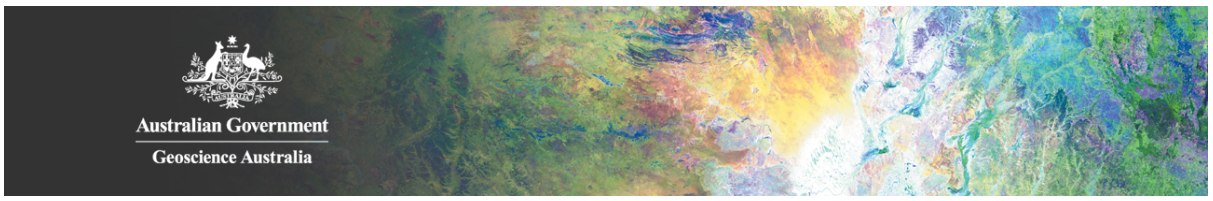

AUSPOS GPS Processing Report

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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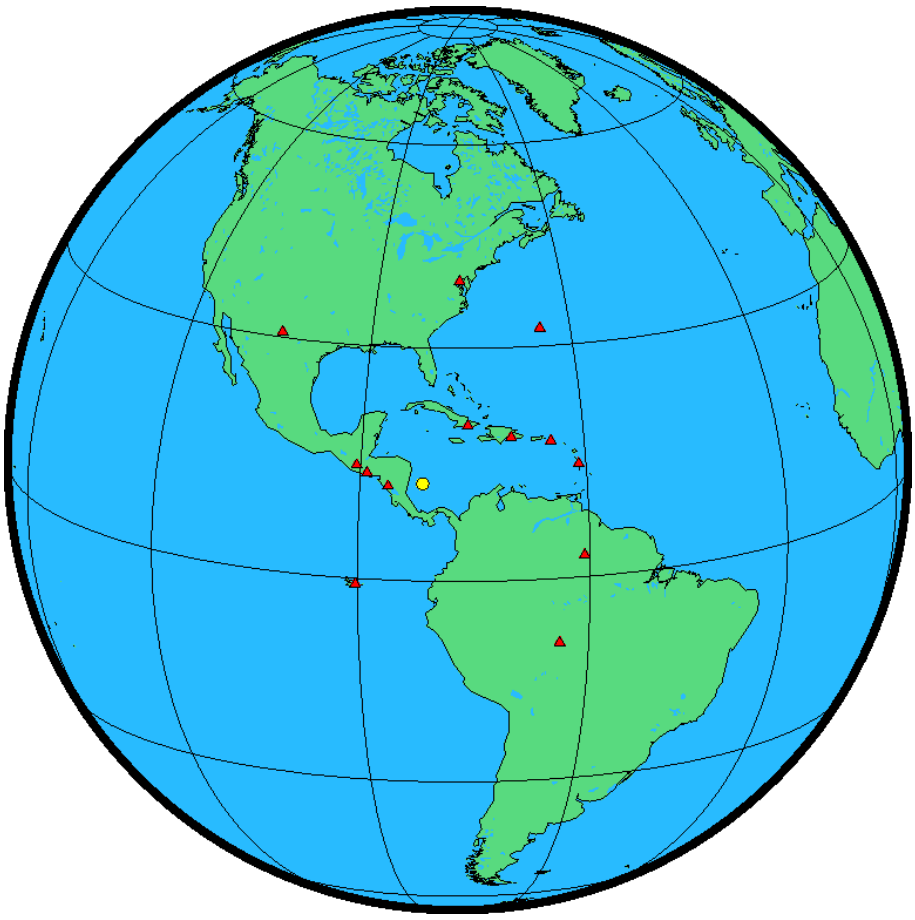
1 User Data

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
SANA	sanaalts2000.19o	SEPALTUS_NR3 NONE	2.000	2019/07/19 17:36:00	2019/07/19 21:44:30

2 Processing Summary



Date	User Stations	Reference Stations	Orbit Type
2019/07/19 17:36:00	SANA	BOAV BRMU CRO1 GLPS GODE GUAT LMMF MANA MDO1 POVE RDSD SCUB SSIA	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 @
SANA	898627.098	-6161080.761	1378923.861	19/07/2019
BOAV	3117452.155	-5555487.863	314480.979	19/07/2019
BRMU	2304703.277	-4874817.169	3395187.046	19/07/2019
CRO1	2607771.340	-5488076.599	1932767.974	19/07/2019
GLPS	-33800.926	-6377516.518	-82154.232	19/07/2019
GODE	1130773.524	-4831253.573	3994200.456	19/07/2019
GUAT	-56063.524	-6174978.643	1596665.295	19/07/2019
LMMF	2993387.389	-5399363.841	1596748.156	19/07/2019
MANA	407981.950	-6222925.656	1333529.105	19/07/2019
MDO1	-1329998.957	-5328393.362	3236504.086	19/07/2019
POVE	2774265.616	-5662060.237	-959415.755	19/07/2019
RDSD	2078678.904	-5683737.231	2006886.954	19/07/2019
SCUB	1474538.003	-5811243.269	2168958.888	19/07/2019
SSIA	95567.097	-6197785.594	1500590.618	19/07/2019

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)
SANA	12 34 08.94729	-81 42 05.81481	4.774	1.507
BOAV	2 50 42.66424	-60 42 04.01619	69.499	84.797
BRMU	32 22 13.43967	-64 41 46.58995	-11.647	20.802
CRO1	17 45 24.83966	-64 35 03.54601	-31.929	11.750
GLPS	-0 44 34.79278	-90 18 13.19609	1.776	5.355
GODE	39 01 18.22118	-76 49 36.59756	14.486	47.751
GUAT	14 35 25.45594	-90 31 12.65656	1519.854	1517.294
LMMF	14 35 41.34375	-60 59 46.23249	-27.112	10.992
MANA	12 08 56.18297	-86 14 56.37437	71.023	66.415
MDO1	30 40 49.83770	-104 00 53.98170	2004.485	2026.564
POVE	-8 42 33.60382	-63 53 46.75284	119.648	107.670
RDSD	18 27 41.03353	-69 54 40.76237	-9.206	26.170
SCUB	20 00 43.43029	-75 45 44.34165	20.914	44.496
SSIA	13 41 49.50811	-89 06 59.74047	626.661	625.233

3.3 UTM Grid, GRS80 Ellipsoid, ITRF2020

Station	East (m)	North (m)	Zone	Ellipsoidal Height (m)	Derived Above Geoid Height(m)
SANA	423785.047	1389592.202	17	4.774	1.507
BOAV	755563.750	314735.565	20	69.499	84.797
BRMU	340415.193	3582757.911	20	-11.647	20.802
CRO1	332034.053	1963998.597	20	-31.929	11.750
GLPS	800120.961	9917784.726	15	1.776	5.355
GODE	341854.137	4320775.451	18	14.486	47.751
GUAT	767172.941	1614480.842	15	1519.854	1517.294
LMMF	715865.049	1614463.277	20	-27.112	10.992
MANA	581710.941	1343135.891	16	71.023	66.415
MDO1	594348.845	3394609.185	13	2004.485	2026.564
POVE	401400.625	9037165.963	20	119.648	107.670
RDSD	403775.721	2041476.414	19	-9.206	26.170
SCUB	420261.907	2212997.846	18	20.914	44.496
SSIA	271084.544	1515227.426	16	626.661	625.233

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

Station	Longitude(East) (m)	Latitude(North) (m)	Ellipsoidal Height(Up) (m)
SANA	0.012	0.008	0.032
BOAV	0.010	0.007	0.018
BRMU	0.010	0.007	0.017
CRO1	0.010	0.007	0.018
GLPS	0.014	0.009	0.020
GODE	0.010	0.008	0.018
GUAT	0.011	0.006	0.018
LMMF	0.010	0.006	0.017
MANA	0.017	0.009	0.034
MDO1	0.014	0.008	0.020
POVE	0.012	0.010	0.034
RDSD	0.010	0.006	0.018
SCUB	0.010	0.006	0.018
SSIA	0.015	0.008	0.033

4 Ambiguity Resolution - Per Baseline

Baseline	Ambiguities Resolved	Baseline Length (km)
GLPS - POVE	23.1 %	3027.656
CRO1 - LMMF	50.0 %	519.114
BRMU - LMMF	66.7 %	1995.950
RDSD - SCUB	72.8 %	638.366
BOAV - LMMF	72.7 %	1297.681
GUAT - SSIA	100.0 %	180.948
MANA - SANA	83.4 %	496.607
BRMU - GODE	90.9 %	1318.645
GUAT - MDO1	13.3 %	2242.474
GUAT - SANA	90.0 %	979.305
BOAV - SANA	70.0 %	2534.357
LMMF - RDSD	88.9 %	1042.005
BOAV - POVE	80.0 %	1323.612
AVERAGE	69.4%	1353.594

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.