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Modelling hillslope evolution in NW Europe under alternating periglacial and temperate regimes

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The development of surface process models (SPMs) contribute greatly to a better knowledge of complex processes governing landscape evolution over various temporal and spatial scales. Landscape evolution of NW Europe in the past 0.8 Ma involved a large number of processes alternatively characteristic of periglacial and temperate regimes. We put the hypothesis that sediment dynamics governing hillslope evolution peaked during cold-warm transitions, still under the predominance of periglacial processes (downslope soil displacement induced by freeze-thaw action). Most actually available SPMs include hillslope processes under the simplistic assumption that their variety can be represented by a single continuous diffusive process controlled by slope gradient. Although several improvements have been done to differentiate specific processes (e.g., karst, glacial) in these models, only a few studies have focused on periglacial hillslope processes.

Within this frame, we now begin a research trying to better understand the evolution of the slopes of Rhenish Massif during the Quaternary. We start from the viewpoint that, among the various periglacial processes which were active in NW Europe during the glacials, solifluction associated with seasonal freeze-thaw cycles was by far the most effective, so that our research will focus on it. Following previous field and modelling works concerned with these processes, we consider that the rate of sediment transport by solifluction is proportional to the slope gradient and to the soil moisture mainly supplied by thaw of ice segregation. We further feel that our model must be able to reflect the different effects of solifluction under permafrost and non permafrost conditions (i.e., plug-like flow vs. “normal” gelifluction events). The presence of permafrost will be detected with a simple model of soil temperature profile estimated from basic climatic variables. The depth of active layer - or the depth of maximum frost penetration in non permafrost conditions - will be calculated in the same manner and therefore reflect the climatic control of solifluction. Furthermore, model calibration will be done on the basis of observations made on slopes that attest former periglacial activity (as slopes found in Belgian Ardennes) and/or on slopes in polar to subpolar regions which are currently affected by solifluction. Our calibrated solifluction model will finally be included in existing SPMs as well as other dominant processes acting on slopes during temperate periods.