OVERVIEW OF THE ANOMALIES AT THE KOUROU BEACON SITE

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Content

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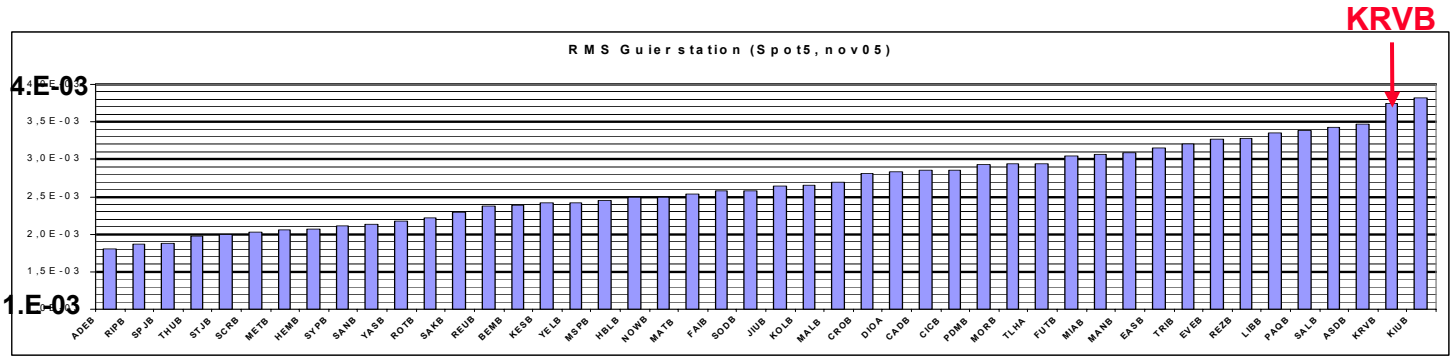
- Signal analysis
  - Attenuations of on-board received power
  - Measurement losses
  - Comparison with GPS reception
  - Mask ?
- Measurement analysis
  - POE residuals
  - Ionospheric correction variability
  - Troposphere contribution
- Conclusions

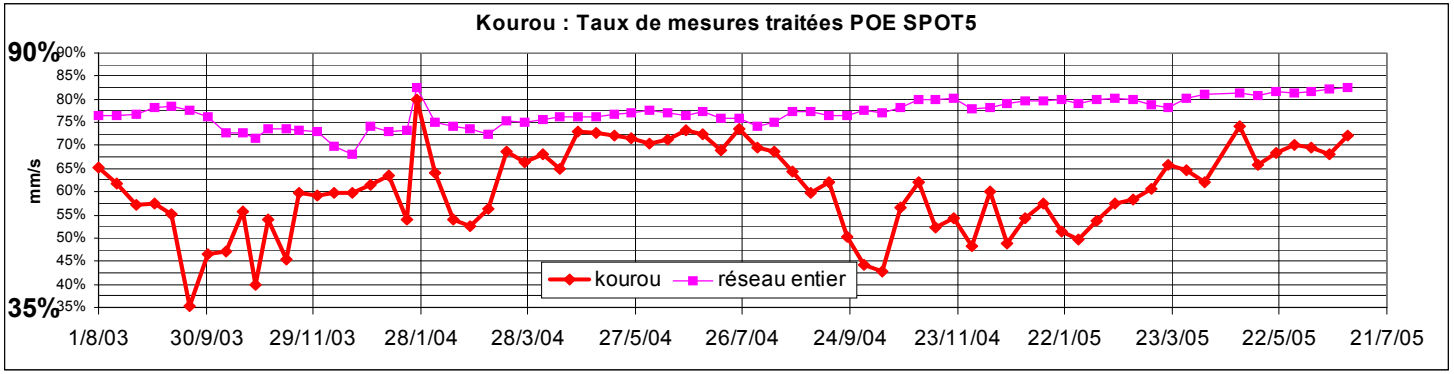
Motivation : situation of Kourou

- Signal losses 400 MHz (cf. B. Bonhoure, 1999)
- Radio-electric interferences (jamming campaign)
- Routine POE processing
  - Guier :
    - Kourou residuals systematically high
    - High elimination rate + seasonal effect
  - Orbit : Kourou's RMS is higher than DORIS network's RMS

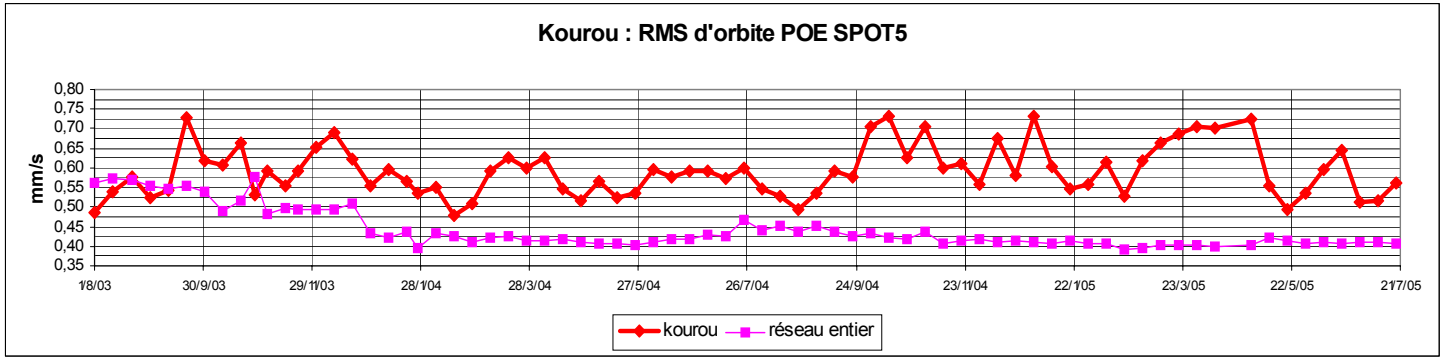
Some examples



Guier RMS
of SPOT5 POE
(Nov. 05)



Rate of validated
measurement
for SPOT5 POE
(August 03 → July 05)



Orbit RMS
of SPOT5 POE
(August 03 → July 05)

Analysis method

- Analysis of the **attenuation** of the received signal power (400 MHz and 2GHz)

  DEF : attenuation = actually received power – expected received power

- Analysis of **signal losses**

  DEF : loss = no signal on either 400 MHz or 2 GHz channel

- Analysis of the **POE orbit** processing statistics

Context of the work :

- 1 year (Oct. 04 to Nov. 05)
- The whole DORIS missions (except Jason POE due to SAA effect)

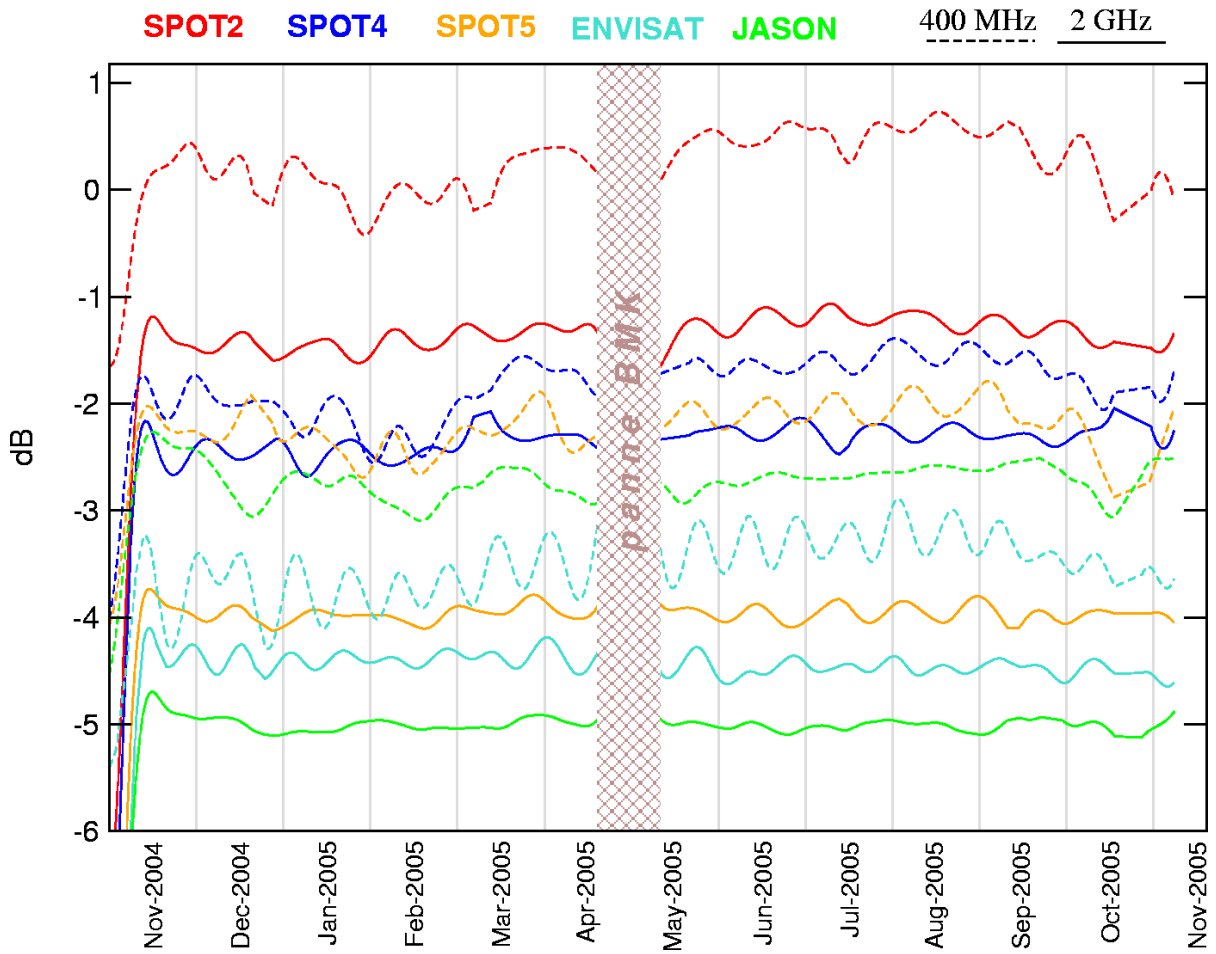
Plan

- Power attenuations
- Signal losses
- POE orbit résiduals
- Measurement correction

Power attenuation (1)

Comparison of the received power levels

Mean values of the power attenuations (low-pass filter)



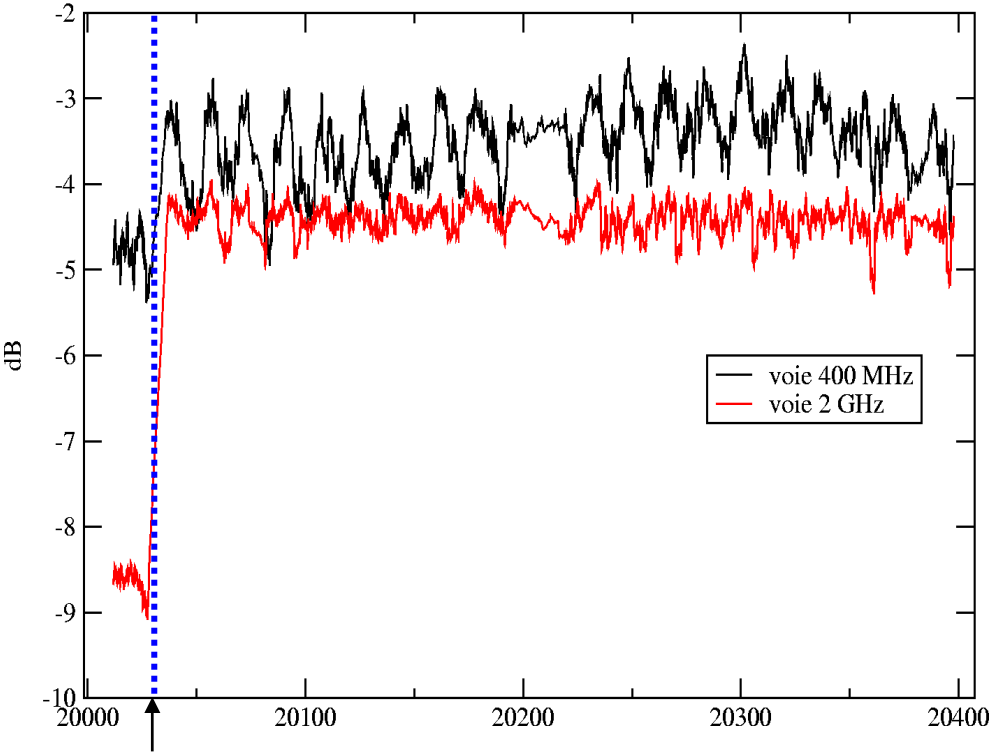
400 MHz better received than 2 GHz

Only D2 on the 400 MHz channel has the expected level

Power attenuation (2)

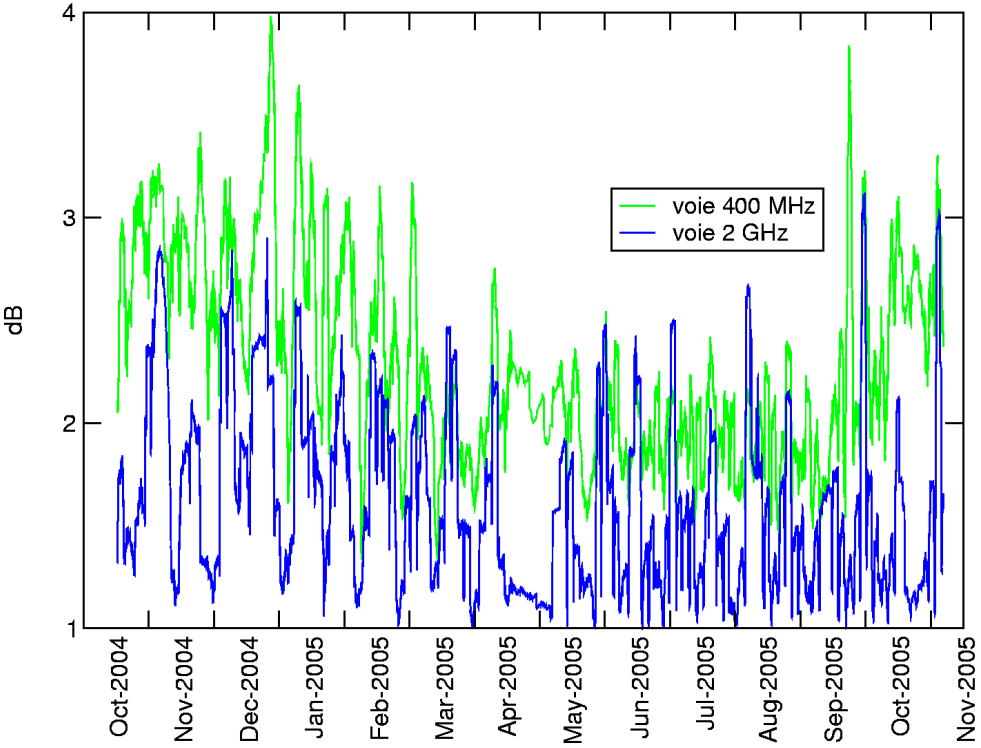
Seasonal effect

Mean over 500 measurements sliding window of the power attenuation for ENVISAT



Beginning of Nov. 2004 :
change of beacon type 1.0 → 3.0

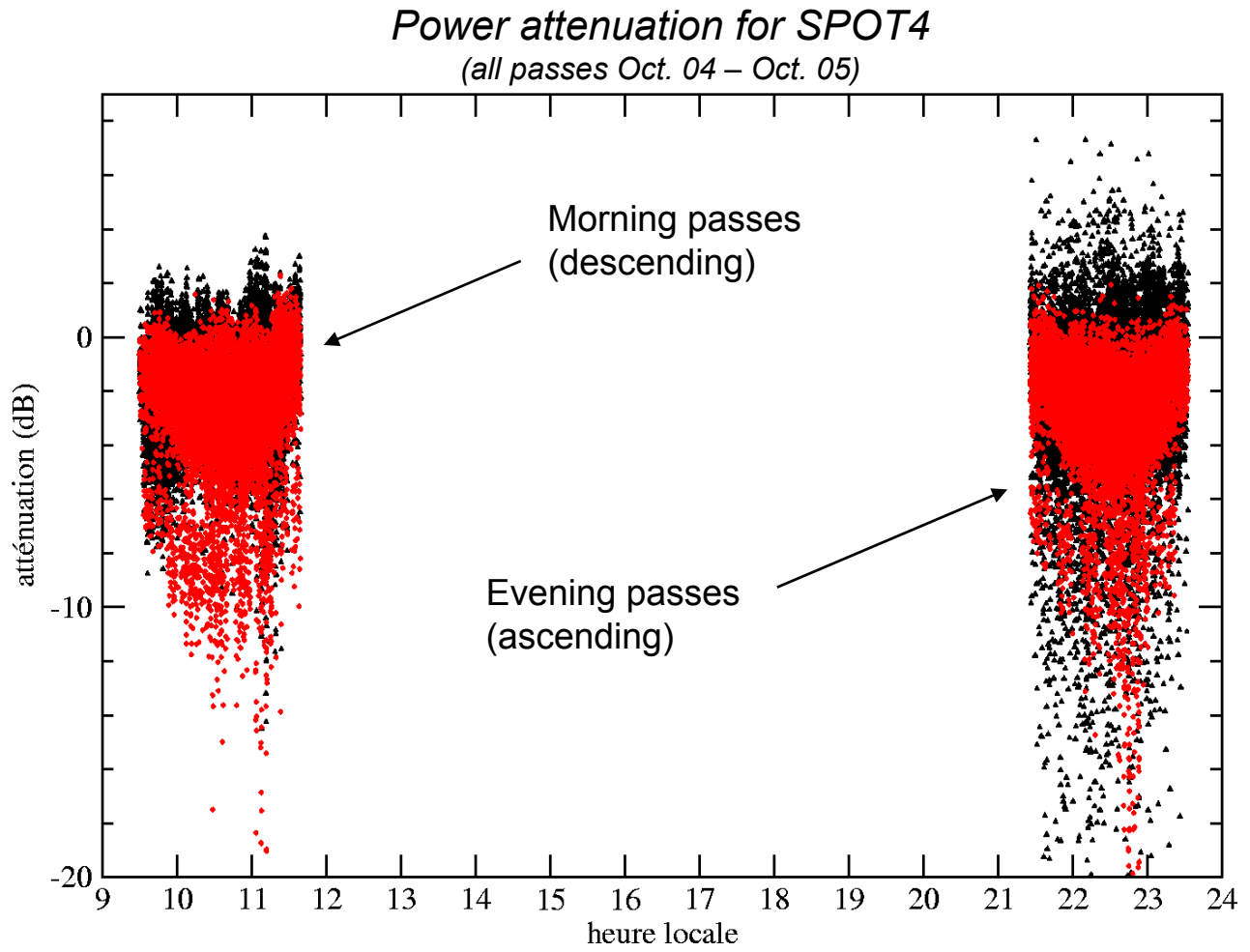
Std dev. over 500 measurements sliding window of the power attenuation for ENVISAT



➔ More dispersion frome October to March

Power attenuation (3)

Local hour effect



➔ Abnormal situations during the evening :

- more dispersion
- some very low levels
- some high levels

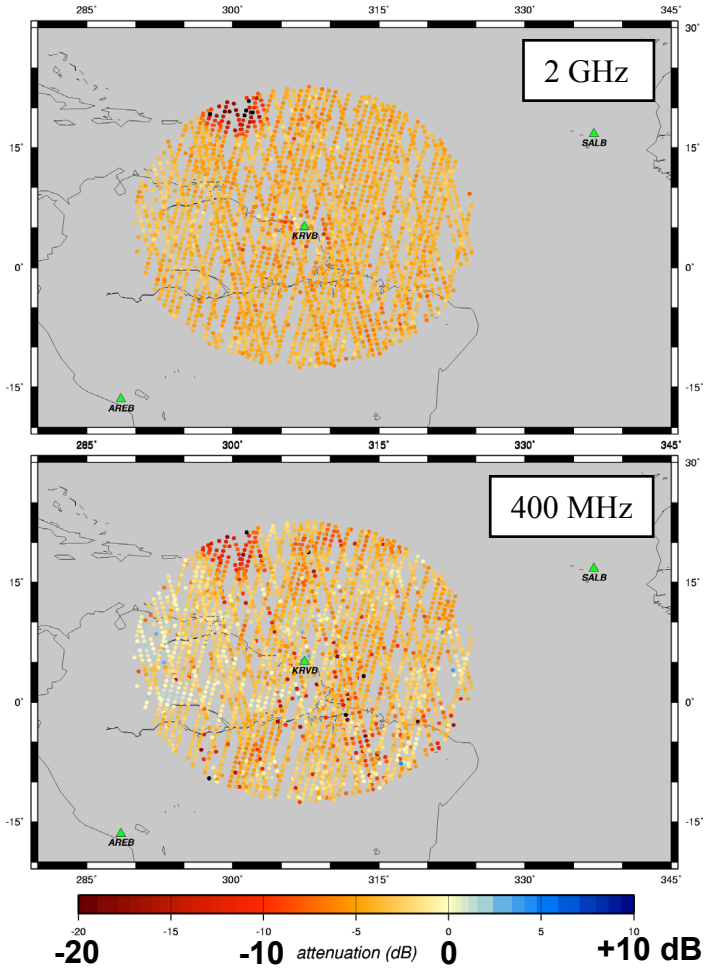
Same behaviour for the other DORIS instruments

Power attenuation (4)

Geographical effect

Winter (min elev = 12°)

ENVISAT (cycle 033 du 14/12/2004 au 17/01/2005)



Presence of an interference source (mask?)

- **20 dB and more**
- **N.W. from Kourou**
- **Persistent all the year**
- **Seen on all missions**

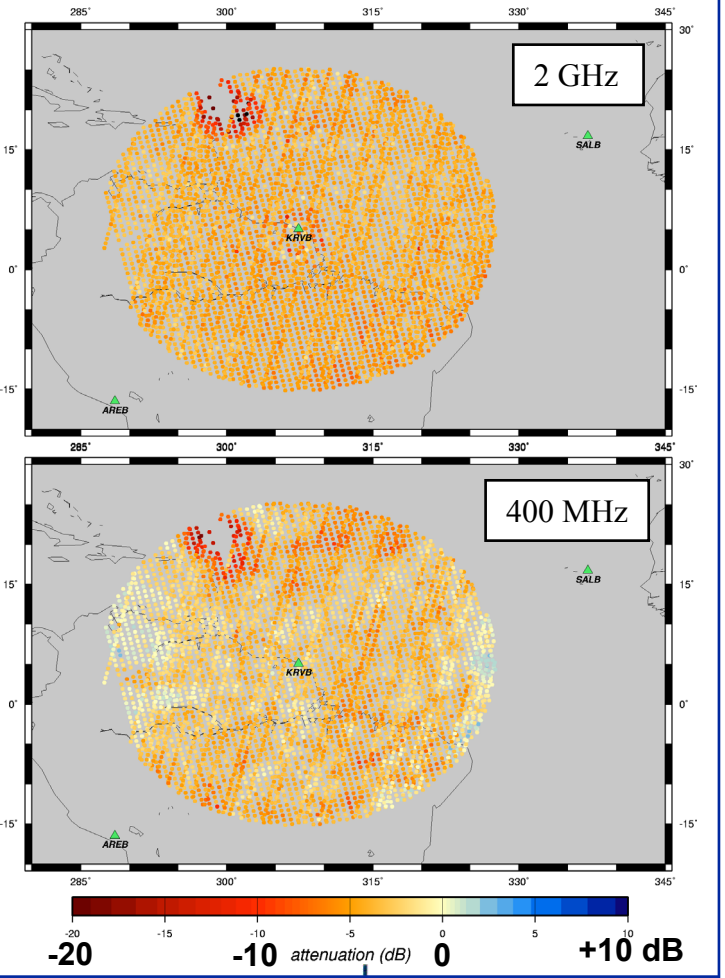
More fluctuations during winter

Good 400 MHz reception on a western area

Weak 2 GHz reception circle at high elevation

Summer (min elev = 8°)

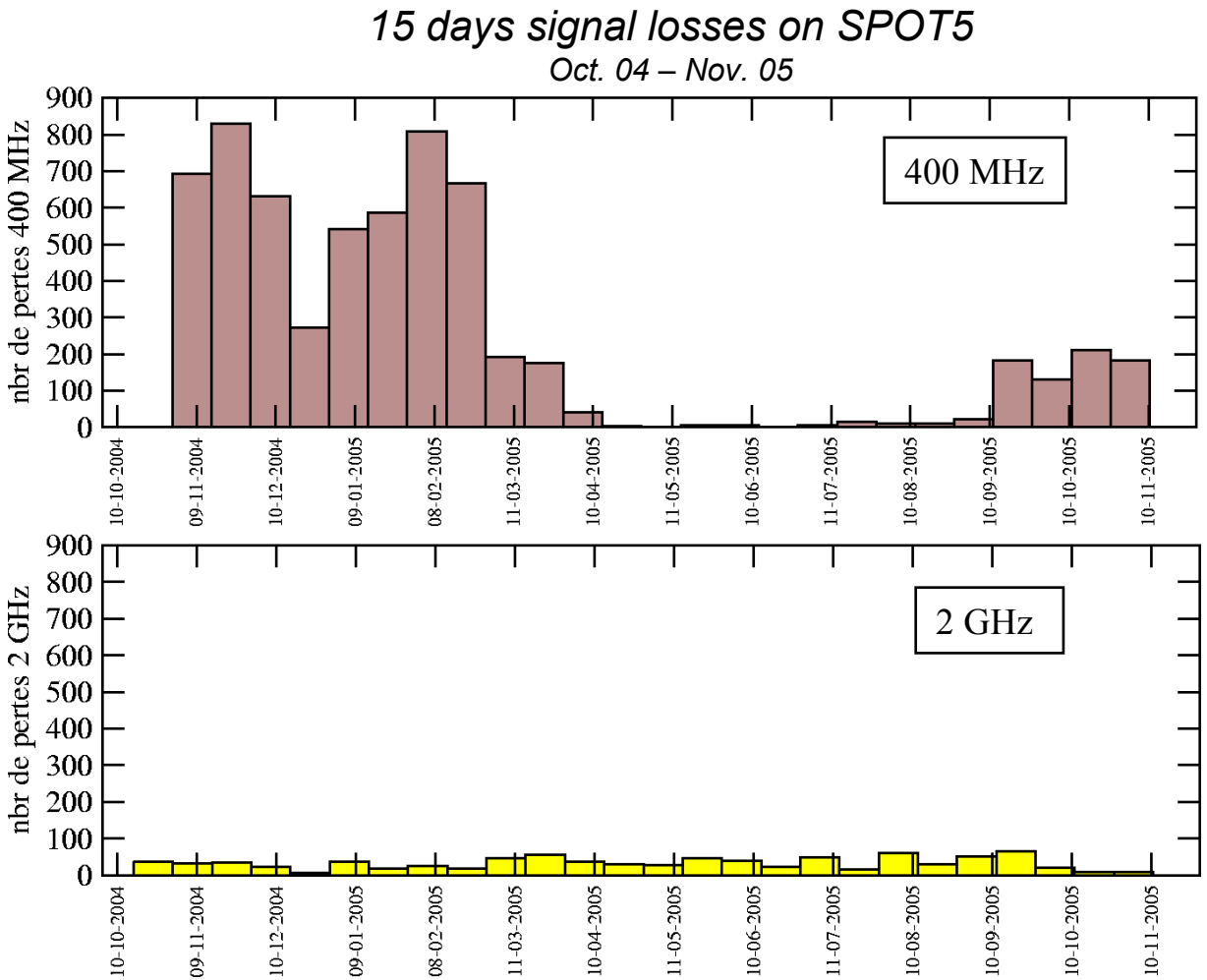
ENVISAT (cycle 038 du 07/06/2005 au 11/07/2005)



Plan

- Power attenuations
- Signal losses
- POE orbit residuals
- Measurement corrections

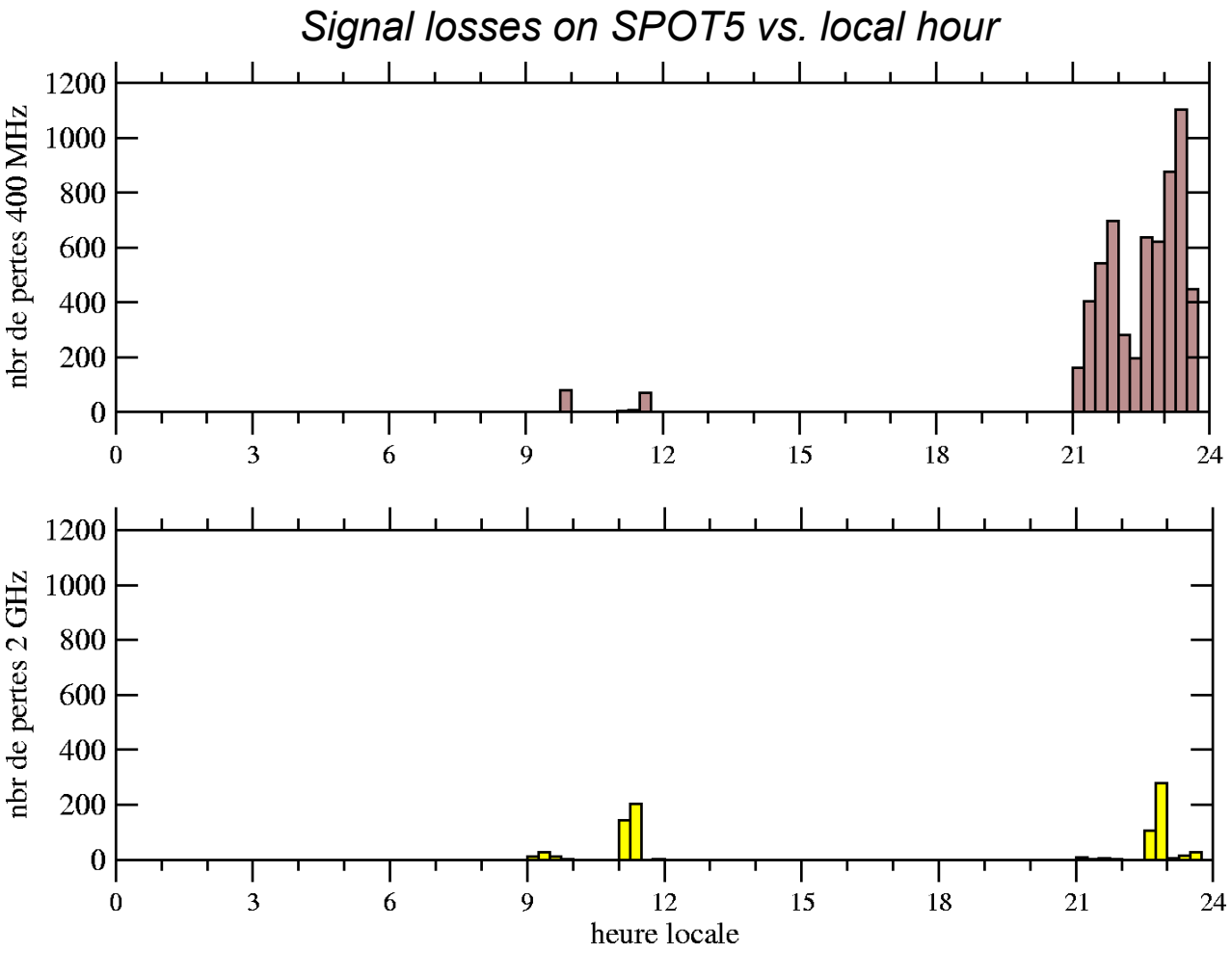
Signal losses (1)
Seasonal effect



- **More losses from Nov. to March on the 400 MHz channel**

- **The same for the other missions**

Signal losses (2)
Local hour effect



- **Evening passes**

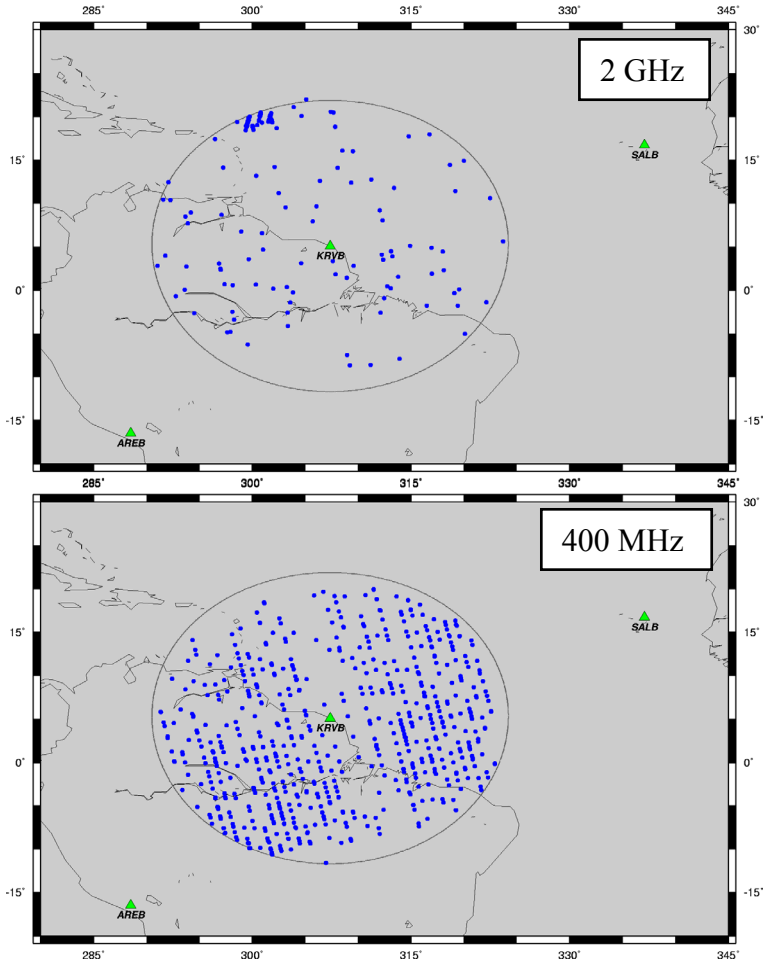
- **Same for the other missions**

- **Jason : 2GHz losses whatever the local time → constant presence of the interference source**

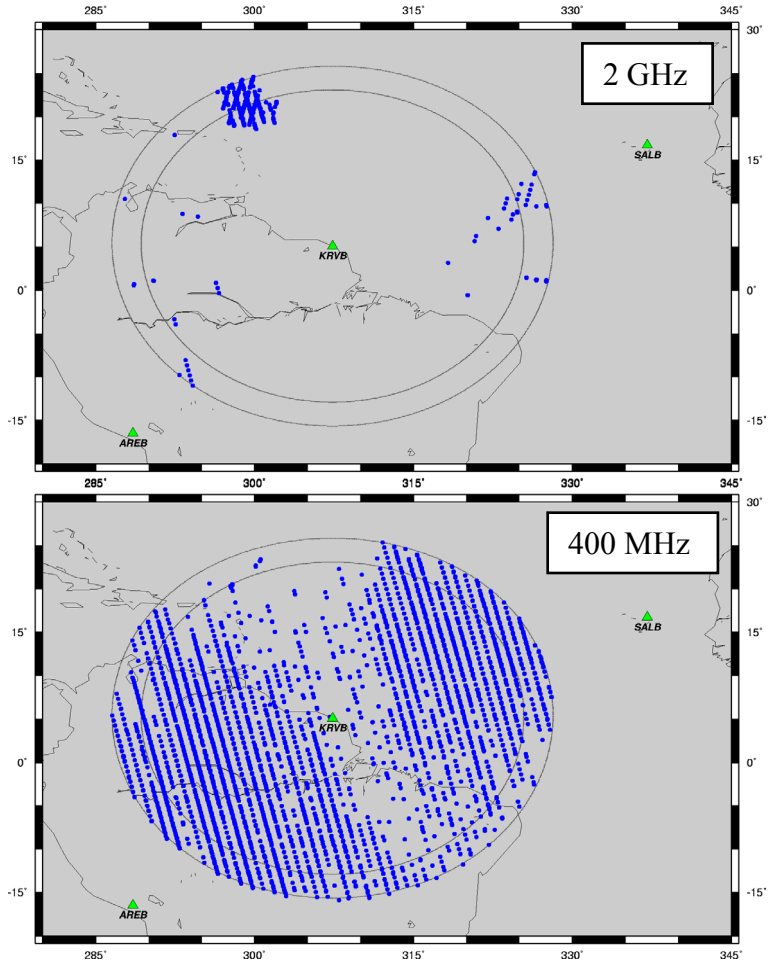
Signal losses (3)
Geographical effect

(SPOT4 similar to SPOT2)

Pertes de signal sur SPOT2 (oct.04 à oct.05)

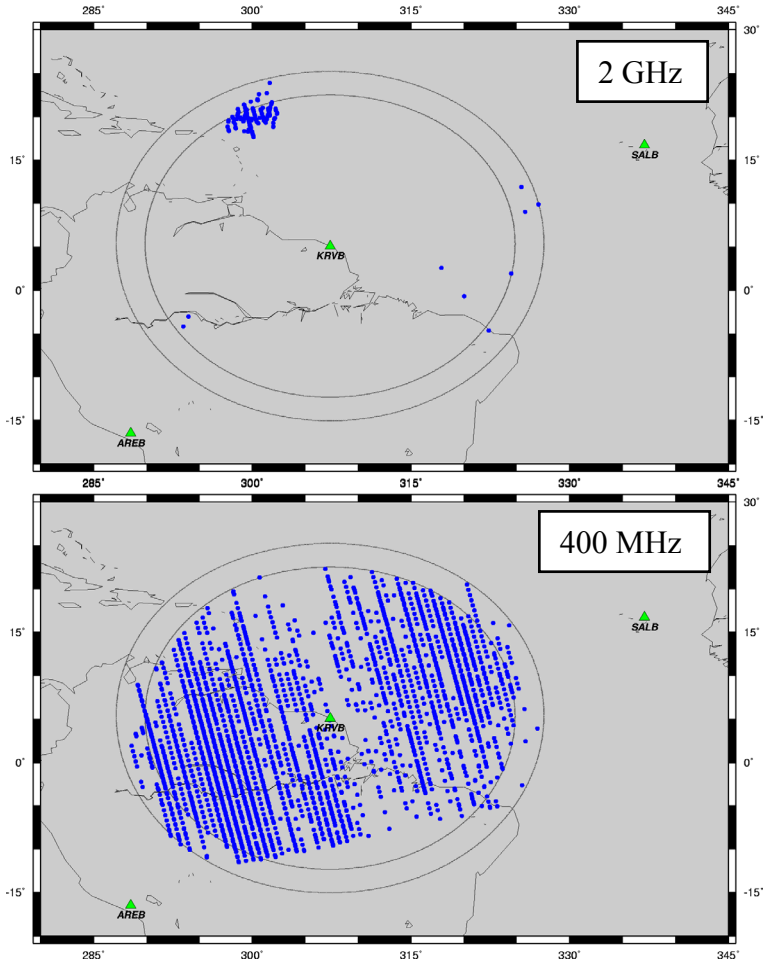


Pertes de signal sur SPOT5 (oct.04 à oct.05)

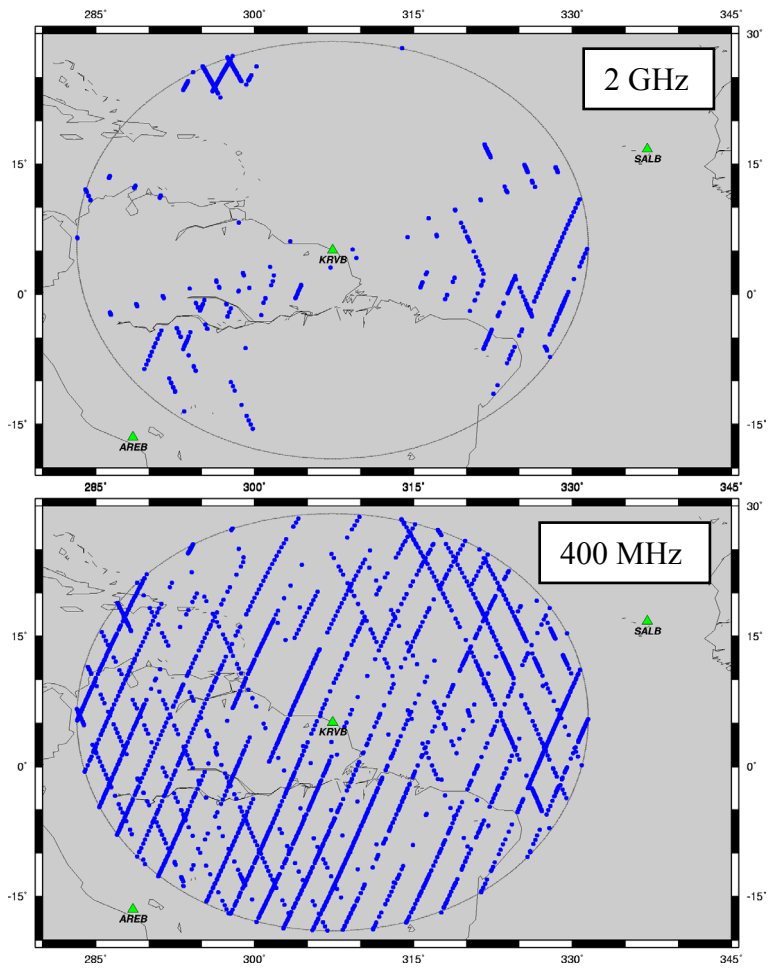


Signal losses (4)
Geographical effect

Signal losses on ENVISAT (Oct. 04 – Oct.05)



Signal losses on JASON (Oct. 04 – Oct.05)



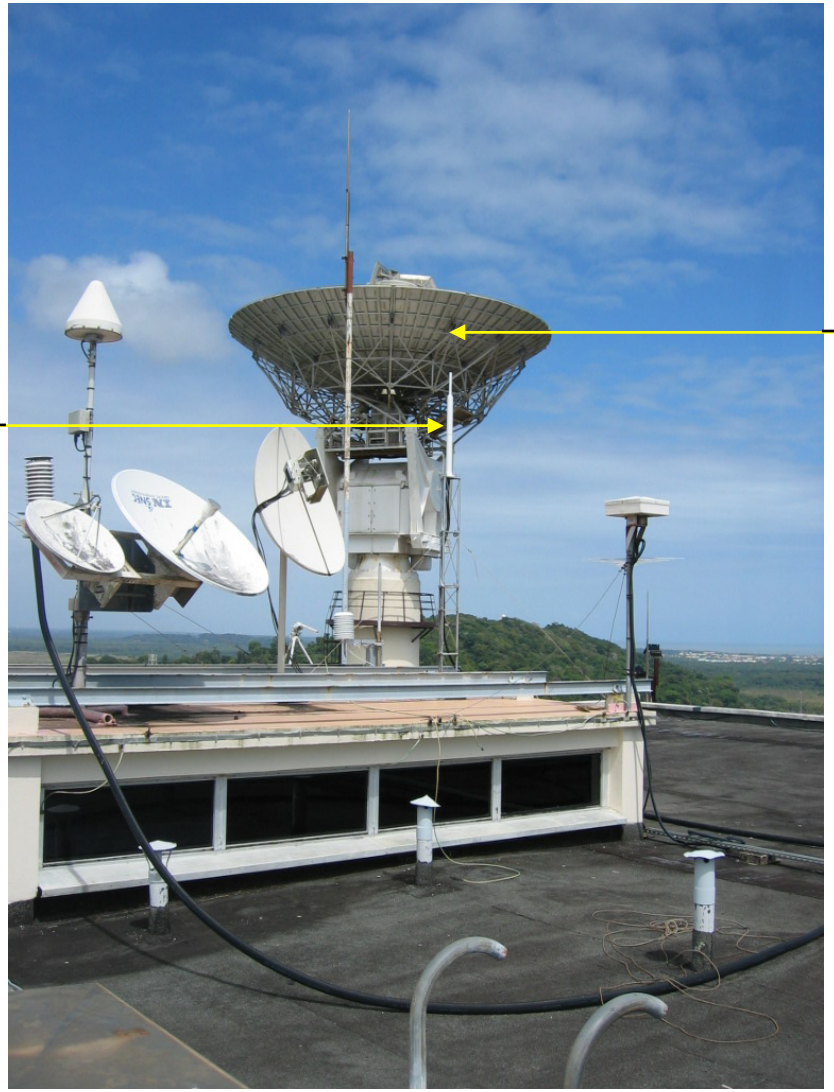
400 MHz more affected

The interfered area affects only the 2GHz losses

Heliosynchronous sat. : losses only on the ascending passes (evening)

Ascending passes with high elevation : less affected

The guilty interference source



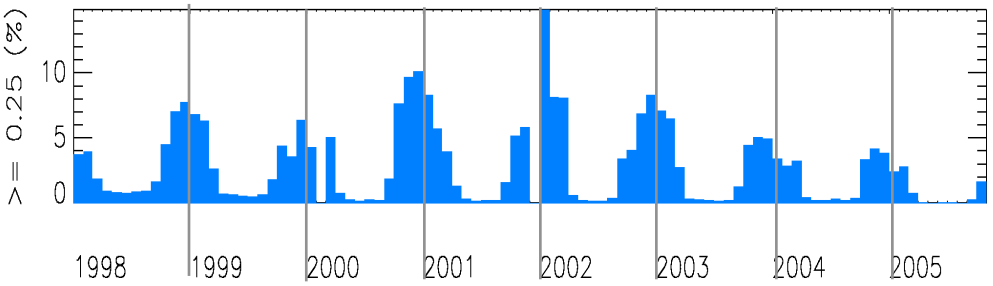
Antenna of the DORIS beacon

Reception antenna of the CNES 2GHz network

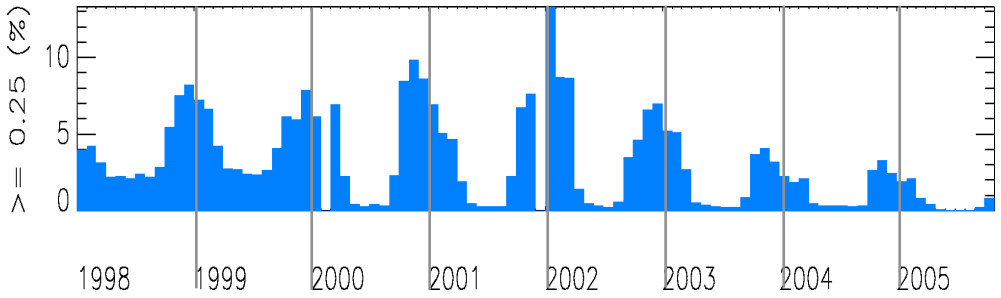
MASK

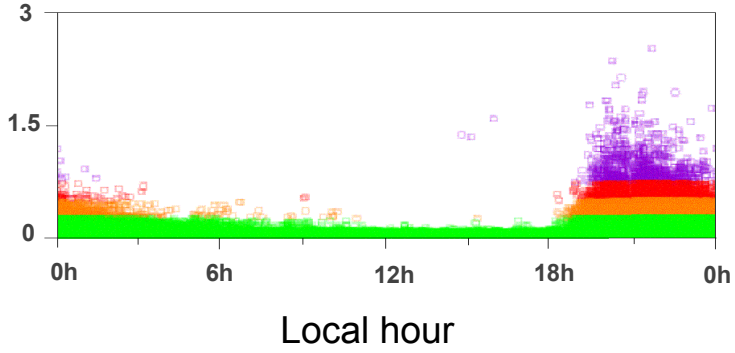
Comparison with GPS reception

L2 measurement losses of lock



Scintillation indices (empirical, [0-1], based on the phase fluctuations, same for both Kourou receiver)





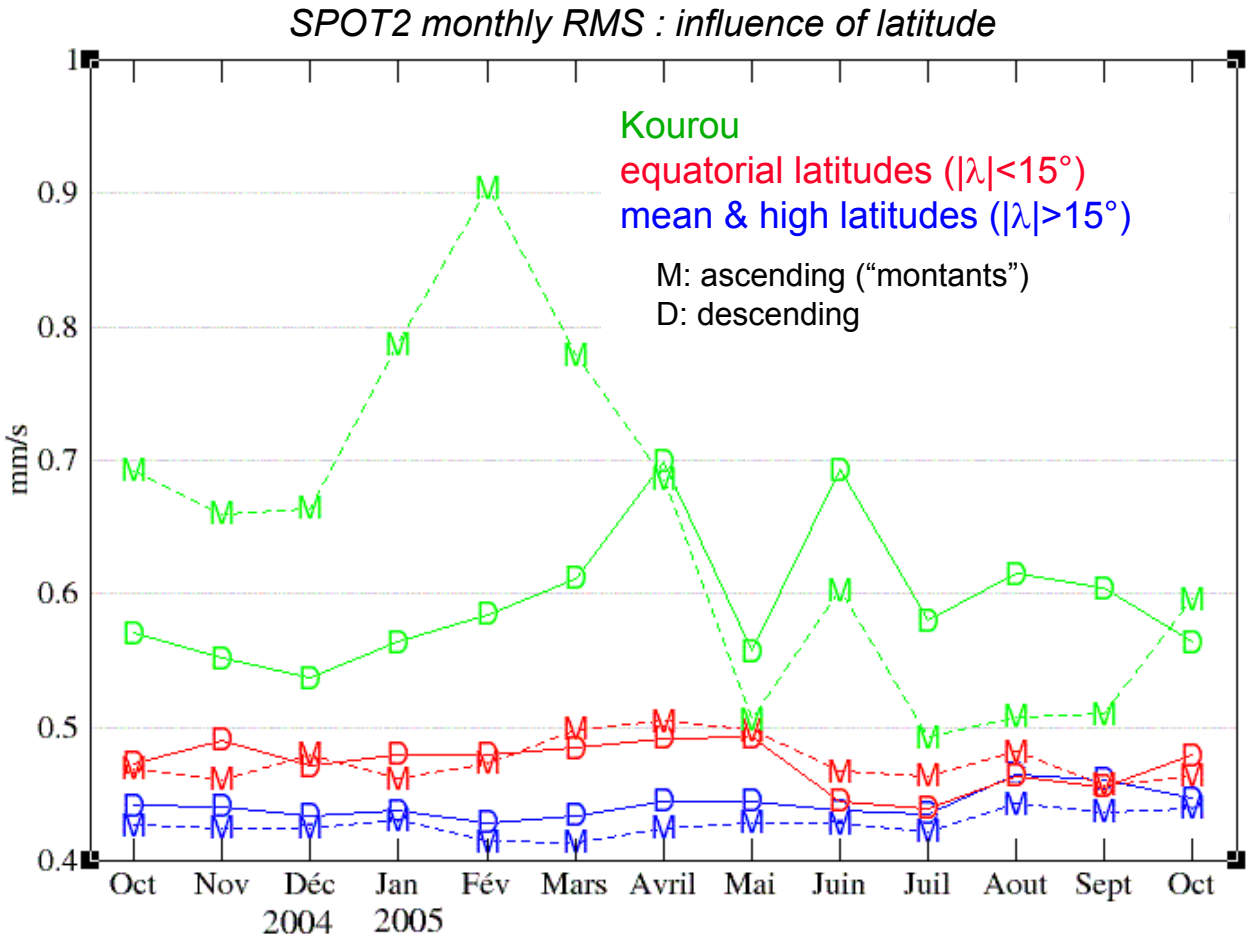
The phenomenon is more important on the **evening** AND **from October to March**

➔ IONOSPHERIC SCINTILLATIONS

Plan

- Power attenuations
- Signal losses
- POE orbit residuals
- Measurement corrections

POE orbit residuals (1)
Comparison Kourou/DORIS network



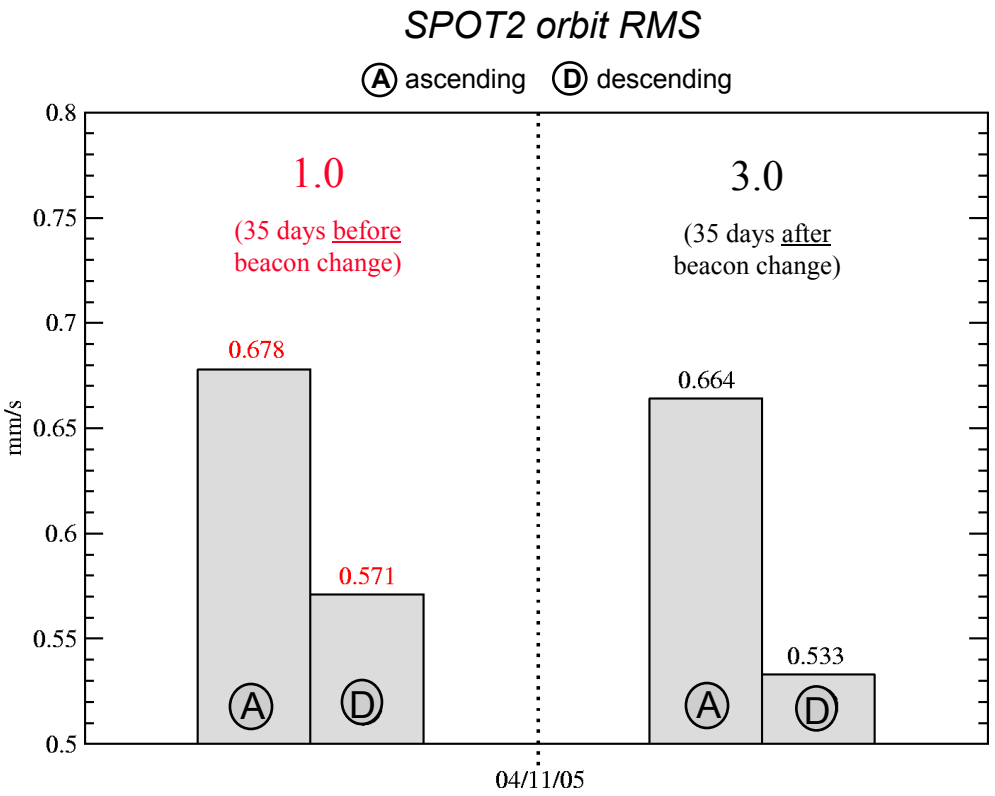
Kourou RMS systematically higher than the other the network beacons (included the equatorials)

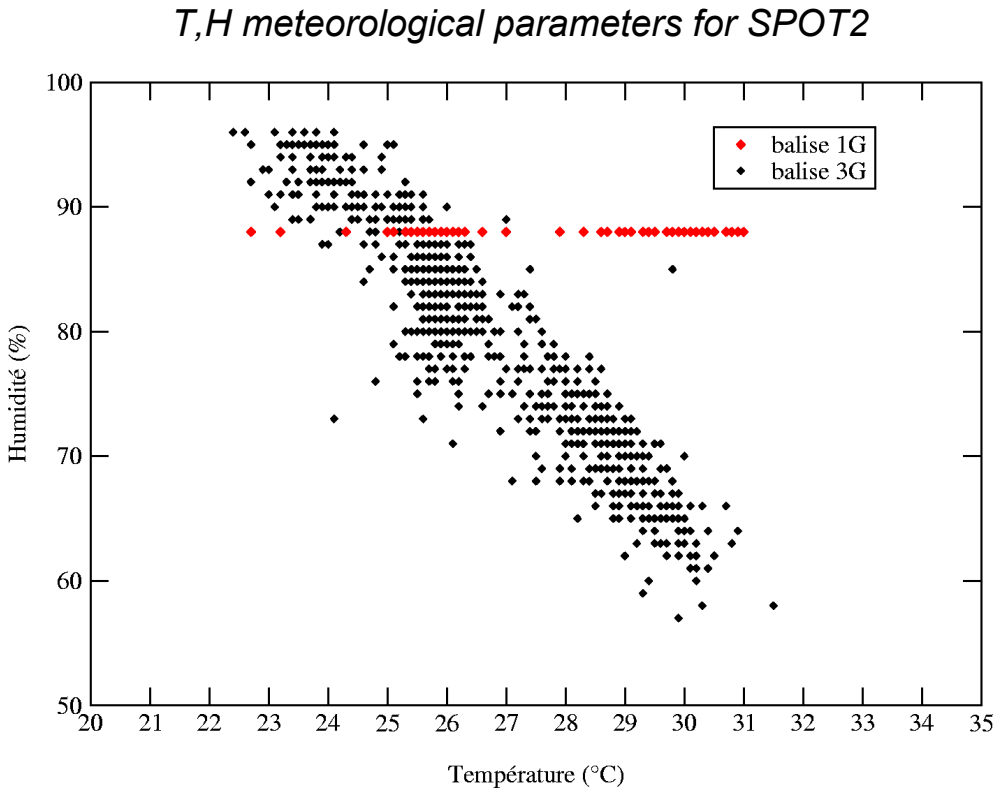
Asc. pass RMS (evening) very high from October to March

Asc. pass RMS lower than the desc. pass RMS from May to September

Same behaviour on the other instruments

POE orbit residuals (2)
Beacon change





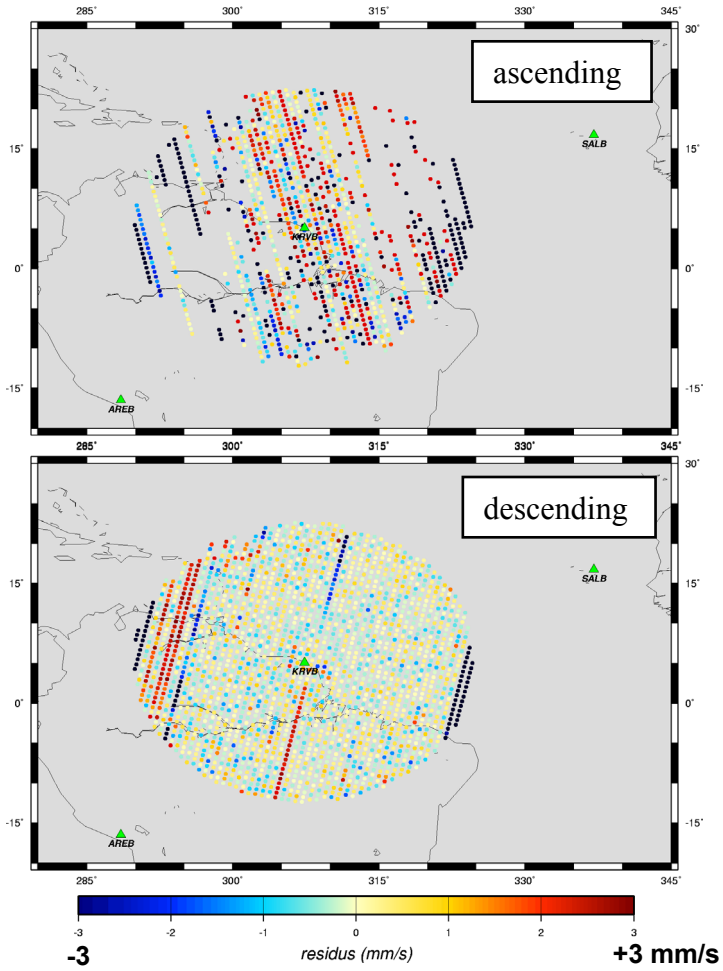
➔ small improvement ?

POE orbit residuals (3)

Geographical effects

***Winter** (min elev = 12°)*

ENVISAT (cycle 032 du 09/11/2004 au 13/12/2004)



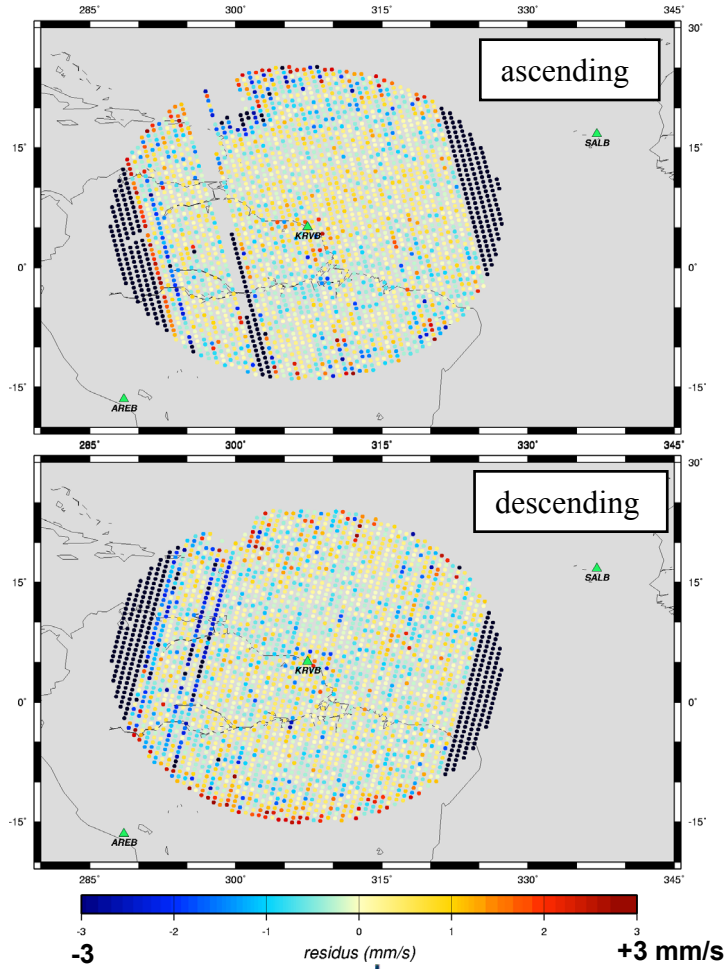
All residuals
(validated + eliminated)

Ascending : summer/winter contrast

Influence of the mask :
- elimination around the NW area
- complete pass eliminated ?

***Summer**, min elev = 8°*

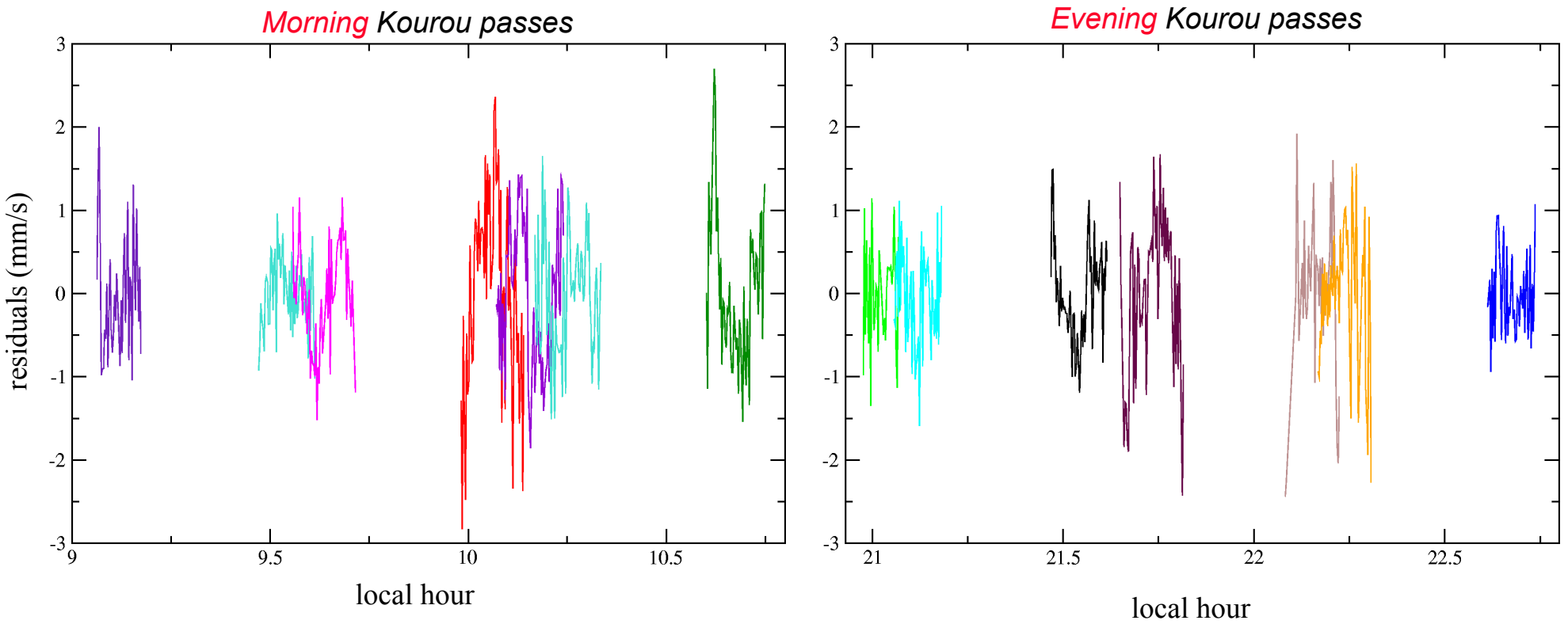
ENVISAT (cycle 038 du 07/06/2005 au 11/07/2005)



POE orbit residuals (4)

Signatures of passes

ex : Envisat, arc 147 (05/04/05 to 11/04/05)



Signatures for both type of pass
→ need an analysis of the measurement correction

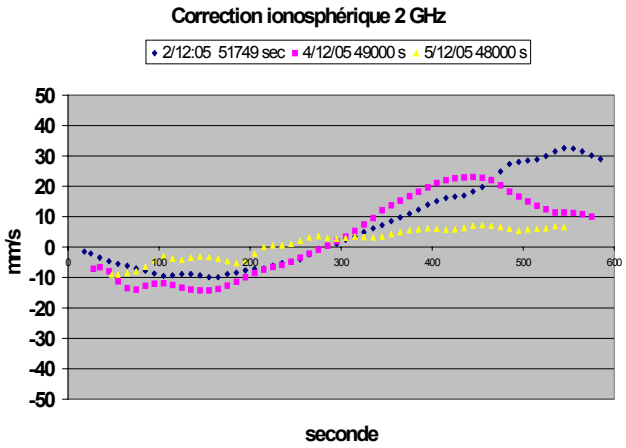
Plan

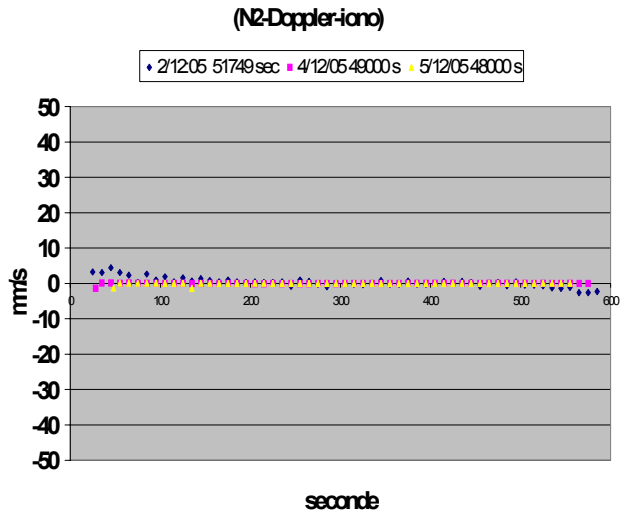
- Power attenuations
- Signal losses
- POE orbit residuals
- Measurement corrections

Measurement corrections (1)

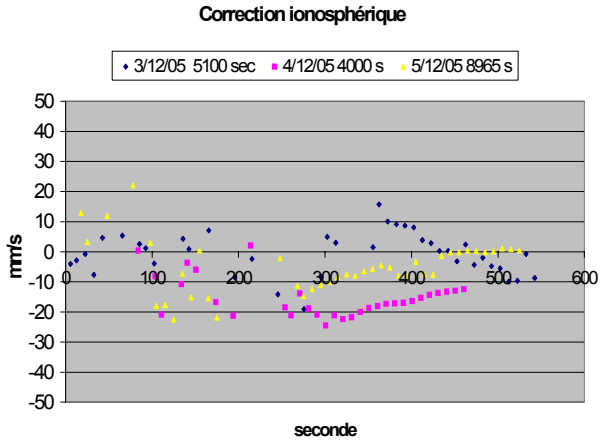
Ionosphere variability – effect on 2 GHz Doppler?

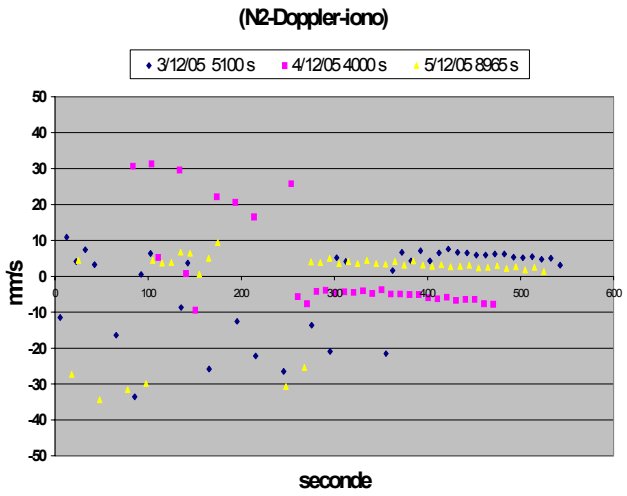
Morning passes





Evening passes



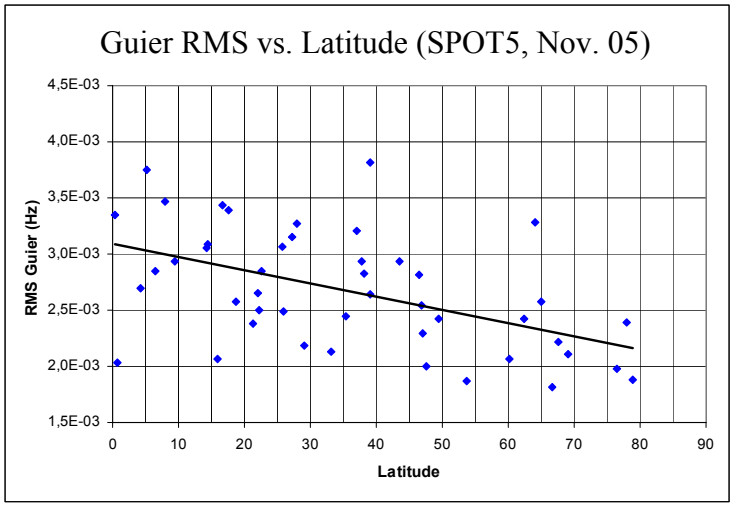


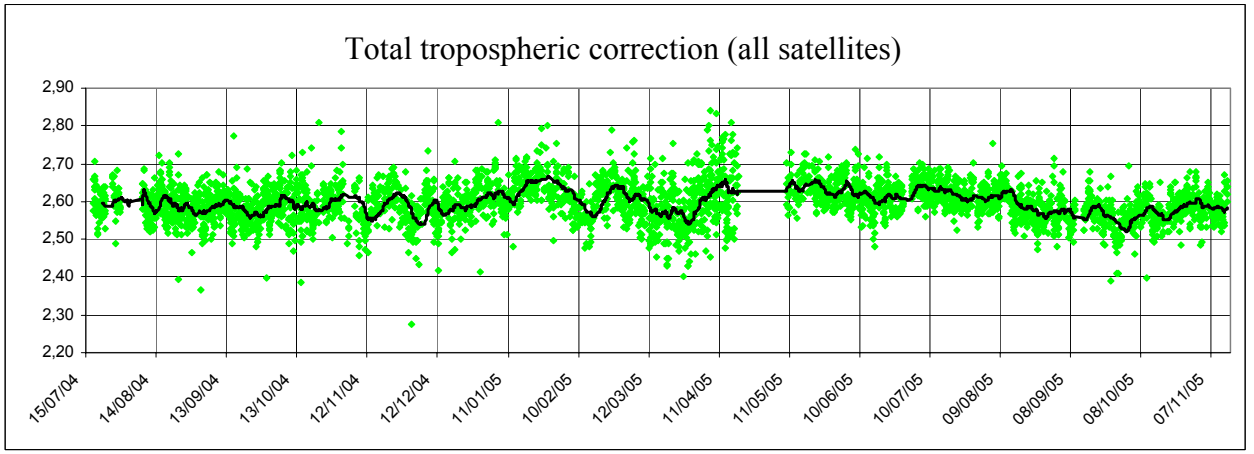
Doris/SPOT5 at Kourou :

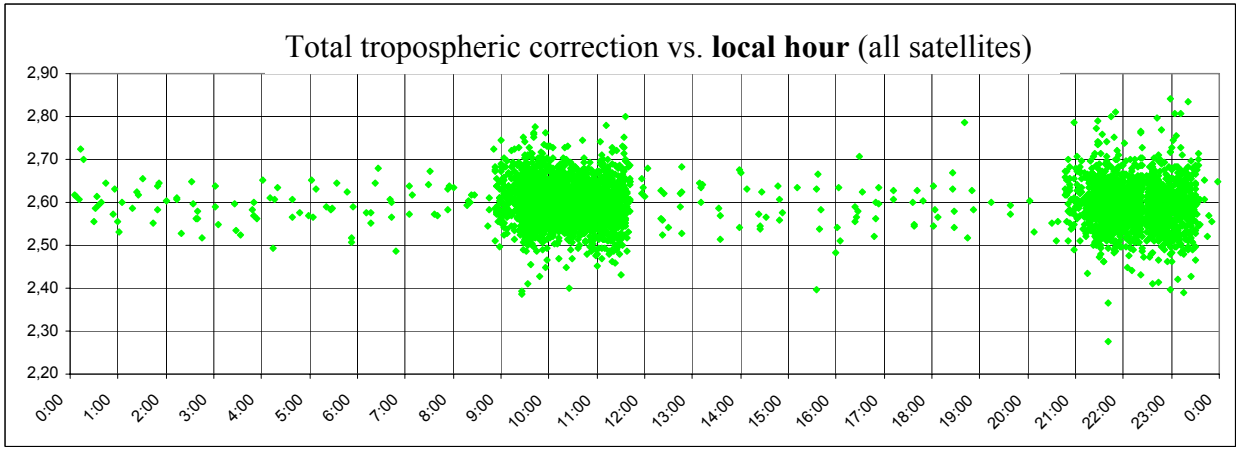
Fast fluctuations of both ionospheric correction and 2 GHz Doppler (scintillation effect ?)

Measurement corrections (2)

Contribution of the tropospheric effect at Kourou?

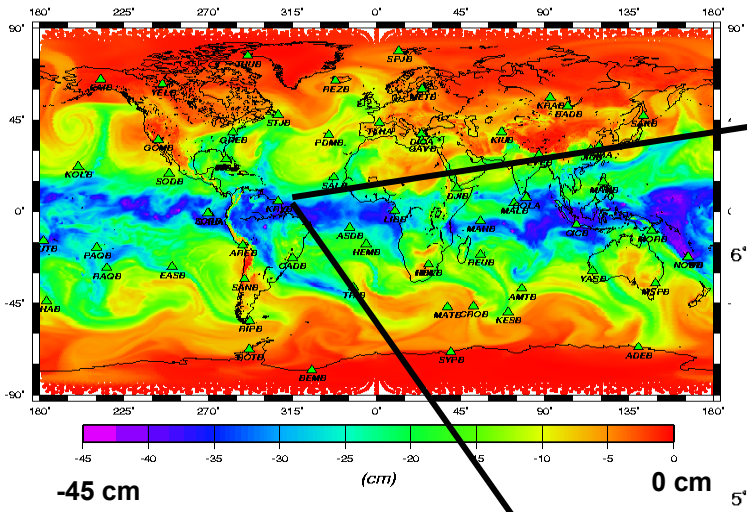






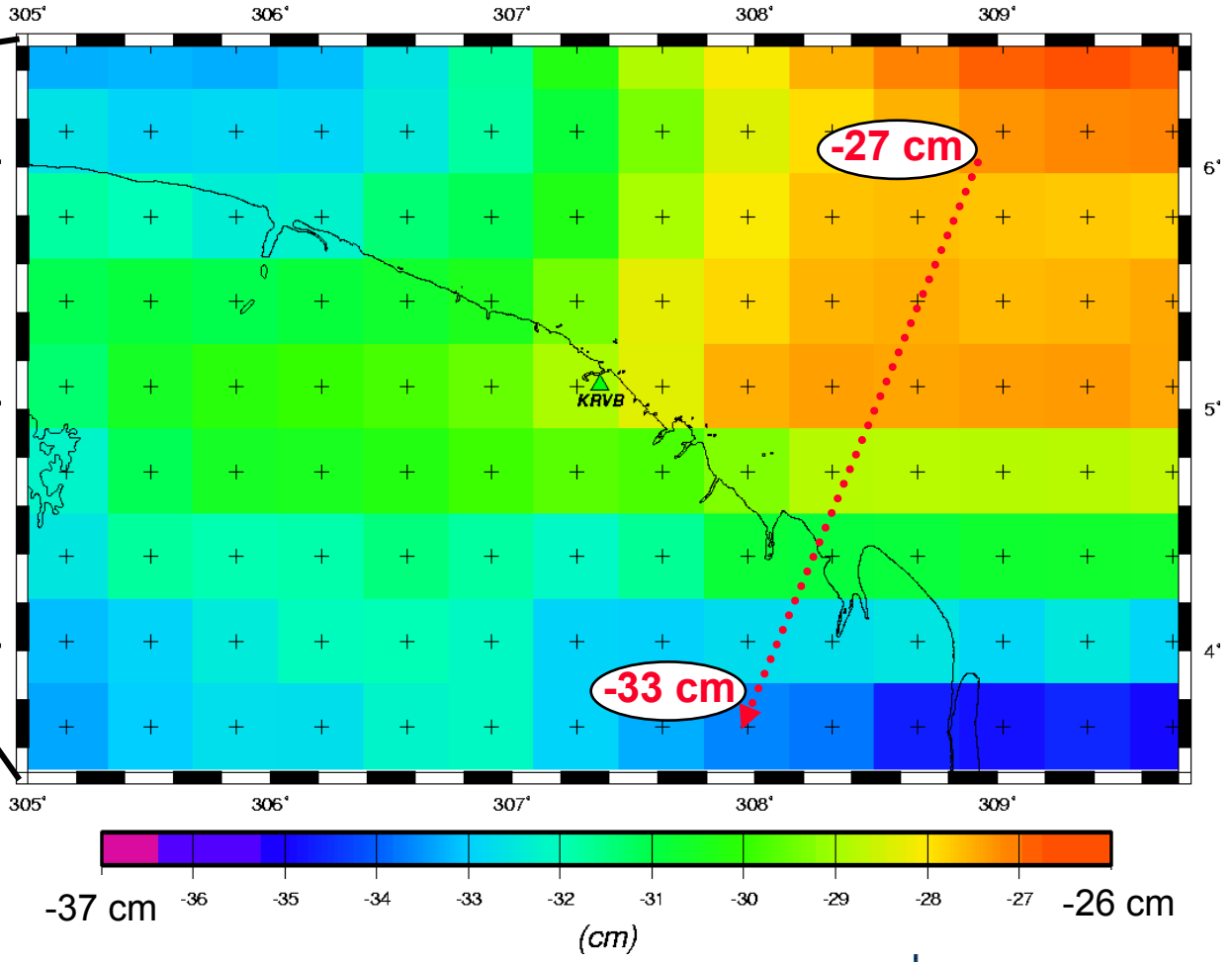
Measurement corrections (3)

Azimuthal variability of the troposphere near Kourou ?



Tropospheric correction grid : wet component

(ex : 01/03/02 at 12h TU)



➔ Use of a non-symmetric elevation function ?

Conclusions

- Beacon change 1.0→3.0 : reception improvement, better orbit residuals

- Signal and residuals (Guier & POE) perturbations :
  - Presence of a mask → attenuations and losses, increase of residuals
  - Seasonal effect of the reception quality (attenuations + losses) :
    - Declining reception during winter and the evening

    → Effect of the ionospheric scintillations