Retrieving CO2 from the NASA OCO-2 observations using RemoTeC

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ABSTRACT

The **RemoTeC** algorithm, previously applied to CO_2 and CH_4 retrievals from **GOSAT**, will be expanded to be used in the multi-angle target mode of **OCO-2**. This would allow better characterization of atmospheric scattering. As a first step, we adapt the algorithm to include polarization within the atmosphere for single-angle viewing observations to account for the polarization sensitivity of the **OCO-2** instrument. Here, we show its application to **OCO-2** measurements and the validation with **TCCON** measurements.

METHODS

The aim of retrieval is to convert observed radiance measurements into the state vector $\boldsymbol{X}$, i.e.,

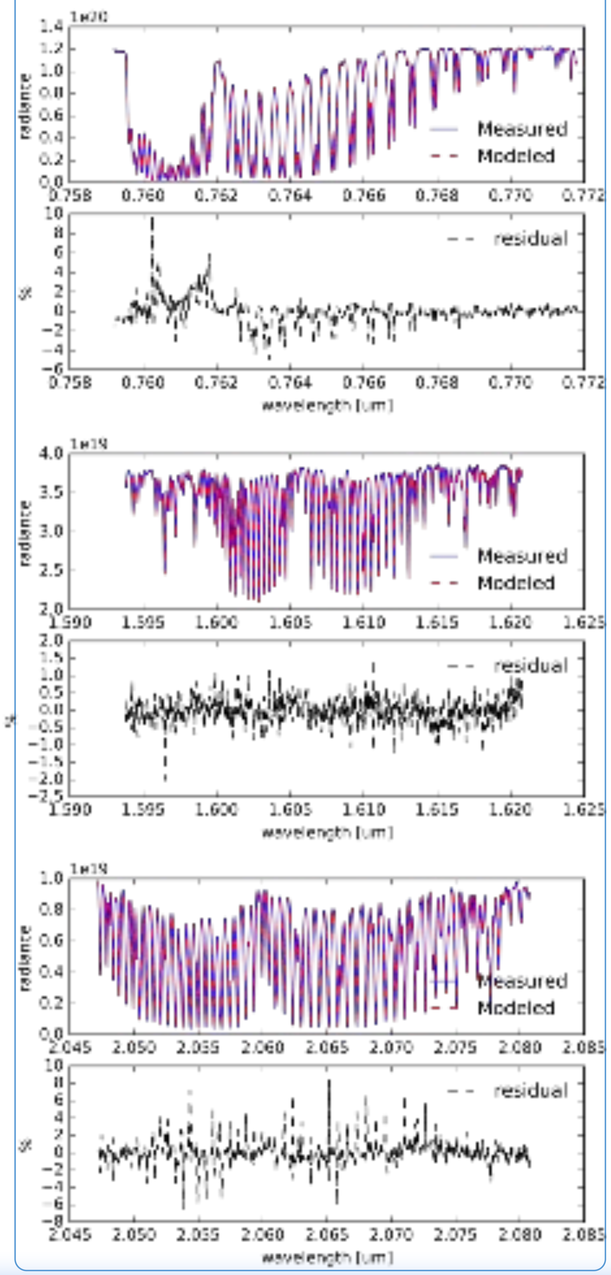
$$\boldsymbol{y} = \boldsymbol{F}(\boldsymbol{X}) + \boldsymbol{e}, \qquad (1)$$

Here $\boldsymbol{F}$ is the forward radiative transfer model, $\boldsymbol{y}$ is the measurement and $\boldsymbol{e}$ is an error term. The forward model used here is the vector radiative transfer model developed by Hasekamp and Landgraf [2002, JQSRT; 2005, JGR]. The linear k-method is used to avoid computationally expensive line-by-line calculations [Hasekamp and Butz 2008, JGR]. The used inverse algorithm is based on Philips-Tikhonov regularization method [Butz et al. 2009, Appl.Opt.; 2010, JGR].

Retrieval parameters include a twelve layer vertical profile of the CO_2 column number density, the total column of H_2O, aerosol total column, size distribution parameter and center height, a second order polynomial for surface albedo, and spectral shift parameters.

OCO-2 Spectra

We exploit nadir (over land) and glint (over ocean) observations in the 3 windows covering the O_2 A band, a weakly absorbing CO_2 band, and a strongly absorbing CO_2 band. Here we show one example of fitness between forward model and OCO-2 spectra.

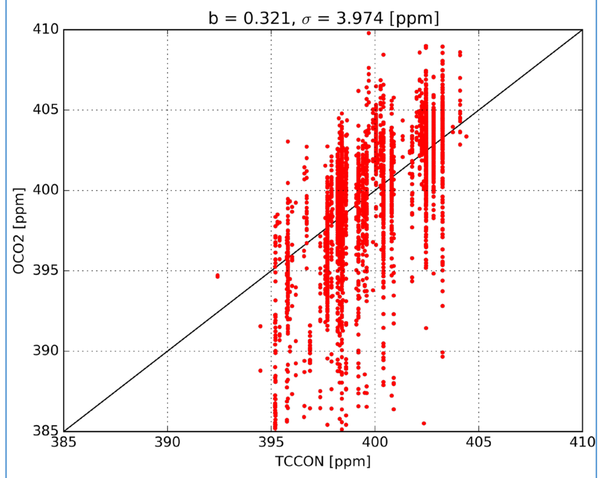


In the retrieval, molecular absorption features of O_2 H_2O, and CO_2 are modeled using appropriate spectroscopic databases [Tran et al. 2008, JGR; Rothman et al. 2009, JQSRT]. For nadir view, land surface reflection is assumed Lambertian and for glint view, bidirectional reflection is modeled through a wind-speed driven Cox-and-Munk reflection model [Cox and Munk 1954, JMR] with a Lambertian albedo slop.

VALIDATION

The target quantity X_{CO2} is calculated by summing the column number densities over the twelve retrieval layers and dividing by dry air column. For validation of X_{CO2} retrievals with TCCON data products, we use spatial collocations within 5 degrees latitude/longitude radius and a temporal coincidence of less than 2 hours mismatch.

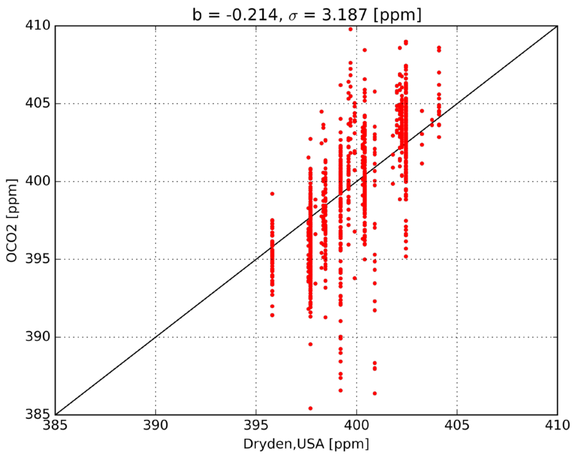
(a), The overall performance is shown below where the red dots indicate the retrieved values without bias correction. We also include the bias b and standard deviation σ between OCO-2 and TCCON.



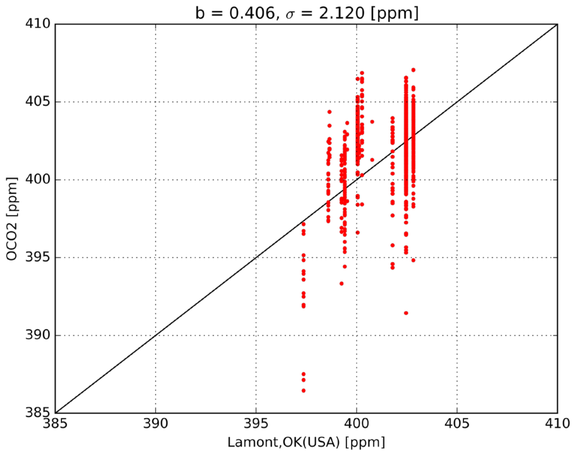
The used OCO-2 measurements is taken between September 08, 2014 and July 30, 2015.

(b), Validation with individual TCCON stations in North-America:

Dryden, USA (34.958ºN 117.882ºW)



Lamont, OK(USA) (36.604ºN 97.486ºW).



Comparison of the retrieved X_{CO2} to TCCON data indicates that X_{CO2} retrieval is promising from OCO-2 measurements.

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