The Cryosphere

Supporting Information for

Recovery of Strength in Thermally Cracked Freshwater and Salt-Water Ice

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1. Numerical simulations

Numerical simulations were performed in Comsol Multiphysics (https://www.comsol.com/) which is based on the finite element method. The ice was assumed to be isotropic for numerical analysis. The following parameters of ice were used during the modelling: ice density of 915 kg/m3, thermal conductivity of 2.22 W/m K, heat capacity of 2100 J/kg K, heat transfer coefficient of 5 W/m^2 K. The results do not change significantly even if we use high values of heat transfer coefficient. A physics-controlled mesh was chosen, which automatically adapts to the geometry of the model with elements in tetrahedral shape. The time dependent study was selected to model temperature distributions at different time steps.

To simulate the heat transfer from air to ice, we used a natural or free convection approach. The convective heat flux on the boundaries in contact with the fluid was then modeled as being proportional to the temperature difference across a fictitious thermal boundary layer. Mathematically, the heat flux is described by the equation:

$$-\boldsymbol{n} \cdot \boldsymbol{q} = h(T_{ext} - T)\ ,$$

where h is a heat transfer coefficient, T_{ext} is the temperature of the external air far from the boundary, T is the temperature of the ice surface, $\boldsymbol{n}$ is normal vector toward exterior, $\boldsymbol{q} = -k\nabla T$ is the convective heat flux, k is thermal conductivity.