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Using sea-ice deformation fields from RADARSAT to constrain mechanical strength parameters of geophysical sea ice

Amélie Bouchat and Bruno Tremblay
Atmospheric and Oceanic Sciences, McGill University, Montreal, Canada

Sea-ice deformations in the Arctic Ocean are of great influence on the local and global sea-ice and ocean state in numerical simulations of the Arctic system. The pack ice deformations indeed affect the ice mass balance, the vertical heat fluxes between the ocean and atmosphere, and the upper ocean salinity. While satellite-derived deformation fields from the RADARSAT Geophysical Processor System (RGPS) are known to exhibit power law scaling properties in their spatial dependence as well as in their probability distribution functions (PDFs), the properties of simulated sea-ice deformations are largely set by the chosen sea-ice rheology, i.e. the relation between the internal ice stress and ice strain rates. Using the viscous-plastic (VP) elliptical rheology, we conduct a sensitivity study to investigate the effects of changing the ice mechanical strength parameters on the PDF properties of the sea-ice strain rate invariants and attempt to reconcile recent contradictory results on the ability of the VP elliptical framework to reproduce the observed PDF power law scaling (Girard et al. 2009, Spreen et al. 2016). To do so, we first reformulate the VP elliptical rheology to eliminate the ellipse aspect ratio e in favor of introducing the more meaningful ice shear strength parameter $S*$, and we also allow the ice to have non-zero isotropic tensile strength, as represented by the ice tensile strength parameter $T*$. By designing experiments where the ice mechanical strength parameters are independently modified, we aim at understanding the dependency of the simulated deformation rates on the rheology parameters, and potentially further constrain the mechanical strength parameters of geophysical sea ice by comparing the simulated results to the observed RGPS PDFs. Results suggest that the widely-used ice strength in compression of P*=27.5 kNm-2 is too large and should be reduced to yield better agreement with observed deformation fields.