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Climate reconstruction fundamentals: Testing proxies for linearity.

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Reconstructing past climate from so-called climate proxies is an important way to understand climate variability. Fundamental properties of the climate system, such as the extent of internal or natural variability and climate sensitivity can be established provided long and accurate reconstructions are available. Many current climate reconstruction methods are based on the assumption that a climate property - such as local or global-mean temperature - is imprinted linearly on proxies, and reconstructors typically build linear models that relate the proxies to the climate variable. The presence of such a linear relationship can be tested using so-called non-parametric additive models, and we apply this tool for the first time to a set of well-documented climate proxies relevant for the temperate northern hemisphere. We find that most of the chosen proxies can indeed be shown to be linear functions of the mean temperature, but one proxy - based on tree ring widths from the Jämtland region of Sweden - does not appear to have a linear relationship with the temperature. The method is quite general and could be used for larger and more extensive sets of proxies - here we restrict the analysis to those proxies that have annual resolution.