Comment on essd-2022-288
Anonymous Referee #1


The authors describe two new datasets for Potential EvapoTranspiration (PET) for the UK. These datasets are based on (processed) observations (provide an estimate of the PET values for the current climate) and model climate scenario from UKCP (and provide an estimate of future conditions of PET). The datasets come as an estimate of PET and include a parameterization of inception on days with rain. The approach leading to both datasets and the assumptions are discussed in the documentation in sufficient detail and the embedding in the literature is well done. The manuscript is a very good read and very clear.

However, there are a few concerns that need to be addressed before acceptance of the paper can be considered. These relate to 1) the uncertainty introduced by the need to use monthly mean values for sunshine duration and wind which are interpolated to the daily level and 2) inconsistencies between the input meteorological data for the historic period and the future period - and how these propagate into the PET estimates.

In addition, it would make the documentation of this dataset even more interesting if the manuscript would add a focus on climatology of more extreme situations and their projected changes. The monthly mean perspective is clearly relevant, but many users will be interested in the shortish warm spells with exceptionally sunny weather as these affect hydrology quite profoundly.

These concerns are detailed below.
My advice to the editor is to accept the paper with major revisions.

Main concerns:
1) It is a pity that daily maps for wind speed and sunshine duration (and air pressure) are not available in the HadUK-Grid dataset. The approach taken by the authors is then probably the best way forward. However, there are potentially large effects on the PET estimates because of the strong underestimation of the day-to-day variation in PET values. As the authors state in the manuscript, PET is non-linearly related to the input which makes the underestimation of day-to-day variations a potential problem. While section 5.3 comes some way in demonstrating that the approach of the manuscript works, but the answers are not quite satifying. In my view, an additional analysis needs to done. The UK Met Office's National Climate Information Centre has long records available (starting in the early 1960s) with daily values of sunshine duration. Long series with wind speed are available as well I guess, but can be obtained through NOAA's Global Summary of the Day (or through the ECA&D). These records allow for a day-to-day comparison of selected UK stations of PET using actual daily values and interpolated values.

The benefit of this approach - easy to do as you already have all the software in place - is that an assessment of the neglect of day-to-day variability on PET and PETI values can be made directly, also for the summer season (which is left-out in section 5.3). In this assessment, the monthly mean perspective is interesting (and in line with the rest of the manuscript), but a view on the under- or overestimation on the more extreme days (like total overcast days or warm and long sunny spells like those in the recent heat waves) is of particular value to the user.

2) Figs. 10 and 11 compare outcomes of PET values based on the (processed) observations and the UKCP climate scenario's. The manuscript discusses some issues with the model results, like the presence of a bias in the variables etc. What is missing a bit is the identification (and assessment of the severity) of a possible mis-match between model and observations. Apart from a possible bias, differences between observations and model meteorological data include the use of sunshine duration (obs) vs. radiation (model) (at least: this is what I expect that is used when processing the UKCP data). The difference between daily mean temperature (model) vs. Tmax and Tmin (obs) is another. Probably these differences are smaller than any model bias, but it would be good to establish this.

3) With the recent heat waves Europe has seen, many people will be interested in how the dataset performs for these more extreme situations. The current manuscript lacks any detail in this respect and that is a pity. An assessment of the quality of the dataset during dry spells/heat waves is required. The comparison of climatology of extreme PET values - like the climatology of 90th or 95th percentiles in daily PET - between the historical period and the projections is required for the user to gain trust that the dataset is reliable in this respect as well.

Other aspects that authors may want to look into
-) E5: (ground heat flux)
In this section, it appears that ground heat flux and ground heat storage are mixed-up. It
was my understanding that the ground heat flux is often neglected when focusing on daily resolution estimates of PE.
- line 325: the period 1985-1992 is remarkably short for any comparison. I think observational data are available for a more expansive period.
- line 330: be clear if the standard deviation and correlation analysis involves the daily values or monthly mean values. The reader will see later in this paragraph (line 338) that daily values are used. Note that for the Pearson correlation, the seasonal cycle needs to be filtered-away (otherwise the correlation is likely to partly reflect that both datasets capture the seasonal cycle).