Storm-Typed Stochastic Storm Transposition in a Quasi-Continuous Framework

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AGU24
Washington, D.C. | 9–13 December 2024
H31J-0727

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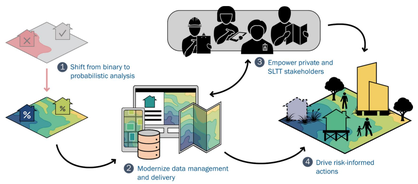
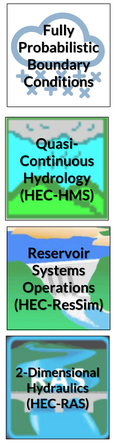
Motivation, Tools, and Goals

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.

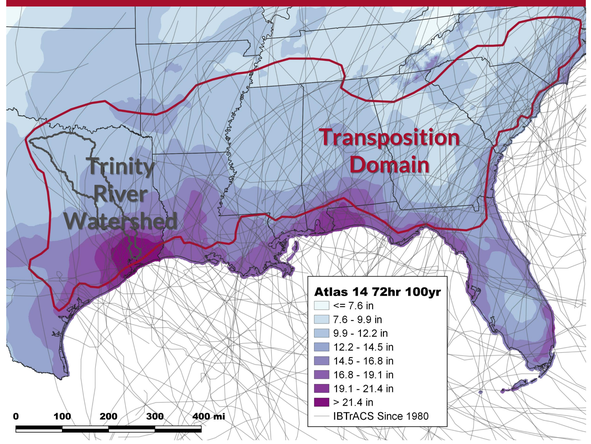


- Produce structure-level estimates of flood hazard from 1/5 – 1/2,000 AEP including uncertainty
- Include fluvial and pluvial-source hazards
- Evaluate potential levee and dam failures



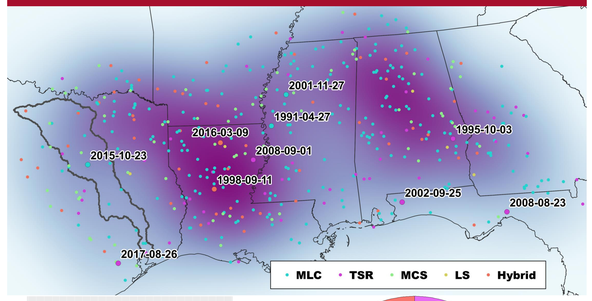
Managed by cloud-compute on AWS
See H41F-05 (12/12/24 09:10 144A-C)

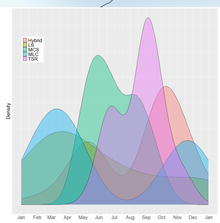
Study Area



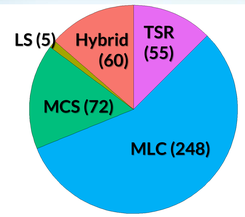
- Trinity River watershed in eastern Texas (17,916 mi²)
- Third FFRD methodology pilot study being performed by USACE

Storm Catalog Contents





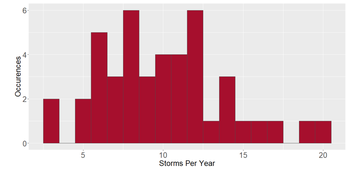
Seasonality of the five storm types.

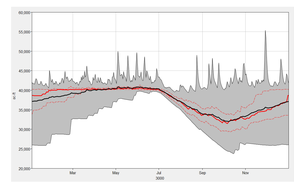


Counts of the five storm types.

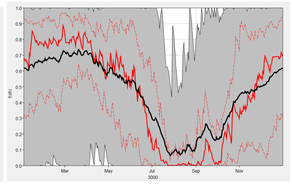
Sampling Framework

- Capture antecedent condition and hydrologic parameter uncertainty
- Select random number of storms from catalog with equal probability
- Initialize hydrologic model for a random year in the POR simulation corresponding to the synthetic date from seasonality distribution
- Select calibration parameter set from one of six event calibrations





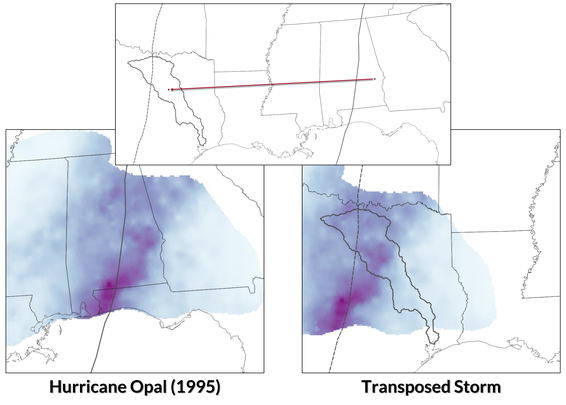
Lk. Arlington Reservoir Storage



Big Bear Cr. S10 Soil Saturation

Modeling Approaches

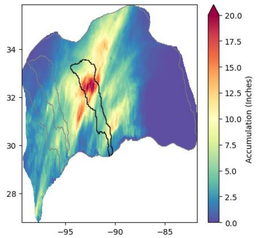
- Stochastic Storm Transposition (SST) for boundary conditions
- Hydrologic antecedent conditions drawn from POR simulation
- All storms in catalog classified into one of five broad storm types
- Precipitation normalization using NOAA Atlas 14 100-yr 72 hr fields



Hurricane Opal (1995) **Transposed Storm**

Storm Catalog Development

- Transposition domain is a region of similar elevation, annual precipitation, dewpoint, and distance to coastline as the watershed
- Storms data from AORC 4 km dataset (Kitzmiller, et al. 2018)
- 440 largest 72-hour storms from each year of the POR (1979-2022)
- Subset of storms manually classified into five storm types to train multinomial regression classifier: Mid-latitude cyclones (MLC), Tropical Storms (TSR), Mesoscale Convection (MCS), Local Storm (LS) and Hybrid.

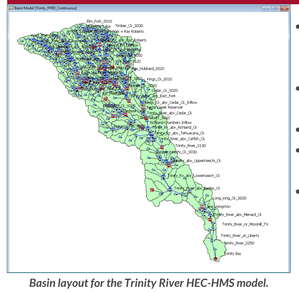


2016-03-09 T001 Hybrid (9.25 in)

Ranking of top ten storms by potential precipitation.

Rank	Date	Type
1	2016-03-09	Hybrid
2	2008-09-01	TSR
3	2015-10-23	MLC
4	2017-08-26	TSR
5	1995-10-03	TSR
6	1991-04-27	MLC
7	2001-11-27	MLC
8	1998-09-11	Hybrid
9	2008-08-23	TSR
10	2002-09-25	TSR

Model Implementation



Basin layout for the Trinity River HEC-HMS model.

- HEC-HMS model developed for water management forecasting adapted for FFRD study
- 289 subbasins, 193 reaches, 31 reservoirs, 23 calibration points
- 6 event calibrations
- 2-year continuous calibration
- 44-year POR simulation forced by AORC used for SST initial states

Process	Method
Loss	Deficit and Constant
Transform	ModClark
Baseflow	2- Layer Linear Reservoir
Discretization	2000m SHG
Potential Evapotranspiration	Gridded Hamon

Effects of Normalization

- Storm non-dimensionalization using mosaic of Atlas 14 grids
- Normalization improves homogeneity of transpositions
- FFRD study in Green River (WA) improved results in mountains
- Further work is needed to characterize normalization procedure

No Normalization **With Normalization**