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VARIABILITY OF THERMOHALINE CIRCULATION UNDER AN ICE SHELF

(Abstract)

by

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The production of Antarctic Bottom Water is mainly influenced by Ice Shelf Water, which is formed through the modification of shelf water masses under huge ice shelves. To simulate this modification a two-dimensional thermohaline circulation model has been developed for a section perpendicular to the ice-shelf edge. Hydrographic data from the Filchner Depression enter into the model as boundary conditions. In the outflow region they also serve as a verification of model results.

The standard solution reveals two circulation cells. The dominant one transports shelf water near the bottom toward the grounding line, where it begins to ascend along the inclined ice shelf. The contact with the ice shelf causes melting with a maximum rate of $1.5\ \mathrm{m\,a^{-1}}$ at the grounding line. Freezing and therefore the accumulation of "sea ice" at the bottom of the ice shelf occurs at the end of the melting zone at a rate on the order of $0.1\ \mathrm{m\,a^{-1}}$. Both rates are comparable with values estimated or predicted by models concerning ice-shelf dynamics.

As one example of model sensitivity to changing boundary conditions, a higher sea-ice production in the southern Weddell Sea, as might be expected for a general climatic cooling event, is assumed. The resultant decrease/increase in temperature/salinity of the inflow (Western Shelf Water) reduces the circulation under the ice shelf and therefore the outflow of Ice Shelf Water by 40%. The maximum melting and freezing rate decreases by $0.1\ \mathrm{m\,a^{-1}}$ and $0.01\ \mathrm{m\,a^{-1}}$, respectively. and the freezing zone shifts toward the grounding line by 100 km.

In general the intensity of the circulation cells, the characteristics of Ice Shelf Water, the distribution of melting and freezing zones and the melting and freezing rates differ from the standard results with changing boundary conditions. These are the temperature and salinity of the inflow, the surface temperature at the top, and the extension and morphology of the ice shelf.

SEASONAL ARCTIC SEA-ICE SIMULATIONS WITH A PROGNOSTIC ICE–OCEAN MODEL

(Abstract)

by

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The seasonal cycle of sea ice, especially the ice margin location in the East Greenland region, is significantly affected by ocean circulation. The ocean circulation in turn can be altered by ice dynamics which cause large amounts of ice to be transported to the ice margin to be melted, thus stratifying the ocean there. By responding to wind changes, the ice dynamics can also create rapid melting or freezing events which can destabilize the ocean.

In an earlier study, Hibler and Bryan (1987) carried out a diagnostic simulation of the Arctic ice-ocean system in which a coupled ice-ocean circulation model was integrated for about five years beginning with mean annual estimates by Levitus (1982) of the observed temperature and salinity fields. As a consequence of this short integration, the mean baroclinic circulation of the ocean deviated little from the initial fields, although seasonal and local effects due to the interactive models were simulated. One particularly interesting result of this study was the presence of fluctuations of oceanic heat flux at the ice margin, which appeared to coincide with strong wind events occurring over a few days which induced periods of freezing.

With this diagnostic model, good results for the location of the ice margin were obtained. However, a global budget analysis indicated that the net northward heat transport through the Faero–Shetland passage was not adequate to balance the heat loss to the atmosphere sustained by the ocean in the fifth year. Moreover, a 20-year simulation without diagnostic terms showed a degraduation of the baroclinic fields in the Arctic Basin possibly due to the very weak wind stress used for this particular years's wind forcing, or perhaps due to excessive damping in the ocean due to computational requirements imposed by the coarse grid.

As a first step in the development of a higher-resolution fully interactive prognostic model, we have modified this model and carried out two prognostic simulations of the Arctic ice ocean system by employing 50-year integrations. The ocean model used for this study is essentially that of Hibler and Bryan (1987). However, the