



## **DATimeS, a new and effective toolbox for land management**

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Phenological studies are a key element of remote sensing vegetation studies. In agriculture studies, they are used for yield determination, and to improve management and timing of field works. In climate change studies, they are also used to calculate carbon cycles. Among the most used indicators for phenological models are NDVI and green LAI. These two indicators only account for green vegetation and do not consider senescence vegetation. Notice that the modeling of senescence vegetation is significantly relevant in dryland agriculture systems, where the crops remind in the fields while they have lost their greenness.

In this study, we independently analyzed the phenological behavior of NDVI, green and brown LAI of different crop types (e.g. wheat, maize, barley, green peas, beet and potato) using Sentinel 2 (S2) products. To model the data, we developed a new user-friendly and powerful time series toolbox written in MATLAB. The so-called Decomposition and Analysis of Time Series (DATimeS) includes a multitude of advanced machine learning regression algorithms (MLRA) (e.g. Gaussian Processes Regression - GPR), harmonic analyses (Fourier Transform) and non-linear least square regression (double sigmoidal function) to facilitate the extraction of the phenological metrics, such as: start of the season (SOS), end of the season (EOS), amplitude, maximum value, day of maximum value, Start and end of the season). From the practical perspective, when it comes to accurate and sufficiently fast processing of imagery to generate vegetation attributes, the preliminary results conclude that the family of kernel-based MLRAs (e.g. GPR) is the most promising processing approach. On the other hand, we determined that the EOS estimated with brown LAI was 10 to 50 days longer than using green LAI or NDVI. It means that the use of brown LAI in the phenological models could solve some of the mismatches between land surface phenology and ground truth phenology. It could be valuable to improve the agriculture management techniques and phenological studies. Lastly, it is worth stressing that DATimeS will become freely available to the community as part of the ARTMO (<http://ipl.uv.es/artmo/>) software framework.