Record 1 of 77

Title: Impacts of preseason drought on vegetation spring phenology across the Northeast China Transect

Author(s): Yuan, MX (Yuan, Moxi); Zhao, L (Zhao, Lin); Lin, AW (Lin, Aiwen); Wang, LC (Wang, Lunche); Li, QJ (Li, Qingjun); She, DX (She, Dunxian); Qu, S (Qu, Sai)

Source: SCIENCE OF THE TOTAL ENVIRONMENT **Volume:** 738 **Article Number:** 140297 **DOI:** 10.1016/j.scitotenv.2020.140297 **Published:** OCT 10 2020

Abstract: Vegetation phenology is undergoing profound changes in response to the recent increases in the intensity and frequency of drought events. However, the mechanisms bywhich drought affects the start of the growing season (SGS) are poorly understood particularly in arid and semi-arid regions. Here, we identified varying degrees of preseason drought events and analyzed the sensitivity of the SGS to preseason drought across the Northeast China Transect (NECT). Our results showed that drought caused a delayed SGS in grassland ecosystems, but an advanced SGS within forest ecosystems. These contrasting responses to preseason drought reflected different adaptive strategies between vegetation types. The SGS was shown to be highly sensitive to short timescales drought (1-3months) in semi-arid grasslands where annual precipitation is 200-300mm(i.e. SAGE(200-300)). Biomes within this region were found to be most vulnerable out of all the ecosystems to drought. Given the frequent nature of droughts in the mid-latitudes, a drought early warning system was recommended accompanied by improvedmodeling of howthe SGS will be affected by intensified drought under future climate change.

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PubMed ID: 32806362

ISSN: 0048-9697

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Record 2 of 77

Title: Does any phenological event defined by remote sensing deserve particular attention? An examination of spring phenology of winter wheat in Northern China

Author(s): Chen, XH (Chen, Xuehong); Wang, WQ (Wang, Wenqing); Chen, J (Chen, Jin); Zhu, XL (Zhu, Xiaolin); Shen, MG (Shen, Miaogen); Gan, LQ (Gan, Liqin); Cao, X (Cao, Xin)

Source: ECOLOGICAL INDICATORS **Volume:** 116 **Article Number:** 106456 **DOI:** 10.1016/j.ecolind.2020.106456 **Published:** SEP 2020

Abstract: Phenology is often considered the leading indicator of ecological responses to climate change, and therefore it is important that researchers have accurate methods to track phenological changes. Remote sensing has been widely used to study phenological responses to climate change. However, land surface phenology observed by remote sensing is fundamentally different from that observed in the field, which raises the difficulty in understanding and validating phenological change observed using remote sensing. In this study, we revisited the criteria of good phenological events and argued that the relationship between phenology and climate factors is one of the most important meanings of phenological studies. Instead of validating remotely sensed phenology by its consistency with field observations, this study aims to judge different possible definitions of phenological events based on remote sensing by their temperature sensitivity and correlation. Using the winter wheat zone in northern China as the study area, we compared the temperature correlation and sensitivities of winter wheat phenology date derived from different methods: the relative threshold method with different thresholds, and the curvature method, based on remotely sensed data. Our results show that there is no distinct phenological event that is overwhelmingly more sensitive or correlative than any others. Therefore, there are no particular phenological events that deserve emphasis when exploring the relationship between phenology date and the pre-season temperature. Instead, the phenological stage (i.e. the threshold of relative threshold method) that is most sensitive or correlative to pre-season temperature varies spatially, showing a good latitude gradient. On an average, the thresholds of the most correlative and sensitive phenological stages to pre-season temperature decreased by 9.92% and 14.69% per latitudinal degree, respectively. The results indicate that the traditional emphasis on discrete phenological events could miss the phenological stages that are most sensitive and correlative to pre-season temperature, thereby resulting in a limited understanding of phenological responses to climate change.

Accession Number: WOS:000540278400006

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Shen, Miaogen	A-8374-2011	0000-0001-5742-8807

ISSN: 1470-160X

eISSN: 1872-7034

Record 3 of 77

Title: Phenological changes in herbaceous plants in China's grasslands and their responses to climate change: a meta-analysis

Author(s): Huang, WJ (Huang, Wenjie); Dai, JH (Dai, Junhu); Wang, W (Wang, Wei); Li, JS (Li, Junsheng); Feng, CT (Feng, Chunting); Du, JH (Du, Jinhong)

Source: INTERNATIONAL JOURNAL OF BIOMETEOROLOGY **DOI:** 10.1007/s00484-020-01974-1 **Early Access Date:** JUL 2020

Abstract: Plant phenological events are sensitive indicators of climate change, and their change could markedly affect the structure and function of ecosystems. Previous studies have revealed the spatiotemporal variations in the phenological events of woody plants. However, limited studies have focused on the phenophases of herbaceous plants. In this study, by using a meta-analysis method, we extracted information about the phenological changes in herbaceous plants in China's grasslands from existing studies (including the period, station, species, phenophases, phenological trends, and climatic determinants) and analyzed the patterns manifested in the dataset. The results showed that the spring phenophases (e.g., first leaf date and first flowering date) of the herbaceous plants mainly advanced over the past 30 years, but a large difference existed across grassland types. The spring phenophases of forages (species from the Cyperaceae, Gramineae, and Leguminosae families) became earlier in the desert steppe and alpine steppe but showed no apparent trends in the alpine meadow and even became later in the meadow steppe and typical steppe. In most cases, the increase in spring temperatures and precipitation promoted the greening up of herbaceous plants, while sunshine duration was positively correlated with the green-up date of herbaceous plants. For the autumn phenophases, the proportions of the earlier and later trends were very close, but the trends varied among the grassland types. The leaf coloring dates of the forages were delayed in the meadow steppe and alpine steppe but showed no distinct pattern in the typical steppe or alpine

meadow and even became earlier in the desert steppe. In most cases, the increase in growing season temperature led to an earlier leaf coloring date of the herbaceous plants, but the increase in the preseason precipitation delayed the leaf coloring date. Our results suggested that the phenophases of herbaceous plants have complicated responses to multiple environmental factors, which makes predicting future phenological changes difficult.

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PubMed ID: 32734424
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eISSN: 1432-1254

Record 4 of 77

Title: Impact of spring phenology variation on GPP and its lag feedback for winter wheat over the North China Plain

Author(s): Guo, LH (Guo, Linghui); Gao, JB (Gao, Jiangbo); Ma, SC (Ma, Shouchen); Chang, Q (Chang, Qing); Zhang, LL (Zhang, Linlin); Wang, SX (Wang, Suxian); Zou, YF (Zou, Youfeng); Wu, SH (Wu, Shaohong); Xiao, XM (Xiao, Xiangming)

Source: SCIENCE OF THE TOTAL ENVIRONMENT **Volume:** 725 **Article Number:** 138342 **DOI:** 10.1016/j.scitotenv.2020.138342 **Published:** JUL 10 2020

Abstract: Spring green-up date (GUD) is a sensitive indicator of climate change, and of great significance to winter wheat production. However, our knowledge of the chain relationships among them is relatively weak. In this study, based on 8-day Enhanced Vegetation Index (EVI) data from Moderate Resolution Imaging Spectroradiometer (MODIS) from 2001 to 2015, we first assessed the performance of four algorithms for extracting winter wheat GUD in the North China Plain (NCP). A multiple linear regression model was then established to quantitatively determine the contributions of the time lag effects of hydrothermal variation on GUD. We further investigated the interactions between GUD and gross primary production (GPP) comprehensively. Our results showed that the rate of change in curvature algorithm(RCCmax) had better performance in capturing the spatiotemporal variation of winter wheat GUD relative to the other threemethods (Kmax, CRmax, and cumCRmax). Regarding the non-identical lag time effects of hydrothermal factors, hydrothermal variations could explain winter wheat GUD variations for 82.05% of all pixels, 36.78% higher than that without considering the time lag effects. Variation in GUD negatively correlated with winter wheat GPP after green up in most parts of the NCP, significantly in 35.75% of all pixels with a mean rate of 1.89 g C m(-2) yr(-1) day(-1). Meanwhile, winter wheat GPP exerted a strongly positive feedback on GUD in N82.42% of all pixels (significant in 28.01% of all pixels), characterized by a humped-shape pattern along the long-term average plant productivity. This finding highlights the complex interaction between spring phenology and plant productivity, and also suggests the importance of preseason climate factors on spring phenology. (C) 2020 Elsevier B.V. All rights reserved.

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eISSN: 1879-1026

Record 5 of 77

Title: Forest Phenology Shifts in Response to Climate Change over China-Mongolia-Russia International Economic Corridor

Author(s): Yu, LX (Yu, Lingxue); Yan, ZR (Yan, Zhuoran); Zhang, SW (Zhang, Shuwen)

Source: FORESTS **Volume:** 11 **Issue:** 7 **Article Number:** 757 **DOI:** 10.3390/f11070757 **Published:** JUL 2020

Abstract: Vegetation phenology is a sensitive indicator of climate change. With the intensification of global warming, the changes in growing seasons of various vegetation types have been widely documented across the world. However, as one of the most vulnerable regions in response to the global climate change, the phenological responses and associated mechanisms in mid-high latitude forests are still not fully understood. In this study, long-term changes in forest phenology and the associated relationship with the temperature and snow water equivalent in the China-Mongolia-Russia International Economic Corridor were examined by analyzing the satellite-measured normalized difference vegetation index and the meteorological observation data during 1982 to 2015. The average start date of the growing season (SOS) of the forest ecosystem in our study area advanced at a rate of 2.5 days/decade, while the end date of the growing season (EOS) was delayed at a rate of 2.3 days/decade, contributing to a growing season that was approximately 15 days longer in the 2010s compared to that in 1980s. A higher April temperature is beneficial to the advance in the SOS, and a higher summer temperature has the potential to extend the EOS in the forest ecosystem. However, our results also suggest that a single temperature cannot fully explain the advance of the SOS, as well as the delay in the EOS. The preseason Snow Water Equivalent (SWE) is also an essential factor in influencing the growing season. A higher SWE in February and March and lower SWE in April tend to advance the SOS, while higher SWE in pre-year December and lower SWE in current year October are beneficial to the extension of the EOS.

Accession Number: WOS:000558649100001
eISSN: 1999-4907

Record 6 of 77

Title: Assessment of varying changes of vegetation and the response to climatic factors using GIMMS NDVI3g on the Tibetan Plateau

Author(s): Zhou, YK (Zhou, Yuke); Fan, JF (Fan, Junfu); Wang, XY (Wang, Xiaoying)

Source: PLOS ONE **Volume:** 15 **Issue:** 6 **Article Number:** e0234848 **DOI:** 10.1371/journal.pone.0234848 **Published:** JUN 17 2020

Abstract: Under the context of global climate change, vegetation on the Tibetan Plateau (TP) has experienced significant changes during the past three decades. In this study, the spatiotemporal changes of growing season vegetation index (GSVI) on the TP were analyzed using various methods from pixel level to ecoregion level. In addition, a relative importance approach was employed to investigate the regulating effect of temperature and precipitation on vegetation. During the period of 1982-2012, vegetation on the TP was generally experiencing a greening trend, but with pronounced fluctuations. The interannual variation of the long-term GSVI was most significant in the Qaidam Basin and southern forest. At ecoregion scale, vegetation in the arid and frigid arid zones showed a browning tendency, with other ecoregions presenting greener trends. Over a large proportion of the TP, there exist change points in the GSVI time series, which were mainly concentered around the year 1996 and 2000. The Hurst exponent identified that a majority (88%) of the vegetation on the plateau would maintain a persistent trend in the future, which would mainly consist of undetermined development and greening trends. TP vegetation during the 1990s experienced more greening than in the 1980s or 2000s according to the interdecadal analysis. The long-term change in growing season vegetation was most positively correlated with the temperature during the same period, followed by the temperature in the preseason and postseason periods. There were more negative relationships of vegetation change with precipitation than with temperature. The relative contribution of the temperature to the vegetation changes exhibited an opposite spatial pattern to that of precipitation. Overall, the findings in this work provide an essential archive of decade-scale vegetation dynamics that may be helpful for projecting the future ecosystem dynamics on the Tibetan Plateau, such as the consistent greening.

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PubMed ID: 32555722
ISSN: 1932-6203

Record 7 of 77

Title: Effect of preseason diurnal temperature range on the start of vegetation growing season in the Northern Hemisphere

Author(s): Huang, Y (Huang, Yan); Jiang, N (Jiang, Nan); Shen, MG (Shen, Miaogen); Guo, L (Guo, Li)

Source: ECOLOGICAL INDICATORS **Volume:** 112 **Article Number:** 106161 **DOI:** 10.1016/j.ecolind.2020.106161 **Published:** MAY 2020

Abstract: Preseason temperature, the air temperature before the vegetation growing season, is the most influential factor controlling the start of the growing season (SOS) in temperate and boreal areas. Although the response of SOS to mean daily temperature (T-mean) and daily temperature extremes during the preseason period has been extensively investigated, the effect of preseason diurnal temperature range (DTR) on SOS remains largely unknown. Here, we analyze the interannual covariation of preseason DTR with SOS, determined from satellite-derived normalized difference vegetation index, over the mid and high latitudes in the Northern Hemisphere from 1983 to 2015. After using partial correlation analyses to remove the correlations between preseason DTR and preseason T-mean, cloudiness, and precipitation, we found that the partial correlation between SOS and preseason DTR was negative (i.e., that a larger preseason DTR delays SOS, and a smaller preseason DTR advances SOS) in 62.8% of the study area and positive in 37.2% of the study area. Multiple regression analysis suggested that a 1-degrees C increase in DTR could induce more than 2.5 days advance (or delay) of SOS in 45.8% (or 24.6%) of the study area. The magnitude of the sensitivity of SOS to preseason DTR was much smaller in areas with greater seasonality in temperature, which could be explained by the intensified thermal tolerance of vegetation. Further analysis showed a considerable difference in the partial correlation between SOS and preseason DTR versus that between SOS and preseason T-mean,T- indicating that preseason DTR can be used as a complementary ecological indicator to preseason T-mean in realistic modeling and predicting SOS. Although the impact of preseason DTR on spring vegetation phenology and its spatial variation are examined here, we advocate that more studies are needed to understand the physiological mechanisms governing the response of SOS to preseason DTR.

Accession Number: WOS:000518385800032

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Record 8 of 77

Title: The relative controls of temperature and soil moisture on the start of carbon flux phenology and net ecosystem production in two alpine meadows on the Qinghai-Tibetan Plateau

Author(s): Chai, X (Chai, Xi); Shi, PL (Shi, Peili); Song, MH (Song, Minghua); Zong, N (Zong, Ning); He, YT (He, Yongtao); Li, YN (Li, Yingnian); Zhang, XZ (Zhang, Xianzhou); Liu, YJ (Liu, Yanjiao)

Source: JOURNAL OF PLANT ECOLOGY **Volume:** 13 **Issue:** 2 **Pages:** 247-255 **DOI:** 10.1093/jpe/rtaa007 **Published:** APR 2020

Abstract: Aims Variations in vegetation spring phenology are widely attributed to temperature in temperate and cold regions. However, temperature effect on phenology remains elusive in cold and arid/semiarid ecosystems because soil water condition also plays an important role in mediating phenology. Methods We used growing degree day (GDD) model and growing season index (GSI) model, coupling minimum temperature (T-min) with soil moisture (SM) to explore the influence of heat requirement and hydroclimatic interaction on the start of carbon uptake period (SCUP) and net ecosystem productivity (NEP) in two alpine meadows with different precipitation regimes on the Qinghai-Tibet Plateau (QTP). One is the water-limited alpine steppe-meadow, and the other is the temperature-limited alpine shrub-meadow.

Important Findings We observed two clear patterns linking GDD and GSI to SCUP: SCUP was similarly sensitive to variations in preseason GDD and GSI in the humid alpine shrub-meadow, while SCUP was more sensitive to the variability in preseason GSI than GDD in the semiarid alpine steppe-meadow. The divergent patterns indicated a balance of the limiting climatic factors between temperature and water availability. In the humid meadow, higher temperature sensitivity of SCUP could maximize thermal benefit without drought stress, as evidenced by the stronger linear correlation coefficient (IV) and Akaike's information criterion (AIC) between observed SCUPs and those of simulated by GDD model. However, greater water sensitivity of SCUP could maximize the benefit of water in semiarid steppe-meadow, which is indicated by the stronger R' and AIC between observed SCUPs and those of simulated by GSI model. Additionally, although SCUPs were determined by GDD in the alpine shrub-meadow ecosystem, NFP was both controlled by accumulative GSI in two alpine meadows. Our study highlights the impacts of hydroclimatic interaction on spring carbon flux phenology and vegetation productivity in the humid and semiarid alpine ecosystems. The results also suggest that water, together with temperature should be included in the models of phenology and carbon budget for alpine ecosystems in semiarid regions. These findings have important implications for improving vegetation phenology models, thus advancing our understanding of the interplay between vegetation phenology, productivity and climate change in future.

Accession Number: WOS:000544726900015

ISSN: 1752-9921

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Record 9 of 77

Title: Precipitation and Minimum Temperature are Primary Climatic Controls of Alpine Grassland Autumn Phenology on the Qinghai-Tibet Plateau

Author(s): An, S (An, Shuai); Chen, XQ (Chen, Xiaoqiu); Zhang, XY (Zhang, Xiaoyang); Lang, WG (Lang, Weiguang); Ren, SL (Ren, Shilong); Xu, L (Xu, Lin)

Source: REMOTE SENSING **Volume:** 12 **Issue:** 3 **Article Number:** 431 **DOI:** 10.3390/rs12030431 **Published:** FEB 1 2020

Abstract: Autumn phenology is a crucial indicator for identifying the alpine grassland growing season's end date on the Qinghai-Tibet Plateau (QTP), which intensely controls biogeochemical cycles in this ecosystem. Although autumn phenology is thought to be mainly influenced by the preseason temperature, precipitation, and insolation in alpine grasslands, the relative contributions of these climatic factors on the QTP remain uncertain. To quantify the impacts of climatic factors on autumn phenology, we built stepwise linear regression models for 91 meteorological stations on the QTP using in situ herb brown-off dates, remotely sensed autumn phenological metrics, and a multi-factor climate dataset during an optimum length period. The results show that autumn precipitation has the most extensive influence on interannual variation in alpine grassland autumn phenology. On average, a 10 mm increase in autumn precipitation during the optimum length period may lead to a delay of 0.2 to 4 days in the middle senescence date ($P < 0.05$) across the alpine grasslands.

The daily minimum air temperature is the second most important controlling factor, namely, a 1 degrees C increase in the mean autumn minimum temperature during the optimum length period may induce a delay of 1.6 to 9.3 days in the middle senescence date ($P < 0.05$) across the alpine grasslands. Sunshine duration is the third extensive controlling factor. However, its influence is spatially limited. Moreover, the relative humidity and wind speed also have strong influences at a few stations. Further analysis indicates that the autumn phenology at stations with less autumn precipitation is more sensitive to precipitation variation than at stations with more autumn precipitation. This implies that autumn drought in arid regions would intensely accelerate the leaf senescence of alpine grasslands. This study suggests that precipitation should be considered for improving process-based autumn phenology models in QTP alpine grasslands.

Accession Number: WOS:000515393800090

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eISSN: 2072-4292

Record 10 of 77

Title: Change in Autumn Vegetation Phenology and the Climate Controls From 1982 to 2012 on the Qinghai-Tibet Plateau

Author(s): Li, P (Li, Peng); Zhu, QA (Zhu, Qiuan); Peng, CH (Peng, Changhui); Zhang, J (Zhang, Jing); Wang, M (Wang, Meng); Zhang, JJ (Zhang, Junjun); Ding, JH (Ding, Juhua); Zhou, XL (Zhou, Xiaolu)

Source: FRONTIERS IN PLANT SCIENCE **Volume:** 10 **Article Number:** 1677 **DOI:** 10.3389/fpls.2019.01677 **Published:** JAN 15 2020

Abstract: Autumn vegetation phenology plays a critical role in the survival and reproduction of vegetation in changing environments. Using GIMMS3g (Global Inventory Modeling and Mapping Studies), MODIS (Moderate Resolution Imaging and Spectroradiometer), and SPOT (Systeme Probatoire d'Observation de la Terre) remote sensing data, we investigated the spatial and temporal dynamics of the vegetation dormancy onset date (DOD) and its response to temperature, precipitation, and cold degree days (CDD) in different biomes on the Qinghai-Tibet Plateau (QTP) from 1982 to 2012. Our results indicated that there was no significant temporal trend in the DOD for the vegetation on the QTP but found clear regional characteristics in the DOD trends with a notably advancing trend in the central region and a widespread delay in the southwestern region (>1 day year(-1), $P < 0.05$). Our results also indicated that temperature plays an important role in the trend of delays in vegetation autumn phenology; in particular, the preseason temperature can delay the DOD significantly; the positive correlations were observed in more than 71% of the study areas. Consistent with previous studies, we observed significant negative correlations between preseason CDD and DOD; the negative correlations were observed in more than 72% of the study areas for all the data sets. In contrast, the effects of precipitation on DOD were biome dependent. We found that precipitation could promote the extension of the growing season in meadow and grass biomes but produce weak effects on vegetation dormancy in forest biomes. Therefore, not only the magnitude but also the timing of changes in temperature and precipitation determines the effects of climate factors on DOD and further suggests that biome-specific phenological responses also need to be integrated into vegetation phenology models for future climate change investigations on the QTP.

Accession Number: WOS:000510670300001

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Record 11 of 77

Title: Vegetation green up under the influence of daily minimum temperature and urbanization in the Yellow River Basin, China

Author(s): Yuan, MX (Yuan, Moxi); Wang, LC (Wang, Lunche); Lin, AW (Lin, Aiwen); Liu, ZJ (Liu, Zhengjia); Li, QJ (Li, Qingjun); Qu, S (Qu, Sai)

Source: ECOLOGICAL INDICATORS **Volume:** 108 **Article Number:** 105760 **DOI:** 10.1016/j.ecolind.2019.105760 **Published:** JAN 2020

Abstract: Climate conditions are the major driving factors of vegetation phenology. However, there is limited effort to monitor dynamics of vegetation phenology and its responses to climate change and urbanization. Using NDVI data from 1982 to 2015, this study investigated the spatiotemporal change of spring green-up date (GUD) across the Yellow River Basin (YRB) and estimated the possible effects of different climatic factors on it. Additionally, the urban-rural differences in GUD and its linkage to spring land surface temperature (LST) for YRB's major cities over 2001-2015 were investigated. The results showed that the GUD significantly advanced at a rate of 0.42 days yr(-1) and delayed spatially from southeast to northwest. The interannual variations in regionally averaged GUD were driven mainly by preseason min-temperature (T-min). Spatially, the effect of preseason T-min was strongest in the central and western region. The confounding effects of preseason maximum temperature (T-max) and precipitation jointly affected the GUD, while insolation had a weak impact on GUD. Moreover, the sensitivity of GUD to preseason T-min and precipitation weakened with an increasing mean annual preseason precipitation gradient, but the sensitivity to preseason T-max was gradually enhanced. Furthermore, the difference in the GUD between urban and rural areas presented a significant logarithmic relationship with the distance away from the urban center, and it was strongly related to the regional LST. Our findings confirmed the importance of T-min and urbanization in regulating changes in GUD and further suggested that LST should be considered to develop an improved model of GUD under future climate change and urban development.

Accession Number: WOS:000493902400075

ISSN: 1470-160X

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Record 12 of 77

Title: Detecting temporal changes in the temperature sensitivity of spring phenology with global warming: Application of machine learning in phenological model

Author(s): Dai, WJ (Dai, Wujun); Jin, HY (Jin, Huiying); Zhang, YH (Zhang, Yuhong); Liu, T (Liu, Tong); Zhou, ZQ (Zhou, Zhiqiang)

Source: AGRICULTURAL AND FOREST METEOROLOGY **Volume:** 279 **Article Number:** 107702 **DOI:** 10.1016/j.agrformet.2019.107702 **Published:** DEC 15 2019

Abstract: Phenological models can effectively infer historically missing phenological data, so as to investigate the long-term relationship between plants and climate change. Large numbers of ecophysiological and statistical models have been developed in the past few decades, but these models have been unable to make accurate predictions based on external data. Machine learning (ML) methods have an advantage over traditional statistical methods for natural science studies. However, only a few phenological models have been coupled with ML methods. In this study, using long-term leaf unfolding date (LUD) observations collected in Harbin, China, we adopted three popular ML algorithms for predicting plant LUD and compared the performances of 10 phenological models. We detected the temperature sensitivity (ST) of the LUD at the species level for the periods 1962-1987 and 1988-2016 (before and after

the recent, sudden warming) and temporal changes in ST with a 15-year moving window for each period. The results show that the gradient boosting decision tree (GBDT) model performs obviously better than the other models for external validation data, while avoiding model overfitting. Most species showed an increase in ST during the 1988-2016 period, and the temporal changes in ST significantly decreased during both periods. The temporal changes in ST from the phenological data predicted by the GBDT model is significantly higher than that of other models, which indicates that the traditional phenological models may underestimate the response of LUD to climate warming. We found a prevalent decline in the magnitude of ST with increasing preseason temperature variance at the species level. Our research suggests that machine learning algorithms should be more widely used in future phenological model research, and temporal changes in ST should be investigated in order to broaden our understanding of plants' ability to adapt to future climate change.

Accession Number: WOS:000500197400013

ISSN: 0168-1923

eISSN: 1873-2240

Record 13 of 77

Title: Contrasting drought impacts on the start of phenological growing season in Northern China during 1982-2015

Author(s): Deng, HY (Deng, Haoyu); Yin, YH (Yin, Yunhe); Wu, SH (Wu, Shaohong); Xu, XF (Xu, Xiaofeng)

Source: INTERNATIONAL JOURNAL OF CLIMATOLOGY **Volume:** 40 **Issue:** 7 **Pages:** 3330-3347 **DOI:** 10.1002/joc.6400 **Early Access Date:** DEC 2019 **Published:** JUN 15 2020

Abstract: Drought is a widely occurring extreme climatic event that may have various effects on vegetation phenology and activity. The change of the start of the phenological growing season (SOS) is one key mechanism for ecosystem responses to droughts yet remain unknown at large scale. This study used abnormal changes in the ratio of reference evapotranspiration (ETO) and precipitation (P) to detect the pre-season (defined as the 3 months before the growing season) monthly drought during 1982-2015. After that, the pre-season drought impacts on SOS were analysed. Drought appeared frequently (>3.6 times/10 years) in the northern and southwest China, as well as the coastal area of south China during the last 34 years. The droughts generally accompany a higher temperature and a stronger radiation, but the drought effects on the SOS differ between humid/sub-humid and semi-arid zones in northern China. Specifically, in the temperate humid/sub-humid zones, SOS under drought was 1.08-4.86 days earlier than during normal (no drought) years, and the response was greater to the droughts that appeared in the first two of the three pre-season months. In addition, in the cold, mid-, and warm temperate zones, the advance response was more concentrated in the SOS about DOY130-140, DOY125-150, and DOY80-160, respectively. However, in the north semi-arid zone, the SOS under drought was 0.66-3.45 days later than during normal years, and the response was greater to the droughts that appeared in the last two of the 3 months. These delay responses also concentrated in the SOS about DOY125-150. The contrasting drought impacts on phenology suggest that we should move beyond the vegetation activity under droughts such as the growth, productivity, and mortality, and pay more attention to the timing of vegetation activity to better quantify the carbon budget at Northern Hemisphere.

Accession Number: WOS:000502165300001

ISSN: 0899-8418

eISSN: 1097-0088

Record 14 of 77

Title: Interactions among the Phenological Events of Winter Wheat in the North China Plain-Based on Field Data and Improved MODIS Estimation

Author(s): Wu, XF (Wu, Xifang); Yang, W (Yang, Wei); Wang, CY (Wang, Chunyang); Shen, YJ (Shen, Yanjun); Kondoh, A (Kondoh, Akihiko)

Source: REMOTE SENSING **Volume:** 11 **Issue:** 24 **Article Number:** 2976 **DOI:** 10.3390/rs11242976 **Published:** DEC 2 2019

Abstract: Identification of complete drivers for phenology changes is crucial for developing prediction models of plant phenology. In addition to climatic factors, the interaction among phenological events has recently been reported as an important driver for the phenology changes of forests, savannas, and grasslands. However, open questions remain as to whether the phenological interaction exists in agricultural ecosystems, among which winter wheat plays a vital role in feeding human beings. In this study, we investigated the interaction among the phenological events of winter wheat in the North China Plain (NCP) using both field and satellite data. Considering the large discrepancies between the existing satellite estimation and field measurements of winter wheat phenology, we first improved the MODIS-based estimation of green-up date (GUD), heading date (HD), and maturity date (MD) through a re-calibrated relative threshold method (RTM) in the NCP. The GUD, HD, and MD were accurately estimated with the mean absolute errors (MAE) and root mean squared errors (RMSE) lower than 7.5 days, compared with the RMSEs ranging from 12.0 to 36.1 days in previous studies. Then, the relationships among the GUD, HD, and MD were analyzed using the field data collected at agricultural meteorological stations. The GUD (HD) showed a significantly positive correlation with the HD (MD). Quantitatively, a one-day earlier GUD (HD) would result in an earlier HD (MD) of 0.57 days (0.60 days). Furthermore, we applied the partial correlation analysis to the improved MODIS estimation of GUD, HD, and MD to investigate their interactions by considering the simultaneous influences from climatic factors. The results showed that the HD (MD) with 85.2% (94.5%) of all winter wheat pixels presented a significantly positive correlation with the GUD (HD). Meanwhile, the GUD (HD) with 84.2% (33.3%) of the entire winter wheat area presented a significantly negative correlation with pre-season temperature. These results suggest that both the climatic factors and phenological interactions should be included in the future development of winter wheat phenology models to improve the prediction accuracies.

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Record 15 of 77

Title: Are phenological variations in natural teak (Tectona grandis) forests of India governed by rainfall? A remote sensing based investigation

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Source: ENVIRONMENTAL MONITORING AND ASSESSMENT **Volume:** 191 **Article Number:** 786 **DOI:** 10.1007/s10661-019-7680-0 **Supplement:** 3 **Published:** DEC 2019

Abstract: Monitoring and assessment of vegetation phenology at the regional to global scale are essential to understand the characteristics of various biophysical parameters in terrestrial ecosystems. Passive optical remote sensing data have been used extensively in the recent past to study phenology of vegetation, also called land surface phenology, at diverse landscapes across the globe. In the present study, the moderate resolution imaging spectroradiometer (MODIS)-derived enhanced vegetation index (EVI) time series data (2000-2013) was used to study the phenology of dry and moist teak (Tectona grandis) forests of different biogeographic provinces of India. Four phenology metrics, viz., start of season (SOS), end of season (EOS), peak of season (POS) and length of season (LOS) were derived using the TIMESAT tool. The SOSs' of dry and moist teak were found during July-August. LOS of moist

teak was found to be much longer (similar to 48 days) than dry teak. Also, a significant difference of leaf area index (LAI) (similar to 2.8) of dry and moist teak forests was noticed during peak season from MODIS LAI product (MOD15A2). Vegetation phenology is greatly responsive to the fluctuation of climatic parameters such as rainfall. Hence, preseason cumulative rainfall data were analysed to understand the control of rainfall over phenological variations in natural teak forests of India. It was noticed that rainfall was reasonably well correlated with SOS (R-2 = 0.57-0.72) for both types of teak forests. The study highlighted the efficacy of time series MODIS EVI data to study the phenological variations in different teak forest types of India in a data-limited situation.

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Record 16 of 77

Title: Estimating the peak of growing season (POS) of China's terrestrial ecosystems

Author(s): Wang, XY (Wang, Xiaoyue); Wu, CY (Wu, Chaoyang)

Source: AGRICULTURAL AND FOREST METEOROLOGY **Volume:** 278 **Article Number:** 107639 **DOI:** 10.1016/j.agrformet.2019.107639 **Published:** NOV 15 2019

Abstract: Vegetation phenology is a sensitive indicator of climate change and has substantial impacts on ecosystem carbon uptake. Previous studies have revealed the importance of the start and end of growing season and investigated their dynamics with climate change. However, the interannual variability of the peak of growing season (POS), which also plays a crucial role in carbon cycle of terrestrial ecosystems, has not been well documented. Here, we used field observations from regional flux measurements to evaluate four methods in POS extraction based on time series of satellite observed normalized difference vegetation index (NDVI). Results showed that the combination of Savitzky-Golay filter and cubic spline (SG-cubic spline) method had overall higher accuracy (R-2=0.77, RMSE=8.3 days) than current approaches for POS detection. We then analyzed the spatial and temporal patterns of POS in China during 1982-2015 and found an overall advanced trend of POS in most regions, but variations were also observed among biomes. Preseason temperature was the most important factor controlling POS for about 25.6% of all pixels, followed by radiation (19.7%) and precipitation (14.6%), respectively. A higher temperature overall advanced POS, while influences of precipitation and radiation were highly biome-dependent. We further investigated the impacts of POS on plant productivity and found that an advanced POS would increase annual GPP, but this relationship was opposite in arid regions, highlighting the role of soil moisture in dry areas. Our study is meaningful for deepening the understanding between phenology and carbon cycling with respect to future climate change.

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Record 17 of 77

Title: Daily minimum temperature and precipitation control on spring phenology in arid-mountain ecosystems in China

Author(s): Du, J (Du, Jun); Li, K (Li, Kai); He, ZB (He, Zhibin); Chen, LF (Chen, Longfei); Lin, PF (Lin, Pengfei); Zhu, X (Zhu, Xi)

Source: INTERNATIONAL JOURNAL OF CLIMATOLOGY **Volume:** 40 **Issue:** 5 **Pages:** 2568-2579 **DOI:** 10.1002/joc.6351 **Early Access Date:** NOV 2019 **Published:** APR 2020

Abstract: Climate anomaly has caused substantial shifts in phenology of mountain ecosystems, but the underlying mechanism of phenological responses to climate change is still not well understood. In essence, the abundance of vegetation communities increases the complexity of phenology-climate relationships, leading to a certain limitation in predictions of future dynamics among different vegetation types using a unified model. In this study, we focused on the climatic constraints on spring phenology in arid mountains (AMs) of China, and emphasis was laid on accurate representation of mechanisms that control phenology across different vegetation types. We Firstly explored spatio-temporal variations in satellite-derived estimates of starting date of vegetation growing season (SOS) over the period 2000-2015 using moderate-resolution imaging spectro-radiometer (MODIS) normalized difference vegetation index (NDVI). Phenological models in response to climate variability were then established by using mixed-effect models based on satellite observations and an extensive dataset of climatic measurements. Our results showed that the climatic regulation on SOS varied greatly over vegetation types. More climatic factors that regulate phenological development were found in grassland than forest and shrubland. At ecosystem level, two critical climate factors, daily minimum temperature (T-min) and precipitation, explained 74-95% of total variability in predicted SOS. The observed sensitivity to T-min is expected to be closely linked with the risk of frost damage, while preseason precipitation determines water availability in spring. The varying ecosystem sensitivity revealed the different resilience and adaptability to changing climate among vegetation types, which have been linked to their eco-physiological characteristics (e.g., water use efficiency) and environmental conditions (e.g., elevation). Overall, our results indicate a strong dependence of spring phenology on T-min and precipitation, and create an opportunity for a more realistic representation of vegetation phenology and growth of AM plants in China in land surface models.

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Record 18 of 77

Title: Forest Phenology Dynamics to Climate Change and Topography in a Geographic and Climate Transition Zone: The Qinling Mountains in Central China

Author(s): Xia, HM (Xia, Haoming); Qin, YC (Qin, Yaochen); Feng, G (Feng, Gary); Meng, QM (Meng, Qingmin); Cui, YP (Cui, Yaoping); Song, HQ (Song, Hongquan); Ouyang, Y (Ouyang, Ying); Liu, GJ (Liu, Gangjun)

Source: FORESTS **Volume:** 10 **Issue:** 11 **Article Number:** 1007 **DOI:** 10.3390/f10111007 **Published:** NOV 2019

Abstract: Forest ecosystems in an ecotone and their dynamics to climate change are growing ecological and environmental concerns. Phenology is one of the most critical biological indicators of climate change impacts on forest dynamics. In this study, we estimated and visualized the spatiotemporal patterns of forest phenology from 2001 to 2017 in the Qinling Mountains (QMs) based on the enhanced vegetation index (EVI) from MODerate-resolution Imaging Spectroradiometer (MODIS). We further analyzed this data to reveal the impacts of climate change and topography on the start of the growing season (SOS), end of the growing season (EOS), and the length of growing season (LOS). Our results showed that forest phenology metrics were very sensitive to changes in

elevation, with a 2.4 days delayed SOS, 1.4 days advanced EOS, and 3.8 days shortened LOS for every 100 m increase in altitude. During the study period, on average, SOS advanced by 0.13 days year(-1), EOS was delayed by 0.22 days year(-1), and LOS increased by 0.35 day year(-1). The phenological advanced and delayed speed across different elevation is not consistent. The speed of elevation-induced advanced SOS increased slightly with elevation, and the speed of elevation-induced delayed EOS shift reached a maximum value of 1500 m from 2001 to 2017. The sensitivity of SOS and EOS to preseason temperature displays that an increase of 1 degrees C in the regionally averaged preseason temperature would advance the average SOS by 1.23 days and delay the average EOS by 0.72 days, respectively. This study improved our understanding of the recent variability of forest phenology in mountain ecotones and explored the correlation between forest phenology and climate variables in the context of the ongoing climate warming.

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Record 19 of 77

Title: Divergent shifts in peak photosynthesis timing of temperate and alpine grasslands in China

Author(s): Yang, JL (Yang, Jilin); Dong, JW (Dong, Jinwei); Xiao, XM (Xiao, Xiangming); Dai, JH (Dai, Junhu); Wu, CY (Wu, Chaoyang); Xia, JY (Xia, Jianyang); Zhao, GS (Zhao, Guosong); Zhao, MM (Zhao, Miaomiao); Li, ZL (Li, Zhaolei); Zhang, Y (Zhang, Yao); Ge, QS (Ge, Quansheng)

Source: REMOTE SENSING OF ENVIRONMENT **Volume:** 233 **Article Number:** 111395 **DOI:** 10.1016/j.rse.2019.111395 **Published:** NOV 2019

Abstract: The changing climate is shifting the seasonality of photosynthesis in vegetation, including the start (SOS), end (EOS), and length (LOS) of the growing season, and the peak photosynthesis timing (PPT). While the SOS, EOS, and LOS have been widely investigated, the PPT of grasslands - as a proxy for the response of seasonal plant photosynthesis to climate change - has been overlooked. In this study, we propose a hybrid generalized additive model (HGAM) method to extract PPT using the Vegetation Photosynthesis Model (VPM)-based gross primary production (GPP) product, and we examine the dynamics, drivers, and consequences of PPT changes in temperate and alpine grasslands in China over 2000-2016. We found that the PPTs in temperate and alpine grasslands have exhibited advancing (with -0.68 days yr(-1), $p < 0.05$) and delaying (with 0.29 days yr(-1), $p = 0.158$) trends, respectively. In addition, preseason precipitation and soil moisture were positively correlated with the PPT in temperate and alpine grasslands, respectively, while the preseason temperature consistently controlled the PPT changes in both grasslands. Furthermore, we found that an earlier PPT was associated with higher annual production in the temperate grasslands but not in the alpine grasslands in China. The divergent PPT patterns indicated the varied adaptation characteristics to climatic constraints in the temperate and alpine grasslands and also caused different consequences on carbon uptake. This study highlights the importance of PPT in understanding the spatiotemporal dynamics of vegetation photosynthesis and the carbon cycle under a changing climate.

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Record 20 of 77

Title: New model for simulating autumn phenology of herbaceous plants in the Inner Mongolian Grassland

Author(s): Ren, SL (Ren, Shilong); Qin, QM (Qin, Qiming); Ren, HZ (Ren, Huazhong); Sui, J (Sui, Juan); Zhang, Y (Zhang, Yao)

Source: AGRICULTURAL AND FOREST METEOROLOGY **Volume:** 275 **Pages:** 136-145 **DOI:** 10.1016/j.agrformet.2019.05.011 **Published:** SEP 15 2019

Abstract: Autumn phenology is important in determining the growing season length and controlling carbon and energy exchanges in terrestrial ecosystems. However, our knowledge on the interaction processes of vegetation autumn phenology and climate changes remains limited, especially for herbaceous plants. In this study, we comprehensively analyzed the responses of autumn phenology of grassland vegetation to climate changes by using ground-observed brown-down date records of 15 grass species and daily temperature, precipitation, and day length data at six stations. Aside from conducting correlation analysis, we also simulated the brown-down date with a newly developed model by incorporating the effect of drought stress (CDDP) into the traditional chilling-degree-days (CDD) model and compared it with the CDD model. Another revised CDD model included the effect of day length (CDDD) and null model (multiyear average, NM). The statistical results showed a predominant significant negative correlation between the brown-down date and previous temperature/day length in 27.3%/40.9% of site species but a predominant significant positive correlation between the brown-down date and previous precipitation in 54.6% of site species. The opposite effects of previous precipitation and previous temperature/day length on the brown-down date were induced by local thermal moisture conditions. With regard to the modeling results, the CDDP model was selected as the optimal model for 73% of site species with insufficient water supply in preseason, while the CDD model was selected as the optimal model for 18% of site species with a relatively wet but cold preseason. The CDDD model was selected as the optimal model for only two cases. The average estimation error based on the CDDP model (7.4 days) was lower by 2.0/1.5/1.7 days than that based on the CDD/CDDD/NM model. Overall, this study comprehensively demonstrated the important role of water availability in controlling the autumn phenology process of herbaceous plants.

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Record 21 of 77

Title: Inner Mongolian grassland plant phenological changes and their climatic drivers

Author(s): Wang, GC (Wang, Guocheng); Huang, Y (Huang, Yao); Wei, YR (Wei, Yurong); Zhang, W (Zhang, Wen); Li, TT (Li, Tingting); Zhang, Q (Zhang, Qing)
Source: SCIENCE OF THE TOTAL ENVIRONMENT **Volume:** 683 **Pages:** 1-8 **DOI:** 10.1016/j.scitotenv.2019.05.125 **Published:** SEP 15 2019
Abstract: Global warming is widely believed to extend the length of plant growing season (LOS) through advancing the start (SOS) and delaying the end (EOS) of plant growing season. However, divergent directions of phenological changes under current climate warming have been frequently reported but poorly understood. Here we collate the long-term filed phenological and climatic records at 8 sites in Inner Mongolian grassland to assess how climate changes regulate the phenological variations with divergent directions and magnitudes in this region. We found that the spring climatic changes (e.g., changes in air temperature and precipitation during March and April) correlate well with variations in SOS. However, our in situ observations show divergent changes in SOS across space, which can be attributed to the generally insignificant changes of climates during the preseasons of SOS. The climate warming prior to the end of plant growing season (EOS) was generally significant at most sites. Nevertheless, the effects of such warming on changes in EOS were possibly overshadowed by the impacts of precipitation in this arid/semi-arid region. As a result, the temporal variations in EOS distribute divergent directions and magnitudes across space and species. Using climate attributes during the preseason of EOS alone can hardly explain changes in EOS. Alternatively, by introducing changes in SOS as an additional driving factor, variations in EOS can be well represented. We therefore infer that plant phenologies can divergently response to current global warming (depending on the seasonal patterns of warming). Moreover, other influential factors such as precipitation and the interactions between the timings of different phenological stages are also needed in predicting the phenological dynamics. (C) 2019 Elsevier B.V. All rights reserved.
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Record 22 of 77
Title: Variations in land surface phenology and their response to climate change in Yangtze River basin during 1982-2015
Author(s): Yuan, MX (Yuan, Moxi); Wang, LC (Wang, Lunche); Lin, AW (Lin, Aiwen); Liu, ZJ (Liu, Zhengjia); Qu, S (Qu, Sai)
Source: THEORETICAL AND APPLIED CLIMATOLOGY **Volume:** 137 **Issue:** 3-4 **Pages:** 1659-1674 **DOI:** 10.1007/s00704-018-2699-7 **Published:** AUG 2019
Abstract: Studying the shifts of vegetation phenology and the response of vegetation phenology to climate change helps to understand the dynamics of future ecosystems. However, since previous studies mostly focused on temperate ecosystems, much less is known about the biogeographic phenological shifts in sub-tropical regions, which have abundant biodiversity. The Yangtze River Basin (YRB) is located in the subtropical region of China and has abundant natural resources, a large population, and rapid economic development. Studying the variation characteristics of phenology and its responses to recent climate changes in YRB are important for understanding the impact of regional climate on subtropical ecosystems. In this study, we extracted the phenological parameters using Global Inventory Modeling and Mapping Studies (GIMMS) data to investigate the spatial and temporal variations of vegetation phenology across YRB during 1982-2015 and to examine how vegetation phenology responds to climate within different ecological zones. The results revealed that the start of growing season (SOS) was significantly advanced by 0.2days/year ($p<0.01$). However, there has been no significant trend in the end of growing season (EOS) throughout the whole study area for the past 34years. The spatial pattern of the phenology metrics showed a high spatial heterogeneity: the SOS in the central YRB was earlier than that in other regions; the EOS in the southeast YRB was later than that in any other regions. Meanwhile, the SOS had a higher correlation with temperature than with precipitation. In particular, the spring temperature had a strong impact on the SOS and the effects of winter temperatures cannot be ignored. Although there were no significant correlations between the EOS and precipitation/temperature, it is interesting to note that when examining the interactions between phonological parameters, the EOS was positively correlated with the SOS. Furthermore, the pre-season temperature had a lag effect on the SOS, but no significant lag effect was observed for the EOS in YRB. In all, the present study can enhance our understanding of phenology dynamics and its relationship with climate in YRB and provide a useful reference to put forward a corresponding ecological protection policy.
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Record 23 of 77
Title: Asymmetric Effects of Daytime and Nighttime Warming on Boreal Forest Spring Phenology
Author(s): Deng, GR (Deng, Guorong); Zhang, HY (Zhang, Hongyan); Guo, XY (Guo, Xiaoyi); Shan, Y (Shan, Yu); Ying, H (Ying, Hong); Wu, RH (Wu Rihan); Li, H (Li, Hui); Han, YL (Han, Yangli)
Source: REMOTE SENSING **Volume:** 11 **Issue:** 14 **Article Number:** 1651 **DOI:** 10.3390/rs11141651 **Published:** JUL 2 2019
Abstract: Vegetation phenology is the most intuitive and sensitive biological indicator of environmental conditions, and the start of the season (SOS) can reflect the rapid response of terrestrial ecosystems to climate change. At present, the model based on mean temperature neglects the role of the daytime maximum temperature (TMAX) and the nighttime minimum temperature (TMIN) in providing temperature accumulation and cold conditions at leaf onset. This study analyzed the spatiotemporal variations of spring phenology for the boreal forest from 2001 to 2017 based on the moderate-resolution imaging spectro-radiometer (MODIS) enhanced vegetation index (EVI) data (MOD13A2) and investigated the asymmetric effects of daytime and nighttime warming on the boreal forest spring phenology during TMAX and TMIN preseason by partial correlation analysis. The results showed that the spring phenology was delayed with increasing latitude of the boreal forest. Approximately 91.37% of the region showed an advancing trend during the study period, with an average advancement rate of 3.38 +/- 0.08 days/decade, and the change rates of different land cover types differed, especially in open shrubland. The length of the TMIN preseason was longer than that of the TMAX preseason and diurnal temperatures showed an asymmetrical increase during different preseasons.

The daytime and nighttime warming effects on the boreal forest are asymmetrical. The TMAX has a greater impact on the vegetation spring phenology than TMIN as a whole and the effect also has seasonal differences; the TMAX mainly affects the SOS in spring, while TMIN has a greater impact in winter. The asymmetric effects of daytime and nighttime warming on the SOS in the boreal forest were highlighted in this study, and the results suggest that diurnal temperatures should be added to the forest terrestrial ecosystem model.

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Record 24 of 77

Title: Winter Wheat Green-up Date Variation and its Diverse Response on the Hydrothermal Conditions over the North China Plain, Using MODIS Time-Series Data

Author(s): Guo, LH (Guo, Linghui); Gao, JB (Gao, Jiangbo); Hao, CY (Hao, Chengyuan); Zhang, LL (Zhang, Linlin); Wu, SH (Wu, Shaohong); Xiao, XM (Xiao, Xiangming)

Source: REMOTE SENSING **Volume:** 11 **Issue:** 13 **Article Number:** 1593 **DOI:** 10.3390/rs11131593 **Published:** JUL 1 2019

Abstract: Vegetation phenology plays a critical role in the dynamic response of terrestrial ecosystems to climate change. However, the relationship between the phenology of winter wheat and hydrothermal factors is inadequate, especially in typical agricultural areas. In this study, the possible effects of preseason climate changes on the green-up date (GUD) of winter wheat over the North China Plain (NCP) was investigated, using the MODIS EVI 8-day time-series data from 2000 to 2015, as well as the concurrent monthly mean temperature (T-m), mean maximum (T-max) and minimum temperature (T-min) and total precipitation (TP) data. Firstly, we quantitatively identified the time lag effects of winter wheat GUD responses to different climatic factors; then, the major driving factors for winter wheat GUD were further explored by applying multiple linear regression models. The results showed that the time lag effects of winter wheat GUD response to climatic factors were site- and climatic parameters-dependent. Negative temperature effects with about a 3-month time lag dominated in most of the NCP, whereas positive temperature effects with a zero-month lag were most common in some of the southern parts. In comparison, total precipitation had a negative zero-month lag effect in the northern region, but two lagged months occurred in the south. Regarding the time lag effects, the explanation power of climatic factors improved relatively by up to 77%, and the explanation area increased by 41.20%. Additionally, change in winter wheat GUD was primarily determined by temperature rather than by TP, with a marked spatial heterogeneity of the T-max and T-min effect. Our results confirmed different time lag effects from different climatic factors on phenological processes in spring, and further suggested that both T-max and T-min should be considered to improve the performance of spring phenology models.

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Record 25 of 77

Title: Opposite effects of winter day and night temperature changes on early phenophases

Author(s): Meng, FD (Meng, Fandong); Zhang, LR (Zhang, Lirong); Zhang, ZH (Zhang, Zhenhua); Jiang, LL (Jiang, Lili); Wang, YF (Wang, Yanfen); Duan, JC (Duan, Jichuang); Wang, Q (Wang, Qi); Li, BW (Li, Bowen); Liu, PP (Liu, Peipei); Hong, H (Hong, Huan); Lv, WW (Lv, Wangwang); Renzeng, WM (Renzeng, Wangmu); Wang, ZZ (Wang, Zhezhen); Luo, CY (Luo, Caiyun); Dorj, T (Dorj, Tsechoe); Zhou, HK (Zhou, Huakun); Du, MY (Du, Mingyuan); Wang, SP (Wang, Shiping)

Source: ECOLOGY **Volume:** 100 **Issue:** 9 **DOI:** 10.1002/ecy.2775 **Early Access Date:** JUN 2019 **Published:** SEP 2019

Abstract: Changes in day (maximum temperature, T-MAX) and night temperature (minimum temperature, T-MIN) in the preseason (e.g., winter and spring) may have opposite effects on early phenophases (e.g., leafing and flowering) due to changing requirements of chilling accumulations (CAC) and heating accumulations (HAC), which could cause advance, delay or no change in early phenophases. However, their relative effects on phenology are largely unexplored, especially on the Tibetan Plateau. Here, observations were performed using a warming and cooling experiment in situ through reciprocal transplantation (2008-2010) on the Tibetan Plateau. We found that winter minimum temperature (T-MIN) warming significantly delayed mean early phenophases by 8.60 d/degrees C, but winter maximum temperature (T-MAX) warming advanced them by 12.06 d/degrees C across six common species. Thus, winter mean temperature warming resulted in a net advance of 3.46 d/degrees C in early phenophases. In contrast, winter T-MIN cooling, on average, significantly advanced early phenophases by 5.12 d/degrees C, but winter T-MAX cooling delayed them by 7.40 d/degrees C across six common species, resulting in a net delay of 2.28 d/degrees C for winter mean temperature cooling. The opposing effects of T-MAX and T-MIN warming on the early phenophases may be mainly caused by decreased CAC due to T-MIN warming (5.29 times greater than T-MAX) and increased HAC due to T-MAX warming (3.25 times greater than T-MIN), and similar processes apply to T-MAX and T-MIN cooling. Therefore, our study provides another insight into why some plant phenophases remain unchanged or delayed under climate change.

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Record 26 of 77

Title: Impacts of snow cover duration on vegetation spring phenology over the Tibetan Plateau

Author(s): Huang, K (Huang, Ke); Zu, JX (Zu, Jiaxing); Zhang, YJ (Zhang, Yangjian); Cong, N (Cong, Nan); Liu, YJ (Liu, Yaojie); Chen, N (Chen, Ning)

Source: JOURNAL OF PLANT ECOLOGY **Volume:** 12 **Issue:** 3 **Pages:** 583-592 **DOI:** 10.1093/jpe/rty051 **Published:** JUN 2019

Abstract: Snow cover occupies large percentage of land surface in Tibetan Plateau. Snow cover duration (SCD) during non-growing seasons plays a critical role in regulating alpine vegetations phenology by affecting the energy budgets of land surface and soil moisture conditions. Different periods snow cover during non-growing season may have distinct effect on the vegetations phenology. Start of season (SOS) has been observed advanced under the ongoing climate change in the plateau, but it still remains unclear how the SCD alters the SOS. This study attempts to answer the following questions: (i) What is the pattern of spatial and temporal variations for SCD and grassland SOS? (ii) Which periods SCD plays a critical role in grasslands SOS?
The remote sensing datasets from the Moderate Resolution Imaging Spectroradiometer (MODIS) were utilized to compute the SOS and SCD on the Tibetan Plateau over 200315. The Asymmetric Gaussian function was applied to extract SOS. We also explored the spatial pattern and temporal variation of SOS and SCD. Then, by using linear correlation coefficients, we investigated the driving effects of different periods non-growing season SCD on SOS.
The non-growing season SCD slightly decreased during 200315, while SOS exhibited an overall advancing trend. Advanced trends in SOS were observed in the eastern plateau, and the delayed trends were mainly founded in western plateau. Snow cover area exhibited two separate peaks during autumn and late winter over the plateau. Extended SCD regions mainly distributed in middle-east of the plateau, while shrunken SCD distributed in other regions of the plateau. SCD of different seasons caused distinct effects on vegetation SOS. Lengthened autumn SCD advanced SOS over the eastern plateau. The slightly lengthened SCD postponed SOS over the western plateau. In the wet meadow regions, advanced SOS was positively associated with SCD during the entire non-growing season, whereas for the dry steppe, SCD over the preseason played a more dominant role. The SCD of previous autumn and winter also showed lag effect on SOS over meadow regions to a certain extent. This study confirmed the importance of SCD to phenological processes at the beginning of growing season and further suggested that role of SCD should be discriminated for different periods and for different heat-water conditions. With the lag effects and SCDs distinct effect of different seasons considered, predictions on the Tibetan Plateaus spring phenology could be improved.

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Record 27 of 77

Title: Interacting effects of temperature and precipitation on climatic sensitivity of spring vegetation green-up in arid mountains of China

Author(s): Du, J (Du, Jun); He, ZB (He, Zhibin); Piatek, KB (Piatek, Kathryn B.); Chen, LF (Chen, Longfei); Lin, PF (Lin, Peifei); Zhu, X (Zhu, Xi)

Source: AGRICULTURAL AND FOREST METEOROLOGY **Volume:** 269 **Pages:** 71-77 **DOI:** 10.1016/j.agrformet.2019.02.008 **Published:** MAY 15 2019

Abstract: Vegetation spring phenology in arid mountain regions is undergoing profound changes as a result of recent climate anomalies. While shifts in the timing of growth onset have been widely attributed to temperature and precipitation, interacting effects of these two climate variables on phenology have not been explored. To better understand whether an interaction between temperature and precipitation may be present, and how it may affect phenology, we first determined the influence of preseason temperature and precipitation on the starting date of vegetation growing season (SOS), and then investigated the spatial pattern of climatic sensitivity of SOS and its relation to preseason temperature/precipitation. We used satellite-derived estimates of SOS for the Qilian Mountains (QLMs) in northwestern China. Our results revealed a significant interaction between temperature and precipitation, contributing up to 30% of total variability in predicted ecosystem-level SOS. This interacting effect was likely achieved through the influence on climatic sensitivity of SOS; we found a close relationship between temperature sensitivity and preseason cumulative precipitation, and a significant association between precipitation sensitivity and preseason temperatures. Spatially, SOS was more sensitive to variability in preseason temperature in wetter than in dryer areas; likewise, a spatial increase in thermal accumulation often corresponded to an enhancement in precipitation sensitivity of SOS. These findings highlight the importance of interacting effects of climatic variables in model projections of future spring phenology, and indicate that unexpected shifts in vegetation phenology in response to climatic extremes may occur under the influence of strong interactions of climatic factors.

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Record 28 of 77

Title: Contrasting wheat phenological responses to climate change in global scale

Author(s): Ren, SL (Ren, Shilong); Qin, QM (Qin, Qiming); Ren, HZ (Ren, Huazhong)

Source: SCIENCE OF THE TOTAL ENVIRONMENT **Volume:** 665 **Pages:** 620-631 **DOI:** 10.1016/j.scitotenv.2019.01.394 **Published:** MAY 15 2019

Abstract: Comprehensive analysis of how wheat phenology responds to environmental factors in global scale is helpful for tackling the possible adverse effects of ongoing climate change on wheat production. In this study, six phenological parameters of global wheat, i.e., the growing season start (SGS), peak (PGS), end (EGS), length (LGS), as well as the vegetative period length (LVP) and reproductive period length (LRP), were retrieved from remote sensing data (1981-2014) by threshold-, logistic-, and shape-based methods. And then, we analyzed the effects of temperature, precipitation, short-wave (SW) radiation, and frost on spatiotemporal patterns of wheat phenology. In addition, haze impacts on wheat phenology were investigated in China and India where haze weather appears frequently in winter-spring seasons. Results showed that the occurrence time of SGS/PGS/EGS is gradually advanced from the pole to the equator and annual mean air temperature can explain >70% of their spatial variations. A dominant advanced SGS/PGS/EGS and a shortened LGS/LVP/LRP were detected in the study region due to the significant increase in temperature and SW radiation, as well as the decrease in frost days. Interannual fluctuations of SGS/PGS/EGS are primarily controlled by air temperature, while precipitation and frost only exerted some obvious impacts in some locations. Higher preseason temperature would induce an earlier wheat phenology and a shorter growing season, while adequate precipitation and frequent frost in preseason could delay the occurrence timing of wheat phenology and lead to a longer growing season. Besides, the decreased temperature resulted from severe haze weather may have partly counteracted the global-warming-induced advancing trend of wheat phenology in China, but further advanced the occurrence timing of wheat phenology through prompting vernalization in India. Overall, though wheat growth is largely constrained by human management, we still highlight the strong impacts of global climate change on wheat phenology.

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Record 29 of 77

Title: Changes in flowering phenology of woody plants from 1963 to 2014 in North China

Author(s): Wang, HJ (Wang, Huanjiong); Zhong, SY (Zhong, Shuying); Tao, ZX (Tao, Zexing); Dai, JH (Dai, Junhu); Ge, QS (Ge, Quansheng)

Source: INTERNATIONAL JOURNAL OF BIOMETEOROLOGY **Volume:** 63 **Issue:** 5 **Special Issue:** SI **Pages:** 579-590 **DOI:** 10.1007/s00484-017-1377-2 **Published:** MAY 2019

Abstract: Existing evidence demonstrates that the first flowering date (FFD) of most plant species became earlier in response to temperature increase over the past several decades. However, the studies on changes in flowering duration (FD) were limited. By using the non-parametric Theil-Sen estimator, this study investigated the temporal trends in 127 time series of FFD, end of flowering date (EFD), and FD of 97 woody plants from 1963 to 2014 at three sites (Harbin, Beijing, and Xi'an) in North China. The relationship between flowering phenophases and temperature was analyzed using two phenological models. The results showed that most of FFD and EFD time series exhibited an apparent advancing trend. Among them, trends of 52.0% (40.9%) of FFD (EFD) time series were significant (P<0.05). FFD and EFD time series (95.3 and 89.8%, respectively) responded negatively and significantly to preseason temperature (P<0.05). The direction of FD changes varied among sites and species. On average, a shortening trend of FD was observed at Harbin (-0.51daysdecade(-1)), with 7.5% of species significantly. However, FD on average extended by 0.42 and 0.93daysdecade(-1) at Beijing (24.5% significantly) and Xi'an (28.9% significantly), respectively. The regression models could simulate the interannual changes in FFD and EFD with the mean goodness of fit (R-2) ranging from 0.37 to 0.67, but fail to simulate the changes in FD accurately (R-2 ranging from 0.09 to 0.18). The growing degree day model could improve the R-2 for simulating FFD and EFD except for FD. Therefore, more phenological models need to be tested, and more drivers of FD need to be further investigated.

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Conference Title: 33rd International Geographical Congress (IGC) of the International-Geographic-Union (IGU)

Conference Date: AUG, 2016

Conference Location: Beijing, PEOPLES R CHINA

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Author Identifiers:

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Record 30 of 77

Title: Variations in the temperature sensitivity of spring leaf phenology from 1978 to 2014 in Mudanjiang, China

Author(s): Dai, JH (Dai, Junhu); Xu, YJ (Xu, Yunjia); Wang, HJ (Wang, Huanjiong); Alatalo, J (Alatalo, Juha); Tao, ZX (Tao, Zexing); Ge, QS (Ge, Quansheng)

Source: INTERNATIONAL JOURNAL OF BIOMETEOROLOGY **Volume:** 63 **Issue:** 5 **Special Issue:** SI **Pages:** 569-577 **DOI:** 10.1007/s00484-017-1489-8 **Published:** MAY 2019

Abstract: Continuous long-term temperature sensitivity (S-T) of leaf unfolding date (LUD) and main impacting factors in spring in the period 1978-2014 for 40 plant species in Mudanjiang, Heilongjiang Province, Northeast China, were analyzed by using observation data from the China Phenological Observation Network (CPON), together with the corresponding meteorological data from the China Meteorological Data Service Center. Temperature sensitivities, slopes of the regression between LUD and mean temperature during the optimum preseason (OP), were analyzed using 15-year moving window to determine their temporal trends. Major factors impacting S-T were then chosen and evaluated by applying a random sampling method. The results showed that LUD was sensitive to mean temperature in a defined period before phenophase onset for all plant species analyzed. Over the period 1978-2014, the mean S-T of LUD for all plant species was -3.2 +/- 0.49days degrees C-1. The moving window analysis revealed that 75% of species displayed increasing S-T of LUD, with 55% showing significant increases (P<0.05). S-T for the other 25% exhibited a decreasing trend, with 17% showing significant decreases (P<0.05). On average, S-T increased by 16%, from -2.8 +/- 0.83days degrees C-1 during 1980-1994 to -3.30 +/- 0.65days degrees C-1 during 2000-2014. For species with later LUD and longer OP, S-T tended to increase more, while species with earlier LUD and shorter OP tended to display a decreasing S-T. The standard deviation of preseason temperature impacted the temporal variation in S-T. Chilling conditions influenced S-T for some species, but photoperiod limitation did not have significant or coherent effects on changes in S-T.

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Conference Title: 33rd International Geographical Congress (IGC) of the International-Geographic-Union (IGU)

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Record 31 of 77

Title: Deciphering impacts of climate extremes on Tibetan grasslands in the last fifteen years

Author(s): Liu, D (Liu, Dan); Wang, T (Wang, Tao); Yang, T (Yang, Tao); Yan, ZJ (Yan, Zhengjie); Liu, YW (Liu, Yongwen); Zhao, YT (Zhao, Yutong); Piao, SL (Piao, Shilong)

Source: SCIENCE BULLETIN **Volume:** 64 **Issue:** 7 **Special Issue:** SI **Pages:** 446-454 **DOI:** 10.1016/j.scib.2019.03.012 **Published:** APR 15 2019

Abstract: Climate extremes have emerged as a crucial driver of changes in terrestrial ecosystems. The Tibetan Plateau, facing a rapid climate change, tends to favor climate extremes. But we lack a clear understanding of the impacts of such extremes on alpine grasslands. Here we show that extreme events (drought, extreme wet, extreme cold and extreme hot) occurred at a frequency of 0.67-4 months decade (1) during 2001-2015, with extreme precipitation predominantly occurring in June-to-August and extreme temperatures in May. Drought and extreme wet cause opposite and asymmetric effects on grassland

growth, with drought-induced reductions greater than increases due to extreme wet. Grassland responses to extreme temperatures, which predominantly occur in May, show a dipole-like spatial pattern, with extreme hot (cold) events enhanced (reduced) growth in the eastern plateau but slightly reduced (enhanced) growth in the western plateau. These opposite responses to extreme temperatures over the eastern plateau are explained by the possibility that the occurrence of extreme cold slows the preseason temperature accumulation, delaying the triggering of spring phenology, while extreme hot hastens the accumulation. In the western plateau, in contrast, positive responses to extreme cold are induced by accompanying high precipitation. Furthermore, high extremeness of climate events generally led to a much lower extremeness in growth response, implying that the Tibetan grasslands have a relatively high resistance to climate extremes. The ecosystem models tested could not accurately simulate grassland responses to drought and extreme temperatures, and require re-parameterization before trust can be placed in their output for this region. (C) 2019 Science China Press. Published by Elsevier B.V. and Science China Press. All rights reserved.

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ISSN: 2095-9273

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Record 32 of 77

Title: Heat and Drought Stress Advanced Global Wheat Harvest Timing from 1981-2014

Author(s): Ren, SL (Ren, Shilong); Qin, QM (Qin, Qiming); Ren, HZ (Ren, Huazhong); Sui, J (Sui, Juan); Zhang, Y (Zhang, Yao)

Source: REMOTE SENSING **Volume:** 11 **Issue:** 8 **Article Number:** 971 **DOI:** 10.3390/rs11080971 **Published:** APR 2 2019

Abstract: Studying wheat phenology can greatly enhance our understanding of how wheat growth responds to climate change, and guide us to reasonably confront its influence. However, comprehensive global-scale wheat phenology-climate analysis is still lacking. In this study, we extracted the wheat harvest date (WHD) from 1981-2014 from satellite data using threshold-, logistic-, and shape-based methods. Then, we analyzed the effects of heat and drought stress on WHD based on gridded daily temperature and monthly drought data (the Palmer drought severity index (PDSI) and the standardized precipitation evapotranspiration index (SPEI)) over global wheat-growing areas. The results show that WHD was generally delayed from the low to mid latitudes. With respect to variation trends, we detected a significant advancement of WHD in 32.1% of the world's wheat-growing areas since 1981, with an average changing rate of -0.25 days/yr. A significant negative correlation was identified between WHD and the prior three months' normal-growing-degree-days across 50.4% of the study region, which implies that greater preseason effective temperature accumulation may cause WHD to occur earlier. Meanwhile, WHD was also found to be significantly and negatively correlated with the prior three months' extreme-growing-degree-days across only 9.6% of the study region (mainly located in northern South Asia and north Central-West Asia). The effects of extreme heat stress were weaker than those of normal thermal conditions. When extreme drought (measured by PDSI/SPEI) occurred in the current month, in the month prior to WHD, and in the second month prior to WHD, it forced WHD to advance by about 9.0/8.1 days, 13.8/12.2 days, and 10.8/5.3 days compared to normal conditions, respectively. In conclusion, we highlight the effects that heat and drought stress have on advancing wheat harvest timing, which should be a research focus under future climate change.

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ISSN: 2072-4292

Record 33 of 77

Title: Climate-phenology-hydrology interactions in northern high latitudes: Assessing the value of remote sensing data in catchment ecohydrological studies

Author(s): Wang, HL (Wang, Hailong); Tetzlaff, D (Tetzlaff, Doerthe); Buttle, J (Buttle, James); Carey, SK (Carey, Sean K.); Laudon, H (Laudon, Hjalmar); McNamara, JP (McNamara, James P.); Spence, C (Spence, Christopher); Soulsby, C (Soulsby, Chris)

Source: SCIENCE OF THE TOTAL ENVIRONMENT **Volume:** 656 **Pages:** 19-28 **DOI:** 10.1016/j.scitotenv.2018.11.361 **Published:** MAR 15 2019

Abstract: We assessed the hydrological implications of climate effects on vegetation phenology in northern environments by fusion of data from remote-sensing and local catchment monitoring. Studies using satellite data have shown earlier and later dates for the start (SOS) and end of growing seasons (EOS), respectively, in the Northern Hemisphere over the last 3 decades. However, estimates of the change greatly depend on the satellite data utilized. Validation with experimental data on climate-vegetation-hydrology interactions requires long-term observations of multiple variables which are rare and usually restricted to small catchments. In this study, we used two NDVI (normalized difference vegetation index) products (at similar to 25 & 0.5 km spatial resolutions) to infer SOS and EOS for six northern catchments, and then investigated the likely climate impacts on phenology change and consequent effects on catchment water yield, using both assimilated data (GLDAS: global land data assimilation system) and direct catchment observations. The major findings are: (1) The assimilated air temperature compared well with catchment observations (regression slopes and R-2 close to 1), whereas underestimations of summer rainstorms resulted in overall underestimations of precipitation (regression slopes of 0.3-0.7, R-2 >= 0.46). (2) The two NDVI products inferred different vegetation phenology characteristics. (3) Increased mean pre-season temperature significantly influenced the advance of SOS and delay of EOS. The precipitation influence was weaker, but delayed SOS corresponding to increased pre-season precipitation at most sites can be related to later snow melting. (4) Decreased catchment streamflow over the last 15 years could be related to the advance in SOS and extension of growing seasons. Greater streamflow reductions in the cold sites than the warm ones imply stronger climate warming impacts on vegetation and hydrology in colder northerly environments. The methods used in this study have potential for better understanding interactions between vegetation, climate and hydrology in observation-scarce regions. (C) 2018 Elsevier B.V. All rights reserved.

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Wang, Hailong	I-6549-2019	0000-0002-1091-0345

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Record 34 of 77

Title: A new algorithm for the estimation of leaf unfolding date using MODIS data over China's terrestrial ecosystems

Author(s): Wang, J (Wang, Jian); Wu, CY (Wu, Chaoyang); Wang, XY (Wang, Xiaoyue); Zhang, XY (Zhang, Xiaoyang)

Source: ISPRS JOURNAL OF PHOTOGRAMMETRY AND REMOTE SENSING **Volume:** 149 **Pages:** 77-90 **DOI:** 10.1016/j.isprsjprs.2019.01.017 **Published:** MAR 2019

Abstract: Using solely vegetation indices (VIs) from remote sensing is not always sufficient to accurately detect spring leaf phenology, i.e., the leaf unfolding date (LUD). Several current phenology products failed to provide reliable LUD estimates for specific regions and plant functional types, e.g., evergreen species at mid-low latitudes. Therefore, increasing efforts have been made to improve LUD modeling by combining VIs and meteorological variables. Temperature before the growing season ('preseason' henceforth) plays an important role in regulating spring phenology. With ground observations of LUD (LUDOBS) across different plant functional types (PFTs) in China during 2001-2014, we analyzed the response of LUDOBS to preseason temperature temporally and spatially, and proposed an improved LUD modeling algorithm by developing a temperature-based scale factor to adjust the traditional VI-based (i.e., two band enhanced vegetation index (EVI2)) LUD estimates. We found that the new algorithm can better characterize the spatial and temporal patterns of LUD variability for different PFTs, especially for evergreen species where MODIS phenology product failed to provide reliable LUD estimates. Furthermore, we investigated the spatio-temporal patterns of LUD over China with respect to both different vegetation types and climate systems. We showed that for similar to 70% pixels, our new model predicted an overall later LUDs than MODIS phenology product, possibly suggesting an overestimated greening potential of China's terrestrial ecosystems. Our study suggests that preseason temperature plays a previously neglected role in modeling spring LUD and instead of using VIs or temperature alone, a combination of temperature and VIs can improve the prediction of spring phenology.

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Record 35 of 77

Title: Combined Effects of Precipitation and Temperature on the Responses of Forest Spring Phenology to Winter Snow Cover Dynamics in Northeast China

Author(s): Qiao, DJ (Qiao, Dejing); Zhou, JM (Zhou, Jianmin); Liang, S (Liang, Shuang); Fu, XY (Fu, Xiyou)

Source: IEEE ACCESS **Volume:** 7 **Pages:** 138950-138962 **DOI:** 10.1109/ACCESS.2019.2943202 **Published:** 2019

Abstract: The start date of vegetation growing season (SOS) is generally considered as an essential indicator to reflect vegetation growth condition. To date, relatively little research has explored the combined effects of temperature and precipitation on the responses of forest spring phenology to snow cover in detail. To investigate this, we applied the developed plant phenology index (PPI) derived from Moderate Resolution Image Spectroradiometer (MODIS) to estimate SOS over Northeast China from 2004 to 2018, and explored the relationship between SOS and climate variables, such as temperature, precipitation and snow cover. Our results indicated that winter snow cover dynamics had a significant effect on the forest spring growth in the following year. SOS showed a negative correlation with snow cover duration (SCD) and the ending date of snow cover (SCED), whereas had a positive correlation with the onset date of snow cover (SCOD). It implied that a longer SCD, later SCED and earlier SCOD would promote forest growth. Furthermore, we first revealed that SOS was more closely associated with the preseason temperature than winter temperature. Most regions exhibited a significant positive correlation with increasing preseason temperature, but the winter temperature showed an opposite pattern except for the cool-temperate needleleaf forest region. Meanwhile, SOS had a negative relationship with precipitation, especially for preseason precipitation. Furthermore, with increasing of temperature and precipitation in winter, the responses of SOS to snow cover phenology in temperate needleleaf and broadleaf mixed-forest region are contrary to that in the other three regions. During the period from SCED to SOS, the responses of SOS to snow cover phenology varied among different vegetation zones and the gradients of temperature and precipitation.

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Record 36 of 77

Title: Contrasting responses of autumn-leaf senescence to daytime and night-time warming

Author(s): Wu, CY (Wu, Chaoyang); Wang, XY (Wang, Xiaoyue); Wang, HJ (Wang, Huanjiong); Ciais, P (Ciais, Philippe); Penuelas, J (Penuelas, Josep); Myneni, RB (Myneni, Ranga B.); Desai, AR (Desai, Ankur R.); Gough, CM (Gough, Christopher M.); Gonsamo, A (Gonsamo, Alemu); Black, AT (Black, Andrew T.); Jassal, RS (Jassal, Rachhpal S.); Ju, WM (Ju, Weimin); Yuan, WP (Yuan, Wenping); Fu, YS (Fu, Yongshuo); Shen, MG (Shen, Miaogen); Li, SH (Li, Shihua); Liu, RG (Liu, Ronggao); Chen, JM (Chen, Jing M.); Ge, QS (Ge, Quansheng)

Source: NATURE CLIMATE CHANGE **Volume:** 8 **Issue:** 12 **Pages:** 1092-+ **DOI:** 10.1038/s41558-018-0346-z **Published:** DEC 2018

Abstract: Plant phenology is a sensitive indicator of climate change(1-4) and plays an important role in regulating carbon uptake by plants(5-7). Previous studies have focused on spring leaf-out by daytime temperature and the onset of snow-melt time(8,9), but the drivers controlling leaf senescence date (LSD) in autumn remain largely unknown(10-12). Using long-term ground phenological records (14,536 time series since the 1900s) and satellite greenness observations dating back to the 1980s, we show that rising pre-season maximum daytime (T-day) and minimum night-time (T-night) temperatures had contrasting effects on the timing of autumn LSD in the Northern Hemisphere (>20 degrees N). If higher T-day leads to an earlier or later LSD, an increase in T-night systematically drives LSD to occur oppositely. Contrasting impacts of daytime and night-time warming on drought stress may be the underlying mechanism. Our LSD model considering these opposite effects improved autumn phenology modelling and predicted an overall earlier autumn LSD by the end of this century compared with traditional projections. These results challenge the notion of prolonged growth under higher autumn temperatures, suggesting instead that leaf senescence in the Northern Hemisphere will begin earlier than currently expected, causing a positive climate feedback.

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Record 37 of 77

Title: The strength of flowering-temperature relationship and preseason length affect temperature sensitivity of first flowering date across space

Author(s): Xu, YJ (Xu, Yunjia); Wang, HJ (Wang, Huanjiong); Ge, QS (Ge, Quansheng); Wu, CY (Wu, Chaoyang); Dai, JH (Dai, Junhu)

Source: INTERNATIONAL JOURNAL OF CLIMATOLOGY **Volume:** 38 **Issue:** 13 **Pages:** 5030-5036 **DOI:** 10.1002/joc.5713 **Published:** NOV 15 2018

Abstract: Temperature sensitivity (S-T) of phenology, defined as the shift of phenophase with per unit change of preseason temperature, has been widely used to quantify phenological response to climate change. The spatial variation in S-T of spring phenology has been well studied for several woody plants, but how to explain it became a challenge. Several hypotheses to explain the spatial variation in S-T have been proposed, but studies examining all potential factors together were very limited. In this study, using first flowering date (FFD) data for five widespread woody plants at 47 stations in China and the other five species at 421 stations in central Europe during 1964-2014, we calculated S-T by using the Sen's slope of FFD on mean preseason temperature for each species at each station. Subsequently, multiple regression analysis was applied to examining whether S-T followed the geographical (latitudinal, longitudinal, or vertical) gradients. At last, four potential influencing factors of S-T were tested by Spearman partial correlation analysis. We found that S-T of FFD was higher at lower latitude for most species in China. However, in central Europe, the variation of S-T did not follow the geographical gradient for most species. Only one species (Fraxinus excelsior) showed a latitudinal gradient, and one (Betula pendula) showed a longitudinal gradient. For most species in both regions, the strength of FFD-temperature relationship and the preseason length could account for the spatial variation of S-T to a more considerable extent compared to preseason temperature variance and chilling conditions. Our results suggest that we need to consider the effects of multiple factors on phenological response to temperature when simulating future phenological change.

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Record 38 of 77

Title: Influence of winter precipitation on spring phenology in boreal forests

Author(s): Yun, J (Yun, Jeongmin); Jeong, SJ (Jeong, Su-Jong); Ho, CH (Ho, Chang-Hoi); Park, CE (Park, Chang-Eui); Park, H (Park, Hoonyoung); Kim, J (Kim, Jinwon)

Source: GLOBAL CHANGE BIOLOGY **Volume:** 24 **Issue:** 11 **Pages:** 5176-5187 **DOI:** 10.1111/gcb.14414 **Published:** NOV 2018

Abstract: Understanding the variations in spring vegetation phenology associated with preseason climate conditions can significantly improve our knowledge on ecosystem dynamics and biosphere-atmosphere interactions. Recent studies have shown that wet winters can delay the start date of the vegetation growing season (SOS) in the high latitudes. However, associated underlying mechanisms remain unclear due to the lack of observation sites as well as complex interactions between various climate and ecosystem variables. In this study, the impact of winter precipitation on year-to-year variations of the SOS in boreal forests from 1982 to 2005 was investigated. Two experiments were performed using the Community Land Model version 4.5. In the control experiment, observed precipitation was used; in the sensitivity experiment, precipitation in the year 1982 was repeated throughout the period. The SOS in the control experiment shows high temporal correlations with the SOS estimated from the satellite-retrieved leaf area index, indicating that the land model is capable of simulating realistic response of vegetation to interannual climate variability. The effects of winter precipitation on the SOS are examined by comparing the two model experiments for wet- and dry winters. After wet winters, the SOS was delayed by 2.7 days over 70.1% of the boreal forests than after dry winters; this accounts for 42.5% of the interannual variation in the SOS. The SOS delay is related to the decrease in the growing degree-days (GDD) based on soil temperatures, suggesting that the effects of heat exposure on vegetation growth is strongly modulated by winter precipitation. The GDD decrease is related to both the increase in snowmelt heat flux and reduced absorption of solar radiation, which are proportional to the amount of winter precipitation and the ratio of short plants to tall trees, respectively. Our results provide a physical basis for the winter precipitation-SOS relationship, suggesting that an increase in winter precipitation can alleviate strong advancing trends in spring vegetation growth in conjunction with global warming even for temperature-limited ecosystems.

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Record 39 of 77

Title: Slowdown of spring green-up advancements in boreal forests

Author(s): Park, H (Park, Hoonyoung); Jeong, SJ (Jeong, Su-Jong); Ho, CH (Ho, Chang-Hoi); Park, CE (Park, Chang-Eui); Kim, J (Kim, Jinwon)

Source: REMOTE SENSING OF ENVIRONMENT **Volume:** 217 **Pages:** 191-202 **DOI:** 10.1016/j.rse.2018.08.012 **Published:** NOV 2018

Abstract: There is a consensus that the spring phenology of deciduous forests is advancing in response to global warming. Since the late 1990s, however, this tendency of spring phenology advancement has been weakened in over 60% of boreal forests, particularly in Siberia (- 0.58 day yr(-1) for 1982-1997 vs. - 0.17 day yr(-1) for 1982-2013) and northwestern North America (NWNA; -0.42 day yr(-1) for 1982-1997 vs. 0.07 day yr(-1) for 1982-2013). This study investigated the major factor in the weakening trends in the advancement of the start of the growing season (SOS) based on the satellite-observed normalized difference vegetation index (NDVI) in 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. The GT explained the majority of the slowdown in the SOS trends in recent decades. In Siberia, the GT increases contributed to the advancement of the SOS during the 1980s and 1990s; however, the GT increase 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. This study demonstrates that the recent slowdown of the SOS advancing trends over Siberia and NWNA was largely attributed to the weakening of the warming trends, rather than the sensitivity changes of spring phenology to climate variables. This study suggests that the natural climate variability strongly affects the decadal variations in the boreal forest spring phenology.

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Record 40 of 77

Title: Reduced geographical variability in spring phenology of temperate trees with recent warming

Author(s): Ma, QQ (Ma, Qianqian); Huang, JG (Huang, Jian-Guo); Hanninen, H (Hanninen, Heikki); Berninger, F (Berninger, Frank)

Source: AGRICULTURAL AND FOREST METEOROLOGY **Volume:** 256 **Pages:** 526-533 **DOI:** 10.1016/j.agrformet.2018.04.012 **Published:** JUN 15 2018

Abstract: The occurrence of species-specific phenological timing among populations over broad geographical areas may have converged or diverged with recent climatic warming. The changes in spatial geographical variability of phenological timing may affect the degree of species overlap, and thus have profound ecological consequences in the context of global change. The potential converging or diverging has been little explored, although advancements of spring phenology due to climate warming have been observed worldwide in the last decades. Here we addressed this question through analyzing temporal changes in the geographical variability for 22 spring phonological events (both leaf-out and flowering phenology) of 16 temperate tree species in Europe. We found that the species-specific geographical variability of spring phenological timing decreased during 1980-2013, indicating that phenological differences among populations over a large geographical area decreased. The reduced geographical variability is mainly due to the fact that populations in cold sites had higher advancement rates and exhibited stronger responses to elevated temperature than those in warm sites. Warming induced convergence of spring phonology in temperate trees over a large geographical area may affect the activities of other species in the food chain through trophic mismatch, and may ultimately affect the ecosystem carbon and nutrient cycles that are driven through functioning of the food chain.

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Record 41 of 77

Title: Warmer winters reduce the advance of tree spring phenology induced by warmer springs in the Alps

Author(s): Asse, D (Asse, Daphne); Chuine, I (Chuine, Isabelle); Vitasse, Y (Vitasse, Yann); Yoccoz, NG (Yoccoz, Nigel Gilles); Delpierre, N (Delpierre, Nicolas); Badeau, V (Badeau, Vincent); Delestrade, A (Delestrade, Anne); Randin, CF (Randin, Christophe F.)

Source: AGRICULTURAL AND FOREST METEOROLOGY **Volume:** 252 **Pages:** 220-230 **DOI:** 10.1016/j.agrformet.2018.01.030 **Published:** APR 15 2018

Abstract: Mountain regions are particularly susceptible and influenced by the effects of climate change. In the Alps, temperature increased two times faster than in the Northern Hemisphere during the 20th century. As an immediate response in certain tree species, spring phenological phases, such as budburst and flowering, have tended to occur earlier. However, recent studies have shown a slowing down of phenological shifts during the last two decades compared to earlier periods, which might be caused by warmer winters. Indeed, cold temperatures are required to break bud dormancy that occurs in early fall; and dormancy break is a prerequisite for cell elongation to take place in spring when temperature conditions are warm enough.

Here we aimed at evaluating the effects of winter warming vs. spring warming on the phonological shift along mountain elevation gradients. We tested the hypothesis that a lack of chilling temperature during winter delayed dormancy release and subsequently spring phonological phases. For this, we used eight years of temperature and phenological records for five tree species (Betula penctula, Fraxinus excelsior, Corylus avellana, Picea abies and Larix deridna) gathered with the citizen science program Phenoclim (www.phenoclim.org) deployed over the French Alps.

Our results showed that for similar preseason (i.e. after dormancy break) temperatures, warmer winters significantly delayed budburst and flowering along the elevation gradient (+ 0.9 to + 5.6 days degrees C-1) except for flowering of Corylus and budburst of Picea. For similar cold winter temperatures, warmer preseasons significantly advanced budburst and flowering along the elevation gradient (- 5.3 to -8.4 days degrees C-1). On average, the effect of winter warming was 2.3 times lower than the effect of spring warming. We also showed that warmer winter temperature conditions have a significantly larger effect at lower elevations.

As a consequence, the observed delaying effect of winter warming might be beneficial to trees by reducing the risk of exposure to late spring frost on a short term. This could further lead to partial dormancy break at lower elevations before the end of the 21st century, which, in turn, may alter bud development and flowering and so tree fitness.

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Record 42 of 77

Title: Climate and Spring Phenology Effects on Autumn Phenology in the Greater Khingan Mountains, Northeastern China

Author(s): Fu, YY (Fu, Yuanyuan); He, HS (He, Hong S.); Zhao, JJ (Zhao, Jianjun); Larsen, DR (Larsen, David R.); Zhang, HY (Zhang, Hongyan); Sunde, MG (Sunde, Michael G.); Duan, SW (Duan, Shengwu)

Source: REMOTE SENSING **Volume:** 10 **Issue:** 3 **Article Number:** 449 **DOI:** 10.3390/rs10030449 **Published:** MAR 2018

Abstract: Vegetation phenology plays a key role in terrestrial ecosystem nutrient and carbon cycles and is sensitive to global climate change. Compared with spring phenology, which has been well studied, autumn phenology is still poorly understood. In this study, we estimated the date of the end of the growing season (EOS) across the Greater Khingan Mountains, China, from 1982 to 2015 based on the Global Inventory Modeling and Mapping Studies (GIMMS) normalized difference vegetation index third-generation (NDVI3g) dataset. The temporal correlations between EOS and climatic factors (e.g., preseason temperature, preseason precipitation), as well as the correlation between autumn and spring phenology, were investigated using partial correlation analysis. Results showed that more than 94% of the pixels in the Greater Khingan Mountains exhibited a delayed EOS trend, with an average rate of 0.23 days/y. Increased preseason temperature resulted in earlier EOS in most of our study area, except for the semi-arid grassland region in the south, where preseason warming generally delayed EOS. Similarly, EOS in most of the mountain deciduous coniferous forest, forest grassland, and mountain grassland forest regions was earlier associated with increased preseason precipitation, but for the semi-arid grassland region, increased precipitation during the preseason mainly led to delayed EOS. However, the effect of preseason precipitation on EOS in most of the Greater Khingan Mountains was stronger than that of preseason temperature. In addition to the climatic effects on EOS, we also found an influence of spring phenology on EOS. An earlier SOS led to a delayed EOS in most of the study area, while in the southern of mountain deciduous coniferous forest region and northern of semi-arid grassland region, an earlier SOS was often followed by an earlier EOS. These findings suggest that both climatic factors and spring phenology should be incorporated into autumn phenology models in order to improve prediction accuracy under present and future climate change scenarios.

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Record 43 of 77

Title: Effect of climate change on vegetation phenology of different land-cover types on the Tibetan Plateau

Author(s): Cheng, M (Cheng, Min); Jin, JX (Jin, Jiaxin); Zhang, JM (Zhang, Jinmeng); Jiang, H (Jiang, Hong); Wang, RZ (Wang, Ruizheng)

Source: INTERNATIONAL JOURNAL OF REMOTE SENSING **Volume:** 39 **Issue:** 2 **Pages:** 470-487 **DOI:** 10.1080/01431161.2017.1387308 **Published:** 2018

Abstract: Research in vegetation phenology change has been one heated topic of current ecological and climate change study. The Tibetan Plateau, as the highest plateau of the earth, is more vulnerable and sensitive to climate change than many other regions. In this region, shifts in vegetation phenology have been intensively studied during recent decades, primarily based on satellite-retrieved data. In this study, we explored the spatiotemporal changes of vegetation phenology for different land-cover types in the Tibetan Plateau and characterized their relationship with temperature and precipitation by using long-term time-series datasets of normalized difference vegetation index (NDVI) from 1982 to 2014. Diverse phenological changes were observed for different land-cover types, with an advancing start of growing season (SOS), delaying end of growing season (EOS) and increasing length of growing season (LOS) in the eastern Tibetan Plateau where meadow was the dominant vegetation type, but with the opposite changes in the steppe and sparse herbaceous or sparse shrub regions which are mostly located in the northwestern and western edges of the Tibetan Plateau. Correlation analysis indicated that sufficient preseason precipitation may delay the SOS of evergreen forests in the southeastern Plateau and advance the SOS of steppe and sparse herbaceous or sparse shrub in relatively arid areas, while the advance of SOS in meadow areas could be related to higher preseason temperature. For EOS, because it is less sensitive to climate change than SOS, the response of EOS for different land-cover types to precipitation and temperature were more complicated across the Tibetan Plateau.

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Record 44 of 77

Title: Diverse Responses of Vegetation Phenology to Climate Change in Different Grasslands in Inner Mongolia during 2000-2016

Author(s): Ren, SL (Ren, Shilong); Yi, SH (Yi, Shuhua); Peichl, M (Peichl, Matthias); Wang, XY (Wang, Xiaoyun)

Source: REMOTE SENSING **Volume:** 10 **Issue:** 1 **Article Number:** 17 **DOI:** 10.3390/rs10010017 **Published:** JAN 2018

Abstract: Vegetation phenology in temperate grasslands is highly sensitive to climate change. However, it is still unclear how the timing of vegetation phenology events (especially for autumn phenology) is altered in response to climate change across different grassland types. In this study, we investigated variations of the growing season start (SOS) and end (EOS), derived from Moderate Resolution Imaging Spectroradiometer (MODIS) data (2000-2016), for meadow steppe, typical steppe, and desert steppe in the Inner Mongolian grassland of Northern China. Using gridded climate data (2000-2015), we further analyzed correlations between SOS/EOS and pre-season average air temperature and total precipitation (defined as 90-day period prior to SOS/EOS, i.e., pre-SOS/EOS) in each grid. The results showed that both SOS and EOS occurred later in desert steppe (day of year (doy) 114 and 312) than in meadow steppe (doy 109 and 305) and typical steppe (doy 111 and 307); namely, desert steppe has a relatively late growing season than meadow steppe and typical steppe. For all three grasslands, SOS was mainly controlled by pre-SOS precipitation with the sensitivity being largest in desert steppe. EOS was closely connected

with pre-EOS air temperature in meadow steppe and typical steppe, but more closely related to pre-EOS precipitation in desert steppe. During 2000-2015, SOS in typical steppe and desert steppe has significantly advanced by 2.2 days and 10.6 days due to a significant increase of pre-SOS precipitation. In addition, EOS of desert steppe has also significantly advanced by 6.8 days, likely as a result from the combined effects of elevated preseason temperature and precipitation. Our study highlights the diverse responses in the timing of spring and autumn phenology to preceding temperature and precipitation in different grassland types. Results from this study can help to guide grazing systems and to develop policy frameworks for grasslands protection.

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Record 45 of 77

Title: Observed and Simulated Sensitivities of Spring Greenup to Preseason Climate in Northern Temperate and Boreal Regions

Author(s): Xu, XY (Xu, Xiyan); Riley, WJ (Riley, William J.); Koven, CD (Koven, Charles D.); Jia, GS (Jia, Gensuo)

Source: JOURNAL OF GEOPHYSICAL RESEARCH-BIOGEOSCIENCES **Volume:** 123 **Issue:** 1 **Pages:** 60-78 **DOI:** 10.1002/2017JG004117 **Published:** JAN 2018

Abstract: Vegetation phenology plays an important role in regulating land-atmosphere energy, water, and trace-gas exchanges. Changes in spring greenup (SG) have been documented in the past half-century in response to ongoing climate change. We use normalized difference vegetation index generated from NOAA's advanced very high resolution radiometer data in the Global Inventory Modeling and Monitoring Study project over the 1982-2005 period, coupled with climate reanalysis (Climate Research Unit-National Centers for Environmental Prediction) to investigate the SG responses to preseason climate change in northern temperate and boreal regions. We compared these observed responses to the simulated SG responses to preseason climate inferred from the Earth system models (ESMs) participating in the Coupled Model Intercomparison Project Phase 5 (CMIP5) over 1982-2005. The observationally inferred SG suggests that there has been an advance of about 1days per decade between 1982 and 2005 in the northern midlatitude to high latitude, with significant spatial heterogeneity. The spatial heterogeneity of the SG advance results from heterogeneity in the change of the preseason climate as well as varied vegetation responses to the preseason climate across biomes. The SG to preseason temperature sensitivity is highest in forests other than deciduous needleleaf forests, followed by temperate grasslands and woody savannas. The SG in deciduous needleleaf forests, open shrublands, and tundra is relatively insensitive to preseason temperature. Although the extent of regions where the SG is sensitive to preseason precipitation is smaller than the extent of regions where the SG is sensitive to preseason temperature, the biomes that are more sensitive to temperature are also more sensitive to precipitation, suggesting the interactive control of temperature and precipitation. In the mean, the CMIP5 ESMs reproduced the dominant latitudinal preseason climate trends and SG advances. However, large biases in individual ESMs for the preseason period, climate, and SG sensitivity imply needed model improvements to climate prediction and phenological process parameterizations.

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Record 46 of 77

Title: Asymmetric Responses of the End of Growing Season to Daily Maximum and Minimum Temperatures on the Tibetan Plateau

Author(s): Yang, ZY (Yang, Zhiyong); Shen, MG (Shen, Miaogen); Jia, SG (Jia, Shugang); Guo, L (Guo, Li); Yang, W (Yang, Wei); Wang, C (Wang, Cong); Chen, XH (Chen, Xuehong); Chen, J (Chen, Jin)

Source: JOURNAL OF GEOPHYSICAL RESEARCH-ATMOSPHERES **Volume:** 122 **Issue:** 24 **Pages:** 13278-13287 **DOI:** 10.1002/2017JD027318 **Published:** DEC 27 2017

Abstract: Climate warming has delayed the end of the growing season (EOS) in temperate and cold ecosystems. However, it is unclear whether asymmetric warming (higher warming at night than during the day) has triggered different responses in the timing of EOS. Here we used satellite-observed EOS of alpine vegetation to reveal its asymmetric responses to nighttime and daytime warming on the Tibetan Plateau. Increased preseason minimum temperature could postpone EOS by 7.92dayK(-1) ($P<0.01$), probably by slowing low-temperature induced leaf senescence, whereas increased preseason maximum temperature could advance EOS by 3.57dayK(-1) ($P<0.05$), likely due to the confounding effects of water limitations. The delaying effect of nighttime warming was stronger in more arid areas of the plateau, where daytime warming has a stronger advancing effect on EOS. Our results provide new insights into understanding and modeling autumn vegetation phenology on the Tibetan Plateau and grassland ecosystems in other temperate and cold regions.

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Record 47 of 77

Title: Changes in temperature sensitivity of spring phenology with recent climate warming in Switzerland are related to shifts of the preseason

Author(s): Gusewell, S (Gusewell, Sabine); Furrer, R (Furrer, Reinhard); Gehrig, R (Gehrig, Regula); Pietragalla, B (Pietragalla, Barbara)

Source: GLOBAL CHANGE BIOLOGY **Volume:** 23 **Issue:** 12 **Pages:** 5189-5202 **DOI:** 10.1111/gcb.13781 **Published:** DEC 2017

Abstract: The spring phenology of plants in temperate regions strongly responds to spring temperatures. Climate warming has caused substantial phenological advances in the past, but trends to be expected in the future are uncertain. A simple indicator is temperature sensitivity, the phenological advance statistically associated with a 1 degrees C warmer mean temperature during the preseason", defined as the most temperature-sensitive period preceding the phenological event. Recent analyses of phenological records have shown a decline in temperature sensitivity of leaf unfolding, but underlying mechanisms were not clear. Here, we propose that climate warming can reduce temperature sensitivity simply by reducing the length of the preseason due to faster bud development during this time period, unless the entire preseason shifts forward so that its temperature does not change. We derive these predictions theoretically from the widely used thermal time model for bud development and test them using data for 19 phenological events recorded in 1970-2012 at 108 stations spanning a 1600 m altitudinal range in Switzerland. We consider how temperature sensitivity, preseason start, preseason length and preseason temperature change (i) with altitude, (ii) between the periods 1970-1987 and 1995-2012, which differed mainly in spring temperatures, and (iii) between two non-consecutive sets of 18 years that differed mainly in winter temperatures. On average, temperature sensitivity increased with altitude (colder climate) and was reduced in years with warmer springs, but not in years with warmer winters. These trends also varied among species. Decreasing temperature sensitivity in warmer springs was associated with a limited forward shift of preseason start, higher temperatures during the preseason and reduced preseason length, but not with reduced winter chilling. Our results imply that declining temperature sensitivity can result directly from spring warming and does not necessarily indicate altered physiological responses or stronger constraints such as reduced winter chilling.

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Record 48 of 77

Title: Spatial variations in responses of vegetation autumn phenology to climate change on the Tibetan Plateau

Author(s): Cong, N (Cong, Nan); Shen, MG (Shen, Miaogen); Piao, SL (Piao, Shilong)

Source: JOURNAL OF PLANT ECOLOGY **Volume:** 10 **Issue:** 5 **Pages:** 744-752 **DOI:** 10.1093/jpe/rtw084 **Published:** OCT 2017

Abstract: Aims

Information about changes in the start and end of the vegetation growing season (SOS and EOS) is crucial for assessing ecosystem responses to climate change because of the high sensitivity of both to climate and their extensive influence on ecological processes in temperate and cold regions. Climatic warming substantially advanced SOS on the Tibetan Plateau from 1982 to 2011. However, it is unclear why EOS showed little delay despite increasing temperature over this period.

Methods

We used multiple methods to determine EOS from the satellite-observed normalized-difference vegetation index and investigated the relationships between EOS and its potential drivers on the Tibetan Plateau over 1982-2011.

Important findings

We found a slight but non-significant delay in regionally averaged EOS of 0.7 day decade(-1) ($P = 0.18$) and a widespread but weak delaying trend across the Plateau over this period. The inter-annual variations in regionally averaged EOS were driven mainly by pre-season temperature (partial $R = 0.62$, $P < 0.01$), and precipitation and insolation showed weak impact on EOS ($P > 0.10$). Pre-season warming delayed EOS mainly in the eastern half and north-western area of the plateau. In the south-west, EOS was significantly and positively related to SOS, suggesting potentially indirect effects of winter weather conditions on the following autumn's phenology through regulation of spring phenology. EOS was more strongly related with pre-season temperature in colder and wetter areas, reflecting vegetation adaptation to local climate. Interestingly, preseason temperature had weaker delaying effects on EOS for vegetation with a shorter growing season, for which SOS had a stronger control on inter-annual variations in EOS than for vegetation with a longer growing season. This indicates that shorter-season Tibetan Plateau vegetation may have lower plasticity in adjusting the length of its growing season, whenever it begins, and that climate change is more likely to shift the growing season than extend it for that vegetation.

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Record 49 of 77

Title: Divergent shifts and responses of plant autumn phenology to climate change on the Qinghai-Tibetan Plateau

Author(s): Zhu, WQ (Zhu, Wenquan); Jiang, N (Jiang, Nan); Chen, GS (Chen, Guangsheng); Zhang, DH (Zhang, Donghai); Zheng, ZT (Zheng, Zhoutao); Fan, DQ (Fan, Deqin)

Source: AGRICULTURAL AND FOREST METEOROLOGY **Volume:** 239 **Pages:** 166-175 **DOI:** 10.1016/j.agrformet.2017.03.013 **Published:** MAY 28 2017

Abstract: Autumn phenology along with spring/summer phenology controls the length of the vegetation growing season and significantly influences ecosystem biogeochemical cycles. Many previous studies have focused on spring/summer phenology. However, fewer studies have addressed autumn phenology because of no available or insufficient observations. Based on a series of long-term and continuous observations of autumn phenological events (8000+ records) on the Qinghai-Tibetan Plateau (QTP), we made a comprehensive assessment of autumn phenological shifts and their responses to climate change during the period from 1981 to 2011. Although a significantly delayed overall trend in autumn phenology was observed across the QTP from 1981 to 2011, the autumn phenologies showed divergent shifting trends and responses to climate change among plant species, phenological events, study periods and thermal conditions. Larger variations were observed for the occurrence dates of fruit-related events than foliar events. Significantly advanced shifts in autumn phenology were observed for woody plants (mostly owing to fruit-related phenological events), while significantly delayed shifts were observed for herbaceous plants (mostly owing to foliar events). The autumn phenology of woody plants varied little among plant species, recording periods and thermal

conditions but varied greatly under different temperature change trends. The autumn phenology of herbaceous plants varied greatly among plant species, recording periods, thermal conditions and sites with different temperature change trends. The occurrence dates of most phenological events for herbaceous plants were positively correlated with the preseason temperature and negatively correlated with the preseason precipitation, while opposite relationships were observed for woody plants. Our results provide new field evidence for the dispersive changes in autumn phenology on the QTP and suggest that the dispersive shifts in autumn phenology and their different responses to climate warming should be considered when assessing the impacts of climate change on vegetation dynamics and ecosystem biogeochemical cycles. (C) 2017 Elsevier B.V. All rights reserved.

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Record 50 of 77

Title: Understanding long-term (1982-2013) patterns and trends in winter wheat spring green-up date over the North China Plain

Author(s): Wang, SS (Wang, Sisi); Mo, XG (Mo, Xingguo); Liu, ZJ (Liu, Zhengjia); Baig, MHA (Baig, Muhammad Hasan Ali); Chi, WF (Chi, Wenfeng)

Source: INTERNATIONAL JOURNAL OF APPLIED EARTH OBSERVATION AND GEOINFORMATION **Volume:** 57 **Pages:** 235-244 **DOI:** 10.1016/j.jag.2017.01.008 **Published:** MAY 2017

Abstract: Monitoring the spring green-up date (GUD) has grown in importance for crop management and food security. However, most satellite-based GUD models are associated with a high degree of uncertainty when applied to croplands. In this study, we introduced an improved GUD algorithm to extract GUD data for 32 years (1982-2013) for the winter wheat croplands on the North China Plain (NCP), using the third-generation normalized difference vegetation index from Global Inventory Modeling and Mapping Studies (GIMMS3g NDVI). The spatial and temporal variations in GUD with the effects of the pre-season climate and soil moisture conditions on GUD were comprehensively investigated. Our results showed that a higher correlation coefficient ($r = 0.44$, $p < 0.01$) and lower root mean square error (22 days) and bias (16 days) were observed in GUD from the improved algorithm relative to GUD from the MCD12Q2 phenology product. In spatial terms, GUD increased from the southwest (less than day of year (DOY) 60) to the northeast (more than DOY 90) of the NCP, which corresponded to spatial reductions in temperature and precipitation. GUD advanced in most (78%) of the winter wheat area on the NCP, with significant advances in 37.8% of the area ($p<0.05$). GUD occurred later at high altitudes and in coastal areas than in inland areas. At the interannual scale, the average GUD advanced from DOY 76.9 in the 1980s (average 1982-1989) to DOY 73.2 in the 1990s (average 1991-1999), and to DOY 70.3 after 2000 (average 2000-2013), indicating an average advance of 1.8 days/decade ($r = 0.35$, $p < 0.05$). Although GUD is mainly controlled by the preseason temperature, our findings underline that the effect of the pre-season soil moisture on GUD should also be considered. The improved GUD algorithm and satellite-based long-term GUD data are helpful for improving the representation of GUD in terrestrial ecosystem models and enhancing crop management efficiency. (C) 2017 Elsevier B.V. All rights reserved.

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