CO2IMAGE RETRIEVAL STUDIES AND PERFORMANCE ANALYSIS

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DLR

This presentation

CO2Image mission

Overview

COSIS & L1->L2 processing

- Simulation of COSIS observations

Signal to noise impact

- CO_2 and CH_4 retrieval errors

Gaussian plume modeling

- Retrieved concentration fields

Poster X5.154

Vertical plume shape

- Retrieval error estimates for unknown plume profiles

Heterogeneous scenes

- Retrieval error induced by light/dark albedo patterns

MISSION OVERVIEW

The CO2Image mission

Mission overview

- National **satellite mission** (DLR), providing public data
- Envisioned as a magnifying glass for global survey missions (e. g. CO2M)
- Planned for launch in 2026 (currently in Phase B2)

Scientific objective

- **Anthropogenic** point source emissions of CO2 and CH4
- Carbon dioxide: **>1 MtCO2/y** (detection >0.3 MtCO2/yr)
- Methane: **>300 kgCH4/hr** (detection >100 kgCH4/hr)

Technical specifications

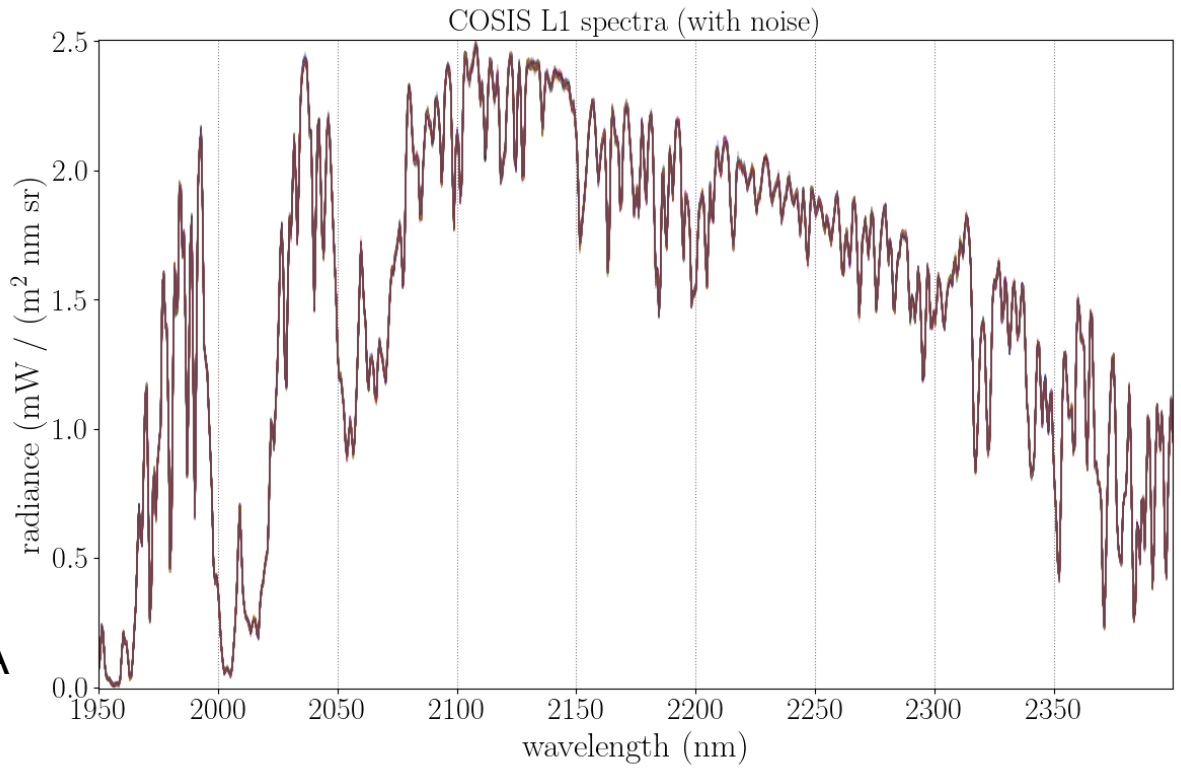
- Push-broom grating instrument **COSIS** (Carbon dioxide Sensing Imaging Spectrometer)
- High spatial resolution (**50 m x 50 m**)
- Short-Wave IR (SWIR) spectra from **1972–2400 nm**
- Moderate spectral resolution **1.30 nm** @ FWHM

COSIS SPECTRA

COSIS spectra & L1 -> L2 processing

COSIS spectra

- Simulate **high resolution at-aperture radiance** (Py4CAtS**,** Schreier et al. 2019)
- Derive total instrument signal, compute photo signal, and apply **COSIS radiometric calibration**
- Convert signal to spectral radiance at instrument resolution (**synthetic Level 1 data**)

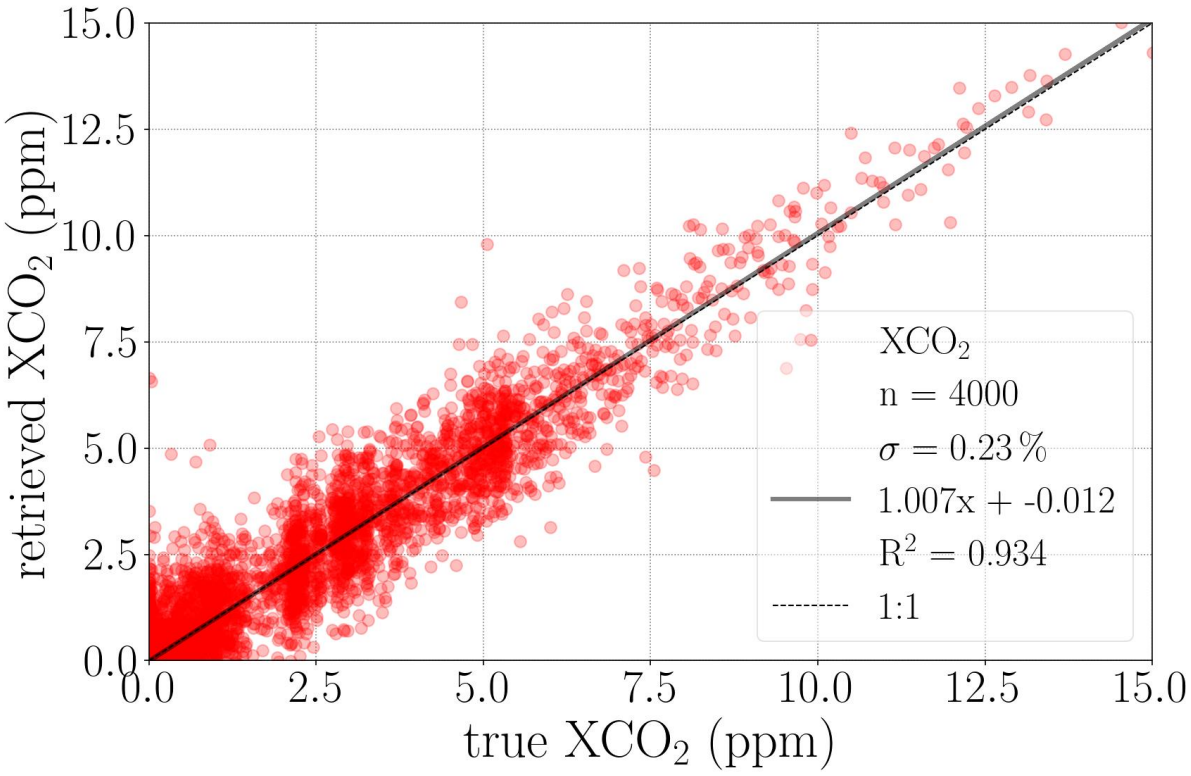


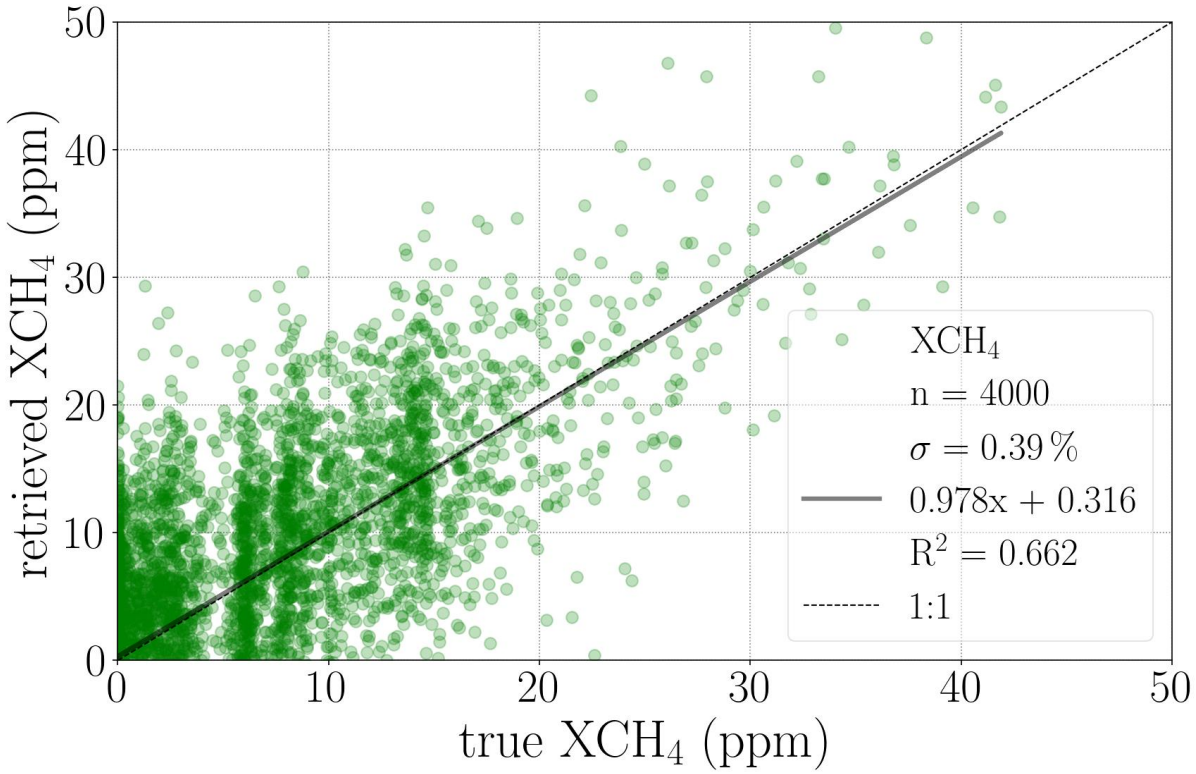
L1 -> L2 processing

- **BIRRA** (Beer InfraRed Retrieval Algorithm)
- **Level 1 spectra** (synthetic COSIS observations)
- COSIS's spectral response **ISRF**
- Spectroscopic **line data** such as HITRAN or GEISA
- **Atmospheric model** data such as p(z), T(z)
- **Priors** for molecular concentration profiles n(z)
- …

SIGNAL TO NOISE IMPACT

COSIS noise impact on retrieval





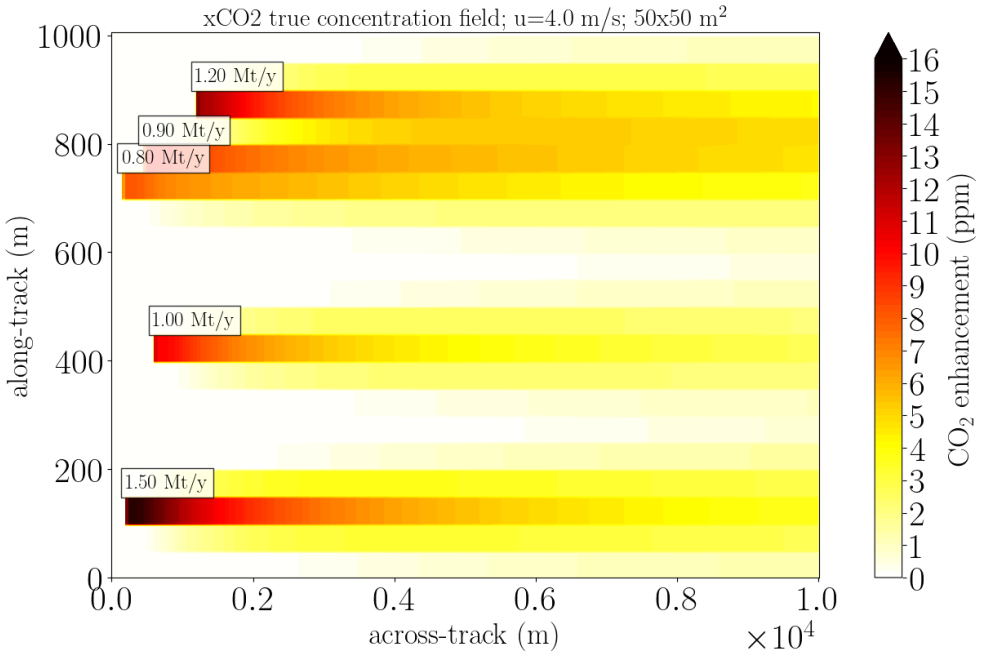
True vs. fitted CO2 (top) and CH4 (right)

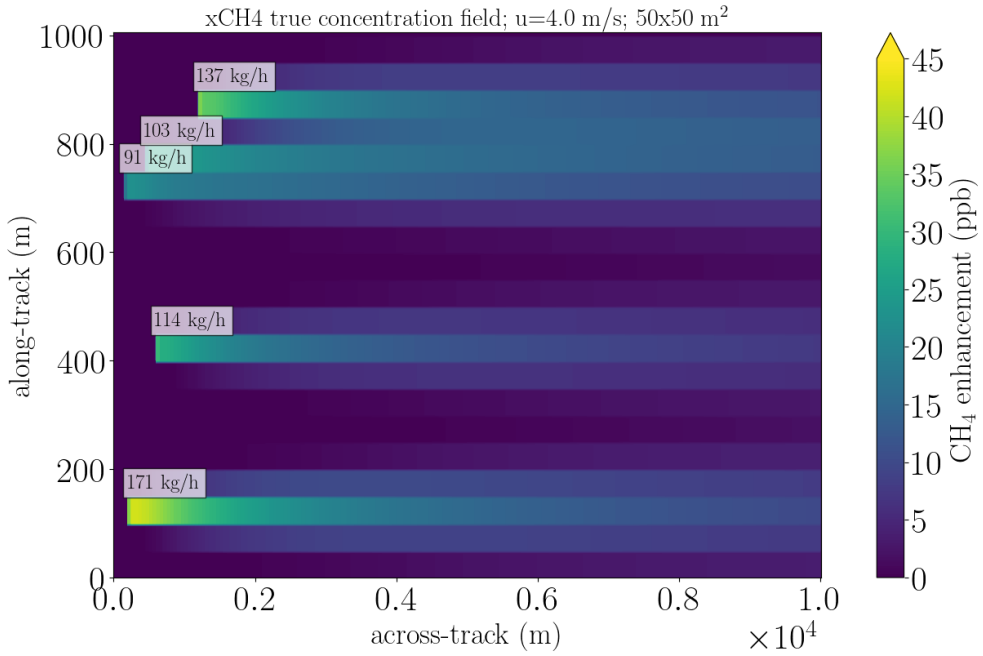
- Various molecular concentration enhancements
- Various surface types (1--80% albedo range)

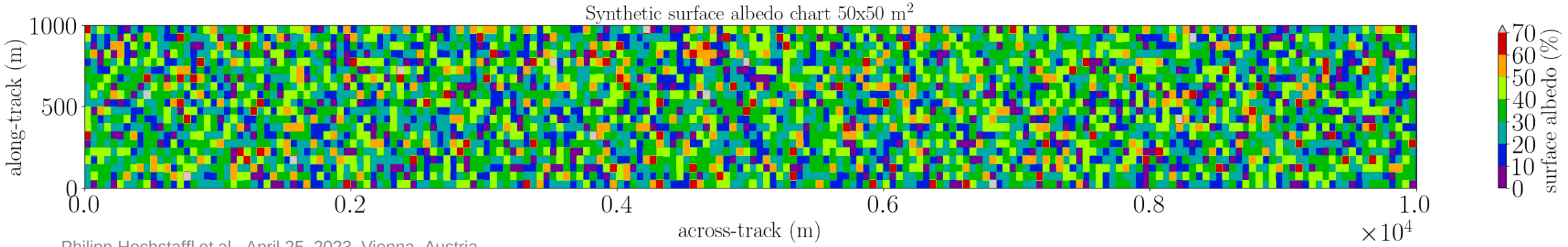
GAUSSIAN PLUMES

Gaussian plume model for CO2 and CH4 point sources

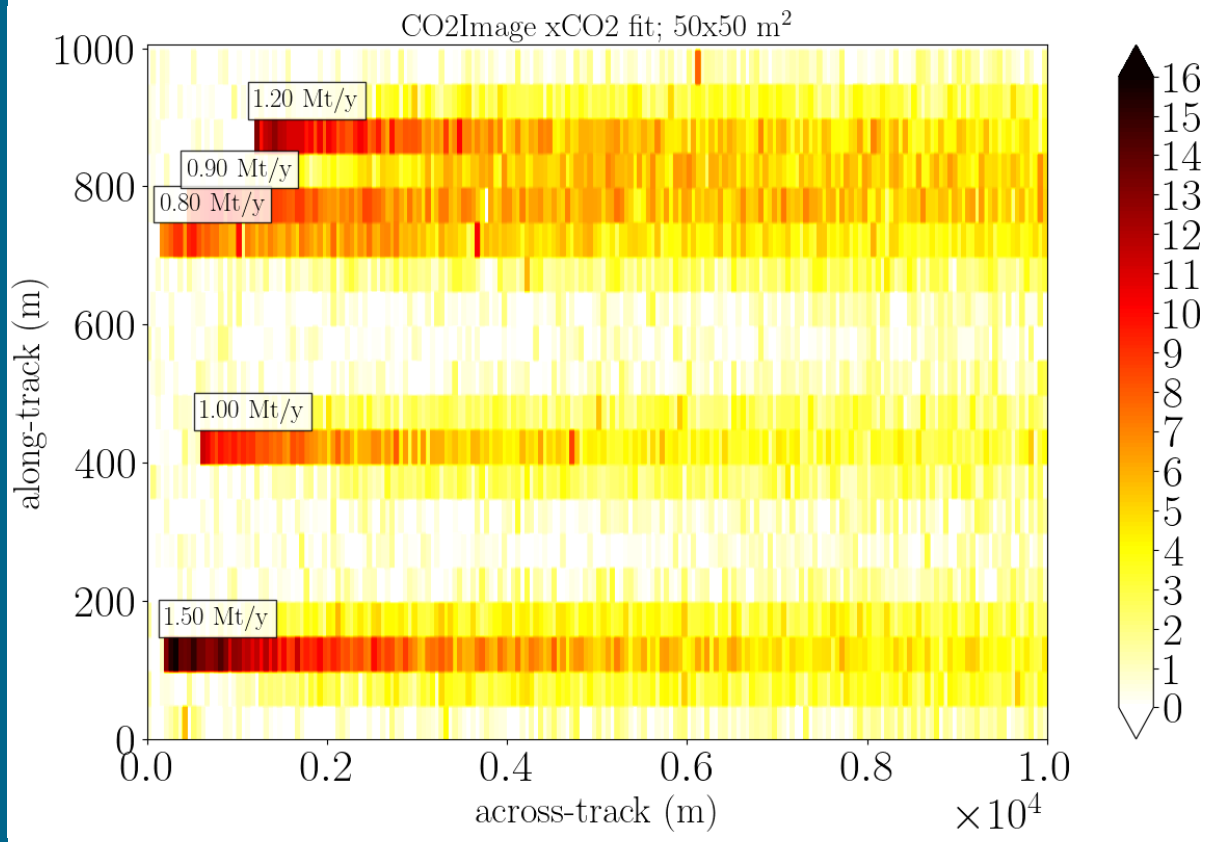
- **Mass concentration field** at location (x, y, z) from given **emission rates** and **wind**
- Model domain [km]: (10, 1, 100)
- Native model resolution [m]: (5, 5, 10)
- **Wind** in across-track direction with speed **u=4 m/s**

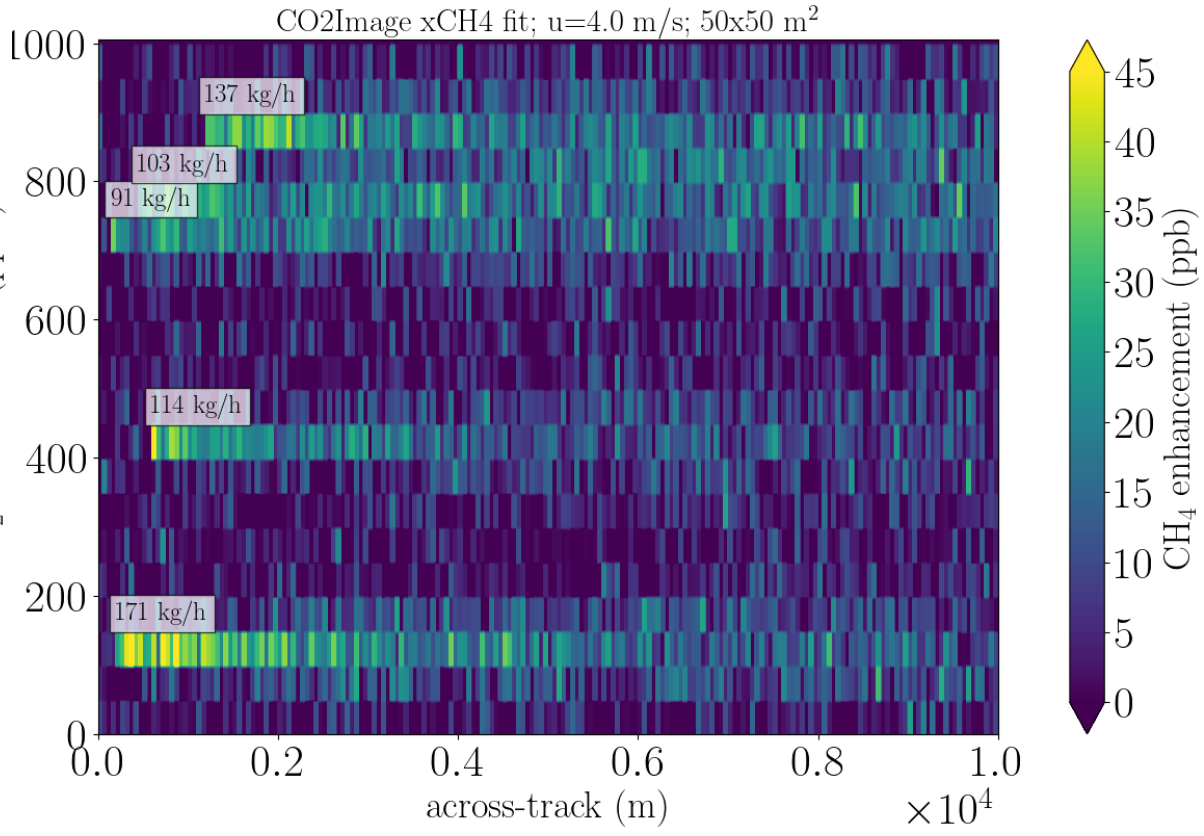




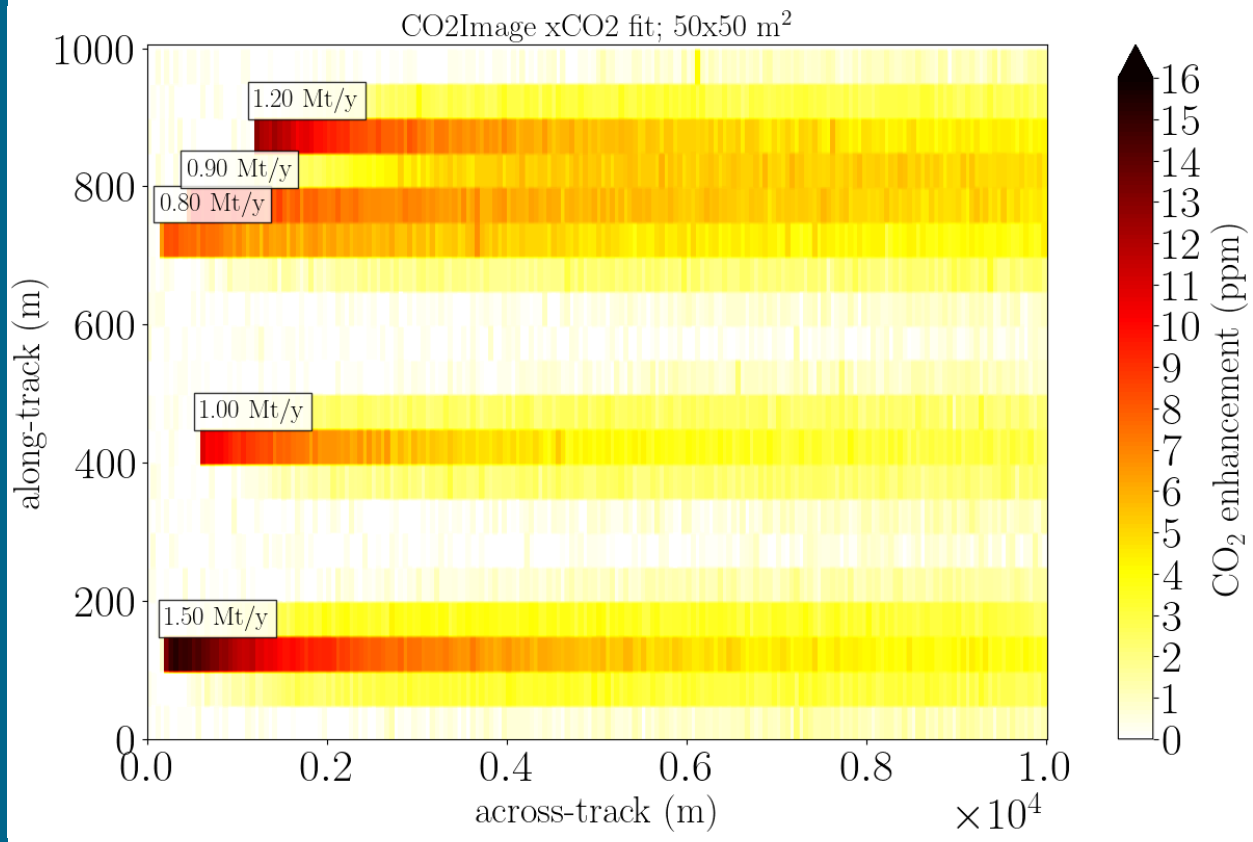


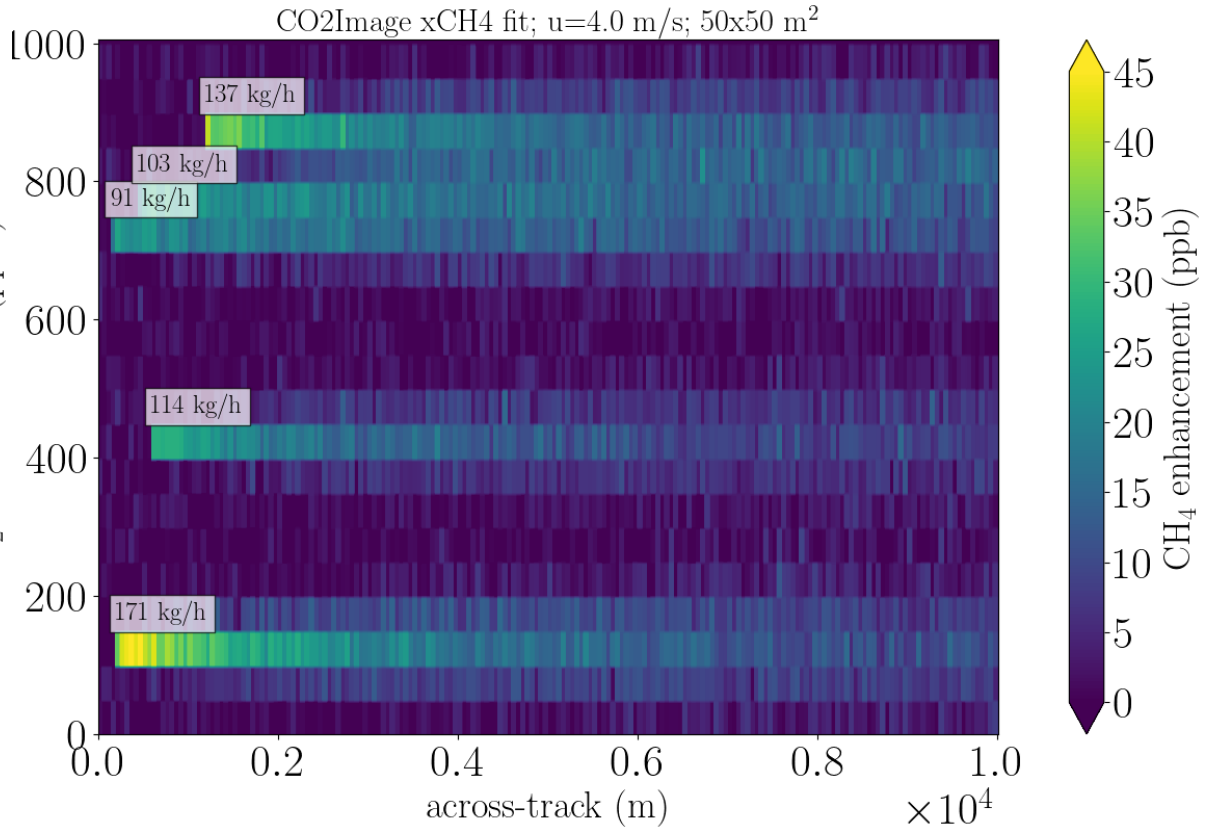
Retrieval results for single overpass





Averaged retrieval results (10 overpasses)





Poster and outlook

See poster X5.154 on Tue, 25 Apr, 16:15–18:00

- Impact of vertical molecular **concentration profiles** on column fit
- Impact of **heterogeneous scene albedo** (light/dark albedo patterns) on the retrieval

Outlook

- **Inversion** of concentration fields for emission estimates
- Examine **fast `data driven` methods** (e.g. for near real time products)
- Evaluation of parameterizations for **light path modifications** in forward modelling

Impressum

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