**Supplementary material**

1. Thermocouple calibration

The accuracy of each thermocouple was checked with a temperature calibrator produced by Fluke (Fluke Calibration 9142 Field Metrology Well). The temperature calibrator was adjusted to constant temperatures that were continuously double-checked with a temperature probe. The apparatus was used to calibrate all the thermocouples used in both field campaigns for temperature points of -25, -20, -15, -10, -5, 0, 5, and 10*ᴼC*. The temperatures recorded by the thermocouples (*Tm*) were plotted against the probe temperatures the thermocouples should measure instead (the actual temperature *Ta*). The relationship of *Tm* vs *Ta* was used to correct the temperature readings obtained from the tank experiments. Figure A illustrates the real temperatures (*Ta*) that the thermocouples should measure against the difference between the real and measured values (*ΔT*) for the thermocouple tank positions in the second year of experiments.

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**Fig. A.** The temperatures that the thermocouples should display (*Ta*) vs the difference between the actual and the values that the thermocouple has a high likelihood to display (*ΔT*).

1. Temperature measurements

Spikes in the temperature signal were recorded in both campaigns, possibly caused by air temperature fluctuations. The temperature spikes that overlap with the thickness measurement time were caused by the sampling procedure, which may have caused water turbulences.

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1. Solar radiation calculations

The measured incoming radiation in this experimental setup does not represent only the radiation that falls on the ice surface but also the radiation absorbed by the first 20 *cm* of the wall of the tank. In this depth, the tank's walls were painted black, thus absorbing all the incoming radiation on the walls. As a result, when the pyranometer faces downwards, the measured values represent the radiation reflected only from the ice surface (including the temporary shade from the wood plank) if the black side walls do not reflect the shortwave radiation. Therefore, the incoming radiation was calibrated for all experiments using the radiation measurements obtained by T05R1, where the snow layer above the ice reached a thickness of 12 *cm*.

The albedo calculated as the ratio between the measured incident and reflected radiation in T05R1 was equal to 0.6. The snow albedo was earlier reported to lie between 0.5 for melting old snow to 0.95 for fresh snow (Grenfell and Maykut, 1977). Another study reports that the fresh snow albedo is 0.87 (Perovich 1996). In this study, a theoretical fresh snow albedo of 0.9 is assumed. The difference between the measured and theoretical albedo is primarily attributed to the absorption of incident radiation by the first 20 cm of the black walls surrounding the ice surfaces. If there were no walls to completely absorb a portion of the radiation, the snow albedo would closely approach its theoretical value. Therefore, the ratio between the measured and theoretical radiation indicates the proportion of incident radiation that reaches the ice surface. For T05R1, this ratio was found to be 0.67 (0.6/0.9). Hence, it is assumed that only 67% of the measured incident radiation reaches the ice surface, while the remaining 33% is absorbed by the tank walls. To correct this, the incoming shortwave radiation was adjusted by multiplying the measured incident radiation by a factor of 0.67.

1. Water heat flux

The water heat flux (*φw*) can be determined by three different methods, the residual method, where *φw* is estimated from the heat flux budget at the ice/water interface (Purdie and others, 2006; Lei and others, 2014; 2018). However, this method is sensitive to the temperature readings in the thin ice and therefore is not used in the current study for modelling. The second method is called the molecular conductivity and assumes that the heat transfer close to the ice/water interface is only driven by the temperature gradient (*TW-TF*) in a restricted water column thickness, for example, equal to (*HW*) 30 *mm*, which corresponds to the position of the thermocouples mounted in the first campaign. Assuming that the water column has a linear temperature distribution, the *φw* can be estimated numerically from the equation:

. (a)

Where *kw* is the molecular thermal conductivity of the water close to the freezing temperature which is equal to 0.556 *W m-1ᴼC-1* (Sengers and others, 1984; Ramires and others, 1995).

The third method that can be used to calculate the water heat flux is the parametrized equation earlier applied in lake ice byShirasawa and others, 1997; 2002; 2006; Ohata and others 2016, which is as follows:

, (b)

where *ρw* is the freshwater density (1000 *kg m-3*), *cw* is the heat capacity of water at 2*°C* and is 0.0488 *W day kg-1°C-1*. *CH* is the heat transfer coefficient equal to 0.002 (Shirasawa and others, 1997; 2006). *Uw* is the water velocity. Considering the calm water in the tank, the corresponding lowest water velocity that was measured in the field was 172.8 *m day-1* (Ohata and others 2016).