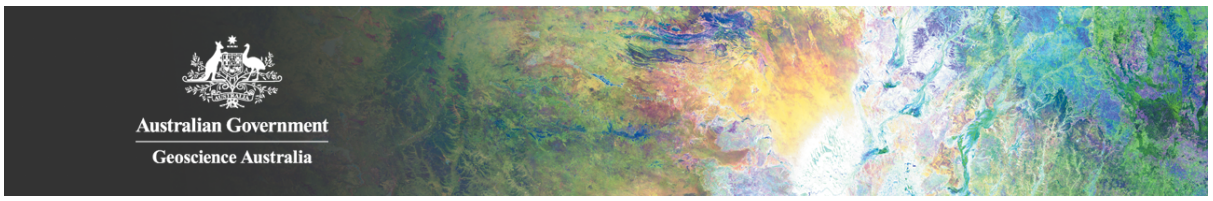

AUSPOS GPS Processing Report

May 3, 2019

This document is a report of the GPS data processing undertaken by the AUSPOS Online GPS Processing Service (version: AUSPOS 2.3) . 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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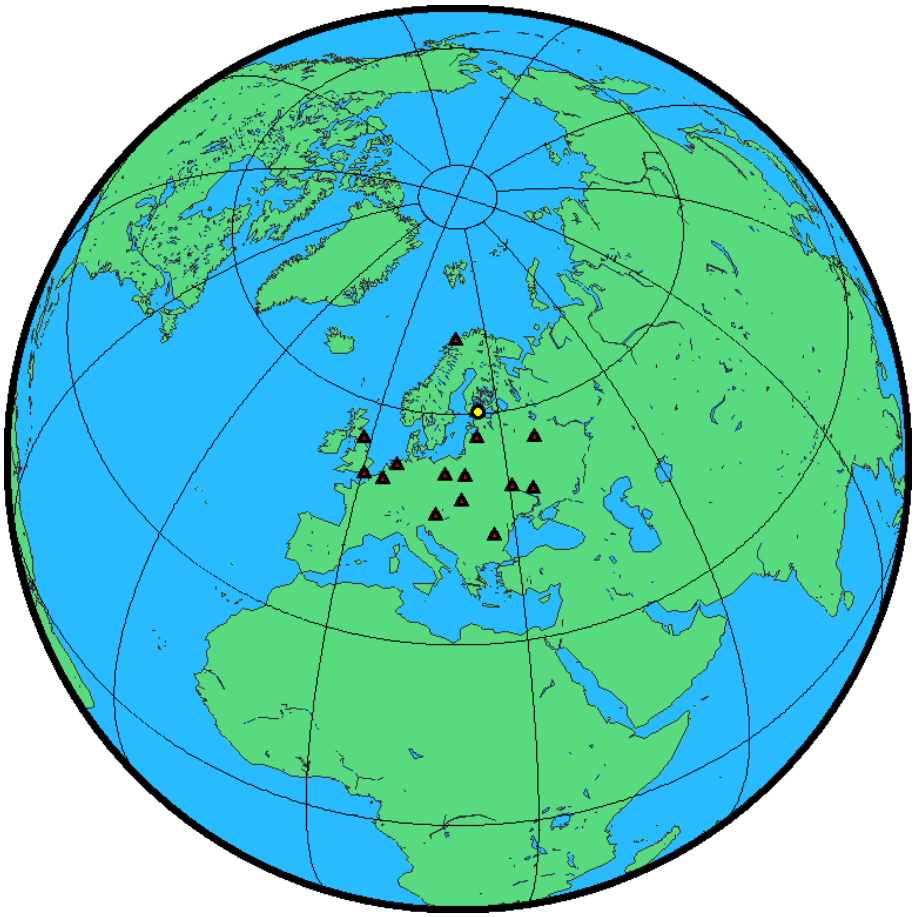
1 User Data

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
1GNS	1GNSS.19O	ASH700718A NONE	1.504	2019/05/02 11:20:30	2019/05/02 12:55:30
2GNS	2GNSS.19O	ASH700718A NONE	1.350	2019/05/02 11:19:30	2019/05/02 12:51:30
3GNS	3GNSS.19O	ASH700718A NONE	1.439	2019/05/02 10:06:30	2019/05/02 12:48:00

2 Processing Summary



Date	User Stations	Reference Stations	Orbit Type
2019/05/02 10:06:30	1GNS 2GNS 3GNS	BOR1 BRUX BUCU GANP GLSV GRAZ HERS JOZE MDVJ METS MORP POLV RIGA TRO1 WSRT	IGS ultra 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 @
1GNS	2885213.316	1335012.603	5510856.146	02/05/2019
2GNS	2885218.683	1334979.500	5510864.481	02/05/2019
3GNS	2885203.618	1334915.487	5510890.501	02/05/2019
BOR1	3738358.214	1148173.931	5021815.895	02/05/2019
BRUX	4027881.383	306998.734	4919499.011	02/05/2019
BUCU	4093760.620	2007794.057	4445130.116	02/05/2019
GANP	3929181.288	1455236.957	4793654.041	02/05/2019
GLSV	3512888.681	2068980.092	4888903.322	02/05/2019
GRAZ	4194423.570	1162702.950	4647245.560	02/05/2019
HERS	4033469.909	23673.126	4924301.449	02/05/2019
JOZE	3664939.903	1409154.084	5009571.504	02/05/2019
MDVJ	2845455.774	2160954.417	5265993.316	02/05/2019
METS	2892570.539	1311843.647	5512634.269	02/05/2019
MORP	3645667.650	-107277.010	5215053.671	02/05/2019
POLV	3411557.043	2348464.162	4834396.986	02/05/2019
RIGA	3183898.940	1421478.698	5322810.919	02/05/2019
TRO1	2102928.234	721619.592	5958196.372	02/05/2019
WSRT	3828735.646	443305.185	5064884.858	02/05/2019

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)
1GNS	60 11 11.33775	24 49 49.36676	22.972	4.974
2GNS	60 11 11.72480	24 49 47.27124	25.715	7.716
3GNS	60 11 13.27969	24 49 43.91233	28.129	10.128
BOR1	52 16 37.05105	17 04 24.45801	124.360	88.830
BRUX	50 47 53.03248	4 21 30.83949	158.136	112.680
BUCU	44 27 50.20724	26 07 32.68133	143.228	107.680
GANP	49 02 04.97513	20 19 22.58299	746.032	703.992
GLSV	50 21 51.06368	30 29 48.25263	226.324	200.782
GRAZ	47 04 01.67517	15 29 36.54373	538.282	490.807
HERS	50 52 02.33737	0 20 10.58959	76.469	31.333
JOZE	52 05 50.19633	21 01 53.55550	141.429	109.883
MDVJ	56 01 17.37783	37 12 52.23308	257.113	241.418
METS	60 13 02.90594	24 23 43.17174	94.659	75.815
MORP	55 12 46.05291	-1 41 07.77426	144.448	94.396
POLV	49 36 09.41592	34 32 34.56554	178.342	159.761
RIGA	56 56 55.03704	24 03 31.60280	34.739	13.615
TRO1	69 39 45.79234	18 56 22.74695	138.130	106.684
WSRT	52 54 52.60753	6 36 16.23296	82.283	40.520

3.3 UTM Grid, GRS80 Ellipsoid, ITRF2014

Station	East (m)	North (m)	Zone	Ellipsoidal Height (m)	Derived Above Geoid Height(m)
1GNS	379679.857	16674156.568	35	22.972	4.974
2GNS	379647.977	16674169.599	35	25.715	7.716
3GNS	379597.829	16674219.385	35	28.129	10.128
BOR1	641456.340	15793868.011	33	124.360	88.830
BRUX	595741.477	15628248.975	31	158.136	112.680
BUCU	430455.808	14923776.114	35	143.228	107.680
GANP	450512.688	15431535.723	34	746.032	703.992
GLSV	321967.798	15582119.606	36	226.324	200.782
GRAZ	537470.383	15212742.434	33	538.282	490.807
HERS	312568.570	15638450.788	31	76.469	31.333
JOZE	502160.761	15771858.170	34	141.429	109.883
MDVJ	388711.402	16209909.924	37	257.113	241.418
METS	355697.043	16678478.678	35	94.659	75.815
MORP	583638.936	16119259.197	30	144.448	94.396
POLV	611484.251	15495592.518	36	178.342	159.761
RIGA	321112.706	16315516.583	35	34.739	13.615
TRO1	420097.385	17729608.548	34	138.130	106.684
WSRT	338933.511	15865458.705	32	82.283	40.520

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

Station	Longitude(East) (m)	Latitude(North) (m)	Ellipsoidal Height(Up) (m)
1GNS	0.017	0.029	0.076
2GNS	0.015	0.026	0.062
3GNS	30.334	21.992	21.234 *
BOR1	0.004	0.003	0.008
BRUX	0.004	0.003	0.008
BUCU	0.004	0.003	0.008
GANP	0.004	0.003	0.008
GLSV	0.003	0.003	0.008
GRAZ	0.004	0.003	0.008
HERS	0.004	0.003	0.008
JOZE	0.004	0.003	0.008
MDVJ	0.004	0.003	0.008
METS	0.003	0.003	0.008
MORP	0.004	0.004	0.010
POLV	0.004	0.003	0.008
RIGA	0.003	0.003	0.008
TRO1	0.004	0.003	0.009
WSRT	0.004	0.003	0.007

***WARNING:**
The estmated coordinates have precision outside of the boundary of 0.095 m
Please use this solution with caution

4 Ambiguity Resolution - Per Baseline

Baseline	Ambiguities Resolved	Baseline Length (km)
GLSV - POLV	90.9 %	302.242
BOR1 - GRAZ	51.5 %	590.347
MORP - WSRT	91.2 %	599.337
METS - WSRT	83.3 %	1353.235
BUCU - GLSV	84.2 %	733.547
GANP - GLSV	75.7 %	747.698
GLSV - METS	80.6 %	1160.642
GRAZ - WSRT	96.7 %	908.671
BRUX - WSRT	86.8 %	281.737
HERS - WSRT	96.8 %	487.618
JOZE - METS	75.0 %	926.874
METS - TRO1	93.3 %	1081.862
METS - RIGA	88.9 %	364.589
2GNS - METS	50.0 %	24.340
3GNS - METS	0.0 %	24.282
MDVJ - METS	85.4 %	885.461
1GNS - 2GNS	83.3 %	0.035
AVERAGE	77.3%	616.030

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-differences. 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 180-6000km baselines, the Phase-Based L5/L3 strategy for 18-200km baselines, the Quasi-Ionosphere-Free (QIF) strategy for 18-2000km 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.