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## AvaFrame as a testing and benchmarking environment for avalanche simulations

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Testing and benchmarking avalanche models is a crucial step in developing models as well as assessing their applicability. This is not only limited to the representation of physical processes within models, be it via first principles or using empirical relationships, but also concerns their computing environment, including compilers, hardware used, programming language, among others.

Test, benchmarking, and comparison strategies can aim at different issues, among others: numerics, the implementation thereof, plausibility, verification, or evaluation. However, they always require reference or expected results. References can come from observations, analytical results, comparison to other models, known physical processes or material properties that cannot be changed – e.g., “avalanches cannot fly”. The question is: which characteristics or properties do we test and how to design appropriate tests?

To facilitate this, as part of the newly developed opensource avalanche framework - AvaFrame -, we started providing commonly accessible tools to make testing and developing easier. This ranges from tools to import data, generate input parameters to automatic analysis and plotting. Not only do we provide the infrastructure for testing, but we also provide a set of test cases complete with all necessary input data, reference results, and run script examples. These tests so far include idealized (generic) topographies, specific test cases for numerical questions, and 6 real world avalanches with distinct characteristics.

In this contribution we present this freely available set of tests and benchmarks suitable to assess various aspects and properties of a shallow water model solver for a dense flow avalanche model, one of the core computing modules of AvaFrame (com1DFA). We highlight how we utilize the entire range of tests in our continuous model development to assure the quality and applicability / validity of our development. Showing results from comparison to existing models, but also how to extend and apply our strategies to other models or research questions, we invite other researchers and developers to make full use of these tools.