LETTER

Delayed spring phenology on the Tibetan Plateau may also be attributable to other factors than winter and spring warming

In their recent paper "Winter and spring warming result in delayed spring phenology on the Tibetan Plateau," Yu et al. (1) reported an interesting but unexpected result that spring phenology initiated retreating in the mid-1990s, despite continued warming for grasslands (both steppe and meadow) on the Tibetan Plateau, and shortening the length of the growing season of the steppe together with an advancing end. Although we have not observed the same phenomenon in our own many years of field studies on the eastern edge of the Tibetan Plateau, we believed that there were indeed some complicated yet poorly understood dynamics and processes in the phenology on the Tibetan Plateau. However, we believe their causes should include factors such as grassland degradation, thawing–freezing processes, climate warming, and their combined effect rather than a sole factor of climate change, like winter and spring warming.

The largest vegetation component of the Tibetan Plateau, grassland (covering about 60% of the whole plateau) (2), has severely degraded over the past decades because of overgrazing and/or climate change, mainly manifested in a decrease in vegetation cover and shrinkage of the meadow (3). The decrease in vegetation cover would result in increase of an albedo, which has a climate cooling effect. Such a cooling effect is more important in spring when solar radiation is high (4). Therefore, a decrease in vegetation cover could result in delayed spring phenology in both steppe and meadow. Furthermore, because spring phenology is earlier in meadow than in steppe (1, 3), shrinkage of the meadow could also lead to delayed spring phenology. Additionally, in the degradation from meadow to steppe, the spring phenology would also be delayed.

The permafrost and seasonal frozen soil are widely distributed on the Tibetan Plateau. Thawing–freezing processes in seasonal frozen soil and the active layer of permafrost also played an important role in the seasonal transition on the Tibetan Plateau (5), including spring phenology, an indicator of seasonal transition, although the progress is very complicated. Moreover, there should be a combined effect of vegetation and freezing–thawing processes on seasonal transition. Hu et al. (3) reported that a decrease in vegetation cover resulted in advancing of the start of freezing and thawing processes because of the insulating effect of vegetation. Furthermore, the influence of vegetation cover on the freezing process is more efficient than the thawing process. Therefore, because of decrease in vegetation cover, the freezing process is significantly advanced and shortened, which in turn, shortens the growth period of the grassland (5). In other words, on the regional scale, the possible delayed spring phenology in meadow and steppe should be attributed not only to the winter and spring warming (not fulfilling plant winter chilling requirements) but also grassland degradation, thawing–freezing processes, and their combined effects. Certainly, additional detailed work to integrate physiological, ecological, and hydrological observed data would help us to better understand and explain such a special phenomenon on the Tibetan Plateau.

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1. Yu H, Luedeling E, Xu J (2010) Winter and spring warming result in delayed spring phenology on the Tibetan Plateau. *Proc Natl Acad Sci USA* 107:22151–22156.
2. Zheng D (2000) *Mountain Geoecology and Sustainable Development of the Tibetan Plateau* (Kluwer, Dordrecht, the Netherlands).
3. Hu H, et al. (2008) Influences of alpine ecosystem degradation on soil temperature in the freezing-thawing process on Qinghai–Tibet Plateau. *Environ Geol* 57:1391–1397.
4. Chapin FS, et al. (2000) Arctic and boreal ecosystems of western North America as components of the climate system. *Glob Change Biol* 6:211–223.
5. Yang M, Yao T, Gou X, Koike T, He Y (2003) The soil moisture distribution, thawing-freezing processes and their effects on the seasonal transition on the Qinghai-Xizang (Tibetan) plateau. *J Asian Earth Sci* 21:457–465.

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