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
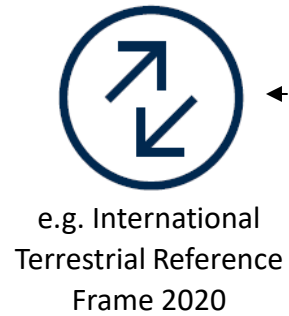
WHY

Day 1, Session 2 [1_2_1]

Overview

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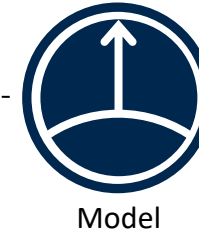- Explaining a Geospatial Reference System to policy makers

Geospatial Reference System

Time Dependent Reference Frame

e.g. International Terrestrial Reference Frame 2020

14 parameter transformation

Static Datum

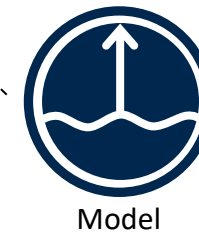New Geocentric Static Datum

Model

Height Datum

New Height Datum

Example of a country Geospatial Reference System

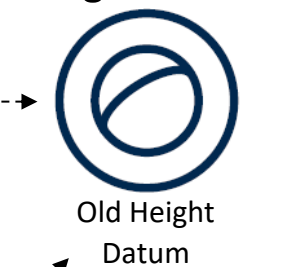People
Standards
Legal frameworks
Software
Technical Manual

Credit: Geoscience Australia

7 parameter transformation

Model

Height Datum

Old Height Datum

Static Datum

Old Geodetic Static Datum

Model

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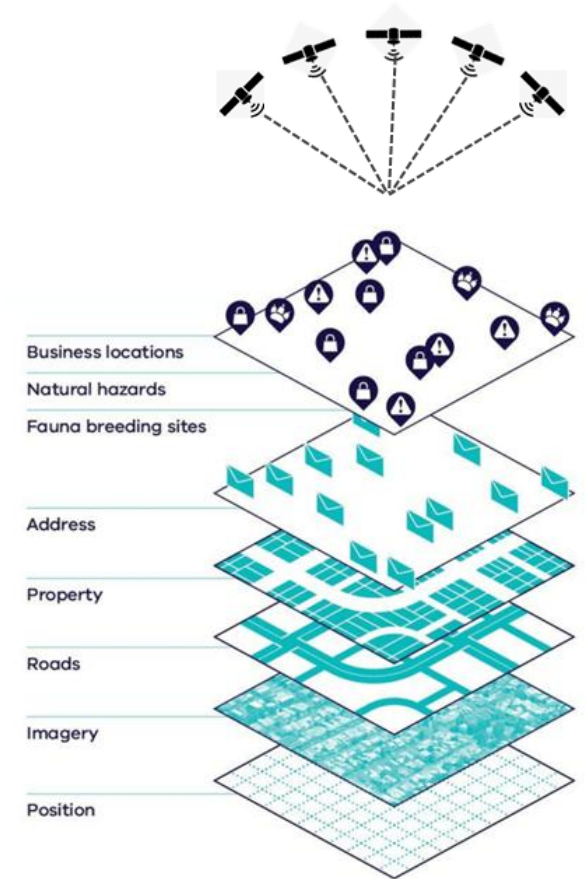TOGETHER.

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

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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.
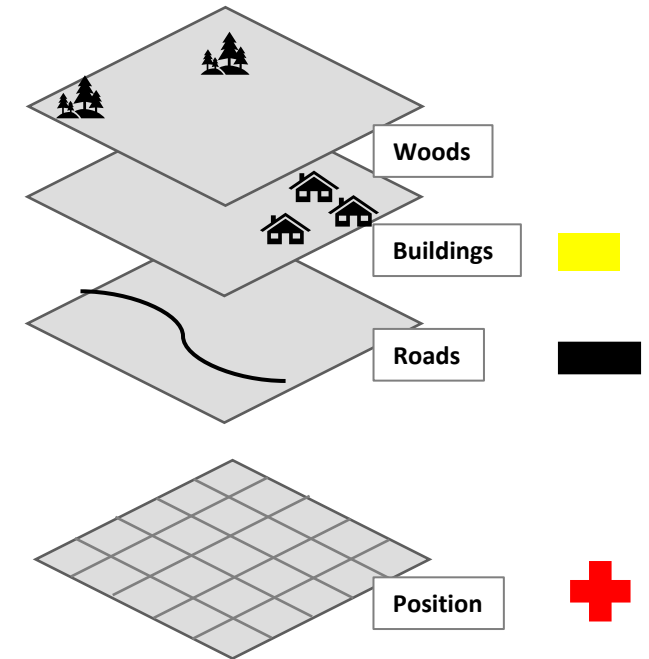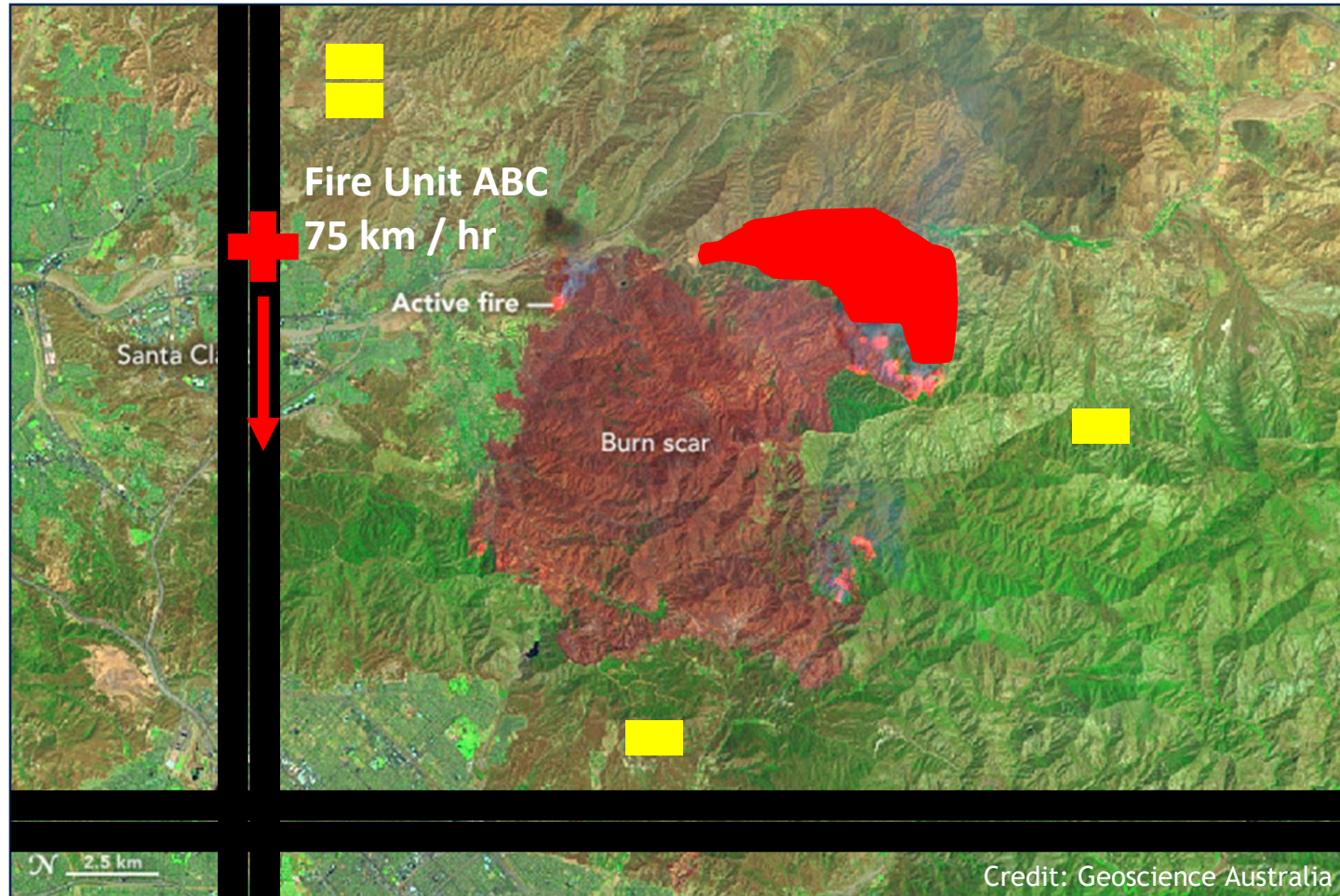

Business locations
Natural hazards
Fauna breeding sites
Address
Property
Roads
Imagery
Position

Credit: Victorian State Government, Australia

STRONGER.
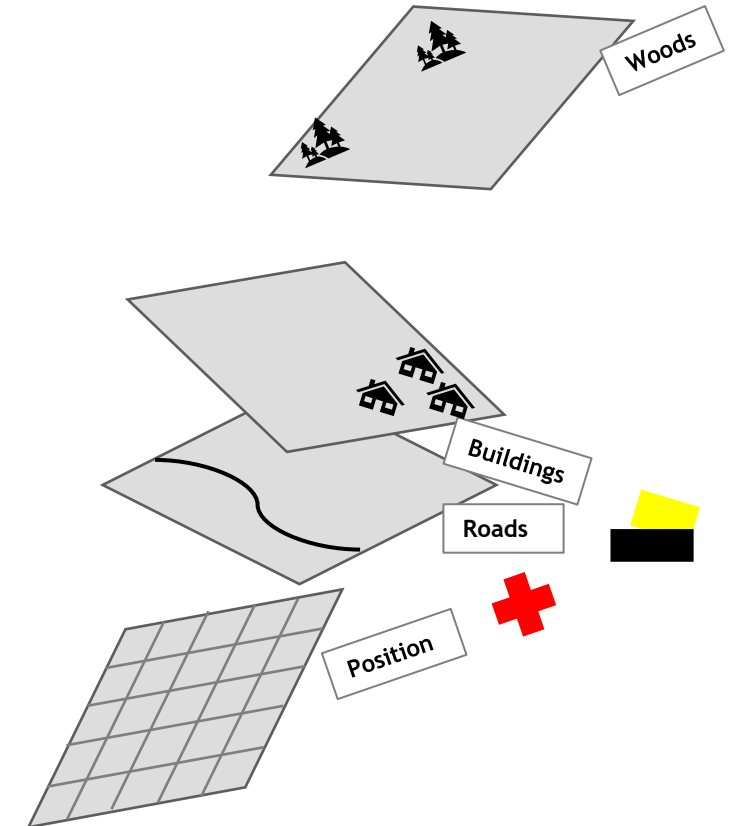TOGETHER.

The Importance of a Geospatial Reference System

Fire Unit ABC
75 km / hr

Active fire —

Santa Cl

Burn scar

2.5 km

Credit: Geoscience Australia

Woods

Buildings

Roads

Position

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The Importance of a Geospatial Reference System

Fire Unit ABC
75 km / hr

Active fire —

Burn scar

Santa Cl...

San Fernando

N 2.5 km

Credit: Geoscience Australia

*Data are not aligned

Woods

Buildings

Roads

Position
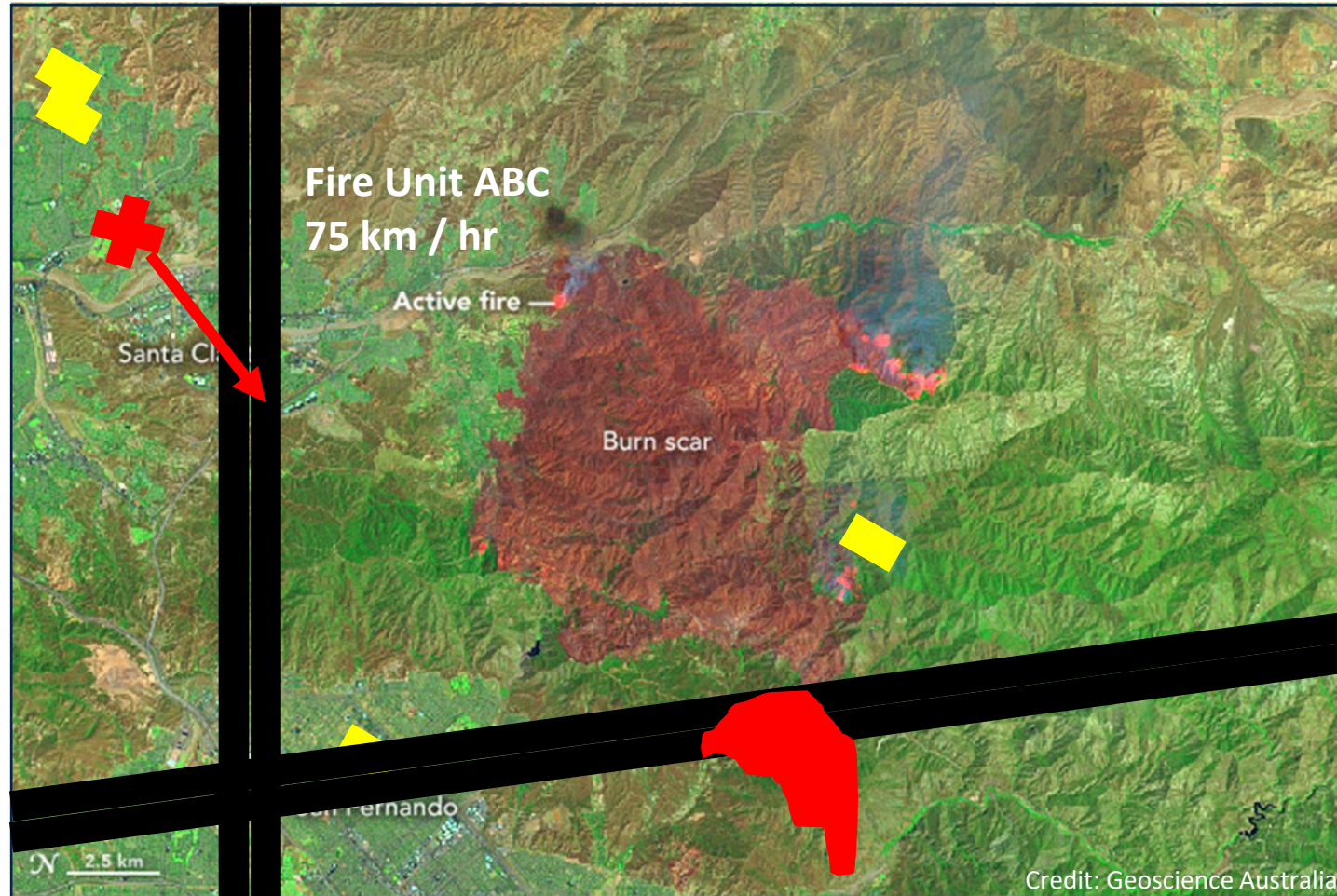
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Static component of GRS

Static Datum

New Geocentric
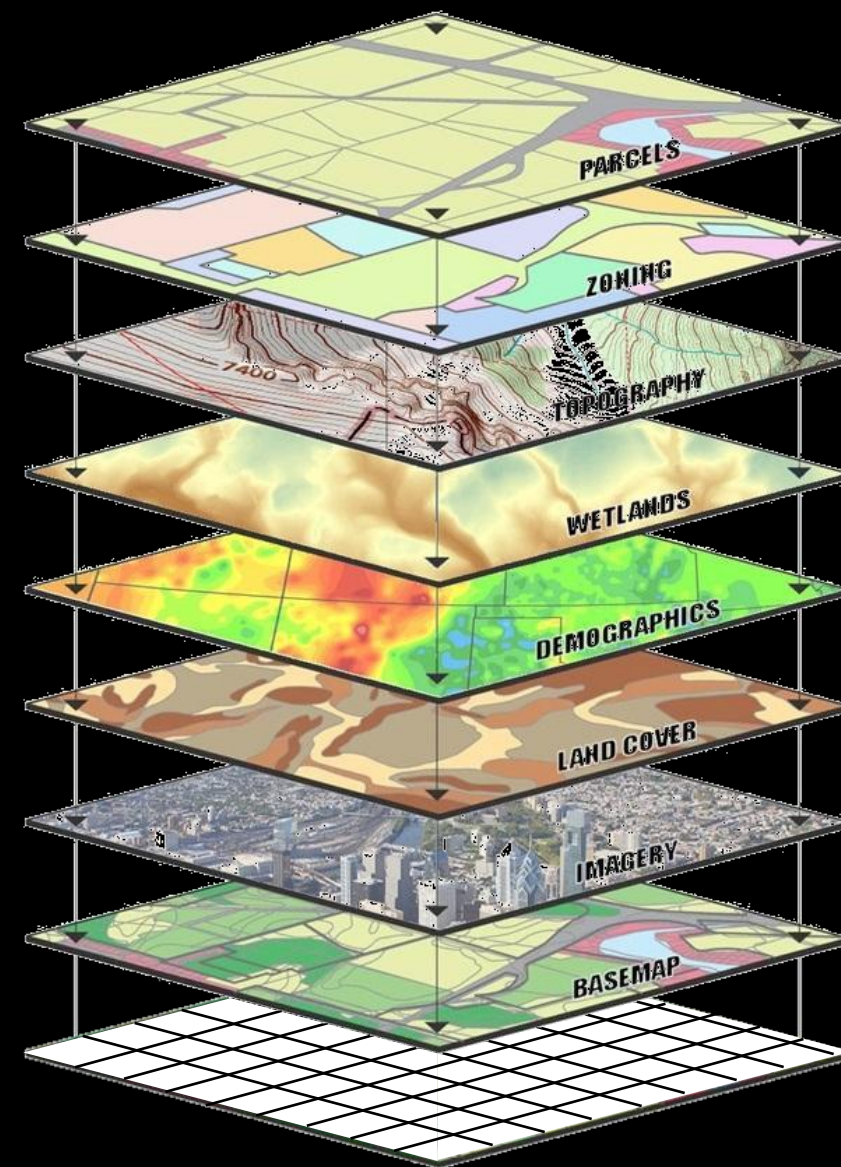Static Datum

7 parameter
transformation

Static Datum

Old Geodetic Static
Datum

PARCELS

ZONING

TOPOGRAPHY

WETLANDS

DEMOGRAPHICS

LAND COVER

IMAGERY

BASEMAP

COORDINATE REFERENCE FRAME

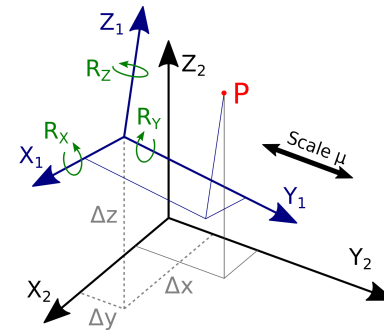# Transformations in GRS

Static Datum

New Geocentric
Static Datum

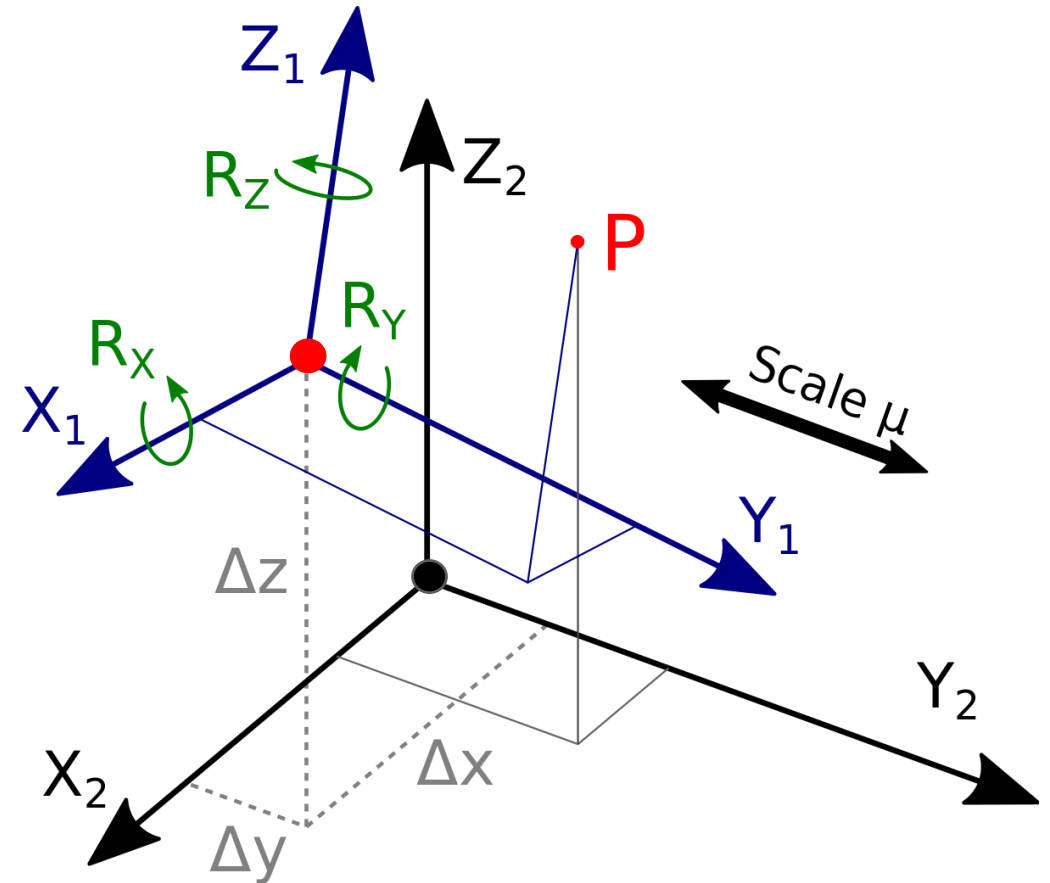7 parameter
transformation

Static Datum

Old Geodetic Static
Datum

Transformation parameters

7 Transformation parameters

- 3 translations

- 3 rotations

- 1 scale

Need: sufficient points where coordinates are known in both datums

Time dependent component of GRS

Time Dependent
Reference Frame

Static Datum

e.g. International
Terrestrial Reference
Frame 2020

14 parameter
transformation

New Geocentric
Static Datum

7 parameter
transformation

Static Datum

Old Geodetic Static
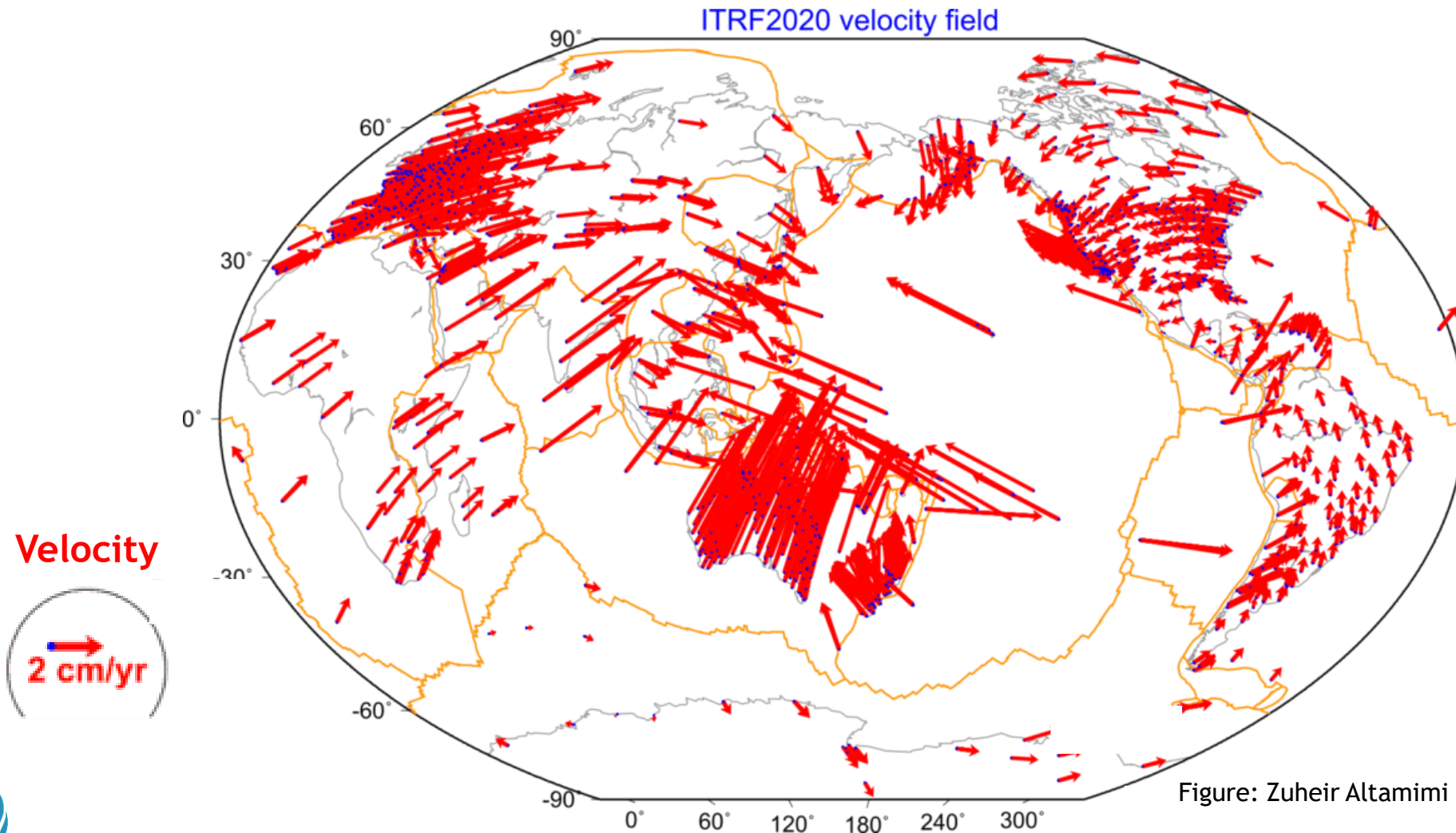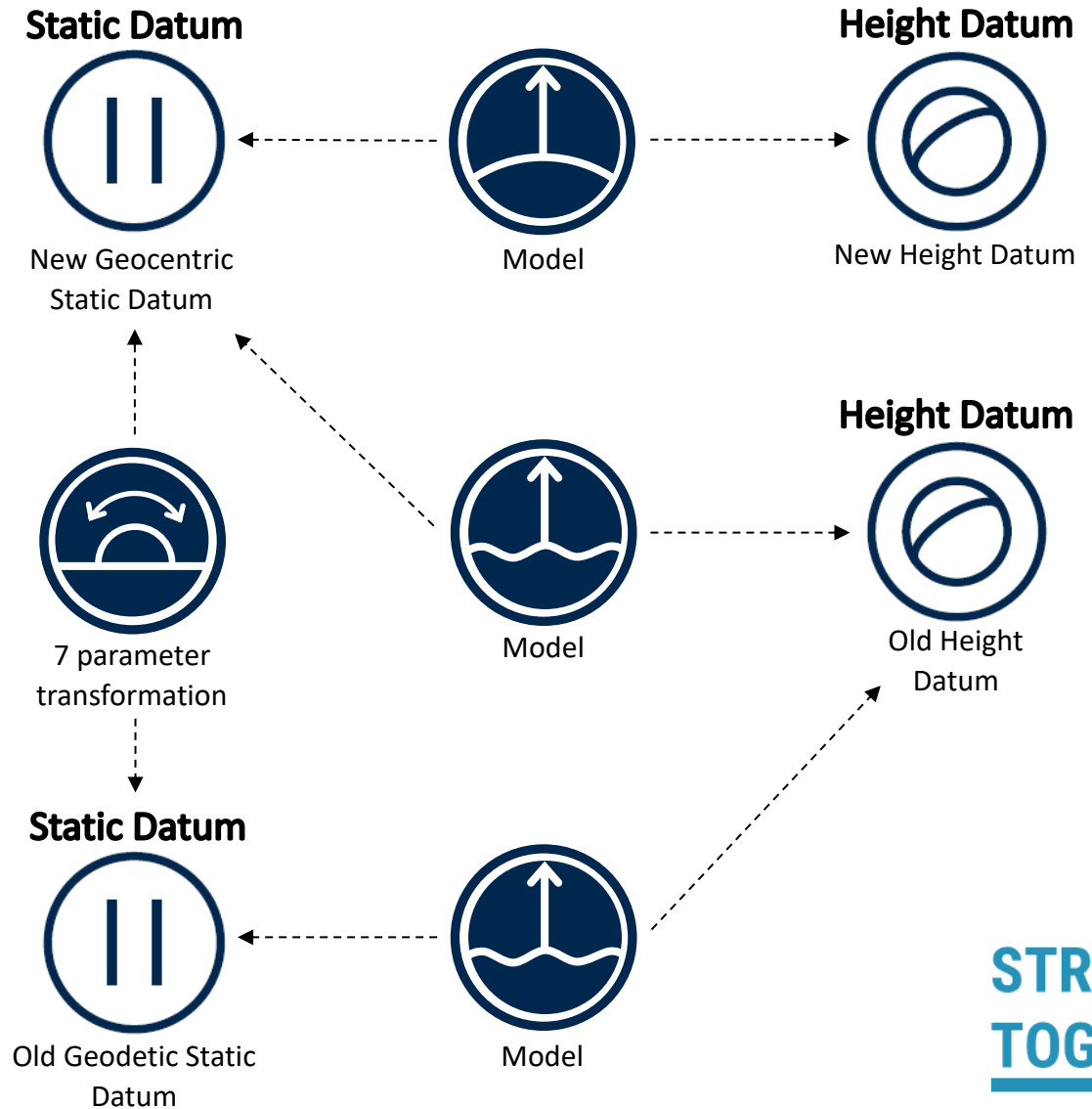Datum

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Time dependent reference frame

ITRF2020 velocity field
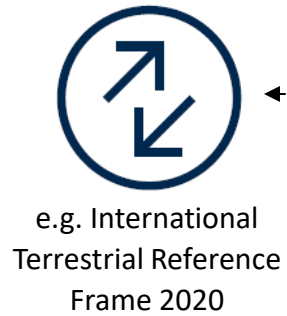
Velocity

2 cm/yr

Figure: Zuheir Altamimi

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Height component of GRS

Geospatial Reference System

Time Dependent Reference Frame

e.g. International Terrestrial Reference Frame 2020

14 parameter transformation

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Example of a country Geospatial Reference System

People **Standards** **Legal frameworks** **Software** **Technical Manual**

Credit: Geoscience Australia

7 parameter transformation

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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.
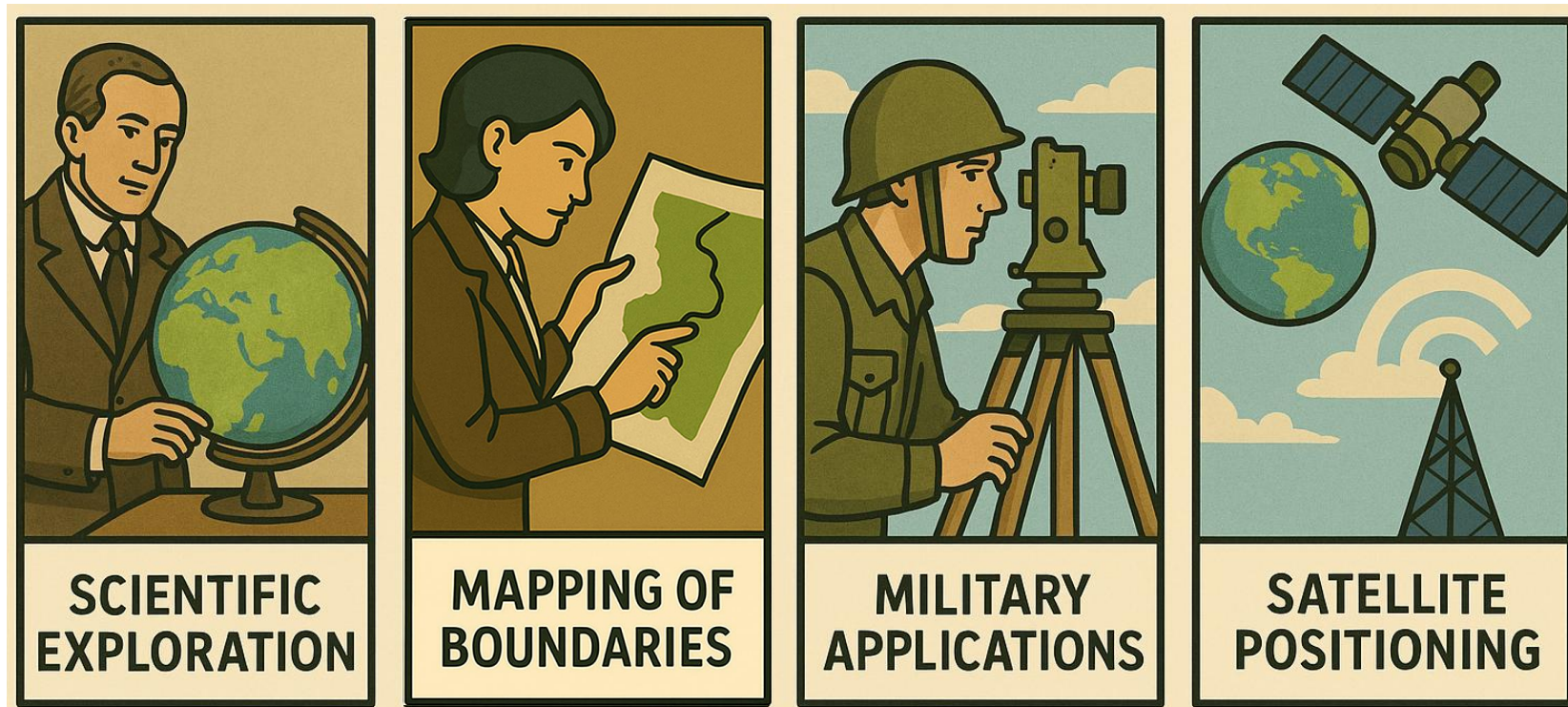- People

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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.

SCIENTIFIC EXPLORATION

MAPPING OF BOUNDARIES

MILITARY APPLICATIONS

SATELLITE POSITIONING

Source: Generated using ChatGPT.

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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

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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

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

Source: Geoscience Australia

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

Source: Geoscience Australia

Construction
- Personal safety
- Aerial surveys

Source: Geoscience Australia

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

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)
- 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

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