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The vertical profile of the sea ice age: theory and preliminary results

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The sea ice age is both an interesting diagnostic tool and parameter for determining the ice physical properties (albedo, strength, salinity, ...). In this work, we focus on the vertical profile of the age in a sea ice layer. We first present the equation of evolution of the age in an one-dimensional ice layer as derived from the age theory. An analytical solution is derived from Stefan's model for a homogeneous horizontal ice layer with a periodic ice thickness seasonal cycle. Two numerical resolutions of the age equation are proposed. In order to capture the vertical profile of the age and its discontinuities, Lagrangian particles are advected in the vertical direction. If one is interested in the mean age of the ice layer using the smallest possible number of degrees of freedom, we adopt a finite element method based on one single Legendre polynomial. A linear polynomial is found to capture the age profile all the better since the ice is aged. The mean value and the standard deviation of the computed age agree well with the analytical solution. Increasing the order of the polynomial doesn't enhance the
solution. Both methods are finally applied to a stand-alone thermodynamic sea ice model of the Arctic. While the Lagrangian particles give an accurate sea ice age profile, the mean and standard deviation of the age of several ice columns are well reproduced by the linear polynomial.