Climate-sensitive radial increment model of Norway spruce in Tyrol based on a distributed lag model with penalized splines for year-ring time series

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Abstract A novel methodological framework is presented for climate-sensitive modeling of annual radial stem increment using year-ring width time series. The approach is based on a generalized additive model with penalized regression splines together with a distributed time lag model taking into account smooth nonlinear effects of a series of monthly temperature and precipitation values, as well as their interactions. Climate effects are also assumed to vary smoothly with time lag. The model framework enables both the detrending of the individual time series and the regression modeling to be performed simultaneously in a single model step. The approach is applied to year-ring width time series of Norway spruce (*Picea abies* (L.) H. Karst.) trees in Tyrol, Austria. The marginal response curves show that tree growth is mainly promoted by high temperatures in late spring and early summer and by precipitation in fall and winter. Summer drought does not have a negative influence on the current year's radial increment; however, when it is associated with high temperatures, it lowers the increment in the subsequent growth period. Higher winter precipitation in conjunction with lower temperatures has a positive effect. A significant non-climate related long-term growth trend is demonstrated, probably reflecting NO_x and SO_2 emission trends in Austria.

References

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