science and technology

Department:
Science and Technology
REPUBLIC OF SOUTH AFRICA

University of Pretoria

UNIVERSITY OF KWAZULU-NATAL

NRF National Research Foundation

HartRAO Hartebeesthoek Radio Astronomy Observatory

Contributions of HartRAO to Space Geodesy, Astrometry and related disciplines

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Philip Mey

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EVGA2015


KEEP
DOOR
CLOSED

HartRAO history

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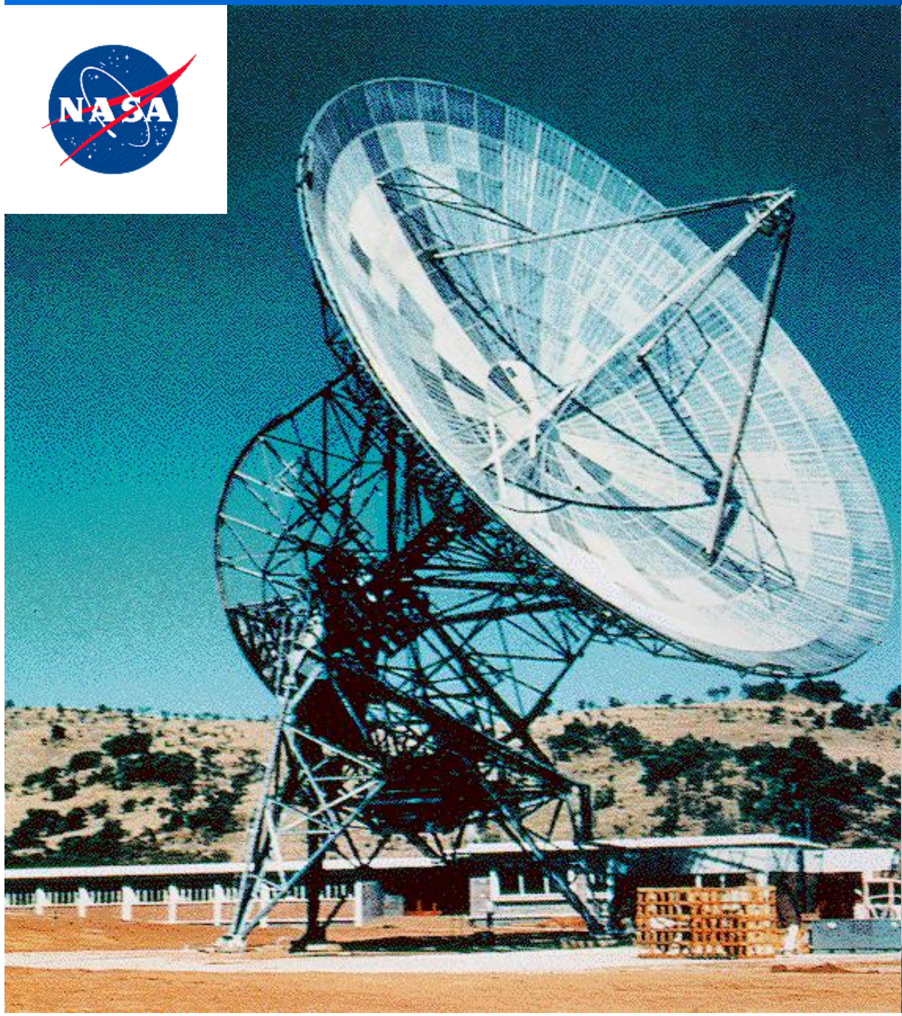
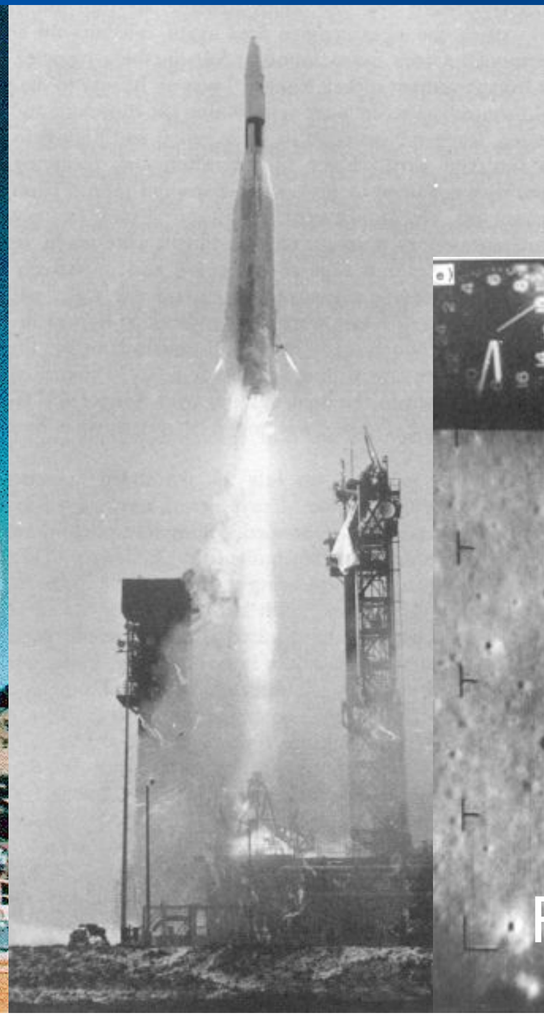
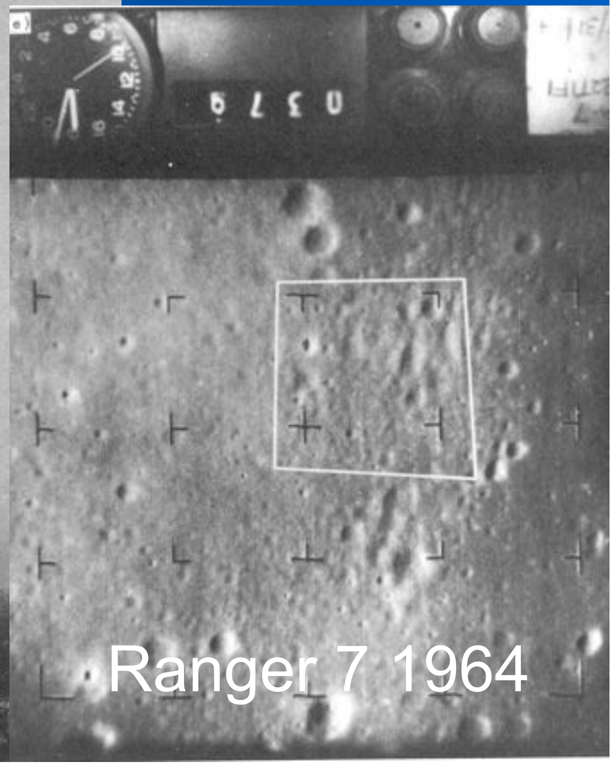
Ex NASA Deep Space Facility 51 (DSF51)







Ranger 7 1964

Space Geodetic Techniques

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- Very Long Baseline Interferometry (VLBI), radio telescopes, provides EOP etc, but low density
- Satellite Laser Ranging (SLR), optical telescope equipped with laser, calibrates satellite orbits, low density
- DORIS, low density, good geometry
- GNSS, relatively inexpensive, can provide high density coverage for crustal deformation

Some collocated equipment at HartRAO

VGOS antenna

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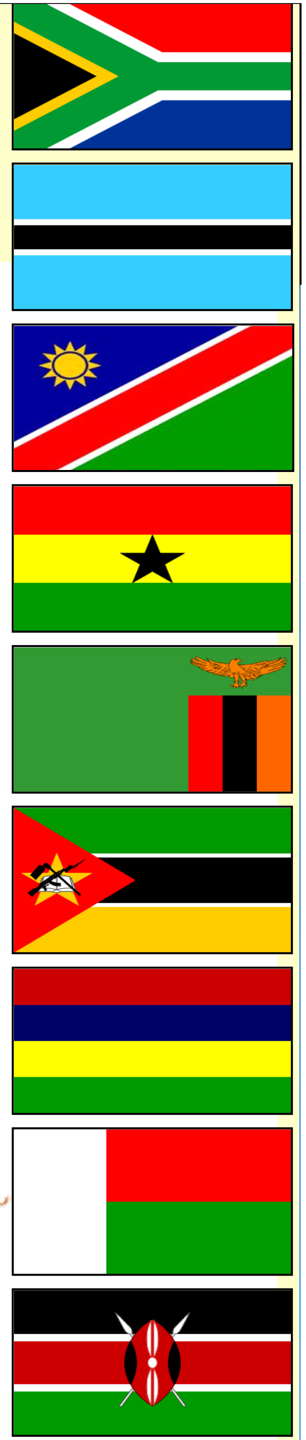
image credit: Tae-Hyun, Jung (MPIfR, 2004)

What and why the AVN?

- Develop a network of VLBI-capable radio telescopes on the African continent;
- Africa (led by South Africa) will co-host the Square Kilometre Array telescope with Australia, 9 African countries to host stations in SKA2 (including SA):
  - Develop the skills, regulations and institutional capacity neede d in SKA partner countries to optimise African participation in SKA2 and enable participation in SKA pathfinder technology development and scien ce;
  - Skills and knowledge transfer in African partner countries to bu ild, maintain and operate radio telescopes independently;
  - Bring new science opportunities to Africa on a relatively short time scale and develop strong RA science communities.

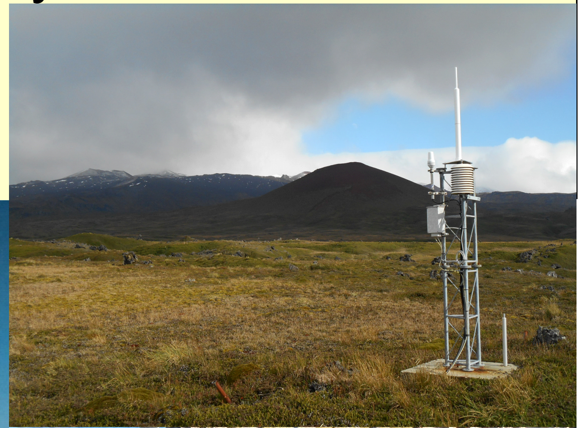
AVN & SKA

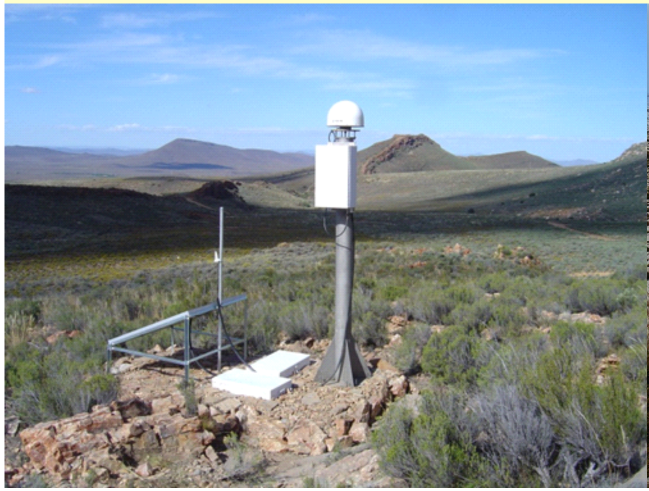
- South Africa,
- Botswana,
- Ghana,
- Kenya,
- Madagascar,
- Mauritius,
- Mozambique,
- Namibia, and
- Zambia



Instruments that can be collocated synergistically with radio telescopes (e.g. AVN) or linked geodetically

- **Satellite Laser Ranging (SLR)**
- **Lunar Laser Langing (LLR)**
- **Geodetic VLBI (ICRF, EOP, ITRF)**
- **GNSS (GPS, Galileo etc.)**
- **DORIS (Doppler Orbitography and Radiopositioning Integrated by Satellite)**
- **optical astrometry**
- **meteorological sensors**
- **seismometer, accelerometer**
- **gravimeter**
- **tide gauge, linked to VLBI via GNSS**
- **ground control segments**
- **ALL of these are included at Hartebeesthoek**





Links of techniques, through IAG services, three pillars, science applications and products, through to natural events which affect life on Earth

GGOS, from cm to mm accuracy


GGOS
http://www.ggos.org
IAG's Global Geodetic Observing System
Markus Rothacher (GGOS Chair), Achim Helm (GeoForschungsZentrum Potsdam)
Ruth E. Neilan (GGOS Vice-Chair) (Jet Propulsion Laboratory)
Hans-Peter Plag (GGOS Vice-Chair) (University of Nevada)
ICSU
International Council for Science
IUGG
Int. Union of Geodesy and Geophysics
IAG
Int. Association of Geodesy
Commissions
Services
GGOS
Global Geodetic Observing System
Kobe 1995 Earthquake
Sumatra 2004 Tsunami
Disaster Monitoring
Deformations
Earth Orientation and Rotat
IERS
Atmospheric Sounding
Geometry and Kinematics
ILRS
IVS
Satellit
St. Helens 1980 Eruption
Surveying
Kainaman 2004 Mudflow


BUS STOP
Search: 68130258
"Where is global warming when you really want it?"

Example: Sea surface height, changing or not changing? Is the global climate changing or not….

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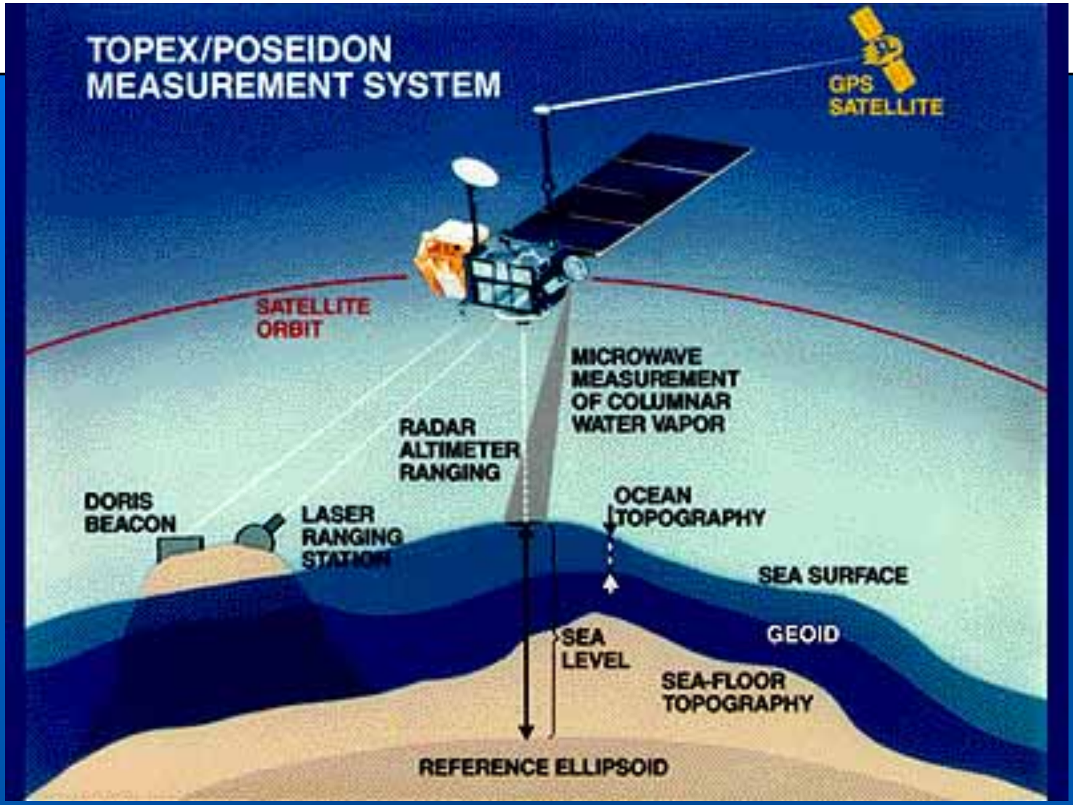

Non-uniform mass distribution in the Earth leads to a gravitation field of the Earth that is also not uniform. These mass distributions have a varying component as the variations of the atmosphere, solid Earth, oceans, and land bound water distributions affects gravity continuously

These subtle variations of the gravitation field influence both the ocean surface and the satellite orbit.

Studying, measuring and continuously improving our knowledge of the Earth's gravity field is crucial to measure global change in ocean levels, ice sheet levels and the complex interaction between the atmosphere, earth and oceans.

Some examples of extending the GNSS/ Seismic/Tide Gauge network

- Marion Island GPS April 2004 (Combrinck and Stronkhorst)
- 2006 GPS fixed, EIA redone (Combrinck and Prozesky)
- 2007 Tide Gauge installed, new GPS, BGAN comms (Combrinck, Botha)
- 2007/8 GPS at SANAE, Antarctica plus TerraSARx reflectors
- 2012 September, new GPS at Gough Island, EIA for tide gauge, Doris, accelerometer and seismometer
- 2013, Gough Island, tide gauge and peripheral equipment installation (Combrinck)
- 2014, Marion Island, Seismometer, accelerometer, geodetic tie (Combrinck)
- Two new GPS at tide gauges to be installed May 2015, Luderitz and Walvisbay, Namibia
- 2015, Klerefontein GNSS, Vault and meteorological station survey +
- 2015+, SANAE IV, TerraSARx network to be expanded to Norwegian (crust) and German base (ice).
- GPS for Tristan da Cunha? There is a (dysfunctional? tide gauge)

TIDE GAUGES

Home page > Data > Tide gauges

Which tide gauges?

The tide gauges for which you will find data in SONEL are shown on the dynamic maps. By clicking on a tide gauge symbol detailed information is provided, as well as acce
available data.

Number of stations displayed : **572** | List of stations

Sea level trends 1960-2010, GPS calibrated

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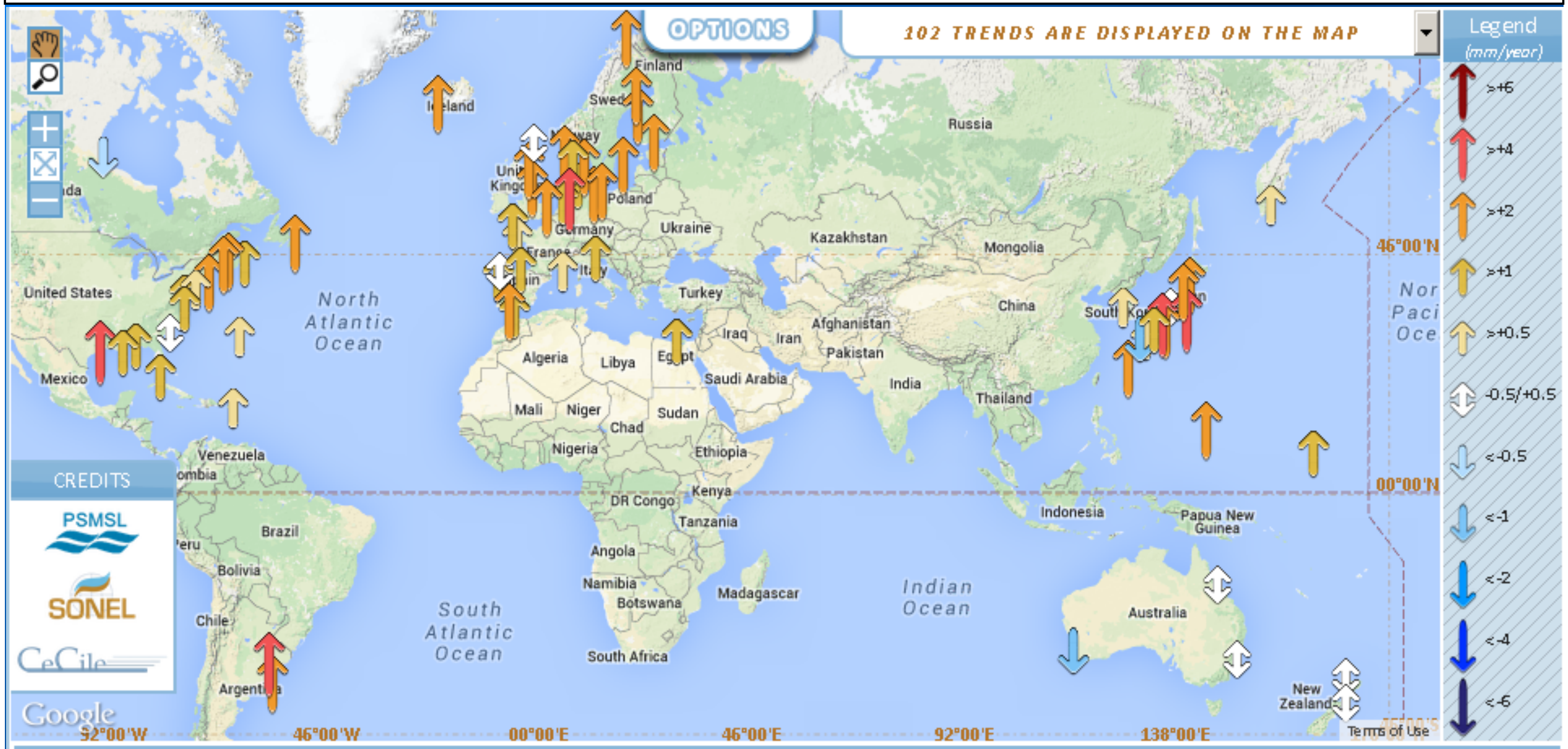


Marion Island Data

SEA LEVEL STATION MONITORING FACILITY

IOC

Intro | Map | Station lists | Station details | Services

[previous station] Station: Marion Island at GMT [next station]

[more details] [GTS message] [show data] [show on map] [monitor]

Station metadata

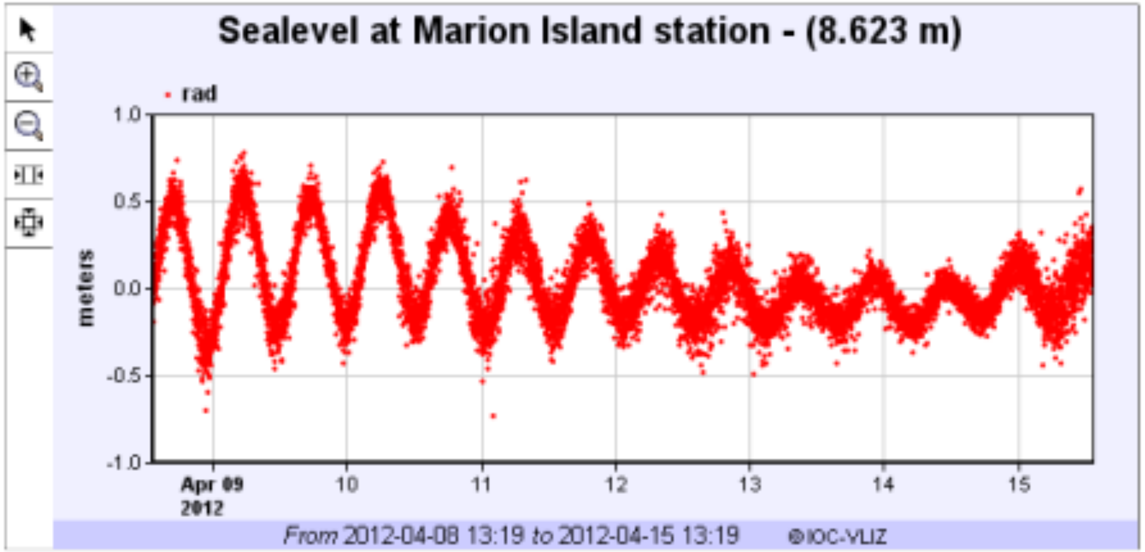
Code	mais
Country	South-Africa
Location	Marion Island
Status	Operational
Local Contact	Hartebeesthoek Radio Astronomy Observatory (South Africa)
Other Contact	GeoForschungsZentrum (Germany)
GLOSS ID	20 [goto handbook]
Latitude	-46.8667
Longitude	37.8667
Connection	GTS message
GTS message type	SXXX32

Sensor 1

Type of sensor	rad
Sampling rate (min)	1

Sensor 2

Type of sensor	bat
Sampling rate (min)	15



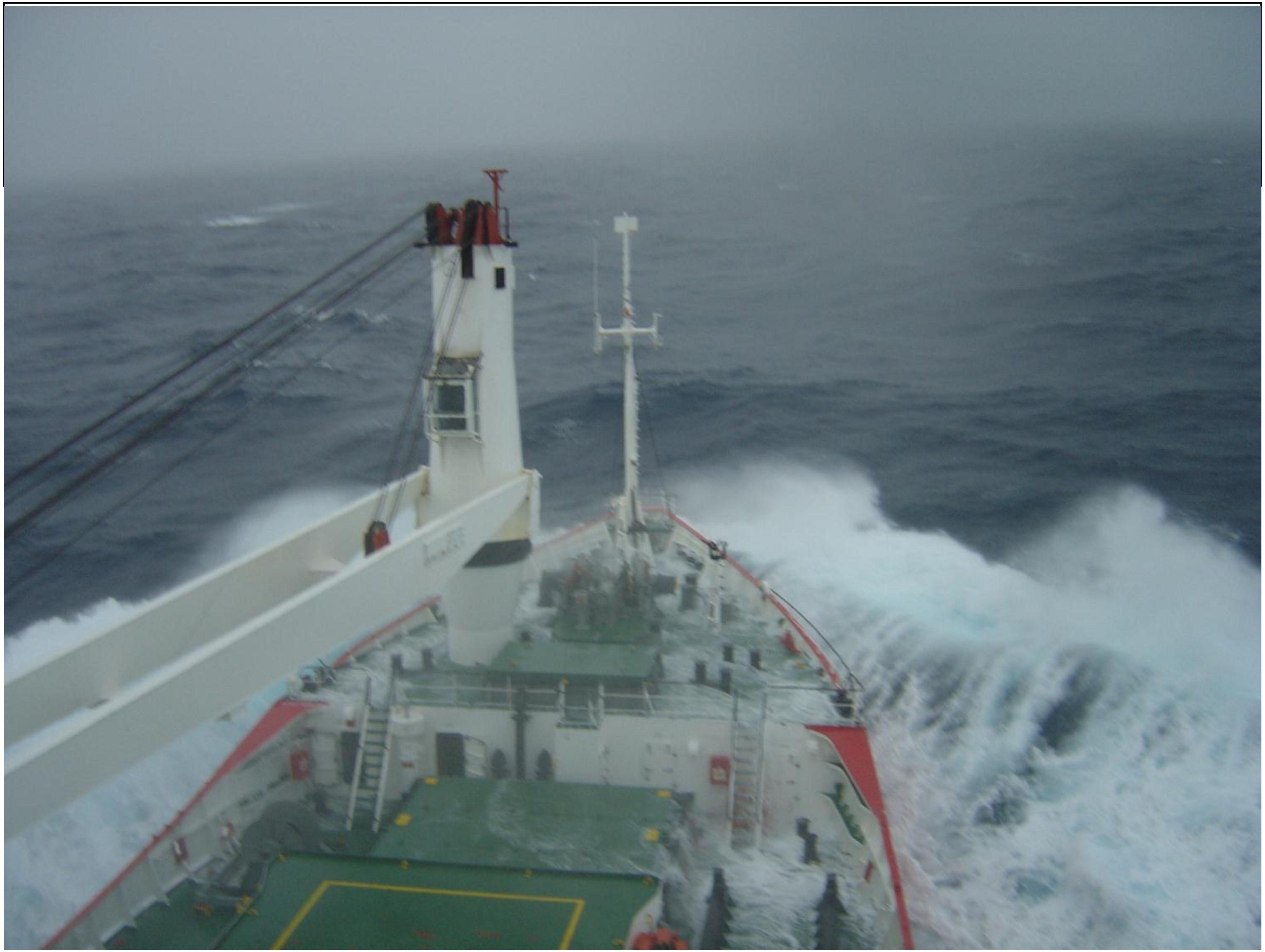
Period
- 12h
- day
- 7 days
- 30 days

Signals
- rad
- Remove outliers
- Remove spikes

Data
- Relative levels= signal - average over selected period
- Absolute levels= as received
- Offset signals= relative signals + offset
- Show battery voltage

Tip:use left icons to zoom & scroll

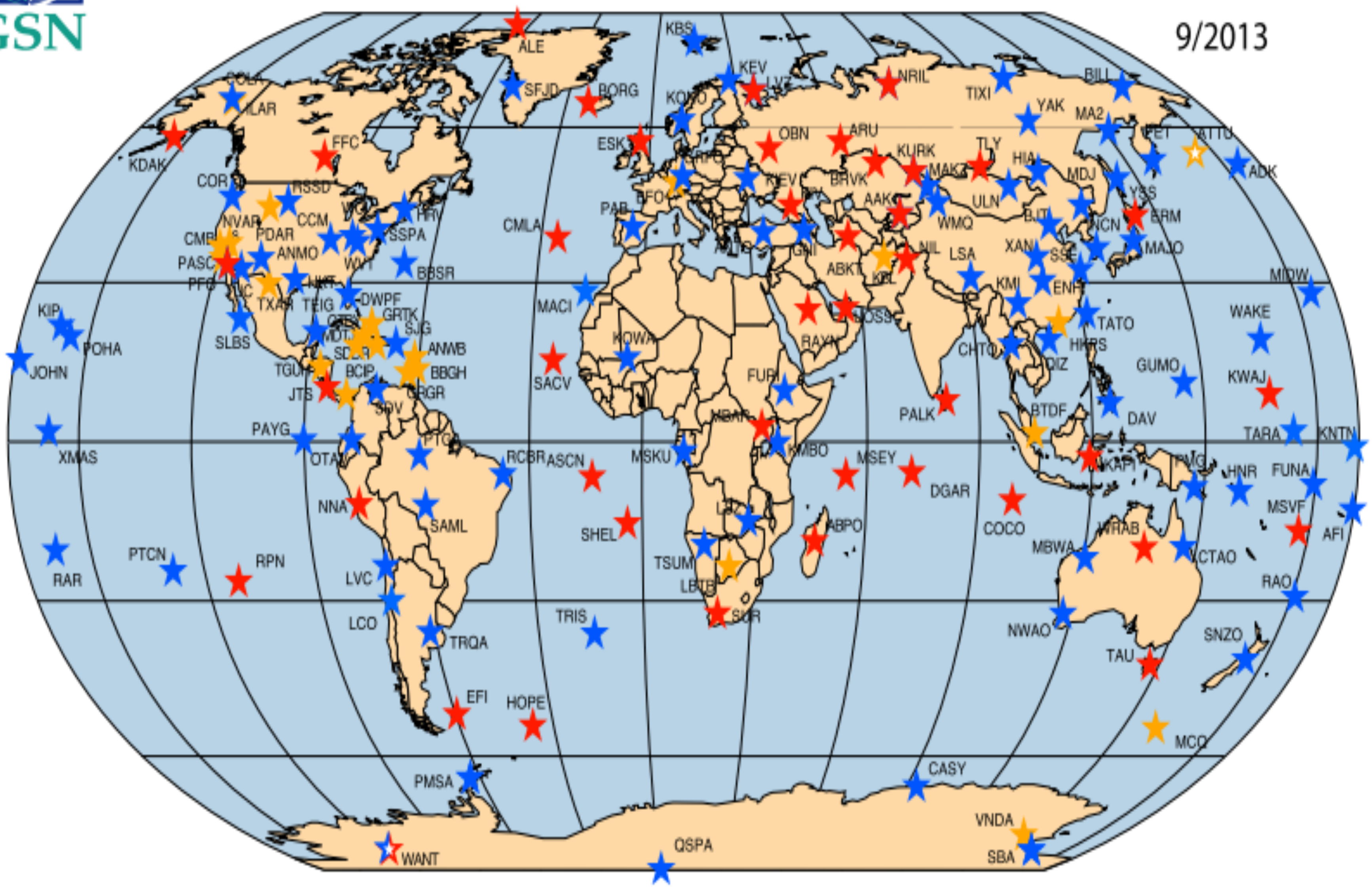
Marion Island base from the air



GLOBAL SEISMOGRAPHIC NETWORK

GSN

9/2013

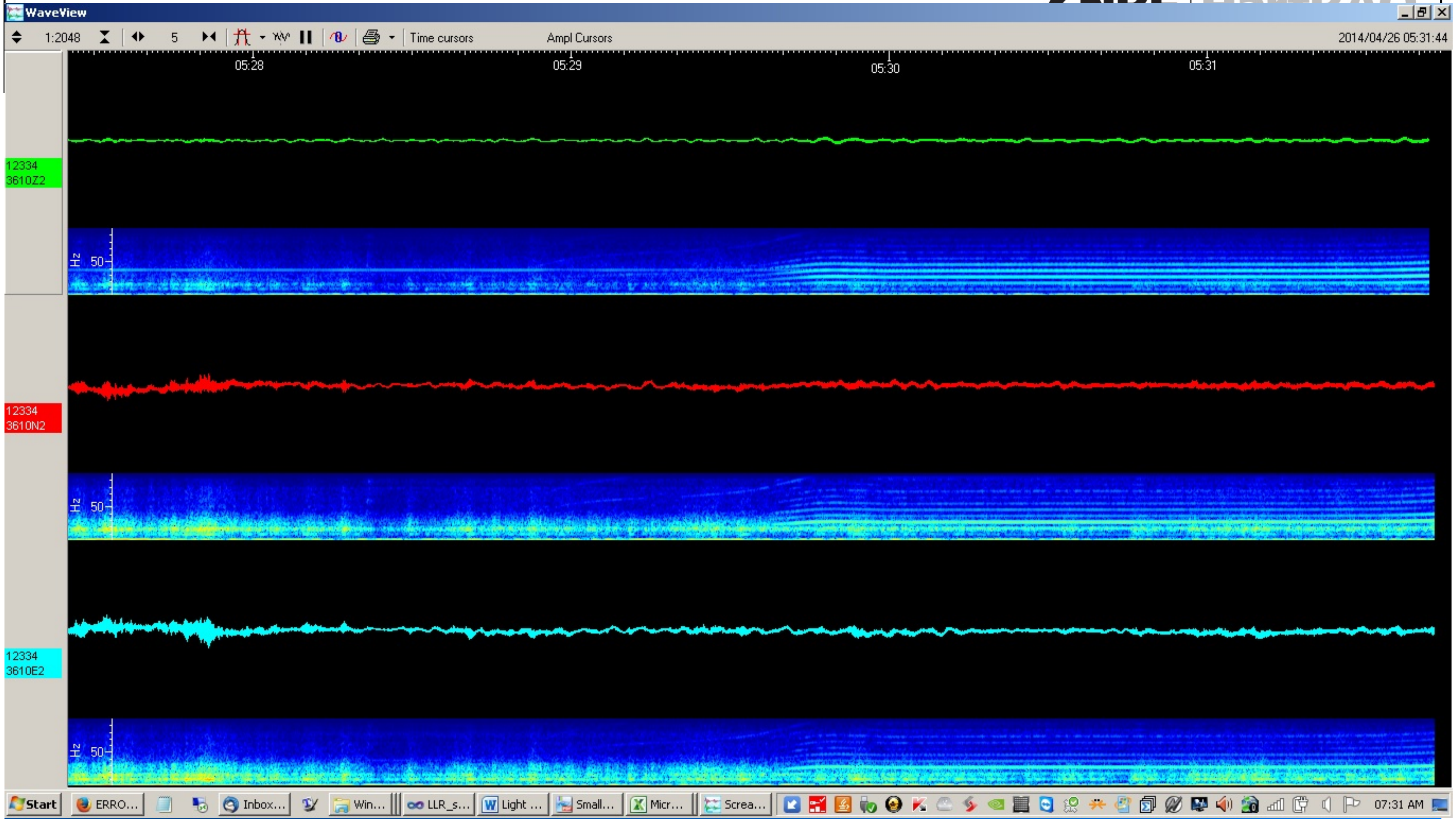


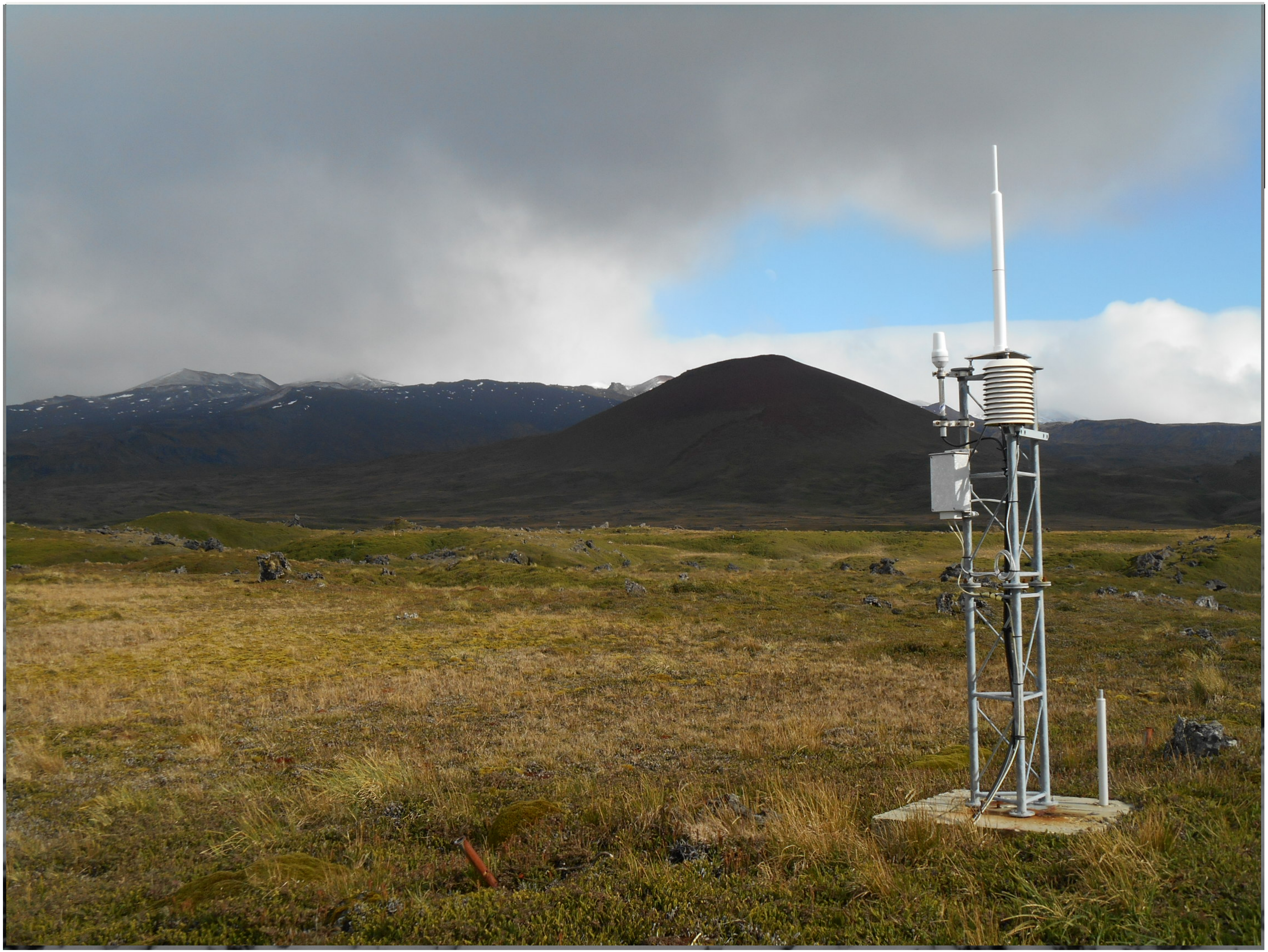
IRIS / IDA Stations

IRIS / USGS Stations

Affiliate Stations

Planned Stations


WaveView
1:2048
5
Time cursors
Ampl Cursors
2014/04/26 05:31:44
05:28
05:29
05:30
05:31
12334
3610Z2
Hz 50
12334
3610N2
Hz 50
12334
3610E2
Hz 50
Start
ERRO...
Inbox...
Win...
LLR_s...
Light ...
Small...
Micr...
Screa...
07:31 AM




ZS-HRP

Satellite and Lunar Laser Ranging

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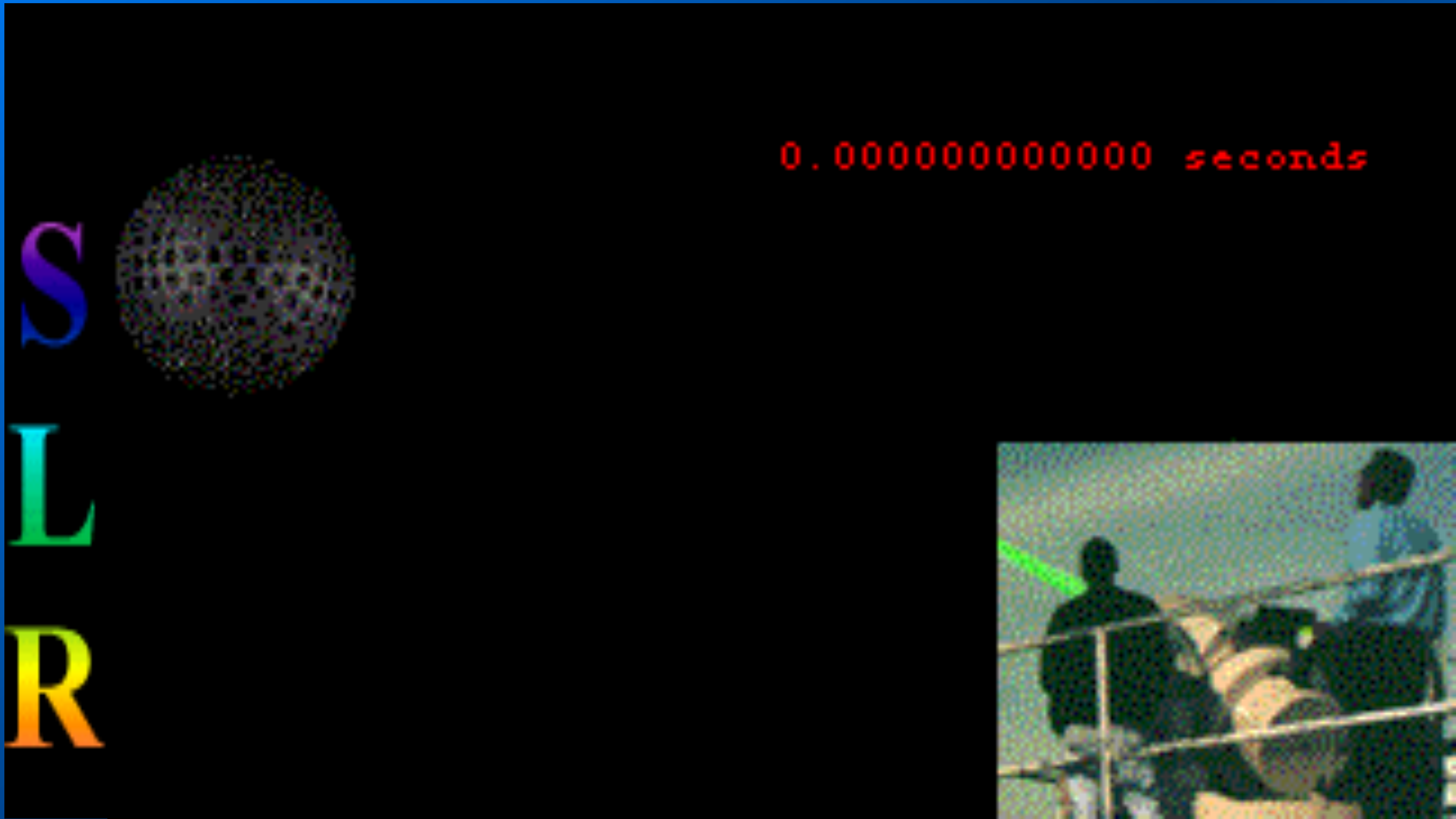
- Ground based station transmits short (pico-second) laser pulse.
- The laser pulse is reflected off a retroreflector on an artificial satellite or the Moon.
- The round trip time of flight is precisely measured and corrected for atmospheric delay and relativistic effects
- Then a geometric range is calculated. Many corrections to range, Earth-tide, pole-tide, ocean and atmospheric loading, tectonic movement

SLR Technique



SLR Missions

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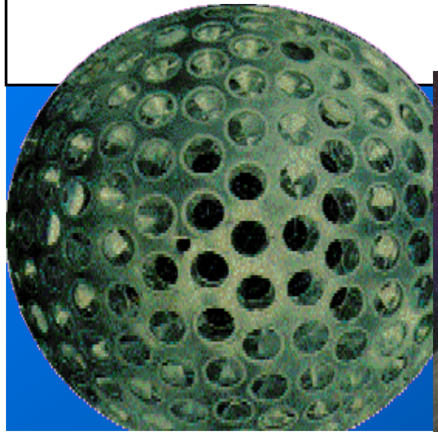
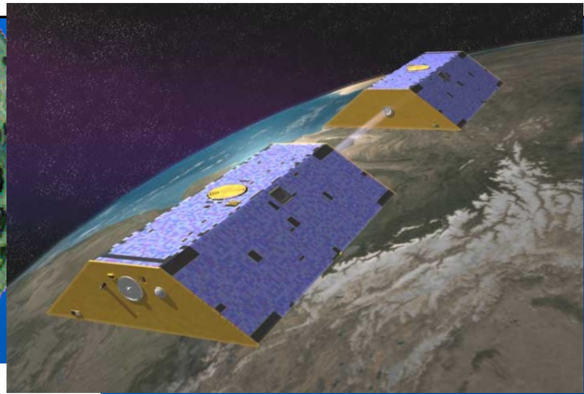
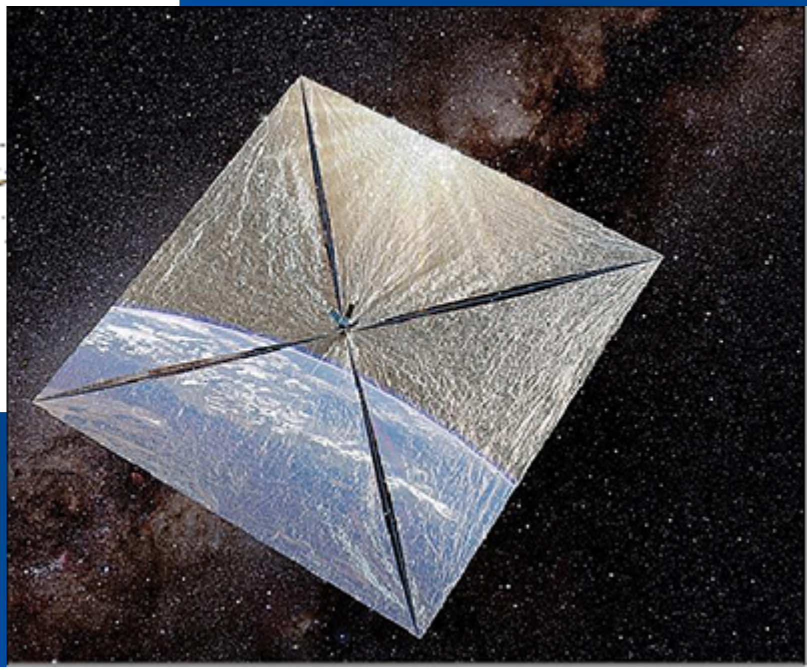






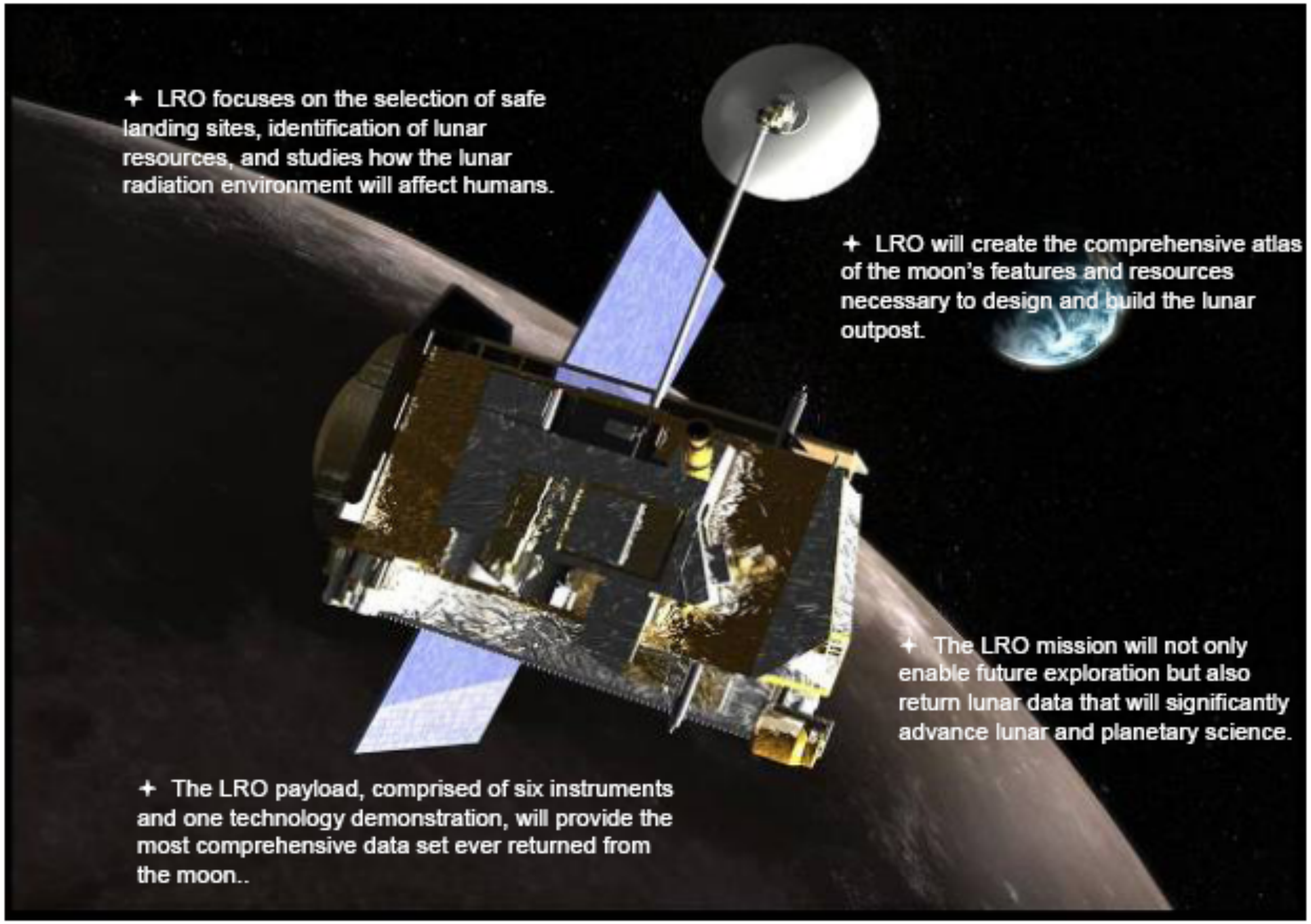
- *Geodetic* – inert massive spheres, e.g. Lageos.
- *Earth sensing and experimental* – equipped with e.g. radar altimeters, gravity probes, etc.

Radio navigation – e.g. GPS

LightSail-A is a propulsion test using a deployed sail
The satellite is planned for launch around 20 May 2015

SLR instrumentation

The Lunar Reconnaissance Orbiter (LRO) is NASA's first step in returning humans to the moon.



International Laser Ranging Service

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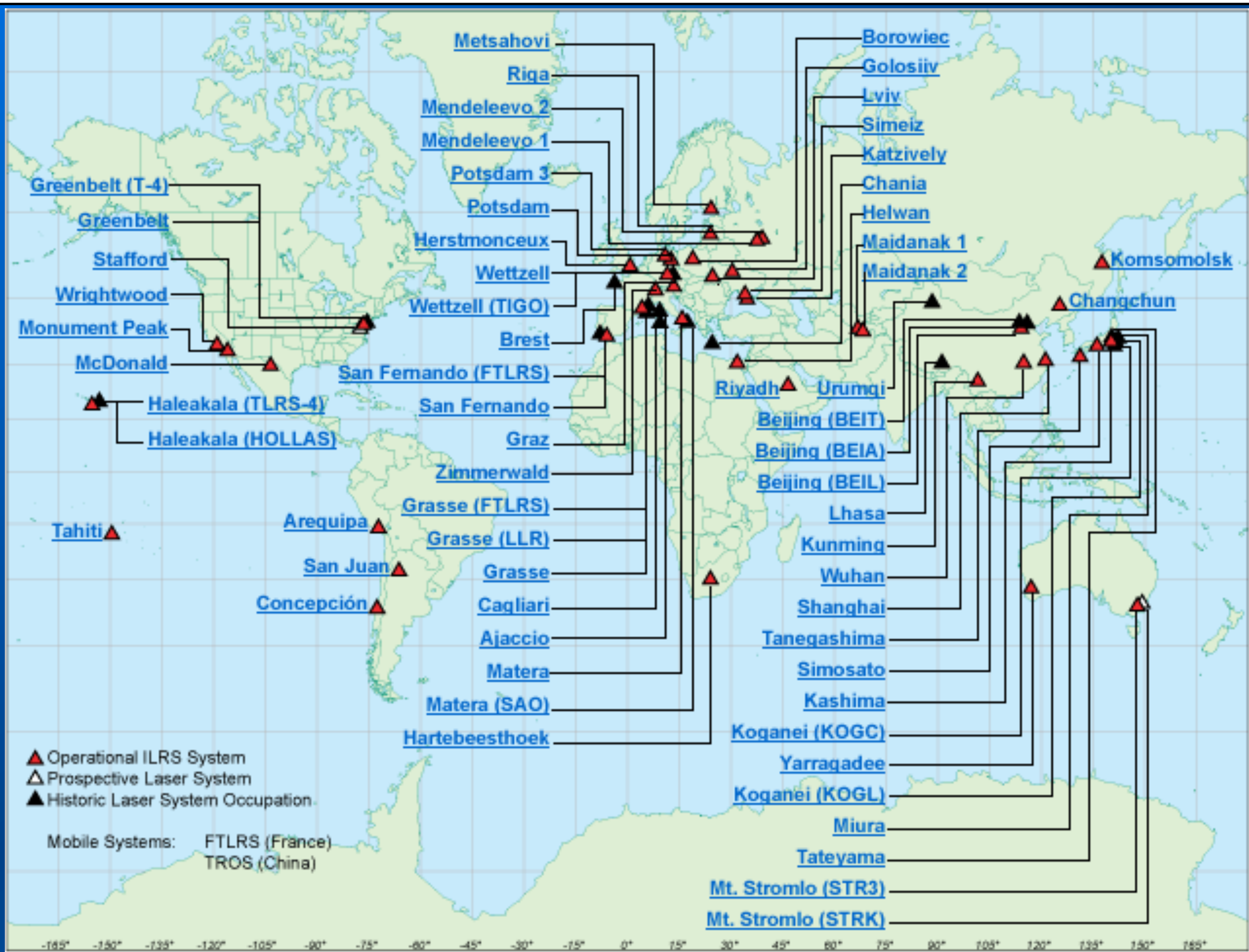

Lunar Laser Ranging

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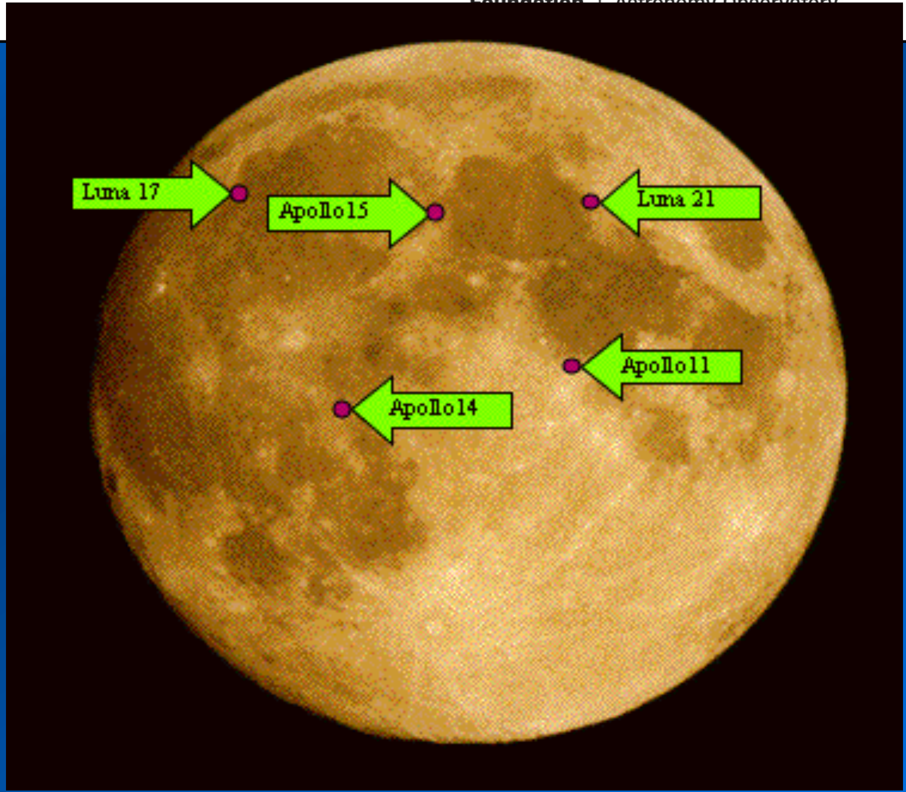
- Purpose:

  To perform tests to verify Einstein's theory of General Relativity.

- Requirement:

  mm-accuracy range measurements to the Moon.



Cooperative Network for GIOVE (test of GALILEO) Observation (DLR/BKG)

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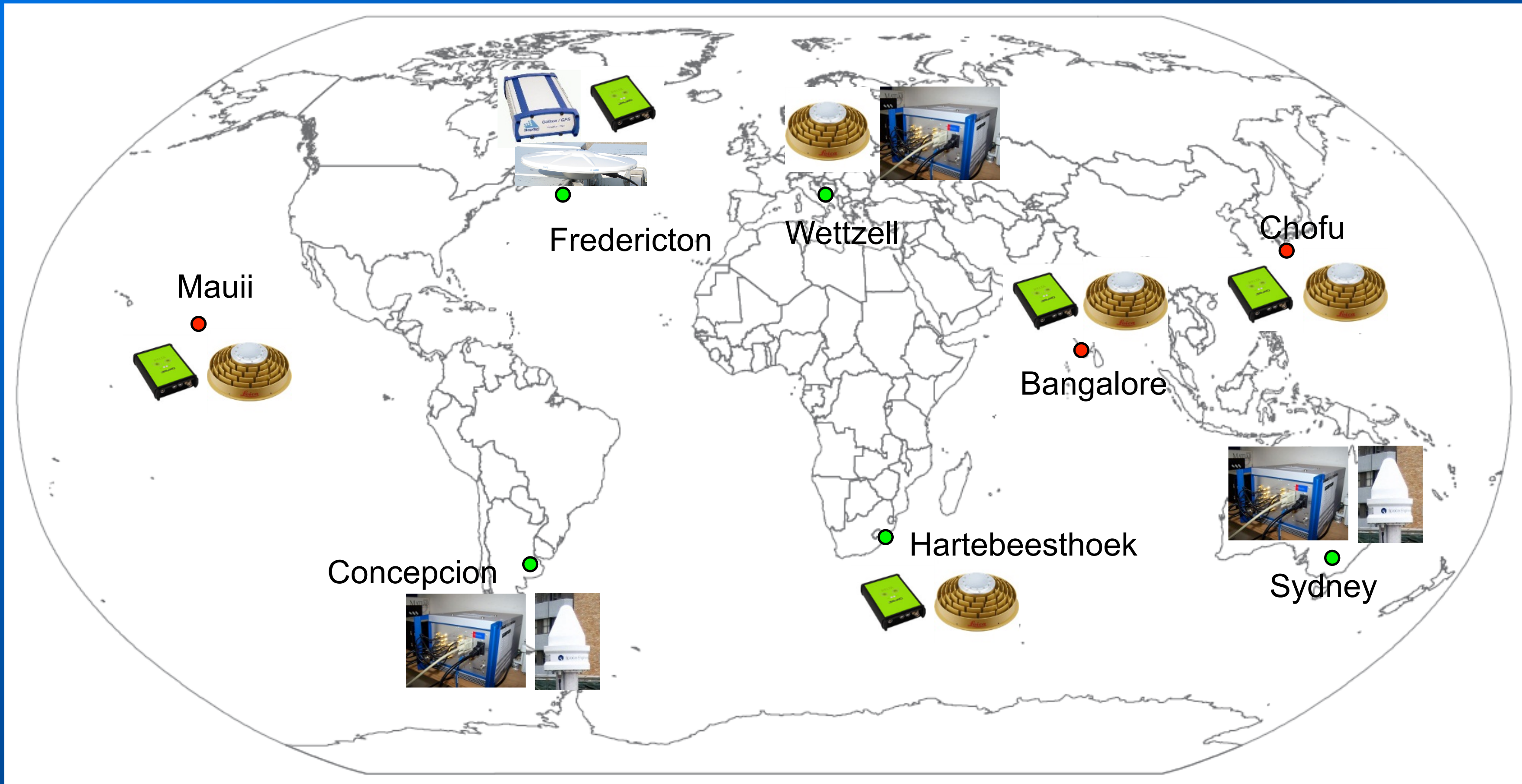

operational   under construction

International GNSS Service

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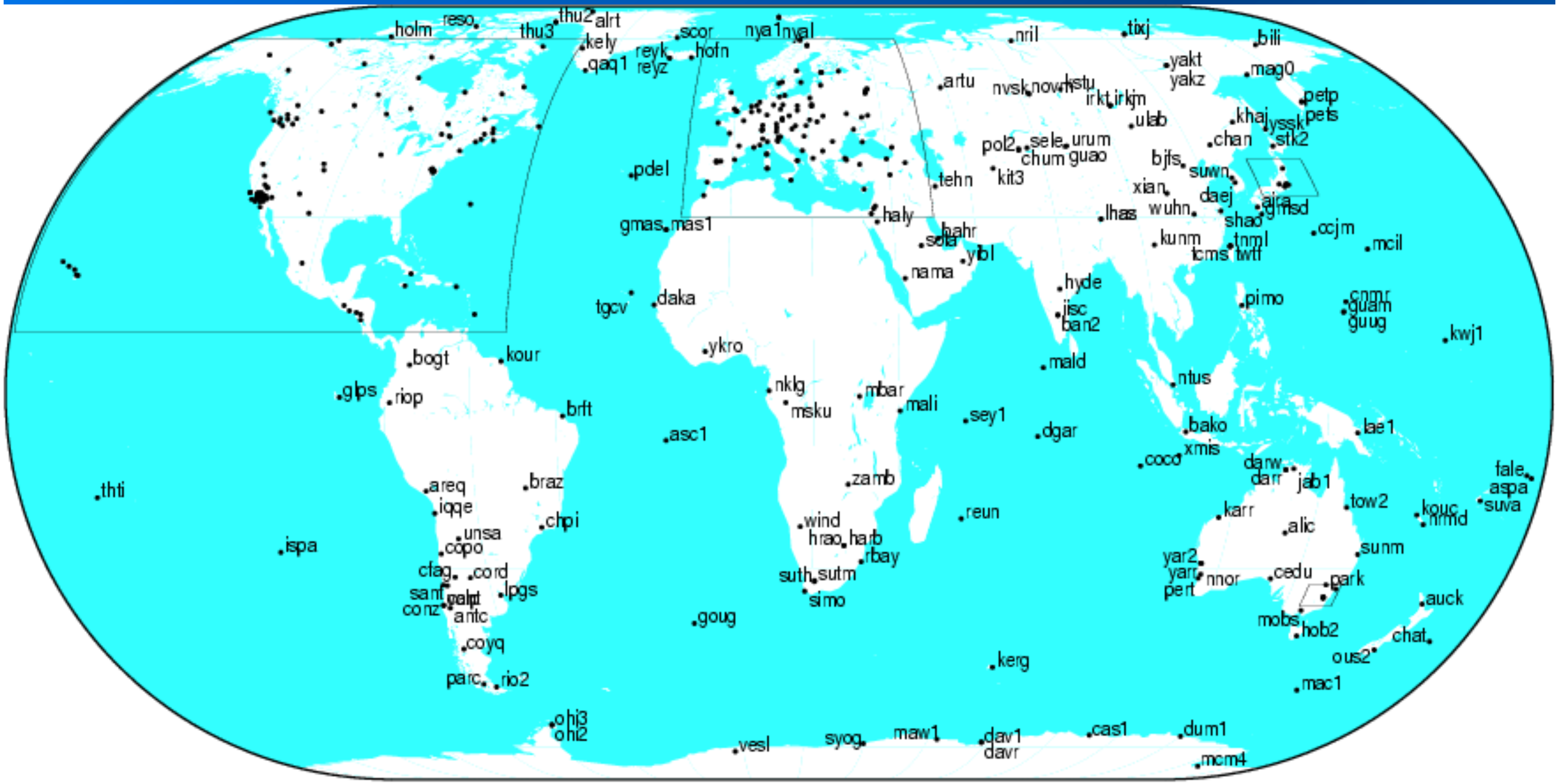

GMT 2007 Jul 12 17:29:18

Where are we?......

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Portable enough, accurate enough

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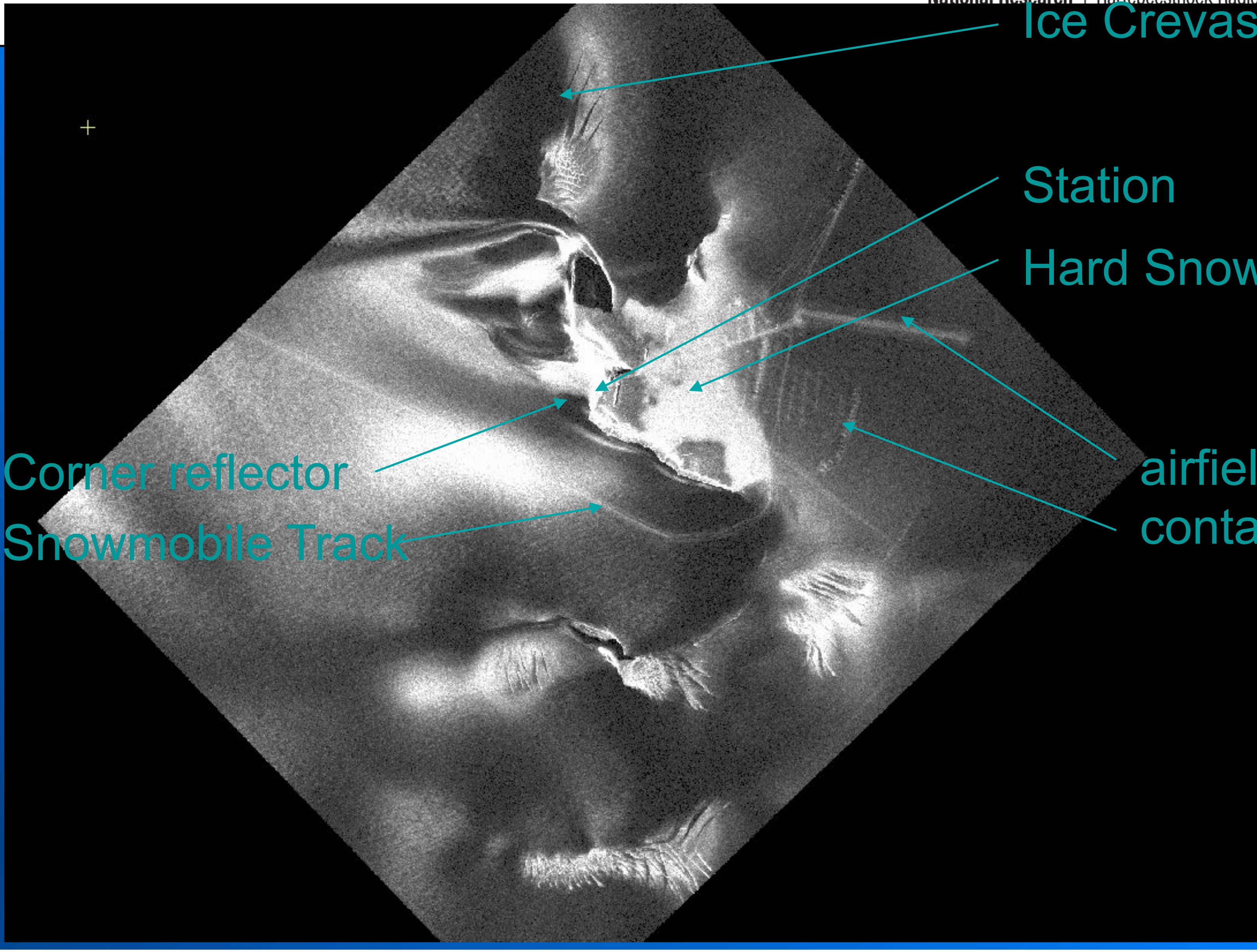
Versatile…..

Terra SAR X Spotlight image



Corner Reflector
overview / stretched / un-stretched

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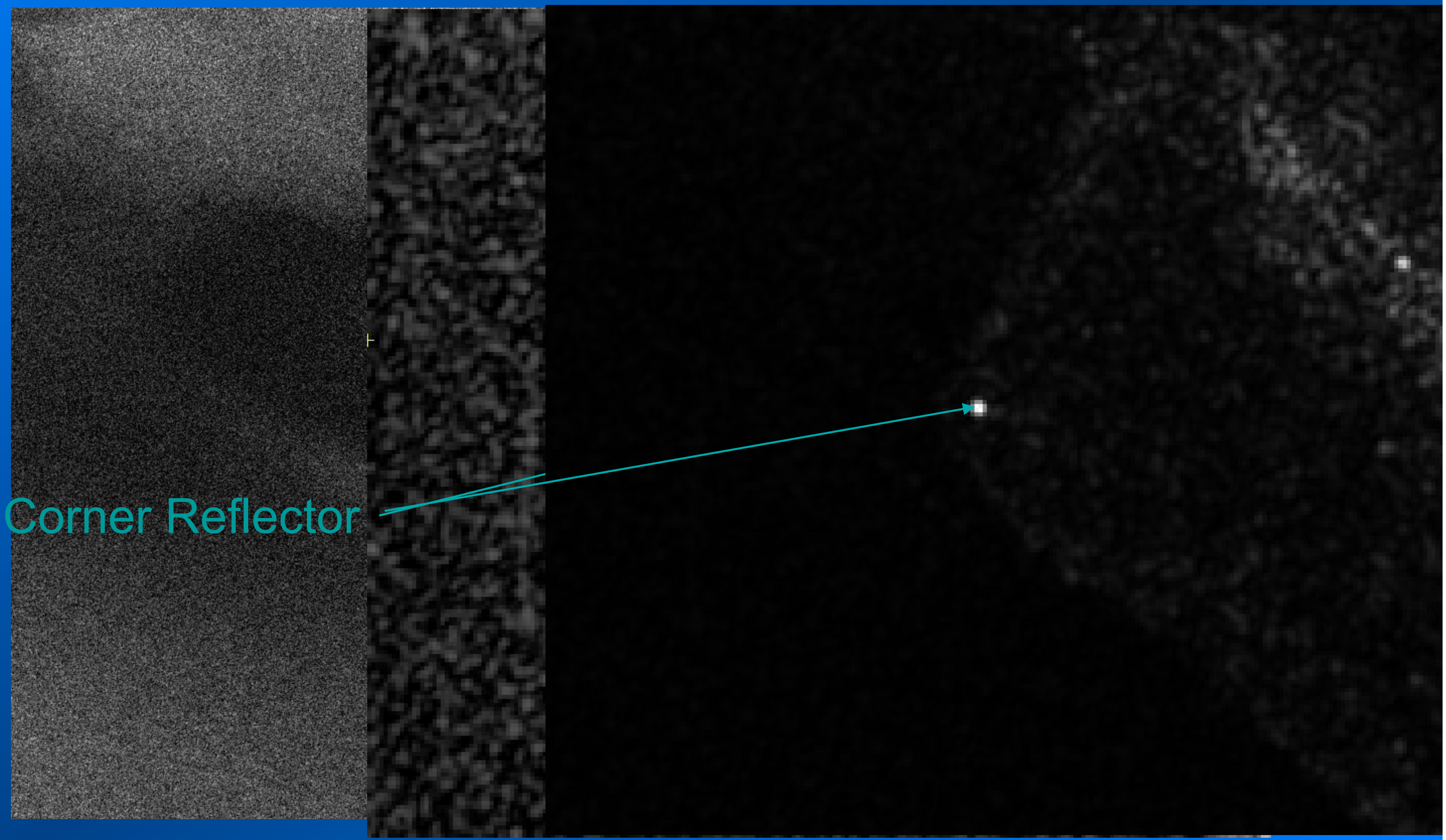

SANAE IV Station Overview

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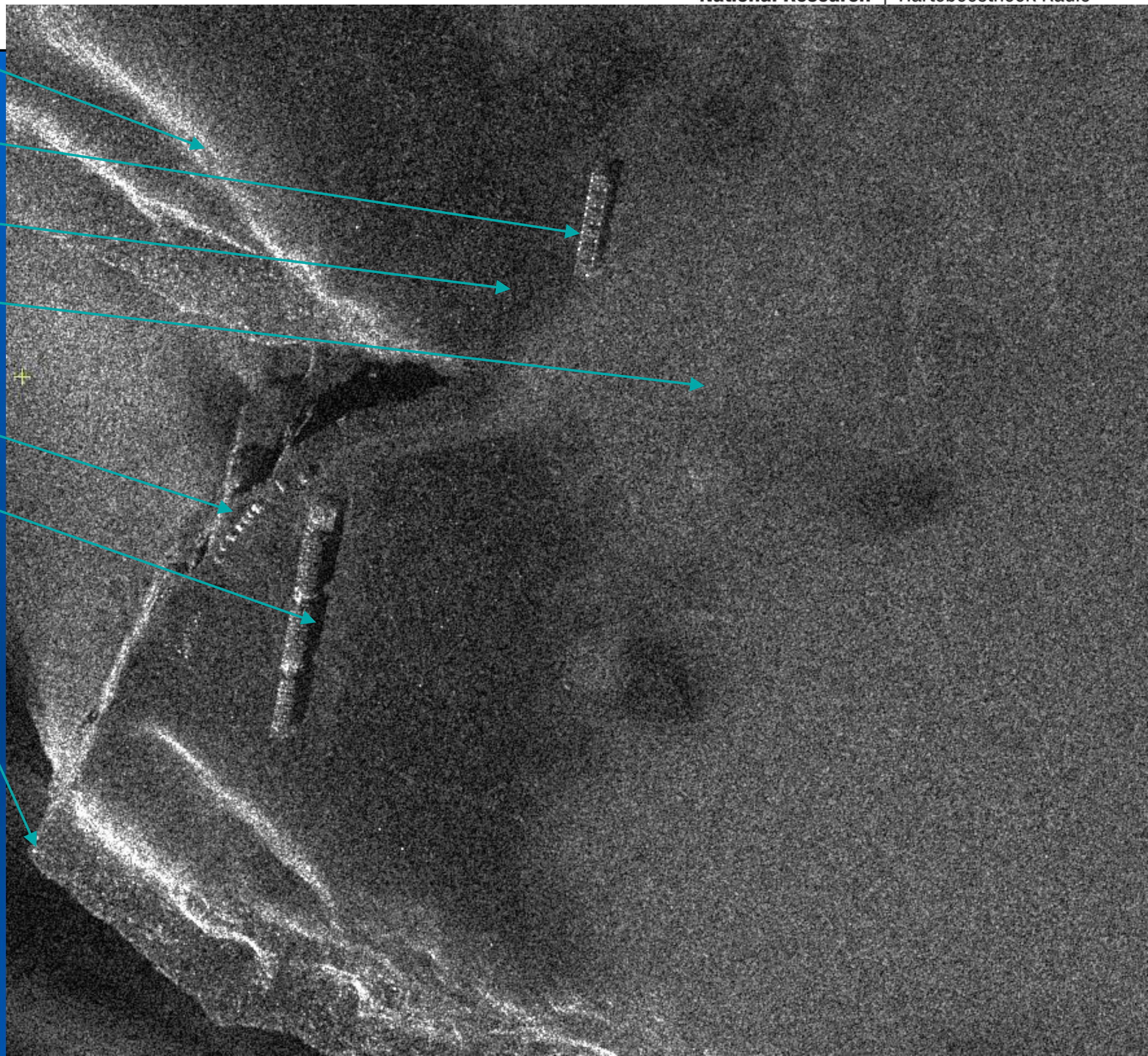
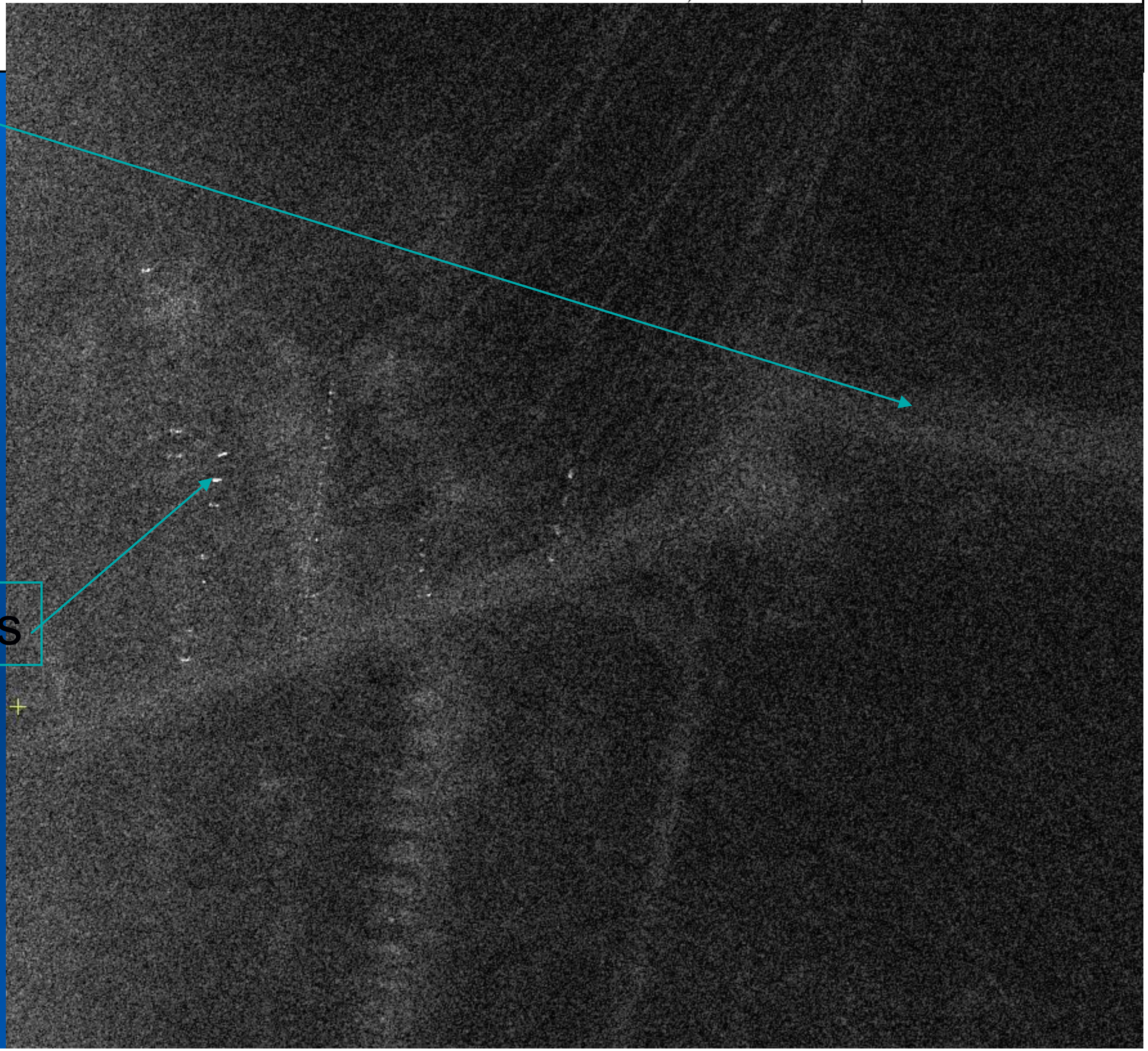
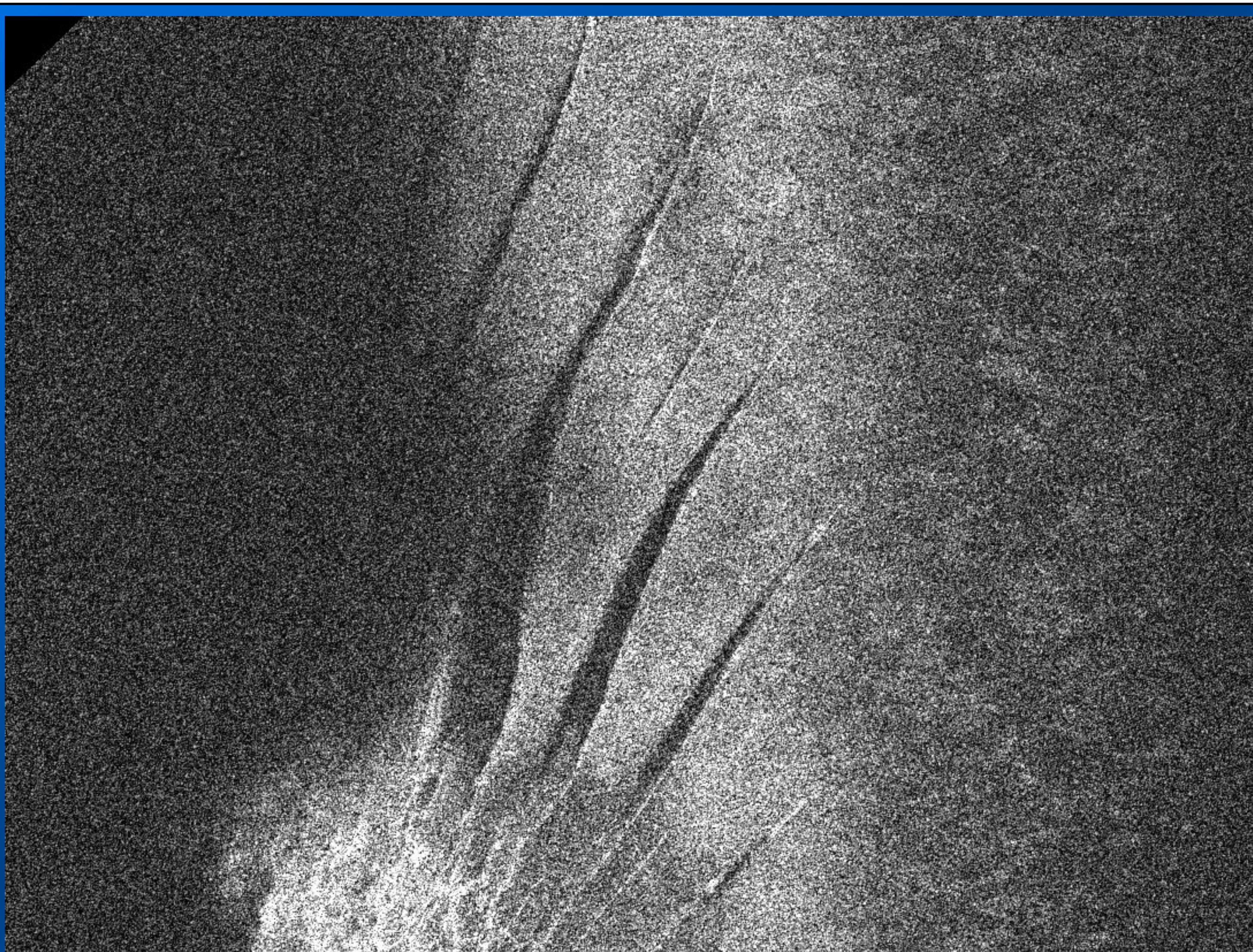


Landing Strip



Ice Crevasses



Outcomes of simple space geodesy application

- Radar reflectors can now be used to facilitate map accurate map production (geo-referencing)
- Crevasses and other features can be mapped
- Self-centring plates can be re-surveyed to determine crustal stability in region
- Motion of Antarctic plate can be determined

Thank you

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