Point-by-point responses to the referees' comments

We sincerely thank the anonymous reviewers for the time and effort devoted to reviewing our manuscript. Their comments were very helpful in improving the quality of the paper, and all of them have been carefully addressed.

Below, reviewer comments are marked in ***black***.

Our responses are given in blue.

The corresponding revisions to the main text are highlighted in *red*.

Response to RC1

This manuscript presents a timely and valuable global long-term dataset of optimized SMOS 40° brightness temperatures (TB), together with the corresponding soil moisture (SM) and vegetation optical depth (VOD) retrievals. It is also the first study to provide SM and VOD products derived from SMOS single-angle information. This represents an important advance, as it complements currently available multi-angular products and facilitates cross-comparison and potential fusion with SMAP-based datasets. Overall, the study is interesting, and the manuscript is well written. The dataset is publicly available, and the validation is extensive, including in situ observations as well as independent satellite and reanalysis products, which fits well within the scope of ESSD. I am positive about the overall contribution; however, before considering publication, several points could be clarified to further strengthen the manuscript:

Response: We sincerely thank the reviewer for the careful reading of our manuscript and for the encouraging feedback. We are deeply appreciative of your overall positive assessment. We have carefully considered the points where you suggested clarifications and these suggestions have been extremely helpful in improving the presentation quality of our work. We have addressed them point-by-point below to strengthen the manuscript.

1. There are too many acronyms throughout the manuscript. Acronyms like IB_HR_mono_SMOSIB, IC_multi_SMOS, etc., are essential but can be challenging for readers to track. Please consider adding a small glossary table in the supplement defining these key acronyms.

Response: We totally agree with you that adding a table in the supplement defining these key acronyms improves the overall readability of the manuscript. Following your suggestion, a table was added in the revised supplementary document. The added table is as follows:

Table S2 List of key abbreviations.

Abbreviation	***Definition***
SMOS	*Soil Moisture and Ocean Salinity*
SMAP	*Soil Moisture Active Passive*
SM	*Soil Moisture*
VOD	*Vegetation Optical Depth*
TB	*Brightness Temperature*
SMOS-IC	*A multi-angular SMOS algorithm developed by INRAE Bordeaux*
SMAP-IB	*A mono-angular SMAP algorithm developed by INRAE Bordeaux*
$IB\_HR_{mono}^{SMOSIB}$	*SM and VOD products retrieved by applying the SMAP-IB algorithm to the fitted SMOS L3 40° TB and updated soil roughness map*
IB_{mono}^{SMOSIB}	*SM and VOD products retrieved by applying the SMAP-IB algorithm to the fitted SMOS L3 40° TB*
$IB_{mono}^{RawSMOS}$	*SM and VOD products retrieved by applying the SMAP-IB algorithm to the SMOS L3 40° TB*
IC_{multi}^{SMOS}	*SM and VOD products retrieved using the processed multi-angle SMOS-L3 TB dataset with quality filtering provided by the Centre Aval de Traitement des Données (CATDS) using the SMOS-IC version 2 algorithm*
IB_{mono}^{SMAP}	*SM and VOD products retrieved by applying the SMAP-IB algorithm to the 25km SMAP-L3 TBs*

2. Lines 179-180 state: "The GLDAS SM (kg/m^2) was also transformed into volumetric unit (m^3/m^3), with daily average SM computed for analysis". Please correct "GLDAS SM" to "GLDAS-Noah SM" for precision. Furthermore, please specify the method used to convert the units from kg/m^2 to volumetric SM (m^3/m^3).

Response: Thanks for pointing this out. In the revised manuscript, the "GLDAS SM" has been corrected to "GLDAS-Noah SM" throughout the manuscript.

We also agree that specifying the conversion method is important for transparency. Regarding the unit conversion, the sentence was revised in the updated manuscript to specify that we followed the method established by Cui et al., (2018). The revised sentence is as follows in L175-177:

" The GLDAS-Noah SM (kg/m^2) was then converted to volumetric unit (m^3/m^3) following the method of Cui et al., (2018) by dividing by the water density and the corresponding soil layer thickness, with daily average SM computed for further analysis"

3. Please add labels (e.g., a, b, c, d) to each subplot in Figure 3 for easier referencing and to ensure consistency with the figure caption descriptions.

Response: Thanks for the suggestion. The labels have been added in Figure 3. The revised figure is as follows:

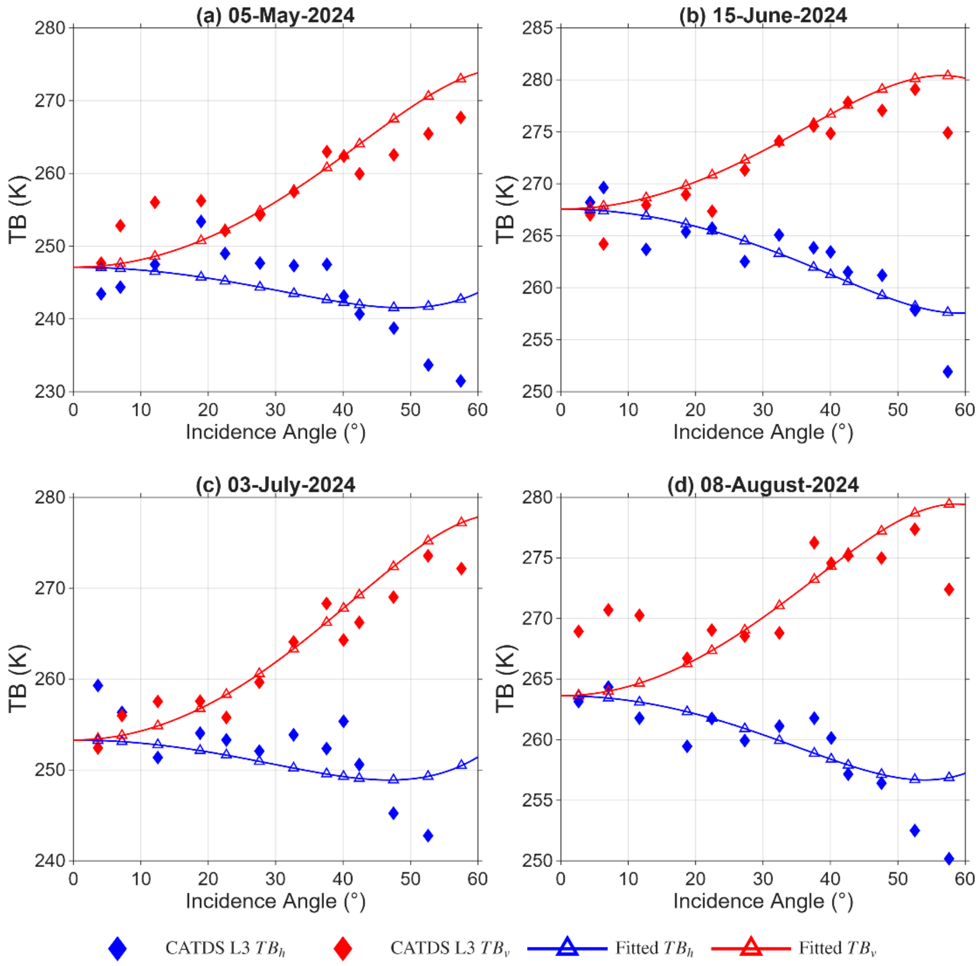

Figure 3: Examples of L-MEB model fitting to CATDS L3 TB at a SMOS pixel located at 83.646°E, 31.661°N. Panels (a) – (d) correspond to May 5, June 15, July 3, and August 8, 2024, respectively.

4. Table 2: The "Scene_Flags" layer is a useful inclusion. For greater clarity, please reference or briefly describe the specific criteria for flags like "moderate Topography" (e.g., stating the specific slope range used) in the supplement or somewhere. Besides, the soil roughness map is very important for this manuscript; was that included in the published dataset?

Response: Thanks for this insightful suggestion. We entirely agree that providing clear definitions for the flags is crucial for data transparency and user clarity.

Regarding the topography flags, the classification criteria for "moderate" and "strong" topography in our dataset are not based on simple slope ranges. Instead, we followed the pixel-based approach developed by Mialon et al. (2008) specifically for SMOS. Briefly, this method quantifies the topographic impact using a parameter "a", which is derived from fitting the semi-variogram of the Digital Elevation Model (DEM). The classification is determined by comparing this parameter against specific thresholds defined by a confidence interval related to radiometric uncertainty (as detailed in Mialon et al., (2008)).

To make this clear, we have added a footnote to Table 2 in the revised manuscript that explicitly references Mialon et al. (2008) for the definitions of these flags. The revised table caption/footnote is as follows:

Table 2: Overview of the gridded data layers included in the IB_HR$^{SMOSIB}_{mono}$ dataset.

Data layer	*Description*	*Units*
CRS	*Coordinate reference systems (CRS) include spatial reference information and geographic transformation parameters*	*/*
lat	*The latitude of the center of each grid cell*	*degree*
lon	*The longitude of the center of each grid cell*	*degree*
Incidence_Angle	*Pixel-based Incidence Angle*	*degree*
TIME_UTC	*Year information starting from 2010*	*/*
BT_H	*Optimized brightness temperature at H polarization*	*K*
BT_V	*Optimized brightness temperature at V polarization*	*K*
Soil_Moisture	*Soil Moisture (SM) retrievals*	m^3/m^3
Soil_Moisture_StdError	*Error on the derived Soil Moisture*	m^3/m^3
Optical_Thickness_Nad	*Vegetation Optical Depth (VOD) retrievals*	*/*
Optical_Thickness_Nad_StdError	*Error on the derived Vegetation Optical Depth*	*/*
Soil_Roughness	*Global Soil Roughness Map*	*/*
RMSE	*Goodness-of-fit between measured TB and modelled TB (Root Mean Square Error, RMSE)*	*K*
Scene_Flags	*8-bit flag* *'00000001': moderate Topography* *'00000010': strong Topography* *'00000100': polluted scene (water+urban+ice > 10% of the pixel),* *'00001000': frozen scene, ECMWF_Surf_Temperature < 273K*	*/*

Note: *The specific criteria for "moderate Topography" and "strong Topography" flags are defined pixel-by-pixel based on the methodology described in Mialon et al., (2008).*

Regarding the soil *roughness* map: Yes, we confirm that the soil roughness map is considered very important and is included as a data layer in the published dataset, as listed in Table 2 ("Soil_Roughness").

5. While using Canopy Water Content (CWC) to validate VOD temporal dynamics is innovative (Section 2.3), the manuscript currently lacks justification for choosing this specific CWC product. Please provide a brief rationale. Besides, please clarify the native spatial

resolution of the CWC product. If it is finer than 25km, please explain the aggregation method used to match the SMOS-IB 25km grid.

Response: Thank you for the helpful suggestion. In response to this comment, we revised the manuscript to provide a clearer description of the rationale for selecting the CWC product, its native spatial resolution, and the aggregation procedure used to match the SMOS-IB 25 km grid. The revised text is as follows (L129-133):

"In addition, this study was the first to use satellite canopy water content (CWC) data from 2016 to 2022 to validate *the temporal behavior of VOD retrievals, since L-band VOD has been demonstrated to have a linear relationship with vegetation water content (Wigneron et al., 2024). The CWC product used here was a newly developed global dataset derived from the integration of Sentinel-2, Landsat-8, and MODIS satellites with a spatial resolution of 0.05°. Its good accuracy and reliability have been previously demonstrated, making it a robust reference for large-scale assessment of VOD dat*a (Ma et al., 2025). *The dataset was obtained through personal communication but will soon be publicly available via ESA data portal. These four vegetation parameters were standardized by projecting them onto the EASE-Grid 2.0 and spatially aggregated to 25 km using arithmetic mean resampling to match the SMOS grid spatial resolution. This same resampling method has also been employed in several earlier VOD studies (Li et al., 2021; Fan et al., 2019)."*

6. The in-situ validation relies on the ISMN, which exhibits a highly non-uniform global distribution (Fig. 1), characterized by dense coverage in North America and Europe but sparse sampling in other regions. Please include a dedicated paragraph in the Discussion section acknowledging this representativeness bias. Discuss the implications for users and suggest how future validation efforts could complement this global assessment.

Response: Thanks for this important comment. We agree that the ISMN stations are unevenly distributed globally, with dense coverage in North America and Europe but sparse sampling across many other regions. This is a real limitation for global validation. We have addressed this issue in the revised manuscript in the following two ways:

1) The Triple Collocation Analysis (TCA) method was employed as a secondary approach for global-scale evaluation of SM quality, owing to its applicability at both the footprint and pixel scales and its independence from ground measurements as the sole reference "truth". We have explained this motivation in the methodology section as follows in L250-254:

"The direct validation of the SM retrievals using sparse in-situ networks may not be sufficient to obtain robust evaluation result due to potential representativeness errors associated with the spatial discrepancy between point-based in-situ SM and satellite SM observations (Al-Yaari et al., 2019; Xing et al., 2021). The TCA method was employed as a secondary approach for global-scale evaluation of SM quality, owing to its applicability at both the footprint and pixel scales (Dong and Crow, 2017) ."

2) Following your suggestion, we have added a new paragraph to discuss this representativeness bias and its implications as follows in L384-387:

"We acknowledge the known non-uniform distribution of ISMN stations (Figure 1), and the validation results in data-sparse regions should be interpreted with caution. This inherent limitation of direct validation motivates the subsequent application of TCA-based comparison and underscores the need for future deployment of denser networks in under-represented regions."

7. How were the inherent mismatches handled regarding different satellite overpass times versus observed SM times, and differing native spatial resolutions between products? Please clarify the methodology by detailing the temporal compositing approach, spatial aggregation methods, and the specific temporal windows used for matching different datasets.

Response: Thank you for this helpful comment. We agree that the temporal and spatial matching procedures should be described more clearly. We have revised the manuscript accordingly and added the following clarification in the methodology section in L242-245 and L144-145:

"..., a four-step procedure was applied to retain valid evaluation results and ensure fair comparisons: (1) all datasets were assessed over the common period from 2016 to 2022, (2) maximum 1-hour temporal matching between in-situ data and satellite overpasses, (3) minimum 31 valid observations (i.e., 1 month) per station for statistical robustness, and (4) restriction to the same stations containing valid evaluation metrics for all TB or SM datasets."

"The SMAP-L3 TB observations were quality-controlled based on corresponding quality flags and resampled to 25 km via weighted area averaging for consistency with the SMOS' grid resolution"

8. Regarding the Triple Collocation Analysis (TCA) method, SM anomalies were computed using a 35-day moving window. Please clarify the rationale behind choosing a 35-day window. Is this choice based on specific references or sensitivity analysis?

Response: Thanks for the comment. We agree that the rationale for using a 35-day moving window should be clarified. In response, we revised the manuscript in L256-257 to specify that this choice follows the validation protocol of Gruber et al. (2020) and Fan et al. (2022) :

"where $\theta_{anom}(t)$ *is the SM anomalies at day t and* $\overline{\theta_{(t-17:t+17)}}$ *is the mean SM value via a 35-day moving window, following Gruber et al., (2020) and Fan et al., (2022)."*

9. Please explain how the high-frequency TB variations (SDHF) were computed. It is suggested to add a short description in the Methodology section to clarify this process for readers.

Response: Thanks for the useful suggestion. We agree and have revised the manuscript to include a brief description of the SDHF calculation in the Methodology section. The revised text is as follows in L232-236:

"(1) The standard deviation of the high-frequency TB variations (SDHF)

To characterize the high-frequency variations of TB, SDHF was calculated on a pixel-by-pixel basis (Wigneron et al., 2021)*. First, the seasonal component of the TB time series was estimated using a 30-day moving average window. Subsequently, high-frequency anomalies were obtained by removing this low-frequency component from the original TB observations. Finally, the SDHF was computed as the standard deviation of these high-frequency anomalies over time."*

10. In Figure 4, the unit for Kelvin should be capitalized “K”, not lowercase “k”. In Figure 6, subplot (d1), please correct the display of percentages, as the numbers are currently overlapping and unreadable.

Response: Thanks for pointing it out. We have corrected the unit notation and improved the readability of the percentage labels in the revised manuscript.

11. Figure 7 requires several corrections. There appears to be a labeling error, as subplot (f) seems to be duplicated; please ensure each panel is uniquely identified. Additionally, the histogram subplots (i), (j), and (k) are currently not cited anywhere in the main text. Please double-check their necessity. Besides, for consistency with other figures in the manuscript, it is suggested to change the legend orientation from horizontal to vertical.

Response: Thank you very much for these detailed suggestions. Following your suggestions, we have revised Figure 7, including correcting the panel labels, citing the relevant subplots in the main text, and adjusting the legend for consistency with the other figures in the manuscript:

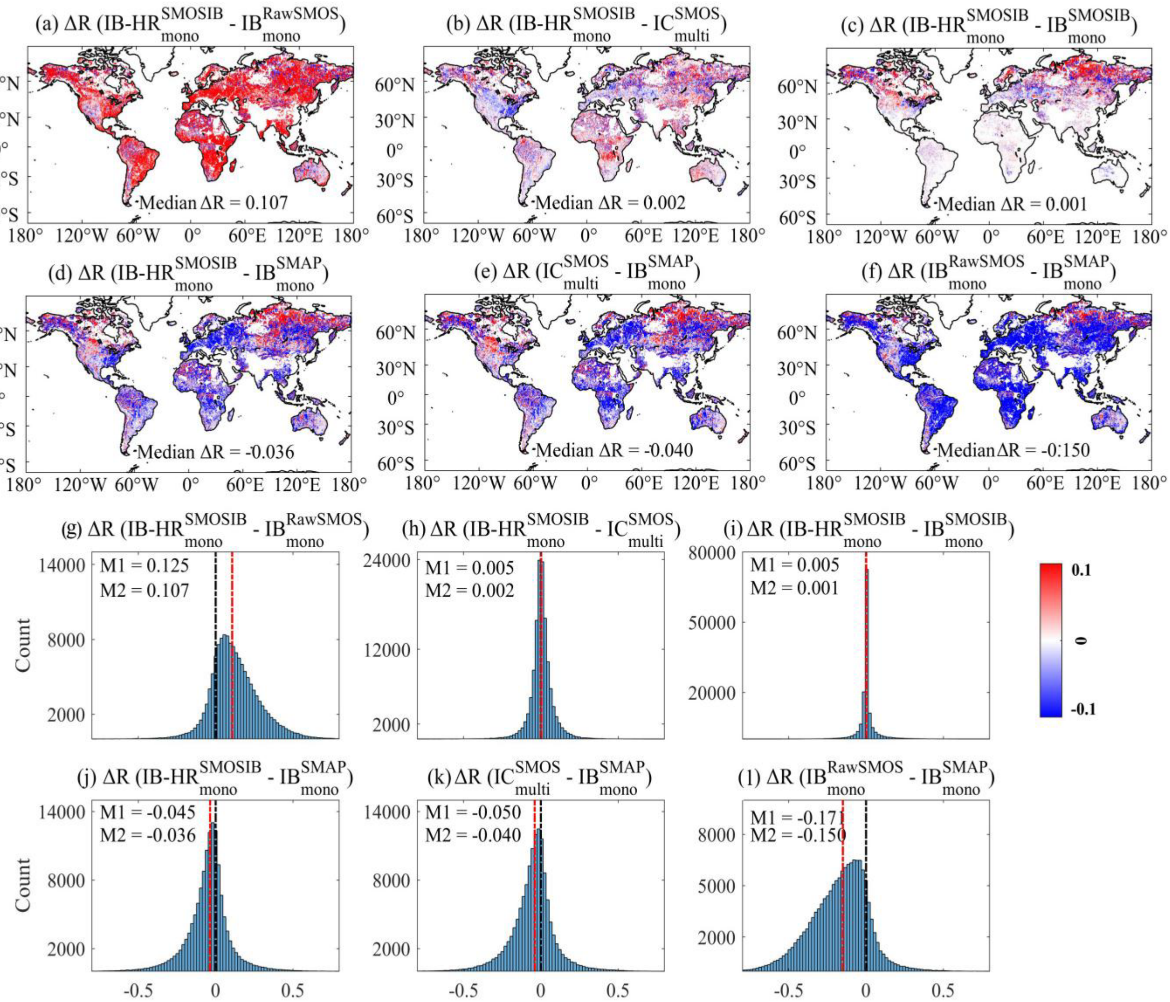

Figure 7: Spatial distribution ((a)–(f)) and histograms ((g)–(l)) of TCA-based R differences between paired SM anomaly products. m1 and m2 denote the mean and median (red line) difference value. A black vertical line marks the zero-difference reference.

12. Please carefully check the reference list for formatting consistency. For instance, some journal names are currently capitalized in full while others are abbreviated. Please ensure all references adhere strictly to the journal's specific formatting guidelines.

Response: Thanks for this careful observation. We have conducted a line-by-line check of the entire reference list to ensure strict adherence to the journal's specific formatting guidelines (Copernicus Publications style). All journal names have been standardized using standard abbreviations, and citation formats (including DOIs) have been unified. The complete, formatted reference list is available in the revised manuscript.

Reference

Al-Yaari, A., Wigneron, J. P., Dorigo, W., Colliander, A., Pellarin, T., Hahn, S., Mialon, A., Richaume, P., Fernandez-Moran, R., Fan, L., Kerr, Y. H., and De Lannoy, G.: Assessment and inter-comparison of recently developed/reprocessed microwave satellite soil moisture products using ISMN ground-based measurements, Remote Sens. Environ., 224, 289-303, 10.1016/j.rse.2019.02.008, 2019.

Cui, Y., Qin, J., Jing, W., and Tan, G.: Applicability evaluation of merged soil moisture in GLDAS and CLDAS products over Qinghai-Tibetan Plateau, Plateau Meteorol., 37(1), 123-136, 10.7522/j.issn.1000-0534.2017.00035, 2018.

Dong, J. and Crow, W. T.: An Improved Triple Collocation Analysis Algorithm for Decomposing Autocorrelated and White Soil Moisture Retrieval Errors, J. Geophys. Res. Atmos., 122, 13,081-013,094, 10.1002/2017jd027387, 2017.

Fan, L., Xing, Z., Lannoy, G. D., Frappart, F., Peng, J., Zeng, J., Li, X., Yang, K., Zhao, T., Shi, J., Ma, H., Wang, M., Liu, X., Yi, C., Ma, M., Tang, X., Wen, J., Chen, X., Wang, C., Wang, L., Wang, G., and Wigneron, J.-P.: Evaluation of satellite and reanalysis estimates of surface and root-zone soil moisture in croplands of Jiangsu Province, China, Remote Sens. Environ., 282, 10.1016/j.rse.2022.113283, 2022.

Gruber, A., De Lannoy, G., Albergel, C., Al-Yaari, A., Brocca, L., Calvet, J. C., Colliander, A., Cosh, M., Crow, W., Dorigo, W., Draper, C., Hirschi, M., Kerr, Y., Konings, A., Lahoz, W., McColl, K., Montzka, C., Muñoz-Sabater, J., Peng, J., Reichle, R., Richaume, P., Rüdiger, C., Scanlon, T., van der Schalie, R., Wigneron, J. P., and Wagner, W.: Validation practices for satellite soil moisture retrievals: What are (the) errors?, Remote Sens. Environ., 244, 10.1016/j.rse.2020.111806, 2020.

Li, X., Wigneron, J.-P., Frappart, F., Fan, L., Ciais, P., Fensholt, R., Entekhabi, D., Brandt, M., Konings, A. G., Liu, X., Wang, M., Al-Yaari, A., and Moisy, C.: Global-scale assessment and inter-comparison of recently developed/reprocessed microwave satellite vegetation optical depth products, Remote Sens. Environ., 253, 10.1016/j.rse.2020.112208, 2021.

Ma, H., Weiss, M., Malik, D., Berthelot, B., Yebra, M., Nolan, R. H., Mialon, A., Zeng, J., Quan, X., Tagesson, H. T., Olioso, A., and Baret, F.: Satellite canopy water content from Sentinel-2, Landsat-8 and MODIS: Principle, algorithm and assessment, Remote Sens. Environ., 326, 10.1016/j.rse.2025.114801, 2025.

Mialon, A., Coret, L., Kerr, Y. H., Sécherre, F., and Wigneron, J. P.: Flagging the Topographic Impact on the SMOS Signal, IEEE Trans. Geosci. Remote Sens., 46, 689-694, 10.1109/TGRS.2007.914788 . hal-00297786, 2008.

Wigneron, J.-P., Li, X., Frappart, F., Fan, L., Al-Yaari, A., De Lannoy, G., Liu, X., Wang, M., Le Masson, E., and Moisy, C.: SMOS-IC data record of soil moisture and L-VOD: Historical development, applications and perspectives, Remote Sens. Environ., 254, 10.1016/j.rse.2020.112238, 2021.

Xing, Z., Fan, L., Zhao, L., De Lannoy, G., Frappart, F., Peng, J., Li, X., Zeng, J., Al-Yaari, A., Yang, K., Zhao, T., Shi, J., Wang, M., Liu, X., Hu, G., Xiao, Y., Du, E., Li, R., Qiao, Y., Shi, J., Wen, J., Ma, M., and Wigneron, J.-P.: A first assessment of satellite and reanalysis estimates of surface and root-zone soil moisture over the permafrost region of Qinghai-Tibet Plateau, Remote Sens. Environ., 265, 10.1016/j.rse.2021.112666, 2021.

Response to RC2

This manuscript presents a well-documented and carefully evaluated global L-band dataset of optimized 40° SMOS brightness temperatures and associated soil moisture and vegetation optical depth products. The work represents an incremental but useful contribution to the community, particularly for users seeking harmonized SMOS–SMAP analyses and long-term global records. The dataset is clearly described, publicly available, and evaluated against multiple independent references. In my view, the paper is suitable for publication in a data-focused journal after minor revisions.

Strengths

- The dataset fills a practical gap by providing a consistent mono-angular SMOS product aligned with SMAP geometry and algorithms.

- The methodology is transparent and reproducible, and the validation strategy (ISMN, TCA, vegetation proxies) is appropriate for a global data product.

- The manuscript clearly documents the processing chain, metadata, and access information, which is essential for long-term usability.

- Performance improvements relative to existing SMOS products are demonstrated and generally convincing.

- The data archive and documentation meet the expectations for an operational community dataset.

Response: Thank you very much for your positive assessment of our manuscript and the associated dataset. We greatly appreciate the time you took to review our work and are encouraged by your recognition of the manuscript as a "well-documented and carefully evaluated" contribution to the community. We particularly value your comments on the dataset's utility for harmonized SMOS-SMAP analyses and the transparency of our methodology. Our point-by-point responses to your comments are provided below.

Minor suggestions for revision

1. The manuscript is generally clear but could be streamlined slightly in the introduction and methods to better emphasize the dataset's intended use cases rather than algorithmic detail.

Response: We thank the reviewer for this constructive suggestion. We totally agree that streamlining the text to better emphasize the SMOS-IB dataset's intended use cases improves the manuscript's readability and focus for an ESSD readership.

1) Regarding Introduction, following your suggestion, we have streamlined the Introduction section. Specifically, we condensed the detailed descriptions of existing SMAP and SMOS retrieval algorithms. We removed technical details about Single-Channel Algorithms (SCA) for SMAP and the specific algorithmic mechanics of SMOS Level 2, Level 3, and SMOS-IC products (e.g., assumptions about pixel homogeneity and specific parameterization schemes). Instead, we now provide a more concise overview of these products, focusing on their fundamental characteristics (mono- *vs.* multi-angular approaches) and pointing readers to relevant literature for algorithmic details. The deleted content is as follows:

"~~The SCA applies either H-polarization or V-polarization to estimate SM, while VOD is prescribed from external NDVI climatology (Jackson, 1993; Chan et al., 2016). On the contrary, DCA, which relies on both polarizations and enables the simultaneous retrieval of SM and VOD (O' neill et al., 2021), is increasingly interest in utilizing VOD for ecological applications, especially in monitoring vegetation dynamics (Frappart et al., 2020; Wang et al., 2024; Wigneron et al., 2024). Currently, several improved DCA approaches have been proposed, with their methodologies and performance comprehensively summarized and compared in (Gao et al., 2021).~~ "

"~~Compared to L2 and L3, IC_{multi}^{SMOS} adopts a simpler algorithmic framework and assumes pixels to be homogeneous in their land surface conditions, thereby reducing reliance on external ancillary datasets to characterize sub-pixel heterogeneity (Li et al., 2020). Additionally, IC_{multi}^{SMOS} also includes optimized parameterizations for key radiative transfer variables including vegetation scattering albedo and soil roughness as detailed in (Wigneron et al., 2021; Liu et 2025; Konkathi et al., 2025).~~ "

We have also expanded the final paragraph of the Introduction in L86-90 to explicitly mention the broader potential applications of not only the optimized TB data but also the derived SM and VOD products. This further emphasizes the dataset's intended use cases for long-term climate and ecological studies.

"Furthermore, the long-term optimized SMOS-IB dataset, including the harmonized TB, SM, and VOD layers, holds great potential for broader applications. The 40° TB data can be used for freeze–thaw monitoring, snow depth estimation, etc., while the consistent SM and VOD records can support long-term climate studies, large-scale hydrological modeling, and

monitoring of global vegetation dynamics and carbon cycles."

2) Regarding the Methods section, following your suggestion, we have deleted the details of Tau-Omega (τ-ω) radiative transfer approach and better focus on data use cases. The deleted content is as follows:

"…, ~~which includes three parts: (1) direct upwelling soil emission attenuated by the canopy $T_G(1 - r_{GP})\gamma_P$; (2) direct upwelling canopy emission $T_C(1-\omega)(1-\gamma_P)$; and (3) downwelling canopy emission reflected upward by the soil $T_C(1-\gamma_P)\gamma_{GP}\gamma_P$:~~

~~$$TB_P = T_G(1 - r_{GP})\gamma_P + T_C(1-\omega)(1-\gamma_P) + T_C(1-\gamma_P)r_{GP}\gamma_P \quad (1)$$~~

~~where T_C and T_G are the effective temperatures of vegetation and soil (*K*), computed using ERA5 soil and skin temperatures; γ_P denotes the vegetation attenuation factor, estimated as γ_P = *exp(−VOD/cosθ)*; The effective scattering albedo *ω* was assigned according to the IGBP land cover types (Kurum, 2013). r_{GP} represents the soil reflectivity and is computed using the H-Q-N semi-empirical model developed by (Wang and Choudhury, 1981), which combines the smooth-surface reflectivity (r^*_{GP}) with a roughness correction governed by *Hr*. In this study, we used the values of a novel global calibrated pixel-level *Hr* data (Konkathi et al., 2025).~~ "

2. Please ensure that all dataset layers, flags, and uncertainties are fully documented in the data repository metadata and user guide for long-term usability.

Response: Thanks for the valuable comment. We have double-checked both the data repository metadata and the manuscript, and confirmed that all dataset layers, flags and uncertainties (see Table 2 below) are fully documented (https://zenodo.org/records/17647385).

Table 2: Overview of the gridded data layers included in the IB_HR$^{SMOSIB}_{mono}$ dataset.

Data layer	*Description*	*Units*
CRS	*Coordinate reference systems (CRS) include spatial reference information and geographic transformation parameters*	/
lat	*The latitude of the center of each grid cell*	*degree*
lon	*The longitude of the center of each grid cell*	*degree*
Incidence_Angle	*Pixel-based Incidence Angle*	*degree*
TIME_UTC	*Year information starting from 2010*	/
BT_H	*Optimized brightness temperature at H polarization*	*K*
BT_V	*Optimized brightness temperature at V polarization*	*K*
Soil_Moisture	*Soil Moisture (SM) retrievals*	m^3/m^3
Soil_Moisture_StdError	*Error on the derived Soil Moisture*	m^3/m^3
Optical_Thickness_Nad	*Vegetation Optical Depth (VOD) retrievals*	/
Optical_Thickness_Nad_StdError	*Error on the derived Vegetation Optical Depth*	/
Soil_Roughness	*Global Soil Roughness Map*	/
RMSE	*Goodness-of-fit between measured TB and modelled TB (Root Mean Square Error, RMSE)*	*K*
Scene_Flags	*8-bit flag* *'00000001': moderate Topography* *'00000010': strong Topography* *'00000100': polluted scene (water+urban+ice > 10% of the pixel),* *'00001000': frozen scene, ECMWF_Surf_Temperature < 273K*	/

Note: *The specific criteria for "moderate Topography" and "strong Topography" flags are defined pixel-by-pixel based on the methodology described in (Mialon et al., 2008).*

3. A short paragraph clarifying recommended applications and limitations (e.g., RFI-affected regions, frozen conditions, or dense vegetation) would help users interpret the dataset appropriately.

Response: Thank you for the helpful comment. We agree that such guidance would help users interpret the dataset appropriately. Accordingly, we added a brief description in the revised manuscript and included a supplementary table summarizing the filtering procedures of the SMOS-IB products for the convenience of users. The revised text in L290-295 is as follows:

"Note that these SM, VOD, and TB products are intended to support large-scale applications, including global drought monitoring, studies of vegetation water and biomass dynamics, freeze-thaw monitoring, etc. However, low-quality observations should be screened before any application or validation analysis. In particular, users should first assess potential RFI contamination, which is especially critical for SMOS. Observations under frozen soil or snow-covered conditions should also be excluded, given the limited applicability of current dielectric models in frozen and snow/ice environments (Wigneron et al., 2017). In addition, pixels with a

high fraction of open water, substantial urban land cover, or strong topographic heterogeneity should be screened out or treated separately prior to use. Accordingly, filtering criteria for $IB\_HR_{mono}^{SMOSIB}$ *with respect to the above influencing factors were recommended and summarized in Table A1."*

Table A1 Summary of the SMOS-IB filtering procedures.

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Filtering type	Threshold value (indicative value that depends on applications)	Conditions of applications
RFI filtering		
RMSE daily filtering	RMSE <6 K or 8 K (depending on applications)	for each pixel and each date
RMSE annual filtering	annual average RMSE <6 K or 8 K	for each pixel and each year
Contaminated pixel filtering • strong topography • polluted scene (water+urban+ice > 10%) • frozen scene ECMWF_Soil_Temperature < 273K	Scene flags≤ 1	for each pixel and each date
Valid-range filtering		
SM range	$0 \leq SM \leq 1$; SM (m^3/m^3)	
VOD range	$0 \leq$ L-VOD ≤ 2	

Note: For temporal compositing, valid-range filtering should be applied after composite generation, because negative daily SM or VOD values may still occur numerically in arid regions, even though they are not physically meaningful.

4. Consider briefly summarizing differences relative to existing SMOS-IC or SMAP-IB products in a concise user-oriented table.

Response: Thanks for this useful suggestion. Following your suggestion, we added a concise user-oriented table in the supplementary to briefly summarize the differences of SMOS-IB relative to existing SMOS-IC or SMAP-IB products. See table below:

Table S2 List of key abbreviations.

Abbreviation	*Definition*
SMOS	*Soil Moisture and Ocean Salinity*
SMAP	*Soil Moisture Active Passive*
SM	*Soil Moisture*
VOD	*Vegetation Optical Depth*
TB	*Brightness Temperature*
SMOS-IC	*A multi-angular SMOS algorithm developed by INRAE Bordeaux*
SMAP-IB	*A mono-angular SMAP algorithm developed by INRAE Bordeaux*
$IB\_HR_{mono}^{SMOSIB}$	*SM and VOD products retrieved by applying the SMAP-IB algorithm to the fitted SMOS L3 40° TB and updated soil roughness map*
IB_{mono}^{SMOSIB}	*SM and VOD products retrieved by applying the SMAP-IB algorithm to the fitted SMOS L3 40° TB*
$IB_{mono}^{RawSMOS}$	*SM and VOD products retrieved by applying the SMAP-IB algorithm to the SMOS L3 40° TB*
IC_{multi}^{SMOS}	*SM and VOD products retrieved using the processed multi-angle SMOS-L3 TB dataset with quality filtering provided by the Centre Aval de Traitement des Données (CATDS) using the SMOS-IC version 2 algorithm*
IB_{mono}^{SMAP}	*SM and VOD products retrieved by applying the SMAP-IB algorithm to the 25km SMAP-L3 TBs*

5. Minor editorial corrections (typos, wording, and figure caption clarity) should be addressed during revision.

Response: Thanks for pointing this out. We have double-checked the manuscript, supplementary and data repository metadata, all the editorial corrections were carefully revised in the new version.

Reference

Al-Yaari, A., Wigneron, J. P., Dorigo, W., Colliander, A., Pellarin, T., Hahn, S., Mialon, A., Richaume, P., Fernandez-Moran, R., Fan, L., Kerr, Y. H., and De Lannoy, G.: Assessment and inter-comparison of recently developed/reprocessed microwave satellite soil moisture products using ISMN ground-based measurements, Remote Sens. Environ., 224, 289-303, 10.1016/j.rse.2019.02.008, 2019.

Al Bitar, A., Mialon, A., Kerr, Y. H., Cabot, F., Richaume, P., Jacquette, E., Quesney, A., Mahmoodi, A., Tarot, S., Parrens, M., Al-Yaari, A., Pellarin, T., Rodriguez-Fernandez, N., and Wigneron, J.-P.: The global SMOS Level 3 daily soil moisture and brightness temperature maps, Earth Syst. Sci. Data, 9, 293-315, 10.5194/essd-9-293-2017, 2017.

Fernandez-Moran, R., Al-Yaari, A., Mialon, A., Mahmoodi, A., Al Bitar, A., De Lannoy, G., Rodriguez-Fernandez, N., Lopez-Baeza, E., Kerr, Y., and Wigneron, J.-P.: SMOS-IC: An Alternative SMOS Soil Moisture and Vegetation Optical Depth Product, Remote Sens., 9, 10.3390/rs9050457, 2017.

Gao, L., Ebtehaj, A., Chaubell, M. J., Sadeghi, M., Li, X., and Wigneron, J.-P.: Reappraisal of SMAP inversion algorithms for soil moisture and vegetation optical depth, Remote Sens. Environ., 264, 10.1016/j.rse.2021.112627, 2021.

Kerr, Y. H., Waldteufel, P., Richaume, P., Wigneron, J. P., Ferrazzoli, P., Mahmoodi, A., Al Bitar, A., Cabot, F., Gruhier, C., Juglea, S. E., Leroux, D., Mialon, A., and Delwart, S.: The SMOS Soil Moisture Retrieval Algorithm, IEEE Trans. Geosci. Remote Sens., 50, 1384-1403, 10.1109/tgrs.2012.2184548, 2012.

Mialon, A., Coret, L., Kerr, Y. H., Sécherre, F., and Wigneron, J. P.: Flagging the Topographic Impact on the SMOS Signal, IEEE Trans. Geosci. Remote Sens., 46, 689-694, 10.1109/TGRS.2007.914788 . hal-00297786, 2008.

Peng, Z., Zhao, T., Shi, J., Hu, L., Rodríguez-Fernández, N. J., Wigneron, J.-P., Jackson, T. J., Walker, J. P., Cosh, M. H., Yang, K., Lu, H., Bai, Y., Yao, P., Zheng, J., and Wei, Z.: First mapping of polarization-dependent vegetation optical depth and soil moisture from SMAP L-band radiometry, Remote Sens. Environ., 302, 113970, https://doi.org/10.1016/j.rse.2023.113970, 2024.

Wigneron, J. P., Jackson, T. J., O'Neill, P., De Lannoy, G., de Rosnay, P., Walker, J. P., Ferrazzoli, P., Mironov, V., Bircher, S., Grant, J. P., Kurum, M., Schwank, M., Munoz-Sabater, J., Das, N., Royer, A., Al-Yaari, A., Al Bitar, A., Fernandez-Moran, R., Lawrence, H., Mialon, A., Parrens, M., Richaume, P., Delwart, S., and Kerr, Y.: Modelling the passive microwave signature from land surfaces: A review of recent results and application to the L-band SMOS & SMAP soil moisture retrieval algorithms, Remote Sens. Environ., 192, 238-262, 10.1016/j.rse.2017.01.024, 2017.