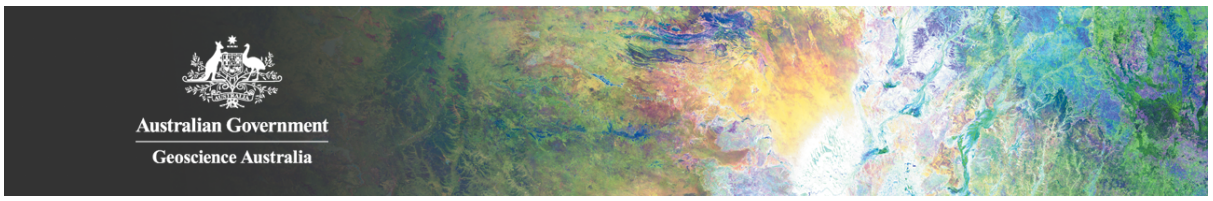

AUSPOS GPS Processing Report

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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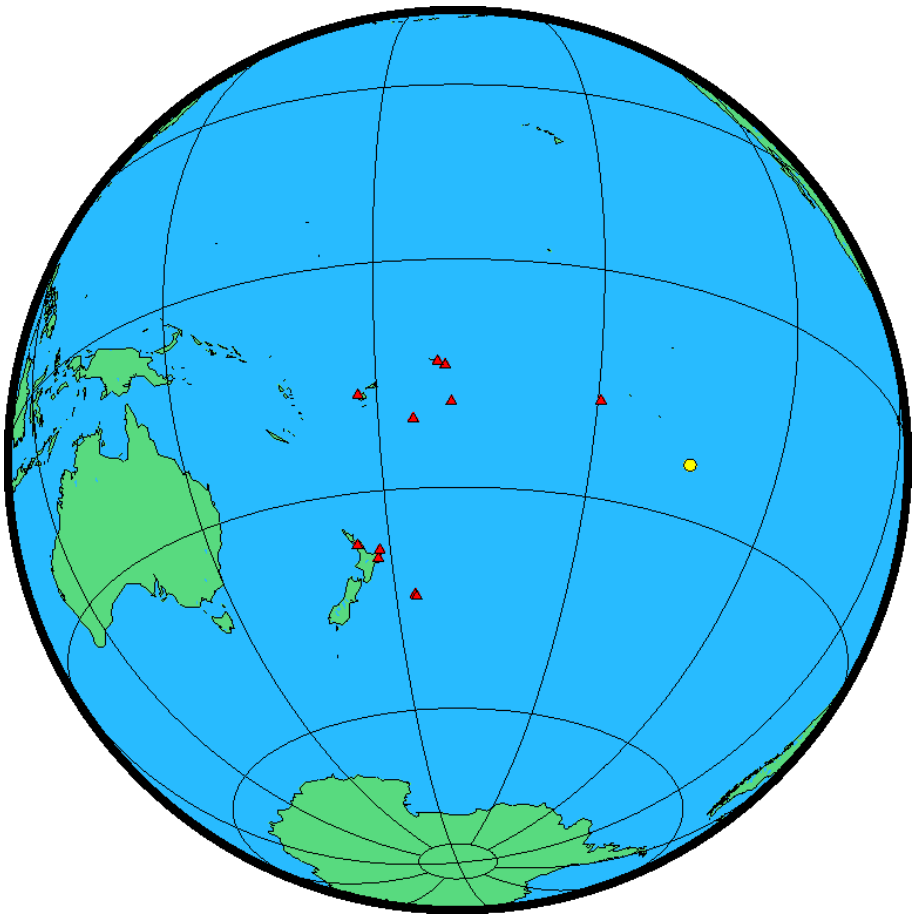
1 User Data

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
RIKI	rikibm60840.19o	SEPALTUS_NR3 NONE	2.000	2019/03/25 17:15:30	2019/03/25 21:24:00

2 Processing Summary



Date	User Stations	Reference Stations	Orbit Type
2019/03/25 17:15:30	RIKI	ASPA AUCK CHTI GAMB GISB HIKB LAUT NIUM 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 @
RIKI	-4147513.901	-4152173.149	-2489254.920	25/03/2019
ASPA	-6100260.171	-996502.657	-1567977.258	25/03/2019
AUCK	-5105681.524	461564.001	-3782181.032	25/03/2019
CHTI	-4607856.221	-272375.378	-4386954.206	25/03/2019
GAMB	-4147127.199	-4152221.856	-2490032.914	25/03/2019
GISB	-4985376.352	184022.226	-3960829.871	25/03/2019
HIKB	-5060143.567	149885.084	-3867001.842	25/03/2019
LAUT	-6075194.679	270923.767	-1917189.078	25/03/2019
NIUM	-5937160.913	-1054675.208	-2071386.021	25/03/2019
OWMG	-4584394.256	-290931.648	-4410047.929	25/03/2019
SAMO	-6129702.398	-890028.558	-1516806.812	25/03/2019
THTG	-5246415.289	-3077260.606	-1913841.788	25/03/2019
TOGT	-5931032.887	-498379.460	-2284874.450	25/03/2019
TONG	-5930303.535	-500148.661	-2286366.276	25/03/2019

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)
RIKI	-23 07 22.96347	-134 58 04.20781	-5.294	2.996
ASPA	-14 19 33.92626	-170 43 20.78950	53.468	20.844
AUCK	-36 36 10.21527	174 50 03.79113	132.693	97.760
CHTI	-43 44 07.69410	-176 37 01.63467	75.685	64.729
GAMB	-23 07 49.27026	-134 57 53.38185	80.649	88.896
GISB	-38 38 07.19959	177 53 09.72527	87.185	65.533
HIKB	-37 33 39.73615	178 18 12.07433	107.306	86.216
LAUT	-17 36 31.71456	177 26 47.69576	89.671	31.711
NIUM	-19 04 35.48437	-169 55 37.46521	89.704	59.085
OWMG	-44 01 27.45493	-176 22 07.69603	21.627	11.968
SAMO	-13 50 57.14047	-171 44 18.34304	76.748	39.507
THTG	-17 34 37.40931	-149 36 23.19399	97.990	90.310
TOGT	-21 07 48.94602	-175 11 48.37211	57.782	5.135
TONG	-21 08 40.96976	-175 10 45.15301	56.291	3.721

3.3 UTM Grid, GRS80 Ellipsoid, ITRF2020

Station	East (m)	North (m)	Zone	Ellipsoidal Height (m)	Derived Above Geoid Height(m)
RIKI	503293.271	7442858.676	8	-5.294	2.996
ASPA	529931.111	8416191.262	2	53.468	20.844
AUCK	306301.232	5947001.372	60	132.693	97.760
CHTI	530833.072	5157435.954	1	75.685	64.729
GAMB	503600.980	7442049.661	8	80.649	88.896
GISB	577116.256	5723317.309	60	87.185	65.533
HIKB	615112.290	5842088.705	60	107.306	86.216
LAUT	547379.897	8053037.518	60	89.671	31.711
NIUM	612878.883	7890359.911	2	89.704	59.085
OWMG	550584.926	5125235.336	1	21.627	11.968
SAMO	420202.827	8468827.602	2	76.748	39.507
THTG	223346.291	8054704.854	6	97.990	90.310
TOGT	687267.506	7662373.153	1	57.782	5.135
TONG	689073.336	7660752.385	1	56.291	3.721

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

Station	Longitude(East) (m)	Latitude(North) (m)	Ellipsoidal Height(Up) (m)
RIKI	0.020	0.010	0.043
ASPA	0.008	0.006	0.015
AUCK	0.008	0.006	0.015
CHTI	0.008	0.006	0.015
GAMB	0.017	0.009	0.030
GISB	0.009	0.008	0.021
HIKB	0.009	0.008	0.022
LAUT	0.009	0.006	0.016
NIUM	0.007	0.005	0.015
OWMG	0.009	0.009	0.024
SAMO	0.009	0.007	0.024
THTG	0.013	0.007	0.022
TOGT	0.012	0.008	0.032
TONG	0.010	0.007	0.029

4 Ambiguity Resolution - Per Baseline

Baseline	Ambiguities Resolved	Baseline Length (km)
ASPA - NIUM	66.7 %	532.359
CHTI - OWMG	82.4 %	37.790
GISB - HIKB	81.2 %	124.736
NIUM - THTG	85.7 %	2143.082
ASPA - TONG	52.9 %	889.570
AUCK - GISB	72.2 %	351.309
GAMB - THTG	88.3 %	1641.942
GISB - OWMG	87.5 %	766.919
HIKB - NIUM	86.7 %	2333.315
ASPA - SAMO	64.3 %	121.746
TOGT - TONG	91.3 %	2.426
GAMB - RIKI	83.3 %	0.870
LAUT - SAMO	86.7 %	1229.263
AVERAGE	79.2%	782.717

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.