

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

**V. Blauhut (Referee)**

veit.blauhut@hydrology.uni-freiburg.de

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The authors propose a novel comparison of commonly used drought indicators and their potential to indicate extreme drought conditions in order to indicate impact on forest health for Finland. The author therefore tested outcomes of the revised version of the JSBACH model with station data and tested drought indicators on their quality to identify drought events that do have an impact on forestry based on the reference year of 2006. I highly appreciate the idea of this study to investigate for drought indicator specific thresholds. Nevertheless I think the study could benefit from several revisions in order to increase readability and understanding for the reader. (Please excuse missing reference recommendations, my citing program just broke and I'm on travelling, but

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in case you want them please contact me)

My general suggestions are: If I understood the methods right, the determined drought indicator thresholds indicate when impacts on forest health occur? This is a crucial point, but more detailed information to what the EDF is, what it is based on etc. is missing or not sufficient. To increase the value of this work I suggest to raise the point of 'impacts on forest' health. SPI and SPEI are standardized products that are aggregated for different timescales. In your study I do not see the application of this benefit. Furthermore I miss a clear definition of the aggregation time applied and chosen as best indicator. A further potential of your work is the comparison of standardized indicators vs. SMI, which gives you 'real' condition estimates. I suggest to focus more on the different outcomes of these to kind of indicators. As your results show, SMI shows less impacts in northern Finland than SPEI (?). So what is the reason for it? (I guess the standardisation background). Thus I suggest the reader could benefit from a conclusion that states e.g.: thresholds should be region specific, standardized drought indicators may show a drought, but in fact there has not been any impact. ...Thus we suggest to a) or b) In general I suggest to revise the structure of the study. Methodological parts are found in the introduction, whereas very important applied methodologies are not described. A distinction between results and conclusion might ease the overview for the reader. By now, my feeling is that some important parts are not sufficiently explained and discussed or my benefit from some 'highlighting'. Abstract: To increase readability I suggest to shorten the methodological of the abstract to a minimum, but therefore put more emphasize to your results and conclusion. 8092 27 last sentence: Please rephrase this sentence. Does your results suggest, or not? And: "...an integrated analysis of projected drought with drought indicators is recommended" is nothing novel, and is not the key conclusion of your study (in my opinion) Introduction: In general I suggest that the introduction would benefit from more homogenized information. For the part of the drought indicators, information is either very general of specific for your application. I suggest that a brief discussion of the benefits of each indicator, examples of application in Finland/ Scandinavia or its monitoring could raise

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more interest. I suggest it is crucial for the reader to easy grasp the research gap that is intended to be faced with this study. Furthermore, the objectives are a bit lost over the introduction. I suggest to finalize the section of introduction with a small paragraph on the successive objectives of your work. 8093 1, very general statement which does not fit the point for either entire Europe and especially not Finland. Please revise. 8093 17, please revise your references, it is not Veit et al. 2015, it is Blauhut et al. 2015 ;) 8093 23, please provide a reference for the previous sentence 8094 15, please provide a reference for the previous sentence 8094 16, please provide a reference for the previous sentence

Data and Method: In prior I suggest to increase the understanding for the reader to split up this paragraphs. I do not see the advantage of having them together. A separate section for methods might increase readability and increase the methods content. Data: Study area Please revise the content of this section. I suggest to reduce the content of the very general (and partly wrong) aspects climatological aspects and focus on the characteristics that drive drought. I like your map information on soil depth. Furthermore I suggest to provide a map for landuse as described in CORINE. I guess both information suite on one page. You described the composition of species detailed. Please provide information on changes of species compositions over time. Observational data I'm missing explicit information on forest health. What is reported? Who and how. I recommend to the author to give more attention to this data, since you base your results on it. I would like to get more information on the choice of 'summer' month? Drought impacts on forestry are not only driven by summer month climate conditions. Especially early year conditions do have great impact on leaf production? Furthermore is the effect of JSBACH land surface modelling I'm not familiar with the details of the JSBACH model. I feel confident with the amount of information here. 8099 16, is Figure 1 really showing soil types? I'm doubting on the terminology here. Drought indicators From your description I assume that you decided on some kind of monthly values with running mean inputs. I would appreciate if you could explain your decision for this (at least for SPI and SPEI) rather short aggregation periods. Diverse

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authors suggest longer aggregation periods (full vegetation period) to indicate drought effects on vegetation, especially forestry. Furthermore I recommend to put a more emphasis to the difference between 'normal' and standardised indicators. 8102 16, 'The SPEI is similar to SPI', please rephrase and be more specific. 8102 22, " a wide range of climates" , I recommend to give some indication of its application for northern climates, since SPEI was 'more less' built for dry climates. Results 8103 'Simulated soil moisture corresponds well.', I recommend not to brush up the results of the model too much. The model performance well, but underestimation and delay or absences (2006) of signals should be explored to guarantee a full understanding of the underlying model processes. 8103 23-28, Here you indicate the usage of two different soil type classifications, why did you not consider to harmonize these input? 8104 25, '... good agreement', Please explain the 'good' agreement, this might become discussable. 8105 9 'grid boxes', please rephrase 8106 1, '(data no shown)', it might increase the understanding for the reader to add this data as an appendix 8106 23, 'relatively higher change', relative to what? 8107 23-5, This chapter was a bit confusing for me. Quiring explicitly stated that thresholds should be region specific, hence I wonder why you did not separate between at least North and South. Furthermore I do not understand the reason of 2% of SPEI, since it already is standardised. If you derive different values for North and South you probably have some noise in your data. By definition, it should be equal, everywhere, for each grid cell. 8109 5, 'shallow soils'... maybe it is just personal interest, but especially these 'shallow' soils are highly interesting. Despite the fact that I appreciate the approach, I'm missing on some discussion of different drought events. By now you base your results on the 2006 events? I know your data is rather limited for this, but it is a point that should clearly be raised, since these thresholds will vary enormous, depending on the event. Please also consider to point out the potential of this kind of analyses for future work. In total I miss some closing overall discussion. For me it is still not clear if it is better to use standardised indicators or SMI, and why is it so? Does the standardised show higher percentage of EDF because of it is a better indicator or because it is standardised and thus and threshold that was derived for

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southern Finland cannot be used for northern Finland

Conclusion In order to increase the understanding for 'brief readers' I recommend to give a little warp up of why you decided for the 2006 event and what the EDF is. I recommend to stay more close to research gaps filled ( if there has been any) and objectives faced with in the work. I miss some more clear recommendations. What did you do in general ( no numbers or results needed here.). What did your work enhance for the drought and forestry – science. In order to open your work to a broader audience I recommend to phrase some line on: What are your recommendations for future work, with regard to modelling, monitoring of climate and vegetation conditions. Impact monitoring? → how to improve all that? 8110 1, '1', good agreement, is it really good? Then please provide indication for that in the results 8110 9, to increase readability, please repeat the aggregation time of SPI and SPEI 8110 21- , for me the question that should be answered here ( or maybe better more explicit in discussion) is does SMI over or under estimate EDF, Does a higher amount of EDF days indicate a higher sensitivity or is it 'just' a wrong signal ( due to standardisation) → again, please discuss the differences between the kind of indicators. 8111 7- , Good. Please also raise also consider to mention that indicators without a linkage to past impacts are 'meaningless' and only indicate climate conditions, whereas the majority is interested in when impacts will happen etc. Thus, it a better impact monitoring is essential.

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