OVERVIEW OF THE ANOMALIES AT THE KOUROU BEACON SITE

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  – Troposphere contribution
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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)

<table>
<thead>
<tr>
<th></th>
<th>SPOT2</th>
<th>SPOT4</th>
<th>SPOT5</th>
<th>ENVISAT</th>
<th>JASON</th>
<th>400 MHz</th>
<th>2 GHz</th>
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</table>

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 from October to March
Power attenuation (3)
Local hour effect

Power attenuation for SPOT4
(all passes Oct. 04 – Oct. 05)

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°)

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°)
Plan

- Power attenuations
- **Signal losses**
- POE orbit residuals
- Measurement corrections
Signal losses (1)
Seasonal effect

15 days signal losses on SPOT5
Oct. 04 – Nov. 05

- More losses from Nov. to March on the 400 MHz channel
- The same for the other missions
Signal losses on SPOT5 vs. local hour

- 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))

2 GHz

400 MHz
Signal losses (4)
Geographical effect

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
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

SPOT2 orbit RMS

<table>
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<tr>
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<th>Ascending</th>
<th>Descending</th>
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<tr>
<td>1.0</td>
<td>0.678</td>
<td>0.571</td>
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<tr>
<td>(35 days before beacon change)</td>
<td>0.664</td>
<td>0.533</td>
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<tr>
<td>3.0</td>
<td>(35 days after beacon change)</td>
<td></td>
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</table>

⇒ small improvement?
POE orbit residuals (3)
Geographical effects

Winter (min elev = 12°)

- 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)

- All residuals (validated + eliminated)
- Ascending : summer/winter contrast

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

Guier RMS vs. Latitude (SPOT5, Nov. 05)

Total tropospheric correction (all satellites)

Total tropospheric correction vs. **local hour** (all satellites)
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