The timing of unprecedented hydrological drought under climate change

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Abstract

The intensified droughts under climate change are expected to threaten stable water resource availability. Droughts exceeding the magnitude of historical variability could occur increasingly frequently under future climate conditions. It is crucial to understand how drought will evolve over time because the assumption of hydrological stationarity of the past decades would be inappropriate for future water resources management. However, the timing of the emergence of unprecedented drought conditions under climate change has rarely been examined.

Here, using multimodel hydrological simulations, we investigate the changes in the frequency of hydrological drought (defined as abnormally low river discharge) under high and low greenhouse gas concentration scenarios and with existing water resources management and estimate the timing of the first emergence of unprecedented regional drought conditions that persist for over several consecutive years. This new metric enables a new quantification of the urgency of adaptation and mitigation with regard to drought under climate change.

The times are detected for several sub-continental-scale regions, and three regions, namely, southwestern South America, Mediterranean Europe, and northern Africa, exhibit particularly robust and earlier critical times under the high-emission scenario. These three regions are expected to confront unprecedented conditions within the next 30 years with a high likelihood, regardless of the emission scenarios. In addition, the results obtained herein demonstrate the benefits of the lower-emission pathway in reducing the likelihood of emergence. The Paris Agreement goals are shown to be effective in reducing the likelihood to the unlikely level in most regions. Nevertheless, appropriate and prior adaptation measures are considered indispensable to when facing unprecedented drought conditions. The results of this study underscore the importance of improving drought preparedness within the considered time horizons.

Keyword: Drought, Climate change, Unprecedented, Timing

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