Linking ecological responses to climatic extremes

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OCEANS AND ATMOSPHERE FLAGSHIP
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Headlines from WGII Summary for Policymakers

1. **Observed impacts of climate change are widespread and substantial.**
2. **People, places, and ecosystems in poor and rich countries around the world are vulnerable and exposed to climate change, *in different ways*.**
3. **Climate-change adaptation is beginning to occur.**
4. **Responding to climate change is a challenge in *managing risks*.**
5. **Climate-related risks are much greater with continued high emissions than with ambitious mitigation. Unchecked emissions increase the likelihood of severe and pervasive impacts that may be irreversible or unanticipated.**
6. **Effective and inclusive climate-change adaptation can help build a richer, more resilient world in the near-term and beyond.**

Impacts of extremes

Floods in Europe in 2002

- resulted in the evacuation of tens of thousands of people,
- billions of dollars of damages
- reassessment of disaster planning for the region

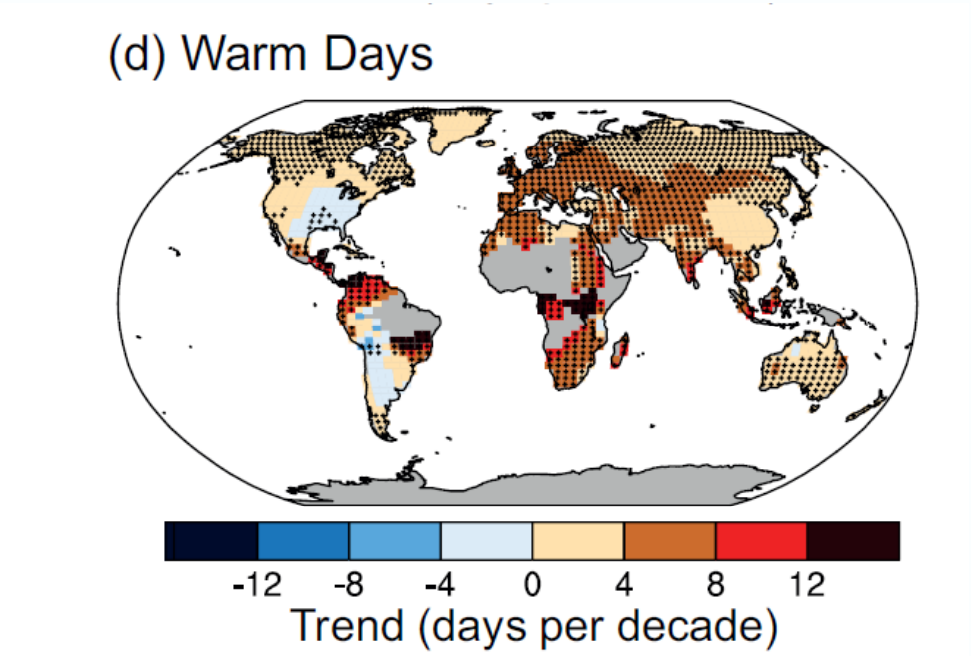
Early-2009 heatwave in SE Australia

- power outages and widespread damage to transport infrastructure
- wildlife mortalities and human heat-related illnesses and deaths
- Black Saturday bushfire – 173 deaths

Are extreme climate events changing?

- *Very likely* the numbers of cold days and nights have decreased and the numbers of warm days and nights have increased globally since ~1950

- *Likely* that the number of heavy precipitation events over land has increased in more regions than it has decreased since ~1950.



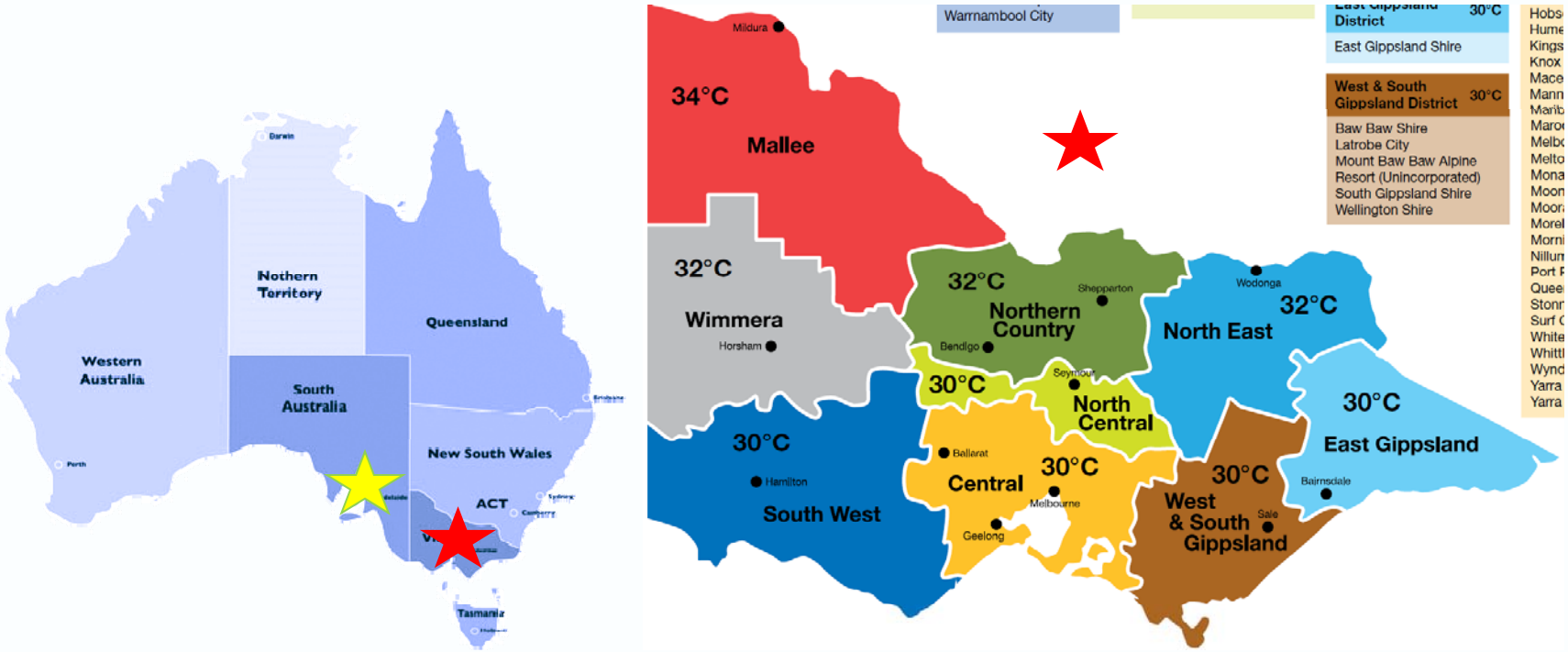
1951-2010

What is a climate extreme?

"The occurrence of a value of a weather or climate variable above (or below) a threshold value near the upper (or lower) ends of the range of observed values of the variable. Some climate extremes (e.g., droughts, floods) may be the result of an accumulation of weather or climate events that are, individually, not extreme themselves (though their accumulation is extreme)."

IPCC 2012 SREX
http://www.ipcc-wg2.gov/SREX/

Heat health index temperature thresholds



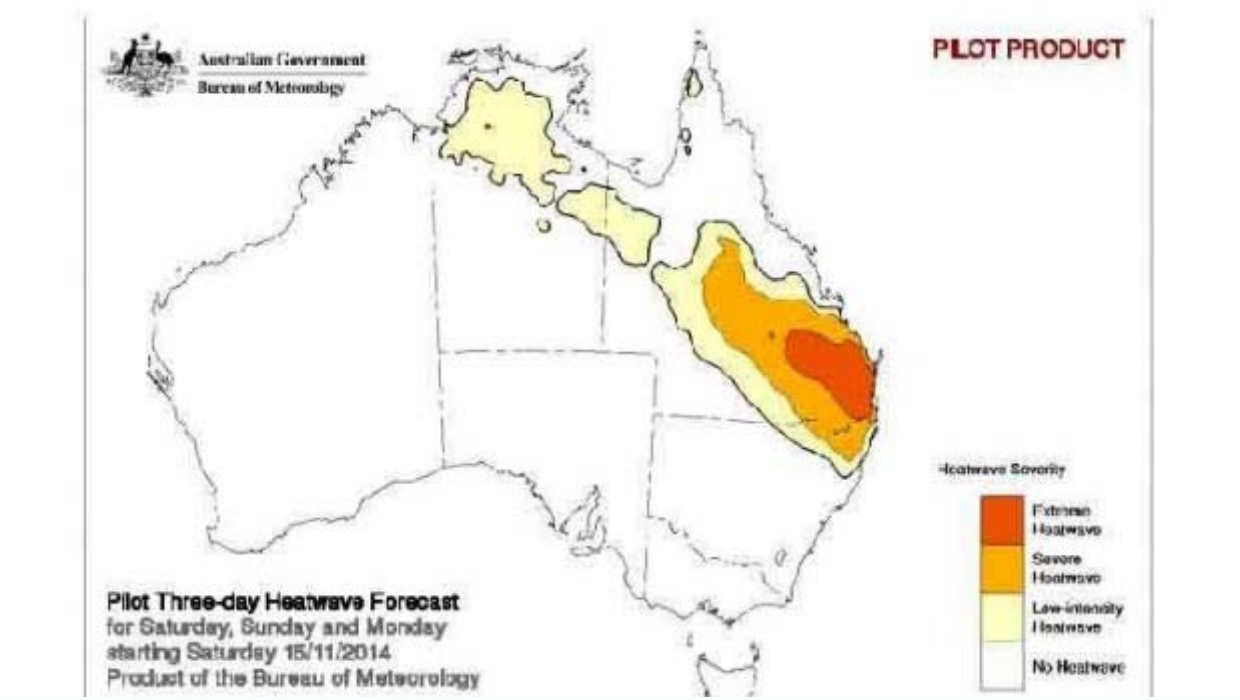
Adelaide: 3+ days with max daily temperature >=35°C

BoM Pilot Heatwave Service for Australia

Provides assessments and forecasts of heatwave intensity

Three or more days of unusually high maximum and minimum temperatures

Excess heat factor: Excess Heat and Heat Stress



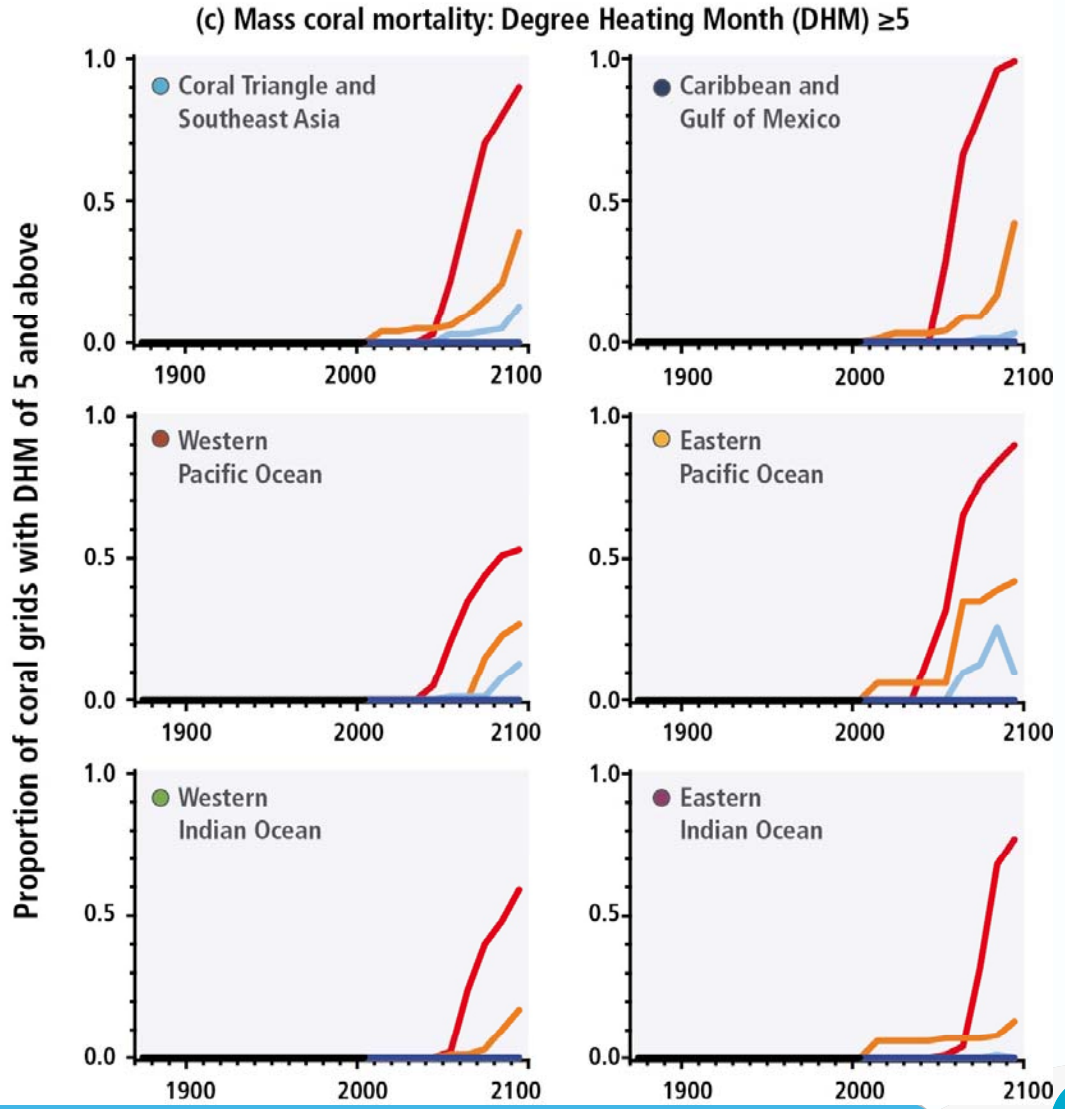
http://www.bom.gov.au/australia/heatwave/

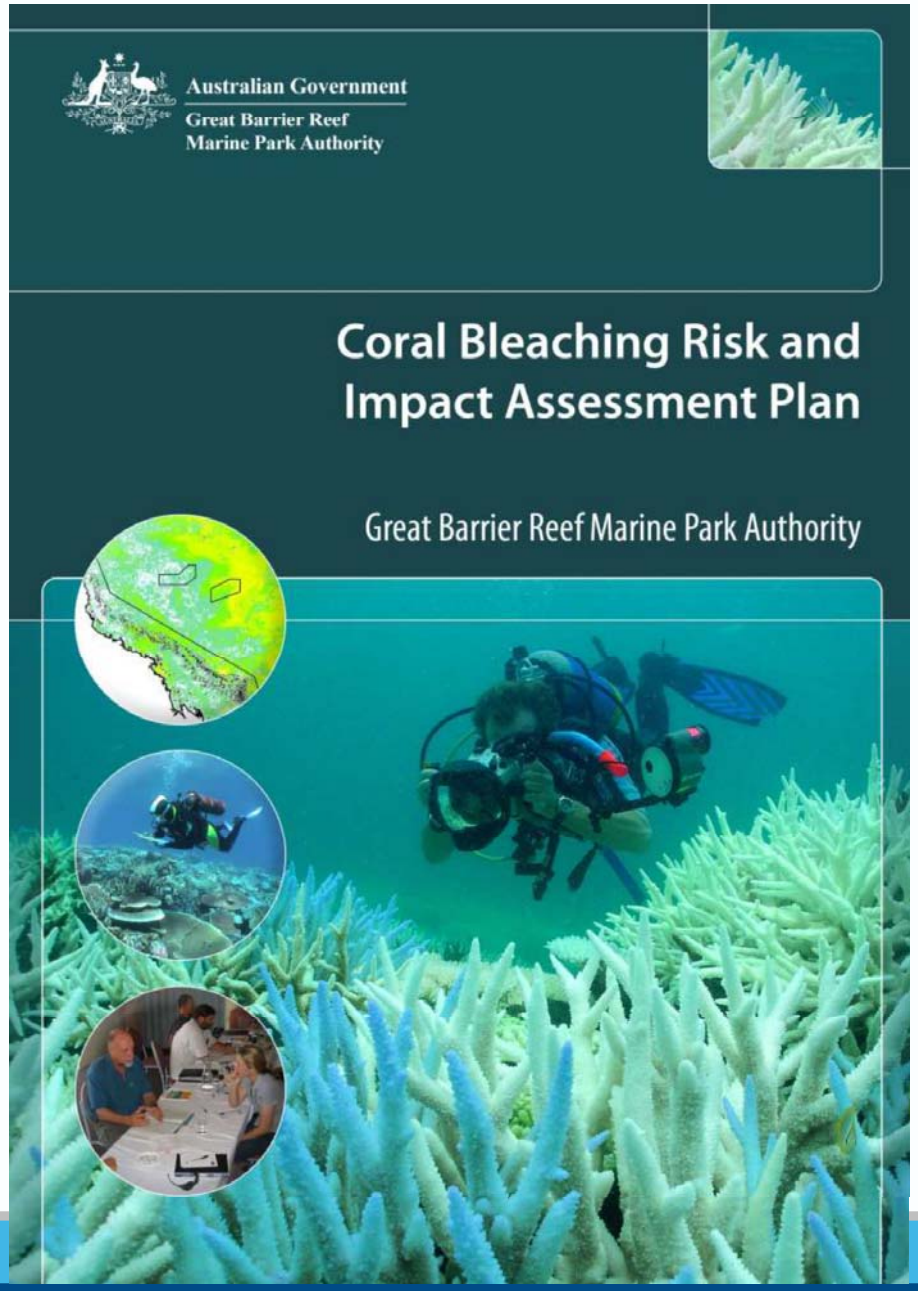
Marine ‘heatwaves’

Event	Impact
1999 Mediterranean	Mass mortality invertebrates
2003 Mediterranean	Mass mortality invertebrates
2012 NW Atlantic (Gulf of Maine)	Northward shifts of commercial fish stocks, new local fisheries, price collapse rock lobsters
2010/11 W Australia	Mass mortality fish and invertebrates, southward shift of tropical species, collapse of local abalone fisheries
1998 Warming of tropical seas globally	Bleaching of ~16% of coral reefs in tropical seas globally

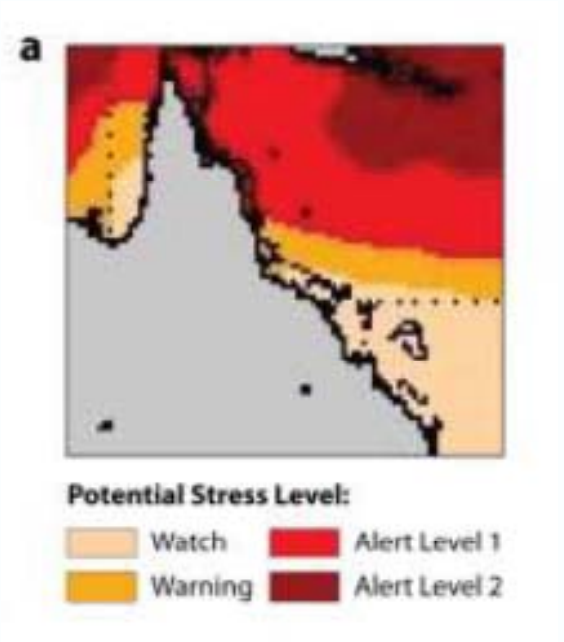
Mass Coral Mortality Events

DHM = 1 month of SST that is 1°C greater than the maximum in the monthly climatology



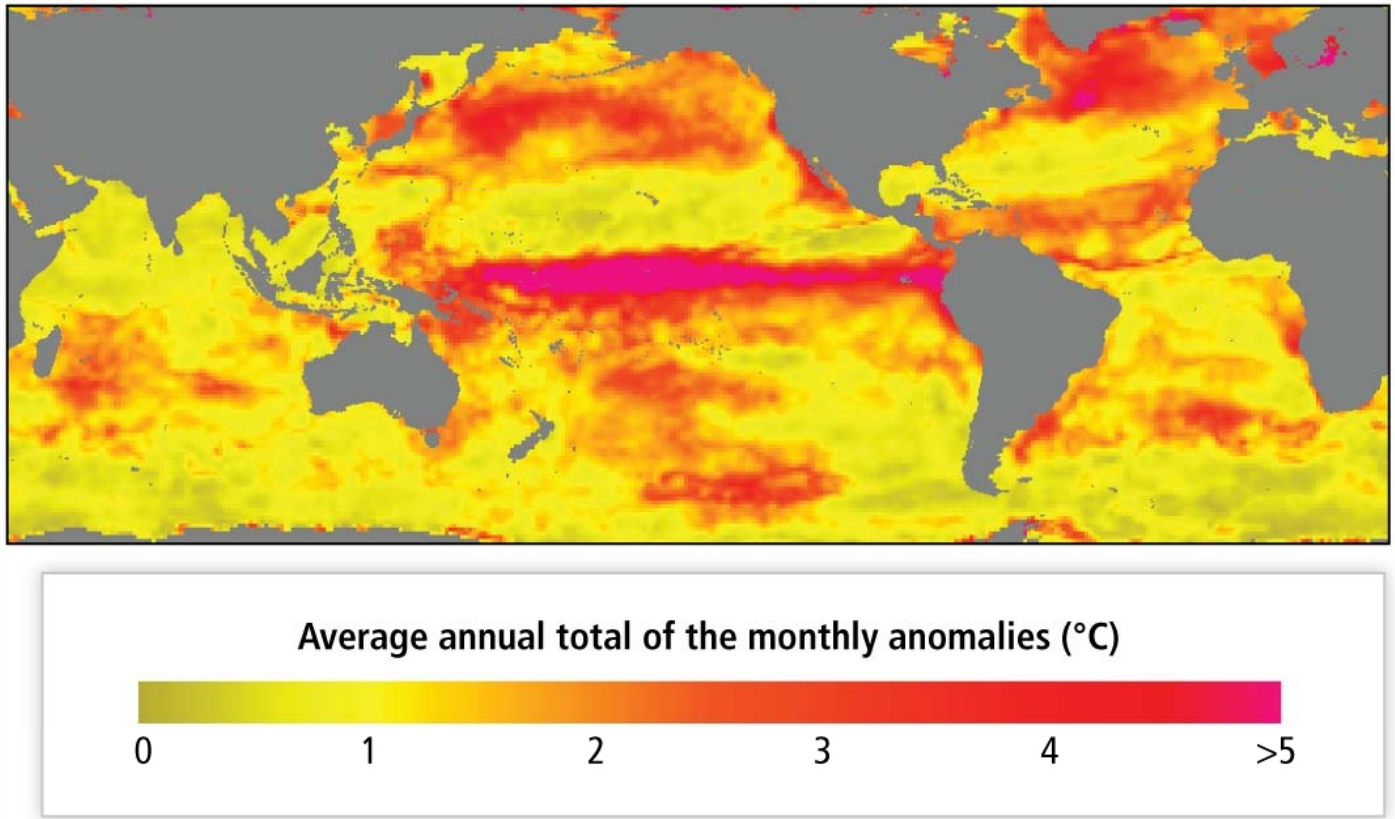


- Early warning
- Incident response
- Communication strategy



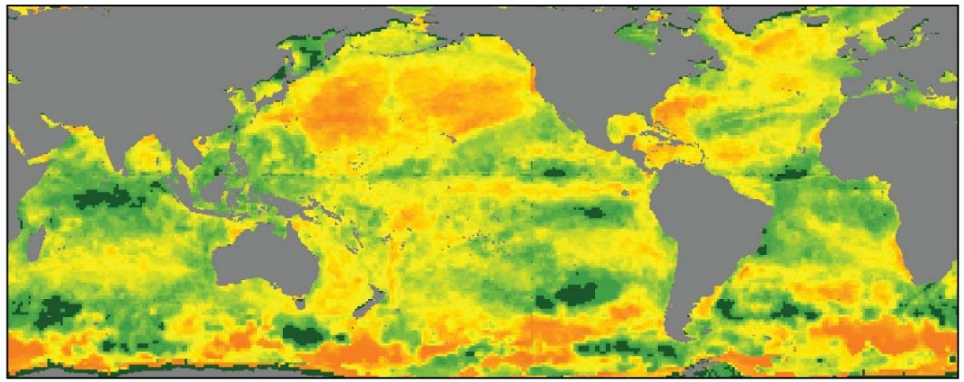
Total thermal stress (SST) 1981-2010

(a) Total thermal stress for the period 1981–2010

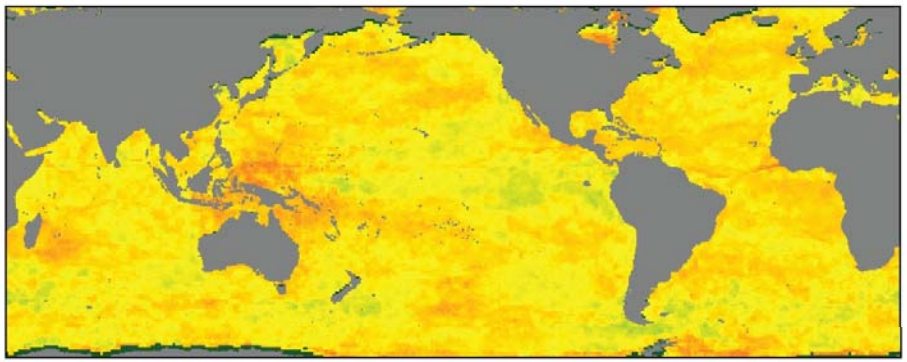


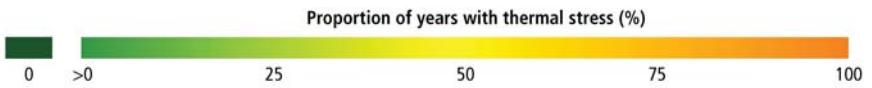
Proportion of years with thermal stress

(c) Proportion of years with thermal stress (1951–1980)

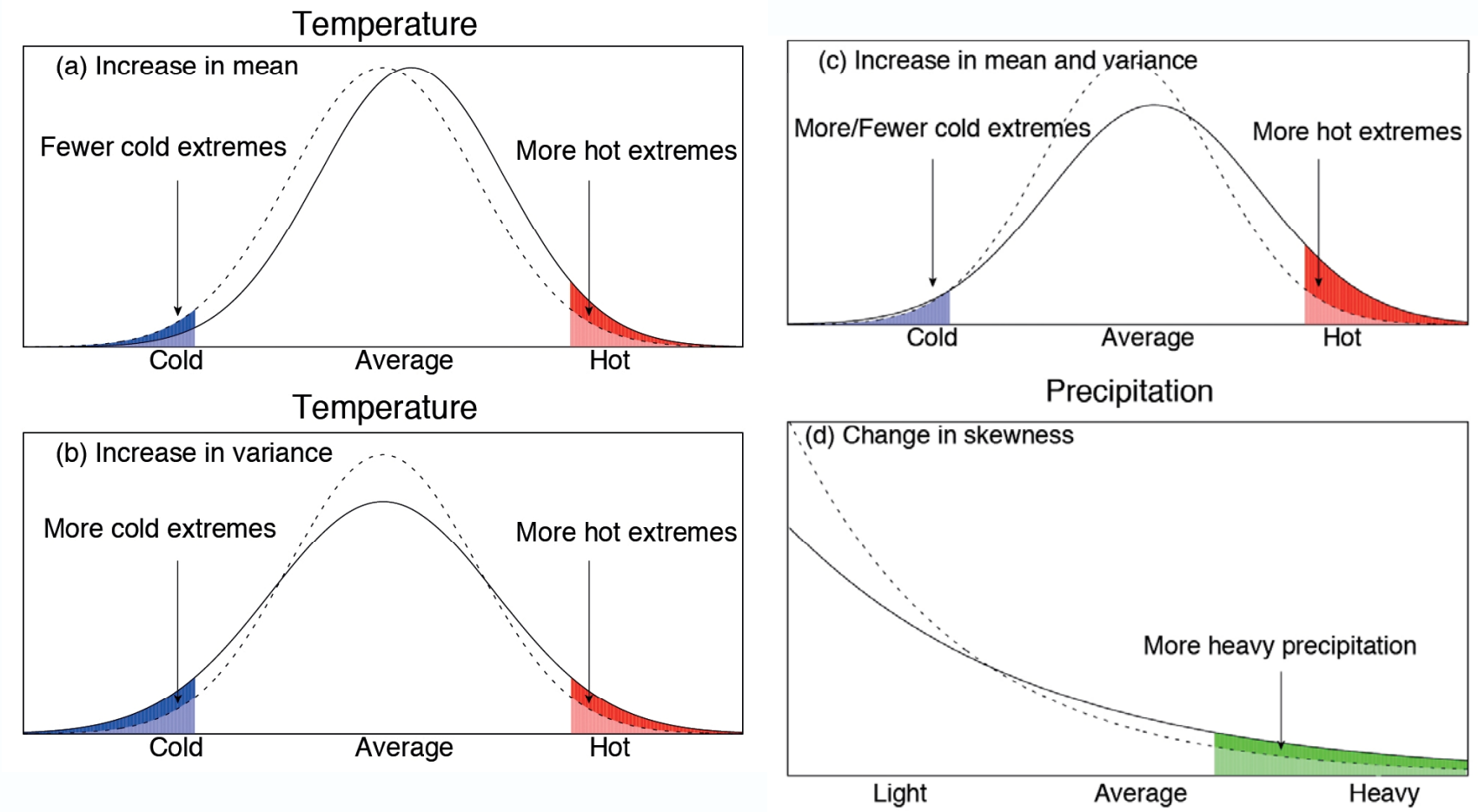


(d) Proportion of years with thermal stress (1981–2010)





How can extremes change?



Some definitions of extremes...

ID	Indicator name	quick definitions
fd	Frost days	Annual count when TMin(daily minimum)<0ºC
id	Icing days	Annual count when TMax(daily maximum)<0ºC
tr	Tropical nights	Annual count when TMin(daily minimum)>20ºC
txx	Max Tmax	Monthly/annual maximum value of daily maximum temp
tnx	Max Tmin	Monthly/annual maximum value of daily minimum temp
txn	Min Tmax	Monthly/annual minimum value of daily maximum temp
tnn	Min Tmin	Monthly/annual minimum value of daily minimum temp
tn10p	Cool nights	Percentage of days when TMin<10th percentile
tx10p	Cool days	Percentage of days when TMax<10th percentile
tn90p	Warm nights	Percentage of days when TMin>90th percentile
tx90p	Warm days	Percentage of days when TMax>90th percentile
wsdi	Warm spell duration indicator	Annual count of days with at least 6 consecutive days when TMax>90th percentile
csdi	Cold spell duration indicator	Annual count of days with at least 6 consecutive days when TMin<10th percentile

Where next...

Generate “novel” indices:

- Widely applicable
- Flexible
- Extendible for future

Test these in ecological models

Project selected indices (CMIP5) not cyclones, storms....

Thank you

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