

## Hydroclimatic modulation of 1988–2001 diatom/*Phaeocystis* blooms in the eutrophicated Belgian coastal waters

Christiane Lancelot

Université Libre de Bruxelles, Ecologie des Systèmes Aquatiques

### Time series Station 330 (Southern North Sea)

#### *Location*

The 20-m-deep Station 330 (N 51°26.00; E 02°48.50; Figure 2.1), located in the central BCZ (Belgian Coastal Zone) is representative of the Southern Bight of the North Sea, as its physico-chemical (depth, temperature, salinity, nutrient enrichment level) and ecological characteristics (early spring diatom bloom, spring *Phaeocystis* bloom, over fished top predators) are similar to those present in large part of the region. The strong along-shore tidal currents (1 m s<sup>-1</sup>) combined with the shallow water depth ensures a permanent vertical mixing of the water column. This area is highly dynamic, with water masses resulting from the variable mixing of the English Channel water inflow coming from the Atlantic and freshwater input from the river Scheldt which results in nutrient enrichment of the area (Figure 1). The inflowing Atlantic waters are themselves enriched with nutrients from the river Seine.

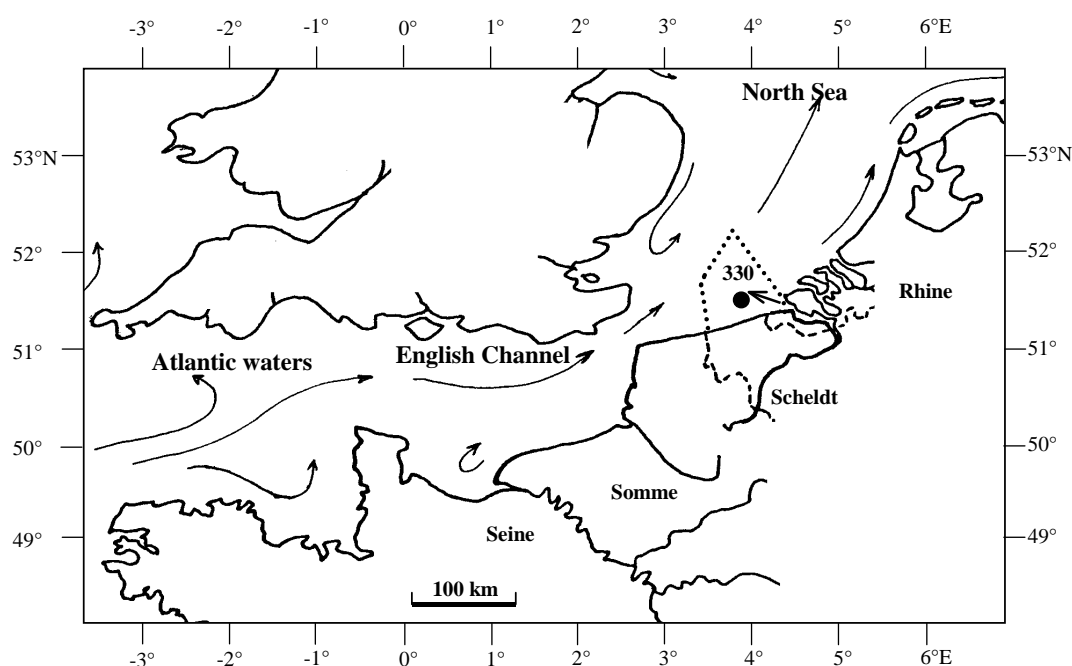


Figure 1. Map showing the borders of BCZ (dotted lines) and location of station 330.

#### *Sampling*

Between 1988 and 2001 subsurface seawater was collected throughout the year at station 330 (Figure 1) at weekly intervals except during winter and summer, when the interval was 2 weeks. From 1988 to 1991 and in 2001, the survey period only ran from February to mid-June.

#### *Measured parameters*

Sub-samples were analyzed for salinity, temperature, major nutrients (NO<sub>3</sub>, NH<sub>4</sub>, PO<sub>4</sub>, Si(OH)<sub>4</sub>), Chlorophyll a (Chl a), dissolved organic carbon (DOC) and main phytoplankton groups [diatoms, nanophytoplankton and *Phaeocystis* colonies (cell number and carbon biomass)].

For some years, bacteria, heterotrophic nanoflagellates, microprotozooplankton and Noctiluca were also measured (cell number and carbon biomass)

**Statistical analysis of diatom/*Phaeocystis* blooms at St.330 over 1988–2001: response to Q1-4 and Q6-7**

Over 1988–2001, diatoms were recorded year-round while *Phaeocystis* colonies occurred as a spring event lasting between 4 and 13 weeks. The diatom-*Phaeocystis* succession was observed every year, but the magnitude of the blooms showed important interannual fluctuations with most years clearly dominated by *Phaeocystis*, but a few by diatoms. Over this period, P loads by the Scheldt river were reduced by about 77% with respect to the level in the early 1980s, but N loads remained unchanged. Yet, the phytoplankton time series collected at station 330 did not reveal any corresponding trend in diatom-*Phaeocystis* blooms. The hypothesis of the additional influence of NAO-driven hydroclimatic factors was explored.

The statistical analysis of the fourteen-year (1988–2001) of intensive phytoplankton monitoring at station 330 in the central Belgian Coastal Zone (BCZ, Southern Bight of the North Sea) suggested that the long-term diatom biomass trend and the spring dominance of *Phaeocystis* colonies over diatoms were determined by the combined effect of the North Atlantic Oscillation (NAO) together with freshwater and continental nitrate carried by the Scheldt. The strong correlation between diatoms and the NAO index was largely explained by the modulating effect of the latter on the water budget at the monitoring station. The relationship between *Phaeocystis* spring blooms and winter NAO (NAOw) was indirect, better expressed by springtime *Phaeocystis* dominance over diatoms due the higher response of the latter to the NAO. The spring *Phaeocystis*:diatom bloom ratio was negatively (or positively) linked to positive (or negative) NAOw values. A complex cascade of events linked large-scale NAO index variations to the local meteorological conditions (wind strength and direction, rainfall) that drove the hydrography and water budget of the BCZ. Local meteorological conditions in turn were modulating the geographical spread of Scheldt nutrient loads in the coastal zone and ultimately regulated the magnitude of *Phaeocystis* spring blooms by determining winter nitrate enrichment. Hence, the absence of a linear relationship between *Phaeocystis* spring blooms and NAOw was explained by the nonlinear response of river-based nitrate pulses to NAO due to local wind-driven hydrodynamical forcing.

**Response to Q8-10**

*Phaeocystis* blooms are accompanied by foam deposition on beaches. This foam deposition is due to the wind-driven mechanical action of waves on ungrazed *Phaeocystis* colonies accumulated in the water. Thresholds are under study based on a combination of natural science (e.g. thresholds for food web disruption) and environmental socio-economy.