General comments:

This study presents gridded irrigation datasets for three major irrigated agriculture regions, including two sites in Europe and one site in Australia. The SM-based inversion water balance model is utilized to estimate irrigation using satellite soil moisture data. Given the scarcity of irrigation data at a large scale, this dataset has a significant potential to serve as a reference for other studies and in this sense, it is a good fit for ESSD. However, it is imperative that the uncertainties involved in the production of this dataset are clearly outlined in the text, particularly in the abstract and conclusion. Additionally, it should be clarified whether this data can be used to validate other studies or if it requires further validation with in-situ datasets (as mentioned in L465 of the conclusion). I outlined my comments below, addressing these comments the paper can be considered for publication:

Specific comments:

Major

1. The reliability of the irrigation dataset outside of the benchmark irrigated areas is questionable as the model is calibrated and validated over the same sites. In order to have a better understanding of the model error outside of the benchmark area it is better to keep at least one of the benchmark areas in each region just for validation (not use it in the calibration process). This way, it will be easier to see how well the model performs in areas that are not part of the benchmarked sites, which constitute more than 80% of total case study area.

2. It is not clear whether this product is produced as a reference (benchmark) for other studies (as it can be inferred from the title or L19-20) or if the authors ask the community to validate this product (L108-110, L465, L471). This should be explicitly mentioned in the abstract.
3. L195: This suggests that you calibrate F over a small fraction of irrigated area, and use the same value for the whole region while they might have different crop types and surface characteristics. Please discuss how this can affect the estimated irrigation, especially over the white area of figure 3.

Moderate

1. L86: I guess it is not improving rather it is an estimation as there is no irrigation module involved in their method, in this sense it is different from the rest of DA studies mentioned here which are improving irrigation estimated by an irrigation module.

2. Figure1: I prefer the climate description over the abbreviations as the readers can better relate to it, for example:
   Cfa = Humid subtropical climate
   To save some space, you can use one legend for both maps if they are identical
3. L127-128: The sentences are sometimes unnecessarily complex and long, use plain language and shorter sentences.
4. L173: Are negative irrigation rates significantly lower than the positive irrigation rates, if yes please report this in your result section.
5. L183: Do you have supplemental irrigation in any of these regions? Please discuss this in the manuscript.
6. L184-186: Some sentences like this one are long you can break them into shorter sentences that are easier to follow by the readers.
7. L186: Using insitu irrigation data in the calibration process can create some limitations as this data is not always available or it might be provided for a part of the study area (like this study). Have you tried to calibrate the F parameter during the rainy season for instance during the drydowns after the rainfall, in this case, you will have the F value for all the pixels and not just in pixels for which you have irrigation data. Another suggestion is to calibrate the model over the rainfed cropland areas during the irrigation season. It would be really interesting to see how much skill will be gained/lost for irrigation estimation.
8. L235: What is the temporal resolution of GNSS soil moisture? It is expected to be more frequent, which I think is an advantage for the SM-based inversion algorithm. You can highlight it here.
9. One of the important inputs (or the most important one!) for your approach is soil moisture data. You have used different satellite technique to retrieve soil moisture that has different accuracy, especially since the GNSS-based method tends to be less accurate. Consequently, the estimated irrigation should not be treated the same, this should be highlighted in the manuscript.
10. are the benchmark irrigation districts representative of the larger irrigated regions (white area in Figure 3)?
11. Table. 1. Do you have one daily irrigation volume value for an 887 km2 area in the Urgell site? Or you have multiple irrigation measurement stations at each benchmark site that measure irrigation for smaller agricultural land parcels? This needs to be clearly explained in the manuscript.
12. Which part of the data is used for calibration and which part is used for validation, add two columns to table one and provide this information for each site.

Minor

1. L94: cannot make sense of this line: "*The high-resolution retrievals of the latest satellite capabilities open …*" rephrase, please.
2. L116: what do you mean by interesting in this sentence: "*with oceanic climate areas (Cfb)* ***interesting*** *the upper part…*"
3. The sentence at L125-126 is difficult to follow
4. L184: *This first step involves* calibration of…?

5. L188: the second **and** is extra: *… the values of* a, b, *and* $Z*$ ***and*** *are re-calibrated…*
6. L248: I think it is better to use irrigation depth or height instead of “irrigation doses”