Climatology of Floods in the United States as Observed by Storm Reports and TRMM Rainfall Data

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Abstract. Floods are the second deadliest weather-related natural disaster in the United States (Ashley and Ashley 2008) and have resulted in $120 billion worth of losses since 1980 (NCEI 2018). The risk of flooding is expected to increase in the future, due to increased heavy precipitation in a warmer and moister climate (Trenberth et al. 2003, Ban et al. 2015, Dai et al. 2017, Prein et al. 2017, Rasmussen et al. 2017). Before understanding how floods may change in the future, it is first critical to understand the characteristics of floods across the continental United States (CONUS) from a climatological perspective. Numerous flood-related climatologies across the CONUS have been performed before, but they have been either from a purely meteorological standpoint through the examination of extreme rainfall (Maddox et al. 1979, Schumacher and Johnson 2006) or from a hydrological perspective through the examination of stream discharge (Michaud et al. 2001, Saharia et al. 2017). However, no prior studies have performed a comprehensive flood climatology over the entire CONUS from a hydrometeorological perspective. The goal of my research is to address this gap by developing a hydrometeorological climatology of floods over the CONUS from 2000–2013, utilizing the National Centers for Environmental Information (NCEI) Storm Events database to identify floods and the Tropical Rainfall Measuring Mission Multi-Satellite Precipitation Analysis 3B42 version 7 (TRMM 3B42) to characterize the associated rainfall.

The NCEI database was used to identify the location, duration, and frequency of slow-rise, flash, and hybrid (a category created for floods labeled as both slow rise and flash flood) flood episodes. After excluding flood episodes with only a single report (which are more likely to be spurious data points), this resulted in approximately 2000 slow rise, 3700 flash, and 1300 hybrid floods over the 13-year period across the CONUS. Since the NCEI Storm Events database does not provide information on the amount of precipitation causing the flood, TRMM 3B42 3-hourly rainfall data was utilized to quantify the rainfall associated with these floods. For each flood episode, rainfall metrics were calculated at the 25th, 75th, and 90th percentiles, such as the total accumulated rainfall and volumetric rainfall. The average accumulated rainfall exceeding the 75th percentile threshold in each county was calculated, as well as the average duration, area, and number of these flood per county in order to understand the characteristics of high-impact flood events across the CONUS. The characteristics and spatial distribution of high-impact floods was found to differ based on flood type and is hypothesized to be due to different underlying atmospheric and hydrologic causes. Such a comprehensive hydrometeorological climatology of floods across the CONUS is unprecedented and the results could aid water resource managers and city-planners in developing more water-resilient communities.