Biogeosciences Discuss.,
https://doi.org/10.5194/bg-2020-116-AC2, 2020

Biogeosciences Discussions

Interactive comment on "Risk of crop failure due to compound dry and hot extremes estimated with nested copulas" *by* Andreia Filipa Silva Ribeiro et al.

Andreia Filipa Silva Ribeiro et al.

afsribeiro@fc.ul.pt

Received and published: 24 June 2020

Reviewer: The manuscript 'Risk of crop failure due to compound dry and hot extremes estimated with nested copulas' uses Archimedian copulas to model trivariate joint distributions between maximum temperature, precipitation and wheat and barley yield deviations. The paper is well structured and well written. It contributes interesting new insights to the literature on compound dry and heat impacts on crop yields.

Author's Reply: Thank you for this positive assessment.

Reviewer: A few comments include: (1) p.4, l.88: I recommend adding the exact

months rather than just naming the seasons. As readers of the paper might come from all over the world, it might not be clear which months include the spring time in Spain.

Author's Reply (1): Thank you for the comment. To clarify the season months in the study region we propose to rewrite the lines 88 – 90 to the following:

"The vegetative cycle of the winter crops in Spain is mainly driven by precipitation and temperature: sowing occurs around autumn (from September through November, SON), followed by the vegetative phase in winter (from December through January, DJF), reproductive phase (more photosynthetically active phase) in spring (from March through May, MAM) and crop harvest occurs in the early summer (around June)"

Reviewer: (2) p.6, l.132: The copula parameter θ should be introduced

Author's Reply (2): Thank you for the suggestion. We propose to rewrite the lines 127-128 to:

"AC can be written in terms of the respective generator function φ, which belongs to a parametric family (φ_θ) dependent on the parameter θ, e.g. for the three-dimensional case:"

in lines 130-131 to:

"Due to the symmetry of bivariate AC, the above trivariate form can be expressed in terms of NAC or HAC, where two of the margins are first coupled by their bivariate copula and then coupled with the third margin, via the same generator on each level but different parameters θ_12 and θ_1, respectively, e.g.:

And in lines 131-132 to:

Equation 8 can also be expressed in terms of the other possible pair copulas C_13 (u_1,u_3;θ_13) and C_23 (u_2,u_3;θ_23) that are coupled with u_2 and u_1 by C_2 and C_3, with expressions C_2 (C_13 (u_1,u_3;θ_13),u_2;θ_2) and C_3 (C_23

(u_2,u_3;θ_23),u_1;θ_3), respectively. Like Eq. (8), among each structure of NAC the same generator is required for each level but with different parameter, hence, both the optimal structure and respective parameters must be determined.

Reviewer: (3) p.8, l.178: Can you interpret what it means that 'C_(u1,u2,u3) is slightly lower than the AIC of C_1 (u3,C_12 (u1,u2))' in terms of compound and single hazards and add a sentence about it?

Author's Reply (3): This means that in the case of barley in Cluster 2, the trivariate copula fits the data slightly better than the two-parameter NAC C(u3, C12(u1,u2)) in terms of AIC, even though the Cramer-von Mises distance is better for the NAC. This could mean that in this case a NAC structure favouring the dependence between yield and precipitation may be less relevant compared to the other clusters and yields. Drought individually seems to play a less dominant role in the compound event, in comparison to the other cereals and regions.

This interpretation would be consistent with our discussion about Figure 8, where barley in Cluster 2 is also the case with the highest difference between drought and compound dry and hot conditions, hence illustrating that here drought is the least dominant driver of crop loss in comparison to the other cereals and regions.

Following the reviewer's suggestion we will add a sentence in the Results section: "The only exception is barley in Cluster 2 whose AIC of Cθ(u1,u2,u3) is slightly lower than the AIC of Cθ1 (u3,Cθ12 (u1,u2)) (Table 2). This feature may suggest that a structure favouring the dependence between yield and precipitation (u1,u2) may not be as relevant as in the other clusters and yields due to a less dominant role of drought individually in this case. Nevertheless, in terms of Cramer-von Mises distance (Sn) the nested copula is the closer to the empirical trivariate copula. For this reason, we modelled the trivariate joint distribution based on nested Frank copulas for all cases. (. . .)"

Reviewer: (4) *Code availability. It is more and more common to publish the code used

in scientific publications and I strongly recommend the authors considering to publish their code once the paper is accepted.

Author's Reply (4): We agree to publish the code in a repository.

Interactive comment on Biogeosciences Discuss., https://doi.org/10.5194/bg-2020-116, 2020.