

We thank Anonymous Referee #2 for the time and effort devoted to reviewing our manuscript. The 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 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 al., 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 ( $\tau$ - $\omega$ ) 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  $T_G(1 - r_{G\bar{P}})\gamma_P$ ; (2) direct upwelling canopy emission  $T_C(1 - \omega)(1 - \gamma_P)$ ; and (3) downwelling canopy emission reflected upward by the soil  $T_C(1 - \gamma_P)r_{G\bar{P}}\gamma_P$ :~~

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

~~where  $T_C$  and  $T_G$  are the effective temperatures of vegetation and soil ( $K$ ), computed using ERA5 soil and skin temperatures;  $\gamma_P$  denotes the vegetation attenuation factor, estimated as  $\gamma_P = \exp(-VOD/\cos\theta)$ ; The effective scattering albedo  $\omega$  was assigned according to the IGBP land cover types (Kurum, 2013).  $r_{G\bar{P}}$  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 ( $r_{G\bar{P}}^*$ ) 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<sup>SMOSIB</sup><sub>mono</sub> 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 <sup>3</sup> /m <sup>3</sup>
Soil_Moisture_StdError	Error on the derived Soil Moisture	m <sup>3</sup> /m <sup>3</sup>
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.**

**Table A1** Summary of the SMOS-IB filtering procedures.

Filtering type	Threshold value (indicative value that depends on applications)	Conditions of applications
<b>RFI filtering</b>		
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
<b>Contaminated pixel filtering</b>		
<ul style="list-style-type: none"> <li>• strong topography</li> <li>• polluted scene (water+urban+ice &gt; 10%)</li> <li>• frozen scene</li> </ul>	Scene flags ≤ 1	for each pixel and each date
<b>Valid-range filtering</b>		
SM range	$0 \leq SM \leq 1$ ; SM (m <sup>3</sup> /m <sup>3</sup> )	
VOD range	$0 \leq L-VOD \leq 2$	

*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.**

<b>Abbreviation</b>	<b>Definition</b>
<i>SMOS</i>	<i>Soil Moisture and Ocean Salinity</i>
<i>SMAP</i>	<i>Soil Moisture Active Passive</i>
<i>SM</i>	<i>Soil Moisture</i>
<i>VOD</i>	<i>Vegetation Optical Depth</i>
<i>TB</i>	<i>Brightness Temperature</i>
<i>SMOS-IC</i>	<i>A multi-angular SMOS algorithm developed by INRAE Bordeaux</i>
<i>SMAP-IB</i>	<i>A mono-angular SMAP algorithm developed by INRAE Bordeaux</i>
<i>IB<sub>HR</sub><sup>SMOSIB</sup><sub>mono</sub></i>	<i>SM and VOD products retrieved by applying the SMAP-IB algorithm to the fitted SMOS L3 40° TB and updated soil roughness map</i>
<i>IB<sub>mono</sub><sup>SMOSIB</sup></i>	<i>SM and VOD products retrieved by applying the SMAP-IB algorithm to the fitted SMOS L3 40° TB</i>
<i>IB<sub>mono</sub><sup>RawSMOS</sup></i>	<i>SM and VOD products retrieved by applying the SMAP-IB algorithm to the SMOS L3 40° TB</i>
<i>IC<sub>multi</sub><sup>SMOS</sup></i>	<i>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</i>
<i>IB<sub>mono</sub><sup>SMAP</sup></i>	<i>SM and VOD products retrieved by applying the SMAP-IB algorithm to the 25km SMAP-L3 TBs</i>

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.

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