1st ESF-MedCLIVAR SUMMER SCHOOL

Climate variability over the Mediterranean area: atmospheric and oceanic components

(Initial title: Mediterranean Climate Variability, Trends and the occurrence of extreme events)

Island of Rhodes-Greece

17-27/09/2008

REPORT

Contributions from:

- Hellenic Centre for marine Research (HCMR)
(Athens headquarters and Hydrobiological Station and Aquarium of Rhodes)
- The Chamber of Commerce and Industry of Dodecanese

1st ESF-MedCLIVAR SUMMER SCHOOL: Climate variability over the Mediterranean area: atmospheric and oceanic components

by

Alexander Theocharis, Elena Xoplaki, Mikis Tsimplis, Vassilis Zervakis, Andreas Sioulas.

1. Summary

The 1st ESF/MedCLIVAR Summer School was held in the island of Rhodes in Greece, during 17-27/9/2008 at the Hydrobiological Station and Aquarium of the Hellenic Centre for Marine Research (HCMR). It was the first of the two Summer Schools planned by MedCLIVAR program, which is a research networking program aiming at coordinating and promoting research on different aspects of Mediterranean climate. It was cosponsored by the European Science Foundation (ESF), the Hellenic Centre for Marine Research (HCMR) and the Chamber of Commerce and Industry of Dodecanese.

Applicants in total were 91 from 29 countries. They have applied until the extended deadline of June, 15, 2008. The nationalities with alphabetical order were: Austria (1), Brazil (1), Bulgaria (1), China (1), Croatia (4), Cyprus (2), France (5), Germany (5), Greece (16), Hungary (1), India (2), Iran (2), Israel (1), Italy (15), Lithuania (1), Malta (1), Morocco (1), Nigeria (1), Pakistan (1), Palestine (1), Romania (1), Russia (1), Spain (15), Switzerland (1), Tunisia (1), Turkey (4), U.K. (1), Ukraine (1) and U.S.A. (2). From this initial population, 53 applicants were male (58.24%) and 38 were female (41.76%). Based on guidelines set by ESF and taking into account the available budget, the Organizing Committee selected as successful 53 applicants with origin from 17 countries, working at institutions in 12 countries. Their corresponding nationalities/institution countries are the following: Austria (1/0), China (1/0), Croatia (2/2), Cyprus (0/1), France (4/2), Germany (3/4), Greece (12/12), India (1/0), Israel (1/2), Italy (11/15), Malta (1/1), Morocco (1/0), Spain (8/7), Switzerland (1/4), Tunisia (1/0), Turkey (4/2), U.K. (1/2) and U.S.A. (1/0). Exceptionally, Prof. Jose Carlos Gonzalez-Hidalgo was invited to participate (by his own expenses), giving a lecture at a side event. The male/female balance was 31 (57.41%) / 23 (42.59%), while the participants were very well balanced in the two major thematic issues (atmospheric: 28/oceanic: 26). Furthermore, the Organizing Committee decided to create a waiting list by selecting six additional participants. At a first stage, all accepted applicants confirmed their participation. Later on, Itzhak Carmona (Israel) and Fengjun Jin (Chinese studying in Israel) cancelled their participation (due to personal reasons and problems with the VISA, respectively) and were replaced by two participants from the waiting list: Jadranka Sepic (Croatia) and Simona Fratianni (Italy), respectively. A few days before the opening, Rosina Grimm (Germany), Simona Fratianni and Frano Matic (Croatia) cancelled their participation for personal reasons. One day before the opening, Beyza Ustaoglu (Turkey) cancelled her participation claiming insufficient financial support (she had to come from Italy and not from her home institution in Turkey), while Faize Saris (Cyprus) due to problems with her VISA. Finally, 49 participants [male: 28 (57.14%), female: 21 (42.86%)] attended the Summer School.

This school has been organized, through keynote talks, interactive sessions and tutorials on the physical, statistical and modelling aspects of seasonal, long term and extreme estimation and projections. The formal opening was taken place in the Chamber of Commerce & Industry of Dodecanese, while all other activities at the HCMR Hydrobiological Station and Aquarium of Rhodes. This gave the opportunity to the

participants to do educational rounds in the Museum and the Aquarium. An excursion was organized around the island for the Saturday of the meeting.

2. Description of the scientific content of the Summer School and discussion at the event.

The 1st MedCLIVAR/ESF Summer School covered 10 school days each consisting of oceanic and atmospheric lectures, which focused on the variability of the Mediterranean oceanic and atmospheric climate as expressed in long term variability (trends), changes in seasonality and changes in the distribution of the extremes. The School opening was realized at the Chamber of Commerce & Industry of Dodecanese with an welcome by Dr. A. Theocharis and two introductory talks given by (i) Dr. D. Georgopoulos on behalf of the President of HCMR and (ii) the President of the Chamber of Commerce & Industry of Dodecanese entitled: (a) "Environmental challenges: What can marine and maritime RTD do?" and (b) "Climate change and commerce", respectively. Then, a one-hour key-note lecture was given by Prof. H. Weiss on "Holocene climate changes and societal adaptations: is the past the future?".

In total, there were 13 lectures on oceanography and 11 on atmospheric aspects that were given by invited scientists. In addition there were two lectures on Impacts and at the end we had presentations by the groups of participants on their work accomplished during their practicals. The sessions concerned atmospheric processes, in the mornings, and oceanic processes, in the afternoons. In addition, six student poster sessions were held during the breaks and practical work during the evenings. The 49 post-graduate students and young researchers participated in what proved to be a lively and interactive school. Issues ranging from observational techniques, homogenization of data, regional and spatial changes in the Mediterranean atmospheric and oceanic climate and their relationships with regional and global changes were discussed, together with the more basic issues of the forcing of the Mediterranean oceanic circulation, its monitoring and modeling efforts.

Additionally, there were organized several side events, such as lectures relevant to climate variability and its impacts on the human life.

All lectures and posters are available in the MedCLIVAR website (www.MedCLIVAR.eu), except of those that lecturers asked not to be included.

The school topics contained:

- Global and regional atmospheric mechanisms dominating the Mediterranean Climate
- the Mediterranean Sea circulation and its dependence on the various atmospheric forcing contributions, either directly, as wind, heat fluxes or evaporation and precipitation, or indirectly as freshwater influx from rivers and the Black Sea, or Atlantic water inflow from the Strait of Gibraltar
- The documented changes in the atmospheric circulation over the last centuries and the documented changes in the oceanic parameters and their link with the changes in the atmosphere
- The feedback mechanisms from the Mediterranean Sea to the Atlantic and the global atmosphere
- The changes in the extremes and seasonality both in atmospheric and oceanic parameters and their links
- preparing for the future: required observations and forecast strategies

The second day the School started at the amphitheater of the Hydrobiological Station and Aquarium of Rhodes with a welcome from the Organizing Committee followed by the formation of the groups of the participants for the needs of the practical work that took place during the whole period of the school. The second day was dedicated to (i) the Mediterranean Climate and its variability and (ii) the Mediterranean large scale ocean circulation and the role of its outflow to the Atlantic Ocean.

Dr. E. Xoplaki covered a wide range of aspects of the first subject in two lectures. In the beginning she presented the weather and climate of the Basin, the temperature and precipitation data, as well as their intra-annual and spatial variability, while in the second part the Atmospheric Circulation and SST influence and Trends in temperature and precipitation. She concluded that:

- The winter precipitation is important for the hydrological balance, but has overall downward trends. Wet winters relate to low pressure, moist air advection and instability. Small scale processes have an important influence on regional precipitation variability.
- Summer temperature increased significantly in western and central Mediterranean has significant social and economic implications. Warm summers are connected with blocking, subsidence and stability.
- Significant amounts of climatic variance can be explained by combined circulation predictors and teleconnections.

The oceanographic session of this day was covered by Prof. H. Bryden in two lectures. He described the Mediterranean giving both the general configuration of the Basin as well as its main oceanographic characteristics, the processes and the related interactions with land and atmosphere. He underlined that the Mediterranean has all the elements of an ocean with shorter time scales in the evolution of all processes and changes. This permits us to study the climate variability and changes in a more efficient way. The lecture was mainly focused on the general circulation and the exchange through the Strait of Gibraltar, giving example of Dynamical Models for Two-Layer Exchange Flows, and the deep-water formation. He also referred to the anthropogenic influence and tried to address questions related to the behavior of the Mediterranean in a changing climate, such as “how the Mediterranean circulation will change?”, “Are we already seeing changes in salinity caused by the increase in evaporation?”, “How will the overturning be modified?”, “Will we be able to observe the change in the overturning by measuring the Gibraltar exchange?”.

The second part was dedicated to the importance of the Mediterranean outflow into the Atlantic Ocean. The formation of the Meddies and the Northward flow of the Mediterranean saline water determine its significant role in the Atlantic circulation and processes.

The day 3, the “Atmospheric” lecture was dedicated to the importance of Homogenization of climate data-sets in studying climate evolution. While the oceanographic afternoon session covered the buoyancy forcing by Dr. E. Tragou, the role of the Straits and the monitoring of the Mediterranean by Dr. J.G. Lafuente. The rather complex bathymetry and geometry of the Mediterranean Sea imposes topographic constrictions to the motion of the water masses that cannot flow freely throughout the basin and determines the pattern of the three-dimensional circulation within the Sea. Obviously, the presence of sills affects the deep circulation but not necessarily the surface flows, if the passage is considerably wider than the internal radius. Only Gibraltar and the

Turkish Straits are real and important topographic constraints for the exchange between basins. The more constraining the strait topography, the greater the thermohaline differences.

The day 5, Dr. V. Pavan focused on winter and summer seasons, giving the features of the Euro-Mediterranean climate and their relation with the large scale circulation (e.g. NAO), dynamics, variability and its impacts on the Euro-Med climate. In the afternoon lecture, Dr. V. Zervakis focused on the water mass characteristics and formation processes and their important changes in time, while Dr. S. Somot and K. Schroeder conducted the relevant practical work. After the afternoon session, Dr. J. C. Hidalgo gave a lecture on the effects of largest daily events on soil erosion and sediment transport, in the frame of the organized side events.

The day 6, Dr. I. Trigo referred extensively to Weather Systems and Cyclones. Composites for winter events suggest these are often associated to an upper trough over Central Europe leading to cyclogenesis to the lee of the Alps (Genoa) and re-development over the Aegean and Black Seas. Development and steering occurs along the Northern Mediterranean Coast – high near-surface baroclinicity. Cyclogenesis to the lee of the Atlas in common Spring – previous upper trough over Iberia. Thermal lows are frequent in summer (e.g., Iberia), exhibiting strong diurnal cycles (development and intensification). In her second lecture she concluded that:

The last 4 decades are marked by a northward shift of winter storm-tracks in the Euro-Atlantic sector. Storm (Low-to-Moderate intensity) frequency exhibits clear negative trends. Those trends are likely to explain the Winter precipitation decrease in the Northern Mediterranean. Trends with opposite sign are observed over N. Atlantic storms and N. Europe precipitation.

In the afternoon session, Dr V. Zervakis explained how the observed changes in the Mediterranean circulation and water properties are forced, while Dr. A. Theocharis focused on the unique abrupt event occurred in the eastern Mediterranean during the 20th century, named the Eastern Mediterranean Transient, which consisted of the shift of the source of the eastern Mediterranean deep waters from the Adriatic to the Aegean Sea.

In the Amphitheater of the College of Rhodes two lectures, sponsored by HCMR, were organized for students, focusing on climate variability and impacts.

In day 7, the first lecture was on Past climate variability in the Mediterranean, given by Dr. F. Gonzàlez-Rouco. The Mediterranean area offers a high quantity of long instrumental series and also a wealth of proxy records of high quality in a wide spectrum of sources from natural biological (e. g. trees; corals) and geological (e. g. speleothems, sediments) to documentary, many of which have so far only been initially surveyed. Available model multi-century simulations, though hampered by their limited resolution, are able to capture the main features of Mediterranean climate and can be used to compare and infer about past reality. This talk addressed the main concepts behind the modelling and reconstruction approaches and present challenges in blending the potential of both lines of work with an emphasis on the larger Mediterranean area. The following talks in oceanography were on observed sea level variability and its forcing, given by Dr. M. Tsimplis. Sea level changes have significant and some times catastrophic impacts on the coastal zone. The coastal environment is very vulnerable to changes in mean sea level, as well as changes in sea level extremes. Changes in wave heights and wave directions also play a very important role, as well as changes in temperature and salinity.

The impacts of sea level rise on the coastal zone include erosion, coastal inundation, habitat loss and ecosystem damage. Sea level changes are also important because they represent an indirect measurement of the melting ice-sheets and water expansion. There are presently two major ways of measuring sea level. The first is by instruments fixed to the coast, the second by use of radars flown on satellites. Satellite altimetry, as it is called, has become operation in 1993 and since then provides almost global estimates of sea level. Dr. M. Tsimplis referred extensively to the sea-level changes, the reconstruction of sea-level from tide-gauges and altimetry and temporal variability of trends. Concerning forcing of the sea-level variability, he mentioned the land movements (*Glacio- isostatic rebound, tectonic movements),* direct meteorological forcing *(atmospheric pressure and wind),* steric sea-level changes *(T and S)* and ocean Circulation). The sea-level rise rates vary in the 20th century in the Mediterranean. But it goes faster during the last few decades. The answer to the question "How much will sea level rise in the Mediterranean in the future?" is complicated, due to the fact that there are several forcing parameters, internal and external, that need to be taken into account. Predicting how important each of the forcing parameters is going to be in the future is not an easy task and involves the use of expert judgement rather than concrete scientific results.

The day 8, Dr. C. Goodess presented precipitation and temperature extremes (floods and droughts, heat waves and cold snaps) in the Mediterranean. She also referred how to define, why to study and what data are needed, focusing also on modeling the impacts of the extremes. In the second part, past and future changes were analyzed. In conclusion:

Temperature indices give greater, more consistent skill than precipitation. On average, measures of excess warmth perform better than those for excess cold. But for neural networks applied to the Eastern basin, precipitation indices give greater skill than temperature indices. All extreme rainfall indices (except for consecutive dry days) give less skill than for average precipitation. Summer, then spring, shows the best results for temperature indices. Precipitation generally is best in winter.

Areas heavily influenced by the Atlantic offer the greatest skill. Atlantic, European, African and Asian predictors are required different in E and W. The last two predictors require more work to acquire or define. Extremes of climate may still escape capture in small regions, due to geographic, and other local, influences.

In the afternoon session, Dr. P. Lionello's lecture was about wave changes and extreme sea levels and waves. He presented Processes affecting waves, Waves and storminess, Wave records: wave gauges and satellite observations, Wave models, Wave model forcing, Wave variability and teleconnections, Present trends of monthly SWH in the med, Changes of monthly SWH. In conclusion, during winter, in the second half of the 20th century, an overall decrease of cyclone activity has been observed. This has produced lower mean SWH in winter and lower extremes. The decreasing mean SWH trend is projected to continue in future climate. More simulations of future wave climate are needed to get an ensemble of simulations and to increase confidence on projections. High resolution simulations are needed to get a better dynamical basis for the estimate of the extremes.

The last day 9, the last lecture was given by Dr. F. Gonzalez-Rouco on "Ocean Circulation and Heat Content in millennial climate simulations". The basic information is that progress in understanding climate variability and change depends on our knowledge

of the transport mechanisms and energy and matter exchanges among the different components of the climate system. Through their energy and mass interactions with the other components of the climate system (atmosphere, cryosphere, biosphere and lithosphere) the oceans act as important pacemakers of climate variability in a wide spectrum of frequencies, from interannual to glacial time scales.
As far as the Impacts are concerned the lecture on "Vulnerability of Mediterranean Ecosystem Services" gave the following key messages:
- Ecosystems are more than species going extinct: ecosystem services!
- Climate projections largely agree for the Mediterranean across scenarios and models: warmer, drier (and more variable).
- Regional and local impacts on water resources, agriculture and ecosystems depend on specific conditions, e.g. topography, hydrology, vegetation mosaic, production systems etc.
- Climate change is one driver of increasing vulnerability / water scarcity.
The Mediterranean is a transition zone with a strong north-south gradient in biophysical and socio-economic vulnerability.
- Integrated land and water management for climate adaptation/mitigation.

3. Results and Impacts

The Mediterranean is located in an area of great climatic interest. The Mediterranean area is particular in many aspects: from the atmospheric point of view it is under the influence of major regional patterns produced by the interaction of the Asian, African and European continents and the Atlantic Ocean. The strong topographic variability permits the development of localized phenomena which dominate at regional scale although they remain linked with larger scales or global forcing. From the oceanographic point of view the existence of deep water formation in both the eastern and western Mediterranean basin and the balancing of the excess of evaporation over precipitation and river influx through hydraulically controlled straits produces a fascinating semi-enclosed sea for studying processes significant for the global ocean and the impacts of large and regional scale climate forcing. Changes both in the oceanic and atmospheric parameters of the Mediterranean Sea have been excessively documented although their forcing has not always been resolved. Moreover, only recently has the attention shifted to the crucial issues of changes in seasonality and extremes which have the potential of changing both the ecologic and the economic balances in the region. More importantly research in understanding the forcing causing extreme or sudden changes is at an early stage. As a result, climate projections have high uncertainties in particular in respect of estimates of changes in the extremes of the important, for society and the ecosystem, physical parameters.

The Summer School fulfilled the aim of the organization to provide an up-to-date and thorough discussion of ongoing research on the oceanic and atmospheric components of the Mediterranean climate, to provide cross discipline interaction by coupling atmospheric with oceanic observations and discuss our understanding of documented long term variability, seasonal changes and changes in the extremes of the various oceanic and atmospheric parameters. The school succeeded to bring together the atmospheric and oceanic components of Mediterranean Climate Variability providing

education across disciplines. This school educated PhD students, post-docs and new researchers, through keynote talks, interactive sessions and tutorials on the physical, statistical and modelling aspects of seasonal, long term and extreme estimation and projections. The lectures along with the posters presented the State of the Art concerning the Mediterranean climate variability and impacts. Some outstanding issues and needs that were underlined during the discussions were the following:

• Observed data (S. Mediterranean)
• Challenges of temporal/spatial scale: observations and models
• Need more systematic and consistent studies, e.g., CIRCE
• Improved process understanding and parameterization e.g., feedbacks: land/ocean/ atmosphere, convection.
• Meeting user needs (impacts, adaptation and vulnerability)

The local and national media gave wide publicity to the MedCLIVAR Summer School including an extensive live television interview. In parallel with the Summer School outreach activities took place, which were open to, and helped to inform, the local community and students. Therefore, three talks were delivered by members of the Organizing Team to local secondary schools.

The programme of the summer school, lectures and posters for can be found at the MedCLIVAR website (http://www.medclivar.eu/ Ongoing and Planned Activities/summer schools)

Finally, a summary of the Summer School aims, contents and achievements is published in the joint edition of **VAMOS No. 5** and **the CLIVAR/ Exchanges Vol.14, No.1, No: 48, p.10-11.**

4. Program of the 1st ESF/MedCLIVAR Summer School.

A more detailed Program of the Summer School is attached to this mail, as a .pdf table.

Lectures:

Lecture Title	***Lecturer***	**Documents**
Welcome	*A. Theocharis*	ppt presentation
Introduction	*G. Chronis*	ppt presentation
Holocene climate changes and societal adaptations: is the past the future? **keynote**	H. Weiss	
Climate of the Mediterranean: processes and	*E. Xoplaki*	ppt

trends. **A1 and A2**		presentation
Mediterranean Circulation. **O1**	H. Bryden	outline
The role of the Mediterranean Outflow. **O2**	*H. Bryden*	ppt presentation and outline
On the eventual link between climate observations and climate evolution. **A3**	*O. Mestre*	ppt presentation
The role of the Straits. **O3**	*J. Garcia-Lafuente*	outline
The buoyancy forcing (heat and freshwater fluxes). **O4**	*E. Tragou*	
Oceanography monitoring of the Mediterranean Sea. **O5**	*J. Garcia-Lafuente*	outline
Homogenization of climate datasets. **A4**	*O. Mestre*	
Large scale atmospheric circulation and the Mediterranean climate. **A5**	*V. Pavan*	ppt presentation and outline
Observed changes in water-mass characteristics. Changes in intermediate and deep water formation. **O6**	*V. Zervakis*	ppt presentation
Weather systems and Cyclones in the Mediterranean. **A6 and A7**	I. Trigo	ppt presentation
How are the observed changes forced? **O7**	*V. Zervakis*	
The EMT, where, how and why? **O8**	A. Theocharis	ppt presentation
Reconstructing and simulating past climate variability. **A8**	*F. Gonzalez-Rouco*	ppt presentation and outline
Observed sea level variability in the Mediterranean. **O9**	*M. Tsimplis*	outline
Forcing of sea level variability. **O10**	*M. Tsimplis*	outline

Precipitation and Temperature extremes in the Mediterranean. **A9 and A10**	*C. Goodess*	ppt presentation
Wave changes. **O11**	*P. Lionello*	ppt presentation
Extreme sea levels and waves. **O12**	*P. Lionello*	ppt presentation
Ocean Circulation and Heat Content in millennial climate simulations. **A11**	*F. Gonzalez-Rouco*	ppt presentation and outline
Atmosphere-Ocean coupling: the Mediterranen. **O13**	*S. Somot*	
Vulnerability - a concept to quantify damages from environmental changes. **impacts**	*W. Cramer*	
Vulnerability of Mediterranean ecosystems due to climate change and water scarcity. **impacts**	*H. Hoff*	ppt presentation
The effect of largest daily events on soil erosion and sediment transport. **side event**	*J. Gonzalez-Hidalgo*	ppt presentation

Posters:

Title	***Author-Presenter***
Evros river water discharge response to changes in rainfall regime	*Aikaterini Karditsa*
Modelling Mediterranean Climate using a Coupled Regional Climate Model	*Alberto Elizalde*
The impact of the recent climate change on forest stand productivity along an altitudinal gradient in Central Italy	Alfredo Di Filippo
Homogenization and analysis of climatic series	*Andrea Toreti*
Combined high resolution climate – hydrology simulations in the Eastern Mediterranean and the Upper Jordan catchment	Andreas Heckl
Seasonal and interannual variability of the Mediterranean outflow in the Strait of Gibraltar	*Antonio Jesus Sanchez Roman*

Climate change scenario and water/nutrient balance response in a semi-arid catchment (Merguelli l-Tunisia)	*Aziz Abouabdillah*
The Marseille tide gaude: Recovery and analysis of high frequency sea level data from 1885	*Camille Letetrel*
Climate-driven changes in density stratification, nitrogen source and plankton food webs in the North Pacific Subtropical Gyre	*Cecelia Hannides*
Regional climate change projections for Eastern Mediterranean: Preliminary results	*Deniz Bozkurt*
NAO-drought connections and their impact on Eastern Mediterranean tree growth	*Dimitrios Sarris*
Contribution to the study of temperature regime in the Mediterranean using a Regional Climate Model	*Eftychia Rousi*
Hydrological impacts of climate change on catchment response in the Mediterranean region	*Emanuela Bruno*
Analysis of a 44-Year Hindcast for the Mediterranean Sea: Comparison with Altimetry and In Situ Data	Enrique Vidal-Vijande
Hydroclimatology of East Black Sea Mountain Region	*Faize Saris*
Modelling early Holocene sapropel formation in the eastern Mediterranean	Fanny Adloff
On the continuity and climatic variability of the meteorological stations in Torino, Asti, Vercelli and Oropa (Piedmont, Italy)	*Fiorella Acquaotta*
Homogenization of daily temperature data for detecting heat waves in the Mediterranean Environment	*Franz Kuglitsch*
An assessment of sea level trends in Greek waters during the last three decades	*George Alexandrakis*
Estimation of heat stress of the human body during an extensive heat wave event in a Mediterranean coastal area	*George Katavoutas*
Biogeochemical evidence for late climatic variability in the Aegean Sea during the formation of Holocene sapropel S1	*Giorgos Katsouras*
Capturing temperature extremes in millennial length tree-ring chronologies	*Giovanna Battipaglia*
Idealised modelling of the Mediterranean outflow using a next-	*Hanna Hiester*

generation ocean model	
The influence of climate change on the Adriatic Sea meteotsunamis	*Jadranka Sepic*
Three-Dimensional Evolution of Large Amplitude Internal Waves in the Strait of Gibraltar	*Jose Carlos Sanchez Garrido*
Sea level variations in the Mediterranean Sea	*Jose Maria Sanchez Reales*
Abrupt changes observed in the deep Western Mediterranean Sea between 2004 and 2006	*Katrin Shröder*
Assessment of changes in climate, extremes and associated sectoral impacts using high resolution regional climate model scenarios for the Eastern Mediterranean	*Konstantinos Varotsos*
Analysis of the energy and mass balance of the Mediterranean Sea in a climate model simulation	*Letizia Congedi*
The importance of ship log data: reconstructing North Atlantic, European and Mediterranean Sea Level Pressure back to 1750	*Marcel Küttel*
Influence of the West African monsoon on the summer Mediterranean climate	*Marco Gaetani*
Tools for evaluation of extreme wave in the Mediterranean Basin	*Maria Barbara Galati*
Low Frequency Variability and the Eastern Mediterranean Teleconnection Pattern	*Maria Hatzaki*
Daylight Climatology in Athens, Greece: Types of diurnal variation of illuminance levels	*Marina Markou*
Impact of interannual variability and climate change on dense water cascading in the Gulf of Lions	*Marine Herrmann*
Feedbacks of Mediterranean anthropized land-use on the regional and global climate	*Matteo Zampieri*
Dynamical downscaling of the ECMWF experimental seasonal forecasts	*Mirta Patarcic*
The use of the regional climate model PRECIS over the Central Mediterranean Area	*Noel Aquilina*
Assessment of zones vulnerable to pollution caused by nitrate	*Ons Oueslati*

and seawater intrusion: The case of Apulia region (Italy)	
Stalagmites from Turkey: Potential climate proxies for the Holocene	*Ozan Mert Göktürk*
Estimation of Return Levels of Extreme Waves Incorporating Non-Stationarities	*Panagiota Galiatsatou*
Coral Li/Ca in micro-structural domains as a temperature proxy	*Paolo Montagna*
The effect of data processing methods on the detection of warming and salting trends in the Western Mediterranean	*Patricia Zunino*
Analysis of the tropopause extreme values with radiosounding data	*Paul Aizpurua Velasco*
Teleconnections between the Indian Monsoon and the Mediterranean Sea as simulated by a coupled General Circulation Model	*Roxy Mathew*
21st Century Climate Scenario for the Mediterranean Climate and the Mediterranean Sea using a Coupled Atmosphere-Ocean Regional Climate Model	*Samuel Somot*
Diet of the invasive piscivorous fish Fistularia commersonii in a recently colonized area of Eastern Mediterranean	*Stefanos Kalogirou*
Northeastern Mediterranean climate and zooplankton variability	*Tiziana Peluso*
Profiling Float Observations in the Aegean Sea	*Vassilios Vervatis*