Where am I? Unlocking the Power of Geodesy with International Collaborations

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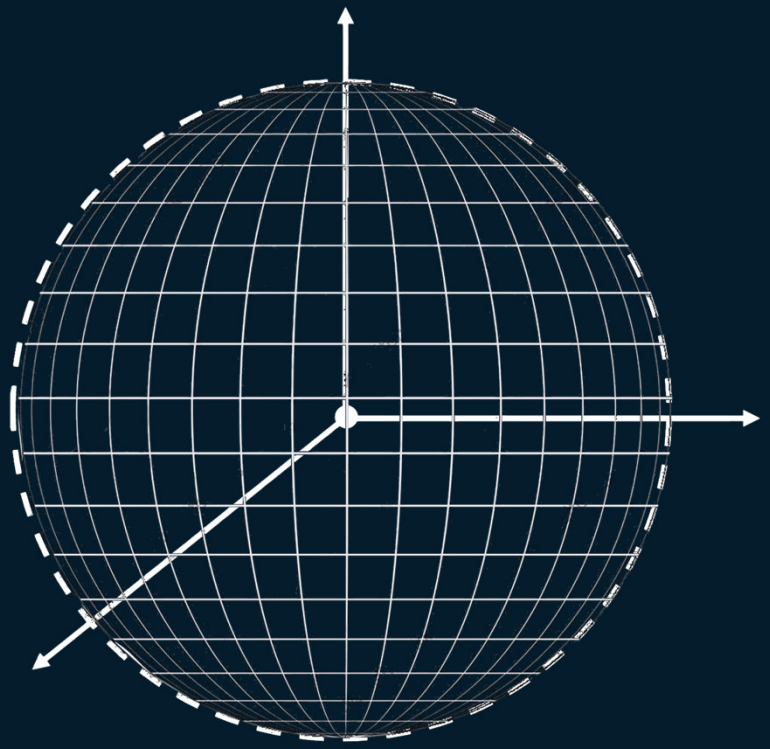
*... with additional contributions from members of the **Global Geodetic Observing System** and **International GNSS Service** executive leadership*

IGS INTERNATIONAL GNSS SERVICE

NASA Jet Propulsion Laboratory California Institute of Technology

IAG GGOS



If you can’t measure it; you can’t manage it.

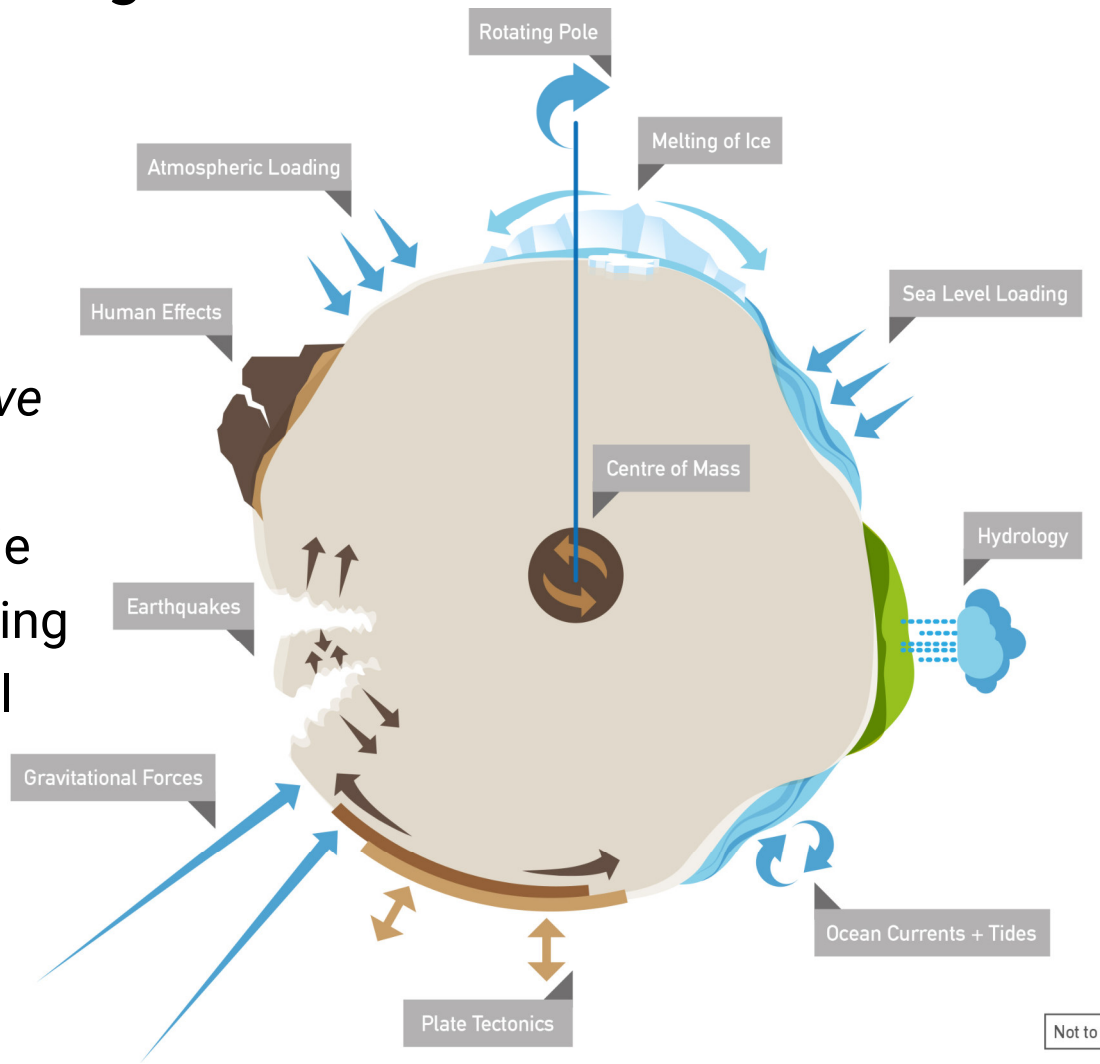
Graphic courtesy of Geoscience Australia

So what is geodesy, anyway?

- Geodesy is the science of the Earth's:
  - Shape (not a sphere!)
  - Gravity field
  - Rotation

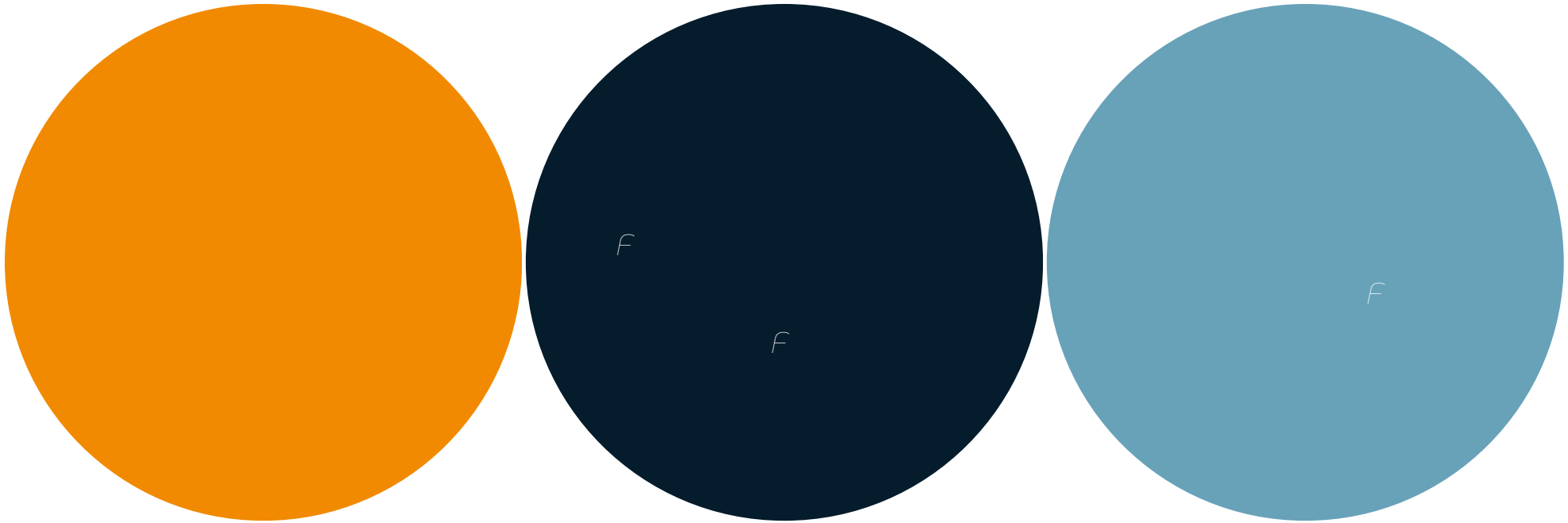
  … as well as variations in all of the above

- Geodesists use Reference Frames to tie all this together for consistent monitoring and understanding of global geospatial change.



Graphic courtesy of Geoscience Australia

The Inherently International Nature of Geodesy

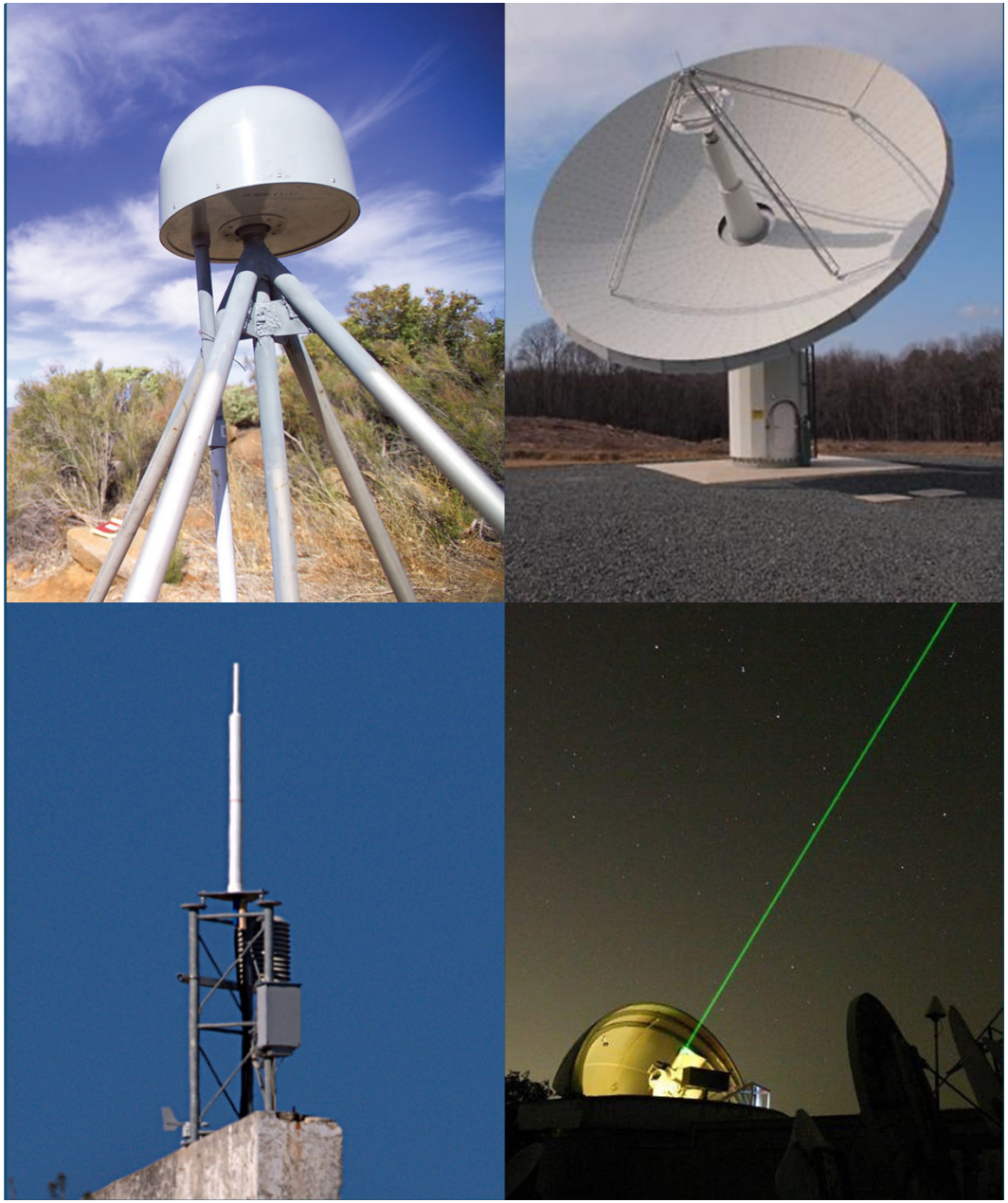


International GNSS Service: Serving Surveyors with Openly Available GNSS Data Products


IGS
INTERNATIONAL
GNSS SERVICE
Providing openly available GNSS data and products
that benefit science and society.
HOB200AUS
Hobart, Australia
Photo courtesy of Geoscience Australia

International GNSS Service (IGS) is....

- Dynamic and indispensable global collaborative platform, **leveraging the collective contributions** of its diverse members to provide unparalleled access to GNSS data.
- **Technological innovator** and **catalyst for scientific advancements**, actively engaging with global organizations to ensure its impact extends far beyond the immediate GNSS community.
- **Providing transformative benefits for scientific, practical, and technological domains** on a worldwide scale.



IGS is one of the technical services of the

International Association of Geodesy (IAG)

and part of the

Global Geodetic Observing System (GGOS)

IUGG

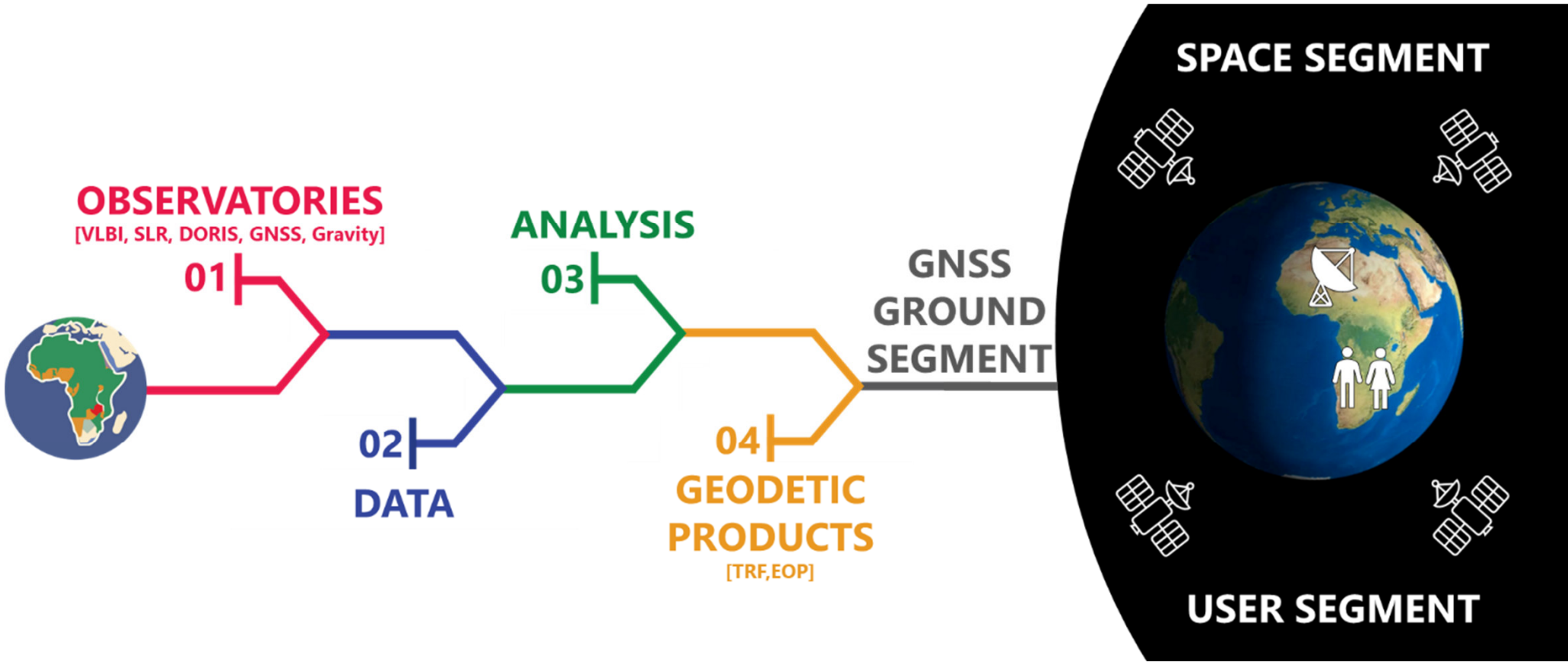
Global Geodetic Observing System

- **IGS** (International GNSS Service) — Global Navigation Satellite Systems (GNSS)
- **ILRS** — Satellite Laser Ranging (SLR)
- **IVS** — Very Long Baseline Interferometry (VLBI)
- **IDS** (International DORIS Service) — Doppler Orbitography by Radiopositioning Integrated on Satellite (DORIS)*

We know that GNSS provides high-precision positioning data for surveying and geospatial applications...

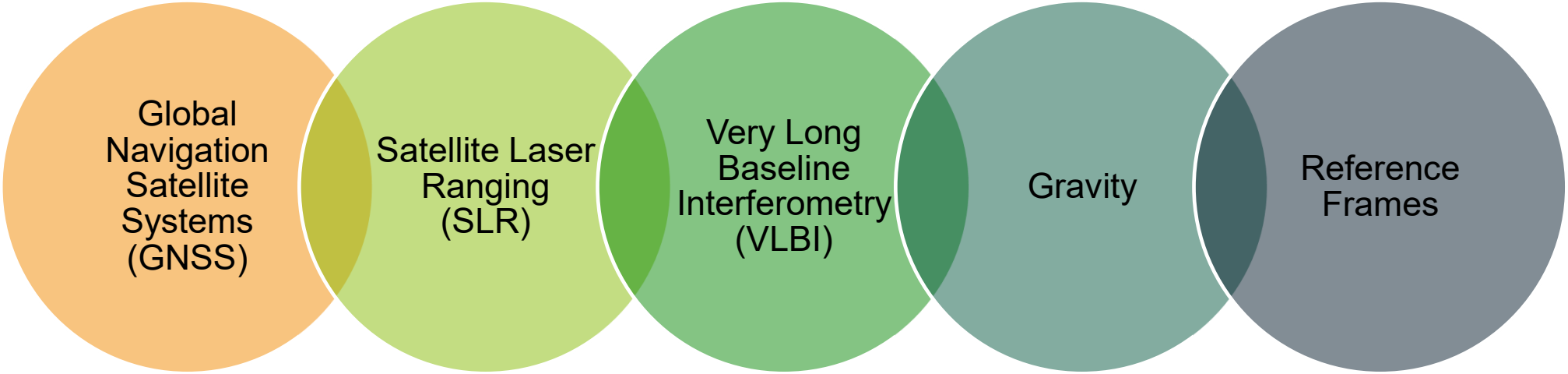
... but what technologies help ensure reliable and robust GNSS?

GNSS and the Global Geodesy Supply Chain



Graphic courtesy of the United Nations Global Geodetic Center of Excellence

Technologies and Resources Underpinning GNSS in the Global Geodesy Supply Chain



Global Navigation Satellite Systems (GNSS)

Used extensively by land surveyors since the late 1980s

Can provide centimeter-level accuracy (or better)

Multi-constellation receivers now enable use in more areas

Connect to local, regional, and international reference frames

Essential for Earth observations

GGOS Component:

International GNSS Service (IGS)

International GNSS Service (IGS) Ground Station: KARR00AUS
Karratha, Western Australia, Australia
Photo courtesy of Geoscience Australia

How do we know the GNSS satellites are where they say they are?

Satellite Laser Ranging (SLR)

By comparing SLR measurements with GNSS-derived orbits, researchers identify and correct errors in the orbit models, leading to more precise positioning and better products for GNSS and scientific satellite missions.

Beyond the validation of GNSS orbits, SLR observations are used to determine precise coordinates of ground stations and Earth rotation parameters, and contribute to the determination of Earth's gravity field

GGOS Component:

International Laser Ranging Service (ILRS)

Yarragadee Geodetic Observatory
International Laser Ranging Service (ILRS) Station and GGOS Core Station
Yarragadee, Western Australia, Australia
Photo courtesy of Geoscience Australia

How do we ensure GNSS satellites have the “right” time?

Very Long Baseline Interferometry (VLBI)

VLBI helps to correct for the Earth's non-uniform rotation effects on GNSS satellite orbits, leading to more precise positioning calculations.

In applications requiring high accuracy, and for the long-term operation of all GNSS constellations, the VLBI-derived UT1 values, which precisely trace Earth's rotation, are an unconditional requirement

GGOS Component:

Mount Pleasant Radio Observatory
International VLBI Service for Geodesy and Astrometry (IVS) Station
Hobart, Tasmania, Australia
Photo courtesy of Geoscience Australia

What does gravity have to do with positioning?

Gravity Measurement

Gravity influences satellite orbits due to the variability of Earth's mass – stronger over mountains, less over oceans – which perturb satellite orbits over time.

GNSS benefits from gravity measurements by enabling more accurate height determination, particularly when calculating precise vertical positions.

GGOS Gravity Services:

Absolute Gravimeter in operation; Ceduna, South Australia, Australia
Photo courtesy of Geoscience Australia

How can we tie this all together?

Terrestrial Reference Frames

ITRF allows GNSS systems to determine positions with centimeter-level accuracy by providing a well-defined reference frame that accounts for Earth's movements, such as the tectonic plate shifts that occur during an earthquake

By using a single reference frame, different GNSS constellations can be seamlessly integrated and used together for improved positioning

Regardless of where a GNSS measurement is taken, the ITRF ensures that the calculated position is referenced to the same standard, allowing for accurate comparisons across different locations as well as providing a stable reference point for long-term observations.

Responsible Service:

Katherine, Northern Territory, Australia
Photo courtesy of Geoscience Australia

Despite its extensive use in surveying and geospatial applications,
geodesy is at risk ...

United Nations “Hidden Risk” Report

- New UN report shows **critical weaknesses in the supply chain** that all satellites, like GPS, need to operate every day.
- Satellite services are at **risk of degradation or failure due to the lack of resources** provided to the global geodesy supply chain.
- Report recommends what countries can do to avoid further degradation of the supply chain including:
  - **strengthening** national awareness and governance in geodesy;
  - **recognizing** the global geodesy supply chain as national critical infrastructure; and,
  - **engaging** in bilateral or multilateral agreements with other Member States.

Surveying and Geospatial Professionals – Geodesy Needs You!

How can you help?

Acknowledge use of IGS GNSS data and supporting GGOS techniques when publishing

Talk to your local political representatives about how openly available GNSS data and reference frames help your business/work

Encourage young professionals and students to study geodesy, as well as the inclusion of geodesy in surveying education

Learn more, collaborate, and connect with the international geodesy community:

https://ggos.org/

https://igs.org/

https://ids-doris.org/

https://ggim.un.org/UNGGCE/

https://vlbi.org/

https://www.fig.net/

https://ilrs.gsfc.nasa.gov/

https://www.iers.org/

https://www.unoosa.org/oosa/en/ourwork/icg/icg.html

THANK YOU

Yarragadee Geodetic Observatory
Global Geodetic Observing System (GGOS) Core Site
Photo courtesy of Geoscience Australia