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Biogeosciences Discussions

Interactive comment on "Improving the monitoring of deciduous broadleaf phenology using the Geostationary Operational Environmental Satellite (GOES) 16 and 17" *by* Kathryn I. Wheeler and Michael C. Dietze

Anonymous Referee #2

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Wheeler and Dietze presented a new satellite dataset to monitor vegetation phenology of deciduous broadleaf forests in the United States. The authors compared ground-based PhenoCam observations with new phenology observations from GOES 16 & 17 and MODIS vegetation indices (MOD13Q1). The authors found that the high-temporal-resolution (sub-daily) GOES product produces estimations of the phenological transition dates with higher confidence (narrower confidence interval) compared with MODIS NDVI and EVI data (16-day resolution). The GOES product correlates with Phenocam observation well in the spring, but less so in the fall.

Overall, this is a useful contribution to the community. It represents a new way to monitor vegetation phenology. The results are robust, and the manuscript is mostly well-written. I have some reservations regarding the discussion on the advantages of GOES vs. MODIS, which I will describe below.

The authors stated that the benefit of the GOES series is the high temporal resolution (sub-daily). The authors used the comparison to the PhenoCam data (and better performance of the GOES data) to support this claim. This claim to me is mostly correct with one exception: the comparison between GOES time-series and MODIS 16-day time-series is not fair because there is a daily MODIS reflectance product at 500 m resolution that takes into account of the impact of sun-sensor geometry – the MOD43A4 product. A quick search using google scholar showed a few papers that use daily MODIS product for phenological studies:

Liu, Y., Hill, M.J., Zhang, X., Wang, Z., Richardson, A.D., Hufkens, K., Filippa, G., Baldocchi, D.D., Ma, S., Verfaillie, J. and Schaaf, C.B., 2017. Using data from Landsat, MODIS, VIIRS and PhenoCams to monitor the phenology of California oak/grass savanna and open grassland across spatial scales. Agricultural and Forest Meteorology, 237, pp.311-325.

Ju, J., Roy, D.P., Shuai, Y. and Schaaf, C., 2010. Development of an approach for generation of temporally complete daily nadir MODIS reflectance time series. Remote Sensing of Environment, 114(1), pp.1-20.

Keenan, T.F., Gray, J., Friedl, M.A., Toomey, M., Bohrer, G., Hollinger, D.Y., Munger, J.W., O'Keefe, J., Schmid, H.P., Wing, I.S. and Yang, B., 2014. Net carbon uptake has increased through warming-induced changes in temperate forest phenology. Nature Climate Change, 4(7), pp.598-604.

The results have demonstrated that GOES ABI is likely better than MODIS 16-day products in capturing spring phenology. Still, proper discussion (and some texts in the introduction) on the daily MODIS product is necessary. The downside of the MODIS

16-day product could potentially be addressed with a daily MODIS product.

A few detailed comments:

Line 51: Adding a sentence on why changing viewing angle limits the temporal resolution could be useful for non-remote-sensing readers.

Line 65: “subject to the same temporal limitations” – but both are subject to cloud impact. No data when there is cloud cover.

Line 144: This approach misses two main features in the GCC curve: The peak in the later spring and early summer, and the gradual decline in GCC in the summer to fall. Similarly, the equation does fit the NDVI data well (misses the summer decline in NDVI). See the following paper and the Klosterman et al. that was cited:

Elmore, A.J., Guinn, S.M., Minsley, B.J. and Richardson, A.D., 2012. Landscape controls on the timing of spring, autumn, and growing season length in midâĂŘA tlantic forests. Global Change Biology, 18(2), pp.656-674.

Using the methods from Elmore et al. or Klosterman et al. could potentially improve the late spring transition date estimation (and the mismatch between satellite the PhenoCam data).

Line 230: the use of “prematurely” gives a sense of that MODIS incorrectly estimates the start of spring. However, another possibility is the green-up of the understory may cause MODIS vegetation indices to increase even when Phenocam data do not show any changes. Richardson and O’Keefe (2009) showed that understory spring is about 10-20 days earlier at Harvard Forest:

Richardson, A.D., and O’Keefe, J., 2009. Phenological differences between understory and overstory. In Phenology of ecosystem processes (pp. 87-117). Springer, New York, NY.

Line 264: It is unclear what the difference is between “canopy greenness” and “leaf

presence and canopy structure”. Both GCC and vegetation indices (EVI and NDVI) are affected by these factors, but in different ways: GCC (R, G, B) can be affected by these factors differently compared with EVI and NDVI (which has a NIR band). I suggest rewriting this sentence.

Section 4.2.: the uncertainties in the fall phenology estimation could also be attributed to the heterogeneity in the timing of fall phenology (compared with much-synchronized spring phenology). Worth some discussion.

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