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What does sea-level change tell us about ocean heat uptake?

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stimates of global mean ocean heat uptake (OHU) play a crucial role in determining the rate at which our planet is warming and represent the key component of Earth's energy imbalance (EEI) on decadal time scales. To date, the most common and reliable approach to estimate OHU is via ocean heat content (OHC) changes derived from in-situ measurements of oceanic temperature and salinity profiles. The in-situ approach provides estimates of long-term OHU at about 0.6 +-0.1 Wm-2 (66% CL) assuming no unknown biases exist.
Nevertheless, this system bears some weaknesses in terms of spatial and temporal sampling that make it impossible to observe OHC changes below 2000 meters, provide complete global coverage (marginal seas and under sea ice), and to track the temporal variability in OHC and OHU beyond the decadal scale. To tackle some of the weaknesses of the in-situ approach and to provide OHC and OHU estimates for verification, independent approaches are crucially needed.

A promising alternative approach is to subtract ocean-mass changes from observed global sea-level changes. The difference is caused by steric expansion, which on a global scale, is driven by ocean heat uptake. However, using this approach, no consensus on the mean state of OHU and its uncertainty has been reached.
In this presentation, we take the audience through the steps of determining OHC and OHU from steric sea level change as derived from total sea level and ocean mass change. A number of corrections and uncertainties are associated with the retrieval of both quantities, such as due to inter-calibration, orbit and geocenter corrections, and GIA and background models, which in part have been quantified and reduced by different research groups.
Here, we look at another form of uncertainty, resulting from the methods used to combine and analyze the datasets that are often not sufficiently described or largely differ in scientific literature. The role of spatial domain selection to approximate the global mean, mismatch in spatial footprints of the different datasets, the use of different heat expansion efficiencies to estimate OHC from steric sea level change, the use of different temporal periods and resolutions all contribute to uncertainty in OHU that we expect to be of similar order as the retrieval uncertainties themselves.

We make use of gridded data of total sea level change from the ESA Climate Change Initiative and ocean mass change from the newest version of GRACE mascons to estimate these methodological uncertainties and bring them into context with retrieval and correction uncertainties inherent to the altimetry and gravimetry datasets. With this, we are also able to provide independent estimates of global mean OHC and OHU that can be used to constrain abyssal heating rates and to improve our understanding of Earth's energy imbalance.