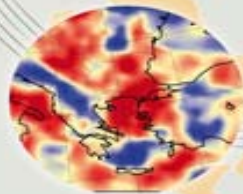
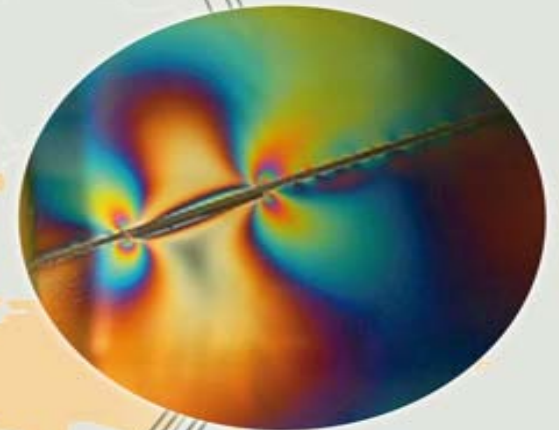




# European Plate Observing System: Getting ready for EPOS construction



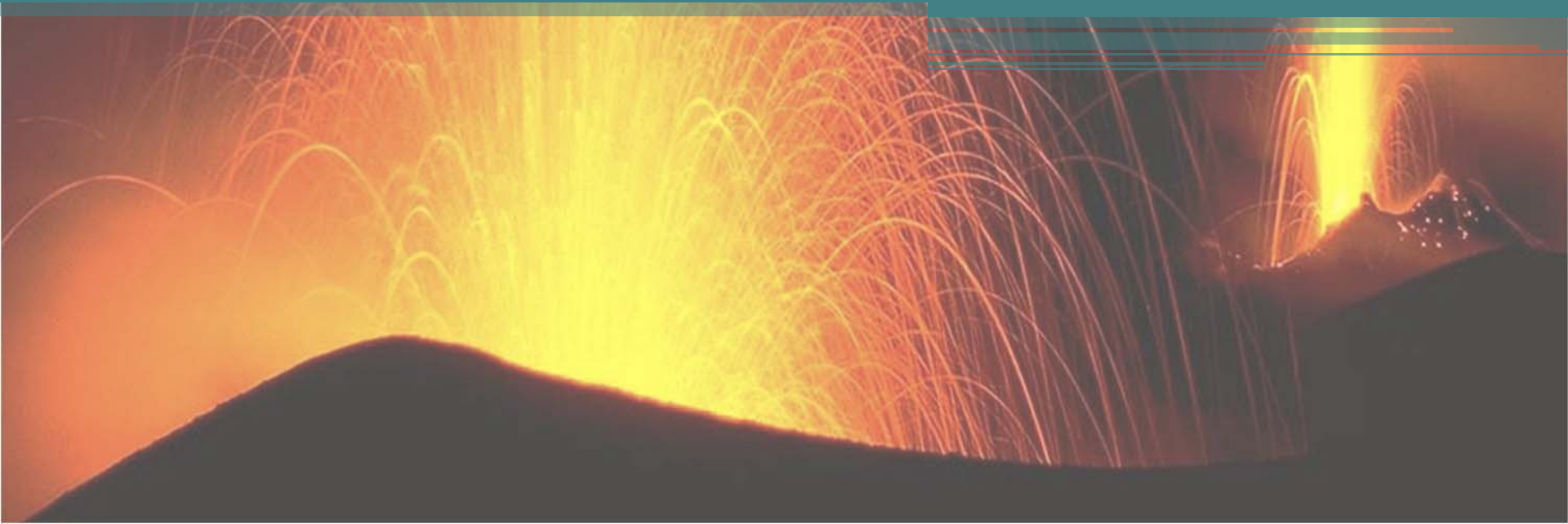
Massimo Cocco & EPOS PP Team



# EPOS a long term integration plan of research infrastructures for solid Earth Science in Europe

Preparatory Phase Project

[www.epos-eu.org](http://www.epos-eu.org)



# What is EPOS ?

**EPOS** is a long-term integration plan that aims to create a single sustainable, permanent and distributed infrastructure that includes:

- geophysical monitoring networks
- local observatories (including permanent in-situ and volcano observatories)
- experimental & analogue laboratories in Europe

**EPOS** will give open access to geophysical and geological data and modelling tools, enabling a step change in multidisciplinary scientific research into different areas



seismic hazard map

# Mission Statement

EPOS will integrate the diverse, but advanced European Research Infrastructures for solid Earth Science, and will build on new e-science opportunities to monitor and understand the dynamic and complex solid-Earth System. EPOS will identify existing gaps and promote implementation plans with other disciplines of environmental science to help solve the grand challenges facing the Earth and its people.

- **ESFRI** has been launched in April 2002  
ESFRI, the **European Strategy Forum on Research Infrastructures**, is a strategic instrument to develop the scientific integration of Europe and to strengthen its international outreach
- ESFRI's role and ambitions:
  - To jointly reflect on the development of strategic *policies for pan-European Research Infrastructures*
  - To prepare a European **Roadmap** with regular updates as *different areas **mature (!)***
  - To act as an **incubator** for *RI projects with pan-European interest* .....but it is not a decision making body

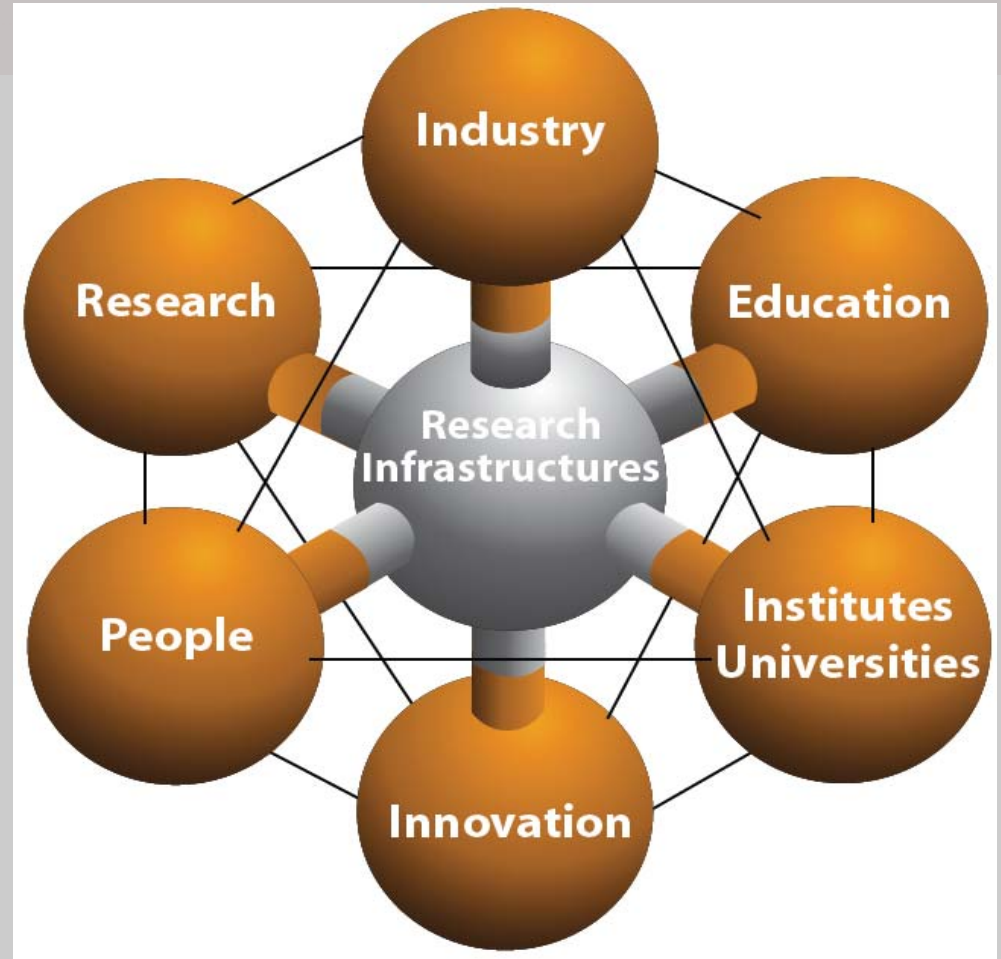
# The ESFRI Roadmap is an ongoing process



- **First edition 2006 and updated in 2008 with 44 projects**
- **2010 update: 47 PP projects**
- **About 10 were expected to fly by 2011**
- **European X-FEL first to go real – civil construction started in 2009 and International convention agreed 2 days ago.**

# The new vision

The centrality of  
**Research**  
Infrastructures  
for Innovation



*John Wood, EGEE09, Barcelona, 2009*

- **Why ?**

- ✓ Clear science case
- ✓ Structuring our community
- ✓ Dual role: pan-European vs national

- **How ?**

- ✓ Clear technical approach

- **Who ?**

- Data & technological providers

- **To whom ?**

- ✓ Solid Earth science community (the users)
- ✓ The society



# Why?

## Responding to the specific needs for Europe

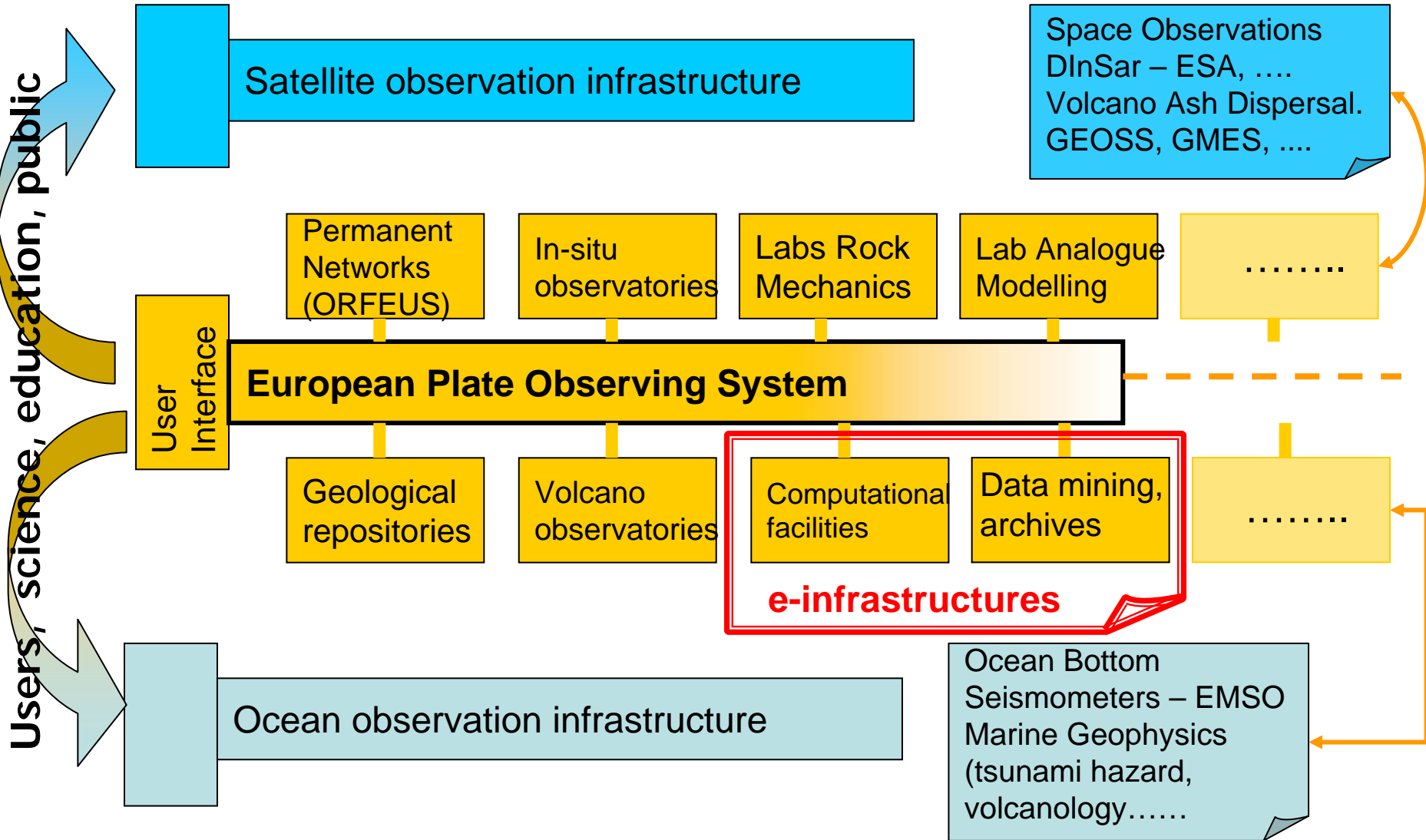
- **Innovation**

- Integrated accessibility to multidisciplinary data will accelerate the discovery of new and novel uses of Earth science results for societal benefit (including both scientific discoveries and technological progress)
- Development of educational, training and dissemination material (e-learning)

- **Connections to other RIs and to other scientific fields**

- **Maintaining a key role and collaborating with other global and international initiatives**

# EPOS infrastructure concept

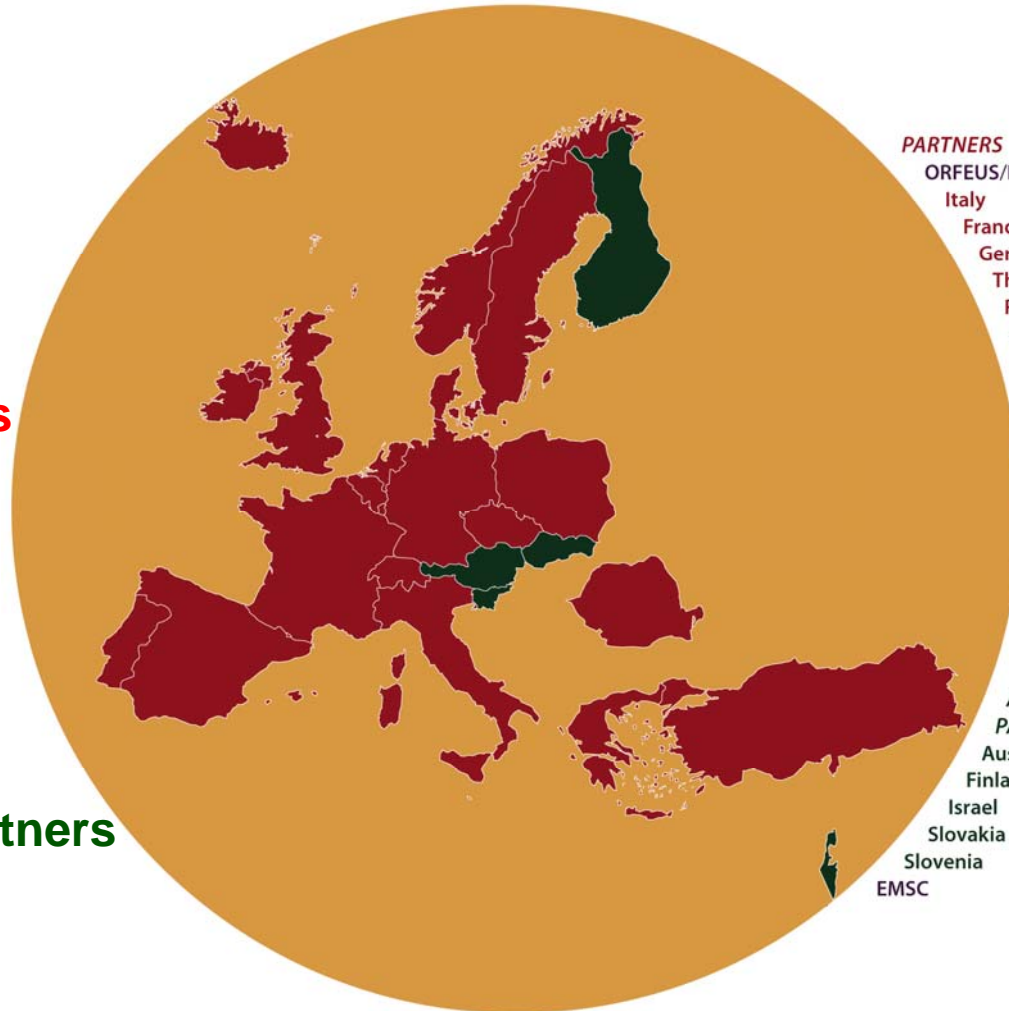


# EPOS: the Partnership

## Who?

**20 partners  
for 18 countries**

**6 associate partners  
for 5 countries**



### *PARTNERS*

ORFEUS/KNMI

Italy

France

Germany

The Netherlands

Romania

Iceland

Switzerland

United Kingdom

Norway

Turkey

Ireland

Portugal

Spain

Greece

Sweden

Poland

Denmark

Czech Republic

### *ASSOCIATE*

### *PARTNERS*

Austria

Finland

Israel

Slovakia

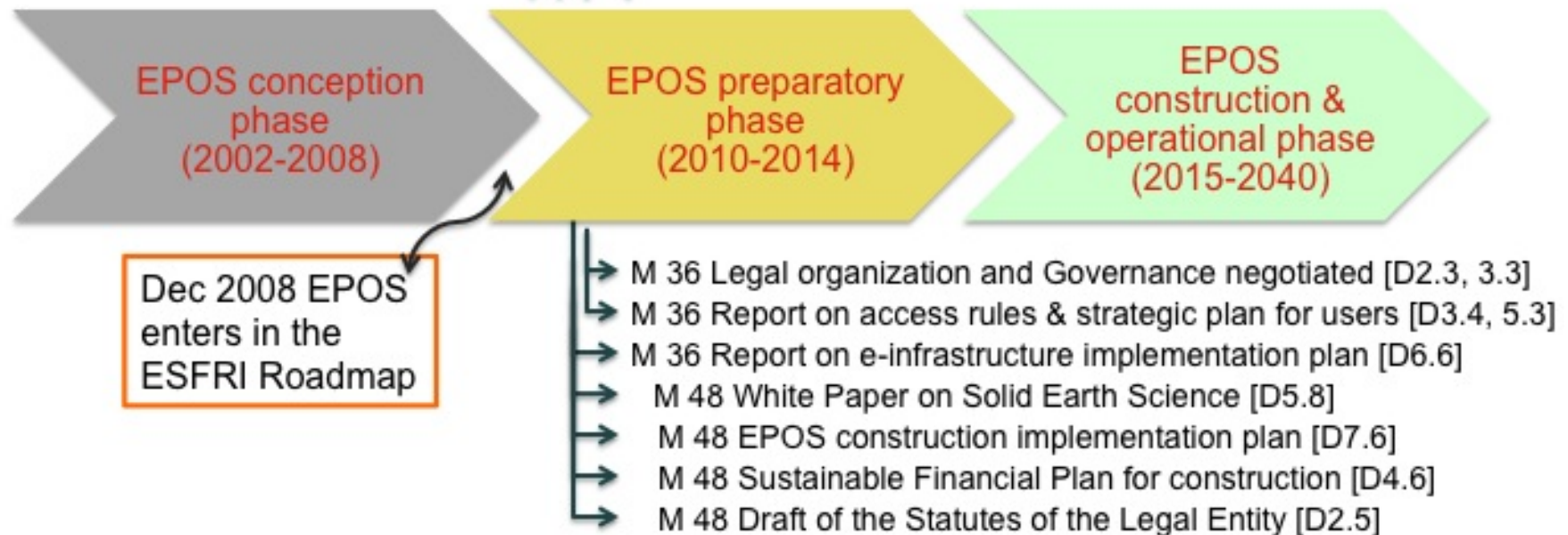
Slovenia

EMSC

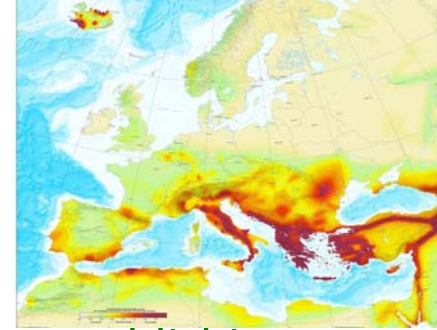
**On going initiatives for integrating the partnership:  
Bulgaria, Belgium, Russia, .....**

MEREDIAN  
NERIES  
EXPLORIS  
VOLCANO  
TOPOEUROPE  
SPICE .....

- M 2 EPOS Management Implementation Plan [D1.1]
- M 12 Report on possible legal models [D2.1]
- M 24 Draft Business Plan for construction [D4.2]
- M 30 Report on financial commitments at national level [D4.3]



# What is EPOS PP?

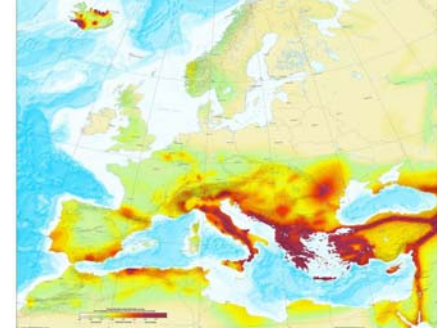


The Preparatory Phase is a timely initiative dedicated to establishing a management framework with efficient centralized coordination to achieve the following objectives:

## Strategic

- To establish efficient coordination and management of the infrastructure at European level that will govern the process of building the necessary components, the expenditure assessment and the outreach at the project level.
- To reach mutual agreement among the countries involved regarding the core legal entity and its governance structure as well as commitments for funding that will ensure the construction of the infrastructure and its long-term operation.

# What is EPOS PP?

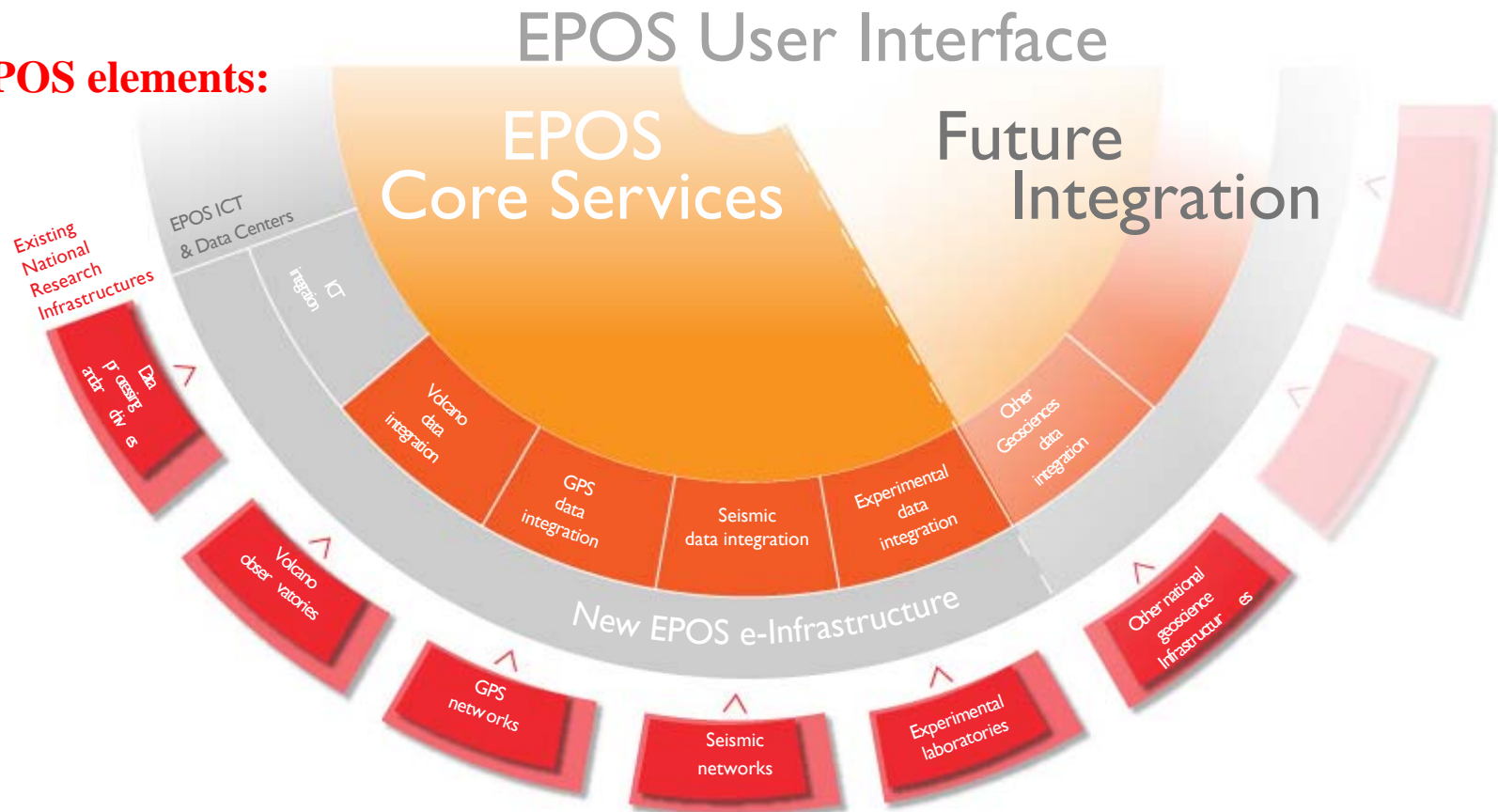


## Technical

- To integrate existing national research infrastructures through the novel EPOS Data Centres representing a network of community service providers for distributed data storage and processing.
- To develop an innovative and coherent e-infrastructure architecture, which will form the platform and data service infrastructure (not community specific) by means of the EPOS Core Services, for interdisciplinary data and metadata exchange, processing tools and computational simulations through the EPOS user interface.
- To link EPOS with other international Earth Observing Systems.
- To promote coherent training, educational and dissemination programmes and outreach.

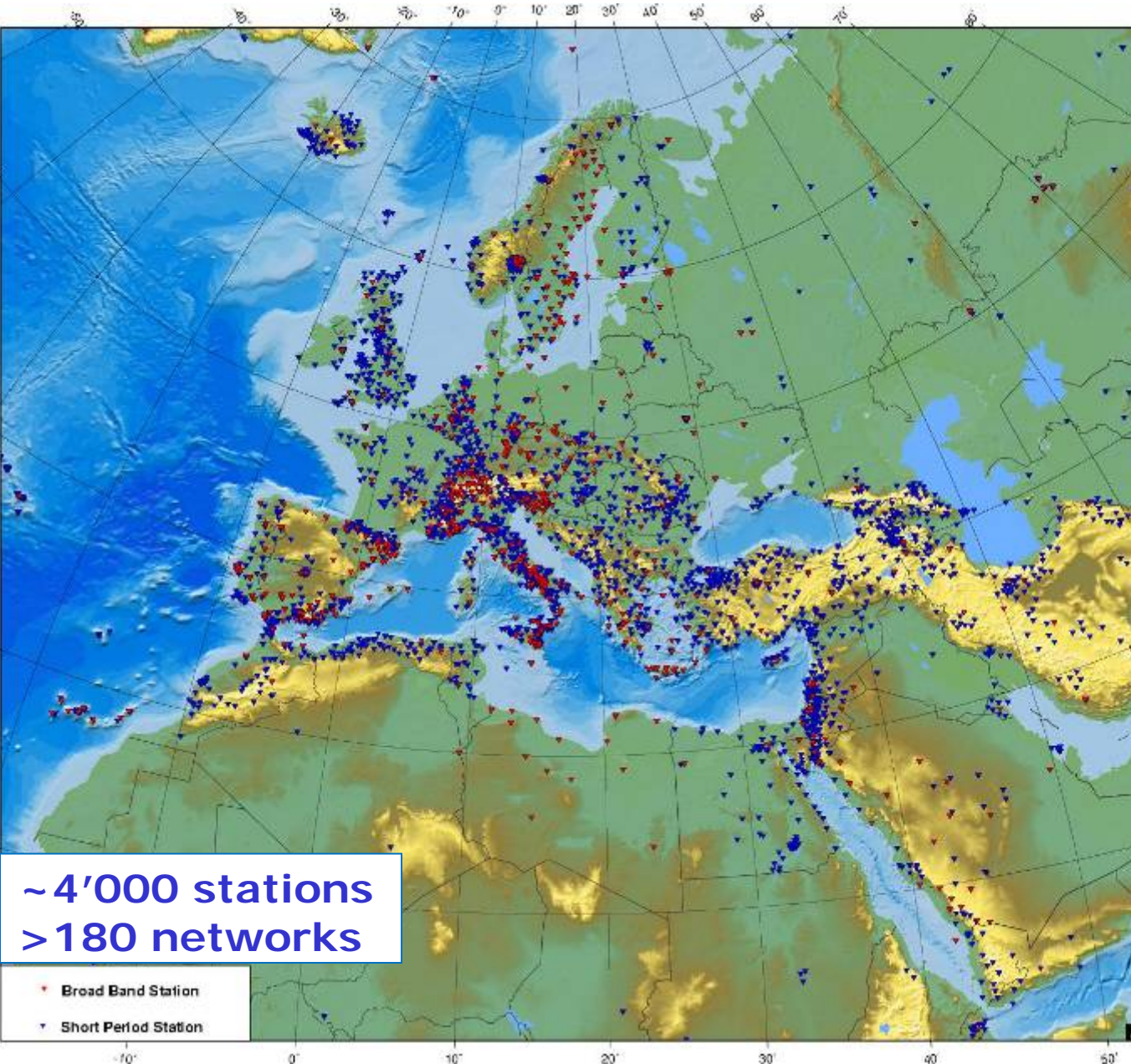
**How?**

**The EPOS elements:**



- The existing national research infrastructures are integrated into the EPOS Data Centres, which represent community specific services for data archiving and mining having their own computational resources.
- Community specific data centres are further integrated by the EPOS Core Services, representing the infrastructure layer consisting of common data services.
- EPOS data service infrastructure will be designed and established during the PP to serve multiple communities studying the solid Earth dynamics.

# Monitoring infrastructure: seismological networks



**Data ownership:**  
National monitoring interests (hazard, warning, etc)

**Regional Coordination:**  
Parameter data  
EMSC  
Waveform data  
ORFEUS

**Current projects:**  
NERIES (EU)  
NERA (EU)  
GEOFON (GR)  
GEOSCOPE (FR)  
MEDNET (I)

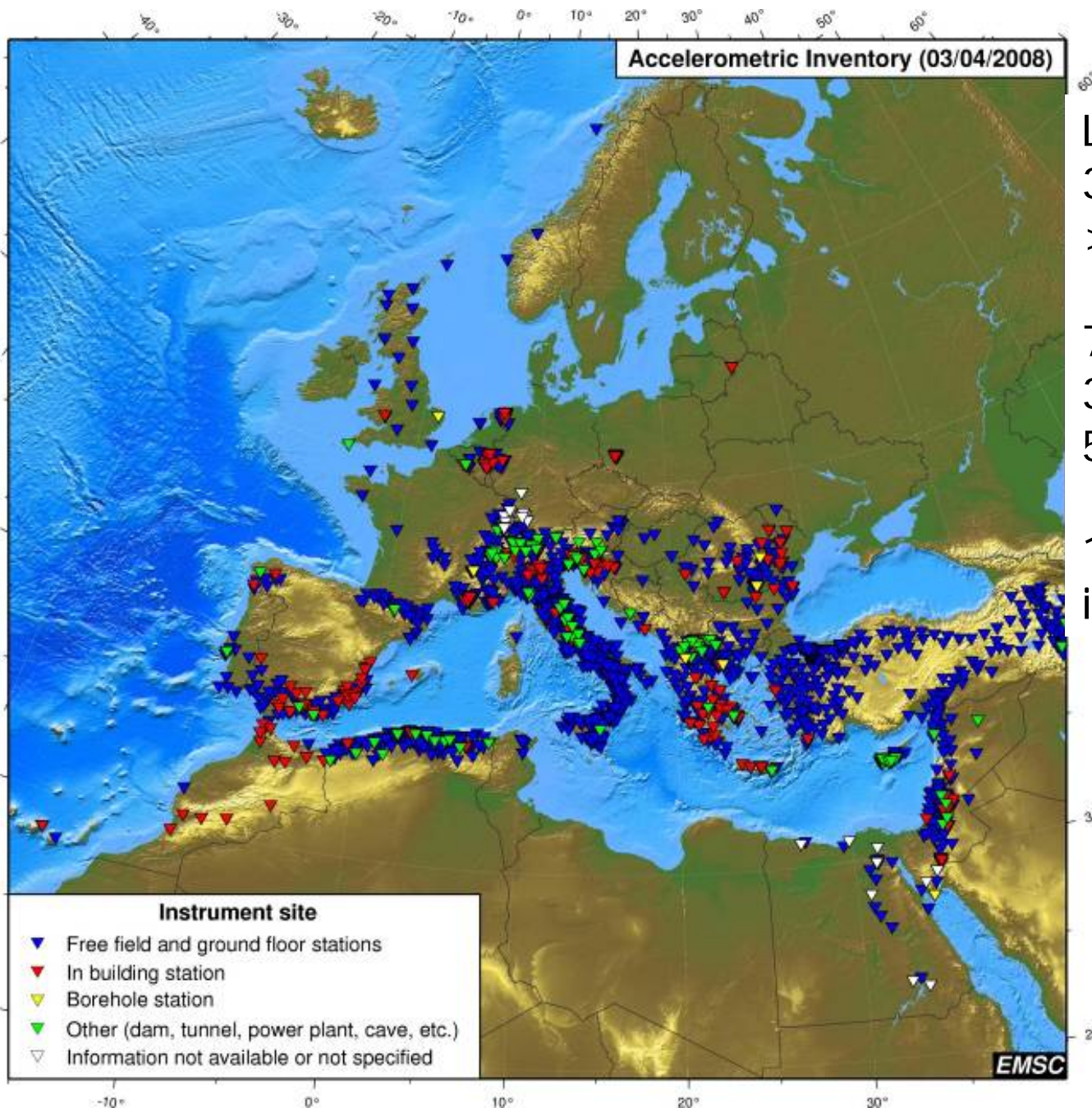
**Orfeus**



ORFEUS & EMSC



# Accelerometer networks and data access



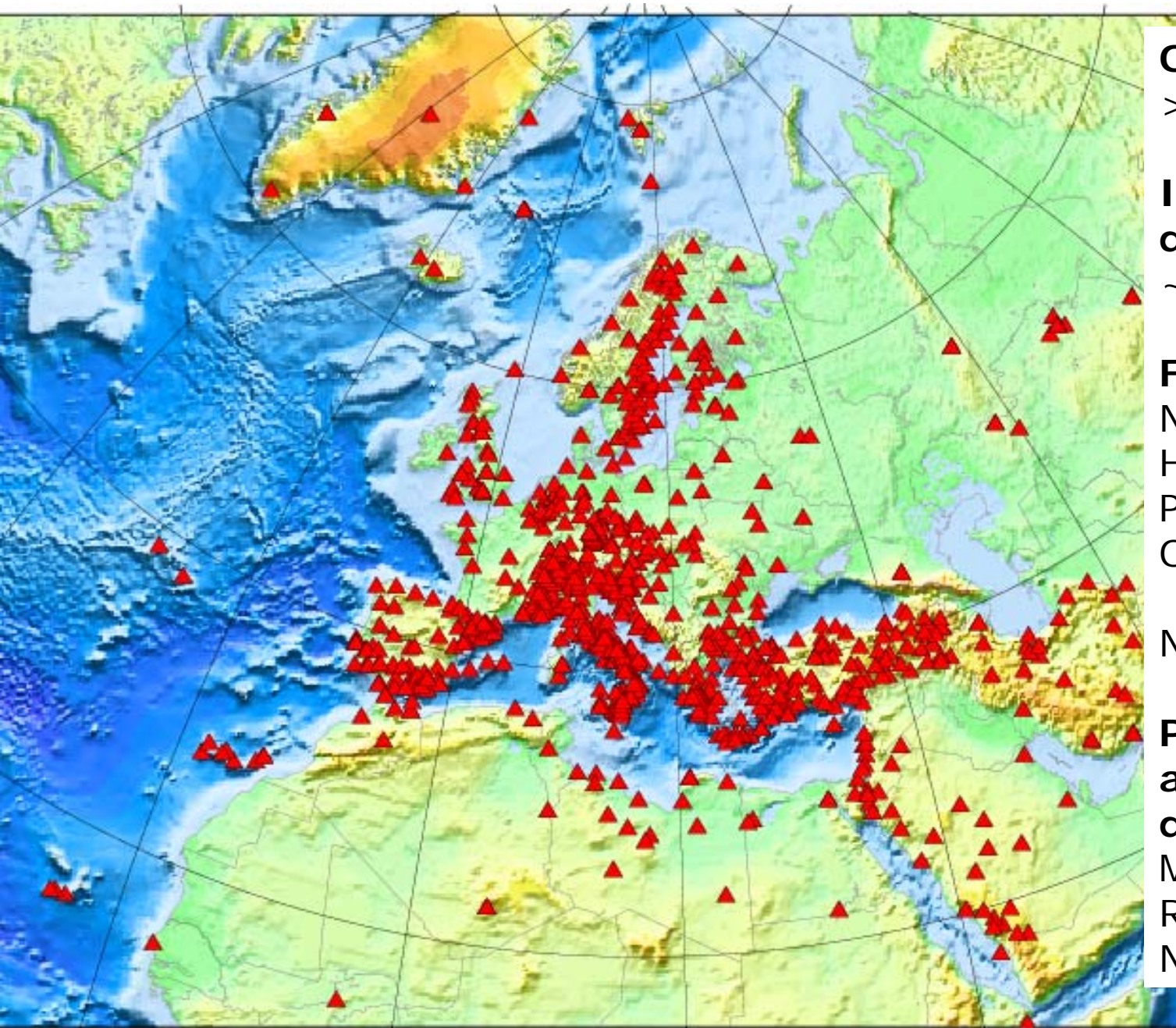
Listed stations:  
3,695 from  
> 51 networks

78% digital  
38% in free field  
52% in buildings

13% accessible in  
integrated archive



# Broadband Stations in Europe and surroundings



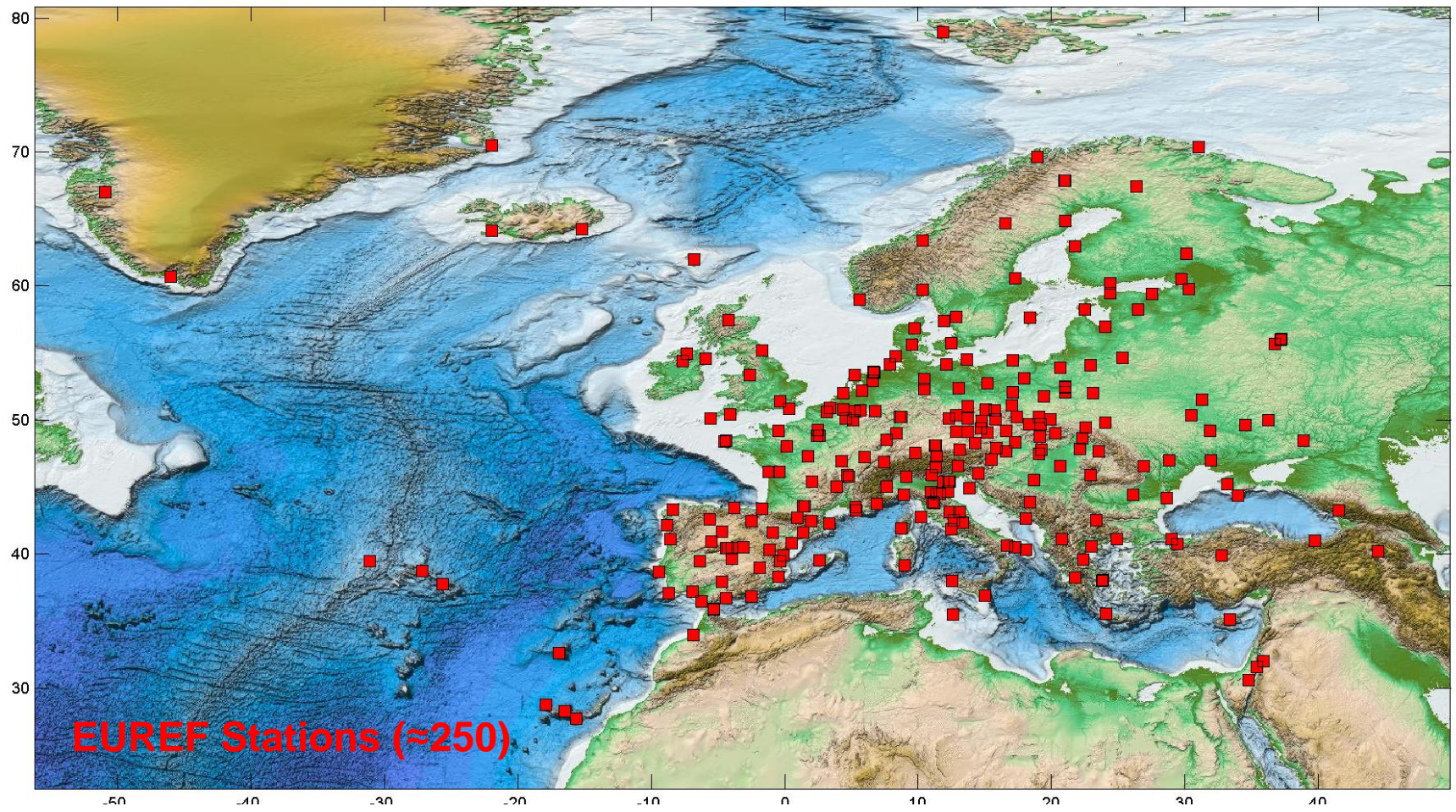
**Observatories:**  
> 100 networks

**Integrated data access:**  
~ 50%

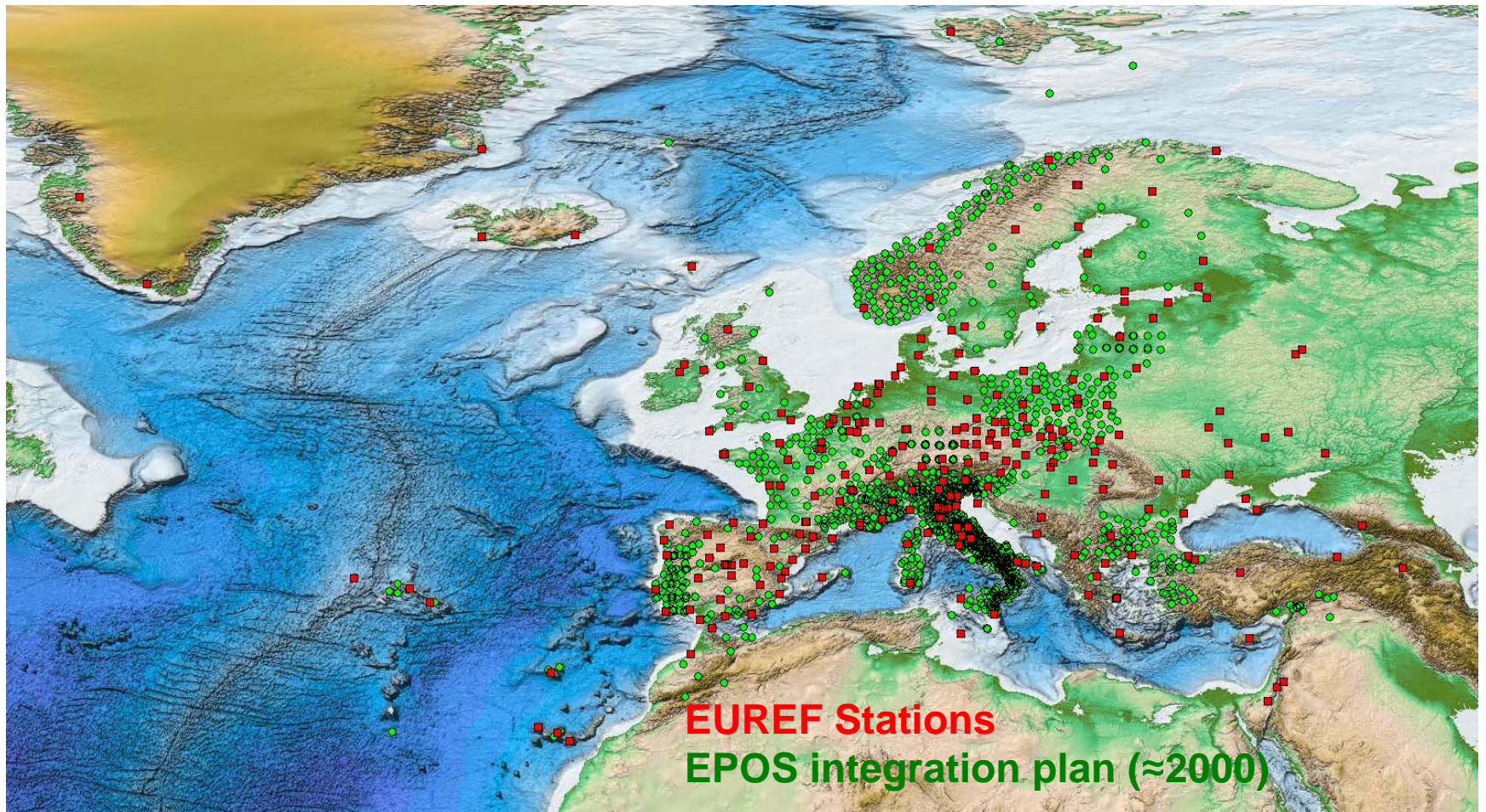
**Funding:**  
National public,  
Hazard/Risk,  
Projects.  
Occasionally  
Research  
No EU funds!

**Political aspects on data exchange:**  
Middle East  
Russia  
Northern Africa

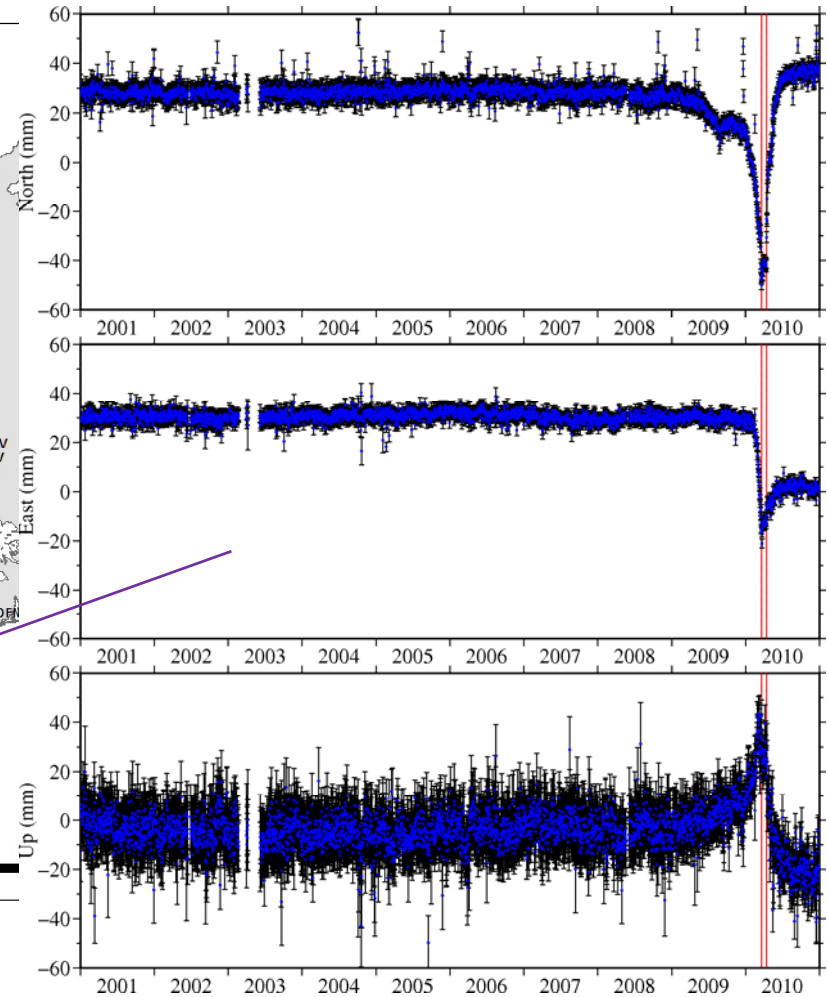
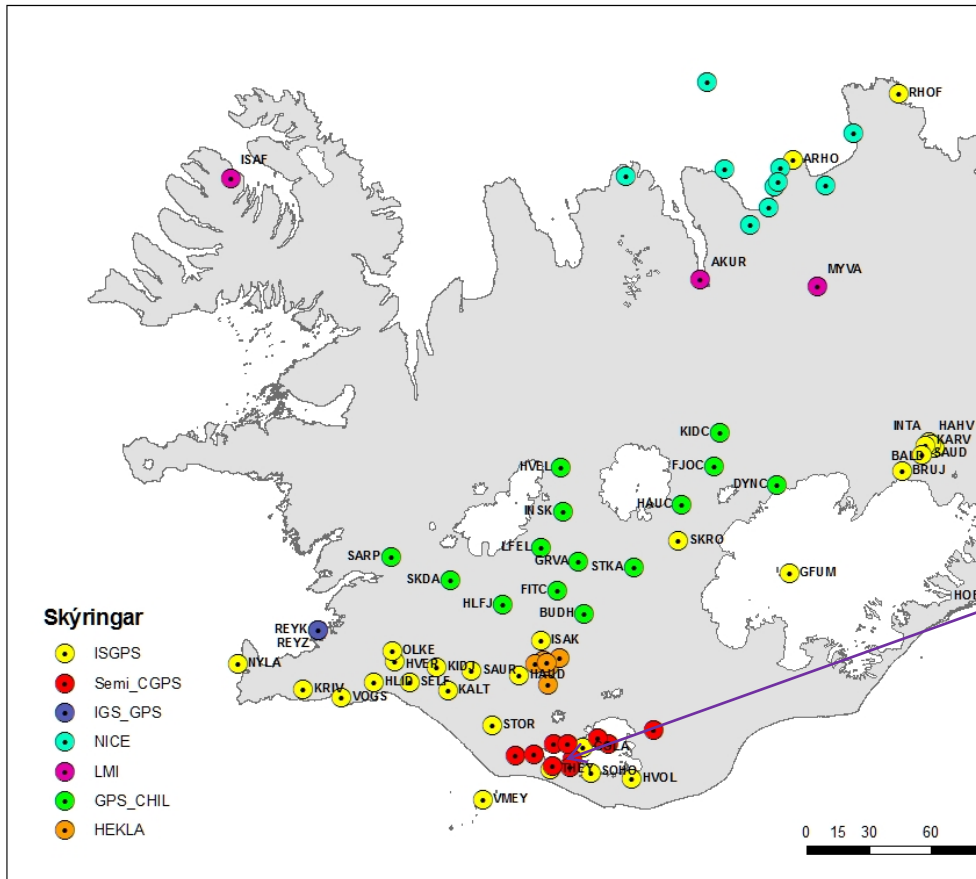
# EPOS: integrating GPS networks



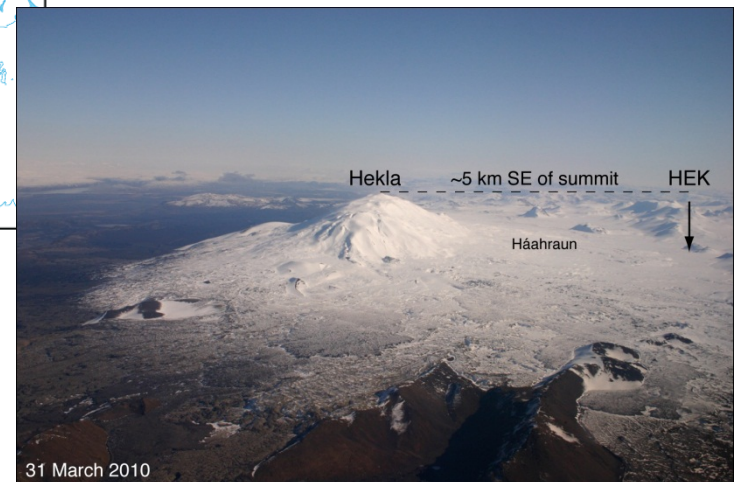
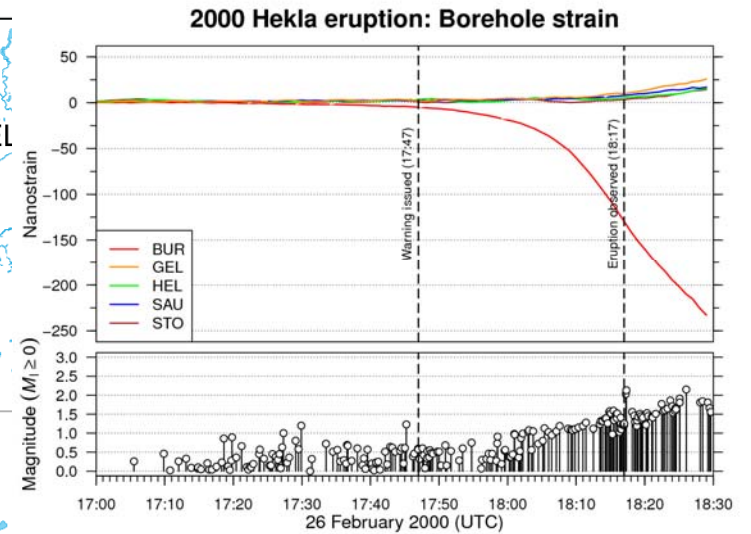
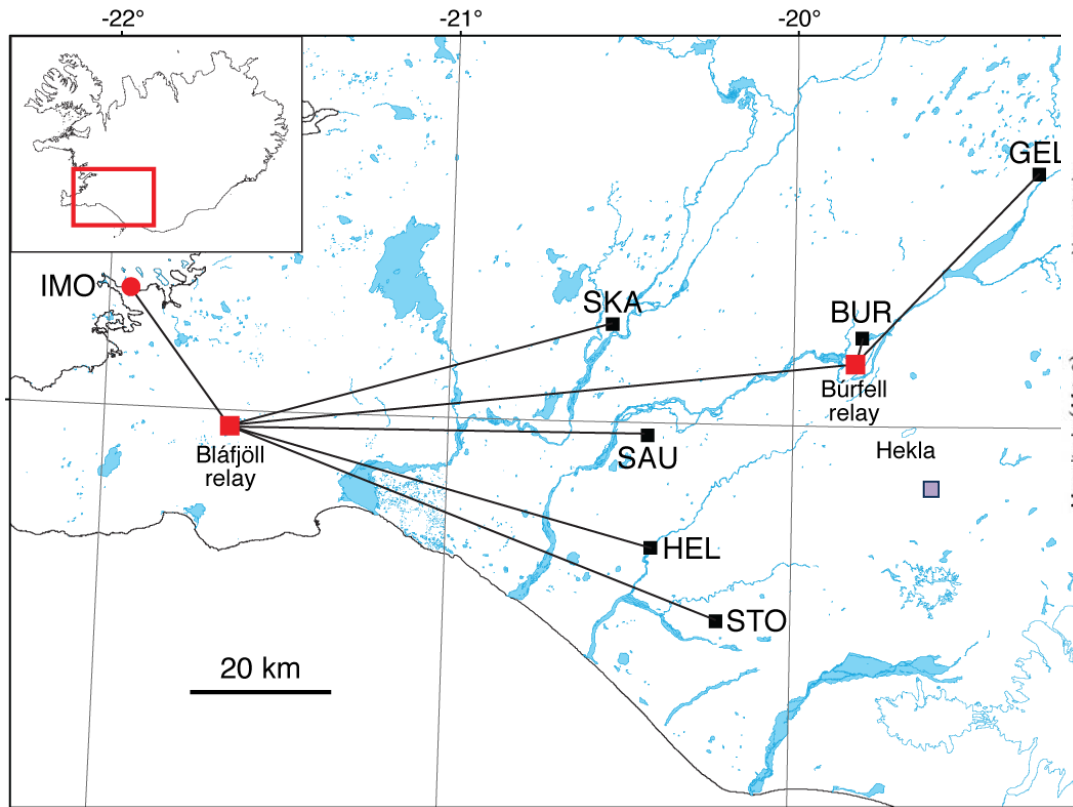
# EPOS: integrating GPS networks



# GPS Networks: ISGPS, IGS\_GPS & LMI and temporary networks



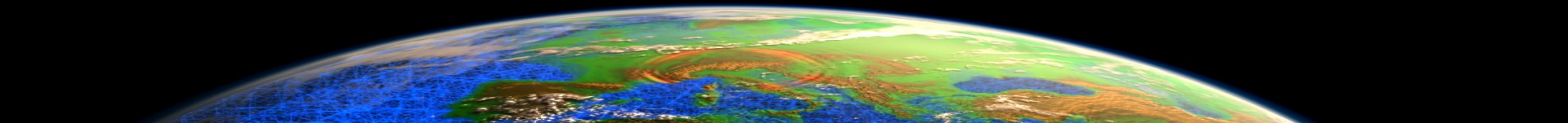
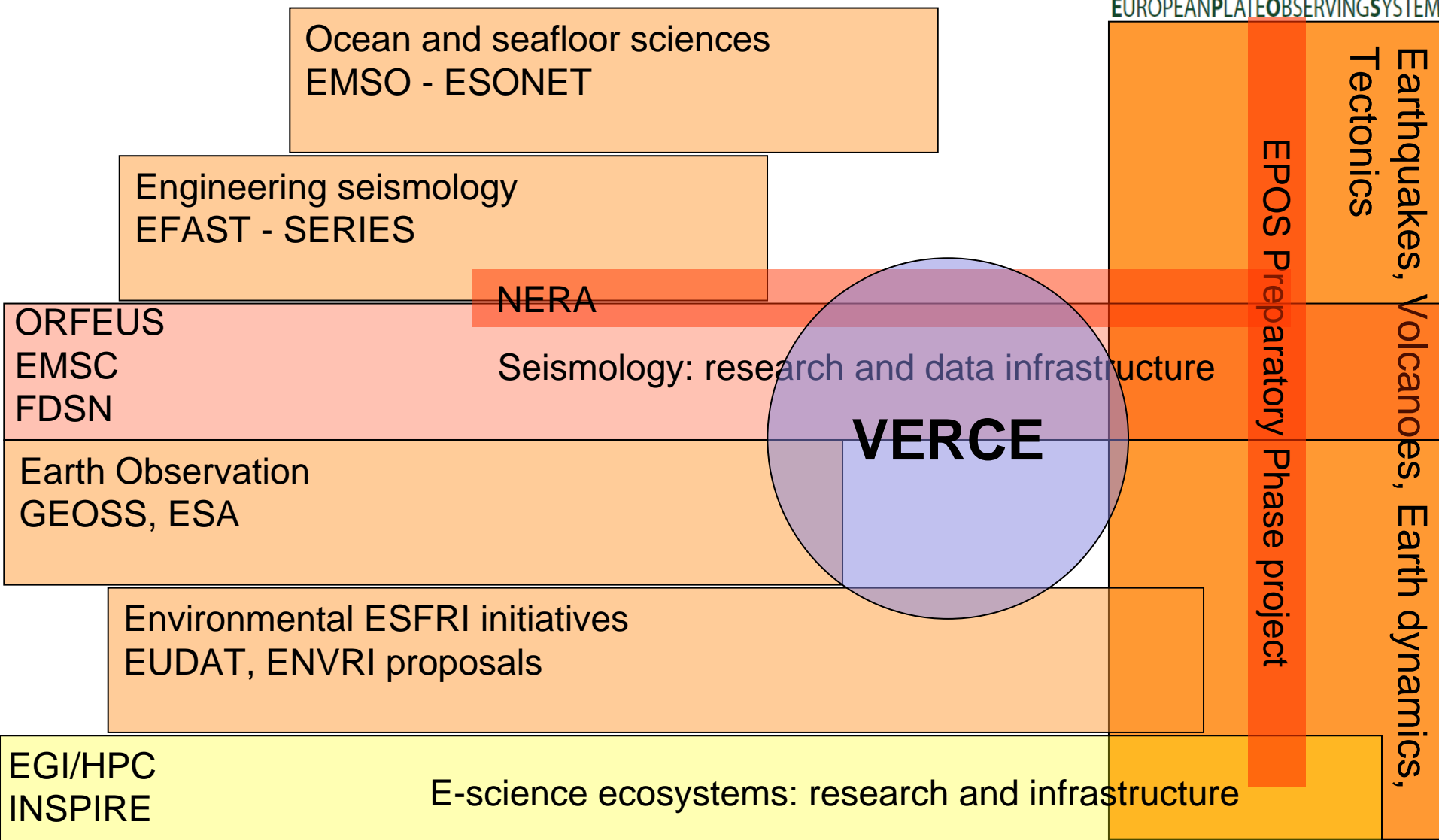
# Borehole Strain Meter Network



# Interactions with existing European platforms



EUROPEAN PLATE OBSERVING SYSTEM



# Data Intensive applications

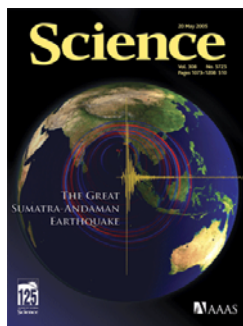
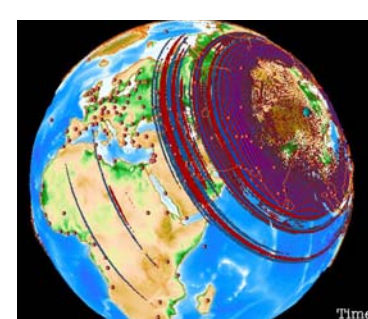
Earthquake and seismology community is facing a fundamental paradigm shift: from data driven to data intensive research:

Large volume data analysis: extracting information from space and time correlations in dense array observations, Data and computing intensive simulation/inversion: 3D wave form information using adjoint methods, stochastic strong motion simulation, Orchestrated workflows across service components.

Seamless access to large volumes of multi-sets data across the Grid and HPC components

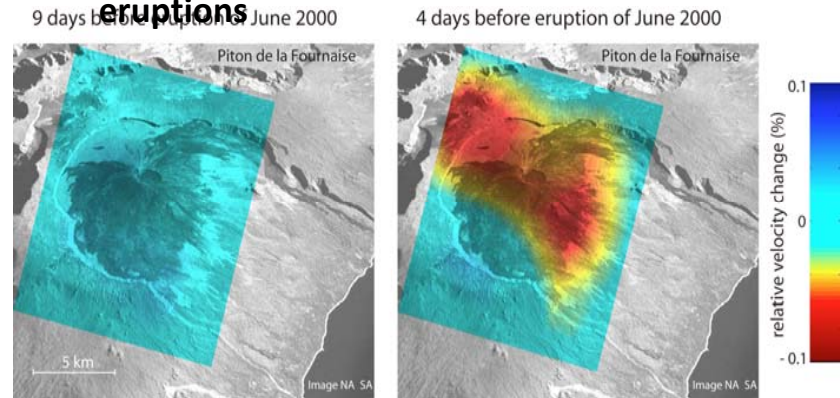
Industrial and societal applications: natural hazards, climate changes and energy resources and national security.

Large earthquake source radiation: Sichuan (Mw 7.9, 2009, China); Sumatra-Andaman (Mw 9.2, 2004, Indonesia)

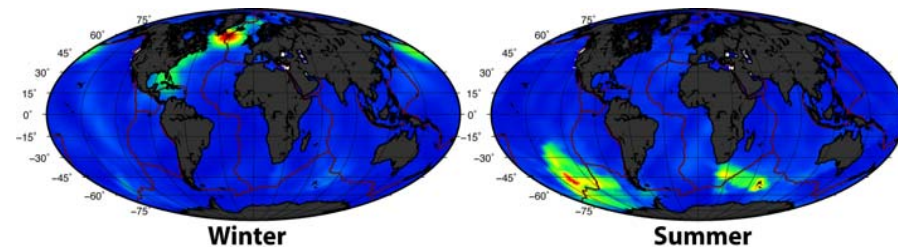


Research groups using SPECFEM3D

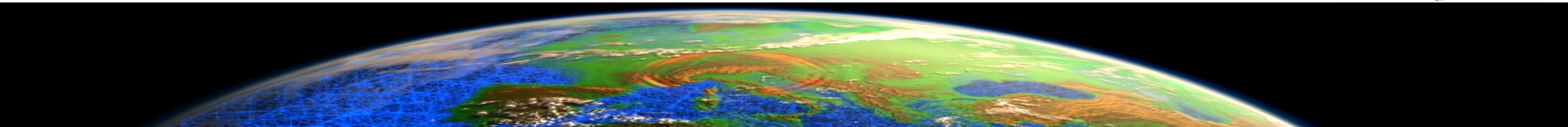
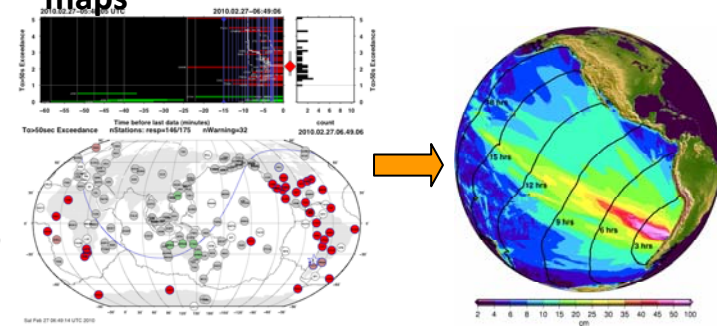
## Seismic noise correlations: observing precursors to volcanic eruptions



## Studying the coupling between the Solid Earth, the Oceans, and the Atmosphere



## Earthquake detection: tsunami impact maps





# VERCE : Virtual Earthquake and Seismology Research Community in Europe e-science environment



Centre National de la Recherche Scientifique (CNRS-INSU), France

University of Edinburgh (UEDIN), United Kingdom

Royal Netherlands Meteorological Institute (KNMI-ORFEUS), Netherlands

European-Mediterranean Seismological Centre (EMSC), France

Istituto Nazionale di Geofisica e Vulcanologia (INGV), Italy

Ludwig-Maximilians-Universität (LMU), Germany

University of Liverpool (ULIV), United Kingdom

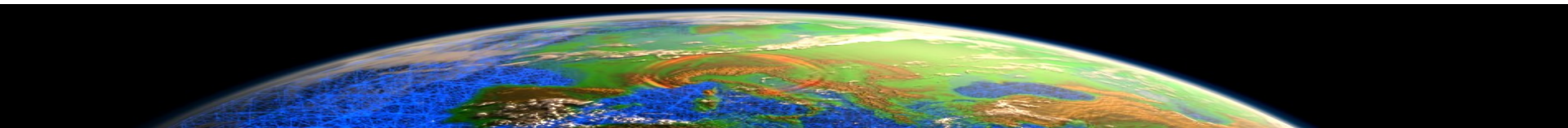
Bayerische Akademie der Wissenschaften (BADW-LRZ), Germany

Fraunhofer-Gesellschaft e.V. (SCAI), Germany

Centro di Calcolo Interuniversitario (CINECA), Italy

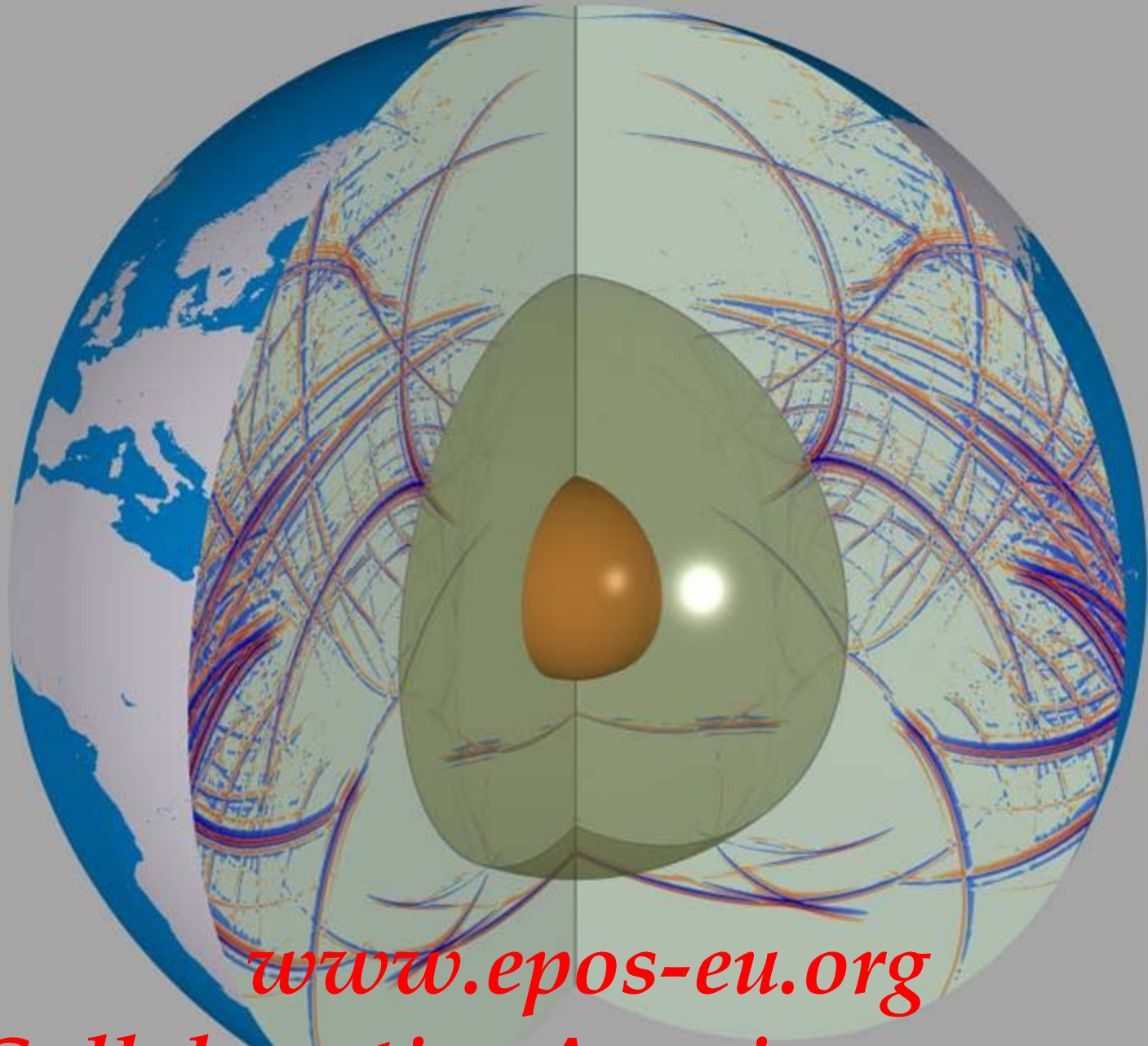


Jean-Pierre Vilotte (CNRS-IPG Paris), Malcolm Atkinson (UEDIN), Torild van Eyck (ORFEUS-KNMI), Anton Frank (BADW-LRZ)



# Supersites Initiative

- Develop three supersites in Europe:
  - Istanbul, Iceland, Italian volcanoes
- Create e-infrastructure at local level
- Making these web-services interoperable
- Linking them with the global supersite web portal
- Identifying “candidate supersites” in Europe
- Identifying “natural laboratories” in Europe
- Implementing common and shared ICT solutions



[www.epos-eu.org](http://www.epos-eu.org)

*Collaborative Area is now open*

# The EPOS NewsLetter ---- Please contribute

**EPOS** newsletter  
www.epos-eu.org

Integrating European Research  
Infrastructures for solid Earth Science

## INSIDE THIS ISSUE

Adding scientific and socio-economic value in...

EPOS web presence



## NEWS

The EPOS Mission Statement. EPOS will integrate the diverse, but advanced European Research Infrastructures for solid Earth Science, and will build on new e-science opportunities to monitor and understand the dynamic and complex solid-Earth System. EPOS will identify existing gaps and promote implementation plans with other disciplines of environmental science to help solve the grand challenges facing the Earth and its people

by Massimo Cocco & EPOS team

### Adding scientific and socio-economic value in Europe by integrating solid Earth science infrastructures

The understanding of the physical processes responsible for earthquakes, volcanic eruptions, landslides, surface and tectonic processes, and tsunamis requires the prompt and continuous availability of high quality data obtained through direct observations and accurate predictive modeling of their temporal and spatial evolution. The accessibility to these data can accelerate the discovery of new and novel uses of Earth science results for societal benefit. The in-situ monitoring and forecast

be completely assessed (for instance in terms of energy supply, insurance and re-insurance companies, financial markets, etc...). In addition to its other effects, the Tohoku earthquake will affect Japan's and the world's supply of some minerals, at least temporarily. Up to one-quarter of the world's iodine and one-third of Japan's cement production may be affected, according to a recently released U.S. Geological Survey report.

Understanding the processes and forecasting, mitigating the effects of such events requires a pan-European coordination of national facilities and expertise. This plan aims at integrating the currently scattered, but highly advanced European facilities

Thank you for attention



# EPOS: the Concept

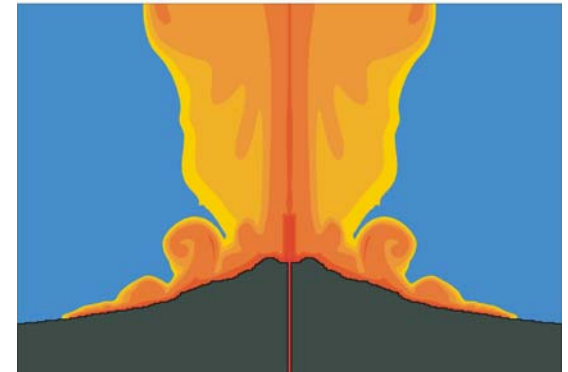


EPOS intends to integrate five existing core elements within one cyber infrastructure to realize:

- A comprehensive geographical distributed observational infrastructure consisting of existing permanent monitoring networks on a European scale (seismic, geodetic, ....)
- Dedicated observatories for multidisciplinary local data acquisition (volcanoes, in-situ fault monitoring experiments, geothermal and deep drilling experiments, geological repositories)
- A network of experimental laboratories creating a single distributed research infrastructure for rock and mineral properties
- Facilities for data repositories as well as for data integration, archiving and mining (including different solid Earth data, such as geophysical, geological, topographic, geochemical)
- Facilities for high performance distributed computing consisting of cyber infrastructures for collaborative computing and large scale data analysis

# Work Packages

- WP 1 Preparatory Phase Management
- WP2 Legal work
- WP3 Governance
- WP4 Financial Plan
- WP5 Strategy
- WP6 Technical preparation
- WP7 Architecture and implementation plan
- Wp8 Stakeholder interactions & dissemination



# WP6 Technical preparation

- Task 1 Inter-operability of RIs
- Task 2 Standardization & Technological Challenges
- Task 3 Access to data centres, modelling and technical facilities
- Task 4 IT standardization
- Task 5 WG integration and overview
  - ✓ WG 1 Seismological data
  - ✓ WG2 Data from Volcano Observatories
  - ✓ WG3 Geological and Surface Dynamics data
  - ✓ WG4 GNSS data and other Geodetic data
  - ✓ WG5 Other Geophysical data
  - ✓ WG6 Analytic and Experimental Rock Physics Laboratories
  - ✓ WG7 e-infrastructures and virtual community (HPC and Grid)
  - ✓ WG8 Satellite data



# Defining Mission Needs

- Identify data providers
- Define the EPOS Working Groups for technological work
- Define EPOS core groups of Users
- Define EPOS technical requirements
- Define optimal legal and governance structure
- Validation, authentication and impact assessment
- Provide long-term sustainability at national level

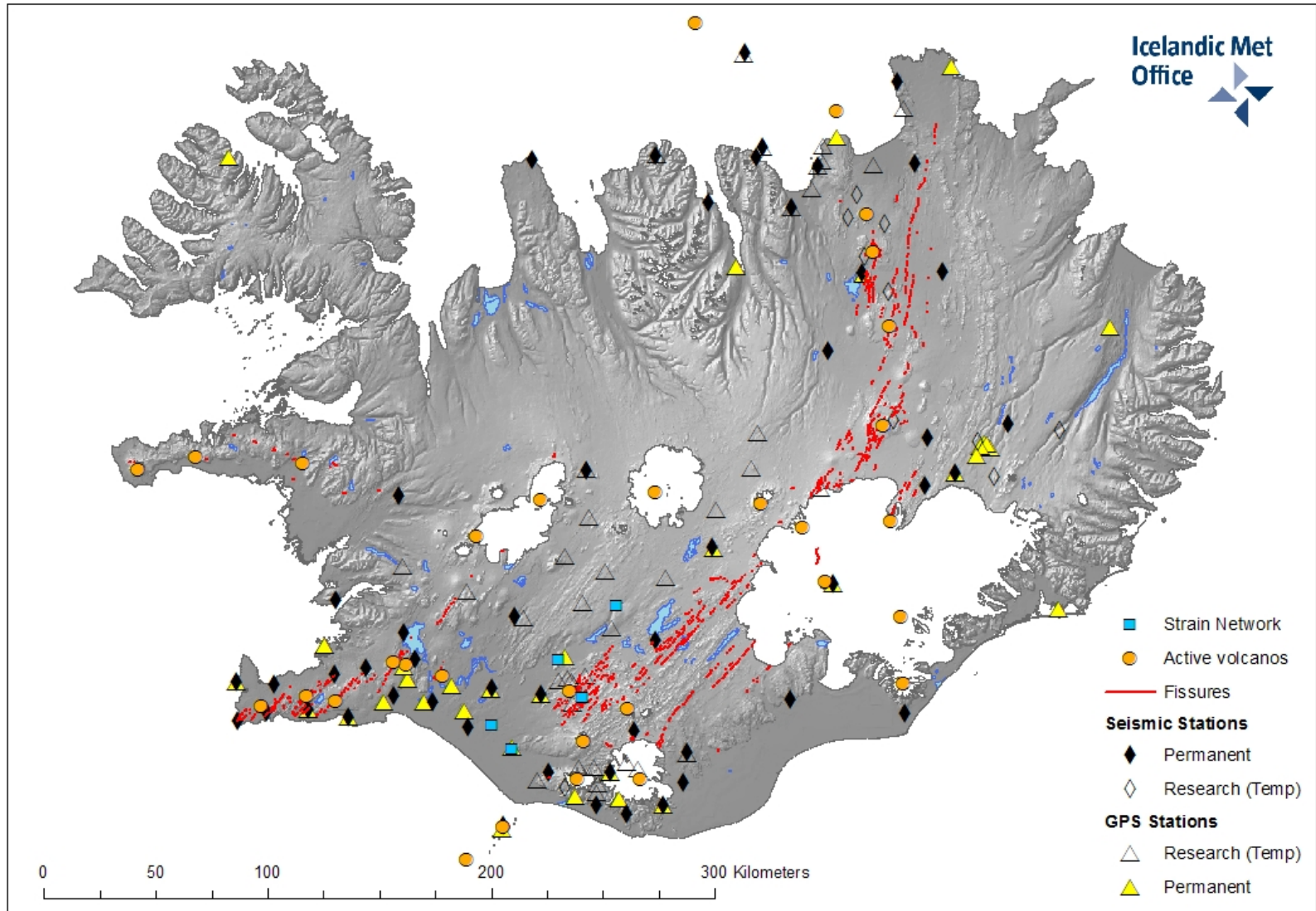


# Distribution of the European volcano observatories

*“In situ” complex Research Infrastructures that install/maintain systems to “observe” active volcanoes*

- Italy: Naples (Osservatorio Vesuviano), Catania (INGV-CT), Palermo (INGV-PA)
- France: Observatoires Volcanologiques, IPGP (Observatoire volcanologique du Piton de la Fournaise (OVPF), Observatoire Volcanologique de la Montagne Pelée, Observatoire Volcanologique et Sismologique de Guadeloupe.
- Iceland: Icelandic Meteorological Office (ICAO state volcano observatory); Institute of Earth Sciences, University of Iceland
- Portugal (Azores Islands): Centro de Vulcanologia e Avaliação de Riscos Geológicos (CVARG-Univ. Açores); Centro de Informação e Vigilância Sismovulcânica dos Açores (CIVISA).
- Spain (Canary Islands): Instituto Geográfico Nacional (IGN); Volcano Monitoring Program; Institute of Technology and Renewable Energy
- Greece: Institute for the Study and Monitoring of the Santorini Volcano (ISMOSAV), National Observatory of Athens
- United Kingdom: The Montserrat Volcano Observatory, British Geological Survey (Tristan da Cunha, Ascension).

# A Natural Laboratory for solid Earth Science



# To whom?

## User Community and Stakeholders

EPOS stakeholders categories:

- (i) National Research Organisations & funding agencies,
- (ii) EPOS data providers,
- (iii) RI data users (including Academia),
- (iv) data and services providers and users outside the research community (including industry).

European Geosciences Union (EGU) & European Seismological Commission (ESC) belong to category (iii)

Regional Conferences are envisioned for the EPOS Strategic Work

Thematic Workshops are promoted

## On-going & short-term Future Actions

- Finalizing RI's inventory (September 2011)
- Finalizing WGs composition (September 2011)
- Updating the e-science plan (October 2011)
- Designing the EPOS Data Centers (end 2011)
- Revising the core group of Data Providers (end 2011)
- First collection of user needs (mid 2012)

### Instrument site

- ▼ Free field and ground floor stations
- ▼ In building station
- ▼ Borehole station
- ▼ Other (dam, tunnel, power plant, cave, etc.)
- ▼ Information not available or not specified

# EPOS-related European Projects

Training Initiatives: links with existing ITN (QUEST & TOPOMOD) and search for opportunities for new ITN (i.e., for Rock Physics Laboratories)

Links with ESF programs and initiatives (**TOPOEurope**, MeMoVolc)

Links with other EC Projects (NERIES/**NERA**, SHARE, .....

Interactions with new submitted EC projects in e-science (**VERCE**, EUDAT, **ENVRI**) and cooperation (REAKT, .....

Interactions with other Global Initiatives (Onegeology, GEM, **GEO**, ...)

Interactions and Collaborations with Satellite data community (ESA, TERRAFIRMA, GENESI-DEC, Supersites)

# Issues for international cooperation: collaborations with US

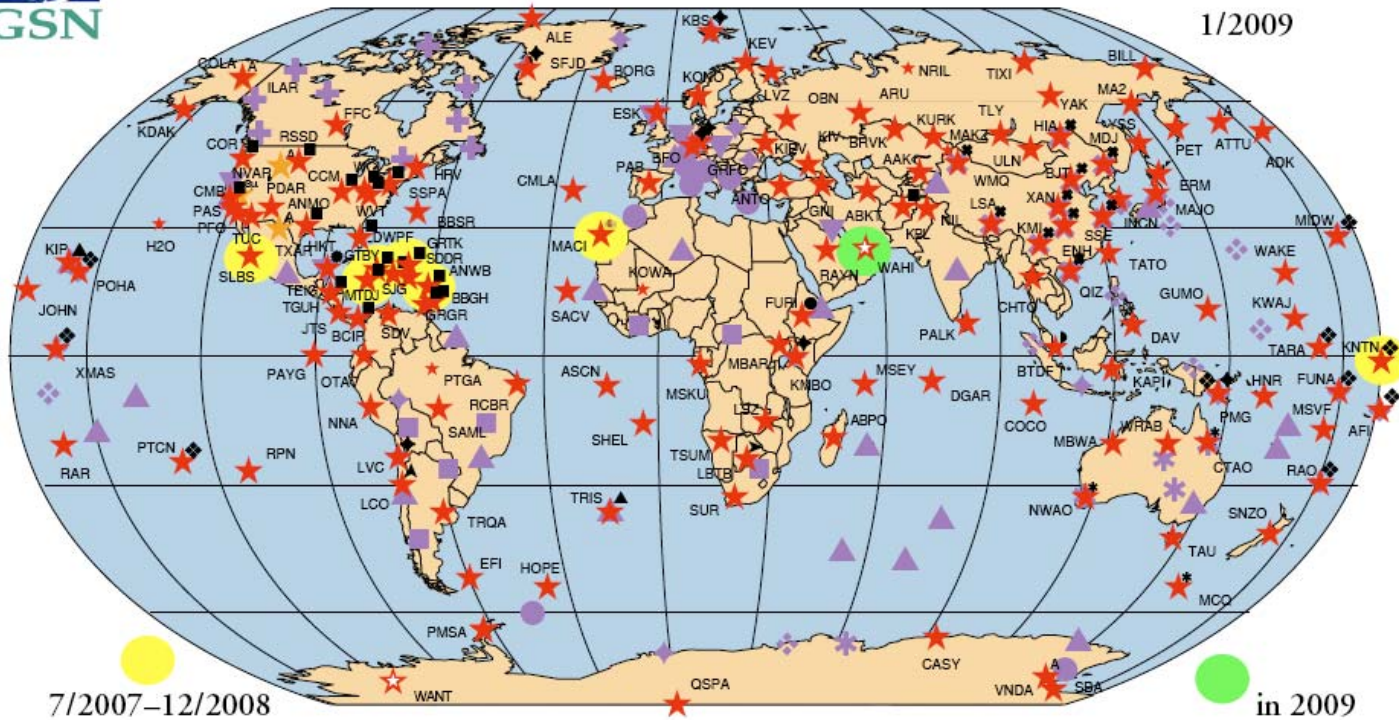
- There are ongoing initiatives for global coordination and integration of infrastructures in geophysics, seismology and geodesy:
  - International Federation of Digital Seismograph Networks (**FDSN**, <http://www.fdsn.org/>) involved in **GEO**
  - Incorporated Research Institutions for Seismology (**IRIS**) and the Global Seismographic Network (**GSN**) coordinated with **ORFEUS** (EPOS partner)
  - UNAVCO ([www.unavco.org/](http://www.unavco.org/)) and European geodesy initiatives
- The Earth science program **EarthScope (NSF)** and collaborations on scientific drilling, geodesy, rock physics and seismology
- USGS through joined participation to projects
- **World Organization of Volcano Observatories (WoVO, [www.wovo.org](http://www.wovo.org))**

# Participating to Global Initiatives



## GLOBAL SEISMOGRAPHIC NETWORK & INTERNATIONAL FEDERATION OF DIGITAL SEISMOGRAPHIC NETWORKS

1/2009



IRIS Current	Affiliate Array	Geoscope	Japan	Mednet	Geofon/AWI/BGR/BFO	China/USGS	Mexico	Singapore	Botswana	Spain	Australia	USGS	AFTAC	SMU
★	★	▲	◆	●	★	★	★	★	★	★	★	★	★	★





# Critical Issues for Management

- To design an optimal structured decision-making process to guarantee that the goals, tasks, schedule & costs are appropriately defined
- To promote involvement of all partners in decision-making (within the Inter-Activity Preparatory Council)
- To promote the involvement of all partners in tasks and working activities

- **EPOS** has been submitted for the update of the **ESFRI** roadmap in **November 2007**
- It has been evaluated during 2008
- During the evaluation phase the EPOS's partnership increased from **7** to **13** countries
- 3 countries are now joining the initiative and in other 5 contacts are going on at national level
- EPOS succeeded and was included in the ESFRI 2008 Roadmap on December 2008

# Impact for INGV

- International Role in seismological data archiving and mining (CNT)
- Visibility & competitiveness of GPS national network (RING-CNT)
- Coordination for a Italian Strong Motion data bank (CNT, RM1, MI)
- Coordination among INGV Volcano observatories
- Links with ICT & HPC international initiatives (VERCE, EUDAT, ENVRI) with (CINECA, EUDIN, LMU, CNRS)
- Data Policies for INGV observing systems (Centro Dati Vulcani Italiani)
- Role of Experimental and Analytic Facilities (Lab) in Italy and Europe
- Role and visibility for Geomagnetic Observatories
- Promoting coordination for geological data repositories
- Coordination and visibility for satellite data (Earth Observations)
- Identifying priorities for strategic development (OBS-seismology, deep scientific drilling, in-situ fault zone observatories, ...)

## Research Infrastructure: definition

- ✦ Research infrastructure means **facilities, resources**, and related **services** that are used by the scientific community to conduct top-level research in their respective fields and covers major scientific equipment or sets of instruments;
- ✦ knowledge-based resources such as **collections, archives** or structures for scientific information;
- ✦ enabling **ICT-based infrastructures**, or any other entity of a unique nature essential to achieve excellence in research.
- ✦ Such infrastructures may be “single-sited” or **distributed**, that is an organized network of resources

# The EPOS PP Management Structure & Advising Boards

## Advisory Board :

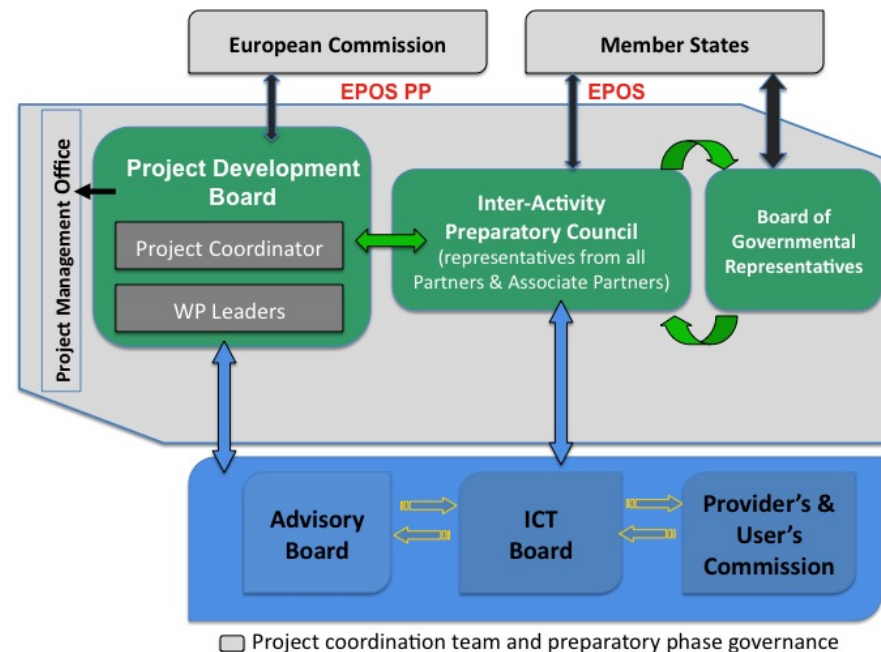
- ✓ Goran Ekstrom (Earthscope)
- ✓ Rui Pinho (GEM, Global Earthquake Model)
- ✓ Mark Robinson (ITER)
- ✓ Enric Banda (Director of Science, Research and Environment at the "La Caixa" Foundation)

## ICT Board

- ✓ Leif Laaksonen (e-IRG)
- ✓ Giuseppe Fiameni (CINECA)
- ✓ Steven Newhouse (EGI)
- ✓ Francois Robida (Onegeology, BRGM)

## DP&U Commission:

- ✓ Mike Jackson (PBO / UNAVCO)
- ✓ Don Dingwell (EGU President)
- ✓ Michael Rast (ESA)
- ✓ Tim Ahern (IRIS)
- ✓ Steinunn Jakobsdottir (ESC President)





## WP1 Preparatory Phase Management

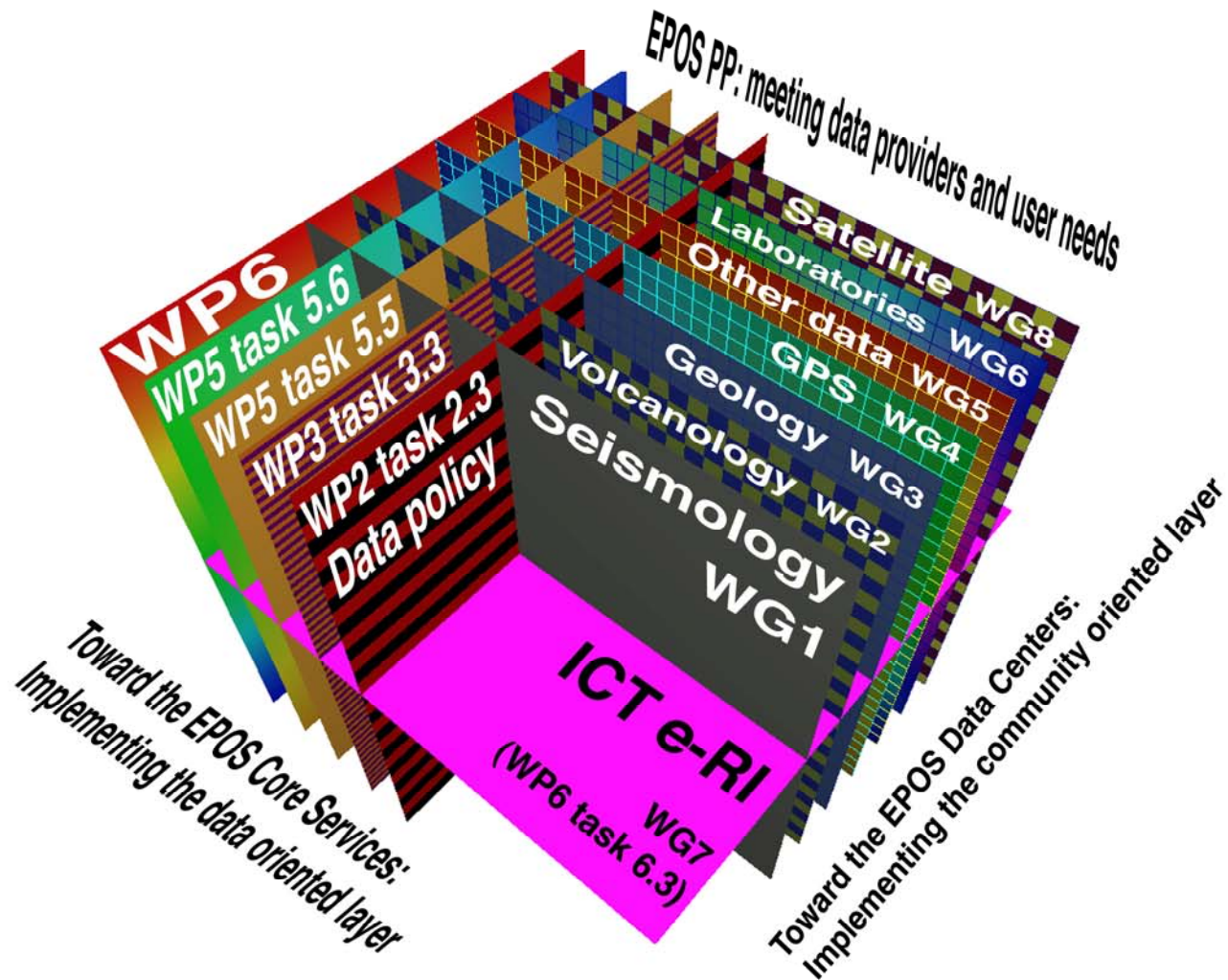


WP7 Architecture and implementation plan



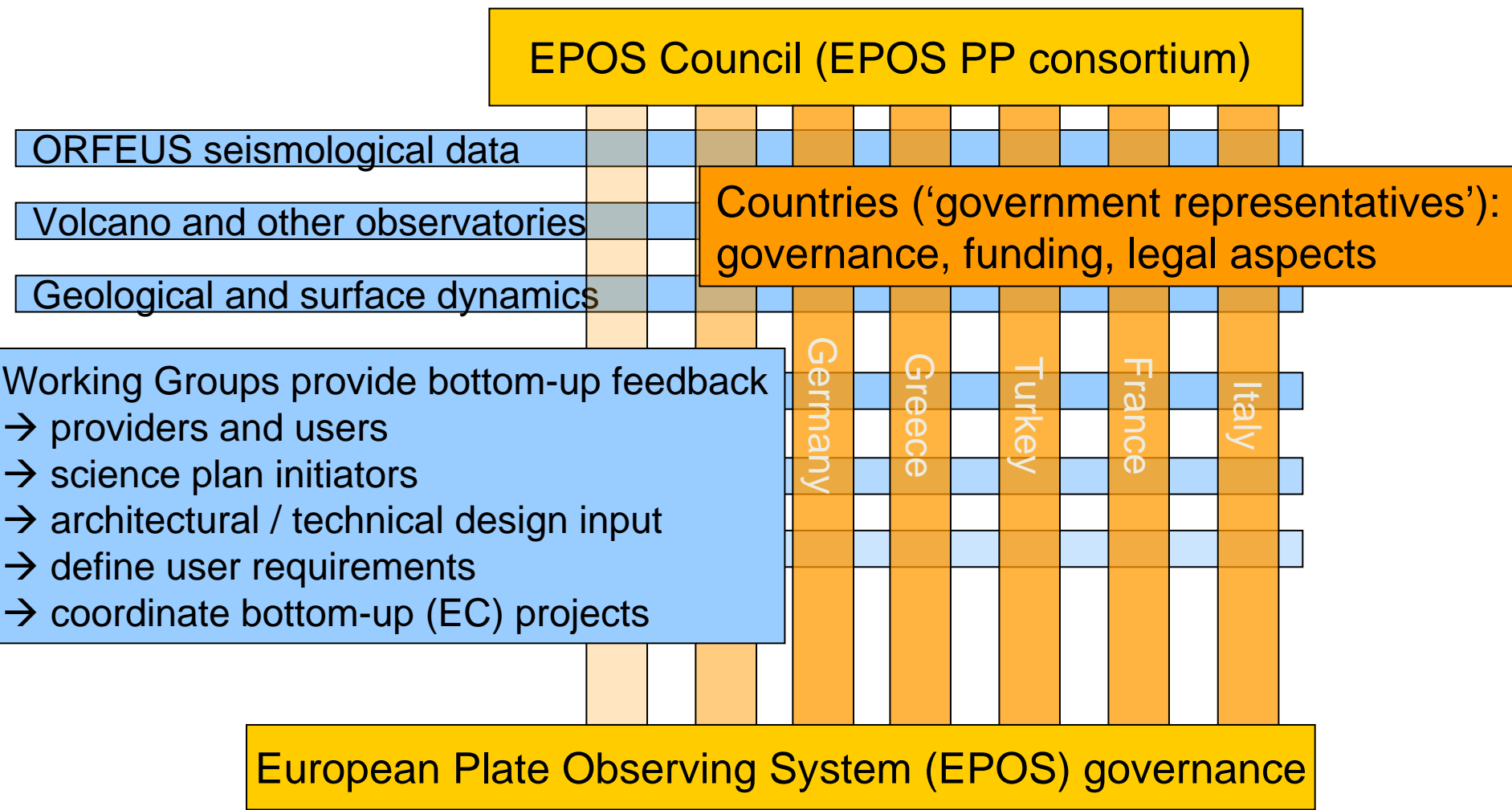
Wp8 Stakeholder interactions & dissemination

# THE EPOS RESEARCH INFRASTRUCTURE FABRIC



# EPOS EPOS PP project Working Groups

## The EPOS research infrastructure fabric





- Influencing national priorities
- Implementing transnational access
- Giving visibility and coherence to our community
- Structuring our community to be competitive for global challenges
- Ensuring long term sustainability of our RIs
- Reducing fragmentation
- Optimizing effectiveness and impact

# EPOS DUAL ROLE

*getting ready for construction phase*



- Pan-European integration of existing research infrastructures
  - Integrating multidisciplinary infrastructures as a key challenge for solid Earth Science
  - Identifying existing gaps and pilot projects to promote a modern implementation of RIs
- Long-term sustainability of research infrastructures at national level
  - Guaranteeing maintenance and the minimum required implementation level
  - Supporting the development of the monitoring infrastructures coordinated with the Epos's pan-European integrated vision