Anonymous Referee #1

This manuscript constructs daily 1-km fields of reference evapotranspiration (ET0) over all of Austria from 1961-2013, by cleverly improving the Hargreaves method and dynamically calibrating it against Penman-Monteith. It is a very nice procedure and product, and I recommend full publication. However, the verification of the final product could be more thorough (comment 1), and the product is implicitly claimed to be suitable for trend analysis when it is not (comment 2), so these concerns need to be addressed first. The writing was also occasionally quite difficult to understand; these spots are detailed after the two major comments.

Major comments:

1) It is very nice to see the verification against Penman-Monteith, in Figure 6. However, Figure 6 just plots the ET0_h.c using *station* derived C. Your final gridded product does not use the station C, but an interpolation from the station C using the types of elevation curves in Figure 8. Critically, the black points (stations) in Figure 8 can be quite far from the red curve-fits, especially in winter at lower elevations. This introduces additional error in your final product, since ET0_h.c using the red curve to get C will be different from ET0_h.c using the station-based C (black dot) and thus somewhat different from ET0_p at the station. So, I highly recommend also comparing your final, *gridded* ET0_h.c to the stationbased ET0_h.c and ET0_p. You could do this by adding a fourth curve to each panel of Figure 6 (for the gridded ET0_h.c at the gridbox containing the station) or by making an additional figure or two of your own design. This will clarify the degree of confidence in your product and in statements like p5065 li27. Similarly, the comparison in Fig. 12 could also involve the station estimates... you could show that at your stations, Fig. 12a is closer to station-measured Penman-Monteith than Fig. 12b is. Right now Fig. 12 doesn't convince me about that, because of this additional error introduced by the imperfect curve-fitting illustrated in Fig. 8.

This is a good suggestion. We will add a new Figure where we show the gridded versus the station based ET0 estimates compared to Penman-Monteith. We think, that adding a fourth line in Figure 6 might be too confusing. Additionally we will plot the station based estimates in Figures 12a and 12b which might show the improvements more clearly, but also indicates uncertainties due to the curve fitting.

2) I disagree with your suggestion at the end of the paper (bottom of 5067 and top of 5068) that your product is suitable for thinking about long-term trends or climate change. This is because a temperature-based method like Hargreaves may match Penman-Monteith just fine for overall magnitude and for year-to-year variability (e.g. in Fig 6a and 6b), but greatly disagree with Penman-Monteith about the long-term trend. There are several ways this could happen. One is that the Penman-Monteith ET0 may have a large long-term trend due to a windspeed trend (like those in McVicar et al. 2012, J. Hydrol., doi:10.1016/j.jhydrol.2011.10.024). In this case there's no hope that your product could catch it, since there is no windspeed input to Hargreaves. Another way is if the long-term increase in greenhouse gases has caused a decrease in Tmax-Tmin that is *not* due to decreasing sunshine-hours, but is solely because of the greenhouse effect. In this case, your dataset will have a spurious downward trend, because Hargreaves will think the climate is getting less sunny (when actually it is not.) You can see this problem in the case of future greenhouse warming by comparing the Hargreaves-based result of Zhang and Cai, 2013, Geophys. Res. Lett., doi:10.1002/grl.50279 (which I think is spurious, for the reason just given) to the more usual Penman-based analysis of e.g. Feng and Fu, 2013, Atmos. Chem. Phys. (doi:10.5194/acp-13-10081-2013) or Scheff and Frierson, 2014, J. Clim. (doi:10.1175/JCLI-D-13-00233.1).
So, I would not include such language about long-term trends or climate change (and I would even include a caution *not* to put much belief in any trend in this dataset!) However, the dataset could still be useful for long-term studies if it is well known that the main change-agent is something other than ET0 (e.g. precipitation or land-use change.) In this case, you could de-trend this dataset and

then use it for the ET0 input to such a study. So perhaps long-term uses could be mentioned, but more cautiously. (Is it possible to calculate Penman-Monteith for your entire 50-year study period, instead of just 2004-2013? If so, then the trends in your product could actually be verified. But I am guessing the required input data is only available after 2004. However, if this is possible, you should definitely do it, and compare the ET0_p trend with the ET0_h.c trend at each station where this is possible. If the trends strongly disagree, you could fix the problem by allowing C to have a long-term linear trend, in addition to its dependence on time-of-year and elevation. Then you would have a very useful product.)

The statement on climate change applicability may indeed be too far-fetched. Unfortunately you are right on the station data availability for calculating Penman-Monteith ET0 (ET0_p). We calculated it, but only a handful of stations had sufficient data to go back to 1984 which would cover 30 years. Comparing the trends of this period (1984-2013) with calibrated Hargreaves estimates (ET0_h.c) we found that the ET0_p trends are generally higher compared to ET0_h.c, for one station twice as high. This analysis additionally showed, that the ET0_p estimation are also afflicted with a high amount of uncertainty due to inhomogeneous input data, which is particularly the case for the wind data. At one station the trend of ET0_p is even lower than the ET0_h.c trend, which mainly emerges from a strongly negative wind trend, which is not very realistic, since it is not apparent at other, nearby stations.
These results indicate that it is not reasonable to add a trend to the C values. We will change the text, avoiding statements like the applicability of the dataset to climate change analysis.

Writing suggestions:

p5056 li7: Since this is the very first use of "FAO", it should be written out as "Food and Agriculture Organization (FAO)". After this, just "FAO" is OK, except perhaps at p5057 li10 (the first use of "FAO" in the body.)

Thanks, we will write it out in the Abstract as well as in the Introduction.

p5056 li12: "conduction" is an odd and confusing word choice here... "use" would be much simpler and easier to understand. Also, since you are *only* using surface elevation to interpolate (i.e. you are not using the horizontal dimensions), it might be good to highlight this by saying "the sole predictor" rather than "a predictor". (Or adding "alone" after "surface elevation.") Similarly, at p5067 li3, you should write "using" rather than "conducting."

Thanks for these suggestions; we will revise the text following these comments.

p5056 li13: Your fits are not splines - they're just simple polynomials (not piecewise.) So should probably say "third order polynomial" or "cubic polynomial" instead of "third order spline."

That´s true, the wording is wrong. We will correct that for "third order polynomials".

p5059 li6: What is meant by "As for"? Do you mean that SRTM DEM is used in SPARTACUS, so you are also using SRTM DEM in this study? If so, it's much clearer to say "As *in* SPARATACUS, the SRTM ... (DEM) is used in this study." Even clearer would be "SPARTACUS uses the SRTM ... (DEM), so the SRTM DEM is also used for the present study." (If you actually mean something else, please make your meaning clear.) "As for" in English is very unclear... it can mean "As in" but it can also mean you're changing to a different subject.

Thank you for your writing suggestion, we will change the text as suggested.

p5059, bottom (beginning of 3.1): Much of this was already explained in the introduction.

So you can probably delete much of this, or preface it with "As explained above, ..."

Yes, we will preface this passage with “As explained above…”, thank you.

p5061 li11: "noticeably" should be "noticeable" - it should be an adjective here, not adverb.
p5062 li17: "For sakes of" should be "For the sake of". Actually, just "For simplicity..." is simpler and better. And on li18 "respectively" is not needed, it’s quite clear anyway.

We will correct these two suggestions accordingly.

p5064 li7: Does this mean that you determine a separate polynomial fit for each day of the year? That is OK to do, but the meaning is not quite clear from the sentence.

Yes, we do the fitting for every day of year. We will rewrite this text passage to make this statement more clearly.

p5066 li16: "unfolded" makes no sense in English here - maybe this is a direct translation from German? How about "Going to higher elevations in the warm season, Cadj decreases until roughly 1000 m.a.s.l."

Thank you for the suggestion, we will change the text as recommended.

p5066 li20: Similarly, what is the meaning of "relativized by this relationship being affected by latitude"? I could not guess what you mean... just re-state in simple English please.

We will rephrase this sentence to: “This altitude dependency of the calibration parameter in HM is mentioned in Samani (2000), but the authors also claimed that this relationship may be affected by different latitudes.”

p5067 li1: "Alternating" means going repeatedly back and forth between two states... oscillating or vibrating. I think you mean "altering" here (or "adjusting", "changing" or similar.)

This is true, “altering” is meant.

Typos:

p5062 li18: "where" should be "were"
p5067 li3: "lower the" should be "lower than"

Typos will be corrected accordingly.