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# The influence of geostrophic coupling between Added and Redistributed heat on ocean warming patterns

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Nearly all of the excess heat in the climate system resides in the global ocean, though the distribution of this heat varies widely in space and is concentrated above the pycnocline. The geographic pattern of ocean warming is a primary control on regional sea level rise and strongly modulates the global radiative feedback strength. The drivers of this pattern are not fully understood, however, complicated by their dual dependence on how preindustrial ocean dynamics passively transport surface temperature anomalies into the interior (or "Added" heat), and on how changes in ocean dynamics redistribute pre-existing ocean heat (or "Redistributed" heat). Most previous studies attribute heat redistribution to changes in high-latitude processes, namey deep overturning, convection, and mixing in the North Atlantic and Southern Oceans. Here we instead propose that a substantial component of global heat redistribution is explained by the local geostrophic adjustment of the velocity field to warming within the pycnocline. We explore this hypothesis by comparing patterns of Added and Redistributed heat in a coupled climate model (the University of Victoria Earth System Climate Model) forced with an 8.5 emission scenario, where Added heat is estimated using a Green's Function of the model's preindustrial ocean transport. Throughout most of the model's subtropical and tropical pycnocline, where the majority of ocean warming occurs, patterns of Added and Redistributed heat are strongly anti-correlated ($R^2$ >≈0.85). This anti-correlation arises because changes in the ocean's velocity field, acting across pre-existing temperature gradients, redistribute heat away from regions of strong passive heat convergence. Over broad scales, this advective response can be estimated from changes in upper ocean density alone, using the Thermal Wind relation. These advective changes smooth spatial gradients in Added heat and alter the distribution of subtropical pycnocline depth. Together, these results highlight the strong geostrophic coupling between Added and Redistributed heat, emphasizing the importance of subtropical and mid-latitude ocean dynamics on the evolution of the future climate response.