



LAWRENCE
LIVERMORE
NATIONAL
LABORATORY

CMIP Global Ocean Diagnostics

P. J. Durack, P. J. Gleckler, K. E. Taylor

April 17, 2014

DOE Climate Modeling PI Meeting
Washington D.C., MD, United States
May 11, 2014 through May 14, 2014

Disclaimer

This document was prepared as an account of work sponsored by an agency of the United States government. Neither the United States government nor Lawrence Livermore National Security, LLC, nor any of their employees makes any warranty, expressed or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States government or Lawrence Livermore National Security, LLC. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States government or Lawrence Livermore National Security, LLC, and shall not be used for advertising or product endorsement purposes.

CMIP Global Ocean Diagnostics

Paul J. Durack^{1,2}, Peter J. Gleckler¹ and Karl E. Taylor¹

¹*Program for Climate Model Diagnosis and Intercomparison,
Lawrence Livermore National Laboratory,
Mail Code L-103, 7000 East Avenue, Livermore, California 94550, U.S.A.
pauldurack@llnl.gov*

²*Centre for Australian Weather and Climate Research,
CSIRO Marine and Atmospheric Research,
GPO Box 1538, Hobart, TAS 7001 Australia*

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% ($\sim 1-3 \times 10^{22}$ 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.

Work undertaken at Lawrence Livermore National Laboratory is supported by the U.S. Department of Energy under contract DE-AC52-07NA27344. LLNL IM release number: LLNL-CONF-XXXXXX.