Response to the editor and reviewers for the manuscript: “Assessing the suitability of global evapotranspiration products over irrigated areas”

We thank the Editor and the Reviewers for their constructive and insightful comments. We have carefully revised the manuscript in response to these comments. All changes are marked using track changes in the revised manuscript. Below, we provide a detailed, point-by-point response (reviewers’ comments are shown in black, and our responses in blue).

Referee 1

Comment 1:

Firstly, in the discussion, it is mentioned that models primarily driven by precipitation-influenced soil water balance mechanisms tend to underestimate soil moisture in irrigated farmlands. However, the authors do not explicitly provide the variation in precipitation across different years and months for the irrigation areas studied, only presenting the characteristic values of precipitation during the peak season in Table 2.

Response:

We agree with the reviewer that providing explicit information on interannual and intra-seasonal precipitation variability strengthens the interpretation of irrigation-related ET anomalies and the discussion of precipitation-driven stress formulations.

We have therefore added precipitation anomalies from MSWEP to the California Valley interannual anomaly analysis and expanded the corresponding discussion in the text. Specifically, we added the following sentences in Section 3.4:

“To help interpret the observed ET variability, precipitation anomalies from MSWEP v2.8 are also examined. These reveal pronounced interannual and intra-seasonal variability in rainfall during the irrigation season in the California Valley. In 2014, strong negative precipitation anomalies in winter and spring coincide with severe drought conditions, the implementation of irrigation restrictions, and marked negative ET anomalies across all ET products, indicating a combined drought- and management-driven suppression of ET. In other years, however, the correspondence between precipitation and ET anomalies is weaker, suggesting that precipitation variability alone does not systematically explain interannual ET anomalies and that ET responses reflect a combination of climatic forcing and irrigation management.”

Changes in manuscript:

- Added MSWEP precipitation anomaly panel to Figure 7.
- Added corresponding text in Section 3.4.

Comment 2:

Secondly, Figure 7 shows the variation in ET during the irrigation season across different years. In addition to the changes in NDVI, could the variation in precipitation also be provided? I believe this would make the results clearer.

Response:

We agree with this suggestion. Precipitation anomalies from MSWEP have now been included as an additional panel in Figure 7, alongside NDVI anomalies, and are discussed in the revised text (Section 3.4).

Comment 3:

Thirdly, in the discussion, the authors focus more on the mechanisms of the models when explaining the reasons for product differences. While these details are thorough, they seem to overlook the potential impact of input data discrepancies on the results. Therefore, it is necessary to further clarify whether differences in input data could lead to variations in the results.

Response:

We thank the reviewer for this important remark. We agree that, beyond differences in model structure and stress formulations, discrepancies in input datasets may also contribute to variations among ET products.

To address this point, we added a dedicated subsection in the Discussion explicitly discussing the role of input data discrepancies. The following text was included:

"Section 4.1.7 Role of input data discrepancies

Beyond differences in model design choices, discrepancies in input datasets may also contribute to variations among ET products over irrigated areas. The products evaluated here rely on different sources of meteorological forcing (e.g., GLDAS for PMLv2, TerraClimate for SSEBop v6.1, ERA5 for ERA5-Land), satellite observations (e.g., MODIS-based vegetation variables in PMLv2 and FLUXCOM RS; VIIRS LST in SSEBop v6.1), and ancillary vegetation or land-cover datasets. Differences in these inputs can affect stress or energy-balance constraints in different ways across models. Consequently, part of the inter-product spread over irrigated regions likely reflects a combination of differences in model design choices and inconsistencies in the underlying meteorological and satellite inputs."

Changes in manuscript:

- Added new subsection "Role of input data discrepancies" in Section 4.1.7 of the Discussion.

Referee 2

Comment 1:

The authors focus on CONUS, Europe, and South Asia. It may be worth noting that East Asia also hosts some of the world's most intensively irrigated agricultural regions, such as the North China Plain, where numerous studies have documented substantial irrigation-induced increases in ET. If feasible, I would recommend adding some brief discussion or analysis related to these regions to further enhance the completeness of the study.

Response:

We agree that other regions, particularly in East Asia, host some of the world's most intensively irrigated agricultural regions. The North China Plain is one of the major irrigation hotspots globally, and numerous studies have documented substantial irrigation-induced increases in ET in this region.

A quantitative evaluation over East Asia was not included in the present analysis because the irrigated-area dataset used here as reference (GMIA v5) is most representative of conditions around the 2000–2010 period, whereas irrigation extent in the North China Plain has changed substantially since then. This temporal mismatch could introduce inconsistencies with the evaluation period considered in this study.

To address the reviewer's suggestion, we added a brief literature-based paragraph entitled "Applicability to other irrigated regions" in the Discussion (Section 4.1.9: Summary of factors explaining ET products' performances over irrigated areas). This paragraph acknowledges the importance of East Asia and clarifies the relevance of our findings for this region. The following text was added:

"**Applicability to other irrigated regions**

Although the present analysis focuses on selected irrigated regions in the CONUS, Europe, and South Asia, similar questions arise in other major irrigation hotspots worldwide. In East Asia, for example, the North China Plain has experienced rapid irrigation expansion in recent decades (Meier2018, McDermid2023, Mehta2024). The sensitivities identified here are likely relevant for such regions, as several ET products rely on remote-sensing constraints (e.g., LST and vegetation properties) that respond to irrigation through similar physical mechanisms. Regional climate conditions, crop types, and irrigation practices may, however, influence the magnitude and detectability of these signals."

Changes in manuscript:

- Added a paragraph entitled "Applicability to other irrigated regions" in the Discussion (Section 4.1.9) acknowledging East Asia and the North China Plain and discussing the broader applicability of the study findings.

Comment 2:

In addition, irrigation impacts on ET are influenced not only by irrigated area but also by regional climate conditions and irrigation methods (e.g., surface, sprinkler, or drip irrigation). A brief discussion of these factors could help clarify why different ET products may perform differently across various irrigated systems.

Response:

We agree that irrigation impacts on ET depend not only on the fraction of irrigated area, but also on regional climate conditions and irrigation practices, which can modulate the strength and detectability of irrigation signals.

To address this point, we added a dedicated subsection in the Discussion that explicitly discusses the role of climate conditions and irrigation methods in shaping how irrigation signals are expressed in ET and detected by different products. The following text was added:

"Section 4.1.8 Role of climate conditions and irrigation practices

Beyond differences in model structure and input data, climate conditions and irrigation practices also influence how irrigation signals manifest in ET and, consequently, how easily they can be detected by different products. Regional climate conditions affect the magnitude and seasonality of irrigation-related ET enhancements. In arid and semi-arid regions, irrigation tends to produce stronger contrasts in ET relative to surrounding rainfed areas, whereas in more humid environments these contrasts are generally weaker. Irrigation methods (e.g., surface, sprinkler, or drip systems) further influence the timing and spatial localization of water inputs, thereby shaping how irrigation signals appear in ET fields. Such management-related differences may partly contribute to regional contrasts in product performance, particularly in areas characterized by perennial crops and localized irrigation systems, such as the California Valley."

Changes in manuscript:

- Added new subsection "Role of climate conditions and irrigation practices" in Section 4.1.8 of the Discussion.

Additional update during revision: inclusion of GLEAM v4.3

In addition to addressing the reviewers' comments, we updated the manuscript to replace GLEAM v4.2a with GLEAM v4.3. This update was communicated to the Editor prior to resubmission and reflects the availability of a newer version of GLEAM that explicitly accounts for irrigation effects. Including GLEAM v4.3 improves the scientific relevance and timeliness of the manuscript.

The description of the GLEAM product was updated in the Materials and Methods section (Section 2.1.2), and all figures, tables, and analyses previously referring to GLEAM v4.2a were recomputed using GLEAM v4.3. Corresponding updates were made throughout the Results, Discussion, and Conclusions.

Overall, GLEAM v4.3 shows substantially improved temporal behavior relative to v4.2a, particularly in capturing seasonal and interannual ET variability over irrigated regions and the drought signal during the 2014 California water restrictions. However, its spatial correspondence with maps of area equipped for irrigation remains moderate across regions. As a result, GLEAM v4.3 is now categorized as exhibiting intermediate consistency with the reference datasets, rather than weak consistency as previously found for v4.2a.

Importantly, the inclusion of GLEAM v4.3 does not alter the main conclusions of the study. FLUXCOM RS, PMLv2, and SSEBop v6.1 remain the products showing the strongest overall consistency with reference datasets over irrigated areas. The updated GLEAM results further support the central interpretation that differences among ET products are strongly linked to how vegetation water stress is represented and whether irrigation-sensitive variables are incorporated.

All modifications related to GLEAM v4.3 are marked using track changes in the revised manuscript.

Minor editorial revisions

In addition to the changes described above, we performed minor editorial revisions throughout the manuscript to improve clarity, consistency, and readability. These include small rewordings, harmonization of terminology, and minor adjustments to improve the logical flow of the text. These changes do not affect the results or conclusions of the study.