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Climatic change caused larger variation of spring phenology in temperate semi-dry grasslands in China

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Vegetation phenology is highly sensitive to climate change. Previous studies focusing on the trends of phenological events have found that temperature and precipitation primarily regulate the dates of spring phenology in temperate grasslands. However, the variation of spring phenology and its controlling factors are still unclear. In this study, we investigated the start of the growing season (SOS) in temperate semi-dry grasslands in China using five methods, and determined the variation of SOS and its primary factor over the study period 1982-2015. We found that, in line with previous studies, the SOS date did not change significantly during the entire study period 1982-2015, but its variation increased significantly from the first subperiod (1982-1998, Std: 8.8±1.1 day) to the second (1999-2015, Std: 10.3±1.1 days), the latter of which coincides with fast warming. The larger variation in SOS may be caused by the different climatic drivers on phenology in different areas. The fluctuation of temperature was significantly increased over the study area and subsequently may result in a larger variation of SOS. Furthermore, precipitation and soil moisture has increased until the mid-1990s, which may lead to the removal of water as a limiting factor and increase the response of semi-dry grassland spring phenology to temperature, and finally result in larger variation in SOS.