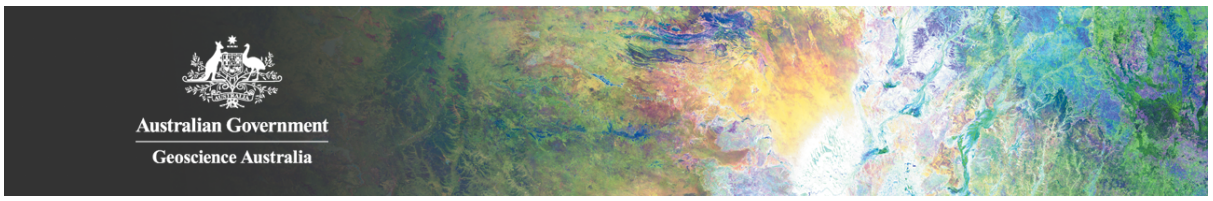

AUSPOS GPS Processing Report

May 5, 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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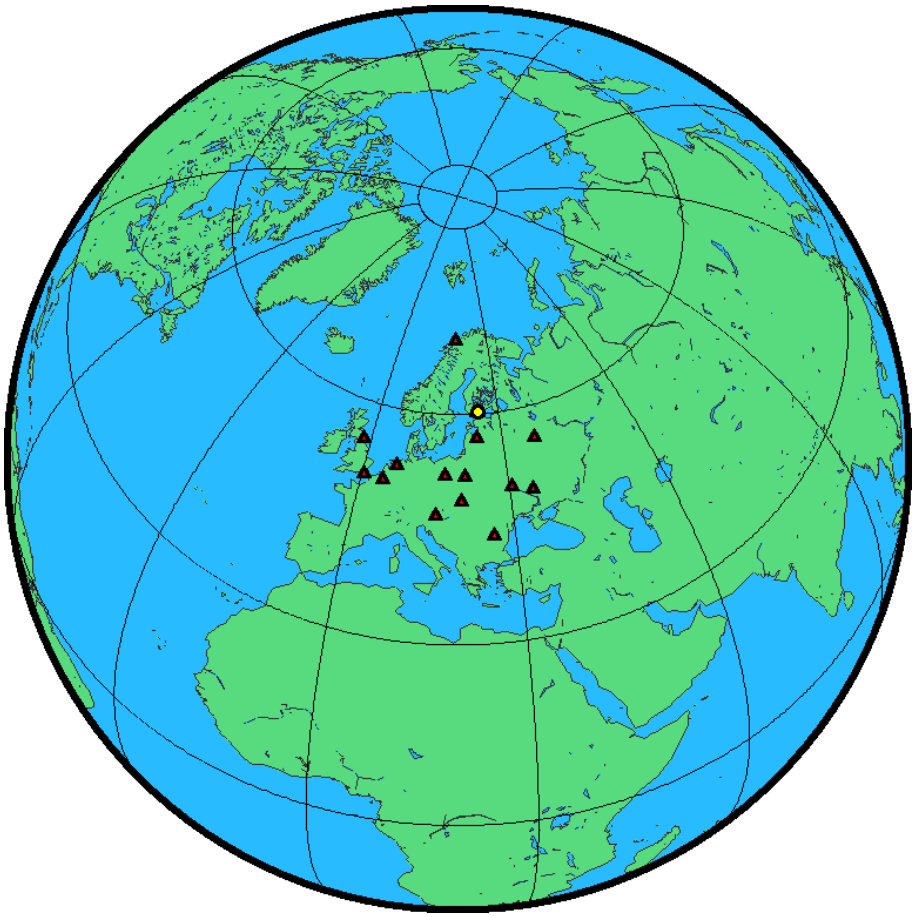
1 User Data

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
B1GN	B1GNSS.19O	ASH700718A NONE	1.338	2019/05/03 07:18:30	2019/05/03 08:51:30
B2GN	B2GNSS.19O	ASH700718A NONE	1.233	2019/05/03 07:23:30	2019/05/03 08:49:30
B3GN	B3GNSS.19O	ASH700718A NONE	1.557	2019/05/03 07:42:00	2019/05/03 08:51:30

2 Processing Summary



Date	User Stations	Reference Stations	Orbit Type
2019/05/03 07:42:00	B1GN B2GN B3GN	BOR1 BRUX BUCU GANP GLSV GRAZ HERS JOZE MDVJ METS MORP POLV RIGA TRO1 WSRT	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 @
B1GN	2884989.868	1335021.571	5510825.559	03/05/2019
B2GN	2885196.886	1334933.526	5510857.009	03/05/2019
B3GN	2885023.361	1335038.935	5510858.588	03/05/2019
BOR1	3738358.217	1148173.935	5021815.900	03/05/2019
BRUX	4027881.380	306998.728	4919499.014	03/05/2019
BUCU	4093760.620	2007794.057	4445130.113	03/05/2019
GANP	3929181.290	1455236.958	4793654.043	03/05/2019
GLSV	3512888.677	2068980.092	4888903.317	03/05/2019
GRAZ	4194423.579	1162702.950	4647245.568	03/05/2019
HERS	4033469.908	23673.127	4924301.451	03/05/2019
JOZE	3664939.902	1409154.083	5009571.501	03/05/2019
MDVJ	2845455.774	2160954.419	5265993.314	03/05/2019
METS	2892570.540	1311843.644	5512634.266	03/05/2019
MORP	3645667.655	-107277.010	5215053.679	03/05/2019
POLV	3411557.044	2348464.163	4834396.985	03/05/2019
RIGA	3183898.938	1421478.697	5322810.915	03/05/2019
TRO1	2102928.234	721619.596	5958196.373	03/05/2019
WSRT	3828735.644	443305.185	5064884.858	03/05/2019

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)
B1GN	60 11 16.42609	24 49 55.98322	-102.514	-120.509
B2GN	60 11 12.70059	24 49 45.15801	-0.202	-18.202
B3GN	60 11 15.90005	24 49 56.09308	-55.120	-73.115
BOR1	52 16 37.05105	17 04 24.45816	124.366	88.836
BRUX	50 47 53.03261	4 21 30.83921	158.137	112.681
BUCU	44 27 50.20720	26 07 32.68131	143.226	107.678
GANP	49 02 04.97512	20 19 22.58298	746.035	703.995
GLSV	50 21 51.06367	30 29 48.25271	226.318	200.776
GRAZ	47 04 01.67515	15 29 36.54366	538.294	490.819
HERS	50 52 02.33744	0 20 10.58964	76.470	31.334
JOZE	52 05 50.19630	21 01 53.55542	141.426	109.880
MDVJ	56 01 17.37778	37 12 52.23320	257.111	241.416
METS	60 13 02.90591	24 23 43.17156	94.656	75.812
MORP	55 12 46.05295	-1 41 07.77425	144.458	94.406
POLV	49 36 09.41587	34 32 34.56555	178.342	159.761
RIGA	56 56 55.03702	24 03 31.60279	34.734	13.610
TRO1	69 39 45.79230	18 56 22.74726	138.131	106.685
WSRT	52 54 52.60757	6 36 16.23295	82.282	40.519

3.3 UTM Grid, GRS80 Ellipsoid, ITRF2014

Station	East (m)	North (m)	Zone	Ellipsoidal Height (m)	Derived Above Geoid Height(m)
B1GN	379786.925	16674310.578	35	-102.514	-120.509
B2GN	379616.424	16674200.846	35	-0.202	-18.202
B3GN	379788.082	16674294.255	35	-55.120	-73.115
BOR1	641456.343	15793868.011	33	124.366	88.836
BRUX	595741.471	15628248.979	31	158.137	112.681
BUCU	430455.808	14923776.112	35	143.226	107.678
GANP	450512.688	15431535.723	34	746.035	703.995
GLSV	321967.799	15582119.605	36	226.318	200.776
GRAZ	537470.381	15212742.434	33	538.294	490.819
HERS	312568.571	15638450.790	31	76.470	31.334
JOZE	502160.759	15771858.169	34	141.426	109.880
MDVJ	388711.404	16209909.923	37	257.111	241.416
METS	355697.040	16678478.677	35	94.656	75.812
MORP	583638.936	16119259.198	30	144.458	94.406
POLV	611484.251	15495592.516	36	178.342	159.761
RIGA	321112.705	16315516.582	35	34.734	13.610
TRO1	420097.388	17729608.547	34	138.131	106.685
WSRT	338933.511	15865458.707	32	82.282	40.519

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

Station	Longitude(East) (m)	Latitude(North) (m)	Ellipsoidal Height(Up) (m)
B1GN	10.760	7.191	9.853 *
B2GN	18.585	13.474	13.009 *
B3GN	11.114	7.158	9.826 *
BOR1	0.002	0.002	0.006
BRUX	0.002	0.002	0.006
BUCU	0.002	0.002	0.006
GANP	0.002	0.002	0.005
GLSV	0.002	0.002	0.005
GRAZ	0.002	0.002	0.005
HERS	0.002	0.002	0.006
JOZE	0.002	0.002	0.006
MDVJ	0.002	0.002	0.006
METS	0.002	0.002	0.005
MORP	0.003	0.003	0.007
POLV	0.002	0.002	0.005
RIGA	0.002	0.002	0.006
TRO1	0.002	0.002	0.006
WSRT	0.002	0.002	0.005

***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)
GANP - GRAZ	95.9 %	421.147
HERS - WSRT	100.0 %	487.618
GLSV - POLV	88.5 %	302.242
BRUX - WSRT	92.3 %	281.737
METS - TRO1	93.6 %	1081.862
B1GN - B2GN	0.0 %	0.052
METS - RIGA	93.3 %	364.589
BOR1 - GRAZ	95.8 %	590.347
MORP - WSRT	92.6 %	599.337
BUCU - GRAZ	95.5 %	874.736
METS - WSRT	88.5 %	1353.235
GLSV - MDVJ	79.3 %	772.090
B1GN - METS	0.0 %	24.326
GANP - GLSV	84.0 %	747.698
GLSV - METS	88.5 %	1160.642
B1GN - B3GN	11.1 %	0.036
GANP - JOZE	88.9 %	344.336
AVERAGE	75.8%	553.296

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.