We thank the reviewer for their thoughtful review and respond to the reviewer comments here.

The reviewer asks if it is possible to estimate quantitative effects of fire on recharge and overland flow through measurements of parameters such as evaporation, transpiration and leaf area index, although also noting that given the nature of the data, this might not be doable. We confirm that our experimental design was focused on the downward flux of water to a shallow cave system. This allowed us to quantify the timing of recharge, and the amount of precipitation needed. Data was not collected to additionally quantify the amounts of recharge or overland flow.

The reviewer asks about any observations of ash filling fractures at our site. We have photographic evidence of the presence of an ash crust, observed on our visits to the site post-fire, and provided in the Supplemental section of the pre-print. We infer that this ash would also have accumulated in fractures, however, to limit disturbance of the research site whilst we were monitoring in the underlying cave, we could not investigate this further. We would also like to note that in our AC3 reply (https://doi.org/10.5194/egusphere-2025-84-AC3) to comments made by CC1 (https://doi.org/10.5194/egusphere-2025-84-CC1), and to better align our conceptual model with the results presented in Bian et al (2019), we modified our conceptual figure and associated text in AC3 to no longer include the requirement for ash filled fractures.

The reviewer asks if we could extract more information from the data. For example, they ask if a comparison with stream discharge would be useful? We thank the reviewer for the suggestion. Such data does exist (for example, an increase in discharge post-fire observed by Scott and Van Wyk, 1990). However post-fire responses can be highly variable and site-specific (see the review of Moody et al 2013), varying from no-response to catastrophic floods. We propose to add a sentence in the Discussion at line 204 of the original manuscript:

"These observations are consistent with the post-fire response in surface streams, which can include an increase in peak flow rates post-fire (Scott and Van Wyk), noting that the post fire response of surface streams is variable and site specific (Moody et al., 2013)."

Two references will be added:

Scott, D.F. and Van Wyk, D.B.: The effects of wildfire on soil wettability and hydrological behaviour of an afforested catchment. J. Hydrol. 121, 239-256, 1990

Moody, J.A., Shakesby, R.A., Robichaud, P.R., Cannon, S.H. and Martin, D.A.: Current research issues related to post-wildfire runoff and erosion processes. Earth Sci. Rev. 122, 10-37, 2013.

The reviewer also asks if we observe ash in the drip zones. We confirm that we do not observe ash deposits in the drip zones in the cave, consistent with the nature of karst systems and the filtering effect of water movement through fractures in the unsaturated zone. Dissolved and less than 100 nm particles (environmental nanoparticles and colloids) the most likely to be transported from the surface to the cave drip waters (Hartland et al 2012). We do not propose adding new text on this point.

The reviewer states that the captions of the figures and tables are insufficiently informative, and we agree. This was also the view of reviewer RC2 (https://doi.org/10.5194/egusphere-2025-84-RC2) and we confirm that the figure captions will be rewritten for clarity as suggested in our AC1 (see below).

AWRA-L and BOM will both be defined in the main body of the text on lines 81-83, this location for the definition of BOM is an update on that proposed in our AC3 (https://doi.org/10.5194/egusphere-2025-84-AC3) response to CC1 (https://doi.org/10.5194/egusphere-2025-84-CC1).

We confirm that Figure 6 has no whiskers because the outliers are >1.5IQR away from the hinge, and so cannot be used as whiskers.

Figure 1 caption has previously been rewritten in our AC1 (https://doi.org/10.5194/egusphere-2025-84-AC1) to account for changes made following RC2 (https://doi.org/10.5194/egusphere-2025-84-RC2):

"Figure 1. a). Photograph of the surface above the cave one day after the fire (source: Andy Baker). b) Australia with karst overlay, yellow triangle indicates the study site (WOKAM; from Chen et al (2017). c) Sentinel S2 visible image, with outer bounds of the Wombeyan Karst Reserve. SentinelS2 True Colour image [2024]. Retrieved from Copernicus Dataspace [7 December 2024], processed by Copernicus. Wombeyan karst conservation reserve boundary: State Government of NSW and NSW Department of Climate Change, Energy, the Environment and Water 2000, NSW National Parks and Wildlife Service (NPWS) Estate, accessed from The Sharing and Enabling Environmental Data Portal [https://datasets.seed.nsw.gov.au/dataset/9bad468a-c2a6-4c90-bfaa-8ae8af72e925], date accessed 2024-11-07."

BOM will now be defined on line 81, when the first climate data is introduced. Figure 2 caption will read:

"Figure 2. Total BOM monthly precipitation, 1961-1990. Aggregated from daily rainfall data from Wombeyan Caves (BOM Station number 63093)."

Figure 3 and 4 captions were already revised following CC1 comments and we propose the changes stated in AC3 (https://doi.org/10.5194/egusphere-2025-84-AC3):

“Figure 3 Daily AET (from the AWRA-L), daily precipitation (light blue when outside the monitoring period) with timing of recharge events shown by red asterisks, and average 15 min total drips.”

“Figure 4 a) 48 h antecedent rainfall classified by month and whether before or after fire. B) box and whisker plots of 48 h rainfall amounts for all 22 recharge events before the fire (black) and 19 recharge events after the fire (red).”

The caption for figure 5 is unchanged.

Figure 6 and 7 captions were already revised following CC1 comments, and we propose to keep the revisions proposed in AC3 (https://doi.org/10.5194/egusphere-2025-84-AC3):

“**Figure 6**: Minimum 48 hr precipitation required for recharge to occur for each month. Black indicates that the minimum recharge threshold occurred pre-fire, while red indicates that the minimum recharge threshold occurred post-fire. These values are bolded in Table 1.”

“Figure 7. Comparison of recharge thresholds pre-and post-fire using BOM data. A) all recharge events B) all recharge events grouped by three-month season C) all recharge events grouped by six month seasons summer/autumn and winter/spring D) all recharge events grouped by six month seasons autumn/winter and spring/summer. Note that sample sizes are different depending on seasonal grouping, most comparable for panel d, where Autumn/Winter have 9 samples for pre-fire, 8 samples for post-fire, and spring/summer have 13 samples for pre-fire, 11 samples for post-fire.”

“Table 1. Summary of recharge events. Data in italics: incomplete returns for the Bureau of Meteorology (BOM) station on these dates. Australian Water Landscape Model v7 (AWRA-L) data was used. Recharge event 7 occurred on 4th May 2015 and was a local rainfall event not captured in the gauge. The monthly minimum recharge thresholds presented in Figure 6 are in bold.”

The caption for Table 2 is unchanged.

The reviewer asks how the ash is removed from the fractures in Figure 8. We note again that this figure and associated text was modified in our AC3 to CC1, which resulted in the fractures remaining open for water movement despite the presence of ash. In this revised model, any ash in the fractures does not need to be removed.

We thank the reviewer for the minor comments.

We have checked for double periods (..) and will remove instances on lines 19 and 97. We will also add a missing article on line 189 (‘the’ is missing in ‘…using the same…’)

The typos in the text in Figure 8 have been removed in the revised version of this figure provided in our AC3 response to CC1 (https://doi.org/10.5194/egusphere-2025-84-AC3).

We will take care to more rigorously separate any discussion from the results. In particular, we agree that on the text from line 158 contains some discussion of methods, and we propose to add a new methods section and revise the existing text. The new methods text is proposed to be a new paragraph starting line 119:

“To investigate whether rainfall recharge thresholds were altered by an intense experimental burn, we qualitatively compared recharge thresholds calculated for the pre- and post-fire intervals. Because 48 h thresholds may be overestimated due to both the coarse sampling interval and the impact of extreme events, we first compared the minimum recharge threshold calculated for each month pre- and post-fire. We then quantitatively analyzed the 48 h rainfall recharge thresholds for all events before and after the fire using the Bureau of Meteorology station data. To overcome the different lengths of monitoring data before and after the fire, we undertook a stratified qualitative analysis with data aggregated by season (DJF, MAM, JAG, SON) and 6-monthly periods (Summer/Autumn and Winter/Spring and Autumn/Winter and Spring/Summer).”

The shortened text, and starting on line 158, will now read:

“48 h rainfall recharge thresholds were compared before and after the fire. Fig. 6 shows a qualitative reduction in the recharge threshold postfire using the minimum recharge in each month. The median 48 h rainfall needed to generate recharge was 22.1 mm before the fire (n=22) and 16.4 mm after the fire (n=19) (Fig. 7a). The pre- and post-fire monitoring periods were of different lengths, with no reliable post-fire monitoring in the late summer / early autumn of 2017, when rainfall recharge thresholds might be expected to be higher due to enhanced evapotranspiration, and a Kruskal-Wallis ANOVA indicates these rainfall recharge thresholds are not significantly different at the 95% level.

Considering December to February (DJF, summer), March to May (MAM, autumn), June to August (JJA, winter) ….”

On line 128, the text “indicating that any observed differences in rainfall recharge thresholds is unlikely to be due to differences in daily precipitation.” Is better suited for the discussion, and we propose to move this to the start of the discussion on line 189:

“Figure 5 demonstrated very little difference in the daily rainfall distribution before and after the fire, indicating that these differences in rainfall recharge thresholds is unlikely to be due to differences in daily precipitation.”

On line 178, there is an interpretation: ”This is likely owing to the absence of post-fire MAM data due to the cessation of monitoring.”. We could not identify a suitable location for this text in the discussion and would propose deleting this text as it does not affect the results.

We will rewrite the text on line 42, replacing carrying capacity to better define this term as the capacity to hold water, with the new text:

"…in general ash has a higher capacity to hold water than soil (Bodí et al., 2014)".

On line 88, we will change 'very high' to 'unusually high', and add a reference to Figure 2, to enable the reader to link outliers shown in this Figure to this sentence.

We agree that we should better clarify in the methods section where we summarise those from Bian et al 2019. We propose to add a leading sentence at the start of the paragraph on line 106:

"Summarizing the main results of the pre-fire and post-fire hydrological and geochemical monitoring of the site presented in Bian et al. (2019), …."

We thank the reviewer for their comment on the difference between BOM and AWRA-L 48-h precipitation totals. There was a mistake on line 135, the difference between two data sources considering all recharge events where BOM data is available and presented in Figure 1 is 17%. This is very similar to the difference between methods for all recharge events, including infilled data, on lines 148-154. For clarity, line 135 will be edited:

"for those events where both BOM and AWRA-L data is available (data is presented in Table 1) suggest that AWRA-L 48 h precipitation is on average 17% lower than the Bureau of Meteorology gauge. No correction was applied."

Cited reference:

Hartland, A., Fairchild, I.J., Lead, J.R., Borsato, A., Baker, A., Frisia, S. and Baalousha, M.: From soil to cave: transport of trace metals by natural organic matter in cave dripwaters. Chemical Geology, 304-305, 68-82, 2012.