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The consolidation of rafted sea ice

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Rafting is an important process in the deformation of sea ice that occurs when two ice sheets collide. This process is particularly common in the North Caspian Sea, where ice floes override one another multiple times to produce thick sea ice features. To date, rafting has received little attention in the literature perhaps because in most regions pressure ridges produce the greatest loads on offshore structures. In the North Caspian Sea the shallow waters constrain the size to which pressure ridges can grow and the low salinity seems to favor rafting over ridging. Therefore it is likely that multiply-rafted sea ice may be the governing design feature for ice loads in the Caspian Sea. Here we present a one-dimensional, thermal-consolidation model for rafted sea ice. This is of interest because the degree of consolidation will affect the strength of a rafted structure, and therefore may be of value for modeling rafted ice loads. Results show that the thickness of the liquid layers reduces asymptotically with time, such that there always remains a thin liquid layer. We propose that when the liquid layer is equal to the surface roughness the adjacent layers can be considered consolidated. Using parameters specific to the North Caspian Sea, calculations show that it took 1hr, 14mins for the ice sheets to consolidate. To test the accuracy of the model concurrent experiments were carried out in the HSVA ice basin. During an experiment, equally sized portions of level ice were manually piled on top of one another to produce a rafted section. The rate of consolidation or bonding of the layers was then monitored by coring and using thermistors that were frozen into the level ice prior to rafting. Once consolidated, strength tests were carried out on the rafted ice and compared with those of level ice.