Hydrol. Earth Syst. Sci. Discuss.,
https://doi.org/10.5194/hess-2020-383-AC1, 2020

Hydrology and Earth System Sciences
Open Access
Discussions

Interactive comment on "A standardized index for assessing sub-monthly compound dry and hot conditions" *by* Jun Li et al.

Jun Li et al.

xshwu@scut.edu.cn

Received and published: 12 October 2020

Reviewer: Understanding the compound dry and hot events is very important to human being society and environments. This study proposes a new compound drought and heat index on daily scale, SCDHI, based on SAPEI and STI. This index is useful to quantify sub-monthly characteristics of compound dry and hot events. The topic is very interesting and suitable for HESS. I recommend the manuscript for acceptance with a minor revision. The detailed comments are provided below:

Reviewer (1): This study focuses the non-arid areas in China. Is SCDHI suitable for the arid areas? Author's Reply (1): Thank you for your comment. In this study, we did not assess the application of SCDHI in arid areas in China, for three reasons: 1)

Printer-friendly version

Discussion paper

replenishment of water resources in the arid region is mainly from melted glacial or perennial frozen soil, not from precipitation. The statistical drought indices are usually limited in revealing drought in such complex situation; 2) meteorological observations in arid regions are too scarce to conduct robust analysis (Wu et al., 2007; Xu et al., 2015); 3) from a practical perspective, calculating drought indices across arid region with large-scale desert regions is less meaningless (TomasâĂŘBurguera et al., 2020). Thus, we did not evaluate the application of SCDHI in arid region. In further study, we will try to develop the compound dry-hot index adopted in arid regions. We will clary this point in data section of the revised manuscript. References: TomasâĂŘBurguera, M., VicenteâĂŘSerrano, S. M., PeñaâĂŘAngulo, D., DomínguezâĂŘCastro, F., Noguera, I., & El Kenawy, A. Global characterization of the varying responses of the Standardized Evapotranspiration Index (SPEI) to atmospheric evaporative demand (AED). Journal of Geophysical Research: Atmospheres, e2020JD033017. Xu, K., Yang, D., Yang, H., Li, Z., Qin, Y., & Shen, Y. (2015). Spatio-temporal variation of drought in China during 1961–2012: A climatic perspective. Journal of Hydrology, 526, 253-264. Wu, H., Svoboda, M. D., Hayes, M. J., Wilhite, D. A., & Wen, F. (2007). Appropriate application of the standardized precipitation index in arid locations and dry seasons. International Journal of Climatology: A Journal of the Royal Meteorological Society, 27(1), 65-79.

Reviewer (2): There was a similar index for characterizing CDHEs (Hao et al., 2020). I suggest the authors to discuss the difference between this study and the study of Hao et al. (2020), and highlight the novelty of this study in the Introduction section. Hao, Z., Hao, F., Singh, V. P., Ouyang, W., Zhang, X., & Zhang, S. (2020). A joint extreme index for compound droughts and hot extremes. Theoretical and Applied Climatology, 1-8. Author's Reply (2): Thank you for your recommendation. The study of Hao et al. (2020) provides a good background for our study and partially inspired the idea to develop SCDHI. We will add the following explanation how the SCDHI differs from that of Hao et al. (2020) in the revised manuscript: "Hao et al. (2019, 2020) recently proposed the standardized compound event indicator and compound dry-hot index to assess the severity of compound dry and hot events by jointing the marginal distribution of standardized precipitation index (SPI) and standardized temperature index (STI) using the copula theory. These two joint indices provide useful tools to improve our understanding of the frequency, spatial extent and severity of the compound dry-hot event. However, the index is inevitably subjected to some shortcomings including the fixed monthly scale and the disregard of evapotranspiration, which may limit its use in monitoring the detailed evolution of compound dry and hot events."

Reviewer (3): Why is the growing season selected to identify CDHEs in Section 3.3? Please explain a little bit more on it. Author's Reply (3): Thank you for your comment and suggestion. The compound dry-hot events were examined during the growing season (April-September) because this is the time when compound dry-hot events cause major impacts on many sectors such as agriculture. Due to the strong seasonal cycle in temperature and precipitation, if focusing on relative exceedance thresholds and mixing seasons, it would be difficult to interpret. We will add this explanation in the revised manuscript.

Reviewer (4): Abstract: the regional difference exists in the future change of the CDHE characteristics. The authors may want to add this in the abstract. Author's Reply (4): Thank you for your suggestion. Indeed, there are differences between regions for future change of the CDHE characteristics. Under RCP 8.5 scenario, CDHE in the central to west parts of China is expected to markedly increase by more than five times; duration in mid-west China potentially increases by approximately 1.5 times; severity over mid-west China is expected to strengthen more than 3 times. We would add the following text in the abstract: "Under the RCP8.5 scenario, the duration, severity, and frequency across mid-west China would increase by at least 1.5 times".

Reviewer (5): P143: how reliable is interpolated data based on the kriging method? Did the author evaluate the interpolated 0.25-degree data? Author's Reply (5): Thank you for your comment. A reliable interpolation method is important to provide fundamental data for research. To generate reliable gridded data in China, previous studies have compared different interpolation methods (e.g., ordinary nearest neighbor, local polynomial, radial basis function, inverse distance weighting, and ordinary kriging), and they found that the ordinary kriging method shows the best performance and yields higher interpolation accuracy than the other methods (Chen et al., 2010; Lin et al., 2002). Datasets based on the kriging method have also been used extensively for drought analyses (Liu et al., 2016; Wu et al., 2013; Shen et al., 2019). Based on these previous research findings, the kriging method was thus used in this study. We will clarify this in data section of the revised manuscript: "The observational station data were interpolated to 0.25× 0.25° gridded data by kriging method, as it yields higher interpolation accuracy than the other commonly used methods such as ordinary nearest neighbor and inverse distance weighting (Liu et al., 2016)." References: Chen, D., Ou, T., Gong, L., Xu, C. Y., Li, W., Ho, C. H., & Qian, W. (2010). Spatial interpolation of daily precipitation in China: 1951–2005. Advances in Atmospheric Sciences, 27(6), 1221-1232. Lin, Z. H., Mo, X. G., Li, H. X., & Li, H. B. (2002). Comparison of three spatial interpolation methods for climate variables in China. Acta Geographica Sinica, 57(1), 47-56. Liu, Z., Wang, Y., Shao, M., Jia, X., & Li, X. (2016). Spatiotemporal analysis of multiscalar drought characteristics across the Loess Plateau of China. Journal of Hydrology, 534, 281-299. Shen, Z., Zhang, Q., Singh, V. P., Sun, P., Song, C., & Yu, H. (2019). Agricultural drought monitoring across Inner Mongolia, China: Model development, spatiotemporal patterns and impacts. Journal of Hydrology, 571, 793-804. Wu, J., Zhou, L., Liu, M., Zhang, J., Leng, S., & Diao, C. (2013). Establishing and assessing the Integrated Surface Drought Index (ISDI) for agricultural drought monitoring in mid-eastern China. International Journal of Applied Earth Observation and Geoinformation, 23, 397-410.

Reviewer (6): P152: what is the standard number of GB/T 20481-2017? It would be clearer if the authors add some more information on it. Author's reply (6): Thank you for your comment. The PDSI is a semi physical drought index based on land surface water balance. The parameters of the standardized procedure of the conventional PDSI, including the climatic characteristic and duration factors, are empirically derived using the meteorological data of the central USA with its semi-arid climate. Therefore,

Printer-friendly version

Discussion paper

the portability and spatial comparability of the conventional PDSI are relatively poor in other regions. To develop a PDSI suited for China, the PDSI calculation procedure was revised based on long-term meteorological data of several in-situ stations distributed over China that represent the climate characteristic of mainland China. A China national standard of classification of meteorological drought with standard number of GB/T 20481-2017 provides the corrected calculation procedure of the PDSI specific for China. We will add the calculation procedure of PDSI of the GB/T 20481-2017 in the supplementary material.

Reviewer (7): P155: soil moisture data in different depths is available in the GLDAS product. Why did the authors choose the root zone soil moisture to evaluate the drought indices? How about soil moisture in the surface layer and in total column? Author's reply (7): Thank you for your comments. Some soil moisture datasets in the GLDAS product provides different depths, e.g., the NOAH model of GLDAS has a total of 4 layers of thickness: 0-10, 10-40, 40-100, and 100-200 cm, while NOAH only has monthly temporal resolution. The CLSM product used in this study does not have explicit vertical levels, instead soil moisture is represented in Surface (0-2cm), and Root Zone (0-100cm). Root zone soil moisture is chosen over the surface soil moisture because it has the applicability of characterizing drought and has lower noise relative to surface soil moisture (Hunt et al., 2009; Osman et al., 2020). For drought monitoring, this product has the advantage of offering spatially and temporally complete root zone soil moisture estimates on a grid. Furthermore, standard drought indices based on a time scale of three months (or longer) seem to be more representative of drought behaviors in deeper soil layers (Fig. 6 in Nicolai-Shaw et al., 2017). We will add the following text in the data section: "The Community Land Model product does not have explicit vertical levels, instead soil moisture is represented for the surface (0-2cm), and the root zone (0-100cm). Root zone soil moisture is chosen over the surface soil moisture due to its applicability to characterize similar droughts as those captured by drought indices with time scales of three months or longer (Nicolai-Shaw et al., 2017); moreover, it has lower noise relative to surface soil moisture (Hunt et al., 2009; Osman et al., 2020)."

References: Hunt, E. D., Hubbard, K. G., Wilhite, D. A., Arkebauer, T. J., & Dutcher, A. L. (2009). The development and evaluation of a soil moisture index. International Journal of Climatology, 29(5), 747-759. Nicolai-Shaw, N., J. Zscheischler, M. Hirschi, L. Gudmundsson, and S. I. Seneviratne (2017). A drought event composite analysis using satellite remote-sensing based soil moisture. Remote Sensing of Environment 203, 216-225. Osman, M., Zaitchik, B. F., Badr, H. S., Christian, J. I., Tadesse, T., Otkin, J. A., & Anderson, M. C. (2020). Flash drought onset over the Contiguous United States: Sensitivity of inventories and trends to quantitative definitions. Hydrology and Earth System Sciences Discussions, 1-21.

Reviewer (8): P163: the resolutions of eight climate models are different. Are the results from these models resampled to the same resolution? Author's reply (8): Thank you for your question. We are sorry that we did not provide a clear description of how the data was processed. Earth system models (ESMs) provide useful information of future climate projections through global-scale simulations. However, the coarse resolution of ESMs restricts their use in many sub-region-scale applications, requiring downscaling of climate model output (Chen et al., 2019; Fenta and Disse, 2018). In this study, the bias-corrected climate imprint method, a statistical downscaling method based on the delta approach, was applied to downscale the climate model output to a spatial resolution of 0.25°. We will clarify this in data section of the revised manuscript: "In this study, the bias-corrected climate imprint method, a statistical downscaling method based on the delta approach, was used to downscale global climate model output to a spatial resolution of 0.25°."

Reviewer (9): P164: five is missing after phase. Author's reply (9): Thank you for your comment. We would correct it in the revised manuscript.

Reviewer (10): P448: what does the national weather reports look like? I did not see the information on the two CDHEs from the national weather reports. Author's reply (10): Thank you for your question. The national weather report is a public service product provided by China Meteorological Administration (http://www.weather.com.cn/).

Specifically, the CDHE in Sichuan-Chongqing region during the summer of 2006 is reported at http://www.weather.com.cn/zt/kpzt, while the other one during July-September of 2009 was recorded in Yearbook of Meteorological Disasters in China 2010. We will rewrite the part to: "Overall, the changes in these two compound dry-hot events based on SCDHI are consistent with the national weather records (http://www.weather.com.cn/zt/kpzt/)and the Yearbook of Meteorological Disasters in China 2010."

Reviewer (11): Figs. 3 and 5: is soil moisture is represented by the standardized anomaly? If yes, please briefly describe this. And what is the solid black line all the way from the beginning time down to the ending time? Author's reply (11): Thank you for your comment. The soil moisture in Figs. 3 and 5 represents the standardized anomaly. To avoid the effect of seasonality, the soil moisture was fitted by Gamma probability distribution, and then was standardized by normal quantile transformation. The value of solid black line is -0.5, indicating the distinction between drought and non-drought according to our definition. We will clarify this in data section of the revised manuscript: "To avoid the effect of seasonality, soil moisture was fitted to a Gamma distribution and then was standardized by normal quantile transformation."

Reviewer (12): Figs. 4, 6, and 10: please add the longitude and latitude on the figures. Author's reply (12): Thank you for your comment. We will add the longitude and latitude on the figures in revised manuscript.

Reviewer (13): Fig. 8: I cannot see the difference among three panels in the last line. Is it because an inappropriate colobar is used? Author's reply (13): Thank you for your comment. We will revise the figure.

Reviewer (14): Figure 11d): the numbers 1.8 and 2 in the colorbar are placed wrongly. They should be exchanged. Author's reply (14): Thank you for your comment. We are sorry for the mistake and will check throughout the manuscript to avoid such similar mistake. We will revise the figure.

Reviewer (15): Figs. 12 and 13: is the historical period used here 1961-2005 or 1951-2018? The authors mentioned that they obtained the model outputs for the 1961-2005 period in Section 2.1. However, the 1961-2005 period does not show up in the results. And is the historical data from the CMIP5 climate models or from the interpolated observations? If the observational data is used as the reference, how the authors resolve the resolution difference between the observational data and the model results? Author's reply (15): Thank you for your comments and question. In Figs. 12 and 13, the historical periods are from 1961 to 2018, and the observational datasets were used. To match the spatial scale, the bias-corrected climate imprint method, was applied to bias correction and downscale the model output to the same resolution in this study. We will clarify these points in data section of the revised manuscript: "We obtained daily climate variables (i.e., precipitation, temperature, relatively humidity, wind speed, and shortwave and longwave radiations) for the future (2050-2100) periods for the three Representative Concentration Pathways (RCPs) including RCP 2.6 (low emission scenario), RCP 4.5 (moderate emission scenario) and RCP 8.5 (high emission scenario)." "In this study, the bias-corrected climate imprint method (Werner and Cannon, 2016), a statistical downscaling method based on the delta approach was applied to downscale the climate model output to a spatial resolution of 0.25°" Reference: Werner, A. T. and Cannon, A. J.: Hydrologic extremes - An intercomparison of multiple gridded statistical downscaling methods, Hydrol. Earth Syst. Sci., doi:10.5194/hess-20-1483-2016, 2016.

Reviewer (16): Please check through the manuscript and correct all the grammar mistakes. Author's reply (16): Thank you. We will check the revision thoroughly to avoid grammar mistakes.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2020-383, 2020.