SPACE GEODESY AT HartRAO

WHY SPACE GEODESY?

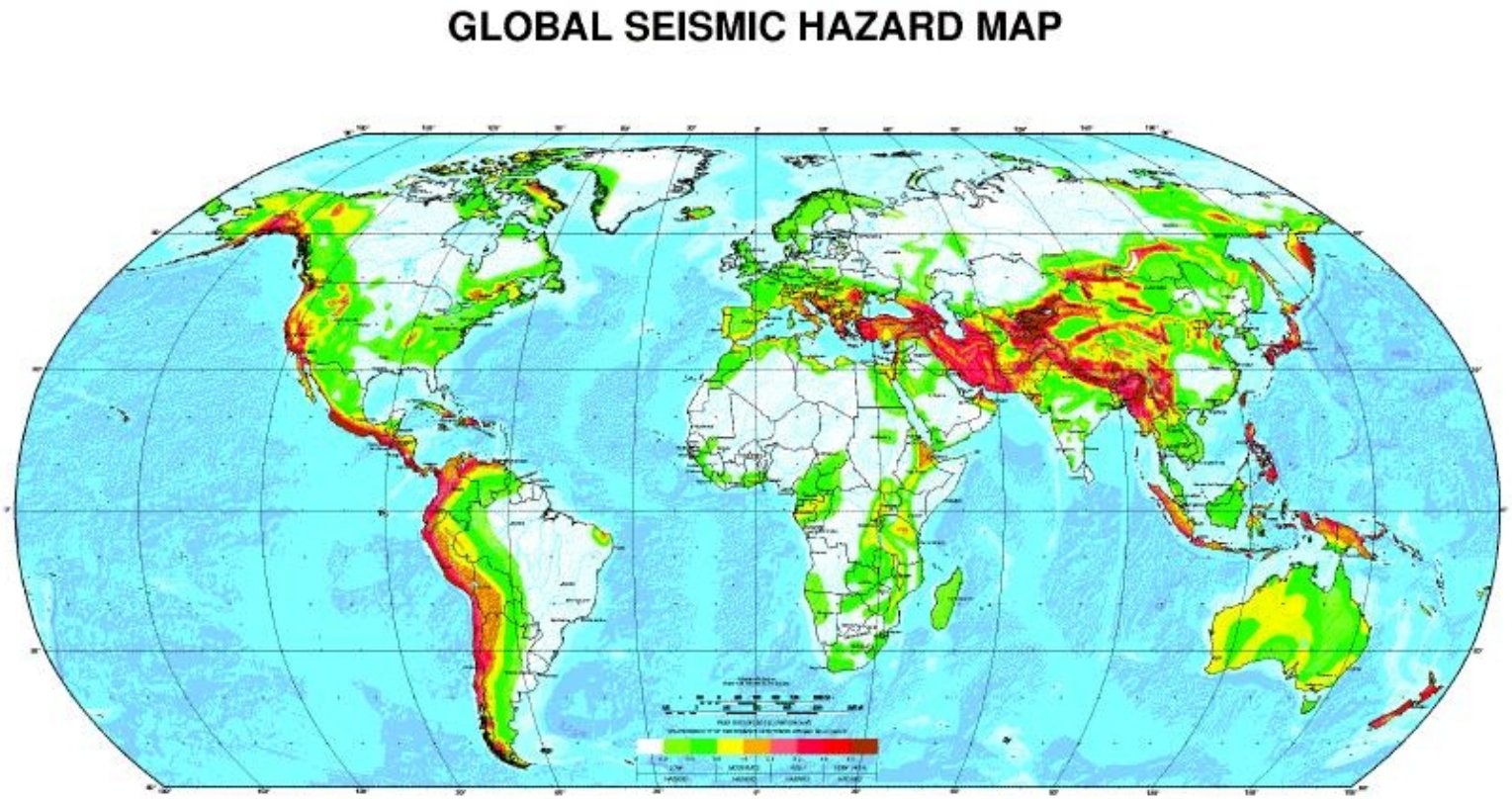
5th ASSA Symposium

November 2002

Space Geodesy Programme
Ludwig Combrinck
Hartebeesthoek Radio Astronomy Observatory
National Research Foundation
South Africa
http://www.hartrao.ac.za

Outline of Presentation

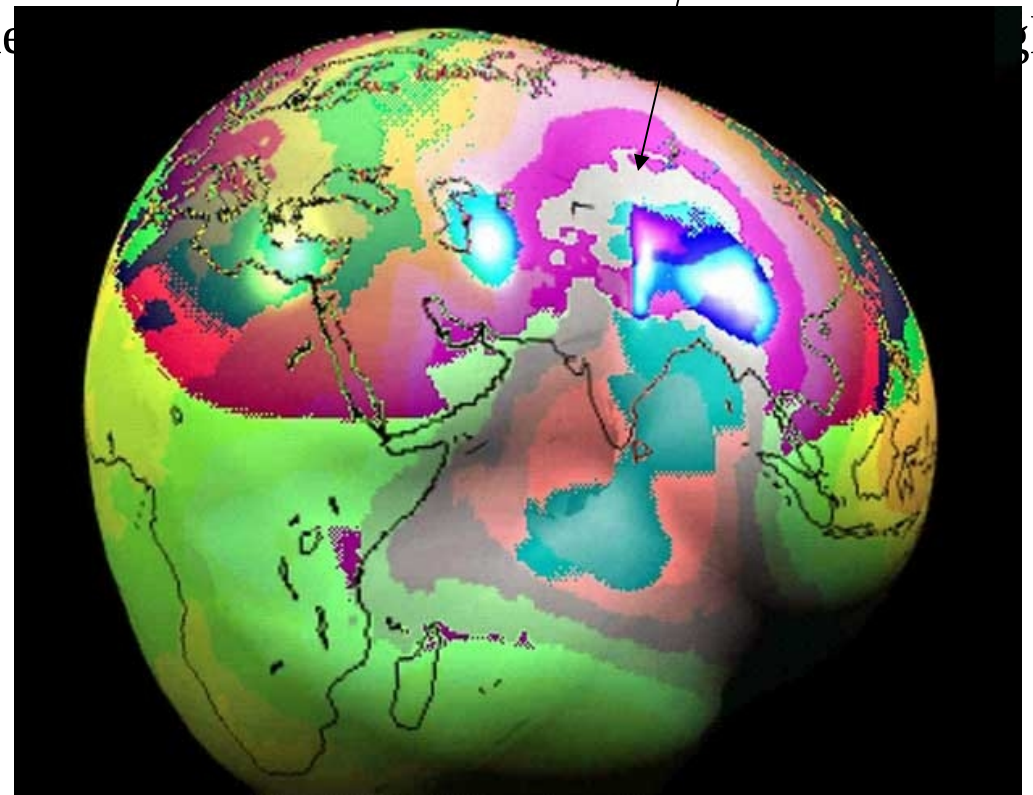
- **What is Space Geodesy?**
- **Multi-disciplinary applications**
- **Three major space geodetic techniques**



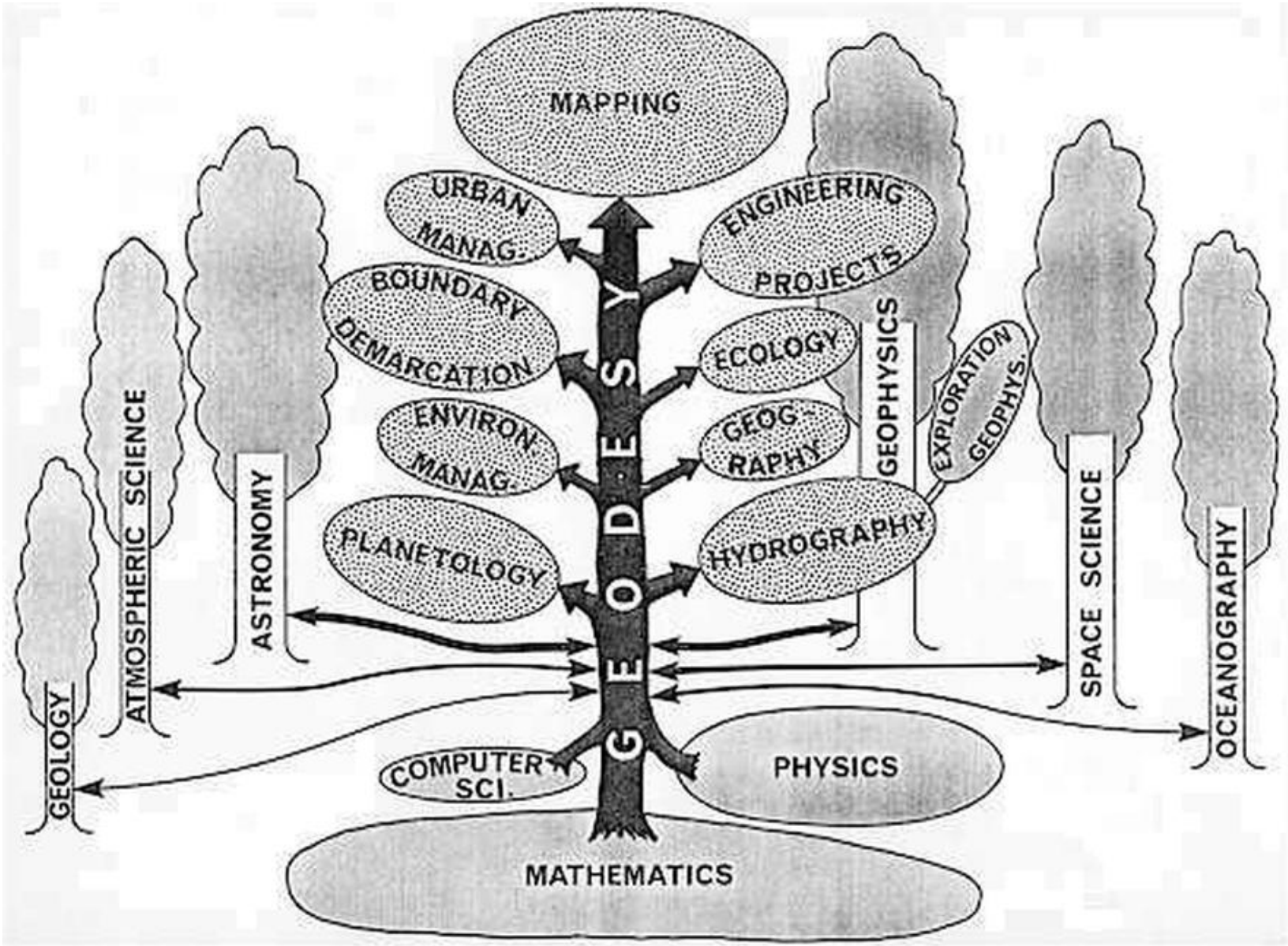
What is Space Geodesy?

Well, you all know what *space* is…….

- *Geodesy* is a branch of applied mathematics
- Uses the principles of mathematics, astronomy and physics
- Applies them within the capabilities of engineering and technology
- To determine exact positions of points, globally, the shape and size of the earth
- It studies the variations of terrestrial gravity
- Space Geode… …global warming etc.



Space Geodesy: Multi-disciplinary tool



Applications of Space Geodesy

So, Space Geodesy is multi-disciplinary…

- earth rotation parameters
- coordinates and velocities of stations
- geocenter coordinates
- parameters of the Earth's gravity field
- high accuracy satellite ephemerides
- determination of fundamental physical constants

These products support scientific objectives including:

- maintenance and realisation of ITRF
- monitoring 3D deformations of the solid earth
- monitoring earth rotation and polar motion
- supports monitoring of mean sea level, wave heights, ice sheet thickness etc.
- scientific satellite orbit determinations
- climatological research
- precise timing

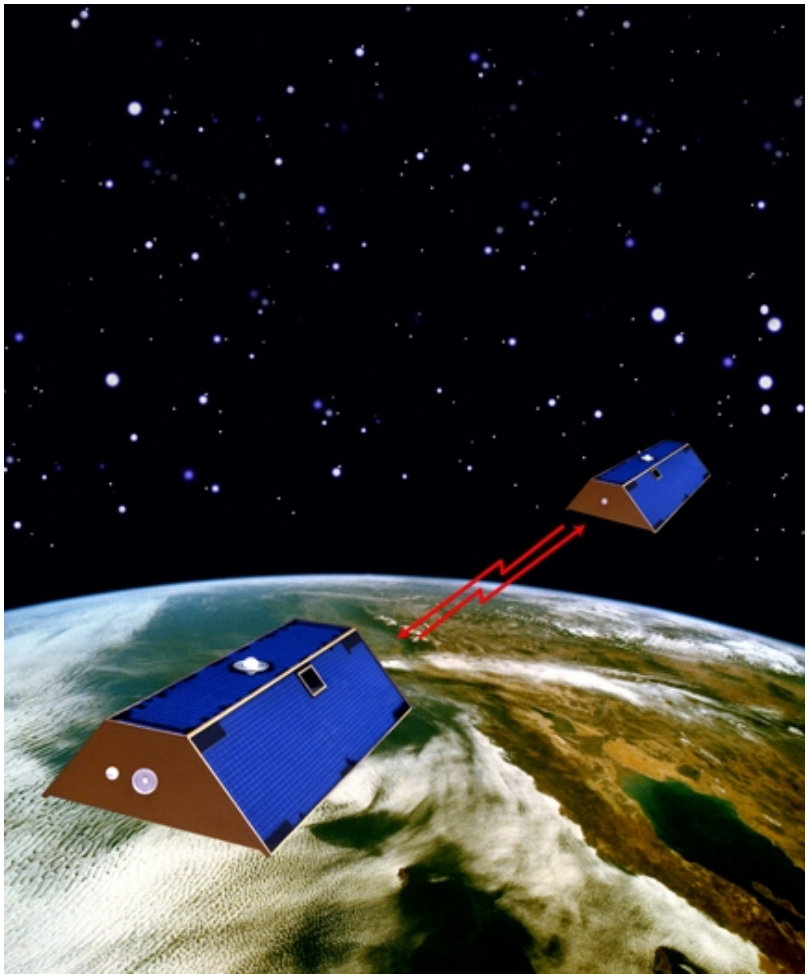
Techniques of Space Geodesy

Well, now you all know what *space geodesy* is…….

- Very Long Baseline Interferometry (VLBI)
- Satellite Laser Ranging (SLR)
- Global Positioning System (GPS)

SLR calibrates GRACE orbit

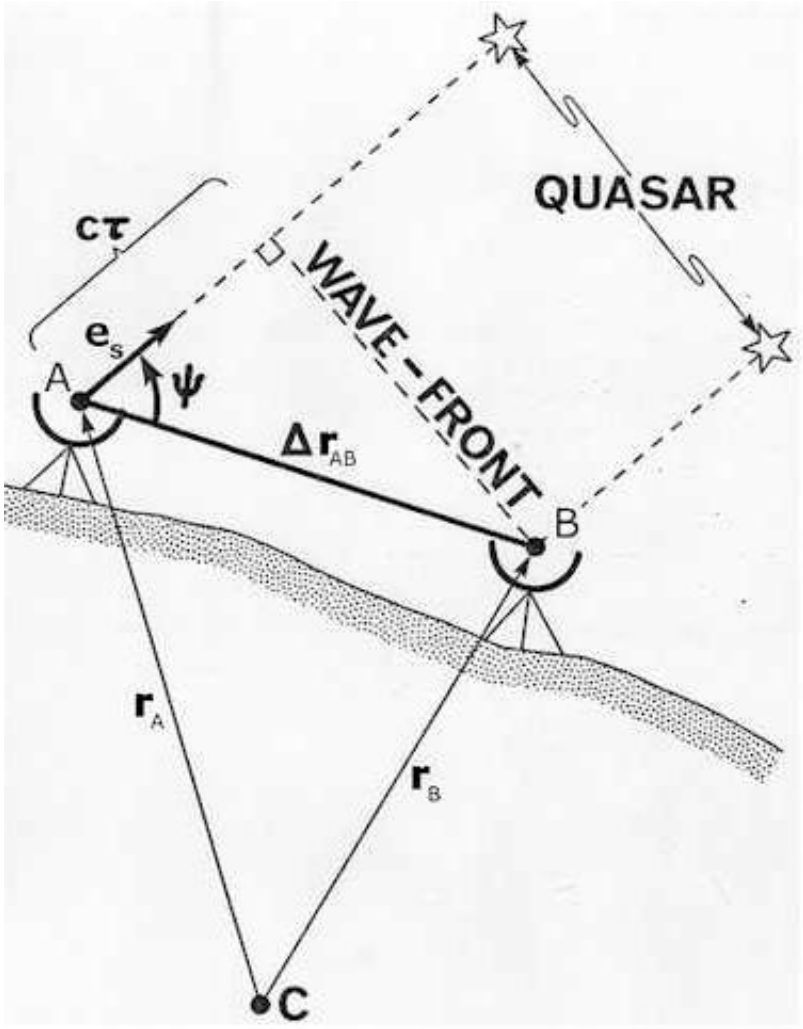
GPS data at Sutherland used to measure long wavelength gravity, applied to GRACE orbital modeling



26 m VLBI Antenna

Geodetic VLBI: Basic Technique

- Time delay t can be measured very accurately (MASER clock)
- Need 3 equations, 3 different quasars, to find baseline vector



$$t = c^{-1} e_s D r_{AB}$$

Space Geodesy and Astronomy

- Geodetic VLBI maintains the International Celestial Reference Frame
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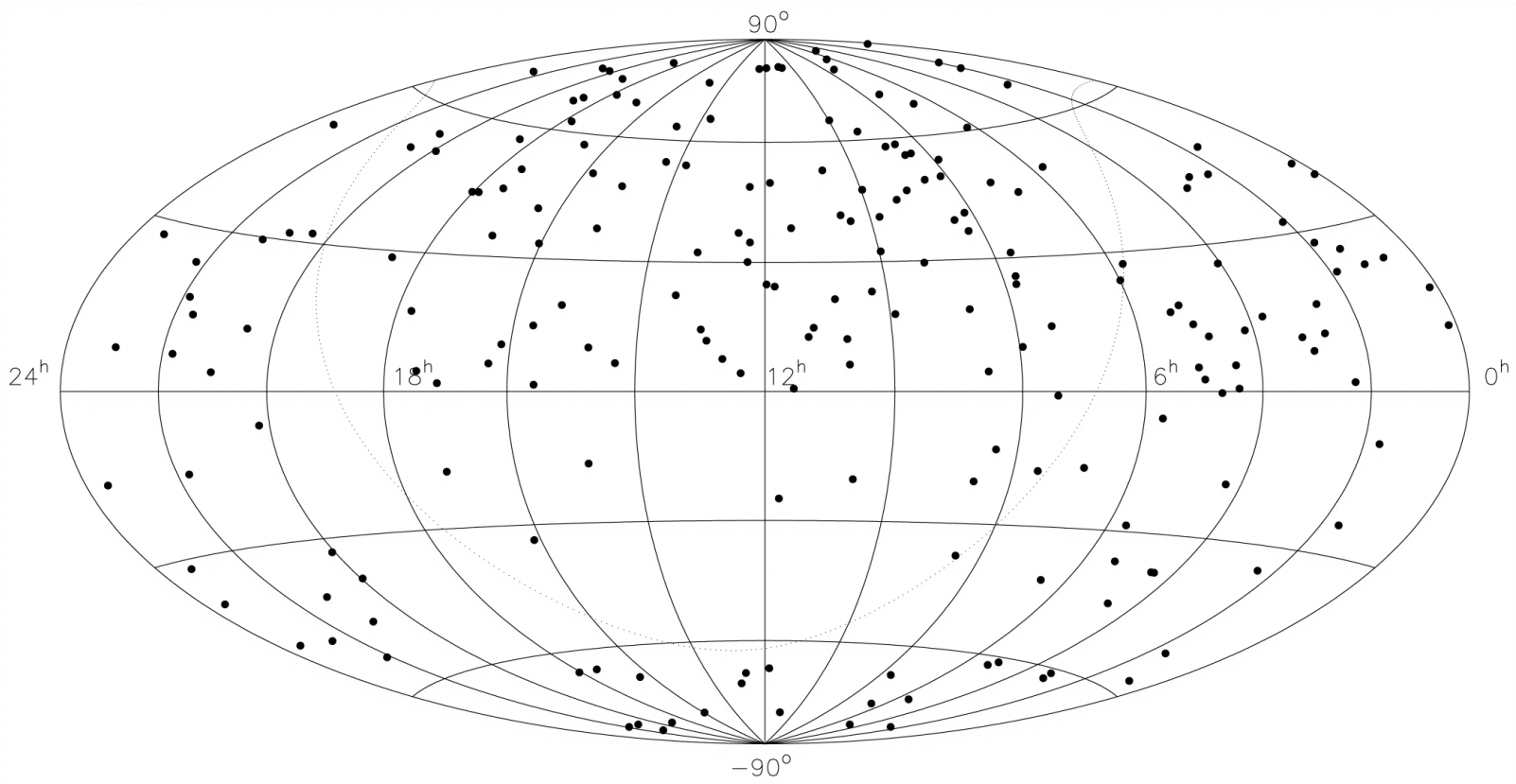
- Adopted by the IAU as the fundamental CRF
- Replaces FK5 optical frame as of 1 January 1998




MOBLAS6

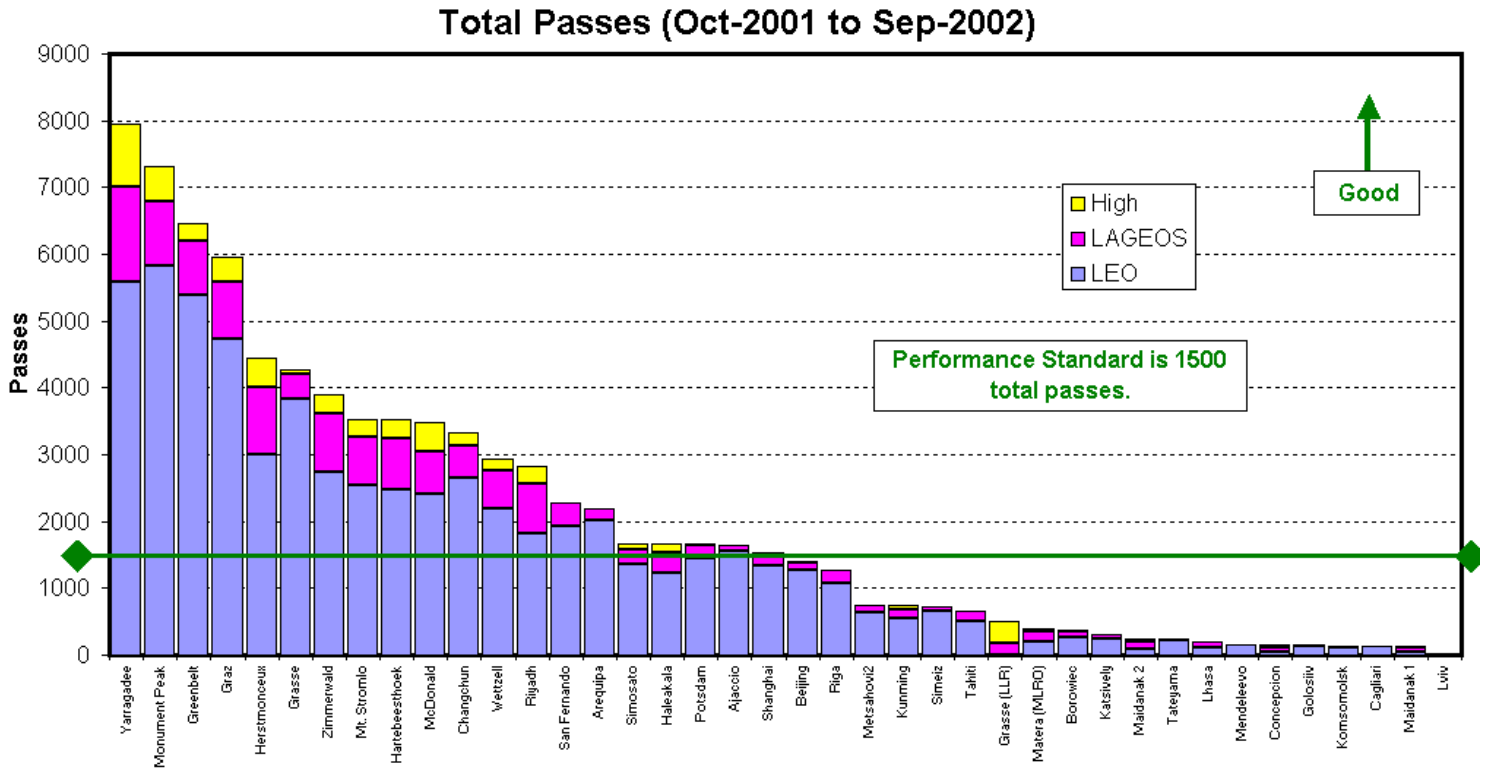

DANGER

Satellite Laser Ranging: Basic Technique

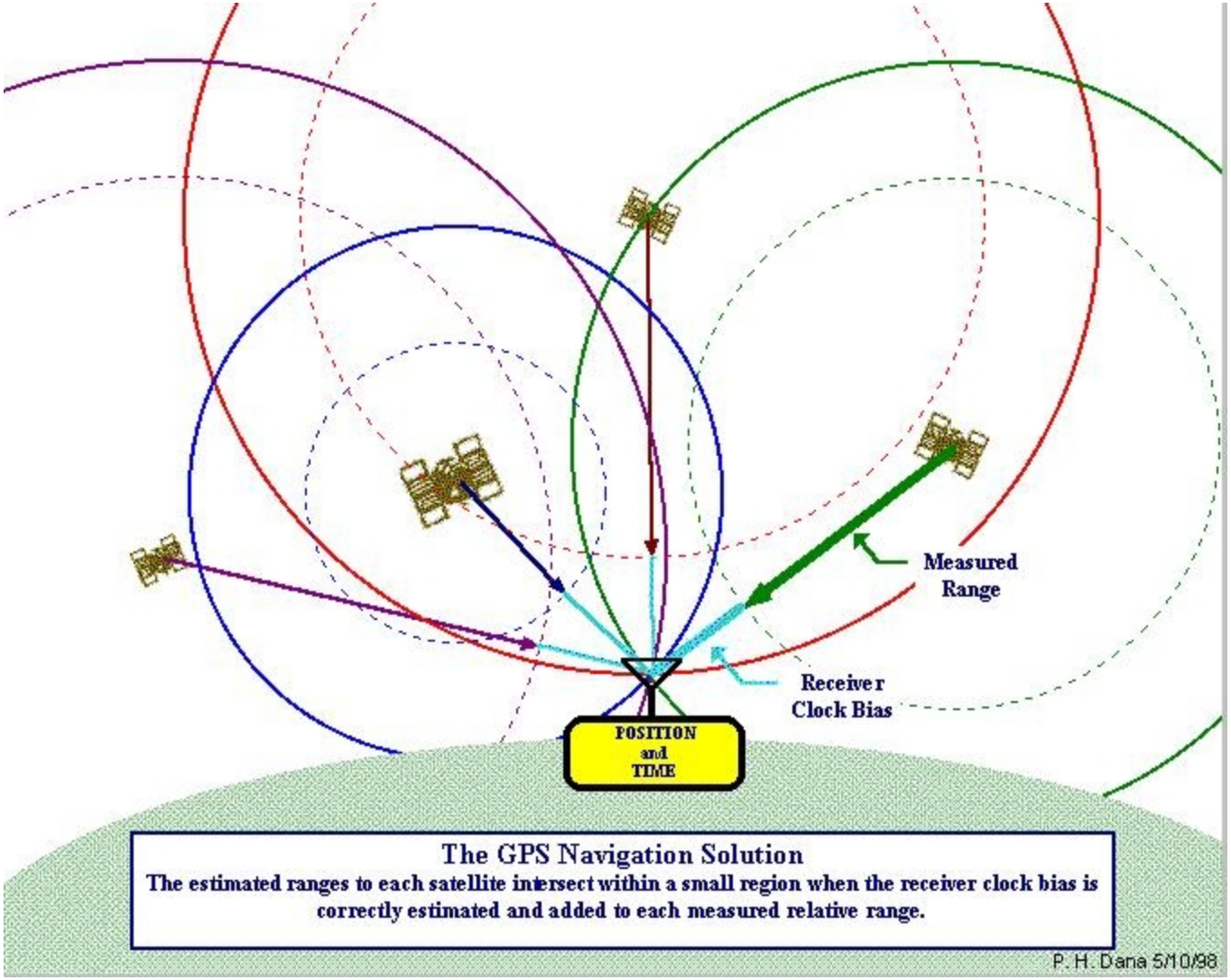
- Ground based station transmits short (pico-second) laser pulse
- The laser pulse is reflected off a retroreflector
- The round trip time of flight is precisely measured
- Corrected for atmospheric delay
- Then a geometric range is calculated

Current status: MOBLAS6 SLR

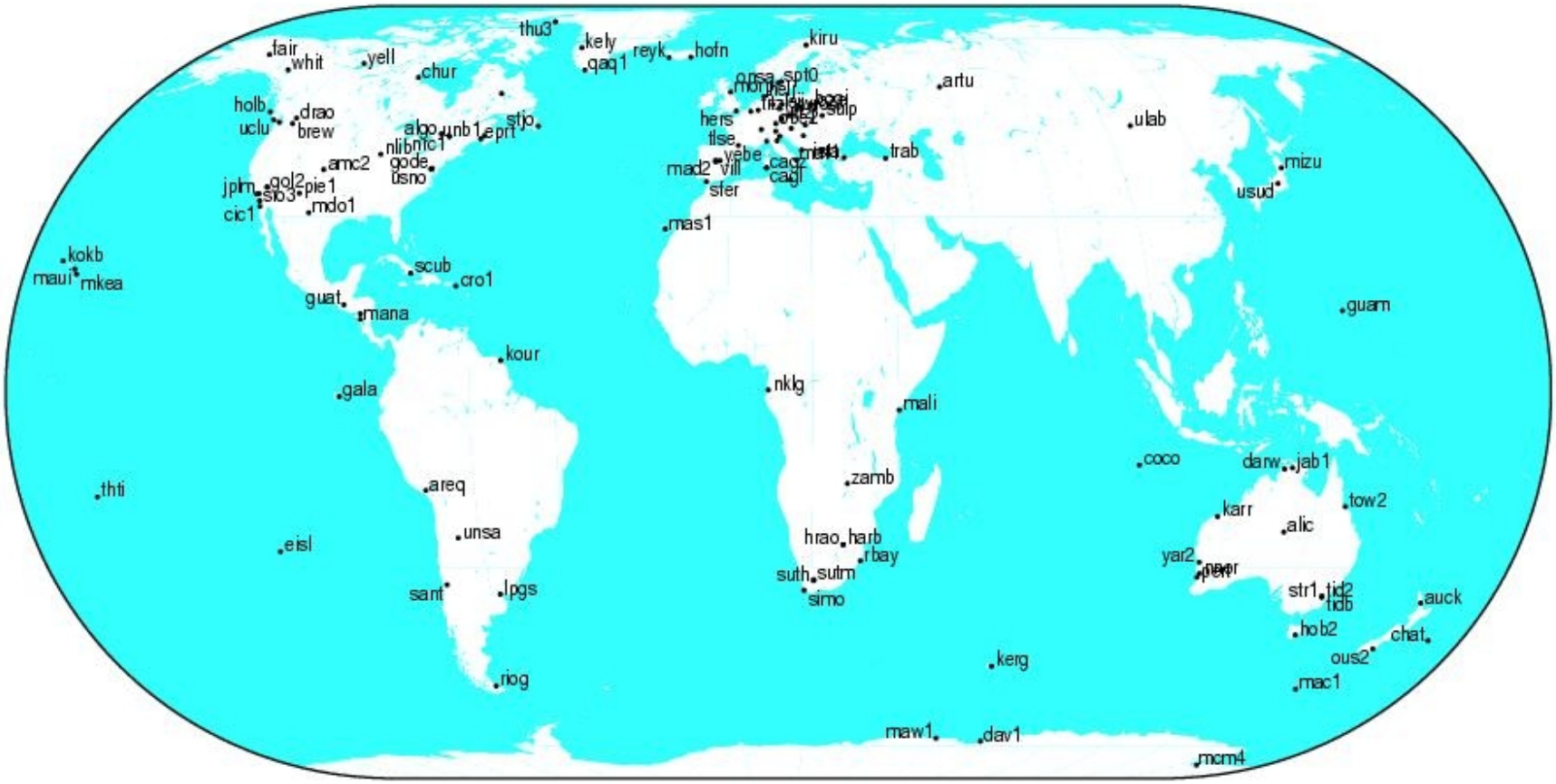
- MOBLAS6 inauguration 20 November 2000
- Achieved mission status 19th June 2001
- Superior performance level July 2002 (> 200 passes/week)
- Operate 16 hours/day, 7 days/week (114 hours)
- Using GFZ IRVs and time bias functions for GRACE, CHAMP



GPS: Basic Technique



IGS Hourly Stations



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Some stations are not labelled in crowded areas

Current status: GPS

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- IGS Data centre for Africa
- TIGA Data centre
- TIGA Associate Analysis Centre
- SADC IGS Network, part of AFREF
- Five new stations in progress


TIGA station RBAY

SADC GPS Network

HartRAO's impact in Africa

- **Densification of the ITRF, contribute to AFREF**
- **Install at least one IGS GPS station in each SADC country**
- **Facilitate *capacity building* through collaboration**
- **Establish a Geodetic Institute at HartRAO**
- **GI can offer studentships, training, directed effort towards capacity building**

Building with capacity, Vehicle Assembly Building (VAB)
Kennedy Space Centre, Florida

160 metres tall, covers 3,25 Hectares
To paint the flag and emblem took 6000 gallons of paint

Projects and Working Groups

- **GPS at Tide Gauge project (TIGA)**
- **HartRAO/GFZ earth-tide project at Sutherland**
- **HartRAO/GFZ IGS installation in Namibia**
- **New Project, Lunar Laser Ranging**
- **Crustal stability at Vaalputs (HartRAO/NECSA)**
- **Total zenith delay mapping for Weather Prediction (HartRAO/POTCH)**
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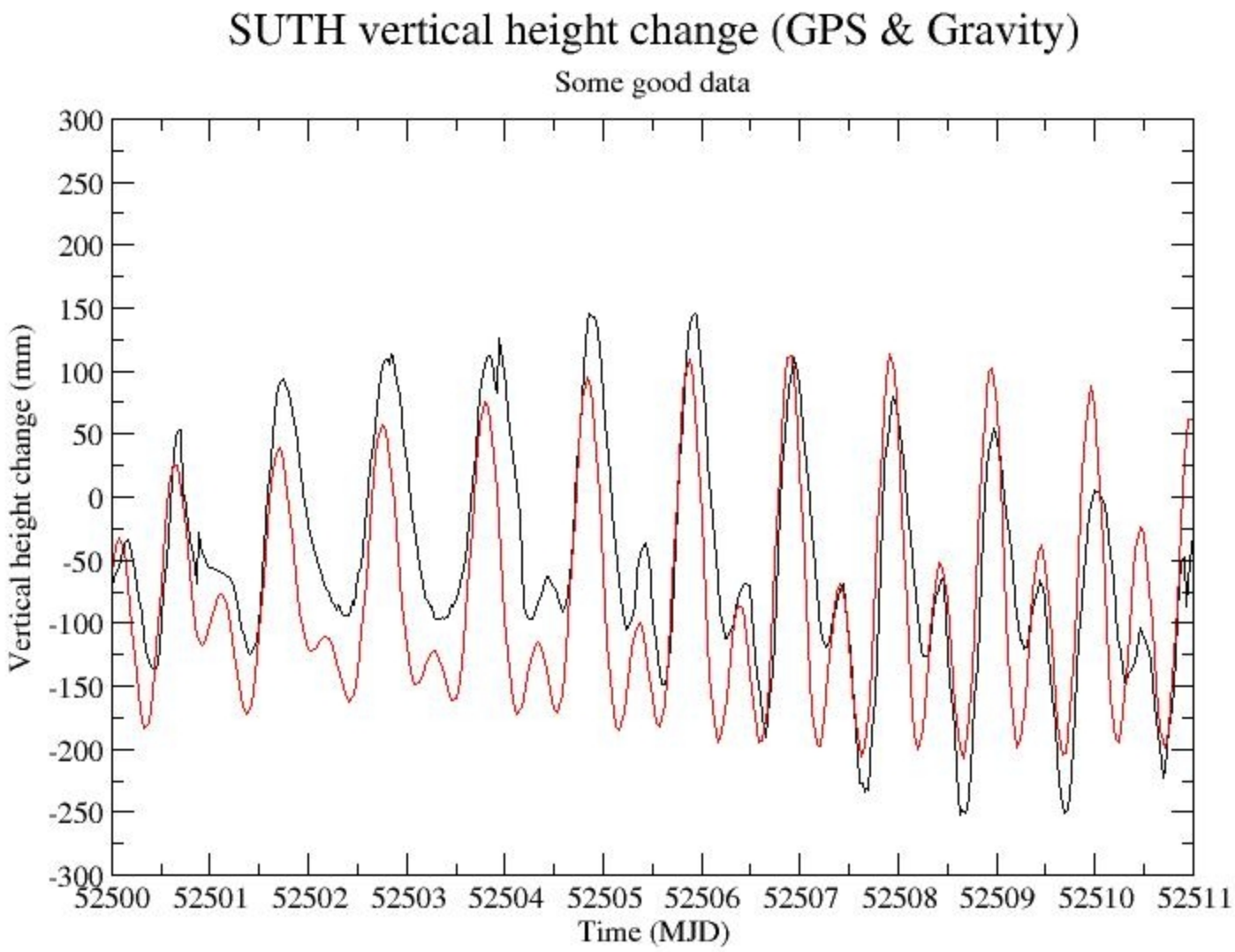
- **other projects!**


SUTH vertical height change (GPS & Gravity)
Some good data
Vertical height change (mm)
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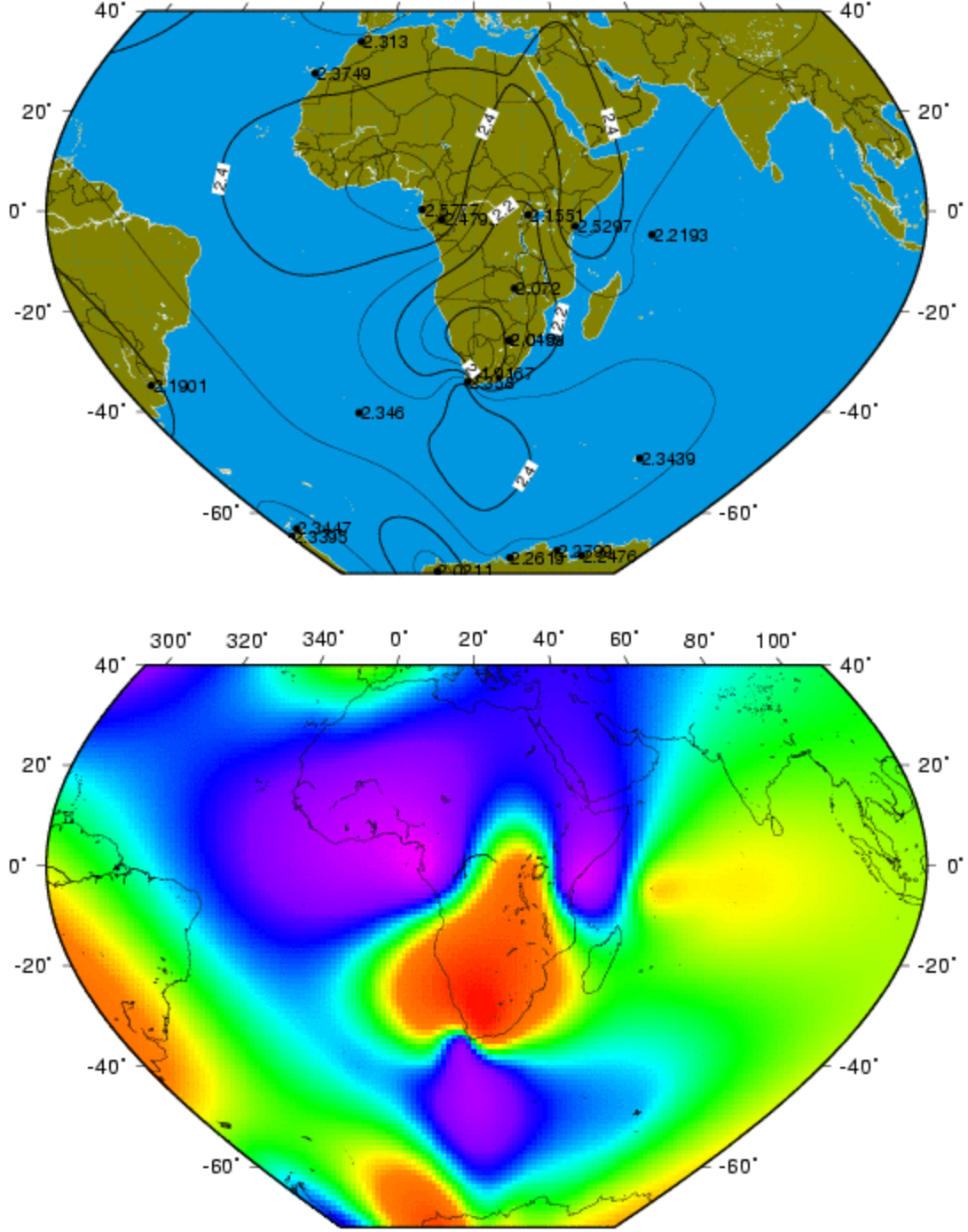
Time (MJD)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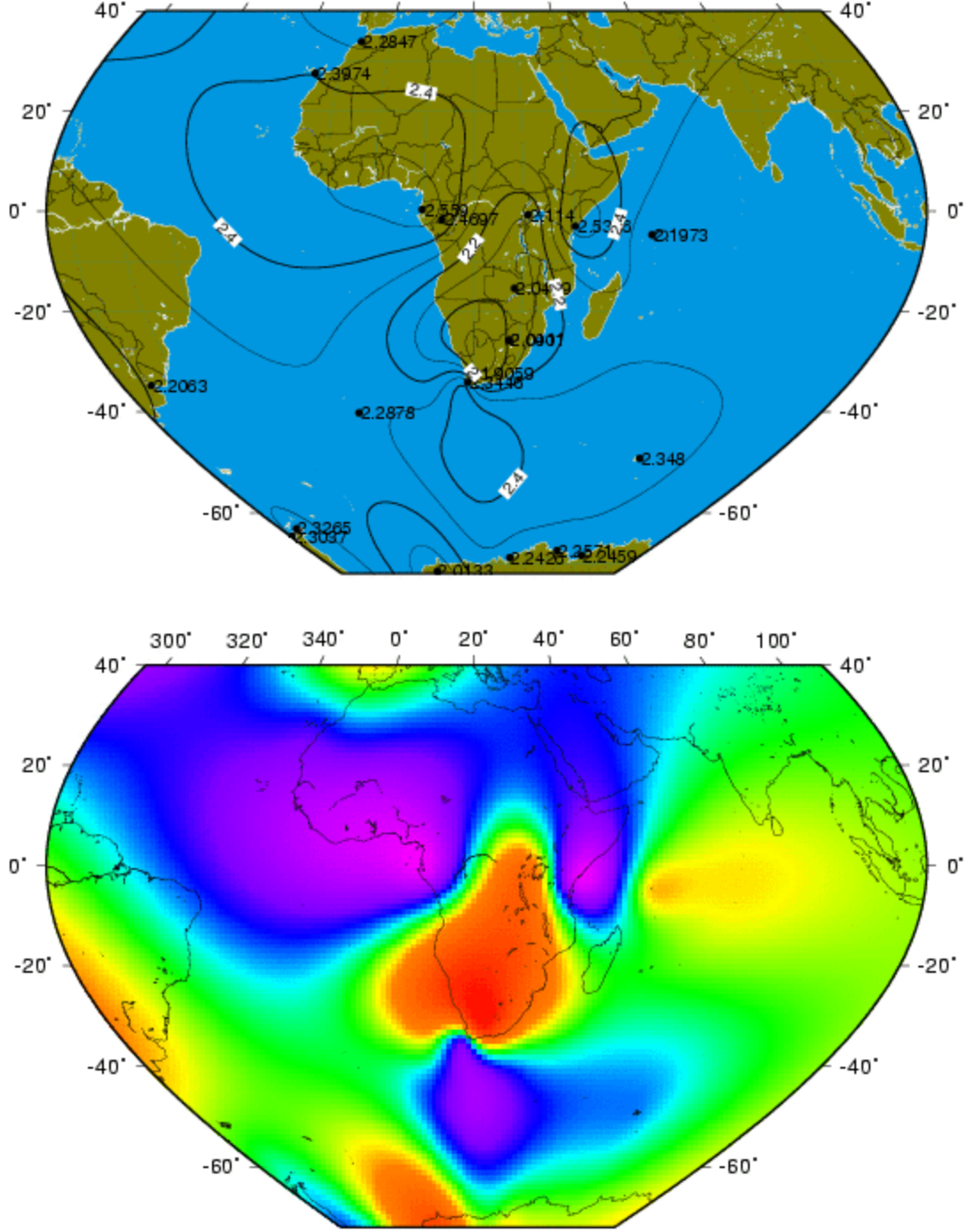
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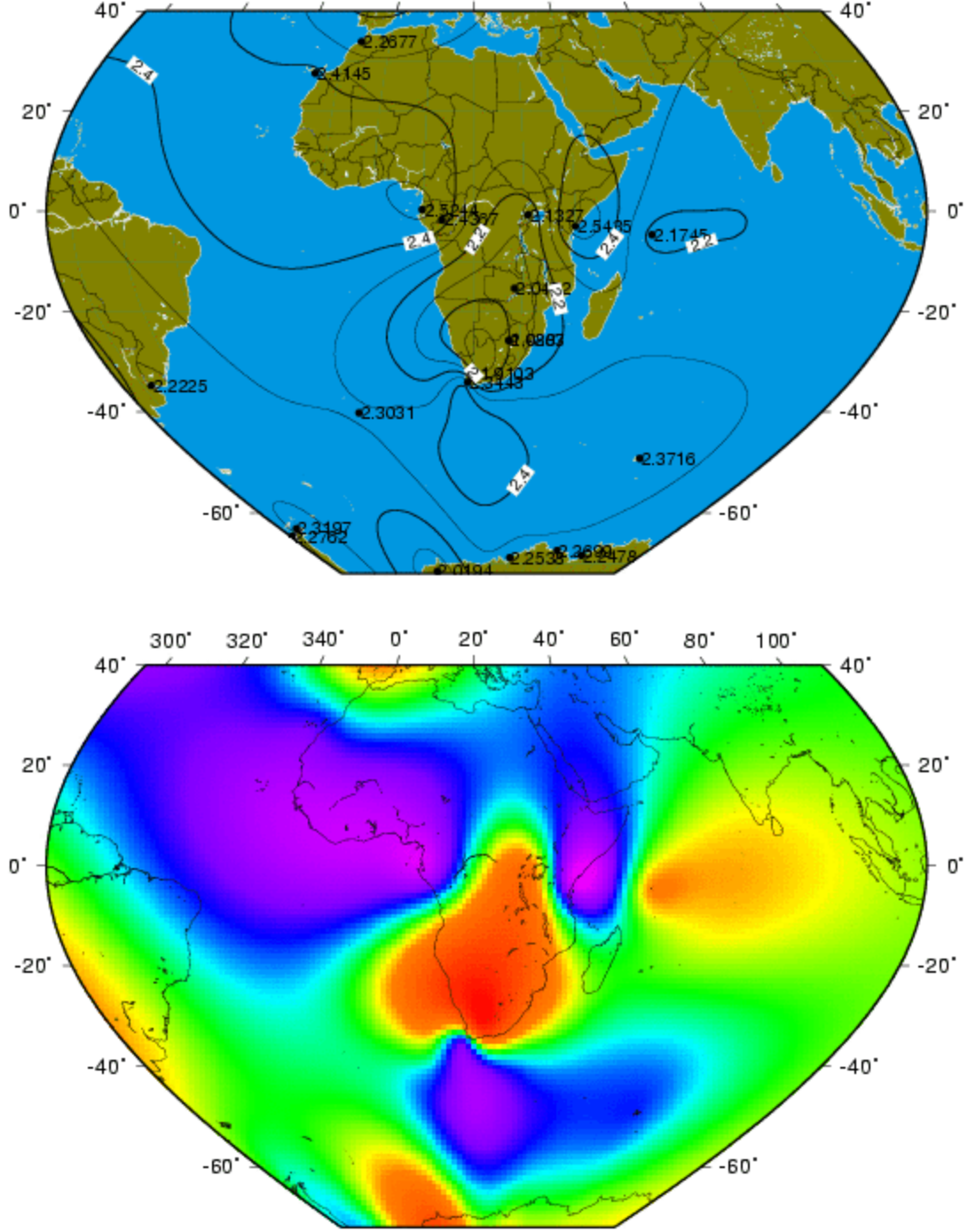
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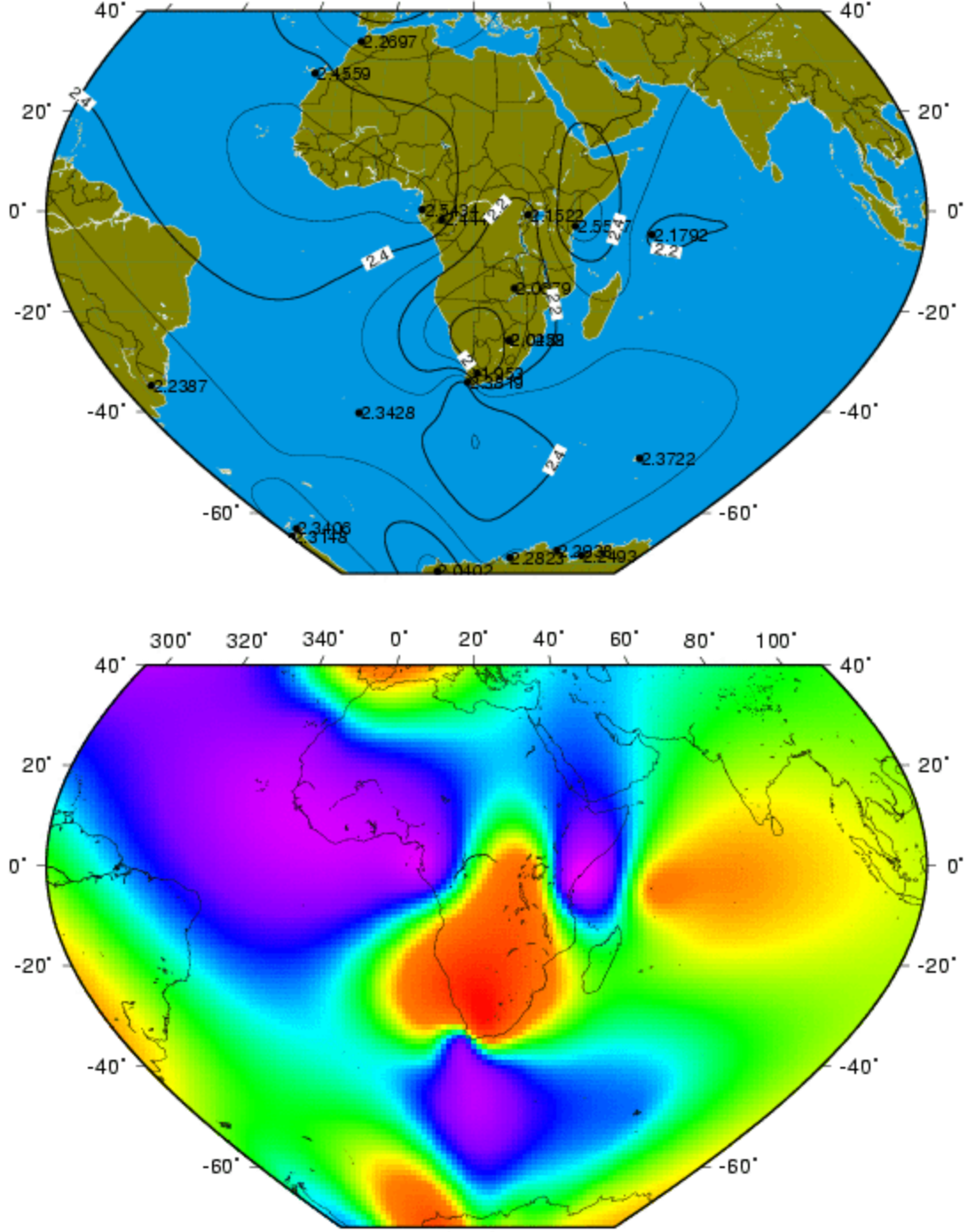
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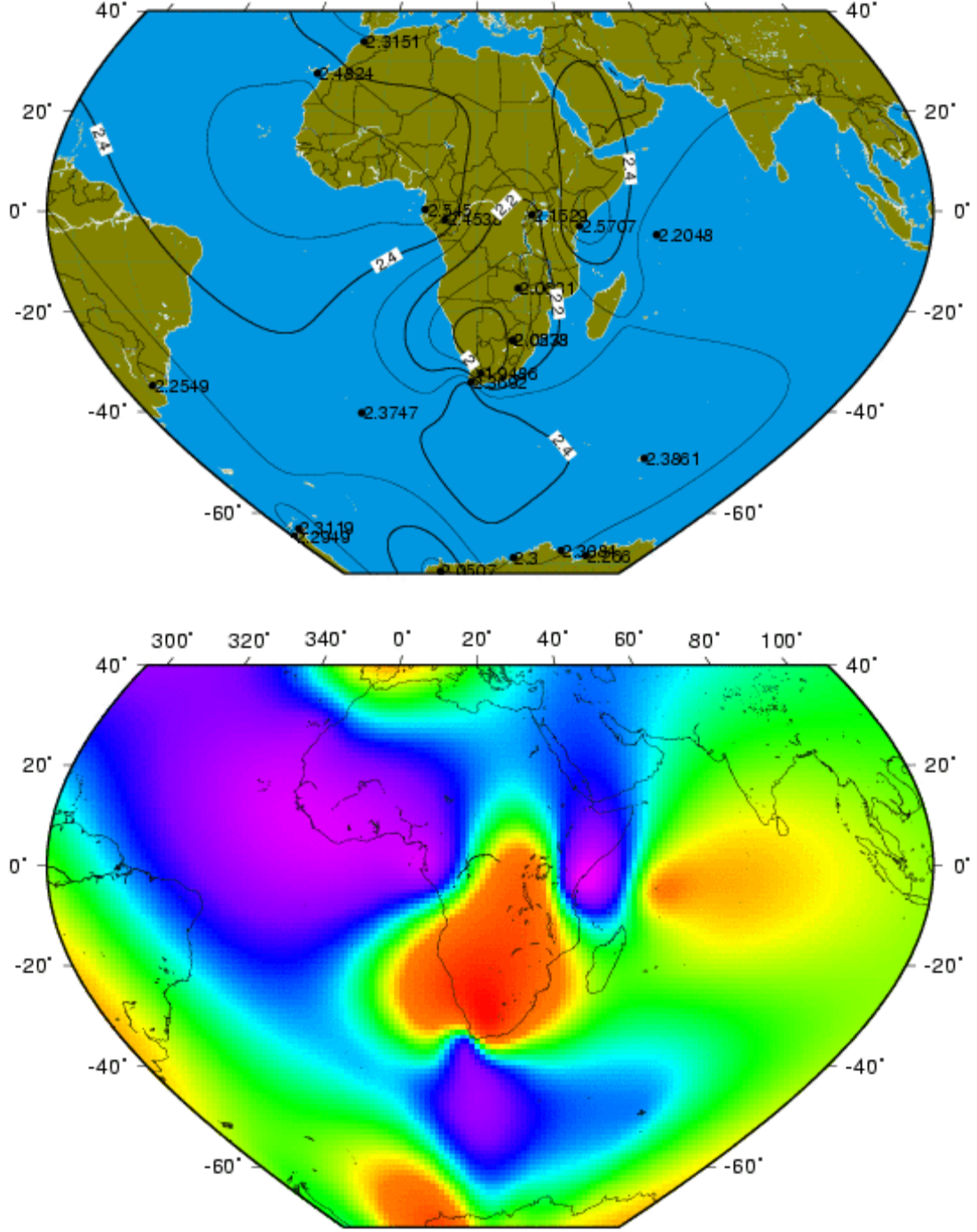
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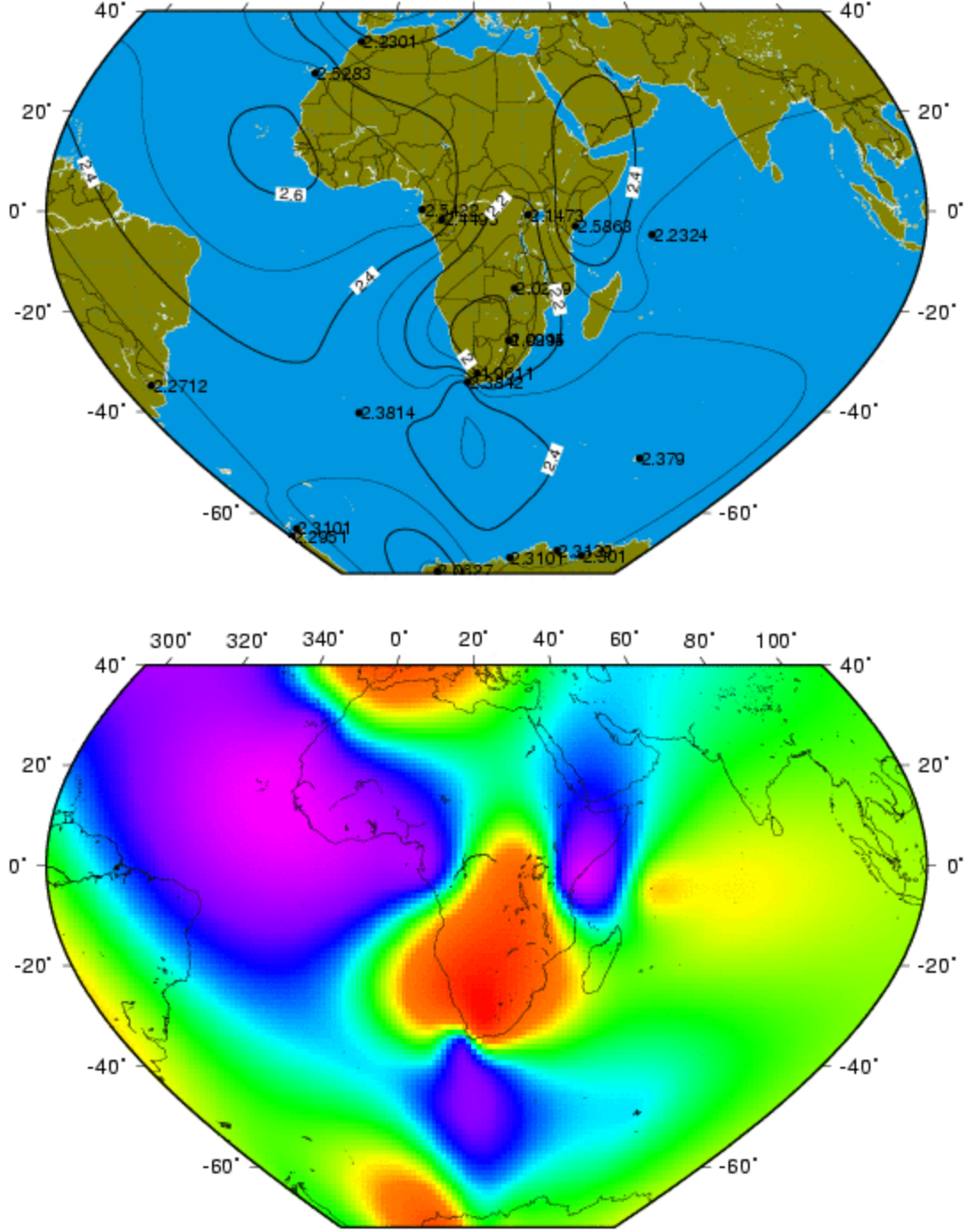
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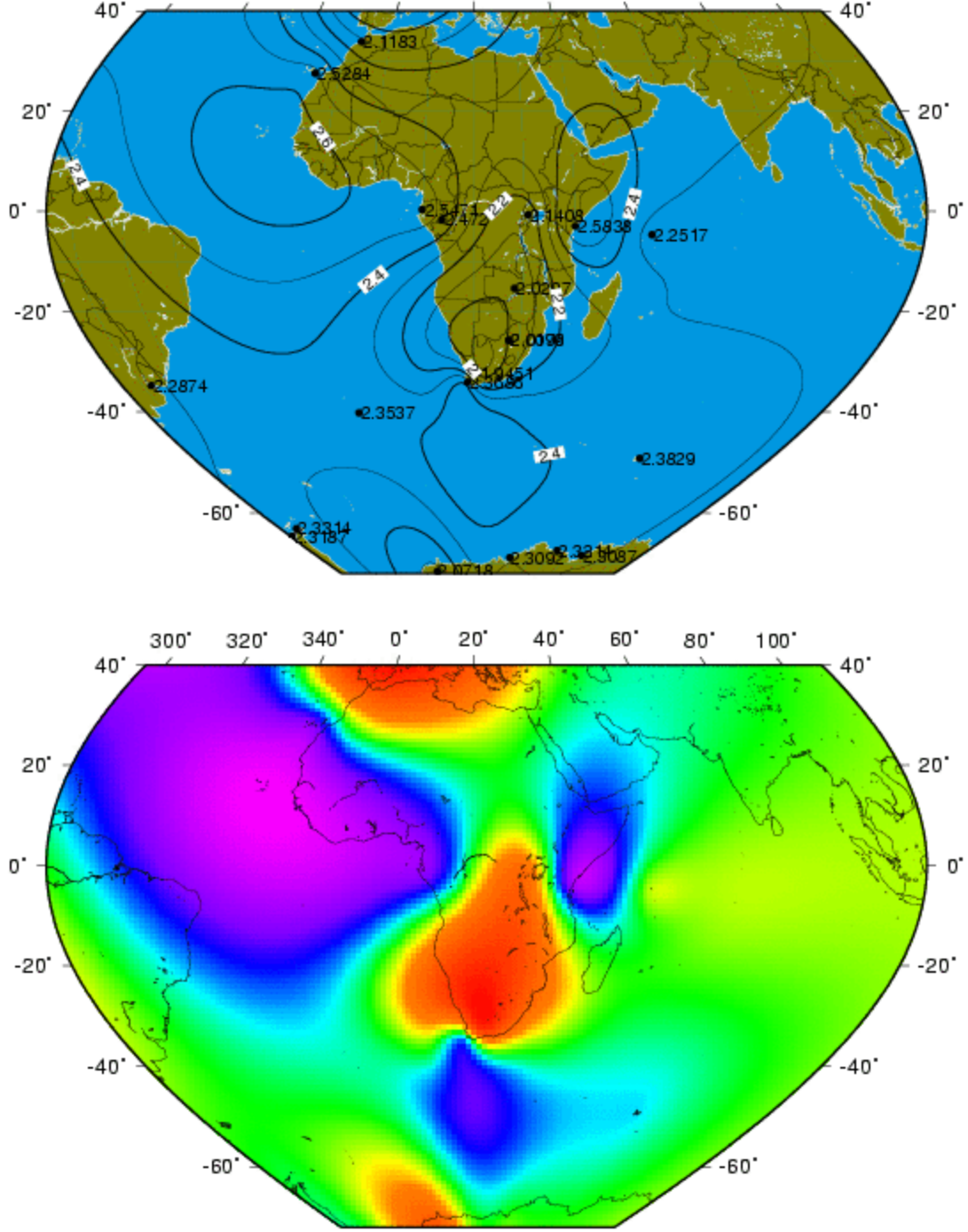
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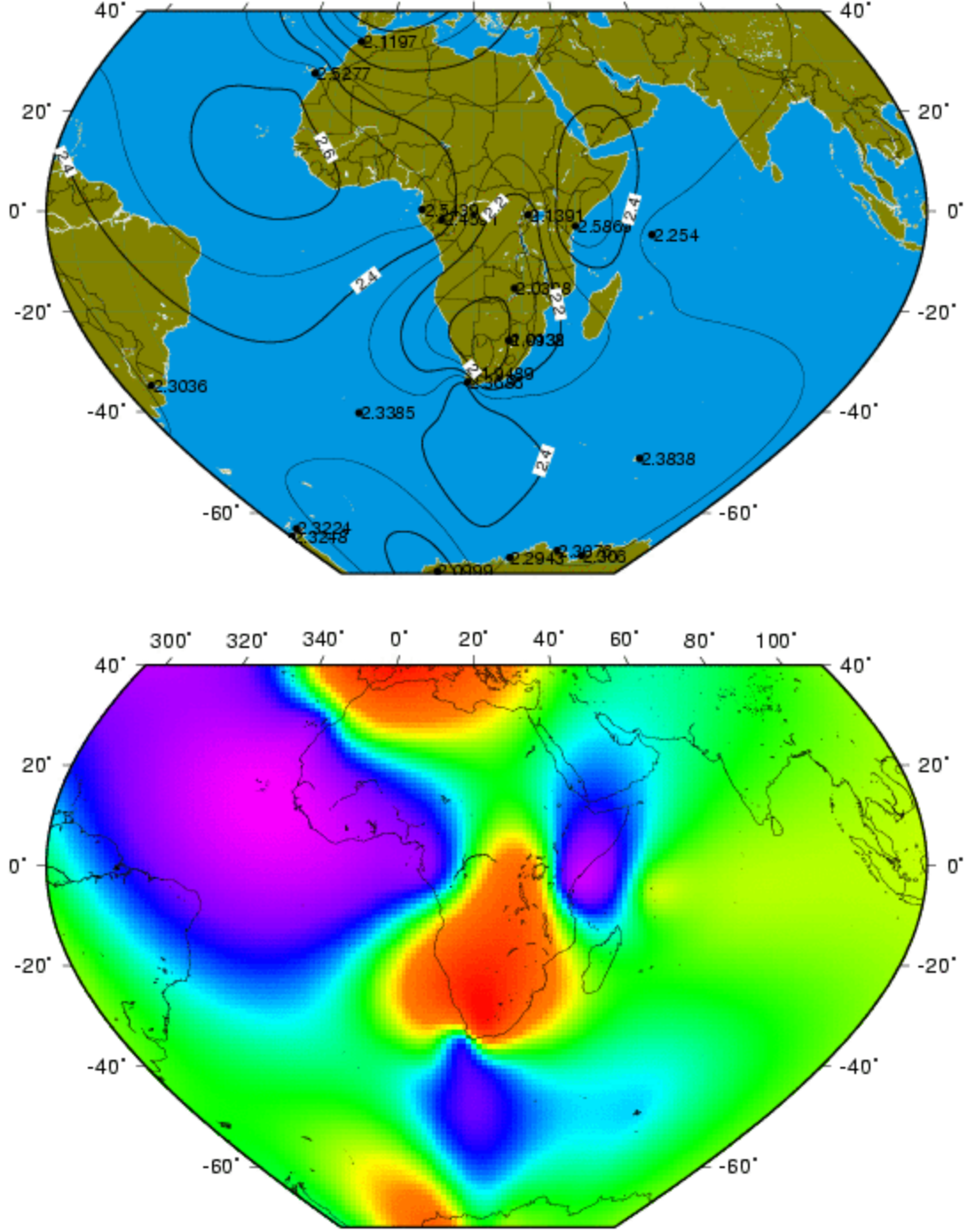
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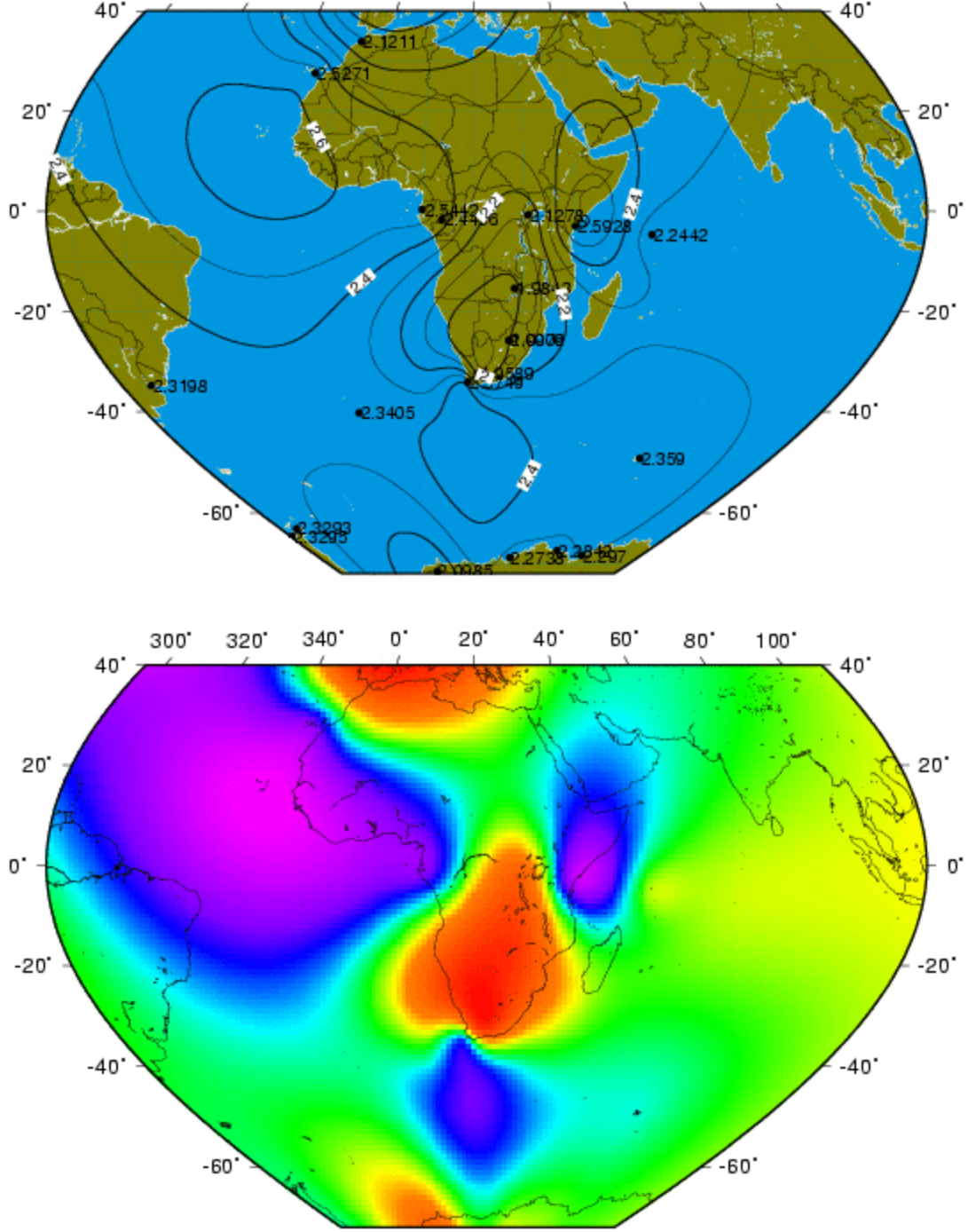
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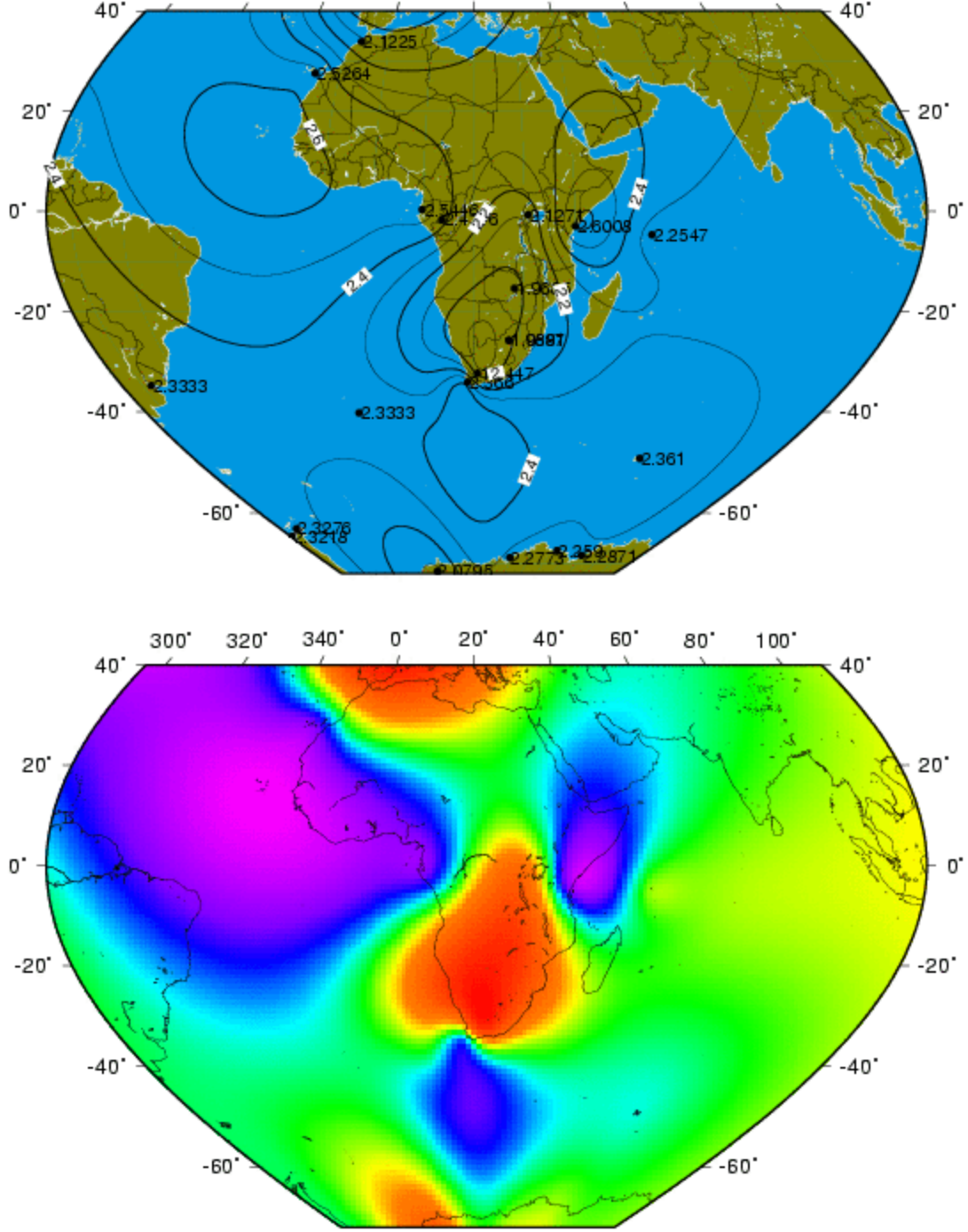
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Summary

- **The ICRF realised by Geodetic VLBI is much more accurate, simpler and stable**
- **It serves the purposes of astronomy and geophysics**
- **VLBI, SLR and GPS together provide an International Terrestrial Reference Frame**
- **Numerous branches of science are supported by Space Geodesy**
- **And, you can use it while camping, hiking, sailing!**

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- **Multi-disciplinary applications**
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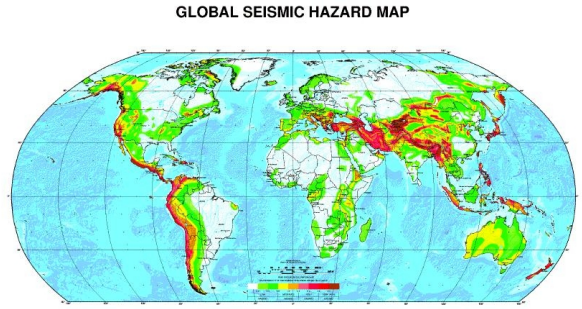

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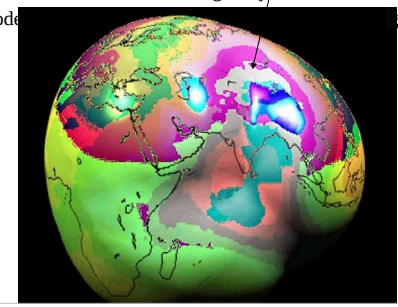
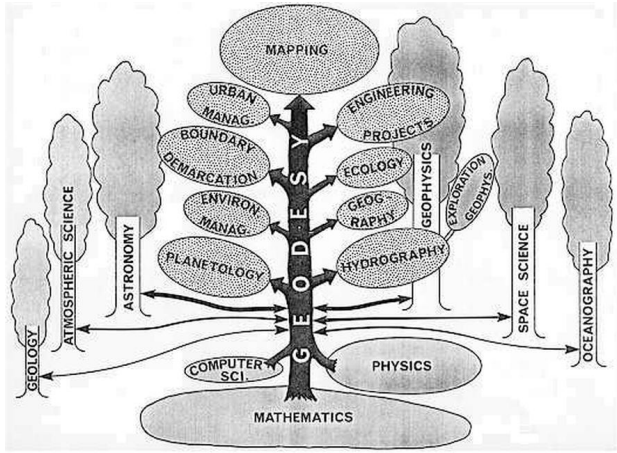


Space Geodesy: Multi-disciplinary tool



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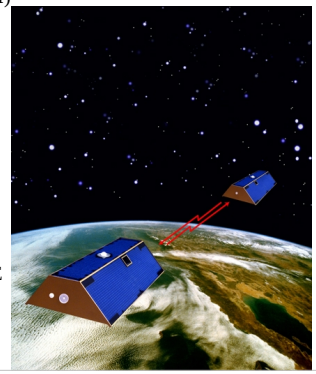

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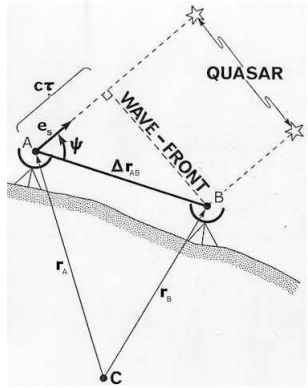

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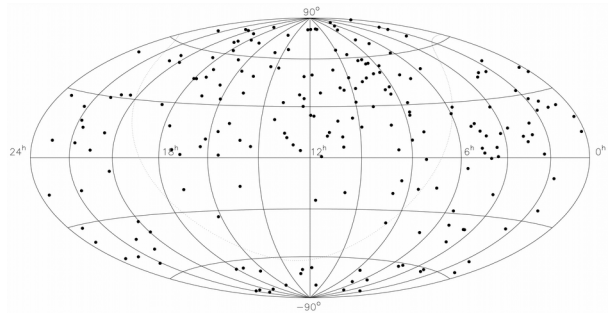


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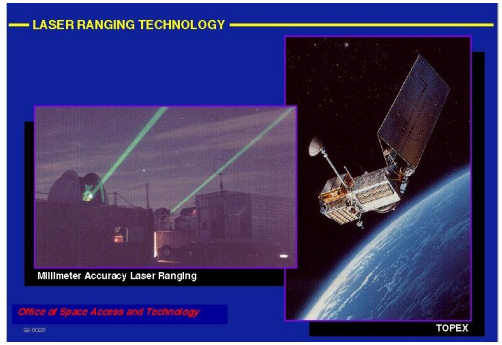

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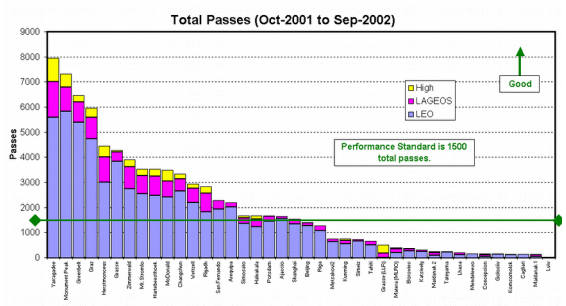
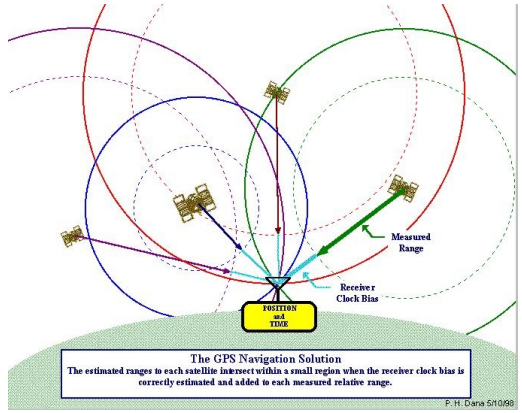


GPS: Basic Technique



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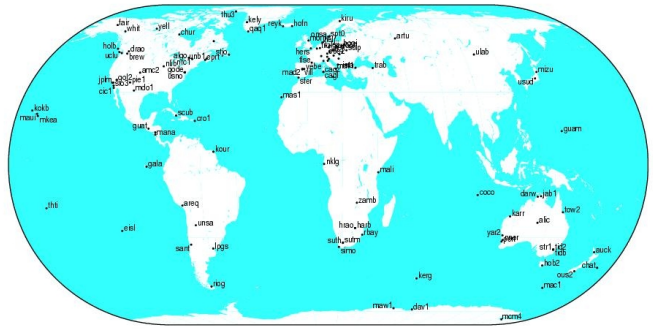

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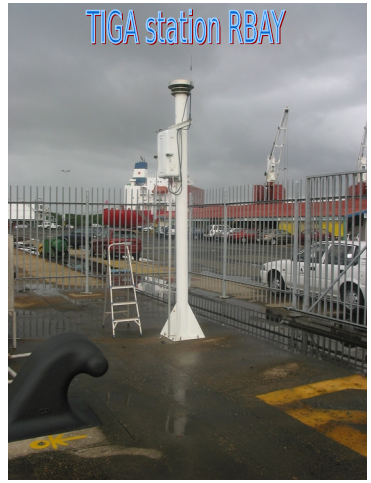
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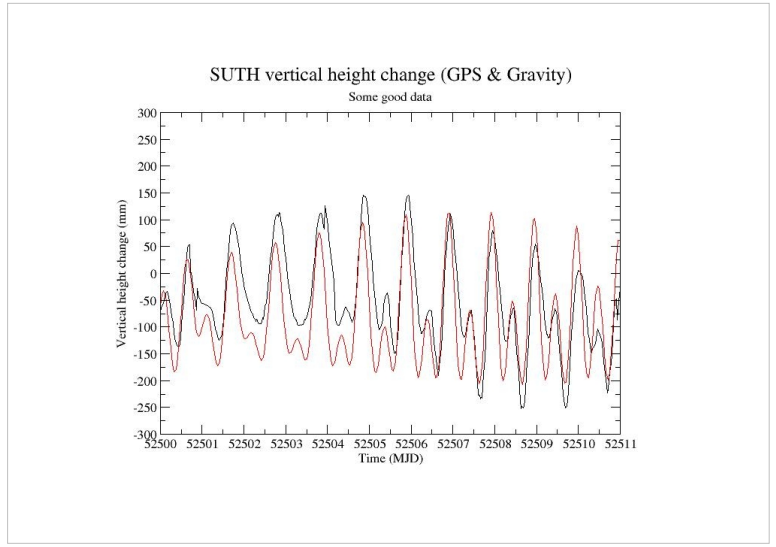
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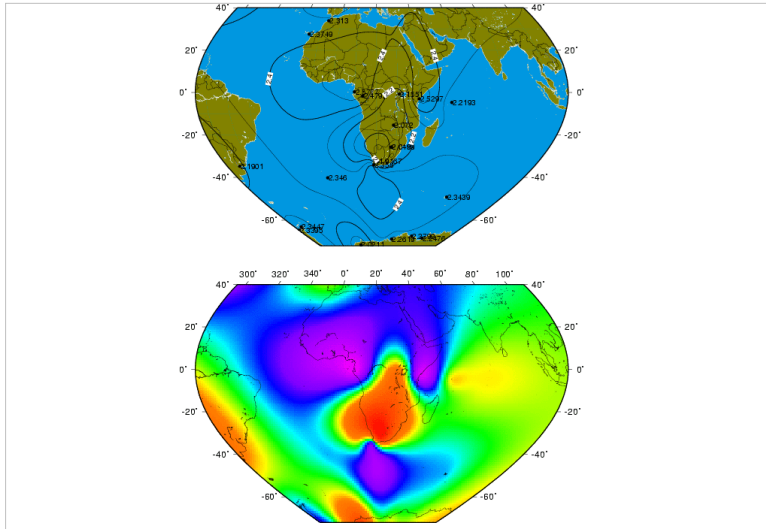
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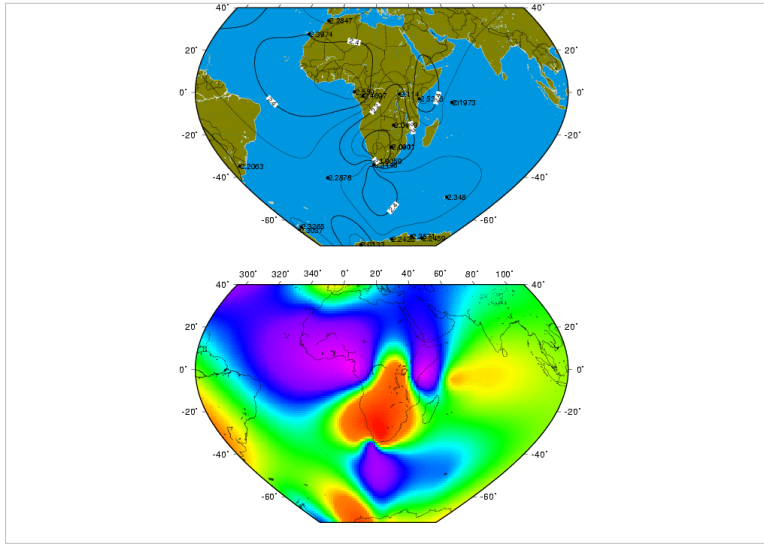
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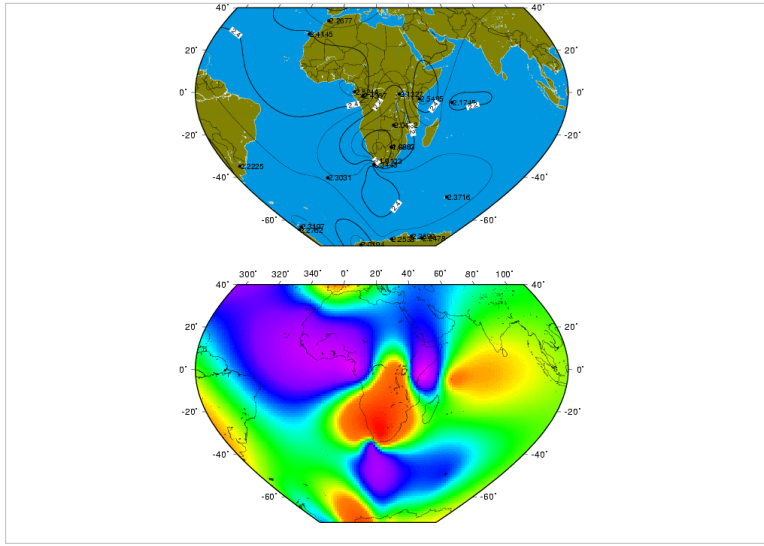
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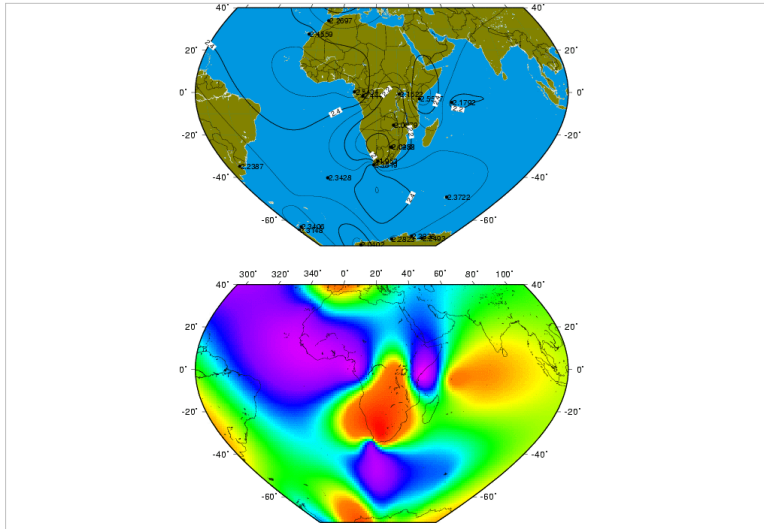
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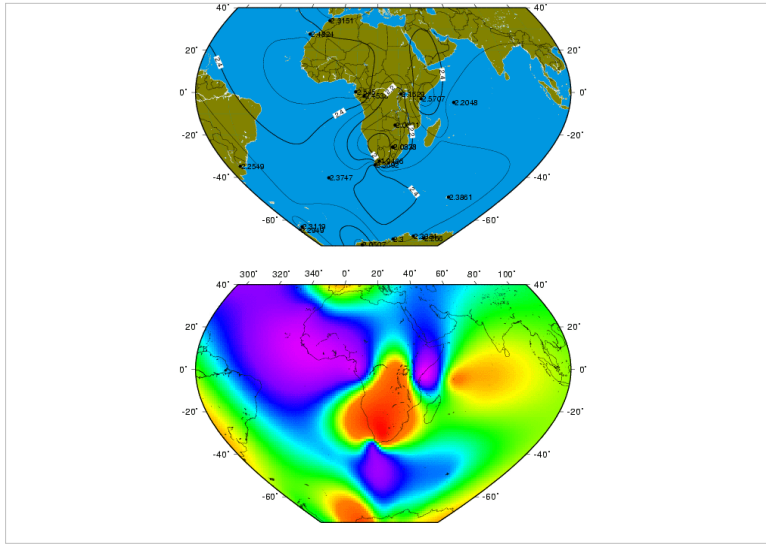
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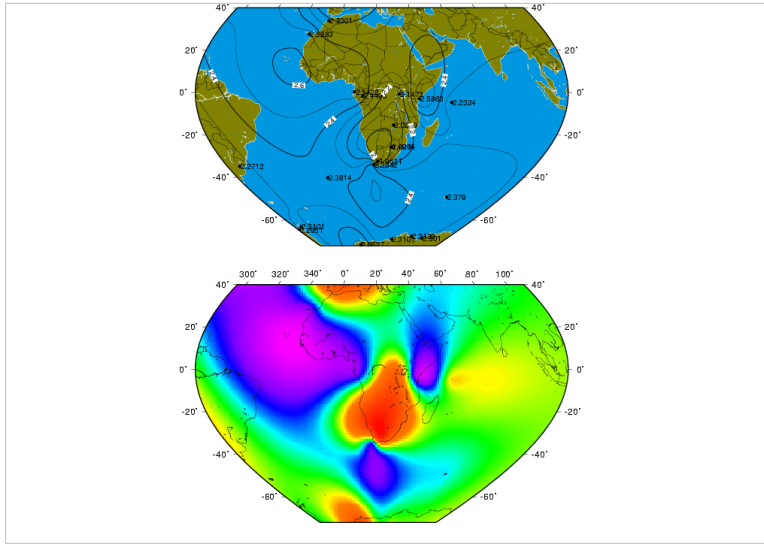
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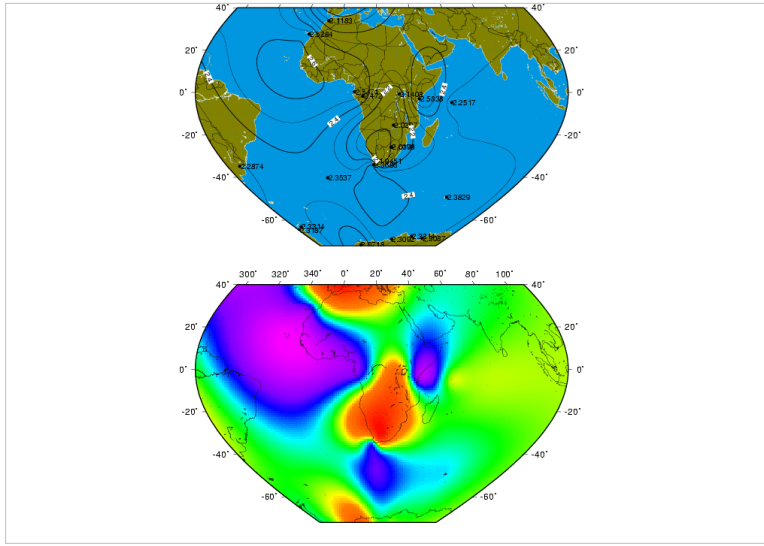
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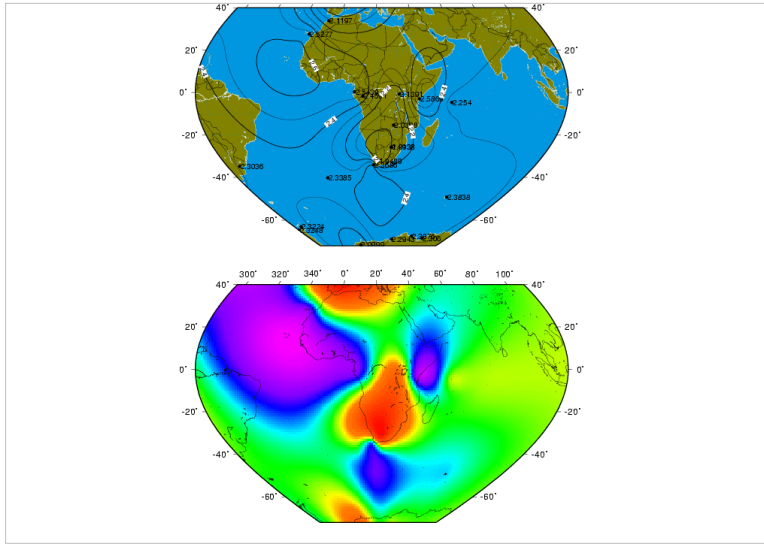
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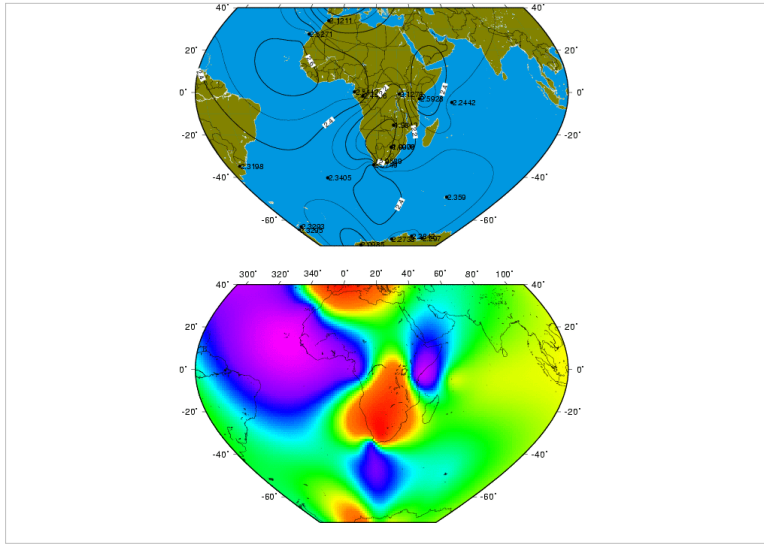
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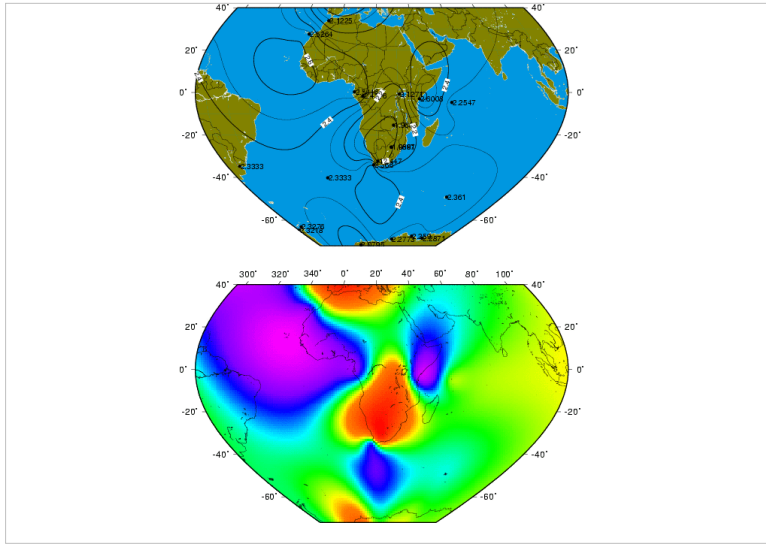
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Summary

- **The ICRF realised by Geodetic VLBI is much more accurate, simpler and stable**
- **It serves the purposes of astronomy and geophysics**
- **VLBI, SLR and GPS together provide an International Terrestrial Reference Frame**
- **Numerous branches of science are supported by Space Geodesy**
- **And, you can use it while camping, hiking, sailing!**