



UNITED NATIONS GLOBAL GEODETIC CENTRE OF EXCELLENCE

MODERNISING GEOSPATIAL REFERENCE SYSTEM CAPACITY DEVELOPMENT WORKSHOP

The importance of a Geospatial Reference System

Nicholas Brown
UN-GGCE

WHY

Day 1, Session 2 [1_2_2]

Acknowledgements: Zuheir Altamimi (FRA); Detlef Angerman (TUM); Roger Fraser (AUS); Richard Gross (IAG); Craig Harrison (AUS); Sarah Kowal (UN-GGCE); Anna Riddell (AUS); Martin Sehnal (GGOS); Jeffrey Verbeurgt (BEL).

Overview

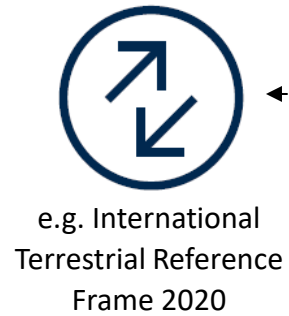
- What is a **modern** Geospatial Reference System?
- What does a Geospatial Reference System enable?
- The components of a Geospatial Reference System
- Explaining a Geospatial Reference System to policy makers



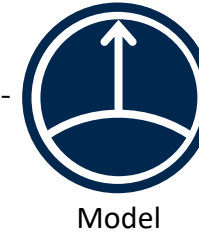
**STRONGER.
TOGETHER.**

Geospatial Reference System

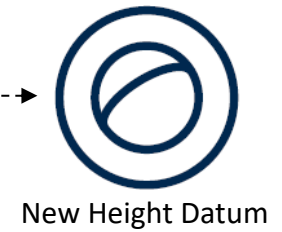
Time Dependent Reference Frame



Static Datum



Height Datum



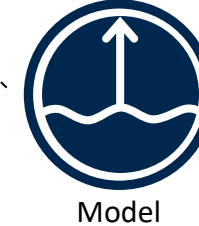
Example of a country Geospatial Reference System

People
Standards
Legal frameworks
Software
Technical Manual

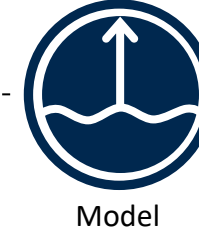
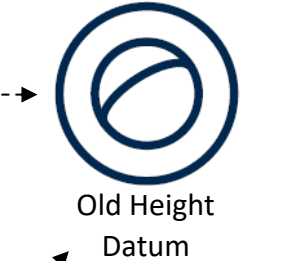
Credit: Geoscience Australia



Static Datum



Height Datum



**STRONGER.
TOGETHER.**



What does a GRS enable?

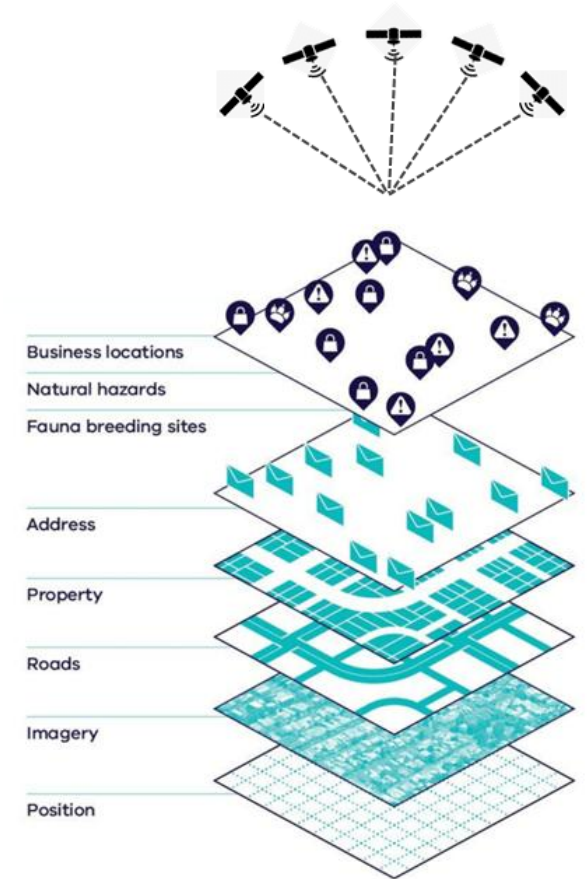
- Accurate positioning and navigation
- Data integration and consistency
- Transformation between different datums
- Spatial analysis with high accuracy
- Real time usage of time dependent data



**STRONGER.
TOGETHER.**

Why is a GRS important?

- A Geospatial Reference System underpins the collection, management and alignment of spatial information to make better decisions.
 - survey, mapping and navigation;
 - civil engineering, industrial automation, agriculture, construction, mining;
 - recreation; location-based services;
 - intelligent transport systems, land use planning and administration;
 - hazard assessment, disaster response and emergency management;
 - environmental studies and scientific research.
- The Geospatial Reference System is the **glue** that allows us to align all geospatial data.

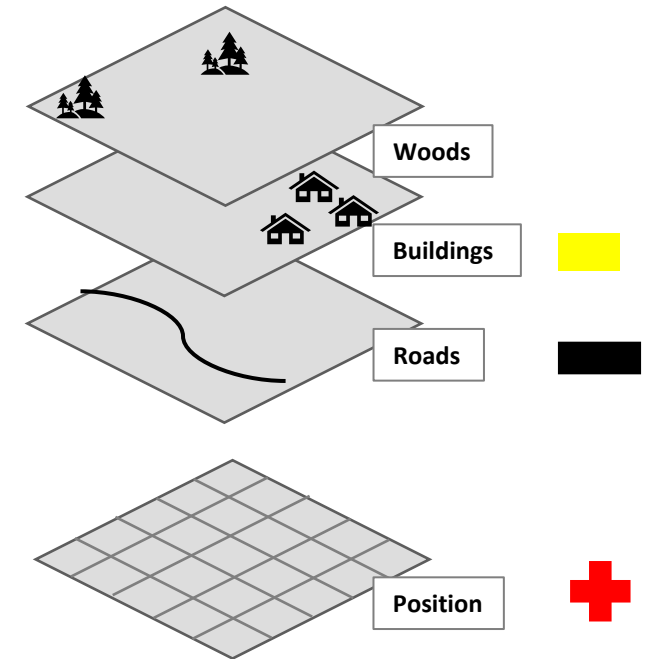
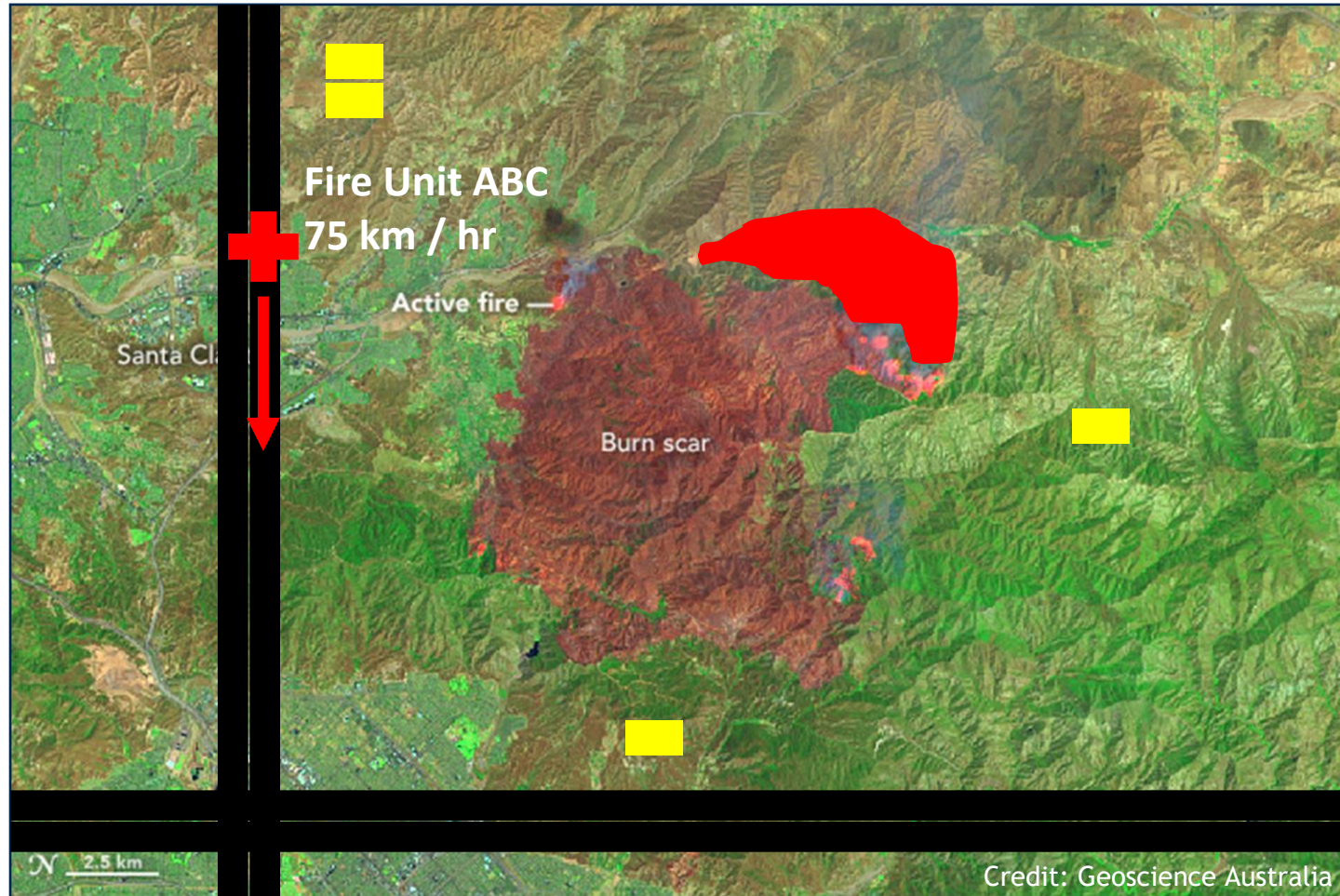


Credit: Victorian State Government, Australia



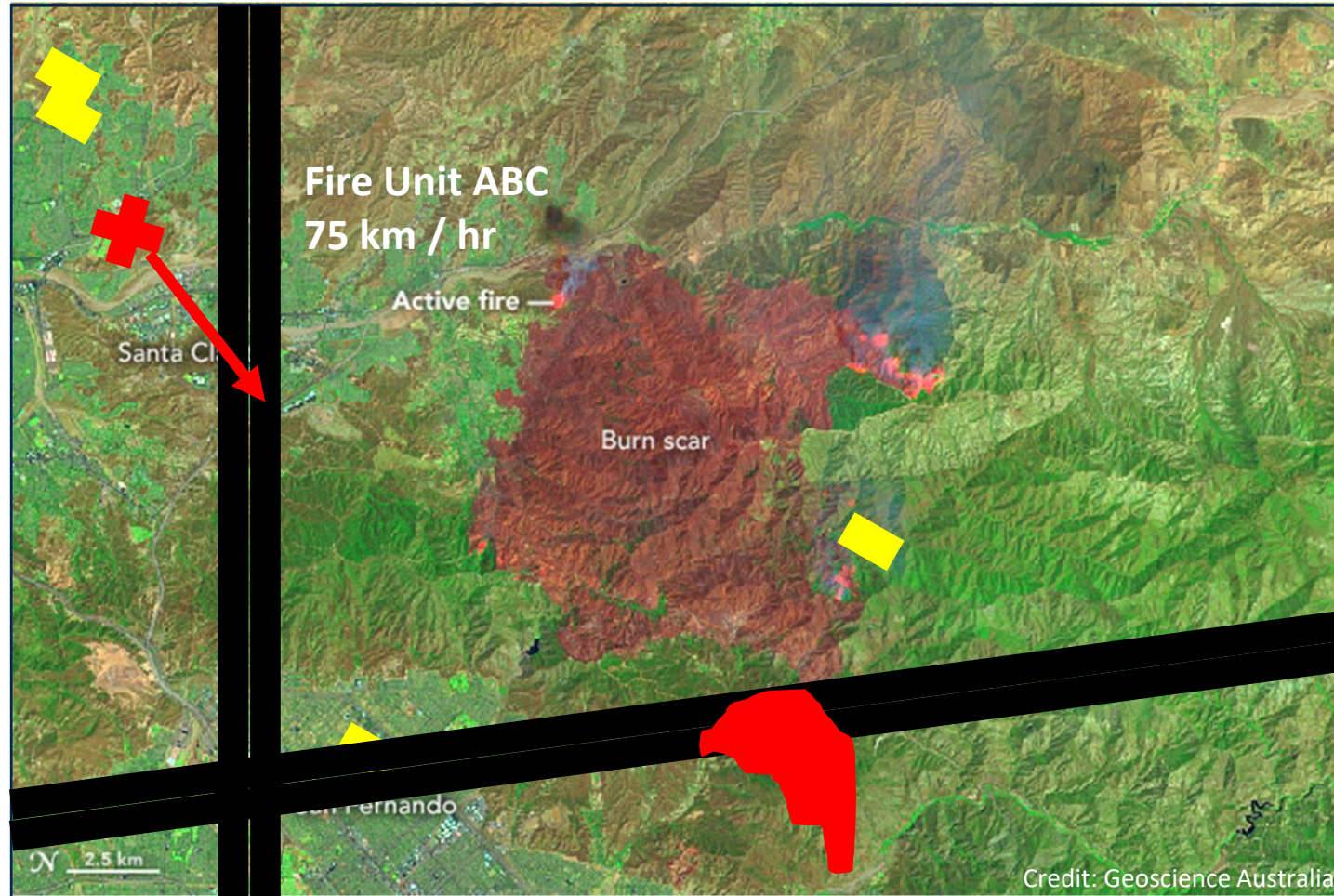
**STRONGER.
TOGETHER.**

The Importance of a Geospatial Reference System

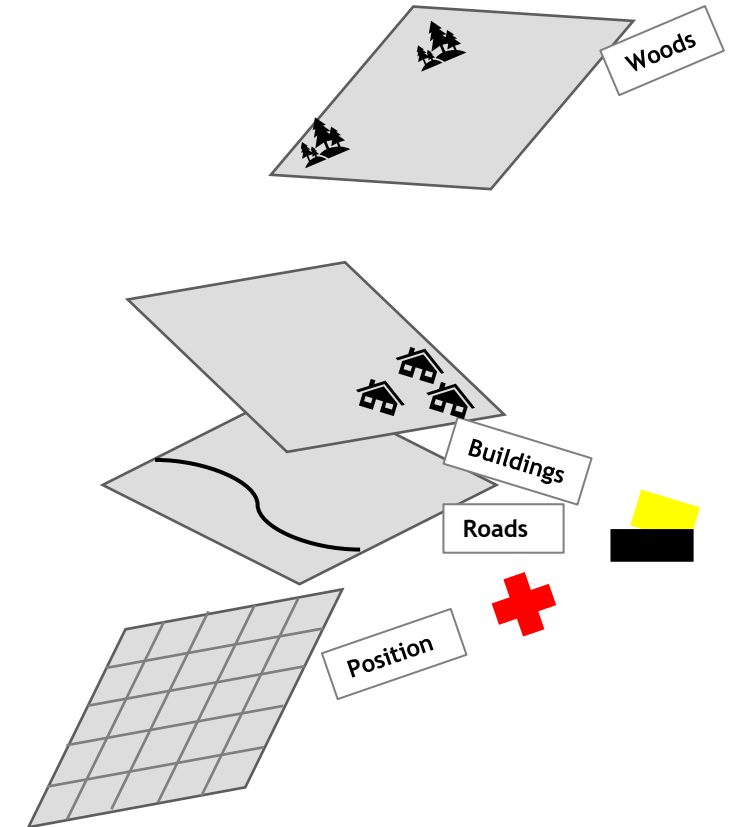


**STRONGER.
TOGETHER.**

The Importance of a Geospatial Reference System



*Data are not aligned



**STRONGER.
TOGETHER.**

Static component of GRS

Static Datum



New Geocentric
Static Datum



7 parameter
transformation

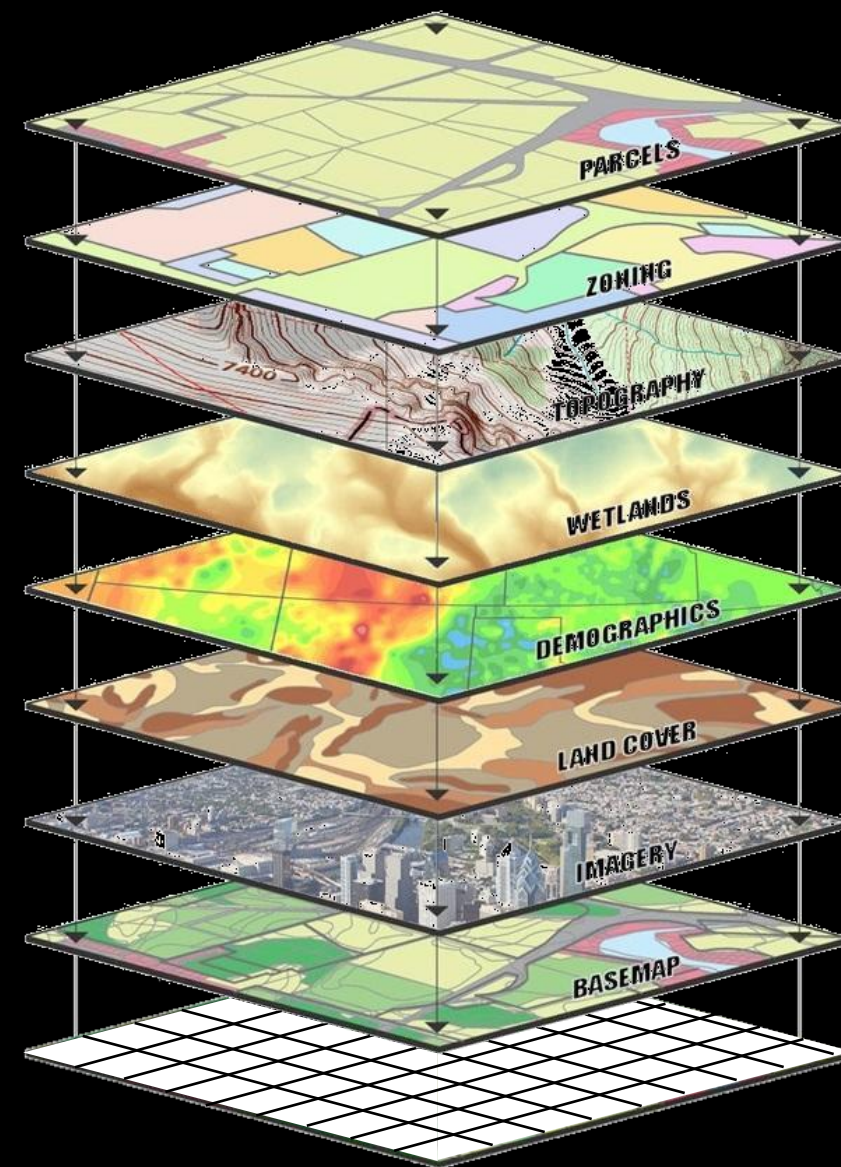
Static Datum



Old Geodetic Static
Datum



**STRONGER.
TOGETHER.**



COORDINATE REFERENCE FRAME

Transformations in GRS

Static Datum



New Geocentric
Static Datum

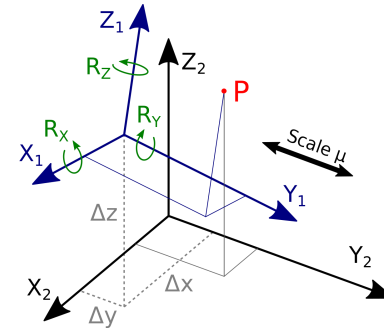


7 parameter
transformation

Static Datum



Old Geodetic Static
Datum



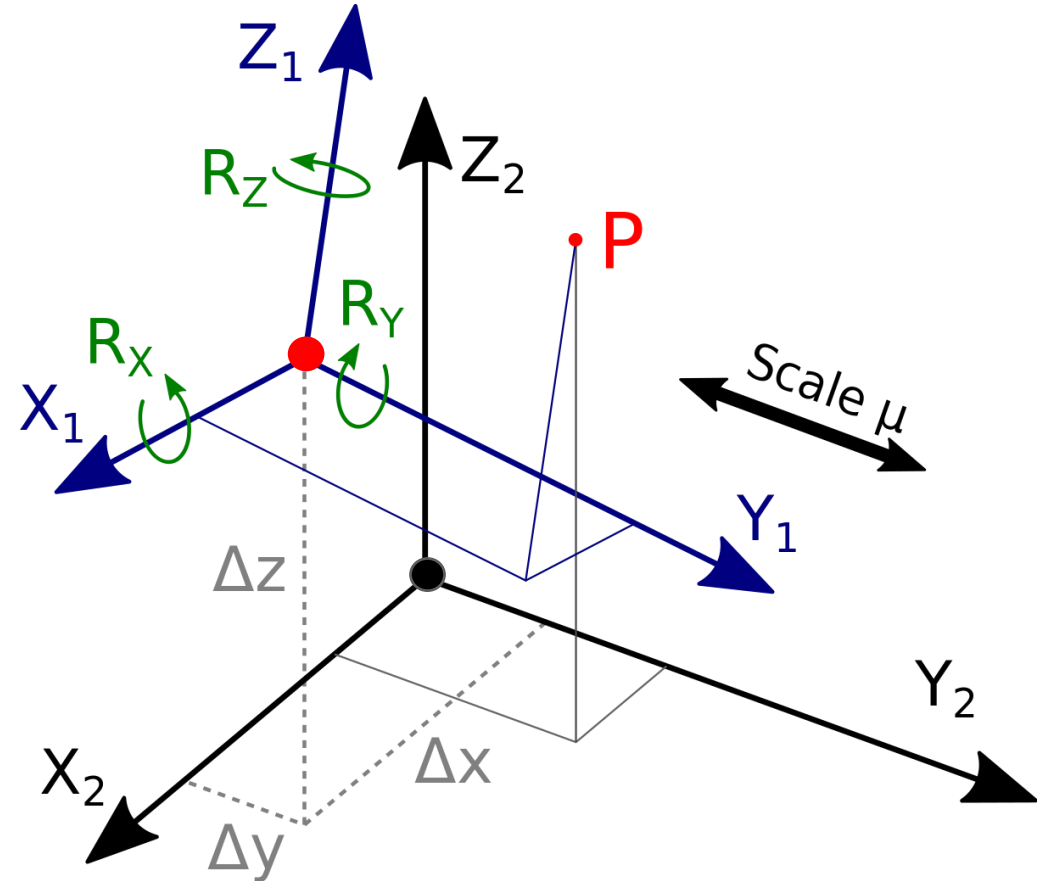
**STRONGER.
TOGETHER.**

Transformation parameters

7 Transformation parameters

- 3 translations
- 3 rotations
- 1 scale

Need: sufficient points where coordinates are known in both datums



**STRONGER.
TOGETHER.**

Time dependent component of GRS

**Time Dependent
Reference Frame**



e.g. International
Terrestrial Reference
Frame 2020



14 parameter
transformation

Static Datum



New Geocentric
Static Datum



7 parameter
transformation

Static Datum

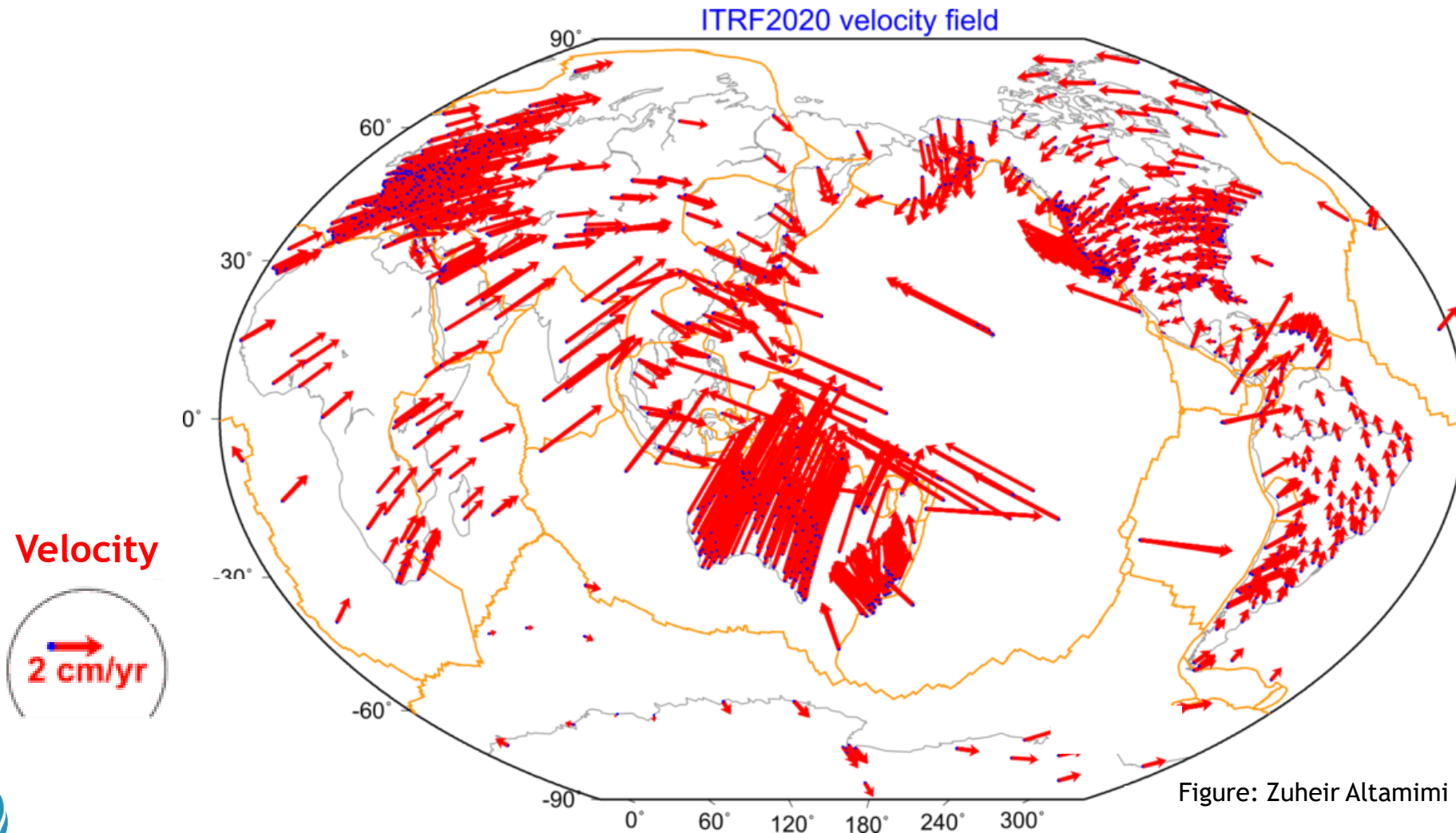


Old Geodetic Static
Datum



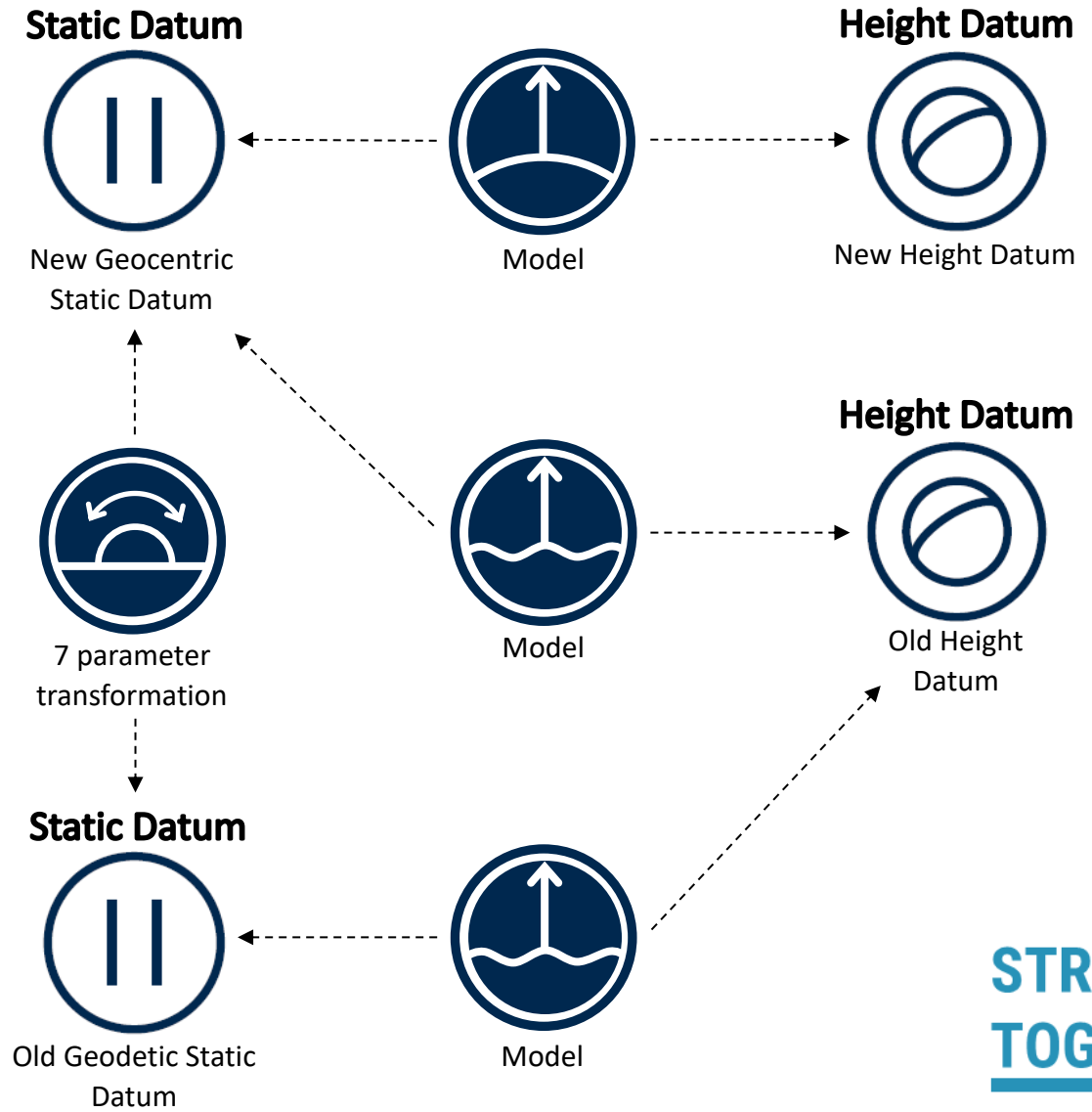
**STRONGER.
TOGETHER.**

Time dependent reference frame



**STRONGER.
TOGETHER.**

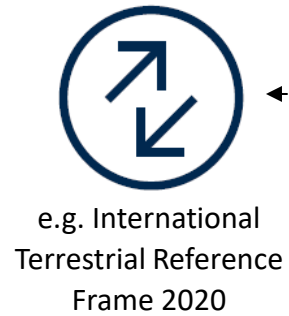
Height component of GRS



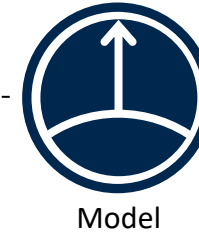
**STRONGER.
TOGETHER.**

Geospatial Reference System

Time Dependent Reference Frame



Static Datum



Height Datum



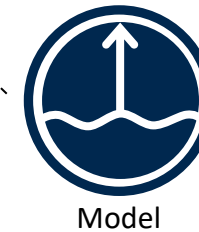
Example of a country Geospatial Reference System

People
Standards
Legal frameworks
Software
Technical Manual

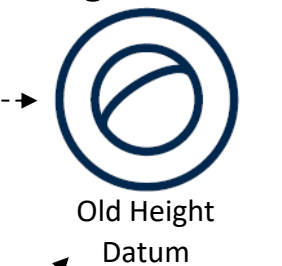
Credit: Geoscience Australia



Static Datum



Height Datum



**STRONGER.
TOGETHER.**



Threads

- Standards and Software

- Standards are required to ensure geodetic information is Findable, Accessible, Interoperable and Reusable.
- A good example is the ISO Geodetic Register and EPSG Register which are repositories of datums and transformations.
- A geodesist develops the datums and transformation and makes this technical information available in a standardised format which allows groups like software developers to apply the datum transformation.
- This abstracts the user from the complexities of the technical elements of geodesy and they can just apply a code to accurately and reliably transform the data.

- Laws or Regulations

- In some countries, the datum is defined in legislation or government regulations.
- These demonstrate the importance of geodesy. Geodesy is providing a foundation for the government and industries which use those laws or regulations.
- For example, cadaster, underground services, aviation, maritime transport, construction industry.
- Increasingly, we will see a reliance on positioning legislation and regulations for drones and intelligent transport services.

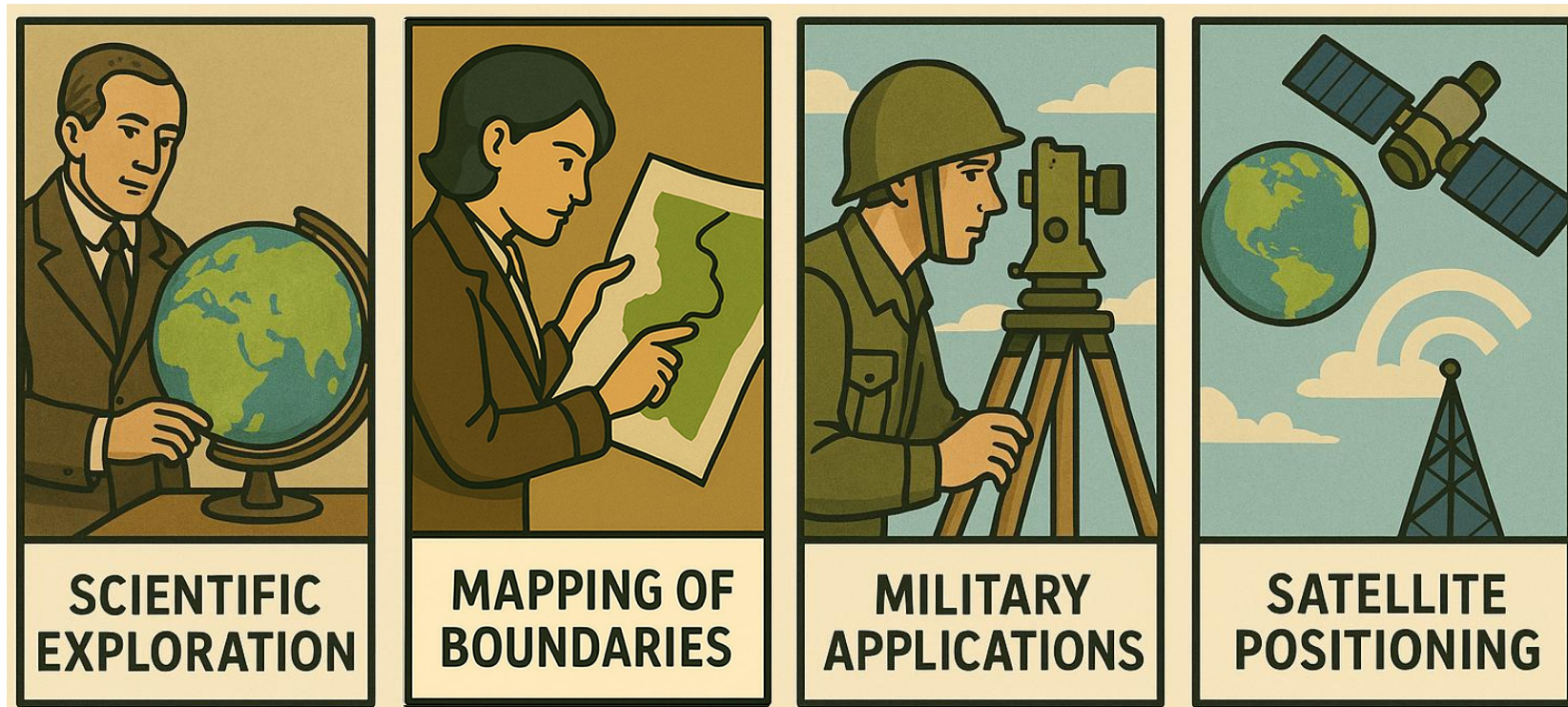
- People



**STRONGER.
TOGETHER.**

Upgrading the GRS is not a new idea

- Over centuries people have been through many phases of upgrading the GRS.
- The reason for the upgrade is always based on the needs of stakeholders.



Source: Generated using ChatGPT.

**STRONGER.
TOGETHER.**

Clear vision in words politicians understand

An integrated national positioning capability to accelerate the adoption and development of location-based technology and applications in Australia



Source: Geoscience Australia



**STRONGER.
TOGETHER.**

Clear vision in words politicians understand

- The Australian Government has contributed **\$1.4 billion** towards a positioning project over the next **20 years**.
 - SouthPAN – SBAS
 - Ground observatories
 - Open Source GNSS analysis
 - People



Budget

Road

- Cooperative Intelligent Transport Systems
- Automated driving
- 3D digital mapping for automated Cooperative Intelligent Transport Systems
- Vehicle speed determination for regulatory applications
- Real-time road pricing



General Aviation

- Approach Procedures with Vertical guidance (APV)
- Helicopter procedures



Image source: Royal Flying Doctor Service of Australia

Rail

- Advanced train management systems
- Track surveys
- Track worker and track vehicle safety systems



Construction

- Personal safety
- Aerial surveys



UAV Aviation

- High-precision drone applications for agriculture and forestry
- Aerial surveys



Agriculture – livestock

- Virtual fencing for strip grazing
- Behavioural modelling to enable early disease detection
- Quantification of reproductive relationships
- Intelligent spatial analytics



Source: Geoscience Australia

Resources

- Mine safety
- Automation of mine sites and supply chains



Source: Geoscience Australia

A low-angle, close-up photograph of a person's lower legs and feet walking on a cobblestone path. The person is wearing dark trousers and black shoes. A white cane with a red stripe is visible, extending from the person's hand down to the ground. The cobblestones are irregular and greyish-brown.

Consumer

- Safe guidance for the visually impaired
- Parcel delivery

Maritime

- Close quarters positioning for improved port operations
- Under keel clearance monitoring for improved productivity
 - Port Hedland; 10 cm = extra \$200M/yr of iron ore exports
- Safer navigation
- Tracking of container movements in intermodal container terminal



Resources or further reading

- Australian Geospatial Reference System Compendium ([https://www.icsm.gov.au/sites/default/files/2022-08/AGRS Compendium 20220816.pdf](https://www.icsm.gov.au/sites/default/files/2022-08/AGRS%20Compendium%2020220816.pdf))
- Positioning Australia industry case studies <https://www.ga.gov.au/scientific-topics/positioning-navigation/positioning-australia/case-studies>
- Positioning Australia economic benefits study <https://frontiersi.com.au/wp-content/uploads/2018/08/SBAS-Economic-Benefits-Report.pdf>
- EUSPA Market Report [https://www.euspa.europa.eu/sites/default/files/external/publications/euspa market report 2024.pdf](https://www.euspa.europa.eu/sites/default/files/external/publications/euspa_market_report_2024.pdf)



**STRONGER.
TOGETHER.**