1000 KM Baseline Determination in Static and Kinematic Mode

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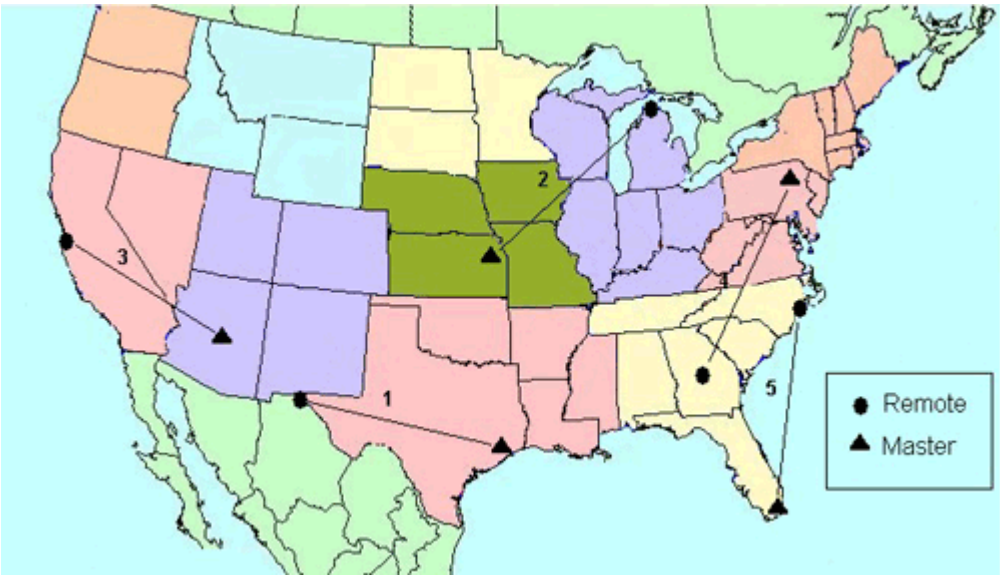
July 2000

Introduction

The purpose of this report is to test the accuracy of GrafNav in determining 1000 KM baselines between CORS stations. The static results obtained by GrafNav are compared against results obtained by JPL's GIPSY program as obtained through their internet service. Lastly this report investigates GrafNav's ability to process 1000 KM baselines in kinematic mode. Although, this is not recommended, it is of interest to examine the results obtained.

Background

For each of the baselines mentioned above, one full day of GPS data was downloaded from the CORS network.



Baseline	Master	Remote	Seperation	Date	GrafNav Horizontal PPM
1	Houston TX	El Paso TX	1074 KM	5/9/2000	0.039
2	Kansas City KS	Cheboygan MI	1154 KM	7/19/1999	0.047
3	Scottsdale AZ	San Francisco	987 KM	4/9/2000	0.048

		CA			
4	Wilkes Barre PA	Macon GA	1167 KM	6/8/2000	0.061
5	Key Biscayne FL	Fort Macon NC	1048 KM	6/8/2000	0.119

Measurement Errors for Long Baselines

Usually when DGPS data is processed, the measurement errors that occur at each station are very similar, and they cancel each other out when the differences between the observations are taken. This is true for short baselines; however as the length of the baseline increases, the errors affecting the observations made at each station differ more and more. When observations at stations on long baselines are differenced, a larger portion of the measurement errors remains.

It is possible to minimize three kinds of measurement errors prior to taking the differences between observations. These errors include the ionospheric errors, the satellite position errors, and the selective availability errors (SA). Ionospheric errors can be eliminated using the Ionosphere-free processing mode. The GPS data must be dual-frequency data for this to work. The satellite position errors and SA can be eliminated almost completely by using the precise ephemeris. Although SA has been removed and is at zero, some of these data sets predate removal of SA.

Procedure

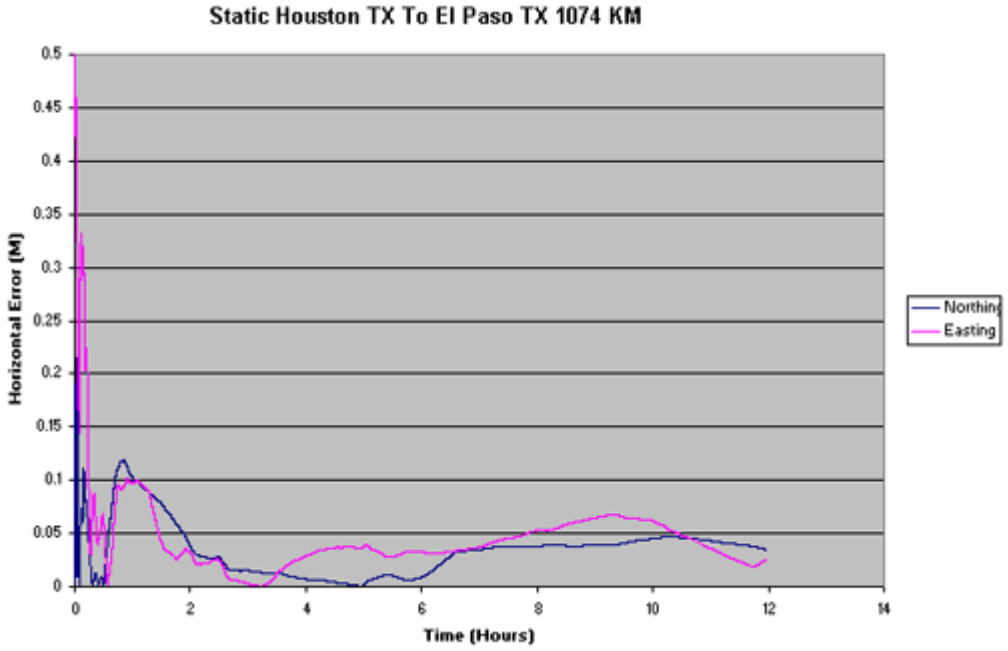
The data used for each of the baselines ranged from July 1999 to June 2000. Data from different days was used to account for a changing environment. The static and kinematic data was all processed using a float Ionosphere-free solution. In a float solution no special techniques are used to force the phase ambiguities to integer values. Ionosphere-free processing uses measurements on two frequencies L1 and L2 to eliminate the ionosphere delay. For each of the baselines a precise ephemeris was used.

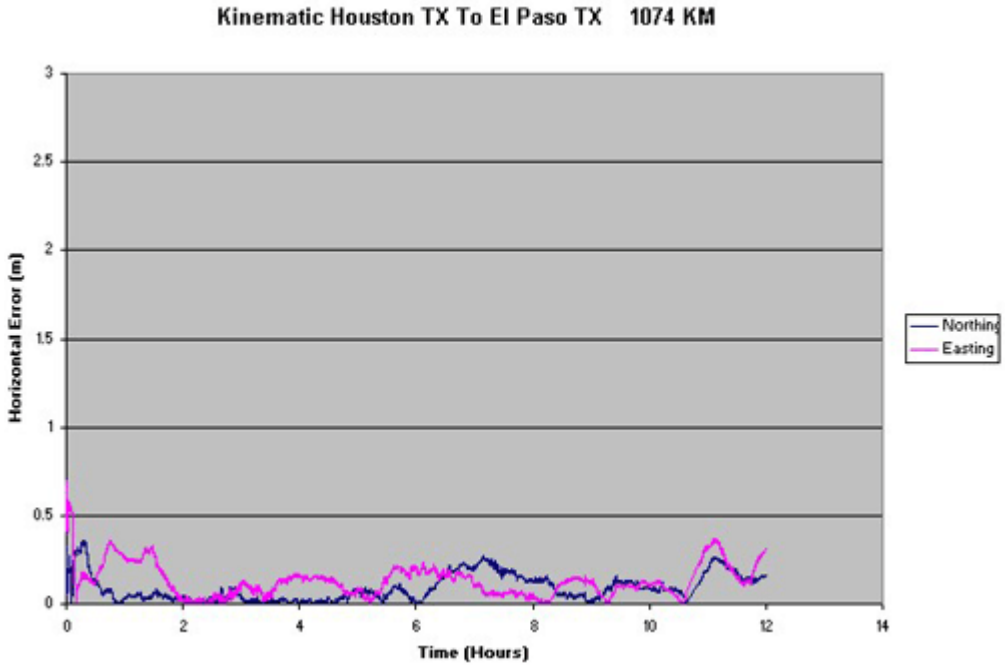
Results

The following are the results broken into five sections one for each of the baselines. The tables show the error in northing, easting and height for GrafNav and GIPSY versus the published CORS coordinates. It also gives the relative error in PPM for GrafNav. The PPM for GIPSY is not provided because it does not use differential methods. The absolute coordinates provided by GIPSY are used. The first plots show the convergence of the static solution with respect to time. The second plot for each baseline is the kinematic convergence plot. The time required for convergence is dependent on the number of satellites that are in common to both stations. The plots are broken into an easting and northing component.

Baseline 1 Houston TX To El Paso TX

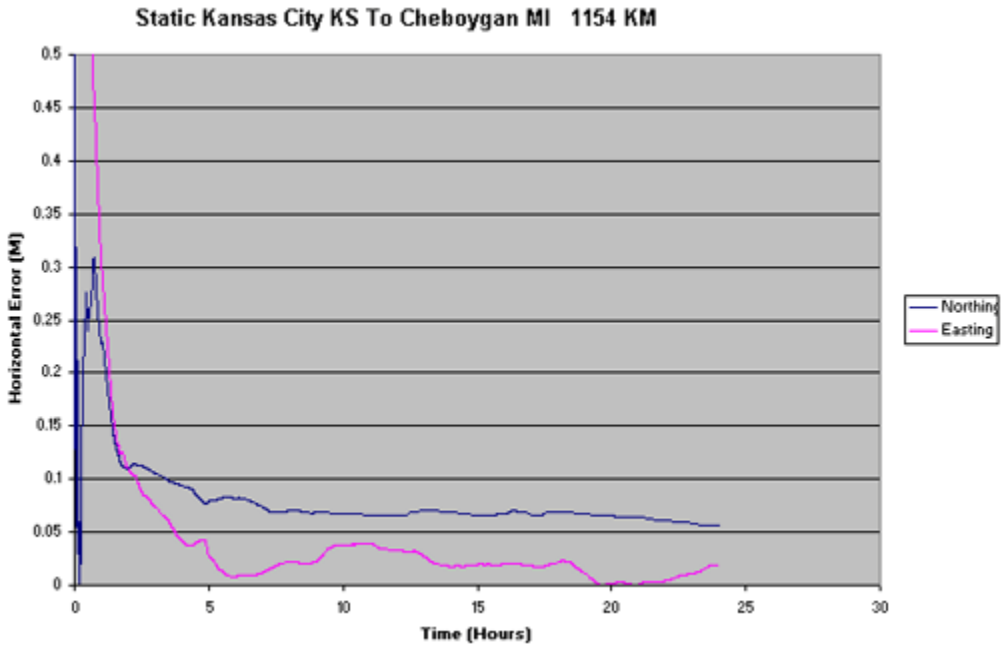
Solution	RE (m)	RN (m) (m)	DH (m)	Horizontal PPM	Vertical PPM
GrafNav	0.0270	0.0342	0.354	0.041	0.330
GIPSY	0.0423	0.0424	0.0525		

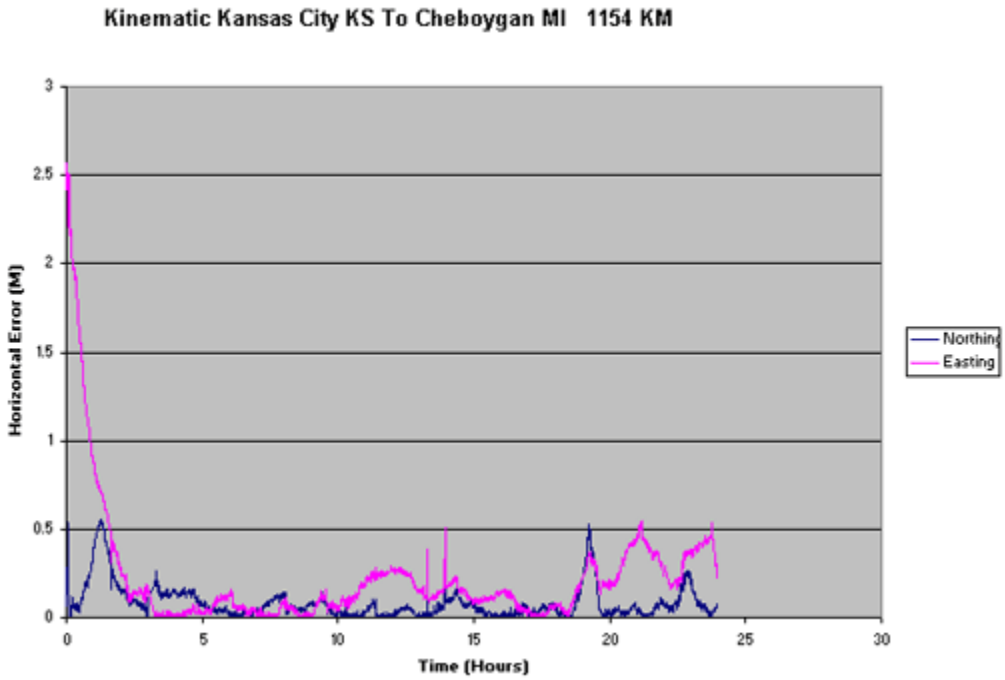




Baseline 2 Kansas City KS To Cheboygan MI

Solution	RE (m)	RN (m) (m)	DH (m)	Horizontal PPM	Vertical PPM
GrafNav	0.0125	0.0687	0.059	0.042	0.051
GIPSY	0.0234	0.0031	0.1215		

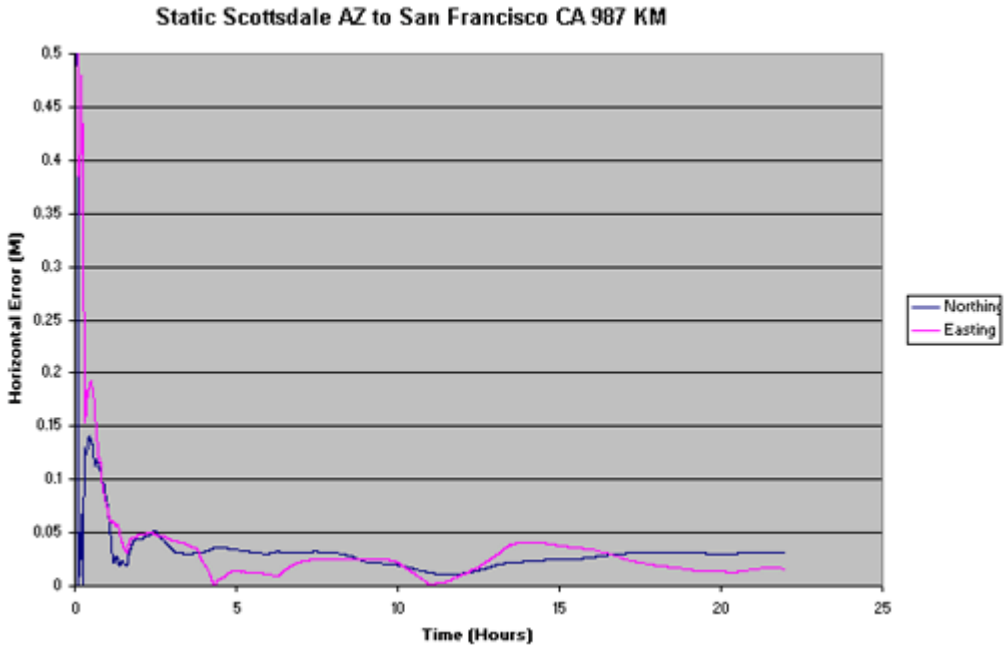


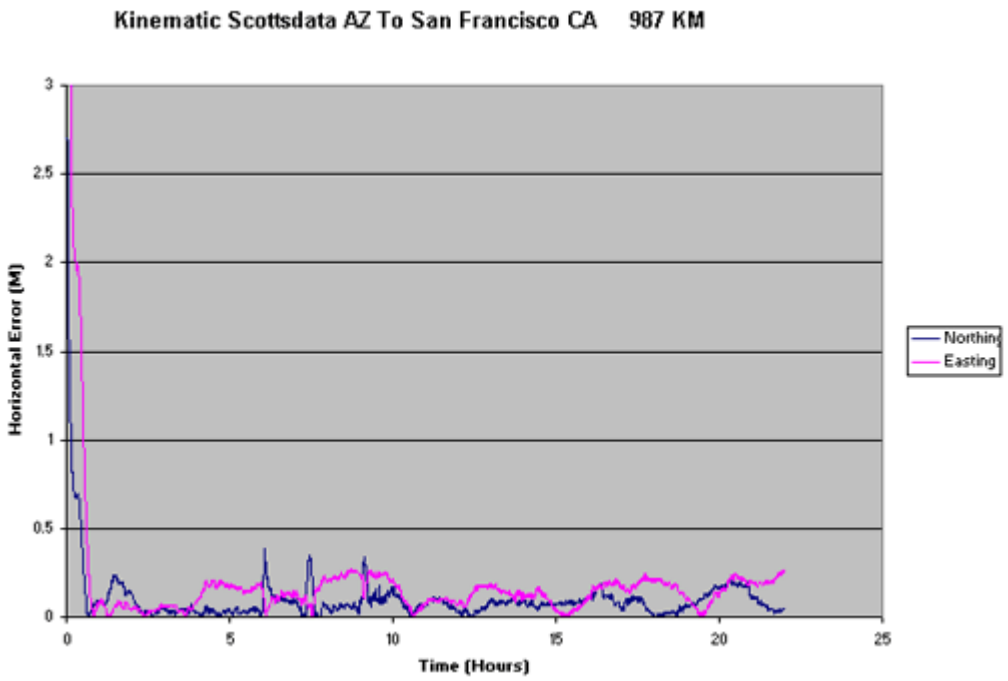


The Kinematic data is interupted with cycle slips after hour 10.

Baseline 3 Scottsdale AZ To San Francisco CA

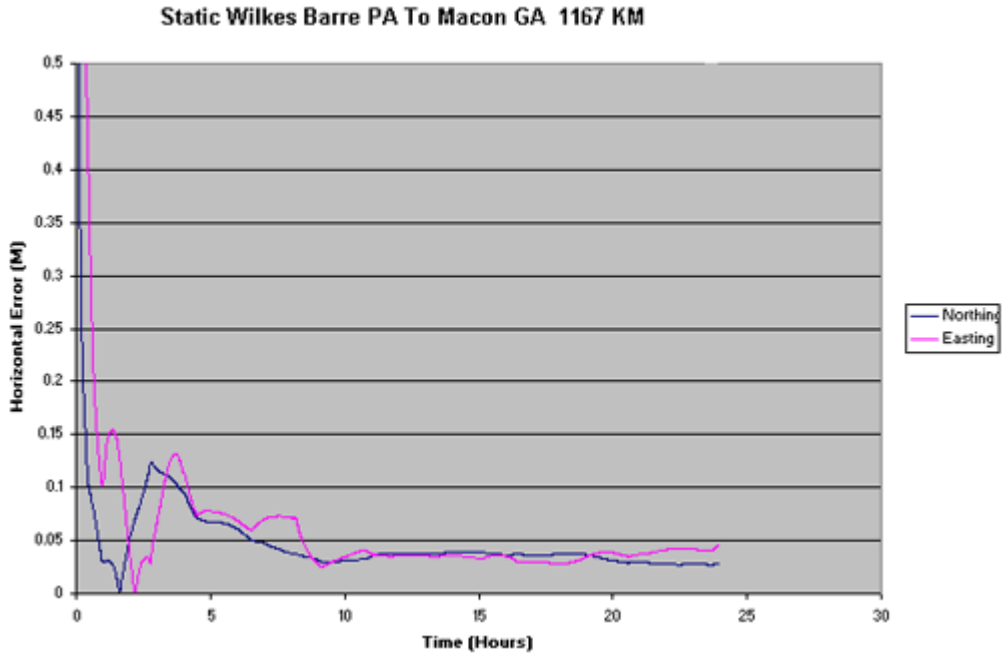
Solution	RE (m)	RN (m) (m)	DH (m)	Horizontal PPM	Vertical PPM
GrafNav	0.0237	0.0255	0.148	0.035	0.150
GIPSY	0.0635	0.0332	0.0291		

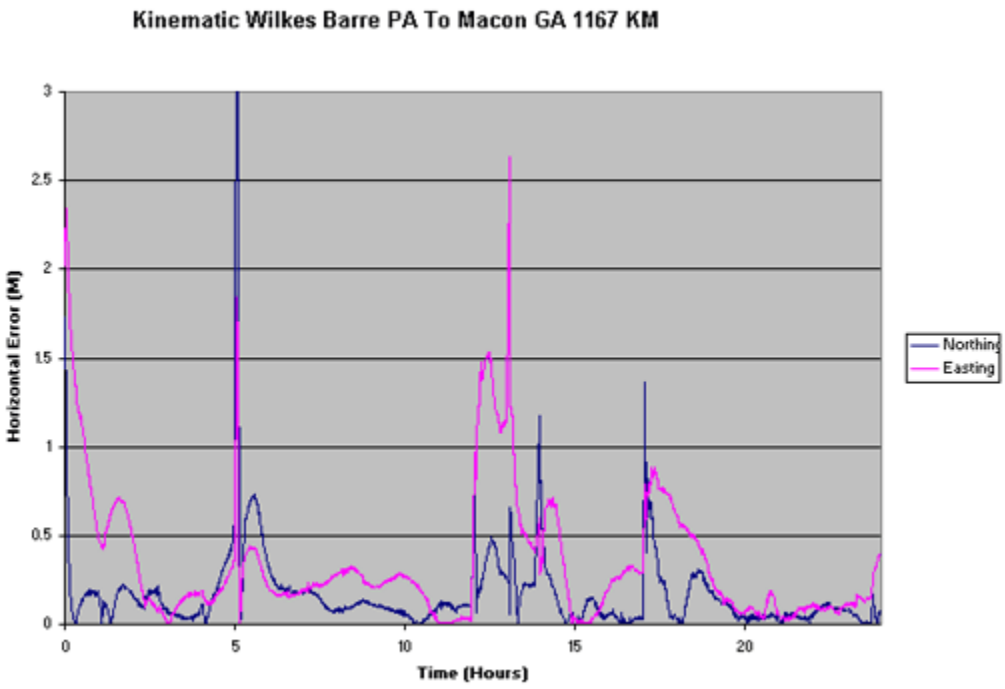




Baseline 4 Wilkes Barre PA To Macon GA

Solution	RE (m)	RN (m) (m)	DH (m)	Horizontal PPM	Vertical PPM
GrafNav	0.0394	0.0294	0.204	0.042	0.175
GIPSY	0.0316	0.0030	0.1230		

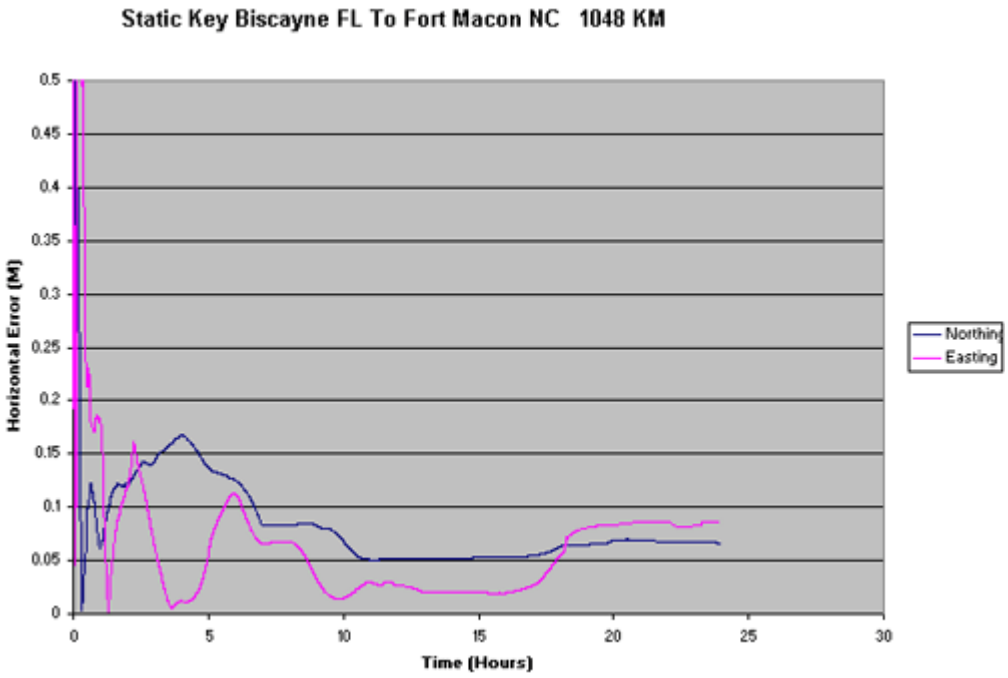




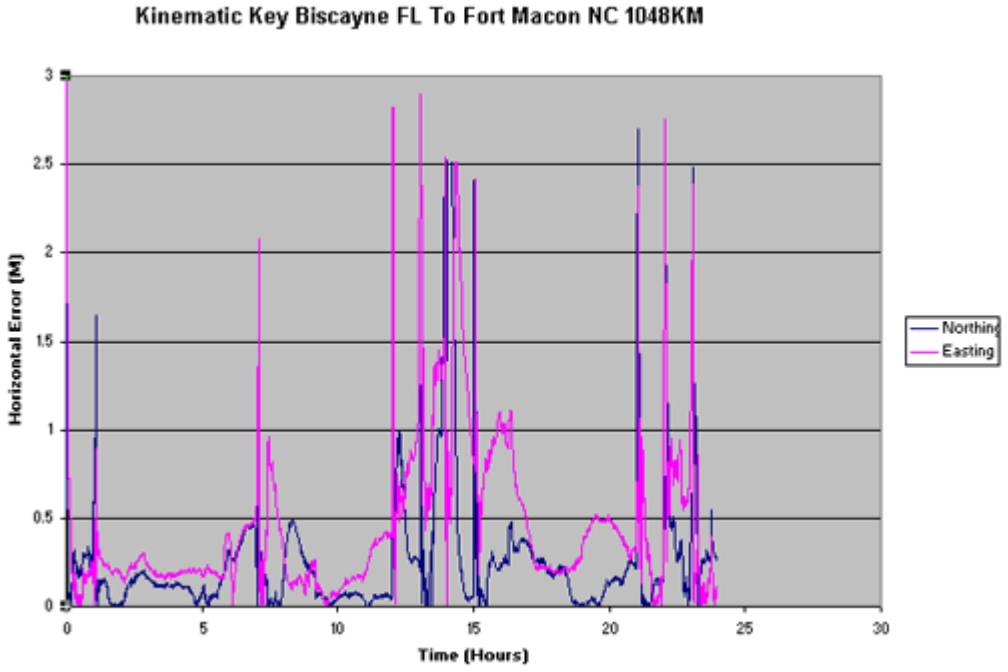
The Kinematic Plot shows the effects of numerous cycle slips and losses of lock.

Baseline 5 Key Biscayne FL To Fort Macon NC

Solution	RE (m)	RN (m) (m)	DH (m)	Horizontal PPM	Vertical PPM
GrafNav	0.0843	0.0648	0.397	0.101	0.379
GIPSY	0.0456	0.0042	0.107		



This solution took a long time to converge (10 hours). For approximately 7 hours a solution of 0.06 PPM horizontally was available. However, after 17 hours the error started to increase. This is due to numerous cycle slips in the data.



After 7 hours numerous cycle slips are seen. This plot shows the dangers of performing a kinematic survey over a 1000 KM baseline.

Conclusions

From the five baselines the averaged relative error for GrafNav is 0.052 PPM horizontally and 0.217 PPM vertically.

With kinematic processing GrafNav appears to provide results within 0.30 PPM horizontally with clean data. The kinematic plots show that the solution usually converges within 1m in 30 min of data.