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Droughts and floods with global warming: a perspective of surface water hydrology

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In many instances, e.g., agricultural and natural ecosystems, and for water resources planning, changes in the variability (or upper/lower extremes) of precipitation (P) (e.g., floods and droughts) can be as important as changes in the mean. With global warming, it is expected that "dry becomes drier and wet becomes wetter". This expectation was recently supported by an ocean study showing "dry becomes drier" over the oceans.

In this presentation, we will start with a theoretical perspective of surface water hydrology to show the fundamental difference between the ocean and land regarding the water cycle. By bringing this hydrologic perspective into both observational results and climate model outputs, we will demonstrate that the theoretical basis for the "dry becomes drier" is invalid over the land. For the other end, the wet part, the expectation is further complicated by aerosols since P extremes tend to decrease with aerosols while tending to increase with [CO_2] according to state-of-the-art climate modelling results.

We analyse observations (1940-2009) of monthly P over the global land surface using a new theoretical framework that can distinguish changes in global P variance between space and time. Interestingly, we found a reduction in global land P variance over space and time that was due to a redistribution, where, on average, the dry became wetter while wet became drier. Our results combined with recent modelling studies lead us to speculate that aerosol loading has played a key role in changing the variability of P.