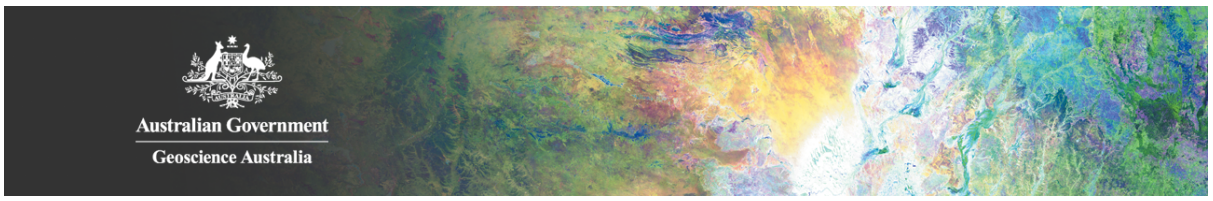

AUSPOS GPS Processing Report

September 1, 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.

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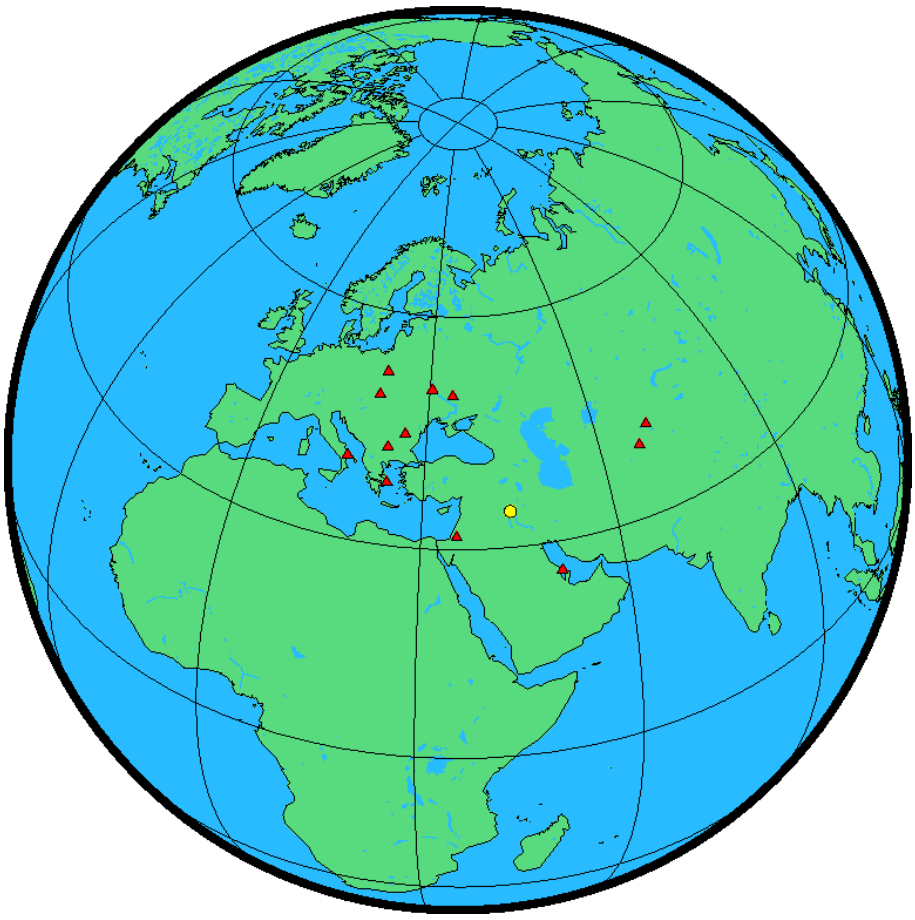
1 User Data

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
TKRR	TkrR99IRQ_R_2022 2380000_01D_01S.22O	UNIUA35 NONE	0.000	2022/08/26 00:00:00	2022/08/26 11:17:00

2 Processing Summary



Date	User Stations	Reference Stations	Orbit Type
2022/08/26 00:00:00	TKRR	BHR4 BUCU DRAG DYNG GANP GLSV JOZ2 KIT3 MAT1 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 @
TKRR	3799969.910	3628489.425	3604022.428	26/08/2022
BHR4	3633910.055	4425277.908	2799863.365	26/08/2022
BUCU	4093760.565	2007794.118	4445130.157	26/08/2022
DRAG	4432980.302	3149432.339	3322110.791	26/08/2022
DYNG	4595220.059	2039434.214	3912625.890	26/08/2022
GANP	3929181.234	1455237.004	4793654.068	26/08/2022
GLSV	3512888.608	2068980.133	4888903.357	26/08/2022
JOZ2	3664880.255	1409190.866	5009618.627	26/08/2022
KIT3	1944944.653	4556652.363	4004326.058	26/08/2022
MAT1	4641951.126	1393053.995	4133281.121	26/08/2022
POLV	3411556.983	2348464.207	4834397.021	26/08/2022
SOFI	4319371.789	1868688.106	4292064.086	26/08/2022
TASH	1695944.731	4487138.686	4190140.762	26/08/2022

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)
TKRR	34 37 39.48127	43 40 39.37512	124.670	119.685
BHR4	26 12 32.92574	50 36 29.34388	-13.896	13.674
BUCU	44 27 50.20870	26 07 32.68492	143.241	107.693
DRAG	31 35 35.53392	35 23 31.46859	31.865	13.611
DYNG	38 04 42.78732	23 55 56.76676	510.575	471.289
GANP	49 02 04.97655	20 19 22.58607	746.030	703.990
GLSV	50 21 51.06545	30 29 48.25629	226.324	200.782
JOZ2	52 05 52.21720	21 01 56.48353	152.519	120.976
KIT3	39 08 05.16379	66 53 07.62370	622.468	659.565
MAT1	40 38 56.63428	16 42 16.38400	534.528	489.025
POLV	49 36 09.41724	34 32 34.56909	178.353	159.772
SOFI	42 33 21.94736	23 23 41.05586	1119.528	1074.451
TASH	41 19 40.97932	69 17 44.05895	439.702	483.272

3.3 UTM Grid, GRS80 Ellipsoid, ITRF2014

Station	East (m)	North (m)	Zone	Ellipsoidal Height (m)	Derived Above Geoid Height(m)
TKRR	378781.248	3832545.304	38	124.670	119.685
BHR4	460854.186	2898904.896	39	-13.896	13.674
BUCU	430455.888	4923776.158	35	143.241	107.693
DRAG	726966.064	3497829.846	36	31.865	13.611
DYNG	757212.231	4218592.071	34	510.575	471.289
GANP	450512.751	5431535.767	34	746.030	703.990
GLSV	321967.872	5582119.658	36	226.324	200.782
JOZ2	502216.448	5771920.631	34	152.519	120.976
KIT3	317236.822	4333861.163	42	622.468	659.565
MAT1	644116.269	4501197.847	33	534.528	489.025
POLV	611484.321	5495592.560	36	178.353	159.772
SOFI	696595.334	4714301.430	34	1119.528	1074.451
TASH	524734.408	4575216.874	42	439.702	483.272

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

Station	Longitude(East) (m)	Latitude(North) (m)	Ellipsoidal Height(Up) (m)
TKRR	0.006	0.005	0.016
BHR4	0.006	0.004	0.011
BUCU	0.005	0.003	0.009
DRAG	0.006	0.005	0.012
DYNG	0.005	0.004	0.011
GANP	0.005	0.004	0.010
GLSV	0.005	0.004	0.009
JOZ2	0.006	0.005	0.012
KIT3	0.006	0.004	0.011
MAT1	0.005	0.004	0.011
POLV	0.005	0.004	0.010
SOFI	0.005	0.004	0.010
TASH	0.006	0.004	0.011

4 Ambiguity Resolution - Per Baseline

Baseline	Ambiguities Resolved	Baseline Length (km)
KIT3 - TASH	82.4 %	318.371
GLSV - POLV	75.0 %	302.242
GLSV - JOZ2	88.9 %	687.747
DRAG - TKRR	80.4 %	842.420
DYNG - TKRR	89.5 %	1803.540
BUCU - GLSV	90.4 %	733.547
BHR4 - DYNG	10.3 %	2802.607
BUCU - DYNG	88.9 %	732.136
BUCU - SOFI	61.5 %	306.072
BUCU - MAT1	66.6 %	880.720
GANP - JOZ2	90.0 %	344.407
BHR4 - TASH	10.3 %	2385.877
AVERAGE	69.5%	1011.640

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.