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Observations and modelling of fast ice growth in the Tiksi Bay, Laptev Sea

Petr Bogorodsky, Aleksandr Makshtas, Andrey Grubiy, and Vasiliy Kustov
(bogorodski@aari.ru)

Fast ice is one of the main features of sea ice cover in the Laptev Sea. The formation of this immobile ice which occupies up to 30% of the sea area and significantly affects the intensity of air-sea energy exchange in the coastal zones had been investigated during winter 2014-2015 in the Tiksi Bay (Buor-Khaya Gulf). The temperature measurements within sea ice thickness and under-ice sea layer using GeoPrecision thermistor string of 10 sensors together with measurements of snow and ice thicknesses were carried out at the distance of 0.5 km from the shore at the 3.5 m water depth.
According to measurements temperature variations qualitatively repeat air temperature variations and, damping with depth, approach to sea water freezing temperature. Vertical temperature distributions allow to recognize snow, ice and water layers by profile inclination in each layer. The temperature profiles within growing ice were quasi-linear, indicating permanence of heat flux inside ice. The linearity of temperature profiles increased during ice growth.
For calculations of fast ice evolution one-dimensional thermodynamic model was used. Besides the empirical formulae, based on frost degree-days, developed in 1930th for the Tiksi Bay was applied. Numerical experiments were carried out with constant values of thermal properties of all media and 10 ppt water salinity, as initial condition. The daily average data from Hydrometeorological Observatory Tiksi, located approximately 1 km from the site of ice observations, were used as atmospheric forcing.
For the examined area evolutions of ice cover thickness estimated from direct measurements, the thermodynamic model and the empirical formulae were almost identical. The result indicates stability of hydrological and meteorological conditions, determining fast ice growth in the Tiksi Bay during last 75 years. Model simulations showed that in shallow waters the growth of ice thickness is stabilized due to increase of sub-ice water layer mineralization. During freezing modeled water salinity in case of 1 m depth reached 800 ppt. It means that freezing point is below [U+F02D]40º. We speculate that such salinization is a reason why shallow water column cannot freeze up to the bottom even at very low air temperatures. During air temperature increase the high water salinity can be a reason of fast ice melting in the coastal shallow zones even at negative air temperatures in opposite to its simultaneous growth far away from the shore. The real values of salinity during sea ice growth probably do not reach the calculated magnitudes due to horizontal water mixing. The salinization effect could be founded in the local shallow parts of the bay with depth below 1 meter.