Ocean-Related Climate Process Teams (CPTs)

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We report on progress for two, ocean-related CPTs. The first CPT focuses on *ocean mixing processes associated with high spatial heterogeneity in sea-ice and implications for climate models*. For this purpose, we implemented a multi-column ocean grid (MCOG) framework in the Community Earth System Model (CESM). This framework enables the sea-ice model to send its subgrid scale ice category spatial extent information to the coupler and allows the ocean model to receive ice-category-dependent surface fluxes. In the ocean model, each horizontal grid is subdivided into columns with each column corresponding to a sea-ice category, including open-ocean. The ocean model then performs vertical mixing for each subcolumn separately. The coupled model simulations show only small impacts of this MCOG parameterization on the model solutions and climate. In contrast, the parameterization leads to substantial improvements in surface chlorophyll and net primary productivity under sea-ice. Specifically, MCOG parameterization reduces phytoplankton growth, thus leading to more realistic chlorophyll distributions. These improvements result from the nonlinearity of the photosynthesis and irradiance relationship: using heterogenous (as in MCOG) light fields versus mean (as in standard implementations) light leads to these differences. This CPT has just been completed.

The second CPT is on *representing internal-wave driven mixing in global ocean models*. Therefore, the overall goal of this ongoing CPT is to refine, develop, and implement dynamically appropriate parameterizations for diapycnal mixing due to internal-wave breaking for use in global climate models. In the ocean interior, the internal wave field is largely responsible for connecting the forcing scales of the circulation to the dissipative scale of turbulence. In particular, internal-wave-induced mixing drives the diabatic evolution of the ocean's stratification on the very time scales of central interest to the climate prediction problem. We highlight a few recent results and ongoing work from the CPT participants. These include accomplishing one of the first goals of this CPT which was to compile all available microstructure measurements of mixing from the last 3 decades. A major finding is that the observationally-based estimates of the diffusivity values are of the same order as that required to power the overturning circulation and water mass transformation rates. Another interesting emerging result is that there may be significant dissipation at the boundaries, i.e., continental margins, with yet unclear effects on ocean circulation.

We conclude with some thoughts on past, current, and future CPTs.