REGIONAL GEODETIC OBSERVING SYSTEMS

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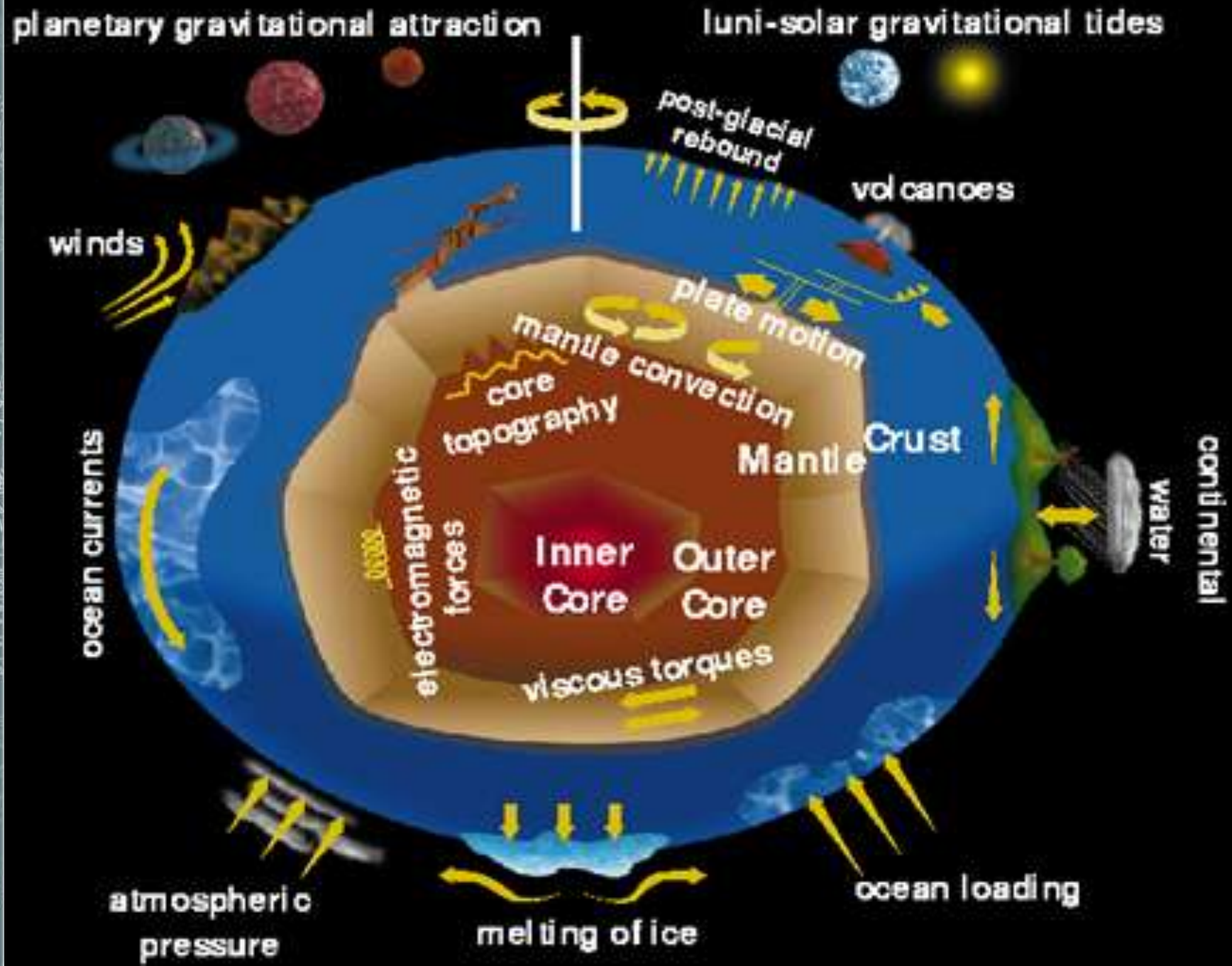
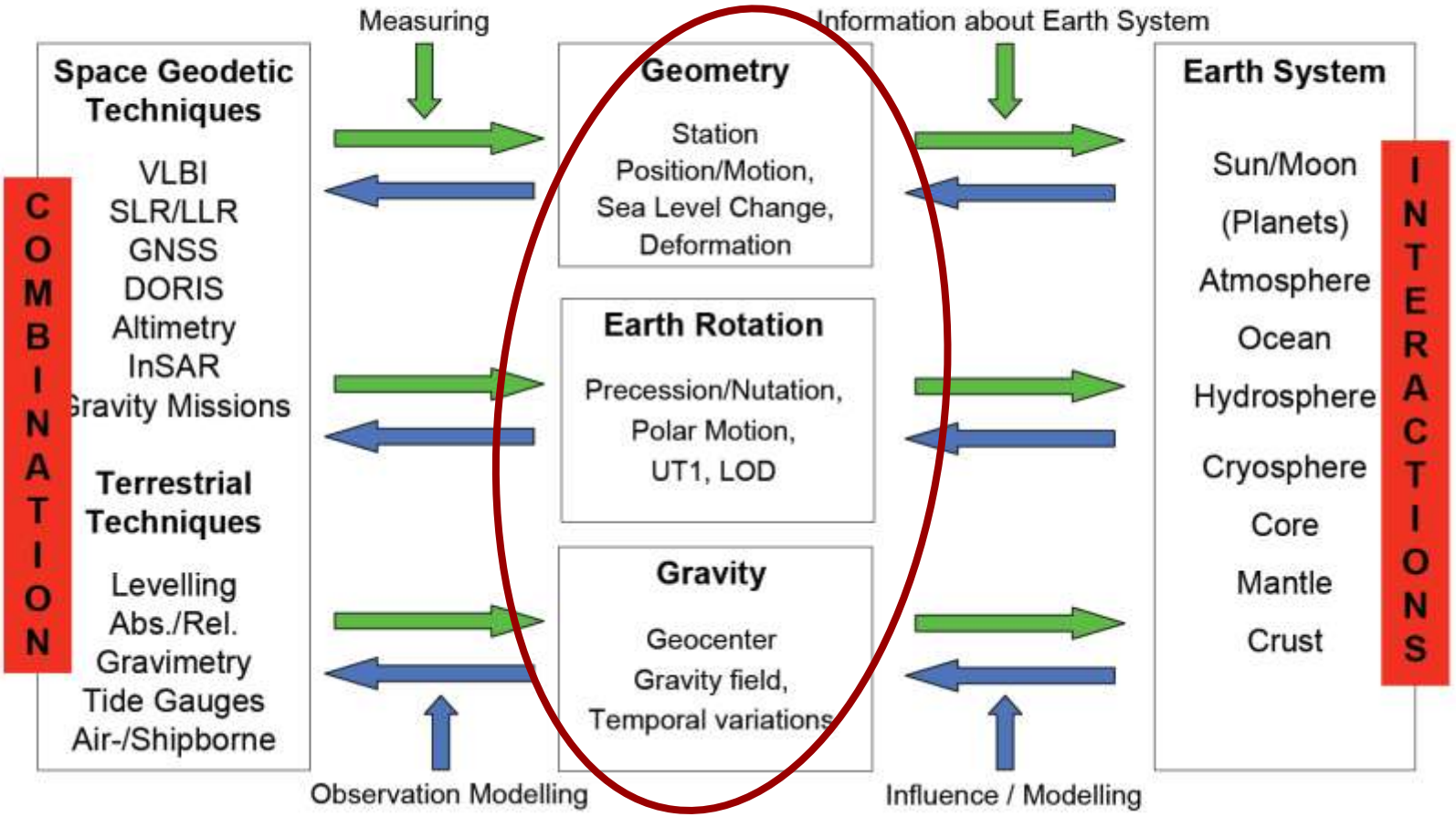
Motivation and background

- Geodetic observations and permanent observing networks have provided a more detailed picture of the Earth's surface and gravity, their temporal variations in all scales, and global changes in the Earth's shape, mass distribution, sea level and orientation in the inertial frame in the accuracy down *to 1 mm level*
- With increased accuracy many concerns on data and products
  - Geodetic networks of different techniques have been separated (reference frames, levelling, gravity)
  - Connection of observations of different techniques is essential
  - Availability of data, access of data and distribution of products to the scientific community and to other users
  - Different ways to apply corrections or physical parameters
  - Quality control of data
  - Continuation and stability of the infrastructure
  - Response to political and societal needs; selection of products
  - Public unawareness of geodesy and geodetic methods

Motivation for multi-technique sites



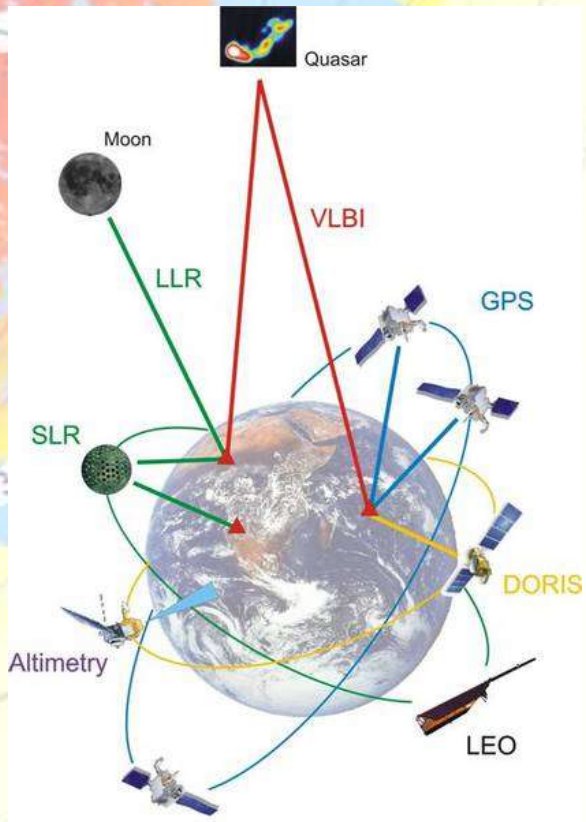
Measuring and Modeling the Earth's System



M. Rothacher/GGOS

Geodetic Observing systems and multi technique sites

- To observe various aspects of Earth-related parameters down to mm-level we need several techniques combined
- This implies: GNSS, SLR, VLBI, AG, SCG, levelling, relative gravimetry, altimetry, InSAR, …
- Geodetic Observing Systems: GGOS, ECGN, NGOS, … to combine existing techniques, networks, products, data processing, …



+ terrestrial

levelling, AG, SCG, rel.g, tide gauges, …

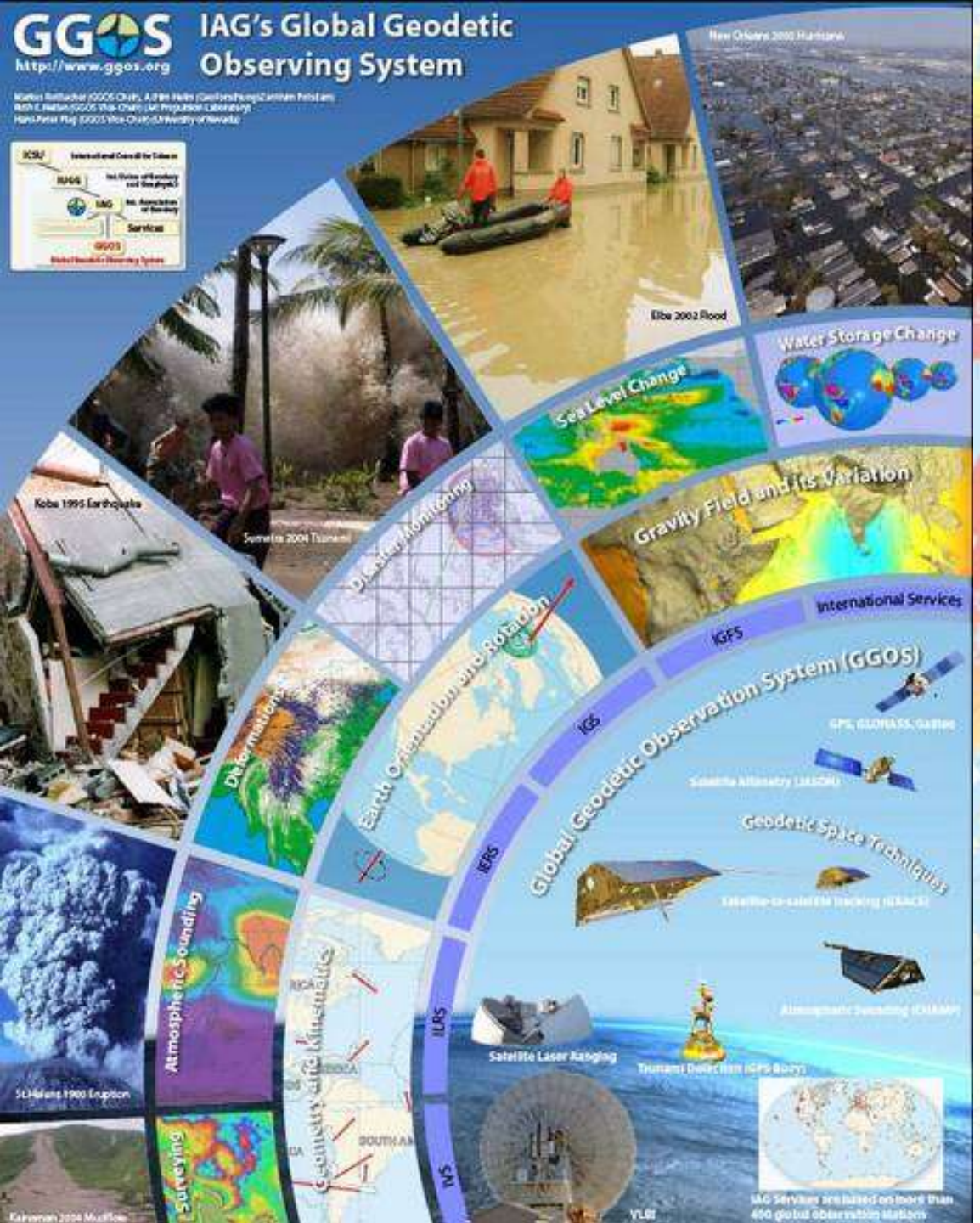
…but we're not going to re-invent a wheel

(In the history of mankind it was a great innovation to use a 3-corner wheel instead of a 4-corner wheel because a 3-corner wheel causes one bump less in every revolution…)

Role of a Geodetic Observing System

- Several ongoing initiatives for a geodetic observing system:
  - *GGOS* (Global Geodetic Observing System), IAG initiative
  - *ECGN* (European Combined Geodetic Network), EUREF initiative
  - *NGOS* (Nordic Geodetic Observing System), NKG initiative

- GGOS is the global system, others are regional
- Necessary infrastructure is mostly in place,
  - GGOS: IAG Services
  - ECGN: EPN, UELN, …
  - NGOS: NKG Working Groups, national networks
- Originally, regional GOS's were thought to become densifications of the global system.
- Development of the GGOS, however, led into a structure where regional GOS's do not play a significant role in GGOS, but GGOS is solely based on the existing IAG services.



GGOS

GGOS integrates different geodetic techniques, different models, different approaches in order to ensure a long-term monitoring of the geodetic observables in agreement with the Integrated Global Observing Strategy (IGOS).

GGOS provides the observational basis to maintain a stable, accurate and global terrestrial reference frame, to link it to the celestial reference frame and to monitor the Earth´s kinematics and dynamics. In this function GGOS is crucial for all Earth observation and many practical applications.

European Combined Geodetic Network

ECGN

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

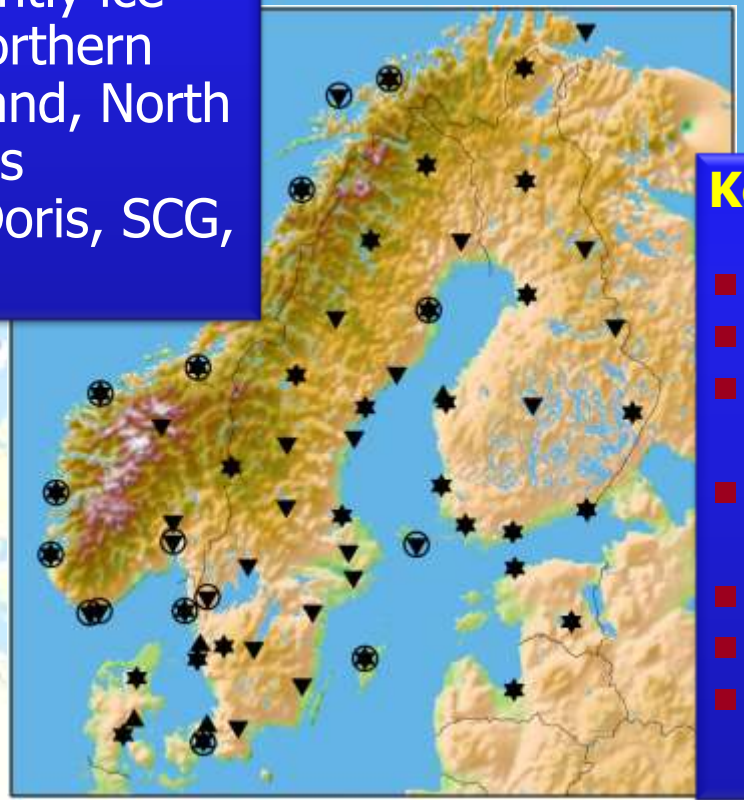
- Realization of a terrestrial reference system and maintenance of long time stability with an accuracy 10^{-9} for Europe especially in the vertical component
- In-situ *combination* of space geodesy (GPS) with Earth gravity parameters (gravity, heights)
- Modelling of influences of *time depended parameters* 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, ...)

◆ Heights of the mean sea level 1997 above the GPS/Levelling quasi geoid of EUVN

October 2003

The Nordic Geodetic Observing System (NGOS)

- Established by the Nordic Geodetic Commission; NKG Task Force
- Formerly and presently ice covered areas in Northern Europe and Greenland, North Atlantic, Arctic areas
- GNSS, SLR, VLBI, Doris, SCG, AG, TG, ...



Key parameters/fields

- Height / height systems
- Sea Level
- Geodetic position, reference frames
- Geopotential and gravity anomalies
- Temporal gravity change
- Postglacial rebound
- Climate change and its consequences

NGOS original plan

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

Future of NGOS

- New WG of NKG; proposed "Geodetic Infrastructure" Working Group
- This WG could be the common umbrella for a more easy access to the data and products for ordinary users
- WG should pay attention (via a Project) on unifying relevant parameters and procedures
- Combination of data
- Local ties between techniques essential for compatibility
- Voice of geodesy (NKG) via the Presidium

Techniques for regional GOSs

Technique	Objective	Accuracy	Component(s)
VLBI			
SLR			
GNSS			
DORIS			
Levelling			
Tide gauges			
Absolute gravimeters			
Superconducting gravimeters			
Spring gravimeters			

IAG SERVICE

IAG SERVICE

EPN, NKG (OK)

IAG SERVICE

UELN, Nordic (OK)

PSML (OK)

AG plan + archive (developing)

GGP (OK, IAG PROJECT ??)

Many sources, partly available

Meta-databases, data archives, partly available

Product availability to users; partly available

Example of a phenomena where multi-technique is needed: GIA

The Glacial Isostatic Adjustment affects on:

- Earth orientation parameters and reference frames
- Post-glacial uplift, contemporary movements and gravity: heights and height systems
- Dynamic ice sheets, glaciology
- Quaternary palaeoenvironments and climate
- Neotectonics and seismotectonics
- Dynamics, structure, properties and composition of the lithosphere

Other signals mixed in GIA

- The GIA signal is contaminated by several other spatially and temporally varying mass changes and crustal deformation. These include seismic deformation, mantle convection and plate tectonics
- Sea level change is an example of a phenomenon which is related to GIA but mixed with other signals.
- The observed sea level change relative to the benchmark on the ground contains components of GIA related crustal vertical motion, eustatic rise of the sea level, changes in semi-permanent sea surface topography and geoid changes.

Three pillars of a regional GOS

1. Stations
   - Multi-technique sites with at least 2 techniques (gravity and GNSS); IAG services on global level
   - Criteria and guidelines for stations
   - Long-term stability and existence of stations
2. Data Banks
   - A lot of data already in data banks
   - Update of the metadata bank needed
3. Combination/products
   - To be organized by the regional host (EUREF, NKG)
   - Analysis, reductions, parameters in a unified way

Summary

- The System Earth is very complicated in the viewpoint of precise observations and reference frames
- No single observing technique is sufficient
- Geodetic observing systems (GGOS, ECGN, NGOS, …) *offer* (or will/should offer) *multi-technique data/sites*
- Global Geodetic Observing System will offer data and products valid for global work, reference frames, &c
- We need also *regional dense networks* (ECGN, NGOS)
- We need also regional multi-technique data/sites and products *in a coordinated way*
- Geodetic Observing Systems should become ”*The voice of Geodesy*”