UNITED NATIONS GLOBAL GEODETIC CENTRE OF EXCELLENCE

MODERNISING GEOSPATIAL REFERENCE SYSTEM CAPACITY DEVELOPMENT WORKSHOP

How to process a GNSS network solution with AUSPOS

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HOW

Day X, Session X [X_X_X]

Coordinates of your CNSS-Sites

- Precise **Geocentric** Coordinate

- In **ITRF2020** Reference frame

- Usage of International GNSS Service (**IGS**) core network station data and products

- Processing with GNSS Bernese Software

- GNSS-Network with up to **20 own GNSS-Sites**

- Network embedded in up to **15 IGS CORS**

- **Results:** Coordinates and Uncertainties of GNSS-Sites in ITRF

- Uncertainties at 95% confidence level

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AUSPOS Online GPS Processing Service

https://www.ga.gov.au/scientific-topics/positioning-navigation/positioning-australia/geodesy/auspos

Observation Data Collection

- Observations in STATIC MODE
- Static dual frequency GPS carrier phase and code data
    - Processing GPS data only
- Measurement interval
    - Equal to or larger than one second
    - Preferable 30 seconds
    - Preferable the same interval rate for all observation files
- Observation duration
    - At least 1 hour (recommended minimum of 2 hours)
    - Maximum of 7 consecutive days
    - Add some observation time at the beginning and end of the intended session
    - 6+ hours observation for cm accuracy
- Data Format RINEX
    - No raw observation file in proprietary format (transformation in RINEX)
    - Accepted RINEX Versions 2,3,4
- RINEX files overlapping time period more than 1 hour

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Observation Data Attributions

- Data Format
  - RINEX - Receiver Independent Exchange Format
  - Data Files ending with
    - "o" - Observations or
    - "d" - Hatanaka Compression of Observations
- Antenna
  - Height - vertically from Ground Mark to Antenna Reference Point (ARP)
  - Type
- File Header information can not be trusted in general!
  They may be incorrect or incomplete
- DO NOT use special characters for "MARKER NAME" and "MARKER NUMBER" in the RINEX header.
- After the "END OF HEADER" line in the RINEX header, only observation data should be present

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Observation Data Submission

- Data Format RINEX
  - Receiver Independent Exchange Format
  - RINEX Version 2,3 or 4
  - Data File ending "o" (Observations)
  - or "d" for Hatanaka Compression
  - Example: ABJN0660.25o
- RINEX File Naming
  - English alphabet
  - No special characters - spaces, parentheses or symbols
- Scan or fill
  - Antenna Height (m)
  - Antenna Type

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Data Processing

- Only GPS data is used for processing
  - Dual-frequency measurements from GPS L1 and L2 signals
  - RINEX file can contain also observations other systems
- Submitted data is resampled (thinned) to a 30-second epoch interval
- Network solution (relative positioning) using a double-difference strategy
- Strategy: Simultaneous multi-baseline processing

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Priority list for observations included in the RINEX file:

For RINEX version 2:
L1 frequency carrier phase: L1
L2 frequency carrier phase: L2
L1 frequency pseudo-range: P1 C1
L2 frequency pseudo-range: P2 C2

For RINEX version 3 (and version 4):
L1 frequency carrier phase: L1P L1W L1C L1X
L2 frequency carrier phase: L2P L2W L2C L2D L2X
L1 frequency pseudo-range: C1P C1W C1C C1X
L2 frequency pseudo-range: C2P C2W C2C C2D C2X

For each RINEX file, ensure there is at least one observation type for each of the two frequencies and for both carrier-phase and pseudo-range measurements.

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Data Prioritization for Processing II

RINEX V2:

- if BOTH C1 and P1 (C2 and P2) code measurements exist, P1 (P2) is given priority. In this case, ensure all GPS satellites contain P1 (P2) measurements.
- if only C1 (C2) code measurements exist, ensure all GPS satellites contain C1 (C2) measurements.

RINEX V3 and V4:

- Currently accepted measurements from frequency:
  - **L1:** C1P and L1P; C1W and L1W; C1C and L1C; and C1X and L1X
  - **L2:** C2P and L2P; C2W and L2W; C2C and L2C; C2D and L2D; and C2X and L2X
- **NOT accepted** C2S (code) and L2S (phase) from L2 frequency

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When to Submit the Data

- DO NOT submit measurements for the current UTC day
- The time submitting your data can influence the result
- Geodetic products for your processing are needed
- AUSPOS calculate your result with the products available at the time of your submission

Orbit products availability:
- FINAL - the best available quality orbits after 2-3 weeks
- RAPID - very good quality orbits after 2 days
- ULTRA RAPID -   less accurate orbits close after observation

CORS data:
- Collection of CORS data (at least UTC 3 AM following day)
- Missing CORS data influence the choice of reference sites

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AUSPOS Exercise

- Use the prepared directory with the RINEX files from CORS
  - Find the stations RINEX files with the ending "o" or "d"
- Open the file and check the file header and the data
  - Find the antenna type and the receiver height information
  - Header information can not be trusted in general! They may be incorrect or incomplete
- Open the AUSPOS website and
  - Upload the RINEX files
  - Include the height information
  - Chose the antenna type from the list
  - Using button SCAN antenna height and type from file header is used
  - Enter your email address
- Submit processing
- You obtain
  - Email information about the submission
  - With some time delay you obtain an email with the result pdf-file

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AUSPOS Exercise Dataset

South Africa stations

- RINEX 2

- Daily files

- Interval 30 sec

- GPS week 2356

- Julian Day 061 to Day 067 or

- Calendar day 2 March to 8 March 2025.

Data from 10 Trignet stations

BETH, DEAR, ELDA, ERAS, HNUS,

KMAN, PBWA, PLET, RBAY, SBOK

Cote d'Ivoire stations

- RINEX 3.02

- Daily files

- Interval 30 sec

- GPS week 2356

- Julian Day 060 to Day 066 or

- Calendar day 1 March to 7 March 2025.
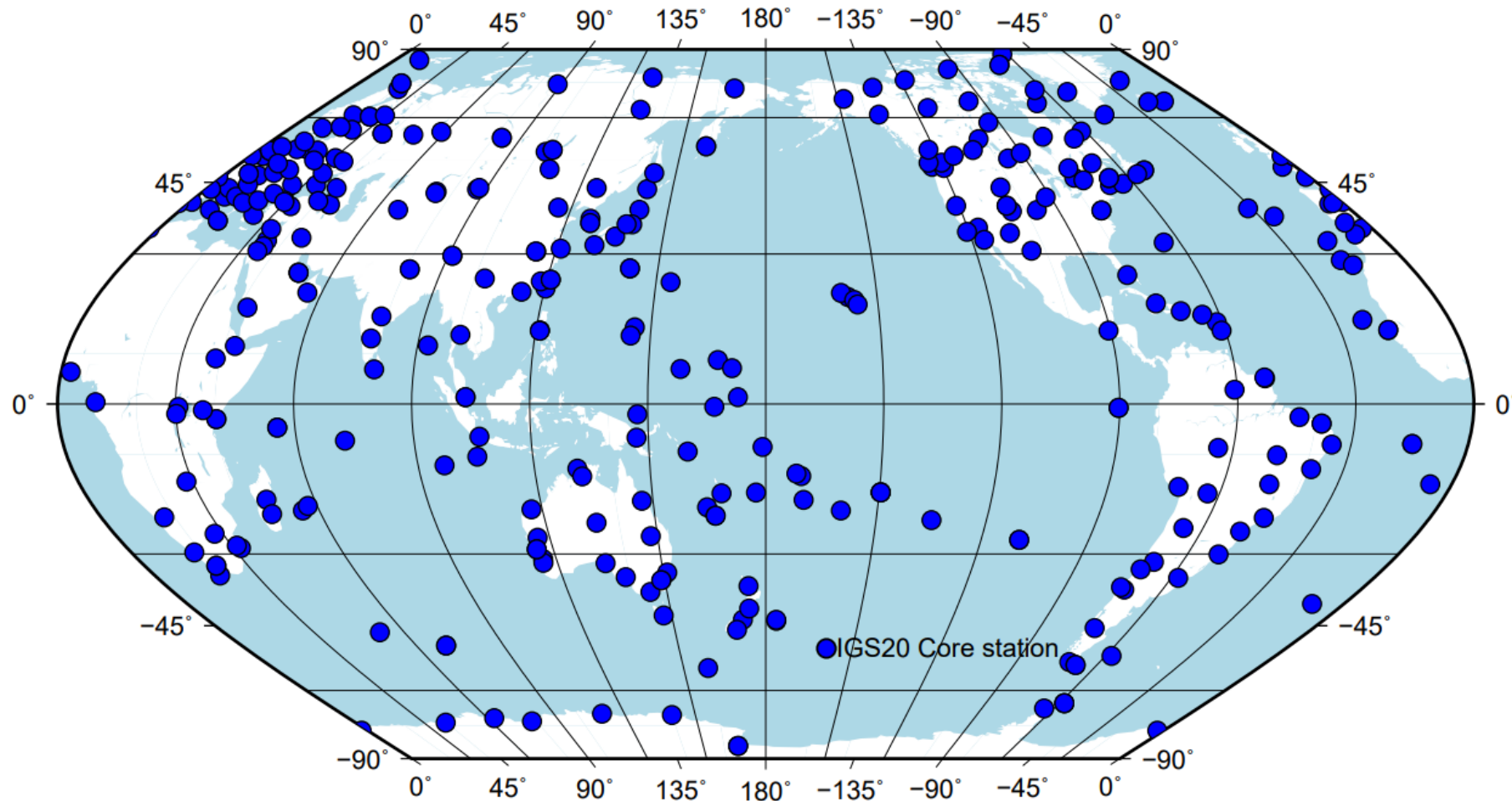
Data from 3 stations

ABEN, ABJN, ADZ

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IGS20 sites

IGS Station used as reference station for processing with AUSPOS.

AUSPOS GPS Processing Report

March 27, 2025

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.
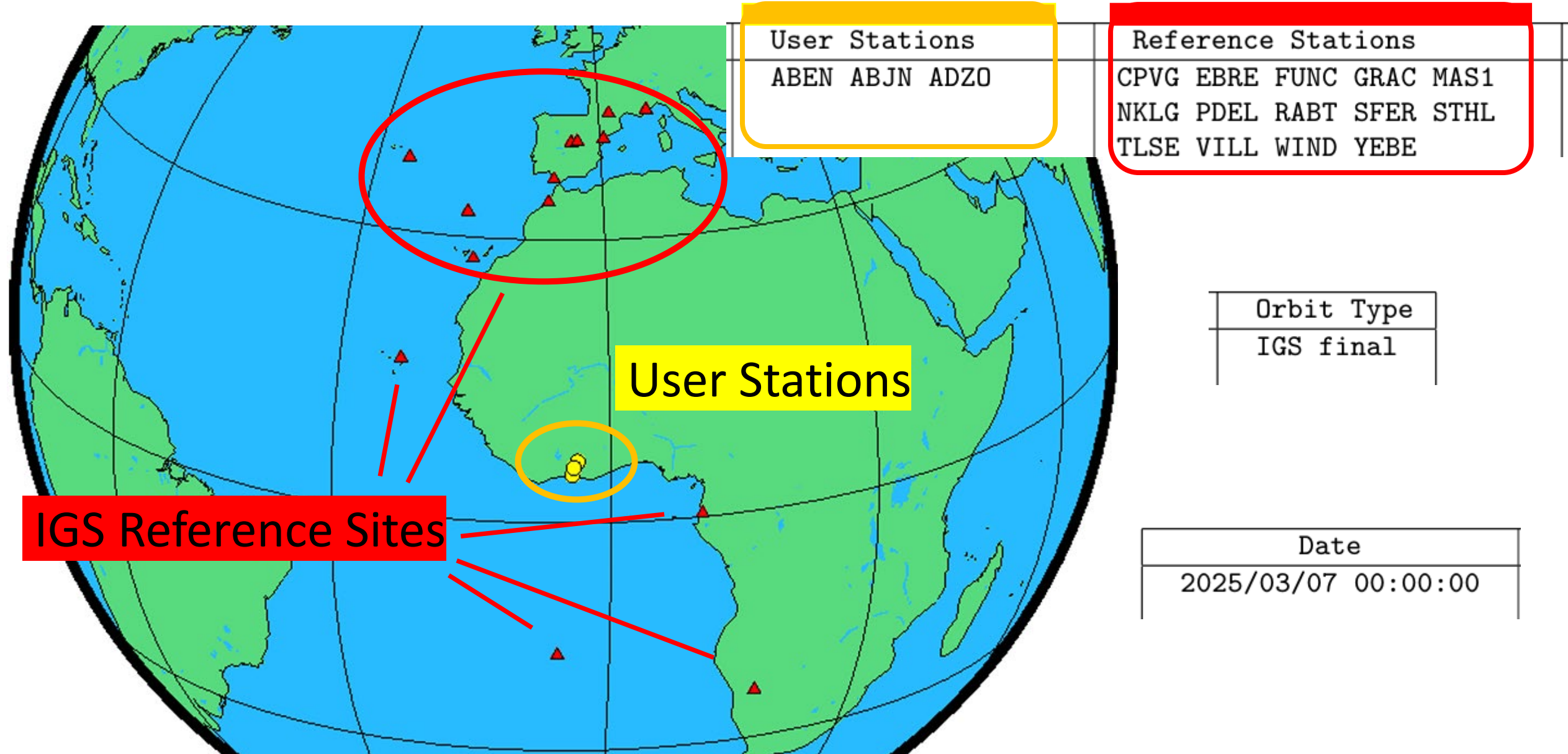
1   User Data

All antenna heights refer to the vertical distance from the Ground Mark to the Antenna Reference Point (ARP).

Station (s)	Submitted File	Antenna Type	Antenna Height (m)	Start Time	End Time
ABEN	ABEN0660.25o	TRM159900.00 NONE	0.000	2025/03/07 00:00:00	2025/03/07 23:59:30
ABJN	ABJN0660.25o	TRM159900.00 NONE	0.000	2025/03/07 00:00:00	2025/03/07 23:59:30
ADZO	ADZO0660.25o	TRM159900.00 NONE	0.000	2025/03/07 00:00:00	2025/03/07 23:59:30

3 Sites from Cote d'Ivoire

AUSPOS Processing Summary

User Stations
ABEN ABJN ADZO

Reference Stations
CPVG EBRE FUNC GRAC MAS1
NKLG PDEL RABT SFER STHL
TLSE VILL WIND YEBE

Orbit Type
IGS final

Date
2025/03/07 00:00:00

User Stations

IGS Reference Sites

AUSPOS Computed Coordinates, ITRF 2020

Cartesian (X,Y,Z)

Station	X (m)	Y (m)	Z (m)	ITRF2020 @
ABEN	6322881.964	-385538.225	743276.322	07/03/2025
ABJN	6335352.923	-442773.911	588525.427	07/03/2025
ADZO	6327921.847	-426651.703	674257.590	07/03/2025

IGS Reference Stations

CPVG	5626883.450	-2380932.244	1824484.067	07/03/2025
EBRE	4833519.928	41537.507	4147461.787	07/03/2025
FUNC	5143339.177	-1563412.406	3421191.852	07/03/2025
GRAC	4581708.075	556133.018	4389341.503	07/03/2025
MAS1	5439192.129	-1522055.111	2953455.147	07/03/2025

AUSPOS Computed Coordinates, ITRF 2020

Geodetic (Lat, Long, Height)
- GRS80 Ellipsoid
- Geoid Height derived from EGM2008

Station	Latitude (DMS)	Longitude (DMS)	Ellipsoidal Height(m)	Derived Above Geoid Height(m)
ABEN	6 44 12.89563	-3 29 21.46051	237.315	209.719
ABJN	5 19 47.71587	-3 59 52.31740	63.519	38.112
ADZO	6 06 32.36383	-3 51 26.11344	131.867	104.700

IGS Reference Stations

CPVG	16 43 55.43000	-22 56 05.75038	94.066	63.284
EBRE	40 49 15.20782	0 29 32.52086	107.790	57.605
FUNC	32 38 52.62360	-16 54 27.40550	78.406	29.187

UMT Grid

- GRS80 Ellipsoid

Station	East (m)	North (m)	Zone	Ellipsoidal Height (m)	Derived Above Geoid Height (m)
ABEN	445926.565	744693.028	30	237.315	209.719
ABJN	389433.871	589222.900	30	63.519	38.112
ADZO	405143.745	675328.099	30	131.867	104.700

IGS Reference Stations included

CPVG	293716.368	1850918.067	27	94.066	63.284
EBRE	288524.406	4521900.781	31	107.790	57.605
FUNC	321080.515	3613867.040	28	78.406	29.187
GRAC	332612.208	4846706.382	32	1319.866	1268.805

AUSPOS Uncertainties

Positional Uncertainty for geodetic coordinates
- 95% Confidence Level

Station	Longitude(East) (m)	Latitude(North) (m)	Ellipsoidal Height(Up) (m)
ABEN	0.006	0.004	0.012
ABJN	0.006	0.004	0.010
ADZO	0.006	0.004	0.011
CPVG	0.005	0.003	0.010
EBRE	0.004	0.003	0.007
FUNC	0.005	0.003	0.008
GRAC	0.005	0.003	0.009
MAS1	0.004	0.003	0.007

Accuracy: Horizontal 4-6 cm; Vertical 10-12 cm

AUSPOS Processing Information

- Ambiguity Resolution – Per Baseline
  - Baseline Length
- Computation System
  - Software, GNSS System
- Preprocessing, Measurement Modelling, Used Parameters
  - Data type, Elevation mask, Sampling rate
  - Ionosphere and Troposphere parametrization
  - Antenna Offset, Satellite parametrization, …..
- Estimation Process
- Reference Frame and uncertainty information

Further Information

AUSPOS Tool and Submission Checklist:
https://www.ga.gov.au/scientific-topics/positioning-navigation/positioning-australia/geodesy/auspos

A Practical Guide to AUSPOS:
https://www.spatial.nsw.gov.au/__data/assets/pdf_file/0015/230622/2022_Janssen_and_McElroy_APAS2022_practical_guide_to_AUSPOS.pdf

International GNSS Service:
https://igs.org

Bernese GNSS Software Manual:
https://www.bernese.unibe.ch/docs/DOCU52.pdf