Changing weather hazards and risks in a warming climate

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TRANSPORT

Scores of easyJet flights cancelled as severe weather causes chaos

A yellow weather warning is in place as more thunderstorms are expected

More than 100 flights were cancelle

GETTY IMAGES

FOOD & DRINK

Bollinger embraces climate data for a better fizz

nbined into a database to find the

Extreme threats show the need for resilience training

Elisabeth Braw | Monday June 12 2023, 12.01am, The Times

Share

Wildfires in the UK are spreading like, erm, wildfire, which is forcing fire brigades to set up "Mediterranean-style" specialist units and beg people not to barbecue on extremely dry days.

Ordinary citizens could, in fact, do a great deal to thwart harm by Mother Nature. But, as we can see, they need instruction. Citizen resilience training would benefit individuals and society alike. And it's not just the threat of extreme weather that is spreading quickly.

THE TIMES

Extreme events and the summer of 2021

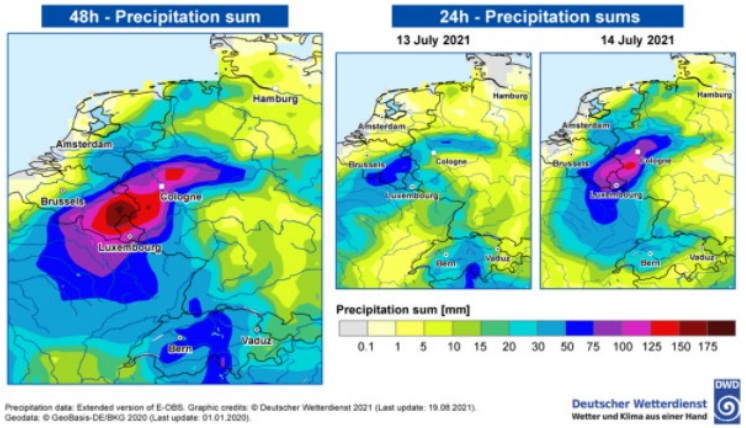
ENVIRONMENT

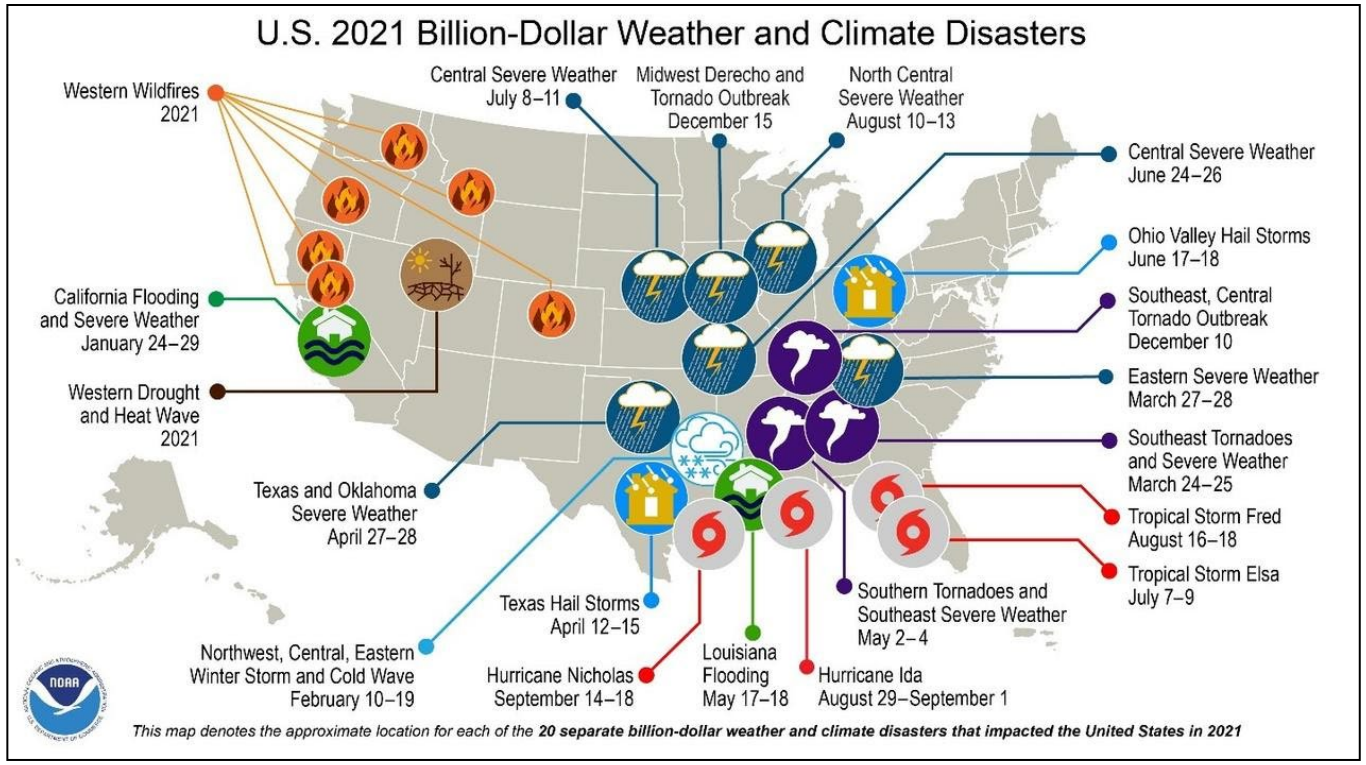
German floods: Climate change made heavy rains in Europe more likely

Burning fossil fuels made the extreme summer rain in Germany, Belgium and the Netherlands more probable and powerful, a rapid attribution study has found.

The floods in western Germany caused huge devastation

Scientists have shown that the deadly floods that devastated northern Europe in July would have been less likely in a world without climate change.





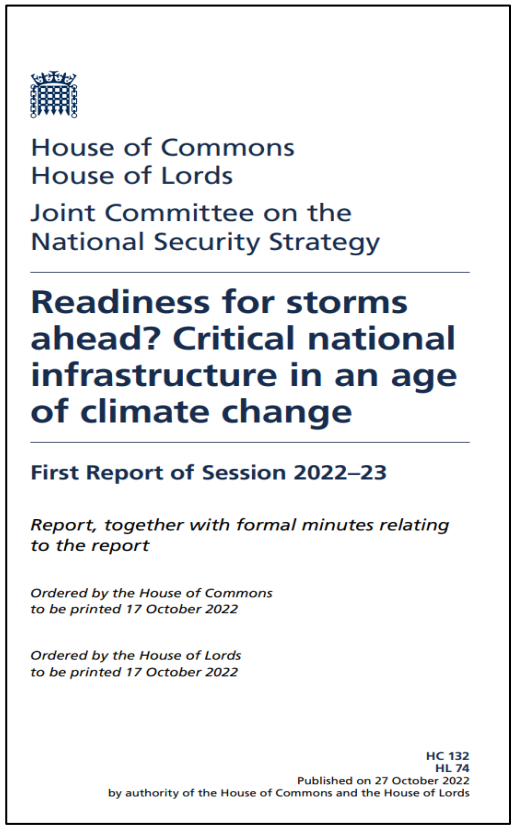
<u>GERMAN FLOODS 2021</u>: Global warming made the heavy summer rainfall between 3% and 19% stronger, and 1.2 to nine times more likely

Infrastructure vulnerabilities

Box 1: Key infrastructure vulnerabilities

The Adaptation Committee of the Climate Change Committee has highlighted the following vulnerabilities of critical national infrastructure to climate change:

- Flooding is set to become more frequent and severe, affecting infrastructure including energy, transport, water, waste and digital communication.
- Projected extended periods of rainfall will also increase the risk of slope and embankment failure: approximately 8% of the UK's transport network is at medium to high risk of landslide disruption.
- Changes in rainfall, combined with population growth, will lead to supply-demand deficits in some water resource zones by the 2050s, with widespread deficits by the 2080s.
- High temperatures can cause "railway tracks to buckle, electricity cables to sag, signalling equipment to overheat and fail", and "road tarmac to soften and rut".
- Increases in maximum wind speeds during storms are likely to have "significant implications for overhead power lines, data network cabling and the rail network, as well as for offshore infrastructure and wind turbines".[18]



House of Commons
House of Lords
Joint Committee on the National Security Strategy

Readiness for storms ahead? Critical national infrastructure in an age of climate change

First Report of Session 2022–23

Report, together with formal minutes relating to the report

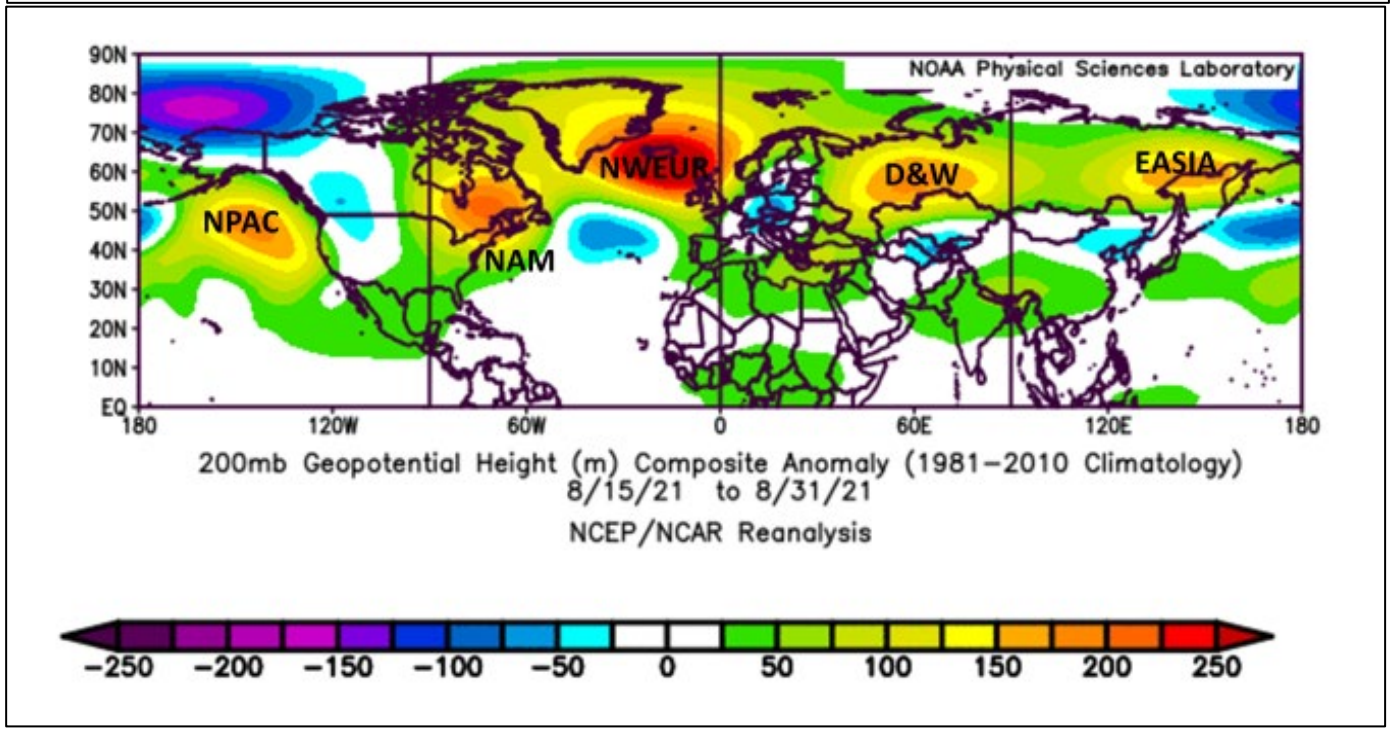
Ordered by the House of Commons to be printed 17 October 2022

Ordered by the House of Lords to be printed 17 October 2022

HC 132
HL 74
Published on 27 October 2022
by authority of the House of Commons and the House of Lords

Summer of 2021

Blocked Pattern causing persistent weather extremes



US/Canadian Heat Dome

New York Floods

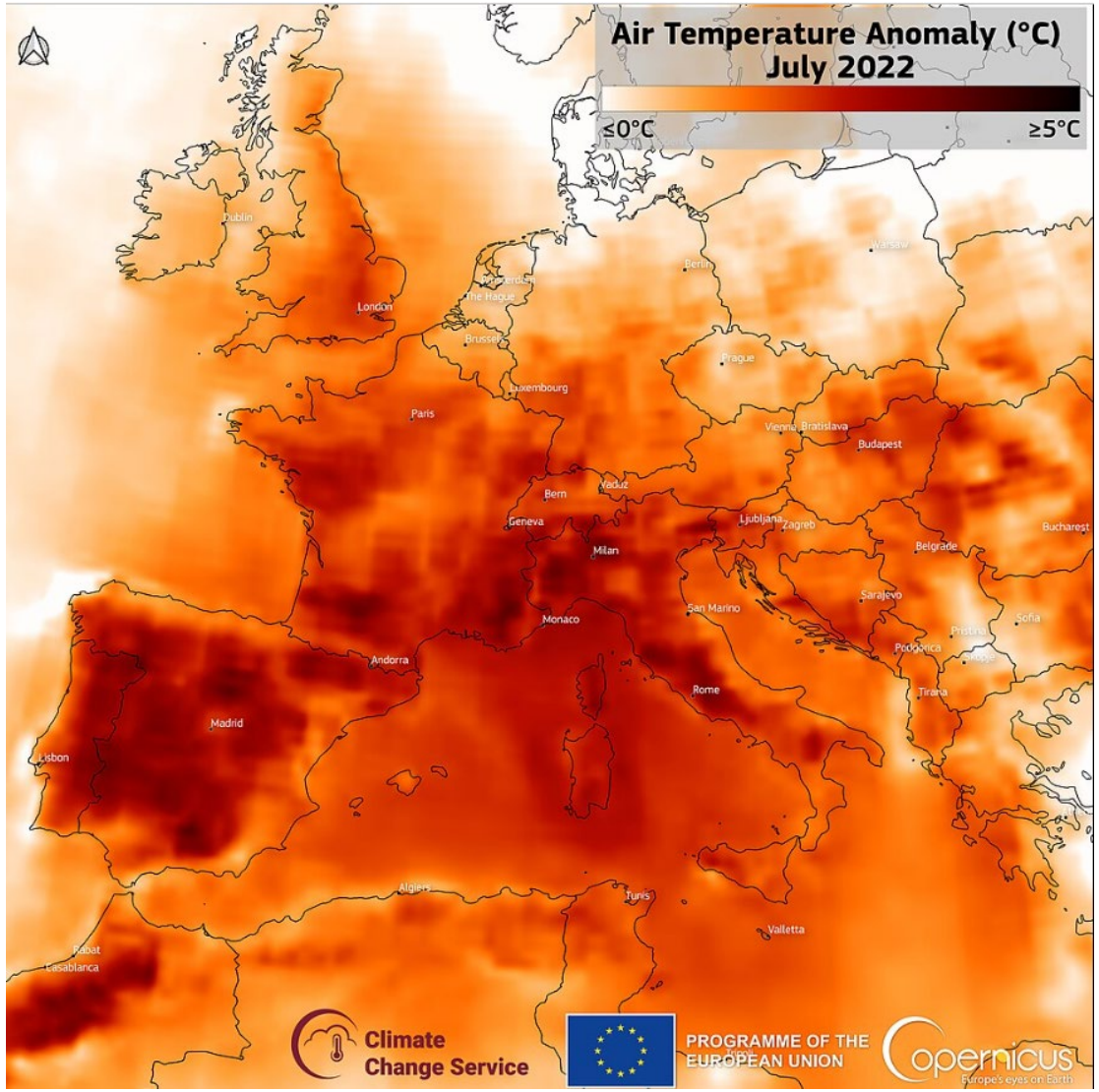
Germany floods

Zhengzhou floods

Siberian wildfires

Courtesy Paul Davies

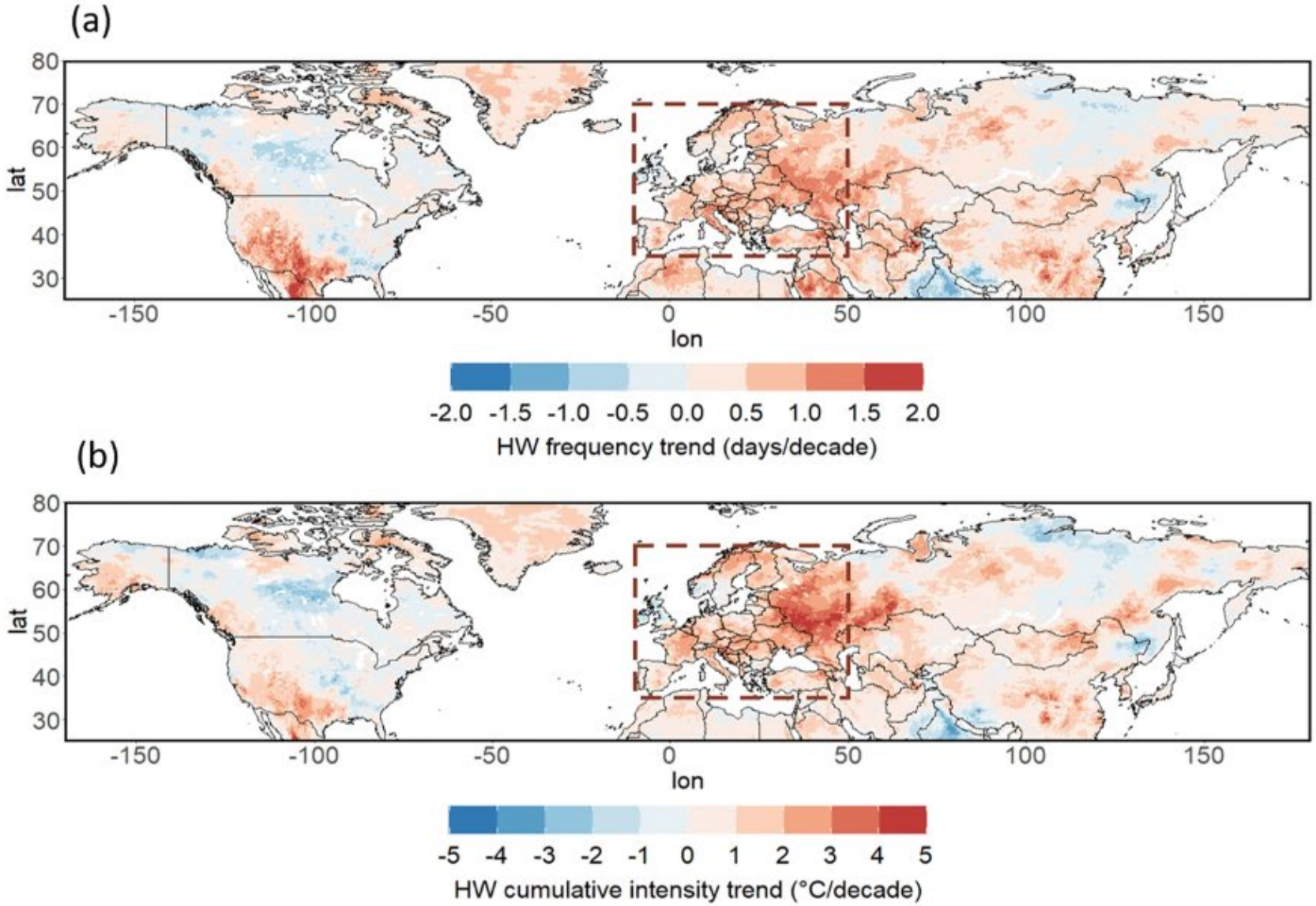
Summer of 2022

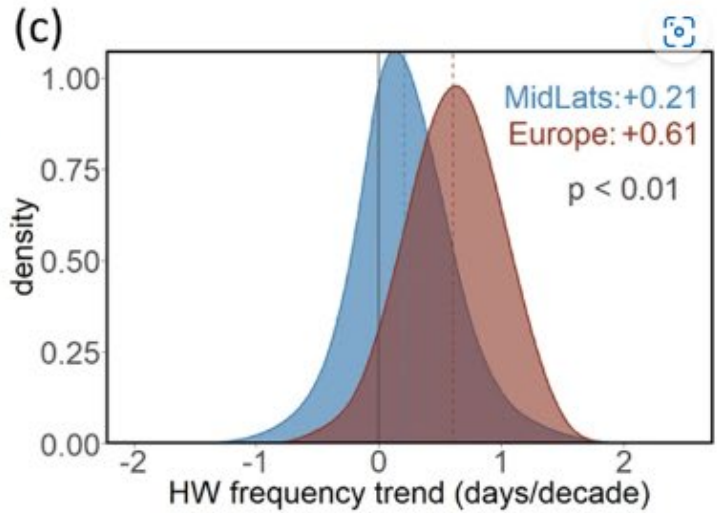


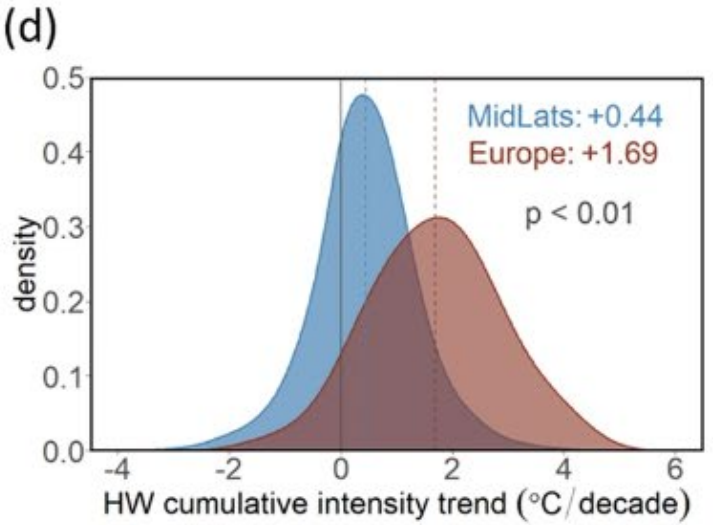
- Same blocked conditions led to a ‘heatdome’ over Europe
- 40degC in the UK!
- Records broken in many locations

- **What will happen this year?**

Increasing heatwave trends over the midlatitudes and Europe







Rousi et al. 2022 Nat Comms https://doi.org/10.1038/s41467-022-31432-y

Changes to storm size and movement as well as intensity with global warming

FUTURE-STORMS

Flooding

This article is more than **2 months old**

Catastrophic floods could hit Europe far more often, study finds

Slow-moving storms such as recent deluge in Germany could become 14 times more frequent by 2100

Damian Carrington
Environment editor
@dpcarrington

Wed 21 Jul 2021 11.36 BST

▲ The aftermath of recent flooding in Bad Muenstereifel, Germany. Photograph: Wolfgang Rattay/Reuters

Catastrophic floods such as those that struck Europe recently could become much more frequent as a result of global heating, researchers say.

High-resolution computer models suggest that slow-moving storms could become 14 times more common over land by the end of the century in a worst-case scenario. The slower a storm moves, the more rain it dumps on a small area and the greater the risk of serious flooding.

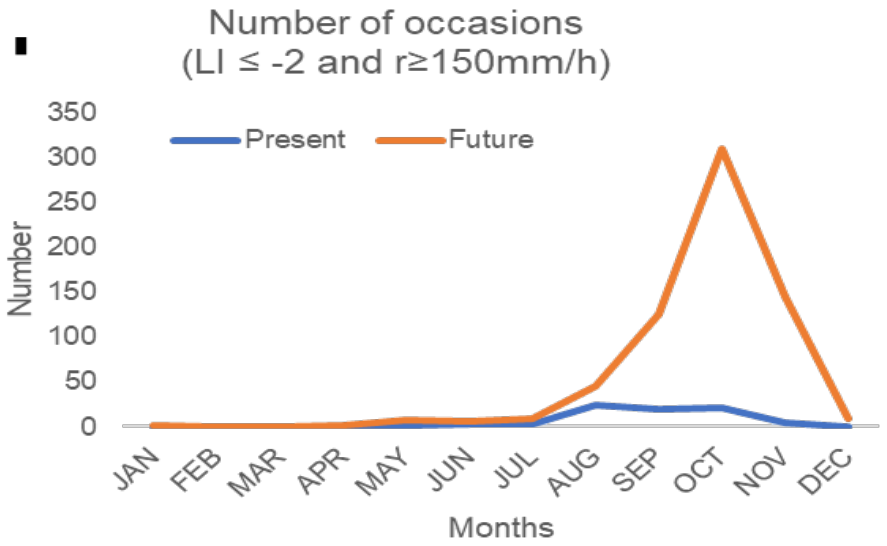
"Slow-moving storms could become 14 times more common over land by the end of the century in a worst-case scenario. The slower a storm moves, the more rain it dumps on a small area and the greater the risk of serious flooding."

Kahraman et al., 2021, GRL, DOI: 10.1029/2020GL092361

Changes to storm size and movement as well as intensity with global warming

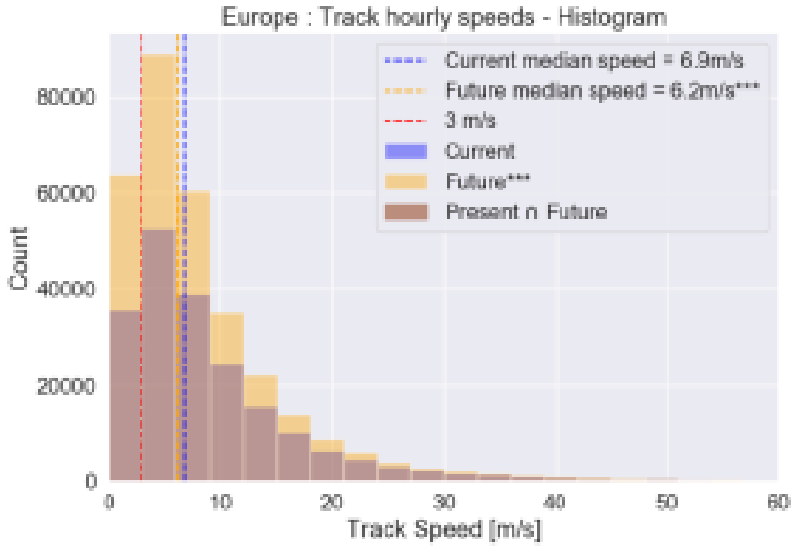
FUTURE-STORMS

Future Increase in MCS Max. 1h Precipitation



Unprecedented intensities?

Future Increase in Slow Moving Storms

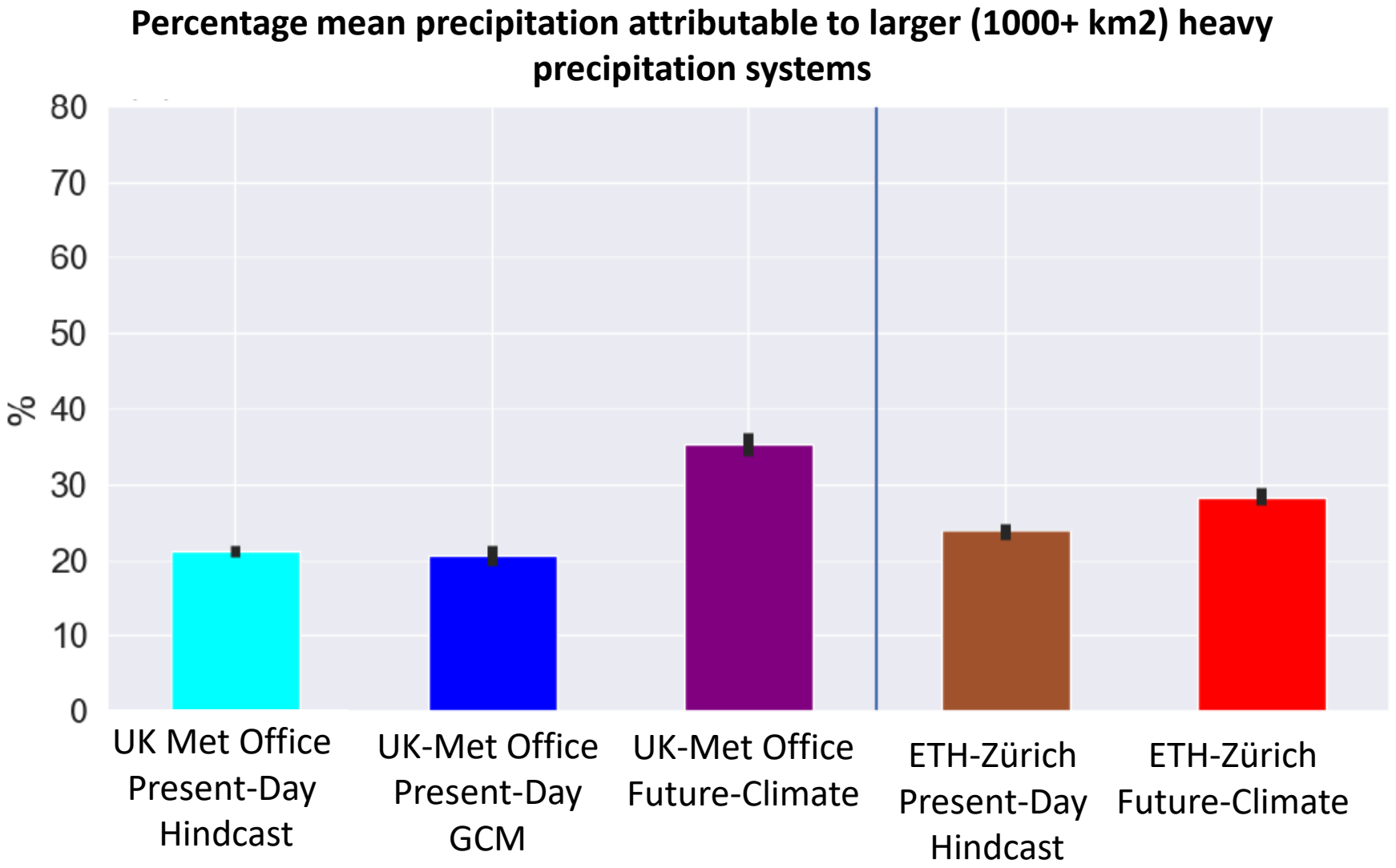


Future MCS have a preference of slow moving, increasing the probability of high, localised accumulations

Future intense storms projected to become more frequent, and slow moving

Kahraman et al., 2021, GRL, DOI: 10.1029/2020GL092361

More large heavy precipitation systems

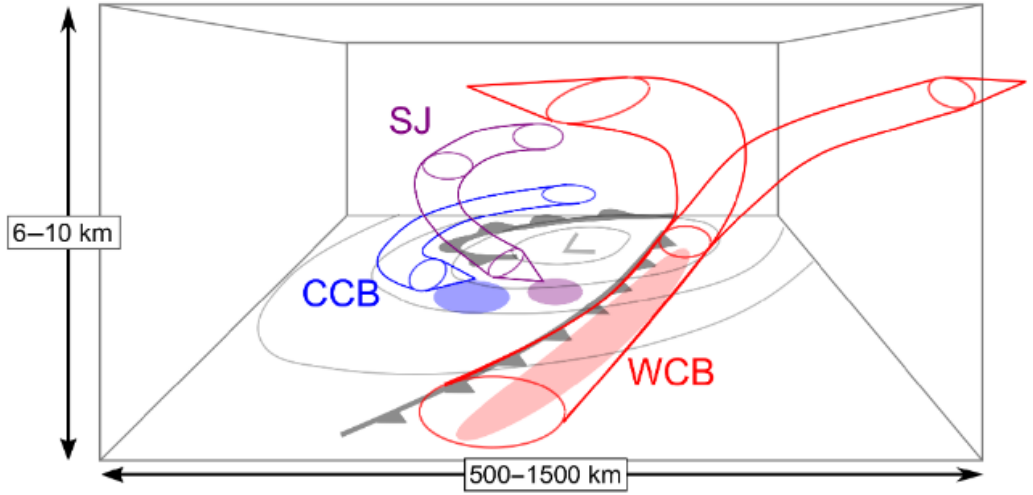


Chan et al. Nature Comms E&E, 2023

What is a Sting-Jet?

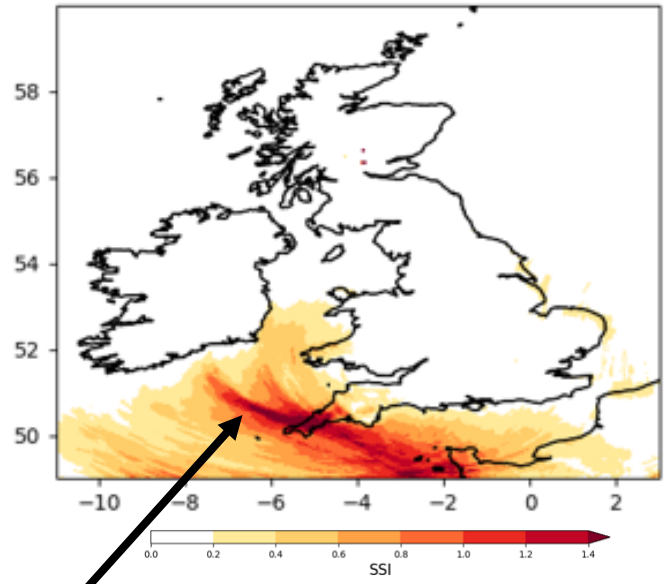
A distinct mesoscale air flow that descends from the mid-troposphere inside the cloud head into the frontal fracture of a Shapiro-Keyser cyclone

3-D Structure



Clark and Gray (2018)

Sting Jet Footprint



SJ: Sting-Jet **CCB:** Cold Conveyor Belt **WCB:** Warm Conveyor Belt

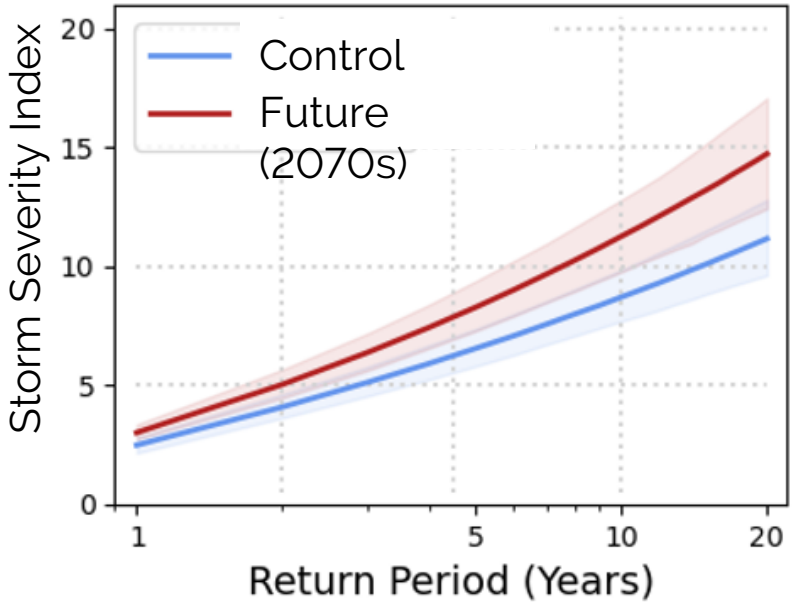
Sting jets produce narrow swathe of very intense wind gusts

https://theconversation.com/why-storm-eunice-was-so-severe-and-will-violent-wind-storms-become-more-common-177468

Projected Increase in Extreme Windstorms and Sting jets over UK

Newcastle University

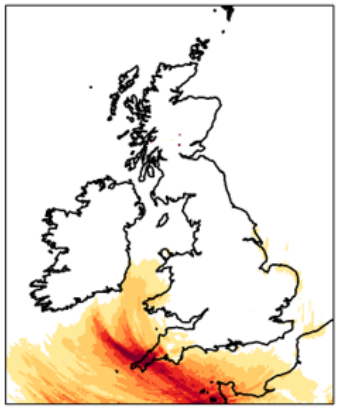
Projected Change in Windstorm Severity



20-30% increase in severity for each *n*-year Return Period

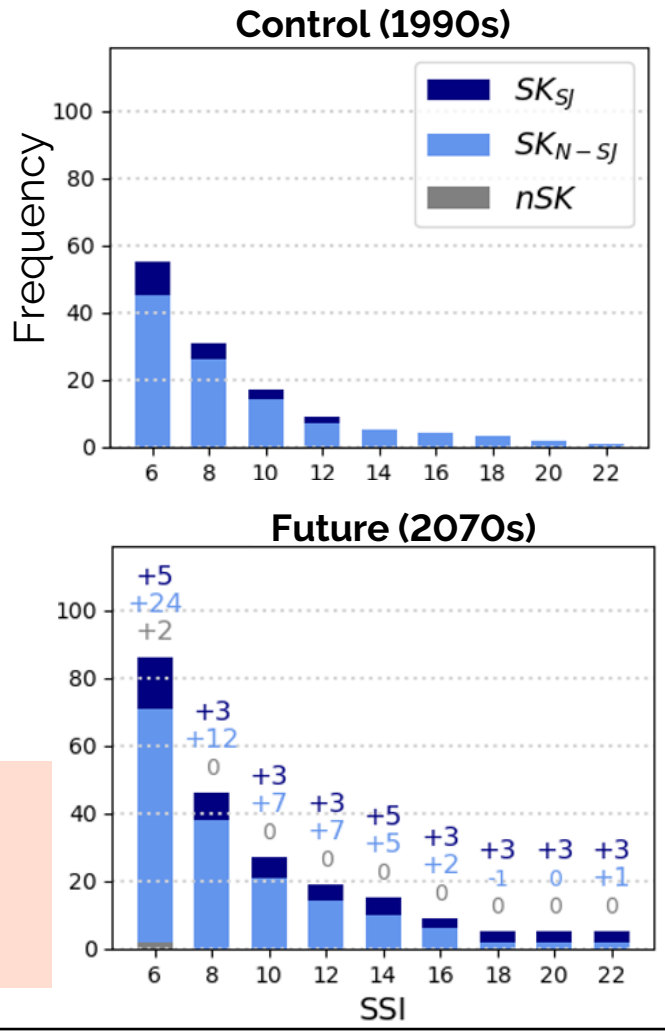
10-year event is projected to occur once every 5-6 years in future

Contribution of Sting Jets



Example Sting Jet Footprint

- Similar event from UKCP18 to Storm Eunice seen in February 2022



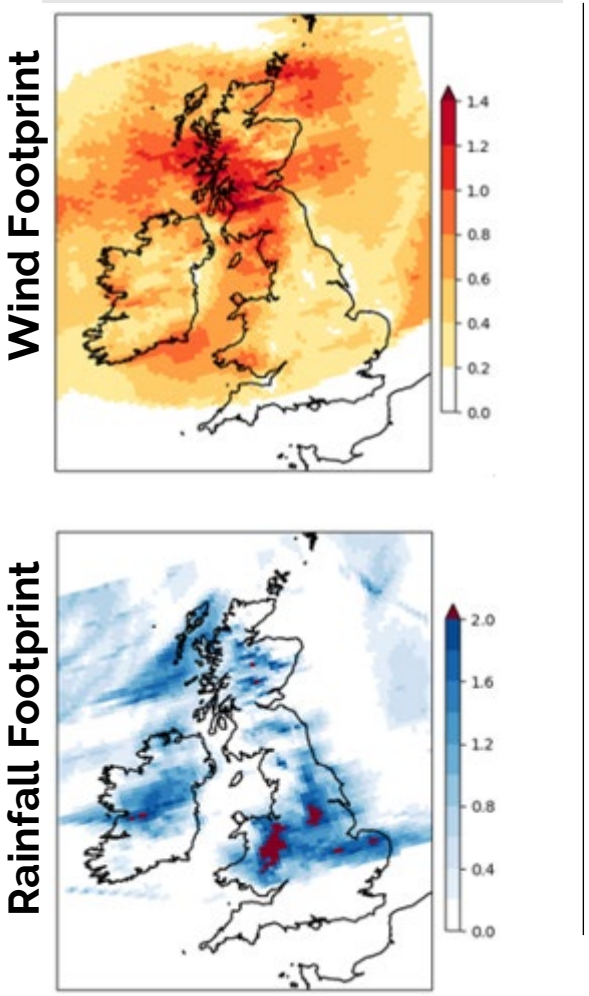
Large contribution from windstorms with sting jets to changes in most extreme events

Manning et al. (In Review, WACE)

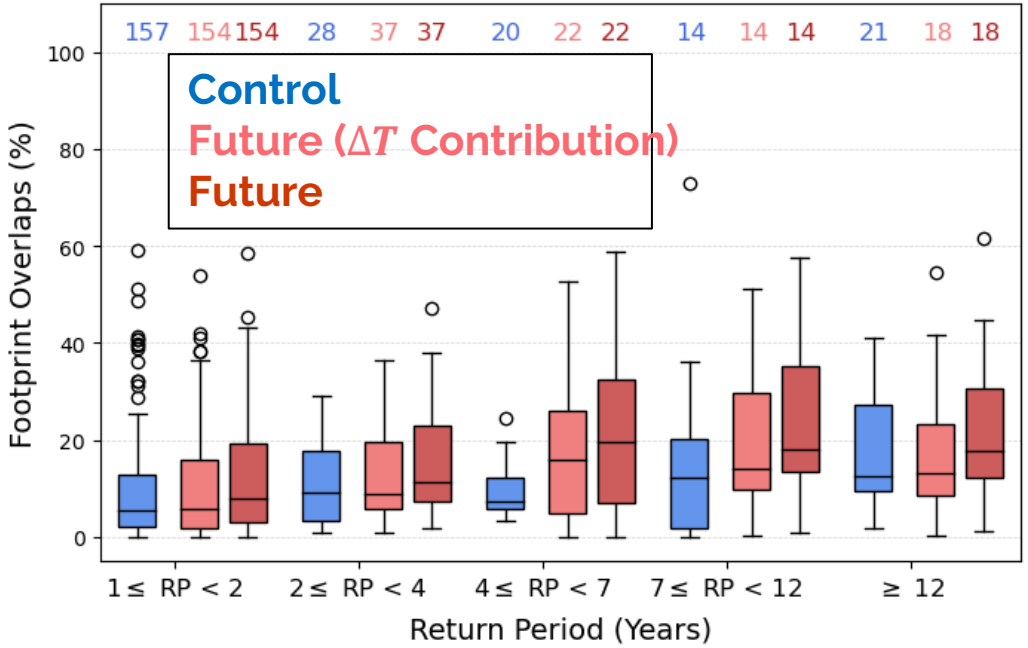
Extreme Wind and Rain Footprints from ExtraTropical-Cyclones

Newcastle University

Example Footprints



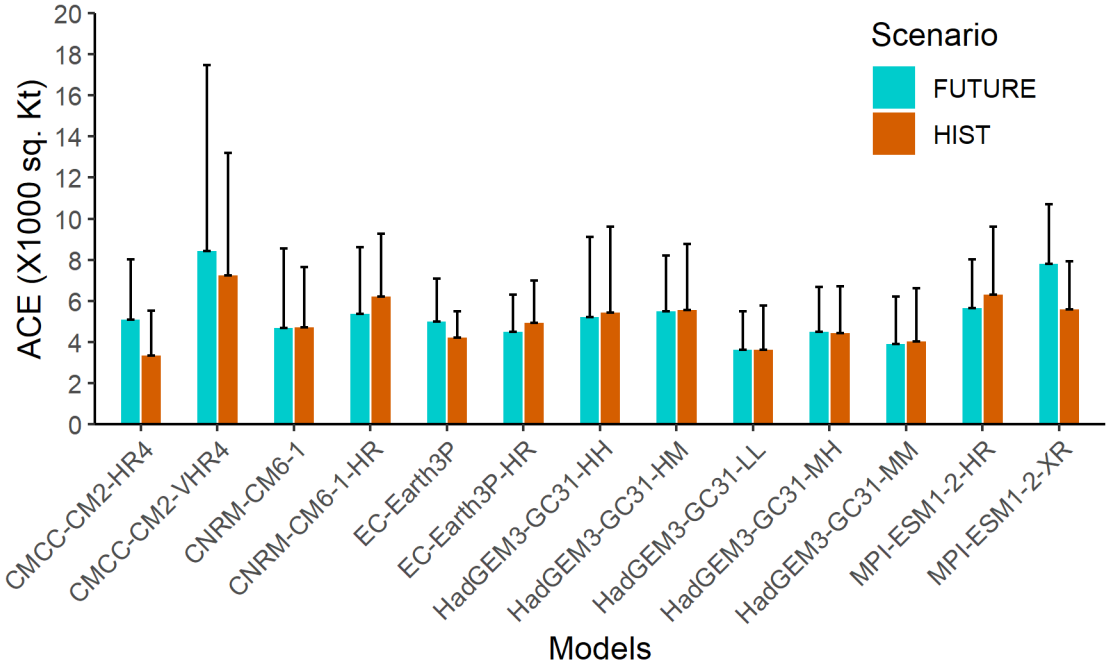
% of Windstorm Footprint over Land Overlapping with Extreme Rainfall



- **Projected increase in the land area experiencing combined wind-rain extremes**
- **This is not explained by the Clausius-Clapeyron relation**
  - Possible contributions from dynamical changes

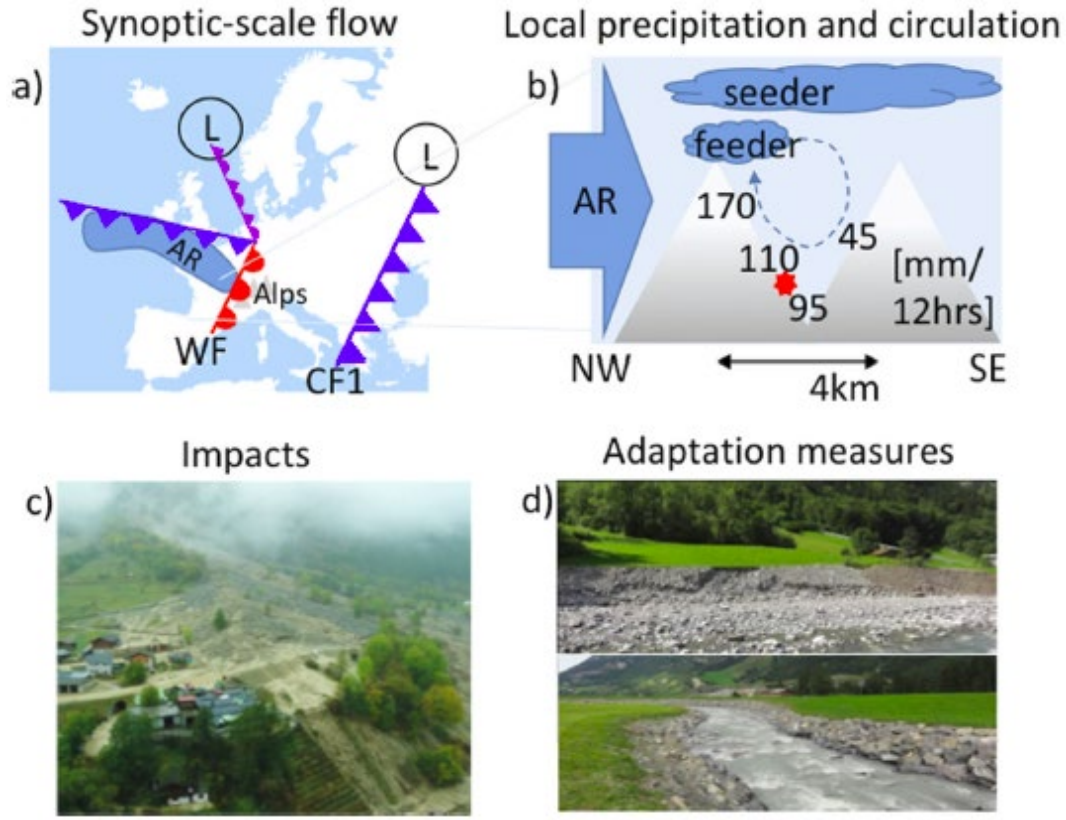
Warming-induced changes to Tropical Cyclones

- Reduced frequency of TCs globally but increased intensity



Chand et al. Nature 2022, https://doi.org/10.1038/s41558-022-01388-4
Ali et al. in review, GRL

Using process understanding and expert judgement to produce storylines of plausible extreme events for risk assessment



Storyline of a past event, but storylines can also be produced for plausible extremes in current and future climates

Shepherd et al., 2018, Climatic Change

STORMY-WEATHER

Time	Water + national authorities	CI	Local authorities	Inhabitants unprotected areas	Inhabitants protected areas
-2 days	Forecast: storm Dordrecht+ high river discharge				
-31 h	pre-warning WL>1.8m		Prepare unprotected areas: close off sewer systems, warn inhabitants, distribute sand bags	Inhabitants remove cars, protect properties	
-24 h	Warning WL > 2.3m				
-21h	Barrier closes, warning: WL will rise to design level		Emergency centre is installed. Dike patrols started		
-17h	Flooding unprotected areas	Roads in harbour areas flooded		Stay indoors	
-10h	Warning: embankments in danger		Communicate to inhabitants: stay indoors, shift on TV/radio		People stay in, 10% leaves the island
0	Dike failure, water flows through	Power switched off on the whole island, gas, communication out of function, flooded roads out of use	Communication possibilities limited (only radio), responders try to rescue and warn people,	Stay in, or act carefully outside	People flee, become rescued, or die
1h	Fast inflow in industrial areas				
2h	First residential areas flooded				
4h	More residential areas flooded, river level reduces fast				
5h	River level below alarm level, unprotected areas dry		Water managers realize flooding will be limited to western part.	Start cleaning, and help fellow citizens	
36h	Max flood extent reached water flows in and out with tides	CI restored in non-flooded areas, out of function in flooded areas	Communication restored in non-flooded areas, rescue, breach repair continues		
7d	Protected areas is emptying		Pumping, repairs		
1 month	Protected area is dry again	CI repair starts	Repairs	Recovered	Repairs start in areas with CI
2 year		CI fully repaired	Repairs finalized		people returned home

Storylines allow planning and management strategies to be tested during crisis situations

de Bruijn et al., 2016, Nat. Haz.

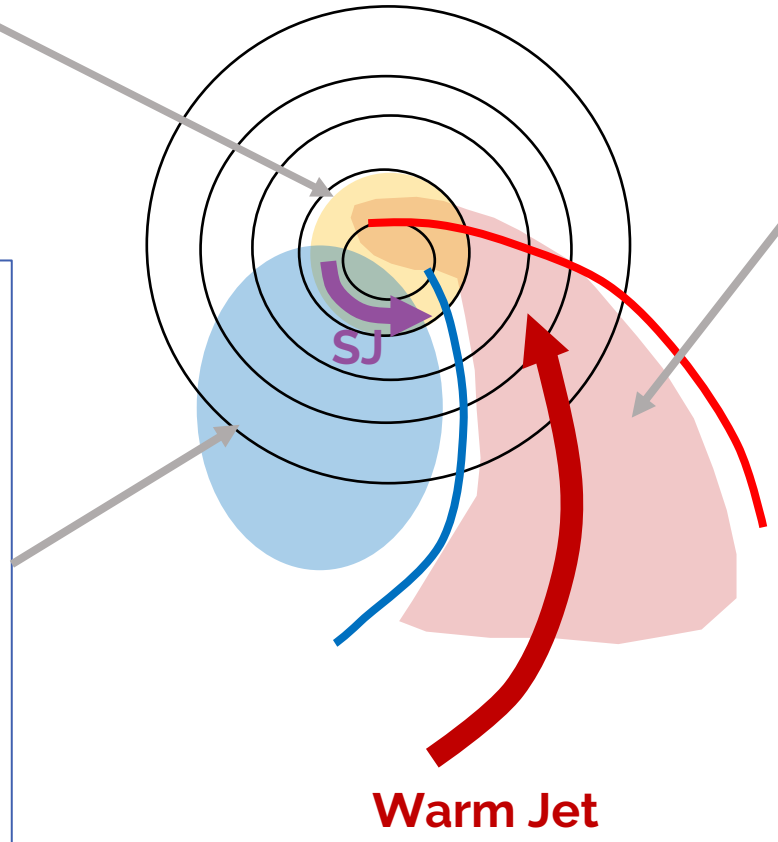
Developing Storylines of Plausible Worst-Case Scenarios

Newcastle University

Quantitative Understanding of Projected Changes for Cyclones over the UK with ~ 4°C Warming

More intense storms
- Changes in cyclones tracks & large-scale drivers (e.g. jet stream)
- Increased latent heating

Cold sector
- 30% increase in windstorm intensity, highest winds in cold sector
- Increased contributions from **sting jets (Storms such as Eunice & '87 are more likely)**
- Larger wind footprints due to increased winds throughout cyclone
- Increased 1-hourly rainfall from convective showers



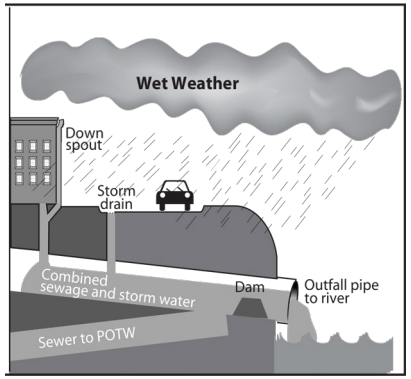
Warm sector
- Hourly rainfall intensity changes close to CC-scaling
- Rainfall footprint volume (incl. area, duration, intensities) are ~70% higher
  - Potentially modulated by cyclone track changes
- Increased frequency of combined wind-rain extremes due to **warm jet**

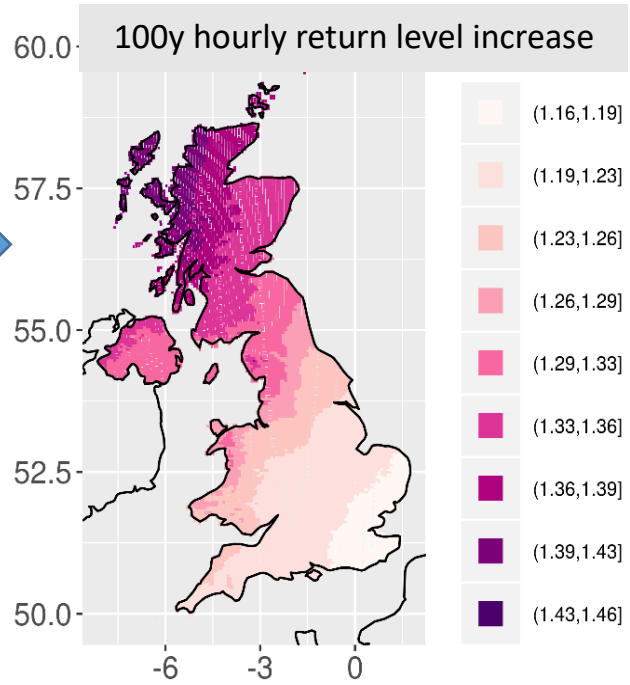
Dependence between wind & rainfall hazards
- Changes shown will not apply to all cyclones equally
- Cyclones with extreme wind and rainfall footprints jointly exceeding 2-year RL are 60% more likely
- Most extreme wind & rainfall footprints tend to occur in isolation, modulated by the strength of the jet stream

Transdisciplinary partnerships are key to providing relevant information for climate resilience

- **Aim:** To provide revised rainfall uplifts for climate change in line with UKCP18, to assess the uncertainty in these rainfall uplifts and provide new guidance for urban drainage design and modelling surface water flooding in urban areas

- **In consultation with stakeholders, translated into information usable to UK water resource stakeholders for climate change adaptation**





FUTURE DRAINAGE
New rainfall uplifts for urban drainage design

Future increases in hourly precipitation extremes (UK-average central estimate of 28%)

UK CLIMATE RESILIENCE PROGRAMME

FUTURE-DRAINAGE

Met Office | University of Exeter | Newcastle University | JBA consulting