# Decoupling of projected oceanic uptake of carbon and heat in the 21st century in a high carbon emission pathway

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The global oceans have been a major sink of anthropogenic $CO_2$ and heat since the preindustrial era, thereby slowing the increase in atmospheric carbon and heat content. At the same time, the uptake of heat and carbon affect the marine environment through changes to the chemistry and temperature of the oceans. While air-sea exchange of both carbon and heat are dependent on similar mechanisms (e.g., air-sea gradients and wind speed), with the general pattern of net storage showing agreement, there is the potential for a divergence due to mechanisms that do not affect both properties (e.g. chemical buffering capacity, temperature-mediated solubility of carbon, andthe role of humidity in heat exchange). This study addresses the question of when, where, and by how much will the pathways for oceanic uptake of heat and carbon diverge in the “Business-as-Usual” (RCP8.5) scenario of atmospheric $CO_2$changes over the 21st century via the Ocean Forecasting Australia Model with an eddy-resolving horizontal resolution (0.1˚). This higher resolution is employed, rather than conventional 1-degree CMIP-style models, as eddies have the potential to contribute substantially to mixing in the ocean. The simulation projects that 21st century cumulative uptake of anthropogenic carbon and heat will be three and ten times higher, respectively, than estimates for the period 1870-1995, with a net storage of carbon of 350 petagrams carbon and heat of $2*10^{24}$ joules in the upper 2000 m of the global ocean. The simulation projects that the carbon uptake rate of the ocean will level off, to between 4 and 4.5 petagrams of carbon per year, by the last quarter of the century, whereas the rate of increase of ocean heat content will continue to rise. Regional analysis indicates that the Southern Ocean south of 40˚ S will remain the major hotspot for both heat and carbon uptake throughout the century. In general, polar oceans experience most of the uptake, and subtropical oceans (between 10 and 40˚ latitude, N and S) experience most of the change in inventory for both anthropogenic heat and carbon. Regional trajectories of uptake and storage indicate a decoupling of the uptake and transport processes involved for heat and carbon, respectively. Further analysis of the differences between heat and carbon properties will be discussed. Understanding the distinct trajectories of heat and carbon uptake is essential to projecting their impacts on the marine environment and their feedbacks to climate.

Keywords: Ocean model, Biogeochemistry, Ocean uptake of carbon and heat