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The water isotopic signal in tree ring cellulose: A model analysis over Europe

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The water isotope signal in tree ring cellulose is becoming a more and more used paleo climate tracer. To understand the measured signal one needs a full understanding (1) of the isotopic signal of ground water taken up by the trees and (2) of the physiological processes affecting the original isotope signal when forming the cellulose. Both steps depend crucially on climatic conditions at the site where the respective tree grows. Many of the factors controlling therefore the tree ring cellulose signal are not well known, at least not over longer periods needed to do a proper calibration of the paleo signal. Here we use the isotope version of the meso-scale model REMO. The model was embedded into the atmospheric GCM ECHAM and focused over Western Europe. Within the European project ISONET numerous cellulose records from Sweden to Spain, from England to Poland have been sampled and isotopically analysed. REMO was integrated over the last 50 years (from 1955-2001) providing us with a physically consistent data set of both monthly resolved isotopic data (δ^{18}O of water vapour and ground water) and climatic parameters (temperature, precipitation, humidity etc.). Using published formulas for the water isotope signal of tree ring cellulose we systematically explore sensitivities of the final signal to the different estimates. In particular we show the importance of a proper estimation of the growing period and of the general hydrological context. The robustness of the derived isotope signal vs. climate parameter relationship again is depending on the climatic/hydrological context. For example, we could show that in a hydrological context where the water taken up by the tree corresponds to the precipitation of the annual mean the tree ring cellulose in Europe can be sensitive to the North Atlantic Oscillation. The latter however

is mainly a winter signal and the isotopic signal of tree ring cellulose is formed during the growing season and is therefore rather a summer signal. In general the model systematically overestimates the relation between the isotopic cellulose signal and different climate parameters (in particular relative humidity). Partly this overestimation is due to the fact that the model approach uses a physically consistent data set whereas in observational studies often quite distinct data sets (spatially and temporally) are used. We investigate the importance of such effects using our pseudo proxy approach.