Geophysical Research Abstracts
Vol. 18, EGU2016-11310, 2016
EGU General Assembly 2016


# The InterFrost benchmark of Thermo-Hydraulic codes for cold regions hydrology – first inter-comparison phase results

Christophe Grenier (1), Wolfram Rühaak (2), and the InterFrost Team

(1) LSCE/IPSL/CNRS (CEA-UVSQ), LSCE, Gif sur Yvette, France (christophe.grenier@lsce.ipsl.fr), (2) Darmstadt Graduate School of Excellence Energy Science and Engineering, Technische Universität Darmstadt, Germany

Climate change impacts in permafrost regions have received considerable attention recently due to the pronounced warming trends experienced in recent decades and which have been projected into the future. Large portions of these permafrost regions are characterized by surface water bodies (lakes, rivers) that interact with the surrounding permafrost often generating taliks (unfrozen zones) within the permafrost that allow for hydrologic interactions between the surface water bodies and underlying aquifers and thus influence the hydrologic response of a landscape to climate change.

Recent field studies and modeling exercises indicate that a fully coupled 2D or 3D Thermo-Hydraulic (TH) approach is required to understand and model past and future evolution such units (Kurylyk et al. 2014). However, there is presently a paucity of 3D numerical studies of permafrost thaw and associated hydrological changes, which can be partly attributed to the difficulty in verifying multi-dimensional results produced by numerical models.

A benchmark exercise was initialized at the end of 2014. Participants convened from USA, Canada, Europe, representing 13 simulation codes. The benchmark exercises consist of several test cases inspired by existing literature (e.g. McKenzie et al., 2007) as well as new ones (Kurylyk et al. 2014; Grenier et al. in prep.; Rühaak et al. 2015). They range from simpler, purely thermal 1D cases to more complex, coupled 2D TH cases (benchmarks TH1, TH2, and TH3). Some experimental cases conducted in a cold room complement the validation approach. A web site hosted by LSCE (Laboratoire des Sciences du Climat et de l'Environnement) is an interaction platform for the participants and hosts the test case databases at the following address: https://wiki.lsce.ipsl.fr/interfrost.

The results of the first stage of the benchmark exercise will be presented. We will mainly focus on the inter-comparison of participant results for the coupled cases TH2 & TH3. Both cases are essentially theoretical but include the full complexity of the coupled non-linear set of equations (heat transfer with conduction, advection, phase change and Darcian flow).

The complete set of inter-comparison results shows that the participating codes all produce simulations which are quantitatively similar and correspond to physical intuition. From a quantitative perspective, they agree well over the whole set of performance measures. The differences among the simulation results will be discussed in more depth throughout the test cases especially for the identification of the threshold times for each system as these exhibited the least agreement. However, the results suggest that in spite of the difficulties associated with the resolution of the set of TH equations (coupled and non-linear structure with phase change providing steep slopes), the developed codes provide robust results with a qualitatively reasonable representation of the processes and offer a quantitatively realistic basis.

Further perspectives of the exercise will also be presented.