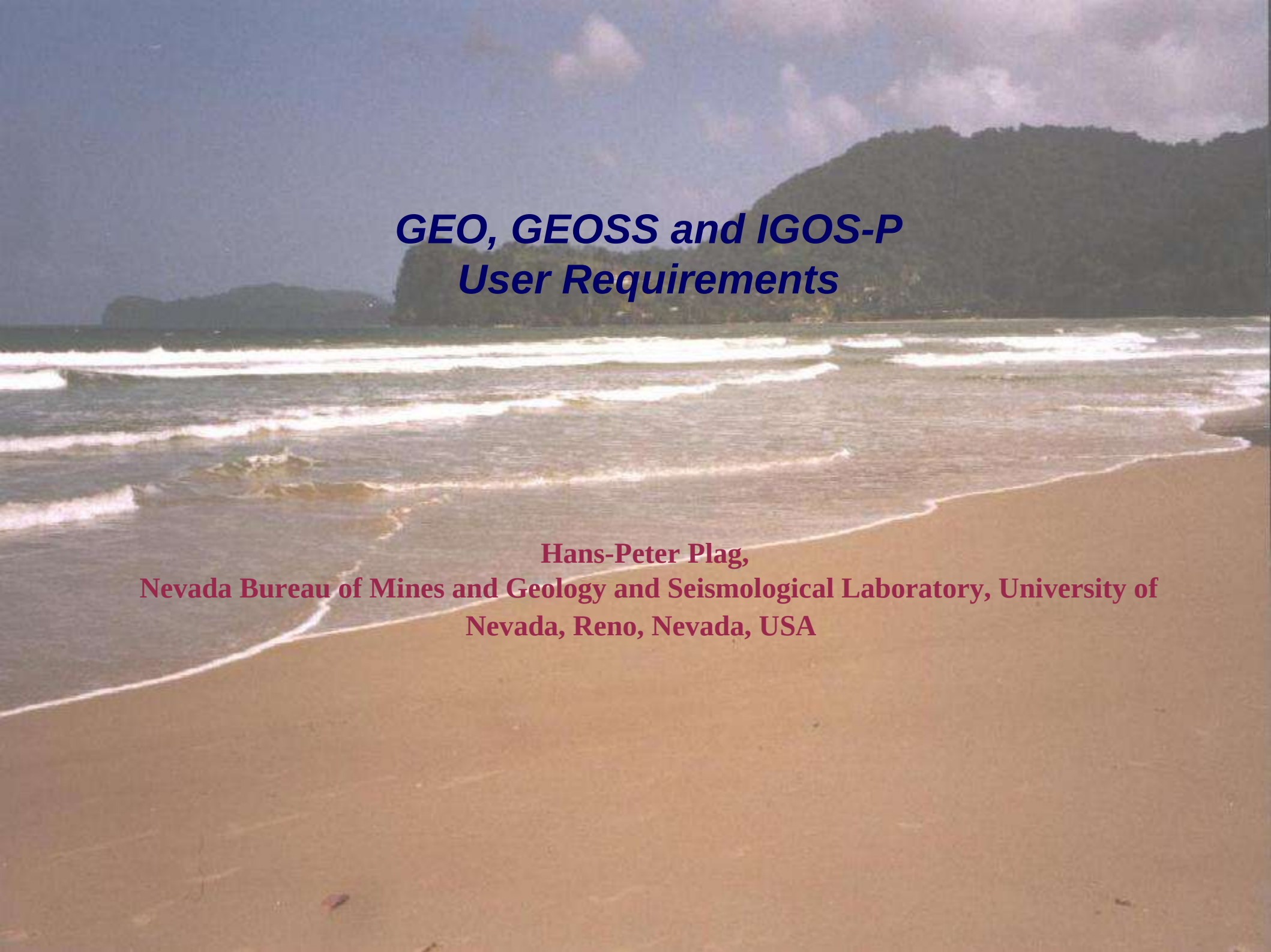

GEO, GEOSS and IGOS-P User Requirements

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Overview

Part 1: Toward an Integrated Global Earth Observation - Brief Historical Overview

- The pre-GEO Era
- The *ad hoc* GEO Phase
- The GEO Era

Part 2: User Interfaces and User Requirements

- IGOS and IGOS-P
- GMES
- GEO User Requirements
- GEO User Interface Mechanism
- GGOS User Requirements and GAGOS

The Background: Pre-GEO area

Selected events:

1972: Club of Rome Report 'Limits of Growth': limitation due to size of resources

1987: Brundlandt Report 'Our Common Future': re-vitalizes the concept of Sustainable Development, equal access to resources

1988: Intergovernmental Commission on Climate Change (IPCC) established by UN agency and WMO: limitation due to ability of environment to absorb the outputs of humankind.

1992: Earth Summit in Rio de Janeiro, Brazil:

- Framework Convention on Climate Change (FCCC)
- Framework Convention on Biodiversity
- Agenda 21

Since early 1990-ies: Three Global Observing Systems (G3OS) initiated with:

Global Climate Observing System (GCOS): UNEP, ICSU, IOC, WMO

Global Ocean Observing System (GOOS): UNEP, ICSU, IOC, WMO

Global Terrestrial Observing System (GTOS): FAO, UNEP, UNESCO, ICSU, WMO

The Background: Pre-GEO Era

Since 1995: Integrated Global Observing Strategy (IGOS) developed.
Mainly for the G3OS, focus on transition from research to operational, sustainable monitoring

May 1998: The Global Monitoring for Environment and Security (GMES) initiative is launched in Baveno, Italy, and adopted by ESA and the European Council in June and November 2001, respectively.

June 1998: Integrated Global Observing System-Partnership (IGOS-P) is formed through exchange of Letters of Understanding.

October 1998: IAG IGGOS Conference in Munich

2001: Start of the Initial Phase of Global Monitoring for Environment and Security (GMES) in Europe.

2002: World Summit on Sustainable Development in Johannesburg, South Africa:
Urgent need for coordinated observations relating to the state of the Earth

The Beginning: The *ad hoc* GEO Phase

June 2003: G8 Meeting in Evian: affirmed importance of Earth Observations

July 2003: First Earth Observation Summit (EOS-I) in Washington, DC: 33 Countries+European Commission and 21 international Organisations:

- Establishment of the *ad hoc* Intergovernmental Group on Earth Observations (*ad hoc* GEO)
- Task of *ad hoc* GEO: initial 10 year Implementation Plan by February 2005

November 2003: Fourth GMES User Forum (co-located with GEO-II) in Baveno, Italy:

- Final report, 10 recommendations;
- No. 7 is the origin of GAGOS

February 2004: Final Report of the GMES IP available.

The Beginning: The *ad hoc* GEO Phase

Up to April 2004: GEO work takes place in five technical subgroups, a small secretariat, three GEO meetings

April 2004: EOS-II in Tokyo, 43 Countries + EC plus 25 international organisations:

- Adoption of the 'Framework Document', which defines nine benefit areas for Earth observations
- IAG joins as Participating Organisation

Up to February 2005: Small writing team drafts the IP with support from the subgroups, three more GEO meetings

February 2005: EOS-III in Brussels:

- Adopts the 10 Year Implementation Plan for a Global Earth Observation System of Systems (GEOSS)
- Establishes the Group on Earth Observations (GEO) with the task to implement GEOSS

The Beginning: The *ad hoc* GEO Phase

Vision for GEOSS is to realize a future wherein decisions and actions for the benefit of humankind are informed by coordinated, comprehensive, and sustained Earth observations and information

The GEO Era

May 2005: GEO-I in Geneva:

- GEO Structure
- Working Groups
- Main priorities for the first year

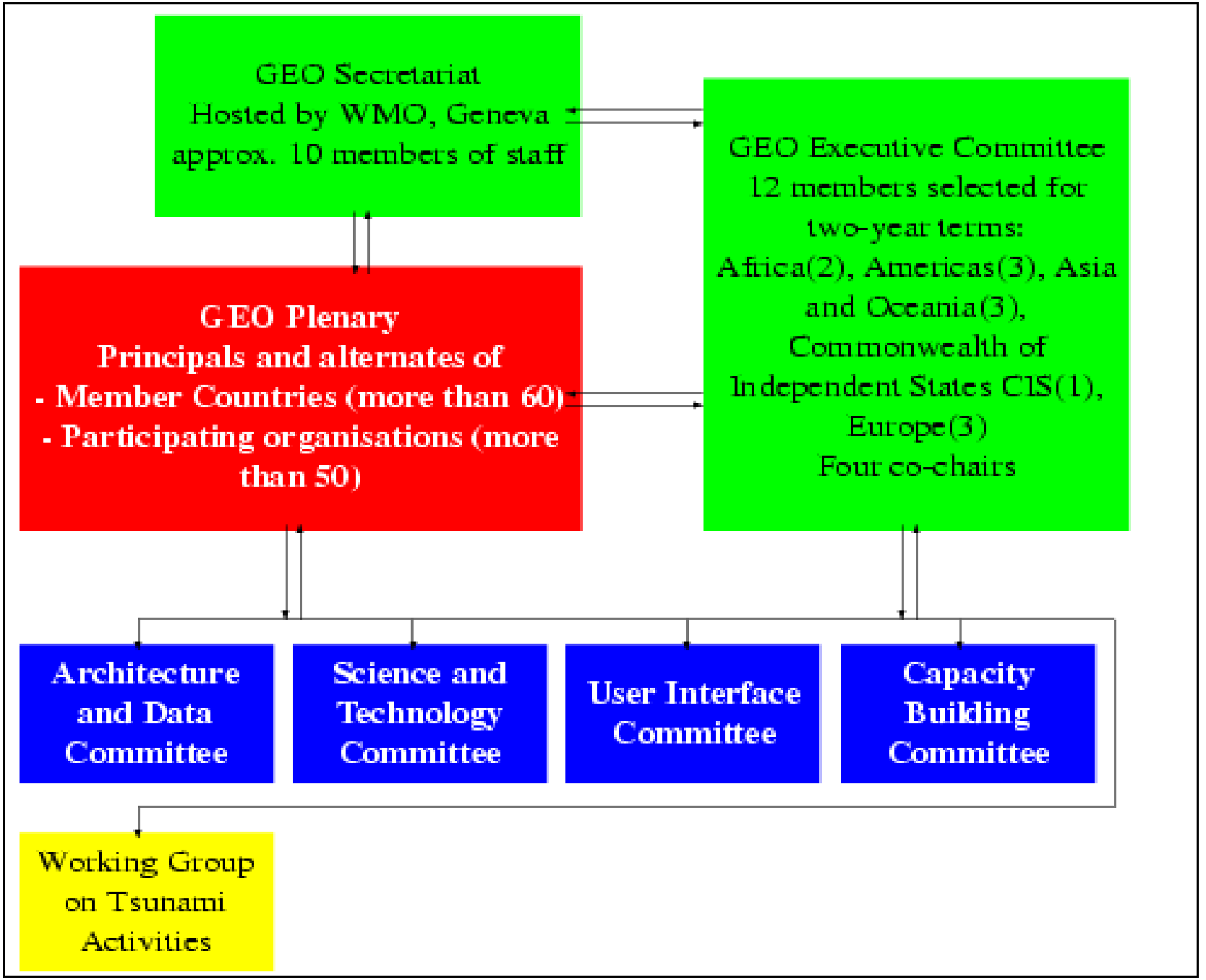
December 2005: GEO-II in Geneva with 60 Member States and 43 Participating Organisations:

- Acceptance of ToRs for Committees and WG
- Acceptance of Work Plan 2006 as 'living document'
- More than 150 new application of Participating Organisations, admission delayed until a procedure is defined.

Currently: Revision of GEO Workplan 2006

Details worked out in Committees and WG until March 15, 2006.

The GEO Era


GEO Secretariat
Hosted by WMO, Geneva
approx. 10 members of staff
GEO Executive Committee
12 members selected for two-year terms:
Africa(2), Americas(3), Asia and Oceania(3),
Commonwealth of Independent States CIS(1),
Europe(3)
Four co-chairs
GEO Plenary
Principals and alternates of
- Member Countries (more than 60)
- Participating organisations (more than 50)
Architecture and Data Committee
Science and Technology Committee
User Interface Committee
Capacity Building Committee
Working Group on Tsunami Activities

The GEO Era

The role of GEO is still under discussion:

- What should GEO actually do?
- What should GEO facilitate and/or coordinate?

At GEO-II: European Commission declares that GMES is the European contribution to GEOSS.

Selected Participating Organisations are:
UNESCO, UNEP, WMO, CEOS, IGOS-P, IEEE, WCRP, IGBP, ICSU, IAG, ...

We will focus here on IGOS-P...

IGOS and IGOS-P

Integrated Global Observing Strategy (IGOS):

- Developed from 1995 onward
- Initially for the G3OS
- Sustainable, comprehensive monitoring of the Earth system:
  - Long-term stability
  - Operational mode
  - Homogeneity in time
  - Multi-parameter sites
  - Global coverage and participation,
  - Integrated observation and data sets
  - Accessible databases
- Transition from research to operational

IGOS and IGOS-P

Integrate Global Observing Strategy (IGOS) Partnership (IGOS-P) was created in June 1998

IGOS-P is a partnership of organisations that are concerned with global environmental change issues.




IGOS and IGOS-P

The Partnership seeks to provide a comprehensive framework to harmonize the common interests of the major space-based and in situ systems for global observations of the Earth.

Its aim is to provide an over-arching strategy for conducting observations relating to climate and atmosphere, oceans and coasts, the land surface and the Earth's interior.

The Partners, through IGOS, will build upon the strategies of existing international global observing programmes, and upon current achievements, in seeking to improve observing capacity and deliver observations in a cost-effective and timely fashion.

Efforts will be directed to those areas where satisfactory international arrangements and structures do not currently exist.

IGOS and IGOS-P

IGOS-P Activities:

Primarily two focused activities:

- the theme approach to define the Integrated Global Observing Strategy
- the production of IGOS promotional material

Goal of IGOS-P is a (small) number of themes with
strong linkages to critical societal issues.

Currently a number Themes exist or are in the planning:

- Carbon Cycle
- Ocean
- Atmospheric Chemistry
- Geohazards
- The Integrated Global Water Cycle Observation Theme
- Coasts (including Coral reefs)
- Cryosphere
- Land

IGOS and IGOS-P

The Geohazards Theme: Plate tectonics, pre-, co- and post-seismic strain, processes associated with volcanos, early warning for tsunamies, subsidence, precarious rocks, landslides, and local and regional predictions of sea level rise are examples of topics that link this theme to geodetic observations.

The Ocean Theme: Ocean circulation, sea level rise, isostacy, dynamic sea surface topography, are linked to the three geodetic quantities, both for the monitoring and studies of the ocean's variability as well as model validation.

Water Cycle Theme: The geodetic observations provide a unique tool to monitor the global to local scale movememts of water throught the Earth system and the theme is strongly linked to geodesy.

The Coast Observation Theme: Sea level and ocean circulation are relevant parameters influencing the dynamic processes in the coastal zone and linking the theme to geodesy.

The Cryosphere Theme: Ice mass balance, glacial isostacy, and induced sea level variations all are important parameters, that are directly observed by the geodetic observation techniques.

The Land Theme: Changes in the elevation are directly observed by geodetic techniques.

IGOS and IGOS-P

GGOS and IGOS-P

GGOS will be partner in IGOS-P pending two formal actions

GGOS considers currently two questions:

- How can GGOS link and contribute to existing Themes
- Should there be a new 'Earth System Dynamics' focused around mass transport in the Earth system and associated dynamics?

IGOS and IGOS-P

The IGOS-P Theme Process:

The Process of Themes selection is based on an assessment of the relevant scientific and operational priorities for overcoming deficiencies in information, as well as analysis of the state of development of relevant existing and planned observing systems.

Goal of IGOS-P is a number of themes with **strong linkages to critical societal issues**.

Process of establishing a new theme is long (normally 18-24 months)

IGOS and IGOS-P

The IGOS Themes Process involves:

- **Agreement by the Partners on a Theme proposal** which must respect certain specified criteria (relevance to social benefit areas, overcoming deficiencies in information, state of development of relevant existing and planned observing systems).
- **Establishment of a Theme team** with appropriate leadership and resources.
- **Approval by the Partnership of the Theme Team's report**, including a common set of essential observations and their technical characteristics (such as accuracy and frequency), and commitments from providers of space-based and in-situ observations.
- **Establishment of an Implementation Team** with the responsibility and capacity required for the long-term implementation of the necessary operational networks.
- A **formal declaration of commitment** to Theme Team recommendations by the governments and organizations who actually implement, maintain and operate the relevant observing systems.

GMES

Identification of Requirements in the Initial Phase (2001-2003):

- Four User Forums, several projects
- Final Report summarizes requirements
  - Policy requirements
  - Lesson from the Initial Period
  - Socio-economic Benefits
- Requirements discussed on a high level, qualitatively

==> *Relevant input to GAGOS!*

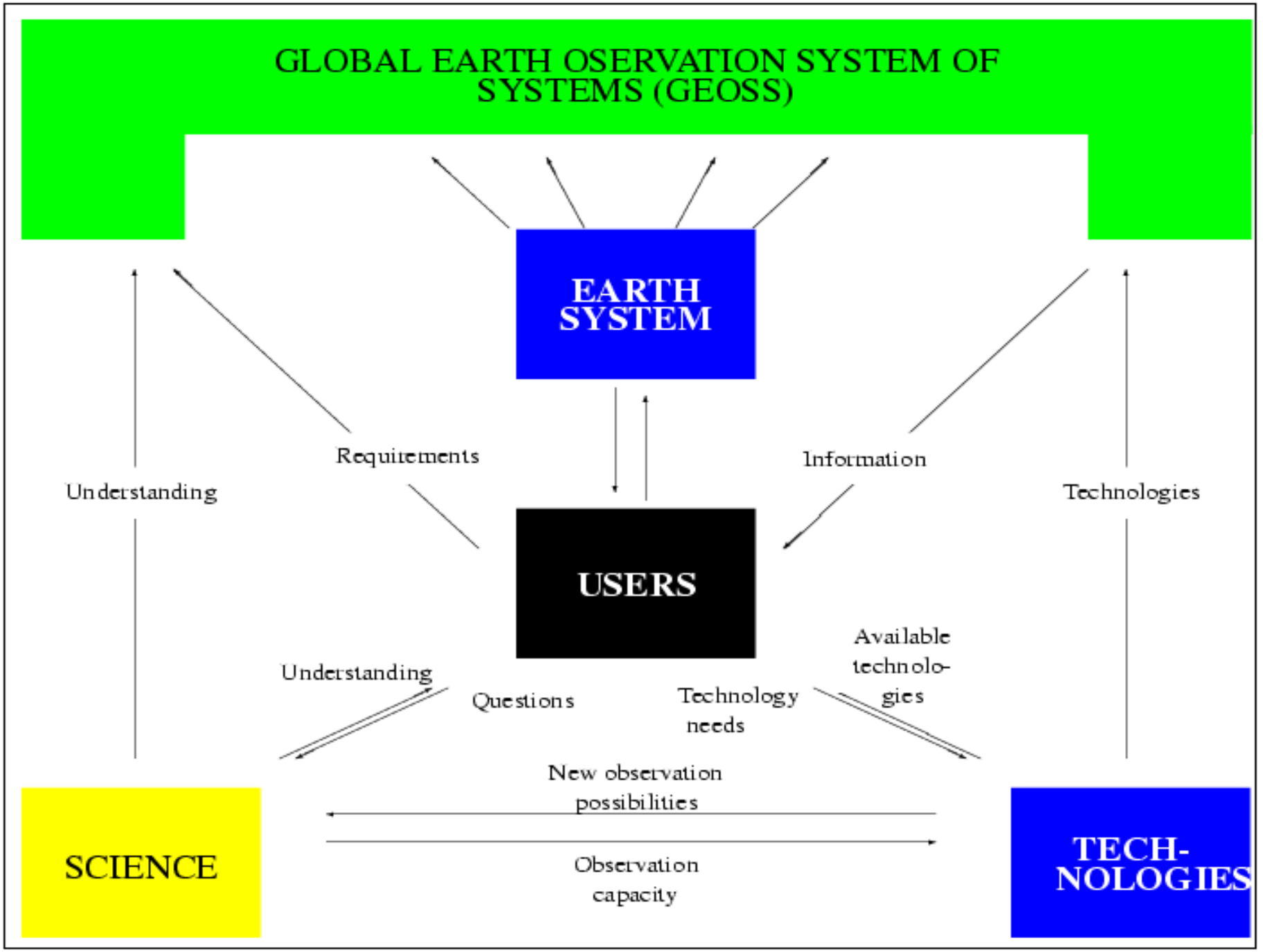
(Recommendation7 - Assess the existing in-situ capabilities of releance for GMES and prepare an implementation plan for complementary adaptions and/or new deployments.)

GEO

Nine Benfit Areas Identified by EOS-II:

- **Disaster**: reducing lost of life and property from natural and human-made disasters
- **Health**: understanding environmental factors affecting human health and well being
- **Energy resources**: improving management of energy resources
- **Climate**: understanding, assessing, predicting, mitigating, and adopting to climate variability and change
- **Water**: improving water resource management through better understanding of the water cycle
- **Weather**: improving weather information, forecasting, and warning
- **Ecosystems**: improving the management and protection of terrestrial, coastal, and marine ecosystems
- **Agriculture**: supporting sustainable agriculture and combating desertification
- **Biodiversity**: understanding, monitoring and conserving biodiversity

GEO


GLOBAL EARTH OSERVATION SYSTEM OF SYSTEMS (GEOSS)
EARTH SYSTEM
Requirements
Information
Understanding
Technologies
USERS
Understanding
Questions
Technology needs
Available technolo-gies
New observation possibilities
Observation capacity
SCIENCE
TECH-NOLOGIES

GEO

Approach to User Requirements in the *ad hoc* GEO Phase:

- Subgroup on 'User requirements and Outreach' provided study with UR examples (in terms of spatial and temporal resolution, accuracy, latency, ...)
- Countries did UR studies (Canada, Netherlands, ...)
- URO SG and Writing Team prepared for each Benefit area a set of requirements in terms of quantities,
- assessed the current status of availability of observation

Recommendations in the GEOSS Reference Document:

- Establish and maintain a distinct and common user requirement database.
- Should be oriented on the CEOS/WMO database of user requirements and observation system capabilities.
- Database should provide a gap analysis mechanism.
- WMO experience in setting, reviewing and updating user requirements could be a basis: 'Rolling Review of Requirements' (RRR)

GEO

Relevant quantities included in GEO, 2005:

- Deformation monitoring, 3-D, over broad areas (3)
- Subsidence maps (3)
- Strain and creep monitoring, specific features or structures (2)
- Gravity, magnetic, electric fields - all scales (3)
- Gravity and magnetic field anomaly data (2/3)
- Groundwater level and pore pressure (4-1)
- Tides, coastal water levels (1)
- Sea level (2-1)
- Glacier and ice caps (2)
- Snow cover (2)
- Moisture content of atmosphere/water vapor (2)
- Extreme weather and climate event forecasts (3)
- Precipitation and soil moisture (3-1)

0: ok
1: marginally acceptable accuracy and resolution
2: could be ok within two years
3: could be available in six years
4. still in research

User Interface Mechanism

Example: CoP Geohazards
- countries A/B (chairs)
- IGOS-P
- IEEE
- Countries ...
- IOC/UNESCO/ISDR
- Decision Makers

Example: CoP Health and Weather
- WMO (co-chair)
- ...

Example: CoP Health and Water
- country A
- UNEP
- FAO
- country B
- Decision Makers

GEO Ex Com

GEO Plenary Member States, Participating Organizations

GEO SEC

User Interface Committee
- **Representative of each Member/P.O.**
- **Representative CoPs**

Example CoP and linkages

Coordinate activities

CoP provides intelligence, expertise and input to GEO and respond to requests from GEO

GGOS User Requirements and GAGOS

The Challenge for GGOS:

- GGOS provides both relevant observations and a utility for Earth observation (in particular GEOSS) and other users.
- Users are often not aware of being users of geodetic products and services.
- Users are mostly not aware of their explicit requirements.
- IAG services and GGOS evolve in a mainly scientific environment (affiliation to IUGG and ICSU).
- ITRF an utility for Earth observation and other applications
- Observations relevant to many non-scientific applications

Current Situation

- **Reference frame:** User groups and user requirements fairly well known internally but far less externally
- **Earth system observations:** User groups less known, user requirements in the frame of GEOSS unclear, particularly for long-term observations

GGOS User Requirements and GAGOS

URs generally well documented

	Users	Geodesy's contribution
Earth observations & earth system models	Earth system scientists and modellers	Reference Frame and Observations
Data-to-Information archiving & services	Earth system service providers	IAG Services
Decision support tool development	Environmental process modellers & researchers	Provision of information, often through others
Decision making	Policy Makers & Environmental managers	Not aware of requirements
Assessment of benefits	Public officials, advocacy groups and the Public	Often not aware of geodesy

Less able to document needs

Modified from G. Foley

GGOS User Requirements and GAGOS

Objective:

Improve the Geodetic Observing System for the benefit of society.

Some steps towards this goal:

- Identify all (main) user groups and their needs
- Identify applications that require geodetic observations and products
- Establish tools that allow a comprison of system performance and requirements
- Educate users concerning their needs
- Promote and improve the visibility and applicability of geodetic products
- Open chanels for dissemination into applications

GGOS User Requirements and GAGOS

A potential GGOS Approach to user requirements:

- Science based approach, looking from GGOS (via GEOSS?) to the users' needs in the benefit areas identified by EOS/GEO.
- Considering the need for comprehensive monitoring, the spatial and temporal characteristics of the observables determine the necessary monitoring system.
- GGOS WG: '*User linkage and Outreach*': Contact to user groups.
- Establish comprehensive User Requirments and System Performance database as an assessment and planning tool.

What are the lessons learned from

- EC funded project '*Assessing and forward planning of the Geodetic and Geohazard Observing Systems for GMES applications*' (GAGOS)
- U.S. Project INDIGO?

User Requirements for Accuracy, Stability and Accessibility of Reference Frame

User groups:

- surveying (incl. positioning of sensors)
- navigation
- geo-information and geo-referenced data
- monitoring of infrastructure, including off-shore
- Earth observation
- research, particularly climate and global change

User requirements:

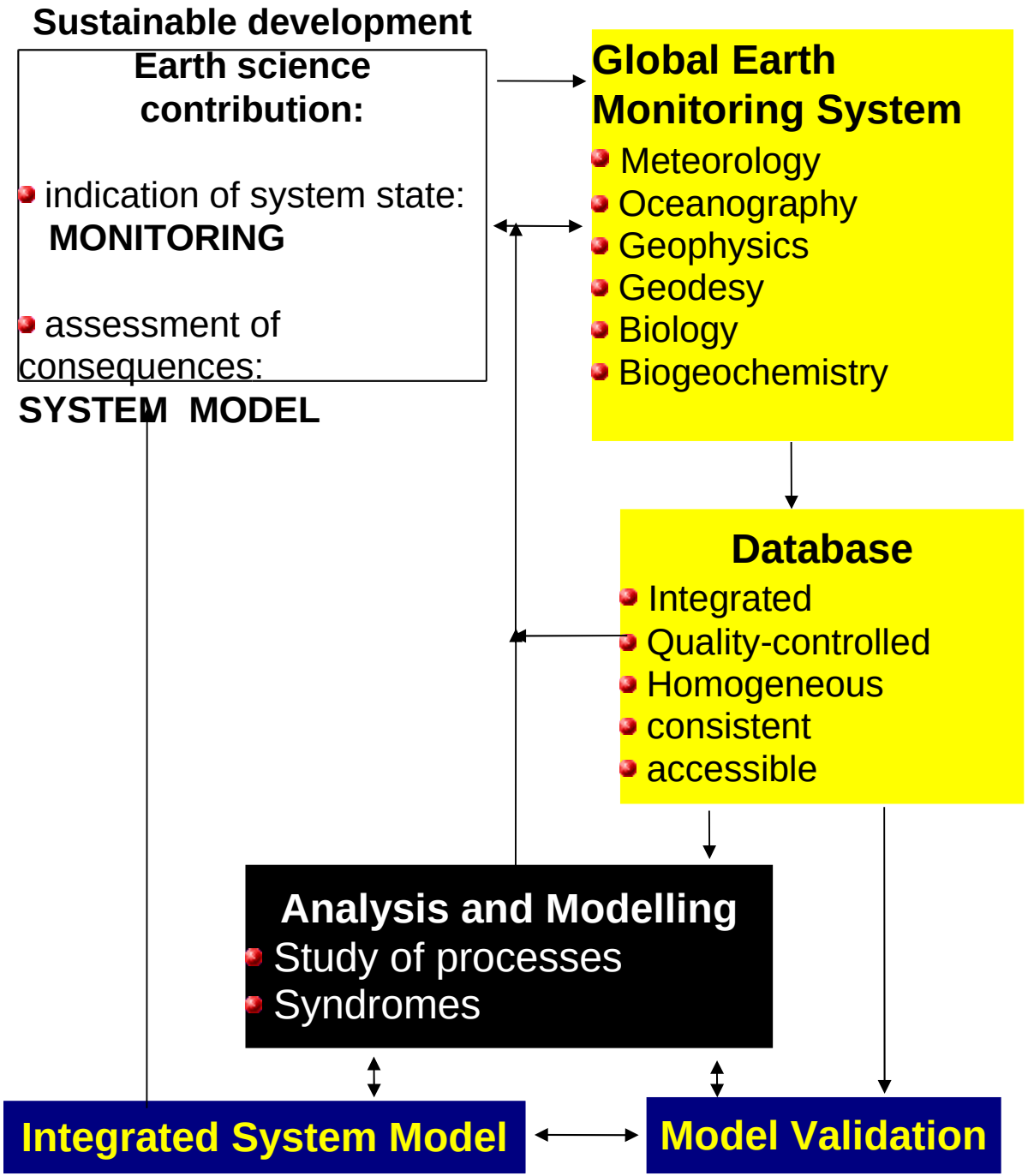
Access to unique global reference frame as a basis for

- National and international frames
- Navigation
- global Earth system studies,
- monitoring of infrastructure and the Earth system

Summary of Urs in terms of Accuracy

- Determination of position in near-real time with an accuracy < 0.1 m
- Determination of position with an accuracy of 0.01 and latency of hours to days
- Determination of changes in position of 0.01 m on monthly time scales with latency of days to weeks
- Determination of secular velocities with an accuracy of < 0.001 m/year
- General accuracy requirement: 10^{-9}

Integrated Earth Observation



Properties of sustainable monitoring (Integrated Global Observing Strategy, IGOS):

- Long-term
- Operational
- Homogeneous in time
- Multi-parameter
- Global
- Integrated
- Comprehensive

Geodetic Contributions:

- Reference Frame (determination and monitoring)
- Access to the Reference Frame
- Observations of Earth system parameters

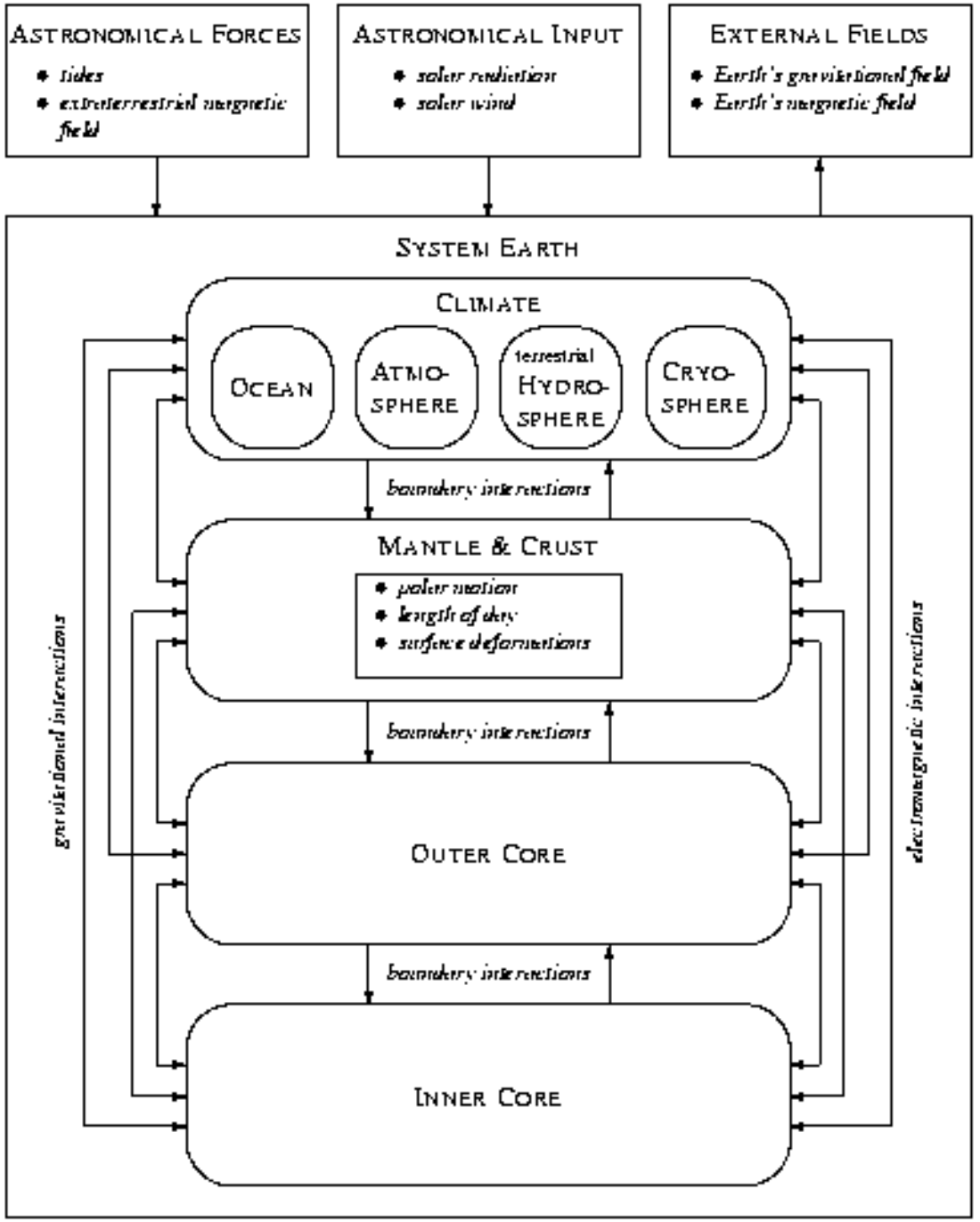
Lesson learned so far (also relevant for GEOSS)

- A science-driven approach may be necessary for some components, particularly those with service functions for other components.

- For some components of the Earth system, the 'IGOS approach' stating the requirements for the observing system as:
  - operational,
  - long-term,
  - comprehensive
  - homogeneous
  - resulting in integrated databases and
  - accessible databases

  may be the only valid way to determine the requirements for the observing system on the basis of characteristics of the Earth system

Challenge of Science-Driven Approach to GGOS:



All is in movement

- **Convection:**
  - chemical anomalies or temperature anomalies?
  - whole mantle convection or layered convection?
- **Plate tectonics:**
  - location of and processes at plate boundaries?
  - extent of deformation zones?
- **Ice sheets/glaciers and sea level:**
  - ice load history, in particular, Antarctica?
  - present-day changes in ice sheets?
  - contribution to sea level changes?
- **Ocean circulation:**
  - improved monitoring required,
  - separation of steric and non-steric component?
- **Hydrological cycle:**
  - quantifying the fluxes?
  - how large are groundwater movements?
  - variations in continental water storage?
- **Seasonal variations:**
  - terrestrial hydrosphere: quantification?
  - cryosphere: mass balance?
  - sea level: steric/non-steric?
- **Atmospheric circulation:**
  - past wind field?
  - Past and present air pressure field?
- **Tides:**
  - validation of ocean tide models?
- **Seismic waves and free oscillations:**
  - structure and mechanical parameter of the solid Earth?