Flooding and changes in extreme precipitation over the UK

Content from: Cotterill, D., Stott, P., Christidis, N., Kendon, E. Increase in the frequency of extreme daily precipitation in the United Kingdom in autumn (Submitted; Weather and Climate Extremes)

Met Office

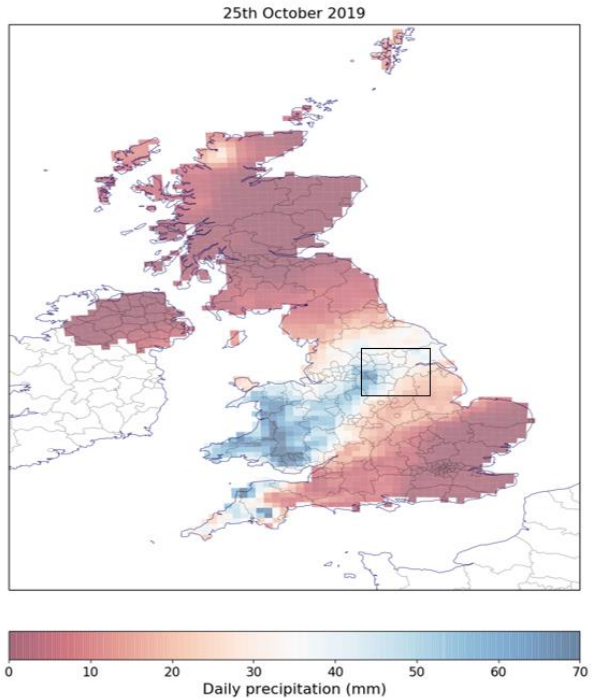
UK Research and Innovation

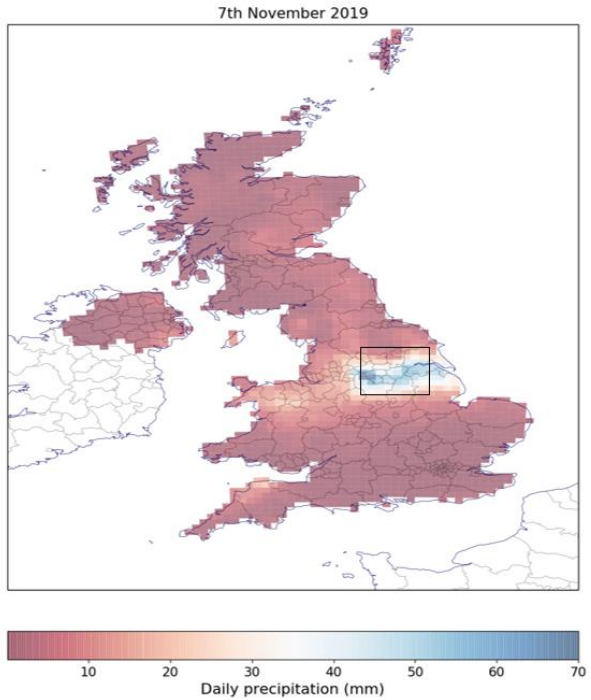
UK CLIMATE RESILIENCE PROGRAMME


Image credit: The Telegraph (2019)

Motivation

South Yorkshire Flooding in November 2019





HadUK-Grid Observations (12km)

- ***Impacts:***
  - 1 Fatality (BBC News, 2019)
  - 500 properties flooded, 1200 properties evacuated as two rivers burst their banks (FloodList News, 2019)
  - Potential insurance loses of up to £120 million (FloodList News, 2019)
- ***Meteorological conditions:***
  - On the 7th November over a month's rainfall fell in 24 hours in some parts (Kendon M., 2019)
  - River catchments already saturated
  - High 24 hours totals two weeks earlier in the same region

Background

Clausius Clapeyron (CC) and extreme rainfall totals

- Intensity of extreme rainfall increasing globally with increases in global mean surface temperatures (Westra et al., 2013)
- CC is the main mechanism for the increase in extreme rainfall, which relates saturation vapor pressure to temperature
- 6-7% more moisture can be held in the air per Kelvin increase in surface temperature

Aims

- **Quantify how the frequency of extreme rainfall totals has changed UK-wide**
- **Use the latest high resolution UKCP climate projections, to quantify how these extreme rainfall totals will change over this century**
- **Focus on Autumn (October-December)**
- Examine whether climate change had an influence on the November 2019 South Yorkshire flooding

Image credit: BBC

Index

Index for UK extreme rainfall (R50mm)

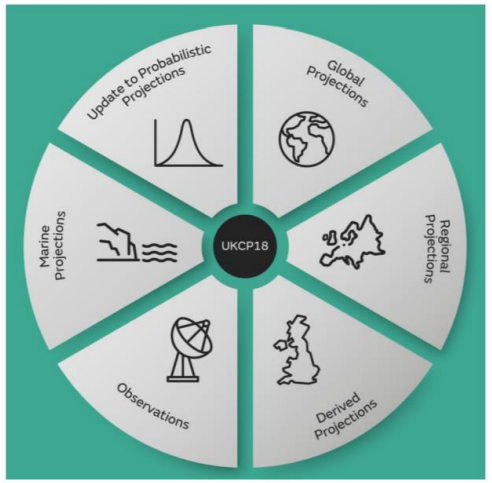
- R50mm= Number of daily precipitation totals > 50 mm per year in OND
  - For each year calculate the number of daily rainfall totals in (OND) >50mm
  - Take mean over all UK grid boxes for UK-wide index

- In October-December (OND) daily total> 50 mm: 99.9th percentile

Data

UKCP18 Regional Climate Projections 12km

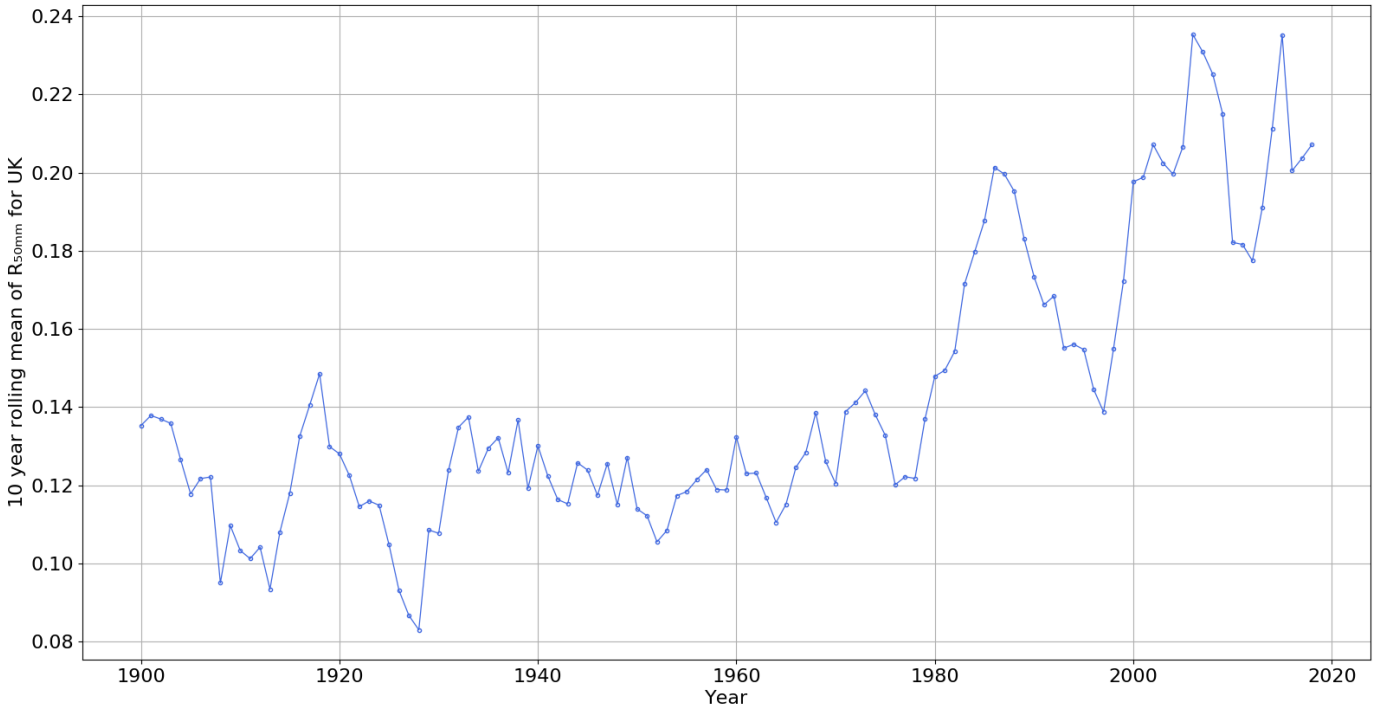
- 12 ensemble member projections at 12km resolution
- Covers 100 year-period 1980-2080
- Representative Concentration Pathway RCP 8.5



HadUK-Grid Observations

- Produced in the Met Office Hadley Centre based off land surface observations
- Gridded datasets at 1 km, 5 km,12 km,25 km and 60 km resolution
- Daily precipitation from 1891 and daily temperature from 1884

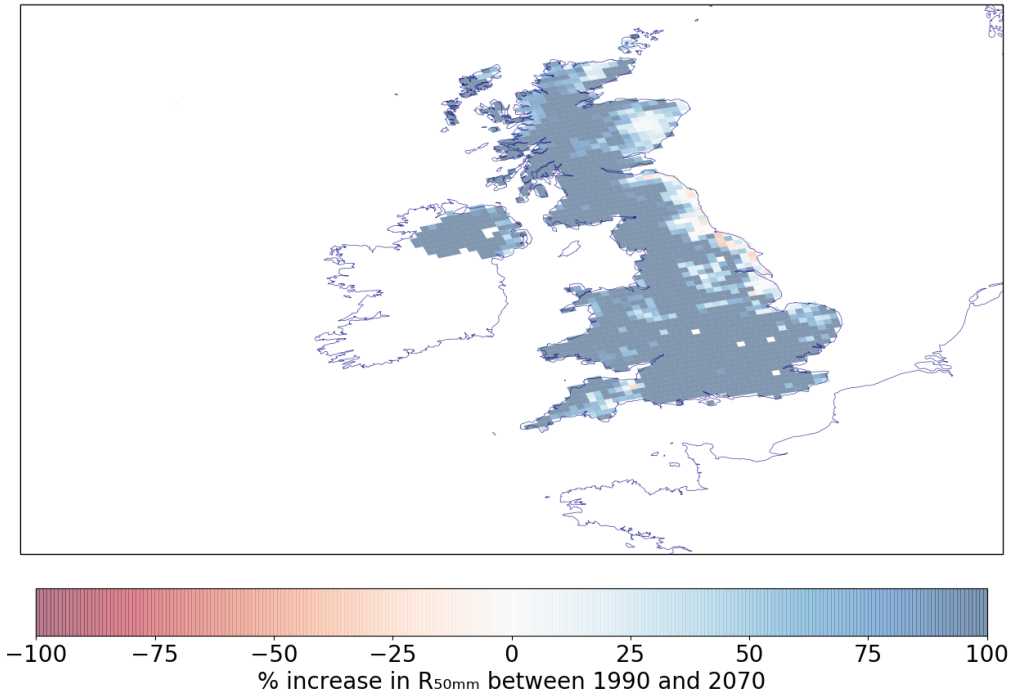
Results (1)



Transient evolution of R50mm using HadUK-Grid daily precipitation data from 1891-2018 at 1km grid resolution from October-December

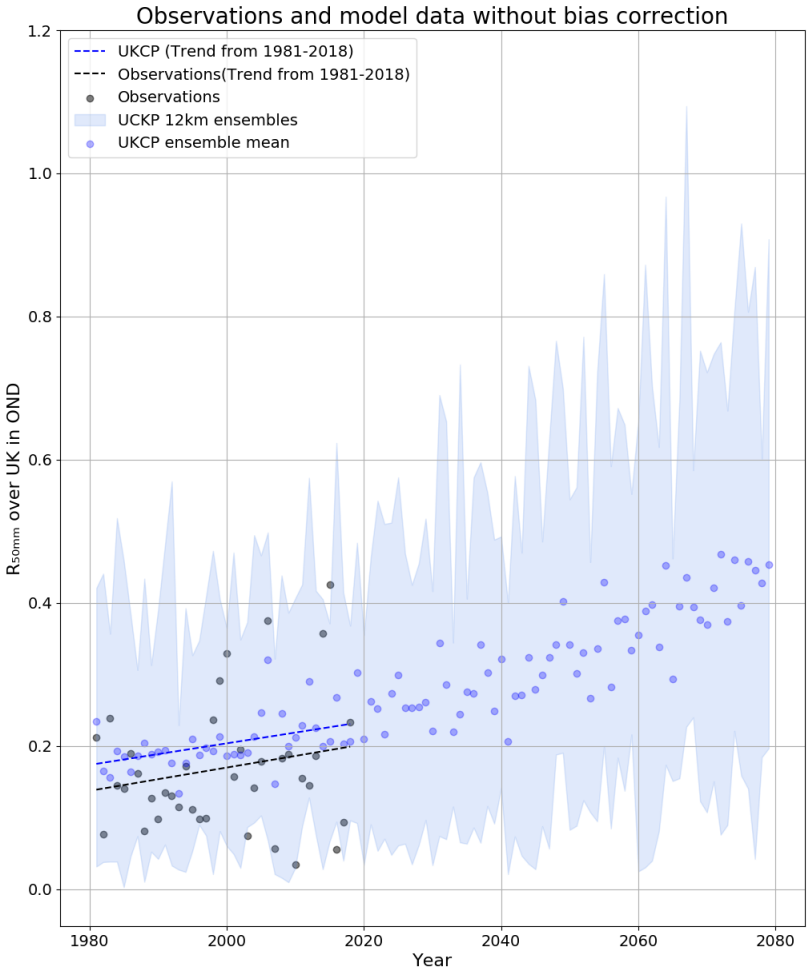
- Strong increase in UK-wide extreme rainfall since 1970/80s (trend significant to the 0.05 level)
- 60% (95% CI: 44-76) increase in R50mm between the beginning of the 20th and 21st centuries

Results (2)



- UKCP18 Regional Climate Model Projections (RCP 8.5)
- Over 100% increase in these events for most of the UK between 1990 and 2070

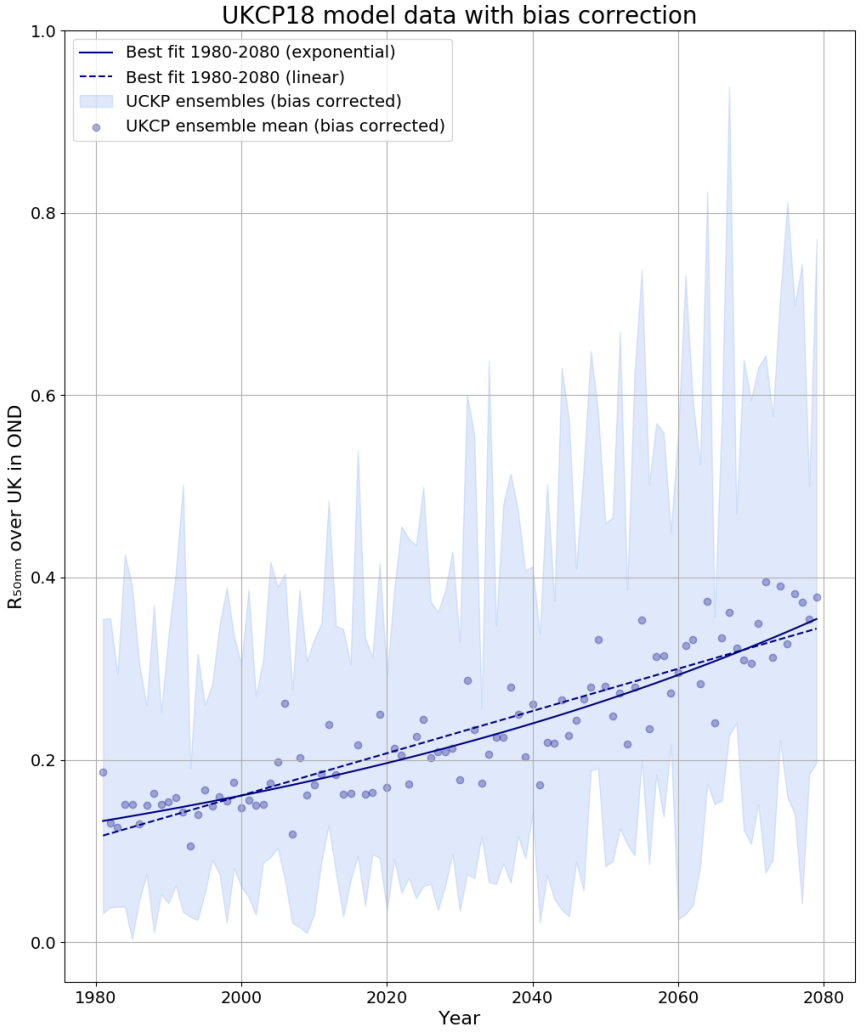
Results (3)



- Observations and UKCP18 regional model projections show same trend between (1980-2018)

- Small bias correction needed
  - Model slightly overestimates R50mm
  - Shift correction using return period

Results (3)



Exponential increase in R50mm over time

85% (95% CI: 73-97) increase in R50mm projected between 2019 and 2080

Results

- Key Findings :
  - Extreme daily precipitation events are projected to increase at an exponential rate in the 21st century UK-wide in October-December with an 85% increase in R50mm between 2019 and 2080
  - Extreme rainfall is projected to increase for all regions of the UK
  - This increase in extreme daily precipitation totals in (OND) over the UK is already being seen in the observations

Image credit: THE TIMES (2019)

Beyond this work

- Use river flow as metric
  - To use high resolution flood model for UK
  - In combination with UKCP18 projections
  - River flow can be translated into impact metrics such as water levels
- Advantages
  - Takes into account limitations of current work
    - Evapotranspiration and rainfall previous to extreme rainfall days taken into account
    - Gives regional breakdown with impact prediction more localised

Thank You

Any Questions?

Contact details

Website: www.ukclimateresilience.org

Twitter: @UKCRP_SPF

YouTube: UK Climate Resilience programme

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UK CLIMATE RESILIENCE PROGRAMME

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