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Satellite Leaf Area Index: global scale analysis of the tendencies per vegetation type over the last 17 years

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The dynamics of terrestrial vegetation is greatly altered by global environmental change. In particular, changes in vegetation greenness have been related to multiple biogeochemical drivers (such as CO_2 concentration in the atmosphere or changes in temperature and precipitation) and land-use effects (fertilization, irrigation, etc.). Impacts of such drivers on the vegetation dynamics and Leaf Area Index (LAI) are expected to depend on the region of the globe but also on the vegetation type. With recent advances in remote sensing techniques, it has become possible to study the LAI variations at the global scale and in a consistent way over the last decades. For instance, the BIOPAR dataset from the Copernicus Global Land Service project (http://land.copernicus.eu/global/) provides satellite derived LAI every 10 days at a 1 km spatial resolution since 1999. Yet, in spite of the high spatial resolution of such datasets, they do not allow to discriminate between vegetation types over mixed pixels.

In this study, we first developed a Kalman Filtering (KF) approach to disaggregate the satellite driven LAI from BIOPAR over nine main vegetation types, including broadleaves, conifers and grassland. We used as a prior information data from the ECOCLIMAP land cover database. Temporal fluctuations of the satellite signal are assumed to be due to changes of the properties of the dominant vegetation types in the pixel grid. The analysed LAI of the dominant cover type absorbs most of the temporal fluctuations that exist in the total LAI. This KF approach permits to separate the individual LAI of different vegetation types that co-exist in a grid pixel. Same approach has been developed by Carrer et al. (2013) to derive bare soil and vegetation albedos from total surface albedo products. In a second step a trend analysis has been conducted using the Mann-Kendall test for each vegetation type independently over the period 1999-2015 and comparisons with the original aggregated LAI have been performed. Resulting trends of the aggregated LAI compare well with previous regional or global studies, showing significant positive trends over a large part of the globe. Moreover, the trend over pixels with one predominant vegetation type expectedly compares well to the trend from BIOPAR LAI. More interesting, for pixels with mixed vegetation, the aggregated trend is partitioned unevenly among the vegetation types. This results demonstrates the usefulness of the disaggregation method compared to simple ones, such as uniform or simple weighted partitioning. The disaggregated LAI product may provide a new tool for monitoring tendencies of each vegetation type all over the globe.