

Towards CO₂ and CH₄ measurements by ground based observations of sunlight scattered from surface targets

1 Introduction

We modify a mobile, commercially available Fourier transform spectrometer (FTS) for the ground-based measurement of surface scattered sunlight spectra. Spectra in the range of 4000 – 14000 cm⁻¹ are recorded. In this region there are absorption bands for CO_2 (6300 cm⁻¹), CH₄ (6000 cm⁻¹), CO (4250 cm⁻¹) and O_2 (7900 and 13100 cm⁻¹), enábling the retrieval of the column density of the respective gasses.

The use of scattered sunlight has several advantages:

• The measurements are more sensitive to concentrations close to the ground, due to the horizontal path component, and therefore ideal for e.g., emission monitoring. • Spectra can be recorded CO2, CH4, independent of the sun's CO, 02 position, allowing for a flexible choice of observation targets. Together with atmospheric scattered CO2, CH4, sunlight spectra CO, 02 insights into atmospheric scattering processes can

2 Instrument

EM27/SUN

be gained.

We start from the EM27/SUN Fourier transform spectrometer for the measurement of CO₂ and CH₄ column densities.

- Reliable, mobile and commercially available
- Measures absorption spectra from direct solar radiation
- Equipped with a motorized automatic sun tracker

Modifications

To record spectra of ground scattered solar radiation a more sensitive detector is used, and the optical throughput of the instrument is increased.

New Sensor:

- A custom designed sensor and amplifier replaces the standard sensor.
- InGaAs PIN photodiode (G12183-203K) from Hamamatsu) with a cutoff wavelength of 2.57 µm.
- Detector operating temperature of __ = -20 °C by a two-stage thermoelectric cooling. Dark signal noise reduced by a factor of 4.

Increased Optical Throughput:

- All apertures are removed from the light path inside the instrument.
- A larger parabolic mirror focuses more light on the photodiode.
- The field of view (FOV) is increased from 0.17° to 0.5° (full angle).



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3 Signal to Noise Ratio (SNR)



• Dependence of the SNR on the solar zenith angle is weak. For CO₂ and CH₄: SNR >300. For O₂ Δ and CO: SNR >100.







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The ILS of the modified EM27/SUN, recorded with (blue) and without (red) a 150 µm aperture.

4 Imaging Camera

- light source.

- emissions, Atmos. Meas. Tech., 8, 3047-3057, https://doi.org/10.5194/amt-8-3047-2015





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• Specific targets by imaging camera boresighted with the optical axis of the FTS. • 10 mm prism reflects part of the beam towards a camera with a 100 mm objective. • Camera FOV of 7.3° is larger then the instrument FOV.

• Calibration of the camera's FOV to the instrument's FOV by a small but bright thermal

• Well known targets make it possible to determine the viewing geometry, especially the

