

Interactive comment on “Creating long term gridded fields of reference evapotranspiration in Alpine terrain based on a re-calibrated Hargreaves method” by K. Haslinger and A. Bartsch

Anonymous Referee #1

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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:

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Interactive Discussion

Discussion Paper



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 station-based $ET0_h.c$ 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.

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 ET_{0_p} trend with the ET_{0_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.)

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.)

p5056 li12: "conduction" is an odd and confusing word choice here... "use" would

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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."

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."

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.

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, ..."

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.

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.

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."

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.

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.)

Typos:

p5062 li18: "where" should be "were"

p5067 li3: "lower the" should be "lower than"

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