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Methane production from mixed tropical savanna and forest vegetation in Venezuela

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Abstract

Measurements of methane concentrations in the boundary layer in the northern part of the Guayana shield, Venezuela, during the wet season (October 1988), showed the presence of substantial methane surface emissions. The measuring site is within the savanna climate region, but is affected by emissions from savanna and forest vegetation. From day versus night concentration measurements, with higher concentrations during night, a methane source strength near the site of $3–7\times10^{11}$ molecules/cm^2/s can be estimated, which includes emissions from small tracts of flooded soils, termites and especially tropical vegetation. Extrapolated to the entire savanna, this may imply a methane source of ~30–60 Tg yr^{-1} similar to the one calculated for tropical vegetation on the basis of recently published in vitro plant emission experiments by Keppler et al. (2006), which indicate emissions of ~30 Tg yr^{-1} for tropical savannas and grasslands and ~78 Tg yr^{-1} for tropical forests.

1 Introduction

The finding by Keppler et al. (2006) of methane production under aerobic conditions by leaves of living plants is a striking discovery in biological and atmospheric chemistry with implications also for climate. Extrapolating from their measurements in incubation chambers to global conditions, using net primary production in various ecosystems as a metric, they derive a global CH_4 production rate of 62–236 Tg/ year of methane, which is 10–40% of the total methane production rate. With the biochemical mechanism still unknown, and the assessment of the implications for the global methane budget depending on how to properly upscale their in vitro results, considerable discussions undoubtedly will follow. Here we reanalyzed 18 year old data, obtained in the Venezuelan savanna climate region that, as we will see, support the occurrence of large methane emission estimates from plants as first reported by Keppler et al. (2006). A map showing the region (Koeppen classification) can be found in Sanhueza et al. (1988). The

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environmental conditions in the Orinoco savanna region have been published by Sanhueza and Crutzen (1998). For a description of the experimental setup and local conditions at the Guri site, we refer to Scharffe et al. (1990).

2 Results and discussion

Because the measurements by Keppler et al. (2006) were conducted on a laboratory scale, up-scaling to the globe causes major uncertainties. Here we reanalyze and reinterpret data obtained during a field campaign 18 years ago in October 1988, in the Venezuelan savanna climatic region during the wet season, first reported by Scharffe et al. (1990), which support the occurrence of high CH_4 production rates from vegetation. In Fig. 1 we reprint measurement results, showing the accumulation of methane during the night under a 100 m high inversion layer (Octavio et al., 1987). From these data a nocturnal production of CH_4 of $(3–7)\times10^{11}$ molecules/cm^2/s was derived. As indicated in the Scharffe et al. paper the savanna measuring site was located nearby ($\leq$1 km) a forest, therefore, the CH_4 data presented in Fig. 1 are most likely affected by both savanna and forest emissions.

Assuming similar methane production rates during the day, which might be an underestimate, an extrapolation of these data to all savanna regions with a total area of 15×10^6 km^2 during the wet season (Bolin et al., 1979) yields a CH_4 production of at least 30 Tg/year. A similar source during the dry season would double the estimated CH_4 source. While Scharffe et al. (1990) invoked termites and small pools as sources of methane, in light of the discovery by Keppler et al. (2006), it now seems likely that the methane emissions largely came from the savanna and forest vegetation. It is interesting to note that the ratios between CH_4 production and net primary productivity (Bolin et al., 1979) for the field measurements were in the order of 0.002–0.004, similar to the ratios in the in vitro study by Keppler et al. (2006).

3 Conclusion

Our old field data are thus in favor of the large CH_4 production rates from vegetation as derived by Keppler et al. (2006), which were based on wide extrapolations from the laboratory to the globe. The concentrations of CH_4 of at least about 1.78 ppmv that were measured in the savanna region, compared to a global background value for 1988 of 1.67 ppmv is a further indication of a large tropical source of methane. Further field studies are needed to clarify and quantify methane emissions from savanna vegetation to establish whether the extrapolations to large scale ecosystems are valid.

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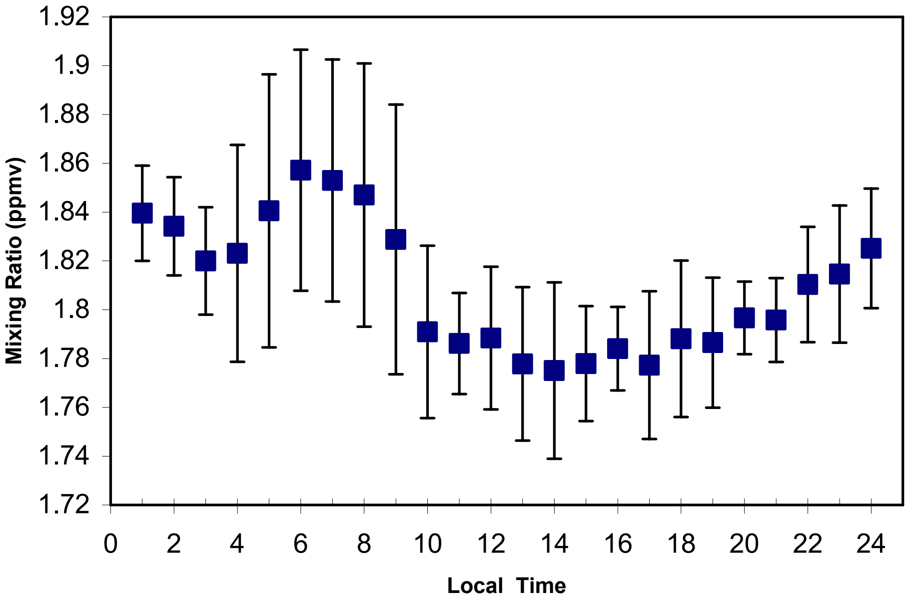

Fig. 1. Diurnal cycle of atmospheric CH_4 mixing ratios at 2 m height derived from 720 measurements at a Savanna site in Venezuela, October 1988.

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