Automating Storm Identification and Classification for Extreme Storm Catalogs to use with Stochastic Storm Transposition

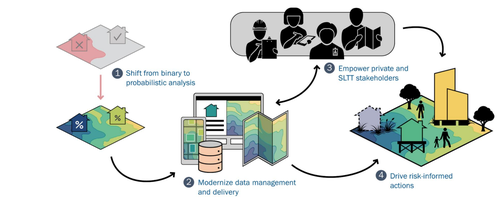
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105TH ANNUAL MEETING 12–16 JANUARY NEW ORLEANS & ONLINE AMERICAN METEOROLOGICAL SOCIETY
Precipitation Processes and Observations for Atmospheric, Land Surface, and Hydrological Modeling Posters
Poster #13

Dewberry
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FEMA
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Motivation

FEMA's Future of Flood Risk Data (FFRD) initiative emphasizes a shift from binary to graduated risk analysis, analyzing hazards at any location in a watershed where development has or can occur.



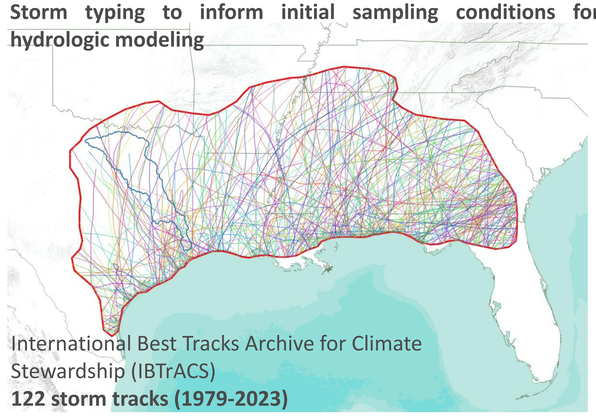
- Produce structure-level estimates of flood hazard from 1/5 – 1/2,000 AEP including uncertainty
- Include fluvial and pluvial-source hazards
- Evaluate potential levee and dam failures

Study Area

Trinity River watershed (HUC4 - 17,916mi^2) and transposition domain (361,557mi^2)

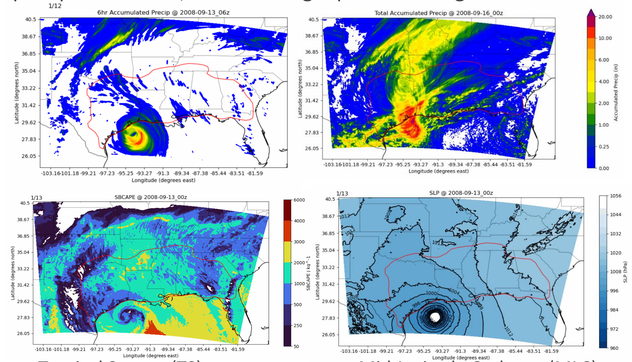
- Multiple storm events occur simultaneously
- High seasonal variability

Storm typing to inform initial sampling conditions for hydrologic modeling



Manual Storm Typing

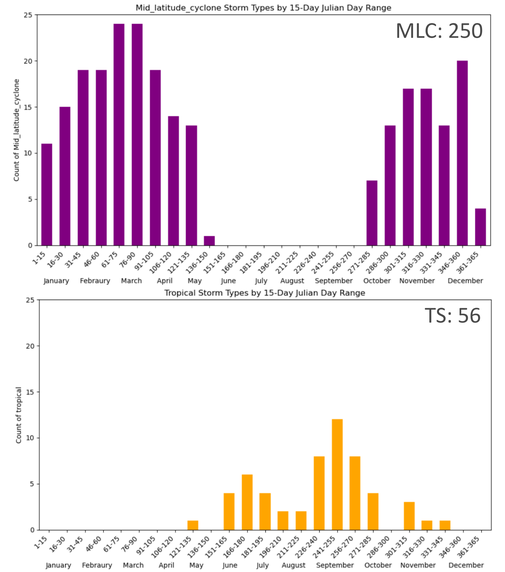
CONUS404 reanalysis and Jupyter notebooks to visualize 213 storms based on precipitation, convective available potential energy, mean sea-level pressure, storm relative helicity, precipitable water, and 500mb geopotential height



- Tropical Storms (TS)
- Mesoscale Convective Storm (MCS)
- Mid-Latitude Cyclones (MLC)
- Local Storms (LS)
- Hybrid (multiple types)

Storm Counts and Seasonality

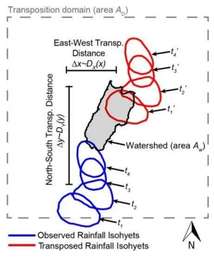
Model applied to top 440 largest 72-hour storms



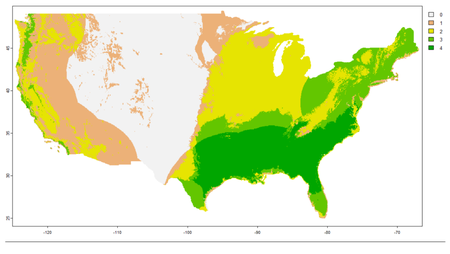
Not pictured - LS : 4

Stochastic Storm Transposition

- **Space for time substitution** to increase the number of realistic storm patterns in a study area
- Climatologically homogenous transposition domain
- Any storm that occurred within the region could be transposed to any other location

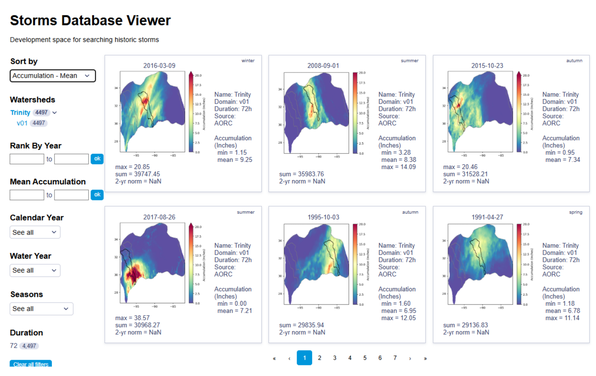


Wright, D.B., Yu, G., & England, J.F. (2020)



- Mean annual precipitation
- Distance to coast (moisture)
- Mean annual dewpoint
- Elevation

Storm Catalog



storms.dewberryanalytics.com

- 4-km 1-hour Analysis of Record for Calibration (AORC) Quantitative Precipitation Estimates (QPE)
- 72-hour sliding window over AORC period of record
  - 1979-2022
- Maximize total accumulation over watershed
- Unique catalog to each SST region and basin of interest

Automated Storm Typing

Multinomial log-linear regression to predict likely storm type using **Precipitation, CAPE, MSLP, Month** of 213 storms (160 training and 53 testing dataset)

- Correctly typed 43/53 test events (81% accuracy)

Storm Counts

	Hybrid	LS	MCS	MLC	TS
Test Dataset	7	3	10	26	7
Predicted	5	5	8	28	7

Contingency Table

Test Dataset (left) Predicted (top)	Hybrid	LS	MCS	MLC	TS
Hybrid	3	0	1	3	0
LS	0	2	1	0	0
MCS	2	2	6	0	0
MLC	0	1	0	25	0
TS	0	0	0	0	7

Precision *(diagonal of CT/row sums of CT)*

Hybrid	LS	MCS	MLC	TS
0.43	0.67	0.60	0.96	1.00