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ALMOFRONT 2 cruise in Alboran sea : Chlorophyll fluorescence calibration

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ABSTRACT: HPLC analyses of phytoplankton particles collected on glass fiber filters were performed to calibrate the fluorescence measurements from a fluorometer mounted on the CTD rosette system during Almofront 2 cruise in Alboran sea. The calibration relation is given.

KEY WORDS: fluorescence, geostrophic front, Mediterranean sea.

Acronymes: JGOFS: Joint Global Ocean Flux Studies

Introduction

The Almofront 2 cruise (December 1997-January 1998) was designed to study different aspects of a frontal structure. It complements, for the winter period, a previous study in the same area (Almofront 1 cruise, April-May 1991, Prieur et al., 1993; Prieur et Sournia, 1994). These cruises were a contribution to the JGOFS-France program.

The bottom topography and the constant inflow of Atlantic surface water into the Mediterranean Sea produce, in Alboran sea, a relatively stable hydrodynamic structure with two large anticyclonic gyres surrounded by a strong geostrophic jet. The main current is a jet which produces, under Coriolis effect, an hydrodynamic surface layer frontal structure which marks, near surface, the frontier between Atlantic like, low salinity, waters and the Mediterranean high salinity waters. This front is known as the Almeria-Oran front (Prieur & Sournia, 1994) with a local divergence on its left side and a convergence on its right, looking downstream.

Cruise characteristics

During this cruise, several CTD and fluorescence profiles were performed. The in vivo fluorescence signal provided by the fluorometer was calibrated against Chla concentration determined by High Performance Liquid Chromatography on water samples.

Leg 1 : 30 November – 22 December 1997;

Leg 2 : 24 December 1997 – 16 January 1997

Leg 1 has been designed to describe the frontal structure in different parts of Alboran Sea, and produce the large scale distributions of oceanographic parameters.

Leg 2 was designed to study different processes and components of the pelagic ecosystem. A North-South transect was sampled and several so-called long stations were set in typical situations relative to the frontal structure

Figure 1 gives the location of sampling stations

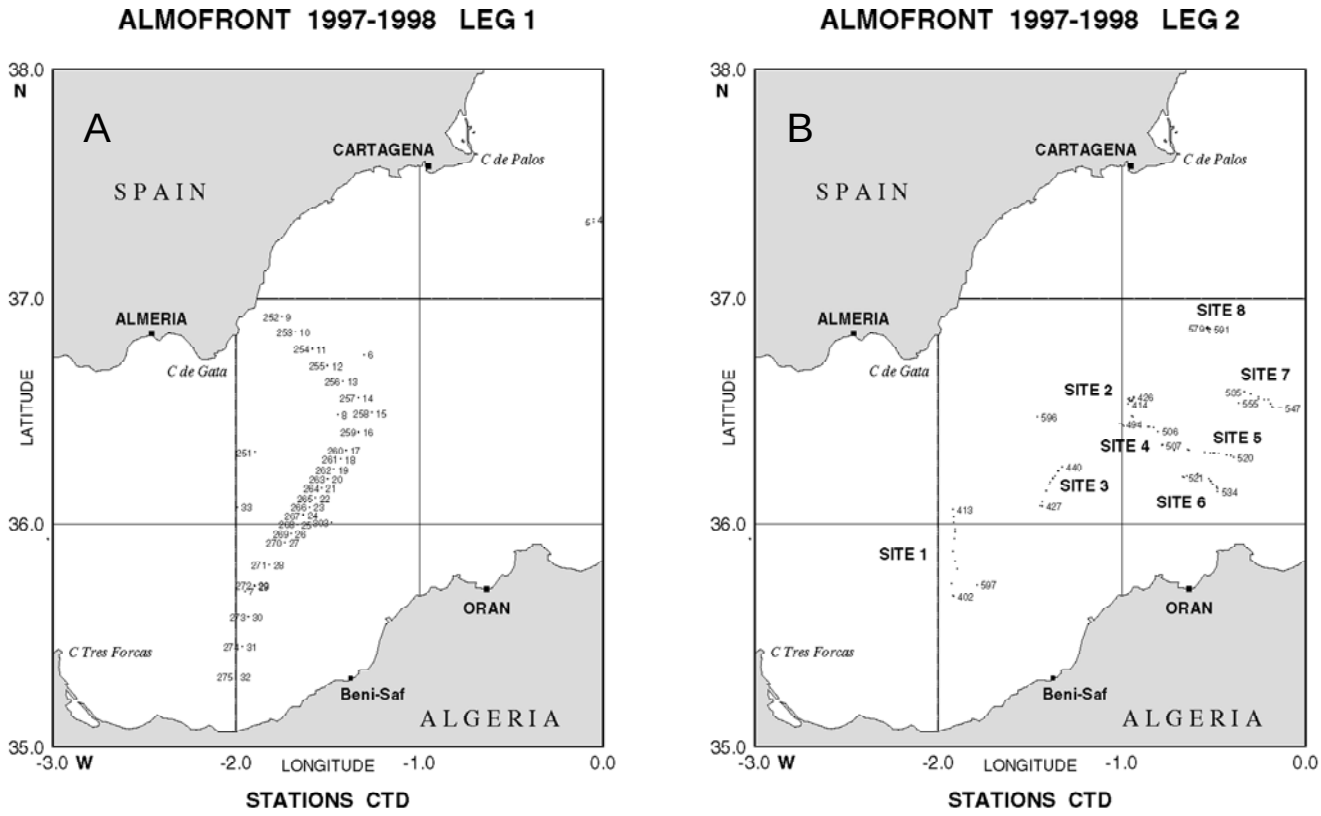

Figure 1 : Station map for Almofront II cruise.

A: Leg 1, only the CTD-rosette transect represented here ((The same transect was sampled twice: stations 9-32 and 252-275),

B: Leg 2, Lagrangian sampling. Sites 1 to 8 are located in characteristic structures of the Almeria-Oran front (Prieur *et al*., 2003, e.g. Van Wambeke *et al*. 2004).

Instruments :

Sampling was done with a rosette of 24 12-liters Niskin bottles on the same frame as a CTD probe (Sea bird SBE 909), a fluorometer (Chelsea) and a transmissometer (SeaTech).

Fluorescence : the Chelsea fluorometer is emitting flash of blue light (5,5 Hz frequency), with a Xenon bulb. The excited Chlorophyll produces a red fluorescence signal with a maximum centered at 685 nm. The following filters were used :

Excitation light : 430 nm, range 105 nm,

Fluorescence emission : 685 nm, range 30 nm

Detection range of the fluorometer: 0,01 to 100 mg Chla m^{-3}.

Calibration method :

Sea water (2 liters) was filtered on GF/F Whatman filters (diameter 25 mm, average porosity 0.7 um). Photosynthetic pigments are extracted and measured directly on board by High Performance Liquid Chromatography method (HPLC) according to Vidussi et al. (1996)

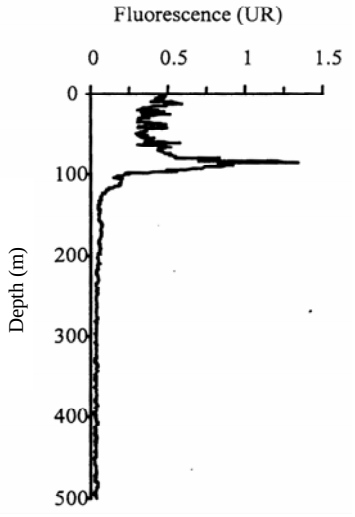

Figure 2: Example of a raw fluorescence profile.
Cast 526 at site 6, Leg 2

Normalization of profiles :

Vertical profiles of raw fluorescence show an offset which gives a spurious chlorophyll concentration at depth deeper than 200m. Samples of water taken in the deep water do not show any chlorophyll. The average value of fluorescence in the layer 350-400m was thus first subtracted at all depth, to produce the depth corrected fluorescence.

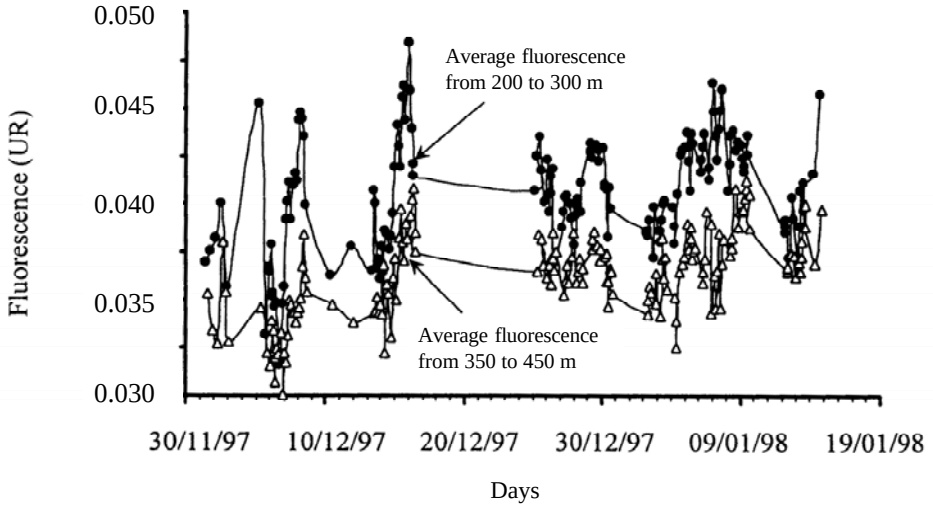

Figure 3 : Offset of fluorescence sensor for two depth ranges, during Almofront II cruise. (although very small this offset is observed on every profile). Compare the fluorescence scale used here to the one used on a complete profile of fig.2.

Calibration relation

Fluorescence, temperature, salinity and density were displayed on the screen of the computer controlling the CTD probe, fluorometer and bottles rosette. Fluorescence values used for calibration were recorded at the closing of each sampling bottle operated from the deck computer.

Figure 4 shows the scatter diagram of chlorophyll versus depth corrected fluorescence for all measurements made during the cruise.

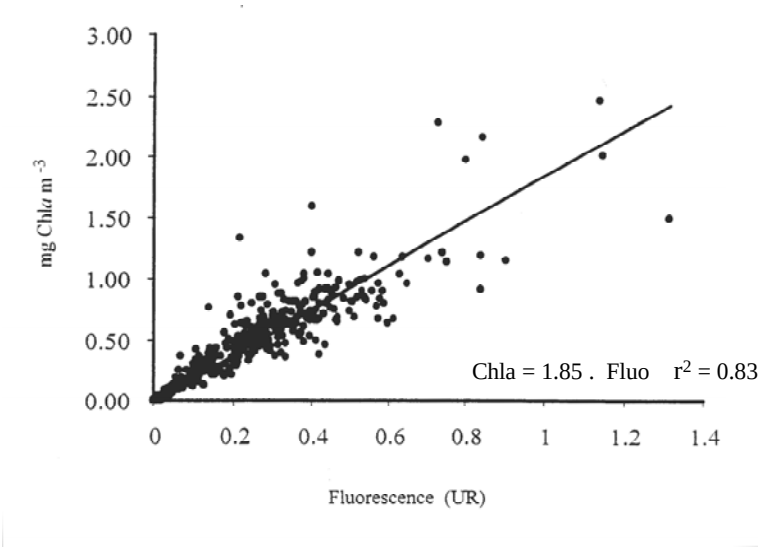

Figure 4 : Scatter diagram from which has been estimated the fluorescence calibration relation

The following linear regression relation can be used to transform depth corrected fluorescence units (Fc, relative units) to chlorophyll (Chla, mg chla. m^{-3}) for Almofront 2 cruise.

$$Chla = 1.85 \, . \, Fc \qquad r^2 = 0.83$$

Chla: Chlorophyll *a* concentration (mg Chla. m^{-3})
Fc: Fc = (F – Offset): depth corrected fluorescence (fluorescence units).

The residual scatter in the diagram can be related to differences in pigment composition or small scale variation in pigment concentration on the vertical (fluorometer is measuring for 2.5 seconds at the depth given by pressure gauge when sampling bottle is averaging the vertical distribution over one meter).

Sharp gradients in phytoplankton distribution which suggest complex turbulence or breaking of internal waves can be seen one the profiles (fig 2). It is to be noted from fig 4, that variance in the chlorophyll *a* estimation is larger in the high fluorescence values range than in the low values range.

Data from this cruise can be found at the web site
http://www.obs-vlfr.fr/cd_rom_dmtt/fr_main.htm

Figure 5 gives, as an example, a distribution of excess density and chlorophyll concentration across the frontal structure, from the North-South transect (station 252 to station 275).

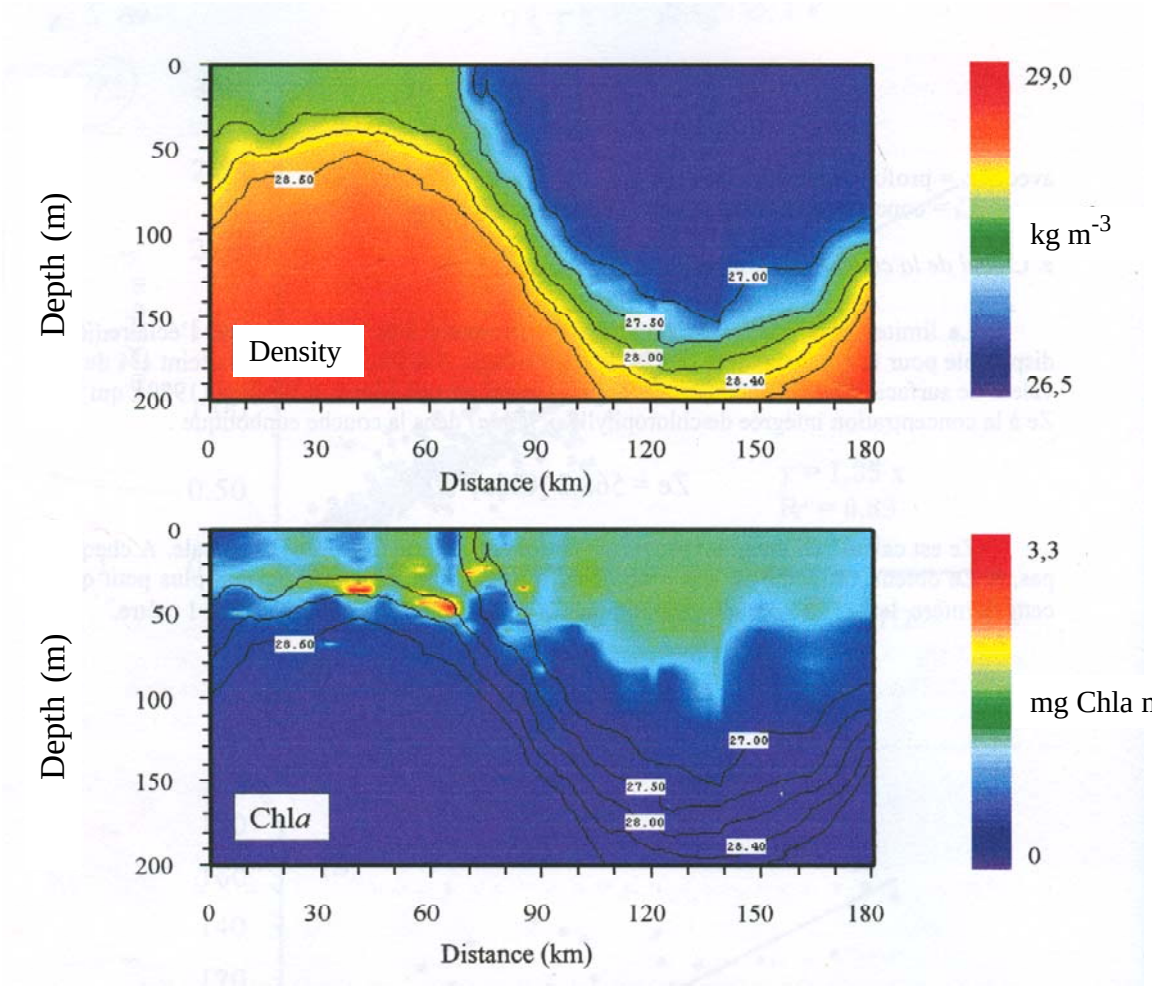

Figure 5 : Cross section of the hydrodynamic front. Mediterranean waters appear on its north side (left) and anticyclonic gyre waters from Atlantic origin, on its south side (right).
A: excess density distribution (color scale and isopycns).
B: chlorophyll *a* distribution derived from fluorescence signal. (black lines are isopycns)

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Web-sites : site Proof JGOFS France:
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