Continuous measurements of nutrient concentrations and phytoplankton density in the surface water of the Western Mediterranean, winter 1970

by

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Introduction

It is well known the fact that the strong and persistent winter winds blowing over the Western basin of the Mediterranean Sea can break the stratification achieved during the summer and stir the water to great depths. Homothermy and convection have been reported to take place to depths greater than 400 m and up to 2500 m [MEDOC Group, 1970]. Vertical transport has been observed and even measured by VOORHIS & WEBB [1970] as well as its periodical change in direction.

In this paper a study of some of the chémical and biological consequences of such convection is presented along a section extending from the Strait of Bocche di Bonifacio to Barcelona made on board the RV *Thomas G. Thompson* from the University of Washington in March 21 - 23, 1970. Dissolved nitrate, silicate and phosphate together with *in vivo* fluorescence were measured in water continuously pumped from a depth of 10 meters using a sampling device and analytical techniques similar to those described by BALLESTER *et al.* [1972] while the ship was steaming at a speed of 5 Knots.

Every minute the Data Acquisition System sampled the signals received from the Fluorometer and the Auto Analyzers and the data were processed on IBM 1130 computers both on board, at the Instituto de Investigaciones Pesqueras and at the University of Washington. All the figures were drawn on CALCOMP plotters linked to the computers.

Conversion of the fluorescence readings to chlorophyll-a concentrations can be made by using the equation given by MARGALEF [1971] for the same section.

Results and discussion

Time series : Figure 1 shows the time series of the variables studied. Three well defined regions can be observed : two peripheral parts with persistently high fluorescence and low nutrient concentrations and a central part, corresponding to the gyre described by ANATI & STOMMEL [1970] for the previous winter and extending for about 100 miles with alternating patches of high and low fluorescence corresponding to low and high nutrient concentrations.

The high fluorescence-low nutrient patches correspond to water that has been at the surface for some length of time, while the low fluorescence-high nutrient patches correspond to water recently upwelled. The boundaries between patches are smooth with very small, if any, high frequency fluctuations.

The region near Barcelona shows extremely high fluorescence and phosphate concentration with very low nitrate and silicate concentrations, probably due to continental drainage rich in the first nutrient.

Phase plane plots : Figures 2 to 5 show in X-Y diagrams the total set of points. Clustering of the points within patches alternates with quasi-linear progressions as the ship steamed through the patch boundaries. The slopes of such progressions oscillate slightly around some average value. Although with some increased scattering and inverse trend, the Fluorescence vs Nytrients plots show a similar pattern to the Nutrient vs Nutrient ones.

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Ratio plots : Figure 6 shows the ratio of the several nutrients and the fluorescence to nitrate. The ratio silicate/nitrate is almost constant in the central region but increases markedly at the side near Barcelona indicating a faster depletion of the nitrate.

The ratio phosphate/nitrate is abnormally high near Corsica where the water seems to be less stirred and is probably due to regeneration of the phosphate by the phytoplankton and/or zooplankton.

Sliding correlation coefficient : Linear relationships between pairs of variables at the boundaries of the patches can only be explained by active lateral mixing of two different water masses assuming each patch has upwelled from a different depth and at a different time.

Although a more detailed study of the frequency distribution of the patches will be presented on this same session, a preliminary analysis has been made by use of the sliding correlation coefficient introduced by one of the authors in a previous paper CRUZADO [1971]. Movement of the ship within a patch produces values randomly clustered around some point with a low correlation coefficient but when the ship moves from one patch to the next, the correlation coefficient takes a relatively high value.

Figure 7 shows the values of the sliding correlation coefficient between nitrate and silicate for different computation intervals along the section studied. The narrowest interval points out the small patches while increasing width of the computation interval damps out the small fluctuations and only the largest patches show up as large valleys. Note that the central region has only very small patches while the periphery has mainly large ones.

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