Geophysical Research Abstracts
Vol. 18, EGU2016-630, 2016
EGU General Assembly 2016

Effects of the sea ice floe size distribution on ocean eddies and sea ice melting

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The influence of the horizontal size of floes on sea ice melting has been previously investigated in terms of the direct influence that the lateral surface area of floes has on the exchange of heat between the ocean, ice, and atmosphere. This effect has been found to play a leading order role on the volume budget of melting sea ice when floes are smaller than about 30 meters. However, these studies ignore the role that ocean dynamics has on the evolution of the sea ice cover, and vice versa. Specifically, lateral density gradients that form at the boundaries of floes may lead to the development of mixed layer sub-mesoscale instabilities with length scales of O(1 km), and time scales of O(1 day), and therefore to a proliferation of ocean eddies. These eddies spread from the ice edge region and lead to lateral mixing and overturning cells that drive enhanced melting of floes. Using a set of high-resolution ocean GCM experiments, we diagnose this effect and develop a theory for how the FSD influences the melting of the sea ice cover, finding that for floe sizes of O(10 km), the timing of ice melt in a typical GCM grid cell is sensitive on the order of weeks to months to changes in the FSD.