The 8th European Congress on Computational Methods in Applied Sciences and Engineering
ECCOMAS Congress 2022
5-9 June 2022, Oslo, Norway

Robust and scalable Newton-type methods for visco-plastic sea-ice models

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Keywords: *sea-ice, visco-plasticity, Newton methods, preconditioners*

We present a novel linearization for the Hibler rheology, a model commonly used to model sea-ice with a continuum model on large scales. The Hibler model involves a viscous-plastic constitutive relation to model the continuous deformation of sea-ice as well as the breakup of sea-ice resulting in so-called leaks. The nonlinearity in the rheology makes the robust numerical solution of these sea-ice models challenging. The proposed Newton-type method has a cost per iteration that is identical to the cost of a standard Newton method. However, it converges much faster and more robust, and allows high-resolution and fully resolved modeling of sea-ice.