Effects of climate change on vegetal cover simulations in a mountainous forest catchment

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Vegetal cover and the water cycle are closely linked. The climate controls the distribution and productivity of terrestrial vegetation and the vegetal cover type is a key determinant for evapotranspiration and global runoff. In this study, a dynamic vegetation model (LPJ) has been coupled to a 3D hydrogeological model (MODFLOW) to estimate the impact of climate change on a small-forested temperate watershed (Strengbach, Vosges, France) for the first time. The models cascade is calibrated with monthly hydrological and climate data over 1987-2009 period. Long-term simulations extending up to 2100 have been performed wih climatic output from the Meteo-France climate model ARPEGE/Climate (IPC, 2007 scenario A1B). With a predicted increase in temperature of 2.6°C and an atmospheric CO_2 rise by 80%, the mean annual precipitation decrease by 4.5% on Strengbach watershed over the course of the century. Based solely on increased atmospheric CO_2, LPJ predicted an decrease of evapotranspiration by about 8%, because of stomatal closure. Based solely on temperature change, LPJ predicted an increase of annual transpiration (0.7 mm/year) linked to the increase of atmospheric evaporative demand and stomatal opening. The model cascade showed a limited decrease of evapotranspiration (by 2.5%) and a significant change of vegetation distribution (a part of evergreen forest is replaced by temperate herbaceous) occurring around 2085, with the combined scenarios of climate change (temperature, atmospheric CO_2 and precipitation). Then, the response of land plants to climate change seems to only weakly affect the water resources on the Strengbach catchment in the future. However, the data highlight the relation between climate change and tree health and the potential consequence for forest management.