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Converging trends and strengthening climatic signal in the radial growth of Abies alba in Austria – between the legacies of "Waldsterben" and the era of climate change?

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Silver fir (Abies alba) is a key forest tree species in Central Europe growing most commonly in its mixtures with Fagus sylvatica and Picea abies. It is also an important species to dendrochronology due to its longevity, historic timber utilization, and generally well-synchronized interannual growth series. However, a growing number of dendroecological studies focusing on climate change has left the species relatively underrepresented even compared to its lower abundance as a dominant forest tree species. It is also due to its weaker growth–climate relationship, compared to species growing in more climatically limited (first of all water-limited) environments. In forest sciences, the species has received wide attention during the complex forest decline phase after the late 1970s and during the 1980s, referred to as the "Waldsterben" in the German-speaking countries of Central Europe, highlighting the negative effects of air pollution of that time, particularly in the context of silver fir. In the era of climate change, the species is gaining renewed interest, especially for its further admixing potential to climatically more resilient forest stands.

In our study, we have investigated the long-term trends and the interannual climatic signal in the radial growth chronologies from monospecific stands of silver fir at seven sites representing a broad climatic and elevational gradient along the distribution of the species. The measured chronologies reveal an increasing low-frequency growth synchrony, starting with a periodic growth increase at the investigated sites since the 1980s, regardless of tree and stand age. Preliminary correlation results suggest that the water-balance related climatic signal has been introduced or has significantly increased between the periods 1961–1990 and 1991–2020. This has been partly associated with a shift or even clear change of sign in the temperature signal. Significant relationships, yet with varying sign, have been also found with the atmospheric water vapor content at each site.

The main research questions aim to focus on the pace and term of this change manifested in the climatic signal, namely (i) whether the growing conditions have changed over longer term or were rather influenced by specific years, (ii) if the change was abrupt or more gradual over time. To answer these questions, different climate data-driven models are fitted to the (detrended) growth

series, and the error of the model fit is assessed by shorter windows. The temporal patterns of the change, together with the general growth trends identified, are compared to the climatic trends and the frequency of drier periods since the 1980s, with attention to the timescale of the “Waldsterben” phenomena. The interpretation of the results shall reflect a complex interplay of different drivers of forest conditions during the last decades of the 20th century and the inherent uncertainties thereof. Nevertheless, it can contribute to the dendroecological knowledge of an ecologically and silviculturally important species at the crossroads of past legacies, current and predicted challenges.