Airglow retrievals from the O2 singlet delta band with MethaneAIR measured spectra and MethaneSAT synthetic spectra

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Poster

The area-mapping MethaneSAT satellite will aim to estimate CH4 oil & gas emissions over regions that account for 80% of O&G production. It will use one spectrometer to retrieve CH4 from a window centered at 1.66 µm, and CO2 from a window centered at 1.61 µm, and a second spectrometer to retrieve surface pressure from the O2 1Δ band at 1.27 µm. 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 spectra, but also to obtain emissions estimates from oil & gas basins in the United States.

MethaneAIR flew over 3 different campaigns in 2019 and 2021 (MAIR), 2022 (MAIR-E), and 2023 (MAIR-X). MethaneAIR first campaign took place in 2019 and 2021 with 10 research flights. The aircraft typically flies at ~12-14 km altitude and observed spectra are thus unaffected by the airglow emission from excited oxygen molecules between ~ 25-75 km. During the last MethaneAIR flight (RF10) the spectrometer was looking upwards to record airglow emission spectra.

Operational retrievals for MethaneSAT will use “proxy” retrievals instead of “full physics” retrievals. A “proxy” retrieval does not include the effect of aerosols on the light path in the forward model, it instead uses the column of another gas retrieved from a band spectrally close to the target gas as proxy for the aerosol-induced light path changes, assuming that they are similar in the two neighboring spectral regions.

Typically, CO2 has been used as the proxy species for XCH4, but the variability in the modelled XCO2 can introduce biases, especially over targets with sources of both CH4 and CO2. We are considering the use of the O2 column from the O2 1Δ band to derive proxy XCH4 and XCO2. XO2 (~0.2095) is much less variable than XCO2. However, the O2 window is more spectrally distant from the CH4 window than the CO2 window, making the O2 proxy more sensitive to aerosols. MethaneSAT observations in the O2 window will also be affected by airglow. Airglow will affect the surface pressure retrieval from MethaneSAT O2 window and will need to be accounted for to improve the use of the O2 column as a proxy species.

We used airglow profiles retrieved from SCIAMACHY limb observations (Sun et al., 2022) to develop a parametrization for obtaining a priori airglow profiles. We will present full physics retrieval results performed with MethaneAIR RF10 measurements and results from MethaneSAT retrievals on synthetic spectra to estimate the effect of airglow on retrieved XCH4 and XCO2 using the O2 proxy method.

Sun, Kang, 2022, "Level 2 data for SCIAMACHY airglow retrieval in 2010", https://doi.org/10.7910/DVN/T1WRWQ, Harvard Dataverse, V1

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