Disruption of the European Climate seasonal clock in a warming world

**ABSTRACT:**
Earlier occurrences of spring events have been reported from phenological markers over Europe without being explained thoroughly from a climate physics perspective. Based on a pure meteorological/dynamical approach, we present in this seminar a novel and objective definition of the season onsets corresponding to the calendar days where the correlation between daily European atmospheric circulation and temperature anomalies switches sign. High atmospheric pressure anomalies over Northern Europe, often referred to as anticyclonic blocking conditions, are indeed associated with cold spells in winter but heat waves in summer over most of the continent. According to this simple metrics assessed from several observational datasets, we first provide robust evidence for an earlier summer onset by ~10 days between the 1960s and 2000s. We then conduct a detection-attribution study based on model ensemble simulations and suggest that this calendar advance is incompatible with the sole internal climate variability and can be attributed to the increased greenhouse gases warming effect mitigated by anthropogenic aerosols. Late winter snow disappearance over Eastern Europe, currently at a tipping point according to both observational and model estimates, is responsible remotely for the present-day and near-future winter shortening over Western Europe. Local altered land-sea contrast interplays later on from ~2050 leading to a total reduction of ~25 days by 2100 based on business-as-usual scenario. Our findings provide a physically based explanation for descriptive phenological changes and helpful insights of the overall disruption of the European climate seasonal pace, e.g. the decrease (increase) in daily winter (summer) temperature variance.

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