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Interactive comment on “The WACMOS-ET project – Part 2: Evaluation of global terrestrial evaporation data sets” *by* D. G. Miralles et al.

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We would like to thank Dr. M. Anderson for her feedback on our manuscript and her advice on how to improve it. In the following we address one-by-one all the points that have been raised. These changes are being implemented in the revised manuscript.

+ P4 L24: "stands as a crucial nexus..."
– True. We will correct it.

+ P5 L9: "computing science, to date, the evaporative..."
– We will correct it as well.

+ P6 L1: "and consistent..."
– Thanks.

+ P6 L30: "Due to the..."
– Indeed. We will correct it.

+ Sec 2.1: Do all the models estimate ET over snow? If so, briefly mention. If not, were snow-cover conditions masked from the global intercomparisons (e.g., in Fig 2)? Also explicitly specify mechanism through which soil moisture constraints on each are conveyed/implemented by each modeling framework.
– In the case of the GLEAM model, for pixels covered by ice and snow, sublimation is approximated based on a PT equation parameterized for ice and super-cooled waters according to Murphy and Koop (2005) – nonetheless, estimates from this scheme are similar to the ones obtained from the application of a standard Priestley and Taylor equation with no evaporative stress (Miralles et al., 2011). The other two WACMOS-ET models (PM-MOD, PT-JPL) do not treat snow sublimation separately, and therefore their estimates of evaporation during snow-covered times are based on the same algorithms and parameterizations that are used for the underlying land cover. This will be clearly mentioned in the description of the models.
– Figures do include snow-cover regions and periods, as it can be seen by the range of values in Antarctica. The only model that does not provide estimates in permanent snowed covers (or deserts) is the FLUXNET-based MPI-MTE, and for this reason, when models are compared to the MPI-MTE model these regions are masked out. This is already mentioned in the caption of Figure 2 and Figure 3, and will be mentioned in the description of the results in the revised manuscript.
– Finally, the soil moisture constrains on evaporation are presented in the description of the models, e.g. pag. 8 L26: '*Unlike GLEAM, however, it [PT-JPL] applies a series of eco-physiological stress factors based on atmospheric moisture (vapour pressure deficit and relative humidity) and vegetation indices (normalized difference vegetation*

index, i.e. NDVI, and soil adjusted vegetation index) to constrain the atmospheric demand for water.'.

+ P11 L2: Specify whether both upwelling and downwelling radiative SRB fluxes were used.
– Both were used. We will clarify this.

+ P14 L12: "...the total annual magnitude for land evaporation..." Again, do these estimates from all the WACMOS models include snow ET/sublimation? How about evaporation from inland water bodies?
– Perhaps an even better question is whether models provide estimates under snow-covered conditions, because whether or not they explicitly consider the sublimation process explicitly is somehow different (i.e. only GLEAM treats sublimation independently). All models except for MPI-MTE provide evaporation estimates across the entire continental domain, including snow-covered regions and deserts. The case of inland water bodies is slightly different, as PM-MOD and PT-JPL classify pixels as being either land or water, while GLEAM uses a fractional coverage of open water per pixel, and estimates (potential) evaporation for this fraction. We will clarify this.
– In the annual totals we provide, we could have masked out from all models those regions where MPI-MTE reported no estimates, but since the use of MPI-MTE is only for benchmarking, we have chosen not to do this. Therefore, the annual totals correspond to the entire continental land, except in the case of MPI-MTE that does not include poles and deserts. Just like in Figure 2. Note that we already mention in the text that '*some of these studies considered the poles and desert regions, while others did not; however, the contribution from these areas to the global means is rather marginal (< 5% of the total based on our analyses).*'. We will phrase this unambiguously in the revised manuscript.

+ P16 L24: The closeness of the R values for PT-MOD/PT-JPL and GLEAM/PT-

JPL suggests that R is not a sufficient measure of spatial agreement in this case. The scatter plots give a very different picture of agreement, especially at the high ET end.
– Indeed, no metric is sufficient on its own. We will add the RMSD and bias to these scatterplots and to the text. Therefore, we will make these plots consistent with the scatterplots in Figure 9.

+ Sec 3.2: A map of ET variability is required to interpret these temporal correlation maps - highlighting areas where correlations are low even when variability is high (the most interesting areas). A lot of the spatial structure in R may just be reflecting structure in seasonal variability in ET.
– True. Ideally one would like to calculate the correlation of the seasonal anomalies, but the three-year record is short. We will add maps of the temporal standard deviation of each model per pixel to these figure, and mention this issue in the text.

+ P18 L18: "arctic"
– Thanks.

+ P19 L25: "..Fig 8 demonstrates that the..." What is it physically in PM-MOD that is most prominently causing the underestimation in ET?
– The Budyko diagrams in Figure 10 show that PM-MOD overestimates the evaporative stress. This can happen for various reasons, given the wide collection of multiplicative stress factors that exist in the model. We will further investigate the cause of this underestimation and suggest a plausible explanation in the text. A possible reason may be that the model has been calibrated based on eddy-covariance data, and eddy-covariance measurements tend to underestimate evaporation as discussed in Part 1 (Michel et al., 2015).

+ This drought example isn't completely compelling on its own. Probably need a longer time series and analysis of response to several drought events to determine

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which model responds most reasonably (from an anomaly standpoint). PM-MOD is always low in this case, and shows no real response... The upper panel doesn't convey additional information. Maybe some other info is more useful here, like net radiation and LAI curves? Could a pluvial event (some- where globally during the period of record) be included for comparison?
– We do not fully agree on this point. What makes this example interesting is that it focuses on a very large catchment and on a multi-year drought period. For this region and period, the cumulative discharge is several orders of magnitude lower than the incoming precipitation, and it can therefore be neglected. This makes it a unique test bed considering our limited 2005–2007 period. In addition, a three-year period is a long-enough record to neglect significant storage changes, thus evaporation totals should approximate precipitation totals over the entire catchment in this example. That provides the opportunity to perform a coarse quality check of the evaporation totals. We believe that neither evaporation doubling precipitation (as in ERA-Interim) nor precipitation doubling evaporation (as in PM-MOD) are realistic scenarios.
– Unfortunately, we agree that short-term dynamics cannot be explored in this fashion; to better understand the short-term response of evaporation to drought we require independent time series of field-measured evaporation. Comparisons to in situ evaporation are performed in the companion article (i.e. Part 1), that explores in more detail the performance of the different models in dry environments, but also the presence of systematic errors. While using LAI is in this figure may be cumbersome, because it is an input to some of the models, we agree that adding more information on the meteorological conditions, in particular net radiation, can be informative and it will be incorporated.

+ P23 L18: "algorithm than the one..."
– True. Thanks.

+ P25: Is there some kind of simple analysis that might be used here to moti-

vate one of these partitionings as being more physically realistic than the others? Maybe plotting T/ET as a function of LAI, or showing seasonal evolution in T/ET and LAI from the different models in different key regions (like the Amazon)? This points to the need for field campaign focus on quantifying E-T separation measurements.
– We are again reluctant regarding the use of LAI as a validation metric since it is an input to some of these models. We agree that this figure points to the need for field campaigns that focus on quantifying these sources separately, as we discuss in the manuscript. We believe that further analysis of this issue should be carried out outside the context of WACMOS-ET, and may be focused on the use of isotopes, sapflow measurements, chlorophyll fluorescence measurements, and others. There are already ongoing efforts in this direction, which have pointed to large levels of dissagrement and suggested possible pathways to narrow down the uncertainties on this partitioning (see e.g., Schlesinger and Jasechko, 2014; Wang et al., 2014).

+ Fig 2 and similar: This color bar seems a little ambiguous. There are purple tones in two parts of the color bar, at least in my print out.
– We will make the two sides of the colormap more distinct.

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