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Experimental Plant Ecology meets Dendroecology: Indications for the influence of winter climate on growth towards the cold distribution margin of European beech (*Fagus sylvatica* L.)

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The dominant forest tree in Europe, European beech (*Fagus sylvatica* L.), covers large parts of continental Europe and thus experiences diverse climatic conditions. In the face of predicted climate change and shifts of distribution ranges, we integrate insights from dendrochronology and climate manipulation experiments to understand the diverse climate-growth relationships towards the distribution margins of beech. Beech is generally reported to be sensitive to summer drought towards dry and continental regions; yet, only few studies have investigated climate sensitivity towards the cold distribution margin of beech. We hypothesized that at colder sites i) growth of beech is more sensitive to winter cold and ii) extreme cold events accompanied by soil frost negatively affect tree growth. We analysed climate-growth relationships and the nature of negative pointer years of eleven beech stands along a large gradient of decreasing winter temperature from more central (Rostock, Germany) to cold marginal (Gdańsk, Poland) beech populations. Additionally, we conducted a multi-site snow manipulation experiment to change soil temperatures and soil frost exposition around our study trees. The effects of altered soil conditions in winter on growth onset and wood increment in the following vegetation period where measured with dendrometers from which we derived onset of growth and absolute growth in 2017. Towards the cold marginal populations, growth became increasingly sensitive to winter cold (February temperature) and less sensitive to summer drought (June precipitation). Manipulated soil temperatures did not have an effect on onset of growth but, across all sites, tree growth increased with warmer soils. Thus, within the study area, the general sensitivity of beech to summer drought shifted towards a sensitivity to winter cold. A range shift of beech across the current cold distribution margin is often assumed to compensate for habitat and productivity losses of drought-prone southern and central populations. With respect to the winter cold sensitivity found in our study, such assumptions should be taken with caution, because influence of winter cold events might persist even during predicted climate warming.