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Low-frequency climate anomalies, changes in synoptic scale circulation patterns and statistics of extreme events over south-east Poland during the Last Millennium

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Long-term predictions of changes in extreme event frequency are of utmost importance due to their high societal and economic impact. Yet, current projections are of limited skills as they rely on satellite records that are relatively short compared to the timescale of interest, and also due to the presence of a significant anthropogenic trend superimposed onto other low-frequency variabilities. Novel simulations of past climates provide unique opportunity to separate external perturbations from internal climate anomalies and to attribute the latter to systematic changes in different types of synoptic scale circulation and distributions of high-frequency events. Here we study such changes by employing the Last Millennium Ensemble of climate simulations carried out with the Community Earth System Model (CESM) at the U.S. National Center for Atmospheric Research, focusing in particular on decadal changes in frequency of extreme precipitation events over south-east Poland. We analyze low-frequency modulations of dominant patterns of synoptic scale circulations over Europe and their dependence on the Atlantic Meridional Overturning Circulation, along with their coupling with the North Atlantic Oscillation. Moreover, we examine whether some decades of persistently anomalous statistics of extreme events can be attributed to externally forced (e.g., via volcanic eruptions) perturbations of the North Atlantic climate. In the end, we discuss the possible linkages and physical mechanisms connecting volcanic eruptions, low-frequency variabilities of North Atlantic climate and changes in statistics of high impact weather, and compare briefly our results with some historical and paleontological records.