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Global characterization of decadal-scale upper ocean heat content variability

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Upper ocean heat content (OHC) is at the heart of natural climate variability on interannual-to-decadal time scales, providing climate memory and the source of decadal prediction skill. Regional expressions of the OHC variability such as its generation and propagation are, however, not fully explored. We here present a global analysis of interannual-to-decadal OHC variability based on an observed subsurface temperature and salinity analysis dataset. Detrended, non-seasonal temperature anomalies are first decomposed into two parts –(1) temperature anomalies that are associated with density anomalies and (2) temperature anomalies that are density-compensated with salinity–by projecting the temperature anomalies on three dimensional density gradients, and then vertically integrated for 100-400m depth range to obtain the each component of OHC anomalies. The former component follows Rossby wave dynamics while the latter behaves as passive tracers subject to advection by background mean flows, distinct underlying mechanisms that are useful in characterizing the OHC variability.

Global variance analysis shows that the density component of OHC variability is large in all the world WBC regions, presumably due to vertical displacement of the thermocline that responds to the basin-wide wind stress variability. On the other hand, the spiciness component is large with the ratio to the total OHC variability exceeding 0.7 in subpolar regions where the mean spiciness gradients are particularly large. These results are consistent with a hypothesis proposed in our previous study that the mean spiciness gradients and axial displacement of subpolar WBCs can be a source of regional OHC anomalies, suggesting the importance of spiciness and hence an active role of salinity in interannual-to-decadal scale OHC variability.