

# **GGOS, ECGN and NGOS: Global and regional geodetic observing systems**

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- GGOS, ECGN, NGOS
- Why?
- How?
- Future?



International  
Association of  
Geodesy

GGOS

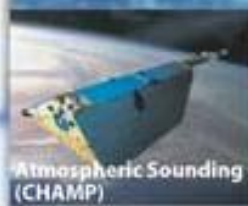
ECGN

NGS

# IAG's Global Geodetic Observing System (GGOS)



Geodetic Space Techniques



Atmospheric Sounding (CHAMP)



Satellite-to-satellite tracking (GRACE)



Satellite Altimetry

Products

Geometry and Kinematics



Earth Orientation and Rotation

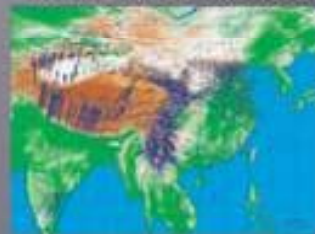


Gravity Field and Its Variability

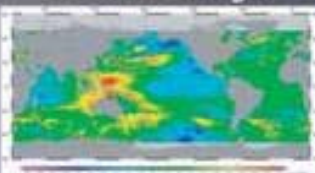


Applications

Positions and Velocities



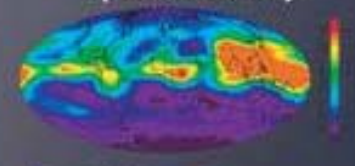
Sea Level Changes



Hydrological Cycle



Specific Humidity



Geohazards

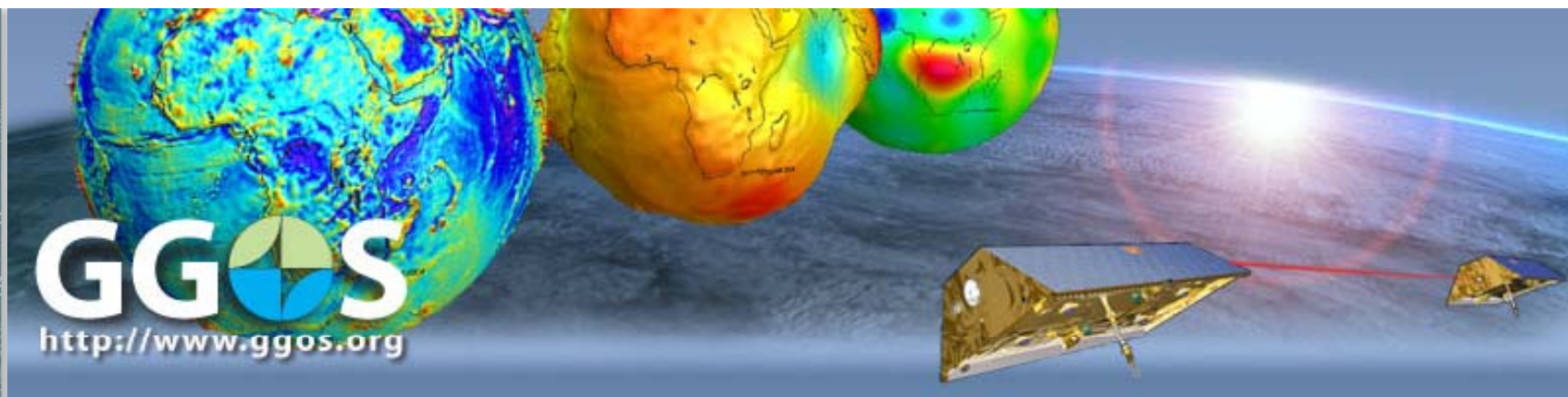


Ice Mass Balance

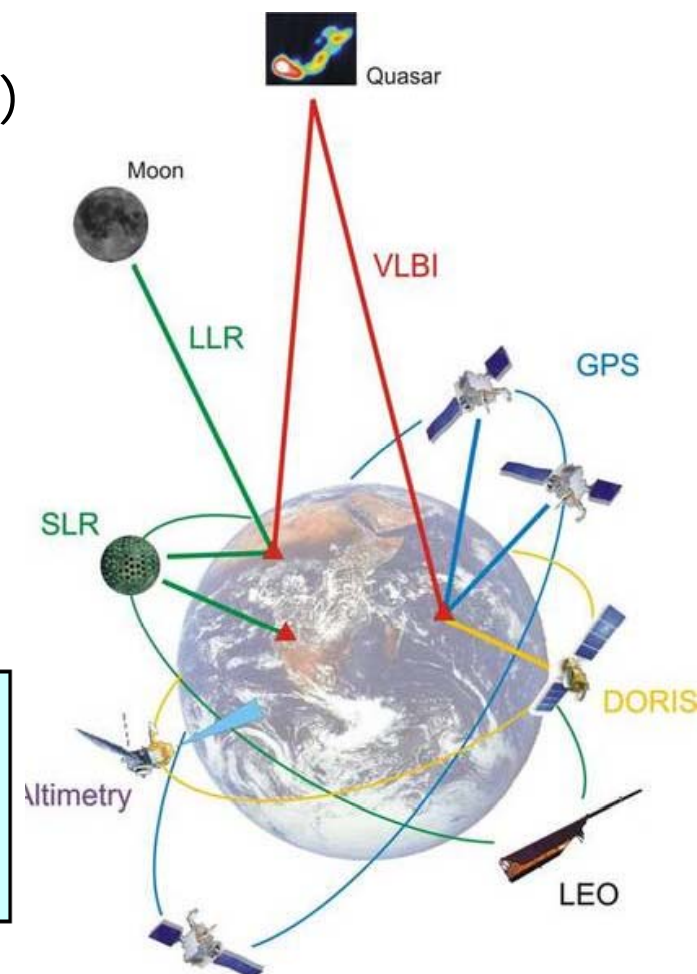
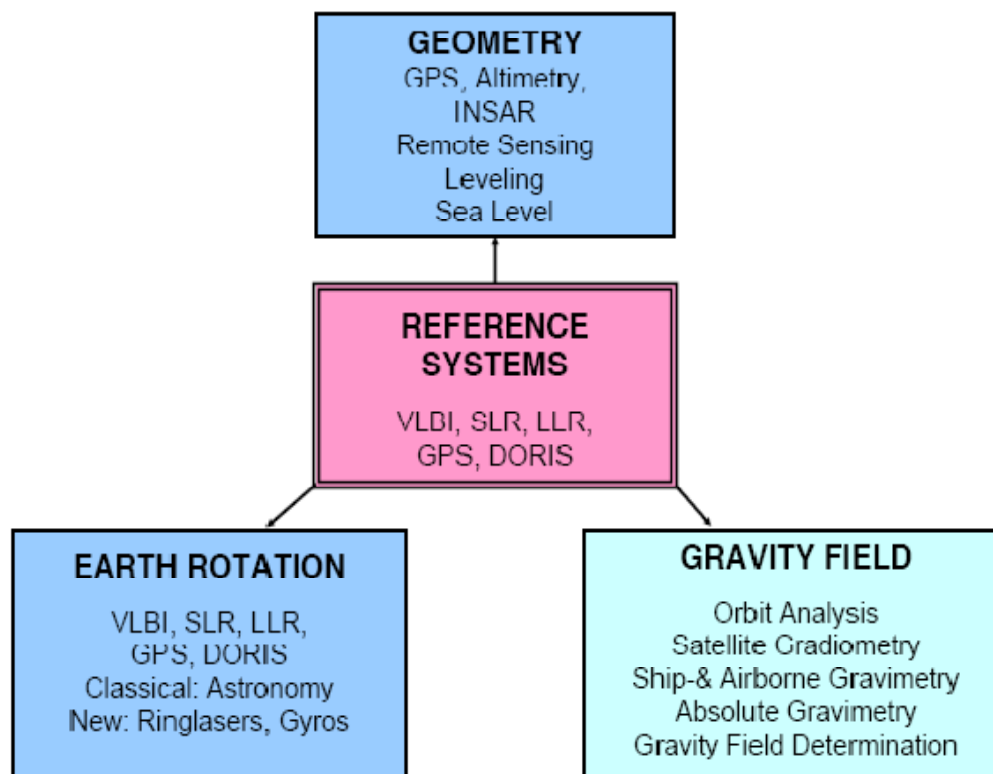
GGOS  
<http://www.ggos.org>

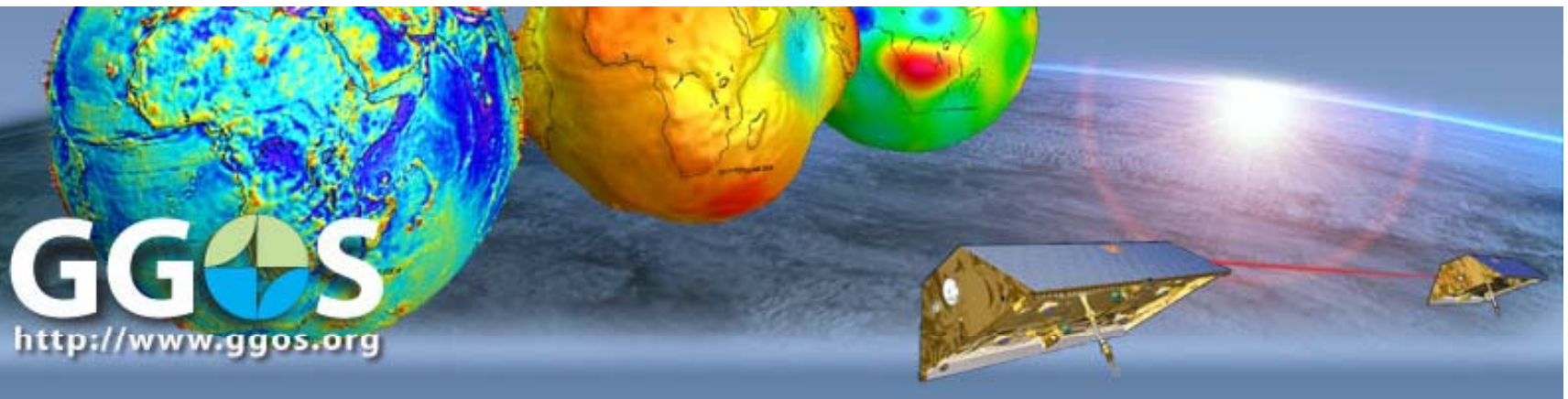
IAG services are based on more than 400 global observation stations.





## Second Level: Three Pillars of GGOS (geodesy)



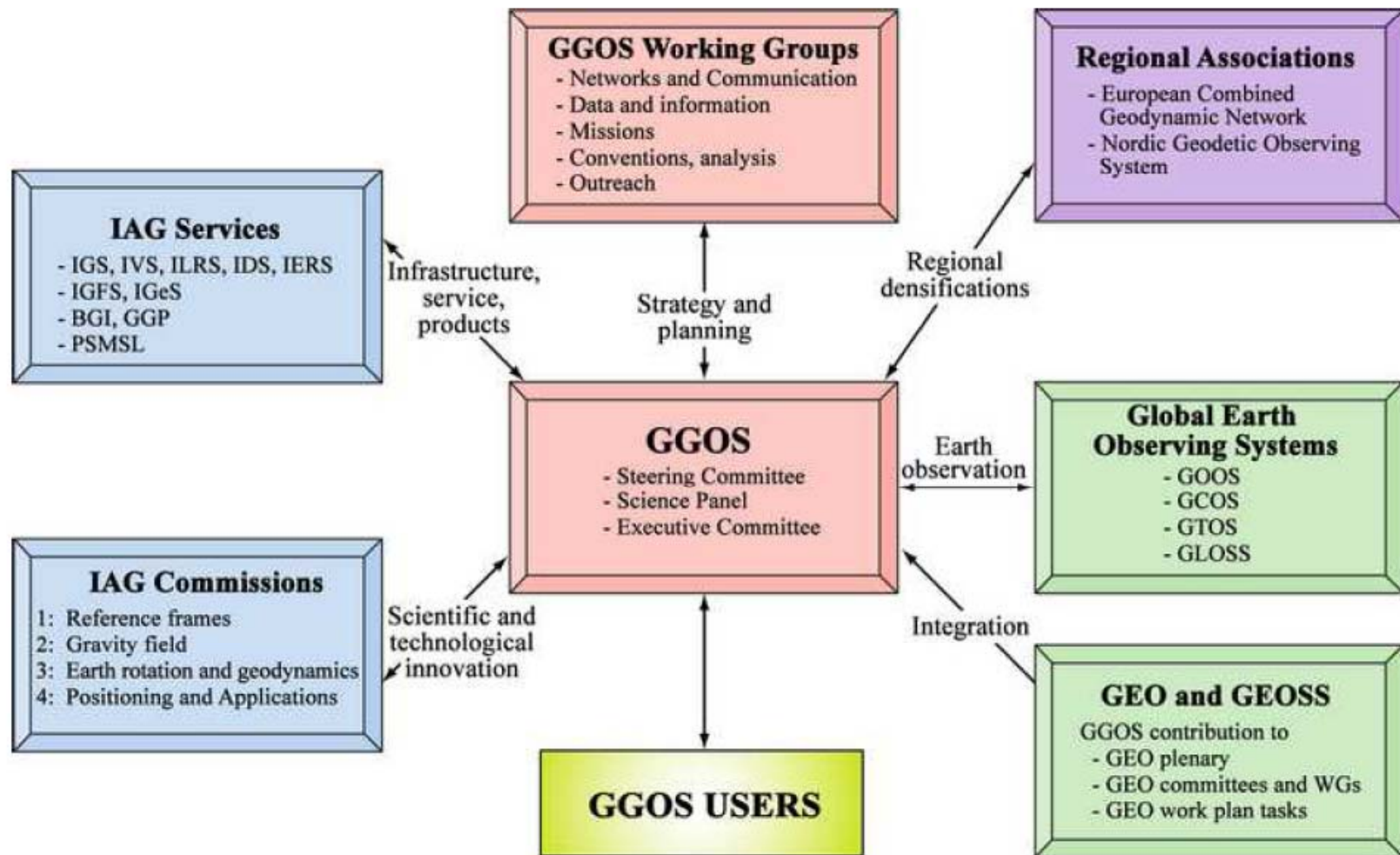


## Coordination within geodesy

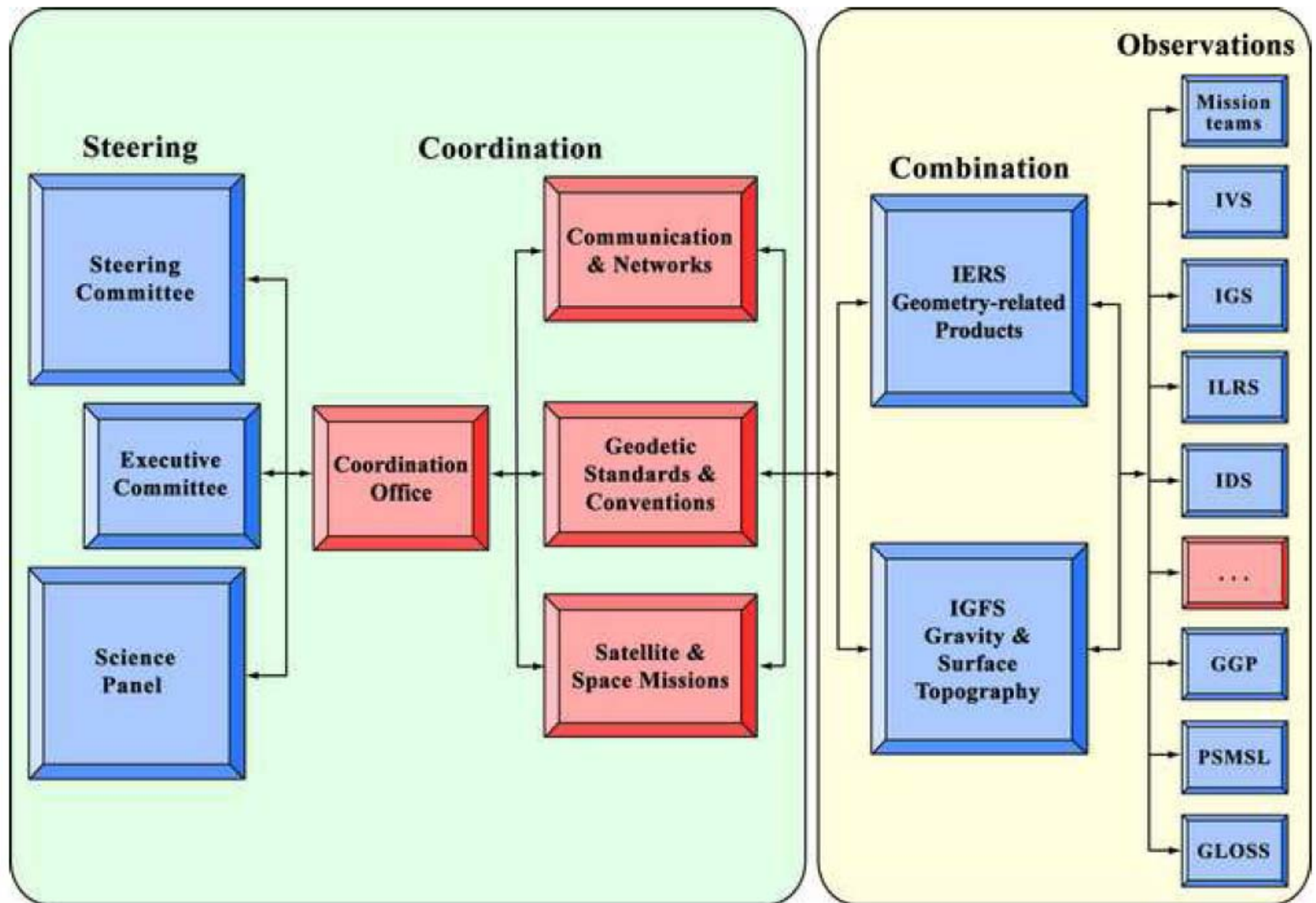
- GGOS aims at maintaining the stability of time series of geometric and gravimetric *reference frames*;
- GGOS ensures the consistency between the different geodetic *standards* used in the geo-scientific community;
- GGOS aims at improving the geodetic *models* at the level required by the observations;
- GGOS focuses on all aspects to ensure the consistency of geometric and gravimetric *products*.



# GGOS Structure



# GGOS Structure



# European Combined Geodetic Network



Objectives of the ECGN as an integrated European Reference System for Spatial Reference and Gravity are:

- Realization of a terrestrial reference system and maintenance of long time stability with an accuracy  $10^{-9}$  for Europe especially in the vertical component
- In-situ combination of space geodesy (GPS) with Earth gravity parameters (gravity, heights)
- Modelling of influences of time depended parameters to TRF (of the solid Earth of the Earth gravity field, the atmosphere, the oceans, the hydrosphere)
- Modelling of terrestrial gravity field components to validate satellite gravity missions
- Geodetic platform in Europe for geo-initiatives (GMES, INSPIRE, GEOSS, GGOS)

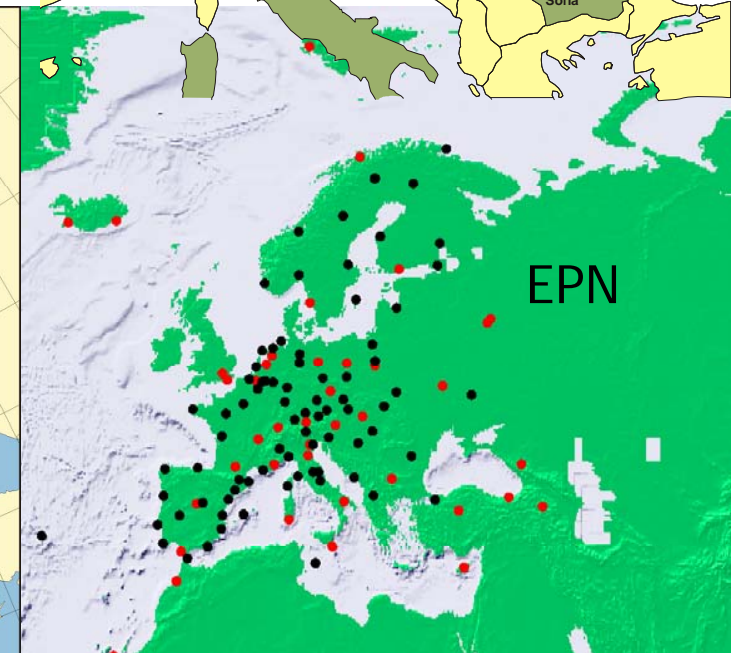
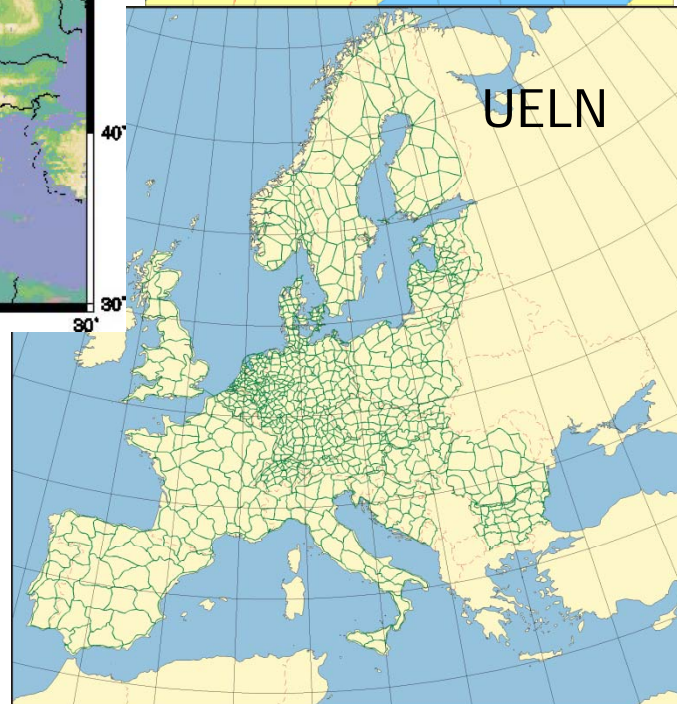
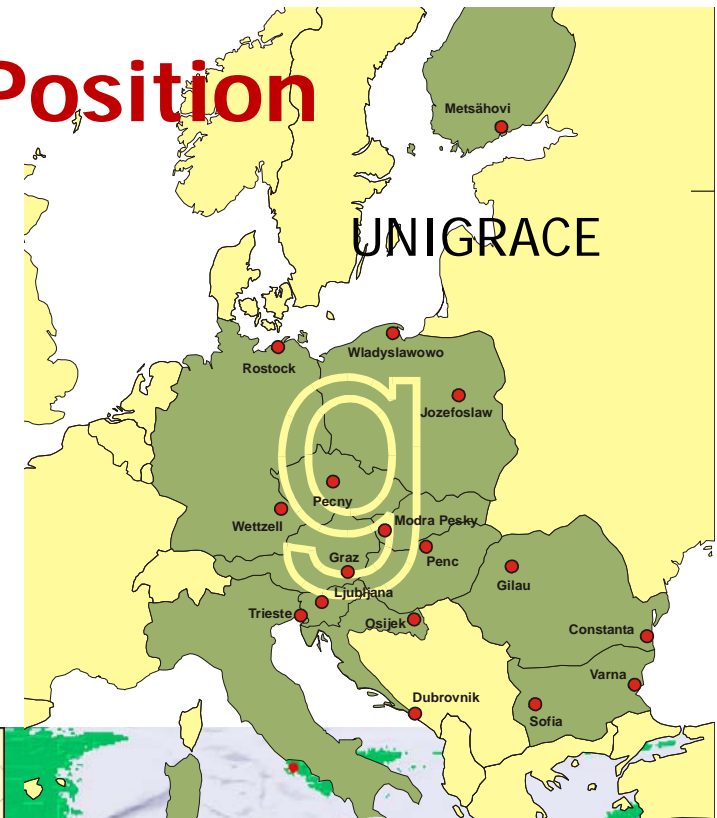
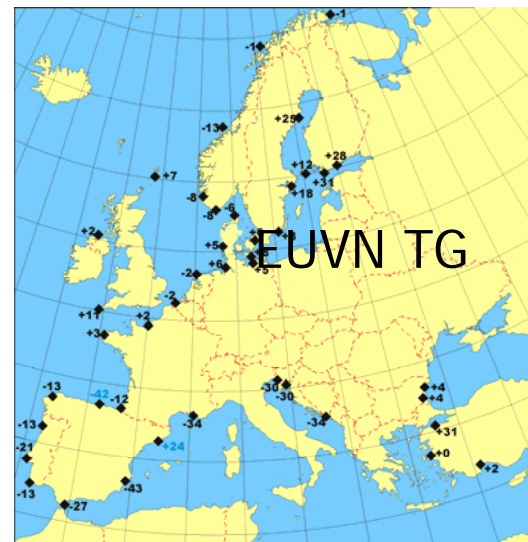
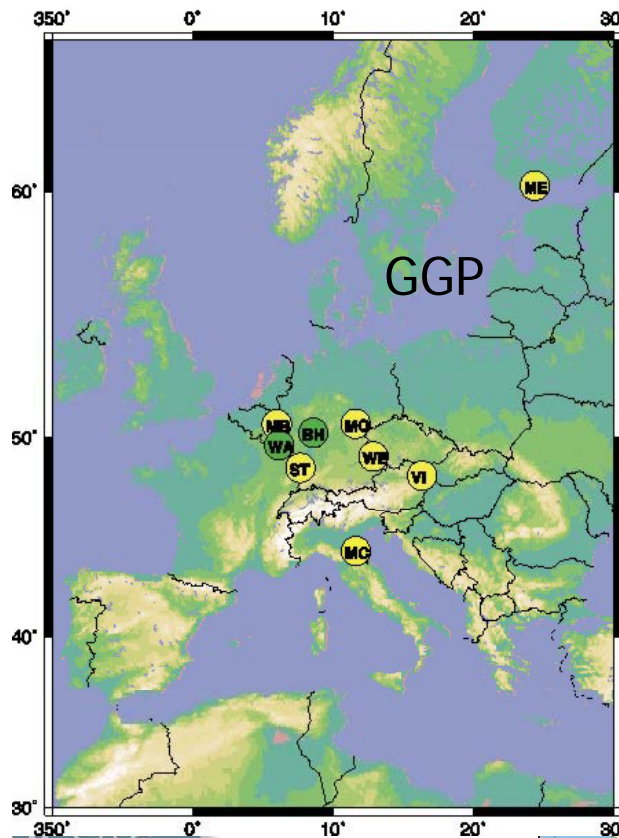
The ECGN is considered as a European contribution to the IAG's Global Geodetic Observation System (GGOS). At the business meeting of the IGGC at the Gravity and Geoid 2002 Symposium in Thessaloniki the ECGN project as a cross-commission project was approved. The primary concern of the project consists in connecting the height component with the gravity determination while allowing for measuring data that are acquired in the European coastal regions and above adjacent seas.



# Motivation – Starting Position



GGP Stations July 03





# Network Infrastructure

1st Call for Participation (April 2003):  
Implementation of ECGN Stations

Elaboration of the observation network of ECGN  
stations with the standard observation techniques:

- GNSS (GPS/GLONASS, GALILEO) permanent
- Gravity (super conducting gravimeter and/or absolute gravimeter) – permanent or repeated
- Levelling connections to the of UELN/EVRS – repeated
- Tide gauges – permanent
- Meteorological parameters – permanent.

# ECGN - Stations



Status: 2007-01-23

Status and Techniques (Standard: GPS, absolute gravity, levelling)

- |                   |   |                             |   |
|-------------------|---|-----------------------------|---|
| core station      | ● | super conducting gravimeter | ○ |
| station           | ● | tide gauge                  | △ |
| candidate station | ■ |                             |   |
| proposed station  | ✦ |                             |   |





# NGOS; Nordic Geodetic Observing System

- A task force from the Presidium of the Nordic Geodetic Commission (NKG)
- The Nordic Geodetic Observing System (NGOS) integrates fundamental geodetic techniques for the longterm observation of Earth system parameters
- **NGOS will be a regional implementation and densification of the GGOS**



## NGOS / Key Areas to Study

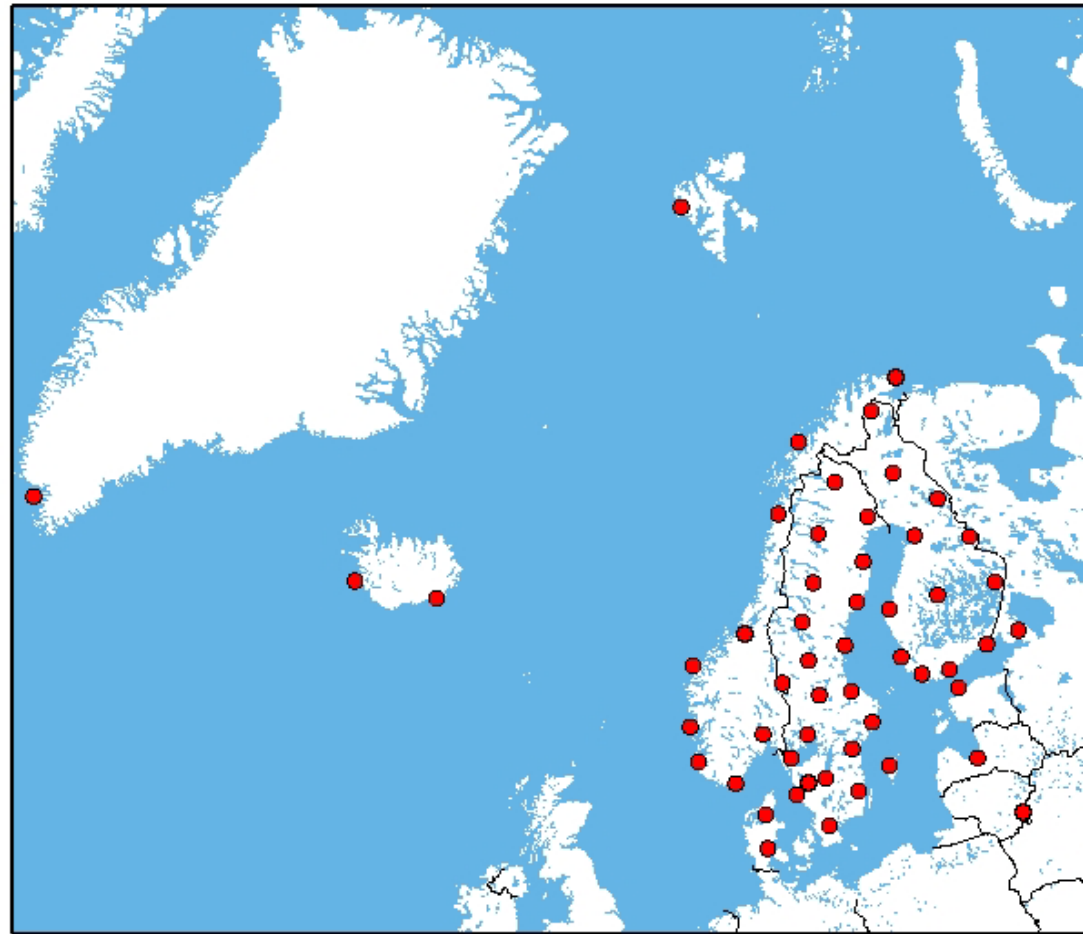
- Glacial dynamics, postglacial rebound
- Crustal stability
- Global climate change and its consequences

## NGOS / Key Parameters

- Height / height systems
- Sea Level
- Geodetic position, reference frames
- Geopotential and gravity anomalies
- Temporal gravity change

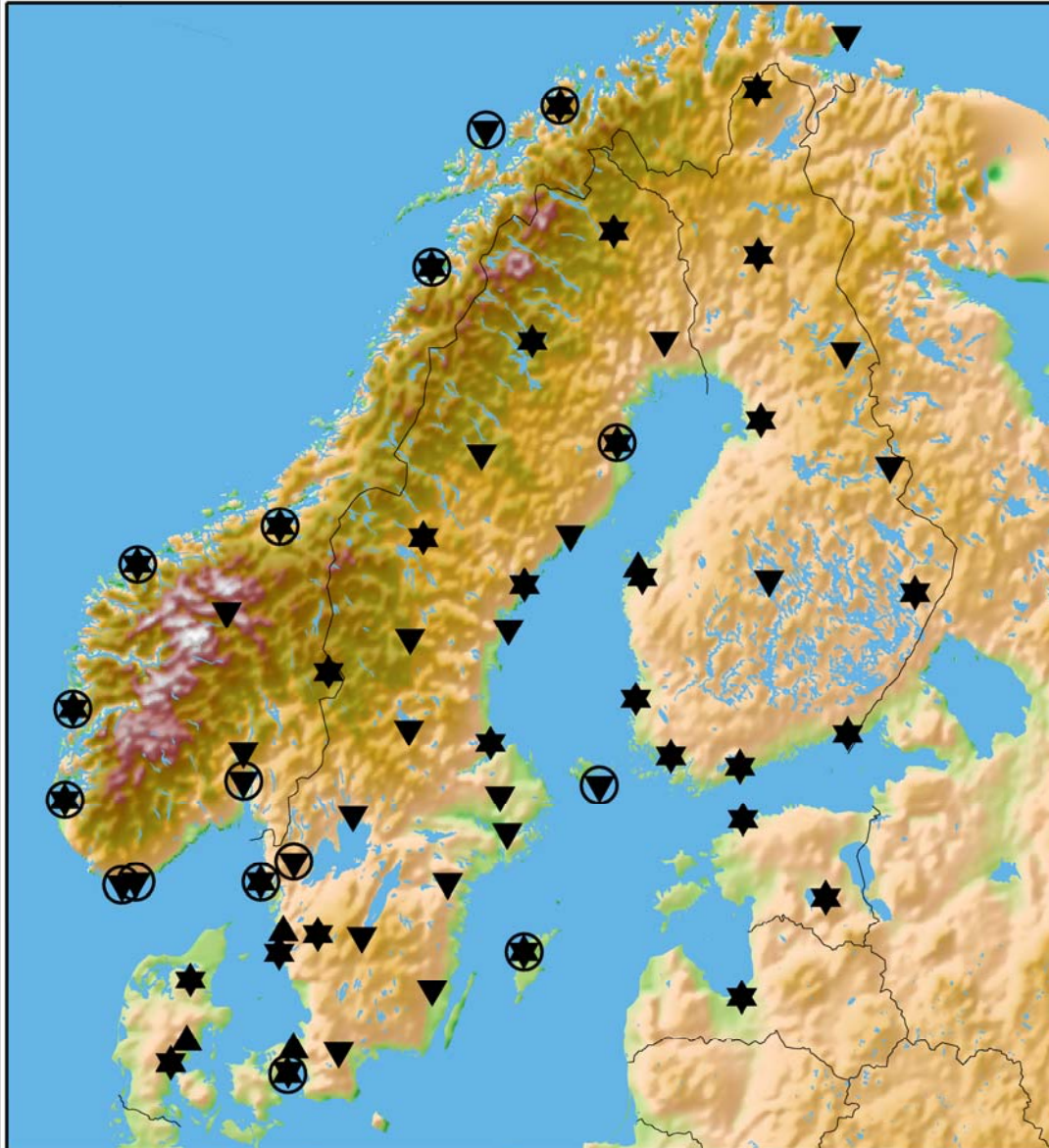
# NGOS / Geographic extent

Formerly and presently ice covered areas of the Northern hemisphere, primarily Northern Europe and Greenland





# NGOS plan, Fennoscandia



Absolute gravity points  
(triangles),

Nordic permanent GPS  
network (upside down  
triangles)

Tide gauges (circles).

All absolute gravity  
points are occupied with  
a GNSS instrument.

+ SLR, geo-VLBI, DORIS

# NGOS Techniques

Technique	Objective	Accuracy	Component(s)
VLBI	Point positioning relative to space	0.001 ppb 0.1 mas	Surface displacement; Earth rotation; Reference frame
SLR	Point positioning relative to many satellites	< 1 cm (range) 1-2 cm	Surface displacement; Earth rotation; Reference frame
GNSS	Point positioning relative to a satellite system	E: 1-2 cm <sup>*)</sup> C: 1-2 mm	Surface displacement; Reference frame
DORIS	Point positioning relative to satellites	1-5 cm	Surface displacement; Reference frame
Levelling	Height differences of points relative to the geoid	< 1 mm/km <sup>1/2</sup>	Surface displacement; Reference frame
Tide gauges	Height of points relative to sea level	E: 10 cm C: 1 cm	Surface displacement; Reference frame
Absolute gravimeters	Absolute gravimetric accelerations	2-3 µGal	Surface displacement; Earth rotation; Gravity; Reference frame
Superconducting gravimeters	Relative gravimetric accelerations	0.1 µGal (< 1 nGal periods)	Surface displacement; Earth rotation; Gravity; Reference frame
Spring gravimeters	Relative gravimetric accelerations	2-3 µGal	Gravity; Reference frame
*) <i>E means episodal and C continuous measurements</i>			



# Example: Nordic Permanent GNSS Network

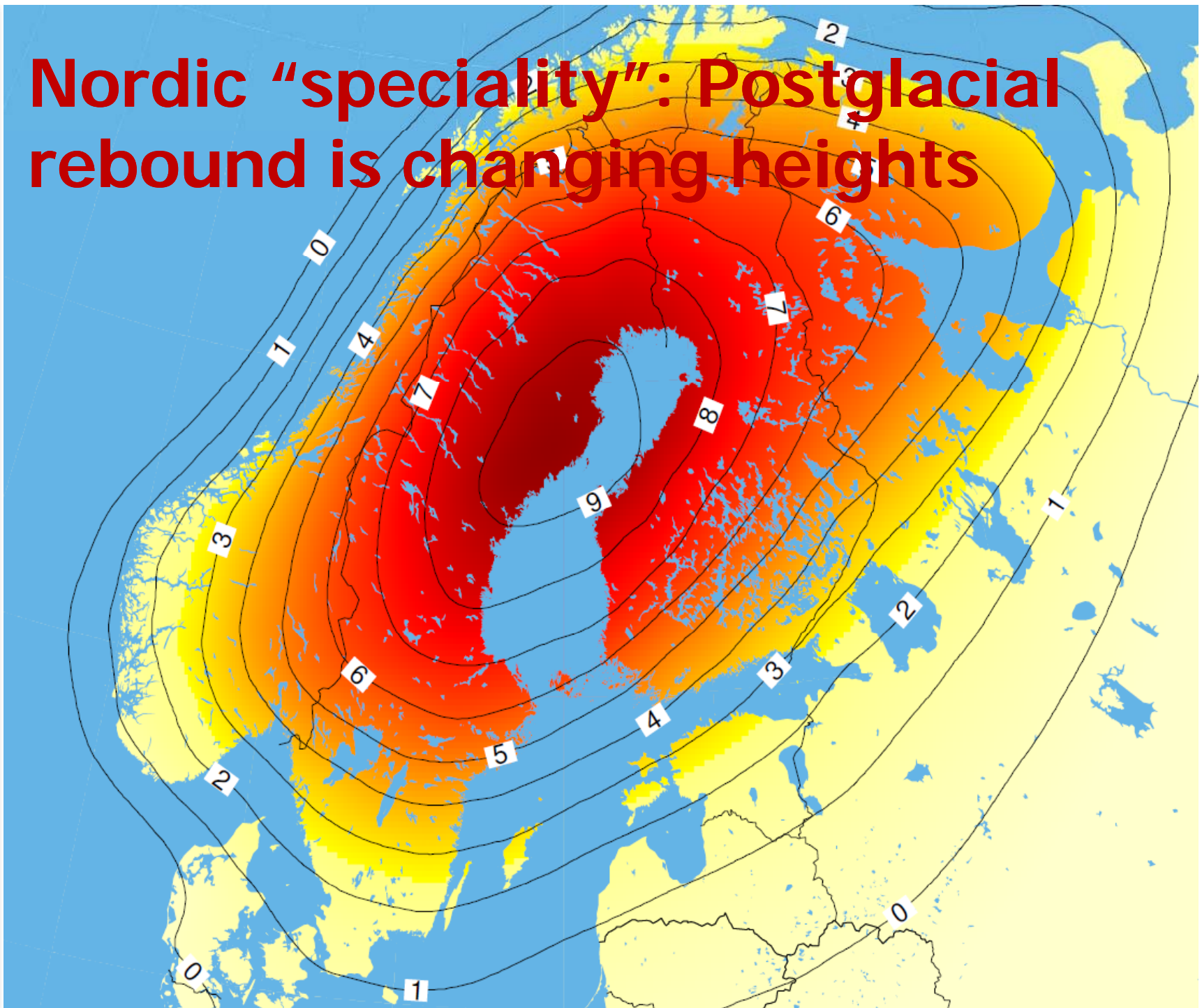
NKG Analysis Center  
and National  
Authorities

- Contribution to **EPN**
- National frames
- Bifrost
- NKG WGs





# Nordic "speciality": Postglacial rebound is changing heights



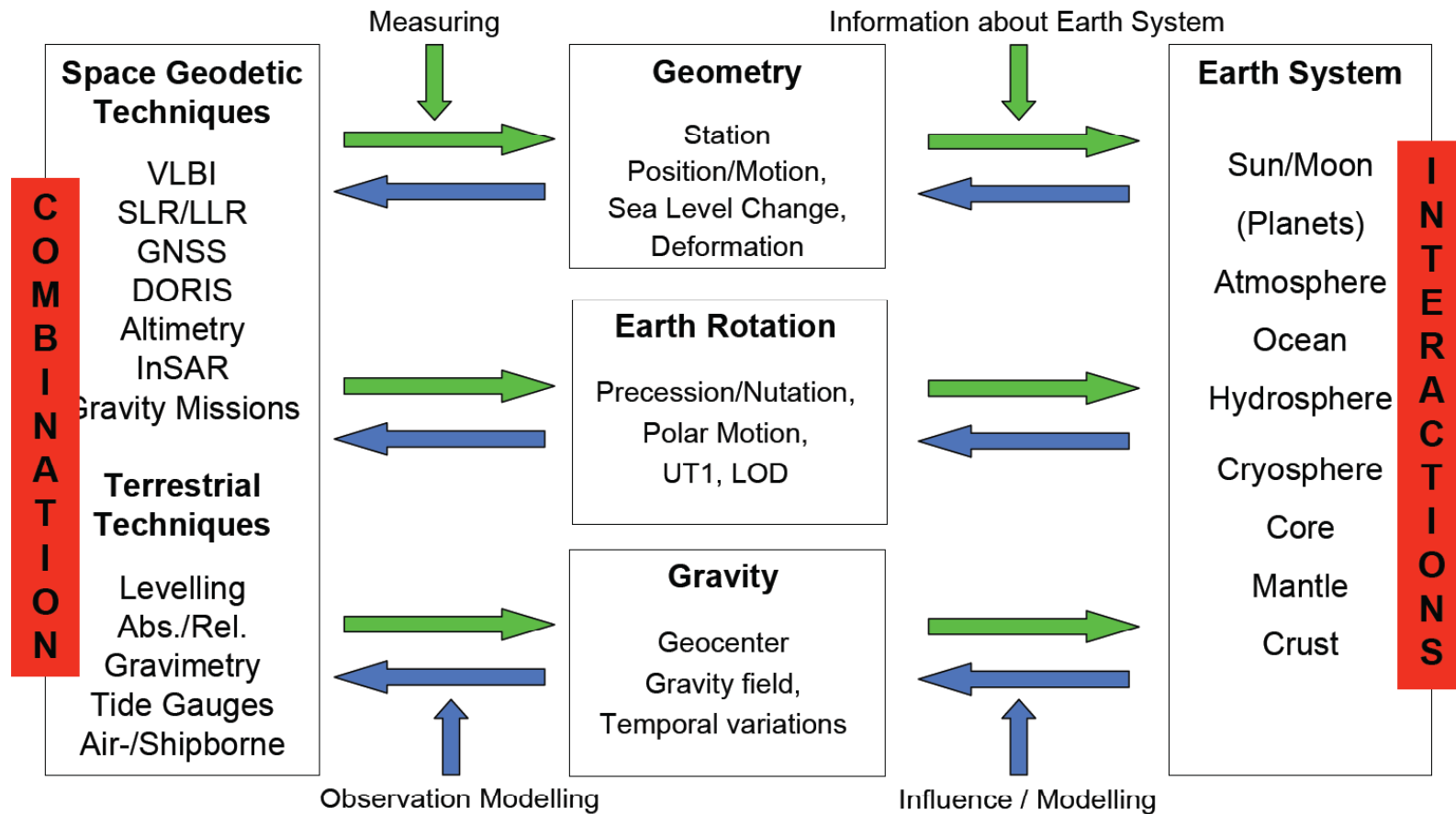


# Why?

- Geodetic networks of different techniques separated (reference frames, levelling, gravity)
- Connection of observations of different techniques
- Availability of data, access of data
- Quality control of data
- Continuation and stability of the infrastructure
- Response to political and societal needs
- Delivery of products to the end users
- Unawareness of geodetic methods

# How?

## Measuring and Modeling the Earth's System

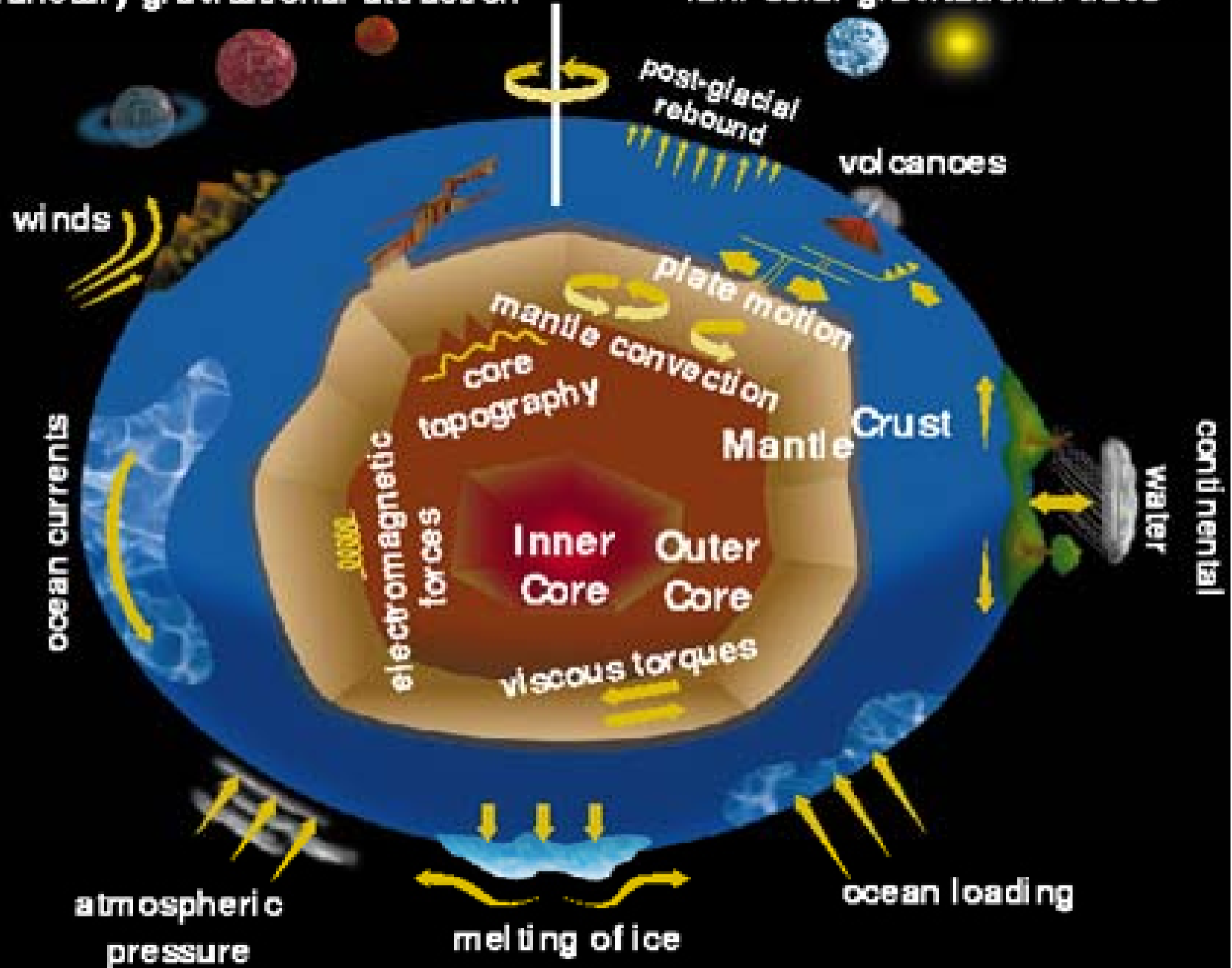


M. Rothacher

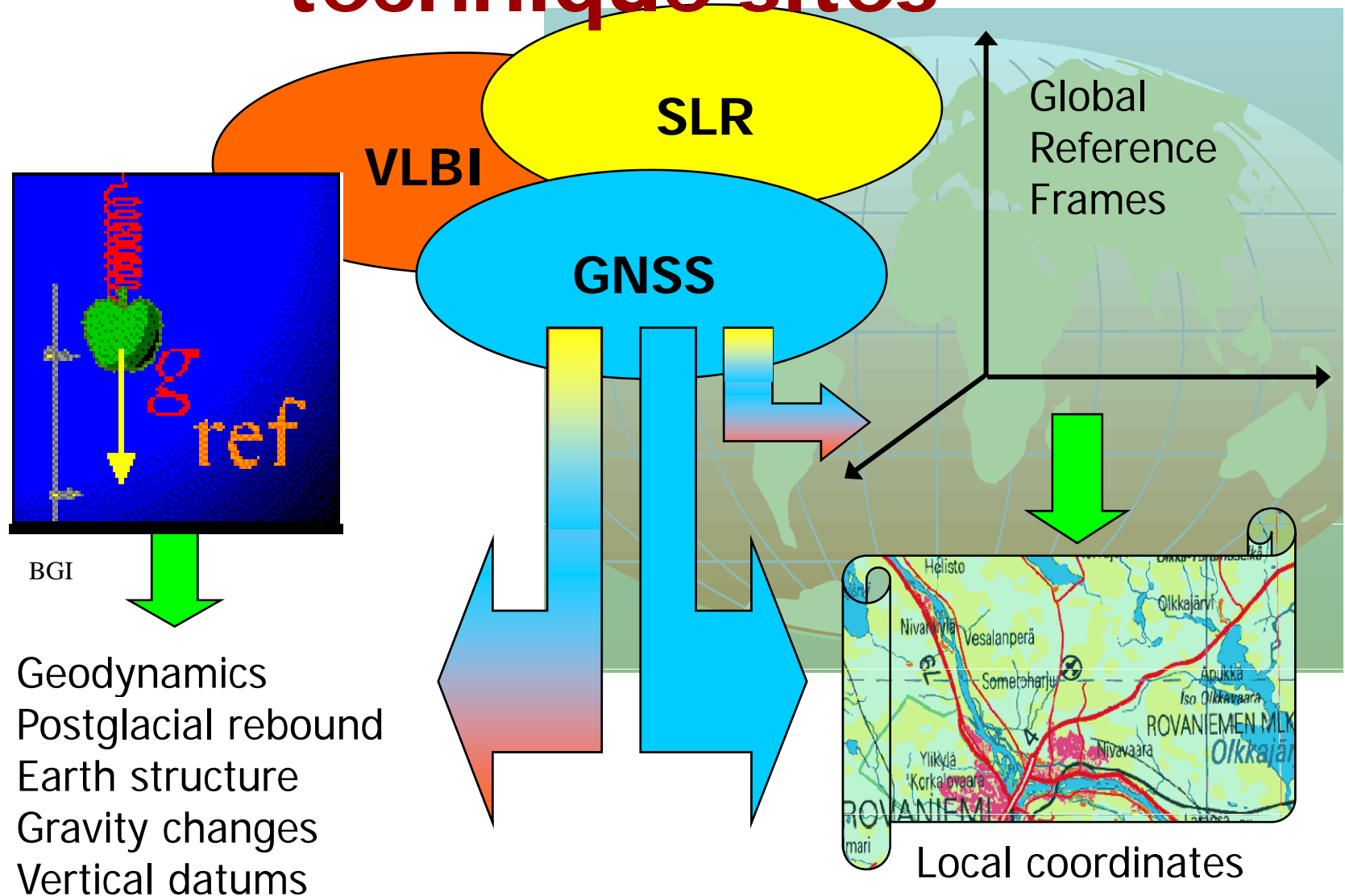


planetary gravitational attraction

luni-solar gravitational tides



# Motivation for multi-technique sites





# Main contributions of Geodesy to global monitoring

1. Maintenance of a highly accurate reference frame as the backbone for all other observation systems
  - Provides the infrastructure and observations to determine and maintain an accurate and stable terrestrial reference frame as the basis for all Earth observations





# Main contributions of Geodesy to global monitoring

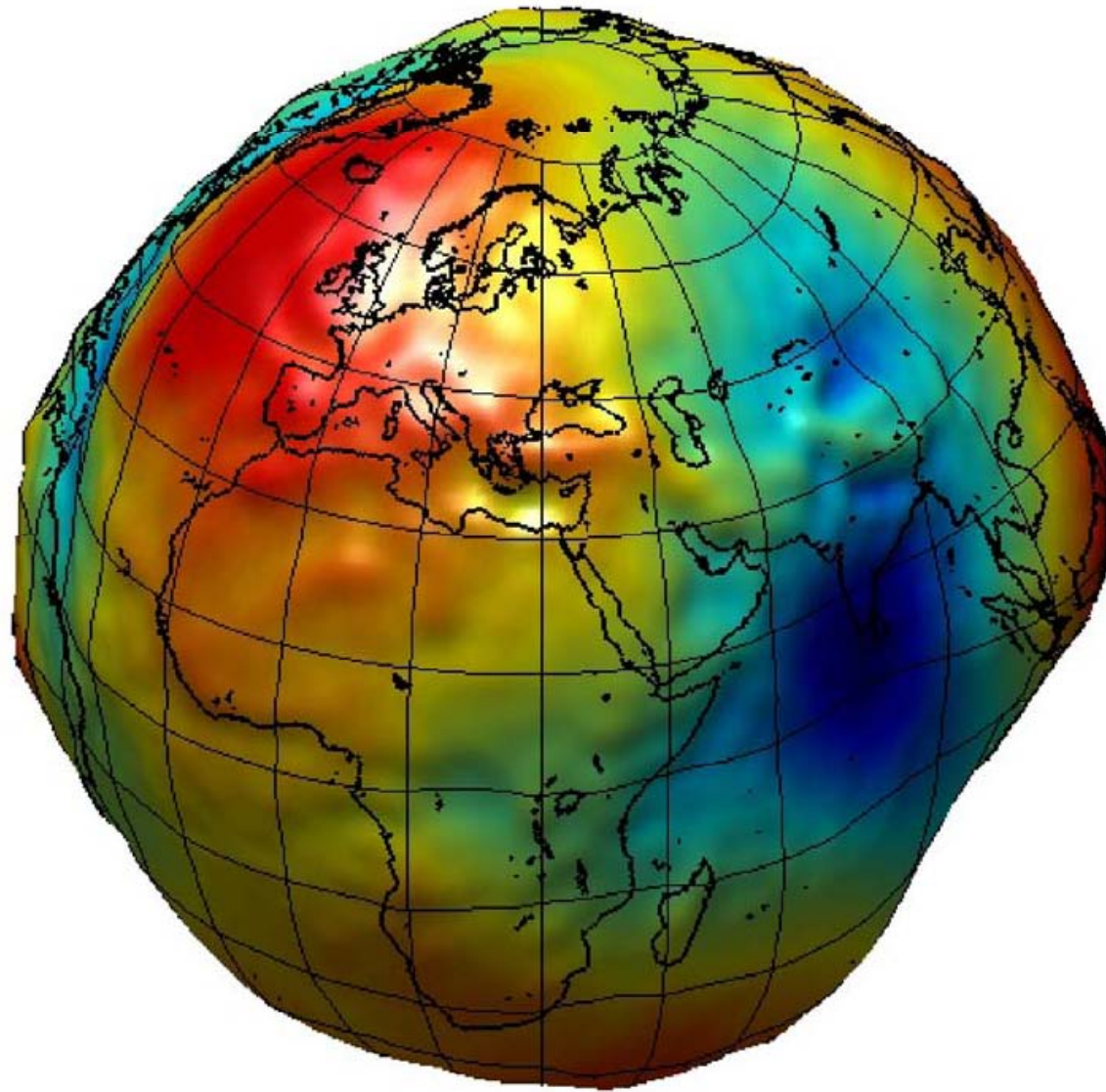
2. Observations of key variables of the Earth system, such as changes in its figure and gravity field, and variations in the Earth's rotation
  - Delivers observations of the changes in the geometry and rotation of the solid Earth as well as changes in the Earth's gravity field.



# Main contributions of Geodesy to global monitoring

3. Monitoring motion and changes in target areas; regional densification of GNSS networks, extension to tide gauges, glaciers, tectonically active structures
4. Constrain mass balance, kinematics, rebound, oceanic circulation, ocean and sea dynamics, sea level monitoring, ...

# Future?







# Challenge for geodesy

- Ignorance and unawareness of geodetic networks and importance of stable and well defined reference frames is common. Every civilized country needs up-to-date, easily accessible reference frames for its societal tasks, and **such frames do not exist without continuous maintenance.**
- Research of global change is an example of the need of geodesy: stable reference frames and precise geodetic observations



## To do...

- Convince dear colleagues about the need of geodetic observing system(s)
- Take a good care of GGOS development + unify conventions of ALL techniques
- Establish regional densifications (examples: ECGN, NGOS, ...; 2-way benefit: use GGOS results locally and contribute to GGOS)
- Create connections to other organizations (GGOS: a member of GEO)
- ... and promote geodesy to the decision makers, politicians and to the great public!