Dissolved inorganic carbon dynamics and CO₂ atmospheric exchanges in the inner and outer Scheldt estuary.
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Since 1992, the Chemical Oceanography Unit of the University of Liège has carried out on a regular basis field cruises in the Scheldt inner estuary and the river plume (outer estuary), during which were measured: pH, total alkalinity, dissolved inorganic carbon, partial pressure of CO₂ (pCO₂), dissolved oxygen and atmospheric flux of CO₂. In the inner Scheldt estuary, pCO₂ values in the upper estuary can be as high as 9000 ppm that is about 25 times the value of atmospheric equilibrium (presently around 370 ppm). These high pCO₂ values induce a high CO₂ efflux and the entire Scheldt can emit up to 790 tons of carbon per day (tC day⁻¹) to the atmosphere. The annually integrated CO₂ emission is estimated to 456 tC day⁻¹ (Frankignoulle et al 1998 Science 282: 434-436). Along the salinity gradient, dissolved inorganic carbon dynamics are dominated on one hand by nitrification at salinities around 5 and on the other hand by dilution. Total alkalinity is not conservative in the upper estuary (salinity 0 to 5) due to intense nitrification which produces H₃O⁺ and leads to a decrease of total alkalinity and a minimum of both pH and oxygen saturation level. For salinities higher than 5, total alkalinity has a conservative behaviour (Frankignoulle et al 1996 Limnol. Oceanogr. 41: 365-369). A simple carbon budget shows that aerobic heterotrophic activity and nitrification produce similar amounts of CO₂ and can explain most of the CO₂ emission from the inner estuary to the atmosphere. The input of CO₂ from fresh water inputs represents only 10% of aerobic heterotrophic activity and nitrification and 10% of the estuarine emission to the atmosphere. The advective flux of CO₂, from the river to the estuary and from the estuarine mouth to the North Sea are one order of magnitude lower than atmospheric exchange in the estuarine zone (Abril et al 2000 Comptes Rendus de l'Académie des Sciences Paris 330: 761-768). In the outer Scheldt estuary, pCO₂ shows a distinct seasonal evolution related to the cycle of biological activity. Throughout the year, the river plume is over-saturated (average pCO₂ value of about 450 ppm) except during the Phaeocystis bloom when values of pCO₂ as low as 50 ppm are observed (Borges and Frankignoulle 1999 J. Mar. Syst. 19: 251-266). The outer Scheldt estuary emits CO₂ on an annual basis at a rate of about 110 tC day⁻¹ that corresponds to about 25% of the emission of CO₂ by the inner estuary. A simple carbon budget shows the input of CO₂ from the inner estuary contributes to about 30% of the emission of CO₂ from the outer estuary. The remaining emission of CO₂ is from the net heterotrophic activity fuelled by organic carbon inputs from the inner Scheldt estuary and the Belgian coast (Borges and Frankignoulle 2002 Biogeochemistry 59: 41-67).