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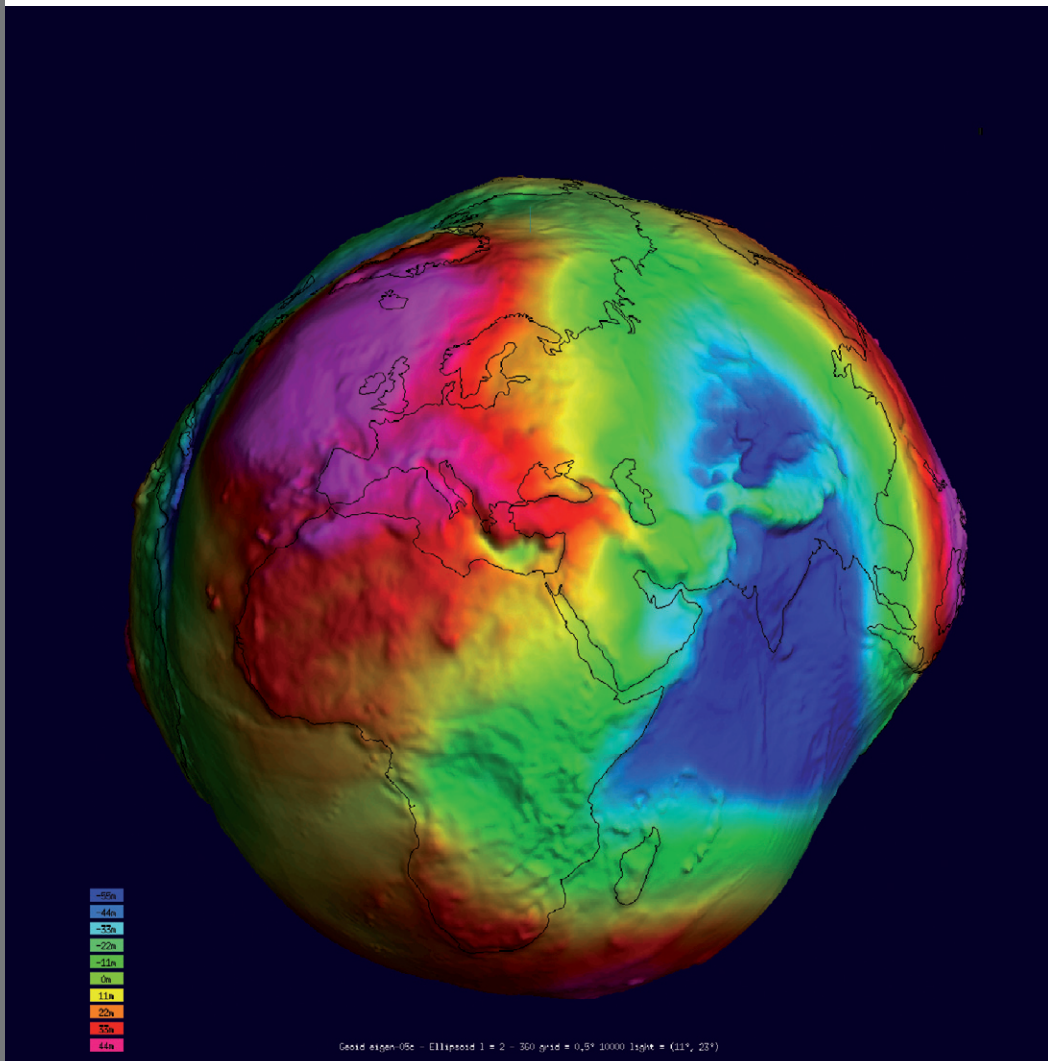
EUROCORES Programme
European Collaborative Research

TOPO-EUROPE

4D Topography Evolution in Europe: Uplift, Subsidence and Sea Level Change



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EUROCORES Programme
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4D Topography Evolution in Europe: Uplift, Subsidence and Sea Level Change (TOPO-EUROPE)

The topography of the continents and their margins is at the interface of deep Earth, surface and atmospheric processes. Topography influences society, not only as a result of slow landscape changes but also in terms of how it impacts on geohazards and the environment. When sea-, lake- or ground-water levels rise or land subsides, the risk of flooding increases, directly affecting the sustainability of local ecosystems and human habitats. On the other hand, declining water levels and uplifting land may lead to higher risks of erosion and desertification. Although natural processes and human activities create geohazards and environmental changes, the relative contribution of the respective components remains poorly understood. That topography influences climate has been known since the beginning of civilisation, but only recently have we been able to model its effects in regions where good (paleo-)topographic and climatologic data are available. The present state and behaviour of the shallow Earth System is a consequence of processes operating over a wide range of temporal and spatial scales. These include the long-term effects of tectonic uplift, subsidence, climate variations and the development of river systems, the residual effects of the ice ages on crustal movement, natural climate and environmental changes over the past millennia up to the present, and the powerful anthropogenic impacts of the last century. If we are to understand the present state of the Earth System, to predict its future and to engineer our use of it, this spectrum of processes, operating concurrently but on different scales, needs to be better understood. The challenge to the Geosciences is to describe the state of the system, to monitor its changes, to forecast its evolution and, in collaboration with others, to evaluate modes of its sustainable use by human society.

Professor S.A.P.L. Cloetingh, Chair
Professor S. Willet, Co-Chair
ESF TOPO-EUROPE Scientific Committee

Programme website:
www.esf.org/topo-europe

List of Funded Collaborative Research Projects (CRPs)

Spatial and Temporal Coupling between Tectonics and Surface Processes during Lithosphere Inversion of the Pyrenean-Cantabrian Mountain Belt (PYRTEC)

(CNRS, NFR)

PYRTEC will study interaction between surface processes, climate, and tectonic deformation during mountain building in the Pyrenean-Cantabrian belt. Collision between the Iberian and European plates resulted in mountain building in the Pyrenees and passive margin inversion in the Cantabrian area. The mountain range topography, however, was shaped by both collision and associated surface processes. Whereas large amounts of material were eroded in the Pyrenees, only minor erosion took place in the Cantabrian mountain range. Although operating at vastly different time and length scales, a significant potential exists for feedback between large-scale tectonic deformation and redistribution of mass by erosion processes. This CRP will use a multidisciplinary approach involving field-based studies, regional data compilation, geochronology and quantitative modelling approaches that will couple tectonic and surface process models.

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Timescales of Sediment Dynamics, Climate and Topographic Change in Mountain Landscapes (SedyMONT)

(DFG, FWF, NFR, SNF)

Understanding the timescales and controls of sediment dynamics are a prerequisite to predict the landscape response to changes in temperature, precipitation and runoff. This requires identification of sediment sources and sinks and the mechanisms and rates of sediment transfer at sites in different environments. SedyMONT will address this topic on the basis of (i) historical records and field monitoring, (ii) morphometric and geologic histories, (iii) a conceptual modelling framework, and (iv) information on past and present climate variability and scenarios of future climate change. Data collected will be about sediment discharge and landscape changes for a variety of settings within Europe.

* Research funded by sources other than the participating ESF Member Organisations listed on page 11

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Plate Re-organisation in the Western Mediterranean: lithospheric causes and topographic consequences (TopoMed)

(CICYT, CNR, DFG, FCT, IRCSET)

The motion between Africa and Europe in the western Mediterranean region has been taken up by subduction. Over the last 30 million years the location of the subduction zone has migrated from present-day southern France and eastern Iberia to the south-southeast towards North Africa and present-day Italy, with sideward expansions to form the Gibraltar and Calabria arcs. This process is now coming to an end. TopoMed investigates the intriguing processes accompanying these last stages and the possibility that a new subduction zone is being created along the North African margin. The results of this project are important for assessing the future geohazards potential of the region.

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Continental Plateaus and Tectonics-Climate Interactions (VAMP)

(APVV, CNR, DFG, NWO, SNF, TÜBITAK)

Orogenic continental plateaus such as Tibet are major geological features of the Earth. They are thousands of km^2 in area, have a flat and elevated interior (up to 5000m) characterised by arid conditions, and steep margins typically the site of large precipitations. They also display anomalous crustal and lithospheric conditions. Plateaus have obvious interactions with climate patterns and it is thought that the uplift of Tibet caused the onset of monsoon circulation in

Asia. Anatolia, the object of VAMP, is a small, young but fully representative continental plateau in Europe. Being easily accessible and having boundary conditions better constrained than larger counterparts, it can provide new fundamental knowledge on plateau formation.

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The Scandinavian Mountain Chain: deep processes (TopoScandiaDeep)

(FNU, DFG, NFR)

Mountains form usually by interaction of tectonic plates and are not expected to form in intraplate settings. The Scandinavian mountains, which are the second largest mountain chain in Europe after the Alpine belt, are, however, far from plate boundaries and the origin of their present high altitude is unknown. The aim of the project is to use geophysical data, in particular newly acquired seismological data, to map the seismic and mechanical properties of the crust and mantle below Scandinavia and analyse which forces and processes can be at the origin of the present-day topography of northern Europe.

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* Research funded by sources other than the participating ESF Member Organisations listed on page 11

From Source to Sink: integrated natural hazard assessment through the quantification of mass transfer from mountain ranges to active sedimentary basins (SourceSink)

(APVV, CNCSIS, CNRS, FWF, GAČR, TÜBITAK)

SourceSink focuses on the quantitative analysis of coupled active mountain and drainage systems through step-wise 4D reconstructions of sediment mass transfer. The Danube River Basin-Black Sea area provides a world-class natural laboratory for the study of interplays between lithosphere and surface processes, including source-to-sink relationships with their impact on global change. Moreover, natural hazards such as earthquakes, landslides, flooding, or subsidence, may result from changes in topography and landforms. The SourceSink consortium, with proven capacity and complementary scientific strength in distinct research domains, provides a solid base for realising an integrated programme for the understanding of coupled mountain range and basin dynamics. The CRP will apply past analogues and present-day evolutionary models, based on new data acquisitions and fieldwork to constrain simulations of recent, past and near future processes.

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* Research funded by sources other than the participating ESF Member Organisations listed on page 11

Refined European Sea Level Estimations by Combining Altimetry, Tide Gauges, Hydrographic and Other Data Sets with Improved Regional GIA Modeling and Tailored Regional GRACE Gravity Field Models (RESEL-GRACE)

(CNRS, DFG, NWO)

The aim of this CRP is to refine European sea level estimations by combining altimetry, tide gauges, ARGO float data, hydrographic and other data sets with improved regional GIA modelling and tailored regional GRACE gravity field models. Objectives of this CRP include (i) to derive regional mean and time-variable gravity models directly from GRACE instrument data for dedicated European regions of interest; (ii) to update the regional sea level rates in the Mediterranean Sea using multisatellite altimetry, tide-gauge and hydrographic data, and to explain the water mass contribution to sea level by using GRACE measurements of gravity due to redistribution of water mass; (iii) to improve estimates of glacial-isostatic adjustment in Northern Europe, and to improve our knowledge of the shallow earth structure and rheology of the region.

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Mantle Forcing of Earth Surface Evolution in Europe and the Mediterranean: from past to present (Topo-4D)

(CNR, NFR, NWO, SNF)

The impact of mantle processes on surface deformation is perhaps conceptually well understood but largely lacks thorough quantification. As a result, in many cases it is impossible to discriminate between mantle-induced and surface-induced contributions to surface deformation. Valuable observations of vertical surface motions can often not be equivocally interpreted unless basic assumptions, such as isostasy, are being invoked. Any progress in understanding present-day topography and topography evolution, and progress in making correct interpretations of valuable surface observables requires quantification of real-Earth mantle dynamics and of the surface response. The European-Mediterranean region is a well-studied natural laboratory for which this progress can now be made and this is what our CRP aims at.

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The Topographic History of the Alps and its Tectonic and Climatic Drivers (TOPO-ALPS)

(DFG, FWF, SNF)

What is the history of topography in the Alps? That is the question to be investigated by the TOPO-Alps project. The rise of the Alps and the evolution of the alpine landscape are the consequence of disparate tectonic and climatic conditions. The processes of continental collision, although active over the last few tens of millions of years, have slowed in more recent times, particularly in the western Alps. Climate has varied greatly from the warm, wet conditions of three to five million years ago to the glacial cycles that have dominated climate and erosional processes in the last million years. The TOPO-Alps project will attempt to unravel these processes through a multidisciplinary study incorporating geochemical methods for measuring paleo-elevation and modern erosion rates, sedimentological methods to estimate past erosion rates and patterns, tectonic field studies to establish tectonic uplift patterns and numerical models to link these processes to the Alpine topography.

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Coupled Climatic/Tectonic Forcing of European Topography revealed through Thermochronometry (Thermo-Europe)

(CNR, CNRS, DFG, MNSW, NWO, SNF)

The topography of Europe's mountains is the consequence of recent tectonic activity and climatically-modulated erosional processes. Our understanding of the coupling between climate and tectonics, which potentially represents the fundamental driver for mountain topography, remains partial. The Thermo-Europe project aims to test mechanisms for the coupling

of climate and tectonics across Europe by combining acquisition of new thermochronologic data on denudation rates and sediment-flux from key areas, development of new methods to increase the resolution of the thermochronologic record, development of quantitative techniques that permit the extraction of information on relief development and transient exhumation rates, and investigation of the coupled effect of climate-induced and tectonic variability in exhumation rates.

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The aim of the European Collaborative Research (EUROCORES) Scheme is to enable researchers in different European countries to develop collaboration and scientific synergy in areas where European scale and scope are required to reach the critical mass necessary for top class science in a global context.
The scheme provides a flexible framework which allows national basic research funding and performing organisations to join forces to support excellent European research in and across all scientific areas.
Until the end of 2008, scientific coordination and networking was funded through the EC FP6 Programme, under contract no. ERAS-CT-2003-980409. As of 2009, the National Funding Organisations provide the funding for the scientific coordination and networking in addition to the research funding.

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THE FOLLOWING NATIONAL FUNDING ORGANISATIONS SUPPORT THE TOPO-EUROPE PROGRAMME:

Fonds zur Förderung der wissenschaftlichen Forschung in Österreich (FWF)
Austrian Science Research Fund, Austria

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Czech Science Foundation, Czech Republic

Forskningsrådet for Natur og Univers (FNU)
Danish Natural Science Research Council, Denmark

Centre National de la Recherche Scientifique (CNRS)
National Centre for Scientific Research, France

Deutsche Forschungsgemeinschaft (DFG)
German Research Foundation, Germany

Irish Research Council for Sciences, Engineering and Technology (IRCSET)
Ireland

Consiglio Nazionale delle Ricerche (CNR)
National Research Council, Italy

Nederlandse Organisatie voor Wetenschappelijk Onderzoek (NWO)
Netherlands Organisation for Scientific Research, The Netherlands

Norges Forskningsråd (NFR)
Research Council of Norway, Norway

Ministerstwo Nauki i Szkolnictwa Wyższego (MNSW)
Ministry of Science and Higher Education, Poland

Fundação para a Ciência e a Tecnologia (FCT)
Foundation for Science and Technology, Portugal

Consiliul National al Cercetarii Stiintifice din Invatamantul Superior (CNCSIS)
National University Research Council, Romania

Agentúra na podporu výskumu a vývoja (APVV)
Slovak Research and Development Agency, Slovak Republic

Comisión Interministerial de Ciencia y Tecnología (CICYT)
Interministerial Committee on Science and Technology, Spain

Schweizerischer Nationalfonds (SNF)
Swiss National Science Foundation, Switzerland

Türkiye Bilimsel ve Teknolojik Arastırma Kurumu (TÜBITAK)
The Scientific and Technological Research Council of Turkey, Turkey

THE FOLLOWING ADDITIONAL ORGANISATIONS SUPPORT THE TOPO-EUROPE PROGRAMME:

Netherlands Research Center for integrated Solid Earth Science (ISES)
The Netherlands

StatoilHydro
Norway

Gobierno Del Principado De Asturias
The Regional Ministry for Education and Science of the Government of the Principality of Asturias, Spain

Università degli Studi Roma Tre
The University of Rome Three, Italy

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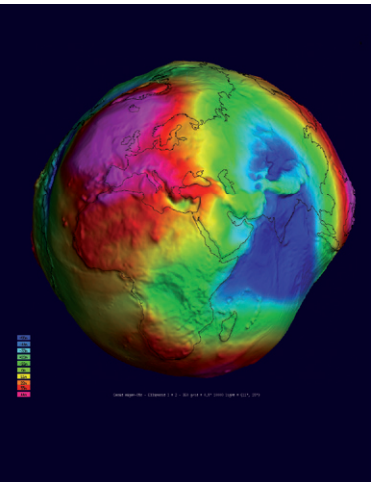

Shape of the Earth's Geoid after
the EIGEN-05C – model.
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