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Sigmoidal soil water retention function with improved behavior under dry and wet conditions

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The popular parameterized soil water retention curve (SWRC) of van Genuchten has a hydraulic conductivity curve associated with it that can have an infinite slope at saturation. The problem was eliminated before by giving the SWRC a non-zero air-entry value. This improved version still had a non-zero asymptote at the dry end, which limited its usefulness for dry conditions and could cause its integral to diverge. We therefore further improved the parameterization by joining its sigmoid mid-section to a logarithmic dry section ending at zero water content for a finite matric potential, as was done previously for a power-law type SWRC. We selected five SWRC parameterizations that produce unproblematic near-saturation conductivities and fitted these and our new curve to data from 21 soils. No clearly superior curve emerged, though the logarithmic dry branches of two of the curves gave much more realistic extrapolations into the dry end of both the retention and the conductivity curves. We tested the original curve, its first improvement, and our second improvement by feeding them into a numerical model that calculated evapotranspiration and deep drainage for nine combinations of soils and climates. The new curve was more robust than the other two. The new curve was better able to produce a conductivity curve with a substantial drop during the early stages of drying than the earlier improvement. It therefore generated smaller amounts of more evenly distributed deep drainage compared to the spiked response to rainfall produced by the earlier improvement.