Using the O_2 column from the O_2 singlet delta band to derive proxy XCH_4 from MethaneAIR observations

Sébastien Roche[1,2], Christopher Chan Miller[2], Amir Souri[2], Jonas Wilzewski[1,2], Eamon Conway[2,*], Jenna Samra[2], Jonathan Franklin[1], Kang Sun[3], Kelly Chance[2], Xiong Liu[2], and Steven Wofsy[1]

1: Harvard John A. Paulson School of Engineering and Applied Sciences, Harvard University, Cambridge, MA, USA
2: Center for Astrophysics | Harvard & Smithsonian, Cambridge, MA, USA
3: Research and Education in Energy, Environment and Water Institute, University at Buffalo, Buffalo, NY, USA
* Now at: Kostas Research Institute, Northeastern University, Burlington, MA, USA

Contact: sroche@g.harvard.edu

The area-mapping MethaneSAT satellite will aim to estimate CH_4 oil & gas emissions from over 80% of emitters. MethaneAIR is the airborne simulator for the MethaneSAT satellite, its observations are used to test the retrieval algorithms that will be used to process MethaneSAT data. Figure 1 illustrates the spectral windows used by MethaneAIR.

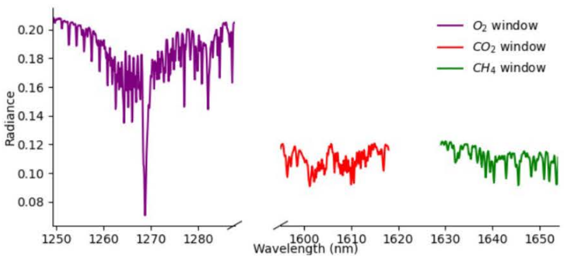

Figure 1: Example MethaneAIR spectrum from each spectral window.

$$X_G^{prxy} = X_{prxy,a}\frac{C_g}{C_{prxy}}$$

with X_G^{prxy} the column-average dry-air mole fraction of gas G computed using $prxy$ as the proxy species, "a" indicates the a priori, and C is the retrieved total column. Fig. 2 presents gridded $X_{CH_4}^{O_2}$ over a controlled release experiment on July 30, 2021.

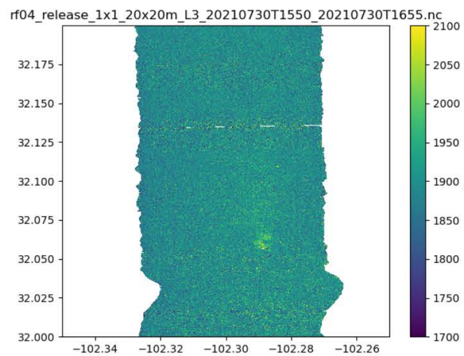

Figure 2: gridded XCH_4 over the RF04 release scene, using O_2 as proxy species.

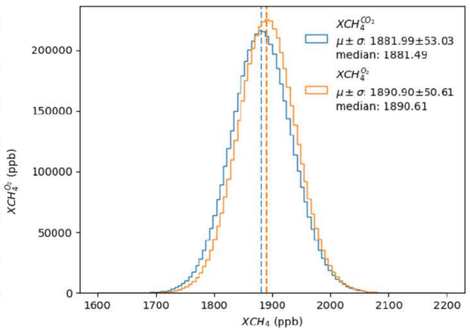

Figure 3: XCH_4 over the RF04 release scene using O_2 and CO_2 as proxy species.

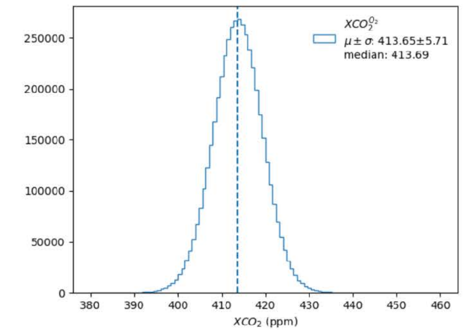

Figure 4: XCO_2 over the RF04 release scene using O_2 as proxy species.

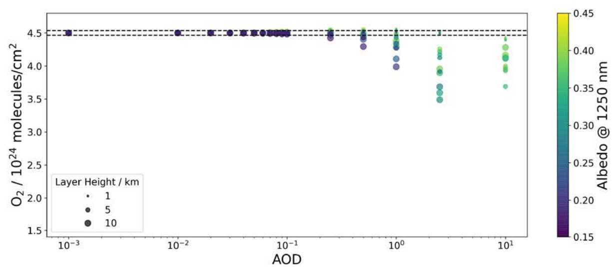

Figure 5: Retrievals of O_2 total columns on synthetic spectra at 180 SNR as a function of dust AOD, dust AOD layer height, and surface albedo. The dashed lines mark the relative precision of the O_2 column from MethaneAIR retrievals (±0.8%).

The O_2 window will be used to retrieve surface pressure and filter for clouds and potentially aerosols (see poster 2-P08). We investigate the use of the O_2 column in deriving $X_{CH_4}^{O_2}$.

The MethaneAIR native resolution precision is ~53 ppb for $X_{CH_4}^{CO_2}$ and ~51 ppb for $X_{CH_4}^{O_2}$ (Fig. 3). The precision for $X_{CO_2}^{O_2}$ is ~6 ppm (Fig. 4).

Based on retrievals with synthetic spectra (Fig. 5), the variability in the O_2 column due to dust AOD starts exceeding the clear-sky O_2 column precision for AOD > 0.2.

Future work will determine the effect of $X_{CO_2,a}$ on $X_{CH_4}^{CO_2}$ and the effect of aerosols and airglow on $X_{CH_4}^{O_2}$.

Other MethaneSAT posters: 1-P02; 2-P02; 2-P06; 2-P08; 3-P05; 3-P17