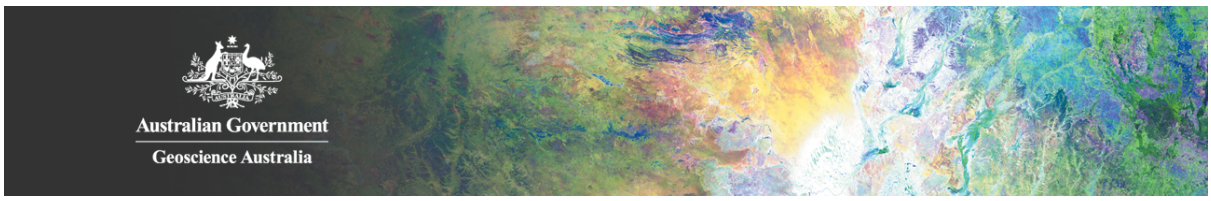

AUSPOS GPS Processing Report

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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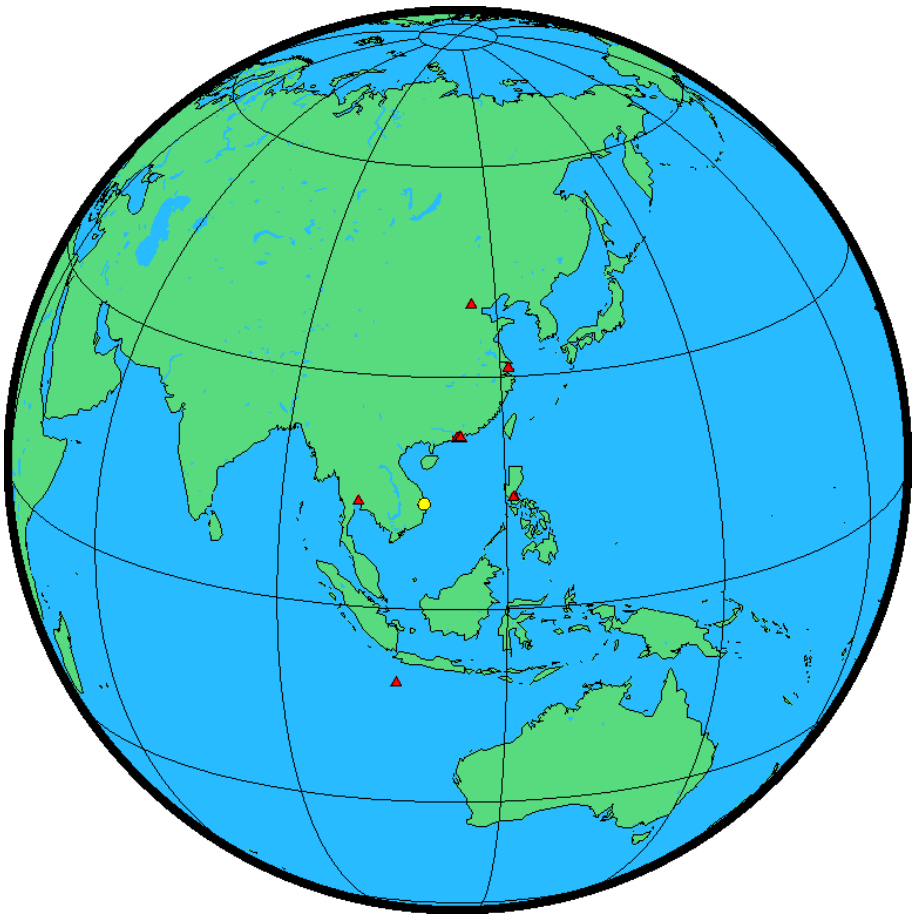
1 User Data

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
QUYN	quynohnkttv.o	SEPALTUS_NR3 NONE	2.000	2024/04/28 03:50:30	2024/04/28 11:24:30

2 Processing Summary



Date	User Stations	Reference Stations	Orbit Type
2024/04/28 03:50:30	QUYN	BJFS COAL CUSV FOMO HKCL HKLM HKMW HKNP HKPC PIMO PTAG SHAO XMIS	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 @
QUYN	-2043162.531	5849299.156	1508816.238	28/04/2024
BJFS	-2148744.697	4426641.140	4044655.765	28/04/2024
COAL	-2363061.497	5418784.781	2386861.855	28/04/2024
CUSV	-1132915.093	6092528.524	1504633.122	28/04/2024
FOMO	-2359952.701	5416529.995	2394688.332	28/04/2024
HKCL	-2392741.730	5397562.768	2404757.576	28/04/2024
HKLM	-2414046.731	5391602.074	2396878.590	28/04/2024
HKMW	-2402484.901	5395262.158	2400726.662	28/04/2024
HKNP	-2392361.063	5400226.006	2400094.176	28/04/2024
HKPC	-2405183.787	5392541.554	2403645.440	28/04/2024
PIMO	-3186293.427	5286624.441	1601158.375	28/04/2024
PTAG	-3184318.519	5291065.612	1590418.269	28/04/2024
SHAO	-2831734.092	4675665.692	3275369.190	28/04/2024
XMIS	-1696344.942	6039590.004	-1149274.860	28/04/2024

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)
QUYN	13 46 29.97921	109 15 15.58336	4.015	4.864
BJFS	39 36 30.95770	115 53 32.97253	87.466	97.507
COAL	22 07 14.46468	113 33 41.00098	169.380	173.801
CUSV	13 44 09.28788	100 32 02.12818	74.251	105.600
FOMO	22 11 50.69000	113 32 32.98350	56.605	61.290
HKCL	22 17 45.02192	113 54 27.82432	7.662	11.081
HKLM	22 13 08.24027	114 07 12.24247	8.504	10.820
HKMW	22 15 20.91560	114 00 11.46748	194.896	197.813
HKNP	22 14 56.62766	113 53 37.97920	350.660	354.006
HKPC	22 17 05.80726	114 02 16.25465	18.084	20.956
PIMO	14 38 08.59417	121 04 39.81645	95.496	51.380
PTAG	14 32 07.59125	121 02 26.74685	86.645	42.924
SHAO	31 05 58.70509	121 12 01.62335	22.008	11.204
XMIS	-10 26 59.84546	105 41 18.62162	261.519	263.036

3.3 UTM Grid, GRS80 Ellipsoid, ITRF2020

Station	East (m)	North (m)	Zone	Ellipsoidal Height (m)	Derived Above Geoid Height(m)
QUYN	311275.563	1523526.735	49	4.015	4.864
BJFS	404924.823	4384902.912	50	87.466	97.507
COAL	764227.950	2448410.171	49	169.380	173.801
CUSV	665854.811	1519047.201	47	74.251	105.600
FOMO	762135.636	2456876.488	49	56.605	61.290
HKCL	799603.946	2468458.782	49	7.662	11.081
HKLM	203099.538	2459885.873	50	8.504	10.820
HKMW	191123.000	2464203.291	50	194.896	197.813
HKNP	798275.728	2463248.957	49	350.660	354.006
HKPC	194761.278	2467361.028	50	18.084	20.956
PIMO	292961.459	1618913.505	51	95.496	51.380
PTAG	288883.330	1607851.042	51	86.645	42.924
SHAO	328369.768	3442037.143	51	22.008	11.204
XMIS	575352.749	8844755.869	48	261.519	263.036

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

Station	Longitude(East) (m)	Latitude(North) (m)	Ellipsoidal Height(Up) (m)
QUYN	0.013	0.012	0.066
BJFS	0.009	0.008	0.018
COAL	0.010	0.007	0.023
CUSV	0.010	0.006	0.017
FOMO	0.010	0.008	0.025
HKCL	0.010	0.007	0.024
HKLM	0.010	0.008	0.028
HKMW	0.010	0.007	0.025
HKNP	0.009	0.006	0.020
HKPC	0.009	0.006	0.020
PIMO	0.010	0.006	0.018
PTAG	0.009	0.006	0.016
SHAO	0.009	0.006	0.018
XMIS	0.008	0.008	0.019

4 Ambiguity Resolution - Per Baseline

Baseline	Ambiguities Resolved	Baseline Length (km)
QUYN - XMIS	57.1 %	2687.367
HKPC - PTAG	56.5 %	1130.790
BJFS - HKPC	59.0 %	1921.364
HKLM - HKPC	59.1 %	11.190
HKCL - HKNP	76.1 %	5.384
COAL - HKNP	65.2 %	37.121
CUSV - HKNP	65.0 %	1693.321
PIMO - PTAG	81.8 %	11.789
PTAG - XMIS	14.3 %	3206.286
HKPC - SHAO	40.9 %	1206.548
HKNP - HKPC	75.0 %	15.365
HKMW - HKPC	71.9 %	4.817
COAL - FOMO	67.4 %	8.718
AVERAGE	60.7%	918.466

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.