Atmos. Meas. Tech. Discuss.,
doi:10.5194/amt-2018-357-RC2, 2019

Atmospheric Measurement Techniques
Discussions

Interactive comment on "The OCO-3 mission; measurement objectives and expected performance based on one year of simulated data" *by* Annmarie Eldering et al.

Anonymous Referee #2

Received and published: 8 February 2019

This paper provides a detailed assessment of the expected performance of the Orbiting Carbon Observatory-3 (OCO-3) mission, in which a direct copy of the OCO-2 shortwave infrared (SWIR) grating spectrometer will be installed on the International Space Station (ISS). Whilst the instrument sensitivity and performance characteristics are therefore expected to be very similar to those of OCO-2 (as referenced in the Introduction section), there are a couple of important differences owing to use of the ISS as a platform for the instrument. Firstly the ISS has a precessing orbit, resulting in the 'significant differences from day to day in the sampling locations and time of day'. The analysis of the spatial and temporal sampling expected from the ISS orbit forms the bulk of this paper. Secondly, the OCO-3 instrument will have a new pointing mirror as-

sembly (PMA) allowing rapid switching between nadir and glint observation modes, as well as target and snapshot modes for dwelling over specific locations on the ground, without having to re-orient the spacecraft. The paper focuses on the two primary viewing modes – nadir-land and glint-water – and correctly leaves the snapshot mode to a companion paper, given the level of detail already present here.

The findings of the paper are based on a year-long simulated OCO-3 dataset, which uses atmosphere and surface model output along with an instrument model based on laboratory testing. The simulated observation geometry uses actual ISS ephemeris data from the year 2015 to take into account the spacecraft position and velocity at a rate of 1Hz. It is not stated whether the spacecraft pitch and roll is either taken into account (i.e. the PMA can compensate for spacecraft pitch and roll in real time) or is assumed to be small enough that the results aren't affected; it would be interesting to know whether the spacecraft orientation is a problem in terms of achieving the required pointing accuracy. The spatiotemporal distribution of the simulated soundings is clearly illustrated in Figures 2 through 5, neatly showing the advantages and limitations of this sampling pattern. Figures 4 and 5 are particularly interesting since they show how the sounding time-of-day varies over the year, in contrast to the polar orbiting sun synchronous OCO-2 and GOSAT missions. The full physics retrieval algorithms used to obtain XCO2 and solar induced fluorescence (SIF) are well established (as can be seen through the references given in Section 4), and the same as those used in OCO-2 operational data processing.

Section 5 provides a useful comparison between the expected OCO-3 performance and that of OCO-2, at both the spectral radiance (Level 1B) and retrieved XCO2 (Level 2) stages. Whilst OCO-3 is expected to have a worse signal-to-noise ratio performance in the CO2 bands (particularly the 1.6 micron band) than OCO-2, owing to a higher detector noise floor and decreased signal incurred by different fore-optics including the PMA, the expected SNR values are still sufficiently high to achieve the desired XCO2 retrieval precision. In the spatial comparison shown in Figure 8, the lack of OCO-2 soundings over the Amazon, sub-Saharan Africa, and China compared with OCO-3 stands out; is this due to the 'deficiencies in the simulation setup' mentioned on page 19 line 28, meaning that in reality we might expect these regions to be filtered out in the OCO-3 data as well as in OCO-2?

The results section concludes with a thorough assessment of the error characteristics of the simulated OCO-3 dataset. The SIF dataset looks as though it will be particularly interesting, the increased coverage at lower latitudes and soundings at different times of day compensating for the worse precision than that achievable with OCO-2. Overall, this work provides a valuable resource for those intending to work with the OCO-3 dataset, and I suggest that it is ready for publication once the questions raised above are addressed, along with the following minor points:

Page 2 Line 7: GOSAT-2 has now been launched, on 29th October 2018

Page 6 Line 4: Update on whether analysis of thermal vacuum testing data is complete (I assume the results will go in the forthcoming manuscript mentioned on Line 5)

Page 18 Line 23: I assume this refers to the same testing data mentioned on Page 6 Line 4; perhaps an 'in preparation' reference would help clarify this?

Page 20 Line 6: Close brackets on 'Figure 7'

Page 25 Line 18: Acronym 'IDP' not defined?

Page 25 Line 25: Move 'e.g.' inside the brackets, i.e. '. . . gases from space (e.g. Aben et al., 2007; Butz et al., 2009)'

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