Geoscience Australia Activities Related to the International GPS Service (IGS)

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The International GPS Service (IGS) and Geoscience Australia continue to have a strong relationship. Geoscience Australia (formerly the Australian Surveying and Land Information Group, AUSLIG) currently provides data from 15 permanently tracking GPS stations to the IGS, these stations are known as the Australian Regional GPS Network (ARGN). Future development of the ARGN will focus on the availability of near real time data and the augmentation of precise clocks and meteorological equipment at selected stations. Additionally Geoscience Australia has been an IGS Regional Network Associate Analysis Centre (RNAAC), contributing an Australian regional GPS solution, for almost six years. Apart from these contributions to the IGS, NMD is currently making use of IGS products, including precise GPS trajectories, Earth Orientation Parameters (EOP) and station coordinates and velocities in the delivery of an Internet based precise GPS processing service (AUSPOS) widely used by both the Australian and International GPS communities. In this poster Geoscience Australia's IGS related activities are reviewed.

1. The Australian Regional GPS Network (ARGN)

The ARGN consists of 15 continuous GPS reference stations on geologically stable observing pillars. Each ARGN site typically consists of: AOA SNR-8100 and/or Ashtech ZXII3 GPS receiver (a spare receiver is kept at most sites); Dorne Margolin T choke ring antenna; Low-loss heliax antenna cable, with in-line amplifier where the cable length is more than 60 metres; PC running Linux operating system and in-house developed software; Uninterruptable Power Supply (UPS); GPS Power Controller (GPC) which allows remote control of the GPS power; Multiplexer, configured to allow remote access and control of most site equipment; Dual modems & phone lines and Internet wherever possible.; and External, high accuracy clock (at selected sites).

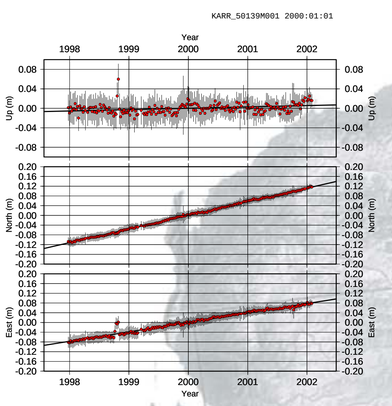
Local stability of the observing pillars is periodically monitored by accurate local surveys to nearby (20 m) deep-driven reference marks. Data is automatically retrieved on an hourly basis. At the end of each UT day, the data is automatically concatenated, converted to RINEX format and quality checked using TEQC. The results of the quality checking are graphically presented at **http://www.auslig.gov.au/geodesy/argn/argnqual.htm**. The data is submitted to IGS within 30 minutes of the end of the UT day. The data is also freely available from Geoscience Australia's anonymous FTP or via a data selection form at **http://www.auslig.gov.au/geodesy/argn/argndata.htm**. Operational status is automatically monitored and "alarm" email are automatically generated for exceptional events. Interested users may subscribe to the ARGN Email list that notifies any outages or unusual events **http://www.auslig.gov.au/geodesy/argn/argnmail.htm**.

Current developments of the ARGN include; Rapid data (hourly, within 10 minutes) is now available from selected sites; High rate data (1-5 sec) will also be implemented for sites with suitable communication links; Meteorological data will be supplied at selected sites; and GPS steered Rubidium clocks are being tested for use.

Geoscience Australia is also Regional Data for the IGS.

ARGN Overview. Near real time data refers to a 30 second RINEX product available 1 hour after observation. Coordinates are ITRF2000 @ 1/1/2000 on the GRS80 ellipsoid

Station	Id	Receiver	Communication	Near Real Time	Met. Equipped	GLONASS	Clock	Latitude (DMS)			Longitude (DMS)			Height(m)
Alice Springs, Australia	ALIC	Turbo Rogue	Dial Up	-	-	-	Internal	-23	-40	-12.4311	133	53	7.8577	603.2896
Casey, Antarctica	CAS1	Turbo Rogue	Internet	-	-	-	Internal	-66	-17	-0.0932	110	31	10.9415	22.4703
Ceduna, Australia	CEDU	Turbo Rogue	Dial Up	-	-	-	Internal	-31	-52	-0.0017	133	48	35.3852	144.7722
Cocos Island, Australia	COCO	Turbo Rogue	Internet	Yes	-	-	Internal	-12	-11	-18.0561	96	50	2.285	-35.2501
Darwin, Australia	DARW	Ashtech ZXII3	Dial Up	-	-	Yes	Internal	-12	-50	-37.3436	131	7	57.8579	125.1512
Davis, Antarctica	DAV1	Turbo Rogue	Internet	Yes	-	Yes	Rubidium (planned)	-68	-34	-38.3625	77	58	21.4088	44.4217
Jabiru, Australia	JAB1	Ashtech ZXII	Dial Up	.	.	.	Internal	-12	-39	-31.8665	132	53	38.0274	74.1514
Hobart, Australia	HOB2	Turbo Rogue	Internet	Yes	-	-	Hydrogen Maser	-42	-48	-16.9711	147	26	19.4418	41.0829
Karratha, Australia	KARR	Turbo Rogue	Dial Up	Yes	-	-	Internal	-20	-58	-53.1554	117	5	49.8841	109.1777
Macquarie Island, Australia	MAC1	Turbo Rogue	Internet	Yes	-	-	Internal	-54	-29	-58.3127	158	56	8.9988	-6.7634
Mawson, Antarctica	MAW1	Turbo Rogue	Internet	-	-	-	Internal	-67	-36	-17.1596	62	52	14.5761	59.1501
Mount Stromlo, Antarctica	STR1	Turbo Rogue	Internet	Yes	-	Yes	Internal	-35	-18	-55.9256	149	0	36.1868	799.9655
Tidbinbilla, Australia	TID1	Turbo Rogue	Internet	-	-	-	Hydrogen Maser	-35	-23	-57.1421	148	58	47.9915	665.3609
Townsville, Australia	TOW2	Turbo Rogue	Internet	Yes	Planned	-	Rubidium (planned)	-19	-16	-9.4137	147	3	20.4744	88.1595
Yarragadee, Australia	YAR2	Turbo Rogue	Dial Up	Yes	-	Yes	Caesium	-29	-2	-47.6027	115	20	49.1123	241.2882

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RMS ENU         0.0067         0.0025         0.0090     M
VEL XYZ        -0.0448         0.0025         0.0513 M/YR
VEL ENU         0.0387         0.0560         0.0028 M/YR
+/- ENU         0.0012         0.0009         0.0014 M/YR
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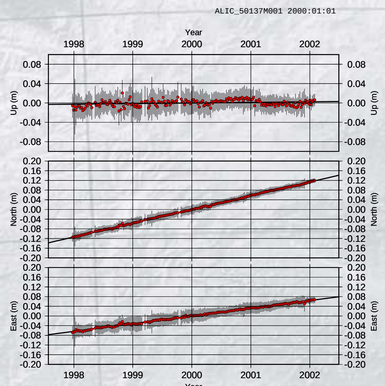
Karratha (KARR)

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RMS ENU         0.0025         0.0017         0.0060     M
VEL XYZ        -0.0395         0.0049         0.0514 M/YR
VEL ENU         0.0319         0.0567         0.0012 M/YR
+/- ENU         0.0013         0.0009         0.0012 M/YR
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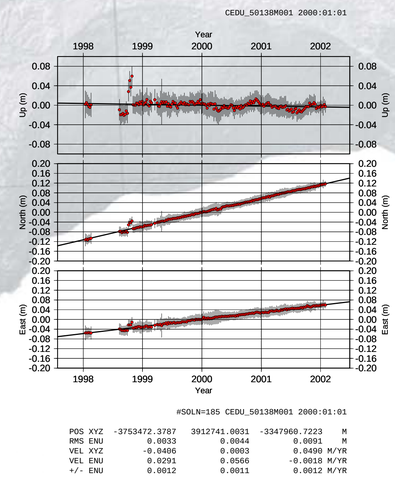


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POS XYZ  -3753472.3787   3912741.0031  -3347960.7223     M
RMS ENU         0.0033         0.0044         0.0091     M
VEL XYZ        -0.0406         0.0003         0.0490 M/YR
VEL ENU         0.0291         0.0566        -0.0018 M/YR
+/- ENU         0.0012         0.0011         0.0012 M/YR
```

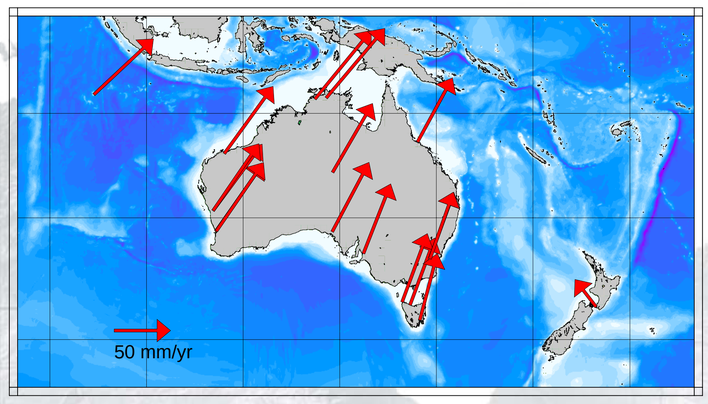
A number of ARGN sites are co-located with other fundamental geodetic facilities. At co-located sites, the facilities are rigorously connected by accurate terrestrial surveys. The results of these terrestrial surveys have been included in the ITRF2000. Results of all terrestrial surveys are available in SINEX format at **ftp://ftp.auslig.gov.au/sgac/sinex/ties/**

Site	SLR	VLBI	GLONASS	DORIS	Absolute Gravity	Tide Gauge
Stromlo	✓		✓	✓	✓	
Yarragadee	✓		✓	✓	✓	
Tidbinbilla		✓			✓	
Hobart		✓			✓	
Darwin			✓			
Townsville					✓	✓
Davis			✓			✓
Mawson						✓
Casey						✓
Macquarie Is.						✓

2. The Geoscience Australia Regional Network Associate Analysis Centre (RNAAC)

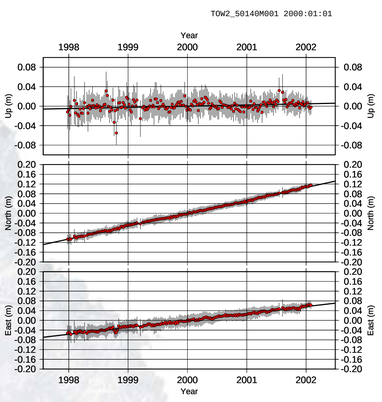
Geoscience Australia participates in the IGS as an RNAAC by processing all IGS stations in the Australian Regional GPS Network (ARGN). The weekly combined SINEX result files are submitted to the Crustal Dynamics Data Information System (CDDIS) as Geoscience Australia's role as an IGS type 2 Associate Analysis Centre. Data processing is undertaken using the Bernese GPS Processing Software version 4.2. Daily solutions are computed using the following strategy: L3 double differenced phase observable; No resolution of integer ambiguities; Elevation cut-off angle of 10° with elevation dependant weighting; Estimation of tropospheric zenith delay parameters at 2 hourly intervals; IGS antenna phase centre variation model applied; IGS final orbits and EOPs held fixed; Station coordinates for a single station constrained (either TID2 or YAR1). Seven daily solutions are combined at the normal equation level to obtain the weekly solution output in SINEX format submitted to the CDDIS. The Geoscience Australia RNAAC weekly SINEX solution files are included in the Type 2 GNAAC combination generated by the Massachusetts Institute of Technology (MIT) GNAAC Polyhedron solution. A regularly updated analysis report can be found at **http://www.auslig.gov.au/geodesy/sgc/gps/.**

ITRF2000 Tectonic Velocities from ARGN/IGS GPS stations



Alice Springs (ALIC)

Townsville (TOW2)

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POS XYZ  -5054582.8070   3275504.4089  -2091539.5520     M
RMS ENU         0.0039         0.0025         0.0095     M
VEL XYZ        -0.0320         0.0132         0.0491 M/YR
VEL ENU         0.0285         0.0529         0.0024 M/YR
+/- ENU         0.0012         0.0008         0.0013 M/YR
```
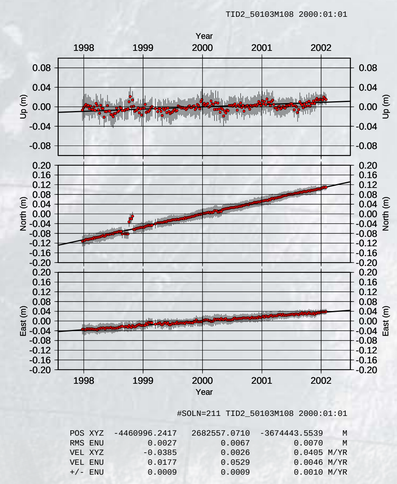

In 1992 GPS observations were completed on eight geologically stable marks at sites across Australia, these marks form the Australian Fiducial Network (AFN). Additional GPS observations were also carried out at a number of existing geodetic survey stations across Australia. In 1993 and 1994 these were supplemented by further observations and results in a network of about 70 GPS sites with a nominal 500 km spacing across Australia and is known as the Australian National Network (ANN). GPS observations at both the AFN and ANN sites were combined in a single regional GPS solution in terms of the International Terrestrial Reference Frame 1992 (ITRF92) and the resulting coordinates were mapped to a common epoch of 1994.0. The positions of the AFN sites were used to define the Geocentric Datum of Australia (GDA). The positions of both the AFN and ANN sites were used to constrain a re-adjustment of the Australian geodetic networks. GDA94 is officially regarded as the Australian national datum.

Ceduna (CEDU)

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POS XYZ  -4460996.2417   2682557.0710  -3674443.5539     M
RMS ENU         0.0027         0.0067         0.0070     M
VEL XYZ        -0.0385         0.0026         0.0405 M/YR
VEL ENU         0.0177         0.0529         0.0046 M/YR
+/- ENU         0.0009         0.0009         0.0010 M/YR
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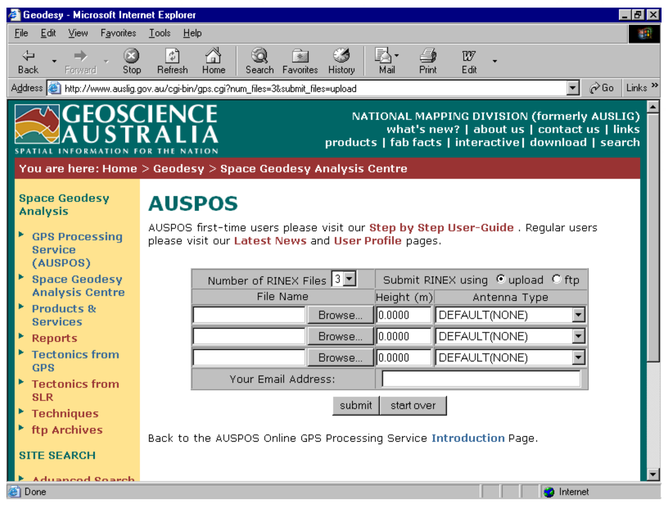
Tidbinbilla (TID2)

3. The Geoscience Australia Online GPS Processing Service (AUSPOS)



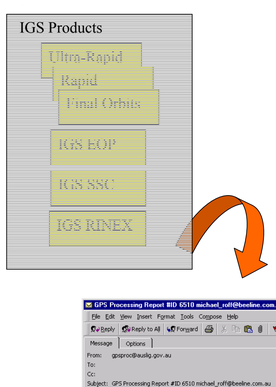
The AUSPOS Overview

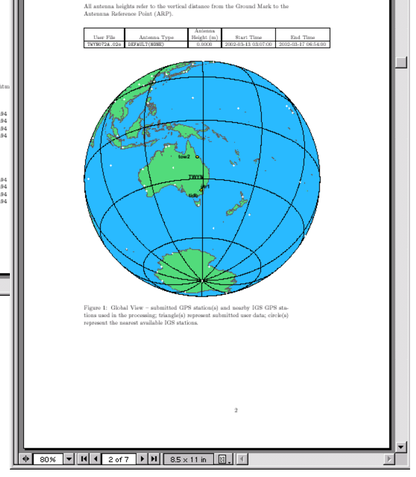
Feature/function	Description
Observations	RINEX dual frequency GPS code and carrier phase. User GPS navigation data is not required.
Data quantity	Minimum of 1 hour, recommended minimum of 6 hours
Multiple files submission	Maximum of 7 user files per submission
Compression	UNIX, ZIP, Hatanaka formats only
Orbit and Earth Orientation	IGS precise, ultra-rapid, rapid, final
Observations used	Double difference carrier phase
Reference frame	IGS-SSC (nominally ITRF2000 at present), GDA94 for Australia
Geoid	Heights above the geoid are supplied within Australia using AUSGeoid98 (Johnston and Featherstone, 1998).
# IGS stations used	3
Results quality	<10mm horizontal <20mm vertical with 6 hours of data
Antenna phase centre	IGS or NGS models
Report delivery	Email and anonymous ftp
Report format	ADOBE PDF

Geoscience Australia's Online GPS Processing Service (AUSPOS) provides users with the facility to submit via the Internet, dual frequency geodetic quality GPS RINEX data observed in a 'static' mode and receive rapid turn-around precise coordinates. The service is free and provides both ITRF and GDA94 coordinates.

This Internet service takes advantage of both the International GPS Service (IGS) analysis product range and the IGS GPS network and works with GPS data collected anywhere on Earth. AUSPOS processes user data differentially using the three closest IGS receivers.

AUSPOS **http://www.auslig.gov.au/geodesy/sgc/wwwgps/**





As high precision global geodetic GPS technology has evolved, processing and analysis software has become more sophisticated and in general more automated. This development has now seen the implementation of Internet based geodetic GPS processing services by various International groups. In Australia these International GPS Processing Services were being widely used by the geodetic GPS community. It was at this time that the potential for user confusion between the International Terrestrial Reference Frame (ITRF), as provided by these International GPS processing services and the Australian national datum, GDA94 was recognised. Since GDA94 was based on the ITRF92 at a fixed epoch of 1994 the latest ITRF coordinates produced were becoming substantially offset. This difference is due largely to the tectonic motion of the Australian plate. Coordinate differences between GDA94 and the ITRF are at this time approximately 0.5 metres in magnitude.

Geoscience Australia traditionally has offered a GPS processing service to its clients in the national interest such as aviation, defence and other commonwealth and state government agencies. For this processing GPS data was generally received on various digital media, including CDROM, floppy disks and email attachments. Customer service then relied on a hand-on-process and as such was not necessarily meeting the needs of the Geoscience Australia clients. Defence clients for example were increasingly requiring a 24 hour x 7 day a week access to a precise GPS processing service.

In this context in early 2000 a decision at Geoscience Australia was then made to develop a 24-hour a day online web based GPS processing service that would provide users with access to GDA94 based coordinates for Australian users, and ITRF for International users. This service known as the Geoscience Australia Online GPS Processing Service or AUSPOS and is accessible via the Geoscience Australia web site at **http://www.auslig.gov.au**. The AUSPOS service is clearly helping the Australian private sector in the growing International spatial information sector by providing access to a sophisticated GPS analysis system free of charge. Feedback shows positive support for the service and Australian companies are competing internationally for contracts using the Geoscience Australia service as an important 'selling' point for own services. Effectively every small survey/GPS organisation now has access to a sophisticated GPS analysis system. Further development of the AUSPOS system is continuing.

AUSPOS was designed and implemented with the following features and design goals;

- an easy to use web page interface;
- dual frequency geodetic GPS data processing capability;
- standard web-browser direct upload or ftp;
- highest quality global GPS processing standards;
- 24 hour x 7 days a week service;
- rapid processing turnaround, < 15 minutes/file;
- results returned by email and ftp server;
- applicable anywhere on Earth; and
- GDA94 compliant for Australian users, ITRF elsewhere.

GEOSCIENCE AUSTRALIA
SPATIAL INFORMATION FOR THE NATION