Surveying With New NovAtel MiLLennium L1 GPS/GLONASS Receivers

Waypoint Consulting Inc.
March 2000

Introduction

This report describes two surveys using the new NovAtel MiLLennium L1 GPS/GLONASS receiver on kinematic data sets collected on March 29, 1999 and April 1, 1999 just east of Calgary. The purpose of the survey was to analyze the measurement noise on the units, as well as, the GPS/GLONASS kinematic convergence in float solution mode. Comparisons of the GPS/GLONASS kinematic results were made with a single frequency GPS-only fixed static solution, as well as, an on-the-fly kinematic ambiguity resolution (KAR) mode.

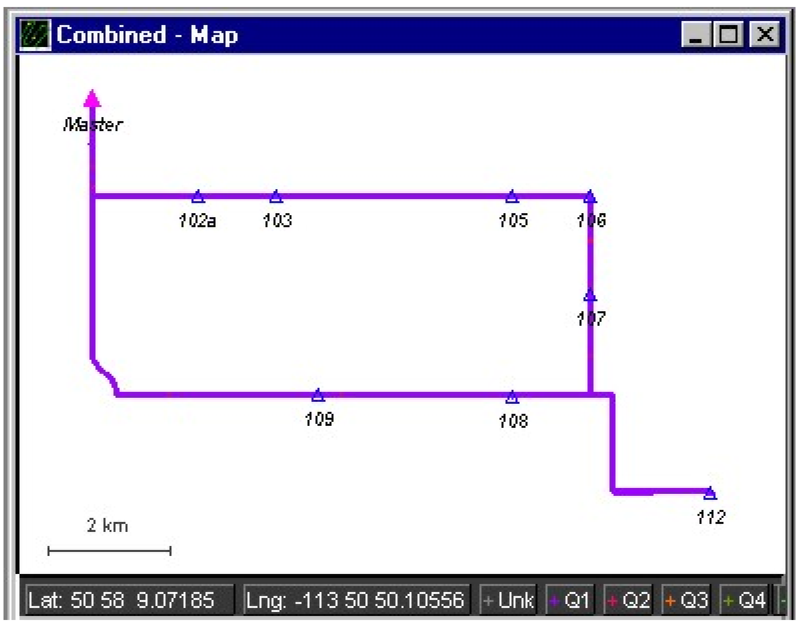

Figure 1: Map of Baseline Survey on April 1, 1999

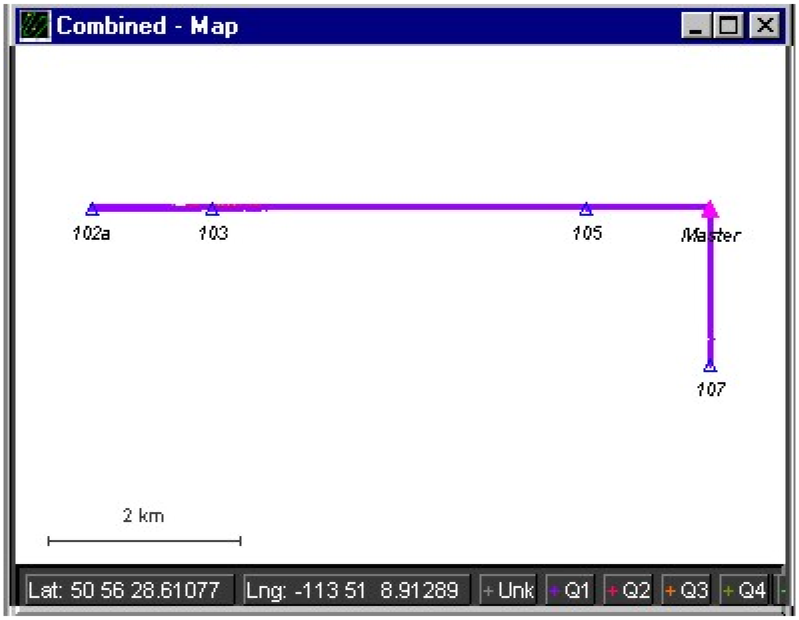

Figure 2: Map of Baseline Survey for March 29, 1999

Description of Survey and Processing

Data was gathered by using an antenna placed on the top of a car travelling from point to point on Waypoint's high precision GPS network, and the antenna was held for 10 seconds at each control point to create tie points for the survey.

Data sets were processed using GrafNav version 6.00 with fixed static, as well as, single frequency kinematic ambiguity resolution. These high precision kinematic data sets were compared and evaluated epoch by epoch to a GPS/GLONASS kinematic float-only solution. The processed results and measurement noise plots are shown in the tables and figures below.

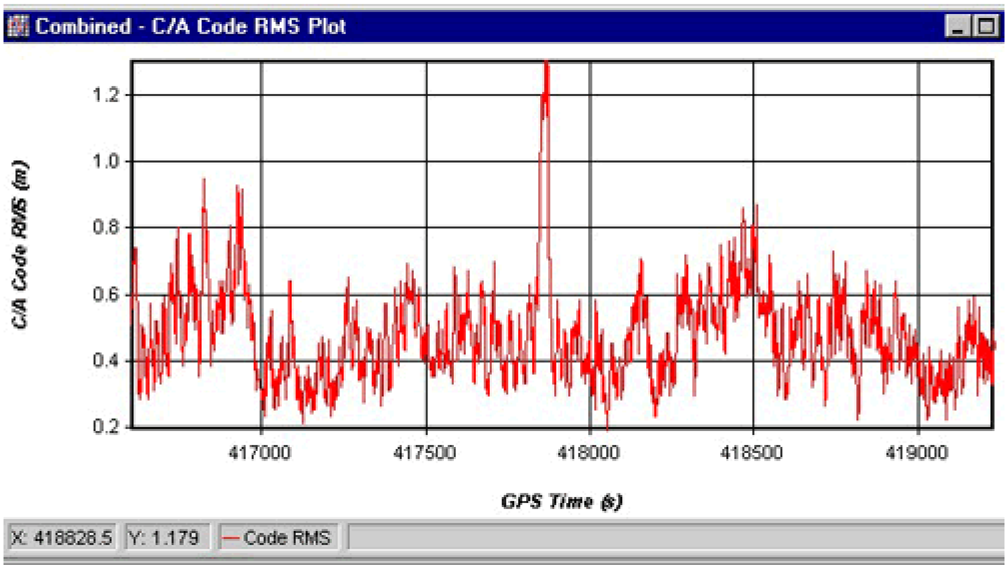

Figure 3: C/A Code RMS residuals for GPS/GLONASS April 1 data set

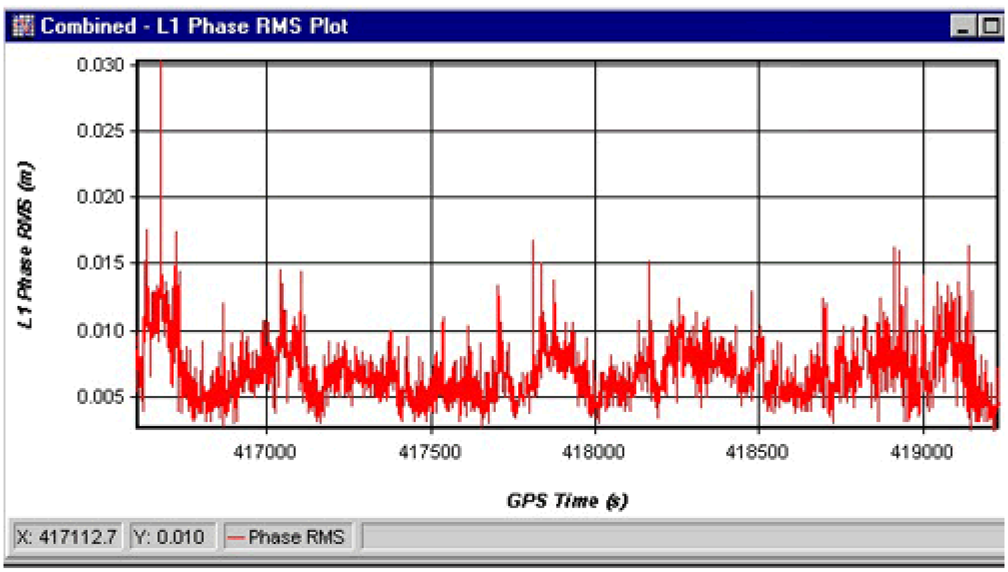

Figure 4: L1 Phase RMS residuals for GPS/GLONASS April 1 data set

The tables below show actual errors in both the fixed ambiguity and float solutions for the GPS and GPS/GLONASS processing at stations in the Waypoint baseline network.

Station	DN	DE	DH
102a	0.014	-0.010	0.017
103	-0.006	-0.004	-0.015
105	0.019	-0.002	-0.020
106	-0.040	0.001	-0.021

107	0.021	0.017	-0.055
112	0.012	0.022	-0.050
108	0.002	-0.020	-0.081
109	0.000	-0.018	-0.047

Table 1: Station Errors for GPS Fixed Ambiguity solution

Station	DN	DE	DH
102a	0.042	0.042	0.025
103	0.007	0.032	0.004
105	0.040	0.036	-0.005
106	-0.032	0.024	-0.002
107	0.036	0.038	-0.045
112	0.053	0.058	-0.045
108	0.042	-0.022	-0.099
106	0.017	-0.022	-0.082

Table 2: Station Errors for GPS/GLONASS kinematic float-only solution (April 1)

Station	DN	DE	DH
105	0.031	-0.092	0.454
103	-0.174	0.226	0.241
102a	0.025	-0.024	-0.031
103	0.010	-0.004	-0.034
105	0.063	-0.044	-0.041
105	0.065	-0.054	-0.038
105	0.065	-0.059	-0.034
105	0.074	-0.057	-0.021
107	0.082	-0.021	-0.025

Table 3: Station Errors for GPS/GLONASS kinematic float-only solution (March 29)

Closures in the order of several centimetres horizontally were observed for the fixed solution processing, while errors in the order of sub-10cm were observed for the GPS/GLONASS float solutions.

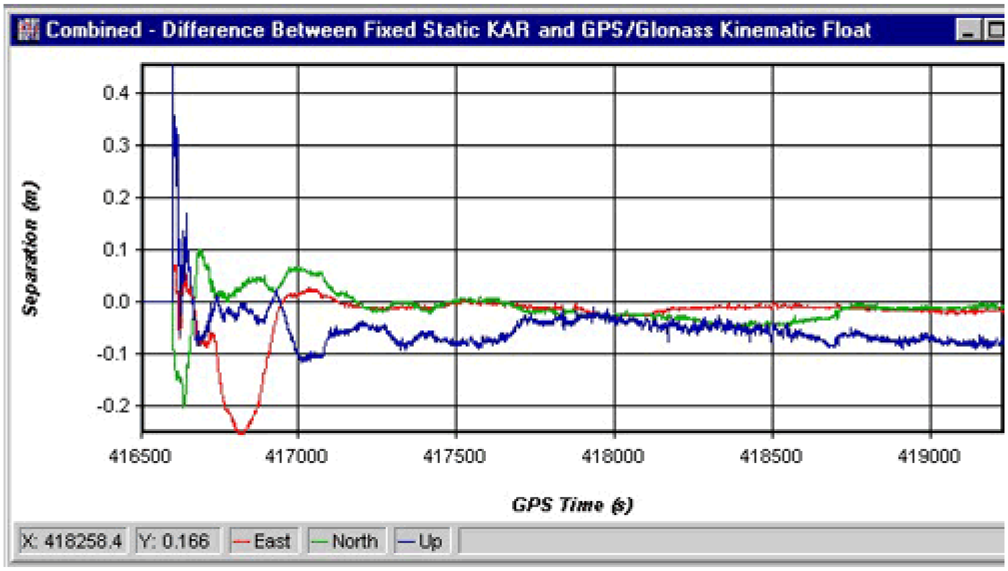

Figure 5: Continuous error difference between the reference solution and the kinematic float GPS/GLONASS April 1 solution

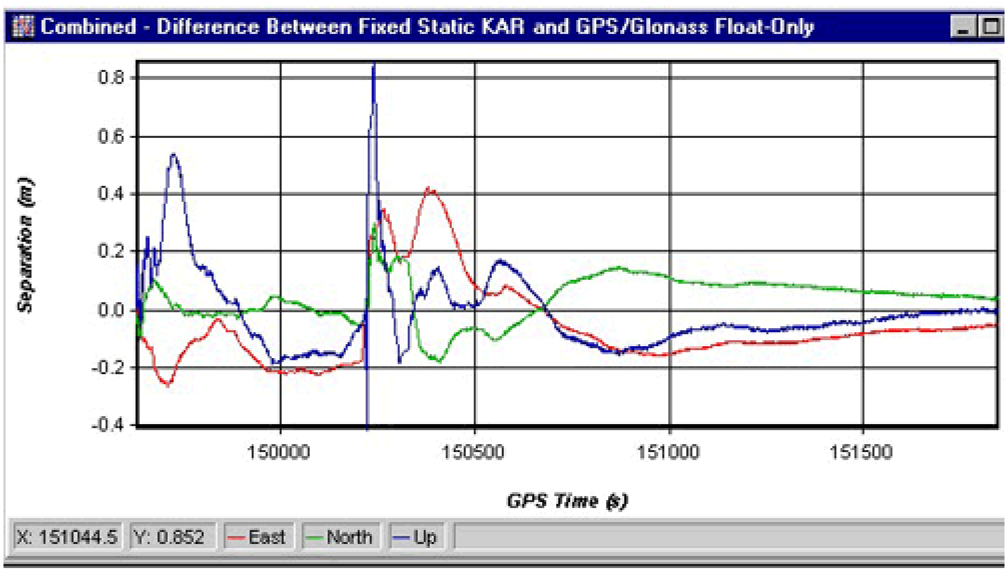

Figure 6: Continuous error difference in the GPS/GLONASS kinematic float-only solution with respect to the Fixed Ambiguity Solution (March 29)

Figures 5 and 6 are epoch by epoch plots of the differences between the high precision fixed ambiguity solutions and the GPS/GLONASS kinematic float-only solutions. The principle difference in the two plots is in the March 29 data set. It can be seen that at GPS time 150250, a major loss of lock was deliberately induced by removing the antenna from the GPS receiver, as illustrated by the spike at that point. This enabled us to assess the behaviour of the GPS/GLONASS solution following loss of lock in a kinematic mode. It is apparent that the solution converges almost immediately to the 30cm level even while the antenna is in motion. Figure 5, on the other hand, displays kinematic data convergence under conditions of constant lock on the satellites.

Conclusion

NovAtel's new MiLLennium L1 GPS/GLONASS receiver was tested on several purely kinematic data sets, and processing was performed using Waypoint's GrafNav GPS processing software. It can be seen from the plots above that the measurement residuals on this receiver are excellent in nature. Code residuals in the order of 50cm were observed, while L1 phase residuals were basically at the sub-centimetre level. Of principle interest in the survey, was the comparison of the fixed ambiguity processing versus the GPS/GLONASS float-only solution. Results indicate that almost instantaneous 20cm - 30cm results are possible with the GPS/GLONASS combination in a low dynamic kinematic environment. Kinematic convergence to the sub-10cm level appears to be routinely possible within 10 minutes of constant lock on the satellites. This would mean that these receivers might have interesting possibilities in areas such as seismic and precision agriculture, as well as, conventional surveys.