UNITED NATIONS GLOBAL GEODETIC CENTRE OF EXCELLENCE

MODERNISING GEOSPATIAL REFERENCE SYSTEM CAPACITY DEVELOPMENT WORKSHOP

The importance of a Geospatial Reference System

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WHY

Day 1, Session 2 [1_2_1]

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).

Summary

What is a modern Geospatial Reference System

- Collection of static & time-dependent datums, height datums, geoid models, transformation parameters and standards needed for accurate positioning and navigation applications.

Why modernize a country Geospatial Reference System?

- Increase compatibility with the International Terrestrial Reference Frame which is the reference frame used for Global Navigation Satellite Systems.
- Improve the efficiency for countries positioning and navigation applications, and real-time decision-making.

Critical Success Factors for modernization?

- Engage stakeholders & users early.
- Focus on capacity development and training for sustainability.
- Use clear, relatable narratives to secure support.

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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

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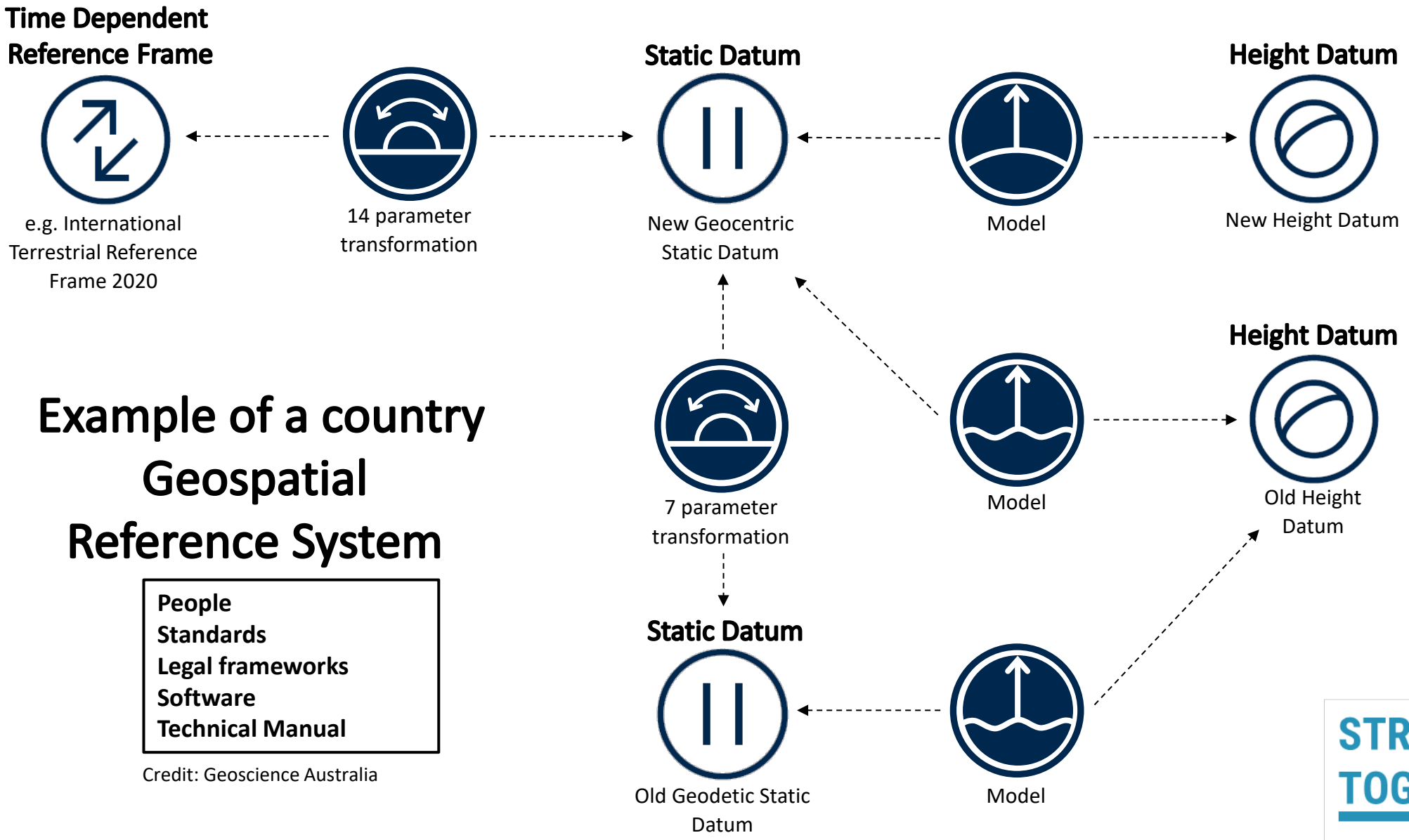
Geospatial Reference System



Example of a country Geospatial Reference System

People
Standards
Legal frameworks
Software
Technical Manual

Credit: Geoscience Australia

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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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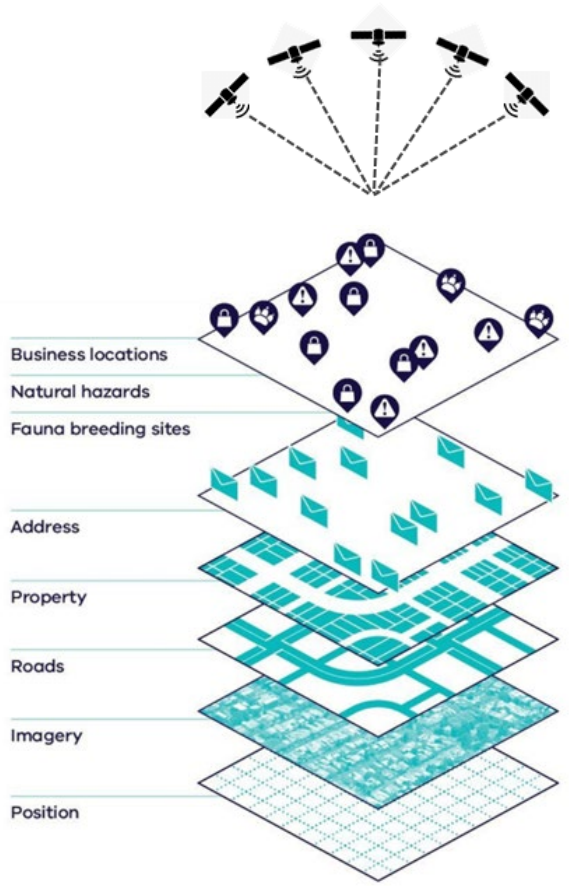
Why is a GRS important?

- 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.



Credit: Victorian State Government, Australia

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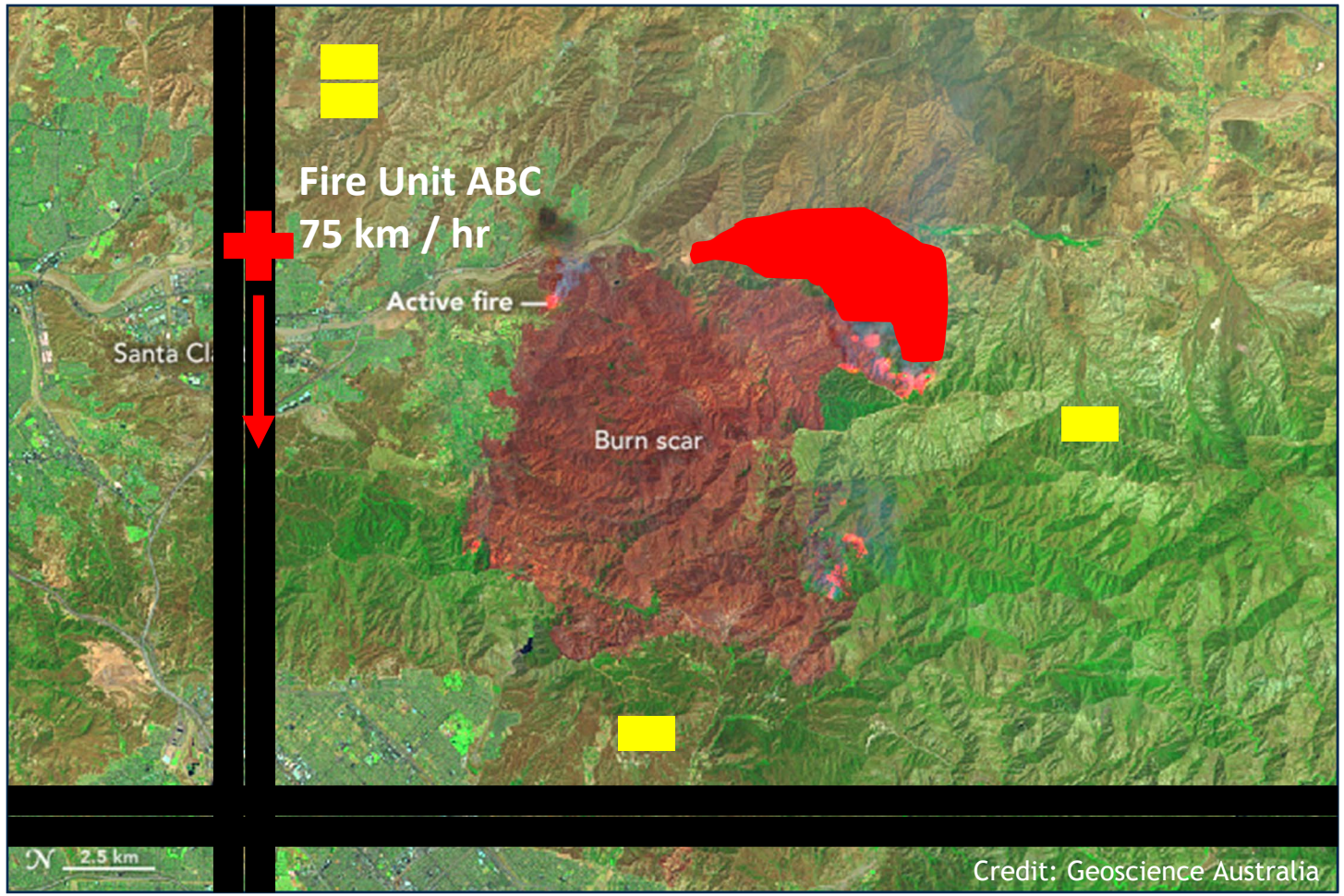
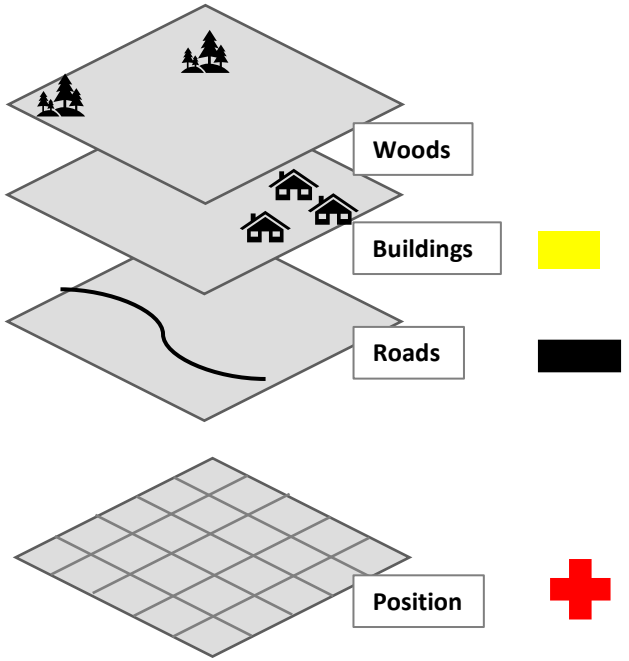
The Importance of a Geospatial Reference System





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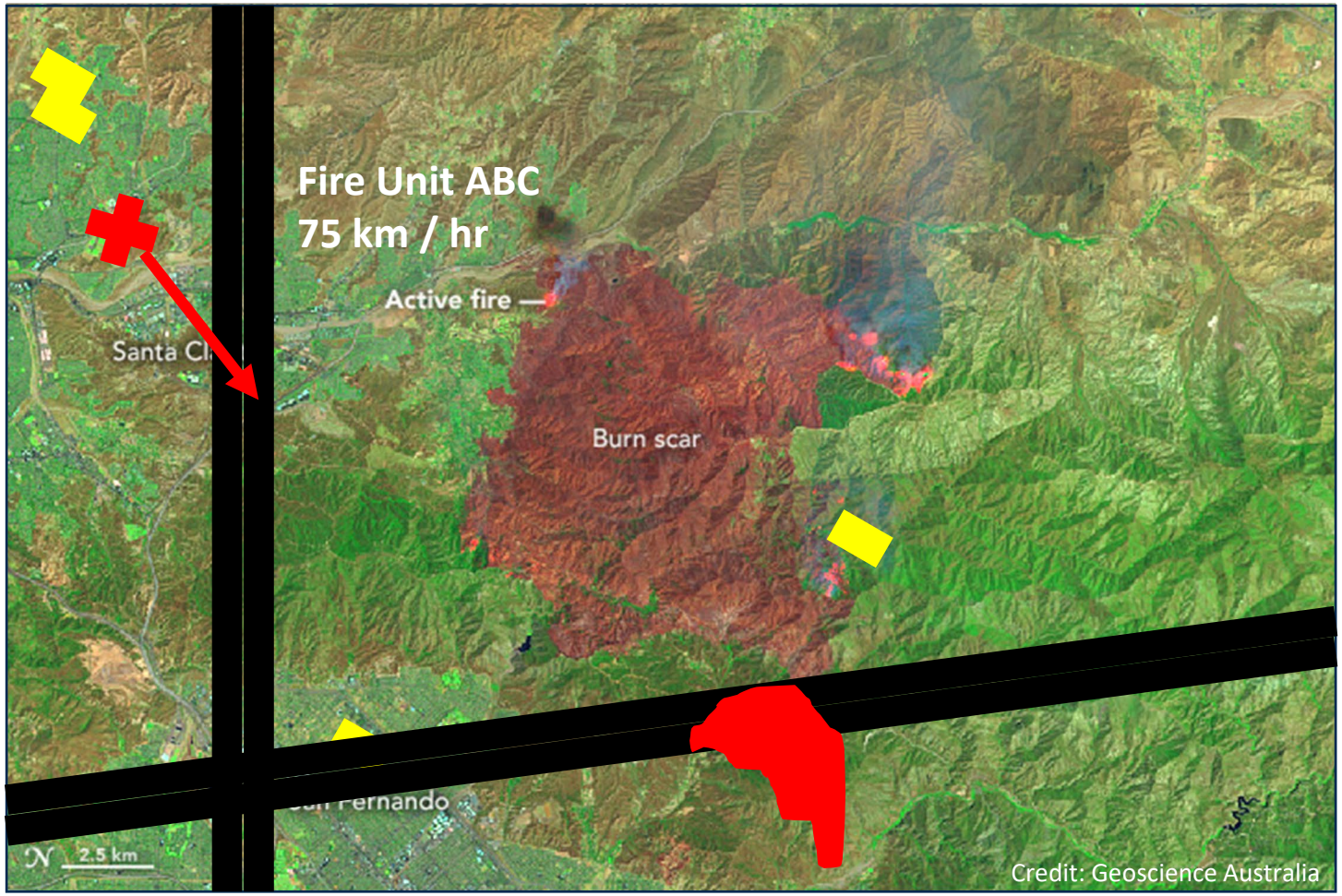
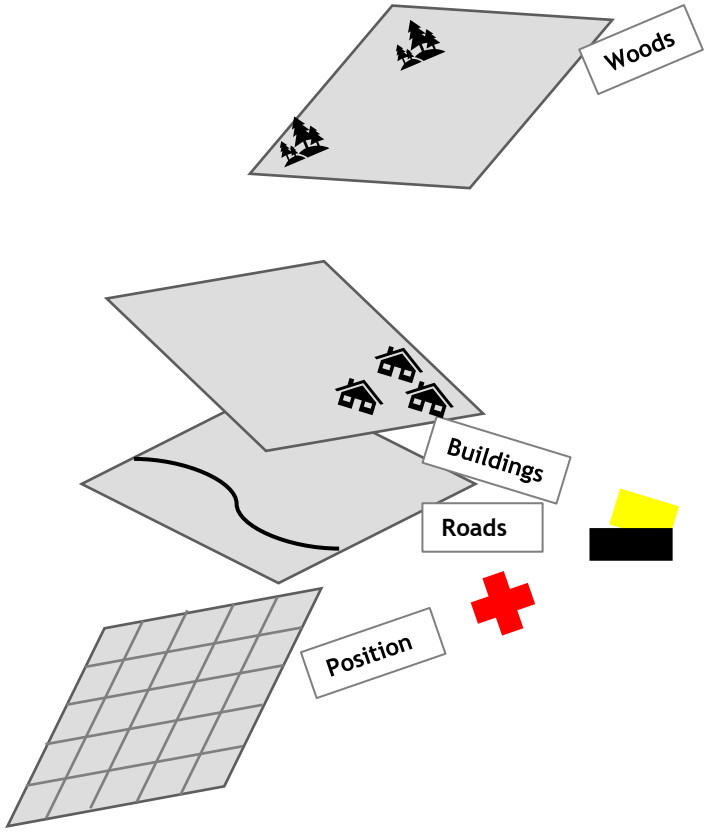
The Importance of a Geospatial Reference System



*Data are not aligned



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Static component of GRS

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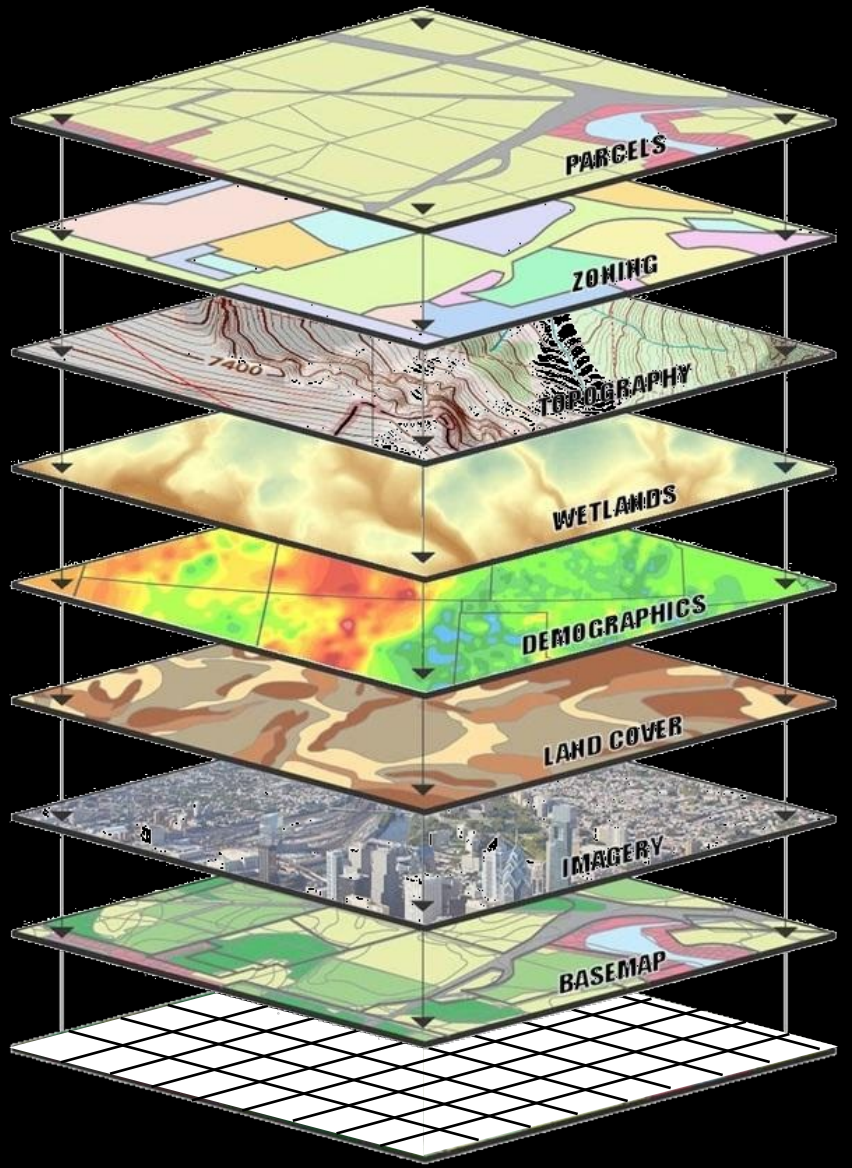


COORDINATE REFERENCE FRAME

Transformations in GRS

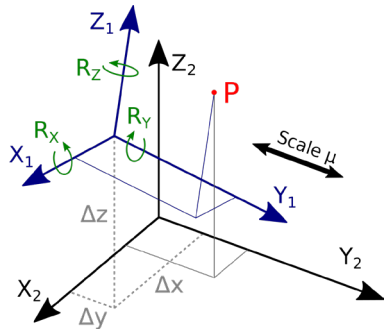
Static Datum

New Geocentric Static Datum

7 parameter transformation

Static Datum

Old Geodetic Static Datum



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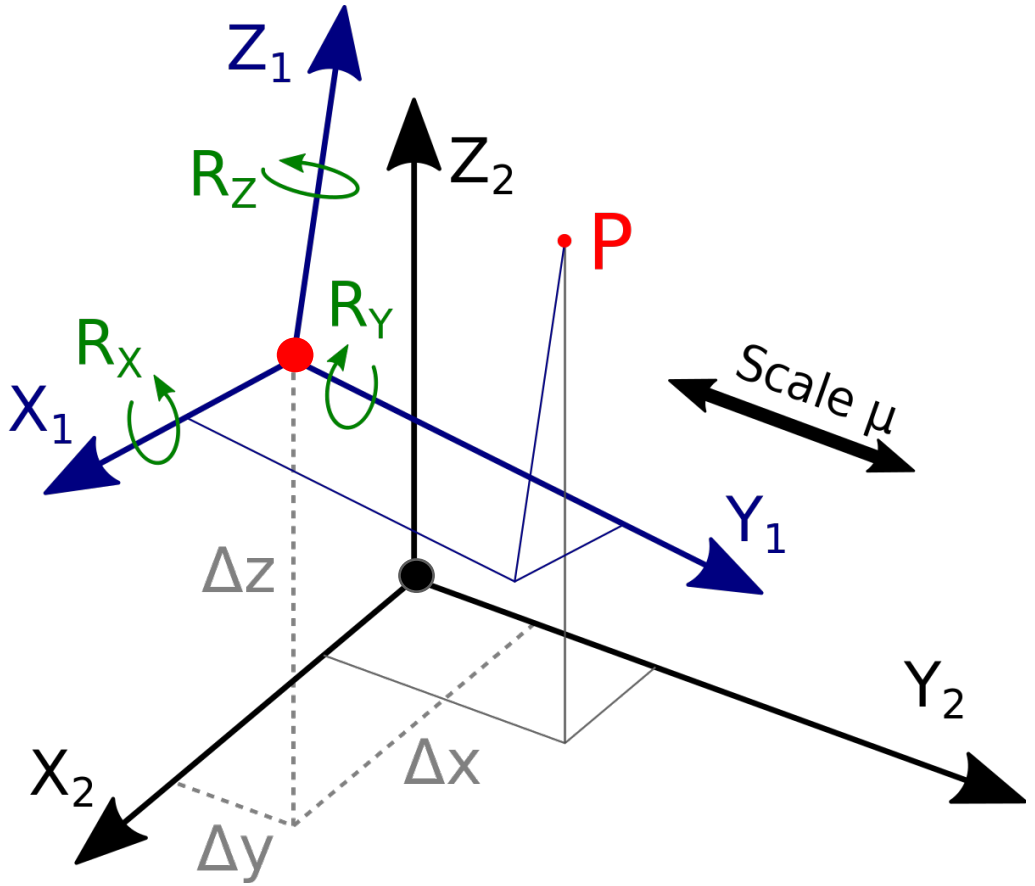
Transformation parameters

7 Transformation parameters

- 3 translations
- 3 rotations
- 1 scale

Need: sufficient points where coordinates are known in both datums



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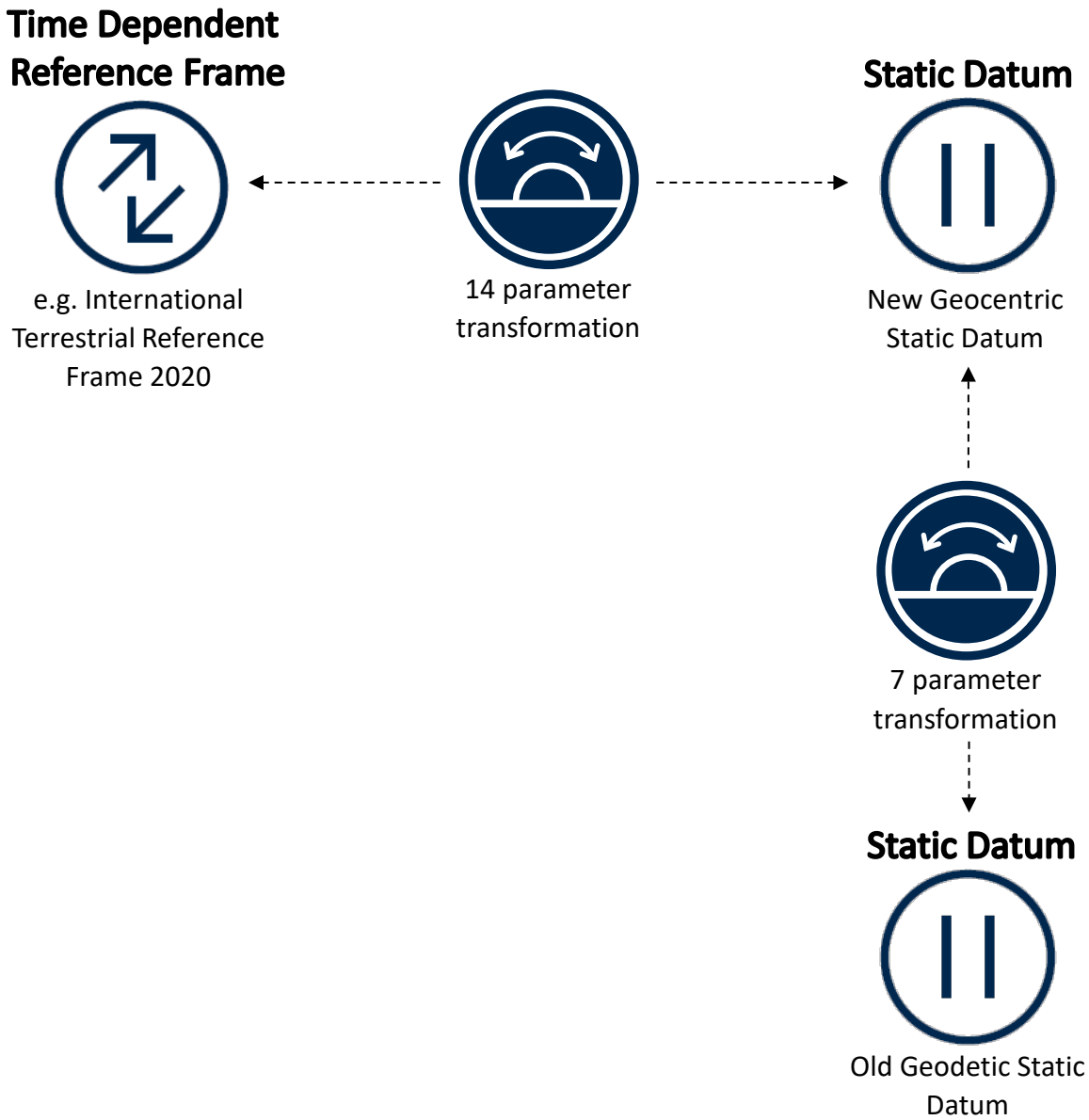
Time dependent component of GRS



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Time dependent reference frame

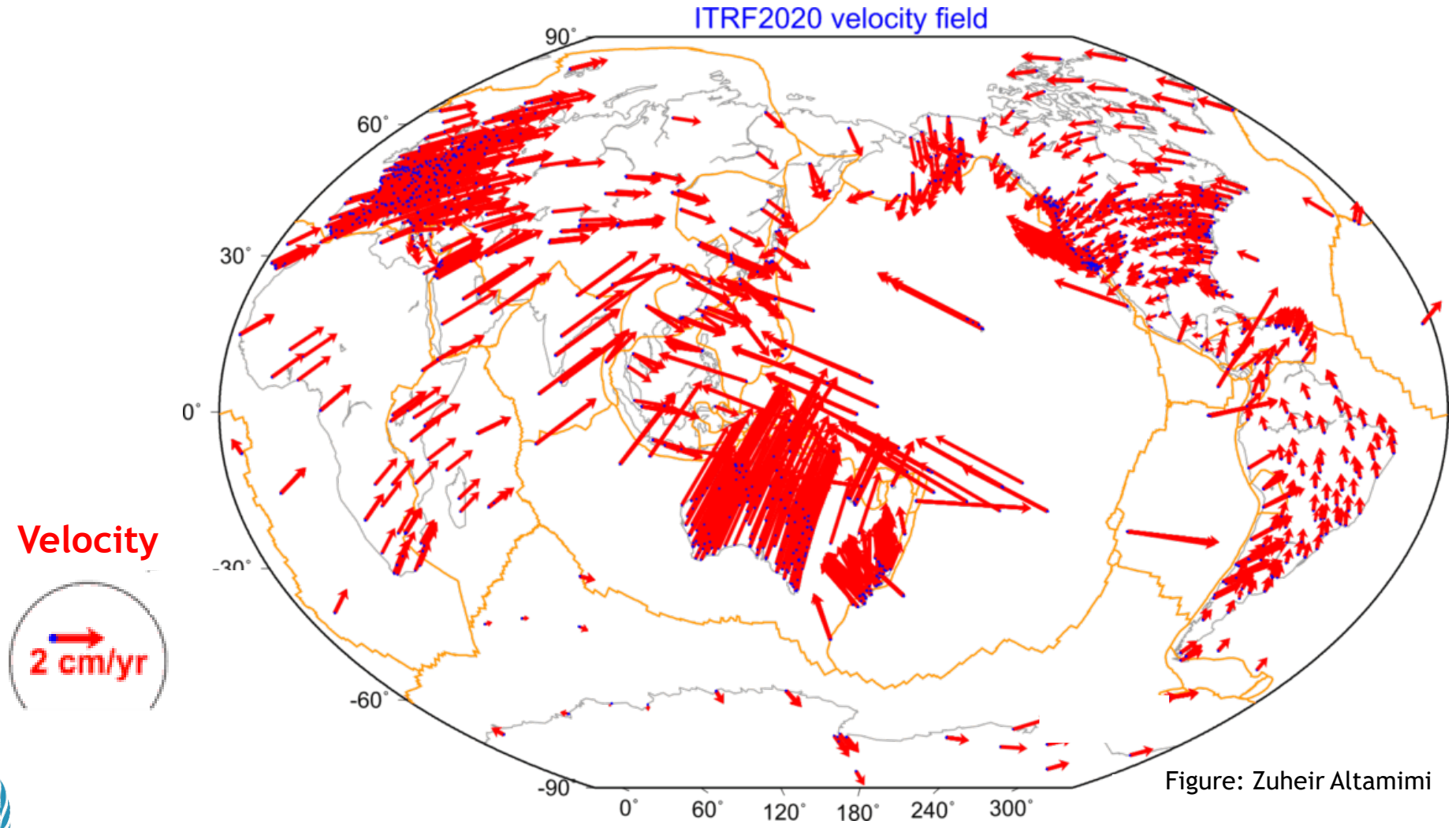

Figure: Zuheir Altamimi

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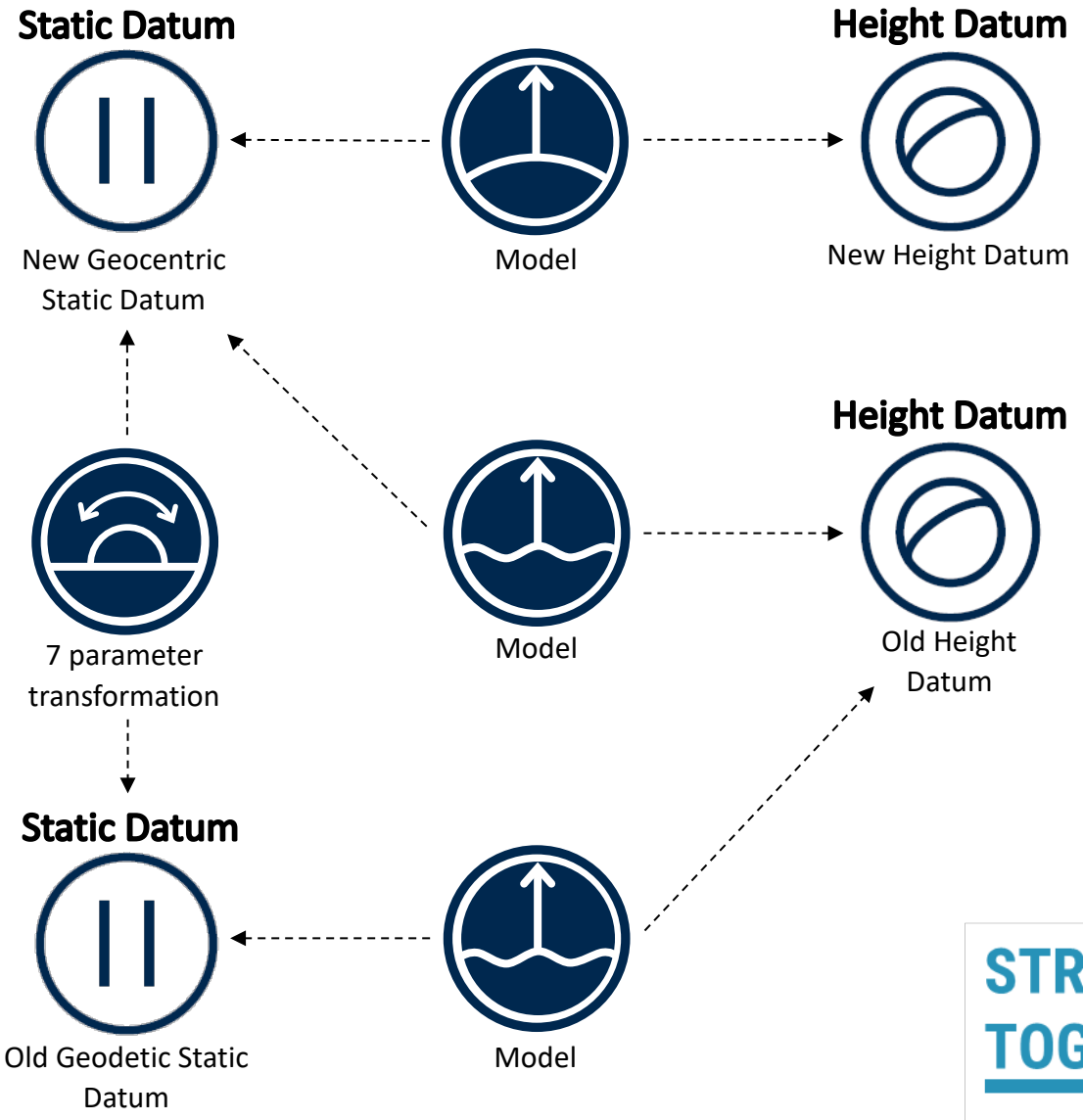
Height component of GRS



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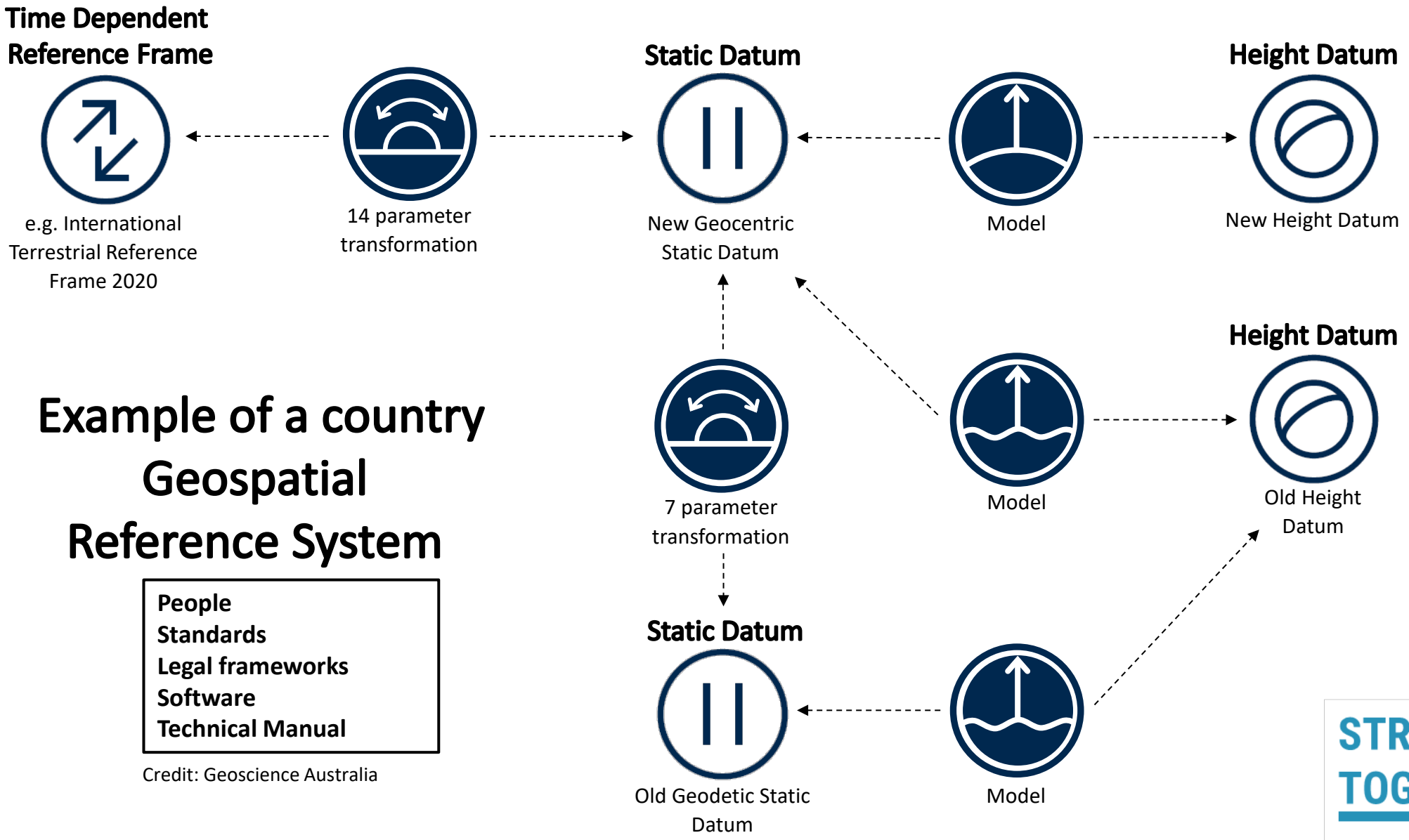
Geospatial Reference System



Example of a country Geospatial Reference System

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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

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.

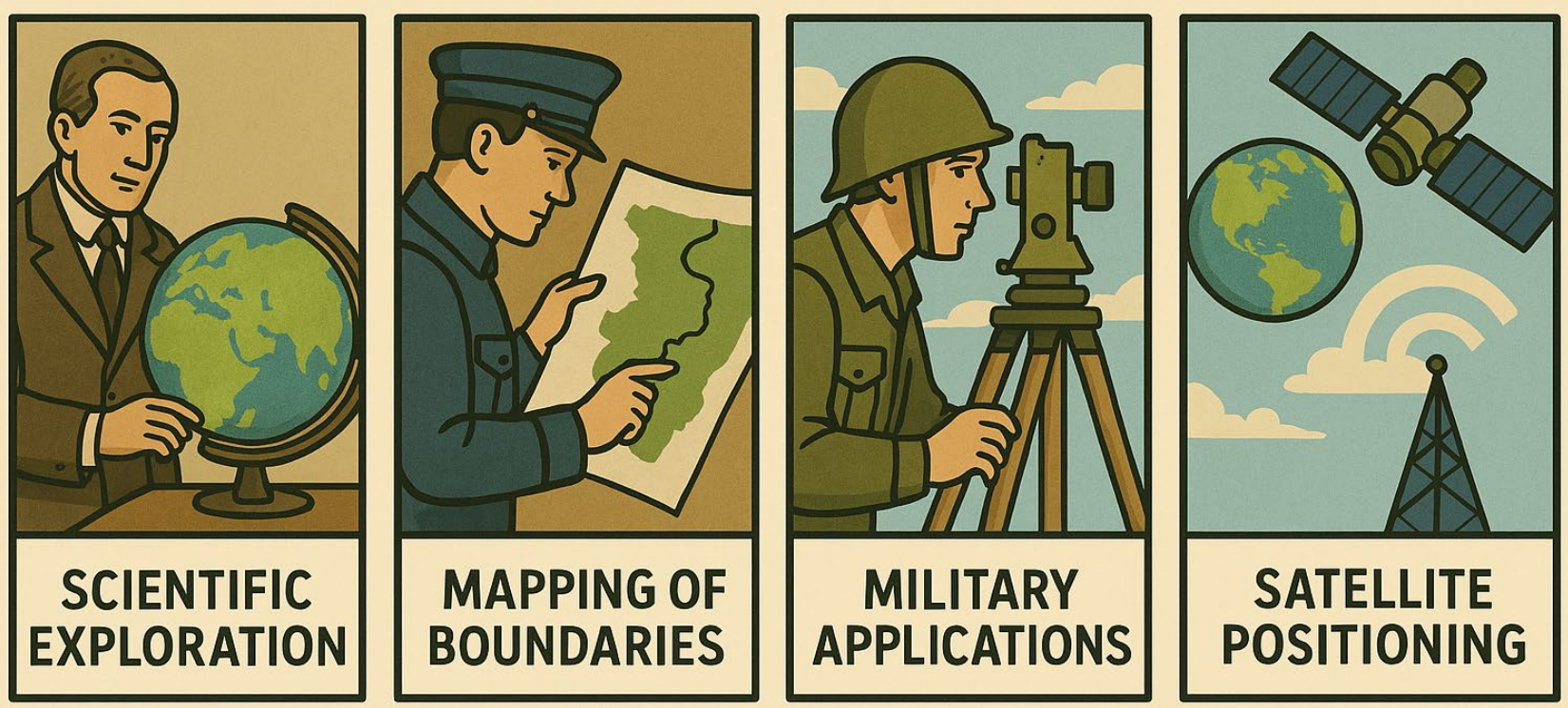

Image generated using ChatGPT.

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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

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

Source: Geoscience Australia

General Aviation

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

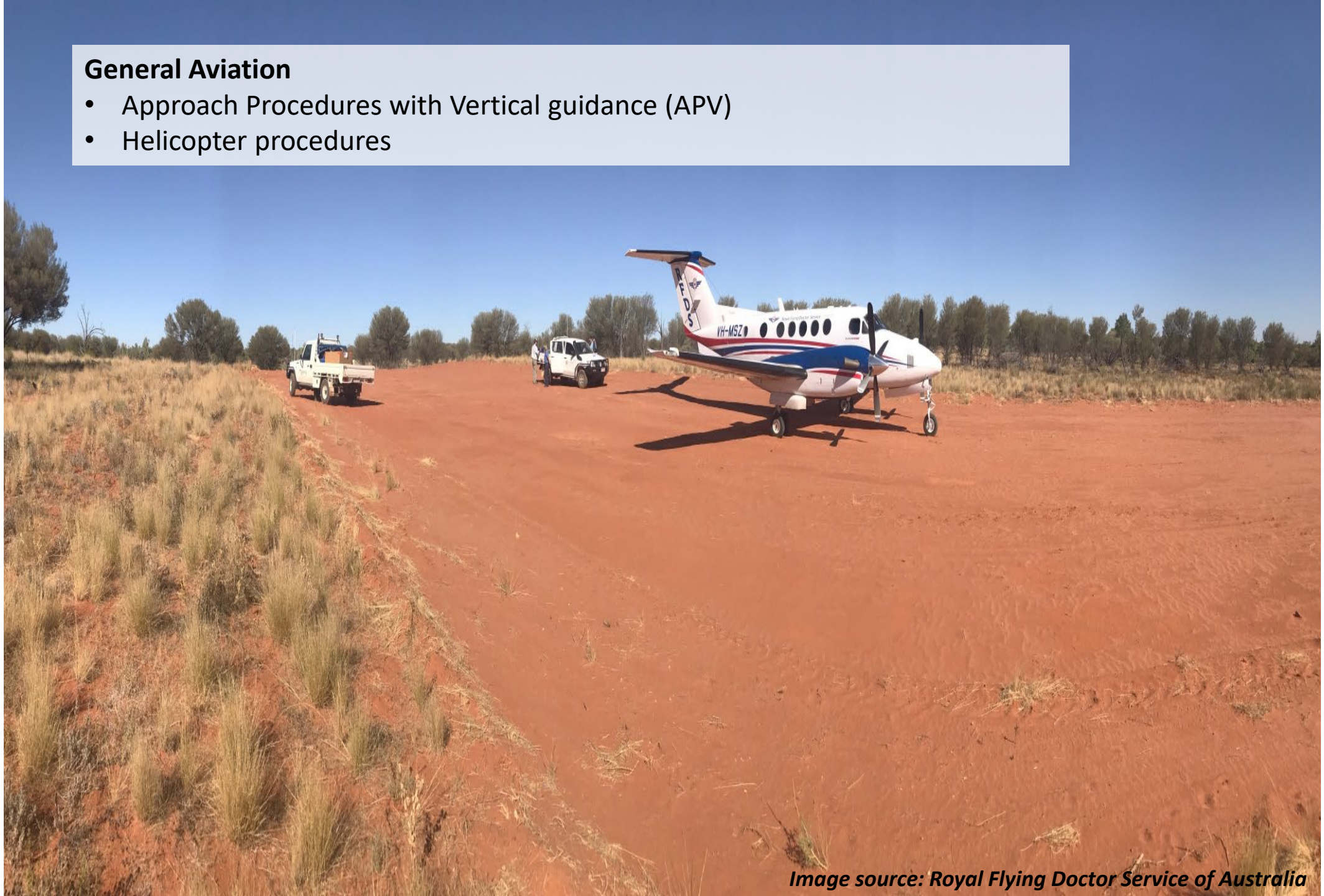

Image source: Royal Flying Doctor Service of Australia

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

Source: Geoscience Australia

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

Source: Geoscience Australia

Summary

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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