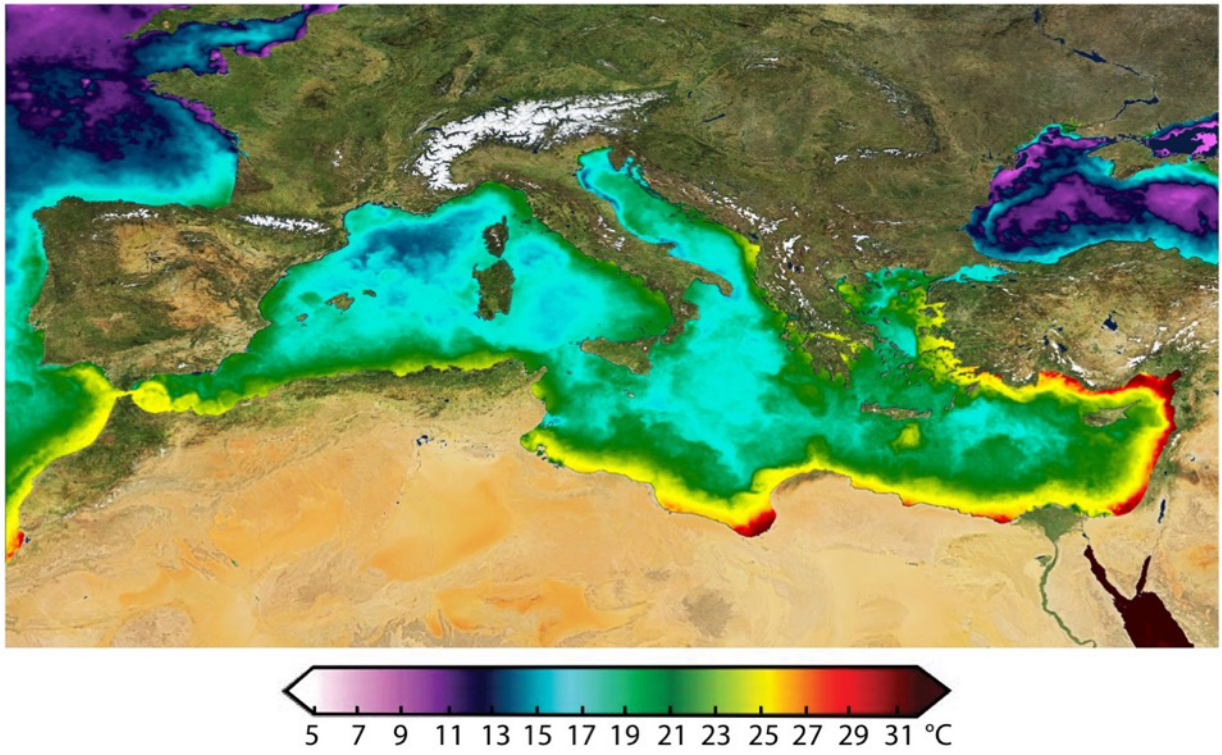
European Geosciences Union

GIFT – Geosciences Information For Teachers



GIFT WORKSHOP - 2017

THE MEDITERRANEAN

Vienna, Austria, 24-26 April 2017

Cover image combines two different products: (a) on land, the ESA GlobCover product, which is an automated global classification chain based on the MERIS instrument (300 m resolution) which was flying on board the satellite ENVISAT of ESA (see https://earth.esa.int/web/guest/-/globcover-v22-land-cover-product-now-available-5999) ; (b) on sea, the different colors are associated to sea surface temperature (SST) values, ranging from about 10 degrees Celsius (blue/violet) to 30 degrees Celsius (dark red), measured in the thermal infrared by the AATSR radiometer on board the satellite ENVISAT of ESA (see http://www.esa.int/Our_Activities/Observing_the_Earth/Earth_from_Space_Hot_Waters)

Dear Teachers,

Welcome to the 23th GIFT workshop of the European Geosciences Union.
This year the workshop will bring together 80 teachers from 25 different countries around the general theme of “The Mediterranean”.

We hope that the choice of this theme will be useful to all of you, as teachers of Earth Sciences, Chemistry, Physics, Biology or Geography in your classroom lessons. The Mediterranean region has a distinctive geological fingerprint that has attracted generations of Earth scientists. Mountain chains, orogenic belts, extensional basins, subduction areas, active volcanoes, violent earthquakes, tsunamis, landslides and floods all testify to the vigorous active tectonics that characterize the region, which has often been referred to as “a laboratory for geophysics”.

The same area, owing to the favourable climate, availability of resources (i.e., water and raw materials) and the presence of the sea, allowed trade and cultural exchanges, making it a cradle of culture.

Currently, the area is densely populated with progressively increasing anthropogenic pressures, which, when combined with the distinctive geological setting, has resulted in heightened vulnerability to climate change enhanced by the increasing atmospheric carbon dioxide. The Mediterranean is thus a key region for understanding the complexities and delicate relationships between civilization, natural processes, catastrophic events and protection of the environment.

In the two and a half days of the GIFT workshop, we will focus on the key aspects of the area. First, Laurent Jolivet will discuss the tectonic evolution of the Mediterranean area , followed by Claudio Faccenna, who will show how the area has been shaped by the deep dynamics of lithosphere-mantle interaction which characterizes convergent margins. Claudia Piromallo will then give us an overall picture of Mediterranean seismicity today, whilst Marco Bonhoff will focus on a particularly active tectonic and seismic area: the Istanbul-Marmara region.

The volcanism of the Mediterranean region will be introduced by Paolo Papale, who will explain how many people are living in the Campi Flegrei area, right in the middle of an active caldera. Meanwhile Angelo Camerlenghi will tell us how, about 6 million years ago, the Mediterranean Sea became an enormous saline basin, the hugest environmental crisis ever recorded in the region.

The particularities of the European climate will be described by Piero Lionello, while Philippe Drobinski will focus on extremes of the water cycle, which are more and more frequent in the context of climate change.

Marco Anzidei and Kurt Lambeck will show how the level of the Mediterranean Sea has changed over time, with its geological and archaeological implications.

Nikos Mihalopoulos and Joakin Garrabou will introduce us to two major aspects of the Mediterranean environmental situation: atmospheric pollution and the endangered biodiversity of the Mediterranean. Finally, Francesco Sarti will show us the some of the applications of space observation helping to unravel the behaviour of our « Middle Sea ».

As in every GIFT Symposium, contributions by the attending teachers on activities that they have used in their classrooms are particularly welcome in the poster session called “Science in

tomorrow's classroom". The session features any type of pedagogic activity, as well as posters describing the Mediterranean region.

Also, during the first afternoon of the workshop, Francesca Cifelli, Jean-Luc Berenguer, Chris King and François Tilquin will present hands-on activities, which you are invited to test and evaluate for use in your own classroom.

At the beginning, Mathias Harzhauser and Herbert Summesberger invite you for a visit to the Natural History Museum in Vienna, one of the most outstanding museums worldwide. For those of you who can stay on Wednesday afternoon, Herbert also proposes to explore a « geological pathway » in Vienna, from Theresia's monument to St. Stephens Cathedral.

The GIFT workshop is sponsored not only by EGU, but also by several science organizations. We would like to continue to offer teachers the opportunity to attend GIFT and similar workshops, but this depends upon us being able to show our sponsors that teachers have used the GIFT information and educational approaches in their daily teaching, or as inspiration for teaching geoscience in new ways in their schools.

Therefore, we ask you

1. To complete the evaluation forms as soon as possible and email them back to us;
2. Make a presentation of your experiences at GIFT to a group of your teaching colleagues sometime after you return from EGU, and
3. Send us reports and photographs about how you have used the GIFT information in your classrooms.
We also encourage you to write reports on the GIFT workshop in publications specifically intended for geoscience, science and geography teachers.

Information on past GIFT workshops is available on the EGU homepage:

http://www.egu.eu/education/gift/workshops/

where you can find the brochures (pdf) and the slides of the different presentations given at the GIFT workshops over the past 10 years. Since 2009, we have also included web-TV presentations, which may be freely downloaded and used in your classrooms. By clicking on http://www.egu.eu/education/ you will find out about all the educational activities of the European Geosciences Union.

Please enjoy your GIFT workshop in Vienna! If you do not enjoy your time with us, please tell us to help us to do better next time. If you do enjoy your visit, please tell your schools, friends and colleagues and encourage them to come to future GIFT conferences.

The Committee on Education
European Geoscience Union

Acknowledgements

The GIFT-2017 workshop has been organized by the Committee on Education of the European Geosciences Union. EGU has supported the major share of the expenses, but the workshop has also benefited from the generous help of:

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Future Ocean, Kiel Marine Science

American Geosciences Institute

National Oceanic and Atmospheric Administration

And we thank all the speakers who have contributed to this educational workshop and their institutions!

European Geosciences Union
Committee on Education

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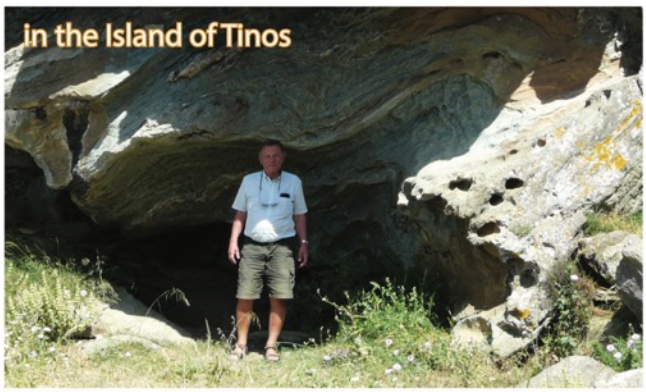
European Geosciences Union
Committee on Education



Carlo Laj

Phil Smith

Friedrich Barnikel

Annegret Schwarz

Francesca Funiciello

Jean-Luc Berenguer

Herbert Summesberger

Francesca Cifelli

Eve Arnold

Steve Macko

Program

European Geosciences Union – General Assembly

GEOSCIENCE INFORMATION FOR TEACHERS (GIFT) WORKSHOP

Vienna, 23-26 April 2017

'The Mediterranean'

Sunday April 23, 2017

16:00 - 18:00 **GUIDED TOUR AT THE NATURAL HISTORY MUSEUM VIENNA**
Herbert Summesberger and Mathias Harzhauser
Natural History Museum Vienna

Monday April 24, 2017

Chairperson: Carlo Laj, EGU Committee on Education

08:30 - 08:45 **WELCOME!**
Hans Thybo
President of EGU

08:45 - 09:15 **INTRODUCTION TO THE 2017 GIFT WORKSHOP**
Carlo Laj
EGU Committee on Education

9:15 – 10:00 **TECTONICS OF THE MEDITERRANEAN SEA AND SUBDUCTION OF THE AFRICAN PLATE: FROM BASINS TO MOUNTAINS AND FROM MOUNTAINS TO BASINS**
Laurent Jolivet
Université d'Orléans, Paris, France

10:00 – 10:30 COFFEE BREAK

Chairperson: Francesca Funiciello, EGU Committee on Education

10:30 – 11:15 **SHAPING THE MEDITERRANEAN FROM THE INSIDE OUT**
Claudio Faccenna
Università degli Studi Roma TRE, Rome, Italy

11:15 – 12:00 **LOOKING AT THE MEDITERRANEAN REGION THROUGH EARTHQUAKES**
Claudia Piromallo
INGV, Rome, Italy

12:00 – 12:15 **INSTRUCTIONS FOR THE POSTER SESSION EOS03**
Eve Arnold
EGU Committee on Education

12:15 – 14:00 **LUNCH** (SANDWICHES)

Chairperson: Annegret Schwarz, EGU Committee on Education

14:00 -14:45 **EARTHQUAKE HAZARD AND SEISMIC MONITORING EFFORTS IN THE ISTANBUL-MARMARA REGION**
Marco Bohnhoff
GFZ, Potsdam, Germany

14:45– 18:45 **HANDS-ON ACTIVITIES** (two groups alternating)

Group 1 **INVESTIGATING THE GEOSCIENCE OF 'THE MEDITERRANEAN' THROUGH CLASSROOM MODELLING ACTIVITIES**
Chris King
Keele University, Keele, United Kingdom

Group 2 **EARTHQUAKES IN THE CLASSROOM: 'THE SEISMO-BOX: DO IT YOURSELF'**
Francois TIlquin[1], Jean-Luc Berenguer[2], Francesca Cifelli[2]
[1]Lycée Marie Curie, Echirolles, France
[2]International High School VALBONNE, FRANCE
[3] Università degli Studi Roma TRE, Rome, Italy

Tuesday April 25, 2017

Chairperson: Phil Smith, EGU Committee on Education

08:30 - 09:15 **LIVING IN A CALDERA: THE CASE OF CAMPI FLEGREI, ITALY**
Paolo Papale,
INGV, Pisa, Italy

09:15 – 10:00 **UNCOVERING THE MEDITERRANEAN SALT GIANT**
Angelo Camerlenghi
OGS, Trieste, Italy

10:00 – 10:30 COFFEE BREAK

Chairperson: Friedrich Barnikel, EGU Committee on Education

10:30 – 11:15 **THE CLIMATE OF THE MEDITERRANEAN REGION: ITS RECENT PAST AND FUTURE EVOLUTION IN THE 21ST CENTURY**
Piero Lionello
Università del Salento, Lecce, Italy

11:15 – 11:45 **WATER CYCLE EXTREMES IN THE MEDITERRANEAN IN A CONTEXT OF CLIMATE CHANGE**
Philippe Drobinski
Ecole Polytechnique, Palaiseau, France

11:45 – 12:00 **OPEN QUESTIONS from the audience**
12:00 - 13:30 LUNCH (SANDWICHES)

Chairperson: Eve Arnold, EGU Committee on Education

13:30 – 14:45 **SEA LEVEL CHANGES IN THE MEDITERRANEAN: CAUSES AND CONSEQUENCES (including the video 'Active Mediterranean')**
Marco Anzidei
INGV, Rome, Italy
Kurt Lambeck
National Australian University, Canberra, Australia

14:45 – 15:00 **Moving to poster session**

15:00 – 19:00 **EOS3 – POSTER SESSION**

Wednesday April 26, 2017

Chairperson: Steve Macko, EGU Committee on Education

08:30 - 09:15 **ATMOSPHERIC POLLUTION IN THE MEDITERRANEAN: SOURCES AND IMPACT ON AIR QUALITY, HEALTH AND CLIMATE**
Nikos Mihalopoulos
University of Crete and National Observatory of Athens, Greece

09:15 - 10:00 **MEDITERRANEAN MARINE BIODIVERSITY: AN ENDANGERED TREASURE**
Joakim Garrabou
Institute of Marine Sciences, CSIC, Barcelona, Spain

10:00 – 10:30 COFFEE BREAK

Chairperson: Carlo Laj, EGU Committee on Education

10:30 – 11:30 **THE MEDITERRANEAN REGION OBSERVED FROM SPACE: EXAMPLES OF SATELLITE DATA APPLICATIONS**
Francesco Sarti
ESA, Frascati, Italy

11:30 – 12:00 **GOOD BYE! END OF THE WORKSHOP**

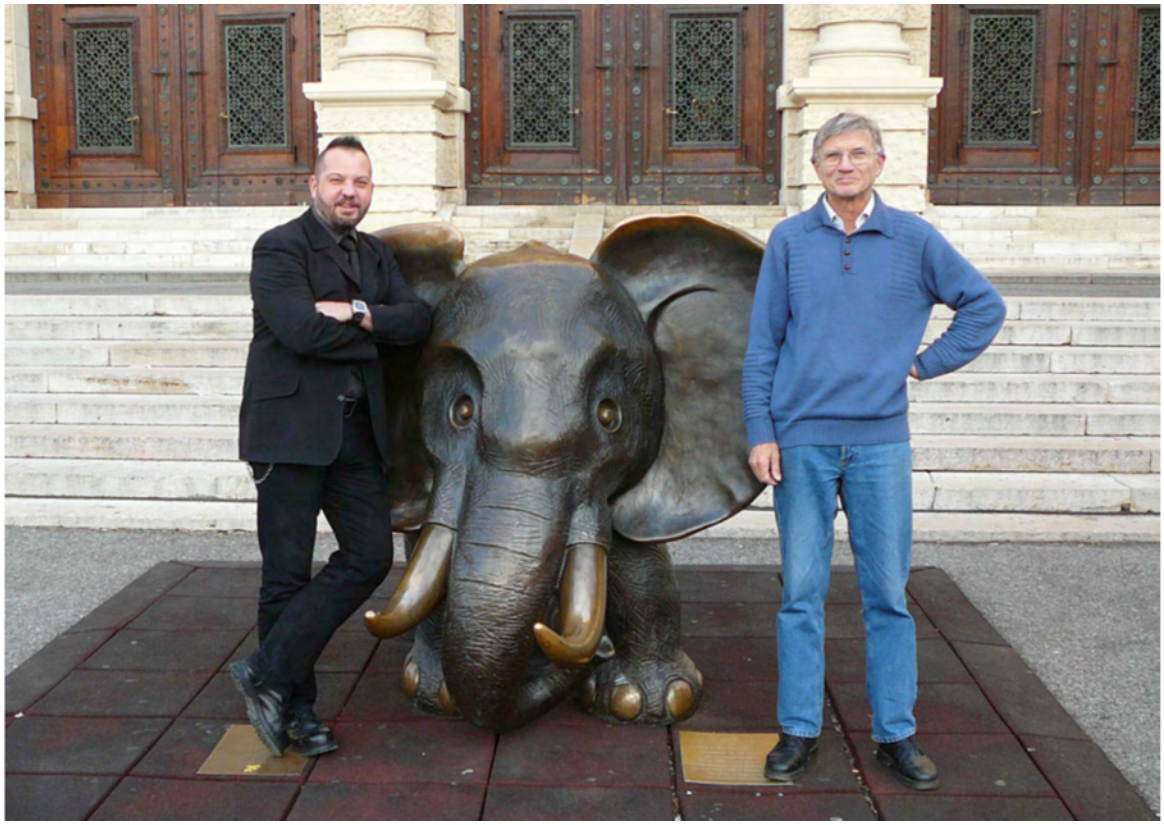
Optional:

14:00 - 15:30 **GEOLOGICAL PATHWAY FROM MARIA THERESIA'S MONUMENT TO ST. STEPHEN'S CATHEDRAL**
Herbert Summesberger, Natural History Museum Vienna

Speakers

GUIDED TOUR OF THE NATURAL HISTORY MUSEUM VIENNA

Herbert Summesberger and Mathias Harzhauser
Natural History Museum Vienna



Standing on each side of the bronze elephant (an artwork of the Viennese artist Gottfried Kumpf) in front of the entrance, our two hosts for the visit to the Natural History Museum Vienna :

Mathias Harzhauser, on the left, Head of the Department of Geology and Palaentology, has earned his degrees from the University of Vienna and has been employed by the NHM after his Master's thesis. His PhD thesis deals with the Paleoceanography of the Oligocene and Lower Miorece Gastropoda of the Eastern Mediterranean and the Western Indo-Pacific.

Herbert Summesberger, on the right, has earned his degrees from the University of Vienna. His PhD thesis deals with structural geology, stratigraphy and palaentology in the Northern Calcareaou Alps. He has organized several international symposia and is the leader of the Working Group on Geosciences, School and Public Relations of the Austrian Geologica Society. Retired since 2004, he is a member of the Board of the Friends of the Museum of Natural History, and organizes exhibitions and seminars for High School teachers. He has also written high school books and a Vienna city guide for building and decoration stones.

Laurent JOLIVET
Professor
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EDUCATION

1977-1981 Ecole Normale Supérieure de Saint Cloud
1981 Agrégation de Sciences Naturelles
1984 PhD thesis (Université Pierre et Marie Curie, Paris)
1988 Habilitation à diriger des Recherches (Université Pierre et Marie Curie, Paris)

CAREER

1984 High-scool teacher, Saint Germain-en-Laye and Evry
1985-1995 Associate professor, Ecole Normale Supérieure de Paris
1995-2017 Professor: 1995-1998, Université de Cergy-Pontoise; 1998-2009, Université Pierre et Marie Curie, Paris; 2009-2017, Université d'Orléans
2007-2017 Institut Universitaire de France

RESEARCH INTERESTS

Tectonics, mountain belts, extensional tectonics, deformation of continents, mantle flow and deforming continents, exhumation of metamorphic rocks, rheology; Asia, Mediterranean, Norway

PUBLICATIONS AND SERVICES

Jolivet, L. et al.., 2013. Aegean tectonics: progressive strain localisation, slab tearing and trench retreat. Tectonophysics 597-598, 1-33.
Jolivet, L., Gorini, C., Smit, J., Leroy, S., 2015. Continental breakup and the dynamics of rifting in back-arc basins: The Gulf of Lion margin. Tectonics 34, doi:10.1002/2014TC003570.

Jolivet, L., La déformation des continents, Editions Hermann, 1995.
Jolivet, L., et Nataf, H.C., Géodynamique, collection Geosciences, Dunod, 1998.
Jolivet, L., Brun, J.P., Prouteau, G., Meyer, B., Rouchy, J.M., Géodynamique méditerranéenne, Vuibert – Société Géologique de France, 2008

Services: 1999-2006 Head of the Laboratoire de Tectonique (UPMC-CNRS), 2004-2006 Head of Doctoral School « Géosciences et Ressources Naturelles » UPMC, 2006-2007 Head of Department of Earth Sciences at UPMC.

AWARDS AND HONORS

1994 CNRS, bronze medal - 1997 Hall, Fallot-Jérémine, Jacob Prize (French Academy of Sciences) - 2003 - Pierre Pruvost Prize (Société Géologique de France) - 2011 Stephan Mueller Medal (European Union of Geosciences) – 2012-2017 PI of the ERC Project RHEOLITH.

TECTONICS OF THE MEDITERRANEAN SEA AND SUBDUCTION OF THE AFRICAN PLATE: FROM BASINS TO MOUNTAINS AND FROM MOUNTAINS TO BASINS

Laurent Jolivet
Université d'Orléans, Paris, France

The Mediterranean Sea has not always been as we see it today. Its Neogene characteristics, with a semi-closed environment limited by collision zones in the east and west, with extensional back-arc basins forming above retreating subduction zones, while accretionary wedges such form near trenches, date back to the transition between the Eocene and the Oligocene, some 35 Myrs ago. Long before the Mediterranean Sea existed, from the Jurassic to the Eocene (from ~160 to 35 Ma), the same region was a part of the western Tethys Ocean, a wide oceanic domain, closing along a more or less continuous subduction zone below the southern margin of Eurasia, with the associated volcanism and already back-arc basins, such as the Black Sea. During this long evolution, which has shaped the familiar Mare Nostrum, mountain belts have formed, some were short-lived, such as the Betic Cordilleras, other are still forming today, such as the Alps. In this presentation, I will scan the tectonic history of the Mediterranean region from the Jurassic to the Present, setting the stage for the next presentation by Claudio Faccenna who will focus on the engine moving and deforming the continental lithosphere, namely the convective flow in the underlying asthenospheric mantle. The tectonic history of the Mediterranean Sea can be described in five main periods:

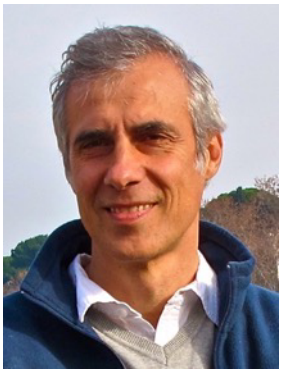
160-100 Ma: The Tethys Ocean is opening and subducting at the same time. A large continental block (Apulia) is detached from Africa by rifting and crosses the main ocean to ultimately collide with Eurasia. The oceanic ridge south of it forms the oceanic lithosphere still present in the Eastern Mediterranean. In the Late Jurassic, a first obduction episode forms the ophiolite nappes of Greece.

100-70 Ma: a drastic change occurs in Africa and the convergence zone with the start of a generalized compression. Rifts are inverted in Africa, the Pyrenees start to form, the collision of Apulia with Eurasia forms the early Alps and a piece of oceanic lithosphere is obducted over the northern margin of Africa from Greece to Oman.

70-35 Ma: stresses are partly released all along the plate boundary, but Apulia continues to subduct below Eurasia, forming the Hellenides, the Taurides and the Cycladic Blueschists, while Europe subducts below Apulia in the west, forming and exhuming many of the blueschists and eclogites of the Alps. The Pyrenees are at their climax.

35-8 Ma: with the collision of Africa with Eurasia in the Zagros mountains, Africa slows down and the subduction regime changes, inducing slab retreat and formation of back-arc basins, Alboran Sea, Liguro-Provençal basin, Tyrrhenian Sea, Aegean Sea and Pannonian basin. The Hellenides, the Taurides, the internal Apennines collapse and are replaced by large outcrops of exhumed metamorphic rocks exhumed below low-angle normal faults. Arabia detaches from Africa. The thrust front of the Alps propagates toward Europe while the Apenninic front propagates toward Apulia.

~8-0 Ma: A new framework is set. Compression starts in the west, shortening the margins of the Liguro-Provençal Basin and leading to the destructive earthquakes shaking North Africa. In Turkey, the North Anatolian Fault starts to form and guides the expulsion of Anatolia toward the west, powered by the retreat of the Hellenic slab. Extension continues in the Southern Tyrrhenian Sea. Compression closes the Gibraltar Strait and causes the Messinian Salinity Crisis some 6 Myrs ago.



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EDUCATION

1997-1998 Visiting scholar at Harvard University, Cambridge (USA).
1993-1995 Post-doc at Université Paris VI and at Geosciences Rennes-Université di Rennes I.
1989-1993 PhD at Department of Earth Science, University of Rome "La Sapienza".
1984-1988 Graduated at Department of Earth Science, University of Rome "La Sapienza

CAREER

2011-present Full Professor at Dept. of Geological Sciences, Università Roma TRE.
2001-2010 Associate Professor at Dept. of Geological Science, Università Roma TRE.
1995-2000 Researcher at Department of Geological Science, Università of Roma TRE

RESEARCH INTERESTS

Topics: subduction and mantle convection, tectonic and morphological evolution of convergent margin, dynamic topography, trench migration and back-arc deformation, evolution of orogenic belt and exhumation of deep metamorphic rocks, volcanism and fluid circulation in the crust.
Tools: Structural geology and geomorphology, analogue/numerical geodynamic modelling, paleomagnetism, seismic lines interpretation.
Field sites: Tethyan belt: Mediterranean to the Middle East (Morocco, Spain, Italy, Greece, Turkey, Iran), Himalaya (Pakistan), Andes (Argentina-Colombia), Antarctica.

PUBLICATIONS AND SERVICES

Faccenna, C. et al. (2014) Mantle dynamic in the Mediterranean, Rev. of Geophysics, doi 10.1002/2013RG000444
Faccenna, C., Becker, T.W., Conrad, C.P. and Husson, L. (2013) Mountain building and mantle dynamics. Tectonics, doi: 10.1002/tect.200, 32, 80–93.
Faccenna C., and Becker T.W. (2010) Shaping mobile belt from small scale convection, Nature, 465, doi:10.1038/nature09064.

AWARDS AND HONORS

2015 Humboldt Research Award from Alexander von Humboldt Foundation
2014 Stephan Muller medal from European Geoscience Union, Division Tectonics and Structural Geology
2013 Prix VIQUESNEL 2013 from Société géologique de France.
2010 Galileo Galilei International Medal for Earth Science from Pisa University and Rotary;
2008 Member of Academia Europaea.

SHAPING THE MEDITERRANEAN FROM THE INSIDE OUT

Claudio Faccenna
Università degli Studi Roma TRE, Rome, Italy

The Mediterranean offers a unique opportunity to study the driving forces of tectonic deformation within a complex mobile belt. Lithospheric dynamics are affected by slab rollback and collision of two large, slowly moving plates, forcing fragments of continental and oceanic lithosphere to interact.

Here we will illustrate the rich and growing set of constraints from geological reconstructions, geodetic data, and crustal and upper mantle heterogeneity imaged by structural seismology. We proceed to discuss a conceptual and quantitative framework for the causes of surface deformation. Exploring existing and newly developed tectonic and numerical geodynamic models, we illustrate the role of mantle convection on surface geology. A coherent picture emerges which can be outlined by two, almost symmetric, upper mantle convection cells. The downwellings are found in the center of the Mediterranean and are associated with the descent of the Tyrrhenian and the Hellenic slabs. During plate convergence, these slabs migrated backward with respect to the Eurasian upper plate, inducing a return flow of the asthenosphere from the back-arc regions toward the subduction zones. This flow can be found at large distance from the subduction zones and is at present expressed in two upwellings beneath Anatolia and eastern Iberia. This convection system provides an explanation for the general pattern of seismic anisotropy in the Mediterranean, first-order Anatolia, and Adria microplate kinematics and may contribute to the high elevation of scarcely deformed areas such as Anatolia and eastern Iberia. More generally, the Mediterranean is an illustration of how upper mantle, small-scale convection leads to intraplate deformation and complex plate boundary reconfiguration at the westernmost terminus of the Tethyan collision.

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EDUCATION

1993 Laurea (M.Sc.) in Physics, University of Bologna

CAREER

Since 2014 Head of the Geodynamics and Earth's Interior Group, INGV Earthquake Dept.
2005-2014 Head of Seismology Group, Seismology and Tectonophysics Dept., INGV-Rome
2003-present Senior Researcher, Istituto Nazionale di Geofisica e Vulcanologia (INGV), Rome
1999-2003 Researcher, INGV, Rome
1994-1999 Research fellow, ING, Rome

RESEARCH INTERESTS

My main interests are in seismology, seismic tomography, study of the Earth structure and geodynamics, at global and regional scales. In particular, I focused on the lithospere-mantle structure and dynamic evolution of the Euro-Mediterranean and Alpine region and on the physical characteristics of worldwide subduction zones.

PUBLICATIONS AND SERVICES

Faccenna, C., T.W. Becker, L. Auer, A. Billi, L. Boschi, J.-P. Brun, F.A. Capitanio, F. Funiciello, F. Horvàth, L. Jolivet, C. Piromallo, L. Royden, F. Rossetti, E. Serpelloni (2014), Mantle dynamics in the Mediterranean, Rev. Geophys., 52, 283–332, doi:10.1002/2013RG000444.

Hueret, A., S. Lallemand, F. Funiciello, C. Piromallo, and C. Faccenna (2011), Physical characteristics of subduction interface type seismogenic zones revisited, Geochem. Geophys. Geosyst., 10, Q01004, doi:10.1029/2010GC003230.

Piromallo C., and A. Morelli (2003), P-wave tomography of the mantle under the Alpine-Mediterranean area, J. Geophys. Res., 108, B2, doi:10.1029/2002JB001757.

LOOKING AT THE MEDITERRANEAN REGION THROUGH EARTHQUAKES

Claudia Piromallo
Istituto Nazionale di Geofisica e Vulcanologia, Rome, Italy

The Mediterranean region, at the westernmost end of the Alpine-Himalayan mountain belt, developed under continuous rearrangement of the oceanic space and continental domains during the progressive shortening of the Tethys belt (i.e. Dercourt et al., 1986). The closure of the wide Tethys ocean started with subduction of oceanic lithosphere below the southern Eurasian plate at the time of opening of the central Atlantic (Jurassic–Cretaceous boundary, about 140 Myr). During Oligocene (from about 35-30 Myr) oceanic basins remained progressively trapped in a wide area between the Africa-Arabian and the Eurasian plates. Later on, by Early Miocene (about 20 Myr), this region underwent the passage from subduction-dominated to continental collision-dominated convergence. On the site of the former seaway, several stages of subduction, formation of new oceanic crust and continental collision, originated the main tectonic features of a complex domain.

The geological history of the Mediterranean results into an area with a present-day convoluted tectonic setting, seismically very active and currently undergoing rather rapid deformation.

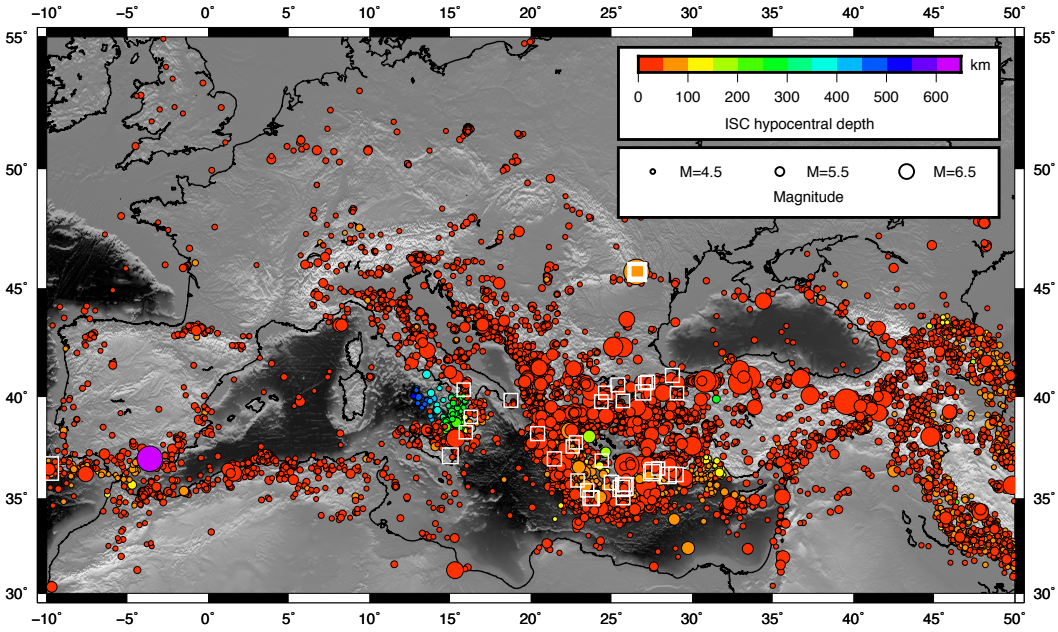

Figure 1: Seismicity of the Mediterranean region. Colored dots represent earthquakes with M≥4.5 extracted from the revised International Seismological Centre On-line Bulletin (2013) for the period 1968-2016, and from the ISC-GEM Global Instrumental Earthquake Catalogue for the period 1900-1967 (Storchak et al., 2013). ISC earthquakes are color coded according to their hypocentral depth and sized according to their magnitude. Refer to legend for color scale and size. White squares represent historical (non-instrumental) earthquakes with M ≥ 6.5 extracted from the SHARE (Seismic Hazard hARmonization in Europe) European Earthquake Catalogue (SHEEC, Stucchi et al., 2012).

The Mediterranean seismicity, plotted in Figure 1 with hypocenters and magnitudes extracted from the International Seismological Center (ISC) catalogues, is characterized by the occurrence of frequent low-to-moderate magnitude events, and occasional large magnitude earthquakes. The most active areas, as testified also by historical records (not based on instrumental data), are interplate regions located at the margins between the main interacting plates (Africa, Eurasia, and Arabia) and microplates (Anatolia and Iberia) of the Mediterranean domain. However, intraplate shallow (depth ≤ 70 km) and rather diffused

seismicity is also present. Deep and intermediate-depth events are instead clustered in the Hellenic Arc (down to ~180 km), Cyprus Arc (down to ~130 km), Calabrian Arc (down to ~500 km), Betic-Rif (down to ~160 km and isolated events at ~600 km depth), and eastern Carpathians (down to ~220 km).

Earthquakes do pose a high hazard in the whole Mediterranean area. Due to high-density population Turkey, Greece, the Balkans, Italy and the Ibero–Maghrebian region are among the most exposed areas where, historically and recently, not only large, but even moderate magnitude events have caused large losses in terms of human lives, property and cultural heritage. In addition, since the source regions of strong submarine earthquakes and major population settlements face each other throughout the Mediterranean basin, some countries have experienced also several catastrophic tsunamis in the past. The most well known occurred near Crete (in 365 and 1303, with M > 8) and Cyprus (in 1222, with M>7), and in the Messina Strait (in 1908, with M>7); but other devastating events occurred in the Gulf of Corinth (in 373 B.C. and 1748), up to the most recent destructive tsunamis occurred in 1956 in the Aegean Sea and 2003 in northern Algeria (Lorito et al., 2008; Sørensen et al., 2012). Investigating the seismicity of the Mediterranean is fundamental since earthquake catalogues and the inventory and characterization of the major faults that could produce earthquakes impacting the region are basic ingredients for seismic and tsunami hazard assessment in order to mitigate risk.

However, studying earthquakes is not only crucial to assess the seismic hazard of a region, but also to understand how the Earth works through indirect observations. The geographical and depth distribution of earthquakes hypocenters, together with the properties of the related seismic sources (earthquake size, source geometry), provide indeed valuable information to reveal tectonic activity and help in depicting the best image of the present-day state of stress/deformation in the area. In addition, the energy radiated by local and distant earthquakes travels the Earth's interior as seismic waves, whose propagation characteristics are tightly related to the physical properties of the material through which they are transmitted. Seismic waves are therefore the primary tool to probe the structure of the inner Earth. In particular, the knowledge of the three-dimensional crust-mantle structural heterogeneities in terms of seismic waves propagation is of major importance for the reconstruction and understanding of past and current dynamic processes that shaped the whole Mediterranean region (i.e. Piromallo and Morelli, 2003; Zhu et al., 2012).

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Zhu H., Bozdag E., Peter D., Tromp J. Structure of the European upper mantle revealed by adjoint tomography. Nature Geosci., 5, 493-498, 2012.

Marco BOHNHOFF

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Dr. Bohnhoff is geophysicist and a certified manager. He is currently head of the research group 'Experimental and Borehole Seismology' at GFZ Potsdam and a professor at the Freie Universität Berlin. His research topics are seismology, seismomechanics, earthquake physics and borehole geophysics with a focus on microseismic monitoring of natural and induced seismicity.

Upon completion of a job training as Electronic Technician he studied Geophysics with a focus on wide-aperture seismic profiling. In that framework he was party chief for several on- and offshore projects and expeditions in both fundamental research and industry. For the last 15 years his primary scientific interest has been on an improved understanding of active shear zones and characterization of geological reservoirs. He has received a Heisenberg-fellowship from the German Research Foundation in 2007 and has been a Research Scholar at Stanford University 2007-9. He is currently co-PI of the ICDP-GONAF observatory, a borehole-based geophysical observatory in the Istanbul-Marmara region where a major earthquake is pending.

Dr. Bohnhoff is author of ~60 peer-reviewed publications and book chapters. He has been executive manager of the German Geophysical Society between 2005-8 and was spokesman of the GFZ think tank between 2013-5.

CAREER:
2006 Venia Legendi (Privat-Dozentur), Ruhr-University Bochum 2006 Habilitation in Geophysics (Dr. rer. nat. habil.), Ruhr-University Bochum 2000 PhD in Geophysics (Dr. rer. nat.), Hamburg University 1997 Diploma in Geophysics (MSc.), Hamburg University 1992 Job Training (Berufsausbildung) as Electronic Technician at Bosch-Siemens HG.

EARTHQUAKE HAZARD AND SEISMIC MONITORING EFFORTS IN THE ISTANBUL-MARMARA REGION

Marco Bohnhoff
GFZ German Research Centre for Geosciences, Germany
Free University Berlin, Germany

The North Anatolian Fault Zone (NAFZ) in Turkey is a 1300 km long plate bounding transform fault separating the Anatolian from the Eurasian plate between eastern Anatolia and the North Aegean Sea (Fig. 1). The NAFZ has produced several large earthquakes in the historic past reaching magnitudes as large 8.0 in the east and 7.4 in the west (Bohnhoff et al., 2016). Since 1939, the fault zone has seen a remarkable sequence of westward propagating large earthquakes, currently leaving the Marmara Sea segment offshore of Istanbul as the only fault segment that has not produced a large earthquake since 1766 (e.g., Stein et al. 1997; Sengör et al., 2005). From historical records and due to the long settlement history of the region it is well known that this region has faced several large (M>7) earthquakes with an average recurrence period of 200-250 years (Parsons, 2004). In consequence, there is currently a high probability for a major earthquake along the Marmara section of the NAFZ including the Princes Islands segment, less than 20 km from the more than 15 million people who live in Istanbul (Fig. 2).

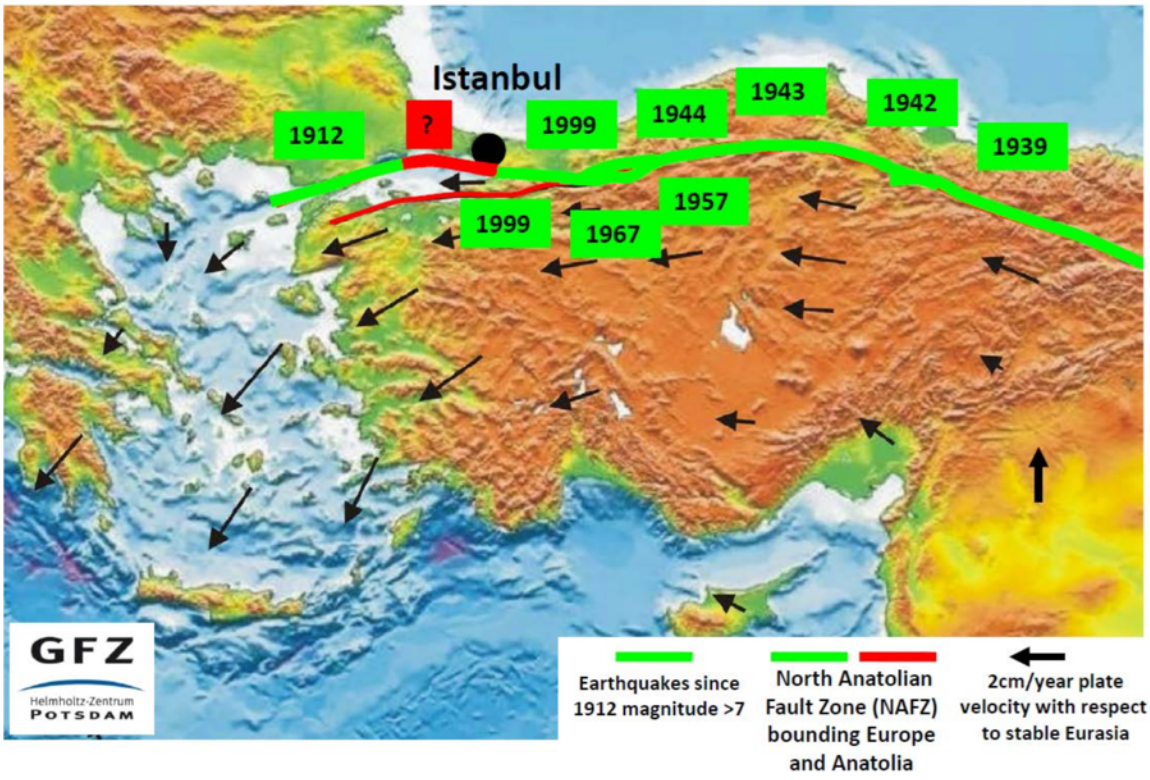

Fig. 1: Aegean-Anatolian region with the Anatolian plate migrating towards the west with respect to fixed Eurasia indicated by the GPS-derived horizontal deformation field (after McClusky et al., 2000). The green line indicates the right-lateral North Anatolian transform Fault Zone (NAFZ) separating both plates. Numbers are years of M>7 earthquakes during the last century. The red line indicates the Marmara section of the NAFZ and is the only part of the entire fault zone that has not produced a large earthquake since 1766. This section is currently overdue for a M>7 event.

The seismotectonic setting of this region raises a number of scientific key-questions with direct socio-economic relevance for the Istanbul metropolitan region where about 40% of the Turkish gross national product is generated. Two of the most evident questions are:

(1) What are the driving physical processes along this transform fault segment that is in the final state of its seismic cycle prior, during and after a large (M>7) earthquake?

(2) How does the structural heterogeneity of the NAFZ below the Sea of Marmara affect the slip distribution, nucleation process, directivity and magnitude of the pending Marmara earthquake? To address these and related questions the seismicity along the Princess Island segment offshore of Istanbul needs to be monitored at low magnitude-detection threshold to detect and locate the numerous small earthquakes that cannot be seen by the regional permanent regional seismic networks. Such monitoring necessarily needs to involve instrumentation operating under low noise conditions, which is a challenge in a densely populated region such as the eastern Sea of Marmara including Istanbul. Moreover, given the fact that the main fault branch is located offshore and only few islands in its direct vicinity exist, conventional surface seismic stations are not suitable in this setting. Consequently, a concept of drilling and instrumenting 300m deep boreholes around the target fault has been developed in order to implement a Geophysical borehole Observatory at the North Anatolian Fault in the eastern Sea of Marmara region (GONAF).

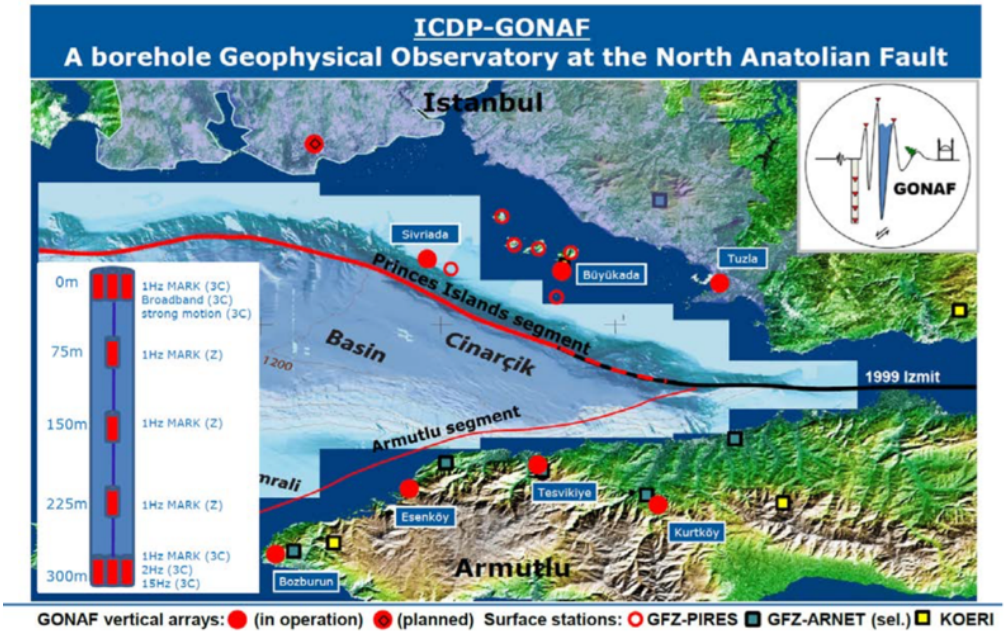

Fig. 2: Eastern Sea of Marmara region with the Princess Islands segment as the main NAFZ fault trace in this region that is located within 20 km distance to the historical city center of Istanbul. Bold red dots indicate locations of the ICDP-GONAF observatory where vertical seismometer arrays were deployed in 300m deep boreholes. The Figure in the lower left shows the typical sensor distribution in the GONAF wells including multiple sensors of different natural frequency to sample the entire frequency band of the seismic wavefield.

GONAF is a joint research venture between GFZ Potsdam and the Turkish Disaster and Emergency Presidency (AFAD) in Ankara. It is co-funded by GFZ, AFAD, Turkish Ministry of Development, the International Scientific Drilling Program (ICDP), and the German Helmholtz Association (HGF). Following an ICDP-funded workshop held in Istanbul in 2007 an implementation plan has been developed and the GONAF observatory has been setup between 2012-15. The observatory now consists of seven boreholes each being equipped with a vertical array of seismometers allowing for high-resolution microseismic monitoring of the region over the entire seismic frequency band under low-noise conditions (Fig. 2). Two of the GONAF borehole arrays are located on Sivriada and Büyakada as part of the Princes Islands within less than 5 km to the Princes Islands segment as the main fault branch of the NAFZ. A further station is located on the Tuzla peninsula in eastern Istanbul in direct vicinity to a prominent seismicity cluster that was activated by the 1999 Izmit Mw7.4 earthquake and that has been active since then (Bulut et al., 2011). The remaining four GONAF vertical arrays are located on the Armutlu peninsula south of the Cinarcik Basin completing a full azimuthal coverage for microseismicity occurring below the eastern Sea of Marmara and to secure homogeneous detectability for Microseismicity throughout the region. Each of the vertical arrays includes three vertical MARK type 1Hz seismometers at 75 m spacing. At the bottom of each well at 300 m depth, also three-component borehole sensors of 1, 2 and 15 Hz natural frequency were installed. All sensors were cemented in the boreholes to ensure long-time operation. Seismic waveform data is sampled at 500 Hz and transmitted in real-time to GFZ and AFAD headquarters where it is further processed and analyzed. In addition to the seven seismic wells for seismic monitoring, four additional 150m deep boreholes co-located with GONAF stations were drilled and equipped with US-PBO-type strainmeters to measure deformation down to atomic scale. This component of the GONAF project is led by UNAVCO from US.

Recent studies focusing on the microseismic activity along the Princess Islands segment concluded that this crucial portion of the Marmara seismic gap is currently locked and thus needs to be considered as a potential nucleation point of the pending M>7 earthquake (Bohnhoff et al., 2013). Studying the geometry of the Cinarcik Basin based on ambient noise recordings of the region allowed to image this pull-apart depocenter extending its depth resolution to below what can be studied from active multi-channel seismic reflection profiles (Acarel et al., 2014). Furthermore, shear-wave splitting studies (Eken et al., 2013) and determination of fault plane solutions (Bulut et al., 2009; Wollin et al., in prep.) were performed to determine the local kinematic setting and to determine the stress field of the region. Studying waveform recordings from the first completed GONAF well on the Tuzla peninsula allowed to confirm the ambitious objectives of decreasing the regional magnitude-detection threshold by two orders of magnitude thereby increasing the number of detected seismic events by a factor of ~100 (Prevedel et al., 2015). Furthermore, those recordings also allowed to determine the near-surface structure around the borehole which is a key-prerequisite for local seismic hazard and risk assessment (Raub et al., 2016).

Fig.3: Start of drilling at the GONAF location on the Tuzla peninsula in eastern Istanbul.

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Raub, C., Bohnhoff, M., Petrovic, B., Parolai, S., Malin, P.E., Yanik, K., Kartal, R.F., Kiliç, T. Seismic wave propagation in shallow layers at the GONAF-Tuzla site, Istanbul, Turkey. Bull. Seismol. Soc. Am., 106(3), 912– 927, doi:10.1785/0120150216, 2016.

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EDUCATION

•BSc Honours in Geology, 2(2); University of Bristol, 1968 - 1971.
•MSc 'Sedimentology', (Distinction); University of Reading, 1976 - 1977.
•Postgraduate Certificate in Education; University of Keele, 1977 - 1978.

CAREER

APPOINTMENTS HELD

•Oct 1971 - July 1976 Geologist, De Beers Consolidated Mines Ltd., Kimberley, South Africa.
•Sept 1978 - July 1996 School Teacher, Altrincham Grammar School for Boys,
•Sept 1996 – Aug 2002 Science Education Lecturer: Earth sciences, Keele University
•Sept 2006 – Dec 2015 Professor of Earth Science Education
•Jan 2016 – today Emeritus Professor of Earth Science Education
•Sept 1999 – Dec 2015 Director of the Earth Science Education Unit at Keele University

MEMBERSHIP OF LEARNED BODIES AND PROFESSIONAL ASSOCIATIONS

•Chair of the International Union of Geological Sciences (IUGS) Commission on Geoscience Education
•Adviser (past-Chair and instigator) of the Council of the International Geoscience Education Organisation
•Chair of the Earth Science Education Forum (England and Wales) (ESEF (E & W)).
•Chair of Examiners, Welsh Joint Education Committee (WJEC) Geology 'A' level Examination Committee.
•Fellow of the Geological Society.

OTHER DETAILS OF CAREER

•Leader of the Earthlearningidea team, publishing Earth science activities for the Earthlearningidea website
•Educational Consultant to the 'Building Earth Science Education Resilience' group

RESEARCH INTERESTS

•the development of Earth science teaching.
•monitoring a national programme of Earth science INSET.
•misconceptions in Earth science understanding.
•the international development of Earth science teaching

PUBLICATIONS AND SERVICES

224 publicatons including: 8 authored books, 5 edited collections, 8 chapters in books, 32 publications in peer-reviewed journals, 128 other journal articles and 43 articles in edited collections.

AWARDS AND HONORS

2003 – winner of the Geological Society's 'Distinguished Service Award'
2012 – winner of the Geologists' Association's 'Halstead Medal'

SUGGESTED READINGS (Chapters in books)

•*King, C. (2017) Fostering deep understanding through the use of geoscience investigations, models and thought experiments – the Earth Science Education Unit and Earthlearningidea. In Vasconcelos, C. (ed) Geoscience education: trends and approaches. Dordrecht: Springer.*
•*King, C. (2013) A review of the Earth science content of Science Textbooks in England and Wales. In Myint Swe Khine (ed) Critical Analysis of Science Textbooks: evaluating instructional effectiveness, 123-160. Dordrecht: Springer. ISBN. 978-007-4167-6.*
•*King, C. (2013). Using Research to Promote Action in Earth Science: Professional Development for Teachers. In, Vincent Tong (ed) Geoscience Research and Education. 311-334. Dordrecht: Springer. ISBN 978-94-007-6942-7.*

INVESTIGATING THE GEOSCIENCE OF 'THE MEDITERRANEAN' THROUGH CLASSROOM MODELLING ACTIVITIES

Chris King
Keele University, Great Britain

14.15 – 16.00 and 16.15 – 18.00 (two groups alternating)

Come to find out how the geology of the Mediterranean works through a range of hands on and interactive activities: make your own earthquake; investigate tsunamis; test 'magma viscosity; work out how best to model eruptions; build your own Alps; erode mountains and coastlines and build your own 'Nile delta' – then try out all these things on your colleagues and discuss their educational potential. Models like these have been used for teaching at a range of levels across the UK and further afield, and research and evaluation have shown how effective they can be in the education of both teachers and pupils. Finally, enjoy the grand finale.

François Tilquin
Lycée Marie CURIE, ECHIROLLES, FRANCE
email: francois.tilquin.38@gmail.com

I am a retired biology and geology teacher in a high-school near Grenoble- France. My students were 15 -18 years old.
I am the author of various teaching *softwares* and pedagogical applications: data acquisition with interface, simulations, numerical and analogical modeling in biology and geology. Even if it is more difficult, I prefer that students make the manipulations by themselves, and test the hypothesis, than when the professor makes the demonstration himself.

Jean Luc BERENGUER
Science teacher
International High School VALBONNE, FRANCE
email: berenguer@unice.fr

I coordinate the national French educational network of seismology (www.edusismo.org).
Teacher at sea aboard the JOIDES Resolution, I try to impulse in Europe the 'ECORD School of Rock', a workshop for teachers to discover and to use IODP (International Ocean Discovery Program) resources into the classroom.
I am also in charge of the organization of the next International Earth Science Olympiad which will take place in France in August 2017.

Francesca CIFELLI
Associate Professor
Department of Science, Roma TRE University
email: francesca.cifelli@uniroma3.it

I'm associate professor in structural geology at the Department of Science of Roma TRE University. My research activity mainly focuses on paleomagnetic studied applied to the reconstruction of the rotational history and structural evolution of curved mountain chains. I'm very active in science communication and high-school teachers training. I'm a member of Educational Committee of Education (CoE) of the European Geosciences Union (EGU) for the organization of the GIFT (Geophysical Information for Teachers) workshop.

EARTHQUAKES IN THE CLASSROOM: "THE SEISMO-BOX: DO IT YOURSELF"

François Tilquin[1], Jean Luc Berenguer[2] and Francesca Cifelli[3]
[1]Lycée Marie Curie, Echirolles, France
[2] International High School Valbonne, FRANCE
[3]Università degli Studi Roma TRE, Italy

To prevent population against seismic risk, people must know where earthquakes take places, when earthquakes occur and how much is the released energy. The seismo-box has been projected with the main goal to answer these main questions!
Experiments that can be made with the seismo-box allow understanding some important aspects of earthquakes: what is the origin of an earthquake, how to record and locate it, the impossibility to predict it, and what are its consequences on buildings. Moreover, it is possible to understand better the difference between seismic hazard (that man cannot control) and seismic risk (that man can and must minimize).
This 'Seismo-box: do-it-yourself' is made with very simple and cheap (and even recycled) materials (Fig. 1). Among the most popular experiments possible with the seismo-box: the record of micro-earthquakes (Fig. 2), the stick-slip experiments (Fig. 2), the simulation of vibrations on small buildings (Fig. 4). Moreover, the free software AZIMUT© FT 12/2011 allows showing which are the characteristics of the various waves which arise from an earthquake, and what is the first movement of the ground (Fig. 5).

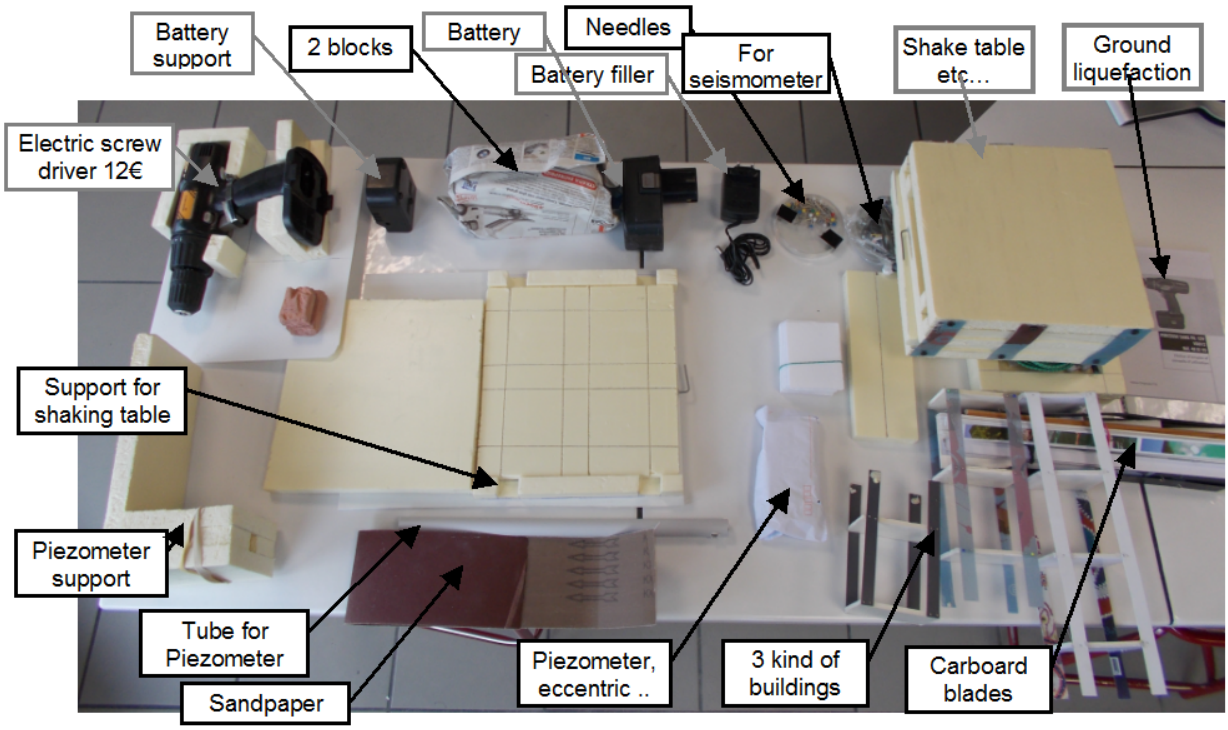

Fig. 1 - Contents of the 'Seismo-box: do-it-yourself'.

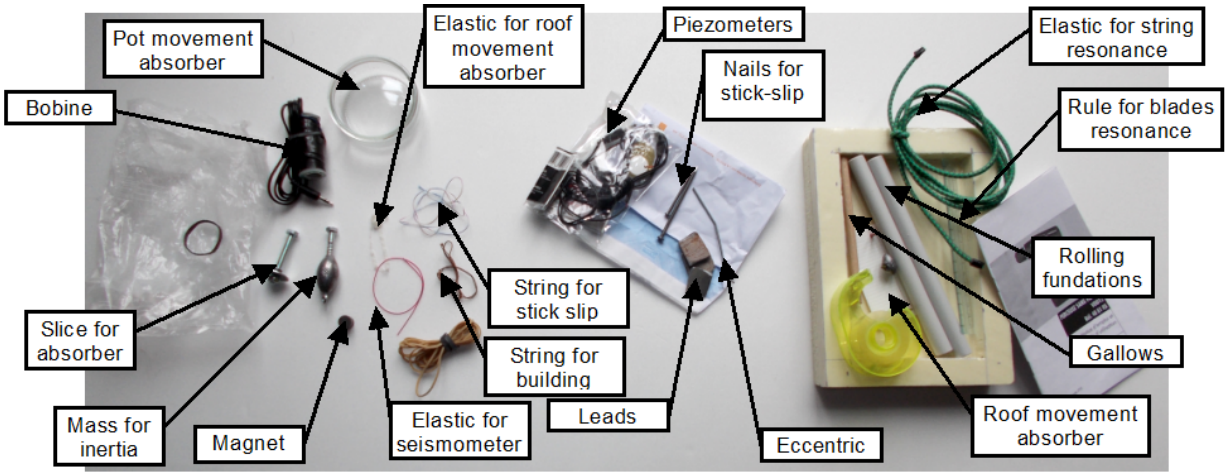

Fig. 2 - Details of the material needed to build seismometer or record table-earthquakes.

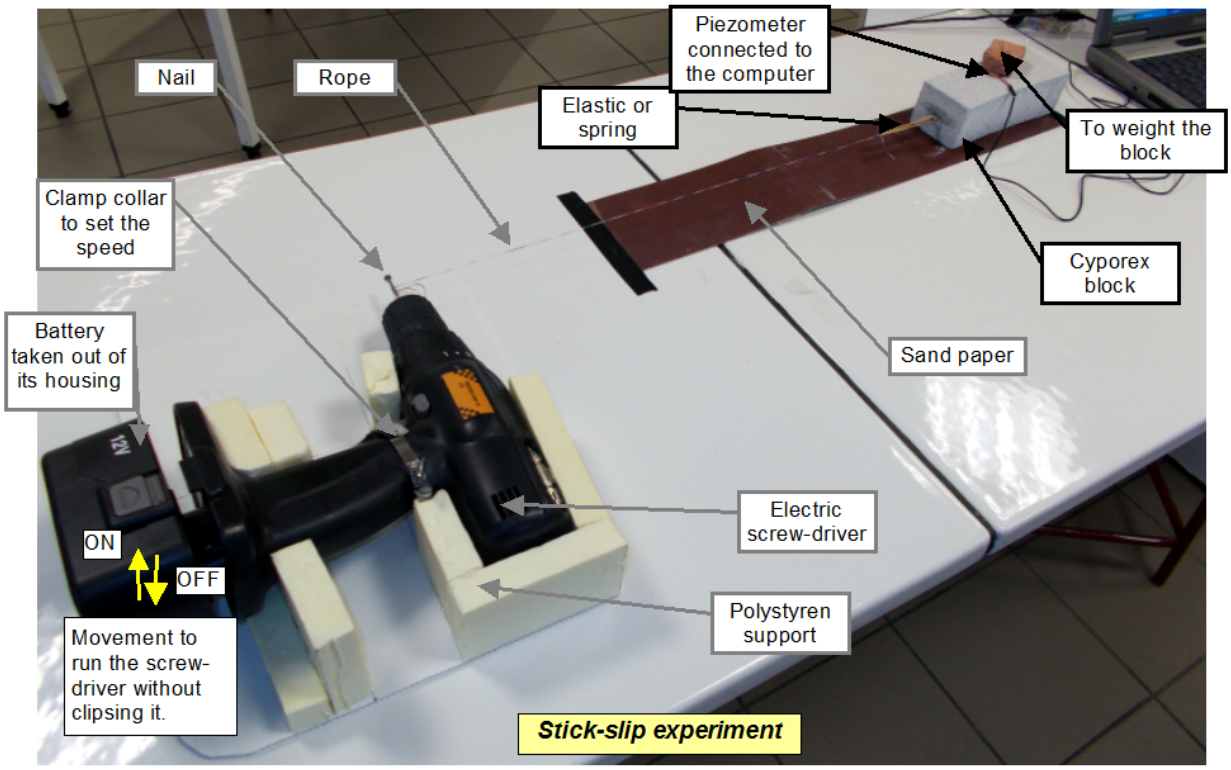

Fig. 3 - The spring-slider block model experiment in classroom to answer the question: is it possible to predict earthquakes?

Before, during or after modelling seismic waves, it is possible to analyse recent data (seismograms) with appropriate software. 'Educarte' (Fig. 5), made for educational purpose, gives us opportunity to analyse seismograms, to locate epicentres, to plot seismicity... so many practical activities for the classroom!

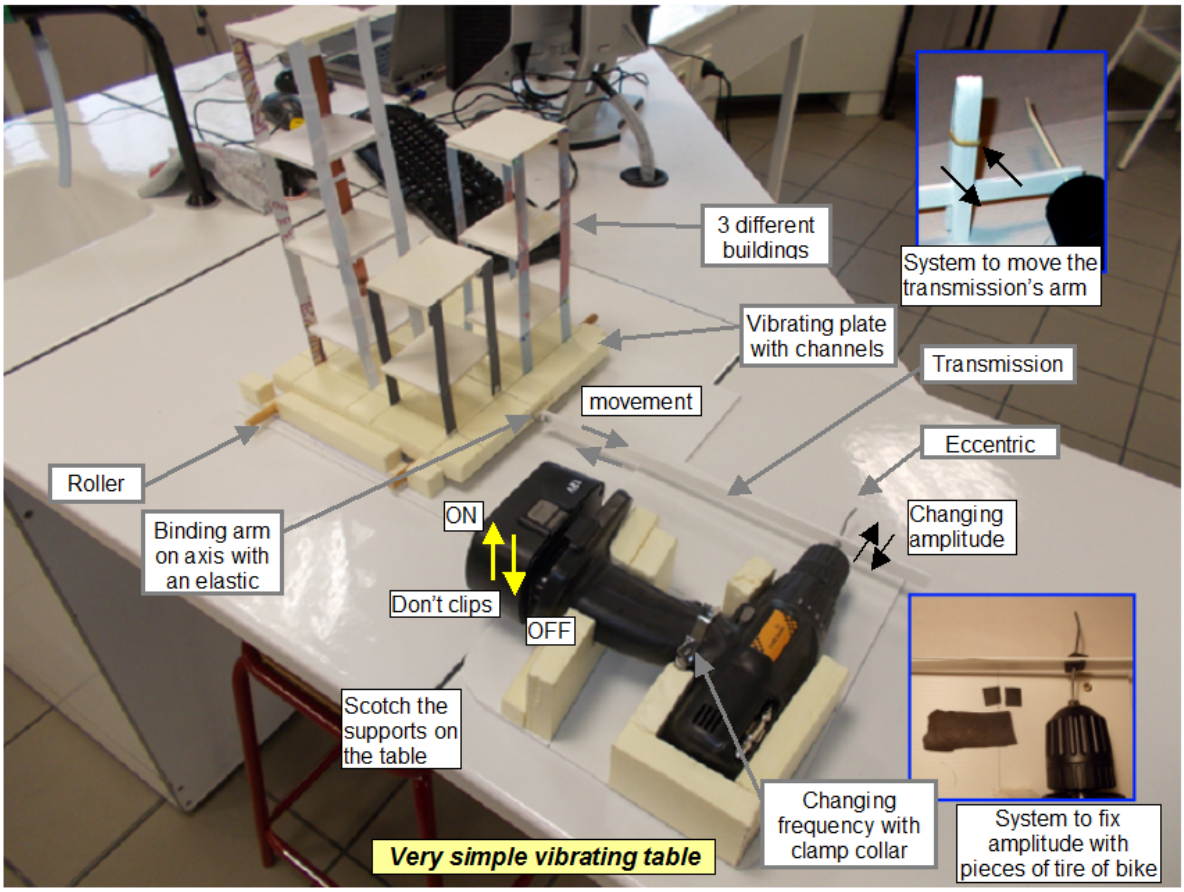

Fig. 4 - Shaking table: the very cheap electric screwdriver rotates an eccentric, which converts rotations in longitudinal movements. They are transmitted to a tray with different height buildings and systems. We can change frequency and amplitude of the vibrations and see the resonance problem, and many other scientific processes.

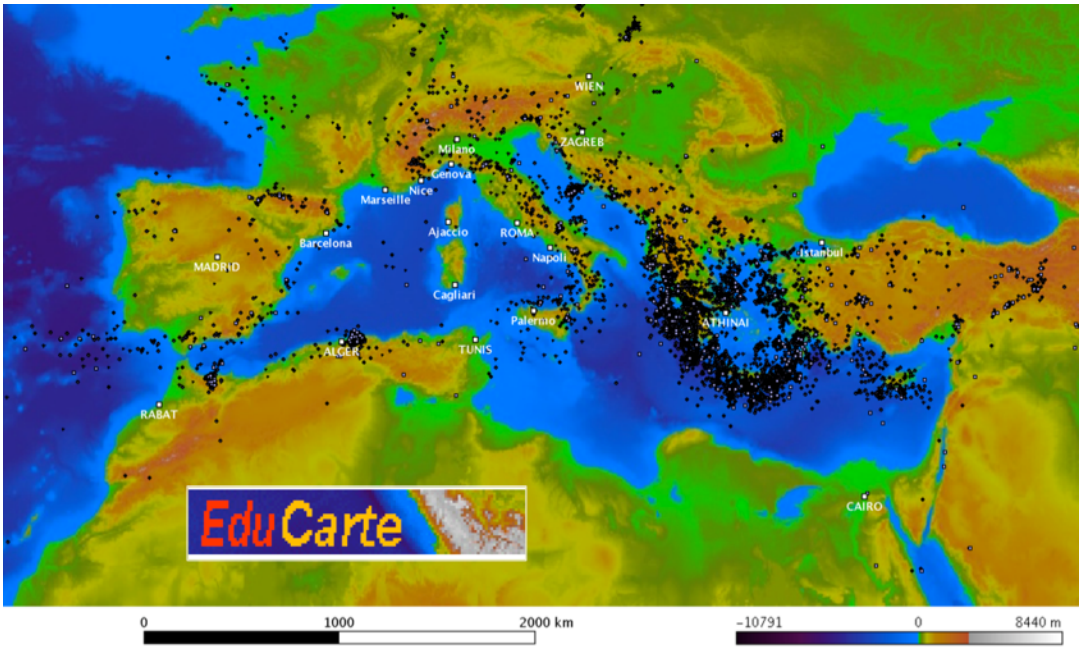

Fig. 5 – Software EduCarte.

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EDUCATION

Degree in Geological Sciences 1989 Dept. of Earth Sciences, University of Pisa, with Full Honours

POSITION CURRENT

Director of Research at INGV; Responsible of the INGV Center for Volcanic Hazards

POSITIONS PAST

2003-present Research Director, INGV; 1999-2003 Researcher – ING/INGV; 1996-1999 Contract Researcher, CNR; 1990-1996 Contracts and Fellowships with ING, CNR, Univ. of Pisa

APPOINTMENTS

Director, Volcanoes Division of INGV, 2013 – 2016; Head of the Unit "Physico-mathematical Modelling and Numerical Simulation of Volcanic Processes", INGV, 2006 – 2013; DPC Committee for the preparation of the Emergency Plan at Campi Flegrei volcano, 2009 – 2011; Scientific Advisory Council, INGV, 2007-2008; Presidential Advisory Board, EGU, in representation of the scientific theme "Solid Earth", 2007-2009; Awarding Committee, EGU Robert Wilhelm Bunsen Medal, 2005 – to date, Chair since 2010; Awarding Committee, EGU Arthur Holmes Medal and Honorary Membership, 2010 – to date; Chair of Awarding Committee, EGU/GMPV YSOPP: "Young Student Outstanding Poster Presentation" award, 2009 – 2011; Chief and Funding Editor, Solid Earth, published by EGU, 2009 – to date; Editorial Board, Journal of Volcanology and Geothermal Research, 1998-2006; Scientific Managing Committee, GNV, 2002-2004

SCIENTIFIC OUTPUT

> 60 refereed papers in international journals and books. Nearly 2000 ISI Web of Science Citations (Papale P*)

h-factor = 25

ADVISORY ROLES

Panel of NSF Merit Reviewers; Panel of EU FP7 Reviewers, Programmes "People" and "Ideas"; Panel of Reviewers, Belgian Government, Remote Sensing Research Programme; Panel of Reviewers, French USAR – Gestion de Programmes de Recherches; Panel of Reviewers, Italian Research Programme PRIN; Reviewer for the main scientific journals in Geosciences (Nature, Nature Geosciences, Journal of Geophysical research, Geophysical Research Letters, Earth Planetary Science Letters, Bulletin of Volcanology, Journal of Volcanology and Geothermal Research, etc.); Chair of the GMPV Programme Committee, European Geosciences Union General Assemblies 2008-2009-2010 (about 100 scientific sessions organized); 20+ Graduating/Doctoral Students supervised; 10+ Postdoctoral collaborators

SYNERGISTIC ACTIVITIES

European Coordinator, FP7 Marie Curie Initial Training Network "NEMOH - Numerical, Experimental and stochastic Modelling of vOlcanic processes and Hazard: an Initial Training Network for the next generation of European volcanologists", 2012 – to date

Principal Investigator, FP7 Cooperation "VUELCO - Volcanic Unrest in Europe and Latin America: Phenomenology, eruption precursors, hazard foreCast, and risk mitigation, 2011 – to date

President, Geochemistry, Mineralogy, Petrology and Volcanology Division – European Geosciences Union, 2007- 2011

National Coordinator of the INGV-DPC Projects in Volcanology, 2004-2006 and 2007-2009, and Head of Managing Committee

Secretary, Volcanology Sub-Division – European Geosciences Union, 2005 – to date

United Nations Commission for the Nyiragongo-Lake Kivu crisis 2002

LIVING IN A CALDERA: THE CASE OF CAMPI FLEGREI, ITALY

Paolo Papale
Istituto Nazionale di Geofisica e Vulcanologia, Sezione di Pisa, Italy

Calderas originate from the collapse associated with some of the largest and most devastating eruptions on Earth. The depression which is formed can be from a few to several tens of km wide, usually a few hundreds of m deep. Subsequent volcanic activity tends to accumulate material inside the depression, progressively filling it up and leaving on a long term a generally flat, fertile area that often becomes the site for human settlements. That's the case of Campi Flegrei, Southern Italy, where about half a million people live inside the volcano, including a large part of the city of Naples, making the caldera and its surroundings one of the highest volcanic risk areas in the world.

After the last large caldera-forming eruption, occurred about 15,000 years ago, eruptions have concentrated in separate periods of intense activity, the last one terminated about 4000 years ago; however, the last eruption occurred as an isolated event in 1538, following decades of ground uplift and subsidence (bradysism), and leaving the hill of Monte Nuovo (literally, "New Mountain"). Since then, subsidence has dominated until the fifties of the last century, with major periods of crisis in 1969-72 and 1982-84 producing tens of thousands earthquakes and a cumulative ground uplift of about 3 m in the village of Pozzuoli, at caldera center, forcing the evacuation of about 40,000 people.

Today the volcano shows clear signs of activity, with continuing ground uplift at a rate of some, up to a few tens, of cm per year, earthquakes in isolated events and swarms, and increasing degassing, which are interpreted by many scientists as the surface manifestation of periodic ascent of magma batches and their emplacement at depths of only 3-4 km. Because of such records the caldera is among the most intensely monitored and studied volcanoes in the world, and it is the object of many national and international projects aimed at understanding its behaviour, forecasting the volcanic hazards, and creating the scientific knowledge for continuous update, by the Civil Protection authorities, of effective emergency plans.

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EDUCATION

Laurea, Milano, Earth Sciences, 1984

MS, College Station TX, Geological Oceanography, 1988

Doctorate, Milano, Earth Sciences, 1991

PROFESSIONAL BACKGROUND

Research Assistant, Ocean Drilling Program, College Station, TX, from 1986 to 1988; Researcher at OGS - Istituto Nazionale di Oceanografia e di Geofisica Sperimentale, from 1991 to 2004; ICREA (Istitució Catalana de Recerca i Estudis Avançats) Research Professor at Departament d'Estratigrafia, Paleontologia i Geociències Marines, Universitat de Barcelona, from 2004 to 2012; Senior Researcher at OGS - Istituto Nazionale di Oceanografia e di Geofisica Sperimentale since 2012.

RESEARCH INTERESTS

Geology and geophysics of continental margins, with special focus on polar depositional systems and marine sedimentary expression of de-glaciations; Submarine geological hazards; Geological setting and distribution of natural gas hydrates in the marine environment; Distribution of Messinian evaporites in the Mediterranean basin. Principal investigator and participant in several research projects funded at a national level in Italy and Spain, by the EC, and by industry; Coordinator of COST Action CA15103 (Uncovering the Mediterranean Salt Giant), 2016-2019, and principal proponent of International Ocean Discovery Program (IODP) Multi-Platform Drilling Proposal Uncovering a Salt Giant.

TEACHING

Associate Professor of Fluids in Marine Sediments, Master of Oceanography and Management of the Marine Environment, University of Barcelona, Faculty of Geology from 2007 to 2010; Contract Professor of Marine Geology, University of Trieste, Department of Mathematics and Geosciences, from 2012.

CO-ORDINATION AND MANAGEMENT OF RESEARCH STRUCTURES AND ACTIVITIES

Member of the Scientific Board of MARUM, University of Bremen, Germany, since 2006; Since 2013, delegate of MIUR (Italian Ministry of Education, University and Research) Management Board of CIESM (The Mediterranean Scientific Committee), in the Management Board of JPI Oceans, and in the Western Mediterranean Dialogue Forum (5+5) Research and Innovation; Member of the EGU Committee on Education from 2003 to 2014.

PUBLICATION RECORD

102 scientific articles published and cited in SCOPUS. Hirsch index (H = 29). Total citations: 2393.

UNCOVERING THE MEDITERRANEAN SALT GIANT

Angelo Camerlenghi
OGS – Trieste, Italy

About 6 million years ago the Mediterranean Sea became an enormous saline basin where more than one million cubic kilometres of salt (6% of the dissolved oceanic salt) accumulated on the seafloor locally exceeding a thickness of 3 km in the deep basins. This extreme, but geologically brief event (640 ka, 5.97 – 5.33 Ma), changed the chemistry of the global ocean and had a permanent impact on both the terrestrial and marine ecosystems of a huge area surrounding the Mediterranean. Increasing Mediterranean salinity was driven by tectonic restriction of exchange with the Atlantic Ocean and modulated by the impact of climatic precession on surface water salinity. The role of eustatic sea level change in generating the huge volumes of salts remains contentious.

The first scenario ever put forth to explain the formation of the MSC was generated following the first scientific drilling expedition in the Mediterranean Sea, the Deep Sea Drilling Project (DSDP) Leg 13 in 1970. It envisaged an almost desiccated deep Mediterranean basin with a dramatic ≈1.5 km drop in sea level. This resulted in the incision of deep river canyons on the continental margins, the deposition of thick evaporites on the Mediterranean abyssal plains, and a catastrophic flooding event when the Mediterranean-Atlantic connection was re-established through the Gibraltar Strait. This initial hypothesis has been challenged and refined over the years and many different scenarios now populate the scientific literature, illustrating a lack of fundamental understanding, especially for the deepest offshore domains. In spite of 43 years of multi-disciplinary research conducted on the MSC (generating over 1800 peer review papers), the processes, timing, causes, chronology and consequence at local and planetary scale are still not yet fully understood, and the MSC event remains one of the longest-living controversies in Earth Science.

The understanding of the Mediterranean salt giant bears a scientific relevance that goes beyond the local geological evolution. Salt-bearing sedimentary basins, preserving kilometer-thick evaporite layers, or 'salt giants', are frontiers for a diverse range of challenging research. Most salt giants in the geological record are old (e.g. Permian Zechstein salt or the Mesozoic salts in the Atlantic) and have typically experienced intense deformation. They are commonly the focus of applied research by the petroleum industry because of the sealing capacity of salt rock, the recurrent association with structural traps for hydrocarbon fluids, and perturbations to in situ stresses associated with salt bodies. Besides the industrial interest, salt giants are the sedimentary expression of extreme environmental events of global relevance, often resulting from a combination of deep earth- system dynamics (e.g.

mantle convection and the initiation of continental break-up) and climatic forcing (evaporation-precipitation budget at the regional scale). Salt deposition impacts the structural, chemical and biological evolution of the sedimentary basins in which it accumulates, and affects global ocean salinity. Because of the variety of chemical environments, salt giants have the potential to harbor an unprecedented diversity of microbial life with exceptional metabolic activity. Finally, quantitative understanding of salt dynamics and associated fluid flow is fundamental to the assessment of submarine geohazards, and exploration or production risks.

Despite their global occurrence and general importance within the global Earth system, there is currently no complete stratigraphic record through an undeformed salt giant. Similarly, there is a significant lack of knowledge about the factors controlling salt giants deposition, their early evolution, the evolution through time of the oceanic gateways that control salt deposition, and the impact that thick salt deposition exerts on the isostatic response of continental margins and on sub-salt formations. COST Action CA CA15103, Uncovering the Mediterranean salt giant (MEDSALT) (http://www.cost.eu/COST_Actions/ca/CA15103) aims to create a new flexible scientific network that will address the causes, timing, emplacement mechanisms, and consequences at local and planetary scale of the Miocene salt layer in the Mediterranean basin, and promote e new phase of scientific drilling in the Mediterranean Sea. While addressing its the scientific objectives the network will promote the participation of young talents and next generation leaders in science and technology. This lecture results from the work in progress of a large group of scientists participating in the MEDSALT COST Action.

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EDUCATION

Degree in Physics

CAREER

Piero Lionello is full professor of atmospheric Physics and Oceanography at University of Salento (Lecce, Italy), where he coordinates the PhD programme in "Ecology and Climate Change. He is the chairman of the MedCLIVAR (Mediterranean CLImate VARiability) network, member of the Scientific Advisory Board of ECMWF (European Center for Medium Range Weather Forecast), member of the board of directors of CMCC (Euro-Mediterranean Center on Climate Change) and has been chairman of the International Scientific Steering Committee of the HyMeX project (Hydrological cycle in the Mediterranean eXperiment)..

RESEARCH INTERESTS

Piero Lionello is a climatologist with a focus on the climate of the Mediterranean Region, its past and future evolution, and extreme events, particularly marine storms.

PUBLICATIONS AND SERVICES

He has edited three books on the Climate of the Mediterranean Region, several special issues of international scientific journals, and organized many conferences and meetings on related topics.

Giorgi F. and P.Lionello, (2008), Climate Change Projections for the Mediterranean Region Global and Planetary Change 63:90-104, DOI: 10.1016/j.gloplacha.2007.09.005

Lionello P. (Ed.) (2012) The Climate of the Mediterranean Region, From the past to the future , Elsevier, Amsterdam, NETHERLANDS, ISBN: 9780124160422 , 502pp

THE CLIMATE OF THE MEDITERRANEAN REGION: ITS RECENT PAST AND FUTURE EVOLUTION IN THE 21ST CENTURY

Piero Lionello
Università del Salento, Lecce, Italy

Mediterranean region is indeed special for climatologists and climate change impacts: many components of its terrestrial and marine environment are already under stress; it has been shown to be very vulnerable to climate change; environmental and morphological gradients are particularly large and it is a region with also large socio-economic contrasts.

The characterization of the region is strongly linked to the Mediterranean Sea, a semi-enclosed, mostly deep regional sea. Its presence is, however, not sufficient for determining an uniform climate. Strong contrasts among different areas are present, deriving from the complicated morphology of the Mediterranean region and its location between the tropical zone to the South and the temperate zone to the North. The connotation of Mediterranean Climate applies only to a fraction of the Mediterranean region and, despite the distance between any area and the sea remains limited to a couple hundred km in most cases, also other temperate, arid and snow climate types are present. The contrasts are large: there are permanent glaciers in the humid alpine area north of the Mediterranean sea and hot subtropical desert areas at the southern African coast, temperate maritime climate at the North Iberian coast west of the Mediterranean Sea and truly Mediterranean areas and steppe in the Middle East regions at the eastern coast (see figure 1)

Several studies show a great consistency in model results concerning the risk of drying during the 21st century and increased temperature. Figure 2 show a former analysis of climate change projections over the Mediterranean region based on a large ensembles global climate change simulations. Recent results substantially confirm these results. Figure 2 (upper panels) shows seasonal temperature increase for a specific emission scenario (A1B) comparing the 2071-2100 period to the 1961-2100 period. In summer (JJA) values reach 3 to 4°C over the sea, grow further to 4 to 5°C in inland areas, with maxima higher than 5°C in Sahara and Middle-East. Projections agree also on a pronounced decrease in precipitation, especially in the warm season, except for the northern Mediterranean areas (e.g. the Alps) in winter. Figure 2 (lower panels) shows the ensemble change of precipitation for the same periods and scenario as in the upper panels. The percent reduction in precipitation is smallest in winter, where it varies from no change in the northern Mediterranean to a 40% reduction in the south. In spring and fall, reduction of precipitation vary between 10% and 40%. The average value of the large summer reduction is in the range 25-30%, but some areas in the north-east and the south show a decrease that is larger than 50%.

The future amplitude of these changes will depend to a great extent on the actual evolution of anthropogenic emissions. Actual values and the detailed spatial distribution of changes, particularly for precipitation, remain uncertain, as they depend strongly on the adopted climate model. However, this component of the scientific debate, aiming at providing a more deeper understanding of processes and a more accurate prediction of the future, should not hide that in the Mediterranean region at the end of the 21st century intense warming is almost certain and substantial drying is very likely. Consequences on the environment will be important and will require all possible effort for mitigation of global climate change and adaptation to new climate conditions at regional scale.

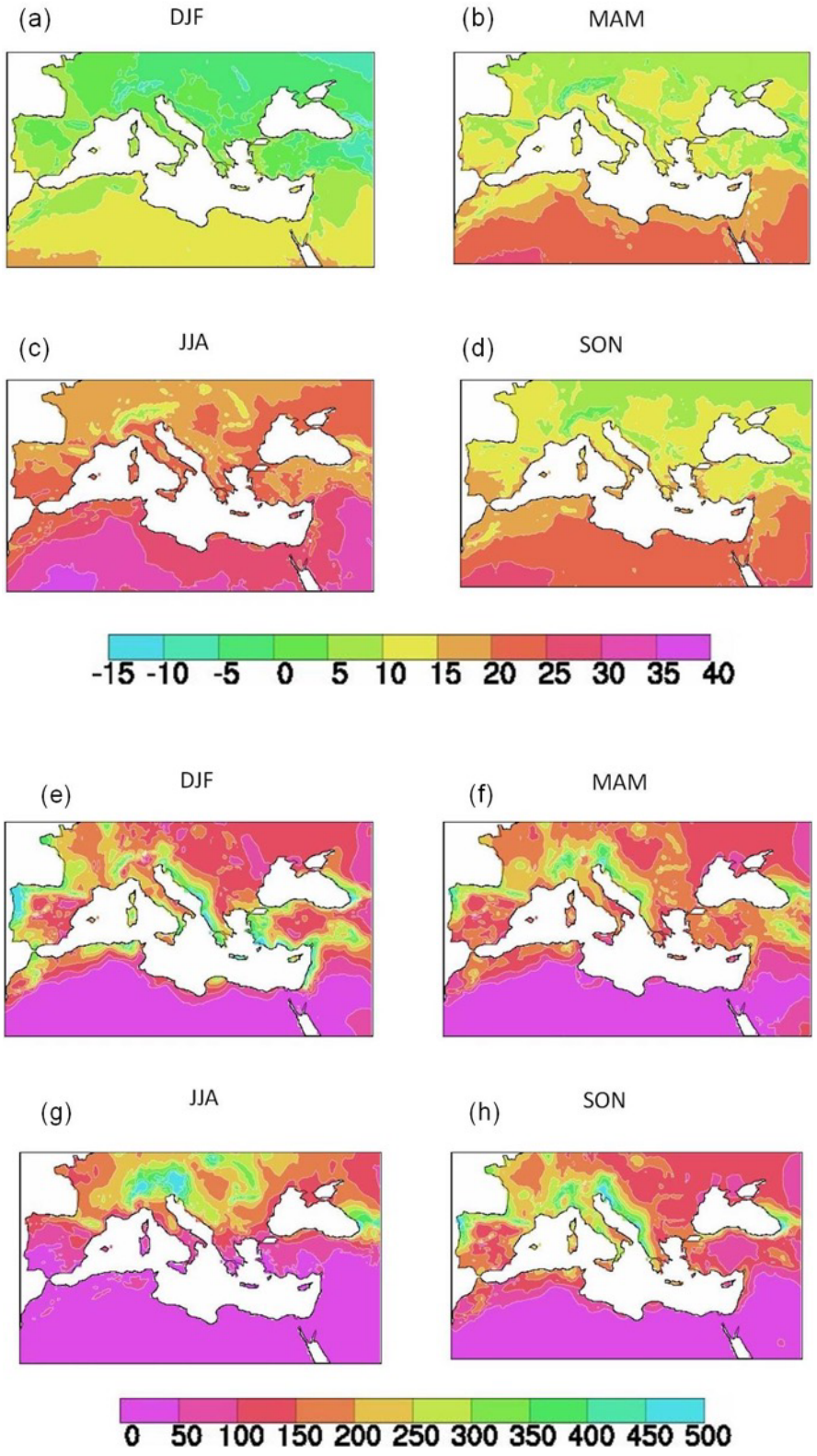

Figure 1 - Seasonal (winter: Dec-Jan-Feb, spring: Mar-Apr-May, summer: Jun-Jul-Aug, autumn: Sep-Oct-Nov) maps of temperature (oC, panels a-d) and precipitation (mm/season, panels e-h) for the period 1961-1990 based on the CRU data (from Lionello et al. 2012)

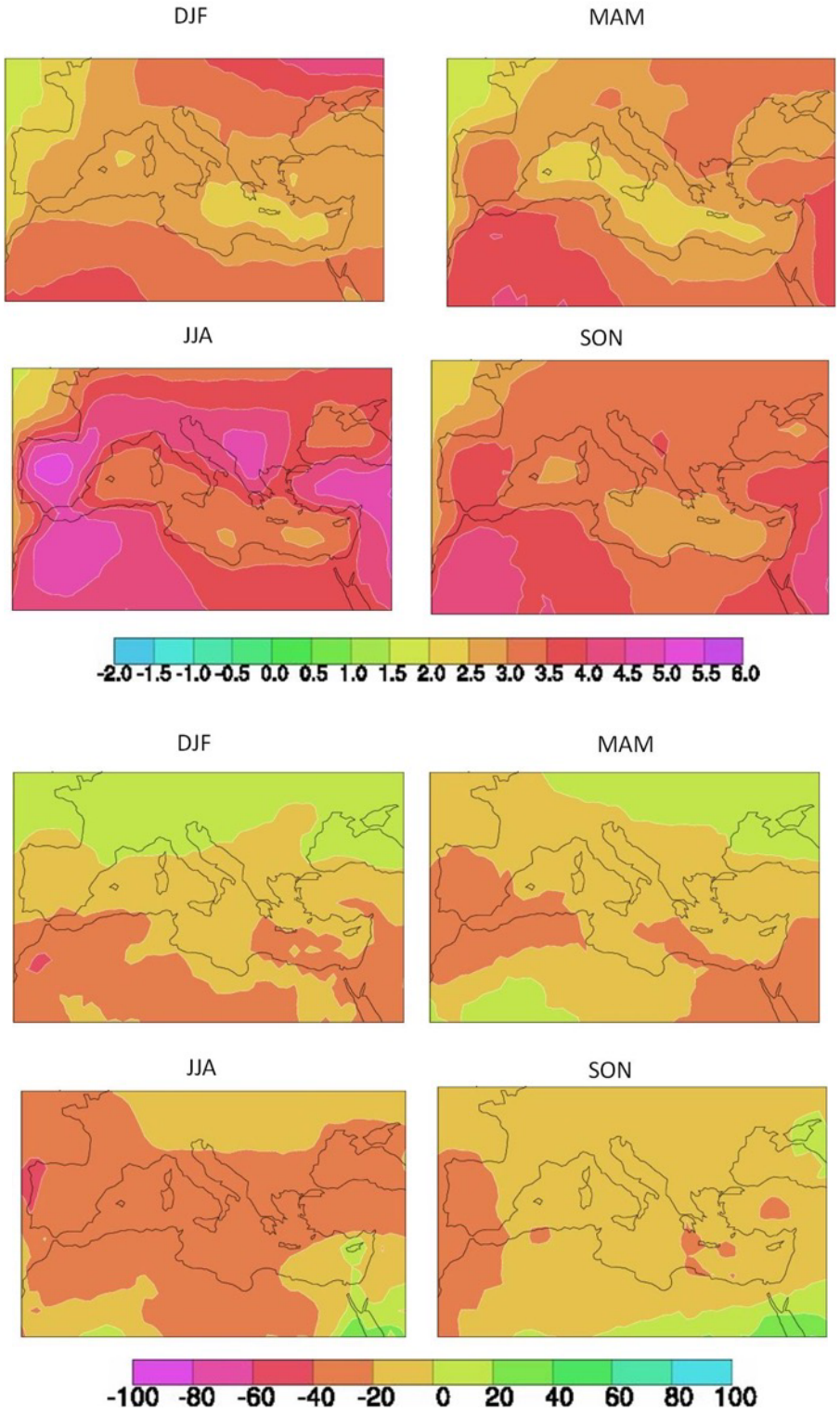

Figure 2 - Seasonal (DJF, MAM, JJA, SON) map of temperature (oC, top panels) and precipitation signal (percent of the value in the reference period, bottom panels) climate change as resulting from an ensemble of GCMs. The maps show the differences between the 2071-2100 period of the A1B scenario and the reference period 1961-1990 (adapted from Giorgi and Lionello, 2008, in Lionello et al., 2012).

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IPCC, 2013. Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 1535 pp.

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PAETH H., VOGT G., PAXIAN A., HERTIG E., SEUBERT S., JACOBEIT J., 2016. Quantifying the evidence of climate change in the light of uncertainty exemplified by the Mediterranean hot spot region. Global and Planetary Change, http://dx.doi.org/10.1016/j.gloplacha.2016.03.003.

Planton S., Lionello P., Artale V., Aznar R., Carrillo A., Colin J., Congedi L., Dubois C., Elizalde A., Gualdi S., Hertig E., Jacobeit J., Jordà G., Li L., Mariotti A., Piani C., Ruti P., Sanchez-Gomez E., Sannino G., Sevault F., Somot S., Tsimplis M., 2012. The Climate of the Mediterranean Region in Future Climate Projections, In: P. Lionello, Editor(s), The Climate of the Mediterranean Region, Elsevier, Oxford, 2012, Pages 449-502, ISBN 9780124160422, 10.1016/B978-0-12-416042-2.00008-2.

Ulbrich U., Lionello P., Belušić D., Jacobeit J., Knippert P., Kuglitsch F.G., Leckebusch G.C., Luterbacher J., Maugeri M., Maheras P., Nissen K. M. , Pavan V., Pinto J. G., Saaroni H., Seubert S., Toreti A., Xoplaki E., Ziv B., 2012. Climate of the Mediterranean : synoptic patterns, temperature, precipitation, winds, and their extremes , In: P. Lionello, Editor(s), The Climate of the Mediterranean Region, Elsevier, Oxford, 2012, Pages 301-346, ISBN 9780124160422, 10.1016/B978-0-12-416042-2.00005-7.

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EDUCATION

1994
Masters in engineering, Ecole Centrale de Lille, Lille , France
Masters in meteorology, oceanography and environment, Université Pierre et Maire Curie, Paris, France
1998
PhD in physics on "Retrieval of atmospheric flow with Doppler lidars: first application", Ecole Polytechnique, France

CAREER

2001: Junior researcher at CNRS affilated to the Service d'Aéronomie research unit
2007-present: Research director at CNRS and associate professor at Ecole Polytechnique (lecture on meteorology and renewable energy), affiliated at the Laboratoire de Météorologie Dynamique research unit
2010-present: Coordinator of the HyMeX international program (Hydrological cycle in the Mediterranean experiment; www.hymex.org)
2015-present: Coordinator of the TREND-X and MISTIGRID research program on the energy transition at Ecole Polytechnique and Paris-Scalay University
2016-2018: Director of the Laboratoire de Météorologie Dynamique research unit

RESEARCH INTERESTS

Atmospheric boundary layer meteorology
Variability and evolution of the Mediterranean climate
Renewable energy and energy transition

PUBLICATIONS AND SERVICES

Author of more than 130 chapters and articles.
Drobinski et al. (2014) HyMeX, a 10-year Multidisciplinary Program on the Mediterranean Water Cycle. Bull. Amer. Meteorol. Soc., 95, 1063-1082
Drobinski P., 2012: Wind and Solar Renewable Energy Potential Resources Estimation, in Solar Energy Conversion and Photoenergy Systems. Encyclopedia of Life Support Systems, EOLSS Publishers, Oxford,UK, [http://www.eolss.net]

AWARDS AND HONORS

CNRS scientific excellence prize (2010, 2014)

WATER CYCLE EXTREMES IN THE MEDITERRANEAN IN A CONTEXT OF CLIMATE CHANGE

Philippe Drobinski
Ecole Polytechnique, Palaiseau, France

The countries around the Mediterranean basin face water problems, including water shortages and floods, that can impact food availability, cause epidemics, and threaten life and infrastructures. These problems are due to a combination of inadequate planning and management policies and of poor capability to predict hydrometeorological and climatic hazards (poor understanding of the processes and poor capability to model them). Indeed, the Mediterranean basin has quite a unique character that results from both physiographic and climatic conditions and historical and societal developments. Because of the latitudes it covers, the Mediterranean basin is a transition area under the influence of both midlatitudes and tropical climate variability. The complex geography of the region, which features a nearly enclosed sea with high sea surface temperature during summer and fall, surrounded by very urbanized littorals and mountains from which numerous rivers originate (Figure 1), plays a crucial role in steering airflow. The Mediterranean Sea acts as a moisture and heat source for the atmosphere through air–sea fluxes, so that energetic mesoscale features are present in the atmospheric circulation, which can evolve to high-impact weather systems, such as heavy precipitation and flash flooding, or heat waves and droughts.

Because it is in such a transition area, the Mediterranean basin is very sensitive to global climate change. Recent periods, several authors have reported an increase of the mean annual temperature of about 0.005°C yr–1, reaching in summer the value of 0.01°C yr–1 for 1976–2000, one of the highest rates over the entire globe, and a decrease in annual precipitation with different seasonal trends. On contrary, the precipitation extremes seem to increase in some regions of the Mediterranean basin at a rate of about few percents per decades. Regarding the future projection of the climate in an anthropogenic scenario, the observed trends are also projected in future climate scenarios. Figure 2 shows a map of a regional climate change index computed over 26 land regions. The index is defined based on the change in regional mean surface air temperature relative to the global average temperature change (or regional warming amplification factor), the change in mean regional precipitation, the change in regional surface air temperature interannual variability, and change in regional precipitation interannual variability. One of the two most prominent hot-spots emerging from the regional climate change index analysis is the Mediterranean, with a strong warming and drying for 2080–99 compared with 1980–99, a large decrease in mean precipitation and an increase in precipitation variability during the dry (warm) season. This summer drying signal, which makes the Mediterranean one of the most responsive regions to global change, has been consistently observed in different generations of model projections. In this context, the exposure of the Mediterranean population may increase dramatically not only because events conducive to floods and droughts may become more frequent but also because the demographic projections from the Mediterranean Action Plan suggest an increase of about 22.6% until 2025.

The lecture provides an overview of the water cycle extremes, especially precipitation extremes and droughts, with a specific insight of the observed change and a discussion on the projected trends.

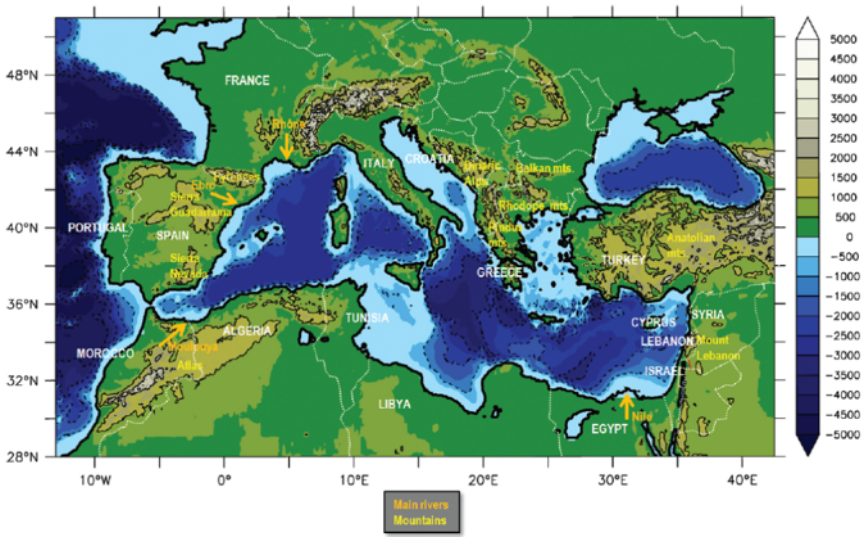

Figure 1. Mediterranean basin. Source: from Drobinski et al., 2014.

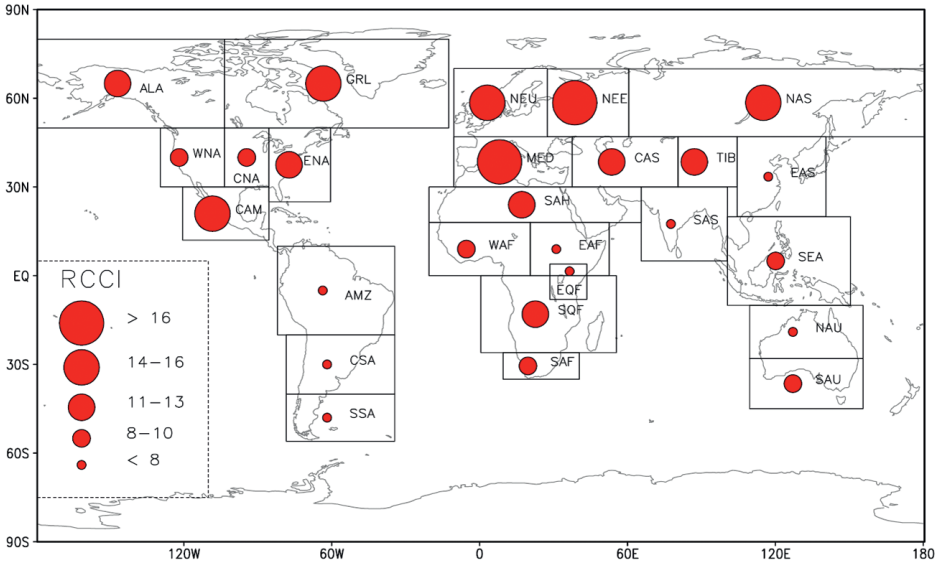

Figure 2: Regional Climate Change Index (RCCI) over 26 land regions of the World calculated from 20 global climate models and 3 IPCC emission scenarios. The bigger the red disk, the largest the regional sensitivity to climate change. Source: from Giorgi (2006).

Basic References:

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Klein Tank, A. M. G., and G. P. Können, 2003: Trends in indices of daily temperature and precipitation extremes in Europe, 1946–99. J. Climate, 16, 3665–3680

Marco **ANZIDEI**

Istituto Nazionale di Geofisica e Vulcanologia, Rome, Italy

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EDUCATION

Degree in Geology, PhD in Geophysics

CAREER

Senior Researcher at the Istituto Nazionale di Geofisica e Vulcanologia since 1987.
Held contract professorships at the University of Calabria (Italy), at the University of Tunis, (Tunisia) and at the Ecole Normale Superieure, Paris (France).

RESEARCH INTERESTS

Crustal deformations in seismic and volcanic areas. Relative sea level changes and maritime archaeological indicators in the Mediterranean region. Sea level rise and flooding scenarios.

PUBLICATIONS AND SERVICES

2004-2007 Head of the INGV Unit Geodesy and GPS Networks;
2014-2017 Head of the INGV Research Line 6 Environment, Safety and Land - coastal subsidence
For publications: https://scholar.google.it/citations?user=JMZSDIEAAAAJ&hl=it
https://www.researchgate.net/profile/Marco_Anzidei

AWARDS AND HONORS

Awards in science Communication: 2012 - Pelagos Communication; 2011 - Docscient Festival

SUGGESTED READINGS (WEB RESOURSES OR SCIENTIFIC JOURNAL PAPERS)

Anzidei, M., Lambeck, K., Antonioli, F., Furlani, S., Mastronuzzi, G., Serpelloni, E. and Vannucci, G., 2014b. Coastal structure, sea-level changes and vertical motion of the land in the Mediterranean. Geol. Soc. London. Spec. Publ., 388, pp. 453–479. http://dx.doi.org/10.1144/SP388.20

INGV Photo Gallery https://www.flickr.com/photos/ingv/
Online multimedia videos (in Italian and English):
Sea level changes in the Mediterranean (2005, multimedia, 27 min)
https://www.sperimentarea.tv/ondemand/il-cambiamento-del-livello-del-mare-nel-mediterraneo-negli-ultimi-2000-anni-un-viaggio-nel-tempo-tra-geologia-archeologia-e-geofisica
Active Mediterranean (2007, multimedia, 57 min)
https://www.sperimentarea.tv/ondemand/mediterraneo-attivo

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The Australian National University, Canberra, Australia
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EDUCATION
D.Phil, DSc. Oxford

CAREER
Professor of Geophyics at the Australian National University since 1977. Before that worked at research institutes in The Netherlands, Greece. USA. France. Held visiting professorships in The Netherlands, France, Sweden, Switzerland and elsewhere

RESEARCH INTERESTS
The physics of the Earth, including the interactions between oceans and atmosphere with the solid Earth. Sea level change and glacial history. Archaeological implications.

PUBLICATIONS AND SERVICES
Director of Research School of Earth Sciences at ANU.
President of the Australian Academy of Science.

AWARDS AND HONORS
Order of Australia; l'Ordre Nationale de la Legion d'Honneur France; Ordine al Merito della Repubblica Italiana

SUGGESTED READINGS (WEB RESOURSES OR SCIENTIFIC JOURNAL PAPERS)
Lambeck, K., 2014. Of Moon and Land, Ice and Strand: Sea Level during Glacial Cycles. The Annual Balzan Lecture, 5, pp 13-54, Leo S. Olschki, Florence.

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Lambeck, K., Antonioli, F., Purcell, A. and Silenzi, S., 2004. Sea-level change along the Italian coast for the past 10,000 yr. Quaternary Science Reviews, 23, 1567-1598, doi:10.1016/j.quascirev.2004.02.009.
Lambeck, K., 1996. Sea-level change and shore-line evolution in Aegean Greece since Upper Palaeolithic time. Antiquity , 70, 588-611.

SEA LEVEL CHANGES IN THE MEDITERRANEAN: CAUSES AND CONSEQUENCES

[1]Kurt Lambeck and [2]Marco Anzidei
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The Earth is a very dynamic body, ever changing over a very broad range of time and length scales, driven by internal geological forces, by surface processes and by external forces. The result is a constant change in landscapes, both on long and catastrophic time scales. The Mediterranean basin is no exception to this with a history that began around 250 million years ago and only after millions of years of plate movements did it approach its present configuration, influenced by the collision of the African and European plates This evolution continues today, with its expression of earthquake and volcanic activities and modulated by the changes wrought by changing climates. For geologists these changes offer the possibility of understanding the underlying processes and of building up forecasting models; for humans these processes provide rejuvenated soils, the origin of myths and legends, exciting recreation areas, and the challenges of living with change. One particular change that will be discussed here is that of sea level, perhaps most dramatically illustrated by a period known as the Messinian Salinity Crisis about 5.5 million years ago when the sea was almost completely desiccated. Less dramatic, but more consequential on human time scales, are the quasi-cyclic changes associated with the glacial cycles during which at times of glaciation large areas of the present sea floor were exposed and land bridges formed. These provided a rich environment for early human movements and settlements around the Mediterranean, only to be inundated when the ice sheets melted once more. The last such flooding started about 20,000 years go, accelerated after about 15,000 years go and approached the present-day configuration about 7000 to 6000 years ago. In some areas shorelines shifted by kilometres during a human's lifetime and it should be no wonder that mythologies are littered with man's struggle with the sea. The pattern of this change in time and space is quite complex because of the interactions between the ice sheets, the oceans and the more solid earth. Scientifically this pattern is important for it provides observational evidence that can be used to understand the glacial cycles themselves, the manner in which the earth responds to the glacial cycle, and the basis for quantifying rates of land uplift and subsidence. Once these are understood it becomes possible to develop predictive models of past change and its impacts on past peoples who built coastal cities, ports and fish tanks, whose remains are found today submerged or uplifted along many coasts and witness the past events. We recall that the Mediterranean has experienced several large natural disasters during the past millennia. Examples include the Bronze Age Santorini eruption and that of Vesuvius in 79 A.D, and very large earthquakes and tsunamis in Crete in 365 and Messina in 1908; events that modified coastal landscapes and changed the history of the human settlements. The documentary Active Mediterranean aims to tell in a simple way and through modern video communications systems some key stories of the Mediterranean to make people aware of the environment they live in.

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EDUCATION and CAREER

Professor Nikolaos Michalopoulos (NM) was born in Piraeus-Greece in 1961 and graduated from the Department of Chemistry of the University of Athens (1984). He obtained a master's degree in Chemistry of Air Pollution and Environmental Physics from the University of Paris (Paris 7; 1985), and a PhD degree from the same University (1989) as a scholar of the State Scholarship Foundation (IKY). He worked as a postdoctoral researcher at Physicalische Chemie, Bergische Universität, Wuppertal, Germany (1989-1991) with a scholarship from EU (Marie-Curie) and at the Centre des Faibles Radioactivités, CNRS, France (1991). In 1993, after completing his military duties, NM was elected as Assistant Professor at the University of Crete, in 1999 promoted to the rank of Associate Professor and in 2003 as Full Professor in Environmental Chemistry. Since 2013 he is the director of the Institute for Environmental Research and Sustainable Development (IERSD) of the National Observatory of Athens (NOA). He has been a visiting professor at the University of Sapporo in Japan, and the Max-Planck Institute of Chemistry in Germany.

RESEARCH INTERESTS

His areas of Expertise are Observational Atmospheric Chemistry and Physics, Global Biogeochemical Cycles, Chemical Kinetics, Environmental Analytical Chemistry. His research team (Crete and Athens) is running since 1993 the WMO/EMEP/ACTRIS/ICOS regional station of Finokalia atmospheric monitoring station in Crete and since 2012 the Athens monitoring stations at the NOA locations at Penteli (IERSD) and Thession (NOA headquarters) investigating factors controlling gaseous and particulate pollutants levels in the Eastern Mediterranean and their impacts on air quality, human health and climate.

PUBLICATIONS AND SERVICES

NM participated in more than 45 research programs (in 30 as coordinator) funded by European and National agencies and acted as a member of the Organizing and Scientific Committee in 15 National and International Conferences. NM has published 230 original papers in peer reviewed scientific journals (one in Nature, one in Science) and more than 500 papers in international conferences (8500 citations, h-index = 50). NM has taught undergraduate and postgraduate courses in Greek universities and research centers abroad and has supervised 13 PhD theses, 32 Master Theses and over 60 Diploma works. He is a member of the editorial board of EGU's Atmospheric Chemistry and Physics Journal (Copernicus Publications, Impact Factor: 5.6), editor of one book and six special issues and active reviewer in 30 international journals. He has been a reviewer of PhD and Habilitation Theses for foreign universities and reviewer of scientific proposals for EU, NATO and funding organizations in Greece, Germany, Switzerland, Israel, France, Germany, US and UK.

AWARDS AND HONORS

National Greek State fellowship (1985-1988); European Union postdoctoral fellowship (1989-1990); Haagen-Smit Award (2014) and Ecopolis award (2016).

ATMOSPHERIC POLLUTION IN THE MEDITERRANEAN: SOURCES AND IMPACT ON AIR QUALITY, HEALTH AND CLIMATE

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The Mediterranean region is a climatically sensitive region, which as a consequence of its unique location is often exposed to multiple stresses, such as a simultaneous water shortage and air pollution exposure (IPCC, 2013).

The region is divided into three basins due to significant changes from west to the east and from north to south. The Western Basin extends from the Iberian Peninsula to the Apennine mountain chain in the west-east direction, and from southern France to the northern African coast in the north–south direction. The Central Basin at the north includes the watershed of the Adriatic Sea from the Apennines to the Balkans, and at the south the Ionic Sea from the east coast of Tunisia, south of Sicily, across the Libyan Gulf, to the west of Crete. The Eastern Basin extends eastwards to the Israeli and Lebanon coasts and includes the Aegean Sea (Millán et al, 2002).

The Mediterranean region is characterized by its unique climatic conditions known as Mediterranean climate. The region is characterized mainly by the strong pressure gradient between the two anchor systems: the high pressure system over the North Atlantic and the low pressure one over the Indian Ocean and Middle East. This pressure gradient drives the North to South flow during all seasons that is further enhanced by differential heating between the Mediterranean Sea and the surrounding lands (Kallos et al., 1998; Millán et. al., 1997). There is a great concern that this climatic pattern will be distorted by the global climate change with impacts related to enhancement of extreme events (e.g. heat waves, intense cyclogenesis) and water budget.

The Mediterranean is also considered as an air pollution hotspot, located at a crossroad of air masses coming from Europe, America, Asia and Africa. Pollutants in form of gases and aerosols of various origins can be encountered within the basin; desert dust transported mainly from the Sahara desert, pollutants emitted by urban and industrial activities over continental Europe, biomass burning aerosols and gases often produced by seasonal forest fires, bioaerosols, marine aerosols and ship emissions originated from the highly busy shipping routes of the Mediterranean Sea. Finally, the transport of anthropogenic pollutants from America and Asia also exerts a significant influence in the chemical composition of the free troposphere (Lelieveld et al., 2002).

During the last decades, the Mediterranean basin has experienced a rapid growth in urbanization, shipping activities, vehicle number and use and industrialization that have been reflected in pollutant emissions to the atmosphere. Urban environments have received special attention for their high air pollutant concentrations and the resulting degradation of the air quality and public health (Kanakidou et al., 2011). Note that several cities with pollution exceeding 1 million of

inhabitants as well as two megacities: Cairo (>15 million) and Istanbul (>12 million) are located in the Mediterranean.

Pollution in this region has been thus extremely high in the last decades and is likely to grow in the future due to the rapid urbanization of the region despite the air quality limits established by the EU to protect human health that are often exceeded. The general climatic conditions in the Mediterranean such as the low precipitation rate, the high radiation intensity and the high temperature favor the accumulation of air pollutants, photochemical reactions and the formation of secondary pollutants, including secondary aerosols. Ozone and aerosol air quality limits are often exceeded over the entire Mediterranean. High ozone and aerosol concentrations are harmful for human health and ecosystems, and they also cause agricultural crop loss and climate change. In addition, in contrast to Central and Northern Europe, in Southern Europe / Mediterranean region, photochemical episodes that favor air pollution can also occur during winter since at these latitudes solar radiation is still important. Finally, the high emissions from fuel-oil combustion, mainly from shipping in the region generate high concentrations of trace elements in the Mediterranean compared to central Europe areas.

Furthermore, the contribution of natural emissions to these exceedances seems significant and remains to be determined. In particular, mineral dust transport from northern Africa, with frequent African dust episodes, significantly impacts air quality mainly in southern European cities. Such dust episodes that can cause PM10 >500 μg m-3 on a daily mean, similarly to those observed in highly polluted Asian cities, are annually recorded in the eastern Mediterranean. These strong increases of mineral dust concentration may lead to serious health impacts and exceedances of air quality standards imposed by the European Community.

The above described sources and multi-scale transport and transformation of gaseous pollutants and aerosols in the area, together with the regional meteorology that is also causing vertical interlayering and stratification of pollutants, significantly impact air quality, human health and Mediterranean climate. The impact of ozone and aerosols on the incoming solar radiation, visibility and the photodissociation rates of pollutants has been identified over the Mediterranean. Heating of the atmosphere mainly by absorption of solar radiation by black carbon increases the atmospheric stability affecting the energy budget of the Mediterranean region with possible effects on the ocean circulation, biochemical cycling of both terrestrial and oceanic ecosystems and rainfall.

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EDUCATION

1992-1997 PhD University of Barcelona, Spain; 1985-1990 B.A., Biology, University of Barcelona, Spain

CAREER

2008-present Senior researcher Spanish Research Council; 2002-2008 Senior researcher Centre National Recherche Scientifique at Centre d'Océanologie de Marseille (France); 2000-2002 Marie Curie Fellow at Centre d'Océanologie de Marseille (France); 1998-2000 Postdoctoral fellow at University of Maryland (USA)

RESEARCH INTERESTS

Dr. Joaquim Garrabou is applying a multidisciplinary approach to the study of global change effects (climate change, invasive species, overfishing) in the conservation of Mediterranean marine biodiversity. In this framework he devoted most of his career in analyzing the role of Marine Protected Areas as tools to counteract the negative effects of human activities. Dr. Garrabou has been also especially active in developing collaborative initiatives to cope with large scales and long-term series unavoidable for the study of global change effects. As main milestones of these initiatives he participated in promoting networks of observation of current warming trend in the Mediterranean mainly supported by MPA's managers (www.t-mednet.org) and with the help of volunteers (www.seawatchers.org) in collaboration with international organizations United Nations Environmental program (UNEP-MAP), International Union for Nature Conservation (IUCN) and Marine Protected Areas Managers Network (MEDPAN). The ultimate objective of his research is raise awareness on the health status of our oceans and to the transfer of knowledge to the society and more specially to the MPA managers to contribute in the effectiveness of management and conservation plans. To date he published over 100 scientific peer-reviewed papers and reports, participated in over 100 communications in scientific research conferences.

PUBLICATIONS AND SERVICES

Linares C, Vidal M, Canals M, Kersting DK, Amblass D, Aspillaga E, Cebrián E, Delgado-Huertas D, Díaz D, Garrabou J, Hereu B, Navarro L, Teixidó N, Ballesteros E. (2015). Persistent natural acidification drives major distribution shifts in marine benthic ecosystems. Proceedings of the Royal Society B, Doi: 10.1098/rspb.2015.0587

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MEDITERRANEAN MARINE BIODIVERSITY: AN ENDANGERED TREASURE

Joaquim Garrabou
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The Mediterranean Sea is considered a hot spot for marine biodiversity since with less than 1% of ocean surface host more than 17000 described species contributing to about 7% to the ocean's biodiversity with a high proportion of endemisms (species that are only found in the Mediterranean)(Bianchi & Morri 2000, Coll et al. 2010). In this presentation, I will present the biological richness of the Mediterranean Sea from shallow coastal habitats to deep sea with special focus on hard bottom habitats (Fig 1).

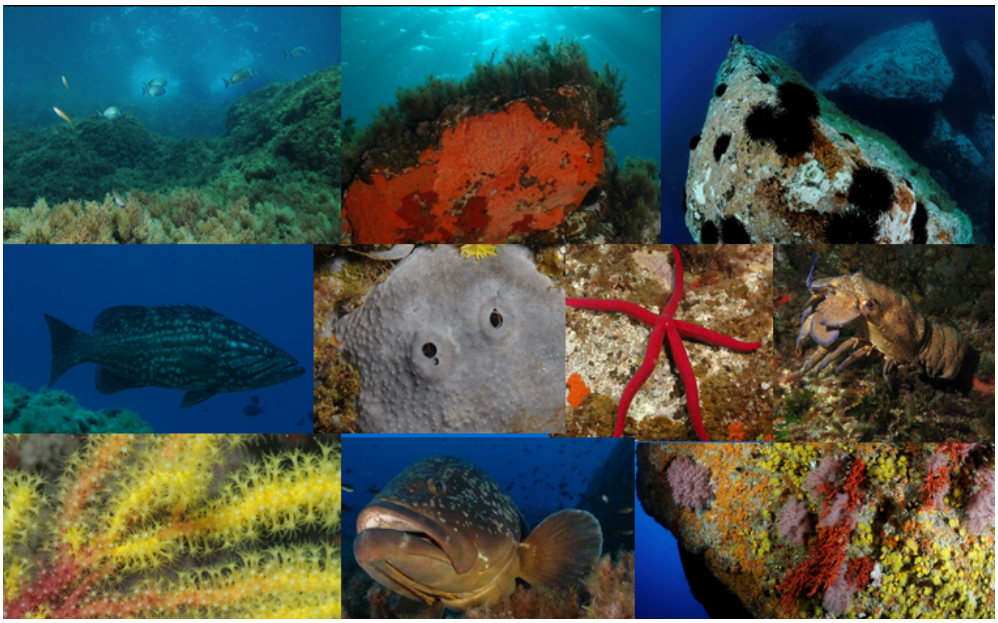

Figure 1. Some examples of the species richness of the Mediterranean marine biodiversity (macroalgal forest, invertebrates –sponges, corals, seastars, decapoda- and fishes.

The Mediterranean Sea witnesses the development of our civilization's during thousands of years. The footprint of the human activities is undeniable and it is expected to continue in the next decades (Coll et al. 2010). A historical sequence of impacts from overfishing, pollution, mechanical habitat destruction, introduction of alien species till the most recent effects of climate change have been reported. These human pressures are affecting numerous species and habitats which are supporting essential ecosystem services from which our societies benefit. For instance, the arrival of alien species from the Red Sea through the Suez Canal is causing major shifts in fisheries and dramatic changes in the marine communities (from macroalgal forests to barren grounds) in the Eastern basin (Sala et al. 2011) (Fig. 2). The colonization of these tropical species benefit from the current warming of the Mediterranean (Macias et al. 2013). Likewise, the warming has been associated with the increase of mass mortality events of marine organisms during the last decades in the Mediterranean (Garrabou et al. 2009, Rivetti et al. 2014, Marba et al. 2015). These events are unprecedented because affected a large number of species (>30 including corals, sponges and molluks) and large geographical scale (thousands of kilometres of coastlines) (Garrabou et al. 2009). These mortalities are equivalent to fire-forests in terrestrial ecosystems and they are deeply modifying the marine seascapes.

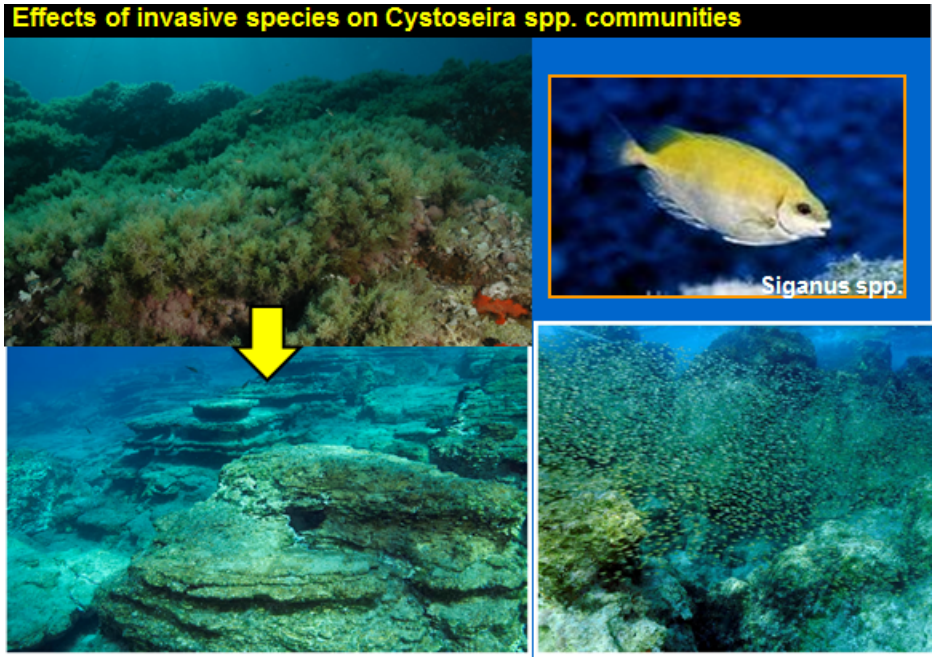

Figure 2. Effects of the colonization of invasive rabbit fishes species Siganus spp. on macroalgal forests in the Eastern Mediterranean (from Sala et al. 2011).

Finally, in the presentation we explore the solutions for guiding management actions towards the conservation of Mediterranean biodiversity. In marine conservation the establishement of marine protected areas (MPAs) are the major flagship to support the conservation of the natural heritage of the Mediterranean. Marine Protected Areas demonstrated their effectiveness to counteract some of the effects of human activities. The diversity, abundance and size of fish and invertebrate species are larger inside the MPAs (Linares et al. 2012, Garcia-Rubies et al. 2013). In this context, under different international conventions, most Mediterranean countries have committed to establish national and regional systems of protected areas covering at least 10% of the Mediterranean Sea by 2020. However, at present protected surface only cover about 6% and besides it is not ecologically representative. In conclusion, bearing in mind its geographic position and oceanographic features as well as the intense human pressures for thousands of years, the Mediterranean Sea is an excellent model to anticipate the consequences of human activities in the oceans worldwide as well as laboratory to test solutions and best practices for marine biodiversity conservation.

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After his Master Degree in Electrical Engineering at the University of Rome La Sapienza, he was hired in 1990 at the Operation Center of the European Space Agency in Germany (ESA/ESOC) in the area of mission analysis and orbit control manoeuvre optimization. He then moved to precise orbit determination and to orbit and attitude control and continued his career at ESA/ESTEC in The Netherlands.

He moved to Toulouse, France, in 1997, where he got a Post-graduate Master in Applied Remote Sensing and Image Processing followed by a PhD on the subject of optical-radar remote sensing for the monitoring of surface deformation (University of Toulouse Paul Sabatier). In France, he was first employed by CESBIO (1998) and later by CNES (1999-2001), working as a Project Manager for the International Charter on Space and Major Disasters, conducting R&D activities for remote sensing applications to disaster management and natural risk monitoring, interferometric monitoring of several seismic areas and providing training courses in Earth Observation.

After a short period at Italian Space Agency (2001) as a technical interface ASICNES for the cooperation COSMO-SkyMed / Pléiades, he joined ESA/ESRIN, in Italy, working in Earth Observation applications; since 2007, he coordinates the Education and Training Activities in Earth Observation. In his spare time (unfortunately not much) he enjoys painting, playing piano and open-air sport like swimming and kayaking.

THE MEDITERRANEAN REGION OBSERVED FROM SPACE: EXAMPLES OF SATELLITE DATA APPLICATIONS

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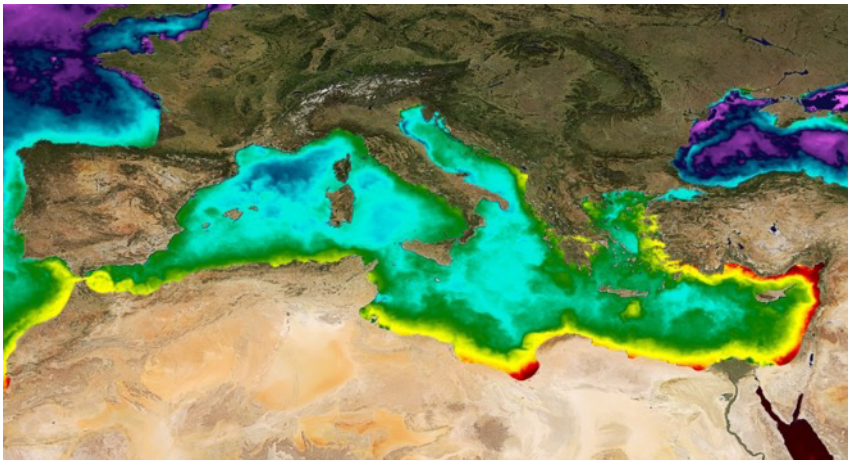
Through its Earth Observation (EO) Programme, ESA undertakes a wide variety of projects related to the application of EO for the monitoring of land, ocean, atmosphere and solid earth from space. Most of our dedicated satellites are placed in a polar orbit, thus acquiring data worldwide, allowing to monitor the whole planet. This was the case of the European radar satellites ERS-1 and -2 (launched in the 90's), followed by the huge satellite ENVISAT, carrying a number of different sensors for a variety of applications (launched in 2002 and operated till 2012), presently followed by the operational family of the SENTINEL satellites, carrying radar and super-spectral sensors for land, ocean and atmospheric monitoring.

Despite the capability to observe and monitor the entire planet, Europe and the Mediterranean are monitored with special attention: a large number of different applications have been already demonstrated, including products and services that have now reached operational maturity and are part of the Copernicus programme of the European Commission. Several observations from space have been selected also as important climate variables of relevance to the Climate Change Initiative.

Examples of applications that have been tested and demonstrated, of particular interest for the Mediterranean region, include: land and vegetation monitoring (forest mapping, deforestation, burnt areas, crop monitoring, agricultural management, biomass estimation, wetlands, land cover, soil moisture, urban monitoring), marine applications (ship detection, oil spills, sea surface temperature, altimetry and sea surface height, currents and waves, wind), atmospheric monitoring (air quality, greenhouse gases), seismic and volcanic monitoring, subsidence monitoring, geodesy, natural hazards.

Several examples gathered during over two decades in the Mediterranean region will be shown, including Europe and North Africa, such as the Greek fires, air quality monitoring in critical urban environments, Etna eruptions, Campi Flegrei deformation, vegetation over the Nile delta, archaeological applications.

Many more examples where different events and phenomena have been mapped and analysed using satellite data have been used in order to create computer exercises for secondary schools teachers, using a free educational software developed and distributed by ESA in the frame of its multilingual web project Eduspace (http://www.esa.int/SPECIALS/Eduspace_EN/).



Sea Surface Temperature over the Mediterranean measured from space

Geological pathway
from Maria Theresia's Monument
to St. Stephen's Cathedral
26th April 2017, 14.00 – 15.30