Jason2 GPS processing studies

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Introduction

The objective is to study the impact of some Jason2 GPS measurements characteristics on the orbit determination errors. The three subjects are : the sampling (the POE processing uses 300 s sampling), the antenna phase correction map (no receiver map in the POE), and the possible remaining 1/2 cycle slips.

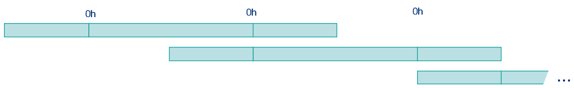
It was shown in 2008 (presented in OSTST 2008 Nice) and confirmed by JPL that the Jason2 receiver may produce phase measurements with half cycle ambiguities. This is a problem for advanced applications like ambiguity fixing, but may also be a limitation for the current processing. The current processing is not able to detect such small values in the cycle slips. It is necessary to investigate the consequence of these remaining errors in the phase measurements for the orbit determination, and the possible detection/reconstruction procedures.

For this purpose, a set of Jason orbits with 30 s measurement sampling was constructed using igs/esa orbits with 30 s clocks. The orbits are two days overlapping arcs. Using these orbits, different solution configurations were studied (effect of phase maps, effect of sampling, correction of cycle slips).

A receiver phase correction map was constructed in 2009 (presented at OSTST Seattle), but is not used in the present POE solutions. An improved phase map is constructed to investigate some anomalies observed in the current configuration (possible bias of the antenna position along the x axis). It is shown that some unobservabilities in the map construction may occur, due to the parameterisation and/or the general observability of the configuration.

Overlapping two days arcs

A recent 10 days period was chosen from 11/04/2010 to 21/04/2010. The attitude law is a yaw steering with maximal amplitude (just after a ramp up).



Configurations : <u>dynamic model similar to the POE configuration</u>

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1/rev term every 24 hours, along and cross track (change at 12 hours, central day)
constant along track every 8 hours
drag and radiation models not adjusted
stochastic case : 1/rev along and cross track, constant along track
                  sigma = 10^-9 ms^-2 and correlation time = 4 hours for 300 s measurement sampling
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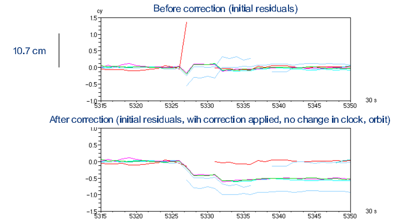
<u>measurements processing, igs/esa orbits and 30 s clocks</u>

Case	Sampling	Phase map	Meas. Processing	GPS orbits
1	300 s	no	std	jpl
2	300 s	no	std	esa
3	30 s	no	std	esa
4	30 s	old (CNES 2009)	std	esa
5	30 s	new	std	esa
6	30 s	new	1/2 slips reconstruction	esa

Simultaneous half cycle slips reconstruction



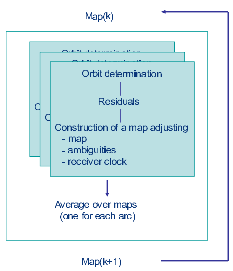
L2 –L1 (widelane) has only integer cycle slips
L1 or L2 may have simultaneous half cycle slips

Possible remaining jumps of ~5.3 cm in the iono-free residuals

The iono-free residuals of a dynamic orbit are processed in order to have relative variations as close as possible to zero, with 0.5 cycle corrections applied at each epoch

Phase maps

Improvement of the method, with orbit determination iterations.



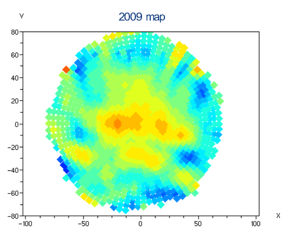
Initial model : case 4, and correction of the ½ cycle slips before residuals processing

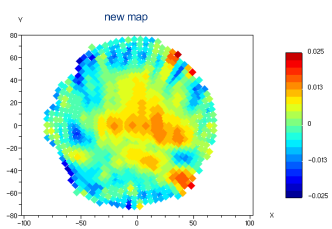
The 2009 map was constructed using only one iteration with fixed orbits

- the convergence is efficient, and the maps corrects the main effects
- some global effects are hidden
  (e.g. position of the phase centre, depending on the attitude case)
- no correction of ½ slips

The new map is obtained with two iterations, beginning with the old map

- equivalent to three iterations
- first correction is mainly a 5 mm displacement along x satellite
- corrections < 1 mm for the last iteration
- impact on the orbit (see difference of configurations 4 and 5)
- correction of ½ slips





<u>Example of observability problems</u>

<u>global undetermination :</u> case of the fixed attitude

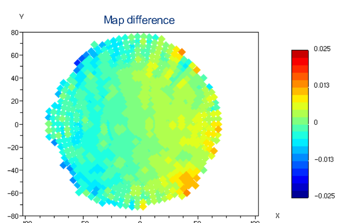
the map along x and the along track position are not separable

the procedure wil give no x offset in the map

<u>forced observability :</u> (due to separate optimisations for map and orbit)

if the dynamic model corrects some effects like along track periodic terms due to an offset of the phase centre

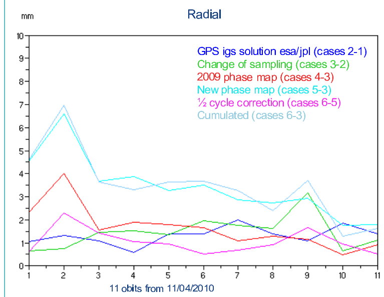
the corresponding map correction is not present in the residuals, and not observed



Global map effects must be adjusted in the orbit determination (centre of phase position)
Local effects are well observed with the current procedure (one iteration and frozen orbits)

Orbits comparison

<u>Dynamic orbits, comparison of the different configurations (sampling, maps, ½ cycles)</u>

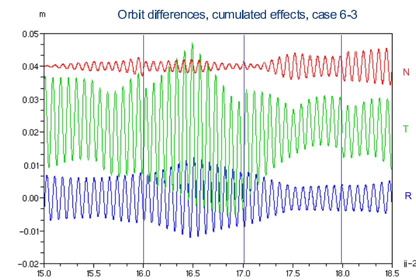


The elementary effects remain small in radial direction

differences between esa and jpl solutions below 2 mm rms

effect of remaining ½ cycles below 2 mm rms

cumulated effects : main contribution is the new phase map effect



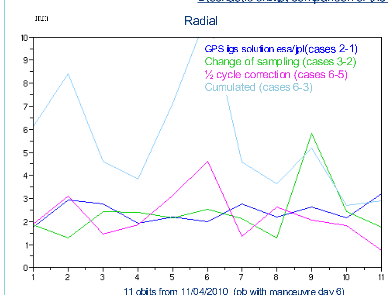
Differences between complete case and no corrections at 30 s
(translations added, 0.02 and 0.04 m for Tangential and Normal)

Example on the first four central parts of the orbits, which are concatenated (very good overlaps), cases 6 and 3

Very stable oscillation in radial

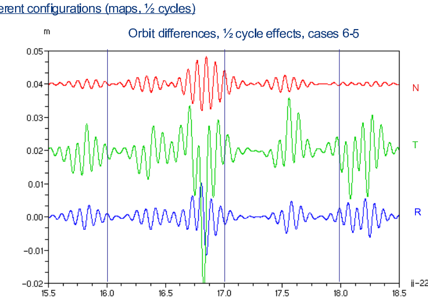
Main effect is the phase map
(4 to 6 mm rms)

<u>Stochastic orbits, comparison of the different configurations (maps, ½ cycles)</u>



Effects slightly higher than for dynamic orbits as expected

The phase map effect reaches 1 cm rms



½ cycle errors produce local effects, which will be more localized if the stochastic coefficients are more decorrelated
(translations added, 0.02 and 0.04 m for Tangential and Normal)

Radial effect can reach locally 1 cm

Conclusion

An efficient procedure with overlapping two days arcs has been implemented. This was necessary to allow higher measurement sampling rate (30 s).

The change from igs/jpl solution to igs/esa solution has 1-2 mm effect in rms radial.

The effects of the receiver phase map correction and ½ cycle errors in the measurements remain well below the centimeter for a dynamic orbit. However, for stochastic orbits, the effect may be close to one centimetre, depending on the configuration.

This must be studied further on longer durations with external verifications (SLR, POE orbits comparisons) in order to refine the tuning of the models (stochastic cases).

All these modifications may produce a centimetric effect in radial, and are negligible for the present products, but may be necessary for the next generation of orbits.