Decomposing the uncertainties in global drought projections

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Droughts are anticipated to intensify in many parts of the world due to climate change. However, the issue of drought definition, namely the diversity of drought indices, makes it difficult to compare drought projections. This issue is widely known, but its relative importance has never been quantitatively evaluated by comparison to other sources of uncertainty.

Here, encompassing three drought categories (meteorological, agricultural, and hydrological droughts) with four temporal scales of interest by a consistent standardized approach, we evaluated changes in the drought frequency using multi-model and multi-scenario simulations to identify areas where the definition issue could result in noticeable uncertainties and to what extent. We investigated the disagreement in the signs of changes between drought definitions, i.e., drought category and temporal scale, and then decomposed the overall uncertainty by a four-way multifactorial analysis of variance (ANOVA) into four main factors (drought definitions, climate change scenarios, global climate models and global water models), as well as their interactions.

Our results highlight specific regions in which differences in drought definitions result in uncertainty, including areas showing opposite signs of significant changes. The drought definition was the dominant source of uncertainty in 17% of the global land area. Although model uncertainties were the primary source of uncertainty in large areas, drought definition uncertainty was the primary source, especially in parts of northern high-latitude. At a global scale, 7% of the uncertainty resulted independently from the definition issue, and that value increased to 44% when 1st and 2nd order interactions were considered. Nonetheless, uncertainty stemming from the issue of drought definition should be avoidable or reducible. Our quantitative results suggest that by clarifying hydrological processes or sectors of interest, one could avoid these uncertainties in drought projections to obtain a clearer picture of future drought.

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