### Introduction

- SWIR spectra contain information about greenhouse gases (CO$_2$, CH$_4$, H$_2$O) and gases with indirect radiative forcing such as CO.
- Down-looking SWIR spectra sensitive to the troposphere.
- SCIAMACHY channels in the SWIR region:
  - Channel 8 mainly used for CO retrievals.
  - Channel 6 exploited by most CH$_4$ and CO$_2$ retrievals.
- Various auxiliary data required for Level 1 processing.

? How do molecular spectroscopy line data impact retrievals? 🤔?

### BIRRA — Beer InfraRed Retrieval Algorithm

Separable least squares fit:

$$F(x) = \sum \frac{r(\nu)}{\cos \partial} l_\alpha(\nu) \exp \left(-\sum \alpha_m \tau_m(\nu)\right) \otimes S(\nu, \gamma) + b$$

$\tau_m$: molecular optical depth; $S$: spectral response function; $\theta$: SZA; $b$: baseline.

#### CO from SCIAMACHY

- Calibrated spectra normalized by SCIA sun measured spectrum.
- Spectral window: 4283 – 4302 cm$^{-1}$.
- Fit vector $x$: scaling factors $\alpha_m$ of absorbers CO, CH$_4$, H$_2$O.
- Coefficients $r_0$, $r_1$, $r_2$ of 2nd-degree reflectivity polynomial.
- Half-width $\gamma$ of instrument slit function.

“Product”

$$\text{CO} \equiv \frac{\alpha}{\alpha_{\text{CO}}} \times \text{VD}$

### Molecular Spectroscopic Databases

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| CO | Hitran 12: update based on Malathy-Devi work.
| CH$_4$ | Hitran 12: 70% of lines replaced, S threshold decreased
| H$_2$O | Hitran 12: number of lines doubled.

### Orbit 8663 — October 2003

- Large land fraction: Russia, Arabian peninsula, East Africa.
- Analysis of latitudinal dependence.
- October: high CO over Africa due to biomass burning.

### Sahara 2003 – 2005

- Analysis of spatial and temporal evolution.
- Relative homogeneous terrain.
- Large cloud-free, high reflectivity, small SZA: high signal.
- Residual norms almost identical for all 3 databases.
- Residual norm relative differences resemble topography (correlation with surface albedo).

### Conclusions

- For SCIAMACHY SWIR measurements recent databases do not show big differences.
- HITRAN 08 $\approx$ GEISA 11 $\approx$ HITRAN 12.
- More recent data appear to be "slightly" better.
- Other retrieval settings presumably more important, esp. calibration.
- Sentinel-5 Precursor: significantly better SNR spectroscopy has a big impact!!!