Federal Agency for
Cartography and Geodesy

Developing an Effective Global Geodetic Reference Framework and Supporting Location-Based Services

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Federal Agency for Cartography and Geodesy

Keynote, Session 3
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Agenda

- Context of Geodesy in Geospatial
  - Role within Spatial Data Infrastructures
  - Coordinate Reference Systems (CRS): From Global to National
- Access to the CRS – Positioning
- Recent developments – Global Geodetic Observing System (GGOS)
- Conclusions

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Context of Geodesy in Geospatial
Role within Spatial Data Infrastructures

Location-based Services

Required geospatial technology

Digital maps + Routing + POI + …
+ Positioning (GNSS, WiFi, …)

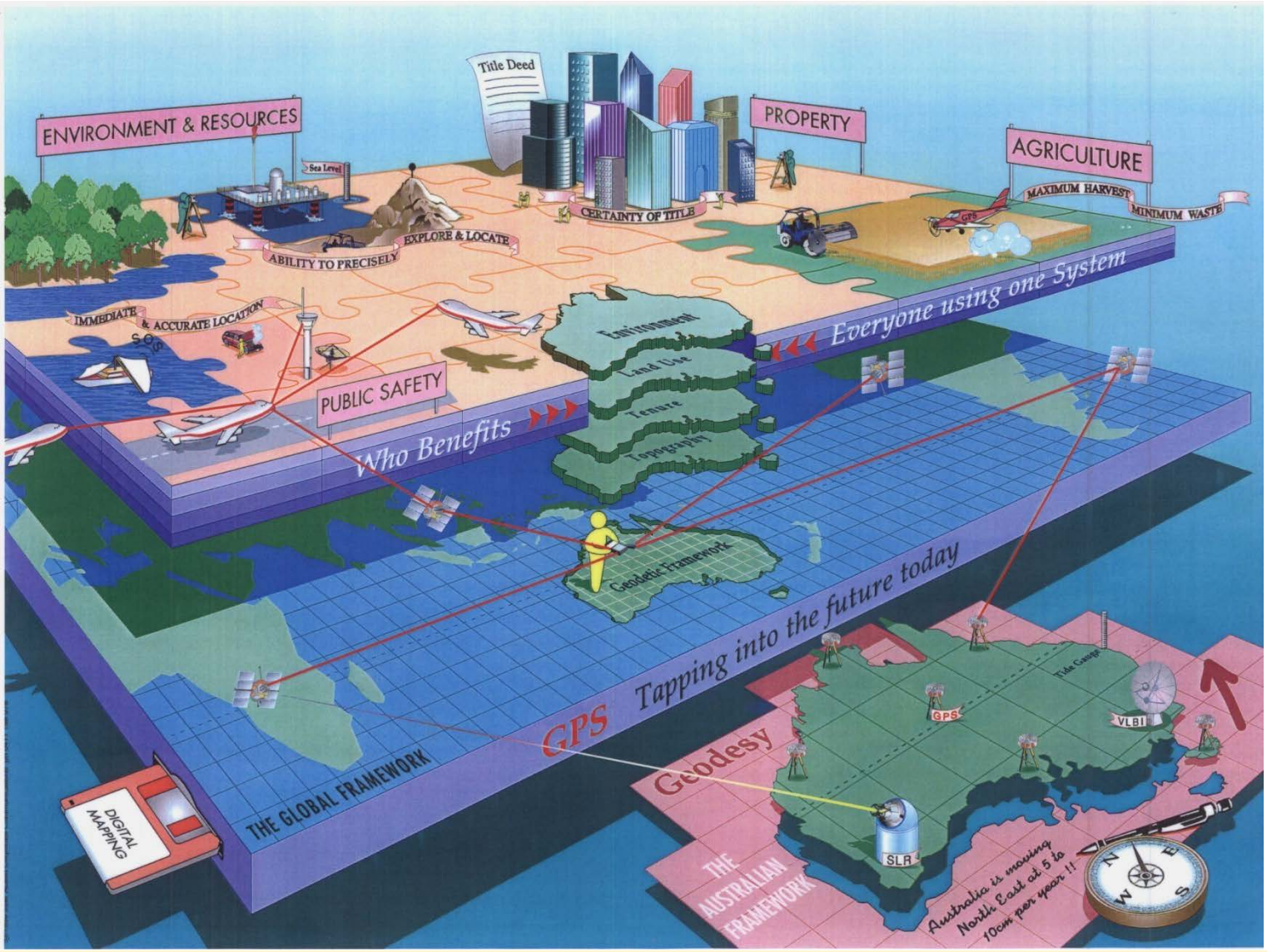
Context of Geodesy in Geospatial
Role within Spatial Data Infrastructures

Example: *ELF* – The European Location Framework

- Interoperability of *Geoinformation*
  - Legal
  - Organizational
  - Semantic
  - Technical
- ELF as *a technical infrastructure* which delivers
  - authoritative
  - interoperable
  - cross-border

  geospatial reference data for analysing and understanding information connected to places and features
- ELF
  - builds a geospatial reference data infrastructure
  - provides interoperable reference data and services from national information assets
  - will be the basis for the official framework providing location information

Context of Geodesy in Geospatial
Role within Spatial Data Infrastructures



Courtesy:
Geoscience
Australia

Context of Geodesy in Geospatial
Role within Spatial Data Infrastructures

Hidden constraints

Modern economic development,
expressed in terms of location-based services (80% rule),
relies – mostly without redundancy –
on the guaranteed availability of and ubiquitous access to
a unique, homogeneous, high-quality CRS
which is consistent with time and height.

For the sake of effectiveness and efficiency
this CRS should serve any purpose and application
regardless of the diverse ways of accessing the CRS.

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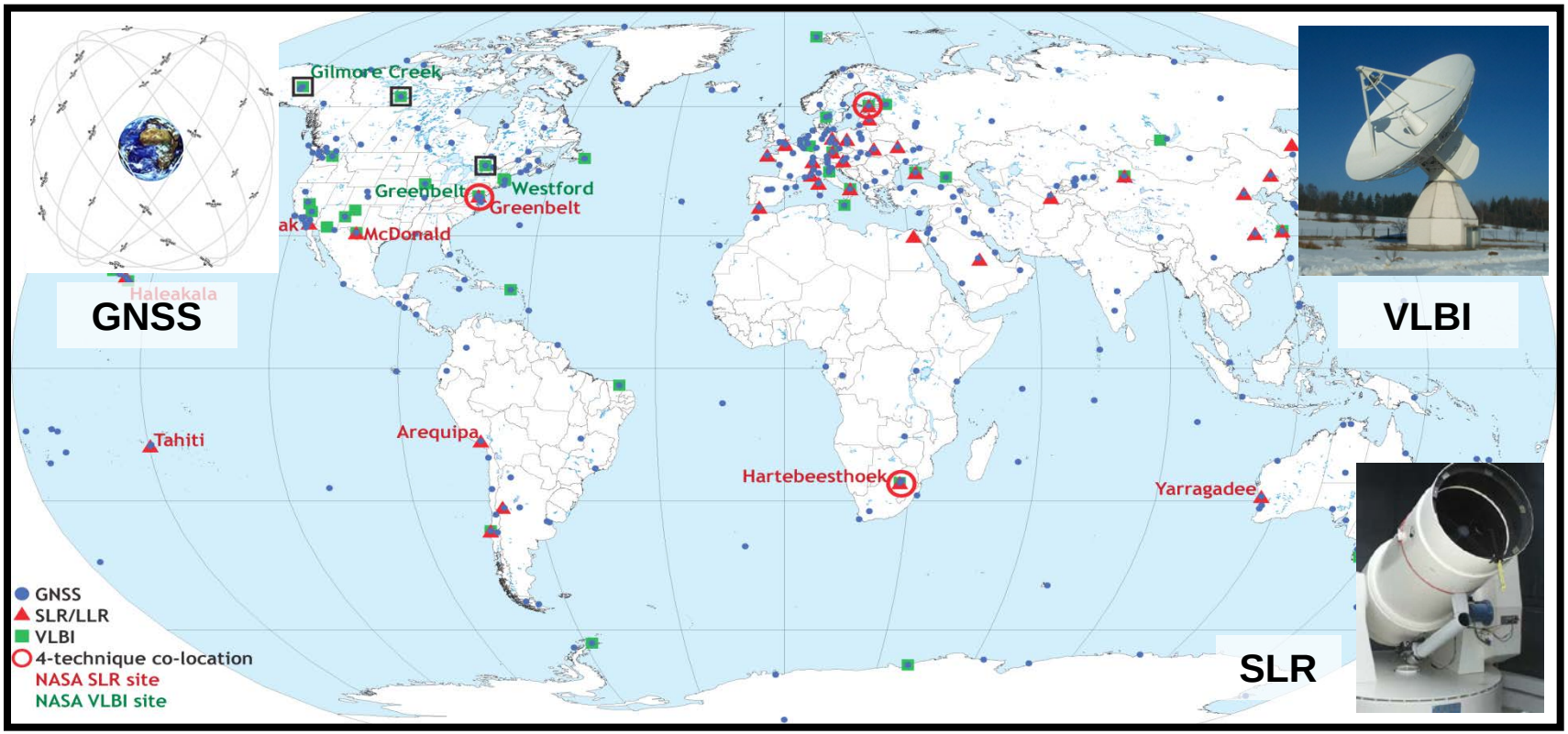
Context of Geodesy in Geospatial Coordinate Reference Systems: From Global to National

An international geodetic network as basis for a unique and consistent geodetic reference frame



Observation hardware: Space-geodetic techniques on terrestrial obs. sites

Providers: National mapping / geodetic agencies; national space agencies

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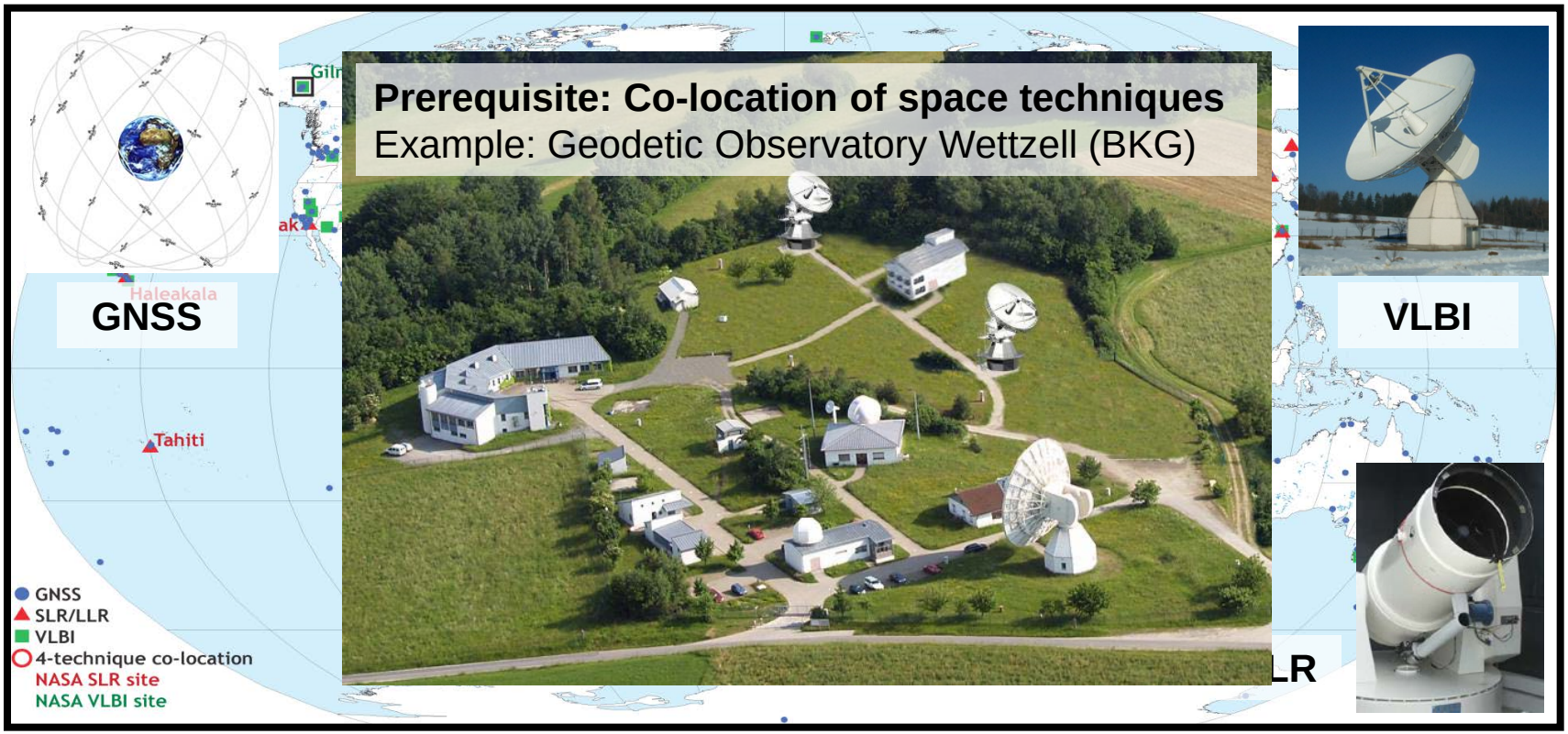

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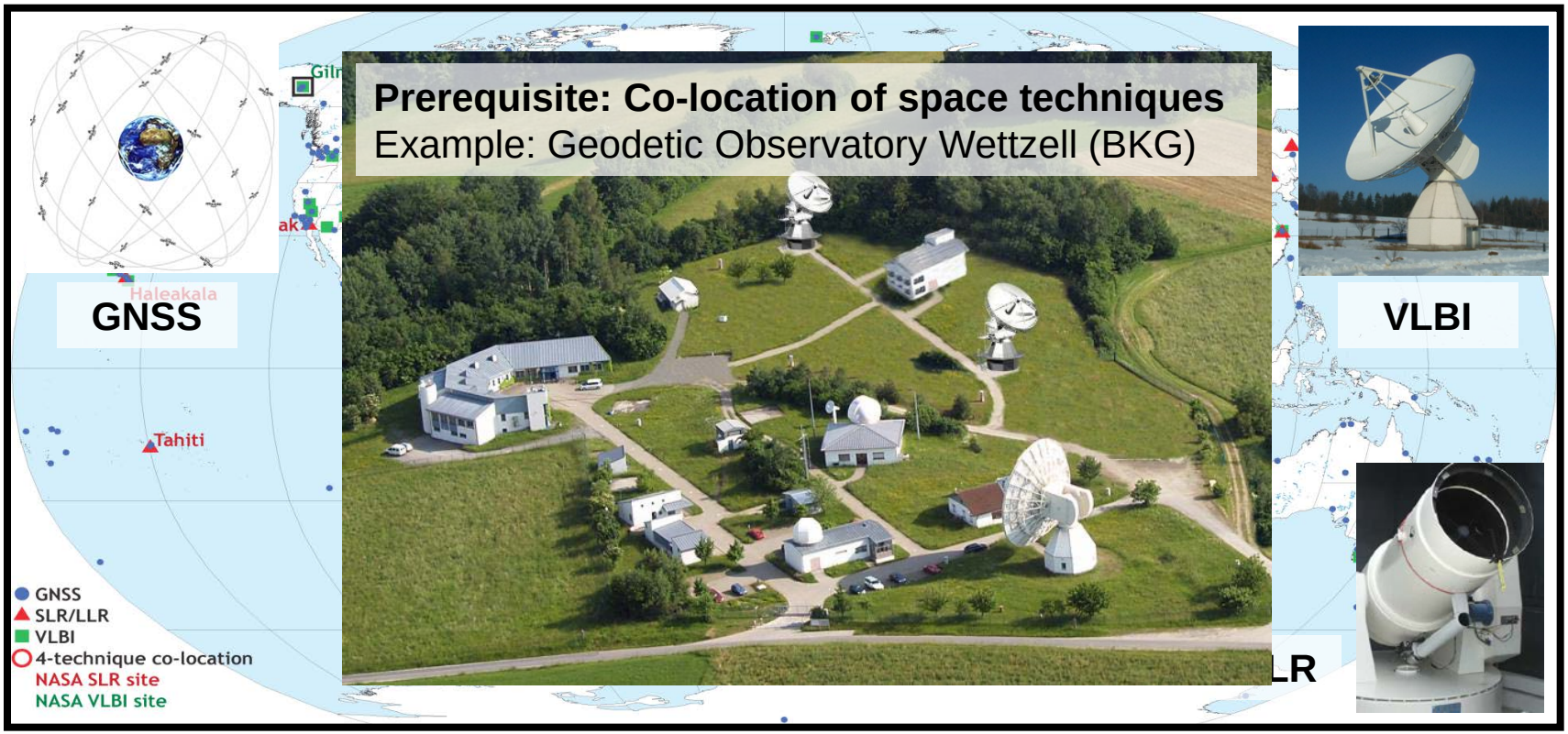

Workflows & Products: Contributions by national agencies & research institutes

Coordination: Services of the IAG (International Association of Geodesy)

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IUGG

Context of Geodesy in Geospatial Coordinate Reference Systems: From Global to National

IAG GGOS

International Union of Geodesy and Geophysics (IUGG)

65 Me **150th anniversary of IAG in 2013 !** ations

International Association of Geodesy (IAG)

Council | Executive Committee | Bureau | Office | COB

Commission 1 Reference Frames	**Commission 2** Gravity Field	**Commission 3** Earth Rotation and Geodynamics	**Commission 4** Positioning and Applications

Inter-Commission Committee on Theory (ICCT)

Services:

IERS	**IGS**	**IGFS**	**BGI**	**ICET**	**BIPM**	**IAS**
ILRS	**IVS**	**IDS**	**ICGEM**	**IGeS**	**IDEMS**	**PSMSL**	**IBS**

Global Geodetic Observing System (GGOS)

Context of Geodesy in Geospatial Coordinate Reference Systems: From Global to National

Characteristics of the International Association of Geodesy (IAG)

- International community with a 150 years tradition in cooperation of academia and government
- Modern structure and well-established network
- Member of, e.g., GEO and CEOS
- Officially accepted expertise and products such as GNSS satellite orbits (IGS) or the International Terrestrial Reference Frame (ITRF)

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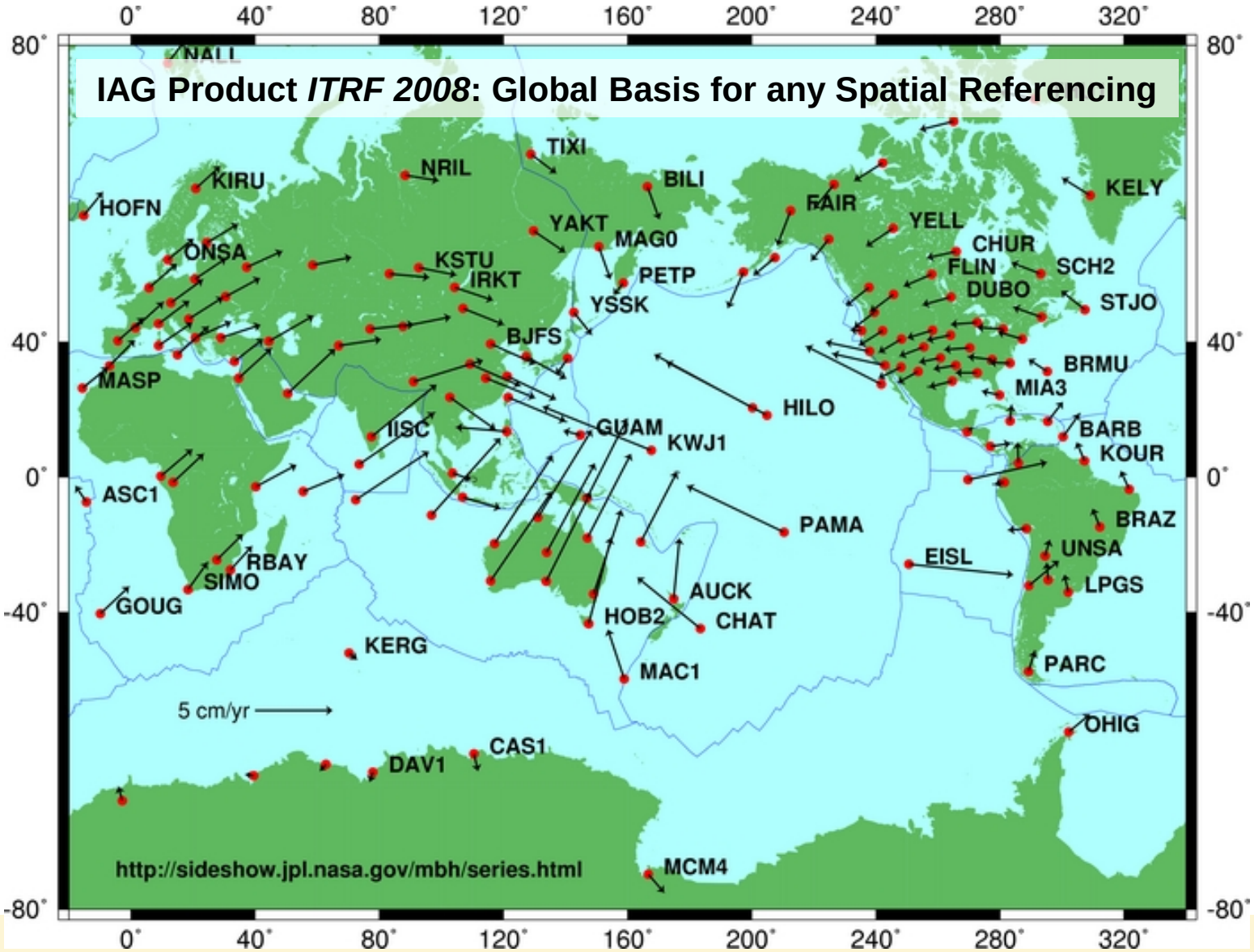
Context of Geodesy in Geospatial Coordinate Reference Systems: From Global to National



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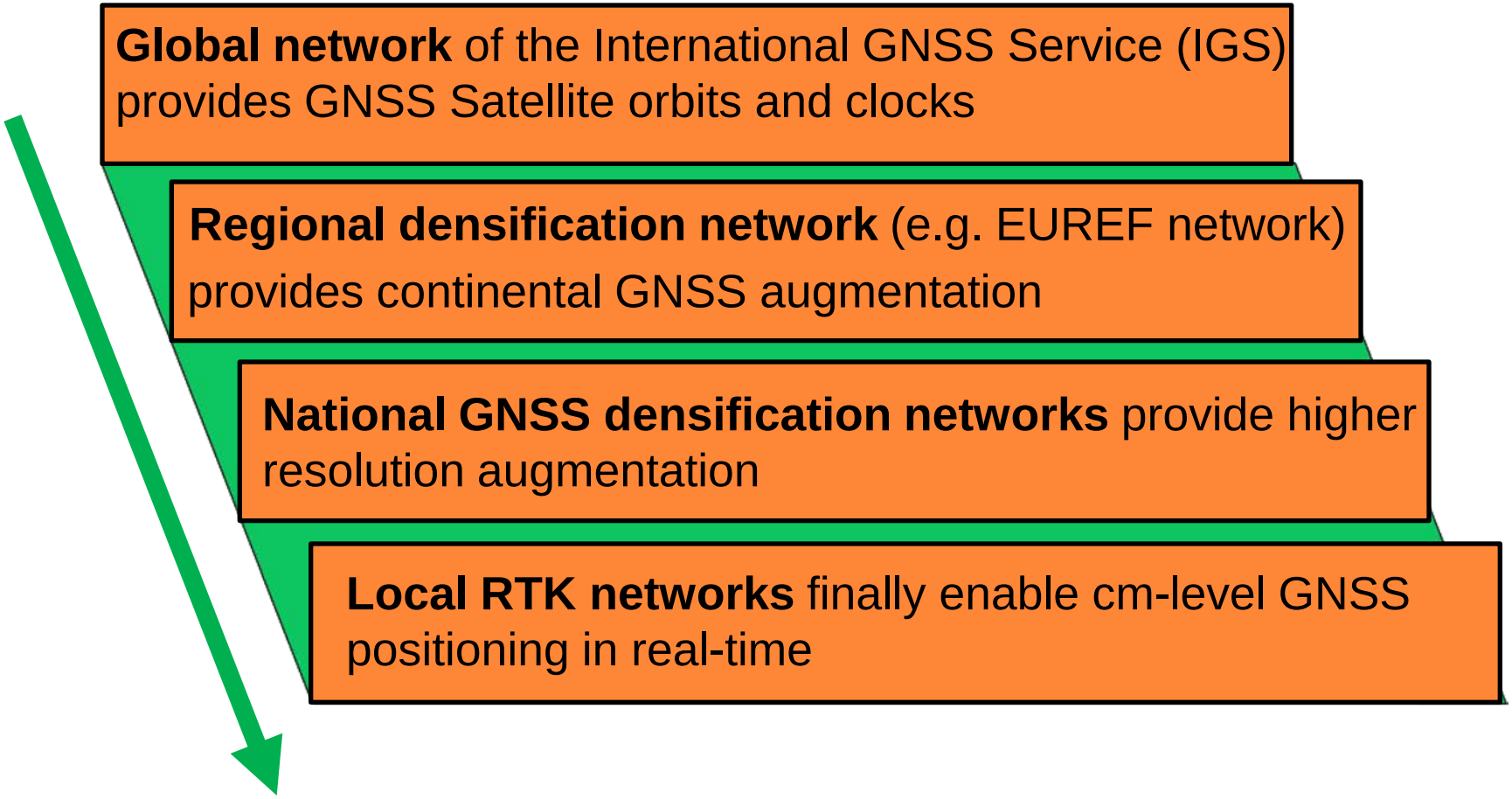


Context of Geodesy in Geospatial Coordinate Reference Systems: From Global to National

EUREF

- Est. in 1987 at the IUGG General Assembly in Vancouver, Sub-commission 1.3a of IAG
- Links to about 130 European organizations, agencies, universities – related to geo-referencing, positioning, and navigation
- Main goals: Definition, realization, maintenance, and promotion of the adoption of
  - ETRS89 European Terrestrial Reference System
  - EVRS European Vertical Reference System

  for referencing of European geospatial data

European Commission

Eurocontrol

INSPIRE

NMCAs

eurogeographics

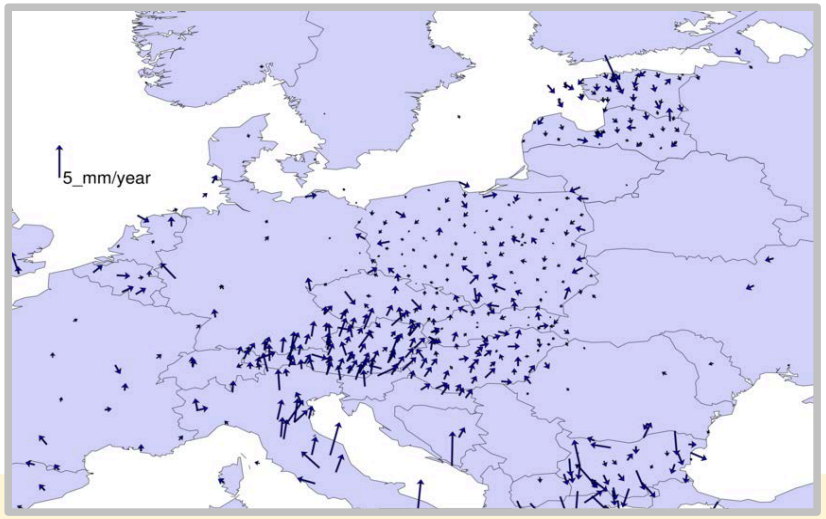
Context of Geodesy in Geospatial Coordinate Reference Systems: From Global to National

EUREF

Regional Densification in Europe

GNSS Permanent Network (EPN)
with 250 stations

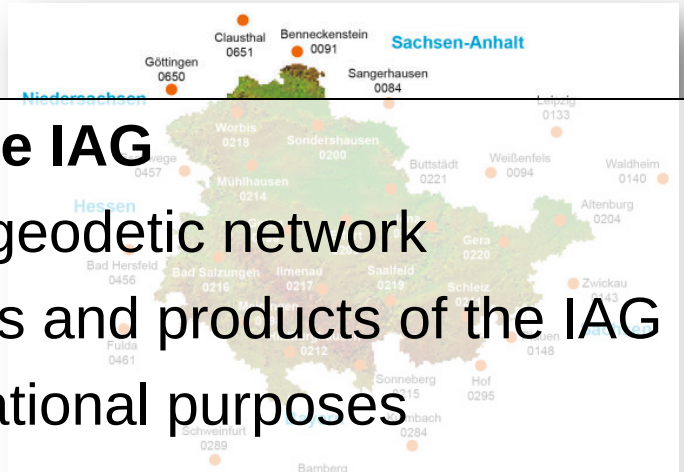
- 130 EPN stations are part of ITRF2008
- About 150 stations provides RT and GLONASS data ⇨ Galileo
- Class A Stations (200 of 250) Position: 1 cm-accuracy coordinates for any epoch of the station's lifetime
- Station movements monitored



Context of Geodesy in Geospatial Coordinate Reference Systems: From Global to National

Example for National Densification
Germany: GREF

Local Densification
SAPOS: Thüringen



National participation in the IAG

- Contribution to the global geodetic network
- Contribution to the services and products of the IAG
- Use of IAG products for national purposes
- Active national GNSS networks as basis for ubiquitous positioning

Products: Data streams carrying observations and corrections

Access to the CRS – Positioning

Developing GIS markets requesting PPP with sub-decimeter accuracy

GIS in Precision Agriculture

Machine Control

Access to the CRS – Positioning

Augmentation Systems

Provider	Service	Coverage	Format	Status
NexTeq	i-PPP	Global	Proprietary	Existing
Trimble	CenterPoint RTX	Global	Proprietary	Existing
IGS	RT-IGS	Global	RTCM	Emerging
EUREF	RT-EUREF	Europe	RTCM	Emerging

- Accuracy: about ± 0.1 meters, RTX: ± 4 centimeters
- Convergence: 15 minutes, RTX: 1 minute
- Product dissemination: Geo satellites and terrestrial IP networks

Precision agriculture

Access to the CRS – Positioning

GNSS Service providers: Example Europe

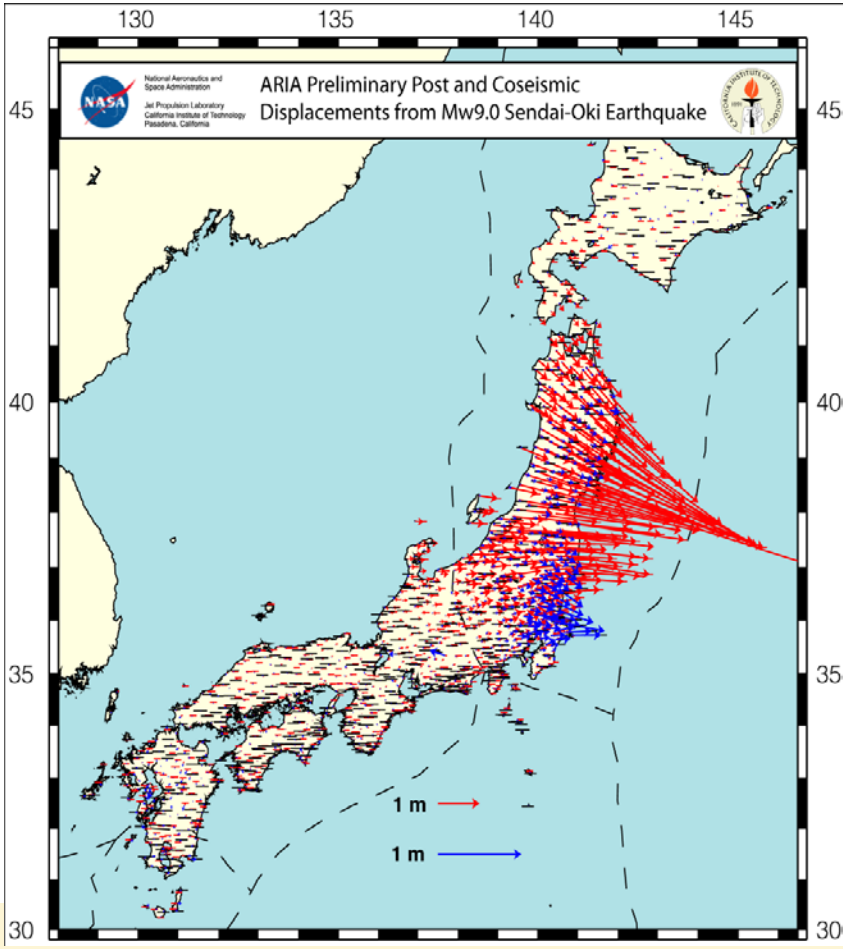
- Both public and private
- “Network RTK” is state of the art
- Western and Central Europe widely covered by local RTK networks
- Galileo ⇨ Multi-GNSS
- Different countries follow different policies ⇨ Open Data?
  - Public services in view of authoritative tasks
  - Private services promoting receiver sales
- All private and public cm-services are subject to charges
- Private sector keeps an interest in proprietary stream formats
- Public sector pushing stream formats following Open Standards

Recent Developments
Motivation

Example: Fast detection and precise quantification of events

Earthquake in Chile, Feb. 27, 2010 (DGFI)

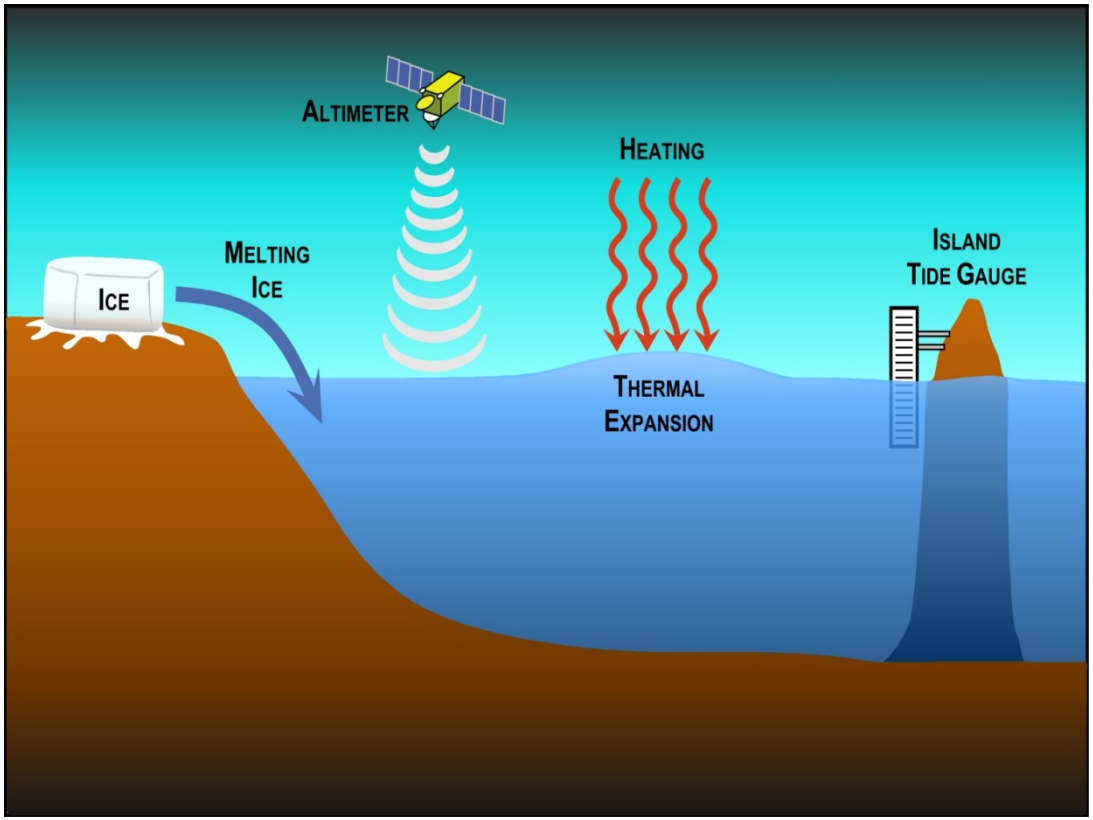
Sendai, March 11, 2011 (NASA)



- Fast reaction is crucial
- Rapid estimation of earthquake magnitude
- Prediction and detection of tsunami
- Including location of main deformations and destructions

Recent Developments
Motivation

Example: Sea Level Change



Integrated approach needed

Requirements:

- precise orbit determination
- accurate ITRF
- high resolution gravity field

Measurements:

- precise satellite altimetry
- tide gauges
- continuous GNSS measurements
- precise levelling

Geodetic Reference Frame Requirement for Sea Level Measurement:

1 mm reference frame position and 0.1 mm/yr velocity

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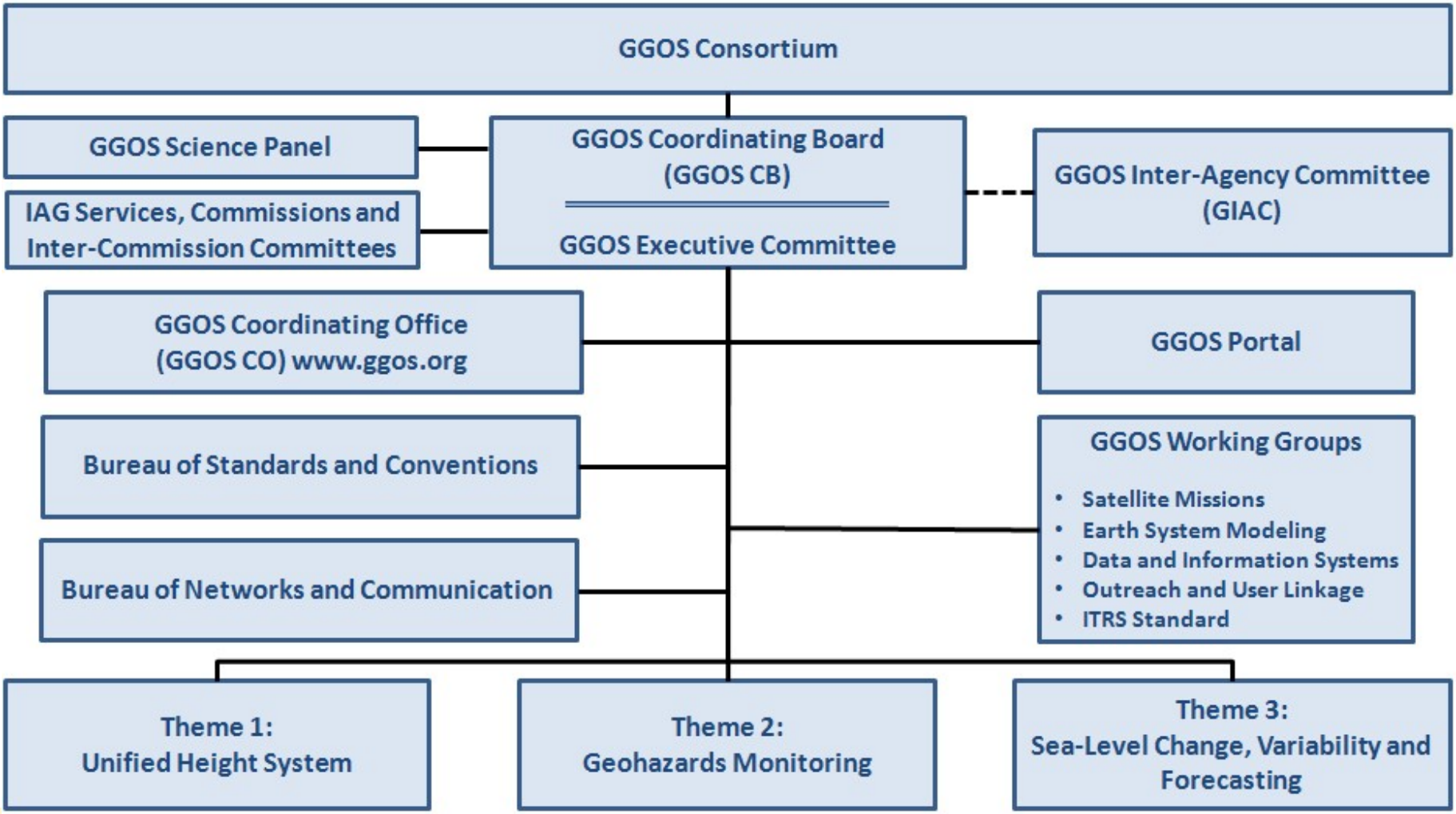
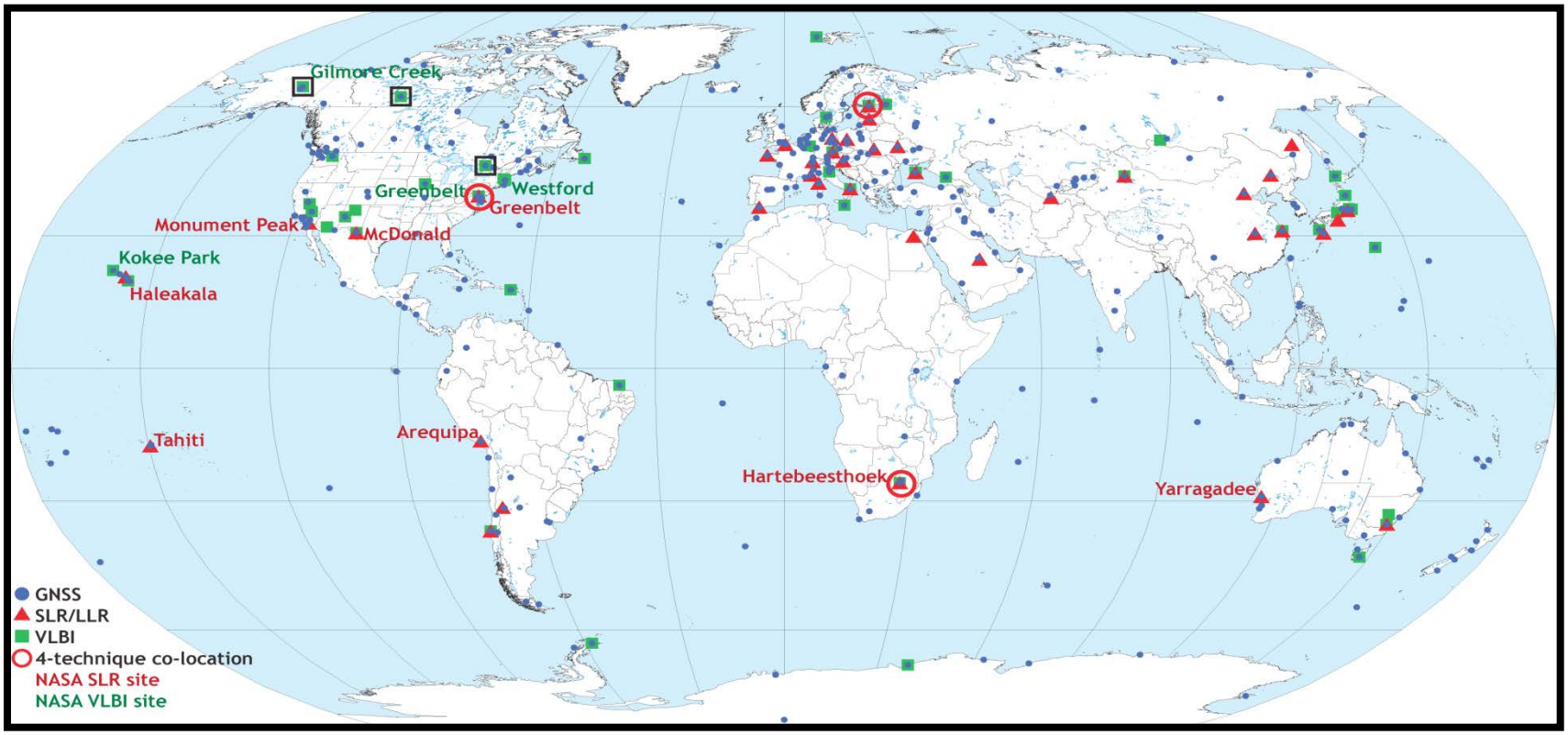
Recent Developments
Global Geodetic Observing System of the IAG

Structure of GGOS, adopted in 2011



Recent Developments
Global Geodetic Observing System of the IAG

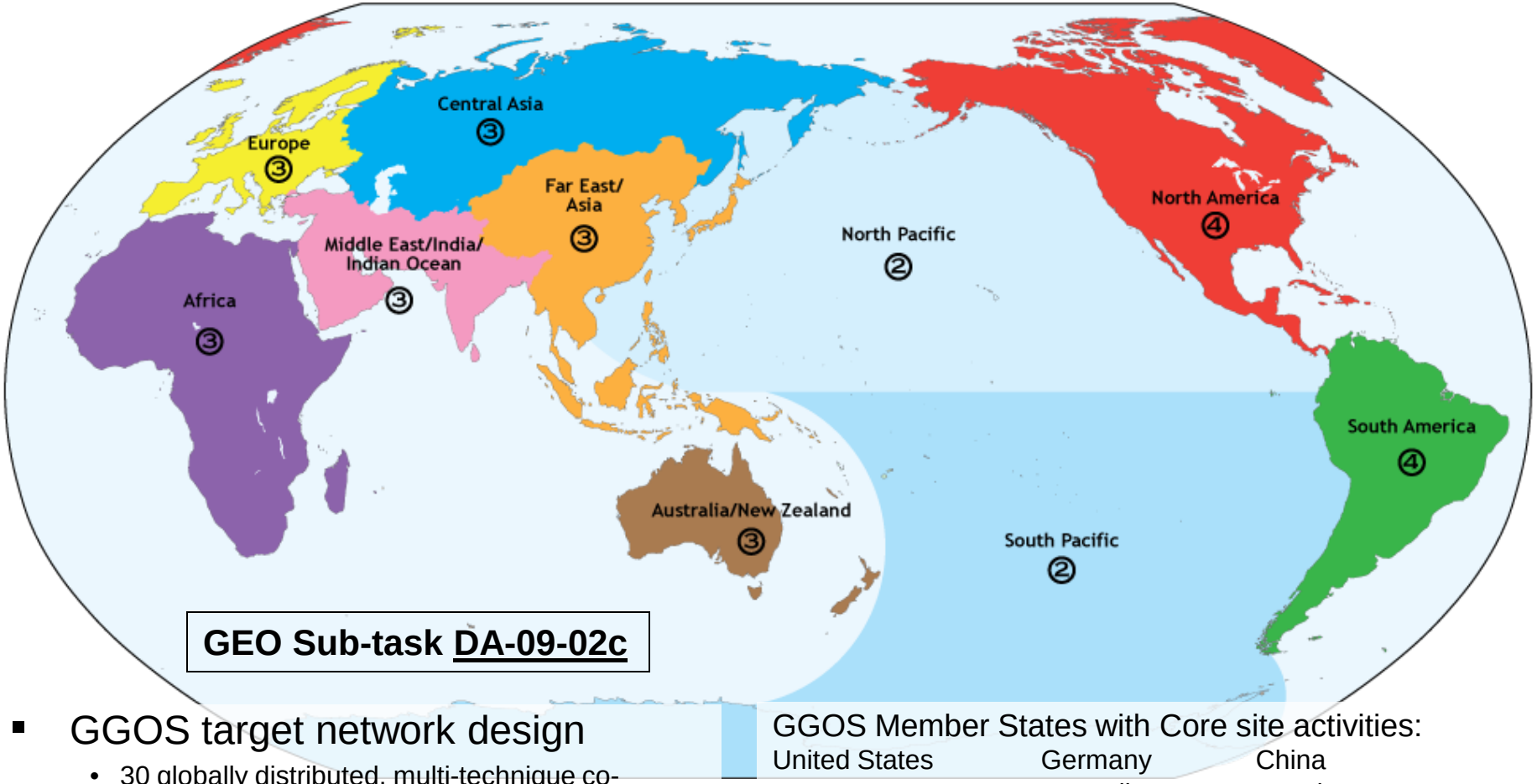
Requests concerning the existing global geodetic network



- Continue the R&D work concerning the applied observation technology
- Improve the geographical distribution of the observation sites

Recent Developments
Global Geodetic Observing System of the IAG

Target global network (GGOS Core Sites)

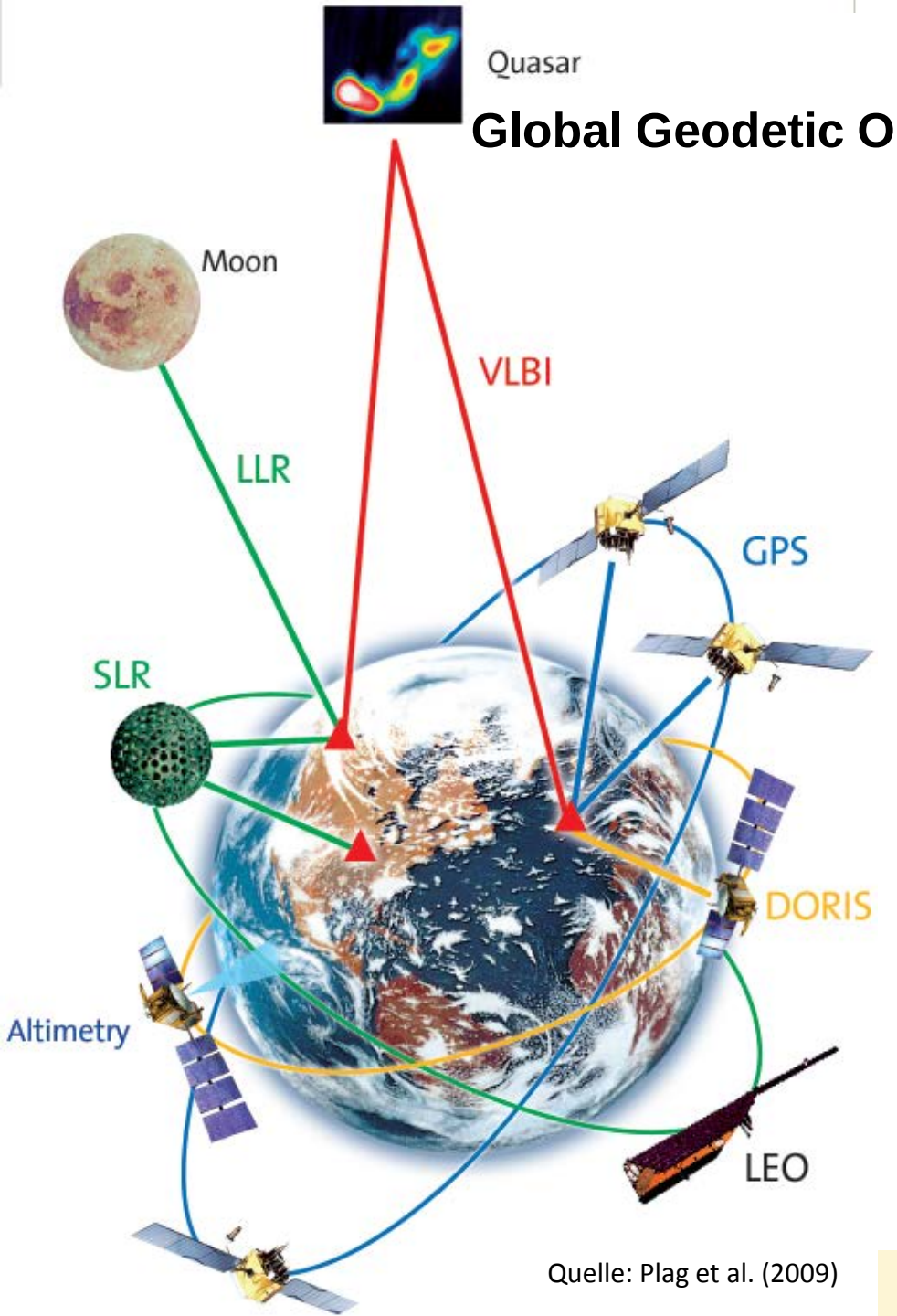


- GGOS target network design
  - 30 globally distributed, multi-technique co-located ground stations
  - 4 techniques/site

GGOS Member States with Core site activities:

United States	Germany	China
Korea	Australia	Russia
New Zealand	India	Saudi Arabia
South Africa	Spain	

Recent Developments
Global Geodetic Observing System of the IAG



Quelle: Plag et al. (2009)

GGOS Infrastructure

Observation Architecture Levels

- ⇨ **Network / System**
- ⇨ **Data Streams**

Level 1:
Ground stations, terrestrial observations

Level 2:
Low Earth Orbiters

Level 3:
Medium / Geostationary Earth Orbiters

Level 4:
Moon, Planets

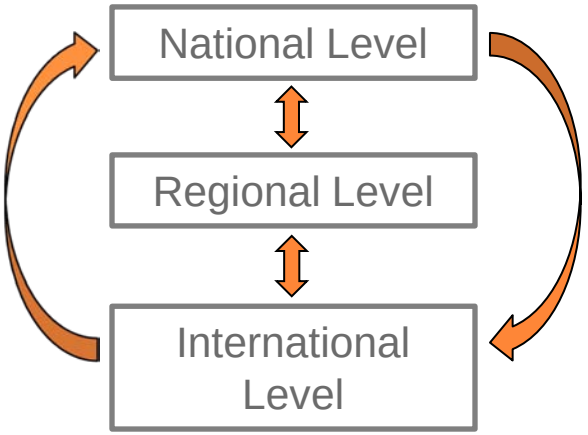
Level 5:
Quasars

Support through the GIAC (GGOS Inter-Agency Committee)

Conclusions

Ongoing Activities

- International Level
  - IAG: ITRF, Services, GGOS ⇦ Scientific Community together with National Agencies
- National Level / Regional Level:
  - Establishment and maintenance of Geodetic Observatories and of active GNSS Networks
  - Development and Adoption of Standards
  - R&D Work



Needs

- *Official* High-Tech Infrastructure for Spatial Referencing with better global coverage
- *Coordinated* Policies
- *Sustainable* Funding
- *Strategic* Partnerships (NMAs, Space Agencies, ...)

Inter-governmental coordination and support ⇨ UN GGIM!