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Event-to-event intensification of the hydrologic cycle from 1.5°C to a 2°C warmer world

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This study presents the first insights into the intensifying impact of global warming on extreme hydrological shifts between wet and dry conditions at the sub-seasonal to seasonal scale. For instance, the flood in England during the summer of 2007 was followed by heavy drought conditions, and a switch took place in the recent past from extreme drought to severe flooding in California. Most recently, the 2018 flood to drought transition in Japan brought on one of the most intense heatwaves the country has ever faced. These are just a few real-world examples. Considering the interconnected nature of the processes governing the increases in wet and dry events, we introduce a new index called 'Event to event variability (E2E)' as a proxy of the hydrological cycle, taking the aforementioned shifts in wet to dry (or dry to wet) transition into account. Based on multi-model large ensemble climate simulations, we assessed the impact of half a degree of additional warming from 1.5°C to 2°C for the global mean temperature, reflecting the warming targets of the Paris agreement of 2015 that were adopted at the 21st Conference of the Parties (COP) of the United Nations Framework Convention on Climate Change (UNFCC). Our results show that for an additional 0.5°C warming, mean intensification of the wet-dry (or dry-wet) transition will be significant on a global scale. The E2E index was further utilized to investigate the extreme conditions of said intensification, which showed extremes will increase 10 times compared to the mean state intensification. We found that event-to-event variability increases with warming for Western North America, Japan, and the UK, exhibiting intensification in both wet and dry conditions, which is potentially attributable to the increased occurrence of the aforementioned extreme events. We believe that our study will provide a new perspective into hydroclimatic stress under the future climate, in particular, for the additional 0.5°C warming and the importance of adhering to the Paris Agreement.