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CMIP Global Ocean Diagnostics

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Disclaimer

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Previous work has highlighted observed patterns of long-term ocean temperature and salinity changes that are replicated in independent observed analyses; however poor spatio-temporal sampling and natural climate variability confound these estimates.

Simulations contributed as part of the CMIP3 and CMIP5 model suites provide a unique resource for which to investigate the role of anthropogenic forcing on the global ocean state and relate these to observed estimates. By utilising the diverse infrastructure developed at PCMDI, we have assessed the very large database of temperature and salinity fields provided by models, and compared these to observations. We highlight three recent PCMDI studies focusing on the analysis of subsurface ocean changes.

The first study compares late 20th Century (1970-2004) changes in upper ocean (0-700 dbar) heat uptake and contrasts the rate of change in the Northern and Southern Hemispheres. Importantly, we validate the simulations against high precision observed dynamic sea surface height (SSH) to examine model biases and investigate physical inconsistencies. This work suggests that all observed global estimates of long-term ocean warming are likely underestimated by up to 15-20% (~1-3 x 10^{22} J).

In our second study we focus on steric changes. We show that in certain regions halosteric (salinity driven) changes can regionally dominate the column-integrated steric total. This result advocates for a more considered examination of salinity-driven changes in future assessments, as these changes may offset coincident thermosteric (temperature-driven) regional changes. This result is particularly relevant with the advent of satellite estimates of SSH; from which inferred thermosteric changes have been made. If halosteric changes are not accounted for, these steric compensations may “hide” additional heat in the column-integrated steric total.

Our third study examines ocean heat content changes for the entire length of CMIP5 historical simulations. The analysis partitions the ocean into the upper (0-700m), intermediate (700-2000m) and abyssal (2000m-bottom) layers. Despite a large spread across the model suite, a strong consistency exists between the CMIP5 multi-model mean and observations. This is true not only for the upper ocean, but for the intermediate and deeper layers as well.

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