Regionalized global budget and drivers of the CO_2 air-sea exchange in continental shelf seas

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Over the past decade, estimates of the atmospheric CO_2 uptake by continental shelf seas have been constrained within the 0.18–0.45 Pg C yr^{-1} range. However, most of those estimates are based on extrapolations from limited data sets of local flux measurements (n<100). Here, we present the first regionalized global budget of the CO_2 air-sea exchange in the continental shelf seas derived from $3 \cdot 10^6$ direct surface ocean CO_2 measurements extracted from the global database SOCAT (Surface Ocean CO_2 Atlas). Our results were areagated using a global segmentation of the shelf in 45 units and 152 subunits to establish a consistent regionalized CO_2 exchange budget at the global scale.Within each unit, the data density determines the spatial and temporal resolutions at which the air-sea CO_2 fluxes are calculated and range from a 0.5° resolution in the best surveyed regions to a whole unit resolution in areas where data coverage is limited. Our approach also accounts, for the first time, for the partial sea ice cover of polar shelves.

Our new regionalized global CO_2 sink estimate of 0.19 ± 0.05 Pg C yr^{-1} falls in the low end of previous estimates. Reported to an ice-free surface area of $22 \cdot 10^6$ km^2, this value yields a flux density of 0.7 mol C m^{-2} yr^{-1}, ~40% more intense than that of the open ocean. Our results also highlight the significant contribution of Arctic shelves to this global CO_2 uptake (0.07 Pg C yr^{-1}). Furthermore, the data coverage in the Atlantic basin allows resolving the seasonality of the CO_2 exchange for most regional units and investigate the relative contributions of the solubility and biological pumps to this seasonal dynamics. The next step in improving the understanding of the CO_2 exchange between continental shelve seas and the atmosphere is to use advanced statisical methods based on artificial neural networks to fill spatial gaps in data and provide high resolution continuous maps including the least monitored regions.