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A model study of the evolution over the past 50 years of air-sea CO_2 fluxes in the Belgian coastal zone (Southern Bight of the North Sea)

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The coupled river-coastal sea model RIVERSTRAHLER-MIRO-CO_2 (R-MIRO-CO_2) is used to appraise how nutrient loads and increased atmospheric CO_2 are affecting contemporary air-sea CO_2 exchanges in the Belgian coastal zone (BCZ) (Southern Bight of the North Sea). R-MIRO-CO_2 results of the offline coupling between RIVERSTRAHLER C, N, P and Si river loads to the coastal zone constrained by meteorological conditions and human activity on the watershed and the MIRO-CO_2 model of C, N, P, Si cycles in the coastal sea. For this application, the marine MIRO-CO_2 model is implemented in a 0D multi-box frame covering the eutrophied Eastern English Channel and Southern North Sea and receiving loads by the river Seine and Scheldt. Model simulations are performed for the period between 1951 and 1998 using real forcing fields for sea surface temperature, wind speed and atmospheric CO_2 and RIVERSTRAHLER simulations for river C and nutrient loads. Model simulations suggest that the BCZ shifted from a source of CO_2 before 1970 (low eutrophication) towards a sink during the 1970-1990 period when anthropogenic N and P loads increased. The period after 1990 is characterized by a progressive decrease of P loads concomitant with a decrease of the CO_2 sink. At the end of the simulation period, the area acts again as a source for atmospheric CO_2. Additional simulations investigating the relative impact of temperature, wind speed, atmospheric CO_2 and river loads variability (compared to 1951) on the simulated air-sea CO_2 fluxes point these latter as drivers of the magnitude and the direction of the air-sea CO_2 fluxes in the BCZ.