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Vegetation patterns and soil-atmosphere water fluxes in drylands

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Periodic and irregular vegetation pattern formation in drylands have been extensively investigated in recent years, showing the importance of local soil water-vegetation feedbacks. Nevertheless, the effect of vegetation spatial patterning on atmospheric-soil water fluxes has yet to be determined in detail. This issue is crucial to understand how much detail is needed when representing vegetation-atmosphere dynamics in arid and semiarid region. Do the evapotranspiration fluxes depend only on bulk vegetation characteristics, such as biomass density or vegetated fraction, or is it necessary to include the vegetation spatial dynamics to represent evapotranspiration fluxes adequately for climatic purposes?

We discuss a new explicit-space model for vegetation dynamics in water-limited ecosystems. To include the effects of rainfall intermittency, we study separately soil moisture dynamics of the surface and deep soil layers. The model shows vegetation spatial self-organization. We study the variation of soil-atmospheric evapotranspiration fluxes as a function of precipitation climatology, when different vegetation pattern states occur. The model outcomes show that evaporation flux depends only on the extent of bare soil, but its contribution to the total evapotranspiration flux is minor. Instead, in this model, transpiration fluxes do not depend only on vegetation bulk property. Due to root action, vegetation patterns have an effect on transpiration fluxes (in the days following a rainfall event), even when biomass density and fraction of vegetation cover are the same. The differences are not very large, but they show that the dynamics of different vegetation patterns is intrinsically different. Therefore, it is not possible to catch completely the vegetation-atmosphere dynamics without representing vegetation spatial mechanisms. The model outcomes also suggest that the fluxes above cultivated (i.e. fixed) vegetation can be completely different from those above natural (i.e. dynamic) vegetation, even when the two vegetation types cover the same fraction of space and have the same biomass density.