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Climate-driven increase in the variability and multi-year mean level of severe thunderstorm-related losses and thunderstorm forcing environments in the U.S. since 1970

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In the year 2011, direct losses from thunderstorms reached US$ 26 billion (insured) and US$ 47 billion (economic), thus equalling the dimension of losses caused by Hurricane Sandy in the New York area 2012. Beyond doubt the 2011 damages had outlier characteristics due to two cities hit by tornadoes. Nonetheless a substantial increase in the variability of normalised direct economic and insured severe thunderstorm-related losses in the U.S. east of the Rocky Mountains over the period 1970-2009 (March – September) has been detected. Besides the annual variability, also the multi-year mean level of losses has strongly increased. Our study focused on sizeable severe thunderstorm events causing at least US$ 250 million in normalized economic losses. The high threshold guarantees homogeneity over time, because those events regularly covered several states and thus are very unlikely to have been missed at any time due to reporting variability.

To shed light on the question whether the strong increase was driven by an external climate driver, the time series of normalized losses (annual counts and annual loss aggregate) was correlated with the time series of thunderstorm forcing environments. The latter were inferred from NCEP/NCAR reanalysis data and comprise 6-hourly CAPE and vertical wind shear data combined to form a variable called Thunderstorm Severity Potential (TSP). From the notable correlation found between the time series of normalized thunderstorm-related losses and meteorologically registered thunderstorm forcing environments (TSP) it could be inferred that climate was the dominant driver for the increase in variability and average level of thunderstorm-related losses over the period 1970-2009. An important component in the rise of TSP over time could be identified in CAPE, as we found a substantial rise in the annual number of exceedances of a high CAPE threshold in the reanalysis data.

Recent studies imply that the changes observed in our study, particularly regarding an increase in high-level CAPE environments, are consistent with the modelled effects of anthropogenic climate change. The physical chain of climate change-driven increasing levels of specific humidity (Willett et al. 2010) leading to rising levels of CAPE as one of the preconditions of more severe thunderstorm forcing environments has already been established by measurements and climate model experiments (Trapp et al. 2007, 2009).

Literature:

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