

Reviewer1:

Overall Assessment

This manuscript presents a physics-constrained transfer learning framework centered on a Spectral-Fidelity-Preserving model for transferring satellite radiance observations between sensors with similar but non-identical spectral response functions. Its key innovation is to derive transfer coefficients from radiative-transfer-simulated and SRF-convolved radiance pairs, rather than relying solely on empirical regression using satellite matchups. The sensitivity analysis in Section 3 is comprehensive, combining distributional similarity metrics, fitting diagnostics, and analytical uncertainty propagation to assess the joint effects of SRF differences and calibration uncertainty. The two case studies in Section 4, cloud amount profile retrieval using CLANN and quantitative precipitation estimation using an UNet framework, further demonstrate that models trained on FY-4A data can be transferred to FY-4B observations without retraining. The proposed quantitative thresholds for SRF scaling and central-wavenumber shifts are also practically useful for satellite calibration and cross-sensor algorithm transfer. Overall, the manuscript is well designed and technically sound, but several issues should still be addressed before publication.

Response: We thank the reviewer for the careful and constructive assessment. In response, we have clarified the target/reference convention and the physical basis of the SFP framework, defined the scope and terminology of the uncertainty-propagation analysis, distinguished spectral harmonization, retrieval-model transfer, and radiometric calibration transfer, reduced redundant text, and corrected the identified cross-references, labels, dates, and language issues. Detailed point-by-point responses and corresponding manuscript changes are provided below.

Specific Comments

comment 1. The direction implied by "target" and "reference" is not fully consistent across sections. Eq. (3) treats y (the output) as the target-sensor radiance and x (the input) as the reference-sensor radiance, whereas Section 4.1 calls the FY-4B input the "target" channel and the FY-4A-equivalent output "reference" — the reverse assignment. The authors themselves note in Section 3.3 that Figure 9 uses the opposite convention from Figure 3. Stating one consistent convention in Section 2.2, and flagging it explicitly wherever it is deliberately reversed, would resolve this.

Response:

We thank the reviewer for identifying this ambiguity. We have retained the convention defined in Eq. (3), in which y represents the fitted target-sensor radiance and x represents the input reference-sensor radiance. Section 4.1 has therefore been corrected so that the FY-4B observations are identified as the reference input and the converted FY-4A-equivalent radiances as the target output. Figure 9 intentionally evaluates the transfer in both directions: the $A \rightarrow B$ case uses FY-4A as the target and FY-4B as the reference, consistent with the assignment in Fig. 3, whereas the $B \rightarrow A$ case reverses these roles. We have revised Section 3.3 to make this bidirectional treatment explicit. These changes clarify the target/reference terminology without altering the underlying formulation or analysis. The corresponding clarifications have been added in Lines 371 – 374, 656 – 659, and 723 – 727 of the revised manuscript.

comment 2. Readers may expect "physics-constrained" to mean a physical penalty term added to a loss function, but here physical consistency is instead built into the training data itself, via the radiative-transfer simulations (Section 2.1) and the SRF-convolution step (Eq. 4). Stating this explicitly would also clarify why the framework reduces SRF-driven bias between sensors. A brief note on why $R^2 \geq 0.95$ and $n \leq 4$ were chosen in Section 2.2, and how many simulated pairs enter each channel's fit, would also help.

Response:

We thank the reviewer for this helpful comment. We agree that the term “physics-constrained” could be interpreted as referring to an explicit physics-based penalty term in a loss function. In the present framework, however, the physical constraint is embedded in the construction of the fitting data: paired radiances are generated using MODTRAN and subsequently convolved with the actual SRFs of the two sensors. The fitted relationships therefore directly incorporate radiative-transfer physics and sensor-specific spectral responses, thereby reducing SRF-related inter-sensor bias without relying on noisy satellite matchups. We have clarified this point in Section 2.1.

We have also clarified the adaptive polynomial-fitting criteria in Section 2.2. The fitting begins with a linear model, and the polynomial order is increased only when R^2 is below 0.95, up to a maximum order of $n=4$. The $R^2 \geq 0.95$ threshold is used as an empirical goodness-of-fit criterion rather than as a test of statistical significance, while the maximum order limits unnecessary model complexity and reduces the risk of overfitting.

Finally, to ensure a consistent comparison among the VIS/NIR channels, we applied a common finite-value mask across the six matched channel pairs. Of the initial 55,600 simulated pairs, 50 cases containing non-finite values in at least one matched channel were excluded, leaving the same 55,550 pairs for each VIS/NIR channel fit. Each IR channel fit used 18,000 valid simulated pairs from five atmospheric conditions. These sample sizes have now been stated explicitly in Section 2.2.

The physical basis of the term “physics-constrained” is clarified in Lines 352 – 361, while the polynomial-order criterion and the numbers of simulated pairs used for fitting are specified in Lines 375 – 386 of the revised manuscript.

comment 3. The manuscript touches on three related applications — spectral harmonization, retrieval-model transfer, and radiometric calibration transfer — without clearly distinguishing them. The FY-4A/FY-4B experiments here mainly demonstrate the first two, while the calibration-transfer claim relies more on the earlier FY-3D/MERSI-II study. A short clarification in the Abstract and Conclusions would make this distinction, and the manuscript's practical claims, more precise.

Response: We thank the reviewer for this helpful suggestion. We have clarified in the Abstract and Discussion that the FY-4A/FY-4B experiments presented in this study demonstrate spectral harmonization and retrieval-model transfer, whereas radiometric calibration transfer was demonstrated in our previous FY-3D/MERSI-II study using MODIS as an independent reference (Yu et al., 2026). These distinctions are now clarified in the Abstract (Lines 90 – 95) and in the Discussion and Conclusions (Lines 882 – 896). The corresponding previous calibration-transfer study is listed in Lines 1204 – 1206.

Reference:

Yu, Q., Min, M., Di, D., Zhao, Y., Li, G., Li, J., Wang, L., Hu, X., and Zhang, P.: Spectral-fidelity-preserving recalibration of reflective solar bands for MERSI-II onboard Fengyun-3D satellite, *IEEE Transactions on Geoscience and Remote Sensing*, 64, 4104116, 10.1109/TGRS.2026.3671371, 2026.

comment 4. Eqs. (17) – (21) and (A20) – (A21) propagate an assumed perturbation in the target channel through a fixed transformation, while uncertainty in the fitted coefficients, SRF characterization, and RTM simulations is implicitly treated as negligible. "Bias," "error," and "uncertainty" are also used somewhat interchangeably. A short paragraph near Eq. (17) or in Section 3.3 stating the scope of this derivation would be enough to resolve this, without a new analysis.

Response: We thank the reviewer for this helpful comment. We have added a clarifying paragraph at the beginning of Section 3.3 stating that the derivation propagates an externally imposed target-channel calibration uncertainty through the already-fitted TL model, while uncertainties associated with the fitted coefficients, SRF characterization, and RTM simulations are not separately propagated. We have also clarified the use of “error,” “uncertainty,” and “bias” throughout this section. The scope and terminology of the uncertainty-propagation analysis are clarified in Lines 604 – 617 of the revised manuscript.

comment 5. The SRF-similarity guidance (scaling factor 0.5 – 1.5; wavenumber shift below 200 cm^{-1} for VIS/NIR, below 20 cm^{-1} for IR window channels) is repeated in near-identical wording in the Abstract, Section 3.2, and Discussion point (2). Keeping the full statement in Section 3.2 and shortening the other two to a brief cross-reference would reduce this redundancy.

Response: We thank the reviewer for this observation. We agree that stating this threshold in full, nearly identical wording in three places reads as redundant. We have kept the complete, detailed statement in Section 3.2 (where the underlying Figures 7 and 8 are discussed) and shortened the Abstract and Discussion point (2) to brief cross-references. The shortened statement appears in the Abstract (Lines 80 – 83) and Discussion (Lines 861 – 872), while the complete empirical thresholds and their interpretation are retained in Section 3.2 (Lines 570 – 588).

Section 3.2

"As a conservative guideline, for VIS/NIR channels, the difference in central wavenumber should be kept below 200 cm^{-1} , while the scaling factor should be constrained to the range of 0.5 – 1.5. In comparison, IR channels, particularly the water-vapor bands, appear to be somewhat more tolerant. However, for atmospheric

window channels around 11 μm , the shifted wavenumber should ideally remain below 20 cm^{-1} , with the scaling factor likewise limited to 0.5 – 1.5."

Abstract

"We further establish practical SRF-similarity thresholds — an allowable scaling-factor range and central-wavenumber-shift limits that are stricter for IR window channels — that support reliable radiance transfer (see Section 3.2 for details)."

Discussion point (2)

"As detailed in Section 3.2, IR channels generally tolerate larger central-wavelength shifts than VIS/NIR channels, with the notable exception of the atmospheric window region, where the same scaling-factor and shift constraints apply."

comment 6. In Section 4.1, the sentence "Consequently, previous work did not attempt to develop an FY-4B/AGRI-based CLANN retrieval model" appears twice in immediate succession, each followed by a similar remark. This reads as a leftover from editing; removing the duplicate would tighten the paragraph.

Response: We thank the reviewer for pointing out this duplication. We have removed the repeated sentence and consolidated the related text in Section 4.1. The duplicated sentence has been removed, and the consolidated description appears in Lines 712 – 720 of the revised manuscript.

comment 7. In Section 3.3, the sentence "Fig. 4 further indicates that when the radiometric calibration bias becomes large (e.g., reaching 6%)..." appears to reference

the wrong figure: Figure 4 shows simulated SRF adjustments, whereas the 1% – 6% error range described matches Figure 9's caption instead. The authors are encouraged to verify and correct this cross-reference.

Response:

We thank the reviewer for catching this cross-reference error. We confirm that "Fig. 4" in this sentence should read "Fig. 9"; the discussion of the 1% – 6% reflectance error range is indeed based on the error-sensitivity heatmaps in Figure 9, not the SRF adjustment examples in Figure 4. We have corrected the sentence in Section 3.3 as follows:

"Regardless of the specific mechanism, Fig. 9 further indicates that when the radiometric calibration bias becomes large (e.g., reaching 6%), the resulting transfer error also increases approximately linearly."

The corrected cross-reference and revised sentence appear in Lines 668 – 670 of the revised manuscript.

comment 8. In Eq. (15), "Upper Fence" is defined as $Q25 - 1.5 \times IQR$ and "Lower Fence" as $Q75 + 1.5 \times IQR$, which is the reverse of standard convention (upper fence = $Q75 + 1.5 \times IQR$; lower fence = $Q25 - 1.5 \times IQR$). The authors are encouraged to correct this labeling.

Response:

We thank the reviewer for this careful check. We confirm that the labels in Eq. (15) were transposed in the manuscript; this was a labeling error in typesetting the equation and does not affect the underlying analysis, which follows the standard Tukey fence definition. We have corrected Eq. (15) as follows:

$$\text{Upper Fence} = Q_{75} + 1.5 \times \text{IQR}$$

$$\text{Lower Fence} = Q_{25} - 1.5 \times \text{IQR}$$

Any residual value lying beyond these two fences is identified as an outlier and counted toward Noutlier.

The corrected upper- and lower-fence definitions appear in Eqs. (15) – (16), Lines 534 – 539 of the revised manuscript.

comment 9. There is a date discrepancy between the text and Figure 11: Section 4.2 gives Case 1 as "11 June 2024" and the extrapolation period as ending in "July 2024," while the Figure 11 caption gives "11 July 2024" and an end date of "August 2024." The authors are encouraged to reconcile these dates.

Response:

We thank the reviewer for identifying these inconsistencies. We verified that Case 1 occurred on 11 July 2024 and have corrected the date in Section 4.2 accordingly. We also corrected the end of the extrapolation period from July 2024 to August 2024, consistent with Case 2 on 10 August 2024. These dates are now consistent throughout Section 4.2 and Figure 11. The corrected dates and extrapolation period appear in Lines 774 – 777 and in the revised Figure 11 caption (Lines 1451 – 1465).

comment 10. In Section 4.2, the Multi-Task UNet model is attributed to "Jaegle et al., 2021," which in the reference list corresponds to the Perceiver architecture rather than a U-Net. The authors are encouraged to verify this citation.

Response: We thank the reviewer for identifying this citation error. Jaegle et al. (2021) describes the Perceiver architecture and is not the appropriate reference for the U-Net model used in this study. We have replaced it with the original U-Net reference

(Ronneberger et al., 2015) in Section 4.2 and removed the incorrect Jaegle et al. (2021) reference from the reference list.

The corrected citation appears in Lines 764 – 765. The corresponding reference is provided in Lines 1167 – 1169: Ronneberger, O., Fischer, P., and Brox, T. (2015), “U-Net: Convolutional Networks for Biomedical Image Segmentation.”

Reference:

Ronneberger, O., Fischer, P., and Brox, T.: U-Net: Convolutional Networks for Biomedical Image Segmentation, Medical Image Computing and Computer-Assisted Intervention – MICCAI 2015, Cham, 234 – 241, 2015.

comment 11. The same $\sim 13.30 \mu\text{m}$ channel is labeled "Channel 15" (FY-4B convention) in the Figure 3 caption but "Channel 14" (FY-4A convention) in Section 3.3. A brief note clarifying the channel-number correspondence between the two sensors would prevent confusion.

Response: We thank the reviewer for this observation. The $\sim 13.30 \mu\text{m}$ channel corresponds to Channel 14 for FY-4A/AGRI and Channel 15 for FY-4B/AGRI because the two instruments use different channel-numbering schemes. To avoid confusion, we have added the following clarification in Section 2, where the AGRI channels are first introduced:

“Note that the same physical channel may therefore be numbered differently under the two sensors' designations; for example, the $\sim 13.30 \mu\text{m}$ channel corresponds to Channel 14 under the FY-4A numbering and Channel 15 under the FY-4B numbering. Channel numbers cited in this manuscript follow the FY-4B designation unless otherwise noted.”

We have also specified in the Figure 3 caption that its channel numbers follow the FY-4B designations, while Section 3.3 explicitly identifies the corresponding band as FY-4A/AGRI Channel 14.

The channel-number correspondence is clarified in Lines 265 – 269 and 675 – 676, and the FY-4B channel-numbering convention is explicitly stated in the Figure 3 caption (Lines 1311 – 1316).

comment 12. A few language points warrant a check: the Abstract's opening sentence has a subject – verb agreement issue ("transformation ... are essential" should be "is essential"); "compared those without applying TL" is missing a preposition; and "F-4A" appears to be a typo for "FY-4A."

Response:

We thank the reviewer for catching these language issues. We have corrected all three instances in the Abstract. The three language corrections appear in Lines 71 – 73, 85 – 87, and 89 – 90 of the revised manuscript.

Subject – verb agreement:

"Accurate spectral transformation across satellite sensors with similar but different spectral response functions (SRFs) is essential for applying the same retrieval algorithms."

Missing preposition:

"...cloud amount profile and quantitative precipitation estimation, when compared with results obtained without applying TL."

Typo:

"...e.g., transferring algorithms developed for FY-4A to FY-4B without operational interruption."

Reviewer2

Overall Assessment

This study presents a physics-constrained transfer learning (TL) framework for transforming satellite radiance observations across sensors with different spectral response functions (SRFs). The core component is a Spectral-Fidelity-Preserving (SFP) model built on MODTRAN-based radiative transfer simulations, which derives polynomial transfer coefficients between spectrally similar channels on different satellite imagers. The framework is evaluated through sensitivity experiments on SRF discrepancies and radiometric calibration uncertainties, and demonstrated through cloud amount profile and quantitative precipitation estimation using FY-4A and FY-4B AGRI observations.

The concept of grounding cross-sensor transfer learning in radiative transfer physics rather than purely data-driven approaches is sound and practically relevant, particularly for operational satellite transitions (e.g., FY-4A to FY-4B). The sensitivity analysis quantifying the impact of SRF width scaling and central wavelength shifts on transfer performance is a useful contribution, and the empirical guidelines (scaling factor 0.5 - 1.5, $JSD \leq 0.3$) provide actionable criteria for operational users.

Overall, the manuscript is well-structured, although several minor concerns and corrections are still needed. I therefore recommend minor revisions prior to acceptance, listed as follows.

Response: We extend our heartfelt gratitude to the reviewer for their insightful and constructive feedback. Having thoroughly reviewed our manuscript in light of your comments, we now provide our point-by-point responses and have incorporated the necessary amendments into the revised text.

Specific Comments

1. The FY-4B/AGRI against CALIPSO validation period for the cloud amount profile experiment is limited to approximately 10 months (June 2022 – March 2023). While the TL model reduces the RMSE by 0.08 km and improves the correlation coefficient from 0.841 to 0.851 (lines 645 – 646), these improvements are relatively modest. Given the limited validation sample, the authors should discuss whether these differences are statistically significant. Reporting confidence intervals, a paired t-test, or a bootstrap significance test on the RMSE/R differences would substantially strengthen the claim that the TL framework yields a "measurable improvement" (line 648). Without such analysis, it is difficult to determine whether the observed gains exceed the natural sampling variability.

Response: We thank the reviewer for this important comment. We agree that the original wording did not sufficiently distinguish a numerical improvement from statistical evidence. Because the correlation coefficients obtained with and without transfer learning were calculated from the same 517,958 collocated CALIPSO – AGRI profile pairs and shared CALIPSO as the common reference variable, we compared them as dependent and overlapping correlations. The correlation between the retrievals with and without transfer learning was 0.927. Zou's 99% confidence interval for the increase in R from 0.841 to 0.851 ($\Delta R = 0.010$) was 0.0093 – 0.0107,

which excluded zero. This result indicates that the increase in R is statistically detectable at the individual-profile level under the sampling assumptions of the test. Nevertheless, we recognize that neighboring profiles along the same CALIPSO track may not be statistically independent, and this possible spatial dependence was not explicitly modeled in the present analysis. We have therefore avoided interpreting the result as a fully dependence-adjusted significance test. In addition, because the available information does not support an equivalent significance analysis of the RMSE difference, the 0.08 km reduction in RMSE is now reported as a descriptive numerical change rather than as a statistically significant improvement. We have accordingly replaced the original expressions “measurable improvement” and “significantly improves” with more cautious wording, clarified that the two representative cases provide qualitative illustrations, and added the limited validation period and potential along-track dependence as limitations in Section 4.1. The statistical comparison, confidence interval, interpretation of the RMSE change, and associated limitations are reported in Lines 731 – 760 of the revised manuscript.

2. The authors separate the theoretical framework into VIS/NIR (Eq. 1) and TIR (Eq. 2) regimes, and the error propagation analysis (Section 3.3) is similarly divided between reflectance-based (Eqs. 20 – 21) and BT-based (Eqs. A20 – A21) formulations. However, the 3.75 μm channel included in the CLANN retrieval model (line 607) contains both reflected solar and thermal emissive contributions during daytime. This dual-source nature means that neither the pure VIS/NIR nor the pure TIR transfer model fully captures the channel's radiative behavior under all illumination conditions. It is suggested to briefly discuss how the SFP model and the transfer coefficients handle this mixed channel, particularly whether the MODTRAN simulations adequately capture the solar reflection component at 3.75 μm across the range of solar geometries in Table 1, and whether the transfer performance degrades for daytime observations at this wavelength.

Response: We thank the reviewer for pointing out the mixed-source nature of the 3.75- μm channel. We agree that daytime observations at this wavelength include both thermally emitted radiance and reflected or scattered solar radiance, and thus cannot be adequately represented by a purely thermal formulation.

To address this, we have clarified the theoretical framework following Eqs. (1) and (2). The 3.75- μm channel is now explicitly described as a mixed-source channel. Its daytime top-of-atmosphere radiance accounts for atmospheric and surface thermal emission, along with atmospheric solar scattering and surface-reflected solar radiance. Accordingly, the SFP model performs the radiative transfer for this channel using the total band-integrated radiance, rather than a thermal-only component.

We also revisited the MODTRAN configuration used to generate the stored infrared simulations. The simulations relevant to channel 07 were produced using the thermal-plus-solar radiance mode (IEMSCT = 2), with multiple scattering enabled (IMULT = 1). The corresponding outputs include non-zero solar-scattering and ground-reflection components, and the TOTAL_RAD field was used for the SRF convolution. Consequently, the FY-4A and FY-4B channel-07 coefficients were fitted to their respective SRF-convolved total radiances, thereby preserving both thermal and daytime solar contributions.

Although channel 07 is processed through the brightness-temperature branch in the operational conversion procedure, its daytime brightness temperature is an effective value corresponding to the total measured band radiance. The procedure first converts brightness temperature to radiance, performs the inter-sensor transfer in radiance space, and then converts the transferred radiance back to the target-sensor brightness temperature. No explicit subtraction of the solar-reflected component is performed.

Using the existing simulation dataset—without conducting additional MODTRAN or CLANN experiments—we further examined the channel-07 transfer performance at the available discrete solar-zenith angles. The analysis included 18,000 matched samples from five infrared atmospheric conditions. The relative RMSEs at solar-zenith angles of 0° , 30° , and 60° were 2.020%, 2.004%, and 2.012%, respectively. Thus, no monotonic degradation with increasing solar-zenith angle was

identified within the available simulations, although a modest dependence on viewing geometry remained.

We have also revised the description of the simulation geometry to clarify that the retained infrared dataset covers solar-zenith angles of 0°, 30°, and 60°. We therefore do not claim channel-07 performance at 45° or 55°. Finally, we now state that the present results characterize total-radiance transfer under the adopted Lambertian surface assumption and do not constitute a general solar-reflection correction for arbitrary surface bidirectional reflectance or strong sun-glint conditions.

The mixed-source nature of the 3.75- μ m channel is clarified in Lines 293 – 302. The MODTRAN configuration and total-radiance treatment are described in Lines 335 – 344, the solar-zenith-angle analysis is reported in Lines 589 – 601, and the associated limitations are discussed in Lines 852 – 860. The available infrared simulation geometries are additionally clarified in the Table 1 note (Lines 1243 – 1248).

3. The manuscript provides several empirically derived guidelines for applying the TL framework, scattered across Sections 3.2, 3.3, and 5. These include: SRF scaling factor within 0.5 – 1.5, central wavenumber shift below 200 cm^{-1} for VIS/NIR channels, below 20 cm^{-1} for IR atmospheric window channels (e.g., 10.80 μm), and $\text{JSD} \leq 0.3$ as a transferability threshold. I suggest providing a concise summary table consolidating these recommended thresholds, for example, organized by channel type (VIS/NIR, water vapor IR, atmospheric window IR) with the corresponding metric, threshold value, and consequence of violation. This would improve the manuscript's practical utility and would serve as a quick-reference guide for potential users.

Response: Thank you for this practical suggestion. We have added Table 2 at the end of Section 3.2 to consolidate the empirically derived SRF-similarity guidelines by channel type. The table summarizes the recommended SRF-width scaling range, central-wavenumber difference, JSD criterion, and the observed consequences when these guidelines are exceeded for VIS/NIR, water-vapor IR, and atmospheric-window

IR channels. Because the present experiments did not establish a single numerical central-wavenumber limit for water-vapor IR channels, this entry is explicitly identified as channel-dependent and should be evaluated using JSD together with the corresponding RMSE, R^2 , and outlier behavior. We have also clarified that these values are conservative empirical guidelines derived from the simulated SRF-perturbation experiments rather than universal sensor-design limits. The empirical guidelines are introduced in Lines 570 – 588 and consolidated in the new Table 2 (Lines 1258 – 1262).

4. The manuscript states that "the classical MODTRAN (Version 4.2) model (Berk and Hawes, 2017)" is employed (line 296 – 297). However, the cited reference (Berk and Hawes, 2017) describes the validation of MODTRAN 6, not Version 4.2. Please make sure that the version of MODTRAN used is correctly cited.

Response: Thank you for identifying this inconsistency. We re-examined the archived simulation scripts and MODTRAN output files and confirmed that the simulations used MODTRAN version 5.3.2, rather than version 4.2. The simulation driver calls the MODTRAN 5.3 executable from the 5.3.2 installation, and the retained output headers identify the model branch as MODTRAN 5.3.2. We have therefore corrected the version statement in Section 2.1 and replaced the MODTRAN 6 reference (Berk and Hawes, 2017) with the version-specific MODTRAN 5.3.2 User's Manual (Berk et al., 2013). The revised text now reads: "Specifically, we employ MODTRAN version 5.3.2 (Berk et al., 2013) as the forward radiative transfer model (RTM) to generate TOA radiances (Unit = $W/(m^2 \cdot sr \cdot \mu m)$) over 0.40–13.5 μm at a spectral resolution of 1 cm^{-1} ." The corrected MODTRAN version and citation appear in Lines 315 – 317, and the version-specific MODTRAN 5.3.2 User's Manual is listed in the reference list at Line 1037.

Reference:

Berk, A., Anderson, G. P., and Acharya, P. K.: MODTRAN®5.3.2 User' s Manual, Spectral Sciences, Inc., Burlington, MA, USA, 2013.

5. Lines 625 – 629 contain a near-identical repeated sentence: "Consequently, previous work did not attempt to develop an FY-4B/AGRI-based CLANN retrieval model" appears twice within five lines. Please clarify.

Response: Thank you for pointing out this duplication. We have removed the repeated sentence in Section 4.1 and consolidated the surrounding description of the limited FY-4B/AGRI – CALIPSO overlap to improve concision and logical flow. The revised text now clarifies that the available overlap period was used for a targeted evaluation of the physics-constrained transfer learning model. The duplicated sentence has been removed, and the revised description appears in Lines 712 – 720.

6. More technical issues:

Technical Comment 1

- Line 92: "adopt algorithms of F-4A to FY-4B": "F-4A" should read "FY-4A."

Response: Thank you for identifying this typographical error. We have corrected “F-4A” to “FY-4A” and revised the sentence for clarity. The corrected text now reads: ‘...transferring algorithms developed for FY-4A to FY-4B without operational interruption.’ . The correction appears in Lines 89 – 90 of the revised manuscript.

Technical Comment 2

- Line 93: The keyword list ("Radiative transfer, transfer learning, Physics-Constrained") uses inconsistent capitalization. Consider standardizing to either title case or sentence case throughout.

Response: Thank you for noting the inconsistent capitalization in the keyword list. We have standardized the keywords to lowercase and revised the final keyword to the complete term “physics-constrained transfer learning.” The revised keyword list now reads: “radiative transfer, transfer learning, physics-constrained transfer learning.” . The standardized keyword list appears in Lines 97 – 98 of the revised manuscript.

Technical Comment 3

- Table 1: The surface type "Forest" uses "P" ($P = 0.08 - 0.83$) instead of " ρ ".

Response: Thank you for identifying this typographical inconsistency. We have replaced the incorrect “P” symbol with the lowercase Greek letter “ ρ ” in the Forest row of Table 1, thereby ensuring consistent notation for surface reflectivity throughout the table and manuscript. The corrected symbol appears in Table 1, identified at Lines 1242 of the revised manuscript.

Technical Comment 4

- The manuscript would benefit from a brief notation table or consistent first-use definitions for the numerous abbreviations (AGRI, SFP, SRF, BT, TL, FTL, MTL, FL, UDA, SSL, etc.), as the density of acronyms in the Introduction may challenge readers from adjacent fields.

Response: Thank you for this helpful suggestion. To improve readability without adding a redundant abbreviation table, we systematically reviewed the abbreviations

throughout the manuscript and ensured that the recurring abbreviations are defined consistently at their first occurrence. Core abbreviations, including SRF, TL, SFP, AGRI, and BT, are introduced using their full terms before subsequent use. We have also removed the one-time abbreviations “MTL” and “FL” and retained their full terms, thereby reducing acronym density. The recurrent abbreviations FTL, UDA, and SSL remain defined at first use and are used consistently thereafter. The principal abbreviations are defined at their first occurrences in Lines 71 – 76, 97 – 98, 103 – 114, 207 – 208, and 257 – 269. The one-time abbreviations “MTL” and “FL” have been removed in Lines 112 – 114.