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Effect of land surface-convective precipitation feedbacks on self-organized patterned vegetation

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Vegetation pattern morphology is suggested as one indicator of system closeness to desertification. Using pattern morphology as an indicator requires understanding the timescales at which patterned vegetation systems respond to drought. Accurately modeling these timescales requires accounting for rainfall intermittency and all the pathways controlling vegetation-precipitation feedbacks. Such feedbacks depend in part on atmospheric conditions determined by processes occurring on scales much larger than those of the vegetation pattern processes, complicating modeling efforts. A simplified model of atmospheric and rainfall dynamics was coupled to a vegetation pattern morphology model. The resulting model was used to investigate the timescales of desertification due to shifts in the total annual rainfall regime for a typical vegetation pattern in Southwestern Niger, as well as the effect of local-scale precipitation feedbacks. The model results indicate changes in pattern morphology responding to shifts in annual rainfall require at least four to five years. The overall local-scale vegetation-precipitation feedback is positive, such that the feedback acts to speed up the vegetation response to drought. Nevertheless, individual storm events may be associated with negative feedbacks. Vegetation-precipitation feedbacks are sufficiently important to speed up changes in vegetation patterns, even in marginal drylands with low biomass levels.