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Modelling long-term effects of climate change in a temperate spruce stand

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During the last two decades the coupling of climate and land surface models became increasingly important. Not only because of climate change, but also due to a steadily growing understanding of the processes in the atmosphere and plants, and more efficient computing resources. The coupling of a land surface with an atmosphere model is a key element to improve regional climate modelling. The aim of this study is to evaluate the Expert-N model system (XN) for its ability to simulate the growth of a coniferous forest stand at the Solling F1 site, Germany, and to assess long term effects of climate change regarding the water balance and biomass production.
Regional climate simulations using the IPCC A1B- and B1-scenario for the Solling F1 site were used to simulate tree growth from 1960 to the year 2100. The process based tree growth model TREEDYN3 was implemented into XN to simulate plant processes (transpiration, photosynthesis etc.) while XN simulated soil processes (evaporation, soil water transport, nitrogen transport/turnover).
Simulation results show a good representation of the biomass production of the three compartments (wood, leaf, and fine root) for the observed time period. Simulated wood biomass decreased after the middle of the 21st century. Rising mean air temperatures affected the simulated primary photoproduction and lead to diminishing assimilate reserves for wood growth.
Simulated long term water balance components shifted to more interception loss, while groundwater recharge and actual transpiration were diminished. This is due to the change in distribution of precipitation throughout the year in combination with rising annual mean temperatures. While precipitation sums stay relatively constant in hydrologic summers, they rise in hydrologic winters. Due to higher interception losses, less water is available for infiltration into the ground and therefore less water can be taken up by the roots and drain to the groundwater.