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3D modelling of the permafrost development in the Paris basin to ascertain its hydrogeologic impact.

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The quaternary [2-0 My] is characterized by drastic climatic oscillations with a period of 100 ky yielding a succession of glacial interglacial stages. These stages of glaciation of the ground over substantial thickness and time periods can create perturbations on groundwater flow in the regional scale aquifers especially by an interruption of the recharge. The impact of these temporal alterations of the recharge can be traced at present day in a multi-layered systems such as those of the Paris basin as shown by Jost (2005 et Jost et al. in press) using a simplifying approach.
It is thus crucial to arrive to a better physical constrain on this process and to develop a quantitative approach to understand the permafrost dynamics within hydrogeological units. Then, this calculation could be used to evaluate the hydrodynamic impact of permafrost development. This calculation introducing the latent heat of fusion of ice in the porous media heat flow equation (diffusion or diffusion-advection) is implemented within the basin model NEWBAS (Belmouhoub, 1996). This model, already used in the case study of the Paris basin (Gonçalvès et al. 2005), simulates the geologic evolution, fluid, mass and heat transfers under the control of processes such as sedimentation, compaction or erosion. It calculates as a function of time the 3D geometry of the basin and the physical properties e.g. the thermal conductivity of the layers.
The calculation of the spatial and temporal permafrost evolution is performed over the last million years. The climatic forcings introduced in the simulations are provided by a GCM model with a refined resolution on Europe, the LMDZ from IPSL which produces regionalized maps of surface temperature. This implementation of permafrost calculation in the NEWBAS model, allows us to propose 3D extensions of the permafrost i.e geographical extension but also the vertical extension taking into account the heterogeneity of the geological layers.

References

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