Event attribution with CMIP5 data

Fraser Lott, Andrew Ciavarella, Peter Stott

WCRP/ICTP Summer School, Trieste 21st July – 1st August 2014

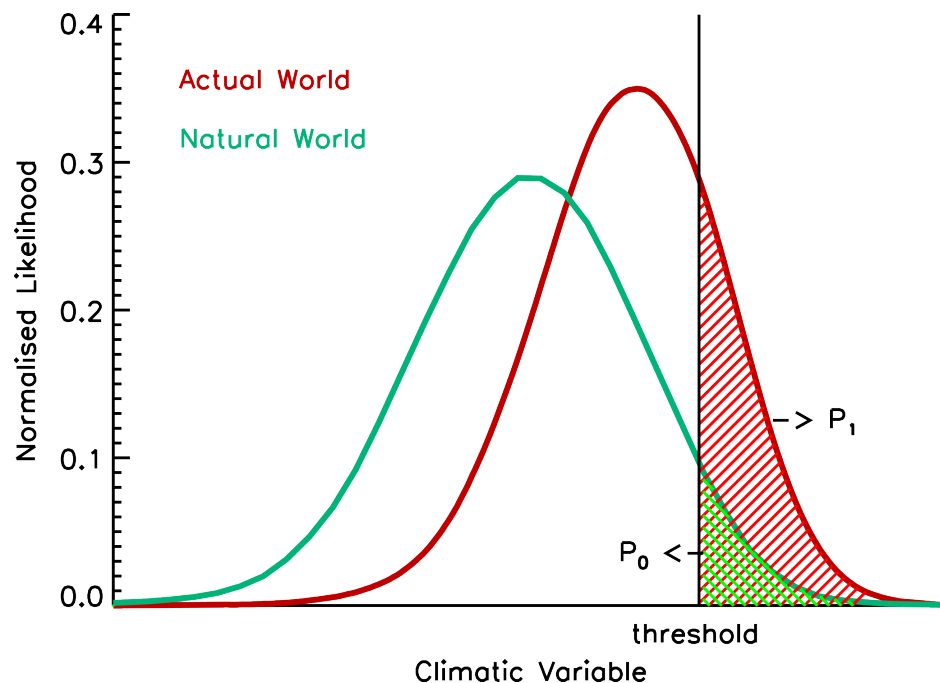# Does climate change cause individual extreme events?

Myles Allen 2003, Nature 421 p891-892

- It is often assumed that individual weather events cannot be ascribed to climate change

- However, climate change may change the probability of that event having taken place

What is the fraction of attributable risk?

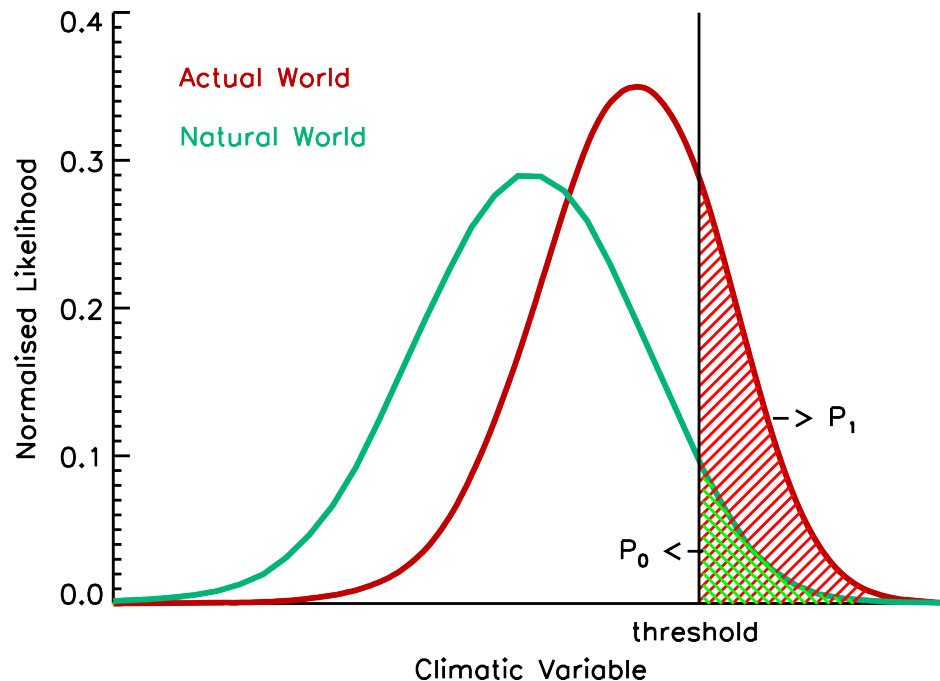- What is a fraction of attributable risk?

P_0: Probability of exceeding a threshold in a "natural world" (no human influence on climate forcings).

P_1: Probability of exceeding a threshold in the real world.

$$F_{AR} = 1 - (P_0 / P_1)$$

$$= 1 - (P_{NAT} / P_{ALL})$$

What do we need to calculate the FAR of an event?

These can both be obtained from ensembles of CMIP5 model runs

- A large enough set of model data with all historical forcings, covering the region, period and variable of interest

- A second set with natural-only forcings, or with the effect of anthropogenic changes removed
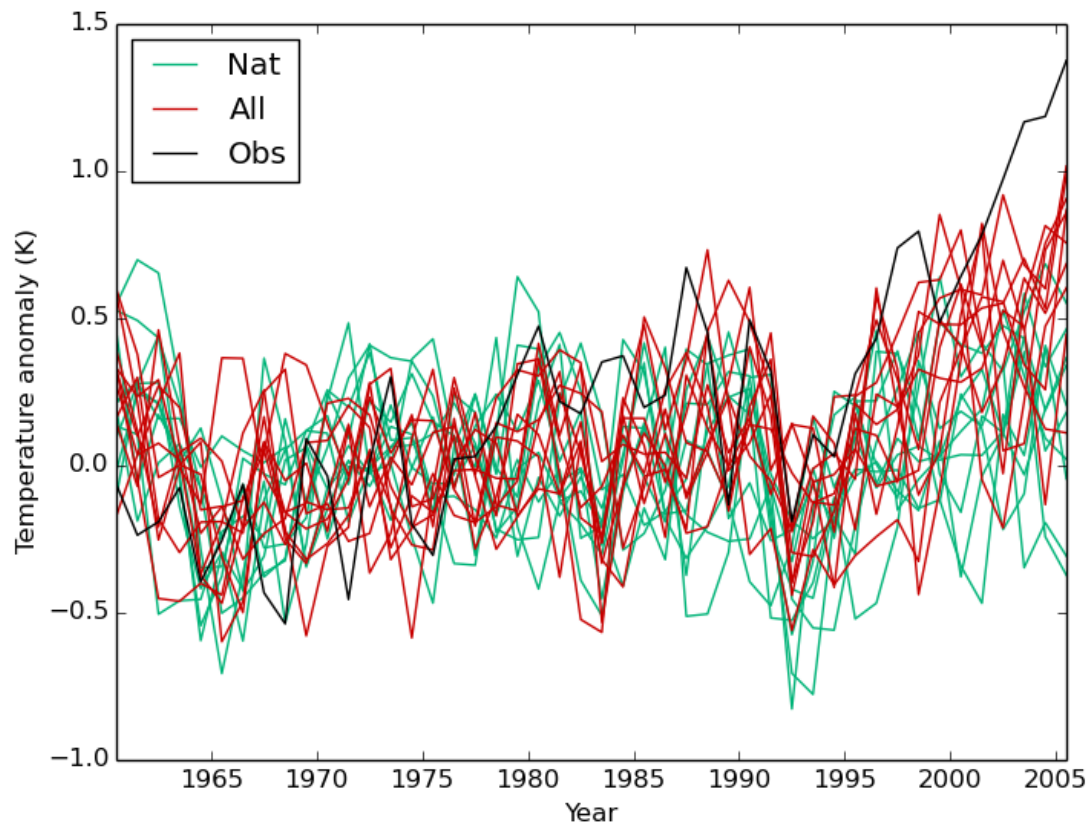
# What else do we need to calculate the FAR of an event?
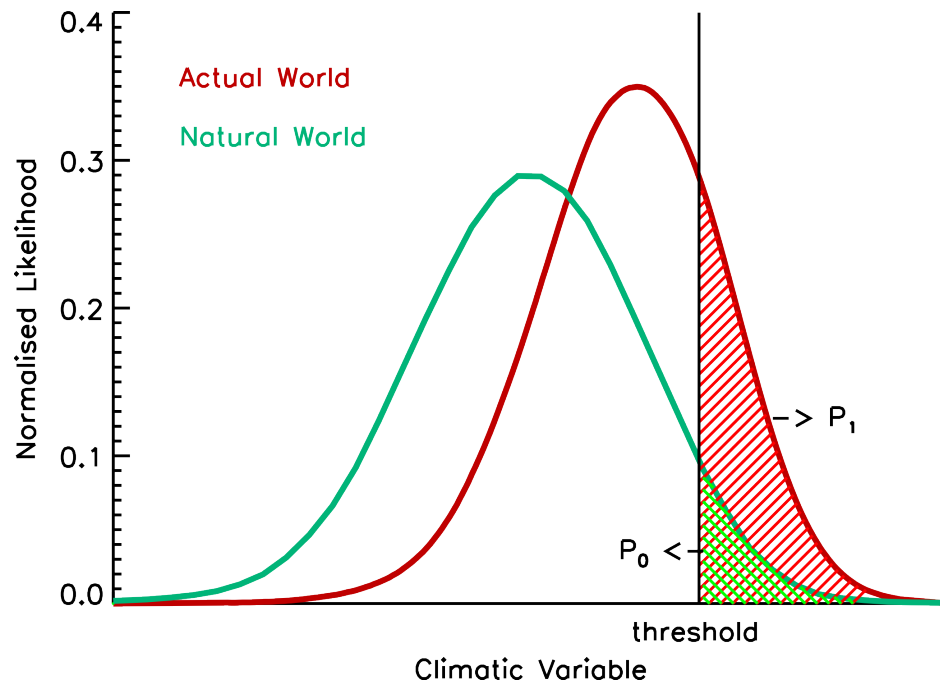
- Real-world observations to establish thresholds and correct biases in the model

- The threshold can be taken as "as bad as the event, or worse", "beyond the second-worst" or as lying in an upper quantile of observed events

Where do we start the project?

- Historical, natural and future forcing runs in CMIP5 give a good starting point

- Global simulations can be sub-selected to focus on given regions

- Comparison with observational datasets give a simple detection study

But what about events?
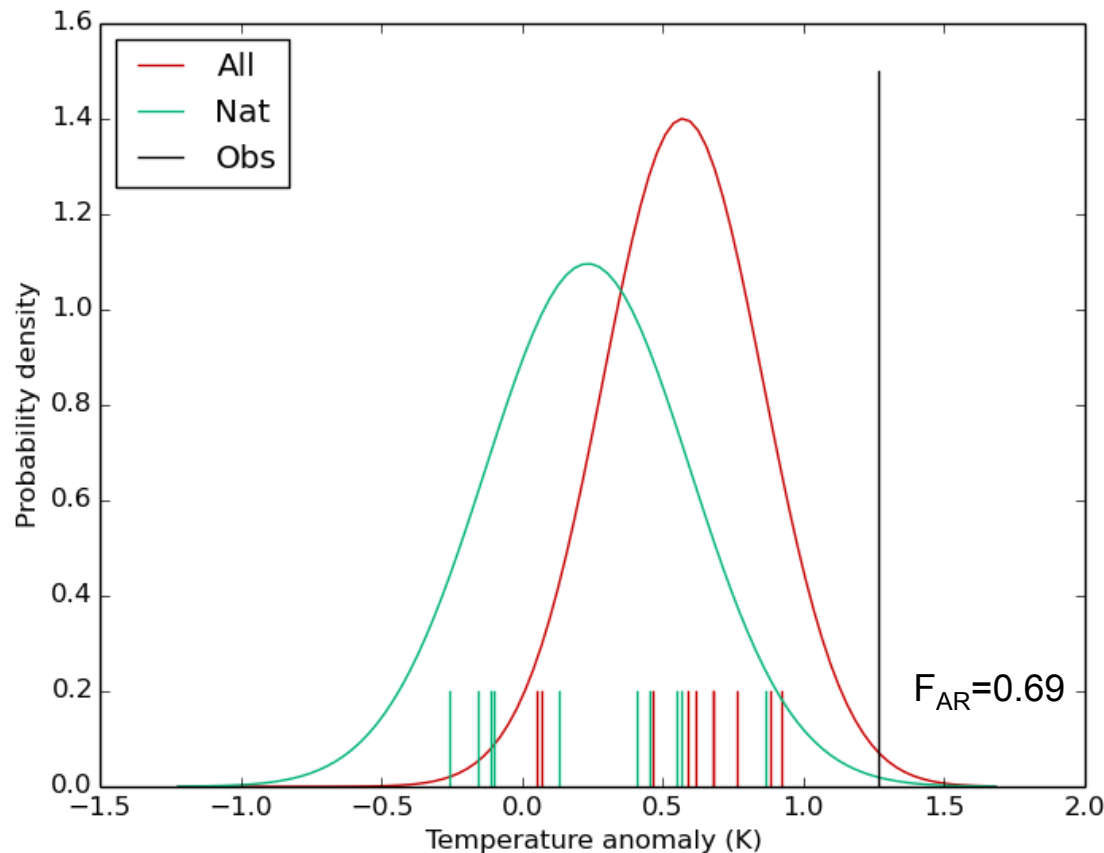
- We can focus on a single season and year to study how a variable's probability has changed with the climate

- Comparison to an observed extreme gives a measure of the fraction of attributable risk

What can we do?

- Choose the event and variable that interests your group

- Examine using larger datasets

- More and different regions

- Better statistical techniques for calculating FAR
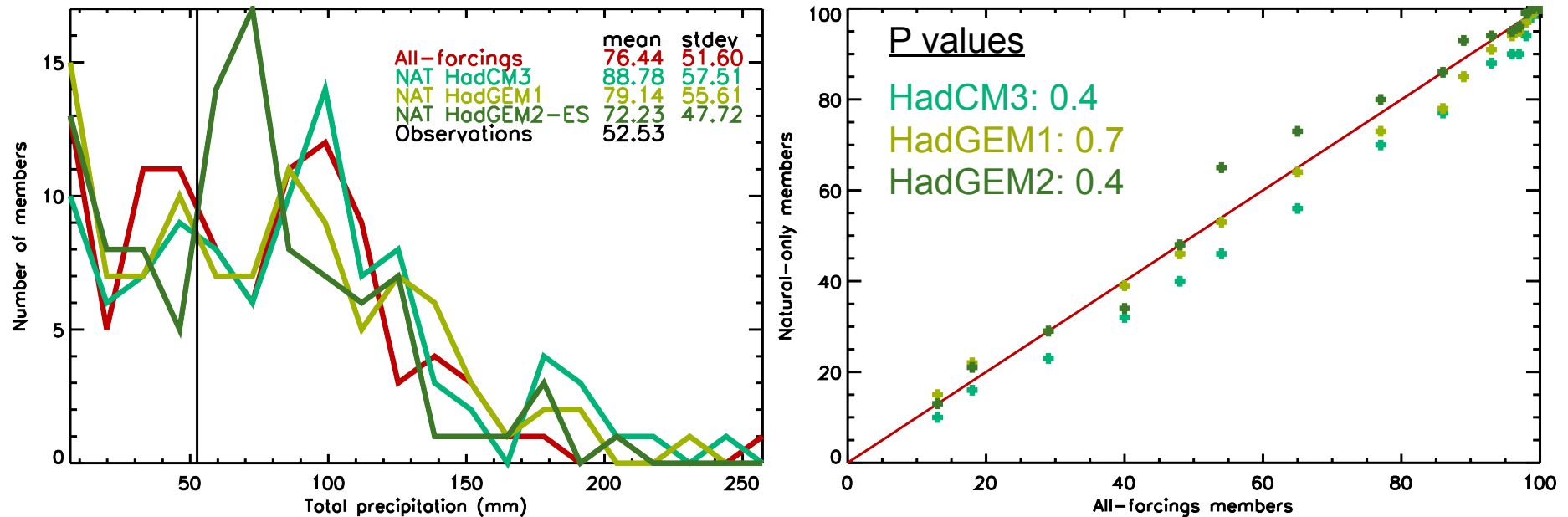
…or something completely new!

The 2010-2011 East African drought

An example project

Short rains 2010

- Histograms created from distribution of seasonal accumulated rainfall for each set of simulations

	mean	stdev
All-forcings	76.44	51.60
NAT HadCM3	88.78	57.51
NAT HadGEM1	79.14	55.61
NAT HadGEM2-ES	72.23	47.72
Observations		52.53

P values

HadCM3: 0.4
HadGEM1: 0.7
HadGEM2: 0.4

- 2-sided Kolmogorov-Smirnov (KS) test shows no significant difference in the curves at the 10% level

- No evidence for any effects of human-induced climate change on 2010 short rains

Long rains 2011

All three sets of natural world simulations are wetter than the all-forcings world
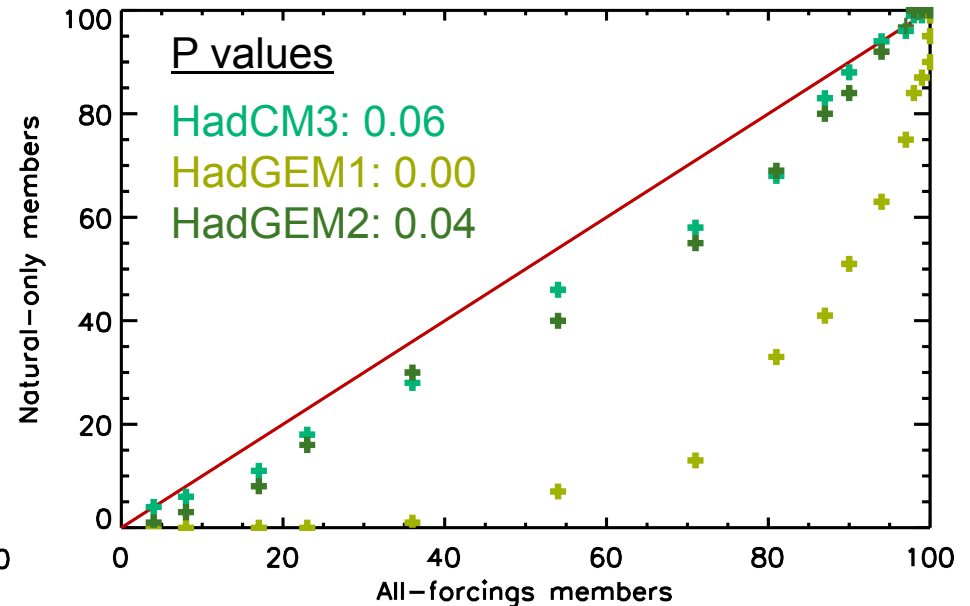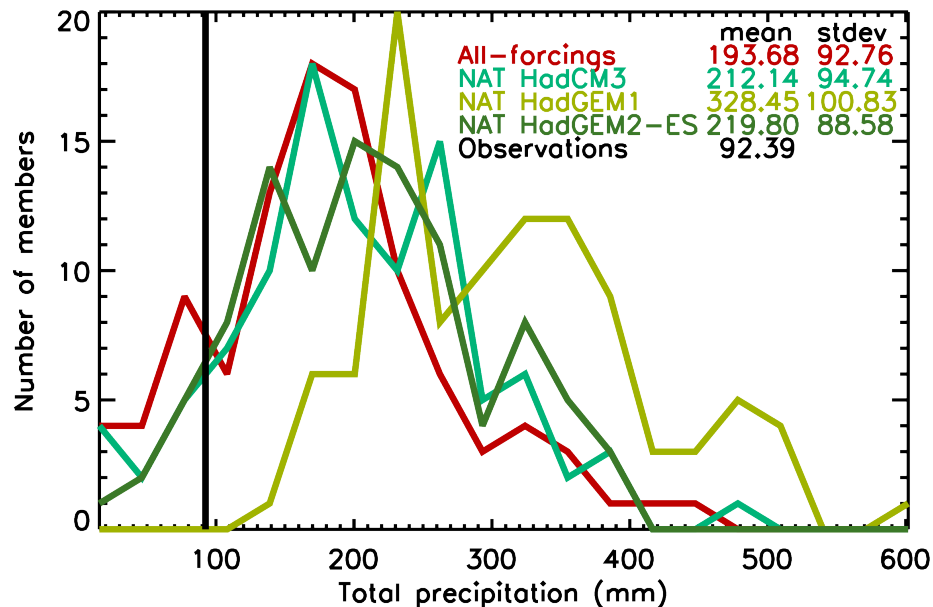
- One-sided KS test determines 2 of 3 shifts significant at 5% level, the third at 10% level

- This is evidence that 2011 long rains failure was more probable due to human influence (F_{AR} = 0.46 / 0.99 / 0.24)

Questions and answers