TU Berlin | Sekr. TIB1-B14 | Gustav-Meyer-Allee 25 | 13355 Berlin

Robert Egel
Matrikelnr. 375766

Fakultät VI | **Planen Bauen Umwelt**
Institut für Bauingenieurwesen
Fachgebiet Wasserwirtschaft und Hydrosystemmodellierung

Prof. Dr.-Ing. R. Hinkelmann
Sekr. TIB1-B14
Gustav-Meyer-Allee 25
13355 Berlin
Gebäude 13b, Raum 510

Tel.: +49 (0)30 314-72429
Fax: +49 (0)30 314-72430
lennart.steffen@wahyd.tu-berlin.de
www.tu.berlin/wahyd

Bearbeiter/in: Lennart Steffen

Berlin, April 4, 2024

Aufgabenstellung zur Bachelorarbeit mit dem Thema

A Novel Approach to Local Time Stepping, using the Shallow Water Equations Model hms^{++}

Motivation

In explicit flow simulations, the time step can be computed adaptively by using a stability criterion such as the Courant number. The allowable time step depends on cell size, flow velocity and wave celerity, and can thus vary greatly across the computational domain. However, its global minimum is generally used throughout the whole domain, to keep the simulation synchronised and stable.

'Local time stepping' refers to methods which mitigate this issue by dividing the domain into regions where a larger local minimum time step is used. While this complicates synchronisation and computation of fluxes across region boundaries, it can lead to overall reduced runtimes. In existing methods, the local time step typically varies by a factor of exactly 2 between neighbouring regions.

At the Chair of Water Resources Management and Modelling of Hydrosystems, we devised a local time stepping algorithm which may exploit any factor > 2 between regions: For every region, the current time and local time step define the end point in time t_{end} until which a state change computation would be stable. This state change can be stored, and – when scaled down to the global minimum time step – repeatedly applied until t_{end} is reached. We wish to explore this algorithm and its potential for use in surface water flow simulations with hms^{++}, an in-house development of a shallow water equations model.

Main Tasks

- Implementation of the local time stepping algorithm described above in hms^{++}
- Investigation of the algorithm's impact on accuracy and runtime
- Adaptation of hms^{++} for macOS/ARM computers, to broaden compatibility and enable the student to use his preferred machine

The thesis must be written in either German or English. All steps must be documented and the results must be discussed. After submission of the written thesis, an oral presentation of the thesis with a subsequent discussion is to be held.

Supervision

Supervisor:	Lennart Steffen, M.Sc.
First examiner:	Prof. Dr.-Ing. Reinhard Hinkelmann
Second examiner:	Dr.-Ing. Franziska Tügel