Spatial downscaling of rainfall fields using a multiple-point geostatistics-based approach

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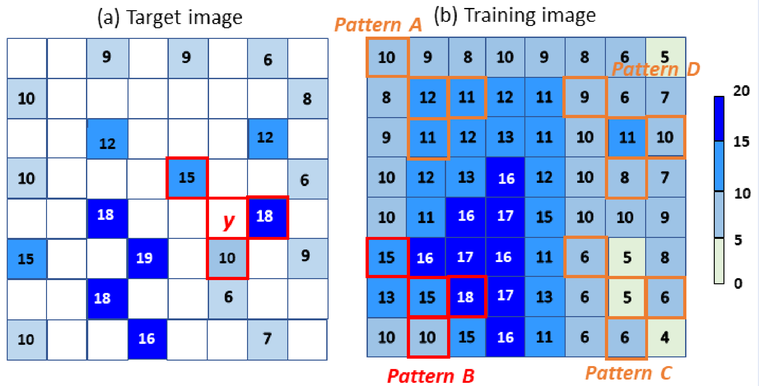
1. Motivation

- Downscaling is required to obtain high-resolution rainfall products for many hydrometeorological applications [1]
- The multiple-point geostatistics model (MPS) has an advantage in downscaling the spatial structure of the rainfall field[2]

2. The MPS model *(https://wp.unil.ch/gaia/mps/qs/)*



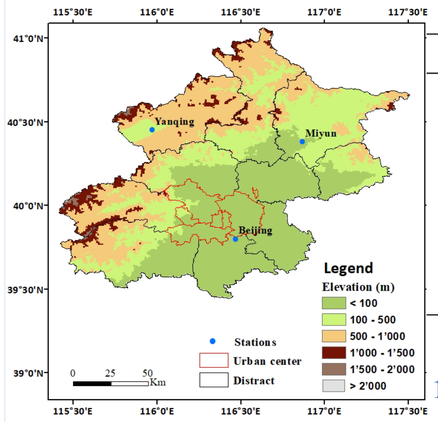
(c) K-sampling strategy

Rank	1	2	3	4	…
Distance	0	75	104	241	
Pattern	B	A	D	C	…

K = 1.5 Sampling probability : B-66.7% A-33.3%

Collect conditional data *N(y) around* unkown *y* (a) → Search similar patterns in the training image (b) → Select patterns by the *K*-sampling strategy (c) → Assign the selected value to the unknown *y* → *Repeat for each unknown grid*

3. Case study: Beijing City



	Dataset	Duration	ΔT	ΔS
Validation data	STATIONS	1954 – 2012	1 h	Point
Target data	CMORPH	1998 – 2019	30 mins	8 km
Training data	CMPAS	2015 – 2020	1 h	1 km

The MPS model

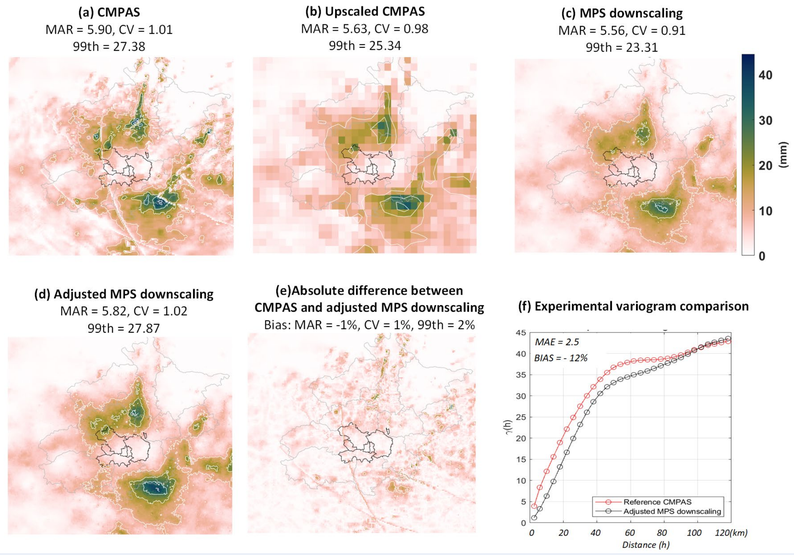
1km downscaled-CMORPH (1998 – 2019)

4. Results

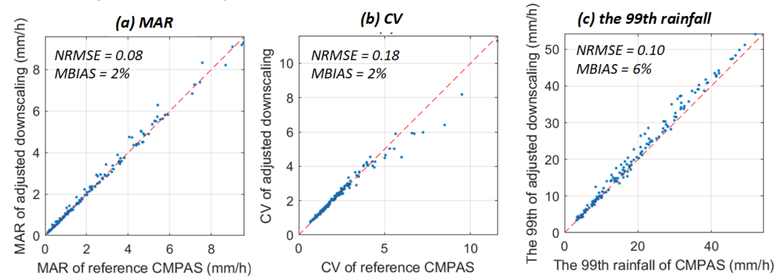
Leave-one-out cross-validation

MAR: mean areal rainfall
CV: coefficient of variation

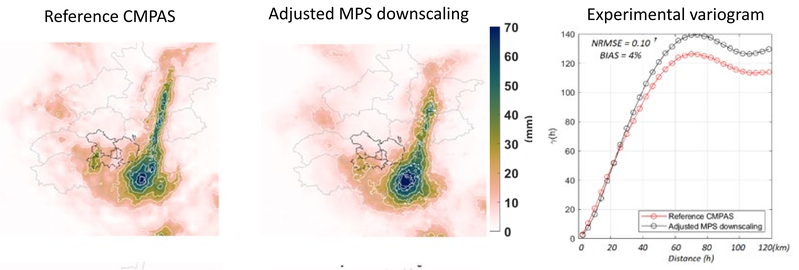
Example



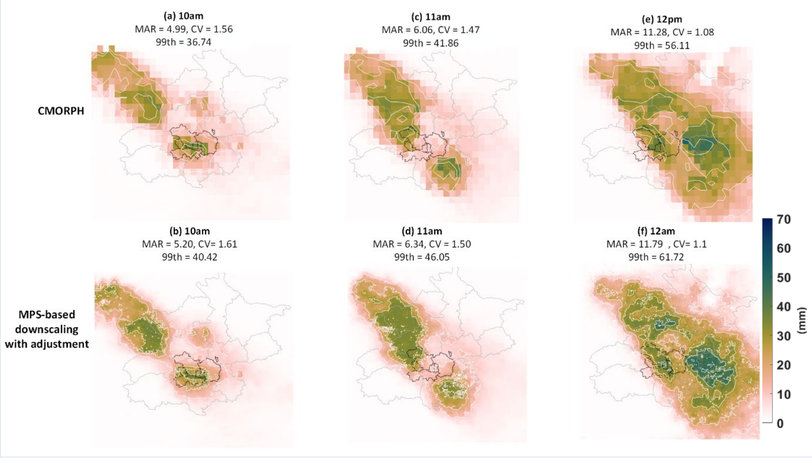
- *Rainfall intensity:*



- *Rainfall spatial pattern:*



Downscaled storm of CMORPH



5. Conclusion

- *The MPS-based downscaling method performs both the intensity and spatial structure of rainfall fields well*
- *The proposed downscaled approach can be applied to other regions and other precipitation datasets*

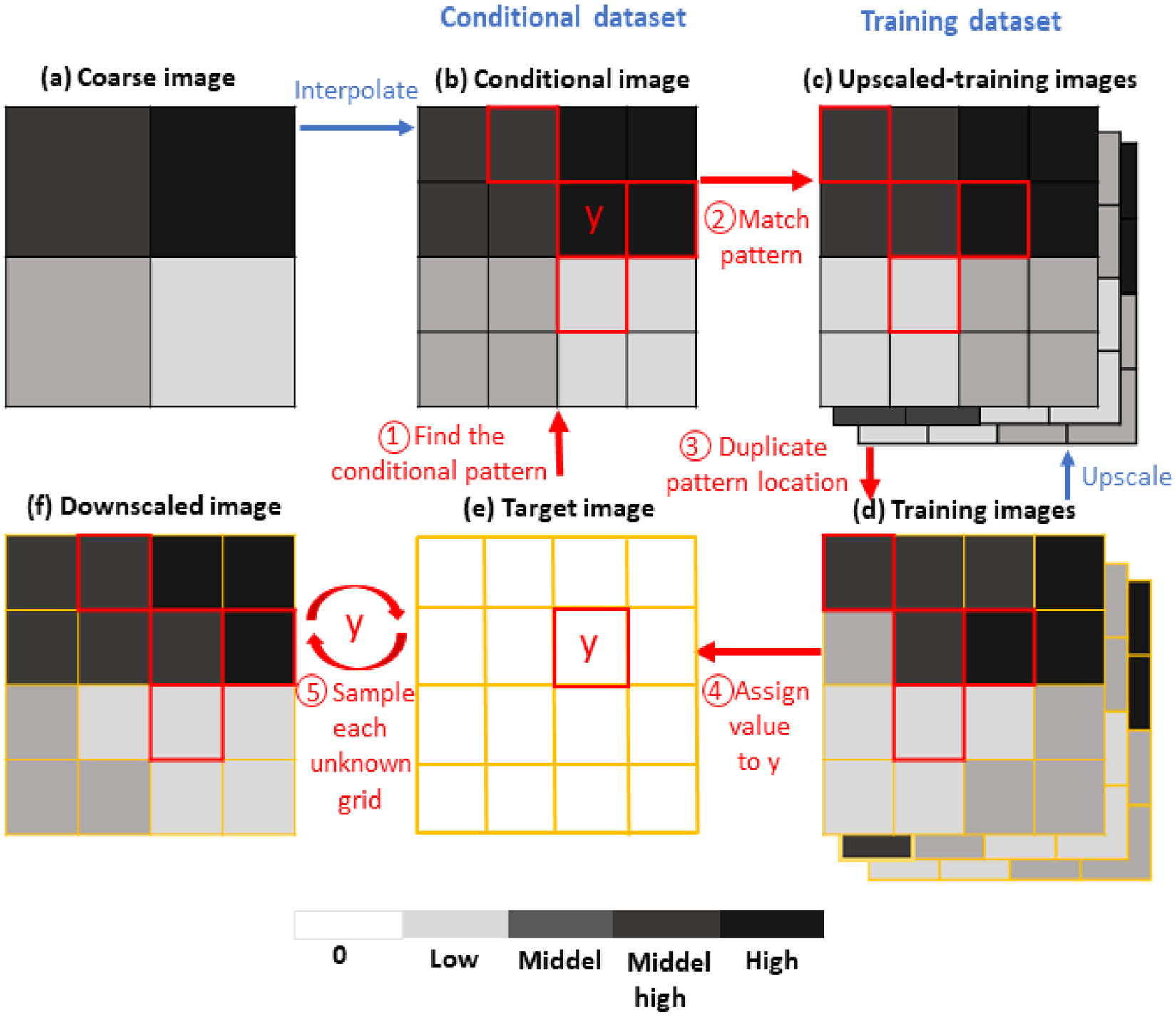
References

[1] Abdollahipour et al., 2022. A review of downscaling methods of satellite-based precipitation estimates. Earth Sci. Inform. [2] Gravey, M., Mariethoz, G., 2020. QuickSampling v1.0: a robust and simplified pixel-based multiple-point simulation approach. Geosci. Model Dev. 13, 2611–2630.

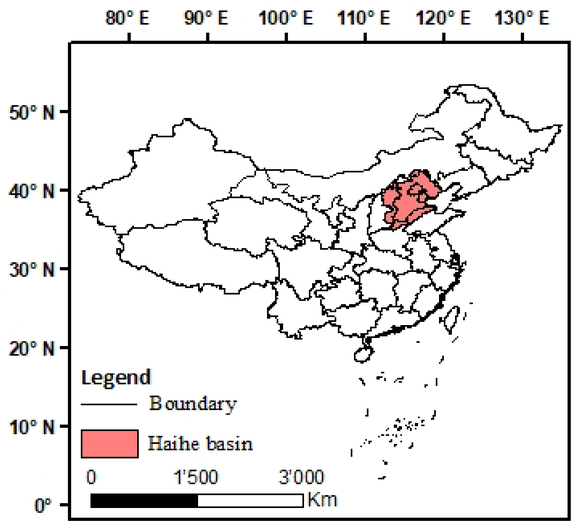
Abstract

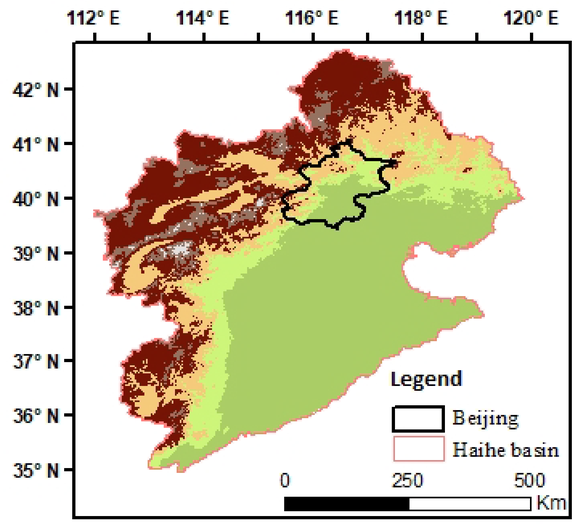
Supplementary

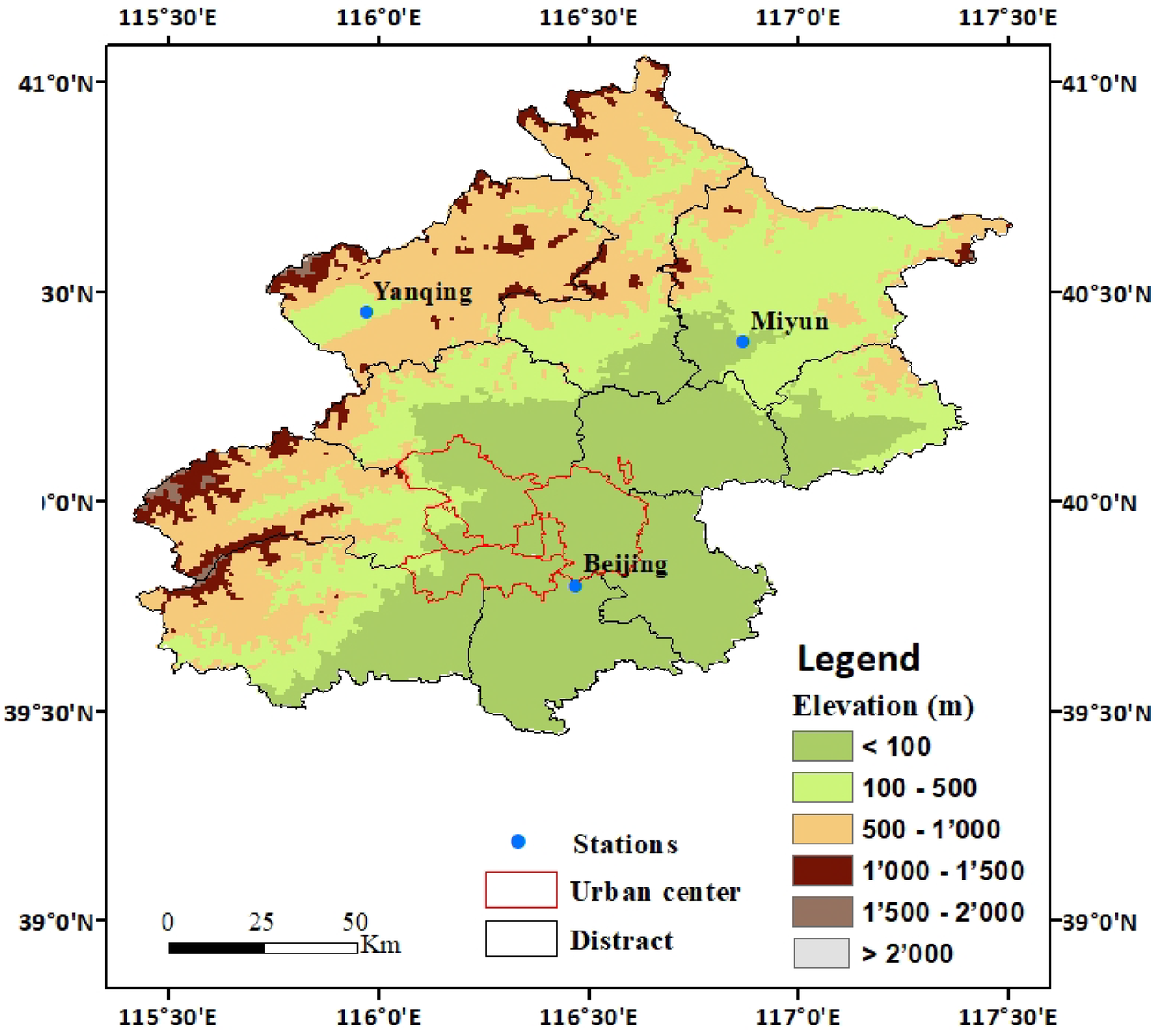
Spatial downscaling workflow



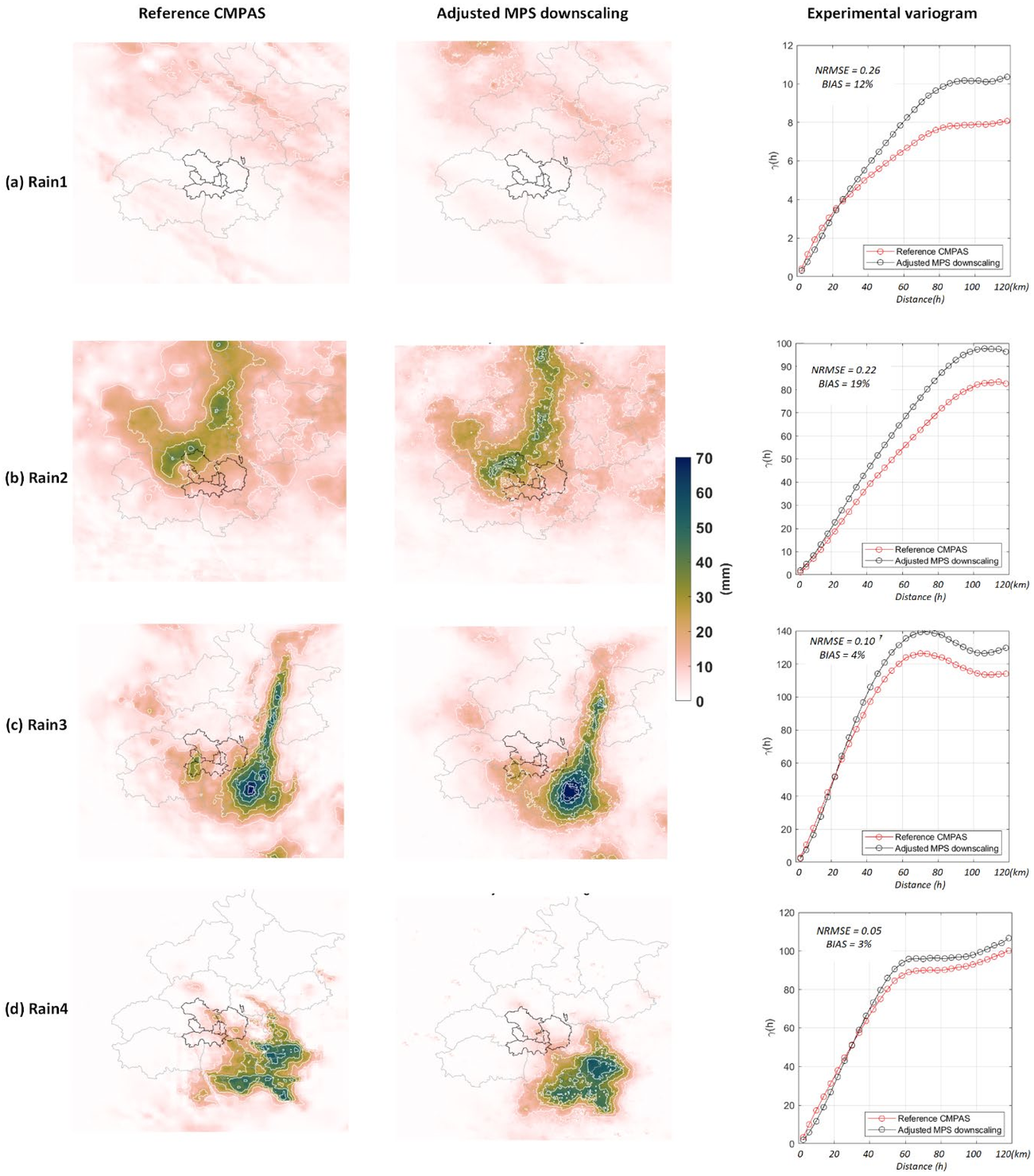
Case study : Beijing area







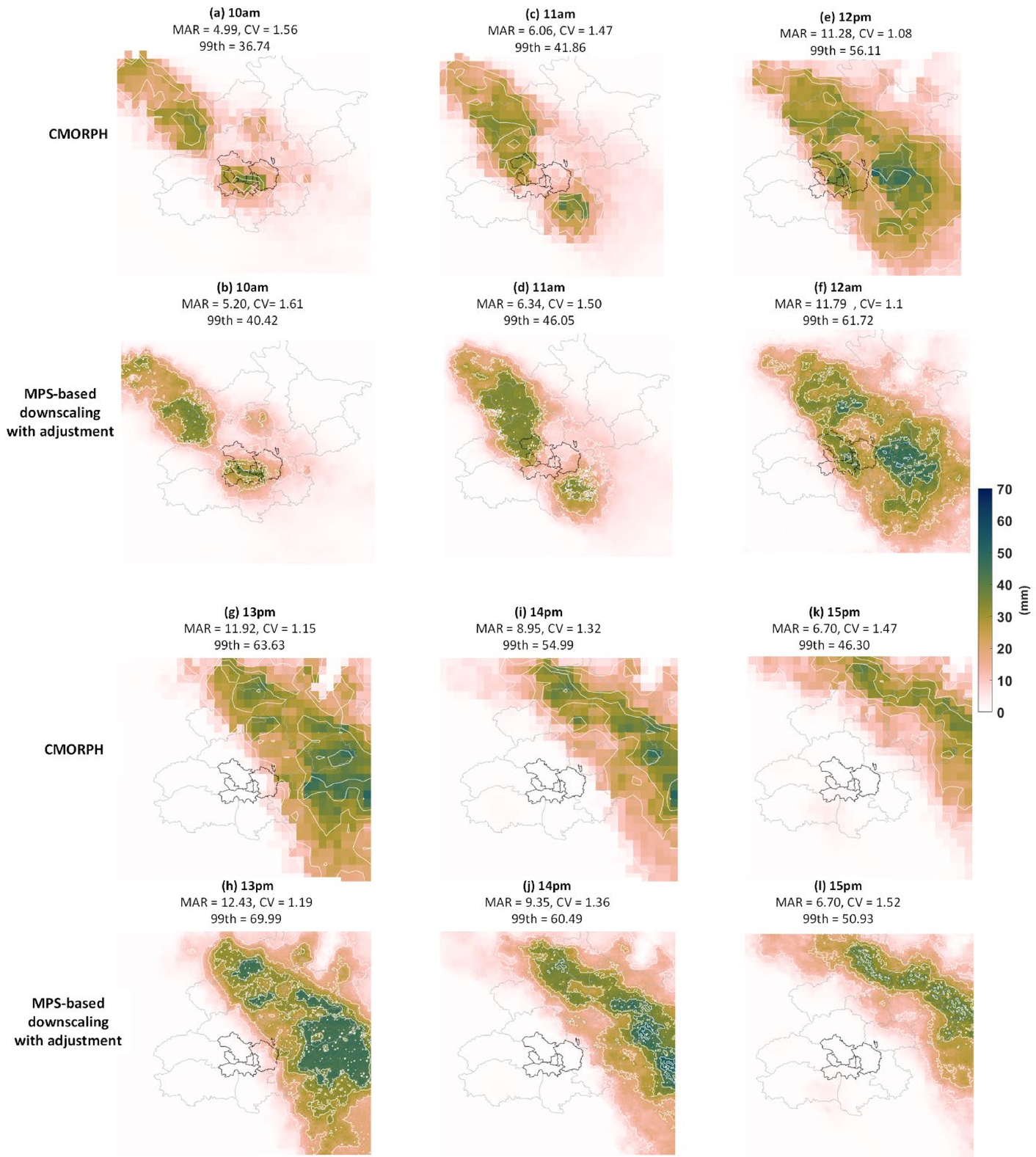
Leave-one-out cross-validation: spatial pattern maintenance



Among all samples, the variograms difference between reference CMPAS and adjusted MPS downscaling at an average distance, 20km and 80km, respectively.

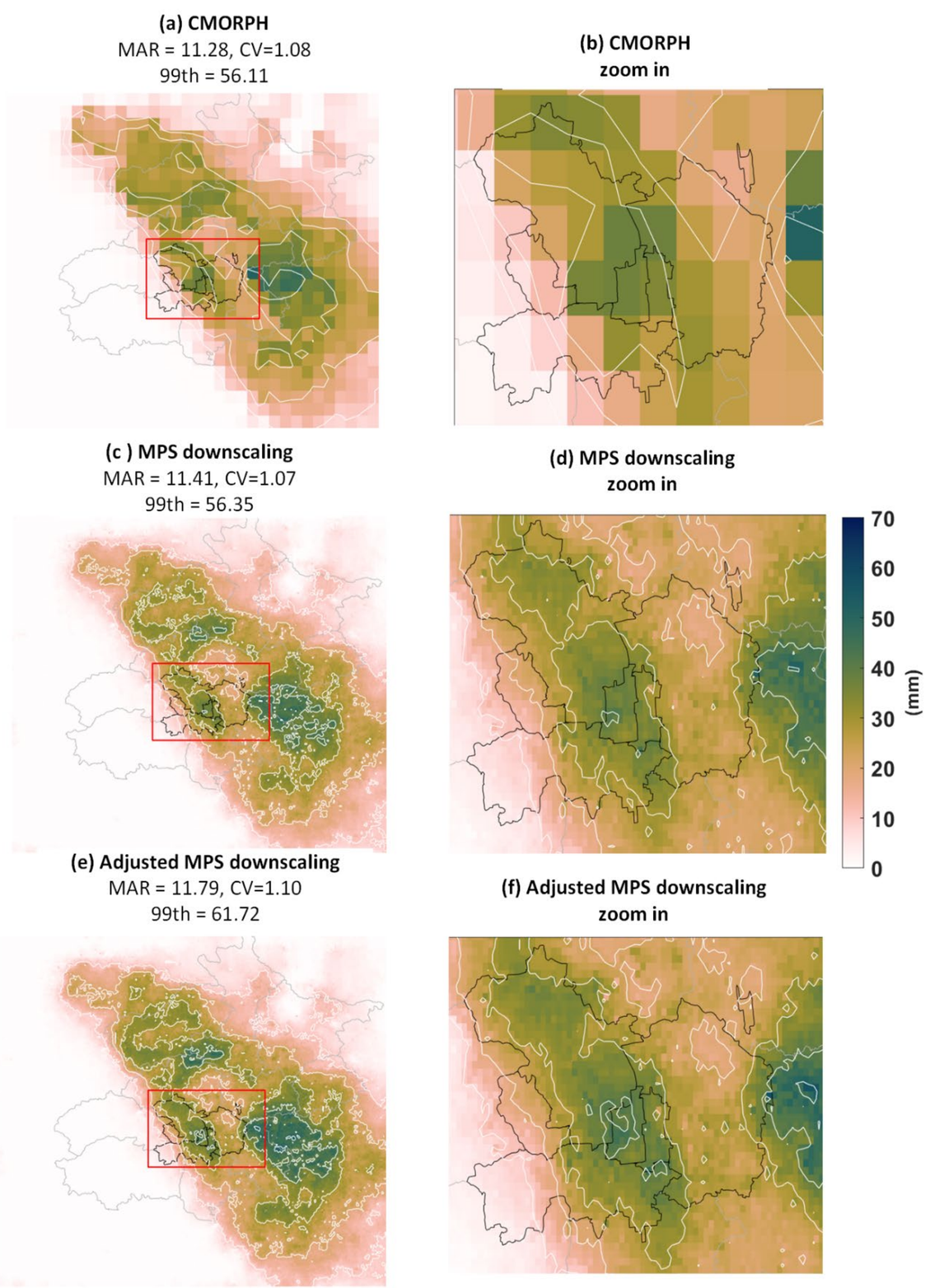
Distance (h)	***Average***	***20km***	***80km***
Mean of NRMSE	*0.12*	*0.17*	*0.21*
MBIAS (%)	*0.05*	*-0.04*	*0.12*

Downscaled storm of CMORPH

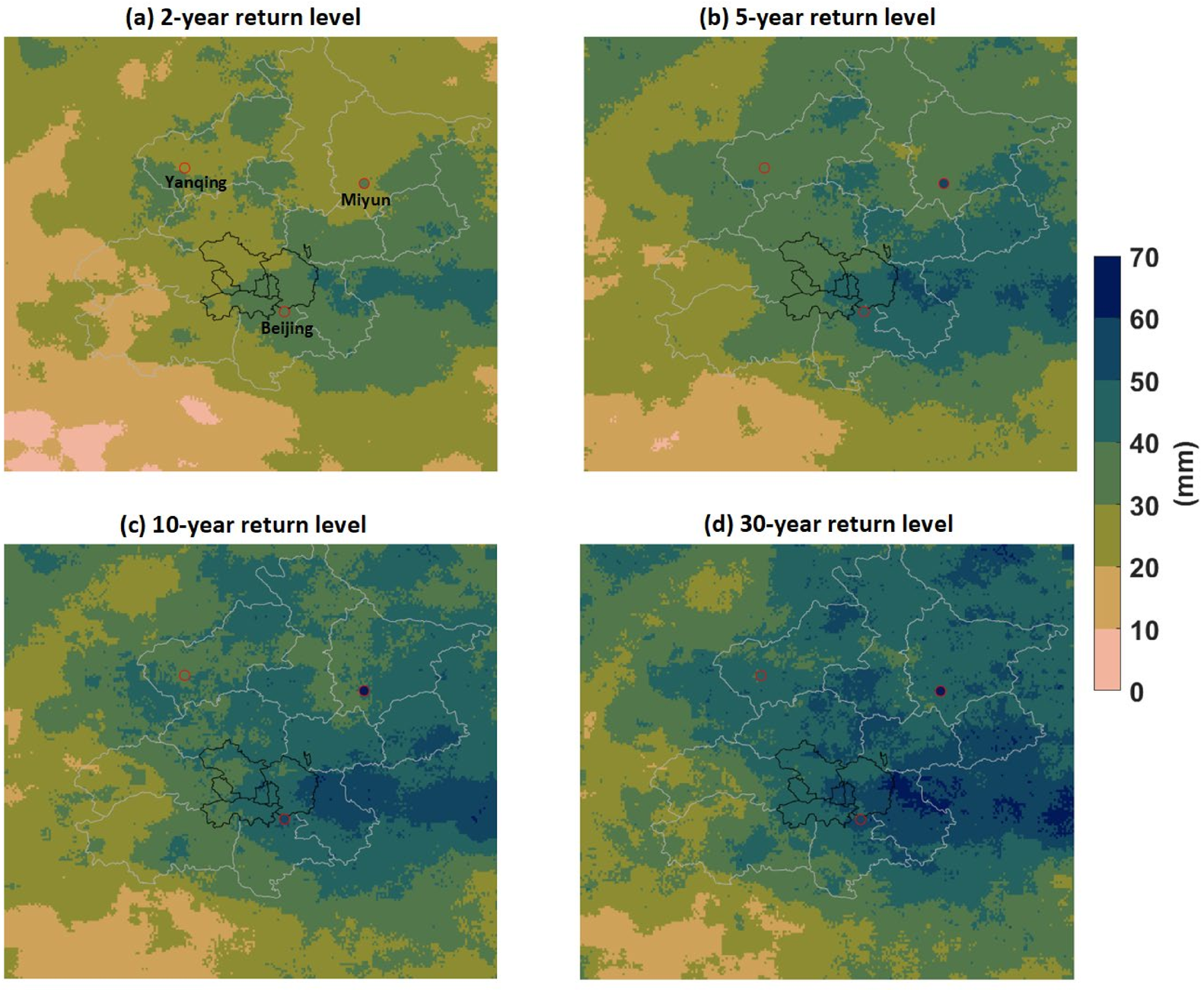


Downscaled CMORPH:
An example

Comparison between 8-km CMORPH, 1-km MPS downscaling and 1-km adjusted MPS downscaling rainfall by taking one hourly storm(on 12 pm 21st July 2012) as an example.



Downscaled CMORPH: return periods



Comparison of the 2, 5, 10 and 30-year return levels between the adjusted MPS downscaling and three stations: Beijing, Miyun and Yanqing (red circle).