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Interactive comment on "N_2O release from agro-biofuel production negates global warming reduction by replacing fossil fuels" *by* P. J. Crutzen et al.

Anonymous Referee #2

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The study derives a global N2O yield factor for reactive N input and applies it to the climate effects of biofuels. Although the concept is interesting, I disagree with the methods used and the way the global agricultural N2O yield factor is applied for the example of biofuels.

The numbers quoted from Prather et al. differ from those in the TAR, which e.g. give an emission from agricultural soils of 4.2 (0.6-14.8) TgN/yr. It is unclear how the range 4.3-5.8 Tg N was derived from the quoted studies.

The N2O yield is applied to crops in the study. Therefore, it should only be calculated for emissions from soils. The deduction from the atmospheric budget seems to include N2O emissions from animal husbandry in the agricultural budget, which would overestimate the emissions from crops. The N cycling in crop production is tighter than in animal husbandry, which is responsible for a large share of N recycling and NH3 emissions with subsequent indirect N2O emissions. Animal husbandry needs to be separated before a global N2O yield can be applied to life cycle assessment of crops. Otherwise a global agricultural N2O yield will overestimate N2O background; emissions from crop production.

Co-products cannot be ignored in the case of biofuels because they are a large fraction of the harvested biomass, and contain most of the harvested N. Co-products could only be ignored in life cycle assessments of solid bioenergy use (e.g. (Freibauer and Kaltschmitt 1998). The calculation presented in the study with an incomplete life cycle assessment attributes too much reactive N, and consequently N2O, to the crop production for biofuels, because not all reactive N is needed for the fraction of the crop that ends as biofuel. The result of the assessment is very sensitive to assumptions made for the allocation of N to the various products. Therefore, the results are not robust without a sensitivity analysis of different allocations, e.g. also - by the harvested mass fraction used for biofuel production. The biodiesel case (Appendix A b) even distinguishes between the fractions. In this simplified life cycle assessment, only the oil fraction should enter the equation. - by N in the biofuel product: the fuels chosen hardly contain any N. Most N ends up in bargasse and oilseed cakes, which are often also commercially used. This would set the accountable N2O emissions almost to zero.

Equation 1 (cv) and Appendix A a), content of ethanol, contain errors in the units.

Equation 1 is incomplete. The equation gives CO2 emissions from the burning of the biofuel. The difference in energy content per mass and in the C-content as compared to the fossil fuel (gasoline or diesel) needs to be considered as well to calculate avoided fossil CO2 emissions.

I do not understand why you need the e factor in Equation 2 since you account for the background emissions already with the y factor. Isn´t this double counting of the N recycled in the agricultural system?

The result that low-input species are more favourable for climate than intensive crops is not new (e.g. (Tilman et al. 2006)).

The study requires a better acknowledgement of the uncertainties derived from the global atmospheric approach and in the assumptions made in the simplistic life cycles. While the global analysis indicates a N_2O yield of 3-5% of reactive N input it is not evident why this value derived for agriculture as a whole should be more realistic for crop production than lower values supported by field studies. The allocation of N_2O emissions to the biofuels and co-products needs to be analysed, and corrections and clarifications made in the equations as indicated. With the assumptions made the compensation effect of N_2O emissions from biofuels is overestimated.

This study is simplistic and may give the wrong signal although I fully agree with the general statement that biofuels are ineffective for climate change mitigation.

Freibauer, A. and Kaltschmitt, M. 1998. Gasförmige Stickstoffemissionen im Lebensweg von Getreide zur Energiebereitstellung (Gaseous nitrogen emissions in the life of energy cereals). Umweltwissenschaften und Schadstoff-Forschung. Zeitschrift für Umweltchemie und Ökotoxikologie, 10(6): 353-365. Tilman, D., Hill, J. and Lehman, C. 2006. Carbon-Negative Biofuels from Low-Input High-Diversity Grassland Biomass. Science, 314(5805): 1598-1600.

Interactive comment on Atmos. Chem. Phys. Discuss., 7, 11191, 2007.