A discussion on the paper “Winter and spring warming result in delayed spring phenology on the Tibetan Plateau”

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Outline

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- Authors’ hypothesis
- Materials and methods
- Results
- Discussion

Background

- The Tibetan Plateau includes areas with an average elevation exceeding 4,500 m within approximately 30° longitude ($75-105^{\circ}$E) and 14° latitude ($26-40^{\circ}$N).
- The Tibetan Plateau stretches approximately 1,000 kilometers north to south and 2,500 kilometers east to west. It is the world's highest and largest plateau, with an area of 2,500,000 square kilometers. ($Wikipedia$)
- The climate of the Tibetan Plateau is characterized by a long period of frost and a relatively short growing season.

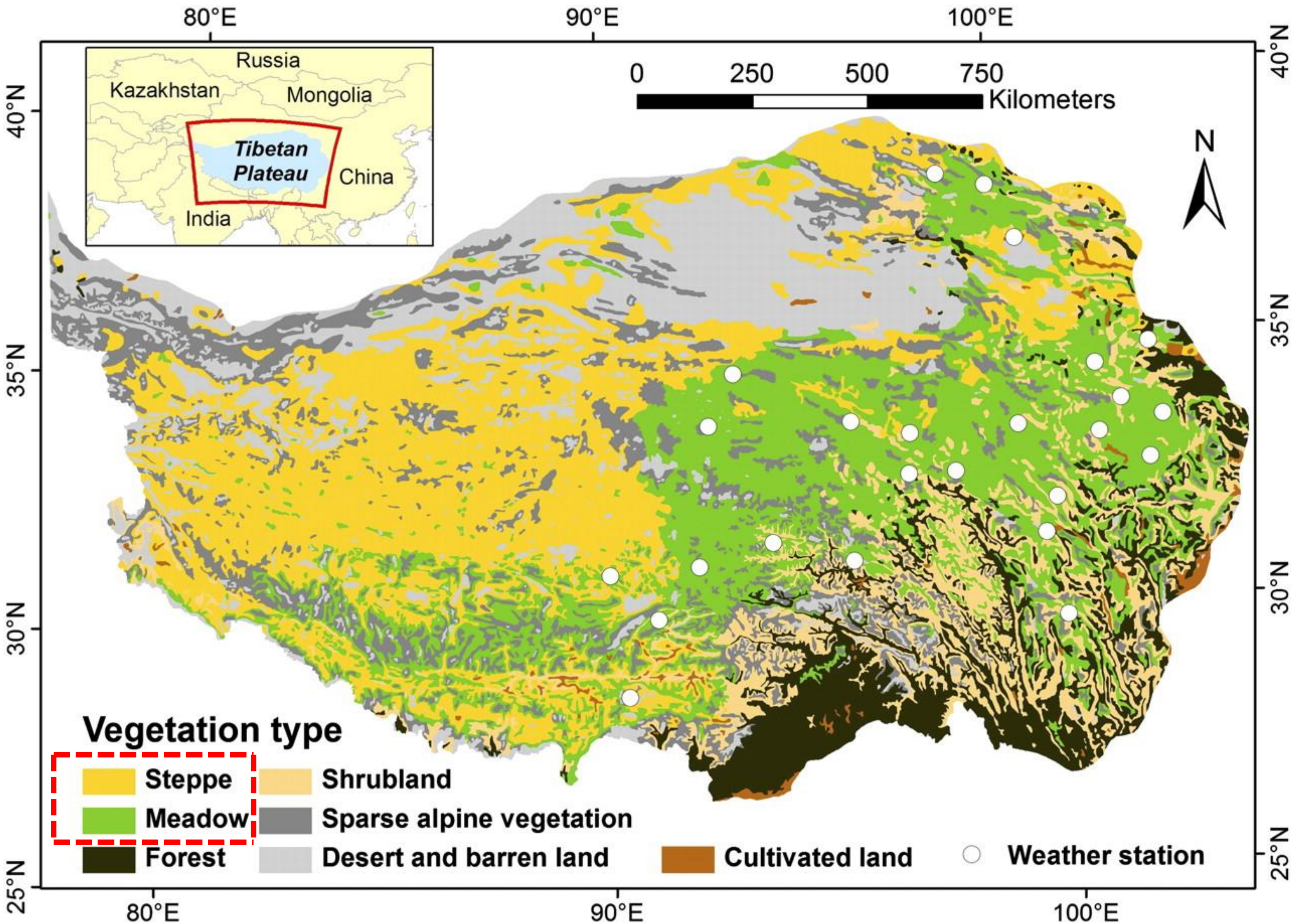

Fig.1 Vegetation types of the Tibetan and locations of weather stations in the region

Earlier research

- In a study that compared more than 125,000 observational time series of plant and animal phenology between 1971 and 2000, authors found that 78% of species showed advanced phenology (significant advances for 22% of all time series). (Menzel et al., 2006)
- An analysis of observations of the first flowering date of 385 plant species in England showed three quarters of species flowering earlier in the decade between 1991 and 2000 than in the previous four decades. (Fitter and Fitter., 2002)

Authors' hypothesis

Strong warming of *the Tibetan Plateau* (every single month indicated significant temperature increases during this period) has led to changes in the effective growing season of meadow and steppe vegetation, with warming in winter leading to delayed onset of the growing season.

Materials and methods

- Target vegetation: meadow and steppe
- Time span: from 1982 to 2006 (25 years)
- Monthly gridded temperature data is obtained from the China Meteorological Administration
- NDVI dataset is derived from imagery obtained from the Advanced Very High Resolution Radiometer (AVHRR) with a spatial and temporal resolution of 8km and 15d
- Averaging data for all image pixels of the temperature grids that had more than 50% cover by the respective vegetation type

Beginning of the growing season (BGS) and end of the growing season (EGS) were modeled using the NDVI ratio method. (White et al., 1997)

$$NDVI_{ratio} = \frac{NDVI - NDVI_{min}}{NDVI_{max} - NDVI_{min}}$$

The NDVI reached its minimum value in February and March.

The average NDVI in these two months was used as $NDVI_{min}$.

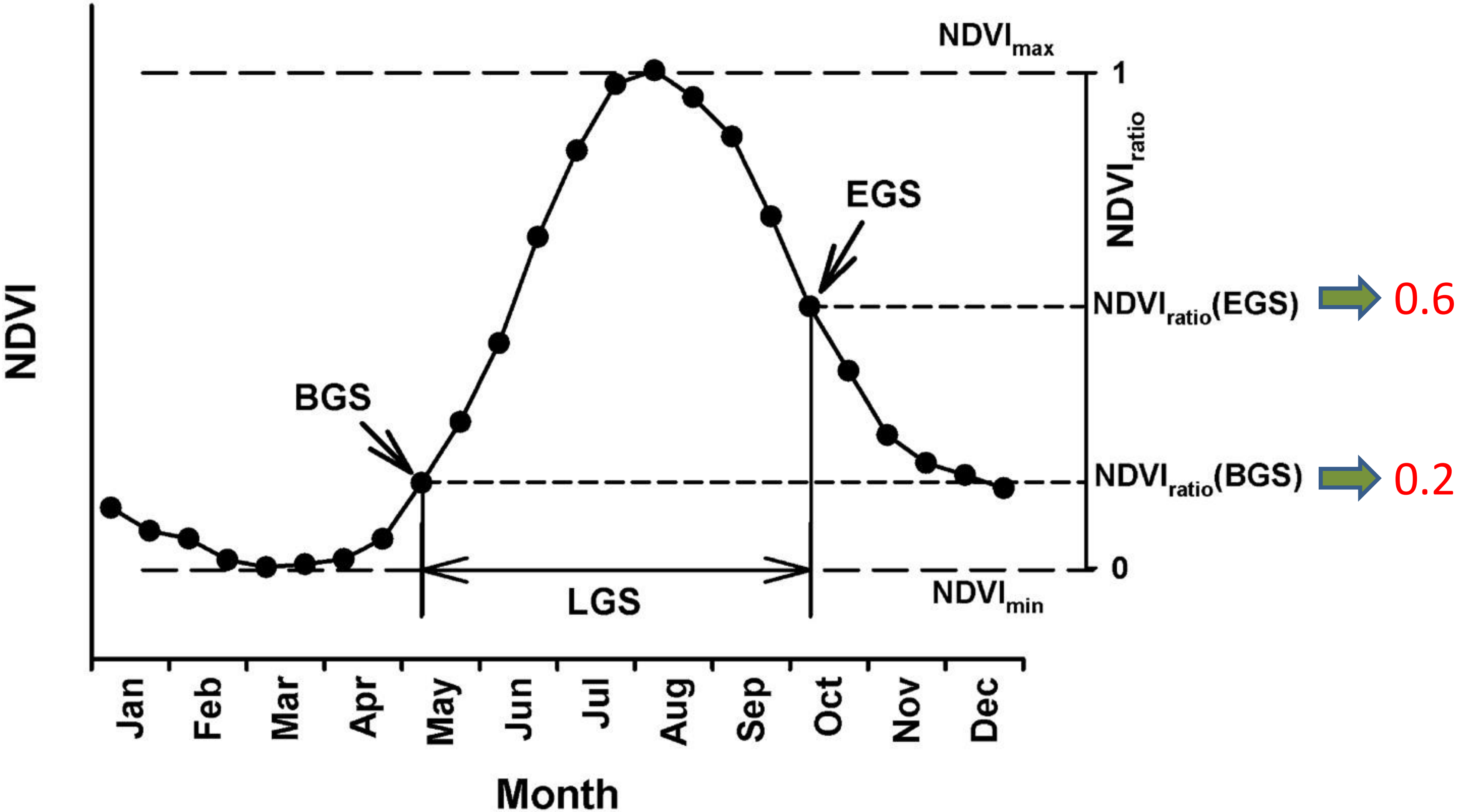

Fig.2 Illustration of the NDVI ratio method used to model the BGS and the EGS

Partial least squares regression(PLS)

- Advantage: this strategy is useful for highly auto-correlated variables, such as the temperatures of the individual months.
- VIP(variable importance in projection) value: an indication of which independent variables are useful for explaining the variation in the dependent variable. VIP value>0.8 means temperature in this month is important for explaining the variation of BGS or EGS dates.
- MC(model coefficients) value: the direction in which that influence is exerted. In the case that MC value is positive means high temperature has a delaying effect on phenology.

Results

- *the spatial distribution* of averaging time of BGS and EGS on the Tibetan Plateau between 1982 and 2006
- *the temporal trend* of BGS, EGS and LGS on the Tibetan Plateau between 1982 and 2006
- *the relationship* between monthly gridded temperature data and changes in the BGS and LGS

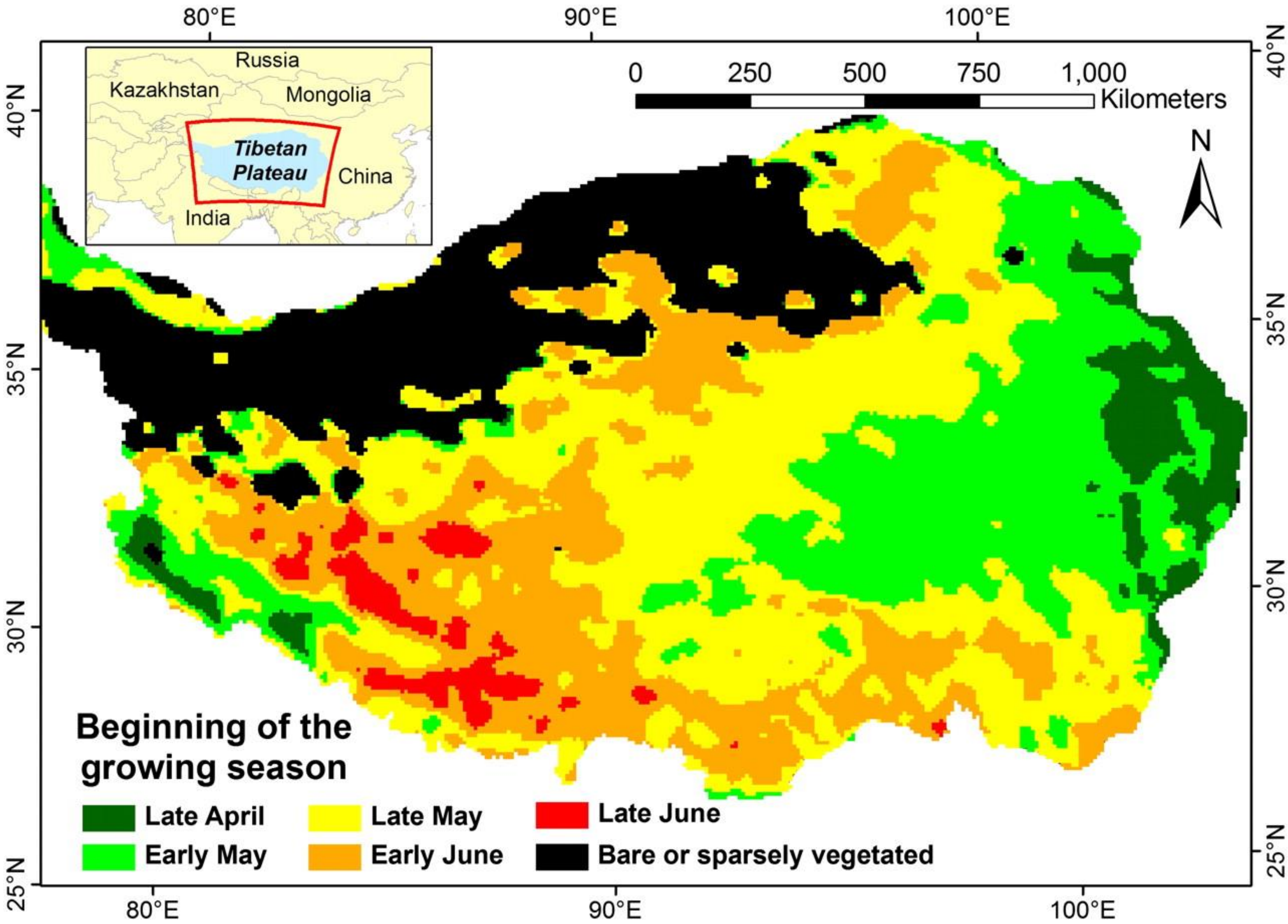

Fig.3 Average timing of the beginning of the growing season (BGS) on the Tibetan Plateau between 1982 and 2006

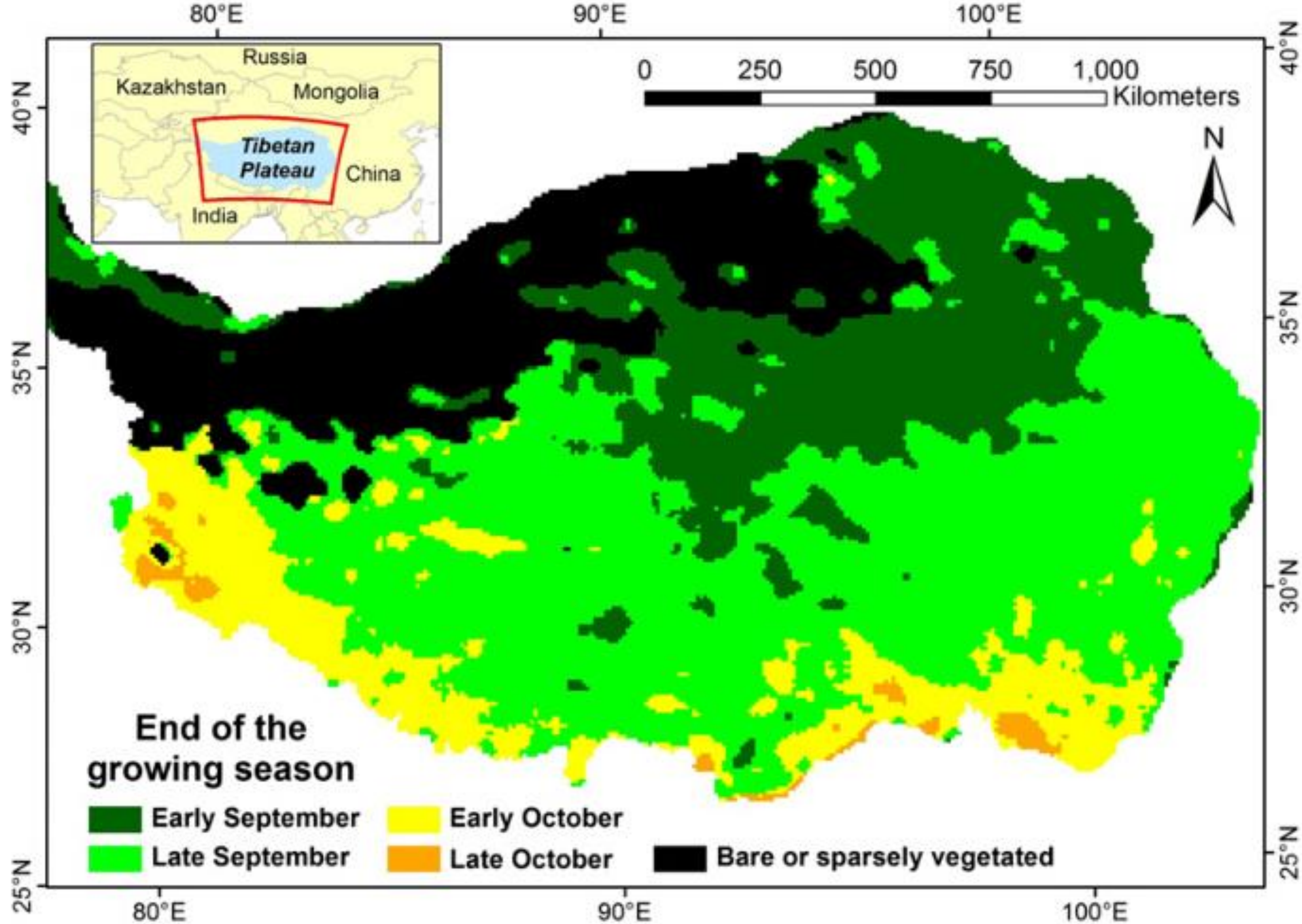

Fig.4 Average timing of the end of the growing season (EGS) on the Tibetan Plateau between 1982 and 2006

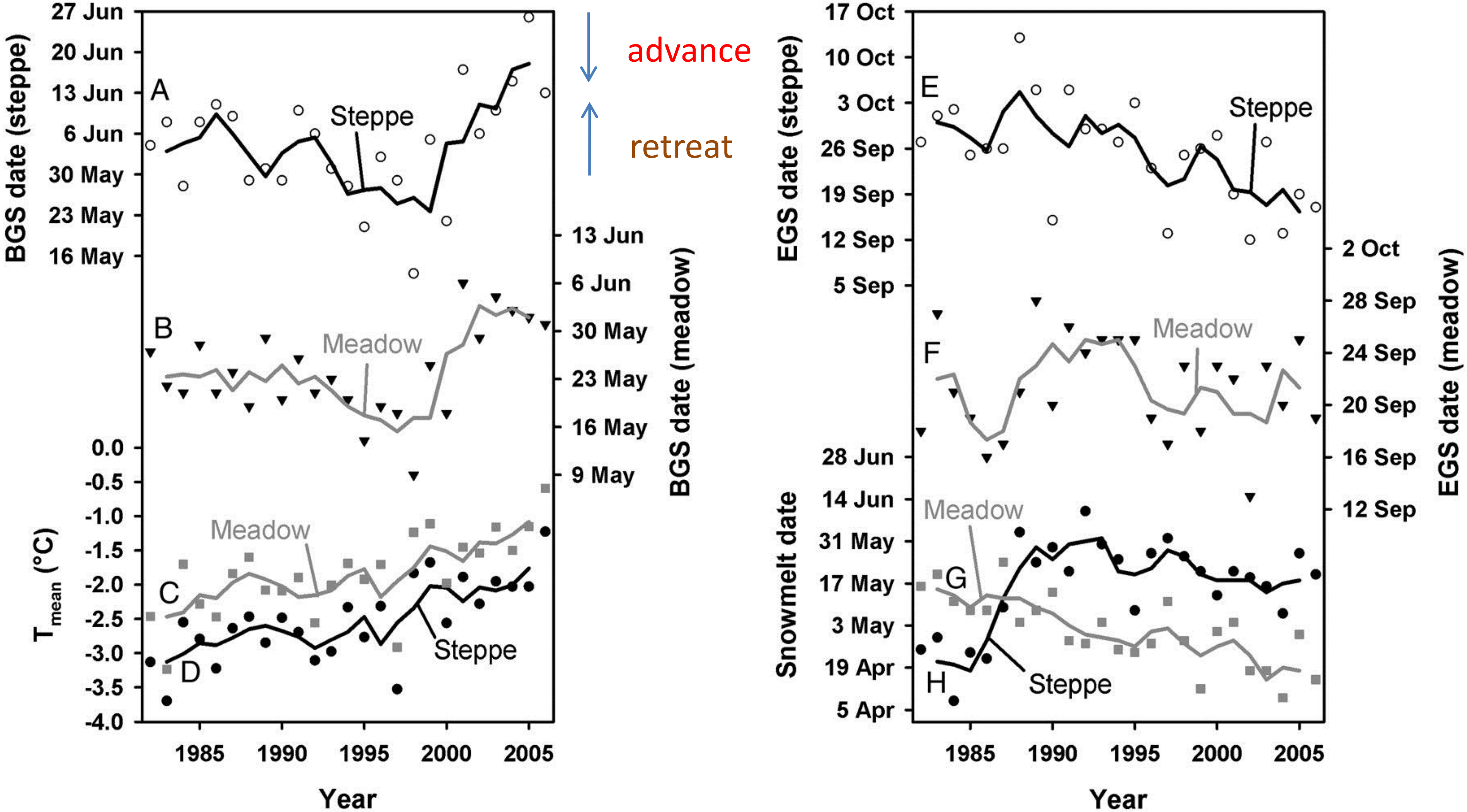

Fig.5 Beginning (A and B) and end (E and F) of the growing season for steppe (A and E) and meadow (B and F) vegetation; annual average temperature (C and D) and Snowmelt date (G and H) on the Tibetan Plateau between 1982 and 2006

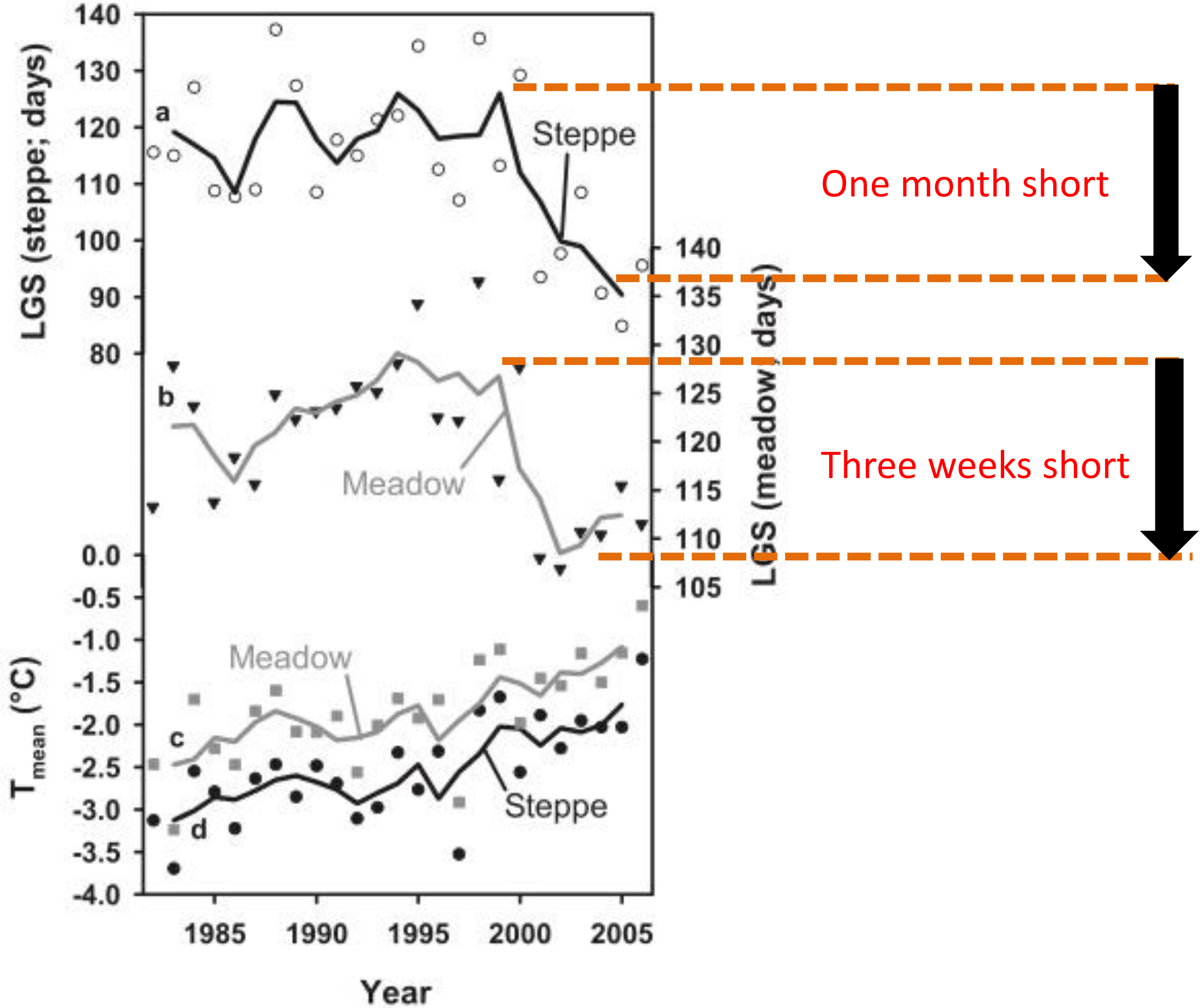

Fig.6 Length of the growing season (LGS) for steppe (a) and meadow (b) vegetation on the Tibetan Plateau between 1982 and 2006. such a trend has not typically been associated with rising temperatures which occurred in both steppe (d) and meadow (c).

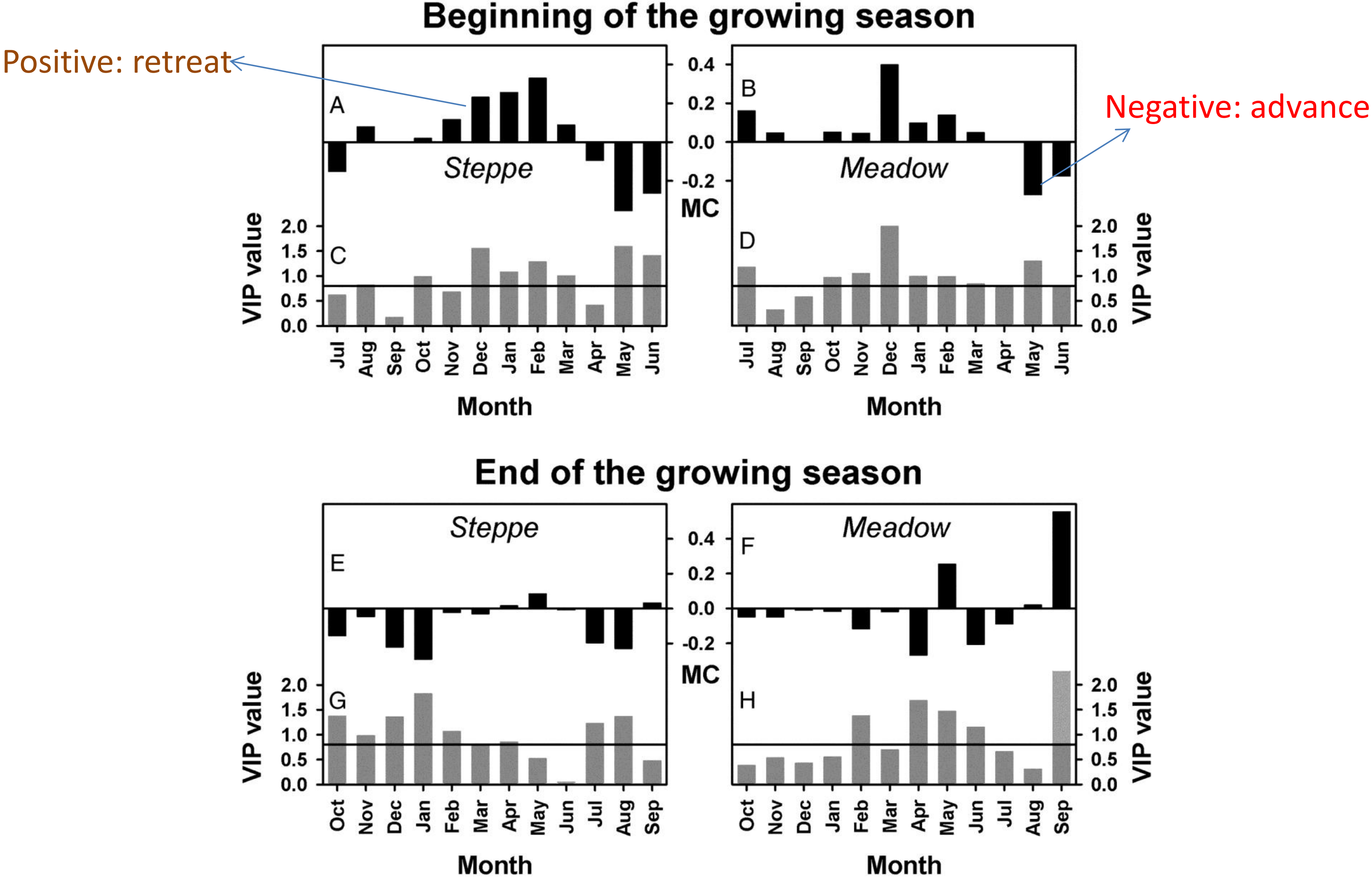

Fig.7 Response of the BGS (A–D) and EGS (E–H) in steppe and meadow vegetation of the Tibetan Plateau between 1982 and 2006 to monthly temperatures, according to PLS regression

Discussion

Compared with others' conclusion, why author's research about the spring phenology of Tibetan plateau's vegetation has different trend? Does precipitation regime or snow cover affect the observed changes in phenology? Has any other evidence to conform to author's view? And what is going to happen in the near future?

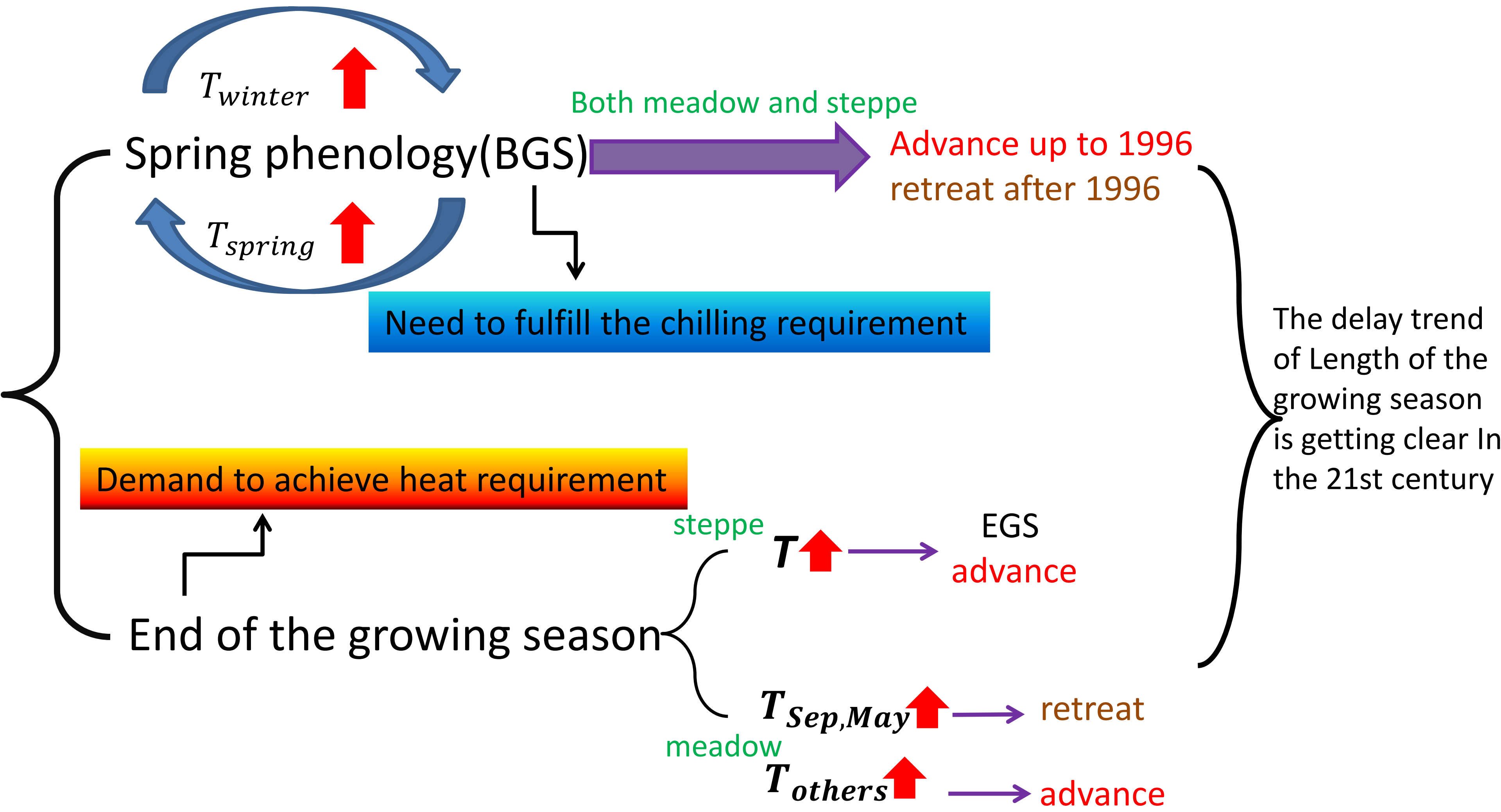

Fig.8 Schematic illustration of phenology stage of meadow and steppe

Changes in phenology are not associated with changes in snow cover or precipitation regime

- Averaged records of monthly precipitation over all stations showed no significant changes over time.
- The snow-melt date, averaged over all pixels used in the PLS regression analysis, showed a delayed trend until the early 1990s, but displayed only slight changes for the rest of the study period.

Taking walnut cultivar Payne in California as example (Luedeling E et al., 2009a,b,c)

premise

66.1 chill portions to achieve chilling requirement and 5139 growing degree hours for leaf-out

By long-term observations of spring phenology

simulation

Projected temperatures for a range of future scenarios in Northern California

Assuming both requirements must be fulfilled in sequence

conclusion

A delay in this phenological stage from mid-March to mid-April by the end of the 21st century

This result, to some extent, Support authors' hypothesis

Fig.9 Climatic changes leading to declining winter chill in California

- Phenology delays may be in store for many regions in the future.
- Continued warming may attenuate or even reverse the advancing trend in spring phenology that has dominated Climate-change responses of plants thus far.
- Future studies of climate-change effects on phenology may be well advised to take the additional effects of winter warming into consideration.

Thank you