The Albany/FELIX First-Order Stokes Dycore

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This talk will give an update on the Albany/FELIX (Finite Elements for Land Ice eXperiments) higher-order Stokes dynamical core (dycore) that is currently under development as a part of the PISCEES (Predicting Ice Sheet and Climate Evolution at Extreme Scaled) project. Focus will be on the forward stress-velocity simulator for the first-order Stokes partial differential equations (PDEs) developed using the Trilinos [1] libraries, and implemented within the Albany [2] code base. The use of Trilinos libraries has enabled the rapid code development of an efficient parallel unstructured grid finite element code, termed "Albany/FELIX", which uses non-linear Newton solvers based on domain decomposition, which leverage dozens of Trilinos capabilities such as distributed-memory linear algebra and automatic differentiation. Following a review of the first-order Stokes physics and the structure of the Albany/FELIX code, some new developments within this code and corresponding results will be presented. We will describe several capabilities for importing Greenland/Antarctica data (geometry, topography, surface height, basal friction, etc.) into Albany/FELIX. We will also give an update on the development of interfaces between Albany/FELIX and the CISM and MPAS codes. Results for some steady-state Greenland and Antarctica simulations obtained on three different kinds of meshes (structured hexahedral grids, structured tetrahedral grids, true unstructured Delaunay triangle grids) will be shown, followed by preliminary results for some dynamic simulations obtained using the MPAS-Albany and CISM-Albany interfaces. We will end by discussing various analyses of the performance of the Albany/FELIX code, including a mesh convergence study, an examination of the code's robustness, and a study of the code's scalability.

This work is in collaboration with Matt Hoffman, Doug Ranken, Kate Evans, Pat Worley, Matt Norman, Mike Eldred and Jakeman.

References

[1] M.A. Heroux *et al.* "An overview of the Trilinos project". *ACM Trans. Math. Softw.* **31**(3) (2005).

[2] A.G. Salinger *et al.* "Albany: A Component-Based Partial Differential Equation Code Built on Trilinos", submitted to *ACM Trans. Math. Software.*.