Non-Thesis Student Work

2022

Survey Control with GNSS Receiver: WPES, How Do I...? Quick Guide

Bea E. Van Dam
University of Maine, bea.vandam@maine.edu

Follow this and additional works at: https://digitalcommons.library.umaine.edu/student_work

Part of the Earth Sciences Commons, and the Other Physical Sciences and Mathematics Commons

WPES, How Do I...?

Quick Guide to

SURVEY CONTROL
WITH GNSS RECEIVER

WPES, How Do I...?

Quick Guide to

Survey Control with GNSS Receiver

Prepared by Bea E. Van Dam

for

Watershed Process and Estuary Sustainability Research Group
University of Maine, Orono, ME
umaine.edu/watershedresearch

This document is formatted for print in booklet form on letter size paper.

Table of Contents

Introduction

This document is a quick guide to establishing survey control points using a Global Navigation Satellite Systems (GNSS) receiver and processing collected point coordinate data.

The WPES Research Group uses a Trimble NetR9 GNSS reference receiver, which is reflected in the specific sequences of button presses outlined in the data profile setup, field operation, and data download sections. Readers using a different receiver may still find the general workflow overview useful and should be able to use the data post-processing section directly.

Pre-survey tasks

1. Equipment list
    1.1. Receiver equipment:
        1.1.1. Trimble NetR9 GNSS receiver
        1.1.2. Trimble Zephyr Geodetic Model 2 antenna
        1.1.3. Antenna cable
        1.1.4. Power cable *if recharging during expedition*
        1.1.5. Tribrach
        1.1.6. Tripod
    1.2. Additional equipment
        1.2.1. Field notebook
        1.2.2. Magnetic compass
        1.2.3. Metric open-reel measuring tape
        1.2.4. Rebar with orange-painted tip (multiple) *for establishing new control points*
        1.2.5. Ethernet cable / computer *if downloading data during expedition*

2. Data collection profile
    2.1. Connect NetR9 receiver to computer.
        2.1.1. Attach ethernet cable between ethernet ports on computer and rear of receiver (Appendix A).
        2.1.2. From home screen of receiver, press "Up" arrow on keypad once to display IP address.

            Note: If address is showing as 0.0.0.0, wait several seconds to a minute for address to update.
        2.1.3. Enter IP address into address bar of internet browser.
    2.2. Click "Data Logging" in menu at left of screen.
    2.3. **If a profile for research group appears under "Session" heading:**
        2.3.1. Skip to step 2.5.

        If there is no profile for research group:
        2.3.2. Continue to step 2.4.

2.4. Set up logging profile.

This ensures that research group data is stored in its own folder.

2.4.1. Click "New Session" under list of sessions.

2.4.2. Set profile options:

Session Name: WPES

Schedule: Always

Measurement Interval: 2 seconds

Position Interval: 5 minutes

(optional) Suffix: W

2.4.3. Click "OK."

2.5. In list of sessions, ensure "Enable" box is checked only for research group profile.

2.6. NetR9 receiver can be powered down and ethernet cable disconnected.

Field operation

Take detailed field notes during this process, including sketched maps showing locations and compass headings of prominent landscape features relative to control points.

1. Occupying control point

   Note: It is desirable for our control points to be long-term stations that will not be disturbed and can be re-occupied for future surveys. In order to get good GPS control, point should not be in dense trees or in the shadow of features (hills, cliffs, etc.) that block signals from GPS satellites to antenna. Clearings on raised ground are preferable.

   1.1. **If establishing new control point**:

      1.1.1. Drive rebar vertically into ground.

      1.1.2. Sketch location of control point relative to surrounding features to make it easier to find and occupy again in future.

   1.2. Continue to step 2.

2. Antenna set-up

   Note: This manual describes setting up antenna with tribrach on tripod, which is the more stable method and therefore preferred. However, the antenna can also be screwed directly onto a prism pole. If you use a prism pole/bipod setup, ensure pole is stable by stomping bipod feet into firm soil and note both that leveling may be less precise and that antenna height cannot be read directly from prism pole without adjusting length of threaded pole adapter.[A] Prism pole setup should not be used on a windy day.

   2.1. Set up tripod and level tribrach.

      2.1.1. Set up tripod over control point, with head (top plate) as level as possible and opening directly above point; make sure tripod feet are securely anchored in soil and slip joint clamps are locked.

         Note: Sight down through the hollow mounting screw to help center over point.

[A] See "WPES, How Do I...?" Quick Guide to Total Station Field Surveying, Appendix B.

2.1.2.	Place tribrach on tripod head and secure using mounting screw.

Note: Tighten to finger tight – do not over-tighten.

2.1.3.	Perform gross leveling using bullseye level bubble on tribrach by making small adjustments to one tripod leg at a time.

Note: Securely re-lock slip joint clamp before moving on to next leg.

2.1.4.	Perform fine leveling of tribrach using level bubble by adjusting leveling foot screws on tribrach.

Note: The easiest way to do this is to face one of the three sides of the tribrach, then use *one* of the two foot screws along that side to level tribrach in the X direction and the third foot screw (at opposite vertex) to level tribrach in the Y direction.

2.1.5.	Looking through optical plummet on side of tribrach, loosen mounting screw and gently slide tribrach until it is directly over point; re-tighten mounting screw.

Note: Do not rotate tribrach while sliding or it will go out of level.

2.1.6.	Check level bubble and repeat steps 2.1.4 and 2.1.5 as necessary until tribrach is level and directly over point.

2.2.	Attach antenna to tribrach.

2.2.1.	Screw antenna onto tribrach and rotate until notch labeled "1" (on underside) is pointed approximately north.

2.2.2.	Measure height from ground to center of antenna notch (transition from grey to white plastic) at three or more points along the edge of the antenna and average them to get antenna height. **Record this value in your field notebook.**

2.2.3.	Connect antenna cable to antenna and to GNSS antenna connection port on rear of NetR9 receiver (Appendix A).

2.2.4.	Continue to step 3.

3.	Logging a point

3.1.	Power on NetR9 receiver by pressing green power button on face.

Note: Landing screen will show battery level at top right and number of satellites the antenna is picking up at left.

3.2. As soon as receiver is powered on and seeing satellites, logging begins without further user input.

Note: Receiver must see at least four satellites for an accurate reading.

3.3. Leave receiver running at site for as long as possible.

*Note: Receiver **must** record for at least 2 hours for most accurate method of post-processing; aim for at least 3 hours. The more obstructed the area around the point is, the longer it should sit. Recording times of less than 45 minutes in moderate tree cover have resulted in not enough usable data to successfully post-process.*

3.4. Continue to step 4.

4. Finishing a point

4.1. Power down NetR9 receiver by holding power button for three seconds.

Note: Receiver will go through "Shutting down in 2...1...0" dialog before shutting down. Button must be held through this sequence.

4.2. Green power indicator LED will turn off. As a check, press any other button on receiver face to make sure that full power-down has occurred.

Note: If screen turns back on, device did not power down and step 4.1 must be repeated (correctly).

4.3. Disconnect antenna cable from antenna and receiver and replace caps over antenna connection ports.

4.4. Unscrew antenna from tribrach and remove tribrach from tripod.

4.5. **If measuring additional points:**

4.5.1. Move to next point and return to step 1 (Occupying control point).

When finished logging points:

4.5.2. Ensure NetR9 receiver is fully powered down and securely store receiver, antenna, tribrach, tripod, and other gear for transport.

Post-survey tasks

1. Data download

    1.1. Connect to NetR9 ethernet interface (see <u>Pre-survey tasks</u> step 2.1).

    1.2. Click "Data Logging" in menu at left of screen.

    1.3. On "Data Logging" page, click "/Internal" under "File System" heading and navigate to your data folder.

    Note: Data folder shares a name with logging session enabled during data collection profile setup. Within the data folder, files are categorized in subfolders for year, month, and day that data were recorded.

    1.4. For each "day" folder:

    1.4.1. Select all files.

    1.4.2. Click "Download Selected Files" icon to download .T02 files for backup.

    Note: You may alternatively click file name to download single file.

    1.4.3. Click "Convert and Download Selected Files" icon.

    Note: You may alternatively click "Convert" button next to file name to convert single file.

    1.4.4. In dropdowns, choose "RINEX 3.00" and "Observables."

    1.4.5. Click "Convert and Download" button.

    1.5. Back up all downloaded files in Google Drive project folder.

2. Equipment storage

    2.1. Return all equipment to equipment room.

    2.1.1. Plug in NetR9 receiver to charge, aligning red dots on charger cable and power cable connection port (Appendix A).

    2.2. If work was done in damp or humid conditions, allow instruments to sit open to indoor air before being stored in closed boxes.

Data post-processing

1. Post-processing Trimble .T02 files

    1.1. Post-process .T02 file at <u>trimblertx.com</u>.

    Note: Requires free registration.

    1.1.1. Set "Coordinate System" and "Tectonic Plate" to "Autodetect."

    1.1.2. Upload .T02 file.

    1.1.3. Enter registered email address and check terms of use box.

    1.1.4. Click "Process."

    1.1.5. Download report PDF from email and back up to project folder.

    1.2. Convert coordinates to UTM and ellipsoid height to ortho height with NOAA Vertical Datum Transformation[B].

    Note: The "Source" values below use the IRTF2014 reference frame values reported by TrimbleRTX. If you wish to instead use the receiver coordinate system autodetected by TrimbleRTX, the Source reference frames (steps 1.2.2 & 1.2.4 below) must be updated accordingly. X,Y,Z Input values (step 1.2.6) must reflect chosen reference frame. The difference in resulting output X,Y,Z values should be within several centimeters.

    The "Target" values below assume that the desired output coordinates are in UTM (NAD83), which uses the NAD83(2011) horizontal reference frame and NAVD88 vertical reference. If that is not the desired target coordinate system, Target reference frame choice (steps 1.2.3 & 1.2.5) must be updated accordingly.

    1.2.1. Regional Information

    Region: Contiguous United States

    1.2.2. Horizontal Information – Source

    Reference Frame: IRTF2014

    Coor. System: Geographic (Longitude, Latitude)

[B] <u>vdatum.noaa.gov/vdatumweb</u>

1.2.3. Horizontal Information – Target

> Reference Frame: NAD83(2011)
>
> Coor. System: Projected UTM (Easting, Northing)
>
> Unit: meter (m)

1.2.4. Vertical Information – Source

> Reference Frame: IRTF2014
>
> Unit: meter (m)

1.2.5. Vertical Information – Target

> Reference Frame: NAVD 88
>
> Unit: meter (m)

1.2.6. Input

> Latitude: *IRTF2014 Lat.* from TrimbleRTX report
>
> Longitude: *IRTF2014 Long.* from TrimbleRTX report
>> *Note: West longitude must be preceded by negative sign.*
>
> Height: *IRTF2014 El. Height* from TrimbleRTX report

1.2.7. Click "Transform" button.

1.2.8. Follow instructions for entering dates using input epoch from TrimbleRTX report.

1.2.9. Output is UTM Northing, Easting, and Ortho Height to be used in step 3.4 below.

2. Post-processing RINEX files

Note: This section is intended only for if TrimbleRTX is unable to find a solution from a .T02 file. We have found that OPUS solutions have been less consistent than TrimbleRTX solutions when logging same point over multiple site visits.

2.1. Open ngs.noaa.gov/OPUS in internet browser.

2.1.1. Use "Choose File" dialog to navigate to RINEX (.22O) data file, and click "Open."

> *Note: If "illegal characters" error message appears, make sure there are no spaces in file path to RINEX file (e.g.,* D:\My Data\filename *will cause an error, while* D:\My_Data\filename *is valid).[C]*

[C] See ngs.noaa.gov/OPUS/about.jsp#error for more information about errors.

2.1.2. Set antenna fields:

> Antenna: TRM57971.00 NONE
>> *Identifier for ZEPHYR GNSS GEODETIC II antenna.*
>
> Antenna height: 0.1747 m
>> *To match setting in NetR9 receiver.*

2.1.3. Enter email address.

2.1.4. Set additional options:

> Formats: "standard"
>
> State plane: "let OPUS choose"
>
> Share my solution: "No, don't share"

2.1.5. Click "Upload to Static."

> *Note: If "Antenna height alert" popup appears, click "OK."*

2.2. Save emailed OPUS report(s) to text files.

2.2.1. Copy full email text to Notepad *(or other text editor)*.

2.2.2. Change font to monospaced typeface *(e.g., Consolas)*.

2.2.3. Save as "[filename]_OPUS_report.txt"

> *Note: e.g., if "FILE" at the top of the report is 123A456W.22O, save as "123A456W _OPUS_report.txt"*

2.3. Troubleshooting for "OPUS aborting" result emails:

2.3.1. Error 9999 "less than two hours in duration": re-run file at OPUS website and choose "Upload to Rapid-Static."

3. Compiling data

3.1. Open spreadsheet *(Excel or equivalent)*.

3.2. In columns A-G, create headings for "Site," "DataFile," "PostProcess," "East," "North," "Ant_elev," "Ant_height," and "Elevation."

3.3. For each logged point, enter the following in a new row:

> Site: *Field site name*
>
> Ant_height: *Antenna height recorded in field notebook*
>> *Note: See <u>Field operation</u> step 2.2.2.*

3.4. For each site, enter the following data derived from downloaded post-processing report:

> DataFile: *.T02 or .220 file name, without extension*
>
> PostProcess: *Post-processing service used (TrimbleRTX or Opus)*
>
> East: *UTM Easting*
>
>> *Note: For TrimbleRTX report see <u>Data post-processing</u> step 1.2.9.*
>
> North: *UTM Northing*
>
>> *Note: For TrimbleRTX report see step 1.2.9.*
>
> Ant_elev: *ORTHO HGT*
>
>> *Note: For TrimbleRTX report see step 1.2.9.*

3.5. Calculate "Elevation" column = "Ant_elev" – "Ant_height"

3.6. Save and close spreadsheet.

Compiled post-processed point data and control point maps sketched in the field should be backed up in project folder. Field teams returning to same sites will use these data to re-occupy control points to tie in subsequent survey measurements without the need to establish new GNSS control.
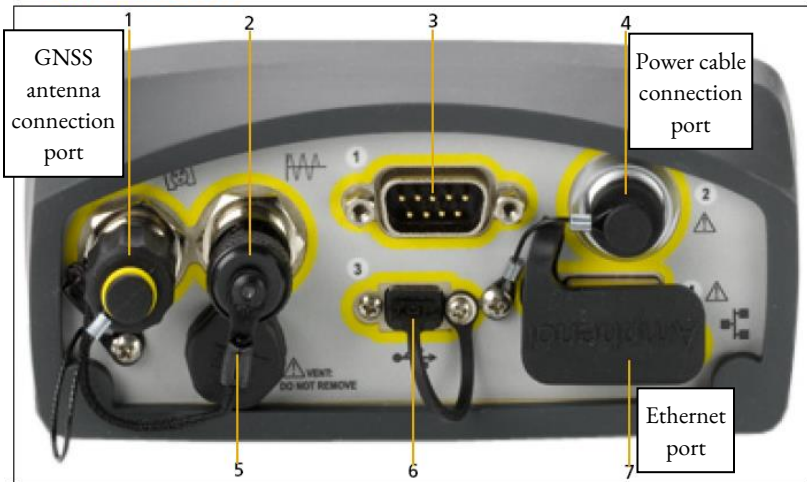
Appendix A

Parts of the Trimble NetR9 GNSS Reference Receiver

Keypad and display

Power button and indicator LED

Rear connectors

GNSS antenna connection port

Power cable connection port

Ethernet port

From Trimble NetR9 GNSS Reference Receiver User Guide (see WPES Lab Resources Google Drive or geospatial.trimble.com/geospatial-support-eol-products for full document).