

climate *prediction*.net

the world's largest climate forecasting experiment for the 21st century

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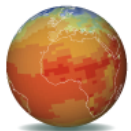
# Probabilistic Event Attribution - from meteorological variables to impacts

WCRP/ICTP summer school Trieste  
21<sup>st</sup> July-1<sup>st</sup> August 2014

Friederike Otto    Environmental Change Institute, University of Oxford

[friederike.otto@ouce.ox.ac.uk](mailto:friederike.otto@ouce.ox.ac.uk)

We can ask how the risk of an extreme event occurring has changed due to human greenhouse gas emissions



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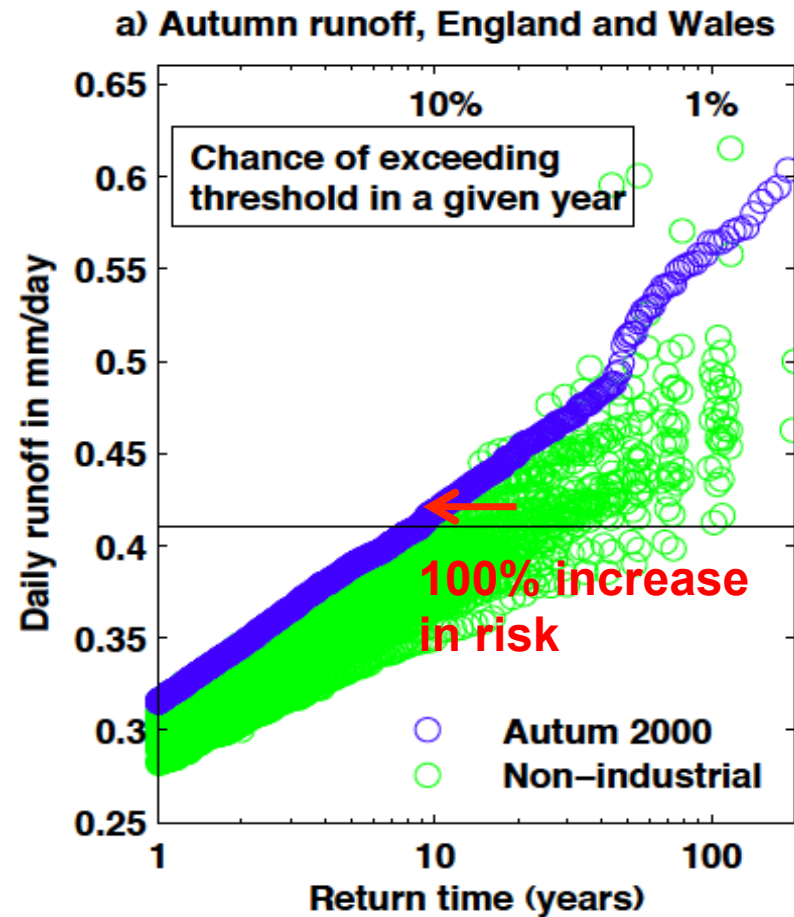
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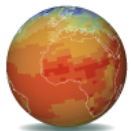


# Results from the Autumn 2000 flood

Substantial, but uncertain, increase in risk



Pall et al. 2011



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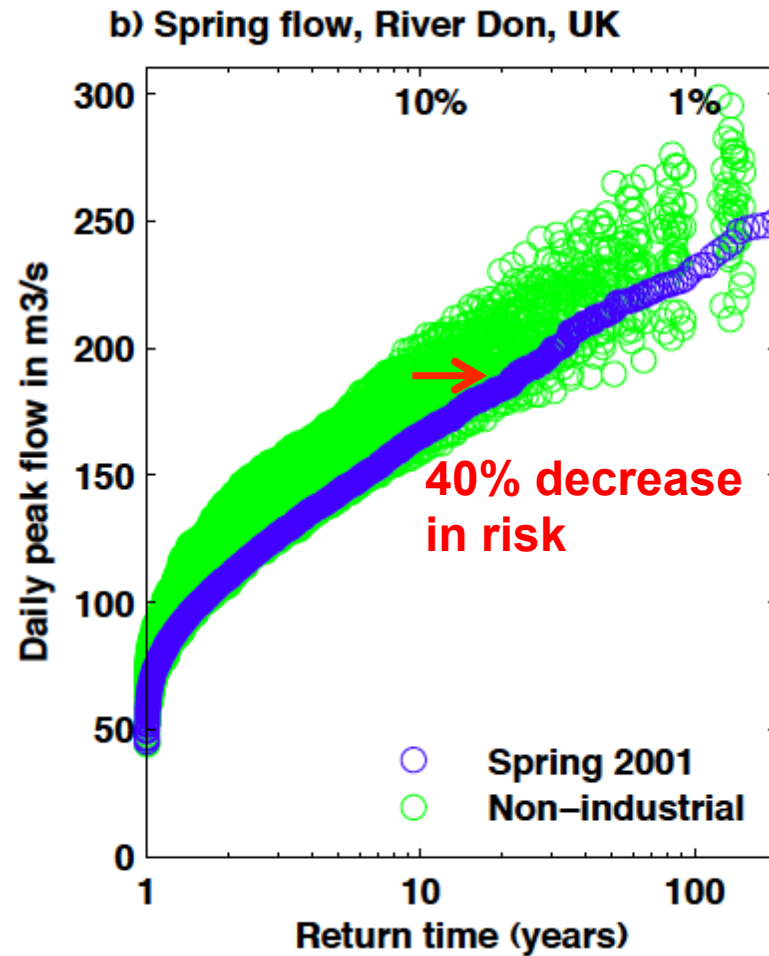
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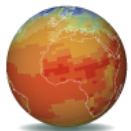


# Not all events are being made more likely

## A flood that didn't happen – in Spring 2001



Kay et al, 2011



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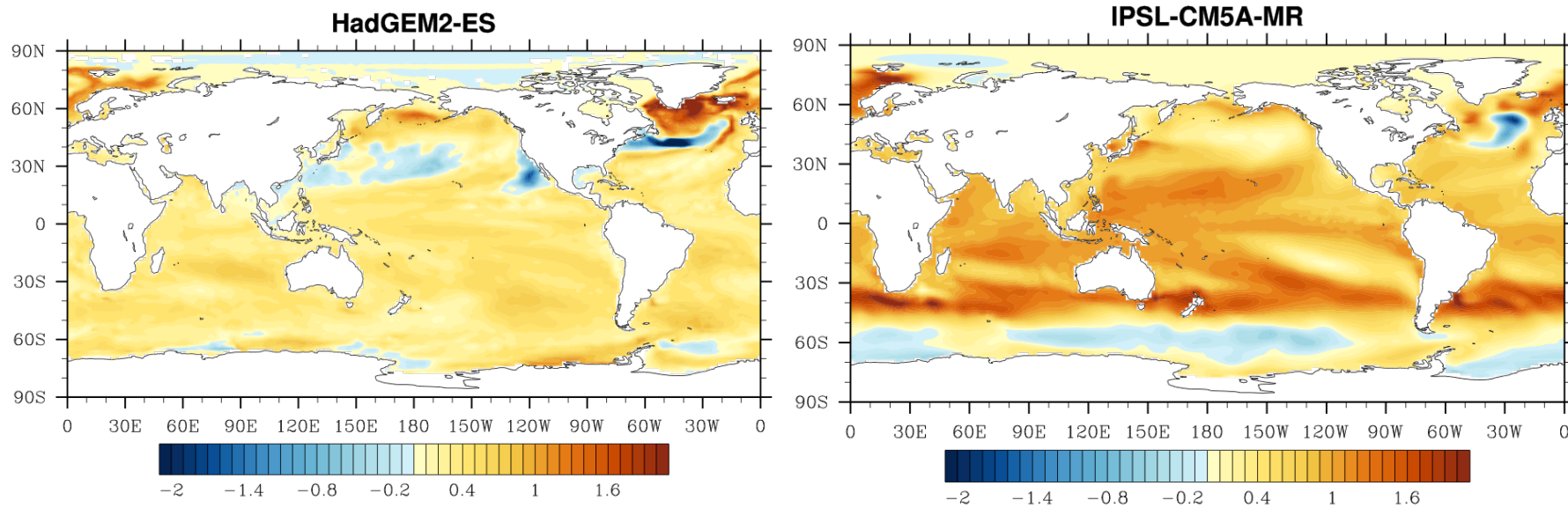
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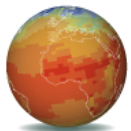


# SST patterns of the world that might have been

Updated experiment set up for precipitation in the UK



DJF SST response pattern to anthropogenic forcing for the HadGEM2-ES (left) and IPSL-CM5R-MR (right) models



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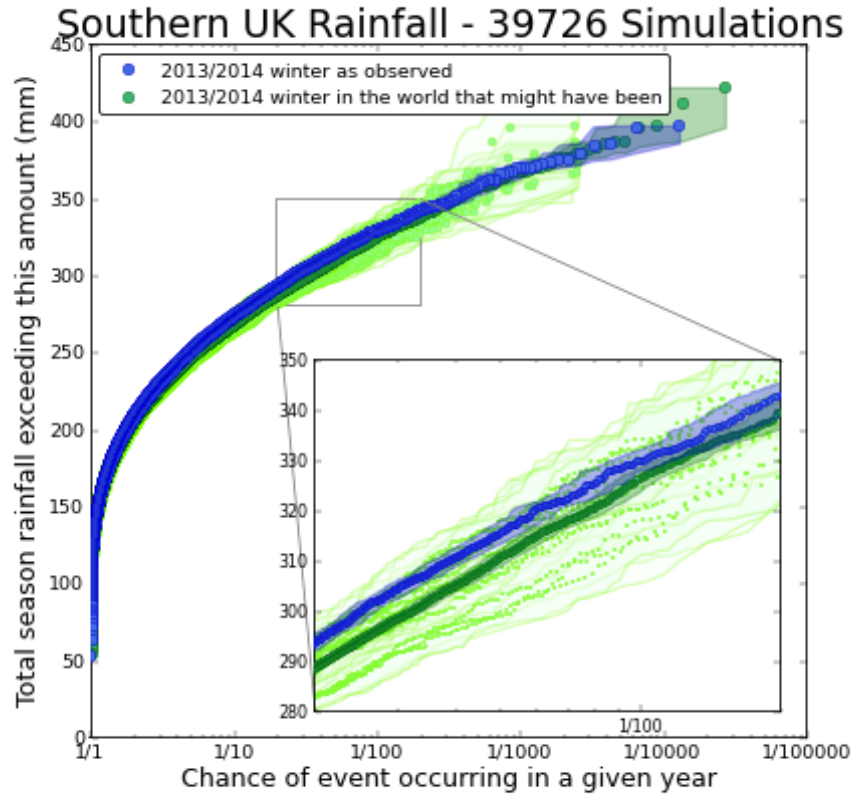
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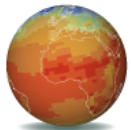
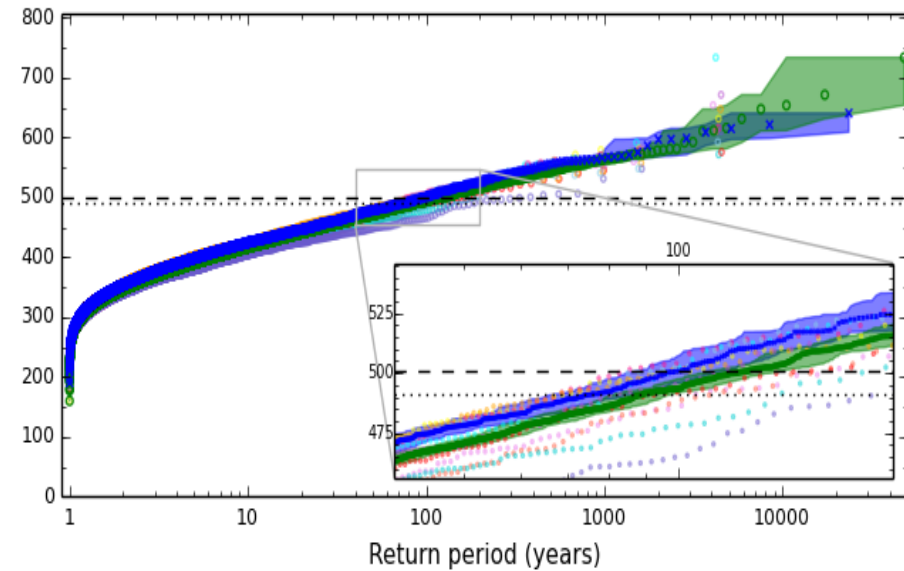




# From precipitation to river flow



## 10-day peak river flow in the Thames catchment



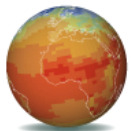
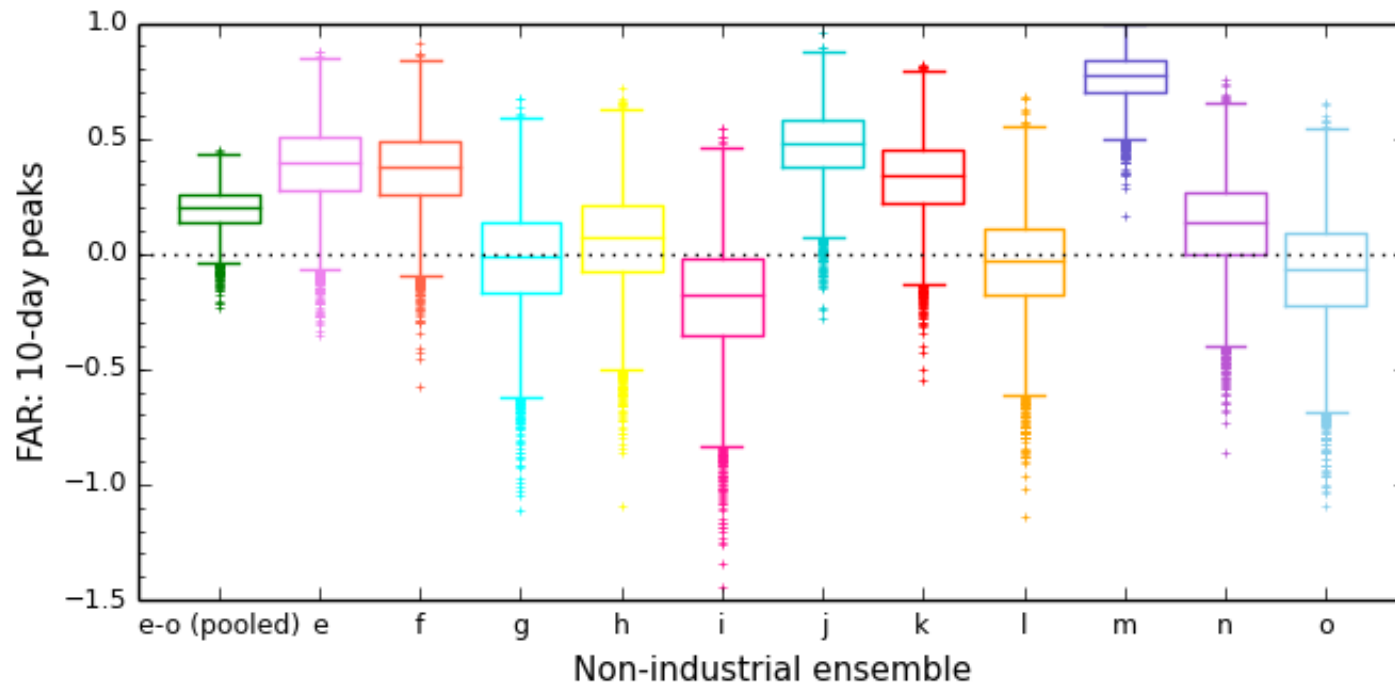
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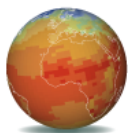
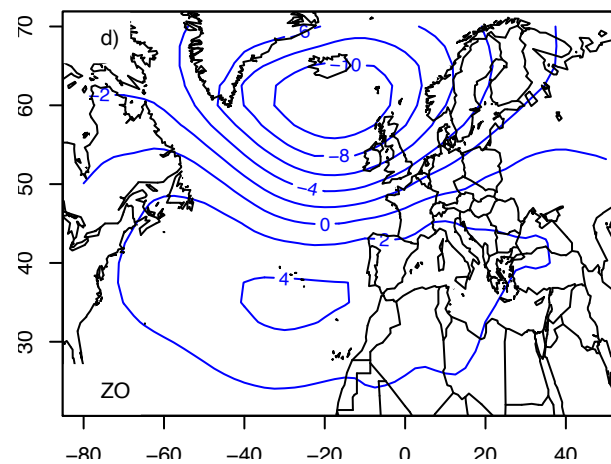
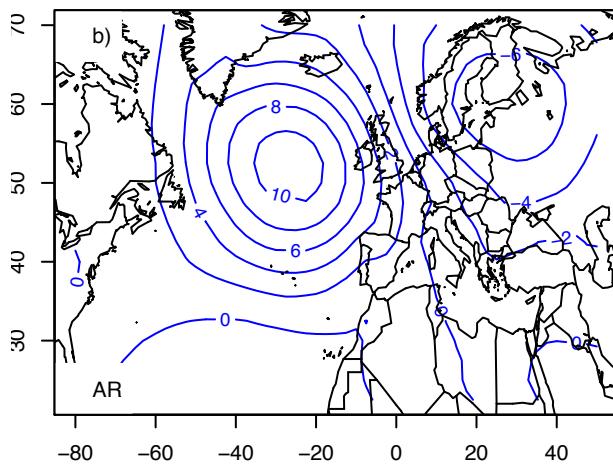
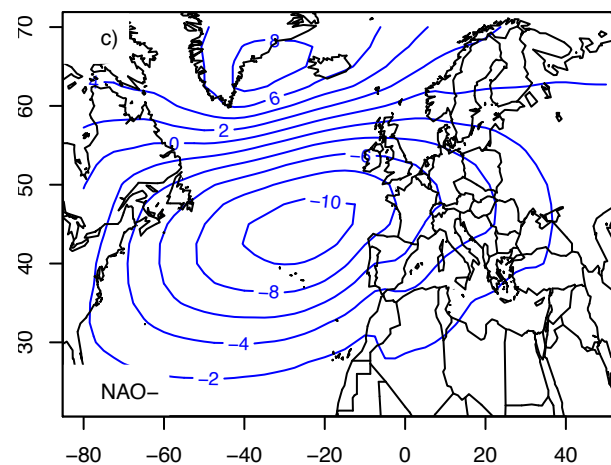
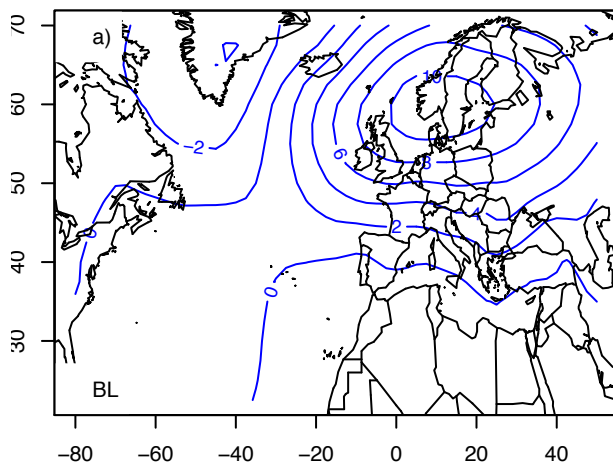


# FAR for river flow depending on the SST pattern removed

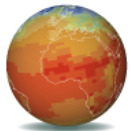
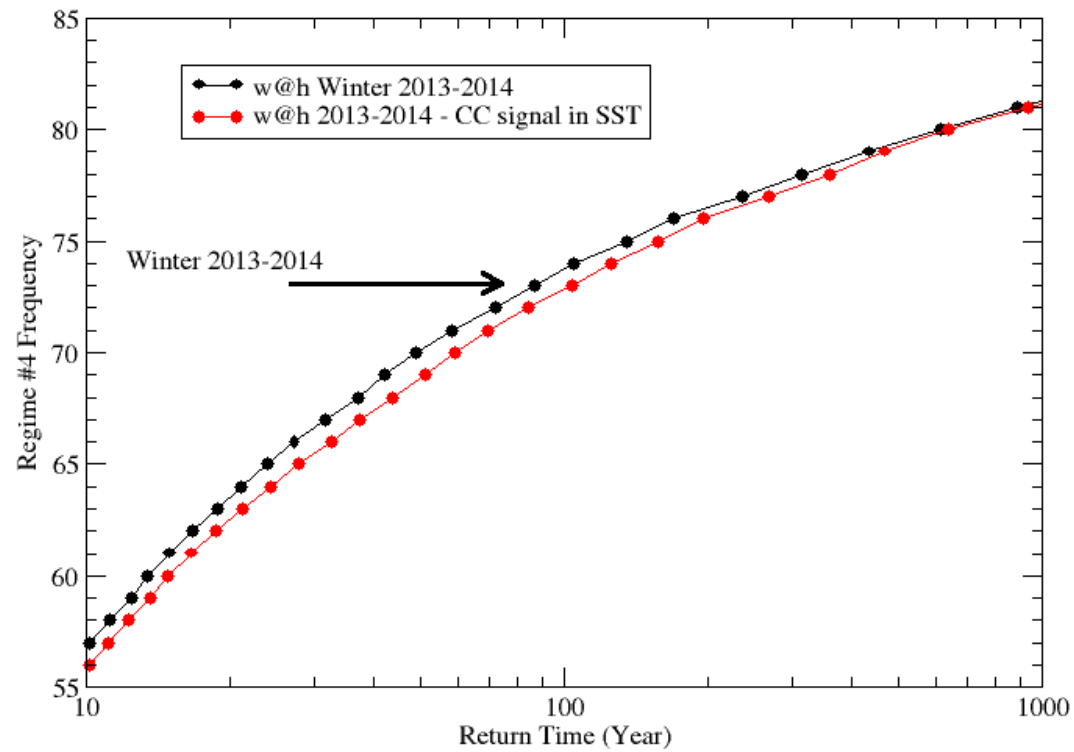




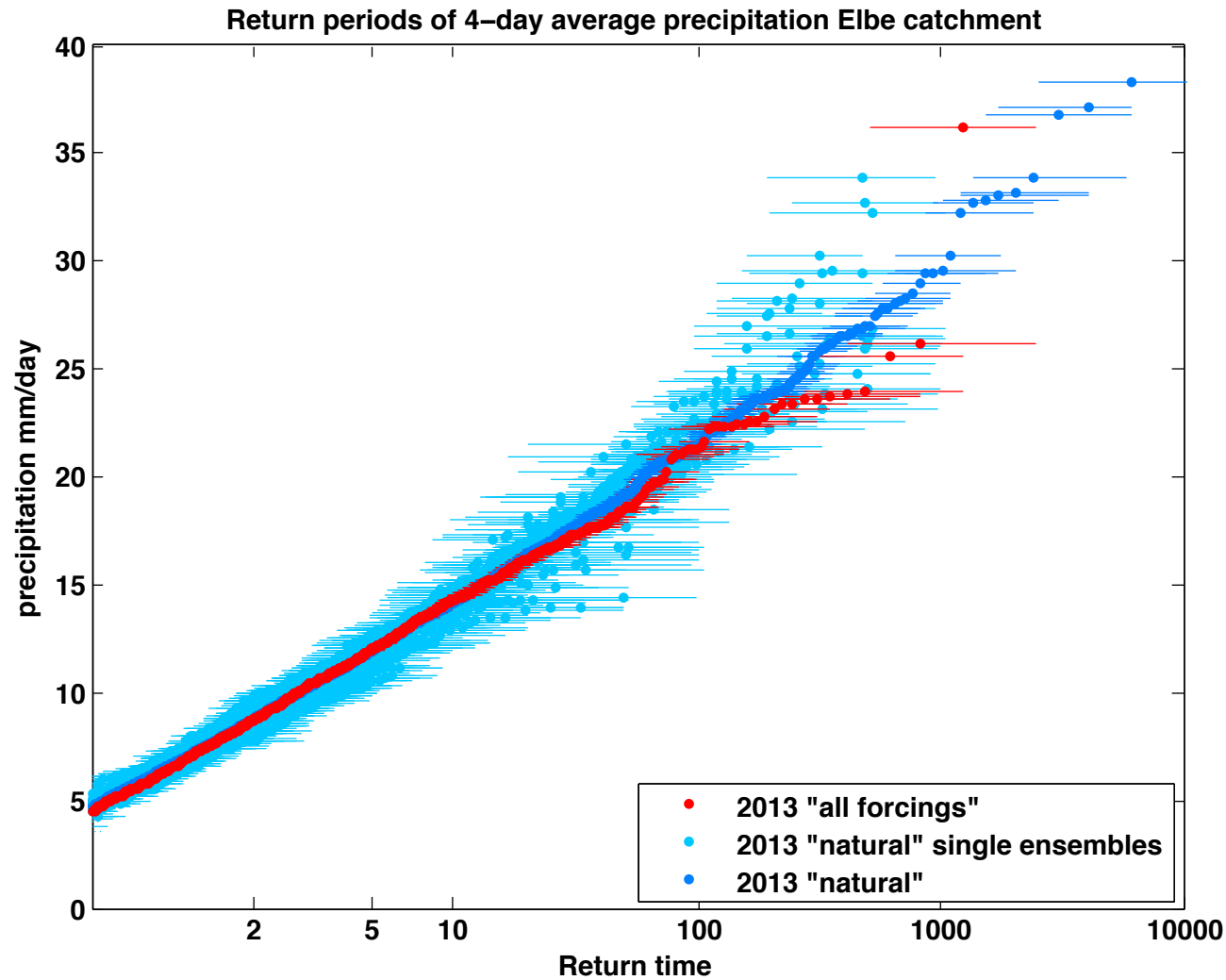
# Regime occupancy



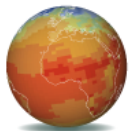
# Return times for regime occupancy



# Interpretation of PEA results is not straight forward



Schaller et al.,  
2014



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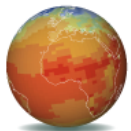
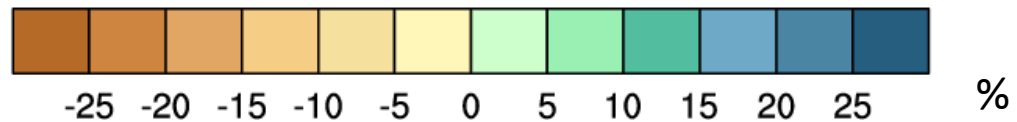
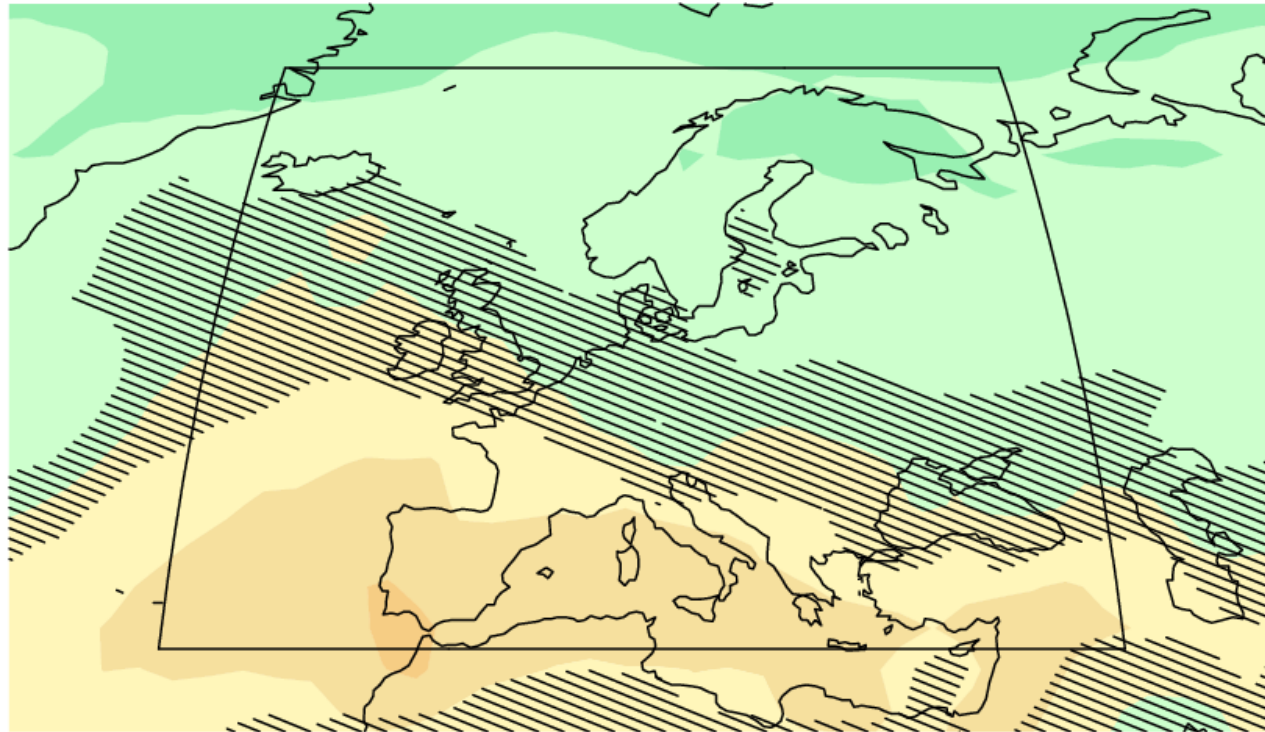
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Image: nasa.gov

Environmental Change Institute



# Precipitation changes in % DJF RCP 4.5 2016-2030



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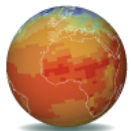
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# From meteorology to impacts



Photo courtesy of Dave Mitchell



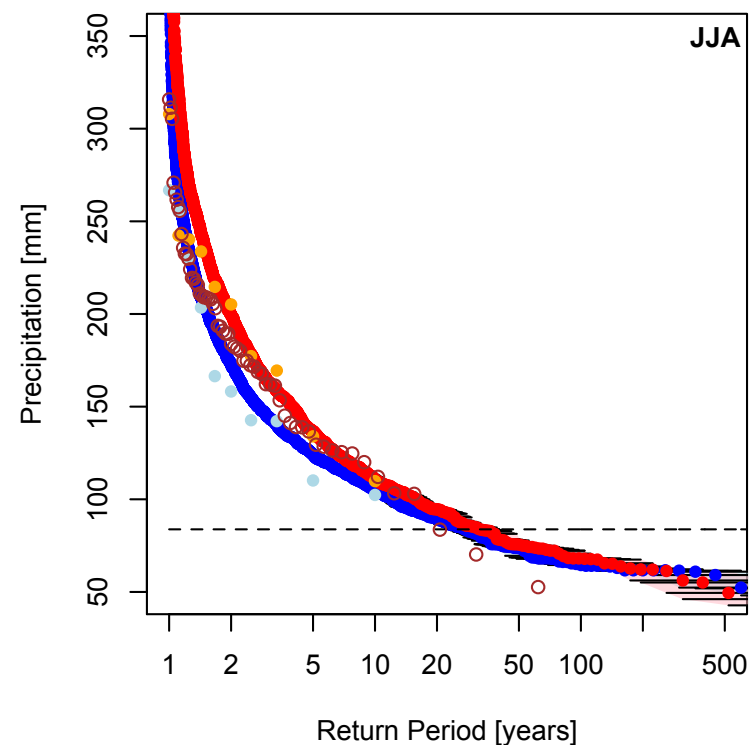
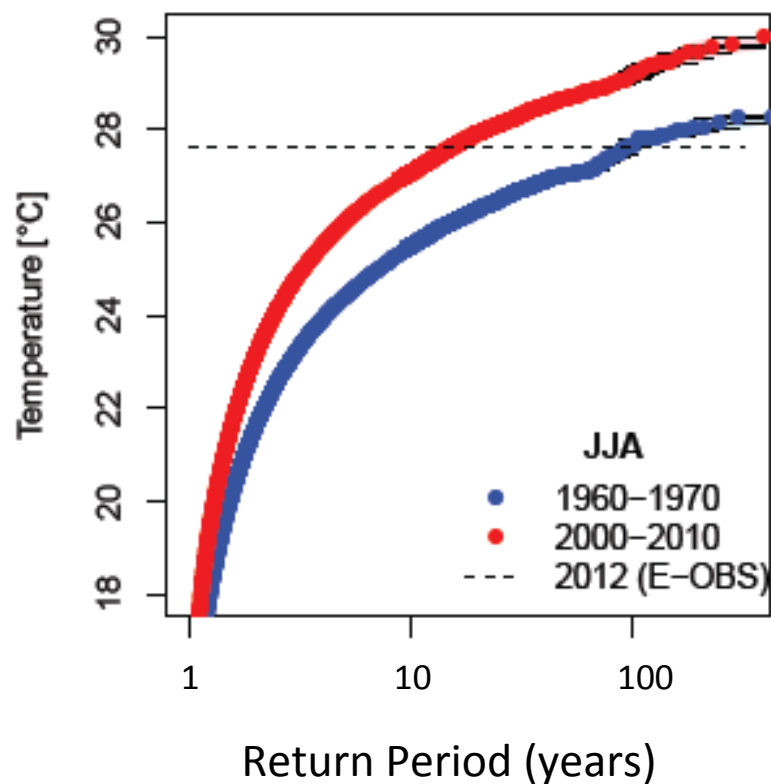
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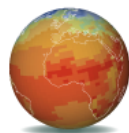
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# Heat wave and drought in Serbia 2012



Sippel and Otto, 2014



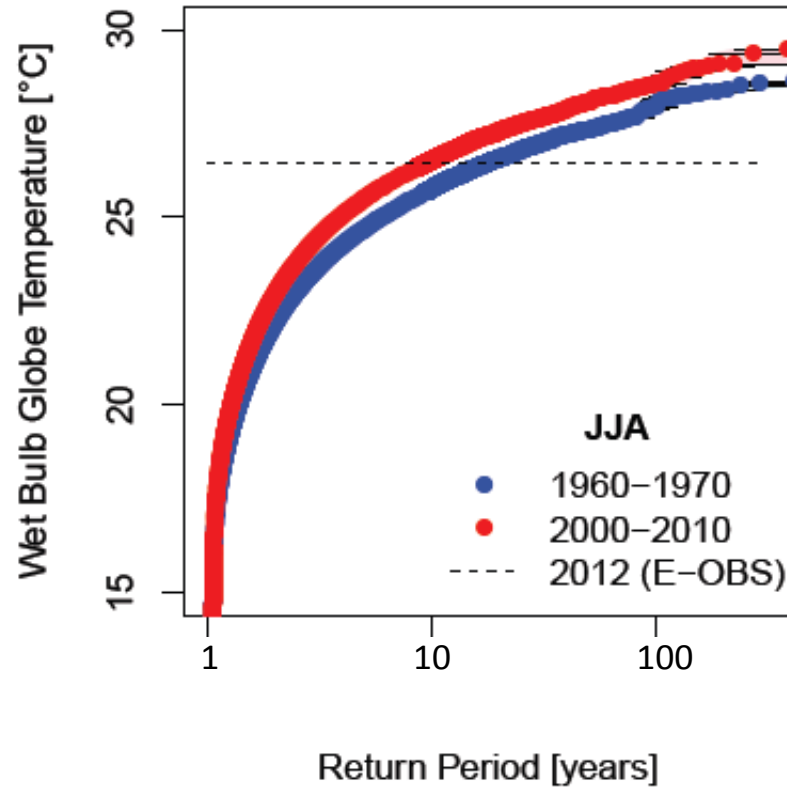
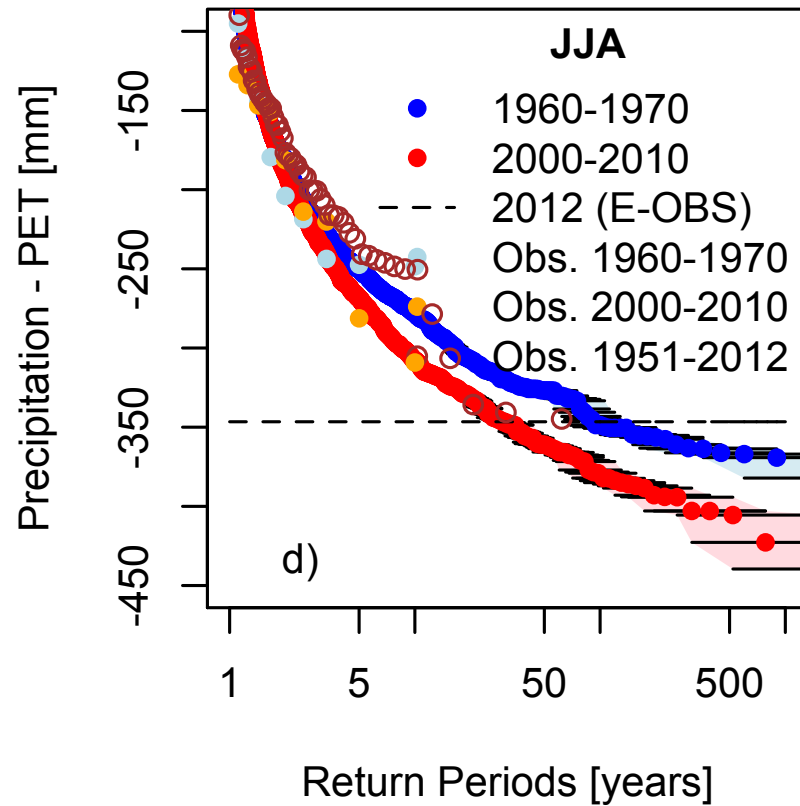
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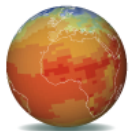
Environmental Change Institute



# Heat wave and drought in Serbia 2012



Sippel and Otto, 2014



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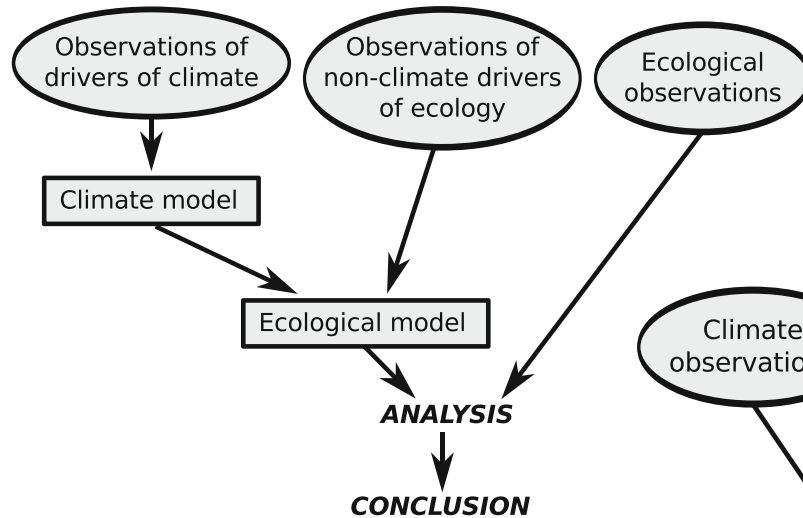




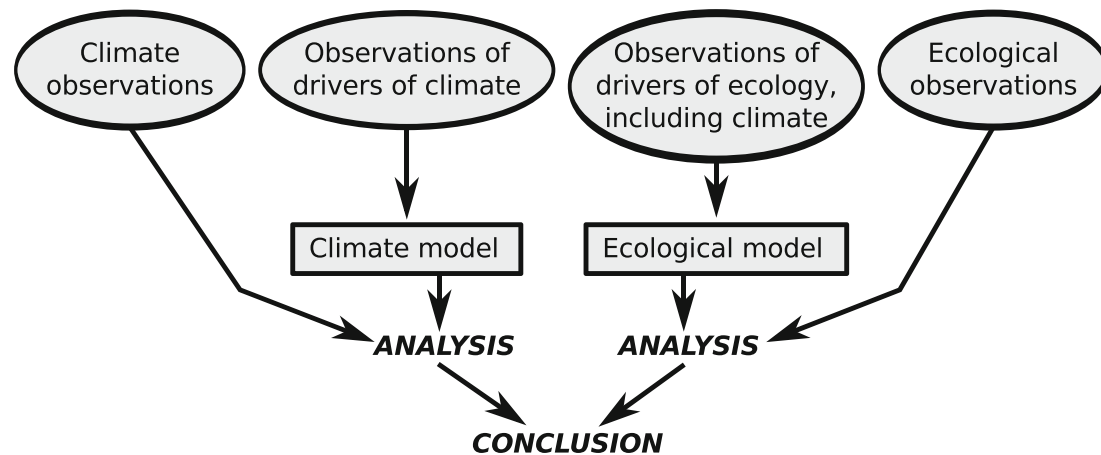


# Attribution of impacts

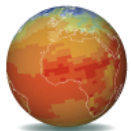
## Single-step approach



## Multi-step approach



Stone et al. 2013



climateprediction.net

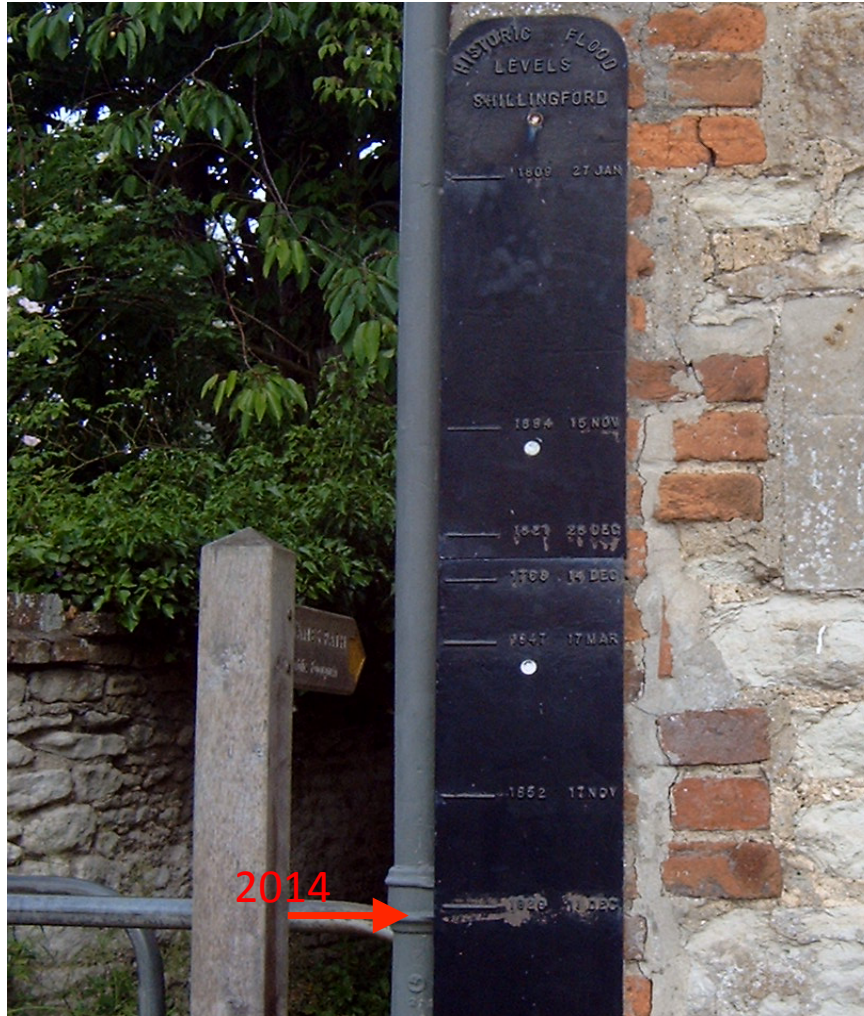
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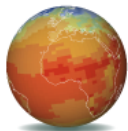


# Model validation for Probabilistic event attribution

Photo courtesy of Dave Mitchell



- Shillingford historic flood levels
- Floods in 1897, 1947, 2000, 2003, 2007, 2014 ...
- What about a 1 in 500 year flood?



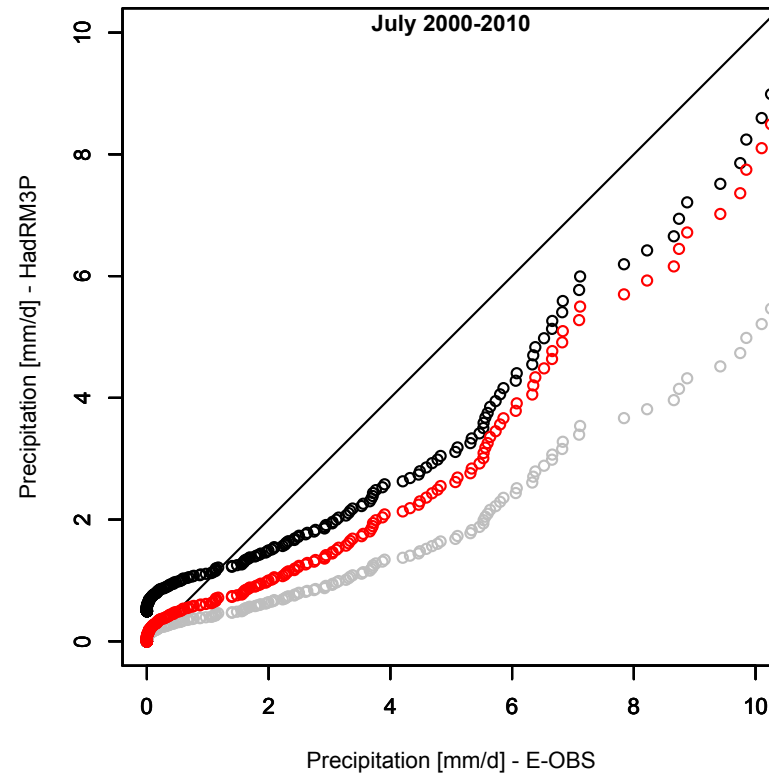
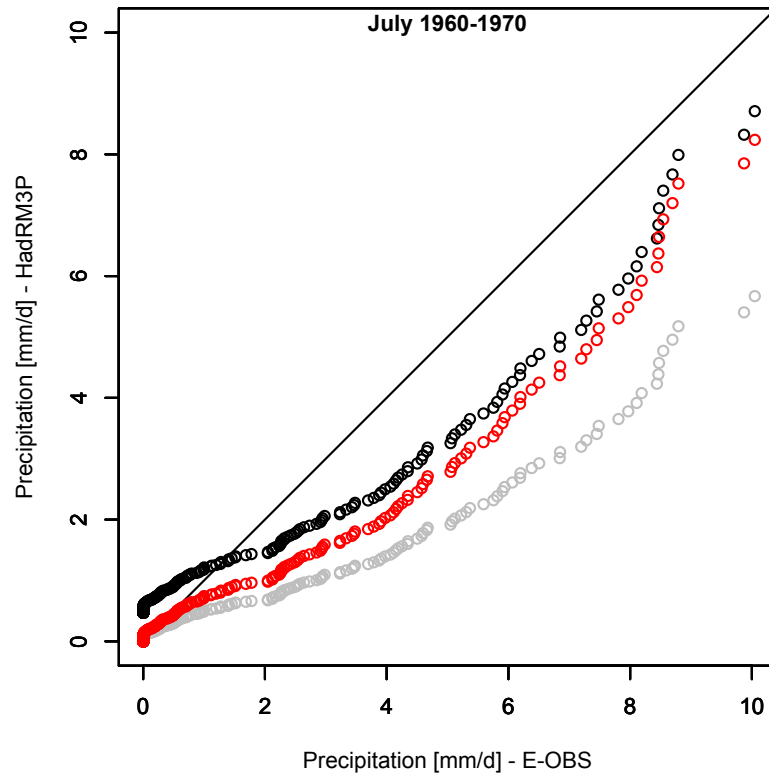
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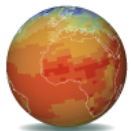
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# q-q plot



Sippel and Otto, 2014



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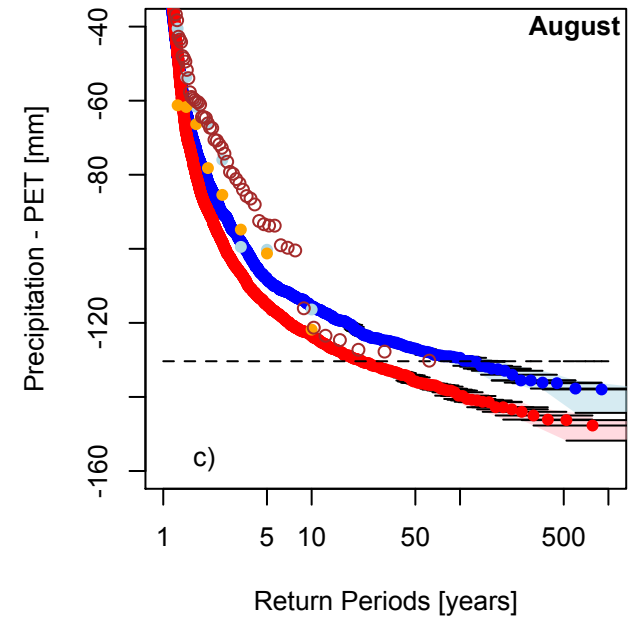
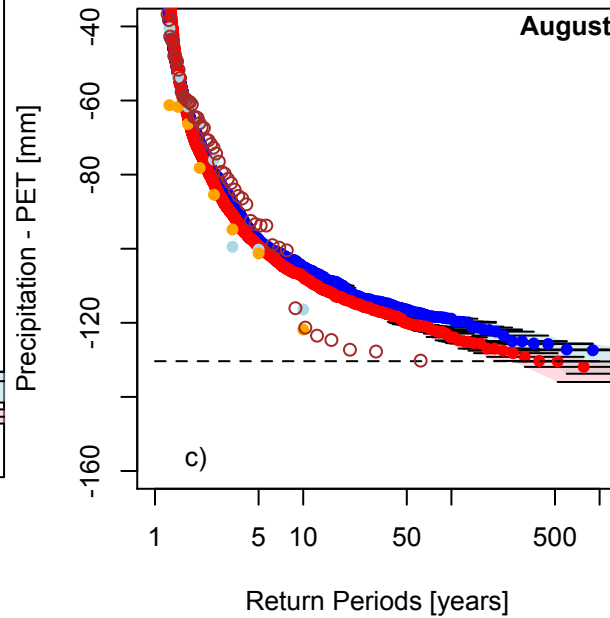
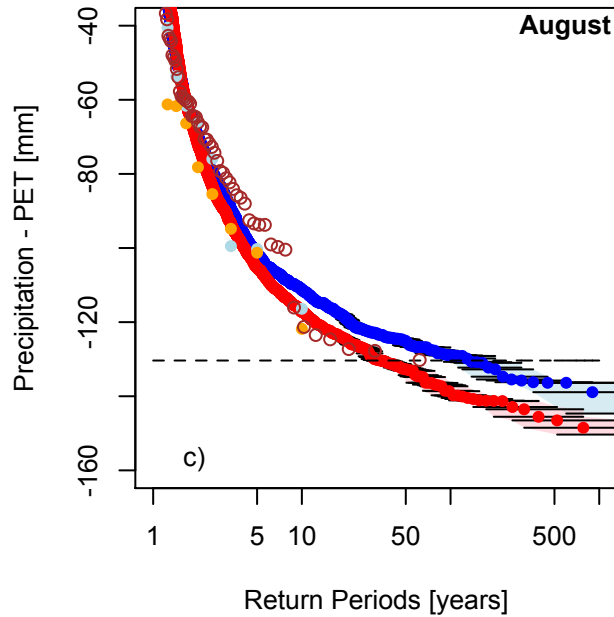
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Image: nasa.gov

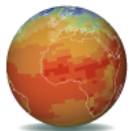
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# Different ways to bias correct



Sippel and Otto, 2014



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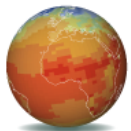
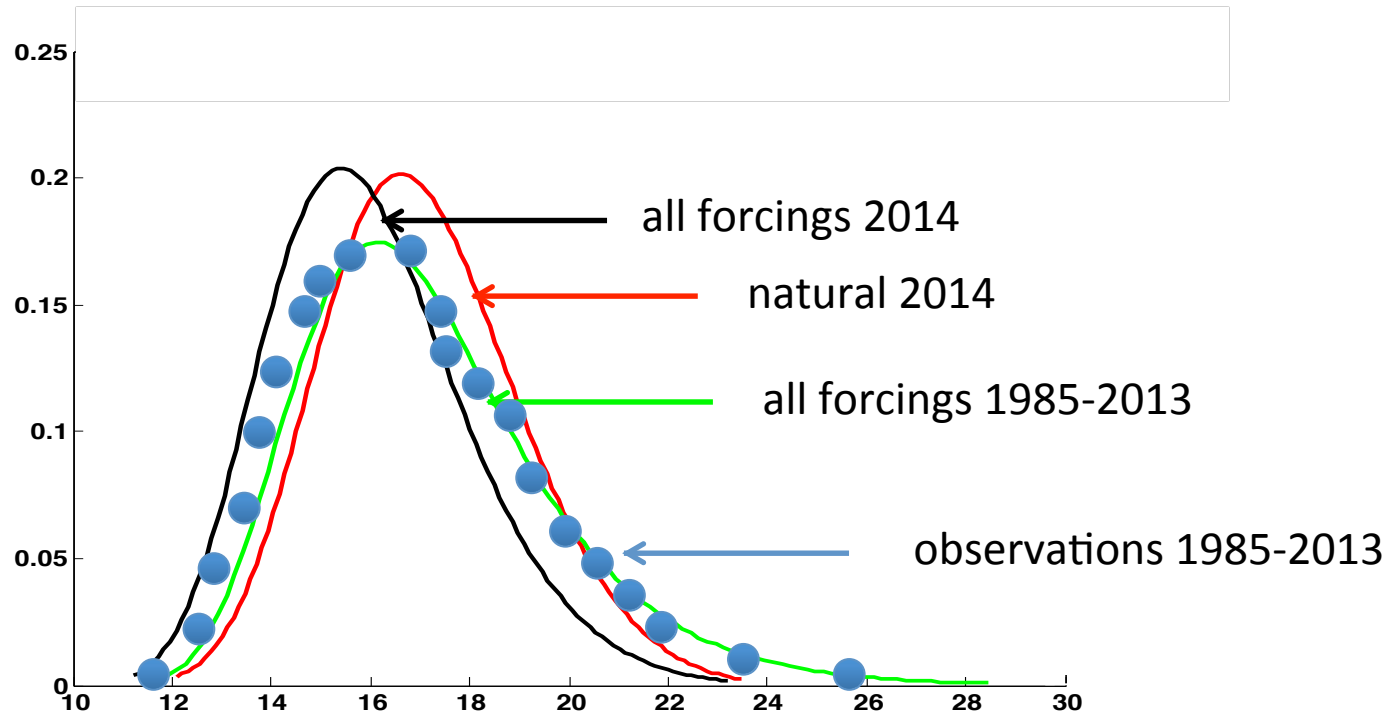
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Image: nasa.gov

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# Relating the model to observations



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Image: nasa.gov

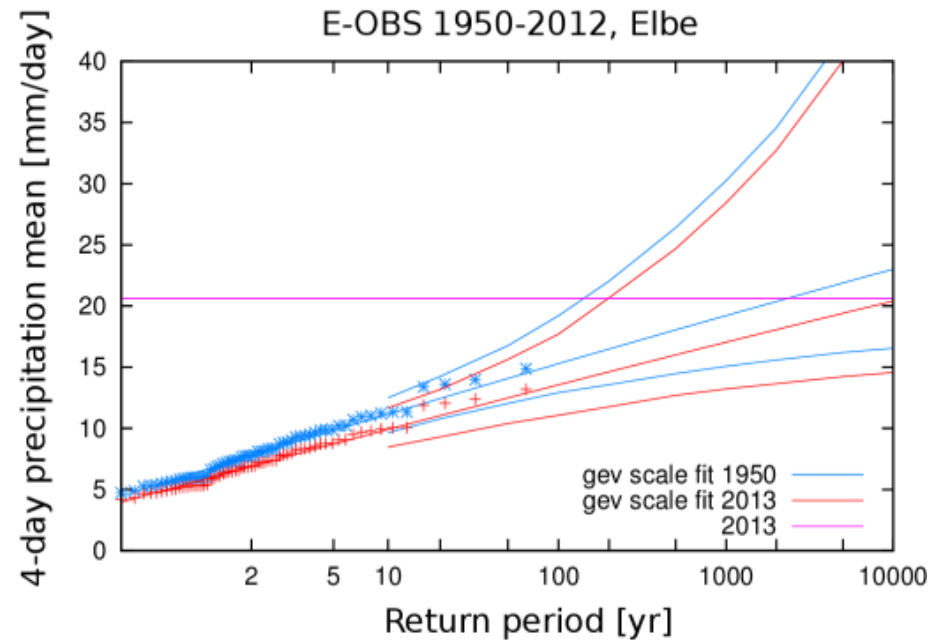
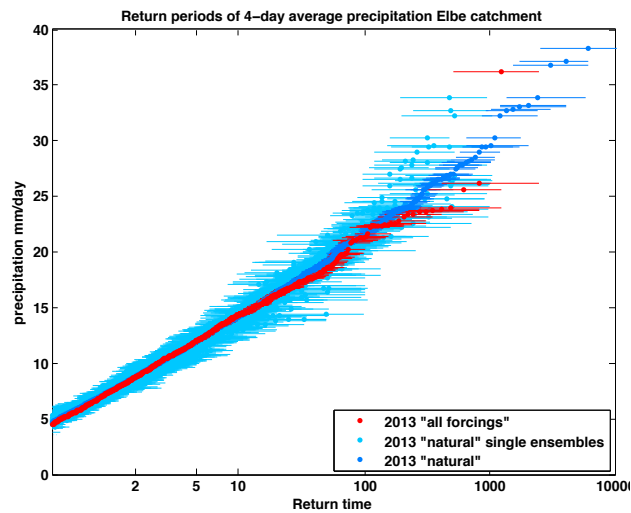
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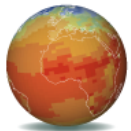
# 4-day precipitation Elbe catchment 2013

In a climate model

and in an empirical model based on observations



Schaller et al., 2014



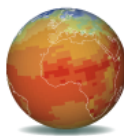
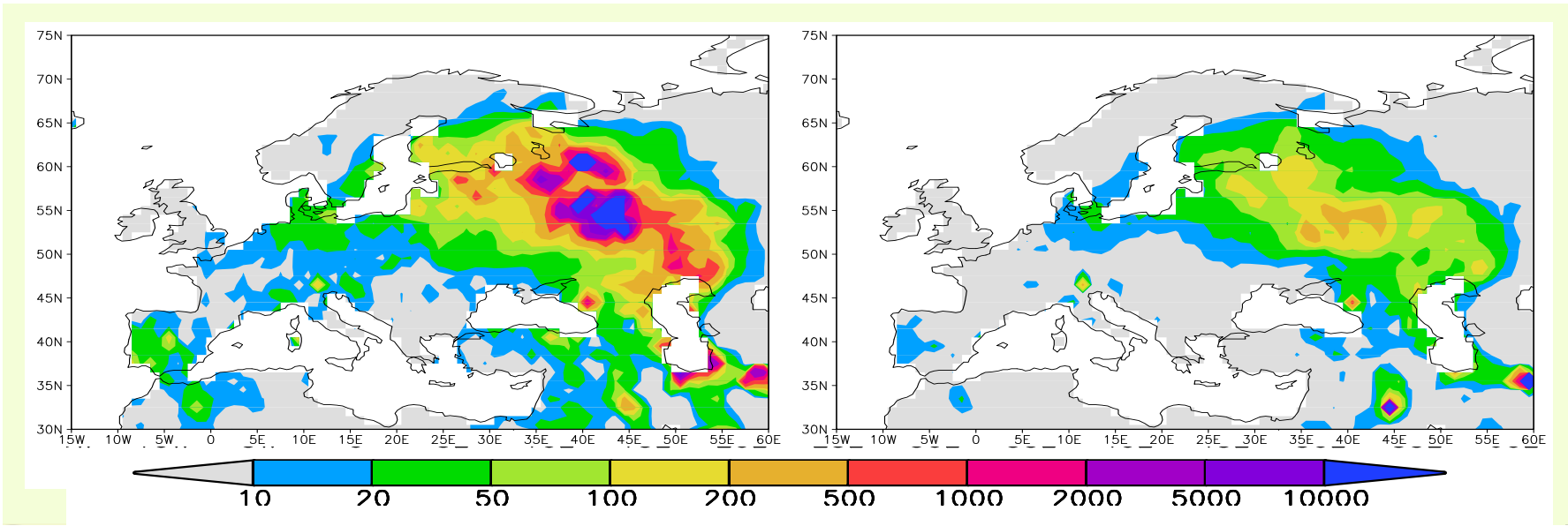
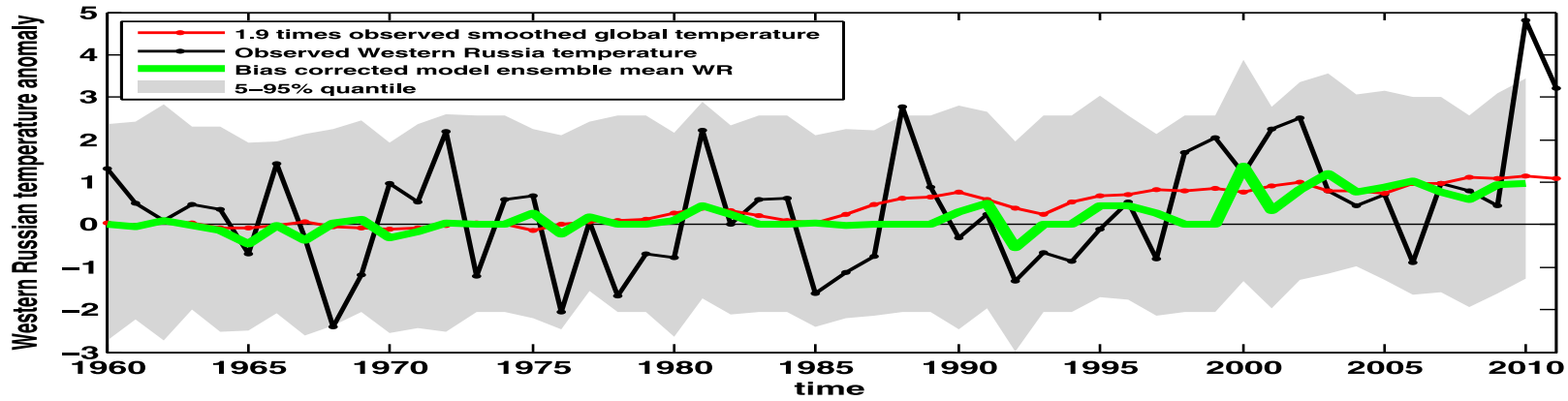
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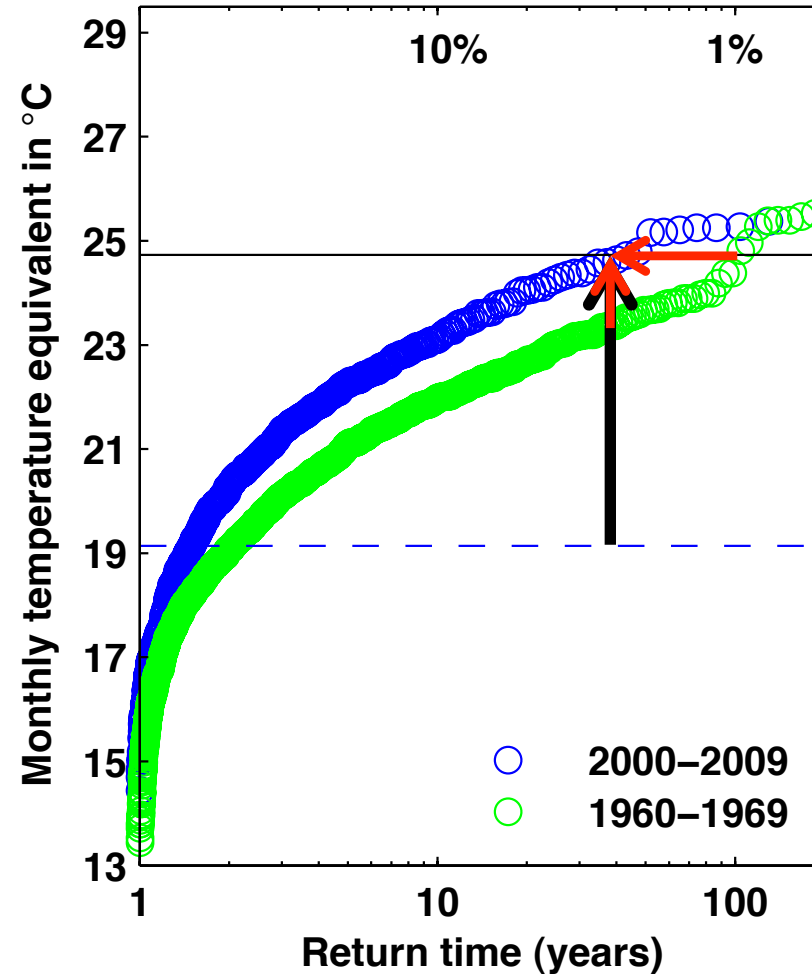
# Multi-step attribution for Russian heatwave 2010



# Reconciling two approaches for attributing the Russian heat wave

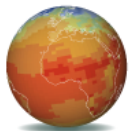
**Not  
“impossible  
without  
warming”**

Otto et al., 2012



**Probability  
framing:  
mainly  
externally  
driven**

**Magnitude  
framing:  
mainly  
internally  
generated**



**climatepredictic**

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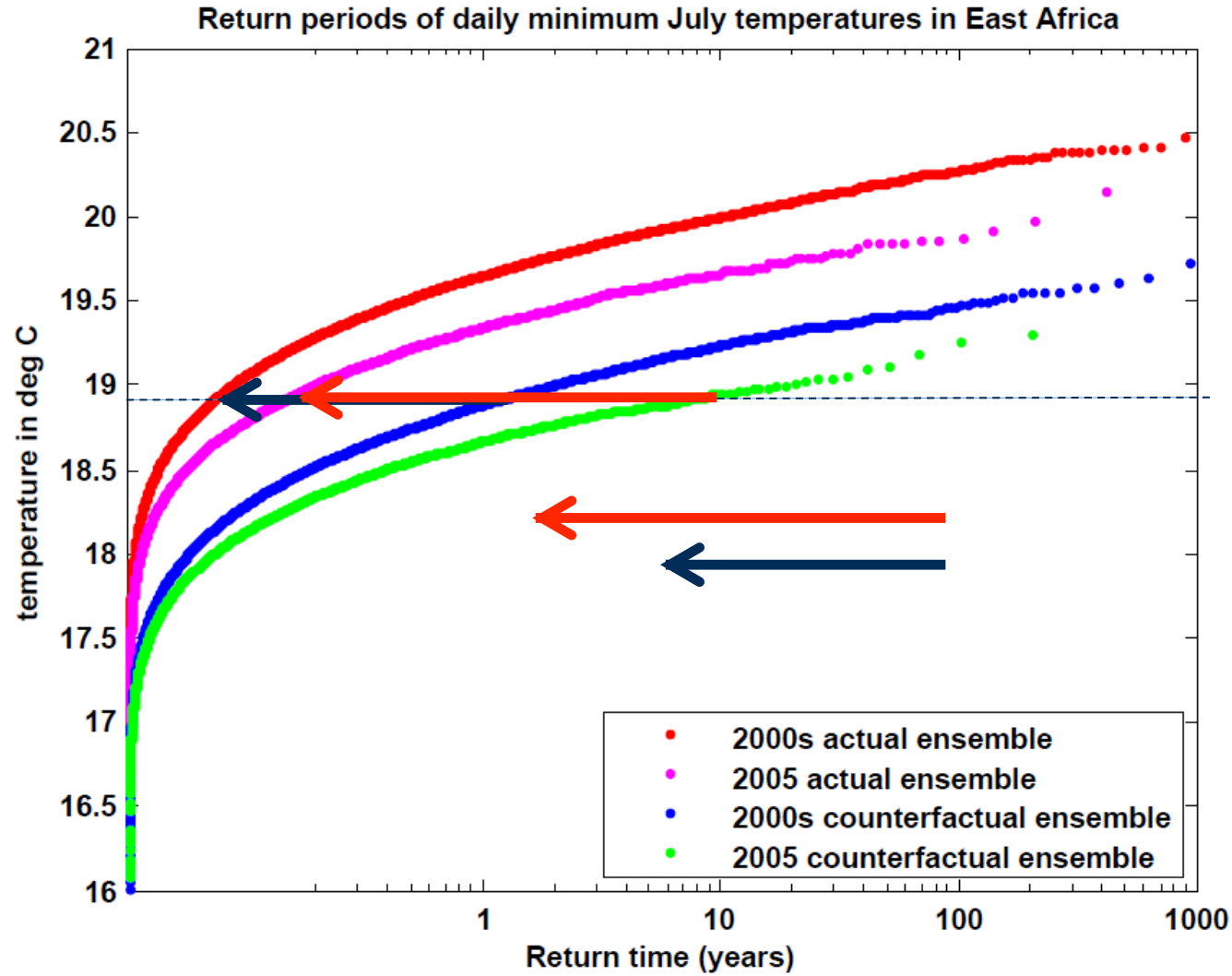
Image: nasa.gov

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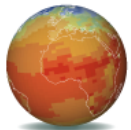




# Framing the question



Otto et al. 2014,  
submitted



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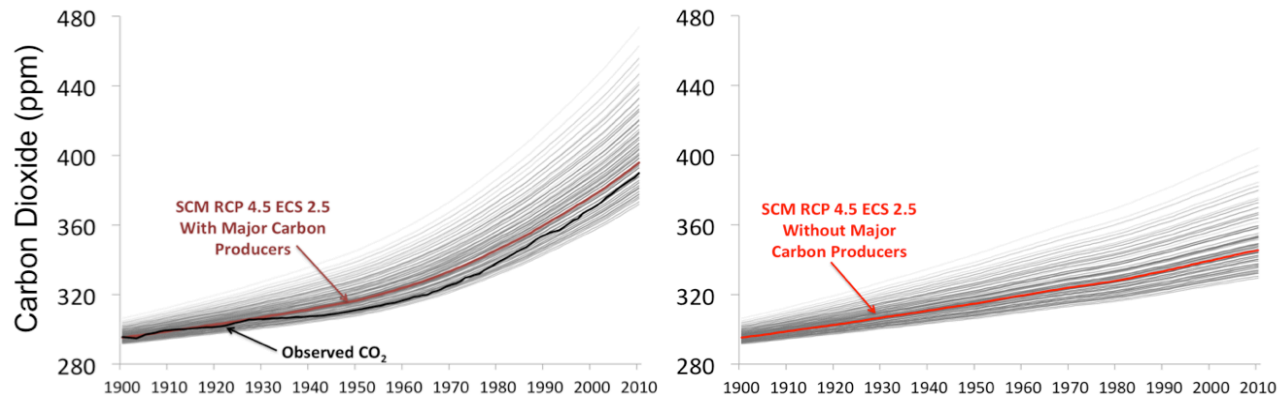
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# Climate accountability project

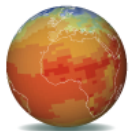
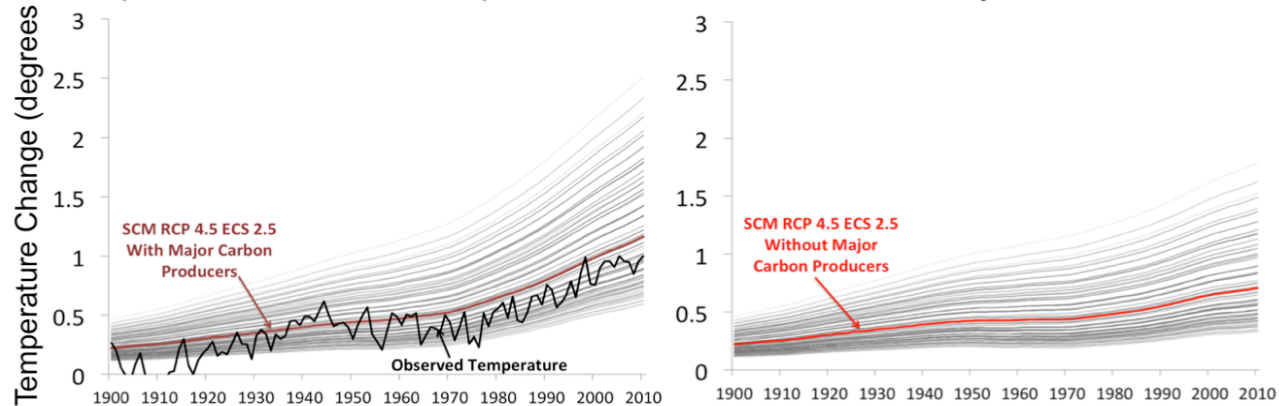
## Atmospheric Carbon Dioxide

Simple Climate Model scan of parameters both with and without Major Carbon Producers



## Global Average Surface Temperature

Simple Climate Model scan of parameters both with and without Major Carbon Producers



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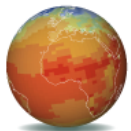
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Ekwurzel et al., 2014 submitted

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# Why does it matter?



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