Geophysical Research Abstracts
Vol. 16, EGU2014-12770, 2014
EGU General Assembly 2014

Thermodynamical effects accompanied freezing of two water layers separated by sea ice sheet

Petr Bogorodsky (1) and Aleksey Marchenko (2)

(1) Arctic and Antarctic Research Institute, 199397, 38 Bering str., St. Petersburg, Russia, (2) University Centre in Svalbard, 9171 Longyearbyen, Norway

The process of melt pond freezing is very important for generation of sea ice cover thermodynamic and mass balance during winterperiod. However, due to significant difficulties of field measurements the available data of model estimations still have no instrumental confirmation. In May 2009 the authors carried out laboratory experiment on freezing of limited water volume in the University Centre in Svalbard ice tank. In the course of experiment fresh water layer of 27.5 cm thickness at freezing point poured on the 24 cm sea ice layer was cooled during 50 hours at the temperature -10º C and then once again during 60 hours at -20º C. For revealing process typical characteristics the data of continuous measurements of temperature and salinity in different phases were compared with data of numerical computations obtained with thermodynamic model which was formulated in the frames of 1-D equation system (infinite extension of water freezing layer) and adapted to laboratory conditions. The known surprise of the experiment became proximity of calculated and measured estimates of process dynamics that confirmed the adequacy of the problem mathematical statement (excluding probably process finale stage). This effect can be explained by formation of cracks on the upper layer of ice at sharp decreases of air temperature, which temporary compensated hydrostatic pressure growth during freezing of closed water volume. Another compensated mechanism can be migration of brine through the lower layer of ice under influence of vertical pressure gradient and also rejection of gas dissolved in water which increased its compressibility. During 110 hours cooling thickness of water layer between ice layers
reduced approximately to 2 cm. According to computations this layer is not chilled completely but keeps as thin brine interlayer within ice body whose thickness (about units of mm) is determined by temperature fluctuations of cooled surface. Nevertheless, despite good coincidence of experimental and model estimates the question of existence of liquid phase under actual conditions is still open and can be clarified in a continuous laboratory experiment.
This work was supported by Russian Foundation for Basic Research (Project # 14-05-00677).