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Mapping of SIF of OCO-2 from Local to Global Scale: A Multivariate Statistical Analysis Approach

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In late 2011, abundance of space borne solar induced florescence (SIF) measurements has opened the possibility to analyze these datasets for different environmental applications. Being a light emission from chlorophyll molecules of plants, SIF is an indicator of the integrative photosynthetic signal from the vegetation cover. Recent satellite missions for SIF retrievals include NASAs Orbiting Carbon Observatory-2 (OCO-2), Japanese Greenhouse gases Observing SATellite (GOSAT), Global Ozone Monitoring Experiment-2 (GOME-2), and others, including the upcoming mission, FLEX, by the European Space Agency. The OCO-2 is providing SIF retrievals with high accuracy and resolution, offering near-global coverage in its 16 days repeat cycle. However, one of the major hindrance associated with these datasets is that, these are Level-2 retrievals of the satellite with a narrow 10 km swath width. It reduces the extent of its daily global coverage and assessment of day-to-day variation, and this drawback eventually propagates in its time-series retrievals as well.

On contrary, traditional products to analyze terrestrial ecosystem dynamics, such as, Normalized Difference Vegetation Index (NDVI), Wide Dynamic Range Vegetation Index (WDRVI), Leaf Area Index (LAI), Fraction of Absorbed Photosynthetically Active Radiation (fAPAR), are complete in space and mostly with 8/16 days temporal resolution. Though space borne SIF retrievals are considered to be the better representative of photosynthetic activities compared to NDVI, LAI, fAPAR, etc., the scattered measurement by OCO-2 restricts its usage from local to global scale.

This work focuses on the global mapping of the SIF retrievals of OCO-2 by combing two traditional correlated datasets: MODIS/Terra Vegetation Indices NDVI layer (MOD13Q1 Version 6) and the MODIS/TERRA Gross Primary Productivity (GPP, MOD17A2H version 6). Existing literature has found that these data products are highly (sometimes linearly) correlated with SIF and can be utilized for the analysis of each other. While NDVI represents the measure of live green vegetation, the GPP is the rate of photosynthesis or rate of carbon intake by the plants in the ecosystem during a specific time. The MODIS Level-3 NDVI and Level-4 GPP data have the spatial and temporal resolution of (250 m, 16-day) and (500 m, 8-day) respectively.

In order to globally map OCO-2's SIF footprints, a multivariate geostatistical spatial interpolation method has been adopted here, namely Semantic CoKriging (SemCK). It can intake the additional NDVI or GPP data as input for the interpolation of the primary variable SIF for the whole study region. Here, the major pre-processing criteria is to check that the OCO-2's SIF measurements and the NDVI or GPP data coexists at the same time instance for the given study regions and are correlated. Compared to the traditional univariate interpolation approaches, this multivariate method is capable to produce more coverage of SIF with enhanced accuracy and can distinguish the dense and healthy vegetation covers outside the narrow swath of OCO-2. Our work is one preliminary attempt to provide a global dataset for vegetation activity and model evaluation, and to monitor changes, e.g., during extreme events, through statistical analysis and data integration approach.