Author responses to comments RC2

MS title: Process-based Modeling of Solar-induced Chlorophyll Fluorescence with VISIT-SIF version 1.0 (egusphere-2024-1542)

We sincerely thank the topic editor, Sato, reviewer1 and reviewer2 for their careful review and comments.
Below, we provided our responses to the review comments. The review comments are highlighted in orange, and our replies are kept in black.

Miyauchi et al. developed a new model, VISIT-SIF version 1.0, to predict SIF and compared it with GOSAT SIF retrievals. The VISIT-SIF model is a significant contribution to the modeling of SIF and has the potential to further our understanding of carbon dynamics. The manuscript is well written and suitable for publication in GMD. However, I have several comments listed below. A revision is necessary before publication.

Major comments:

1. The abstract could be strengthened by emphasizing the uniqueness of the VISIT-SIF model and mentioning how it differs from other existing models. The authors could highlight the capability of the VISIT-SIF model to simulate SIF from different angles. Additionally, it would be beneficial to briefly summarize the application of modeling SIF to broader contexts, either in the abstract or conclusion.

Reply1: Thank you for your careful and helpful review. We revised the abstract following your comments.

L13-18:
“Implementation of radiation transfer models (RTMs) helps to address the interaction of chlorophyll fluorescence with vegetation and atmosphere. However, the computation of RTMs becomes more time-consuming, which can make it impractical in application to satellite observations with larger data volumes. This study resolves this issue by parameterizing the radiation transfer processes and its geometric relationships. This approach enables ease of implementation of VISIT-SIF for simulating satellite SIF retrievals even for the satellites having off-nadir observation angles.”

2. GOSAT-SIF data used in this study contain negative values. Why do the authors not consider data filtering on the GOSAT-SIF before comparison with VISIT-SIF?

Reply2: As you mentioned, the negative SIF values are not actual physical quantities caused by retrieval nose and such nosy data often removed by filtering. However, in this study, we used all satellite observation data for comparisons to prevent significant biases in the probability distribution of SIF variability. Relevant descriptions were described as below.

L313-315:
"The negative SIF values are not actual physical quantities because of the presence of retrieval noise, but this study used all the satellite observations without discarding the negative values to prevent significant biases in the probability distribution of the SIF variability."

3. In Eq.2 and Figure 1, how is fu calculated?

Reply3: f_u was calculated as the average fraction of upward chlorophyll fluorescence to tatal emitted chlorophyll fluorescence across the 60 canopy layers in SCOPE. We revised the sentences related to f_u as follow.

L152-157:
"The variable f_u represents the fraction of the SIF emitted in the upward direction to that in both the upward and downward directions at the canopy level. It was obtained as the average fraction across the 60 canopy layers by operating the SCOPE model. The variable can be used to estimate canopy-level fluorescence by considering radiative transfer processes within the canopy layers; however, reabsorption at single leaf level in fluorescence yield was not reflected. In addition, Equation (2) describes indirect incorporation of VISIT and SCOPE by multiplying $\Phi_{F,sun}$, $r_{oz/sz}$ and f_u."

Minor comments:
Line 32: "increases to prevent damae to the photosynthetic system due to the accumulation of excess energy." Should damae be damage?

Reply4: We appreciate your careful review and for pointing out misspellings. As you mentioned, it was a misspelling. We corrected it to damage.

Line 33-34: “hence, the quantum yield of photochemistry is positively and negatively correlated with fluorescence and heat dissipation" to “hence, the quantum yield of photochemistry is positively correlated with fluorescence and negatively correlated with heat dissipation”.
Line 69: “has not been developed since the launch of GOSAT in January 2009” to “has not been developed until the launch of GOSAT in January 2009”.
Line 257: “for the satellite observations and model simulations” to “between the satellite observations and model simulations”.
Ling 258: “according to this comparison” to “According to this comparison”
Line 377: “temperature and water and light limitations.” To “temperature, and water and light limitations.”
Line 401-403: Please give relevant reference to GOME-2, OCO-2, TROPOMI, etc.

Reply5: We appreciate your careful reading. As you pointed out, I revised our manuscript.
Regarding L33-34, since the positive or negative correlation among photochemistry, heat dissipation, and chlorophyll fluorescence is not necessarily consistent under varying environmental conditions, we revised it as follow.

L36-37:
“- hence, the quantum yield of photochemistry is correlated with fluorescence and heat dissipation (Flexas et al., 2000).”

Regarding L33-34, we changed the sentence according to RC1.

L72-73:
“GOSAT has been operated since the launch in January 2009, and of which SIF retrievals have the longest observation record of any single satellite sensor.”

Figure 1: The description to the figure is too short. Please give necessary information about the diagram, for example the major components or the work flows.

Reply6: We added the explanation of our model and work flows as follow.

L127-132:
“The model system consists of biochemical/biophysical processes and geometric and radiative transfer processes. The former simulates the canopy structures and the radiative conditions within the canopy and the actual and potential electron transport rates for a given grid. The simulated electron transport

rates are inputs for the quantum yield of chlorophyll fluorescence, and the absorbed photosynthetically active radiation (APAR) is used to calculate SIF. The latter simulates radiative transfer processes for the SIF emitted from the upper canopy. The practical operation manner to simplify the simulation of radiation transfer processes is given later in this subsection."

Figure 6: The circles are overlapped. It is recommended to show them in different colors or shapes.

Reply7: We revised Figure 6 using different colors.

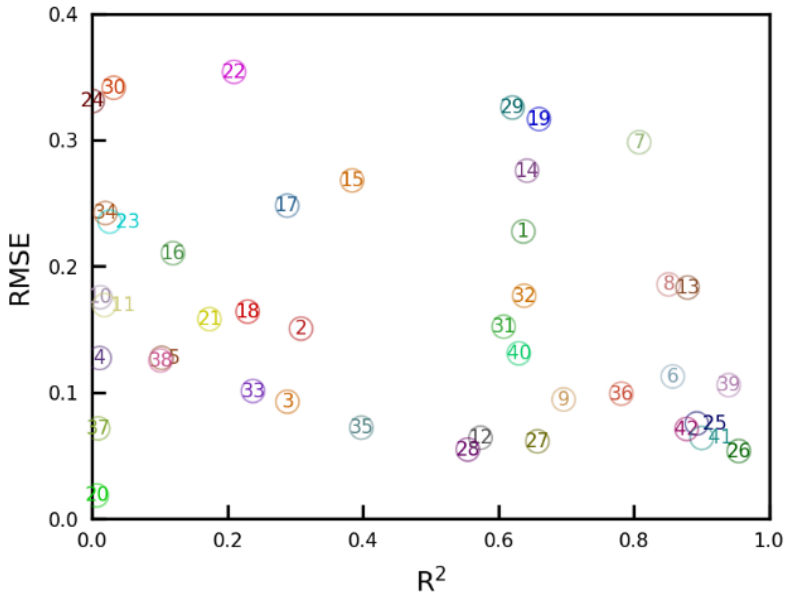

Figure 6. The relationships between R^2 and RMSE for the mean monthly variability in the VISIT-SIF simulations and GOSAT retrievals in the 42 subcontinental regions. The numbers in the figure correspond to the regional IDs shown in Fig. C1.

Figure 7: Only 9 regions are selected to show, is there any specific reason that other regions are not shown?

Reply8:

We selected nine characteristic regions for discussion. There is no specific reason for not displaying other regions; however, Figure 7 presents characteristic all-period monthly SIF extracted from 7-years mean monthly SIF shown in Figure 6. To avoid redundancy, other regions were not displayed.

Others:

1. We added the caption for Fig. 5c.
2. We had revised the Eq.14 due to a mistake in unit.