Geophysical Research Abstracts
Vol. 20, EGU2018-11620, 2018
EGU General Assembly 2018

CO_2 profile retrieval from near-infrared spectra

Sébastien Roche (1), Kimberly Strong (1), Debra Wunch (1), Joseph Mendonca (1), Geoffrey C. Toon (2), and Brian J. Connor (3)

(1) Department of Physics, University of Toronto, Toronto, Canada, (2) Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, USA, (3) BC Consulting Limited., Martinborough, New Zealand

The Total Carbon Column Observing Network (TCCON) is composed of high-resolution ground-based Fourier transform Infrared (FTIR) spectrometers that record solar absorption spectra. Column-averaged dry-air mole fractions of CO_2 (XCO_2) are retrieved from the recorded spectra and used to validate satellite observations of XCO_2 and to study the carbon cycle.

Variations in XCO_2 are partly driven by local surface fluxes of CO_2, and partly by transport from remote locations. Even though TCCON XCO_2 observations are precise, they lack information about the vertical distribution of CO_2 in the atmosphere, which is of interest for the validation of satellite measurements and model simulations.

GFIT is a non-linear least-squares spectral fitting algorithm used for TCCON retrievals. A forward model computes an atmospheric transmittance spectrum using a priori knowledge of atmospheric conditions. An inverse method then compares the measured spectrum with the resulting calculation, and adjusts the retrieved parameters to obtain the best fit. In GFIT, these parameters include volume mixing ratio scale factors for the different fitted gases. A single scale factor scales the a priori concentration profile of each fitted trace gas, thus it does not change the shape of the profile.

GFIT2 is a profile retrieval algorithm that allows the profile shape to vary during the retrieval process. The algorithm thus has more freedom to fit the observed spectra, but is also more sensitive to uncertainties in the forward model calculations such as spectroscopic errors and instrument misalignment, for example.

To improve CO_2 profile retrievals, it was necessary to improve the forward model of GFIT2. More accurate absorption coefficients of CO_2 and other trace gases were implemented. A solar gas shift parameter is now retrieved to better model solar absorption lines. Layering of the retrieval grid was varied to decrease oscillations in the retrieved profiles. To exploit different sources of vertical information, CO_2 profiles were retrieved from spectral windows of varying opacity, centered at 1.58, 1.61, 1.65, and 2.06 μm. Retrievals were performed using the true CO_2 profile as a priori, where in-situ Aircore CO_2 profiles were used as the truth. In that case the scale factors retrieved by GFIT2 would ideally be equal to one at each grid level, but the retrieved profiles present oscillations caused by remaining errors in the forward model. A method to correct those oscillations and combine the profiles retrieved from the different windows is being tested.