Report: ESF-MedCLIVAR Workshop
"Climate Change Modeling for the Mediterranean region",
13-15 October 2008, ICTP, Trieste, Italy

The Workshop brought together 38 scientists from several European institutions and projects.
The main topic of the Workshop was to identify and inter-compare high resolution climate model simulations available for the Mediterranean region. The results brought out a new and updated assessment of climate change at sub-regional scales, along with related uncertainties and underlying processes.
The discussions of research needs was useful to improve the understanding of Mediterranean climate change. Specific proposals for future activities and climate change simulation results for contributing to the MedCLIVAR meta-data archive have been presented and discussed.

Presentations and discussions focused on the following themes:

- Regional Climate Modeling and Regional Climate Change over Mediterranean regions
- Regional Climate Modeling and Extremes for the Mediterranean regions
- Global and Regional Coupled Modeling and Climate Change
- Modeling Issues, Atmospheric Circulation Changes and Precipitation
- Impacts and Adaptation

Projects represented

- The new German project KLIWEX-MED: Changes in weather and climate extremes in the Mediterranean Basin

Recommendations and outputs:
Climate change impacts the entire coupled Biosphere-Hydrosphere-Atmosphere system. The need of the quantification of the feedbacks between this system and regional climate requires the description of all climate relevant physical, chemical, and biological processes. The main output of the workshop was the necessity in the MedCLIVAR community to move towards the regional earth system modeling to aim to a better representation of all the mechanism and feedbacks of the Mediterranean climate.
For this purpose the validation data are of extreme importance and therefore the continuous upgrade of the MedClivar meta-data archive is needed.

To foster the dialogue between climate scientists on the one hand and policy and decision makers and other stakeholders on the other hand is one of the focus of the MedCLIVAR community therefore the provision of missing climate information, in order to design robust adaptation strategies, support adaptive management and reduce climate-related risks has to be of high priority.

Summary of the presentations and discussion

1. Regional Climate Modeling and Regional Climate Change

Several simulation results from global and regional model were presented for the climate change scenario simulations.
Low-resolution global atmospheric general circulation model, high-resolution regional atmospheric model for the Mediterranean basin, and an oceanic general circulation model

for the Mediterranean Sea have been used either individually in forced mode or all together in coupled mode to reproduce the current climate of the Mediterranean and in projecting its future evolution.

Climate change trends over the whole Mediterranean region based on the latest results of the regional climate simulation experiments showed that the climate change signal is not uniform over the region, and differences can be seen when different model resolutions are achieved. Local forcings due to the complex topography and coastlines substantially affect the *fine scale* climate change signal. This calls for the use of high resolution models to adequately describe local scale effects and produce specific local climate change information for impact and adaptation assessment studies

The regional response to large-scale climate events (such as a weakening of the Atlantic Ocean's overturning circulation, a greening of the Sahara and changes in the sea surface temperature of the West Pacific) in a climate change scenario simulation have been also presented.

Examples of the result sensitivity to different downscaling modes have been presented using the ensembles of the EH5OM global coupled model (part of the IPCC AR4). The downscaling modes differ in the way how the RCM integrations are created. For continuous runs, initial conditions are defined only once, at the beginning of a 30-year period for which a continuous downscaling is then performed. Some preliminary results of the 35-km RegCM downscaling over south Europe and the northern Mediterranean have been shown and differences are visible between the results of the two downscaling procedures.

2. Regional Climate Modeling and Extremes

Most of the work presented highlighted the importance of the accurate reproduction of the extreme temperature and precipitation events for the hydrological cycle in the Mediterranean regions. High resolution is needed for this purpose and many of the simulation showed results at 30 – 25 km resolution.

The most recent Regional Climate Models future projections results of the extreme rainfall and temperature conditions over the Mediterranean area showed an increase of the extreme temperatures while the results concerning the extreme rainfall present some discrepancies.

The RCMs simulates reasonably well the extremes. Extreme precipitation seems to increase almost everywhere over Mediterranean. RCMs project increases in daily extreme rainfall but smaller increases in longer duration extremes. However, there is still uncertainty about the change in large quantiles, especially in the case of the shape parameter.

All the participants agree on the importance in investigating the uncertainty in the modeled projected extremes because of their crucial role in the hydrological cycle and the impact for the life and society. The use of an ensemble of model projections can improve the representation of this uncertainty and several examples have been showed taken from the latest model results of the EMSEMBLE project.

3. Global and Regional Coupled Modeling and Climate Change

Common consensus was reached on the need of regional earth system models to be able to account and reproduce all the process and feedbacks of the Biosphere-Hydrosphere-Atmosphere system.

Several twin experiments using atmosphere alone and complete and/or partial coupled atmosphere-ocean and hydrological models were completed and presented also as part of EU project like CIRCE. Differences between the two simulation results highlighted how the coupled model simulations are often able to reduce the model biases and improve the correlation with observations of several atmospheric fields.
In climate change projection mode the differences in spatial and temporal pattern of the SST changes lead to significant changes in the surface temperature and precipitation response.

The need of the assessment of uncertainty was discussed several times in this section and highlighted by quite few presentations. This involves the uncertainty of the SRES scenario, ocean model, surface forcing, Atlantic forcing, river runoff and the Black Sea.

Workshop participants agree that in the near future a coordinated international effort to assess the future of the Mediterranean sea, could be a step forward in the assessment of the future climate projection of the whole Mediterranean climate (MedCLIVAR and Hymex).

4. Modeling Issues, Atmospheric Circulation Changes and Precipitation

In this section the atmospheric circulation patter leading to extreme events like Mediterranean cyclones and extreme precipitation have been presented and discussed.

Mediterranean cyclones are one of the most important sources for heavy precipitation events in many parts of the Alps and northern Italy. The role of this cyclonic circulation in a changed climate has not yet been extensively investigated. The possible development of tropical cyclones over the Mediterranean Sea under anthropogenic climate change conditions was examined by using for example two types of regional climate model ensembles: a multi-model ensemble approach and a mixed-physics ensemble with one RCM. In both types of ensembles, tropical cyclones are found in some simulations, but not in others. This indicates that the occurrence of such extreme events can be a future possibility, but it comes along with important uncertainties.

Also a case of extreme precipitation events modulated by regional mechanisms such as Black Sea SSTs have been discussed in region like Romania and the importance of these mechanism for the regional climate variability under both present and climate change conditions has been showed.

The importance to focus on these aspects of the atmospheric circulation for better modulation the future climate has been discussed together with the need of the uncertainty assessment.

5. Impacts and Adaptation

The improved climate information for adaptation and mitigation strategy is definitely needed for fostering a continued dialogue between climate scientists on the one hand and

policy and decision makers and other stakeholders on the other hand.

In this section many examples were presented on how the climate change projections from global or regional climate models are translated in to impact models. Changes of precipitation are not linearly translated in change of water availability or crop growth through hydrological and crop models.
The possibility in the next years to have higher model resolution, ensemble simulations, and model intercomparisons will help to synthesize and provide missing climate information, in order to design robust adaptation strategies, support adaptive management and reduce climate-related risks.

Common consensus was reached on the need of information such as

- changes in climatic averages, variability and frequency and intensity of extremes, including rates of change;
- spatial patterns and hotspots of change;
- thresholds of sudden, non-linear and potentially irreversible changes;
- averages and ranges of climate scenarios and projections; and
- sources, magnitude and propagation of uncertainties from global and regional climate models to impact and vulnerability assessments.