A WESTERN MEDITERRANEAN SEA GENERAL CIRCULATION MODEL

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A high resolution general circulation model of the Mediterranean Sea was forced during 20 years by imposing daily atmospheric forcing and transports through the straits. The daily atmospheric forcing is provided by the analyzed outputs of the Météo-France Arpége operational model and the transports through the straits are driven by the density gradients between the Mediterranean sea and the Atlantic ocean (strait of Gibraltar) and the Eastern Mediterranean Sea (strait of Sicily). The grid mesh is 10km*10km and 31 levels are used on the vertical. The turbulence is parametrized by a second order closure scheme based on the mixing length as defined in BLANKE and DELECLUSE (1993).

After 20 years the model is in equilibrium. Energy is quite steady. The Levantine Intermediate Water has progressed from the Sicily strait until the Gibraltar strait following the West coast of Sardinia and the northern coast of the Western basin. Deep water formation is occurring every winter at the end of February. During summer, a realistic re stratification is observed. The transport through the Gibraltar strait is maximum during the January-June period where it reaches a value of 1.3 Sv. up to 1.5 Sv and minimum between July-October with 1.1 Sv.

A large anticyclonic eddy forms in the western basin of the Alboran Sea. The surface current is very unstable in the eastern Alboran Sea and along the Algerian coast where strong velocities are observed (up to 40 cm/s). At the level of the Sicily Strait, the current splits into two branches : one enters the strait while the other one continues along the Italian coast. The latter crosses the Corsican Channel and forms the Northern Current. The surface circulation is qualitatively consistent with the pattern described in MILLOT (1987 b). Meanwhile the Levantine Intermediate Water (LIW) exits the Strait of Sicily, turns eastward along the Italian coast and flows cyclonically around the Tyrrhenian Sea. Outflowing south of Sardinia, the LIW current follows the western coast of that island and progresses towards the northern basin. It then flows westward, trapped along the Italian and French coasts. Velocities in the current are typically 4 to 5 cm/s.

The most surprising result of the simulation is the importance of the barotropic circulation. The Northern Current barotropic transport is about 1 Sv, comparable to the observed transport that varies between 1.5 and 2.2 Sv. The barotropic transport amounts 2 Sv in the Tyrrhenian Sea, while it reaches about 10 Sv in the Alboran Sea gyre.

The transports through the different straits show strong annual variability which is investigated in terms of atmospheric forcing.

DESCRIPTION OF THE ADRIATIC OUTFLOW CURRENT AS OBSERVED FROM THE ELNA DATA

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The primary export of Northern Adriatic surface waters is shown to be restricted to a well-defined outflow on the western side, the Adriatic Outflow Current (AOC). This is a small-scale version of an equatorward, continental-shelf boundary current that is stable with respect to planetary vorticity, like for example, the Mid-Atlantic Bight Shelf Current or the East Greenland Current. The Po runoff and effluents from smaller rivers distributed along the Italian coast comprise the sources of fresh water that sustain a less-dense, shelf water mass. This coastal input of buoyancy generates an isostatic sea-level rise towards the coast that geostrophically drives the barotropic boundary current. The bottom flow generates an offshore frictional transport, that causes a prograde tilt to the pycnocline and an opposing baroclinic shear with depth (i.e. a downwelling circulation). The AOC can be strongly influenced by local winds (cf. ORLIC *et al.*, 1992). The orographic definition of the land boundaries tends to orient winds along the axis of the basin. Most importantly, the wind-driven effect of the Sirocco, from the southeast, counterpoises the AOC and can, with sufficient strength, set up a temporary upwelling circulation. Winds from the northwest accelerate the AOC circulation; and Bora winds, from the northeast, create a similar but more complicated response (Ekman and barotropic flows in opposition at the surface). The low-frequency consequence, of the AOC transporting water out from the northern terminus of the Adriatic, is a compensating inflow and a cyclonic tendency to the mean circulation of the Northern Adriatic.

A primary objective of the ELNA (Eutrophic Limits of the Northern Adriatic) Project is to establish seasonal budget for carbon-related parameters in the Northern Adriatic. Fundamental to this objective is a quantification of the transport and associated mass fluxes exiting the Northern Adriatic by means of the AOC. This work presents preliminary assessments of these transports from the seven ELNA cruises, and selected values from the monthly sections (from Feb' 93 to Dec' 94) of Senigallia and Cesenatico, using the steric-height method (HOPKINS, 1994). The treatment allows for a reasonably clear depiction of the seasonal, along-stream, and lateral structure of the AOC under different runoff and wind forcing conditions. Several examples of mass-flux calculations are given of the CTD-derived variables, such as freshwater and chlorophyll. The freshwater flux is matched with the estimates of runoff to ascertain the uniqueness of the AOC as the surface export mechanism for the Northern Adriatic. Preliminary conclusions, concerning the implications of the observed AOC variability to the Northern Adriatic ecosystem, are also presented.

REFERENCES

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