Rigorous Geodetic Positioning in the Americas

Neil D. Weston and Tomás Soler
National Geodetic Survey, NOS, NOAA

8th FIG Regional Conference 2012
Montevideo, Uruguay, 26-29 November

Online Positioning User Service - OPUS

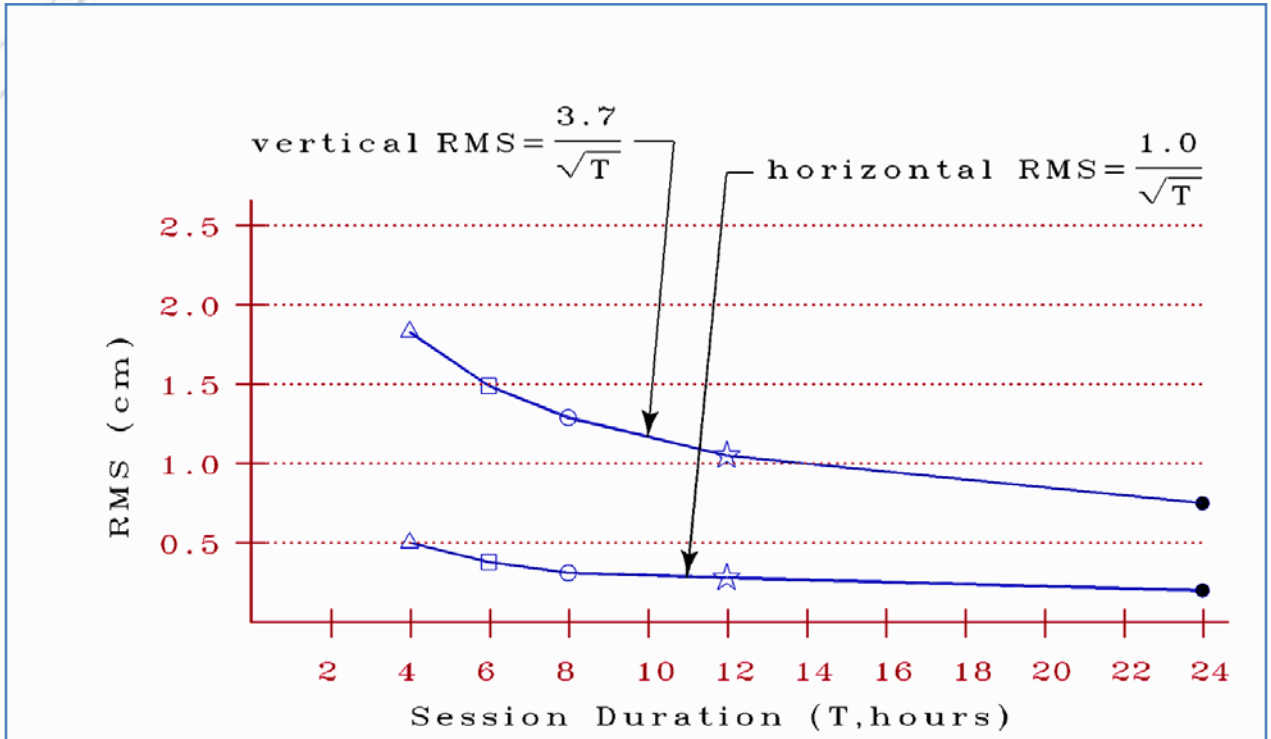
- Web-based GPS Positioning Tool
- Simplified Web Interface
  - RINEX File or Native GPS Receiver File
  - Email Address
  - Antenna Type
  - Antenna Height
- Processing / Adjustment Performed on NGS Servers
- Solution Report via Email

How Does OPUS Work

- Prepare and quality control submitted data
- Estimate an approximate position for the rover
- Compute distance to many nearby CORS
- Select the five best CORS based upon:
  - Being closest to the user's site
  - Having common satellite visibility
  - Having more than 80% of the possible data available
  - Having low multipath
- Complete single-baseline processing to all five CORS
- Select the best three solutions
- Solution Report via Email

OPUS Algorithm

- Computations performed in ITRF / IGS
- Satellite coordinates held rigidly fixed
- CORS coordinates heavily constrained
- Tropospheric and ionospheric modeling
- Double-differenced, ion-free carrier phase observables
- Carrier phase ambiguities are fixed to their integer values



OPUS Web Interface

OPUS: Online Positioning User Service

National Geodetic Survey

NGS Home | About NGS | Data & Imagery | Tools | Surveys | Science & Education | Search

tools/OPUS Menu
Upload
About OPUS
OPUS Projects
View Published Solutions

<-- back

Upload your Data File

Tie your GPS observation to the National Spatial Reference System.
[what is OPUS?] [FAQs]

* Email address - your solution will be sent here.

Browse...

* Data file of dual-frequency GPS observations. [sample]

Sample Solutions

Antenna type - choosing wrong may degrade your accuracy.

0.0 meters above your mark.
Antenna height of your Antenna's Reference Point.

Options to customize your solution.

Upload to RAPID-STATIC
for data > 15 min. < 2 hrs.

Upload to STATIC
for data > 2 hrs. < 48 hrs.

process your solution.

- * required fields
- We may use your data for internal evaluations of OPUS use, accuracy, or related research.

FILE: brft2370.12o OP1348760626205 ** Fortaleza in Brazil

1008 NOTE: Antenna offsets supplied by the user were zero. Coordinates
1008 returned will be for the antenna reference point (ARP).
1008

NGS OPUS SOLUTION REPORT

==========

All computed coordinate accuracies are listed as peak-to-peak values.
For additional information: http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy

USER: rick.foote@noaa.gov
RINEX FILE: brft2370.12o

DATE: September 27, 2012
TIME: 15:48:21 UTC

SOFTWARE: page5 1106.16 master53.pl 082112
EPHEMERIS: igs17025.eph [precise]
NAV FILE: brdc2370.12n
ANT NAME: LEIAX1202 NONE
ARP HEIGHT: 0.00

START: 2012/08/24 00:00:00
STOP: 2012/08/25 00:00:00
OBS USED: 45659 / 46216 : 99%
FIXED AMB: 125/162 : 77%
OVERALL RMS: 0.017(m)

REF FRAME: IGS08 (EPOCH:2012.6463)

X:	4985393.477(m)	0.011(m)
Y:	-3954993.421(m)	0.023(m)
Z:	-428426.608(m)	0.010(m)

LAT:	-3 52 38.80531	0.009(m)
E LON:	321 34 28.06472	0.023(m)
W LON:	38 25 31.93528	0.023(m)
EL HGT:	21.627(m)	0.007(m)

UTM COORDINATES - UTM (Zone 24)

Northing (Y) [meters]	9571397.538
Easting (X) [meters]	563779.005
Convergence [degrees]	-0.03884794
Point Scale	0.99965035
Combined Factor	0.99964695

BASE STATIONS USED

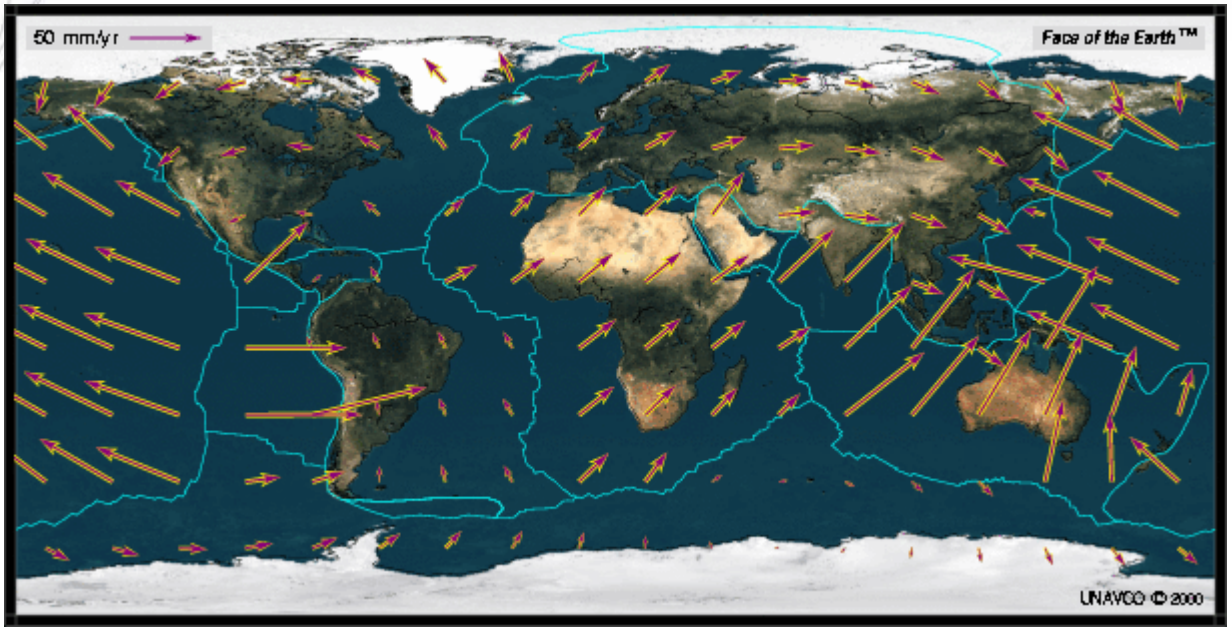
PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DH8854	PMB1 PARAMARIBO CORS ARP			2136143.0
DH8856	SRZN ZANDERIJ CORS ARP			2121939.7
CHPI				2187099.5

OPUS Solutions

Transform Coordinates – SIRGAS2000

- Two Step Approach

A. Determine velocities of the plate where the point is located.



B. Transform coordinates from IGS08 to ITRF2000, epoch 2000.4 (SIRGAS2000)

Velocities - Plate Motion Calculator

http://www.unavco.org/community_science/science-support/crustal_motion/dxdt/model.html

Enter coordinates and (optionally) other selections:

Latitude:	degrees North minutes North seconds North E.g. enter the latitude as –56.25 degrees or –56 degrees 15 minutes for **56 degrees 15 minutes South**.
Longitude:	degrees East minutes East seconds East E.g. enter the longitude as –102.5 degrees or –102 degrees 30 minutes for **102 degrees 30 minutes West**.
Height:	height (meters) ***optional*** WGS-84 height of geographic coordinate (default = 0 meters)
XYZ:	... or enter the position in WGS-84 XYZ coodinates: 4985393.477 X (meters) -3954993.421 Y (meters) -428426.608 Z (meters)

Model
GEODVEL 2010
MORVEL 2010
APKIM2005-DGFI
APKIM2005-IGN
GSRM v1.2
CGPS 2004
REVEL 2000
ITRF2000
HS3-NUVEL 1A
APKIM2000.0
HS2-NUVEL 1A
NUVEL 1A
NUVEL 1

Model	Latitude	Longitude	Speed mm/yr	Azimuth (cw from N)	N Vel. mm/yr	E Vel. mm/yr	Plate (reference)	Site Name
GEODVEL 2010	3° 52' 38.81" S -3.877446°	38° 25' 31.94" W -38.425538°	12.65	340.93°	11.96	-4.13	SA(NNR)	
MORVEL 2010	3° 52' 38.81" S -3.877446°	38° 25' 31.94" W -38.425538°	11.67	337.57°	10.79	-4.45	SA(NNR)	
APKIM2005-DGFI	3° 52' 38.81" S -3.877446°	38° 25' 31.94" W -38.425538°	12.58	343.21°	12.05	-3.64	SA(NNR)	
APKIM2005-IGN	3° 52' 38.81" S -3.877446°	38° 25' 31.94" W -38.425538°	13.58	345.75°	13.17	-3.34	SA(NNR)	
GSRM v1.2	3° 52' 38.81" S -3.877446°	38° 25' 31.94" W -38.425538°	12.73	344.35°	12.26	-3.43	SA(NNR)	
CGPS 2004	3° 52' 38.81" S -3.877446°	38° 25' 31.94" W -38.425538°	11.97	338.37°	11.12	-4.41	SA(NNR)	
REVEL 2000	3° 52' 38.81" S -3.877446°	38° 25' 31.94" W -38.425538°	11.81	333.68°	10.58	-5.24	SA(NNR)	
ITRF2000 (AS&B [2002])	3° 52' 38.81" S -3.877446°	38° 25' 31.94" W -38.425538°	12.54	338.11°	11.64	-4.68	SA(NNR)	
HS3-NUVEL1A	3° 52' 38.81" S -3.877446°	38° 25' 31.94" W -38.425538°	12.90	334.86°	11.68	-5.48	SA(NNR)	
APKIM2000.0	3° 52' 38.81" S -3.877446°	38° 25' 31.94" W -38.425538°	10.30	338.30°	9.57	-3.81	SA(NNR)	
ITRF2000 (D&A [2001])	3° 52' 38.81" S -3.877446°	38° 25' 31.94" W -38.425538°	12.79	340.86°	12.08	-4.19	SA(NNR)	
HS2-NUVEL1A	3° 52' 38.81" S -3.877446°	38° 25' 31.94" W -38.425538°	13.12	335.16°	11.91	-5.51	SA(NNR)	
NUVEL 1A	3° 52' 38.81" S -3.877446°	38° 25' 31.94" W -38.425538°	12.91	334.87°	11.68	-5.48	SA(NNR)	
NUVEL 1	3° 52' 38.81" S -3.877446°	38° 25' 31.94" W -38.425538°	13.31	334.81°	12.04	-5.66	SA(NNR)	

Modeled vs. Computed Velocities

Modeled – NUVEL 1A

N Vel. (mm/yr) = 11.68 E Vel. (mm/yr) = -5.48

Modeled – ITRF2000 (AS&B)

N Vel. (mm/yr) = 11.64 E Vel. (mm/yr) = -4.68

Computed – IGS Multi-year solution

N Vel. (mm/yr) = 12.30 E Vel. (mm/yr) = -4.70

Transform Coordinates – IGS08 to SIRGAS2000

http://www.ngs.noaa.gov/TOOLS/Htdp/Htdp_transform.html

Input Reference Frame: IGS08
Output Reference Frame: ITRF2000
Starting Epoch: 2012.6463
Ending Epoch: 2000.4

X: 4985393.477 Y: -3954993.421 Z: -428426.608
N Vel. (mm/yr) = 11.68 E Vel. (mm/yr) = -5.48
Up Vel. (mm/yr) = 0.00

HTDP OUTPUT – SIRGAS2000

** Using modeled velocities: NUVEL 1A
HTDP (version 3.2.3) OUTPUT

TRANSFORMING POSITIONS FROM ITRF2008 or IGS08 (EPOCH = 08-24-2012 (2012.647))
TO ITRF2000 or IGS00/IGb00 (EPOCH = 05-26-2000 (2000.400))

	INPUT COORDINATES	OUTPUT COORDINATES	INPUT VELOCITY
BRFT			
LATITUDE	3 52 38.80531 S	3 52 38.81033 S	11.68 mm/yr north
LONGITUDE	38 25 31.93528 W	38 25 31.93318 W	-5.48 mm/yr east
ELLIP. HT.	21.627	21.636 m	0.00 mm/yr up
X	4985393.477	4985393.516 m	-2.79 mm/yr
Y	-3954993.421	-3954993.369 m	-4.78 mm/yr
Z	-428426.608	-428426.763 m	11.65 mm/yr

Thank You

Dr. Neil D. Weston

neil.d.weston@noaa.gov
+1 301-713-3191