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Structure differences as a possible mechanism for biomat flow

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Recent studies highlight the importance of the upper layer of soil which may play an important role in hillslope catchment runoff generation. This biomat layer usually consists from very porous material with high organic content. Using staining tracers it was already shown that biomat on forested hillslopes can transport solutes for quite long distances (lateral displacement was about 1.2 times larger than for subsurface lateral flow) before infiltration into deeper layers. One of the popular explanations of this phenomenon is soil water repellency. However, all three staining experiments were carried out under different moisture conditions, including up to 1 cm of precipitations just before the experiment. No change in biomat transport was observed under these conditions (which actually imply water repellency decrease). Thus, the main aim of this contribution was to study the border between biomat and main soil mass, as well as possible structure influence, in detail.
An undisturbed soil sample containing both boimat and deeper consolidated soil was taken (4x3x2.5 cm). Unfortunately, it was not possible to obtain it from the same study area where staining experiments have been carried out. Three-dimensional structure was obtained using X-ray microtomography device with resolution of 15 microns. Local hydraulic properties, e.g., permeability, water retention properties, entry pressure were determined using pore-network modeling. Sample property fluctuations were quantified using local porosity analysis. Current results support the idea that structural differences alone can explain the lateral transport observed in field. Possible water repellency influence on biomat-soil border can also play an important role, however this conjecture needs more investigations (wide data set, repellency measurements, etc.). Finally, we provide a discussion on how to implement such results into conventional hydrological models.