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Heat and carbon changes in the ocean as a transient response and tool for decomposing heat uptake

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Whilst anthropogenic activities are significantly altering the climate, both warming the atmosphere and increasing CO2, the ocean is

significantly ameliorating both effects. This effect is so important that the transient climate response to carbon emissions (TCRE), can be

formulated primarily in terms of the ocean. We show that in direct analogy to the TCRE, Anthropogenic Carbon (Canth) and temperature increases in the ocean are

linearly related, both globally and integrated over a range of scales. These ocean responses are typically of order 0.02K/mumol/kg,

(equivalently ~80MJ/mol). This linear relation allows for direct translation between temperature and carbon inventory increases. Furthermore,

we are far better able to decompose DIC changes into Canth increases and that of other carbon pools, than we are decomposing heat

inventory changes into added and redistributed heat. By separating total DIC change into Canth and that of other carbon pools, we can therefore remove the effect

of the transient response relationship between heat and carbon. This allows the production of estimates of added and redistributed heat in the

ocean from remaining DIC changes. Our results suggest that the variability of the transient response is predominately set by heat uptake, not carbon, and that this

variability may be traced to individual water masses. Therefore, it may be necessary to separate this transient response regionally in order

to obtain accurate estimates of added and redistributed heat at a global scale using this technique. The Eulerian transient response is set

predominantly by isotherm heave. The part of the transient response set by climate sensitivity, analogous to a semi-Lagrangian approach, is

set largely by patterns of regional heat uptake.