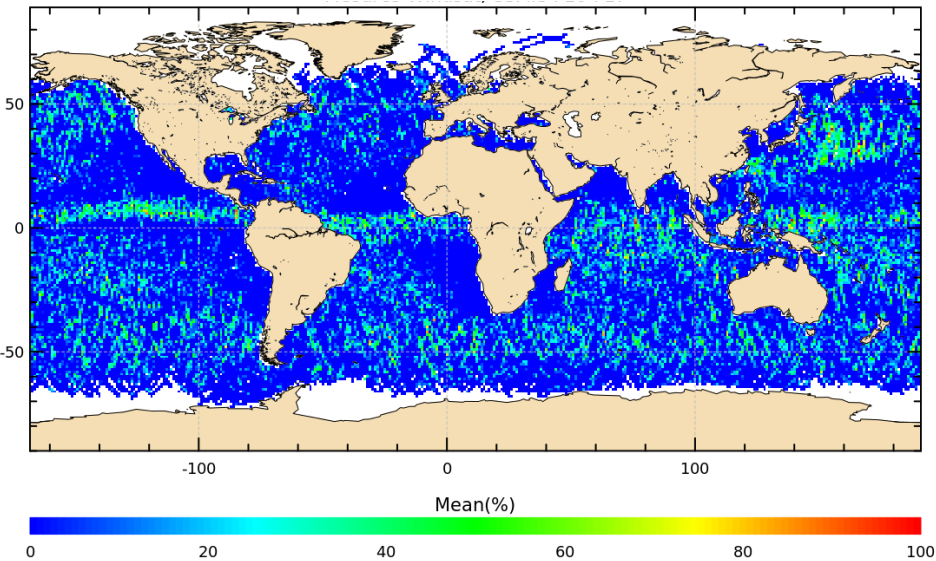
% of flagged data by the CWT + Thermal noise

Conclusions

❑ Even if the Ka-band is very sensitive to the presence of atmospheric water, data lost **is lower than expected** thanks to margins in the link budget.

❑ However, waveforms and thus all geophysical estimates derived from WF are impacted by rain events ➔ the **slope of the trailing edge and the thermal noise** parameters can be used to detect rain events.

❑ Several methods to detect rain events exist : The Matching Pursuit algorithm provides good 1Hz rain flag when combined with the radiometer liquid water content and is available in AltiKa products.

❑ A powerful detection algorithm is constructed from the combination of the CWT applied on the slope of the trailing edge and a thermal noise threshold.

➔ Results are in agreement with the radiometer measurements (colocalized) and can be directly used at 40Hz to edit data polluted by rain events

❑ Both algorithms estimate that ~10% of AltiKa measurements are affected by rain in deep ocean.

Thank you for your attention