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Watertable fluctuation-induced variability in the water retention curve: Sand column experiments

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The soil water retention curve (WRC), describing the relation between the soil water content and its corresponding capillary pressure, relies not only on whether drying or wetting occurs but also on the pore scale water flow velocity. Here, we investigated the effects of the watertable fluctuations on the WRC through 28 laboratory experiments covering a wide range of fluctuation amplitudes and periods. Results show that both the response of the capillary pressure and soil water content lag behind the watertable fluctuation, and the vertical capillary pressure distribution in the unsaturated zone is non-hydrostatic, especially for the fluctuations with shorter period. As a consequence of watertable fluctuation, the measured WRC deviates from that under static conditions, depending on both the fluctuation amplitude and period. Moreover, the air-entry pressure under dynamic conditions is considerably larger than that under static conditions, and it first increases and then decreases as the fluctuation period decreases. The effects of the watertable fluctuations on the dynamic capillary coefficient was further examined. It is found that the relation between the dynamic capillary coefficient and saturation is nonunique even for the drying and wetting of a given sand and watertable fluctuation, suggesting a hysteretic dynamic capillary coefficient, and the dynamic capillary coefficient is rate-dependent, decreasing with an increase of fluctuation rate.