Numerical Simulation Methods in Geophysics, Report 1

1. MGPY+MGIN

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Report 1

Objective: Use Finite Elements to solve heat transfer into the Earth caused by periodic surface temperature (upper BC)

$$T(z=0) = T_0 + \Delta T \sin \omega t$$

initial condition: $T(z) = T_0$ (ignoring the previous heat!)

Tasks

1. Implement functions for stiffness matrix & mass matrix using FE (including BC)
2. Use a non-equidistant discretization of the Earth with increasing layer thicknesses (choose and substantiate).
3. Solve instationary heat equation with periodic boundary condition (yearly cycle) for the Earth using a constant but meaningfull thermal diffusivity.
4. Compare the solutions using explicit, implicit and mixed timestepping methods with the analytical solution.

Questions

- Interpret the results in terms of physical behaviour. How does a change in the diffusivity affect the result?
- After which time approaches the numeric solution the analytical one?
- Make a statement about the stability and accuracy of the methods.
- Is there a difference between FD and FE discretizations? Why (not)?
- How can you evaluate the numerical accuracy if there is no analytical solution?

Deliverables

- Format can be Jupyter Notebook and/or PDF
- Complete codes to run the results