

Supplementary file for

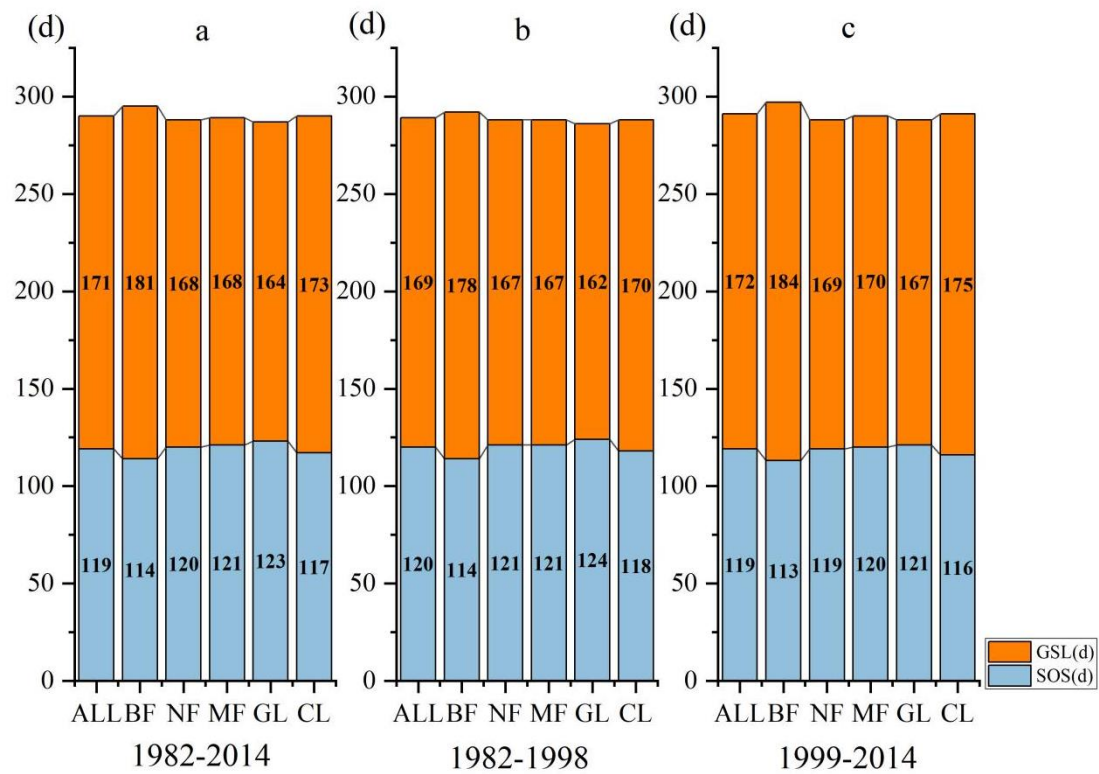
**Phenological changes and their influencing factors under the joint action of water and  
temperature in northeast Asia**

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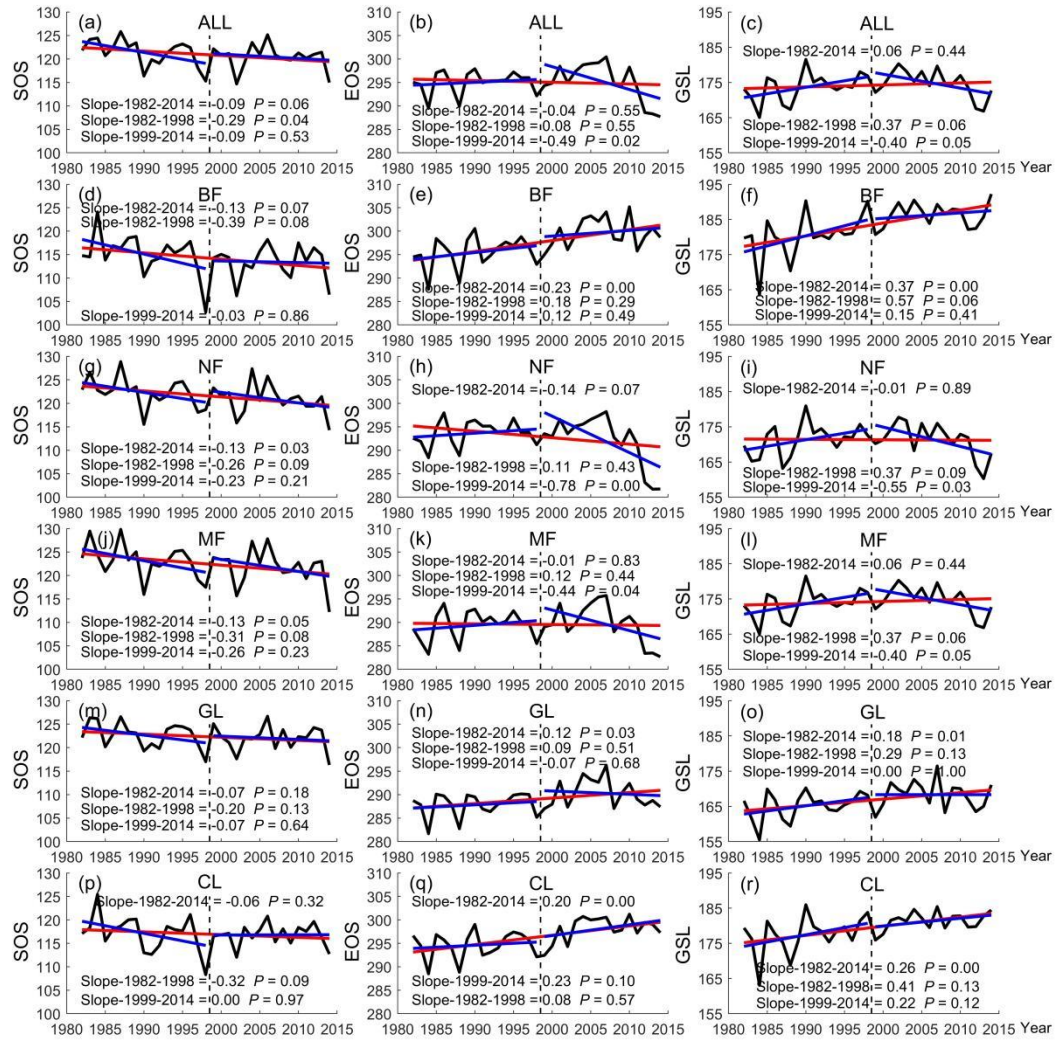
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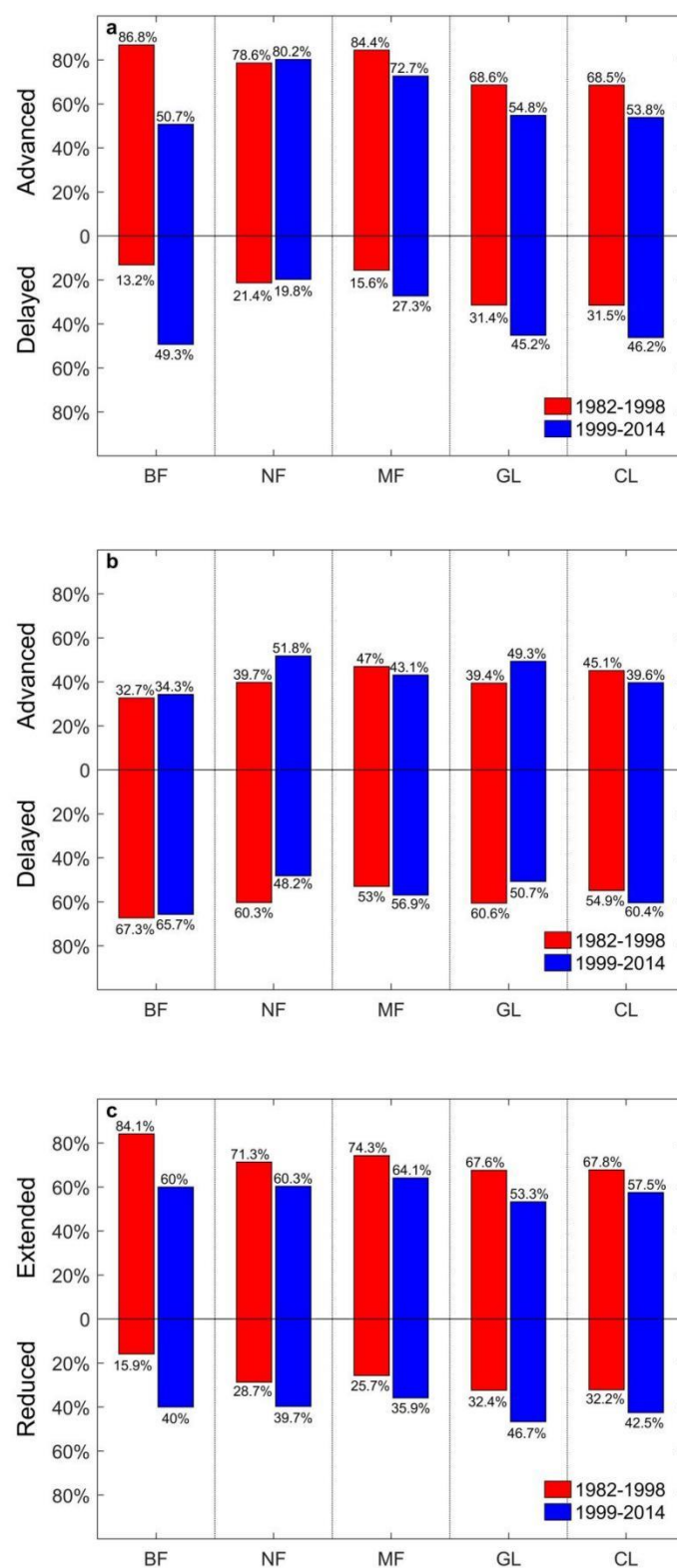
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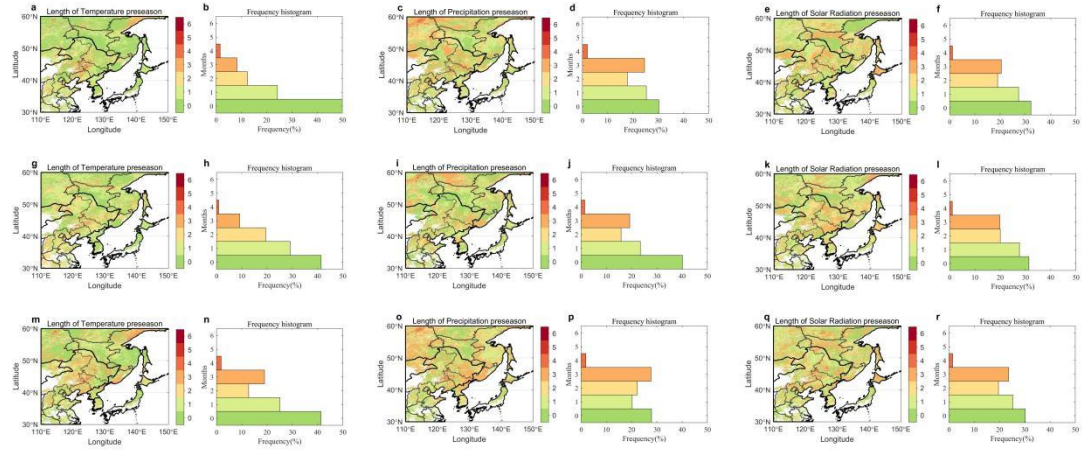
**Supplementary Figure 1.** Phenological phase annual average value of different vegetation types during different time periods in northeast Asia. Different vegetation including all represent vegetation (ALL), broad-leaf forest (BF), needle-leaf forest (NF), mixed forest (MF), grassland (GL), and cropland (CL).



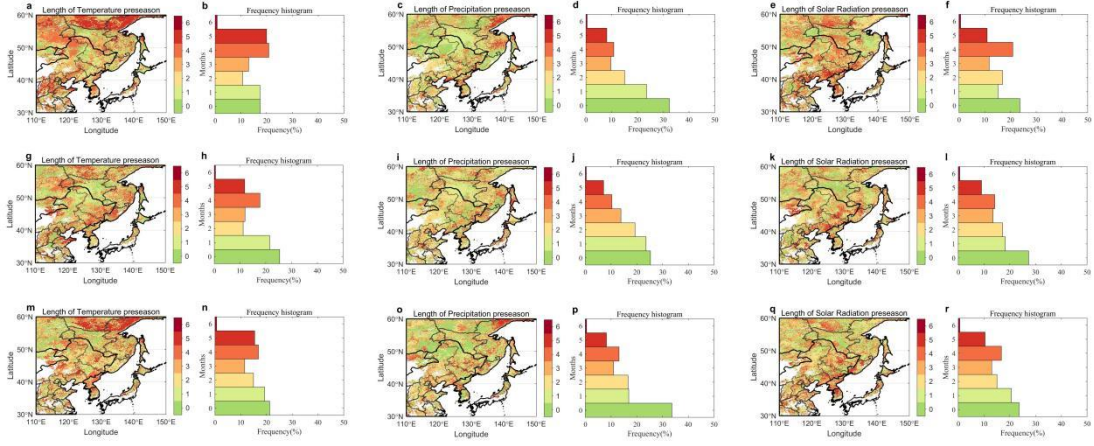
**Supplementary Figure 2.** Trends of different vegetation types in northeast Asia (the black line represents the annual sequence of vegetation phenology from 1982 to 2014, the red line represents the trend of inter-annual variation from 1982 to 2014, and the blue line represents 1982–2014. The inter-annual change trends in 1998 and 1999–2014, (a), (d), (g), (j), (m), and (p) all represent vegetation, broad-leaved forest, needle-leaf forest, mixed inter-annual changes in spring phenology of forest, grassland, and cultivated land; and (b), (e), (h), (k), (n), and (q) all represent vegetation, broad-leaved forest, needle-leaf forest, and mixed forest. The inter-annual changes of autumn phenology of grassland, and cultivated land; (c), (f), (i), (l), (o), and (r) all represent vegetation, broad-leaved forest, needle-leaf forest, mixed forest, and inter-annual variation in growing season duration of the grassland and cultivated land).



**Supplementary Figure 3.** Statistical percentages of (a) SOS, (b) EOS, and (c) GSL advancement and delay of different vegetation types between 1982–1998 and 1999–2014.

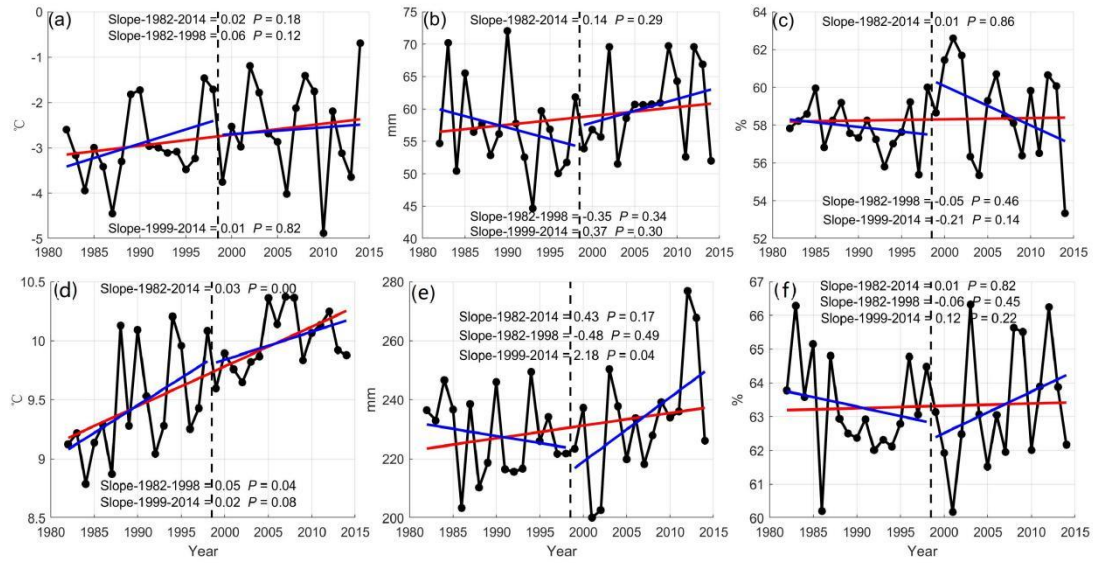


**Supplementary Figure 4.** SOS preseason temperature duration and probability distribution before and after warming periods; a, g, and m represent the spatial distribution patterns of pre-season temperature duration; b, h, and n represent the probability distribution histograms of pre-season temperature; c, i, and o represent the spatial distribution patterns of pre-season precipitation duration; d, j, and p represent the histograms of pre-season radiation probability distribution; e, k, and q represent the spatial distribution patterns of pre-season temperature duration; and f, l, and r represent the probability distribution histograms of pre-season temperature. a-f represent the spatial distribution patterns from 1982 to 2014, g-l represent the spatial distribution patterns from 1982 to 1998, m-r represent the spatial distribution patterns from 1999 to 2014.

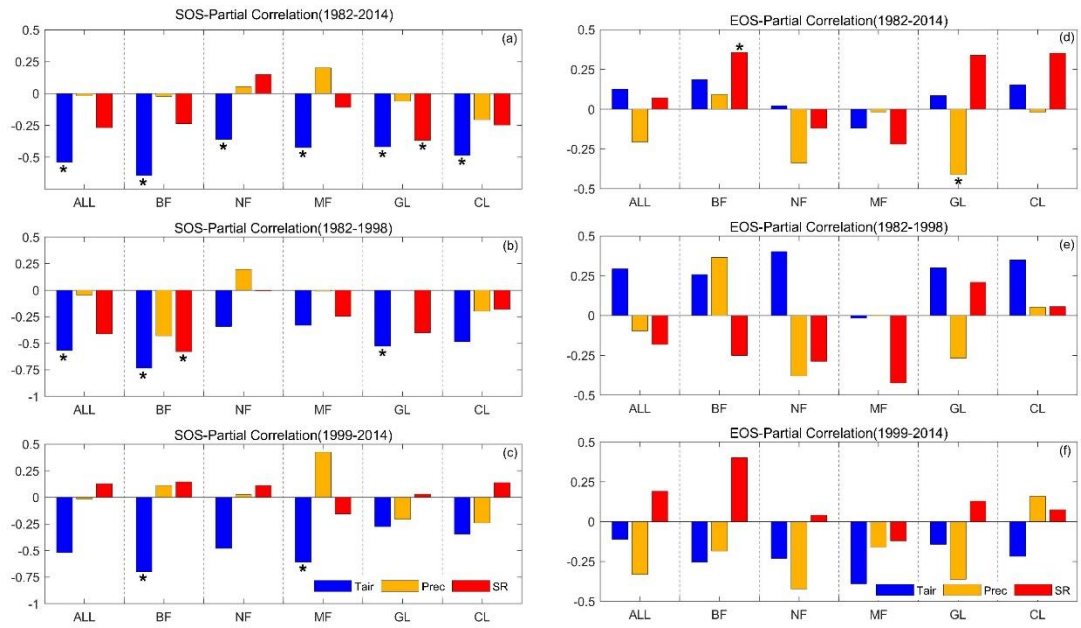


**Supplementary Figure 5.** EOS preseason temperature duration and probability distribution before and after warming periods; a, g, and m represent the spatial distribution patterns of pre-season temperature duration; b, h, and n represent the probability distribution histograms of pre-season temperature; c, i, and o represent the spatial distribution patterns of pre-season precipitation duration; d, j, and p represent the histograms of pre-season radiation probability distribution; e, k, and q represent the spatial distribution patterns of pre-season temperature duration; and f, l, and r represent the probability distribution histograms of pre-season temperature. a-f represent the spatial distribution patterns from 1982 to 2014, g-l represent the spatial distribution patterns from 1982 to 1998, m-r represent the spatial distribution patterns from 1999 to 2014.



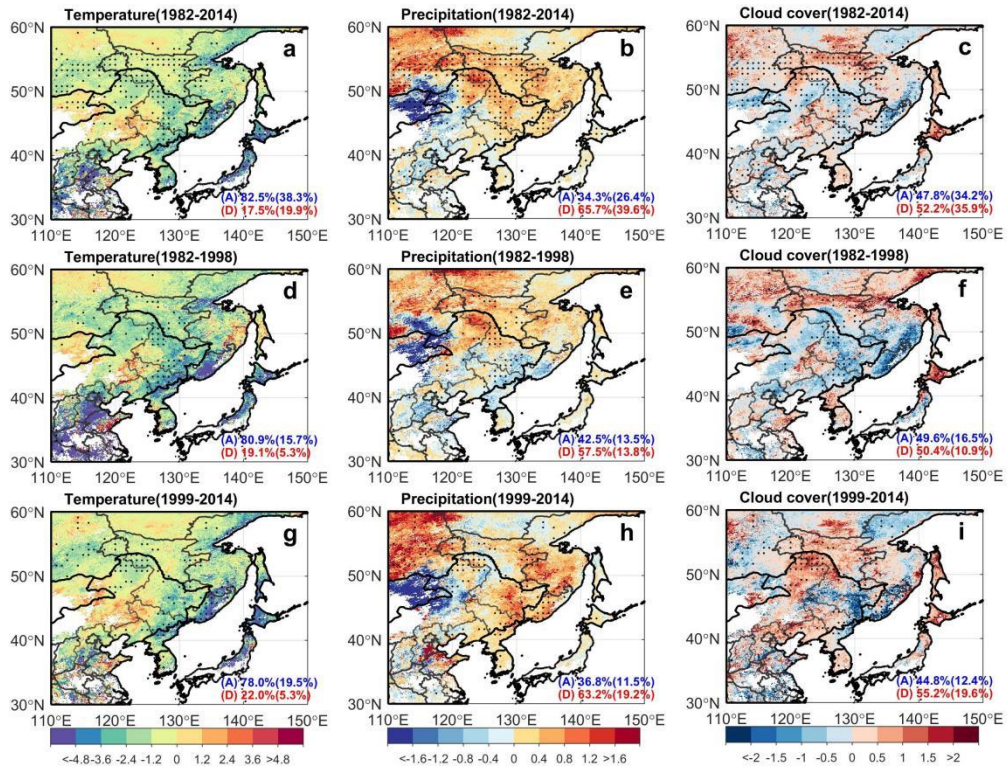


**Supplementary Figure 6.** The inter-annual change trend of pre-season climatic factors in different time periods in northeast Asia. (The black line represents the annual sequence of vegetation phenology from 1982 to 2014, the red line represents the trend of inter-annual change from 1982 to 2014, and the blue line represents the trend of inter-annual change from 1982 to 1998 and 1999 to 2014; a, b, and c represent the inter-annual variation trends of temperature, precipitation and solar radiation before the spring phenology; d, e, and f represent the inter-annual variation trends of temperature, precipitation, and solar radiation before autumn phenology).

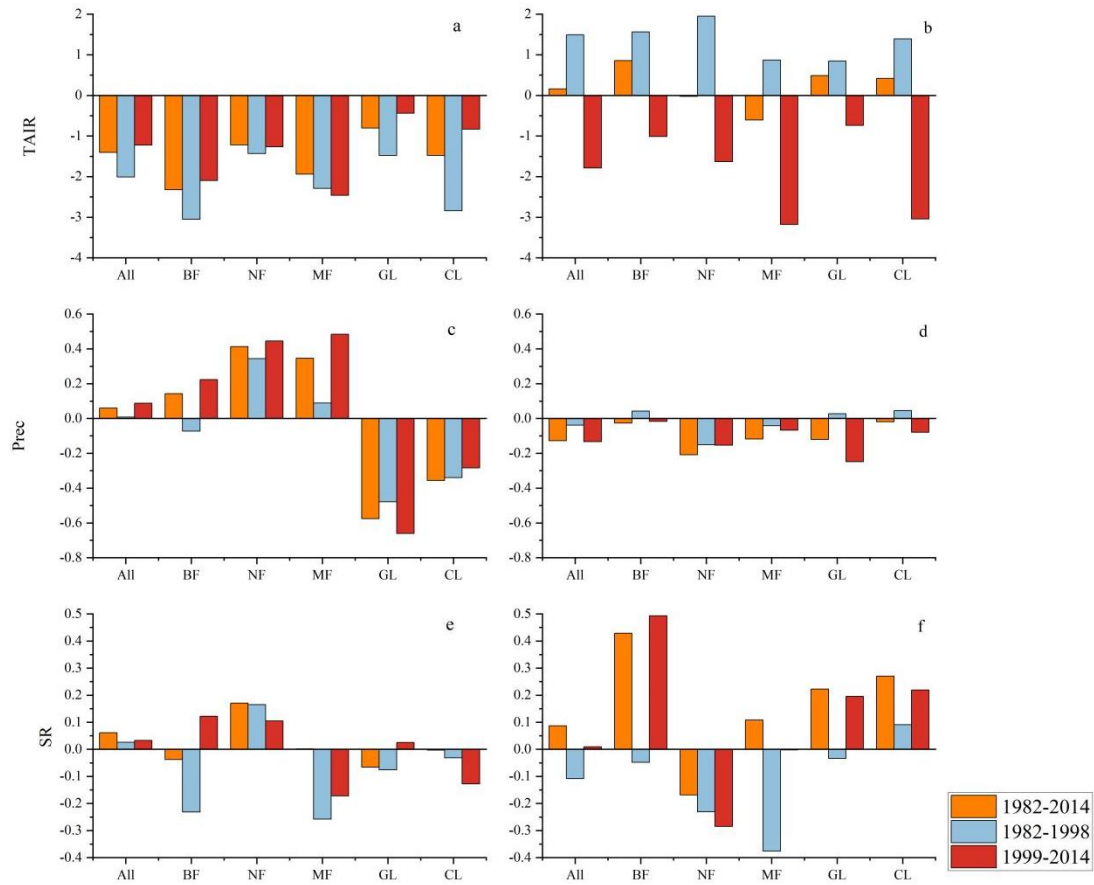


**Supplementary Figure 7.** Statistical map of partial correlation coefficients of spring (autumn) phenology and climatic factors of different vegetation types during different time periods in northeast Asia (a: 1982–2014; b: 1982–1998; c: 1999–2014; d: 1982–2014; e: 1982–1998; f: 1999–2014). a, b, and c stand for spring, d, e, and f stand for autumn.

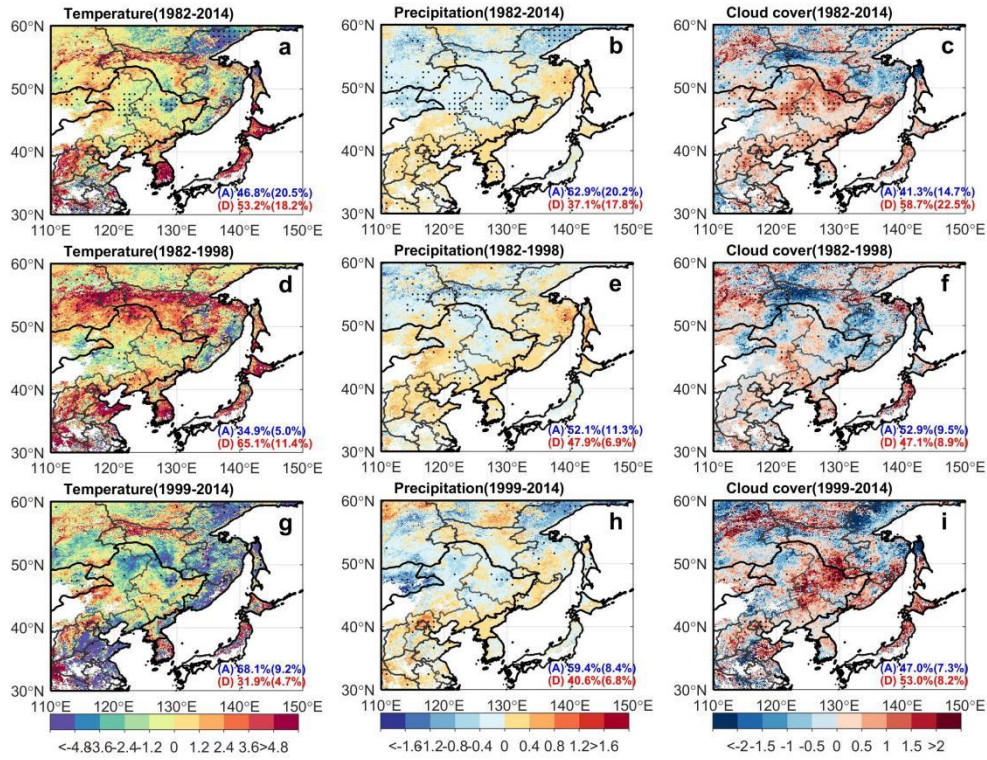




**Supplementary Figure 8.** Spatial distribution map of spring phenology sensitivity to climate change in northeast Asia (a, b, and c represent the sensitivity of spring phenology and pre-season temperature, precipitation, and solar radiation from 1982 to 2014 respectively; d, e, and f from 1982 to 1998; and g, h, and i represent 1999 to 2014).



**Supplementary Figure 9.** Statistical charts of the mean sensitivity of climate change of different vegetation types in spring and autumn phenology during different time periods in northeast Asia; a, c, and e represent the sensitivity of spring phenology and pre-season temperature, precipitation and solar radiation, respectively; b, d, and f represent the sensitivity of autumn phenology and pre-season temperature, precipitation, and solar radiation, respectively. Tair is tempure of air, Prec is precipitation, SR is srad radiation.



**Supplementary Figure 10.** Spatial distribution map of autumn phenology sensitivity to climate change in northeast Asia (a, b, and c represent the sensitivity of autumn phenology and pre-season temperature, precipitation and solar radiation from 1982 to 2014, respectively; d, e, and f represent 1982–1998; g, h, and i represent 1999–2014).