Probability of compound extreme precipitation events to inform engineering design

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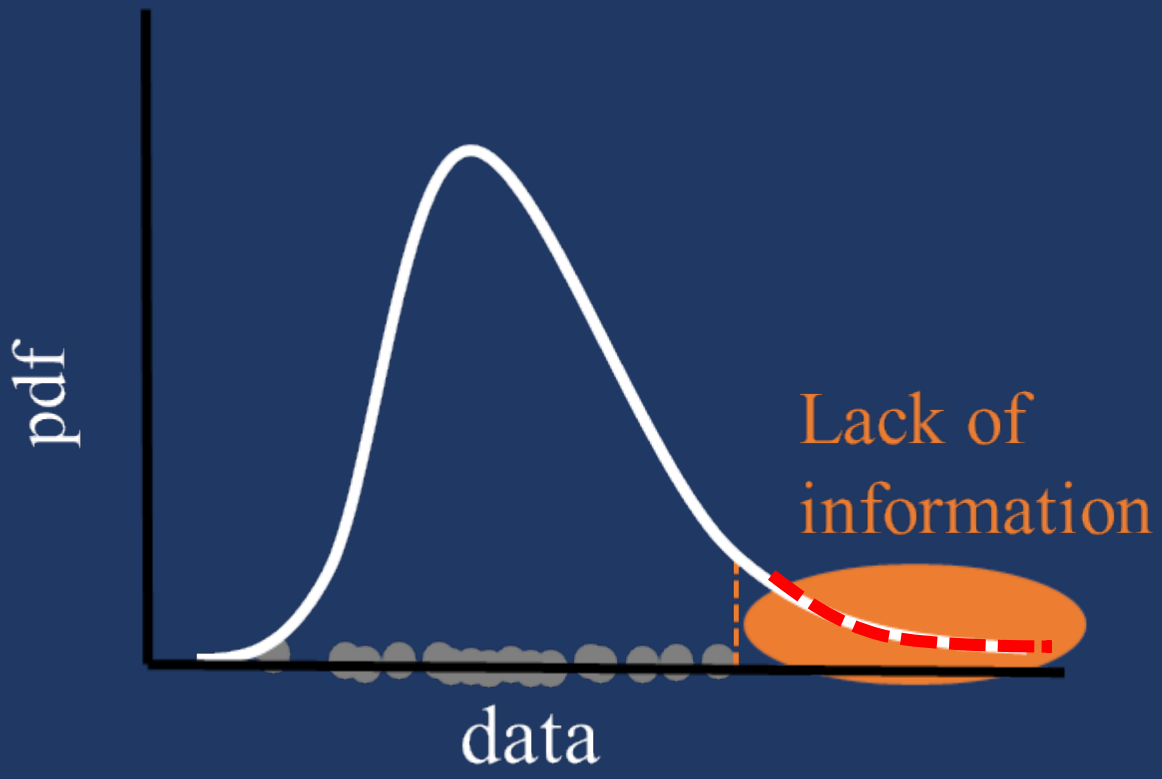
Frequency Analysis



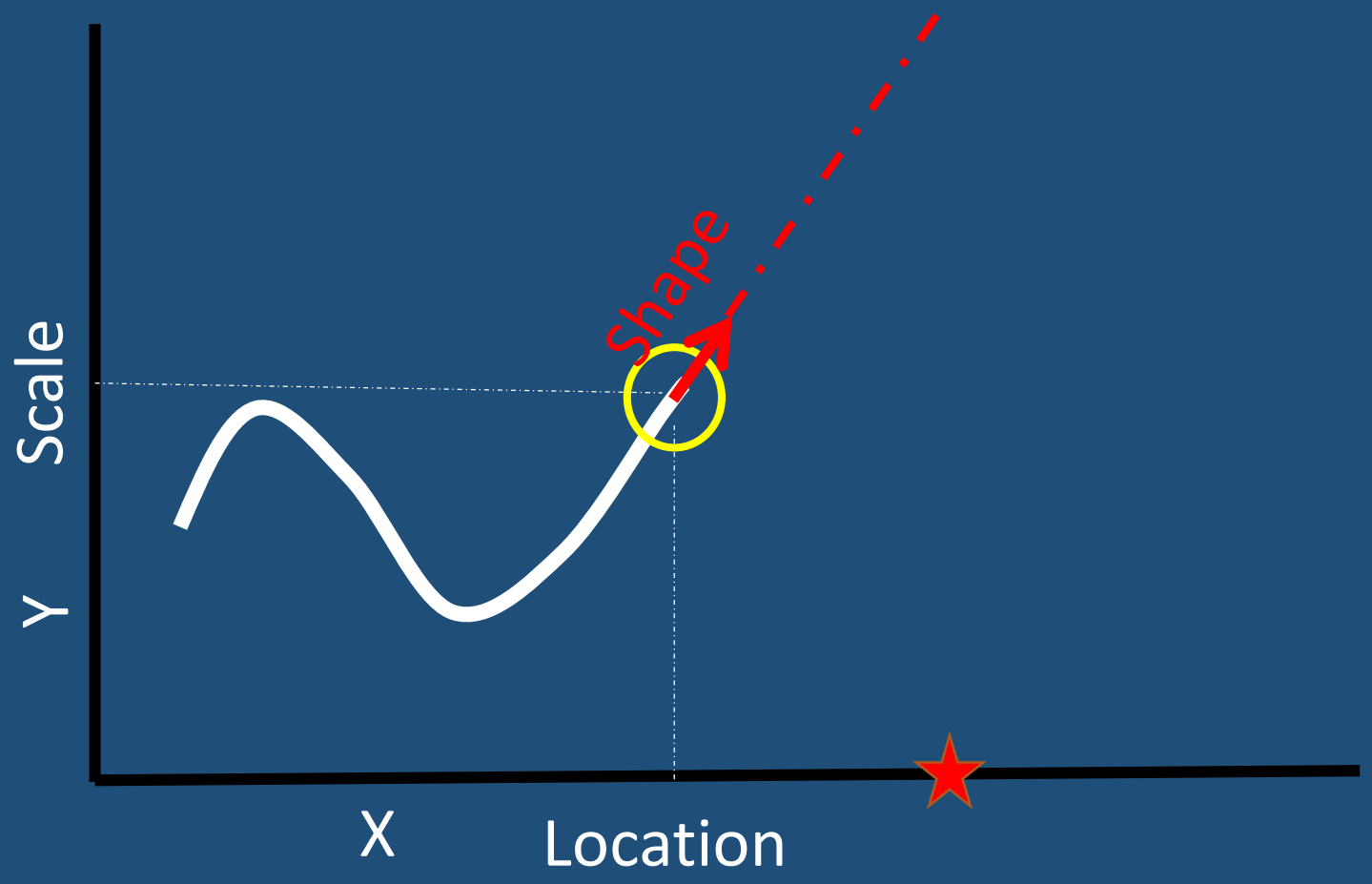
Extraction of the information

- The form of the distribution is unknown
- The extreme value paradigm: base tail models on asymptotically-motivated distributions
- Estimation of the parameters (maximum likelihood, PWM, Bayesian,..)

Extrapolation

- Location
- Scale
- Stable shape

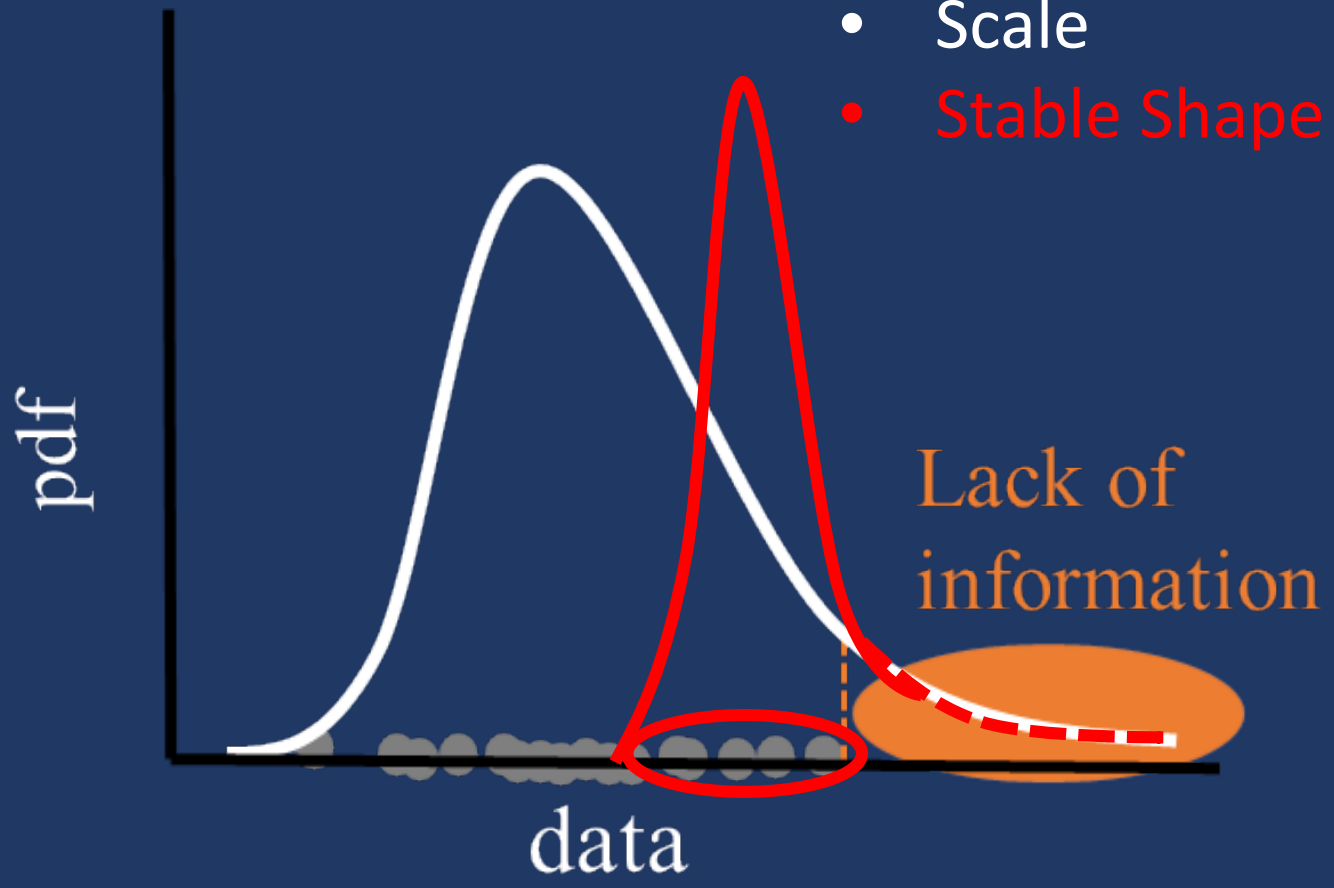
Extrapolation straight line



Extreme Value Theory

- Location
- Scale
- Stable Shape

Extreme value distribution
(GEV or GPD)

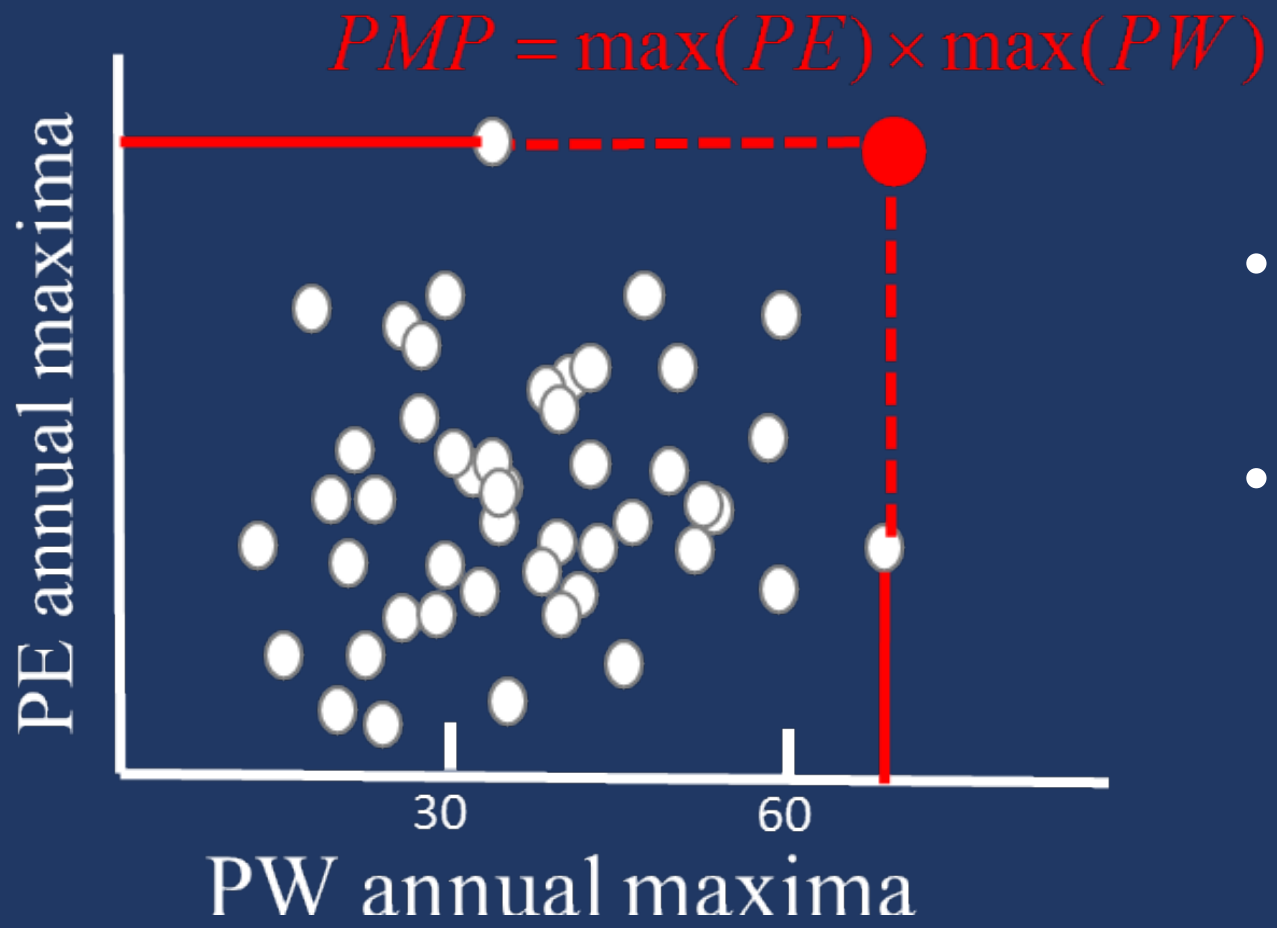


Drawbacks of using the Extreme value theory

1- The stability assumption of the Shape parameter

2- The information content of data

Probable maximum precipitation (PMP)



- Rational engineering solution
- A practical upper limit where scientific knowledge does not provide the desired guidance

Drawbacks of the PMP concept

1- The interpretation of the PMP .

2- The lack of uncertainty quantification.

3- The bad extraction of the information.

Objective

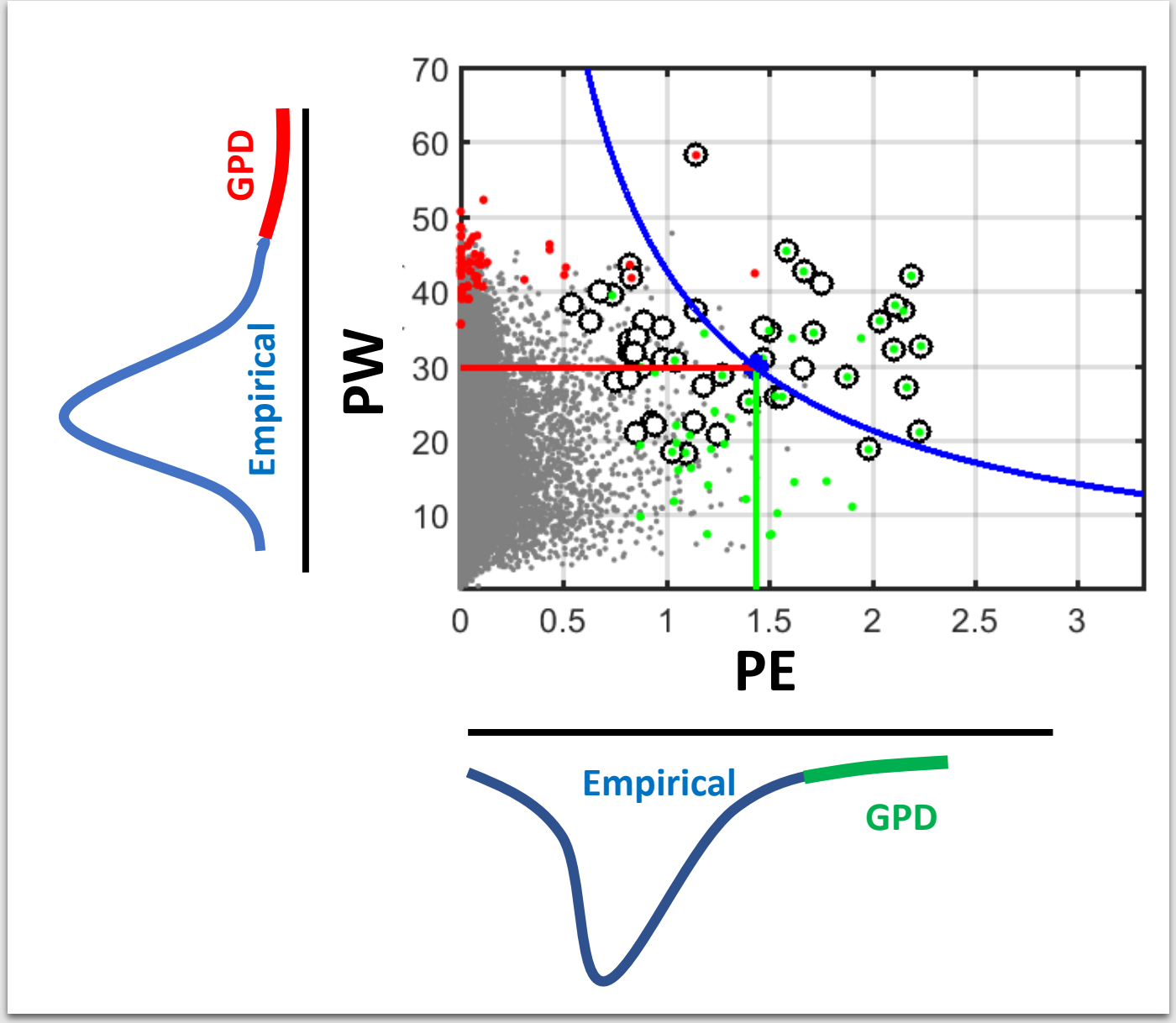
Probability of compound extreme precipitation events

1- A first attempt to unify the two schools of though (PMP and statistical frequency analysis) in estimating very rare extreme precipitation

2- The pdf of precipitation is synthesized by using plausible combinations of its major components for which data are available.

Precipitation as a compound event

Using the conditional approach for multivariate extreme values (Heffernan, J.E. and Tawn, J.A., 2004)



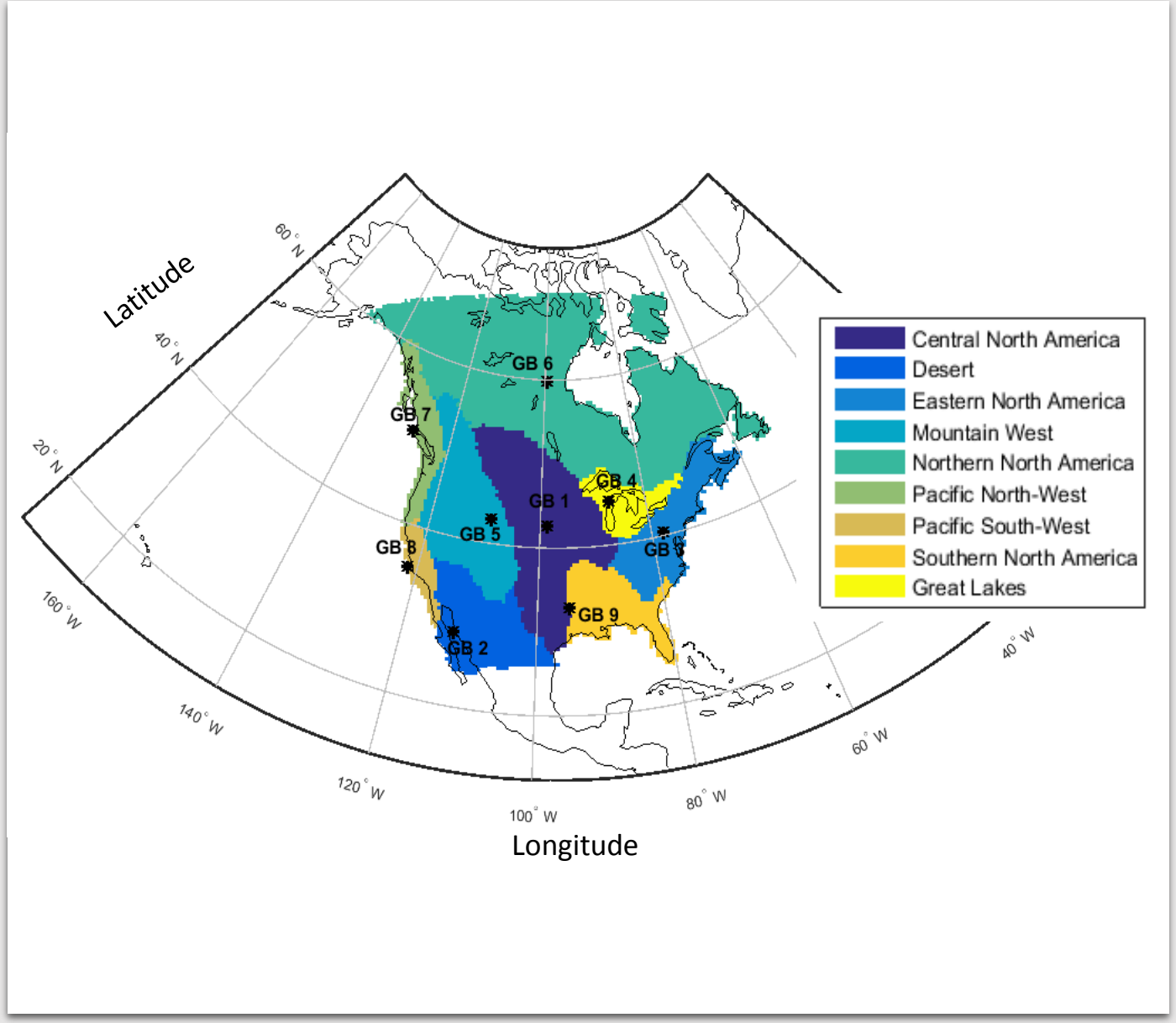
Application

- CanRCM4 regional climate model
- Total precipitation (6h)
- Precipitable water (6h)
- Period: 1951-2000 (50 years)

Validation

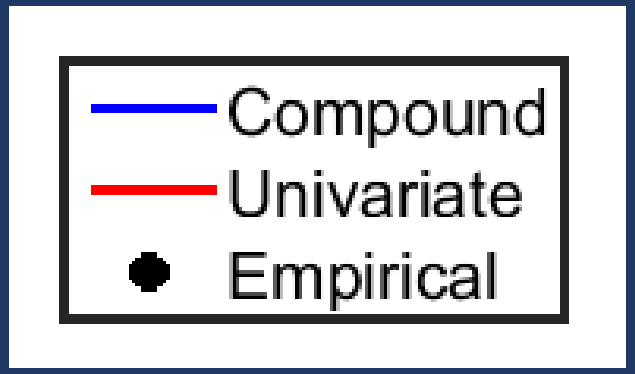
- 35 ensembles of CanRCM4-CanESM2
- 1750 annual maxima of total precipitation

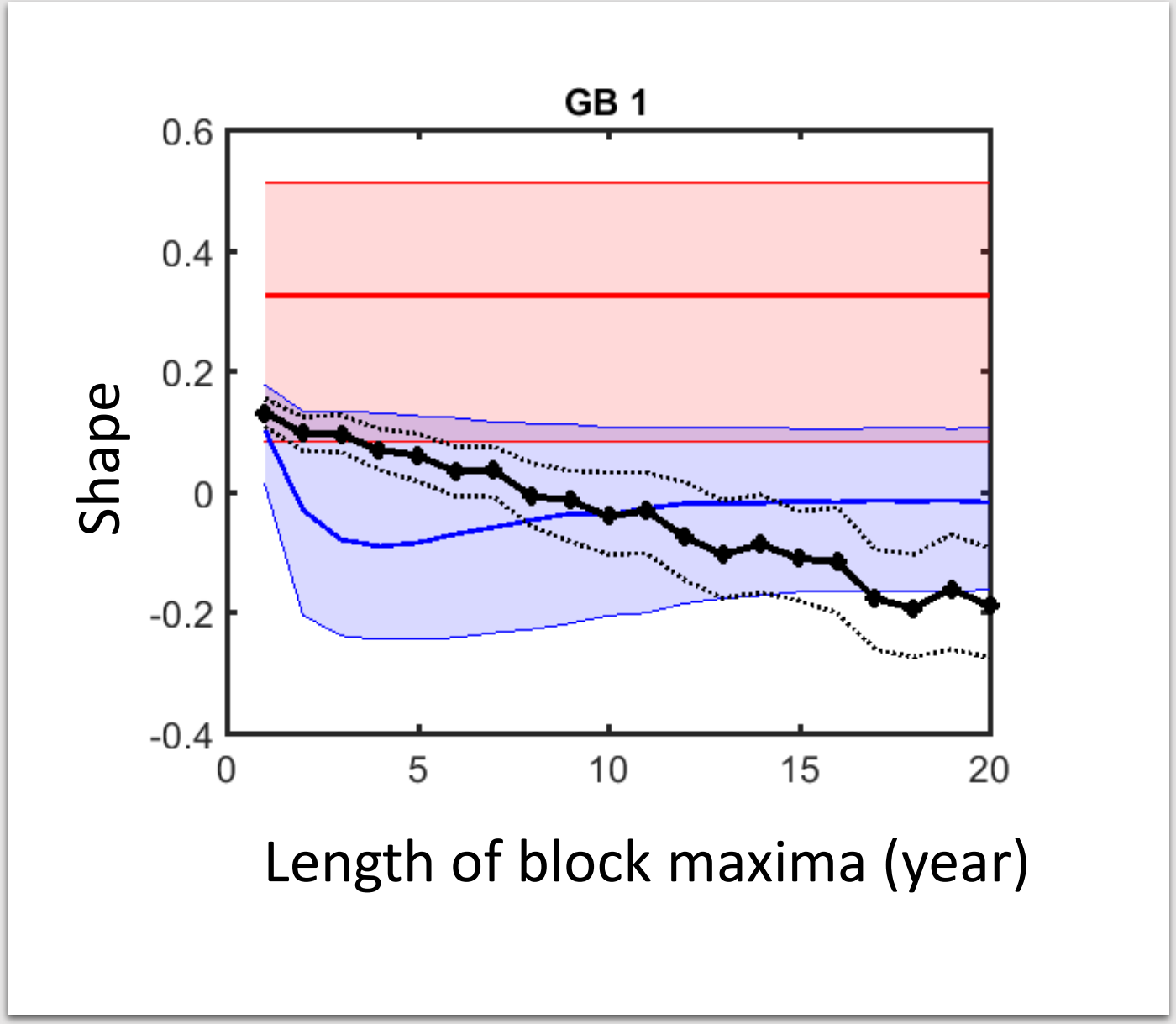
9 grid boxes (GB) from different climate regions in North America.



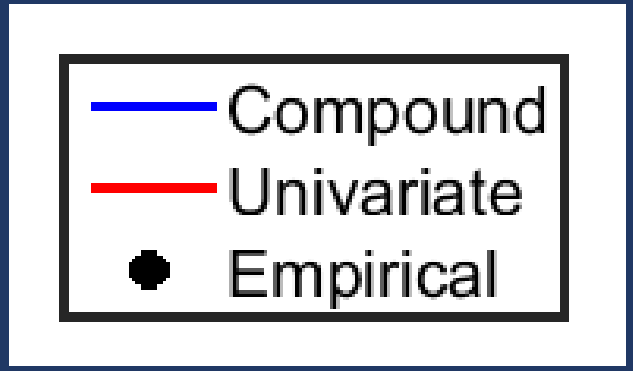
Results:

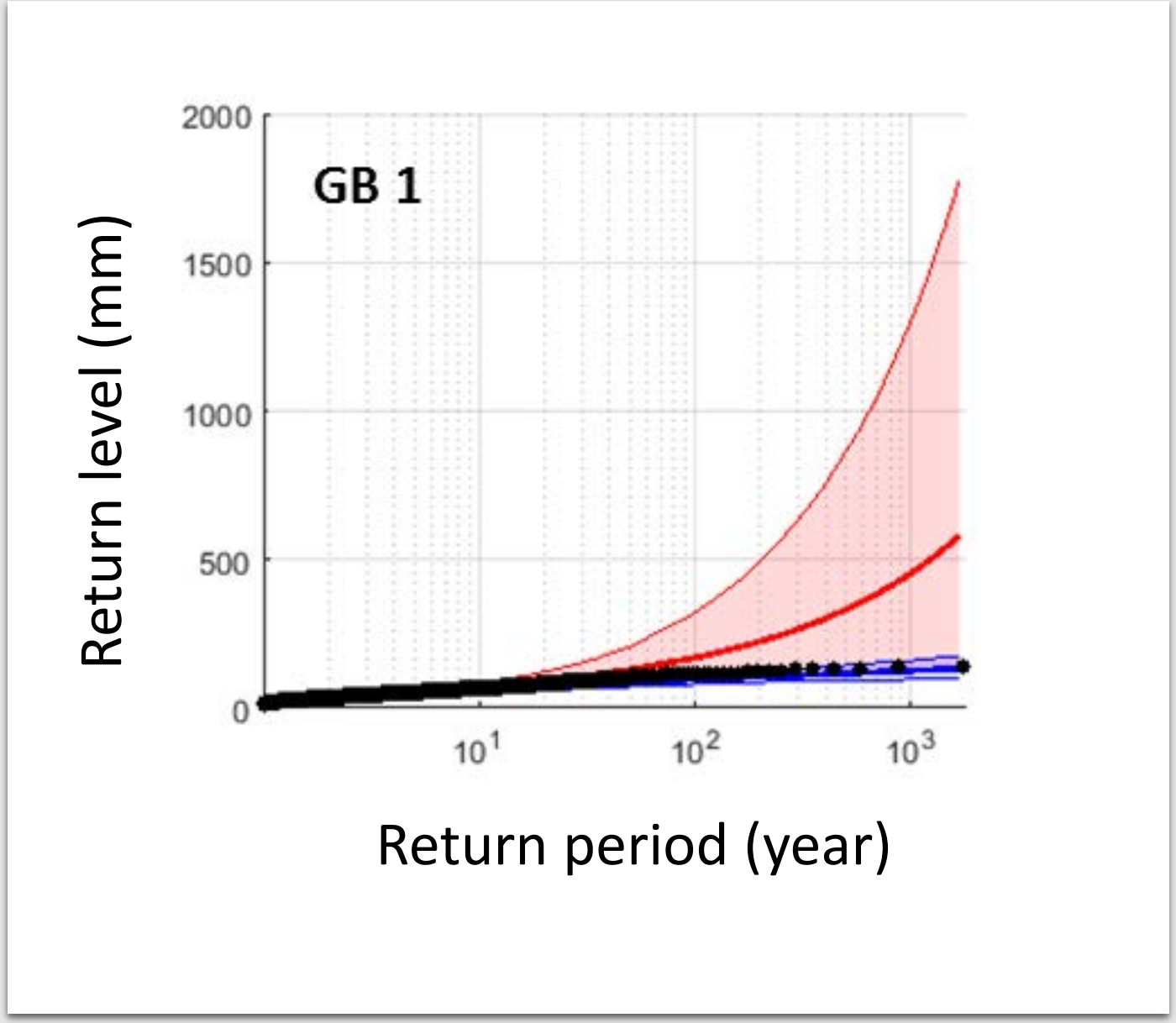
Shape parameter



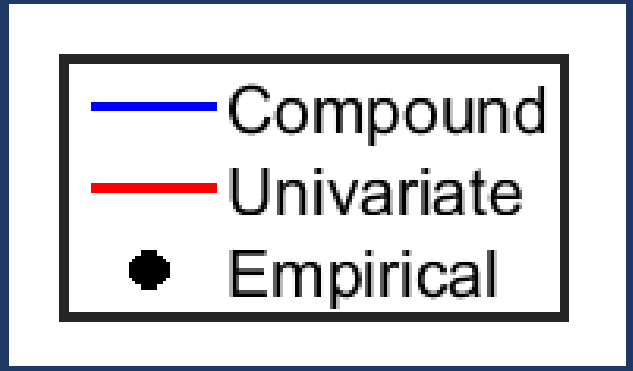


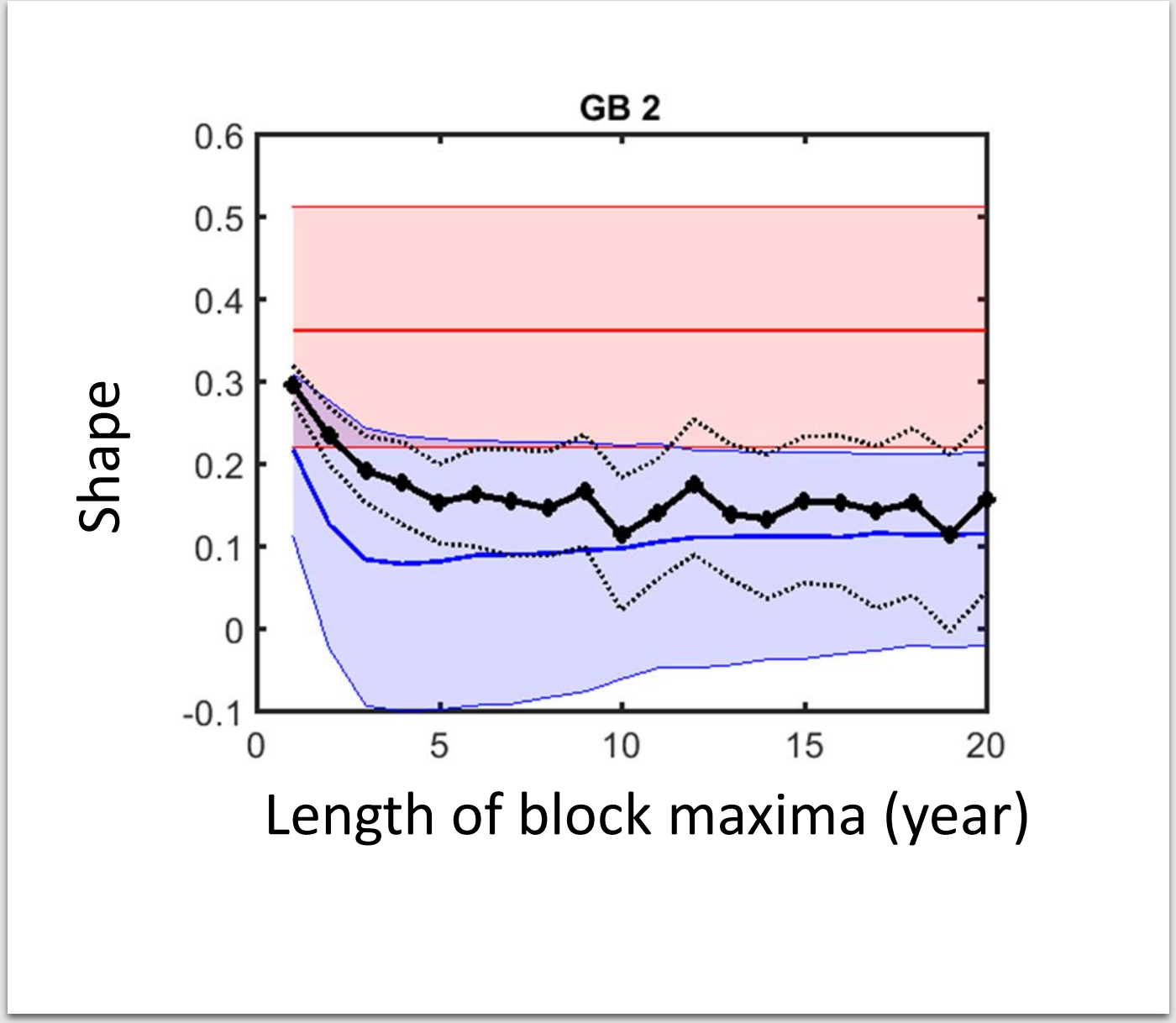
Results GB 1: Return level



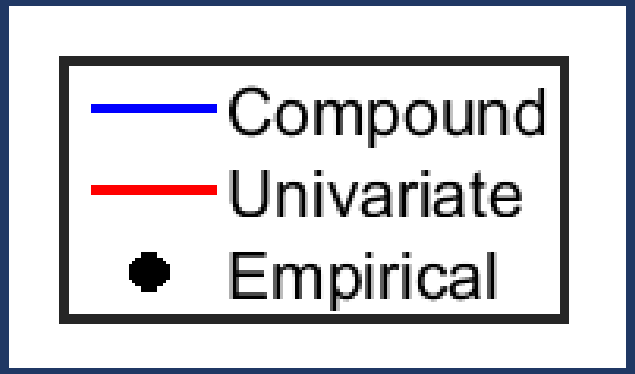


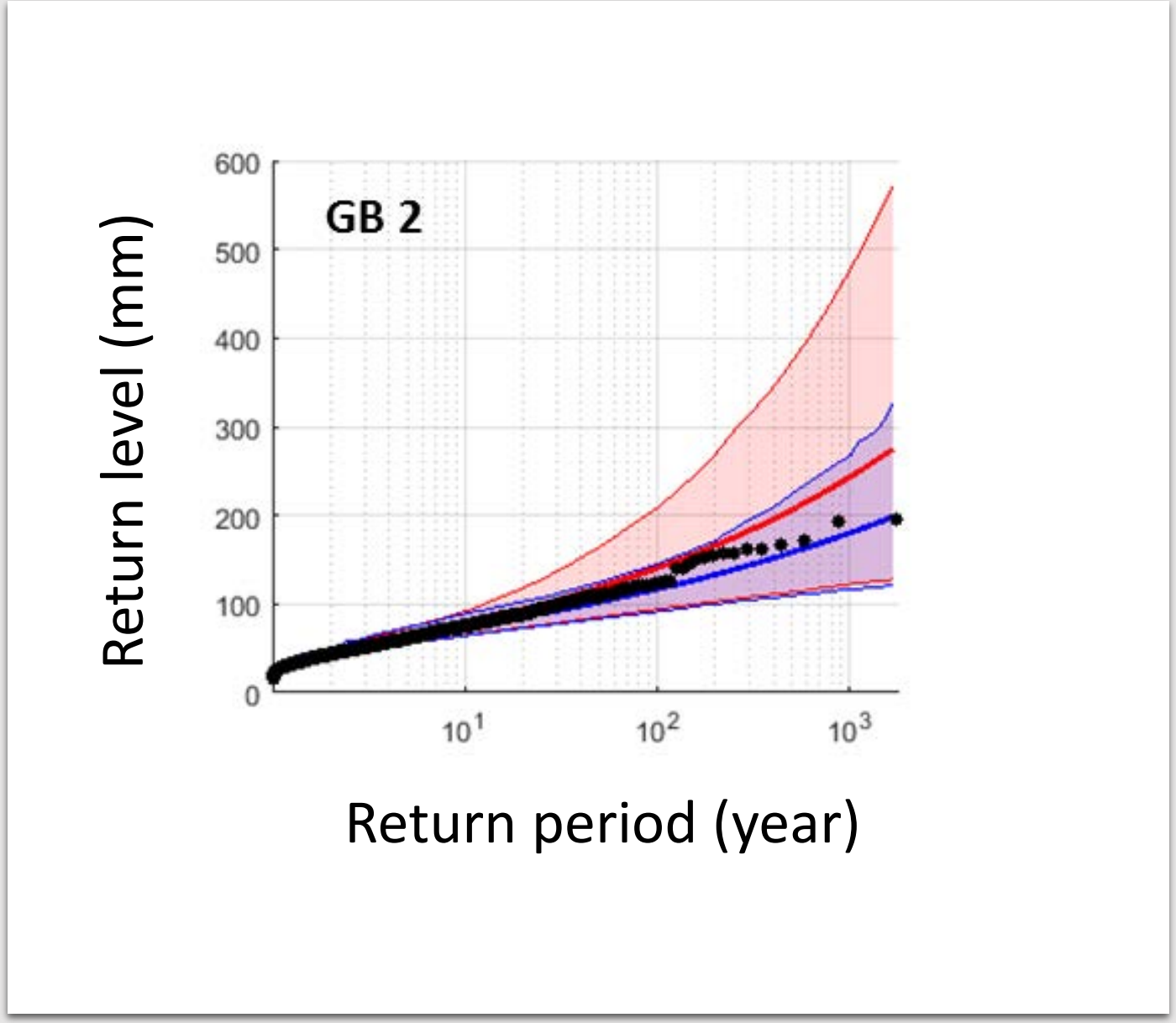
Results (GB2): Shape parameter



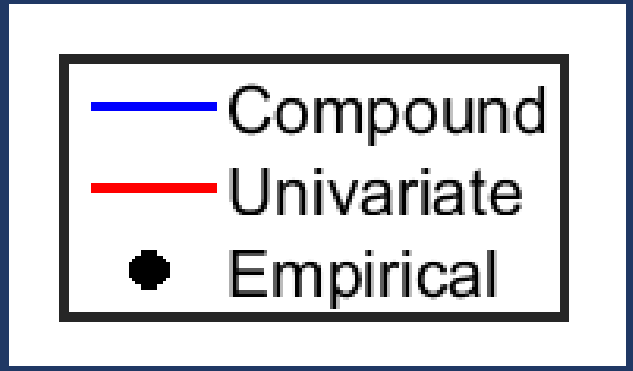


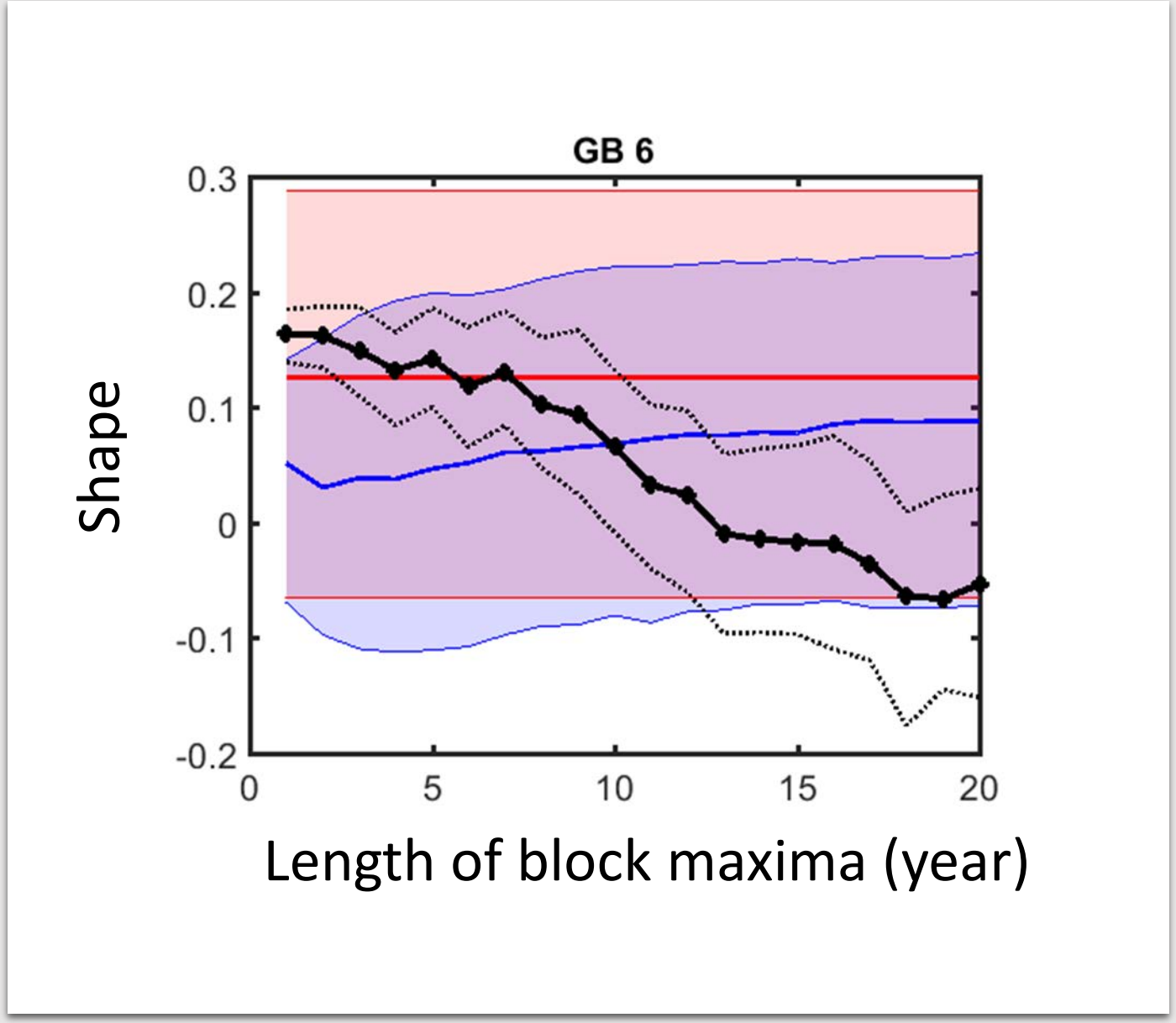
Results GB 6: Return level



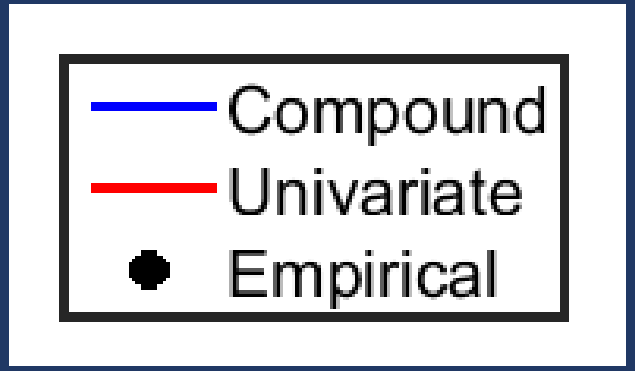


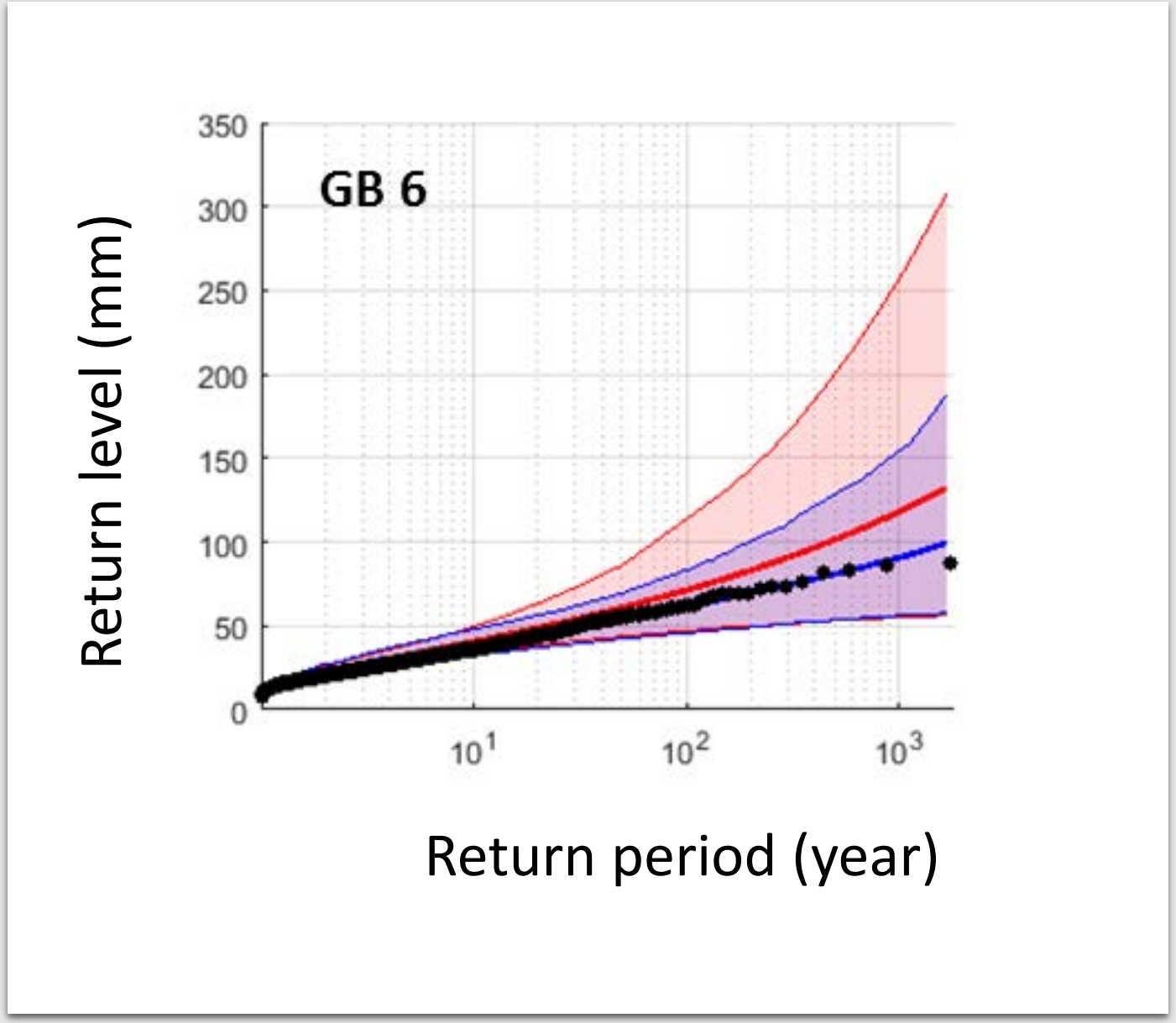
Results (GB6): Shape parameter



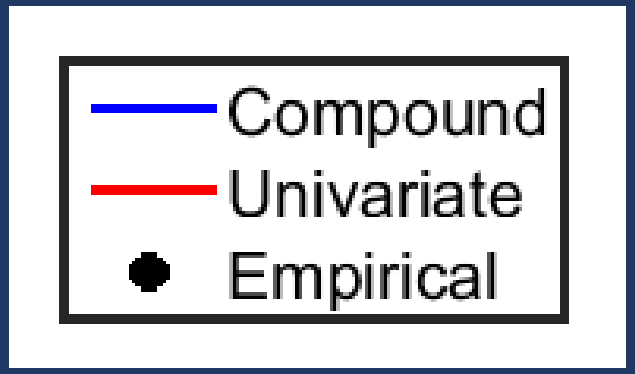


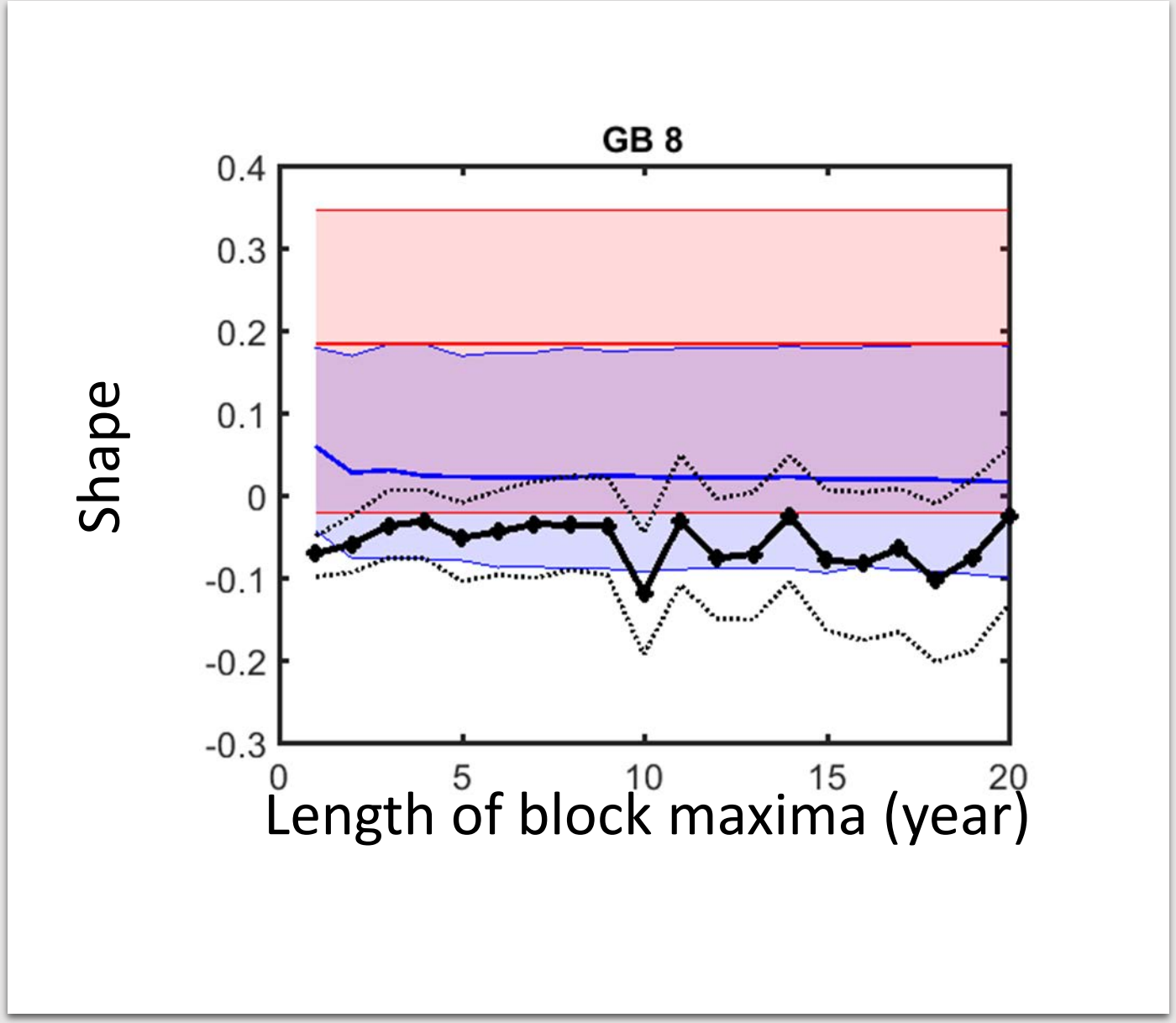
Results GB 3: Return level



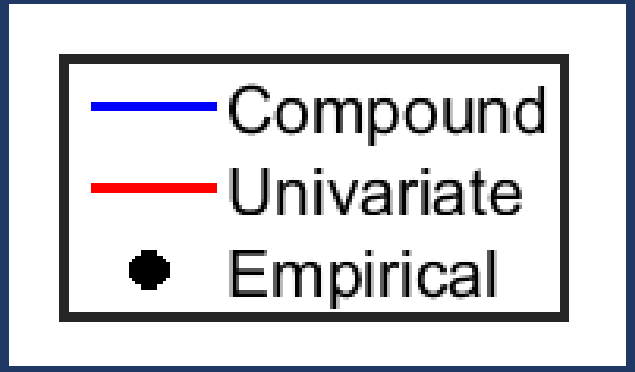


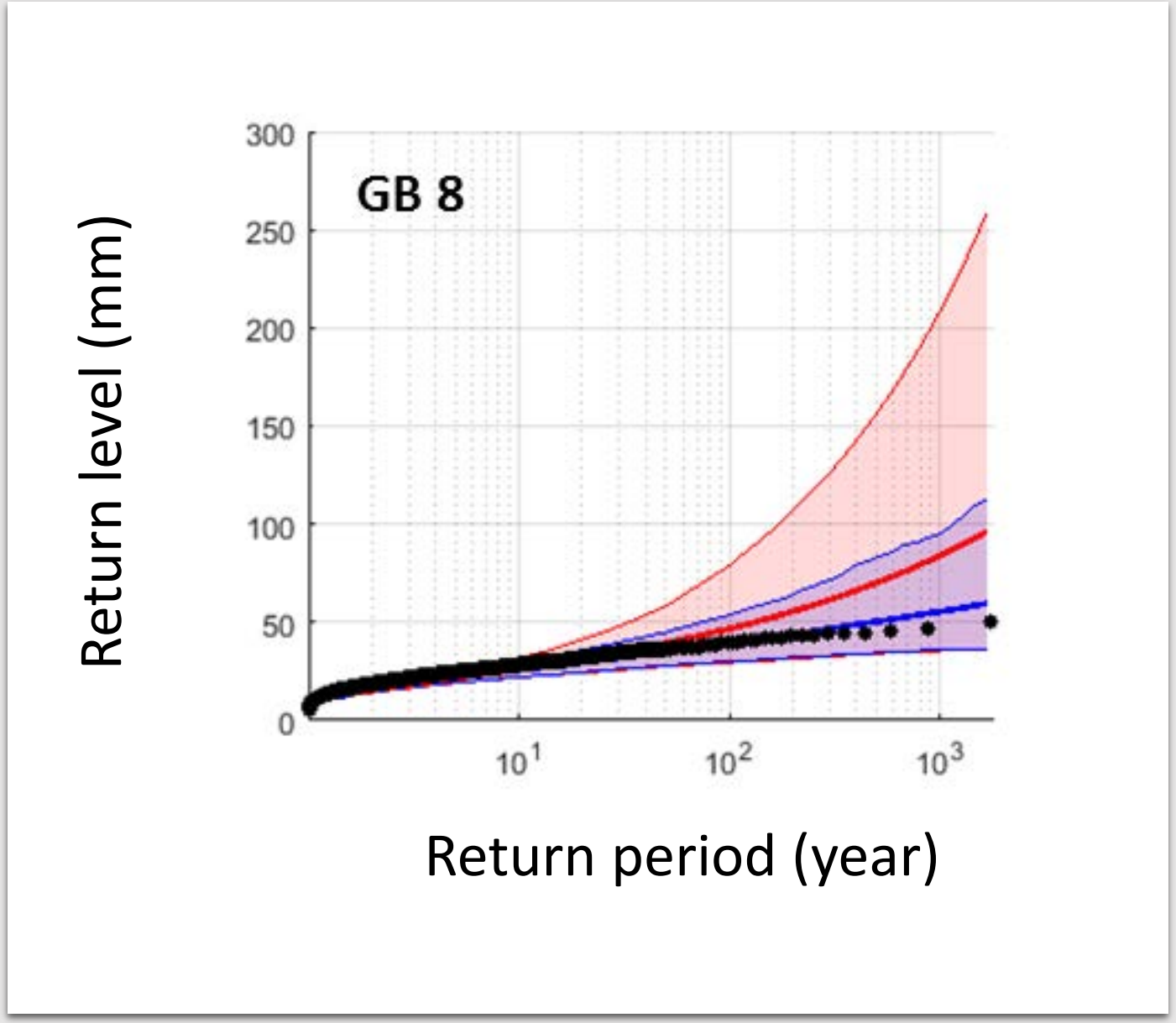
Results GB 8: Shape parameter



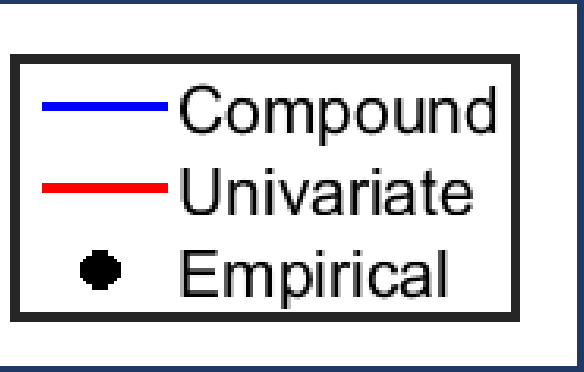


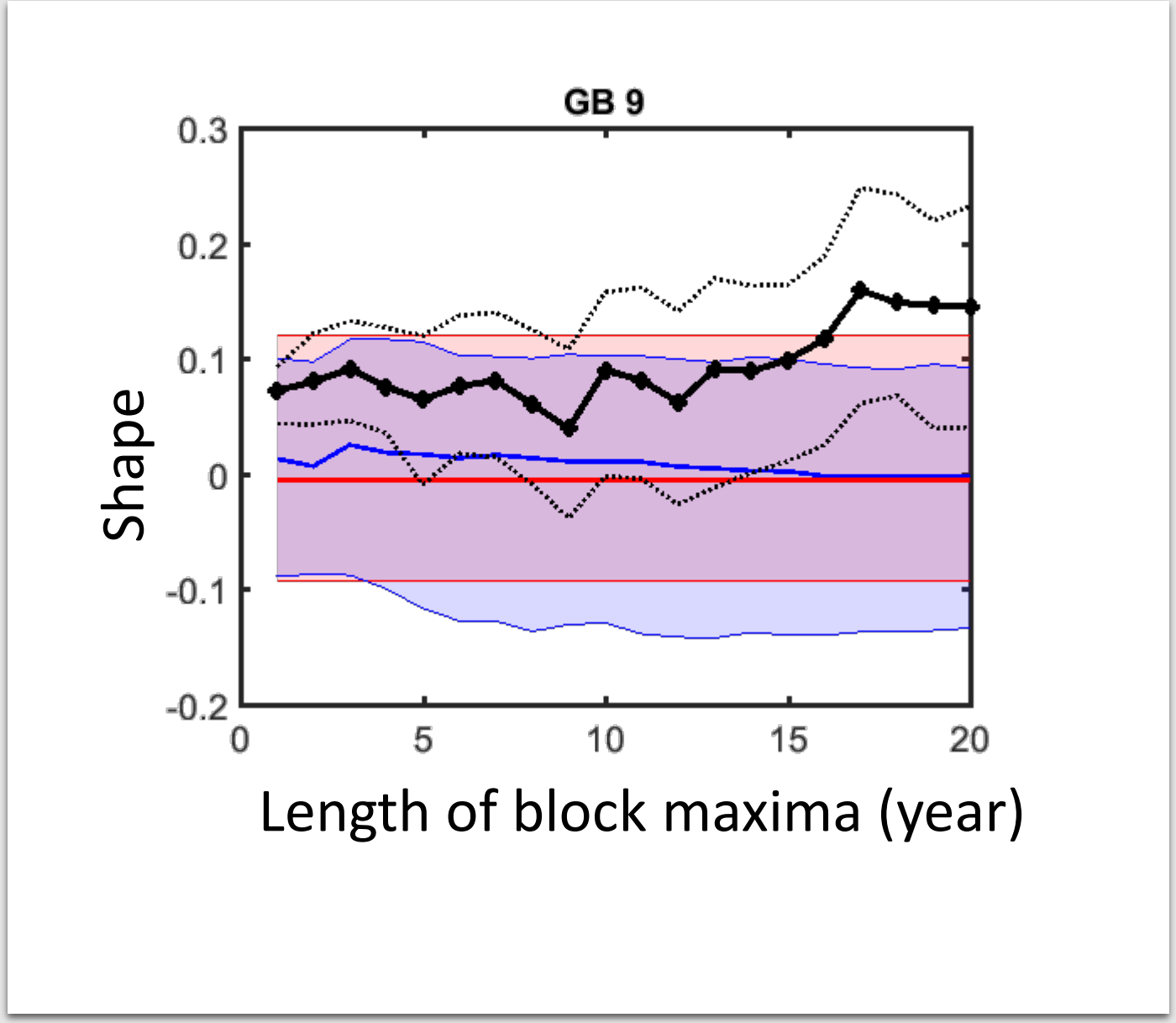
Results GB 8: Return level



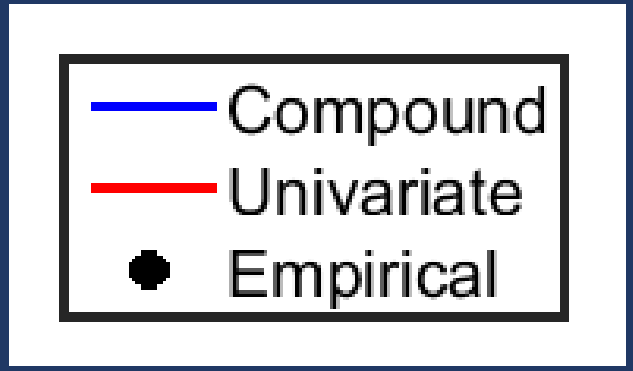


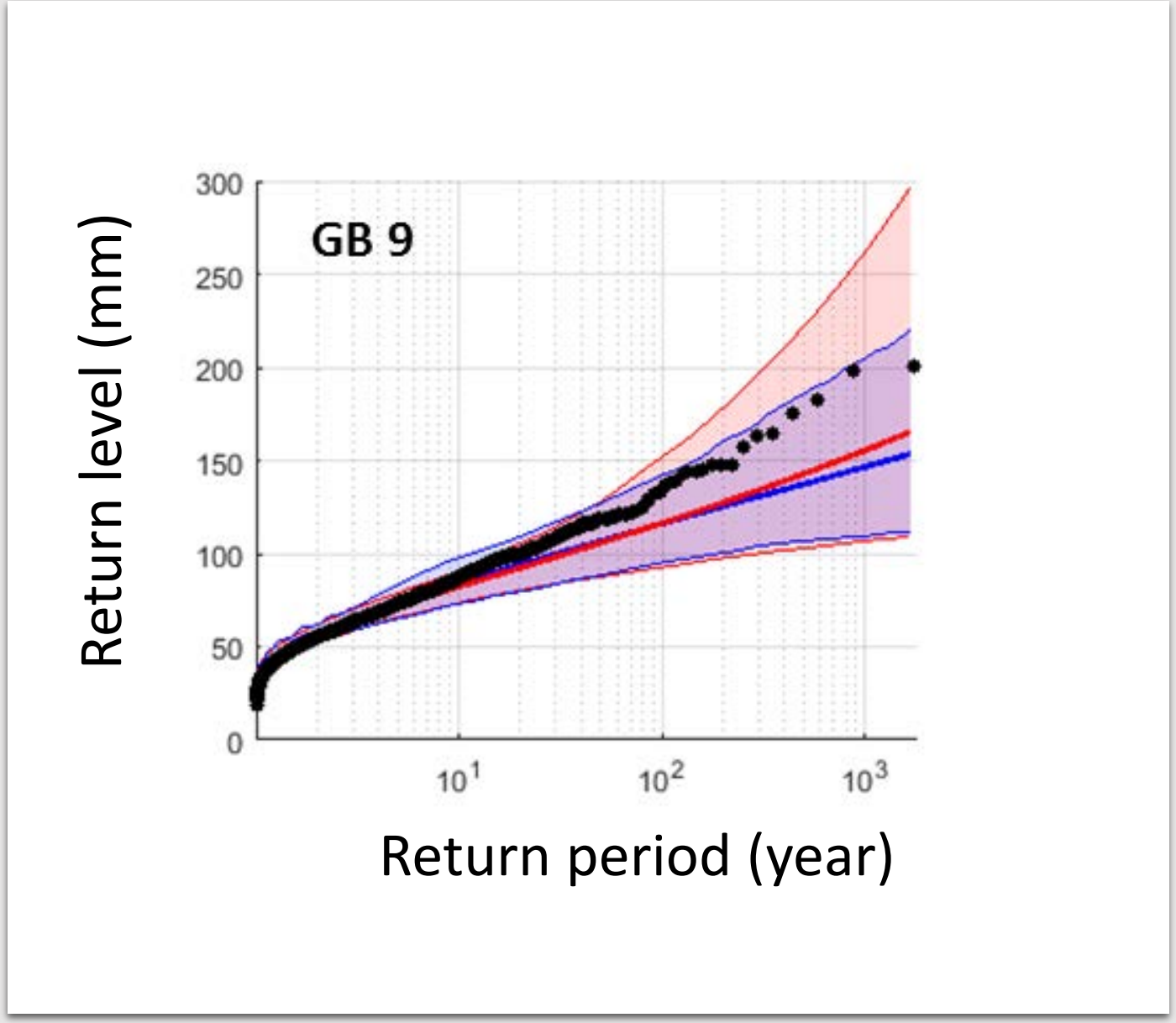
Results GB 9: Shape parameter





Results GB 9: Return level





Conclusion

Treating hydro-meteorological extremes as compound events

1- Makes possible the use of more information from a given period

2- Corresponds more directly to the physical processes

3- Can incorporate a bit from our knowledge about the physical process that produces extremes when extrapolating using an extreme value theory, and thus a better scientific and empirical scrutiny

Thank you