Resolving GPS Integer Phase Ambiguities for Jason-1

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Abstract
This study evaluates a number of aspects of ambiguity resolution issues that includes the bootstrapping method and their effect on Jason’s orbit. The orbit of the spacecraft, tropospheric corrections, and pseudorange information must be of sufficient accuracy prior to resolving the phase ambiguities. This bootstrapping method does not require a search process but instead uses the covariance matrix to select the best determined set of double-differences. A confidence test procedure is implemented to ensure biases are correctly fixed to integer values. All phase ambiguities that satisfy the confidence requirements will be simultaneously fixed and any unfixed biases will be treated in subsequent iterations. Orbit comparison between the bias-free and bias-fixed solutions will be evaluated and the percentage of resolved ambiguities will be analyzed.

Methodology
At least 20 ground stations are processed simultaneously with Jason’s GPS data using the reduced-dynamic orbit determination technique. All data are processed in go-to-second data interval using JPL’s GIPSY-OASIS II software package. The FLINN GPS orbit solutions are treated as true orbits in Jason’s orbit determination and ambiguity resolution processes. GIPSY double-differenced the undifferenced data from parameter estimation for ambiguity resolution. Carrier phase ambiguities are resolved based on a confidence test procedure that calculates the cumulative probability function. The cumulative probability function is derived from the distance between the real value bias estimate and its nearest integer, and the formal error of the bias estimate.

The wide-lane bias is first solved using the pseudorange method. The fixed wide-lane bias is then used as a constraint to estimating the narrow-lane bias. All wide-lane/narrow-lane bias pairs that satisfy the confidence test procedure are fixed to their integer values. The double-differenced biases are then converted back to undifferenced estimates, updates are made to the solution and covariance matrix. This bias-fixing procedure is repeated until all remaining unfixed biases are fixed.

The above method used to resolve the phase ambiguities is so-called the bootstrapping method.

Analysis
Histograms above represent the wide-lane and narrow-lane double-differenced bias distributions for 4 days. The wide-lane distribution has a more distinct Gaussian distribution with respect to the narrow-lane and distributions vary from day to day. These distributions conclude that there are still unresolved systematic errors in the orbit solution.

Discussion
Very few (>1%) phase ambiguities were fixed in this attempt. Further investigation is still needed to justify the value of the bootstrapping method in this study.

There is a discrepancy of 35 cm in the antenna phase center location between the GPS pseudorange and carrier phase measurements. This analysis was done by JPL recently. It is still unclear at this point why the difference exists.

A 35 cm error is large enough to restrict the resolution of the double-differenced phase bias. Thus making ambiguity resolution impossible. However, in-depth analysis has to be done to confirm this claim.

Future Work
Resolve the 35 cm discrepancy between the two measurement types.
Process GPS measurement data with a different data interval.
Repeat ambiguity resolution with FLINN GPS orbit solutions as true solutions.
Estimate both GPS and Jason-1 orbits simultaneously and resolve phase ambiguities without frame constraint.

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