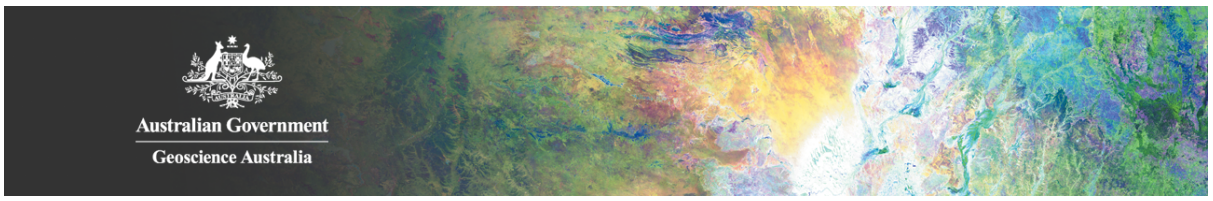

AUSPOS GPS Processing Report

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
LMON	lmonalts2680.22o	SEPALTUS_NR3 NONE	2.000	2022/09/25 16:32:30	2022/09/25 23:28:00

2 Processing Summary

Date	User Stations	Reference Stations	Orbit Type
2022/09/25 16:32:30	LMON	ABMF AREG BOGT GLPS 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 @
LMON	763384.215	-6235549.553	1099013.993	25/09/2022
ABMF	2919785.785	-5383744.963	1774604.900	25/09/2022
AREG	1942816.460	-5804077.164	-1796884.321	25/09/2022
BOGT	1744398.869	-6116036.984	512731.947	25/09/2022
GLPS	-33800.753	-6377516.518	-82154.199	25/09/2022
KOUG	3855263.296	-5049732.020	563040.568	25/09/2022
KOUR	3839591.313	-5059567.584	579957.265	25/09/2022
LMMF	2993387.430	-5399363.802	1596748.211	25/09/2022
MANA	407981.960	-6222925.648	1333529.137	25/09/2022
MDO1	-1329998.995	-5328393.358	3236504.066	25/09/2022
NLIB	-130934.888	-4762291.688	4226854.603	25/09/2022
POVE	2774265.592	-5662060.195	-959415.718	25/09/2022
SCUB	1474537.996	-5811243.252	2168958.901	25/09/2022
WDC5	1112158.601	-4842855.639	3985496.998	25/09/2022

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)
LMON	9 59 19.12105	-83 01 13.16222	13.641	3.434
ABMF	16 15 44.30560	-61 31 39.12784	-25.550	15.325
AREG	-16 27 55.51979	-71 29 34.45213	2489.355	2449.500
BOGT	4 38 24.27100	-74 04 51.38259	2576.198	2553.337
GLPS	-0 44 34.79171	-90 18 13.19052	1.774	5.353
KOUG	5 05 54.49977	-52 38 23.10213	107.251	141.834
KOUR	5 15 07.85987	-52 48 21.45714	-25.770	8.491
LMMF	14 35 41.34562	-60 59 46.23067	-27.112	10.992
MANA	12 08 56.18407	-86 14 56.37403	71.022	66.414
MDO1	30 40 49.83706	-104 00 53.98310	2004.480	2026.559
NLIB	41 46 17.72697	-91 34 29.63532	206.973	239.836
POVE	-8 42 33.60287	-63 53 46.75292	119.595	107.617
SCUB	20 00 43.43088	-75 45 44.34172	20.902	44.484
WDC5	38 55 14.03311	-77 03 58.74788	59.002	91.867

3.3 UTM Grid, GRS80 Ellipsoid, ITRF2020

Station	East (m)	North (m)	Zone	Ellipsoidal Height (m)	Derived Above Geoid Height(m)
LMON	278530.581	1104834.496	17	13.641	3.434
ABMF	657348.817	1798516.970	20	-25.550	15.325
AREG	233835.553	8177939.160	19	2489.355	2449.500
BOGT	601939.807	512945.123	18	2576.198	2553.337
GLPS	800121.134	9917784.759	15	1.774	5.353
KOUG	318229.349	563780.473	22	107.251	141.834
KOUR	299847.146	580829.189	22	-25.770	8.491
LMMF	715865.103	1614463.335	20	-27.112	10.992
MANA	581710.951	1343135.925	16	71.022	66.414
MDO1	594348.807	3394609.165	13	2004.480	2026.559
NLIB	618446.023	4625398.112	15	206.973	239.836
POVE	401400.622	9037165.992	20	119.595	107.617
SCUB	420261.905	2212997.864	18	20.902	44.484
WDC5	320865.668	4309991.440	18	59.002	91.867

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

Station	Longitude(East) (m)	Latitude(North) (m)	Ellipsoidal Height(Up) (m)
LMON	0.010	0.006	0.021
ABMF	0.011	0.007	0.025
AREG	0.011	0.009	0.027
BOGT	0.014	0.008	0.029
GLPS	0.010	0.007	0.017
KOUG	0.010	0.006	0.015
KOUR	0.010	0.006	0.016
LMMF	0.010	0.006	0.016
MANA	0.011	0.008	0.024
MDO1	0.011	0.006	0.018
NLIB	0.013	0.009	0.020
POVE	0.010	0.008	0.020
SCUB	0.011	0.007	0.019
WDC5	0.018	0.010	0.031

4 Ambiguity Resolution - Per Baseline

Baseline	Ambiguities Resolved	Baseline Length (km)
BOGT - LMMF	56.5 %	1802.411
AREG - POVE	83.3 %	1188.625
KOUG - LMMF	84.2 %	1390.548
NLIB - WDC5	28.1 %	1268.868
MANA - LMON	62.5 %	425.990
ABMF - LMMF	50.0 %	193.117
KOUG - KOUR	82.2 %	25.070
POVE - LMON	93.3 %	2934.223
GLPS - LMON	87.5 %	1432.067
LMON - SCUB	35.0 %	1352.981
MDO1 - WDC5	8.3 %	2600.168
KOUG - POVE	88.2 %	1965.038
MDO1 - LMON	87.5 %	3126.348
AVERAGE	65.1%	1515.804

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.