Introduction

A portable, field-deployable spectrometer for measurements of surface-scattered sunlight is under development and first results look promising (1). This reflected-sun observation geometry is highly sensitive to the atmospheric composition in the boundary layer due to the long horizontal path component. The pioneering reflected-sun experiment is CLARS-FTS (3) overlooking the Los Angeles basin from the top of Mt. Wilson. However, these measurements are also prone to aerosol scattering. Since retrieval methods rely on accurate knowledge of the actual lightpath, rigorous radiative transfer modeling is required to evaluate spectral measurements of surface-scattered sunlight with high accuracy (2).

Method

The radiative transfer and retrieval software RemoTeC retrieves XCO₂ and XCH₄ together with atmospheric scattering properties (2). Reusing modules and routines from the RemoTeC retrieval tool (dark red line) we build a simulation environment (highlighted in brighter red) for radiative transfer calculations.

Consistency

We retrieve 150 simulated multiple-scattering spectra and keep all settings constant. Then we compare the scatter of all retrieved quantities with their retrieval errors and with the noise level of the synthetic measurement. Exemplary plots are shown for O₂. The standard deviation of retrieved is $O_2 \sigma_{\text{retr}} = 5.61 \cdot 10^{21} \text{ molecules/cm}^2$ and mean of retrieval errors is $\mu_{\text{retr}} = 6.01 \cdot 10^{21} \text{ molecules/cm}^2$. The same validation holds for the other retrieved quantities. Therefore, in the range of the error bars the retrieval represents the simulation truth.

Forthcoming research

In the next step we will adapt the inversion to the reflected-sun lightpath and repeat consistency checks. Once this is done, we want to use this promising tool to investigate and improve on the accuracy of radiative transfer modeling for reflected-sun measurements. We will calculate simulation studies to quantify errors of the retrieval tool, evaluate information content of reflected-sun measurements and investigate on the accuracy of the lightpath-proxy approach. The final goal will be to develop a refined approach for the evaluation of reflected-sun measurements based on these studies.

References


Toward CO₂ and CH₄ measurements by ground based observations of surface-scattered sunlight: Radiative transfer modeling

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