Fernerkundung von
Methanabluftfahnen aus EnMAP
Beobachtungen

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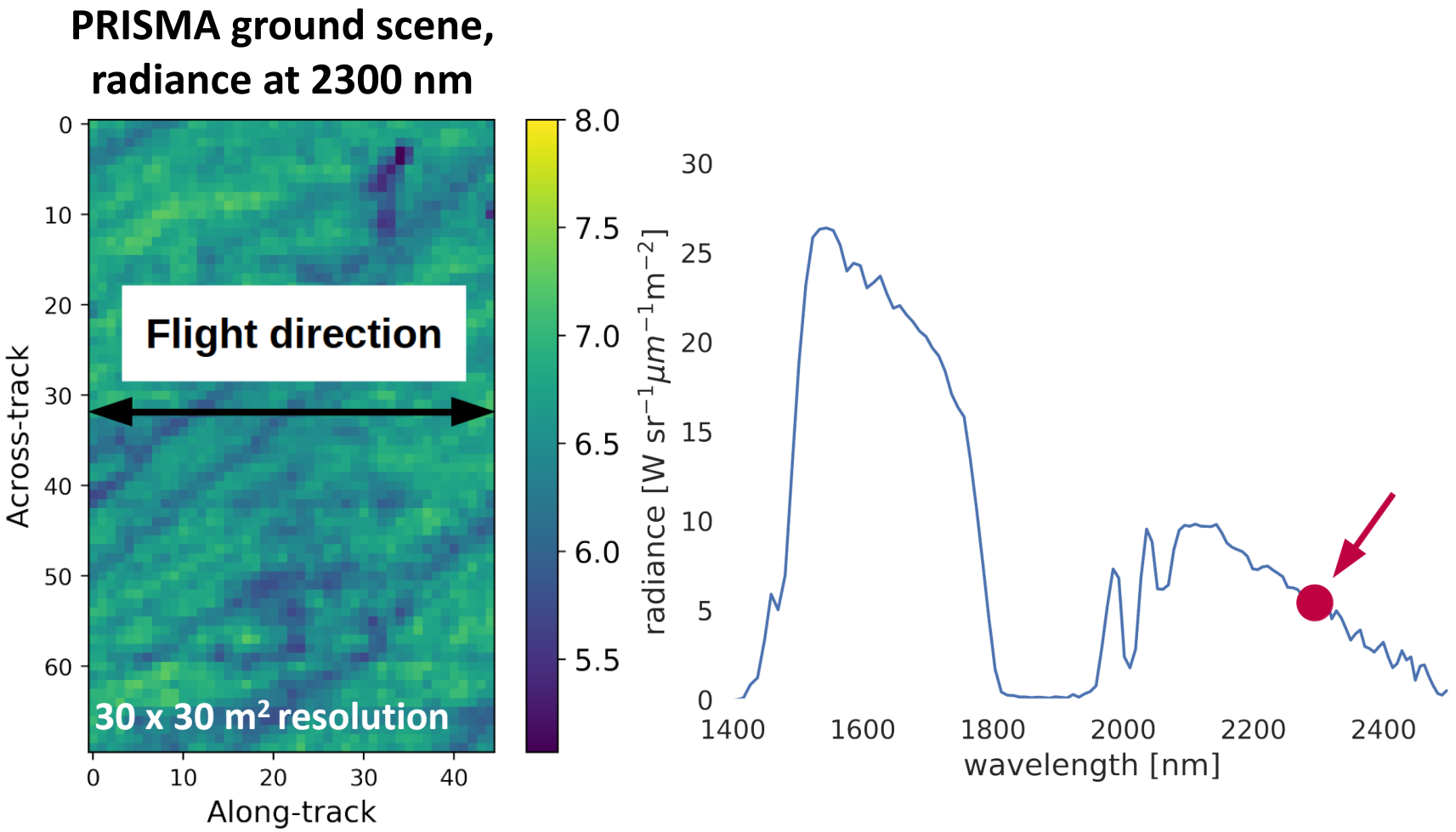
Hyperspectral imaging of methane hotspots

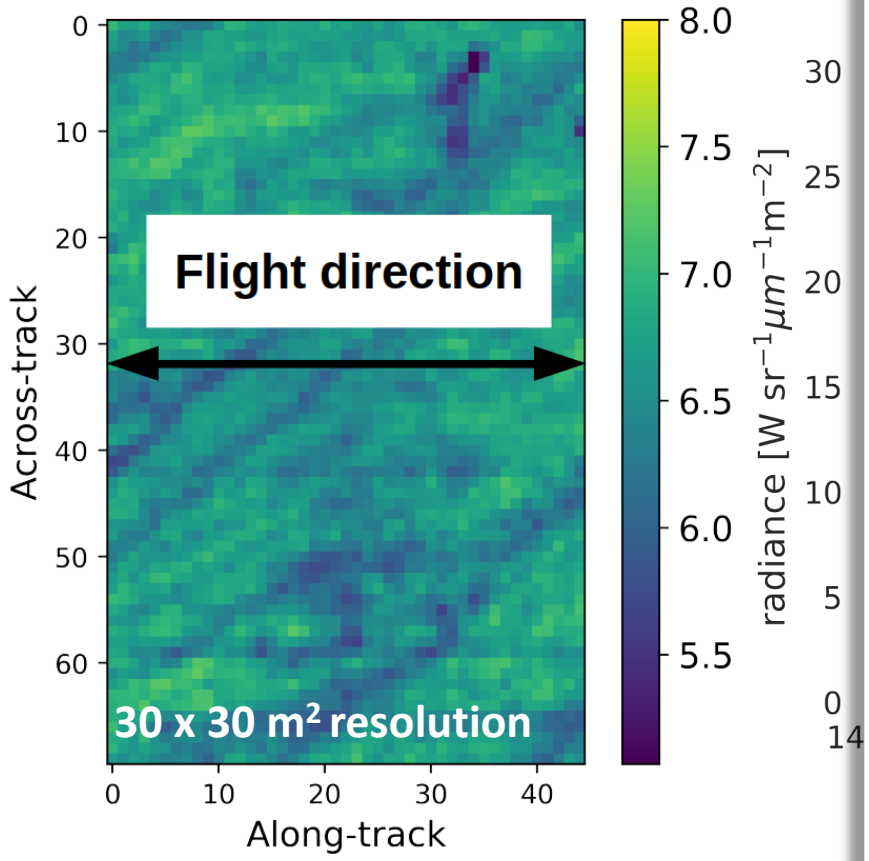


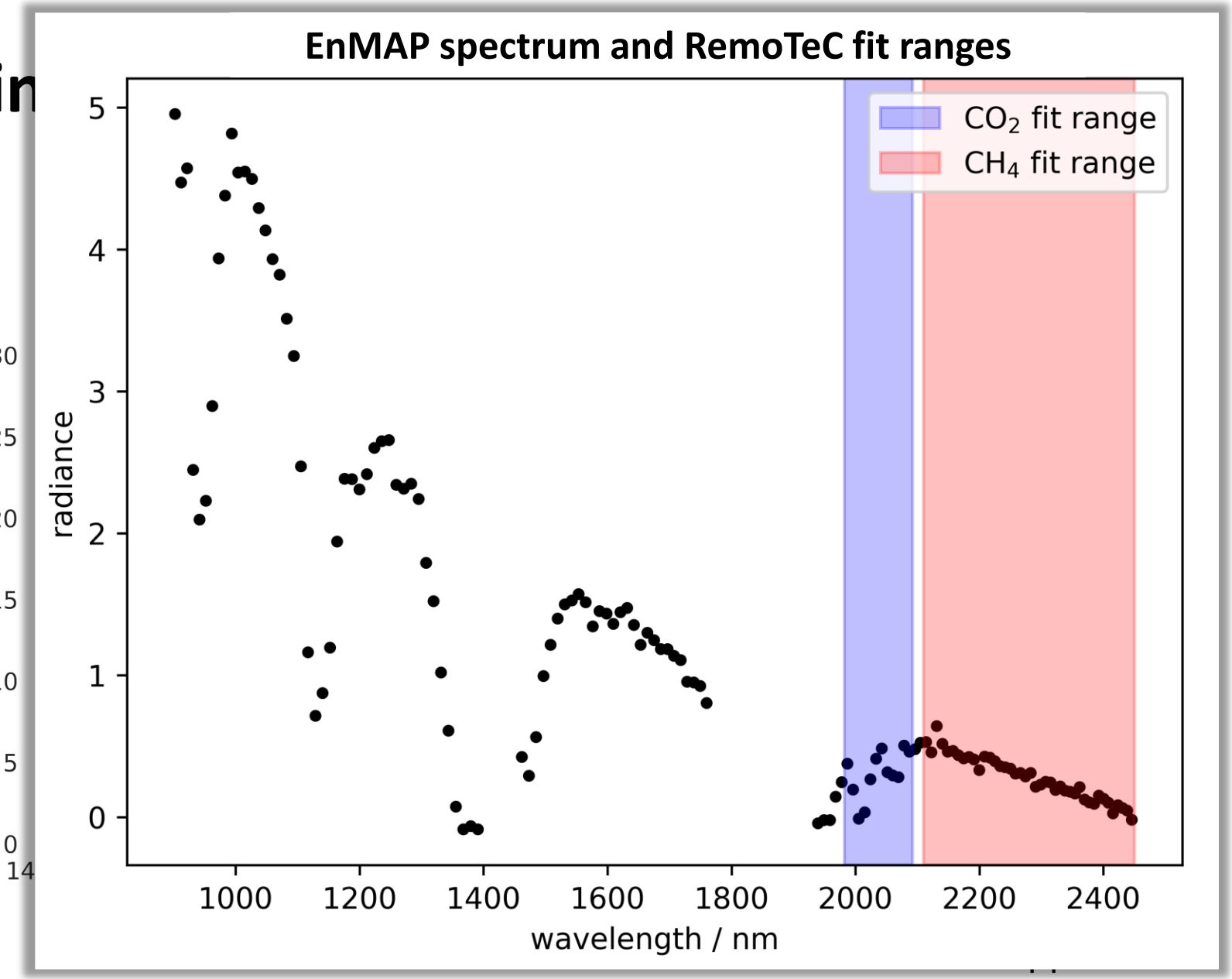
- Hyperspectral imaging techniques (EnMAP, PRISMA, HySPEX, EMIT, ...) can „see“ the **absorption of exhaust plumes from large localized CH_4 sources** (oil & gas industry, coal mining, landfills).
- Thus, hyperspectral imaging might be an **important tool in climate change mitigation MVS** (monitoring and verification support capacities)

[see work by Luis Guanter ... e.g. Guanter, L. et al., RSE, https://doi.org/ 10.1016/j.rse.2021.112671, 2022]

Hyperspectral imagin

PRISMA ground scene, radiance at 2300 nm





capacities)

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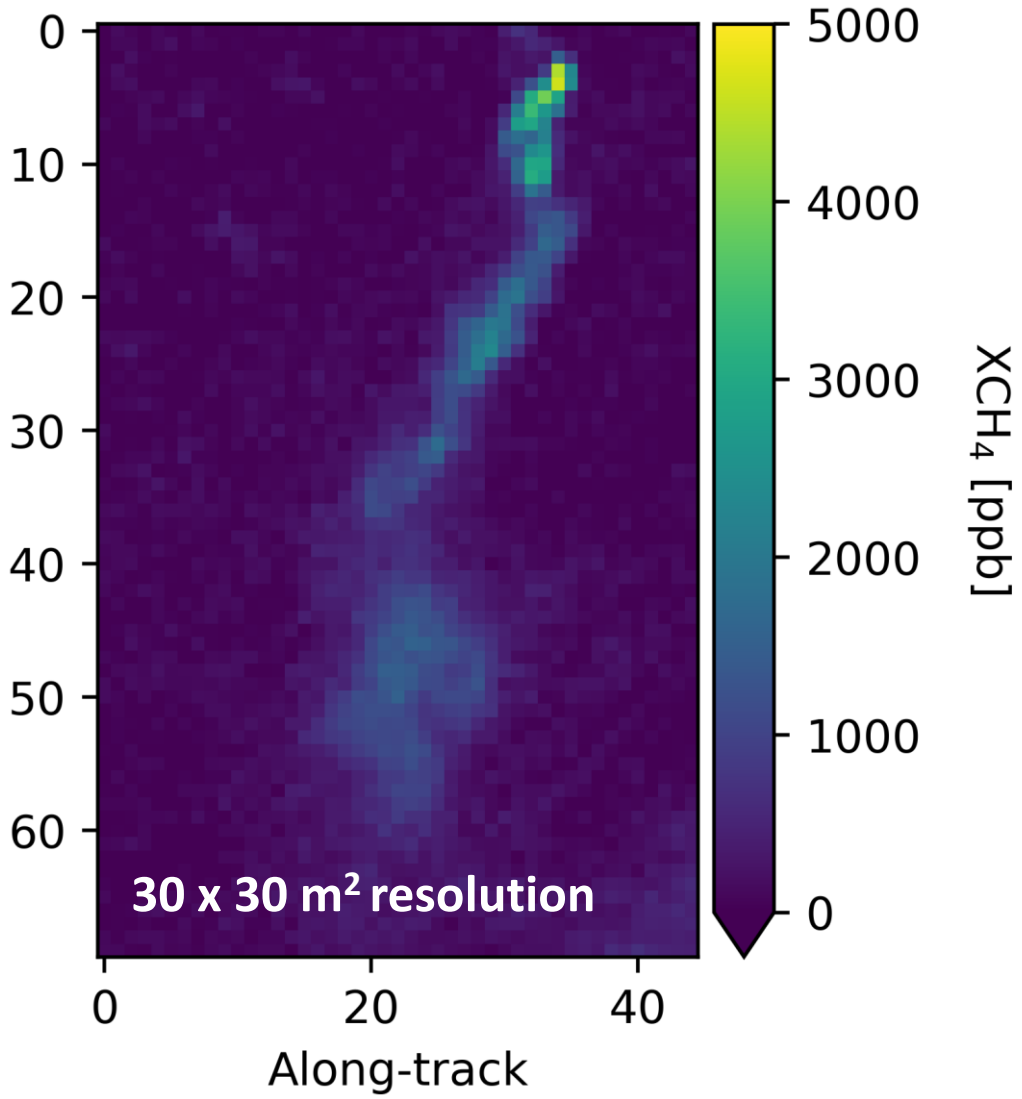
Hyperspectral imaging of methane hotspots

CH_4 plume from oil & gas production, imaged by the PRISMA satellite



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[PRISMA retrievals by Ida Jandl.]

Challenges for contributing to MVS

- How do we get **from plume images to emission rates**?

  → My talk on Monday, Session 2a: Fernerkundung von Treibhausgaspunktquellen – Fahnenidenfikation und Emissionsbestimmung durch Maschinelles Lernen

- How do we get to **better precision and accuracy to also „see“ smaller sources above all surfaces**, not just the huge ones above bright, homogeneous ground?

  → Here and Julia Marshall‘s talk this morning, Session 6b, 9:30-10:30h: CO2Image

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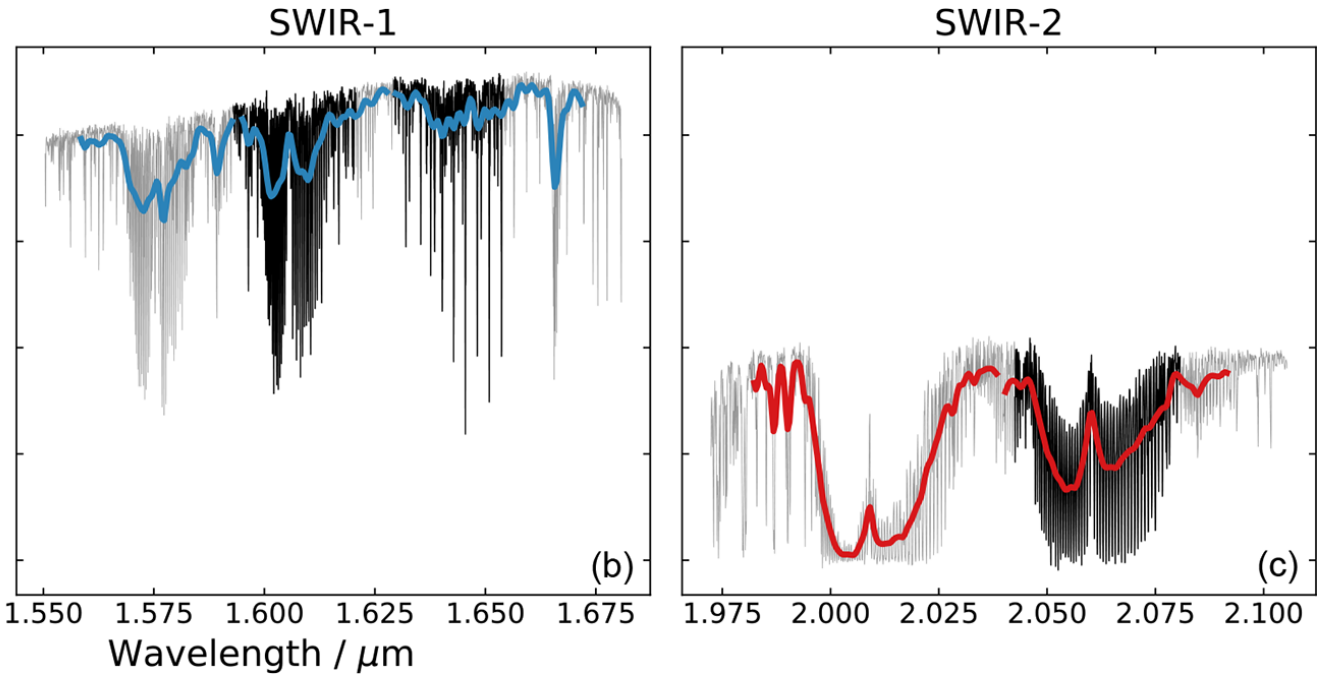
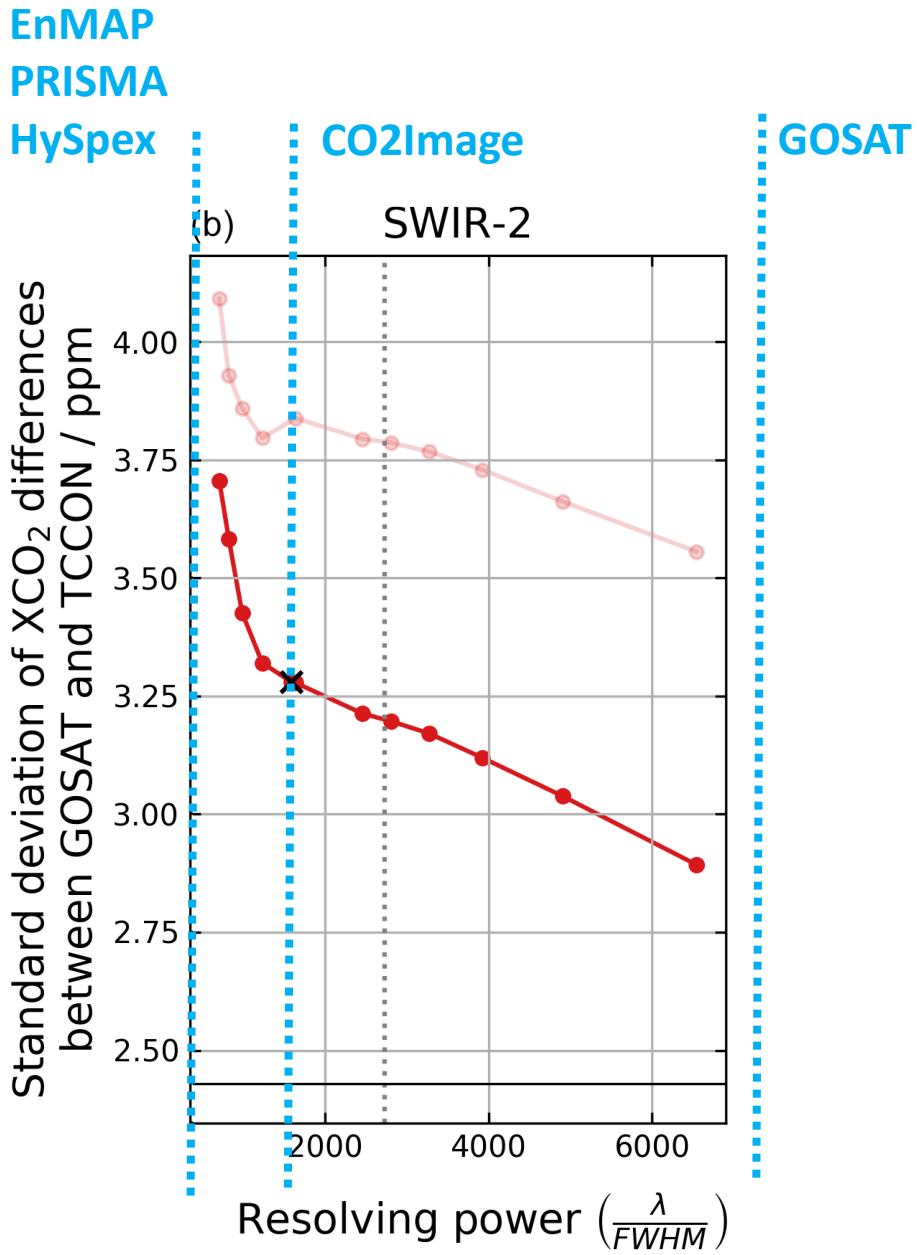
We use an **RT-based CH_4 algorithm, RemoTeC,** that is/will be in quasi-operational use for GOSAT, OCO-2, Sentinel-5 Precursor, Sentinel-5 and **image-processing algorithms such as Matched Filters** to find out about the **error sources** of hyperspectral CH_4 imaging.

Spectral resolution matters



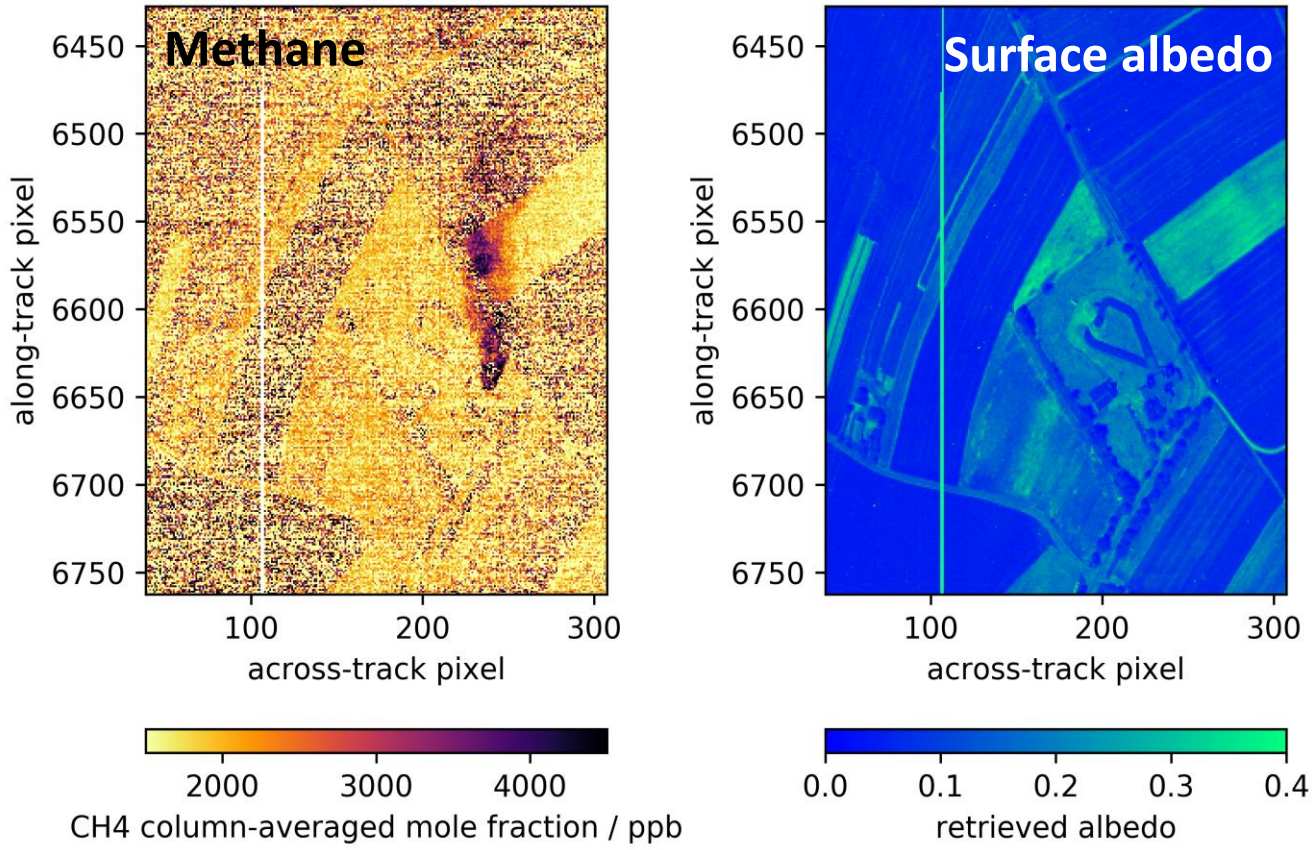


Degrading GOSAT's spectra ($\lambda/\Delta\lambda>10^4$) to hyperspectral resolution ($\lambda/\Delta\lambda$~300) shows clear tendency to large departures from ground truth.

[Wilzewski et al., AMT, 2020, https://doi.org/10.5194/amt-13-731-2020]

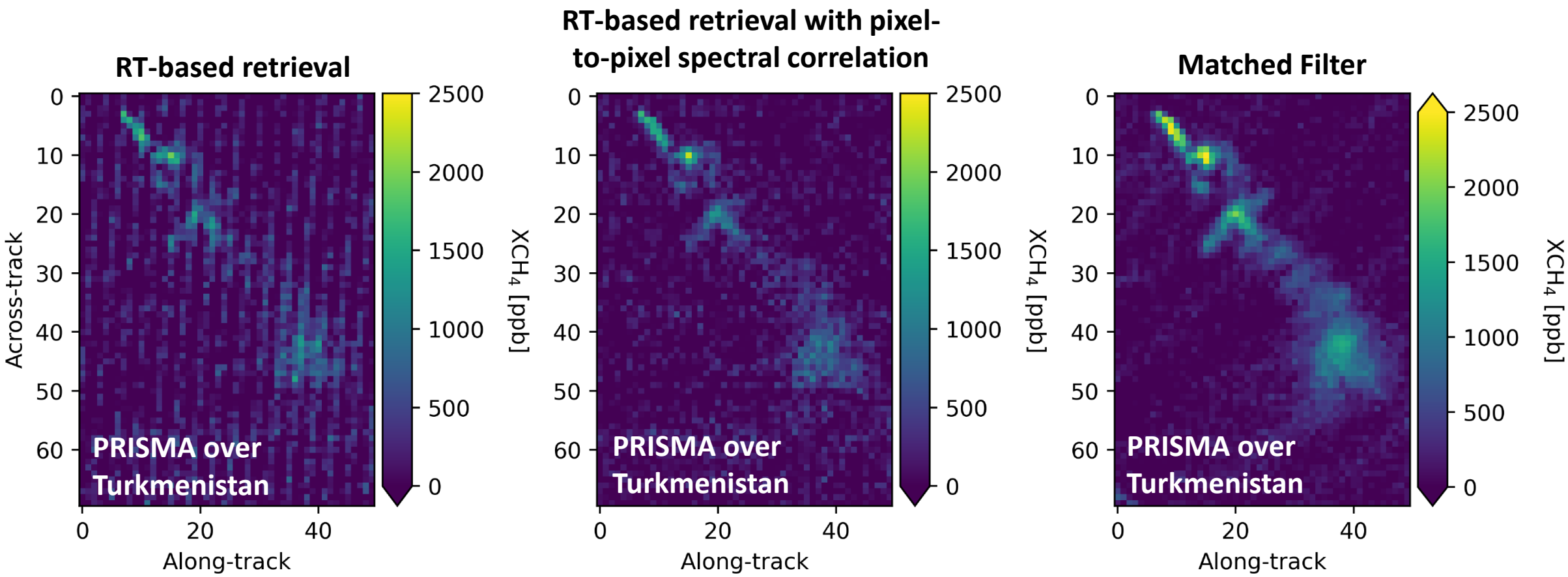
Albedo correlations hinder emission quantification

HySpex (airborne) measurements above coal mine ventilation facility in Poland



- CH_4 plume from coal mine ventilation facility clearly identified.
- Surface structures spectrally interfere with CH_4 signal.

Instrument calibration matters



- Large quantitative differences between the methods.
- Matched filter is excellent in avoiding interferences between „striping“ pattern and CH_4 target signature.

Conclusions / Outlook

- Hyperspectral imaging from satellites is a **tool to infer emission rates of large sources**.
- Contribution to **MVS challenged by systematic biases and limited capabilities for smaller sources** and heterogeneous surfaces.
- We are on our way to assess some of the uncertainties via a comparison of RT-based and image-processing-based CH4 retrievals: **spectral resolution, albedo correlations, instrument calibration** ...
- Next: We want to use **EnMAP, but data format is not ideal for „atmospheric user community“**: We fancy netcdf-files per tile or orbit with lots of ancillary information (solar and viewing angles, geolocation info, topography, calibration data, instrument spectral response functions etc.)

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