How Stable is GDA94 and when will an update become necessary?

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QUICKCLOSE

The question

Will GDA94 ever need to be updated, and if so, when?

The foundation

A stable geodetic datum is the foundation stone of any modern spatial data infrastructure !

GNSS can now extend our "RM" network over 4000 km with cm accuracy

We need to better understand the implications of this accuracy and the effects of datum change on our SDI

Drivers for Datum Change

1. To keep GDA in alignment with ITRF and WGS

   Standardisation of GNSS/GIS datums

   Navigation & safety

2. Accuracy improvements

   Homogeneity of CORS networks

   Seamless integration of different surveys and spatial data

Drivers for no Datum Change

1. The cost

   Updating GIS / mapping software & navigation systems

   Re-referencing of spatial datasets (e.g. DCDB)

   Issues with paper based spatial data (e.g. maps)

   Implementation costs

Is there any economic, environmental or safety of life benefit?

2. High possibility of confusion in absence of datum metadata

   Similarity of coordinates between GDA94 and a new GDA would be less than 2 metres if implemented by 2020

Where are we heading?

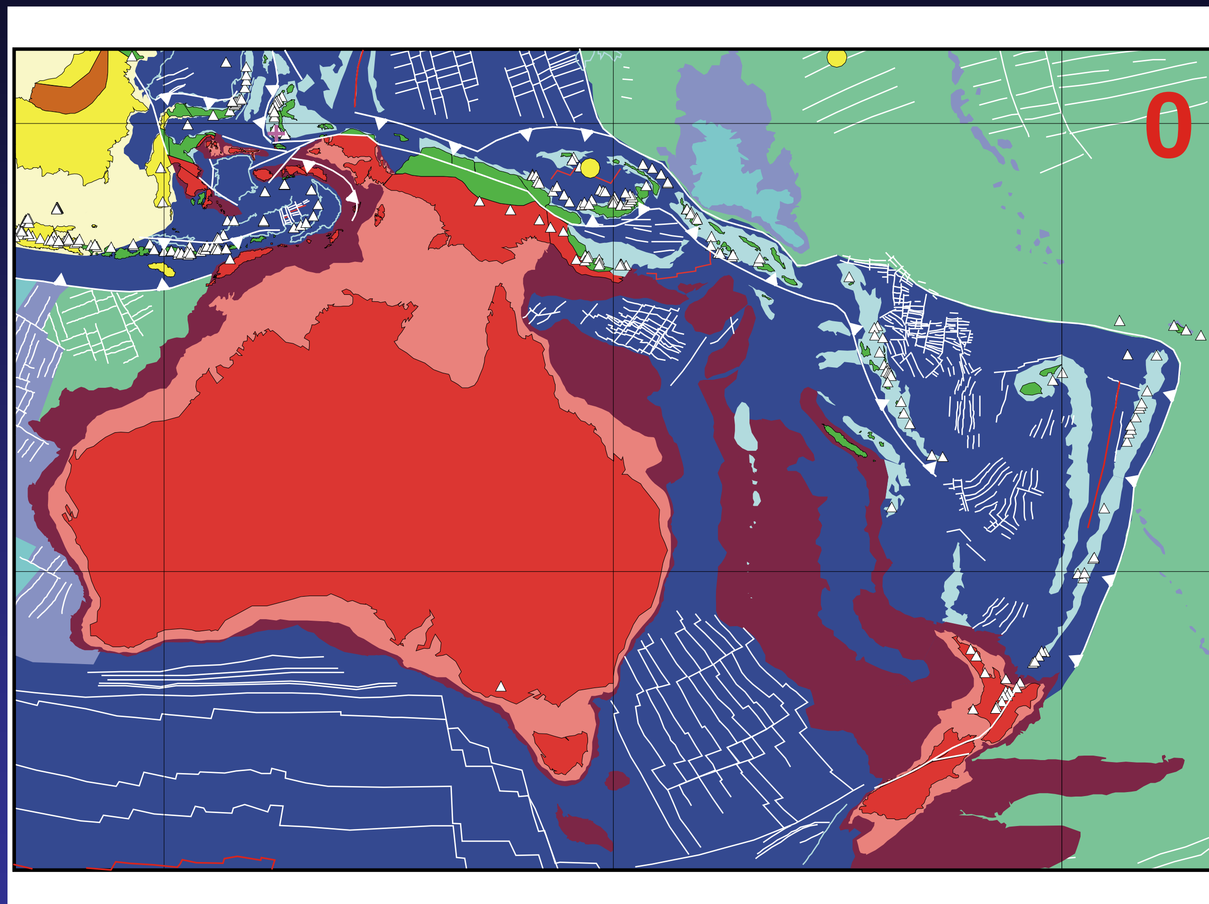
The "flat earth" surveying paradigm is doomed!

Keeping GDA in alignment with ITRF and WGS

GDA is a static datum, whereas ITRF and WGS are dynamic

This means that ITRF & WGS coordinates for “fixed” points change constantly up to 8 cm / yr due to motion of the Australian tectonic plate

Movement of the Australian Plate

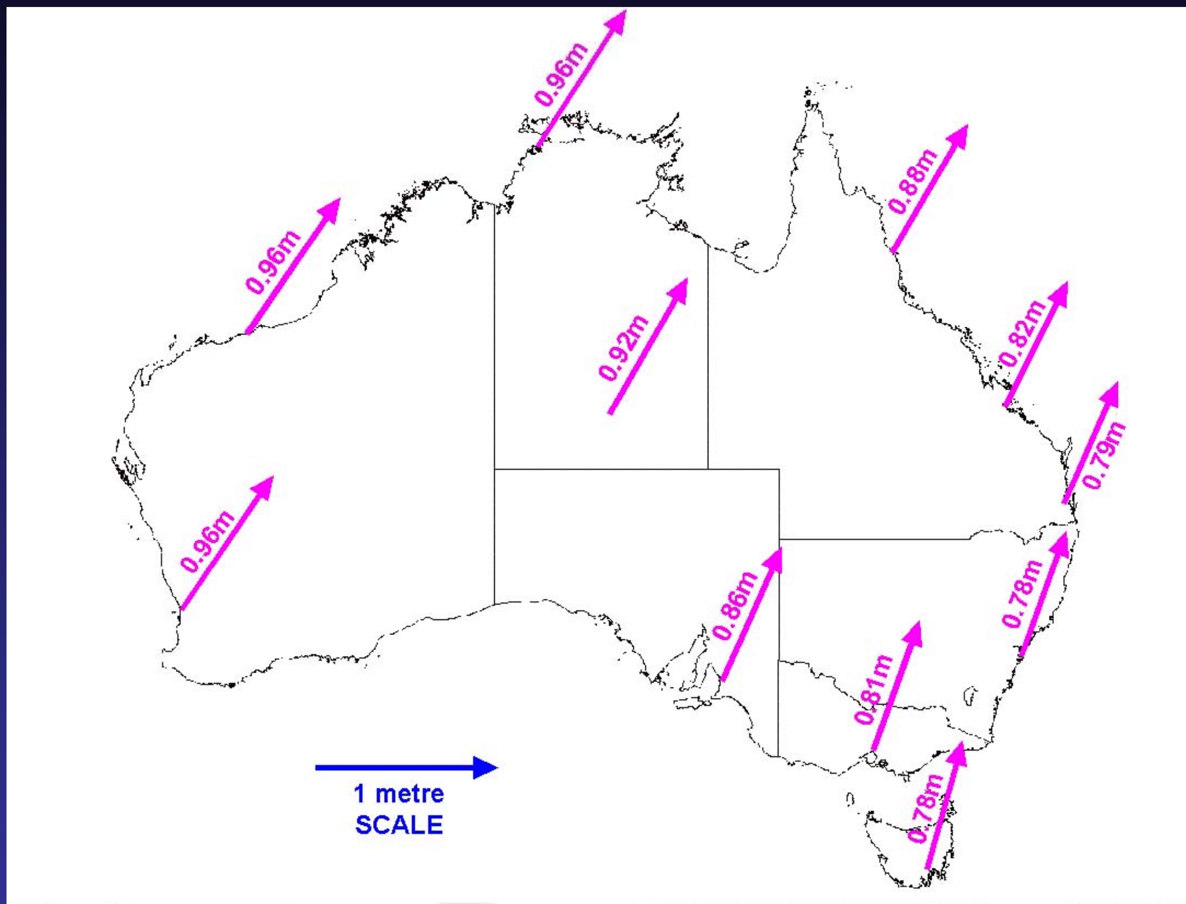


← Millions of Years b.p.

← ITRF/WGS84

Hall, R. 2002. Cenozoic geological and plate tectonic evolution of SE Asia and the SW Pacific: computer-based reconstructions and animations. Journal of Asian Earth Sciences, 20 (4), 353–434.

Difference between WGS84/ITRF and GDA94 in 2008



Arrows indicate motion of the Australian Plate between 1994 and 2008

(and as a consequence the difference between GDA94 and WGS84 in 2008)

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How far should GDA be allowed to diverge from ITRF/WGS before an update is required?

Required navigation accuracy - 5 metres?? (This will happen towards 2050)

Precision landing of aircraft is "forced" using Instrument Landing Systems (ILS) on close approach anyway

Improvements to navigation & GIS software

At present most GNSS navigation equipment (e.g. handheld GPS, Car navigation & aircraft navigation systems) & GIS software use fixed parameters for datum transformations

This strategy is OK for 3-5 metre accuracy

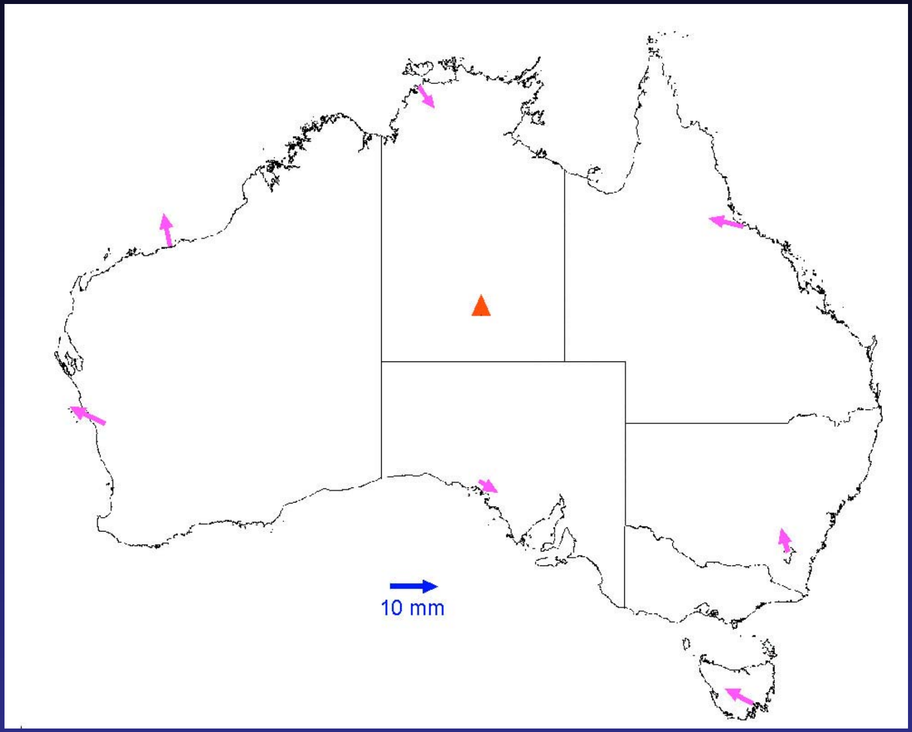
By 2015 most receivers are likely to attain sub-metre accuracy as a result of improvements to GNSS (e.g. Galileo) and widespread use of differential services

So, users (i.e. 2 minute spatial experts) will notice coordinate mismatches with GDA94

Problem can be solved by implementation of time dependent transformation parameters in the software to account for tectonic deformation

If the software can be improved, why change the datum?

Internal stability of the Australian Plate



Australian Datum internally homogeneous at <10mm over 15 year period

(excluding localised deformation events such as subsidence soil creep & coseismic displacement)

Intraplate deformation of the Australian continent between 1994 and 2007
(from baseline analysis of ITRF2005 solution)

Stability of the Australian Plate is advantageous

Relative baseline changes across the continent < 1 mm a year between bedrock monuments

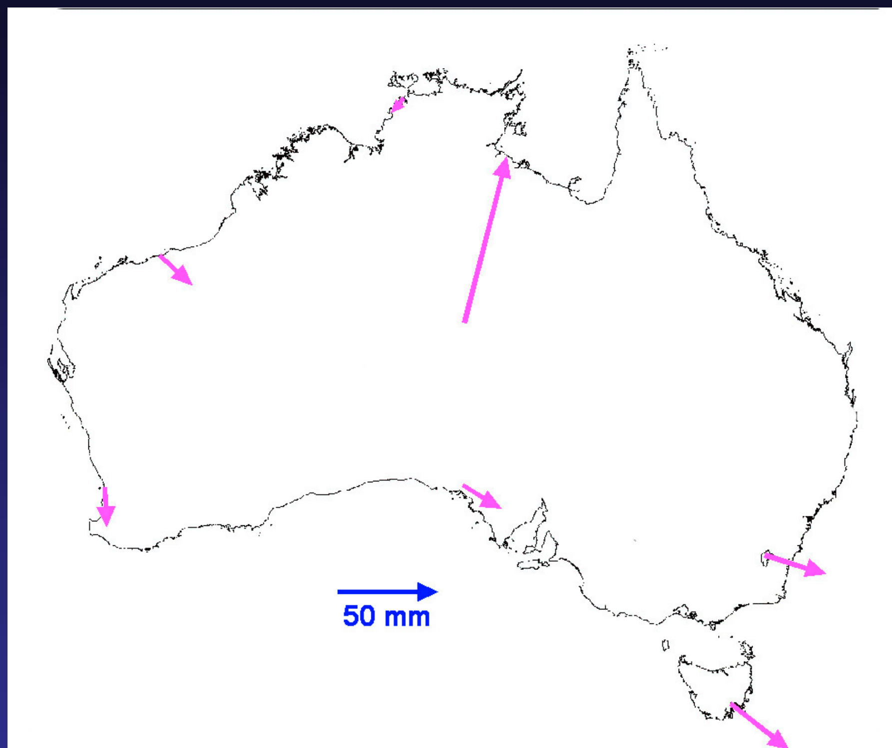
Coseismic displacements very uncommon and are usually localised

This stability is very beneficial to a “static” Australian datum

Positional uncertainties within a stable reference frame (datum) will decrease over time as technology & geodetic infrastructure improves

BUT!

How "accurate" is GDA94?



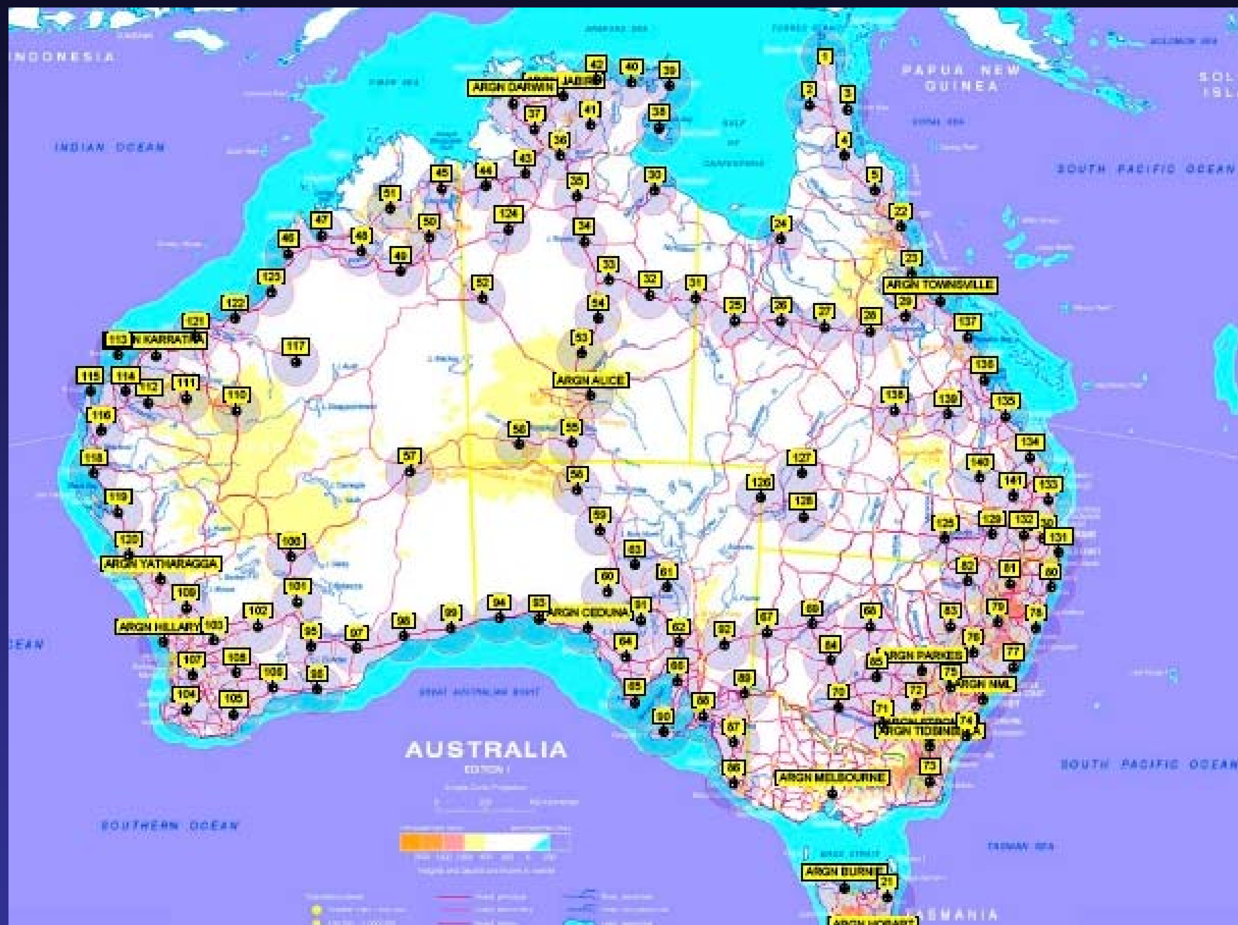
Difference between GDA94 and ITRF2005 at Epoch 1994.0

GDA94 is a "snapshot" of an earlier version of ITRF (ITRF92) at the beginning of 1994

Latest version of ITRF is ITRF2005

Coordinate difference typically < 30mm in major cities

AuScope CORS network



Problems with CORS integration using existing GDA94

Network misfits between existing AFN stations of up to 10 cm

Misfit significant between Alice Springs and surrounding AFN

How will an integrated nationwide CORS network (e.g. AuScope) accommodate 10 cm misfits across the network?

Two options:

1. Readjust GDA94 to ITRF2005 at Epoch 1994.0
2. Constrain urban GDA94 and accommodate misfit in CORS boundaries (mostly rural areas)

Current strategy adopted by GA for AUSPOS is to smooth out the misfit using 14 parameter transformation

How can GDA94 be adjusted?

GDA94 could be "updated" to fit ITRF2005 at Epoch 1994 (e.g. GDA94b)

Difference between GDA94 and GDA94b would be 3-4 cm in most urban areas, 10 cm in Central Australia

Any change in datum definition has ramifications

Alternatively, GDA94 could be left unadjusted, with the misfit being distributed over a transition zone between AFN stations

To summarise

Life of GDA94 can be extended by implementing time dependent parameters in GPS/GIS software to account for tectonic deformation on a continental scale

Otherwise, mismatch between GDA94 and ITRF/WGS of 5 metres by 2050 (where safety may become an issue)

GDA94 should be retained due to the stability of the Australian continent and for purposes of continuity and integrity of the SDI

Errors in GDA94 can be modelled out using transformation parameters