Abstract

California is currently in the midst of a record-setting drought. The drought began in 2012 and now includes the lowest calendar-year and 12-mo precipitation, the highest annual temperature, and the most extreme drought indicators on record. The extremely warm and dry conditions have led to acute water shortages, groundwater overdraft, critically low streamflow, and enhanced wildfire risk.

Analyzing historical climate observations from California, we find that precipitation deficits in California were more than twice as likely to yield drought years if they occurred when conditions were warm. We find that although there has not been a substantial change in the probability of either negative or moderately negative precipitation anomalies in recent decades, the occurrence of drought years has been greater in the past two decades than in the preceding century. In addition, the probability that precipitation deficits co-occur with warm conditions and the probability that precipitation deficits produce drought have both increased. Climate model experiments with and without anthropogenic forcings reveal that human activities have increased the probability that dry precipitation years are also warm. Further, a large ensemble of climate model realizations reveals that additional global warming over the next few decades is very likely to create ~100% probability that any annual-scale dry period is also extremely warm. We therefore conclude that anthropogenic warming is increasing the probability of co-occurring warm–dry conditions like those that have created the acute human and ecosystem impacts associated with the “exceptional” 2012–2014 drought in California.

摘要

加州現在正處於紀錄設定預期的乾旱，開始於 2012 的這次乾旱，包含了最低的年和 12 個月的降雨、最高的年均溫、以及有紀錄以來最高的乾旱指標。急遽的高溫和乾旱，加速水的短缺、地表水的流失、水流流量減少、進而促成野火燎原的危機。

分析加州的歷史氣候觀測資料，我們發現，乾旱時加州的降雨其減少的量將近是高溫時降雨減少亮的兩倍。我們發現，縱使近幾十年來，降雨異常的減少或緩慢減少的機率並無太大變化，然而在過去二十年內乾旱的發生遠多於上世紀的發生次數。除此之外，伴隨暖化造成的降雨量減少的發生機率，以及因為降雨減少造成乾旱的機率，兩者將會越來越頻繁。

分別採用和為用人為影響的氣候模式實驗，顯示了人為活動增加了高溫和乾旱年發生的機率，除此之外，從一大型氣候模式的系集得知，在未來幾十年內，越多的全球暖化，將使每年的乾旱期增溫的機率趨近於 100%。

因此我們可以得知，人為造成的暖化，正在增加高溫和乾旱同時發生的機率，這類影響，正如同 2012~2014 在加州的乾旱，對人類和生態系造成急遽影響。