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Thermo-hydrologic modelling of permafrost with OpenFOAM®: perspectives of applications to the study of weathering in boreal areas

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The weathering in permafrost dominated areas is strongly affected by the seasonnal freeze/thaw cycles of the active layers (e.g.: [1], [2]). Thus the expected evolution of the lengthes and of the intensities of these freeze/thaw cycles in response to the climate changes will lead to possibly strong interactions between climate changes and permafrost thermo-hydrological dynamics (e.g.: [3]), due for example to the link between the weathering processes and the climate [4]. The potential release to the atmosphere of organic carbon stored within the permafrosts may also be a strong source of feedbacks between the active layers dynamics and the global changes [5].
Consequently the study and the modelling of the thermo-hydrological behaviour of the active layers of permafrost dominated areas are important stakes for the improvement of our understanding of the continental surfaces dynamics under climate changes. In this work we will present a new numerical solver for the coupled water and thermal transfers within soils, developed in the framework of OpenFOAM® [6]. The use of OpenFOAM® allows using of parallel computing on 3D geometries in an easy way (e.g.: [7]). The goal that have motivated the development of this numercial tool is to be able to deal with the large space scales and time scales that are encountered for example in the study of the evolution of the weathering processes at the experimental watershed scale (e.g.: [8], [9]).
After a brief presentation of the adopted theoritical description of the considered transfer phenomena (with Richards equation for the flow of water and an advection-diffusion-dispersion equation with phase change for the thermal transfer), we will show first results obtained in the framework of the benchmark INTERFROST ([10], [11]) and some preliminary results for an applicaion of the developped numerical tool to the study of the active layers in experimental watersheds of Central Siberia [12]. Finally the perspective of applications of this tool for the study of the weathering processes in boreal areas will be discussed.

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