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Interactive comment on "GPCC Drought Index – a new, combined, and gridded global drought index" *by* M. Ziese et al.

Anonymous Referee #3

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General Comments

The paper describes a combined drought index, the so called GPCC DI, an indicator computed as the average (where possible) of the Standardized Precipitation Index (in the slightly modified version used by the DWD, i.e. the SPI-DWD) and the Standardized Precipitation Evapotranspiration Index (SPEI). Such combined indicator is used by the GPCC center to provide the users with a quasi-real time global map of drought conditions. The global gridded data, at different time-steps and a spatial resolution of 1ËŽx1ËŽ (Lon-Lat), can be freely downloaded at the official website of the GPCC. So, the paper presents an indicator that has been constructed for an online service, not for research purpose. In general, the paper is well-written and detailed with maps and tables that help the reader understand the methodology, the scope of the paper, and the

practical use of the combined indicator. However, there are a few major shortcomings that should be addressed to improve the paper. Otherwise (see the detailed review), one can find it somewhat too concise or hasty, in particular regarding sections 2, 3, and 6. Moreover, some key explanations of the methodology can puzzle an expert reader as it seems that they are not enough motivated. To be honest, I do not understand why the authors decided to combined two indicators (one of them based on PET), if they want to study precipitation anomalies, as stated in the text. Also, it seems that the authors aims at providing results without going too much in details about the statistical background of the indicators chosen. More citations are needed, in particular in the first sections of the paper. Finally, neither case studies nor comparisons with published literature are presented, thus the reader cannot be convinced that the methodology presented is effective. I suggest a major revision before the paper might be published. I suggest the authors going through my comments, without necessarily amending the manuscript following all of them, but spending more time to motivate their choices and decisions and adding more citations in first sections.

Detailed Review

P 243: Use capital letter after the - in the title.

Abstract P244 L2: Are you sure that the GPCC-DI provides estimations of precipitation anomalies? If you combine two indicators, one of them is based on PET, the final result will not be dealing with precipitation anomalies only. P244 L8: Averaging? What do you mean? Do you mean that use averages (you should refer to accumulation periods, in drought studies it is far more common) of the input variables over the months and then you compute the drought indicators?

1. Introduction P244 L20-22: too simplistic. You should say more about drought definitions. For example, see Mishra and Singh (2010). P 245 L1: citation needed about the differences between aridity and drought. See, e.g., Wilhite (1993).

2. Some existing drought indices P 245 L20: there are a few global studies that need

to be cited here. You should also cite the sc-PDSI, not only the PDSI, as it is currently more used than the PDSI. Some relevant studies are: Dai et al. (2004), Dai (2011, 2012, 2013), Sheffield et al. (2013), Trenberth et al. (2014). P 245 L24-25: Though the RDI is based on the ratio P/PET and on a log-normal distribution, there are some tricks that let you compute it when the PET is 0. For example, if you assign to PET the minimum values of values above 0 when it is 0, this may slightly bias the outputs, but it prevents you to "no values" when PET is 0 (cold climate). P 246 L2: Globally, the SPI has been recently applied by Spinoni et al. (2013), you should cite this study. P246 L8: In my opinion, you should also cite two other relevant publications regarding the SPEI, i.e. Vicente-Serrano et al. (2012) and Begueria et al. (2013). P246 L10: You should give now a few details about the measurement of PET.

3. Some existing drought index data sets and monitoring tools In general, I would put first the global datasets, then the continental, and then the regional ones. However this is my personal opinion and you do not have to change this Section. But avoid jargon (exclamation marks).

4. Used data P 248 L8: regular grid. You may provide the spatial resolution at this point. P 248 L 14-15: CAMS is more important - please motivate. P 248 L 18: say more about the re-gridding.

5. How to calculate the GPCC-DI P248 L23-25: You say you think that an interpolation of station data is more error-prone that the calculation of DI based on gridded data. Motivate this statement. In general, it is true, but it may also depends on the choice/ability of the interpolation procedure, the input variables used, the quality-check and the homogenization of records and so on. Sometimes, also the gridded databases suffer from gaps, outliers, and so on. P249 L9-10: looking at the figures, it seems that longer "averaging" periods correspond to more frequent normal conditions. Is this just happening for January 2014? It makes me wonder if you are averaging the DI values over six months. If this is true, it is a different procedure compared to drought indicators. Drought indicators for six months of accumulation periods are based on the

cumulated P (or P-PET, etc.) over the previous six months, consequently the SPI-6 (or the SPEI-6) is standardized over the cumulated values of six months (for each month) and we should not see such "green maps" all over the world. I see that you want to show precipitation anomalies: this way, the averaging does make sense, but I don't get why you did not just compute precipitation anomalies instead of a combined drought indicator. P 249 L11: If the evapotranspiration is really high and precipitation is normal, you might see drought conditions, so you should not say that droughts occur in areas where P is below normal, as you structured your indicator taking into account PET also. P 249 L16: fails? Physically, the Th's model says that PET=0 when mean temperature is near or below 0ËŽC, because when it happens the soil water layer is frozen and thus no evapotranspiration occurs. However, a small evapotranspiration still may occur, consequently some authors just assign 1mm to the lowest possible PET value. This way, you can compute the SPEI even when PET is very low. P249 L17: Which other parameterizations? You probably need to mention the Penman-Monteith's model (see e.g. Allen et al., 1998). Don't say that something else exists without naming it. P249 L24-25: see comment above. Moreover, you can simply shift the Gamma distribution to compute the SPEI when the PET is 0. Also, you can use the log-logistic distribution instead of the Gamma. There are many ways to overcome such problem. The fact that you do not compute the SPEI in cold regions may bias the outputs, because in such regions only precipitation drives the drought events in the GPCC-DI. P250 L6-7: comparable? Visually comparable? Provide statistical and spatial comparisons, not only comments.

5.1 How to calculate the parameters for the SPI-DWD and (the) SPEI P250 L 10: why 1961-990 and not 1971-2000 or 1981-2010? P250 L16: interval P250 L20-23: this sentence is puzzling. You should be more accurate when you describe statistical quantities.

6. How to calculate the GPCC-DI P251 L1: to be precise, this is not a standardized precipitation anomaly. Firstly, you are accounting for P and PET. Secondly, if, for a

grid-point, one indicator is always available and the other one is not always available, you are averaging two indicators for some months and using just one of them for some other months: this way, the DI is not standardized anymore. P 251 L5: precipitation totals less than normal do not necessarily mean that drought is occurring. Written in this way, this sentence may be misleading.

7. Access to the GPCC-DI P 251 L15: Avoid jargon (exclamation mark)

8. Conclusions P252 L17-18: common sense. Drought can also occur in cold areas with “hostile” conditions (hostile: what for?). P252 L 21: data are not homogenized, this is a key point, you should not say in the last lines of the paper.

References P255 L1: year of publication is 2010.

Please, consider adding some of the following references, as suggested in the comments: *) Allen, R. G., Pereira, L. S., Raes, D., & Smith, M. (1998). Crop evapotranspiration-Guidelines for computing crop water requirements-FAO Irrigation and drainage paper 56. FAO, Rome, 300, 6541. *) Beguería, S., VicenteâĂŘSerrano, S. M., Reig, F., & Latorre, B. (2013). Standardized precipitation evapotranspiration index (SPEI) revisited: parameter fitting, evapotranspiration models, tools, datasets and drought monitoring. International Journal of Climatology. *) Dai, A., Trenberth, K. E., & Qian, T. (2004). A global dataset of Palmer Drought Severity Index for 1870–2002: relationship with soil moisture and effects of surface warming. Journal of Hydrometeorology, 5(6). *) Dai, A. (2011). Drought under global warming: a review. Wiley Interdisciplinary Reviews: Climate Change, 2(1), 45-65. *) Dai, A. (2011). Drought under global warming: a review. Wiley Interdisciplinary Reviews: Climate Change, 2(1), 45-65. *) Dai, A. (2012). Increasing drought under global warming in observations and models. Nature Climate Change, 3(1), 52-58. *) Mishra, A. K., & Singh, V. P. (2010). A review of drought concepts. Journal of Hydrology, 391(1), 202-216. *) Sheffield, J., Wood, E. F., & Roderick, M. L. (2012). Little change in global drought over the past 60 years. Nature, 491(7424), 435-438. *) Spinoni, J., Naumann, G., Carrao, H., Barbosa,

P., & Vogt, J. (2013). World drought frequency, duration, and severity for 1951–2010. International Journal of Climatology. *) Trenberth, K. E., Dai, A., van der Schrier, G., Jones, P. D., Barichivich, J., Briffa, K. R., & Sheffield, J. (2014). Global warming and changes in drought. Nature Climate Change, 4(1), 17-22. *) Vicente-Serrano, S. M., Beguería, S., López-Moreno, J. I., Angulo, M., & El Kenawy, A. (2010). A New Global 0.5° Gridded Dataset (1901–2006) of a Multiscalar Drought Index: Comparison with Current Drought Index Datasets Based on the Palmer Drought Severity Index. Journal of Hydrometeorology, 11(4). *) Wilhite, D. A. (1993). Drought assessment, management and planning: theory and case studies. Kluwer Academic Publishers.

Amend the citation details where necessary.

Tables and Figures P259-260 F1-2: Kelvin? Why not Celsius?

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