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## AUSPOS Online GPS Processing Report

Space Geodesy Analysis Centre  
Minerals and Geohazards Division, Geoscience Australia

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This document is a report of the GPS data processing undertaken by the AUSPOS Online GPS Processing Service. The AUSPOS Online GPS Processing Service uses International GPS Service (IGS) products (final, rapid, ultra-rapid depending on availability) including Precise Orbits, Earth Orientation, Coordinate Solutions (IGS-SSC) to compute precise coordinates in ITRF anywhere on Earth. The Service is designed to process only dual frequency GPS phase data.

The AUSPOS Online GPS Processing Service is a free service and you are encouraged to use it for your projects. However, you may not charge others for this service. Geoscience Australia does not warrant that this service a) is error free; b) meets the customer's requirements. Geoscience Australia shall not be liable to the customer in respect of any loss, damage or injury (including consequential loss, damage or injury) however caused, which may arise directly or indirectly in respect of this service.

An overview of the GPS processing strategy is attached to this report. Please direct email correspondence to [geodesy@ga.gov.au](mailto:geodesy@ga.gov.au)

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# 1 User and IGS GPS Data

All antenna heights refer to the vertical distance from the Ground Mark to the Antenna Reference Point (ARP).

User File	Antenna Type	Antenna Height (m)	Start Time	End Time
APMP1760.040	DEFAULT (NONE)	0.0000	2004-06-24 05:20:59	2004-06-24 23:59:59
APMP1770.040	DEFAULT (NONE)	0.0000	2004-06-25 00:00:00	2004-06-25 23:59:59
APMP1780.040	DEFAULT (NONE)	0.0000	2004-06-26 00:00:00	2004-06-26 23:59:59
APMP1790.040	DEFAULT (NONE)	0.0000	2004-06-27 00:00:00	2004-06-27 23:59:59
APMP1800.040	DEFAULT (NONE)	0.0000	2004-06-28 00:00:00	2004-06-28 23:59:59
APMP1810.040	DEFAULT (NONE)	0.0000	2004-06-29 00:00:00	2004-06-29 23:59:59

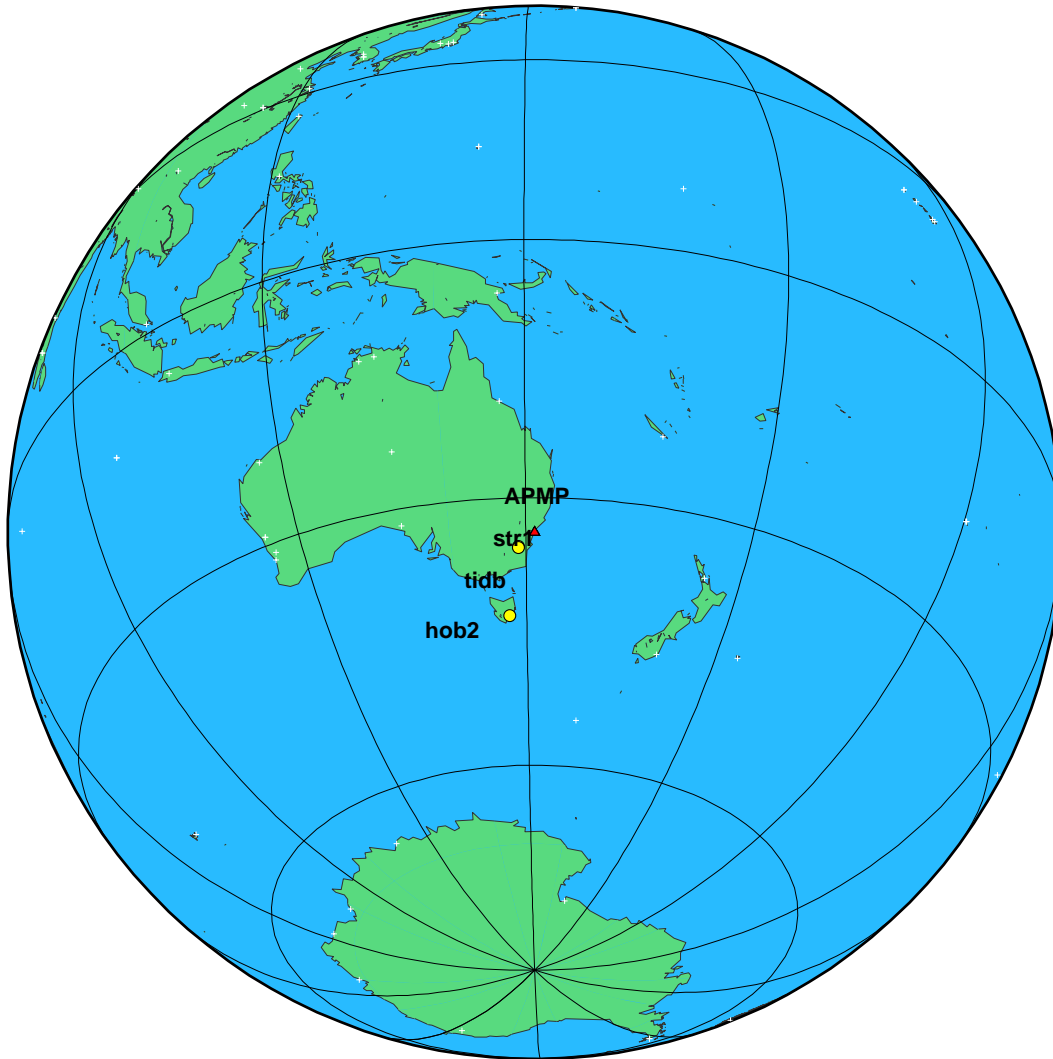


Figure 1: Global View – submitted GPS station(s) and nearby IGS GPS stations used in the processing; triangle(s) represent submitted user data; circle(s) represent the nearest available IGS stations.

## 2 Processing Summary

Date	IGS Data	User Data	Orbit Type
2004-06-24	str1 tidb hob2	APMP	IGS Final
2004-06-25	str1 tidb hob2	APMP	IGS Final
2004-06-26	str1 tidb hob2	APMP	IGS Final
2004-06-27	str1 tidb hob2	APMP	IGS Final
2004-06-28	str1 tidb hob2	APMP	IGS Final
2004-06-29	str1 tidb hob2	APMP	IGS Final

## 3 Computed Coordinates, GDA94

For Australian users Geocentric Datum of Australia (GDA94, ITRF92@1994.0) coordinates are provided. GDA94 coordinates are determined from ITRF coordinates by an Geoscience Australia (GA) derived coordinate transformation process. GA transformation parameters between ITRF and GDA94 are re-computed weekly, incorporating the latest available tectonic motions (determined from the GA GPS network). GA recommends that users within Australia use GDA94 coordinates. All coordinates refer to the Ground Mark. For general/technical information on GDA94 see [www.ga.gov.au/nmd/geodesy/datums/gda.jsp](http://www.ga.gov.au/nmd/geodesy/datums/gda.jsp) and [www.icsm.gov.au/icsm/gda/gdatm/](http://www.icsm.gov.au/icsm/gda/gdatm/)

### 3.1 Cartesian, GDA94

	X(m)	Y(m)	Z(m)	
tidb	-4460996.065	2682557.135	-3674443.860	GDA94
hob2	-3950071.284	2522415.222	-4311638.526	GDA94
str1	-4467102.303	2683039.532	-3666949.981	GDA94
APMP	-4648199.343	2560483.959	-3526506.586	GDA94

### 3.2 Geodetic, GRS80 Ellipsoid, GDA94

The height above the Geoid is computed using the GPS Ellipsoidal height and subtracting a Geoid-Ellipsoid separation. Geoid-Ellipsoidal separations are computed using a bilinear interpolation of the AUSGeoid98 grid. The height above the Geoid is only provided for sites within the AUSGeoid98 extents. For information on AUSGeoid98 see [www.ga.gov.au/nmd/geodesy/ausgeoid/](http://www.ga.gov.au/nmd/geodesy/ausgeoid/)

	Latitude(DMS)		Longitude(DMS)		Ellipsoidal Height(m)	Above-Geoid Height(m)	
tidb	-35-23	-57.1560	148 58	47.9845	665.425	646.139	GDA94
hob2	-42-48	-16.9852	147 26	19.4355	41.145	44.451	GDA94
str1	-35-18	-55.9396	149 0	36.1797	800.030	780.693	GDA94
APMP	-33-46	-58.2154	151 9	5.7893	99.174	76.035	GDA94

### 3.3 MGA Grid, GRS80 Ellipsoid, GDA94

	East(M)	North(M)	Zone	Ellipsoidal Height(m)	Above-Geoid Height(m)	
tidb	679807.859	6080884.476	55	665.425	646.139	GDA94
hob2	535873.397	5260777.226	55	41.145	44.451	GDA94
str1	682726.017	6090110.670	55	800.030	780.693	GDA94
APMP	328860.453	6260386.829	56	99.174	76.035	GDA94

## 4 Computed Coordinates, ITRF2000

All computed coordinates are based on the IGS realisation of the ITRF2000 reference frame, provided by the IGS cumulative solution. All the given ITRF2000 coordinates refer to a mean epoch of the site observation data. All coordinates refer to the Ground Mark.

### 4.1 Cartesian, ITRF2000

	X(m)	Y(m)	Z(m)	ITRF2000 @
tidb	-4460996.415	2682557.093	-3674443.372	2004/06/27
hob2	-3950071.669	2522415.263	-4311638.078	2004/06/27
str1	-4467102.653	2683039.489	-3666949.493	2004/06/27

APMP	-4648199.675	2560483.895	-3526506.097	2004/06/27	
APMP	0.008 m	0.017 m	0.008 m		RMS

## 4.2 Geodetic, GRS80 Ellipsoid, ITRF2000

The height above the Geoid is computed using the GPS Ellipsoidal height and subtracting a Geoid-Ellipsoid separation. Geoid-Ellipsoidal separations, in this section, are computed using a spherical harmonic synthesis of the global EGM96 geoid. More information on the EGM96 geoid can be found at [earth-info.nga.mil/GandG/wgsegm/egm96.html](http://earth-info.nga.mil/GandG/wgsegm/egm96.html)

	Latitude(DMS)	Longitude(DMS)		Ellipsoidal Height(m)	Above-Geoid Height(m)
tidb	-35-23 -57.1379	148 58 47.9931		665.369	646.206
hob2	-42-48 -16.9669	147 26 19.4432		41.095	44.605
str1	-35-18 -55.9214	149 0 36.1883		799.975	780.730
APMP	-33-46 -58.1976	151 9 5.7977		99.117	76.263
APMP	0.001 m	0.014 m		0.014 m	RMS

## 5 Solution Information

To validate your solution you should check the :-

- Antenna Reference Point (ARP) to Ground Mark records;
- Apriori Coordinate Updates (valid range is 0.000 - 15.000 m);
- Coordinate Precision (valid range is 0.001 - 0.025 m);
- Root Mean Square (RMS) (valid range is 0.0005 - 0.0250 m); and
- % Observations Deleted (valid range is 0 - 25) %;

### 5.1 ARP to Ground Mark, per day

All heights refer to the vertical distance from the Ground Mark to the Antenna Reference Point (ARP). The Antenna Offsets refer to the vertical distance from the ARP to the L1 phase centre.

Station	Height(m)	Antenna Offsets(m)			yyyy/mm/dd
	Up	East	North	Up	
APMP	0.0000	0.0000	0.0000	0.0000	2004/06/24
APMP	0.0000	0.0000	0.0000	0.0000	2004/06/25
APMP	0.0000	0.0000	0.0000	0.0000	2004/06/26
APMP	0.0000	0.0000	0.0000	0.0000	2004/06/27
APMP	0.0000	0.0000	0.0000	0.0000	2004/06/28
APMP	0.0000	0.0000	0.0000	0.0000	2004/06/29

### 5.2 Apriori Coordinate Updates - Cartesian, per day

	dX(m)	dY(m)	dZ(m)	yyyy/mm/dd
APMP	-0.006	0.006	0.001	2004/06/24
APMP	0.153	-0.425	0.162	2004/06/25
APMP	0.008	-0.001	0.008	2004/06/26
APMP	-0.003	0.004	-0.002	2004/06/27
APMP	0.003	0.001	0.004	2004/06/28
APMP	0.024	-0.035	0.026	2004/06/29

### 5.3 Coordinate Precision - Cartesian, per day

1 Sigma	sX(m)	sY(m)	sZ(m)	yyyy/mm/dd
APMP	0.005	0.005	0.005	2004/06/24
APMP	0.005	0.005	0.005	2004/06/25
APMP	0.006	0.006	0.006	2004/06/26
APMP	0.005	0.005	0.005	2004/06/27
APMP	0.005	0.005	0.005	2004/06/28
APMP	0.006	0.006	0.006	2004/06/29

## 5.4 Coordinate Value - Cartesian, ITRF2000, per day

	X(m)	Y(m)	Z(m)	ITRF2000 @
APMP	-4648199.669	2560483.896	-3526506.093	2004/06/24
APMP	-4648199.688	2560483.915	-3526506.110	2004/06/25
APMP	-4648199.664	2560483.897	-3526506.095	2004/06/26
APMP	-4648199.673	2560483.902	-3526506.097	2004/06/27
APMP	-4648199.679	2560483.892	-3526506.098	2004/06/28
APMP	-4648199.674	2560483.859	-3526506.084	2004/06/29

## 5.5 Geodetic, GRS80 Ellipsoid, ITRF2000, per day

	Latitude(DMS)		Longitude(DMS)		Ellipsoidal Height(m)		
APMP	-33-46	-58.1975	151	9	5.7975	99.111	2004/06/24
APMP	-33-46	-58.1975	151	9	5.7972	99.142	2004/06/25
APMP	-33-46	-58.1977	151	9	5.7974	99.109	2004/06/26
APMP	-33-46	-58.1975	151	9	5.7974	99.119	2004/06/27
APMP	-33-46	-58.1976	151	9	5.7979	99.120	2004/06/28
APMP	-33-46	-58.1975	151	9	5.7989	99.095	2004/06/29

## 5.6 RMS, Observations, Deletions per day

Data	RMS (m)	# Observations	% Obs. Deleted	Date
tidb	0.0112	13977	8 %	2004-06-24
hob2	0.0108	12987	8 %	2004-06-24
str1	0.0100	14203	7 %	2004-06-24
APMP	0.0107	41167	8 %	2004-06-24
tidb	0.0104	15037	15 %	2004-06-25
hob2	0.0109	13407	18 %	2004-06-25
str1	0.0113	14948	16 %	2004-06-25
APMP	0.0109	43392	16 %	2004-06-25
tidb	0.0116	15642	7 %	2004-06-26
hob2	0.0109	15192	2 %	2004-06-26
str1	0.0111	15827	6 %	2004-06-26
APMP	0.0112	46661	5 %	2004-06-26
tidb	0.0098	16961	5 %	2004-06-27
hob2	0.0111	15806	5 %	2004-06-27
str1	0.0095	16620	7 %	2004-06-27
APMP	0.0101	49387	6 %	2004-06-27
tidb	0.0111	15983	5 %	2004-06-28
hob2	0.0108	15275	3 %	2004-06-28
str1	0.0106	16149	4 %	2004-06-28
APMP	0.0108	47407	4 %	2004-06-28
tidb	0.0116	15501	8 %	2004-06-29
hob2	0.0136	14849	5 %	2004-06-29
str1	0.0114	15751	6 %	2004-06-29
APMP	0.0122	46101	6 %	2004-06-29

# A GPS Computation Standards

## A.1 Measurement Modelling

Observable	Ionosphere corrected L1 double difference carrier phase, Psuedo-range only used for receiver clock estimation, Elevation cut-off 15°, Sampling rate 30 seconds, Weighting 1.0cm for double difference, elevation dependent $1/\sin(E)$ .
Troposphere	Hopfield, Niell mapping function
Preprocessing	Receiver clocks estimated using pseudo-range information
Satellite center of mass correction	Block II x,y,z: 0.2794, 0.0000, 1.0259 m Block IIA x,y,z: 0.2794, 0.0000, 1.2053 m
Satellite Antenna Phase centre calibration	Not applied
Ground Antenna phase centre calibrations	Elevation-dependent phase centre corrections are applied according to the model IGS01, the NGS antenna calibrations are used when the antenna used is not a recognised IGS type. The corrections are given relative to the Dorne Margolin T antenna.
Atmospheric Drag	Jachhia Model
Centre of Mass Correction / Attitude	Nil

## A.2 Orbit Modelling

Earth's Gravitational (Static) Potential Model	EGM96 - degree and order 12
Solid Earth Tides (Dynamic) Potential	Love Model
Ocean Tide (Dynamic) Potential	Christodoulidis
Third Body Perturbations	Sun, Moon and Planets  Values for physical constants - AU, Moon/Earth mass ratio, GM(moon, sun and planets) from JPL DE403 Planetary Ephemeris.
Direct Solar Radiation Pressure	Rock

## A.3 Station Position Modelling and Reference Frame

Precession	IAU76/IERS96
Nutation	IAU80/IERS96 (including epsilon and psi corrections)
Sine terms added to accumulated precession and nutation in Right Ascension	As in IERS TN 21, p. 21
Geodesic Nutation	As in IERS TN 21, P. 37
Polar Motion	IGS Earth Orientation Parameters (Ultra-rapid, Rapid, Final) - apriori
Earth Rotation (UT1)	IGS Earth Orientation Parameters (Ultra-rapid, Rapid, Final) - apriori
Daily and Sub-daily tidal corrections to X, Y and UT1	Applied (IERS2000)
Plate Motion	IGS Cumulative SSC
Planetary and Lunar Ephemeris	JPL DE403
Station Displacement - Solid Earth Tide Loading	Williamson and Diamante (1972) + Wahr (1980) for the frequency dependent elastic response of the Earth's fluid interior.
Station Displacement - Ocean Tide Loading	not applied
Station Displacement - Pole Tide	applied
Station Displacement - Atmosphere Loading	not applied
Reference Frame	IGS Cumulative SSC