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SEASONALLY-VARIABLE SURFACE-WATER CO_2 GRADIENTS AND FLUXES ALONG THE GULF AND ST. LAWRENCE ESTUARY (QUEBEC, CANADA)

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The Estuary and Gulf of St. Lawrence (EGSL), at the lower limit of the subarctic region in eastern Canada, make up the world's largest estuarine system. In summer, the St. Lawrence River delivers warm, high pCO_2 waters to the Upper St. Lawrence Estuary (USLE) near Quebec City while upwelling brings cold, CO_2-enriched waters to the surface at the head of the Lower St. Lawrence Estuary (LSLE) near Tadoussac. The surface-water pCO_2 then decreases seaward to reach a minimum in the middle of the LSLE as CO_2 is actively taken up by photosynthetic organisms. As surface-water nutrient concentrations and primary productivity wane, as waters enter the Gulf of St. Lawrence (GSL) and their residence times increase, pCO_2 values approach atmospheric values. In winter, the surface-water pCO_2 at the head of the estuary is lower but decreases more slowly than in the ice-free season as cold waters flow seaward into the LSLE and the GSL. Lower respiration rates and depressed photosynthetic activity in the USLE and LSLE due to cold temperatures and limited insolation in the winter along the Laurentian Channel explain the seasonal difference. Whereas the air-sea CO_2 fluxes are positive (towards the atmosphere) and similar in the USLE throughout the year, they remain positive in the LSLE but are higher in winter due to limited drawdown by photosynthetic activity. CO_2 fluxes along the Laurentian Channel in the GSL are, within the uncertainty of the estimates, nearly null throughout the year as the surface waters appear to be in equilibrium with the atmosphere. These interpretations are supported by the differential behavior of the stable carbon isotopic composition of the dissolved inorganic carbon (δ^{13}C-DIC) along the estuary. The potential impact of climate change and weather conditions on CO_2 fluxes at the air-sea interface in the EGSL will be discussed based on recent, future projections of the biochemical and physical properties of these waters.