

Interactive comment on “The Orbiting Carbon Observatory (OCO-2): spectrometer performance evaluation using pre-launch direct sun measurements” by C. Frankenberg et al.

Anonymous Referee #1

Received and published: 18 August 2014

The paper under review evaluates pre-launch performance of the grating spectrometers onboard the recently launched Orbiting Carbon Observatory (OCO-2). The study is based on spectra collected during an on-ground testing phase about 2 years before launch. Then, the OCO-2 instrument was fed with direct sunlight via a heliostat. The setup allows for comparison to similar measurements by a Fourier Transform Spectrometer (FTS) operated nearby within the Total Carbon Column Observing Network (TCCON). The study examines quality of the spectral fitting, random noise patterns, consistency of the spatial detector channels, instrument line shapes effects, linearity of the detector electronics. The manuscript further demonstrates the feasibility

C2245

of detecting temporal concentration variability above Los Angeles well below the 1 ppm level with temporal resolution of seconds (when the instrument is operated in direct sun view).

The paper is timely and of great interest to readers of Atmospheric Measurement Techniques (AMT) who work on instrument development and characterization, OCO-2 retrieval algorithms, and OCO-2 data usage. The paper is well written; most analyses and conclusions appear robust and accurate. Therefore, I recommend publication in AMT after consideration of some comments below.

Comments:

1. The manuscript attributes inter-footprint differences in XCO_2 (p.7650, l.12+) and variability for different exposure conditions (MATADOR test, p.7651, l.15+) to variable illumination of the spectrometer slit by the heliostat. Are the time dependent inter-band differences between XCO_2 retrieved from the wCO₂ and sCO₂ bands also due to this effect?

While it appears true that heliostat effects are of no concern per se for OCO-2 performance in orbit, heterogeneity within the footprint of the nadir-viewing OCO-2 instrument could cause inhomogeneous illumination of the detector slit. Could you comment on the sensitivity of in-orbit performance on scene heterogeneity?

2. The MATADOR test is not very convincing with respect to its initial goal of quantifying (non-)linearity. If taken at face value, the 2-3 ppm differences for smaller signal levels in Figure 8 could be of concern, but then, the test seems inconclusive due to changes in the optical imaging. The latter might be of concern by itself (see comment above).

C2246

Would it be possible to strengthen the case? It might be helpful relating to lab-based non-linearity testing, showing ratios of spectra with strong and weak illumination, comparing weakly and strongly absorbing bands (which should be affected differently by non-linearity, in particular if non-linearity is most severe for low count rates)?

3. Figure 11 compares XCO_2 derived from the wCO_2 and sCO_2 bands to TCCON records. While TCCON XCO_2 is calculated from observed O_2 concentrations, XCO_2 from the OCO-2 instrument is calculated from external pressure records (if I understand correctly). Would it make things better or worse using O_2 concentrations from OCO-2's O_2A -band? How does the OCO-2 derived O_2 concentrations compare to TCCON and the external pressure data?

Technical comments:

p.7642, l.18: ppm -> ppm

p.7642, l.22: Define "TVAC" e.g. in line 10.

p.7645, l.19: can't -> cannot

p.7649, l.11: "... to spectra collected within a short time period ...". Please try to reword, sentence appears very complicated.

p.7649, l.24: it -> its

p.7651, l.21: remove "being"

C2247

p.7652, l.19: "in the other plots". What other plots?

p.7655, l.1: total column -> total column fit

Interactive comment on Atmos. Meas. Tech. Discuss., 7, 7641, 2014.