AUSPOS GPS Processing Report

November 7, 2023

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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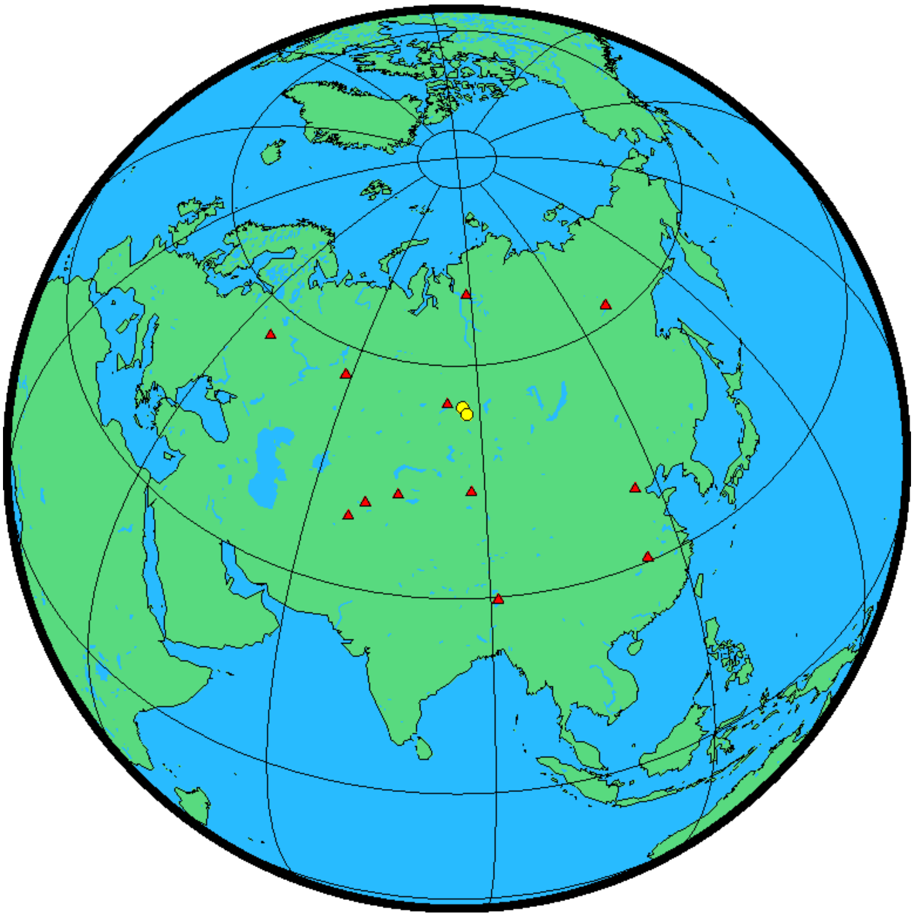
1 User Data

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
NVKZ	NVKZ204.rnx	NONE NONE	0.000	2021/07/23 00:00:30	2021/07/23 23:59:30
POLY	POLY204.rnx	NONE NONE	0.000	2021/07/23 00:00:30	2021/07/23 23:59:30

2 Processing Summary



Date	User Stations	Reference Stations	Orbit Type
2021/07/23 00:00:30	NVKZ POLY	ARTU BJFS CHUM JFNG KIT3 LHAZ MDVJ NOVM NRIL TASH URUM YAKT	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 @
NVKZ	189708.580	3775106.051	5120442.971	23/07/2021
POLY	239370.329	3695874.222	5175528.204	23/07/2021
ARTU	1843956.322	3016203.264	5291261.803	23/07/2021
BJFS	-2148744.611	4426641.151	4044655.786	23/07/2021
CHUM	1228950.345	4508080.012	4327868.541	23/07/2021
JFNG	-2279829.137	5004706.440	3219777.369	23/07/2021
KIT3	1944944.688	4556652.368	4004326.064	23/07/2021
LHAZ	-106942.210	5549269.752	3139215.235	23/07/2021
MDVJ	2845455.726	2160954.447	5265993.330	23/07/2021
NOVM	452260.671	3635877.608	5203453.339	23/07/2021
NRIL	64536.821	2253782.911	5946363.514	23/07/2021
TASH	1695944.763	4487138.677	4190140.757	23/07/2021
URUM	193030.121	4606851.287	4393311.526	23/07/2021
YAKT	-1914999.311	2308241.445	5610225.487	23/07/2021

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)
NVKZ	53 44 57.31589	87 07 23.38641	189.459	229.756
POLY	54 35 39.64569	86 17 39.49974	216.645	255.466
ARTU	56 25 47.36092	58 33 37.66871	247.582	253.906
BJFS	39 36 30.95878	115 53 32.96910	87.458	97.499
CHUM	42 59 54.60551	74 45 03.97494	716.343	759.333
JFNG	30 30 56.03223	114 29 27.68024	71.298	84.708
KIT3	39 08 05.16356	66 53 07.62242	622.486	659.583
LHAZ	29 39 26.40351	91 06 14.52009	3624.613	3659.304
MDVJ	56 01 17.37864	37 12 52.23611	257.113	241.418
NOVM	55 01 49.80337	82 54 34.17953	150.085	186.316
NRIL	69 21 42.59901	88 21 35.24393	47.940	62.034
TASH	41 19 40.97914	69 17 44.05751	439.702	483.272
URUM	43 48 28.61973	87 36 02.42049	858.865	922.244
YAKT	62 01 51.44953	129 40 49.11316	103.404	108.870

3.3 UTM Grid, GRS80 Ellipsoid, ITRF2014

Station	East (m)	North (m)	Zone	Ellipsoidal Height (m)	Derived Above Geoid Height(m)
NVKZ	508121.708	5955631.214	45	189.459	229.756
POLY	454403.848	6049881.044	45	216.645	255.466
ARTU	596235.186	6255011.365	40	247.582	253.906
BJFS	404924.742	4384902.947	50	87.458	97.499
CHUM	479712.412	4760678.445	43	716.343	759.333
JFNG	259237.975	3378594.108	50	71.298	84.708
KIT3	317236.791	4333861.156	42	622.486	659.583
LHAZ	316496.230	3282318.874	46	3624.613	3659.304
MDVJ	388711.455	6209909.948	37	257.113	241.418
NOVM	622047.134	6099852.355	44	150.085	186.316
NRIL	553484.953	7695302.993	45	47.940	62.034
TASH	524734.375	4575216.868	42	439.702	483.272
URUM	548313.480	4850717.938	45	858.865	922.244
YAKT	535596.120	6877815.579	52	103.404	108.870

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

Station	Longitude(East) (m)	Latitude(North) (m)	Ellipsoidal Height(Up) (m)
NVKZ	0.005	0.004	0.009
POLY	0.005	0.004	0.009
ARTU	0.006	0.004	0.010
BJFS	0.006	0.004	0.010
CHUM	0.005	0.004	0.008
JFNG	0.006	0.005	0.014
KIT3	0.006	0.004	0.011
LHAZ	0.006	0.005	0.012
MDVJ	0.006	0.005	0.013
NOVM	0.005	0.004	0.008
NRIL	0.005	0.005	0.011
TASH	0.005	0.004	0.009
URUM	0.005	0.004	0.010
YAKT	0.006	0.005	0.011

4 Ambiguity Resolution - Per Baseline

Baseline	Ambiguities Resolved	Baseline Length (km)
LHAZ - URUM	70.0 %	1597.152
CHUM - NVKZ	80.5 %	1498.482
KIT3 - TASH	81.5 %	318.371
NOVM - NVKZ	81.5 %	308.559
CHUM - URUM	76.2 %	1042.674
POLY - NVKZ	89.2 %	108.528
NVKZ - YAKT	22.6 %	2611.776
ARTU - NVKZ	79.5 %	1828.018
BJFS - JFNG	93.9 %	1015.759
BJFS - POLY	87.8 %	2741.530
NRIL - POLY	93.4 %	1644.500
CHUM - TASH	87.5 %	487.331
ARTU - MDVJ	71.0 %	1317.228
AVERAGE	78.1%	1270.762

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.