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Attributing Compound Events to Anthropogenic Climate Change

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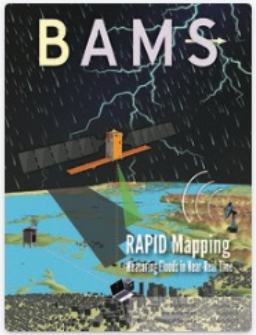

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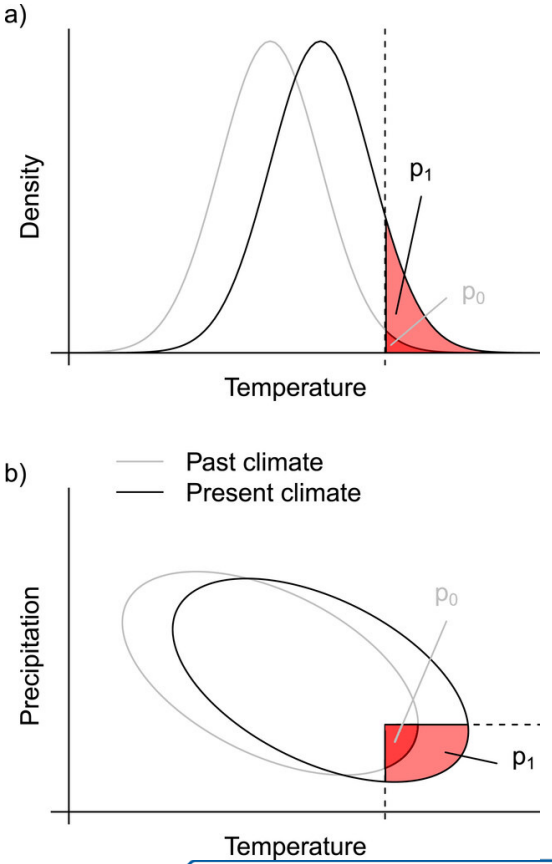
From univariate FAR to multivariate FAR

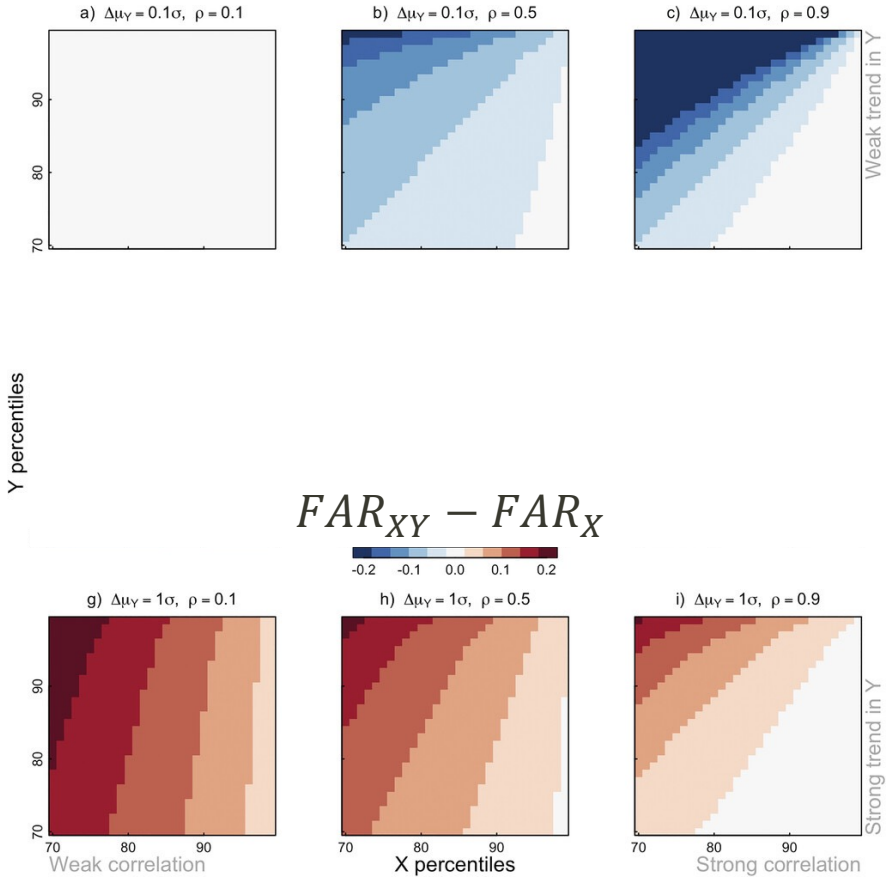
- Fraction of Attributable Risk is based on exceedance probabilities: $FAR = 1 - \frac{p_0}{p_1}$
- These can also be computed for multivariate distributions
- Under which conditions does the multivariate FAR differ from its univariate counterparts?

- Multivariate FAR is a function of

a) Extremeness of the event in the marginals
b) Trends in the marginals
c) Dependence between contributing variables



A simulation study



Bivariate Gaussian distribution (X, Y) with trend in X = 1 standard deviation

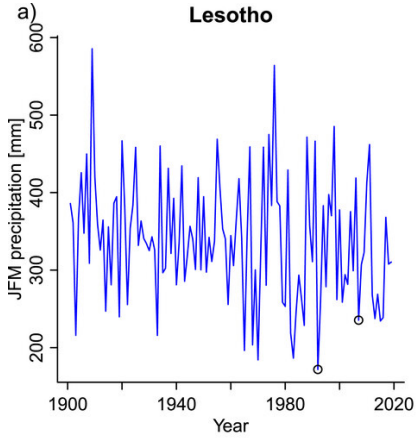
Varying trend in Y and varying dependence.

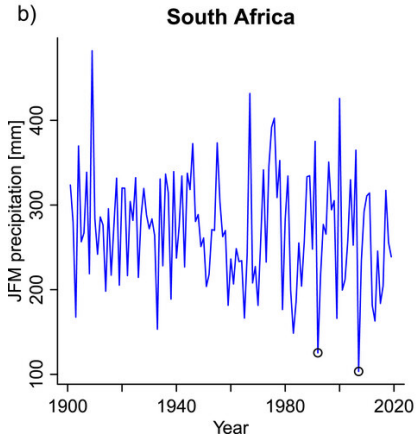
Under which conditions $FAR_{XY} > FAR_X$?

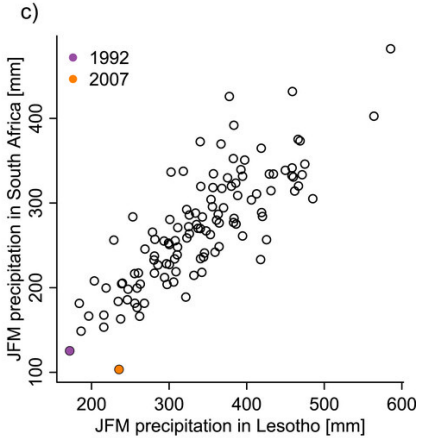
Bivariate FAR is larger than both univariate FARs when

- Dependence is weak and/or
- Trends in both variables is strong

Case study: concurrent crop failure in Lesotho and South Africa

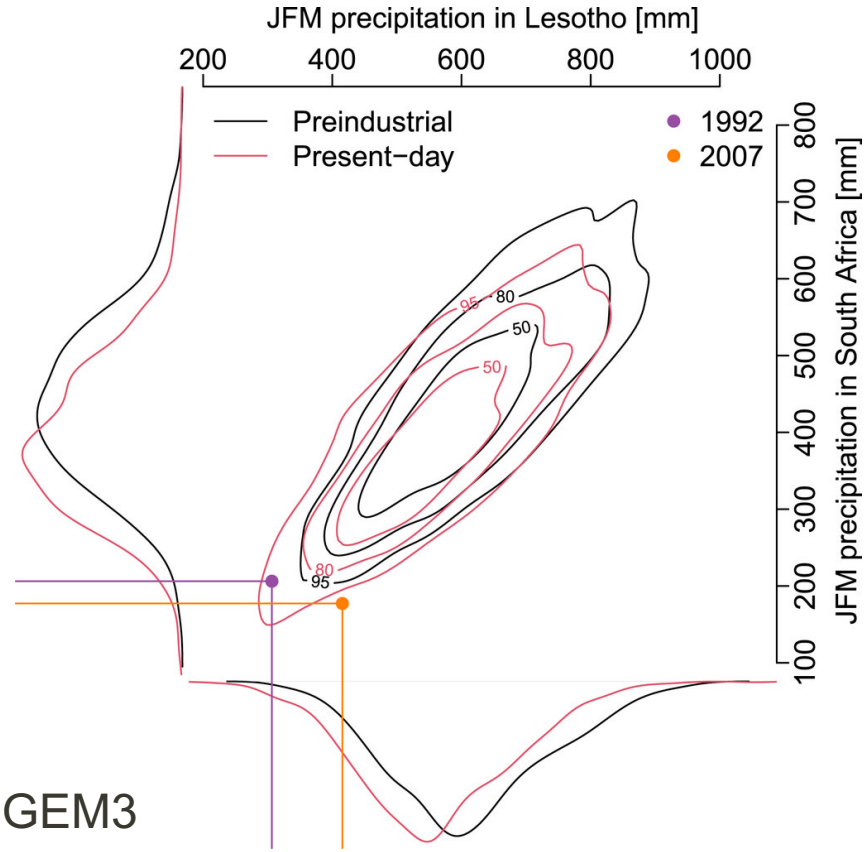






- Concurrent strong rainfall deficit in two crop producing regions with strong trade between them → spatially compounding event
- Strong dependence between the rainfall in the two regions

Univariate and bivariate attribution



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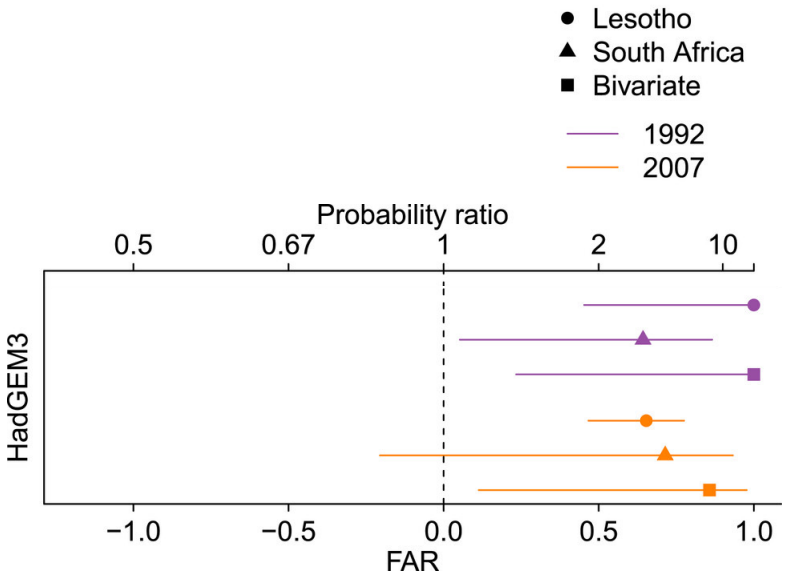

Conclusions

- High-impact events are typically associated with multiple climate drivers
- Event attribution can easily be extended to the multivariate domain
- Additional insights are expected if drivers are only weakly correlated or trends in the contributing variables are of similar magnitude

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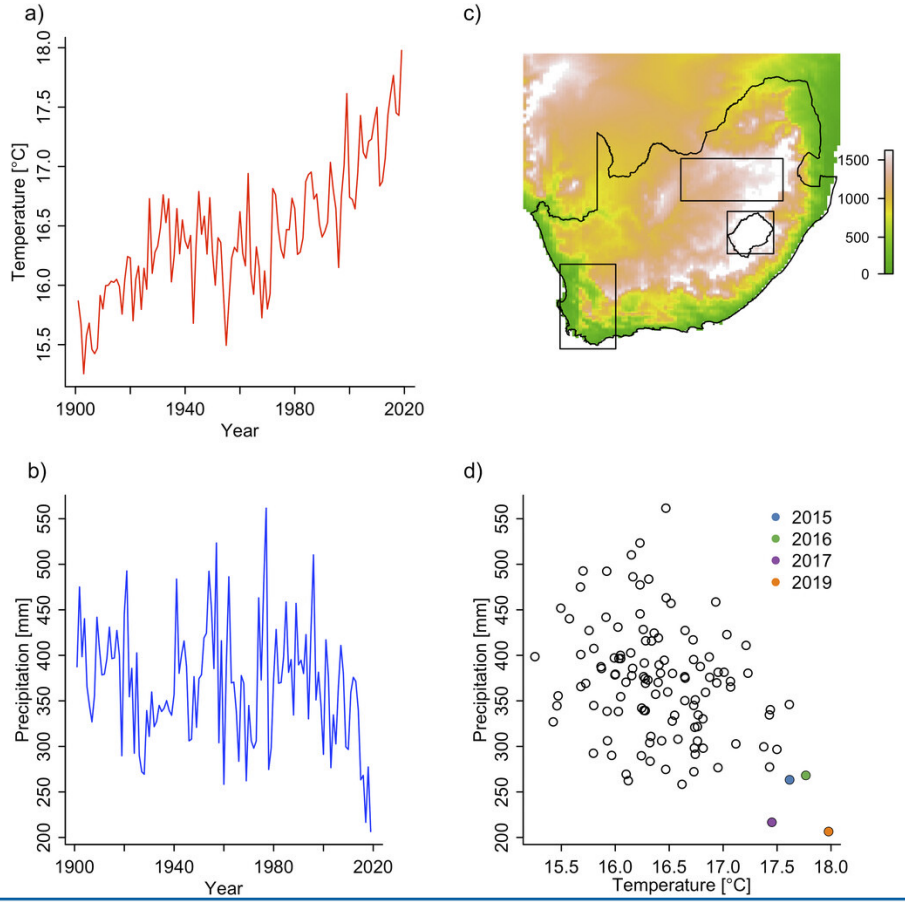
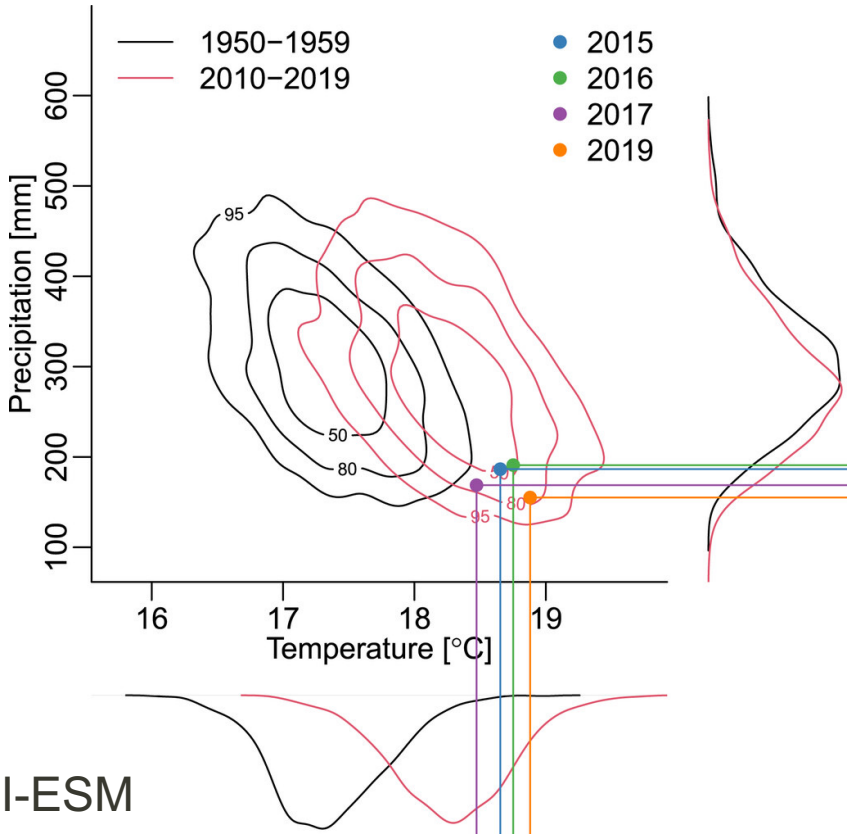
Case study: Cape Town drought dry and hot years



- Concurrent extremely hot temperatures and extreme rainfall in the same region → multivariate compound event
- Moderate dependence between temperature and rainfall

Univariate and bivariate attribution



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