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Interannual to millennial variability of climate extreme indices over Europe: evidence from high resolution proxy data

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Interannual to millennial time scale variability of precipitation (R20mm, Rx5day, R95pTOT), cold (TN10p, CSDI and CFD), heat (TX90p and WSDI) and drought (CDD) extreme climate indices is investigated using long-term observational and proxy records. We detect significant correlations between these indices and various high resolution proxy records like lake sediments from southern Germany, stable oxygen isotopes from Greenland ice cores and stable oxygen isotopes from Red Sea corals during observational period. The analysis of long-term reanalysis data in combination with extreme climate indices and proxy data reveals that distinct atmospheric circulation patterns explain most of the identified relationships. In particular, we show that a sediment record from southern Germany (lake Ammersee), which records flood frequency of River Ammer during the last 5500 years, is related to a wave-train atmospheric circulation pattern with a pronounced negative center over western Europe. We show that high frequency of River Ammer floods is related not only to high frequency of extreme precipitation events (R95p) in the Ammer region but also with significant positive anomalies of various extreme temperature indices (TX90p and TXx) over northeastern Europe. Such extreme temperatures are forced by cloudiness anomaly pattern associated with flood related atmospheric circulation pattern. Based on this record we discuss possible interannual to millennial scale variations of extreme precipitation and temperature indices over Europe during the last 5500 years. Coherent variations of extreme precipitation and temperature indices over Europe and stable oxygen isotopes from Greenland ice cores and northern Red Sea corals during observational period are related to atmospheric blocking variability in the North Atlantic region. Possible variations of climate extreme indices during different time slices of the Holocene period and their implications for future extreme climate variability are also discussed.