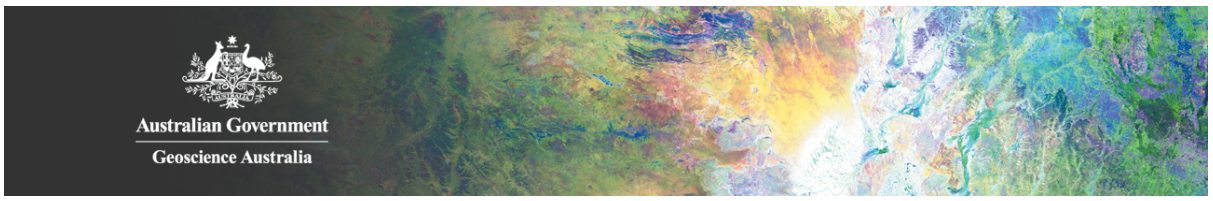

AUSPOS GPS Processing Report

March 13, 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.

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

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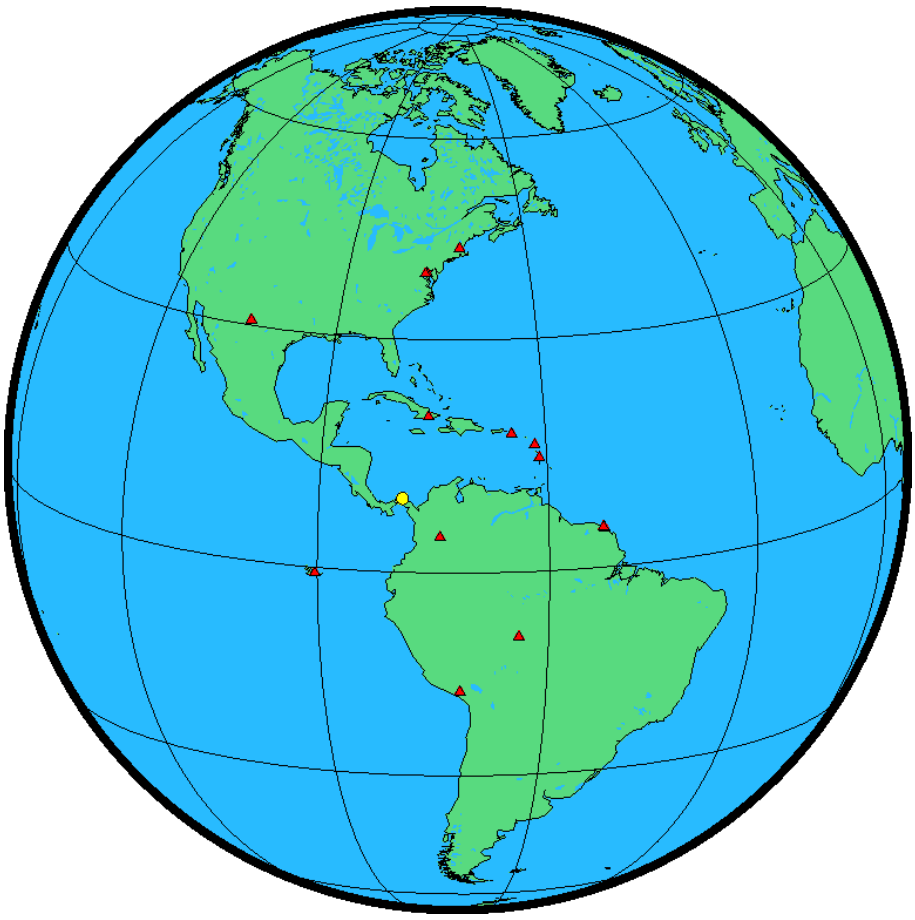
1 User Data

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
ELP2	elporveniruh2.o	SEPALTUS_NR3 NONE	2.000	2023/09/23 02:05:00	2023/09/23 07:50:30

2 Processing Summary



Date	User Stations	Reference Stations	Orbit Type
2023/09/23 02:05:00	ELP2	ABMF AREG BOGT CRO1 GLPS GODE KOUG KOUR LMMF MDO1 POVE SCUB WDC5 WES2	IGS final

3 Computed Coordinates, ITRF2020

All coordinates are based on the IGS realisation of the ITRF2020 reference frame. All the given ITRF2020 coordinates refer to a mean epoch of the site observation data. All coordinates refer to the Ground Mark.

3.1 Cartesian, ITRF2020

Station	X (m)	Y (m)	Z (m)	ITRF2020 @
ELP2	1205723.829	-6173539.006	1052116.134	23/09/2023
ABMF	2919785.825	-5383744.926	1774604.917	23/09/2023
AREG	1942816.507	-5804077.183	-1796884.309	23/09/2023
BOGT	1744398.872	-6116036.969	512731.957	23/09/2023
CRO1	2607771.372	-5488076.564	1932768.023	23/09/2023
GLPS	-33800.706	-6377516.506	-82154.189	23/09/2023
GODE	1130773.466	-4831253.584	3994200.474	23/09/2023
KOUG	3855263.290	-5049732.029	563040.578	23/09/2023
KOUR	3839591.309	-5059567.591	579957.276	23/09/2023
LMMF	2993387.424	-5399363.773	1596748.213	23/09/2023
MDO1	-1329999.009	-5328393.356	3236504.060	23/09/2023
POVE	2774265.595	-5662060.206	-959415.707	23/09/2023
SCUB	1474537.982	-5811243.266	2168958.905	23/09/2023
WDC5	1112158.575	-4842855.627	3985496.994	23/09/2023
WES2	1492232.949	-4458089.508	4296046.100	23/09/2023

3.2 Geodetic, GRS80 Ellipsoid, ITRF2020

Geoid-ellipsoidal separations, in this section, are computed using a spherical harmonic synthesis of the global EGM2008 geoid. More information on the EGM2008 geoid can be found at http://earth-info.nga.mil/GandG/wgs84/gravitymod/egm2008/.

Station	Latitude (DMS)	Longitude (DMS)	Ellipsoidal Height(m)	Derived Above Geoid Height(m)
ELP2	9 33 30.23332	-78 56 56.21933	10.257	1.674
ABMF	16 15 44.30627	-61 31 39.12607	-25.558	15.317
AREG	-16 27 55.51911	-71 29 34.45081	2489.383	2449.528
BOGT	4 38 24.27138	-74 04 51.38237	2576.184	2553.323
CRO1	17 45 24.84135	-64 35 03.54451	-31.931	11.748
GLPS	-0 44 34.79137	-90 18 13.18900	1.762	5.341
GODE	39 01 18.22168	-76 49 36.60000	14.495	47.760
KOUG	5 05 54.50010	-52 38 23.10245	107.254	141.837
KOUR	5 15 07.86024	-52 48 21.45737	-25.766	8.495
LMMF	14 35 41.34591	-60 59 46.23038	-27.138	10.966
MDO1	30 40 49.83685	-104 00 53.98365	2004.478	2026.557
POVE	-8 42 33.60245	-63 53 46.75300	119.605	107.627
SCUB	20 00 43.43087	-75 45 44.34233	20.912	44.494
WDC5	38 55 14.03339	-77 03 58.74882	58.986	91.851
WES2	42 36 48.01153	-71 29 35.98969	85.001	113.628

3.3 UTM Grid, GRS80 Ellipsoid, ITRF2020

Station	East (m)	North (m)	Zone	Ellipsoidal Height (m)	Derived Above Geoid Height(m)
ELP2	725128.495	1057257.400	17	10.257	1.674
ABMF	657348.870	1798516.990	20	-25.558	15.317
AREG	233835.592	8177939.181	19	2489.383	2449.528
BOGT	601939.814	512945.134	18	2576.184	2553.323
CRO1	332034.098	1963998.649	20	-31.931	11.748
GLPS	800121.181	9917784.769	15	1.762	5.341
GODE	341854.078	4320775.468	18	14.495	47.760
KOUG	318229.339	563780.483	22	107.254	141.837
KOUR	299847.138	580829.200	22	-25.766	8.495
LMMF	715865.112	1614463.344	20	-27.138	10.966
MDO1	594348.793	3394609.158	13	2004.478	2026.557
POVE	401400.620	9037166.005	20	119.605	107.627
SCUB	420261.887	2212997.864	18	20.912	44.494
WDC5	320865.645	4309991.449	18	58.986	91.851
WES2	295497.586	4720891.551	19	85.001	113.628

3.4 Positional Uncertainty (95% C.L.) - Geodetic, ITRF2020

Station	Longitude(East) (m)	Latitude(North) (m)	Ellipsoidal Height(Up) (m)
ELP2	0.012	0.007	0.031
ABMF	0.010	0.006	0.022
AREG	0.011	0.008	0.024
BOGT	0.017	0.007	0.027
CRO1	0.008	0.005	0.015
GLPS	0.010	0.006	0.015
GODE	0.007	0.006	0.013
KOUG	0.008	0.005	0.014
KOUR	0.008	0.006	0.015
LMMF	0.007	0.005	0.013
MDO1	0.009	0.005	0.016
POVE	0.010	0.007	0.020
SCUB	0.011	0.008	0.017
WDC5	0.008	0.007	0.017
WES2	0.009	0.008	0.024

4 Ambiguity Resolution - Per Baseline

Baseline	Ambiguities Resolved	Baseline Length (km)
GODE - LMMF	88.2 %	3088.666
GLPS - POVE	66.7 %	3027.656
CRO1 - LMMF	57.6 %	519.114
AREG - POVE	83.4 %	1188.625
KOUG - LMMF	61.8 %	1390.548
ABMF - LMMF	60.9 %	193.117
GODE - WDC5	91.3 %	23.598
KOUG - KOUR	86.4 %	25.070
GODE - MDO1	84.2 %	2622.337
GLPS - ELP2	73.3 %	1692.512
GODE - WES2	80.0 %	600.845
KOUG - POVE	60.0 %	1965.038
LMMF - SCUB	53.4 %	1674.507
BOGT - POVE	45.8 %	1853.089
AVERAGE	70.9%	1418.909

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.

5 Computation Standards

5.1 Computation System

Software	Bernese GNSS Software Version 5.2.
GNSS system(s)	GPS only.

5.2 Data Preprocessing and Measurement Modelling

Data preprocessing	Phase preprocessing is undertaken in a baseline by baseline mode using triple-difference. In most cases, cycle slips are fixed by the simultaneous analysis of different linear combinations of L1 and L2. If a cycle slip cannot be fixed reliably, bad data points are removed or new ambiguities are set up A data screening step on the basis of weighted postfit residuals is also performed, and outliers are removed.
Basic observable	Carrier phase with an elevation angle cutoff of 7° and a sampling rate of 3 minutes. However, data cleaning is performed a sampling rate of 30 seconds. Elevation dependent weighting is applied according to $1/\sin(e)^2$ where e is the satellite elevation.
Modelled observable	Double differences of the ionosphere-free linear combination.
Ground antenna phase centre calibrations	IGS20 absolute phase-centre variation model is applied.
Tropospheric Model	A priori model is the GMF mapped with the DRY-GMF.
Tropospheric Estimation	Zenith delay corrections are estimated relying on the WET-GMF mapping function in intervals of 2 hour. N-S and E-W horizontal delay parameters are solved for every 24 hours.
Tropospheric Mapping Function	GMF
Ionosphere	First-order effect eliminated by forming the ionosphere-free linear combination of L1 and L2. Second and third effect applied.
Tidal displacements	Solid earth tidal displacements are derived from the complete model from the IERS Conventions 2010, but ocean tide loading is not applied.
Atmospheric loading	Applied
Satellite centre of mass correction	IGS20 phase-centre variation model applied
Satellite phase centre calibration	IGS20 phase-centre variation model applied
Satellite trajectories	Best available IGS products.
Earth Orientation	Best available IGS products.

5.3 Estimation Process

Adjustment	Weighted least-squares algorithm.
Station coordinates	Coordinate constraints are applied at the Reference sites with standard deviation of 1mm and 2mm for horizontal and vertical components respectively.
Troposphere	Zenith delay parameters and pairs of horizontal delay gradient parameters are estimated for each station in intervals of 2 hours and 24 hours.
Ionospheric correction	An ionospheric map derived from the contributing reference stations is used to aid ambiguity resolution.
Ambiguity	Ambiguities are resolved in a baseline-by-baseline mode using the Code-Based strategy for 200-6000km baselines, the Phase-Based L5/L3 strategy for 20-200km baselines, the Quasi-Ionosphere-Free (QIF) strategy for 20-2000km baselines and the Direct L1/L2 strategy for 0-20km baselines.

5.4 Reference Frame and Coordinate Uncertainty

Terrestrial reference frame	IGS20 station coordinates and velocities mapped to the mean epoch of observation.
Australian datums	GDA2020 and GDA94.
Derived AHD	For stations within Australia, AUSGeoid2020 (V20180201) is used to compute AHD. AUSGeoid2020 is the Australia-wide gravimetric quasigeoid model that has been a posteriori fitted to the AHD. For reference, derived AHD is always determined from the GDA2020 coordinates. In the GDA94 section of the report, AHD values are assumed to be identical to those derived from GDA2020.
Above-geoid heights	Earth Gravitational Model EGM2008 released by the National Geospatial-Intelligence Agency (NGA) EGM Development Team is used to compute above-geoid heights. This gravitational model is complete to spherical harmonic degree and order 2159, and contains additional coefficients extending to degree 2190 and order 2159.
Coordinate uncertainty	Coordinate uncertainty is expressed in terms of the 95% confidence level for GDA94, GDA2020 and ITRF2020. Uncertainties are scaled using an empirically derived model which is a function of data span, quality and geographical location.