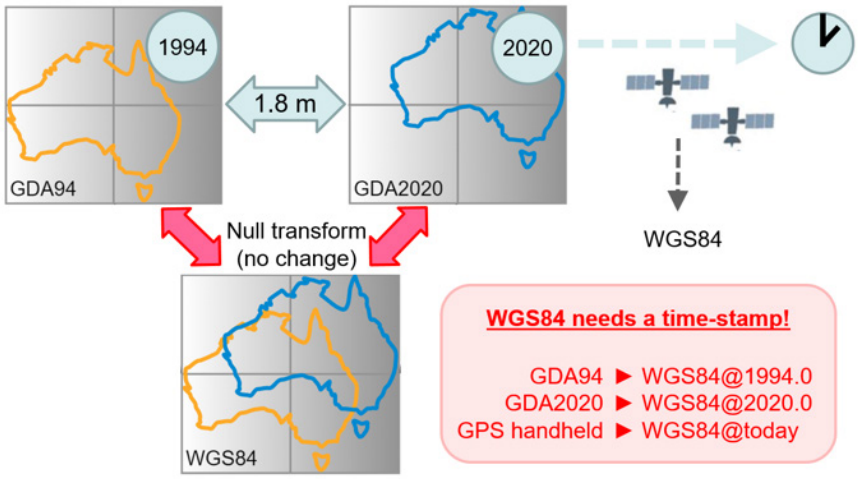
WGS84 and Australia's misaligned web-maps

Information Sheet November 2019



GDA94 and GDA2020 are misaligned when projected into WGS84

The Geocentric Datum of Australia 2020 (GDA2020) is Australia's new National Datum and the first step in our datum modernisation program. GDA2020 aligns more closely with GPS and GNSS positioning services to support current and future high-accuracy positioning applications. GDA2020 coordinates are approximately 1.8 metres to the north-east of GDA94 coordinates, which represents the movement of the Australian tectonic plate between 1994 and 2020.

The modern dependence on web-mapping now presents a significant problem when visualising data on screen: **GDA94 and GDA2020, when displayed together using the defacto-standard 'WGS84 Web Mercator' projection can be misaligned by 1.8 metres. This affects all web-mapping software.**

GDA94 and GDA2020 are static datums ... WGS84 is not

Both GDA94 and GDA2020 provide a snapshot of where the Australian tectonic plate is on the earth's surface, in 1994 and 2020 respectively. These **static datums** are fixed to the tectonic plate, and coordinates of a point on the ground do not change as the plate moves.

In contrast, WGS84 remains fixed to the centre of the earth while the tectonic plates move over it, with coordinates changing over time. **WGS84's coordinates are 'time-dependent':**

- On 01 January 1994, GDA94 and WGS84 were aligned.
- On 01 January 2020, GDA2020 and WGS84 will be aligned.
- GPS observations from a handheld device describe coordinates in WGS84@today.

Australia's misaligned maps

The EPSG Geodetic Parameter Registry is used by all web-mapping software to define datums, projections and the relationships between them. The official transformation parameters for use in Australia are:

1. GDA94 to GDA2020 transformation which reflects Australia's movement of approximately 1.8 metres to the North East (EPSG::8048 accurate to 0.01m).
2. GDA94 is defined as: 'equal to WGS84'(EPSG::1150 accurate to 3 metres).
3. GDA2020 is defined as: 'equal to WGS84' (EPSG::8450 accurate to 3 metres).

Web-mapping simplifies WGS84

Web-mapping has always assumed that WGS84 does not change over time. To date, this hasn't been a problem because WGS84 has generally been used to gather or display coordinates of low-accuracy (metre-level or greater). Additionally, most maps are stored in a single local national datum, and then transformed to one of many types of WGS84 for display, while ignoring the nominal low accuracy of those transformations. All layers were expressed in the same epoch (date) of WGS84, and all layers lined up. That paradigm is changing.

There is increasing demand to use web applications to deliver, display and analyse high accuracy spatial data gathered over different time periods by different custodians. This now causes a problem when mixing data from GDA94 and GDA2020 while assuming WGS84 is a static datum:

- Web-mapping applications use pre-rendered map tiles to improve performance and scalability. **This freezes map tiles at a point in time in WGS84.**
- To facilitate interoperability, a de facto standard projection of WGS84 Web Mercator has been adopted. This is based on the WGS84 **time-dependent** datum.
- Mixing **static maps** with a **time-dependent datum** leads to potentially misaligned map layers, especially in a multi-datum user environment.

Australia's web-mapping problem … is an international problem

Australia is facing map mis-alignment challenges earlier than most. Our fast moving tectonic plate (~7cm per year) means that readily available, centimetre-level GPS positioning deviates noticeably from our previous static national datum, GDA94.

As a result, we are the first nation faced with multiple national static datums co-existing with modern GPS/GNSS positioning. In the not too distant future an Australian time-dependent datum (ATRF) will be introduced to account for known movement and deformation allowing users to bring data accurately together across time.

Although Australia is first, we are not alone. North American agencies are also undertaking a datum modernisation program, introducing several new time-dependent datums in 2022.

Proposed solution

To support web-mapping from multiple datum sources requires a proper treatment of time-dependence in spatial data. Centimetre-level data cannot ignore metre-level movements.

The solution requires effective international collaboration to update standards and software. At a recent meeting with the Open Geospatial Consortium (OGC), Australian representatives helped to highlight the importance and immediate need to include time-dependence in spatial data and standards for any data at metre-level accuracy or better.

As a result, work is underway to update the EPSG registry and ISO standards to reflect the time-dependent nature of accurate spatial data. Of course, it will take time for these changes to filter through standards and software to most users.

DCS Spatial Services advocates a 'truth in labelling' approach to WGS84 until standards are updated. In the short term, it is necessary to choose an appropriate **static datum and/or epoch** for web-mapping, to avoid metre-level misalignments:

> **Where DCS Spatial Services provides data and web-services in WGS84, these will be provided in WGS84@1994.0 (the nominal equivalent of GDA94) unless otherwise indicated, to align with existing cached GDA94 data.**
>
> **Other NSW agencies are recommended to adopt the above principle, or at very least clearly communicate the 'Coordinate Epoch' associated with all WGS84 datasets.**

Where can I find out more about WGS84, GDA94 and GDA2020?

Keep informed via Fact-sheets, FAQ and a discussion forum on GDA2020: www.icsm.gov.au/gda2020

For more information, please email the GDA2020 Team at DCS Spatial Services: GDA2020@customerservice.nsw.gov.au

Author: DCS Spatial Services P19/10/042