

NAVARINO
ENVIRONMENTAL
OBSERVATORY

ANNUAL REPORT

2015



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Foreword

Stockholm May 2015

A handwritten signature in blue ink, appearing to read 'Stefan Nordlund', is centered on the page. The signature is fluid and cursive, with the first name 'Stefan' written in a larger, more prominent script than the last name 'Nordlund'.

Stefan Nordlund
Chairman of NEO Steering Committee

1. Introduction

Navarino Environmental Observatory (NEO), cooperation between Stockholm University, the Academy of Athens and TEMES S.A., is dedicated to research and education on the climate and environment of the Mediterranean region. Located at Costa Navarino, Messinia, Greece, NEO is a dynamic hub where scientists from all over the world conduct frontline research, develop new tools and methods, as well as meet to exchange knowledge and ideas.

The Mediterranean area faces considerable environmental and climate challenges in coming decades. In addition to the long-standing problems of marine, atmospheric and terrestrial pollution, the ongoing climate change is predicted to lead to significant changes in this part of the world. Particularly the Ionian and Aegean Seas have been described as the crossroads of transboundary transport of air pollutants and atmospheric aerosols, which have an important effect on the radiation balance of the region and therefore influence climate change. The ongoing climate change is predicted to lead to higher summer temperatures and an increase in drought events as well as in the frequency of forest wild fires. All this will significantly affect the environment and human societies.

The research taking place at NEO is orientated towards these future challenges. Multi-disciplinary research is conducted within relevant research fields, such as: i) atmospheric composition and climate changes, ii) geology, geomorphology and landscape changes, and iii) climate, water and environmental changes. The atmospheric composition and meteorological parameters are continuously monitored in order to track the origin of pollutants and detect climate change signals. Global and regional scale modelling is applied for climate projections and future pollution level simulations. Hydrological research, monitoring and evaluation are undertaken in order to understand past, present and future processes and to develop suitable water resource management strategies for the region. Tectonic, climate, environment and landscape studies are carried out in a long-term perspective, to understand the physical science basis of our earth. Specific further goals are to understand the role of natural versus human induced climate/environmental changes and to analyse the role of physical factors in the context of tourism and urbanism. All monitoring activities are linked to international networks.

In addition to the research taking place at NEO, emphasis is given to the education and training of students and young researchers. For this reason special courses and excursions are made in the field, training workshops are organized, and postgraduate and PhD students are involved in NEO research activities.

2. Partners

Stockholm University with the Bolin Centre for Climate research

Stockholm University, located in the capital of Sweden, is a major northern European university and carries out research and education within the natural and social sciences, the humanities and law. Stockholm University is the largest university in Sweden and one of the largest employers in the capital.

The Bolin Centre for Climate research at Stockholm University is a pioneering institute within the field of climate and environmental research. The late Bert Bolin, professor at Stockholm University, was the leading force behind the establishment of the UN Intergovernmental Panel on Climate Change (IPCC), which was awarded the Nobel Peace Prize in 2007. The centre carries on Bolin's heritage by conducting fundamental research on critical processes in the climate system.

More information: www.su.se , <http://www.bolin.su.se/>

Academy of Athens

The Centre of Environmental Health and Biophysics of the Biomedical Research Foundation of the Academy of Athens has been involved in pioneering research on ozone, chemistry-radiation interactions and global change during the past decades. The Biomedical Research Foundation is a non-profit institution, established by the Academy of Athens, which traces its name to the 3rd century BC Plato's Academy; it therefore brings the heritage of the first Academy on Earth. The Centre has participated in all WMO/UNEP Ozone Assessments and in numerous competitive international research projects and campaigns.

More information: www.academyofathens.gr <http://www.bioacademy.gr/?lang=gr>

TEMES SA

TEMES S.A. (Tourist Enterprise of Messinia) is a premier developer of luxury mixed-use resorts in the Mediterranean region. Costa Navarino in Messinia is its flagship development. At the heart of the company's business philosophy is its strong commitment to environmental and social responsibility with the aim of achieving sustainable tourism development in complete harmony with the natural environment and traditions of the destination.

More information: www.costanavarino.com

3. Research

3.1 Atmospheric composition and climate changes

Research description

The main objective of the atmospheric and climate research programme of NEO is to study atmospheric composition in the area of western Peloponnese with focus on air quality, atmospheric radiation perturbations and links to the origin of air masses and meteorology. Using the observations at Methoni station the aim is to identify important sources of atmospheric aerosol and trace gases influencing regional air quality and climate in the Eastern Mediterranean. The results provide important data sets to be used in regional and global climate models and in validation of satellite-based remote sensing observations.

Research activities 2014

The activities during 2014 have focused on running the continuous observations and evaluating the results obtained so far. It seems that the new location of the instrument setup (i.e. Methoni) is influenced by the same type of sources as at Costa Navarino, at least for January-February, which is a good indicator that also previous location in the library tower at Costa Navarino captured the more large scale features of flow conditions and source profiles.



Figure 1: NEO Atmospheric Lab at Methoni HNMS premises.

At NEO there are two local dominating wind directions, WSW to WNW and NNE to E, only interrupted by occasional SSE winds (figure 2). The wind directions depend on the general wind flow superimposed by the land-sea breeze giving a daily steady breeze from the sea changing into a very slow wind from the inland of Messina during nighttime.

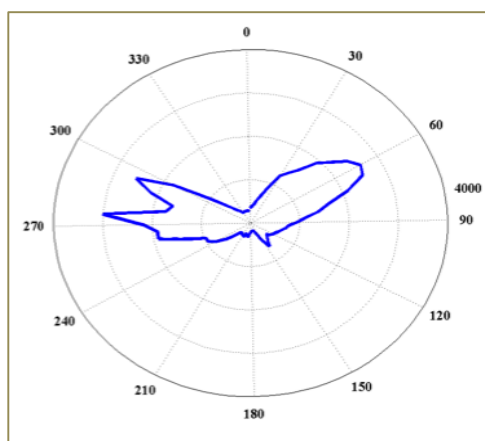


Figure 2. The local wind directions during the period , April 2011 to October 2013.

The land–sea breeze will bring the emissions from the inland during the day out to sea to mix with the general flow often coming from the north along the Adriatic sea giving a mixture of long distance transported air pollutants with emission along the coast of Croatia and Greece. The mixed air returns during the night carrying the mixed long range and more recent emissions. However during the shift there is no wind causing the very local emission to accumulate and dominate the observed air pollutant concentrations. The sea-land breeze with periods of no wind causes a strong influence of the local emissions.

Following the daily variations of total number of particles show that high concentrations occur in the morning and during the evening (figure 3). This is concurrent with low wind speed and shift in wind direction. In between the concentrations are quite stable and thus considered representative for a larger region.

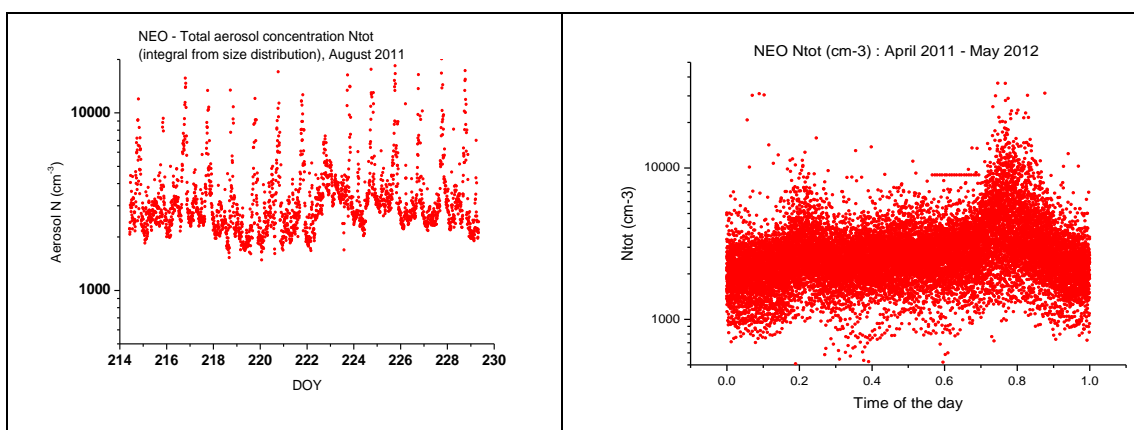


Figure 3. The left panel shows the how the total number of particles varies over the month of August 2011. The right panel shows the diurnal variation of the total number of particles during the first year of measurements.

There is a distinct difference when comparing the seasonal distributions, where the summer distribution is unimodal while the winter and autumn distributions show bi-modal distributions, typical of influence of cloud processing. The aerosol during the warm period is typical of an aged aerosol with strong gas-to-particle transformation due to atmospheric gas phase reactions forming compounds condensing on the particles. The cold period aerosol shows clear signs of cloud activity and precipitation acting on a polluted aerosol.

Planned activities for 2015

During 2015 the plan is to:

1. After service and redesign of the aerosol microphysical set up (aerosol number density, size distribution and absorption), the instrumentation will be installed and measurements started again at Methoni during spring 2015
2. Continuation of long-term measurements

3.2 Geology

Research description

The aims of NEO geological research are 1) to further our quantitative understanding of the role of mountain building as a controlling factor of Earth's climate, and 2) to estimate how often earthquakes occur on active faults in Peloponnese.

Research activities in 2014

How does mountain building control Earth's climate?

On geological timescales, mountain building is a major factor controlling Earth's climate. Chemical weathering of the silicate minerals that comprise mountains, removes CO₂ from the atmosphere, reducing the greenhouse effect. The extreme pressure and temperature in the core of a mountain belt causes metamorphism: rocks are transformed to accommodate the extreme pressures and temperatures. During this metamorphic transformation, CO₂ is released and enters a mobile fluid phase which flows upwards bringing metamorphic CO₂ to Earth's surface. This increases the greenhouse effect. Unraveling these competing processes is the aim of this study.

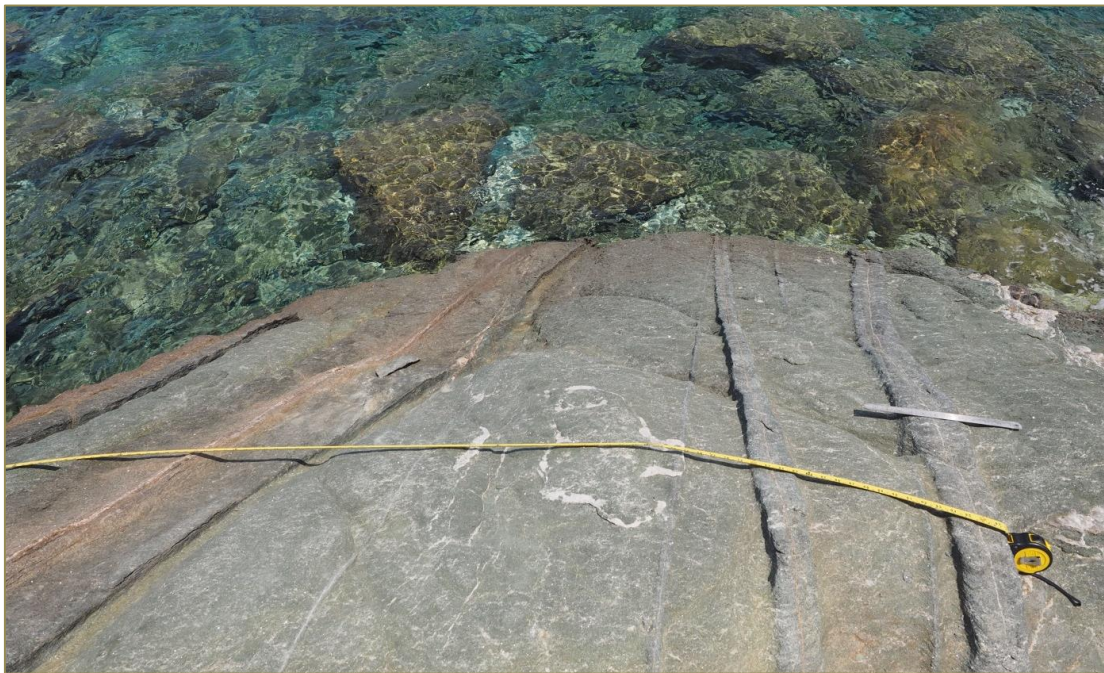


Figure 4: Ancient fluid flow channels, Syros, Greece

This study was undertaken on Syros, where we calculated a flux for carbon along a fault during mountain building of $110\text{--}450 \text{ mol CO}_2\text{.m}^{-2}\text{.yr}^{-1}$. This estimate is based on reactive transport modeling of the preservation of a carbonated blueschist facies (high pressure – low temperature) mineral assemblage adjacent to a fault at greenschist facies (low pressure – low temperature) conditions. This carbon flux can be compared with the carbon flux we calculated for the surrounding rocks: $0.4 \text{ mol CO}_2\text{.m}^{-2}\text{.yr}^{-1}$. Both carbon fluxes exceeds the drawdown flux for CO₂ due to silicate weathering in mountains ($0.02\text{--}0.2 \text{ mol CO}_2\text{.m}^{-2}\text{.yr}^{-1}$; Huh, 2010), but carbon fluxes are localized in

time and space. This study is part of a PhD study conducted by Barbara Kleine, who is partly funded by NEO.

How often do earthquakes occur on active faults in Peloponnese?

Previous studies have used chlorine isotopes (e.g. Benedetti et al., 2003) and rock chemistry (e.g. Carcaillet et al., 2008) on exhumed fault scarps to calculate how often earthquakes occur (earthquake periodicity) and how far a fault moves during an earthquake (fault slip), which in turn gives information about the magnitude of the earthquake. This was the initially purpose of our study. However, we discovered that variations of rock chemistry and probably also chlorine isotope ratios are actually controlled by an uneven distribution of fault gouge (crushed rock along the fault plane produced by earthquakes), which builds up behind asperities (protrusions of rock on a fault surface, which break during an earthquake).



Figure 5: The fault scarp at Gerolimenas

This means that previous studies must be challenged and chemical and isotopic data from fault scarps can be used to study the rupturing process during an earthquake. This study is a licentiate project conducted by Ruben Fritzon.

Planned activities for 2015

During 2015 the plan is:

1. Barbara Kleine will defend her PhD thesis April 28, 2015.
2. Ruben Fritzon will give his licentiate exam June 2, 2015.
3. Fieldwork on the role of mountain building as a controlling factor of Earth's climate will be continued by Professors Alasdair Skelton and Uwe Ring.
4. Fieldwork on how often earthquake occur on active faults in Peloponnese will be continued by Professors Alasdair Skelton, Arjen Stroeven and Uwe Ring, Dr. Bradley Goodfellow and Prof. Mark Caffey (Purdue University).

3.3 Geomorphology and landscape changes

Research description

Geomorphological evolution in Greece during the Late Quaternary is affected by large-amplitude climatic swings and uplift/subsidence related to large-scale tectonism resulting in forcing of the geomorphological evolution that is both area-specific and highly variable over time. A deeper understanding of the current geomorphology and its evolution therefore requires a framework regarding the spatial patterns and more detailed nature of first-order drivers and the second-order controls on geomorphic evolution.

Research activities in 2014

The focus during the year was on analysing, and writing up results from fieldwork as well as map and remote sensing studies of Peloponnese landforms. Two undergraduate reports on the ravine systems in Messinia were presented at Stockholm University in the spring.

In September NEO researchers Johan Kleman and Ingmar Borgström, together with station manager Giorgos Maneas, ascended the Prophet Elias, the highest point of the Taygetos Mts and Peloponnese. The visit is part of an ongoing research project on the long-term tectonic and geomorphologic evolution of the Taygetos Mountains and the Mani Peninsula. Targets for the fieldwork investigation was an ancient high elevation valley immediately north of the summit and the large north-facing glacial cirque (steep valleyhead), which contains numerous moraines built by glaciers that existed 15 – 20 000 years ago.



Figure 6: NEO researchers Johan Kleman and Ingmar Borgström enjoying the view from Taygetos summit (2 407 m).

During the year, a manuscript, aimed to be submitted to *Zeitschrift für Geomorphologie*, was worked out. The article is a comprehensive analysis of the tectonic and climatic events that have shaped the Taygetos Mountains and the Mani Peninsula during the last three million years. It also brings together the geomorphological research with the tectonics research led by prof. Alasdair Skelton.

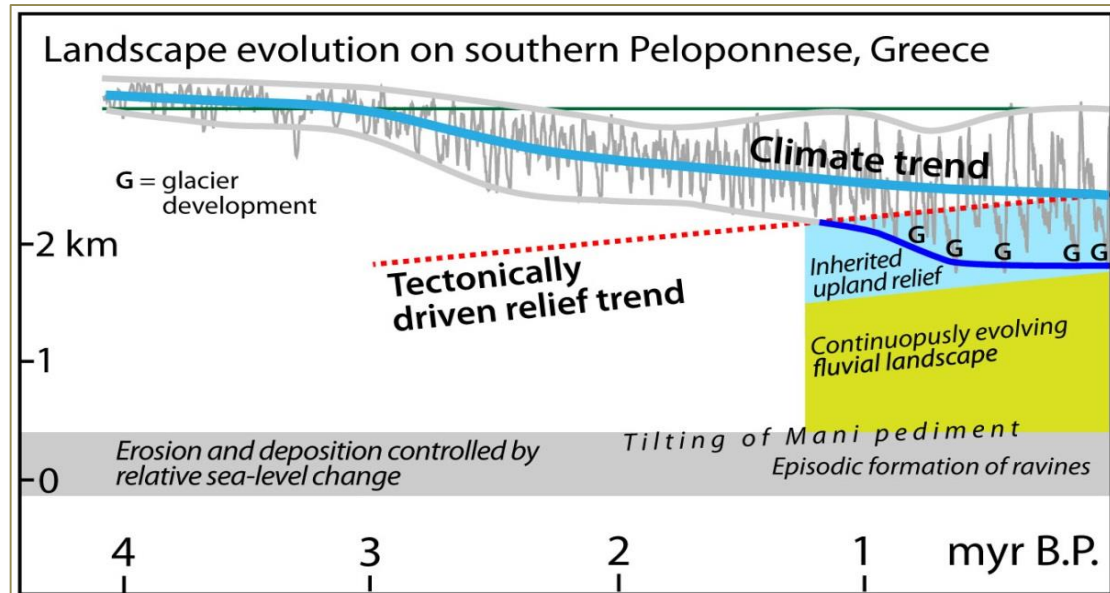


Figure 7: Landscape evolution on southern Peloponnese, Greece

Planned activities for 2015

During 2015 the plan is to:

1. Submit a paper to *Zeitschrift für Geomorphologie*
2. Organise and implement fieldwork in the Taygetos mountains in September

3.4 Water research

Research description

We carry out research on hydrology and water resources in the Mediterranean region. A main aim is to understand and quantify the development and changes occurring from past through present to future hydro-climatic conditions in the region. A second main aim is to assess and evaluate management practices and strategies for regional water resources in view of the past, ongoing and expected future hydro-climatic changes.

Research activities in 2014

In 2014, [Mazi \(2014\)](#) completed the first NEO PhD thesis, considering multiple change pressures on water resources, and particularly losses of coastal groundwater resources due to increased seawater intrusion driven by changes in climate, sea level and water conditions in the landscape. Such groundwater losses may be critical for many people living in the commonly densely populated coastal regions. It is therefore important to assess the risks and the dominant controls associated with seawater intrusion, in order to enable safe use of coastal groundwater under coupled human-natural and spatiotemporally variable forcing conditions.

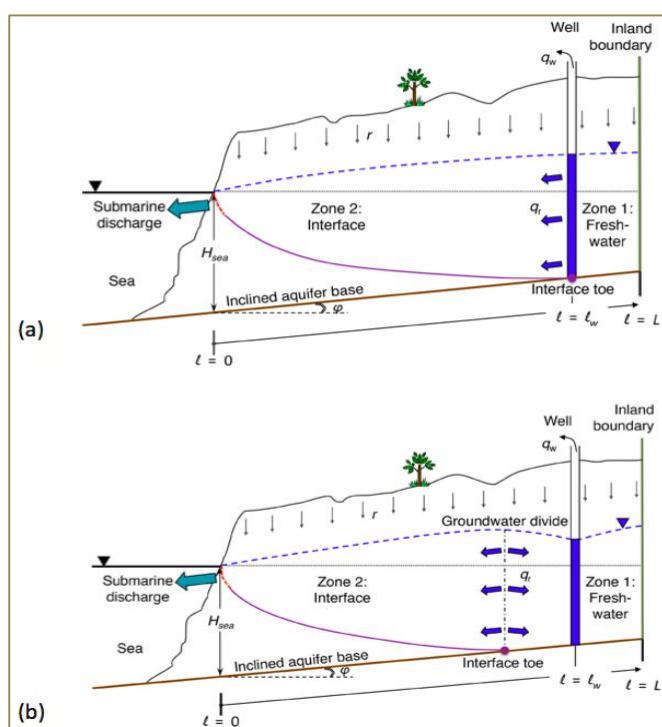
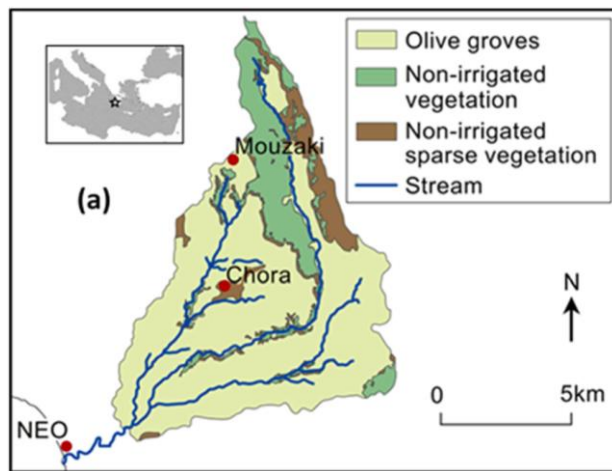


Figure 8. Critical limits of seawater intrusion: (a) intrusion into pumping wells, and (b) complete aquifer intrusion. *Source:* [Mazi \(2014\)](#).

As part of the thesis, which was also published as a separate study in 2014 ([Mazi et al., 2014](#)), seawater intrusion was site-specifically investigated for three prominent Mediterranean aquifers, subject to intensive exploitation and modified hydrologic regimes by human activities: the Nile Delta, Israel Coastal and Cyprus Akrotiri

aquifers. The study reviewed the salinization history and current status of these aquifers, and quantified their resilience and vulnerability to current and future seawater intrusion forcing. The results showed that: (a) intruding seawater currently seriously threatens the Nile Delta aquifer, (b) in the Israel Coastal aquifer the seawater intrusion approaches pumping wells, and (c) the Cyprus Akrotiri aquifer is currently somewhat less threatened by increased seawater intrusion than the other investigated aquifer cases.

In another study of regional hydro-climatic changes, Klein et al., (2014) conducted scenario analysis to explore the impacts of climate and land-water management changes, using an 89-km² catchment near the Navarino Environmental Observatory (NEO) as a regionally representative case study (Figure 9). The objective was here to quantify potential impacts on groundwater storage and stream flow in the catchment.



To achieve this, a relatively simple hydrological model was calibrated to 3 years of available data (2009–2011) and used to explore the following: (1) impacts of climate change (specifically, IPCC projections for 2071–2100), (2) impacts of land-water management changes associated with expansion of tourism activities (specifically, the addition of irrigated golf courses), and (3) the combined impact of both climate and land-water management changes.

Figure 9. Site map of the investigated Sellas catchment (a) and its location in Greece (insert). *Source:* Klein et al. (2014).

The model results indicated potential vulnerability of water resources to future climate change, which could, for example, reduce stream flow between 33 and 97 % of current annual flows, depending on the scenario considered. Future land-water management change could also reduce stream flow (even under current climate conditions) by around 5 %. Clearly, the latter effect would be exacerbated by expected future climate changes. These results highlight the importance of environmental monitoring, which is part of the mission of the NEO, to inform management and planning in this and other Mediterranean regions.

Planned activities for 2015

The plans for 2015 are to continue research on the long-term, past and future, hydro-climatic changes in Greece. Specifically for future changes, we will assess the implications for hydro-climate in Greece of the IPCC multi-model ensemble of the Coupled Model Intercomparison Project Phase 5 (CMIP5). This synthesizes the latest research in global climate modeling, which we use for investigating the climate projection implications for freshwater changes across different world regions, including Greece as a key regional node.

3.5 Tree-ring research

Research description

This research makes use of annual rings in trees to study past changes in the climate. The project is assembling new tree-ring records from different parts of Greece with the goal to cover the last c. 1,000 years and add to the international network of tree-ring data for the larger Mediterranean. The overarching aim is to improve our understanding of climate change in this region.

Tree rings may also be used to study and precisely date extreme environmental disturbances in the past, such as the effects of explosive volcanism. A second aim is therefore to explore novel methods to trace and quantify such events in the physical and chemical properties of tree rings. The results will extend our knowledge of the timing and magnitude of these events in the past..

Major research activities 2014

A 1,500-year long tree-ring chronology was finalized in 2014 based on data collected in the high Pindos Mountains of Greece during previous three years of fieldwork. This is currently the longest, single provenance, tree-ring chronology from the Mediterranean and a detailed description and analysis of the data will be published as part of Paul Krusic's PhD thesis in 2015. Novel methods for climate response validation and climate reconstruction have been developed by Paul Krusic using other available tree-ring data (Krusic et al, in press).

The European Mediterranean region is governed by a characteristic climate of summer drought that is likely to increase in duration and intensity under predicted climate change. The new data produced for Greece fills a gap in the international network of tree-ring data and allow this region to be part of large-scale analyses. During 2014, Paul Krusic took part in an international research effort to reconstruct past drought over Europe and the Mediterranean (Cook et al. in review) (Fig. 10).

Paul Krusic also took part an investigation on the spatial aspects of drought variability across the Mediterranean that identified a distinct East-West climate dipole that has been in operation during the last 700 years (Seim et al. 2014). He was also part of studies on: the 19th century summer cooling in Central Europe (Buentgen et al. in revision); a large-scale analysis of past drought over Europe and the Mediterranean Basin (Buntgen et al. in press), and an analysis of Northern Hemisphere hydroclimate patterns over the last 12 centuries (Ljungqvist et al. in review). Håkan Grudd was involved in a study of the effect of drought on high-elevation Iberian pines (Galvan et al. 2015), and an analysis of the spatial variability and temporal trends in water-use efficiency of European forests (Saurer et al. 2014).

In 2014 we included Greek samples in a large international project that aims at independent dating of events, such as volcanic eruptions, using extraterrestrial signatures of radiocarbon pulses (Buentgen et al. 2014). Specifically, the ^{14}C to ^{12}C isotopic ratios will be measured in dendrochronologically dated wood samples from 770-780 and from 990-1000 CE to detect and to describe the putative global signature of the extraterrestrial 775 and 994 radiocarbon pulses.

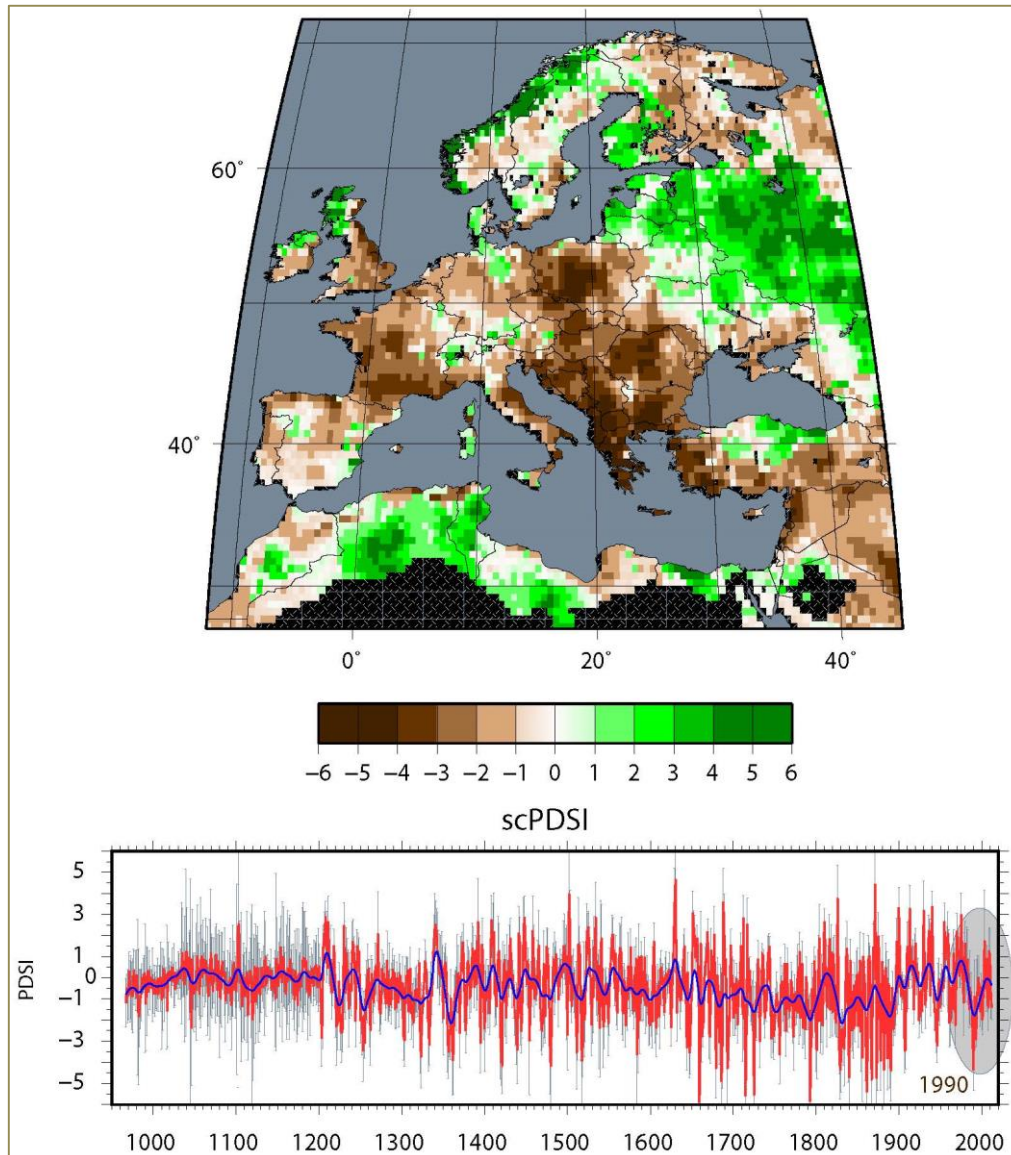


Figure 10. Tree-ring reconstructed drought (from Cock et al., in review Science). The units are Palmer Drought Severity Index (PDSI). The upper panel shows the reconstructed spatial pattern for the year 1990. The lower panel shows the reconstructed drought record for all Greece All Greece, average PDSI from 976-2012.

Planned activities for 2015

The plans for 2015 are to:

1. Finalize the PhD thesis by Paul Krusic. The thesis will include the above mentioned paper describing the 1 500-year Greek record; the methods paper (Krusic et al. in press); the and the paper on Northern Hemisphere hydroclimate patterns over the last 12 centuries (Ljungqvist et al. in review); along with a paper on the Northern Hemisphere temperature patterns in the last 12 centuries (Ljungqvist et al. 2012).
2. Continue collaborative research on identifying signatures of past volcanic eruptions in the physical and chemical properties of tree rings.

3.6 Cave speleothems and wetland sediments

Research description

The focus of this research is to understand past climate and environmental variability, flooding events and sea-level history, using cave speleothems and sediments from wetlands in Messinia, Lakonia and Arcadia. The caves of Peloponnese provide opportunities to study the co-evolution of climatic, environmental and cultural changes in a historical perspective, going back to Bronze Age civilizations and beyond. Multi-proxy analyses of speleothems and lake sediments reveal changes in regional sea levels, precipitation, temperature and vegetation in the past. Combining results from analyses of speleothems and lake sediments will help us distinguishing between the human role versus climate factors behind observed changes in vegetation.

Major research activities 2014

Martin Finné defended his PhD thesis in November (Finné 2014). The results from the studies of speleothems in Kapsia Cave were published in the international scientific journals (Finné et al. 2014, Finné et al. 2015). Karin Holmgren and Martin Finné participated in a research application led by Erika Weiberg, Department of Archaeology and Ancient History Uppsala University, entitled *Domesticated landscapes of the Peloponnese: Social-environmental dynamics from the Final Neolithic to the Roman era (4000 BCE-300 CE)*. The application was approved with 10 MSEK over the 4-year period 2015-2018. Martin Finné will thus continue the research on climate and environment in the Peloponnese in his 4-years post-doc position at Uppsala University.



Figure 11. Meighan Boyd coming out from a narrow opening in Alepotrypa cave

PhD student Meighan Boyd has continued her studies on stalagmites from Alepotrypa Cave. To date a total of five field visits have been conducted under the supervision of Dr. Panagiotis Karkanas of the Ephorate of Paleoanthropology and Speleology and

the collaboration with the archaeological research team is firmly established. With each visit, measurements of temperature, humidity, and CO₂ levels were taken, and dripping water collected at multiple sites within the cave. This provides a baseline of present day cave environment which may be compared to modern environmental conditions and weather data. A number of stalagmites are currently being analysed for paleoclimatic reconstruction. The stalagmites cover the time periods circa 68 000 – 17 000 years ago (including periods of stop in growth) and circa 6 000 – 1 100 years ago. There is evidence of sooty organic material in the stalagmites, which will give insights into which elements humans were adding to the cave air which may reveal the materials used in various tasks. The first results of the study have been summarized in a book chapter ‘Alepotrypa Cave in the Mani, Greece: A festschrift to honor Dr. G. Papathanasopoulos on the occasion of his 90th birthday’. eds. A. Papathanasiou, M. Galaty, P. Karkanis, W. Parkinson και D. Pullen, Oxbow Books

In 2014 PhD student Christos Katrantsiotis was recruited. He aims to reconstruct Holocene environmental and climate changes in one of the richest agricultural and most densely populated areas of the ancient Greek world. Apart from his supervisors at Stockholm University he collaborates with Dr Katarina Kouli, University of Athens, Dr Pavlos Avramides, University of Patras and Dr Nikos Zacharias, University of the Peloponnese. The first diatom-based paleo-environmental record from Greece (Katrantsiotis, submitted), of sediments from Agios Floros, shows the existence of a former water body which underwent fluctuations from marshy to deep water conditions and open water environments over the last 6000 years. The group now continues with pollen analysis of the Agios Floros sediment and on multiproxy-analyses on sediment cores retrieved from Gialova Lagoon.



Figure 12. Christos Katrantsiotis, Pavlos Avramidis and Jan Risberg during fieldwork in Gialova

Planned activities for 2015

During 2015 several papers will be submitted as the result of the three PhD studies and the workshop held in April 2014. We will continue with field work in wetlands and caves, perform analysis of retrieved material and disseminate the results at conferences and in publications.

4. Education

4.1 Courses

Bachelor level course in Physical Geography and Quaternary Geology, Stockholm University, 7-13 March, 2014

The fourth Physical Geography course at NEO took place on March 7–13. Sara Cousins, Ingmar Borgström, Martin Finné and Uwe Ring were the instructors of the field course and 35 students from Stockholm University attended the course. During the excursion they visited a number of sites mainly in Messinia. Among them are the Gialova/Navarino Bay area, Artemisia, Verga, Loussios River, Kapsia Cave, Mesochori, Methoni and Finikounda (Fig. 14). The students studied different subjects e.g. tectonics, geomorphology, land use changes, erosion and deposition, forest fires, biodiversity and hydrological processes. The different localities represent different types of environments e.g. coasts, mountains and plains, placing the subjects in different context for the students. In the Gialova area and in Loussios River students worked in smaller groups with projects providing them with basic field work skills for example measuring distance, elevation and slope angles. In the Loussios River the projects involved the study of water discharge and water chemistry. In Gialova students worked with sand dune morphology, water chemistry, land use changes and bird diversity.



Figure 13: Stockholm University students during the 4th Student Field Course at NEO, drawing landscapes next to Artemisia village on Taygetos Mountains.

Master students' course in Plant biodiversity and evolution,

Stockholm University, 3-10 May, 2014

The third Masters course "Plant Biodiversity and evolution - a global perspective", took place at NEO. Catarina Rydin was the instructor of the field course. During the excursion, the students visited a number of sites mainly in Messinia. Among them are the Gialova/Navarino Bay area, Taygetos mountains, Polylimnio and the surroundings of NEO. Moreover, the students met with Andrianna Lappa owner at the soap factory 'Naked King' in Gialova and got a demonstration on how herbs are used for soap production (Fig. 15).



Figure 14: Students and teachers from Stockholm University during a soap making demonstration at 'Naked King' soap factory in Gialova.

Plant diversity and evolution is a course at the master level, given by Stockholm University. During 10 weeks, students explore plant diversity in time and space. One week is spent in Messinia, Greece, and this week is a central part of the course. The students study the diversity of the area, and this knowledge forms the basis of minor individual research project conducted by the students when back in Stockholm.

Bachelor students' course in Biology and Earth sciences,

Stockholm University, 10-17 May, 2014

A group of students from the Biology-Earth science programme, Department of Physical Geography and Quaternary Geology, carried out field work for their Bachelor degree thesis at NEO! The students dealt with different projects on biodiversity, nature conservation, ecosystems services and ecotourism and were supervised by Bo Eknert, Christina Schaffer, Maria Damberg and Giorgos Maneas.

After the field work in Greece, the students wrote and presented their reports in a seminar at Stockholm University June 19.

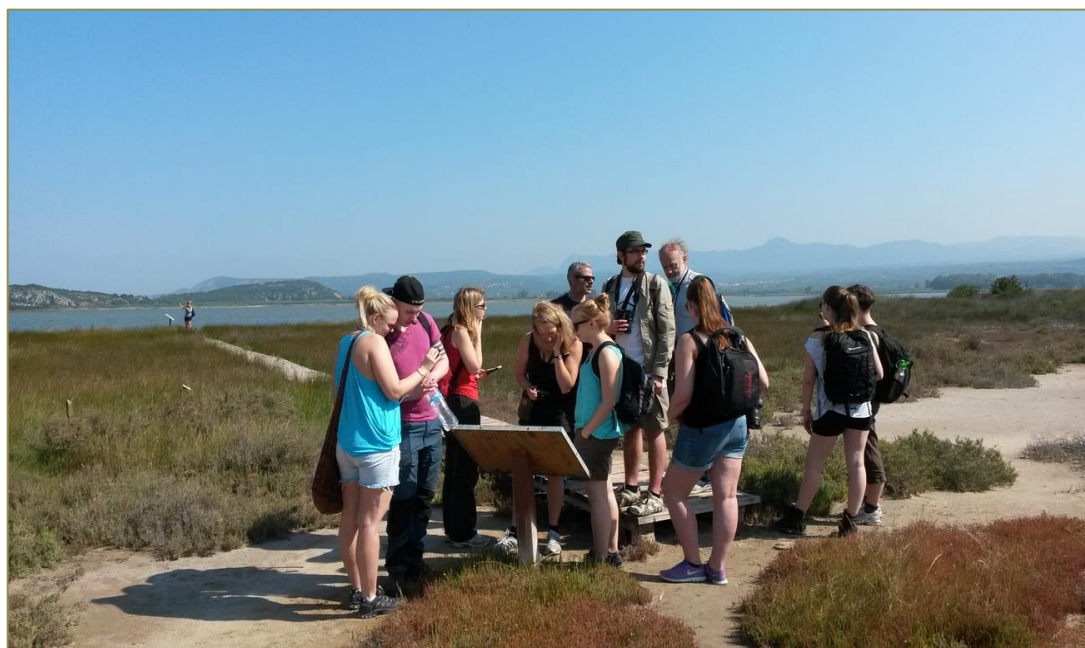


Figure 15: Students and teachers from Stockholm University during the Biology-Earth course in Gialova

This course has been made possible through a generous economic contribution from ‘Captain Vassilis Foundation’.

Master students’ course in Climate, Climate Change Impacts: Greece,

Justus-Liebig University of Giessen, 26-30 September, 2014

In the frame of the project-course "Climate, Climate Change Impacts: Greece", BSc, MSc students and postdoctoral researchers of the Department of Geography at the Justus-Liebig University of Giessen, Germany, visited NEO from 26-30 September 2014. This was the second visit of the partner group to NEO and has being established in the Geography studies curriculum. The project course is aiming at providing interdisciplinary knowledge on the climate of Greece and the Eastern Mediterranean, volcanism and impacts on climate and societies, the Mediterranean Sea circulation, palaeoproxies, climate reconstruction and methodologies, impacts of climate variability and change on ecosystems, hydrology and water resources, atmospheric monitoring, archaeology, plant eco-physiology. The project consists of three interrelated parts, theoretical, methodological and a field excursion. The students prepare a scientific report combining knowledge acquired from the theory and methods and knowledge obtained during the excursion. The group of geographers visited the sites of Gialova lagoon, Paleokastro and Archaia Messini, the Taygetos Mountain and the Polilimio site under the guidance of Mr. Giorgos Maneas.



Figure 16: Students and teachers from the Justus-Liebig University of Giessen, Germany

Students' course in Natural disasters from natural and social science perspectives,

Värmdö Gymnasium, Upper secondary school, Stockholm 4-11 October, 2014

As part of a one semester Natural Science Specialization course a group of students from Värmdö Gymnasium, visited NEO. This was the second time students from this school visited NEO.



Figure 17: Student and teachers from Värmdö Gymnasium, Stockholm

The specialization course is aimed at third year students attending the natural science programme with a global perspective, and the course theme is “*Natural disasters from a natural- and social science perspective*”. The visit to NEO was highly appreciated, and the week included visits to geological, biological as well as historical sights of interest. The purpose of the week was to give the students more understanding of how the landscape is shaped through geological processes and what effect these processes have on biological systems.

PhD students' course

Stockholm University, 25-31 October 2014

A group of PhD students from Stockholm University has visited NEO for field studies. Together with Dr. Christophe Dupraz, they went to Gialova lagoon and checked the lagoon's biogeochemistry. Prof. Uwe Ring led an excursion to an exposed fault scarp near the city of Sparta. The fault is the probable site of the 464 BC earthquakes that ruined Sparta. A hunt for fossils, in rocky outcrops and in the limestone building material of the Paleokastro Castle was led by Dr. Otto Hermelin. On the last day, the group visited the Hellenic Centre for Marine Research (HCMR) - where Dr. Alexandra Gogou, led interesting discussions on the marine environment, and gave a tour around the different labs at the HCMR.



Figure 18: PhD Students in Gialova lagoon after microbial mats.

Interdisciplinary Masters course in Water management issues from a social science and management perspective,

Stockholm University, Swedish Institute at Athens, Linköping University, University of Uppsala, 20-27 November 2014

The question of water quality and quantity in urban and rural areas was studied with a focus on Greece, including examples of sustainable water usage and exploitation over

time. During their visit at NEO, the students followed several lectures and also organized and implemented a series of interviews with farmers, fishermen, locals, representatives from the Water Management agency of Pylos, the Captain Vassilis Foundation and associates from the Costa Navarino resort in order to deal with different aspects of water related issues for settlements and water management. This master course is one of the courses within a broader university programme for internationalization developed by Swedish universities and the Swedish Institutes around the Mediterranean. (For more details see www.usinetwork.se.)



Figure 19: Students taking the path from Palaiokastro back to Gialova lagoon.

Bachelor students' course in Air Pollution

Physics Department, University of Patras, 10-11 December 2014

The 4th year students of the Physics Department, University of Patras that followed the course on "Atmospheric Pollution" had the chance to visit NEO at Pylos, Greece and received a 2-days training course on air pollution. They visited the air pollution station at Methoni, followed lectures about the air pollution characteristics of the area, the measurement methodologies, the quality control and assurance procedures of the station instrumentation and delivered projects based on the air pollution and meteorological measurements at NEO. In addition to the above mentioned, Myrto Gratsea, PhD student at the National Observatory of Athens (NOA), gave a lecture about remote sensing technics (MAX-DOAS & MFR).



Figure 20: Happy students in front of NEO building

4.2 Internships

For the period May – June 2014 Giorgos Kosmopoulos - student at the Physics department, University of Patras - implemented his internship at NEO on ‘Validation of solar radiation estimations at NEO’. Moreover, Giorgos participated in the day-to-day activities concerning the running of the NEO station such as collecting data at the new measurement location at Methoni and providing assistance to researchers and students visiting NEO.

4.3 Navarino Natura Hall

Astronomy

"Astronomy nights" is an interactive experience at Costa Navarino organized by the NEO, where visitors are introduced to the stars and the constellations of the night sky and they become the astronomers deciding how the night unfolds.

Under the guidance of the National Observatory of Athens and with the excellent support from the Navarino Collections team, we have managed to organize this event on a weekly basis and we are happy to see that most of the times it was fully booked!

In September, the telescope ‘travelled’ to Pylos where visitors during Researcher’s Night had the opportunity to learn and observe stars and constellations visible from Messinia!



Figure 21: Visitors during Researcher's night were introduced to stars and constellations visible from Messinia.

5. Dissemination and outreach

5.1 Workshops

Mediterranean Holocene Climate and Human Societies 22-26 April 2014

Karin Holmgren initiated and led the organization of an international workshop in April entitled *Mediterranean Holocene climate and human societies* (Holmgren et al. 2014). The workshop took place at NEO and at the Westin Resort, Costa Navarino. Sixty-one participants from a total of 16 countries attended. They represented a range of disciplines as: history, archeology, paleoclimatology, hydrology and modeling. A special issue of the international science journal *Quaternary Science Reviews* with 16 contributions from the workshop is in progress. The workshop was co-sponsored by NEO, PAGES, the MISTRALS/ PaleoMex program, the Labex OT-Med, the Bolin Centre for Climate Research at Stockholm University, and the Institute of Oceanography at the Hellenic Centre for Marine Research.



Figure 22: Participants at the “*Mediterranean Holocene climate and human societies*” held at NEO and Costa Navarino.

5.2 Publications

Scientific Peer-review Publications (NEO researchers highlighted in bold)

Büntgen U, Wacker L, Nicolussi K, Sigl M, Gütler D, Tegel W, **Krusic PJ**, and Esper J, (2014): Extraterrestrial confirmation of tree-ring dating. *Nature Climate Change*, 4: 404-405.

- Finné M**, Bar-Matthews M, Holmgren K, Sundqvist HS, Liakopoulos I, Zhang Q, (2014): Speleothem evidence for late Holocene climate variability and floods in Southern Greece, *Quaternary Research*, 81, 2, 181-392, 2014.
- Finné, M**, (2014): Climate in the eastern Mediterranean during the Holocene and beyond - A Peloponnesian perspective. PhD Dissertation, No 45 (Physical Geography), Department of Physical Geography and Quaternary Geology, Stockholm University, Sweden. ISSN 1653-7211, ISBN 978-91-7447-995-9, Print: US-AB, Stockholm, 2014.
- Galván JD, Büntgen U, Ginzler C, **Grudd H**, Gutiérrez E, Labuhn I, and Camarero JJ, (2015): Drought-induced weakening of growth–temperature associations in high-elevation Iberian pines. *Global and Planetary Change*, 124, 95-106.
- Holmgren, K**, Sicre, M.-A, Gogou, A, Xoplaki, E and Luterbacher, J, (2014): Mediterranean Holocene climate and human societies. Workshop report. *Past Global Changes Magazine*, 22 (2), 54, <http://www.pages-igbp.org/products/pages-magazine/5082-22-2-dust>
- Klein J, Ekstedt K, Walter MT, **Lyon SW**, (2014): Modeling Potential Water Resource Impacts of Mediterranean Tourism in a Changing Climate. *Environ. Model. Assess.*, 20, 117-128.
- Kleine, BI, Skelton, A**, Huet, B and Pitcairn, IK, (2014): Preservation of Blueschist-facies Minerals along a Shear Zone by Coupled Metasomatism and Fast-flowing CO₂-bearing Fluids. *Journal of Petrology* 55 (10), 1905-1939.
- Mazi K, Koussis AD, Destouni G**, (2014): Intensively exploited Mediterranean aquifers: resilience to seawater intrusion and proximity to critical thresholds. *Hydrology and Earth System Sciences*, 18, 1663–1677,.
- Mazi K**, (2014): Seawater intrusion risks and controls for safe use of coastal groundwater under multiple change pressures. PhD Dissertation, No 42 (Physical Geography), Department of Physical Geography and Quaternary Geology, Stockholm University, Sweden. ISSN 1653-7211, ISBN 978-91-7447-907-2, Print: US-AB, Stockholm, 2014.
- Saurer M, et al. (includes **Grudd H**), (2014): Spatial variability and temporal trends in water-use efficiency of European forests. *Global Change Biology*, 20(12), 1365-2486.
- Seim A, Treydte K, Trouet V, Frank D, Fonti P, Tegel W, Panayotov M, Fernández-Donado L, **Krusic PJ**, and Büntgen U, (2014): Climate sensitivity of Mediterranean pine growth reveals distinct east–west dipole. *International Journal of Climatology*, 1097-0088.
- Zerefos, CS**, Tetsis, P, Kazantzidis, A, Amiridis, V, Zerefos SC, Luterbacher, J, Eleftheratos, K, **Gerasopoulos, E**, Kazadzis, S, and Papayannis, A, (2014): Further evidence of important environmental information content in red-to-green ratios as depicted in paintings by great masters. *Atmos. Chem. Phys.*, 14, 1–29, 2014. doi:10.5194/acp-14-1-2014
- Zerefos, C.**, K. Tourpali, P. Zanis, K. Eleftheratos, C. Repapis, A. Goodman, D. Wuebbles, I. S. A. Isaksen, J. Luterbacher, (2014): Evidence for an earlier greenhouse cooling effect in the stratosphere before the 1980s over the Northern Hemisphere”, *Atmos. Chem. Phys.*, 14, 7705-7720.

NEO Annual Report 2013 was published and up-loaded on the NEO web.

NEONEA

Four newsletters, called NEONEA, were published on the NEO web.

5.3 Presentations at conferences

Boyd, M. et al, Septemeber 2014: ITRAX XRF and colour intensity analysis on modern and mid-holocene Greek speleothems. Karst Record conference, Melbourne, Australia.

Cook ER, and **Krusic PJ**, (2014): The Old World Drought Atlas: Tree-ring reconstructions of past drought over Europe and the Mediterranean Basin since 1200 C.E. World Dendro Conference, Sydney, AU.

Krusic PJ: Old World Drought Atlas. Final cooperators meeting. Birmensdorf, Switzerland. 8-11 April 2014.

Ljungqvist FC and **Krusic PJ**: Northern Hemisphere hydroclimate patterns over the last 12 centuries. Bolin Days. Stockholm Sweden. 19-20 November 2014.

Ruben Fritzon, Arjen P Stroeven, **Alasdair Skelton**, Brad W Goodfellow and Marc W Caffee, 2014. Identifying paleoseismic information from limestone normal faults with a handheld XRF. Geophysical Research Abstracts, Vol. 16, EGU2014-8436, EGU General Assembly.

Kleine, B.I., Skelton, A.D.L., Huet, B., Pitcairn, I.K.: Preservation of blueschist facies minerals along a shear zone by fast flowing CO₂-bearing fluids - A field study from the Cycladic Blueschist Unit on Syros, Greece - AGU Fall Meeting 2014, San Francisco.

Kleine, B.I., Skelton, A.D.L., Huet, B., Pitcairn, I.K.: Preservation of blueschist facies mienrals along a shear zone by coupled metasomatism and fast flowing high XCO₂ fluids - 31th Nordic Geological Winter Meeting 2014, Lund.

Krejci R., P. Tunved, E. Gerasopoulos, N. Kalivitis, M. Hagman, M. Andren, T. Henning, **G. Maneas, H.-C. Hansson**, Atmospheric aerosol observations at Navarino Environmental Observatory (NEO), Greece, 12th International Conference on Meteorology, Climatology and Atmospheric Physics (COMECAP), Heraklion, Greece, 28 – 31 May 2014

Krejci R., P. Tunved, E. Gerasopoulos, N. Kalivitis, M. Andren, T. Henning, **G. Maneas, C.S. Zerefos, H.-C. Hansson**, Atmospheric observations at Navarino Environmental Observatory (NEO), Greece, Bert Bolin Climate Center annual meeting, Stockholm, Sweden, 18 – 19 Nov 2014

Poster presentation:

Kleine, B.I., Zhao, Z., Skelton, A.D.L.: Extremely fast fluid fluxes through metamorphic rocks on Syros, Greece - Bolin Days 2014, Stockholm

5.4 Popular Science presentations

Café-NEO,

Science cafe at coffee places around the Peloponnese

The *café-NEO* meeting, organized by NEO, is an attempt where, for the price of a cup of coffee or a glass of wine, anyone can come to explore the latest ideas in science and technology.



Figure 23: Cafe-NEO at Discover cafe in Patra

While in Patra, we had the opportunity to discuss the benefits and the risks of the solar radiation with Dr. Andreas Kazantzidis (Fig. 24), Physics Department, University of Patras, in Kalamata we learned about the ‘*origin of the Christmas star*’ in a meeting with Dr. Fiori Metallinou, National Observatory of Athens. Following the success of those events NEO is organising more meetings in 2015.



Figure 24: Cafe-NEO at Vino-banco Tapas bar in Kalamata

***Swedish Institute in Athens,
April 3, Athens***

Karin Holmgren gave a lecture on "*Climate, environment and past societies. What do we want to know - and why?*" following an invitation from the Swedish Institute in Athens (SIA). The lecture that also included a presentation of NEO was given at SIA's official annual meeting, held in the Acropolis Museum. In the audience were, among others, the Swedish Ambassador in Greece, representatives for all Swedish Institutes in the Mediterranean Region and several members from NEO Steering Committee.

***NEO at Researchers night,
Pylos, September 26***

Researcher's night is a celebration for science and research organized annually in more than 300 cities around Europe. In Greece, it was organized by the National Center for Scientific Research "DEMOKRITOS" in 9 cities, among them Pylos. NEO participated with several posters highlighting our research, video projection and an astronomy event. Moreover, we had a small exhibition with cave field-work equipment.



Figure 25: NEO exhibition setup at Researcher's Night 2014.

4th ARCH_RNT Symposium, Archaeological Research and New Technologies' October 1-3 University of Peloponnese, Kalamata

NEO film, '*Natural archives reveal climate history and more...*' was shown at the 4th ARCH_RNT Symposium. Giorgos Maneas also presented the preliminary results from our research related to Palaeoenvironmental Reconstruction of SW Peloponnese. The Symposium was organized by the Laboratory of Archaeometry, Department of History, Archaeology and Cultural Resources Management, University of the Peloponnese led by Ass. Professor Nikos Zacharias.

5.5 Meetings, Lectures and Visits

Meetings

- In October, Karin Holmgren and Vasilis Karakousis participated in an International Meeting organized by the Piraeus Bank Group Cultural Foundation. The meeting took place in Athens and Lake Stymfalia and was entitled: 'Cultural Landscapes in Natura 2000 sites: towards a new policy for the integrated management of cultural and natural heritage'

- A workshop dedicated to the results of the XENIOS project "Climate Change Impacts on the Touristic Development of Sensitive Areas in Greece. Pilot Study: Messinia - Area of Integrated Tourist Development" coordinated by Prof. Zerefos under National funding, was organized in Athens at the Cultural Center of the University of Athens. The XENIOS project, a collaboration of the University of Athens, the National Observatory of Athens and TEMES S.A., is devoted to the investigation of climate change impacts as well as the consequences of geophysical phenomena, which are accelerated and enhanced by anthropogenic factors, such as

tourism. The workshop offered an excellent opportunity to communicate the goals and achievements of NEO.

The workshop was under the auspices of SETE (Association of Greek Tourism Enterprises) and was partly attended by the General Secretary of Tourism Prof. Kokossis.



Figure 26: Participants at the presentation of the XENIOS project results

- Karin Holmgren, Vangelis Gerasopoulos and Giorgos Maneas participated in a meeting with the rector of the University of Peloponnese, Kostas Masselos, and Associate Professor Nikos Zacharias on 4 April. The aim of the meeting was to discuss a proposal by Prof Zacharias to initiate a 2-year Master program on “Natural and Cultural Environmental Studies” and the possible participation by NEO and NOA.

Visits

- In connection to the SC meeting, the Vice-Chancellor of Stockholm University, Astrid Söderbergh Widding, and the Dean of the Faculty of Science, Anders Karlhede visited NEO and Costa Navarino for discussion on the future cooperation and a new agreement for the continuation of NEO operation for the coming 5 years was agreed upon.

- As part of their field trip in Greece, students and teachers from the University of Tübingen working in the fields of geology and archaeology visited NEO in order to learn more about the research activities. Giorgos Maneas, welcomed them at the station and gave them a presentation on past, on-going and future activities implemented under the umbrella of NEO.

- Karin Holmgren and Giorgos Maneas visited the Tarfala Research Station in the Kebnekaise Mountain, for the exchange of ideas between the two research stations and to learn from each other.



Figure 27: The NEO management visiting Tarfala research Station. Photo courtesy: Ninis Rosqvist

5.6 Media

NEO Management has created a facebook page:

<https://www.facebook.com/Navarino.Environmental.Observatory>

The Swedish Embassy in Athens is marketing NEO on:

- www.swedenabroad.com/en-GB/Embassies/Athens/Current-affairs/News/Navarino-Environmental-Observatory-NEO---upcoming-educational-events--sys/
- www.facebook.com/EmbassyOfSwedenInAthens
- <https://twitter.com/SwedeninGR>

International media

Giorgos Maneas gave an interview to:

- Mikael Persson a Swedish journalist (Vagabond) about NEO and its activities in research, education and dissemination of science.
- Geordie Torr, editor at large, for the Geographical Magazine of the Royal Geographical Society.

National media

NEO Station Manager gave an interview to:

- Mrs Natasha Blatsiou, Journalist at Kathimerini, a Greek national newspaper who was interested about the ‘Astronomy nights’ events which is held on a weekly basis at Costa Navarino by NEO.

- A Greek national TV channel (ANT1 “Se Proto Plano”) about NEO. Part of the interview was shown on June 22 in a TV-show aiming to present the broader picture of Costa Navarino, from different angles, as well as the relation with local communities. The program is available online: http://www.antenna.gr/webtv/watch?cid=4lk423_dc_f9_e%3d

Videos

NEO Management together with Dionisis Dimitrakopoulos and with support from the SU filming team produced two documentaries about NEO activities:

Students from all over the world meet in Greece for educational activities:

<http://www.youtube.com/watch?v=CZT61RxQgRk>

Natural archives reveal climate history and more... :

<http://www.youtube.com/watch?v=YdFOOcEpwd8>

Please enjoy the video and choose 1080p in YouTube!

Press releases

Several press releases advertising cafe-NEO were sent to local media in Messinia. Moreover, the cafe-NEO meeting was advertised in radio and covered by local TV channels.

6. NEO management

6.1 Administration

The NEO Steering Committee had two meetings in Athens during 2013.

The NEO Steering Committee (NEO SC) consists of Chairman and two delegates from Stockholm University, two delegates from Academy of Athens and two delegates from TEMES.

- Stefan Nordlund, Professor (Chairman)
Department of Biochemistry and Biophysics
- Johan Kleman, Professor
Department of Physical Geography and Quaternary Geology
- Georgia Destouni, Professor
Department of Physical Geography and Quaternary Geology
- Christos Zerefos, Professor
Atmospheric Environment Division Biomedical Research Foundation
Academy of Athens
- Evangelos Gerasopoulos, Research Director
Institute of Environmental Research and Sustainable Development
National Observatory of Athens
- Marina Papatsoni, Marketing & Communications Director
TEMES S.A
- Vasilis Karakousis, Environment & Sustainability Manager
TEMES S.A

6.2 Infrastructures

The NEO building

In 2014, we have seen 8 courses, an international workshop and several fieldwork visits taking place and we have had no less than 225 visitors staying for in total 1244 nights at NEO Research Station!!

The Methoni station

The main part of the atmospheric measurements of NEO is conducted at the "Methoni station". The station is on top of the hill surrounding Methoni from the west and it belongs to the Hellenic National Meteorological Service (HNMS). Under an MoU the station is now disposed to NEO for operating its atmospheric instrumentation. NEO station at Methoni premises include:

- a container that hosts aerosol state-of-the-art instrumentation
- the main building used as offices, material stocking and in the future for short term hosting of researchers/student
- a fully equipped, automated meteorological station operated by HNMS

6.3 Researchers involved (NEO-responsible researchers underlined)

Atmospheric research:

- Christos Zerefos, Professor, Academy of Athens (AA)
- Evangelos Gerasopoulos, Research Director, National Obs. of Athens (NOA)
- Hans-Christen Hansson, Professor, Stockholm University
- Amiridis Vassilis, NOA
- Douvis Konstantinos, AA
- Eleftheratos Konstantinos, UoAthens
- Kazadzis Stylianos, NOA
- Kazantzidis Andreas, University of Patras
- Kalivitis Nikos, University of Crete
- Liakakou Eleni, NOA
- Paraskevopoulou Despoina, PhD student
- Hennig Tabea, Stockholm University
- Krejci Radek, Stockholm University
- Tunved Peter, Stockholm University
- Maneas Giorgos, Stockholm University

Geology and Geomorphology:

- Johan Kleman, Professor, Stockholm University
- Alasdair Skelton, Professor, Stockholm University
- Ingmar Borgström, Lecturer, Stockholm University
- Bickle Mike, Cambridge University, England.
- Caffey Mark, Purdue University, USA
- Goodfellow Bradley, Stockholm University
- Holness Marion, Cambridge University, England.
- Kleine Barbara, Stockholm University
- Ruben Fritzon, Stockholm University
- Stroeven Arjen, Stockholm University

Hydrology:

- Georgia Destouni, Professor, Stockholm University
- Asokan Shilpa M., Stockholm University
- Jarsjö Jerker, Stockholm University
- Koussis Antonis, Stockholm University
- Lyon Steve, Stockholm University
- Mazi Katerina, Stockholm University
- Prieto Carmen, Stockholm University

Tree-ring research:

- Håkan Grudd, Stockholm University
- Christos Zerefos, Academy of Athens

- Eleftheratos Konstantinos, University of Athens
- Krusic Paul, Stockholm University

Caves and wetlands:

- Karin Holmgren, Professor, Stockholm University
- Avramides Pavlos, University of Patras
- Bar-Matthews Mira, Geological Survey of Israel
- Boyd Meighan, Stockholm University
- Finné Martin, Stockholm University
- Hoffmann Dirk, National Research Centre for Human Evolution, Burgos, Spain
- Kalivitis Nikos, University of Crete
- Karkanis Panagiotis, Ephoreia of Palaeoanthropology-Speleology of Southern Greece
- Katrantsiotis Christos, Stockholm University
- Kouli Katarina University of Athens
- Maneas Giorgos, Stockholm University
- Norström Elin, Stockholm University
- Risberg, Jan, Stockholm University
- Zacharias Nikos, University of the Peloponnese

6.4 Associated members

Six associated members have joined NEO family:

- The National Observatory of Athens
- The Environmental Chemical Processes Laboratory (ECPL), Department of Chemistry - University of Crete
- The Laboratory of Atmospheric Physics, Department of Physics - University of Patras (LAPUP)
- The Laboratory of Climatology, Climate Dynamics and Climate Change, Department of Geography - Justus Liebig University Giessen
- The Laboratory of Archaeometry, Department of History, Archaeology and Cultural Resources Management - University of Peloponnese.
- The Soil and Water Lab within the Department of Biological and Environmental Engineering at Cornell University.

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