Answer to reviewer number 1

Thank you for the time and effort spent into this review. Most of your comments have been directly addressed. They allowed us to improve the clarity of the paper, especially the overall structure and to provide a more intuitive understanding of the study.

Specific comments:

1) First and foremost, I would say that the paper is not very well organized. Due to its very descriptive nature, one loses the purpose of the paper. I would, hence suggest moving some of the techniques used in the paper to the appendix. Towards the end of section 2.3, the authors can add the first paragraph of section 2.4.1 accordingly, making necessary changes. Section 2.4.3 can be added as the last paragraph of section 2.3.

We agree with the reviewer that a reader would easily lose the purpose of the paper during the long description of the method. Following some of your suggestions, the paper has thus been substantially reorganized. The order of paragraphs has changed and portions of the text have been simplified. However, we did not merge some of the "optimization" sections (2.4.1 and 2.4.3) into the section 2.3 as suggested but rather keep them separated and reduced to the core points. The main changes are thus:

- **A drastic reduction of the method section with a decrease of the text by nearly 50% in order to keep only the main points that constitutes the backbone of the paper.**
- **We have thus created an Appendix to gather all methodological details that are needed to fully understand the different derivations.**
- **As the method section refers to CO_2 and OCS concentration measurements early in the section, we moved the corresponding paragraph 2.3 (measurements' description) at the beginning of the method section.**
- **As mentioned above, we did not merge section 2.4.3 (optimization setup) into section 2.3 but kept the description/choice of the errors associated to the parameters that we optimize (flux model error and transport error) separate from the description of the optimization scheme itself.**

2) Give a brief description of the three DGVMs selected, at least in the appendix and 3) Define "S2" reference simulation.

Brief descriptions of the 3 DGVMs that were used and of the protocol used for the so-called "S2" simulations of the TRENDY inter-comparison have been added to the article: only the main points are described in the main text (short and concise) and a more detailed description was added in the appendix.

3) Use a common terminology –MSE or RMSE:

The exact denomination should be "MSE" and this has been corrected throughout the entire article.

4) The labeling on Figs 9 & 11 are tiny:

Figures 9 and 11 have been reworked (this was also a concern of reviewer #2), and the labeling uses now larger fonts.

5) There are too many subsections and subsubsections under each section. I would recommend to avoid this. All the sections should be made more concise. Suggested plan:

2 The different surface OCS fluxes and their representation in models
2.1 Sea-air OCS emissions
2.2 uptake of OCS and CO2 during photosynthesis
2.3 Soil-atmosphere OCS emissions
2.4 Other sources and sinks of OCS
3 Models used in this study
3.1 Terrestrial biosphere models (2.1.2)
3.2 Atmospheric transport model
4 Atmospheric OCS observations used for validation
5 Experiments and data analysis
5.1 Forward simulations for OCS
5.2 Forward simulations for CO2
5.3 Optimization scenarios for OCS
5.4 Data analysis
6. Results (to be reorganized accordingly)
Etc…

We agree with the referee that the subsubsections were adding complexity to the paper structure and we thus followed his advice to make it simpler and clearer. We have thus dropped one level of sub-heading and decreased the number of subsections. This was possible given a substantial reduction of the text (mainly of the method section). We mostly followed the plan proposed by the referee, although with few differences:

- **The paragraphs describing the optimization scheme and the corresponding results have been maintained as we believe it is an important aspect of the paper that highlights the combine potential of OCS and CO_2 tracers in an optimization scheme (atmospheric inversion or model parameter optimization)**

- **The result section presents the simulated OCS surface fluxes in the same order as described in the method section, which makes the paper-structure more linear and easier to follow.**

Note finally, that the way to present or discuss the atmospheric concentrations of OCS in the different sections (forward modeling, optimization and general discussion) has been standardized. Each of them is discussed in this order:

- **The long term trend**
- **The amplitude and phase of the mean seasonal variations**
- **The annual mean concentrations of OCS and the north-south gradient**

Technical comments:

We thank the reviewer for all these suggestions. Overall, all technical comments have been addressed, including improvements of grammar, organization and clarity of the paper and adding several important definitions:

I wouldn't recommend abbreviations in the title. Replace 'of current vegetation models' to 'in current vegetation models'

done

P1 (abstract)
7. define LRU in the abstract where it is first used

done

8. velocities *of* plants

done

14 *in* soil and vegetation uptakes

done

P3
20: Here, we use OCS

done

29: For *this*, we modeled the

done

P4
9: In the next step, we define uncertainties

done

20: uncertainties *in* the surface fluxes

done

23: uncertainties *in* OCS surface processes

done

25: *In* the second *section*, we investigate

done

P7
16-17: seasonal cycle from each model and compute the uptake of OCS by leaves using GPP (as described above)

done

P8
5: define C4 plants

done

16: range *on initial estimate of surface fluxes* (Table 2)

done

P9
15: Here, we adopted a different approach *for* the uptake

done

P10
10: The last term in Eq. 3 is not defined

The definition of $[OCS]_{atm}$, the atmospheric concentration of OCS (in ppt) has been added.

14: Two different approaches for estimating…here. The first one is *from* Morfopoulos

done

19-20: The second approach is *from* Bousquet et al., (2011) where an atmospheric… H2 concentration is used < continue with the next paragraph here >.

done

24: *allowing* for the

done

27: remove 'being paid'

done

P11
2: Therefore, the *representation* of OCS emissions by anoxic soils in our model was largely

done

4: because of *the* large uncertainties associated with those fluxes, we finally

done

6-8: Rewrite as 'we used the seasonal maps of methane emissions by Wania… from both categories of soils as simulated … model, to locate the hot spots of OCS emissions from anoxic soils temporally and spatially"

The new paragraph now stands as "Anoxic soil types were mapped accordingly to the representation used in the work by Wania et al. (2010) to represent seasonal methane emissions, as simulated using the LPJ-WHy-ME model. This way, anoxic soils activity were located via methane emissions and translated into hot spots of OCS emissions from anoxic soils, with similar temporal and spatial patterns. "

13: remove 'a' from with an assigned +-30%

done

P15
13-14: For each data point, we selected the closest monthly mean

done

21: "%" missing

done

P16
20: Mention "(refer Table 1 for details)"

done

25: replace "to changes in" to "for varying"

done

P23
14 & 22: Instead of "methods section", give the section number

done

P24
24: Explain Fig 2 and then continue with the explanation

Before driving conclusions from the figure, the explanation of the figure is now clearly made at the beginning of the paragraph: "Figure 2 compares the simulated monthly mean atmospheric OCS concentrations with the observations at Mauna Loa (MLO). Mauna Loa (MLO) is a mid-latitudinal background station in the middle of the tropical Pacific Ocean (20°N, altitude 3500 m). The data therefore represents the integrated contribution of the surface fluxes from the entire Northern Hemisphere (Conway et al., 1994)."

P25
7: The annual trends of OCS in SPO is not shown in Fig. 3 : remove "(Fig 3") from this line

done

10: Again, explain "smooth seasonal cycle" in the text of fig 3

As requested, the definition was added in the figure caption: "Raw data were fitted with a function including a polynomial term (1st order) and four harmonics. The residuals of the functions were further smoothed in the Fourier space, using a low pass filter (cutoff frequency of

65 days) to define a so-called smoothed curve (function plus filtered residuals). The mean seasonal cycle is defined from the smoothed curve after subtraction of the polynomial term. The corresponding smoothed seasonal variations obtained are displayed in lower panels. "

P28-29
26-28: Line incomplete. Rewrite

Now correctly standing as: "Table 2 summarizes the initial and the optimized values of the surface fluxes for the different optimization configurations. "

P32
8: Remove "remaining" and replace with "other biases still exist"

done

12: Replace the title of section 4.1 as "Additional biases in simulated atmospheric OCS concentrations"

done

P34
8: pointing out again the *possibility* of too *high* leaf uptake, which

done

18: arise due to the optimization of only one global annual scalar for each flux component

done

P36
8-11: Rewrite the sentence as "the version of the LMDz model used here is believed to have large mixing in the …, which would thus dampen the amplitude…

As requested, the new sentence now stands as "The version of the LMDz model used here is believed to have too large mixing in the planetary boundary layer (PBL) (Patra et al., 2011, Locatelli et al., 2013), which would thus dampened the amplitude of the seasonal cycle."

P39
13: Replace "evidenced" with "shown"

done