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Impact of permafrost 3D distribution, growth and decay over one climate cycle on regional groundwater flow

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In France, permafrost occurs only during cold periods of climate cycles. The aim of this work is to assess the impact of permafrost growth and decay on the groundwater flow dynamics over one climate cycle. It is part of Andra's study program (Andra = French Nuclear Waste Agency) to understand groundwater flow system and surface environment evolution through time and over 1 million years in the future. The studied site is centered on Andra underground research laboratory, located in the East part of the Parisian sedimentary basin. In this area, permafrost might have reached a 300-m depth at the end of the Pleniglacial. Permafrost acts mainly in 2 ways on the groundwater system: 1, it stops groundwater recharge at the aquifer outcrops; 2, it drastically decreases the hydraulic conductivity of aquifer by freezing pore water. The numerical model describes 5 geological layers, with a whole maximum thickness of 800 m. It includes 3 aquifers and 2 impermeable layers (from Tithonian limestones on top, down to Upper Dogger limestones). Groundwater flow is simulated by a sequence of transient simulations with different hydraulic parameters and different initial conditions corresponding to different permafrost stages. Permafrost 3D dynamics over one climate cycle is modelled by a conceptual model of permafrost depth (ref abstract). Five main stages are described in 3D: sporadic, discontinous, deep continous, relic permafrost...Anisotropic homogeneized hydraulic properties are used in order to allow different horizontal and vertical flow dynamics. Permafrost impact is analysed in terms of flow directions and outlets as well as global velocity of the groundwater. Although, the groundwater system dynamics is slow, permafrost significantly decreases the mean long-term flow velocity. It also may locally and temporarily change flow

directions.