Response to editor's comments
"Mechanisms of hydrological responses to volcanic eruptions in the Asian monsoon and westerlies-dominated subregions" by Zhihong Zhuo et al.

We are very grateful to Editor Allegra N. LeGrande for your kind efforts and thoughtful comments, which are very helpful for enhancing the quality of the manuscript. We have revised the manuscript according to the comments. The list of the editor's comments (*in italic*) as well as our responses are listed below. The revised texts are shown in blue.

Comments to the author*:*
Zhou et al follow-up

It is difficult to get into the details of tropical precipitation without speaking of ENSO – Zanchettin et al 2022 (doi: 10.5194/gmd-15-2265-2022) goes through VolMIP (the updated versions of the PMIP3/CMIP5 models specifically checking out volcanic forcing), and should be referenced. Khodri 2017 needs to be cited and integrated too (doi:10.1038/s41467-017-00755-6). Volcano-ENSO links which will have hydroclimate impacts as well. It is a bit odd quite frankly not to reference VolMIP at all. At least a paragraph should be added.

This is a follow-up study after Zhuo et al., 2020, in which we analyzed the climate response to volcanic eruptions with detailed proxy-model comparison, and we used one paragraph discussing the volcano-ENSO links, in which we noted that "Following the method in Iles et al. (2013), we test this uncertainty by repeating the SEA analysis after regressing out the effect of ENSO. Consistent with Iles et al. (2013) and Iles and Hegerl (2014), it only results in a lower amplitude response, but the temporal and spatial patterns remain largely unchanged." (Zhuo et al., 2020). This study is focused on explaining the mechanism of the response patterns identified in Zhuo et al. (2020), in order to avoid redundance, we didn't discuss ENSO again in this study, but we added some text in the final part to emphasis the necessity of future studies on it. We agree that, like PMIP4/CMIP6, VolMIP should also be mentioned. Considering these comments, we added following concluding remarks as shown in line 334-345 in the revised manuscript:

Except for forcing inputs, uncertainties of the hydrological responses can also come from internal variability, especially, as discussed in Zhuo et al. (2020), the initial state of the El Niño-Southern Oscillation (ENSO) and its response to volcanic eruption. Studies tend to consensus on a El Niño tendency after tropical and NH volcanic eruptions (Khodri et al., 2017; Liu et al., 2022, Stevenson et al., 2016), but this can be an overestimation of the forced response relative to natural ENSO variability (Dee et al., 2020). More studies are also needed to understand the ENSO response to SH volcanic eruptions. Besides, the interaction between post-eruption ENSO and monsoon precipitation varies in different monsoon regions. A weakened African monsoon due to post-eruption cooling in Africa leads to the El Nino response after tropical eruptions (Khodri et al., 2017), but a more frequent occurrence of El Niño in the first boreal winter after eruptions lead to an enhanced EASM (Liu et al., 2022). The interaction among ENSO, monsoon and volcanic eruptions remains unclear. The Model Intercomparison Project on the climatic response to Volcanic forcing (VolMIP, Zanchettin et al., 2016) and its potential future phases with improved protocol addressing the pre-eruption ENSO state (Zanchettin et al., 2020) can be valuable resource to investigate these questions.

The change quoted below makes this paragraph make less sense. A precipitation epoch analysis is exactly a 'degree of dryness' analysis. But that turn of phrase really doesn't make very much sense. Also, not all arid places get wetter after volcanism. Take Manning et al 2017 (https://doi.org/10.1038/s41467-017-00957-y) – volcanoes made Nile Valley drier.

"ITCZ moving toward a warmer hemisphere with less volcanic aerosol loading leads to inversed climate impacts in two hemispheres (Colose et al., 2016; Haywood et al., 2013; Iles and Hegerl, 2014; Zhuo et al., 2021). NH arid regions get wetter These studies focused on mechanisms of instant precipitation response, which does not reflect the degree of dryness after volcanic eruptions. And the analysis was conducted holistically over the investigated region. Zuo et al. (2019b) adopted both precipitation and drought reconstruction data in their analysis, all of them showed wetter conditions in arid regions after all types of volcanic eruptions, which is due to an enhanced cross-equator flow after SHVAI and a monsoon-desert coupling mechanism after SHVAI and NHVAI(Zuo et al., 2019b). NHVAI. However, moisture budget analyses were also conducted holistically over the hemispheric arid regions in Zuo et al. (2019b). These cannot fully explain mechanisms of local precipitation hydrological responses to volcanic eruptions in subregions of the AMR, as regional responses and local feedback processes were not considered. Zhuo et al. (2021) indicates Spatial analyses were conducted in Zhuo et al. (2021) in order to understand the mechanism of precipitation responses to volcanic eruptions in the SASM region. Results indicate a dynamical response to VAIand a , with changed interhemispheric thermal contrast and land-sea thermal contrast, local cloud cover changes in different areas, this leads to subsequent physical feedback of local cloud on local temperature response, together with the adjusted horizontal and vertical motion of local water vapor, leading to a decreased precipitation in the SASM region after NHVAI. No spatial analysis is conducted in order to understand the mechanisms of hydrological responses to volcanic eruptions in areas of the AMR. Responses in different subregions of the AMR and related mechanisms need further investigation."

We further refined this part as follows:

ITCZ moving toward a warmer hemisphere with less volcanic aerosol loading leads to inversed climate impacts in two hemispheres (Colose et al., 2016; Haywood et al., 2013; Iles and Hegerl, 2014; Zhuo et al., 2021). With moisture budget analyses over the hemispheric arid regions, Zuo et al. (2019b) showed wetter conditions in NH arid regions due to an enhanced cross-equator flow after SHVAI and a monsoon-desert coupling mechanism after NHVAI. However, these analyses cannot fully explain mechanisms of local hydrological responses to volcanic eruptions, as regional responses and local feedback processes were not considered. Based on spatial analysis, Zhuo et al. (2021) showed that dynamical responses to NHVAI change local cloud cover. A subsequent physical feedback of local temperature and adjusted horizontal and vertical motion of local water vapor lead to a decreased precipitation in the SASM region. Responses in different subregions of the AMR and related mechanisms need further investigation.

We agree that not all arid places get wetter after volcanism. Zuo et al. (2019b) took NH arid regions as a whole, which ignored the potential difference in different local areas. This is why it is important to investigate into local hydrological responses. We always point out that the response is in the areas of the AMR, like that written in the abstract "with an intensified aridity in the relatively wettest area (RWA) but a weakened aridity in the relatively driest area (RDA) of the AMR".

Figure 4,6,8 – I have a strong preference for hatching to be on the insignificant data because it makes the significant data easier to see instead of obscured. I think this is the opposite way of this figure. I suggest doing this the opposite way.

We tried to replot the figures hatching the insignificant data as suggested, but for figure 4 and 6, because there are less significant data than insignificant data, especially for GSH classification, it does not contribute to improve the clarify, instead, it may highlight the insignificant data. Thus, after thinking twice, we do not change figure 4 and figure 6 in the revised manuscript. For figure 8, as suggested, we revised the figures to hatch the insignificant data. We tried different hatches, i.e. slashes, cross signs, and dots, and finally choose dots for insignificant data, as it is better to highlight the shades and arrows, and make it able to distinguish this figure from other figures that hatch significant data with slashes and cross signs. We hope this makes the figure clear now. Thanks a lot for the suggestion.

Figure 8 – the winds plus the hatching make this figure incredibly difficult to read.

To make it clearer, we revised the figure to hatch the insignificant data as suggested above, and changed the slashes and cross signs to dots to avoid covering shades and arrows.

*Figure 9 – given that the stratospheric aerosol fields were *zonally averaged* for PMIP3/CMIP5, I am not sure that a map-view figure is needed.*

Yes, the volcanic forcing is zonally averaged, but as shown in the figure, the clear-sky OSR is not exactly the same as the forcing, which is not totally identical at the same latitude, especially for the GSH classification, besides, the map-view figure is useful to be compared with the full-sky OSR map-view in figure 10. Considering these, we think it helps to keep the map-view figure.

Figure 10 – the figure label here for the top row looks identical to figure 9 but the figures are different (put why in the caption). C is not a good shorthand for percent cloudiness, 'cloud total' or similar is better.

Figure 9 is outgoing shortwave radiation in clear sky, while figure 10 is in full sky, we wrote the difference in the figure caption. Considering the comment, we think it's better to make it clearer in the figure itself, so we revised the y-label in figure 9 and figure 10 to Clear-sky OSR and Full-sky OSR, specifically. We used C to make it shorter in the figure caption, but clarity is more important, considering the comment, we replaced the figure caption directly with "Cloud area fraction" in the revised figure.