Changes in Dependence between Drivers of Compound Flooding around the Contiguous United States Coastline

Ahmed Nasr[1*], Thomas Wahl[1], Md Mamunur Rashid[1], Paula Camus[2], Ivan D. Haigh[2]

[1] Civil, Environmental, and Construction Engineering & National Center for Integrated Coastal Research, University of Central Florida, Orlando, FL 32816-2450, USA
[2] Ocean and Earth Science, National Oceanography Centre Southampton, University of Southampton, Southampton, SO14 3ZH, UK

MOTIVATION

Previous work (e.g., Wahl et al., 2015) demonstrated increased risk of compound flooding from storm surge and rainfall for major US cities due to increased dependence between surge and precipitation. Here, we build on that and further investigate temporal changes in dependence between surge and discharge; and between discharge and precipitation.

DATA

Observational data from multiple sources starting as early as 1900 until 2019 with at least 50 years of overlapping records between drivers from Nasr el al. (2021) are used.

Data	Source	Resolution (t)
Water Level	NOAA	Hourly
Discharge	USGS	Daily
Precipitation	GHCN-D	Daily

METHODOLOGY

1. Pick locations with overlapping data records (**Fig. 2**).
2. Calculate tail (extremal) dependence (χ) (threshold=0.90) on a moving time window of length 30 years and timestep of 1 year (**Fig. 3**).
3. Show locations with time-variable tail (extremal) dependence between surge (S) and discharge (Q) for entire year and two half-years (tropical and extra-tropical) (and consequently increased risk due to increased compound flooding potential) (**Fig. 1**).

This material is based upon work supported by the National Science Foundation (NERC-NSF joint funding opportunity) under the NSF grant (grant no. 1929382 for Thomas Wahl and Ahmed A. Nasr). Paula Camus and Ivan D. Haigh's time on this research has been supported by the UK NERC grant (CHANCE; grant no. NE/S010262/1).

(Extremal) Dependence between oceanographic and inland flooding drivers has changed over time and across seasons (Tropical vs. Extra-tropical). This change in dependence alters risk of compound flooding potential from surge and discharge at coastal locations in the United States.

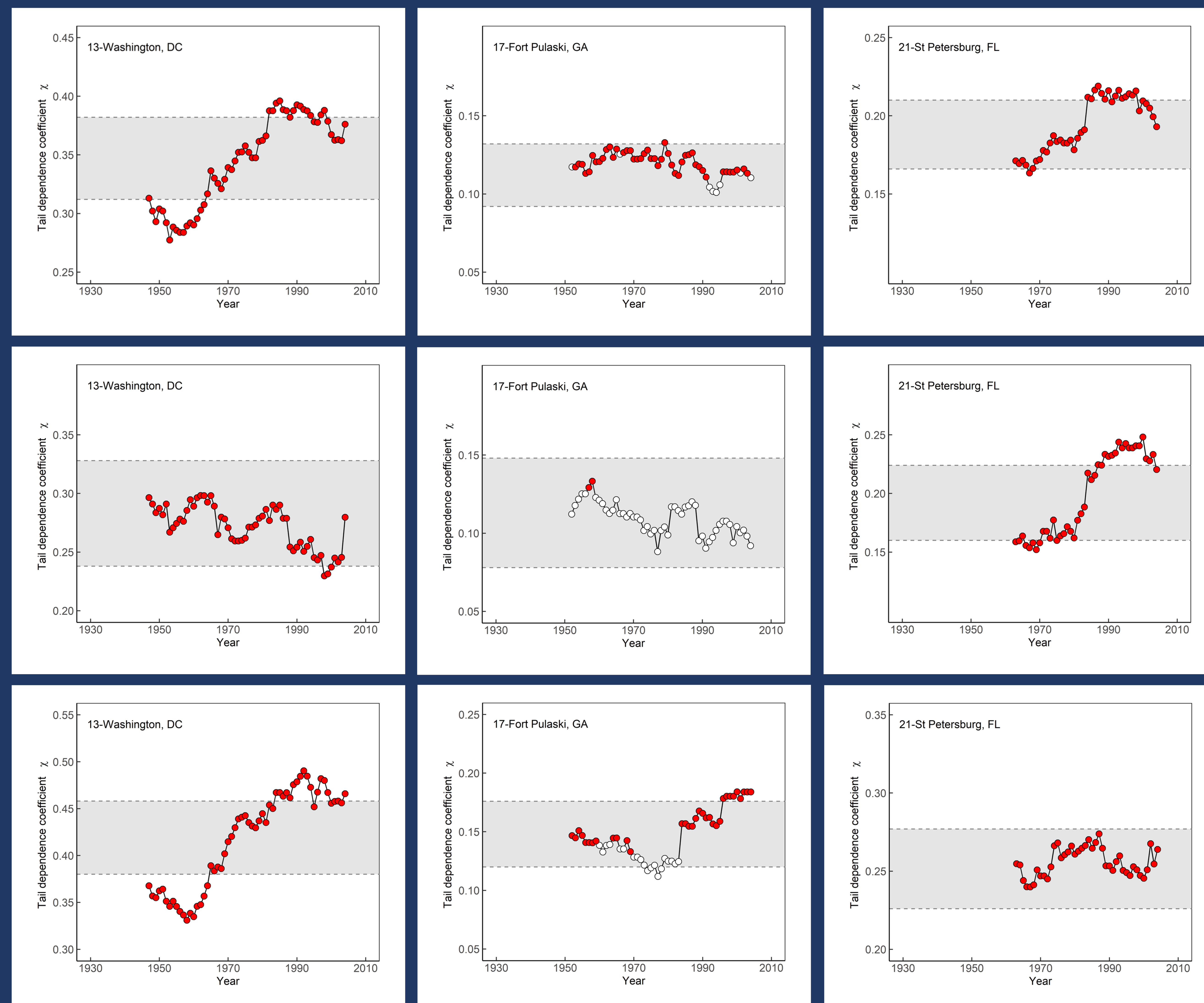

Fig. 1: Extremal (tail) dependence (at threshold = 0.9) between surge and discharge calculated using a time window of length 30 years for three locations: Washington, DC (left column); Fort Pulaski, GA (middle column); St. Petersburg, FL (right column). Extremal dependence calculated for the daily timeseries for entire year (top row), Tropical season (June-November; middle row), and Extra-Tropical season (bottom row). Grey region is range of natural variability of tail dependence (10% and 90%). Red markers indicates significant tail dependence value (at 95% level) and insignificant values are marked in white.

***Contact Details**

@aanasr

ahmed.nasr@knights.ucf.edu

Find out more

https://doi.org/10.5194/hess-25-6203-2021

SUPPORTING INFORMATION

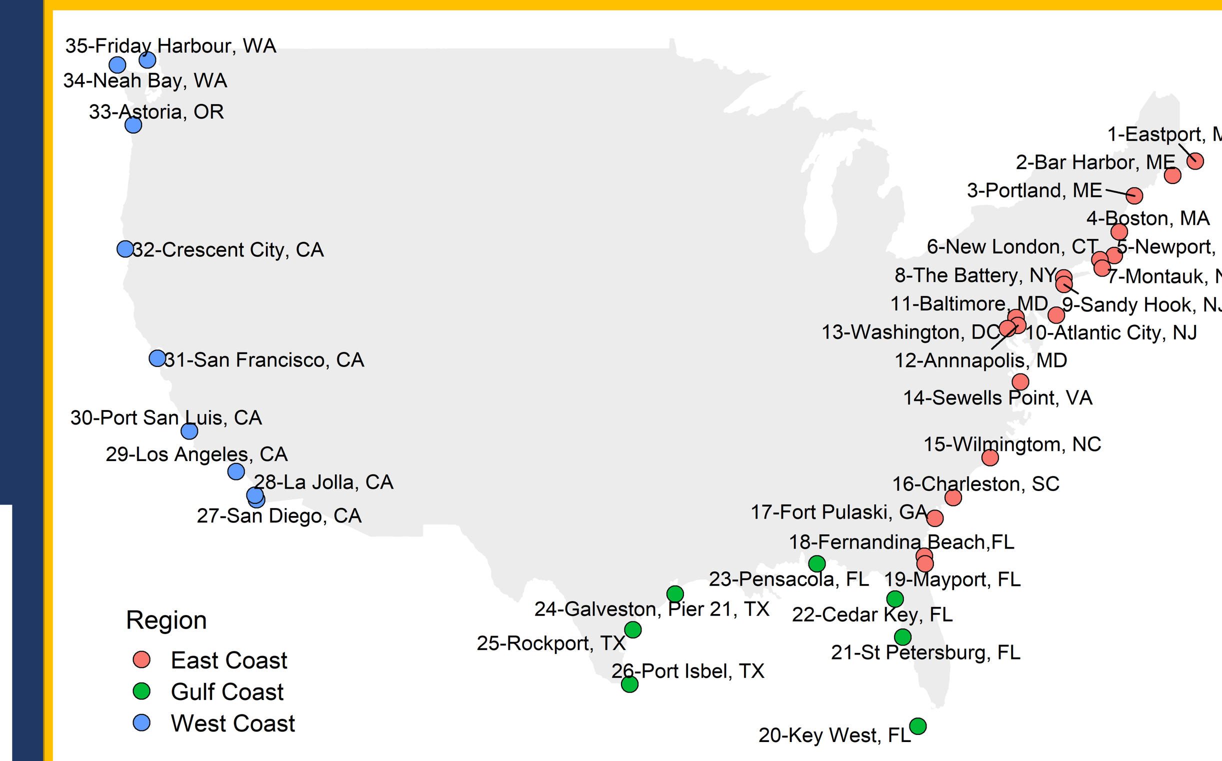

Fig. 2: Selected study Locations (Nasr et al. 2021)

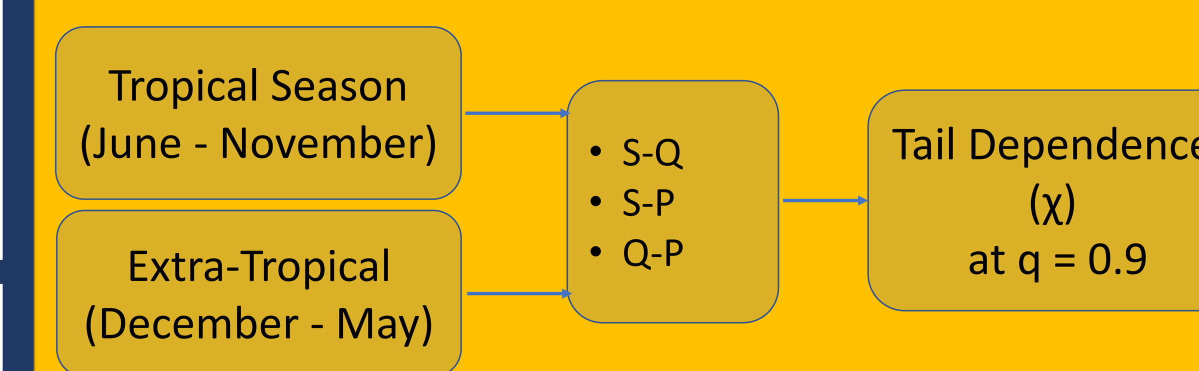

Fig. 3: Flowchart of (Extremal) dependence calculation

WAY FORWARD:

- Complete Analysis for other driver combinations (e.g., surge-precipitation and discharge-precipitation).
- Assess changes in dependence structure in addition to changes in dependence magnitude.
- Investigate the relationship between changes in dependence and large-scale climatic drivers (e.g., ENSO, NAO, etc.).

REFERENCES

Wahl, T., Jain, S., Bender, J., Meyers, S. D., and Luther, M. E.: Increasing risk of compound flooding from storm surge and rainfall for major US cities, Nat. Clim. Change, 5, 1093–1097, 2015.

Nasr, A. A., Wahl, T., Rashid, M. M., Camus, P., and Haigh, I. D.: Assessing the dependence structure between oceanographic, fluvial, and pluvial flooding drivers along the United States coastline, Hydrol. Earth Syst. Sci., 25, 6203–6222, 2021.