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Expected Effects of Regional Climate Change on the Soil Moisture Regimes in Central Europe and Central US

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Soils are an important control on water fluxes in the landscape and in many parts of the world act as the most important water reservoir mitigating the effects of rainfall variability. Soil moisture and temperature regimes are inherently more stable and quantifiable than their atmospheric counterparts and are essential in determining the environmental conditions of any region. They can also be used to demonstrate the impacts of climate change on a given region as they integrate not only the change of climate variables but also existing soil condition status and plant cover. In addition, the globally valid analysis of soil moisture and temperature regimes (http://soils.usda.gov/use/worldsoils/mapindex/smr.html) makes it possible to present a variety of consequences of climate change in terms of analogs. In order to easily estimate the soil moisture and temperature regime at a given site, or within a selected region, a software SoilClim was developed, tested, and applied in two markedly different regions of the Northern Hemisphere. SoilClim is based on an enhanced daily water

balance model that incorporates interactions between the soil and atmosphere through a dynamic module of vegetation cover. In addition, a snow cover effect on the water balance (through freezing and thawing), as well as on the soil temperatures, is taken into account through the incorporation of a snow cover simulator. SoilClim was developed by an international and interdisciplinary team of researchers and students, and then was tested using daily values of soil moisture, soil temperature, reference (ETr) and actual evapotranspiration (Eta) estimated by the model from routinely observed atmospheric variables and were compared with the observations across multiple sites in Austria, the Czech Republic, and Nebraska. In all cases SoilClim estimated well daily values of ETr and Eta and also reproduced successfully seasonal variations of the soil moisture and soil temperature across number of experimental sites and soil conditions. After the evaluation, SoilClim was run both in Central Europe and in Nebraska with the climatic data corresponding to the conditions expected under future climates taking into account three Global Circulation Models (NCAR-PCM, ECHAM and HadCM) and assuming the B1 and A2-SRES scenarios with low and high climate sensitivity for time slices of 2025, 2050 and 2100. It was found that under the present climate only a fraction of the territory of Central Europe is situated within the dry tempudic soil moisture regime, with high drought risk being confined to a small area. However, under a changing climate, a notable increase of the areas with a high probability of dry events was noted as well as sharp reduction of perudic (very-wet) mountainous areas that are essential for sustainable river flow. We found an especially alarming rate of these shifts in the soil climate characteristics taking place within decades rather than centuries. In the case of Central US (High Plains region) the eastward expansion of drier soil moisture regimes up to several hundred kilometers is to be expected. The predicted changes in the soil climate regimes are closely related to drought impacts (e.g. decrease of crop yields, damage to forest stands, low stream flow and reservoir levels, etc.) or changes in the dynamics of key soil processes (e.g. rate of carbon sequestration or mineralization) and should be a part of a complex climate change impact assessment.

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