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Full Stokes glacier model on GPU

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Two different approaches are commonly used in glacier ice flow modeling: models based on asymptotic approximations of ice physics and full stokes models. Lower order models are computationally lighter but reach their limits in regions of complex flow, while full Stokes models are more exact but computationally expansive. To overcome this constrain, we investigate the potential of GPU acceleration in glacier modeling.

The goal of this preliminary research is to develop a three-dimensional full Stokes numerical model and apply it to the glacier flow. We numerically solve the nonlinear Stokes momentum balance equations together with the incompressibility equation. Strong nonlinearities for the ice rheology are also taken into account.

We have developed a fully three-dimensional numerical MATLAB application based on an iterative finite difference scheme. We have ported it to C-CUDA to run it on GPUs. Our model is benchmarked against other full Stokes solutions for all diagnostic ISMIP-HOM experiments (Pattyn et al.,2008). The preliminary results show good agreement with the other models. The major advantages of our programming approach are simplicity and order 10-100 times speed-up in comparison to serial CPU version of the code.

Future work will include some real world applications and we will implement the free surface evolution capabilities.

References:

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