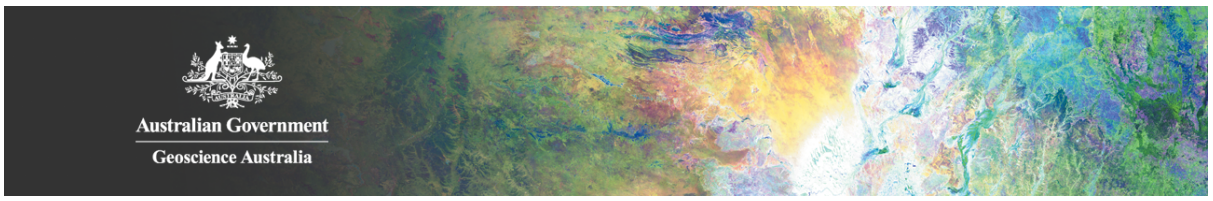

AUSPOS GPS Processing Report

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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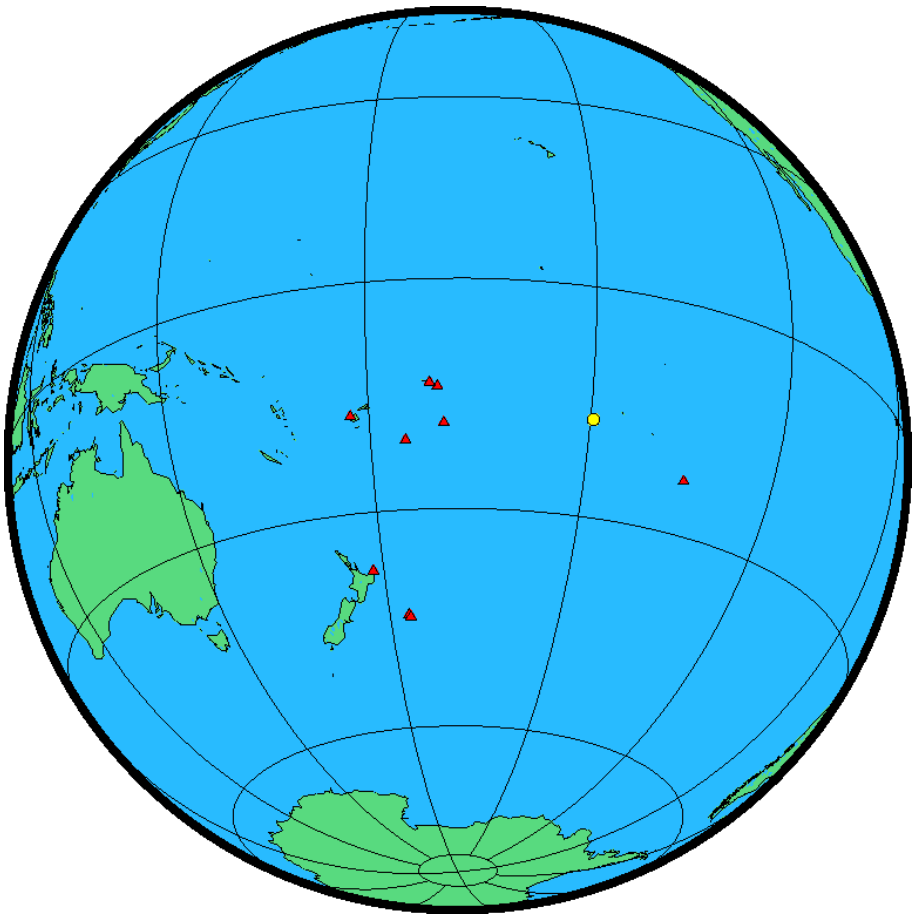
1 User Data

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
PAPE	papeNU20800.19o	SEPALTUS_NR3 NONE	2.000	2019/03/21 20:06:00	2019/03/22 00:24:00

2 Processing Summary



Date	User Stations	Reference Stations	Orbit Type
2019/03/21 20:06:00	PAPE	ASPA CHTI GAMB HIKB LAUT NIUM NIUT OWMG SAMO THTG TOGT 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 @
PAPE	-5245722.221	-3081140.390	-1909229.779	21/03/2019
ASPA	-6100260.181	-996502.667	-1567977.261	21/03/2019
CHTI	-4607856.221	-272375.375	-4386954.208	21/03/2019
GAMB	-4147127.209	-4152221.859	-2490032.918	21/03/2019
HIKB	-5060143.571	149885.088	-3867001.840	21/03/2019
LAUT	-6075194.672	270923.768	-1917189.076	21/03/2019
NIUM	-5937160.917	-1054675.211	-2071386.024	21/03/2019
NIUT	-5937831.771	-1055480.654	-2068907.678	21/03/2019
OWMG	-4584394.252	-290931.644	-4410047.928	21/03/2019
SAMO	-6129702.385	-890028.555	-1516806.806	21/03/2019
THTG	-5246415.298	-3077260.605	-1913841.795	21/03/2019
TOGT	-5931032.865	-498379.458	-2284874.436	21/03/2019
TONG	-5930303.517	-500148.658	-2286366.266	21/03/2019

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)
PAPE	-17 32 00.97580	-149 34 17.84040	9.484	1.907
ASPA	-14 19 33.92624	-170 43 20.78922	53.480	20.856
CHTI	-43 44 07.69416	-176 37 01.63478	75.686	64.730
GAMB	-23 07 49.27025	-134 57 53.38200	80.659	88.906
HIKB	-37 33 39.73602	178 18 12.07415	107.308	86.218
LAUT	-17 36 31.71457	177 26 47.69570	89.664	31.704
NIUM	-19 04 35.48442	-169 55 37.46513	89.710	59.091
NIUT	-19 03 10.79091	-169 55 14.35554	37.658	7.067
OWMG	-44 01 27.45499	-176 22 07.69618	21.622	11.963
SAMO	-13 50 57.14041	-171 44 18.34308	76.734	39.493
THTG	-17 34 37.40946	-149 36 23.19418	98.000	90.320
TOGT	-21 07 48.94586	-175 11 48.37212	57.757	5.110
TONG	-21 08 40.96969	-175 10 45.15308	56.270	3.700

3.3 UTM Grid, GRS80 Ellipsoid, ITRF2020

Station	East (m)	North (m)	Zone	Ellipsoidal Height (m)	Derived Above Geoid Height(m)
PAPE	226979.088	8059566.678	6	9.484	1.907
ASPA	529931.120	8416191.263	2	53.480	20.856
CHTI	530833.069	5157435.952	1	75.686	64.730
GAMB	503600.976	7442049.661	8	80.659	88.906
HIKB	615112.285	5842088.709	60	107.308	86.218
LAUT	547379.895	8053037.518	60	89.664	31.704
NIUM	612878.885	7890359.909	2	89.710	59.091
NIUT	613570.325	7892959.244	2	37.658	7.067
OWMG	550584.922	5125235.334	1	21.622	11.963
SAMO	420202.825	8468827.604	2	76.734	39.493
THTG	223346.285	8054704.849	6	98.000	90.320
TOGT	687267.506	7662373.158	1	57.757	5.110
TONG	689073.334	7660752.388	1	56.270	3.700

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

Station	Longitude(East) (m)	Latitude(North) (m)	Ellipsoidal Height(Up) (m)
PAPE	0.014	0.008	0.032
ASPA	0.009	0.006	0.016
CHTI	0.008	0.007	0.015
GAMB	0.018	0.008	0.031
HIKB	0.010	0.009	0.024
LAUT	0.009	0.006	0.016
NIUM	0.008	0.006	0.015
NIUT	0.010	0.007	0.025
OWMG	0.010	0.010	0.026
SAMO	0.010	0.008	0.027
THTG	0.012	0.008	0.025
TOGT	0.010	0.007	0.024
TONG	0.010	0.007	0.026

4 Ambiguity Resolution - Per Baseline

Baseline	Ambiguities Resolved	Baseline Length (km)
SAMO - TOGT	69.2 %	884.752
CHTI - HIKB	83.3 %	808.219
CHTI - OWMG	69.2 %	37.790
NIUM - NIUT	90.6 %	2.691
NIUM - THTG	75.0 %	2143.082
LAUT - TOGT	85.7 %	864.756
PAPE - THTG	83.3 %	6.067
GAMB - THTG	76.9 %	1641.942
NIUT - TOGT	84.6 %	597.536
HIKB - TOGT	81.8 %	1918.807
ASPA - SAMO	57.2 %	121.746
TOGT - TONG	92.3 %	2.426
AVERAGE	79.1%	752.485

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.