

# Simulation of the Mediterranean climate in the framework of HYMEX

## Abstract

This study intends to investigate the complex interactions between atmosphere and ocean in the Mediterranean. A special focus will be on areas with intensive atmospheric and oceanic convective activity as well as on local wind systems. In a study of Giorgi [2006] the Mediterranean is identified as a “climate change hot-spot”. Due to a decrease in precipitation and an increase in variability during summer the Mediterranean region is very sensitive to climatic changes.

By using highly resolved regional climate simulations, we plan to investigate this sensibility. These investigations should lead to new insights, which will help to improve the parameterizations of convection and wind, and by this also to improve the simulated water budget and extreme weather events in the Mediterranean.

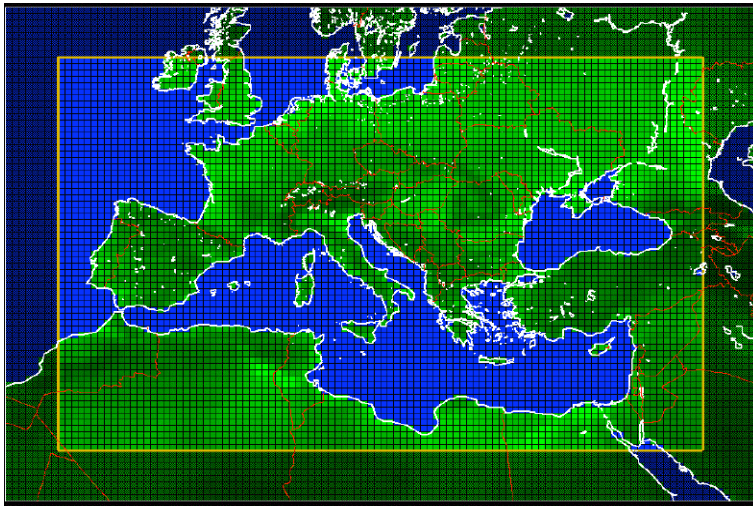
One of the main objectives of HYMEX is to improve the understanding of the water cycle, with emphasis on extreme events, by monitoring and modelling the Mediterranean atmosphere-land-ocean coupled system [<http://www.hymex.org>]. Our contribution to this project consists in the performance of regional coupled and uncoupled ocean-atmosphere simulations, and in the analysis of these simulations in order to understand and improve the ocean-atmosphere feedback, regional wind systems, and the influence of dynamic vegetation. Further, the simulations will be part of an intercomparison with other regional climate models, such as ALADIN or RegCM4 [<http://www.medcordex.eu/models.php>].

Basis for our analyses are the regional climate model COSMO-CLM, and the ocean model NEMO, which are focused on the Mediterranean. The COSMO-CLM (CONsortium for Small-scale MOdeling-Climate Limited-area Model) is a state-of-the-art non-hydrostatic RCM (see <http://www.clm-community.eu>). It is the climate version of the COSMO-model (see <http://www.cosmo-model.org>), which several European weather services use for mesoscale weather forecasting. The ocean model is based on NEMO v3.2, which was adapted for the Mediterranean (NEMO\_MED12). The two models are coupled with the OASIS3 coupler. The simulations will be done on the computational domain, which is used in the framework of the HyMeX (Hydrological cycle in the Mediterranean EXperiment) and the CORDEX (Coordinated Regional Climate Downscaling Experiment) projects (Fig. 1).

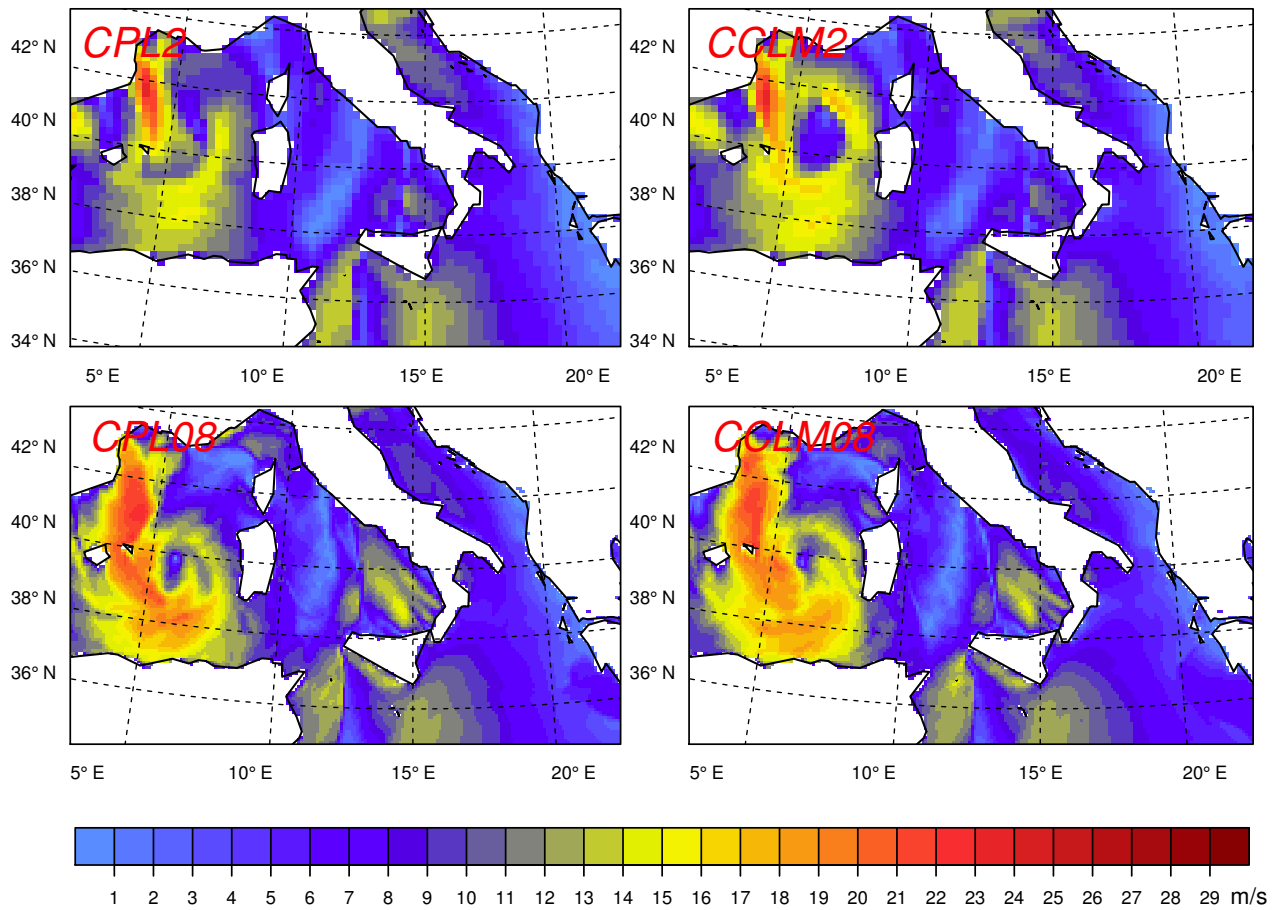
To investigate the influence of the forcing data, ERA-Interim reanalysis data for the period 1979-2012 are used as driving data for the uncoupled ocean and atmosphere models. This illuminates the individual adaptation processes of the models at the ocean-atmosphere boundary layer, and later these simulations will be used as a control experiment to the fully coupled simulations. With the proven model configuration, projection runs will be done for the years 1951 to 2100. These projections will be driven with MPI-ESM data using the emission scenarios RCP4.5 and RCP8.5.

Some of the simulations will be done with different horizontal grid spacings of  $0.44^\circ$  and  $0.088^\circ$ . This is on the one hand to suffice the requirements of HyMex project, and on the other hand to investigate small scale processes such as regional wind systems. For instance the Mistral causes deep-water formation, and therefore it is important for modelling the circulation of the Mediterranean Sea. By using different model resolutions we will be able to analyse in what regions and under which climatic conditions the higher horizontal resolution gives an added value. First tests showed that the simulation of medicanes gives significant better results when using a horizontal resolution of  $0.088^\circ$  instead of  $0.44^\circ$  or  $0.22^\circ$  (see Fig. 2).

To identify deficiencies in the wind parameterization the simulation data will be compared with data from QuikSCAT, buoys and the Advanced Scatterometer ASCAT onboard the METOP satellite. Sensitivity simulations will show if the wind parameterization can be improved by using more sophisticated approaches. Possible modifications of the Charnock formula for high winds will be assessed as well as possible improvements due to processes over land. The coupling of the COSMO-CLM to a new routing model is intended to improve the closure of the water cycle in the Mediterranean region. Additionally, the introduction of a new phenology is expected to have a positive impact on the seasonal cycle of transpiration by vegetation, and therefore to improve an important component (beside precipitation) of the water cycle over land. And due the coupling via the latent heat flux also the energy cycle is expected to benefit from this.



**Figure 1** Computational domain for the Mediterranean (0.44°).



**Figure 2** 10-m wind speed simulated by: COSMO-CLM + NEMO 0.22° (upper left), COSMO-CLM 0.22° (upper right), COSMO-CLM + NEMO 0.088° (lower left), COSMO-CLM 0.088° (lower right).

## References

Giorgi, F. (2006). Climate change hot-spots. *Geophysical Research Letters*, 33(8). doi:10.1029/2006GL025734