

Percolation threshold for fluid permeability in Antarctic granular sea ice

K. M. Golden, A. Gully, C. S. Sampson, D. J. Lubbers, and J.-L. Tison

ABSTRACT: The fluid permeability of sea ice governs a broad range of physical and biological processes in the polar marine environment. For example, in the Arctic, melt pond drainage is largely controlled by the fluid permeability of the ice. Melt ponds in turn have a significant effect on ice albedo, a critical parameter in climate models. Algae in the ice depend on nutrients from the ocean transported through the porous microstructure of sea ice when it is permeable. Columnar sea ice is effectively impermeable for brine volume fractions below about 5%, while above this threshold fluid can flow through the ice. In the Antarctic, granular ice with a much different crystallographic structure makes up a significant portion of the ice pack. Data gathered during SIPEX II in 2012, as well as mathematical models, indicate that the percolation threshold for the fluid permeability of granular sea ice is around 10%. These findings are significant, as both ecological models involving nutrient transport and physical process models, such as for snow-ice formation, must take this much higher value into account.