

# **Mapping Surface Rupture (Plate Boundary Deformation): St. Elias Mountains and Gulf of Alaska**

## **Contact Information**

Terry Pavlis  
Department of Geology and Geophysics  
University of New Orleans  
New Orleans, LA 70148  
Tel: 504-280-6797  
Fax: 504-280-7396  
[tpavlis@uno.edu](mailto:tpavlis@uno.edu)  
<http://www.geology.uno.edu/~tpavlis/>



**Katalla Area located 56 miles southeast of Cordova, Alaska**

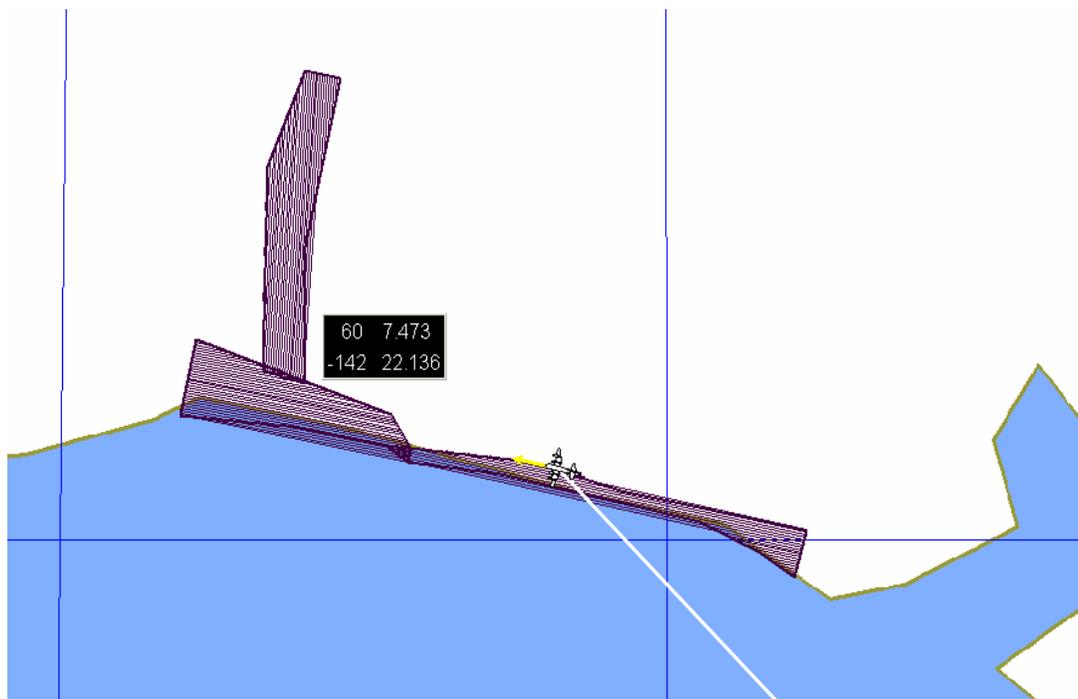
## Survey Area

The proposed survey consisted of three separate polygons: Katalla Area, Sullivan Anticline, and the Duktoth River Transect. The Katalla polygon was flown in its entirety, the Sullivan Anticline was over 90% completed; but no survey lines were flown over the Duktoth River Transect due to weather: this area was never clear of clouds. The Katalla Area (Figure 1) was partially flown on September 2, 2005 (2 flights) and completed on September 8, 2005 (2 flights). This area is located approximately 56 miles southeast of Cordova, Alaska.



Figure 1. Katalla Area project shape, located 56 miles southeast of Cordova, Alaska.

Figure 2 (below) is a plot showing the location of the Sullivan Anticline (coastal polygon) and the Duktoth River Transect (north-south polygon). The Sullivan Anticline was surveyed with 5 flights over a period of 8 days from September 3, 2005 through September 10, 2005. Low clouds and a substantial amount of rain precluded the completion of this polygon, but all lines except four were flown. The survey aircraft made several attempts to fly into the Duktoth River Transect but this area which rises steeply from the coastline was never clear enough from low clouds to approach. These polygons are located approximately 140 miles southeast of Cordova, Alaska.



**Figure 2. Sullivan Anticline (coastal polygon) and Duktoth River transect (north-south polygon) are located 140 miles southeast of Cordova, Alaska.**

## Survey Parameters

The laser survey was conducted using an Optech 1233 Airborne Laser Terrain Mapper (<http://www.optech.ca/>) mounted in a twin engine Piper Chieftain (N931SA). Infrared images were taken with a DuncanTech MS4100-RGB/CIR, also mounted in the aircraft. The Katalla Area was flown with 70 flight lines. Beginning from the north end, lines 1-53 are oriented east-west. Lines 54-70 are oriented north-south, with the southern end of the survey area following the coastline (Figure 1). Figure 3 shows the flight planning parameters for the Katalla area. The Sullivan Anticline consisted of 53 flight lines, all but 4 were flown. This coastal survey area (lines 1-22 and lines 23-53) had east-west flight headings. Figure 4 shows flight planning parameters for the Sullivan Anticline.

Active Area			
◀	Area	<b>1</b>	of <b>3</b> ▶
Draw Area	Edit Corners	Generate Box	Load from File
Pass Orientation			
Optimize	<input type="range" value="270"/>		
	0	30	60 90 120 150 180 210 240 270 300 330 360
Flight Profile		LIDAR Settings	
Altitude (m AGL)	<b>600</b>	System PRF (kHz)	<b>33.333</b>
Pass Heading (deg)	<b>258</b>	Scan Freq (Hz)	<b>28</b>
Overlap (m)	<b>218.38</b>	Scan Angle +/-	<b>20</b>
Speed (m/s)	<b>70</b>	Desired Res (m)	<b>0.992</b>
Turn Time (min)	<b>7</b>	Cross Track Res	<b>0.734</b>
Passes	<b>53</b>	Down Track Res	<b>1.25</b>
Pass Spacing (m)	<b>218.38</b>	Swath (m)	<b>436.76</b>
Survey Totals			
Total Passes	<b>79</b>	Swath Area (km <sup>2</sup> )	<b>179.73</b>
Total Length (km)	<b>827.53</b>	AOI Area (km <sup>2</sup> )	<b>171.691</b>
Total Flight Time	<b>12:19:47</b>	Total Laser Time	<b>03:17:02</b>

Figure 3. Katalla Area flight planning parameters.

Draw Area	Edit Corners	Generate Box	Load from File										
<b>Pass Orientation</b>													
Optimize	<input type="text" value="282"/>												
	0	30	60	90	120	150	180	210	240	270	300	330	360
<b>Flight Profile</b>													
Altitude (m AGL)	<b>600</b>												
Pass Heading (deg)	<b>282</b>												
Overlap (m)	<b>218.38</b>												
Speed (m/s)	<b>70</b>												
Turn Time (min)	<b>6</b>												
Passes	<b>22</b>												
Pass Spacing (m)	<b>218.38</b>												
<b>LIDAR Settings</b>													
System PRF (kHz)	<b>33</b>												
Scan Freq (Hz)	<b>28</b>												
Scan Angle +/-	<b>20</b>												
Desired Res (m)	<b>0.996</b>												
Cross Track Res	<b>0.741</b>												
Down Track Res	<b>1.25</b>												
Swath (m)	<b>436.76</b>												
<b>Survey Totals</b>													
Total Passes	<b>81</b>		Swath Area (km <sup>2</sup> )	<b>306.78</b>									
Total Length (km)	<b>1403.94</b>		AOI Area (km <sup>2</sup> )	<b>251.705</b>									
Total Flight Time	<b>14:04:52</b>		Total Laser Time	<b>05:34:16</b>									

Figure 4. Sullivan Anticline flight planning parameters.

## GPS Reference Stations

Three GPS reference stations were used during the survey. One receiver was placed on a newly set mark at the west end of Merle K (Mudhole) Smith Airport in Cordova, Alaska. This station (CORD) logged GPS data at a 1-second rate and was turned on 30 minutes pre-flight until 30 minutes post-flight for 7 flights between September 2, 2005 (Day 245) and September 8, 2005 (Day 251). Two other receivers were placed on newly set marks at the west end of the air strip at Cape Yakataga. These marks were designated YAGN and YAGS. Receivers at YAGN and YAGS were equipped with deep-cell marine batteries and each had 80 Mb of available memory. With this configuration GPS observations were logged 24 hours a day for 9 days between September 2, 2005 and September 11, 2005. YAGN logged at a 3-second rate while YAGS logged at a 5-second rate. These GPS files were then interpolated to a 1-second rate using an NGS program INTERPO, available for download at the NGS website (see <http://www.ngs.noaa.gov/CORS/Utilities/Interpo/Dos/>). The remote stations YAGN and YAGS at the air strip at Cape Yakataga needed fresh memory cards and freshly charged batteries every three days which was accomplished using a charter aircraft.

Three 24-hour sessions from YAGN and YAGS and three 12-hour sessions from CORD were submitted to the NGS online static GPS processor OPUS, and these solutions are attached as Appendix A. Final coordinates for all reference stations were based on these OPUS solutions. For more information on OPUS see (<http://www.ngs.noaa.gov/OPUS/>). For more information on the CORS network, refer to <http://www.ngs.noaa.gov/CORS/>.

Vertical agreement for ellipsoid height from these OPUS solutions was excellent. The range in the height value for CORD and YAGS was 0.010 meters, for YAGN it was 0.011 meters. Horizontal position repeatability was also excellent among the nine OPUS solutions, with positional differences less than 0.020 meters for all three stations.

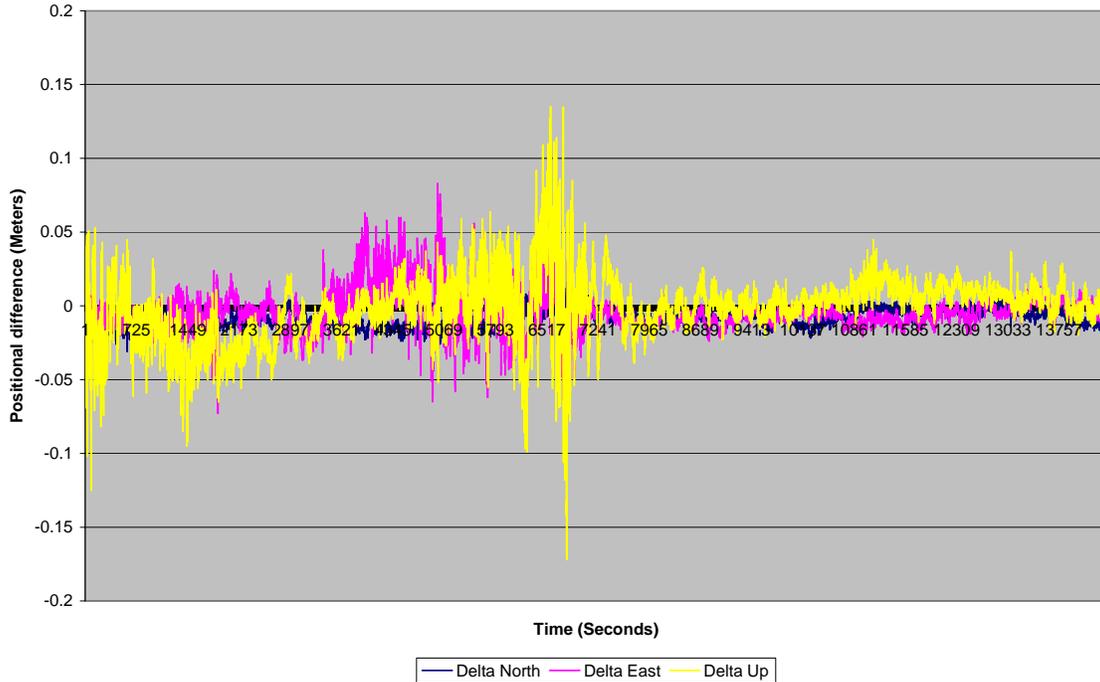
Ground equipment included ASHTECH Z-Extreme receivers and choke ring antennas (Part #700936.D) mounted on a 1.5 m fixed height tripod.

## **Navigation Processing**

Airplane trajectories were processed using KARS (Kinematic and Rapid Static) software written by Dr. Gerry Mader of the NGS Research Laboratory. The KARS differential GPS solution is dual-frequency, phase-differenced, and fixed integer. For most flights two separate airplane trajectories were processed in KARS software using two different reference stations and then positional differences between the separate solutions were plotted.

Figure 5 (below) is a plot of the positional differences in an airplane trajectory processed from station CORD and YAGN from a survey flight over the Katalla area on September 3, 2005.

**Positional Differences in Aircraft Trajectory Processed From Different Reference Stations**



**Figure 5 - Positional Differences in Aircraft Trajectory Processed From Different Reference Stations**

Project logistics including distances between survey areas and the GPS reference stations for this project were not typical of projects done in the lower 48: for instance the distance between station CORD and YAGN was 170 Km, and there was no road access to Cape Yakataga from Cordova. Reference stations at Cape Yakataga were extremely remote and left unmanned: they had to be serviced by arranging charter flights around inclement weather. For this reason it was not always possible to have good redundant reference station GPS for all flights. For all flights where redundancy was possible Table 1 (below) list the statistics of the aircraft trajectories as processed from different base stations.

	<b>X</b>	<b>Y</b>	<b>Z</b>	<b>Northing</b>	<b>Easting</b>	<b>Upping</b>
<b>cord246a - yagn246a</b>						
<b>average difference:</b>	0.019	0.017	-0.044	-0.002	0.000	-0.050
<b>RMS of differences:</b>	0.013	0.011	0.015	0.011	0.011	0.017
<b>cord246b - yagn246b</b>						
<b>average difference:</b>	0.007	0.005	-0.004	-0.008	-0.004	-0.002
<b>RMS of differences:</b>	0.009	0.010	0.022	0.005	0.014	0.021
<b>cord247 - yagn247</b>						
<b>average difference:</b>	0.016	0.013	-0.023	0.000	0.006	-0.030
<b>RMS of differences:</b>	0.012	0.011	0.036	0.005	0.019	0.035
<b>cord252 - yagn252</b>						
<b>average difference:</b>	0.027	0.017	-0.076	0.003	-0.011	-0.081
<b>RMS of differences:</b>	0.013	0.009	0.019	0.010	0.015	0.017

**Table 1 – Statistics of Positional Differences in Aircraft Trajectory Processed From Different Reference Stations – all values in meters.**

When processing trajectories the closest GPS reference station to the aircraft was always used as the reference.

After GPS processing, the trajectory and the IMU (Inertial Measurement Unit) data collected during the flight were input into APPLANIX software POSPROC which uses a Kalman Filter algorithm to produce a final navigation solution (aircraft position and orientation) at 50 Hz, in SBET format (Smoothed Best Estimated Trajectory).

## Ground Truth and Calibration

A relative calibration was performed using TerraMatch software from TerraSolid: see [http://terrasolid.fi/ENG/Tuote\\_kuvaukset/TMatch.htm](http://terrasolid.fi/ENG/Tuote_kuvaukset/TMatch.htm) for detailed information.

Cross lines were flown in all of the flights where weather permitted and then input into TerraMatch routines that solve for the calibration parameters of roll, pitch, heading, and scanner-mirror scale. Results for several test areas showed consistent values for these calibration values. Table 2 (below) is a listing of some calibration results from TerraMatch.

	Flight 251c	Flight 246b	Flight 245	Average Shift	St Dev of Shift
<b>Starting average Delta Z:</b>	0.218	0.063	0.193	0.158	
<b>Final average Delta Z:</b>	0.174	0.050	0.158	0.127	
<b>Standard error of unit</b>	0.077	0.022	0.071	0.057	
<b>Heading shift</b>	0.0049	0.0074	0.0104	0.0076	0.0028
<b>Roll shift</b>	0.0191	0.0201	0.0205	0.0199	0.0007
<b>Pitch shift</b>	-0.0065	-0.0003	-0.0029	-0.0032	0.0031
<b>Scale shift</b>	0.0009	0.0013	0.0002	0.0008	0.0006

**Table 2 – Relative calibration shift values computed by TerraMatch .**

## Laser Point Processing

All coordinates were processed with respect to NAD83 and referenced to the national CORS network. The projection for the 9-column output for the Katalla area is UTM Zone 6, with ellipsoid heights, and units in meters. The projection for the 9-column output for the Sullivan Anticline area is also UTM Zone 6, with ellipsoid heights, and units in meters.

All other output – filtered and unfiltered point clouds and DEMs – have been converted to orthometric heights in NAVD88, computed using the NGS GEOID99 model as GEOID03 model is not available for Alaska.

The most complete output format is nine-column ASCII (space delimited), one file per flight strip. The nine columns are as follows:

1. GPS time (seconds of week)
2. Easting last stop (UTM Zone number (6) is appended)
3. Northing last stop
4. Height last stop (Ellipsoid)
5. Intensity last stop
6. Easting first stop (UTM Zone number (6) is appended)
7. Northing first stop
8. Height first stop (Ellipsoid)
9. Intensity first stop

Note that in these 9-column files no geoid model has been applied - height values are ellipsoid heights and these height values will NOT match orthometric heights (elevations) found in the 4-column output or in the 1-meter DEM grid nodes.

During processing, a scan cutoff angle of 0.5 degrees was used to eliminate points at the edge of the scan lines. This was done to improve the overall DEM accuracy (points farthest from the scan nadir are the most affected by small errors in pitch, roll and scanner mirror angle measurements). Points with very low intensity values were also filtered out (intensity values less than 7), because these points also tend to be the least accurate. This is due to the fact that very weak return pulses yield the noisiest range measurements. These points represent a very small percentage of the total number of points, usually in the neighborhood of a few hundredths of one percent.

All hardware parameter files as well as all raw observation files (both GPS and ALTM) necessary to reprocess this project in its entirety are archived by UC Berkeley.

## **Filtering and DEM Production**

Digital elevation models (DEMs) were produced at 1.0 meter spacing for all areas from last stop elevations using Surfer 8 (Golden Software). Vegetation removal (filtering) was completed using TerraScan, an MDL application of Bentley's Microstation.

The resulted Surfer grid tile set was exported to ESRI ArcInfo floating point binary format and using an in-house C++ application the overlap was trimmed from each tile. The trimmed tiles were exported to ESRI ArcInfo GRID format and merged into a seamless raster dataset for each of the 3 areas. Shaded relief maps and contour maps (from the filtered DEMs) were generated based on the seamless ArcInfo grids.

The Sullivan Anticline area was too large to fit into only one ArcInfo grid (due to current software limitation of 2GB of data per grid file), so it was split in 2 parts – East and West. Details about the ArcInfo datasets can be found in the Readme.pdf file.

## APPENDIX A.

### GPS Reference Station Coordinates from OPUS

From: opus@ngs.noaa.gov  
 Sent: Friday, November 04, 2005 2:32 PM  
 To: michaels@ufl.edu  
 Subject: OPUS solution : cord251d.05o 000389914

FILE: cord251d.05o 000389914

#### NGS OPUS SOLUTION REPORT =====

USER: michaels@ufl.edu  
 RINEX FILE: cord251q.05o

DATE: November 04, 2005  
 TIME: 19:32:14 UTC

SOFTWARE: page5 0411.19 master28.pl                    START: 2005/09/08 16:39:00  
 EPHEMERIS: igs13394.eph [precise]                    STOP: 2005/09/09 03:33:00  
 NAV FILE: brdc2510.05n                                OBS USED: 21578 / 22637 : 95%  
 ANT NAME: ASH700936D\_M                               # FIXED AMB: 97 / 98 : 99%  
 ARP HEIGHT: 1.5                                        OVERALL RMS: 0.014(m)

REF FRAME: NAD\_83(CORS96) (EPOCH:2003.0000)                    ITRF00 (EPOCH:2005.6875)

X:	-2594689.941(m)	0.012(m)	-2594690.772(m)	0.012(m)
Y:	-1784901.360(m)	0.048(m)	-1784900.305(m)	0.048(m)
Z:	5527816.299(m)	0.046(m)	5527816.628(m)	0.046(m)

LAT:	60 29 38.49758	0.009(m)	60 29 38.50037	0.009(m)
E LON:	214 31 27.46105	0.033(m)	214 31 27.37328	0.033(m)
W LON:	145 28 32.53895	0.033(m)	145 28 32.62672	0.033(m)
EL HGT:	27.160(m)	0.059(m)	27.489(m)	0.059(m)
ORTHO HGT:	13.047(m)	0.064(m)	[Geoid99 NAVD88]	

	UTM COORDINATES		STATE PLANE COORDINATES	
	UTM (Zone 06)		SPC (5003 AK 3)	
Northing (Y) [meters]	6707401.520		723241.970	
Easting (X) [meters]	583745.742		528815.280	
Convergence [degrees]	1.32667664		0.45629910	
Point Scale	0.99968594		0.99991017	
Combined Factor	0.99968169		0.99990592	

US NATIONAL GRID DESIGNATOR: 6VWN8374607402(NAD 83)

BASE STATIONS USED				
PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
AH3757	POT3 POTATO POINT 3 CORS ARP	N610322.533	W1464148.518	91385.5
AH8301	CHI3 CP HINCHINBROOK 3 CORS ARP	N601415.040	W1463847.552	70648.4
AH2492	GNAA GLENALLEN CORS ARP	N620644.576	W1455812.701	182278.9

NEAREST NGS PUBLISHED CONTROL POINT			
UW8134	CORD	N602937.361 W1452831.526	38.4

This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

From: opus@ngs.noaa.gov  
Sent: Friday, November 04, 2005 2:22 PM  
To: michaels@ufl.edu  
Subject: OPUS solution : cord246d.05o 000389913

FILE: cord246d.05o 000389913

NGS OPUS SOLUTION REPORT  
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USER: michaels@ufl.edu  
RINEX FILE: cord246r.05o

DATE: November 04, 2005  
TIME: 19:22:24 UTC

SOFTWARE: page5 0411.19 master12.pl                   START: 2005/09/03 17:48:00  
EPHEMERIS: igs13386.eph [precise]                    STOP: 2005/09/04 03:56:30  
NAV FILE: brdc2460.05n                                OBS USED: 19976 / 20931 : 95%  
ANT NAME: ASH700936D\_M                              # FIXED AMB: 85 / 99 : 86%  
ARP HEIGHT: 1.5                                      OVERALL RMS: 0.019(m)

REF FRAME: NAD\_83(CORS96)(EPOCH:2003.0000)                   ITRF00 (EPOCH:2005.6738)

X:	-2594689.947(m)	0.021(m)	-2594690.778(m)	0.021(m)
Y:	-1784901.361(m)	0.053(m)	-1784900.306(m)	0.053(m)
Z:	5527816.285(m)	0.055(m)	5527816.614(m)	0.055(m)

LAT:	60 29 38.49720	0.010(m)	60 29 38.50000	0.010(m)
E LON:	214 31 27.46088	0.035(m)	214 31 27.37311	0.035(m)
W LON:	145 28 32.53912	0.035(m)	145 28 32.62689	0.035(m)
EL HGT:	27.150(m)	0.069(m)	27.479(m)	0.069(m)
ORTHO HGT:	13.037(m)	0.073(m)	[Geoid99 NAVD88]	

	UTM COORDINATES	STATE PLANE COORDINATES
	UTM (Zone 06)	SPC (5003 AK 3)
Northing (Y) [meters]	6707401.509	723241.958
Easting (X) [meters]	583745.739	528815.278
Convergence [degrees]	1.32667660	0.45629906
Point Scale	0.99968594	0.99991017
Combined Factor	0.99968169	0.99990592

US NATIONAL GRID DESIGNATOR: 6VWN8374607402(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
AH3757	POT3 POTATO POINT 3 CORS ARP	N610322.533	W1464148.518	91385.5
AH8301	CHI3 CP HINCHINBROOK 3 CORS ARP	N601415.040	W1463847.552	70648.4
AH2492	GNAA GLENALLEN CORS ARP	N620644.576	W1455812.701	182278.9

NEAREST NGS PUBLISHED CONTROL POINT

UW8134	CORD	N602937.361	W1452831.526	38.4
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

From: opus@ngs.noaa.gov  
Sent: Friday, November 04, 2005 2:22 PM  
To: michaels@ufl.edu  
Subject: OPUS solution : cord245d.05o 000389912

FILE: cord245d.05o 000389912

NGS OPUS SOLUTION REPORT  
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USER: michaels@ufl.edu  
RINEX FILE: cord245s.05o

DATE: November 04, 2005  
TIME: 19:22:20 UTC

SOFTWARE: page5 0411.19 master13.pl                    START: 2005/09/02 18:01:00  
EPHEMERIS: igs13385.eph [precise]                    STOP: 2005/09/03 05:54:00  
NAV FILE: brdc2450.05n                                OBS USED: 23852 / 25065 : 95%  
ANT NAME: ASH700936D\_M                               # FIXED AMB: 107 / 109 : 98%  
ARP HEIGHT: 1.5                                        OVERALL RMS: 0.015(m)

REF FRAME: NAD\_83(CORS96)(EPOCH:2003.0000)                    ITRF00 (EPOCH:2005.6712)

X:	-2594689.943(m)	0.012(m)	-2594690.774(m)	0.012(m)
Y:	-1784901.362(m)	0.042(m)	-1784900.307(m)	0.042(m)
Z:	5527816.290(m)	0.038(m)	5527816.620(m)	0.038(m)

LAT:	60 29 38.49736	0.007(m)	60 29 38.50017	0.007(m)
E LON:	214 31 27.46109	0.031(m)	214 31 27.37331	0.031(m)
W LON:	145 28 32.53891	0.031(m)	145 28 32.62669	0.031(m)
EL HGT:	27.153(m)	0.047(m)	27.483(m)	0.047(m)
ORTHO HGT:	13.040(m)	0.054(m)	[Geoid99 NAVD88]	

	UTM COORDINATES	STATE PLANE COORDINATES
	UTM (Zone 06)	SPC (5003 AK 3)
Northing (Y) [meters]	6707401.514	723241.963
Easting (X) [meters]	583745.742	528815.281
Convergence [degrees]	1.32667665	0.45629911
Point Scale	0.99968594	0.99991017
Combined Factor	0.99968169	0.99990592

US NATIONAL GRID DESIGNATOR: 6VWN8374607402(NAD 83)

BASE STATIONS USED				
PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
AH3757	POT3 POTATO POINT 3 CORS ARP	N610322.533	W1464148.518	91385.5
AH8301	CHI3 CP HINCHINBROOK 3 CORS ARP	N601415.040	W1463847.552	70648.4
AH2492	GNAA GLENALLEN CORS ARP	N620644.576	W1455812.701	182278.9

NEAREST NGS PUBLISHED CONTROL POINT				
PID	CORD	LATITUDE	LONGITUDE	DISTANCE(m)
UW8134		N602937.361	W1452831.526	38.4

This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

From: opus@ngs.noaa.gov  
Sent: Friday, November 04, 2005 2:01 PM  
To: michaels@ufl.edu  
Subject: OPUS solution : yagn253d.05o 000389902

FILE: yagn253d.05o 000389902

NGS OPUS SOLUTION REPORT  
=====

USER: michaels@ufl.edu  
RINEX FILE: yagn2530.05o

DATE: November 04, 2005  
TIME: 19:00:47 UTC

SOFTWARE: page5 0411.19 master4.pl  
EPHEMERIS: igs13396.eph [precise]  
NAV FILE: brdc2530.05n  
ANT NAME: ASH700936D\_M  
ARP HEIGHT: 1.5

START: 2005/09/10 00:00:00  
STOP: 2005/09/10 23:59:00  
OBS USED: 47077 / 50514 : 93%  
# FIXED AMB: 244 / 273 : 89%  
OVERALL RMS: 0.022(m)

REF FRAME: NAD\_83(CORS96)(EPOCH:2003.0000) ITRF00 (EPOCH:2005.6918)

X:	-2530436.107(m)	0.008(m)	-2530436.930(m)	0.008(m)
Y:	-1941077.772(m)	0.032(m)	-1941076.710(m)	0.032(m)
Z:	5505063.501(m)	0.020(m)	5505063.809(m)	0.020(m)
LAT:	60 4 55.76141	0.007(m)	60 4 55.76619	0.007(m)
E LON:	217 29 29.51374	0.030(m)	217 29 29.42684	0.030(m)
W LON:	142 30 30.48626	0.030(m)	142 30 30.57316	0.030(m)
EL HGT:	17.805(m)	0.024(m)	18.075(m)	0.024(m)
ORTHO HGT:	5.193(m)	0.035(m)	[Geoid99 NAVD88]	

	UTM COORDINATES	STATE PLANE COORDINATES
	UTM (Zone 07)	SPC (5002 AK 2)
Northing (Y) [meters]	6661518.411	677351.137
Easting (X) [meters]	416074.700	471700.855
Convergence [degrees]	-1.30752763	-0.44071354
Point Scale	0.99968631	0.99990981
Combined Factor	0.99968353	0.99990702

US NATIONAL GRID DESIGNATOR: 7VDG1607561518(NAD 83)

BASE STATIONS USED				
PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
AH3757	POT3 POTATO POINT 3 CORS ARP	N610322.533	W1464148.518	253959.7
AH8301	CHI3 CP HINCHINBROOK 3 CORS ARP	N601415.040	W1463847.552	230392.2
AH2492	GNAA GLENALLEN CORS ARP	N620644.576	W1455812.701	293248.3

NEAREST NGS PUBLISHED CONTROL POINT				
UV3105	YAK	N600452.565	W1423032.154	102.1

This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

From: opus@ngs.noaa.gov  
Sent: Friday, November 04, 2005 1:51 PM  
To: michaels@ufl.edu  
Subject: OPUS solution : yagn246d.05o 000389889

FILE: yagn246d.05o 000389889

NGS OPUS SOLUTION REPORT  
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USER: michaels@ufl.edu  
RINEX FILE: yagn2460.05o

DATE: November 04, 2005  
TIME: 18:51:02 UTC

SOFTWARE: page5 0411.19 master4.pl  
EPHEMERIS: igs13386.eph [precise]  
NAV FILE: brdc2460.05n  
ANT NAME: ASH700936D\_M  
ARP HEIGHT: 1.5

START: 2005/09/03 00:00:00  
STOP: 2005/09/03 23:59:00  
OBS USED: 48121 / 51058 : 94%  
# FIXED AMB: 223 / 250 : 89%  
OVERALL RMS: 0.020(m)

REF FRAME: NAD\_83(CORS96)(EPOCH:2003.0000) ITRF00 (EPOCH:2005.6726)

X:	-2530436.100(m)	0.012(m)	-2530436.923(m)	0.012(m)
Y:	-1941077.777(m)	0.033(m)	-1941076.715(m)	0.033(m)
Z:	5505063.498(m)	0.030(m)	5505063.807(m)	0.030(m)
LAT:	60 4 55.76143	0.010(m)	60 4 55.76623	0.010(m)
E LON:	217 29 29.51427	0.025(m)	217 29 29.42737	0.025(m)
W LON:	142 30 30.48573	0.025(m)	142 30 30.57263	0.025(m)
EL HGT:	17.801(m)	0.039(m)	18.072(m)	0.039(m)
ORTHO HGT:	5.189(m)	0.047(m)	[Geoid99 NAVD88]	

	UTM COORDINATES	STATE PLANE COORDINATES
	UTM (Zone 07)	SPC (5002 AK 2)
Northing (Y) [meters]	6661518.412	677351.137
Easting (X) [meters]	416074.708	471700.863
Convergence [degrees]	-1.30752750	-0.44071341
Point Scale	0.99968631	0.99990981
Combined Factor	0.99968353	0.99990702

US NATIONAL GRID DESIGNATOR: 7VDG1607561518(NAD 83)

BASE STATIONS USED				
PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
AH3757	POT3 POTATO POINT 3 CORS ARP	N610322.533	W1464148.518	253959.7
AH8301	CHI3 CP HINCHINBROOK 3 CORS ARP	N601415.040	W1463847.552	230392.2
AH2492	GNAA GLENALLEN CORS ARP	N620644.576	W1455812.701	293248.4

NEAREST NGS PUBLISHED CONTROL POINT				
PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
UV3105	YAK	N600452.565	W1423032.154	102.1

This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

From: opus@ngs.noaa.gov  
Sent: Friday, November 04, 2005 1:52 PM  
To: michael@ufl.edu  
Subject: OPUS solution : yagn254d.05o 000389891

FILE: yagn254d.05o 000389891

NGS OPUS SOLUTION REPORT  
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USER: michael@ufl.edu  
RINEX FILE: yagn2540.05o

DATE: November 04, 2005  
TIME: 18:51:39 UTC

SOFTWARE: page5 0411.19 master3.pl                    START: 2005/09/11 00:00:00  
EPHEMERIS: igs13400.eph [precise]                    STOP: 2005/09/11 23:59:00  
NAV FILE: brdc2540.05n                                OBS USED: 38066 / 51660 : 74%  
ANT NAME: ASH700936D\_M                               # FIXED AMB: 325 / 402 : 81%  
ARP HEIGHT: 1.5                                        OVERALL RMS: 0.022(m)

REF FRAME: NAD\_83(CORS96)(EPOCH:2003.0000)                    ITRF00 (EPOCH:2005.6946)

X:	-2530436.103(m)	0.009(m)	-2530436.926(m)	0.009(m)
Y:	-1941077.762(m)	0.027(m)	-1941076.700(m)	0.027(m)
Z:	5505063.494(m)	0.042(m)	5505063.802(m)	0.042(m)

LAT:	60 4 55.76156	0.004(m)	60 4 55.76634	0.004(m)
E LON:	217 29 29.51338	0.016(m)	217 29 29.42648	0.016(m)
W LON:	142 30 30.48662	0.016(m)	142 30 30.57352	0.016(m)
EL HGT:	17.794(m)	0.048(m)	18.064(m)	0.048(m)
ORTHO HGT:	5.182(m)	0.054(m)	[Geoid99 NAVD88]	

	UTM COORDINATES	STATE PLANE COORDINATES
	UTM (Zone 07)	SPC (5002 AK 2)
Northing (Y) [meters]	6661518.416	677351.141
Easting (X) [meters]	416074.694	471700.850
Convergence [degrees]	-1.30752772	-0.44071363
Point Scale	0.99968631	0.99990981
Combined Factor	0.99968353	0.99990703

US NATIONAL GRID DESIGNATOR: 7VDG1607561518(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DE9153	ZAN1 ANCHORAGE WAAS 1 CORS ARP	N611345.129	W1494648.804	417409.2
AH3757	POT3 POTATO POINT 3 CORS ARP	N610322.533	W1464148.518	253959.7
AH8301	CHI3 CP HINCHINBROOK 3 CORS ARP	N601415.040	W1463847.552	230392.2

NEAREST NGS PUBLISHED CONTROL POINT

UV3105	YAK	N600452.565	W1423032.154	102.1
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

From: opus@ngs.noaa.gov  
Sent: Friday, November 04, 2005 2:00 PM  
To: michael@ufl.edu  
Subject: OPUS solution : yags250d.05o 000389895

FILE: yags250d.05o 000389895

NGS OPUS SOLUTION REPORT  
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USER: michael@ufl.edu  
RINEX FILE: yags2500.05o

DATE: November 04, 2005  
TIME: 18:59:41 UTC

SOFTWARE: page5 0411.19 master29.pl                    START: 2005/09/07 00:00:00  
EPHEMERIS: igs13393.eph [precise]                    STOP: 2005/09/07 23:59:00  
NAV FILE: brdc2500.05n                                OBS USED: 49506 / 51327 : 96%  
ANT NAME: ASH700936D\_M                               # FIXED AMB: 174 / 207 : 84%  
ARP HEIGHT: 1.5                                        OVERALL RMS: 0.018(m)

REF FRAME: NAD\_83(CORS96)(EPOCH:2003.0000)                    ITRF00 (EPOCH:2005.6836)

X:	-2530442.296(m)	0.008(m)	-2530443.119(m)	0.008(m)
Y:	-1941080.854(m)	0.034(m)	-1941079.792(m)	0.034(m)
Z:	5505059.655(m)	0.035(m)	5505059.963(m)	0.035(m)
LAT:	60 4 55.50937	0.013(m)	60 4 55.51415	0.013(m)
E LON:	217 29 29.42827	0.022(m)	217 29 29.34137	0.022(m)
W LON:	142 30 30.57173	0.022(m)	142 30 30.65863	0.022(m)
EL HGT:	17.856(m)	0.042(m)	18.127(m)	0.042(m)
ORTHO HGT:	5.245(m)	0.049(m)	[Geoid99 NAVD88]	

	UTM COORDINATES	STATE PLANE COORDINATES
	UTM (Zone 07)	SPC (5002 AK 2)
Northing (Y) [meters]	6661510.646	677343.348
Easting (X) [meters]	416073.201	471699.474
Convergence [degrees]	-1.30754729	-0.44073381
Point Scale	0.99968632	0.99990981
Combined Factor	0.99968352	0.99990702

US NATIONAL GRID DESIGNATOR: 7VDG1607361511(NAD 83)

BASE STATIONS USED				
PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
AH3757	POT3 POTATO POINT 3 CORS ARP	N610322.533	W1464148.518	253962.0
AH8301	CHI3 CP HINCHINBROOK 3 CORS ARP	N601415.040	W1463847.552	230391.7
AH2492	GNAA GLENALLEN CORS ARP	N620644.576	W1455812.701	293253.7

NEAREST NGS PUBLISHED CONTROL POINT				
UV3105	YAK	N600452.565	W1423032.154	94.2

This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

From: opus@ngs.noaa.gov  
Sent: Friday, November 04, 2005 1:54 PM  
To: michael@ufl.edu  
Subject: OPUS solution : yags246d.05o 000389893

FILE: yags246d.05o 000389893

NGS OPUS SOLUTION REPORT  
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USER: michael@ufl.edu  
RINEX FILE: yags2460.05o

DATE: November 04, 2005  
TIME: 18:54:23 UTC

SOFTWARE: page5 0411.19 master23.pl                    START: 2005/09/03 00:00:00  
EPHEMERIS: igs13386.eph [precise]                    STOP: 2005/09/03 23:59:00  
NAV FILE: brdc2460.05n                                OBS USED: 48115 / 51058 : 94%  
ANT NAME: ASH700936D\_M                              # FIXED AMB: 227 / 248 : 92%  
ARP HEIGHT: 1.5                                      OVERALL RMS: 0.021(m)

REF FRAME: NAD\_83(CORS96)(EPOCH:2003.0000)                    ITRF00 (EPOCH:2005.6726)

X:	-2530442.292(m)	0.010(m)	-2530443.115(m)	0.010(m)
Y:	-1941080.856(m)	0.032(m)	-1941079.794(m)	0.032(m)
Z:	5505059.648(m)	0.028(m)	5505059.957(m)	0.028(m)

LAT:	60 4 55.50931	0.010(m)	60 4 55.51410	0.010(m)
E LON:	217 29 29.42853	0.026(m)	217 29 29.34163	0.026(m)
W LON:	142 30 30.57147	0.026(m)	142 30 30.65837	0.026(m)
EL HGT:	17.849(m)	0.036(m)	18.120(m)	0.036(m)
ORTHO HGT:	5.238(m)	0.044(m)	[Geoid99 NAVD88]	

	UTM COORDINATES	STATE PLANE COORDINATES
	UTM (Zone 07)	SPC (5002 AK 2)
Northing (Y) [meters]	6661510.644	677343.346
Easting (X) [meters]	416073.205	471699.478
Convergence [degrees]	-1.30754723	-0.44073375
Point Scale	0.99968632	0.99990981
Combined Factor	0.99968352	0.99990702

US NATIONAL GRID DESIGNATOR: 7VDG1607361511(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
AH3757	POT3 POTATO POINT 3 CORS ARP	N610322.533	W1464148.518	253962.1
AH8301	CHI3 CP HINCHINBROOK 3 CORS ARP	N601415.040	W1463847.552	230391.7
AH2492	GNAA GLENALLEN CORS ARP	N620644.576	W1455812.701	293253.7

NEAREST NGS PUBLISHED CONTROL POINT

UV3105	YAK	N600452.565	W1423032.154	94.2
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

From: opus@ngs.noaa.gov  
Sent: Friday, November 04, 2005 1:53 PM  
To: michael@ufl.edu  
Subject: OPUS solution : yags254d.05o 000389896

FILE: yags254d.05o 000389896

NGS OPUS SOLUTION REPORT  
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USER: michael@ufl.edu  
RINEX FILE: yags2540.05o

DATE: November 04, 2005  
TIME: 18:52:39 UTC

SOFTWARE: page5 0411.19 master3.pl                    START: 2005/09/11 00:00:00  
EPHEMERIS: igs13400.eph [precise]                    STOP: 2005/09/11 23:59:00  
NAV FILE: brdc2540.05n                                OBS USED: 38158 / 51658 : 74%  
ANT NAME: ASH700936D\_M                               # FIXED AMB: 332 / 400 : 83%  
ARP HEIGHT: 1.5                                        OVERALL RMS: 0.022(m)

REF FRAME: NAD\_83(CORS96)(EPOCH:2003.0000)                    ITRF00 (EPOCH:2005.6946)

X:	-2530442.295(m)	0.008(m)	-2530443.118(m)	0.008(m)
Y:	-1941080.843(m)	0.028(m)	-1941079.781(m)	0.028(m)
Z:	5505059.647(m)	0.039(m)	5505059.955(m)	0.039(m)
LAT:	60 4 55.50945	0.001(m)	60 4 55.51423	0.001(m)
E LON:	217 29 29.42774	0.018(m)	217 29 29.34084	0.018(m)
W LON:	142 30 30.57226	0.018(m)	142 30 30.65916	0.018(m)
EL HGT:	17.846(m)	0.045(m)	18.116(m)	0.045(m)
ORTHO HGT:	5.235(m)	0.051(m)	[Geoid99 NAVD88]	

	UTM COORDINATES	STATE PLANE COORDINATES
	UTM (Zone 07)	SPC (5002 AK 2)
Northing (Y) [meters]	6661510.648	677343.350
Easting (X) [meters]	416073.193	471699.466
Convergence [degrees]	-1.30754742	-0.44073394
Point Scale	0.99968632	0.99990981
Combined Factor	0.99968353	0.99990702

US NATIONAL GRID DESIGNATOR: 7VDG1607361511(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DE9153	ZAN1 ANCHORAGE WAAS 1 CORS ARP	N611345.129	W1494648.804	417410.8
AH3757	POT3 POTATO POINT 3 CORS ARP	N610322.533	W1464148.518	253962.0
AH8301	CHI3 CP HINCHINBROOK 3 CORS ARP	N601415.040	W1463847.552	230391.7

NEAREST NGS PUBLISHED CONTROL POINT

UV3105	YAK	N600452.565	W1423032.154	94.2
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.