Wide-Lane ambiguity fixing anomalies observed in Repro2 solutions

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Introduction

The CNES-CLS IGS Analysis Centre solution uses a two steps procedure for zero difference ambiguity fixing. The first step constructs the Wide-Lane (WL) combination (Melbourne-Wubenna four observables combination) for each station-satellite visibility and solves for the corresponding integer ambiguity together with satellite and receiver biases. The daily WL satellite biases (WSB) are available at our AC website (http://igsac-cnes.cls.fr), and are used by i-PPP users for single receiver WL ambiguity fixing.

For the WL processing, it is necessary to reconstruct the P1 pseudo-range using the C1 pseudo-range for some receivers like cross-correlated (CC) Trimble receivers. This is usually performed using the C1-P1 biases available at IGS and the cc2noncc IGS tool. So the WL data sets are consistent between different receiver models.

This is applied successfully today for the routine processing and was also used in the Repro2 solutions. However, we faced to increasing problems processing data in the past, before 2004, with a lot of unfixed ambiguities. The WL satellite biases were suitable for ambiguity fixing on Ashtech and Rogue ACT receivers, but not efficient for CC receivers corrected using the cc2noncc tool (Trimble or Rogue receivers).

Here we focus on the widelane satellite biases, depending on the receiver technology, for period 2001-2003. The widelane satellite biases are constructed for different combinations and receiver families (Ashtech, Rogue ACT, Trimble, Rogue 8000) using (P1,P2) observables or (C1,P2) observables.

Background

Expressions for Melbourne-Wubenna four observables combination (widelane, iono-free and geometry free) :

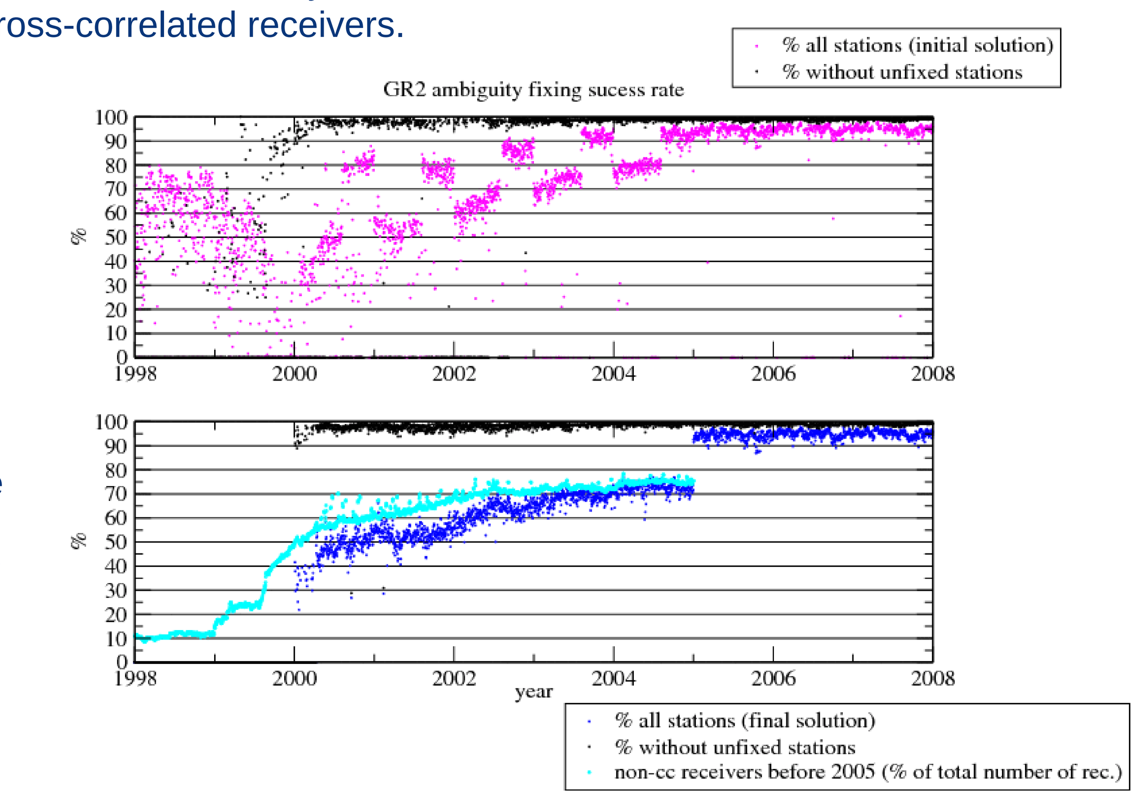
$$
\begin{aligned}
W(P_1,P_2) &= L_2 - L_1 + f(P1,P2) && \text{geometry free and iono free}\\
W(P_1,P_2) &= N_w + \tau_{rec} - \tau_{sat} && N_w \text{ constant integer for a satellite-station visibility}\\
& && \text{hourly } \tau_{rec} \text{ station widelane bias}\\
& && \text{hourly } \tau_{sat} \text{ satellite widelane bias}
\end{aligned}
$$

Single receiver solution : τ_{sat} is known (daily values, available at grg website)
ftp://ftpsedr.cls.fr/pub/igsac/Wide_lane_GPS_satellite_biais.wsb

$$W(P_1,P_2) + \tau_{sat} = N_w + \tau_{rec}$$

Remarks : τ_{sat} values are suited for P1,P2 combination (semi-codeless receivers)
for recent receivers (C1,P2), C1 is corrected using cc2noncc IGS program
for old receivers (cross-correlated) (C1,P2'), C1 and P2 are corrected

Final ambiguity fixing ratios for repro2 initial solution : before 2004, the observed fixing ratios are not satisfactory, this is due to incorrect widelane ambiguity fixing on cross-correlated receivers.

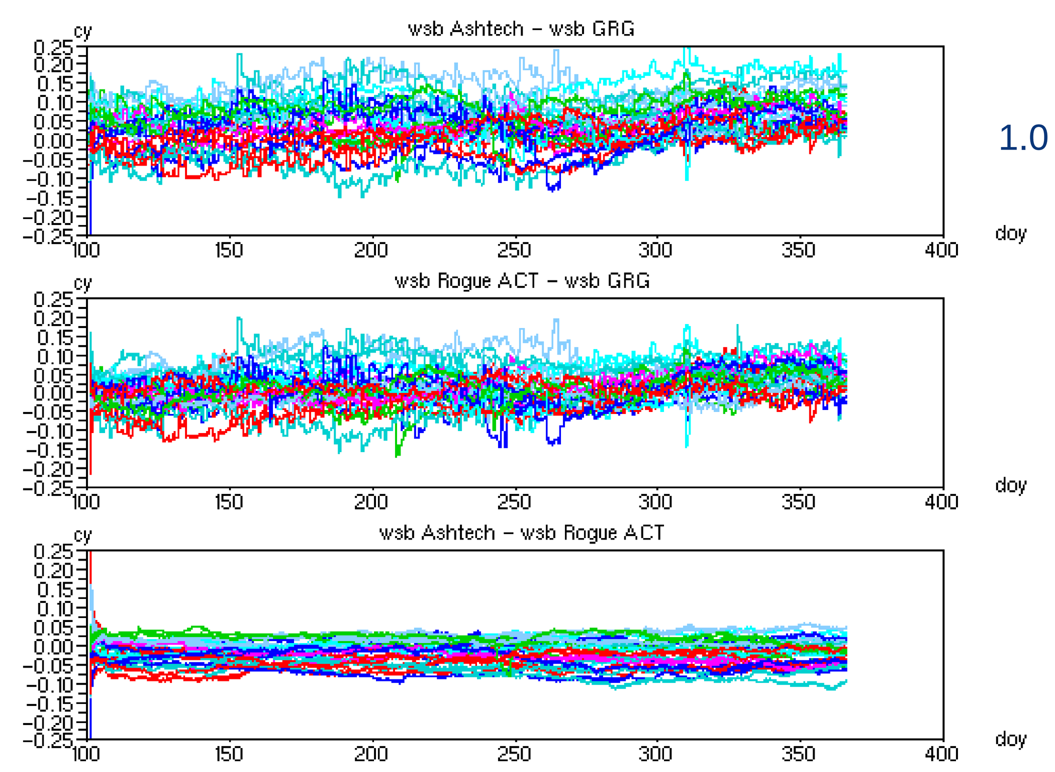


The solution used (due to shorts delays) was to remove these receivers from the ambiguity fixing process (they are solved in floating mode)

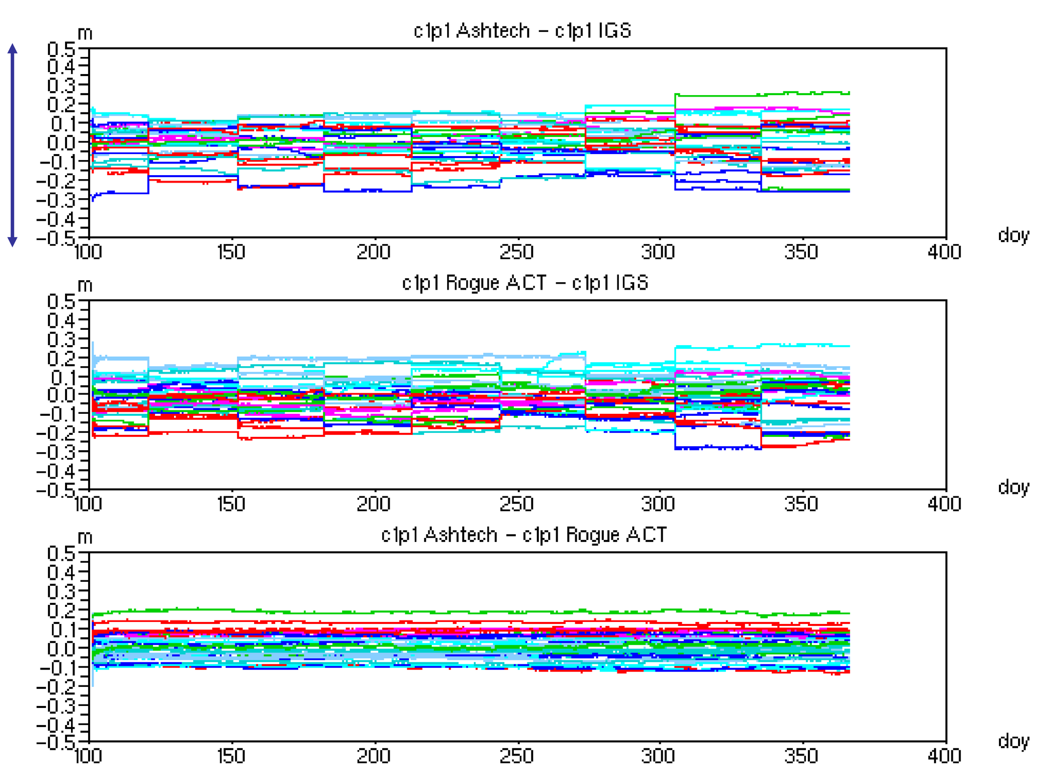
Widelane and C1P1 biases elementary solutions

Combinations used		W(P1,P2)	C1-P1	W(C1,P2')
Ashtech	C1,P1,P2	x	x	
Rogue ACT	C1,P1,P2	x	x	
Rogue 8000	C1,P2'			x
Trimble	C1,P2'			x
IGS		x	x	

0.5 cy



1.0 m



Hourly mean biases are solved for May 2001 - Dec 2001, with Kalman filter, for each configuration (widelane with P1,P2 or C1P2', and C1-P1), similar results hold for the complete period May 2001 – Dec 2003 (see analysis from JPL in IGSMAIL 2320 for C1-P1 biases)

P1C1 bias effect (correction applied by cc2noncc to reconstruct P1,P2 and then W(P1,P2)) :

$$
\begin{aligned}
W(C_1+b_1,P_2') &= W(C_1,P_2') + 1.16 b_1 && \text{(Trimble 4000, Rogue 8000...)}\\
W(C_1+b_1,P_2) &= W(C_1,P_2) + 0.65 b_1 && \text{(Trimble NETRS...), not analyzed here}
\end{aligned}
$$

Independent Ashtech and Rogue ACT widelane biases values are very close

GRG biases slightly different (probably due to use of C1P2' receivers in the solution)

C1P1 biases from Ashtech and Rogue ACT are verydifferent (up to 0.3 meters) but they are very stable along time (better than 0.05 m).

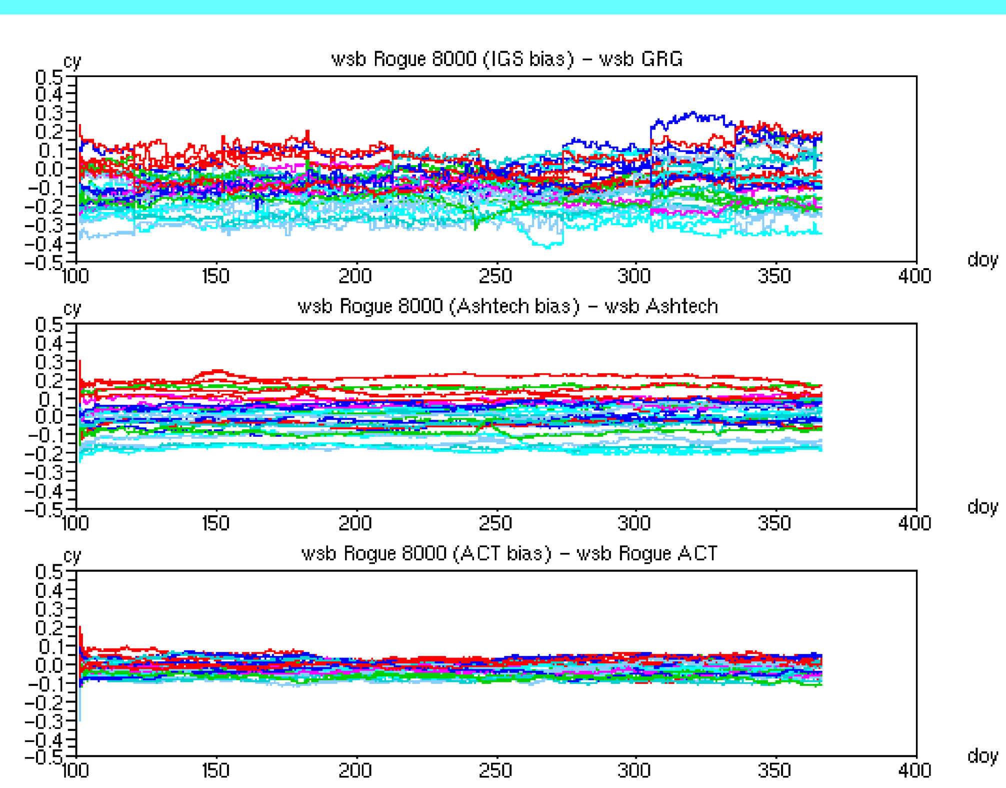
C1P1 biases from IGS are not so stable, and are also different (up to 0.4 meters)

Which biases are suited for the correction of Rogue 8000 or Trimble widelane combinations W(C1,P2')?

Sensitivity is ~1.2 cy/m : variations of 0.2-0.3 meters are significant for ambiguity fixing performance

Cross correlated receivers biases correction

0.5 cy



Rogue 8000 widelane C1,P2' biases corrected using Rogue ACT C1P1 biases are consistent with Rogue ACT (and Ashtech) widelane biases

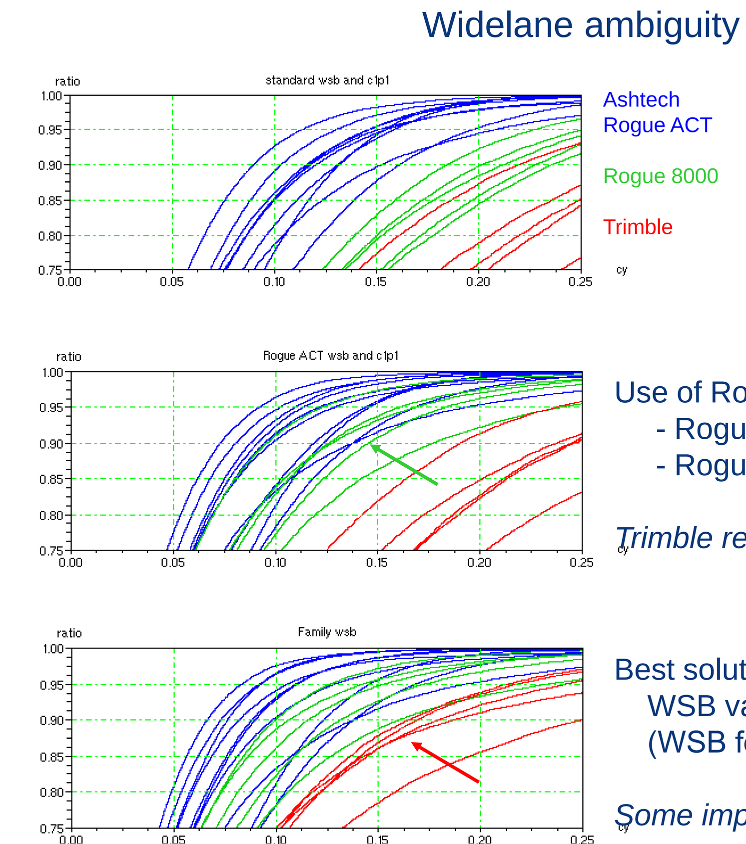
Ashtech C1P1 biases and IGS C1P1 biases are not suited
C1P1 Ashtech and C1P1 Rogue ACT are too different

Trimble receivers cannot be processed this way
a specific wsb history for Trimble receivers is probably needed

A set of widelane biases can be constructed for semi-codeless receivers (P1,P2) using Ashtech and Rogue ACT receivers.

Different corrections (similar to C1-P1 biases) must be used for other receivers. They are different for Rogue receivers and Trimble receivers (and maybe other families)

Widelane ambiguity fixing statistics



Standard processing
- GRG WSB values
- IGS C1P1 biases

Problems with cc receivers

Use of Rogue C1P1 bias
- Rogue ACT,Ashtech WSB
- Rogue ACT C1P1 biases

Trimble receivers are not correctly handled

Best solution :
WSB values identified for each family
(WSB for C1P2' widelane combination, cc receivers)

Some improvement for Trimble receivers

Conclusion

The difficulties observed between 2001 and 2003 for widelane ambiguity fixing in grg repro2 solutions are probably due to the use of some cross-correlated receivers in the network. The current processing uses the IGS C1P1 biases values to correct the observables (cc2noncc software). This works correctly for recent receivers widelane processing but not for old cc receivers.

In this study, hourly values for widelane biases and C1P1 biases were identified on the 2001-2003 period, for different receiver technologies. The results show that the best correction for Rogue 8000 receivers is to use C1P1 biases identified using Rogue ACT observables (similar processing as the early estimations of JPL, which used Ashtech only). The biases obtained with Ashtech receivers are different from the Rogue ACT biases, and also from IGS values. The differences may reach 0.3-0.4 meters. This is too large to achieve efficient corrections on the C1 and P2' observables, allowing a correct widelane ambiguity fixing.

The stability of the observed C1P1 biases for Ashtech and Rogue receivers is very good (better than 0.1 m), and also the difference between these two sets of biases is very stable (better than 0.05 m).

Further studies are necessary to improve the cc receivers ambiguity fixing using the widelane combination (specifically for Trimble receivers). Also similar inconsistencies were observed between different receiver technologies on recent studies (L1,L5)

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