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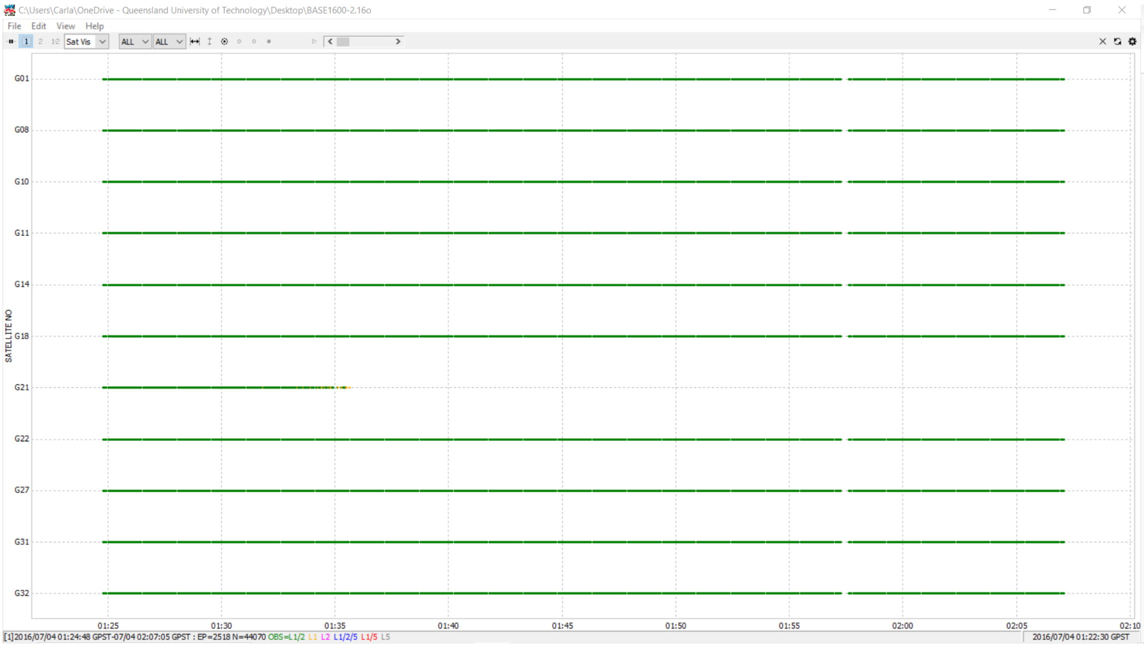
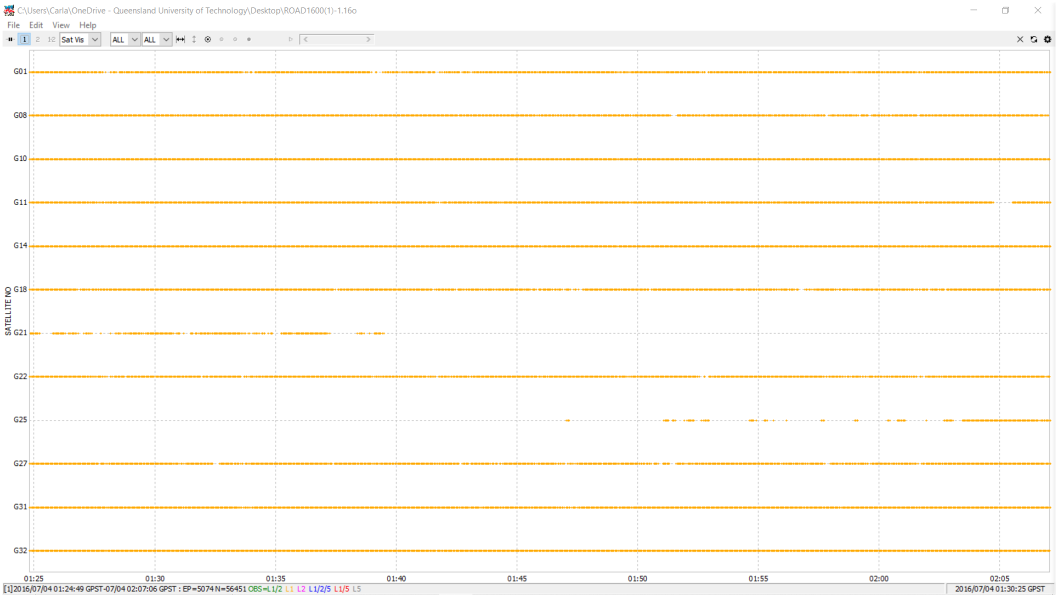
2.1.1 Examination of RINEX Data Sets

BASE1600.16o



1. 2016/07/04 01:22:30 GPST.
2. OBS = L1/2 L1 L2 L1/5 L5
    - **L1/2**: Dual-frequency carrier phase observation (L1 and L2).
    - **L1**: Single-frequency carrier phase on L1.
    - **L2**: Carrier phase observation on L2.
    - **L1/5**: Observation combining L1 and L5.
    - **L5**: Single-frequency carrier phase observation on L5.
3. Approximately from 01:25 to 02:10 GPST, sample rate is around 1 second.

ROAD1600.16o



1. 2016/07/04 01:30:25 GPST
2. OBS = L1/2 L1 L2 L1/5 L5
    - **L1/2**: Dual-frequency carrier phase on L1 and L2.
    - **L1**: Carrier phase on L1.
    - **L2**: Carrier phase on L2.
    - **L1/5**: Observation combining L1 and L5 frequencies.
    - **L5**: Carrier phase observation on L5.
3. From **01:25 to 02:10 GPST**, sample rate is around 1 second with small intervals between data points.

2.1.2 Visualization and Discussion using RTKPLOT: **<u>ROAD1600.16o</u>**

b) Skyplots for L1 signals of all visible satellites

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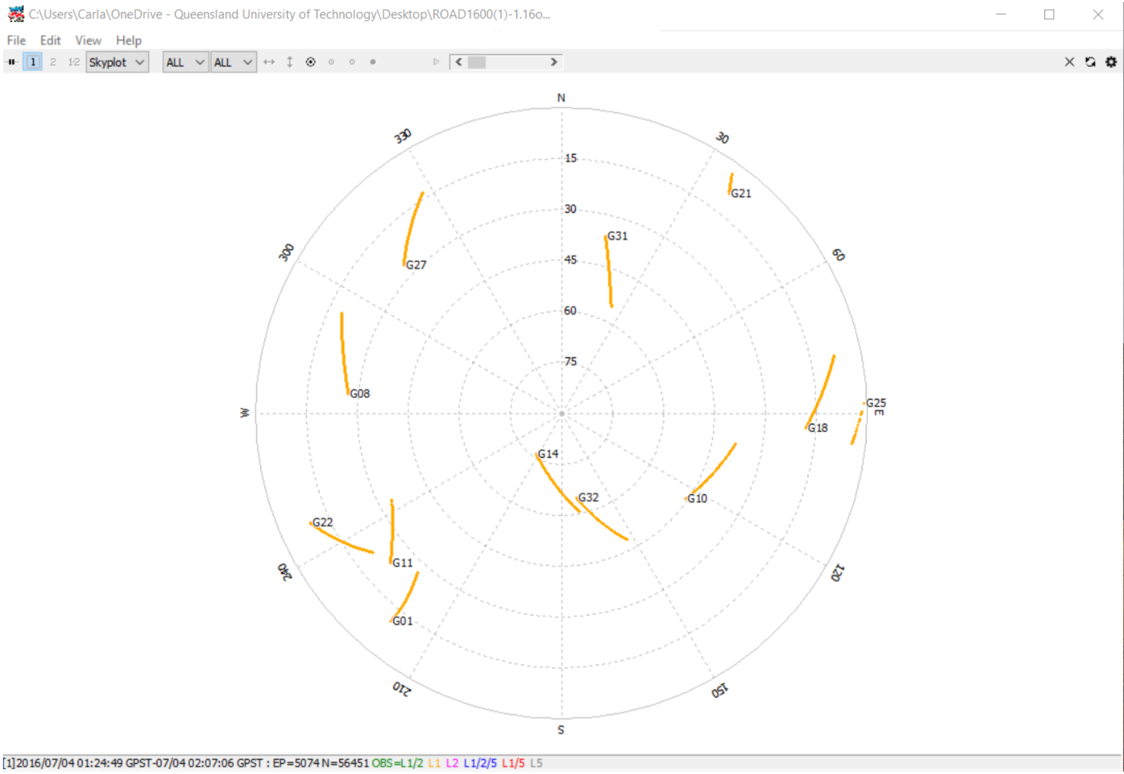
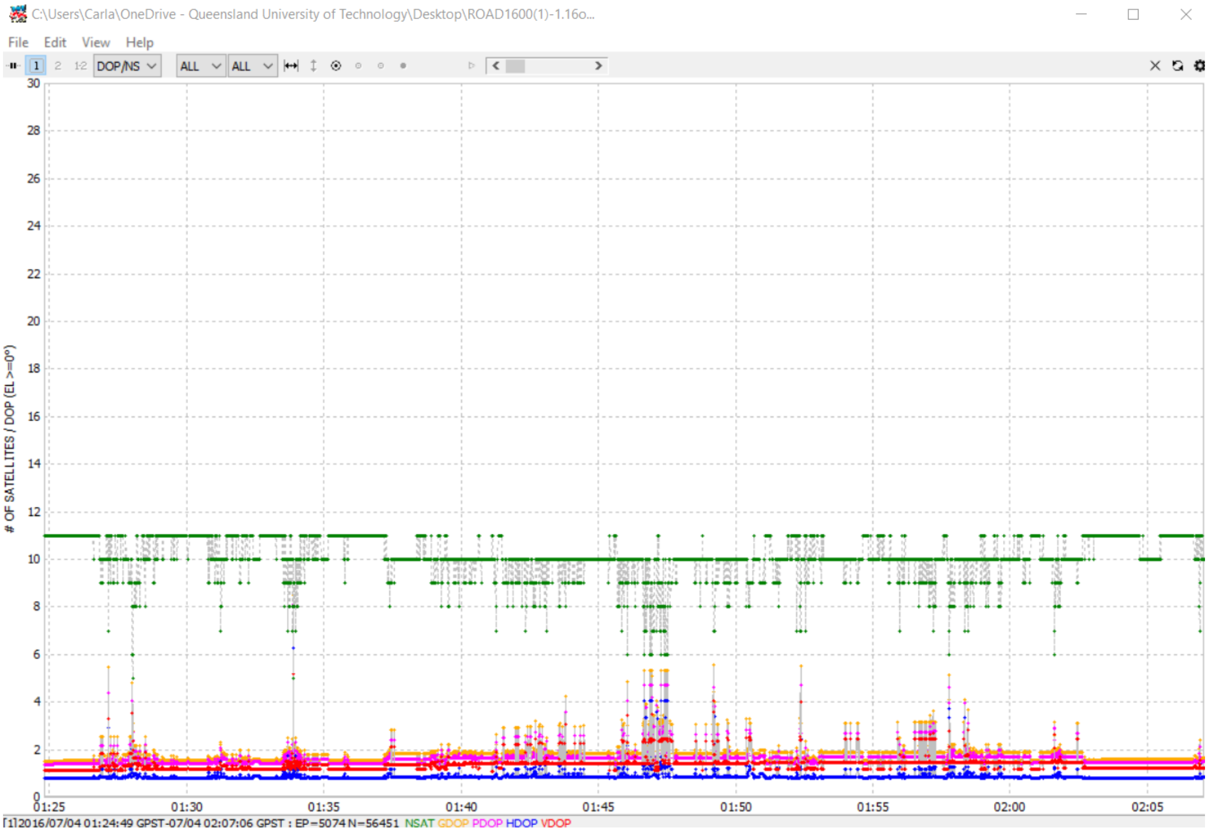


Good Satellite Distribution: They are well distributed across the sky, so there is a good range of azimuth and elevation values. It improved positioning accuracy as the geometric configuration is strong.

Signal Blockage: If the satellite arcs are incomplete, it reveals moments when the receiver lost track of those satellites, which may lead to temporary decreases in accuracy or even gaps in the positioning solution.

c) DOP (Dilution of Precision) and satellite count (NSAT) for all satellites



NSAT (Satellite Count): The green line shows that satellite visibility is generally stable but has some brief drops, which might momentarily affect positioning accuracy.

Good Satellite Geometry: The overall low DOP values show good satellite geometry, which means that the satellites are spread out well across the sky, reducing positional error.

2.1.3 Positioning Analysis with RTKPOST

a) Plots of ground track and position for all three modes.

- Single

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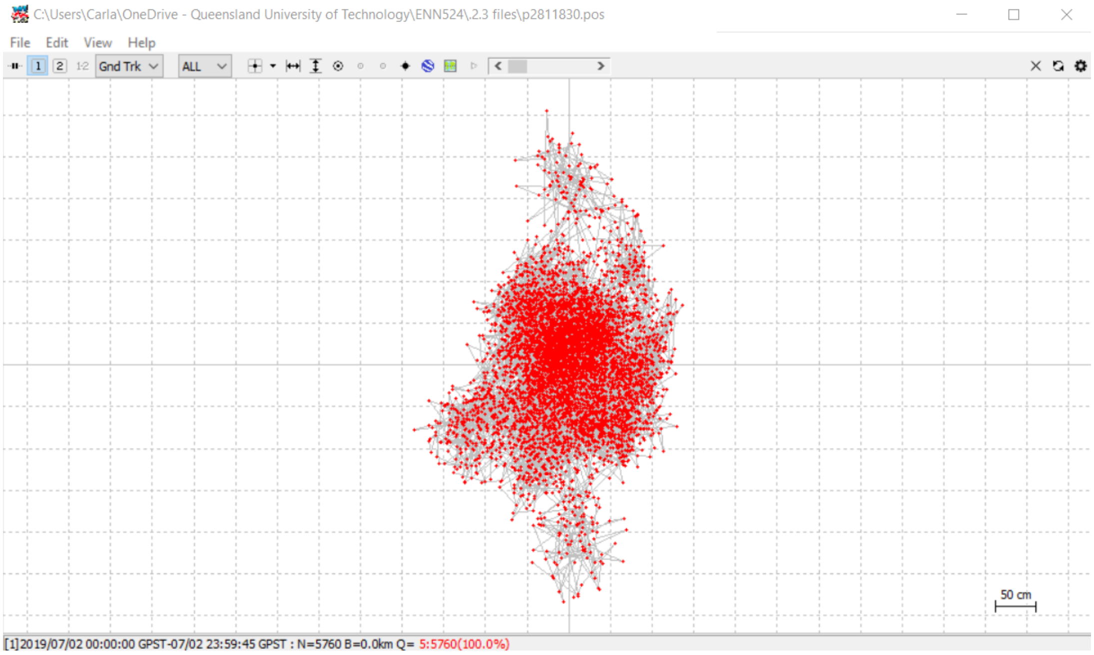
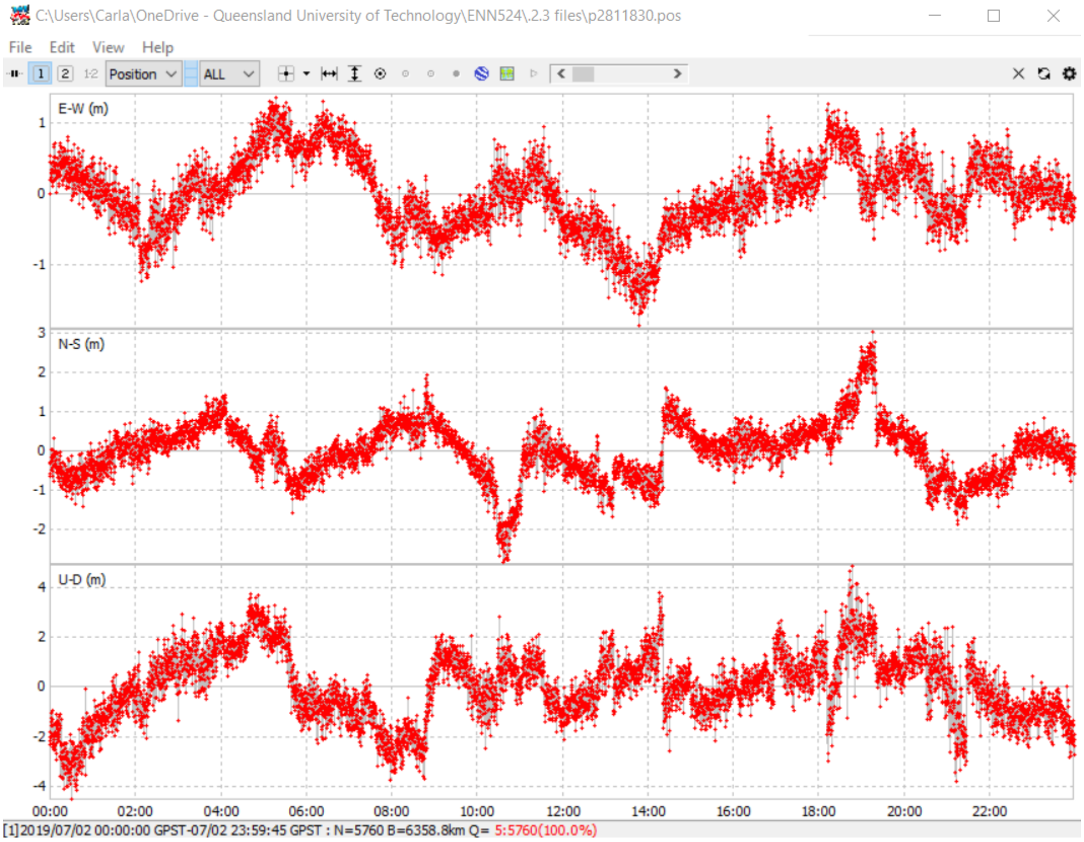
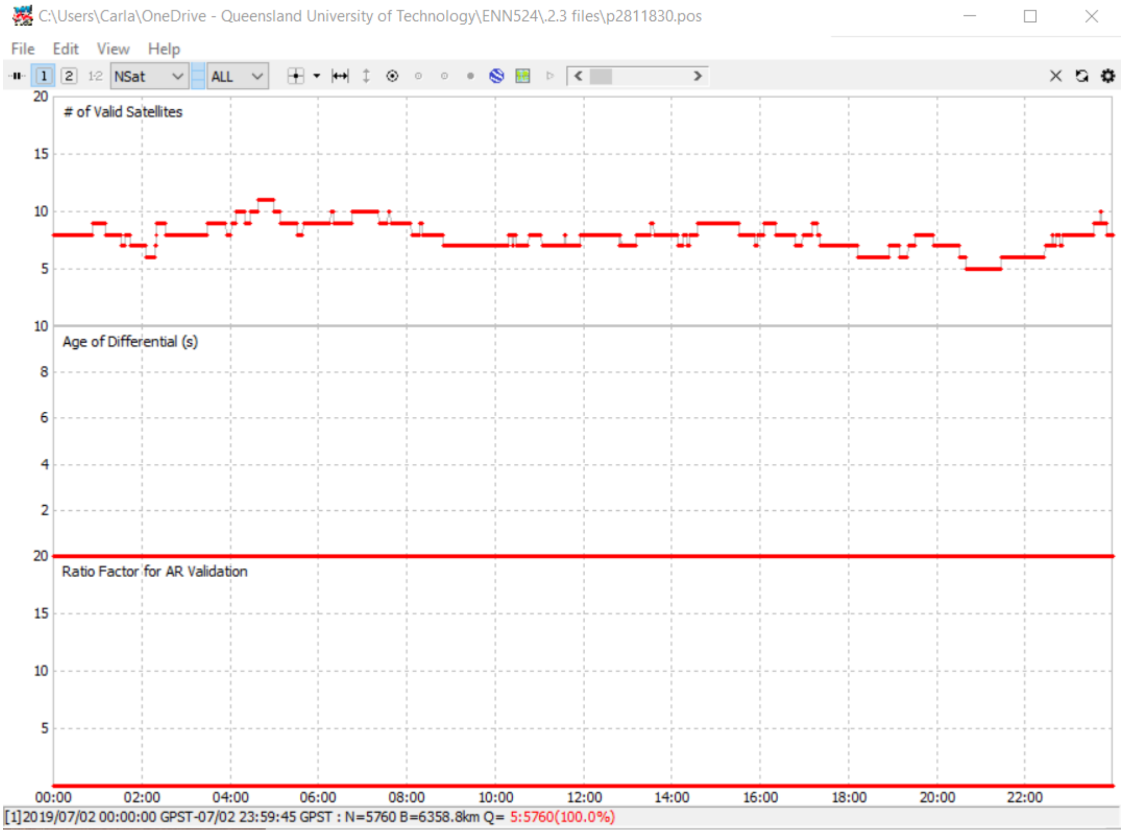


- Kinematic



- Static



b) Comparison of position and ground track results, discussing the accuracy of each mode.

- **Kinematic mode:** It shows a good balance between accuracy and mobility, offering a clean and precise ground track.
- **Single mode:** It shows less accurate with noticeable drift and scatter in the positioning data.
- **Static mode:** It performs the most accurate results as it minimizes errors over time.

c) RMS values for positioning errors in East-West, North-South, and Up-Down directions (Sigma for stdn, stde, and stdu).

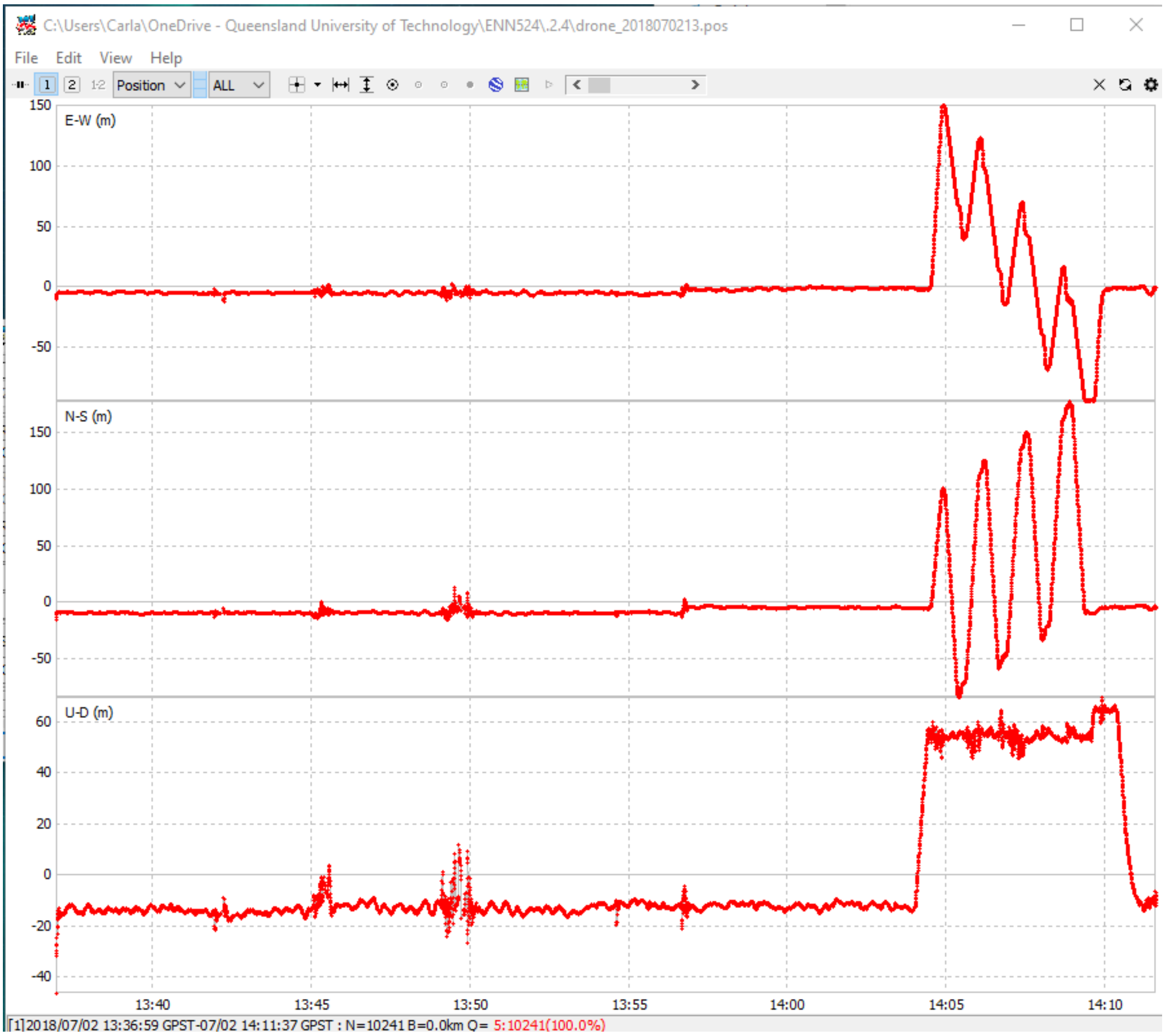
- **Kinematic mode:** It offers low RMS errors in horizontal positioning with some increase in the vertical direction.
- **Single mode:** It has higher RMS errors, especially in the Up-Down direction.
- **Static mode:** It shows minimal errors across all directions.

d) Evaluate the impact of changing the elevation mask angle to 5 degrees on the positioning results.

Lowering the elevation mask to 5 degrees increases satellite visibility but introduces more noise, especially in **Single mode**, due to low-elevation satellites. The influence is less severe in **Kinematic mode**, and **Static mode** shows the least degradation.

2.1.4 Comparative Analysis using Road and Drone Data

a) Single positioning mode with drone and road data.



The plot for the drone data shows significant fluctuations in the East-West (E-W), North-South (N-S), and Up-Down (U-D) directions around the time between 13:40 and 14:10 GPST.

Large spikes appear in the E-W and N-S directions around 14:05 GPST. These are likely artifacts of either poor satellite geometry or a signal disruption, causing the position to deviate significantly.

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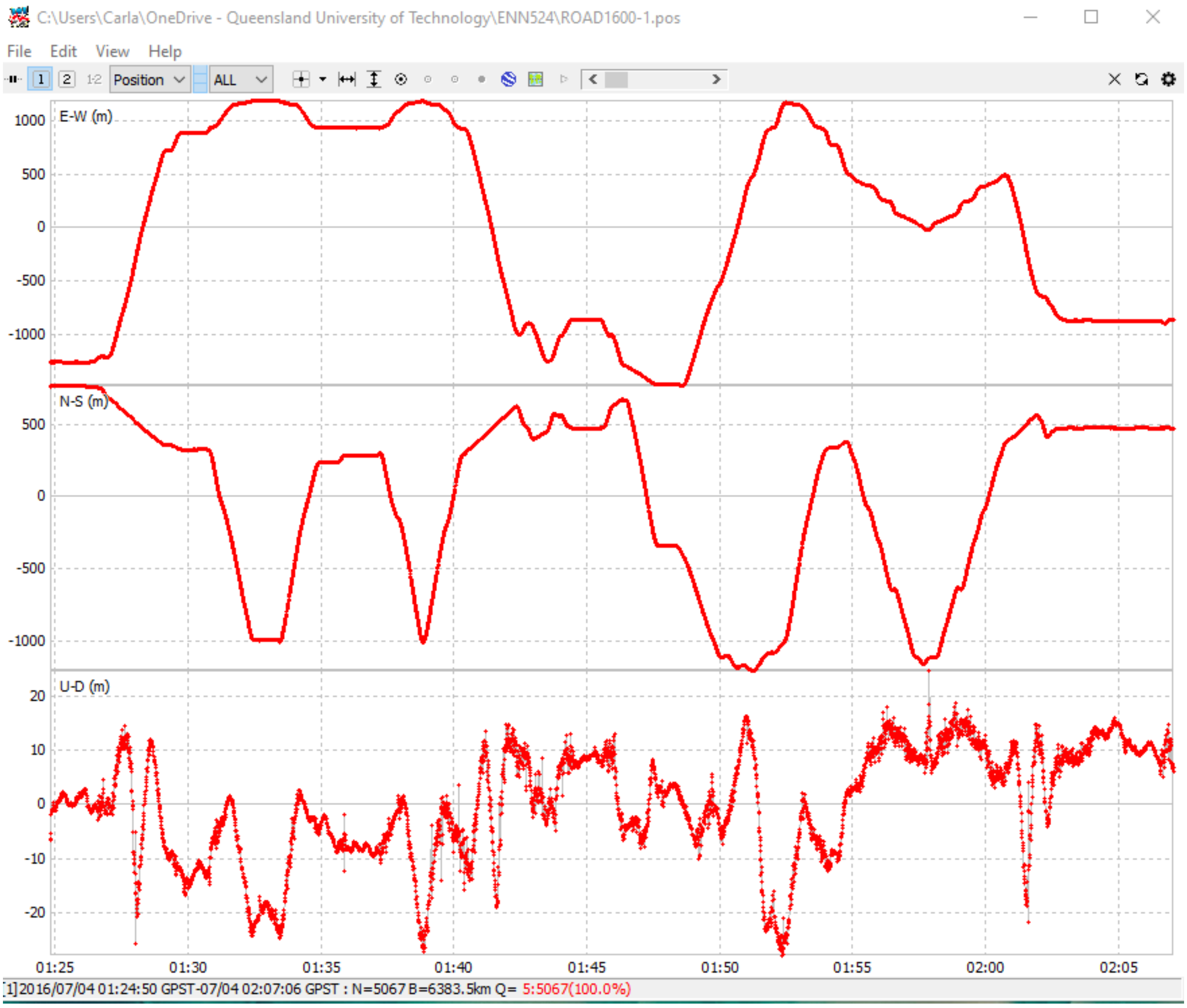
b) Kinematic positioning mode with base station and moving data files.



The road data plot shows more stable fluctuations in the E-W, N-S, and U-D components compared to the drone data. However, it still displays notable undulations over the observation period from 01:24 to 02:07 GPST.

c) Compare and discuss findings from both plot sets

The comparison between the drone and road data shows differences in positional stability. The drone data displays large positional spikes, especially in the East-West (E-W) and North-South (N-S) directions, with considerable fluctuations in the vertical (Up-Down) direction, particularly after 14:05 GPST. In contrast, the road data shows smoother and more stable positional changes across all components, with smaller deviations in the vertical direction, indicating better satellite coverage and signal conditions. The constrained movement of the road vehicle and its clearer line of sight to satellites contributed to more accurate positioning. In summary, the drone data's dynamic flight path led to greater instability, while the road data was more reliable and consistent.

Question 2.2 Exploring and Analyzing Variations in Australian CORS Station Coordinates for 2022 (3%)

2.2.1 Coordinate System Explanation

I choose GDA2020 as my coordinate system to analyse this project. Because it is the official geodetic datum for Australia, providing a modern, earth-centered reference frame that aligns closely with the International Terrestrial Reference Frame (ITRF).

Geocentric Datum of Australia 2020 (GDA2020)

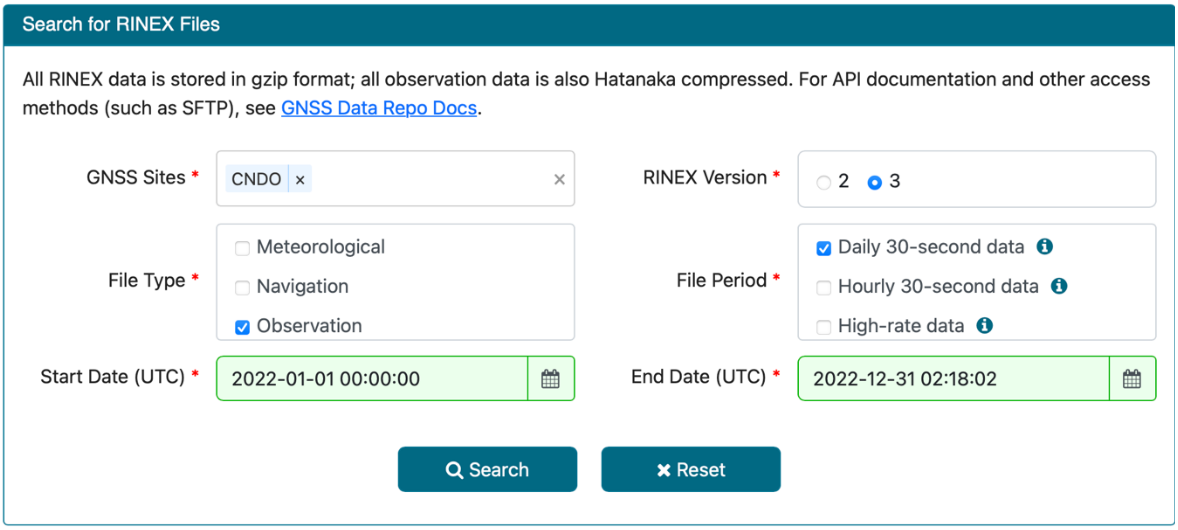
Last updated: 14 December 2017

Home > Scientific topics > Positioning and navigation > Geodesy > Geodetic datums and projections > Geocentric Datum of Australia 2020 (GDA2020)

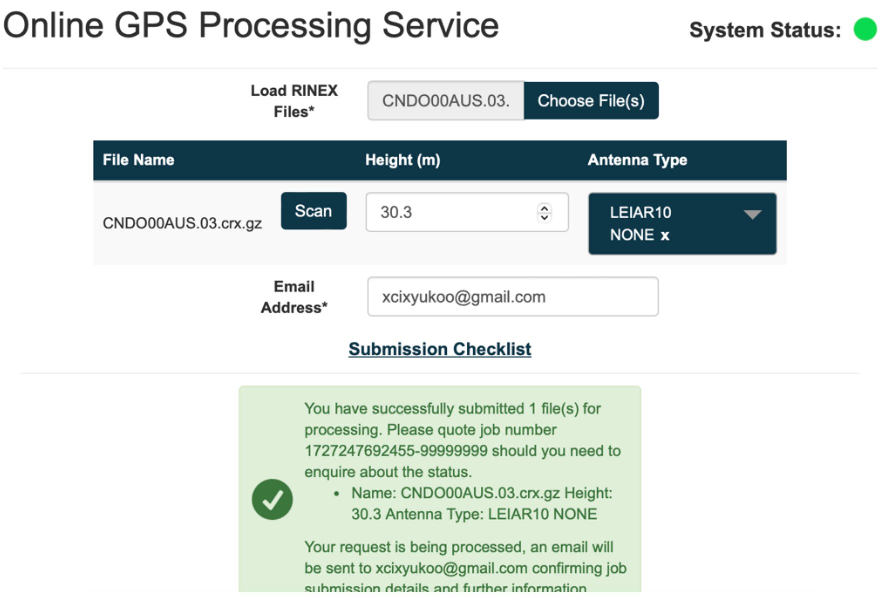
There have been significant technology developments recently that provide ready access to accurate positioning systems. It is anticipated that the Global Navigation Satellite System (GNSS) will be capable of providing positioning services with centimetre accuracy in real-time to the mass market on mobile devices. Given that data from GNSS is referenced to a global reference frame, specifically the International Terrestrial Reference Frame 2014 (ITRF2014), it is appropriate that the Australian datum is closely aligned to the same global reference frame.

2.2.2 CORS Selection Justification & AUSPOS Service Process Description

Firstly, I downloaded RINEX observation files for three specific days (Day 001, Day 181, and Day 365) for the chosen CORS station: CNDO, because this station available RINEX files on the three dates, not every station does. I search start date from 01.01.2022 to 31.12.2022, only attracting three date of files: 01.01, 01.07, 31.12.



Then, I uploaded orderly the three RINEX files to the AUSPOS service, ensuring that the files were correctly formatted.



However, before submitting, I have to rename the file to match the system's requirement; also, fill up lost information of antenna type and height by checking on following page: GNSS Site Manager.

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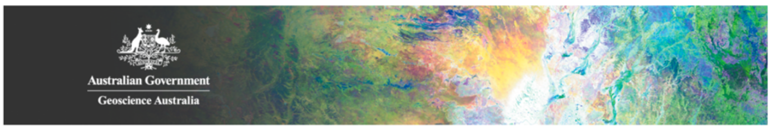
You have logged in as "carla" and are not authorised to edit CNDO.

- Site Administration
- Site Information
- GNSS Receivers (+ New | + Update)
- GNSS Antennas (+ New | + Update)

Current GNSS Antenna (Since 2010-10-15) (Edit | Delete)

Antenna Radome Type	LEIAR10 NONE
Serial Number	13110012
Antenna Reference Point	BAM
Marker ARP Up Eccentricity (m) *	0.002
Marker ARP North Eccentricity (m) *	0
Marker ARP East Eccentricity (m) *	0
Alignment From True North (degrees)	0
Radome Type	NONE
Radome Serial Number	
Antenna Cable Type	LMR400 / LMR195
Antenna Cable Length (m)	30.3
Date Installed (UTC) *	2010-10-15 00:00:00
Date Removed (UTC)	
Notes	Surge Protection (Polyphaser DGXZ+15NFNF-A) and Divider (Rojone AMA23012N) installed at receiver end. Antenna cable length split into two

Finally, I got three emails with analysis result separately from AUSPOS system, which means the data has being process successfully.



AUSPOS GPS Processing Report

September 25, 2024

This document is a report of the GPS data processing undertaken by the AUSPOS Online GPS Processing Service (version: AUSPOS 3.0). The AUSPOS Online GPS Processing Service uses International GNSS Service (IGS) products (final, rapid, ultra-rapid depending on availability) to compute precise coordinates in International Terrestrial Reference Frame (ITRF) anywhere on Earth and Geocentric Datum of Australia (GDA) within Australia. The Service is designed to process only dual frequency GPS phase data.

An overview of the GPS processing strategy is included in this report.

Please direct any correspondence to GNSSAnalysis@ga.gov.au

2.2.3 Coordinate Presentation

Based on the analysis from AUSPOS system, the differences of location in each date record are within 0.006 meters (6 mm), showing remarkable stability across datasets.

01.01.2022

X: -4494125.391, Y: 2901707.733, Z: -3461983.704

3.1 Cartesian, GDA2020

Station	X (m)	Y (m)	Z (m)
CNDO	-4494125.391	2901707.733	-3461983.704
ALIC	-4052052.744	4212835.986	-2545104.588
BBDH	-4506141.313	2965164.204	-3392734.360
CARG	-4443674.683	2956180.629	-3480854.307
CEDU	-3753473.201	3912741.029	-3347959.698
FORB	-4521549.636	2824612.680	-3489863.361
HOB2	-3950072.255	2522415.362	-4311637.403
MCHL	-4857858.933	3018464.368	-2814983.223
MOBS	-4130636.760	2894953.144	-3890530.236
PARK	-4554255.214	2816652.438	-3454059.698
PRKS	-4542904.177	2819303.629	-3466681.105
TID1	-4460996.964	2682557.084	-3674442.636
TOW2	-5054583.402	3275504.110	-2091538.467
TULL	-4538265.869	2883438.091	-3419825.066
WWLG	-4471091.778	2868001.279	-3519326.359

01.07.2022

X: -4494125.389, Y: 2901707.737, Z: -3461983.701

3.1 Cartesian, GDA2020

Station	X (m)	Y (m)	Z (m)
CNDO	-4494125.385	2901707.732	-3461983.698
ALIC	-4052052.740	4212835.980	-2545104.587
BBDH	-4506141.303	2965164.198	-3392734.353
CARG	-4443674.681	2956180.629	-3480854.303
CEDU	-3753473.202	3912741.031	-3347959.695
FORB	-4521549.632	2824612.680	-3489863.357
HOB2	-3950072.258	2522415.363	-4311637.402
MCHL	-4857858.934	3018464.371	-2814983.226
MOBS	-4130636.759	2894953.142	-3890530.233
PARK	-4554255.213	2816652.439	-3454059.691
PRKS	-4542904.181	2819303.633	-3466681.109
TID1	-4460996.961	2682557.082	-3674442.632
TOW2	-5054583.401	3275504.110	-2091538.471
TULL	-4538265.867	2883438.091	-3419825.061
WWLG	-4471091.770	2868001.277	-3519326.354

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31.12.2022

X: -4494125.385, Y: 2901707.732, Z: -3461983.698

3.1 Cartesian, GDA2020

Station	X (m)	Y (m)	Z (m)
CNDO	-4494125.389	2901707.737	-3461983.701
ALIC	-4052052.746	4212835.984	-2545104.587
BBDH	-4506141.305	2965164.198	-3392734.354
CARG	-4443674.689	2956180.635	-3480854.311
CEDU	-3753473.204	3912741.030	-3347959.693
FORB	-4521549.632	2824612.678	-3489863.356
HOB2	-3950072.255	2522415.361	-4311637.403
MCHL	-4857858.938	3018464.374	-2814983.227
MHOP	-4438624.258	3003816.771	-3446678.830
MOBS	-4130636.757	2894953.141	-3890530.233
PRKS	-4542904.184	2819303.633	-3466681.112
TID1	-4460996.957	2682557.080	-3674442.630
TOW2	-5054583.403	3275504.110	-2091538.471
TULL	-4538265.875	2883438.098	-3419825.068
WWLG	-4471091.761	2868001.272	-3519326.349

2.2.4 Discussion of Results

01.01.2022

6 Ambiguity Resolution - Per Baseline

Baseline	Ambiguities Resolved	Baseline Length (km)
MCHL - TOW2	94.1 %	792.554
HOB2 - TID1	96.2 %	832.290
CEDU - MCHL	98.0 %	1517.716
FORB - TULL	80.3 %	92.980
MCHL - PARK	82.6 %	735.746
FORB - PRKS	68.9 %	31.963
HOB2 - MOBS	96.2 %	590.525
CNDO - TULL	76.6 %	63.714
PARK - PRKS	89.1 %	17.181
CARG - CNDO	73.2 %	76.607
CNDO - CNDO	100.0 %	0.030
BBDH - TULL	79.0 %	91.897
ALIC - CEDU	97.9 %	907.625
MOBS - PARK	87.1 %	613.262
FORB - WWLG	80.3 %	72.778
AVERAGE	86.6%	429.125

Please note for a regional solution, such as used by AUSPOS, ambiguity resolution success rate of 50% or better for a baseline formed by a user site indicates a reliable solution.

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01.07.2022

6 Ambiguity Resolution - Per Baseline

Baseline	Ambiguities Resolved	Baseline Length (km)
MCHL - TULL	86.0 %	697.284
MCHL - TOW2	93.6 %	792.554
HOB2 - TID1	96.2 %	832.290
FORB - TULL	78.6 %	92.980
FORB - PRKS	72.2 %	31.963
HOB2 - MOBS	96.1 %	590.525
CNDO - TULL	71.2 %	63.714
PARK - PRKS	94.4 %	17.181
ALIC - MCHL	95.5 %	1465.838
BBDH - TULL	81.9 %	91.897
ALIC - CEDU	98.0 %	907.625
MOBS - PARK	88.9 %	613.262
CNDO - CNDO	100.0 %	0.030
CARG - CNDO	77.9 %	76.607
FORB - WWLG	81.2 %	72.778
AVERAGE	87.4%	423.102

Please note for a regional solution, such as used by AUSPOS, ambiguity resolution success rate of 50% or better for a baseline formed by a user site indicates a reliable solution.

31.12.2022

6 Ambiguity Resolution - Per Baseline

Baseline	Ambiguities Resolved	Baseline Length (km)
MCHL - TOW2	88.9 %	792.554
CEDU - MCHL	97.8 %	1517.716
FORB - TULL	83.9 %	92.980
TID1 - TULL	92.8 %	333.397
FORB - PRKS	68.3 %	31.963
HOB2 - MOBS	96.0 %	590.525
CNDO - TULL	74.0 %	63.714
CARG - MHOP	93.4 %	58.844
MCHL - WWLG	92.9 %	817.513
BBDH - TULL	81.3 %	91.897
ALIC - CEDU	93.8 %	907.625
CNDO - CNDO	100.0 %	0.030
CARG - CNDO	72.7 %	76.607
MOBS - WWLG	94.7 %	504.409
FORB - WWLG	88.3 %	72.778
AVERAGE	87.9%	396.837

Please note for a regional solution, such as used by AUSPOS, ambiguity resolution success rate of 50% or better for a baseline formed by a user site indicates a reliable solution.

The ambiguity resolution success rates show a high level of reliability in the coordinate solutions, with an average success rate above 86%. While most baselines exhibit robust ambiguity resolution, certain baselines like FORB - PRKS show lower success rates. Overall, the coordinate solutions derived from these baselines are accurate and trustworthy for geospatial analysis.

Summary Reflection

Throughout the completion of Question 2.1 and Question 2.2, I gained a deeper understanding of GNSS data processing and positioning techniques. In Question 2.1, I explored the use of RTKLIB software to process GNSS data, focusing on static, kinematic, and single positioning modes. The detailed analysis of RINEX data sets, satellite visibility, and position plotting provided hands-on experience with interpreting real-world GNSS data. In Question 2.2, I have successfully found the suitable station data by myself and let AUSPOS to process, which bring me a lot of confidence as I never know such technology before. I learned that CORS stations provide highly reliable reference points for GNSS positioning. However, allow the system processing just the first step while understanding the report of data result with vary proper nouns is the hardest part in this section. Therefore, with this chance, I will have to read more reference and articles about how GNSS data working in modern society with IT technology so that I can feel more how big step is I have taken.