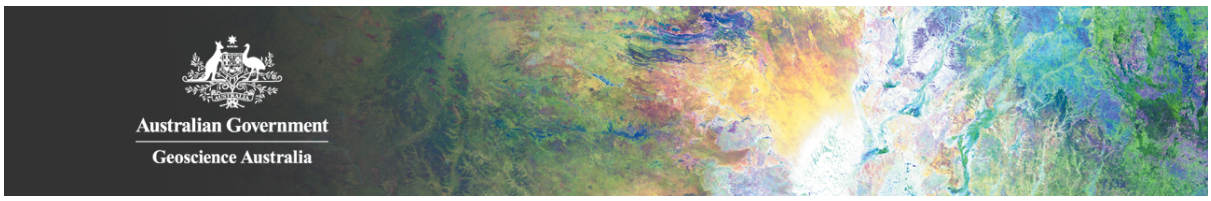

AUSPOS GPS Processing Report

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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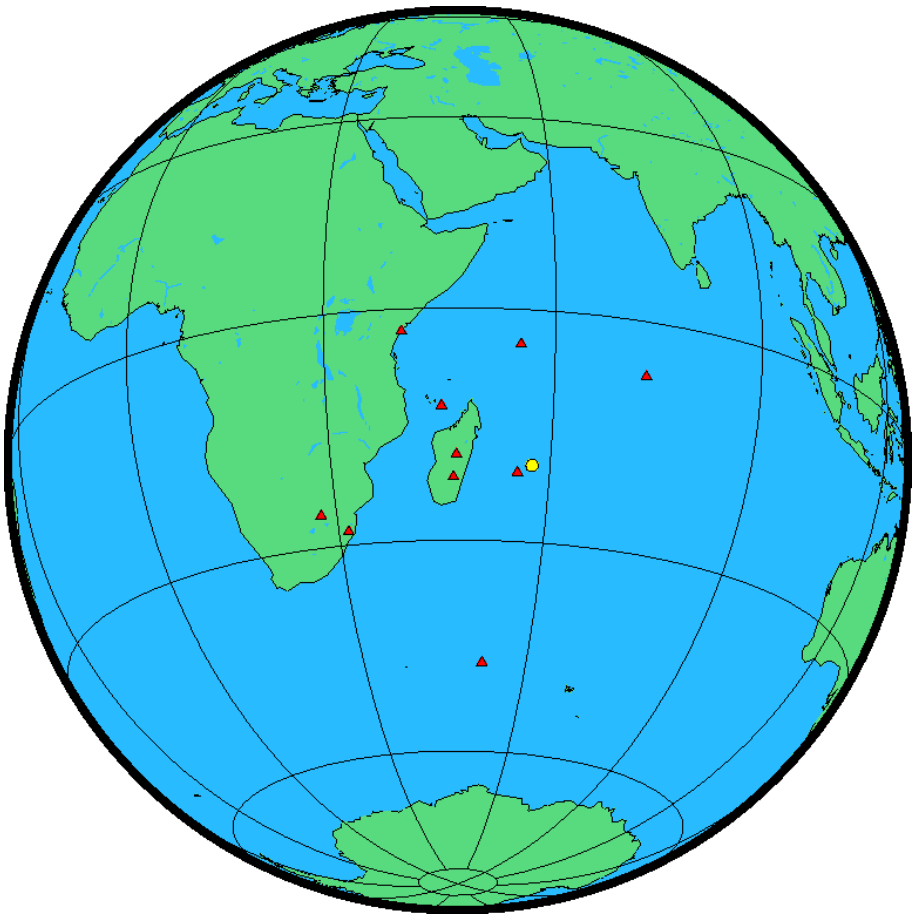
1 User Data

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
PTLU	ptlutg3490.19o	SEPALTUS_NR3 NONE	2.000	2019/12/15 07:15:00	2019/12/15 14:01:00

2 Processing Summary



Date	User Stations	Reference Stations	Orbit Type
2019/12/15 07:15:00	PTLU	ABPO CZTG DGAR HARB HRAO MAL2 MAYG REUN SEYG ULDI VACS VOIM	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 @
PTLU	3217971.626	5052038.148	-2184042.533	15/12/2019
ABPO	4097216.545	4429119.204	-2065771.184	15/12/2019
CZTG	2719994.799	3463392.654	-4598612.945	15/12/2019
DGAR	1916268.769	6029977.731	-801719.422	15/12/2019
HARB	5084657.610	2670325.404	-2768480.896	15/12/2019
HRAO	5085352.451	2668396.145	-2768731.298	15/12/2019
MAL2	4865385.436	4110717.481	-331137.381	15/12/2019
MAYG	4379104.235	4418744.627	-1401897.807	15/12/2019
REUN	3364098.933	4907944.672	-2293466.695	15/12/2019
SEYG	3597835.891	5240884.111	-516780.953	15/12/2019
ULDI	4796680.894	2930311.695	-3005435.627	15/12/2019
VACS	3215946.909	5047449.765	-2198718.161	15/12/2019
VOIM	4054014.089	4316070.348	-2365223.936	15/12/2019

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)
PTLU	-20 09 25.95080	57 30 15.44013	-0.884	2.811
ABPO	-19 01 05.89565	47 13 45.16957	1552.967	1553.757
CZTG	-46 25 54.82729	51 51 19.73706	202.800	151.005
DGAR	-7 16 10.85123	72 22 12.88291	-64.928	8.953
HARB	-25 53 13.05747	27 42 26.09004	1558.081	1532.770
HRAO	-25 53 24.36886	27 41 13.13997	1414.171	1388.815
MAL2	-2 59 45.79116	40 11 38.92659	-20.929	9.486
MAYG	-12 46 55.38823	45 15 29.35927	-16.531	4.060
REUN	-21 12 29.60676	55 34 18.20094	1558.368	1552.135
SEYG	-4 40 43.43139	55 31 50.27638	-37.613	3.389
ULDI	-28 17 35.21634	31 25 15.33424	607.952	583.457
VACS	-20 17 49.46788	57 29 49.33914	421.160	424.072
VOIM	-21 54 22.68134	46 47 35.76909	1163.392	1159.560

3.3 UTM Grid, GRS80 Ellipsoid, ITRF2020

Station	East (m)	North (m)	Zone	Ellipsoidal Height (m)	Derived Above Geoid Height(m)
PTLU	552699.213	7771041.919	40	-0.884	2.811
ABPO	734645.788	7895659.182	38	1552.967	1553.757
CZTG	565724.583	4857608.499	39	202.800	151.005
DGAR	209611.467	9195594.953	43	-64.928	8.953
HARB	570848.376	7136643.567	35	1558.081	1532.770
HRAO	568816.559	7136306.378	35	1414.171	1388.815
MAL2	632707.789	9668770.794	37	-20.929	9.486
MAYG	528019.031	8586952.128	38	-16.531	4.060
REUN	351756.245	7654138.823	40	1558.368	1552.135
SEYG	337019.629	9482677.632	40	-37.613	3.389
ULDI	345152.749	6869315.465	36	607.952	583.457
VACS	551895.105	7755565.800	40	421.160	424.072
VOIM	685246.087	7576462.404	38	1163.392	1159.560

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

Station	Longitude(East) (m)	Latitude(North) (m)	Ellipsoidal Height(Up) (m)
PTLU	0.011	0.008	0.029
ABPO	0.009	0.006	0.016
CZTG	0.009	0.008	0.019
DGAR	0.011	0.008	0.021
HARB	0.012	0.008	0.029
HRAO	0.014	0.009	0.032
MAL2	0.010	0.008	0.019
MAYG	0.010	0.007	0.024
REUN	0.010	0.006	0.018
SEYG	0.010	0.007	0.018
ULDI	0.012	0.008	0.027
VACS	0.009	0.006	0.018
VOIM	0.009	0.006	0.017

4 Ambiguity Resolution - Per Baseline

Baseline	Ambiguities Resolved	Baseline Length (km)
ABPO - CZTG	77.8 %	3040.502
PTLU - VACS	72.0 %	15.509
MAL2 - MAYG	73.9 %	1215.680
ABPO - VOIM	80.0 %	322.984
ABPO - HARB	80.0 %	2135.930
ABPO - MAYG	88.9 %	721.316
ABPO - DGAR	81.2 %	2986.153
HARB - HRAO	90.5 %	2.066
MAYG - SEYG	95.0 %	1438.654
HARB - ULDI	76.2 %	454.611
ABPO - REUN	76.3 %	904.754
ABPO - VACS	80.0 %	1084.732
AVERAGE	81.0%	1193.574

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.