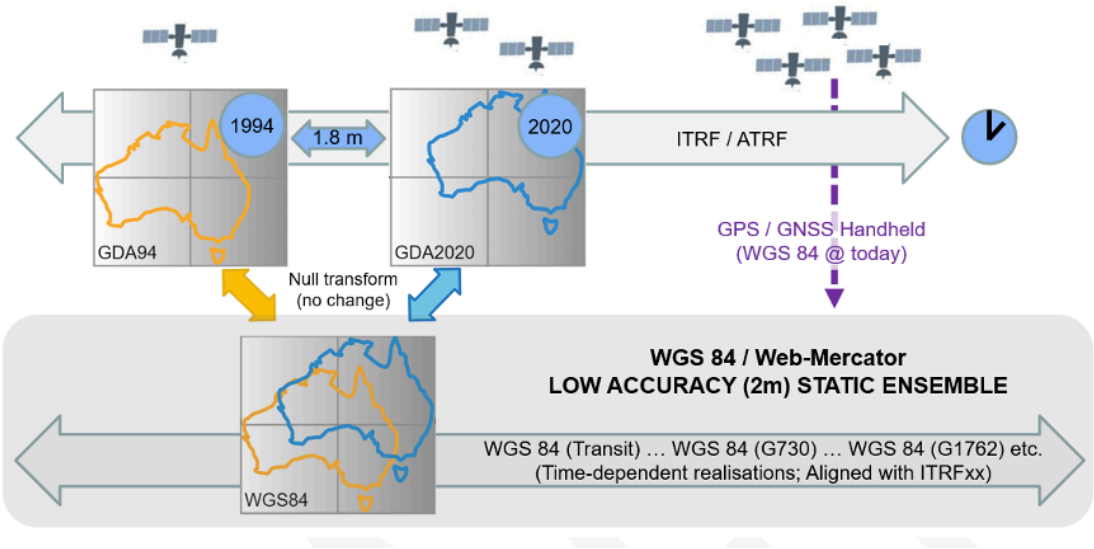
WGS 84 and misaligned spatial data in Australia

Information Sheet April 2021



GDA94 and GDA2020 can be misaligned when projected into WGS 84

The Geocentric Datum of Australia 2020 (GDA2020) is Australia's new National Datum which aligns closely with modern GPS and GNSS positioning services to support high-accuracy positioning applications. GDA2020 coordinates are approximately 1.8 metres to the north-east of GDA94 coordinates, which indicates the movement of the Australian tectonic plate between 1994 and 2020.

WGS 84 and its 'Web Mercator projection' have historically been used as a defacto standard in web mapping applications. Unfortunately, these applications often assume that GDA94 ≈ WGS 84 ≈ GDA2020. **Misalignments of approximately 1.8 metres may occur when projecting GDA94 and GDA2020 spatial data into WGS 84 / Web Mercator. This issue affects all web mapping and GIS software.**

WGS 84 is a low accuracy, static 'ensemble' datum

The datum that most spatial data users call WGS 84 (often identified as EPSG:4326, or 3857 Web Mercator) is actually a collection or 'ensemble' of at least six different versions of WGS 84 developed over time to support GPS (and pre-GPS) global satellite positioning capabilities. This global datum provided a useful and universal datum on which to communicate global spatial datasets.

Unfortunately, this history relegates the WGS 84 ensemble to a **nominal accuracy of 2 metres**. This low accuracy is then further degraded through the common practice of ignoring tectonic movement, which makes the WGS 84 ensemble a static datum, unable to account for Australia's steady movement of ~7 cm per year.

Why was WGS 84 adopted if it is low accuracy?

Web mapping adopted WGS 84 because of the benefits of a common and conventional datum with global extent. It became standard practice to transform high-accuracy authoritative datasets (for example, state-wide imagery or cadastre) from a regional datum into this global datum as a basis for web mapping.

In Australia authoritative data in GDA94 was often simply renamed to WGS 84 (via a null transformation) for web mapping. Other spatial data such as GPS-derived positioning was often gathered in WGS 84 (in real time while ignoring tectonic movement) but was of low accuracy (metre-level) and didn't challenge the assumption that WGS 84 was equal to GDA94. New spatial data was aligned to the existing GDA94 / WGS 84 datasets. Everything lined up and there was an illusion of accuracy based on a datum of low accuracy.

In contrast, modern spatial data and visualisations are expected to cater for ever increasing data accuracy. With the promise of centimetre-level handheld positioning and the adoption of GDA2020 which more closely aligns to modern GPS positioning (i.e. WGS 84 @ today's date), this 'WGS 84 illusion of accuracy' is now being challenged. Eventually, a replacement for WGS 84 will be required for high-accuracy web mapping.

EPSG support for WGS 84, GDA94 and GDA2020

The EPSG Geodetic Parameter Dataset is used by GIS and web mapping software to define datums, projections and the relationships between them.

When GDA2020 was released in 2017, new EPSG codes (below) were released to define its relationship to GDA94 and WGS 84. These reflected the low accuracy of the WGS 84 ensemble. Unfortunately, the accuracy of WGS 84 transformations is often ignored and spatial data projected into WGS 84 is misaligned.

EPSG	Transformation and Description (Refer to https://epsg.org for more info)				Accuracy
8048	GDA94	⇔	GDA2020 (1)	7 parameter transformation	0.01 m
8446	GDA94	⇔	GDA2020 (2)	NTv2 Conformal transformation	0.05 m
8447	GDA94	⇔	GDA2020 (3)	NTv2 Conformal + Distortion transformation	0.05 m
1150	GDA94	⇔	WGS 84 (1)	**NULL:** Datums equivalent at low accuracy	3 m
8450	GDA2020	⇔	WGS 84 (2)	**NULL:** Datums equivalent at low accuracy	3 m

Recently, an extension to the EPSG code list was requested to provide more control when transforming to or from WGS 84. Four new 'two-step' transformations were published in 2021:

EPSG	Transformation and Description (Refer to https://epsg.org for more info)				Accuracy
9688	GDA94	⇔	WGS 84 (2)	[GDA94 *<7 Parameter>* GDA2020 *<NULL>* WGS 84]	3 m
9689	GDA94	⇔	WGS 84 (3)	[GDA94 *< NTv2-CPD >* GDA2020 *<NULL>* WGS 84]	3 m
9690	WGS 84	⇔	GDA2020 (3)	[WGS 84 *<NULL>* GDA94 *<7 Parameter>* GDA2020]	3 m
9691	WGS 84	⇔	GDA2020 (4)	[WGS 84 *<NULL>* GDA94 *< NTv2-CPD >* GDA2020]	3 m
	Note: in cases where these transformations are not yet adopted in software, it is often possible to create custom transformation(s) to replicate the above.				

Advice for custodians and consumers

Misalignments when combining data from different sources can be minimised.

Where possible, data custodians and web service publishers should:

- Provide clear metadata information regarding the origin of WGS 84 datasets and web services
- Publish services which support GDA2020 (and/or GDA94) requests
- Publish services which support WGS 84 ≈ GDA2020, if explicitly offering WGS 84
- Do not publish services with support for WGS 84 only

Consumers of data and web services can address or correct potential misalignments by:

- Requesting data and web services based on GDA94 or GDA2020, not WGS 84, where available. Note: Some web services will transform at server-side when requested in different datums.
- Where server-side transformation is not available, consider transforming data on-the-fly (client-side). More information should be available from your software and web service providers.
- When mixing and matching WGS 84 data from different custodians be prepared for misaligned data.

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

For more information, visit:

- www.spatial.nsw.gov.au/surveying/geodesy/gda2020
- www.icsm.gov.au/gda2020
- GMIWG advisory on WGS 84
- or email GDA2020@customerservice.nsw.gov.au

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