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Mediterranean Climate: From Past to Future

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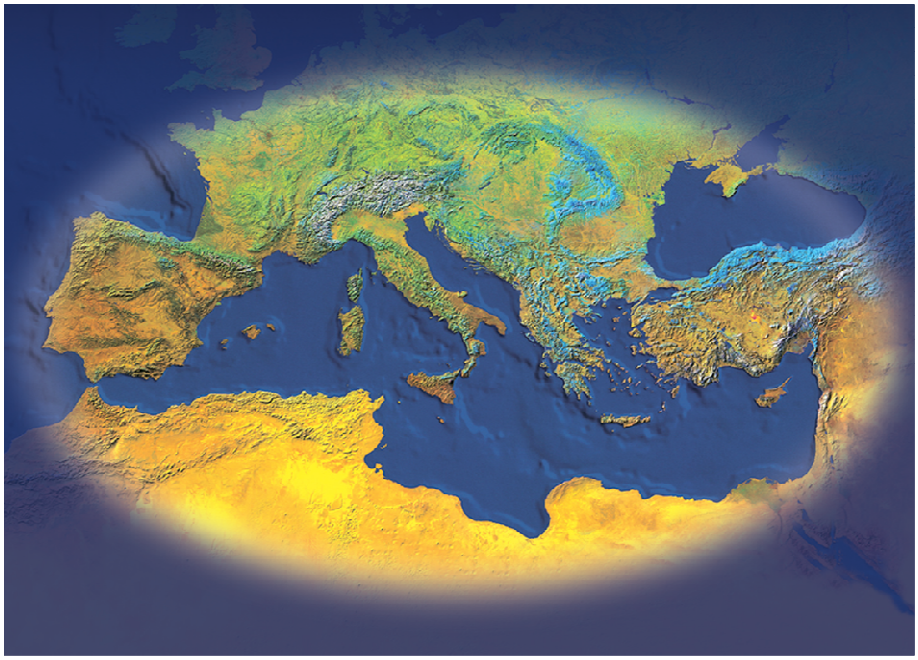

Abstracts

INVITED SPEAKERS - Abstracts

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ABSTRACT

Global Dimming or Local Dimming? The Megacities Contribution

During the 1950-1990s years, a significant decrease of surface solar radiation was observed at different locations throughout the world. We relate this phenomenon, now widely termed global dimming, with anthropogenic air pollution. A global database Global Energy Balance Archive (GEBA) of surface radiation time series for the 25-year period 1964-1989 was used. Circumstantial evidence that human activity does determine global dimming was obtained with the aid of a comparison between surface radiation changes in highly populated sites and ones in sparsely populated sites. The comparison of year-to-year variations of annual radiation fluxes shows a decline of about 0.41 $W/m^2/yr$ for highly populated sites, which is 2.6 times as large as the surface radiation decline for sparsely populated sites (0.16 $W/m^2/yr$). Moreover, for highly populated sites the sharpest decline (1.25 $W/m^2/yr$) in the Northern hemisphere corresponds to the latitudinal zone from 10^oN to 40^oN surrounded by zones with less pronounced declines. For sparsely populated sites, year-to-year variations of annual radiation fluxes reveal a pronounced increase in the equatorial zone from 15 ^oS to 15^oN. Additional evidence is shown for the large megacities contribution to solar dimming over India. There are also interesting mutual interactions between son insolation and aerosols to be discussed.

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ABSTRACT

The Mediterranean water cycle: To couple or not couple, what are the questions?

The Mediterranean basin has quite a unique character that results both from physiographic conditions and historical and societal developments. The region features a nearly enclosed sea surrounded by very urbanized littorals and mountains from which numerous rivers originate. This results in many interactions and feedback between ocean-atmosphere-land processes that play a prominent role in climate and high-impact weather. The Mediterranean Sea is also characterized by a negative water budget (evaporation excess over freshwater input from precipitation and river runoff) balanced by a two-layer exchange at the Strait of Gibraltar and is a relevant proxy to investigate the regional water cycle at the various time scales with the integration of the contribution of all Earth compartments (atmosphere/continent/ocean). In this study, atmosphere/ocean coupling is investigated and organized into three major questions that are preliminary addressed:
1. is there a need for investigating coupled processes in the Mediterranean?
2. at what time scale and over what spatial domain do coupled processes contribute significantly to the water cycle?
3. are the effect of coupled processes on the Mediterranean water cycle measurable with sufficient accuracy?
These questions will be illustrated with first simulations and observations performed and collected in the framework of the HyMeX (Hydrological cycle in the Mediterranean Experiment; www.hymex.org) and MED-CORDEX (Coordinated Downscaling Experiment; http://cordex.dmi.dk).

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ABSTRACT

HyMeX – an observation and modelling programme dedicated to the Mediterranean Water Cycle

The HyMeX (HYdrological cycle in the Mediterranean Experiment, http://www.hymex.org/) programme is a concerted effort at the international level aiming at advancing the scientific knowledge of the water cycle variability and improving the technologies and processes-based models needed for predicting natural hazards in the Mediterranean basin and adopting mitigation strategies against the impacts of climate change and human activity on their frequency and severity.

Specifically, HyMeX seeks to:

- improve our understanding of the water cycle, with emphasis on hydrometeorological natural hazards, by monitoring and modelling the Mediterranean atmosphere-land-ocean coupled system, its variability from the event to the seasonal and interannual scales, and its characteristics over one decade (2010-2020) in the context of global change,

- assess the social and economic vulnerability to hydrometeorological natural hazards in the Mediterranean and the adaptation capacity of the territories and populations therein.

A multi-disciplinary and seamless (from climate to event scales) strategy is developed for both observation and modeling set-up:

- A Long Observation Period (LOP) (2010-2020) provides observations and regional climate simulations of the whole Mediterranean coupled system in order to perform water budget and analyze the seasonal-to-interannual variability of the water cycle. They will support validation and improvement of regional coupled systems used within the IPCC AR5 framework (MED-CORDEX) with aim to reduce uncertainties of the future climate projections in Mediterranean.

- The Enhanced Observation Period (EOP) and Special Observation Periods (SOP) (2011-2014) will provide detailed and specific observations to study key processes in specific Mediterranean target areas. EOP should provide mandatory observations for making progresses in the modeling of the continental hydrological cycle and thus in the monitoring of water resources and droughts. SOPs will constitute a unique test-bed for the future generation of convective-scale ensemble hydrometeorological forecasting systems to improve the prediction capabilities of high-impact events.

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ABSTRACT

The chemistry-aerosol Mediterranean experiment (ChArMEx) initiative

The marine atmosphere of the Mediterranean basin is of particular interest for studies of atmospheric chemistry because it is heavily impacted by long range transported pollution converging from varied surrounding continents in a context of increasing anthropogenic pressure in coastal regions all around the basin. Moreover, a large part of Europe is expected to experience a Mediterranean type of climate in a few decades following global change.

Several programmes between the late 1980' and early 2000' have addressed specific questions on air pollution and transport mechanisms. However, despite major expected climatic and anthropogenic changes in the Mediterranean and high levels of tropospheric loads in gaseous and particulate pollutants, especially in summer, we are still missing an integrated view (i) of the environmental status of the Mediterranean atmosphere, (ii) of its various regional impacts, and (iii) of their recent and possible future evolution. In addition, no background Mediterranean atmospheric observatory exist yet in the western basin.

The French ChArMEx initiative for a Chemistry-Aerosol Mediterranean Experiment is described. It aims at a large international coordinated effort for an updated scientific assessment of the present and future state of the atmospheric environment in the Mediterranean Basin, and of its impacts on the regional climate, air quality, and marine biogeochemistry. The major stake is an understanding of the future of the Mediterranean region in a context of strong regional anthropogenic and climatic pressures. The target of ChArMEx is short-lived (<~1 month) particulate and gaseous tropospheric trace species which cause atmospheric pollution, have two-way interactions with climate, or impact the marine biogeochemistry. Work packages include (i) Emissions and source apportionment, (ii) Chemical ageing processes, (iii) Transport processes and impact on air quality, (iv) Radiative forcing and regional climate impact, (v) Atmospheric deposition and biogeochemical impact, (vi) Trends and variability, and (vii) Future evolution.

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ABSTRACT

Consistent geographical patterns of changes in high-impact European heatwaves

Climate-change projections suggest that European summer heatwaves will become more frequent and severe during this century, consistent with the observed trend of the past decades. The most severe impacts arise from multi-day heatwaves, associated with warm night-time temperatures and high relative humidity. Here we analyse a set of high resolution regional climate simulations and show that there is a geographically consistent pattern among climate models: we project the most pronounced changes to occur in southernmost Europe for heatwave frequency and duration, further north for heatwave amplitude and in low-altitude southern European regions for health-related indicators. For the Iberian Peninsula and the Mediterranean region, the frequency of heatwave days is projected to increase from an average of about two days per summer for the period 1961–1990 to around 13 days for 2021–2050 and 40 days for 2071–2100. In terms of health impacts, our projections are most severe for low-altitude river basins in southern Europe and for the Mediterranean coasts, affecting many densely populated urban centres. We find that in these locations, the frequency of dangerous heat conditions also increases significantly faster and more strongly, and that the associated geographical pattern is robust across different models and health indicators.

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ABSTRACT

Explosive Cyclones in the Mediterranean: Vertical Structure and Dynamics

Explosive cyclones are characterized by exceptionally and unusually large deepening in the midlatitudes, being associated with a band of strong winds and surrounded with a spiraling wall of deep cumulonimbus and strong convection. Although these events occur rarely in the Mediterranean in comparison to the oceans, they present great interest due to their serious social and economic impacts on shipping and coastal regions.

In this study, the surface explosive cyclones in the Mediterranean are detected with the aid of the University of Melbourne Cyclone Tracking Algorithm (MS), using the 1^0 X 1^0 resolution ERA-40 datasets, from 1962 to 2001, during the cold period of the year (October-March). In order to describe the vertical profile of the surface explosive cyclones, the Vertical Tracing Software of MS algorithm is used at five selected isobaric levels: 850, 700, 500, 300 and 200hPa, following the corresponding surface centres. The kinematic characteristics and metrics of the explosive cyclones are examined at various levels. The dynamics of the explosive cyclones at lower and upper levels are further investigated with the aid of composite maps of selected parameters, such as potential vorticity, sea surface fluxes, equivalent potential temperature.

It was found that that explosive cyclogenesis in the Mediterranean is mainly a maritime phenomenon, with maximum frequency along Northern coast of Western Mediterranean, in accordance to the ordinary cyclogenesis. The surface explosive cyclones present a well organized structure, since they presented one, at least, track point extending up to the 200hPa. The vast majority (almost 96%) present westward tilting, which is stronger than their ordinary counterparts, implying the importance of baroclinicity as one of the main mechanisms driving explosive development. Larger and deeper cyclones are located in the area between South Italy – Sicily – South Ionian Sea – West of Crete, where heat fluxes are strong. However, upper level forcing is also important. A negative tendency of system density was detected at the surface in whole Mediterranean, which becomes positive at 500 hPa in the eastern basin. However, a positive trend of depth was found in the western basin.

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ABSTRACT

Is the Adriatic-Ionian Bimodal Oscillating System (BiOS) responsible for the Eastern Mediterranean Transient (EMT) preconditioning?

The aim of this presentation is to carry out a detailed comparison between the Ionian, Cretan and Levantine basins in order to discuss the interaction between these basins seeking for a possible impact of the BiOS on sea level and salt content variations in the Levantine and thus on the preconditioning mechanism for the EMT-like phenomena. If shown, that would mean that the preconditioning favorable for the EMT was not a single episode in the Mediterranean dynamics, but it is a recurrent (decadal) feature. Furthermore, the same mechanism (the BiOS) underlying preconditioning of the EMT-like events would explain the switch from Adriatic to Cretan Sea (and again to Adriatic) as dense water source for the EMed. In fact, the anti-correlation between the salt content variations of the upper layer of the Ionian Sea and the Levantine basin can be easily extended to the Adriatic and the Cretan Sea. However, the dense water formation in the Cretan Sea would occur only if, in addition to favorable preconditioning, air-sea heat fluxes are strong enough to generate vertical overturning as it happened in early 1990's.

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ABSTRACT

Open issues on long-term Mediterranean Sea level variability.

We will present an overview of recent achievements in understanding Mediterranean sea level variability at interannual and interdecadal scales. We will comment on the various physical forcings contributing to observed sea level changes. Within this context we will discuss the steric component (accounting for changes in the density of the water column), the mass component (increase/decrease of the total amount of mass of the basin) and the regional atmospheric component (accounting for the mechanical forcing of atmospheric pressure and wind). The related uncertainties and the unexplained residual changes will lead to the discussion of several open issues that are crucial for a better understanding of long-term Mediterranean Sea level variability. The role of the Strait of Gibraltar in linking sea level changes inside the Mediterranean with those in the nearby Atlantic and the uncertainty associated with present observations will be the two points of focus. The capabilities of global and regional models to diagnose sea level variability will also be discussed, linked with the uncertainties in the freshwater and heat fluxes used to force the models. Finally, other issues such as land movements or the link between coastal and open sea level will also be discussed.

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ABSTRACT

HyMeX – an observation and modelling programme dedicated to the Mediterranean Water Cycle

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ABSTRACT

A protocol for early drought warning systems in Mediterranean countries

Drought is one of the major environmental disasters in Mediterranean countries, and has resulted in extensive damage to the environment and economy. Recent predictions on climate change projections suggest this situation may worsen, projecting and lead to an increased frequency and severity of drought. Advance warning of drought, and the implementation of effective drought management in response, offers the potential to mitigate adverse impacts. Drought preparedness and education can additionally increase resilience of affected societies, allowing these to cope better, and help break the disaster-response cycle. This work is developed in the framework of DEWFORA, a major new project with the aim which aims to develop a framework for the provision of drought early warning and response. This paper presents the main objectives components of the early warming protocol, providing an outlook to how the project aims to increasing the effectiveness of drought forecasting and warning and highlights the importance understanding the social vulnerability in the future and current climate. The proposed framework will cover the whole chain from monitoring and vulnerability assessment, to forecasting, warning, response, and knowledge dissemination. Improved drought indicators that consider the wider domain of water use and water users, and their dependence on variable water resources will be developed and these indicators will be applied used to map drought vulnerability in the current climate conditions, but also to assess the change in drought hazard and vulnerability in the future, changed, climate.

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ABSTRACT

Application of statistical methods for regional climate change projections in the Mediterranean area

Besides dynamical downscaling by regional climate modelling, there is a vast field of statistical approaches to estimate regional or local climate changes from projections of large-scale predictor variables. These approaches may be grouped according to different techniques like transfer functions between large and small spatial scales, synoptic downscaling based on weather or circulation types, artificial neural networks, and conditional weather generators.

Within each group a lot of variants can be applied, e.g. multiple regression or canonical correlation or generalized linear models in the scope of transfer functions, considering different predictor fields or even particular ensembles of statistical models based on different calibration periods – or with respect to synoptic approaches, the identification of appropriate analogues or the inclusion of predictands into classification schemes with different percentages of their contribution to the overall grouping.

With regard to the Mediterranean area, some examples of future assessments will be discussed, referring to both seasonal mean values as well as indices of extremes defined on the basis of particular percentiles. Examples include assessments for temperature and precipitation, based on station and on gridded data, considering different large-scale predictor fields from different global climate models and different SRES scenarios. Particular treatment has been considered for widespread non-stationarities in the relationships between large and local scales by deriving statistical model ensembles whose members include different variants of these relationships. Results in general do not only depend on season and predictand, but also show considerable spatial variability within the Mediterranean domain.

Investigations are funded by the German Research Foundation DFG.

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ABSTRACT

Synoptic patterns, cyclones and weather in the Mediterranean. Present situation and trends

Cyclones are a key feature of Mediterranean climate. Genesis mainly occurs within the Mediterranean Basin itself, but a significant share of the systems enters the basin from the Atlantic, from North Africa, and Europe. Cyclone occurrence is related to large scale weather patterns affecting the region (the North Atlantic Oscillation, the Scandinavian Pattern and the East Atlantic / West Russian pattern). Extreme events occurring in conjunction with the cyclones include windstorms, heavy precipitation, and other significant weather impacts. With respect to windstorms, it is possible to identify wind tracks and assign them with cyclone tracks. It turns out that western Mediterranean windstorms are partly associated with cyclones over the central Europe. Climate models can be validated in terms of cyclones and associated wind storms, laying a basis for the interpretation of signals in greenhouse gas scenario simulations. These simulations show a decreasing trend in cyclone tracks and windstorms over the Mediterranean.

Heavy precipitation can be linked to intense cyclones, of course, but also moderate (even weak) cyclones can trigger heavy precipitation, through the appropriate organisation of a wet and warm feeding inflow of Mediterranean air. The role of the Mediterranean cyclones in the heavy rain occurrence can be identified in particular cases or through statistical approaches. Some previous work, regarding cases, statistical relationship between presence of cyclones and heavy rain and synoptic patterns associated to intense precipitation, is reviewed in this presentation, which mainly focuses on Western Mediterranean results. If intense or moderate (even weak) cyclones are usually associated to heavy rain, the observed and projected tendencies for cyclonic and heavy rain frequencies can be also associated. According available work on these matters, an observed and foreseen decreasing of the winter-time cyclonic frequencies can be compatible with a general decreasing of the precipitation in the region. As known, a main characteristic of the Mediterranean climate is a dry summer, caused by the total domain of the Subtropical anticyclone. Recent observed tendencies can justify a singular warming of the late spring, through an extension of the Mediterranean summer into the spring, associated to a longer duration of the Subtropical anticyclone domain.

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ABSTRACT

Evaluation of the role of the moist air transport and intensity of jet streams in the Mediterranean precipitations based on results of an AOGCM simulation experiment

Analysis of results of climate change simulation experiment over the Mediterranean region (MR) will e presented. The experiment with AOGCM ECHAM5 (GHG A1B SRES)has been performed at INGV-CMCC, Bologna, Italy under EC FP6 CIRCE project. A novel methodology designed for investigation of the mechanisms responsible for formation of extreme precipitation climate events is applied. Results of the analysis demonstrate a notable role of the variations in the frequency of extreme events in the upper troposphere in determining that of extreme precipitation events in the Mediterranean region. The experiment projects significantly varying during the cool season climate change trends in the frequency of extreme events in atmospheric dynamics and precipitation over the MR. A positive trend in the frequency of extreme precipitation events ~ 0.4 - 0.8 days/month) is projected for autumn. During the winter months however a tendency to increase in the frequency of days with extreme precipitation (~ 0.8 days/month) over the south-eastern part of the MR is detected.

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ABSTRACT

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ABSTRACT

Increasing heat stress and air pollution in the Middle East

Climate projections for the 21st century indicate that the temperature in the Middle East is likely to increase between 2-4℃ in winter and 2-6℃ in summer. Heat stress is expected to be significant with a remarkably large increase in the number of hot days per year. Heat waves can aggravate air pollution and it is highly probable that these conditions will become more common. Air pollution levels in the Middle East are already high, due to both natural and anthropogenic emissions. The fine aerosol particles are mostly composed of sulphates and particulate organic matter, whereas the coarser particles are dominated by desert dust. The concentration of fine aerosol particles is expected to grow substantially due to increasing emissions of sulphur dioxide and nitrogen oxides. In summer the region is largely cloud-free, and the relatively intense solar radiation promotes the formation of ozone. It is likely that the Middle East will be a persisting air pollution 'hot spot'. The expected warming and drying will be conducive for ozone formation, especially during heat spells, and this can have major consequences for city dwellers.

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ABSTRACT

A review on recent efforts of the Mediterranean regional climate modeling

The Mediterranean climate is known for its particular regional characteristics: large seasonal contrast for temperature and rainfall, strong wind systems, intense precipitations and Mediterranean cyclones. The Mediterranean Sea is a marginal sea, surrounded by lands and complex mountains. Oceanic processes at different spatial temporal scales, all together, participate to the formation and circulation of the complex water mass system. The Mediterranean Sea is a concentration basin with an evaporation rate much larger than the precipitation rate and the runoff, which constitutes the fundamental reason for the Mediterranean Sea to form deep waters and then to have an overturning circulation. The Mediterranean Sea is a source of water vapor and energy to the atmosphere and has a strong impact on the nearby climate, even climate in remote regions. It is also sensitive to global-scale climate variation. The objective of this presentation is to make a review on the state of the art for modeling the Mediterranean regional climate. Two main parts will be developed. The first part is devoted to atmospheric parameters. A general review describes the basic performance of both global and regional climate models in simulating the Mediterranean climate. We focus then on the added-value that high-resolution models can bring in terms of surface winds, surface hydrology and intense rainfall events. The second part focuses on the general circulation of the Mediterranean Sea. We make a general review on the performance of current oceanic models of both coarse resolution (about 1 to 2 degrees) and high resolution (about 1/8 to 1/16 degrees). A comparison among a few coupled models gives a good assessment about our current skill in modeling the Mediterranean climate.

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ABSTRACT

Mediterranean Climate: recent progresses and open issues P.Lionello

Many initiatives have contributed in the last 5 years to understanding the Mediterranean climate, its future evolution, and impacts on ecosystems and societies. This presentation aims at a brief discussion of recent progresses, new research issues and open questions. Recent progresses include growing consensus that future conditions will be warmer and drier than present and with a larger interannual variability, availability of regional climate simulations and projections covering longer time periods and at higher resolution than previously, implementation of regional models with a dynamically interactive Mediterranean Sea. There are new issues that are being systematically addressed such as the importance of regional effects on the Mediterranean Sea level (and its distinct behaviour with respect to the global value), the role of land cover feedbacks at regional scale, climate change detection at regional scale, the effects of natural and anthropogenic aerosols on the Mediterranean climate, the effects of future climate change on ecosystems and societies.
Open questions on which progresses are being achieved are the closure of the heat and mass budget of the Mediterranean Sea and the role of the exchanges across the Gibraltar strait in future climate scenarios. An admittedly heterogeneous and incomplete list of open issues include also actions to reduce (or to strongly constrain) uncertainty in climate projections to mach the requirements by policymakers and stakeholders, analysis of urban climate (on which societal and climate dynamics strongly interact), an improved synthesis of climate evolution during instrumental time over north Africa and middle east, integration of satellite and in situ precipitation data, variability of the deep circulation and propagation of the global climate change signal in the Mediterranean sea.
The previous lists do not aim at being complete and exhaustive, but to provide material for a discussion on future research priorities and coordination.

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ABSTRACT

Hydrometeorological Risks evolution in Catalonia (Spain): climate variability and vulnerability (oral)

One of the aspects analysed in the Second Report on Climate Change in Catalonia (SRCCC; Llebot, 2010) has been the evolution of natural risks associated to atmospheric/climatic factors, called by UNISDR (2009), hydrometeorological hazards, that also include some hazards more related with geological factors like snow avalanches and landslides (Llasat and Corominas, 2010) . This contribution is mainly focused on the results presented in this report, after the analysis of the evolution of extreme rainfalls using the ETCCDI precipitation and temperature indices, floods, droughts, tornadoes and forest fires. These results have been updated and complemented using more recent studies that deal with aspects related with hazard and vulnerability (Gayà et al, in press; Turco and Llasat, in rev; Llasat et al, 2010; Barredo, 2010). Main conclusions points to the more important role developed by changes produced in vulnerability and exposure factors than by changes produced in hazard factors as a consequence of climatic variability or climatic change. Although these conclusions mainly refer to the period 1970 until nowadays, floods and droughts have been analysed for a longer period. Mitigation measures and social perception have also been considered.

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ABSTRACT

The Report on Climate Change in Catalonia (poster)

The Second Report on Climate Change in Catalonia has been elaborated by the *Grup d'Experts en Canvi Climàtic de Catalunya (GECCC, Experts team of Catalonia on climate change)* and coordinated by J. E. Llebot (Llebot, 2010). It analyses present and future climate change impacts and policy options in Catalonia (NE Iberian Peninsula) from a multidisciplinary perspective and it provides continuity to the 2005 First Report (Llebot, 2005). The study is structured in four main parts: 1) the scientific foundations of climate change, with special reference to the past, present and future climate in Catalonia; 2) the impacts and vulnerability of the biophysical environment to climate-related risks, with an emphasis on water resources and ecosystems; 3) the analysis of different economic sectors from the perspectives of mitigation and adaptation, taking into account legal frameworks, management tools and social impacts; and 4) the status of climate change related research in Catalonia, highlighting the most important research areas, the leading institutions and the cross-fertilisation across institutions and disciplines.

The main results of parts 1 and 2 include the increase of the mean annual temperature in 0,21ºC/decade for the period 1950-2008, the decrease of precipitation recorded in spring, the increase of 43,2% of emissions of green house gases in comparison with 1990, although part of them can be compensated by the great forest mass and the sea and coastal sediments. An average temperature increase of 2ºC is expected for 2050, mainly in summer and inland, meanwhile, for precipitation, uncertainties are greater although an average decrease between 5% and 15% is pointed for the end of the century, being major in summer. Meanwhile for extreme precipitation only the maximum length of the dry spill (CDD) shows a significative trend, all the indexes related with extreme temperatures are increasing. The report shows the difficulty of associating some observed changes in natural risks to climate change due to variations in vulnerability and feedback processes; in this sense flash floods have increased meanwhile the number of forest fires have decreased. It is expected a change in the hydrological cycle and a decrease of water resources, including a modification of different biogeochemical processes that determine the water quality. Changes in the duration of the vegetative period joined to the decrease of water resources and the aridity increase is giving place to changes in the community composition and location, in the functional activities of terrestrial ecosystems and in some genotypes to be adapted to new climatic conditions. To these changes, a decrease in the variety of some species has been detected. The SST has experienced an increase of 0,7ºC affecting the ecosystems in the sea, and as a consequence of the increase of the sea level a major erosion is expected on the coast. A decrease/increase in the number of strong/moderate sea storms has been detected.

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ABSTRACT

Modeling Mediterranean Ocean Climate for the LGM and the Early Holocene.

A regional ocean model of the Mediterranean is used to investigate past climate variations in the Mediterranean. The model is forced with atmospheric forcing derived from steady state simulations with an earth system model.

For the Last Glacial Maximum, the model is essentially able to reproduce the pattern of SST anomalies reconstructed from assemblages of foraminifera. These anomalies are characterized by a strong cooling in the northwestern Mediterranean (strongest in summer) and a moderate cooling in the Levantine. The lower sea level leads to reduced exchange across the sills resulting in an enhanced salinity gradient to the Atlantic in spite of reduced net evaporation.

The early Holocene is characterized by the presence of oxygen depleted deep waters in the eastern Mediterranean. One obvious cause could be the presence of stagnating deep waters. The model is used to assess the effectivity of several potential mechanisms to decrease or entirely suppress deep water formation in the eastern Mediterranean. This includes enhanced run off from the Nile and the onset of a potential outflow from the Black Sea.

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ABSTRACT

International CLIVAR and Potential Future Interactions with MedCLIVAR

The World Climate Research Program (WCRP), and therefore CLIVAR as one of its core projects, is developing a new organizational structure designed to address the increased and more diverse societal requirements placed on the climate research community. Although the details of the new WCRP/CLIVAR structures remain to be defined, issues to be addressed have been identified. With respect to CLIVAR, historically it has been directed at the physical processes that determine the ocean's role in climate. The study of these processes will remain the CLIVAR core. However, the reconstituted CLIVAR will have a more diverse portfolio including biogeochemical and ecosystem research, increased emphasis on regional issues and capacity building, and development of climate services. The project has identified seven imperatives to provide the foundation for its increased diversity. The imperatives are Anthropogenic Climate Change, Decadal Variability, Predictability and Prediction, Intraseasonal and Seasonal Predictability and Prediction, Improved Atmosphere and Ocean Components of Earth System Models, Data Synthesis and Analysis and Uncertainty, Ocean Observing System and Capacity Building. The goals of each imperative will address the multidisciplinary issues described previously. The imperatives can be used to provide the framework for collaboration between the two projects. For example, the regional nature of MedCLIVAR can provide valuable insight for the development of the future regional components of the international imperatives. Conversely, the two programs can work together to further the development of the downscaling of global numerical models to address Mediterranean problems.

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ABSTRACT

Application of climate models for regional climate change projections on the Mediterranean area

Future climate change is investigated by means of climate model simulations covering the 21st century, taking into account different anthopogenic greenhouse gases emission scenarios. Dynamical and statiscal approaches are used to downscale global climate projections at the scale of the Mediterranean area. Here we focus on results that have been recently published regarding future climate change using the dynamical approach. They include those recently obtained with coupled regional climate models that reveal, at least in one case, a significant dependancy of climate change to the air-sea coupling. They also include results obtained in the context of european projects like ENSEMBLES and CIRCE that allow a better characterisation of uncertainties at the regional scale.

Besides methodological aspects, we will present a brief synthesis of key aspects of expected changes in the Mediterranean region, concerning the mean climate and climate extremes. We will also give some insights on possible changes in Mediterranean sea temperature, salinity, circulation, water and heat budgets, and sea level. We will conclude by a discussion on some aspects of the level of confidence we can attribute to these projections.

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ABSTRACT

Climate Local Information in the Mediterranean region: Responding to User Needs

CLIM-RUN aims at developing a protocol for applying new methodologies and improved modeling and downscaling tools for the provision of adequate climate information at regional to local scale that is relevant to and usable by different sectors of society (policymakers, industry, cities, etc.). Differently from current approaches, CLIM-RUN will develop a bottom-up protocol directly involving stakeholders early in the process with the aim of identifying well defined needs at the regional to local scale. The improved modeling and downscaling tools will then be used to optimally respond to these specific needs. The protocol is assessed by application to relevant case studies involving interdependent sectors, primarily tourism and energy, and natural hazards (wild fires) for representative target areas (mountainous regions, coastal areas, islands). The region of interest for the project is the Greater Mediterranean area, which is particularly important for two reasons. First, the Mediterranean is a recognized climate change hot-spot, i.e. a region particularly sensitive and vulnerable to global warming. Second, while a number of countries in Central and Northern Europe have already in place well developed climate service networks (e.g. the United Kingdom and Germany), no such network is available in the Mediterranean.

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ABSTRACT

Thermohaline variability in the western Mediterranean Sea

The Mediterranean Sea is in many ways a miniature ocean. It has deep water formation varying on interannual time scales and a well-defined overturning circulation, and there are distinct surface, intermediate and deep water masses circulating between the western and the eastern basin. What makes the Mediterranean particularly useful for climate change studies is that its time scale is much shorter than for the global ocean, with a turnover of 60 years compared with 500 years for the global ocean. Changes can happen faster, on the time scale of a human lifetime. Thus the Mediterranean is useful as a laboratory for documenting changes within it (and hence anticipating similar changes in the global ocean) and for understanding the role of key processes involved in climate change (thus to make inferences on those processes on the global scale).
Even if generally the description of the large-scale thermohaline circulation relies on this hypothesis, the Mediterranean is not a steady system. On the contrary, during the last decades, significant changes of the deep water have been observed both in the eastern basin (Eastern Mediterranean Transient, EMT) and in the western basin (Western Mediterranean Transition, WMT).
In the deep layers of the western basin, a constant trend towards higher salinity and temperature has been observed since the 50's. More recent observations evidenced an acceleration of this tendency. An alteration of the stratification, an abrupt temperature and salinity increase have been observed since 2005. This new deep water has spread out into the western Mediterranean so that now it forms a bottom layer of warm salty water up to 1000 m thick throughout the western Mediterranean basin. This talk aims at promoting a discussion about extension, causes and effects of this remarkable event, in the context of longer term changes of the Mediterranean climate.

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ABSTRACT

The international Med-CORDEX initiative: A multi-component and multi-model approach to study the physical processes, the variability and the trends of the Mediterranean regional climate system

The Mediterranean region is considered as particularly vulnerable to climate variability and change (Giorgi, 2006; IPCC, 2007), in particular, to changes in its regional water cycle. This climate vulnerability is a key issue for the 500 million inhabitants living in the 30 Mediterranean countries. Besides, the Mediterranean basin is a good case study for climate regionalization. It is indeed surrounded by various and complex topography channelling regional winds (Mistral, Tramontane, Bora, Etesian, Sirocco) that defined local climates. Many small-size islands limit the low-level air flow and its coastline is particularly complex. Strong land-sea contrast, land-atmosphere feedback, intense air-sea coupling and aerosol-radiation interaction are also among the regional characteristics to take into account when dealing with the Mediterranean climate modeling. What is true for the Mediterranean climate is also true for the Mediterranean Sea that shows complex bathymetry including narrow and shallow straits, strong eddy activity and various distinct and interacting water masses.
For all these reasons, the Mediterranean area has been chosen as a CORDEX sub-domain (MED) leading to the Med-CORDEX initiative endorsed by the MedCLIVAR and HyMeX programs. In addition to the core CORDEX framework (Atmosphere-only RCM, 50 km, ERA-Interim, RCP4.5, RCP8.5), two more tiers have been defined for Med-CORDEX: the first one targets to assess the added-value of higher-resolution RCMs increasing the horizontal resolution up to 10 km. The second one will serve to test new regional climate modeling tools called Regional Climate System Models (RCSM) including a high-resolution and coupled representation of all the physical components of the regional climate system: atmosphere, land surface, vegetation, surface hydrology, rivers and ocean. In addition, the Med-CORDEX initiative is strongly coordinated with the HyMeX program that plans a long-term observation period (2010-2020), large field campaigns in the Mediterranean area, development of new regional satellite products and meso-scale modeling activities targeting the study of the Mediterranean hydrological cycle and the related extreme events. The coordination with MedCLIVAR and HyMeX ensures the set-up of a large and multi-skilled Med-CORDEX evaluation team as well as the access to specific databases and to the regional impact community.
More than 10 modeling centers have already joined the Med-CORDEX initiative including groups in Italy, Spain, France, Israel, Turkey, Germany, Tunisia and Serbia. The first ERA-Interim driven runs have been carried out with the RCMs at 50 km, the RCMs at 10 km and the RCSMs. The RCP driven runs are now starting closely following the global CMIP5 simulations. The design of the Med-CORDEX inter-comparison experiment as well as the first results using the ERA-Interim driven runs will be presented.

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ABSTRACT

Extreme precipitation in the Mediterranean: evolution and related large scale circulation

The Mediterranean region has been considered a hot-spot of climate change that is, and will be more, vulnerable and exposed, especially to climate extreme events, such as heat waves and flood events. The achievement of a reliable statistical and dynamical characterization of these events is crucial. In this frame, a set of more than 400 daily precipitation series, mostly covering the period 1950-2006, has been collected and quality checked. Extended winter (October to March) extreme precipitations have been analyzed by applying a procedure based on methods developed within the Extreme Value Theory. Then, the behavior of the large scale atmospheric circulation associated with these events has been investigated by using the 20th century reanalysis (e.g. geopotential height at 500 hPa) and applying a new 3-step classification algorithm. Results reveal remarkable spatial differences within the basin, in terms of the parameters of the extreme distributions and associated anomalous large scale circulation. Besides observations, a new set of climate model runs, carried out in the framework of the EU-FP6 Climate Change and Impact Research: the Mediterranean Environment - CIRCE project by using innovative high resolution global/regional climate models, has been also analyzed.

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ABSTRACT

Atmospheric circulation associated with major heatwaves in the Euro-Mediterranean region

The first decade of the 21st century has been characterized by severe summer heatwaves within the Euro-Mediterranean region, such was the case of western Europe (2003), Iberia (2006), Italy and the Balkans (2007) and, more recently, Ukraine and Russia (2010).
The exceptional summer of 2003 increased mortality by around 70,000 heat-related deaths in western and central Europe and caused large financial losses due to crop shortfall and forest fires. This heatwave was characterized by very high maximum and minimum temperatures and extremely low humidity levels over Iberia triggering the most devastating sequence of large fires ever registered in Portugal with an estimated total burnt area was about 450.000 ha. This heatwave event was characterized by an outstanding blocking pattern over western Europe and preceded by dry conditions due to lack of precipitation in winter and spring.
The 2007 heatwave affected essentially the central Mediterranean sector and is analyzed here with focus on the meteorological conditions associated with the two periods characterized by large fire events in Italy and Greece (July 24-25 and August 22-27). Structural similarities found between the two episodes led to a relatively simple conceptual model of meteorological conditions that triggered both events.
In summer 2010, eastern Europe was struck again by a severe heatwave with a maximum located over western Russia where preliminary estimates indicate more than 55,000 heat-related excessive deaths. Other countries including Finland, Latvia, Estonia, Belarus, Ukraine and Kazakhstan were also affected by extreme temperatures that broke the summer records of the last 140 years at many temporal scales. The most evident features associated with the 2010 event were: 1) quasi-stationary anticyclonic circulation anomalies, which produce warm conditions at surface by enhancing subsidence, solar radiative heating and warm-air advection, 2) deficit of precipitation during the winter and spring months, resulting in a continuous reduction of soil moisture content and enhanced sensible heat fluxes that exacerbate the strength of summer heatwave.

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ABSTRACT

Open issues on long-term Mediterranean Sea level variability.

We will present an overview of recent achievements in understanding Mediterranean sea level variability at interannual and interdecadal scales. We will comment on the various physical forcings contributing to observed sea level changes. Within this context we will discuss the steric component (accounting for changes in the density of the water column), the mass component (increase/decrease of the total amount of mass of the basin) and the regional atmospheric component (accounting for the mechanical forcing of atmospheric pressure and wind). The related uncertainties and the unexplained residual changes will lead to the discussion of several open issues that are crucial for a better understanding of long-term Mediterranean Sea level variability. The role of the Strait of Gibraltar in linking sea level changes inside the Mediterranean with those in the nearby Atlantic and the uncertainty associated with present observations will be the two points of focus. The capabilities of global and regional models to diagnose sea level variability will also be discussed, linked with the uncertainties in the freshwater and heat fluxes used to force the models. Finally, other issues such as land movements or the link between coastal and open sea level will also be discussed.

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ABSTRACT

Synoptic patterns, cyclones and weather in the Mediterranean. Present situation and trends

Cyclones are a key feature of Mediterranean climate. Genesis mainly occurs within the Mediterranean Basin itself, but a significant share of the systems enters the basin from the Atlantic, from North Africa, and Europe. Cyclone occurrence is related to large scale weather patterns affecting the region (the North Atlantic Oscillation, the Scandinavian Pattern and the East Atlantic / West Russian pattern). Extreme events occurring in conjunction with the cyclones include windstorms, heavy precipitation, and other significant weather impacts. With respect to windstorms, it is possible to identify wind tracks and assign them with cyclone tracks. It turns out that western Mediterranean windstorms are partly associated with cyclones over the central Europe. Climate models can be validated in terms of cyclones and associated wind storms, laying a basis for the interpretation of signals in greenhouse gas scenario simulations. These simulations show a decreasing trend in cyclone tracks and windstorms over the Mediterranean.

Heavy precipitation can be linked to intense cyclones, of course, but also moderate (even weak) cyclones can trigger heavy precipitation, through the appropriate organisation of a wet and warm feeding inflow of Mediterranean air. The role of the Mediterranean cyclones in the heavy rain occurrence can be identified in particular cases or through statistical approaches. Some previous work, regarding cases, statistical relationship between presence of cyclones and heavy rain and synoptic patterns associated to intense precipitation, is reviewed in this presentation, which mainly focuses on Western Mediterranean results. If intense or moderate (even weak) cyclones are usually associated to heavy rain, the observed and projected tendencies for cyclonic and heavy rain frequencies can be also associated. According available work on these matters, an observed and foreseen decreasing of the winter-time cyclonic frequencies can be compatible with a general decreasing of the precipitation in the region. As known, a main characteristic of the Mediterranean climate is a dry summer, caused by the total domain of the Subtropical anticyclone. Recent observed tendencies can justify a singular warming of the late spring, through an extension of the Mediterranean summer into the spring, associated to a longer duration of the Subtropical anticyclone domain.

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ABSTRACT

The Dead Sea sedimentary archive: insights into high resolution paleoclimate reconstructions of the last ~300 ka

The present Dead Sea is located in the lowest continental exposed elevation on Earth and has been intermittently filled by several water bodies since the Neogene. Previous investigations have shown that sedimentation in the Dead Sea basin has been continuously modulated by global climate and tectonism along the Dead Sea transform fault. Its sedimentary infill has comprehensively recorded both climatic and tectonic changes through time, thus providing a unique continuous archive of those environmental and structural parameters at regional and global scales.
The hydrological regime of the Levant during the Quaternary was primarily controlled by Mediterranean systems associated with North Atlantic climate shifts. The water levels of terminal lakes in the Dead Sea basin reflect these hydrological changes. While high stand conditions developed throughout glacial intervals, low stands occurred during interglacials. However, deposition of travertines and speleothems south of the Dead Sea during past interglacials suggests significant, albeit brief, intrusions of humidity through the Red Sea corridor, probably in relation to enhanced activity of tropical storms. These events, also recorded by sporadic freshwater floods in the Dead Sea lakes and increased phreatic activity along the Gulf of Aqaba, are superimposed on the long-term interglacial arid conditions.
Deep drilling in lakes sponsored by the International Continental Scientific Drilling Program (ICDP) continuously brings new insights into past environmental changes at various temporal scales. Within that framework, initial results from a ~460 m core obtained at ~300 m water depth in the Dead Sea provide valuable information that complements the previous studies. This will help to better understand the environmental conditions that accompanied human development and migration through the Dead Sea corridor.

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ABSTRACT

Large-scale atmospheric circulation driving extreme climate events in the Mediterranean and related impacts

It is widely accepted that the Mediterranean basin represents one of the most prominent “hotspots” of climate change and particularly vulnerable regions in the world. Recent trends towards a hotter and drier climate appear to be related to changes in atmospheric circulation patterns, particularly over western Mediterranean. The combined effects of precipitation decrease and surface temperature increase in the Mediterranean will most probably lead to important changes in the region’s water cycle. In fact, the present tendency towards a drier climate with higher frequency of drought events agrees with climate change scenarios that point to increasing probabilities of drought episodes and severe heat waves. The talk is referring to the latest MedCLIVAR book chapter that provides a multi-disciplinary review on the state–of–the–knowledge science of the two natural hazards in the Mediterranean. It covers a wide range of atmospheric circulation phenomena with direct impact on climate and socio-economic activities in the twentieth century and with relatively high probabilities of changing significantly throughout the present 21st century (e.g., water resources, renewable energy, agriculture, vegetation dynamics) but also natural hazards (e.g., droughts, heat waves, sea surges and flooding in Venice).

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ABSTRACT

Variability of the Eastern Mediterranean overturning circulation, with emphasis on Aegean Sea developments

In the last 30 years the Eastern Mediterranean overturning circulation exhibited significant variability, which caused a thorough revision of the oceanographic community's understanding of the relative functioning of the various sub-basins of the sea. In this work we will review the "regular" overturning circulation of the Mediterranean and describe the Eastern Mediterranean Transient event, its progress and the various forcing scenarios presented in the literature. Furthermore, we focus on the Aegean Sea, presenting the developments during and after the EMT event (with reference to parallel developments in other basins of the Eastern Mediterranean). The period of very energetic overturning in the Aegean in the late 1980s – early 1990s was followed by a long stagnation period in the North Aegean. During this period the deep layers of all sub-basins of the region behaved in a similar manner, exhibiting increased rates of dissolved oxygen decay and rise of nutrient concentration. Starting in 2001, sporadic episodes of mild deep water formation episodes have been recorded, signifying the end of stagnation in the North Aegean. We proceed to examine mechanisms controlling deep water formation in the various sub-basins of the Aegean Sea and the potential connection to the thermohaline circulation of the greater Eastern Mediterranean Sea.

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ABSTRACT

Climate Change and Tourism: Southeastern Anatolia Region and Southeastern Anatolia Project (Gap) in Turkey as a Case Study

The Republic of Turkey has a special place in the Mediterranean Region from the respects of both its social-economic structure and its geo-politic and geo-strategic importance. It is also a model for the Middle East Countries by combining the traditional and modern life styles. The Southeastern Anatolia Project (GAP), one of the most important projects to develop the remarkable natural resources of the world, is accepted as a change for getting benefit from rich water and agricultural resources of the Southeastern Anatolia Region for Turkey and the region. The climatic changes have been observed in the region after formation of artificial lakes and the process of watering. The terrestrial climate which has been resigned in the region has started to leave its plave to caused changes in the structure of rural tourism in the region. It is also created new types of flora and an environment for alternative tourism types. Recent years, remarkable developments have been observed from respect of both eco-tourism and agro-tourism in the region. And, also an increase in the flow of tourists to the region also has been observed. The main purpose of this study is to analyze the effects of climatic changes from devrestrial climate to soft are in the region. For this reason, in the first section, a brief introduction of the region and the GAP Project will be given. In the second section, the climatic structure of the region will be examined. Also, both the climatic feature and touristic structure of the region before and after the GAP Project will be included in examination. In the third section, the results of climatic changes and new tourism alternatives will be analyzed. Again, in this section, the existing tourism potential will be determined. This study will present a series of policies and strategies for differential tourism and tourism development after the climatic changes in this region

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ABSTRACT

Upper ocean climate of the Eastern Mediterranean during the Holocene Insolation Maximum – a model study

9000 years ago, the northern hemisphere experienced enhanced seasonality caused by an orbital configuration with a larger precession amplitude. To assess the impact of this ``Holocene Insolation Maximum`` on the Mediterranean Sea, we use a regional ocean general circulation model forced by atmospheric input derived from global simulations. The stronger seasonal cycle is manifested in the model, which shows a relatively homogenous winter cooling and a summer warming with well-defined spatial patterns, in particular a subsurface warming in the Cretan area. The mechanisms responsible for the peculiar subsurface pattern are found to be a combination of Ekman pumping, increased wind mixing due to strengthened Etesian winds and enhanced thermal forcing due to higher summer insolation rate. Together they induce a stronger heat transfer from the surface to the subsurface during late summer in the Cretan region. The validation of simulated early Holocene SSTs with SST reconstructions from planktonic foraminifera transfer functions shows that the unusual subsurface warming pattern is recorded by both model and proxies. However, this conclusion is only possible if the transfer function SST is reinterpreted as reflecting the conditions throughout the upper water column and not strictly the 10-m level to which it has been calibrated. Such a depth-integrated approach accounts for the vertical range of preferred habitat depths of the foraminifera used for the reconstructions. With a linear integrated approach, we obtained temperature reconstruction averaged over 0-30 m depth and improved the agreement between modelled and reconstructed temperature signal.

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ABSTRACT

The effect of meteorological conditions on PM10 in Istanbul

Istanbul is a metropolitan city, which is exposed to high PM10 levels between October and May. In order to evaluate the relationship between PM10 values and synoptic conditions, modeling studies for dust loading and satellite data for aerosol optical depth (i.e., between 2004 and 2010) have been evaluated. According to the meteorological observation and model results, Istanbul has high PM10 emissions due to long-range transport of pollutants as well as transport of natural dust. Region has been affected by anthropogenic pollution by northwestern winds and mineral dust by mainly south and southwestern winds. Especially, dust from Saharan Desert has been shown to reach to Istanbul via models and satellite data. More than 50% of PM10 exceedances have occurred between October and May of 2004-2010 time period. Specifically more than 40 exceedance events happened during winter and spring (the daily average does not exceed 50 μg/m3 on more than 35 days annually according to the EU Clean Air Directive). It is hypothesized that more than 75% of these events occurred, due to anthropogenic emissions during winter and more than 50% of these events occurred due to transport of mineral dust during spring. This study presents the relationship between aerosol transport to Istanbul and synoptic conditions, and impacts of aerosols on the city's air quality. Air quality measurement data have been evaluated according to the data obtained from Turkish Ministry of Environment and Forestry. Dust modeling studies have been evaluated according to the DREAM Model of Barcelona Supercomputing Center, and aerosol optical depth satellite data were obtained from MODIS-Terra Version 5. Sensitivity simulations by RegCM4 have been run for 21-24 March 2008 episodes. The results were analyzed to quantify the effect of mineral dust on the temperature and precipitation change over Turkey for a spring episode.

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ABSTRACT

High-Resolution Late Holocene Climatic Records of Lakes and Lagoons at Western Turkey

This study focuses on climatic and environmental sedimentary records of the last 6000 years in Kьзьkзekmece Lagoon (Эstanbul), Uludap glacial (Bursa), Yeniзapa (Bolu) and Bafa (Mupla) Lakes in western Turkey. The water bodies are located on a N-S transect in western Turkey, and as such their records are important for assesment of Late Holocene eastern Mediterranean climatic changes.
A total of 12 cores varying between 0.6 and 4.8 m are analyzed at 5 mm resolution using Multi Sensor Core Logger (MSCL) having magnetic susceptibilty, P-Wave, density and resistivity sensors, XRF (X-Ray Fluoresance) core scanner multi element analysis at a 0.2 mm resolution. The cores are then sampled at 20, 50 and 100 mm intervals for different analyses. The samples are analyzed for total inorganic (TIC) and organic carbon (TOC). The ostracoda and benthic foraminifera shells in the sand size fraction of the sediment samples are identified under binocular microscope and suitable species are picked and analyzed for the stable oxygen and carbon isotope analysis. The cores are dated using AMS 14C analysis. The data indicate a major dry period during ca 2600-1300 a BP and a wet period during ca 1300-600 BP in the Bafa and Yeniзapa Lakes, with the latter period corresponding to the Medieval Warm Period. The Little Ice Age record was found in all three areas with a relatively wet spell in the north and a dry spell in the south. The results further indicate the evolution of Lake Bafa from a coastal inlet of an estuary into a brackish water lake ca 3000 BP.

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ABSTRACT

Meteorological Database Over The Mediterranean Sea Through Old Royal Navy Logbooks

Paleoclimatic studies are useful in understanding the present climate variations, because they put the variability of the relatively short instrumental period in perspective. Beyond the usual single-station reconstructions, the generation of gridded variables as large-scale sea level pressure (SLP) is crucial when addressing past climates.

In this sense, the Mediterranean Sea seems to have more than a local interest. Recent studies show that data over Mediterranean sea improve the SLP reconstructions in all Eurasia. Therefore, it is quite interesting to obtain further data over this region to improve the current reconstructions of a large portion of the Northern Hemisphere.

Ship's logbooks have proved to be one of the most effective sources to reconstruct the past climate and to generate gridded databases where no other high resolution data are available (as is the case of open waters). Royal Navy documents from the 17th, 18th and 19th centuries along the Mediterranean Sea are quite abundant and up to now, they have not been fully exploited. These documents have a big potential to improve the climatic information in the Mediterranean in the pre-instrumental period.

In this poster a new database from English logbooks over the Mediterranean sea is presented, comprising information scanned, transcribed, and analyzed from a total of 313 logbooks of The National Archives at Kew, UK. As well, some examples of the kind of information available, excerpts from the resulting database, and some preliminary results with the first analysis of this database are shown. Finally, the next challenges in this line of research are outlined.

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ABSTRACT

Coccolithophores Response To NAO-Like Millennial Forcing: A Time-Space Reconstruction Over The Last 30 Ka In The Thyrrhenian Sea

A substantial portion of Mediterranean region climate variability is strongly influenced by the main teleconnection acting on the North Atlantic sector, the North Atlantic Oscillation (NAO). NAO corresponds to positive and negative winter oscillations between the Azores High and the Icelandic Low (Visbeck et al., 2001), occurring on a wide range of time. Over the Tyrrhenian Basin, during a positive phase, temperate and dry conditions occur; the negative phase is characterised by cold and wet conditions (Hurrel, 1995; Visbeck et al., 2001). In the Tropics, Mediterranean Region and North Atlantic quasi- periodic cycles of about 2.3-2.5 kyr have been observed in Holocene (Keigwin and Pickart, 1999; Rimbu et al., 2004) and Pliocene records (Munoz et al., 2002; Kloosterboer-van Hoeve et al., 2006) and related to long-term NAO forcing. In this study, data obtained on coccolithophores assemblages from ODP Site 974D have been compared and integrated with published data from BS79-33 (Sbaffi et al., 2001), C18 (Amore et al., 2004), C106 (Buccheri et al., 2002) gravity cores, localised in the Tyrrhenian Sea at different latitudes and water depths, in order to recognise high frequency oscillations occurred over the last 30 ka. Coccolithophores have been used in recent to better understand the dynamics controlling changes in the climate system. Statistical analyses in the frequency and time domain have been used in understanding the spectral content and the relations among the studied time series. ODP Site 974D and BS79-33 gravity core are localised at the deepest investigated water depths and they allow defining the influence of the deep current on the coccolithophores assemblages. C18 and C106 gravity cores are localised close to the coastline at the shallowest depths, allowing to identify surface dynamics and river run-off influences. Thanks to the four chosen cores, time-space reconstructions of the Tyrrhenian Sea have been carried out in terms of changes in the water column structure and in winds intensity causing changes in coccolithophores assemblages during NAO-like phases. In order to collocate the recognised events in a global scenario, δ18O records (available for BS79-33, ODP 974D and C106 site) have been correlated with NGRIP ones.

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ABSTRACT

Towards a more complete knowledge of the Iberian ocean waters climate through baroclinic ocean climate simulations

A project aimed at generating, through numerical modeling, regional ocean climate products for the Mediterranean and the Iberian Atlantic waters is currently being developed by Spain's AEMET (Agencia Estatal de Meteorologна) and Puertos del Estado. These simulated products include variables such as wave, sea level, currents, temperature and salinity. By accomplishing these tasks, it is expected to get a more complete knowledge of the current ocean state and its possible evolution under climate change scenarii, around the Iberian Peninsula and over the Mediterranean.

Within the project, different baroclinic hindcasts and climate change scenario runs are planned. To this aim, a configuration based on the new regional baroclinic ocean model NEMO-MED12 (Brossier et al., 2010) has been defined and tested for the geographical domain to study. Two hindcasts are ongoing by prescribing to the regional ocean model, air-sea surface fluxes from a dynamical downscaling of ERA40 (1961-2000) and ERA-interim (1989-2008), performed by means of the RCA3.5 atmospheric model. On the other hand, climate change scenario simulations, spanning from 1961 to 2050, will be achieved with surface boundary conditions corresponding to the SRES A1B scenarii derived from RCA3.5-downscaled ECHAM5 and HADCM3 global models. The Atlantic Ocean temperature and salinity are relaxed to DRAKKAR climatology, ECHAM5 or HADCM3 data, depending on the integration. The river runoff and Black Sea freshwater inputs come from monthly mean climatologies. In addition to the simulations, comparisons will be carried out to validate hindcasts and to verify consistency of the future projections.

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ABSTRACT

The role of the Euro-Atlantic circulation in the occurrence of summer temperature anomalies and extremes in the Mediterranean

The main goal of the study presented here is the identification of the mid-latitude circulation patterns related to summer air temperature anomalies and extremes in the Mediterranean basin.

At seasonal (June-July-August; JJA) time-scale, the statistical relationships have been explored for the period 1979-2008, applying the Singular Value Decomposition (SVD) analysis to the NCEP-DOE Reanalysis 2 (R-2). In June-July, the main T850-Z500 covariance mode (explaining about 50% of the variability) shows a northwest-southeast temperature anomaly dipole associated to a similar geopotential anomaly pattern. On the other hand, in August, the main T850-Z500 covariance mode (about 50% explained variability) shows high temperature anomalies over the Mediterranean associated to high pressure anomalies over southern Europe and low pressure anomalies over northern Europe. The temperature anomalies in the Mediterranean can be associated to the subtropical jetstream variability, that modulates the circulation in the mid and high troposphere through the across-jet ageostrophic circulation in its exit and entrance regions.

Hot days (HDs) have been defined, at a basin scale, as the days when the daily T850 at Z12 exceeds the 90th percentile in JJA 1979-2008, while a heat-wave (HW) is defined as a sequence of 3 or more hot days. The number of HDs, short (3-5 days) and long (6 days and more) HWs dramatically increased in the last decade (1999-2008), in agreement with results from the analysis of in situ data in the Mediterranean. The circulation anomalies associated to the long HWs show the presence of a strong Z500 positive anomaly over central Europe, related to an anticyclonic anomaly aloft and a southerly low-level warm advection over western Europe; the Atlantic jet deeply penetrates northern Europe, while the African jet migrates eastward, and a concomitant anomalous downward motion enhances the subsidence over the eastern MB.

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ABSTRACT

Dynamical downscaling of climate change projections for Catalonia (NE Spain) during the 21st Century.

A dynamical downscaling technique is presented to generate climate change projections for the 21st century in Catalonia from the outputs of the ECHAM5/MPI-OM atmosphere-ocean coupled general circulation model. This technique consists of long intregations (5 years) with the MM5 mesoscale model using three one-way nesting domains of 135, 45 i 15 km horitzontal resolution and 23 vertical levels. Two possible emission scenarios from the Special Report on Emission Scenarios (SRES) are used in order to generate regional projections: A2 (severe) and B1 (moderate).

Only 2-m temperature and precipitation are analysed in detail, as they are the variables with the highest social interest and play an important role in hydric resources in Catalonia. The space-time general patterns of these variables are correctly captured by the used methodology, but not for precipitation seasonal cycle. The developed simulations also presents a significant cold bias for temperature, as well as a general precipitation overestimation.

The obtained scenarios project a significant increase in temperature (> 5ϵC at the end of this century) and a decrease in annual-mean precipitation for this century, but with a high spatial and temporal variability. This decrease is higher during the warm part of the year (> 50% for summer at the end of this century). On the contrary, it is projected a light increase for nearly the whole cold part of the year. Regarding extreme values, a significant increase in extreme hot event and a light decrease in the coldest episodes are expected. In precipitation, it is projected a very important increase in dry periods. However, it is also projected an increase in extreme precipitation events. The projected changes are more significant for A2 scenario than B1 scenario.

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ABSTRACT

A study of anthropic and natural sources of aerosol in central Mediterranean Sea by bulk PM10 and size-segregated aerosol chemistry

Due to the relevant role of aerosol in affecting climate, studies of variability in aerosol chemical composition at marine sites coupled with optical properties are requested in order to understand the complex aerosol-climate interactions, and reduce the uncertainty in the determination of the aerosol radiative forcing. In particular the Mediterranean region has been identified as one of the Hot-Spots in future climate change projections. In order to understand the contribution of natural and anthropic source and their optical properties in the Central Mediterranean Sea continuous observations of greenhouse gases concentration, aerosol properties, total ozone, ultraviolet irradiance, and other climatic parameters are routinely carried out at Lampedusa (35ўX N, 12.6ўX E). Since June 2004, PM10 sampling continuous campaign has been performed. A spot campaign with 8-stage impactor was also carried out in spring 2008. Each filter was analyzed for main and trace ions, and selected metals (HNO3, pH = 1.5). Half of PM10 filters were analysed by PIXE for total (soluble and insoluble) elemental content. The main sources impacting the site are primary marine, crustal, anthropic from long range, ship emission and biogenic productivity. Here in particular ship emission and biogenic activity are presented and described in detail.Ship emissions are identified using V as specific marker of this source, back trajectories analysis confirm that the selected events are affected by sea going ship and not from local pollution (i.e. Lampedusa harbour) confirming their provenience from the ship track crossing the Strait Sicily. A seasonal behaviour with summer maxima is observed for the ship aerosol markers, in this season the aerosol from ship emission contribute for about 0.9 ƒЭg m-3 and represent as average the 3% of the PM10. A very intense event in spring 2008 was chemically and size characterised showing that elements arising from heavy oil combustion (V, Ni, Al, Fe) are distributed in the sub-micrometric fraction of aerosol and the metals are present as carbonates, idroxides or metallorganic compounds so that they are dissolved in mild condition. About the marine biogenic source a linear correlation between satellite monthly mean marine primary productivity and atmospheric concentration of MSA was found. Indeed, a possible link between MSA concentration and atmospheric condition over Mediterranean basin correlated to North Atlantic Oscillation index was investigated.

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ABSTRACT

Forests and climate change. Recent evidences from the ICP-Forests intensive monitoring network in Italy

Forests are ecosystems naturally sensitive to the occurrence of climate anomalies or extreme events because of the long life-span of trees and of their permanent interaction with the growth medium, i.e. atmosphere and soil. Trees record therefore any deviation from the steady status of the growth environment, beyond the natural seasonal fluctuation. A quite sensitive parameter is the radial stem growth and that is why "growth assessment" is one of the basic actions performed within the "Intensive monitoring of forest ecosystems" in the pan-European level II network ICP-Forests, currently running under LIFE+ FutMon. Among the chemical and physical concurring or counteracting factors driving today the soil-tree-atmosphere relationships in the Mediterranean region, climate deviations at local up to geographical scale and extreme events (drought coupled with high air temperature, rainfall shortage, storms, etc.) are playing a major role. The main recent evidence of such occurrences is the heat wave in summer 2003 that affected a large part of Europe. Within its Southern boundary (Northern-Central Italy), it resulted in a marked water stress due to the heavy rainfall deficit coupled with high and prolonged air temperature. A growth reduction up to 50% was detected on two/thirds of plots located within the concerned area. Sites at low elevations and the more sensitive tree species (i.e. oaks and beech) were involved. Lately, a growth decrease was recorded mainly in the coniferous forests located at medium-high elevations in the Alps. In this region, the repeated occurrence of anomalous seasons, both in terms of rainfall and air temperature, was highlighted over the last five years. Finally, the occurrence of a heavy change in tree species composition related to the length of the monitored period (13 years), has been measured in a plot located at the Southern border of the Po valley. Here, two oak species, with a different auto-ecology as for water demand, live together within the same forest. The more drought-tolerant species (Turkey oak) resulted less affected (higher growth rate and much lower tree mortality) by the significant increase of air temperature and water stress occurred at this site. A multivariate analysis allowed us to identifying the driving factors of Sessile oak decline: GPRI, LFI, WI, SI.

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ABSTRACT

Climate in Spain: Past, Present and Future (Poster)

This report by the CLIVAR-Spain Thematic Network summarizes and assesses the available information on the physical aspects of the changes that have been observed in the climate of the Iberian Peninsula (IP), both in current times and in the distant past, and tries to enhance our understanding of those changes in order to better predict the impacts of future changes.

The r It is based on the contributions of a large number of researchers (>100) and has been revised both by the contributors themselves and by external reviewers. In addition to these contributions, the report includes findings from many other national and international scientists, with the aim of documenting all relevant results. It is also important to point out that the information contained in this report is based in its entirety on peer-reviewed publications listed in the Science Citation Index (SCI).

The poster will summarize the principal findings of a recently published scientific report by the CLIVAR-SPAIN community that synthesizes and assesses the available information on the physical aspects of the changes that have been observed in the climate of the Iberian Peninsula (IP), both in current times and in the distant past. The report tries to enhance our understanding of those changes, in order to better predict the impacts of future climate variations. It is based on the contributions of a large number of researchers and has been revised both by the contributors themselves and by external reviewers. Understanding the causes and effects of climate variations as well as the multiple interactions that take place within the climate system is a complex scientific challenge. In order to understand climate change at a regional scale it is necessary to adopt a wide perspective and acquire a detailed knowledge of the internal dynamics of climate and its natural variability. For this reason, this report on the climate of the IP is structured in five chapters, ranging from past climates, to current climate changes, to future climate projections, and includes two chapters dealing with climate variability in the IP. In chapter I, the state of affairs in paleoclimate research in the IP is presented. In chapter 2, recent changes in the main atmospheric variables (temperature and precipitation) are discussed and compared to the range of variability observed during the instrumental period. Chapter 3 examines observed variations in the temperature and salinity of the waters of the different basins that surround the IP, as well as sea level variations and changes in coastal and oceanic currents. The next chapter is devoted to the atmospheric teleconnections that influence the climate of the Euro-Atlantic sector on seasonal to decadal timescales, focusing on the NAO and ENSO. The last chapter deals with regional climate projections for the IP: the mean state of the climate, changes in interannual variability and changes in the frequency of extreme phenomena are examined.
The report also identifies gaps in knowledge and major uncertainties that need to be resolved in order to increase our confidence in short and long term predictions of future climate and be able to better predict the impacts of future climate changes.

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ABSTRACT

Connections Between The Summer NAO And Drying In The Mediterranean Region (Oral)

Climate simulations for the XXIst century project pronounced precipitation decreases in the entire Mediterranean region, particularly in summer. This projected summer drying is very consistent across models, which makes this projection particularly reliable, but only in a multi-model sense. Overall, however, there is little observational evidence that this signal has already started to emerge from the background of natural variability. The mechanisms associated with this projected summer drying have also not been sufficiently studied. We attempt to increase our confidence in model projections by investigating whether the large-scale mechanisms that influence summer precipitation in the Mediterranean region are well represented in the models. Specifically, we compare the role of the summer NAO in driving interannual and long-term changes in precipitation in the observations and in the models. The spatial structure of the summer NAO is significantly different than that of the winter NAO, being more spatially confined and shifted to northern latitudes. Consequently, the impact of the summer NAO on precipitation is roughly opposite in sign to that of the winter NAO. Thus, summers with a positive NAO tend to be characterized by warm and dry conditions in northwest Europe (particularly the British Isles) but cold and wet conditions in the northern Mediterranean (particularly Italy and the Balkans). Although most climate models reproduce the spatial pattern of the summer NAO, the simulated impact in the Mediterranean region is far too weak. The failure of models to capture the observed pattern of enhanced precipitation during summers with a positive NAO is a matter of concern for simulations of future climate because many of these models predict an upward trend in the summer NAO. Thus the model errors in representing the influence of the summer NAO will impact the projected precipitation trends in the Mediterranean. In particular, we argue that models may be overestimating future precipitation decreases in this region.

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ABSTRACT

Understanding the climatological structure of the Mediterranean winter-time storm track

The cyclones of the Mediterranean storm track dominate the weather and climate of the Mediterranean. Subtle variations in the storm track are associated with marked changes in precipitation, wind speed and temperature over the whole area. There is evidence to suggest that such changes may have had profound impacts on the development of ancient cultures and civilisations and, looking to the future, the Mediterranean is commonly identified as a hotspot of climate change. It is therefore essential to understand the physical processes associated with the Mediterranean storm track in order to produce confident and robust projections of climate change over Europe and the Mediterranean.

Motivated by previous work looking at past changes in the storm track over the Mediterranean (Brayshaw et al, 2010), this poster will outline a new research project that examines how the Mediterranean storm track is controlled by the interaction of both local processes (e.g., orography, land-sea contrast, moisture availability) and the large-scale atmospheric flow (e.g., the circulation over the North Atlantic area). This will use a combination of "semi-realistic" GCM experiments and reanalysis datasets, to extend a framework which has already proven successful in understanding the drivers of the Atlantic and Pacific storm tracks (Brayshaw et al 2011a, 2010, 2009). The understanding developed will be related to changes in the Mediterranean climate over the past several millennia (building on the Holocene climate work described in Brayshaw et al 2011b,c and 2010) and in future projections.

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ABSTRACT

Towards a long-term climatology of Medicanes.

Medicanes, strong mesoscale cyclones with some resemblance with tropical cyclones and polar lows (warm core, cloud-free eye, winds up to hurricane speed), are known to develop occasionally over the Mediterranean Sea. Medicanes are rare phenomena in present climate; however, due to the strong dependence on air-sea fluxes, their intensity and frequency are likely to be highly sensitive to regional climate change in the Mediterranean area.

The scarcity of observations over sea and the coarse resolution of the long term reanalysis datasets and global models projections make it difficult to study systematically the statistical and dynamical properties of those events, both for climatological values and for future climate.

Our goal is to assess the Medicanes long term variability and trends, using the COSMO-CLM limited area model to perform a dynamical downscaling of the NCEP data for 1960-2010 and of GCM outputs in future climate scenarios, and defining an appropriate set of conditions to characterize and track Medicanes.

As a proof of the robustness of this method, we show results on the model skill to reproduce a number of test cases studied in the literature, and on the performance of the detection and tracking algorithms.

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ABSTRACT

Investigating relationships between Oscillation Patterns around the Mediterranean and their influence on aerosol transport using a Regional Climate Model (RegCM4).

Oscillation Patterns such as the North Atlantic Oscillation (NAO), Mediterranean Oscillation (MO), Western Mediterranean Oscillation (WeMO), North Sea- Caspian Pattern (NCP), Central African-Caspian Oscillation (CACO), as well as others, have important impacts on the climate and meteorology of the Mediterranean, one of which is aerosol transport. The Regional Climate Model RegCM4, is being used to simulate the climate of 1970 to 2000 for a domain covering most of the northern latitudes, and spanning from the North Atlantic to the Middle East, at 50 km resolution. Indices for these patterns will be extracted from this simulation and any interactions with each other, and wind vectors will be studied. Since aerosol transport is dependent on wind vectors, the aerosol transport will be studied by using data from major emission sites and analysing the wind activity in those regions. Since the model considers black carbons and dust amongst others, an evaluation of the climate impact in the Mediterranean region will be performed. From this simulation, the Mediterranean domain will be extracted and the studies will be applied to this region.

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ABSTRACT

Trends and variability in precipitation extremes along the eastern Adriatic
The spatial-temporal change in seasonal and annual precipitation during the second half of the 20th century and the first decade of the 21st century is analysed along the eastern Adriatic coast. Change in extreme precipitation conditions is investigated by trend analysis of seven indices of precipitation extremes proposed by World Meteorological Organization (CCl and CLIVAR). They are calculated using daily and multi-day precipitation data for 23 rain gauge stations on the islands and the coast. The data series from the period 1953-2009 meet the criteria for calculating the indices. Trend for each station is estimated by means of Kendall's tau method and the statistical significance is tested using the non-parametric Mann-Kendall test. The overall significance is assessed by Monte Carlo method. In order to evaluate the intensity and frequency of more rare events, the Generalized Extreme Value (GEV) distribution is applied to the time series of annual maxima of 1-day and 5-day precipitation amounts. Since the middle of 20th century a general decrease in annual precipitation is found, becoming stronger from north to south. Seasonal trends are found to be less homogeneous, both in direction and magnitude. Overall significant increase in the frequency of dry days is accompanied by slight change in the frequency of wet and very wet days. According to the daily intensity index, positive trends dominate over the analysed area. In spite the total precipitation decrease, part of annual precipitation amount coming from very wet days is increased. The 1-day and 5-day annual maxima showed large interannual variability. GEV distribution shape parameter has mainly negative values meaning that for the longer return periods the return values are likely to be overestimated. The estimates of 20-year return values calculated for 30-year moving periods indicate a strong influence of the upper outliers. An appearance of the upper outliers during the observed 60 years is discussed according to the 20-year return value.

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ABSTRACT

Assessing improvement of RCM with respect to GCM climate simulations over the Mediterranean region: mean monthly fields

This study analyzes the monthly precipitation and temperature climatology produced by climate models in the Mediterranean region and compares it with the gridded observational CRU (Climate Research Unit) dataset of the East Anglia University. The purpose is to identify and quantify improvements obtained by RCMs (Regional Climate Models) with respect to the GCMs (Global Climate Models) that supplied the initial and boundary conditions. Data are provided by the GCMs and RCMs that were used in the PRUDENCE and ENSEMBLES European projects. RCMs are very good at compensating the GCM bias for temperature, but less successful for precipitation. They are less effective reducing the root mean square error, meaning that improvements during some months/areas is partially spoiled by deterioration during other months/areas. In general, though errors on temperature are smaller than errors on precipitation, unfortunately, improvements by RCM are larger for temperature than for precipitation. RCMs outperform GCMs quite convincingly in summer months for both variables, but not for precipitation in winter. RCMs are very effective at reducing systematic GCM errors in coastal areas and at high levels over complicated orography. It is shown that errors of GCM temperature can be only partially compensated by a simple correction based on a constant (both in space and time) lapse rate accounting for wrong elevation. For precipitation, RCMs do not always improve results over large continental areas, where individual RCM and also their ensemble mean can get worse than GCM. Ensemble mean for both RCM and GCM provides results that, though they are not always better than those of the individual models, are exempt from major problems. RCMs systematically outperform GCMs when considering climate type classifications.

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ABSTRACT

Mediterranean Operational Oceanography Network in support of environmental applications

The Mediterranean operational oceanography research community started to develop the backbone of the Mediterranean ocean Forecasting System-MFS in early 1998 and it has been progressing ever since. The Mediterranean Operational Oceanography community is working, since 1998, to plan, implement and sustain the operations of operational marine forecasting services. In the past ten years European projects contributed to develop the international scientific base for the deployment of an efficient and accurate forecasting system at basin scale, which is nowadays used by many institutes/agencies from all the countries bordering the Mediterranean.
As a result of these developments, a new network has been established, the Mediterranean Operational Oceanography Network (MOON, http://www.moon-oceanforecasting.eu/) coordinating the upgrades of the MFS, the sub-regional nested systems, the observation system and their applications. MOON services are based on and contribute to the GMES (Global Monitoring for Environment and Security www.gmes.info) European initiative that, through the MyOcean project (www.myocean.eu.org), is building the Marine Core Service (MCS) for European Seas. MOON products include downstream services such as environmental indicators and oil spill detection and forecasting systems.
An example of environmental indicator is the one developed for the European Environment Agency-EEA). This indicator is based on ocean colour products that have been used to estimate Chl-a trends in European Seas. The work aims to complement the EEA CSI023 indicator for eutrophication, which is based on chlorophyll-a (Chl-a) in-situ observations, by developing a new indicator based on ocean colour data. The new indicator, called CSI023(+) is computed from MyOcean ocean colour gridded data as a temporal trend at each grid point, starting from 1998. Thus CSI023(+) consists of significant Chl-a trends normalized by the Chl-a standard deviation. Validation of ocean colour products has been carried out by comparison with observations of the Eionet EEA database, and it is believed that such validation should continue in the future, perhaps with a dedicated data collection exercise.
In the field of oil spill MOON support REMPEC (Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea) and MOON partners are collaborating with National Coast Guards. Several oil spill models have been developed and adapted to interface with the MOON real time oceanographic data. MOON oil spill forecasting systems have been used in several oil spill emergencies starting from the Lebanon 2006 oil spill crisis. Subsequently, MOON established a collaboration agreement with REMPEC and an Emergency Response Office to support REMPEC in managing oil spill emergencies.

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ABSTRACT

Holocene vegetation and marine environment variability in Central Mediterranean from a direct land-sea correlation.

This study seeks to characterize the nature and amplitude of terrestrial and marine ecosystem changes in the Central Mediterranean region in response to orbital and abrupt climatic variability during the current interglacial. We present a high resolution multi-proxy record from the marine core MD04-2797CQ covering most of the Holocene and including terrestrial and marine climatic proxies (pollen, alkenone-based sea surface temperatures (SST), planktonic foraminifera assemblages and derived SST, dinocyst associations, planktonic carbon and oxygen stable isotopes). This core was retrieved from the Siculo-Tunisian Straight in the central Mediterranean Sea and represents the most meridional site studied in the framework of the LAMA project on "Holocene changes in environment and climate, and history of human societies in Central Mediterranean as reflected by lake and marine records". The coupled marine and terrestrial proxy analyses enable to correlate without chronological ambiguities the detected vegetation and climatic changes in Sicily and mainly Northern Tunisia to the central Mediterranean Sea environment variations. This direct land-sea correlation will contribute to tackle the marine and atmospheric mechanisms controlling the past temperature and hydrological changes in Central Mediterranean at orbital and millennial time-scales.

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ABSTRACT

Climate-change induced bioclimatic shifts in Italian beech (Fagus sylvatica L.) forests assessed through a tree-ring network crossing the Mediterranean-Temperate biomes

Tree cores were extracted from a tree-ring network made of several beech forests with few signs of human disturbance spread throughout the Italian territory. Sites where selected in order to cover the largest part of the species distribution range in Italy and cover most of its altitudinal range over the studied territory. Tree-ring data were standardized to amplify their climate signal and obtain a site chronologies for each forest. The spatial organization of the climate signals in tree–rings was used to build a bioclimatic classification of Italian beech forests according to their main limiting climatic factors. The application of multivariate classification techniques on moving windows evidenced an instability of the detected bioclimatic classification in the last decades following the recent climate warming. In particular, an upward shift of the zonation was detected in central Italy's mountains, were some stands at the boundary between two altitudinal zones passed to the upper one after changing their response to climate. Moreover, we observed a northward shift of mediterraneity, with Summer drought effects expanding to eastern Alps low-elevation beech forests in the last decade. Since the observed bioclimatic shifts were related to recent climate warming, this study can offer a framework into which the potential impact of global change on Italian forests functioning and services can be assessed. In particular, the multidecadal stand productivity variations in the different bioclimatic zones were analyzed and put in relation with climate variability.

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ABSTRACT

Radiative forcing by Mediterranean aerosols in the infrared spectral range

The infrared contribution to the aerosol radiative forcing is often neglected in climate studies. The IR radiative effect produced by desert dust and marine aerosols may be significant, and offset a significant fraction of the cooling effect produced by the aerosols over the ocean in the shortwave. Both desert dust and marine particles are main contributors to the Mediterranean aerosols, and the IR effects may play an important role in regulating regional climate. To our knowledge, no direct determinations of the IR effect of Mediterranena aerosol has been obtained so far. In this study the infrared signature of atmospheric aerosols at the surface has been investigated using several years (2006-2010) of measurements made at the Station for Climate Observations on the island of Lampedusa (35.5°N, 12.6°E), in the central Mediterran ean. Measurements of aerosol optical properties and column water vapour, retrieved from Multi-Filter Rotating Shadowband Radiometer (MFRSR), temperature and relative humidity, measured by the local meteorological station, and downward longwave irradiance, measured with a Precision Infrared Radiometer (PIR), are used. The PIR radiometer is mounted on a solar tracker, and is regularly calibrated (at least every two years) versus the World Radiation Reference of the World Meteorological Organization. Cloud-free period are selected on the basis of solar global and diffuse measurements. The aerosol IR forcing is derived by using the direct method, i.e. plotting the measured downward irradiance versus theobserved aerosol optical depth. The slope of the linear fit to the data is the IR forcing efficiency, i.e. the IR forcing produced by aerosols with unit optical depth. In order to remove the influence of air temperature and atmospheric water vapour, the direct method was applied to measurements obtained at fixed temperature and within a limited interval of column water vapour. Cases of desert dust and marine/ mixed particles have have been selected for spring/summer conditions (temperature between 26.5 and 27°C) and autumn/winter (temperatures betw een 16.5 and 17°C). For both aerosol groups the IR surface forcing is positive. The surface IR forcing efficiency is (43.5±2.3) W/m2 in autumn/winter and (39.9±1.2) W/m2 in spring/summer for desert dust, and is (64.4±1.9) W/m2 in summer for mixed/marine particles. Considering all particles types together, we derive an IR forcing efficiency of (27.6±1.9) W/m2 in autumn/winter and (31.9±0.7) W/m2 in spring/summer. The aerosol effect thus compensates for 20-35% of the shortwave instantaneous forcing, and up to 40% of the daily shortwave forcing at the surface.

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ABSTRACT

Main Circulation Types Associated With Weather Regimes Of Significantly Decreasing Precipitation In The Mediterranean (1950 - 2000)

The significant decrease of monthly and seasonal precipitation in the Mediterranean Basin between 1950 and 2000 concerns five cases distributed in four regions: the Mediterranean Iberia (in October), the Atlantic Iberia (in March), Greece (in January and winter) and the Near East (in winter). They have been explained by four main basic circulation types. The main circulation types related have been determined from CCAs (Canonical Correlation Analyses) on monthly and seasonal precipitation of all the stations in the whole Mediterranean Basin and 500hPa geopotential height data in the Euro-Atlantic window. Each type of data has been simplified before by PCAs (Principal Component Analyses). The main circulation types have been determined by choosing the significantly precipitation decreasing scores (one or two) of the CCPs (Canonical Correlation patterns). Seven teleconnection patterns best explain the regional rainfall significant decreases: West Iberia / Eastern Mediterranean, West Iberia / West Russia, North Sea / West Russia, Eastern Mediterranean / East Atlantic, North West Atlantic / West Russia, Central Mediterranean / West Russia and Central Mediterranean/ West Atlantic. The corresponding weather regimes have been studied at the daily timescale. For each of the five cases they have been divided into two subsets according to the importance, high or low, of the daily rainfall they bring for the concerned region.
Weather regimes are very much influenced by the physical features of the Mediterranean Basin: the existence of that inland sea which is the Mediterranean, the latitude and the drawing of the coastlines making a difference between coast with or without peninsulas which partitioned the Basin.
So a circulation pattern gives rise to several regional weather regimes according to the different areas of the Basin and conversely certain types of daily weather regimes are linked with different circulation types. In the 5 cases studied as mentioned earlier the number of days with regimes bringing high raintotal decreases when the number of days with low rain total increases.

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ABSTRACT

Projection of future climate in the Mediterranean based on multiple GCMs and stochastic weather generator

The models (e.g. crop models) commonly used to assess impacts of the anticipated climate change (CC) require weather series representing the present and future climates. To account for uncertainties in projecting the climate, we use the stochastic weather generator (WG), whose parameters are derived from the observed weather series and then modified according to the multiple CC scenarios. The WG represents the natural climate variability, and the set of CC scenarios accounts for uncertainties in climate sensitivity, emission scenario, and choice of GCM. The CC scenarios are derived using the pattern scaling method, in which the scenario for a specific future is defined as a product of change in global mean temperature (estimated by simple climate model MAGICC for several combinations of climate sensitivity factor and emission scenario) and standardised scenario (changes related to 1K rise in global temperature are derived from GCM simulations included in IPCC-AR4 dataset).

(part 1) Construction of multi-GCM CC scenarios for whole Mediterranean. We will (i) present maps showing probabilistic (based on all GCMs) projection of temperature, precipitation and PDSI index, and (ii) discuss options for choosing a representative subset of GCMs (though it is recommended to use all available GCMs, it is often preferred to use only their subset).

(part 2) The methodology consisting in using the multivariate daily WG (M&Rfi) linked with GCM-based CC scenarios will be presented. The focus will be on (i) optimal settings of the WG model, (ii) the way in which the WG parameters are modified according to the CC scenario, (iii) complexity of the employed CC scenarios (which may include changes in the means, variabilities, and wet day probability).

(part 3) This methodology is used to assess climate change impacts on crop yields and fire risk in areas representing 3 important agroecosystems of the Mediterranean Basin (Sardinia, Apulia, Morocco). In this contribution, we use observational station weather data from these areas and apply the above methodology to project changes in extreme temperature and precipitation characteristics (including lengths of wet/dry/hot/cold spells). The projected changes will be discussed from a point of view of the “optional” features of the applied methodology: choice of GCMs, WG settings, and complexity of the CC scenarios.

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ABSTRACT

Simulation of anthropogenic CO2 uptake in the Mediterranean sea with the NEMO-MED12 model; Impact on water masses acidification.

The Mediterranean basin is under a very strong and increasing anthropogenic pressure. It is also a hot spot of the climate change. At global scale, atmospheric concentration of carbon dioxide (CO2) increased from about 280ppm, in pre-industrial period, to almost 390ppm at present. A significant amount of the CO2 released in the atmosphere is dissolved in the ocean. This anthropogenic CO2 uptake results in an acidification of water masses, with possible consequences on calcification, and hence on phytoplankton. We focus here on the acidification of water masses at the regional scale of the Mediterranean basin. The impact of anthropogenic CO2 uptake is investigated using a Mediterranean version of the NEMO model: MED12, an eddy-resolving model of the Mediterranean Sea, developed in the context of SiMED and MORCE-MED projects. First, the general circulation obtained with MED12 was validated by simulating CFC invasion, and confronting it to observations covering the recent period 1990-2000. Then a 210-year simulation of anthropogenic CO2 uptake was performed, using a perturbation approach over the period 1800-2010. In this case, anthropogenic CO2 is only simulated as a passive tracer, just considering it as a perturbation of the natural signal [Sarmiento and Orr,1992]. The simulation is then compared to existing estimations estimated with the transit time distribution method [Waugh et al. 2004], calculated by Schneider et al. [in press].

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ABSTRACT

Water Mass Variation In The Mediterranean Sea And Relation To Climate Change

The mass component of the Mediterranean Sea level over 1970-2009 is analysed from GRACE and from a reconstruction of sea level corrected for the steric component.

Over 2003-2009 the GRACE observation show a water mass increase with a rate of 5.3 +/- 1.7 mm/yr. This rate being compensated by the decrease of the steric sea level due to an increase in salinity, the total sea level variability is almost zero.

The mass change estimated from the steric-corrected reconstruction has a trend of 1.17 +/- 0.15 mm/yr. The long term trend of the water cycle parameters shows an evolution towards a drier regime and an increase in the loss of freshwater over the Mediterranean Sea. Their combination with the water mass change indicates an increase in the net flow at Gibraltar.

The interannual variability of mass change is highly correlated to the North Atlantic Oscillation Index and related to atmospheric changes.

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ABSTRACT

Impact of wind forcing resolution on the coastal turbulent stuctures and mixing

Firstly, a 10 years (1990-2000) run of a high resolution coastal model - NEMO 64 - has been performed in the Gulf Of Lions using ERA40 and REMO atmospheric forcings for comparison. Secondly, the MARS 3D code has been run during the year 2005 in the same area when field campaign including TETHYS II RV cruises, HF radar current maps, drifted buoys trajectories and ADP mootrings were performed for validation. Thus, three different wind forcings have been compared: ALADIN (10 km, 3 hours), AROME (3 km, 1 hour) and MM (3 to 10 km, 3 hours).

Main results are concerned with the interannual variability of the coastal circulation, including dense water formation during winter 1990-91 and sensitivity of coastal patterns to the wind forcing resolution. Upwellings, quasi-inertial circulation, mesoscale vortices and internal wave generation have been compared using twin or threefold numerical runs. A 10 km /3 hours resolution was found to be a satisfactory wind forcing, when more energetic higher resolution AROME wind forcing was found to enhance vortices and internal wave fields and improve vortices lifetime and trajectory. However, coastal models still fail in reproducing vortices in the right time, implying a great interest in data assimilation in coastal areas.

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ABSTRACT

Summer Mediterranean SST impact on Saharan aerosols transport: seasonal modulation and related atmospheric circulation regimes

The Mediterranean region is interested by aerosol transport of different origins: anthropogenic pollution from Europe, marine and forest fires emissions, mineral aerosol from the Sahara. The Saharan aerosol intrusion into the Mediterranean is related to specific atmospheric conditions favourable to the extraction from the surface, the lifting above the boundary layer and finally the advection northwards. The summer Mediterranean SST is characterized by a positive gradient toward the Levantine basin, and this longitudinal thermal profile is linked to the circulation anomalies over the basin. The aim of this work is to highlight the relationship between the Mediterranean SST variability and the Saharan aerosol transport in summer (June through September, JJAS), through the investigation of circulation atmospheric regimes over Europe and northern Africa. We focus on the low and mid troposphere circulation to study mineral aerosol extraction and transport, respectively.

Using NOAA Extended Reconstructed SST and NCEP-DOE Reanalysis 2 atmospheric variables, the covariance between Mediterranean SST and atmospheric circulation over Europe and northern Africa is studied, through a Singular Value Decomposition in the period 1979-2009. The association between SST gradient in the Mediterranean and mineral aerosol transport from the Sahara is investigated using the aerosol index measured by the NASA Total Ozone Mapping Spectrometer, in the period 1979-2005. A Mediterranean SST gradient index (MGI) is defined as the standardized difference between the eastern and western sub-basins, and the high-low MGI differences are computed for the aerosol load and the low and mid troposphere wind field. Weak anomalies in the near surface wind over the Sahara are related to high MGI values, with consequent low aerosol extraction. On the other hand, the aerosol load shows a strong positive anomaly from western Sahara to central Mediterranean, displaced along a southwesterly flow associated to a low-high pressure dipole between central Europe and North Africa.

The Saharan aerosol transport in the Mediterranean is also investigated on an intraseasonal time-scale, by analysing selected summer seasons with large aerosol loads. Specifically, an analysis of the occurrence of different atmospheric circulation daily regimes in the Mediterranean, by using the circulation classification tool developed in the framework of COST733 Action (Harmonisation and Applications of Weather Type Classifications for European regions), is proposed.

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ABSTRACT

Large-scale atmospheric response to eastern Mediterranean summer SST anomalies.

Recent studies have shown that anomalous state of the eastern Mediterranean Sea strongly influences the summer West African monsoon system, not only enhancing the humidity content of the lower troposphere but also forcing circulation anomalies. Observations and modelling experiments are analysed in order to give evidences of a large-scale atmospheric response associated with those Mediterranean surface anomalies. Results support the hypothesis of a hemispheric pattern initiated in the Mediterranean basin, pointing out both a local baroclinic response and a barotropic circumglobal circulation. This atmospheric teleconnection pattern extends to the entire Northern Hemisphere midlatitudes, reflecting the waveguide effect of the westerly jets. The remote impacts present, however, a nonlinear signature: warm conditions influencing on northern Europe and Euro-Asia, whereas cold conditions impacting more on the North Pacific basin. A linear behaviour is found upon a regional impact over north eastern African continent. These results emphasize the importance of the Mediterranean Sea both as local and large-scale predictor, hence for the success of seasonal forecasting skill.

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ABSTRACT

Proxy-reconstructions of climate variability and environmental/ biogeochemical changes in the NE Mediterranean Sea during the Holocene

Early Holocene sediment records collected in the Eastern Mediterranean Sea (EMS) bear witnesses for the formation of the most recent sapropel S1, closely associated with distinct minima in the orbital precession cycle and the insolation-driven monsoon maxima. The different scenarios of S1 deposition involve changes in marine productivity, organic matter preservation and circulation changes and are still under debate [1], [2], [3].
Herewith, we present a high-resolution study of organic geochemistry proxies in three gravity cores collected from the EMS, namely the cores SL152 and NS-14 collected from the Aegean Sea (north and southeast, respectively), and core HCM2/22 collected from the open EMS. Our goal is to investigate the patterns of organic matter accumulation and preservation and reconstruct paleo-SSTs based on alkenone unsaturation index Uk´37 during the Holocene with focus on the deposition of sapropel S1 along a north-south transect in the EMS. Depending on the water column depth, the sediment accumulation rates and the proximity to freshwater and water formation sources, S1 deposited in our records between ~9.8 to 6.4 kyr BP. During the Holocene climatic optimum, SSTs increase gradually more than 4℃ and reaches values as high as 21.2℃, 22.5℃ and 23℃ (in cores 152SL, NS-14 and HCM2/22 respectively). Our records also show a pronounced centennial-scale cooling that culminates from ~8.2 to 7.6 kyrs BP, coeval to the N. Atlantic cooling event [4], causing an interruption in the deposition of S1 in all sites. SST fluctuations are detected between 4.9 and 4.1 kyr BP in core NS-14, with a sharp positive shift to 24.9℃ indicating the presence of a warm period in the mid Holocene [5]. Higher accumulation rates of TOC and all marine biomarkers were recorded within the sapropelic layer S1a and less pronounced within S1b in the Aegean Sea compared to the open EMS site. Organic carbon stable isotopes values span a narrow range. The different types of δCorg excursions associated with stronger fluvial delivery (terrestrial inputs) in the north Aegean Sea whereas the other two sites received most marine organic matter. The distributions of land plant biomarkers are indicative of variable terrigenous organic matter supply and the concomitant transport of nutrients to surface waters. Furthermore, distribution patterns and characteristic ratios of marine biomarkers exhibit differences in the paleoproductivity trends and ventilation changes over the last 20 kyr. Lighter values of δ15N within S1 and Mid Holocene Humid (MHH) phases reflect a significant contribution of N-fixing organisms to the N-cycle related probably to higher demand for nitrogen (denitrification/ P regeneration) due to the established dysoxia in the water column/sediment interface.

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ABSTRACT

MOPREDAS, a new tool for subregional precipitation trend analyses of Spain.

We present global results of the new precipitation monthly dataset of Spain (MOPREDAS) after an exhaustive quality control of AEMet (National Spanish Meteorological Agency) archives.
From more the 10,000 original precipitation monthly stations, a total of 2670 series (complete and homogeneous) between 1946-2005 were transformed in a high resolution grid (0.1є x 0.1є).
Annual trends in the conterminous Spain do not show a significant and generalized pattern, although the signal of trend is mostly negative. Inland mountain areas seem to be the only areas where negative trend is significant. The monthly and seasonal trend analyses discovered a high temporal and spatial variability of precipitation. At monthly scale only March and June (negative) and October (positive) show a generalized and significant pattern of trends. At seasonal scale trends were significant and negative in spring. As a consequence of monthly and seasonal behaviour of precipitation, we detected a clear change in rainfall regimes to the inland areas, being substituted spring regimes by autumn ones. This change was not produce by increase in precipitation during autumn, but for decrease of precipitation during spring, mostly by the effect of March.

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ABSTRACT

Ocean biogeochemical modeling of scenarios leading to eastern Mediterranean sapropel formation during the early Holocene

During the early Holocene, a series of changes in the conditions of the Mediterranean hydrography, and correspondingly its biogeochemistry, occurred. This led to the formation of an organic rich sediment layer, the so called sapropel S1, which has been attributed to a better preservation of organic carbon in oxygen depleted deep water masses. The absence of oxygen in the deep water (anoxia) might be the result of a stagnating deep-water circulation, which prevents the ventilation of the deep water column, or an enhancement of the surface primary production, which would lead to an enhanced oxygen utilization rate, or a combination of a stagnating deep-water circulation and enhanced oxygen utilization. The aim of this study is to identify plausible scenarios leading to the sapropel S1 formation.

For this purpose, we set up a regional version of the general ocean circulation model MPI-OM for the Mediterranean (20 km horizontal resolution, 29 levels) coupled to the biogeochemical model HAMOCC. The model is forced with atmospheric data derived from equilibrium time slice simulations for pre-industrial conditions and 9 kyr BP with the atmosphere-ocean-dynamical vegetation model ECHAM5/MPI-OM/LPJ. To identify the plausible scenarios leading to sapropel formation we conducted several experiments with a stagnating deep-water circulation and/or enhanced primary productivity.

Results show that a 3 times increase in riverine nutrient input within a well ventilated ocean does not lead to the development of a deep water anoxia since the enhanced oxygen utilization rate is not strong enough to overcome the continuous deep water ventilation. Consequently, a stagnating deep water circulation seems a pre-request for sapropel formation. From our results we estimate that the development of a deep water anoxia in a stagnant ocean takes around 7000 years, which is a rather long time period. Measured carbon accumulation rates from sediment cores imply a present-day like or higher carbon flux during the formation of the sapropel S1. However, in a stagnant ocean new production, and hence export production and oxygen utilization, are strongly decreased because of the reduced upwelling of nutrients from the deep layers. Hence, to sustain a present-day like or higher biological production under a stagnating ocean, nutrients from external sources (e.g. rivers) are required. The simulation with a 3 times increase in riverine nutrient input in combination with a stagnating circulation might lead to a deep water anoxia within 2000-6000 years. The latter model result lies well within the estimates from proxy data of 1000 to 6000 years for the period of the stagnation and the onset of the deep water anoxia.

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ABSTRACT

Modelling recent climate and climate change over the eastern Adriatic

Temperature and precipitation from five regional climate models (RCMs), all run at 25-km resolution, are compared with point observations for the 50-year period of the 20th century. Climatological stations are located in the eastern Adriatic, either on the islands or at the coast. The stations are under strong maritime influence and the main cause of sub-grid scale variability comes primarily from a very complex coastal configuration and the land-sea contrast; local orography plays less important role there. All RCMs were driven by the same global climate model (GCM) and such a setup enables an assessment on how different physical parameterisations affect the downscaling process.

On average, monthly means of observed temperature are overestimated by models in the colder part of the year and underestimated in the warm period. Precipitation is generally overestimated by models throughout the year, but approaching observations in summer, when normally small amounts prevail. Model errors are not changed much across the stations although some slight differences exist. The overall poorer RCMs simulations in winter than in summer may indicate a stronger impact of the GCM lateral boundary conditions when large-scale circulation is relatively strong. Simulated interannual variability for temperature is generally lower than observed and for precipitation higher than observed, especially during the warm part of the year. When long time-series of individual variables are compared, interannual variability is found to be strikingly similar among the models although they have different systematic errors. This indicates a prevailing impact of the same lateral boundary conditions from the driving GCM over the regional physics. The analysis of cumulative distribution functions reveals that temperature extremes are, similar to mean values, overestimated by RCMs. Extremes in precipitation are generally overestimated but no uniform picture from model simulations emerges.

Climate change and variability, with respect to the 20th century climate, are analysed for three 30-year climate periods of the 21st century for the IPCC A1B scenario. For temperature, a warming in all three periods is statistically significant in all seasons and at all locations. The warming is strongest in summer irrespective of the climate period considered. Later in the 21st century, the warming is accompanied with precipitation deficit during spring and summer, which would make the eastern Adriatic region particularly vulnerable to climate change. Models disagree on the sign of precipitation change in autumn and winter, even towards the end of the century.

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ABSTRACT

Making Use Of Scenarioplanning In Identifying Climate Change-Related Research Hotspots In The Mediterranean

To cope with water related climate change impacts we need to determine a reasonable strategy. In the course of defining our strategy, and in order to develop action plans for certain regions or for certain economic sectors we must be able to rank impacts and evaluate adaptation options. In this paper we discuss the issue of determining a strategy by adopting an existing method of scenario planning. This known method maps driving forces on two axes, assessing each of them on an uncertain/predictable and important/unimportant scale. A brief assumption of water related impacts of climate change in the Mediterranean region is already given as a result of our FP7 project "ClimateWater", already going on for two years. We have formulated the next dilemma: in the current very urgent situation what might be the spontaneous social-economic responses to these impacts and what would be the most effective – and at the same time feasible solution – answer to this challenge. In other words we want to see the possible various typical attitudes and the reasonable strategies - risk management, adaptation, innovation, etc. - based on the results of climate-research. We are also going to investigate the strengths and weaknesses of all response options. We use this method for the already known impacts in the Mediterranean.Our finding/result is that the used method makes the many driving forces and determining factors more transparent as well as defining the direction of influencing – or supporting - spontaneous responses easier.

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ABSTRACT

What induced the exceptional 2005 convection event in the northwestern Mediterranean basin? Answers from a modeling study

Open-sea convection occurring in the northwestern Mediterranean basin (NWMED) is at the origin of the formation of Western Mediterranean Deep Water (WMDW), one of the main Mediterranean water masses. During winter 2004–2005, a spectacular convection event occurred, observed by several experimental oceanographers, that called it the Western Mediterranean Transient (WMT). It was associated with an exceptionally large convection area and unusually warm and salty WMDW. Explanations were proposed tentatively, relating the unusual characteristics of this event to the Eastern Mediterranean Transient (EMT) or to the atmospheric conditions during winter 2004–2005 in the NWMED. They could, however, not be supported until now.

Here we used numerical modeling to understand what drove this convection event. The weakness of the winter buoyancy loss during the 90's in the NWMED prevented strong convection to occur, enabling heat and salt contents to increase in this region. This resulted in the change of WMDW characteristics observed in 2005. The strong buoyancy loss of winter 2004–2005 was responsible for the intensity of the convection in terms of depth and volume of newly formed WMDW. The EMT did not fundamentally modify the convection process but potentially doubled this volume by inducing a deepening of the heat and salt maximum that weakened the preconvection stratification.

From this particular case study, we propose mechanisms responsible for the interannual variability of deep convection in the NWMED.

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ABSTRACT

The relative contributions of radiative forcing and internal climate variability to the late 20th century drying of the Mediterranean region

The roles of radiative forcing and internal climate variability in causing the Mediterranean region's late 20th Century drying trend are examined using 19 coupled models from the Intergovernmental Panel on Climate Change Fourth Assessment Report. Much of the observed drying was influenced by the robust positive trend in the North Atlantic Oscillation from the 1960s to the '90s. Model simulations and observations are used to attempt to determine the probable relative roles of radiative forcing and internal variability in explaining the circulation trend that drove much of the precipitation change. Using the multi-model ensemble we assess how well the models can produce multidecadal trends of realistic magnitude, and apply signal-to-noise maximizing EOF analysis to obtain a best estimate of the models' SLP and precipitation responses to changes in radiative forcing. The observed SLP and Mediterranean precipitation fields are regressed onto the timeseries associated with the models' 20th Century externally forced pattern and the implied linear trend in both fields between 1960 and 1999 is calculated. It is concluded that the radiatively forced trends are a small fraction of the total observed trends. Instead it is argued that the robust trends in the observed NAO and Mediterranean rainfall during this period were largely due to multidecadal internal variability with a small contribution from the external forcing. The radiatively forced trends in circulation and precipitation are expected to strengthen in the current century and this study highlights the importance of their contribution to future precipitation in the region.

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ABSTRACT

Climatic variability of the near-surface sea temperatures in the Aegean-Black Sea system and relation to meteorologic forcing

High-quality temperature timeseries are constructed for winter and summer in the near-surface layer in two areas in the Aegean Sea and two areas in the Black Sea with dense data coverage in the MEDATLAS database during the period 1950-2000. The investigation is based on unfilterted temperature records with maximal resolution and minimal statistical errors that are explicitly provided. Two trend regimes are identified: A period of decreasing sea temperatures from the early/mid 60s to the early/mid 90s and an apparent warming afterwards. Intense meteorologic winter cooling events occur in the periods of the regime shifts, i.e., within 1963-1965 and 1991-1993. Trends in the NAO and the EAWR indexes appear to correlate with trends in the winter sea temperatures for parts of the long records, but the year-to-year changes in the sea temperatures cannot be justified by the sign changes of NAO and/or EAWR as the correlations between the NAO/EAWR winter (JF) records and the unfiltered winter sea-temperature records are low. The winter atmospheric circulation of the period 1950-2000, in terms of sea-level-pressure distributions, is investigated in order to fully visualize the origin and the cooling/warming effect of the air masses advected in the study area. The mean winter circulation for 1950-2000 is specified along with characteristic patterns of strong deviations from the mean that are repeatedly associated with local peaks (cooling or warming events) in the winter temperature records. These deviations include structures that are not accounted for by the typical North-Atlantic or East Atlantic-West Russia positive or negative dipoles, as the Siberian High, for example, can also induce warm winters in our study area. The NCEP-reanalysis net heat heat flux records for winter have several peaks in common with the corresponding near-surface winter sea-temperatures but their overall correlations are low, a fact which is believed to be due to a) horizontal and vertical heat exchanges with the water column and b) unkonwn, yet considerable, errors that are unavoidably inserted in the estimation of the reanalysis net-heat flux values with limited ocean data. A frequency-domain spectral-coherence analysis of the unfiltered winter sea-temperature and the teleconnection NAO/EAWR records, shows that common spectral and coherence peaks for the period 1950-2000 exist at ~5-6 years, ~9-10 years and ~15-17 years.

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ABSTRACT

Influence of atmospheric circulation on turbulent air-sea heat fluxes over the Mediterranean Sea during winter: An overview

The influence of large scale and regional atmospheric circulation during winter on the turbulent air-sea heat fluxes over the Mediterranean Sea is investigated. Turbulent fluxes variables are retrieved from WHOI OAFLUX Project data products. We employ a correlation analysis between turbulent variables and several climatic indices. The spatial characteristics and the behavior of latent and sensible heat, wind stress, air temperature and specific humidity are also studied using standard deviation and EOF analysis. The climatic indices exhibit an opposed impact between the western and the eastern Mediterranean basins while the intra-basin sea level pressure field is proven more influential than the large scale atmospheric patterns. In all cases the impact of indices representing a zonal pressure gradient is much stronger than the impact of indices representing a meridional pressure gradient. The turbulent variables over the eastern sub-basin are more sensitive to the variation of these patterns than their counterparts over the western basin. The opposed response of the two Mediterranean tips to the atmospheric forcing is also supported by the principal modes of variability obtained by the EOF analysis of the turbulent variables.

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ABSTRACT

Climatologic analysis of northern Adriatic Sea physical variations occurred in the recent period (1970-2007)

The Adriatic Sea, and its northern sector (NA) in particular, is a peculiar and relevant area of the Mediterranean Sea. NA is characterized by winter production of dense water (among the densest of the Med Sea), by the largest river runoff of Med Sea, by high biological productivity, by episodic events like anoxia, harmful algal blooms, massive mucilage appearances. Analysis of historical data sets have been carried out aiming to describe recent climatology and changes in northern Adriatic basin. Thermohaline bimonthly climatology is analyzed for the 1990-2007 period, as well as its anomalies (together with air temperature and Po River runoff) in comparison to the 1970-1989 period. The results show that air and sea temperature exhibit a significant increase in recent years compared to the 1970-1989 period. A relevant warming of sea temperature has been detected in sea surface layer for the cold season, and also, with differences, at intermediate and bottom layers. Salinity shows large variations in the surface layer, which are related to variations of precipitation and Po River inflow, and much smaller variations at intermediate and bottom layers. A statistical analysis of annual and seasonal time series at selected locations reveals significant trends in several cases.

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ABSTRACT

Precipitation extremes in regional climate model simulations estimated by the region-of-influence method

Heavy precipitation events are associated with large negative impacts on human society, mainly as they may trigger floods and landslides. There is also concern that climate change may increase severity of precipitation extremes in many parts of Europe, even in areas and seasons in which mean precipitation is projected to decline. The present study evaluates applicability of the region-of-influence (ROI) method for estimating probability density functions of precipitation extremes in regional climate model (RCM) simulations with a 25 km resolution from the ENSEMBLES project. Precipitation extremes are considered at a wide range of time scales from hourly to multi-day amounts, and in winter and summer seasons. Climate change scenarios of precipitation extremes for the late 21st century (2070-99) are evaluated in a large ensemble of RCMs driven by several global models, with focus on comparisons between seasons (winter, summer), variables (hourly, daily and multi-day amounts) and individual European regions, including the Mediterranean. We also discuss the issue of computational demands of the ROI method in a large matrix of data like that from a high-resolution RCM. An analytical expression for confidence interval estimates is found a useful approximation that may replace the resampling procedure, after adjustment for spatially dependent data.

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ABSTRACT

The ENSO influence on the Mediterranean rainfall. A multidecadal modulated relationship?

Several studies have shown how the anomalous precipitation over the Euro-Mediterranean region is influenced by the ENSO phenomena. However, this influence is not stationary, with maximum correlations in the beginning of the twenty century and since the 1970's and no influence during the 1940's- 50's-60's.
The role of Natural Multidecadal Variability in the non-stationary relationship between ENSO and interannual precipitation over the Euro-Mediterranean region is analysed for the 20th century. As representative of the natural multidecadal variability, we have chosen the Atlantic Multidecadal Oscillation (AMO) and the Pacific Decadal Oscillation (PDO). The correlation along this period between the Nino3.4 index and the Mediterranean rainfall for a 20-year sliding window shows a significance multidecadal modulation, particularly with AMO. Also, a Gram-Schmidt orthogonalization methodology has been used to generate an orthogonal base able to discriminate the AMO, PDO and Global Warming (GW) SST influence on the interannual rainfall modes. Next, Principal Component Analysis (PCA) of the interannual anomalous rainfall is performed considering or not the projection on each elements of the base.
A significant multidecadal modulation of the ENSO influence on the Euro-Mediterranean interannual precipitation, together with the influence of GW in the last decades of the 20th century, has been found. In winter (JFM) this modulation influences the atmospheric variability, with changes in the Sea Level Pressure (SLP) anomalous projection, from a zonally-symmetric dipolar NAO-like pattern to an undulatory pattern. In spring (MAM) the modulation with AMO become stronger, with influence on a North Atlantic quadrupole over the SLP. The results suggest that this non stationary influence of ENSO on the European rainfall is statistically related to the Atlantic Ocean mean state. In this way, a significant relation appears with the Atlantic-Pacific Nicos connection, which could play an important role in the generation of this relationship.

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ABSTRACT

Effects of climate change on UHI with focus on Mediterranean cities

Motivated by the increase of urban population in the world, this paper intends to contribute to a further understanding of the urban climate in the context of climatic change considering that urban climate is an important parameter for health and quality of life of citizens. We recall that urban climate is influenced by several factors according to the scale considered being synoptic, regional or local. Urban landscape is totally different from the rural surroundings, impermeable surfaces predominate over soils and vegetations and there are a multitude of buildings which increase surface roughness of the space. In a context of Green House Gases increasing emissions, global warming of climate system is an unavoidable process. In particular, the Mediterranean area lies in a transition zone between the arid climate of North Africa and the temperate and rainy climate of central Europe and therefore this region is likely to be more sensitive and vulnerable to climate change effects. Cities typically experience the so called Urban Heat Island (UHI) effect that is associated to a positive gradient of temperature of the urban area with respect to their surrounding rural areas. Mediterranean cities are likely to experience more frequently episodes of heat waves in a general context of drying and warming conditions in summer season. Though much work is available in the literature for the UHI, little is known about the projected effect of climate change on UHI in Mediterranean area. Starting from the known shape and building morphometry of a Mediterranean city (Lecce,IT), distribution and type of vegetation, in this work, we intend to analyze some possible scenarios of changes based on both experimental work and numerical simulations. Lecce, is a medium-size city, typical of southern Italy and of the eastern Mediterranean area. In particular we base our analysis on results of thermography measurements in some neighbourhoods of the city and assess the microclimate through the ENVI-MET model. Envi-MET is a prognostic three dimensional microclimate model, based on fundamental laws of fluid-dynamics and thermodynamics created to simulate surfaces-plant-air interactions. To study the effects of climate change on UHI, future scenarios are built on the projected temperatures, derived from a climate model based on change projections over the Mediterranean region. Central in our work is to identify possible adaptation strategies, to mitigate the UHI effect, so Envi-MET has been run, with and without vegetation and with different kind of tree and grass coverage, to underline the role of vegetation on mitigating the UHI effect in the context of climate change.

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ABSTRACT

Characterization of Coarse and Fine Particles in Tel Aviv, Israel, during Dust Storm Episodes of Spring 2006.

Four African and Arabian dust outbreak episodes affecting the city of Tel Aviv on the Mediterranean Coast in spring 2006 have been characterized. The Saharan (from the west sector) and Arabian (from the east sector) air masses increased significantly the daily concentrations up to 250 for coarse (PM10-2.5) and 63 microgram/m3 for the fine fraction (PM2.5). A detailed chemical and microscopical characterization has been performed for the particles collected dust event days and clear days (before or after the dust intrusion). Levels of mineral elements increased during the dust episodes. In addition, the levels of anthropogenic heavy metals registered during the dust episode were considerably higher than levels recorded during clear days. High concentrations of sulfates were observed in the coarse fraction of dust episodes, and were not correlated with sea salt particles. They could be part of the soil matrix and probably formed by the reaction of sulfur oxides with the natural aerosols. These reactions may be favored by the high concentration of coarse mineral particles during the Saharan and Arabian episodes. Those results were substantiated by single particle analysis of selected samples.

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ABSTRACT

Changes in storm surges in southern Europe during the 21st century

Changes in storm surges in the Mediterranean Sea and the Atlantic Iberian coasts during the 21st century are explored based on the outputs of a numerical barotropic regional model. Three different climate scenarios (A2, A1B and B1) for the period 2000-2099 together with a control run for 1950-2000 have been simulated forced by GHG concentrations. A hindcast run for the 20th century (1958-2001) forced with a dynamical downscaling of ERA40 reanalysis has also been performed. Comparisons between hindcast and control run show consistency on their average statistics and their spatial distribution in terms of extreme events. Results for the 21st century reveal that storm surges frequency and magnitude decrease. Changes reach 50% in the number of episodes and up to 8 cm in the 50-year return levels. The analysis shows a progressive decrease in the return levels not fully explained by a negative trend in the mean atmospherically-induced sea level and a linear dependence with winter NAO. Likewise, negative events show the opposite behaviour, with an increase in their frequency and magnitude although more moderate than for positive surges.

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ABSTRACT

Decadal climate variability and drought in the Mediterranean region

The Mediterranean region is among the “Hot Spots” projected to experience major climatic changes in the twenty-first century as a result of the global increase in greenhouse gas (GHG) concentrations. However the way in which these changes will initially become manifest in the Mediterranean will also depend on internal decadal variability and its impacts on climate in this region. Here, we present an analysis of the main decadal climate variations that have influenced past drought conditions in the Mediterranean/South Europe region since the mid-nineteenth century. Results point to significant connections with decadal and multi- decadal variability in the Atlantic. Namely, a significant influence of the North Atlantic Oscillation on Mediterranean precipitation and a relationship between regional temperatures and the Atlantic Multi-decadal Oscillation which may imply a certain degree of decadal predictability. Based on an ensemble of coupled simulations from the WCRP Coupled Model Intercomparison Project-Phase 3, in the longer term “forced” regional changes from GHG increases would bring significantly drier conditions over land resulting from both a decrease in mean precipitation and an increase in surface air temperature.

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ABSTRACT

Climate of relatively stable warm periods. A Mediterranean palэo-perspective

The Mediterranean region is characterized by mild wet winters and warm to hot, dry summers; the northern area presents a maritime west coastal climate, while the southern part presents a subtropical desert climate [Kцppen, 1936, Handbuch der Klimatologie; Lionello et al., 2006, SPRINGER]. Successful Mediterranean agriculture depends on the amount and timing of rain; changes of only 10-20% over several successive years may either enhance its expansion or, quite the opposite, destroy it. Although the last century is likely to be neither the warmest nor a uniquely extreme climatic period of the last millennia, it is clear that human activity has increased greenhouse gases at an unprecedented speed [Crutzen, 2002, NATURE; Joos & Spahni, 2005, PNAS]. Considering this context, for example, in the Iberian peninsula, mean precipitation is expected to decrease and precipitation intensity to increase (i.e. greater risk of droughts, longer periods between rainfall events, drying tendency during summer, controversial in winter) [Perez & Boscolo, 2010, Climate in Spain: Past, Present and Future].

If we are to understand the climate of past periods of stable elevated temperatures, similar to the present one, we first need to understand the historical period. Our study presents interdependent aspects between environment and history of recent and ancient civilisations, as recorded in marine sediments recovered in the Mediterranean basin. Fossil organic compounds, originally forming part of bacteria, archaea or eucarya organisms, have been quantified in their strata in order to continuously reconstruct the environment over the past millenia at centennial-to-decadal scale. This geological record proves invaluable as an archive of relatively stable warm periods. One result stands out: over the last millennia, annual mean sea surface temperatures estimated by alkenones have changed abruptly during some specific events, particularly within periods of pronounced minima in solar activity and after the volcanic eruptions began to increase in frequency. A representative compound of vascular terrestrial plant dust has been tending to increase during the last millennia at a considerable speed; this proxy is tracing wind strengthening and generally arid, cold conditions. Additionally, the oxygenation of the Mediterranean sea floor, which is perfectly traced by the biomarkers, has undergone significant changes: decreasing during the progressive colonisations by different cultures in the western Mediterranean (the Greek, the Carthaginian, the Roman), increasing during the Little ice age and decreasing again over the last decades; this present level of ventilation highly resembles the pattern preceding a major change.

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ABSTRACT

Study on climate change and its potential impacts on vegetation over last five decades in Syria

Climate change may cause profound effects on terrestrial ecosystems. Global warming is likely to alter patterns of global air circulation and hydrological cycle that will change global and regional precipitation regimes. Mediterranean basin one of the most prominent hot spot of climate change in the world. Most climate scenarios predict increased temperature and an overall decrease in rainfall for the Mediterranean region, with more rain events in winter, fewer rain days, and longer drought periods between events, thus making rainfall patterns more extreme. Meteorological data for fifteen stations located in humid semi humid, semi arid, arid, and extreme arid regions in Syria were used to detect changes in annual and seasonal mean values of temperature,precipitation, Evapotranspiration and drought intensity and duration during the period (1958-2008). Results showed significant positive trends in mean ,maximum, minimum and extreme temperatures especially in warm seasons and negative annual precipitation trends for all stations due to decrease in spring and winter rainfall amounts. There was a significant decreasing trend in annual Evapotranspiration values in all studied regions. Our results showed an increasing in drought intensity, dry days number and dry spells duration. All these changes will have potential effects on vegetation which in turn aggravate desertification risk.

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ABSTRACT

Paleoclimatic reconstruction of the Medieval Climate Anomaly and the Little Ice Age from continental and marine records of the Iberian Peninsula

A compilation of natural paleoclimatic archives from the Iberian Peninsula (IP), including different continental and marine records, that span the last 2000 years, provide a reconstruction of the main climate fluctuations experienced in this area during the Dark Ages (ca. 500-900 yrs AD), the Medieval Climate Anomaly (MCA: 900-1300 yrs AD), the Little Ice Age (LIA: 1300-1850 yrs AD) and the last 150 years. The multidisciplinary analysis of these records, and the high chronological resolution provided by a combination of radiometric dating (137Cs, 210Pb, AMS 14C) and, in some cases varve counting, provide an integrated approach that enables a detailed reconstruction of the main environmental, hydrological and temperature changes experienced in the IP during this period. Despite local differences and some minor chronological inconsistencies, clear evidences of generally warm and dry conditions during the MCA in this area have been found. This stage was characterized by decreased lake water balance, increased xerophytic or helyophytic vegetation, low frequency of flood episodes in several lakes, warmer sea surface temperatures and less fluvial input to the marine basins. However, the LIA stands out as a generally moister period. A detailed correlation between records from the Pyrenees reveals a general advance of glaciers, colder conditions recorded by tree ring-based temperature reconstructions, and fluctuating but higher lake levels, with an increase in fluvial input. However, spatial changes and a complex internal hydrological variability, likely related to solar forcing, within this period have also been recorded.This reconstruction is consistent with global paleoclimate records and also provides support to the hypothesis proposed by Trouet et al. (2009) suggesting that a persistent positive mode of the NAO was dominant during the MCA, leading to more negatives values extending during the LIA. Additionally, the IP reconstructions show similarities in the timing of main abrupt hydrological changes (e.g. MCA vs LIA) observed in the Eastern Mediterranean region but with different/opposite responses, probably because of the relatively lower influence of NAO variability in these easternregions.

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ABSTRACT

Studying The Dynamics Of The Ecosystems Of Mountainous Country Applying Multi Spectral Satellite Images (Armenia)

The studies indicate that the evolution of landscapes on the entire territory of Armenia displays a common inclination–a change of feebly pronounced humid sub-tropic landscapes into variably humid forest and moderately humid meadow-steppe, then topsoil-steppe and true steppe landscapes. This means that dominating inclination was that to aridization, a process that is still going on nowadays, too. Bearing in mind all the said, we made an attempt to investigate the dynamics of ecological status of landscapes for the last 40 years in the context of global climate change and employing remote sensing techniques. Application of remote sensing data (RSD) that encompass vast areas and reflect natural interrelations, allows exclusion of random or short-term changes and thus focus on the processes of transformation of ecological status of the study ecosystem. To achieve the stated goal, multi-zonal satellite images Landsat. Ecosystems reflected on multi-zonal satellite images represent a whole range of objects differing by color, brightness. For such a purpose, we employed techniques based on the analysis of spectral curves and vegetation indices. Spectral curves characterize reflecting property of the objects on different zones of the spectrum and are one of most essential interpretation and classification features of natural and man-made objects. For the analysis we select a vegetation index NDVI–a simple index of the quantity of photosynthetically active biomass and one of the most popular and applicable indices in solution of tasks involving qualitative assessment of ecosystem. Digital treatment of satellite images was implemented using GIS-package ERDAS IMAGINE program.
The analysis of the obtained data proves that over recent decades natural ecosystems of Syunik marz (province) underwent moderate and strong changes, resulting in about 6.6% decrease of the share of man-altered and deforested landscapes and about 3.6%, reduction of the area of formerly forested sites. In the structure of vertical zonality transitive landscape plots are most sensitive and vulnerable to climate changes and man-made interventions, whereas lower plots of each zone are more stable and protected. At the same time, one marks an upward drift of desert-semi-desert and dry steppe ecosystems. In forested regions detectable is a slow but stable approach of semi-deserts to the lower outskirts of the forest. Detectable is also a drift of a semi-desert zone towards steppe, then to meadow-steppe and sub-Alpine belt. A steppe-forest ratio changes, too, this being manifested by intrusion into steppe grassland in the lower outskirts of the forest.

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ABSTRACT

Is the Ionian Sea getting warmer and saltier? A case study using 35 years of data obtained from profiling floats and CTD casts

The use of in-situ data as provided by profiling floats and CTD surveys allows to investigate the 3D spatial structure and temporal evolution of the thermohaline properties of seawater in a marginal sea at sub-basin scale, such as the Ionian Sea. The float data are also fundamental for assimilation in nowcasting and forecasting models (e.g., the Mediterranean Forecasting System - MFS) whose target is to improve the knowledge of the Mediterranean dynamics and climate. When regularly sampled, the profiling float and CTD data permit to analyze the temperature and salinity trends at various depths. Trends in water temperature and salinity are important indicators to monitor the climate and environmental evolutions that have a large impact on the marine circulation and global change. Several studies have shown that the temperature and salinity of the Mediterranean Sea have increased during the last 50 years. In this study we use about 30 years of CTD data (1975-2008) and 10 years of float data (2000-2010) to describe the thermohaline variability in the Ionian Sea over selected depth intervals: the entire water column between 0 m and the bottom, the surface layer between 0 and 150 m, the intermediate level between 150 and 600 m and the deep layer between 600 m and the bottom. The results show positive temperature trends with an annual increment of a few thousandths of a degree in the deep layer and a few hundredths in the surface and intermediate layers; a positive trend of a few thousandths PSU per year is also found for the salinity in the surface and deep layers, while the intermediate level has no significant trend.

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ABSTRACT

Phase-coherent oscillatory modes in solar/geomagnetic activity and climate variability

Oscillatory modes with the period of approximately 7-8 years were detected in monthly time series of sunspot numbers, geomagnetic activity aa index, NAO index and near-surface air temperature from several mid-latitude European locations. Instantaneous phases of the modes underwent synchronization analysis and their statistically significant phase coherence, beginning from 1950`s, has been observed. Focusing on geographical distribution of the phenomenon we study Northern Hemisphere patterns of phase coherence between solar/geomagnetic activity and ERA40 and NCEP\NCAR surface temperature reanalysis.

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ABSTRACT

Holocene glacier fluctuations in the Italian Alps

Nearly a thousand glaciers are present in the Italian Alps, the majority of which are very small and highly sensitive to climate changes. After the last Pleistocene advance, dated to the Younger Dryas, glaciers since about 10 ka BP were reduced to their present size. From 10 to 5 ka BP, glaciers were almost continuously in a reduced state. As recorded by a peat section buried by glacigenic sediments, Ruitor Glacier was much smaller than now from about 9.5 to 7 ka BP. A short episode of advance possibly occurred between 7 and 6.7 ka. Ten 14C dates from reworked peat blocks are uniformly distributed between about 6.7 to 5.6 ka BP. Although minor glacial advances cannot be excluded, environmental conditions favourable to peat deposition prevailed at the present front of the Ruitor glacier from 9.5 to 5.6 ka BP. During the last 5 – 6 millennia there is evidence of Neoglacial advances. A first signal of glacier regrowth is given by the “Iceman”, which became buried in snow on ice-free ground at about 5.2 ka BP and since then remained continuously preserved in cold ice at the upper edge of the Giogo Basso Glacier, in the Eastern Alps. In the Western Alps, the Miage glacier (Monte Bianco) advanced and dammed the trunk valley, at about 5 – 4.6 ka BP. Neoglacial advances at about 3 – 2.5 ka BP, comparable in extent to the LIA, are reported for a few glaciers in the Central and Western Alps. Another phase of advance is recorded in the Early Middle Ages, around 770-960 AD. The Little Ice Age (LIA) moraines are ubiquitous, well preserved and generally represent the Holocene maximum advance. In the Italian Alps LIA moraines are mainly dated to the XIX century. Earlier phases are recorded by floods from the ice-dammed Ruitor lake, that occurred at the end of the XIII century, in the first decades of the XV century, each year since 1594 to 1598, in 1630, 1640, 1646, 1679, 1680, 1751, and the last one in 1864.In the Western Alps many glaciers reached their maximum extent in 1818-1820. After a retreat in the 1830s a second largest advance occurred in 1845-1860. Since the second half of the XIX century all the Italian glaciers have been retreating, with only minor re-advances around 1890-95, 1920-25 and in the 1965 – 1985. At present more than 90% of the surveyed glaciers are retreating.

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ABSTRACT

Dynamical downscaling of future climate change of extreme events in the Mediterranean area

The German research project KLIWEX-MED (Changes in weather and climate extremes in the Mediterranean Basin) aims to analyse the regional characteristics of climate change in the Mediterranean Basin with special focus on temperature and precipitation means and extreme events like heavy precipitation, heat waves and droughts. For this investigation, we consider simulations of the coupled global climate model ECHAM5/MPI-OM (1.875°) as well as simulations of the high-resolution (0.5°) regional climate model REMO which is nested in ECHAM5/MPI-OM for the time period 1961-2050. The simulations are forced by observed GHG emissions for 1961-2000 and A1b and B1 emission scenarios during 2001-2050.

Our recent focus lies on the dynamical downscaling of extreme temperature and precipitation events including single day events as well as extreme events lasting several days, e.g. heat waves, cold spells or droughts, on a seasonal resolution. The extreme values of a present-day (1961-90) and future time slice (2021-50) are derived from climate model output by the peaks-over-threshold approach and fitted by the Generalized Pareto distribution (GPD). Corresponding distribution parameters are determined using the method of L-moments and thereafter, return values for several return times can be calculated. A Monte Carlo sampling approach gives uncertainty ranges of the estimated return values for the present-day and future time periods and thus, significant future climate change is indicated when the corresponding confidence intervals do not overlap.

We compare the resulting REMO return values and uncertainty ranges for the time periods 1961-1990 and 2021-2050 and identify significant future changes on a seasonal resolution. For the present-day time period these findings are validated with corresponding extreme events of the observational E-OBS Version 2.0 dataset. Finally, for both time periods the REMO results are compared to those of ECHAM5/MPI-OM in order to reveal the added value of high-resolution regional climate modelling in decadal future climate change projections in the Mediterranean region.

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ABSTRACT

The interplay between North Atlantic and Mediterranean climatic influences in Central Europe during the Holocene: a view from cave ice cores

The influence of the Mediterranean climate extends beyond the immediate vicinity of the Mediterranean Sea, and the geographic area once impacted varied in the past. Conversely, under the projected global climatic changes, a similar behavior is expected in the future, with most of the climatic models suggesting an expansion of the area under the influence of the Mediterranean climate towards mainland Europe. It is thus important to understand past climate variability around the Mediterranean realm, in order to better predict the possible climatic changes to be expected there. Here we present a 9000-year long multidecadal reconstruction of climate variability in western Romania, using oxygen and hydrogen stable isotopes in cave ice cores as proxies for air temperature. The region where Scarisoara Ice Cave is located is under the influence of both the North Atlantic and Mediterranean climates, with the former being dominant in present. Our reconstruction shows that the North Atlantic has strongly influenced the climate in western Romania, both in its general trends and short-term variability (i.e., Bond events 0-7, 8.2 ka event). The cooling episodes also correlate well with similar ones from western and eastern Mediterranean, whereas the mid-Holocene Climatic Optimum (HCO, ~6 to 5 ka BP) shows better timing with events in the Mediterranean, rather than the North Atlantic region. We suggest that during cooling episodes in the North Atlantic, both westerly and northern circulation were strengthened, thus leading to a rapid and synchronous transfer of the climatic signal towards central and southern Europe. However, during warmer periods, the connection between the North Atlantic and our investigated site was weaker. Weakening of the westerly circulation and strengthening of the meridional one may have caused a northward expansion of the Mediterranean climate influence, and the delayed-onset of the HCO in east-central Europe. This hypothesis gains further support when considering the decadal reconstruction of the climate over the past 2000 years, showing a remarkable resemblance with the Adriatic Sea SST reconstructions especially during the Medieval Warm Period and Roman Warm Period.

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ABSTRACT

Climate data analysis in the WASSERMed project

The WASSERMed project (Water Availability and Security in Southern EuRope and the Mediterranean) analyzes, in a multidisciplinary way, ongoing and future climate induced changes of hydrological budgets and extremes in southern Europe, North Africa and Middle East under the frame of threats to national and human security. Five case study areas have been chosen in order to illustrate and represent situations that deserve special attention. Within WASSERMED, this study aims at collecting and processing results from existing model simulations (e.g. those provided by the ENSEMBLES project) in the Mediterranean region with special emphasis on precipitation and on the case study areas. Among existing climate model scenarios, the set produced by the ENSEMBLES project has the advantages of being a coordinated ensemble of transient simulations covering the period 1951-2050 (or 1951-2100) and the whole Mediterranean region at high spatial resolution (25 km). Here we present an intercomparison study among model results, in situ observations at sub-regional/basin scale and also using data from EOBs and CRU data set, focusing on three case study areas: 1) Merguellil watershed (Tunisia), a river basin which concentrates multiple and conflicting water uses and characterized by rainfall highly variable in time and space 2) Jordan river basin that consists of three sub-basins, namely: the upper Jordan River, the Yarmouk River and the lower Jordan catchments. This was once a water rich area whereas it has become now very scarce in water resources due mainly to abstraction and use of water upstream 3) Nile River system, focusing mainly on Egypt that depends almost completely on the Nile river inflow.

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ABSTRACT

A palaeoclimatic framework for the late Pleistocene human occupation of the North African Mediterranean: correlating marine and terrestrial proxies from the stable isotope analysis of molluscs

The North African Mediterranean archaeological record preserves evidence for remarkable changes in human behavior and society. During the late Pleistocene, the emergence of modern human behaviour has been inferred through material culture such as development of complex microlithic technologies and the use of personal ornamentation. Some contend that these developments were stimulated by major shifts in climate and environment. Evaluation of this hypothesis requires high-resolution analysis of local and regional climate records paired with well dated archaeological sequences. The Haua Fteah in Libya provides an ideal laboratory to test this hypothesis as the cave contains one of the longest and most complete sequences of human occupation in North Africa as well as abundant material for paleoenvironmental reconstruction. Stable isotope analyses from the topshell Osilinus turbinatus and the pulmonate snail Helix melanostoma have allowed the construction of paired marine and terrestrial climate curves from the Haua Fteah. These analyses have been interpreted with reference to analogue studies on modern marine and terrestrial molluscs from Libya. In marine molluscs, δ18O records fluctuations in sea surface temperature. In terrestrial molluscs, δ18O varies according to the water ingested by the animal as the shell grows, which in turn is linked to water and air temperature at the moment of precipitation whilst δ13C provides a proxy for palaeovegetation patterns and water stress. Intrashell stable isotope series from the Haua Fteah record snapshots of sub-seasonal climatic variations covering rapid and profound climatic fluctuations from MIS 4 to MIS 1. This high-resolution climatic framework coupled with the well-dated record of cultural change, allows an examination of human-environment interactions during critical periods of late Pleistocene climate change.

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ABSTRACT

Evolution of extreme temperatures over Portugal - recent changes and future scenarios (Poster)

Changes in surface air temperature extremes over mainland Portugal since the early 1940s are investigated on the basis of daily maximum and minimum temperatures available from 23 stations time series. For the maximum (minimum) temperature we have obtained a decrease of -0.17ϵC/decade (-0.19ϵC/decade) for the 1941-1975 followed by an increase for the 1976-2006 period of 0.49ϵC/decade (0.54ϵC/decade), significantly higher than similar trends computed at the global and European level. A large set of climatic indices is analysed to detect the presence of trends and quantify the variations of the indices for different periods. In the 1976-2006 period many stations reveal statistically significant positive trends in the annual number of tropical nights, summer days, warm spells, warm nights and warm days. At the seasonal level we detect statistically significant increments of heat extreme events for spring and summer seasons, and a decrease of cold extremes in winter. We then use the HadRM3 output to study changes of the maximum and minimum temperature distributions and associated changes in the likelihood of extreme events occurrence in future (2071-2100) under two changing scenarios. Changes obtained in future are consistent with those found since the mid-1970s in Portugal with an increase in maximum temperature of 3.2ϵ C (4.7ϵC) for the B2 (A2) scenario in summer and around 3.4ϵC in both scenarios for spring. For minimum temperature results are similar with increases for summer (spring) that range from 2.7ϵC (2.5ϵC) in the B2 scenario to 4.1ϵC (2.9ϵC) in the A2 scenario.

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ABSTRACT

Changes in Present and Future Circulation Types Frequency in Northwest Iberian Peninsula (Oral)

Circulation types are associated with surface climatic variables, like precipitation or temperature. Therefore, circulation types can also be a useful tool not only to validate the control simulations of the coupled general circulation models (CGCM) but also to analyse changes in the circulation patterns under future climate change scenarios. In this study, the circulation type used was an automated version of the Lamb weather types adopted with success for the NW Iberian Peninsula in 2008 by Lorenzo et al. Mean seasonal circulation type frequencies for the period 1948-2008 were also computed. Linear trends were analysed taking into account not only all period of analysis but also for two sub-periods (1948-1975 and 1976-2008); these two sub-periods are coincident with a general change in circulation in the Northern Hemisphere (Trenberth, 1990; Ramos et al, 2009). The particular case of the winter will be analysed in more detailed. We have also studied changes in WT frequency in future climate change scenarios based on the output runs of several GCMs used for the IPCC 4AR. The chosen models were the IPSL-CM4; the ECHAM5/MPI-OM and the CCSM3 motivated by the availability of the daily data. To do so, we have used Sea Level Pressure (SLP) data from different forcing simulations corresponding to three emission scenarios representing low (B1), medium (A1B) and high (A2) concentration of CO2 and from a 20th century control simulation. The difference between the seasonal mean SLP fields of three models and the reanalysis are computed in order to evaluate the ability of the models to reproduce the present climate. After assessing the behaviour of the three models in the 20th century, we examine changes in the frequency of the circulation types for the three scenarios A1B, B1 and A2. The differences between the respective control run (1961-1999) and the 3 models are accessed and discussed for two future periods of analysis: 2046-2065 and 2081-2099.

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ABSTRACT

North African Palaeoclimate over the last ~80 ka: Isotopic Analysis of Mammalian Tooth Enamel from Northeast Libya

The topographical and morphological diversity of the Mediterranean basin produces locally diverse responses to regional and global climate change. As such, in order to understand the impact of climate change on local ecosystems and human populations a local view of climate must be obtained. The southern Mediterranean sits at the boundary between two distinct climatic regimes, with the mid-latitude westerlies to the north, and the sub-tropical monsoons to the south. This position makes the area particularly sensitive to changes in atmospheric circulation and climate. Despite this, so far, relatively little palaeoclimatic data is available for the region when compared to more northerly parts of the Mediterranean basin.

This paper contributes to the small, but growing, body of palaeoclimatic work from North Africa. Through the isotopic analysis of mammalian tooth enamel from archaeological sites, aspects of long-term climate change and seasonality have been reconstructed. The δ18O of mammalian enamel is correlated with the δ18O of local meteoric water because 1) teeth and bones mineralise in isotopic equilibrium with body water, and 2) the diet and drinking water of an animal determines the δ18O of its body water. Furthermore, quantitative estimates of past climate from fossil remains are possible when a relationship between modern animals, and modern climate, is established. Focusing on the Gebel Akhdar region of northeast Libya, climate over the most recent ~80ka is discussed.

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ABSTRACT

Characterization of cyclones producing intense precipitation events in the Mediterranean region

This study considers the association between cyclones and winter precipitation events along the Mediterranean coast. Precipitation events are characterized as sequences of wet days with large accumulated total precipitation values. Long sequences with multiple precipitation maxima are split in sets of shorter events. Cyclones are provided by an tracking algorithm applied to the ERA-40 (ECMWF Re-Analysis) dataset for the period 1958-2002. Data for The analysis of daily precipitation are provided by the ECA (European Climate Assessment, hosted at Royal Netherlands Meteorological Institute, KNMI) dataset. It is found that cyclones producing precipitation vary across the region: different systems are responsible for precipitation in different areas of the Mediterranean region:

i)In the north-western areas systems are either of Atlantic origin or secondary cyclone associated with the passage of major cyclones north of the Mediterranean basin, ii)In the eastern areas cyclones producing intense precipitation are mostly generated inside the basin itself, iii)an important fraction of severe precipitation in the southern areas are produced by cyclones that are generated over northern Africa.

Intensity of the circulation (Slp minimum, Laplacian, slp gradient, depth,size) are relevant, but the average speed of the cyclone centre and moisture content of the middle troposphere appear to be the most important characteristics explaining the severity of the precipitation event.

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ABSTRACT

Extreme rainfall events: changing magnitudes, frequencies and impacts in the Mediterranean.

Extreme rainfall events, resulting in surface impacts such as floods and landslides, are a common feature of the Mediterranean environment and communities around the Mediterranean are vulnerable to these impacts. Analysis of the Emergency Events database (EM-DAT http://www.emdat.be/), for example, reveals that a total of 225 'damaging flood events' affected the countries bordering the Mediterranean between 1950 and 2007 resulting in more than 8550 fatalities. The seasonality of these extreme flood events changes across the Mediterranean from 50 or 60% occurring in the autumn (SON) in the Western and Central Mediterranean, respectively, to a much more even seasonal distribution in the Eastern Mediterranean (e.g. 38% SON). The analysis also reveals changes in the vulnerability of communities over time as well as the increasing importance of pluvial flooding in urban centres in addition to the more conventional fluvial flooding events.

In order to understand the changing nature of the interaction between extreme rainfall events and their impacts across the Mediterranean, this study uses daily rainfall records from 1950 to 2005, in order to explore this interaction in three study areas: Eastern Spain, Southern Italy and Cyprus. If an extreme rainfall event is defined as an event with a 5-day total exceeding 10% of mean annual rainfall, then the frequency of extreme events appears to have been declining across the Mediterranean from 3 to 2 events/year in eastern Spain, from 1.6 to 0.6 events/year in Southern Italy and from 2.8 to 2.4 events/year in Cyprus over the 55 year period analysed. The study questions the extent to which, within particular regions, events of similar magnitudes have similar impacts. It demonstrates that a complex interaction exists between event magnitude and frequency, with impacts mediated by changes in vulnerability, and raises issues about the likely impacts of future changes in climate variability and associated extreme rainfall events in the Mediterranean.

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ABSTRACT

Long-Term Evolution of the Mediterranean Water Column and Biological Response

In recent times, several mass mortalities of benthic organisms occurred in the Mediterranean sea, due to sudden deepening of warm surface waters. The warmed layer tends to deepen, probably due to global warming, having dramatic effects on species that thrive below the warmer surface waters of the summer.
Our hypothesis is that the warmer layer tends to become thicker in the recent years (as suggested by the biological response of long lived benthic organisms) and that the depth of the sharp shift between the warm surface layer and the rest of the water column tend to increase. To test this hypothesis we analyzed vertical profiles of temperature and density drawn from Mediterranean data banks (such as MEDAR/MEDATLAS), from Mediterranean long-term observatories (e.g. DYFAMED), from a hierarchy of models (from mixed layer to climate models). Representative depths in the temperature profile have been identified with specific algorithms (such as the split and merge technique, introduced by Pavlidis and Horowitz, 1974), namely the mixed layer depth and the thermocline base. The profile analysis was carried out over the whole Mediterranean Sea and regionally over individual subbasins. Sampling clearly represents a crucial issue in this kind of investigations, and even though a quantitative assessment would request data specifically collected for such a purpose, a deepening of the mixed layer depth at the end of the warm season and a prolongation of the seasonal summer behavior of the water column have been identified, in particular in the DYFAMED data base. These results confirm the importance of long-term modifications of the physical forcing on the time evolution of Mediterranean biota.

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ABSTRACT

Climatic change and sea level variations off Alexandria, Egypt

The mean annual air temperature over Alexandria region increased by about 2.24℃ during the study period (1974-2006), with a rate of about 0.6℃/decad e. Changes in water levels at Alexandria are analyzed for the same study period. The recorded hourly values of water level varied between 5cm and 90 cm above the zero level of the tide gauge. The monthly mean water levels are between 37.2 cm in March and 58.1 cm in August. The annual mean sea level increases by 9.95 cm over the study period giving a sea level rise of 3 mm/year. The probability of occurrence of different water levels is presented and the most pronounced frequency was concentrated in the level 50 cm.

Estimation of abnormal water levels obtained in order to extrapolate the trends of the frequencies necessary to determine the optimum height for sea coast protection. The results indicted that; the water level may reach 165 cm once in 100 years and may reach 181 cm once in 500 years. No extreme years has been observed during the study period and the high extreme level of 80 cm have a return period of 100 years and their design lifetime has a risk of 0.64.

Three scenarios could be predicted from the present study; a sea level rise of 15-20cm by 2020 would be of little consequence, augmentations over 30-50cm by 2050 would have more serious effects, and a sea level rise of 100cm by 2100 could flood land within 30km of the coast or more, affecting 12-15% of Alexandria's land.

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ABSTRACT

Mediterranean Coupled Models comparison: response of the thermohaline circulation to climate change

Within the framework of the EU CIRCE project, 5 regional coupled ocean-atmosphere models dedicated to the study of the future climate of the Mediterranean region have been developed. The five models simulated the same period 1951-2050 following the A1B scenario, for the GHG and aerosols concentration, after year 2000. One of the main goals of such coordinated modeling effort has been the assessment of the uncertainty issue. In particular during this presentation will be shown a comparison analysis performed on the five oceanic components of the coupled systems. Such a comparison has been mainly focused on the strength and hydrological properties of the Mediterranean thermohaline circulation. As the Mediterranean thermohaline circulation is sustained by the atmospheric forcing but is also controlled by the narrow and shallow Strait of Gibraltar, the analysis has been concentrated on the different ways the models reproduce the exchange flow through the Strait. Examining the simulated net flow through the Strait of Gibraltar for the past and present periods, it emerges that all the models simulate a net mean flow close to the observations. For the future period (2021-2050) all the models predict a decrease, respect to the previous period, both in the inflow and the outflow. Nevertheless in all the simulations the net inflow is predicted to increase. A comparison of the main processes affecting the climate variability of the Mediterranean thermohaline circulation in the five models has been also analyzed, and will be discussed during the presentation.

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ABSTRACT

Links between Sea Level in the Northern Adriatic Sea and large scale patterns

This study explores the link between sea level in the Northern Adriatic Sea, large scale SST (sea surface temperature), SLP (sea level pressure) and Mediterranean sea temperature and salinity at levels between 0 and 500 meters depth. Sea level data are provided by monthly values recorded at 7 tide gauges distributed along the northern coast of the basin, SLP data by the ERA-40 reanalysis that has been produced by ECMWF, SST by the extended reconstructed sea surface temperature (ERSST) that is based on the most recently available International Comprehensive Ocean-Atmosphere Data Set and is distributed by NCDC. Temperature and salinity data are provided by MEDATLAS/2002 database, from MEDAR/MEDATLAS project that stored temperature, salinity and bio-chemical parameters for the Mediterranean basin and Black Sea. The inverse barometric effect and the thermosteric effect provide the physical basis for the link, implying a sea level increase for increasing temperature and decreasing atmospheric pressure. The results are produced by a combination of PCA (Principal Component Analysis) and linear regression techniques. These linear statistical techniques have provided a good reconstruction of the temporal variability patterns and also of the individual time series of tide gauge stations.

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ABSTRACT

Paleoenvironmental transitions in the central Peloponnese: A sediment record from a former lake near Asea, Greece

We use Greece as an example to explore how human cultures have for millennia responded to paleoenvironmental forcing. Greek archaeology has produced a rich and well-dated time-line of cultural change during the Holocene (i.e. the last ca. 11,000 years) that can be directly compared with radiocarbon-dated paleoclimatic and paleoenvironmental changes in Greece over the same time period. Our project develops a well-dated paleoenvironmental record from a former lake bed in the heart of the Peloponnese near Asea for correlation against archaeologically known chronological units and transitions in regional cultural history.

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ABSTRACT

Mediterranean sea level variability changes and projections at high frequencies (1-100 days)

Long-term sea level variability changes (1960-2000) and projections (2000-2100) over the Mediterranean have been investigated, in order to document the changes in sea level energy and extremes over different frequency bands (1-3, 3-10, 10-100 days). An ocean 2D numerical model with resolution of 1/6o has been forced by surface wind and air pressure fields derived from regional atmospheric model runs, under the control and three different climate scenario runs (A1B, A2, B1) forced by GHGs concentrations. Sea level variability obtained by the control run has been verified on the hindcast ocean model run forced by ARPEGE reanalysis surface fields, and on the available tide gauge data. A noteworthy decrease in sea level energies over the Mediterranean can be seen over 1-3 day periods for A2 and A1B scenarios, and smaller for B2 scenario, being compliant with a negative trends projected for cyclonic activity found in literature. For 3-10 and 10-100 day periods, of which the latter encompass the planetary wave dynamics and its influence to the sea, the decrease rate is much smaller and can be found in the eastern and western parts of the Mediterranean, while higher energies (and even increase in B2 projections) can be found in central Mediterranean and southern shorelines. A negative energy trends over planetary wave frequencies indicate a decrease in duration of coastal floods, which, together with a noteworthy decrease in cyclonic activities, may partially mitigate coastal flooding caused by the plausible increase in mean sea level.

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ABSTRACT

Ability of Synoptic Downscaling techniques for analysing precipitation extremes in the Mediterranean area

In the context of Mediterranean precipitation variability under global climate change conditions, special attention is paid to the dynamics of extreme events. They have an enormous impact on society, but at the same time quantifying future changes is highly difficult. On the one hand there is a lack of comprehensive long-term precipitation datasets which are the basic requirement for extreme-value analysis. On the other hand common downscaling techniques, e.g. the synoptic weather-type approach, are encountering particular difficulties in capturing the variability at the tails of the underlying probability distribution. Nevertheless there is a legitimate interest in applying those techniques as well to the assessments of extreme events: Synoptic Downscaling, e.g. based on circulation-type classifications, gives insight into large-scale dynamical patterns accompanying local extreme events and thereby leads to a better understanding of the responsible mechanisms.
The recent results have been gathered in the framework of a current Project funded by the German Research Foundation (DFG) analysing precipitation and temperature extremes in the Mediterranean area in a changing climate. Precipitation variability and the related extremes are analysed based on long-term daily weather-station data mainly for the Western, Northern-Central and Eastern Mediterranean area (ECA-D, EMULATE & GLOWA-Jordan projects, Aemet). An extreme-value adjusted predictor screening - taking into account several circulation parameters like geopotential heights, sea-level pressure, relative and specific humidity, moisture flux and vorticity - helps to identify appropriate large-scale variables capturing the seasonal circulation conditions related to extremes at particular stations. In order to cover periods as long as possible, predictor variables are extracted from 20th-Century Reanalysis V2 data ranging from 1871 to 2009.
Based on varying windows related to Western, Central and Eastern Mediterranean regions, different synoptic techniques, like the Analog-method and weather-type classifications, were tested with regard to their suitability to reproduce daily variability in modelled precipitation, thus providing a basis for comparing shifts in the extremes under climate change conditions. Moreover, circulation patterns which are meaningful for Mediterranean precipitation extremes, will be pointed out and analysed in their frequency-changes throughout the time. In general, lots of modifications are necessary for applying the Synoptic Downscaling approach for the above mentioned purposes.

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ABSTRACT

Sea Level Reconstruction using Altimetry and Tide Gauges within the Mediterranean Basin

The spatial sea level patterns derived from Empirical Orthogonal Functions (EOFs) from a 16 year satellite altimetry dataset are used in conjunction with available tide gauge observations to reconstruct sea level variability backwards in time for the Mediterranean basin. The reconstructed sea level dataset period is between 1899 and 2009. The reconstruction method is based on Church et al. (2004). These finding are compared with previously published methods. We explore the robustness of this method in terms of estimating the basin trend with a realistic error.

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ABSTRACT

PaleoMex (Paleo-Mediterranean) Initiative

PaleoMex aims at documenting the Mediterranean climate and hydrological cycle over the Holocene and its impact on human societies. The Mediterranean basin is lying within a transition zone between subtropical and temperate climates where strong E-W and N-S gradients exists and where important changes have occurred in the past and are predicted in the near future by IPCC scenarii (IPCC, 2007). Owing to its climatological location, the small size of the basin, and the important development of ancient societies in its surroundings, the Mediterranean region represents a unique experimental object to foster our knowledge on the complex interactions between climate, environment and man in the recent past. For this, climate needs to be understood at regional and local scales to fully appraise paleo-hydrological regimes. Assessment of the seasonality of precipitations and temperatures is an important issue as these factors undoubtedly played a central role for agriculture and plant cultivation in the Levant basin and motivated sedentary economy in the Early Holocene (Neolithization). Mediterranean climate fluctuated significantly over the Holocene at a rather small scale but many areas of the Mediterranean basin lack of high-resolution proxy reconstructions. Here, we present 5 projects that have been proposed by the PaleoMex program to organize a research network for generating proxy reconstructions along two E-W transects using continental archives (HOTMED and ISOMEX). Extreme events will also be investigated using lagoonal deposits and coastal sediments (WEATHER and GOLHO). In parallel, the ARCHEOMED project will explore the links between abrupt changes and social and cultural in the Balkan-Aegean Sea that have occurred since the 8.2 kyr event.

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ABSTRACT

The role of SSTs on summer drought episodes in the Mediterranean area (Poster)

Several drought indices (e.g. SPI, PDSI) have been used to characterize the spatial and temporal evolution of dry/wet conditions over the entire Mediterranean or sub-regions. We have used the Self Calibrated PDSI (scPDSI), initially proposed by Wells et al (2004), as we have found this index more representative of the variability presented by instrumental records. This index relies on water supply-demand budgets, based on monthly temperature and precipitation series, and soil type classification. This dependence on precipitation and temperature series led us to test correlations with large-scale atmospheric indices (e.g. NAO, SCAND). We found important anti-correlation with several teleconnections, particularly the winter NAO (below -0.50) and SCAND pattern (above 0.40), and particularly on western and central areas. Lagged links proved that the scPDSI retains memory from winter meteorological events throughout the following seasons, fact that motivated us to develop a simple regression model for mean summer scPDSI prediction (6 months in advance) based on the mean winter scPDSI and large-scale indices as predictors. This model presented a correlation coefficient of 0.7 (Sousa et al., 2011).
Hertig et al. (2010a, b) have proved successful in using SST information as a tool for seasonal forecasting of precipitation and temperature for several sub-domains of the Mediterranean. Based on their approach, we have defined 8 areas over the oceans and found significant links, especially with Atlantic sectors SST anomalies. Interestingly, a particularly relevant result for us was the existence of significant links between scPDSI series in Turkeyand SST anomalies, as no such links were found with atmospheric circulation indices for this region.
These results led us to also test these SST anomalies series as possible predictors for summer scPDSI mean values in the Mediterranean basin. In fact, these predictors bring some extra value to the model, as winter SST anomalies from the Mediterranean and East Atlantic areas are included by the stepwise regression model. This new model for the mean summer scPDSI of the Mediterranean basin (as a whole) presents a correlation coefficient of 0.8, and skill scores of +58% and +11% against climatology and persistence, respectively (Sousa et al., 2011). These satisfying results for such a large domain raised prospects of testing this method at a finer scale, so we have tested similar models for sub-regions (e.g. Iberia, Italian peninsula).

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ABSTRACT

Links between fire regimes in Iberia and large-scale meteorological variability (oral)

Wildfires constitute one of the major natural hazards that affect the Mediterranean basin. The recent outstanding number of large fires that struck Portugal (2003), Spain (2006) and Greece (2007) have stressed again this fact. In this work we have organized a comprehensive Iberia wildfire database, by analyzing records of fire occurrences in Portugal and Spain for the 1980-2005 period, corresponding to a total of 66 sub-regions. We performed a k-means cluster analysis in order to distinguish fairly independent domains in terms of burned area time series inside the peninsula. The best results were obtained using either 4 or 5 clusters, with spatial patterns and seasonal regimes compatible with land cover, topography and climate conditions. The analysis aggregates provinces in terms of fire regime as follows: northwestern, southwestern, central and Mediterranean areas, with the northern Provinces (Asturias, Cantabria and Basque Country) forming an additional region if we opt for 5 clusters. It has been shown that summer burned areas in western Iberia result mainly from two distinct forcing factors (Pereira et al., 2005): 1) favorable pre-summer climatic conditions, namely a rainy winter and dry and hot spring and 2) large-scale stationary blocking circulation patterns in summer that induce heat-wave conditions. Taking this into account, we evaluated the contribution of meteorological variables obtained from the high resolution CRU dataset (monthly mean temperature, monthly precipitation). Afterwards we evaluated the role of large-scale circulation patterns, such as the NAO, SCAND, EA, EA\WR, POL, and also large-scale SST anomalies towards summer fires regime for the individual clusters identified previously.
We have considered the two most western clusters that include northwestern areas of Portugal and Spain and the southwestern sector of Iberia. After evaluating the seasonal cycle of burned area we restricted our models to the months of July and August, and considered the anomalies of the previously referred variables for each month since the beginning of the corresponding year. Some obviously expectable correlations were found with late spring/summer temperature and precipitation series (above 0.35 and below -0.35 respectively). Furthermore, we have also obtained some less obvious correlations with winter variables, particularly with SST anomalies relative to various sectors of the Atlantic (above 0.25) for both considered clusters.
The existence of an important number of statistically significant correlations (from previous seasons) with summer burned area totals raises good prospects of using these variables as predictors in statistical forecast models. Using a similar methodology used by the authors in a recent work concerning drought episodes (Sousa et al., 2011), we tested stepwise regression models, in order to predict the July-August burned area. These models were calibrated and validated between 1980 and 2006, with a lead time of up to 2 months, having obtained good correlation results after cross-validation (above 0.70). Finally, the relatively good performance of these statistical models based on simple meteorological variables opens the prospect to evaluate how fire regimes will behave in future scenarios, based on GCM outputs.

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ABSTRACT

Climate change impact on agricultural water demand in Italy

This work aims at investigating the possible impacts of climate change on crop water and irrigation requirements in Mediterranean environments. Input climate data were developed by CMCC model within the framework of CIRCE integrated project founded under EC FP6 (www.circeproject.eu) and cover the period 1985-2065. Data refer to A1B SRES scenario and represent a set of 80x80km grid point locations over the whole Mediterranean region. In this study were used the monthly data over the Italian territory resembling the average climatic conditions for years 2000 and 2050. The impact of climate change was modelled on durum wheat and sunflower crops applying a simple water balance approach of CROPWAT model based on crop evapotranspiration and effective precipitation. The impact of climate on crop evapotranspiration and irrigation requirements was modelled considering: i) the changes in temperature, having an impact on the growing season and its duration, and ii) the changes in precipitation pattern, affecting the irrigation scheduling and agricultural water demand. The overall results indicated i) a general increase of the climatic water deficit (the difference between reference evapotranspiration and precipitation) especially during the spring-summer-autumn season; ii) a likely decrease of crop water requirements for almost all locations and for all crops due to reduction of the growing season; iii) an irregular trend of irrigation requirements depending on the precipitation distribution.

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ABSTRACT

MyOcean: Mediterranean Monitoring and Forecasting Centre

Within the Global Monitoring for Environment and Security program (GMES) and its Marine Service Fast Track , My Ocean consolidates the European community past efforts in pre-operational ocean monitoring and forecasting capacity in Europe developed through European projects as MERSEA, BOSS4GMES, GSE MARCOAST and POLARVIEW.
MyOcean aims at providing a sustainable service for Ocean Monitoring and Forecasting validated and commissioned by users. The MyOcean information includes observations, analysis, reanalysis and forecasts describing the physical state of the ocean and its primary biogeochemical parameters. It also contributes to research on climate by providing long time-series of reanalysed parameters.
MyOcean's products & services bring added-value to European organisations in charge of Ocean-related issues, public and private organisations within the Member States (Meteorological Agencies, Ocean centres, Environmental Agencies, Research Centres, Navies, Coast guards …), commercial service providers, and intergovernmental bodies in charge of Ocean protection.
MyOcean proposes a first model of governance for a Marine Service organisation while also preparing a long-term roadmap. By including major European centres involved in operational ocean monitoring & forecasting, by involving users from day one and by fostering scientific excellence, MyOcean coordinates the effort to avoid duplication through an integrated pan-European capacity for ocean monitoring and forecasting.
The Mediterranean Monitoring and Forecasting Centre (MFC) is one of the regional production centre of the MyOcean system.
The Med-MFC is a key operational centre for the provision of basic modelling data sets that are at the basis of the continuous monitoring and forecasting of the marine environment for this region. This monitoring and forecasting products are at the basis of a new approach for the protection and management of the marine environment and the planning of investments.
The validation of the products is based on the observations and sub-regional forecasting system of the Mediterranean Operational Oceanography Network (MOON) which is the EuroGOOS regional Task Team that developed the institutional network providing all the elements of the core service for the Mediterranean area.

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ABSTRACT

Climate change induced trends on water availability in the Island of Crete, Greece

Climate change is expected to have a significant impact on the hydrologic cycle, resulting in changes on freshwater resources. The Mediterranean has been described as one of the main climate change hot-spots, with recent simulations showing a collective picture of substantial drying and warming. This effect appears more pronounced during warm periods, when the seasonal decrease of precipitation can exceed control climatology by 25-30%. However, the scientific question on the quantitative impact of these signals to small scale coastal watersheds and Mediterranean islands has not been answered. The rapid development of Crete in the last 30 years has exerted strong pressures on the natural resources of the region. Urbanization and growth of agriculture, tourism and industry had strong impact on the water resources of the island by substantially increasing water demand. In the frame of the present study, the state-of-the-art ENSEMBLES RCMs and WATCH (FP6) downscaled GCMs dataset, under A1B, A2 and B1 emission scenarios was employed to assess the impact of the changing climate on the water availability of the island of Crete at a basin scale. In order to examine future trends in hydrologic regime and water resources under different climatic scenarios, precipitation and temperature time series for the period 1970-2100 are used as input to hydrological model. Data analysis for this period reveals an overall decreasing precipitation trend that when combined with an increasing temperature trend, leads to a substantial reduction of water availability. Knowledge of future hydrological changes in Crete will provide the data required to improve existing policy to effectively tackle water shortages.

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ABSTRACT

StymphaCore – Reconstructing the Climate History of the Northern Peloponnesus, Greece

The interdisciplinary research project “StymphaCore” aims to understand the relationship between the climate and the historical record, as well as the natural versus human-induced environmental change on the Northern Peloponnesus. To answer these questions, two study areas, Lake Stymfalia and the Prokopos Lagoon, were selected for high resolution comparative analyses. In a first field campaign in March 2010, several lake sediment cores were recovered at both sites using a piston coring device on a floating platform. The planned Sediment analyses include the combination of geochemi¬cal (i.a., XRF-scanning, CNS) and geophysical methods (i.a., Magnetic Susceptibility). High-resolution AMS 14C dating is used to establish detailed time series of the climate variables (samples have been submitted but the dates are not yet available). Known from the ancient Heracles myth of the Zeus’ son slaying the Stymphalian birds, the mountainous landscape of Stymphalos is an ideal site to study the environmental history of the area by combining the climate archive of lake sediments with the historical and archaeologi¬cal record. Settlement activity is known from least the 5th century BC and was specified by Pausanias in his “Description of Greece”
A 15.54 m long sediment core (STY1) was retrieved, with the first lithological characterization of the mainly clayey sediments suggesting that the core spans the entire Holocene and parts of the Late Glacial. In contrast, the Prokopos Lagoon is separated from the Ionian Sea by a ca. 1.5 km wide, arboreous dune ridge and shielded to the North by the carbonate cliff of Cape Araxos. At this site, emphasis is placed on (1) reconstructing the paleo-climate, (2) establishing paleo-geographic scenarios including sea level fluctuations and (3) disentangling the human-envi-ronment interaction. 3 sediment cores of up to 4 m length each were retrieved along a transect. First results indi-cate a predominance of dark, shell- and organic-rich sand which is sporadically dissected by gyttja or peat layers. Additional information about environmental changes will be derived from recent and historical maps, from ancient travel reports and from the archeological record of the Mycenaean for-tress Teichos Dymaion located on Cape Araxos. Human activity is known to have occurred in this area since the end of the Neolithic.
Focusing on the balance between sustainability and exploitation, important questions of the StymphaCore project are: How did the different cultures i.a. Myceneans, Classic Greeks and Romans, manage the water resources? And how sustainable was the agricultural land use?

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ABSTRACT

Percentile-based extreme indices of precipitation in the Mediterranean area in a multi-model ensemble of global climate models

The German KLIWEX-MED (Changes in weather and climate extremes in the Mediterranean Basin) project is concerned with the analysis of the regional characteristics and intensity of climate change in the Mediterranean Basin and with the quantification of the corresponding uncertainties. In further steps of research, the frequency and strength of extreme events like heat waves, droughts and heavy precipitation are investigated.

For this purpose, individual simulations of different global climate models of the fourth IPCC assessment report derived from the WCRP CMIP3 Multi Model dataset are analyzed in a statistical and probabilistic sense. Aside other variables like sea-level pressure, special focus is given to precipitation and temperature for the the different GHG emission scenarios A2, A1B and B1.

The following four percentile-based extreme precipitation indices are derived: the entities trespassing the 95th percentile of the daily precipitation amount in the reference time period, the percentage as a ratio of this amount to the total amount, the cumulative amount and the mean daily intensity of precipitation associated to these events. Using these indices a good coverage is given to detect changes in the frequency and intensity of heavy precipitation events. Particular attention is paid to highlighting the results in a seasonal context. Future changes are shown as the results are calculated for both past simulations and future simulations separately.

With the objective to facilitate a quantitative model intercomparison across all the simulations and to build ensembles and superensembles, all models have been interpolated on a homogenous 3˝x3° spatial model grid.

Further background is provided by an analysis of means and trends of the different model simulations based on seasonal and yearly mean values and an accomplishment of an analysis of variance, which concerns with the uncertainty derived from the different climate projections of the specific simulations and models. Here, the amount of climate variability that is common to all models and, thus, can be considered as a comparatively confirmed signal of climate change, is set into ratio to the internal variability inherent to each climate model due to uncertain initial conditions and the variablility between different climate models due to different specifications like parametrizations and discretizations. Thus, it is proved if it will be possible to distinguish a multi-model trend imposed by radiative forcing of a certain scenario against the background of model uncertainty developed by the internal model and inter-model variability.

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ABSTRACT

Recent temperature trend in the Middle East, Northern Africa and Eastern Mediterranean

In this paper, observations, National Center for Environmental Protection (NCEP) and European Center for Medium Weather Forecast (ECMWF) reanalyses, and fine-resolution simulations from the Geophysical Fluid Dynamics Laboratory (GFDL) General Circulation Model (HIRAM) are used to analyze the regional surface temperature trends in Northern Africa, the Middle East and the Mediterranean regions over the last 30 years. The data indicate that the trends are especially large over the Balkan and Anatolia peninsulas and in the Middle East, where the magnitude exceeds 1K/decade. The African Sahel region and south of the Arabian Peninsula experience negative temperature trends, although they are not always statistically significant. The observed trends have a pronounced seasonal structure maximizing in the summer (June-July-August) and becoming less pronounced in the winter (December-January-February). Although the reanalyses and the simulation data qualitatively reproduce the observed surface temperature trends, their spatial patterns and magnitude differ in the various data sets with the simulation trends closer to observations than either the NCEP or the ECMWF reanalysis.
By considering the evolution of the seasonal cycle, defined as the difference between summer and winter temperatures, we found a remarkably consistent picture of seasonality change among all data sets. In particular, the seasonal variability increases in the Eastern Mediterranean, while it decreases in the Sahel. The consistency between the data sets increased when a low frequency bias present both in the winter and the summer series was removed.
Remote Sea Surface Temperature (SST) changes and global warming may cause this regional low frequency variability. The seasonal cycle appears to be significantly affected by processes acting on the regional scale. Because the simulation captures the observed changes, we used simulation data to conduct a process analysis. We found that changes in the temperature and in the annual cycle in the Sahel and southern part of the Arabian Peninsula can be attributed to an increase in cloudiness in the Sahel region associated with a 0.5-degree northward shift of the summer ITCZ. The corresponding shift in the mean latitude of the inter-tropical convergence front and the tropical rain belt affect the surface temperature. In the Eastern Mediterranean, the increase in amplitude of the annual temperature cycle results from the fair weather conditions and associated dryness due to decreases in precipitation and cloudiness, which strongly affect the surface temperature in the summer.

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