Geophysical Research Abstracts
Vol. 21, EGU2019-16618, 2019
EGU General Assembly 2019

Multiscale analysis of the interaction between water table depth and soil salinity

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The excess accumulation of salt in soil is a global problem. Accumulation of salt in soil adversely influences the vegetation and crop production. As water evaporates, salt concentration in the pore space increases continually until it precipitates. Recent studies confirmed the porous nature of the precipitated salt and the complex dynamics of its evolution during evaporation (Shokri-Kuehni et al., 2017, 2018). The presence of porous salt at the surface causes top-supplied creeping of the solution feeding the growth of subsequent precipitation. Such a phenomenon leads to additional water evaporation from soil. In the present study, we have investigated saline water evaporation from porous media in the presence of water tables fixed at various depths below the surface. Our results illustrate the significant impact of the presence of hydraulically connected precipitated salt at the surface with the water table on the total evaporative water losses. High-resolution thermal imaging enabled us to investigate the rapid temperature changes at surface of the precipitated salt in the presence of a water table, providing further confirmation of precipitated salt contribution to the evaporation. When water table was hydraulically connected to the surface via capillary induced liquid flow, more salt precipitation was observed in the case of deeper water table. This observation was consistent with our results obtained by continuum-scale numerical modelling (Jambhekar et al., 2015) where higher solute concentration close to the surface was obtained when the water table was deeper. Moreover, we made use of two global-scale databases containing topsoil salinity, soil texture and water table depth data to reveal the relevance of our findings to the large-scale responses and the relationships between the water table depth and soil salinity at the global-scale. Our multiscale analyses illustrate how the pore-scale physics constrain the responses at the global scale.

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