Fluctuations and interrelationships among nutrient concentrations and phytoplankton density in the Western Mediterranean, winter 1970

by

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Introduction

The breakdown of stratification in the Western Mediterranean caused by strong winter winds is evidenced in the near-surface water by small-scale patchiness in the central region. More stable water near the coasts of Barcelona and the Strait of Bocche di Bonifacio is characterized by patchiness on a much larger scale [CRUZADO & KELLEY, 1972]. Spectral analyses of the distributions of the dissolved primary nutrients - nitrate, phosphate, and silicate - and *in vivo* fluorescence measured during a transect made across the Western Mediterranean by the R/V *Thomas G. Thompson* in March 21-25, 1970, clearly indicate the dominant patch sizes. Spectral analyses were carried out in two ways. First, normal Fourier transforms were taken on the time series data and the spectral densities of each variable computed by standard methods [JENKINS & WATTS, 1968]. Second, the multivariate time series, considering all four variables simultaneously was fit with an autoregressive model suggested by JONES [1964]. The spectral densities of the individual variables were calculated from the autoregressive model together with the coherences and the phase differences between variables.

Results & Discussion

Univariate spectral analyses : Univariate time series of each of the variables were considered for three separate regions : the coastal area near the Strait of Bonifacio, the central region of the Western Mediterranean, and the coastal area near Barcelona. The spectral densities of each of the variables were computed for each region. The analyses from the two coastal areas were quite similar and together they differ markedly from the central region. In the coastal area near the Strait of Bonifacio the only patch size visible in the nutrient variables is 13.2 km. Fluorescence shows a small peak at that scale, but does not contain any obviously significant patches. In the Barcelona coastal area the dominant patch size in the nutrients is 9.9 km. Fluorescence responds differently exhibiting patches of 13.2 and 7.2 km in size.

By contrast, the central region of the Western Mediterranean is characterized by alternating concentrations of the nutrients and fluorescence which consistently change over much shorter distances than in the coastal areas. Spectral analyses of the data from the central region indicate the existence of dominant patch sizes of 19.8 km, 8.7 km, 6.6 km, 6.1 km, and 5.3 km. The larger size phenomena may indicate the ambient condition of the distribution of nutrients and the smaller size phenomena, which are twice as small as the smallest nutrient patches in the coastal areas, may represent the effects of loss of stratification in the region.

Multivariate time series : Multivariate time series analysis of the data from each of the three regions does not show the changes in the patch sizes among regions because the variables do not all behave consistently enough for high resolution in the spectra, but the coherence measurements and phase difference calculations served to help explain the behavior of the sliding correlation coefficient discussed elsewhere [CRUZADO & KELLEY, 1972].

Rapp. Comm. int. Mer Médit., **22**, 8, pp. 121-122 (1974).

The definition of spatial inhomogeneity in the chemistry of the surface waters of the ocean is receiving increasing attention primarily because of the biological consequences. Understanding the ecological dynamics of the ocean depends upon a knowledge of the dominant spatial scales of patchiness and the temporal persistence of spatial patches.

References

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