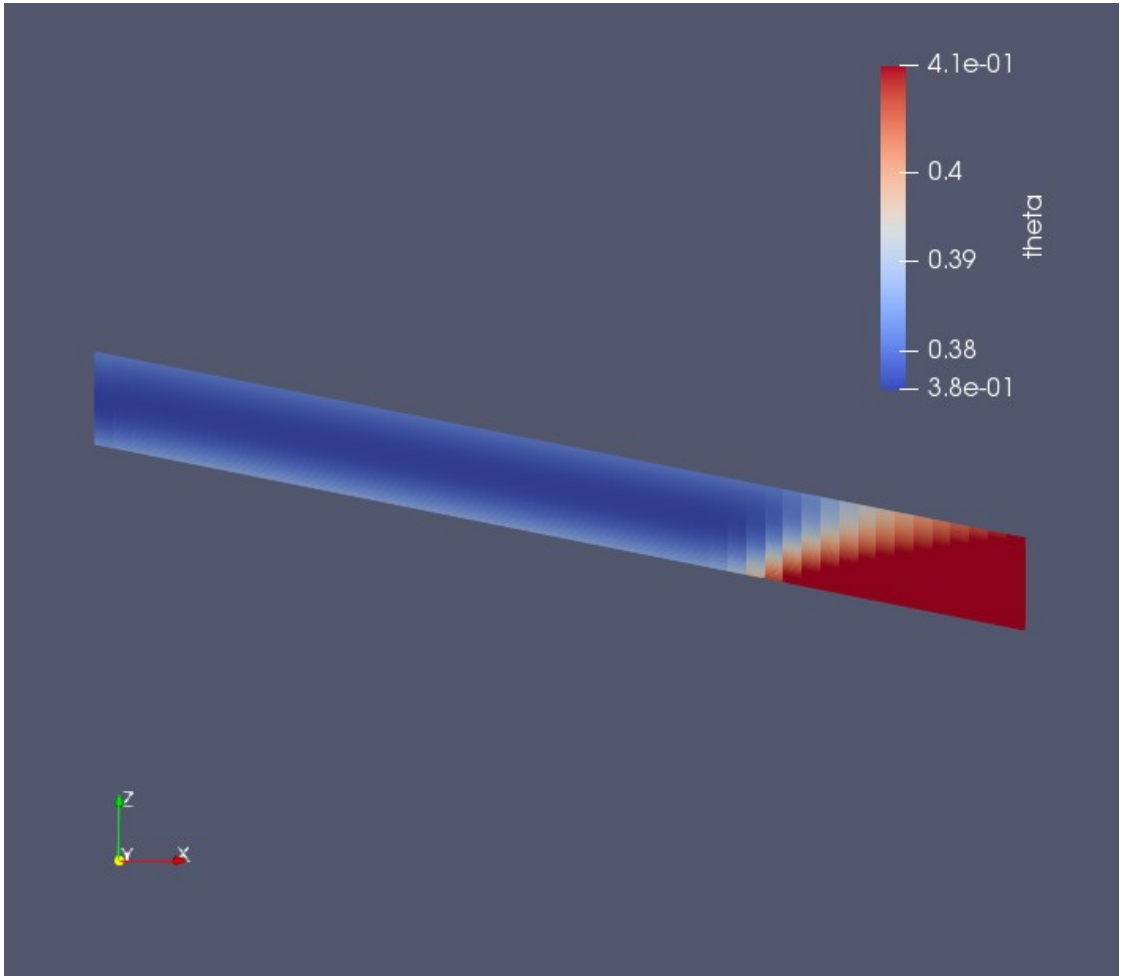
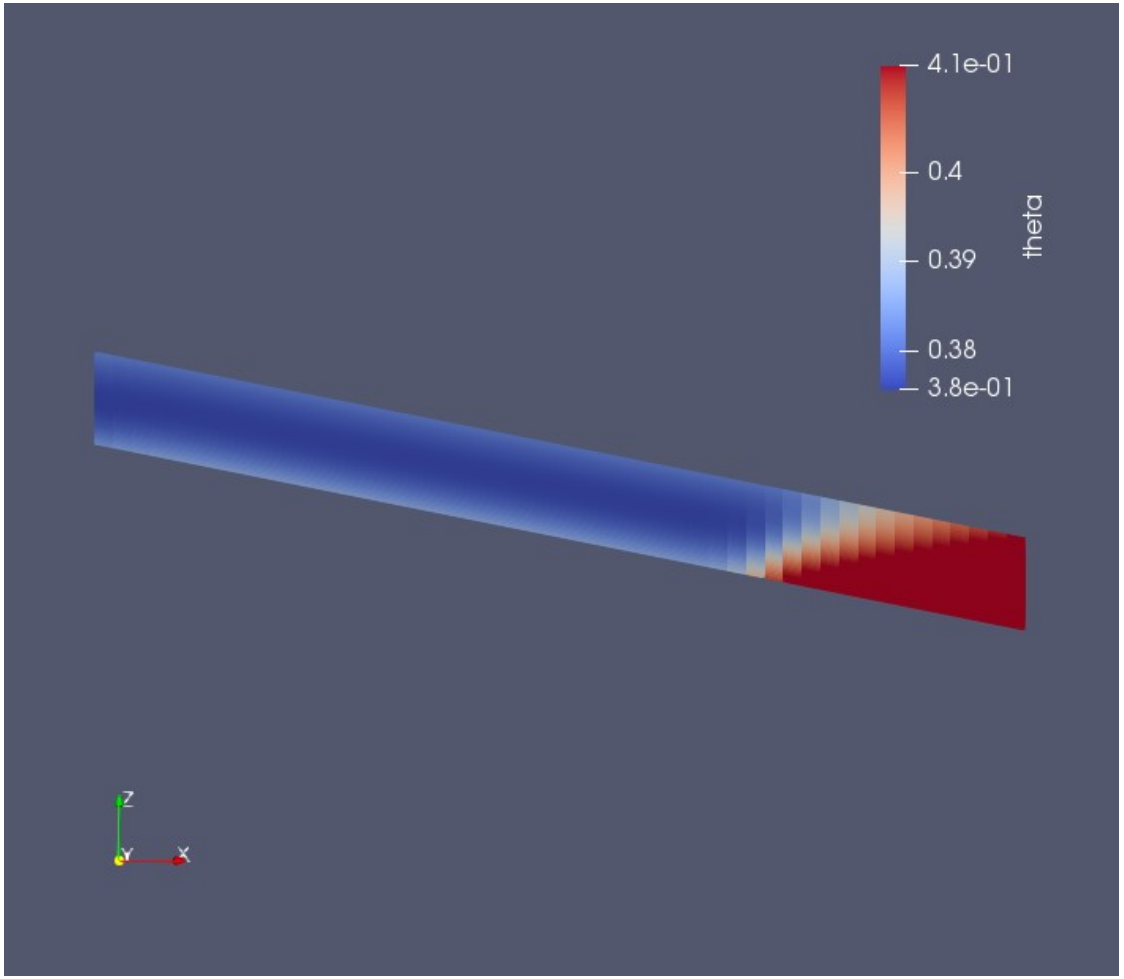
RichardsFoam3_demoCase

Modelling rain infiltration with evapotranspiration in an inclined loam bank with RichardsFoam3, an OpenFOAM solver for flow in variably saturated porous media.



See Orgogozo *et al.,* 2014, and Orgogozo, 2015, published in *Computer Physics Communications* for details on the RichardsFoam3 solver

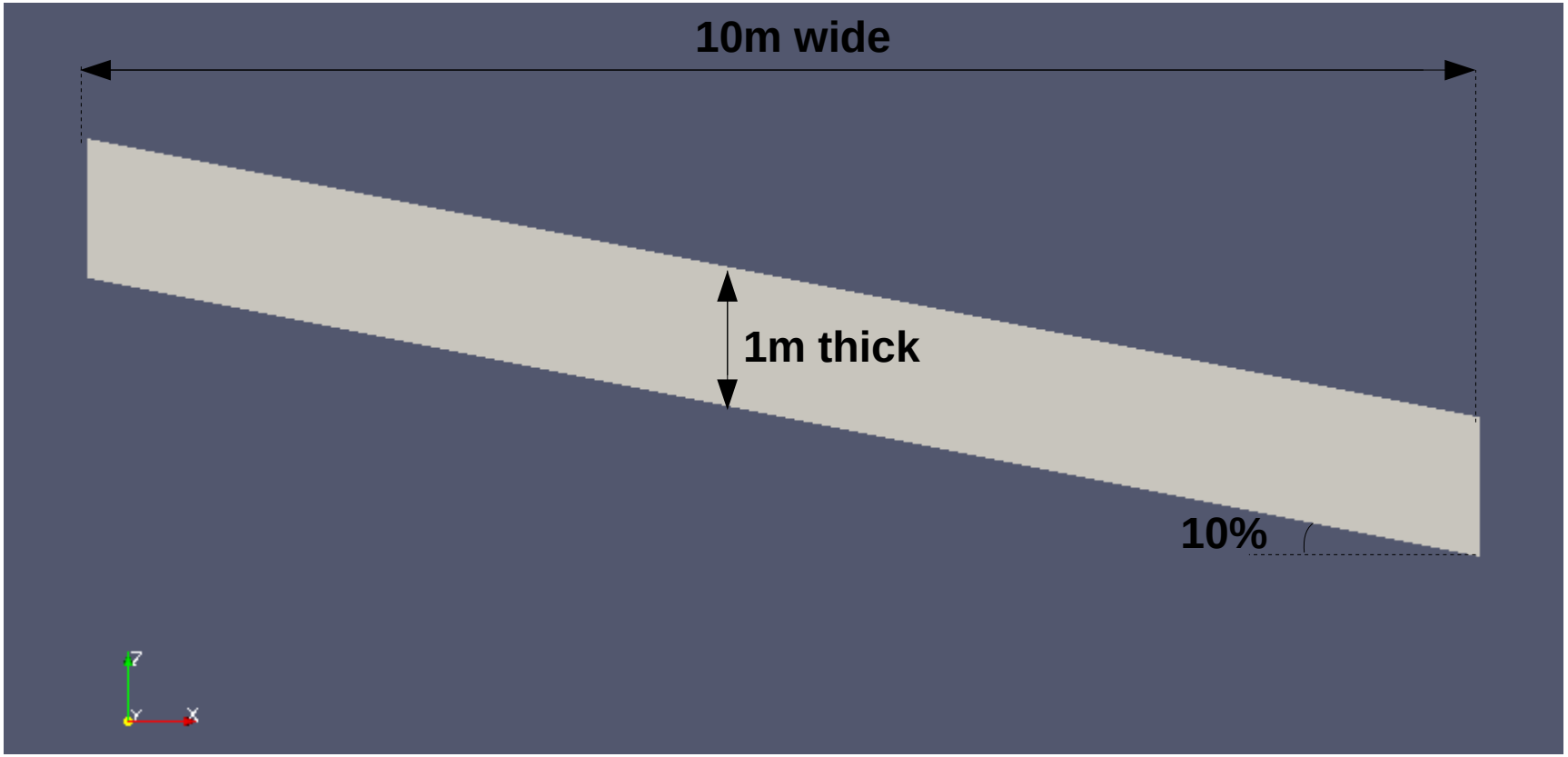
In order to illustrate the capabilities of RichardsFoam3, we propose to model the hydrological behaviour of a partially water saturated loam bank during a one month long period of rain with concomitant evapotranspiration. This document details the geometrical features, the initial conditions, the cilmatic forcings, the boundary conditions, and some results associated with this modelling.



This demonstration test case may also serve to validate your installation of the RichardsFoam3 package on your own computer, by comparing the post-processed results obtained in the postProcessing directory with those contained in expected_postProcessing directory – they should be the same!

Geometrical features and medium properties

The domain of modelling is a 2D bank of loam, with 10m of width, 1 m of thickness, and 10% of slope.



Geometrical features and medium properties

The domain of modelling is constituted of loamy soil. The considered hydrodynamic and thermal properties are the same that those which are used for describing the mineral horizon in Orgogozo *et al.*, 2019, published in *Permafrost and Periglacial Processes*.

K_s [m.s^{-1}]	4.63 1e-7
α [m^{-1}]	0.82
n [-]	1.2179
θ_s [-]	0.412
θ_r [-]	0.01
θ_{WP}[-]	0.149
S [m^{-1}]	4.04 1e-5

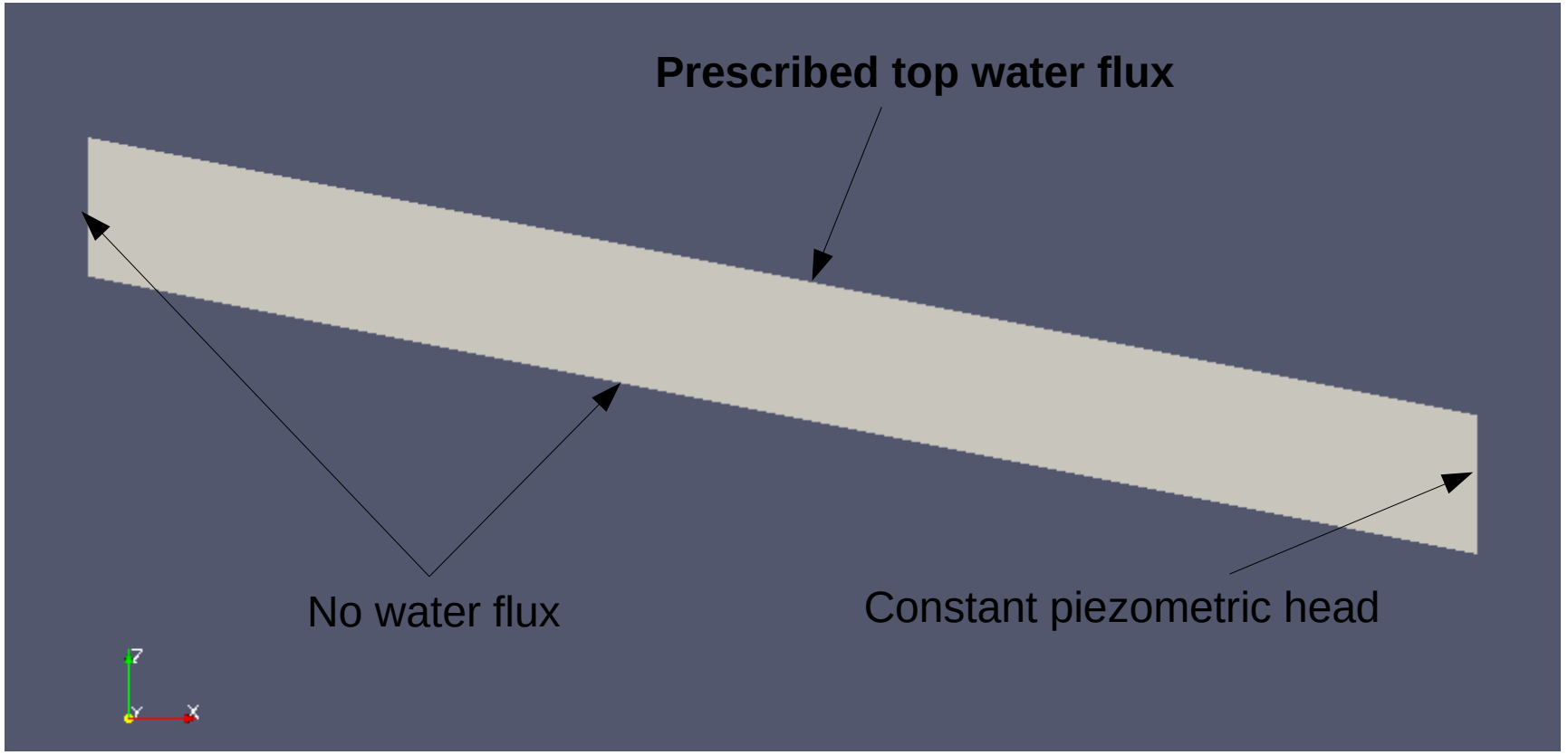
Meteorological forcings

We consider a period of one month of rain infiltration from the top of the bank, while evapotranspiration occures within the whole depth of the bank. The meteorological forcings are detailed below (note that these values are all prescribed in a single place, in the 0/include/climaticConditions file).

Monthly top water flux: 48 mm/month (*i.e.* 1.85*1e^{-8} m.s^{-1})
Monthly potential evapotranspiration: 51.8 mm/month (homogeneously distributed in the bank, *i.e.* a ponctual sink term of 2*10^{-8} s^{-1})

Boundary conditions

The domain is impermeable at the upslope and bottom boundaries. At the top boundary, the water flux is prescribed at this top boundary, with a peculiar feature: the fixed water flux boundary condition switch to a fixed pressure head (equal to 0m) whenever the porous medium become water saturated (that is what does the rainFallFlux boundary condition). At the downslope boundary, a constant piezometric head H = z + psi = 0 m represents the contact with a river.



Initial conditions

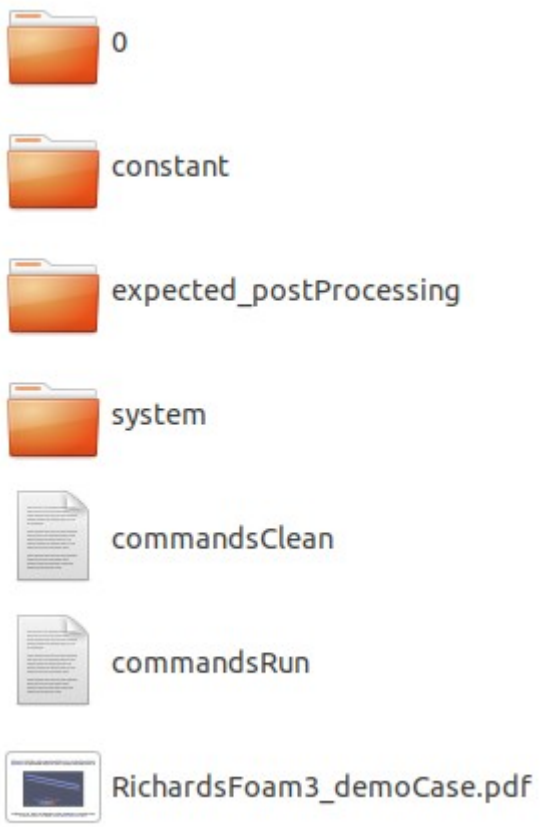
The initial conditions describe a smoothly unsaturated state of the bank.

- Homogeneous pressure head psi = -0.8 m

- As a consequence, homogeneous volumteric water content = 0.38

Structure of the RichardsFoam3_demoCase

The structure of the permaFoam_demoCase is the classic structure for a simple OpenFOAM case.



The file commandsRun contains all the commands that must be executed to run the RichardsFoam3_demoCase, while commandsClean contains all the commands needed to clean the case. The expected_postProcessing contains the postProcessing as it should be once the case has been ran, for validation of your installation of RichardsFoam3. You are currently reading RichardsFoam3_demoCase.pdf, which contains a brief description of the RichardsFoam3_demoCase.

Run the RichardsFoam3_demoCase

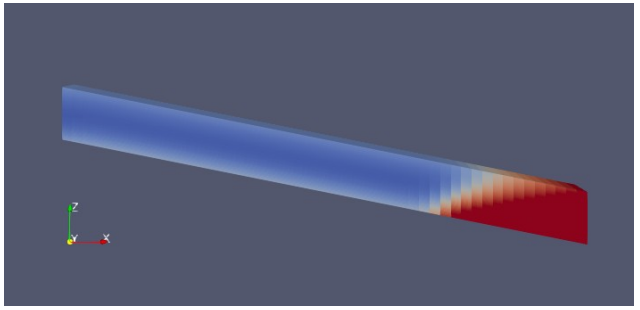
In order to run the RichardsFoam3_demoCase, you need first to install OpenFOAM_v1912 and to compile the RichardsFoam3 solver and the associated specific boundary conditions rainFallFlux and noRainFlux. See the readMe file of the RichardsFoam3_package for more details.

Then copy the RichardsFoam3_demoCase directory in the "run/" directory of your openfoam workspace, and execute the following command from within the copied directory you have just created:

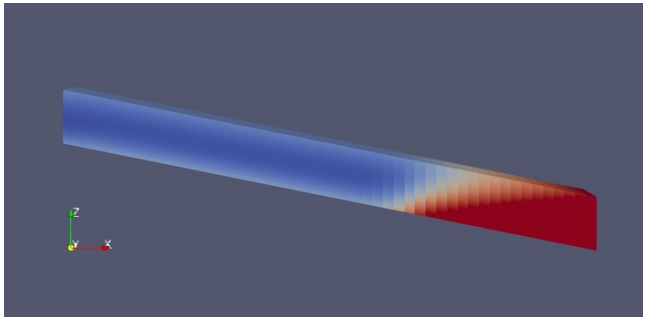
source commandsRun

It will run the case. The computation time for the completion of the run of the two cases rainSeason and drySeason is less than 1 mn, using a computer with a processor Intel® Core™ i5-8350U CPU @ 1.70GHz × 8, 15.5 Go of RAM and a 64-bit Ubuntu 18.04.5 LTS linux distribution OS.

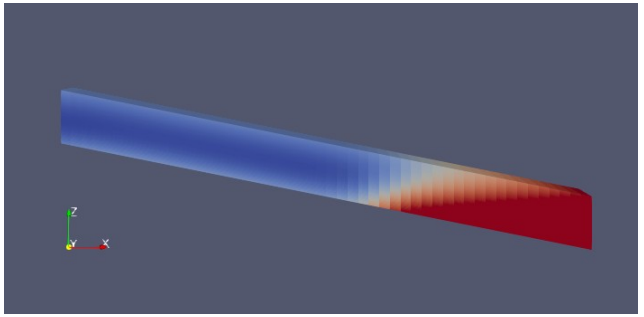
Example of results of the RichardsFoam3_demoCase: computed water content fields



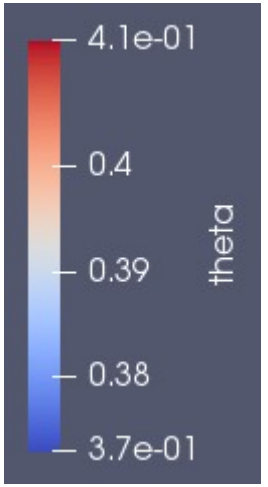
1 week



2 weeks



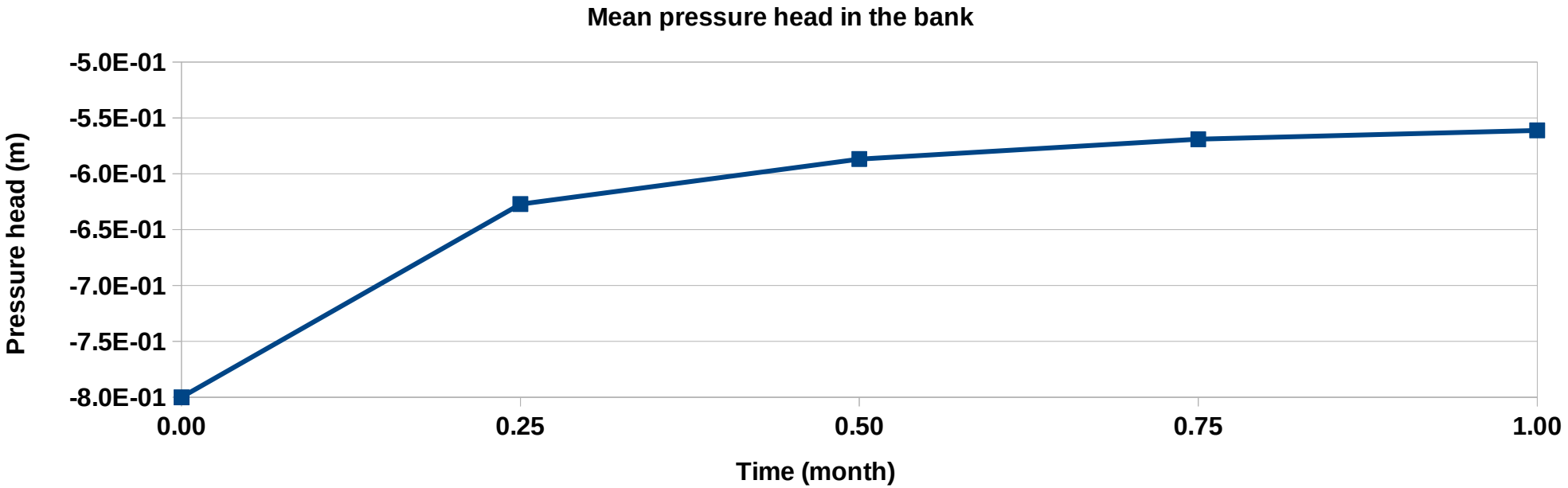
3 weeks

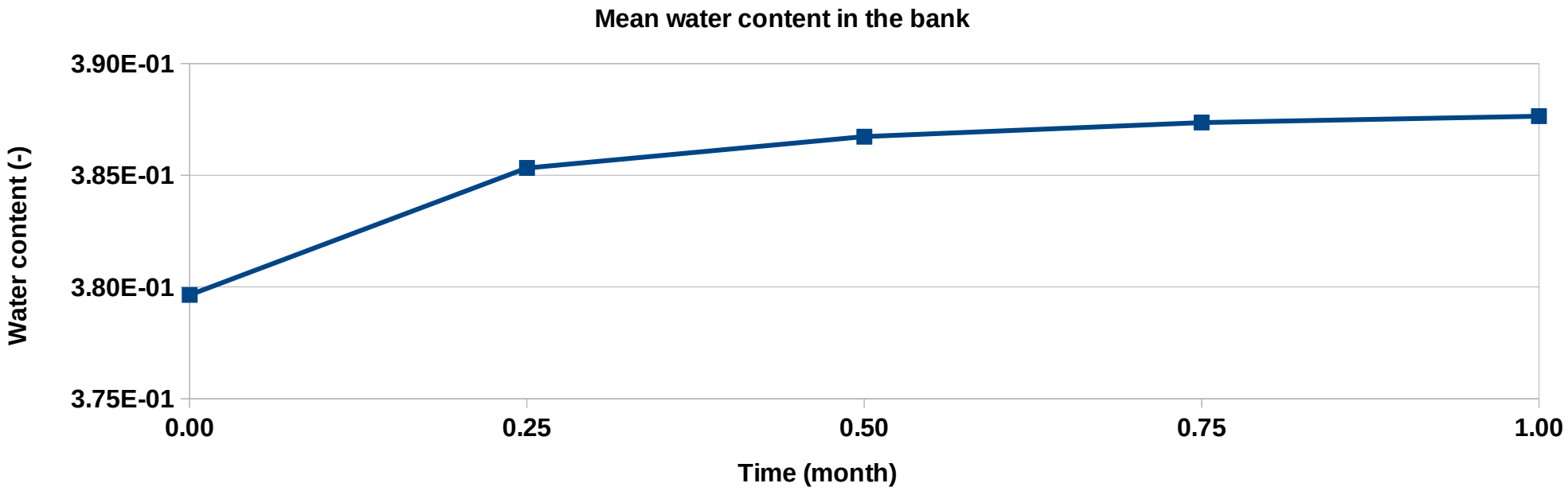


theta (-)

(paraFoam displays of the water content field along computations; note that the use of the same theta color scale for all figures hide partly some patterns)

Example of results of the RichardsFoam3_demoCase: postprocessing results for internal fields





Enjoy RichardsFoam3!

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