

# ***Interactive comment on “N<sub>2</sub>O release from agro-biofuel production negates global warming reduction by replacing fossil fuels” by P. J. Crutzen et al.***

**P. J. Crutzen et al.**

Received and published: 21 September 2007

Donner (2007) provides a very interesting overview on the current understanding on global N<sub>2</sub>O emissions. It may seem surprising but the figures we present are not in discrepancy to this current state of research.

The IPCC plot scale direct emission factor is presented as 0.003 - 0.03 kg N<sub>2</sub>O-N per kg N fertilizer applied (IPCC, 2006). The upper end of the range is consistent with the lower end of our range (0.03-0.05), while we consider indirect emissions in addition. Furthermore, Seitzinger et al. (2000) estimate indirect emissions from rivers, estuaries and continental shelves between 0.9 and 9.0 Tg N per year (best estimate 1.9), with a large share (more than two thirds, at least in the best estimate case) due to

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anthropogenic nitrogen. All of the anthropogenic  $\text{N}_2\text{O}$  source we assume in our paper (5.6–6.5 Tg N) can be explained by the indirect emissions alone, if using the upper end estimate. We could add that indirect emissions are not necessarily limited to aquatic regimes.

The point is that due to extreme variability in emission patterns, both temporally and spatially, it is extremely difficult to obtain consistent and reliable measurement results. Despite considerable efforts, emission factors of  $\text{N}_2\text{O}$  are still highly uncertain. This problem calls for an alternate approach that allows assessing such emissions at higher precision. We claim to be able, at least on a global scale, to provide such an approach. We also claim that this is not in discrepancy with the set of measurements available. But we reject the expectation that our result should fit the best estimate of a very uncertain set of data.

There is reason to believe that uncertainty margins applicable for plot scale are largely overestimated on the global scale (see the agreement observed by Mosier et al., 1998). In that case, additional indirect  $\text{N}_2\text{O}$  formation needs to be assumed, as from re-use of reactive nitrogen and subsequent  $\text{N}_2\text{O}$  formation during animal husbandry and in form of manure fertilizer (see Ammann et al., 2007, and our response). Note that, according to IPCC (2006), manure application will be regarded a cause of additional  $\text{N}_2\text{O}$ , while it is no additional reactive nitrogen. This supports rather than alters our argument.

A global approach as presented by Crutzen et al. (2007) will not allow a direct attribution of emissions to a specific country and a specific source. This will be needed to be useful for IPCC. Also for this purpose - here we fully agree with Donner (2007) - a better understanding of soil processes, especially of the nitrogen mobilization, is required.

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