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Interactive comment on "Methane emissions from boreal and tropical forest ecosystems derived from in-situ measurements" *by* V. Sinha et al.

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comment by Peter Bergamaschi, Maarten Krol, Jan Fokke Meirink, and Christian Frankenberg

The paper presents two 2-week CH4 measurement time series, one from a boreal measurement site (Hyytiäla , Finland), and one from a tropical forest site (Brownsberg, Surinam).

The paper illustrates nicely, how concentration changes in the nocturnal boundary layer can be used to estimate regional sources (or sinks).

We want to comment, however, on 3 points:

(1) The authors compare their in-situ measurements from the Hyytiäla site with column-averaged CH4 mixing ratios from SCIAMACHY and corresponding model simulations presented in Figure 5 of [Bergamaschi et al., 2007; hereafter B07]. However, these quantities cannot be directly compared, due to the significant vertical CH4 gradient (in particular in the stratosphere). This is illustrated in Figure 1:

ftp://ftp-ccu.jrc.it/pub/bergamas/comment_Sinha_ACPD_2007/TM5_CH4_HYY.pdf

where we have plotted the vertical model gradient over the Hyytiäla site (average for 16/04/2003-01/05/2003, for model scenario S1 in B07). For our comparison with the SCIAMACHY data in B07 we had calculated model column-average mixing ratios (XCH4) according eq. (2) in B07, taking into account the vertical a priori CH4 profile used for the retrieval procedure and the averaging kernels (see [Frankenberg et al., 2006, Fig. 2). The XCH4 for the model profile over Hyytiäla (evaluated here for an air mass factor of 2.0) is also shown in Fig 1 (red line), clearly illustrating the significant difference to modelled values at the surface.

In Figure 2 we have plotted the simulated CH4 surface mixing ratios (daily averages) at the Hyytiäla site (again for scenario S1 in B07) and the measurements presented in this paper. This illustrates that the model results are within the relative large uncertainty range of 2.5 % of the measurements. For comparison also XCH4 is plotted (red curve) in Figure 2, being typically about 100 nmol/mol lower than simulated CH4 surface mixing ratios.

(2) The presented diurnal cycles of CH4 mixing ratios combined with measurements of nocturnal boundary layer are indeed a very attractive method to study regional emissions. However, at the same time it is clear that the typical region of influence is relatively small. With a wind speed of ˜1 m/s and 10 hours persistence of NBL the extension of the influence region is $<$ 36 km. However, the authors use the measurements of this relatively small footprint to estimate the global total for the boreal forest ecosystem (i.e. wetland emissions plus potential aerobic plant emissions). As the au-

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thors show, the emissions are probably dominated by a small percentage of wetlands and lakes within the region of influence of the measurement site. Extrapolating their measurements to global total emissions thus assumes that the wetland / lake percentage in their region of influence are representative numbers for the global boreal forest. Furthermore this analysis ignores completely any seasonal variation (the presented data are just 14 days in April).

(3) In section 3.3.2 the measured vertical gradients of CO2 are used to show that the nocturnal boundary layer is well mixed. Therefore it is argued by the authors that the measured mixing ratios at the 8.5 m level can be taken as representative for the entire boundary layer. Although under cloudy and/or windy conditions the nocturnal boundary layer can be neutral or even turbulent, the situation depicted in figures 5a and 5b is a typical example of a stable nocturnal boundary layer. These layers are characterized by a cooling surface and a strongly laminar flow with low wind speeds close to the surface. The laminar structure of these layers prevents vertical mixing and the vertical profiles of conserved properties with a surface source or sink (like potential temperature, CO2, and CH4) typically show a logarithmic shape (see potential temperature profile in figure 5b). The reason that the CO2 profiles in figure 6 show variations of less than 0.5% can be explained by the high concentration of CO2. The profile is slightly perturbed by a respiration flux at the surface. However, if we assume a 0.5% variation in the nighttime profile of the methane mixing ratio, the concentration difference between the surface and 70 m would amount to 9 nmol/mol. This concentration difference is by no means small compared to the 30 nmol/mol nighttime increase in the mixing ratio. Obviously the well-mixed assumption leads to a systematic overestimate of the derived flux. A much better assumption would be a logarithmic concentration profile!

References

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