Identification of Novel Remote Sensed Based Indicators for Phenology

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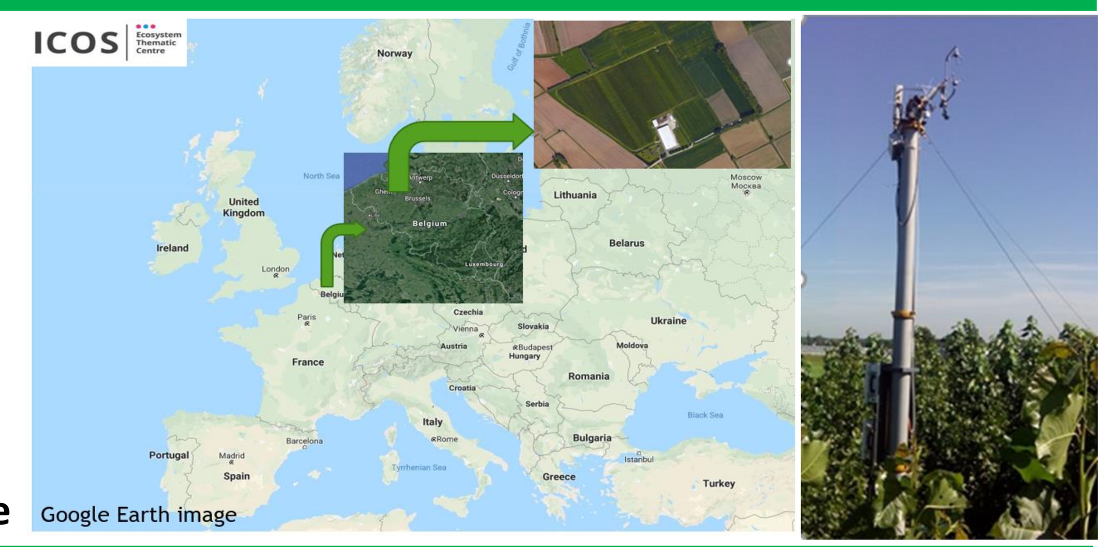
Aims

- To improve estimation of Start and End of Season (SOS/EOS) of a Poplar plantation in Belgium.
- To use Very High Resolution Satellite imagery.
- To test several structural and chlorophyll sensitive Vegetation Indices derived from Sentinel-2 (e.g. Modified Terrestrial Difference Vegetation Index (MTCI) & Normalized Difference Vegetation Index (NDVI)).
- To analyze the impact of different meteorological drivers to find out which explain ecosystem phenology.



Fluxnet site

Flux measurements in this study were performed at a bioenergy plantation established in Belgium in 2010.

Data & Method

✓ Satellite Data: Sentinel-2

Temporal resolution: 5 days depending on weather
Spatial resolution: 10 m & 20 m
Spectral bands & Vegetation Indices (VIs) calculation
NDVI at 10 m: NDVI = (b8 – b4)/ (b8 + b4)
Band8= 842 nm, Band4= 665 nm
MTCI at 20 m: MTCI = (b6 – b5)/ (b5 + b4)
Band6=740 nm, Band5= 705 nm

✓ Experimental site data

Flux data:
Gross Primary Production (GPP)
Net Ecosystem Exchange (NEE)
Leaf Area Index (LAI)

✓ Phenological extraction methods (Smoothing algorithm functions)

- Savitzky-Golay filtering method (Savgol)
- Harmonic Analysis of time series method (Hants)
- Polynomial function (Polyfit method)

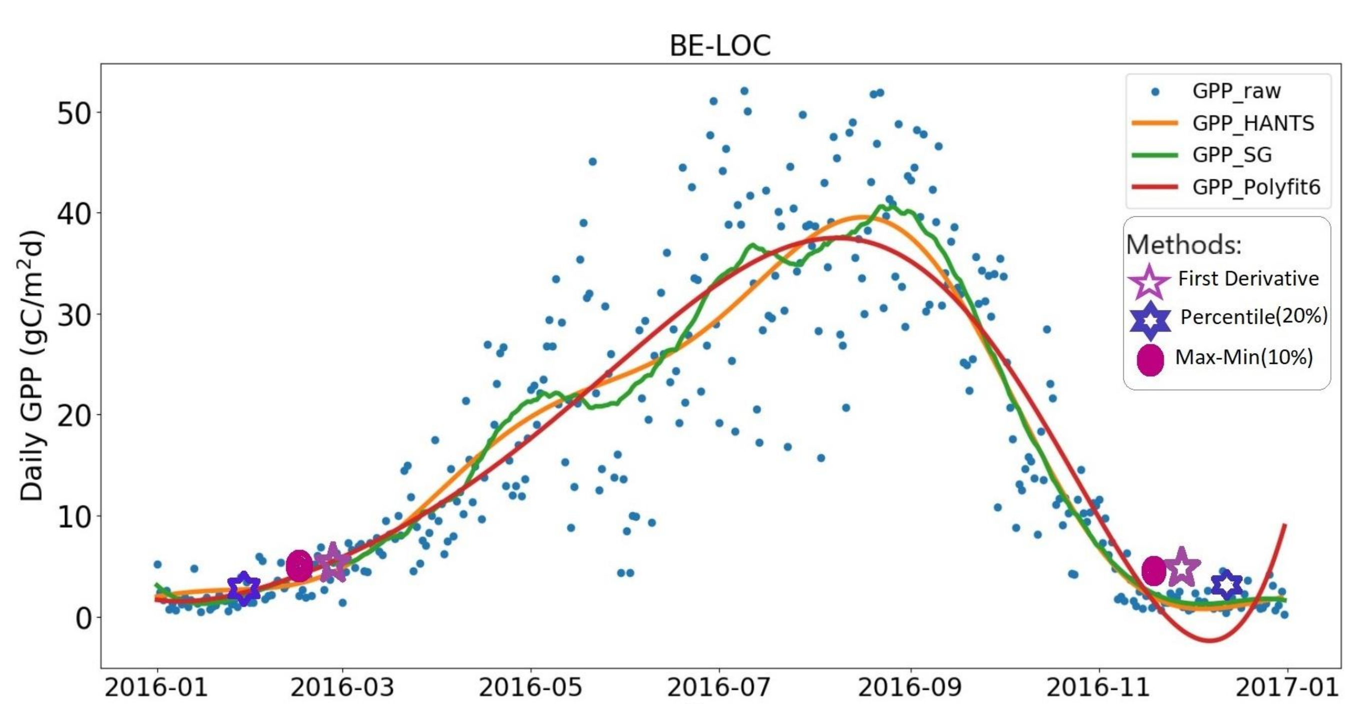
✓ Estimating the Start and End of the Season

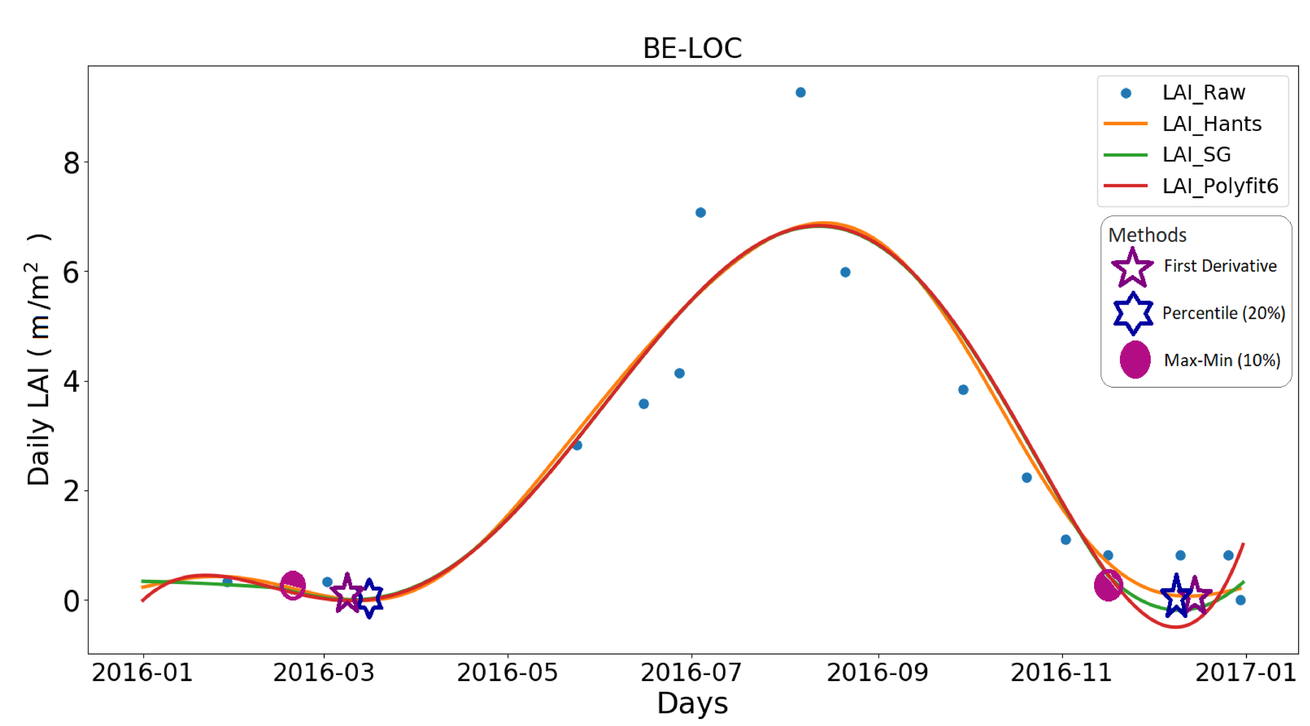
Estimating the Start and End of the Season by comparing the VIs derived by Satellite data in three methods: First derivative, 20th percentile, and Max-Min (10%)

✓ Evaluate the result

Defining which VIs are ideal proxies for vegetation phenology

GPP & LAI * Result1 *





Each line represents smoothing method (Savitzky Golay, Hants, and Polyfit method).
The three colored points indicate the three different methods to define the Start and End of the season (First derivative function, 10% of the range between minimum and maximum averaged over the smoothing line, and average 20th percentile of the three smoothed lines from low to high).

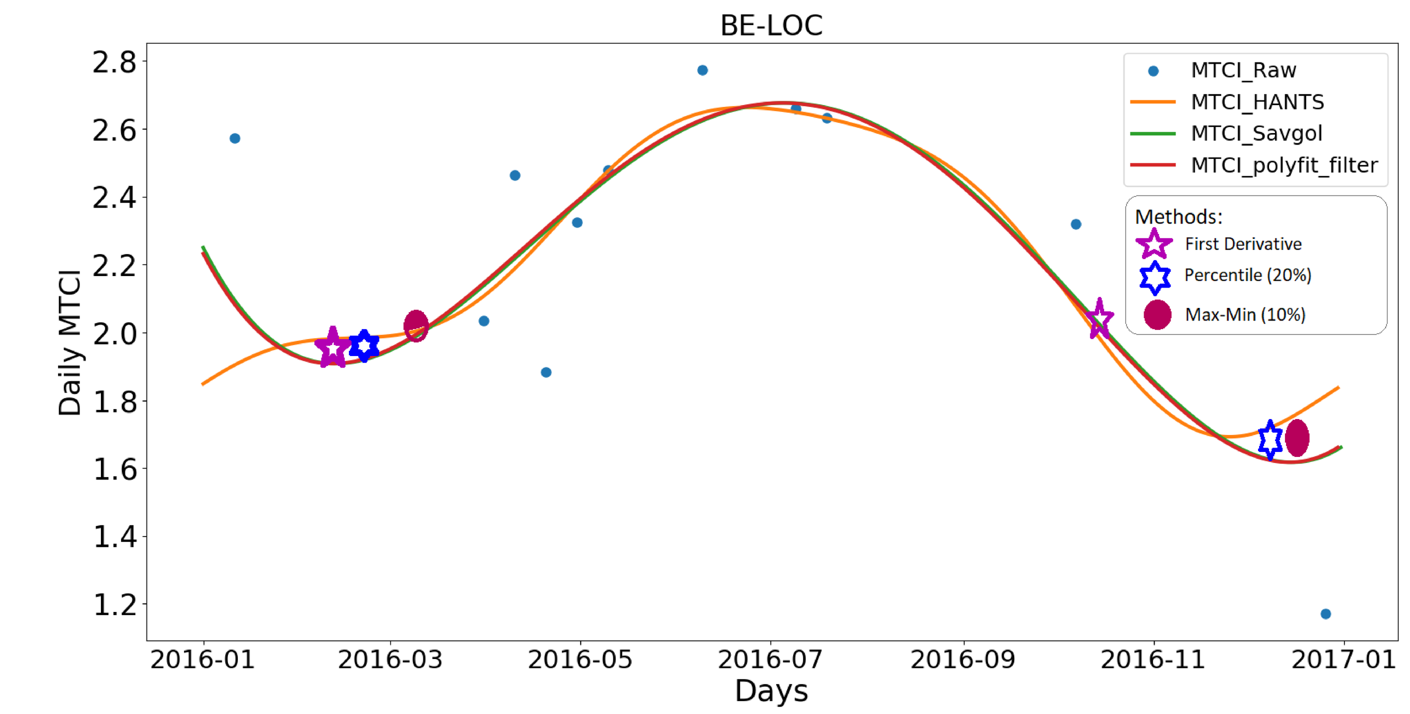
NDVI & MTCI * Result2 *

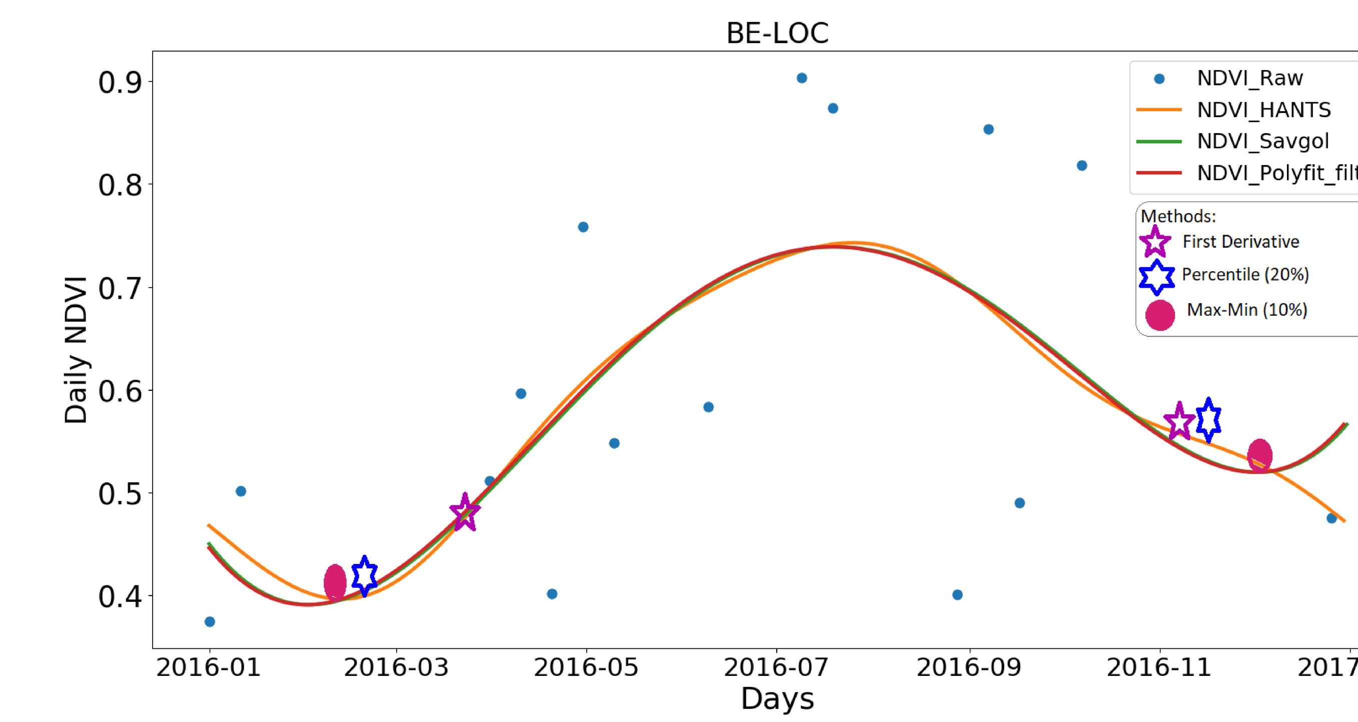
The spectral bands of Sentinel-2 offer the opportunity to calculate VI related to pigment content such as MTCI. The first method (purple star) indicates that season starts earlier and finishes sooner than two other methods.

Greenness based VIs, such as NDVI, are often used to parameterize land surface models.
First derivative function method (purple star) shows the start of the season late and finishes early.

	Smoothing Algorithm function	Start of Season	End of Season	Length of Season
GPP	Savitzky-Golay	55	325	270
	Hants	52	331	279
	Polyfit	37	338	301
LAI	Savitzky-Golay	78	334	256
	Hants	58	340	282
	Polyfit	61	324	263
NDVI	Savitzky-Golay	57	316	259
	Hants	62	355	293
	Polyfit	56	315	259
MTCI	Savitzky-Golay	66	327	261
	Hants	60	311	251
	Polyfit	65	326	261

Table above shows the average of three different methods for driving the Start and End of the Season for each phenological extraction methods. The last column indicates the Length of the season for each method.





Conclusion

- Sentinel-2 data for Belgium in 2016 provided not enough cloud-free data to track phenological changes well. This year was exceptionally cloudy.
- Some smoothing algorithm functions fit better at the beginning of the season with the pattern of the data, some better at the end of the season.
- Finding the ideal proxy for GPP and improving the phenological changes is challenging.

Recommendation

- Along with Sentinel-2, having data from different satellite products may help to have better estimation.
- The more data sites we have, the better analysis will be.
- During cloudy periods, remote Sensing products like high resolution satellite is not reliable to track phenological changes.
- Each phenological extraction method represents a different pattern. With applying more methods a more accurate result will be estimated.

Acknowledgements

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