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Understanding climate variability in Greenland ice cores for the last two centuries: insights from the weather regime approach

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Greenland ice cores offer highly resolved (seasonal to annual) δ^{18}O reconstructions over the last few centuries to millennia. Previous analyses relate multidecadal variability in these reconstructions to changes in Arctic temperature, the North Atlantic Oscillation, the Atlantic Multidecadal Oscillation and also to blocking activity in the North Atlantic. However, the relative weight of each driver remains unclear. In this study, we analyse the regional imprints of different large-scale modes of variability as well as external forcings on δ^{18}O reconstructions from Greenland ice cores. For this purpose, a compilation of 20 different shallow ice-core reconstructions over Greenland has been considered to provide the best spatial coverage possible within the instrumental era, all covering the period from 1767 to 1967AD. This guarantees an overlap of about a century with several instrumental indices of climate variability (NAO, AMO and Southwest Greenland temperatures), large-scale climate datasets (SSTs and sea-ice cover from HadISST), and also with the second version of the Twentieth Century atmospheric Reanalysis (20CRv2), which spans from 1871 to 2008AD. This latter reanalysis is used to assess the impact of daily atmospheric variability on ice core records, through the calculation of the North Atlantic weather regimes (using clustering techniques) and the respective changes in their time of occurrence. In particular, we investigate if the fraction of δ^{18}O variance explained by the common climate indices can be improved by considering the weather regimes and by taking into account both the changes in their seasonal frequency of occurrence and the spatial shifts in their centers of action. Finally, the link between water isotopes and weather regimes is further explored by using two isotope simulations with the IsoGSM and LMDZ-iso models, both nudged to the 20th century reanalysis. This allows to further evaluating the relationship between isotopes and other climate variables like temperature and precipitation.