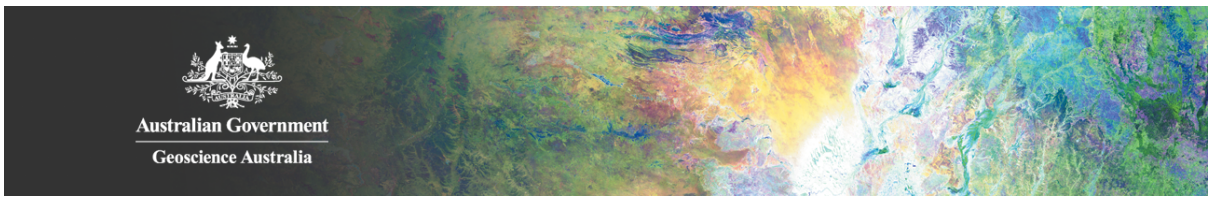

AUSPOS GPS Processing Report

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
QUEP	quepalts2720.22o	SEPALTUS_NR3 NONE	2.000	2022/09/29 15:40:00	2022/09/29 23:23:00

2 Processing Summary

Date	User Stations	Reference Stations	Orbit Type
2022/09/29 15:40:00	QUEP	ABMF AREG BOGT CRO1 GLPS GODE KOUG KOUR LMMF MANA 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 @
QUEP	639166.117	-6260063.243	1037611.204	29/09/2022
ABMF	2919785.822	-5383744.949	1774604.905	29/09/2022
AREG	1942816.465	-5804077.175	-1796884.321	29/09/2022
BOGT	1744398.863	-6116036.994	512731.961	29/09/2022
CRO1	2607771.350	-5488076.552	1932768.006	29/09/2022
GLPS	-33800.757	-6377516.516	-82154.198	29/09/2022
GODE	1130773.484	-4831253.571	3994200.467	29/09/2022
KOUG	3855263.294	-5049732.024	563040.569	29/09/2022
KOUR	3839591.315	-5059567.594	579957.269	29/09/2022
LMMF	2993387.427	-5399363.817	1596748.212	29/09/2022
MANA	407981.960	-6222925.598	1333529.111	29/09/2022
MDO1	-1329998.993	-5328393.352	3236504.065	29/09/2022
NLIB	-130934.878	-4762291.680	4226854.603	29/09/2022
POVE	2774265.587	-5662060.184	-959415.706	29/09/2022
SCUB	1474537.993	-5811243.268	2168958.890	29/09/2022
WDC5	1112158.591	-4842855.609	3985496.986	29/09/2022

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)
QUEP	9 25 31.54449	-84 10 12.64161	14.623	3.253
ABMF	16 15 44.30571	-61 31 39.12652	-25.543	15.332
AREG	-16 27 55.51967	-71 29 34.45206	2489.367	2449.512
BOGT	4 38 24.27144	-74 04 51.38287	2576.206	2553.345
CRO1	17 45 24.84101	-64 35 03.54501	-31.955	11.724
GLPS	-0 44 34.79167	-90 18 13.19062	1.773	5.352
GODE	39 01 18.22169	-76 49 36.59916	14.483	47.748
KOUG	5 05 54.49980	-52 38 23.10226	107.252	141.835
KOUR	5 15 07.85998	-52 48 21.45726	-25.761	8.500
LMMF	14 35 41.34553	-60 59 46.23102	-27.100	11.004
MANA	12 08 56.18357	-86 14 56.37392	70.968	66.360
MDO1	30 40 49.83714	-104 00 53.98310	2004.474	2026.553
NLIB	41 46 17.72715	-91 34 29.63491	206.968	239.831
POVE	-8 42 33.60254	-63 53 46.75293	119.581	107.603
SCUB	20 00 43.43037	-75 45 44.34196	20.911	44.493
WDC5	38 55 14.03346	-77 03 58.74801	58.970	91.835

3.3 UTM Grid, GRS80 Ellipsoid, ITRF2020

Station	East (m)	North (m)	Zone	Ellipsoidal Height (m)	Derived Above Geoid Height(m)
QUEP	810785.478	1043144.594	16	14.623	3.253
ABMF	657348.856	1798516.973	20	-25.543	15.332
AREG	233835.555	8177939.164	19	2489.367	2449.512
BOGT	601939.798	512945.136	18	2576.206	2553.345
CRO1	332034.083	1963998.638	20	-31.955	11.724
GLPS	800121.130	9917784.760	15	1.773	5.352
GODE	341854.099	4320775.468	18	14.483	47.748
KOUG	318229.345	563780.474	22	107.252	141.835
KOUR	299847.142	580829.192	22	-25.761	8.500
LMMF	715865.093	1614463.332	20	-27.100	11.004
MANA	581710.955	1343135.910	16	70.968	66.360
MDO1	594348.807	3394609.167	13	2004.474	2026.553
NLIB	618446.032	4625398.118	15	206.968	239.831
POVE	401400.622	9037166.003	20	119.581	107.603
SCUB	420261.897	2212997.849	18	20.911	44.493
WDC5	320865.665	4309991.451	18	58.970	91.835

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

Station	Longitude(East) (m)	Latitude(North) (m)	Ellipsoidal Height(Up) (m)
QUEP	0.010	0.006	0.021
ABMF	0.010	0.006	0.020
AREG	0.011	0.009	0.029
BOGT	0.017	0.008	0.031
CRO1	0.009	0.006	0.017
GLPS	0.010	0.007	0.017
GODE	0.009	0.006	0.017
KOUG	0.009	0.006	0.015
KOUR	0.010	0.006	0.016
LMMF	0.009	0.006	0.015
MANA	0.010	0.007	0.024
MDO1	0.010	0.006	0.017
NLIB	0.010	0.008	0.020
POVE	0.011	0.008	0.021
SCUB	0.011	0.008	0.020
WDC5	0.010	0.008	0.023

4 Ambiguity Resolution - Per Baseline

Baseline	Ambiguities Resolved	Baseline Length (km)
BOGT - KOUG	14.3 %	2365.436
GODE - NLIB	64.7 %	1284.831
ABMF - SCUB	60.0 %	1557.887
AREG - POVE	89.5 %	1188.625
KOUG - LMMF	85.8 %	1390.548
MANA - QUEP	78.6 %	377.350
ABMF - LMMF	60.0 %	193.117
GODE - WDC5	84.0 %	23.598
KOUG - KOUR	65.7 %	25.070
GODE - MDO1	94.7 %	2622.337
POVE - QUEP	63.2 %	2984.020
GLPS - QUEP	84.2 %	1311.699
ABMF - CRO1	85.7 %	365.039
KOUG - POVE	66.7 %	1965.038
MDO1 - QUEP	94.1 %	3095.279
AVERAGE	72.7%	1383.325

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.