Latsis Foundation
1st International Summer School
Environment: Climate – Climate Change – Impacts

Organizing Committee

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1. List of Active partners who have taken part in the Summer School

Country	Full Name of the Institution	Number of Invited Speakers (Table 1 Appendix)	Number of Students (Table 2Appendix)
Greece	Aristotle University of Thessaloniki	6	4
	National Observatory of Athens	4	1
	University of Athens	3	3
	University of Ioannina	1	2
	University of the Aegean	1	1
	University of Patra	0	1
	Civil Protection National Operations Center	1	
	Hellenic Centre for Marine Research, Greece		1
UK	University of East Anglia	1	
	University of Liverpool	1	1
	Imperial College		1
	University of Reading		1
Switzerland	University of Geneva	1	1
	Federal Institute of Technology		1
Spain	University of Cantabria,	1	
	Universitat de Barcelona		1
Cyprus	Cyprus Institute	1	
Israel	University of Haifa	1	1
Italy	University of Florence	1	
	University of Salento, Lecce	1	
	ARPA, Italy	2	
	University of Turin		1
Czehc	Hydrometeorological Institute, Brno	1	
Finland	Finnish Meteorological Institute	1	
Germany	MPI-Max Planck Institute for Meteorology		1
	Interdisciplinary Env.Res.Centre, Freiberg		1
Poland	University of Lodz		1
Serbia	University of Belgrade		1
Sweden	University of Stockholm		1
Iran	Isfahan University of Technology		1
Lithuania	Vilnius University		1
Hungary	Eotvos Lorand University		1
Austria	University of Innsbruck,		1
Total		**28**	**30**

2. Description of the timetable of the Summer School (detailed program in Appendix)

Stage of the Summer School (start end dates)	**Activities undertaken**
Day 1 (7/7/2009)	Arrival of the participants
Day 2 (8/7/2009)	Registration, Introduction, lectures
Day 3 (9/7/2009)	Lectures and workgroup
Day 4 (10/7/2009)	Lecture and workgroup
Day 5 (11/7/2009)	Lectures
Day 6 (12/7/2009)	Free day-visit at Acropolis Museum
Day 7 (13/7/2009)	Lectures and poster section
Day 8 (14/7/2009)	Lectures and workgroup
Day 9 (15/7/2009)	Lectures, outcomes and evaluation

Overall Description of the Summer School

The aims and the objectives of the Summer School were the students–participants to have the opportunity to

- Extend and expand their knowledge in climatology, climate change and impacts issues.
- Obtain the know-how over updated software used in many Research Institutes for the thorough study and analysis of the physical factors that may influence the future climate change (labs – workgroups during the Summer School under the supervision of expert scientists)
- Participate in an international meeting and to work with worldwide known scientists
- Present results of their personal work in front of a scientific audience
- Learn how to work as members of a team and to enforce inter-scientific interdisciplinary collaboration, since the invited speakers have various specialties expertise

The objectives were achieved through the attentive selection of the invited speakers, who are scientists with worldwide recognition among the international climate community and the subjective selection of the participants whose Master/Phd thesis were relevant to the subject of the Summer School.

Organization aspects

A variety of climatological subjects were presented in the Latsis Foundation 1st International Summer School. It last for 7 working days and it was structured in such a way that the main theme of the Summer School was fully covered by dividing it into sub-themes explored by lectures and workshops. The main aim of the lectures was to present and explore the topic under consideration, while the workshops task was to expand their knowledge over updated software. There was a clear thematic link between lectures and workgroups. Participants had the opportunity to present their personal work during the poster session (Appendix, posters), while discussions among students and between students and the invited speakers were taken place during all sessions. Also, participants worked as members in what we call the "team of the day". It was a group of students that was organized in order to report the different scientific themes of the summer school. We strongly encourage future organizing committee to involve actively all students in the courses by discussions and reports as well as to schedule periods for individual study as further reading, writing and informal meetings.

The lecturers (invited speakers) of the summer school are professors and renowned experts from leading Universities and research Institutes, with worldwide recognition among the international climate community. Most of them have long time experience of participation in European research projects concerning the changes of the climate on global and planetary change as well as the impacts of these future changes to the environment and to the human lives.

30 Master and PhD students were selected out of the 117 applications (Figure 1). The student's selection (Figure 2) was made on the basis of the following criteria:

a) Foreign and Greek post graduate and PhD student

b) The subject of their Master/PhD thesis should be relevant to the subjects of the Summer School

c) Qualification of the Applicants

d) Full attendance from the participants to the Summer School

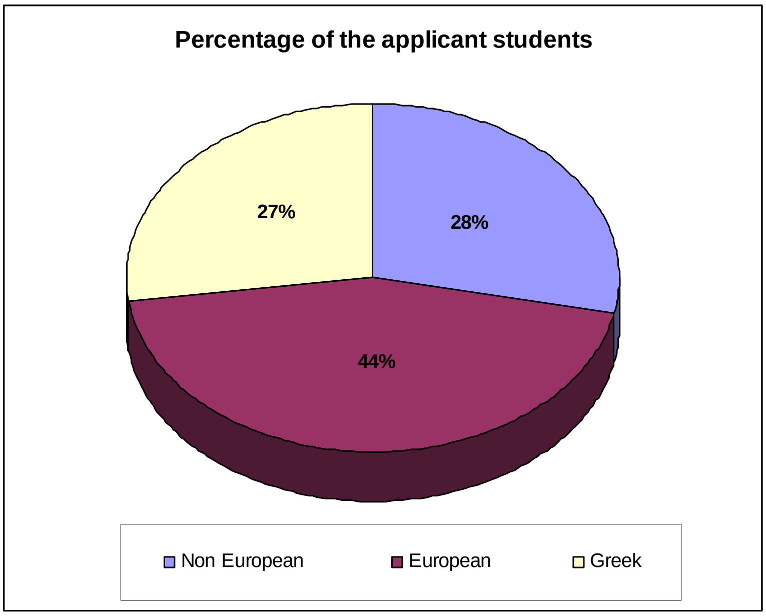

Figure1. Percentage of the applicant students according their nationality

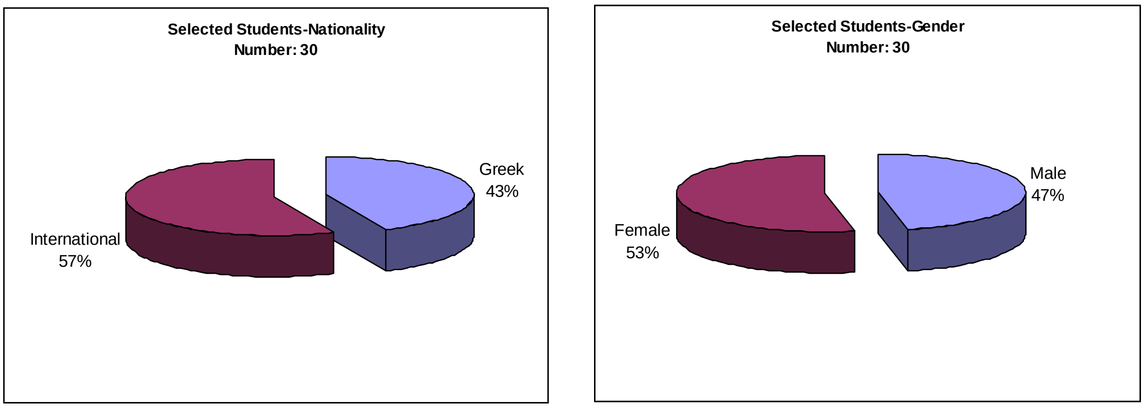

Figure2. Percentage of the selected students according their nationality (a) and their gender (b)

Outputs -Scientific report

The summer school aimed to explore and understand the climate parameters and their influence on the environment and other fields of the human activities as well as to provide insights into the most crucial point such as the climate change and the extremes. The summer school main theme was divided in four sub-themes a) General Climatology, b) Climate Change, c) Extremes and d) Impacts.

The ***first sub-theme*** "General Climatology" provided theoretical insights on those key-concepts and offer analyse about their specific meaning within a changing climate. A detailed presentation about the global temperature records was presented by **Prof. P. Jones**. He talked about the problems of homogeneity in temperature datasets, the baises between past and present temperatures and the problems of the sampling on the datasets. He concluded that warmest year was 1998, while the year to year changes in temperature are strongly related to ENSO variability. It is very likely that the 20^{th} century is the warmest of the past 1300 years, the anthropogenic climate change should be considered at the decadal scale. According IPCC the global warming is unequivocal. **Prof. P. Maheras** talked about circulation types. He gave the definitions of weather and circulation types, descript the Lamp weather types (Great Britain), the Hess –Brezowsky circulation types (Central Europe) and the automated classification of the circulation types by Maheras et al. (2000) (Greece). He said that there was a clear increasing trend of the anticyclonic types in eastern Mediterranean the last decades. Prof. P. Maheras presented some results about the relationship between the circulation types over Greece and the circulation types over Central and western Europe. He also talked about the relationship between circulation types and rainfall variability as well as the relationship between circulation types and extremes temperatures, especially in Greece. Finally, he presented a new flexible automated classification scheme that can classify atmospheric circulation all over Europe. **Dr. E. Kostopoulou** gave a thorough description of climate models by giving the definition, the structure, the way they were constructed and their evolution in the time. She presents estimations of temperature and precipitation all around the world by different climate models. Also, she explained why we need to evaluate climate models and she presented some methods of evaluation. Finally she showed some results on application studies over Eastern Mediterranean. **As. Prof. A. Bartzokas** talked about the inter-annual variability of precipitation in Greece. By using the

Factor Analysis technique on 10-days precipitation datasets they detected two main categories of precipitation in Greece, where the the intra-annual variation of precipitation is simple for the marine and costal areas and double for the continental areas.

Another session of the sub-theme “General Climatology” focused on large scale circulation and teleconnection patterns. In this session, **Prof. Haim Kutiel** explained basic idea of teleconnections by giving the definitions (connections - *act of connectings;* tele - *act a distance;* Teleconnection - *connection between distance.* He gave examples of Teleconnections such as NAO, ZIC (Zonal Index Circle), EOF1 of SLP. In the next part, the speaker gives examples of annular modes, such as NAM (Northern Annular Modes), which have positive and negative phases. For example, in the positive phase a stratosphere is cooler and the circulation is stronger; in a negative phase the stratosphere is warmer and the circulation is much weaker. Other similar annular modes are AO (Arctic Oscillation) and NAO (North Atlantic Oscillation). More attention is paid to centres of actions, which affect the Mediterranean region (Mediterranean Oscillation, North Sea-Caspian Pattern, Central Africa-Caspian Oscillation, North Africa-Western Asia Pattern, and East Atlantic-Western Russia). Moreover some results were shown from his research for the 1958-1998 period for the height of the 500 hPa geopotential. The circulation around Northern Caspian and North Sea regions were compared. **As. Prof. H. Flocas** talked about climate variability based on teleconnection patterns. Teleconnection patterns appear as preferred modes of low-frequency (or long timescale) natural variability of the atmospheric circulation with geographically fixed centres of action (poles). She showed the main characteristics of the Eastern Mediterranean Pattern (EMP) that are identified at 500 and 300 hPa in winter, weakens at 700 hPa while it does not exist at lower levels and the upper level pattern weakens in spring, fades away in summer and returns in autumn. The EMP affects the climate of Eastern Mediterranean with inverse impact between the two phases (positive, negative) in the mean climate as well as the extreme events, the positive phase of the EMP corresponds to decrease of precipitation and the negative phase to increase of precipitation. The impact is more prominent in the temperature than on the precipitation regime and on the mean rather the extreme regime. The large scale atmospheric circulation patterns was introduced by **Dr. V. Pavan**. She described the global temperature, the Pacific-Northern American pattern (PNA), the features of the Euro-Atlantic Climate international variability and their relation with large-scale circulation dynamics (in winter and summer). One of the most important phenomena is El Nino, which has largest amplitude in the winter, resulting in an increase of heat transportation to the north, more energetic conditions over the Pacific and stronger winds. Dr. V. Pavan explained NAO (North Atlantic Oscillation) conditions in positive and negative phases. Positive phases produce stronger thermal winds – jet stream. In winter NAO brings warmer and wetter conditions in northern Europe and colder and dryer conditions in southern Europe. The negative phase provides blocking for East Atlantic-West Russia. Some results were shown for temperature (ERA 40) and precipitation (GPCP) at the 850 hPa level in summer and winter for 1960-2000 and 1976-2006. Furthermore, some NAO indices, such as Jones index, Hurrel index, NOAA roateted PC over North Hemisphere Z500 and the 1st PC of Z500 over Euro-Atlantic (90W-60E, 20N-90N) were explained.

The **second sub-theme** regarded *Climate change*. Dr. **Rodica Tomozeiu** gave a lecture on some techniques used in the detection of climate change. She started her presentation with the definition of climate and climate change. After she talked about the statistical tests used to determine climate change. Changes can appear in mean, variance or trend of the variables. She pointed out that the check of the significance of the results is always needed, but first we always have to check if the distribution of our data is a normal distribution or not. Some techniques she mentioned were the Man-Kendall-test, backwards statistics (which determines the moment of trend-change) and the F-test. It is also important that tests show just dependence and not cause. **Dr. K. Tolika** presented the main results of the RT4, WP4.3 “Understanding extreme weather and climate events” for the ENSEMBLES project. There were 3 RCMs used in this study for the Mediterranean region. At first an evaluation of RCM data was made comparing them against observational gridded data regarding extreme climate indices of temperature and precipitation (TXQ90, TNQ10, FD, HWD, PQ95, PX5D, CDD). As far as the control period is concerned, the main conclusions are that all models underestimate extreme warm temperatures, while they perform better in the simulation of extreme cold temperatures. All models show lower skill in simulating precipitation indices and they generally show drier conditions than the observed data. After the control run period analysis, the future projections were studied for the periods 2021-2050 and 2071-2100. According to the results, all models indicate a shift towards warmer climates since all extreme temperatures indices are expected to rise. Furthermore large positive trends are found for temperature parameters. Precipitation indices present similar present and future spatial distribution. Increasing trends are expected for winter extreme precipitation for the northern Mediterranean, while larger dry periods are predicted and seem to be more pronounced in the eastern part of the basin. **Dr. Jose Manuel Gutierrez** presented “Downscaling climate change scenarios for impact studies”. He pointed out, that there is a great necessity to use multiple scenarios and multiple models when dealing with climate change matters. One big problem is that uncertainties may be so high, that projections can be useless. Nevertheless, uncertainties could be high or low, when look at a particular region. The resolution of the Global Climate Models (GCMs) is about 200 km per grid (i.e. ECHAM5/MPI-OM). Thus, downscaling is needed, the common downscaling methodologies are a) dynamical downscaling (solving of the equations with a different resolution) & statistical downscaling (combination of dynamical model-output and empirical models fitted to data using historical records); methods such as transfer-function approaches (linear regression, neural networks) and non-generative algorithmic methods (analogs, weather typing). Day by day downscaling gives signals not only for means but also for extremes. In average, for Spain mean precipitation the models are good. For extremes, they are sometimes not sufficient. Thus, it is necessary to adjust projections using observations. One example for this are two stations in Spain, where in a) Navacerrada observated precipitation was below the projections of MPEH5, whereas in b) Madrid observed precipitation was higher than MPEH5. A correction of the projection with observations followed.

The ***third sub-theme*** was “Extremes”. **Prof. M. Beniston** talked about extreme events at a changing climate. Climate had an important impact during 1960 to 1999 on different hazards and was responsible for more than the half of economical as well as three quarters of insured losses. Climatic extremes can be defined in several ways: a rare event based on frequency and occurrence, an intense event based on exceeding a threshold and also they can be defined with respect to the impact they have on society. For the last point the vulnerability of a system has to be assessed and it is important not to associate all extreme impacts with weather impacts. Extreme events can come from a perturbation of circulation embedded within an atmospheric circulation, from a modulation of normal weather by decadal climatic variability or by enhancements of the energy required to trigger a warmer climate forced by increased atmospheric greenhouse gas concentrations. If we look at the governing equations of atmospheric dynamics it can be seen that all variables are connected and can affect each other through many pathways. It is important to realise that if there is an amplification of a response that it is often difficult to know the exact origin of the change. Some illustrated examples of extreme events show that in 2003 there was a heatwave throughout Europe. The outcome of an extreme event can be shown in different manner in either if we look the variability of an event or the mean of an event. As well it has to be clear which variables we compared together and in which scales they are related to. As an example it was shown that temperature is a local event and should not be related to precipitation, since the latter has a synoptic scale origin. Looking to future climate; we can conclude that ¾ of the warmest seasons have occurred during the last 100 years and that the climate of today is below the 10 percentile of tomorrow's climate. If we focus on the heatwave on 2003, it can be a state that this extreme summer event will be in a statistical way one out of two summers of the future climate. So we can use these recent seasonal extremes as a proxy as season that will be likely the norm by the end of this century in order to assess the environmental and socio-economical impacts of these extremes. This allows us to have an advanced planning of the expected impacts to enable the risks to be reduced. The Extreme Events in the Mediterranean Climate were presented by **As. Prof. P. Lionello**. He presented al lot of examples of climatological extremes pointing out that the intensity of an extreme event does not necessarily exhibit a linear relationship to its damage potential. He focused on how difficult is to define what an extreme is. This definition requires a deterministic method to describe a specific event, involving a statistical and a climatologic approach. Climatologists describe extreme events by using statistical properties such as mean, variability and shape. Extreme events are those events located in the tails of the PDF distribution. User specific definitions of extremes have a different approach once the information is not based on any linear mechanism inside the climate system. The definition for this case comes from risk and damage evaluation, whether or not the event is considered extreme from the climatological perspective. According to the IPCC, an extreme event is an event rarer than the 10^{th} or 90^{th} percentile. Therefore, to determine how rare an event is, it is necessary to know the statistics, establish a degree of social exposure, question how many events are being observed (past and future), project the trends and establish a degree of social response. It is necessary to understand extreme events and the uncertainties associated with them before linking them to climate change. It is also erroneous to use catastrophic events as an indication of climate change: the extreme definition should not be related to hazards. Some statistical methods to define extreme events were presented by **Dr. C. Anagnostopoulou.** According to her presentation **e**xtremes are characterized by time, intensity and duration. However it was suggested that is also important for a better understanding to take into account location and the human element, since in locations far away from civilization extremes do not impact on society as severely. Two main methods in order to study extremes were presented, the no parametric method (based on the calculation and the analysis of climatological indices) and the parametric method (assuming that the data comes from a type of probability distribution). Results using rainy seasonal length (RSL) index were presented for Thessaloniki to show that we need more information in order to provide a holistic view. This was the reason for introducing later the Generalized Extreme Value distribution (GEV), which embodies the following parameters: location, scale and shape. GEV is calculated by using the block maximum method (one maximum per period) and there are two methods for its estimation, the maximum likelihood estimation (MLE) and the Bayesian method. With the purpose of determining the timing of an extreme we need the return levels of the GEV. Return levels show the level of the variable that is expected to be exceeded on average once every 1/p. years. Thereafter, Generalized Pareto Distribution (GPD) was presented. GPD doesn't use block maxima but Peaks Over a Threshold (POT). There are two methodologies in order to define the POT, these are: 'mean residual life plot' (mrlp) and 'threshold choice revisited'. Consecutively both GEV and GPD give good results for large periods, but GPD presents a practical advantage in a smaller time period. Following, a project was displayed where two different models, KNMI and C4I, used to detect changes in precipitation, were compared. The indices in those models were the precipitation medium (Pm), the precipitation of 20 year return value (P20) and the precipitation of 100 year return value (P100). The results showed that KNMI gave higher values of precipitation than C4I. The conclusions were that the two estimates (MLE and Bayesian) present similar results for the reference period but different for the future period. As far as it concerns the indices, P20 presents increase especially in central Mediterranean, while Pm presents no change or a slight decrease for the future time period in the Mediterranean. Finally **Dr. P. Hadjinikolaou** presented some results about climate changes and extremes in eastern Mediterranean and Middle East. In his presentation, He compared Global Climate Models (GCMs) with Regional Climate Models (RCMs) concluding that the RCMs are better at capturing mesoscale processes and representing coastlines, islands and topography. He focused on his results for Cyprus using ensembles, looking at maximum and minimum temperature along with precipitation for the periods 1961 – 1990 and 2071 – 2100 in order to detect changes in future climate and in extreme events. One of his focal points was CIMME project which focuses on impacts of climate change in the Eastern Mediterranean & Middle East. This project is funded by the Cyprus Institute (Cyl) collaborating with the neighbouring countries. The topical reports of CIMME are based on climate assessment, energy, water, air quality and health. Two RCMs were also mentioned; PRECIS, a regional climate modelling system developed at the Hadley Centre and HadRMCIP, which both use precipitation, wind speed, temperature and humidity as inputs. Finally, he described the methodology of HadCM3CIO, a coupled ocean-atmosphere GCM with horizontal resolution 25×25 km, temporal frequency using 150 variables (decadal, yearly, seasonal and monthly) and input data from the Met Office. This particular model was simulated up to 2100 and it was found out that one of the basic limitations was the reduced height of the topography. Some areas for further investigation were his concluding remarks, such as model validation, (difficult to achieve since the local Met department required $20.000 for the data), diagnosing of temperature and the impact studies. **Prof. T. Karacostas** talked about extreme storms. He explained the structure of a cumulonimbus and how it can developed to storm.

In the ***forth sub –theme*** “Impacts” the participants explored the impacts of climate change and extremes events in the environment. **Dr Andy Morse** and his team work on “Climate change and deceases’’. He suggested a complete impact study combination between climatologists and meteorologist and other scientists (sociologists, psychologists, doctors etc) and policy makers is needed. Analyzing of the past data before predicting is a very important part. He said that Malaria is one under the top 3 deceases (1.2 million cases/year, 155,000-310,000 deaths, 60-80% in Africa). There is relationship between malaria and meteorological parameters (temperature, precipitation, moisture), but also important are some social factors. Because of this relation they try to figure out the impacts of climate change on the decease.This can be done by composing impact models by combining climate and malaria models (impact model). Two kinds of models are used: statistical (operational use) and dynamic (research). Statistical models need good meteorological observation data and malaria data. They create equations for statistical model, aiming at predicting the expansion of the decease. Dynamic models are process models using meteorological parameters like temperature, rainfall and humidity and parameterize the malaria-cycle (mosquito-population, malaria-transmission). This can provide seasonal forecast and prediction of malaria-plume and changes in malaria distribution. As a conclusion Dr. Morse mentioned that health integration needs improvement of forecast skills and increase of interest in the integration of climate and health. Also a raise of awareness at all levels and the built of wider communities is necessary. Furthermore, **Prof. N. Mousiopoulos** talked about atmospheric pollution and health. He showed up how the air quality affect the health of human beings. He explained the outdoor and indoor sources of air pollution and the human groups that are in risk. He named the primary and secondary pollutants and their impact in health. Finally he finished his lecture by presenting the result of the case study of Thessaloniki city.Another parameter that presented in impact sessions was the effect of urbanization. **Dr. P. Petrakis** explained the effect of urbanization on local and micro-climate, as well as on the daily life of inhabitants. The main problems arise from urbanization are a) Pollution from traffic up to 95% (air pollution, noise, waste), b) Impacts of climate change (water, energy, health), c) Heat Island Effect, d) Mobility (Everyday movement) and e) Waste: Production and disposal. He showed up the example of Athens city. Athens is also an area with great degree of urbanization in the last few decades and with some special characteristics. The topography of Athens, along with the prevailing climatic characteristics (direction of wind mainly) does not allow the proper ventilation of Athens. This has definite implications on air quality. The effect is also attributed to the rapid increase of the population and the number of motor vehicles mainly after 1970. Using NOA long records the Heat Island Effect is investigated. In order to do that, several indices and parameters have been developed, i.e. *no discomfort, most of population suffers discomfort* etc. An indication of the impact on local climate is that the days with temperature greater than 40 degrees have increased in the last 150 years by 400%. Industrial areas suffer more from discomfort. The heat island phenomenon has a serious impact on the energy consumption of buildings, increases smog production, while contributing to an increasing emission of pollutants from power plants, including sulphur dioxide, carbon monoxide, nitrous oxides and suspended particulates. From this investigation it is shown that heat island intensity is mainly influenced by urbanization factors. Finally, he referred some measures for the negative consequences of urbanization, such us the use of environmental friendly materials, the use of public means of transportation, the use of clean technology and renewable sources of energy, law enforcement and to change the human behavior towards a more environmental-friendly. The Research Director of IERSD, **Dr. C. Balaras**, said to students how can be improved the energy performance of buildings. He presented the energy losses of residential, offices, hotels and hospitals and introduced ways on saving energy for heating and cooling and how to improve microclimate on buildings. **Dr. K. Helmis** was focused on ground-based remote sensing measurements by using SODAR (Sound Detection And Ranging). The goal was to measure the mixing height of the ABL (Atm Boundary Layer). This knowledge is important for predicting the ABL evolution and its diffusion capabilities, and in turn this in useful for meteorological and air-pollution studies. Two methods are used for measuring the mixing heights (MH-that is equivalent to the turbulent ABL height where the wind speed and direction profiles are almost constant): ones is based on thermodynamic arguments and measures the temperature profiles, the second is based on kinetic movements and measures the wind speed. According to the analyse of their measurements he concluded that in urban areas, high values of convection and elevated layers are observed due to the "heat island" effect; in rural areas moderate values of convection and neutral conditions are observed and in mountainous areas high values of convection are observed due to the solar radiation. In the case study of Thessaloniki, there is a shallow convection layer during the night and a strong one during the day. **Dr. P. Zanis** talked about the impacts of climate change on tropospheric and stratospheric ozone. Ozone (O_3) is a constituent of the troposphere and also an important constituent of certain regions of the stratosphere commonly known as the Ozone layer. It absorbs UV radiation and solar energy. So it determines the dynamics of stratosphere. It is an important greenhouse gas and strong photo-oxidant at the earth's surface. Both stratospheric and tropospheric O_3 are pollutants. The budget of tropospheric ozone in the atmosphere is a result of the many factors such us stratosphere-troposphere exchange (Large scale dynamics; Photochemical production; Photochemical destruction; Deposition; Tropospheric burden. The climate and global changes have a certain effect on both tropospheric and stratospheric ozone. Along with all other meteorological variables, ozone changes as well due to atmospheric processes, anthropogenic emissions and natural emissions. Some of the impacts of climate change on stratospheric ozone are:

1. Stratospheric cooling enlarges polar clouds causing the increase of ozone; 2. Climate change will affect the rate of ozone recovery differently at various altitudes and latitudes and both in a direct and indirect way, 3. It affects the chemical reactions. Concluding, the speaker said that climate change is likely first to affect seriously tropospheric ozone mainly through the induced changes in: a) stratosphere-troposphere exchange, b) solar radiation levels, c) water vapor concentrations and d) biogenic emissions and second to affect seriously stratospheric ozone mainly through: a) the GHGs induced stratospheric cooling, b) the changes in stratospheric concentrations of water vapor and methane and c) the changes in stratospheric dynamics. **Prof. G. Kallos** presented the atmospheric processes that influence the regional Mediterranean Climate. In his lecture, he underlined some regional climate characteristics of Mediterranean weather and focused on the impacts of Saharian dust and the sea-salt. He reported the effects of soil dust in the atmosphere and he explained how can be model the dust cycle. He presented some examples of dust storms in the Mediterranean region and explained the whole structure of the phenomenon. Finally he referred many examples for the impacts of dust in many meteorological and climatological parameters (precipitation, temperature, ozone etc). Another parameter mentioned in the impact sessions was the impact of climate change on groups and forests. **Dr. R. Ferrise** referred to the impact that climate change has on crops and several methods were presented in order to quantify crop responses. When talking about climate and crops, someone has to bear in mind that crops are highly affected from variations in several meteorological variables directly and indirectly. For instance, variations in temperature directly affect growing season and crop yield. On the other hand, variations in CO_2 affect crop yield (increase of CO_2 concentration leads to increase of crop yield) and yield quality. However, there is also an indirect effect of climate change to crops. Pests and diseases, soil fertility and erosion are greatly affected by the prevailing temperature. Moreover, the area for cultivation keeps changing due to climate change. In order to study the impact and quantify it, there are several approaches. One of them is the impact approach, which is conventional one, and the other one (which is explained here) is the probabilistic method. This is actually a RISK-based approach. Using a model and statistical methods, the combined effect of CO_2, temperature and precipitation on crops for a single point is simulated over Mediterranean. Models are represented too in order to assess the impacts. For the first 30 years there seems to be a decrease of the risk

because of the presence of CO_2 and then an increase. **Dr. D. Anastasiou** presented the impact of climate variability on agriculture. The data used for ADAGIO are based on ENSEMBLES. He divided his presentation into two parts: In the first (*qualitative*) part he introduced the ADAGIO project in showing various adaptation options to local climatic and environmental variability. The idea of ADAGIO is to collect information on European farmers' perception of climate change and their willingness to adapt new farming methods such as crop varieties or irrigation schemes. Besides, existing adaptation strategies of European farmers are registered. The information was collected by means of field observations, interviews with both experts and farmers as well as by questionnaires (*bottom-up approach*). Interviews are being carried out by help of maps and graphs which had beforehand been processed through spatial diversity indices and land use codes. These graphs give a picture on predicted future temperature and rainfall patterns and hence likely impacts on growing seasons, plant productivity or biological diversity. In this regard, the speaker gave several examples in within the *quantitative* part of his presentation. **Dr. A. Venalainene** presented the impact of climate change in the boreal forest. The boreal forests cover 1270 million ha of land including boreal coniferous forests, boreal tundra and boreal mountains mainly in Canada, Alaska, Finland, Sweden, Norway and Russia. The effects of recent climate change appear to have been greater in boreal forests than in other forests. Forest productivity is expected to generally increase in the Northern boreal forests due to longer and warmer growing seasons and to decrease in the currently more productive southern forests due to the impacts of increasing drought, insects and fire (leading to large carbon emissions that will intensify climate change). In the boreal domain, primary productivity is in general expected to increase through the following three main mechanisms: (i) CO_2-fertilization; (ii) temperature increases and lengthening of growing seasons; and (iii) precipitation increases under water-limited conditions that lead to a greater water availability. Pines and birches are expected to become more while the opposite is expected for spruces. Boreal forests are vulnerable to increases in tree mortality leading to an increased frequency of stand-replacing fires, made worse by a warming climate. Given recent observations and model projections, an increase in fire episodes throughout the boreal forests is very likely and is expected to substantially increase carbon emissions from the boreal domain. Some of adaptation possibilities are natural forest regeneration, managing of forest seeding, earlier forest thinning and harvesting, new origins from the warmer climate and finally, limitations to tree transport in order to block diseases and pests. The lecture of **Dr. A. Paralika** focused on forest fires and especially on the the fire disaster in Peloponnesus (Greece) on 2007.. He noticed that 11 of the past 12 years rank among the 12 warmest years in the record of global surface temperatures since 1850 and that the expected consequences of climate change is the increase in temperature and sea level as well as extreme weather conditions (heat waves, storms, droughts). As Dr Paralikas referred, climate change increases the probability for water shortage, forest fires, heat waves and intensive rainfalls. The parameters for handling are meteorological (temperature, relative humidity, rain, wind speed); landscape factors (altitude, local landscape); vegetation (humidity, condition, species). The main reasons that cause devastating fires are the unusually long periods of extremely high temperatures, the prolonged drought of the past months, the simultaneous strong winds blowing in the regions where the fire started, arsons unintentional or deliberate. He presented the example of the worst forest fire experienced in Greece, in summer of 2007, where about 80 people lost their life, 1710 buildings were burned, many villages were evacuated and many hectares of land were destroyed. Three out of five fires broke out in the west of Peloponnesus at the end of August. The main characteristics of this disaster were extremely intensive fires and huge speeds of fire spread, caused by long periods of drought, three heat waves, very strong winds and very low humidity. Assistance was provided by European countries, by means of aircrafts and helicopters as well as by ground forces (personnel, engines). The aim of Greek Fire Service is to reduce the vulnerability to natural disaster. Among the responsibilities of the Greek Fire Service are the operational planning, the emergency preparedness and the emergency response. The Mega Challenge for the Fire Service is to face problems that concern co-ordination, insufficient means, multiple casualties, international cooperation and training needs. Finally Prof. P. Tsartas presented the impact of climate change on tourism by focusing on the economical depentancy and the sustainability issue in tourism policy.

Appendix

Table 1. List of the invited Speakers

1. Dr. Dimos Anastasiou Research Assistant National Observatory of Athens
2. Constantinos Balaras PhD Mechanical Engineer, Research Director IERSD, Group Energy Conservation (GREC), Institue for Envieronmental Research & Sustainable Development (IERSD), National Observatory of Athens (NOA)
3. As. Prof. Aristides Bartzokas Associate Professor, Department of Physics, University of Ioannina, Greece
4. Prof. Martin Beniston Full Professor at the University of Geneva (the chair for Climate Research)
5. Roberto Ferisse Research Associate at the University of Florence
6. As. Prof. Elena Flocas Assistant Professor, Faculty of Physics, University of Athens
7. R. Prof. José Manuel Gutiérrez Full research professor at the Spanish National Research Council
8. Dr, Panos Hadjinikolaou Associate Research Scientist,Atmosphere and Climate Modelling Group, Energy Environment & Research Center (EEWRC), The Cyprus Institute
9. As. Prof Konstantinos Helmis Associate Professor, Faculty of Physics, University of Athens, Greece
10. Prof. Phil D. Jones Full Professor and Director, Climatic Research Unit, University of East Anglia
11. Prof. Georgios Kallos Professor, Faculty of Physics, University of Athens
12. Prof. Theodoros Karacostas Professor of Meteorology, Department of Meteorology and Climatology, School of Geology, Aristotle University of Thessaloniki, Greece
13. Prof. Haim Kutiel Full Professor at the University of Haifa, Israel

14. Ass. Prof. Piero Lionello Associated Professor at the University of Salento
15. Prof. Panagiotis Maheras Professor of Climatology, Department of Meteorology and Climatology, School of Geology, Aristotle University of Thessaloniki, Greece
16. Dr. Andy Morse Reader at the University of Liverpool
17. Prof. Nikolaos Mousiopoulos Full Professor at the Aristotle University of Thessaloniki
18. Apostolos Paralikas, Civil Protection National Operations Center, General Secretariat for Civil Protection, Athens, Greece
19. Dr. Valentina Pavan Researcher ARPA-SIM, in climate group
20. Michael Petrakis PhD Director of the Institute for environmental research and sustainable development, National Observatory of Athens (Senior Researcher)
21. Dr. Petr Štěpánek Chief of Department of Meteorology and Climatology at regional office Brno of the Czech Hydrometeorological Institute
22. Dr. Rodica Tomozeiu Researcher in ARPA-SIM, in climate group
23. Prof. Paris Tsartas University of the Aegean
24. Dr. Ari Venäläinen Head of Climate Research and Applications group, Finnish Meteorological Institute
25. As. Prof. Prodromos Zanis Assistant Professor Department of Meteorology and Climatology, School of Geology, Aristotle University of Thessaloniki, Greece

Table 2. List of the participants

Akritidis Dimitris	Aristotle University of Thessaloniki, Greece
Kotti Maria-Christina	University of Athens, Greece
Beguin Andreas	Federal Institute of Technology, Switzerland
Nicole Gallina	University of Geneva, Switzerland
Exarchou Eleftheria	MPI-Max Planck Institute for Meteorology, Germany
Fortuny Didac	Universitat de Barcelona, Spain
Frediani Maria Eugenia	Hellenic Centre for Marine Research, Greece
Giannakopoulou Evangelia-Maria	Imperial College, United Kingdom
Hoy Andreas	Interdisciplinary Env.Res.Centre, Freiberg, Germany
Jedruszkiewicz Joanna	University of Lodz, Poland
Lukovic Jelena	University of Belgrade, Serbia
MacLeod David	University of Reading, United Kingdom
Kyriopoulos Fotis	University of Ioannina, Greece
Michailidou Christine	Aristotle University of Thessaloniki, Greece
Mikulcak Friederike	University of Stockholm, Sweden
Mitropoulou Aggeliki	University of Athens, Greece
Mohammad Abdolhosseini	Isfahan University of Technology, Iran
Nariunaite Ieva	Vilnius University, Lithuania
Oikonomou Christina	University of Athens, Greece
Pantavou Katerina	University of Athens, Greece
Pappas Vasileios	University of Ioannina, Greece
Pieczka Ildiko	Eotvos Lorand University, Hungary
Rapti Eleni	University of Aegean, Greece
Reiser Hadas	University of Haifa, Israel
Rousi Efi	Aristotle University of Thessaloniki, Greece
Mohammad Shafiq	University of Innsbruck, Austria
Varotsos Konstantinos	National Observatory of Athens, Greece
Zagouras Athanasios	Patras University, Greece
Aquaotta Fiorella	University of Turin, Italy
Zittis George	Aristotle University of Thessaloniki, Greece