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A multi-approach skill-score procedure to optimize continental-scale ice-sheet models

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Simulations of large-scale ice sheet models are crucial to understand the long-term evolution of an ice sheet and its response to climate forcings. However, solving the ice-flow equations and processes proper of the ice sheet at large spatial scales requires reducing the model computational complexity to a certain degree. To do so, coarse-resolution models represent several physical processes and ice characteristics through model parameterisations. Ice-sheet boundary conditions (e.g. basal sliding, surface ablation, grounded and marine basal melting) as well as unconstrained ice-flow properties (e.g. ice-flow enhancement factor) are some examples. However, choosing the best parameter values to well represent such processes is a demanding exercise. Statistical methods, from simple to advanced techniques involving Bayesian approaches, have been taken into account to evaluate the model performance. Here we optimise the performance of a new state-of-the-art hybrid ice-sheet-shelf model by applying a skill-score method based on a multi-misfits approach. A large ensemble of paleo-to-present transient simulations of the Greenland ice sheet (GrIS) is produced through the Latin Hypercube Sampling technique. Results are then evaluated against a variety of information, comprising the present-day state of the ice sheet (e.g. ice thickness, ice velocity, basal thermal state) as well as available paleo reconstructions (e.g. glacial maximum extent, past elevation at the ice core sites). Results are then assembled to generate a single skill-score value based on a gaussian approach. The procedure is applied to various model parameters to evaluate the best choice of values associated with their parameterisations.