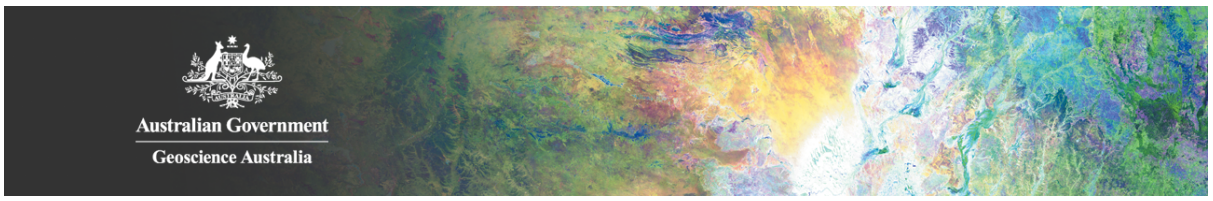


AUSPOS GPS Processing Report

May 8, 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

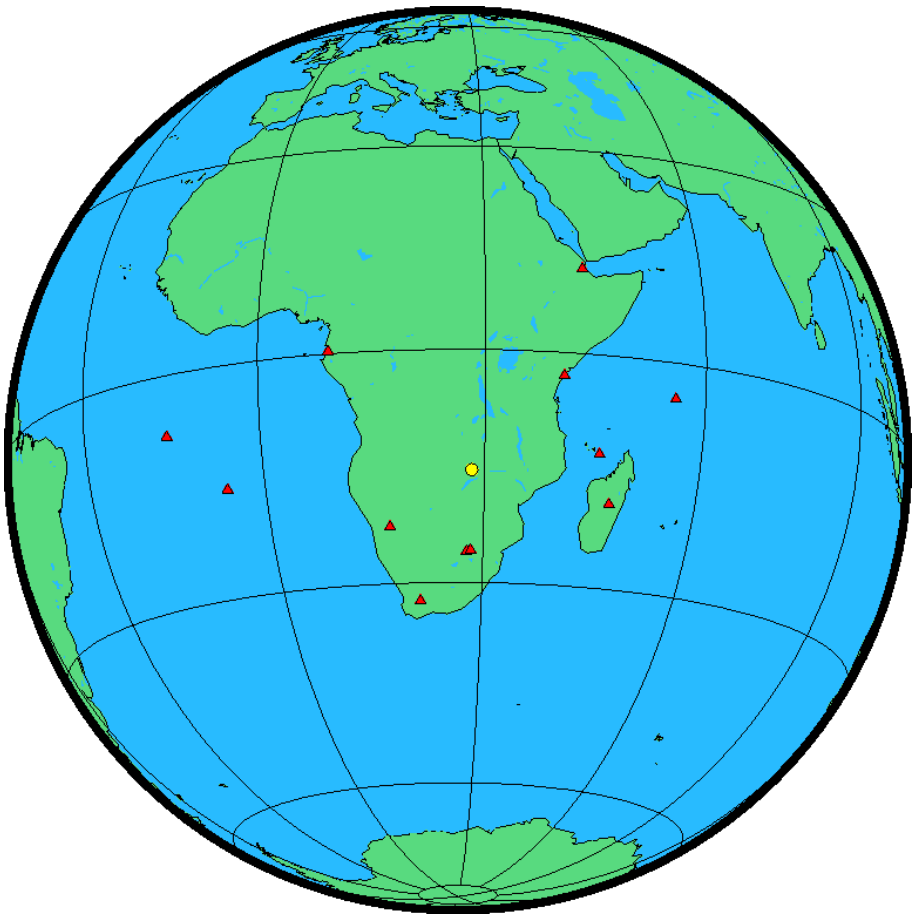
Geoscience Australia
Cnr Jerrabomberra and Hindmarsh Drive
GPO Box 378, Canberra, ACT 2601, Australia
Freecall (Within Australia): 1800 800 173
Tel: +61 2 6249 9111. Fax +61 2 6249 9929
Geoscience Australia
Home Page: http://www.ga.gov.au

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
ZAMB	zamb0450.22o	NONE NONE	0.000	2022/02/14 00:00:00	2022/02/14 23:59:30

2 Processing Summary



Date	User Stations	Reference Stations	Orbit Type
2022/02/14 00:00:00	ZAMB	ABPO ASCG DJIG HARB HRAO MAL2 MAYG NKLG PRE3 SEYG STHL SUTH WIND	IGS final

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 @
ZAMB	5415352.994	2917210.271	-1685888.578	14/02/2022
ABPO	4097216.517	4429119.242	-2065771.150	14/02/2022
ASCG	6121151.552	-1563978.963	-872615.281	14/02/2022
DJIG	4583085.888	4250982.702	1266243.241	14/02/2022
HARB	5084657.602	2670325.443	-2768480.863	14/02/2022
HRAO	5085352.432	2668396.171	-2768731.254	14/02/2022
MAL2	4865385.406	4110717.538	-331137.345	14/02/2022
MAYG	4379104.170	4418744.654	-1401897.774	14/02/2022
NKLG	6287385.696	1071574.908	39133.237	14/02/2022
PRE3	5066223.440	2719223.282	-2754406.232	14/02/2022
SEYG	3597835.836	5240884.130	-516780.924	14/02/2022
STHL	6104817.281	-605827.756	-1740738.641	14/02/2022
SUTH	5041274.904	1916054.482	-3397075.661	14/02/2022
WIND	5633708.799	1732018.076	-2433985.467	14/02/2022

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)
ZAMB	-15 25 31.93660	28 18 39.65527	1324.987	1324.559
ABPO	-19 01 05.89452	47 13 45.17116	1552.965	1553.755
ASCG	-7 54 58.60921	-14 19 57.59335	37.955	23.006
DJIG	11 31 34.64122	42 50 49.44251	711.395	724.121
HARB	-25 53 13.05636	27 42 26.09140	1558.077	1532.766
HRAO	-25 53 24.36765	27 41 13.14110	1414.147	1388.791
MAL2	-2 59 45.78995	40 11 38.92863	-20.917	9.498
MAYG	-12 46 55.38739	45 15 29.36144	-16.563	4.028
NKLG	0 21 14.07418	9 40 19.66216	31.500	21.514
PRE3	-25 44 47.37361	28 13 26.56545	1413.798	1389.059
SEYG	-4 40 43.43050	55 31 50.27819	-37.630	3.372
STHL	-15 56 33.11541	-5 40 02.43567	453.180	436.519
SUTH	-32 22 48.74725	20 48 37.67642	1799.758	1763.218
WIND	-22 34 29.70189	17 05 21.96665	1734.666	1702.900

3.3 UTM Grid, GRS80 Ellipsoid, ITRF2014

Station	East (m)	North (m)	Zone	Ellipsoidal Height (m)	Derived Above Geoid Height(m)
ZAMB	640671.950	8294178.606	35	1324.987	1324.559
ABPO	734645.836	7895659.216	38	1552.965	1553.755
ASCG	573556.330	9124898.470	28	37.955	23.006
DJIG	265181.258	1275054.352	38	711.395	724.121
HARB	570848.414	7136643.601	35	1558.077	1532.766
HRAO	568816.591	7136306.415	35	1414.147	1388.791
MAL2	632707.852	9668770.831	37	-20.917	9.498
MAYG	528019.097	8586952.154	38	-16.563	4.028
NKLG	574791.370	39120.347	32	31.500	21.514
PRE3	622767.244	7151820.298	35	1413.798	1389.059
SEYG	337019.684	9482677.660	40	-37.630	3.372
STHL	214447.144	8235594.739	30	453.180	436.519
SUTH	482171.725	6417404.107	34	1799.758	1763.218
WIND	714826.946	7502031.327	33	1734.666	1702.900

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

Station	Longitude(East) (m)	Latitude(North) (m)	Ellipsoidal Height(Up) (m)
ZAMB	0.005	0.003	0.009
ABPO	0.006	0.003	0.011
ASCG	0.006	0.003	0.011
DJIG	0.006	0.005	0.013
HARB	0.005	0.003	0.008
HRAO	0.005	0.003	0.008
MAL2	0.006	0.003	0.008
MAYG	0.006	0.003	0.011
NKLG	0.006	0.003	0.008
PRE3	0.006	0.004	0.011
SEYG	0.006	0.003	0.009
STHL	0.006	0.003	0.010
SUTH	0.005	0.003	0.009
WIND	0.005	0.003	0.010

4 Ambiguity Resolution - Per Baseline

Baseline	Ambiguities Resolved	Baseline Length (km)
NKLG - STHL	34.0 %	2452.540
HARB - ZAMB	84.0 %	1158.584
DJIG - MAL2	85.7 %	1628.187
ASCG - NKLG	74.5 %	2793.754
ABPO - MAYG	84.6 %	721.316
HARB - PRE3	92.7 %	54.119
HARB - HRAO	100.0 %	2.066
MAL2 - ZAMB	76.3 %	1887.399
HARB - SUTH	95.7 %	982.822
ZAMB - WIND	89.6 %	1418.453
MAYG - SEYG	85.1 %	1438.654
NKLG - ZAMB	30.4 %	2672.548
MAL2 - SEYG	88.4 %	1708.339
AVERAGE	78.5%	1455.291

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.