1 Methane from biomass burning emissions

Using typical emission factors of CO and CH$_4$ from biomass burning of tropical forest (see Table 1 in main document), we can estimate the enhancement of CH$_4$ relative to background levels emitted from biomass burning.

\[
(CH_4)_{BB} = \frac{EF(CH_4)}{EF(CO)} \cdot (CO)_{BB}
\]

\[
= \frac{6.8}{104} \left( \frac{\text{g CH}_4}{\text{g CO}} \right)^{-1} \cdot (CO)_{BB}
\]

\[
= \frac{6.8}{104} \left( \frac{16.04 \text{g mol}^{-1}}{28.01 \text{g mol}^{-1}} \right)^{-1} \cdot (CO)_{BB}
\]

\[
= 0.114 \cdot (CO)_{BB}
\]

For example, during the events of biomass burning pollution in LDS2005 CO enhancements of up to $1.5 \times 10^{18}$ molec cm$^{-2}$ above background are observed (see Petersen et al. (2008)). From these observed CO levels, we estimate $1.7 \times 10^{17}$ molec/cm$^2$ of additional methane from tropical fire biomass burning:

\[
(CH_4)_{BB} = 0.114 \cdot (CO)_{BB}
\]

\[
= 0.114 \cdot (1.5 \times 10^{18} \text{ molec cm}^{-2})
\]

\[
= 1.7 \times 10^{17} \text{ molec cm}^{-2}
\]

From the observed CO levels during the LDS 2005, we expect 0.3 to $1.7 \times 10^{17}$ molec/cm$^2$ of additional methane from biomass burning assuming tropical forest emission factors. This is equivalent of around 0.1 to 0.5% (2 to 9 ppb).

2 Biomass burning signatures in the ratio CH$_4$/CO$_2$

In this section, we investigate the influence of biomass burning on the CH$_4$/CO$_2$ ratio. Using typical emission factors of CO and CO$_2$ from biomass
burning of tropical forest (see Table 1), we can estimate the enhancement of CO\textsubscript{2} relative to background levels emitted from biomass burning.

\[
(CO_2)_{BB} = \frac{EF(CO_2)}{EF(CO)} \cdot (CO)_{BB} \\
= \frac{1580 \text{ [g CO}_2\text{]} }{104 \text{ [g CO]}} \cdot (CO)_{BB} \\
= \frac{1580}{104} \left( \frac{16.04 \text{ g mol}^{-1}}{44.01 \text{ g mol}^{-1}} \right)^{-1} \cdot (CO)_{BB} \\
= 9.67 \cdot (CO)_{BB}
\]

For the high CO enhancement of $1.5 \times 10^{18}$ molec cm\(^{-2}\) during the LDS 2005, this yields

\[
(CO_2)_{BB} = 9.67 \cdot (CO)_{BB} \\
= 9.67 \cdot (1.5 \times 10^{18} \text{ molec cm}^{-2}) \\
= 14.5 \times 10^{18} \text{ molec cm}^{-2}
\]

The ratio CH\textsubscript{4}/CO\textsubscript{2} for background level of 1720 ppb for methane and 360 ppm for carbon dioxide is

\[
\frac{CH_4}{CO_2} = \frac{1720 \text{ ppb}}{360 \text{ ppm}} \\
= \frac{3.7 \times 10^{19} \text{ molec cm}^{-2}}{7.7 \times 10^{21} \text{ molec cm}^{-2}} \\
= 0.00481 \text{ molec cm}^{-2}
\]

For the CO enhancement of $1.5 \times 10^{18}$ molec cm\(^{-2}\) during the LDS 2005, the ratio is

\[
\frac{CH_4 + (CH_4)_{BB}}{CO_2 + (CO_2)_{BB}} = \frac{(3.7 \times 10^{19} + 1.7 \times 10^{17}) \text{ molec cm}^{-2}}{(7.7 \times 10^{21} + 14.5 \times 10^{18}) \text{ molec cm}^{-2}} \\
= 0.00482 \text{ molec cm}^{-2}
\]

The methane emissions due to biomass burning are hidden in the CH\textsubscript{4}/CO\textsubscript{2} ratio as both species are enhanced in a similar way, as shown above. The good agreement of the CH\textsubscript{4}/CO\textsubscript{2} ratio of FTIR and satellite and the differences between the FTIR and satellite XCH\textsubscript{4} indicate that the influence of
biomass burning for methane can hardly be detected by the satellite (with this retrieval method). The consistency of the FTIR and satellite observations of CH$_4$/CO$_2$ suggests that biomass burning might be the cause for the observed differences between the FTIR observations and the satellite observations of XCH$_4$ and the TM5 model.

References
