An impact of subgrid-scale ice-ocean dynamics on sea-ice cover

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Abstract

A coupled sea-ice-ocean numerical model is used to study the impact of an ill-resolved subgrid-scale sea-ice-ocean dynamical process on the areal coverage of the sea-ice field. The process of interest is the transmission of stress from the ocean into the sea-ice cover and its subsequent interaction with the sea-ice internal stress field. An idealized experiment is performed to highlight the difference in evolution of the sea-ice cover in the circumstance of a relatively coarse-resolution grid versus that of a fine-resolution one. The experiment shows that the ubiquitous presence of instabilities in the near-surface ocean flow field as seen on a fine-resolution grid effectively leads to a sink of sea-ice areal coverage that does not occur when such flow instabilities are absent, as on a coarse-resolution grid. This result also implies that a fine-resolution grid may have a more efficient atmosphere-sea-ice-ocean thermodynamic exchange than a coarse one. This sink of sea-ice areal coverage arises because the sea-ice undergoes sporadic, irreversible plastic failure on a fine-resolution grid that, by contrast, does not occur on a coarse-resolution grid. This demonstrates yet again that coarse-resolution coupled climate models are not reaching fine enough resolution in the polar regions of the world ocean to claim that their numerical solutions have reached convergence.