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Interactive comment on "Recent changes and drivers of the atmospheric evaporative demand in the Canary Islands" *by* S. M. Vicente-Serrano et al.

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Interactive comment on "Recent changes and drivers of the atmospheric evaporative demand in the Canary Islands" by S. M. Vicente-Serrano et al. Anonymous Referee #1
Received and published: 16 April 2016

The manuscript presents a trend analysis of the FAO-56 reference evaporation using meteorological data from 8 sites at the Canary Islands. Interestingly the results show a remarkable heterogeneity in both the drivers of ET0 and its trends, which I did not expect due to the maritime climate. The most consistent effect is the decrease in relative humidity at most sites and thus an increase of the aerodynamic component of ET0. Generally the paper is well written, the data analysis is comprehensive and well designed. The topic of observed ET0 changes and choice of the sites are relevant and

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Discussion paper

well suited for publication in HESS. Although I have a some remarks I am positive that the authors can implement these and recommend minor revisions.

We would like to thank the Reviewer#1 for his/her positive assessment of our manuscript. We are also very grateful with the detailed revision of the manuscript and the constructive comments raised with the purpose of improving our research article. They have been discussed below and implemented in this revised version.

Comments and remarks The trends in ET0 seem to be significant because of the low values in the beginning of the chosen period. The results of the two sites with longer coverage show no significance. Thus the trend seems to be rather an effect of decadal scale variability. Please indicate this within the discussion of the results.

We thank for this point and fully agree with this suggestion. This has been included in the discussion section of the revised manuscript:

“In any case, we must also stress that trends in ETo at the regional scale are mostly significant because of the low values in the beginning of the study period starting in the 1960s. Thus, the results of the two sites with longer temporal coverage (i.e., Izaña and Santa Cruz de Tenerife) do not show significant trends. This makes necessary to consider these trends with caution since they could be driven by variability processes at the decadal scale.”

Abstract: L16 ET0 is not explained, please state here in the abstract that you estimate AED by the FAO-56 reference evaporation equation

The Reviewer#1 is right and we have included this information in the abstract:

“Overall, the annual ETo, which was estimated by means of the FAO-56 Penman-Monteith equation, increased significantly by. . .”

L17-18 The sentence “The radiative component . . . did” can be removed because this is again stated in the next sentence. Also explain the meaning of the two components.

The sentence has been removed as suggested and we have explained the meaning of aerodynamic and radiative components as follows:

“In this study we analysed the contribution of (i) the aerodynamic (related to the water vapour that a parcel of air can store) and (ii) radiative (related to the available energy to evaporate a quantity of water) componets to the decadal variability and trends of ETo.”

Introduction: The main research hypotheses should be clearly formulated

Thanks for this suggestion. The main hypothesis of our study has been included in the introduction section:

“The main hypothesis of the study is that in opposition to other continental temperate regions of the North Hemisphere, the warm and humid climate of the subtropical Canary Islands provides the water supply to the atmosphere needed to maintain the AED constant under the current global warming scenarios; consequently, only wind speed and solar radiation could affect the observed decadal variability and trends of the AED.”

Section 2.1 L107-116: The homogenisation alters the original data and can affect the detection of trends. To achieve reproducibility of the results I recommend to provide an overview about data gaps, breakpoints and corrections which should be added as supplement.

The Reviewer#1 is right when stating that homogenisation alters the original data, but this “alteration” is really necessary in any study that focuses on climate variability and trends using observed datasets. On the contrary, there is a substantial risk on the robustness of the obtained climate trends based on inhomogeneous or not quality-controlled and tested series. For this reason, independently of the alteration of the series after the homogenisation tests, the application of homogenisation methods is strictly mandatory in any climate study aimed at retrieving long-term trends.

Moreover, we completely agree with the Reviewer#1 on the need of including further information on the data gaps and homogeneities found in the different variables. We

have included a new table in the manuscript indicating these issues (please see below).

Section 2.3 L160-171 I do like the simple yet illustrate way to determine the effects of single variables on the detected trend. By design this is done as a local sensitivity analysis where one variable is changed holding the others fixed. However, it is not a global sensitivity analysis and co-variation of the forcing variables is neglected. Especially for the meteorological variables used here, I suspect that the variables and eventually their trends in time do co-vary - e.g. temperature and relative humidity. Did you consider such effects and are they important to understand the long-term variability?

We agree that co-variation of the forcing variables is not considered here because co-variation between meteorological variables in the Canary Islands is really low. This is illustrated in a set of box-plots below in which the correlation between the seasonal and annual series of the meteorological variables in the eight meteorological stations is shown. With the exception of the high positive correlations found between maximum and minimum air temperatures, the correlation among the other variables is really low and mostly non-significant. Only in winter and spring there are dominant significant correlations between the sunshine duration and the maximum air temperature. Given the strong independence in the variability of the different climate variables the co-variation study suggested by Reviewer#1 would not provide any new result in comparison with that applied here. In any case, we much appreciate this raised comment.

L195 . . . the aerodynamic component (Eq. 3).

Replaced.

Discussion: L303- 305 differences in ET0 trends across sites . . . "must be considered either due to random effects and uncertainty at various levels or due to microgeographic effects . . . " I think the differences of the trends and the different strength of the aerodynamic / radiative components at the sites deserve more attention in the discussion. The results are presented already in a detailed manner and these aspects should be discussed. That means is there a link of the different strength of certain

forcing variables and the magnitude of ET0 trend at a given site.

We have included some discussion about this issue in the revised manuscript:

“There is not a general pattern that may connect the observed trends in a certain forcing variable with the observed trend of ETo in each of the eight analysed stations although those that showed a higher increase in ETo (i.e., Lanzarote, Los Rodeos and Gran Canaria) displayed a higher increase in the aerodynamic component; a process which is in agreement with the significant reductions observed in relative humidity.”

L514: in preparation

Replaced in the revised manuscript.

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Replaced.

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L514: in preparation

Replaced in the revised manuscript.

Figure 1: Please add LAT - LON coordinates as a grid and a scale for the distance

Figure 1 has been replaced following the Reviewer's suggestion.

Figure 4 and 5: The grey lines are not very informative. Please adapt the figures, using different colors or line types for the sites. It might be also useful to demean the time series for the display. In the annual panel the bold line is missing.

We have removed grey lines and only included the two meteorological stations with longest records (Izaña in green, and Santa Cruz de Tenerife in brown)

Fig. 5 the labels are too small to be readable

Labels have been replaced to be readable.

Finally, we wish to thank the Reviewer#1 for reviewing our paper and for your useful comments/suggestions.

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Code	Longitude	Latitude	Name	relocation	Relative humidity		Sunshine duration		Wind speed		maximum temperature		minimum temperature	
					data gaps	Inhom.	data gaps	Inhom.	data gaps	Inhom.	data gaps	Inhom.	data gaps	Inhom.
C029O	-13.60	28.95	Lanzarote/Airport	1972	2.20%	1998	0.78%	1978-2002	0.47%	1971	1.23%	2004	1.23%	1988
C139E	-17.75	28.61	La Palma/Airport	1970	0.94%		2.51%		0.47%	1976	0.37%		0.37%	1997
C249I	-13.85	28.43	Fuerteventura/Airport	1969	0.15%	2000	1.25%	1995-2005	0.15%		0.23%	1983	0.23%	1977
C430E	-16.48	28.30	Izaña	--	1.72%	1999	7.40%	2005	6.91%		5.20%	1985	5.20%	
C447A	-16.31	28.46	Los Rodeos	--	0.31%		1.10%	1966	0.15%	1970	0.30%	2005	0.30%	2005
C449C	-16.25	28.45	Santa Cruz de Tenerife	--	0%		0.94%		0%	1987	0%		0%	1994
C649I	-15.38	27.91	Gran canaria/Airport	--	0.15%	1981-1994	2.67%	1978	0.31%	1972	0.20%	1984	0.20%	1994
C659P	-15.41	28.15	San Cristóbal	1994	11%		1.88%	1980	10.50%	1994	5.30%	1966	5.30%	

Fig. 1.

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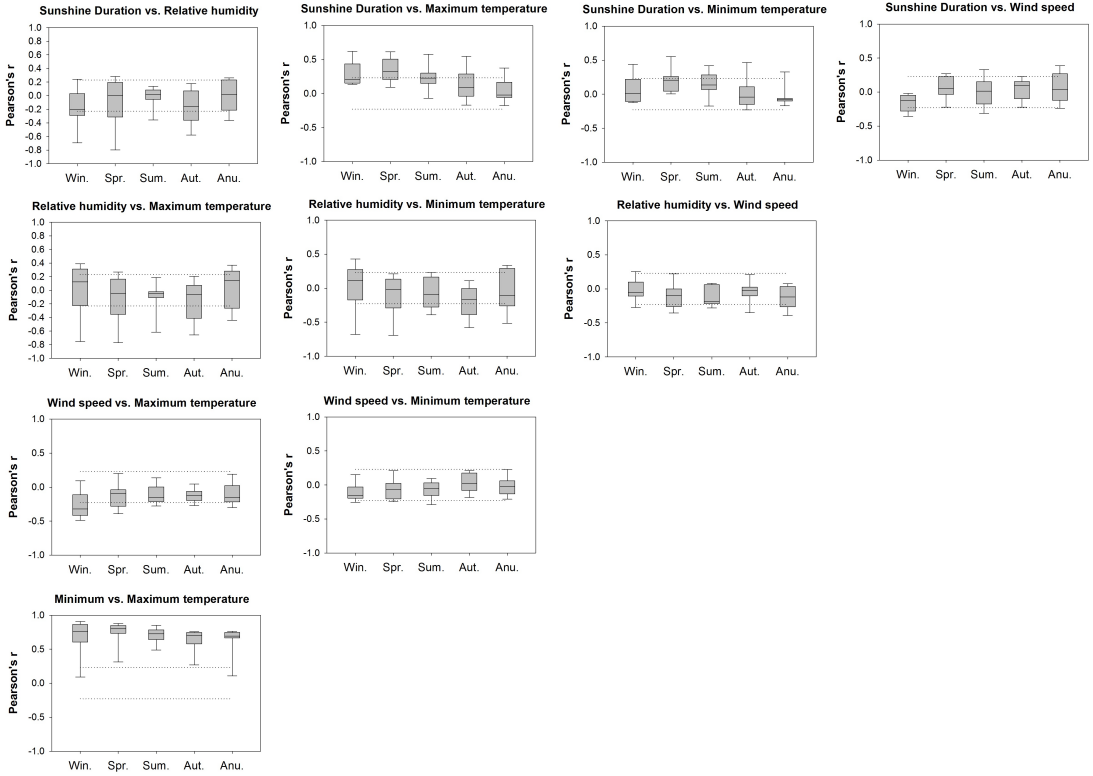
Sunshine Duration vs. Relative humidity
Sunshine Duration vs. Maximum temperature
Sunshine Duration vs. Minimum temperature
Sunshine Duration vs. Wind speed
Relative humidity vs. Maximum temperature
Relative humidity vs. Minimum temperature
Relative humidity vs. Wind speed
Wind speed vs. Maximum temperature
Wind speed vs. Minimum temperature
Minimum vs. Maximum temperature
Pearson's r
Win. Spr. Sum. Aut. Anu.

Fig. 2.