

Response to comments from Referee#1:

The authors propose a new drought index (SVVAI) derived from vertical velocity anomalies and compare it with the 3-month Standardized Precipitation Index (SPI-3). Although the overall idea of the SVVAI may be original and the quantified performance of the newly introduced index seems to be fairly good, the manuscript has major issues that, in my opinion, make it not suitable for publication in ESD.

Response:

Thank you for the comments. The paper proposed a new drought index and preliminarily investigate its performance in case studies. The approach is not perfect but we try to display some discoveries and the potential in drought prediction. With the help of your detailed major concerns, we will solve the issues listed below and improve the manuscript.

Please find below my major concerns:

(1) The English is poor, so that while reading the paper I had difficulties in understanding many sentences and their key messages. Punctuation sometimes is incorrect, and references are not well incorporated within the text. I suggest to let a native English-speaker check carefully the whole text before a possible re-submission.

Response:

We surely check it firstly with the software called Grammarly, and then surely seek help from native English-speaker to make it readable.

(2) At the end of the manuscript (Discussion/Conclusion(s) sections), it is not clear to me what really are the advantages that the SVVAI may bring to for example operational forecast of drought, compared to the SPI-3. Moreover, the Discussion section only highlights the limitations of the SVVAI. It is good to mention them, but I would have expected at least a balance between pros and cons.

Response:

The referee#1's concern is the advantages the SVVAI brings to the operational drought forecast. Case studies in section 6.1 displayed preliminary results. That is, the forecasted region-scale SVVAI performs more steady (less standard deviation and less bias) within limited lead times when compared with SPI. Also, the SVVAI perform the potential in the forecast spatial distributions of the 2011 megadrought over southern China in section 6.2. Cases studies at the region and grid scales tend to display the potential of application of the concurrent SVVAI in forecasting.

Indeed, this comment helps us realize that more explicit conclusions are needed, and we will further make it clear and brief.

(3) The SVVAI has been compared to the SPI-3, but how it performs compared to the other SPI indices (e.g. SPI-1 and SPI-6)? And how it performs more generally compared to other indices of drought, such as the PDSI and SPEI?

Response:

SVVAI employed in case studies are three-month, consistent with the same timescales of SPI3. That is, SVVAI and SPI in the paper are always concurrent and have the same timescales. We will surely make it clear in the manuscript to avoid possible misunderstandings. Thank you for the comment.

The physically explicit and comprehensive PDSI and SPEI are indeed useful and popular in drought communities. However, surface air temperature is a fundamental part when computing these two drought indices via the intermediate variable of potential evapotranspiration. Our original idea is that we did not choose PDSI and SPEI as the target index because we try to avoid the consideration of surface air temperature when proposing SVVAI. Specifically speaking, the relationship between atmospheric dynamical subsidence and precipitation deficit is physically explicit, but it might be not always the case for the influence of dynamical subsidence on surface air temperature. Indeed, the considerations of PDSI and SPEI can help

understand the mechanisms behind hot droughts (i.e., concurrent drought and heatwave) or issues related to climate change, and we will illustrate it in the discussion part.

(4) What the authors can say about the fact that SVVAI is computed with daily observations, whereas the SPI is computed with monthly data, by also including a time-lag in this case of 3 months?

Response:

Both of SVVAI and SPI employed herein are three-month (90-day in practice) scale updated daily. That is, the index located on 1st April 1999 is calculated originally based on the 90-day values from 2nd Jan 1999 to 1st April 1999.

This comment helps us realize that section 2.3 may be confusing and not readable. We will modify it and give a clear and brief description.

(5) In Section 2.5, the main definition of the SVVAI index is not clear. Equations 2-3 need to be amended to fully reflect the SVVAI definition. What is the range of values of the SVVAI? Is it the same as the SPI or different? This is again not clear and very important, because many figures show SVVAI and SPI-3 values on the same range of values and colors.

Response:

We understand your concern about the definition in Eq. 2-3. In particular, sub-indices herein is implicit, and we will list all of them in the next version.

We did not investigate the value ranges of the SVVAI and difference compared with the SPI. Since performance in Figure 4-5 and Figure S4-5 can indirectly indicate good index applicability, we did not consider it. Even so, we think the comment is constructive and help make the SVVAI more strict. We will claim it in the discussion part and improve it in further study. Thank you for this comment.

(6) Within the analyses the authors made use of the Temporal Correlation Coefficient (TCC) and Pattern Correlation Coefficient (PCC), but no key references are provided with respect to these two statistical tests. In addition, statistical significance (p-values) of these correlations are not provided. Therefore, it is difficult to quantify the robustness of the results.

Response:

Key references and relevant details are provided in the supplement file, as illustrated in LINE 211. Therein we tell readers can find details about PCC (i.e., Anomaly Correlation) in section 8.6.4 of the book (Wilks, 2011). Anyway, we will move the key reference from supplement files to section 2.6 to make it clear.

Also, the statistical significance of correlations will be provided.

References:

Wilks, D. S. (2011). *Statistical Methods in the Atmospheric Sciences* (3 ed. Vol. 100): Academic Press.

(7) The Figure captions are not exhaustive, so that it is difficult to interpret the plots. I suggest adding more information so that the reader can understand the plots without the need to refer to other sections of the paper.

Response:

Thank you for the comment, and we will further make the figure captions as exhaustive as possible.