

larger peak-to-peak annual range of 5 Sv, while the second eight years have a semi-annual cycle with a distinct minimum in July and peak-to-peak range of 4 Sv. Filtered Florida Current transports contain a two to three year variation between 2 and 3 Sv in amplitude and a decadal variation of about  $\pm 2$  Sv. The decadal changes in the Florida Current transport are significantly correlated ( $R=0.75$  at 95% significance) to the North Atlantic Oscillation Index.

This presentation will discuss this recent extended time series in the context of historical observations of the Florida Current.

OS52C-10 1605h INVITED

**Linkages Between Modern Oceanic Processes and Fossil Carbon Flux in the Cariaco Basin**

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The Cariaco Basin, historically a natural laboratory for biogeochemists, also contains a record of past climate change. Under interglacial conditions, the formation of sediment varves at the bottom of the basin is related to variability near the ocean's surface, and appears to reflect variations on the scale of the Atlantic Ocean. The CARIACO (Carbon Retention In A Colored Ocean) program established a time series of oceanographic observations at 10°30' N, 64°40' W to examine the connection between changes in the sediment and variability in upwelling and vertical particulate carbon flux. Over the past five years, CARIACO observed significant interannual variation. Increased upwelling and productivity were observed in 1997 due to subsurface ventilations and in 2001 due to stronger winds. Most notable was reduced upwelling and productivity in 1998. We examine the effect of these changes on vertical particulate carbon flux.

URL: <http://paria.marine.usf.edu>

OS52C-11 1620h

**The Bermuda Testbed Mooring and Emerging Technologies for Interdisciplinary Research**

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The Bermuda Testbed Mooring (BTM) program provides the oceanographic community with a deep-water platform for testing new instrumentation. Scientific studies also utilize data collected from the BTM, particularly in conjunction with the U.S. JGOFS Bermuda Atlantic Time-series Study (BATS) program. Additionally, the BTM has been used for groundtruthing of satellite ocean color imager (SeaWiFS) data. The mooring is located about 80 km southeast of Bermuda. Surface instruments have collected meteorological and spectral radiometric data from the buoy tower and measurements at depth have included: currents, temperature, bio-optical, chemical, and acoustical variables. The BTM captures a broad dynamic range of oceanic variability (minutes to years). Key results include: 1. Data obtained during passages of cold-core eddies have been used to estimate the role of such features on new production and carbon flux to the deep ocean. One of the observed features contained the greatest values of chlorophyll observed during the decade of observations at the site (based on BATS historical data base). The measurements provide high frequency, long-term data, which can be used for a) detailed studies of a variety of physical, chemical, bio-optical, and ecological processes on time scales from minutes to years, b) contextual information for many other observations made near the BTM/BATS sites, c) evaluation of undersampling/aliasing effects, and d) developing/testing models. 2. The dynamics of the upper ocean have been observed during transient

re-stratification events and during passages of hurricanes and other intense storms. These observations are unique and the subject of ongoing modeling efforts. 3. BTM papers have provided new insights concerning bio-optical variability on short (minutes to day) time scales and have proven valuable for ocean color satellite groundtruthing. 4. During the BTM project, several new sensors and systems have been tested by U.S. and international groups. These include new measurements of pCO<sub>2</sub>, dissolved oxygen, nitrate, trace elements, several spectral inherent and apparent optical properties, 14C for primary production, and currents.

OS52C-12 1635h

**Linkage between transient upper ocean physical and biological forcing and deep ocean flux at the Bermuda time-series site**

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In late Nov 1996, the Bermuda Testbed Mooring evidenced a fall phytoplankton bloom which was forced by the interplay between mixed layer destratification driven by meteorological forcing and mesoscale eddy dynamics. Nearly coincident with the arrival of this productive eddy at the BTM site, the Oceanic Flux Program (OFP) sediment traps located nearby recorded an abrupt, 2.5x increase in mass flux at 3200 m depth, suggesting a direct causal linkage.

Even more pronounced was the increase in flux of bioactive organic material as indicated by the lipid biomarker composition of the recovered trap material. Labile phytoplankton-derived compounds and polyunsaturated acids (PUFAs) increased in flux by 10-60x. Fluxes of lipid degradation products and bacteria-derived biomarkers similarly increased by greater than an order of magnitude, indicating that the phytoplankton-derived material was undergoing active microbial degradation. Using the E. huxleyi-derived alkenone unsaturation (UK'37) temperature calibration, we estimate the phytoplankton-derived material in the traps at the flux peak was synthesized in late Nov-early Dec, which is consistent with the BTM data and also shipboard measurements of elevated alkenone concentrations made in overlying surface waters in mid Dec. These results indicate that transient upper ocean features associated with synoptic scale meteorological forcing and mesoscale eddies may foster greatly enhanced fluxes of labile organic carbon and associated elements to the deep ocean.

OS52C-13 1650h

**Zooplankton and Micronekton Studies at Bermuda: An Historical Perspective.**

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Studies of zooplankton and fishes around Bermuda have a fairly long history, with collections and descriptions dating back to the late 19th century, at least. This talk reviews the history of these studies at Bermuda, and looks for long-term generalizations about diversity, biomass and seasonality. The first organized sampling program was probably the Bermuda Oceanographic Expedition led by William Beebe in 1929-1931. Beebe worked on mesopelagic fishes and zooplankton for many years at Bermuda, making the first manned dives to the midwater zone in the Bathysphere. More systematic investigations began in 1940 with the work of Moore who used (fairly) consistent sampling methods and reported on the diversity and distribution of zooplankton around the island. Moore paid particular attention to vertical migrations and seasonal shifts in species dominance, but did not provide quantitative data in the modern sense. From the 1960's onward there were a series of programs to sample and quantify zooplankton around Bermuda, mainly in the upper water layers. Since 1994, the BATS program has made monthly zooplankton collections in the top 200

m that are analyzed for biomass and species composition. This sampling, combined with the various historical records of zooplankton occurrence, other sampling efforts at the Bermuda Biological Station, and physical and biogeochemical datasets of the BATS program, forms a valuable time-series of zooplankton dynamics, which should be continued as part of a Sargasso Observatory program.

OS52D MC: 309 Friday 1330h

**Oceanography of the Eastern Boundary Region of the Subtropical North Atlantic Gyre II (joint with B, V, PP)**

Presiding: S Neuer, Arizona State University; G Parrilla, Instituto Español de Oceanografía

OS52D-01 1330h INVITED

**An Overview on the Mediterranean Undercurrent and its Associated Eddies in the North Atlantic**

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The North Atlantic, especially in the subtropical region, has a strong influence of a highly saline and warm water of Mediterranean origin. The flow of the Mediterranean Water not only establishes a typical thermohaline field at intermediate layers, but also plays an important role in the transport of suspended sediments and live organisms of Mediterranean origin. This role is highly reinforced by the activity of submesoscale vortices (meddies) which detach from the Mediterranean Undercurrent and, being in rotation, tend to conserve for long periods (order of years) not only their original thermohaline characteristics but also the dissolved and suspended material. These aspects have been investigated in the frame of several research projects within which the european funded CANIGO brought a relevant contribution. A review is presented of the main results, from both observations and modeling, of the Mediterranean Undercurrent along the Iberian continental slope and its associated eddies. Time variability of the Undercurrent, generation of dipoles and some aspects of the chemical properties associated with the flux of Mediterranean Water are important issues to be outlined in this review.

OS52D-02 1345h

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This investigation summarises the results derived from fourteen oceanographic cruises which were carried out in the Subtropical Eastern North Atlantic during the last decade as part of different research programmes. We determined the biomass of and carbon fluxes between different compartments with the aim of building up the planktonic carbon balance for the region. Depth-integrated chlorophyll a concentrations did not show significant differences among cruises (18 mg Chla m<sup>-2</sup>) and was largely constituted by picoplankton (76%). Particulate organic carbon production (POCP) averaged 317 mg C m<sup>-2</sup> d<sup>-1</sup> and presented a six-fold variation among cruises. 33% of the recently photosynthesised carbon flowed to the dissolved organic pool. The ratio between bacterial and photosynthetic biomass ranged between 0.7 and 1.4. The estimated bacterial carbon incorporation rate largely exceeded the rate of dissolved organic carbon production by microbial populations. Independent estimates of the ratio between organic matter production and consumption derived either from direct determinations of oxygen production/respiration rates or from the carbon budget of the microbial community both converged in the heterotrophic behaviour of the planktonic system in the region. Microzooplankton grazing accounted for

a large fraction of POCp (between 79 and 105 %). On average, herbivorous mesozooplankton removed 15 mg C m<sup>-2</sup> d<sup>-1</sup>, which approximately equals the amount of net POCp not consumed by micrograzers. The results presented in this study stress the need to advocate for allochthonous sources of organic matter to close the carbon budget of the region.

## OS52D-03 1400h

### The Eastern Boundary Current System Between the Canary Islands and the African Coast

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To study the Eastern Boundary Current system off Northwest Africa in detail several CTD/ADCP-sections and long-term mooring work were carried out in the channel between Lanzarote and Africa. The observations are compared with a fine resolution model, which was developed in the framework of the CANIGO project. The water masses, which are observed in this area, are characterised and classified in density ranges. The current field shows a high spatial and temporal variability with maximum velocities of about 35 cm/s. Seasonal means as well as currents averaged across the channel are only a few cm/s. In the surface water a steady southward flow in the middle of the channel indicates the Canary Current in this area. During fall a strong northward current is observed close to the African shelf. Though the Canary Current strengthens during summer and fall due to an increase of the trade winds, the transport in the channel decreases or turns northward during that time due to the enhanced poleward current at the eastern side. A northward undercurrent with a mean velocity of +2.3 cm/s is observed at the African slope in 950 m depth. The poleward transport of AAIW increases during fall and a strong influence of relatively fresh AAIW is observed during that time. Most of the observations fit well to the results of the CANIGO model, but the occurrence of MW at the bottom of the channel and the corresponding southward flow cannot be resolved by the model.

## OS52D-04 1415h

### Does the Labrador Water reach the CANIGO area?

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Four of the cruises conducted as part of the CANIGO (Canary Islands Aores Gibraltar Observations) project were made in an area enclosing a box off the African coast with limits at latitudes 29N and 32N and longitude 18W. The vorticity distribution shows along the 32N section relatively minimum values centered at about 2000-2500 m of depth. At this depth interval there also appear high oxygen concentrations (>5.8 ml/l) and low nitrates and silicates (< 19.5 and 20 micromol/kg respectively).

Taking into account diverse possibilities to find the origin of this water core, the observations seem to point out that a small amount of the Labrador Water may be arriving -below the Mediterranean Water- to this latitude (there is no sign of it at latitude 29N), hence the increase in salinity due to this pathway. The subject is open to other possibilities but not enough references have been found to justify the case

## OS52D-05 1430h INVITED

### Interannual Variability of Biological Production in the Canary Current: a Remote Sensing and Modeling Perspective

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The present constellation of sea-viewing satellites provides an unprecedented opportunity to understand biological-physical interactions. Here we use measurements of wind speed, sea surface temperature (SST), sea surface height, photosynthetically available radiation, and ocean color to address the interannual variability of physical forcing and biological response in the Canary Current. Changes in productivity in the Canary Current, an eastern boundary current, reflect wind forcing and the characteristics of the upwelled water in the coastal area, and advective supply due to filaments and atmospheric dust deposition further offshore. A previous study comparing ocean color-based primary production of eastern boundary currents found that potential production on an annual basis in the Canary Current (0.3 Gt C/y for 1997-1999) was, due to the large area in which chlorophyll concentration surpasses 1 mg Chl/m<sup>3</sup>, second only to that in the Benguela Current. Interannual variability between 1998 and 1999 in the Canary Current was comparable to variability in the Humboldt Current, though less

than in the California Current. SST was anomalously high in 1998 in the Canary Current with a clear negative impact on the spatial extent of high chlorophyll concentrations. The present study compares biological productivity estimated from ocean color and from a planktonic ecosystem model for the period 1996 to 2000 within the context of observations at other eastern boundary currents and in relation to environmental conditions measured from space-borne sensors.

## OS52D-06 1445h INVITED

### Fluxes of Microorganisms Along a Productivity Gradient in the Canary Islands Region (29° N): Implications for Paleoreconstructions.

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To understand the processes controlling the formation of the sediment record, seasonal variations of living communities, fluxes through the water column and sediment accumulation rates of diatoms, coccolithophores and planktic foraminifera were studied through seasonal water column sampling, sediment traps and multi-core sediment sampling in the Canary Islands region (29° N), from the productive NW African coastal area to offshore oligotrophic waters.

A close relationship between the phytoplankton composition and hydrographic conditions was observed. Coccolithophores dominate the phytoplankton community throughout the year. The seasonal flux variability of the various groups as measured in the upper trap samples (=500 - 900 m water depth) reflects the seasonal changes of their vertically integrated standing stocks in the overlying water column. Distinct high standing stocks of all three groups can be related to the influence of upwelling filaments at the nearshore site (EBC). At the offshore sites (ESTOC and LaPalma) all groups display a late winter/early spring maxima related to local increased production. In addition, the increase in flux of all the organisms observed in the deeper traps at both offshore sites can be explained by lateral advection of living material by surface filaments. In addition, the occurrence of diatom and foraminifera species characteristic of high productivity coastal areas in the traps indicates that the material must come from a highly productive coastal region, rather than production in the overlying oligotrophic surface water.

Investigation of the phytoplankton assemblages in the water column, sediment traps and surface sediments reveals: (i) sediment assemblages have been somewhat modified both by differential dissolution in the water column and in the sediments and possibly also by reworking, (ii) the original composition is fundamentally preserved. Diatoms are the most affected by differential dissolution both during settling and within the sediments. Planktic foraminifera (zooplankton) appear to be less altered by dissolution. For both groups, however, the dominant taxa during the upwelling episodic events (Chaetoceros and Globigerina bulloides) are the ones that dominate the assemblages found in the sediments underlying Cape Ghir, the most productive area of the Canary Islands region.