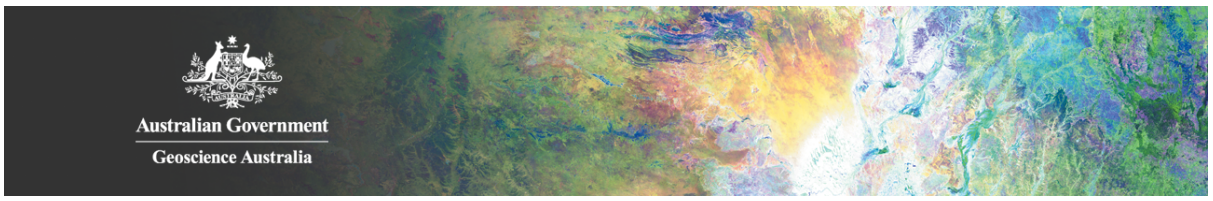

AUSPOS GPS Processing Report

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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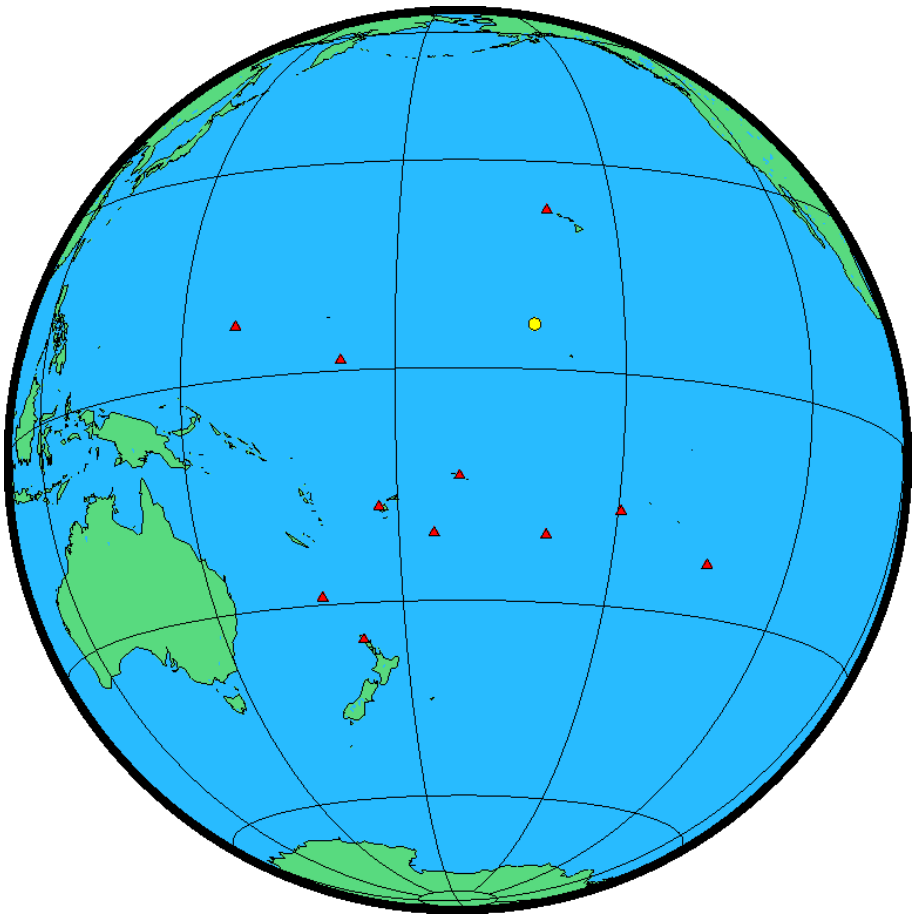
1 User Data

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
PALM	palmyrauh1.o	SEPALTUS_NR3 NONE	2.000	2024/01/16 04:35:00	2024/01/16 08:31:00

2 Processing Summary



Date	User Stations	Reference Stations	Orbit Type
2024/01/16 04:35:00	PALM	CKIS GAMB KIRI KOKB KTIA LAUT NORF POHN SAMO THTG TONG	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 @
PALM	-6037237.684	-1951237.150	649973.176	16/01/2024
CKIS	-5583182.794	-2054142.498	-2292166.085	16/01/2024
GAMB	-4147127.480	-4152221.690	-2490032.783	16/01/2024
KIRI	-6327822.280	785605.457	149769.677	16/01/2024
KOKB	-5543838.370	-2054585.552	2387810.570	16/01/2024
KTIA	-5190163.679	612173.563	-3644201.128	16/01/2024
LAUT	-6075194.720	270923.708	-1917188.936	16/01/2024
NORF	-5457454.518	1166108.400	-3078178.828	16/01/2024
POHN	-5879158.136	2350293.022	767748.712	16/01/2024
SAMO	-6129702.468	-890028.256	-1516806.646	16/01/2024
THTG	-5246415.516	-3077260.359	-1913841.635	16/01/2024
TONG	-5930303.494	-500149.091	-2286366.298	16/01/2024

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)
PALM	5 53 17.85708	-162 05 20.94300	19.284	2.243
CKIS	-21 12 03.67624	-159 48 02.23844	18.396	5.775
GAMB	-23 07 49.26529	-134 57 53.39296	80.673	88.920
KIRI	1 21 16.51378	172 55 22.38401	36.161	4.850
KOKB	22 07 34.56746	-159 39 53.78195	1167.358	1150.334
KTIA	-35 04 08.12535	173 16 23.20131	127.452	89.108
LAUT	-17 36 31.70977	177 26 47.69783	89.665	31.705
NORF	-29 02 36.02258	167 56 19.80501	159.002	112.157
POHN	6 57 35.81470	158 12 36.37170	90.671	39.380
SAMO	-13 50 57.13504	-171 44 18.35335	76.733	39.492
THTG	-17 34 37.40386	-149 36 23.20509	98.012	90.332
TONG	-21 08 40.97048	-175 10 45.13805	56.295	3.725

3.3 UTM Grid, GRS80 Ellipsoid, ITRF2020

Station	East (m)	North (m)	Zone	Ellipsoidal Height (m)	Derived Above Geoid Height(m)
PALM	822343.686	651696.892	3	19.284	2.243
CKIS	416902.235	7655394.562	4	18.396	5.775
GAMB	503600.664	7442049.813	8	80.673	88.920
KIRI	713949.892	149807.756	59	36.161	4.850
KOKB	431424.207	2446953.127	4	1167.358	1150.334
KTIA	707269.731	6116950.454	59	127.452	89.108
LAUT	547379.958	8053037.665	60	89.665	31.705
NORF	786189.632	6783647.517	58	159.002	112.157
POHN	412744.974	769394.204	57	90.671	39.380
SAMO	420202.517	8468827.768	2	76.733	39.492
THTG	223345.961	8054705.016	6	98.012	90.332
TONG	689073.767	7660752.358	1	56.295	3.725

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

Station	Longitude(East) (m)	Latitude(North) (m)	Ellipsoidal Height(Up) (m)
PALM	0.014	0.011	0.042
CKIS	0.010	0.007	0.016
GAMB	0.018	0.010	0.041
KIRI	0.010	0.007	0.016
KOKB	0.011	0.008	0.018
KTIA	0.012	0.012	0.029
LAUT	0.011	0.007	0.018
NORF	0.013	0.010	0.029
POHN	0.011	0.008	0.018
SAMO	0.011	0.008	0.025
THTG	0.014	0.008	0.026
TONG	0.013	0.009	0.029

4 Ambiguity Resolution - Per Baseline

Baseline	Ambiguities Resolved	Baseline Length (km)
KIRI - POHN	80.0 %	1741.104
SAMO - TONG	40.7 %	885.431
KTIA - NORF	92.9 %	835.864
PALM - SAMO	90.0 %	2414.467
LAUT - TONG	48.3 %	867.086
CKIS - THTG	92.3 %	1141.627
KIRI - KOKB	73.7 %	3700.019
GAMB - THTG	83.3 %	1641.942
KTIA - TONG	39.3 %	1904.937
CKIS - SAMO	100.0 %	1501.675
KIRI - SAMO	81.8 %	2371.598
AVERAGE	74.8%	1727.795

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.