MGEX Galileo measurements characterization

F. Mercier, C. Boulanger, F. Perosanz, S. Loyer
CNES, Toulouse, France (flavien.mercier@cnes.fr)

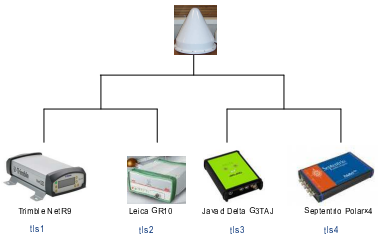
Introduction

In the MGEX network there are various receiver types. Here we focus on the observables measured for the four Galileo satellites and the two GPS L5 (GIOVE A and B, IOV 1 and 2, GPS 01 and 25). A dedicated test campaign has been conducted in CNES Toulouse to characterize the different available commercial receivers, in order to be able to process in a consistent way the data from the REGINA network (CNES/IGS multi-GNSS network), which are also available in the MGEX network.

The test is a zero baseline measurement between receivers. The different pseudo range and phase biases are analyzed (systematic biases for GIOVE data are observed, and also for some phase measurements).

The satellite widelane biases are studied for the complete MGEX network, and a set of widelane biases is constructed (as for GPS in the GRG IGS analysis centre solution). These informations are not sensitive to the knowledge of the satellite orbits, so this study can be conducted, even with few active stations, and without precise orbits.

Zero baseline tests



Observables : C1,L1, C5,L5 (f5a frequency band)
Six satellites : IOV 1 and 2, GIOVE A and B, GPS 1 and 25
Two datasets :
days 125-127 : Trimble and Septentrio
days 165-169 : Trimble, Leica, Javad, Septentrio
Same external frequency reference

Septentrio and Trimble are not measuring consistent observables for Galileo satellites

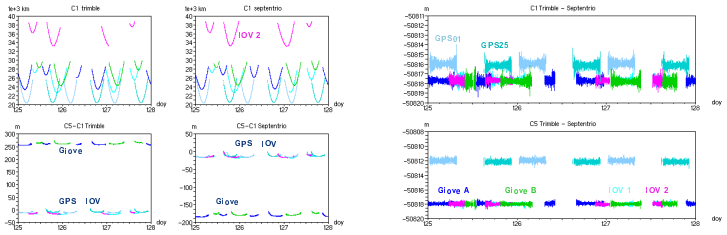
It is possible to fix ambiguities between the six satellites using the current method (as in grg igs GPS solution)
- widelane N5-N1 (with calibration of pseudo-range delays)
- N1 (10.9 cm wavelength)

Pseudo-range comparison

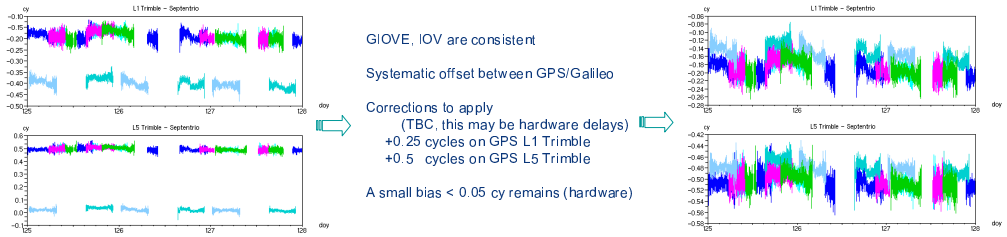
-important offsets between GIOVE and IOV satellites (C5) correction on C5 GIOVE
Trimble : -276 m
Septentrio : 164 m
(-100m doc. correction not applied)

Remaining biases after correction :
- between GPS and Galileo satellites (intersystem bias)
- between GPS25 and GPS01 (?)

Days 125-127 Trimble and Septentrio



Phase comparison



GIOVE, IOV are consistent

Systematic offset between GPS/Galileo

Corrections to apply
(TBC, this may be hardware delays)
+0.25 cycles on GPS L1 Trimble
+0.5 cycles on GPS L5 Trimble

A small bias < 0.05 cy remains (hardware)

Observed biases for pseudo-range, days 165-169
(relative to Septentrio, aligned on GPS, IOV 2 not measured)
(C5 bias corrected for Trimble and Septentrio as for days 125-127)

	Trimble		Leica		Javad	
	C1	C5	C1	C5	C1	C5
GIOVE A	-1,61	-5,80	16,71	19,38	0,39	-0,14
GIOVE B	-1,70	-5,86	16,46	19,28	0,13	-0,50
IOV 1	-1,58	-5,87	16,85	19,56	0,64	0,30
GPS01	0,02	0,02	0,06	0,06	0,03	0,01
GPS25	-0,02	-0,02	-0,06	-0,06	-0,03	-0,01

GPS biases are consistent between receivers (~ 10 cm)
errors maybe due to differential clock error (not taken into account)

Important Inter system biases between all receivers, also on C1

Inter satellites variations may be important for Galileo
(0.8 cm observed on Javad, due to clock effects ?)

Four observables Widelane ambiguity is stable
ambiguities can be fixed in a consistent way between the receivers
the biases are depending on the receiver type

Observed fractional biases for phase, days 165-169
(relative to Septentrio)

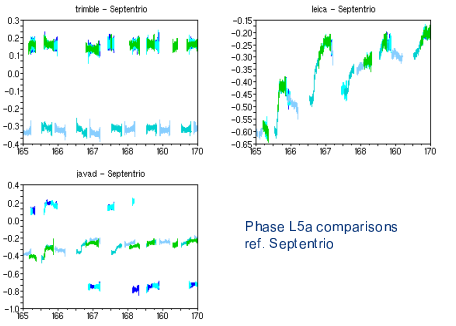
	Trimble		Leica		Javad	
	L1	L5	L1	L5	L1	L5
GIOVE A	-	-	0,5	-	-	0,5
GIOVE B	-	-	-	-	-	-
IOV 1	-	-	0,5	-	-	0,5
IOV 2 (*)	-	-	0,5	-	-	0,5
GPS	-0,25	0,5	-	-	-	-

* : observed after synchronization, days 181-184

Phase measurements agree well if fractional biases are corrected
(TBC, not separable from receivers internal delays)

Leica, Javad, Septentrio agree for GPS L1/L5, Trimble is different

Clock variations on Javad (0.2 m) and Leica (0.45 m),
sensitivity to thermal perturbations ?



Phase L5a comparisons
ref. Septentrio

Network results : widelane ambiguity fixing

MGEX network processing, days 165-169, receivers Trimble, Leica, Javad, Septentrio
Leica receivers : incomplete data sets (only GPS is correct)
zero baseline receivers added : tls1, tls2, tls3, tls4

- application of phase offsets corrections
- no pseudo range correction

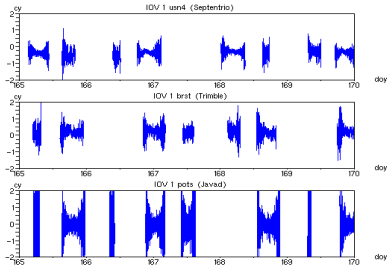
Example : observed widelane combination
(four observables, pseudo range and phase)

raw widelane results on IOV 1, stations usn4, brst, pots
30 s data, five days

- bias is stable along time for receivers and satellite

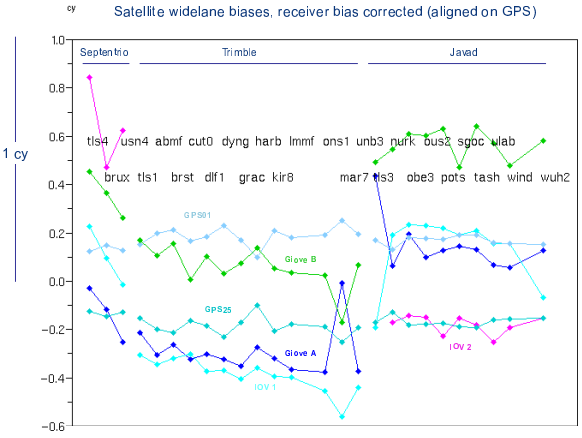
- different noise and signatures

Widelane biases are stable (receiver and satellites)



Estimation of independent constant satellite biases for each receiver is possible (5 days)

Satellite widelane biases, receiver bias corrected (aligned on GPS)



- widelane biases depend on receiver type (and firmware ...)
on GPS : consistent within ~ 0.1 cycle
calibrations are needed to process simultaneously all receivers
- some receivers may observe very different biases (brux, mar7, tls3, wuh2)

Conclusion

**MGEX receivers produce good quality L1/L5a measurements on both GPS and Galileo,
Leica receivers data availability must be improved**

**Satellite pseudo-range biases depend on the receiver type (problem similar to C1-P1 for GPS processing)
it is possible to process Galileo and GPS L1/L5 simultaneously (6 satellites widelane ambiguity fixing)**

**Phase biases are present between the different receiver types (0.5 cycles, 0.25 cycles)
some phase references must be clarified**

**Widelane ambiguity fixing validated on the zero baseline (6 satellites).
Galileo satellite widelane biases are stable over periods of a few days (zero baseline)
Stability confirmed with the analysis on the complete network**