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Ocean carbon storage uniquely linked to ocean heat

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As the climate warms due to greenhouse gas emissions, the ocean absorbs excess heat and carbon. The patterns of ocean excess heat and carbon storage appear tightly linked when the large-scale circulation is fixed. This unique link is not shared with any other ocean tracer, such as Chlorofluorocarbons (CFCs). At the same time, ocean excess carbon storage patterns are mostly unchanged whether the large-scale circulation is free to evolve, or fixed to the pre-industrial circulation pattern, as the climate warms. Here, we interpret the reason for this behavior by breaking ocean carbon storage into two parts: uptake of atmospheric anomalies by the surface ocean, and subsequent internal storage by the ocean's circulation. We show that the patterns of surface ocean carbon anomalies are dictated by mean state biogeochemical properties and therefore mostly unchanged by circulation changes. Furthermore, surface biogeochemical properties are strongly shaped by the ocean temperature, providing a link between ocean heat and carbon uptake. CFCs on the hand, lack chemical buffering and therefore the patterns of CFC storage do not correlate with heat as much as carbon patterns do. The patterns of surface anomalies ultimately explain most of the differences in how temperature, carbon and CFCs are stored by the ocean, while changes in internal pathways are of secondary importance. Furthermore, the ratio of total ocean carbon and heat storage is roughly constant across warming scenarios and climate models, which might have further implications for relating ocean carbon storage to important climate metrics, such as the transient response to cumulative emissions.