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Some recent aspects of the modelling of the Circulation of the Mediterranean Sea

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In this work, we present several process studies which have been obtained with the 3D primitive equation numerical model of LODYC prior to make a realistic model of the circulation of the Western Mediterranean Sea.

First, deep water formation is investigated with a high resolution three dimensional model. A rectangular basin is forced by various sea surface heat and salt fluxes. A 1,000 thick patch of dense water is formed within the forcing area, which is surrounded by a cyclonic vortex. Meanders develop at the periphery of the patch and then tend to occupy the whole patch area. Energy studies show that the meanders are generated through a baroclinic instability process. These features agree with observations. Sensivity studies of the space and time variability of the forcing are presented. It is found that these variabilities greatly affect deep water formation. Deep water formation appears to depend on a convective process parameterized by a simple non-penetrative convective adjustment and on the vertical motion induced by baroclonic instability. The two processes are strongly linked. Furthermore, deep convection induced by the thermohaline forcing drives an horizontal cyclonic circulation of the same order of magnitude as that estimated from observations. Hence it is found that thermohaline forcing is important in driving the Mediterranean circulation andthat it must be included in any numerical model of this area.

Second, the behavior of the Algerian current is investigated. The current is forced by an initial field of density in a periodic rectangular channel. After a long time which is of the same order as that observed on the physical simulations made on the large rotating table of Grenoble, meanders develop. Their wavelength is of the same order as those observed in nature and in the physical simulation. These meanders are due to baroclinic instability and their characteristics fit an analytical theory which has been developed.

Third, the generation of the flux through the strait of Gibraltar and the formation of the Almeria-Oran front is investigated. A fixed density gradient is imposed between the Mediterranean Sea and the Atlantic Ocean. It is maintained constant by a newtonian restoring on climatological values. This procedure generates a realistic flux through the strait which has some degrees of freeedom and allows variability linked to variations in the density gradient. Furthermore, the gyres of the Alboran Sea are generated and their behavior is discussed.