Response to Reviewer 2

General comment

Drought and salinity are considered to be the two main factors limiting crop productivity. Remote sensing enables the assessment of the impacts of extremes on crops, but it is seldomly used in the study of compound effects of drought and salinity stress. The novelty of this study is to assess the impacts of drought, salinity, and their combination on crop traits using multiple remote sensing observations and explore their relationships with stress timings and drought levels. The manuscript makes a contribution to the assessment of compound extremes' impacts using remote sensing and the writing is well organized. I suggest this manuscript should be accepted by HESS after minor revisions.

Response: Thank you for your positive comments about our work. We appreciate your support of the novelty and potential applications of compound extremes' impacts on a large scale. Our itemized responses are attached below. In order to facilitate the review, the comment of the reviewer is displayed in black, and the reply is displayed in blue font.

Specific comments:

Q1. In this study, only the 2018 case over the Netherlands was analyzed, are the conclusions robust? As the available data range from 2004 to 2018, are there any else cases to verify the conclusions? If there is no more cases, it is better to add the name of this case in the title.

Response/Action: From a detailed and thorough review (Wen et al., 2020), we found that at present nobody has investigated the combined effects of drought and salinity at such a scale using remote sensing. So, while this is an important novelty of our study, it also hampers verifying our conclusions with other cases. We use the years 2004 to 2018 to create a baseline of local hydrological conditions and to be able to evaluate the local deviations in those conditions for 2018 (given that 2018 was by far the year with the most extreme drought conditions in that period), but we cannot use the other years to verify our patterns as this would lead to circular arguments. At the same time, we believe our conclusions are robust in light of the approach we used and its consistency with results from small-scale local studies. We are currently validating our analysis for a much larger area in the USA, which should provide extra support for this study. The findings however are outside the scope of this particular paper. Concerning the current limits of this case, we agree with your opinion and will revise the title to 'Monitoring the combined effects of drought and salinity stress on crops using remote sensing in the Netherlands' in the revised manuscript.

Q2. Add a map of the crop distribution over the study region.

Response/Action: We will add a crop map of North-Holland province to Figure 2.

Q3. Line 89-90: The standard deviation of SPEI is 1 (Vicente-Serrano et al 2010), why do you define drought when SPEI is less than -321?

Response/Action: In this study, we adopted daily SPEI for the period from April 1st to October 30th, a total of 214 days, as this coincided with the crop growth period. We defined -1 and -1.5 as daily thresholds for different drought severity classes according to previous classifications (McKee et al., 1993;Tao et al., 2014). Thus, (cumulative) SPEI for no drought should be between -214 to 0, SPEI for moderate drought should be between -321 to -214 and for severe drought, SPEI should be lower than -321 for the whole growing period. We will add more information on thresholds of drought classifications to the revised manuscript.

Q4. The captions of Table 1, figure 3, and figure 4 should be described in detail, e.g. what are MD, MS, SS, ab, and abc short for in fig. 3?

Response/Action: We will describe the meanings of all stress conditions in the caption of Fig.3 and Fig. 4 of the revised manuscript. All the different letters (e.g. ab) refer to the post hoc result from pairwise comparisons. It is a common way to show significant differences in bar plots throughout scientific literature as we have explained with the sentence 'Different letters in each panel indicate significant differences ($p < 0.05$)' in the caption.

Q5. As figures 3-4 show the values of crop traits from May to September, it is better to show their standardized anomalies compared with climatology, which enables the comparison between different timings.

Response/Action: Unfortunately, due to several limitations, we cannot provide a climatology. In this case, we calculated traits based on Sentinel-2 which is only active since 2015. As such, sentinel-2 does not have observations (yet) to investigate the long-term behavior of those traits, thereby limiting us to define a climatology for no-stress conditions. While Landsat and other comparable satellites exist that could be used for this, we chose not to use this information because of the differences in wavelengths and resolutions among different satellites. In addition, we chose not to adopt a non-drought year (like 2015 or 2016) as a control (no stress condition) in this research, because we could not quantify the natural variation (in respect to a long-term climatology) based on those specific years. Hence, we were restricted in our approach to make a comparison to a control treatment. This comparison to the control provides the baseline for no-stress conditions that can be directly compared to the responses in stressed conditions. This avoids the need for including climatology.

Q6. What is the best explanation of the different responses among the five crop traits to such stresses?

Response/Action: Each of the five traits is associated with different functions of plants that might be individually impacted by the different stressors. Therefore, focusing on only one individual metric (as commonly done; see Wen et al. (2020) for a review) limits our capacity to gain full insight into drought and salinity responses. Hence we chose explicitly not to focus on analyzing individual traits but on the conjoint of them. LAI, FAPAR, and FVC showed similar patterns to stress since their highly physical correlation (Hu et al., 2020). The different patterns of Cw and Cab point to different drought and salinity resistance strategy components associated with these traits: LAI (and FAPAR/FVC) reflect the decrease in biomass due to stress, partly because stress directly and negatively impacts growth and partly because having a lower biomass decreases the evapotranspiration demands of the crop, which increases the resilience of the crop to deal with drought. Cw represents another pathway to reduce evapotranspiration demands, i.e. by reducing the amount of water per gram of leaves. Also this response may be a direct effect of the more negative pressure heads due to drought or due to increased osmotic pressures (due to salinity). It may also be part of the adaptive strategy of the crop to increase its resilience. Cab also responds to drought and salinity, but in its own way, i.e. by adapting its photosynthetic capacity while being affected by a lower stomatal conductance (due to drought and/or salinity). See e.g. Wright et al. (2003) for a framework explaining these nitrogen-water interactions. In our revised manuscript, we will expand our discussion section to better explain these different responses of the five traits.

References

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