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The direct and lagged responses of vegetation productivity to seasonal compound events

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Compound climate events can significantly impact vegetation productivity, yet the direct and lagged vegetation productivity responses to seasonal compound warm-dry and cold-dry events remain unclear. Using observationally-constrained and process-based model data, we analyze vegetation productivity responses to the compound conditions of precipitation and temperature in spring and summer. Our results show the regional asymmetries in direct and lagged effects of compound warm-dry events. In high-latitudes (>50°N), compound warm-dry events raise productivity. In contrast, in mid-latitudes (23.5-50°N/S), compound warm-dry events reduce productivity and compound warm-dry springs can cause and amplify summer droughts, thereby reducing summer productivity. Moreover, compound cold-dry events impose directly and indirectly adverse synergistic effects on productivity in mid-to-high latitudes and their effects exceed individual cold and dry impacts. Our results highlight that a multivariate perspective is necessary to appropriately investigate the impacts of climate extremes on vegetation productivity as precipitation and temperature often covary.