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The climate of the Mediterranean region: understanding its evolution and effects on environment and societies

BOOK OF ABSTRACTS

Universitat de Barcelona
GOBIERNO DE ESPAÑA MINISTERIO DE ECONOMÍA Y COMPETITIVIDAD
AEMet Agencia Estatal de Meteorología
MUSEO DEL TRAJE Centro de Investigación del Patrimonio Etnológico

Sessions

Regional processes and climate change impacts
Chair: Piero Lionello

Modelling of the Mediterranean climate system and climate projections
Chair: Serge Planton

Circulation and mean sea level of the Mediterranean Sea
Chair: Damià Gomis and Alex Theocharis

Paleoclimate of the Mediterranean region
Chairs: Isabel Cacho and Blas Valero

Climate variability, trends and extremes
Chairs: Ileana Bladé and Elena Xoplaki

Organizing Committee

Belén Rodríguez de Fonseca, Ileana Bladé, Riccardo Buccolieri, Isabel Cacho, Ernesto Rodríguez Camino, Damià Gomis, Alicia Lavín and Enrique Sánchez Sánchez.

Invited Speakers:

Other contributions:

Invited speakers

The Mediterranean Is Getting Saltier

Bryden, H.L. [(1),] and Schroeder, K.

School of Ocean and Earth Science, University of Southampton, Southampton, U. K.

The deep waters of the Mediterranean Sea have been getting saltier and warmer for at least the past 40 years. Here we show that two processes contribute to these increases in temperature and salinity. On interannual time scales, deep water formation events in severe winters transmit increasingly salty intermediate waters into the deep water. The second process is a slow, steady downward flux of heat and salt through the thermo-halocline that connects the Levantine Intermediate Water with the Deep Water. We illustrate these two processes using a set of repeat surveys of the western Mediterranean basin from 2002 to 2010.

Summer heat and drought in continental midlatitudes: of soil moisture and other things

D'Andrea, F.

Laboratoire de Meteorologie Dynamique. Ecole Normale Superieure, 24 Rue Lhomond 75231 PARIS CEDEX 05 – France

This will be in part a review talk, but will also include some of my own recent work. I will talk about the climatology of heaatwaes, including summer 2003 in Europe and 2010 in Russia, and then go on discussing the impact of the land surface on them. This includes soil moisture and vegetation. From that, I will have a look to what is known on the feedbacks between the land surface on one side and precipitation and temperature on the other. I will also way few words on the potential predictability coming from the knowledge of these feedbacks and on the future studies needed.

Reconstructing the past, projecting the future: a regional earth system perspective for the Mediterranean region

Dell'Aquila, A.

UTMEA-CLIM, ENEA, CR Casaccia, Rome, Italy

We here present a validation of the Regional Earth System Model (RESM) PROTHEUS assembled at ENEA in terms of capability in reproducing the major features of present climate over the Mediterranean region.

RESMs can both help filling time/spatial gaps in historical data and enhance our capacity of providing tailored information on projected climate change to end-users. In this perspective, the RESMs can be also a key resource for climate services. A quantitative assessment of RESMs skills and limitations in describing climate variability and change is therefore an important pre-condition for reliable services. With the perspective of responding to user needs it will be also important to compare the model skills with the expected standards.

An assessment of the model performances is done by using available observational datasets in terms of leading seasonal cycle of key environmental parameters and on large deviations from it. Specific regard is paid to the representation of the hydrological cycle.

Finally, we will discuss the results of the downscaling of an A1B XXI century scenario simulation showing that the adoption of a RESM for the Mediterranean region permits a narrower identification of the effects of a warmer climate on intense precipitation events and on other key environmental indicators.

Simulation of extreme events in climate projections

Déqué, M.

Météo-France/CNRM

Climate change is often feared because the frequency of some extreme events is expecting ti increase. Contrary to temperature elevation, for which model bias is partly canceled out when considering future-present differences, extreme indices (e.g. number of frost days, mean daily rainfall above 20 mm) depend on absolute thresholds. It is important to correct model series before evaluating the indices. We will examine how far this correction may modify the model response.

Another important point in climate projection is uncertainty. Part of this uncertainty is the sampling uncertainty: indices are built from 30-year series. But another part comes from the way modelers mimic the reality. The FP7-ENSEMBLES project offers a wide database (about 20 models) of 25-km scenarios over the Mediterranean basin. Because local climate is a combination of regional processes and large-scale forcing, it is possible to generate, thanks to a statistical technique based on weather regimes, artificial time series from any pair of RCM, GCM involved in the project. This leads to about 60 “models”. The pdf derived for the extreme indices is thus smoother and one can evaluate bivariate pdfs for which the link between the mean temperature response and the index response. We will show different indices for the mediterranean cities illustrated in the Circe final report (part 1, chapter 2.4) : Madrid, Marseilles, Rome, Athens, Cairo and Tunis

Climate in the last 2 millennia: model data comparison

Gonzalez-Rouco, F.

Dpto. Astrofisica y CC. de la Atmosfera / Instituto de Geociencias (UCM-CSIC).
Facultad CC Fisicas, Universidad Complutense de Madrid.

Late Holocene climate offers an immediate temporal context against which the warming of the recent decades can be compared. The relative abundance of high resolution proxy data in comparison to earlier periods has allowed to develop reconstructions that target the time, and sometimes the spatial evolution of some of the most relevant climate parameters, as well as of past external forcing factors. In turn, the latter have been used as boundary conditions to produce climate model simulations, many of them spanning the last millennium. Reconstructions and simulations are both affected by different sources of uncertainty and thus subjected to their own strengths and limitations. This work presents several examples illustrating: different ways in which model-data comparison may be undertaken; how model and reconstruction uncertainties can be dwelt with; and what can be learned from this approaches that may be useful for our understanding of future climate change.

The climate change signal in the Mediterranean area as obtained with a set of regional projections performed with a realistic representation of the Mediterranean Sea

Gualdi, S.

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In this study we present a description of an innovative multi-model system developed within the CIRCE EU-FP6 Project and used to produce simulations of the regional climate with a realistic representation of the Mediterranean Sea. The “CIRCE models” are a set of five coupled climate models composed by a high-resolution Mediterranean Sea coupled with a relatively high-resolution atmospheric component and a global ocean, which allow to explore and assess the role of the Mediterranean Sea and its complex, small-scale dynamics in the climate of the region. In particular, they make it possible to investigate the influence that local air-sea feedbacks might exert on the mechanisms responsible for climate variability and change in the area. In many regards, they represent a new and innovative approach to the problem of regionalization of climate projections in the Mediterranean region.

The CIRCE models have been integrated from 1951 to 2050, with initial conditions obtained from a long spin-up run of the coupled systems. The simulations have been performed using observed radiative forcing (solar constant, greenhouse gases concentration and aerosol distribution) during the first half of the simulation period and the IPCC SRES A1B scenario during the second half (2001-2050).

The projections indicate that remarkable changes in the Mediterranean region climate might occur already in the next few decades. A substantial warming (about 1.5°C in winter and almost 2°C in summer) and a significant decrease of precipitation (about 5%) might affect the region in the 2021-2050 period compared to the reference period (1961-1990), in an A1B emission scenario. However, locally the changes might be even larger. In the same period, the projected surface net heat loss decreases, leading to a weaker cooling of the Mediterranean Sea by the atmosphere, whereas the water budget appears to increase, leading the basin to loose more water through its surface than in the past. The climate change projections obtained from the CIRCE models are overall consistent with the findings obtained in previous scenario simulations, such as PRUDENCE, ENSEMBLES and CMIP3. This agreement suggests that the results obtained from the climate projections are robust to substantial changes in the configuration of the models used to make the simulations.

Finally, the CIRCE models produce a 2021-2050 mean steric sea-level rise that ranges between +7 cm and +12 cm, with respect to the period of reference.

Within the CIRCE project the results obtained from these models have been used to investigate the climate of the Mediterranean region and its possible response to radiative forcing. Furthermore, the data have been made available for climate change impact studies that are included in the Regional Assessment of Climate Change in the Mediterranean that has been prepared in the context of the CIRCE project.

2000 years of paleo climate evidence from the Mediterranean

Luterbacher, J. and MedClivar Paleo consortium.

Climatology, Climate Dynamics and Climate Change, Giessen, Germany

The integration of climate information from instrumental data and documentary and natural archives, evidence of past human activity derived from historical, palaeoecological and archaeological records, and new climate modeling techniques promises major breakthroughs for our understanding of climate sensitivity, ecological processes, environmental response, and human impact. In this contribution, we review the availability and potential of written records, and terrestrial and marine natural proxy archives from the Mediterranean region over the past 2000 years. We describe known and anticipated challenges posed by integrating multiple diverse proxies in high resolution climate variation reconstructions, including proxy limitations to robust reconstruction of the natural range of climate variability, and problems specific to temporal scales from inter-annual to multi-centennial. Finally, we highlight the potential of palaeo models to contribute to climate reconstructions in the Mediterranean, by narrowing the range of climate sensitivity estimates and by assimilating multiple proxies.

Mediterranean sea level under climate change scenarios: from regional to local scales

Marcos, M.

IMEDEA, UIB-CSIC, Palma de Mallorca, Spain

Mean sea level changes, storm surges and waves together with the non-climate contribution of vertical land movements are crucial factors for the management and protection of the coastal environment. Sea level change projections must therefore integrate the different sea level contributions at a regional scale. Mediterranean mean sea level is expected to increase during the 21st century as a consequence of global warming, according to global and regional climate models, exacerbating the coastal impacts of extreme sea level events. Projections of storm surges under different climate change scenarios will be presented based on the results of a barotropic regional ocean model; in particular, changes in both frequency and intensity of the strong episodes will be examined. Likewise, projections of wave climate and extremes generated by a wave model will be described for the western Mediterranean. The coastal impacts of the combined effect of these contributions are also influenced by the local vertical crustal motions. It will be also shown how both GPS and tide gauge observations serve to identify areas under higher risk of flooding due to subsidence. Examples of the combination of information on sea level changes at particular sites will be discussed

The Holocene in the context of previous interglacials: the Iberian margin

Martrat, B.

IDÆA-CSIC, Barcelona, Spain

At present, Iberia has a warm temperate climate, absolutely dry during summer and spatially confined between the warm temperate fully humid climate from the north and the arid climate from the desert in the south. The Iberian margin climate may be considered as relatively stable since the beginning of the present interglacial (Holocene, about 11700 years ago) and particularly since the end of the last deglaciation (approximately 8200 years ago). Relatively stable means, for instance, temperature changes of less than 30% in amplitude of the total variability during the interglacial climate development, from the early to late stages.

The structure of the events recorded during previous interglacials does not differ much from the structure in the Holocene: after a complex period of deglaciation, a temperature maximum is reached and a trend towards colder climatic conditions commences, sometimes gradually, others abruptly. This cooling trend is interrupted by a number of brief warm periods (current warm period, Medieval climate anomaly, the Roman warm period, etc). Interestingly, warm and stable long periods similar to the Holocene always ended abruptly after long millennia of natural deterioration of climate conditions. The final shift was truly enormous and swift (in just few centuries, a change of more than 60 % in amplitude of the total interglacial temperature variability).

Comparisons drawn between the Holocene and previous interglacials are a useful tool for predicting when the climate would start to definitively deteriorate. Knowledge on periods when the Earth was as warm as or warmer than the present will help to explain the gradual and abrupt natural changes observed and how these changes interact with those presumably originating from human influence. This is not an academic exercise, but it is imperative to answer questions that societies must face, for example the way these changes affect their organization and the link between their economic activities and the environment.

Drought in Mediterranean Europe: future projections from multiple climate models

Osborn, T.J.

Climatic Research Unit, University of East Anglia, Norwich, UK.

This talk will analyse projected changes in the frequency and severity of drought, with a focus on the Mediterranean and southern European region. The projections are developed by the so-called "pattern-scaling" approach: changes in the geographic, seasonal and multi-variate patterns of climate are diagnosed from simulations with climate models, and then assumed to vary quasi-linearly as a function of global average temperature change. Though this assumption is not perfect, in many cases it is a reasonable approximation, and has been extended here to include changes in the variability of precipitation as well as changes in mean precipitation and mean temperature. These changes are used to represent possible future changes in drought, together with other measures of drought occurrence such as the Standardised Precipitation Index. The pattern-scaling approach allows consistent comparisons between multiple climate models, and the spread of results between them will be used to illustrate part of the uncertainty in future projections of climate. The spread of an ensemble is not necessarily a good measure of overall uncertainty, however, because the available climate models are not a random sample from the population of all models that are compatible with our understanding of the climate system. The approach is extended, therefore, to consider weighting the models according to some measure of their present-day performance and to include an ensemble of models with perturbed physical parameter values. The weighting makes little difference to the overall spread, but in some regions the perturbed physics ensemble is very different from the multiple model ensemble.

Holocene climate variability and change in the Mediterranean region

Roberts, N.

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Our sources of data on past Mediterranean climate variability change depending on the timescale under investigation. For the last 100-200 years, systematic instrumental measurements of weather conditions provide direct records of temperature, precipitation, etc, with daily to monthly time precision. Prior to ~AD1850 and back as far as ~2500 years ago (2.5 ka BP), documentary sources like diaries and ships' logs offer rich but less complete data sets on historic meteorological conditions. For still older time periods we have to rely on proxy sources of palaeoclimate, such as the isotopic composition of carbonate sediments from caves and lakes. Some of these proxy methods, notably from tree rings, overlap with those from instrumental and documentary records, and provide data on past weather during historic times. Proxy methods therefore represent the main source of empirical data by which Mediterranean climate variability can be reconstructed for the period since the end of the last Ice Age around 15 ka BP. These reconstructions can provide an important way of testing numerical simulations of regional climate under boundary conditions significantly different from the present-day, including changes in radiative forcing, ice volume and atmospheric greenhouse gas concentrations.

The last 15 ka may be divided time periods that include

- The Late Glacial and onset of the Holocene (15-11 ka BP), a period of high amplitude, often very rapid shifts in climate, which marked the transition from glacial to interglacial conditions
- The early Holocene (11-7 ka BP), when boundary conditions – both global and regional – differed from today, and which led - for example - to an expanded African-Asian monsoon in the Northern Hemisphere
- The mid Holocene (7 -2.5 ka BP); a transitional phase in global climate and in some parts of the Mediterranean
- The late Holocene (2.5 ka BP to present), when modern boundary conditions were established

For each of these time periods, I will assess the spatial and temporal pattern of past climate variability; for example, by comparing East and West Mediterranean sub-regions. In conjunction with numerical model simulations, this provides insights into the mechanisms that have controlled long-term shifts in atmospheric circulation and climate dynamics.

Numerical study on the sensitivity of Mediterranean thermohaline circulation to the resolution adopted at Gibraltar and tidal forcing

Sannino, G.

ENEA – CR Casaccia – Rome

The Mediterranean Sea is a semi-enclosed basin displaying an active thermohaline circulation sustained by the atmospheric forcing and controlled by the narrow and shallow Strait of Gibraltar. In the Strait of Gibraltar the thermohaline circulation takes the form of a two-way exchange: at surface fresh and relatively warm Atlantic water spreads in the Mediterranean basin, while at the bottom colder and saltier Mediterranean water sinks as a tongue in the North Atlantic at intermediate depths. The interaction between the intense tidal forcing and the complex geometry of the Strait influences the two-way exchange via hydraulic control. The exchange is subjected to vigorous mixing and entrainment as well as intermittent hydraulic controls over the main sills and in narrowest sections. Non-hydrostatic processes associated to large amplitude internal waves, generated in the middle of the Strait, and propagating mainly eastward, add further complexity in the Strait dynamics.

In the last years the exchange through the Strait of Gibraltar has been investigated by means of numerical models of different complexity. However, among these models none was fully 3D non-hydrostatic, tidally forced, initialized with realistic climatology and at very high resolution. To fill the gap, here we present the state of the art model of the Strait of Gibraltar model. It is based on the MITgcm, is non-hydrostatic and is characterized by a resolution of about 30m .

The first objective of this work is to show the effects produced by the hydrostatic limitation on the simulated two-way circulation, in terms of transports, bore propagation and hydraulics.

To this aim, a comparison between the results obtained by a sigma-coordinate hydrostatic model and the MITgcm will be shown. Here we stress that the non-hydrostatic version of the MITgcm, when implemented at very high resolution, is able to explicitly capture the largest-scale mixing processes responsible for entrainment. In other words the presented MITgcm model represents the first mixing permitting model used to study the Strait of Gibraltar circulation. Consequently the results that will be presented provide a benchmark against which other models at lower resolution may be compared.

The work will be also focuses on the effects produced by an increased resolution at Gibraltar in an eddy-permitting/resolving Mediterranean model. The effect of imposing explicit tides in the Mediterranean model will be also discussed.

Dynamics of extreme precipitation in the Mediterranean región

Toreti, A.

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Extreme precipitation events in exposed and vulnerable areas (e.g. the Mediterranean region) can seriously affect societies and economies. The understanding and the characterization of those events, although scientifically challenging, are essential. Several factors, acting at different time and spatial scales, contribute to the development of extreme precipitation events. Their role and their interactions are key elements to achieve a proper understanding of the underlying processes.

The complex dynamics and the spatial complexity of the Mediterranean region increase the aforementioned intrinsic difficulties. Therefore, advanced methods/approaches must be developed and applied to analyze extreme precipitation. The spatial variability of precipitation does not allow to take the Mediterranean region as a whole, so extreme events in specific areas are investigated by using daily instrumental time series covering the last six decades. Furthermore, different reanalyses are used to characterize the large scale atmospheric processes associated with those events. A novel statistical approach (developed in the frame of Extreme Value Theory) is combined with an analysis of the upper tropospheric dynamics. Coherent structures, i.e. vortices and streamers, associated with the identified events (with different return periods) are studied. Moreover, an event-based characterization of eddy-driven and subtropical jet streams is provided.

The impact of large-scale patterns on renewable energy resources in Iberia

Trigo, R.

IDL, University of Lisbon, Portugal.

Western Mediterranean countries (Portugal and Spain) have been investing in the last two decades considerable amounts of resources in wind farms and solar power plants. Wind production alone is currently supplying (on average) roughly 15% of the total electric demand. Resource evaluation and prediction is necessary to guarantee the success of the management-decision-making regarding the planning of new solar plants and wind farms. However, the lack of long-period in-field measurements makes this a daunting task. In this regard the use of high-resolution hindcasted climate simulations can help to bridge the gap between the needs and the potential of the instrumental records. In this work we use the longest high-resolution regional climate simulation available driven by reanalysis data spanning from 1959 to 2007 and covering the entire Iberian Peninsula. This long run was obtained using the MM5 model with a spatial resolution of 10 km, aimed at quantifying and modeling both the month-to-month intraannual and the monthly inter-annual variations of the hydrological, solar and wind resources in Iberia.

We focus on three major drivers for the Iberian wind field, namely the North Atlantic Oscillation (NAO), the Scandinavian Pattern (SCAND) and the East Atlantic Oscillation (EA). The results, confirmed by real production data, reveal the main role played by the NAO on determining wind speed and direction, precipitation and solar radiation in Iberia, and the marked spatial and monthly dependence of the NAO-impacts. The largest signals appear over western, central and southern areas, being more prominent in the late winter months. In general, negative NAO phases enhance the wind (about 10-20% at the near-surface level and up to 60% at 100-m altitude) and precipitation (over 100%) resources, while diminishes the solar resource (10-20%). Besides the NAO we focus on the SCAND and EA patterns showing that roughly 50% of the total wind variability in Iberia to the combined influence of these three modes. Finally, we develop several multi-linear regression models that take into account the contribution from all these major large-scale patterns on the inter-annual evolution of precipitation, wind and solar resources. The results were validated, whenever possible, with observations and real hydroelectric, eolic and solar production data obtaining a satisfactory agreement. These findings should help to improve the predictability and long-term planning of the resources.

Summer circulation in the eastern Mediterranean and the Middle East: influence from the South Asia monsoon and midlatitude dynamics

Tyrlis, E.

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The summer circulation over the Eastern Mediterranean and the Middle East (EMME) is dominated by persistent northerly winds (Etesians) whose ventilating effect counteracts the adiabatic warming induced by large scale subsidence. Both phenomena appear to be reconciled manifestations of the South Asian monsoon influence as they feature maxima in July that are strikingly synchronous to the monsoon convection over northern India. The variability of the Etesians is a synthesis of a diurnal cycle, high frequency variability originating in the midlatitudes and interannual/intraseasonal variability controlled by the South Asia monsoon. This study also aims at the compilation of an objective climatology of enhanced northerlies over the Aegean (Etesian outbreaks) with the aid of the ERA40 and Interim datasets. The outbreaks are most abundant from mid July until mid August. The recent positive trend in the frequency of outbreaks for June and the striking negative trend for September imply an earlier arrival and decay of the Etesians that could be linked with an earlier onset of the Indian monsoon.The negative frequency trend for the core July-August period identified in the ERA40 period diminishes later in the 2000s. The stronger Etesians during daytime over the central and southern Aegean is a result of the deepening of the Anatolian thermal low due to daytime sensible heating near the surface. The onset of outbreaks is controlled by wave disturbances originating in the North Atlantic that provide the seed for the development of a strong ridge over the Balkans. The latter induces anomalously strong northerly flow and subsidence over the Aegean, which trigger the development of sharp tropopause folds and stratospheric intrusions of high PV air. Finally, evidence is presented that links the collapse of the Etesians in summer 2002 with the simultaneous failure of the Indian monsoon and the flooding in central Europe.

Other contributions

(Oral presentation)

Sensitivity of the Mediterranean Sea to boundary forcings in a 21st century climate change scenario

Adloff, F.(1),Somot, S., Sevault, F., Déqué, M., Herrmann, M., Dubois, C., Aznar, R., Padorno, E., Alvarez-Fanjul, E., Jorda, G. and Gomis, D.

(1) CNRM-GAME

The Mediterranean climate has been described as one of the most responsive region to climate change (Giorgi 2006) its climate is expected to become warmer and drier during the 21st century. This typical response and the associated changes may vary, depending on the scenario chosen for the projection. However, the choice of the boundary conditions could also impact the response of the regional ocean model.

To assess and quantify the sensitivity of the Mediterranean Sea to the boundary conditions, a set of numerical experiments was carried out with the regional ocean model NEMOMED8 set up for the Mediterranean Sea. The simulations follow the design described in Somot *et al*. (2006). The model is forced by air-sea fluxes derived from the regional climate model ARPEGE on a 50km stretched grid. Freshwater input from the rivers and the Black Sea are prescribed. At the Atlantic boundary, temperature and salinity are relaxed towards values derived from a global model.

Control simulations representing the climate of the period 1961-2000 were run to verify the stability of the model. From this baseline, various sensitivity experiments were performed for the period 2001-2100, following the IPCC-A2 scenario. In these simulations, the three main boundary forcings (river runoff, near-Atlantic water hydrography and air-sea fluxes) were alternatively changed to better identify the role of each forcing in the way the ocean responds to climate change.

Our numerical experiments suggest that the choice of the boundary forcings substantially impacts the response of the Mediterranean Sea to an IPCC-A2 scenario. This is especially true for the near-Atlantic behaviour which is very uncertain in global ocean scenario simulations. Our analysis particularly focuses on the changes in the thermohaline circulation. We also analyse the various water masses at a sub-basin scale. Finally, we address the question about the robustness of former modelling studies which only considered one set of forcing (e.g. Somot *et al*. 2006).

(Poster presentation)

Mediterranean past weather through English Logbooks. (1675-1850)

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[(1)] Universidad Pablo de Olavide, Sevilla

Climate in the Mediterranean region has more than a local interest. Recent studies demonstrate that data over Mediterranean Sea improve the SLP reconstruction in all Eurasia. Therefore, it is of great interest obtain further data over this region to enhance the current reconstructions in this area. Ship's logbooks have proved to be one of the most effective sources to reconstruct the past climate and to generate databases with instrumental data where no other high resolution data are available. Royal Navy documents from the 17th, 18th, and 19th centuries from vessels that were sailing along the Mediterranean Sea are quite abundant and 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.

The main objective of this poster is to present a new database of daily weather observations for the Mediterranean Sea between 1675-1850 as one of results of the recently complete project "Characterization of the climate in the Iberian Peninsula in the period 1750-1850". The new database will improve significantly our knowledge of the circulation variability in the Mediterranean area during the period under study and offers the opportunity of comparing past wind variability with instrumental records. Thus, with this database it will be possible to identify weather patterns and extremes. In this poster are shown some examples of the information available, excerpts from the resulting database, results from a preliminary analysis of the database and the next challenges in this line of research.

(Oral presentation)

Climate simulations of the 20th and 21st centuries Mediterranean Sea and Iberian Peninsula waters

Aznar, R.[(1)], Álvarez-Fanjul, E., Sánchez-Perrino, J. C., Rodríguez-González, J. M., Ramos, D., Rodríguez-Camino, E., Jordà, G., Marcos, M., Gomis, D. and Somot, S.

[(1)] Puertos del Estado

A set of baroclinic ocean climate simulations is performed in the framework of the collaboration established between the Spanish Met-Office (AEMET), Puertos del Estado, IMEDEA and Météo-France. The geographical domain covers the Atlantic areas surrounding the Iberian Peninsula as well as the whole Mediterranean Sea.

The regional baroclinic model NEMOMED12 at 1/12º of resolution is used to carry out two hindcast simulations, in which the surface boundary conditions come from atmospheric fluxes derived from dynamical downscalings of ERA-interim (1989-2004) and ERA-40 (1960-2000). These simulations allow to evaluate the model performance by comparing their results with observational data.

On the other hand, two future climate integrations from 2000 to 2050 are achieved by forcing the ocean model with atmospheric fluxes corresponding to the SRES-A1B climate change scenario, obtained from dynamically downscaled HadCM3 and ECHAM5 global model outputs.

The main ocean variables results gathered from these simulations will constitute a high-resolution ocean climate database aiming at offering products to fulfill more specific studies.

(Poster presentation)

Pollen-vegetation calibration and pollen-based climate reconstruction from modern surface samples: a prior survey to assess the impact of extreme events on West Mediterranean vegetation

Azuara, J.[(1)], Combourieu-Nebout, N., Lebreton, V., Mazier, F., Peyron, O., Marquer, L., Cugny, C., de Munnik, N., Thibaudon, M. and Dezileau, L.

[(1)]MNHN and ENS Lyon

Over the last decades, European and Mediterranean environments have experienced severe damages due to human impacts and extreme weather events, such as drought, storms and floods. However the interactions between climate change and the frequency, location and severity of extreme events are not yet demonstrated. If the Mediterranean vegetation is adapted to long-term seasonal aridity, its resilience and adaptation to abrupt and extreme climate events is questioned.

The WEATHER project (PaleoMex, French INSU-MISTRAL program, CNRS) aims to characterize the impact of extreme events (floods and storms) on the western Mediterranean vegetation during the two last millennia. A multidisciplinary approach, including pollen analysis, sedimentology and geochronology was conducted on lagoon deposits to assess the impact of extreme climatic events on past local and regional vegetation.

Several lagoon sites, including the Palavasian system lagoon (southern France), were selected across the Mediterranean coastline. Lagoon sediments are mainly composed of fluvial and marine sediments, so that the environmental and climatic signals recorded in the lagoon sediments might be biased. In order to understand how the lagoon pollen assemblages record the surrounding vegetation and to improve the reliability of past-climate reconstruction from lagoon sediments, modern pollen samples were collected from various contexts such as marine surface sediments, inside the lagoon and along the banks, rivers sediments, moss polsters and soil samples from the surrounding hinterland, and airborne pollen data from the nearest cities (data courtesy of the French aerobiology network, RNSA). The modern pollen assemblages are compared with i) present day vegetation in the aim of split local and regional sources in the pollen assemblage, and ii) current meteorological data to refine the pollen-based reconstruction of past climate.

Associated with this survey, other samples were collected around Lodève (ca. 50km north from Palavasian system lagoon) in order to estimate pollen productivity (PPE) for key Mediterranean taxa. While PPE, one of the important parameters of current models of pollen dispersal and deposition, have already been obtained for several northern European taxa, PPE for Mediterranean taxa have never been investigated before. This study is a first attempt to quantify past vegetation abundance from sedimentary pollen records in Mediterranean area. It will help to assess the impact of extreme weather events on past vegetation.

(Oral presentation)

Consistency of recently observed trends over the Mediterranean region with climate change projections

Barkhordarian, A.[(1)], von Storch, H., Bhend, J. and Zorita, E.

[(1)]Helmholtz-Zentrum Geesthacht (HZG)

Future climate change in general is an issue of broad interest satisfying a general intellectual curiosity but also having much to do with practical managerial decisions about how to plan, design and shape our future on global to local scales. In this study, we examine to what extent the observed climate trends in the Mediterranean region are already an indication of the conditions described by the climate change scenarios at the end of this century. With this purpose, we investigate whether the observed changes are likely to have been due to natural (internal) variability alone, and if not, whether they are consistent with what models simulate as response to anthropogenic forcing (Greenhouse gases and Sulfate aerosols). The natural (internal) variability is estimated using pre-industrial control simulations. Having established that external forcings are detectable and that anthropogenic forcing is a plausible explanation for the observed change, in the last step we assess whether the ensemble of projections encompass the observed trends, if this is the case, we conclude that the observed change can be interpreted as a harbinger of future change. This approach is being applied to near-surface temperature, precipitation, 500 hPa geopotential height, mean and extreme sea-level pressure, surface relative and specific humidity, cloud cover and solar irradiance changes.

(Poster presentation)

Defining Current Climate Regions of Turkey by a Hierarchical Clustering Method with an Extended Meteorological Database

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Researches on climate change are seriously ongoing. Alterations in weather patterns and existence of extreme events can be considered as important indicators of this change. The validity of these occurrences can also be judged by analyzing the climate data thoroughly. In this study, considering the change in climate, the climate regions of Turkey is redefined using the meteorological data including 12 variables such as precipitation, average temperature, minimum temperature, maximum temperature, average of minimum temperatures, average of maximum temperature, minimum of average temperatures, maximum of average temperatures, ground surface temperature, humidity, cloudiness and mixture ratio based on vapor pressure and atmospheric pressure. This data are obtained from 221 stations of Turkish State Meteorological Service for the time period of 1960-2010. The missing observations in the dataset are completed by using the Monte Carlo Markov Chain method based on Expectation minimization (EM-MCMC). Thus, having the largest number of variables recorded in the longest time span, this is an extended database than the ones used in the climate related studies of Turkey by now. Then, the climate zones of Turkey are determined via a hierarchical clustering approach, called the Ward method, and the clusters obtained are analyzed via objective criteria and also evaluated subjectively by the domain experts.

(Oral presentation)

The summer North Atlantic oscillation in CMIP3 and CMIP5 models and related uncertainties in projected summer drying in Europe

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This study discusses uncertainties in climate model projections of future summer drying in the Euro-Mediterranean region related to errors and uncertainties in the simulation of the summer North Atlantic Oscillation (SNAO). The SNAO is the leading mode of sea-level pressure variability in the North Atlantic/European sector in summer and is known to greatly modulate precipitation not only in the immediate vicinity of the SLP dipole (northwest Europe) but also in the Mediterranean region, particularly Italy and the Balkans. Here, a comprehensive analysis of CMIP3 models is conducted to determine the extent to which models reproduce the spatial signature of the SNAO and its impact on precipitation in the Euro-Mediterranean region and to assess the role of the SNAO in the projected precipitation reductions. Most CMIP3 models correctly simulate the spatial pattern of the SNAO and the dry anomalies in northwest Europe that accompany the positive phase. The models also qualitatively capture the concurrent wet conditions in the Mediterranean, but the amplitude of this signal is too weak overall, especially in the Balkans, where many models fail to reproduce the observed maximum. This error is related to the poor simulation of the upper level circulation response to the SNAO, in particular, a 200-hPa trough over the Balkans that creates potential instability and favors precipitation in nature. The SNAO is generally projected to trend upwards in CMIP3 models, leading to a consistent signal of precipitation reduction in NW Europe. The intensity of the SNAO trend, however, varies greatly across models and results in large uncertainties in the magnitude of the projected drying, thus accounting for a very large portion of the inter-model spread. In the Mediterranean region, instead, because the simulated influence of the SNAO is too weak, no increase in precipitation occurs even in the presence of a strong SNAO trend and thus no partial compensation of the drying external to the SNAO. Because of the uncertainty in the SNAO trend and because of the common bias in the Mediterranean (which may feedback into a wider region), reduced confidence should be placed in CMIP3 future climate scenarios in the Euro-Mediterranean region.

Results from available CMIP5 simulations will also be presented to assess whether the new generation of models performs better with regard to the summer NAO.

(Poster presentation)

Response of Alpine glaciers in north-western Italian Alps for different climate change scenarios

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In the densely populated Alpine regions, glaciers represent an important source of freshwater and a significant component of tourism economy and hydro-electric power production. The shrinking of glaciers inevitably leads to a reduction of the frozen water supply they are able to store. This is one of the reasons why it is important to model and quantify, over time, the response of Alpine glaciers for different climate change scenarios.

In this work, we analyzed the impact of climate variability on a set of glaciers in the north-western Italian Alps during the last 50 years, considering the fluctuations in glacier terminus positions (or snout). The method adopted here involves the use of a linear empirical and stochastic model, in which glacier snout variations depend on temperature and precipitation fluctuations. In the study of Calmanti et al., 2007, it has been shown that linear empirical models are able to reproduce and predict the mean response of glaciers to climate variability.

Considering the cross-correlation between time series of temperature and precipitation fluctuations and those of snout variations, we obtained a set of potential predictors related to specific seasons of the year. Then, through a screening of this predictors with appropriate statistical techniques such as backward stepwise regression and cross-validation, we obtained a simple lagged-linear empirical stochastic model which is able to reproduce past snout fluctuations. The selected model depends only on four predictors: summer temperatures and winter precipitation with time delay of five and ten years respectively, spring temperature and precipitation in the year of the snout fluctuation. These predictors are justifiable in terms of glacier physics: delayed winter precipitation likely estimates accumulation, delayed summer temperatures estimate a part of summer ablation, while spring temperatures and precipitation can significantly influence the response of the glacier during the summer months thereafter. This model is then used to estimate the average response of Alpine glaciers for different climate change scenarios, assuming that the selected predictors are suitable also for future climate conditions. The SRES A1B scenario, simulated by the regional projections of the ENSEMBLE project (aggregated by the Multimodel SuperEnsemble technique), and the new RCPs scenario simulated by the EC-Earth GCM model have been considered. For all selected scenarios, our empirical model confirms the average retreat of glaciers in the NW Italian Alps. In the most dramatic cases, the estimated retreat can be of the order of a kilometer in the SRES A1B regional scenario.

(Poster presentation)

El Niño impacts on maize production in Spain

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El Niño event is a main driver of seasonal climate variability that greatly impacts agriculture and regional economies (Legler *et al*., 1999). The understanding of the relationship between El Niño and the crop production may help to improve the predictability of annual crop yields, thereby contributing to the early adaptation of farming systems and improving risk management, combining tools as agricultural insurance and changes in varieties and management (changing planting date, fertilization and irrigation). The objective of this work is to study the influence of the El Niño on maize production in several representative agricultural locations in Spain with contrasting temperature and precipitation regimes. The study also compares the adjustment of crop yield simulated with observed and re-analysis climate data.

This study uses crop yield data simulated with the ecophysiological crop model CERES-maize, included in DSSAT v.4.5 (Decision Support System for Agrotechnology Transfer). To simulate maize yields, daily data of radiation, maximum and minimum temperature and precipitation were used. The observed data were obtained from the State Metereological Agency of Spain (AEMET) and the re-analysis climate data were obtained from NCEP/NCAR 40-year reanalysis project (NOAA National Center for Environmental Prediction) and ECMWF Data server (European Centre for Medium-Range Weather Forecasts). Simulations were made on three locations where site- specific calibrations were done and validated with independent field data: Lugo (northwestern), Getafe (centre) and Albacete (southeastern Spain). In the simulations real soil profiles were included, specifying the representative maize variety and management of each location.

Preliminary results indicated that El Niño event affects the irrigated maize crop in different ways depending on the location in the Iberian Peninsula. In the Northwest the results show a significant linear correlation between temperature anomalies (SST) in the equatorial Pacific associated with El Niño and yield, while in the Southeast an important part of the variability cannot be explained by a simple linear analysis: high yields are associated with the Pacific Decadal Oscillation (PDO) and low yields are associated with La Niña events, not getting anything conclusive related to El Niño events.

(Poster presentation)

Euro-Atlantic variability modes: How much progress has been made from CMIP3 to CMIP5?

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This study evaluates the assertion that higher-resolution experiments and/or more sophisticated process models within the CMIP5 global climate models improve the simulation of variability modes over the CMIP3 models.

The use of variability modes as a diagnostic tool for climate model assessment can be justified by the fact that variability modes determine local climate conditions and their likely change may have important implications for future climate changes.

Main emphasis has been put on the ability of CMIP5 and CMIP3 models to capture the structure of the ERA40 main leading modes of variability over the Euro-Atlantic region during the winter period 1980-2000.

(Poster presentation)

Climate projections of extreme storm surges in the Mediterranean Sea

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The knowledge of future changes of storm surge extremes along the coast of the Mediterranean Sea has recently become an important issue for its obvious consequences on the evaluation of coastal risk and management of coastal defenses. This study describes the evolution sea level extremes at the Mediterranean coasts that results form a 4-member model ensemble covering the period 1951-2050 under the A1B emission scenario. The results are obtained by forcing a hydro-dynamical shallow water model (HYPSE) with 6-hourly meteorological fields produced by state-of-the-art global and regional climate models that have been used in the CIRCE fp6 project. Model validation is based on a preliminary comparison between extreme surge values at 21 tide gauges distributed along the Mediterranean coast and the results of a model hindcast covering the period from 1958 to 2001, during which the HYPSE model was forced by hourly fields provided by the European project HIPOCAS (Hindcast of Dynamic Processes of the Ocean and Coastal Areas of Europe). The same period is used also for validating the Sea Level climate produced by the 4-member model ensemble. Climate signal is computed as the difference between the extreme Sea Level statistics in the 1951-1975 and 2026-2050 period. All signals are filtered in order to cancel sea level rise and steric effect and consider only the "storminess" contribution. Results show that: 1) the spatial distribution of surge extremes is well reproduced by both model hindcast and climate simulations, although extremes are underestimated. 2) Large sea level extremes occur only in the North Adriatic and in the Gulf of Gabes and this situation does not change in future climate scenarios 3) extreme values are not expected to significantly change during the next decades because of changes in storminess. However, changes in mean sea level and subsidence (which are not considered in this study) might change significantly the hazard posed by coastal floods in spite of the low sensitivity of storminess to climate change.

(Poster presentation)

At about the consistency of precipitation trend validated by models in the Iberian Peninsula (period 1961-2000)

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Precipitation is the most relevant climate factor around Mediterranean basin by its scarcity and irregularity, and thus predictions are difficult to assess at high spatial resolution level. In these study we have validated the output of a set of 11 models by using the MOPREDAS datasbase of monthly precipitation in conterminous Spain. The period of validation is 1961-2000, and the confidence of results is given because of MOPREDAS at present is the highest dense database of precipitation in the Iberian Peninsula (2670 stations, overall density 1 observatory/200 km2, converted in a high resolution grid of 25 km2).

We will present, in two steps and at seasonal and annual scale the model validation, i.e. temporal behavior of output model versus historical records. In the first step, climatologies of both, models and MOPREDA, are quite similar in their spatial distribution, showing the well known spatial distribution across a diagonal from highest values to the northwest to lower ones to the southeast. Differences between them are researched by using the normalized differences ((Predicted-Observed)/observed), and results are discussed in terms of their spatial distribution and relative bias.

In a second step we analyze the trend of model otput and MOPREDAS both in terms of change in magnitude and change in variability. Also the differences observed are discussed.

As a general conclusion, the ensamble of models used produce reliable results in central-western areas, while poorer results are achieved along Mediterranean coastland, Ebro basin to north-east inland and northern fringe coastland. Better results are achieved during winter, than in summer, and spring and autumn differ accordingly areas.

Our results suggest that future scenarios should be considered with caution in the Iberian Peninsula because of capability of model to reproduce precipitation differ accordingly spatial factors, and generalization could be under error.

(Poster presentation)

Weather Types effects on Autumn and Spring monthly precipitation of Iberian Peninsula

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Rainfall regime of the Iberian Peninsula is spatially highly variable and seasonal contribution differs between four main areas. Winter regime extends from northern area to western and south-western including most of the Portuguese land. Mediterranean fringe shows an autumn rainfall maximum, while spring regime extends between the previous ones affecting both mountain and inland plains. This global scheme includes sub categories, but it is most interesting to note that spatial variations have been observed during the second half of the 20th century, mostly affecting the spring rainfall areas that have been substituted by autumn regime.

The nature of this changes is far from clear but seems to be related to the observed trends of spring precipitation decreased particularly in March; i.e. the observed spatial changes of rainfall regime in the Iberian Peninsula seems to be promoted by the decrease of spring precipitation. Furthermore, the positive trend detected in October affected the north-west areas of Iberian Peninsula, and no significant trends were observed in the Mediterranean coastland areas.

As a conclusion important changes in the temporal distribution of precipitation in the IP have occurred during the last decades of the 20th, characterized by an increase of temporal dependence and temporal concentration of annual precipitation in favor of autumn precipitation.

Previous analyses confirmed that different Weather Types (WTs) act simultaneously at the monthly level in the IP. In general terms precipitation to the north-west, west and south-west areas have been related to Atlantic flows, while east land areas precipitation were related to Mediterranean flows. In this research we provide a comprehensive evaluation of WTs changes and their impact on precipitation using a high resolution monthly database. We achieve this through the identification of the main WTs that produce precipitation, and also the associated trends of the main WTs responsible of such precipitation. To explore such changes we used the ratio between the frequency trend and mean frequency during 1948-2003.

We observe that the conspicuous decline of precipitation over most of Iberia during March is clearly associated with a corresponding negative trend of "wet" WTs, such as Cyclonic (-116%), West (-66%) and South West (-90%).

Likewise significant changes of monthly frequency of WTs do not have necessarily to be related with changes of precipitation over Iberia, that is the case of April where we can observe significant increments of NE (67%) and CW(238%) that are counter balanced by similarly significant decreases of CE (-167%) and NE(-93%), expressed as before.

Finally, changes of precipitation in October are associated with increments of wet weather types that, although very impressive, are not statistically significant, namely SW (99%), W (40%), NW (40%) and C (103%).

(Oral presentation)

Stochastic rainfall downscaling of the PROTHEUS regional climate model

D'Onofrio, D., Artale, V., Calmanti, S., von Hardenberg, J., Palazzi, E. and Provenzale, A.[(1)]

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Regional climate models have a temporal resolution which is often adequate for the application in climate change impact studies, but a spatial resolution which can be insufficient to resolve precipitation extremes and small-scale variability, particularly in the presence of complex terrain and heterogeneous orography. In the absence of fully deterministic models of small-scale rainfall, this scale gap can be bridged using stochastic downscaling techniques to generate ensembles of high-resolution scenarios of rainfall patterns.

The aim of this work is to investigate whether precipitation produced by a regional climate model, and downscaled stochastically, is able to reproduce the main properties of precipitation observed by a network of rain gauges. We use a version the stochastic downscaling procedure RainFarm (Rainfall Filtered Auto Regressive Model), optimized for climatic applications, to downscale the rainfall field produced by the atmospheric-ocean regional climate model PROTHEUS. The same downscaling procedure is applied also to the precipitation fields from ERA40, the large-scale driver of PROTHEUS.

The statistics of the downscaled rainfall fields are compared with rainfall data from a network of 122 rain gauges located in the Piedmont region, North-West of Italy, for the time period from 1958 to 2001. We find that the high-resolution precipitation fields obtained downscaling the PROTHEUS model outputs reproduce well the seasonality and the amplitude distributions of observed rain gauge precipitation during most of the year. Of course, a stochastic downscaling procedure cannot correct the model outputs at large-scales, as evidenced by a the presence of a bias in average precipitation and a disagreement in the frequency of precipitation events, particularly during the winter season. We also show an application of the downscaling procedure to the A1B future precipitation scenario produced by PROTHEUS, to analyze possible changes in the amplitude distribution of small-scale precipitation fields.

(Poster presentation)

Wildfire Risk in the Mediterranean under the Future Climate

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Regarding the projected temperature increase accompanied by the precipitation decrease, an increased wildfire risk may be expected in the Mediterranean in the forthcoming decades. The present projection of the future wildfire risk in the Mediterranean is based on using the (Canadian) Fire-Weather Index (FWI) implemented in the M&Rfi Weather Generator (WG), which is calibrated with the present-climate surface weather data and then perturbed using a set of GCM- and RCM-based climate change scenarios. The projection will be made for whole Mediterranean with a stress on several regions (Sardinia, Apulia and Croatia) and will be presented in maps showing selected statistics of FWI (e.g. probability of FWI threshold exceedance).

The contribution will address several aspects of the applied methodology and resulting wildfire risk projection: (1) Validity of WG for FWI calculations. An advantage of using the WG for wildfire risk forecasting and/or assessing climate change impacts on wildfire risk emerges from the fact that this approach may be applied also for ungauged locations (by using an interpolated WG) and allows one to make a probabilistic projection (by using multiple and/or long synthetic weather series). The WG validity will be tested by comparing the FWI statistics obtained with the synthetic weather series vs observed weather series. (2) The WG will be calibrated using the surface weather data from two sources: Firstly, the main focus will be put on the three regions of interest for which the weather station data will be available. Secondly, to project the future wildfire risk for the whole Mediterranean area, the WG will be calibrated using the bias-corrected RCM outputs (simulations from the ENSEMBLES project). (3) Uncertainty in future FWI projection will be assessed based on a set of climate change scenarios (used to perturb the WG parameters) derived from available global climate models. The set of applied scenarios will represent uncertainties in climate sensitivity, emission scenario and modelling (GCM). The FWI projection will be presented using the probabilistic maps showing multi-GCM means of the future FWI statistics together with the inter-GCM variability.

Acknowledgements:

The contribution brings outputs of the WG4VALUE project (development of the weather generator), CNR-ASCR bilateral project (implementing the weather generator for use in wildfire risk projection), and FUME project (Forest fire under climate, social and economic changes; 7FP, Theme ENV.1.3.1.1, Grant Agreement 243888).

(Poster presentation)

Precipitation extremes in the wettest Mediterranean region (Krivošije) and associated atmospheric circulation types

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Montenegro so far has been poorly investigated in terms of climate extremes. The aim of this paper was analysis of extreme precipitation indices in the wettest Mediterranean region - Krivošije, Montenegro, from 1951 until 2007 and their relationships with atmospheric circulation using SynopVis Grosswetterlagen (SVG) series. Data from two stations were analysed Crkvice (42º 34' N and 18º 39' E) and Herceg Novi (42º 27' N and 18º 3' E). Four indices of precipitation extremes (SDII, R75p, R95p, R95pTOT) were assessed including number of dry days. The trend was analysed using Man-Kendall non parametric test while the slope is estimated using Sen's slope estimator. The results suggest that the number of days with precipitation decreased. To analyse the relationship between extreme precipitation events and circulation types we have used an efficiency coefficient (Ec). Regarding relation to atmospheric circulation, westerly, southwesterly and northwesterly circulation types with anticyclonic features over Central Europe are more frequent for dry days (days with R < 1.0 mm) and northerly, easterly and southerly types for wet and very wet days (R75p and R95p indices). The types with cyclonic condition over Central Europe show a large proportion of wet and very wet days.

(Oral presentation)

Resolving explicitly the Black Sea flow into the Mediterranean Sea with a fully coupled atmosphere-ocean model

Elizalde, A.[(1)], Jordà-Sánchez, G., Stanev, E. and Mikolajewicz, U.

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The Black Sea is one of the major contributors of freshwater to the Mediterranean Sea. The water transport through the Dardanelles and Bosphorus Straits accounts for approximately 18% of the total Mediterranean freshwater budget. The transport is driven by several factors: the constraint of the narrow morphology of the straits, the hydrological system of the Black Sea and the meteorological conditions affecting the Black Sea area. Up to now, numerical ocean models of the Mediterranean represent the water input from the Black Sea in a highly simplified way by simply integrating over the hydrological budget of the Black Sea (precipitation minus evaporation plus river runoff) and adding the amount as an extra river in the Marmara Sea. We have included the Black Sea as a part of our Mediterranean Sea simulations in order to to resolve explicitly its hydrological system. A high resolution regional atmosphere model is fully coupled to a regional ocean model to achieve an interactive surface interface, including sea level pressure and calculation of surface fluxes. A terrestrial runoff model closes the water budget. This allows for a variable outflow with episodes of inflow of Mediterranean water into the Black Sea.

The goal of this work goes one step forward on the understanding the Black Sea hydrological system as an input of water transport to the Mediterranean Sea. The Bosphorus transport signal is decomposed and reconstructed using its main driving components: the atmospheric dynamical forcing and the freshwater input integrated over the basin. The analysis is based on daily averages of the model output for the period from 1996 to 2000. Most of the variability of the net Bosphorus transport is found at intraseasonal time scales which are mainly forced by the wind and sea level pressure. At those scales the relative importance of the two forcings is similar. The yearly cycle signal of the transport is mainly driven by the freshwater input. April is the month where the maximum value of Black Sea freshwater flux is reached, while the maximum value for Bosphorus transport into the Mediterranean Sea takes place during May. The delay of one month is attributed to the superposition of the wind annual cycle which is out of phase respect to the freshwater cycle. The effects of sea level pressure in the yearly cycle is negligible. Our results suggest that the common approach of assuming that the Bosphorus transport is equal to the freshwater budget in the Black sea may be oversimplistic.

(Poster presentation)

Decadal variability of precipitation in the Iberian Peninsula since the mid-19th century

Fernández-Montes, S.[(1)], Rodrigo, F.S., Trigo, R.M. and Valente, M.A.

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The Mediterranean climate is characterised by high decadal, inter-annual and intra-seasonal precipitation variability. Natural and anthropogenic forcings may change the frequency and intensity of precipitation. According to state-of-the-art modelling studies, there is increasing probability of more intense events by the end of this 21st century. Adequate interpretations of future projections require a good understanding of past changes. Hence accurate climate variability studies using long, complete and homogenous series with a daily resolution are necessary.

In this work we use the longest daily precipitation series available in the Iberian Peninsula, beginning between 1850 and 1893 (9 series) and extending until 2006. Decadal variability of the frequency and the intensity of rainy days, and of seasonal accumulated precipitation is analysed at each station. We focus on the wettest tail of precipitation distribution, by assessing changes in the 75th and 95th percentiles of daily precipitation. Particular attention is given to winter season.

Precipitation variability is discussed in relation to the frequency of atmospheric circulation types which were previously derived from clustering Sea Level Pressure fields (Fernández-Montes *et al*. 2012), covering the period 1850-2003. Additionally, the role of other physical factors relevant to precipitation intensity is analysed, such as anomalies in Atlantic and Western Mediterranean Sea Surface Temperatures. The results deepen our knowledge of long-term precipitation variability in the Iberian Peninsula and its causal mechanisms.

References:

Fernández-Montes, S., Seubert, S., Rodrigo, F.S., Hertig, E. Wintertime circulation types over the Iberian Peninsula: long-term variability and relationships with weather extremes. Climate Research, 2012. DOI:10.3354/cr01095

(Poster presentation)

Robust precipitation changes over the Mediterranean region in observations and CMIP3 models

Fortuny, D.[(1)] and Bladé, I.

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Despite claims to the contrary, time series of annual-mean Mediterranean precipitation do not exhibit robust, significant, changes in the last decades. Because of the strong multi-decadal variability present in the series, trend estimates for Mediterranean precipitation are in fact highly dependent on the chosen period and also vary from one dataset to another. Nevertheless, generally speaking, a wet period (1900-1920) and two dry spells (1940-1960 and 1980-now) can be identified. The most recent dry interval seems to be the result of strong winter reductions in precipitation partially compensated for wetter than normal autumns, with no change in summer precipitation. In order to better understand the precipitation changes that the Mediterranean area has experimented since the beginning of the 20th century, we investigate whether these results are robust and uniform over the entire basin and which specific months are affected.

We also used the complete set of CMIP3 climate simulations for the 20th century to inquire whether the simulated recent annual trends are consistent with observations. Our results show that the seasonal distribution of the simulated trends does not coincide with that in observations: the observed annual trends are dominated by changes in winter while the simulated trends are largest in summer and autumn. We then use the individual climate simulations to assess which models more closely reproduce the observed trends. These results will allow us to assess the plausibility of future projections.

(Poster presentation)

Statistical Downscaling of Precipitation in Spain for the 21st Century Using a Multi-model Ensemble

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Variations in frequency and intensity of precipitation events due to Climate Change would be devastating to the socioeconomic development and ecosystems. Recent studies suggest changes in precipitation extreme events globally, but there are still many uncertainties about the effects at local and regional. Here we present an Empirical-Statistical Downscaling by the Method of Analogues for Spanish peninsula and the Baleares Islands using precipitations gridpoint of high resolution and the output of four GCM to project the ensemble mean rainfall patterns annual and seasonal for the twenty-first century. In this study, we identify important variations in the average composition of annual and seasonal precipitation. The method predicts changes of until ±6% in annual extreme precipitation events during the first 40 years in great part of the eastern and central Spain and an increase in extreme drought events of Asturias, Cantabria, Euskadi, Andalusia and the Balearic Islands during practically all century. However, the major percentage changes are found in the seasons with variation of until ±15% regarding at present climate. These changes are very important in the climate context of Spain, which certainly can not be studied only from the perspective of the annual precipitation. In this work we use only four GCMs for estimating changes in precipitation where ensemble mean error is less than the introduced by a single model. At present, understanding the inherent variability in the climate projections of precipitation are fundamental to improve the estimates for the multiple scenarios of the Global Change and estimate the effects of anthropogenic emissions of greenhouse gases on the Earth System.

(Oral presentation)

Regional scenarios for the Spanish climate change adaptation plan (PNACC-2012): dynamical downscaling results

Gaertner, M. A.[(1)], Domínguez, M., Romera, R., Sánchez, E., López-de la Franca, N., Fernández, J., García-Díez, M., Ll. Fita, Montávez, J.P., Jiménez-Guerrero, P., Cabos, W. D. and Liguori, G.

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We present results of the Spanish project ESCENA, in which four RCMs (PROMES, WRF, MM5 and REMO) have been applied for generating regional climate change scenarios with the main aim of contributing to the current Spanish climate change adaptation plan (PNACC-2012). The scenario data have international interest, as the simulation domains include part of the Mediterranean area and of the northeastern Atlantic. Different emission scenarios (A2, B1 and A1B) and nesting GCMs (ECHAM5, HadCM3 and Arpege) have been selected, trying to complement the scenarios from european project ENSEMBLES. A horizontal resolution of 25 km has been used in the simulations, which cover the period 1951-2050. Results from the evaluation runs (nested in ERA-Interim) and from the scenario runs are shown.

(Poster presentation)

Decadal to interannual influence of the Mediterranean SST on the Sahel precipitation

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Recent studies have found an increasing influence of the eastern Mediterranean SST anomalies on the monsoonal Sahelian rainfall from the 1970s. Polo *et al*. (2008) showed the presence of a Mediterranean mode after the 1970s as an SST pattern independent from the variability in the tropical SST. The response to this Mediterranean mode was analyzed in Fontaine *et al*. (2010), who found how a warmer eastern Mediterranean increases the specific humidity in the lower troposphere and the northeasterly moisture flux, strengthening the low levels convergence and thus the West African monsoon in the Sahel. More recently, an intercomparison exercise with AMIP type simulations (Mohino *et al*., 2011) has indicated how most of the models are sensible to a Mediterranean mode of covariability with West African rainfall after the 1970s but not before. Rodriguez-Fonseca *et al*. (2011) show how the influence of the Mediterranean before the 1970s was related to the Guinean rainfall but the global SST signature of the Mediterranean indicated the presence of other external contributors. Removing the quasi-global effect, Fontaine *et al*. (2011) have found a robust relationship throughout the 20th century between the Sahel monsoonal precipitation and the Mediterranean and Indian ocean SST. Specifically, positive SST differences between eastern Mediterranean and Indian ocean are concomitant to wet anomalies in the Sahel, related to an enhanced convergence between the northeasterly moisture transport from the Mediterranean and the southwesterly monsoonal flow.

The present study extends all these analysis from the turn of the 20th century, looking for the causes of the non-stationary influence of the Mediterranean SST on the West African rainfall. The global signature and possible modulators of the relationships found, together with the implications in seasonal predictability are also discussed. The results of this study are important in the MedClivar contest as they point to the Mediterranean as a determinant actor in global teleconnections.

(Oral presentation)

Future evolution of Growing Grape Indexes: a study of future climate scenarios on Spanish vineyards using Climate Models under a two-step analog statistical downscaling

Gaitán, E., Monjo, R., Pórtoles, J. and Ribalaygua, J.[(1)]

[(1)]Climate Research Foundation

Climate and soil are two of the most important limiting factors for agricultural production. Nowadays climate change has been documented in many geographical locations affecting different cropping systems. The General Circulation Models (GCM) have become important tools to simulate the most relevant aspects of the climate expected for the XXI century considering climatic change. These models are able to reproduce the general features of the atmospheric dynamics but their low resolution (about 200 Km) avoids a proper simulation of lower scale meteorological effects. Downscaling techniques allow overcoming this problem by adapting the model outcomes to local scale.

In this context, the Climate Research Foundation (FIC) has developed a statistical downscaling technique based on a two step analogue method. This methodology has been broadly tested on national and international environments leading to excellent results downscaling future climate models. This statistical downscaling technique was applied to predict future scenarios for the grape growing systems in Spain in a collaboration project.

This technique allows to calculate different bioclimatic indexes related to the grape, detecting areas that are highly sensitive to negative impacts produced by climate modifications (such as plague of mildew, drought and heat waves).

These results are part of the “Simulación del clima futuro a escala local para viticultura con implicaciones prácticas en la gestión del viñedo”, funded by the Spanish Centre for Industrial Technological Development (CDTI).

(Poster presentation)

Simulation of Past Mediterranean Warming in CMIP5 Models

Gámez, P.[(1)] and Bladé, I.

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The European climate has experienced a significant but seasonally and geographically varying warming during the last half century. The spatial-temporal structure of this warming has been described as a European Climate Oscillation or ECO (Giorgi and Coppola, 2007) whereby the warming in winter is restricted to northern latitudes whereas in summer it is more pronounced in the south.

We investigate this ECO in more detail by examining all seasons and all time periods. We find a much more complex pattern of warming than identified in Giorgi and Coppola. Generally speaking, the winter warming is only significant relative to the middle part of the century (i.e., periods ending in 2011 and longer than 50 years) and only in some areas of Scandinavia and eastern Europe. Instead, there has been significant summer warming in recent decades (i.e, periods ending in 2011 and longer than 20 years) and it is largest in central Europe and eastern Mediterranean. There has also been significant spring warming in recent decades, particularly in the western Mediterranean (Iberia, Italy and France).

We carry out an analysis to test whether the simulated temperature in the Mediterranean in the newly performed CMIP5 simulations (IPCC, AR5) is consistent with the observed pattern of warming. The ultimate goal is to increase our confidence in projections of future evolution of the European warming.

(Oral presentation)

Statistical downscaling technique application to a phytoclimatic study for Spanish National Parks

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A National Park is a unique space where the absence of human intervention allows its flora and fauna to develop freely. Each National Park presents its own composition and is largely determined by the climatic characteristics of the area. Therefore, major climate changes could alter the normal development of the Park. Knowing the evolution of climate over the XXI century and the implications that these changes may have on the forest cover of the Parks it is very important to take mitigation and adaptation measures to ensure its preservation and continuity.

We performed a phytoclimatic study for the XXI century in all the Spanish National Parks. The phytoclimatic methods used have been the "Subtipos" method and the "Especies" method. Both methods work with monthly values of temperature and precipitation from which the different phytoclimatic index needed to determine the phytoclimatic developments in the area of interest have been computed.

To carry out the above study, it is necessary to generate local scenarios of future climate, ie temperature and precipitation series for the XXI century. These scenarios have been generated using a statistical downscaling technique based on an analog method in two steps developed by the Climate Research Foundation (FIC).

Said phytoclimatic study requires that input series are corrected and evenly distributed along the zone of interest. For this reason the implicit systematic error associated to the "raw" series simulated by downscaling has been corrected, and an interpolation has been carried out in each one of the Parks. The systematic error correction has been computed on a monthly basis since it is the timescale on which this study is performed, and the interpolation technique used (TPS-2D, TPS-3D TPS-2D + variance, IDW) varies depending on the Park under study. As a final result, corrected monthly series of temperature and precipitation for a grid of 200m x 200m for each of the National Parks have been obtained.

These results are part of the “Estudio del impacto del cambio climático sobre la diversidad y la composición de las cubiertas forestales en los parques nacionales españoles” study, co-funded by the Biodiversity Foundation (Spanish Agriculture, Food, and Environment Ministry).

(Oral presentation)

Temperature reconstructions and paleoceanographic changes during the last 2 millenia in the north Aegean Sea (northeastern Mediterranean)

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[(1)]HCMR

Studies of proxy records from several paleoclimate archives worldwide (including tree rings, lake sediments, marine cores and speleothems) have enabled identification of five climatic periods during the last two millennia (Mann and Jones, 2003). These have been characterized in terms of temperature and precipitation variability and include: the Roman Warm Period (RWP; 0-500 years AD), the Dark Ages (DA; 500-900 AD), the Medieval Warm Period (MWP; 900-1300 AD), the Little Ice Age (LIA; 1300-1850 AD), and a subsequent period of warming.

In this study, we focus on paleoclimate variability in the northeastern Mediterranean during the last 2 ka BP, using marine archives (multicores) retrieved from the North Aegean Sea (M-2: 40.05N, 24.32E, water column depth 1018m). Multicores have been sectioned at 0.5 cm intervals and dated by 210Pb and radiocarbon. Multi-geochemical and micropaleontological proxy indices have been used, namely the alkenone-based Uk37 Sea Surface Temperature (SST), calcareous nannofossils and benthic foraminifera, which allowed to delineate climatic changes and their impacts on marine ecosystems.

During the Roman Humid Period (2000-1600 yrs BP), higher values of Florisphaera profunda and Braarudosphaera bigelowii support the establishment of low-salinity, stratified waters and the onset of nutrient-rich environment in the deep photic zone. In Dark Ages interval (1600 -~1000 yrs BP) an increased upper photic zone productivity is associated with the increase in abundance of placoliths. SSTs fluctuate with an average value of 17°C. The base of Medieval Climate Anomaly (~1000 -650 yrs BP) is characterized by drastic changes in productivity, with the increase of both coccolithophore productivity proxies F.profunda and Helicosphaera spp. SST is also increased (max=19.5^{o}C). Decreased 15N values, associated with higher TOC during this time, points to enhanced stratification and better OM preservation (Mobius *et al*. 2010), or increased contributions from N fixing organisms (Slomp *et al*. 2004).

In the cold phase of the Little Ice Age (~650-100 yrs BP), SST ranged from 14-19^{o}C and productivity fluctuations allowed the detection of periods of extreme solar inactivity. Dysoxic benthic foraminifera although in low abundances, are appearing towards the top of LIA, indicating a slowing in deep water formation following cold conditions. Short intervals characterized by low concentrations of the species and spp. combined with slightly increased incidences of cool formats EHMC, are recorded during the period ~ 650-100 yr BP in the North Aegean Sea, and reflect the presence of minimal solar activity periods and consequent reduced surface productivity. More specifically, we the interval 870- 910 yr BP (1040-1080 AD), known as Oort minimum.570-600 yr BP (1280-1350 AD) as the Wolf minimum, 0.49-0.44 ka BP (1460- 1550 AD) as Sporer minimum, the interval 0.31 - 0.24 ka BP (1645-1715 AD) as the Maunder minimum and the latest in 0.16-0.12 ka BP (1750-1830 AD) is known as the Dalton minimum; all featured by minima in stratification and alkenone Uk37 SSTs.

(Oral presentation)

Wind speed evolution study for Iberian Peninsula and Baleares in the XXI century

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The impact of the human activity in the climate evolution is supported by numerous studies developed by different scientific disciplines. Their conclusions have been summed up in the IPCC reports. Although the great majority of scientific community efforts have been focused on precipitation and temperature fields, there are some papers about the effects of the climate change on the wind speeds. This topic is not only interesting from a scientific point of view but also from an energetic point of view. A better knowledge of the wind field variability allow us to know and optimize the wind resources in a given region. The wind power is becoming a important energy source in the last decades for some areas like Iberian Peninsula. For instance, wind power in Spain covered in 2010 the 16,6% of electrical energy demand, making wind energy the third most important electrical energy source in Spain.

Here we study the wind evolution in the Iberian Peninsula and Baleares with an ensemble of five RCMs (Regional Climate Model). The RCM simulations cover most of Europe, with a domain centered in the Iberian Peninsula and a horizontal resolution of 25 km x 25 km.

This study is divided in two parts:

First we validate the wind variables simulated by the different RCMs. To this end, the mean wind speeds, the extreme wind velocities, the mean wind speed distributions for the different models are compared to analogous fields from the ERA-Interim reanalysis database. The models are able to simulate with a reasonable skill the mean wind speeds in the Iberian Peninsula, identifying the areas with known high and low wind power potential. Then we analyze the wind evolution in the Iberian Peninsula in the RCMs. We study the evolution of the wind power in different areas of the Iberian Peninsula and Baleares under different scenarios and forced by different global circulation models.

(Oral presentation)

Towards a warmer and more saline Mediterranean Sea: the impact on mean sea level

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All global and regional projections show a warmer and more saline Mediterranean Sea by the end of the 21st century. While the impact of the increasing temperature on sea level is well known, the impact of a regional salinity increase is less clear; the reason is that the halosteric contribution does not represent by itself actual sea level variations, since changes in the salinity of the water column also imply changes in the mass component of sea level that have opposite sign to halosteric changes. In this presentation we first formulate sea level variability in terms of the contributing physical processes, paying particular attention to the role of salinity changes. Then we intend to clarify the estimation of the different sea level components from both, observations and model outputs; the computation of sea level from regional models deserves particular attention.

The formulation is applied to the historical data available with the aim of inferring the impact of temperature and salinity changes on the sea level changes observed during the last decades of the 20th century. An important result is that different data bases give rather different results for salinity which leads to large uncertainties in the estimation of the mass component of sea level. Conversely, it will be shown that the estimation of freshwater changes is relatively robust. Finally we quantify the impact of temperature and salinity changes projected for the 21st century. We show that if the role of salinity is not properly understood, the increase of Mediterranean mean sea level can be underestimated by several tens of cm by the end of the century. A correct interpretation of model results also leads to higher consistency among models in the projections of Mediterranean sea level.

(Poster presentation)

Optimal spatio-temporal design of an hydrographic sampling aimed to monitor climate change in the Mediterranean Sea

Gomis, D., Jordà, G. and Llasses, J.[(1)]

[(1)]IMEDEA

Monitoring climate change is a priority for environmental management, since an early detection of climate change signals would allow more efficient adaptation strategies to future scenarios. Concerning the temperature and salinity of the Mediterranean Sea, there are two key factors that hinder climate change detection: the fact that climate change signals are still smaller than the short-term natural variability of the fields, and the paucity and irregularity of the spatio-temporal distribution of available observations. Historical databases such as MEDATLAS have been shown to be insufficient to properly characterize the temperature and salinity variability: the intra-annual variability is poorly represented, the interanual variability has significant errors and trends are largely underestimated. In this study we evaluate the suitability of different distributions of observations in the Mediterranean Sea to identify temperature and salinity climate change signals.

The methodology bases on the extraction of temperature and salinity pseudo-observations from the outputs of a numerical model in order to simulate different observational designs. The pseudo-observations are then used to generate gridded products using Optimal Statistical Interpolation. Finally we compare those products with the original model data to get a quantitative estimate of their accuracy, particularly regarding the estimation of long-term trends. The pseudo-observations have been generated with the NEMOMED-8 model (spatial resolution of 1/8º) forced with the outputs of the ARPEGE atmospheric climate model (50 km resolution) run under the A2 scenario. Different data distributions are tested, including the distribution of observations gathered during the last decades, a regular sampling simulating a mooring net and a random distribution of observations simulating ARGO buoys. In this presentation we compare the capabilities and shortcomings of each observational distribution in terms of a proper detection of temperature and salinity variability at different spatial and temporal scales. The ultimate aim is offering some guidance for future monitoring strategies.

(Poster presentation)

Comparison of NAO projections of CMIP5 derived from geopotential and sea level pressure

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Results from the IPCC AR4 report and other recent analyses of temperature and precipitation dataset, agreed that Mediterranean region and Iberian Peninsula are areas highly affected by the climate change. Due to the connections between those variables and the North Atlantic Oscillation (NAO), is interesting to derive the NAO projection under increasing emissions scenarios to apply this study for regional downscaling. Variables at the surface and different pressure levels are affected differently by global warming. Since several definitions are given for the NAO, considering sea level pressure or geopotential, we propose a study to compare the different projections of the NAO according to these two variables. The patterns are obtained with sea level pressure and 500 hPa geopotential height data from the World Climate Research Programme's (WCRP's) Coupled Model Intercomparison Project phase 5 (CMIP5) with the experiments "Historical" and "RCP 8.5". The method used in this study is Partial Least Squares Regression (PLS), applied in two different phases, in order to obtain the patterns and indices of the NAO. Globally, the time series evolution of sea level pressure is expected to show less significant trend than geopotential, having a different impact on precipitation and temperature projections.

(Poster presentation)

Objectif Terre: Mediterranean Basin (OT-Med), an initiative for studying interactions between global change and Mediterranean societies

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[(1)]CNRS CEREGE

The Mediterranean basin has been a key area of human-environment interactions for thousands of years, representing significant risks as well as huge opportunities for sustainable development. The OT-Med project wants to create an interdisciplinary group of French laboratories focussing on the environment and sustainable development of Mediterranean and semi-arid environments, to strengthen collaborations with similar laboratories in the world and to consolidate the bridge between physical-biological sciences and the socio-economic sciences. It intends also to contribute to the meta-program MISTRALS launched by the French national research structures working on the Mediterranean region.

Both short- and long-term time scales will be considered: history is often a key in understanding the present as well as in predicting the future. A first axis is devoted to the study of climatic and anthropogenic changes and natural hazards. This includes landslides, extreme climatic events, sea-circulation changes, perturbation of aquifers and hydrosystems. A second axis aims to understand the impact of climate and socio-economic changes on ecosystems with a focus on the ecosystem services, in particular related to biodiversity, soils, agriculture, forestry, marine biogeochemistry and food-web interactions. Strongly rooted in the social sciences, the third axis will analyse human-environment interactions, looking at the perception of hazards, adaptation and mitigation. It will focus on modeling decision-making in the context of risks and compare the functioning of international environmental regimes for climate and biodiversity. It will also study ancient Mediterranean civilizations with respect to their adaptation to climatic changes. A transversal axis coordinates the observation systems and the databases necessary to collect these observations; a second one will target an important final product of OT-Med, an integrated model extending from the climate system to the socio-economic agents.

Synergies between the scientists will be achieved by organizing and structuring interdisciplinary exchanges in research and education, in the following ways: (1) by promoting interdisciplinary research projects with funding to strengthen synergies (internal calls for proposals); (2) by coordinating an ambitious policy for the reception of visiting researchers, post-docs and Ph.D. fellowships, and exchanges with southern countries; (3) by developing a policy of Academy-Industry Chairs; (4) by organizing international symposia and workshops; (5) by improving the existing observation systems and organizing them into a local network; (6) by organizing a regular series of workshops, summer schools and conferences; (7) by developing interdisciplinary exchanges and training with Master and Doctoral level programmes, with a particular emphasis on North African countries; (8) by organizing scientific, technical and socio-economic databases resulting from research to benefit researchers, notably modellers. OT-Med will create a reference portal for expertise with the construction and maintenance of document archives, databanks, expertise and joint project support for both local and national governments, firms and associations. OT-Med wants to strengthen institutional ties with the universities involved in parallel projects, with particular emphasis on universities and research centres in developing countries and the Mediterranean area. This is then a call for collaborations towards scientists working on the Mediterranean climatic change.

(Oral presentation)

Climatic variations across the Mediterranean Basin reconstructed from pollen and vegetation model

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The Mediterranean basin has been a key area of human-environment interactions for thousands of years, representing significant risks as well as huge opportunities for sustainable development. Its history is rich of events where climate was a possible trigger or at least an amplification of society decline or collapse (DeMenocal, 2001; Weiss & Bradley, 2001). Numerous studies are devoted to such correlations (see for example Kaniewski *et al*, 2008). We may cite the end of the Bronze age, the end of the Roman period, the Little Ice Age... A combination of paleoclimatological and archaeological studies is the key of this type of correlations. We propose here to complete this approach by using a vegetation model in inverse mode to reconstruct Mediterranean past climate form pollen (Guiot *et al*, 2009) and so relating vegetation changes to climatic changes in a more mechanistic way.

The proxy data used are the pollen series stored in the European Pollen Database (EPD) for the Mediterranean Basin. The period covered is the last 10 ky and the climatic variables are winter, summer temperature and precipitation, as well as soil water which is the most limiting factor for Mediterranean vegetation and which is also an indicator of water stress for agriculture. BIOME4 model (Kaplan *et al*, 2003) uses as inputs monthly temperature, precipitation variables and provides outputs comparable to pollen data (assuming that there is a relationship between plant productivity and pollen counts). The idea behind paleoclimatological reconstructions is then to obtain inputs, given outputs. This procedure, called model inversion, is achieved with appropriate algorithms in the frame of the Bayesian statistical theory. As CO2 atmospheric concentration is also an input of the model, it is possible to take into account the true variations of the concentration across Holocene to reconstruct the climate. We will present gridded maps of climatic change for typical periods where Mediterranean civilizations have known important declines and maps of bioindicators related to wood and food resources needed by these societies. This is a preliminary study which will prepare an more exhaustive approach where society reaction to climatic changes will be simulated by an agent-based model coupled to managed land model (Bondeau *et al*, 2007).

(Poster presentation)

Evaluation of the SST as a predictor for Catalan river flow

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[(1)]Universidad de Granada

Accurate simulation and forecasting of water availability is of major importance in efficient management of water resources. According to the 2007 IPPC report, a large reduction of water resources is expected in Mediterranean semiarid areas due to climate change. The focus of this study relies in Catalonia, a region located in northeastern Spain and characterized by a varied orography and its proximity to the Mediterranean Sea. Therefore the aim of this project is to use oceanic SST as a predictor for Catalan river flow for the 1970-2010 period in order to improve previous predictability experiments carried out for the same region. In order to do so we use monthly-standardized data of seventeen gauging stations representative of two areas, those characterized for having peak flows in winter and those where this maximum peak appears in spring. For the sake of simplicity we use the data of two of the 17 gauging stations, those two that were originally less subjected to gap filling processes.

Prior experiments carried out in this area by our group consisted in the performance of Singular Spectral Analysis (SSA) in order to identify the main oscillatory modes of the raw flow series. Secondly an autoregressive-moving-average (ARMA) model was fitted to the filtered series and a forecasting experiment was carried out.

In this study a thoroughly search for predictors has identified several key regions where residual streamflow anomalies obtained from the previous modeling experiment are stably correlated with previous SST anomalies during the period under study (1970-2010). A modeling scheme based on linear regression is developed and applied to simulate streamflow anomalies from the key SST regions.

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(Oral presentation)

Statistical downscaling of daily precipitation in the Mediterranean area taking into account non-stationarities

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Within the scope of projecting future climate change, General Circulation Models (GCMs) are commonly used to assess changes resulting from further increases of atmospheric greenhouse gases. Different types of regionalization techniques have been developed to infer regional to local information below the skilful scale of the GCMs. In this context statistical downscaling presents a computationally inexpensive technique which can be adapted for a wide range of applications. Statistical downscaling approaches are based on statistical relationships linking a set of large-scale atmospheric variables (predictors) to regional climate variables (predictands) during an observational period. In this regard validation of the statistical models is of utmost importance: the established statistical relationships are verified during a period independent from the calibration period and are subsequently used to predict the future response of regional climate to climate model changes of the large-scale variables. Despite the extensive efforts to measure and evaluate performance of statistical downscaling models, little attention has been paid so far to the handling of non-stationarities in the predictors-predictand relationships.

The present study aims to introduce a novel downscaling approach which explicitly takes non-stationarities into account. For the illustration of this approach the Mediterranean area is chosen, because it shows a wide range of different climatic characteristics, from humid conditions in the western, northern and eastern Mediterranean regions in winter to arid conditions in the southern and eastern Mediterranean regions in summer.

Precipitation in the Mediterranean area is assessed by using a combined circulation- and transfer-function-based approach. Daily station data for the Mediterranean area is used as local precipitation predictand. As large-scale predictors geopotential heights of the 700hPa level in the area 20°N-70°N, 70°W-50°E are selected to include large-scale atmospheric regimes showing inter-annual to decadal variability. To account for daily to inter-annual influences on precipitation 700hPa-geopotential heights are used, again, but now within the scope to obtain circulation patterns within station-specific predictor domains. Furthermore, 700hPa-relative humidity, zonal and meridional wind components of the 700hPa level and convective inhibition are included to describe within-type characteristics of the circulation patterns. At first the statistical models are established using the whole time period available for a particular station. Subsequently, 31-year sub-periods are used to detect non-stationarities in the predictors-predictand-relationships. As a measure of performance the bias and its confidence interval limits are used for error analysis of the distributional mean. If non-stationarities are detected, the varying predictors-predictand-relationships are analysed for the underlying reasons and statistical model ensembles are built to capture the range of observed relationships. In case of the absence of non-stationarities the statistical downscaling approach follows a conventional split-sampling approach for verification. Finally the statistical models and model ensembles are used to predict mean daily precipitation in the Mediterranean area until the end of the 21st century under increased greenhouse warming conditions.

This research project is funded by the German Research Foundation DFG.

(Poster presentation)

The snow advance index influence on the winter streamflow in Douro's basin (Spain)

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In this study we evaluate the hydrological response of winter streamflow anomalies in Douro river basin (Spain) to the Eurasian snow cover increase during the previous October. The recently proposed Snow Advance Index (SAI) was employed to monitor this snow cover increase. The database used comprises around 50 gauge stations, which present less than 10% of missing values in the study period (1973-2008). The linear correlation between SAI and the streamflow anomalies in the following winter was computed in order to evaluate their relationship. Furthermore, a stability analysis based on the significance of moving window correlations was used to determine the robustness of this relationship. This stability analysis provides useful information about the suitability of this index as a potential predictor of winter streamflow anomalies.

In addition, we identified the differences in streamflow anomalies when marked positive and negative anomalies in SAI occurred in the previous October. The results show significant and stable positive correlations in a wide area of the Douro basin, being more intense in the central region. On the other hand, gauging stations located on the mountain areas of the basin present the lowest values of correlation and stability. The response of streamflow anomalies is higher in years when SAI present lower values, presenting remarkable negative anomalies. In summary, this work show the existence of a significant relation between the winter streamflow anomalies, mainly the negative ones, with the previous October SAI, which may be a useful tool for water resources management.

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(Poster presentation)

The Climate Shift and the impact of the ENSO signal on the Southwestern Europe spring rainfall

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ENSO is one of the most important phenomenon of the global climate variability. There are several works that studied its impact on the mid-latitudes and particularly over Europe at different seasons. The multidecadal changes on the atmosphere circulation can change the strength and the relation of this teleconnections. The Climate Shift (CS) is one of those changes that took place in the Pacific basic state and ENSO dynamics on the 1977. The aim of this work is to study the connection between ENSO and rainfall on the Northwest Iberian Peninsula (NWIP) taking into account the whole observational period and the decades before and after the CS. In a previous work we found that the Spring NWIP rainfall (NWIPR) has significant positive correlation for the period 1951-2006 with the equatorial Pacific SST of the previous four seasons that overlaps with the Niño 3 and Niño 1+2 indices areas. Due to the fact that the ENSO influence over the European precipitation has varied over time, this previous study used 21-year sliding means that show a change in Niño 3 winter-NWIPR spring correlation around the 70's which can be related to the CS. To analyze this fact we study changes in the dynamics and its impacts before and after the CS. Results showed that there is no linearity on the periods. Before the CS (1951-1977) Niña events showed a positive correlation with the SLP over the NWIP while Niño events did not affect the area under study. It seems that Niña events produces humidity springs on the Southwest of Europe, but the connection is not clear. After de CS (1978-2006) Niño events present a higher negative correlation with the SLP over the NWIP, producing rainy springs with a clear connection, whilst Niña events did not show any significant relationship.

(Oral presentation)

Residual tidal currents in the Gulf of Cadiz: Do they drive the Mediterranean Outflow to some extent?

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The modelling of the Mediterranean Outflow Water (MOW) has proven to be a challenge for global or basin-scale general circulation models. The wide range of spatial and temporal scales involved sets the requirement of a high horizontal resolution and simultaneously the need for the inclusion of the larger scale feedbacks. The width of the MOW plume in the Gulf of Cadiz is less than 100 km; therefore it should be considered the possibility that tidally induced local-scale processes may impact on MOW properties and spreading. To check this hypothesis, we make use of a global set up of the Max Planck Institute Ocean Model (MPI-OM). The MPI-OM is a free-surface, z-coordinate Ocean General Circulation Model using an orthogonal curvilinear grid allowing for an arbitrary placement of the grid poles, thus allowing us to have a high horizontal resolution around the Iberian Peninsula and to include a full ephimeridic luni-solar tidal potential. The chosen grid configuration permits a realistically open Strait of Gibraltar, while having a mean global resolution 1.0°. OMIP climatology was used for the surface forcings. The model reproduces properly the tidal structure in the Gulf of Cadiz as compared to available data and to existing tidal models. A series of numerical experiments have pointed out that tides strongly influence the pathway of the MOW in the Gulf of Cadiz, resulting in a much better model output agreement with the existing hydrological observational data when tides are included. We show in our experiments that the major impact of tides on the MOW spreading is not driven by the tidal mixing, as it could be expected, but by tidally induced residual currents. Finally, a theroretical mechanism for the generation of such relevant residual tidal currents is proposed.

(Poster presentation)

Holocene vegetation and climate changes recorded at Lake Trifoglietti in southern Italy

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The major climate changes which developed from the end of the last Glacial to the Holocene are now relatively well established in Europe. On the continent, climate history is recorded though different indicators including vegetation changes driven by variations in the orbitally-induced insolation change and associated variations in climate parameters such as precipitation and growing-season temperature. Whereas the Holocene climate may appear as a relatively stable temperate period, it was nethertheless punctuated by numerous rapid cold events such as the Preboreal and Boreal oscillations, the 8.2 kyr event and the Neoglacial climate cooling at cal. 6000-5000 cal. BP

These events are also recorded in the Mediterranean area, where they suggest a strong connection between higher and lower latitude regions. However, on closer examination, paleoenvironmental records point to regional diversity in the effects of rapid climate change throughout the Mediterranean region. This underscores the complexity of the Mediterranean climate, which may reflect contrasting influences from both higher latitudes (e.g. deglacial events, the North Atlantic Oscillation) and lower latitudes (e.g. the tropical monsoon) which, for instance, may have affected westerly activity and associated precipitation changes over the Italian Peninsula.

Moreover, particularly in the Mediterranean regions where human impact has been widespread at least since the Neolithic, it is sometimes difficult to disentangle the climatic and anthropogenic forcing factors in palaeoenvironmental records. This complexity is reinforced by a possible climate determinism for human societies and by human-induced environmental changes (on a wider-than-local scale) which are expected to enhance regional climate impact. While the pollen proxy does not escape this ambiguity in paleoenvironmental reconstructions and interpretations, it may be of great interest in providing direct and/or indirect evidence of anthropogenic activities.

Southern Italy is a place where climate and human influences are superimposed, with (1) orbitally induced long-term climate changes and possible short-term time-transgressive climate oscillations developing according to latitude, and (2) major cultural changes such as the Neolithic expansion in south-eastern Italy between 9000 and 8000 cal. BP and in south-western Italy between 8000 and 7500 cal. BP.

Thus, southern Italy is of great importance when discussing natural vs anthropogenic forcing of vegetation changes. However, on the other hand, pollen-based Holocene vegetation records from southern Italy are still sparse and most of them are from low altitudes. Palynological study of the Trifoglietti site (Joannin *et al*., submitted) in the meridional part of the Apennines help to fill the gaps between previous studies. It may give evidence of elements characterising long-term vegetation dynamics and the possible influences of Holocene rapid climate changes. Finally, it may provide additional data for a better understanding of regional climate variability and possible contrasting changes in seasonality between central and southern Italy.

(Oral presentation)

Vegetation dynamics and climate instabilities during the Mid Pleistocene Transition: why did Mediterranean climate experience an anomalously long MIS 31/30 interglacial?

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The Mediterranean climate is particularly complex, being subject to both high-latitude (i.e., North Atlantic Oscillation) and low-latitude influences (tropical monsoon) at timescales ranging from decades to thousands of years. Instrumental records (which only cover ~ a century) are too short to address the complexity of this system. One has to study high-quality, natural archives to fully understand the response of the Mediterranean climate to both external (insolation) and internal forcings. By doing so, it will be possible to better anticipate its future evolution in the context of anthropogenic environmental change.

The onset of the Mid-Pleistocene Transition (MPT), about ~ 1Myr ago, constitutes a particularly well-suited time interval based on a number of reasons. First, because if one wants to fully understand the climate dynamics of the Late Pleistocene, it is mandatory to analyse the environmental conditions at the onset of the ~ 100 kyr glacial-interglacial oscillations. Second, because it has been suggested that the MPT may have resulted from a drop in atmospheric pCO2, implying that the ~ 41 kyr oscillations that had dominated the Early Pleistocene could be the natural mode of oscillations in a high-pCO2 world. Third, because it has been shown that the warm period that started with interglacial Marine Isotopic Stage (MIS) 31, just at the onset of the MPT, was anomalously long in the Mediterranean region, extending into the glacial MIS 30, thereby raising several questions about the regional specificity of the Mediterranean climate with respect to global environmental changes: Why did warm conditions last exceptionally long across MIS31/30 in the Mediterranean region. Can this be explained by insolation forcing alone through a combination of obliquity and precession influences? Was it associated to rapid (sub-Milankovitch) internal feedback mechanisms?

We attempt to answer these question by reported studies which used pollen-based vegetation and climate quantifications from all Mediterranean. A particular emphasis to the millennial-scale climate variability will be bring on records from ODP site 976 (Alboran Sea ; Joannin *et al*., 2011) and Montalbano Jonico section (South Italy ; Joannin *et al*., 2008).

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(Oral presentation)

Oceanic heatwaves in Mediterranean Sea. Analysis of the last decades and projections for the XXIst century

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[(1)]IMEDEA (UIB-CSIC)

Heatwaves over land have been widely analysed from observations and models at different spatial and temporal scales. Conversely, few studies have addressed the occurrence of heatwaves in the ocean despite their impact on marine ecosystems can be large. In this presentation we first use sea surface temperature (SST) satellite data to characterize the heatwaves observed in the Mediterranean Sea during the last decades. We analyse their spatial structure and the correlation among regions to show that their spatial range is of hundreds of km and present a clear dipole structure between the western and eastern basins. The physical mechanism underlying oceanic heatwaves in the Mediterranean Sea combines high air temperatures and low winds (i.e. low mixing of the surface waters). In the second part of the presentation we analyse the Mediterranean SST projections for the 21st century from ten global ocean-atmosphere coupled models and two regional ocean models. The calibrated time series from the models show an increase in the occurrence of heat waves from the present 0.25 events/yr to 0.78 events/yr in 2050, reaching 1 event/yr in 2100. Also the averaged intensity will increase from 19.15ºC day to 500ºC day in 2050 and 3400ºC day in 2100. The cause of this change is the increase in the mean temperature (2.77 + 1.06ºC in 100 yrs) and the increase in the amplitude of its seasonal cycle (0.62 + 0.51ºC in 100 yrs). Finally, we show an example of the consequences of the enhanced heatwaves on marine ecosystems. A semi-empirical model shows that warming will lead to the functional extinction of Posidonia Oceanica meadows by the middle of this century (2049 + 10) even under a scenario of relatively low green-house gases emissions.

(Oral presentation)

What numerical models and observations can and cannot tell us about Mediterranean Sea marine climate

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Numerical models are a basic tool to understand the climate system and to complement observations, which have a limited coverage in space and/or time. However, the relatively coarse spatial and temporal resolution of models and forcings as well as uncertainties and limitations of model physics can be a serious handicap for the reliability of model results. In this presentation we review the state-of-the-art of Mediterranean Sea climate models to show what they can reproduce and what they cannot. We make special emphasis on the open issues that the modelling community has identified as crucial for future model improvements. We also analyse the capabilities of hydrographic historical datasets to characterize Mediterranean sea climate variability. We show that the interannual variability of temperature can be relatively well characterized in the upper layers but not at intermediate and deeper layers. Salinity is much worse sampled and little can be said at any layer. Finally, we analyse the reliability of long term trends from models and observations in order to elucidate whether climate change signals can be identified or not.

(Oral presentation)

Towards the reconstruction of late Holocene extreme climatic events in the Gulf of Genoa, Ligurian Sea

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Little is known about the long-term behavior of modern climate modes like the Arctic Oscillation / North Atlantic Oscillation (AO/NAO) on multi-decadal to centennial timescales, yet this is exactly the behavior that is most critical to predictions of climate change for the recent century. The Gulf of Genoa area contains a large potential for studying past rainfall variability as it is one of the major Mediterranean centers for cyclogenesis. The strongest depressions form when cold arctic/subarctic air outbreaks, which are more frequent during negative AO/NAO, flow through the Rhone valley into the Gulf of Lions and the Ligurian Sea during late autumn when sea surface temperatures (SST) are still relatively high. As well, significant negative correlations exist between NAO and winter/spring precipitation and river discharge in northwestern Italy. During R/V Poseidon cruise P413 (May 2011), ~60 sediment cores were taken along the Ligurian shelf, continental slope and in the basin between off Livorno and the French border. Preliminary results based on surface sediments suggest that some biomarker-based proxies are well-suited to reconstruct SST and the input of terrestrial organic material (TOM). The U^{K}_{37} SST reconstruction reflects very closely modern spring/autumn SST distributions suggesting a great sensitivity of this proxy for SST reconstruction in the Gulf of Genoa. However, reconstructed SSTs using TEX86 indices are overestimated and present a pattern opposite to the U^{K}_{37} SSTs. Two proxies for TOM input (C27+C29+C31 n-alkanes concentrations and BIT index) have higher values close to the major river mouths and decrease offshore suggesting that these may be used as proxy for the variability in TOM input.

High resolution (mm) analyses of major elements using XRF core-scanning from two cores with extremely high resolution (0.2-0.4 cm/year) over the last 2.5 kyr were performed. Typical elements of detrital origin (i.e. Ti, Fe) present a very high variability, what is very probably related to extreme runoff events during the late Holocene. A local reservoir age of ~374±80 yr at ~950 yr cal BP could be established based on the preliminary age models. An attempt of spectral analysis on these records reveals significant periodicities around 4-5 and 7-8 years, i.e. within the spectral band of AO/NAO variability.

We expect that our new records will provide important information on Holocene and last glacial changes in continental rainfall and surface ocean conditions and will allow establishing relationships to regional oceanographic changes as well as to large-scale atmospheric variability such as the AO/NAO.

(Poster presentation)

Drought Assessment for the Duero Basin (Central Spain) by means of Multivariate Extreme Value Statistics

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Droughts cause important losses. On the Iberian Peninsula non-irrigated agriculture and the tourism sector are affected in regular intervals by droughts. The goal of this study is the description of droughts and their dependence in the Duero basin in Central Spain. Monthly precipitation data is used to analyze meteorological droughts. Cumulative precipitation deficits below a threshold are used to define droughts. This drought indicator is similar to the commonly used standard precipitation index. However, here the focus lies on the modeling of severe droughts, which is done by applying multivariate extreme value theory (MEVT). Data from several stations are assessed jointly, thus the uncertainty of the results is reduced. Our approach captures severity and spatial extension. In general we find a high correlation between deficit volumes and drought duration, thus the duration is not modeled explicitly. We apply a MEVT model with asymmetric logistic dependence function, which is capable to model asymptotic dependence and independence [Ramos and Ledford, 2009]. To summarize the information on the dependence in the joint tail of the extreme drought events, we utilise the fragility index (FI) [Geluk *et al*., 2007].

With 53mm/month precipitation on average, the Duero basin has many arid and semi-arid regions. However, most of the agricultural products are grown without irrigation. To capture impacts on agriculture, the drought definition levels are chosen as 30.5mm/month (1mm/day) and 42.7mm/month (1.4mm/day). The chosen levels correspond to critical levels, where irrigation measures might be necessary. The according drought events have on average a length between 2 and 3 months and occur 1 to 3 times per year.

Results show that the most severe droughts occur in the South-East of the central plain of the Duero basin (the sub-watershed Bajo Duero). The bivariate FI, which measures the dependence between two stations, hints to asymptotical independent data in about two third of the cases. The FI decreases with spatial distance of the stations. However, it shows a large variability over all distances, which hampers the deduction of a general rule for the dependence-distance relation. When analyzing the spatial structure of the bivarate dependencies to a station in the center of the dry Bajo Duero crop lands (Castronuño), dependence to the Western part of the Duero basin is strongest. In the irrigation period (May to October), extreme droughts at this station are strongly dependent with stations all over the Duero basin, which hints to a general dry situation. Furthermore, 6 regions from the central plane of the Duero basin, where the land use is predominantly agriculture, are analyzed. When looking at the more severe droughts, a strong dependence (FI > 1.5) is found for the Eastern regions. For droughts defined with the 42.7mm/month level, the Southern regions show strong dependence.

All in all it shows that the MEVT model is suitable to analyze bivariate dependence of the stations. Furthermore, it is a tool to describe the dependence between few regions. This is a first step towards spatial analysis. The results can be used to adapt short-term irrigation measures.

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(Oral presentation)

Climate change and political instability: Syria's drought, migration and its contribution to the uprising of 2011

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The recent strong drought in Syria (2005-2010), given its unusual magnitude and longevity particularly in the country's agricultural northeast, potentially played a role in the current uprising that began in 2011. The persistent lack of winter rainfall over several years exposed Syria's water vulnerabilities and led to an unprecedented mass migration of families from rural areas to urban centers that exacerbated existing strains from the recent migratory wave of 1.5 million Iraqi refugees. These links between the drought, crop failures and consequent mass migrations appear clear. Drying over recent decades in Syria is consistent with estimates of anthropogenic hydroclimate change to date in the Mediterranean region. Looking to the future, global climate models predict further drying of the region increasing the likelihood of future extreme dry winters. Given existing water stress, more proactive measures are necessary to reduce agricultural dependence on yearly rainfall and to alleviate the social consequences of future multi-year droughts.

(Oral presentation)

CMIP5 Mediterranean precipitation climatology and trend since 1950, natural and externally forced

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Winter and summer greater Mediterranean precipitation climatology and total and estimated externally forced trend patterns since 1950 as simulated by the newest generation of global climate models, the Coupled Model Intercomparison Project Five (CMIP5), are evaluated with respect to observations and the previous generation of models (CMIP3) used in the Intergovernmental Panel on Climate Change Fourth Assessment Report. Individual model runs and single and multi-model ensembles are compared to two high resolution observed gridded datasets from the Climate Research Unit and the Global Precipitation Climatology Centre by examining spatial correlation, variance and root mean squared difference during extended winter (Nov-Apr) and summer (May-Oct) over the greater Mediterranean, including Europe, northern Africa and western Asia. Observed precipitation in the Mediterranean region is defined by wet winters and dry summers, and the spatial and interannual variability are substantial. The observed drying trend since 1950 was dominated by multidecadal internal variability associated with the North Atlantic Oscillation (NAO) but it has been estimated that external forcing also played a role, although the magnitude of this contribution varies considerably over the domain. A common CMIP5 model signal is derived and used to estimate the externally forced portion of the modeled and observed trends since 1950. Results of this study reveal modest improvement for the CMIP5 multi-model ensemble in representing the observed winter and summer climatologies, particularly in locations of orography and along land-water boundaries, but the relative contribution to this improvement by the increase in spatial resolution is uncertain. During summer, the amplitude of the climatologies and total trend patterns are less consistent with observations than in winter. In total, the CMIP5 represents a step forward in its simulation of Mediterranean precipitation, although the uncertainty during summer is considerable. Estimates of externally forced trend reveal pattern correlations and amplitudes that are more in agreement with observations than for total trend, which includes low frequency natural variability, but with a large spread in amplitude between the models. The results of this study are important for assessment of model predictions of hydroclimate change in the Mediterranean region, often referred to as a “hotspot” of future subtropical drying.

(Poster presentation)

The effects of decadal variability in the thermohaline circulation and properties of the Eastern Mediterranean on long term air-sea interaction

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We examine the relation between air-sea heat and freshwater fluxes with the observed variability of the circulation and properties in the entire Eastern Mediterranean.

Our work is based on a 1960-2000 hindcast simulation experiment using a 1/10o x 1/10o POM model implemented within the Mediterranean basin. The atmospheric forcing that was used for the simulation and the analysis of the resulting heat and freshwater fluxes, is the high resolution (~0.5degrees) ARPERA dataset, which was produced upon downscaling the ERA40 ECMWF reanalysis.

Model results, during the simulated 40-year period show that Deep Water Formation (DWF) processes act to alter the Atlantic Water and the Levantine and/or the Cretan Intermediate Water pathways, creating characteristic and alternating patterns of circulation that result in lateral redistribution of heat and salt between the sub-basins on a decadal time scale. DWF activity is found strongly correlated with periods of increased salinity and temperature over each sub-basin. Although the relation between the salinity variations and the DWF activity in the Mediterranean Sea is well documented in the literature the increased heat content seems to be contradictory to the functioning of DWF process, as it provides positive buoyancy, which in the first place acts to weaken deep convection by antagonizing the surface buoyancy loss. Further investigation reveals that increased lateral heat inflow is correlated with increased evaporation due to the ability of the active DWF area to sustain thermal fluxes with the atmosphere. Thus, although the initial influence of increase in heat content reduces the convection process, the intensification of air-sea interaction acts as a secondary mechanism to further enhance salinity preconditioning of the source area through the corresponding increase in evaporation.

The above reasoning implies that the lateral redistribution of heat in the different sub-basins of the EMED modifies the long term air-sea interaction resulting in coupled ocean-atmosphere interactions.

(Poster presentation)

The relevance of the North-Sea Caspian Pattern (NCP) in explaining temperature variability in Europe and the Mediterranean

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The impact of the upper level (500 hPa) teleconnection between the North-Sea and the Caspian (NCP) on the temperature and precipitation regimes in the Eastern Mediterranean (EM) have been studied and reported and an index (NCPI) that measures the normalized geopotential heights differences between the two poles of this teleconnection has been defined.

In the present study, the impact of the NCP on the temperature regime over the entire European continent is presented. In particular, the correlation between temperature and the NCPI has been evaluated, on a monthly basis, over the entire Euro-Mediterranean domain for the 1948-2007 period.

The results highlight a significant positive correlation in the north-western area of the domain and a significant negative correlation in the south-eastern one. These two poles were also highlighted by comparing the temperature anomalies associated with both phases of NCP.

The importance of this sort of NCP-induced temperature bi-pole in the context of temperature variability over Europe and the Mediterranean has been evaluated by applying a Principal Component Analysis to the temperature dataset. The results showed that the temperature bi-pole is associated with the second most important mode of temperature variability over the domain, but if the analysis is restricted to the months associated to NCP (+) and NCP (-), it becomes the first mode with 29.2% of associated variance.

(Poster presentation)

Multi-model calibration and combination of seasonal sea surface temperature forecasts over three different tropical regions

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Current technological development allows forecast centers from all around the world to predict climate at seasonal time scales using dynamical prediction systems. These systems are far from perfect and have substantial systematic errors. Forecasters have used different techniques to infer the best information about the future climate evolution. The multi-model ensemble technique is one of them. This technique combines several dynamical models to take into account in their predictions two important sources of forecast error: the one due to uncertainty in the initial conditions, by using initial-condition ensembles, and the one due to model inadequacy. Users require a single source of probabilistic information, instead of a set of uncalibrated solutions for the future. Different post-processing methods based on multiple linear regression are used to combine multiple forecasts. More sophisticated methods might contribute to reduce forecast errors. The Forecast Assimilation (FA) is a Bayesian approach for calibrating and combining predictions from different sources. In the example described here, predictions for tropical sea surface temperature (SST) from both dynamical and statistical-empirical systems are used to illustrate the relative merits of different methods of combination. The skill of these combinations is compared to the skill of a simple multi-model (SMM) where all single models are equally weighted. SST averaged over three different regions has been considered: the Niño3.4 SST index (170ºW - 120ºW, 5ºS - 5ºN), the Subtropical Northern Atlantic SST index (55ºW - 15ºW, 5ºN - 25ºN), and the Western Tropical Indian Ocean SST index (50ºE - 70ºE, 10ºS - 10ºN). The combination methods have been used to combine the European Center for Medium-Range Weather Forecasts Seasonal Prediction System 3 (System 3) and the National Centers for Environmental Prediction Climate Forecast System 2 (CFSv2). A simple statistical model based on SST persistence was also used. The forecast quality was assessed from a deterministic and probabilistic point of view. The results show that outperforming the SMM predictions is a difficult task. Robust estimation of the regression coefficients is one of the reasons for this due to the colinearity of errors from the different forecast systems used in the combination and the small samples available. On the other hand, the FA method proved to be competitive against the other combination methods and the SMM, improving both the accuracy and the reliability of the predictions.

(Oral presentation)

Modelling the Mediterranean region: Evaluation of air-sea fluxes in the perspective of ocean-atmosphere coupling

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The Mediterranean Sea is a morphologically complex basin where intense local air-sea interactions together with the Atlantic inflowing water drive the thermohaline sea circulation. Surface fluxes play a key role in triggering crucial dense water formation processes, and a good description of their variability is therefore essential to improve our understanding of the Mediterranean Sea circulation.

Currently available gridded dataset at the global scale which are commonly used as surface boundary conditions for hind-cast ocean simulations (NCEP or ECMWF reanalysis) do not have sufficient spatial resolution to effectively drive deep convection in the main interested areas. A common way to overcome this problem consists in performing dynamical downscaling by means of Regional Climate Models (RCMs), thus correcting the underestimation of spatial and temporal extreme air-sea fluxes.

However, climate hind-cast simulations for this region still exhibit a sizeable model spread. Recent work has focused on the analysis of monthly and annual mean climatology of the heat and fresh water fluxes components, as well as on their annual mean budget. High resolution regional ERA40 driven simulations from the ENSEMBLES EU Project were considered. In this study, the fulfillment of a mean annual constraint for the water and heat budgets is used as a criterion to evaluate model performance, and is proposed as a prerequisite for the further forcing of an ocean model.

Nevertheless, a correct representation of spatial and temporal variability of surface boundary conditions is fundamental to drive the localized overturning processes which occur in the basin. Therefore we carried out an extensive inter-comparison study of the spatial and temporal low frequency variability of modeled surface fluxes from the same set of RCMs, by performing a EOF decomposition of the air-sea surface fluxes components. Inter-annual and seasonal variability of local forcing has also been characterized over the dense water formation areas highlighted by the modal decomposition.

This model inter-comparison can be considered as a preliminary evaluation of the potential outcomes of coupled Atmosphere-Ocean Regional Models for the Mediterranean area which are currently being developed.

(Oral presentation)

Nonstationary relationship between the Euro-Mediterranean rainfall and the El Niño phenomenon

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The precipitation over Europe and the Mediterranean region has been usually associated to the North Atlantic Oscillation (NAO). However, several studies have shown how, the El Niño-Southern Oscillation (ENSO), which is the globally dominant climate mode at interannual timescales, also influences the Euro-Mediterranean Rainfall variability (iEMedR). An interesting point is that, at interannual timescales, the regional atmospheric spatial pattern at surface levels over the Euro-Mediterranean region associated with the Pacific El Niño presents a similar structure to the one associated with the NAO (Brönnimann, 2007, García-Serrano *et al*., 2011). In this way, although most of the NAO signal has an internal origin, external contributions associated with Sea Surface Temperature (SST) changes in the Pacific can have a determinant impact on the centers of action of the NAO, which makes difficult distinguish between NAO and ENSO signals over the Mediterranean.

Other studies have found nonstationary features in these signals along the 20th century (Mariotti *et al*., 2002, Zanchettin *et al*., 2008, Vicente-Serrano *et al*., 2008). Specifically, this study represents a continuation of the results recently published by the same authors (Lopez-Parages and Rodríguez-Fonseca, 2012), where they presented statistically significant evidences about how the Atlantic Multidecadal Oscillation (AMO) and Pacific Decadal Oscillation (PDO) seem to play and important role in the nonstationary relationship between El Niño phenomena and the leading mode of variability of the iEMedR. Although this study point to the fact of considering the changes in the mean state as the modulator factor of ENSO teleconnections, many questions, mainly related to the possible mechanisms which could explain the nonstationary relationship identified, remain open. Here, new analysis based on observations and also on the CMIP5 simulations of the CNRM-CM5 model have been done. The analysis of the long control run shows how the model is able to reproduce the leading mode of precipitation, and how its relation with El Niño is non stationary, as in the observations. Also, the model shows how this changing teleconnection has a periodicity which broadly coincides with the periodicity of the AMO and PDO of the model. Moreover, observations and model results suggest changes in the zonal mean flow, and in the Walker-Hadley circulations, associated to the non-stationary El Niño- iEMedR teleconnection.

The results of this study confirm, in this sense, the lack of stationarity, but also represent a step forward in the state of the art, by the identification of multidecadal natural variability as a potential modulator of the interannual teleconnections.

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(Poster presentation)

Evaluation of the dynamical downscaling of the impact of the NAO on the wind energy resources over the western Mediterranean region for present climate and climate change conditions

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In this study we analyze the influence of the changes in the NAO pattern under climate change conditions on the wind energy resources over the Iberian Peninsula. To this aim we use the outputs of Regional Climate Models (RCMs) that have been nested in the ECHAM-5 and HadCM3 Global Climate Models (GCMs) under the framework of the European project ENSEMBLES.

Our results indicate that the use of RCMs significantly improves the simulation of the impact of the NAO on the wind energy resources in the south of the Iberian Peninsula and North Africa, capturing some observed features of the spatial balancing of wind energy that are missed in the GCMs simulations.

Our results also point to an increase of the inter-annual variability of the wind resources over the south of the Iberian Peninsula under climate change conditions (A1B scenario).

(Oral presentation)

Climate variability and summer forest fires in a Mediterranean context: the case of Catalonia

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In this study we analyze the relationship between summer forest fires and climate variability in Catalonia (NE of the Iberian Peninsula). Two main datasets have been used: Spain02 for precipitation and temperature (1950-2008 and 0.2º x 0.2º) and a database of forest fires spanning 41 years, from 1970 to 2010. We show that the interannual variability of fires is significantly related to concurrent and antecedent climate conditions, highlighting the importance of climate not only in regulating fuel flammability, but also fuel load. On the basis of these results we have developed a linear regression model that produces reliable out-of-sample predictions of the impact of climate variability on summer forest fires. This methodology is then applied to explore the impact of climatic change in past decades and to assess the possible scenarios for the coming decades. By exploiting the relationship with antecedent climate, the feasibility of forecasting forest fires at seasonal scale is also considered.

(Oral presentation)

Identification of the climate modes driving present Mediterranean sea level variability.

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The influence of the first four modes of atmospheric variability in the North Atlantic/Europe region on Mediterranean sea level and its components is evaluated. The modes considered, namely the North Atlantic Oscillation (NAO), East Atlantic pattern (EA), Scandinavian pattern (SCAN), and East Atlantic/West Russian pattern (EA/WR), are obtained from the NOAA Climate Prediction Centre. The sea level data sets consist of coastal tide gauge records, satellite altimetry data and a 58-year long (1950-2008) sea level reconstruction over the Mediterranean Sea. Atmospherically-induced and steric sea level components are also examined using a 60-year long barotropic run over the Mediterranean region and hydrographic data bases, respectively. The resulting impacts of each mode are characterized seasonally for the entire basin and different subbasins.

(Poster presentation)

Detected Changes in spatio-temporal drought characteristics in Syria over last five decades

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Global warming is likely to alter patterns of global air circulation and hydrological cycle that will change global and regional precipitation regimes. Because of the interactions of processes at a wide range of spatial and temporal scales, the climate of this region is characterized by a great diversity of features, resulting in a variety of climate types and great spatial variability , so it is considered as one of the most prominent “Hot-Spots” in future climate change projections which suggest an increase in drought conditions that will be more frequent and intense. The characteristics of meteorological droughts in twenty synoptic Syrian stations were determined using the Standardized Precipitation Evapotranspiration Index (SPEI) as a measure for seasonal and annual drought severity and intensity during the period (1958-2008). Mann-Kendall test was used to detect any monotonic trend in SPEI values whereas, Regime Shift index (RSI) was used to determine the years of changes. The results showed decreasing trends in SPEI values in all stations which were statistically significant (p=0.05 and p=0.01) in most. Significant negative step changes were detected by Regime Shift index (RSI) in annual SPEI values for all stations ranged between (-0.91 in Hmaimeem) and (-4.72 in Kamishli). An increasing in drought frequency was illustrated in whole region.

(Poster presentation)

Climate variability and human activities impact on Mediterranean environment during the Holocene, along a west-east transect

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Since the beginning of global warming with pre-industrial time, climate change affects our environment with varying intensity according to regions. Most current regional climate models predict changes in temperature of a few degrees, as well as changes in extreme events like monsoons, and altered balance of precipitation and drought in different areas. Moreover, the action of man on his environment and the development of our societies, multiply the destructive impact of intense weather events. The regionalization of climate change and the study of possible changes to extreme climatic events thus constitute major research objectives. The aim of our study is to establish high-resolution records of environmental and climate change, along a west-east transect across the Mediterranean with a focus on paleohydrological changes. On the basis of a multi-proxy approach combining geophysical, geochemical and bio-indicators, the study of four lake and peat-bog sediment sequences from Crete, Sicily and Spain will allow us to highlight the respective impact of past climate variability and human activities on changes in the ecosystem trajectories. Over the last years, the study in the western Mediterranean give evidence of a south-north partition of the Mediterranean climate (Vannière *et al*., 2011; Magny *et al*., 2011, 2012). In this project, we want to test how the west-east gradient could have been another key feature during the Holocene in the Mediterranean basin for the climate forcing factors and mechanisms, as well as for ecosystems trajectories. First results from the Cretan peat bog of Asi Gonia, shows four successive climatic phases over the last two millennia: the beginning of peat formation (50-100 cal.AD) is illustrated by a strong remaniement in the terrigenous material (magnetic susceptibility analysis) and the peat bog's accumulation (between 100 and 600 cal.AD). It follows, a relatively wet stage (600-1200 cal.AD) interrupted by a first major anthropic event around 1200 cal. AD put in evidence by an increase in the ratio inorganic carbonate/organic carbonate and magnetic susceptibility. Between 1200-1400 cal. AD, the terrigenous signal diminished in favor of authigenic organic matter (LOI) probably caused by a reduced human activity at this place. Since 1400 cal. AD the peat bog records a gradual transition to dryer climate conditions input by the increase in the terrigenous material (Si and inorganic Ca) that could be linked with the Little Ice Age. Finally, the study of Lake Kournas sediment sequence in Crete also provides additional data to document climate changes during the second half of the Holocene which is marked by increasing runoff mainly climatic. The on-going study of the Holocene Medina sediment sequence from Southern Spain will complete our transect to the west.

(Poster presentation)

Evaluation of Extreme precipitations over Iberian Peninsula and Balearic Islands using several CMIP5 Earth System Models: a comparative of historical periods using statistical downscaling

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Thanks to the CMIP5 (Coupled Model Intercomparison Project Phase 5), a set of Earth System Models have been made available for its use in climatic studies. Every model provides a group of experiments and allows the use of a complete set of meteorological variables under different time steps. In our work, we have used the historical experiment simulation of recent past as its nature of baseline simulation for model evaluation allows us to skill the models used over our study area.

These models provide outputs which can be downscaled; in our case, we have run a two-step analog statistical downscaling method that has been successfully tested in Spain, Europe and other regions, a method based in the joined use of analogues and monthly empirical probability distribution function. We have used the Spanish Meteorological Agency (AEMet) observations as a set of meteorological observatories in order to evaluate the performance of the different climate models when simulating the precipitation over our study area (the Spanish territory of Iberian Peninsula and Balearic Islands). In order to assess how accurate this methodology is, the 40-yr ECMWF Re-Analysis (ERA-40) has been used.

In the special case of precipitation, we have used several statistical estimators for measuring the performance of the models, such as BIAS, probability distribution tests, and measures of pattern similarity. For the study of extremes and heavy rainfalls, not only some high percentiles but also rainfall return periods (based in specific PDFs) have been also studied and compared.

(Poster presentation)

Climate variability during the Holocene inferred from northeastern Iberian speleothems

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Although the general climate trends during the Holocene in the Iberian Peninsula have been well described after the study of marine and lacustrine records, many questions regarding the timing of some of the events together with the characterization of the higher-frequency climate variability are still poorly understood. New speleothem records from several caves in northeastern Iberia provide data to explore Holocene climate changes. The selected caves are located in a latitudinal transect from the Pyrenees to the Iberian Range and placed at different altitude. Two of them, 5 de Agosto and Pot au Feu, belong to the same karstic complex in Cotiella massif (Central Pyrenees, 1600 m asl). B-1 is a cave in Ordesa National Park, also in Central Pyrenees at 1060 m asl, with few Holocene speleothems. Seso Cave, also in the Central Pyrenees but at 781 m of altitude, and Molinos cave, a cavity very rich in speleothems located at 1040 m in the Iberian Range, complete the transect. Although in all the caves precipitation coming from Atlantic fronts dominates over the year, a significant Mediterranean influence, specially in summer months, is identified after rainfall monitoring during two years in the Iberian Range and one year in the Pyrenees.

Speleothem formation during the Holocene occurred at a very low pace in 5 de Agosto cave (80yrs/mm) and increased dramatically at low-altitude caves and during particular periods proved to be wetter (eg. Early Holocene in Molinos cave, less than 10yr/mm). In Seso and Pot au Feu caves, up to seven studied speleothems only grew during short climatic events such as the Iron Cold Period (3000-2500 cal yr BP) or the Little Ice Age (1300-1850 yr AD) that, although cold, were particularly humid periods in northeastern Spain. First stable isotope results highlight the importance of comparing speleothems with similar growing rates and from the same cave to extract climate information and discard other influences. From the integration of four stalagmites from Molinos cave covering since the Holocene onset to 2000 cal yrs BP, the Early Holocene (11.7-8.5 ka BP) with $\delta^{13}C$ values between -11 and -9‰ appears as the wetter interval. The highest isotopic values are reached during Middle Holocene (8.5-5.5 ka BP) while there is a tendency towards more negative values during Late Holocene (last 5000 yrs). The range of $\delta^{18}O$ values is low (about 2‰) but still lighter values during Early Holocene and heavier afterwards are well marked. Shorter events characterized by more negative $\delta^{13}C$ and $\delta^{18}O$ values are observed at 4 ka, 6 ka, 7.5 ka, 8.2, 8.7, 9.2, 10.3 ka and preliminarily interpreted as cold but probably wetter periods with denser vegetation cover and soil development over the cave. However, changes in the source of precipitation (Atlantic vs. Mediterranean) or the influence of fresh-water outbursts in North Atlantic can not be neglected.

(Oral presentation)

Aerosol radiative impact on the Mediterranean climate in coupled atmosphere-ocean regional climate simulations

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The Mediterranean region is characterized by the accumulation of aerosols from different sources : industrial and urban aerosols from Europe and North African towns, biomass burning from Eastern Europe, dust aerosols from Africa, and marine particles from the sea. These aerosols show a strong spatio-temporal variability and a resulting large variety in aerosol optical properties over this basin. Through their interactions with solar and thermal radiation, they have very important effects on its climate.

In order to better understand the influence of aerosols on the Mediterranean climate, we consider in the present work a regional climate modelling approach, using the ALADIN-climate model. This regional climate model can be coupled to the ocean model NEMOMED8 to take into account the feedback of the sea surface temperature (SST). Aerosols are included in ALADIN through monthly interannual climatologies, which come from a combination of satellite-derived and model-simulated products. The aim is to have the most possible relevant estimation of the atmospheric aerosol content for the five most relevant species (sea salt, desert dust, sulfates, black and organic carbon aerosols). Simulations have been carried out both in a forced mode (only the atmospheric model ALADIN) and in a coupled mode (ALADIN with NEMOMED8), with and without aerosols. The first results confirm the strong impact of aerosols due to absorption and scattering of the incident radiation, and also show contrasts between different regions. Regional climate response to aerosols is all the more complex in a region where local winds, complex coastlines and orography interact with the atmospheric flow. We will present the aerosol direct effect in both modes (forced and coupled) on shortwave and longwave radiation, and atmospheric parameters such as temperature, dynamics and precipitation, as well as on ocean-atmosphere fluxes and SST for coupled atmosphere-ocean simulations.

(Poster presentation)

The development of Fohn winds due to Saharan dust outbreaks in Crete Island, Greece

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Crete Island is located in the south most border of East Mediterranean basin, facing exacerbating atmospheric conditions (mainly concentrations of particulates) due to Saharan dust outbreaks. It is worth to note that these episodes are more frequent during spring and autumn, when mild climatic conditions become intolerable due to the synergy of the so called Föhn winds. Cretan mountains, especially Psiloritis Mt. (summit at 2456 m), are orientated perpendicularly to the south-west air mass flow, generating the Föhn winds. Propagating from the leeward of the mountains, these dry, hot winds have an effect on prevailing bioclimatic conditions. While descending to the lowlands on the leeward side of the range, the wind becomes strong, gusty and desiccating. This wind often lasts for 3 days or more, with gradual weakening after the first or the second day. Sometimes, it stops very abruptly.

In this work, the authors examined and analyzed specific case studies during which Föhn winds appeared in Heraklion city at the leeward of Psiloritis Mt, during extreme Saharan dust episodes, observed within the period 2000-2010. In order to verify the development of Föhn winds, synoptical meteorological observations of half hour duration, were acquired from the Heraklion meteorological station installed by the Hellenic National Meteorological Service (HNMS). The meteorological parameters measured were air temperature, relative humidity and wind.

The results of the performed analysis showed an increase of more than 10^{o}C in air temperature, a more pronounced decrease of 30% in relative humidity and an increase of wind speed (~20m/s) during the events of Föhn winds. At this point it is worth to notice that respiratory admissions, recorded at the two main hospitals of Heraklion city, were higher due to Saharan dust events. This situation got worse when hot/dry environmental conditions were combined, as a result of strong, desiccating winds on the leeward side of the mountains.

(Poster presentation)

Synoptic composite means and anomalies of meteorological parameters associated with high sea waves in the Eastern Mediterranean

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Sea waves are of great interest due to the impacts they have on sailing and on the development of erosion processes at coastal environments. Thus, the analysis of sea waves characteristics is of importance in socio-economic and environmental sectors.

This research focuses on the relation between wave characteristics and synoptic composite means and anomalies of various meteorological parameters for the area of Eastern Mediterranean and specifically at Ionian and Aegean Seas. Sea surface elevation data were obtained by deep water located buoys in the Greek Seas installed by the Hellenic Centre of Marine Research, for the Poseidon Marine Monitoring Network, during the period 2006-2011. The recording period is 17 minutes, the recording interval is 3 hours and the sampling frequency is 1Hz. These data were analyzed using MatLab's Toolbox WAFO and provided wave parameters such as height and period. Daily means of these two parameters, consisted in total of 6921 measurements, were estimated and the upper 10% from their distribution were selected for Ionian Sea (2719 measurements), the North Aegean (2415 measurements) and South Aegean (1787 measurements). In order to evaluate the weather patterns associated with the upper 10% of waves height and period, daily composite means and anomalies of meteorological parameters from NCEP-NCAR reanalysis were used, only for the dates of incidence of the upper 10% of the two wave parameters. The meteorological parameters analyzed were: Sea Level Pressure, 500 hPa Geopotential Height, Zonal wind (u), Meridional Wind (v) and Surface Vector Wind (w).

The results of the performed analysis showed that the highest values of wave heights and periods do not always occur due to similar weather patterns. Moreover, in the area of the Ionian Sea, high values of height and period occur when low Sea Level Pressure (SLP) appears over the wider area of Italy. For the area of North Aegean, high waves are associated with extended low SLP from Italy to Cyprus. In contrast, low SLP over southern Turkey and Middle East affects sea wave characteristics of the South Aegean Sea. Significant spatial variability appears with respect to middle atmosphere and Zonal/Meridional Wind at the surface, revealing specific patterns for the three examined domains.

Future work will include analysis of varying values of wave height and period as well as correlation to climatic impact scenarios.

(Oral presentation)

Seasonal feedbacks models for the Western Mediterranean variability: inferences for predictions

Ortiz-Beviá, M.J.[(1)], Alvarez-García, F.J., Ruiz de Elvira, A. and Liguori, G.

[(1)]University of Alcalá

We characterise the relationships between the interannual variability of the Western Mediterranean and the large scale modes of variability, and estimate its feedbacks from some of these modes at different seasons. Among the relevant modes considered are the Pacific North America, the Southern Oscillation, the North Atlantic Oscillation, the Indian Core Monsoon and the Scandinavian teleconnection pattern. Based on these relationships and using the methodology developped in OrtizBeviá *et al* (2012) we formulate some stochastic models for the Western Mediterranean variability, focusing specially in summer and autumn. From each of these feedback models, a statistical analysis extracts spatial patterns whose evolution in time exhibits predictive capabilities for the Western Mediterranean variabiliy that are above those of persistence, and that could be improved to develop useful forecasts. The characteristics of the spatial patterns and their associated temporal variability will be presented and its relationships with regional and large scale dynamics discussed.

References:

OrtizBeviá M.J., Alvarez-García F.J., Ruiz de Elvira A., Liguori G. and Carretero J.H. (2012) The Western Mediterranean Summer Variability and its feedbacks. Climate Dyn., (in press).

(Oral presentation)

Deep-water variability and inter-basin interactions in the Eastern Mediterranean Sea

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The investigation of the deep-water characteristics and their variability on long time scales can help in the understanding of the possible mechanisms, sensitivity, localization and frequency of water mass formation, and their links to atmospheric forcing. The need to document and understand deep-water variability is especially acute in the case of the Eastern Mediterranean Sea, where basin-wide and inter-basin thermo-haline transport components are connected with multiple sites of convection. We examine deep-water variability in relation to new water mass sources, transport processes and atmospheric forcing variations. Deep-water properties extracted from multi-decadal data sets acquired in the deep basins of the Eastern Mediterranean Sea, complemented by the extensive POEM, SESAME and other recent data sets, atmospheric re-analysis data sets (ERA-40, ERA-Interim, ARPERA) reveal a complex picture of temporal / spatial variability.

Apart from the very long-term changes, decadal variability dominates the temporal evolution of the deep waters. It is observed that the Eastern Mediterranean Transient (EMT) stands as the most extraordinary deep-water episode, while other inter-decadal changes of varying strength are predominantly detected in certain areas of the Eastern Mediterranean. The largest inter-decadal variability is observed in the Aegean and Adriatic Basins, where changes are consistently observed since the first part of the last century. An abrupt increase of salinity and density with an associated drop in temperature marks the EMT starting in the 1990's in the Aegean Basin. In the deep Levantine Basin the EMT event starts at the same time, particularly after the 1992-93 cooling event, but lasts throughout the 2000's for about two previous decades, with stepwise increases in temperature, salinity and density. In the deep Levantine Basin, salinity changes dominate the decadal variability. The deep Ionian Basin variability in seawater properties is similar, with relatively higher variability in salinity as compared to temperature. The evolution of the Eastern Mediterranean deep-water characteristics also suggests a strong interaction between the various sub-basins.

(Oral presentation)

Climate change scenarios in the Mediterranean Sea from a regional ocean model

Padorno, E.[(1)], Aznar, R., Álvarez-Fanjul, E., Somot, S., Sevault, F., Déqué, M., Herrmann, M., Adloff, F., Jordá, G., Marcos, M. and Gomis, D.

[(1)]Puertos del Estado

Significant differences in the Mediterranean Sea water characteristics are foreseen to appear during twenty first century, as reported in the Third Assessment Report of the Intergovernmental Panel on Climate Change (IPCC, 2007).

Main changes could be a warmer and drier ocean that would lead to warming and saltening waters. Mean sea level increase, thermohaline circulation variations, and deep water convection changes could be some of the direct consequences.

Seven 140-years (1960-2099) long simulations were carried out with the regional high-resolution ocean model NEMOMED8, following the scheme described in Somot *et al*. (2006). Differences between the set of experiments were the characteristics of the regional and global climate models used to force the regional ocean model, and the time frequency to insert these boundary and initial conditions in. Forcing are air-sea fluxes at the surface, Atlantic buffer zone, and river runoff water.

Model stability was checked out with a control run (1961-2000) under present climate conditions, then, beyond 2000, three scenarios runs were carried out under the SRES-A1B, A2, and B1 scenario forcing.

The ensemble of simulations allows us to do many analyses; in particular, this study mainly focuses on evaluating the behavior of the Mediterranean basin, under the impact of the scenario choice along the 21st century. Thermohaline circulation evolution, surface water characteristics, winter ocean deep-water formation at different areas, and Gibraltar Strait evolution will be study.

Additional studies are planned to answer some issues as the uncertainty assessment, and the model sensitivity to the forcing.

(Poster presentation)

Contrasting patterns of climatic changes during the Holocene in central Mediterranean area (Italy) reconstructed from pollen data

Peyron, O.[(1)], Dormoy, I., Goring, S., Joannin, S., Brayshaw, D., de Beaulieu, J.L., Brugiapaglia, E., Kotthoff, U. Kouli, K., Pross, J., Sadori, L., Combourieu-Nebout, N. and Magny, M.

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The Holocene period is particularly well investigated in the Mediterranean area by a large amount of data including palynological, speleothems, lake isotopic or lake-level evidence. All these data show the Holocene to have a complex pattern of climatic change across the Mediterranean region with strong and spatial and temporal variability. Thus, recent studies based on lake-level records from Italy suggest a North-South climatic partition in the central Mediterranean through the Holocene (Magny *et al*., 2012). Clearly, two opposite patterns clearly appear with the northern sites characterized by a mid-Holocene minimum in summer precipitation, and the sites located south of 40°N marked by maximal precipitation during the mid-Holocene. If the recent precipitation estimates based on pollen records of lakes Accesa (Tuscany) and Pergusa (Sicily) seem support the interpretation of North-South climatic pattern during the mid-Holocene, given the scarcity of reliable palaeoclimatic records in the north and central-south Mediterranean, new evidence is needed to validate this hypothesis. This study aims to provide robust and precise quantitative estimates of the Holocene climate in the Mediterranean region based on four high-resolution pollen records taken from lakes located along a latitudinal gradient from the northern Italy to the south Italy. Three lakes are from peninsular Italy (Lake Ledro, Lake Accesa, Lake Trifoglietti), and one is from Sicily (Lake Pergusa). We investigate climatic trends during the Holocene and test the hypothesis proposed by Magny *et al*., (2012) of opposite mid-Holocene summer precipitation regimes between the north-central and south Mediterranean, with a minimum in north central Italy and a maximum in Sicily. We also aim to test the reconstruction of the precipitation seasonality which can be validated by independent proxies obtained for same records, i.e. lake-levels, charcoal/fires (Magny *et al*., 2011; Vannière *et al*., 2011).

Our purpose is to produce a robust climate reconstruction: a multi-method approach is favoured for the reconstruction to better assess the error of reconstruction inherent in pollen-based climate predictions. We have chosen four methods: Weighted Averaging method (Ter Braak and Van Dam, 1989), Weighted Average Partial Least Squares regression (Ter Braak and Juggins, 1993), Best Modern Analogues Technique (Guiot, 1990), and the Non-Metric Multidimensional Scaling/Generalized Additive Model method (Goring *et al*., 2009). The resulting uncertainties are large, but allow a more robust assessment of the reconstructed climatic variations than in the studies based on a single method.

In order to test the reliability of the reconstructed climate, we have compared the results with (1) pollen-inferred climate in the Mediterranean basin reconstructed from marine pollen cores in the Alboran , Adriatic and Aegean sea, (2) recent GCMs climate simulations.

(Poster presentation)

Seasonal Prediction of climate extreme events: extreme precipitation over the western mediterranean area

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This study aims at delivering a synthesis of the seasonal forecast quality of climate extreme precipitation events over the Western Mediterranean predicted with global dynamical models. It describes and assesses different aspects of the forecast quality of extreme event predictions at seasonal time scales, interpreting the differences between a set of start dates. It also describes a strategy for communicating climate information in the context of the development of a climate service application for the insurance industry.

The precipitation extreme prediction used the Decadal Climate Prediction System (DePreSys) of the ENSEMBLES project. DePreSys is a nine-member ensemble perturbed-parameter system where each version samples a different set of parameter perturbations to the HadCM3 model.

Extreme value theory has been applied to the model output and the results compared against those obtained from observational datasets like the European High Resolution Data Set (EObs) and the ERA-Interim reanalysis. Diagnostics on the basis of seasonal and monthly statistics for the boreal summer and for the month of August were performed. The study includes an analysis of the observational uncertainty sources, an illustration of some predictions and a verification of the prediction system used. An evaluation has been done for specific regions to illustrate the main characteristics of the predictions.

The results obtained so far show that climate prediction systems are able to reproduce the main features of the observed extreme precipitation, especially in wetter areas. Moreover, DePreSys is able to predict the extreme monthly rainfall in certain areas of Europe, especially for short lead times. The limitations of the system to provide predictions of better quality for extreme rainfall in certain locations could be due to a) the low resolution of the model and b) the inherent difficulty of predicting precipitation because its variability has multiple origins.

Performing these predictions including downscaling techniques to increase the resolution could improve the forecast quality, and thus it may offer more useful information in the climate services context.

(Poster presentation)

Analysis of precipitation along the North African and Middle East shore of the Mediterranean Region

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A data set of long-term in situ observation of precipitation at monthly scale was compiled covering five country of the North Africa and Middle East: Tunisia, Egypt, Libya, Jordan and Syria. Data have been statistically tested with respect the homogeneity using a combination of methods. An intercomparison with data from EOBs and CRU data set has been done and shows that in situ data are useful for improving the knowledge of climatology in these areas. Trend of precipitation correlation with north hemisphere teleconnection patterns have been investogated. Results show a different behaviour of trend and correlation depending on the country. As an example, the northern coast of Egypt display an increase of precipitation from 1968 to 2000 of about 10mm, whereas, in the opposite, the Jordan experience a decrease of about 50mm from 1968 to 2000. Also correlation with teleconnection indices shows different behaviour depending on the area.

(Poster presentation)

Multidecadal variability of Mediterranean sea level in connection with local and remote atmospheric and marine parameters

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Sea level is a key interdisciplinary environmental observable, whose changes result from land, ocean and atmospheric processes and causes significant impacts on human life and activities. During the 20th century the Mediterranean sea level has shown a peculiar behaviour, different from that of the global ocean, remaining almost unchanged from the 1960's to the early 1990's, then rising at a higher rate than prior to 1960. Similar regime changes can be found also in local marine and atmospheric variables, as, for instance sea-level pressure and the ocean heat content, and large-scale indicators, like the North Atlantic Oscillation index, the Sahel precipitation index and the Atlantic Multidecadal Oscillation index. The Mediterranean Sea feels the dynamics of not only the mid-latitudes atmospheric circulation, but also that of the Tropics, therefore here we study the connections between sea level anomalies and those of local atmospheric and marine variables and indicators of the large-scale atmospheric circulation. Sea level comes from observations made at selected long-term Mediterranean tide-gauge stations, namely Ceuta in the Alboran Sea, Marseille in the northwest Mediterranean, Trieste in the Adriatic Sea, Antalya in the north Levantine basin and Alexandria in the south Levantine basin. Monthly values are obtained from the Permanent Service for Mean Sea Level sea level data bank, but other data sources are used when possible to extend the time series, identify and correct possible datum discontinuities and fill gaps. Calendar yearly means are used for the analyses, that are performed after linear trends are subtracted. The period of interest is mainly the second half of the 20th century. Correlation exists with local sea level pressure at all stations, as a result of the inverted barometer effect, more pronounced at Marseille and Trieste, and with local heat content, that contributes to most of the steric effect. at most stations but Ceuta. Such relationships can be connected with the Atlantic and Tropical circulation indices variability. It is well known that sea level pressure anomalies are connected with North Atlantic Oscillation variability, and, in fact, North Atlantic Oscillation index and sea level time series are correlated. All the sea level time series appear to be correlated with Atlantic Multidecadal Oscillation, only a few of them are correlated with the Sahel index. Correlations between heat content and Atlantic Multidecadal Oscillation and between heat content and Sahel index can be found in the west and east Mediterranean. Rodionov's Regime Shift Index is used to detect the regime changes in the various time series.

(Poster presentation)

Seasonal changes in daily precipitation extremes in mainland Portugal from 1941 to 2007

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This study aims mostly at understanding variations in the intensity, frequency and duration of extreme precipitation events in mainland Portugal (south-western Europe), using the most dense regional network used over Portugal for this purpose and paying special attention to regional differences and seasonality. Data are daily series of precipitation from 57 meteorological stations which were chosen based on a combination of tests for data length, completeness, quality and homogeneity, and their scattered spatial distribution over mainland Portugal, for the period 1941-2007. Selected indices of daily and extreme precipitation are explored for trends at the seasonal scale, and at the point and regional levels; different time periods and seasons are investigated. Additional analyses include the study of the correlations between seasonal extreme precipitation indices, and the large scale influence on these indices, aiming at identifying dynamical characteristics of low frequency variability.

Results show that, at the seasonal scale, there are sometimes marked changes in precipitation indices. Trends in spring and autumn precipitation have opposite signals. In spring, statistically significant drying trends are found together with a reduction in extremes. In autumn, wetting trends are detected for all indices, although overall they are not significant at the 5% level.

These results seem to indicate a tendency for a reduction in the duration of the rainy season, a result that is consistent with most climate change scenarios provided in the last IPCC report. Results also confirm that, over mainland Portugal, the North Atlantic Oscillation (NAO) is one of the most important teleconnection patterns in all seasons, being the mode of variability that has the highest influence on precipitation extremes in the area, particularly in winter and autumn.

(Oral presentation)

Surprises and confirmations in the impact of global warming on the thermal stratification of the Mediterranean Sea

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The deepening of the surface warm water layer formed during summer months recently caused several mass mortalities of benthic organisms in the Mediterranean sea. A modification of the thermal structure in the surface layer, probably due to global warming, can be considered as the trigger of great modifications in Mediterranean biota.

It is consequently extremely relevant to understand how thermal changes have already affected and how they will affect marine ecosystems to identify areas particularly exposed to thermal anomalies, to set monitoring programs and to individuate mitigation strategies, identifying the proper temporal and spatial scales for finding trade-off and thresholds within an adaptive management framework.

We analyzed all the vertical profiles (202307) of temperature available for the Mediterranean Sea (from 1945 through 2011) including bottle, Mechanical Bathy-Thermographs (MBT), eXpendable Bathy-Thermographs (XBT) and Conductivity-Temperature- Depth profiles (CTD) taken from the MEDAR/Medatlas database, from the World Ocean Database 2009 and XBT measurements taken within the MFS-VOS (Mediterranean Forecasting Sistem-Voluntary Observing Ship) program with the aim of: 1- quantifying the patterns, if any, of temperature change across the basin, 2- identifying areas particularly exposed to thermal anomalies.

To estimate the existence of a pattern of temperature change at Mediterranean scale, the basin has been divided into four regions: North, Central, Eastern and Western Mediterranean. The behavior of seasonal temperature in each region has been investigated for the period 1945-2011 considering 4 levels of depth: 10, 30, 50, 100 m. The climate change signal was assessed by identifying differences between temperature anomalies for 4 periods (1945-1960, 1960-1975, 1975-1990, 1990-2005) over the entire period of measurements (1945-2011).

To identify areas particularly exposed to thermal anomalies each region was divided into smaller sub-basins and the profile analysis was carried out for each of them.

Results show large differences among regions and seasons, and interpretation is made problematic by change of instrumentation, spatial heterogeneity, irregular distribution in time. Notwithstanding the limits in the available data set, evidently not designed to test the hypothesis that global warming affects the thermal stratification of the Mediterranean Sea, a clear signal of warming has been identified in the western part of the Mediterranean, in winter months, in the central part both in summer and autumn months and a cooling signals has been identified in the first 50m of the northern Mediterranean.

These results show some evidence of a warming trend at regional scale in the Mediterranean Sea in the second half of the 20th century. However, insufficient observations (which are very sparse in space and irregular in time) and large multi-decadal variability likely prevent detecting a clear climate signal. This study stresses the importance of recovering past observations and of a dedicated and sustained monitoring program for studying the evolution of the Mediterranean water column in the next decades.

(Poster presentation)

Long-term trends of extreme climate events over Alexandria region, Egypt

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The climate of the Mediterranean is mild and wet during the winter and hot and dry during the summer. Extreme weather and climate events have received increased attention in the last few years; due to the often large loss of human life and exponentially increasing costs associated with them. The present work focuses on changes in extreme temperature, precipitation and sea level events over Alexandria region during the period 1979-2011.

The results indicated that the mean annual air temperature over the studied region increased by about 2.24°C during the period of investigation, with a rate of about 0.6°C/decade. The yearly precipitation over Alexandria region varied between a minimum of 24.37 mm in 1999 and a maximum of 368.80 mm in 2004, with an average annual precipitation of about 183 mm. The mean precipitation rate over the study period was 5 mm/rainy day. The historical sea level data indicated that, the hourly values of water level at Alexandria during the study period varied between 5cm and 86cm above the zero level of the tide gauge with a mean water level of 47.9 cm.

Three extreme events have been recorded during the study period; scarce precipitation (2.71 mm/rainy day) in 1999, extreme high precipitation (23 mm/rainy day) in 2004, and extreme surge (> 1 m elevation) in winter 2010. Climate variability during these events has been discussed in the present work in details.

(Poster presentation)

Regional modeling of dry spells characteristics over the Mediterranean basin for present and future climate conditions

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One of the main Mediterranean basin climatic features is the important role of hydrological stresses. There are meteorological processes of high precipitation intensity, particulary in the early autumn, but one major concern not only from climate, but also for agricultural, socioeconomic and other perspectives, are the distribution of dry periods, that are frequently large and intense. Here we propose the analysis of a group of regional climate model (RCM) simulations from ENSEMBLES european project (covering the whole basin), and Spanish ESCENA project (covering the western half of the Mediterranean) describing the main characteristics of dry periods over the domain. The whole distribution, and not only the largest or the mean dry spells is analyzed, compared with the available observational gridded databases, to see how models at 25km horizontal resolution are able to reproduce the main features of non-precipitation periods. Once RCMs are studied for present conditions (ERA-forced simulations), future climate projections for the XXIst century forced by several global climate models are analyzed to see how dry spells conditions are expected to change due to increased greenhouse gases concentrations.

(Poster presentation)

Evaluation of climate models based on physical processes

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There is currently a wide variety of methods and approaches designed to evaluate the capacities and limitations of climate models. Most methods belong to two big categories: system-level evaluation and component-level evaluation. Whereas, system-level evaluation is focused on the outputs of the full model, component-level evaluation isolates particular components of the model to test them independently of the complete model. However, many methods in both categories are not specifically aiming to evaluate physical processes and coupling between subsystems of the climate system (as. e.g., land and atmosphere). A new method -with an associated metric- is presented for the evaluation of climate models based on the comparison of pairs of empirical relationships among model outcome variables measuring the performance of selected physical process. The method has been applied for the specific case of evaluation of land surface-atmosphere coupling in regional climate models. The usage of a metric based on the Hellinger coefficient allows a quantitative estimation of how well models are performing in simulating the relations among surface magnitudes. The election of ERA-Interim re-analysis as ground-truth is, in its turn, discussed and justified by comparison against in-situ and satellite observations.

(Poster presentation)

Spatial differences of PM10 concentration across Spain with respect to established legal limits and weather types

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The new Directive 2008/50/EC on ambient air quality and cleaner air for Europe recognizes the fact that several Member States have particular difficulties in achieving compliance with the limit values for particulate matter (PM10). The recognized adverse health effect of the PM10 particles leads to an increasing demand of a more efficient control of pollutant emissions especially in industrial and/or urban sites.

This work aims to describe the state of PM10 in Spain, by analyzing the number of times that the established limit for health protection of PM10 concentrations has been exceeded (35 24-hour periods with an average of over 50 µg/m3, per year) in 12 different regions of Spain, working with daily series for 6 years (from January 2005 to December 2010).

We worked with data from 38 stations in 12 provinces of Spain representing the overall situation of the country. The selection criteria took into account area, population density, industrial activity, traffic, location and climate. We computed daily averages for PM10 concentrations from hourly means, for 8 a.m. to 7 a.m. periods.

The results show that 74% of the stations exceeded the legal limit at least one out of the six years of the analyzed period. It has also been observed that the inner provinces are more prone to surpass the 50 µg3 daily limit that coastal ones, especially during the summer. Also, this limit is exceeded more frequently in the South than in the North, which could be explained by the influence of Saharan dust on PM10 concentrations. An analyses of weather types is performed to identify the weather conditions under maximum concentration occurred.

(Poster presentation)

Global and regional factors contributing to the past and future sea level rise in the Adriatic Sea

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This study aims at producing a seamless evolution of Sea Level (SL) in the Adriatic Sea for the 20th and 21st century. A linear regression model (LRM) is built and validated, which computes SL variations using sea level pressure over Europe (MSLP), Adriatic sea surface temperature (SST) and salinity (SSS). SL data are provided by monthly values recorded at 7 tide gauges distributed along the north-Italian and Croatian coast (available at the PSMSL, Permanent Service of Mean Sea Level). MSLP data are provided by the EMULATE data set. Mediterranean SST and SSS data are extracted from the MEDATLAS/2002 database. The study shows that annual SL variations at Northern Adriatic stations are very coherent, so that the northern Adriatic SL can be reconstructed since 1905 on the basis of only two stations: Venice and Trieste. The LRM is found to be robust and consistent with the physical mechanisms responsible for SL evolution and very successful at explaining interannual SL variations. Results show that SL in the 20th century has a large trend, which cannot be explained by this LRM, and it is interpreted as the superposition of land movement and a remote cause (such as polar ice melting). When the LRM is used with the MSLP, SST and SSS from climate model projections for the 21st century (A1B scenario), it produces a SL rise in the range from 2.3 to 14.1 cm, with a best estimate of 8.9 cm.

It is shown that the behavior of the remotely forced SL rise during the 21st century is the main source of future SL uncertainty, which further expands the range from 16 to 60 cm, due to the regional forcings. Extreme interpretation of the data can produce even higher SL rise values.

(Oral presentation)

Impact of climate change on the Figeh Spring system in Damacsus /Syria

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The contribution describes and discusses the hydrological climate change impact analysis for the third largest spring the world located at Figeh, which serves as a major water source for the city of Damascus in Syria. It consists of two parts. In the first part a model ensemble of downscaled climate change data is presented. It results from transient experiments with two versions of the regional climate model MM5 run with boundary forcings from ECHAM5 and HadCM3 global models employing the A1B SRES scenario. The data ensemble has as spatial resolution of 0.25 degree has been investigated for the periods 1961-1990 for present day climate and for two future periods 2021-2050 and 2070-2099. The investigation focus is on changes of monthly surface air temperature, precipitation and snow cover, and their inter-annual variability.

The second part considers the Figeh Spring discharge assessment with a hydrological runoff model based on an Artificial Neural Network (ANN) approach developed for the hydro-geologically complex arid and semi-arid area. The ANN model was formulated and validated for the years 1987-2007 applying daily meteorological driving data and then applied to future periods with the simulated climate change data. The ANN simulations indicate that under future climate conditions water supply from the Figeh spring might face serious problems. Until 2050 the precipitation in the area is simulated to decrease in order of 11 % in winter and 8 % in spring. Together with increased annual mean temperatures and expected significant decreases in snow mass negative effects on the water recharge potential can be expected. In the future period 2070 - 2099 and compared to the 1961-1990 mean, the annual precipitation is simulated to reduce by 22% and annual mean temperature to increase by 4°C. The ensemble mean of the relative change in mean Figeh Spring discharge reveals a simulated decrease during the peak flow from March to May with values up to -20 % in 2021-2050 and almost -50 % in the period 2069-2098 both related to the 1961-1990 mean.

(Poster presentation)

Evidence for warm and humid Mid-Holocene in the Aegean and northern Levantine Seas (Greece, NE Mediterranean)

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Evidence from North and SE Aegean and Northern Levantine Seas document continuous albeit weak African monsoon forcing during the Mid-Holocene that apparently was even more weakened at the north part of the Aegean basin. In particular, pollen data record an expansion of forest cover after ~5.4 ka BP, attributed to an increase in available humidity. Marine proxies clearly support on-going warm and humid conditions between 5.5-4.0 ka BP and the establishment of relative stratified conditions of the upper water column not only in the semi-enclosed Aegean basins, but also at the deep Northern Levantine. During this interval, SST fluctuates in the Aegean Sea; however it exhibits a clear positive shift at 4.8 ka BP. This pattern allows us to conclude that similar climatic factors (warm/wet conditions associated to enhanced monsoon activity) that triggered fluvial discharge, wet deposition and amplified nutrient inputs during the Holocene Climate Optimum and the associated sapropel S1 depositional interval, also favored the establishment of high productive conditions during the Mid-Holocene, leading to the deposition of a sapropel-like layer only in the SE Aegean site.

The warm and humid climatic conditions triggered upper water column stratification and enhancement of the DCM, led to the establishment of dysoxic conditions in the shallow basins. In contrast to the shallow water column depth SE Aegean, the deeper North Aegean and the deepest Northern Levantine sites, although experiencing stratification in the upper parts of the water column, did not succeed to develop bottom-water dysoxia. Thus, a top-bottom mechanism of stratification-DCM development -fast transport and burial of organic matter, proves to be a reliable explanation for the preservation of productivity signal in shallow sites, leading to sapropelic conditions during the warm and humid Mid-Holocene.

The termination of the Mid-Holocene warm and humid phase coincides with the 4.2 ka significant Northern Hemisphere rapid climate cooling. Our humidity evidence exhibits a N-S time trangressive aridification gradient in the Aegean Sea, most probably associated with the progressive southward shift of the NH summer position of the ITCZ during the Mid-Holocene.

(Poster presentation)

Variability of Surface Winds in Ten Major Cities of Turkey

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In climate studies, variability of wind field has been analyzed relatively less than temperature and precipitation. In the last few decades, wind speed variability has become one of the focal points of climate research. Long term changes in surface winds could lead to significant changes in local air quality, pollution transport, insurance policies related to the strong wind damages, forest fires, intensity of heat waves and wind power electricity production. Investigation of temporal and spatial variability of wind field near surface and aloft might increase our understanding of the regional impact of climate change over a region in relation to changes in atmospheric circulation. However, surface roughness alterations due to degree of urbanization, growth of trees, changing of recording instruments, faulty equipment, re-location of meteorological stations modify temporal features of the surface winds. Eventually, they might hinder the climate change related signals while analyzing the surface wind data. In this study, the long term and seasonal trends of wind speed and wind direction were investigated by using hourly observations. Ten meteorological stations were selected to represent the different climate zones and geographical regions in Turkey. The wind data have periods of 28-51 years in between 1960 and 2010. Quality of observations is checked by visually and using metafiles of the stations provided by State Meteorological Service of Turkey. However, there are still doubtful records in the data set which cannot be explained. Major results show that ten stations have experienced significant weakening in annual and seasonal mean wind speeds during the study period except Samsun station along the central Black Sea coast. Large declines are found in Antakya, Izmir and Antalya. There are seasonal differences in the stilling of the winds over Turkey. The mean wind speeds in winter season are reduced most on the western part of Turkey while summer winds are reduced on the southern parts of the country. The frequency of the calm days shows pronounced increase especially over the eastern regions of Turkey. Furthermore significant weakening of wind speed has occurred primarily in strong wind categories. The light winds have even increased in the most of the regions except Erzurum, Artvin and Urfa because of the large declines in strong wind categories.

In addition to the analyses of surface winds, upper air wind fields, geopotential heights at 1000hPa, 850hPa, 500 hPa and 200hPa and sea level pressure are analyzed for 1960-2010 period by using NCEP re-analysis data. The surface wind variations are discussed in relation to the upper air circulation changes over Turkey.

(Oral presentation)

European Summer Temperature Variations over the Past Millennium

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We present new gridded summer temperature reconstructions for the past 1200 years over the European / Mediterranean land areas (Euro_Med consortium 2012). We used a process based Bayesian Hierarchical Model (BHM), an algorithm recently presented by Tingley and Huybers (2010a) and Werner *et al*. (2012). The reconstructions are based on a number of expert selected, high quality annual records: ten tree ring series from Fenno-Skandia, the Alps, the Pyrenees, the Tatra, the Carpathians, and Albania as well as a composite of documentary based summer temperature series from central Europe.

The results are validated against withheld high quality, low resolution proxies -speleothem and lake sediment data - to test for conservation of low frequency variability. Agreement of the results derived through very different methods boosts confidence in the new reconstructions. We find that European summer temperature in recent decades are higher than during any previous period.

References:

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(Poster presentation)

Impact of climate change and anthropogenic activities on zooplankton community in the waters of Alexandria, Egypt.

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Long-term changes in abiotic factors (water temperature and salinity), air temperature as well as Nile River discharge are examined to clarify the impact of climate variability and anthropogenic activities on zooplankton community in the waters of Alexandria region.

The change in the mean annual air temperature is not linear but polynomial, with correlation coefficient equals 0.82. During the last 35 years, the mean annual air temperature increased by about 2.24°C giving an increasing rate of about 0.6oC/decade. The average yearly discharge of the Nile River from 1966 to 2007, i.e. for the last 42 successive years, amounted to only 3.92 km^3, representing about 8% of the average value for the period prior to 1965. The annual cycle of the discharge has also changed.

The results indicated that, both of climate change and anthropogenic activities have great impacts on zooplankton community in the Egyptian Mediterranean waters. During 1961, in the pre-Dam period, the annual average zooplankton density was 25285 ind. /m3 and increased to reach 82334 ind./m^3 in 1965. In 1966, shortly after construction of the Dam, the average annual zooplankton density sharply decreased to 24062 ind./m^3 in 1967, 6362 ind./m^3 in 1971, 1366 ind./m^3 in 1984 to much lower 735 ind./m^3 in 2008.

Copepoda constituted the main bulk of the total zooplankton community in the study area. The copepod diversity increased from 83 species during 1961-1963 to 116 species during 1970-1971 and reached 126 species during 1984-1985. Oithona nana, Euterpina acutifrons, Paracalanus parvus, Clausocalanus arcuicornis, Oithona plumifera and Acartia spp were recorded as biomass builders during all surveys (1961-2008). The majority of the recorded species during 1984-2008 are of warm-water affinity, indicating the effect of global warming. Isias clavipes completely missed in the surveys carried out after construction of the High Dam.

Keywords: Climate change, anthropogenic activities, zooplankton, Erythrean migrants, Eastern Mediterranean, Egypt.

(Oral presentation)

Combined effect of irrigation and managed water reservoirs on the Mediterranean climate.

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Anthropic modification of the water cycle for agricultural purpose is the most intense forcing to the surface climate at the local scale.

In fact, irrigation results in increased evapotraspiration that cools down the land surface. This effect is enhanced by dams and managed lakes that aim to provide more water in the growing period, which is in phase with the dry season of the Mediterranean climate for most crops.

These anthropic modifications of the water cycle are neglected in most climate models. We implemented a parameterization for these effects in the Community Land Model, developed at the National Center for Atmospheric Research, and we study the effect of the modified water cycle on the land surface energy budget.

Irrigation and dams results in increased evapotraspiration that has profound effects in reducing the extreme temperature in the late spring and summer months, that were overestimated in the control simulation respect to the observations.

The annual river discharge in the Mediterranean and the Black Sea is reduced, but the seasonality of the discharge is amplified.

The implications of the modified freshwater input for the circulation of the Mediterranean and Black Seas are addressed in the context of a regional coupled model for the Mediterranean area of which we show preliminary results.

(Oral presentation)

Interdecadal Changes in the Links between Mediterranean Evaporation and Regional Atmospheric Dynamics and Precipitation

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Evaporation data from the Woods Hole Oceanographic Institution (WHOI) data set for 1958-2010 are used to investigate interannual variability of Mediterranean evaporation and its links to regional climate during two climate periods 1958-1978 and 1979-2010, which were characterized respectively by downward and upward trends of evaporation. The first and second EOFs of evaporation are characterized by the monopole (EOF-1) and east-west dipole (EOF-2) patterns in all seasons. However, during fall there is a tendency for the dipole pattern to be the first EOF mode.

During winter EOF-1 of Mediterranean evaporation is linked to the East Atlantic (EA) teleconnection pattern. However, this link has weakened in 1979-2010. During other (non-winter) seasons relation to regional atmospheric dynamics is more complex and subject to larger intraseasonal and interdecadal changes.

Significant interdecadal changes have been found in the links between Mediterranean evaporation and regional precipitation. In particular, for January links between Mediterranean evaporation and precipitation over eastern Europe/European Russia became stronger in 1979-2010. On the contrary, for March these links were essentially stronger in 1958-1978. Strong links to February precipitation over northern Africa were found in 1958-1978, but not in 1979-2010. Overall, results of the study imply essential non-stationarity (at the different time scales) in the links between Mediterranean evaporation and regional climate.