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The effects of basin morphology on soil water content and vegetation stress

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Soil water content plays an important role especially in water limited ecosystems. It controls the partition of net radiation into sensible and latent heat, the movement of solutes and pollutants, the soil temperature and affects the water stress of vegetation. All these processes are intimately interconnected and strongly influenced by the radiation balance. The available solar radiation, that depends on climatic conditions and morphology, may strongly modify hydrological processes at the local scale.
Basin morphology in fact modifies the amount of direct solar radiation, and also the amount of diffuse and reflected solar radiation received by a given point in the basin. Using the analytical model developed by Allen et al. (2006), it is possible to describe the radiation balance taking in to consideration the effects of basin morphology. This approach is extremely useful to describe the spatial distribution of solar radiation and the maps of potential evapotranspiration during any phase of the year. Using this approach in cascade with the analytical form of the soil water balance equation proposed by Laio et al. (2001), we identified the main statistics of soil moisture dynamics as well as the dynamic water stress of the vegetation (Porporato et al., 2001) during the growing season. The model has been applied using three study cases: 1) a flat river basin under stationary climate; 2) a river basin with morphology under stationary climate; 3) a river basin with morphology under stationary climate with imposed initial conditions. It is necessary to specify that the initial conditions for the last study case were defined based on the climatic conditions during the dormant period, while the vegetation water stress refers to the growing season.
Results show that basin morphology (case 2 and 3) significantly affects the spatial distribution of vegetation water stress increasing its variability. The variability of this index increases when taking into consideration the initial conditions for the simulation, because during the winter period differences in the radiation balance are generally larger that during the growing period.

References

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