Scaling of Space-Based Measurements of Sun Induced Chlorophyll Fluorescence to Global Gross Primary Production

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Gross Primary Productivity (GPP) is the amount of atmospheric carbon dioxide taken up by ecosystems via photosynthesis. This is the single largest flux of the global land carbon budget and makes plants an important component of the global climate system. The uncertainties of modeling terrestrial global GPP are large, partly because of lacking direct global measurements. The measurement of sun induced chlorophyll fluorescence (SIF), which is linked to photosynthesis could be therefore of vital importance for the modeling of GPP. The fluorescence signal, whose maximum lies in a spectral range of 650 nm - 800 nm, can be monitored globally with the GOME-2 instrument on board of the Metop-A satellite which has been launched in October 2006. Although the link between photosynthesis and fluorescence at the leaf scale is relatively well known based on lab- and field-experiments, the relationship at the canopy level and for the coarse spatial resolutions provided by space-borne instruments (of the order of 10 km-100 km) is still uninvestigated. An inspection of the functional relationship between remotely sensed SIF and a state of the art statistically upscaled GPP product on grid box basis (0.5° resolution) reveals good linear relations almost everywhere on the globe. However changes of tlhe slopes between pixels are observed, which are expected to be caused by canopy related properties. These can be structural effects, which alter the outgoing fluorescence signal by scattering and reabsorbtion, or changing efficiencies of photosynthesis and fluorescence. As estimates of these quantities are missing on a global scale, a set of meteorological variables (temperature, precipitation, etc.) and the clumping index are used as proxy variables. The changing relationship is then modeled with a model based partitioning algorithm.

It can be shown that the model complexity can be drastically reduced without a significant loss of model performance by going from a per-pixel-fitting to the model based partitioning approach. As a result of this study we provide global estimates of GPP based on SIF observation on a monthly basis.