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A Full Stokes Model for Large Scale Ice Dynamics Simulations

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In contrary to scaled equations, Elmer applies Full Stokes (FS) simulations, where horizontal scales of the mesh are of similar size than vertical, leading to a scale-up of the problem size by a factor 100. Models earlier run on a single workstation consequently occupy 100 and more processors if FS is applied, demanding parallel computations on clusters or Grid environments. The main focus of the work presented here is to make the needed modules for FS ice-dynamics modeling within Elmer available on the EGEE environment. With the increased capacity of the EGEE infrastructure, we attempt to obtain an enhanced resolution down to a horizontal scale in the size of a few kilometers, resulting in computations containing millions of degrees of freedom. At these scales, details such as ice streams, which were below the resolution of a standard SIA run can be investigated. This provides an enhanced insight into the mechanics and thermodynamics of ice sheets.

3. Impact

First tests on the EGEE environment applied to the complete Greenland Ice Sheet (GIS), which proved to work on a coarse computational mesh, are scheduled for end 2007. The EGEE environment provides a reliable and economic platform to perform production runs on high ressolution meshes that are needed for instance for computationally extensive sensitivity studies.

4. Conclusions / Future plans

The OS FEM code Elmer has been ported to the EGEE environment. Currently models for using the code as a tool for high-resolution ice-dynamics simulations are being developed and tested within the environment. In close future they will provide a tool to investigate ice dynamics of continental ice sheets with resolutions down to sub-kilometer scale omitting the limitations introduced by codes applying scaled equations, as has also been demanded in the IPCC report on climate change.

Provide a set of generic keywords that define your contribution (e.g. Data Management, Workflows, High Energy Physics)

Finite Element, Geophysics, Glaciology, Ice Sheets,

1. Short overview

Current state-of-the-art ice sheet models apply scaled equations, such that even computations of large ice masses fit in a single work station. Nevertheless, this scaling prohibits correct numerical treatment of ice-domes, ice streams and ice margins with a possible transition to ice-shelves. In order to address these shortcomings the Open Source (OS) FEM software Elmer has been adapted to simulate the dynamics of ice on high resolution meshes and introduced to the EGEE environment.

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