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The inorganic carbon distribution in Irish coastal waters

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Despite their relatively small surface area, coastal and shelf waters play a crucial role in the global climate through their influence on major biogeochemical cycles. Due to growing concern about ocean acidification as a result of increasing atmospheric CO_2 concentrations, measurements of inorganic carbon parameters (dissolved inorganic carbon (DIC), total alkalinity (TA), pH and pCO_2) have been made with increasing regularity over the past two decades. While it is clear that open ocean surface waters are acidifying at a fairly uniform rate (-0.02 pH units per decade), less is known about changes in coastal waters due to the high complexity and spatial variability in these regions. Large spatial and temporal variability in coastal CO_2 parameters is mainly due to nutrient inputs, biological activity, upwelling and riverine inputs of alkalinity and inorganic and organic carbon. The inorganic carbon system in Irish coastal waters is presented here, gathered from 9 surveys around the Irish coastline between 2009 and 2013. There are striking contrasts in the CO_2 system between different areas, largely attributed to the bedrock composition of the nearby rivers. Freshwater end-member concentrations of TA, calculated from TA-salinity relationships in outer estuarine and nearshore coastal water, were supported by riverine TA data from the Irish Environmental Protection Agency. A large portion of Ireland is covered with limestone bedrock and as a result, many of the rivers have extremely high TA (>5000μmol/kg) due to the carbonate mineral content of the underlying bedrock. While such high TA has resulted in elevated pH and calcium carbonate saturation states in some coastal waters, (e.g. Galway Bay and Dublin Bay), the high TA in other areas was accompanied by particularly high DIC (e.g. River Shannon on the west coast), resulting in lower pH and aragonite/calcite saturation states and even CO_2 degassing in the Shannon estuary. Due to non-limestone lithology in many parts of Northern Ireland, rivers and surrounding coastal water have lower TA and hence calcium carbonate saturation states that are directly related to salinity (e.g. Lough Foyle). This study highlights the complexity of the inorganic carbon system in Irish waters and the need for region-specific case studies to be carried out to assess the potential impacts of ocean acidification on coastal ecosystems.