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Links between central Greenland stable isotopes, atmospheric blocking and extreme temperature variability over Europe

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The link between central Greenland stable oxygen isotopes and extreme temperature variability over Europe is investigated using high resolution stable isotope records from central Greenland ice cores, observational data, as well as isotope-enabled model (ECHAM5-wiso) experiments. Analysis of model simulations reveals a strong increase in the probability of occurrence of extreme low temperatures over Europe during periods characterized by positive relative to periods characterized by negative stable oxygen isotope anomalies in central Greenland precipitation. Relatively small changes in the mean and upper tail of the daily European temperature distribution are also recorded in the model simulation. Analysis of simulated atmospheric circulation reveals that an increase in the frequency of atmospheric blocking in the North Atlantic region during warm (positive oxygen isotope anomalies) relative to cold (negative oxygen isotope anomalies) conditions in central Greenland is responsible for changes in the lower tail of the distribution function of daily European temperatures. Analysis of observed high resolution stable isotope records from central Greenland ice cores (CRETE, GRIP and GISP2), observed blocking frequency in the North Atlantic region and observed extreme temperature indices over Europe confirms the model results. Furthermore, the stable isotope records from central Greenland ice cores, the North Atlantic blocking frequency and extreme low temperatures over Europe show enhanced variability at 10-30 and 50-70 year time scales during observational period. Such qusiperiodic signals are identified also in the central Greenland stable isotope ice core records during the last millennium suggesting similar variations in the North Atlantic blocking frequency and extreme low temperatures over Europe. We argue that long-term variations of extreme temperatures over Europe as well as blocking activity in the North Atlantic region, as derived from observational data, can be put into a long-term perspective using stable isotope records from central Greenland ice cores.