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Impact of vertical mixing on sea surface pCO_2 in temperate seasonally stratified shelf seas

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A key parameter in determining the exchange of CO_2 across the ocean-atmosphere interface is the sea surface pCO_2. Temperate seasonally stratified shelf seas are thought to represent a significant sink for atmospheric CO_2. Here an analytical model is used to quantify the impact of vertical mixing across the seasonal thermocline on the sea surface value of pCO_2. The model includes the impacts of the resultant dissolved inorganic carbon, heat, salt and alkalinity fluxes on the solubility of CO_2 and also the effect of the inorganic carbon sink created by the primary production fuelled by the flux of limiting nutrient. The results indicate that diapycnal mixing drives a modest but continuous change in the sea surface value of pCO_2 of order 1-10 matm per day. In quantifying the individual impacts of the fluxes of the different parameters we find that the impact of the fluxes of DIC and nitrate fluxes dominate, with both the direction and magnitude of the change in sea surface pCO_2 strongly dependent on the C:N uptake ratio in primary production. Whilst the smaller impacts of the heat and salt fluxes tend to compensate for one another other at mid-shelf locations, the heat flux dominates close to the shelf break. The analysis highlights the importance of the accurate parameterisation of the C:N uptake rate by primary production, the surface mixed layer depth and the TKE dissipation rate within the seasonal thermocline in models to be used to predict the air-sea exchange of carbon dioxide in these regimes.