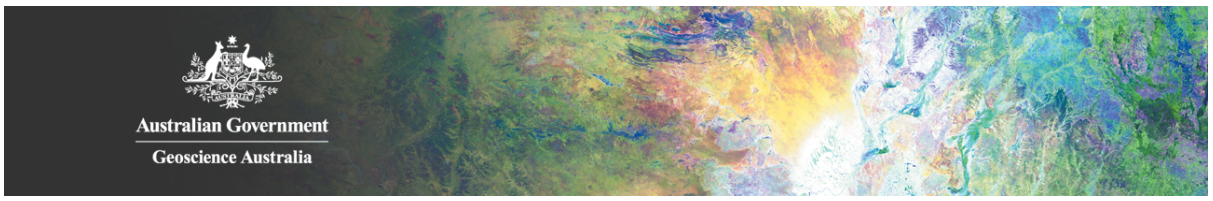

AUSPOS GPS Processing Report

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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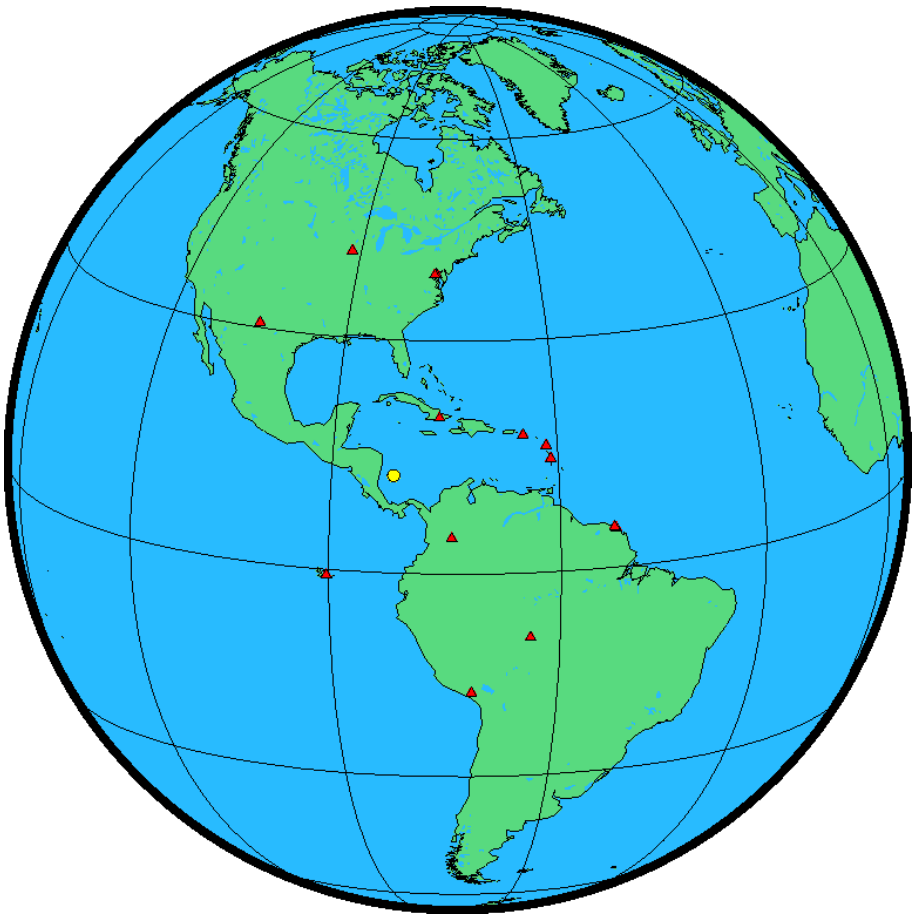
1 User Data

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
SNDG	sanandresgps1.o	SEPALTUS_NR3 NONE	2.000	2023/09/29 15:40:30	2023/09/29 22:16:00

2 Processing Summary



Date	User Stations	Reference Stations	Orbit Type
2023/09/29 15:40:30	SNDG	ABMF AREG BOGT CRO1 GLPS GODE KOUG KOUR LMMF MDO1 NLIB POVE SCUB WDC5	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 @
SNDG	898641.903	-6161069.365	1378965.144	29/09/2023
ABMF	2919785.777	-5383744.938	1774604.921	29/09/2023
AREG	1942816.477	-5804077.141	-1796884.322	29/09/2023
BOGT	1744398.838	-6116037.002	512731.962	29/09/2023
CRO1	2607771.344	-5488076.571	1932768.023	29/09/2023
GLPS	-33800.698	-6377516.498	-82154.194	29/09/2023
GODE	1130773.480	-4831253.564	3994200.473	29/09/2023
KOUG	3855263.277	-5049732.032	563040.571	29/09/2023
KOUR	3839591.300	-5059567.600	579957.272	29/09/2023
LMMF	2993387.426	-5399363.794	1596748.215	29/09/2023
MDO1	-1329998.998	-5328393.354	3236504.063	29/09/2023
NLIB	-130934.897	-4762291.675	4226854.606	29/09/2023
POVE	2774265.627	-5662060.204	-959415.726	29/09/2023
SCUB	1474538.001	-5811243.250	2168958.907	29/09/2023
WDC5	1112158.588	-4842855.598	3985496.992	29/09/2023

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)
SNDG	12 34 10.32325	-81 42 05.27499	4.838	1.572
ABMF	16 15 44.30649	-61 31 39.12766	-25.569	15.306
AREG	-16 27 55.51997	-71 29 34.45131	2489.340	2449.485
BOGT	4 38 24.27147	-74 04 51.38373	2576.207	2553.346
CRO1	17 45 24.84142	-64 35 03.54547	-31.937	11.742
GLPS	-0 44 34.79156	-90 18 13.18872	1.754	5.333
GODE	39 01 18.22200	-76 49 36.59924	14.481	47.746
KOUG	5 05 54.49989	-52 38 23.10285	107.249	141.832
KOUR	5 15 07.86008	-52 48 21.45778	-25.765	8.496
LMMF	14 35 41.34579	-60 59 46.23067	-27.119	10.985
MDO1	30 40 49.83701	-104 00 53.98325	2004.476	2026.555
NLIB	41 46 17.72733	-91 34 29.63574	206.965	239.828
POVE	-8 42 33.60302	-63 53 46.75205	119.620	107.642
SCUB	20 00 43.43106	-75 45 44.34156	20.903	44.485
WDC5	38 55 14.03382	-77 03 58.74801	58.965	91.830

3.3 UTM Grid, GRS80 Ellipsoid, ITRF2020

Station	East (m)	North (m)	Zone	Ellipsoidal Height (m)	Derived Above Geoid Height(m)
SNDG	423801.449	1389634.427	17	4.838	1.572
ABMF	657348.823	1798516.997	20	-25.569	15.306
AREG	233835.578	8177939.155	19	2489.340	2449.485
BOGT	601939.772	512945.137	18	2576.207	2553.346
CRO1	332034.069	1963998.651	20	-31.937	11.742
GLPS	800121.189	9917784.764	15	1.754	5.333
GODE	341854.097	4320775.478	18	14.481	47.746
KOUG	318229.327	563780.477	22	107.249	141.832
KOUR	299847.126	580829.195	22	-25.765	8.496
LMMF	715865.103	1614463.341	20	-27.119	10.985
MDO1	594348.804	3394609.163	13	2004.476	2026.555
NLIB	618446.013	4625398.123	15	206.965	239.828
POVE	401400.649	9037165.988	20	119.620	107.642
SCUB	420261.909	2212997.870	18	20.903	44.485
WDC5	320865.665	4309991.462	18	58.965	91.830

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

Station	Longitude(East) (m)	Latitude(North) (m)	Ellipsoidal Height(Up) (m)
SNDG	0.011	0.008	0.025
ABMF	0.012	0.008	0.026
AREG	0.011	0.009	0.024
BOGT	0.015	0.009	0.034
CRO1	0.010	0.007	0.020
GLPS	0.010	0.007	0.016
GODE	0.010	0.008	0.018
KOUG	0.010	0.006	0.017
KOUR	0.010	0.006	0.017
LMMF	0.010	0.006	0.018
MDO1	0.010	0.007	0.018
NLIB	0.012	0.009	0.021
POVE	0.010	0.008	0.023
SCUB	0.012	0.008	0.021
WDC5	0.010	0.009	0.025

4 Ambiguity Resolution - Per Baseline

Baseline	Ambiguities Resolved	Baseline Length (km)
GODE - NLIB	43.8 %	1284.831
AREG - POVE	86.6 %	1188.625
KOUG - LMMF	61.1 %	1390.548
ABMF - LMMF	30.4 %	193.117
GLPS - MDO1	77.8 %	3714.065
GODE - WDC5	91.6 %	23.598
KOUG - KOUR	94.4 %	25.070
GODE - MDO1	88.2 %	2622.337
GLPS - SNDG	66.7 %	1746.759
ABMF - CRO1	85.8 %	365.039
SNDG - SCUB	28.0 %	1038.328
KOUG - POVE	81.3 %	1965.038
AREG - GLPS	93.8 %	2678.833
BOGT - POVE	38.1 %	1853.089
AVERAGE	69.1%	1434.948

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.