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Processes controlling the seasonal variations of the air-sea CO2 fluxes in the Loire Estuary and adjacent surface waters of the Bay of Biscay

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The constraint of air–sea CO2 fluxes and their variability at various time and spatial levels remain a central task in global carbon and climate studies. The spatial variability of these fluxes is large from one coastal ecosystem to the other and it was recently proposed to classify continental shelves as sinks and near-shore ecosystems as sources of atmospheric CO2. However, the role of estuarine plume, the transition zone from inner estuaries to continental shelves, on the global estimates of air-sea CO2 fluxes remains poorly understood. Here, we investigate the seasonal variability of the air-sea fluxes of CO2 in the Loire estuary, the estuarine plume and the adjacent surface waters of the Bay of Biscay in northern Europe.

During 2009, three cruises were carried out at each season covering a grid of 40 stations from the inner part of the Loire estuary to the outer plume and adjacent waters in an area situated between 46.5°N; 2°W and 48.5°N; 5°W. The spatial coverage of the surface waters allowed us to compare pCO2 distribution in different regions of the shelf going from inner estuary to outer plume. Large oversaturation of pCO2 compared to the atmosphere (average atmospheric pCO2 of 385 μatm) was observed each season in the inner estuary. Maximum pCO2 values in the estuary varied from 1500 μatm in spring to 2600 μatm in summer and fall. The estuarine plume extension (arbitrary limit S = 34) showed large inter-seasonal variability, extending 70 km off the estuarine mouth in spring and 15 km in fall. This estuarine plume had contrasting effect on the seasonal pCO2 distribution, with strong undersaturation in spring (values of 220 μatm) and strong oversaturation in fall (values of 600 μatm). The processes (biological vs physical) controlling the pCO2 distribution at each season will be evaluated and the impact of the estuarine plume on the air-sea CO2 flux estimates in the region will be assessed.