ANNUAL CYCLE OF PELAGIC METABOLISM IN THE SCHELDT ESTUARY

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INTRODUCTION

Estuaries are semi-enclosed zones where continental dissolved and particulate material transfer to the coastal zone. These systems are usually characterized by striking physico-chemical gradients and enhanced biological activity due to high inputs of organic matter and nutrients from rivers. The Scheldt estuary is a turbid, eutrophic coastal plain estuary in the southwest of the Netherlands and northeast of Belgium (see Fig. 1). It drains about 21,580 km2 of land and in one of the most densely populated and highly industrialised regions of Europe. The residence time of water in the entire estuary is approx. 100 days. We present results of pelagic gross primary production (GPP), community respiration (CR) and nitrification (Nit) measured by the oxygen Winkler method, from an annual study in 2003. Five stations along the estuary were monthly investigated at fixed salinities (0, 2, 10, 18 and 25; see the average position of each station in Fig 3).

RESULTS

1) pCO2 and O2 concentrations

Fig. 3: Surface pCO2 and O2 (% salinity) at each incubated station over an annual cycle. Very low O2 concentrations and high pCO2 were found in the inner part of the estuary (sal 0 and 2), with the lowest O2 concentration found at salinity 2 (74 atm) and the highest pCO2 measured at salinity 0 (101.10 atm) in June (see Fig. 3). In the freshwater part (sal 0), a decrease of pCO2 and an increase of O2 concentrations were observed in summer well related to high GPP and positive NCP values measured in this section of the estuary during this period (see section 3). In the lower part of the estuary (sal 18 and 25), O2 oxygenation (highest in April; 116% at salinity 25) was found in spring; pCO2 values measured during this period correspond to the lowest ones observed in the estuary in 2003 (lowest value in April at sal 25: 440 atm).

2) Nutrients concentrations

Fig. 4: Surface nutrient concentrations at each incubated station over an annual cycle. Ammonium (NH4) concentrations (Fig. 4) showed a clear seasonal cycle with highest values measured in winter and early spring. At salinity 0, a strong peak (110 µmol L-1) is observed in May corresponding to higher O2 concentrations (Fig. 3) and enhanced nitrification/respiration activities (Fig. 5). The nitrate (NO3) cycle is less clear although highest values were also globally observed in winter and early spring. Nitrite (NO2) showed a strong increase in the inner part (sal 0 and 2) from January to June with a highest value observed in July in the freshwater part (~30 µmol L-1). In the outer part, Nitrogen and Nitrate concentrations were less variable. Phosphate (PO4) concentrations were globally lowest in brackish and marine waters in winter and early spring and increased till late summer, while in the freshwater part highest values were observed in winter with a maximal concentration in December (~10 µmol L-1). Silicates (SiO4) presented a strong decrease in summer especially at the inner part reaching a lowest value at salinity 2 (0.5 µmol L-1) well related to high pCO2 values observed in this section of the estuary in summer and then mainly attributed to dinoflagellates species.

DISCUSSION & CONCLUSION

This study showed the strong heterotrophic status of the turbid Scheldt estuary over an annual cycle. Annual averaged NCP values along the salinity gradient are presented in Fig. 6 and compared with a previous models-based estimate. Higher NCP values were observed but showing the same trend along the salinity gradient. Net Community Production rates measured during these campaigns are among the lowest reported in the literature, leading to elevated pCO2 and low O2 concentrations in surface waters, especially in the inner part of the estuary. The nitrification process accounted for a significant part of the oxygen consumption (and organic matter production) especially at salinity 2 where the annual average nitrification rate represented almost 30% of all NCP values.

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