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Closed-form parametric relations for describing hydraulic properties of soils with bimodal lognormal pore-size distributions

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Appropriate parameterization of the soil hydraulic properties represents a key issue for reliable modeling water transport processes in soil. Many analytical relationships can be found in the literature to describe the soil hydraulic properties, namely the soil water retention and unsaturated hydraulic conductivity function, but the various facets of soil hydraulic behavior can hardly be kept in its wholeness by even complex parametric expressions. In case of structured and well-aggregated soils, we have developed soil hydraulic relations whose parameters maintain a physical meaning while improving the predictions of unsaturated conductivities. We assume that the soil water retention function is made up by a superposition of two distinct modalities, each of which is described by a Kosugi-type log-normal function. These two modalities can be schematically associated to a more textural and a more structural retention behavior, respectively.
It is shown that these two components of the water retention response are linked by a weighting factor to which a physical meaning can also be given. An important and practical advantage of the proposed bimodal water retention function (bWRF) is that a closed-form analytical expression is obtained for the bimodal hydraulic conductivity function (bHCF). A sensitivity analysis and comparisons with experimental data are used to evaluate the proposed bimodal log-normal hydraulic functions and demonstrate their effectiveness of better predicting the hydraulic conductivity characteristic of soils.