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Core-top calibrations cannot detect seasonality of marine temperature proxies

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Most core-top calibrations of marine temperature proxies (e.g. Uk37 or Tex86) show that annual mean temperature is the best predictor of the core-top data. Based on this result, it is often concluded that proxy-data can be safely interpreted as annual mean values. In this study, we demonstrate that this is not necessarily correct. For statistical reasons, it is very unlikely to detect a seasonal bias in proxy records by only analysing core-top data. This is caused by the strong similarity of the spatial temperature pattern across different seasons which is mainly determined by the latitude and distance to land. However, in interpreting down-core proxy timeseries, for example the Holocene temperature evolution, this undetected seasonality can lead to significant misinterpretations. The seasonality bias in reconstructed climate timeseries is determined by the covariance between the temperature evolution in different seasons. This can be very low, especially for climate periods dominated by orbital forcing. By performing idealized simulations of the core-top calibration and of down-core climate reconstructions, this study demonstrates the influence of proxy seasonality on the calibration and reconstruction process.