EGU21-9568
https://doi.org/10.5194/egusphere-egu21-9568
EGU General Assembly 2021

The SERGHEI model and its core shallow water solver

Mario Morales-Hernández[1], Ilhan Özgen-Xian[2], and Daniel Caviedes-Voullième[3]
[1]Fluid Mechanics, University of Zaragoza, Zaragoza, Spain (mmorales@unizar.es)
[2]Geochemistry Department (EESA), Lawrence Berkeley National Laboratory, CA, USA (iozgen@lbl.gov)
[3]Institute for Advanced Simulation (IAS), Jülich Supercomputing Centre (JSC), Jülich, Germany (d.caviedes.voullieme@fz-juelich.de)

The Simulation Environment for Geomorphology, Hydrodynamics and Ecohydrology in Integrated form (SERGHEI) model framework is a multi-dimensional, multi-domain and multi-physics model framework. It is designed to provide a modelling environment for hydrodynamics, ecohydrology, morphodynamics, and, importantly, interactions and feedbacks among such processes, at different levels of complexity and across spatiotemporal scales. SERGHEI is in essence, a terrestrial landscape simulator based on a hydrodynamics core, designed with an outlook towards Earth System Modelling applications. Consequently, efficient mathematical and numerical formulations, as well as HPC implementations are at its core. SERGHEI intends to enable large scale and high resolution problems, which will allow to acknowledge and simulate emergent behaviours rising from the small-scale interactions and feedbacks between different environmental processes, that often manifest at larger spatiotemporal scales.

At the core of the technical innovation in SERGHEI is its HPC implementation, built from scratch on the Kokkos programming model and C++ library. This approach facilitates portability from personal computers to Tier-0 HPC systems, including GPU-based and heterogeneous systems. This is achieved by relying on Kokkos handling memory models, thread management and computational policies for the required backend programming models. In particular, using Kokkos, SERGHEI can be compiled for multiple CPUs and GPUs using a combination of OpenMP, MPI, and CUDA.

In this contribution, we introduce the SERGHEI model framework, and specially its first operational module for solving shallow water equations (SERGHEI-SWE). This module is designed to be applicable to hydrological, environmental and consequently Earth System Modelling problems, but also to classical engineering problems such as fluvial or urban flood modelling. We also provide a first showcase of the applicability of the SERGHEI-SWE solver to several well-known benchmarks, and the performance of the solver on large-scale hydrological simulation and flooding problems. We also show and discuss the scaling properties of the solver (on several Tier-0 systems) and sketch out its current and future development.