

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.

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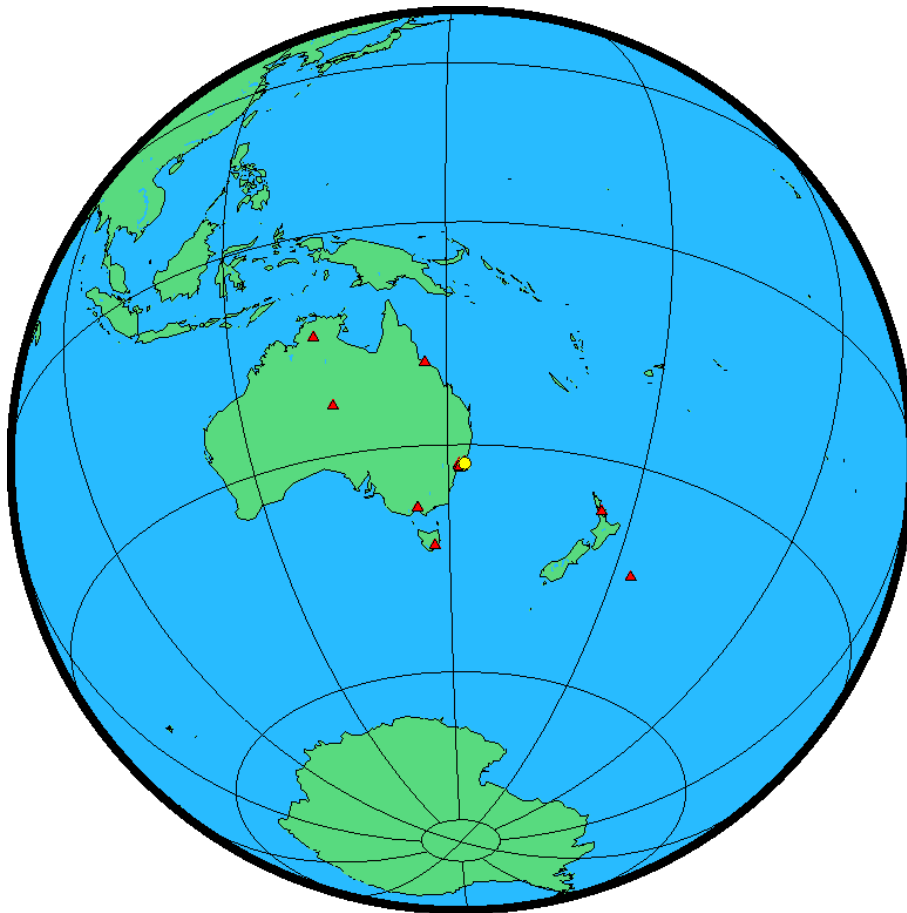
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1 User Data

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
METR	BASE_reach_raw_202205062101.220	EML_REACH_RS2 NONE	1.817	2022/05/06 21:01:30	2022/05/07 00:00:00

2 Processing Summary



Date	User Stations	Reference Stations	Orbit Type
2022/05/06 21:01:30	METR	ALIC ANNA AUCK BING CHTI FORS HOB2 KAT1 MOBS MTLT NEWE NWCS RAYM TOW2	IGS ultra rapid

3 Computed Coordinates, GDA2020

For Australian users Geocentric Datum of Australia 2020 (GDA2020, ITRF14@2020.0) coordinates are provided. GDA2020 coordinates are determined from ITRF2014 by application of a plate model transformation. For general and technical information on GDA2020 see <http://www.icsm.gov.au/datum/gda2020-and-gda94-technical-manuals>.

3.1 Cartesian, GDA2020

Station	X (m)	Y (m)	Z (m)
METR	-4782826.026	2489392.841	-3395832.204
ALIC	-4052052.737	4212835.977	-2545104.585
ANNA	-4742987.285	2512731.386	-3433939.901
BING	-4743762.800	2559346.292	-3399327.904
FORS	-4792819.965	2492603.021	-3379342.980
HOB2	-3950072.251	2522415.360	-4311637.409
KAT1	-4147413.820	4581462.588	-1573359.082
MOBS	-4130636.760	2894953.140	-3890530.235
MTLD	-4722247.207	2557539.756	-3429484.970
NEWE	-4722485.489	2533368.568	-3446899.695
NWCS	-4721164.224	2535155.637	-3447434.297
RAYM	-4729113.441	2541530.501	-3431897.184
TOW2	-5054583.400	3275504.110	-2091538.470

3.2 Geodetic, GRS80 Ellipsoid, GDA2020

The Australian Height Datum (AHD) is computed from a gravimetric quasigeoid model that has been a posteriori fitted to AHD. The derived AHD is only provided for sites within the extents of the AUSGeoid2020 product, see <http://www.ga.gov.au/ausgeoid/>. For sites within the GDA extents but outside the AUSGeoid2020 extents, satellite altimeter derived mean sea surface weights are provided, see AUSPOS FAQ Question 4.5.

Station	Latitude (DMS)	Longitude (DMS)	Ellipsoidal Height(m)	Derived AHD (m)
METR	-32 22 35.96093	152 30 13.19275	98.990	71.661
ALIC	-23 40 12.39650	133 53 07.87807	603.238	587.502
ANNA	-32 47 05.24202	152 05 10.79296	41.571	15.441
BING	-32 24 42.36561	151 39 08.39346	486.750	458.882
FORS	-32 12 03.99307	152 31 20.64243	38.000	9.976
HOB2	-42 48 16.93903	147 26 19.45333	41.038	44.740
KAT1	-14 22 33.58366	132 09 11.79631	184.291	137.335
MOBS	-37 49 45.85117	144 58 31.22810	40.571	35.863
MTLD	-32 44 13.11353	151 33 37.07949	49.304	22.843
NEWE	-32 55 26.26991	151 47 19.49693	30.086	4.391
NWCS	-32 55 46.46566	151 45 54.84050	52.861	27.153
RAYM	-32 45 46.33892	151 44 43.54585	43.478	17.201
TOW2	-19 16 09.38064	147 03 20.49214	88.100	29.468



3.3 MGA Grid, GRS80 Ellipsoid, GDA2020

Station	East (m)	North (m)	Zone	Ellipsoidal Height (m)	Derived AHD (m)
METR	453310.887	6417705.318	56	98.990	71.661
ALIC	386353.242	7381852.299	53	603.238	587.502
ANNA	414440.764	6372201.494	56	41.571	15.441
BING	373272.675	6413122.479	56	486.750	458.882
FORS	454986.709	6437172.540	56	38.000	9.976
HOB2	535873.808	5260778.648	55	41.038	44.740
KAT1	192975.038	8408794.958	53	184.291	137.335
MOBS	321820.084	5811181.519	55	40.571	35.863
MTLD	365105.641	6376954.684	56	49.304	22.843
NEWE	386749.558	6356491.678	56	30.086	4.391
NWCS	384558.020	6355844.194	56	52.861	27.153
RAYM	382486.825	6374304.293	56	43.478	17.201
TOW2	505852.112	7869376.778	55	88.100	29.468

3.4 Positional Uncertainty (95% C.L.) - Geodetic, GDA2020

Station	Longitude East (m)	Latitude North (m)	Horizontal (m)	Ellipsoidal Height(Up) (m)	Derived AHD(m)
METR	0.021	0.019	0.024	0.079	0.216
ALIC	0.013	0.012	0.016	0.029	0.232
ANNA	0.015	0.014	0.018	0.041	0.176
BING	0.015	0.015	0.018	0.042	0.193
FORS	0.015	0.015	0.018	0.042	0.192
HOB2	0.013	0.013	0.016	0.028	0.161
KAT1	0.013	0.013	0.016	0.028	0.194
MOBS	0.012	0.013	0.015	0.027	0.160
MTLD	0.015	0.014	0.018	0.041	0.171
NEWE	0.015	0.015	0.018	0.042	0.163
NWCS	0.015	0.015	0.018	0.045	0.166
RAYM	0.015	0.014	0.018	0.041	0.171
TOW2	0.013	0.012	0.016	0.027	0.188

Horizontal positional uncertainties are calculated according to Guideline for Adjustment and Evaluation of Survey Control of ICSM, see <http://www.icsm.gov.au/publications/standard-australian-survey-control-network-special-publication-1-sp1>.

4 Computed Coordinates, GDA94

For Australian users, Geocentric Datum of Australia 1994(GDA94, ITRF92@1994.0) coordinates are also provided. GDA94 coordinates are transformed from GDA2020 coordinates by coordinate transformation see

<http://www.icsm.gov.au/datum/gda2020-and-gda94-technical-manuals>. For general and technical information on GDA94 see <http://www.ga.gov.au/earth-monitoring/>

geodesy/geodetic-datums/GDA.html and
<http://www.icsm.gov.au/datum/gda2020-and-gda94-technical-manuals>.

4.1 Cartesian, GDA94

Station	X (m)	Y (m)	Z (m)
METR	-4782825.200	2489392.990	-3395833.433
ALIC	-4052051.763	4212836.189	-2545106.020
ANNA	-4742986.448	2512731.521	-3433941.129
BING	-4743761.962	2559346.434	-3399329.140
FORS	-4792819.140	2492603.175	-3379344.211
HOB2	-3950071.266	2522415.201	-4311638.521
KAT1	-4147412.942	4581463.004	-1573360.592
MOBS	-4130635.784	2894953.093	-3890531.444
MTLD	-4722246.364	2557539.889	-3429486.203
NEWE	-4722484.647	2533368.697	-3446900.923
NWCS	-4721163.382	2535155.766	-3447435.526
RAYM	-4729112.600	2541530.634	-3431898.415
TOW2	-5054582.657	3275504.559	-2091539.879

4.2 Geodetic, GRS80 Ellipsoid, GDA94

AHD is computed from a gravimetric quasigeoid model that has been a posteriori fitted to AHD. The derived AHD is only provided for sites within the extents of the AUSGeoid2020 product, see <http://www.ga.gov.au/ausgeoid/>. For sites within the GDA extents but outside the AUSGeoid2020 extents, satellite altimeter derived mean sea surface weights are provided, see AUSPOS FAQ Question 4.5.

Station	Latitude (DMS)	Longitude (DMS)	Ellipsoidal Height(m)	Derived AHD (m)
METR	-32 22 36.00618	152 30 13.17311	99.088	71.661
ALIC	-23 40 12.44602	133 53 07.84812	603.336	587.502
ANNA	-32 47 05.28741	152 05 10.77333	41.668	15.441
BING	-32 24 42.41115	151 39 08.37344	486.847	458.882
FORS	-32 12 04.03832	152 31 20.62272	38.097	9.976
HOB2	-42 48 16.98565	147 26 19.43591	41.121	44.740
KAT1	-14 22 33.63353	132 09 11.76526	184.395	137.335
MOBS	-37 49 45.89856	144 58 31.20674	40.660	35.863
MTLD	-32 44 13.15910	151 33 37.05958	49.400	22.843
NEWE	-32 55 26.31539	151 47 19.47721	30.182	4.391
NWCS	-32 55 46.51115	151 45 54.82078	52.957	27.153
RAYM	-32 45 46.38442	151 44 43.52604	43.574	17.201
TOW2	-19 16 09.42797	147 03 20.46540	88.208	29.468



4.3 MGA Grid, GRS80 Ellipsoid, GDA94

Station	East (m)	North (m)	Zone	Ellipsoidal Height (m)	Derived AHD (m)
METR	453310.380	6417703.922	56	99.088	71.661
ALIC	386352.406	7381850.769	53	603.336	587.502
ANNA	414440.266	6372200.092	56	41.668	15.441
BING	373272.169	6413121.069	56	486.847	458.882
FORS	454986.199	6437171.145	56	38.097	9.976
HOB2	535873.405	5260777.212	55	41.121	44.740
KAT1	192974.126	8408793.413	53	184.395	137.335
MOBS	321819.594	5811180.047	55	40.660	35.863
MTLD	365105.141	6376953.273	56	49.400	22.843
NEWE	386749.062	6356490.272	56	30.182	4.391
NWCS	384557.524	6355842.787	56	52.957	27.153
RAYM	382486.326	6374302.885	56	43.574	17.201
TOW2	505851.331	7869375.323	55	88.208	29.468

4.4 Positional Uncertainty (95% C.L.) - Geodetic, GDA94

Station	Longitude East (m)	Latitude North (m)	Horizontal (m)	Ellipsoidal Height(Up) (m)	Derived AHD(m)
METR	0.022	0.020	0.025	0.079	0.216
ALIC	0.014	0.014	0.017	0.031	0.232
ANNA	0.016	0.016	0.019	0.043	0.176
BING	0.016	0.016	0.020	0.044	0.193
FORS	0.016	0.016	0.019	0.044	0.193
HOB2	0.014	0.014	0.017	0.030	0.161
KAT1	0.014	0.014	0.017	0.031	0.194
MOBS	0.014	0.014	0.017	0.029	0.160
MTLD	0.016	0.016	0.019	0.043	0.171
NEWE	0.016	0.016	0.020	0.044	0.163
NWCS	0.017	0.016	0.020	0.047	0.167
RAYM	0.016	0.016	0.019	0.042	0.171
TOW2	0.015	0.014	0.017	0.030	0.189

Horizontal positional uncertainties are calculated according to Guideline for Adjustment and Evaluation of Survey Control of ICSM, see <http://www.icsm.gov.au/publications/standard-australian-survey-control-network-special-publication-1-sp1>.

5 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.

5.1 Cartesian, ITRF2014

Station	X (m)	Y (m)	Z (m)	ITRF2014 @
METR	-4782826.106	2489392.834	-3395832.097	06/05/2022
ALIC	-4052052.829	4212835.965	-2545104.459	06/05/2022
ANNA	-4742987.365	2512731.379	-3433939.795	06/05/2022
AUCK	-5105681.587	461563.991	-3782180.922	06/05/2022
BING	-4743762.881	2559346.285	-3399327.796	06/05/2022
CHTI	-4607856.286	-272375.258	-4386954.119	06/05/2022
FORS	-4792820.044	2492603.013	-3379342.873	06/05/2022
HOB2	-3950072.344	2522415.380	-4311637.312	06/05/2022
KAT1	-4147413.904	4581462.558	-1573358.947	06/05/2022
MOBS	-4130636.852	2894953.150	-3890530.130	06/05/2022
MTLD	-4722247.289	2557539.750	-3429484.862	06/05/2022
NEWE	-4722485.570	2533368.562	-3446899.588	06/05/2022
NWCS	-4721164.306	2535155.632	-3447434.190	06/05/2022
RAYM	-4729113.522	2541530.495	-3431897.077	06/05/2022
TOW2	-5054583.473	3275504.076	-2091538.346	06/05/2022

5.2 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)
METR	-32 22 35.95683	152 30 13.19441	98.990	71.952
ALIC	-23 40 12.39201	133 53 07.88071	603.237	588.093
ANNA	-32 47 05.23790	152 05 10.79463	41.571	15.722
AUCK	-36 36 10.21120	174 50 03.79176	132.677	97.744
BING	-32 24 42.36148	151 39 08.39516	486.750	459.181
CHTI	-43 44 07.69078	-176 37 01.64019	75.666	64.710
FORS	-32 12 03.98897	152 31 20.64410	37.999	10.284
HOB2	-42 48 16.93479	147 26 19.45480	41.037	44.750
KAT1	-14 22 33.57916	132 09 11.79906	184.291	137.952
MOBS	-37 49 45.84687	144 58 31.22993	40.571	35.979
MTLD	-32 44 13.10940	151 33 37.08119	49.304	23.110
NEWE	-32 55 26.26578	151 47 19.49860	30.085	4.670
NWCS	-32 55 46.46154	151 45 54.84217	52.860	27.454
RAYM	-32 45 46.33479	151 44 43.54753	43.477	17.482
TOW2	-19 16 09.37637	147 03 20.49447	88.100	30.165

5.3 UTM Grid, GRS80 Ellipsoid, ITRF2014

Station	East (m)	North (m)	Zone	Ellipsoidal Height (m)	Derived Above Geoid Height(m)
METR	453310.930	6417705.444	56	98.990	71.952
ALIC	386353.316	7381852.437	53	603.237	588.093
ANNA	414440.806	6372201.621	56	41.571	15.722
AUCK	306301.245	5947001.498	60	132.677	97.744
BING	373272.718	6413122.606	56	486.750	459.181
CHTI	530832.949	5157436.057	1	75.666	64.710
FORS	454986.752	6437172.667	56	37.999	10.284
HOB2	535873.843	5260778.778	55	41.037	44.750
KAT1	192975.119	8408795.097	53	184.291	137.952
MOBS	321820.126	5811181.652	55	40.571	35.979
MTLD	365105.683	6376954.811	56	49.304	23.110
NEWE	386749.600	6356491.806	56	30.085	4.670
NWCS	384558.062	6355844.322	56	52.860	27.454
RAYM	382486.867	6374304.420	56	43.477	17.482
TOW2	505852.180	7869376.909	55	88.100	30.165

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

Station	Longitude(East) (m)	Latitude(North) (m)	Ellipsoidal Height(Up) (m)
METR	0.010	0.009	0.036
ALIC	0.006	0.005	0.012
ANNA	0.007	0.006	0.019
AUCK	0.009	0.006	0.013
BING	0.007	0.006	0.019
CHTI	0.009	0.006	0.014
FORS	0.007	0.006	0.019
HOB2	0.005	0.006	0.012
KAT1	0.006	0.005	0.012
MOBS	0.005	0.005	0.012
MTLD	0.007	0.006	0.019
NEWE	0.007	0.006	0.019
NWCS	0.007	0.006	0.021
RAYM	0.007	0.006	0.018
TOW2	0.006	0.005	0.012

6 Ambiguity Resolution - Per Baseline

Baseline	Ambiguities Resolved	Baseline Length (km)
KAT1 - TOW2	83.3 %	1672.422
MTLD - TOW2	76.9 %	1554.355
MTLD - RAYM	89.3 %	17.586
BING - RAYM	68.8 %	39.909
FORS - METR	87.7 %	19.547
AUCK - FORS	0.0 %	2094.106
HOB2 - MOBS	91.7 %	590.525
NEWE - RAYM	90.0 %	18.320
ANNA - FORS	78.6 %	76.611
MOBS - RAYM	85.7 %	832.722
ANNA - RAYM	80.0 %	32.032
NEWE - NWCS	100.0 %	2.286
ALIC - KAT1	78.6 %	1043.680
AUCK - CHTI	75.0 %	1073.428
AVERAGE	77.5%	647.681

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.

7 Computation Standards

7.1 Computation System

Software	Bernese GNSS Software Version 5.2.
GNSS system(s)	GPS only.

7.2 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 at 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 hours. 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 order effects 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.

7.3 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.

7.4 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.