

**Online Precise Point Positioning Using the
Natural Resources Canada
Canadian Spatial Reference System (CSRS-PPP)**

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I. Precise Point Positioning

Precise Point Positioning (PPP) is a GPS data processing technique which generates a high-precision autonomous solution. There are several online PPP services – this document describes getting started with the Canadian Spatial Reference System PPP service (CSRS-PPP).

This document is a condensed summary on how to obtain PPP solutions from Trimble receiver data files. However, the PPP service can use data files from any receiver as long as they are first converted to the RINEX format. A more detailed users manual for the CSRS-PPP service is available on-line:

http://www.geod.nrcan.gc.ca/userguide/index_e.php

II. How to Use the CSRS-PPP Online Positioning Service

In general, longer data files, and a longer lag in submitting the data for processing (for precise orbit and clock files to become available), the more accurate the PPP solution will be. 24-hour files are preferable, but shorter files often yield coordinates with sufficient accuracy. For PPP processing of data taken on snow or ice, it is important to consider the velocity at which the ice is moving. For glacier measurements the motion in a day may exceed the processing precision obtained from a 24-hour file; in such cases it may be useful to send data files of various lengths to CSRS-PPP to gain confidence in the coordinate. The *teqc.exe* program can be used to break up long GPS files into shorter ones; refer to the *teqc* instruction manual. Information about this program is given in section 2B below. Also, see section 6) for a note on the kinematic processing option available from CSRS-PPP.

1) Convert GPS Data Files from .T00 to .DAT Format.

Trimble receivers record data in the proprietary, compressed .T00 format. These files must first be converted to the proprietary, uncompressed .DAT format. The Trimble Data Transfer Utility, available online from Trimble will perform this conversion.

2) Convert GPS data files from .DAT to RINEX (Receiver INdependent EXchange) format.

This can be done in many ways; two methods are described here.

A) Use Trimble *Convert to RINEX* program.

For Windows computers with Trimble Geomatics Office installed, this program is generally found under the *Trimble Office/Utilities* menu under the *Windows Start/Program* menu. When you start the program, the following window will appear:

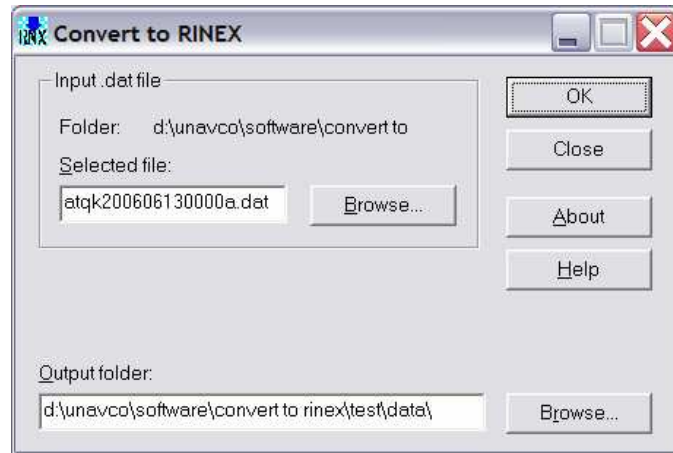


Figure 1: Main menu of the Trimble *Convert to Rinex* program

Select the .DAT file, select the output folder and hit OK. The Configuration window will then appear.

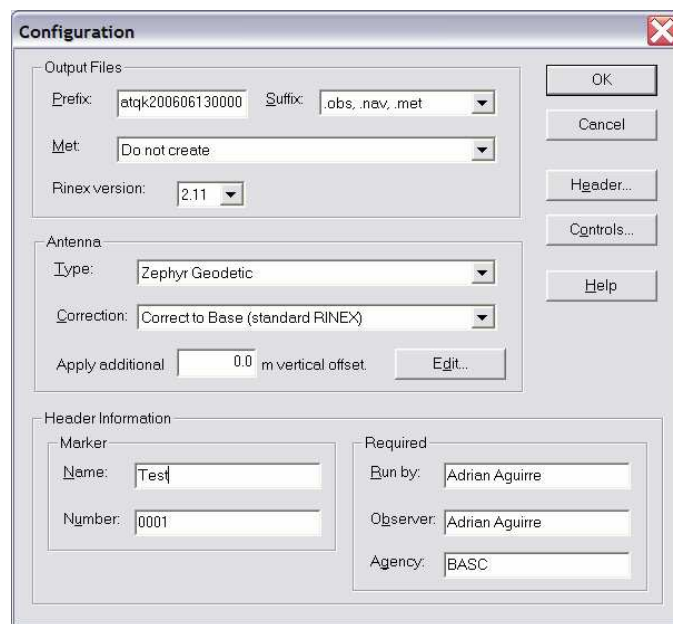


Figure 2: Configuration window

Enter antenna type, choose Correct to Base, and if necessary, enter in the vertical offset between the bottom of your antenna and the survey mark. For example if you used an 18 cm spike mount, enter 0.018 in the *Apply additional X m vertical offset* box. Don't worry about the *Edit* button under the *Antenna* section; this will just confuse the issue. You can also enter the *Header Information* (name, Number, Run by etc). Click OK and the file will be converted to RINEX. Two files will be created, with extensions .xxo and .xxn, where xx is the two digit year. The "o" file is the RINEX observation file; this is the file to send to CSRS-PPP. The "n" file is the RINEX navigation file, which is not used for this analysis.

B. Use the *teqc.exe* program.

This program is a stand-alone executable and is available for various computing platforms. The program and documentation can be downloaded from UNAVCO.

Place the *teqc.exe* program in the same directory as your .dat file, and from a command window execute the line:

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teqc -tr d filename.dat > filename.xxo
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where xx is the 2-digit year. This will create a RINEX observation file, designated by the “o” at the end of the filename. This is the file you need to send to CSRS-PPP. You may get a message about GPS week, which will be self-explanatory. The number of any GPS week can be found at <http://www.ngs.noaa.gov/CORS/Gpscal.html>

3) Open the RINEX file and verify antenna values.

CSRS-PPP delivers a three-dimensional coordinate which represents the position of your survey mark or GPS monument. To accomplish this, it first calculates the position of the antenna’s electrical phase center (APC). It must then subtract the distance from the APC to your survey mark. This distance is composed of two values: A) the distance from the APC to the bottom plane of the antenna (ARP), and B) the distance from the bottom plane of the antenna to the survey mark. You should always verify that the RINEX file has the correct antenna model and vertical offset values before sending the file to CSRS-PPP.

A) NGS antenna ID number.

It is rare that a data file from a permanent GPS base station will have an incorrect antenna type stored in its configuration, but is more common for user-installed temporary GPS base stations. In any case, if this happens it will introduce a vertical error into your solution.

For each antenna, the distance from its APC to the center of its bottom plane is recorded in an antenna database such as that maintained by the National Geodetic Survey (NGS). Open the RINEX file with a text editor and verify that the correct NGS antenna ID number is listed in the **ANT # / TYPE** line, as shown in Figure 3. This example shows the ID number for a Trimble Zephyr Geodetic, NGS ID TRM41249.00. A few common Trimble antennas and their NGS identification numbers are listed below.

Trimble Zephyr Geodetic:	TRM41249.00
Trimble Zephyr	TRM39105.00
Trimble Choke Ring	TRM29659.00

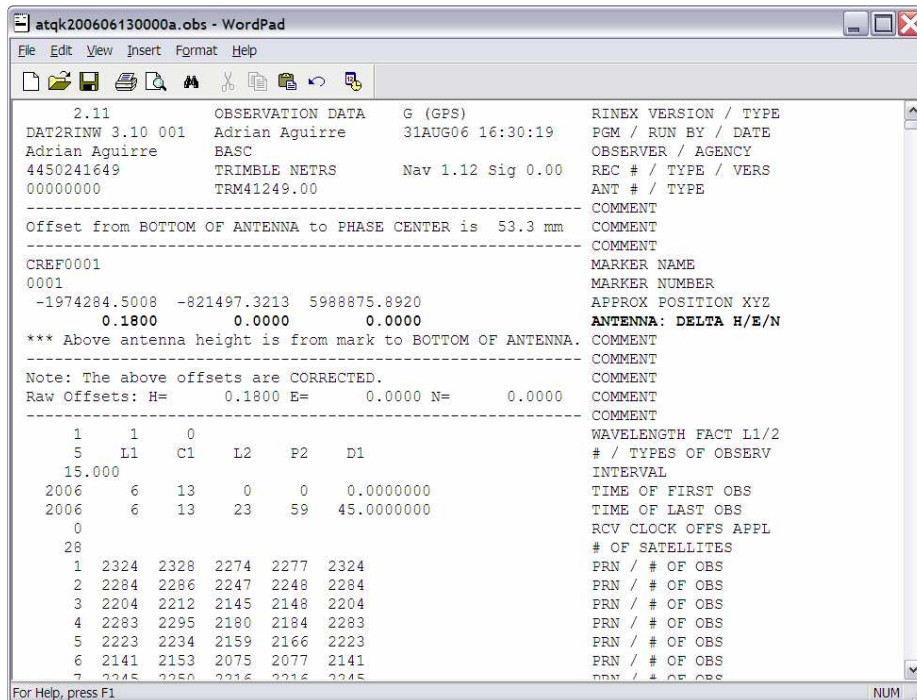
ID numbers for additional antennas can be found at the NGS website:

<http://www.ngs.noaa.gov/ANTCAL/>

B) Antenna Vertical Offset Value

Also verify that the vertical antenna offset value is correct. This value is in the leftmost column of the line labeled **ANTENNA: DELTA H/E/N** (the bold line in **Figure 3**). If you used Trimble *Convert to RINEX*, this should be the value you entered in the *Apply additional X m vertical offset* box; if you used *teqc*, this value will simply be copied from the value in the original .dat file.

It is always important to check this field before submitting your RINEX file to CSRS-PPP. The CSRS-PPP service expects a file which conforms to the standard RINEX format; in this format, the three columns in the **ANTENNA: DELTA H/E/N** are the distances by which the center of the bottom plane of your antenna is offset from your survey mark. For all survey applications where any standard antenna mount is used, the center and right columns will be zero since these columns are the horizontal offsets (East and North) between your antenna and the mark. The left column is reserved for the vertical distance between the survey mark and the center of the bottom of your antenna. A *Delta H* value of zero means there is no offset between the bottom of the antenna and the survey mark.



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atqk200606130000a.obs - WordPad
File Edit View Insert Format Help

2.11 OBSERVATION DATA G (GPS) RINEX VERSION / TYPE
DAT2RINW 3.10 001 Adrian Aguirre 31AUG06 16:30:19 PGM / RUN BY / DATE
Adrian Aguirre BASC OBSERVER / AGENCY
4450241649 TRIMBLE NETRS Nav 1.12 Sig 0.00 REC # / TYPE / VERS
00000000 TRM41249.00 ANT # / TYPE
-----
Offset from BOTTOM OF ANTENNA to PHASE CENTER is 53.3 mm COMMENT
COMMENT
COMMENT
CREFO001 MARKER NAME
0001 MARKER NUMBER
-1974284.5008 -821497.3213 5988875.8920 APPROX POSITION XYZ
0.1800 0.0000 0.0000 ANTENNA: DELTA H/E/N
*** Above antenna height is from mark to BOTTOM OF ANTENNA. COMMENT
Note: The above offsets are CORRECTED. COMMENT
Raw Offsets: H= 0.1800 E= 0.0000 N= 0.0000 COMMENT
-----
1 1 0 WAVELENGTH FACT L1/2
5 L1 C1 L2 P2 D1 # / TYPES OF OBSERV
15.000 INTERVAL
2006 6 13 0 0 0.0000000 TIME OF FIRST OBS
2006 6 13 23 59 45.0000000 TIME OF LAST OBS
0 RCV CLOCK OFFS APPL
28 # OF SATELLITES
1 2324 2328 2274 2277 2324 PRN / # OF OBS
2 2284 2286 2247 2248 2284 PRN / # OF OBS
3 2204 2212 2145 2148 2204 PRN / # OF OBS
4 2283 2295 2180 2184 2283 PRN / # OF OBS
5 2223 2234 2159 2166 2223 PRN / # OF OBS
6 2141 2153 2075 2077 2141 PRN / # OF OBS
7 2245 2250 2216 2216 2245 PRN / # OF OBS
For Help, press F1 NUM
```

Figure 3: RINEX header format

4) Create a User Account with CSRS-PPP

Go to the Canadian Spatial Reference System webpage at

http://www.geod.nrcan.gc.ca/online_data_e.php

Click Apply as a new user and follow the instructions. You will be sent a username and temporary password soon afterwards. Once you can log in, scroll down and click *GO* under *CSRS - Precise Point Positioning (PPP)*. A window will appear as in Figure 4.

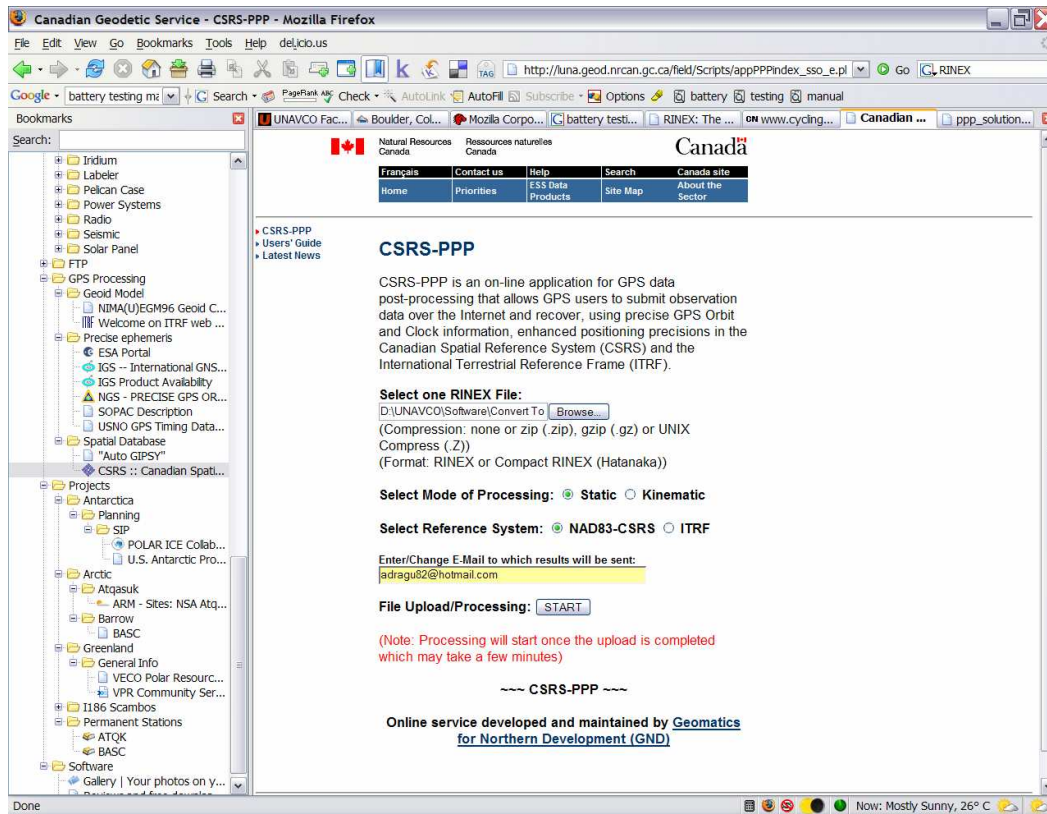


Figure 4: CSRS-PPP website

5) Send the RINEX Observation File to CSRS-PPP

Browse for the RINEX file you just created, select *Static* and either the *NAD83-CSRS* or *ITRF* reference frame (definitions of both from the CSRS website are at the end of this document). UNAVCO usually uses the ITRF reference frame for PPP solutions. Enter your email address and click *Start*. A new page will appear when it uploads the file. When done you will receive via email a PDF file with a summary of the processing results, and a link to a more detailed report on the analysis. Open the PDF file (Figure 5). The coordinates at the bottom of the page are the survey mark.

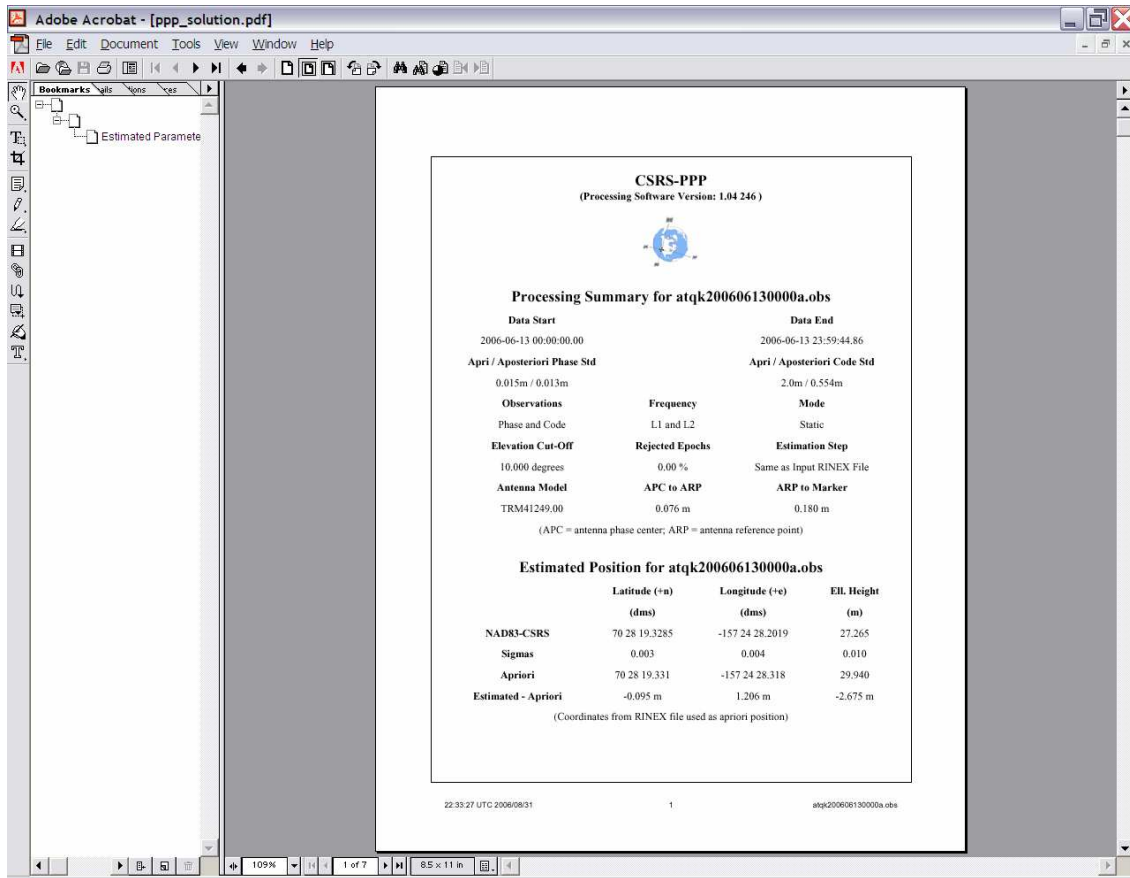


Figure 5: CSRS-PPP processing results

6) A note on Kinematic Processing

CSRS-PPP can provide a kinematic solution, epoch-by-epoch, for your RINEX file. Depending on the velocity of the GPS station, for example on a glacier, it may be more efficient to do Kinematic processing rather than a series of Static points. Which option is best is completely dependent on the nature of the motion being measured, as well as the length of available data files. Simply check the *Kinematic* option before submitting your file for processing.

7) CSRS-PPP Reference Frames

NAD83: The North American Datum of 1983 (NAD83) is the adopted reference coordinate system in both Canada (NAD83(CSRS)) and the United States (NAD83(NSRS)). It is a 3-dimensional representation of the NAD83 horizontal datum adopted in 1986. To comply with a resolution of the International Association of Geodesy (IAG), the North American plate fixed NAD83(CSRS) is rigorously related to the current International Terrestrial Reference Frame via a 6 parameter transformation (3 translations and three rotations). The ITRF scale was adopted for NAD83 (CSRS) so that the two reference frames are very similar except for an approximate 2m difference in earth centre position.

ITRF: The models that define the geocentric reference system along with the station coordinates and velocities used to realize the International Terrestrial Reference Frame currently give the best representation of the solid Earth and its time variations on a global scale. The coordinates of the reference frame are based on combinations of several geodetic space techniques including VLBI, SLR, DORIS and GPS. The ITRF reference system is global and as such is not fixed to any specific tectonic plate. Therefore, coordinates defined in ITRF will change over time due to the displacement of the plates and possibly to some intra-plate motions. It is for that reason that the ITRF frame defined in terms of both coordinates and velocities is referenced to a specific epoch of time. The specific ITRF frame used by PPP is the one realized by IGS at the epoch for which the precise GPS orbits were computed. With the production of orbit estimates on a daily basis, the ITRF realization epoch will always be within a day of the submitted GPS data.