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Carbon fluxes estimation with aleatoric and epistemic uncertainties at high spatial resolution over large areas

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Gross primary production (GPP) represents the amount of carbon captured via vegetation photosynthesis, being this process one of the main drivers of climate regulation. Due to its importance, GPP is routinely estimated at global scales using different operational algorithms combining remotely-sensed data from medium spatial resolution sensors and ancillary meteorological information. There are numerous processes at multiple spatio temporal scales that result in GPP variability. Since these processes occur simultaneously at finer resolutions but also across large areas there is a need for GPP products that meet these specifications. The estimation of GPP requires consistent mosaics and long time series of high spatial resolution satellite information, which are often plagued by data record gaps as a result of cloud contamination, radiometric differences across sensors, scene overlaps, and their inherent sensor noise. To overcome these constraints, we used the HIghly Scalable Temporal Adaptive Reflectance Fusion Model (HISTARFM) algorithm that fuses spectral data from Landsat and MODIS and produces monthly gap free surface reflectance data at 30m over large areas with associated well-calibrated data uncertainties. Combining this monthly high resolution data with daily meteorological information, along with in-situ eddy covariance GPP estimates leads us to be able to create accurate and continuous high spatial resolution GPP estimates and their corresponding uncertainties (aleatoric and epistemic) using machine learning approaches. The processing pipeline is implemented in the Google Earth Engine (GEE) to produce a long time series (20 years) of continuous GPP estimates over Europe at 30m. This work enables more precise carbon studies and understanding of land-atmosphere interactions, as well as the possibility of deriving other carbon, heat and energy fluxes at an unprecedented spatio-temporal resolution.