Geophysical Research Abstracts
Vol. 13, EGU2011-2491, 2011
EGU General Assembly 2011

Impact of the spatial distribution of the wind maximum on the deep convection in the Gulf of Lions and the Ligurian Sea (western Mediterranean)

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Our modelling study focuses on the role of the atmospheric winds on the deep ocean convection process that occurs in the western Mediterranean. Three sources of winds are identified in the north-western Mediterranean associated to marine polar, marine arctic and continental polar regimes, resulting in the Tramontane and the north-west and/or north-east Mistral (Béthoux 1980). In the north-western Mediterranean, two cyclonic gyres are mentioned in the literature, the large extended MEDOC gyre in the Gulf of Lions (Schott et al. 1996) and the low extended Ligurian gyre in the Ligurian Sea (Fusco et al. 2003). Our study investigates the role of the position and stationnarity of the winds to well simulate these two gyres. The comparison of two numerical works differing essentially by the atmospheric forcing highlights the need of very high horizontal resolution atmospheric forcing to simulate these two gyres, in particular in the Ligurian Sea.

For the ocean, we use two regional configurations of the Mediterranean Sea, the eddy-resolving model MED16 (Béranger et al. 2010) based on the rigid-lid OPA OGCM (Madec et al. 1997), and, the eddy-resolving model MED12 (Lebeaupin Brossier et al. 2011) based on the free-surface OPA OGCM in NEMO (Madec 2008). These models are eddy-resolving. They are forced by different products of the ECMWF.

Three simulations are analyzed over the period 1998-2002: MED16-ERA40, with MED16 forced by the ERA40 reanalyses, which have a resolution of about 100km; MED16-ECMWF, with MED16 forced by the ECMWF analyses, which have a resolution of about 50km; and MED12-WRF, with MED12 forced by the WRF atmospheric fields, which have a resolution of 20km. The WRF fields are performed by a dynamical downscalling of the ERAInterim reanalyses.

The comparison between MED16-ERA40 and MED16-ECMWF first shows that a resolution of at least 50km for the atmospheric field is necessary to well reproduce the north-west Mistral and Tramontane wind maximum above the MEDOC gyre. Regarding that only deep convection can be achieved in MED16-ECMWF, the adequate representation of the wind intensity and orography trapping because of the atmospheric resolution is a crucial element to take into account.

Then, the comparison between MED16-ECMWF and MED12-WRF shows the role of the north-east Mistral above the Ligurian Sea. The position of this wind maximum above the Ligurian gyre can only be achieved in WRF forcing and deep convection in the Ligurian Sea can only be achieved in MED12-WRF, showing that atmospheric winds of at least 20km are necessary to represent the deep convection in the Ligurian Sea.