Climate change and water (food) security

By
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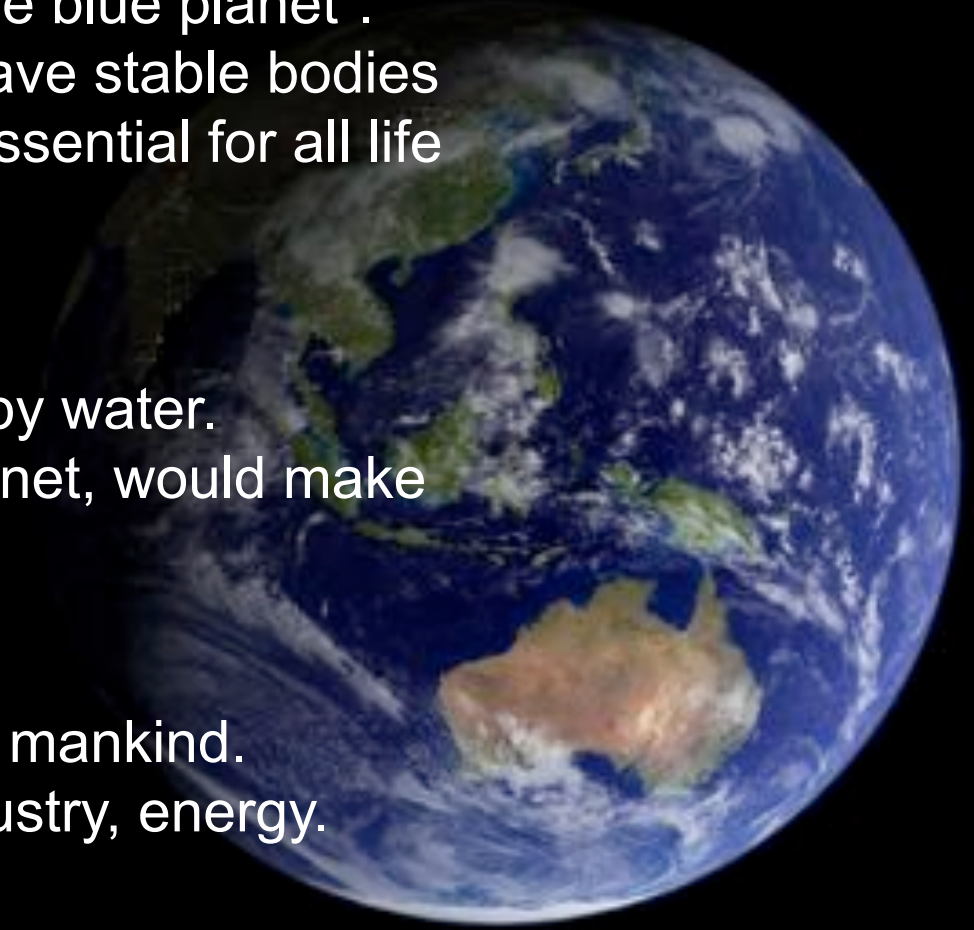
Earth deserves it nick name “the blue planet”.
It is the only known planet to have stable bodies of liquid water on its surface. Essential for all life forms as we know them.



71% of the surface is covered by water.
Distributed equally over the planet, would make a 2700 m tick layer.

Only a tiny fraction available to mankind.
Drinking water, agriculture, industry, energy.

Water is vital for all natural and human systems.
The availability is threatened by climate change.

Water cycle

Climate change

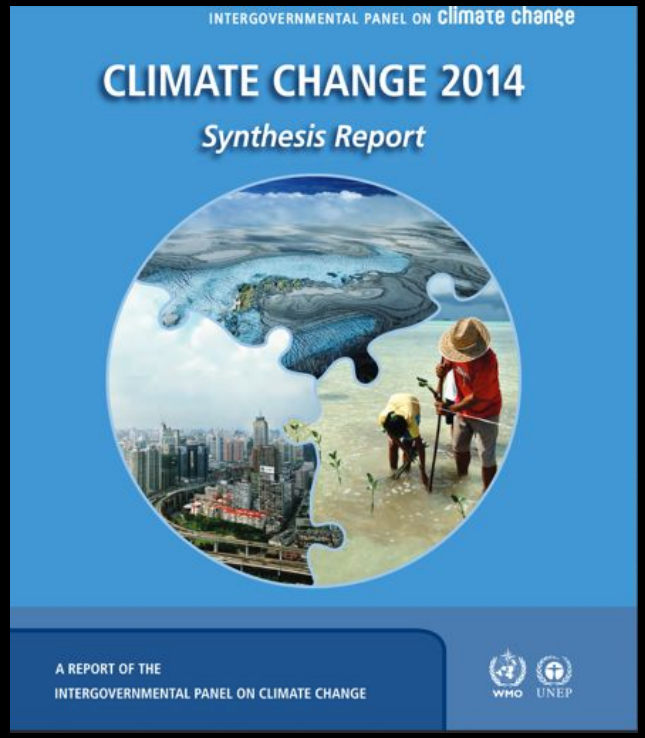
Climate extremes

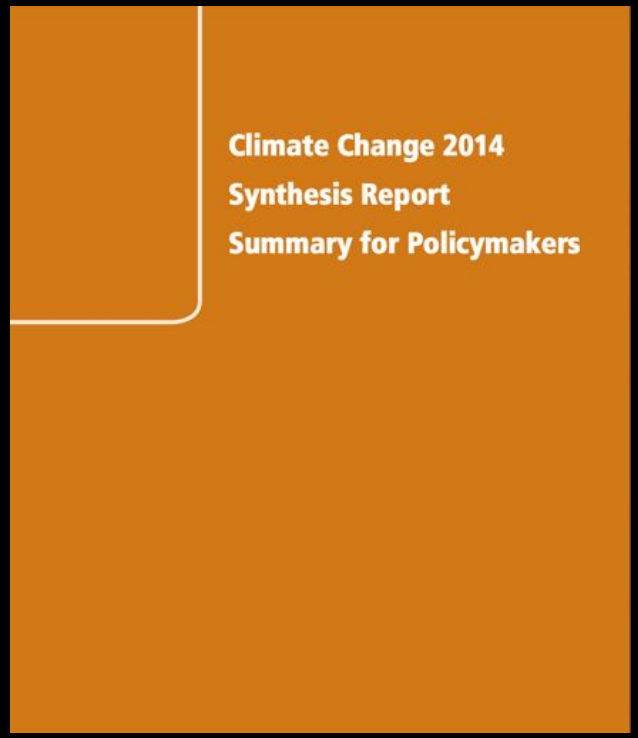
Risks and impacts

Future climate

Food production

Paris agreement

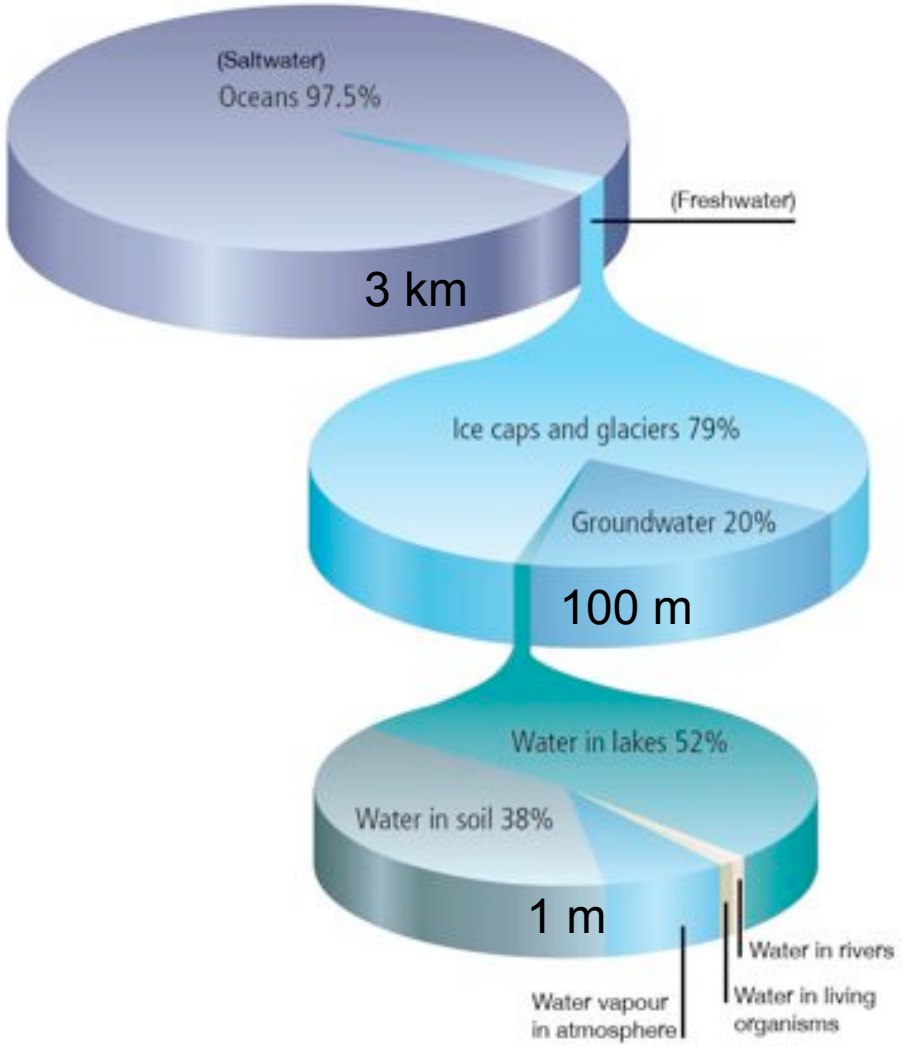


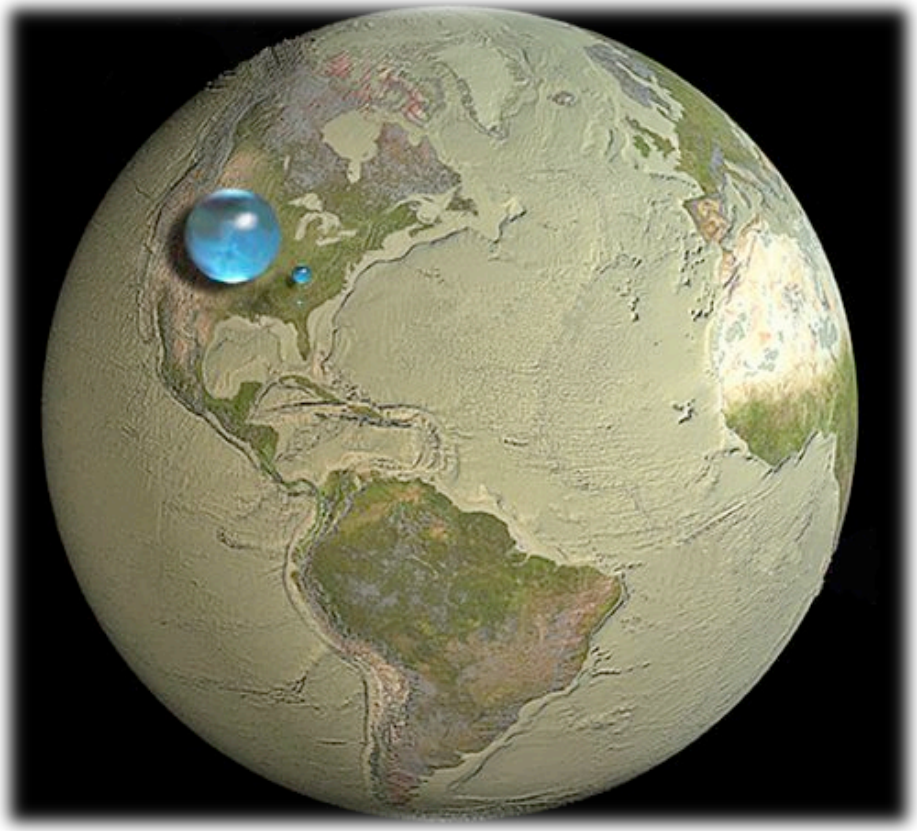


http://www.ipcc.ch/report/ar5/

Water cycle

Water on Earth

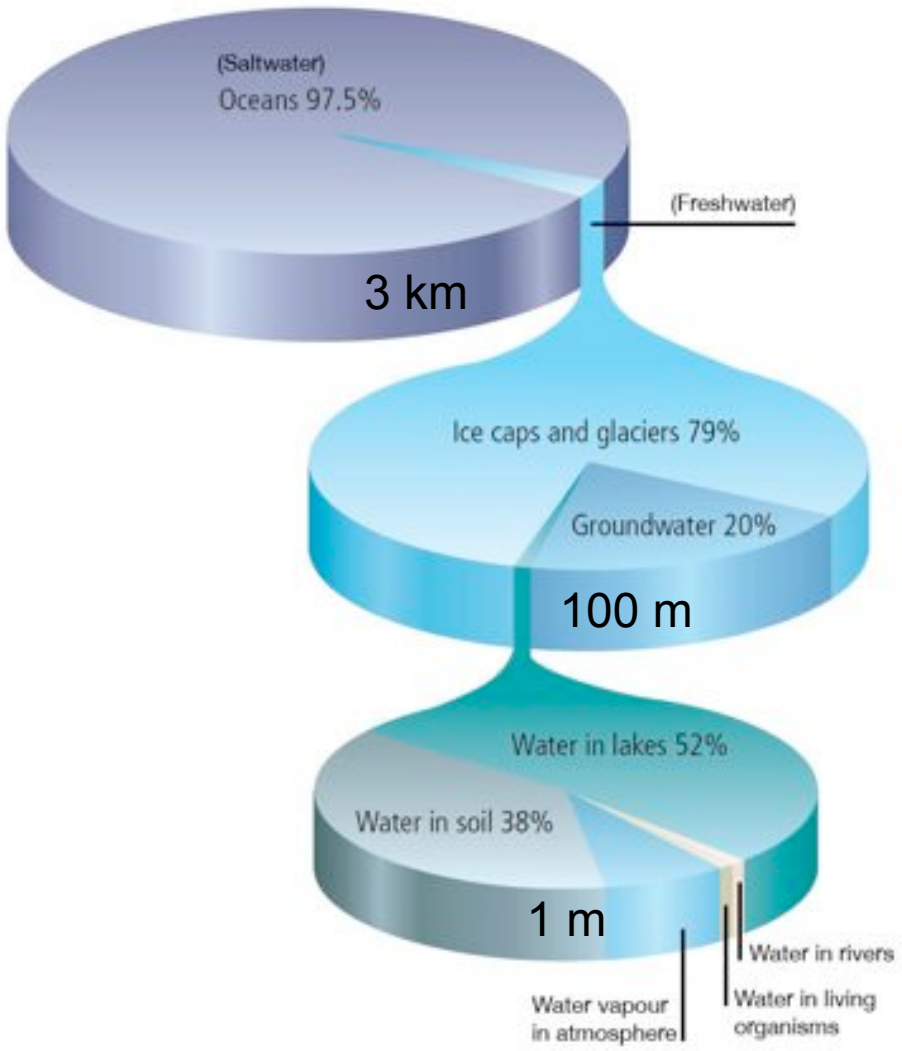




All water, floating freshwater, available

https://sites.google.com/a/mtholyoke.edu/water/home/global-water-resources

Water and Climate

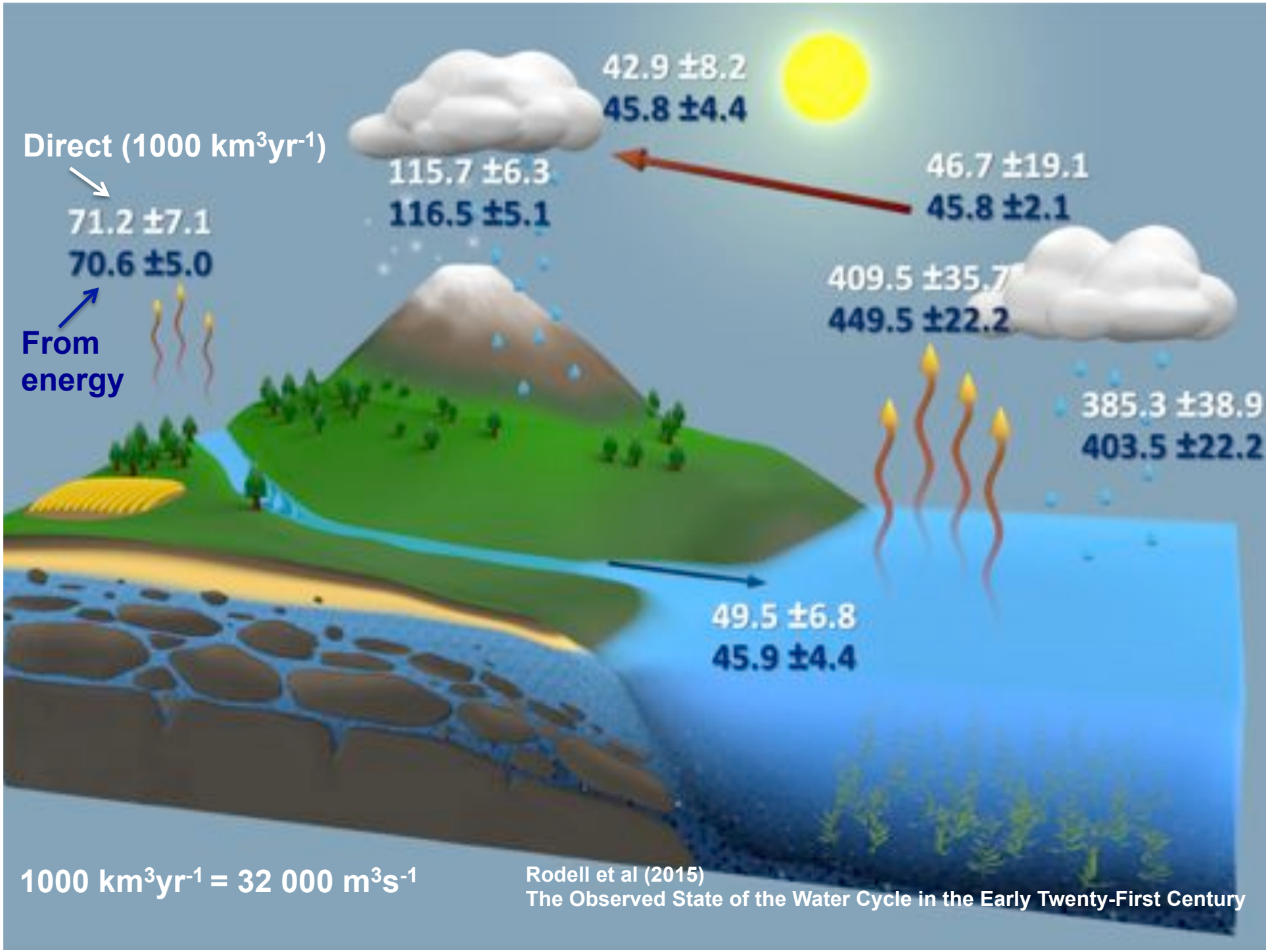


Liquid form
World oceans – absorbs / transports heat
Ground water – drinking water, agriculture
Soil moisture – food, regulates climate
Lakes – drinking water, agriculture
Rivers - water supply, hydropower, erosion
Precipitation – drinking water, soil moisture
Clouds – Reflection, regulates climate

Frozen form
Ice caps Antarctica and Greenland
Other glaciers, sea ice, snow cover
permafrost - Reflection, water storage, sea level, erosion

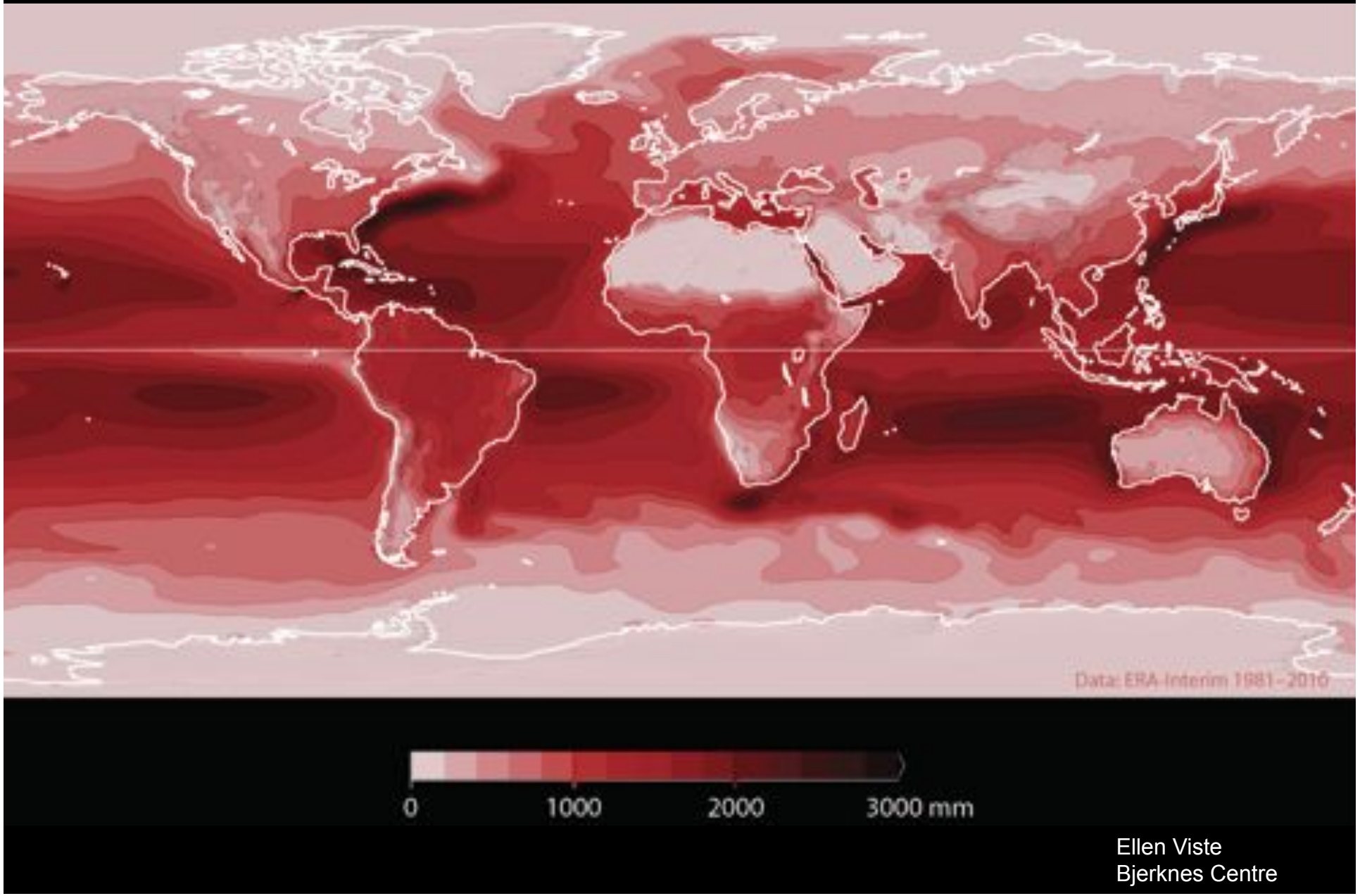
Gas form
Water vapour – Greenhouse effect, evaporation, precipitation, heat transport

https://sites.google.com/a/mtholyoke.edu/water/home/global-water-resources



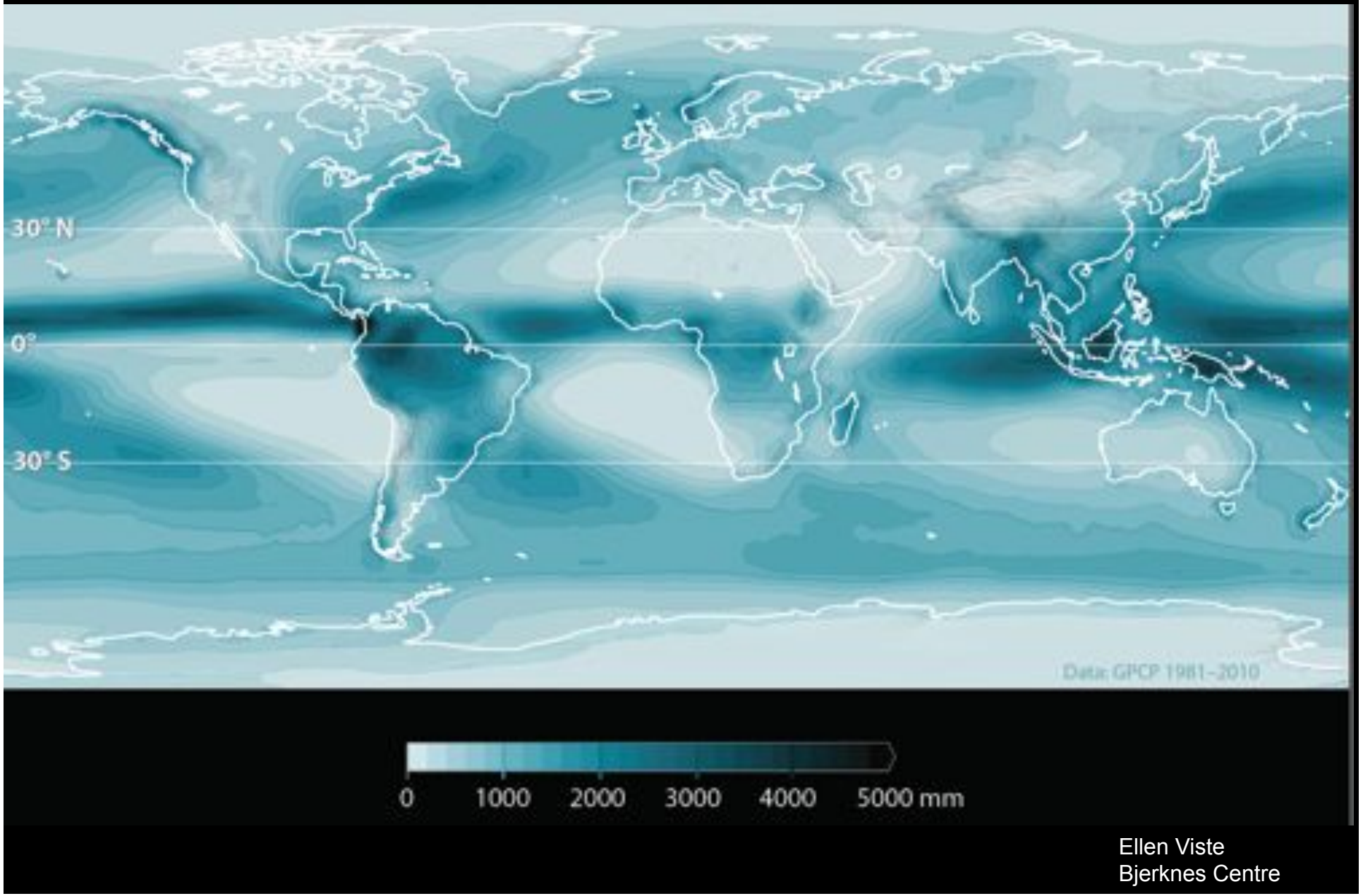
Rodell et al (2015)
The Observed State of the Water Cycle in the Early Twenty-First Century

Annual evaporation



Ellen Viste
Bjerknes Centre

Annual precipitation



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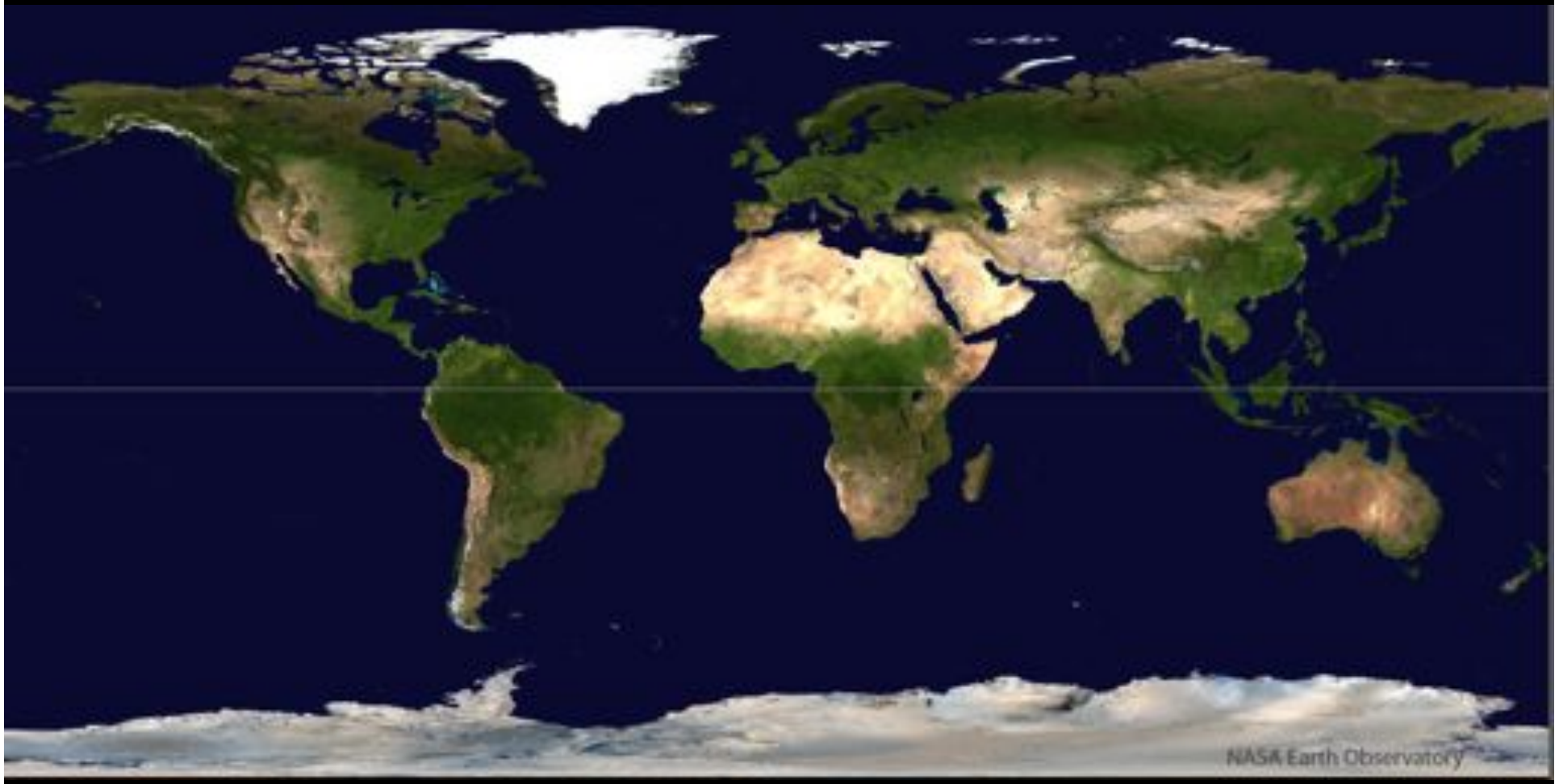
The green planet



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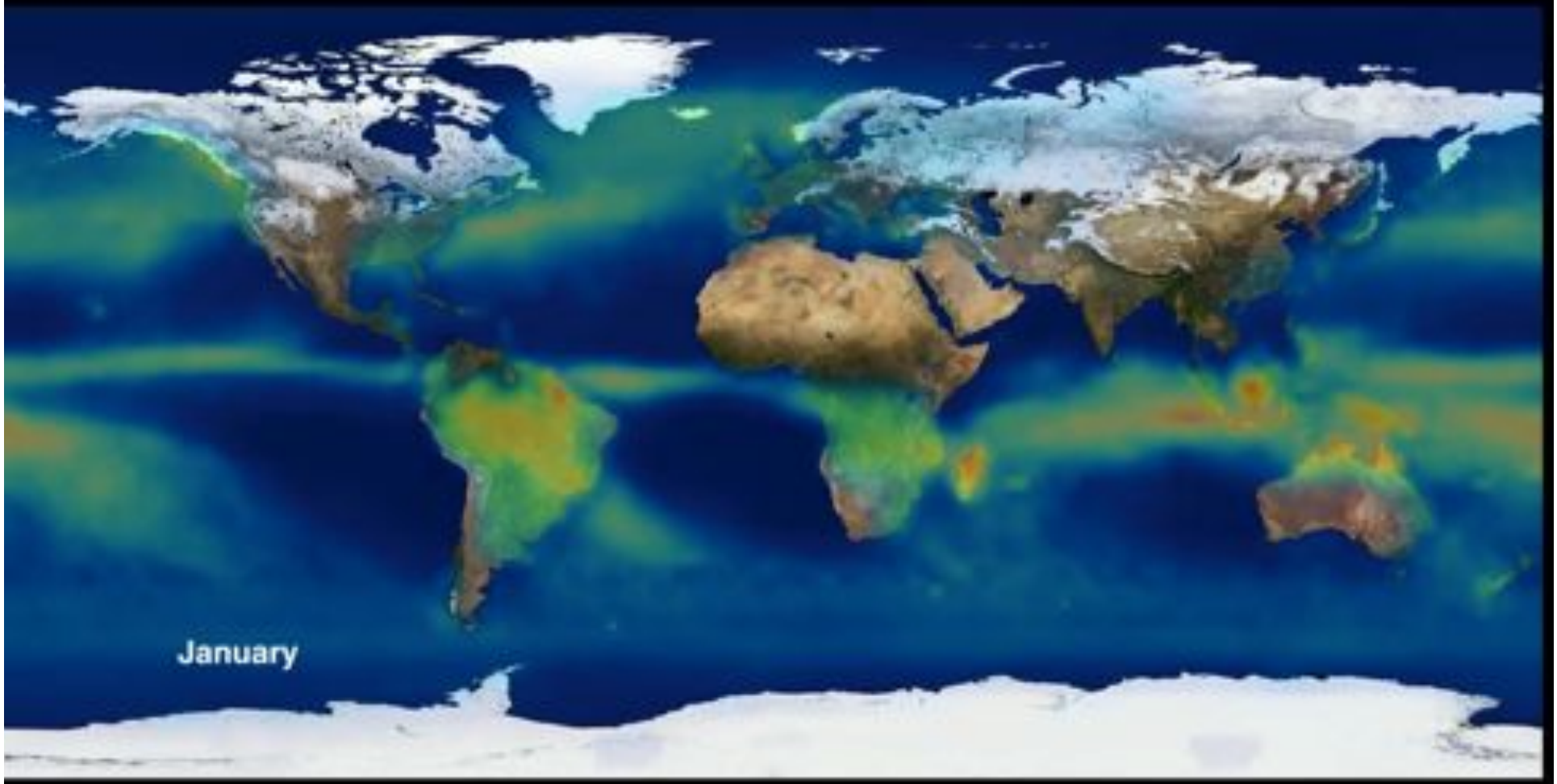
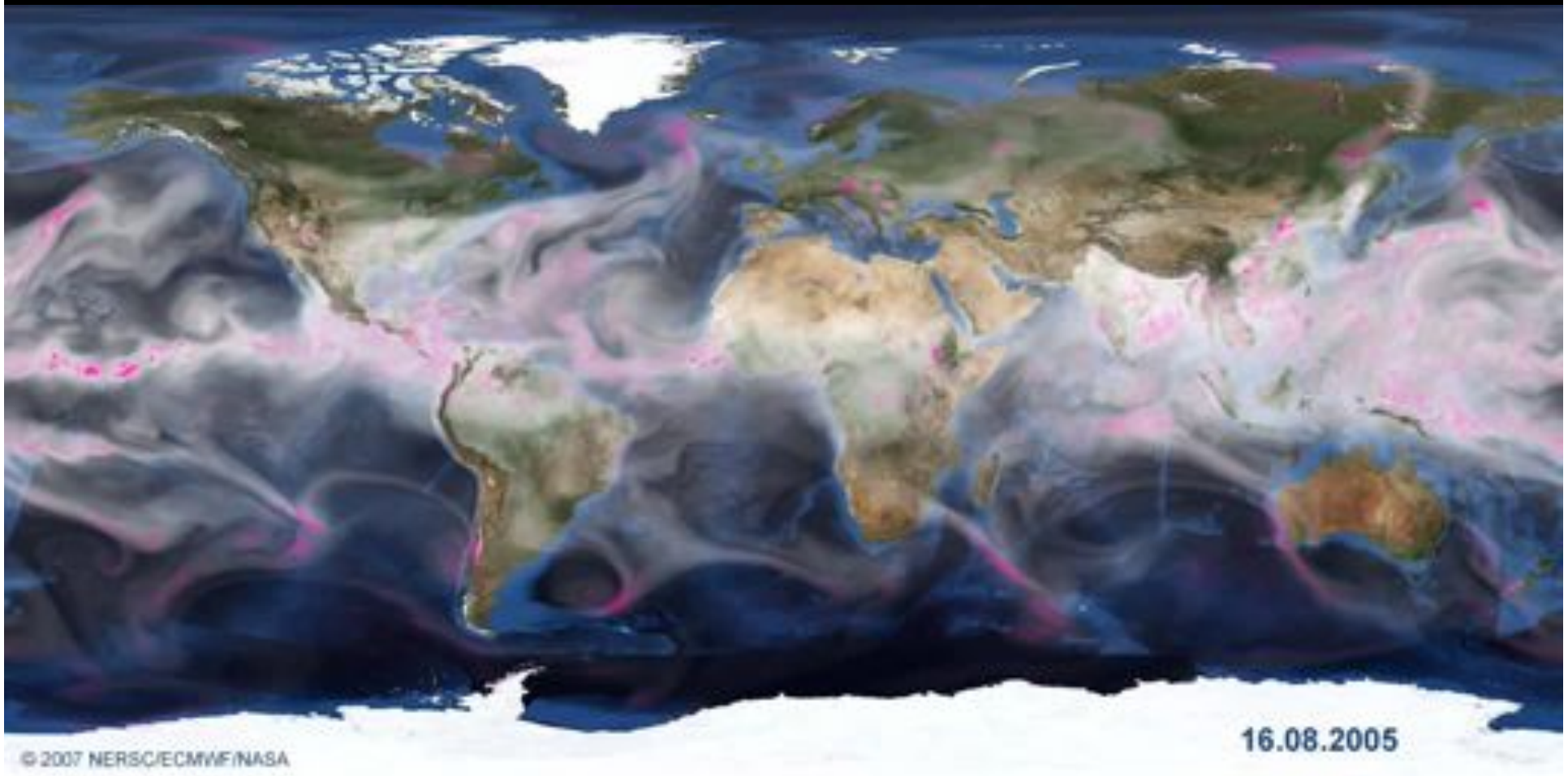
Seasonal migration of rainfall

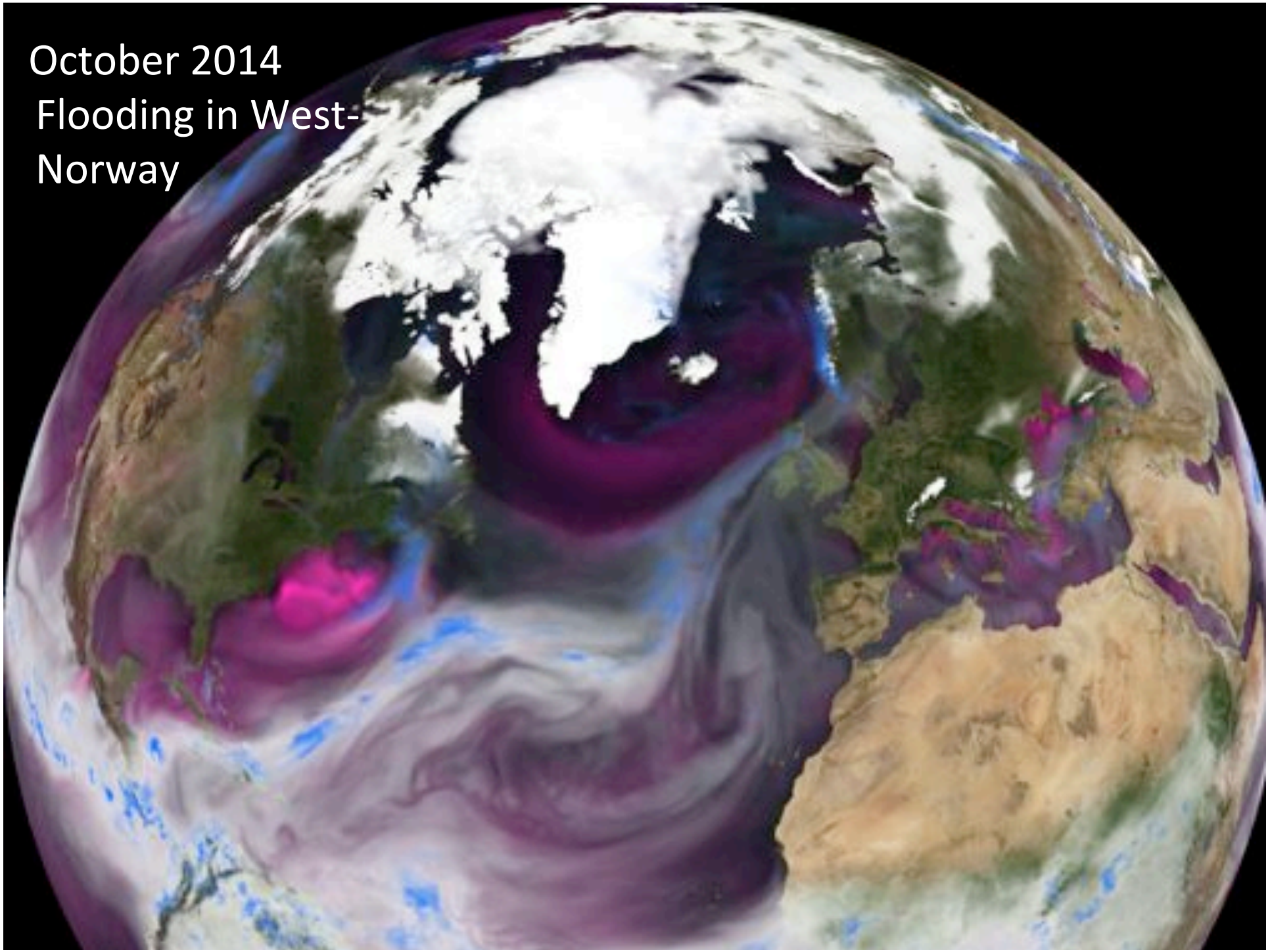


NASA

Transport of water in the atmosphere



Mats Bentsen
Bjerknes Centre


October 2014
Flooding in West-
Norway

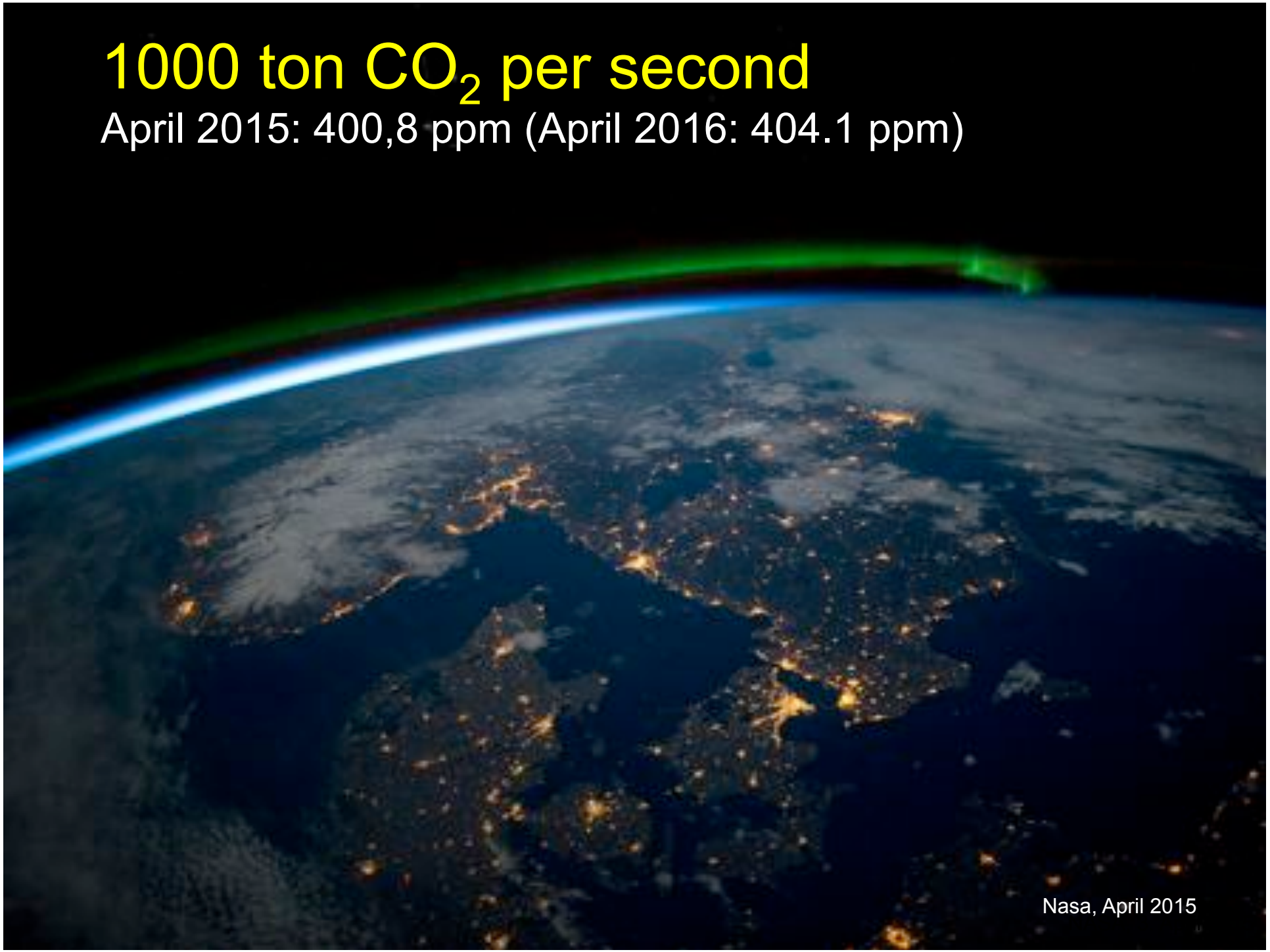
Odda, 29 October 2014

Rune Sævig/Heidi Grotle, BT

Climate change

1000 ton CO_2 per second

April 2015: 400,8 ppm (April 2016: 404.1 ppm)



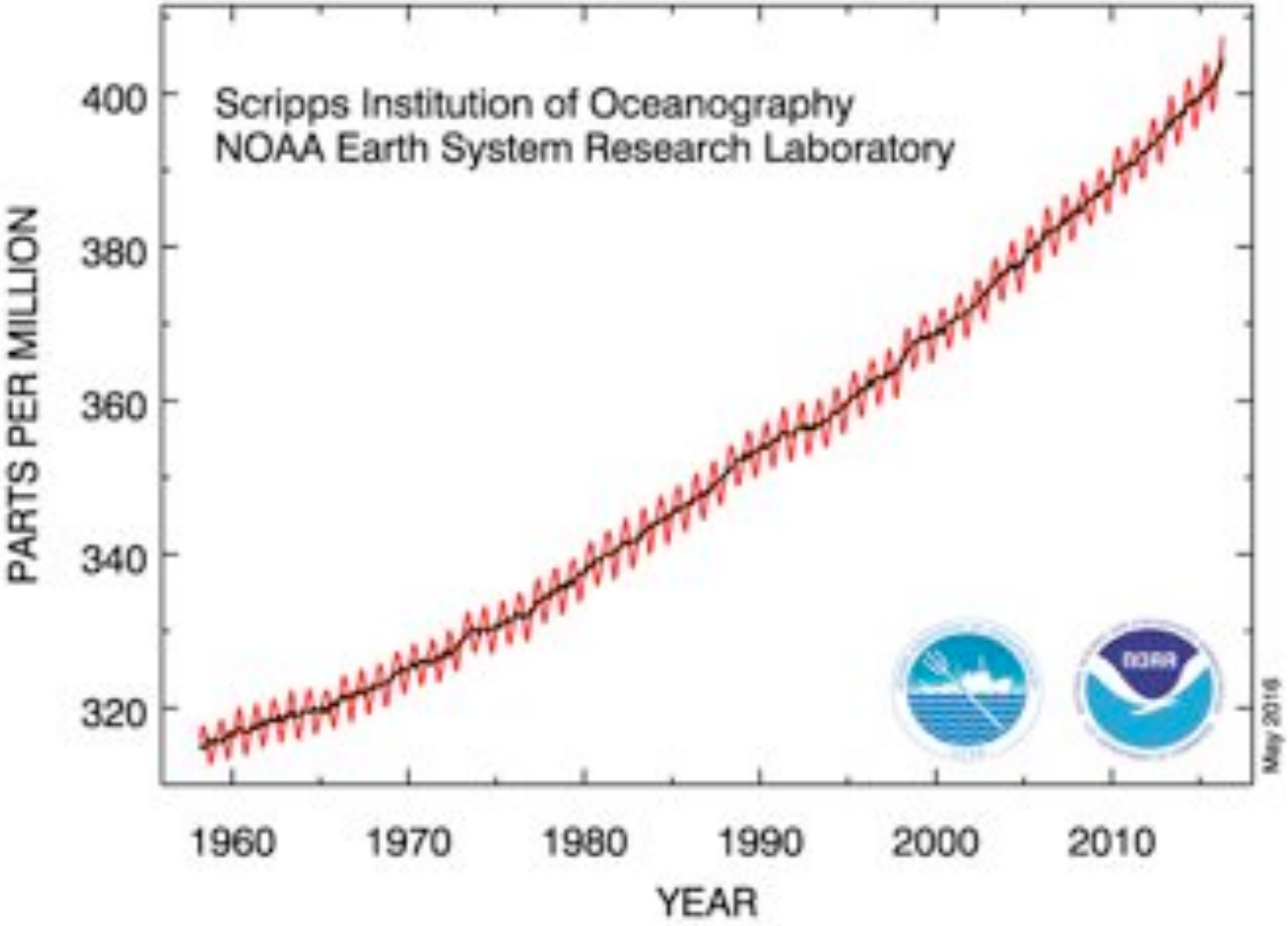
Drivers:

population, economy, energy, carbon intensity

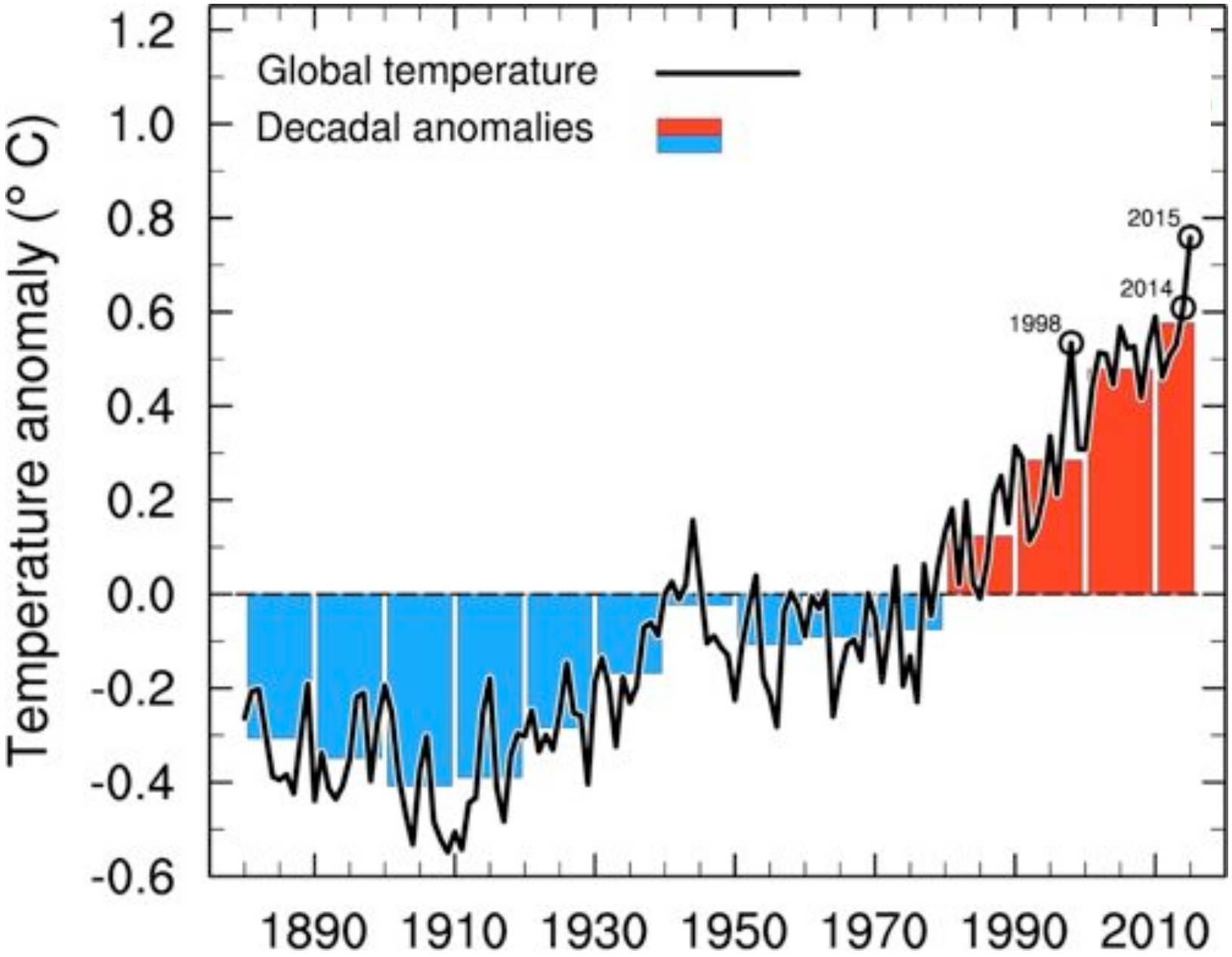
(Total CO_2=population x bnp/capita x energy/bnp x CO_2/energy)

Shanghai 19. April 2015. Photo: Johannes Eisele, AFP

Atmospheric CO2 at Mauna Loa, Hawaii

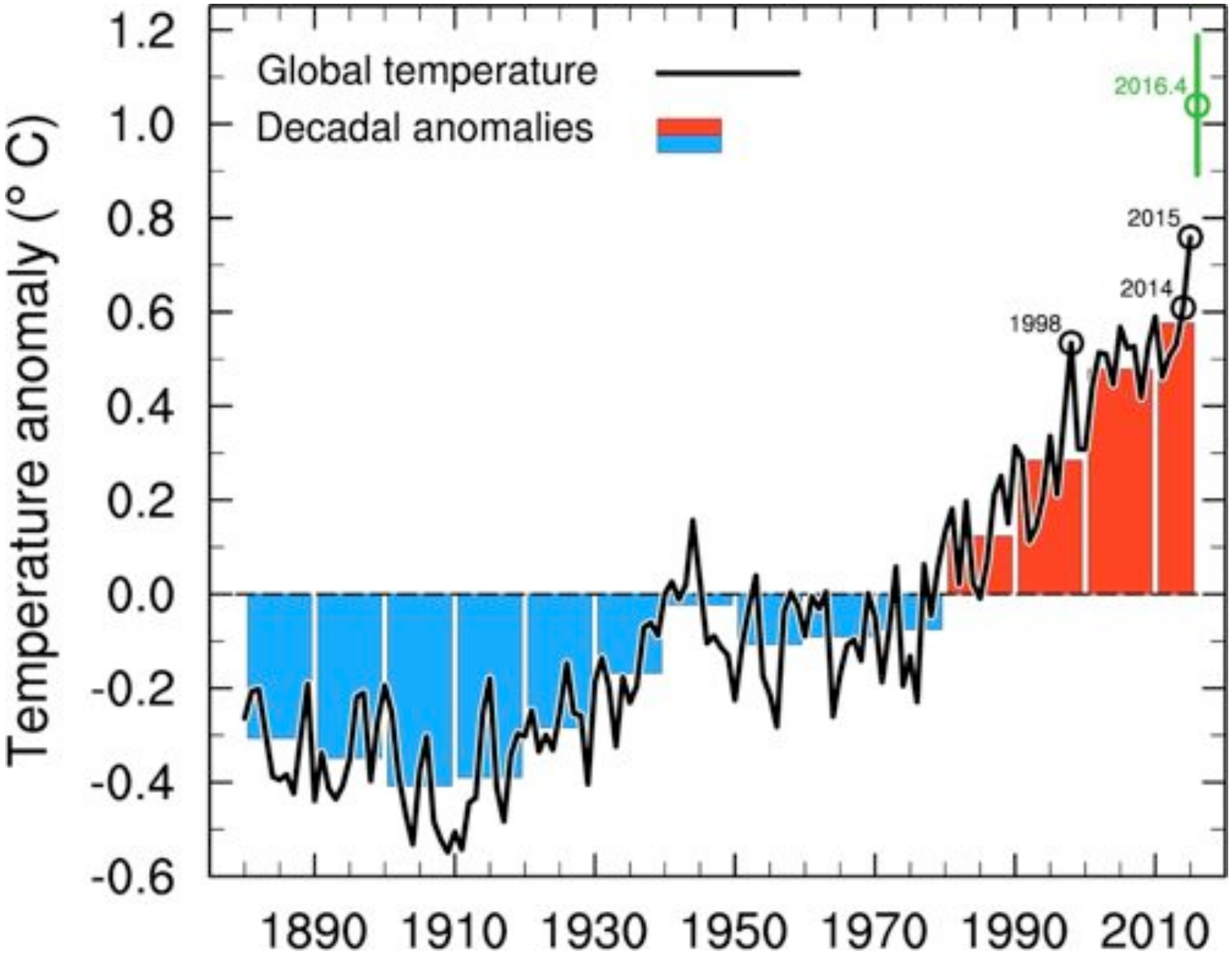


Global temperature



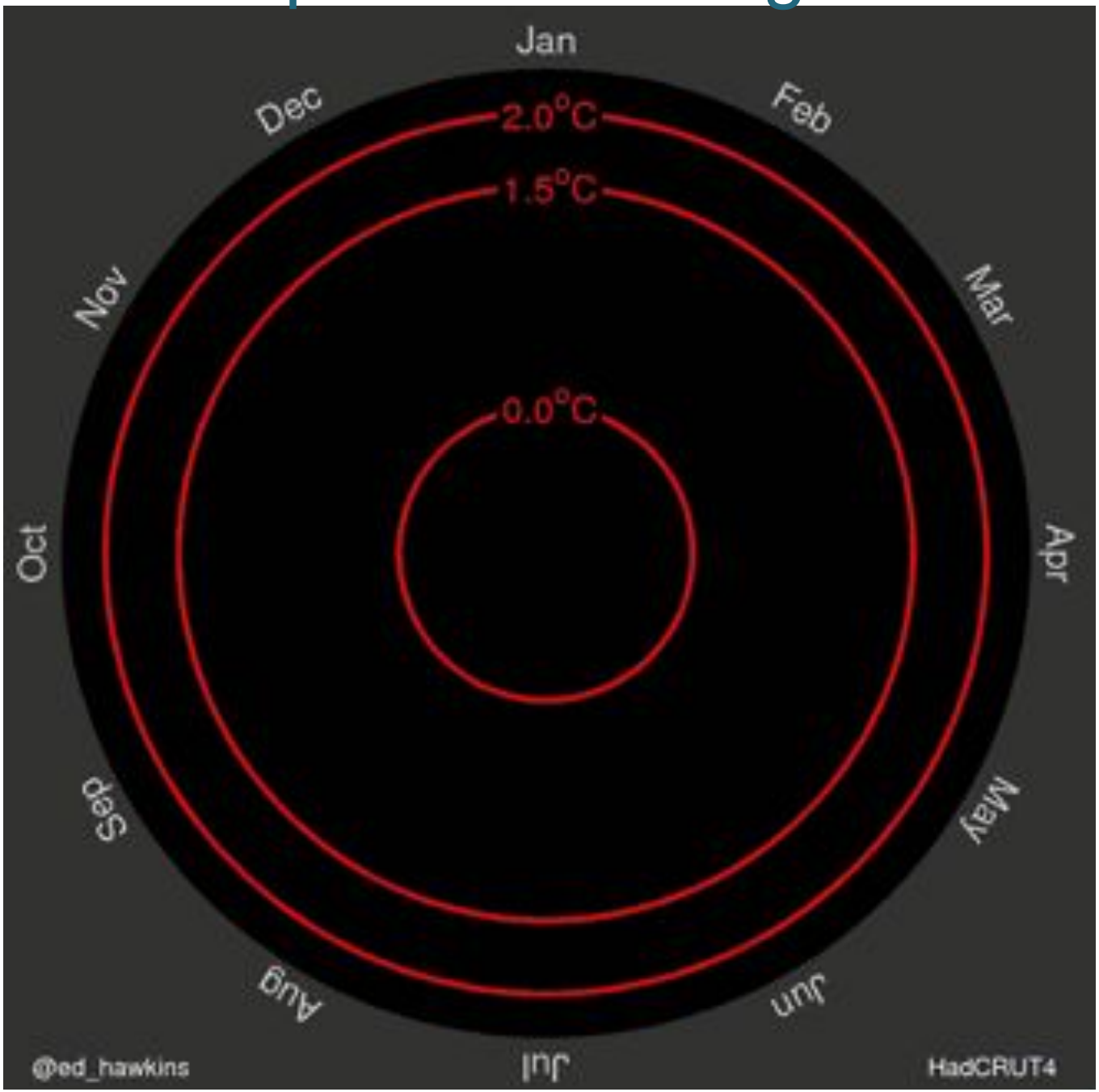
Helge Drange,
Bjerknes Centre

Global temperature



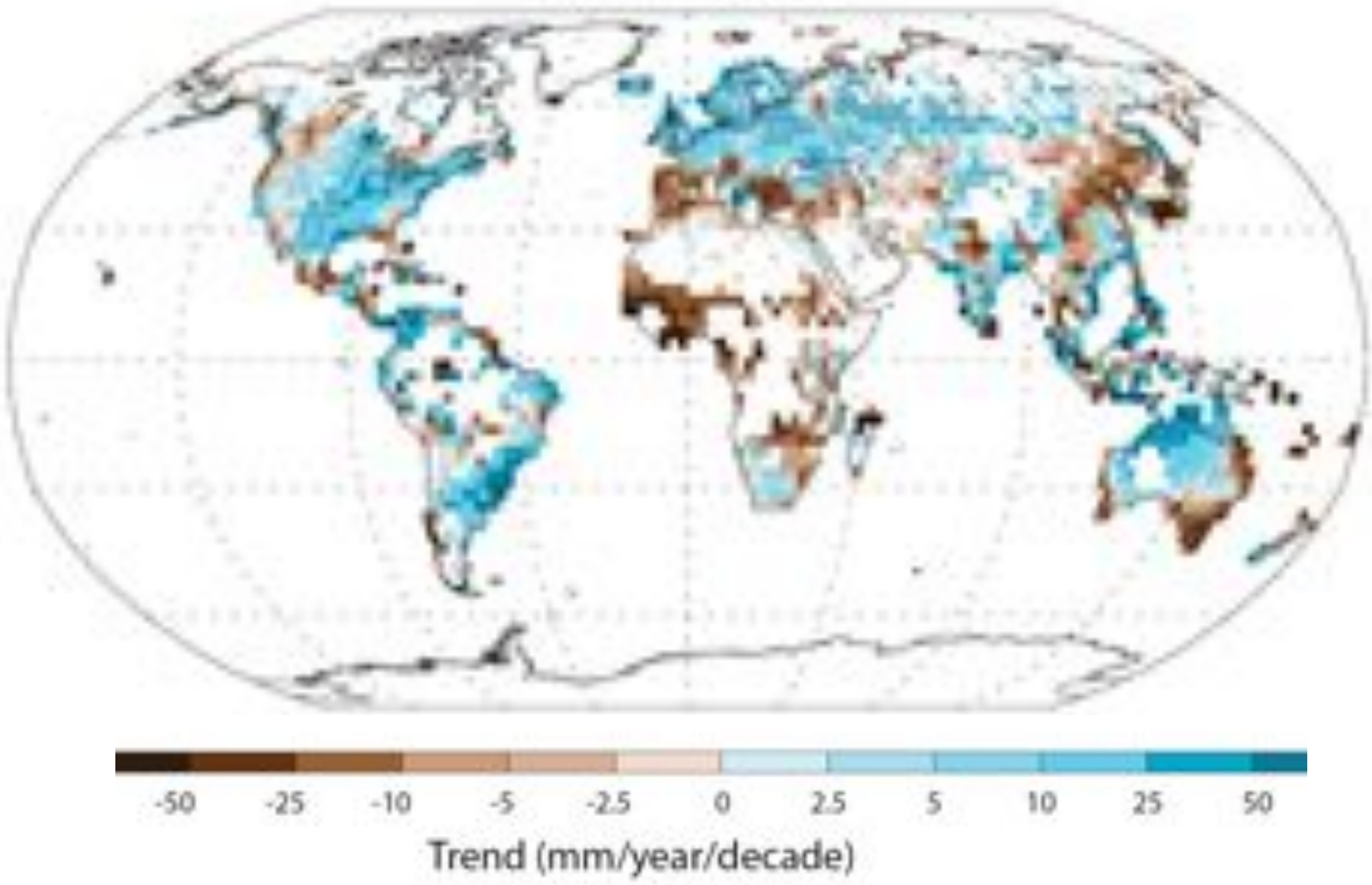
Helge Drange,
Bjerknes Centre

Global temperature change 1850-2016



Ed Hawkins, U Reading

Global precipitation trend 1951-2010

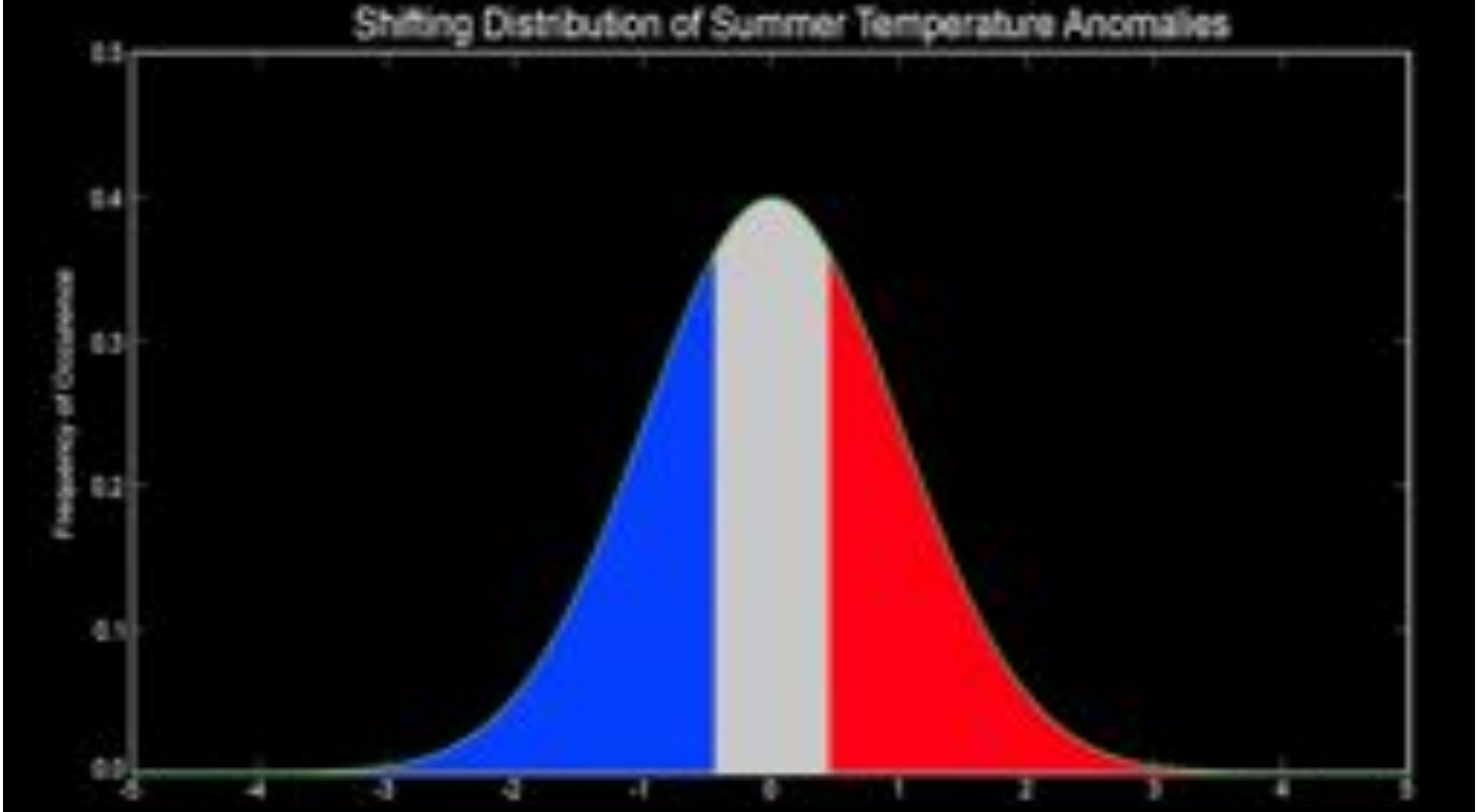


More precipitation high latitude and tropics. Less in subtropics.

IPCC AR5 SPM

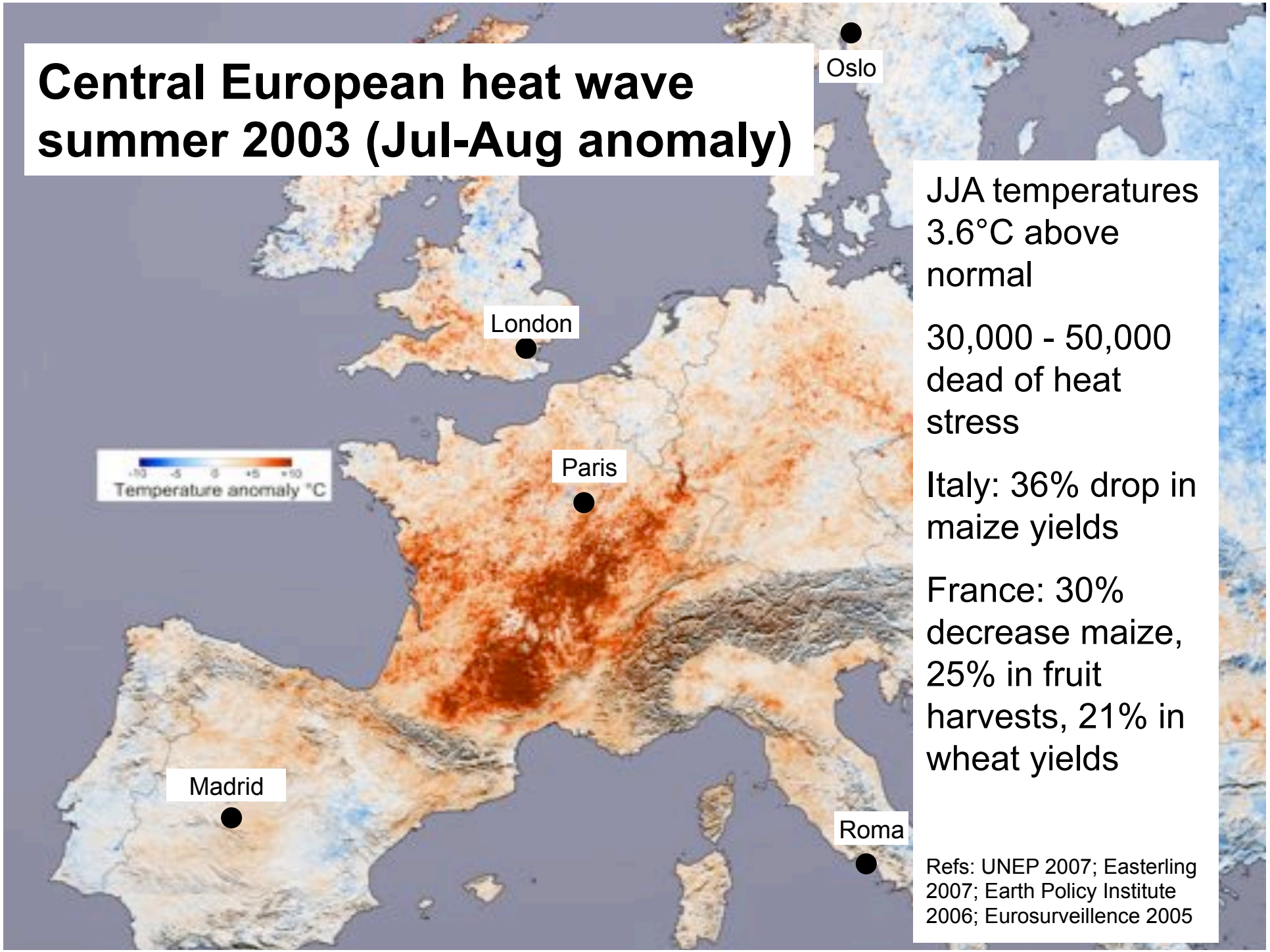
Climate extremes

Global distribution of temperatures



Hansen et al, 2012

Central European heat wave summer 2003 (Jul-Aug anomaly)



JJA temperatures 3.6°C above normal

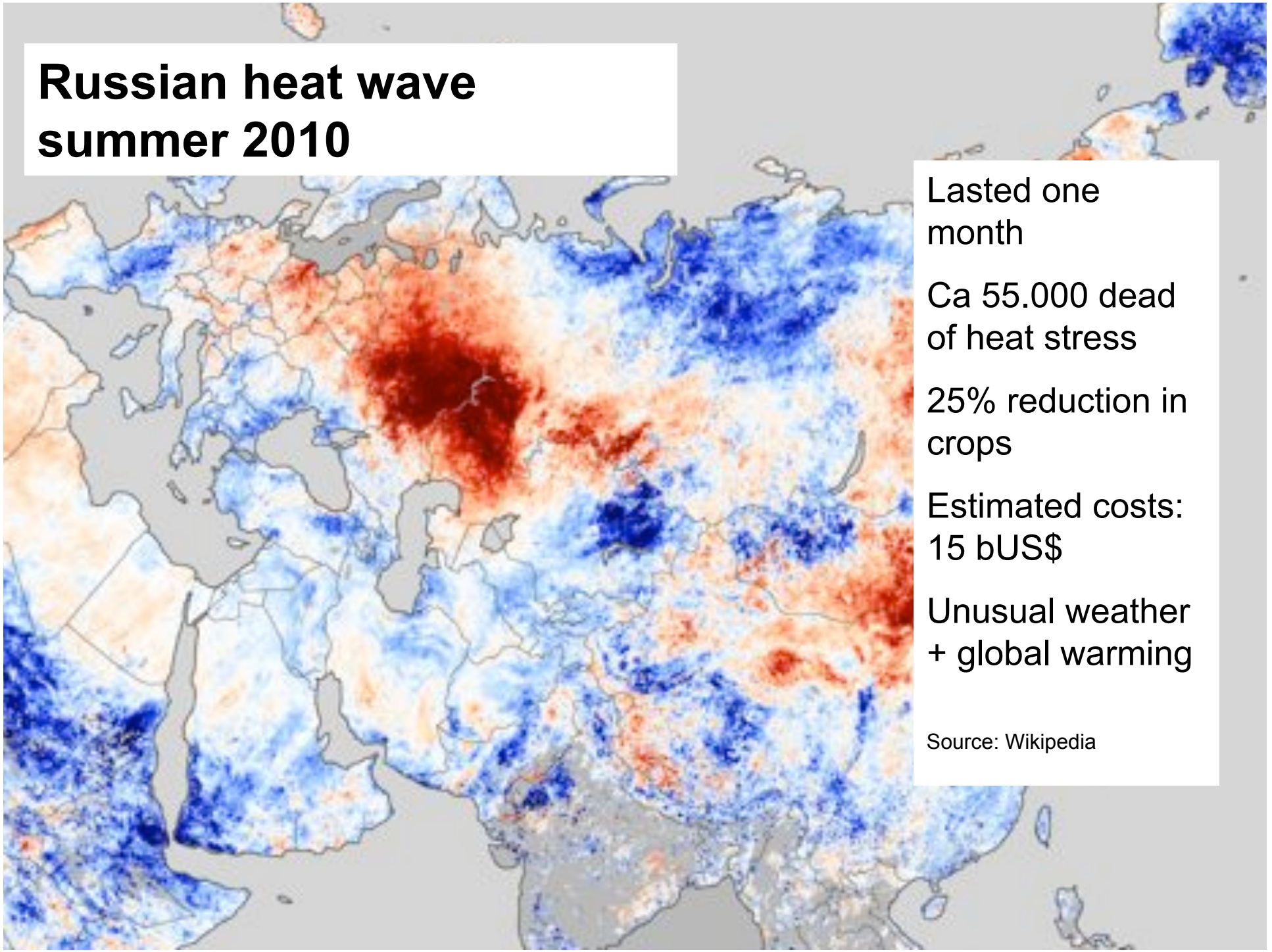
30,000 - 50,000 dead of heat stress

Italy: 36% drop in maize yields

France: 30% decrease maize, 25% in fruit harvests, 21% in wheat yields

Refs: UNEP 2007; Easterling 2007; Earth Policy Institute 2006; Eurosurveillence 2005

Russian heat wave summer 2010



Lasted one month

Ca 55.000 dead of heat stress

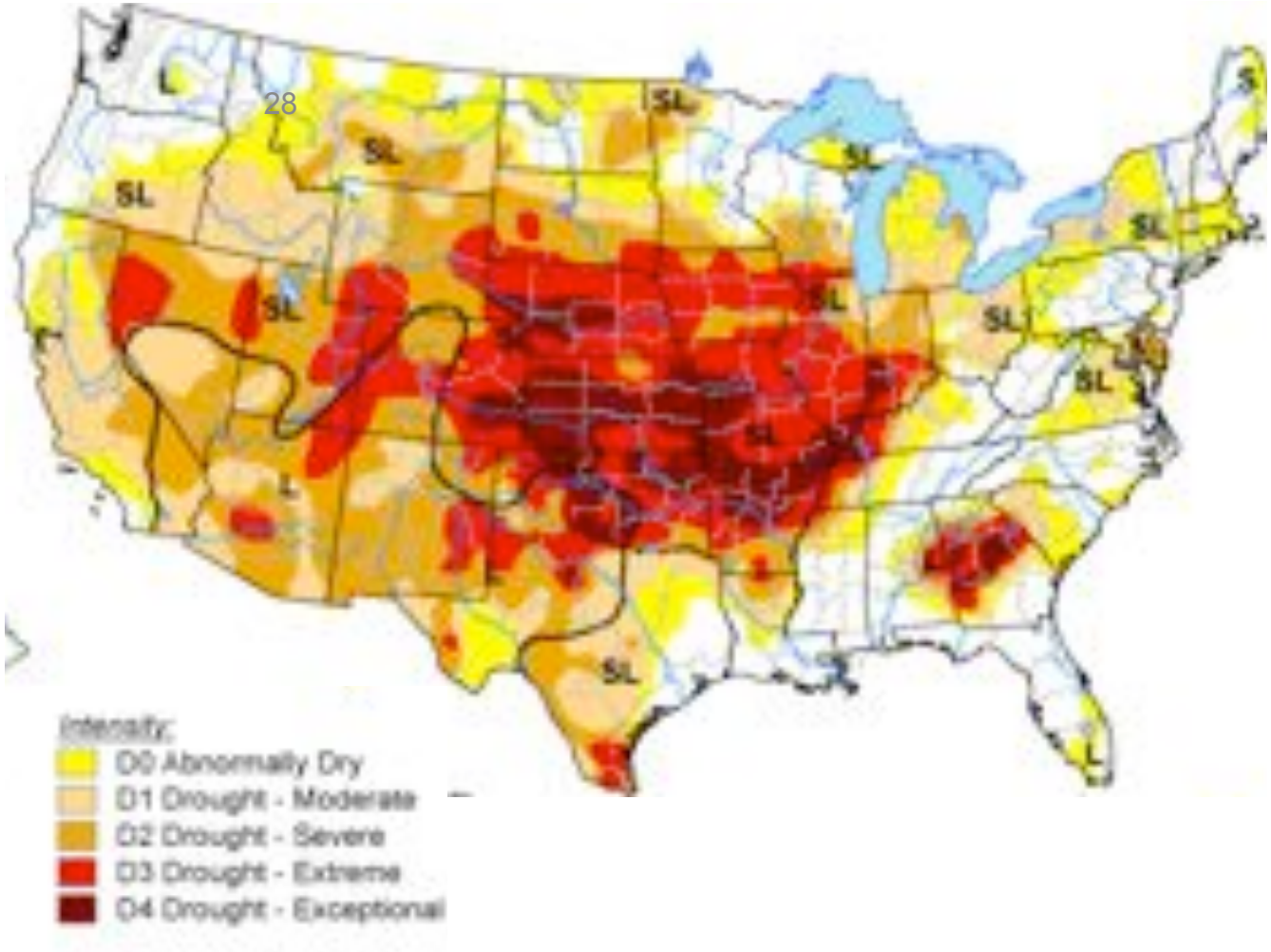
25% reduction in crops

Estimated costs: 15 bUS$

Unusual weather + global warming

Source: Wikipedia

US heat wave and drought summer 2012



http://droughtmonitor.unl.edu/

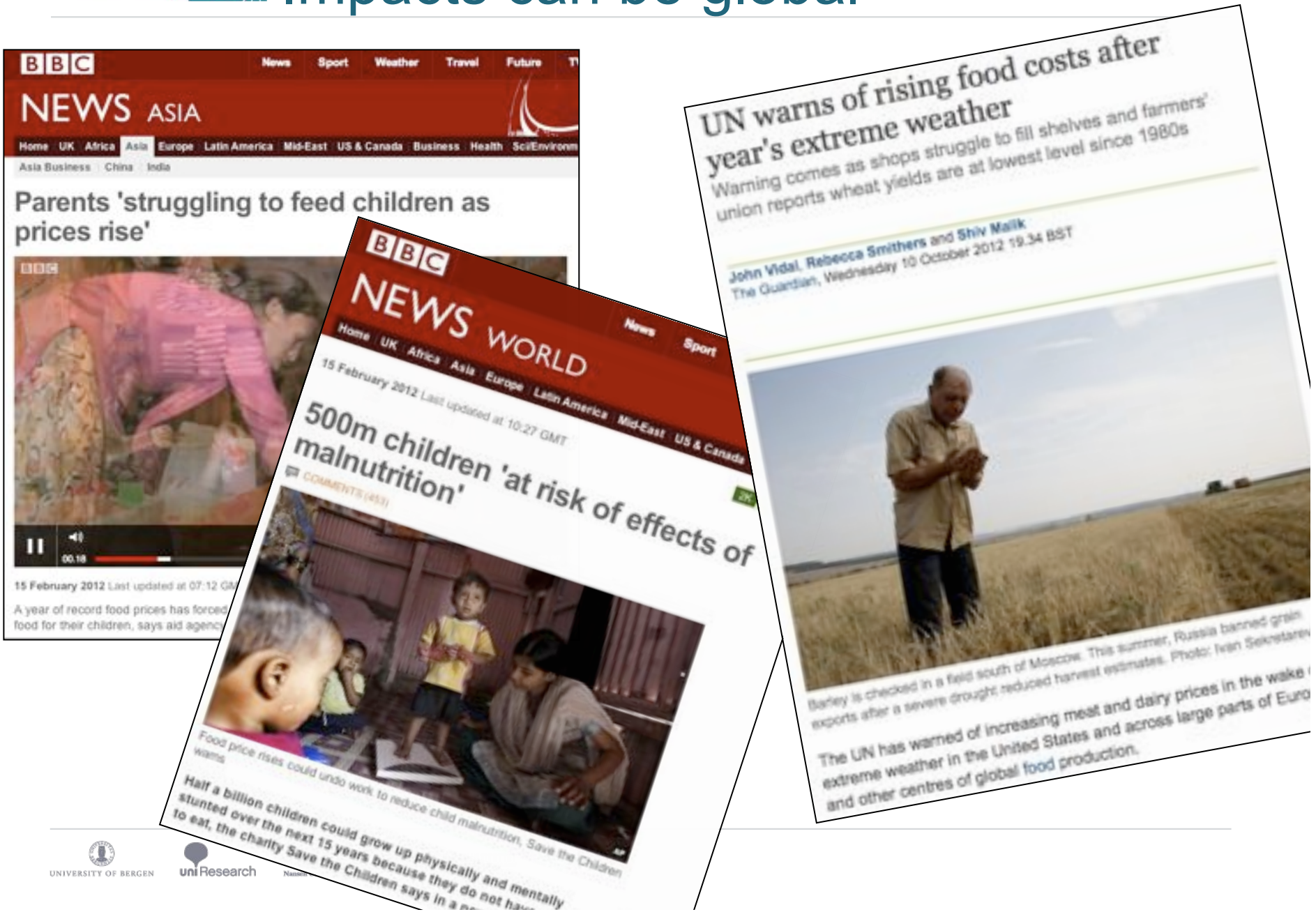
August 2012: Half of US counties designated disaster zone

End of September: 64% of US has drought

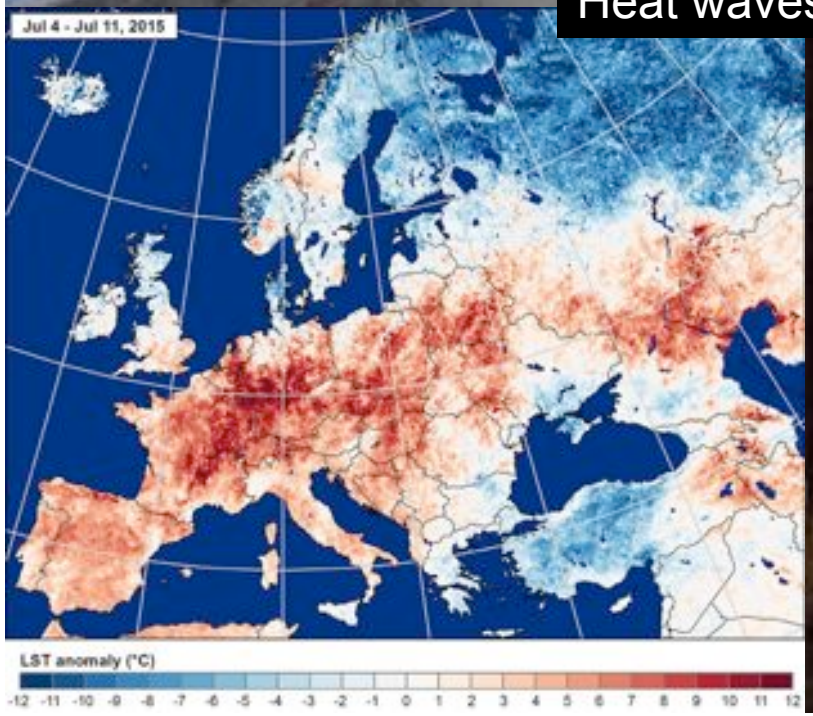
51% of the maize and 38% of soybeans rated poor or very poor by US Dep. of Agriculture

By far the most expensive natural disaster in US history (75-150 bill USD)

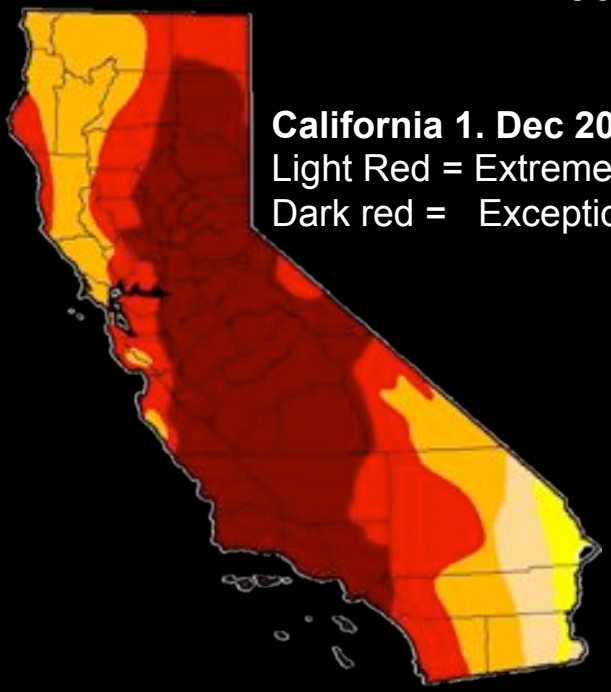
Impacts can be global



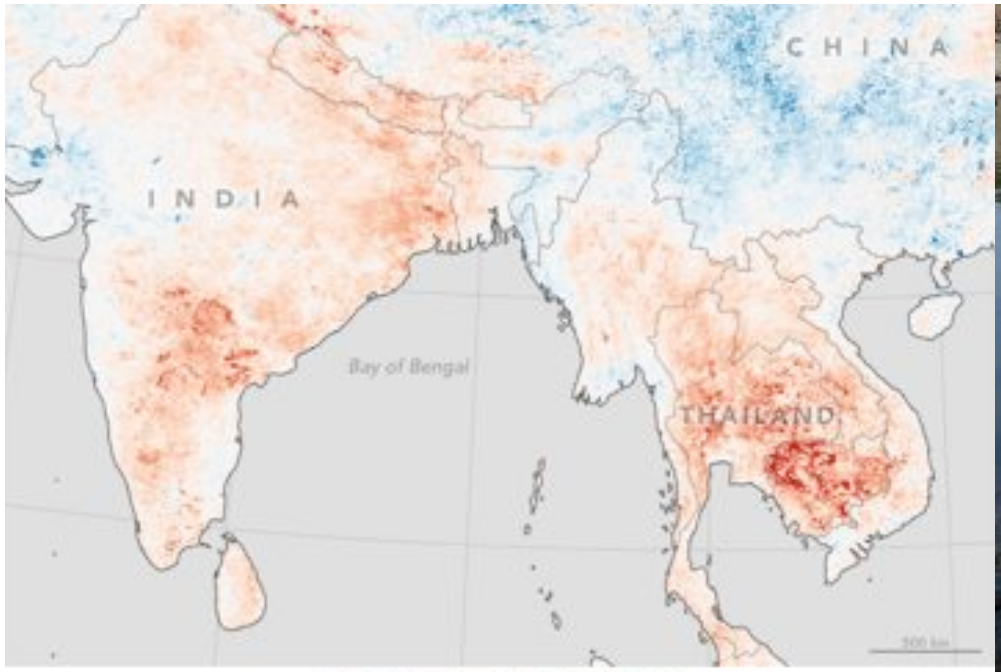
Heat waves. May 2015 India. July 2015 Europe.



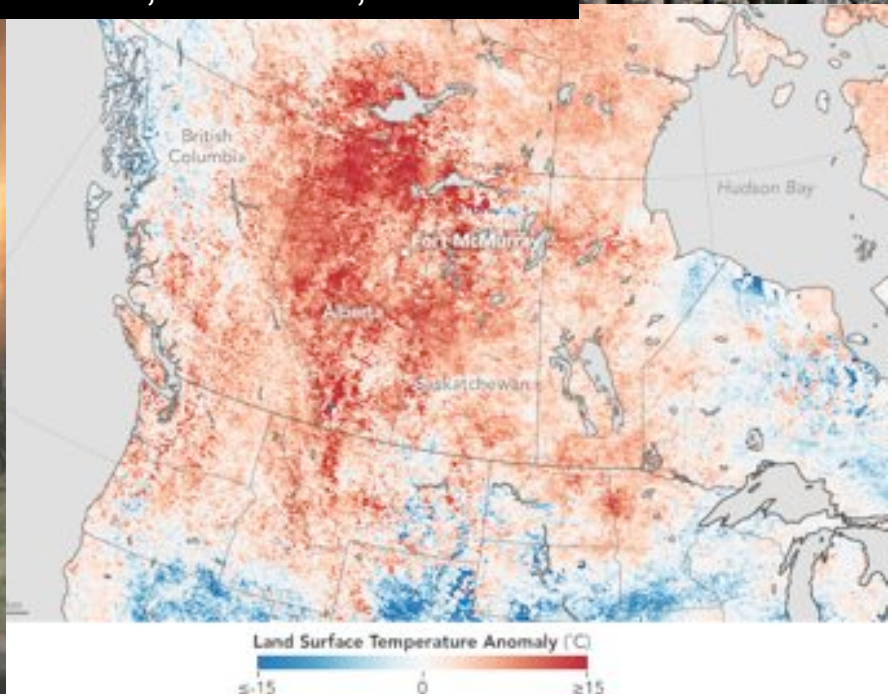
Droughts. Dec 2015 Somalia, Ethiopia and California



California 1. Dec 2015
Light Red = Extreme drought
Dark red = Exceptional drought



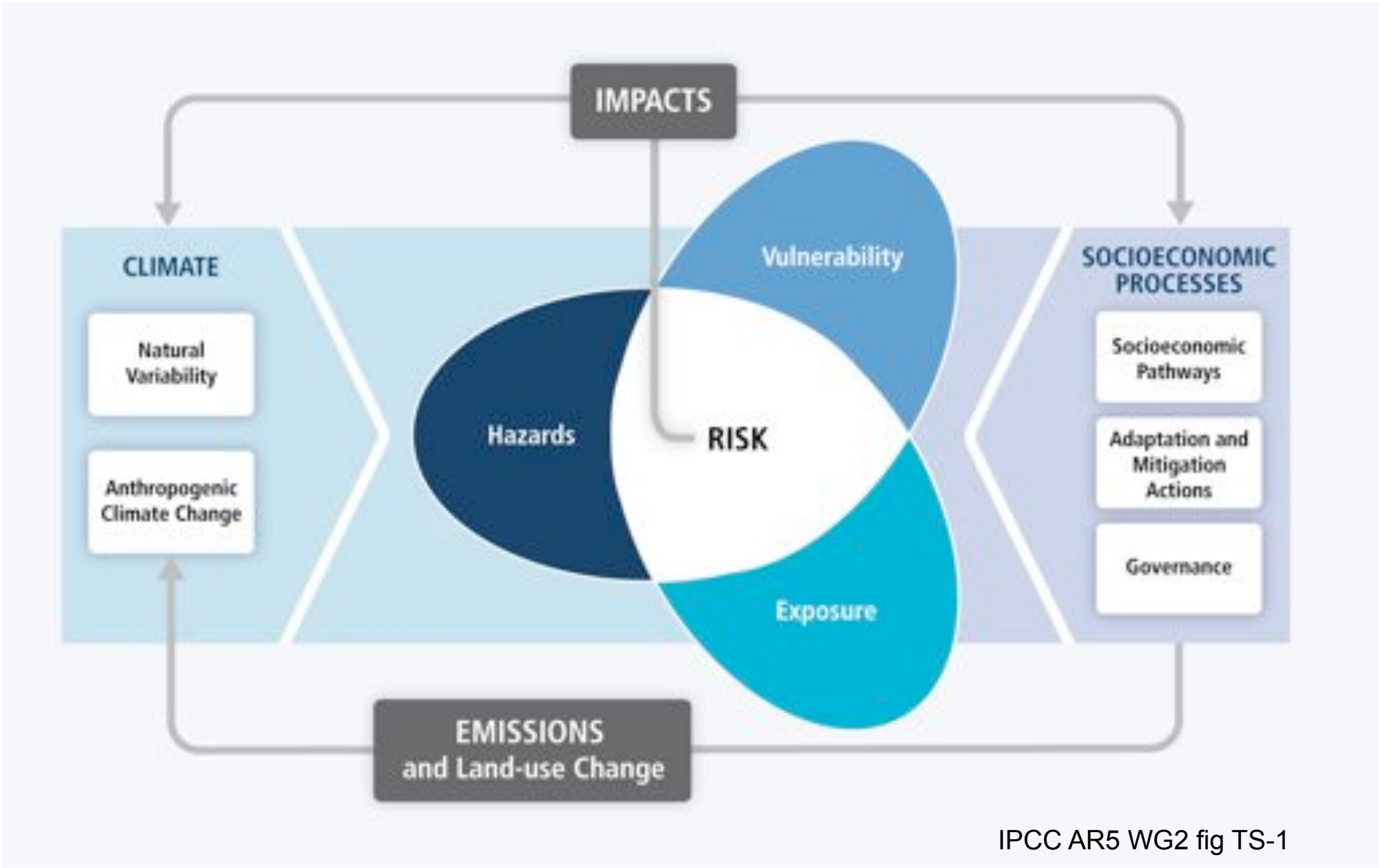
Heat waves. May 2016 India, Thailand, Canada




Fort McMurray, Canada
2400 houses destroyed

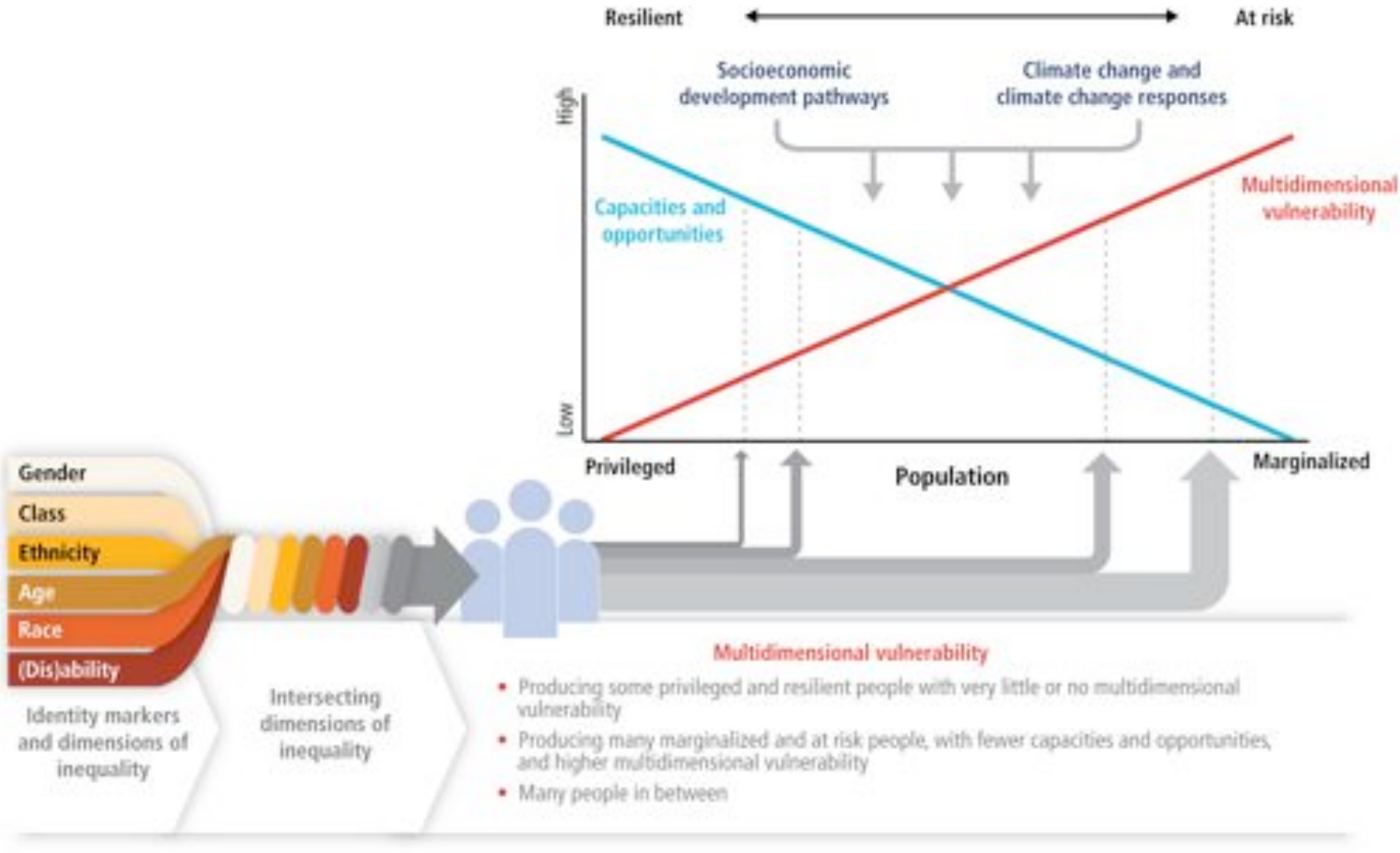
Risks and impacts

Risk a function of three factors



IPCC AR5 WG2 fig TS-1

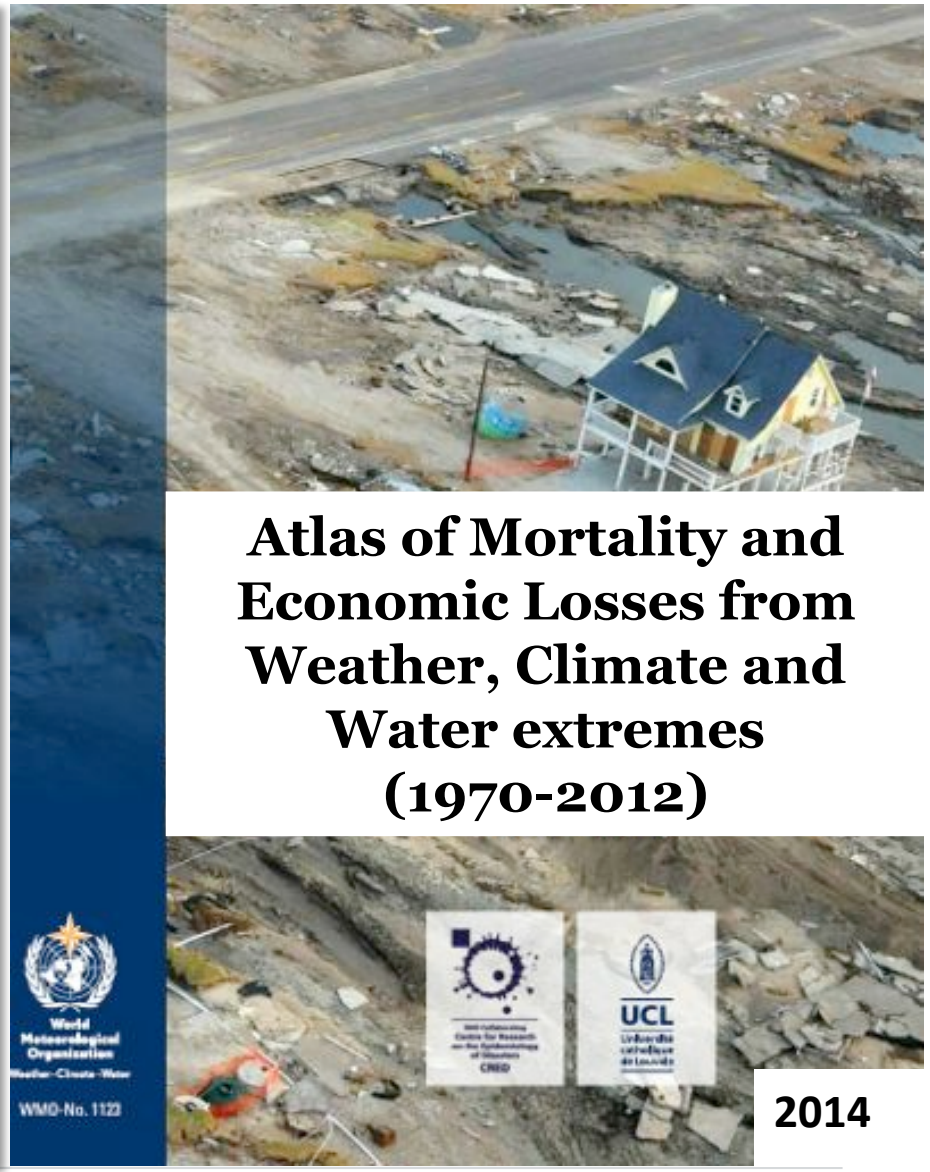
Many factors lead to vulnerability



IPCC AR5 WG2 fig 13.5

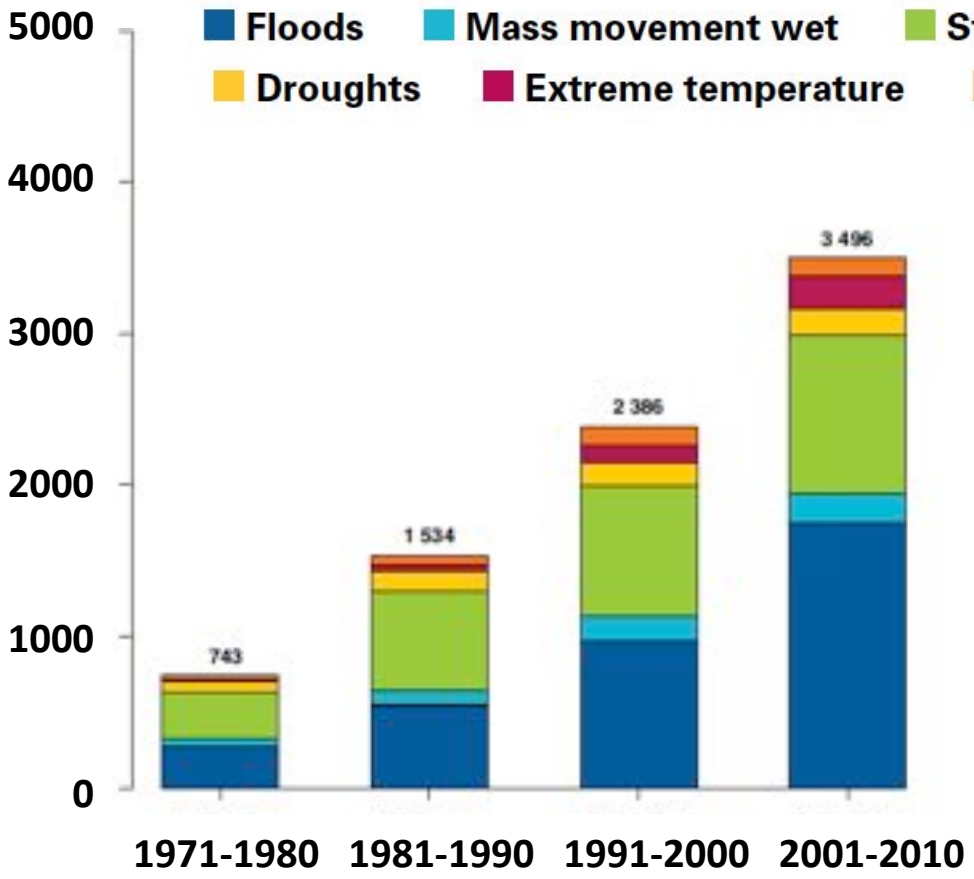
Impacts of climate extremes

2013



2014

More weather- and climate events?



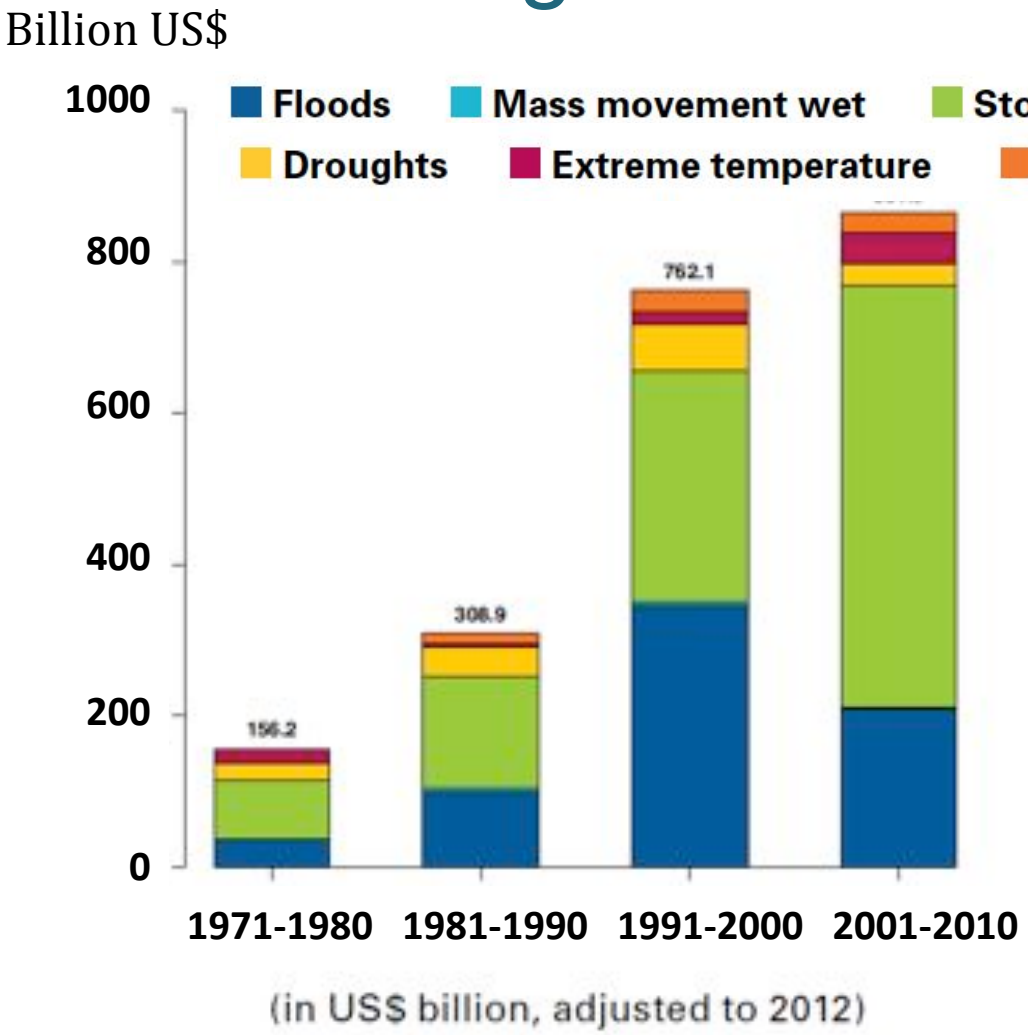
Four times more reported events in four decades

Floods and storms most frequent

Floods increased most

WMO Atlas of Mortality and Economic Losses from Weather, Climate and Water extremes

Higher economic costs?



Total loss 2001-2010:
864 billion USD

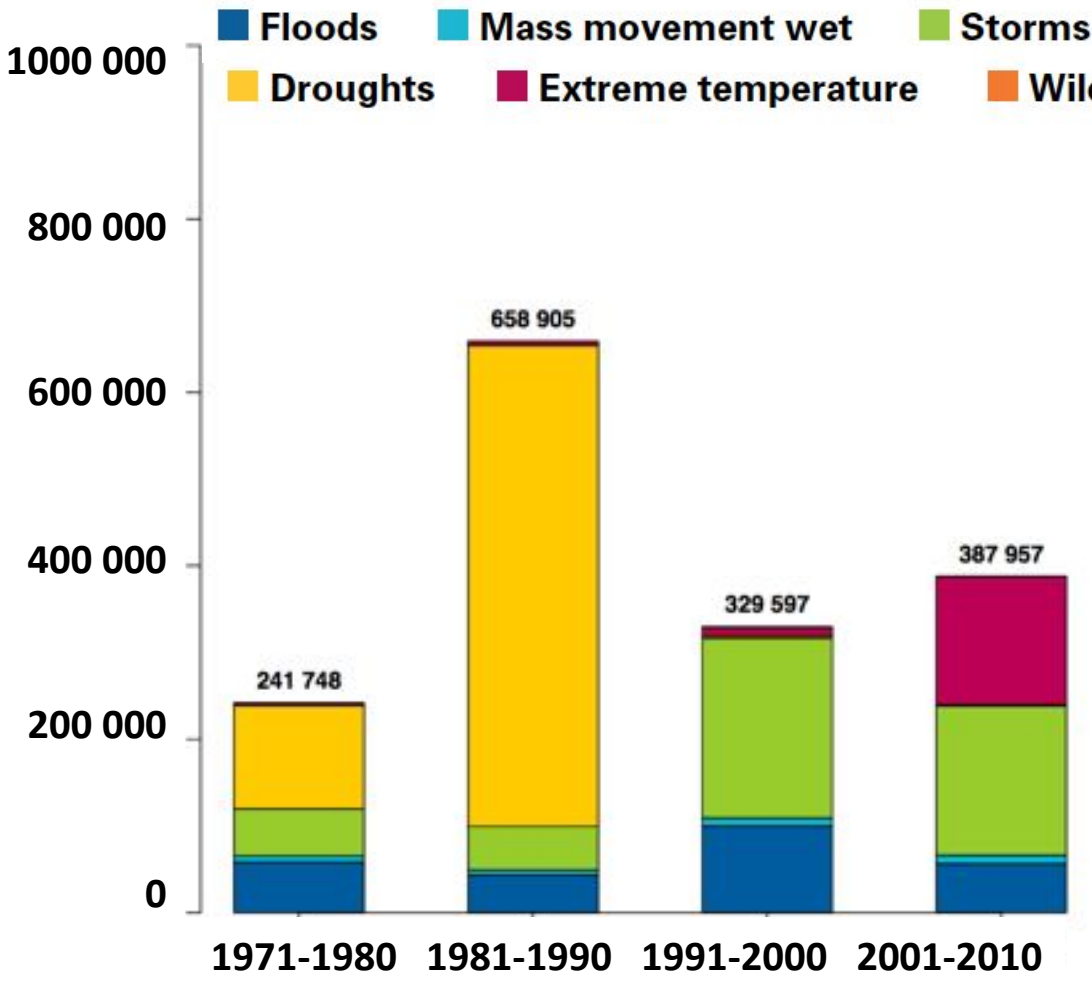
Five times increase

Floods and storms highest loss

Storms increased most

WMO Atlas of Mortality and Economic Losses from Weather, Climate and Water extremes

Higher death tolls?



Total deaths 2001-2010:
388 000 people.

No overall trends

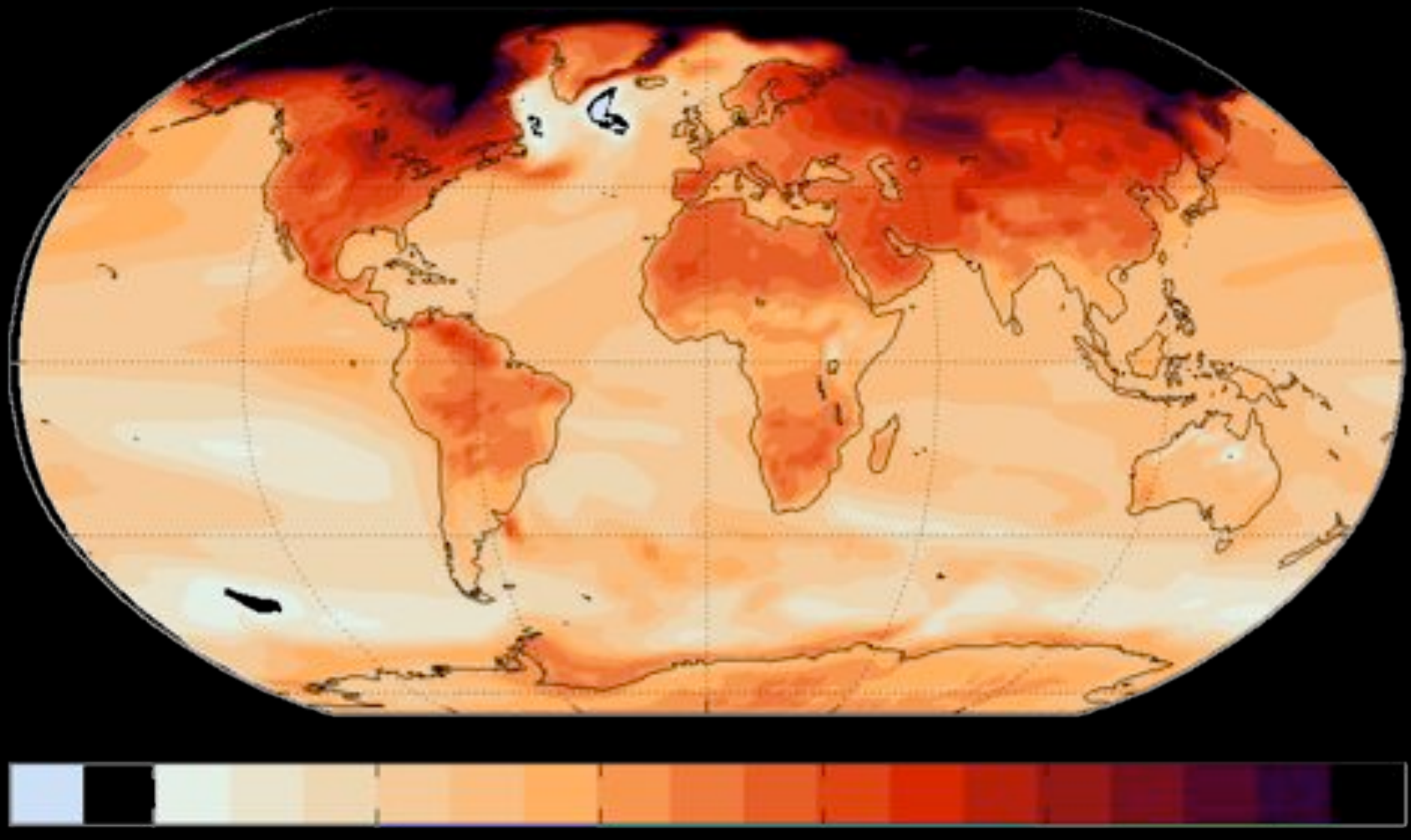
Economic development
More resilient societies

A new type of risks – extreme temperatures. 2001-2010:
138 000 deaths in Europe

WMO Atlas of Mortality and Economic Losses from Weather, Climate and Water extremes

Future climate

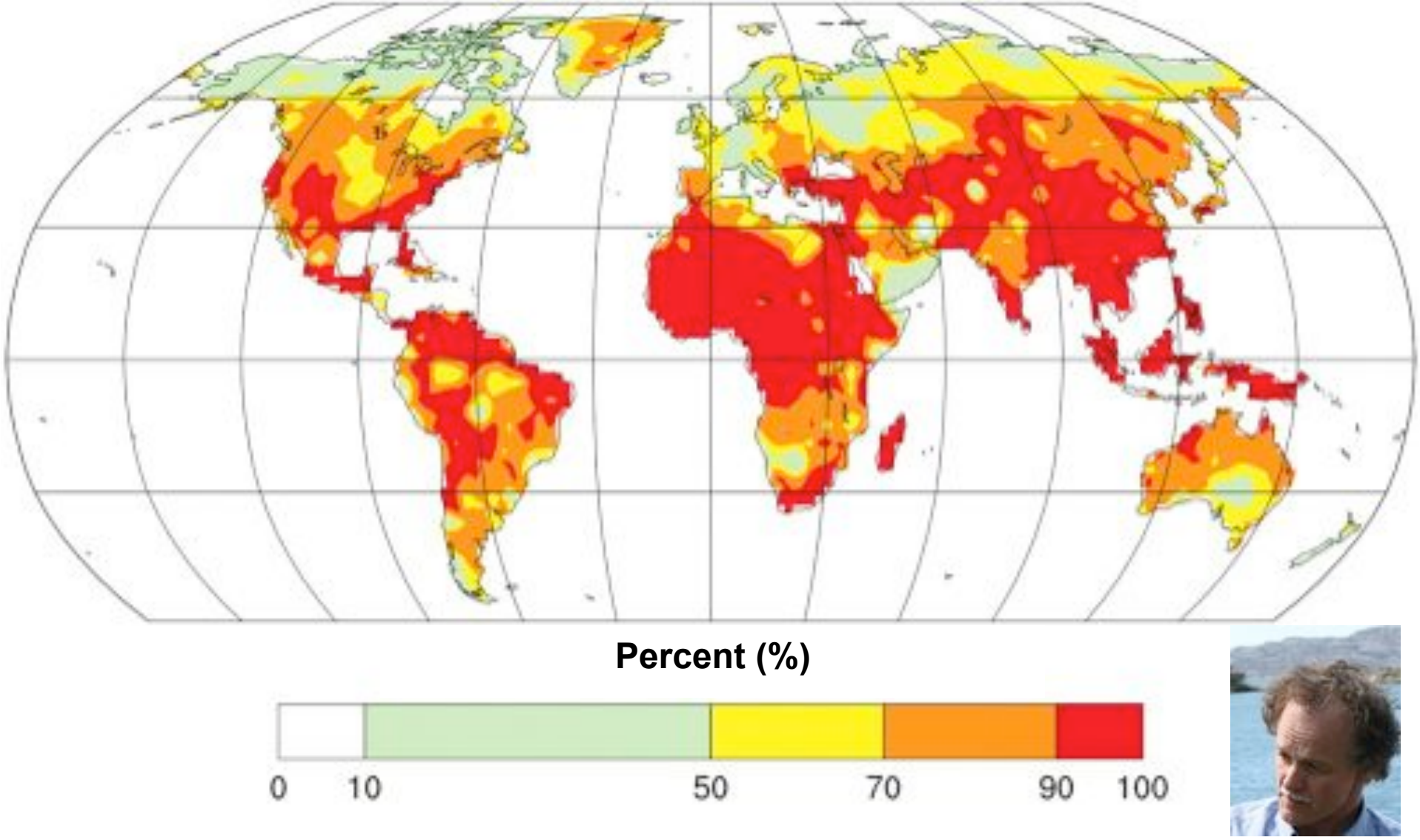
Temperature changes towards the end of this century ("business as usual" scenario)



(°C, 2090-99 vs 1961-90, RCP8.5)

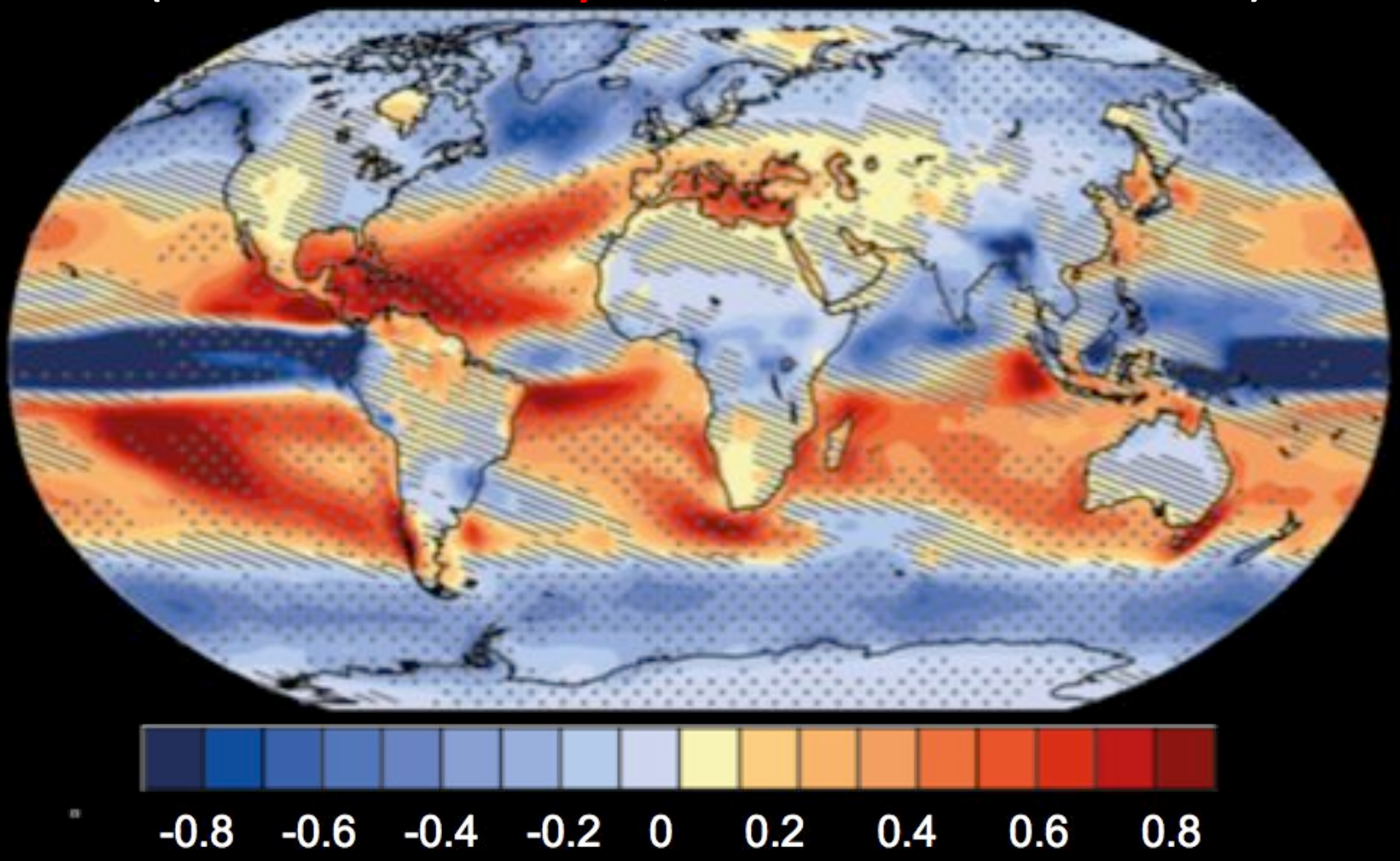
Bjerknes Centre

Percentage chance for a 2080-2100 growing season to be warmer than ever observed 1900-2006



Battisti og Naylor (2009)

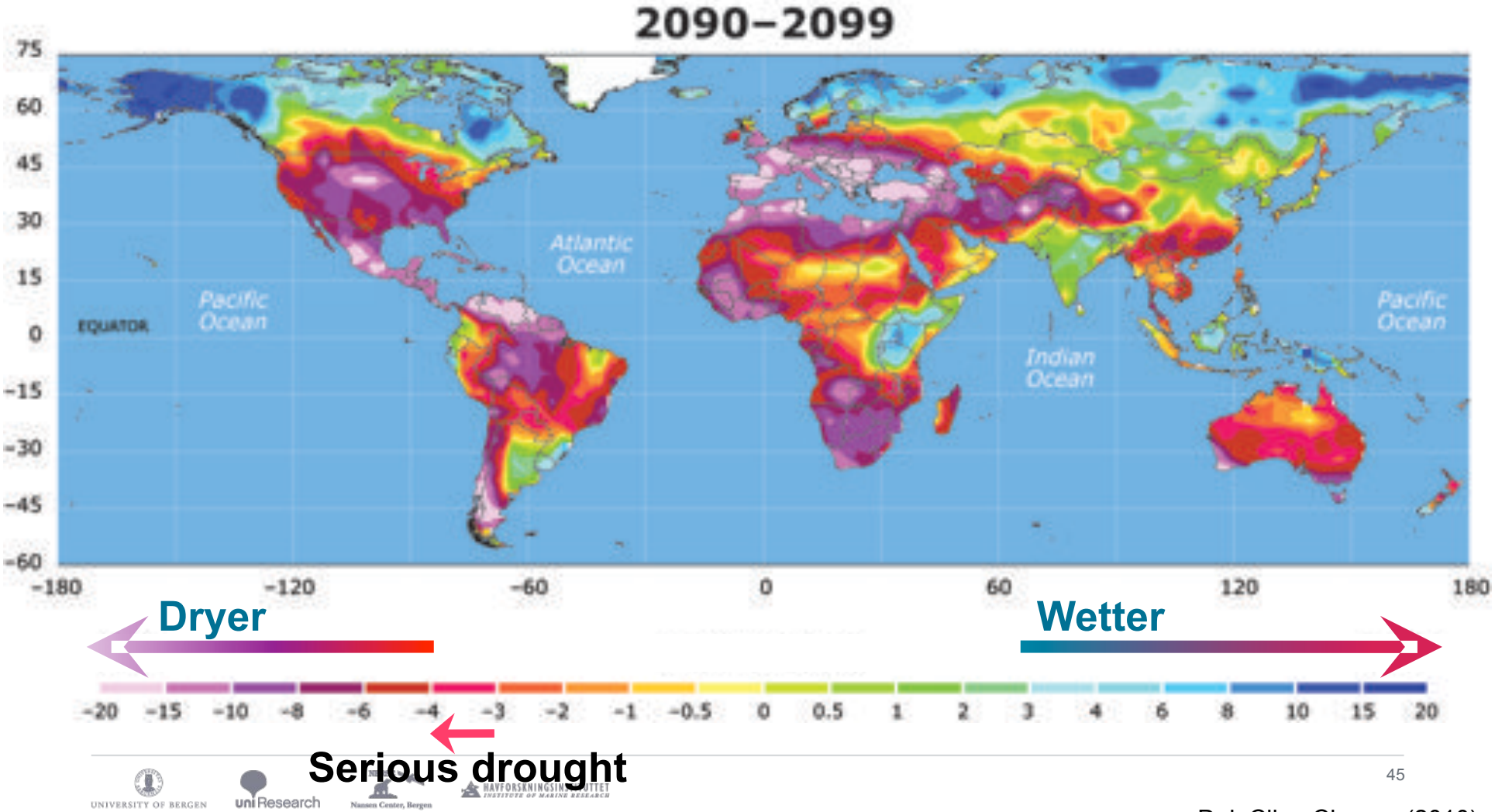
Changes evaporation minus precipitation
(Red areas = dryer, Blue areas = wetter)



IPCC AR5
technical summary

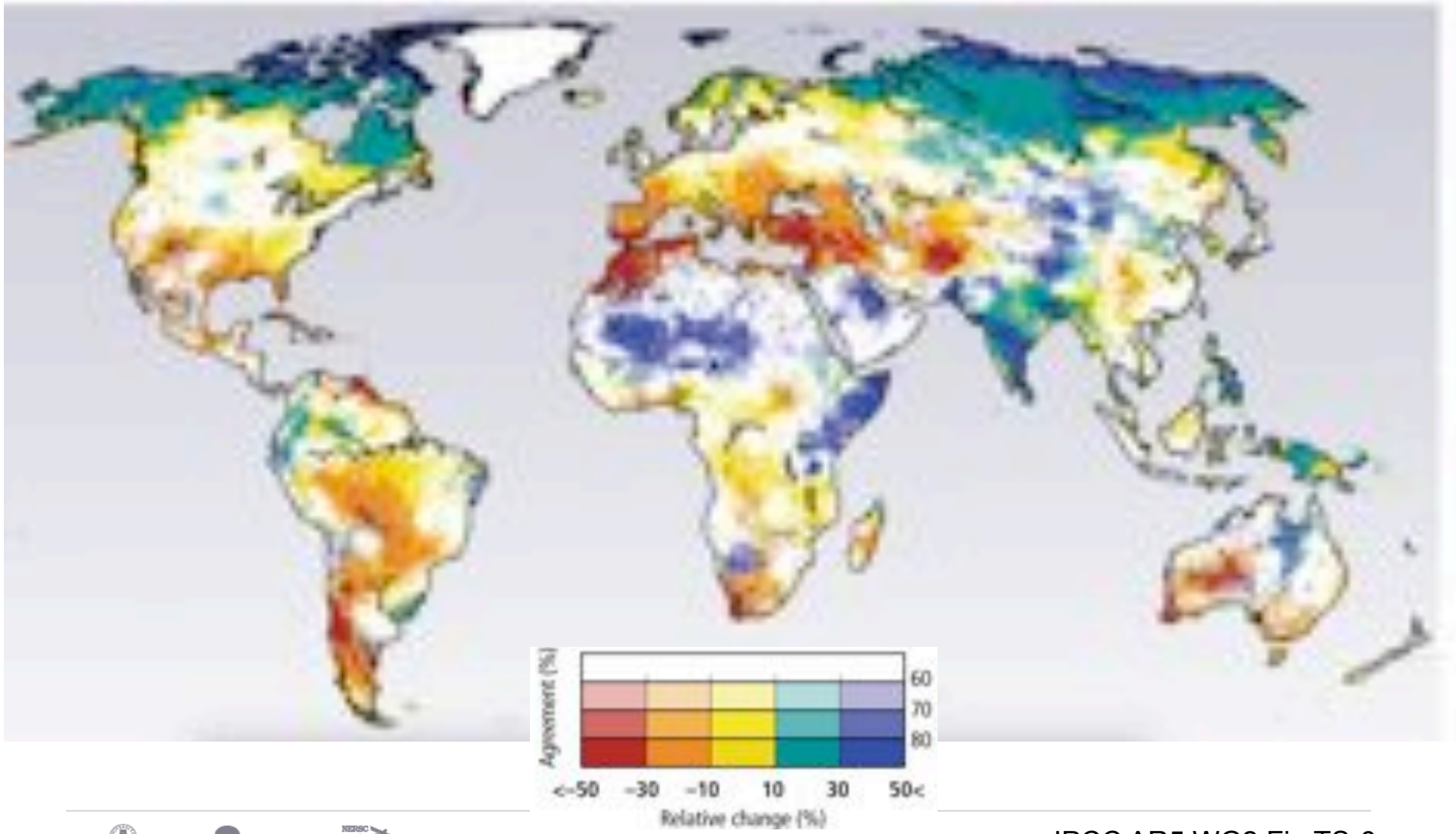
Extreme summer temperatures + less precipitation => droughts

Drought index (PSDI) based on 22 climate models (SRES A1B)



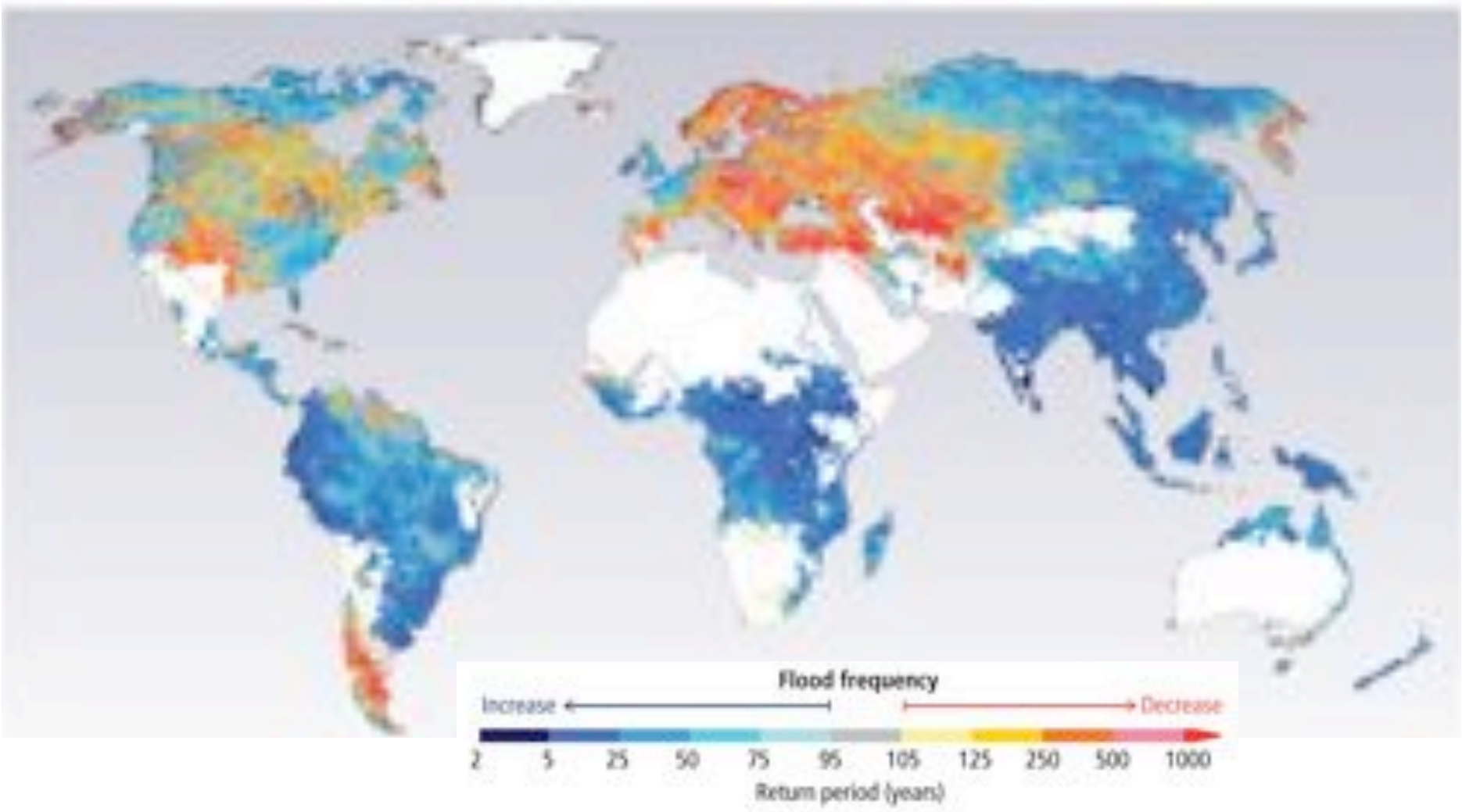
Dai, Clim. Change (2010)

Change in mean annual streamflow for a 2 deg warming



IPCC AR5 WG2 Fig TS-6

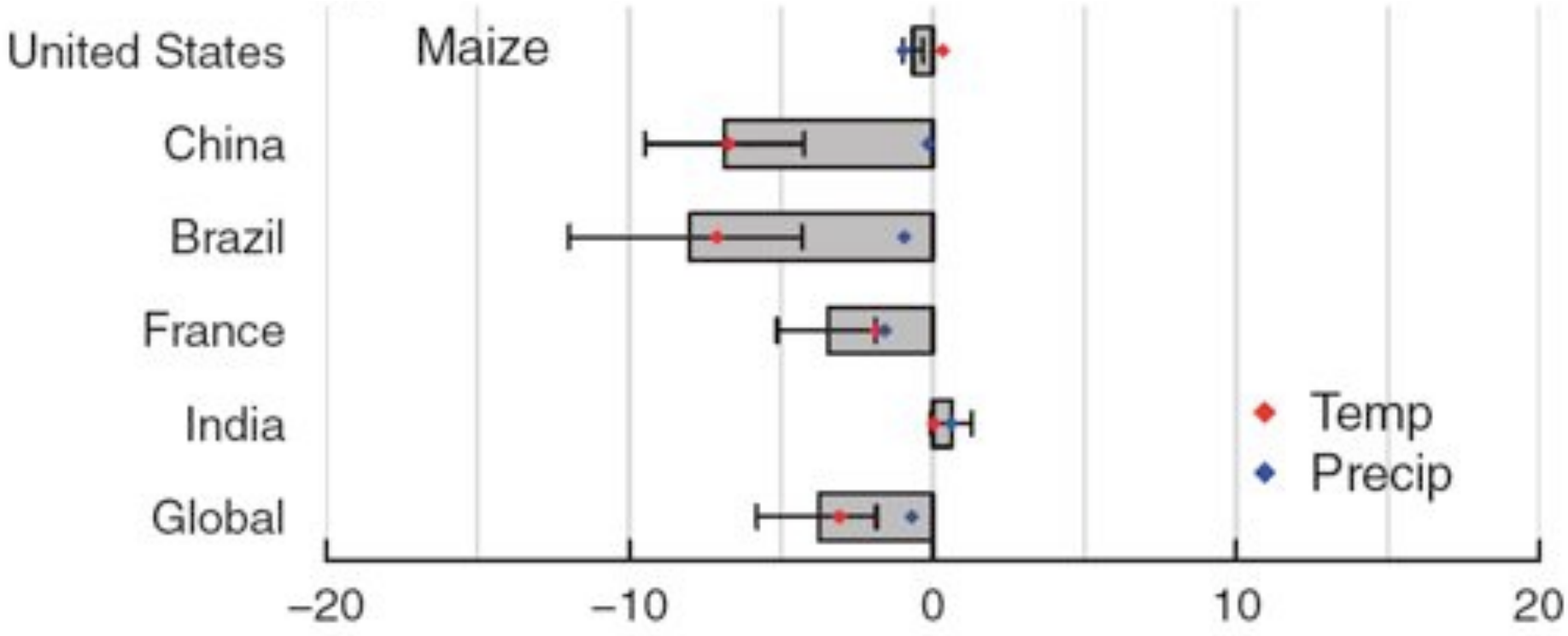
Change in flood frequency (present 100 years event)



IPCC AR5 WG2 Fig TS-6

Food production

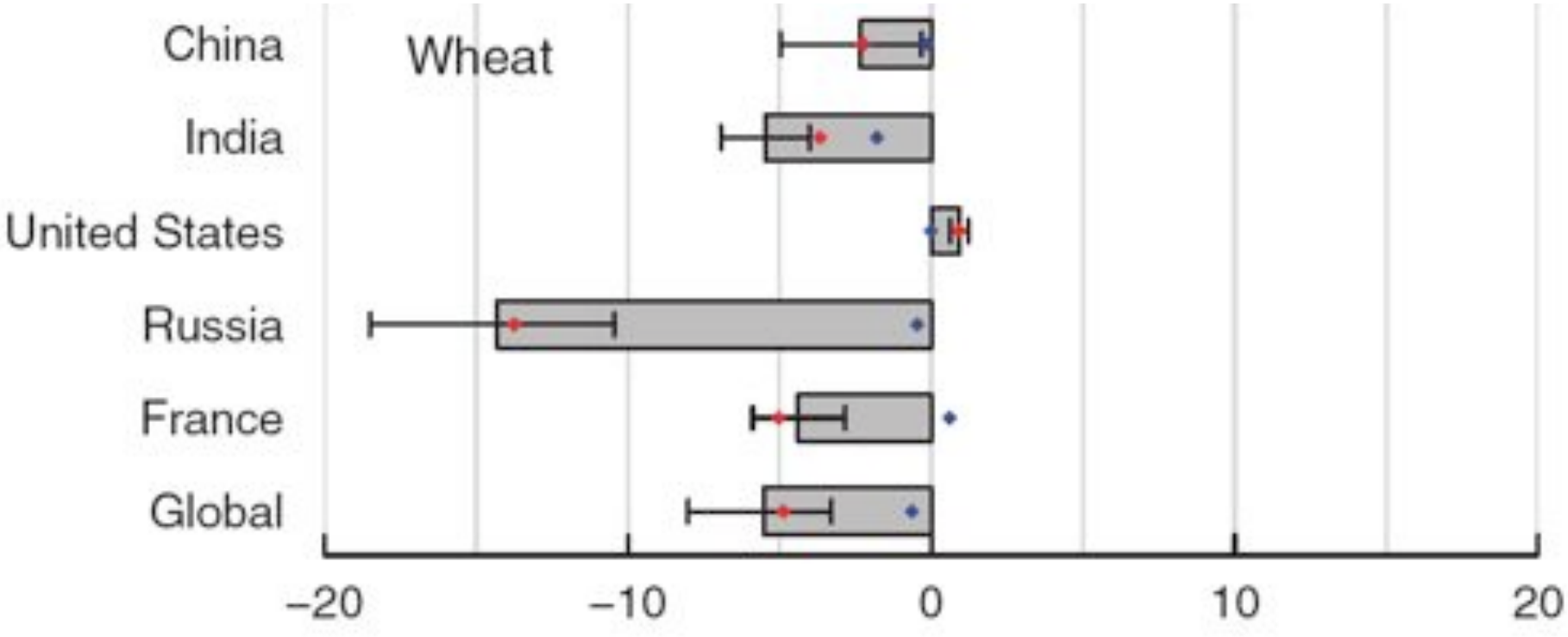
Effects of climate change on production of maize 1980-2008



Global loss similar to total annual production of maize in Mexico (23 MT)

Lobell et al, 2011

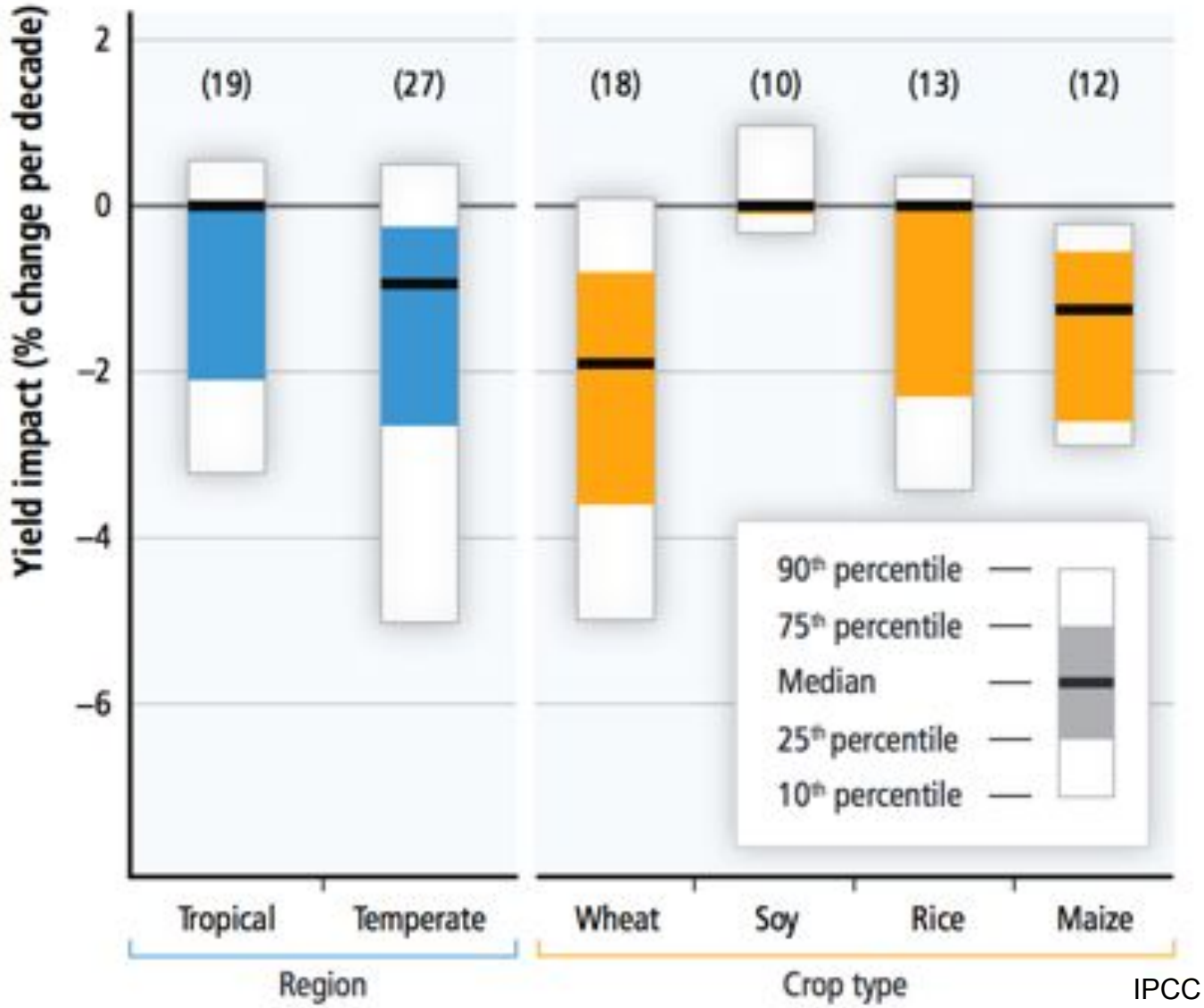
Effects of climate change on production of wheat 1980-2008



Global loss similar to total annual production of wheat in France (33 MT)

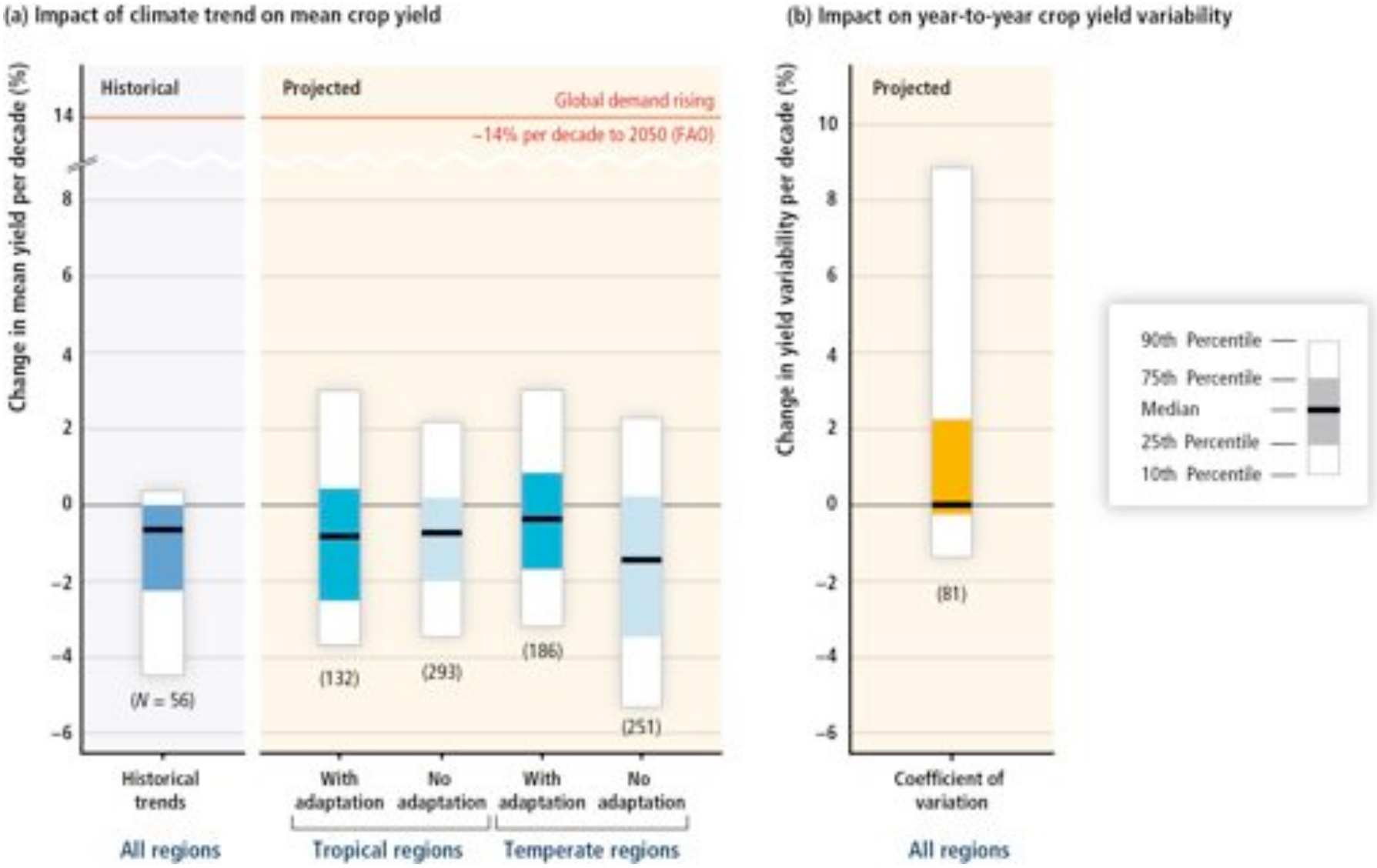
Lobell et al, 2011

Effects of climate change on food production



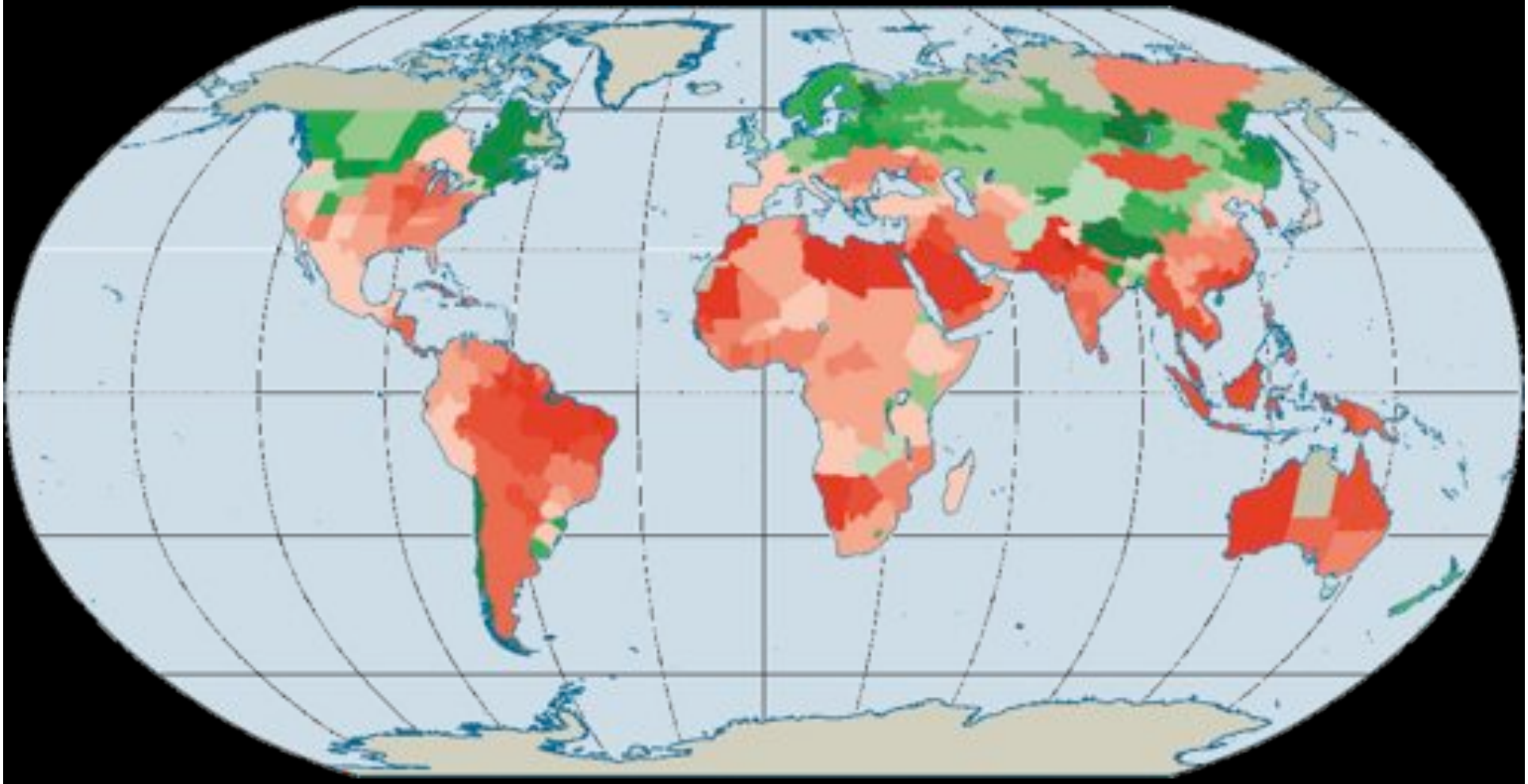
IPCC AR5 SPM Fig 2

Less food, more variable crop yield



IPCC AR5 WG2 Fig 7-7

Climate driven changes in food production 2000 to 2050

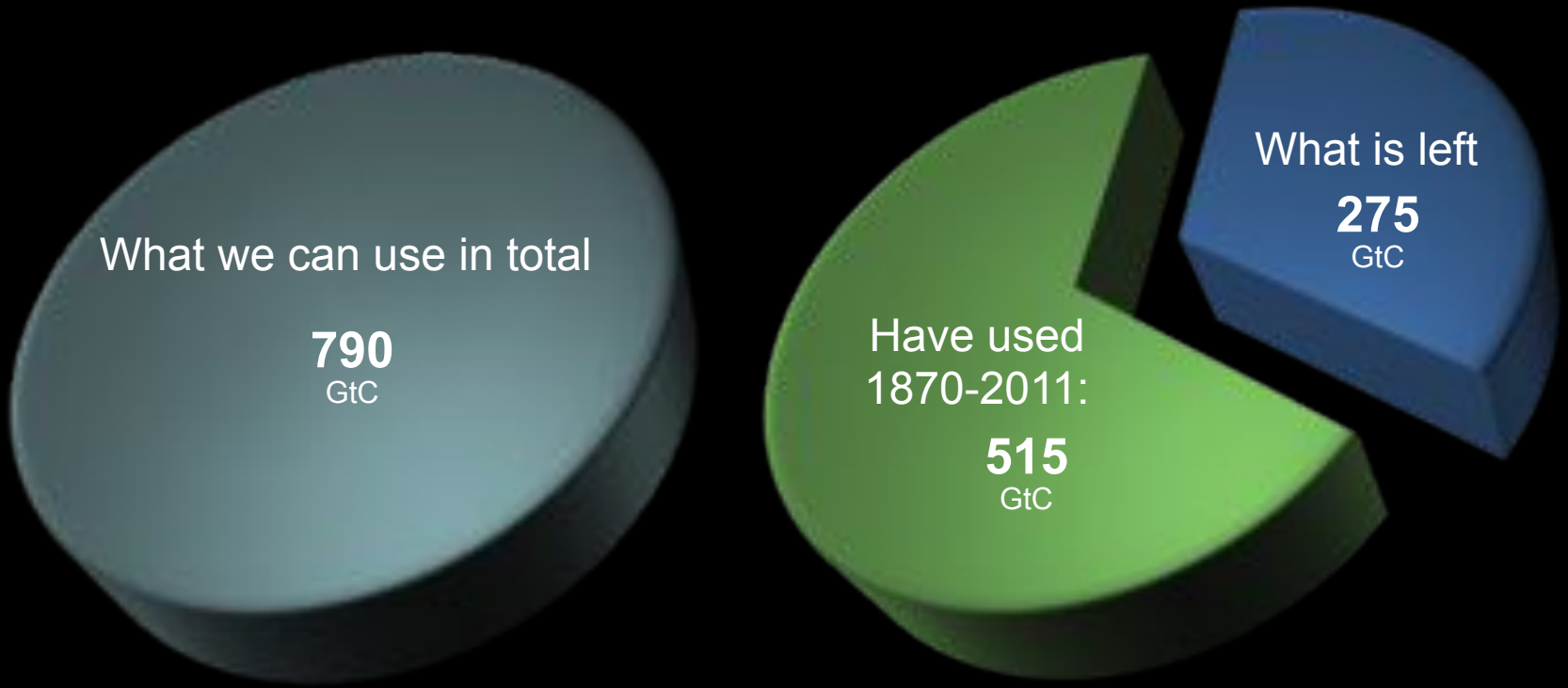


% change between yrs 2000 and 2050

Müller mfl. (2010)
Wheeler & von Braun (2013)

Paris agreement

The 2°C target and carbon budget



2/3 of our carbon budget already used

3/4 of all known oil, gas, coal resources must stay in ground (Unless large-scale carbon capture and storage)

IPCC AR5 WGI SPM

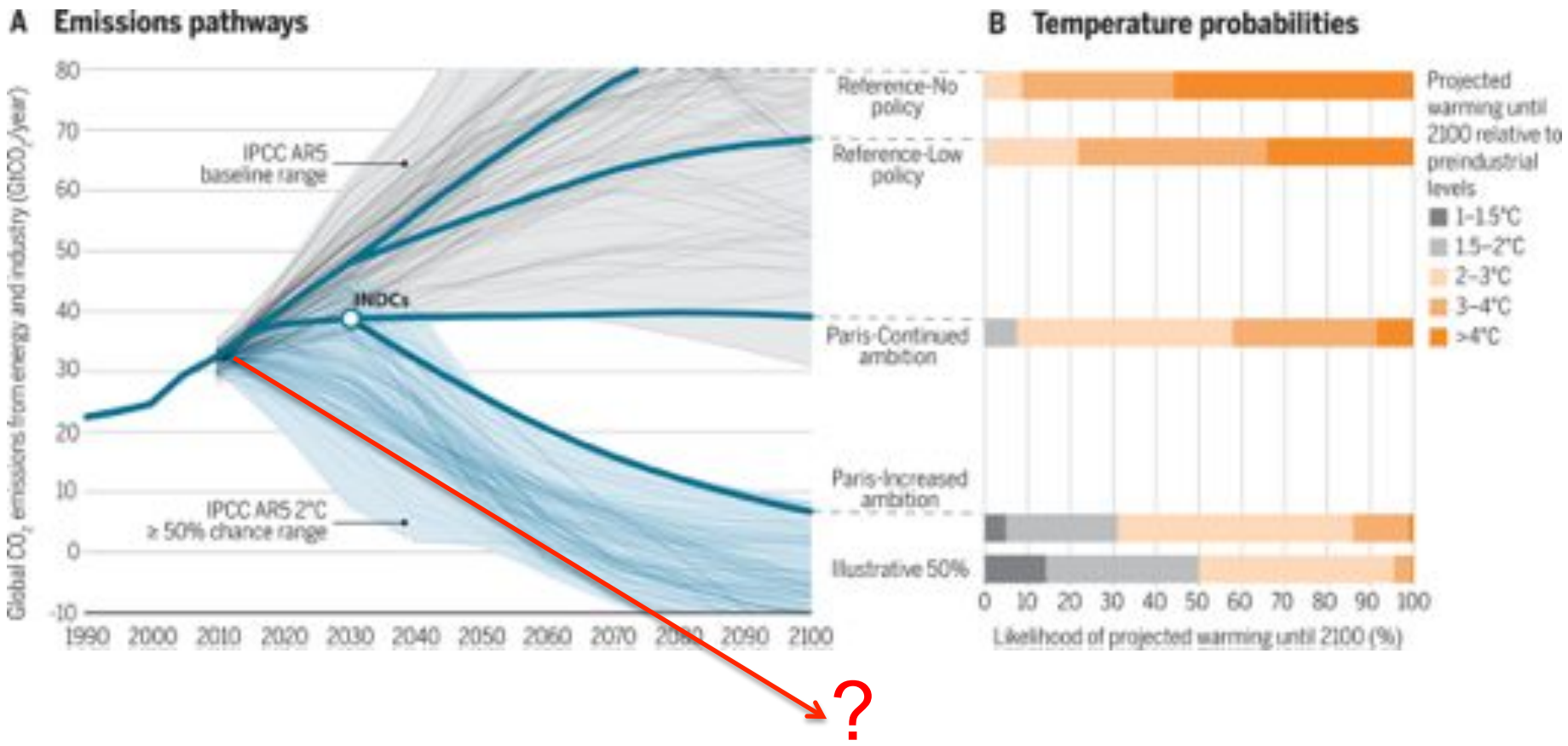
Saturday 12 Dec 2015 at 7.27pm: ”I see the positive reactions, I see no objections, the Paris agreement is adopted!


1.5 DEGREES

The Paris agreement

- ✓ covers all countries, all emissions (Kyoto only 10-15%)
- ✓ builds on 186 national climate plans that will be revised and strengthened every 5. year
- ✓ will keep warming well below 2 degrees and pursue efforts to limit the increase to 1,5 degrees (requires negative emissions in latter part of the century)
- ✓ From 2020 at least 100 billion USD each year for technology support to poor countries.
- ✓ Poor countries impacted by climate change can get support, but no automatics

Paris agreement requires rapid and strong emission cuts and negative emissions after 2050

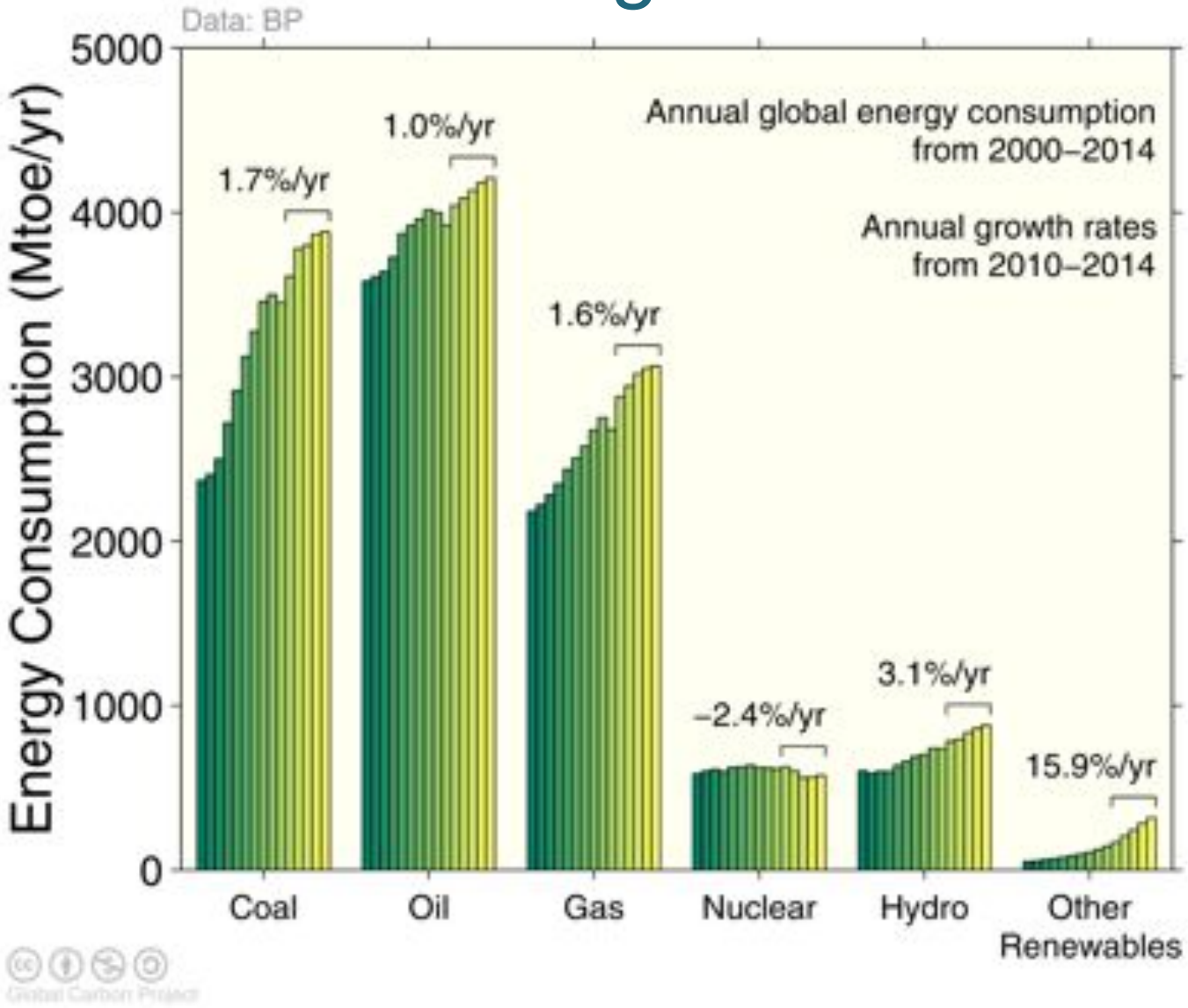


Is it possibly to achieve the 1,5 degree target?

Published by AAAS

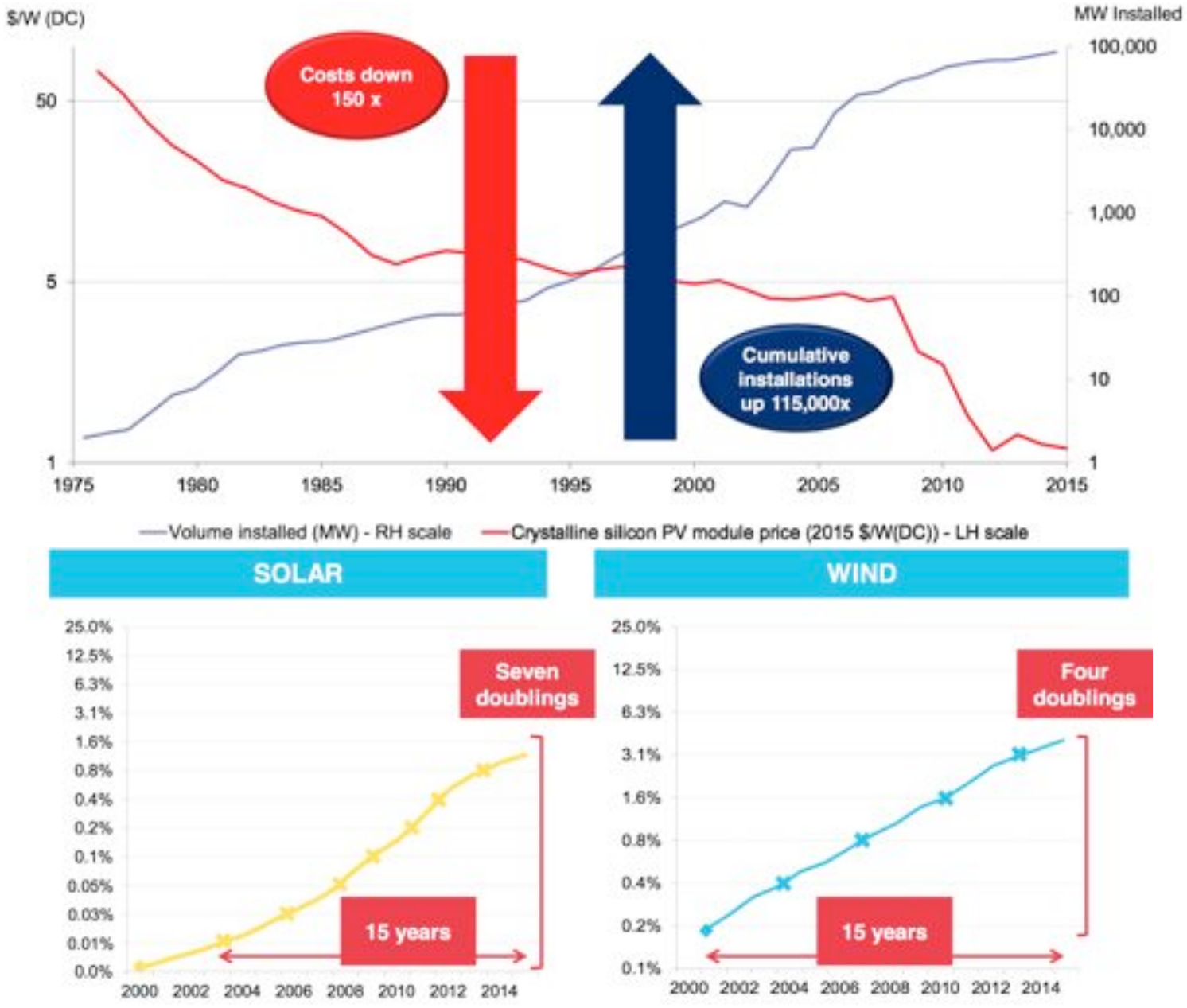
Fawcett et al. Science, 2015

Renewable energy – still small but fastest increasing



Global carbon project

Wind and solar energy revolution



Bloomberg.com

Conclusion

We are on a path towards 4°C warming by the end of the 21st century

Huge negative impacts due to extreme summer temperatures, droughts or flooding, sea level rise, food production,…

Some impacts beyond adaptation limits for natural and human systems

Paris meeting – for the first time an agreement encompassing all nations, all emissions

Political, economical, technological trends point in the same direction: A green shift has started, and will accelerate in the coming years!

THE END