



EMLID Reach RS

ACCURACY OF A RTKLIB-POST CORRECTION AND/OR SIMPLE STATISTICAL POINT-DISTRIBUTION ANALYSIS OF RAW DATA.

We need vertical and horizontal coordinates for our ground control points for the correction of aerial imagery. For studies on surface hydrology we often need good absolute vertical coordinates. We have taken a series of measurements with the EMLID Reach RS to check the accuracy and reproducibility. We corrected the raw data taken from EMLID Reach RS with RTKLIB-POST together with the precise GPS orbit information of the external base station (IGS Ephemeris sp3). As base station we took the data of the CORS station OAX2. The absolute accuracy was checked by a known horizontal and vertical geodesic point of INEGI. At the same time we did a simple statistical point distribution analysis of the raw data with LibreOffice-Calc or Excel and compared it with the absolute coordinates. In parallel, a Precise Point Positioning (PPP) correction was made with the online service of Natural Resources Canada (NRCan) after 2 hours and after 1 week.

In our practice we are mainly interested in three things:

1. Reliable base coordinates with sufficient accuracy. Since with the EMLID Reach RS a statistically relevant number of raw data points can be determined relatively quickly, we wanted to know what the accuracy looks like when we determine the median within the point cloud of raw data. If the accuracy is sufficient, we could use it as the base coordinate point for the EMLID Reach RS base to correct the rover unit for surveying.
2. A workable workflow that allow to determine a base point with relatively accurate horizontal and vertical coordinates without using a dual frequency GPS but the EMLID Reach RS. Usually a field work starts with a first inspection. During this inspection, the EMLID Reach RS can be placed over a marked point and collect data during this time. Back in the office, this raw data could be corrected at least to centimeter level (<25 cm) with RTKLIB-POST and could be injected into the base station as base coordinates for correcting the Rover during survey.
3. In the case that there is no CORS base in sufficient proximity (within 100 km), to make a post-correction with RTKLIB-POST, we are interested in a reasonably accurate base position without correction, only with the raw data of an EMLID Reach RS. We are therefore interested in a quick method to decide which average coordinates we can use to achieve an absolute accuracy of about one meter. The annoying thing about the L1 GPS frequency is the inaccuracy of the verticals. With one meter of absolute vertical accuracy we could live in most cases.

RESUME

- In a first phase, we statistically compared the results with **different configurations**. The EMLID Reach RS (used as rover but configured as base) was always mounted on the same height on a roof on a level tripod and allowed to stand for 6 hours with the following settings: Static-Fixhold, Kinematic-Fixhold, Kinematic-Continuous. **Predictably, the Static Fixhold attitude was far superior.**
- Then we checked how exactly the **RTKLIB POST** correction is to the absolute position. This was done with the mentioned vertical and horizontal geodesic point. We placed the EMLID Reach RS exactly above this point and allowed the unit to collect data for 2 hours. We evaluated the raw data and the result after the RTKLIB-POST correction (Raw, Q1 and Q2). **The absolute accuracy of the RTKLIB POST correction is very good (<6 cm for Q1 Fix with baseline of 6.3km).**
- Particularly interesting is the good approximation of the **medians and means of the GPS raw data** (by simple statistical evaluation of the raw data) to the absolute position in its vertical position. If we determined the statistical median of the XYZ point distribution of the raw data, **we still reached an absolute position of about 1m in the horizontal as in the vertical.** That is very pleasing.
- **Precise Point Positioning (PPP)** correction with NRCan shows a big difference between immediate processing and after one week (which was predictable). It is interesting that the horizontal coordinates **are relatively close to the absolute value of the reference point, while the vertical is far away.** In this case, a 2D plot can simulate accuracy which is strongly deteriorated in the 3D plot. The converted raw data (RINEX 2.11) contains no usable antenna data for NRCan. That is why the vertical coordinates have to be taken with caution.



Settings and configurations

RTK settings

RTK

Positioning mode: Static

GPS AR mode: Fix-and-hold | GLONASS AR mode: On

Elevation mask angle: 15° | SNR mask: 35

Max acceleration: Vertical 1 m/s² | Horizontal 1 m/s²

GNSS select: GPS, GLONASS, GALILEO, SBAS, QZSS, BEIDOU

Update rate: 5Hz

Base mode

Corrections output: OFF ON

Serial | NTRIP | TCP | **LoRa** | BT

Frequency: 915.0 MHz | Output power: 6 dBm (20 dBm)

Air data rate: 18.23 kb/s

Base coordinates: Average single

Coordinate accumulation time: 30 min

RTCM3 messages:

1002	GPS L1 observations	1Hz	<input checked="" type="checkbox"/>
1006	ARP station coordinates	0.1Hz	<input checked="" type="checkbox"/>
1008	Antenna type	0.1Hz	<input checked="" type="checkbox"/>
1010	GLONASS L1 observations	1Hz	<input checked="" type="checkbox"/>
1019	GPS Ephemeris	1Hz	<input checked="" type="checkbox"/>
1020	GLONASS Ephemeris	0.5Hz	<input type="checkbox"/>
1097	GALILEO	0.5Hz	<input checked="" type="checkbox"/>
1107	SBAS	0.5Hz	<input checked="" type="checkbox"/>
1117	QZSS	1Hz	<input type="checkbox"/>
1127	BeiDou	1Hz	<input type="checkbox"/>

User Friendly CORS (UFCORS)

National Geodetic Survey

Download Custom CORS data files

NOTICE: Updated: 2014-APR-08, Tuesday, 1414h EDT

Selection Criteria: *Start Date: 01/07/2018

Start Time: 16:00 | Time Zone: UTC (GMT)

Site ID: OAX2 | CORS Map

Available Satellite Systems: GPS (L1+L2+L2C+L5), GLO+GAL+BEI

Optional Files: Coordinate File, NGS data sheet, IGS Orbits in SP3(c) format

get CORS data file

RTKPOST ver.2.4.3 Emlid b27

Time Start (GPST): 2000/01/01 00:00:00 | Time End (GPST): 2000/01/01 00:00:00 | Interval: 24 H

RINEX OBS: Rover: [file path] | Base Station: [file path]

RINEX NAV/CLK, SP3, FCB, IONEX, SBS/EMS or RTCM: [file path]

Solution: Dir C:\Users\6979621\Desktop\EMLID_VERSUCHE\09_VERSUCH_PUNTO_GEODESICO\BASE\POST

Options dialog:

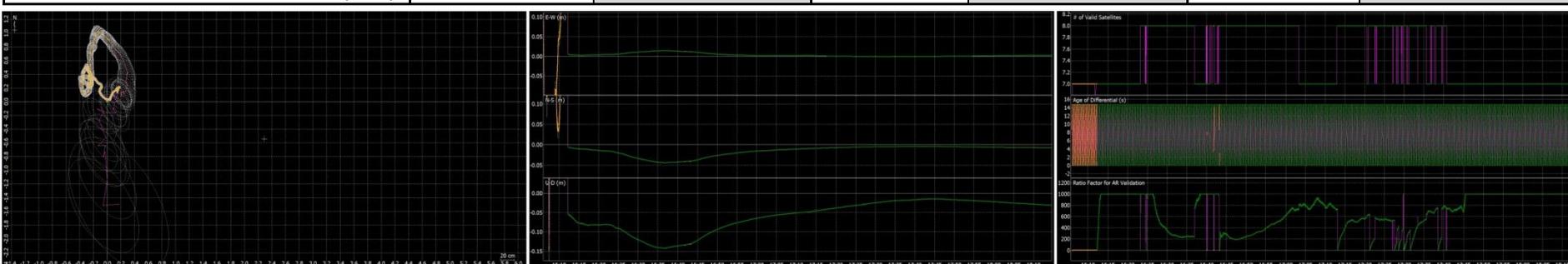
- Positioning Mode: Static
- Frequencies / Filter Type: L1 Forward
- Elevation Mask (*): 15 | SNR Mask (dBHz): ...
- Integer Ambiguity Res (GPS/GLO/BDS): Fix and I | ON | ON
- Min Ratio to Fix Ambiguity: 3
- Min Confidence / Max FCB to Fix Amb: 0.9999 | 0.25
- Min Lock / Elevation (*) to Fix Amb: 0 | 0
- Min Fix / Elevation (*) to Hold Amb: 10 | 0
- Outage to Reset Amb/Slp Thres (m): 5 | 0.050
- Max Age of Diff (s) / Sync Solution: 30.0 | ON
- Reject Threshold of GDOP/Innov (m): 30.0 | 30.0
- Max # of AR Iter/# of Filter Iter: 1 | 1
- Min Fix Sats / Min Hold Sats: 2 | 2
- Max Pos Var for AR / AR Filter: 0.9900 | ON

POSITION Geodesic Point V201679 - INEGI (Mexico) - ITRF 2008			
	X-Lon	Y_Lat	Z_Elev (m)
	96°43'50.28782" W -96.73063551	17°01'24.28041" N 17.02341123	1524.51 1524.51
UTM14-WGS84 (N-E)	741581.19	1883546.08	1524.51
ANTENNA HEIGHT (EMLID REACH RS)			1.07
SETPOINTS (UTM-14-N WGS84)	741581.19	1883546.08	1525.58
POSITION CORS OAX2 INEGI-OAXACA)	-96.71673889	17.07834167	1607.30
BASELINE ROVER (EMLID Reach RS) TO BASE (CORS-OAX2): 6.3 km			



RAW DATA SOLUTION LOG: STATIC - FIX-HOLD

	X-LON	Deviation from the X-LON setpoint (m)	Y-LAT	Deviation from the Y-LAT setpoint (m)	Z-ELEV (m)	Deviation from the Z-ELEV setpoint (m)
SAMPLE NUMBER	38486		38486		38486	
% NO DATA	0.31		0.31		0.31	
MEAN	741581.43	0.25	1883547.2	1.14	1524.7	-0.83
MIN	741579.42	-1.77	1883544.0	-2.07	1514.6	-10.96
MAX	741584.57	3.39	1883549.66	3.58	1538.07	12.49
MAX-MIN	5.16		5.65		23.45	
SD	0.70		0.69		2.95	
MEDIAN	741581.44	0.25	1883547.18	1.10	1524.62	-0.96
20% QUANTILE	741580.85	-0.34	1883546.67	0.59	1522.36	-3.22
80% QUANTILE	741582.02	0.84	1883547.78	1.70	1527.26	1.68
1.QUANTILE	741580.96	-0.22	1883546.78	0.70	1522.75	-2.83
3.QUANTILE	741581.91	0.72	1883547.66	1.58	1526.73	1.15
QUARTILE COEFFICIENT OF DISPERSION	1.28E-06		4.68E-07		2.61E-03	
RELATIVE STANDARD DEVIATION (RSD)	9.46E-07		3.67E-07		1.93E-03	



RTKLIB POST-CORRECTION - Q2 (FLOAT): STATIC-FIXHOLD

	X-LON	Deviation from the X-LON setpoint (m)	Y-LAT	Deviation from the Y-LAT setpoint (m)	Z-ELEV (m)	Deviation from the Z-ELEV setpoint (m)
SAMPLE NUMBER	2018		2018			
% Q2-SOLUTION DATA	5.20		5.20			
MEAN	741581.09	-0.09	1883546.3	0.22	1526.6	1.05
MIN	741580.76	-0.42	1883544.5	-1.55	1525.4	-0.15
MAX	741581.45	0.26	1883547.07	0.98	1541.05	15.47
MAX-MIN	0.69		2.54		15.62	
SD	0.19		0.24		1.26	
MEDIAN	741581.11	-0.07	1883546.25	0.17	1526.30	0.72
20% QUANTILE	741580.90	-0.29	1883546.16	0.07	1525.80	0.22
80% QUANTILE	741581.30	0.12	1883546.45	0.37	1527.01	1.43
1.QUANTILE	741580.90	-0.28	1883546.18	0.10	1525.83	0.25
3.QUANTILE	741581.30	0.12	1883546.41	0.32	1526.96	1.38
QUARTILE COEFFICIENT OF DISPERSION	5.39E-07		1.17E-07		7.44E-04	
RELATIVE STANDARD DEVIATION (RSD)	2.54E-07		1.26E-07		8.26E-04	

RTKLIB POST-CORRECTION - Q1 (FIX): STATIC-FIXHOLD

	X-LON	Deviation from the X-LON setpoint (m)	Y-LAT	Deviation from the Y-LAT setpoint (m)	Z-ELEV (m)	Deviation from the Z-ELEV setpoint (m)
SAMPLE NUMBER	38486		38486		38486	
% Q1-SOLUTION DATA	94.77		94.77		94.77	
MEAN	741581.16	-0.02	1883546.0	-0.05	1525.5	-0.06
MIN	741581.16	-0.03	1883546.0	-0.08	1525.4	-0.15
MAX	741581.17	-0.01	1883546.04	-0.04	1525.56	-0.02
MAX-MIN	0.02		0.04		0.13	
SD	0.00		0.01		0.04	
MEDIAN	741581.16	-0.03	1883546.03	-0.05	1525.53	-0.05
20% QUANTILE	741581.16	-0.03	1883546.02	-0.06	1525.48	-0.10
80% QUANTILE	741581.16	-0.02	1883546.04	-0.04	1525.55	-0.03
1.QUANTILE	741581.16	-0.03	1883546.02	-0.06	1525.49	-0.09
3.QUANTILE	741581.16	-0.02	1883546.04	-0.04	1525.55	-0.03
QUARTILE COEFFICIENT OF DISPERSION	5.88E-09		7.61E-09		3.86E-05	
RELATIVE STANDARD DEVIATION (RSD)	5.82E-09		6.44E-09		2.59E-05	

- RAW DATA CLOUD (38486 XYZ-POINTS)
- SETPOINT (KNOWN GEODESIC POINT)
- ⊕ RAWDATA (MEAN AND MEDIUM)
- ⊗ Q1 RTKLIB-POST (MEAN AND MEDIUM)
- ⊗ Q2 RTKLIB-POST (MEAN AND MEDIUM)
- ⊕ PPP - NRCan (after 2 hours)
- ⊕ PPP - NRCan (after 1 week)

