CENTRE NATIONAL D'ÉTUDES SPATIALES

# Jason GPS solutions

**Flavien MERCIER, Luca CERRI, Pascal PERRACHON**
**Sabine HOURY, Jean-Paul BERTHIAS**

**CNES**

General description of current GPS solutions

Effect of parameterization, Antenna maps

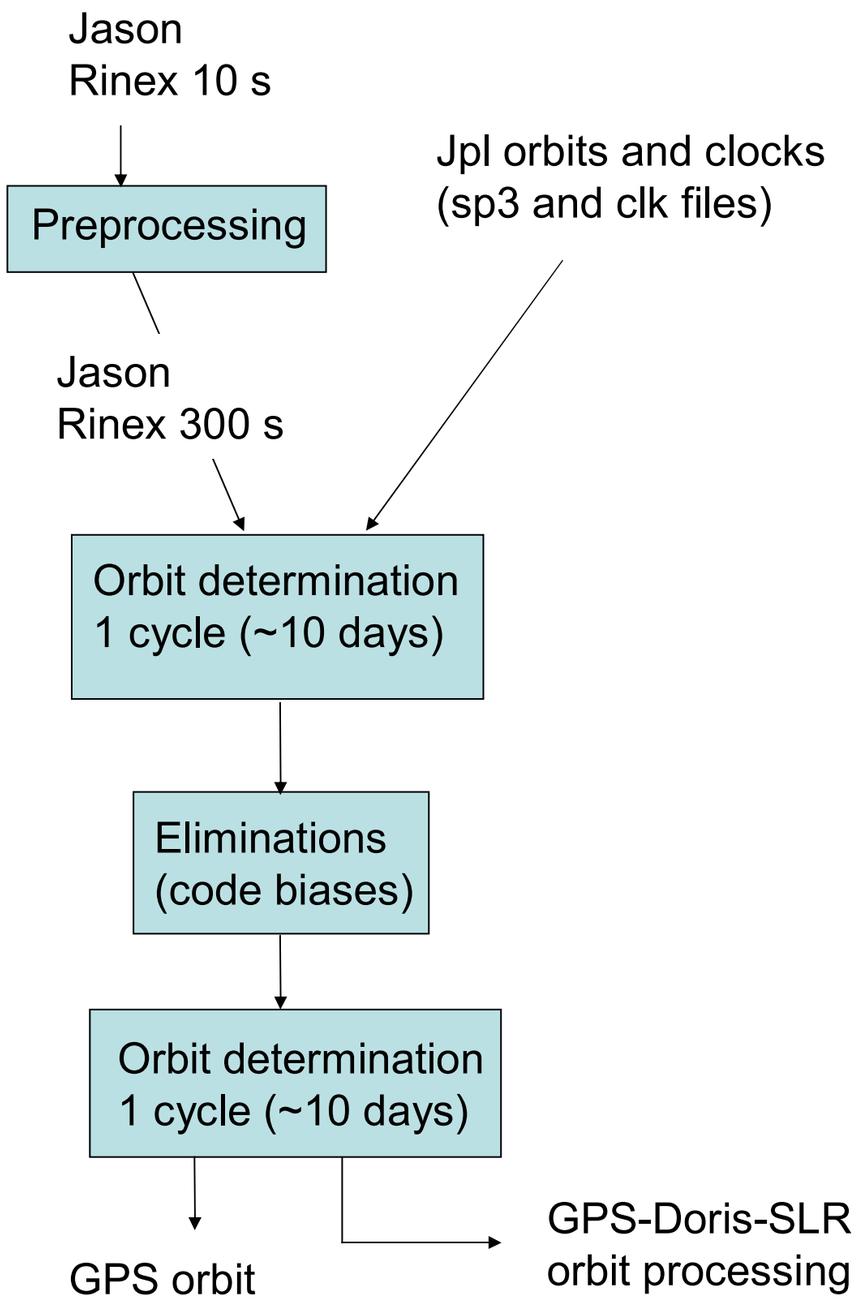
- some oscillations in 12 h empirical accelerations show that there are possible improvements in the GPS modelisation
- antenna maps improve the performances of the solutions, but must be carefully used with consistent hypotheses for the measurement modelisations

Integer ambiguity fixing

- study of single differences with ground stations
- ~100 % widelane ambiguity fixing
- N1 fixing, study using JPL or CNES orbits, good performances, antenna correction map is necessary. When compared with JPL orbit fixed ambiguities, CNES orbits show a sufficient observation of integer N1 ambiguities to start a bootstrap method

Further work : orbit determination using these results not yet implemented in OD software

# POE GPS characteristics




Dynamics :

- Initial Position and Velocities
- Drag coefficient, continuous segments, every 2 orbits
- 1/rev along and cross track, 12 hours
- Attitude (measured quaternions)

Measurements

- Iono-free code and phase
- Satellite clock (one value every 300 s)
- One adjusted ambiguity per pass

Remarks :

- shorter intervals for 1/rev terms are not stable
- reduced dynamics doesn't improve the orbit performance in the current cases

# Jason measurements Preprocessing

Use of measurements only, 10 s sampling (P1,P2,C1,L1,L2)  (no model)

Determination of cycle slips locations by finite differences algorithm on :

- C1 : elimination of outliers
- L1-C1/$\lambda$1 : L1 cycles slips (< 100 cycles)
- L2-$\lambda$1/$\lambda$2*L1 : iono phase (<10 cycles, added for L2 ramps)
- L2-$\gamma$*$\lambda$1/$\lambda$2*L1 : iono free (< 1 cycle)

P1 and P2 outliers (resp. comparison with C1 and P2)

Definition of passes, downsampling and code normal points computation for 300 s

Very efficient : all measurements at the beginning of the orbit determination process are valid, except for some passes with code biases (very small effect on the orbit results)

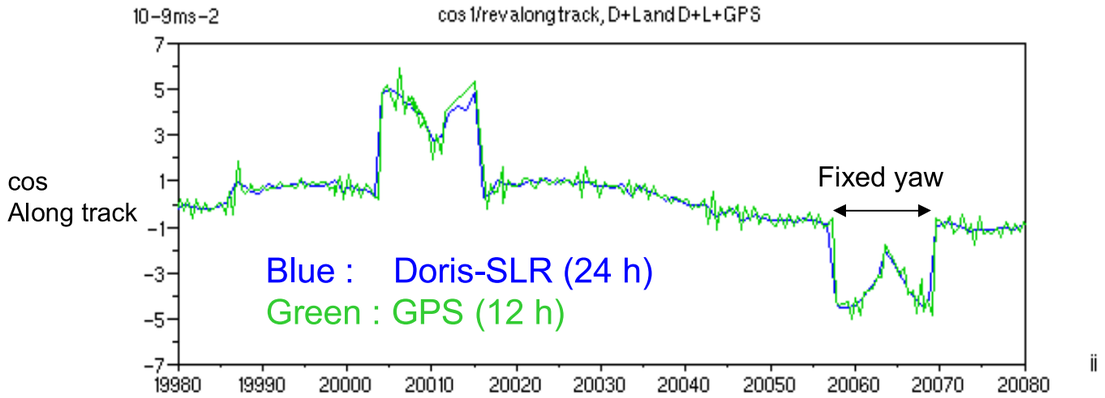
Limitations : only important L1 cycle slips are detected
for example a simultaneous jump :  9 on L1 and -7 on L2 is not detected

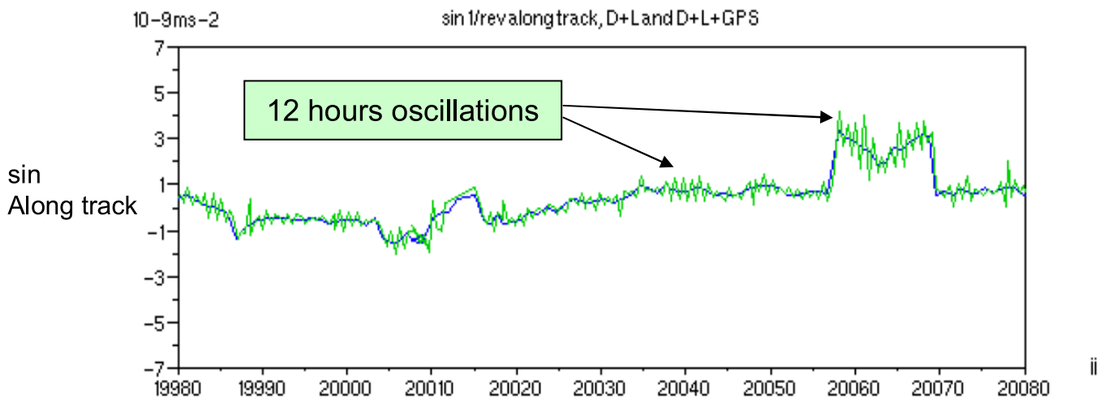
Passes are cut at each day change (phase is systematically interrupted at 0h)

Applied successfully on Champ and Grace processing (CNES/GRGS)

Similar processing used for 30 s IGS data processing at CNES

# 1/rev terms behaviour




Very clear global signature due to the radiation model precision,

Same signature on GPS and Doris/SLR orbits (see general presentation)

Oscillations on the identified amplitudes for GPS orbits, 12 hours intervals :

- probably due to the measurements, and not to the dynamic modeling

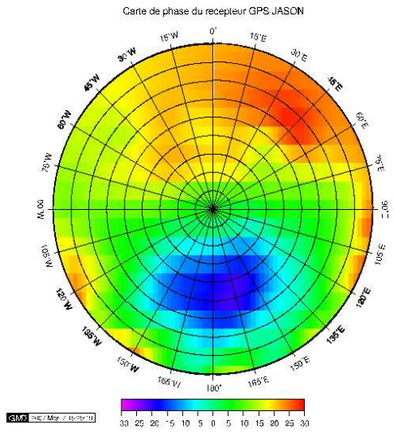
- present on all components (cross track, along track)

- 12 h intervals are used in current GPS and Doris/SLR/GPS orbits because the performance (altimeter crossovers) is slightly better

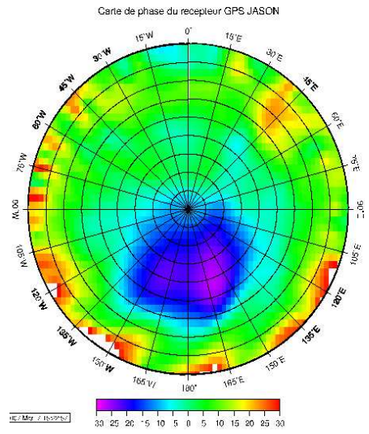
→ Not explained yet

# Antenna phase correction maps

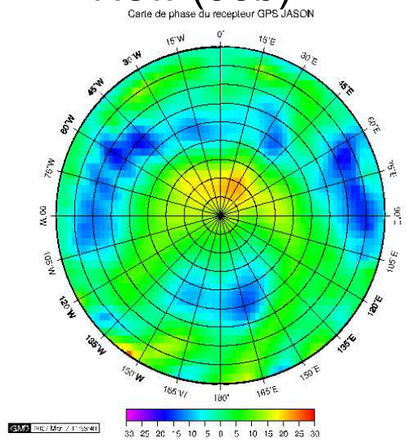
Initial




POE




New (06b)




Correction in antenna axes

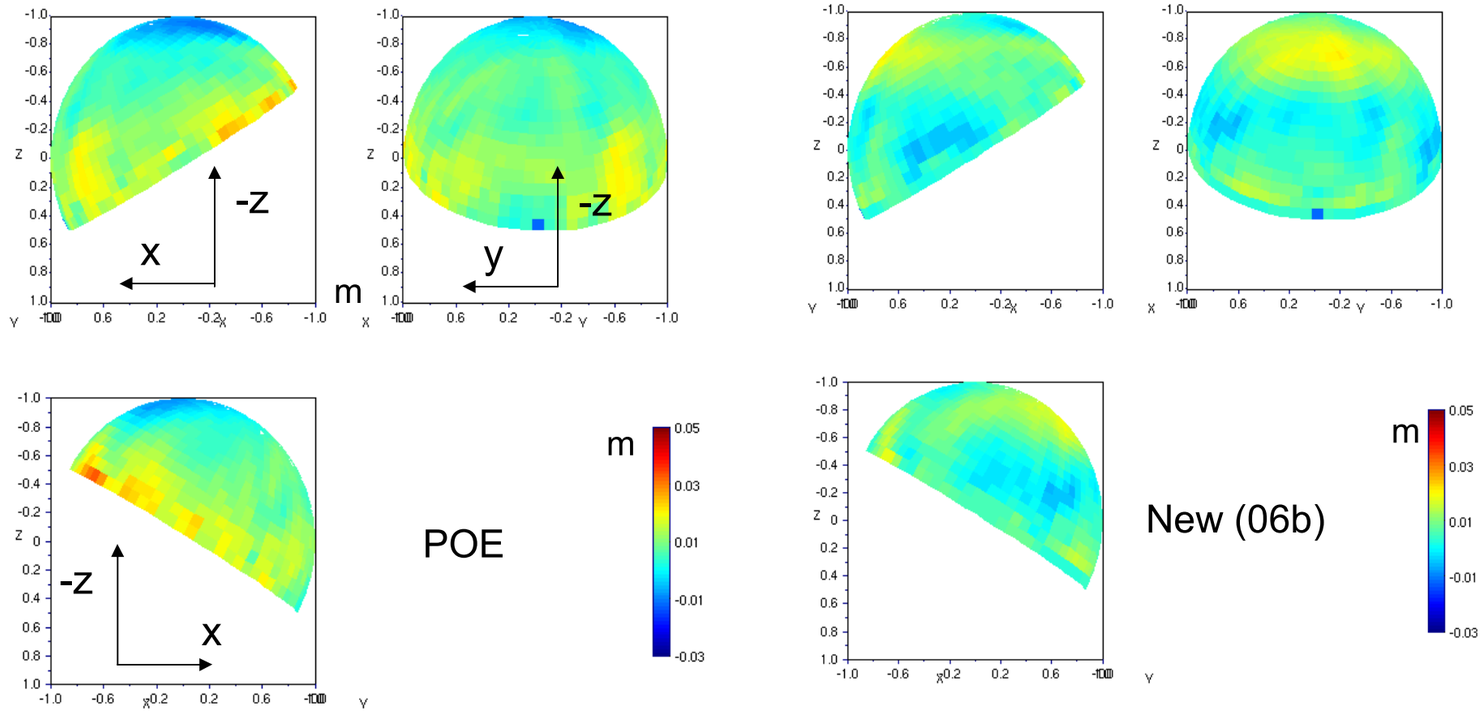
Three maps computed by JPL :
- initial map
- improved map used in for POE
- new map (06b)

The initial and POE map corrects an important signature in the residuals corresponding to a Z satellite bias

The new map (06b) cannot be used without corrections on the GPS side :
Z bias is not corrected by this map alone

When using the new map without GPS corrections maps, the Jason residuals are much higher.

3d visualization
In satellite axes



# Integer ambiguities study

Double differences : see Yoke T. Yoon  thesis

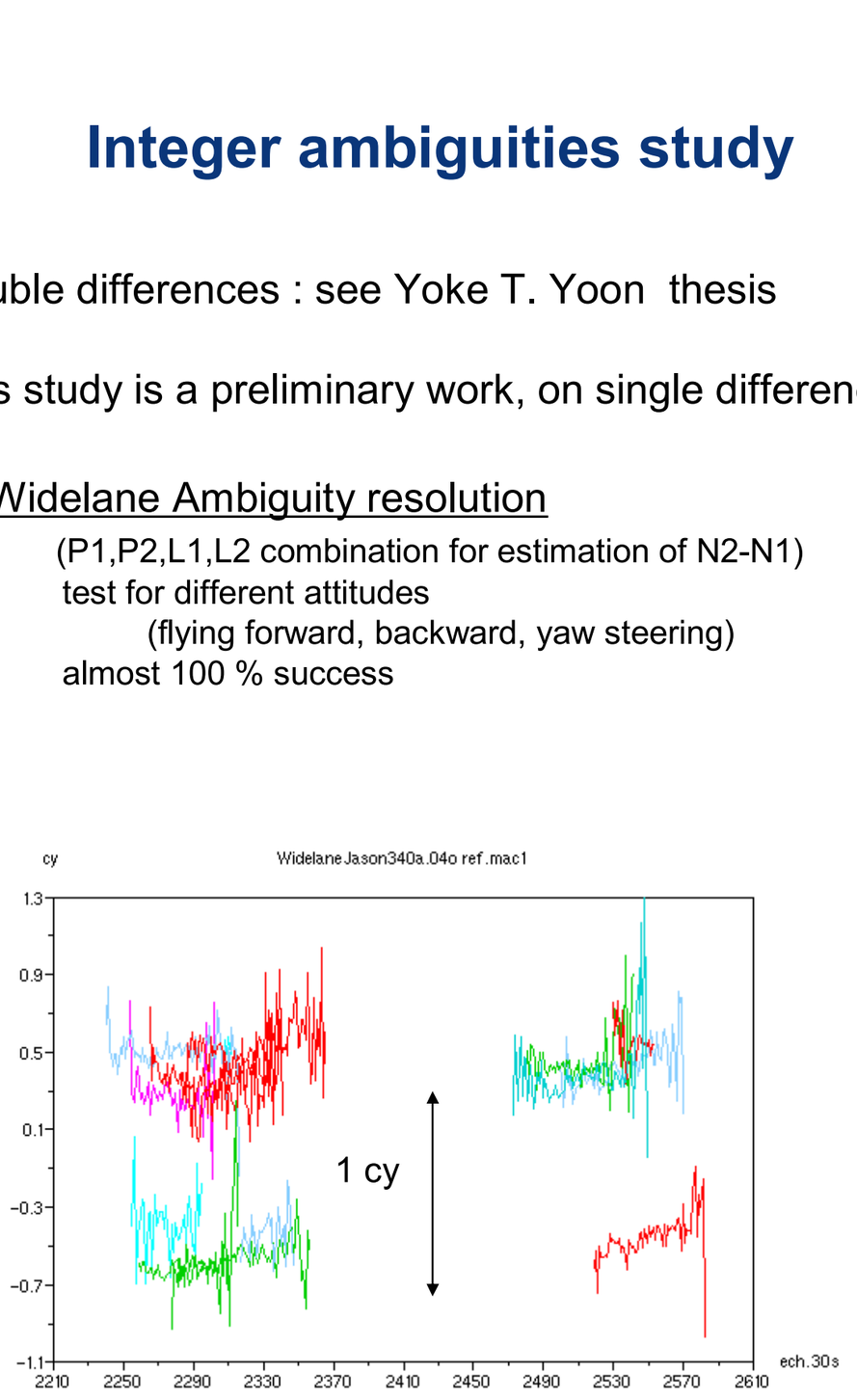
This study is a preliminary work, on single differences with ground stations, similar approach :

1 Widelane Ambiguity resolution

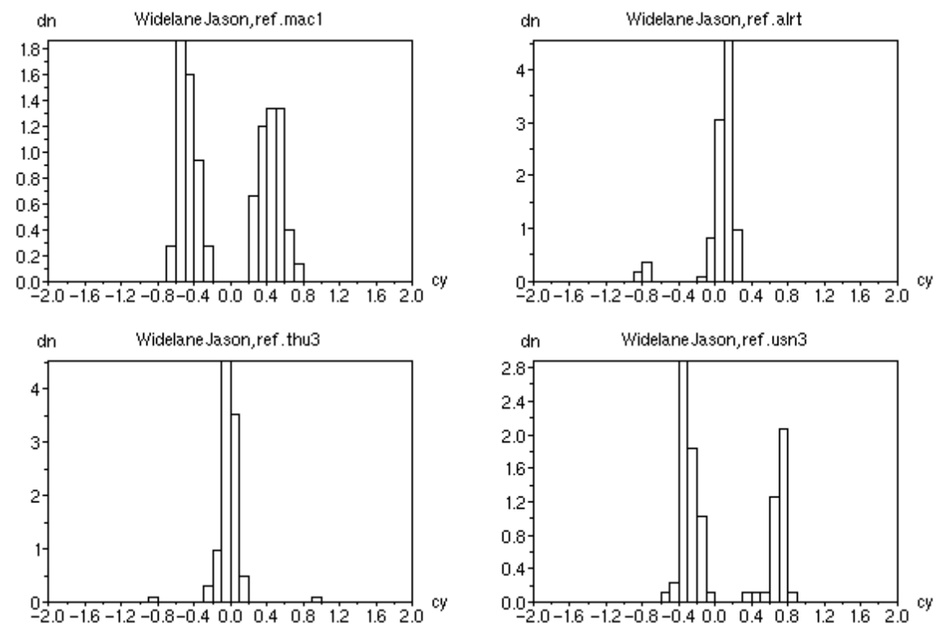
(P1,P2,L1,L2 combination for estimation of N2-N1)
test for different attitudes
(flying forward, backward, yaw steering)
almost 100 % success

2 N1 ambiguity on iono-free combination

(wavelength 10.7 cm)
difficulties to observe the integers
important effects of the phase correction maps




Single difference widelane ambiguities Jason
(reference mac1)

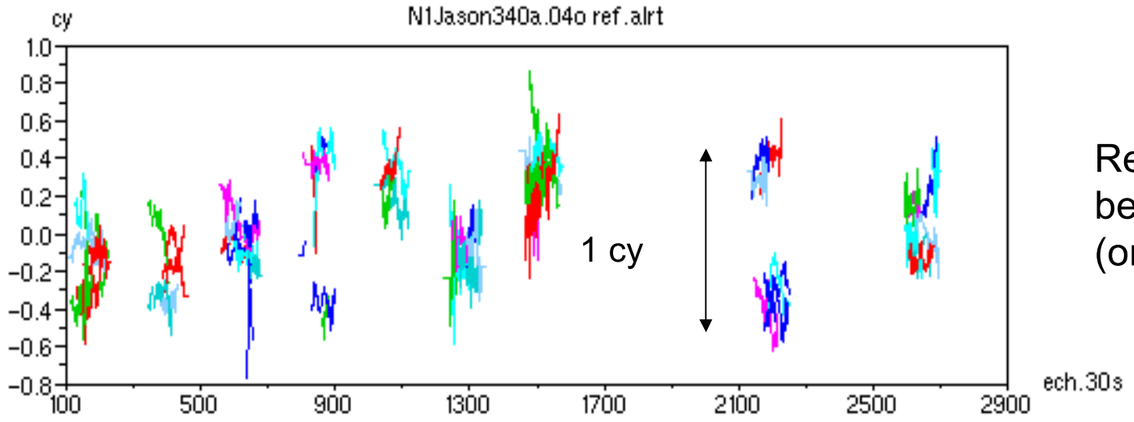



Single difference widelane statistics on four stations

# N1 ambiguity analysis

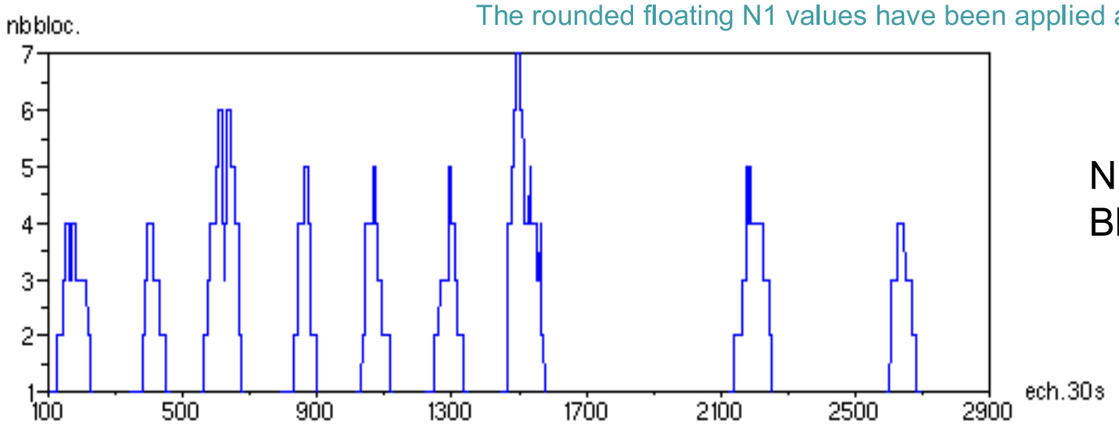
Iono-free phase residuals with integer N1 and widelane fixed, single differences with a reference ground station
JPL orbits for GPS constellation, comparison of Jason orbits (JPL and CNES)
Analysis on simultaneous passes with duration > 3000 s.

blocking criteria : 10 epoch overlap (300 s), mean difference < 0.25 cycles
works only if initial orbit quality is better than the wavelength (10.7 cm)



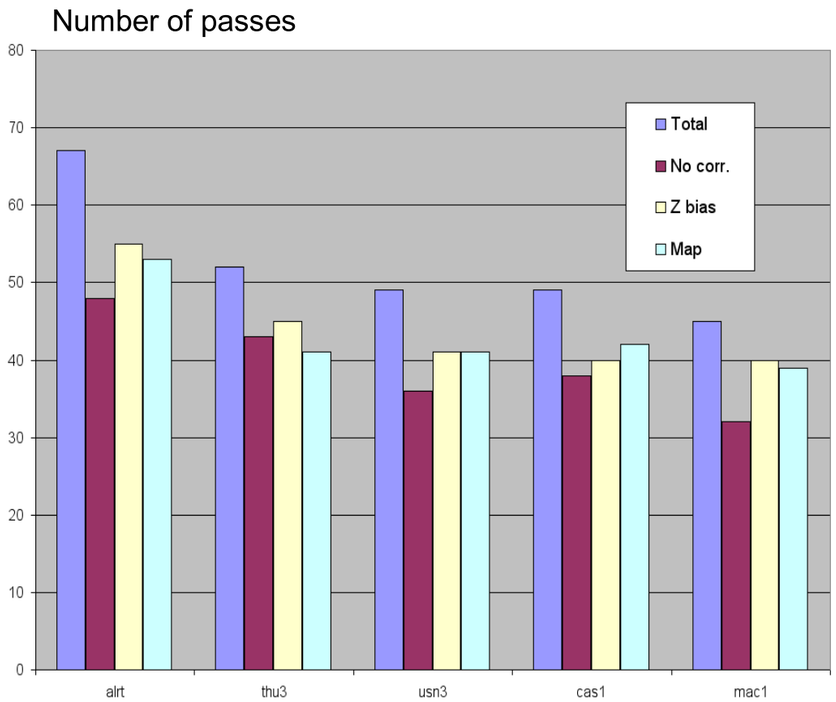

Residuals
before N1 identification
(one colour per pass)

The rounded floating N1 values have been applied as preliminary correction to have lisible plots




Number of
Blocked values

# Results for 5 ground stations day 340 04 (JPL GPS orbit)




day 340

JPL GPS orbit case, three configurations for Jason

without phase correction antenna map
without phase correction antenna map, 4 cm offset in Z
with current map (2005 map)

The phase map, or a Z correction, is necessary to achieve a good ambiguity observation

82 % of ambiguities can be observed with the antenna correction map

5 stations, days 340 and 342 (fixed yaw, forward and backward)
reference : N1 identified with JPL orbits and correction map
N1 identified with CNES orbits and z offset
N1 identified with CNES orbits and antenna map

Better results with the antenna map

Only 4% of N1 values are different between JPL orbits and CNES orbits

Allows a good initial configuration for a bootstrap method with CNES orbits