

## ***Interactive comment on “Consistent satellite XCO<sub>2</sub> retrievals from SCIAMACHY and GOSAT using the BESD algorithm” by J. Heymann et al.***

**Anonymous Referee #1**

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The study by Heymann et al. compares retrievals of column-average carbon dioxide (XCO<sub>2</sub>) from SCIAMACHY and GOSAT using the BESD algorithm. The satellite retrievals are validated against ground-based TCCON measurements and intercompared for a 2-year overlap period. The study aims at demonstrating the consistent accuracy of the SCIAMACHY and GOSAT XCO<sub>2</sub> datasets. Covering more than a decade, the combined satellite record would constitute an appealing dataset for climate studies.

Previous studies evaluated SCIAMACHY BESD XCO<sub>2</sub> retrievals e.g. by comparison to TCCON (e.g. Reuter et al., 2010). Multiple previous studies compared GOSAT retrievals by other algorithms to TCCON (e.g. Morino et al., 2011, Butz et al., 2011, Wunch et al. 2011, ...). Several previous studies compared and combined SCIAMACHY and/or various GOSAT XCO<sub>2</sub> records (e.g. Oshchepkov et al., 2013, Takagi

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et al., 2014), including publications of the authoring team (e.g. Reuter et al., 2013, 2014).

So, the novelty of the study is the report on how well the BESD algorithm performs for GOSAT measurements over TCCON sites. Although several other GOSAT XCO<sub>2</sub> algorithms have been reported operational for years, the study topic could be of interest to the readers of AMT in particular if it was shown that BESD-GOSAT and BESD-SCIAMACHY are of better consistency than any other SCIAMACHY and GOSAT records. The study, in my opinion, falls short of this goal due to several serious shortcomings.

1. The performance evaluation is limited to TCCON coincidences. Previous studies, amongst others led by the authoring team (Reuter et al., 2013), have shown that algorithm performance at TCCON sites is not necessarily representative for consistency on the global scale. BESD-SCIAMACHY and BESD-GOSAT must be compared for a globally representative ensemble to comply with the paper title.
2. The above concern is even more urgent given that the paper only discusses BESD-GOSAT retrievals after a 6-parameter bias correction has been applied. To the best of my knowledge, no other GOSAT XCO<sub>2</sub> retrieval algorithm needs that many parameters (e.g. Wunch et al., 2011, Guerlet et al., 2013). Using 6 free parameters to improve the match to TCCON and then, only discussing performance at TCCON sites appears overly optimistic. Since it is the first study on BESD-GOSAT, the study needs to document and discuss performance without bias corrections applied.
3. The coincidence criterion of 10 deg x 10 deg is not very sophisticated. Various other teams have put great effort in improving coincidence criteria for satellite evaluation at TCCON sites (e.g. Wunch et al., 2011, Guerlet et al., 2013, Nguyen et al., 2014). The study should adopt one of the state-of-the-art techniques or at least, perform a sensitivity study to quantify the impact of the chosen coincidence criterion on the reported performance.

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4. The study should raise the question whether combining BESD-SCIAMACHY and BESD-GOSAT is finally better than combining BESD-SCIAMACHY with any of the other GOSAT retrievals (NIES, ACOS, RemoTeC, UoL, PPDF, EMMA, ...) e.g. for inverse modelling of surface-atmosphere CO<sub>2</sub> exchange. Reuter et al., 2013, suggest that using ensembles of algorithms is better than using a single algorithm (with potentially persistent biases).

Other comments:

Section 6 and 7: The discussion of error patterns is hard to follow. Previous TCCON comparison studies highlighted the station-to-station bias deviation as the most important diagnostic since it is a measure for regionally correlated error patterns. While this measure is quoted several times in the conclusions, it does not show up in the results section nor in any table nor in the "i), ii), iii), iv)" listing on page 1802. Is "relative accuracy" the same as the station-to-station bias deviation? Are all the numbers consistent among sections 6 and 7?

Tables 5 and 6. Add columns for retrievals without bias corrections.

Figures 5, 6 and 8: Figures are too small and contain information mostly redundant with tables 5, 6, 7. The only new information I tend to see is that seasonal cycles between TCCON and BESD are different. If so, this should be discussed. If not, I suggest removing the figures.

Figures to be added: It would be interesting to see how the satellite-TCCON differences correlate with geophysical parameters such as used for bias correction. It would be interesting to see maps comparing BESD-SCIAMACHY and BESD-GOSAT globally.

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