Introduction: Within the framework of the Arctic Ocean Model Intercomparison Project (AOMIP) results from several coupled sea ice–ocean models (Alfred Wegener Institute, AWI, M.Karcher; New York University, NYU; D. Holland, NASA; Goddard Space Flight Center, GSFC; I. Sigø, Håkkinen; University of Washington, UW; J. Zhuang, Naval Postgraduate School, NPS; W. Maslowski, and Institute of Ocean Sciences, IOS) are compared in order to investigate vertically integrated properties of the Arctic Ocean. In this first stage of the project, only readily available outputs are compared, accepting that forcing as well as numerical parameterizations are essentially different. Depending on availability, results from timeseries runs (year 1998, denoted with _98) are compared as well as results from climatological mean forcing (denoted with _c). Annual means of streamfunction, freshwater and heat content are shown together with annual cycles, averaged over certain areas. Thereby for streamfunction the entire water column is integrated, whereas for heat and freshwater content integration is over the upper 1000 m. For intercomparison, the different model results are interpolated to a common domain (Fig.1). Forcing differs as well as the modeled timeperiods. Moreover monthly as well as daily forcing are applied.

Discussion: In the current stage of AOMIP, where atmospheric forcing is not standard, forcing appears to be the main contributor in creating differences between model results. E.g., it turned out that the OMP-forcing (AWI_c in this study) leads to very cold intermediate water in the Barents Sea which enters the Arctic Ocean via St. Anna Trough. Using the same OMP-forcing the IOS-model produces a similar pattern as the AWI-model with cold water production in the Barents Sea. Responses of the heat and freshwater content to different windstress representations account for differences of up to 1 GJ m^-2 and changes in the range of a few meters. Differences attributed to model parameterisations are few, so far. Heat transport is strongly affected by model parameterisations for eddy−topography interaction (shear), leading to negative streamfunction values in the Canada Basin for IOS model. Without the OMP-forcing the IOS model leads to a pattern quite similar to the NYU model with an equally weak Eurasian Basin circulation and anticyclonic circulation with a maximum of about 2 Sv in the Canada Basin. Other ideas related to the influence of resolution, as well as the influence of mixing are too speculative at this stage and will be addressed more care fully in the upcoming AOMIP-phase.

Heat content: All models show the offset of warm and salty Atlantic water penetrating into the Arctic Ocean via Fram Strait and Barents Sea, but obvious differences are visible in the Eurasian and Canada Basin. The heat content varies from -3.8 to 0.8 GJ m^-2 in the eastern Nansen Basin and from -3.5 to 1.8 GJ m^-2 in the Canada Basin, showing both too high heat contents and too low heat contents compared to PHC values of 0.15 and ~0.8 GJ m^-2 in the Nansen and Canada Basin. Differences between the simulated heat contents can be at least partially related to differences in the representation of the Atlantic water pathways through Fram Strait and Barents Sea. The lowest values are correlated with a sharp front already in Fram Strait, suggesting an underestimation of the Atlantic water inflow via Fram Strait (e.g., NYU). However an overestimation of the heat loss at the surface leads to a similar picture. Too low heat content can also be caused by too cold water entering the Eurasian Basin via St. Anna Trough. The Barents Sea branch of the Atlantic water inflow thus becomes very cold and fills the Barents Sea at mid depth with an extreme water mass (AWI_c). The largest heat content can be found in the NPS98 model, which is partially related to the vertical heat transport and underestimations of the eastward propagation along the Laptev Sea shelf. However in 1998 warm water, which entered the Eurasian Basin in the late 1980s and the early 1990s may still be represented slowly moving around the Canadian Basin to exit back through Fram Strait. AWI_98, as well, shows exceptionally warm water in 1998 in the Eurasian Basin.

Freshwater content: shows differences mostly in the Canada Basin where maximum values vary between about 6 m and 24 m, compared to about 18 m in PHC. Within the Eurasian Basin, almost any model shows a close correspondence between high heat and low freshwater content, related to the Atlantic inflow. In the Canadian Basin, however, the freshwater content is influenced by other processes as well. A sensitivity study, carried out with the IOS model, shows that, e.g., river discharge affects the freshwater maximum in the Beaufort Sea less effectively than changes in the windstress formulation. However, a change from 2445 km^3 to 3249 km^3 yearly discharge by including ungauged river runoff along the coast increases the freshwater content in the Beaufort Sea by 0.9 to 1 meter (Fig.5).