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Energy, water and carbon balance of managed forests: comparing the future to the past

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Intensification of forest management concerns a growing fraction of temperate and tropical forests. It is thought to affect wider areas in the near future for facing biomass, fiber and wood demands. Intensively managed forests are submitted to increased soil preparation, fertilization, drainage, thinning, clear-cutting, whole tree - harvesting and rotation shortening. They are composed of fast growing stands commonly planted with enhanced tree varieties or clones of eucalypts, pines, poplars, willows among others.
Altogether these practices have substantial effects on forest exchanges with atmosphere and groundwater and therefore on local and regional climates and water resources.
Using data collected from flux tower sites, MODIS products and forest and soil inventories together with our process based model of forest growth, GO+, we analysed the impacts of intensified management on forest canopy exchanges of heat, short and longwave radiations, water and CO_2 and its interaction with soil and climate.
Results obtained under present climate conditions evidenced interactions between intensification effects and soil and climate conditions. We show that biophysical impacts on radiative forcing potential, through albedo increase and convective fluxes of heat and water, are in the same order of magnitude than changes in the biogeochemical cycle of carbon.
Drought affects dramatically the net carbon and water balances of forest stands independent of management and age. However, the effects of successive management operations (ploughing, vegetation burial, thinning) overtook climate impacts and make the young stands and intensive alternatives more independent and resilient to climate change impacts.
The model applications to the analysis of future climate scenarios allowed to attributing the role of management alternatives, soil conditions and climate and their interactions. For intensively managed forests, the frequency of soil preparation operations, the management efficiency and vegetation management were the major drivers of the carbon and water balances, respectively. For more extensive management options, the climate and rotation duration were more important.
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