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FNSNF

Simulating fast surface-to-depth coupling in frozen debris slopes

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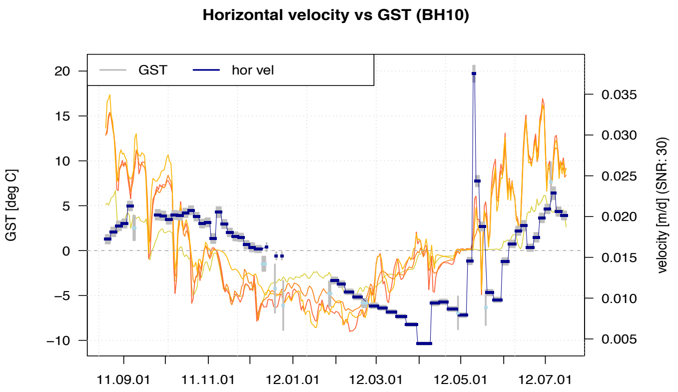
Problem outline

Geo-modelling is an important part of X-SENSE because of its role in the interpretation of observations and exploring future scenarios. Several points in the rock glacier show a fast acceleration of lateral movement in spring during after snowmelt. We assume that this is due to the infiltration in the soil, and, in particular, to the rapid transport of the infiltrating water in depth through macroporosities. In order to study the driving process, we reproduce this behaviour in the GEOtop model.



The GEOtop model

The GEOtop physical-based model is able to reproduce the strong coupling between water and energy balance taking place in soil freezing and thawing processes. It also describes the lateral fluxes of water, and the mass and energy budgets in the snow cover as well as the temporal evolution of the snow depth and its effect on soil temperature.

The main characteristics of GEOtop are the following:

1) three-dimensional numerical solution of water flow equation and one-dimensional (vertical) solution of soil heat equation
2) representation of soil freezing/thawing
3) representation of the energy exchange with the atmosphere (surface heat flux) that accounts for **complex terrain**
4) descriprion of the evolution of snow cover, with a full energy balance approach and a multilayer representation (-> vertical gradients and percolation).

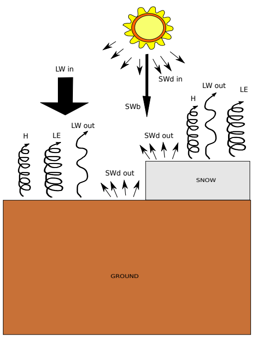


Figure 1: Surface energy balance (SWb = direct shortwave radiation, SWd = diffuse shortwave radiation, LW = longwave radiation, H = sensible heat flux, LE = latent heat flux)

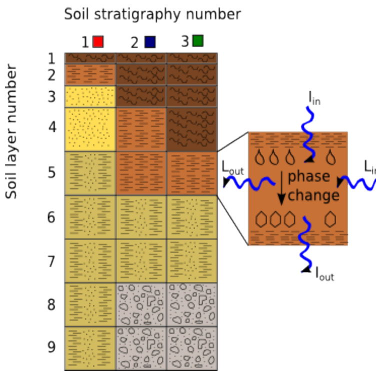
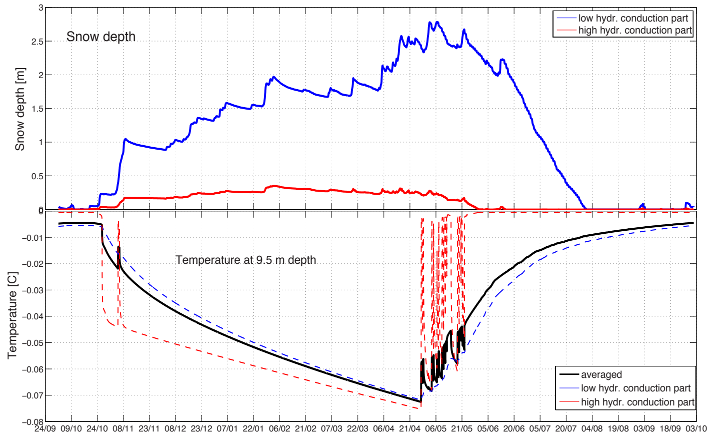


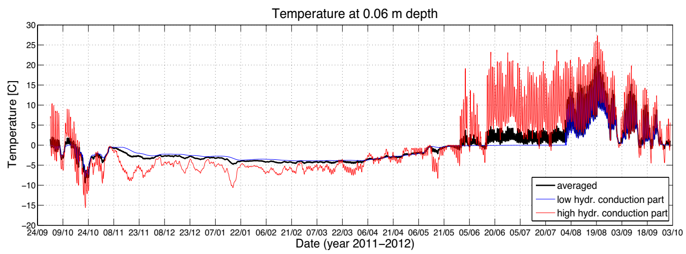
Figure 2 : Soil discretization

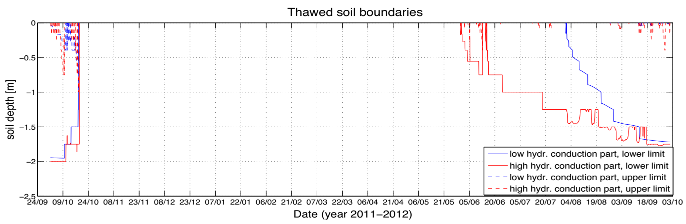
Method

In this work we investigate if in a one-dimensional simulation the implementation of a dual porosity can reproduce a fast increase of temperature in the deep soil. This may be responsible for the acceleration. The dual porosity is given by the combination of a soil portion with very high hydraulical conductivity (0.01 m/s) and a portion of moderate conductivity (1E-7 m/s), typical of a silty-sandy soil. The two portions exchange water and energy.

Results







Conclusion

Considering a dual porosity we can reproduce temperature rise pulses in depth corresponding to water infiltration during snowmelt. A slow temperature rise during the summer is also reproduced and may be responsible of the slow acceleration. This is just a preliminary application. Further parameter calibration is needed to better reproduec the processes.