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Future scenarios of forest microclimates using a Land Surface Model.

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The forest understory generally experiences temperature variations that are dampened compared to adjacent open areas (known as the “buffering effect”), allowing the development of a forest microclimate and associated ecological conditions. It is however unclear to what extent forests will maintain this buffering effect under increasing global warming. Providing reliable projections of future forest microclimates is therefore crucial to anticipate climate change impacts on forest biodiversity, and to identify corresponding conservation strategies. Recent empirical studies suggest that the buffering of air temperature extremes in forest understory compared to open land could increase with global warming, albeit at a slower rate than macroclimate temperatures. Here, we investigate the trend of this temperature buffering effect in a high-emission global warming scenario, using the process-based Land Surface Model CLM5.1. We find biome-dependant buffering trends with strongest values in tropical forests where buffering increases for every degree of global warming by 0.1 °C for maximum soil temperature, and by 0.2 °C for maximum canopy air temperature. In boreal regions, forest microclimate exhibits a strong seasonality and the effect of global warming on forest understory is less clear. This first Land Surface Model assessment of future forest microclimate highlights the specific importance of tropical forest canopies in particular, in maintaining hospitable conditions for understory species while also increasing their climate debt under global warming. Our research also illustrates the potential and limitations of Land Surface Models to simulate forest microclimate, and calls for further collaborations between Earth system modelers and ecologists to jointly question climate and biosphere dynamics.