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Snowmelt timing influences the start of the Arctic-boreal fire season across North America

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Snowmelt timing influences arctic-boreal ecosystem functioning through influences on surface hydrology and energy balance. Spring snow cover extent in the Northern Hemisphere has declined since the mid-20th century by up to 46 % in June, including a strong decrease after the mid-1980s. Regions of arctic-boreal North America have simultaneously experienced increases in the number and size of fires. With early snowmelt timing, the likelihood of early fire ignitions also increases as fuel is exposed and organic soil can begin to dry. Early fire ignitions can potentially develop into larger fires as a prolonged fire season may extend the period of favourable weather conditions for fire spread. Despite the importance of snowmelt timing, ignition timing, and fire size for predicting future boreal fire regimes across North America, these relationships are not well understood. Here we analysed snowmelt and ignition timing across ecoregions for boreal North America from 2001 to 2019. Using newly developed satellite-based fire products, we retrieved and matched ignitions with snowmelt timing in a spatially explicit manner.

Results indicate that snowmelt timing has occurred 0.2 ± 0.17 days year^{-1} earlier in western arctic-boreal North America and 0.27 ± 0.33 days year^{-1} later in eastern arctic-boreal North America between 2001 and 2019. Similarly, we found that ignitions have occurred 0.61 ± 1.12 days year^{-1} earlier and 0.3 ± 0.58 days year^{-1} later for the western and eastern ecoregions. In 13 out of 16 ecoregions, there was a significant positive relationship (p < 0.01) between the timing of snowmelt and ignition. This suggests that snowmelt timing helps controlling the fire season start. The mechanisms behind the spatial gradient in the snowmelt timing over the last two decades are less understood and may result from differences in larger climatic oscillations influencing the polar front jet stream and Arctic sea ice extent. Decades of colder air temperature and higher amounts of winter precipitation may explain the later snowmelt and fire season start in the eastern ecoregions. Our results show that a shift in the snowmelt timing has resulted in earlier fire season starts in western boreal North America and in later fire season starts in eastern boreal North America.