Impact of observation-based snow/ice albedo with starting temperature of −2°C for surface melting effect on a global ocean simulation

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Based on detailed field observations, we conducted global ocean simulation experiments with modification of starting temperature for surface melting effect from −1°C to −2°C in the snow/ice albedo parameterization. An ensemble mean field of five experiments with the modified parameterization starting from December 1989–January 1990 were compared with the original experiment. Significance of the impact of the modification was evaluated by using the ensemble spread, which measures the internal variability.

In the Arctic Ocean, the mean albedo was reduced by up to 0.015 in June–July by the modification of the parameterization (i.e. lower albedo in the ensemble mean of the modified experiements than in the original experiment), which resulted comparably from both direct effect of the modification and indirect effect via changes of the snow and ice distributions by the albedo reduction. Snow thickness on the sea ice was reduced by up to 1.5 cm in June–July but afterward impact of the modification was diminished as the snow mostly melted away. Impact of the modification on the sea ice firstly appeared in the rim regions of the snow cover with the bare ice fraction extended and, in August–September, ice thickness decreases by 1.5 cm were achieved over most of the Arctic Ocean. On the other hand, ice thickness increases were seen in some marginal ice zones, which were attributed to reduced ocean surface circulation, such as in the Beaufort Gyre, resulting from reduced surface stresses with reduced ice cover.

In the Southern Ocean, the albedo reduction by up to 0.015 in December–January resulted from comparable contributions of the direct effect of the modification of the parameterization and the indirect effect via the snow thickness decrease, as in the Arctic Ocean. In contrast to the Arctic Ocean, the decrease impact of the snow thickness by up to 2.5 cm in the Weddell Sea partly remained through year. In addition, increases of the ice thickness were widely distributed in December–January. A detailed analysis revealed that the warming effect of the albedo reduction by the modification enhanced the reduction of the sea ice concentration, in particular that of thinner ice, which weakened the ice pressure and enhanced thicker ice formation via the rheology, leading to the increases of the ice thickness. Note that thicker ice is less affected by thermodynamical melting effect than thinner ice. This thickening impact of the sea ice remained through year in the Weddell Sea. These changes by the modification of the parameterization were robust compared with the ensemble spread.

Although the above experiments and results might be rather preliminary, we believe that our demonstration of the potential impact of the new observational insight on ocean general circulation model simulations would be of value for further enhancing both observation and modelling/prediction

activities and their collaborative study.

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