UNITED NATIONS GLOBAL GEODETIC CENTRE OF EXCELLENCE

MODERNISING GEOSPATIAL REFERENCE SYSTEM CAPACITY DEVELOPMENT WORKSHOP

The importance of understanding the needs of your stakeholders

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Agriculture – livestock

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

Source: Geoscience Australia

General Aviation

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

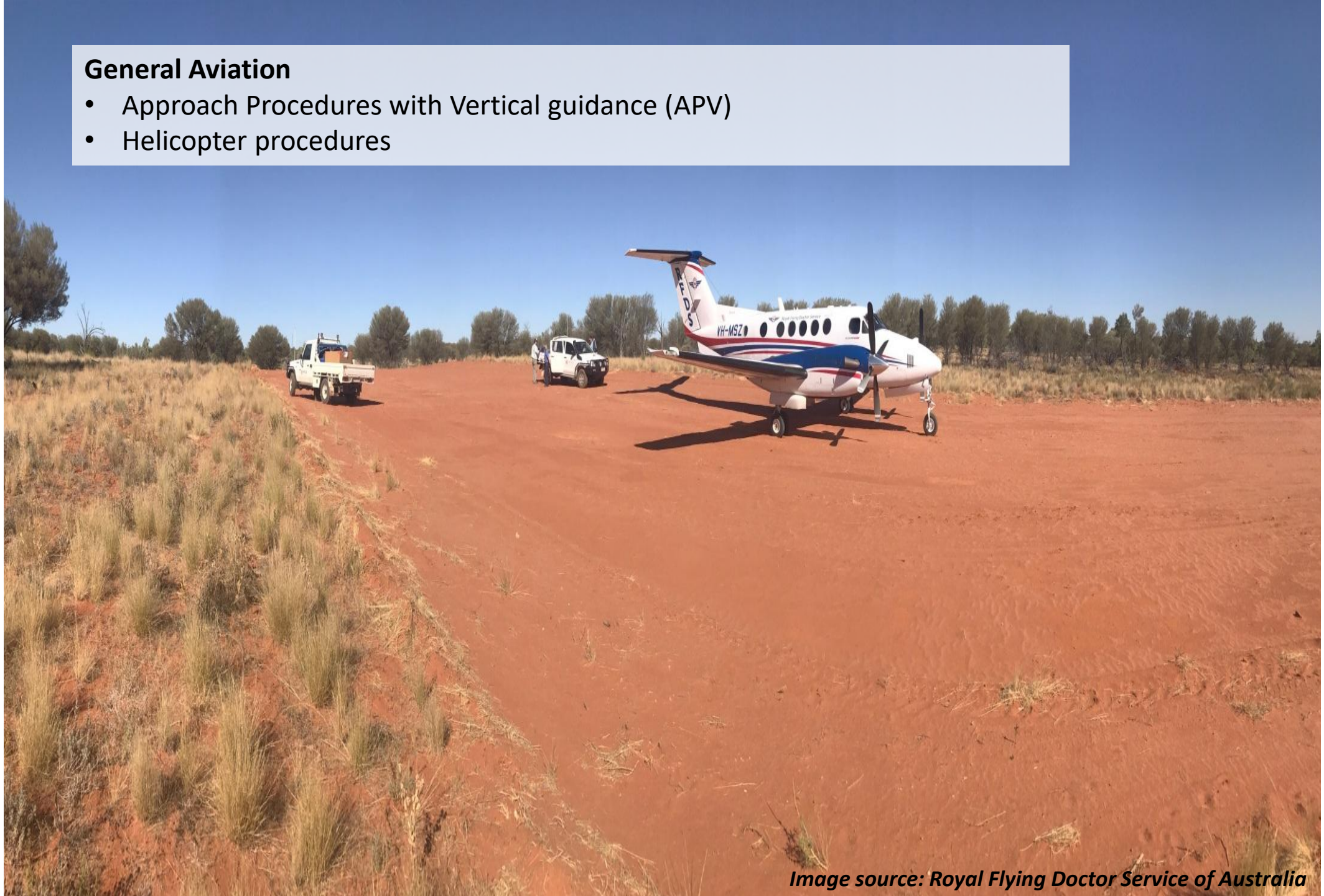


Image source: Royal Flying Doctor Service of Australia

Resources

- Mine safety
- Automation of mine sites and supply chains

Source: Geoscience Australia

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

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

Construction

- Personal safety
- Aerial surveys

Source: Geoscience Australia

UAV Aviation

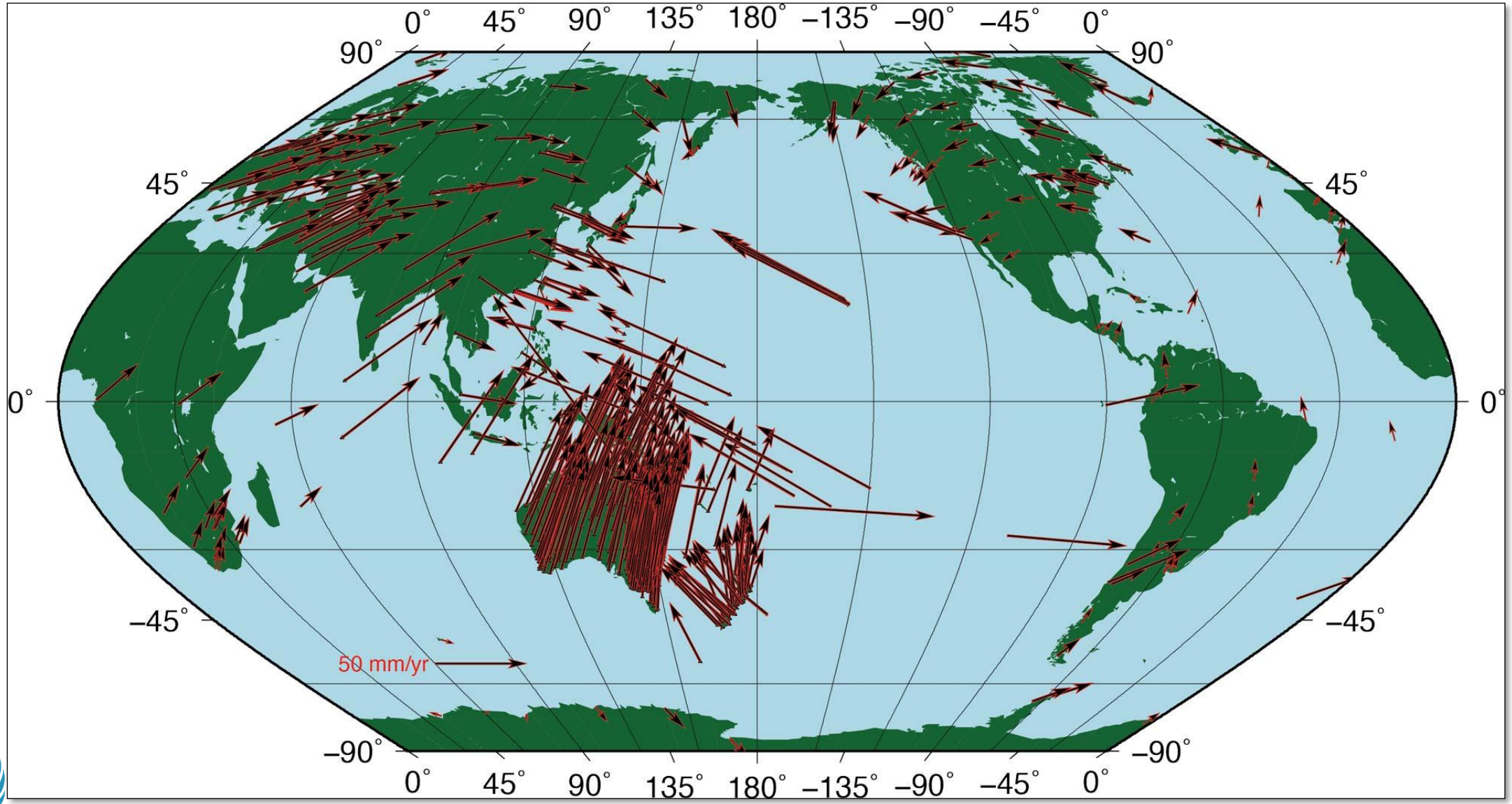
- High-precision drone applications for agriculture and forestry
- Aerial surveys

Consumer

- Safe guidance for the visually impaired
- Parcel delivery

Source: Geoscience Australia

Context



Static vs Time-Dependent Reference Frames

ITRF2020 – Time Dependent Reference Frame

WGS84 – Time Dependent Reference Frame

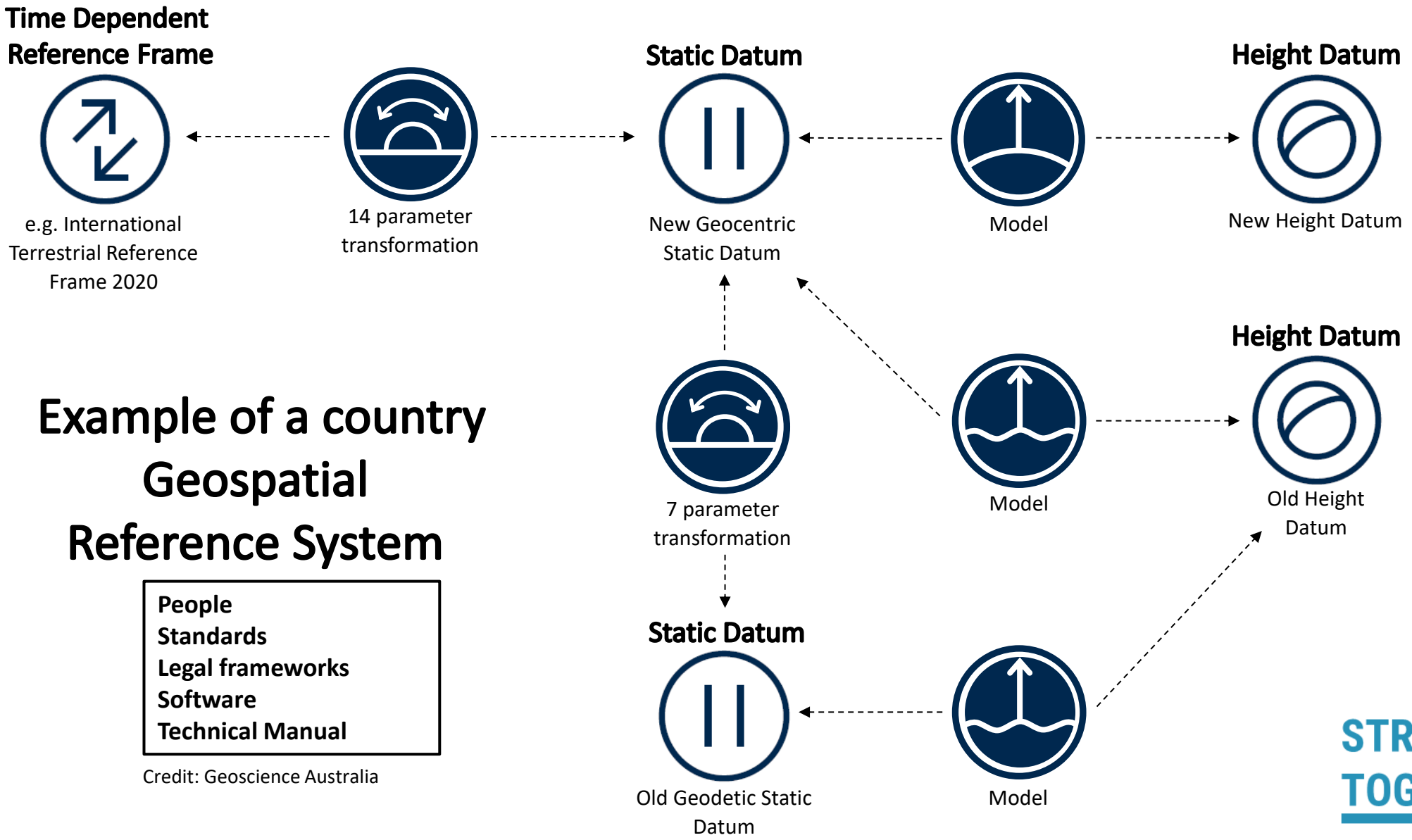
ETRS89 – Static

GDA2020 – Static

Time dependent - In Australia, the coordinates of survey mark measured with respect to ITRF2020 on 1 Jan 2024 (ITRF2020@2024.0) and 1 Jan 2025 (ITRF2020@2025.0) will be different by ~7 cm.

Static - In Australia, the coordinates of survey mark measured with respect to GDA2020 on 1 Jan 2024 and 1 Jan 2025 will be the same because a model is used to propagate coordinates back to 1 Jan 2020 to remove the influence of continental plate motion.

Geospatial Reference System



Example of a country Geospatial Reference System

People
Standards
Legal frameworks
Software
Technical Manual

Credit: Geoscience Australia

STRONGER.
TOGETHER.

Ways to create a regional reference frame

Asia-Pacific Reference Frame (APREF)

- Regional realization of the ITRF
- APREF is a time dependent reference frame
- APREF Central Bureau provides updated coordinates weekly to reflect tectonic plate motions, seismic shifts, and other geodynamic processes.
- Some national geodetic datums use the time dependent APREF as constraint for national static datums (e.g. Australia and New Zealand)
- Australia uses a plate motion model based on APREF data to propagate coordinates between the national static datum (fixed to 2020) and ITRF
- The regional time dependent reference frame supports applications in the Asia-Pacific region, where plate motion and seismic activity are significant (e.g. earthquake monitoring, tsunami warning systems, and high-precision navigation)

Ways to create a regional reference frame

European Terrestrial Reference System 1989 (ETRS89)

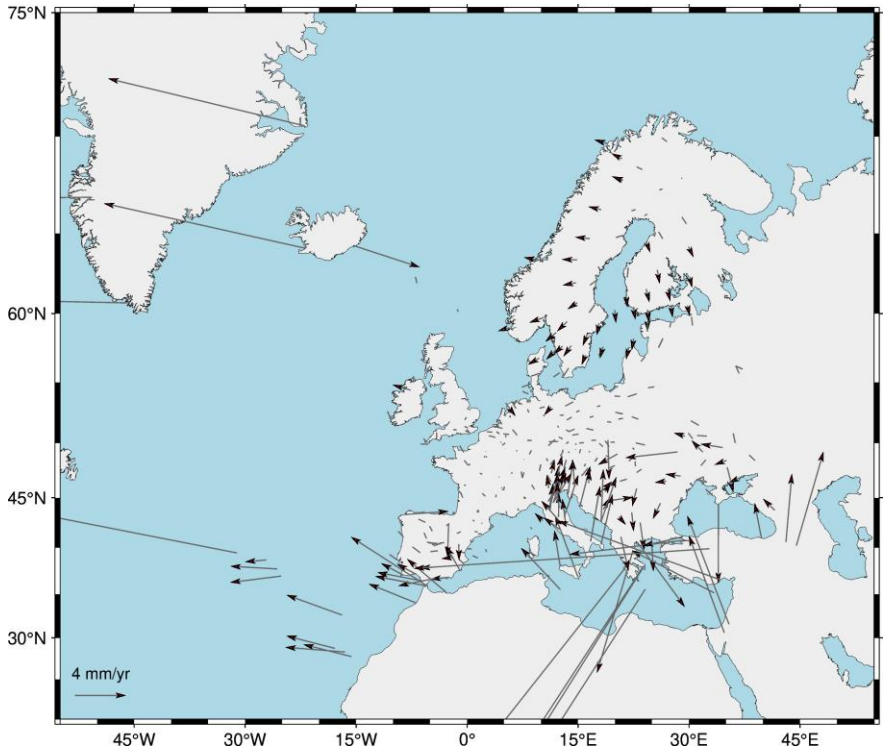
- Regional realization of the ITRF fixed to the Eurasian plate at epoch 1989.0.
- ETRS89 is static
- Since the Eurasian plate moves at an approximate rate of **2.5 cm per year**, the difference between the ITRF2020 coordinates and ETRS89 increases by 2.5 cm per year with time. To handle this, a **time-dependent transformation** (a continental plate motion model) is applied:
- While continental drift is largely mitigated, there are residual effects that cannot be entirely removed:
  - Local Tectonic Deformation: Regions within Europe that experience seismic activity or crustal deformation (e.g., near plate boundaries or fault zones) may still see small positional changes over time.
  - Plate Flexing: Even within the "stable" part of the Eurasian plate, minor deformations can occur, causing slight deviations in position over long periods.
- Updates to ETRS89 (e.g., ETRF2000, ETRF2014) are released periodically to reflect advancements in geodesy but maintain the static plate-fixed assumption.
- Uses fixed transformations to align GNSS-derived coordinates (in ITRF) with the static Eurasian plate framework.

Ways to create a regional reference frame

- While both **ETRS89** and **APREF** serve as regional geodetic reference frameworks, their design is different.
- **APREF**, was designed to with time dependency in mind, due to the tectonic activity and complexity of the Asia-Pacific region.
  - Stays in direct alignment with the ITRF at all times
  - Enables different national datum implementations to be performed to meet different user requirements
  - Each national datum implementation is different (e.g. Australia and New Zealand)
- The **ETRS** is static, tied to the Eurasian plate.
  - ETRS is simpler
  - ETRS may have worked well for a period of time
  - **Does ETRS limit the national implementations to be performed with highest possible accuracy?**

Ways to create a regional reference frame

European Terrestrial Reference System 1989 (ETRS89) – “minimizing the residuals”



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Coordinate Reference Systems Basic User Guide
https://www.eurocontrol.int/sites/default/files/2024-12/eurocontrol-coordinate-reference-systems-basic-user-guide.pdf