General comments

This paper proposed an index "standard compound drought and heat index (SCDHI)" to identify the concurrent dry and hot event. The SCDHI is a combination of two indexes: drought index SAPEI and hot index STI. The advantage of SCDHI is to reflect the dry and hot condition at sub-monthly scale. Such a feature benefits from the use of the SAPEI index which is a daily drought index and enables the drought index calculation at different monthly time scales (e.g., 3, 6, 9, and 12 months). The authors validated the SCDHI index through three evaluation metrics and applied the SCDHI index to three future climate projections. The paper addresses a water resources management question which is within the scope of HESS. However, the innovation of this paper is unclear; the descriptions of the index and experiments are incomplete and not well organized; and a few method choices are not properly justified. Moreover, the paper needs more proofreading. The current presentation is far from the publication criteria of HESS.

Major comments to the authors

1. The innovation of this paper is unclear.
    1) The development of SCDHI includes two steps. The first step is developing SAPEI, and the second step is merging SAPEI and STI into SCDHI. If I understand correctly, the development of SAPEI has been published in Li et al. (2020, JHM), and the development of SCDHI looks the same as Hao et al. (2019, JH). The innovation of this work to me is that the authors applied their previously developed SAPEI index to SCDHI. In this regard, I think the novelty of this work is limited and it is not worth publishing in HESS. If this is incorrect, I hope to see the authors explain their novelty compared with Li et al. (2020, JHM) and Hao et al. (2019, JH).
    2) Given that this paper focuses on developing SCDHI based on SAPEI and the development of SAPEI have been published in Li et al. (2020, JHM), I suggest the authors merging the Sections 2.2.1 and 2.2.2 into one section, and adding details about the calculation of the STI index. In this way, the calculation of SCDHI is more complete.
    3) Moreover, to make the calculation of SCDHI look clear, I suggest the authors moving the graphical illustration of the SCDHI construction (Figure S4) from supplementary to the main context.
    4) Considering the focus of this paper, I suggest the authors removing Section 3.1 Evaluation of SAPEI because the development process of SAPEI has been published in Li et al. (2020, JHM). The authors can cite the relevant reference to prove the validation of SAPEI, which will make this paper concise and focused.

2. I'm not satisfied with the structure and descriptions of Section 2 Methods.

1) Regarding PDSI and SPEI (Section 2.1 Data), the introduction of PDSI and SPEI should not be mixed with data (e.g., meteorological dataset), the authors can add a new sub-section to introduce the both indexes. Moreover, please clarify what are the two indexes compared with, SCDHI or SAPEI (lines 136-138)? Last, please explain in detail how to calculate PDSI and SPEI. Currently, there are no explanations for the variables of Equations S1-4, and there are no explanations for the calculation of SPEI.
2) Regarding SCDHI (Section 2.2.2 Construction of SCDHI), how are the marginal distribution and the joint probability distribution calculated (equation (2))? Please add equations or references. Moreover, as I mentioned earlier, please add the calculation equation for STI. Last but not the least, please explain/justify in detail why the Frank copula was chosen based on the three goodness-of-fit measures (lines 260-263).
3) Regarding the three verification metrics (Section 2.2.2 Construction of SCDHI), I think these metrics can be separate from the construction of SCDHI, after all, the three metrics are not part of the SCDHI index but part of the evaluation of SCDHI. Moreover, the authors need to justify why the three verification metrics are selected, for instance, what can each of them reveal, what is the relationship between them, etc.
4) For ease of understanding, I suggest the authors adding a paragraph or sub-section describing the experiment of this work. For instance, after introducing all the data, developed indexes and evaluation metrics, the authors can explain the work flow of this paper, such as firstly validating the developed SCDHI index, and then applying SCDHI to three future climate scenarios. Now the structure of this paper is confusing, only after I read the results section, I understood what the authors want to do.
5) Section 2 Methods should also explain how are the frequency, duration, severity and intensity of the compound dry-hot events defined and calculated (Figs 10, 11). These metrics are used in Section 3.3 Application without proper explanations.

3. Presentation of the paper. The writing of this paper needs to be largely improved. I found it hard to understand some sentences, the definitions of several terms are missing, and the figures are not well titled and explained. Please see the below for details.

Minor comments to the authors

1. Please define the term "compound dry-hot event" and give some examples. This term plays a key role in your work, but it lacks an appropriate definition (lines 43-45).
2. Lines 30-31, I'm not sure the purpose of this sentence here.
3. Line 171, the reference "rlilpl" looks not being used in this article.
4. Line 237, "less than" should be "less than or equal to".
5. Lines 331-333, I doubt that the first half sentence is supported by Fig. S6.
6. Some references in writing are unclear. For instance,
1) Lines 57, "this approach".
2) Lines 242-244, "p to the given marginal sets".

3) Line 354, "It".
4) Line 379, "detect" what?
5) Line 455, "they".

7. Many sentences have grammatical errors or are unclear. Please correct them and add elaborations. Below are just some examples.
   1) Line 131, change "perennial frozen soil" to "perennially frozen soil".
   2) Line 132, change "Chinese arid regions" to "the arid regions of China".
   3) Line 135, I guess "less meaningless" should be "less meaningful".
   4) Lines 154-156, two "well".
   5) Lines 161-165.
   6) Lines 225-228
   7) Lines 252-253. The citation format is incorrect.
   8) Lines 269-274. "is" vs. "are".
   9) Lines 284-286.
   10) Lines 320-322.
   11) Lines 371-379.
   12) Lines 403-405.
   13) Line 417, change "twenty thousand km2" to "20,000km2".
   14) Line 420, change "first case studies" to "the first case study".
   15) Lines 454-457.
   16) Line 467, past tense.
   17) Line 472, please elaborate on the "run theory".
   18) Lines 510-516. Please re-write these sentences to make them clear.
   19) Figure 12 title has grammar error.
   20) Lines 536-538.
   21) Lines 543-544.
   22) Lines 570-571.

8. Please add references for the following sentences:
   1) Lines 146-148.
   2) Lines 157.

9. The section numbering of 3.2.1 and 3.2.2 has problems.