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Quantifying the effect of crops surface albedo variability on GHG budgets in a life cycle assessment approach : methodology and results.

Morgan Ferlicoq, Eric Ceschia, Aurore Brut, and Tiphaine Tallec

CESBIO, UMR 5126 - CNES-CNRS-UPS-IRD- 18 avenue Edouard Belin 31401 Toulouse cedex 9, France (morgan.ferlicoq@cesbio.cnes.fr)

We tested a new method to estimate the radiative forcing of several crops at the annual and rotation scales, using local measurements data from two ICOS experimental sites. We used jointly 1) the radiative forcing caused by greenhouse gas (GHG) net emissions, calculated by using a Life Cycle Analysis (LCA) approach and in situ measurements (Ceschia et al. 2010), and 2) the radiative forcing caused by rapid changes in surface albedo typical from those ecosystems and resulting from management and crop phenology.

The carbon and GHG budgets (GHGB) of 2 crop sites with contrasted management located in South West France (Auradé and Lamasquère sites) was estimated over a complete rotation by combining a classical LCA approach with on site flux measurements. At both sites, carbon inputs (organic fertilisation and seeds), carbon exports (harvest) and net ecosystem production (NEP), measured with the eddy covariance technique, were calculated. The variability of the different terms and their relative contributions to the net ecosystem carbon budget (NECB) were analysed for all site-years, and the effect of management on NECB was assessed. To account for GHG fluxes that were not directly measured on site, we estimated the emissions caused by field operations (EFO) for each site using emission factors from the literature. The EFO were added to the NECB to calculate the total GHGB for a range of cropping systems and management regimes. N2O emissions were or calculated following the IPCC (2007) guidelines, and CH4 emissions were assumed to be negligible compared to other contributions to the net GHGB.

Additionally, albedo was calculated continuously using the short wave incident and reflected radiation measurements in the field (0.3-3μm) from CNR1 sensors. Mean annual differences in albedo and deduced radiative forcing from a reference value were then compared for all site-years. Mean annual differences in radiative forcing were then converted in g C equivalent m-2 in order to add this effect to the GHG budget (Muñoz et a. 2010).

Increasing the length of the vegetative period is considered as one of the main levers for improving the NECB of crop ecosystems. Therefore, we also tested the effect of adding intermediate crops or maintaining crop voluntary re-growth on both the NECB and the radiative forcing caused by the changes in mean annual surface albedo. We showed that the NEP was improved and as a consequence NECB and GHGB too. Intermediate crops also increased the mean annual surface albedo and therefore caused a negative radiative forcing (cooling effect) expressed in g C equivalent m-2 (sink). The use of an intermediate crop could in some cases switch the crop from a positive NEP (source) to a negative one (sink) and the change in radiative forcing (up to -110 g C-eq m-2 yr-1) could overwhelm the NEP term.