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# The Effects of Tidal Changes on the Frequency of Nuisance Flooding Events in the United States

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# Background

- Tides have been changing over past century
- More Flooding events are experienced in recent decades

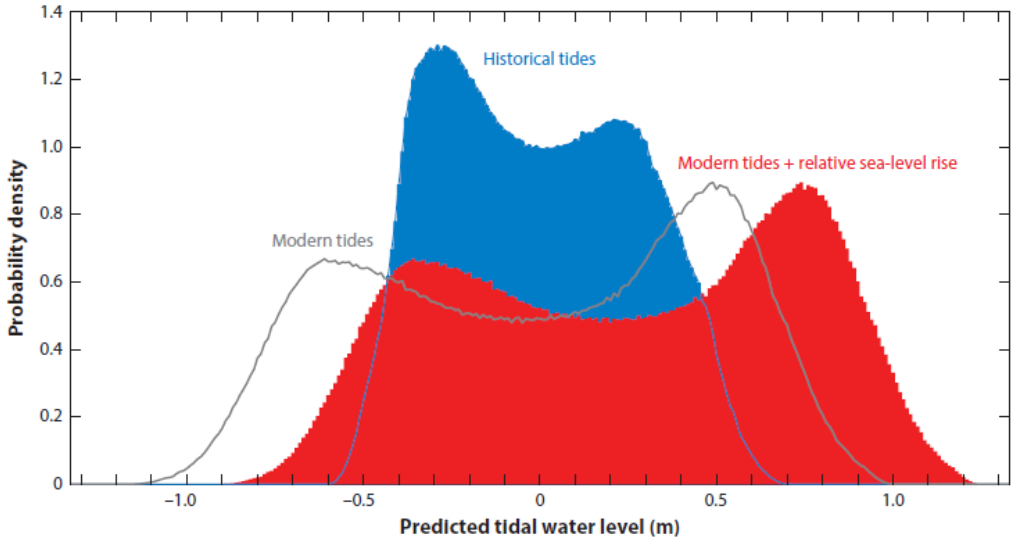



Figure 6

Distribution of predicted hourly tidal elevations in Wilmington, North Carolina, over an 18.61-year nodal cycle based on historical (1887) and modern (2017) hourly records. The gray curve indicates the modern distribution of predicted tidal water levels if no relative sea-level rise had occurred, while the red curve includes an estimated ~0.25 m of sea-level rise since 1910, based on the NOAA trend line from 1935 to 2018 (e.g., Sweet et al. 2017). The predicted water levels and nodal corrections were made using T-TIDE (Pawlowicz et al. 2002). The data are described in Familkhalili & Talke (2016).

(Talke and Jay, 2020 )

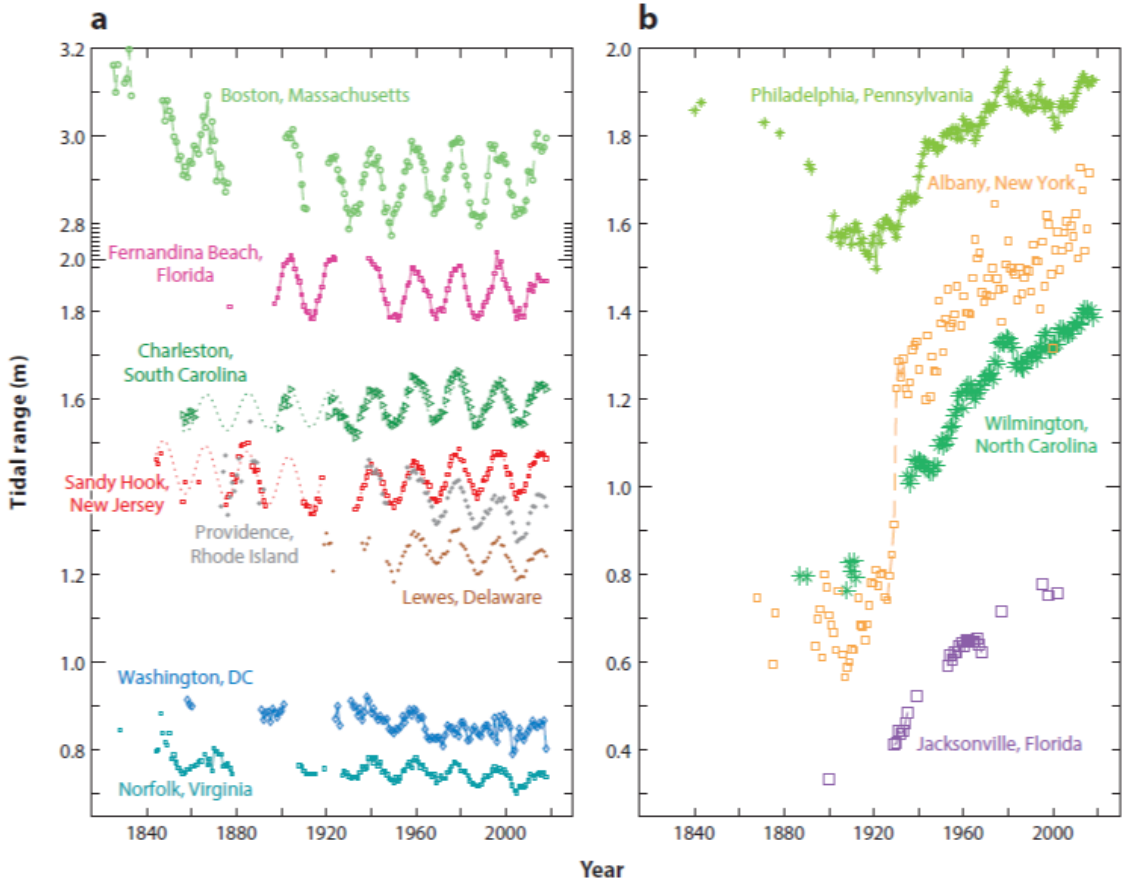



Figure 2

Examples of (*a*) minor or moderate changes and (*b*) major changes in tidal range for selected locations along the US East Coast with long records. The plots are a combination of NOAA data and archival records described by Talke et al. (2014, 2018), Familkhalili & Talke (2016), Talke & Jay (2017), and Ralston et al. (2019). The dashed lines for Sandy Hook and Charleston show how a best-fit regression line that includes a trend and nodal cycle is fit to the data, following the method of Woodworth (2010).

(Talke and Jay, 2020 )

# Objectives

- Quantify how changes in tides contributed to past changes in the frequency (and duration) of high tide (or nuisance) flood events along the U.S. coastline

- Aggregate results across all tide gauges and separately for coastal and estuarine locations

- Assess the role of the 4.4- and 18.6-year tidal cycles in modulating high tide flooding frequencies (not shown here)

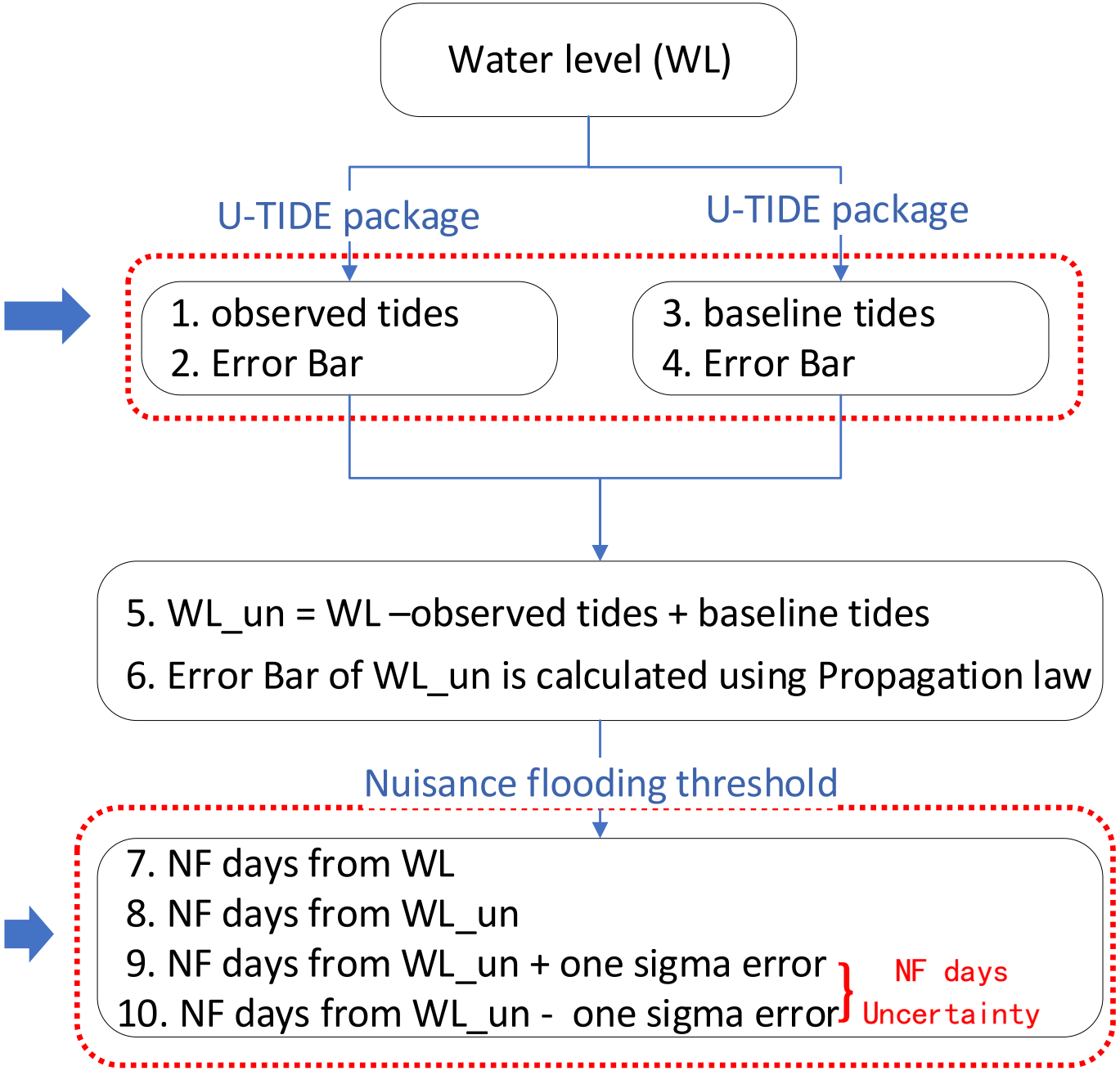
# Methodology

No. 1 & 3: obtain ‘observed’ and historic ‘baseline’ tides

No. 2 & 4: drive error bars of all tidal constituents with U-TIDE; then calculate error bars of ‘observed’ and ‘baseline’ tides via Propagation of Uncertainty.

No.7-10. $NF_{WL} - NF_{WL\_un}$ represents the difference in NF (nuisance flooding) days, attributed to changing tides.

$NF_{WL} - NF_{WL\_un+sigma}$ and $NF_{WL} - NF_{WL\_un-sigma}$ represent uncertainty in the difference of NF days.



# Results

Tidal range at Wilmington (North Carolina) increased (~0.57 m) over the past century (Familkhalili & Talke, 2016). The differences of Mean Highest Astronomical Tides (MHAT) between ‘observed’ tides and ‘historic’ tides (here derived from the first xx years of data) increase with time and is up to ~0.18 m recently.

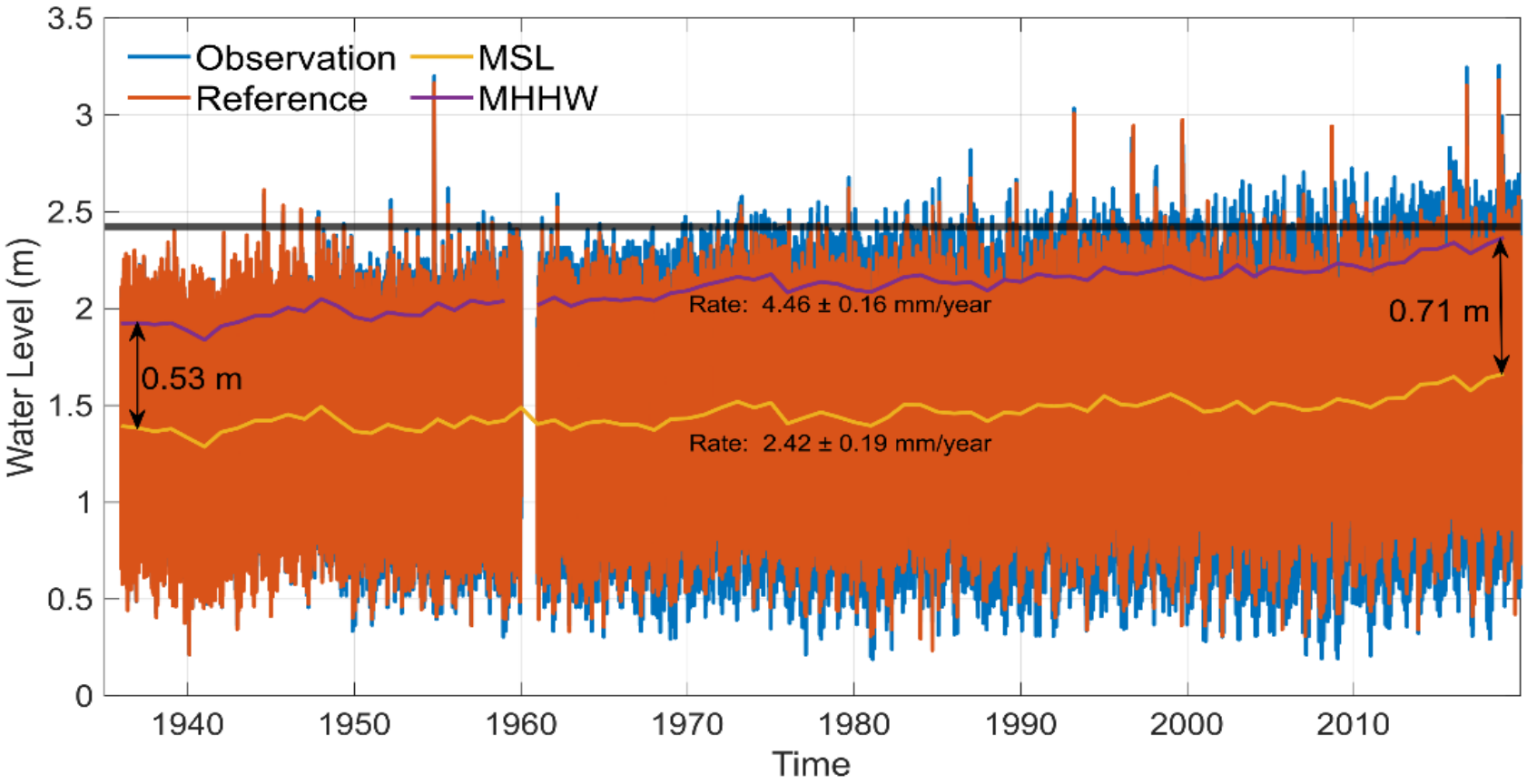




Figure 1. Tides change at Wilmington from 1935 to 2019. The black line is the NF threshold (2.424 m). MHHW is the yearly mean higher high water level (only tides + MSL). The ‘baseline’ series was derived by removing the observed tides and adding the ‘historic’ tides.

# Results & Discussion

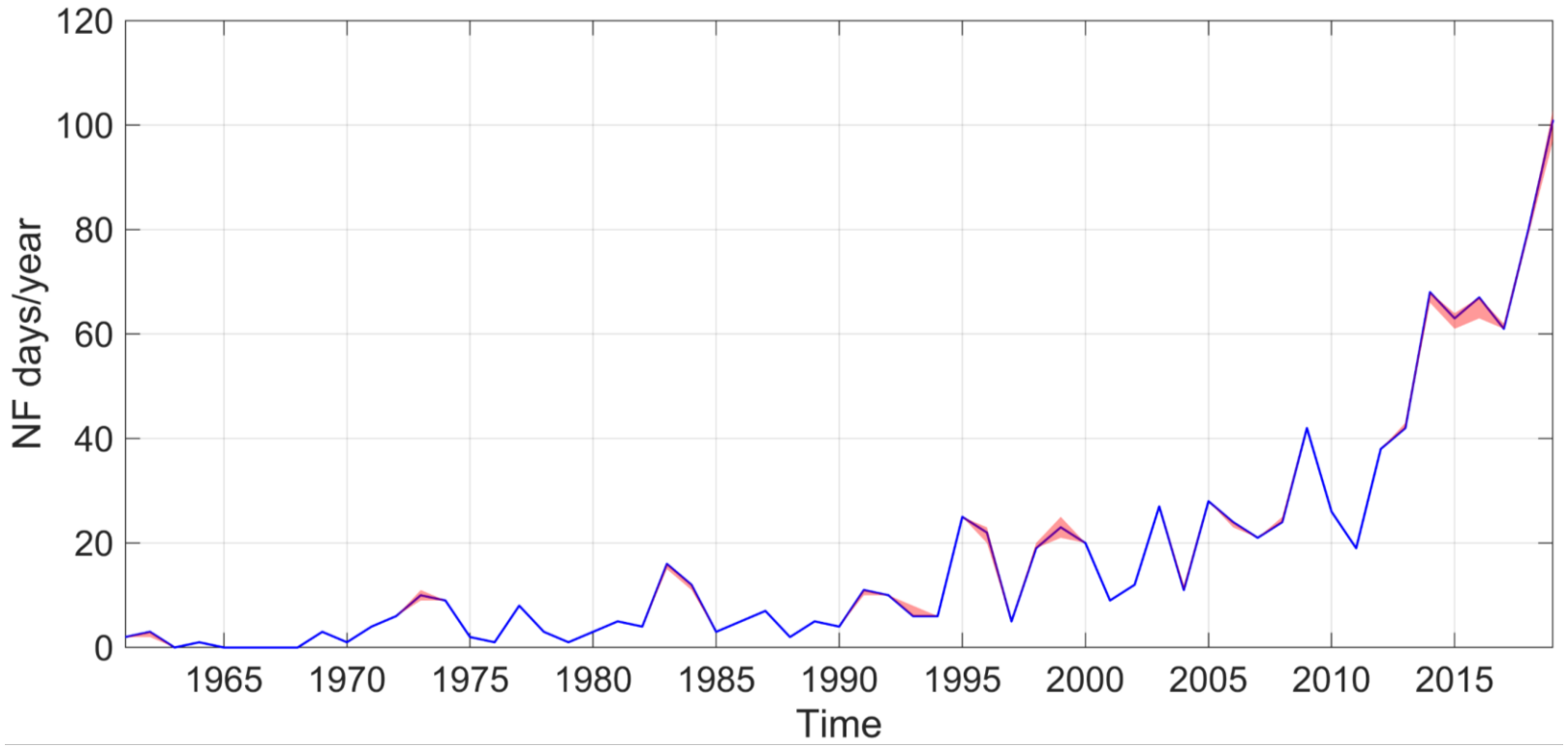



Figure 2. Difference in NF days at Wilmington when assuming historic tidal conditions. The red shaded area is the one sigma uncertainty

The tide gauge Wilmington is located in the Cape Fear estuary, 47 km upstream of the estuarine mouth. The tidal range has increased by approximately 0.38 m since 1936 (0.57 m since 1887), mainly due to dredging. The relative channel deepening $\Delta h/h$ (48% change from 1932 to 2001) greatly amplified the tidal range. This resulted in ~100 additional NF days in 2018 that would not have occurred if tidal conditions remained stable.