Static GPS/GNSS Data Processing with OPUS Manual

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This is a guide for converting RINEX files to a position using OPUS (Online Positioning User Service). Users should first learn how to convert files to RINEX using the appropriate software supplied by your GNSS systems manufacturer. These conversions can often be completed by TEQC, a command-line application developed by UNAVCO, in the absence of other dedicated software. OPUS also accepts Compressed UNIX, gzip, pkzip, or Hatanaka formats, if needed for multiple file archives. For more information, visit https://www.ngs.noaa.gov/OPUS/.

Introduction to OPUS

OPUS (Online Positioning User Service) is a National Geodetic Survey (NGS)–operated system for baseline processing of standardized RINEX files into fixed positions. A GNSS survey records a string of positioning observations and metadata records that are typically stored in a proprietary format and converted to RINEX files. The RINEX files are uploaded to OPUS, and your survey's observations are compared to known positions and observations recorded at CORS (Continuously Operating Reference Station). This establishes a baseline between your survey location and the chosen CORS site and allows errors in positioning to be minimized. OPUS then returns a single, corrected position for your observed location.

OPUS is a relatively quick, easy solution to processing GNSS data, but it is limited in its nature. The quality of positioning solution will be limited by the quality of your metadata, precision of setup measurement, length of observation, and distance and availability of local CORS sites. OPUS provides an availability map of CORS stations, which is updated regularly; check this before performing a survey that depends on an OPUS solution.

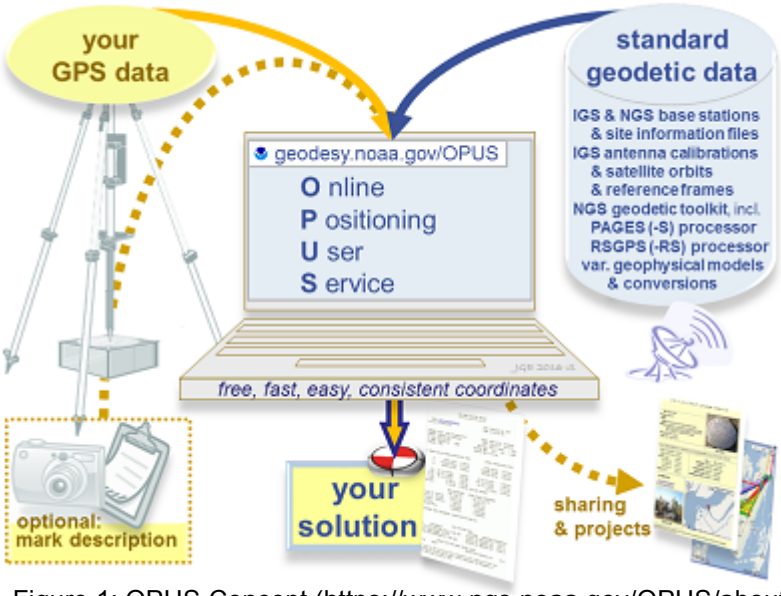

Figure 1: OPUS Concept (https://www.ngs.noaa.gov/OPUS/about.jsp)

OPUS Availability Map: https://www.ngs.noaa.gov/OPUSI/Plots/Gmap/OPUSRS_sigmap.shtml

The maximum potential accuracy of OPUS is 1–2 cm vertical and 0.5 cm horizontal. If your intended application needs higher accuracy than this, you may need to consider alternative methods. Alternatives to OPUS include processing baselines using proprietary software designed for the specific equipment you are using or academic-level processing software such as GIPSY/OASIS or GAMIT. These require greater knowledge of the specific software package you are using.

Processing with OPUS

This guide starts with a RINEX file. Convert your observation files to RINEX using proprietary software or the TEQC system. Information and downloads of TEQC can be found on UNAVCO's software page at https://www.unavco.org/software/data-processing/teqc/teqc.html.

1. Visit the OPUS webpage at https://www.ngs.noaa.gov/OPUS/.
2. Select the observation file (RINEX) you are uploading using this button: Choose File
3. Fill out basic metadata, including the antenna model, antenna height, and options.
    a. Additional options allow you to customize the processing; most options should be left in their default position, unless you have a specific need.
    b. The most common change is alter your base stations. Occasionally, specific base stations may be selected to provide consistency over multiple surveys or to exclude stations that are known to give bad results in your area.
4. When you are finished, select either Upload to Rapid-Static or Upload to Static, depending on the length of your survey (rapid-static: 15 minutes–2 hours; static: 2–48 hours).
5. You should receive an email within several minutes, but it may take several hours, if there is heavy traffic or you submitted a large file. The email will be either a position solution, like the example listed below, or a failure message.
6. Locate your position on the report. Note that the report has positions in multiple systems, ellipsoid and orthometric heights, and errors.

Example report from OPUS, https://www.ngs.noaa.gov/OPUS/about.jsp#solution

NGS OPUS SOLUTION REPORT
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9999 OPUS DISCLAIMER OPUS DISCLAIMER OPUS DISCLAIMER OPUS DISCLAIMER
error and warning messages are appended here

USER: Your.email@domain.com Your **email address**	DATE: October 27, 2004 The date and time you used OPUS
RINEX FILE: 7615289n.04o Your **data file name**	TIME: 18:49:54 UTC Coordinated Universal Time
SOFTWARE: page5 0407.16 master7.pl The software we used	START: 2004/10/15 13:37:00 The first observation in your data file
EPHEMERIS: igr12925.eph [rapid] The orbit file we used	STOP: 2004/10/15 18:10:00 The last observation in your data file
NAV FILE: brdc2880.04n The navigation file we used	OBS USED: 8686 / 8804 : 99% Usable / total observations in your data file
ANT NAME: ASH700829.3 SNOW	# FIXED AMB: 41 / 42 : 98%

Your selected **antenna type**	For static: Fixed / total **ambiguities** in your data file For rapid static: quality indicators from network and rover mode solutions (ambiguities are always 100% fixed)
ARP HEIGHT: 1.295 Your selected **antenna height**	OVERALL RMS: 0.020 (m) For static: The formal statistical root mean square (RMS) error of your solution For rapid static: a unitless normalized RMS

Your position:

earth-centered cartesian coordinates in the International GNSS Service (IGS) Reference Frame.

The North American Datum of 1983 (NAD83) is also reported, if applicable.

Accuracies below are reported as either **peak-to-peak errors** (static) or standard deviation estimates (rapid static)

All initial computations are performed in IGS. Your NAD83 coordinates are derived by transforming IGS vectors into the NAD83 reference frame and recomputing the 3 independent and averaged positions (not a direct transformation of the IGS coordinates; a direct transformation could be considered more accurate, but wouldn't fit your surrounding NAD83 network as well.) For both IGS and NAD83, the reference coordinates for each CORS are derived from the NGS integrated database and are updated using crustal motion velocities from **HTDP (Horizontal Time-Dependent Positioning** software to your data file's epoch. Your final IGS reference frame coordinates retain this observed epoch, while your NAD83 coordinates are transformed again to the standard epoch date of January 1, 2010.

REF FRAME: NAD_83(2011)(EPOCH:2010.0000)	IGS08 (EPOCH:2004.7887)
X: -552474.327(m) 0.015(m)	-552475.001(m) 0.015(m)
Y: -4664767.953(m) 0.021(m)	-4664766.631(m) 0.021(m)
Z: 4300548.721(m) 0.024(m)	300548.654(m) 0.024(m)
ellipsoidal coordinates (latitude, longitude, ellipsoidal height) and accuracies	
LAT: 42 39 59.51026 0.007(m)	42 39 59.53576 0.008(m)
E LON: 263 14 44.18589 0.013(m)	263 14 44.14967 0.013(m)
W LON: 96 45 15.81411 0.013(m)	96 45 15.85033 0.013(m)
EL HGT: 314.705(m) 0.041(m)	313.753(m) 0.033(m)
The North American Vertical Datum of 1988 (NAVD88) orthometric height, if applicable, along with the geoid model used	
ORTHO HGT: 340.240(m) 0.041(m)	[NAVD88 (Computed using GEOID12A)]

Your position:

Universal Transver Mercator (UTM) coordinates.

State Plane Coordinates (SPC) are also reported, if applicable.

Also reported are the associated zone IDs, meridian convergence, point scale, and combined factor

UTM COORDINATES	STATE PLANE COORDINATES
UTM (Zone 14)	SPC (4002 SD S)
Northing (Y) [meters] 4726229.423	43336.983
Easting (X) [meters] 684026.367	893325.488
Convergence [degrees] 1.52234197	2.46893915
Point Scale 1.00001666	1.00004366
Combined Factor 0.99996731	0.99999430
US NATIONAL GRID DESIGNATOR: 14TPN8402626229(NAD 83) The **US National Grid coordinates** and referenced datum are reported, if applicable	
BASE STATIONS USED The **CORS** we used as reference stations and the **nearest published mark** are reported along with their positions and distances from your position.	
PID DESIGNATION	LATITUDE LONGITUDE DISTANCE(m)
AI1569 NLGN NELIGH CORS ARP	N421224.250 W0974743.043 99724.2
DF7469 SDSF EROS DATA CORS ARP	N434401.727 W0963718.541 119065.7
AH5054 OMH1 OMAHA 1 CORS ARP	N414641.765 W0955440.671 120751.8
NEAREST NGS PUBLISHED CONTROL POINT	
NM0874 D 276	N423846. W0964505. 2286.4
The numerical values for this position solution have satisfied the quality control criteria of the National Geodetic Survey. The contributor has verified that the information submitted is accurate and complete. Because OPUS is automated and assumes your entries are valid, we add this disclaimer to all solutions.	