Multi-method attribution of the extreme precipitation and flood of 2018 in Kerala, India

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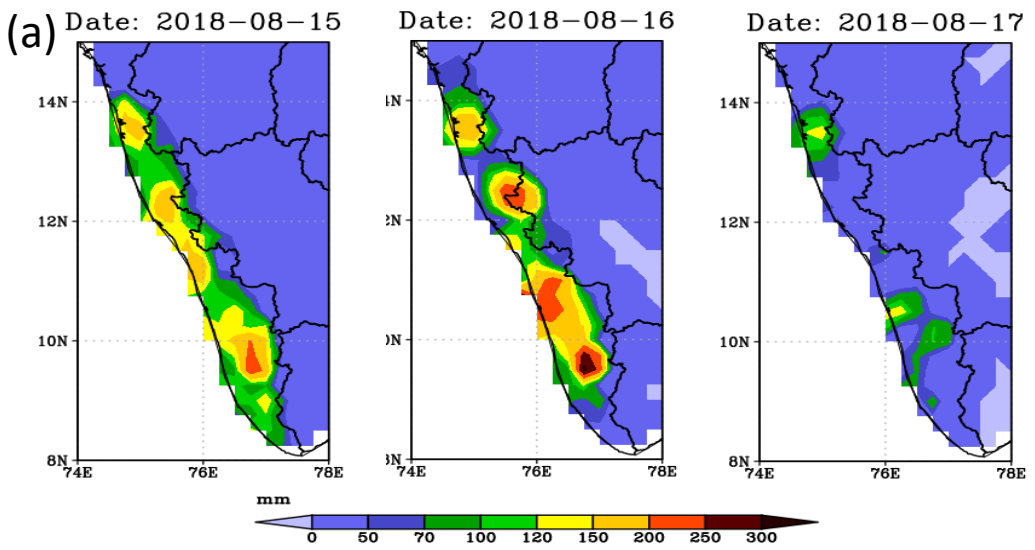
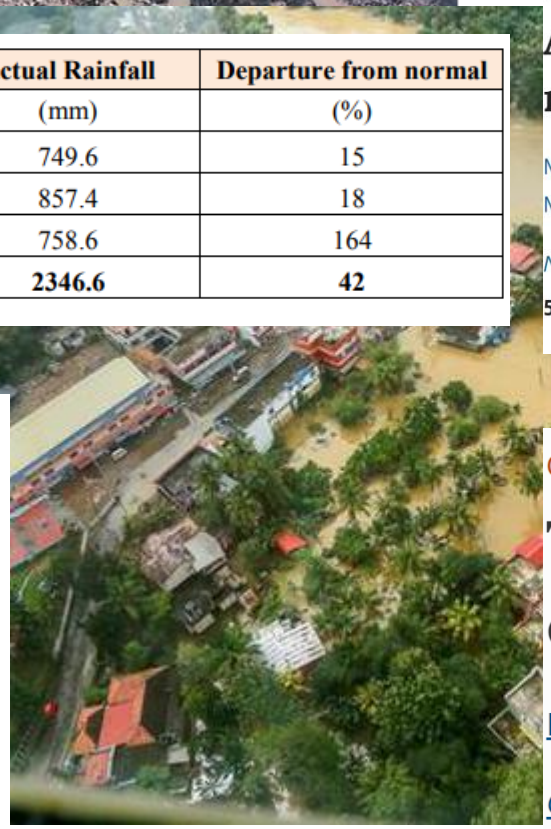
150 YEARS OF CELEBRATING THE MAHATMA

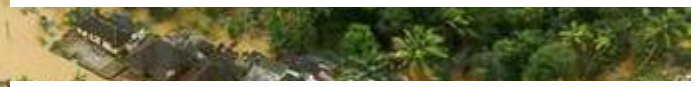
Kerala floods 2018

Period	Normal Rainfall	Actual Rainfall	Departure from normal
	(mm)	(mm)	(%)
June, 2018	649.8	749.6	15
July, 2018	726.1	857.4	18
1-19, August, 2018	287.6	758.6	164
Total	**1649.5**	**2346.6**	**42**

Source: CWC







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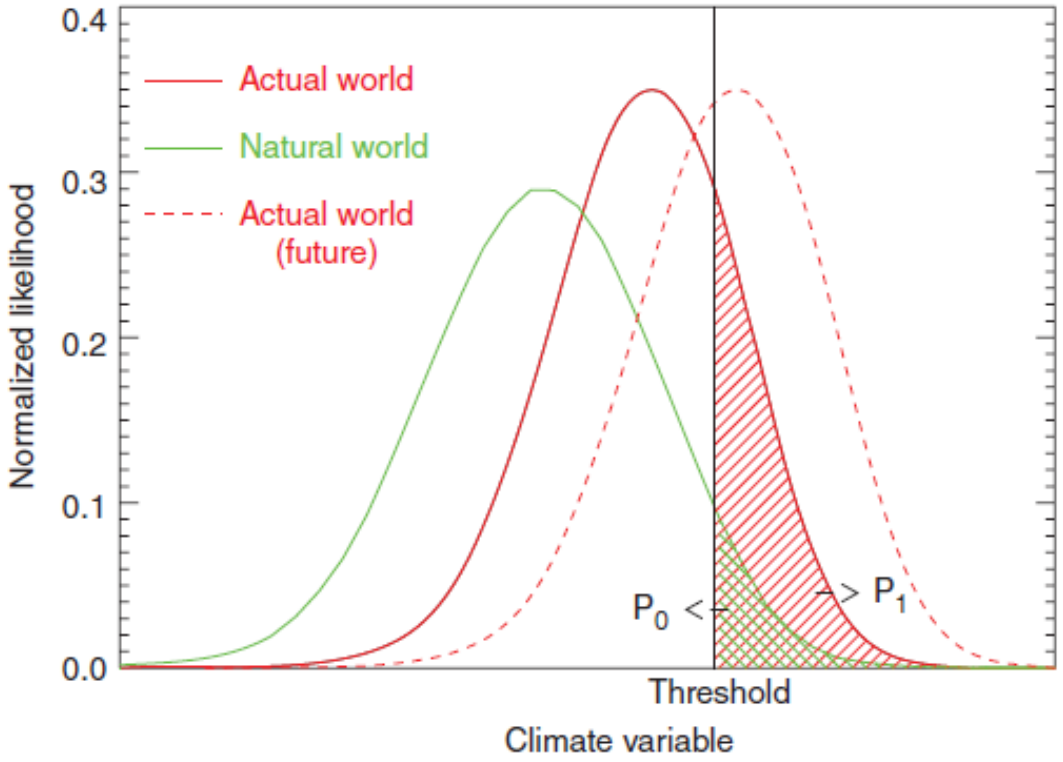
(a) IMD observed rainfall over Kerala.

https://reliefweb.int/report/india/study-report-kerala-floods-august-2018-september-2018

Probabilistic Event Attribution (PEA)



- PEA rely largely on climate model simulations. GCMs provide most comprehensive simulation of climatic system.
- The distribution of the variable in the 'actual' world and the counterfactual 'natural' world without human influence on climate can thus be constructed, from which estimates of the FAR for the event under investigation are obtained.

Source: Stott et al.(2016)

Fraction of Attributable Risk

$$FAR = 1 - \frac{P_0}{P_1}$$

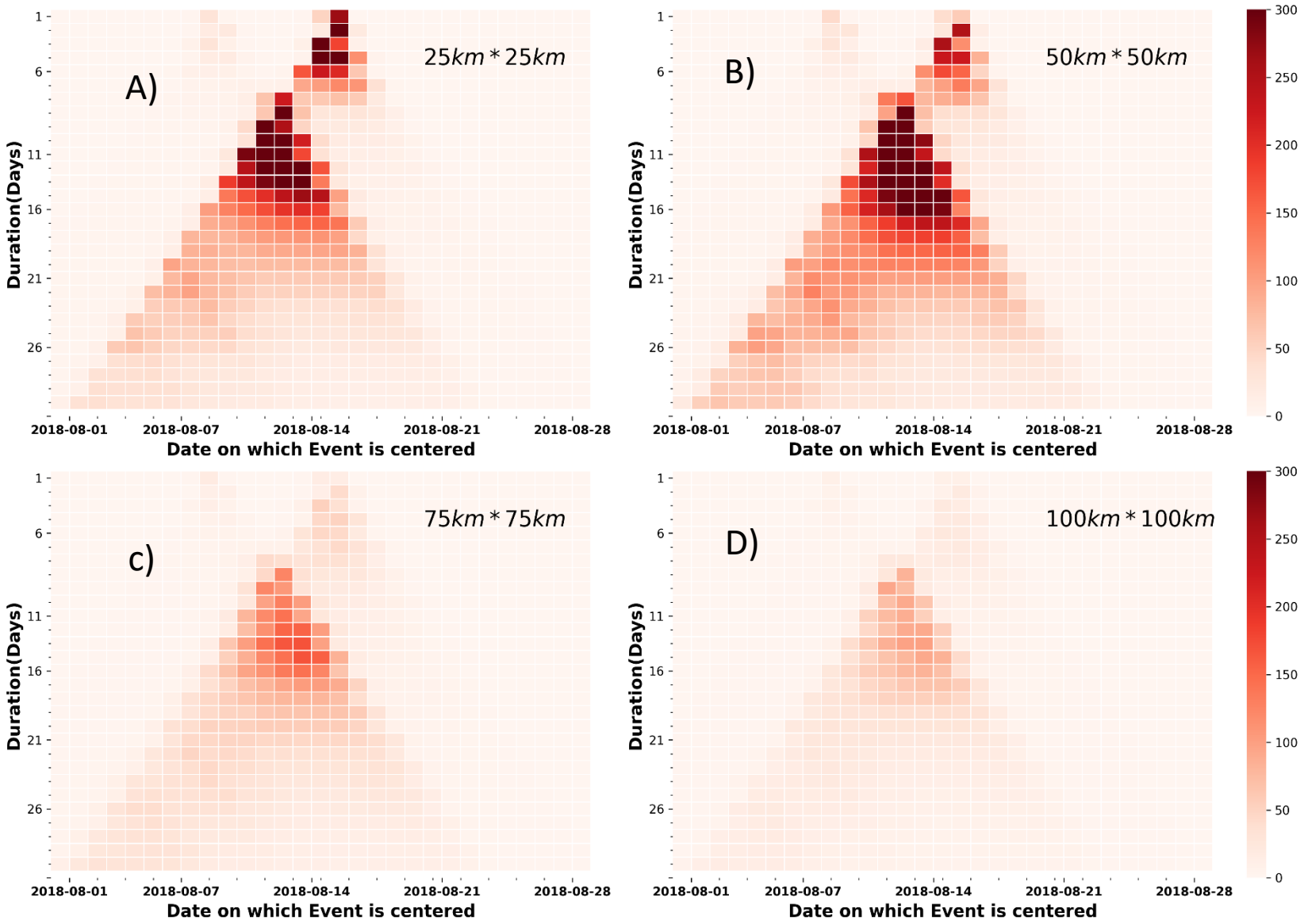
P_0 →probability of occurrence in counterfactual (NAT) world

P_1 →probability of occurrence in Actual (ACT)world

Event Definition

- Return period of the event for different spatial resolutions (25 km x 25 km, 50 km x 50 km, 75 km x 75 km, 100 km x 100 km), centred at 9.375N , 76.875E, and different durations (y-axis), centred at individual dates in Aug, 2018 (x-axis).

- Therefore we defined the event as a 4-day event centered on 16 Aug, for 25 * 25 km^2 area.



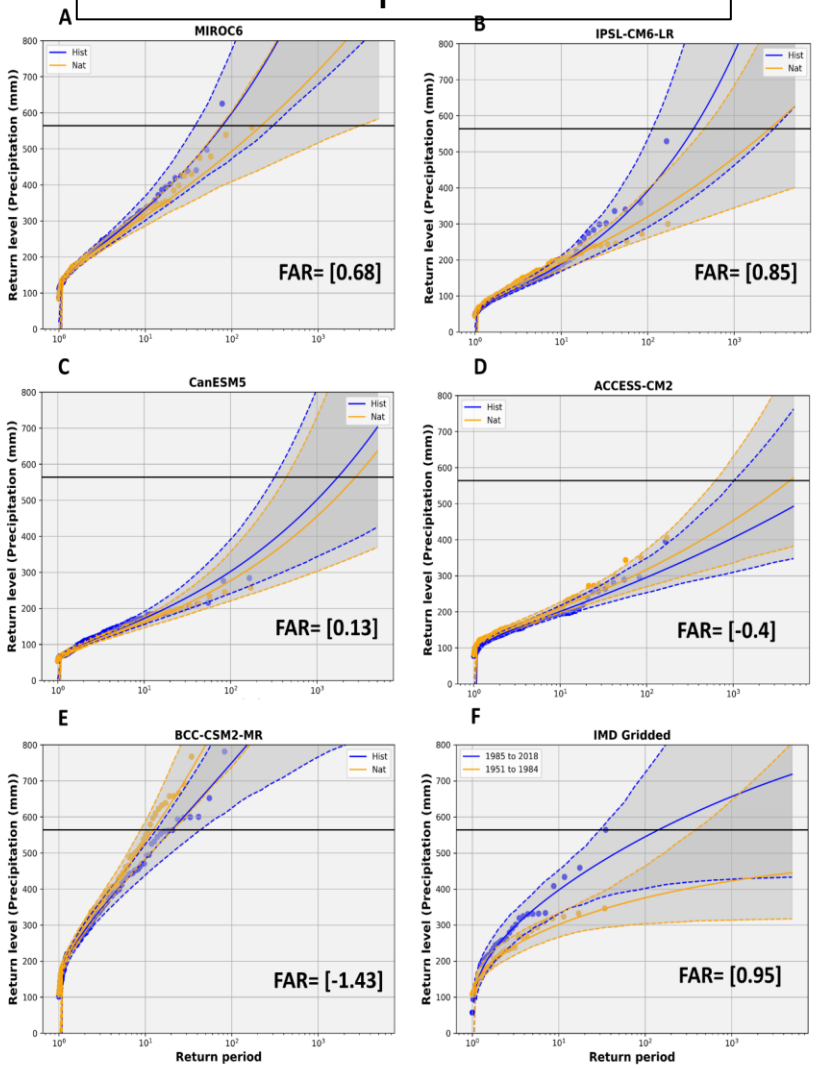
Calculation of FAR using CMIP6 models

- We have used these 5 CMIP6 models to calculate the FAR (based on the availability of historical and natural simulation).
- We also setup and calibrated the VIC hydrological model for the Periyar basin and obtained the NSE equal to 0.61.

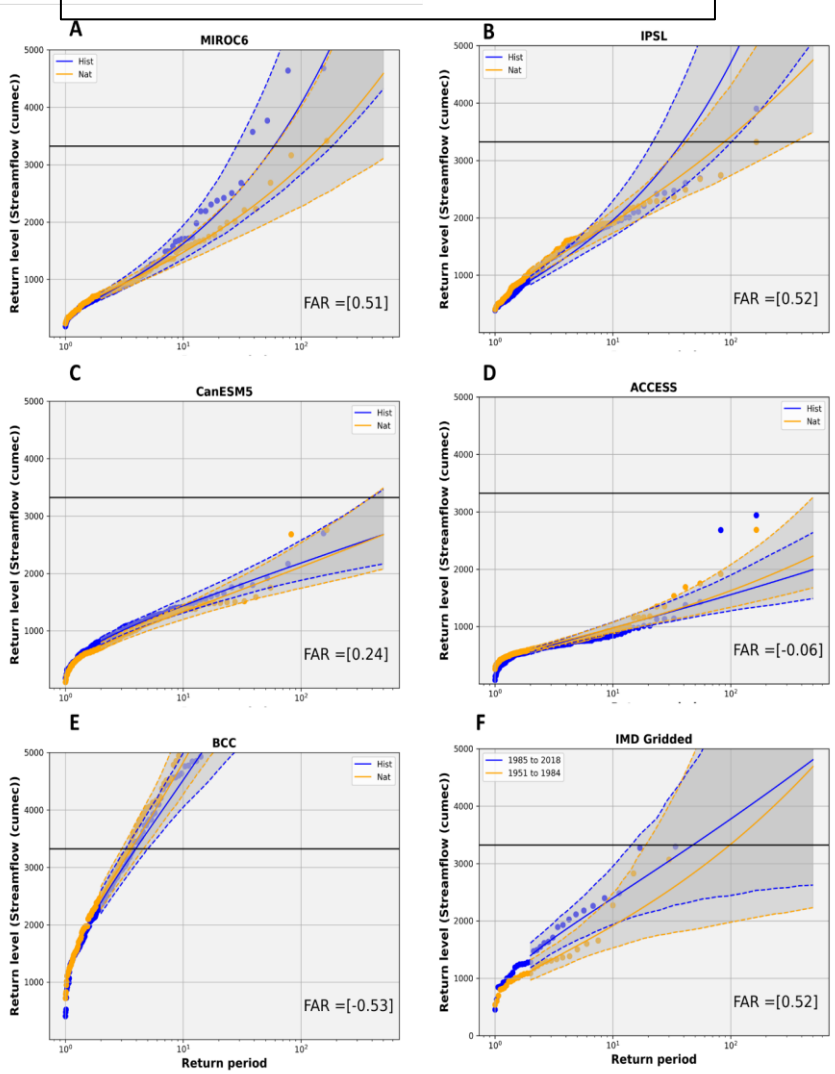
S. No.	Model name	Latitude resolution (degree)	Longitude resolution (degree)	Period
1	ACCESS-CM2	1.25	1.875	1850-2014
2	BCC-CSM2-MR	1.1215	1.125	1850-2014
3	CanESM5	2.7906	2.8125	1850-2014
4	IPSL-CM6-LR	0.7018	0.703125	1850-2014
5	MIROC6	2.5	2.5	1850-2014

Probabilistic Event Attribution (PEA)

Precipitation



Streamflow



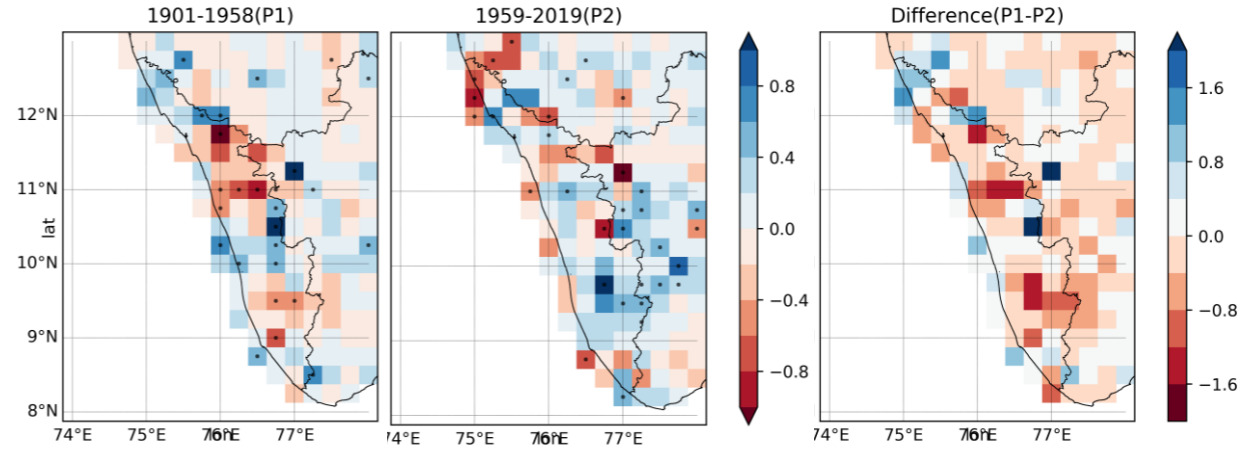
Return period for the precipitation of historical and natural runs of CMIP6 models. Blue color represent the historical and orange color represents the natural run.

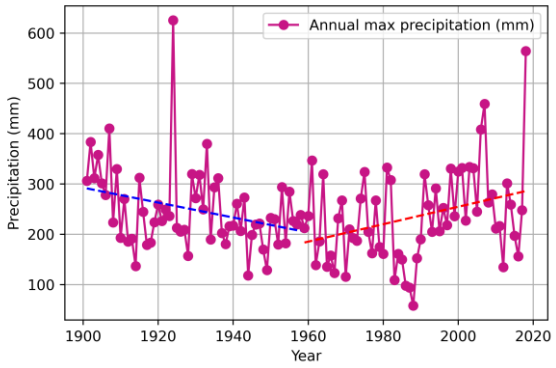
This event has a return period of 373 years (90% CI: 72-1200 years), 34 years (90% CI: 12-286 years) for streamflow.

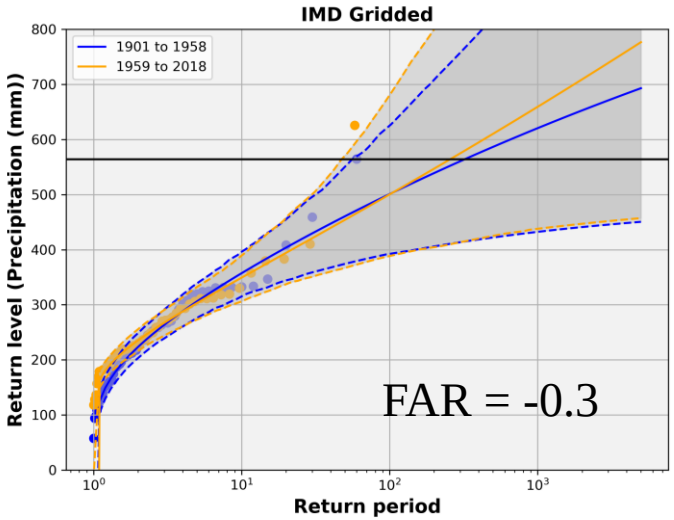
FAR for ensemble CMIP6 models is -0.18 for rainfall and -0.14 for streamflow

Observation based attribution analysis

Time slice method





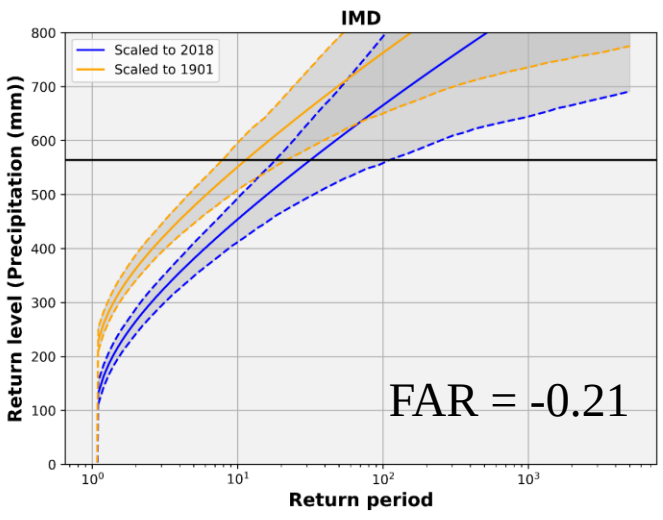


Scaling method

Assumption: the PDF of the event does not change shape, but shifts to higher or lower values under climate change.

$$F(x) = exp\left[-\left(1+\xi\frac{x-\mu}{\sigma}\right)^{1/\xi}\right]$$

$$\text{where } \mu = \mu_0 exp\frac{\alpha T'}{\mu_0}$$



Blue represent for GEV scale fitted to 2018 and orange represent for GEV scale fitted to 1901

Conclusion

- We first define the 2018 event as the 4-day cumulative rainfall over the Periyar river basin (PRB), during 15- 18 August 2018. This event has a return period of 373 years (90% CI: 72-1200 years).
- Simulated using VIC hydrological model, the streamflow event is found to have a return period of 34 years (90% CI: 12-286 years).
- Multi method attribution study shows that the likelihood of the Kerala flood in 2018 is not altered by anthropogenic climate change.
- These values imply that the 2018 event is exceptionally less likely due to climate change.

Thankyou

Abstract

Author’s webpage

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