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Hiatus of spring green-up advancements in Northern Hemisphere boreal forests

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There is consensus that the spring phenology of deciduous forests is advancing in response to global warming. Since the late 1990s, however, this tendency of advanced spring phenology has been weakened in over 60% of boreal forests, particularly in Siberia and northwestern North America. The present study investigated the cause of the weakening trends in the advancement of the start of the growing season (SOS) based on remotely sensed normalized difference index (NDVI) with emphasis on the above two regions by quantifying the effects of four climatic fields?winter duration (WD; the number of freezing days), pre-season temperature (PT; accumulated temperature from late winter to early spring), green-up temperature (GT; accumulated temperature around the green-up date), and pre-season precipitation (PR; accumulated precipitation before the green-up date)?on changes in the spring green-up trend. GT explained the majority of the slowdown in SOS trends in recent decades. In Siberia, GT increases caused the advancement of SOS during the 1980s and 1990s; however, the GT increase was reduced to less than half of these periods resulting in a slowdown of the SOS advancing trend since the early 2000s. In NWNA, GT increases and WD shortening drove the SOS advancement until the late 1990s; however, both effects have been diminished to near zero to result in no further SOS advancements. The present study demonstrated that the slowdown of SOS advancing trends, i.e., green-up hiatus over Siberia and NWNA, is mainly caused by slowed GT increases around the green-up period that linked to the recent global warming hiatus, not a consequence of sensitivity changes of spring phenology to climate variables. The present study suggested that the natural variability of climate exerts substantial effects on the decadal variations in spring phenology.