Accuracy Tests on Kinematic Long Distance Baselines

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This experiment involves forming three baselines using four United States NGS CORS stations, and examining the kinematic position accuracies over time for the purpose of determining the feasibility of using kinematic carrier phase on long baselines.

The processing was done with Waypoint Consulting Inc's GrafNav post-processing software package. Base stations were chosen in the following places, English Turn, LA (ENG1), Egmont Key, FL (EKY1), and Point Blunt, CA (PBL1). The remote station from all three baselines was in Galveston, TX (GAL1). All of the stations were equipped with Ashtech Z-12 receivers. The lengths for each of the three baselines were 460km, 1180km, and 2640km respectively. In all cases, the data at the roving station was considered totally kinematic even though the antenna was in fact stationary. There was no actual static initialization performed in the GPS data processing.

It is realized that this represents an ideal case where the GPS antenna is considered to be in kinematic mode, even though the dynamics are negligible. These tests will still provide some valid idea of how a GPS solution will behave under moderate dynamics on a very long baseline. It gives an indication of accuracy on kinematic runs with few cycle slips.

Four tests were performed on each baseline. Each test used three hours of data collected at 30s intervals. A higher data rate would not offset the results significantly. The parameters for each test are described in the table below. An ionosphere free model was used for those tests that used both L1 and L2.

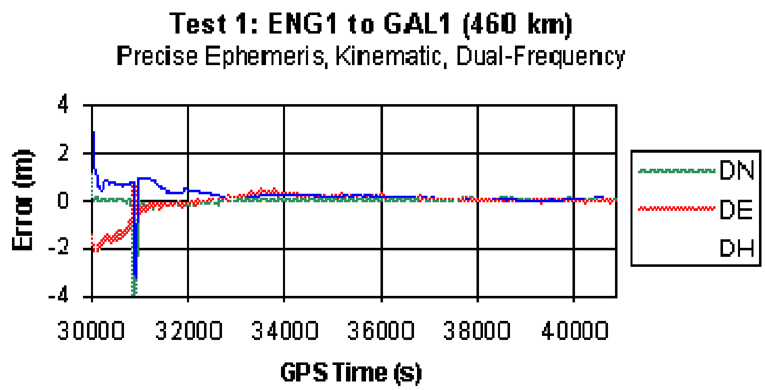
Table 1: Test Parameters

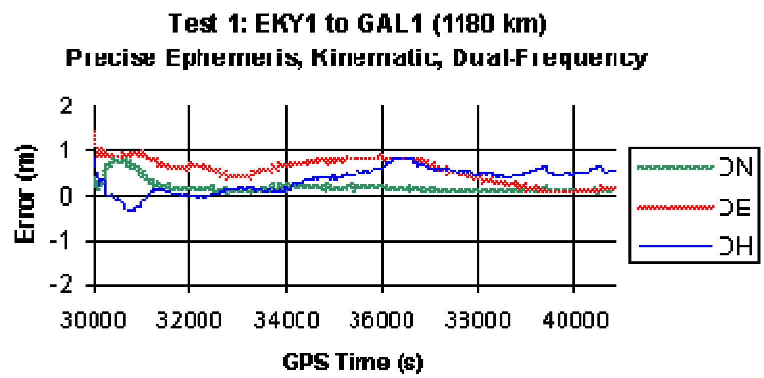
Test Number	Processing Direction	Ephemeris Used	Frquencies Used
1	Forward	Precise	L1 and L2
2	Forward	Broadcast	L1 and L2
3	Forward	Precise	L1
4	Forward	Broadcast	L1

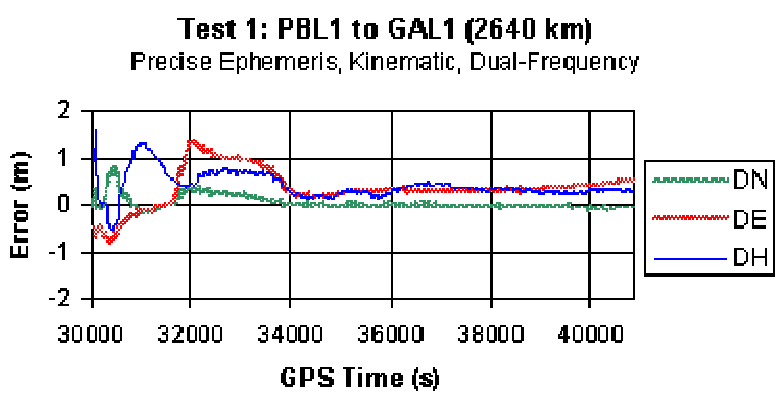
Test 1: Precise Ephemeris and Dual Frequency Data

This test shows a correlation between the size of the position errors and the length of the baseline. The first two baselines achieved sub-meter accuracy within about 20min. The third baseline took about an hour to achieve sub-meter accuracy. For the remainder of the survey, accuracies of 30cm

(0.6ppm) on the ENG1 to GAL1 baseline, 80cm (0.7ppm) on the EKY1 to GAL1 baseline, and 1m (0.4ppm) on the PBL1 to GAL1 baseline can be expected.



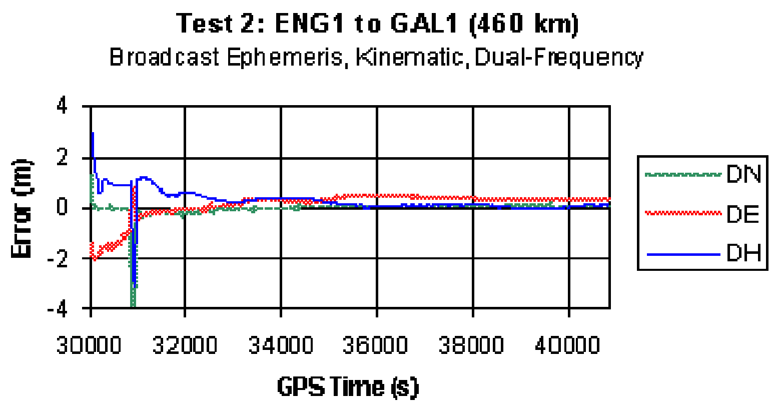


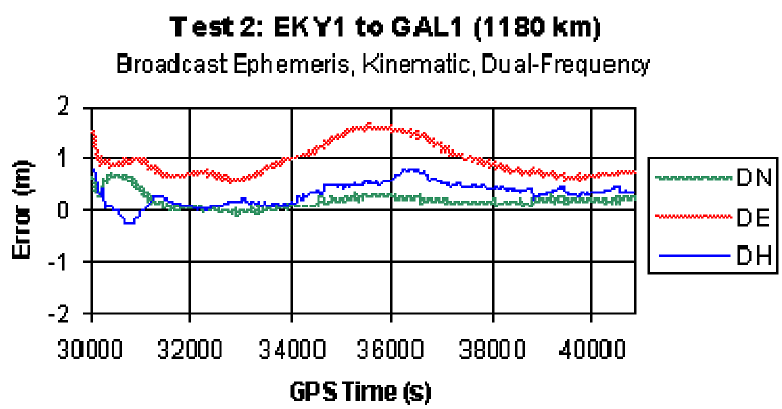


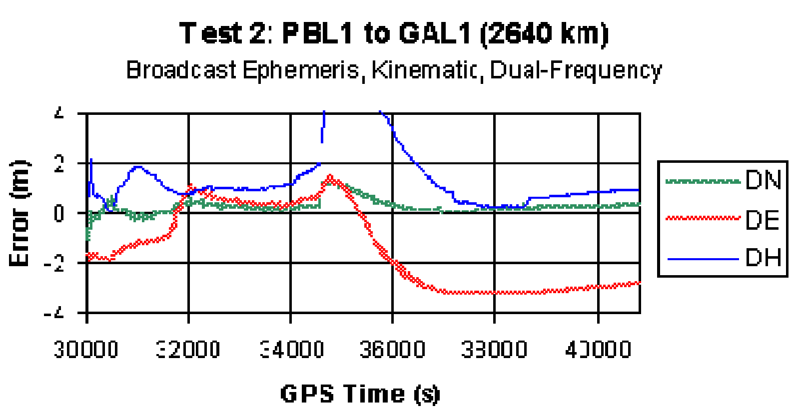
Test 2: Broadcast Ephemeris and Dual Frequency Data

This test examines the effect of not using the precise ephemeris in the processing of the data. On the ENG1 baseline, accuracies of 60cm (1.3ppm) were achieved and maintain after about 20min.

The EKY1 baseline acheived accuracies of 1.5m (1.3ppm). Finally on the PBL1 baseline, accuracies of 6m (2.2ppm) were observed.

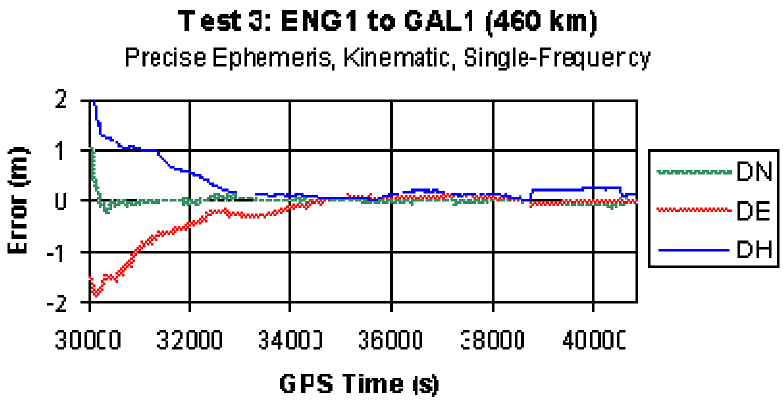


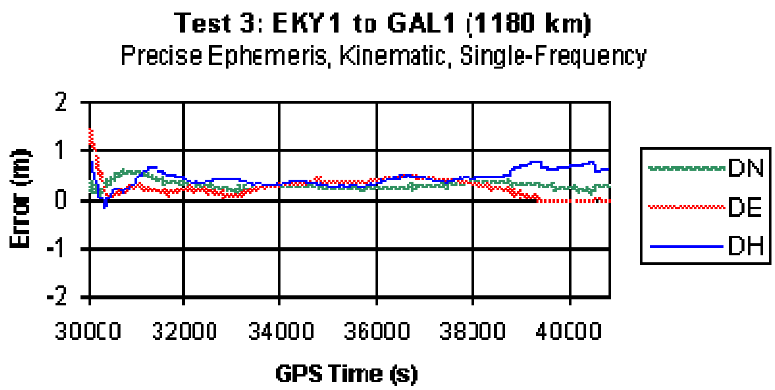


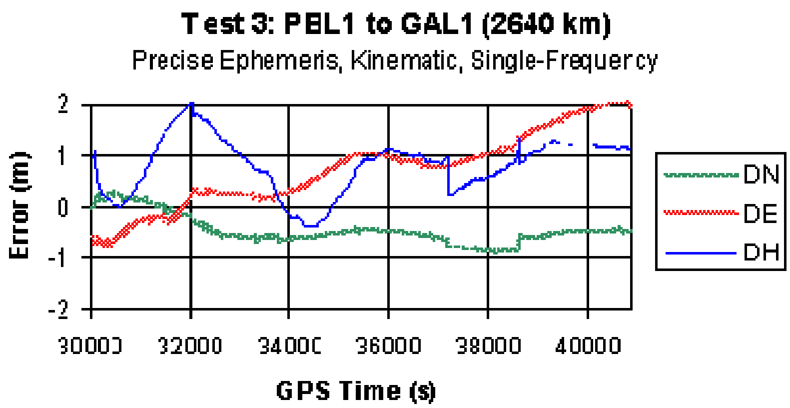


Test 3: Precise Ephemeris and Single Frequency Data

In this test, we see that the effect of using only a single frequency when processing the survey data. On the ENG1 baseline, the computed coordinates were good to 30cm (0.6ppm). The EKY1 baseline produced accuracies of 80cm (0.7ppm), and the PBL1 baseline produced accuracies of 2.3m (0.9ppm). In the cases of the two shorter base lines, the results were only marginally worst than those achieved in test 1. For the PBL1 baseline, the result was a bit more significant (0.5ppm).

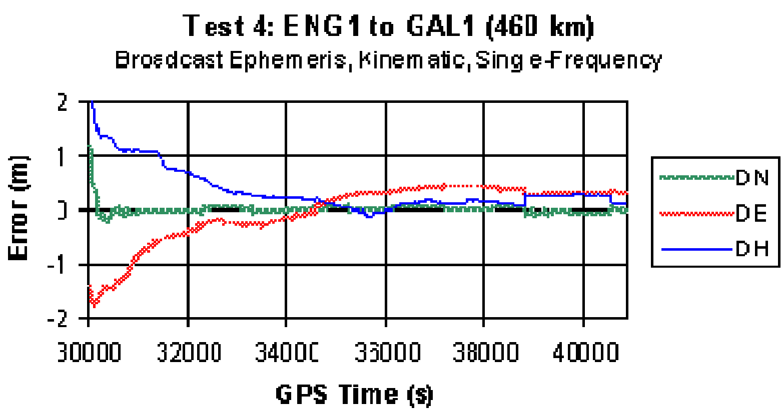


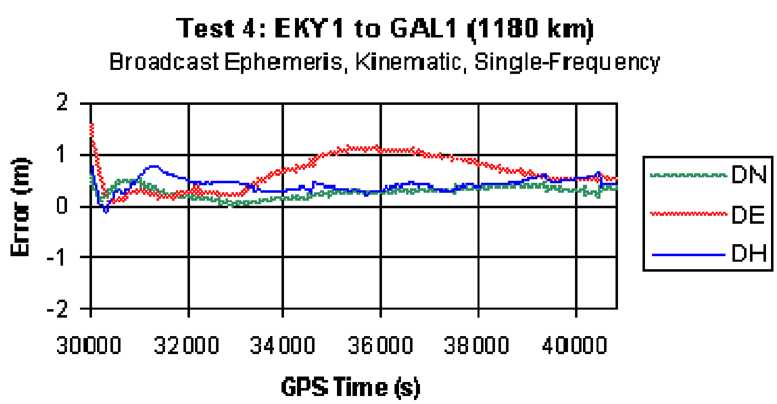


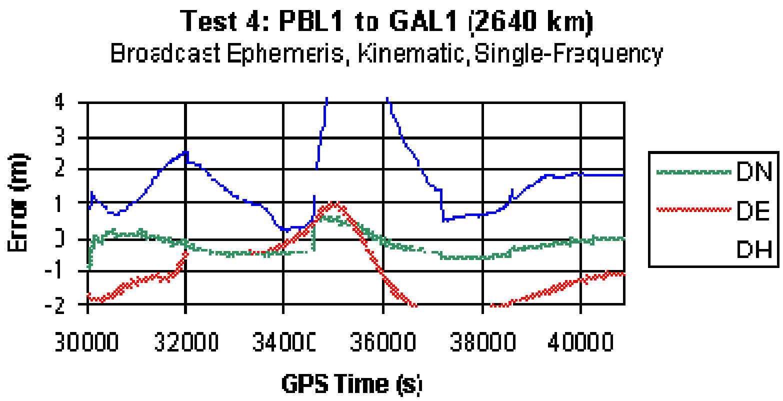


Test 4: Broadcast Ephemeris and Single Frequency Data

This test combines the tests 2 and 3, but it eliminates L2 frequency and the precise ephemeris. Acurracies similar to those seen in test 2 were achieved. The ENG1 baseline achieved accuracies of 40cm (0.9ppm), and the EKY1 baseline achieved accuracies of about 1m (0.8ppm). Finally, the PBL1 baseline achieved accuracies of 6m (2.3ppm). The elimination of L2 had little effect compared to the effect of excluding the precise ephemeris.







Conclusions

The data that was used to produce the results shown above indicate clearly that kinematic processing of GPS code and phase data on long baselines are feasible and can yield very useful results. On all three of the baselines used, sub-meter accuracies were achieved in non-static observation times of 20 - 60 minutes, provided the precise ephemeris and dual frequency were used. Kinematic accuracies converged to 30cm on the 460km baseline, about 50cm on the 1180 km baseline and, 1m on the 2640km baseline after 3 hours of observations. Using broadcast ephemeris and single frequency data, these results degraded to 40cm on the shorter baseline, about 1.5m on the 1100km baseline, and 5m on the 2640km baseline. It is still significant that such results can be obtained with only single frequency and broadcast data.

For the ENG1 baseline of 460 km, the accuracies for all of the tests were between 30cm and 40cm. From this, we can infer that the precise ephemeris is not vital, and that the L2 frequency is not necessary for sub-metre results even in kinematic mode.

The EKY1 baseline of 1180 km showed that in order to achieve sub-metre accuracies, the precise ephemeris must be used. The L2 frequency did not have all that great of an effect. The benefit of using L2 amounted to only about 0.1ppm in this particular case.

The PBL1 baseline of 2460 km illustrates that it is impossible to process a baseline of this length with sub-metre accuracy unless both the precise ephemeris and the L2 frequency are used. By not using the L2 frequency, the accuracy only drops to about 2.3m. However, with the broadcast ephemeris, the accuracy drops to 6m making the errors highly unpredictable. On such a long baseline, it appears that precise ephemeris and L1/L2 ionospheric modeling is imperative for high accuracies.