Precision Analysis of GPS for Datum Modernisation in Australia

Guorong HU, Australia

SUMMARY

An increasingly important requirement for Australia's geodetic reference system is that the relationships between the International Terrestrial Reference Frame (ITRF) and the national horizontal and vertical datums are well understood. To support the development of improved geodetic infrastructure in Australia, we have analysed GPS data observed at 2310 survey marks. These data, observed between 1995 and 2009, across continental Australia were processed with consistent standards to generate a combined solution with an estimated uncertainty of better than 5 and 20 mm (1 sigma) in the horizontal and vertical components, respectively. Our combined solution, which was mapped to ITRF2005 at the reference epoch of 2000, is the first unified single-epoch solution with sufficient resolution to support datum modernisation in Australia. We review the considerable work undertaken to determine the optimum analysis procedure, including comparisons of solutions using different antenna phase centre variations (PCV) calibration models, and find that the heights determined using relative PCV models differ from those determined using absolute PCV models by a maximum of 27 mm and an average of 6 mm. Also, we assess the impact of both observation session lengths and crustal velocity modelling. There will be two important applications for this new GPS solution. First, will be the development of an improved model for the estimation of Australian Height Datum (AHD) values from GNSS observations, and the solution will be an important input into the Australian Height Modernisation Project. Second, will be its use as constraining dataset for the readjustment of the terrestrial geodetic observations used in GDA94 as part of the creation of the Geodetic Model of Australia, and will potentially lead to a new national datum.

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Precision Analysis of GPS for Datum Modernisation in Australia

Guorong Hu, John Dawson, Gary Johnston and Nicholas Brown

National Geospatial Reference Systems Project

Geoscience Australia

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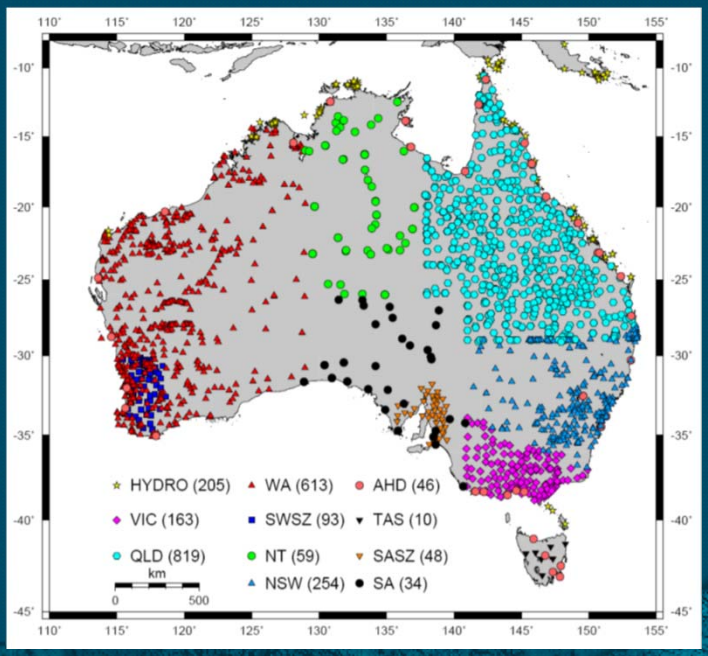
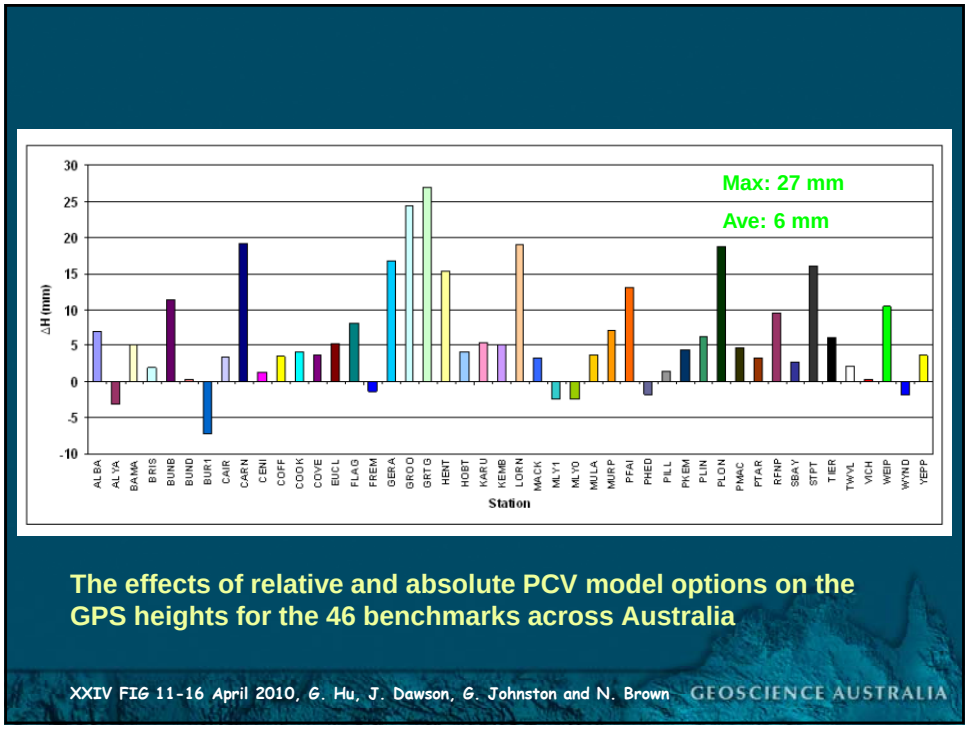


Objectives

- To meet the requirement of understanding the relationships between the ITRF and the national horizontal and vertical datums in Australia
- To support the development of improved geodetic infrastructure in Australia


Max: 27 mm
Ave: 6 mm
ΔH (mm)
Station
The effects of relative and absolute PCV model options on the GPS heights for the 46 benchmarks across Australia
XXIV FIG 11-16 April 2010, G. Hu, J. Dawson, G. Johnston and N. Brown
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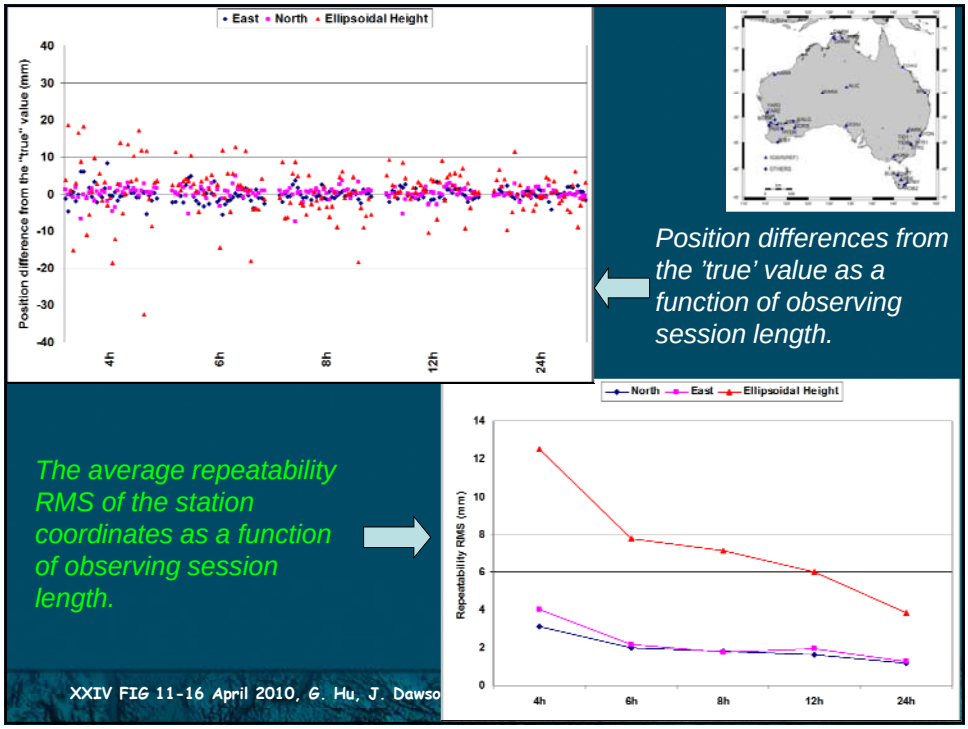
East North Ellipsoidal Height
Position difference from the "true" value (mm)
Position differences from the 'true' value as a function of observing session length.
The average repeatability RMS of the station coordinates as a function of observing session length.
North East Ellipsoidal Height
Repeatability RMS (mm)
XXIV FIG 11-16 April 2010, G. Hu, J. Dawso

Statistics of the estimated formal standard deviations of the 1968 sites (unit: mm).

	Max	Min	Mean	STD
Ellipsoidal Height	14.2	0.1	2.3	1.8
North	9.3	0.0	0.6	0.7
East	8.1	0.1	1.0	1.0

Conclusions

1. **In order to achieve the highest possible accuracy positions, particularly for the height component in the recent realization of ITRF2005, IGS absolute PCV models have to be used in data processing;**

2. **At least 6-hr duration occupations are needed to ensure to obtain reliable results especially for the GPS derived heights;**

3. **There will be two applications for this new GPS solution:**

   a) an important input into the Australian Height Modernisation Project.

   b) as constraining dataset for the new national datum in the future.


Thank you
To all station operators and their agencies
XXIV FIG 11-16 April 2010, G. Hu, J. Dawson, G. Johnston and N. Brown
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Standards and Practices for GNSS CORS Infrastructure, Networks, Techniques and Applications

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Presentation Outline

- Drivers for Production of Guidelines
- Tiers of GNSS CORS
- Organisational Model Impacts
- Challenges
- The Guidelines
- Final Remarks

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A Clarification

- This presentation is based on the drafting of a document.
- The document is only in draft format and has not yet been approved by ICSM.
- The final version of the document will be guidelines, not standards.

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Drivers

- ICSM GTSC produce the *"Standards and Practices for Control Surveys"* also known as SP1, which is undergoing revision.
- The latest revision makes significant content and format to the document.
- GTSC recognises that GNSS CORS is playing an increasing role in control surveys, however previous versions of SP1 have not included the topic of GNSS CORS.
- SP1 to be split into a number of documents, an overarching "standards" document, and a series of subsidiary "guideline" documents.
- The GNSS CORS Guidelines are the first subsidiary document to be drafted.

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Tiered GNSS CORS

- The GNSS CORS Guidelines use the concept of Tiers of GNSS CORS (Rizos, 2008).
- The Tiers help to breakdown the requirements of a station based on the purpose of the station.
- The guidelines consider the first three Tiers, there are potentially more.
- Tier 3 GNSS CORS network operators are encouraged to install approximately 10% of their stations to Tier 2 standards and contribute the data from these stations to government agencies responsible for geodetic datum.

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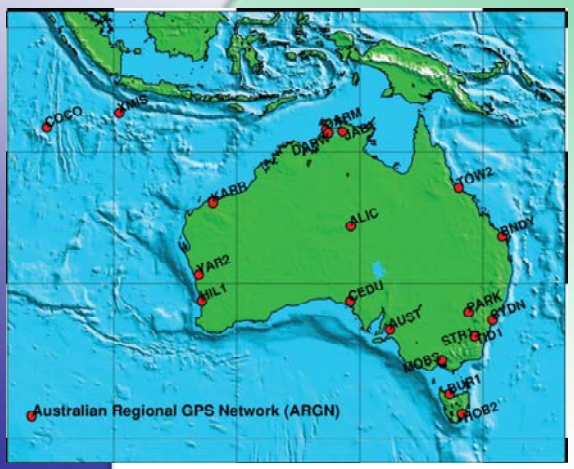

Tier 1

- Tier 1 stations are those that contribute to global geodesy through international cooperation such as IGS.
- The CORS in the Australian Regional Geodetic Network are examples of Tier 1 GNSS CORS.

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Tier 2

- Tier 2 stations are those that contribute to the primary national network.
- In Australia Tier 2 is currently being populated through the AuScope project.

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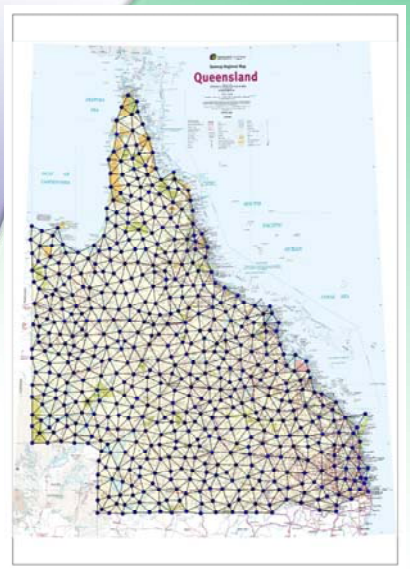
Tier 3



- Tier 3 stations include those that contribute to state and territory geodetic objectives and private industry networks.
- In Australia Tier 3 networks are being created by private industry as commercial services, and by state governments as datum realisation.

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Organisational Model Impacts

- It may not be immediately apparent that an organisational model may impact on the production of guidelines for GNSS CORS.
- As the deployment of GNSS CORS in Australia involves multiple parties, and these parties often have different business needs, it becomes important to ensure that the guidelines allow for as many participants as possible.
- The aim is to minimise the duplication and expense of infrastructure, and maximise the number of potential applications.

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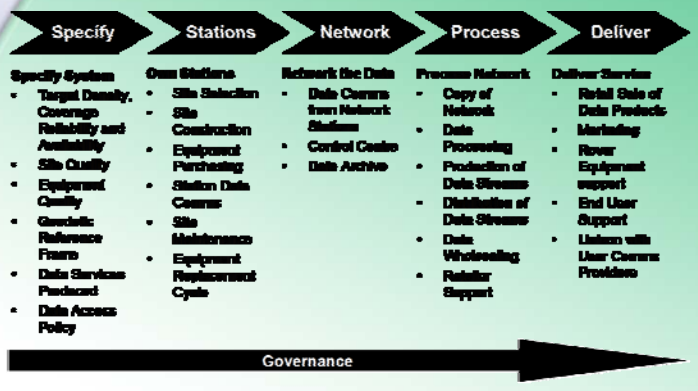
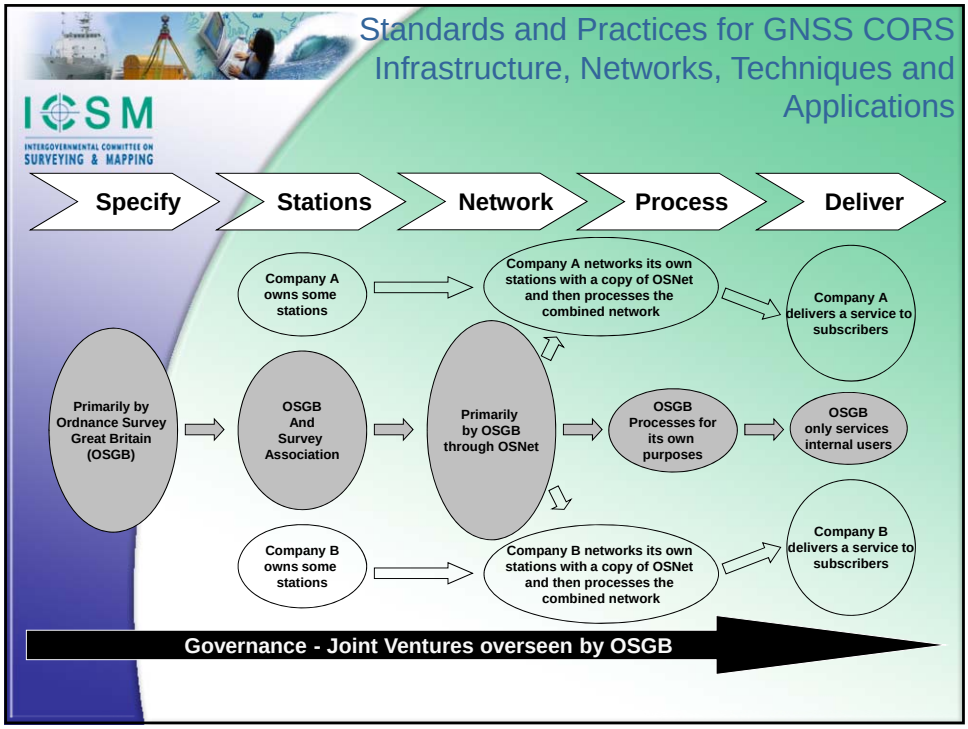


A Model for Describing Organisational Roles in Precise Positioning Services (Source: Higgins (2008))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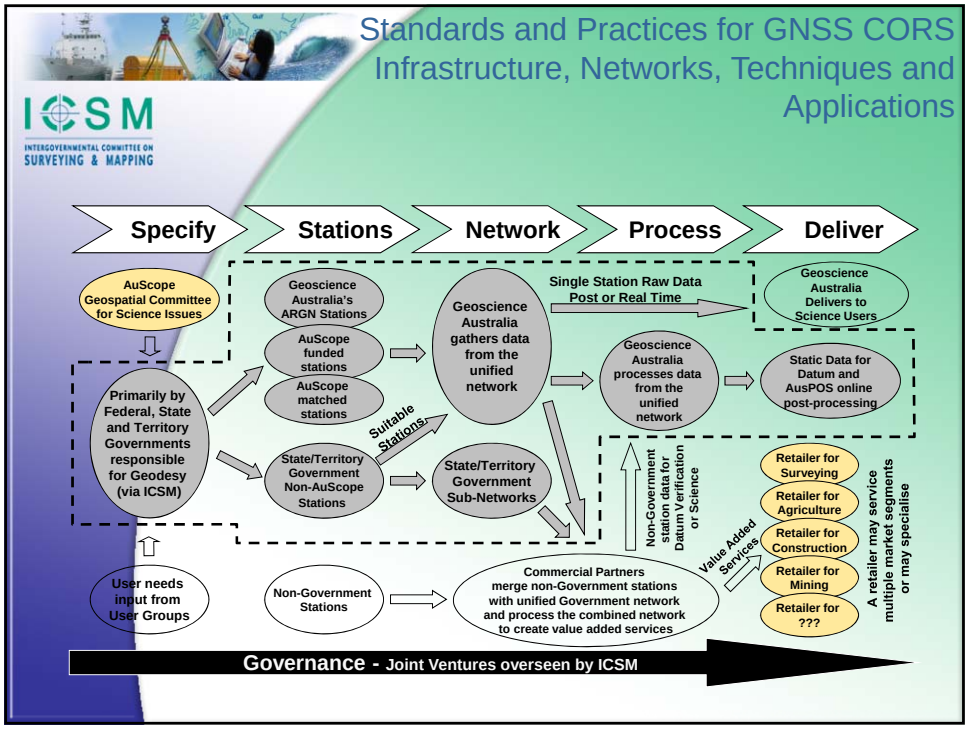
Specify
Stations
Network
Process
Deliver
Company A owns some stations
Company A networks its own stations with a copy of OSNet and then processes the combined network
Company A delivers a service to subscribers
Primarily by Ordnance Survey Great Britain (OSGB)
OSGB And Survey Association
Primarily by OSGB through OSNet
OSGB Processes for its own purposes
OSGB only services internal users
Company B owns some stations
Company B networks its own stations with a copy of OSNet and then processes the combined network
Company B delivers a service to subscribers
Governance - Joint Ventures overseen by OSGB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Specify
Stations
Network
Process
Deliver
AuScope Geospatial Committee for Science Issues
Geoscience Australia's ARGN Stations
AuScope funded stations
AuScope matched stations
Geoscience Australia gathers data from the unified network
Single Station Raw Data Post or Real Time
Geoscience Australia Delivers to Science Users
Geoscience Australia processes data from the unified network
Static Data for Datum and AusPOS online post-processing
Primarily by Federal, State and Territory Governments responsible for Geodesy (via ICSM)
Suitable Stations
State/Territory Government Non-AuScope Stations
State/Territory Government Sub-Networks
Non-Government station data for Datum Verification or Science
Value Added Services
Retailer for Surveying
Retailer for Agriculture
Retailer for Construction
Retailer for Mining
Retailer for ???
A retailer may service multiple market segments or may specialise
User needs input from User Groups
Non-Government Stations
Commercial Partners merge non-Government stations with unified Government network and process the combined network to create value added services
Governance - Joint Ventures overseen by ICSM

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Challenges

- Existing documents outlining guidelines on GNSS CORS, CORS monuments, or CORS networks.
- Trying to produce guidelines that aid multiple parties in providing GNSS CORS infrastructure cooperatively and for multiple purposes.
- Appreciating that each site is different, though CORS operators need guidance in a general sense.
- Each recommendation has a cost implication on the construction of the site.
- We are setting these guidelines from the perspective of the spatial industry, yet the users of GNSS CORS are often outside of the traditional spatial industry, in construction, mining, agriculture and utilities.
- Ensuring that all systems are interoperable through a common realisation of the datum.
- Keeping the document current.

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The Guidelines

- The GNSS CORS Guidelines are split into two sections.
- The first section deals with **site establishment**.
- The second section deals with **site operation and maintenance**.


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Site Establishment
Site establishment is further split into two section.
The first section deals with site selection.
The second section deals with equipment selection.


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Site Selection
Site selection provides guidelines for potential GNSS CORS operators on issues such as:
site foundation,
sky visibility,
multipath issues,
site security,
radiofrequency interference sources,
power and communications issues.


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Equipment Selection
Equipment selection provides guidelines for potential GNSS CORS operators on issues such as:
Antenna type,
Signal tracking,
Power and communication,
Remote configuration,
Standard data protocols,
On board logging,
Additional sensors.


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Site Operation
Site Coordination
Stability Monitoring
Data formatting
Data access
Metadata

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Final Remarks

- The GNSS CORS Guidelines are in draft format and are being refined by the ICSM GTSC.
- The Guidelines are planned to be a subsidiary document to a revised SP1.
- It is hoped that the guidelines will enable multiple parties to have an understanding of the quality and capability of GNSS CORS.