REVIEWER COMMENTS

The manuscript presents a Fourier transform–based approach to correct temperature induced diurnal artifacts in in-situ soil moisture (SM) measurements from dielectric sensors. Constrained by the physically consistent land surface model (LSM) reanalysis products (ERA5-Land and MERRA-2), the authors aim to restore physically realistic diurnal behavior of dielectric-based SM and improve the interpretation of land–atmosphere interactions at sub-daily timescale.

The topic is highly relevant to the hydrology and land–atmosphere coupling communities. The manuscript is generally well written, methodologically innovative, and supported by extensive datasets. The proposed correction has the potential to substantially improve the usability of high-frequency in-situ SM observations. However, several issues need to be addressed before the manuscript can be considered for publication.

➔ *We thank the reviewer for your thorough and constructive comments, which have helped us to clarify the scope and strengthen the manuscript. Below we respond point-by-point and describe the corresponding revisions.*

Major comments

1. Introduction: Literature review on correction of SM is too limited, only the second last paragraph of the introduction section. At least correction methods of the same type as those used in this study should be reviewed in detail.

➔ *We thank the reviewer for this valuable suggestion. In response, we have substantially expanded the literature review on temperature correction methods for soil moisture measurements. Specifically, we added a more detailed discussion of empirical regression-based approaches, including studies that utilize diurnal amplitude-temperature relationships and data-driven correction schemes (e.g., Lu et al., 2015; Kapilaratne and Lu, 2017). The revised discussion can be found in Lines 91-100.*

"Regarding empirical correction approaches, Chanzy et al. (2012) proposed a daily correction coefficient derived from diurnal variations in permittivity and temperature, which are potentially influenced by SM and conductivity. This coefficient was applied to adjust measured permittivity, utilizing periods of minimal moisture change (i.e., early morning or late afternoon) to ensure stable estimation. More recently, regression-based schemes have been developed to link SM diurnal amplitude with soil temperature (TS) variability. For instance, Lu et al. (2015) developed a regression framework to quantify the artificial positive coupling between SM and TS on the diurnal scale. By modeling SM variations as a function of concurrent TS fluctuations, they isolated and removed the temperature-induced component embedded in dielectric sensor measurements, thereby mitigating thermally induced diurnal artifacts. Building upon this approach, Kapilaratne and Lu (2017) introduced a refined calibration strategy to enhance the robustness of regression-based corrections across diverse hydroclimatic conditions."

메모 포함[ES1]: 수정함.

2. Data: Three land reanalysis datasets (ERA5-Land, MERRA-2, GLDAS) are discussed, but only two are used in the adjustment. The rationale for this choice is not sufficiently clear.

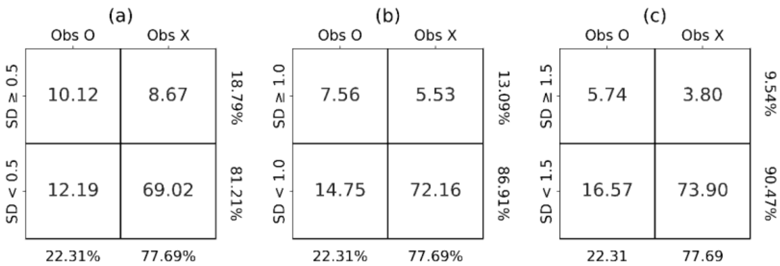
➔ *We thank the reviewer for pointing out this ambiguity. Although three land reanalysis datasets (ERA5-Land, MERRA-2, and GLDAS) are introduced in the Data section, only ERA5-Land and MERRA-2 were used in the adjustment due to temporal resolution constraints. The proposed method relies on resolving and comparing sub-daily (diurnal) phase and power characteristics* *using FFT-based analysis. ERA5-Land and MERRA-2 provide hourly soil moisture outputs, which are essential for accurately capturing diurnal variability and phase information. In contrast, GLDAS is available at a 3-hourly temporal resolution, which limits the reliable estimation of diurnal phase and power and prevents a consistent comparison with hourly in-situ observations. Therefore, GLDAS was excluded from the adjustment procedure, although it is introduced for completeness as a widely used land reanalysis product.*

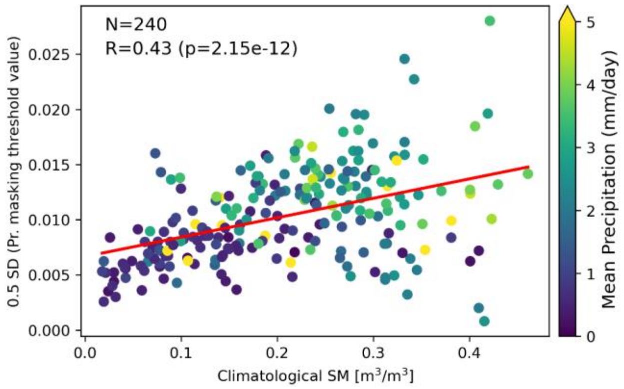
We have revised the manuscript to explicitly clarify this rationale in the Data section (Lines 163).

3. Methodology: The manuscript excludes all days identified as "rainy" based on SM tendency thresholds or precipitation totals. This approach is questionable, particularly in arid and semi-arid regions. Light precipitation events often evaporate rapidly and may have negligible impacts on daily soil moisture, especially near the surface.

➔ *Regarding the precipitation masking, we acknowledge that SM response to precipitation may vary across climate regions. To determine an appropriate masking threshold, sensitivity tests were conducted using multiple SD thresholds (0.5, 1.0, and 1.5 SD). The results indicate that the 1.5 SD threshold primarily detects only strong and abrupt SM spikes, whereas the 0.5 SD threshold achieves a better balance by increasing the overlap between precipitation observations and SD-based rainy-day identification while reducing the fraction of missed rainfall-affected days. Therefore, the +0.5 SD criterion was adopted for precipitation removal. Furthermore, the magnitude of the threshold relative to climatological SM variability is very small (approximately 0–0.02), which is negligible compared to the typical range of SM variations (up to approximately 0.5). This suggests that the masking criterion is not strongly dependent on climate regime and is applicable across both humid and arid regions. This clarification has been added in the revised manuscript (Lines 208-214 and Figs. S2 and S3).*

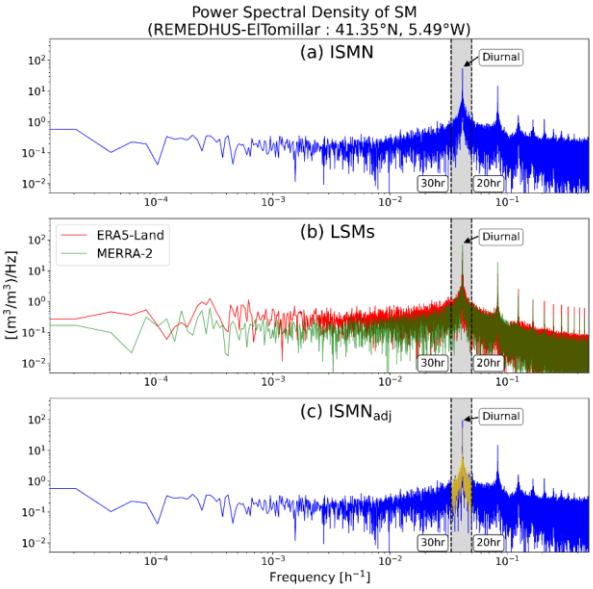
"To exclude rainy days at observation sites, hourly SM measurements are aggregated into a daily resolution to calculate the day-to-day SM tendency. When this tendency exceeds a threshold of +0.5 standard deviations (SD), determined over the entire analysis period, both the current and following days are identified as precipitation-affected and excluded from the adjustment (Step 1 in Fig. 3a). The exclusion of the following day is specifically implemented to mitigate the influence of post-precipitation dry drifting, which typically introduces the most significant distortion to the SM diurnal cycle. The SM-based threshold is optimized through comparison with collocated precipitation data (Fig. S2); notably, these threshold values vary according to local climatology, with higher thresholds assigned to wetter regions (Fig. S3)."





4. Methodology: The power spectral densities shown in the manuscript are unevenly distributed in frequency space, with sparse low-frequency bins and dense high frequency bins. This makes interpretation of the diurnal peak less robust. Recommend applying frequency or logarithmic smoothing to the power spectra.

➔ *Indeed, the diurnal frequency was not explicitly labeled in the original figure, which may have made its identification less clear to the reader. Although the peak corresponds exactly to 1/24 h^{-1} and was confirmed to represent the maximum power within the diurnal band, this was not sufficiently highlighted in the visualization. To improve clarity, we have revised the figure to explicitly indicate the diurnal frequency in Figure 4.*

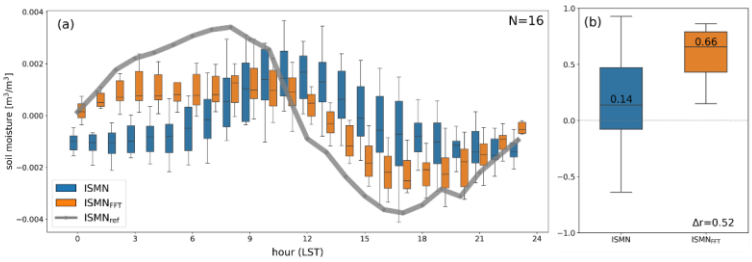


5. Results: The evaluation strategy compares adjusted SM time series with reference sensors located up to 200 km away. Given the extreme spatial heterogeneity of soil moisture, such comparisons raise concerns about physical meaning. Even at distances of a few meters or hundred meters, SM can differ substantially due to soil texture, vegetation, topography, and land management.

➔ *We agree with the reviewer that soil moisture exhibits strong spatial heterogeneity due to variations in soil texture, vegetation, topography, and land management, and that this can limit the physical interpretability of comparisons across large distances. The initial 200 km radius was chosen to ensure a sufficient number of reference sensor pairs for statistical evaluation, particularly in regions with sparse stations.*

Importantly, the evaluation targets the temporal correlation and phase consistency of the diurnal cycle, rather than absolute soil moisture magnitude. Even when mean soil moisture differs between sites, stations located within similar climatic regimes can exhibit comparable diurnal timing characteristics.

In response to the reviewer's suggestion, we conducted a sensitivity analysis by reducing the distance threshold to 50 km. Although the number of available station pairs decreased from 20 to 16, the sample size remained sufficient for a statistically robust evaluation. Therefore, we adopted the 50 km distance criterion in the revised manuscript, which improves physical representativeness while maintaining adequate statistical reliability.



Minor comments

1) The correction is only for dielectric-based SM, this should be pointed out in the Title.

➔ *Thank you for this comment. We have revised the title to explicitly indicate that the proposed correction is applicable to dielectric-based in-situ soil moisture measurements.*

Revised title: "Adjusting Diurnal Error in Dielectric-Based In-Situ Soil Moisture Measurements via Fourier Time-Filtering Using Land Surface Model Datasets"

2) L124-125: This has been reported in the introduction and do not need to repeat here.

➔ *Thank you for pointing this out. The repeated statement has been removed from Lines 124–125 to avoid redundancy with the Introduction.*

3) L168: References introducing eddy-covariance method are needed here, there are multiple classical papers and books. Pastorello et al., 2020 is not a perfect one.

➔ *We thank the reviewer for this comment. The originally cited reference was removed because it was considered not sufficiently appropriate for introducing the eddy-covariance method.*

4) L172: Reference for FLUXNET2015 is missing here. Pastorello et al., 2020 is the right citation.

➔ *We appreciate this comment. The reference for FLUXNET2015 has been added, using Pastorello et al. (2020) as the appropriate citation in Line 176.*

"FLUXNET2015, the latest major release of globally harmonized flux tower observations (Pastorello et al., 2020), provides Tier 1 data accompanied by quality flags for each variable, along with the flag of uncertainty and gap-filled data."

5) L205: Fig4a -> Fig 3a? And similar issues below.

➔ *Thank you for pointing this out. The figure reference has been corrected (Fig. 4a → Fig. 3a), and similar inconsistencies below have also been fixed.*

6) L239: What adjustment?

➔ *We have clarified this sentence to explicitly specify the nature of the additional adjustment. The revised text now reads (Lines 252-254):*

➔ ***"Since this approach yields negative values in reconstructed SM time series during extremely dry periods, the diurnal amplitude is further constrained for such instances to ensure physical plausibility. This adjustment, detailed below, prevents the artifact of negative soil moisture while maintaining the integrity of the diurnal signal."***