Submitted Abstract

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Abstract

Forests are long-lived ecosystems, very sensible to rapid environmental changes. In mountain areas, the effect of climate warming on the upper treeline and the subalpine forest belt can already be observed today. Although rising temperature may improve forest growth and promote treeline expansion towards new elevation ranges, other aspects such as water availability, soil conditions, incoming radiation as well as land-use and management activities may alter these effects. So far, many studies have focused on single effects of climate variability on treeline forest dynamics. Nonetheless, only few have attempted to project the future response of treeline ecotone using dynamic vegetation models, with a spatially explicit approaches that allow evaluating landscape-scale patterns that could deliver meaningful insights to ecosystem managers. Focusing on a mountain forest landscape in the Central Alps (Stubai Valley, Austria), we aimed at evaluating the effects of climate and land-use change on the treeline ecotone by simulating forest dynamics from the stand to the landscape scale. We applied a process-based forest landscape model (iLand) under different climate and forest management scenarios. Additionally, we compared two land-use scenarios that might affect treeline dynamics, namely business-as-usual versus land abandonment. Our preliminary results showed that the upper treeline will generally advance in elevation promoted by rising temperature, but this effect is highly heterogeneous and contingent on multiple factors across such a complex mountain terrain. The treeline reached highest elevations under the high emission climate scenario, but its expansion was highly modulated by different land-use, which strongly influenced forest regeneration patterns across the landscape. Overall, we observed an expansion of the forest area in the subalpine belt which was considerably greater under the abandonment scenario. Heterogeneous soil conditions also affected the future spatial pattern of treeline dynamics. Although modelling future treeline dynamics remains a challenge due to the complexity of multiple interacting factors acting at different scales, our study highlights the potential of dynamic forest landscape models to project future treeline development. Such modelling approaches also allow exploring future spatial patterns of the upper treeline with a landscape perspective. This can be useful for decision makers in the context of forest management planning, particularly to alpine ecotone biodiversity, improving conservation strategies and to maintain the provision of future ecosystem services.