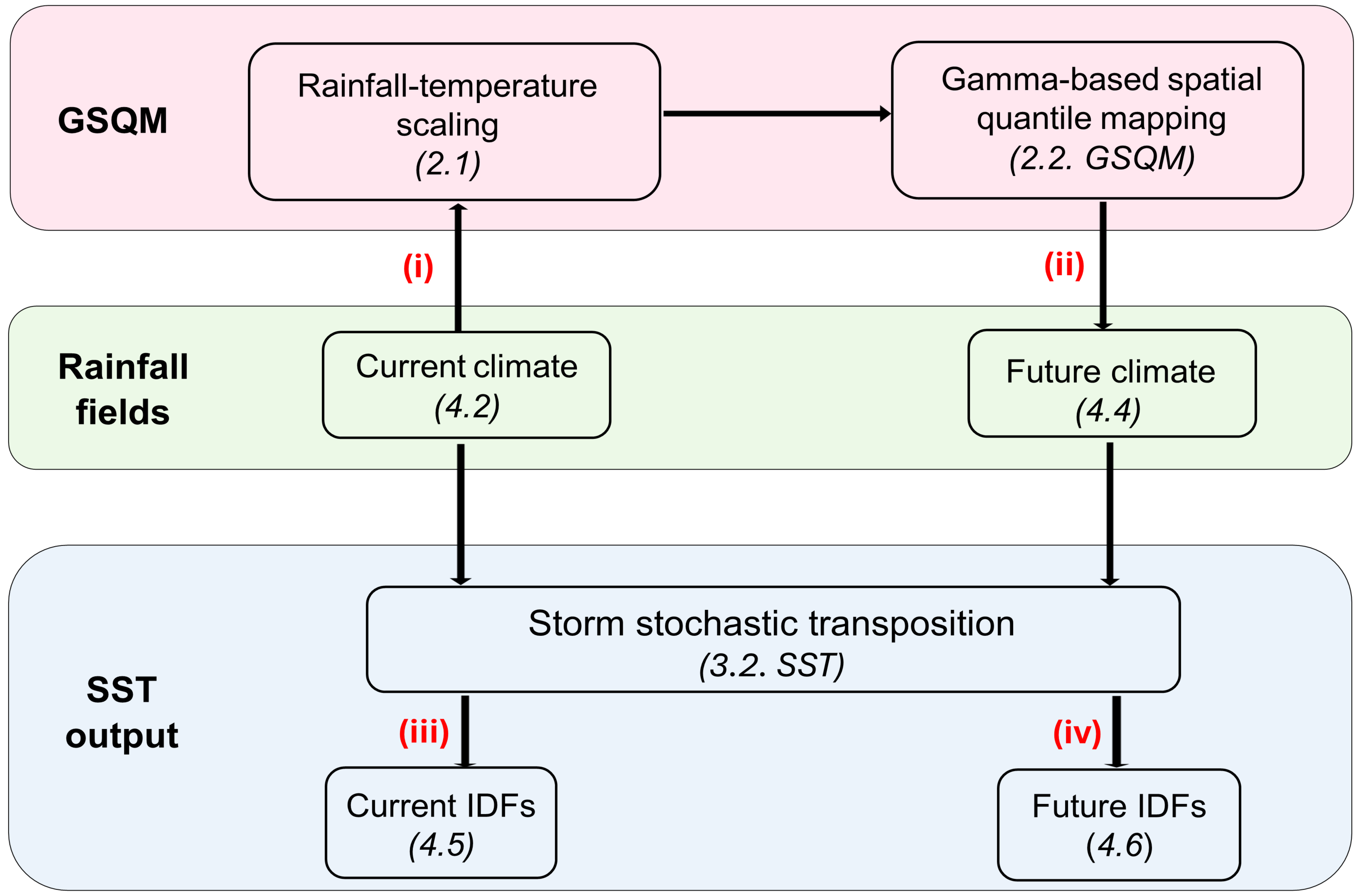
Supplementary

The GSQM-SST framework to project future rainfall extremes



Stochastic Storm Transposition (SST)

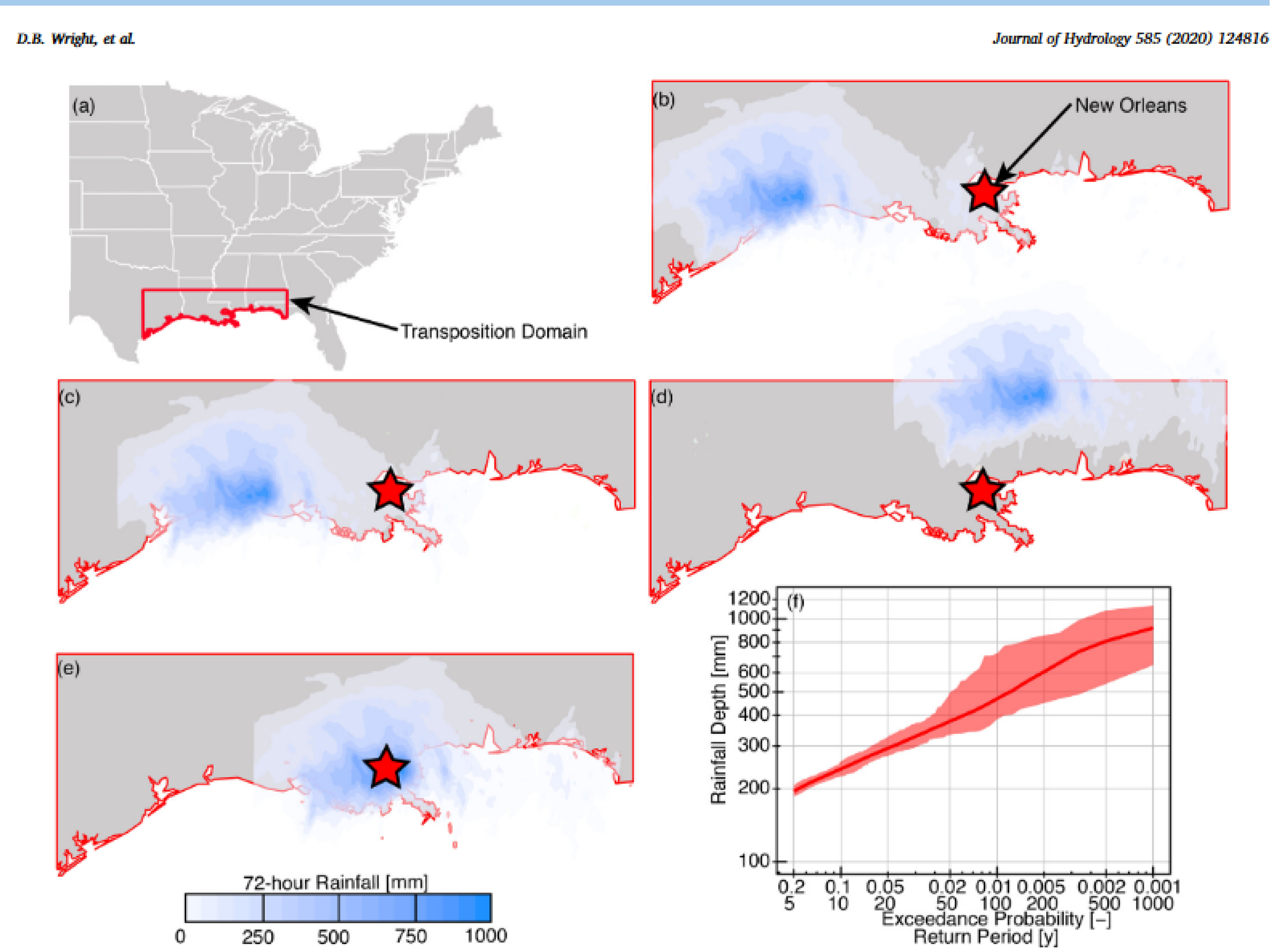


Fig. 2. (a) Transposition domain for a region surrounding New Orleans, Louisiana along the southern United States Gulf Coast. (b) Peak 72-hour rainfall map for Hurricane Harvey in August 2017, based on Stage IV gage-corrected radar rainfall data (Lin, 2011). (c) to (e) three possible random transpositions of Hurricane Harvey rainfall which produce little, no, and extreme rainfall over New Orleans, respectively. (f) Example 72-hour IDF curve for New Orleans generated using the RainyDay software (Section 4.4); shaded area portrays the spread of 100 distinct realizations, each consisting of 1000 annual rainfall maxima.

Gamma-based Spatial quantile mapping (GSQM)

Morph *WARp* based on S_{WAR}

Choose Gamma distribution to obtain the quantile map of *R*

Adjuast *R99p* based on S_{R99}

Obtain *Tem-projected* R_p from the inverse Gamma distribution

Based on Gamma distribution

$$WARp = WAR \cdot S_{WAR}$$

$$Q(x, y) = G[R(x, y), a, b].$$

$$a = \frac{1}{\mathrm{CV}^2}, b = \mathrm{MAR} \cdot \mathrm{CV}^2.$$

$$G_p^{-1}[Q > 99, a_p, b_p] = R99 \cdot S_{R99},$$

$$a_p = \frac{1}{(CV \cdot S_{CV})^2} \quad b_p = (MAR \cdot S_{MAR}) \cdot (CV \cdot S_{CV})^2.$$

$$R_p(x, y) = G_p^{-1}[Q(x, y), a_p, b_p].$$

Discussion

Rainfall-temperature scaling

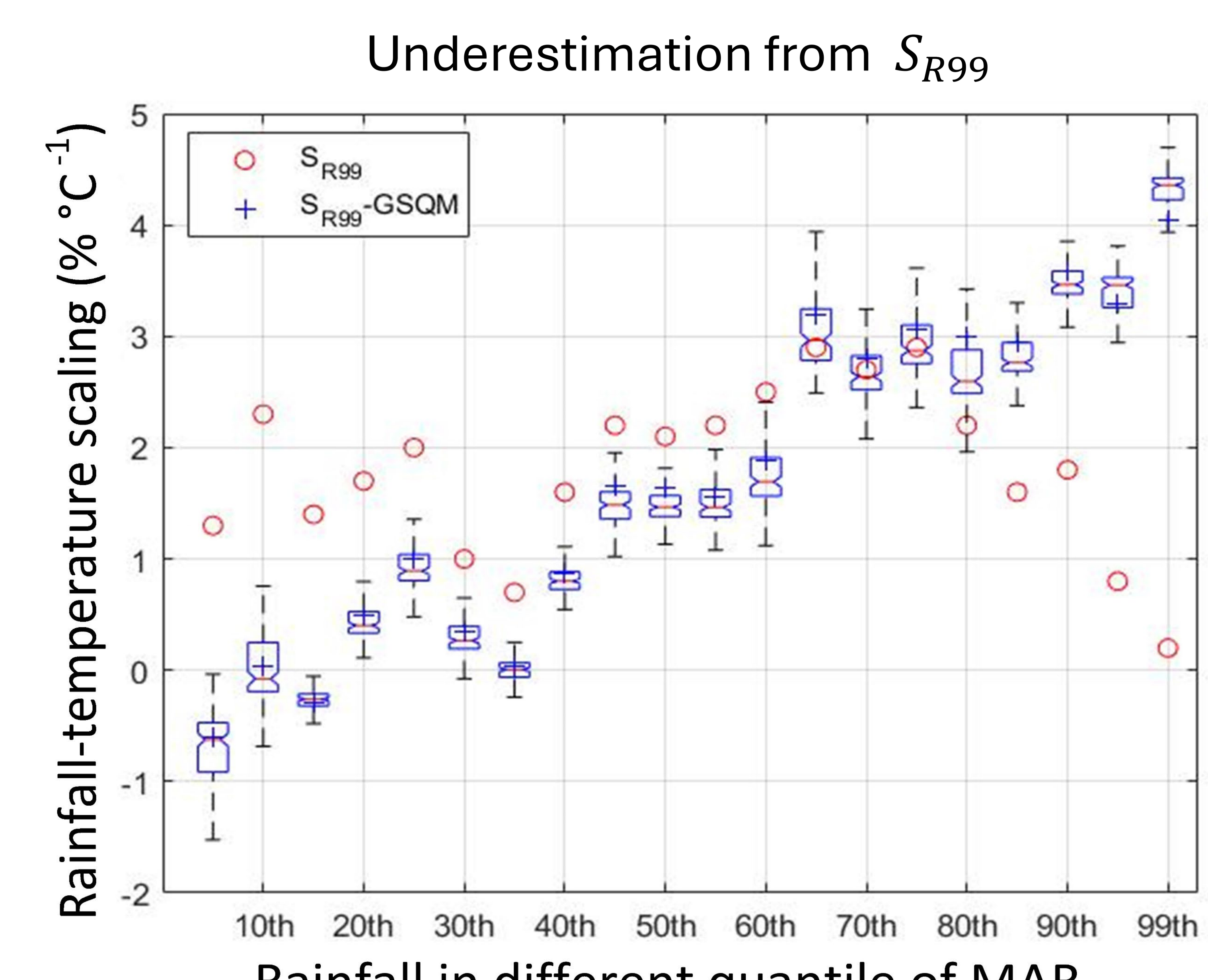
- S_{MAR} is up to 3.6%, lower than 7%
- Sample size: 20 years
- Hook structure

GSQM and SST parameters

- Other marginal distribution
- Underestimation from S_{R99}
- Assumption in future SST

Advantages and limitations of GSQM-SST

- Simple and efficient
- Less uncertainty compared to the Climate model-based method
- Need to consider dynamic factors



Code Access

[1] Zou, W., & Peleg, N. (2025). Gamma-based Spatial Quantile Mapping (GSQM) of heavy rainfall fields -- an example of a heavy storm in Beijing, China [Software]. Zenodo. https://doi.org/10.5281/zenodo.15046546

[2] *Wasko, C., & Sharma, A. (2014). Quantile regression for investigation scaling of extreme precipitation with temperature. Water Resources Research, 50(4), 3608-3614.*

[3] Peleg, N. et al., (2022). Mapping storm spatial profiles for flood impact assessments. Advances in Water Resources, 166, 104258.