

Interactive comment on “Assessing various drought indicators in representing drought in boreal forests in Finland” by Y. Gao et al.

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The manuscript by Gao et al investigates how various meteorological indicators of drought capture patterns of drought in boreal forests in Finland. Results are interesting and this is likely to be a valuable contribution to the field, however, I do a number of suggestions.

1) P8093, L5: there is a very interesting dichotomy here, in that in a warming world over the last 60 years Sheffield et al (2012) find no increase in drought, yet we seem to be more sure about the simulated future than we are about the observed past: why is that? I suggest that the Sheffield et al (2012) paper should be cited here and the degree of certainty we have about the future of drought be toned down.

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2) Section 2.2, I encourage to explore the use of reflective remotely sensed indices to track the drought conditions in Finland. Caccamo et al (2011) compare agreement of 4 vegetation greenness indices and 4 vegetation water indices with standard climatological drought indices. As snow is going to confound these signals in Finland use of the monthly vegetation condition index (which compares the per-pixel response of one month (e.g., Aug 2015) to the range in conditions observed for all Augusts in the population, McVicar and Jupp, 1998, pp 419) when vegetation growth is not limited by temperature is encouraged. The same form can be used for microwave soil moisture data.

3) P8102, L20: Allen et al. (1998) defines a crop reference evapotranspiration (ET_o) this is NOT a formulation of potential evapotranspiration (ET_p). They are different concepts, and cannot be equated. ET_o is used for water scheduling of irrigation areas and uses key prescribed (or fixed or reference) land surface parameters for crops. ET_o, like ET_p, does provide an estimate of atmospheric evaporative demand (AED); in comparison pan evaporation (E_{pan}) is a measurement of AED. AED is umbrella term under which ET_o, ET_p and E_{pan} all sit, however this does not mean they are equivalent terms.

The most obvious way to check that ET_o is not a ET_p formulation is to consider the surface resistance (r_s). In Allen et al.'s (1998) ET_o the r_s has a prescribed value of 70 s/m, this is much larger than what is implied in the meaning of a ET_p, where r_s = 0 s/m. Hence, there is some confusion regarding the concepts of crop reference evaporation and potential evaporation; this needs improvement. As a scientific discipline we must be very clear about definitions, and must ensure that clarity comes to this currently muddled subject. We all have a role to play to achieve this goal, and it only comes through careful thinking about the fundamental (or underpinning) conceptual definitions. Nowhere in (Allen et al., 1998) does it suggest that ET_o replaces estimates of ET_p. After downloading the FAO56 report from <http://www.fao.org/docrep/X0490E/x0490e00.htm> please searched for the term 'potential evaporation' and it is only found twice in the body text and in these two instances

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the authors are not equating crop reference evaporation with potential evaporation. Additionally in Chapter 1 of (Allen et al., 1998) they state (on page 30 of the PDF file) “The use of other denominations such as potential ET is strongly discouraged due to ambiguities in their definitions.” This can be found by searching for the word ‘potential’ in the FAO56 report.

If you have the data to calculate ETo then you have the data to calculate Penman’s (1948) formulation, as provided by Shuttleworth (1993), of ETp which Donohue et al (2010) showed to be the most appropriate form of ETp when considering a changing climate. The Penman formulation of ETp is also a physically-based form of ETp, meaning that all the key variables that govern the evaporative process are explicit in the formula (McVicar et al 2012), which is important when considering the widely reported reductions in: (1) AED estimates (via ETp and ETo); and (2) AED observations (via Epan). It is important that the hydrological community better understand fundamental concepts of ET; you need to ensure that a form of ETp is used here (not ETo).

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