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Canary Islands, Azores, Gibraltar Observations (CANIGO), Volume II: Studies of the Azores and Gibraltar regions

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CANIGO (Canary Islands Azores Gibraltar Observations) is an European research project that was carried out as a target study in the European Union's MAST (Marine Science and Technology) III program from 1996 to 1999. Its general objective was to gain a better understanding of the physics, biogeochemistry, and paleo-oceanography of the eastern subtropical North Atlantic. The study region of CANIGO encompassed the subtropical frontal system of the Azores, the Gibraltar exchange, the northern Canary Islands region, and the transition zone of the NW African upwelling margin. For a detailed description of the project see the editorial of Vol. 1 (DSRII 49/17), which comprises the studies conducted in the northern Canary Islands basin, and the present volume includes those on the Azores frontal region and the Gibraltar/Mediterranean outflow. Together, both volumes provide an integrated understanding of the oceanography of the Canary–Azores–Gibraltar region.

The observations in the Azores region included repeated CTD and water-sample sections across the Azores front and associated mesoscale cyclonic eddies, as well as altimetric observations from the TOPEX/POSEIDON and ERS-1/2 satellites. Efficient processing techniques were developed to merge TOPEX/POSEIDON and ERS-1/2 altimeter data and provided a high-resolution description of sea-level and ocean-circulation variations in the Azores/Canary basin. Analyses of altimeter data have provided a detailed and often novel description of the mesoscale and large-scale variability in the Azores/Canary basin, using altimetry coupled with hydrographic and atmospheric parameters to investigate the large-scale sea-level variation and their relation with air–sea interaction. Altimeter data also were assimilated in near real-time in an ocean model to optimise some of the CANIGO cruises conducted in the frontal region. A new scheme is proposed for the formation of the freely rotating cyclonic eddies observed in the Azores current. One of these eddies, generated from the Azores Current, was intensively sampled after detection in TOPEX/POSEIDON altimetry data, and their physical, chemical and biological properties are described for the first time here. The biogeochemical studies of the Azores front included an analysis of the optical properties and the penetration of solar UV radiation in the upper water layers and a description of the particulate matter and plankton across the Azores Front. Evidence of significant changes in the dominance of calcareous plankton both in space and time, closely coupled to the Azores frontal boundary, is shown and interpreted with respect to the paleo-oceanographic reconstruction of the frontal zone in the quaternary North Atlantic.

The observations in the Gulf of Cadiz and the southern Iberian Basin were focused on the Mediterranean Water flow. They included large-scale surveys with a series of sections across the main stream of the Mediterranean Outflow in the region west of the Strait of Gibraltar, in the Gulf of Cadiz, and further downstream along the Iberian slope. Current-meter/ADCP moorings and deep-sea floats were deployed at the levels of the two main cores of Mediterranean Water. A repeated XBT line off south Portugal supplemented these observations. Significant seasonal variations of the inflow at the Strait of Gibraltar were observed, and the main physical characteristics of the high amplitude steady waves at the Gibraltar sill are described here. Different monitoring techniques based on acoustic tomography were also tested; they should be a useful component for a future monitoring system in the Strait of Gibraltar. The inorganic carbon chemistry was studied, and source and sink terms of atmospheric CO2 at the Strait are quantified. Plankton community structure in this region is controlled by hydrodynamics; particularly the position and oscillation of the interface of North Atlantic and Mediterranean water, and mixing processes were found crucial for the physical–biological coupling in the Strait. Plankton biomass and velocity profiles were measured, and both total plankton biomass transport and the relative contribution of different organism groups to the exchange of plankton through the Strait are estimated.

A joint analysis is present for the geostrophic velocity field and the thermohaline distribution patterns of the Mediterranean outflow in the Gulf of Cádiz. Modelling studies supplemented field data, for the Mediterranean outflow dynamics, the horizontal variations of the outflow properties at Gibraltar, and the turbulent, negatively buoyant jet discharging into the Gulf of Cádiz. New insights on the formation of meddies and dipoles by the Mediterranean water undercurrents southwest of Portugal were obtained from float and hydrographic observations. The spreading characteristics and the chemical interaction of the Med outflow with the surrounding waters were studied, and the suspended particulate matter load and its origin was characterised for the Mediterranean Water at the Gulf of Cadiz.

In addition, CANIGO data are publicly available at the Irish Marine Data Center (datacentre@marine.ie; http://www.marine.ie/datacentre/projects/CANIGO/).