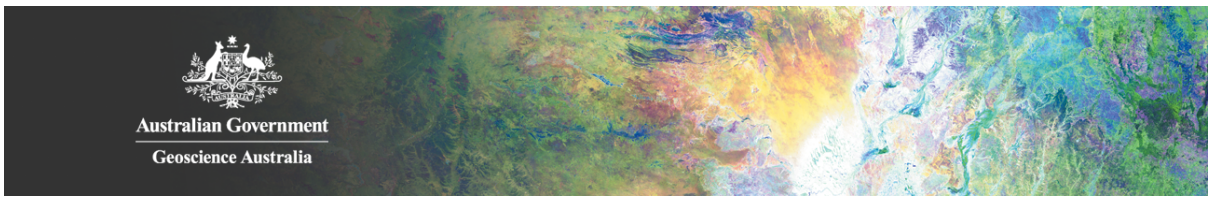

AUSPOS GPS Processing Report

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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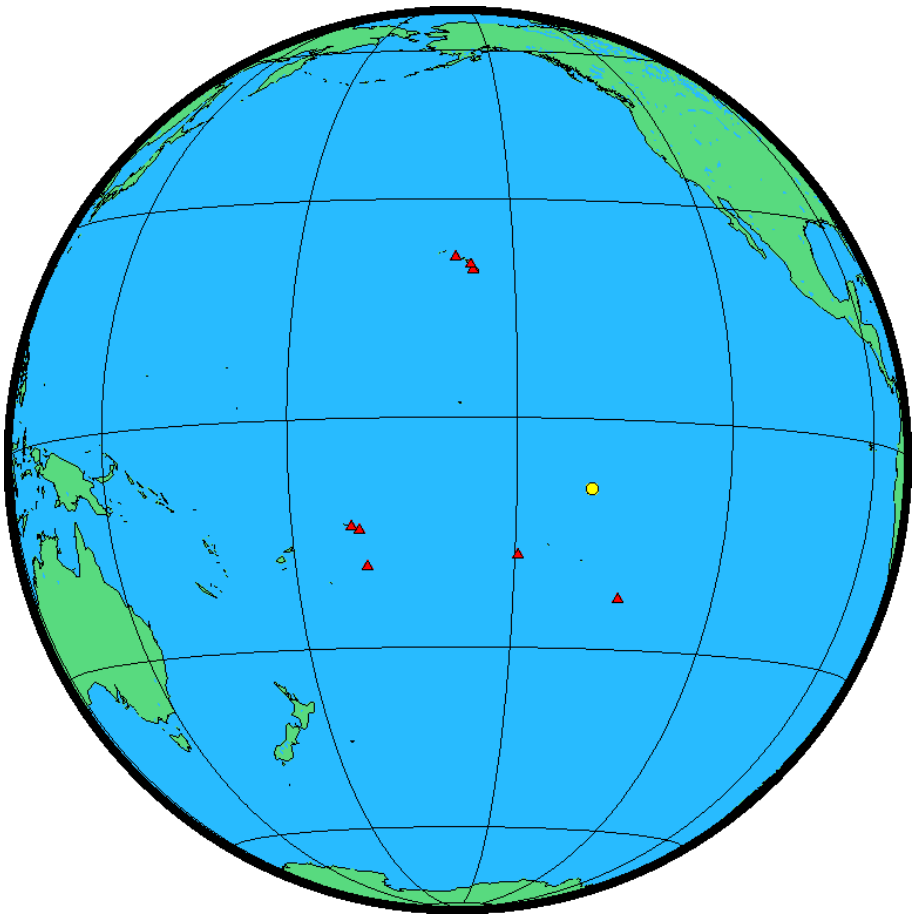
1 User Data

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
NUKU	nukubm40760.19o	SEPALTUS_NR3 NONE	2.000	2019/03/17 19:39:00	2019/03/17 23:39:00

2 Processing Summary



Date	User Stations	Reference Stations	Orbit Type
2019/03/17 19:39:00	NUKU	ASPA GAMB MLO1 NIUM NIUT SAMO THTG UPO5 ZHN1	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 @
NUKU	-4834077.900	-4042505.654	-981871.758	17/03/2019
ASPA	-6100260.179	-996502.662	-1567977.262	17/03/2019
GAMB	-4147127.223	-4152221.875	-2490032.918	17/03/2019
MLO1	-5478044.885	-2487693.530	2120497.303	17/03/2019
NIUM	-5937160.909	-1054675.212	-2071386.020	17/03/2019
NIUT	-5937831.776	-1055480.655	-2068907.678	17/03/2019
SAMO	-6129702.382	-890028.564	-1516806.799	17/03/2019
THTG	-5246415.286	-3077260.612	-1913841.787	17/03/2019
UPO5	-5464032.205	-2446031.323	2193283.814	17/03/2019
ZHN1	-5508636.785	-2234492.750	2303722.238	17/03/2019

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)
NUKU	-8 54 53.82697	-140 05 45.20588	7.762	2.943
ASPA	-14 19 33.92632	-170 43 20.78936	53.478	20.854
GAMB	-23 07 49.27000	-134 57 53.38195	80.679	88.926
MLO1	19 32 09.32501	-155 34 34.38576	3429.538	3401.849
NIUM	-19 04 35.48438	-169 55 37.46504	89.701	59.082
NIUT	-19 03 10.79084	-169 55 14.35551	37.662	7.071
SAMO	-13 50 57.14019	-171 44 18.34276	76.731	39.490
THTG	-17 34 37.40929	-149 36 23.19376	97.990	90.310
UPO5	20 14 45.20990	-155 53 01.76447	78.343	60.704
ZHN1	21 18 46.77228	-157 55 14.99295	24.218	8.652

3.3 UTM Grid, GRS80 Ellipsoid, ITRF2020

Station	East (m)	North (m)	Zone	Ellipsoidal Height (m)	Derived Above Geoid Height(m)
NUKU	599401.333	9014428.935	7	7.762	2.943
ASPA	529931.115	8416191.260	2	53.478	20.854
GAMB	503600.977	7442049.668	8	80.679	88.926
MLO1	229661.959	2162161.270	5	3429.538	3401.849
NIUM	612878.887	7890359.911	2	89.701	59.082
NIUT	613570.326	7892959.246	2	37.662	7.071
SAMO	420202.835	8468827.610	2	76.731	39.490
THTG	223346.298	8054704.854	6	97.990	90.310
UPO5	198710.765	2241317.452	5	78.343	60.704
ZHN1	611926.137	2357171.138	4	24.218	8.652

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

Station	Longitude(East) (m)	Latitude(North) (m)	Ellipsoidal Height(Up) (m)
NUKU	0.020	0.010	0.038
ASPA	0.010	0.008	0.017
GAMB	0.021	0.010	0.035
MLO1	0.020	0.015	0.035
NIUM	0.010	0.008	0.017
NIUT	0.012	0.009	0.030
SAMO	0.014	0.009	0.032
THTG	0.014	0.009	0.029
UPO5	0.020	0.015	0.035
ZHN1	0.020	0.015	0.036

4 Ambiguity Resolution - Per Baseline

Baseline	Ambiguities Resolved	Baseline Length (km)
ASPA - NIUM	66.7 %	532.359
NIUM - NIUT	100.0 %	2.691
NIUM - THTG	90.0 %	2143.082
MLO1 - UPO5	90.9 %	85.029
NUKU - THTG	76.9 %	1403.670
UPO5 - ZHN1	72.8 %	242.765
GAMB - THTG	84.6 %	1641.942
ASPA - SAMO	76.9 %	121.746
THTG - ZHN1	14.3 %	4308.928
AVERAGE	74.8%	1164.690

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.