The authors are immensely grateful for the invaluable review, corrections and suggestions given by the reviewer.

Reviewer comment	Author response
	Signficant concerns of the reviewer appears to arise from non-familiarity with the postulation, development and derivation of the MEP theory which have been comprehensively published by (Wang and Bras, 2009;Wang et al., 2010;Wang and Bras, 2011;Wang et al., 2014). This is understandable as the MEP is a relatively new method of ET estimation. The focus of this manuscript is not to re-derive the MEP method, it is to apply and create a continental scale product based on a method that has been established, tested and validated.
Each and every input data set should be systematically characterized in terms of its nature, units of measurements, spatial and temporal resolution, accuracy (error bar), and source. Much of that information is currently lacking for most of the inputs used	The authors will include a table which details the input datasets nature, units, resolutions and the citation of sources.
Assuming that the heat flux into the ground G is null for vegetated areas is a crude approximation at best. At the very least, this should be supported by ample empirical evidence	The authors did not assume Ground heat flux (G) is null in vegetated areas. The MEP Evaporation equations in Eqn 2-4 over soil calculate for G while the MEP Eqns 5 and 6 for Transpiration neglects G on the canopy as it will have been accounted for under the canopy through the evaporation equations. See (Wang and Bras, 2011). The manuscript will be updated to ensure clarity of the above point.
Soil moisture, derived from a mix of space-based instruments, is arguably the most important source of information in this study, and likely the driving factor that guarantees reasonable results. Yet, there is no discussion of the accuracy of that product, nor of the dependency of the output on that accuracy.	The soil moisture is an important variable used in the MEP method in this study. However, it is only used in the Evaporation calculations. The accuracy of this product (ESA CCI Soil moisture v 04.4) (Dorigo et al., 2017) has not been extensively discussed as there are manuscripts dedicated to the validation and review of this soil moisture products (Dorigo et al., 2015;McNally et al., 2016;An et al., 2016;Dorigo et al., 2017). However, a discussion regarding this will be included in the updated manuscript.
The Authors correctly point out, in the introduction, the difficulty of mixing and merging (let alone assessing) input data obtained at widely different spatial and temporal scales and resolution. Yet, little or no discussion of this key issue appears in the paper: Satellite-derived soil moisture data comes at a spatial resolution of 25 km. Re-sampling it at 5 km may be convenient programmatically, but that does not mean	The challenges surrounding scales and resolutions will be discussed in the updated manuscript. The statement in lines 204 – 205 has been removed. However, It was mentioned in lines 205 and 206, that the effects of the footprint of the obtained EC data from FLUXNET is not considered in this study. The authors considered that similar studies globally like we have undertaken, have compared ET products to EC tower ET results without

that this information is suddenly available (and reliable) at this finer resolution. Similarly, saying that field data obtained from flux towers have a footprint "ranging from 100 m2 up to about 2 km2 depending on the measuring height of the EC system and vegetation height" (lines 204–205) has to be taken at face value, because no evidence is provided to support such a claim. Hence, comparing those outcomes and claiming that one validates the other is a gross oversimplification of the matter

footprint analysis (Jin et al., 2011;Velpuri et al., 2013;Mu et al., 2011a;Hu et al., 2015). This is due to the difficulty of multi-scaling analysis as well as availability of footprint data from the FLUXNET daily analysis. The use of EC flux tower data in regional/continental scale studies such as ours give an indication of the relative closeness or divergence to ground-based measurements in location with EC data thereby giving a certain degree of confidence to regional to continental scale products such as this. Otherwise there would be no way to give any indication of accuracy.

The paper does not discuss the concept of potential evaporation (PE: the maximum rate of evaporation when water supply is not a limiting factor), nor does it provide a map of the annual mean precipitation over Australia. Yet, both of those variables constitute caps which evapotranspiration (ET) is not supposed to exceed... A map of precipitation for Australia is available from the Bureau of Meteorology at (http://www.bom.gov.au/jsp/ncc/climate_averages/ra infall/index.jsp). Comparing the ET output of MET with that map, it is not obvious that the mean evapotranspiration (first Figure 3 on p. 12) is everywhere lower than the precipitation at the same location..

One of the unique features of the MEP method is the fact that the method does not require potential Evaporation to compute ET (See (Wang and Bras, 2011). Also, regarding the use of the annual mean precipitation map suggested by the reviewer, this was initially considered by the authors, but discovered to be inappropriate as the map from the BOM was an average of the period between 1961 -1990. However, we have produced the ET product over Australia for the period of 2003 – 2013, which were especially dry due to the millennium drought. Hence the possible differences observed by the reviewer. Since the map was not representative of the study period, it was decided by the authors to be excluded from the manuscript for comparison.

The MEP model mobilizes multiple input sources as well as a large number of equations or algorithms with (often fixed) empirical parameters. The latter may have been derived for other locations or time periods. It is not clear what is achieved by this complexity, or to what extent each source actually contributes to the final outcome. Could a much simpler model account for the bulk of the variability? What is gained by the complexity, especially when it involves constant parameters? When developing large models like the MEP, it is essential to document the relative importance of the main inputs and the sensitivity of the outputs to those inputs

The goal of this paper was to create evaporation and transpiration products over the entire Australia using the MEP method. All empirical equations used in this manuscript were developed for Australian conditions. As with all regional to continental scale ET products (MOD16, LSA-SAF MSG, SSEBop ET), there are required data which are not available at regional scale e.g specific humidity, surface roughness, stomatal conductance etc. The authors attempt to obtain such parameters through the use of empirical equations or other derived algorithms. While it is acknowledged that these estimations will propagate some error through the product, it is often the most practical way. Hence the use of ground-based measurements to compare, to determine if the results are acceptable or not, which is what we have done in this study. The importance of the principal inputs and their sensitivity have been documented in the MEP development articles (Wang and Bras, 2009; Wang et al., 2010; Wang and Bras, 2011; Wang et al., 2014).

Although the study is carried out over a decade (2003–2013), the manuscript does not discuss very much the time evolution of ET during that period. Figure 4 does show some time series over periods ranging from 80 to

The evolution of ET during the study period will be included in the updated manuscript.

about 350 days, but it is not clear whether those are The time series in figure 4 was a comparison between for a particular year or averaged over the entire period the EC tower data and the three products (MEP, AWRA-(and if so, where do these occur in the calendar year?). L and MOD16). The analysis was constrained to the In any case, why are those time series exhibited over days where the EC data intersected the three products such different periods? For similar reasons, the between 2003 -2013, hence the range from 80 - 350 enigmatic second Figure 3 (on p. 12) barely addresses days. the issue of confronting the time evolution of ET Due to the comparison of three products with the EC generated by MEP with actual measurable evidence. tower sites, only days where there was data across the Options include comparisons with agricultural output, four datasets being compared was used. Hence it is drought and flood periods, or any other biogeophysical impracticable to include dates. In the Figure 3, we will variable that could betray the impact of ET fluctuations include a comparison of the MEP yearly average with during that decade the yearly average of another continental scale ET product. Lastly the legends of the Tables and Figures are so We are sorry, we recognize we have been too brief in minimalist as to be largely useless to understand their our figure captions. We will update these in the revised manuscript to be much more explanative. contents. Please provide essential information to understand and appreciate the nature and contribution of those displays Lines 56-63: Replace "accepted" by "used": MODIS We agree, this will be updated in the manuscript. products are widely used because they are available and accessible, and because standard tools exist to manipulate the large data sets. The word "accepted" implies a vetting of the quality and performance of the product which may or may not apply, as indicated by the Authors themselves (lines 58 to 64). - Line 68: This model is called 'Maximum Entropy This model was named "Maximum Entropy Production Production', but there is no indication about what is method" by the authors of the method (Wang and maximized, or what connection may exist with the Bras, 2009; Wang and Bras, 2011) and the derivation and conceptualization have been extensively concept of entropy. documented. We have tried to make this a data paper as much as possible without repeating the whole conceptualization in this manuscript. Indeed, the specific humidity of air at the target surface Line 71: Clarify that MEP requires the specific humidity of the air (soil or canopy) is a requirement of the MEP method. This will be updated in the manuscript. - Lines 94 and 102: Indicate explicitly that qs refers to This refers to soil or canopy surface. Soil surface for the the air specific humidity: the expression 'surface evaporation equation and canopy surface for the specific humidity' can be ambiguous transpiration equation. This will be clarified and updated in the manuscript. - Lines 94–95: The text mentions q but the equation qs is specific humidity of air at the target surface (soil uses qs. Adding to the confusion, the subscript s is or canopy) used throughout the paper to designate soil variables, while q appears to be an atmospheric variable... This will be clarified and updated in the manuscript. - Lines 95-97: Equations (3) and (4) show that the heat The MEP method is completely derived mathematically flux into the ground G and the latent heat flux Es are through the lagrange multiplier method by optimising both proportional to the sensible heat flux from the the dissipation function in (Wang and Bras, 2011). No soil surface to the atmosphere Hs, but there is no parameters in the MEP have been fine tuned for any indication about how the latter is actually estimated. Is specific location. The authors avoided re-deriving the

it assumed to be the residual in Equation (1)? If so, MEP equation in this manuscript as this has been what about the sensible heat flux from the plant comprehensively covered in (Wang and Bras, canopy to the atmosphere Hv? This system of 2009; Wang and Bras, 2011; Wang et al., 2014). equation does not appear to be complete or energy conserving as stated. What is the accuracy of those The equations 2, 3 and 4 are solved using a numerical equations, and to what extent are they (in particular solver which partitions E, H and G based on the three the inverse Bowen ratio βs) relevant and applicable to equations. The inverse bowen ratio is purely the Australian environment, given the presence of mathematically derived. gs and Ts over canopy and soil empirical coefficients, which may have been fineare derived differently. See table 1. qs over canopy is tuned for US conditions? Where are the values of qs derived from air relative humidity while qs over soil is and Ts coming from, what are their accuracy, spatial derived from soil surface water potential obtained from and temporal resolutions? soil moisture as detailed in the section 2.2 - Lines 111–114: Comments on the flowchart in Figure While the MEP method produces values for E, H and G, 1: * This Figure describes how the various input data in this manuscript, the focus is only on E, which is the sets are processed by MEP to generate the desired evapotranspiration, which is a sum of the evaporation output, evapotranspiration. Yet, none of those boxes and transpiration. Hence the outputs of H and G are appear to require any of the fluxes H, E or G not reported in this manuscript. The development of mentioned earlier: only Rn is discussed or used the MEP method has been comprehensively analysed subsequently. So what is the relation, if any, between and tested in manuscripts on point or catchment the materials and equations described between lines scales (Wang and Bras, 2011; Hajji et al., 2018), hence 89 and 108, on one side, and the rest of the paper? the derivations are not repeated in this manuscript, this manuscript is focused on the application of those pre-derived equations at continental scale and the development of a dataset over Australia. Nevertheless, we will update the manuscript to explain that it is focused on the evapotranspiration component while referring the reader to the development papers to questions on the derivation of the method as a whole. * Figure 1 distinguishes between "soil surface relative The equation for obtaining specific humidity from humidity" and "soil surface specific humidity", yet the relative humidity has been included in the Appendix. equations or algorithms to derive those variables are The equation for sigma over target surface is derived nowhere to be seen... According to Equation (2), the from target surface temperature and target surface variable soil sigma (σs) is derived from both soil specific humidity as indicated in the Figure 1. Sigma surface temperature Ts and atmospheric specific over a target surface is dependent on the temperature humidity qs, yet, the Figure does not show this latter and specific humidity over the target surface as dependency indicated in Figure 1. This will be better described in the manuscript to improve clarity - Line 118: What are the source, accuracy, spatial and The Rn was calculated from solar radiation data developed as part of the SILO data suite (Jeffrey et al., temporal resolutions of Rn? 2001). The spatial and temporal resolution will be included in the table the reviewer requested above in the updated manuscript. - Line 119: FPAR is mentioned here (on page 6), but The FPAR product from the MODIS satellite is used in that product does not appear as an input in Figure 1. partitioning the evaporation and transpiration Also, it is not clear what its role is at this point (this is component. The product is used as a surrogate for the

vegetation cover in the Figure 1. This will be included in

only clarified on page 20!-see the comment on Line the table of input data requested by the reviewer in the 292 below). updated manuscript. Good point, this will be updated as the fractional - Line 121–125: The text appears to use the expressions "vegetation cover" and "vegetation vegetation cover in the updated manuscript. fraction" as synonyms. This is confusing, as "vegetation cover" could be understood as "land cover", which typically refers to the type of ecosystem (forest, savanna, etc.) while "vegetation fraction" hints to the more appropriate concept of "fractional vegetation cover". This latter variable is itself generally poorly defined (and hard to estimate when the Leaf Area Index is less than 3), as is often the case in arid environments like Australia. In any case, if the fractional vegetation cover Fc is derived from FPAR, then Figure 1 should show FPAR in the crossed-out box, and Fc should appear in a separate box. - Lines 59-61 and 131: There is an internal While the authors mentioned in this line, the reported inconsistency in first decrying the poor quality of the challenges with the MODIS LST, the product is still one MODIS temperature product and in using it of the best products out there in terms of spatial and nevertheless. This Reviewer cannot comment on the temporal resolution, hence its usage in the MEP. value of this product, but if the Authors estimate it is Moreover, the authors explained the MEP is much less incorrect, they should use another one sensitive to the temperature input data in lines 75 – 76, which was also noted by the developer of the MEP method (Wang and Bras, 2011). We will make a note in the revised manuscript on this apparent issue. As mentioned in the comment above, the MEP is much - Lines 131–134: The rationale for using the lowest Ts during the month is dubious: what is the accuracy and less sensitive to temperature in the algorithm. reliability of that product, generated on an 8-day basis However, as with all continental scale products, (according to Line 59), if the area of interest happens concessions would have to be made in cases such as to be overcast on successive 8-day periods? And even cloud cover (there is no current perfect product if Ts is always observed at least once a month, that without cloud cover). The authors acknowledge these limitations of producing a continental scale product, measurement would necessarily occur on a clear (relatively hotter) day, so there is still a bias towards hence the comparing to results from ground-based high temperatures during cloudy days. What is the eddy covariance data to give a degree of confidence as possible impact of that bias? necessary with all such regional to continental scale products after making concessions in producing such datasets. - Lines 135-149: This whole paragraph appears very This paragraph will be revised in the updated confusing, because it amounts to a somewhat manuscript taken the comments of the reviewer into disparate assemblage of algorithms and equations account. found in the literature, using multiple empirical coefficients which may or may not be applicable to Australia. Why mention methods that are not used? And again, those tools depend on additional soil properties (whose accuracy, spatial and temporal resolutions are unknown, by the way) apparently obtained from the Australian Soil Resource Information System (ASRIS), though the latter is not reported as an input in Figure 1. As the Authors rewrite this paragraph, they would be well advised to

describe the necessary steps in logical order, to

explicitly provide the full equations, to indicate clearly	
what inputs are needed, where they come from, their	
spatial and temporal resolutions, accuracy, etc.	
- Line 140: The text appears to indicate that the values	The text does indicate that specific soil types with
of the soil water content at wilting point and at field	specific properties have a determinable soil water
capacity are fixed in space and time to -1.5MPa and -	content at wilting point and field capacity. It is based
10kPa, respectively. What evidence is there that this is	on this principle that the Hutson and Cass method is
reasonable, given the high diversity of soil types and	applied to calculate the soil surface water potential
properties?	across each grid cell, based on the specific soil
	properties from ASRIS.
	This is updated as part of the revision of the paragraph
	requested above
- Line 145: What exactly is implied here by "modest	This is updated as part of the revision of the paragraph
data requirement and relative accuracy"? Constant	requested above.
values would be even simpler This is not an	
acceptable rationale: the selection of models and	
parameterizations should be guided by strict	
requirements in terms of accuracy and performance to	
achieve a particular objective, not in terms of data	
volume or approximate value. Besides, how small	
should a database be to be "moderate", and what is	
the benchmark to evaluate the "relative accuracy"?	
- Line 151: The authors introduce the concept of	The concept of distance "z" above the target surface
"distance z above the target surface for which the	was not introduced by the authors in this manuscript,
Monin-Obukhov similarity theory is valid in the	the concept of "z" was introduced as part of the
formula of the thermal inertia of turbulent air above	postulation of the MEP theory of evapotranspiration
soil surface", but none of those Equations are	and its relevance was also discussed (Wang and Bras,
provided. A Table of (fixed) values is provided, and a	2009; Wang and Bras, 2011). This paper refrained from
map of z over Australia is produced, but what are the	re-deriving every parameter in the MEP equation to
significance and implications of this variable in the	avoid this manuscript becoming a re-print of the MEP
MEP model? Since 90% or more of that continent is	development paper.
covered by low vegetation anyway, does it matter to	
consider this parameter?	
- Line 155: What is the scientific basis for assigning	Literature has been cited to support the values and the
those particular values in Table 1? Note also that the	text will be updated in the manuscript to take this and
text refers to z as a "target distance", while the legend	the noted inconsistency into account.
appears to refer to a "target surface".	·
- Line 158: In Figure 2, why is there a blue block	
corresponding to z values of 11 m when Table 1 does	This will be fixed in the manuscript along with the
not show any land cover with that value? And why is	labelling.
the legend to this figure labeling z as the 'target height	
(z)', which would be normally understood as the	
height of vegetation, rather than the theoretical	
concept mentioned above?	
- Line 161: The text refers to Eq. 14, but that Equation	The equation number will be corrected in the updated
(on line 197) has nothing to do with "the Hutson and	manuscript.
Cass coefficients a and b": this probably refers to an	·
equation in another paper	

- Line 166: Where does the soil density come from?	Soil data including soil density are obtained from CSIRO
What is its accuracy and spatial resolution?	see line 147-149. The resolution is 0.05 degrees, it is
	updated in the manuscript.
- Lines 171–181: The ESA CCI Soil Moisture (SM)	The authors' aim of resampling the data was to unify
product is delivered at the spatial resolution of 0.25°.	the resolution of this dataset with the other input
Resampling it (by duplication or interpolation) on a	datasets and not to change the data. The version 04.4
grid at 0.05° may be programmatically convenient or	of the data is used and it has been updated in the
necessary, but that does not change the intrinsic	manuscript.
nature or properties of the product! Also, which	
version of that product is actually used here, since it	
has already been released 6 times?	
- Lines 186–187: Please provide an explicit description	The data was obtained as is from SILO and the
of the interpolation procedure as well as the formula	interpolation procedure used to produce the data by
to calculate the specific humidity of the atmosphere	the SILO team is comprehensively described in the
using the Clausius-Clapeyron equation: any reader	cited published paper (Jeffrey et al., 2001).
should be allowed to duplicate the work without	The specific humidity calculation is described in the
having to guess which tools, techniques or equations	appendix. This will be clarified in the updated
should be used.	manuscript.
- Line 200: The text mentions the variables xn and yn,	This is fixed in the updated manuscript.
but there are no such variables in the equations above,	
and it is not clear what distinguishes them anyway.	This is fixed in the conducted as a consist.
- Line 201: The diacritical marks on top of the Q	This is fixed in the updated manuscript.
symbols are barely distinguishable on this line, and	
almost impossible to differentiate in the Equations	
above (Lines 193–198). Please use other signs or	
reformat or enlarge the Equations Lines 204–205: The wording here may be misleading:	Several published papers and products have been
The "MEP ET product" may be technically available "at	created globally with certain inputs available at lower
5 km2 resolution", but to the extent the space-derived	resolutions, while other inputs are at higher
soil moisture data is the dominant input, the actual	resolutions, with the final resolution determined to be
spatial resolution may be closer to 25 km by 25 km or	at the resolution of the highest data input (Jeffrey et
625 km2 , as noted in the comment above (Lines 171–	al., 2001;Mu et al., 2013;Mark and Damien, 2015).
181). Similarly, the statement "tower flux data with	Hence the authors are of the opinion that this is an
footprints ranging from 100 m2 up to about 2 km2 " is	acceptable practice in the scientific community.
purely gratuitous, in the absence of evidence, or	However, we will make clear in the revised manuscript
algorithms, to support these estimates. Hence	that the spatial accuracy of the product is determined
comparing these products and claiming that this is a	by a combination of data layers with different spatial
validation is unwarranted, on the basis of the	resolutions.
information presented here.	
·	The statement on the flux footprints will be revised and
	updated in the manuscript.
- Lines 229–233: Please note that there are two	This will be corrected in the updated manuscript
Figures labeled "Figure 3" on this page	
- Line 231: In the second Figure 3, what is the source of	The data source is the Bureau of Meteorology Australia
those data? What is the area concerned (the whole of	(BOM). These are annual mean precipitation over
Australia)? Is this the result of an accumulation of data	Australia.
from rain-gauges, or a satellite product, or a	http://www.bom.gov.au/climate/current/annual/aus/#
reanalysis? What is the accuracy of those precipitation	<u>tabs=Rainfall</u>
estimates? What is the spatial representativity of the	
precipitation data? Do they provide a spatial coverage	
comparable with the gridded data of MEP? And of	

course, most importantly, what is the error bar	The spatial coverage is the entire Australia as the MEP.
associated with the MEP estimates?	More detail on this product will be included in the
	revised manuscript.
- Line 247: The legend of Table 2, or the text (or both),	This will be updated in the manuscript.
should indicate that the numbers set in bold face in	
this table point to the best performing method to	
evaluate the evapotranspiration rate at the various	
Eddy Covariance (EC) sites, according to the criteria	
indicated in the table header.	
- Line 292: At long last, the text reveals that "The FPAR	The NDVI product was used in the initial analysis but
product [is] used in partitioning net radiation between	the FPAR was used as a surrogate for the vegetation
	cover due to resolution and data availability. Moreover,
soil and canopy". However, this is basically incorrect	
and inappropriate: FPAR is a measure of the	Los et al. (2000) after extensive analysis, opined that
effectiveness of the vegetation in absorbing	the spatial distribution and seasonal changes of the
photosynthetically active radiation (PAR), not in any	FPAR is in close alignment with the NDVI. Furthermore,
way an indicator of the fractional vegetation cover. A	other publications (Xu et al., 2012;Mu et al., 2011b)
particular value of FPAR derived from satellite	have successfully used the FPAR as a surrogate of the
observations could be obtained from a wide range of	vegetation cover, hence our use of the FPAR in this
ecosystems with widely varying Fc and Leaf Area Index	study.
(LAI), not to mention other possible factors.	
- Lines 307 and 335: Table 3 is mentioned in the text	This will be fixed in the updated manuscript
before Table 2, and no Table is labeled 3 in this	
document. However, there is a Table 2 starting on Line	
244, and another one starting on Line 335	
- Line 312: The Figure referred to by "as a percentage	This will be fixed in the updated manuscript
of rainfall (Fig 2)" exhibits the spatial distribution of z,	
not precipitations. In fact, there is no precipitation	
map in the paper, although one would be useful, as	
noted above.	
- Line 346: The statement "The MEP model appears	The spatial discontinuity in the MEP has been tested
lacking spatial continuity, probably due to the use of	and attributed to the discontinuous soil types in ASRIS
pedotransfer functions" is invalid. Those functions	when used in the model along with the pedotransfer
are just mathematical formulae, fitting functions: they	functions to determine wilting point and field capacity.
cannot by themselves generate spatial discontinuities.	The definite boundaries of the soil types in model
If the MEP model outputs appear spatially	propagates the discontinuity through the evaporation
discontinuous, it must be because the soil moisture	model of the MEP. This is a necessary compromise in
input data themselves are discontinuous, or because	creating a regional model such as this.
of model (coding) errors. For this reason too, it would	This is rightly not observed in the transpiration model
be useful to conduct sensitivity analyses to establish to	which does not require the soil data. Hence the sum of
	•
what extent each input and algorithmic parameter or	the evaporation and transpiration model smoothens
equation contributes to the outcome. If the	out the final evapotranspiration model. We will update
discontinuity does arise from the intrinsic variability of	the revised manuscript to reflect this issue better.
the soil moisture data, no amount of tuning of the	
pedotransfer functions will reduce those	
discontinuities. A contrario, if the soil moisture data	
are reasonably homogeneous to start with, then there	
may indeed be a problem with the way those	
functions, or other aspects of the model, are	
implemented. In either case, the conclusion that	
"Hence, further improvement to the MEP model may	
be achieved by improving the parameterization of the	

pedotransfer functions for each soil type." is currently	
unfounded.	
- Line 351: The text states "The low correlation of the	This will be updated in the manuscript.
MEP model" but does not indicate with what MEP	
does not correlate well.	
- Lines 410–411: The acknowledgment mentions the	These data were only used for comparison and not in
use of FLUXNET and ERAInterim reanalysis data: Why	the MEP model. They were appropriately cited in Table
are those data sets not mentioned in the text and	2.
appear in Figure 1?	

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