Geophysical Research Abstracts
Vol. 14, EGU2012-11314, 2012
EGU General Assembly 2012

Arctic Ocean Watermasses: Volumes, Locations and Variabilities Derived from Models, Climatologies and Observations

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A water mass census has been carried out for the Arctic Ocean Basin, including its marginal seas but not the GIN Sea. Data examined included output from 3 ocean models, 3 climatologies, and observations archived in the NODC WOD09 data base. The focus of the studies were mainly the Atlantic water (AW), and the deep waters, especially those of the Canadian and Eurasian basins (CBDW and EBDW, respectively). The comparisons included volumetric statistics, geographic extent with depth ranges, and seasonal and interannual variabilities. The models used were HYCOM [Bleck, Ocean Modelling 37, 2002; Chassignet et al, Oceanography 22, 2009], NCOM [Barron et al, Ocean Modelling 11, 2006, p.347; Kara et al, ibid, p.376] and POP [Maltrud and McClean, Ocean Modelling 8, 2005]. The respective resolutions were 0.083, 0.125, and 0.100 degrees The overall period of the model simulations was from 1994 to 2011, with HYCOM and NCOM output analyzed for 2011, and POP output for 2003. The principal climatology examined and compared with the models was the WOA09 of NOAA/NODC.

In the summer of 2011, waters with temperature T > 0 deg C (referred to often as Atlantic Water AW) were found to "circumnavigate" the Arctic in the latitude range 82N-89N for all three models and the WOA09 climatology. This layer lies in the depth range 150-1100m in the Eurasian Basin for HYCOM and 175-800m for NCOM, with the warmest layers centered on depth levels of $\sim$400m and $\sim$300m, respectively. In the Canadian Basin, the corresponding depth ranges were 350-1000m and 250-850m for the two models, with the warmest layers centered on 600m and 500m, respectively. For POP in the summer of 2003, the layer depth ranges are 125m-1100m and 200m-1100m in the two basins, with the warmest layers centered on depths of $\sim$400m and $\sim$500m, respectively. For the WOA09 climatology, the depth ranges were 150-800m and 250-900m in the two basins, with the warmest waters centered on the 300m and 400m depth levels, respectively. NCOM and HYCOM had excellent agreements for the intermediate waters, and POP and NCOM for Arctic Surface Waters ASW. Only HYCOM had good agreement for CBDW, but all three models had good agreement in their last simulation year for EBDW.

In summary, the properties of the Arctic water masses (volume census, geographic extent, etc) were found to be a useful metric for long-range (simulation times > annual) model-model and model-data comparisons.