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Antarctic sea ice surface processes: a comparison of field results with a thermodynamic-hydraulic model

T. Maksym (1)

(1) British Antarctic Survey, Cambridge, UK (emak@bas.ac.uk)

Antarctic sea ice growth and decay is dominated by processes associated with its relatively thick snow cover, which controls three of the four modes of thermodynamic thickening. Yet most sea ice models adequately describe only one of these processes (congelation) and include only a rudimentary snow cover. We investigate the role of snow and related surface processes in controlling the evolution of sea ice with a complex thermodynamic-hydraulic model that includes flooding and snow-to-ice conversion (snow ice formation) and summer surface processes such as superimposed ice formation and the evolution of so-called gap layers. These results are compared with observations of snow and sea ice properties taken in late summer/early autumn 2007 in the Bellingshausen Sea where such phenomena were found to be widespread, consistent with previous studies. In particular, both model and field results suggest snow ice formation to be the dominant mode of thermodynamic thickening in the perennial ice zone. We show that such models can provide useful bounds on the amount of precipitation and accumulation and on the role of snow ice and frazil in sea ice thickness. While some of these processes are of lesser importance for large-scale modelling of the sea ice thickness distribution, they play a major role in the evolution of sea ice ecosystems.