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Compound flood risk from storm surge and rainfall in coastal China

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The interaction between storm surge and concurrent rainfall can cause greater flooding impacts than either in isolation. This paper investigates the relationship between these two hazards by using observational records of hourly sea level from 11 tide gauges and daily precipitation data from neighbouring stations along the coast of China. Statistically significant dependence between the two drivers of coastal flooding exists the majority of locations that were analysed, but the strength of the correlation varies spatially and depending on how extreme events are defined. In general, we find higher correlation at tide gauge sites in the south compared to the north. Seasonal variations in the dependence are also evident. Overall there are more sites with significant dependence in the summer, dependence is appearing in autumn in the southern parts. Tail dependence coefficients (TDCs) are also significant (and larger than the rank correlation) indicating higher incidence of joint events in the upper tail region, especially in the summer season. We also test the sensitivity of the number of compound events to several large-scale climate indices. Based on historical disaster damages, in Hong Kong, impacts from flooding during compound events are typically larger as when resulting from either freshwater or coastal flooding. Considering the low capacity of drainage systems in many Chinese urban areas, these findings have important implications for flood risk assessments and management, highlighting the necessity to jointly assess the two most important flood drivers to accurately quantify and mitigate compound flood risk.