Crop models and satellite data to assess regional CO2 fluxes over agricultural areas: Comparison of interanual variability provided by three approaches

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We estimate the temporal and spatial variations of CO2 fluxes over a typical European agricultural area using three different approaches of combining crop production models with satellite data (coarse and high spatial resolution observations in the solar spectrum) for several years. We assess the sensitivity of the methods to variations in climatic conditions and we discuss the relative interest of satellite time series when used as driving variables or as constraints of production models.

The models are either production efficiency models or mechanistic crop models. The Kumar and Monteith (1981) efficiency model is driven by the temporal profile of the fraction of absorbed photosynthetically active radiation (FPAR) derived from satellite observations. This model is first applied at the regional scale, using only coarse spatial resolution data, with an estimation of the light use efficiency at that scale. In the second approach, the model is applied for each crop, using a parameterization of the seasonal course of the FPAR for each crop which is constrained by high spatial resolution data. At the regional scale, the results of these two different ways of applying a production efficiency model are rather similar because of two opposite biases in the modelling. The sensitivity of the parameterization to the uncertainty is discussed.

The third approach uses mechanistic crop production models for the major crops. For each crop, the individual simulation is constrained by high spatial resolution satellite data. The aggregation of the simulated individual crop radiometric profiles gives the regional profile that can be tested against the coarse satellite observations. This approach leads to regional estimates of CO2 fluxes which are significantly lower than the ones obtained using production efficiency models: this could be due to the light-use efficiency simulated by the mechanistic models which can be reduced by various environmental conditions. Since more biological processes are accounted for, and since a partial validation is provided by satellite observations, this approach seems to be the most reliable for estimating CO2 fluxes at that scale.