ABSTRACT

The objective of our study is to investigate the possible relationship between the phytoplankton community composition and the *Chla* concentration within the surface layer [$Chla_s$]. In this view, ~ 2000 HPLC-determined vertical profiles of *Chla* and accessory pigment concentrations are merged. The database comprises data collected in various open-ocean waters, characterized by diverse trophic and hydrological regimes. Following the approach proposed by Vidussi *et al.* (2001, JGR 106, 19,939-19,956), taxonomic pigments are used to generate size class markers of phytoplankton groups (microphytoplankton, nanophytoplankton and picophytoplankton). The results show that the proportion as well as the vertical distribution of the three phytoplankton groups largely depend on the trophic regime and can be indexed on [$Chla_s$]. Subsequently, a parameterization is developed to model the vertical distribution of each phytoplankton group using [$Chla_s$] as unique input parameter. Such a parameterization applied to [$Chla_s$] derived from satellite ocean color, can provide synoptic fields of phytoplankton community composition. These fields would be useful for the improvement of the parameterization and/or the validation of biogeochemical and bio-optical models.

FROM SURFACE CHLOROPHYLL a TO PHYTOPLANKTON FUNCTIONAL GROUPS

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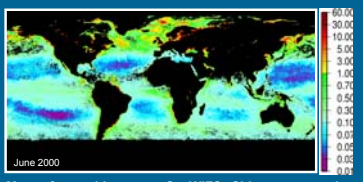
1. INTRODUCTION



Map of monthly mean SeaWIFS Chla concentration ($mg.m^{-3}$) within the surface layer in June 2000.

How is the ocean color signal currently used ?

QUANTITY OF PHYTOPLANKTON BIOMASS

* Content of *Chla* within the euphotic layer
* Vertical distribution of *Chla*

What is proposed to use the ocean color signal more efficiently ?

QUALITY OF PHYTOPLANKTON BIOMASS

* Composition and vertical distribution
* Photo-physiological properties

What are the approaches ?

Relationships between the vertical distribution of *Chla* and the surface *Chla* ($Chla_s$): Morel & Berthon, 1989, Longhurst *et al.*, 1995, Sathyendranath *et al.*, 1995

The phytoplankton biomass quality depends on its quantity (Claustre, 1994, Vidussi *et al.*, 2001) ➞ Possible relationship between $Chla_s$ and the composition and the vertical structure of the phytoplankton communities ?

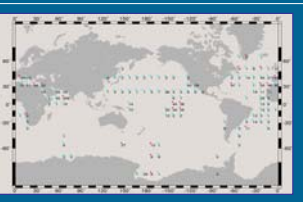
What are the perspectives ?

Global C fixation *via* phytoplankton ⇩ BIO-OPTICAL MODELS OF PRIMARY PRODUCTION

Fate of C in phytoplankton functional groups ⇩ BIOGEOCHEMICAL MODELS (REGIONAL OR GLOBAL SCALE)

2. HPLC-PIGMENT DATABASE

* More than 2000 stations sampled in the world ocean in various trophic and hydrological conditions
* Vertical profiles of *Chla* and carotenoids
  - ➞ Phytoplankton biomass
  - ➞ Composition of the communities
  - ➞ Photo-physiological properties



Number of stations per square of 10°x 10°. More than 50% of stations in **mixed waters (Ze<Zm)** or in **stratified waters (Ze>Zm)** in a particular square. Zm according to Levitus. Ze according to Morel and Maritorena (2001).

3. METHOD

* **$Chla$ partitioned into 3 phytoplankton size classes** from relevant pigments criteria (Claustre, 1994 and Vidussi *et al.*, 2001)
  - ·Zeaxanthin, TChl*b* -> **pico-Chla** (< 2 µm): *e.g.* Prokaryotes and small Eukaryotes
  - ·19'-HF, 19'-BF, Alloxanthin -> **nano-Chla** (2-20 µm): e.g. *Emiliana*
  - ·Fucoxanthin, Peridinin -> **micro-Chla** (> 20 µm): e.g. Diatoms
* **Computation of a mean pigment profile for each trophic category indexed on $Chla_s$** according to Morel & Berthon, 1989
  - Generate dimensionless profiles -> $\xi = z / Z_e$ (optical depths)

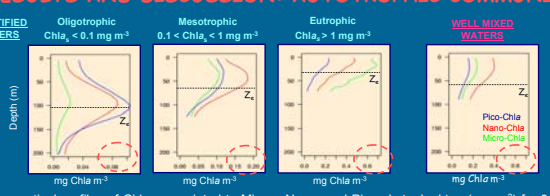
    -> $Chla(\xi) = Chla(z) / Chla_{Ze}$

    $Chla_{Ze}$: average Chla concentration within the euphotic layer ($mg.m^{-3}$)
  - Interpolate profiles in a range from $\xi = 0$ to $\xi = 2$ (interval 0.1) -> profiles can be superimposed or pooled together
  - For each trophic category: a mean dimensionless pigment profile is calculated and recomputed according to the relevant Z_e and $Chla_{Ze}$
* **Inference of the pigment profiles from $Chla_s$**
  - The generalized Gaussian profile (Lewis *et al.*, 1983), added to a background depth-varying $Chla$ concentration, is adopted to reproduce the mean vertical profiles:

$$Chla(\xi) = C_0 + C_b \xi + C_{max} \exp\{ - [(\xi - \xi_{max}) / \Delta\xi]^2 \}$$

  - These 5 parameters (C_0, C_b, C_{max}, ξ_{max} et $\Delta\xi$) are indexed on $Chla_s$

4. RESULTS AND DISCUSSION: AUTOTROPHIC COMMUNITY COMPOSITION



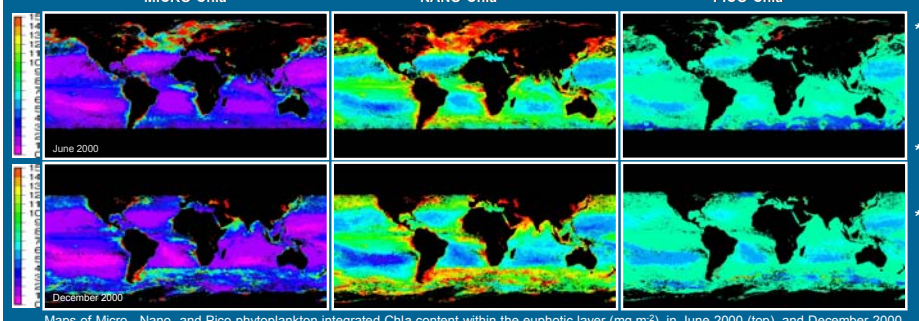
Mean vertical profiles of Chla associated to Micro-, Nano- and Pico-phytoplankton ($mg.m^{-3}$) for 3 major trophic categories in the stratified waters, and for the mixed waters.

The composition and the vertical distribution of the phytoplankton biomass largely depend on the hydrological and trophic status:

* As expected, pico-phytoplankton is the main population in oligotrophic regimes, micro-phytoplankton is associated with eutrophic regimes and nano-phytoplankton composes an ubiquitous population.
* In mixed waters, the phytoplankton populations are uniformly distributed within the euphotic layer.

➞ **The vertical Micro , Nano and Pico Chla profiles can be inferred from $Chla_s$**

5. APPLICATION: DISTRIBUTION OF THE PHYTOPLANKTON FUNCTIONAL GROUPS IN THE WORLD OCEAN



Maps of Micro-, Nano- and Pico-phytoplankton integrated Chla content within the euphotic layer ($mg.m^{-2}$), in June 2000 (top), and December 2000 (bottom). Black color identifies earth and clouds. Red color identifies values greater than 15 $mg.m^{-2}$.

* The micro-phytoplankton varies over a larger range than the two others groups. Extremely low values (< 2 $mg.m^{-2}$) are typical of the subtropical gyres, while values greater than 5 $mg.m^{-2}$ are associated with high latitude environments and coastal areas.
* The nano-phytoplankton follows the general trend of the surface *Chla* concentration.
* The pico-phytoplankton varies within a much restricted range of concentrations. This group is the main contributor to the autotrophic biomass in the tropical gyres. It also displays the weakest seasonal variability among the three groups.

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