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Modelling surface water and energy transfer in karstic mediterranean forests

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Droughts are a major factor in the vulnerability of Mediterranean ecosystems, particularly forest ecosystems, which are mainly located in karstic environments. Under the effects of global change, these environments are exposed to increasingly frequent and intense droughts. Recent ecophysiological and isotopic studies have shown that tree roots are able to feed deep enough in the epikarst to support transpiration during periods of water stress. However, the quantification of stocks and temporal dynamics are not yet fully established. This calls for the development of models adapted to the complexity of the environment, with the aim of improving our knowledge of both aquifer recharge and the hydric functioning of forests. The work carried out in this study goes in this direction. It aims to suggest, implement and test a SVAT-type model of energy and water exchanges at the soil-vegetation-atmosphere interface, adapted to Mediterranean forest environments in karstic zones. The modelling objective is dual: i) to jointly simulate the processes of diffuse infiltration into the soil (i.e. the superficial part of the root zone) and rapid infiltration into the network of karstic fractures (i.e. the deep part of the root zone); ii) to simulate the transpiratory and water extraction processes throughout the root zone. To do this, an adaptation of the SiSPAT model was developed and then deployed for the first time on two sites in the ICOS network, namely the forest sites of Font-Blanche (Bouches-du-Rhône, P.I. URFM) and Puéchabon (Hérault, P.I. CEFE). The results highlight the importance to represent both diffuse and preferential flows in SVAT modelling for karstic areas. It particularly shows that preferential infiltration builds up deep water reserves throughout the year. It helps to reproduce better observed transpiration by the plant canopy during periods of water stress. It also significantly affects the different hydrological components of the surface, e.g. runoff and drainage to the aquifers.