Poster Presentation
Theme 3.1: Biogeochemical Processes - Processes Understanding and Human Impacts
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Lateral input dominates anthropogenic carbon budget in high-resolution simulations of the Arctic Ocean

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The Arctic Ocean is projected to experience amplified ocean acidification, more than other oceans. To model its future changes, we must first be able to simulate the Arctic's baseline conditions and acidification over the industrial era. Although global ocean models are needed to assess centennial scale changes of ocean carbon, typical coarse-resolution models may be inadequate to properly resolve the Arctic Ocean. Here we assess how simulations of ocean uptake of anthropogenic CO_2 (the main driver of acidification) in a global ocean circulation-biogeochemistry model (NEMO-PISCES) change when moving from coarse to eddy permitting resolution. Results of the simulated anthropogenic carbon inventory (total mass stored in Arctic basin) depend on model resolution. While the coarse-resolution model configuration (2°) stored 1.6 Pg C between 1860 and 2005, the eddying versions (½° and ¼°) took up 1.9 and 2.2 Pg C, respectively. Although data-based estimates are higher (2.7 Pg C), they may over-predict the Arctic anthropogenic carbon inventory, as previously shown for the Mediterranean Sea. Indeed, evaluation of the models with CFC-12 (another transient tracer) suggests that simulated ventilation of subsurface waters is roughly on target in the ¼° model; conversely, data-based estimates of anthropogenic carbon (based on CFC-12) overestimate deep-water concentrations. The Arctic Ocean only contains ~1% of the global ocean volume, but it retains around 2% of the global ocean anthropogenic carbon inventory. This enhanced regional inventory results from ~75% of the anthropogenic carbon entering the Arctic Ocean through lateral transport rather than by a flux across the air-sea interface. Furthermore the simulated Arctic inventory increases with model resolution as input from net lateral transport increases. The Arctic Ocean's relative importance of lateral transport is much more prominent than in other ocean regions except perhaps for the subtropical gyres. Hence a 3-D model, most likely with eddying resolution, is necessary to properly simulate anthropogenic carbon in the Arctic Ocean. Wider comparison to results from the Coupled Model Intercomparison Project Phase 5 (CMIP5) reveals larger diversity. Although the ocean components of these models have coarse resolution, they also generally indicate that lateral transport is a prominent means by which anthropogenic carbon enters the Arctic. Furthermore, only the CMIP5 models with higher lateral transport obtain anthropogenic carbon inventories that are close to the data-based estimates.

Poster Session (see poster session schedule)