

Seminar “Physics and Chemistry of the Atmosphere”,  
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## Impact of stray light on greenhouse gas concentration retrievals and emission estimates as observed with the passive airborne remote sensing imager MAMAP2D-Light

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MAMAP2D-Light is an airborne passive remote sensing imaging push-broom spectrometer developed at the Institute for Environmental Physics at the University of Bremen to determine atmospheric methane ( $\text{CH}_4$ ) and carbon dioxide ( $\text{CO}_2$ ) column anomalies in the  $1.6\ \mu\text{m}$ -band to quantify point-source emissions. In its initial version, as flown in 2022 in Canada, a significant stray light level of 5.6 % of the measured signal has been observed post-campaign, causing apparent error patterns in the retrieved  $\text{CO}_2$  and  $\text{CH}_4$  column anomalies.

Measurement data collected during the airborne campaign in 2022 in Canada offer the unique opportunity to investigate the end-to-end impact of stray light and its correction on the retrieved  $\text{CO}_2$  and  $\text{CH}_4$  column anomalies, as well as the derived emission rates. The stray light correction is investigated for its impact on the  $\text{CH}_4/\text{CO}_2$  proxy method, the  $\text{CH}_4$  column, and derived point-source emissions. In nearly all cases, applying the  $\text{CH}_4/\text{CO}_2$  proxy method reduced the stray-light-related column errors below the column noise. The derived emission rates for the proxy-retrieval with and without straylight corrected spectra are comparable, proving for the first time the capabilities of the  $\text{CH}_4/\text{CO}_2$  proxy method to correct stray light-related artifacts. Additionally, the impact on the  $\text{CH}_4$  total column retrieval for a high-contrast scene condition, for which correction using the proxy method is no longer sufficient, is shown. Following the initial campaign in 2022, the post-campaign stray light characterization and analysis revealed that a significant fraction of stray light was attributed to reflective surfaces in the object plane of the spectrometer. Based on these findings, the total stray light was reduced by  $\sim 63\%$  by implementing a hardware modification from 2023 onward.