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## Comparison of different capillary models to predict the hydraulic conductivity from the water retention curve

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The relative hydraulic conductivity relations of two contrasted soils, a clay and a sand, are predicted from their water retention curves using the expression of van Genuchten in combination with three capillary models: i) Burdine, ii) Mualem and iii) Fatt & Dykstra. Predicted conductivity curves are used to obtain the cumulative infiltration,  $I(t)$ , and infiltration rates,  $q(t)$ , according to Philip's quasi-analytical solution. The reference solution being obtained with the measured hydraulic conductivity. For the clay,  $I(t)$  and  $q(t)$  obtained with the first two models are severely underestimated. Moreover, the results of these two models are physically irrelevant, since the infiltration rate decreases to a value less than the saturated conductivity. On the other hand, the results obtained by the third model are very close to the reference, and do not show any physical anomaly. For the sand,  $I(t)$  and  $q(t)$  computed with the three models are compared with experimental data. In this case also, the first two models underestimate the observations, without any physical anomaly however. By contrast, the results obtained with the third model compare accurately with the data. Most probably, the systematic underestimation of the first two models is due to the derivative of the conductivity with respect to the water content which is infinite at saturation. The anomalies noted for the clay are likely due to the derivative of the conductivity with respect to the water pressure at saturation which is infinite in this case. Neither of these derivatives is infinite for the third model. The first two models give acceptable results for coarse graded soils, but they are not suitable for fine graded ones. On the other hand, the third model give satisfactory results for the two soils. The main disadvantage of this last model is that, unlike the first two ones, it cannot be expressed in a closed-form equation, which is a minor one when dealing with numerical and/or analytical solutions.

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