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# *Interactive comment on* "Methane production from mixed tropical savanna and forest vegetation in Venezuela" *by* P. J. Crutzen et al.

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The report by Keppler et al. (2006) that methane is emitted in significant amounts by plant leaves has generated, not unexpectedly, a great deal of interest – and much comment, some of it informed, some of it quite the opposite! Obviously it is desirable to collect additional evidence to help quantify any such new source, so that the implications for the composition of the global methane budget can be assessed. Crutzen et al, in their short paper, have reproduced data from Scharfe et al. (1990), obtained in a field study in Venezuela in 1988, on the accumulation of methane in the atmosphere at night in an area partly covered by savanna vegetation and partly by forest. This reexamination of old data, in the hope of throwing some light on a possibly important new pathway for CH4 entering the atmosphere, is in principle a very useful way forward.



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In the original Scharfe et al. paper, the forest soils were shown by chamber methods to be a substantial sink for methane ($5\times10^{10}$ molecules $cm^{-2}$ $s^{-1}$), while the savanna soils were a source ($3–4\times10^{10}$ molecules $cm^{-2}$ $s^{-1}$). However, the estimate of methane emissions in the area, based on the accumulation under the nocturnal boundary layer, was $5\times10^{11}$ molecules $cm^{-2}$ $s^{-1}$, i.e., as stated by the authors, more than 10 times larger than the direct emissions recorded from the soils. They concluded that other significant dispersed sources of CH4 must have existed in the region, e.g. small tracts of flooded soil and termites. However, in this particular instance, the calculation of the CH4 emission source appears to be entirely dependent on two major assumptions: (1) that the nocturnal boundary layer (NBL) was at a height of 100 m, as reported for another occasion by Octavio et al. (1987), and (2) that the methane was uniformly mixed from ground level to this height. Using these assumptions and calculating the accumulation in the imaginary "box" under the NBL, gives a value (upscaled to the entire savanna regions of the globe) of 60 Tg CH4, over a full year, as in the paper, but on the basis of other studies (admittedly carried out in different ecosystems) it seems likely that this estimate may be an order of magnitude too high. It seems to be widely established within the micrometeorological community that, during the build-up of the NBL, gases do not mix well within the layer, and steep vertical profiles (such as those cited below) are common, and these profiles should be integrated over the NBL depth to infer the surface source strength (Culf et al., 1999). For example, Denmead et al. (1996) reported that when a NBL formed over pasture in Australia the accumulated CO2 was virtually all confined within a height of 40 m above the ground, and furthermore the concentration decreased curvilinearly from the ground surface to this maximum height. On a visual examination of their graph, the equivalent "box height", assuming uniform mixing, would only have been about 16–17 m. Applied to the Venezuelan data, this would reduce the global emission estimate to 10 Tg $y^{-1}$. Also, in an EU-supported study of methane emission from rice fields in Italy, nocturnal accumulations of CH4 and CO2 were large and easily measured, but generally declined steeply with increasing height, and were down to ambient levels at no more than 10 m above the ground



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(Conen, 2000). Here, the average “box height”, again assuming uniform mixing, would only have been 4–5 m, and any estimate based on a 100 m NBL would be exaggerated by 20–25 fold. Reducing the Crutzen et al. estimate by such a factor would bring their emission rate into the realm represented by Scharfe et al.’s chamber measurements, and thus obviate the need to invoke any non-soil source to explain the observed nocturnal accumulation of CH4. So a re-examination by the authors of the uncertainty in their estimate of the source strength would be welcome.

To question the magnitude of this particular estimate of CH4 emissions is not necessarily to dispute the evidence produced by Keppler et al. that vegetation releases methane to the atmosphere. However, it would appear that alternative approaches to finding supporting (or contradictory) evidence may have to be employed. There may well be other useful studies from the past which can be returned to in the way attempted here by Crutzen et al. and readers of this debate should be encouraged to think of likely examples that can be investigated.

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