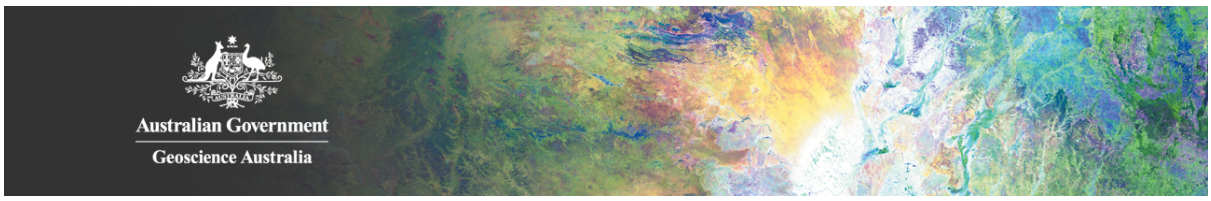


AUSPOS GPS Processing Report

July 31, 2022

This document is a report of the GPS data processing undertaken by the AUSPOS Online GPS Processing Service (version: AUSPOS 2.4) . 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.

Please direct any correspondence to GNSSAnalysis@ga.gov.au

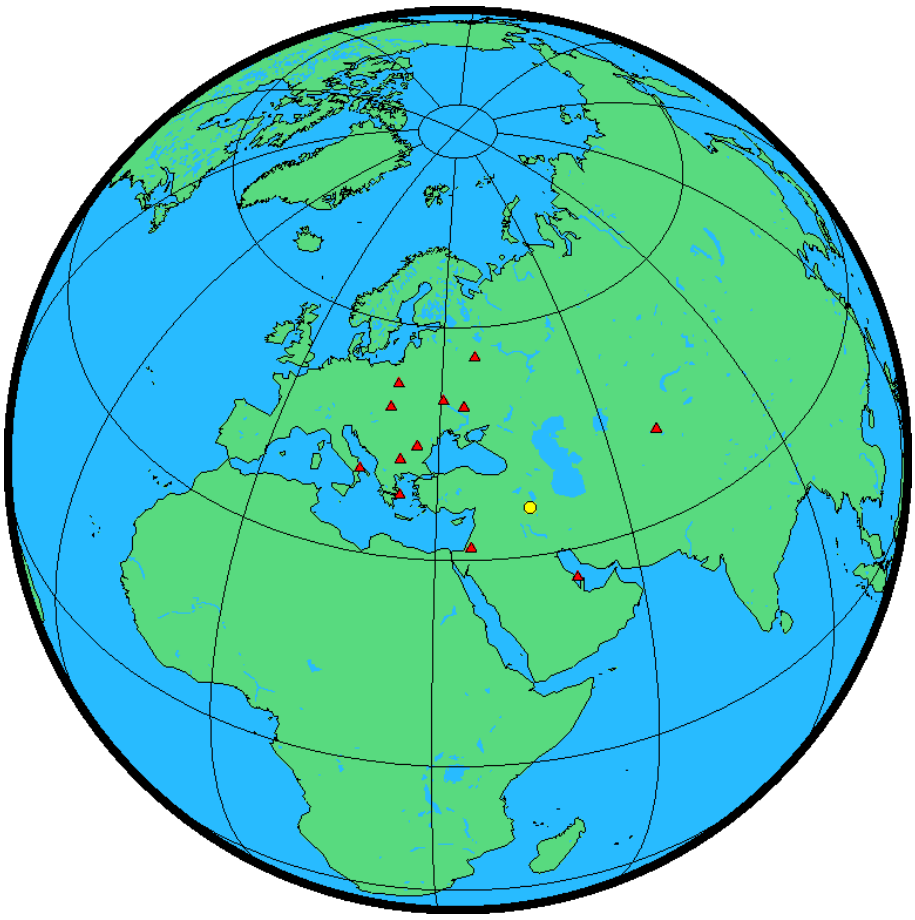
Geoscience Australia
Cnr Jerrabomberra and Hindmarsh Drive
GPO Box 378, Canberra, ACT 2601, Australia
Freecall (Within Australia): 1800 800 173
Tel: +61 2 6249 9111. Fax +61 2 6249 9929
Geoscience Australia
Home Page: http://www.ga.gov.au

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
RANR	RanR.220	UNIUA35 NONE	0.000	2022/07/20 00:00:00	2022/07/20 23:59:30

2 Processing Summary



Date	User Stations	Reference Stations	Orbit Type
2022/07/20 00:00:00	RANR	BHR4 BUCU DRAG DYNG GANP GLSV JOZ2 MAT1 MDVJ POLV SOFI TASH	IGS rapid

3 Computed Coordinates, ITRF2014

All coordinates are based on the IGS realisation of the ITRF2014 reference frame. All the given ITRF2014 coordinates refer to a mean epoch of the site observation data. All coordinates refer to the Ground Mark.

3.1 Cartesian, ITRF2014

Station	X (m)	Y (m)	Z (m)	ITRF2014 @
RANR	3653573.235	3632807.145	3747980.746	20/07/2022
BHR4	3633910.065	4425277.913	2799863.369	20/07/2022
BUCU	4093760.560	2007794.112	4445130.150	20/07/2022
DRAG	4432980.303	3149432.335	3322110.786	20/07/2022
DYNG	4595220.055	2039434.215	3912625.891	20/07/2022
GANP	3929181.237	1455237.004	4793654.069	20/07/2022
GLSV	3512888.607	2068980.130	4888903.351	20/07/2022
JOZ2	3664880.253	1409190.863	5009618.619	20/07/2022
MAT1	4641951.125	1393053.994	4133281.120	20/07/2022
MDVJ	2845455.698	2160954.455	5265993.331	20/07/2022
POLV	3411556.985	2348464.208	4834397.020	20/07/2022
SOFI	4319371.782	1868688.101	4292064.080	20/07/2022
TASH	1695944.735	4487138.693	4190140.765	20/07/2022

3.2 Geodetic, GRS80 Ellipsoid, ITRF2014

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)
RANR	36 13 01.15726	44 50 12.14957	570.426	558.042
BHR4	26 12 32.92569	50 36 29.34371	-13.885	13.685
BUCU	44 27 50.20869	26 07 32.68476	143.231	107.683
DRAG	31 35 35.53382	35 23 31.46846	31.861	13.607
DYNG	38 04 42.78739	23 55 56.76687	510.573	471.287
GANP	49 02 04.97651	20 19 22.58600	746.033	703.993
GLSV	50 21 51.06538	30 29 48.25618	226.318	200.776
JOZ2	52 05 52.21710	21 01 56.48339	152.511	120.968
MAT1	40 38 56.63426	16 42 16.38395	534.526	489.023
MDVJ	56 01 17.37912	37 12 52.23749	257.104	241.409
POLV	49 36 09.41716	34 32 34.56908	178.354	159.773
SOFI	42 33 21.94740	23 23 41.05578	1119.518	1074.441
TASH	41 19 40.97924	69 17 44.05889	439.710	483.280

3.3 UTM Grid, GRS80 Ellipsoid, ITRF2014

Station	East (m)	North (m)	Zone	Ellipsoidal Height (m)	Derived Above Geoid Height(m)
RANR	485323.316	4008028.402	38	570.426	558.042
BHR4	460854.182	2898904.894	39	-13.885	13.685
BUCU	430455.884	4923776.158	35	143.231	107.683
DRAG	726966.061	3497829.843	36	31.861	13.607
DYNG	757212.233	4218592.073	34	510.573	471.287
GANP	450512.750	5431535.765	34	746.033	703.993
GLSV	321967.869	5582119.656	36	226.318	200.776
JOZ2	502216.445	5771920.628	34	152.511	120.968
MAT1	644116.268	4501197.847	33	534.526	489.023
MDVJ	388711.480	6209909.962	37	257.104	241.409
POLV	611484.321	5495592.558	36	178.354	159.773
SOFI	696595.333	4714301.431	34	1119.518	1074.441
TASH	524734.407	4575216.872	42	439.710	483.280

3.4 Positional Uncertainty (95% C.L.) - Geodetic, ITRF2014

Station	Longitude(East) (m)	Latitude(North) (m)	Ellipsoidal Height(Up) (m)
RANR	0.005	0.003	0.011
BHR4	0.005	0.003	0.008
BUCU	0.004	0.003	0.007
DRAG	0.004	0.003	0.007
DYNG	0.005	0.003	0.008
GANP	0.004	0.003	0.008
GLSV	0.004	0.003	0.007
JOZ2	0.005	0.003	0.008
MAT1	0.005	0.003	0.008
MDVJ	0.004	0.003	0.008
POLV	0.004	0.003	0.008
SOFI	0.004	0.003	0.008
TASH	0.006	0.003	0.010

4 Ambiguity Resolution - Per Baseline

Baseline	Ambiguities Resolved	Baseline Length (km)
GLSV - POLV	84.3 %	302.242
GLSV - JOZ2	88.1 %	687.747
DRAG - RANR	76.2 %	1011.183
BUCU - GLSV	93.0 %	733.547
BHR4 - DRAG	76.2 %	1593.436
GLSV - MDVJ	86.6 %	772.090
BUCU - DYNG	94.4 %	732.136
BUCU - SOFI	57.6 %	306.072
DRAG - DYNG	85.5 %	1267.725
GANP - GLSV	93.4 %	747.698
BUCU - MAT1	71.2 %	880.720
BHR4 - TASH	35.6 %	2385.877
AVERAGE	78.5%	951.706

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	IGS14 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	IGS14 phase-centre variation model applied
Satellite phase centre calibration	IGS14 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	IGS14 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 ITRF2014. Uncertainties are scaled using an empirically derived model which is a function of data span, quality and geographical location.