MODELLING IN A PERPETUAL MODE THE MEDITERRANEAN CIRCULATION USING ATMOSPHERIC FIELDS AT DIFFERENT SPACE-TIME RESOLUTIONS

Cindy Lebeaupin Brossier [1]*, Karine Béranger [2] and Philippe Drobinski [1]
[1] Laboratoire de Météorologie Dynamique, Palaiseau, France - cindy.lebeaupin@lmd.polytechnique.fr
[2] Ecole Nationale Supérieure de Techniques Avancées - ParisTech, Palaiseau, France

Abstract

This paper presents a sensitivity study in regional air-sea numerical modelling. The NEMO-MED12 ocean model is driven by different forcing fields coming from the WRF atmospheric model. We examine here the modifications in the thermohaline circulation and in the small scale ocean response especially under intense meteorological events, when varying the temporal resolution or the spatial resolution of the atmospheric forcing.

Keywords: Models, Atmospheric Input, Air-Sea Interactions, Gulf Of Lions

The Mediterranean Sea circulation with its complex patterns is sensitive to the regional climate [1] and to local extreme meteorological events that frequently occurred over the region. In the framework of the MORCE-MED project, a two-way ocean-atmosphere coupling is developed between the WRF atmospheric model [2] and the NEMO-MED12 ocean model [3]. The future ocean-atmosphere coupled system is part of the future regional numerical platform including also the modelling of the continental superficial layers, atmospheric chemistry and marine biogeochemistry. The whole regional coupled model aims to study the impacts of the climate change over the Mediterranean basin. Before applying the full two-way interactive coupling between the two regional models, the forcing mode is considered through a sensitivity study.

The downscaling of the NCEP reanalyses over the full Mediterranean basin with a 20-km resolution has been done with WRF between August 1998 and July 1999. The WRF model is able to well represent the Mediterranean climate and annual heat and freshwater budgets (Fig. 1), and with a good representation of extreme meteorological events such as strong local winds or heavy precipitation.

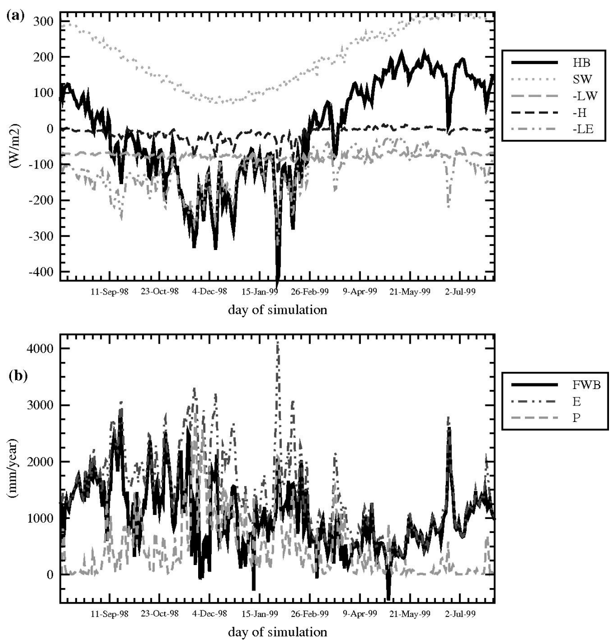

Fig. 1. (a) Heat and (b) freshwater budgets over the Mediterranean [HB (W/m^2)= SW (short-wave radiation -LW (long-wave radiation) -H (sensible heat flux) -LE (latent heat flux); FWB (mm/year)= E (evaporation) -P (precipitation)] according to the daily-averaged WRF simulation fields at 20-km resolution between the 1-Aug-1998 and the 31-July-1999.

The daily atmospheric fields obtained are then used to drive the MED12 ocean model (6-8 km resolution) in a perpetual mode during a spin-up of 8 years. Then, four experiments are done for a period of 4 years. The first experiment (or control experiment CTL) is the continuity of the spin-up. In the second experiment (ZOOMGOL), a finer spatial resolution is applied over the Gulf of Lions area in order to better represent atmospheric mesocale patterns, in particular the channelling of the mistral and tramontane. In the third experiment (3HFREQ), a higher temporal resolution is used, i. e. the frequency of the forcing is 3 hours, allowing a good representation of the diurnal cycle and of the extreme air-sea exchanges during severe meteorological events. Finally, the fourth simulation (HIGHRES) combines the high temporal frequency and the zoomed forcing fields over the Gulf of Lions.

Even if few differences are found between the four MED12 experiments at the basin scale, the local effects of increasing the space-time resolution are significant. The better representation of the mistral/tramontane channelling and acceleration in the zoom modifies the ocean response over the Western basin. Some convective chimneys persist in the Gulf of Lions a few days later than in the control experiment (Fig. 2). The diurnal cycle limits in some extent the surface seasonal warming/cooling, and modifies also the deep convection (Fig. 2); The intense and short-range peaks in the precipitation rate or in the wind stress locally modify the ocean freshening and/or cooling. This results confirm the conclusions already discussed using a 1D ocean model [4].

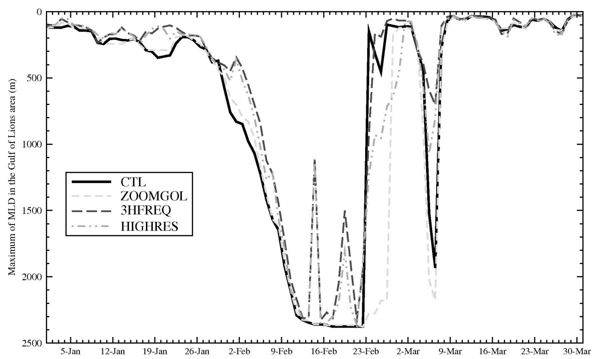

Fig. 2. Evolution of the maximal mixed layer depth (MLD- meters) in the Gulf of Lions area during winter of year 12, for the four experiments.

References

1 - Somot S., Sevault F. and Déqué M., 2006. Transient climate change scenario simulation of the simulation of the Mediterranean Sea for the 21st century using a high-resolution ocean circulation model, *Climate Dynamics*, 27 (7-8): 851-879.
2 - Skamarock W. C., Klemp J. B., Dudhia J., Gill D. O., Barker D. M., Duda M. G., Huang X.-Y., Wang W. and Powers J. G., 2008. A description of the Advanced Research WRF Version 3, *NCAR Tech. Note NCAR/TN-475+STR*: 125pp.
3 - Madec G., 2008. NEMO ocean engine, *Note du Pole de modélisation, Institut Pierre-Simon Laplace (IPSL) France*, No 27 ISSN No 1288-1619.
4 - Lebeaupin Brossier C., Ducrocq V. and Giordani H., 2009. Effects of the air-sea coupling time frequency on the ocean response during Mediterranean intenses events, *Ocean Dyn.*, 59 (4): 539-549.