

A person is juggling three red balls on a beach at sunset. The person is silhouetted against the bright orange and yellow sky. The ocean waves are visible in the background, and the sky is filled with colorful clouds. The overall scene is peaceful and evocative of the theme of juggling uncertainty.

**The Actuarial Profession**

making financial sense of the future

## **GIRO Conference and Exhibition 2012**

Juggling uncertainty the actuary's part to play

**20 September 2012**



## **GIRO Conference and Exhibition 2012**

# **Weather and climate related aspects of catastrophe risk**

**Dr Emily Shuckburgh, British Antarctic Survey**

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# Agenda

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## Weather and Climate Risk

- A review of weather and climate events of 2011
- Attributing the risk of weather events
- Quantifying future climate risk
- The international political dimension
- Summary

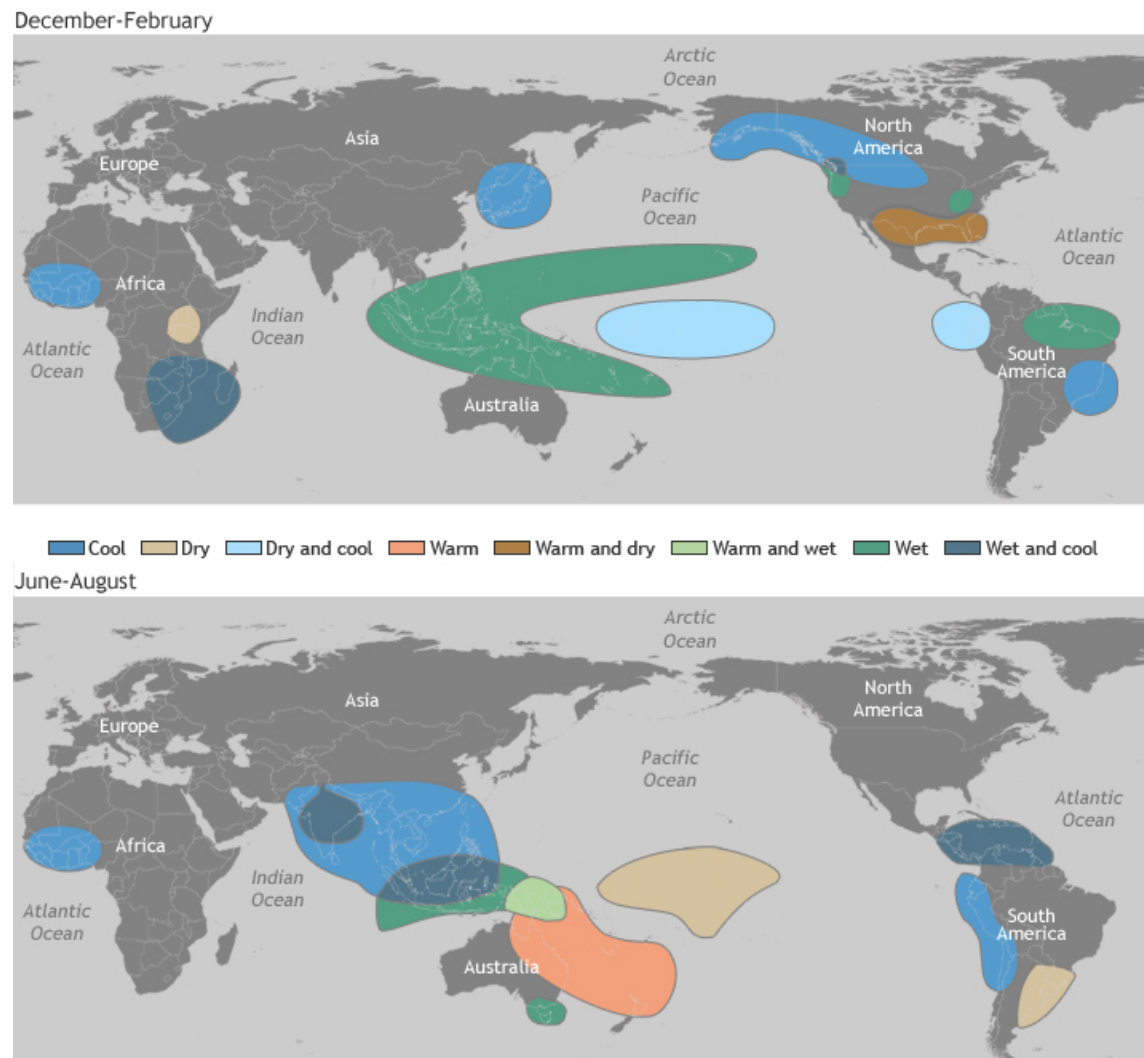
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# A review of weather and climate events of 2011

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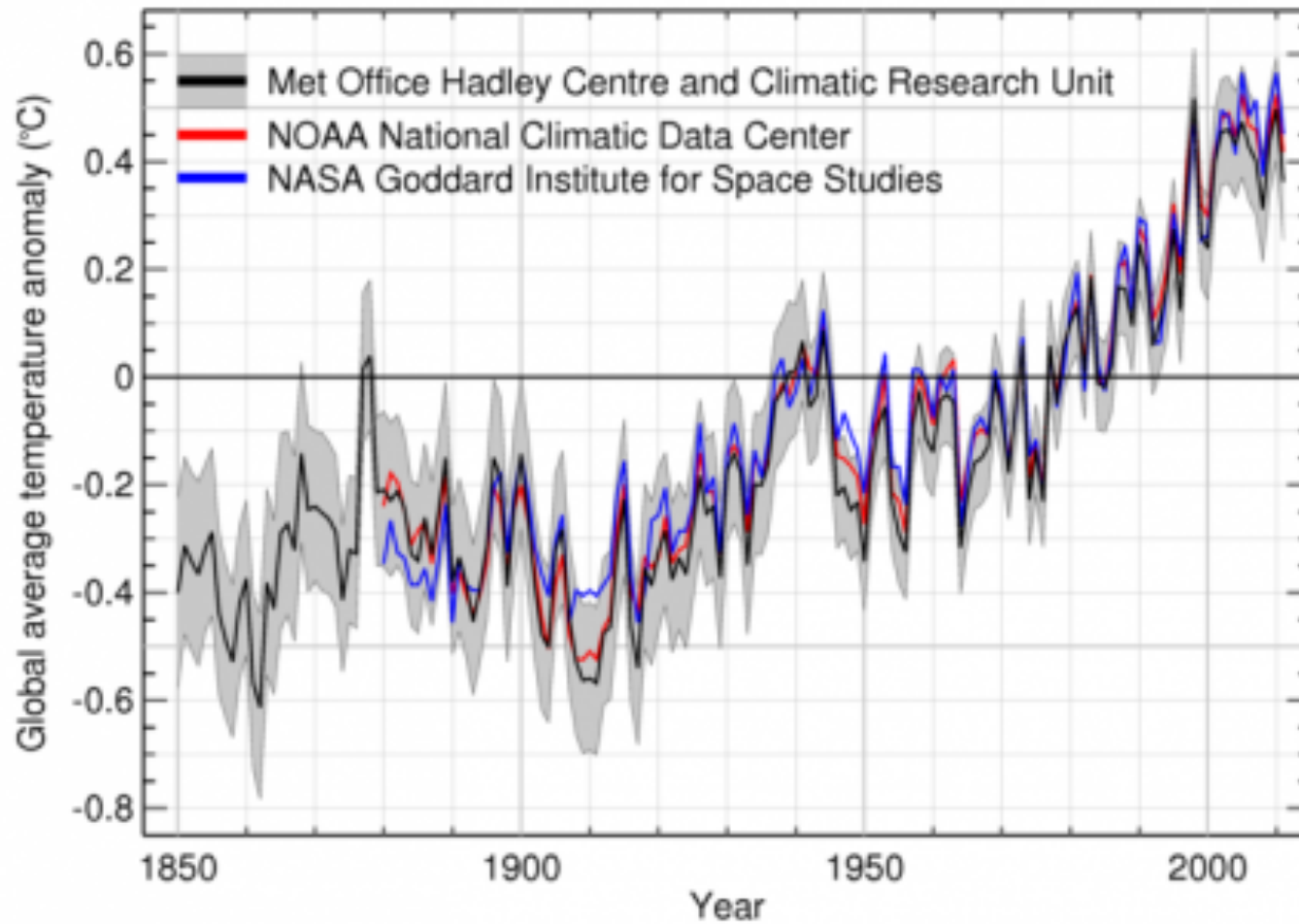


# La Niña influences weather worldwide



Source: NOAA, 2012

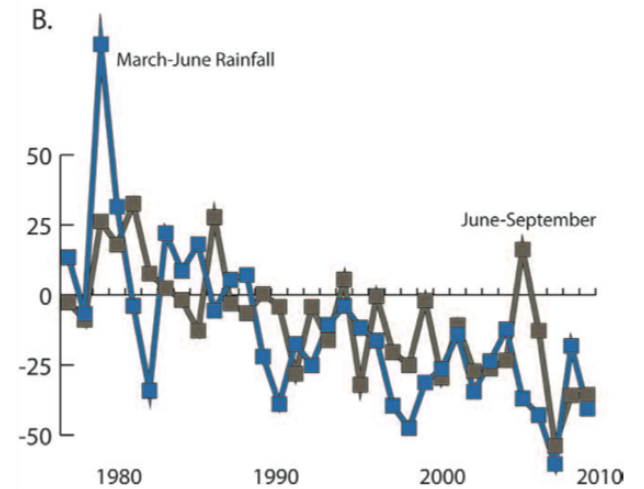
# Global climate change



# Drought in East Africa 2011



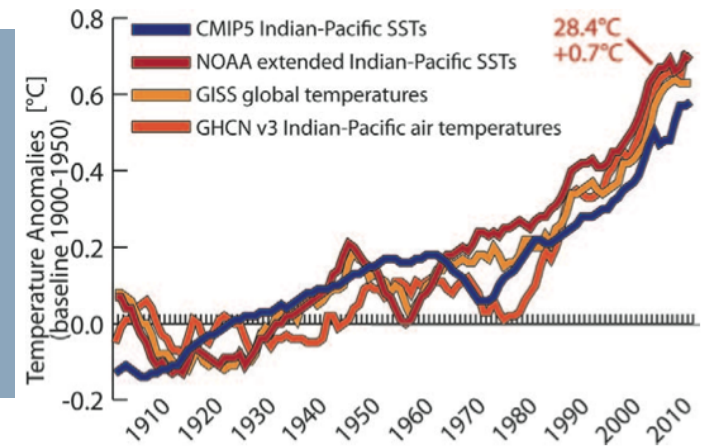
**Rains failed** in fall 2010 – only  $\frac{1}{4}$  usual moisture delivered to the region – and in spring 2011.



Drought in East Africa, with social & political factors, led to **food insecurity** in parts of Ethiopia & Kenya and **famine** in Somalia.

**Worst drought in 60 years** (UN Food and Agriculture Organization)

Link to **La Niña** and **warm sea surface temperatures** in central and southeastern Indian Ocean.



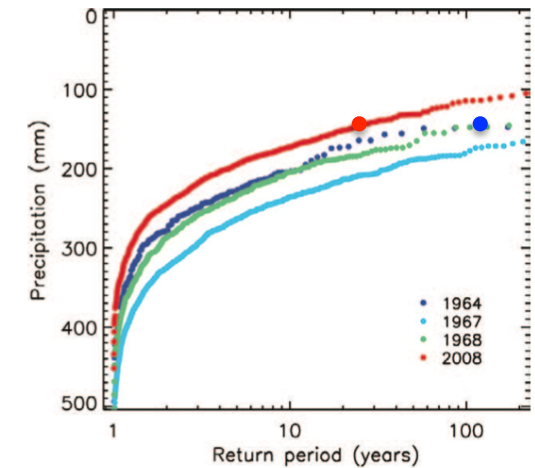
# Drought in southern United States 2011



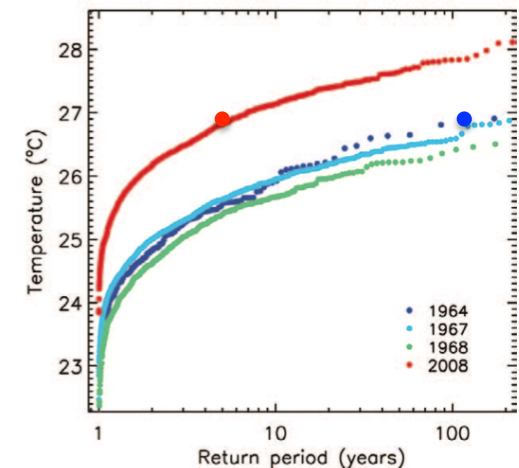
In **Texas**, growing season (March-August) and summer (June-August) were **hottest and driest on record** (back to 1895).

Texas agriculture producers lost **\$7.62bn**. Costliest drought in the state's history.

The **100-yr return period** March-August **precipitation** is now **25-yr return** (taking into account La Niña conditions)



The 100-yr return period March-August **heat event** is now **5-yr return**.



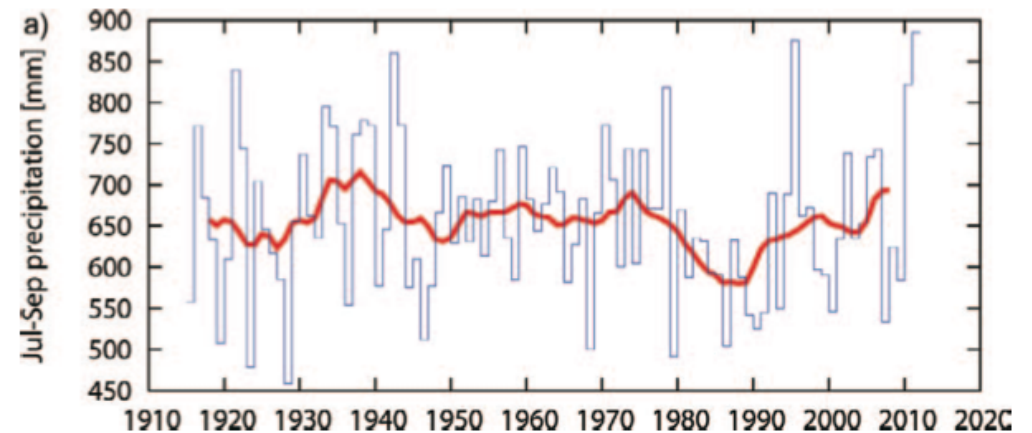


# Thai floods 2011



Storms and heavy rain from July-October contributed to **worst flooding** since 1942.

Cost global insurance business **\$12bn** (highest insured loss ever for freshwater flooding).  
Total damage estimated **\$45bn** (World Bank).



Monsoon season for Chao Phraya basin wettest on record. Estimated 140-yr return time.

Likely influence of La Niña, but no clear climate change trend. Models indicate **future increase in mean & variability of precipitation** (but much uncertainty).

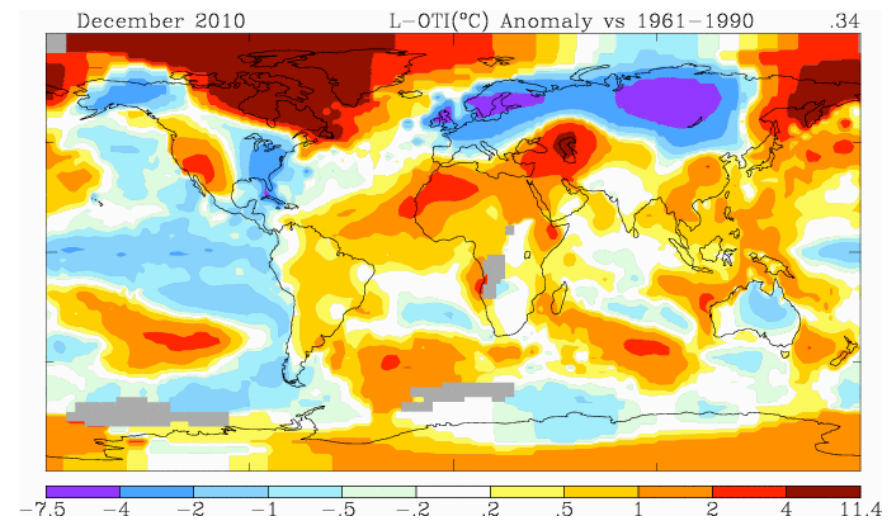
# UK weather winter 2010/11 and spring 2011



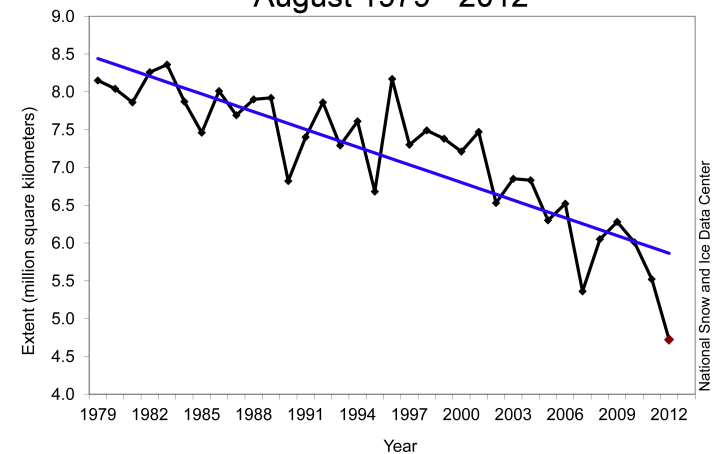
**Coldest December** in UK in the last 100 years (but global average was warm). Estimated to have cost UK economy £1.2bn per day.

Followed by **warmest spring** in 100 years.

Source:  
NASA-  
GISS



Average Monthly Arctic Sea Ice Extent  
August 1979 - 2012



Possible link  
between cold  
winter in UK  
and **Arctic sea  
ice decline?**

Source: NSIDC, 2012

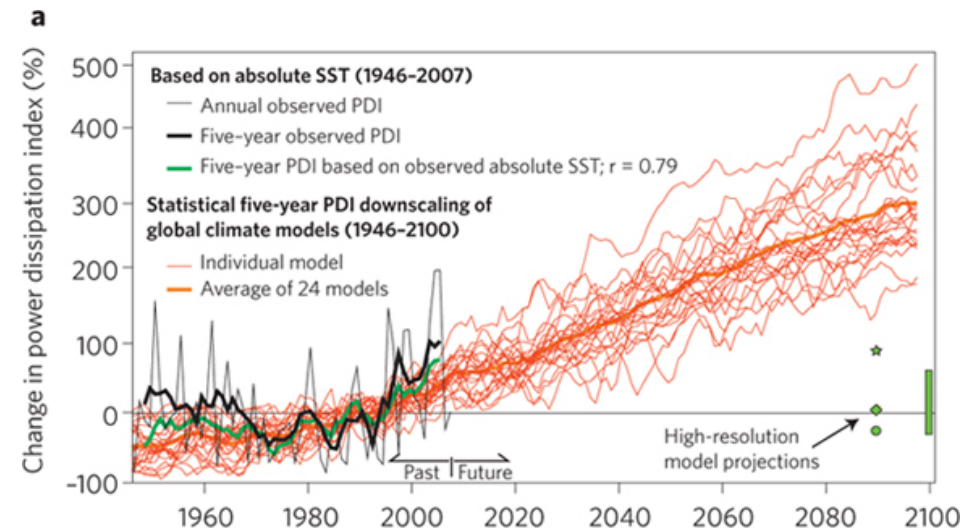


# Hurricane Irene 2011

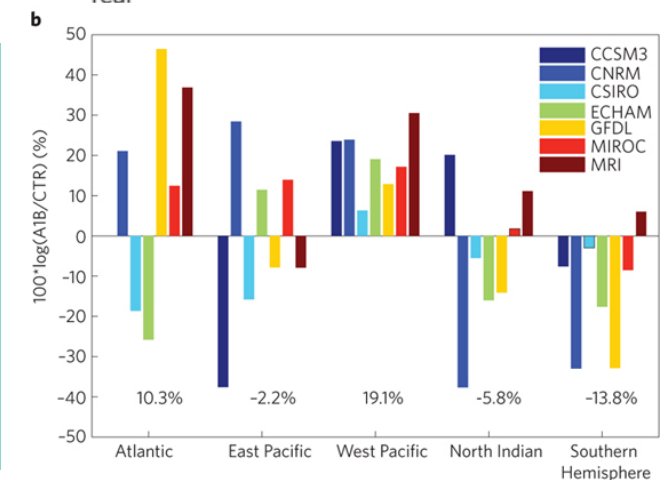


August 2011: first US landfalling hurricane since 2008.

50m estimated to live in its path. Disrupted power to more than 7m homes and businesses. Caused 45 deaths. **Estimated \$19bn property damage.**



Future projections uncertain. It is **more likely than not** that frequency of most **intense storms** will **increase** in some ocean basins.



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# Attributing the risk of weather events

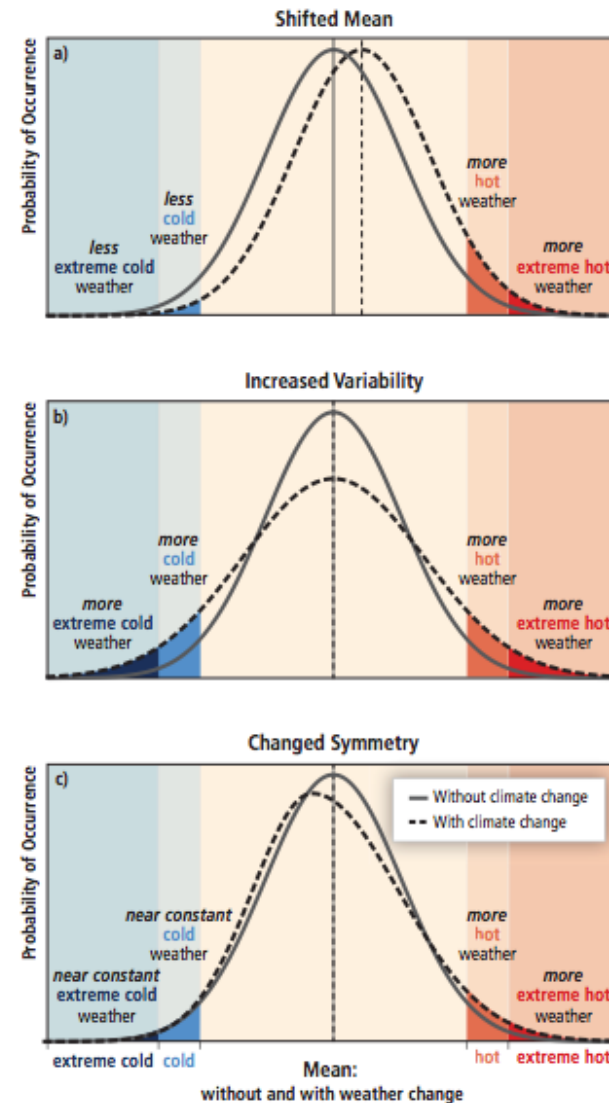
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# Impact of climate change on extremes

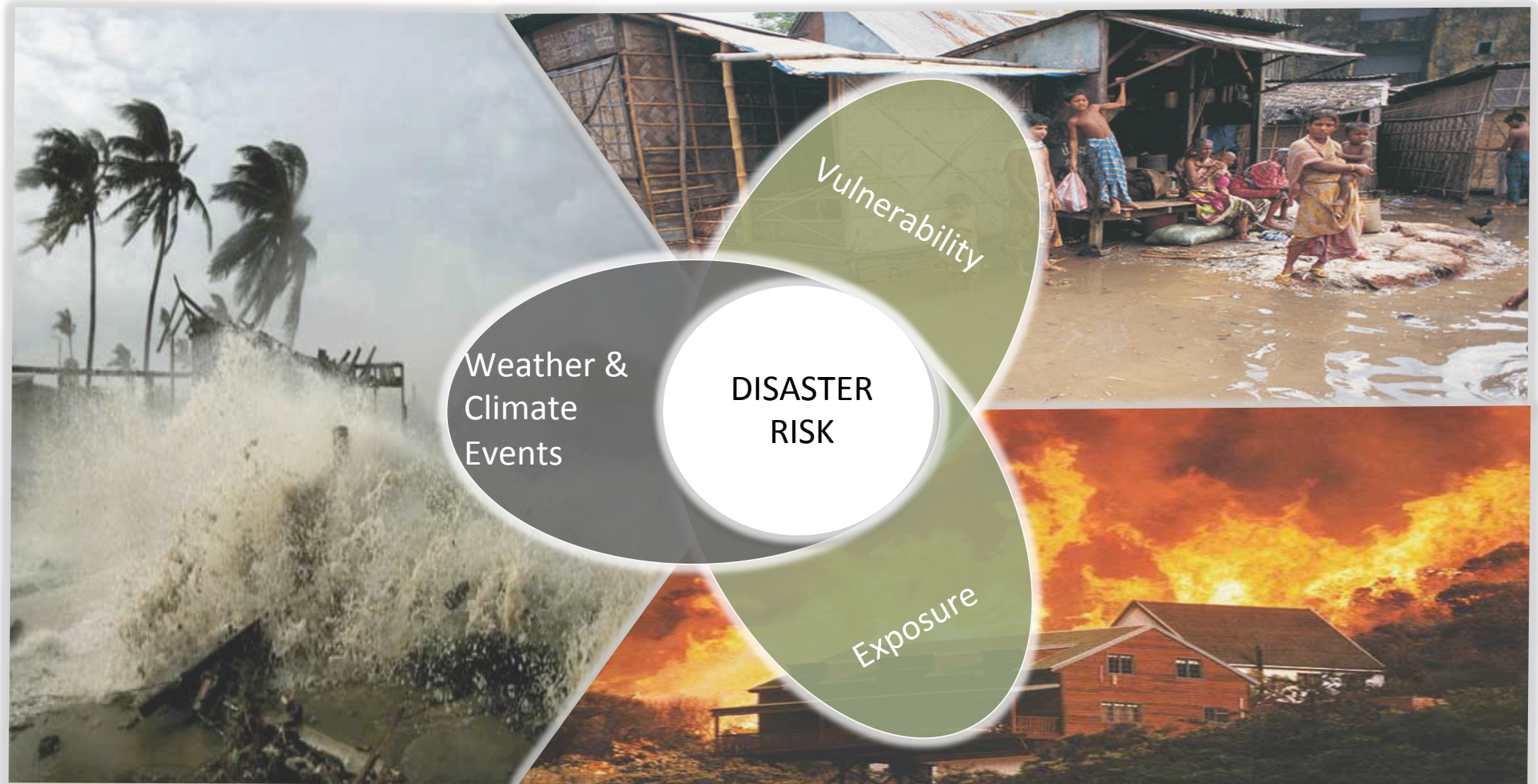
Risk of extreme weather can be altered by:

- Shifted mean
- Increased variability
- Changed symmetry

Source: IPCC SREX report, 2012



# Increasing vulnerability, exposure or severity/frequency of climate events increases disaster risk



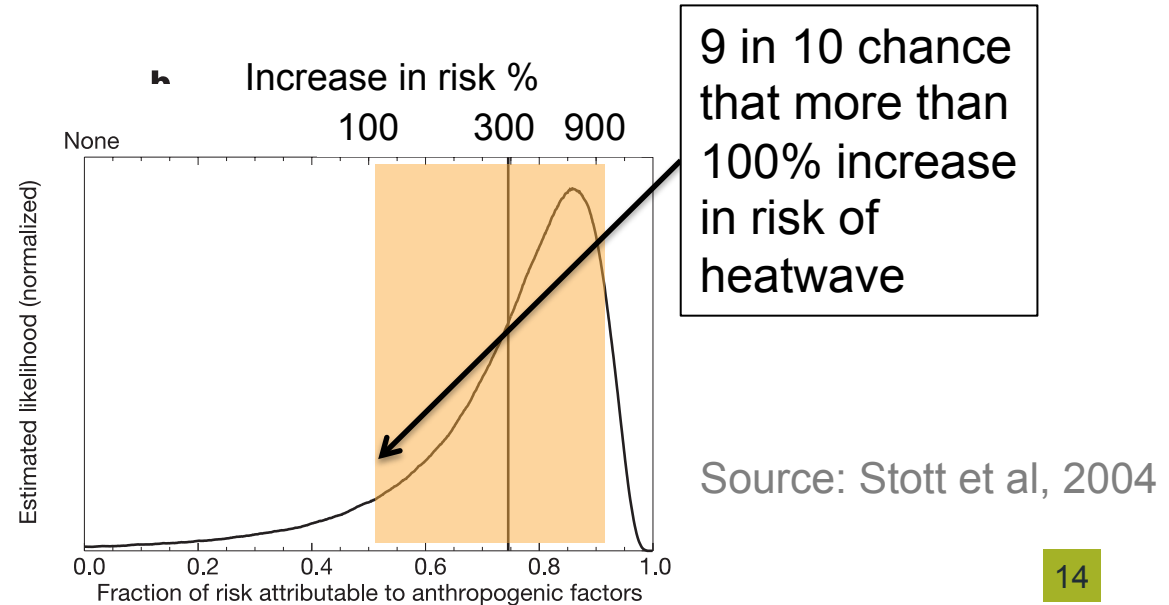
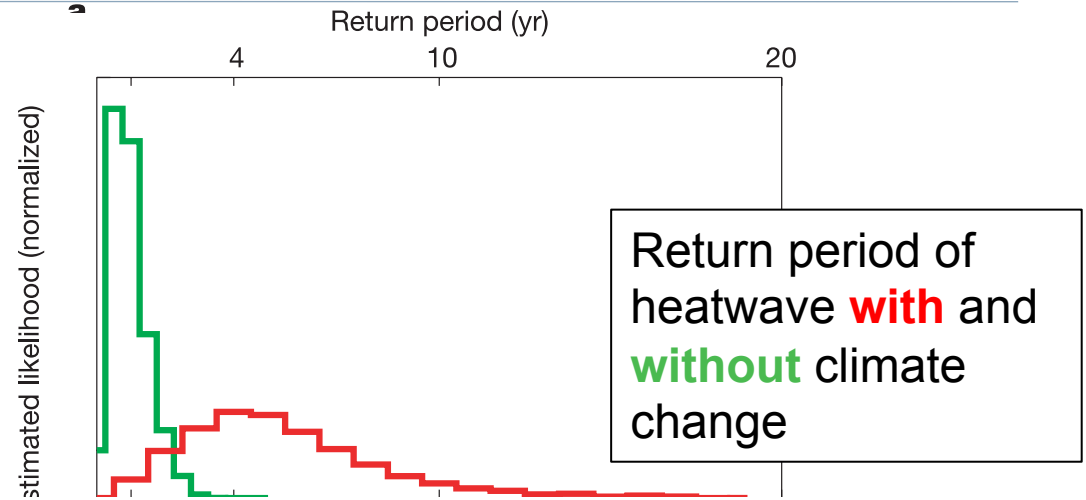


# European heatwave summer 2003



Death toll in Europe estimated at 30,000. **Deadliest natural disaster in Europe in 50 years** (UNEP).

Very likely **climate change** doubled the odds of heatwave.



Source: Stott et al, 2004

# UK floods autumn 2000

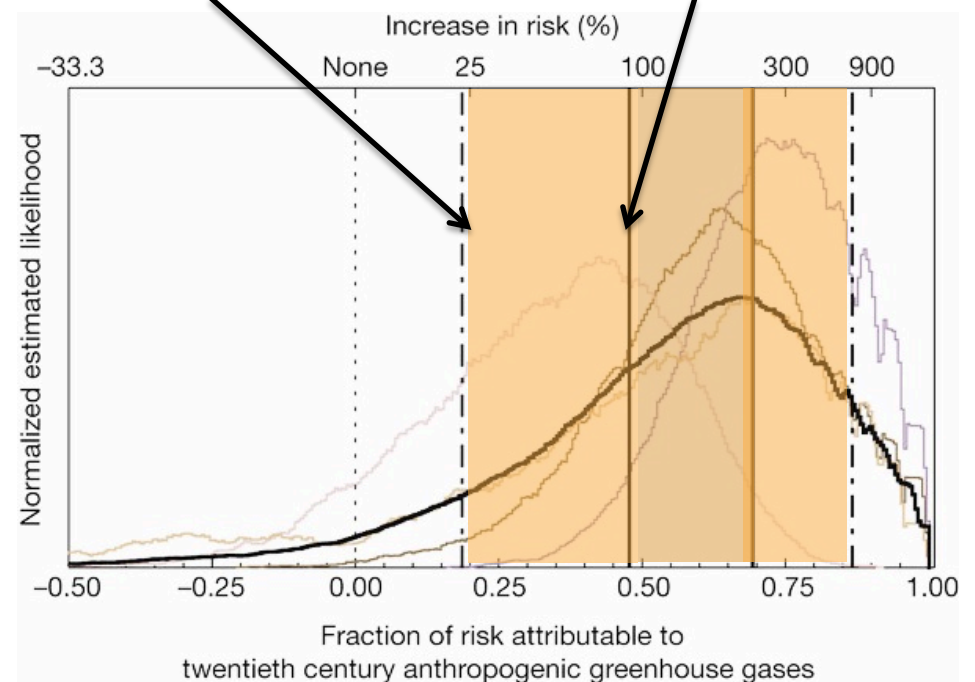


Autumn 2000 was wettest on record in England and Wales. Flooding estimated to have cost **£3.5bn.**

Likely **climate change doubled the odds** of the flooding.

9 in 10 simulations showed more than 20% increase in risk of flood

2 in 3 simulations showed more than 90% increase in risk of flood



Source: Pall et al, 2011

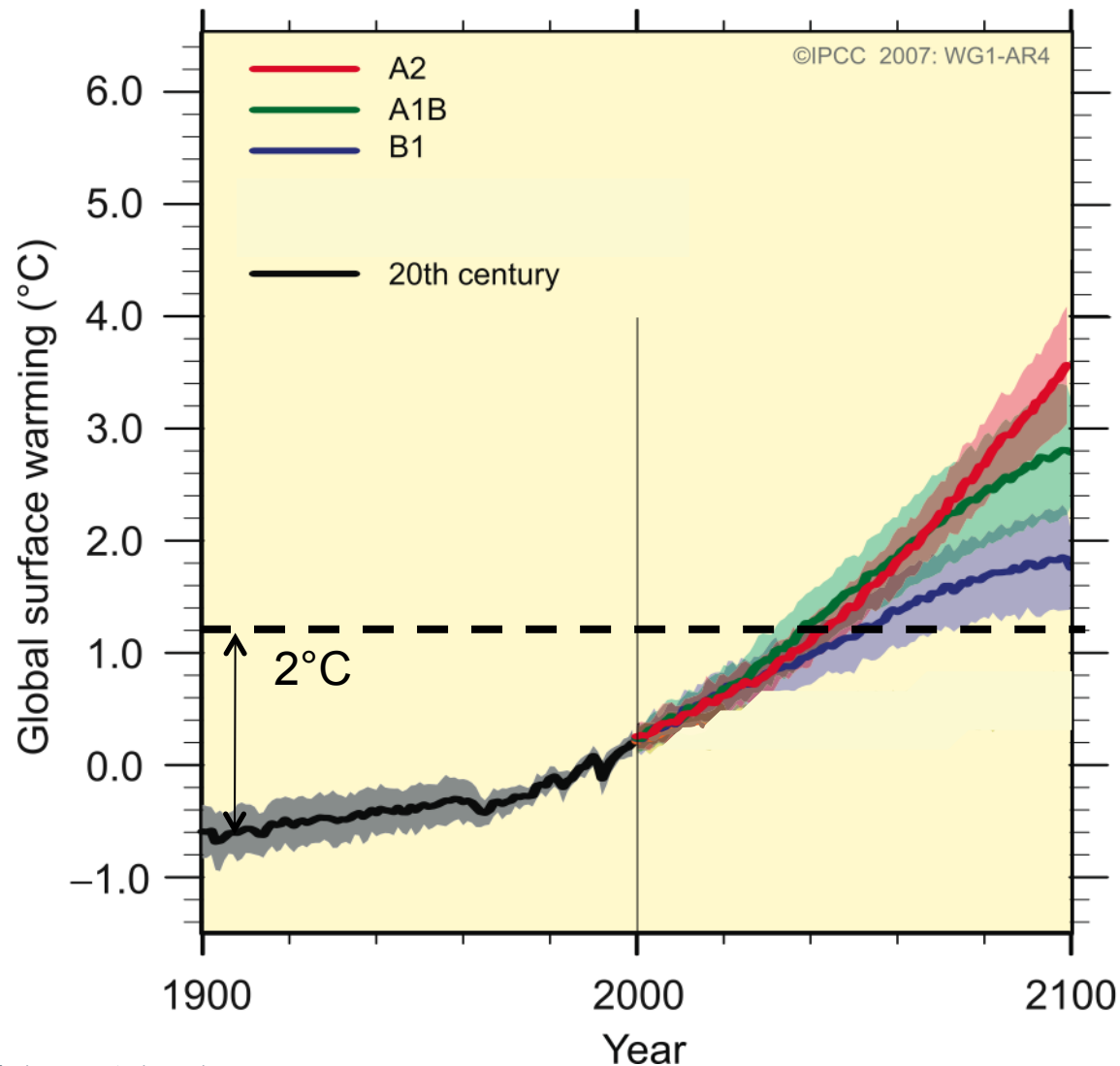


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# Quantifying future climate risk

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# Projected temperature change



Source: IPCC, AR4, 2007

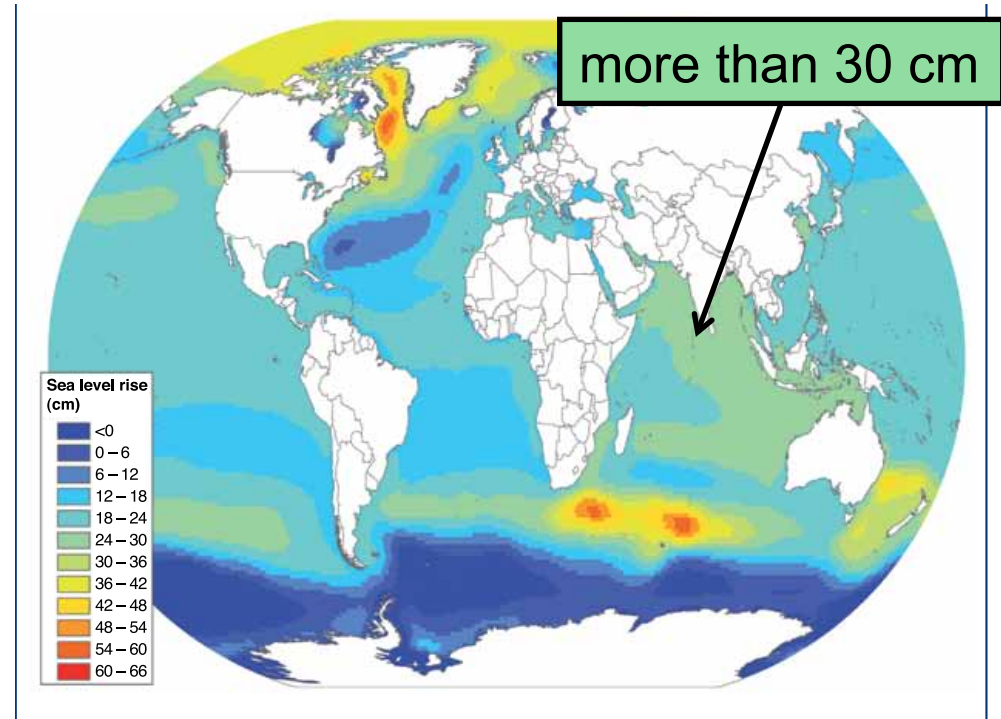
# Risk of coastal flooding over coming decades

**Sea level:** fear that rise by 2100 may be up to **1 m**

**People at risk:** about 150 million people in Asia exposed to coastal flooding; **could more than double with 30 cm rise**

**Cities and infrastructure at risk:** London, Rotterdam, New York, Tokyo, Shanghai, Bangkok, Dhaka at risk of flooding

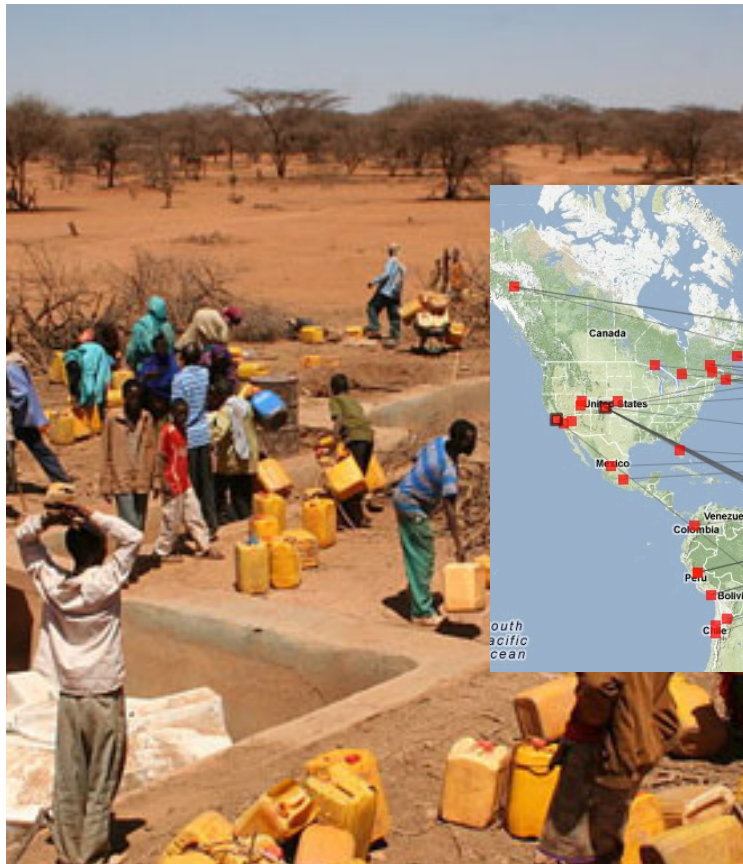
Sources: IPCC 2007; APN 2011; Foresight 2011



Projected sea level rise for 2040 (relative to 1980-99).

Source: Foresight report on Migration, 2012

# Climate risk: droughts and floods



More intense and longer droughts



Greater risk of flooding



Source: IPCC SREX report, 2012



# Interconnected risks

Risk of flash floods in Kenya

Interconnected: health & sanitation, infrastructure

Climate-risk to infrastructure

Interconnected: energy and water supply

Risk of drought in West Africa

Interconnected: food & water security, health

Urban flood risk

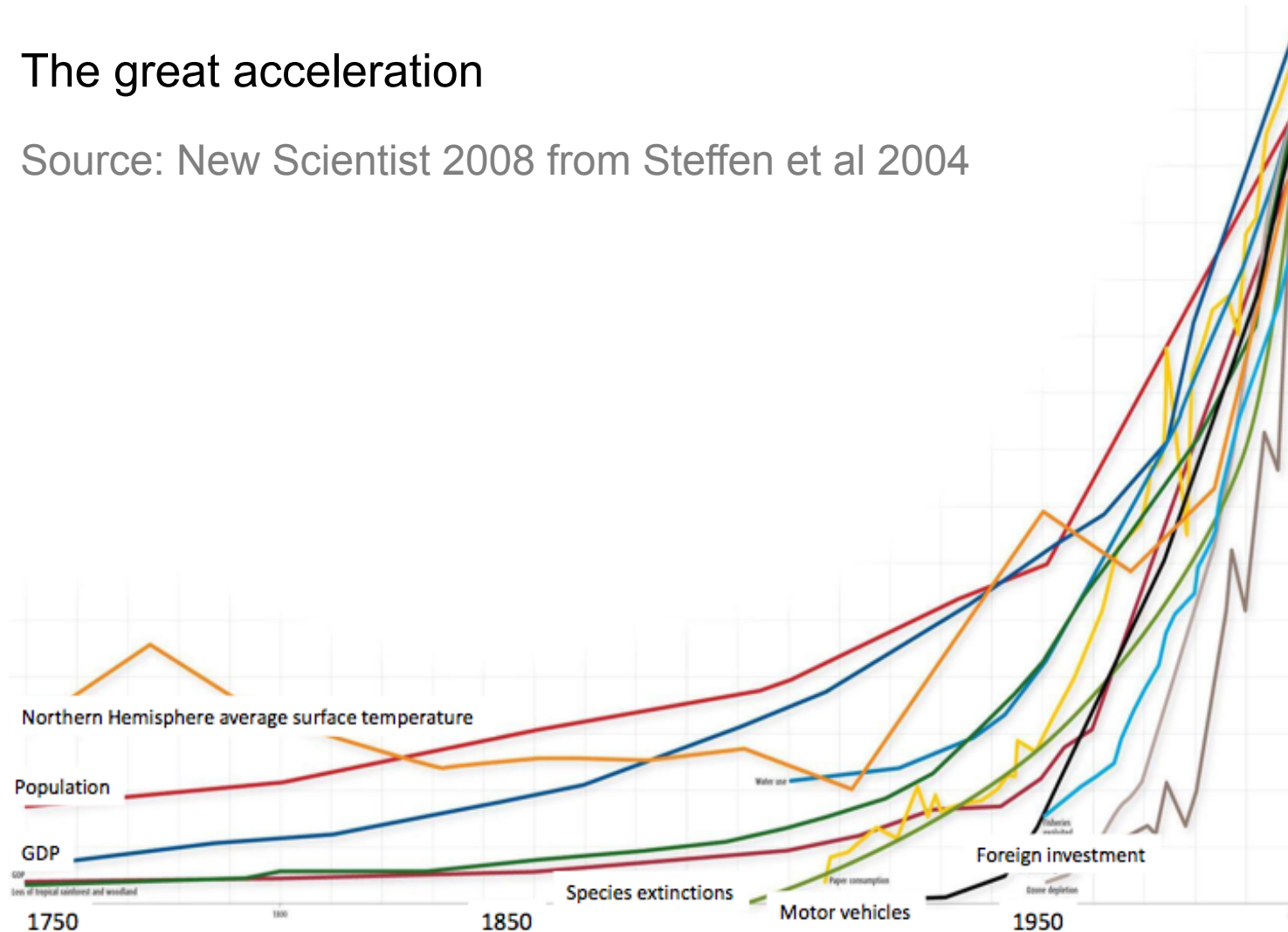
Interconnected: health, infrastructure, economy



# Interconnected risks

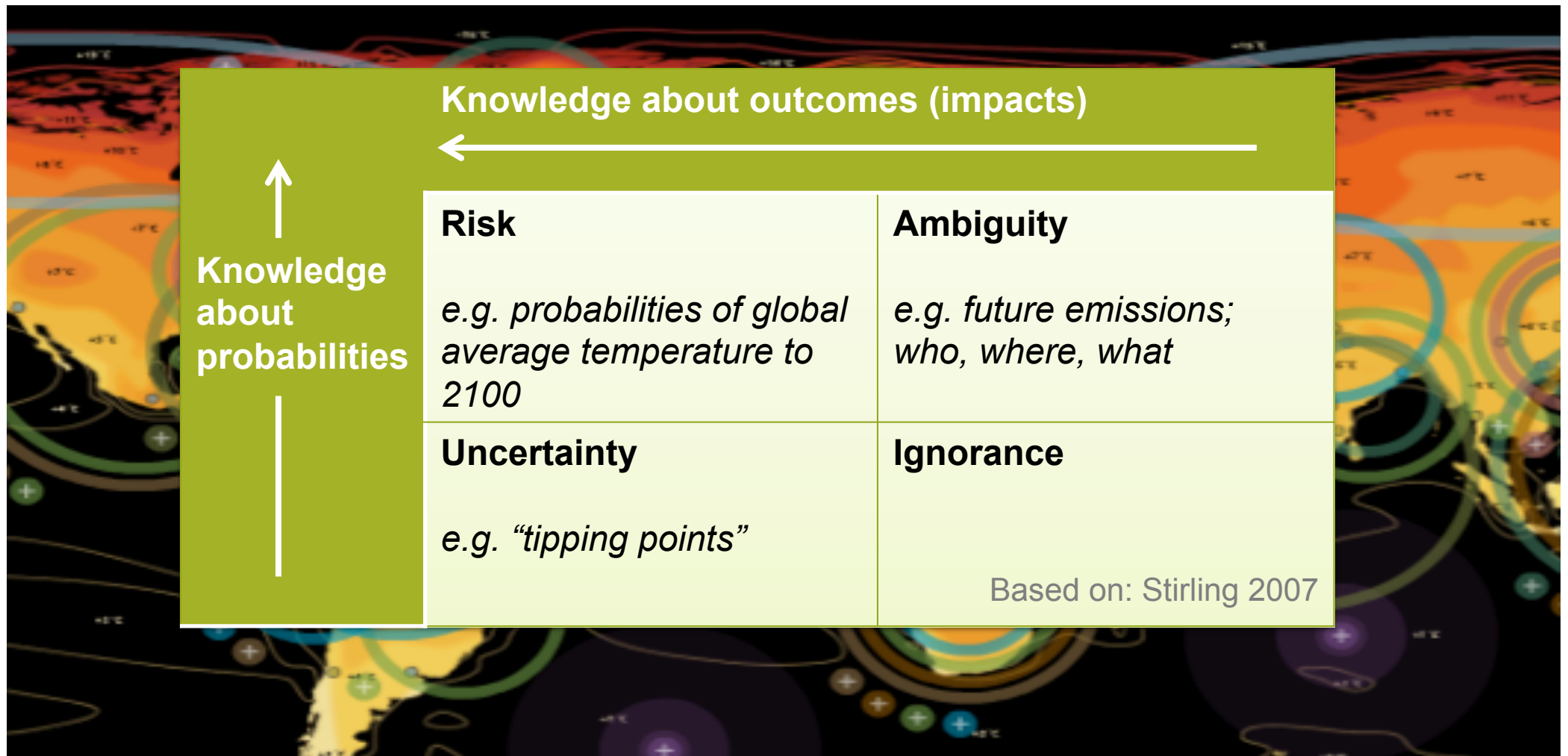
## The great acceleration

Source: New Scientist 2008 from Steffen et al 2004





# Accounting for uncertainty



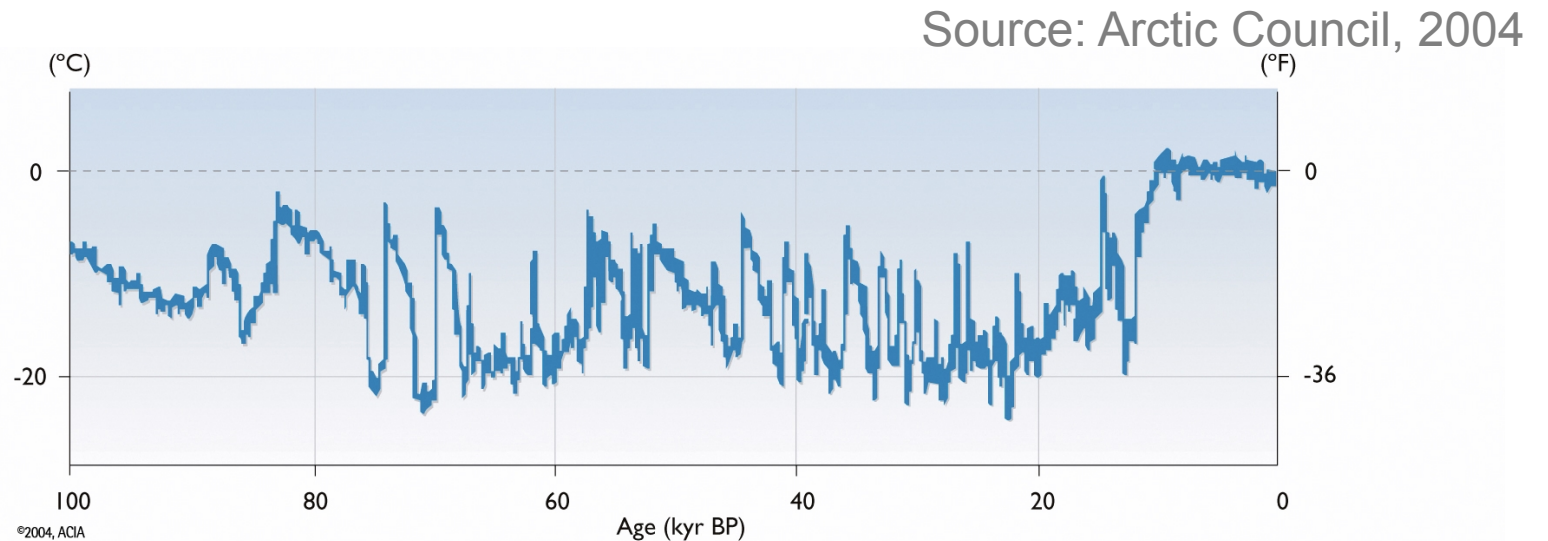
# Risk of irreversible change



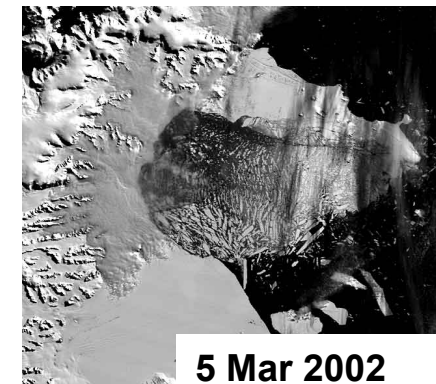
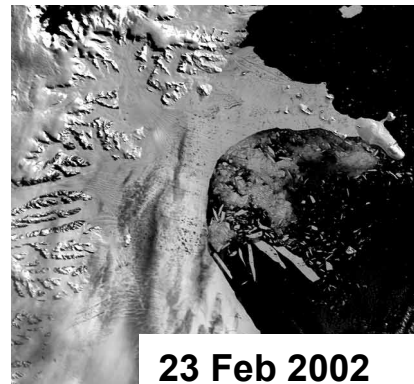
Source: Lenton, 2011

# Risk of rapid change

In the past, changes of  $10^{\circ}\text{C}$  have occurred in Greenland over a decade or so.

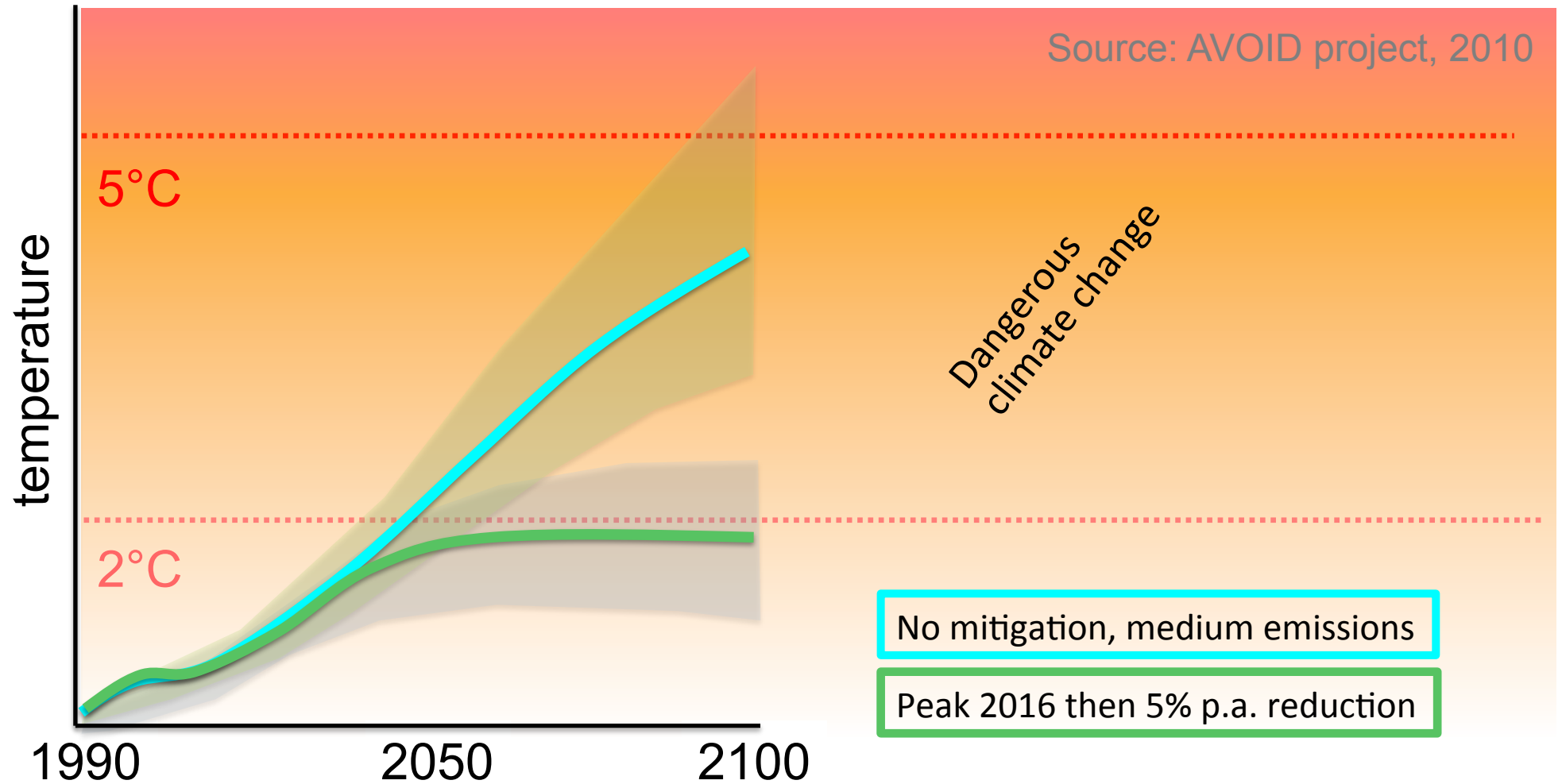


In 2002 an ice sheet the size of Rhode Island state collapsed in a few weeks

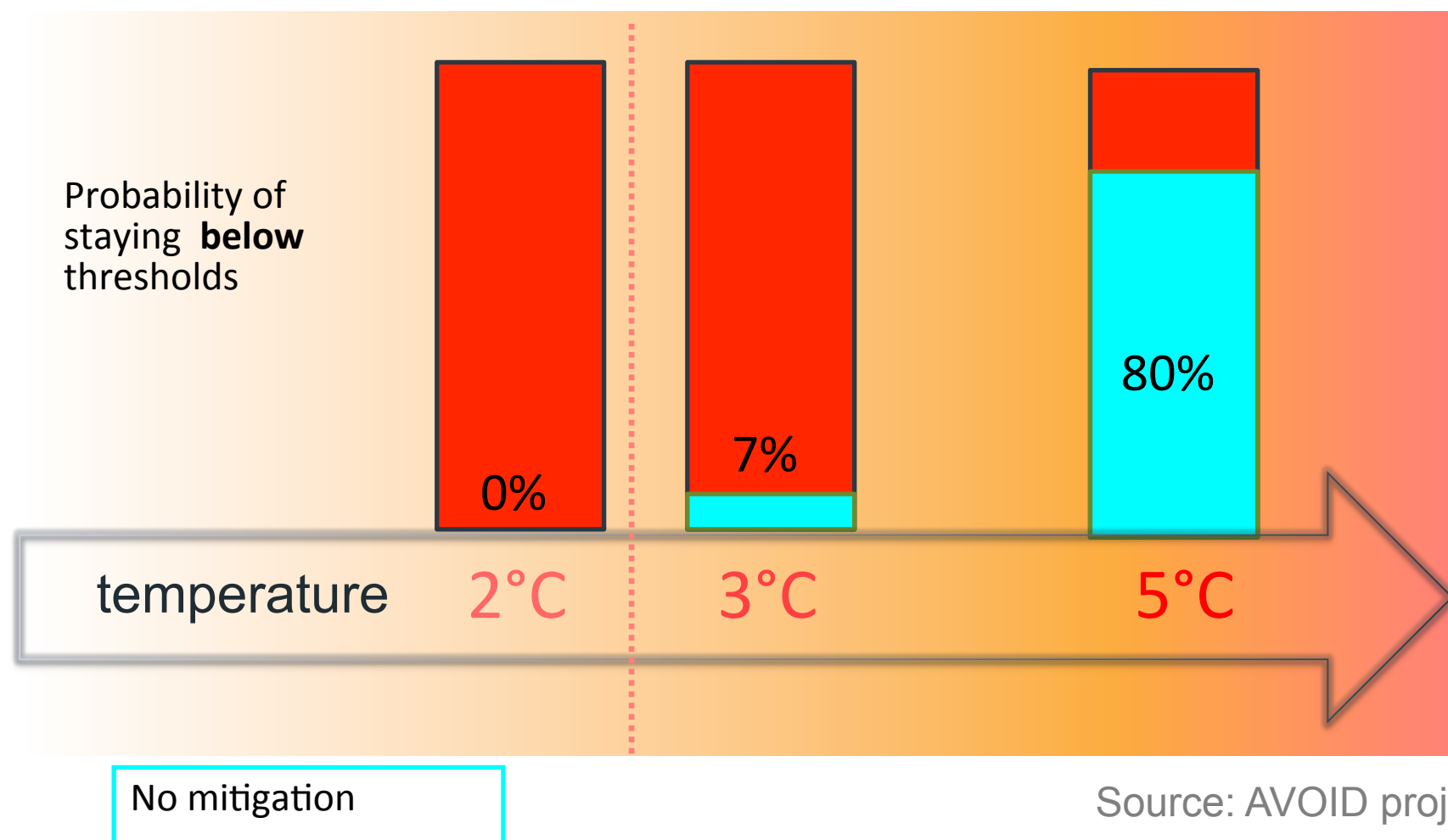


Source: NASA, 2002

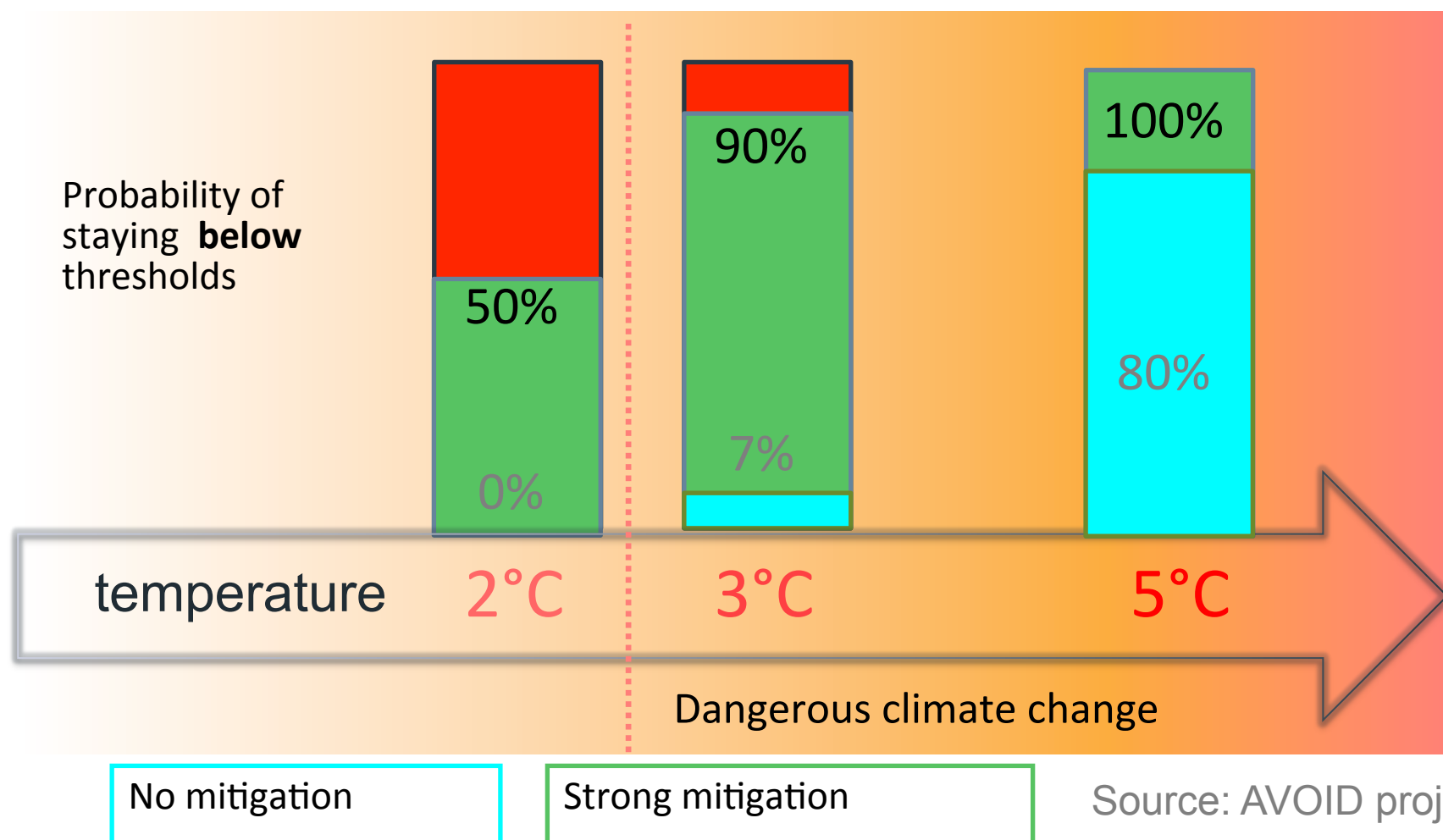
# Risk of dangerous climate change



# Chances of staying below thresholds



# Chances of staying below thresholds



Source: AVOID project, 2010



# Impacts in 2080

## Food



50%

decrease in crop suitability as % of cropland

## Water



850

Millions of people with increase in water stress

## Flood



50%

% of flood-prone population with increased hazard

No mitigation

Source: AVOID project, 2010

# Impacts in 2080



## Food

50%

30%

decrease in crop suitability as % of cropland



## Water

850

450

Millions of people with increase in water stress



## Flood

50%

25%

% of flood-prone population with increased hazard

Strong mitigation

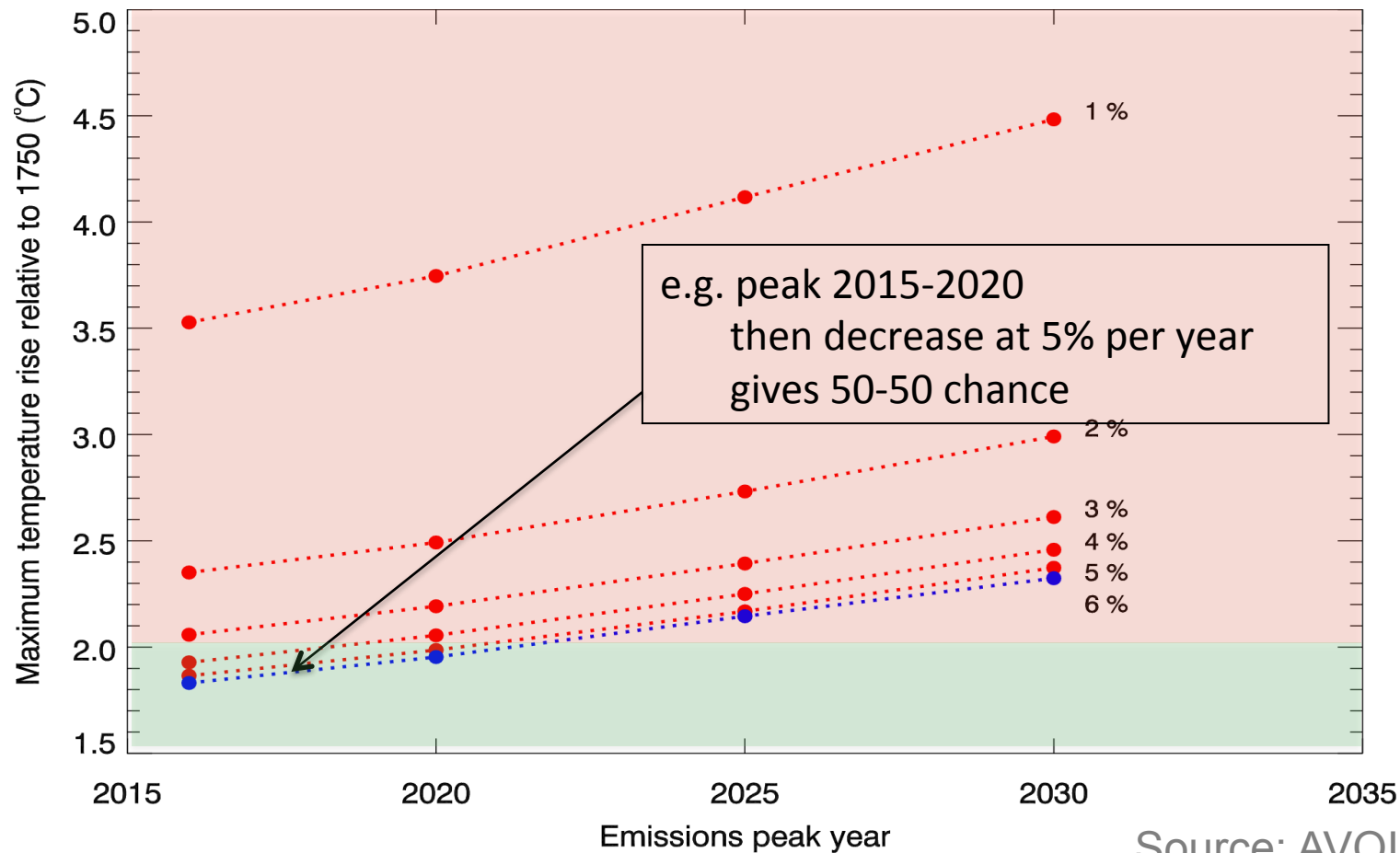
Source: AVOID project, 2010

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# The international political dimension

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# Possible mitigation strategies



Source: AVOID project, 2010



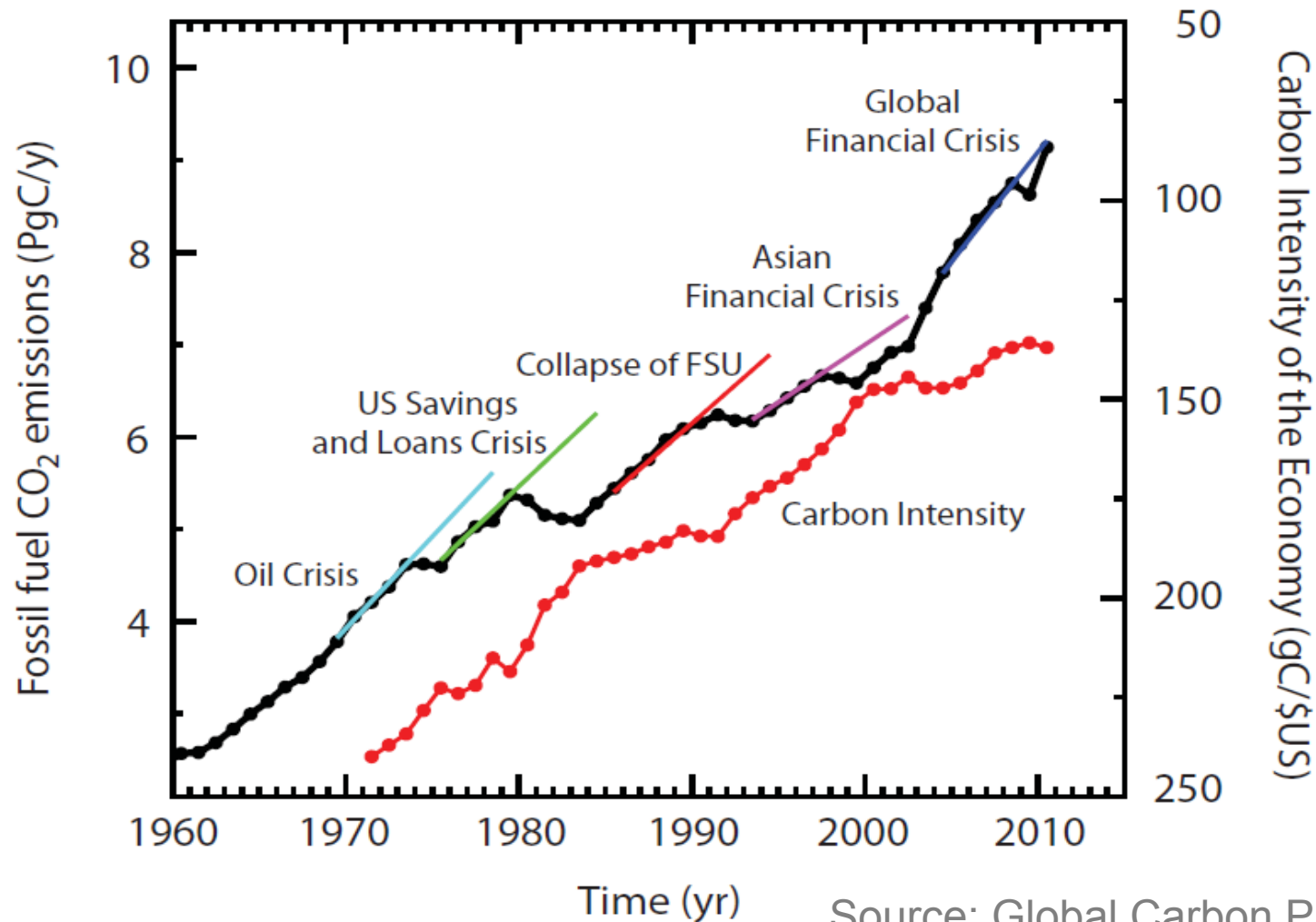
# Possible mitigation strategies

Year of peak emissions	Decrease after peak for 50-50 chance of avoiding dangerous climate change
2016	4% p.a. or more
2020	5% p.a. or more
2025	n/a
2030	n/a

But, IEA World Energy Outlook 2011: risk of “lock-in” – after 2017 may have to prematurely scrap assets to avoid exceeding 2°C

Source: AVOID project, 2010 and IEA, 2011

# Current carbon trajectory



Source: Global Carbon Project, 2011

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# Summary

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- **Climate change is altering return periods** of some weather events
- **Future risk** of more intense and longer **droughts** and more **flooding** (coastal and river) in many areas
- Increasing vulnerability, exposure or severity/frequency of climate events increases **disaster risk**
- Climate risk assessment needs to include uncertainty, ambiguity & ignorance (**recent past not a good guide to future**)
- **Risk are highly interconnected** (and in ways that are not always appreciated)
- Can avoid dangerous climate change, but only if **rapid and strong mitigation** undertaken
- High risk some impacts cannot be avoided: **adaptation will be required**

**All this offers threats and opportunities for the risk profession**

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# Questions or comments?

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Expressions of individual views by members of The Actuarial Profession and its staff are encouraged.

The views expressed in this presentation are those of the presenter.

