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Adaptive multiresolution method for problems of computational geodynamics

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Practical geodynamic problems require high-resolution numerical models. Often computational requirements for such calculations are very high and thus advanced computational strategies are needed.

We present adaptive finite element grid refinement method for mechanical (Stokes), thermal or coupled thermo-mechanical problems arising in computational geodynamics. Fully automatic mesh adaptation is implemented using a novel approach based on wavelet analysis. Both linear ($\mathrm{Q}_1\mathrm{P}_0$, $\mathrm{Q}_1\mathrm{Q}_1$) and quadratic ($\mathrm{Q}_2\mathrm{P}_{-1}$) elements are supported for Stokes system.

The method was successfully applied for linear (Rayleigh–Taylor instability) and non-linear (extension / compression with brittle faulting) problems. Obtained results are shown to be in excellent agreement with those obtained on non-adaptive grid and with analytical solutions. At the same time, computational requirements of the method compared to non-adaptive grid approach are few orders of magnitudes lower in terms of both time and memory usage.