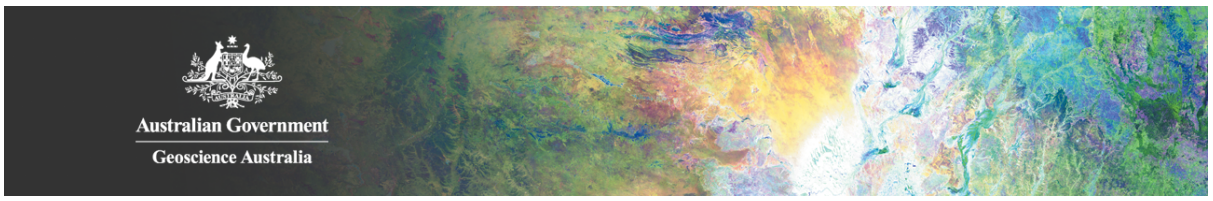


AUSPOS GPS Processing Report

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.

Please direct any correspondence to GNSSAnalysis@ga.gov.au

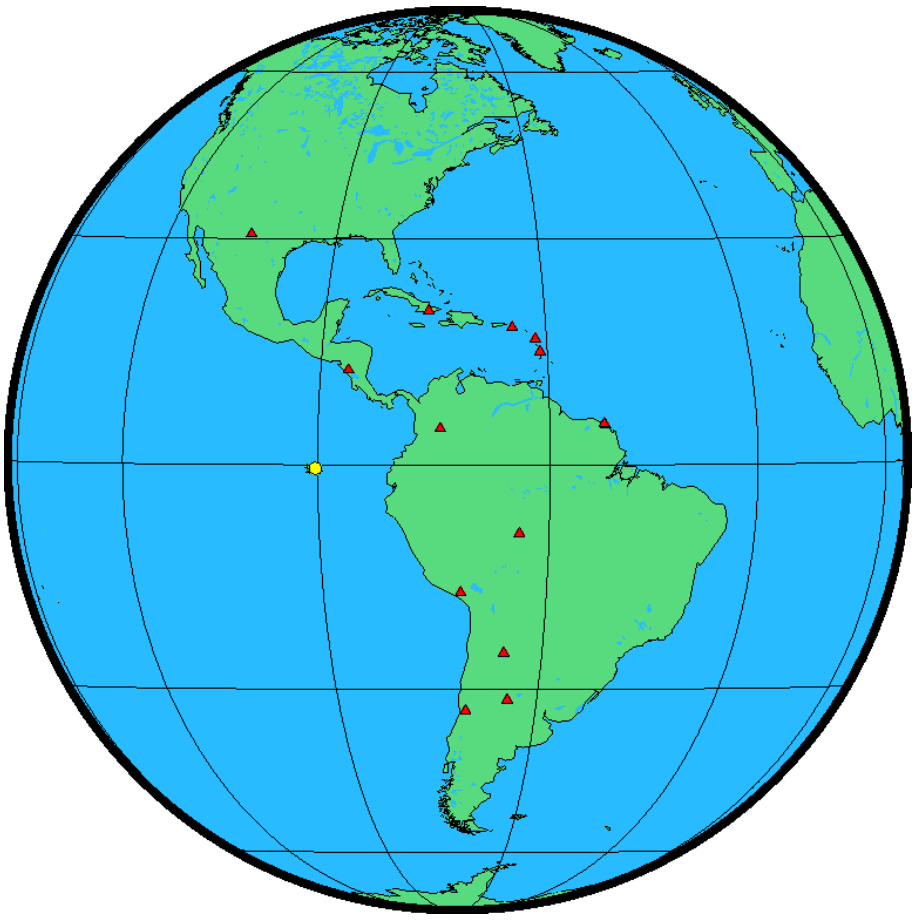
Geoscience Australia
Cnr Jerrabomberra and Hindmarsh Drive
GPO Box 378, Canberra, ACT 2601, Australia
Freecall (Within Australia): 1800 800 173
Tel: +61 2 6249 9111. Fax +61 2 6249 9929
Geoscience Australia
Home Page: http://www.ga.gov.au

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
BALT	baltra2470.22o	SEPALTUS_NR3 NONE	2.000	2022/09/04 16:32:30	2022/09/04 21:24:00

2 Processing Summary



Date	User Stations	Reference Stations	Orbit Type
2022/09/04 16:32:30	BALT	ABMF AREG BOGT CORD CRO1 GLPS KOUG KOUR LMMF MANA MDO1 POVE SANT SCUB UNSA	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 @
BALT	-31757.250	-6377881.546	-48163.150	04/09/2022
ABMF	2919785.802	-5383744.904	1774604.898	04/09/2022
AREG	1942816.461	-5804077.157	-1796884.315	04/09/2022
BOGT	1744398.875	-6116036.967	512731.951	04/09/2022
CORD	2345503.876	-4910842.921	-3316365.194	04/09/2022
CRO1	2607771.358	-5488076.552	1932768.010	04/09/2022
GLPS	-33800.756	-6377516.513	-82154.195	04/09/2022
KOUG	3855263.295	-5049732.014	563040.567	04/09/2022
KOUR	3839591.313	-5059567.580	579957.262	04/09/2022
LMMF	2993387.432	-5399363.804	1596748.205	04/09/2022
MANA	407981.969	-6222925.623	1333529.123	04/09/2022
MDO1	-1329998.986	-5328393.356	3236504.068	04/09/2022
POVE	2774265.592	-5662060.190	-959415.711	04/09/2022
SANT	1769693.515	-5044574.311	-3468320.864	04/09/2022
SCUB	1474537.988	-5811243.262	2168958.893	04/09/2022
UNSA	2412830.514	-5271936.779	-2652208.839	04/09/2022

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)
BALT	-0 26 08.07532	-90 17 07.04147	6.684	10.896
ABMF	16 15 44.30594	-61 31 39.12640	-25.592	15.283
AREG	-16 27 55.51968	-71 29 34.45201	2489.347	2449.492
BOGT	4 38 24.27117	-74 04 51.38226	2576.183	2553.322
CORD	-31 31 42.35948	-64 28 12.17545	746.825	720.437
CRO1	17 45 24.84110	-64 35 03.54477	-31.951	11.728
GLPS	-0 44 34.79158	-90 18 13.19061	1.770	5.349
KOUG	5 05 54.49977	-52 38 23.10202	107.245	141.828
KOUR	5 15 07.85980	-52 48 21.45704	-25.773	8.488
LMMF	14 35 41.34538	-60 59 46.23066	-27.110	10.994
MANA	12 08 56.18379	-86 14 56.37367	70.995	66.387
MDO1	30 40 49.83717	-104 00 53.98280	2004.478	2026.557
POVE	-8 42 33.60267	-63 53 46.75285	119.590	107.612
SANT	-33 09 01.03324	-70 40 06.79675	723.131	695.228
SCUB	20 00 43.43054	-75 45 44.34209	20.906	44.488
UNSA	-24 43 38.83641	-65 24 27.51421	1257.787	1224.375

3.3 UTM Grid, GRS80 Ellipsoid, ITRF2020

Station	East (m)	North (m)	Zone	Ellipsoidal Height (m)	Derived Above Geoid Height(m)
BALT	802184.496	9951801.249	15	6.684	10.896
ABMF	657348.860	1798516.980	20	-25.592	15.283
AREG	233835.557	8177939.163	19	2489.347	2449.492
BOGT	601939.817	512945.128	18	2576.183	2553.322
CORD	360433.092	6510895.599	20	746.825	720.437
CRO1	332034.090	1963998.641	20	-31.951	11.728
GLPS	800121.131	9917784.763	15	1.770	5.349
KOUG	318229.352	563780.473	22	107.245	141.828
KOUR	299847.148	580829.186	22	-25.773	8.488
LMMF	715865.103	1614463.328	20	-27.110	10.994
MANA	581710.962	1343135.917	16	70.995	66.387
MDO1	594348.815	3394609.168	13	2004.478	2026.557
POVE	401400.624	9037165.998	20	119.590	107.612
SANT	344386.456	6330812.748	19	723.131	695.228
SCUB	420261.894	2212997.854	18	20.906	44.488
UNSA	256465.349	7263089.047	20	1257.787	1224.375

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

Station	Longitude(East) (m)	Latitude(North) (m)	Ellipsoidal Height(Up) (m)
BALT	0.010	0.007	0.021
ABMF	0.010	0.006	0.020
AREG	0.010	0.007	0.020
BOGT	0.012	0.008	0.030
CORD	0.010	0.009	0.026
CRO1	0.009	0.006	0.016
GLPS	0.009	0.006	0.015
KOUG	0.009	0.005	0.015
KOUR	0.009	0.005	0.015
LMMF	0.008	0.005	0.015
MANA	0.011	0.008	0.029
MDO1	0.011	0.007	0.018
POVE	0.010	0.006	0.018
SANT	0.010	0.009	0.029
SCUB	0.010	0.006	0.018
UNSA	0.009	0.006	0.015

4 Ambiguity Resolution - Per Baseline

Baseline	Ambiguities Resolved	Baseline Length (km)
CORD - UNSA	61.9 %	758.963
CORD - SANT	83.3 %	610.354
GLPS - POVE	85.7 %	3027.656
ABMF - SCUB	55.6 %	1557.887
AREG - POVE	93.8 %	1188.625
KOUG - LMMF	81.2 %	1390.548
MANA - BALT	77.8 %	1458.237
ABMF - LMMF	70.6 %	193.117
AREG - UNSA	63.2 %	1111.605
KOUG - KOUR	81.2 %	25.070
GLPS - BALT	88.9 %	34.054
ABMF - CRO1	77.8 %	365.039
KOUG - POVE	92.8 %	1965.038
MDO1 - BALT	76.9 %	3684.548
BOGT - POVE	73.7 %	1853.089
AVERAGE	77.6%	1281.589

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.