Dissolved inorganic carbon dynamics and CO_2 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 CO_2 (pCO_2), dissolved oxygen and atmospheric flux of CO_2. In the inner Scheldt estuary, pCO_2 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 pCO_2 values induce a high CO_2 efflux and the entire Scheldt can emit up to 790 tons of carbon per day (tC day^{-1}) to the atmosphere. The annually integrated CO_2 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 H_3O^+ 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 CO_2 and can explain most of the CO_2 emission from the inner estuary to the atmosphere. The input of CO_2 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 CO_2, 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, pCO_2 shows a distinct seasonal evolution related to the cycle of biological activity. Throughout the year, the river plume is over-saturated (average pCO_2 value of about 450 ppm) except during the *Phaeocystis* bloom when values of pCO_2 as low as 50 ppm are observed (*Borges and Frankignoulle 1999 J. Mar. Syst. 19: 251-266*). The outer Scheldt estuary emits CO_2 on an annual basis at a rate of about 110 tC day^{-1} that corresponds to about 25% of the emission of CO_2 by the inner estuary. A simple carbon budget shows the input of CO_2 from the inner estuary contributes to about 30% of the emission of CO_2 from the outer estuary. The remaining emission of CO_2 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*).