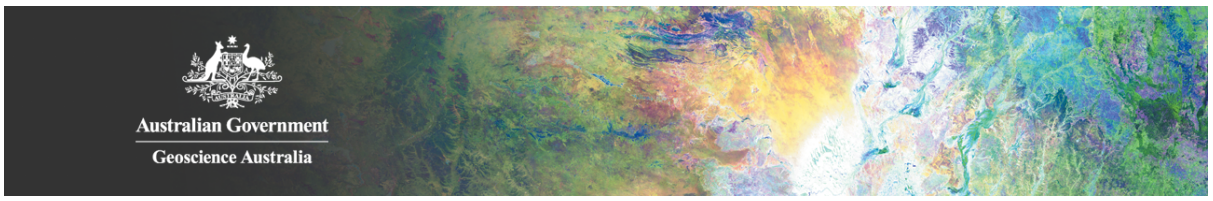

AUSPOS GPS Processing Report

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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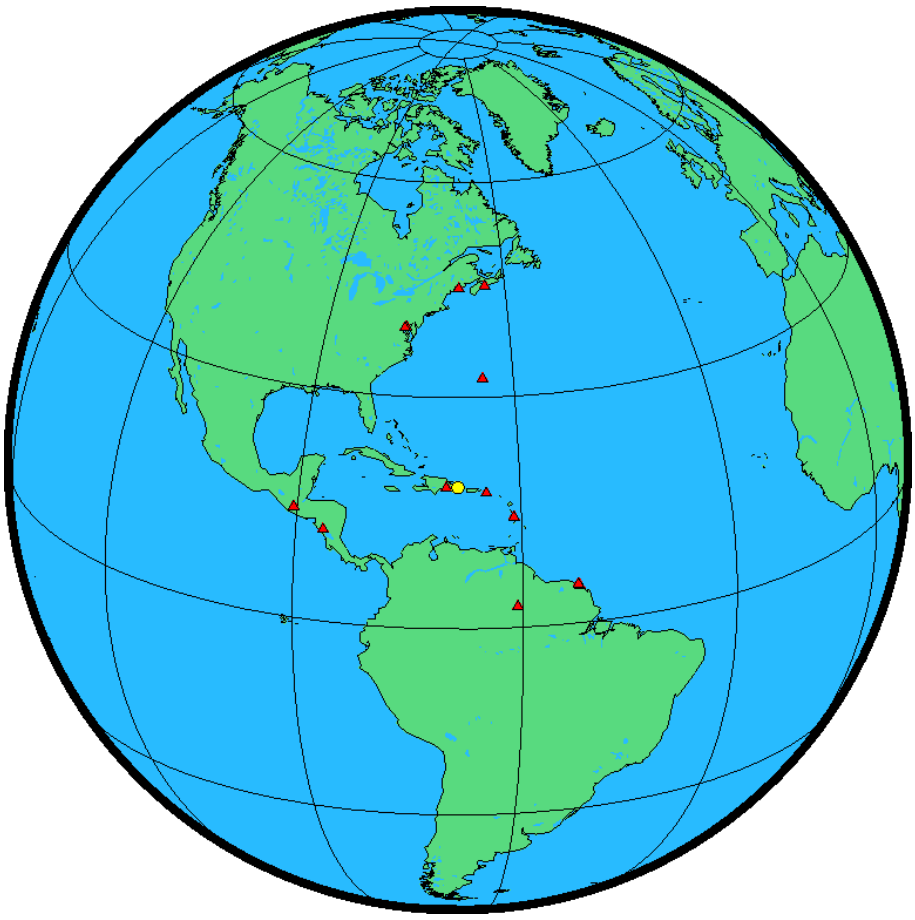
1 User Data

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
PUCA	pucauh51470.19o	SEPALTUS_NR3 NONE	2.000	2019/05/27 18:01:00	2019/05/27 22:01:30

2 Processing Summary



Date	User Stations	Reference Stations	Orbit Type
2019/05/27 18:01:00	PUCA	BARH BOAV BRMU CRO1 GODE GUAT HLFX KOUG KOUR LMMF MANA RDSD WDC5	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 @
PUCA	2229587.737	-5624553.198	2011513.962	27/05/2019
BARH	1693644.614	-4239067.593	4439567.314	27/05/2019
BOAV	3117452.159	-5555487.874	314480.976	27/05/2019
BRMU	2304703.281	-4874817.168	3395187.050	27/05/2019
CRO1	2607771.336	-5488076.594	1932767.967	27/05/2019
GODE	1130773.526	-4831253.567	3994200.452	27/05/2019
GUAT	-56063.526	-6174978.646	1596665.294	27/05/2019
HLFX	2018905.532	-4069070.523	4462415.497	27/05/2019
KOUG	3855263.315	-5049732.031	563040.515	27/05/2019
KOUR	3839591.323	-5059567.581	579957.233	27/05/2019
LMMF	2993387.394	-5399363.839	1596748.157	27/05/2019
MANA	407981.940	-6222925.651	1333529.092	27/05/2019
RDSD	2078678.907	-5683737.242	2006886.961	27/05/2019
WDC5	1112158.635	-4842855.625	3985496.984	27/05/2019

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)
PUCA	18 30 20.04795	-68 22 35.38096	-40.260	3.602
BARH	44 23 42.17596	-68 13 18.09520	6.757	31.505
BOAV	2 50 42.66414	-60 42 04.01628	69.510	84.808
BRMU	32 22 13.43978	-64 41 46.58981	-11.644	20.805
CRO1	17 45 24.83949	-64 35 03.54604	-31.937	11.742
GODE	39 01 18.22118	-76 49 36.59743	14.479	47.744
GUAT	14 35 25.45588	-90 31 12.65660	1519.857	1517.297
HLFX	44 41 00.78213	-63 36 40.61703	3.097	24.461
KOUG	5 05 54.49799	-52 38 23.10184	107.267	141.850
KOUR	5 15 07.85884	-52 48 21.45682	-25.770	8.491
LMMF	14 35 41.34378	-60 59 46.23233	-27.110	10.994
MANA	12 08 56.18262	-86 14 56.37469	71.014	66.406
RDSD	18 27 41.03363	-69 54 40.76240	-9.194	26.182
WDC5	38 55 14.03290	-77 03 58.74637	58.989	91.854

3.3 UTM Grid, GRS80 Ellipsoid, ITRF2020

Station	East (m)	North (m)	Zone	Ellipsoidal Height (m)	Derived Above Geoid Height(m)
PUCA	565816.297	2046234.856	19	-40.260	3.602
BARH	561984.581	4916046.114	19	6.757	31.505
BOAV	755563.748	314735.562	20	69.510	84.808
BRMU	340415.196	3582757.914	20	-11.644	20.805
CRO1	332034.052	1963998.592	20	-31.937	11.742
GODE	341854.140	4320775.452	18	14.479	47.744
GUAT	767172.940	1614480.840	15	1519.857	1517.297
HLFX	451557.117	4947979.579	20	3.097	24.461
KOUG	318229.358	563780.418	22	107.267	141.850
KOUR	299847.155	580829.157	22	-25.770	8.491
LMMF	715865.054	1614463.278	20	-27.110	10.994
MANA	581710.931	1343135.880	16	71.014	66.406
RDSD	403775.720	2041476.417	19	-9.194	26.182
WDC5	320865.704	4309991.432	18	58.989	91.854

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

Station	Longitude(East) (m)	Latitude(North) (m)	Ellipsoidal Height(Up) (m)
PUCA	0.019	0.012	0.069
BARH	0.009	0.008	0.017
BOAV	0.011	0.008	0.020
BRMU	0.009	0.007	0.017
CRO1	0.010	0.007	0.019
GODE	0.009	0.008	0.018
GUAT	0.012	0.008	0.020
HLFX	0.009	0.008	0.018
KOUG	0.011	0.007	0.018
KOUR	0.014	0.008	0.020
LMMF	0.010	0.006	0.017
MANA	0.014	0.008	0.036
RDSD	0.010	0.006	0.018
WDC5	0.010	0.009	0.026

4 Ambiguity Resolution - Per Baseline

Baseline	Ambiguities Resolved	Baseline Length (km)
BOAV - KOUG	85.7 %	928.405
CRO1 - LMMF	66.7 %	519.114
BRMU - LMMF	50.1 %	1995.950
KOUG - LMMF	42.3 %	1390.548
BARH - HLFX	82.3 %	367.717
BARH - WDC5	76.4 %	953.345
GODE - WDC5	73.7 %	23.598
KOUG - KOUR	56.8 %	25.070
MANA - RDSD	64.3 %	1880.256
PUCA - RDSD	36.7 %	162.165
BARH - BRMU	75.0 %	1366.858
GUAT - MANA	53.3 %	535.610
LMMF - RDSD	80.0 %	1042.005
AVERAGE	64.9%	860.819

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.