The Australian phenology product

from MYD13A1 (16-days, 500m resolution) User's Guide

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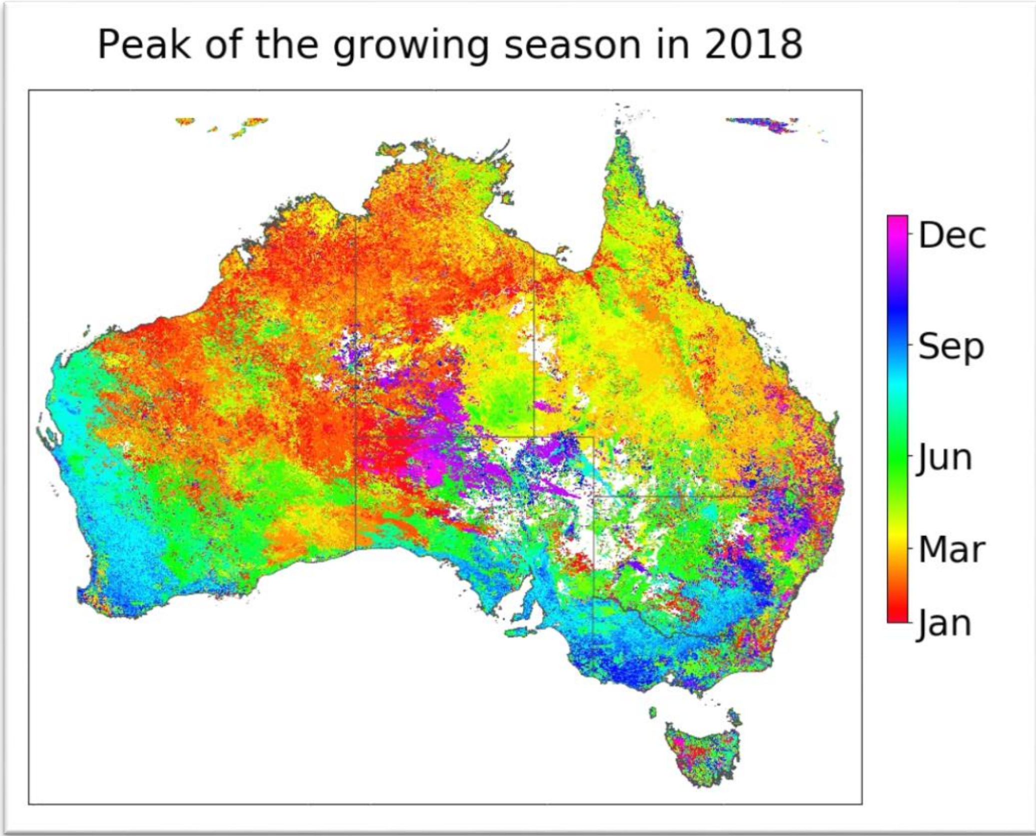

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1. Product naming convention

The naming convention is arranged as follows:

Phenological Metrics_YYYY_SEASON.tif

Table 1. Phenological Metrics in this product

Phenological metrics	Value range	Unit	Description
SGS (start of the growing season)	-150 ~ 345	day of year	Negative value means that SGS is in the previous year, e.g., -150 means SGS is 150 days prior to Day 1 of the current year
PGS (peak of the growing season)	9 ~ 361	day of year	
EGS (end of the growing season)	25 ~ 519	day of year	Values larger than 361 (the last MYD13A1 product in every year) are EGS in the next year, e.g., 519 means PGS is x days after the last day of the current year, for non-leap years, x = 519-365, for leap years, x = 519-366
LGS (length of the growing season)	32 ~ 320	days	
Minimum_EVI_1	0 ~ 10000	-	minimum EVI value prior season, scale factor: 10000
Minimum_EVI_2	0 ~ 10000	-	minimum EVI value after season, scale factor: 10000
Peak_EVI	0 ~ 10000	-	seasonal maximum EVI value, scale factor: 10000
Integral_EVI	0 ~ 200000	-	seasonal integral EVI value, scale factor: 10000

YYYY: year

SEASON contains:

Season1: the first growing season

Season2: the second growing season

Thus, the following filename

SGS_2003_Season1.tif

Identifies start of the growing season for the first growing season in 2003.

2. Product input data

The input data of the Australian phenology product is the MYD13A1 product. The data was downloaded from NASA Land Processes Distributed Active Archive Center (LP DAAC) (https://e4ftl01.cr.usgs.gov/).

3. Data preprocessing

3.1 Quality control

We discarded observations with VI quality = '10' or '11' (keeping the highest 2 quality levels), or VI usefulness > 7 (keeping the highest 2 quality levels), or Aerosol Quantity = '11 high' (keeping the highest 3 quality levels), or mixed clouds present, or adjacent cloud detected (Huete, A. et al, 1999; Solano, R. et al, 2010). We then gap-filled the low quality observations screened in the previous step in per-pixel 2002 to 2019 EVI time series using cubic spline interpolation (Dougherty et al., 1989).

3.2 Correcting 16-day composite EVI time series with actual acquisition dates

Despite composite MYD13A1 images being nominally equidistant in time (one image every 16 days), EVI values can be acquired in each day of the 16-day compositing period to which they refer. As a result, the actual temporal distance between the adjacent EVI images can vary from 1 to 32 days. To mitigate the influence of such uncertainty on the extraction of phenological metrics, in this product, we corrected the MODIS 16-day composite EVI time series with actual acquisition dates using the band "Composite day of the year", which contains the date of acquisition of the reflectances used in vegetation indices computation per pixel. The original EVI time series was interpolated using a cubic spline interpolation to generate a coherent and temporally equidistant EVI time series (Testa, S. et al. 2014).

3.3 Filtering

As a last pre-processing step, we used a Savitzkye-Golay smoothing filter (Savitzky, A. et al, 1964) with a window size of 12 time steps and a 5th order polynomial to reduce noise in the gap filled time series.

4. Phenology metrics extraction algorithm

Based on per-pixel greenness time series measured by MODIS EVI, we retrieved eight phenological metrics for each year, defined as:

1. Start of the Growing Season (SGS): the beginning date of enhanced seasonal vegetation productivity;
2. Peak of the Growing Season (PGS): the date of maximum vegetation greenness;
3. End of the Growing Season (EGS): the end date of enhanced seasonal vegetation productivity;
4. Length of the Growing Season (LGS): the duration of enhanced vegetation productivity, defined as the difference between the end and start of the growing season;
5. Minimum EVI value prior season: the minimum greenness value prior to the growing season;
6. Minimum EVI value after season: the minimum greenness value after the growing season;
7. Peak EVI value of the growing season: the peak greenness value during the growing season;
8. Integral EVI value of the growing season: the gross productivity of the growing season, calculated as the integral EVI from SGS to PGS.

In this product, PGS is define as the date when EVI reaches the maximum value during the growing season. SGS was defined as when EVI value reaches the minimum value prior to the growing season plus 20% of seasonal amplitude (peak EVI value minus minimum EVI value before PGS) during the green-up phase. EGS was defined as when EVI reaches the value that equals the minimum value after growing season plus 20% of seasonal amplitude during the brown-down phase (peak EVI value minus minimum EVI value after PGS). LGS was calculated as the difference between EGS and SGS. Minimum EVI value prior/after season was defined as the minimum EVI value prior/after the growing season (Broich, M. et al, 2015; Ma, X. et al, 2015). Peak EVI value of the growing season was the maximum value during the growing season. To avoid random peaks, we discard the PGS less than 110% of the annual average EVI value. Integral EVI value of the growing season was calculated as the integral EVI value from SGS to PGS. The conceptual definition of the phenological metrics is shown in Figure 1. In this product, we account for up to two seasons each year. The data processing flow of the Australian phenology product is shown in Figure 2.

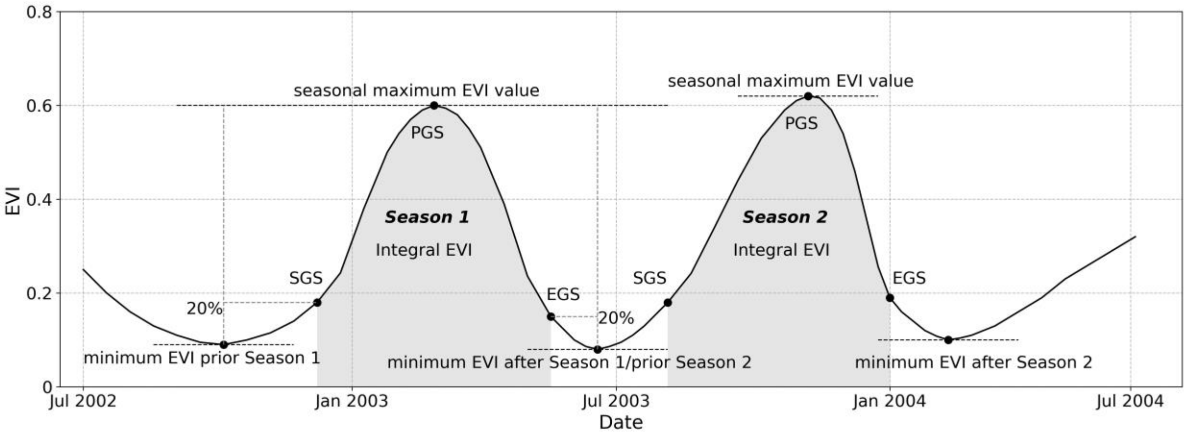

Figure 1. Diagram of algorithm for deriving phenological metrics from MODIS EVI time series.

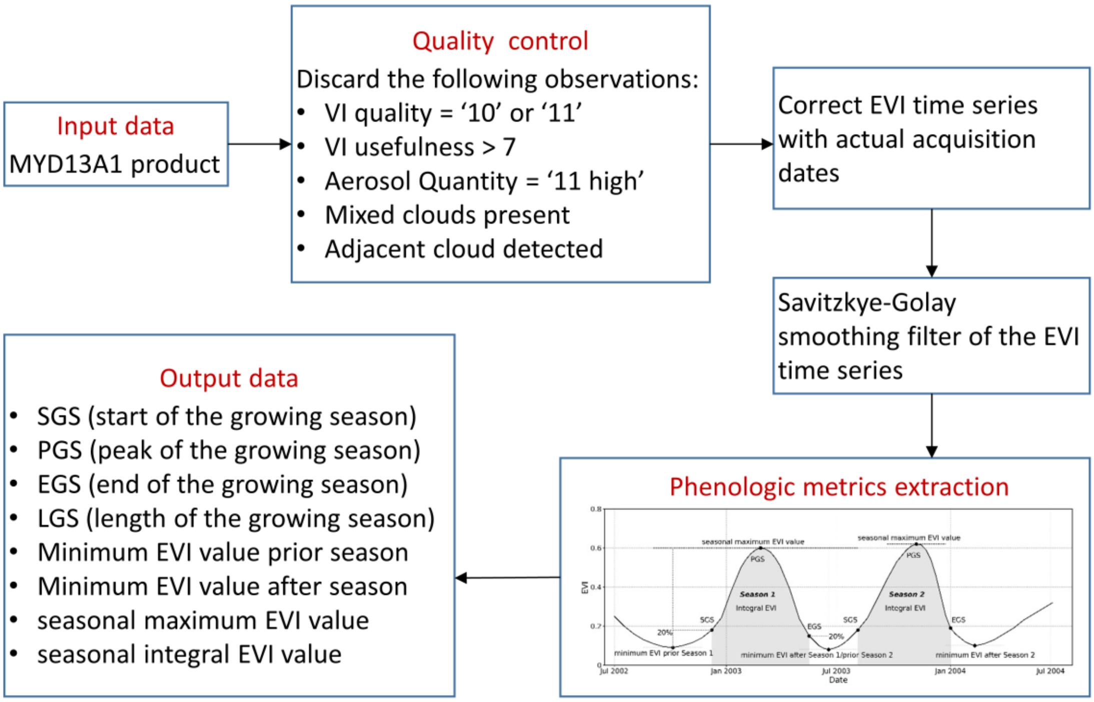

Figure 2. The Australian phenology product data processing flow

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