We thank the referee#1 for taking the time to read the manuscript and offer helpful comments and suggestions. The referee's comment is repeated with our response in bold.

Responses to those comments are listed below:

This paper attempts to make progress in understanding the global budget of OCS and how vegetation uptake of OCS relates to gross primary production (GPP) and net CO2 flux. A set of flux and transport model runs is compared to OCS and CO2 observations in hope of providing a better constraint on model processes. The novel aspect of the paper is in using collocated ground-based FTIR tropospheric column OCS and CO2 data. OCS column data from 3 sites and CO2 from 2 are used to characterize seasonality at mid to high NH latitudes. HIPPO airborne in situ data are used to characterize latitude gradients in different seasons. Although the paper asserts that using OCS data can help understand biospheric processes in models, the findings and conclusions of the paper break little new ground: there are too many inconsistencies in the model-data comparisons and too many unconstrained elements in the OCS budget to critically evaluate the model representation of GPP and respiration processes for CO2.

Response: **We agree with the referee that there are uncertainties remaining in this study that we cannot currently address. However, the main new point of our paper is using column data of simultaneously measured CO_2 and OCS to study the biospheric processes, and our studies yield new results. We have qualitatively discussed the possible causes of these inconsistencies between model and measurements in section 5.2 and 5.3. This provides ideas for future experiments, and further improves our understanding in underlying processes. We also agree that there are still many unconstrained elements in the OCS budget; however, the other sources and sinks (e.g. ocean exchange) have less effect on the seasonal cycle in the Northern Hemisphere. Despite the unconstrained elements, it is still valuable to evaluate the model representation of OCS land fluxes, and to improve our understanding about both GPP and respiration. The knowledge of OCS fluxes and the relationship between OCS and CO_2 plant uptake will be improved in future studies, since this is becoming a topic of increasing interest (Berkelhammer et al. 2014; Campbell et al., 2015; Maseyk et al., 2014). More work is planned in different groups, such as more measurement campaigns and laboratory experiments, and therefore more data are emerging, which can then be used to better constrain the OCS budget. This is now discussed in the paper.**

Although this and previous analyses provide some hope of eventually using the combined data to constrain processes, the findings here are not new or unique. The problem is not that the paper's methods are faulty or conclusions incorrect. It is that most of this has been done before and in some cases, better.

Response: **The aim of the study is to exploit ground-based FTIR networks to study the relationship between OCS and CO_2, which has not been studied before. The model simulations are based on the previous studies (Suntharalingam et al., 2008; Berry et al., 2013), but are not identical. We list here the new and/or interesting aspects of this paper:**

1. **This is the first time that total/partial column data from FTIR networks have been used to study the relationship between OCS and CO_2. The NOAA and NASA DC-8 data used in previous global/regional model studies is sparse and integrating more data from more platforms is needed. Notholt et al. (2003) has proved that the FTIR could capture the OCS variation in the free troposphere resulting from atmosphere-surface exchanges and convection. When interpreted by models, total column measurements are much less sensitive to assumptions on boundary layer mixing, because every molecule in the atmospheric column is detected, independent of whether it is at the surface or in the upper troposphere. In order to obtain realistic fluxes using inverse models, assumptions must be made on the vertical mixing in the atmosphere, which is currently a large uncertainty in the transport of most models (Wunch et al., 2011; Yang et al., 2007; Keppel-Aleks et al., 2011). Therefore, column data provide additional information for evaluating the terrestrial exchange of CO_2 and OCS.**

2. **For the first time, simultaneously measured time series of OCS and CO_2 were compared to simulations based on coupled fluxes of OCS and CO_2 from SiB. By looking at both gases simultaneously, we analyzed the possibilities for the model-measurement mismatches, in order to gain new insight on GPP estimation. This is the first time that this has been shown in a paper.**

3. **We investigated the latitudinal distribution of the OCS land flux in SiB, and related this to the latitudinal distribution of GPP, which is also new.**

4. **We, for the first time, showed the phase differences between measurements and model simulations for both OCS and CO_2, and we used this to evaluate the photosynthesis and respiration in SiB.**

5. **In addition to the column data, we used HIPPO data to validate the latitudinal distribution of the OCS fluxes, which is valuable (though we agree with the concerns of the reviewer that these HIPPO data only provide a limited snapshot of the latitudinal distribution). By looking at the comparison between HIPPO CO_2 data and the SiB simulation, we can conclude that either the photosynthesis distribution or the relationship between OCS and CO_2 uptake needs to be adjusted in SiB.**

The paper would be better suited for publication in ACP if it focused less on redundant comparison to models at a few sites, and used a more complete set of tropospheric column data, eg., all available NDAAC and TCCON, to diagnose OCS behavior that may not be illuminated by the previous works, e.g., the large inferred tropical ocean source.

Response: **We agree that including more sites would be ideal. We have included Eureka and Mauna Loa in the revised manuscript. However, it is not yet possible to include Southern Hemispheric sites at this time. We have been working on a harmonized retrieval approach with other groups to ensure inter-site consistency, because the tropical and Southern Hemispheric sites are in wet conditions and the retrievals from the spectra are affected substantially by water. Mauna Loa is at high altitude, and therefore also less affected by water vapor. The retrieval strategy works well for the rather dry Northern sites we have**

chosen in the paper; however, we cannot yet be sure that the effects of water and how it is handled in the retrievals are consistent between dry and wet sites, and this may have impact on the relative seasonal cycles and latitudinal patterns. We prefer to err on the side of caution, and not include more additional measurements for which we might over-interpret the resulting trends and patterns. In addition, the Southern Hemispheric OCS seasonal cycles are more affected by ocean fluxes, which have large uncertainties. In this paper, we focus on the Northern Hemispheric land fluxes and only rescaled the ocean fluxes in a simple way to balance the global budget. This method can be used to get a reasonable latitudinal gradient, which was evaluated with the help of HIPPO data. After this rescaling, we can analyze the seasonal variation in the Northern Hemisphere mainly driven by biospheric fluxes.

More specifically, the sensitivity modeling with multiples of the Kettle et al., JGR, 2002 fluxes does very little to diagnose model processes. It has been shown repeatedly that the original Kettle fluxes (and updates) are not accurate in simulating several aspects of the atmospheric OCS observations. The sensitivity tests are not very useful since as the authors state (p. 26039) 'This scaling, while not realistic, . . .' and this has been done previously by Suntharalingam et al., 2008. Perhaps keep one of these simulations for historical context, but this material could be omitted or greatly reduced in emphasis.

Response: **We agree with the referee's comment that rescaling the K2002 fluxes does not help to diagnose underlying processes. The OCS simulation with K2002 provides a baseline for evaluating the sources and sinks of OCS. We rescaled the OCS fluxes to find a better match to the column measurements, which may get different results than in-situ measurements, and the HIPPO latitudinal distributions. Although simply rescaling is not realistic, it can provide a comparison to SiB fluxes, because the flux distributions and variations can be different when having similar total annual amount. Therefore we have kept this in the paper, but reduced the content of description.**

The SiB modeling is essentially the same as Berry et al., 2013, who did a much better job of comparing seasonal/latitudinal/altitude dependences as well as diagnosing the process implications of the model-data comparisons.

Response: **We agree that Berry et al., 2013 did a good job of SiB OCS. It was the first time simulating OCS land fluxes in a biosphere model, and provided a tool to use OCS to diagnose carbon cycle processes and the reason why we chose SiB for this study. However, this is the first time to use SiB for the comparison with FTIR column measurements. This is also the first time simulating OCS and CO_2 simultaneously using coupled land fluxes from SiB and comparing to measured time series of both species. Berry et al. (2013) only showed the relative seasonal amplitude of CO_2 and OCS, but not the full seasonal cycles. Through looking at the disagreement in seasonal amplitude and seasonal cycle phase of both gases, we evaluated the photosynthesis and respiration represented in SiB. We also evaluated the latitudinal distribution of GPP in SiB with the help of HIPPO data, which is also not done**

in Berry et al. (2013). Additionally, the SiB fluxes we used are not the same as those used in Berry et al. (2013). We have made some significant improvements such as the soil uptake calculation which is described in the manuscript.

Again, focus on what new insights are provided in this analysis that haven't been shown before, in particular what the FTIR data have to say about the model across the full range of latitude. Relate this to use of the NDACC column OCS data by Kettle et al., ACP, 2002.

Kettle et al. (2002b) used FTIR OCS total column measurements to estimate hemisphere-integrated OCS fluxes and confirmed the understanding of OCS global budget. This proved that the FTIR network is valuable in OCS studies. The FTIR OCS product used by Kettle et al. (2002b) has been improved since then to have a better accuracy on seasonal amplitude, which is important for studying the carbon cycle and resolving the temporal variability of OCS fluxes. We have included Eureka and Mauna Loa in the revised manuscript, but we would like to be sure about the site consistency before including (wet) Southern Hemispheric sites.

The comparisons with HIPPO, while valuable, need to be recognized as a single realization of the gradient from one flight transect. In addition, vertical gradients (which can be large near source/sink regions) in HIPPO are convolved with latitude. As stated, the column data are less sensitive to these representation limitations. Focus on the column data to diagnose seasonal and latitudinal discrepancies and consistencies with SiB modeling, and use the HIPPO to substantiate. Perhaps this will lead to new insights.

Response: **We agree that the HIPPO data only provide a limited snapshot of the latitudinal distribution (mainly over the Pacific Ocean). It would be better if more campaigns through different longitude regions were available. However, HIPPO data are very valuable to validate the latitudinal gradient. Contrary to the referee's statement, the HIPPO data actually cover five different campaigns, which took place during different months/seasons, and therefore present the gradient at different seasons when the influences of sources and sinks are different.**

Minor Points: The paper occasionally uses imprecise phrasing, loose language, and has misspellings, which should be cleaned up. A few examples are called out below, but overall it should be carefully copy edited.

Response: **Thank you for helping to correct the language errors. We have checked the manuscript carefully and corrected spelling and imprecise phrasing.**

P. 26027, line 8: mean -> means;

Response: **Corrected.**

lines 20-21: reads 'fluxes . . . are used.. and compared to measurements' but it is concentrations that are compared. Clean up.

Response: **We deleted 'and compared to measurements'.**

P. 26029, line 11: source -> sources;

Response: **Corrected.**

line 14: more measurements of what, where?

Response: **Change to "more OCS measurements at different latitudes and ecosystem regions are needed to validate the estimates."**

line 15: delete 'this'.

Response: **Done.**

Line 22: They -> This

Response: **Corrected.**

P. 26031, line 18: cite personal communication properly.

Response: **Corrected.**

P. 26032, line 14: the cited errors for tropospheric partial column seem unrealistically low. Explain better what they represent.

Response: **The errors presented in this study include measurement errors and forward model parameter errors, calculated based on Rodgers (2000). The measurement errors are due to measurement noise. The model parameter errors are calculated using a perturbation method and our best estimate of the uncertainties in temperature, solar zenith angle, line intensity, and air broadening. We modified the best estimates and added the interference errors including interference species error and retrieval parameters error in the revised manuscript, and the errors increased to about 3% for the troposphere. However, these are the calculated errors. The real error can only be accessed with the help of additional measurements.**

Lines 18-23: are these the TCCON reported data (http://tccon.ornl.gov) or is this a separate retrieval performed by the authors? Explain please.

Response: **These are the TCCON reported data. We added the following sentence to the manuscript: "We use the GGG2012 version of the TCCON CO_2 data, available on http://tccon.ornl.gov/2012".**

P. 26036, lines 13: ran -> run

Response: **Corrected.**

P. 26040, line 1-5: increased/decreased, fluxes/mean values, lower/larger are mixed up. Re-compose.

Response: **Deleted this part to reduce the content of rescaling fluxes.**

P. 26041, line 21ff: previous simulations in Berry et al., 2013 used coupled fluxes of OCS and CO2. What is the point here?

Response: **We deleted "Unlike previous simulations of CO2 and OCS". We meant to point out that this is the first time comparing the time series of both OCS and CO2 to simulations using coupled land fluxes of those two gases, and analyzing the seasonal cycles including amplitudes and phases. Berry et al. (2013) didn't analyze the full seasonal cycles of both gases by looking at their time series together. We apologize if this sentence has been misleading.**

P. 26043, lines 10ff: uptake is not on/off as characterized here. Relative rates differ at different times. Revisit discussion of this paragraph.

Response: **These sentences were modified as follows:**

The simulation with SiB fluxes reaches the minimum earlier than the measurements. If we discount transport errors, this indicates that there is more OCS uptake (either from plants or soils) in the real world than that calculated in the model in the autumn.

P. 26044, line 16: production -> uptake

Response: **Corrected.**

lines 19ff: 'rebound' is not standard usage; rephrase.

Response: **We changed those to "indicating that the increase of CO2 after growing season is slower in the model"; "This supports the late minimum in comparison to the FTIR measurements".**

P. 26045, lines 3-29: Discussion is speculative, qualitative, and conclusions unsupported. Tighten up.

Response: **We modified the discussion in the revised manuscript.**

P. 26046, lines 10-17: Column and HIPPO comparisons sound inconsistent. Clarify.

Response: **We have clarified this in the revised manuscript.**

P. 26047, section 7: do it.

Response: This is indeed our goal, however, it is not possible at this time. The retrievals at the tropical and Southern Hemispheric sites need to be further optimized to ensure inter-site consistency. In this paper, we focus on the biosphere in the Northern Hemisphere to minimize the influence of the ocean fluxes. The verification of the relationship between OCS and CO2 plant uptake in SiB is important but complicated, and it's not our aim in this

paper. The inter-annual variations will be investigated in future work. This study presents for the first time the use of FTIR column measurements to study the biosphere processes. We presented the measured time series of OCS and CO_2, and compared them to model simulations, and analyzed possibilities for the disagreement. Though there are questions remaining, we believe these questions can give us some inspiration in how to improve the model representation of underlying processes.

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