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Consistent Generation of Ice-Streams viaThermo-Viscous Instabilities Modulated by Membrane Stresses

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Accurate computation of ice-stream location and dynamics is a key aspiration for theoretical glaciology. Ice-sheet models with thermo-viscous coupling have been shown to exhibit stream-like instabilities using shallow-ice approximation mechanics, but the location and width of these streams depends on the numerical implementation and are not unique. We present results from thermo-viscously coupled ice-sheet models incorporating membrane stresses. Spontaneous generation of fast-flowing linear features still occurs under certain parameter regimes, with computed stream widths between 20km to 100km, comparable with observations. These features are maintained as the grid-size is decreased. The basic thermo-viscous feedback mechanism that generates ice-streams under the shallow ice approximation still seems to operate, but now selects a unique stream size. Computations of thermo-viscous ice flows should include membrane stresses when the bed is approximately flat, e.g. parts of Antarctica and former ice-sheets of the Northern hemisphere. Calculations using the shallow ice approximation should be reassessed.