

AUSPOS GPS Processing Report

August 24, 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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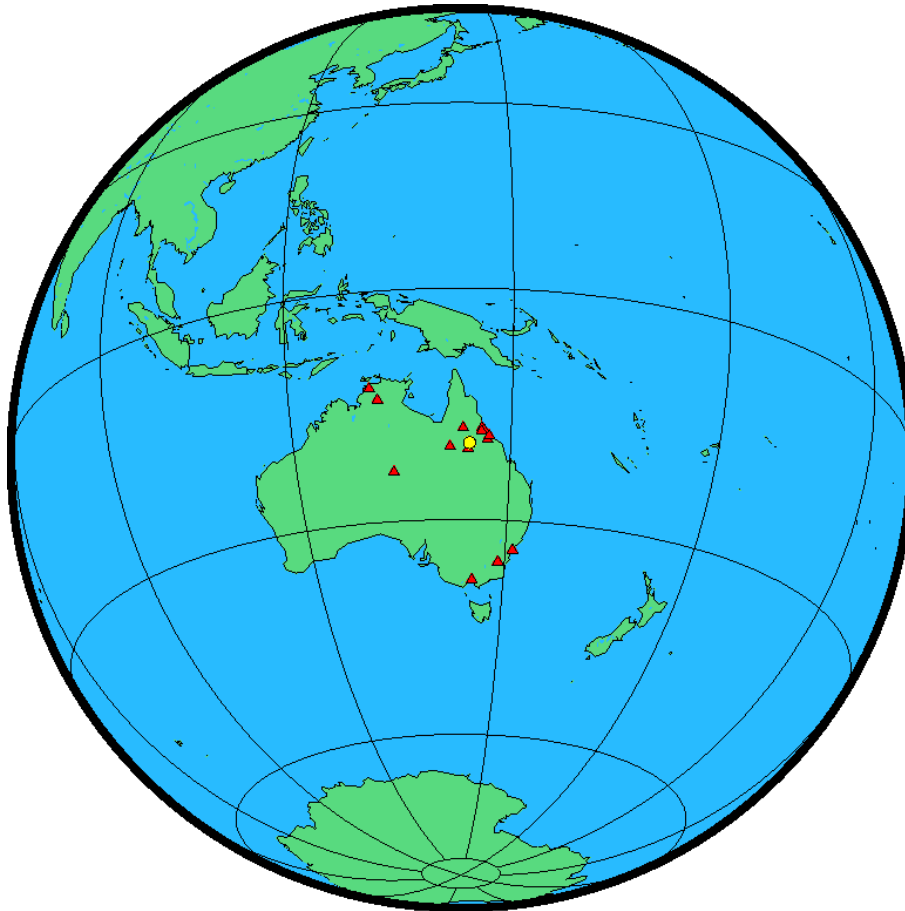
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1 User Data

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
R000	GPS20230817203044AUS.230	EML.REACH_RS2 NONE	2.000	2023/08/17 20:31:30	2023/08/18 09:20:30

2 Processing Summary



Date	User Stations	Reference Stations	Orbit Type
2023/08/17 20:31:30	R000	ALIC CDWL DARW GGTN HUGH JLCK KAT1 MOBS MRT1 MRT4 MRT5 SYDN TID1 TOW2	IGS 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)
R000	-4871094.020	3485208.077	-2187510.976
ALIC	-4052052.735	4212835.974	-2545104.584
CDWL	-5024260.849	3386082.873	-1986505.395
DARW	-4091359.615	4684606.420	-1408579.124
GGTN	-4872083.246	3599807.376	-1990678.372
HUGH	-4833918.686	3485758.726	-2266147.621
JLCK	-4687826.441	3697044.270	-2237232.163
KAT1	-4147413.817	4581462.584	-1573359.084
MOBS	-4130636.757	2894953.141	-3890530.234
MRT1	-5026787.728	3285235.542	-2142451.474
MRT4	-5034709.339	3354132.338	-2013869.151
MRT5	-5010599.506	3380168.088	-2030373.435
SYDN	-4648240.860	2560636.442	-3526317.785
TID1	-4460996.953	2682557.085	-3674442.628
TOW2	-5054583.394	3275504.104	-2091538.463

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)
R000	-20 11 15.74330	144 25 00.27897	866.216	812.435
ALIC	-23 40 12.39651	133 53 07.87809	603.234	587.498
CDWL	-18 16 01.67837	146 01 19.69991	72.240	12.437
DARW	-12 50 37.30840	131 07 57.87936	125.106	73.881
GGTN	-18 18 21.44988	143 32 26.28820	367.089	310.972
HUGH	-20 56 50.74842	144 12 16.09556	523.997	475.395
JLCK	-20 40 09.36159	141 44 20.39069	169.398	124.588
KAT1	-14 22 33.58377	132 09 11.79632	184.288	137.332
MOBS	-37 49 45.85117	144 58 31.22801	40.568	35.860
MRT1	-19 45 25.39761	146 50 00.77618	138.631	81.152
MRT4	-18 31 39.64745	146 19 42.15595	68.367	9.053
MRT5	-18 41 05.73849	145 59 46.53165	94.933	35.611
SYDN	-33 46 51.13836	151 09 01.37673	85.570	62.634
TID1	-35 23 57.10965	148 58 48.00432	665.311	646.325
TOW2	-19 16 09.38053	147 03 20.49220	88.091	29.459

3.3 MGA Grid, GRS80 Ellipsoid, GDA2020

Station	East (m)	North (m)	Zone	Ellipsoidal Height (m)	Derived AHD (m)
R000	230029.528	7765645.621	55	866.216	812.435
ALIC	386353.243	7381852.298	53	603.234	587.498
CDWL	396633.987	7979983.003	55	72.240	12.437
DARW	731470.072	8579191.187	52	125.106	73.881
GGTN	768561.825	7974092.805	54	367.089	310.972
HUGH	209275.927	7681133.390	55	523.997	475.395
JLCK	576972.648	7714279.549	54	169.398	124.588
KAT1	192975.039	8408794.954	53	184.288	137.332
MOBS	321820.082	5811181.519	55	40.568	35.860
MRT1	482561.773	7815394.070	55	138.631	81.152
MRT4	429113.360	7951300.383	55	68.367	9.053
MRT5	394154.770	7933737.010	55	94.933	35.611
SYDN	328743.037	6260602.798	56	85.570	62.634
TID1	679808.388	6080885.896	55	665.311	646.325
TOW2	505852.114	7869376.781	55	88.091	29.459

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)
R000	0.012	0.012	0.015	0.036	0.198
ALIC	0.010	0.010	0.013	0.023	0.231
CDWL	0.011	0.011	0.013	0.028	0.171
DARW	0.011	0.011	0.013	0.023	0.213
GGTN	0.011	0.011	0.013	0.026	0.169
HUGH	0.011	0.011	0.013	0.026	0.169
JLCK	0.011	0.011	0.013	0.025	0.157
KAT1	0.011	0.011	0.013	0.022	0.193
MOBS	0.010	0.011	0.013	0.022	0.159
MRT1	0.011	0.011	0.014	0.028	0.202
MRT4	0.011	0.011	0.014	0.029	0.196
MRT5	0.011	0.011	0.013	0.027	0.202
SYDN	0.011	0.011	0.013	0.025	0.162
TID1	0.010	0.011	0.013	0.022	0.181
TOW2	0.010	0.010	0.013	0.022	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) co-ordinates 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)
R000	-4871093.227	3485208.481	-2187512.397
ALIC	-4052051.761	4212836.186	-2545106.019
CDWL	-5024260.105	3386083.338	-1986506.820
DARW	-4091358.746	4684606.861	-1408580.644
GGTN	-4872082.467	3599807.819	-1990679.814
HUGH	-4833917.880	3485759.109	-2266149.037
JLCK	-4687825.605	3697044.638	-2237233.597
KAT1	-4147412.940	4581463.001	-1573360.595
MOBS	-4130635.781	2894953.094	-3890531.442
MRT1	-5026786.976	3285235.977	-2142452.882
MRT4	-5034708.596	3354132.800	-2013870.572
MRT5	-5010598.756	3380168.543	-2030374.857
SYDN	-4648240.000	2560636.545	-3526319.008
TID1	-4460996.049	2682557.130	-3674443.846
TOW2	-5054582.652	3275504.553	-2091539.873

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)
R000	-20 11 15.79129	144 25 00.25178	866.322	812.435
ALIC	-23 40 12.44603	133 53 07.84814	603.332	587.498
CDWL	-18 16 01.72602	146 01 19.67262	72.348	12.437
DARW	-12 50 37.35835	131 07 57.84807	125.211	73.881
GGTN	-18 18 21.49812	143 32 26.26030	367.197	310.972
HUGH	-20 56 50.79643	144 12 16.06851	524.102	475.395
JLCK	-20 40 09.41014	141 44 20.36284	169.503	124.588
KAT1	-14 22 33.63365	132 09 11.76527	184.392	137.332
MOBS	-37 49 45.89855	144 58 31.20665	40.657	35.860
MRT1	-19 45 25.44499	146 50 00.74953	138.738	81.152
MRT4	-18 31 39.69501	146 19 42.12881	68.475	9.053
MRT5	-18 41 05.78613	145 59 46.50447	95.041	35.611
SYDN	-33 46 51.18404	151 09 01.35711	85.665	62.634
TID1	-35 23 57.15599	148 58 47.98429	665.403	646.325
TOW2	-19 16 09.42787	147 03 20.46547	88.199	29.459



4.3 MGA Grid, GRS80 Ellipsoid, GDA94

Station	East (m)	North (m)	Zone	Ellipsoidal Height (m)	Derived AHD (m)
RO00	230028.761	7765644.133	55	866.322	812.435
ALIC	386352.406	7381850.769	53	603.332	587.498
CDWL	396633.194	7979981.535	55	72.348	12.437
DARW	731469.115	8579189.660	52	125.211	73.881
GGTN	768560.984	7974091.333	54	367.197	310.972
HUGH	209275.171	7681131.899	55	524.102	475.395
JLCK	576971.836	7714278.060	54	169.503	124.588
KAT1	192974.127	8408793.409	53	184.392	137.332
MOBS	321819.592	5811180.047	55	40.657	35.860
MRT1	482560.999	7815392.613	55	138.738	81.152
MRT4	429112.570	7951298.919	55	68.475	9.053
MRT5	394153.982	7933735.541	55	95.041	35.611
SYDN	328742.557	6260601.382	56	85.665	62.634
TID1	679807.854	6080884.478	55	665.403	646.325
TOW2	505851.333	7869375.327	55	88.199	29.459

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)
RO00	0.014	0.013	0.016	0.038	0.199
ALIC	0.012	0.012	0.015	0.026	0.231
CDWL	0.013	0.012	0.015	0.030	0.171
DARW	0.012	0.012	0.015	0.026	0.213
GGTN	0.012	0.012	0.015	0.029	0.169
HUGH	0.012	0.012	0.015	0.029	0.170
JLCK	0.012	0.012	0.015	0.028	0.157
KAT1	0.012	0.012	0.015	0.025	0.193
MOBS	0.012	0.013	0.015	0.025	0.160
MRT1	0.013	0.013	0.015	0.031	0.202
MRT4	0.013	0.013	0.016	0.032	0.197
MRT5	0.013	0.012	0.015	0.030	0.203
SYDN	0.012	0.013	0.015	0.028	0.163
TID1	0.012	0.012	0.015	0.025	0.182
TOW2	0.012	0.012	0.015	0.025	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>.

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 @
R000	-4871094.139	3485208.032	-2187510.782	17/08/2023
ALIC	-4052052.877	4212835.956	-2545104.389	17/08/2023
CDWL	-5024260.962	3386082.818	-1986505.201	17/08/2023
DARW	-4091359.743	4684606.371	-1408578.915	17/08/2023
GGTN	-4872083.364	3599807.325	-1990678.175	17/08/2023
HUGH	-4833918.807	3485758.683	-2266147.428	17/08/2023
JLCK	-4687826.566	3697044.230	-2237231.968	17/08/2023
KAT1	-4147413.947	4581462.538	-1573358.877	17/08/2023
MOBS	-4130636.899	2894953.156	-3890530.071	17/08/2023
MRT1	-5026787.842	3285235.492	-2142451.282	17/08/2023
MRT4	-5034709.452	3354132.285	-2013868.957	17/08/2023
MRT5	-5010599.620	3380168.035	-2030373.242	17/08/2023
SYDN	-4648240.988	2560636.437	-3526317.621	17/08/2023
TID1	-4460997.087	2682557.087	-3674442.464	17/08/2023
TOW2	-5054583.507	3275504.052	-2091538.272	17/08/2023

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)
R000	-20 11 15.73660	144 25 00.28264	866.215	813.408
ALIC	-23 40 12.38957	133 53 07.88217	603.234	588.090
CDWL	-18 16 01.67173	146 01 19.70359	72.239	13.065
DARW	-12 50 37.30143	131 07 57.88366	125.106	74.646
GGTN	-18 18 21.44315	143 32 26.29197	367.089	311.700
HUGH	-20 56 50.74172	144 12 16.09921	523.996	476.351
JLCK	-20 40 09.35481	141 44 20.39446	169.398	125.473
KAT1	-14 22 33.57681	132 09 11.80058	184.288	137.949
MOBS	-37 49 45.84451	144 58 31.23084	40.568	35.976
MRT1	-19 45 25.39099	146 50 00.77976	138.630	81.814
MRT4	-18 31 39.64082	146 19 42.15961	68.366	9.720
MRT5	-18 41 05.73185	145 59 46.53532	94.932	36.296
SYDN	-33 46 51.13195	151 09 01.37931	85.570	62.878
TID1	-35 23 57.10315	148 58 48.00696	665.310	646.463
TOW2	-19 16 09.37392	147 03 20.49580	88.090	30.155

5.3 UTM Grid, GRS80 Ellipsoid, ITRF2014

Station	East (m)	North (m)	Zone	Ellipsoidal Height (m)	Derived Above Geoid Height(m)
R000	230029.631	7765645.829	55	866.215	813.408
ALIC	386353.357	7381852.513	53	603.234	588.090
CDWL	396634.094	7979983.208	55	72.239	13.065
DARW	731470.203	8579191.400	52	125.106	74.646
GGTN	768561.939	7974093.010	54	367.089	311.700
HUGH	209276.029	7681133.598	55	523.996	476.351
JLCK	576972.758	7714279.757	54	169.398	125.473
KAT1	192975.164	8408795.170	53	184.288	137.949
MOBS	321820.147	5811181.725	55	40.568	35.976
MRT1	482561.877	7815394.274	55	138.630	81.814
MRT4	429113.466	7951300.588	55	68.366	9.720
MRT5	394154.877	7933737.215	55	94.932	36.296
SYDN	328743.100	6260602.997	56	85.570	62.878
TID1	679808.459	6080886.095	55	665.310	646.463
TOW2	505852.219	7869376.984	55	88.090	30.155

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

Station	Longitude(East) (m)	Latitude(North) (m)	Ellipsoidal Height(Up) (m)
R000	0.005	0.005	0.016
ALIC	0.004	0.004	0.010
CDWL	0.005	0.004	0.012
DARW	0.004	0.004	0.010
GGTN	0.004	0.004	0.011
HUGH	0.004	0.004	0.011
JLCK	0.004	0.004	0.011
KAT1	0.004	0.004	0.010
MOBS	0.004	0.005	0.009
MRT1	0.005	0.004	0.012
MRT4	0.005	0.005	0.013
MRT5	0.005	0.004	0.012
SYDN	0.004	0.005	0.011
TID1	0.004	0.004	0.010
TOW2	0.004	0.004	0.009

6 Ambiguity Resolution - Per Baseline

Baseline	Ambiguities Resolved	Baseline Length (km)
JLCK - TOW2	100.0 %	577.437
JLCK - KAT1	100.0 %	1230.841
HUGH - R000	37.0 %	86.983
MOBS - TID1	85.1 %	448.268
JLCK - MOBS	90.0 %	1920.210
MRT5 - TOW2	86.2 %	128.958
CDWL - MRT5	79.4 %	46.325
ALIC - JLCK	100.0 %	874.663
DARW - KAT1	77.8 %	202.319
HUGH - JLCK	86.1 %	258.497
MRT4 - MRT5	88.1 %	39.135
GGTN - JLCK	96.8 %	322.792
MRT1 - TOW2	81.1 %	58.817
MOBS - SYDN	63.9 %	715.774
AVERAGE	83.7%	493.644

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.