Validation of SNPP VIIRS Green Vegetation Fraction phenology using PhenoCam data

Zhangyan Jiang[1,2], Marco Vargas[1], Ivan Csiszar[1]

[1] NOAA National Environmental Satellite, Data, and Information Service, Center for Satellite Applications and Research, College Park, MD, 20740. [2] IMSG inc. Rockville, MD 20852

Contact: Ivan.csiszar@noaa.gov; Zhangyan.jiang@noaa.gov

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Introduction

Real-time GVF is needed in the numeric weather, climate and hydrological models. The NOAA operational GVF product is derived from AVHRR top of atmosphere NDVI data at 16-km resolution. Since August 2012, the Suomi National Polar-orbiting Partnership (SNPP) Visible Infrared Imager Radiometer Suite (VIIRS) GVF has been produced as a NOAA-Unique Product (NUP) for applications in numerical weather and seasonal climate prediction models at the National Centers for Environmental Prediction (NCEP). Since NCEP, the main VIIRS GVF user, especially interested and concerned on the seasonal cycles of the VIIRS and AVHRR GVF data, we compared and validated VIIRS GVF time series seasonal cycle with PhenoCam greenness index time series. Seasonal cycles of the operational AVHRR GVF data and the AVHRR GVF climatology data were also compared with PhenoCam data. We designed a study to (1) extract phenological dates, including the dates of onset of leaf growth, maximum leaf area, senescence, dormancy and length of growing season, from VIIRS GVF, AVHRR GVF and the AVHRR GVF climatology; (2) extract phenological dates from the ground PhenoCam data as reference data; (3) compare the GVF phenological dates with the PhenoCam phenological dates for validation.

Data

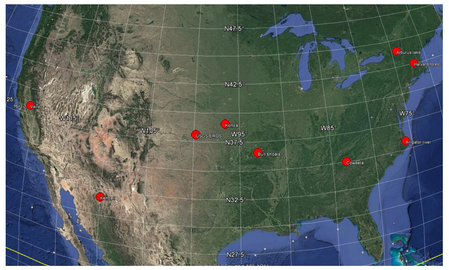
PhenoCam data:

The PhenoCam Network provides automated, near-surface RGB images of canopy phenology across the North America. Images are uploaded to the PhenoCam server every half hour. Ten PhenoCam sites in USA were selected in this study. Daily PhenoCam images acquired at noon 12:00 were downloaded from PhenoCam website at https://phenocam.sr.unh.edu/webcam/network/download/. A region of interest (ROI) was identified for each site. The digital numbers of the red (R), green (G) and blue (B) within ROI were averaged and Green Chromatic Coordinate (GCC) was calculated based on the daily mean R, G, B values for each site (Klosterman et al 2014; Richardson et al 2009).

$$GCC = G/(R+G+B)$$

R: digital number of the red channel
G: digital number of the green channel
B: digital number of the blue channel

GCC measures the relative (or normalized) brightness of the green channel.



Location of the 10 selected PhenoCam validation sites

GVF data:

(1) SNPP VIIRS 4-km Daily rolling weekly GVF data were extracted over 10 sites between September 2012 and December 2015.
(2) Operational NOAA-19 AVHRR 16-km weekly GVF data (Jiang et al 2010) were extracted over 10 sites between September 2012 and December 2015.
(3) 16-km monthly AVHRR GVF climatology data were extracted over 10 sites.

Extracting phenological dates from GCC and GVF time series

1. Fitting double logistic functions (Jeremy et al., 2006) to PhenoCam GCC, VIIRS GVF, AVHRR GVF and AVHRR GVF climatology

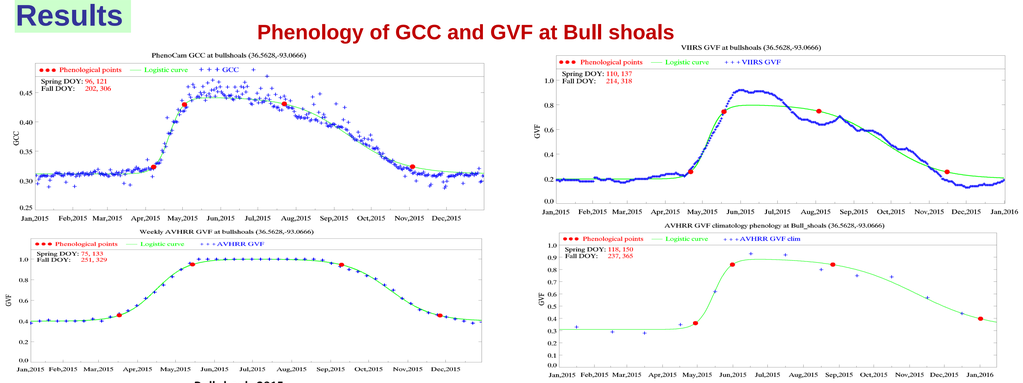
$$y(t) = \frac{c}{1+e^{a_1+b_1 t}} - \frac{c}{1+e^{a_2+b_2 t}} + d$$

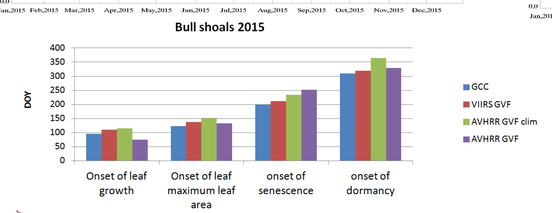
where t is the time in days, y(t) is the GVF or GCC value at time t, a_1,a_2, b_1 and b_2 are fitting parameters, c+d is the maximum value, and d is the initial background value.

2. Extract phenological dates, including the dates of onset of leaf growth, maximum leaf area, senescence, dormancy and length of growing season, from PhenoCam GCC, VIIRS GVF, AVHRR GVF and the AVHRR GVF climatology according to the method of Zhang et al. (2003)
3. Compare the GVF phenological dates with the PhenoCam phenological dates for validation.

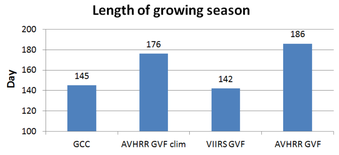
Results

Phenology of GCC and GVF at Bull shoals



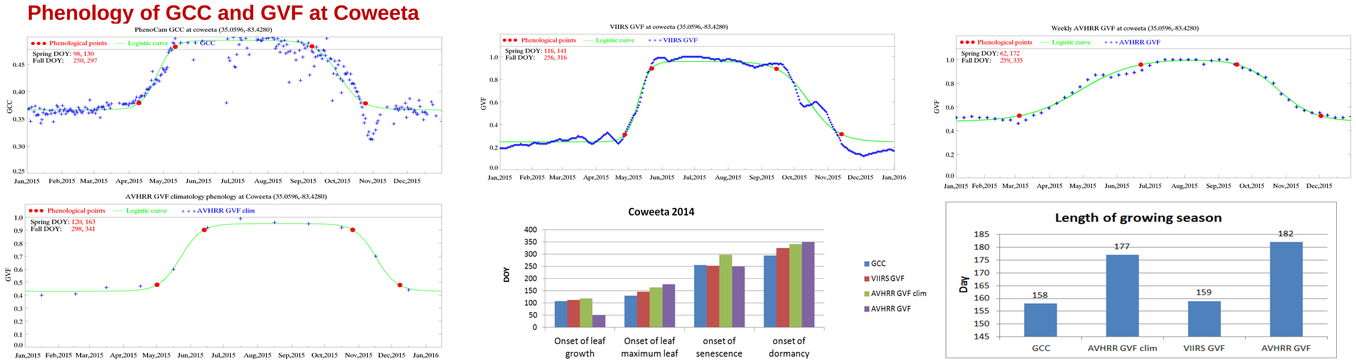


➢ *Phenological dates of VIIRS GVF growing season matched those of GCC*



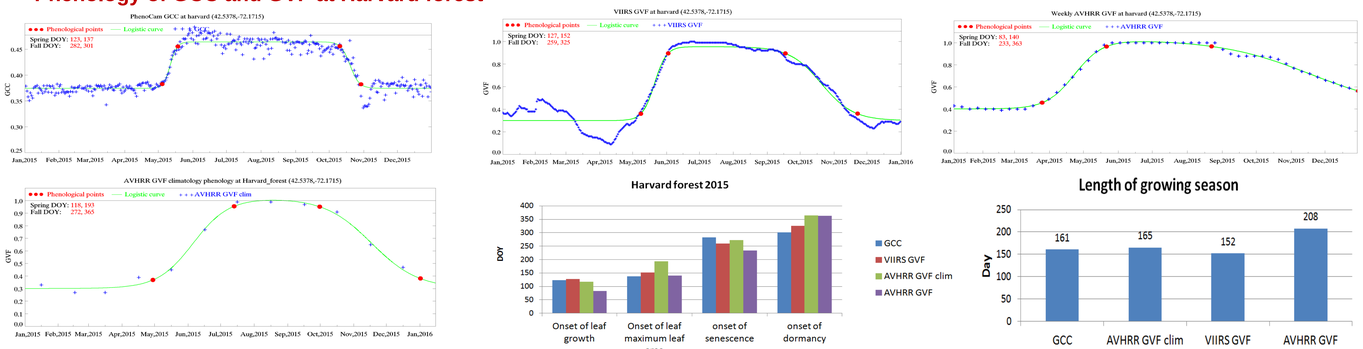
➢ *Length of VIIRS GVF growing season was similar to that of GCC*

Phenology of GCC and GVF at Coweeta

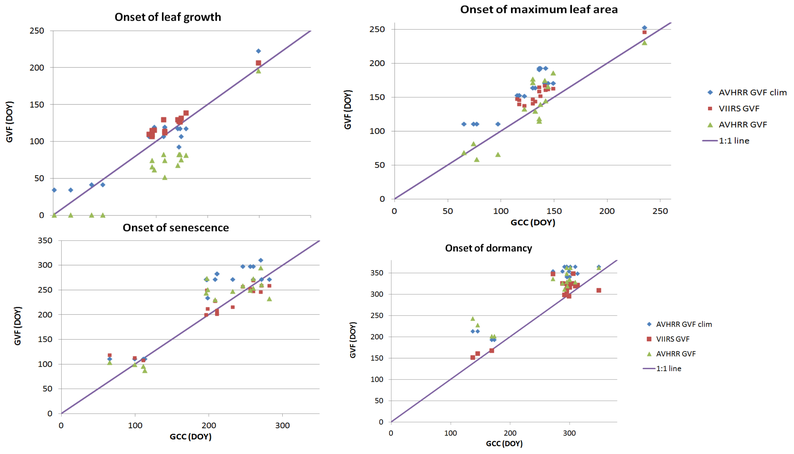


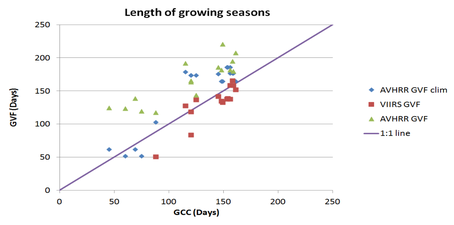
Length of VIIRS GVF growing season was similar to that of GCC

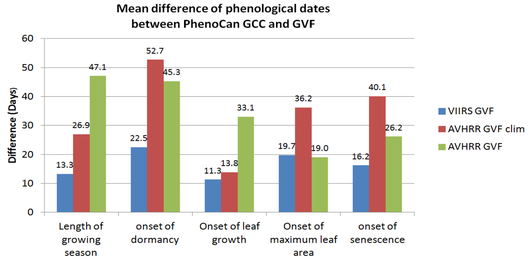
Phenology of GCC and GVF at Harvard forest



Validating GVF phenology using GCC phenology







Conclusions:

1) **Compared with the GCC phenology, VIIRS GVF was more accurate than the AVHRR GVF and the AVHRR GVF climatology**
2) **The lengths of growing seasons of the AVHRR GVF were found longer than PhenoCam measured lengths of growing seasons**
3) **VIIRS GVF seasonal cycles matched the seasonal cycles of phenoCam measured greenness**
4) **More validation sites will be included in the future study**

Reference:

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