Reviewer's report for essd-2022-403

Regional data sets of high-resolution (1 and 6 km) irrigation estimates from space

Summary -
Irrigation water has been a majority portion of human total water use but detailed information at high-resolution for water resource instructions has been limited. In this study, the authors presented high-resolution regional datasets derived from remote sensing through SM-based method (water balance equation) for three basins, Erbo and Po basin (1-km) in Europe, and Murray basin (6-km) in Australia. The products are evaluated through detailed benchmark irrigation rate data collected in these three basins. The results are valid and valuable for Erbo and Murray basin, as for Po basin, large uncertainty exist due to limited length of benchmark data. The authors highlighted the limitations of this method and proposed ideas for future studies.
The manuscript presented has great significance for remote sensing and land model communities and has great potential to achieve large-scale application. Despite its importance, some comments and issues need to be addressed before it can be accepted for the journal. Please see my comments and questions below:

General comments -

1. Eq (1) shows the water balance terms used in the SM-based method. Does any of these three basin would have snowfall and snowpack in winter and snowmelt contributing to soil moisture water balance in spring? As no word of snow is mentioned in the manuscript, would it be possible that the overestimated high irrigation rate in winter and early spring peak due to a missing (snow) component in Eq (1).
2. Another possibly neglected component would be the groundwater contribution to soil moisture, the g(t) term, if the groundwater table is shallow, it would be possible that rainfall from other area could drain to river and groundwater aquifer which provides lateral transport of moisture, contributing to soil moisture.
3. 3.2 Input data sets, the authors used different sources of input data sets with various resolution, soil moisture (1-km), PET (0.25°) and precipitation (9-km), can the authors also provide a discussion on the way of spatial aggregation, would it affect the results obtained in the dataset?
4. The authors also highlighted the uncertainty and future exploitation of ET data, would it be possible to apply a physical process-based land surface model (LSM), which has more sophisticated ET calculation, to obtain SM-based irrigation rate, rather than the soil moisture balance Eq (1)?
5. The scatter plot in Figure 5,7,9. It seems that there are some systematic underestimation in Ebro basin and Murray baxin, and overestimation in Po basin. Any speculation on these, would it be due to the physical landscape, i.e. missing processes in Eq (1) used to estimate SM? If this is true, what caution would the authors recommend to users when propogating this method to use in large regional application in other regions of the world?
6. Do these three basins in pilot areas use the same irrigation method? If different irrigation methods are used in these three basins, would these affect the SM-based inversion approach, reflected on the results? The authors could provide a discussion on the irrigation methods and also

7. The authors mentioned applying irrigation map and crop calendar to constrain irrigation dataset in Discussion. When applying these constrains, would it affect the calibration parameters, i.e. these parameters would need to re-calibrate?

Specific comments -

1. In general, the presentation of the manuscript is good. But there are several places where paragraphs are too long. For example, the first paragraph of Introduction is too long, the authors may divide it into separate paragraphs that may be helpful for readers.
2. L307: "… to the Urgell district" could use a separate paragraph.