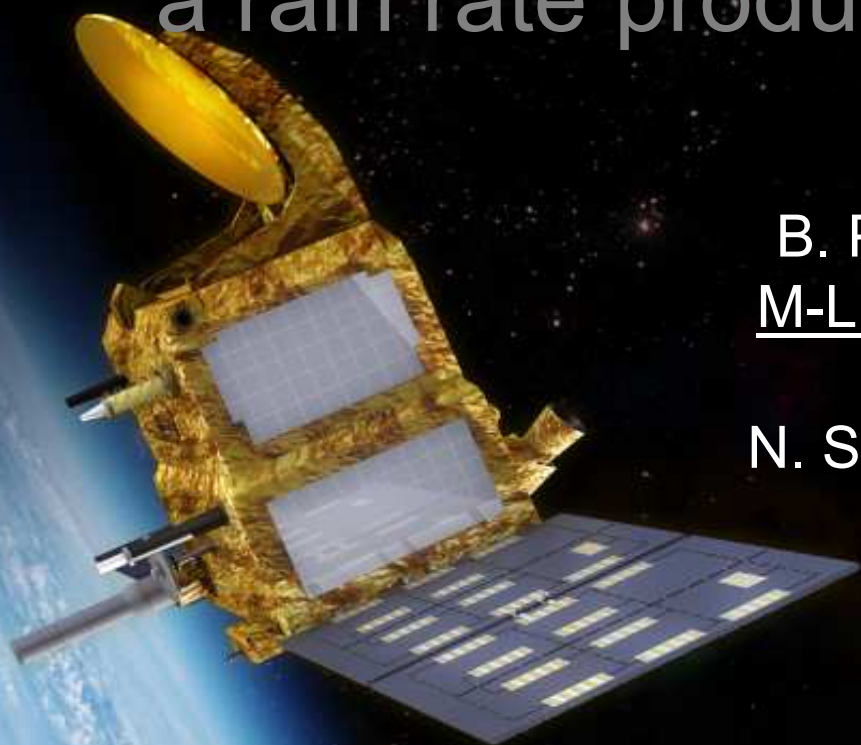
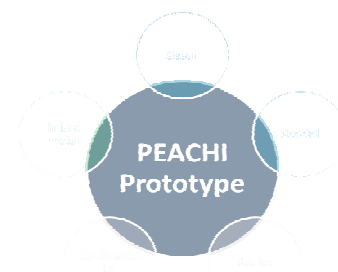


# Raindrops keep falling: a first step towards a rain rate product for AltiKa



B. Picard<sup>(1)</sup>, M. Siméon,  
M-L Frery<sup>(1)</sup>, E. Obligis<sup>(1)</sup>  
L. Eymard<sup>(2)</sup>  
N. Steunou<sup>(3)</sup>, N. Picot<sup>(3)</sup>

(<sup>1</sup>): CLS  
(<sup>2</sup>): IPSL  
(<sup>3</sup>): CNES



Ocean Surface  
Topography Science  
Team

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Konstanz, Germany

# Let's the stormy clouds chase (\*)

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- A first altimeter is measuring range at Ka band, with no loss on valid data availability
- A “closest” rain rate (RR, mm/hr) product is built from observations provided by instruments dedicated to the atmosphere monitoring
- The goals are
  - to have a reference allowing to identify rain and no rain events
  - potentially to fix an upper limit for the rain rate above which the impact on altimeter measurements is critical.

(\*) *Singing in the rain*, Kelly, Renolds, O'Connor, 1952

# The closest thing to rain (\*)

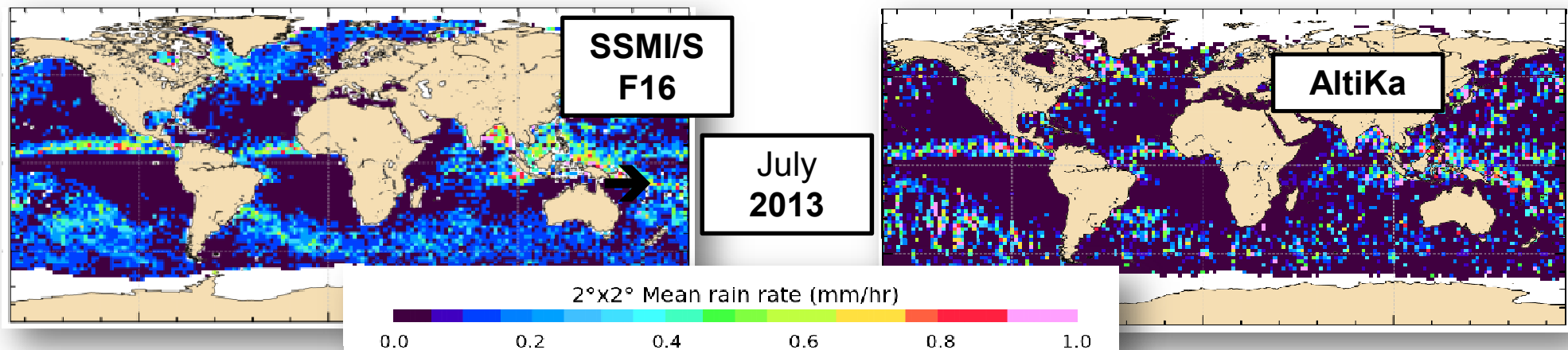
- Three different sources have been used:  
SSMIS F16 and F17 (DMSP) and Windsat (Coriolis).  
Rain rates products are generated by Remote Sensing System.



(\*) Swings, Josh Ritter, 2003

# The closest thing to rain (\*)

- For a given measurement of AltiKa, **the closest observation in time and space is kept**
- Good consistency of the rain rate product for AltiKa even if some gaps can be observed when no external data could be found



(\*) Swings, Josh Ritter, 2003

# The closest thing to rain (\*)

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- Definition of a flag of confidence:
  - Rain
  - No rain
  - “false alarm” : In order to take into account errors due to the “interpolation” scheme, if the “closest” RR is positive but no impact are found on both the 37 GHz channel TB and the atmospheric attenuation of the altimeter backscattering coefficient (no rain seen by AltiKa)

Confidence Flag CF = “False alarm”:

$RR > 0 \ \& \ (TB_{37} < 180 \text{ K}) \ \& \ (A_{ATM\_SIG0} < 1.5 \text{ dB})$

- Addition of the time lag ( $\Delta t$ ) between the altimeter and the external observation date to the dataset:
  - ➔ 10% of effective rain rates ( $RR > 0$ ) with a confidence flag set to “rain” have  $\Delta t$  lower than 5 min.

(\*) Swings, Josh Ritter, 2003

# How much rain ... ? (\*)

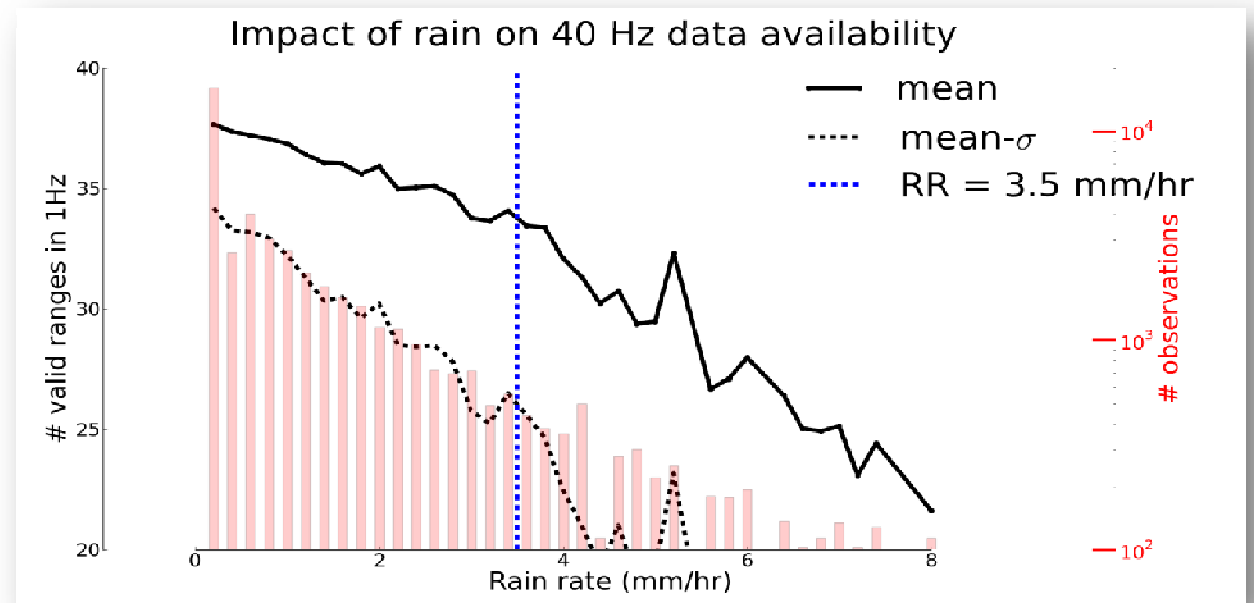
## Use case 1 :

- Averaged number of elementary valid measurements in 1 Hz measurements (NB\_DALT) per bins of 0.2 mm/hr for  $RR \geq 0$  over AltiKa first 12 cycles.
- Selection of  $\Delta t \leq 5$  min and  $CF == 0$  (recommended)
- Up to  $RR \sim 3.5$  to 4 mm/hr, averaged NB\_DALT is close to 35 with a stdev  $\sim 7$ .
- Over this limit, the dispersion on NB\_DALT seems critical.

see also

**Tournadre et al 2014**

where the 'closest' RR product is used for the validation of the **matching pursuit rain flag**.

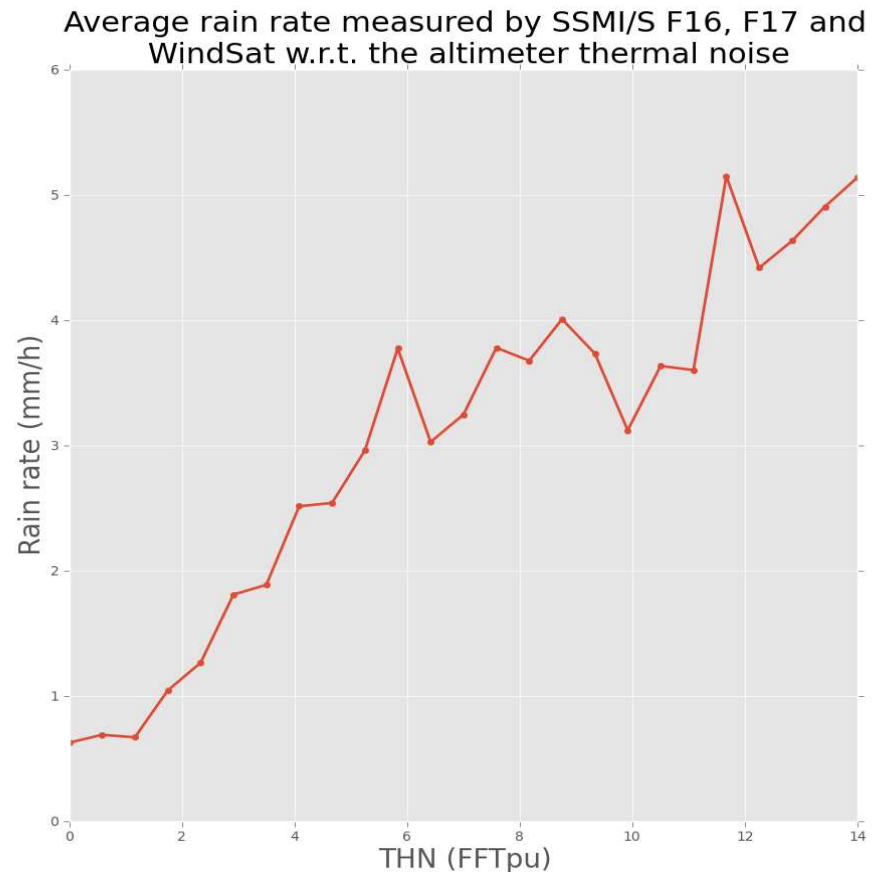


(\*) *How Much Rain Can One Man Stand*, Waylon Jennings, 1968

# How much rain ... ? (\*)

## Use case 2 :

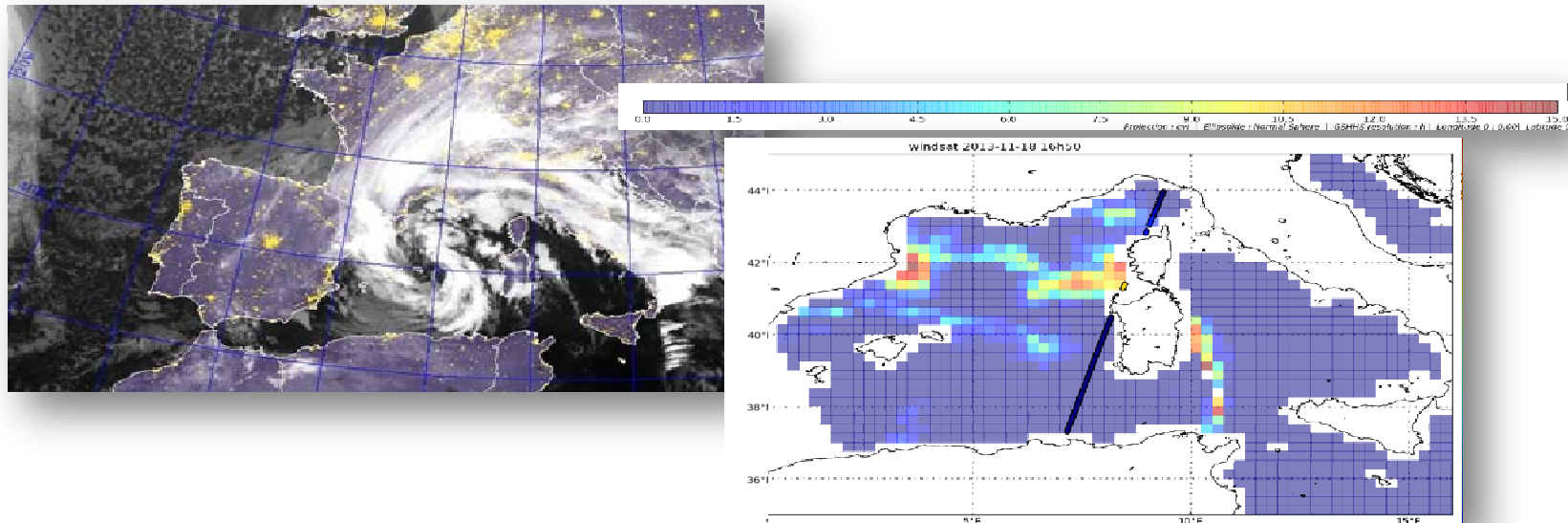
- Thermal noise of the altimeter in function of the rain rate  
( $RR > 0$ ,  $CF = \text{rain}$ ,  $\Delta t \leq 5 \text{min}$ )
- See more on the talk of JC Poisson in the Error Splinter on Thursday morning (Wavelet Analysis of AltiKa measurements)



# Until the next rain fall (\*)

## Illustration

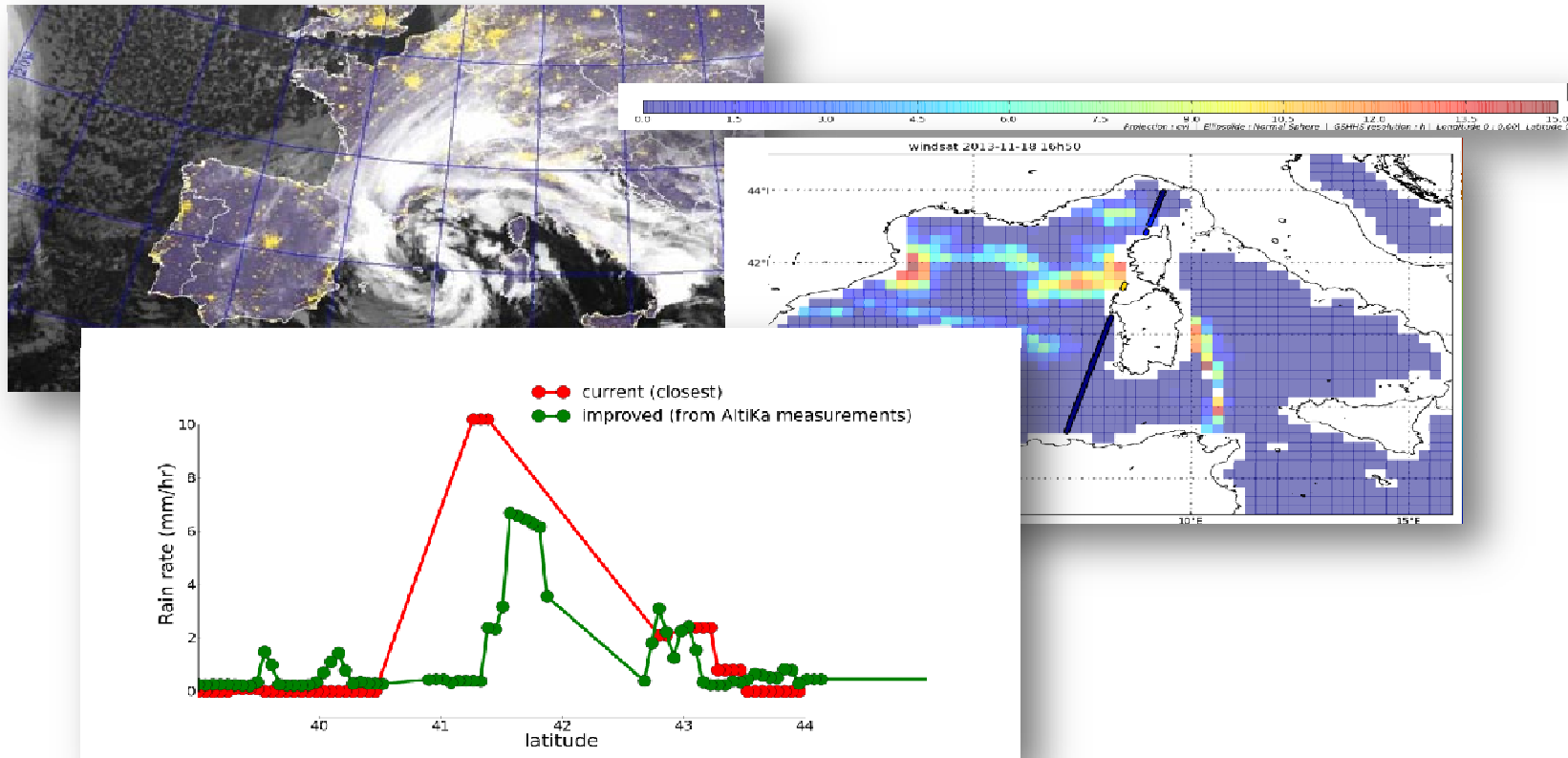
- The **Cleopatra (Ruven)** storm occurred on 18th November 2013 and has been overflown by AltiKa at 6 PM, track 130 of cycle 8 (see **Bonnefond et al 2014**).





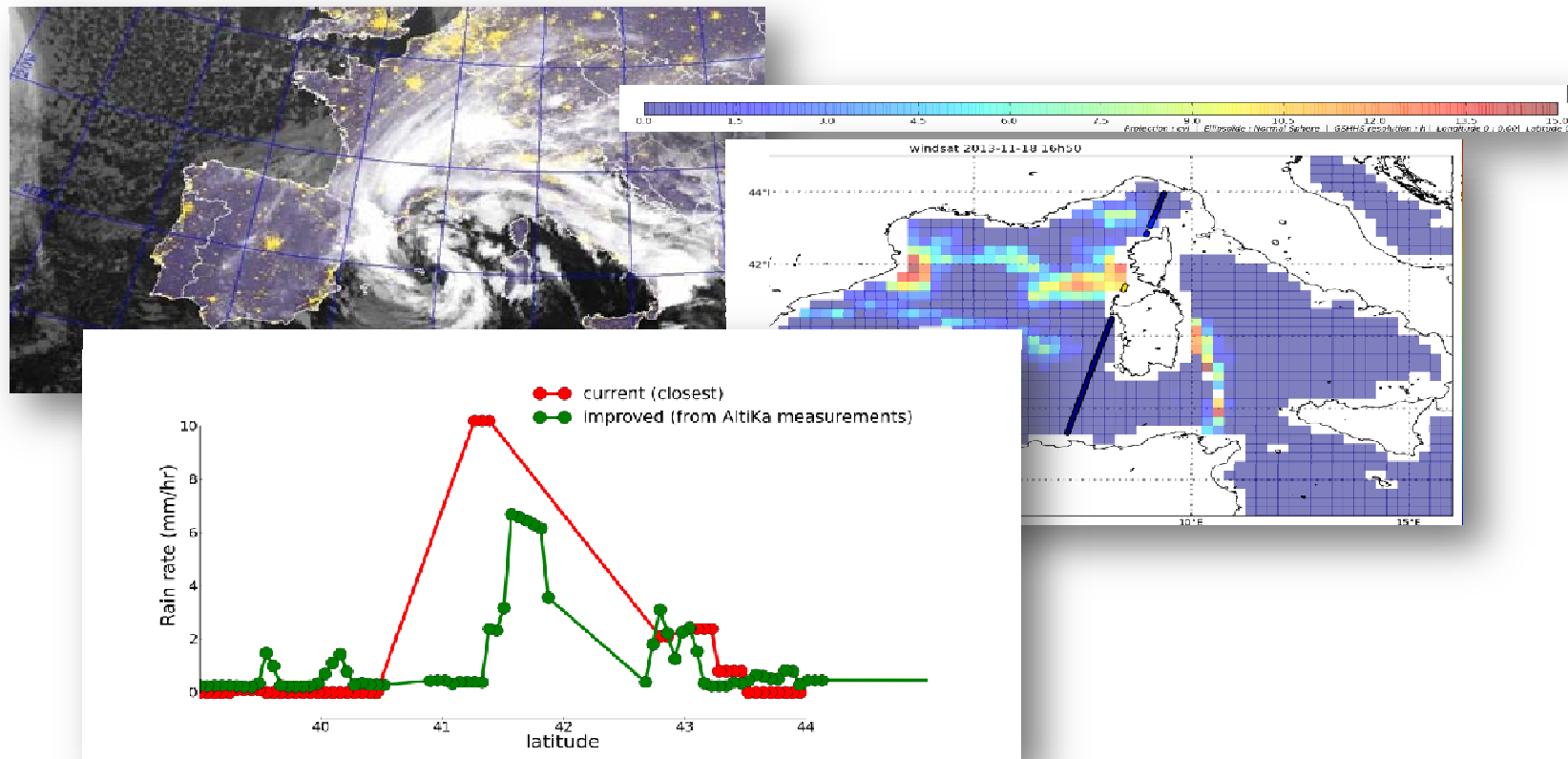
# Until the next rain fall (\*)

- A rain rate of about 10mm/hr is sparsely given in the AltiKa dataset, corresponding to observations by WindSat at 5 PM.



# Until the next rain fall (\*)

- A first attempt to retrieve a rain rate directly from MWR TBs and altimeter sig0 shows the potential of such approach, with a much better spatial coverage.



# Conclusion & Perspectives

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- A 'closest' rain rate product is available for AltiKa together with
  - the time lag between the external source and AltiKa measurements
  - a confidence flag
- Can be used for the validation of rain flag development or assessment of the impact of rain on Ka-band altimetry measurement

**→ Estimating the rain rate from AliKa measurements would be a real improvement**

- Ref: **Tournadre et al**, *Marine Geodesy Saral Special Issue*, 2014
- 'closest' rain rate will be available on PEACHI dataset on  
<http://odes.altimetry.cnes.fr>

*Yes now the rains weep o'er his hall, and not a soul to hear  
the Rains of Castamere*

OST - Konstanz