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How much does subsurface heterogeneity alter the impact of climate and land use changes on groundwater recharge?

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Karst aquifers are an important source of drinking water in many regions of the world, but their resources are likely to be affected by changes in climate and land use. In fact, climate characteristics control the supply of water to karst systems and the evaporative demand, while land use characteristics control the actual evapotranspiration losses. Understanding karst hydrology and estimating karst groundwater resources at a large-scale is critical for preventing threats to water supply in a changing world. Hartmann et al. (2015, Geosci. Model Dev.) introduced a parsimonious karst recharge model, called VarKarst-R, which allows for large-scale simulations of groundwater recharge while explicitly taking into account karst heterogeneities, i.e. preferential flow paths. The first objective of the present study is to introduce vegetation processes into the VarKarst-R model to better estimate evapotranspiration losses depending on the land use characteristics. We test the model at Fluxnet sites located in carbonate rock areas. Secondly, the VarKarst-R model so modified is used to assess the relative influence of changes in climate and land use on aquifer recharge. We establish a sensitivity analysis framework to analyse the interactions between climate descriptors (e.g. mean precipitation, precipitation seasonality), vegetation parameters (e.g. canopy storage capacity, rooting depth) and soil parameters (e.g. soil storage).