Author Response to Referee #2 Comments

Long-term irrigation water use datasets from multiple Earth Observation-based methods in major irrigated regions

Laluet et al., essd-2025-737

We thank Referee #2 for their constructive and insightful comments. Below, we provide a detailed, point-by-point response (referees' comments are shown in black, and our responses in blue).

Comment 1:

The three methods rely on different assumptions, and their performance varies across regions. It would be helpful if the authors could further clarify how these assumptions influence uncertainty and dataset differences. A more systematic comparison linking methodological assumptions to regional climate, irrigation practices, soil conditions, and water sources would strengthen the manuscript.

Response:

We thank the referee for this comment. This point is closely related to Referee #3's Comment 3, and we have addressed both together. In the revised manuscript, we have integrated interpretive elements throughout Section 3 that explicitly link the observed spatial and magnitude differences to the methodological characteristics of each approach. Please refer to our detailed response to Referee #3, Comment 3.

We note that a fully systematic analysis linking methodological assumptions to regional factors such as irrigation practices (e.g., drip vs. flood), water sources (groundwater vs. surface water), or soil properties would require dedicated investigations beyond the scope of this dataset description study. Nevertheless, the interpretive elements added in Section 3 provide a first-order explanation of the main differences observed across methods and regions.

Comment 2:

In several regions, correlations are moderate and biases remain noticeable. It would be beneficial for the authors to further discuss whether the current level of accuracy is sufficient for intended applications, such as climate modeling or trend analysis.

Response:

We thank the referee for this comment. We have revised the Recommendations for users section (Section 4.5) to better specify the intended scope of the datasets. We now clarify that the datasets are primarily intended as a coordinated benchmarking resource for the irrigation research community, rather than as ready-to-use products for specific applications, and we direct users to the evaluation results in Section 3 when assessing fitness for use.

Changes in manuscript (Section 4.5):

"Beyond these interpretation guidelines, the datasets are primarily designed as a coordinated benchmarking resource for the irrigation research community, supporting large-scale analyses, intercomparison exercises (e.g., Dari et al., 2025a), and model benchmarking, rather than as ready-to-use products for specific applications. Combining them with complementary observations or model outputs can further support robust interpretation and help mitigate uncertainties associated with individual datasets. Users should consider the evaluation results presented in Section 3 when assessing the suitability of specific datasets for their intended use."

Comment 3:

The study applies static irrigated-area maps over long time periods. In regions where irrigated area has changed over time, this may introduce bias. A clearer discussion of how this limitation may influence long-term analysis would improve the paper.

Response:

We thank the referee for pointing out this important limitation. We have added a new subsection in Section 4 (Section 4.3) discussing this issue.

Changes in manuscript (new Section 4.3):

"An additional source of uncertainty relates to the irrigated-area maps used across the three approaches. The SM-based Delta and SM-based Inversion methods use GMIA v5, representing conditions around 2005, while the Model-observation integration approach uses the Landsat-derived LGRIP30 map for the year 2015. Neither map captures temporal changes in irrigation extent, which may affect long-term IWU estimates in regions where irrigated areas have evolved over the study period. The main irrigated regions analysed here have generally exhibited relatively stable irrigation extents over the last two decades (Mehta et al., 2024), although local changes may still have occurred. Future developments could benefit from recently available temporally resolved irrigation maps (e.g., Kebede et al., 2025) to better account for such changes."

Comment 4:

The results vary depending on the soil moisture, ET, and irrigation datasets used. The manuscript would benefit from a clearer explanation of why certain input datasets perform better than others, including a discussion of their respective strengths and limitations.

Response:

We agree that the choice of input datasets influences the resulting IWU estimates, and the evaluation presented in Section 3 (heatmaps in Figures 2, 5, and 7, and Table 4 for India) documents how performance varies across all SM and ET input combinations. In the revised manuscript, we have added interpretive elements in Section 3 that explain how the methodological characteristics of each approach, as well as the type of input data used (e.g., SM and ET for the Delta approach vs. primarily SM for the Inversion approach), contribute to the main differences observed.

However, explaining why specific SM products (e.g., CCI Passive vs. ASCAT) perform differently across regions would require a dedicated assessment of each product's retrieval characteristics over irrigated areas, which is beyond the scope of this dataset description study. The influence of irrigated-area maps is discussed in the new Section 4.3. Previous evaluations of ET products over irrigated regions (Laluet et al., 2026; https://doi.org/10.5194/hess-30-1779-2026) provide useful guidance on this aspect.

Comment 5:

Several key thresholds and parameters are applied uniformly across all regions. The authors may consider evaluating the sensitivity of the results to these settings and discussing whether region-specific calibration could further improve performance.

Response:

We thank the referee for this suggestion. We have added a short acknowledgement of this limitation in Section 4.1 for the SM-based approaches. The sensitivity of the Noah-MP irrigation-triggering thresholds is already discussed in Section 4.2.

Changes in manuscript (Section 4.1):

"The SM-based approaches also rely on fixed thresholds, such as the 0.12 relative SM increase filter in the Delta method (Zaussinger et al., 2019) or the 5% GMIA irrigation mask, which were adopted from previous studies and applied uniformly across regions. Assessing the sensitivity of the IWU estimates to these settings would help further characterise the robustness of the retrieved irrigation signal."

Comment 6:

The discussion section could be strengthened by providing a more integrated cross-regional synthesis that highlights common patterns, key differences, and broader implications of the results.

Response:

We thank the referee for this suggestion. The interpretive elements added throughout Section 3 (see response to Comment 3 from Referee #3) now provide cross-regional context. Several consistent patterns emerge across regions: (i) SM-based approaches systematically produce smoother spatial patterns than the Model-observation integration approach, reflecting the coarser and more spatially averaged nature of the soil moisture signal at 0.25°; (ii) the Model-observation integration approach yields the strongest spatial correlations with reference data but also the largest biases, reflecting the combined effect of detailed irrigated-area mapping and model parameterisation uncertainties; and (iii) no single SM input dataset consistently outperforms the others across regions, as relative performance depends on regional conditions. These cross-regional patterns are also reflected in the Conclusions section. We believe these elements address the referee's concern without requiring a separate synthesis section.

Comment 7:

The readability of the heatmaps in Figures 2, 5, and 7 could be improved by enlarging axis labels, legends, and color scales.

Response:

We thank the referee for this suggestion. The axis labels, legends, and color scales in Figures 2, 5, and 7 have been enlarged in the revised manuscript.