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INTERNAL MELTING IN ANTARCTIC SEA ICE: DEVELOPMENT OF “GAP” OR “FREEBOARD” LAYERS

SF Ackley

Clarkson University, Potsdam, NY, United States

Gap or freeboard layers consisting of a partially melted honey-comb like ice structure are found below a surface snow and ice layer in summer in Antarctic sea ice, are widespread there, but are not typically observed in the Arctic.

A first explanation of these layers in previous work, because of the high concentration of biological material found within the observed layers, was suggested as a *Physical-Biological Feedback* process where concentrations of dark algal material accelerated melting by increased absorption of solar radiation. A second mechanism suggested the layer was formed by the incomplete refreezing of the surface slush layer as conditions warmed during summer. The surface ice layer, in this case was suggested to be *Superimposed Ice Formation* by the refreezing of fresh snowmelt on top of the unconsolidated slush layer below. No biological interaction was necessary in this case, however, sufficient snow melting to refreeze as superimposed ice was necessary as a cap on the unconsolidated slush layer.

A thermal model is presented here, different from either of the previous models. This model takes into account the change in thermal properties of the upper layer of the sea ice when it warms and loses salinity through brine drainage. At temperatures still below the melting point for snow (0 C) but above the freezing point of sea water (-1.8C), heat from the upper snow and sea ice can then be conducted, without melting the intermediate freshened layer, directly to the layer located near sea level and used to melt the ice in this (still saline)internal layer. A simple diffusive heat flux model using observed upper layer properties and temperature gradients in summer in Antarctic sea ice and snow covers gives a melting rate of 0.5 to 1.0cm/day. These values correspond reasonably with observations of gap layer thicknesses of 10 to 20 cm in Antarctic sea ice assuming 20 to 30 days of available heat flux in midsummer. This explanation avoids invoking the special conditions of the previous models, of biological growth in the first case, and of both flooding and snowmelt in the second, and is more generally applicable to the widespread observations of gap layers in Antarctic sea ice covers where these special conditions have not necessarily been observed concurrently.