Dr Aletha de Witt

Director: Radio Astronomy Projects
Department of Science, Technology
and Innovation (DSTI)

Towards a SAGWG and GGOS Africa: Building local and regional capacity

Making sure it's possible

science, technology & innovation
Department:
Science, Technology and Innovation
REPUBLIC OF SOUTH AFRICA

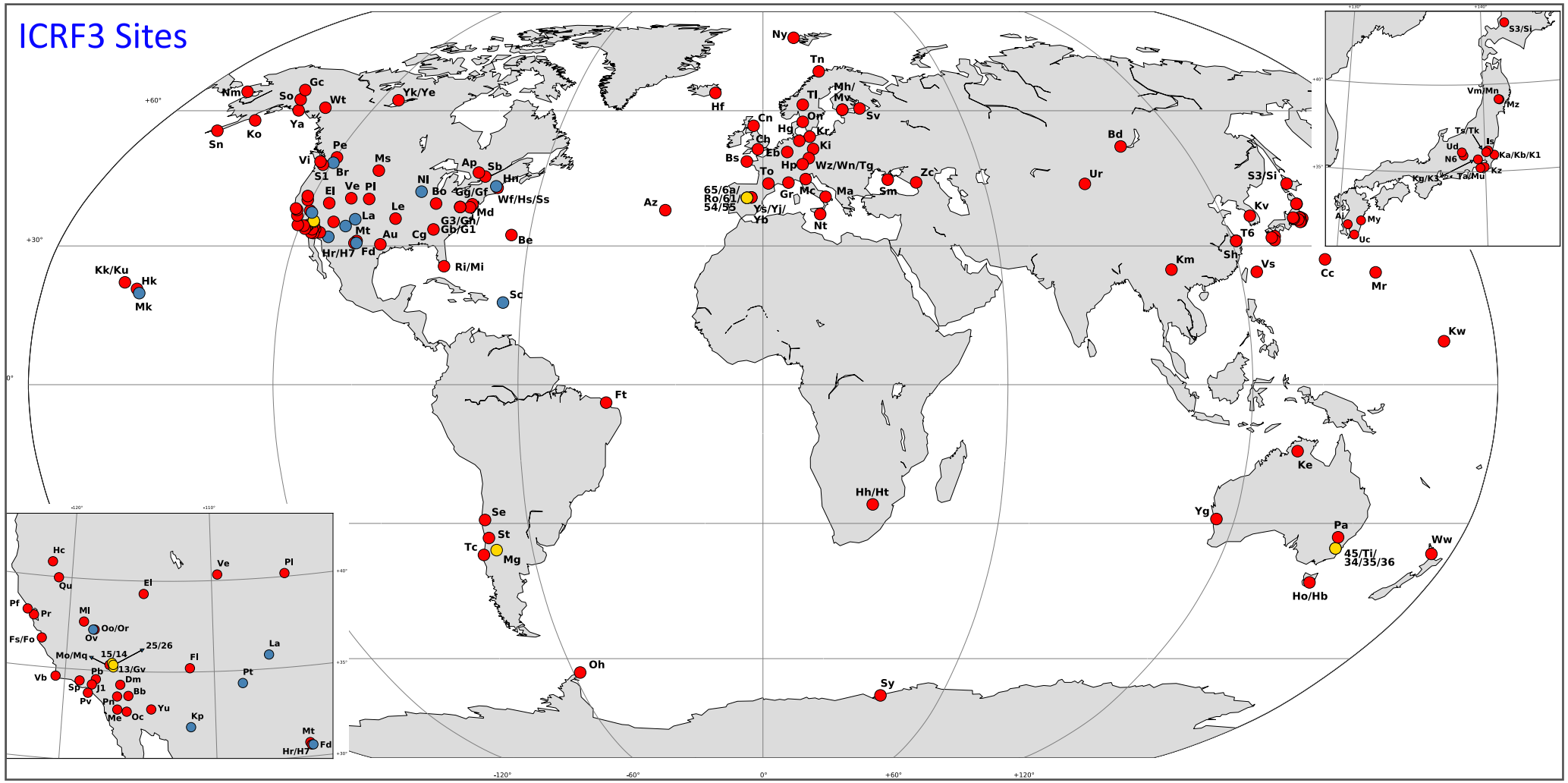
South African Geodesy Workshop

1-2 October 2025, SAAO, Cape Town

SAGWG
South African Geodesy
Working Group

2030 NDP

The Current Geodetic Landscape in Africa



The 167 antennas (situated on 126 different sites) that participated in the observations used for ICRF3

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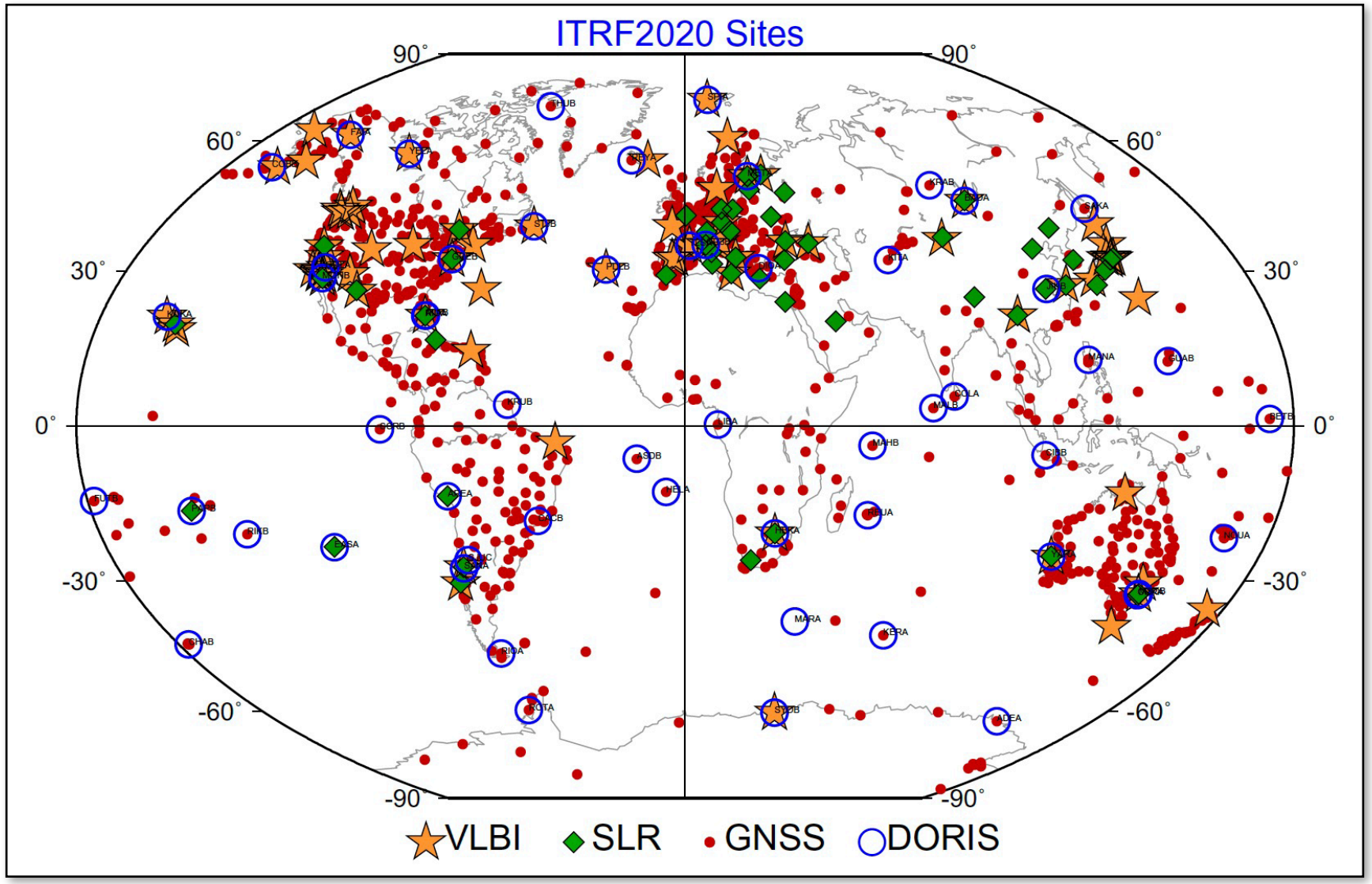

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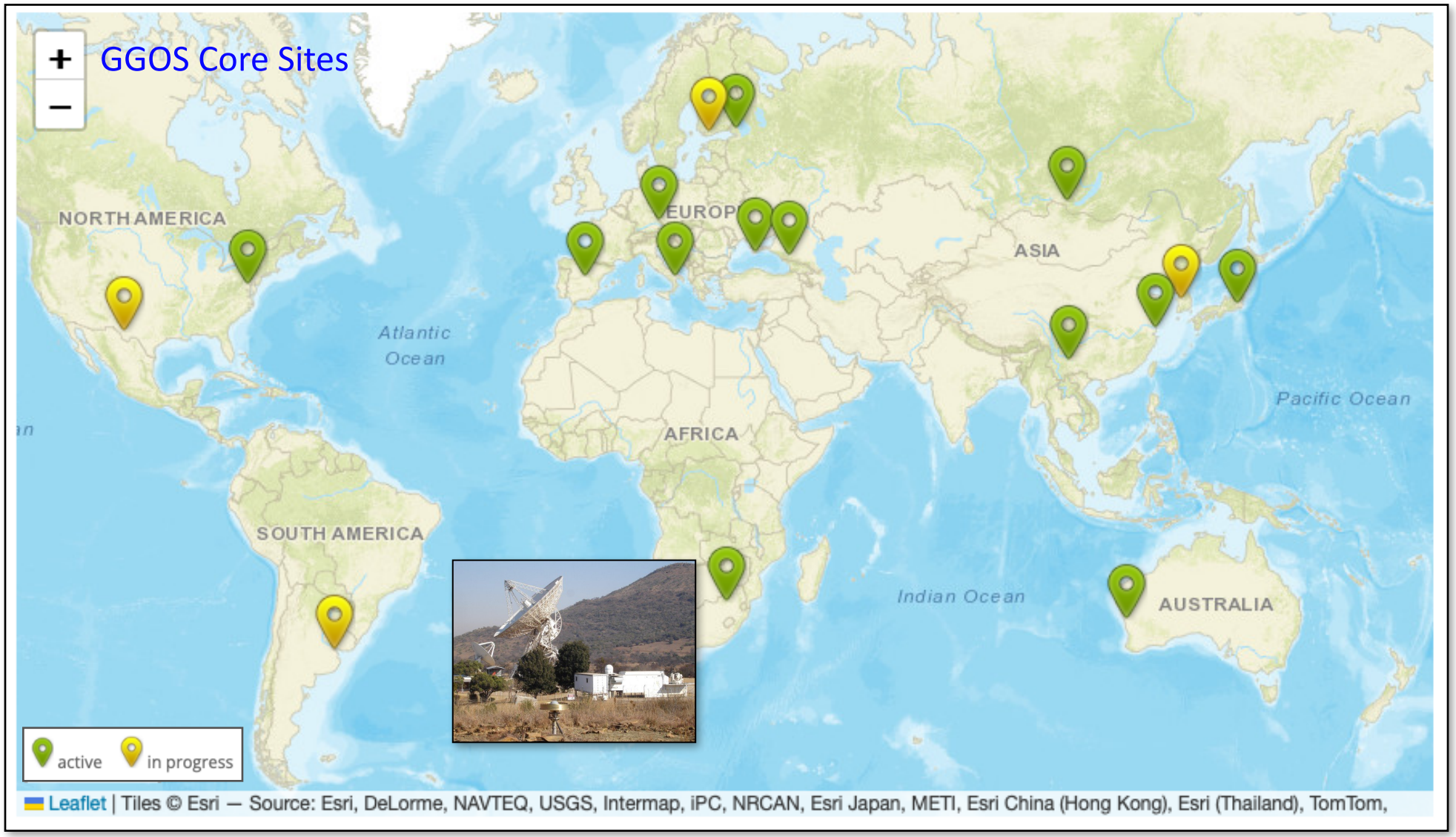

Africa: A Key to Global and Local Solutions

Limited Geodetic Infrastructure in Africa

The Global Geodesy Supply Chain Needs Africa

- **Geographic Coverage:** balancing global ground station distribution and improving accuracy
- **Unique Geophysical Data:** Africa's diverse landscape provides critical environmental and geophysical data
- **Improving Global Models:** Improving global satellite systems, Earth observations, and climate models

Africa's Own Need for Geodetic Data

- **Climate change, environmental monitoring, and disaster response**
- **Navigation, surveying, and mapping**
- **Infrastructure development**
- **Urban planning and sustainable development**
- **Economic growth**

Africa: A Key to Global and Local Solutions

Science Summit at UNGA79
10 - 27 September 2024

Africa Rising: Shaping Our Common Future Through Geodesy

Implementing the UN General Assembly Resolution A/RES/69/266
"Global Geodetic Reference Frame for Sustainable Development"

Friday, 27 September 2024 | 8:30 am – 3:00 pm ET (UTC-4) | on-site and online event
Location: CURE, 345 Park Avenue South, New York, NY 10010, United States

join us at
https://sciencesummitunga.com/science-summit-unga79/

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Department:
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REPUBLIC OF SOUTH AFRICA

United Nations
Global Geodetic
Centre of Excellence

GGOS
Global Geodetic
Observing System

Challenges in Geodesy in Africa

Limited Geodetic Infrastructure in Africa

Limited Geodetic Infrastructure

- Limited geodetic networks
- Infrastructure ownership
- Outdated equipment
- Inadequate monitoring stations

Limited Access to Data & Outdated Geodetic Systems

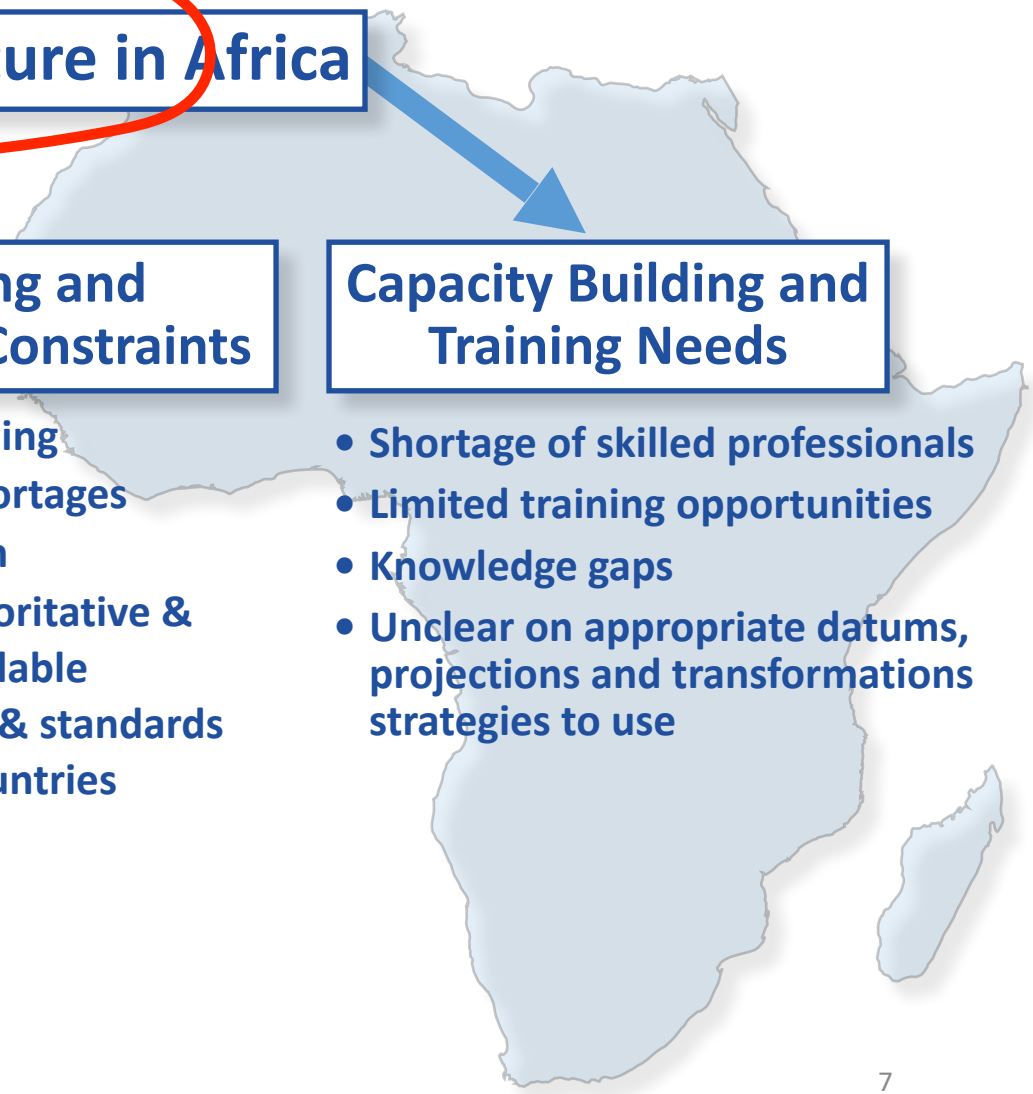
- Data availability, quality, management
- Outdated surveys
- No records of legacy systems
- Multitude of different non-geocentric datums, ellipsoids & different projections and levelling datums

Funding and Resource Constraints

- Limited funding
- Resource shortages
- Prioritisation
- Lack of authoritative & publicly available information & standards for many countries

Capacity Building and Training Needs

- Shortage of skilled professionals
- Limited training opportunities
- Knowledge gaps
- Unclear on appropriate datums, projections and transformations strategies to use



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Collaboration, Partnerships, Knowledge Sharing, Awareness

Progress to Date: GGOS Africa

Identification of Need:

Recognition of the need for a Pan-African Institute or Organisation for Geodesy

- **GGOS Implementation Plan 2024:**

  Diagnose current situation and explore possibilities for implementation (2024).

  Establishment of GGOS Africa Affiliate (2025)

- **Key Events to Promote the Establishment of GGOS Africa:**

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- **Starting with South Africa:**

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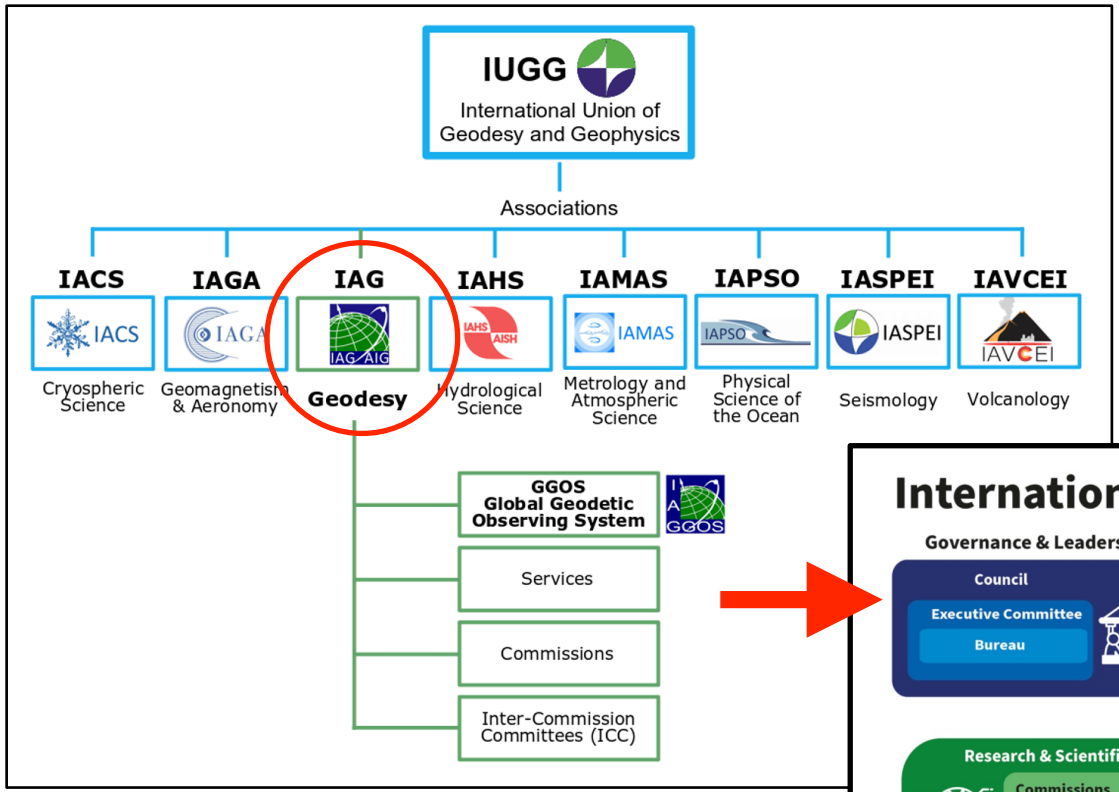
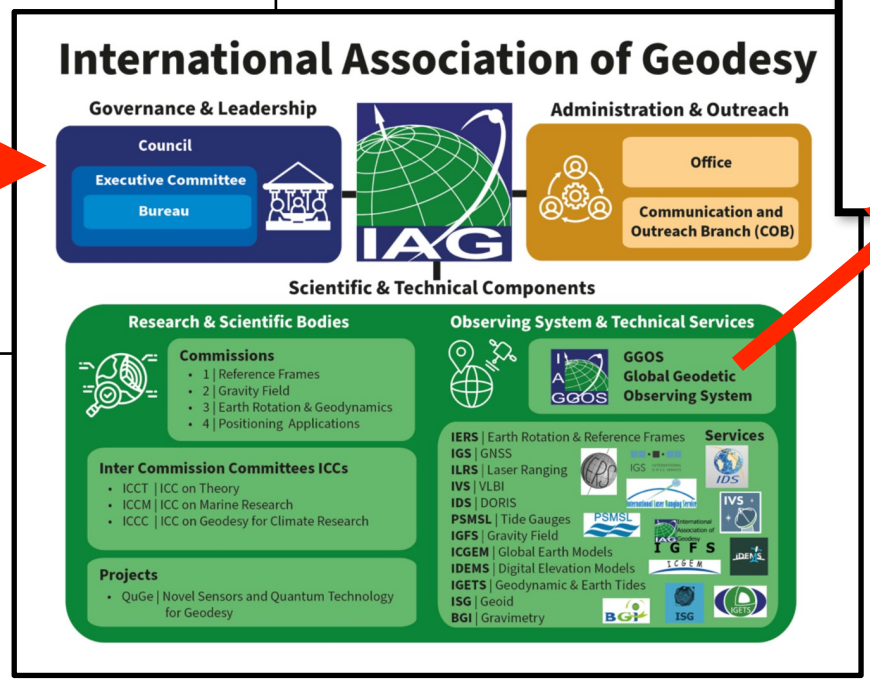
A GGOS Affiliate





A GGOS Affiliate is a national or regional organization that coordinates geodetic activities in that country or region. GGOS Affiliates provide a forum for multi-technique, space geodetic discussions, work to improve the quality of space geodetic observations, and encourage cooperation among the various agencies in that country or region that own, operate, and maintain the space geodetic infrastructure there. To become a GGOS Affiliate, interested organizations submit an application to GGOS, which is approved by the GGOS Governing Board by vote.

GGOS Affiliates are:

- GGOS Japan
- GGOS D-A-CH
- GGOS IberAtlantic

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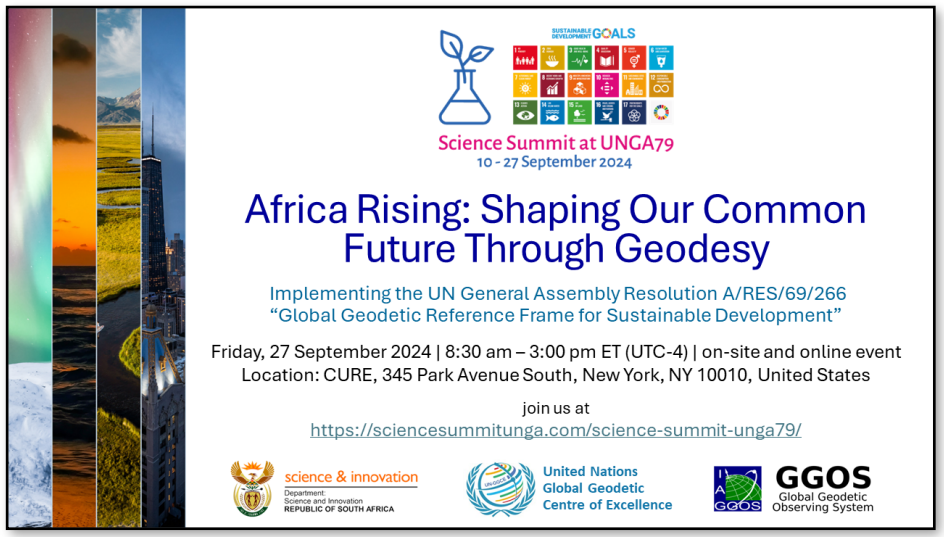
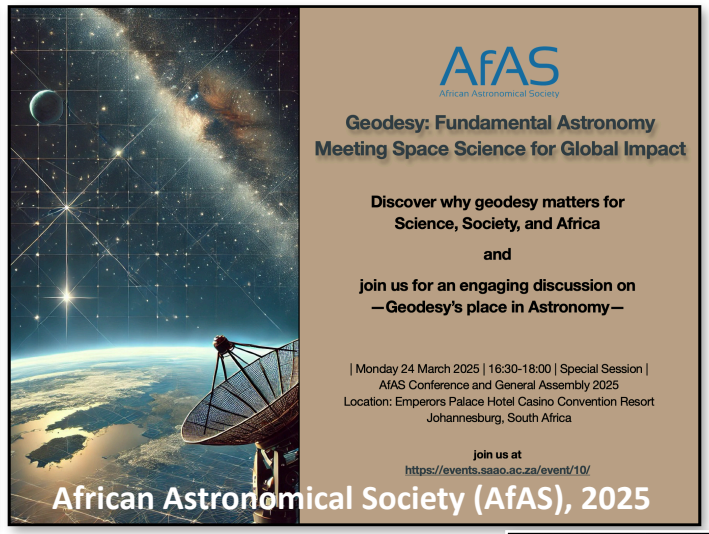
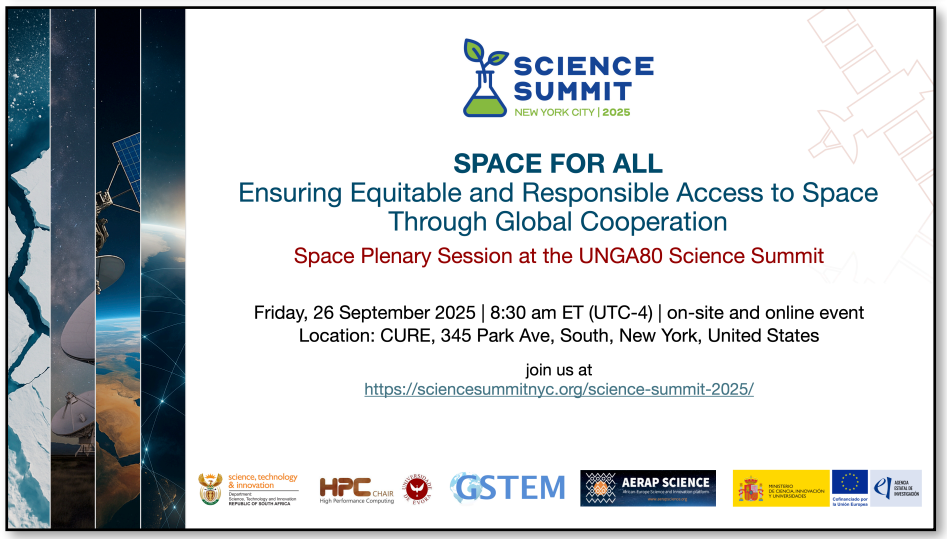
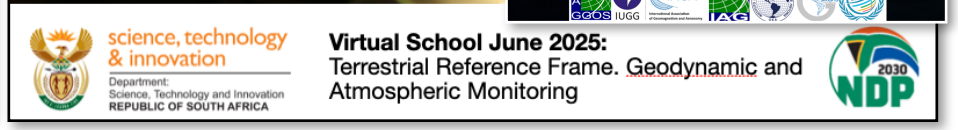




African Astronomical Society (AfAS), 2025

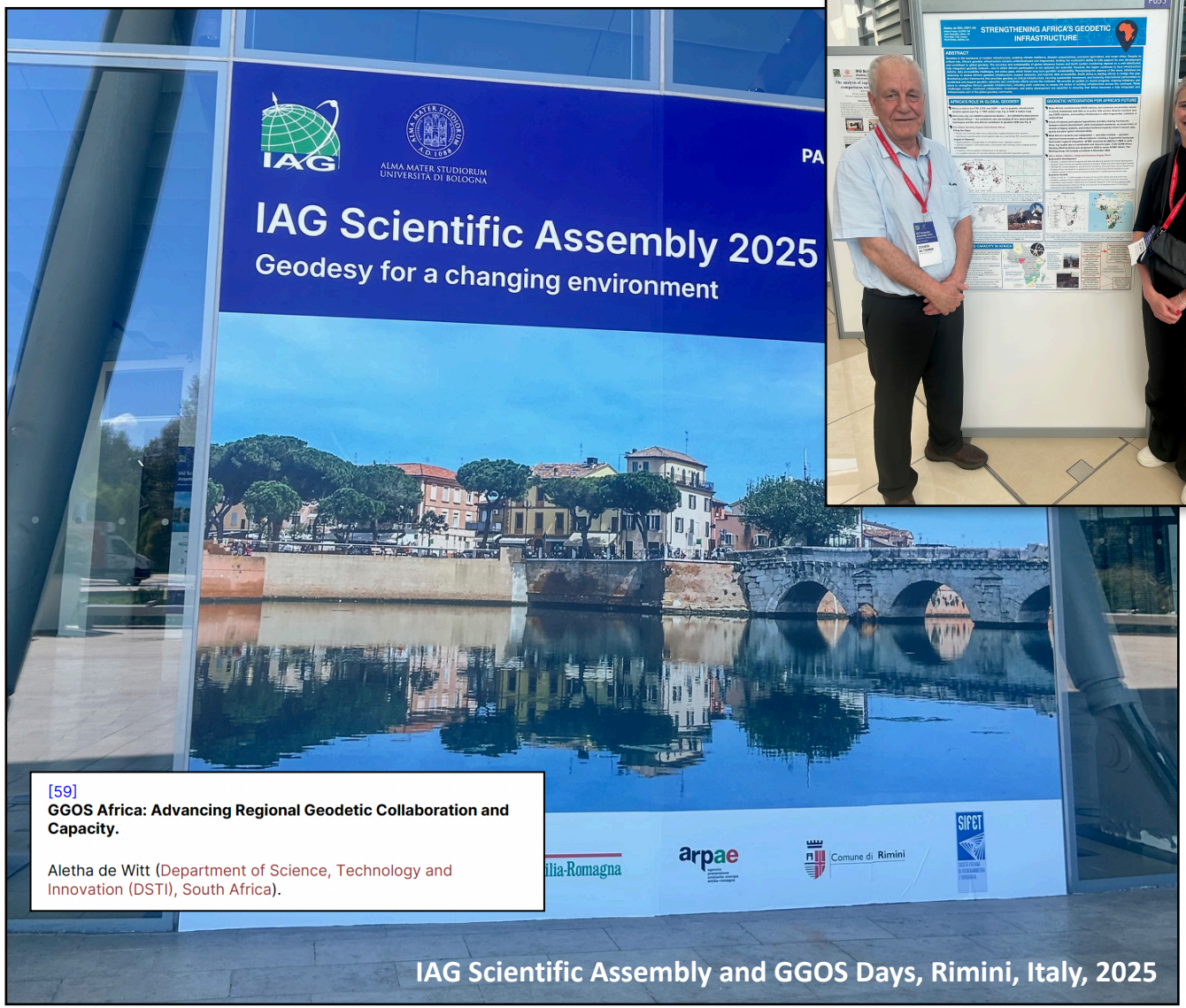


Geodesy at the UN Science Summit, New York, 2024/25



SIRGAS 2025 Virtual School

Promoting GGOS Africa



[59]
GGOS Africa: Advancing Regional Geodetic Collaboration and Capacity.

Aletha de Witt (Department of Science, Technology and Innovation (DSTI), South Africa).

IAG Scientific Assembly and GGOS Days, Rimini, Italy, 2025

Aletha de Witt, DSTI, SA
Aslam Parker, DLRRD, SA
Jack Radcliffe, UMan, UK
Paul Baki, TUK, Kenya
Roelf Botha, SARAO, SA

STRENGTHENING AFRICA'S GEODETIC INFRASTRUCTURE

ABSTRACT

Geodesy is the backbone of modern infrastructure, enabling climate resilience, disaster preparedness, precision agriculture, and smart cities. Despite its critical role, Africa's geodetic infrastructure remains underdeveloped and fragmented, limiting the continent's ability to fully support its own development and contribute to global geodesy. The accuracy and sustainability of global reference frames and Earth system monitoring depend on a well-distributed, fully integrated geodetic network—one in which Africa's participation is not optional, but essential. However, the region continues to face infrastructure deficits, data accessibility challenges, and policy gaps, which hinder long-term geodetic sustainability. Recognising the urgency of this issue, initiatives are underway to assess Africa's geodetic infrastructure, expand networks, and improve data accessibility. South Africa is leading efforts to bridge this gap, developing policy frameworks that prioritise geodesy as critical infrastructure, securing sustainable investment, and fostering international partnerships to modernise and expand geodetic networks and coordinate efforts across the continent. We provide an update on recent progress, ongoing initiatives, and plans to strengthen Africa's geodetic infrastructure, including work underway to assess the status of existing infrastructure across the continent. While challenges remain, continued collaboration, investment, and policy development are essential to ensuring that Africa becomes a fully integrated and indispensable part of the global geodesy community.

AFRICA'S ROLE IN GLOBAL GEODESY

- Africa is vital to the ITRF, ICRF, and GGRF — but its geodetic infrastructure remains sparse (see Fig. 1: ITRF station map, Fig. 2: ICRF-3 station map)
- Africa has only one GGOS Fundamental Station — the SARAO/Hartebeesthoek site (South Africa) — the continent's sole site hosting all four space geodetic techniques and the only African contributor to geodetic VLBI (see Fig. 3)
- **The Global Geodesy Supply Chain Needs Africa:**

Filling the Gaps:
→ Africa's vast landmass helps reduce spatial bias in global reference frame solutions
→ Contributes essential tectonic & atmospheric data (e.g., East African Rift, equatorial ionosphere)

Impact of Absence:
→ Sparse geodetic coverage leads to unmodelled errors in geodetic products
→ Satellite navigation, Earth observations, and disaster early-warning systems degrade globally

Conclusion:
→ Investing in African geodetic infrastructure is not optional...
→ It's a global imperative for accurate reference frames and Earth observation systems

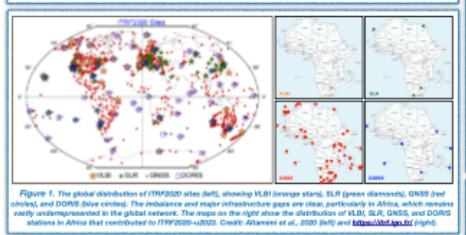


Figure 1. The global distribution of ITRF2020 sites (left), showing VLBI (orange stars), SLR (green diamonds), GNSS (red circles), and DORIS (blue circles). The imbalance and major infrastructure gaps are clear, particularly in Africa, which remains vastly underrepresented in the global network. The maps on the right show the distribution of VLBI, SLR, GNSS, and DORIS stations in Africa that contributed to ITRF2020.+v2023. Credit: Altamimi et al., 2020 (left) and https://doi.ggos.fz (right).

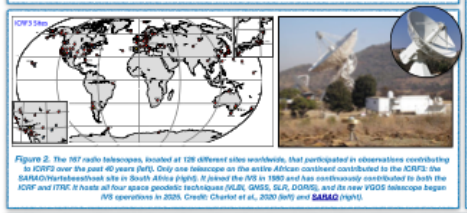


Figure 2. The 167 radio telescopes, located at 128 different sites worldwide, that participated in observations contributing to ICRF3 over the past 40 years (left). Only one telescope on the entire African continent contributed to the ICRF3: the SARAO/Hartebeesthoek site in South Africa (right). It joined the IVS in 1980 and has continuously contributed to both the ICRF and ITRF. It hosts all four space geodetic techniques (VLBI, GNSS, SLR, DORIS), and its new VGOS telescope began IVS operations in 2020. Credit: Charlot et al., 2020 (left) and SARAO (right).

GEODETIC INTEGRATION FOR AFRICA'S FUTURE

- Many African countries have GNSS stations, but numerous are privately owned or poorly maintained, with little or no public data access. Several countries lack any CORS stations, and existing infrastructure is often fragmented, outdated, or underutilised
- A lack of national and regional repositories and data-sharing frameworks hampers national development, while inconsistent standards, no preservation of records of legacy systems, and limited technical capacity result in uneven data quality and poor system interoperability
- Most African countries use independent — and often multiple — geodetic reference frames based on different datums, creating a fragmented landscape that hinders regional integration. AFREF, launched by UNECA in 2000 to unify these, has stalled due to coordination and resource gaps. A UN-GGIM-Africa Geodesy Working Group was proposed in 2024 to revive AFREF efforts. The Working Group will formally constitute in November 2025.
- **Africa Needs a Modern, Integrated Geodesy Supply Chain:**

Sustainable Development:
→ Geodesy underpins national mapping and land-use planning essential for African development
→ Supports early warning and reposes systems for drought, floods and other regional geo hazards
→ Strengthens climate adaptation, environmental monitoring, and sustainable natural resource use
→ Enables African-led research on geodynamics and climate across diverse ecological zones
→ Supports resilient infrastructure and spatial development in rapidly growing African cities

Economic Growth:
→ Africa is home to ~1.5 billion people with some of the world's fastest-growing economies
→ Geodetic underpins Africa's digital transformation and 4IR innovation across the continent
→ Essential for cross-border infrastructure and regional integration under the AU's Agenda 2063
→ Harmonised geospatial reference frames are essential for full implementation of the African Continental Free Trade Area (AfCFTA)

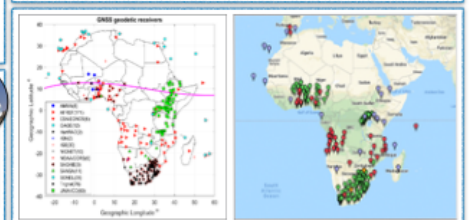


Figure 3. Distribution of known GNSS geodetic and reference receivers in and around Africa (left). Some receivers/networks are privately owned and data is not freely available. NOAA/CORS and NRGNET were shut down 2017 and 2020. GNSS data from "AFREF" CORS (right) is archived at the AFREF Operational Data Centre (AODC), http://www.afrefdata.org, hosted by the National Geospatial Information (NGI), South Africa. Credit: Baki et al., 2023 (left) and NGI (right).

GROWING CAPACITY IN AFRICA

Ongoing infrastructure and human capacity building for astronomy in the SKA African partner countries:

- Ghana 32-m radio telescope conversion (GRAO)
- Planned SKA-Mid telescope for Botswana (BIUST/MPIfR/SARAO)
- These new and planned radio telescopes provide the potential for an African VLBI Network (SARAO/AIRAP)
- Co-location of geodesy infrastructure
- Deployment of high performance compute infrastructure and training (e.g. NICIS/CHPC)
- Big Data Africa School (BDAS) in SKA partner and other African countries
- Deployment of training instruments for astronomy and geodesy (e.g. the Transient Array Telescope—TART)
- Astronomy and geodesy undergraduate training workshops and post-graduate funding (e.g. DARA)

Policy frameworks and seed funding are in place to launch **GGOS Africa** — enabling coordination, and strategic expansion of geodetic capacity across the continent

At 10th meeting of UN-GGIM-Africa, it was resolved to reinstate a Regional Committee in Geodesy to co-ordinate the implementation of the **AFREF project** at the continental level and to undertake an inventory of already established CORS in every country

UN-GGCE Capacity Development Workshop for Africa, May 2025, Nairobi, Kenya. In the process of compiling Geodesy Fact-books for each country

Africa-UK Geodesy partnership: UKRI/STFC seed funding secured to launch GGOS Africa and to assess geodetic infrastructure, compute platforms, and human capacity across Africa, to enable coordinated gap analysis, regional planning, and network expansion

GEODESY COORDINATION & CAPACITY BUILDING

Towards a **structured repository** of geodetic infrastructure, technical capacity, and geodetic reference systems across Africa

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Geodesy Workshop to bring together all Geodesy stakeholders in SA

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land reform & rural development
Department: Land Reform and Rural Development
REPUBLIC OF SOUTH AFRICA

SANSA
SOUTH AFRICAN NATIONAL SPACE AGENCY

NRF National Research Foundation | SARAO South African Radio Astronomy Observatory

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

University of Cape Town

SAGWG
South African Geodesy Working Group

- Govt. Departments, National Facilities, Universities, Industry
- ToR, Roadmap, Implementation of UN-GGCE 1st Joint Development Plan
- Eight Pillars or Subcommittees

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Inform Policy Frameworks —> National Strategy for Geodesy

1. Governance, Partnerships & Reporting
2. Advocacy & Comms
3. Infrastructure & Operations
4. Spectrum Protection
5. Data, Standards & Open Access
6. Reference Systems & Regional Frames
7. HCD and Outreach
8. R&D & Next-Gen Supply Chain

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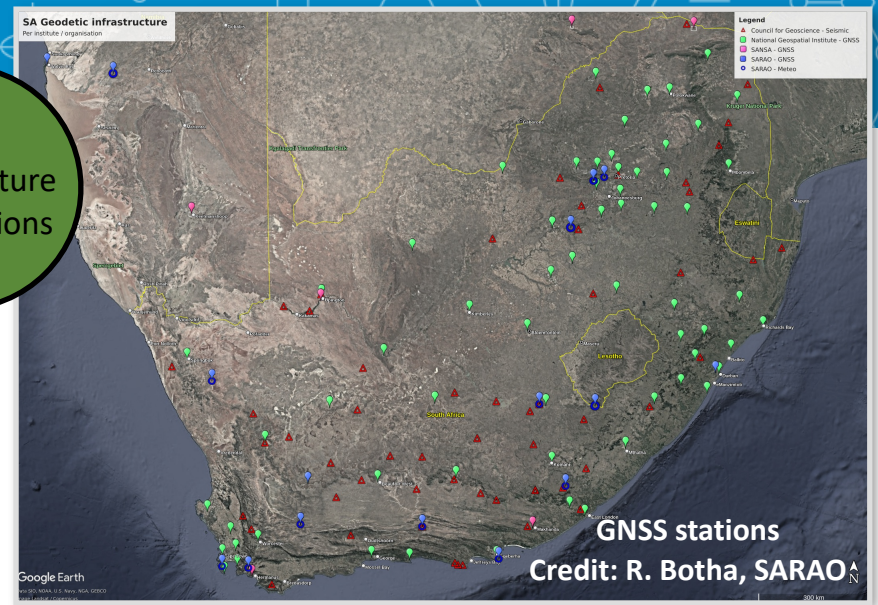
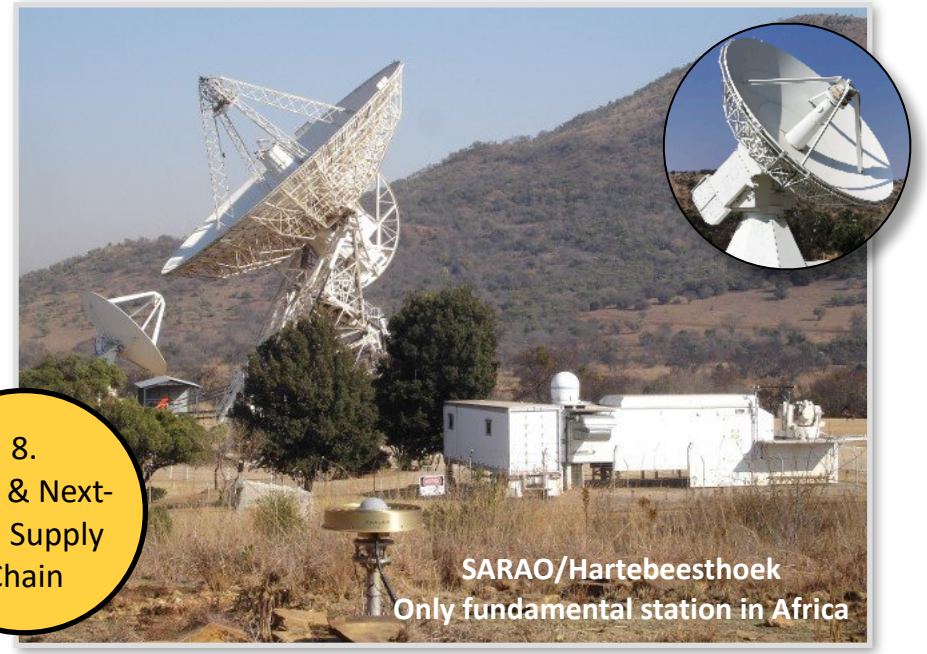
South African Geodesy Working Group

3. Infrastructure & Operations



GNSS stations
Credit: R. Botha, SARAO


SARAO/Hartebeesthoek
Only fundamental station in Africa

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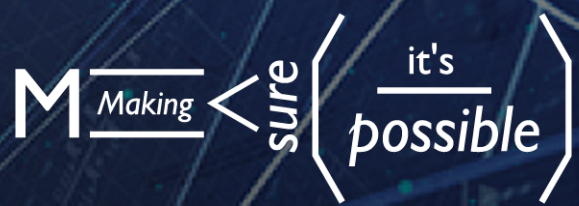
Dankie
Enkosi
Ha khensa
Re a leboga
Ro livhuwa
Siyabonga
Siyathokoza
Thank you



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1-2 October 2025, SAAO, Cape Town

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