Geophysical Research Abstracts
Vol. 16, EGU2014-11127, 2014
EGU General Assembly 2014

Discontinuous Galerkin Approaches for Stokes Flow and Flow in Porous Media

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Firstly, we present results of a study comparing two different numerical approaches for solving the Stokes equations with strongly varying viscosity: the continuous Galerkin (i.e. FEM) and the discontinuous Galerkin (DG) method. Secondly, we show how the latter method can be extended and applied to flow in porous media governed by Darcy's law.

Nonlinearities in the viscosity or other material parameters can lead to discontinuities in the velocity-pressure solution that may not be approximated well with continuous elements. The DG method allows for discontinuities across interior edges of the underlying mesh. Furthermore, depending on the chosen basis functions, it naturally enforces local mass conservation, i.e. in every mesh cell. Computationally, it provides the capability to locally adapt the polynomial degree and needs communication only between directly adjacent mesh cells making it highly flexible and easy to parallelize.

The methods are compared for several geophysically relevant benchmarking setups and discussed with respect to speed, accuracy, computational efficiency.