remote sensing

MDPI

Supporting Information for

Distribution and attribution of earlier start of the growing season over the Northern Hemisphere from 2001–2018

Xiaona Chen [1,2,] *, Yaping Yang [1,2], and Jia Du [1,2]

[1] National Earth System Science Data Center, State Key Laboratory of Resources and Environmental Information System, Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, Beijing 100101, China; chenxn@lreis.ac.cn

[2] Jiangsu Center for Collaborative Innovation in Geographical Information Resource Development and Application, Nanjing 210023, China;

* Correspondence: chenxn@igsnrr.ac.cn; Tel.: +86-10-6488-9452

Text S1: Consistency between MCD12Q2-C6 and MCD12Q2-C5

To explore the consistence between other satellite-retrieved vegetation phenology datasets, the MCD12Q2-C5 over the NH for the period 2001–2014 at a spatial resolution of 500 m and MEaSUREs VIP over the NH for the period 2001–2016 at a spatial resolution of 0.05° were also employed in this study. Comparisons of vegetation phenology with ground measurements showed that both the MCD12Q2-C5 (Ganguly et al. 2010; Zhang et al. 2006) and MCD12Q2-C6 (Chen and Yang 2020) provided realistic estimates of the SOS in spring vegetation studies, separately. However, a comprehensive comparison between MCD12Q2-C5 and MCD12Q2-C6 is still lacking. Compared with the MODIS vegetation phenology dataset, the MEaSUREs VIP provides another selection for continental-scale SOS monitoring. The MEaSUREs VIP estimates vegetation phenological metrics globally using surface reflectance data from the Advanced Very High Resolution Radiometer (AVHRR) during 1981–1999 and MODIS during 2000–2016 (Didan and Barreto 2016). For the present study, the "start of season 1" using the time series of EVI2 was used as the SOS, in which "start of season 1" was defined as the point in time for which the EVI2 value had increased by 10% of the distance between the minimum and maximum values (Jönsson and Eklundh 2004), which is the fundamental difference between algorithm used in MODIS vegetation phenology dataset.

Limited by the temporal coverage of MCD12Q2-C5, the cross-comparison between MCD12Q2-C6 and MCD12Q2-C5 was performed for the overlapping period of 2001–2014. The 14-year averaged SOS over the NH in stable regions with natural vegetation types calculated from MCD12Q2-C6 and MCD12Q2-C5, and their longitudinal and latitudinal differences, are displayed in Figure S1.

Both MCD12Q2-C6 (Figure S1a) and MCD12Q2-C5 (Figure S1b) captured the latitudinal distribution of SOS from tropical to mid- to high latitudes over the NH, with earlier SOS observed at latitudes around 20° N and 40° N and later SOS distributed at latitudes around 70° N. The 14-year averaged SOS over the NH stable natural vegetated regions derived from MCD12Q2-C6 and MCD12Q2-C5 were 69 (± 38) and 83 (± 45) days of the year (DOY) for 2001–2014,

respectively. Compared with MCD12Q2-C6, MCD12Q2-C5 had systematically later SOS over the NH, especially at high latitudes. In contrast, the SOS was earlier in MCD12Q2-C5, especially for the mid-latitudes around 40° N (Figure S1c), including the southeast United States and southeast China. Moreover, the discrepancies between MCD12Q2-C6 and MCD12Q2-C5 were systematic, with highly similar peaks and valleys in the latitudinal (Figure S1e) and longitudinal (Figure S1f) distributions. This was reasonable because the same input dataset was used to develop MCD12Q2-C6 and C5, even when the surface reflectance data were updated to C6, and the climatology differences were small.

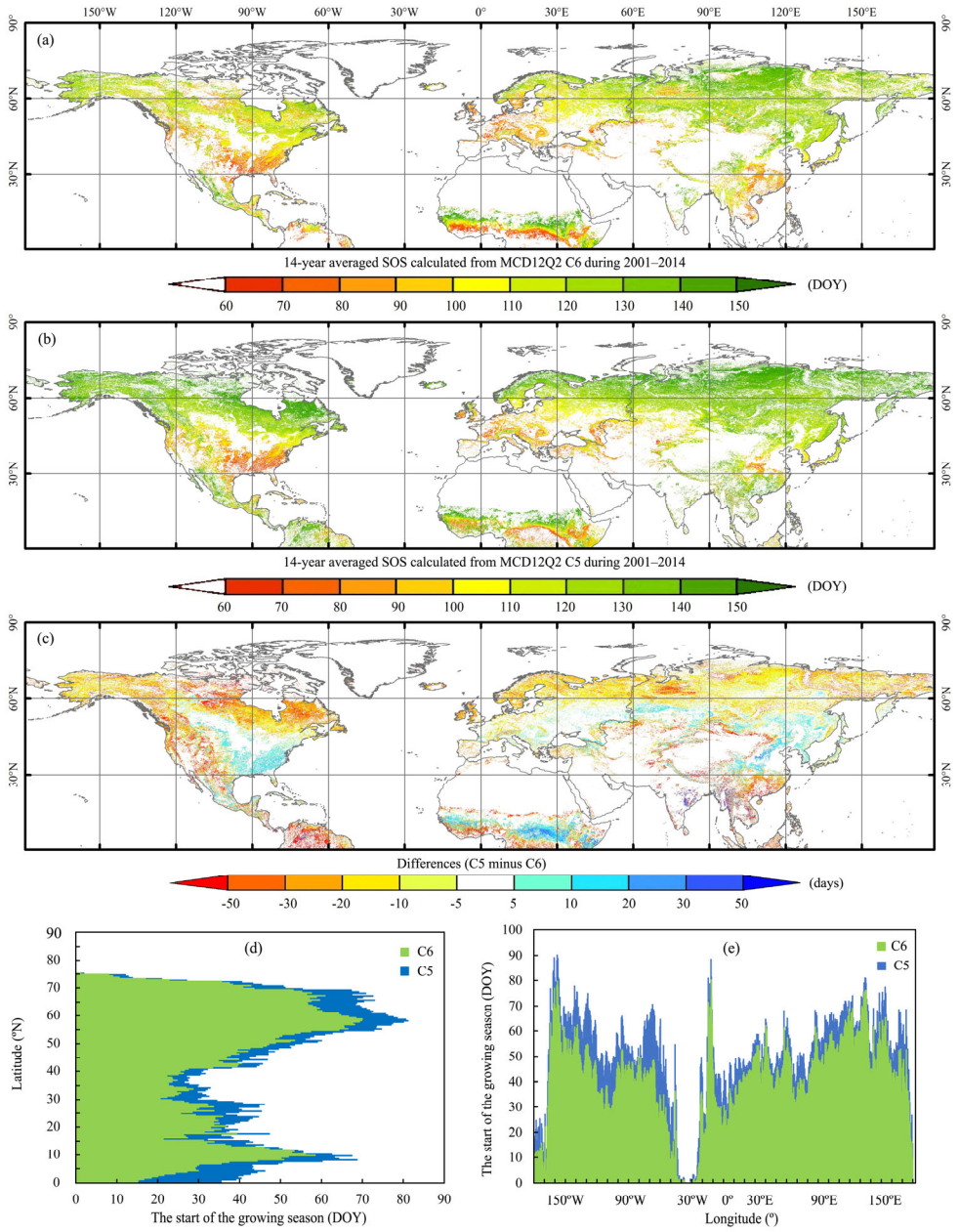

Figure S1. The 14-year averaged SOS over the NH derived from (a) MCD12Q2-C6 and (b) MCD12Q2-C5 during 2001–2014, and (c) differences. The (d) latitudinal and (e) longitudinal differences between MCD12Q2-C6 and MCD12Q2-C5 during 2001–2014.

Table S1. IGBP legend and class definitions of MCD12C1 product.

Value	Name	Description
1	Evergreen Needleleaf Forests	Dominated by evergreen conifer trees (canopy >2m). Tree cover >60%.
2	Evergreen Broadleaf Forests	Dominated by evergreen broadleaf and palmate trees (canopy >2m). Tree cover >60%.
3	Deciduous Needleleaf Forests	Dominated by deciduous needleleaf (larch) trees (canopy >2m). Tree cover >60%.
4	Deciduous Broadleaf Forests	Dominated by deciduous broadleaf trees (canopy >2m). Tree cover >60%.
5	Mixed Forests	Dominated by neither deciduous nor evergreen (40-60% of each) tree type (canopy >2m). Tree cover >60%.
6	Closed Shrublands	Dominated by woody perennials (1-2m height) >60% cover.
7	Open Shrublands	Dominated by woody perennials (1-2m height) 10-60% cover.
8	Woody Savannas	Tree cover 30-60% (canopy >2m).
9	Savannas	Tree cover 10-30% (canopy >2m).
10	Grasslands	Dominated by herbaceous annuals (<2m).
11	Permanent Wetlands	Permanently inundated lands with 30-60% water cover and >10% vegetated cover.
12	Croplands	At least 60% of area is cultivated cropland.
13	Urban and Built-up Lands	At least 30% impervious surface area including building materials, asphalt, and vehicles.
14	Cropland/Natural Vegetation Mosaics	Mosaics of small-scale cultivation 40-60% with natural tree, shrub, or herbaceous vegetation.
15	Permanent Snow and Ice	At least 60% of area is covered by snow and ice for at least 10 months of the year.
16	Barren	At least 60% of area is non-vegetated barren (sand, rock, soil) areas with less than 10% vegetation.
17	Water Bodies	At least 60% of area is covered by permanent water bodies.