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Disruption of the European climate seasonal clock in a warming world

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Temperatures over Europe are largely driven by the strength and inland penetration of the oceanic westerly flow. The wind influence depends on season: blocked westerlies, linked to high-pressure anomalies over Scandinavia, induce cold episodes in winter but warm conditions in summer. Here we propose to define the onset of the two seasons as the calendar day where the daily circulation/temperature relationship switches sign. We have assessed this meteorologically-based metric using several observational datasets and we provide evidence for an earlier summer onset by ∼10 days between the 1960s and 2000s. Results from a climate model show that internal variability alone cannot explain this calendar advance. Rather, the earlier onset can be partly attributed to anthropogenic climate change. The modification of the zonal advection due to the earlier disappearance of winter snow over Eastern Europe, which reduces the degree to which climate has continental properties, is mainly responsible for the present-day and near-future advance of the summer date in Western Europe. Our findings are in line with with phenological-based trends (earlier spring events) reported for many living species over Europe, for which we provide an alternative interpretation to the traditionally evoked local warming effect. Based on the Representative Concentration Pathway 8.5 scenario, which assumes that greenhouse gas emissions continue to rise throughout the twenty-first century, a summer advance of ∼20 days compared to preindustrial climate is expected by 2100, while no clear signal arises for winter onset.