Mesocale features (seamounts, oceanic fronts and cyclonic rings) in the NE subtropical Atlantic: their role in the carbon budget of the euphotic layer
Universidad de Vigo

Beatriz Mouriño Carballido. PhD thesis

The effect of three types of mesoscale features (the Great Meteor Tablemount, GMT; the Azores Current/Subtropical Front system, AC/SFT; and cyclonic eddies budded from the Azores Current, Storms eddies) over the nutrients input into the photic layer was studied in order to determinate if the potential increments in primary production linked to these features could explain, at least partially, the organic carbon deficit described in the NE subtropical Atlantic (Duarte et al., 2001; González et al., 2001, 2002; Serret et al., 2001, 2002).

Five oceanographic surveys were conducted at the GMT (30.0º N, 28.5º W) throughout the 1992-1999 period. Upwelling of isotherms observed over the GMT was linked to biomass (>0.15 mg m^{-3}) and primary production (>0.4 mgC m^{-3} h^{-1}) increments. However, both hydrographic characteristic of the water column over the seamount, as well as their effect over phytoplankton biomass and production were subjected to a large degree of temporal and spatial variability, both at seasonal and shorter time scales. Despite of the relevance of these features from a local perspective, their contribution to the organic carbon deficit described in the NE subtropical Atlantic must be negligible.

Two oceanographic cruises were carried out in the AC/STF region in Julio 1997 and April 1999. Both the magnitude of chlorophyll-a values and primary production rates associated with the STF, as well as their vertical distribution varied sharply associated to subtle changes in seasonal thermal stratification. A significant relationship between the vertical ageostrophic velocity field and nitrate and chlorophyll-a distributions was not detected. However, these variables were significantly correlated with the depth of the 16º isotherm ($r2=0.64$, $p<0.01$; $r2=0.64$, $p<0.01$; respectively). Vertical advective fluxes of nitrate across the base of the DCM were about two orders of magnitude higher than vertical diffusive nitrate transport (-6.6-3.7 mmol m^{-2} d^{-1} versus 0.01 to 0.07 mmol m^{-2} d^{-1}). Diffusive nitrate fluxes only account for < 15 % of the total primary production rates measured in the region. These rates were, however, consistent with the total (diffusive+advective) flux of nitrate to the upper productive layer calculated in this study. The STF would be responsible for a 5% maximum increment of the net primary production in the NE subtropical Atlantic region, what would mean a 8% reduction in the organic matter deficit estimated for the region.

Primary production rates were slightly higher inside than outside a Storm eddy studied in the NE subtropical Atlantic in April 1999. Shallowing (>50 m) of the deep chlorophyll maximum (>0.3 mg m^{-3}) was observed at the eddy centre associated with vertical displacements of the isotherms (>100 m) within the photic layer. Eddy diffusive fluxes across the nitracline (0.02 to 0.10 mmol NO_3 m^{-2} d^{-1}) explained less than 25% of the nitrate required to sustain the estimated new production carried out in this study. Seventeen cyclonic eddies were detected and monitored for time periods ranging from 50 to 360 days. They were characterized by mean westward velocities, amplitudes and diameters of about 2 km d^{-1}, 8 cm and 193 km, respectively. The generation of cyclonic eddies was subjected to an important interannual and seasonal variability. The annual surface occupied by Storms represented less than 2% of the NE Atlantic region considered in this study. On average, these eddies accounted for <1% of the net community production in the region.

The Great Meteor Tablemount, the Subtropical Front and the cyclonic Storm eddies, although altering significantly hydrographic properties of the water column, represent a small (<10%) contribution to the organic carbon deficit measured in the subtropical NE Atlantic.