InterFrost spread sheet for participant's code information

File is code related, if you use more than one code please provide one file per code …

Aims: 1°) provide pieces of information that will probably be essential to understand possible differences in the results or performances, 2°) provide info that will be essential to improve the codes from a "best practice" perspective.

Name of the code : permaFoam (plug-in for the open source CFD tool box OpenFOAM – www.openfoam.com).

Participant laboratory : GET, LSCE, VN Sukatchev institute of forest.

Participant name(s) : Laurent Orgogozo, Oleg S. Pokrovsky, Yves Goddéris, Christophe Grenier, Jérôme Viers, David Labat, Stéphane Audry, Anatoly Prokushkin.

Is the code used or developed by the team? Yes for both of these questions.

Numerical scheme, order of the numerical scheme : Finite volume, second order.

Time discretization strategy (fixed time steps / if adaptative, provide further information) : adaptative time stepping ; criterium : minimum 3 and maximum 8 iterations for the Picard loops ; a stabilisation procedure is used for the increasing of the time step. See Orgogozo et al., CPC 2014 for addditionnal details.

Spatial discretization

- 2D / 3D : 3D
- external/internal mesh generator : internal (mesh generators OpenFOAM).
- structured or unstructured grids, what kind of polyhedral mesh (tetra ? hexa ?) : both structured and unstructured grids are supported.

Treatment of non-linearities?

- Method used (Newton, Picard …) : Two consecutive Picard loops (fixed point linearisation) are used, one for the flow equation (Richards equation) and one for the heat transfer equation (Fourier equation in variably saturated porous medium with freeze/thaw of water).
- Convergence criterion expression and threshold value : 1) Richards loop : averaged difference between water pressure fields computed in two successive Picard iterations. 2) Heat transfer equation : maximum value of difference between temperature fields computed in two successive Picard iterations.

Resolution of linear systems

- Linear solvers : Richards : PCG ; Fourier : BiCG
- pre-conditioner : Richards : DIC ; Fourier : DILU

How is the TH coupling managed?

- Sequential resolution / iterative process / simultaneous inversion? : Sequential resolution

List of available boundary conditions options in the code : Numerous (see openfoam.com or even openfoamwiki.net/index.php/Contrib/swak4Foam).

Sources of averaging (under relaxation, spatial averaging on variables …) : assumption of local thermal equilibrium, time lag (one time step) in the application of the heat fluxes related to phase change.

Constitutive laws implemented

- Saturation curve : Exponential (see McKenzie et al. 2007) ; other kind of saturation curve suc as linear saturation curve may easily be implemented.
- Permeability as a function of temperature : Power law (see McKenzie et al. 2007) other kind of saturation curve such as a linear one may easily be implemented.

What kind of averaging for the properties (depending on water, ice, bulk parameters)? Volume averaging.

Is (massively)parallel resolution implemented? Yes, but it remains to be extensively tested. The parallel performances are expected to be comparable with those shown in Orgogozo et al. CPC 2014.

- Which approach (domain decomposition, loop decomposition) : domain decomposition.
- Indicative number of processors : a hundred (tested) to thousands (to be tested).

Papers / reports / web siteproviding (further) information :

Orgogozo L. et al., 2014. Numerical modelling of heat and water transfer in permafrost-dominated watersheds. In “Permafrost: Distribution, Composition and Impacts on Infrastructure and Ecosystems”, ed. O.S. Pokrovksy, Nova Publishers.

Further pieces of information? permaFoam is based fo the water transfer part on the Richards equation solver RichardsFOAM, presented in Orgogozo et al. CPC 2014. It will be presented at the EGU general assembly 2015.