OBSERVED AND MODELLED CURRENTS ON THE SPANISH CONTINENTAL SHELF NEAR RIO EBRO

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Abstract: Current meter deployments were made at two stations AF (115m) and AM (58m) with near surface and near bottom meters, offs the Rio Ebro. The observed currents are not strongly correlated with the wind except in the 3-4 day period range which is only 20% of the low frequency energy. A diagnostic shelf model shows the importance of the NW Mestral wind jet which forms wintertime contra-rotating gyral circulation in the waters off the Ebro Valley.

Experiment Description: An ongoing experiment is being conducted on the dynamics of the area between Cabo San Antonio and Cabo Creus including the continental shelf and slope in the Gulfs of Valencia and San Jordi, adjacent to the Catalan Sea. The initial observations are from current meter moorings suspended from two oil rigs, AF (115m) and AM (58m) off the Rio Ebro. Each mooring has two Aanderaa current meters located at 8 m above the bottom and 8 m below the surface on a taut mooring with no surface buoy. AF extends from March to October, 1980 and AM from April, 1980 to the present. The overwater wind is recorded at a tanker near AF as well as at several coastal stations.

Data Analysis and Results: Analysis of the current and wind series using complex rotary cross spectra and other statistical techniques show:

1) Inertial currents are up to 50% of the total energy especially at the offshore stations in summer. Strong baroclinic inertial effects cause large bottom inertial currents that are 180° out of phase with the top currents.

2) Low frequency energy (3-24 day period) is partitioned into a 3-4 day band (20% of low frequency energy); 6-12 day band (40-50%); and 24 day band (30-40%). At the deep stations's bottom meter in summer, the 24 day period contained up to 60% of the low frequency energy.

3) The wind and currents have poor coherence except in the 3-4 day band where the coherence is only fair. Wind effects can be seen to perturbate the flow but not determine the general flow direction.

4) In winter the average current at AF is southward at 7.3 cm/s at the bottom and onshore at 2 cm/s at the surface. At AM the surface current is also southward at 3.3 cm/s which is opposite the prevailing wind.

5) In winter the surface and bottom currents at AM are northward during a time of prevailing NW Mestral winds. The currents have an average northward speed of 2.5 - 3.0 cm/s.

Discussion: The circulation on the continental shelf near the Rio Ebro is difficult to describe in detail with only this preliminary data. However, the important driving forces can be evaluated in the inner and outer regions of the shelf. The outer shelf is totally dominated by the flow imposed from offshore in the Catalan Sea. The inner shelf is also affected by the deep sea boundary but the wind has a greater influence. At both stations the wind stress seems to only modulate the larger, externally forced flow. The largest currents found were those at AF at the bottom in summer 1980 when the current reached speed of 25 cm/s with a direction which was uniformly southward for 70 days. The flow at AM at the surface is southward during the same period, opposite the prevailing wind stress. The surface flow at AF was directly shoreward, opposite the expected Ekman transport. This summer onshore flow is confirmed by the drouge track in August, 1978 as reported by Lamy and Millot (1978).

The wintertime flow is dominated by the NW mestral winds. The nearshore mooring AM showed bottom flow to the north, opposite the alongshore component of the wind stress. One explanation of this effect is the influence of the blocking of the mestral winds by the coastal mountain ranges which results in the wind entering the shelf as a concentrated jet centered on the Rio Ebro mouth. This local wind maximum creates an Ekman suction through the curl of the wind stress and this torque is compensated for by a pair of contra-rotating gyres in the interior and bottom flow. A vorticity balance model of the region, similar to that of Han, Hansen and Galt (1980) illustrates the effect of the wind curl and the model results confirm the observed northward flow.

Future Work: The investigation of the shelf and slope region is continuing with the moorings at AF and AM maintained from October, 1982 onward for at least a year. Wind and pressure data is being received from one overwater station and four coastal sites. Two more current meters will be installed at 85 m depth off Cabo Creus along with an automatic weather station on Isla Medas. Another weather station will be installed on the AM oil platform. Tide gages at Palma and Vandellos (in Gulf of San Jordi) will possibly be supplemented by another gage at Blanes, north of Barcelona. Cruises are planned for study of the hydrography and interaction of the slope and Catalan Sea waters. Details of the flow are planned to be studied possibly with Argos drifting buoys and some additional current moorings.

References

Han, G. C., D. V. Hansen and J. Galt, 1980, Steady State Diagnostic Model of New York Bight, Jour. Phys. Oceanog., 10, 1998-2020.

Lamy, A. and C. Millot, 1978, Lion 78, Rapport de presentation des mesures, Mus. Natl, d'Hist. Nat., 79-03, 250 p.