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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Potential evaporation trends over land between 1983–2008: driven by radiative or turbulent fluxes?" *by* C. Matsoukas et al.

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Reply to Referee 1

We appreciate the Referee comments and the effort involved in compiling this review. The comments and recommendations have been taken into account and our point-by-point reply follows:

Specific comments:

1. A similar comment has been made by the other Referee, as well. In our reply we pointed out that most of our references dealing with pan evaporation trends had data up to the early 90's, when dimming was prevalent. Based on our study, we would expect a global increase in potential evaporation and consequently pan evaporation in the late 90's and 2000's. However, it is hard to grasp the global picture from observations, because potential evaporation trends form a patchy pattern with regional positive and negative trends, while most recent publications deal with regional and not global measurements. In our response to the other Referee, we presented a Table with comparisons between recently observed pan evaporation trends and our results for different regions. This comparison is now included in the manuscript. The qualitative agreement between the observations at the specific sites and our results, provides us with more confidence that the global picture we provide here is correct, and that potential evaporation has indeed increased globally.

2. As the Referee requested, we have added the following Table 2, which presents the trends of the original timeseries.

3. The use of ERA-40 only produces low E_a values compared to ERA Interim, as the Referee suspects and as we showed in our manuscript. The main reason is the quite lower values of wind speed in ERA-40. We do not know what is the error we introduce by using ERA-40 values before the start of Interim (1989) to derive trends. However, if we compare the trends calculated separately by ERA-40 and ERA Interim in their common time period (January 1989–August 2002), we see that they are similar. For example, the slopes of the normalised anomalies of E_a are 0.66 and 0.56 decade^{-1} for ERA-40 and ERA Interim, respectively. For E_p the same slopes are 0.66 and 0.63 decade^{-1}. The similarity in the slopes is also visually supported by the proximity of the blue and red lines of Figs. 4c and

Table 2. Global, NH and SH decadal trends for the original timeseries of potential evaporation over land areas and other relevant physical quantities. The period of reference is July 1983 – June 2008 for Q_s, Q_l, and E_r. For U, $e_s - e$, E_a, and E_p, periods of reference are July 1983 – June 2002 (ERA-40) and January 1989 – December 2007 (ERA Interim), i.e. complete years in both cases. The units of each trend are the units of the relevant quantity divided by decade.

Time Series	Global		NH		SH	
Q_s ($\mathrm{W\,m^{-2}}$)	0.263		1.065		-1.292	
Q_l ($\mathrm{W\,m^{-2}}$)	0.274		0.509		-0.231	
E_r ($\mathrm{mm\,day^{-1}}$)	0.007		0.028		-0.031	
	ERA-40	ERA-Int.	ERA-40	ERA-Int.	ERA-40	ERA-Int.
U ($\mathrm{m\,s^{-1}}$)	-0.023	-0.001	-0.014	-0.027	-0.041	0.058
$e_s - e$ (mb)	0.111	0.371	0.208	0.418	-0.088	0.274
E_a ($\mathrm{mm\,day^{-1}}$)	0.008	0.135	0.057	0.154	-0.091	0.096
E_p ($\mathrm{mm\,day^{-1}}$)	0.033	0.030	0.055	0.040	-0.012	0.009

6. Therefore, there is evidence that using ERA-40 even before 1989 to calculate trends does not produce significant errors.

Also, we agree there is the possibility that spurious trends exist in our radiation model inputs, such as the ones reported by Evan et al. (2007) for ISCCP. However, radiation flux trends derived by our earlier works compare well with observations from ground stations and satellites (Hatzidimitriou et al. (2004), Hatzianastassiou et al. (2005), Fotiadi et al. (2005)). We address the above at the end of Section 3.2 of the manuscript's new version.

4. The Referee is concerned about the robustness of the here calculated trends, should the input data come from other surface radiation datasets or other reanalyses. Although we understand this concern, as the Referee mentions it is beyond the scope of our study. We feel that this paper would lose its focus if we were to go to each one of the mentioned databases and derive trends for all relevant

quantities. However, we now clearly state in the revised manuscript at the end of Section 3.2 that "We should mention that there are many reanalyses available, as well as many surface radiation flux datasets, which sometimes show different trends in the physical quantities related to potential evaporation. It is encouraging to see good agreement between the U, VPD, E_a, and E_p normalised anomaly trends produced with ERA-40 and Interim data during the common period (January 1989–August 2002) in Figs. 4 and 6). A thorough comparison between many more datasets and a sensitivity study with respect to the estimation of potential evaporation trends would be very useful, but is out of the scope of this work".

5. The Referee's point has been taken into account and we have changed the wording in all relevant parts of the manuscript.

Details:
L30. The suggested reference of Roeckner et al. (1999) is now included in the Introduction of the revised manuscript at the end of the first paragraph.

L94. We corrected the wording, so as to correspond to five priorities.

L.163. The Referee is right. We corrected the phrase to "G is the energy flux advected away from the surface", meaning advected from the surface to deeper soil layers.

L. 167. The energy balance method produces E_r, which is *not* an estimate of evaporation rate, even though its notation may suggest so. The Referee is correct in pointing out that sensible heat flux H is neglected. However, we do not present E_r as an alternative way of estimating evaporation, because it would consistently overestimate it in cases of positive H and underestimate it in cases of negative H. The calculation of E_r is merely a step towards the application of Penman's method. The inclusion of the sensible heat flux in E_r is correct in the framework of Penman's method. We rephrased some passages, trying to eliminate this source of confusion.

L. 371. We have included a brief comparison to Vautard et al., 2010 in Section 3.3.

Figures 4–6. We have added a zero-line to enhance the perception of the trend in Figs. 4–6.

References

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