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Comment on hess-2021-126

Joshua Fisher (Referee)

Referee comment on "A continental-scale evaluation of the calibration-free complementary relationship with physical, machine-learning, and land-surface models in Australia" by Daeha Kim et al., Hydrol. Earth Syst. Sci. Discuss., <https://doi.org/10.5194/hess-2021-126-RC2>, 2021

This is a good paper that discusses in depth the complementary relationship (CR) of evapotranspiration (ET), and conducts an extensive evaluation of the CR over Australia. The paper is well-motivated—the vapor pressure deficit (VPD)-soil moisture (SM) CR is widely used in ET estimation, primarily because high quality and high spatial resolution SM is not always readily available; whereas, VPD may be more readily available. Semi-arid places like in Australia are where the CR may be most important, and potentially where it may be the most uncertain.

The Introduction and Discussion are written very intelligently, taking a deep dive into the theory and formulations of the CR and ET estimation. The authors do a good job of describing each of the respective ET models and datasets. Relative to the strength of the overall writing, especially from these sections, the analysis and results were somewhat lacking in depth, however. Ultimately, the results were just a handful of maps and time series of the different products, with no real "truth" to benchmark against. Given how intelligent the authors were with their communication and writing of the theory, I was surprised to see the analysis so shallow. I would have liked to have seen that same intelligence from the writing applied to the analysis. The authors could have gone into much more analytical depth on spatial patterns, sensitivities, etc.

Related to the tenuous/lack of benchmarking, I suggest editing the language for use of words like bias and under/over-estimation e.g. in the Results. These terms generally refer to a metric of truth, of which none is given here (I don't consider the water balance the "truth" given that it is also a model of models; see also comments from Reviewer 1). Better, to stick with language such as larger/smaller/etc. as the comparisons are just relative to one another.

Moreover, be cognizant in attributing pattern to process relative to model run conditions,

especially when it comes to relative magnitudes. Any one model can be high or low depending on the forcing dataset it used (see e.g. comments from Reviewer 1), which is not necessarily indicative of the model (or, importantly for this paper, the inferred processes therein). The closest approximation to ascertaining process from pattern would be to identify spatial and temporal patterns regardless of magnitude. For example, the patterns mentioned for AWRA-L in L251 are interesting and likely indicative of process (though they could have easily just been attributable to something unusual in the forcing used for that model).

Line-specific comments:

- Abstract is written a bit, well, abstractly. It could use more take-home information/detail like what exactly where the models and what exactly was their performances.
- L37. See [Fisher et al., 2017].
- L39. See [Polhamus et al., 2013].
- L47. See [Fisher et al., 2011].
- L54. See, for reference, [Purdy et al., 2018].
- L192. PT-JPL [Fisher et al., 2008] also incorporates the complementary relationship, citing Bouchet, in the soil evaporation component—e.g., RH^{VPD} . This simple formulation tracks relative surface wetness well [Fisher et al., 2008], and has since been used in other major models of ET, e.g., PM-MOD16 [Mu et al., 2011]. Still, advection will contaminate the relationship, and replacement with direct soil moisture e.g. [Purdy et al., 2018], can eliminate that contamination. The new ECOSTRESS mission [Fisher et al., 2020] uses PT-JPL for the global ET product, but is currently being updated to incorporate the [Purdy et al., 2018] soil moisture formulation and inclusion, downscaled using the measured LST and NDVI following [Colliander et al., 2017].
- Figure 3. I suggest making the symbols in the Taylor diagram more distinguishable.
- Figure 4. PT-JPL data are available from 1984 from the same link where you got the current data.
- L402. See [Purdy et al., 2018] for soil moisture incorporation into PT-JPL.
- Figure 8. This seems to be redundant with Figure 4.

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