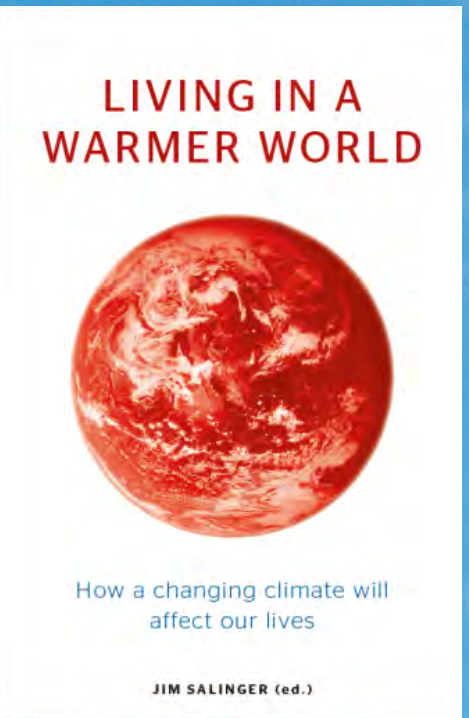
Living in a warmer world:
Climate change impacts on Auckland



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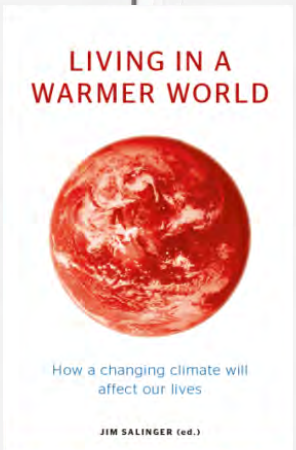
THE UNIVERSITY OF AUCKLAND
NEW ZEALAND
Te Whare Wānanga o Tāmaki Makaurau

Outline

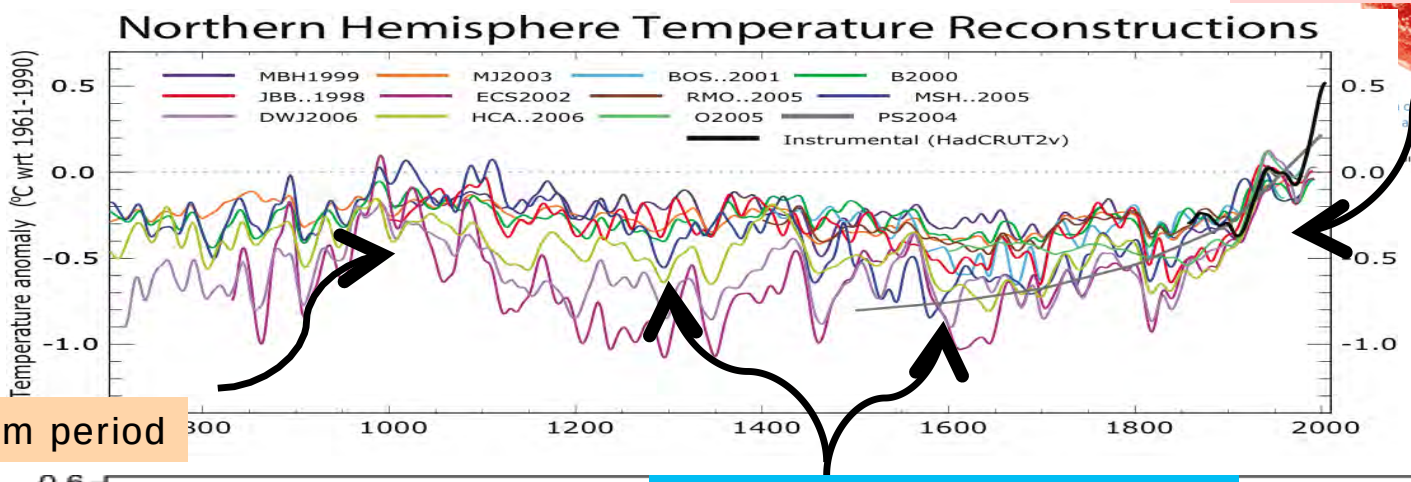
- Our changing climate
- Future projections: Auckland
- Impacts: Extremes
- Agriculture and Health
- Oceans and fisheries
- Pacific Communities – our front yard

Contents

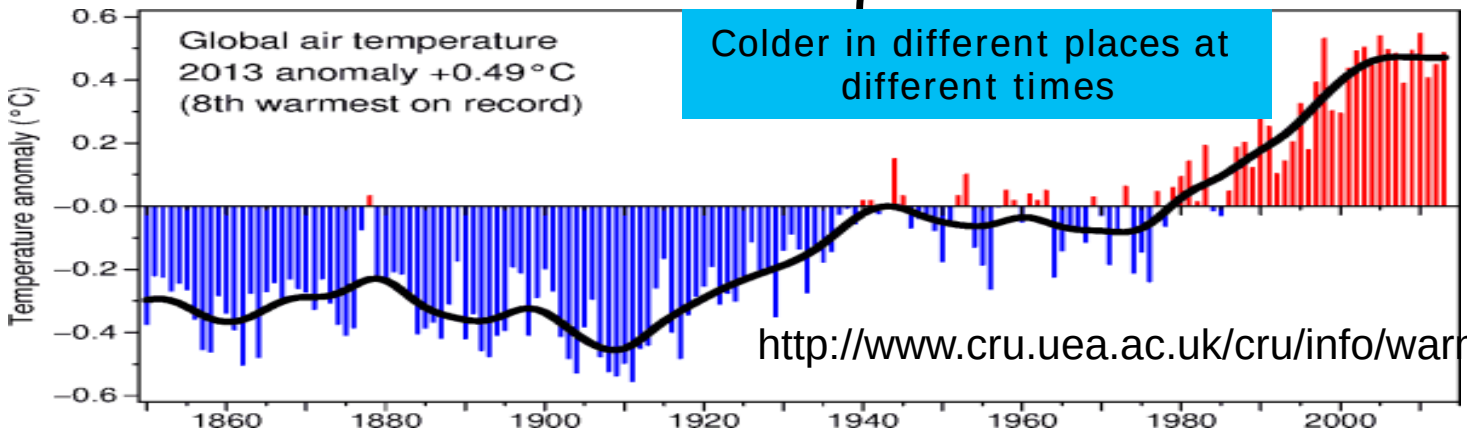


Our changing climate

Rapid warming



A mediaeval warm period

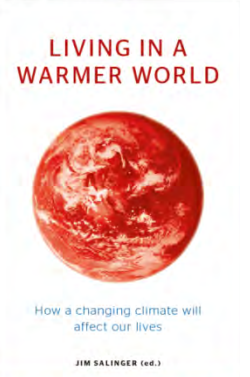


Colder in different places at different times

http://www.cru.uea.ac.uk/cru/info/warming/

- Little Ice Age a time of cooler climate lasting 250 years
- Temperatures have warmed 0.85°C from 1850
- Warming is unequivocal

Our changing climate



- 2014 on course to be one of hottest, possibly hottest, on record at +0.57°C above the 1961-1990 average; – WMO 4 December:
- Global heat in the oceans down to 2 km the hottest;
- Spring 2014 was Australia's warmest on record;
- Mean temperatures were 1.67 °C above average;
- NZ not heading for any record, currently running at +0.3°C above the 1961-1990 average.

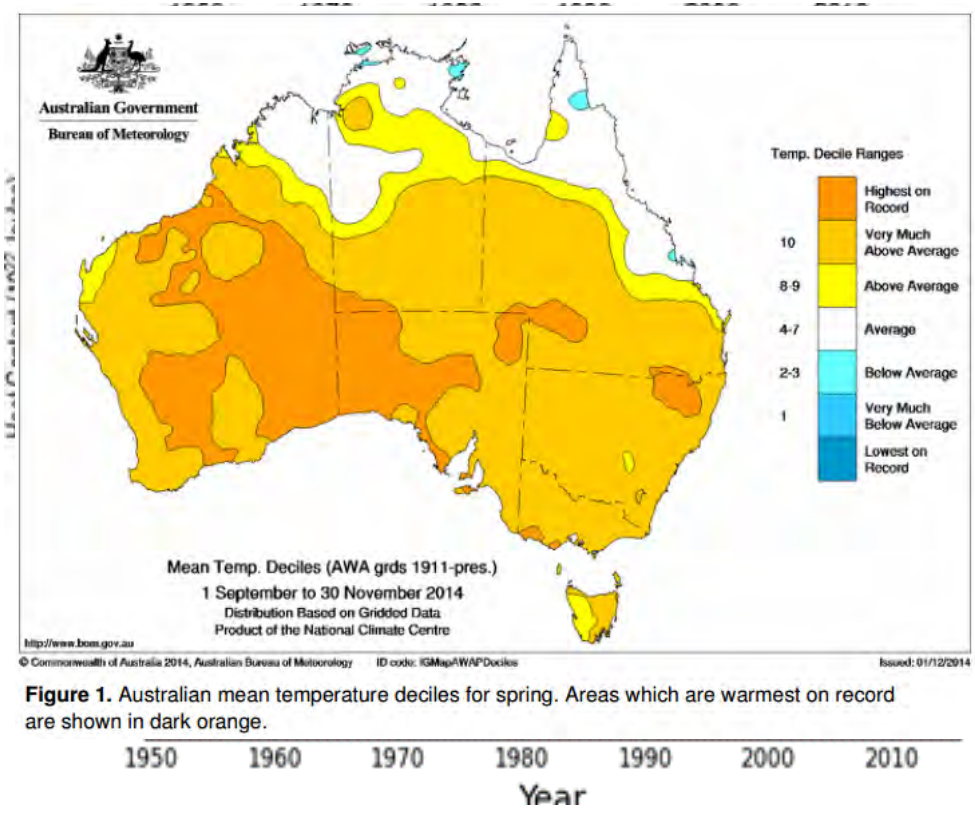
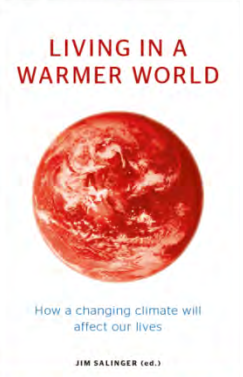


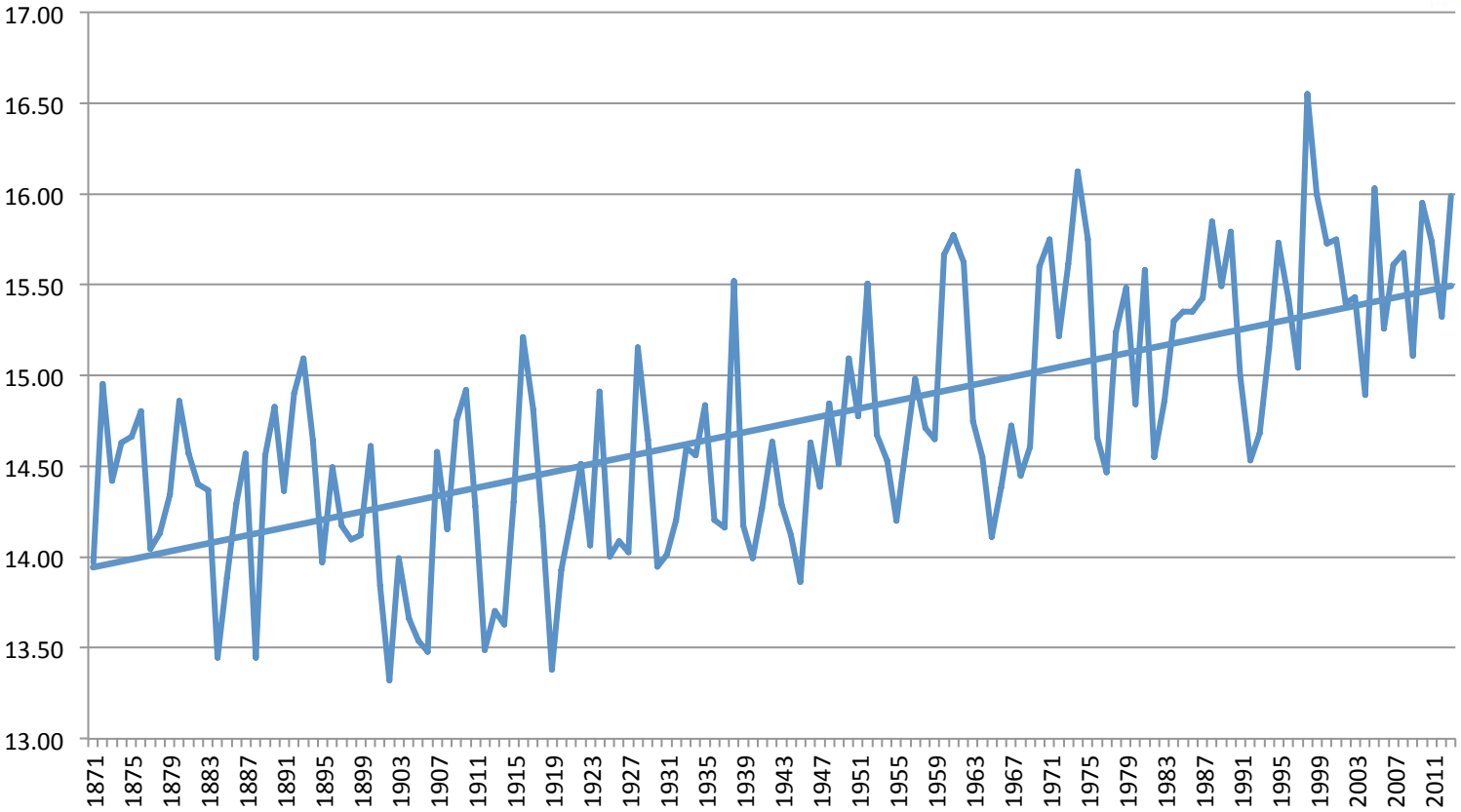
Figure 1. Australian mean temperature deciles for spring. Areas which are warmest on record are shown in dark orange.

Our changing climate



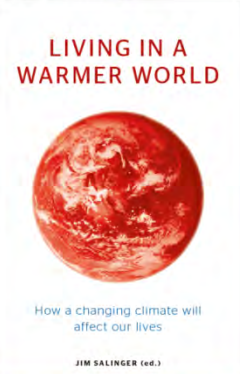
Annual mean temperature

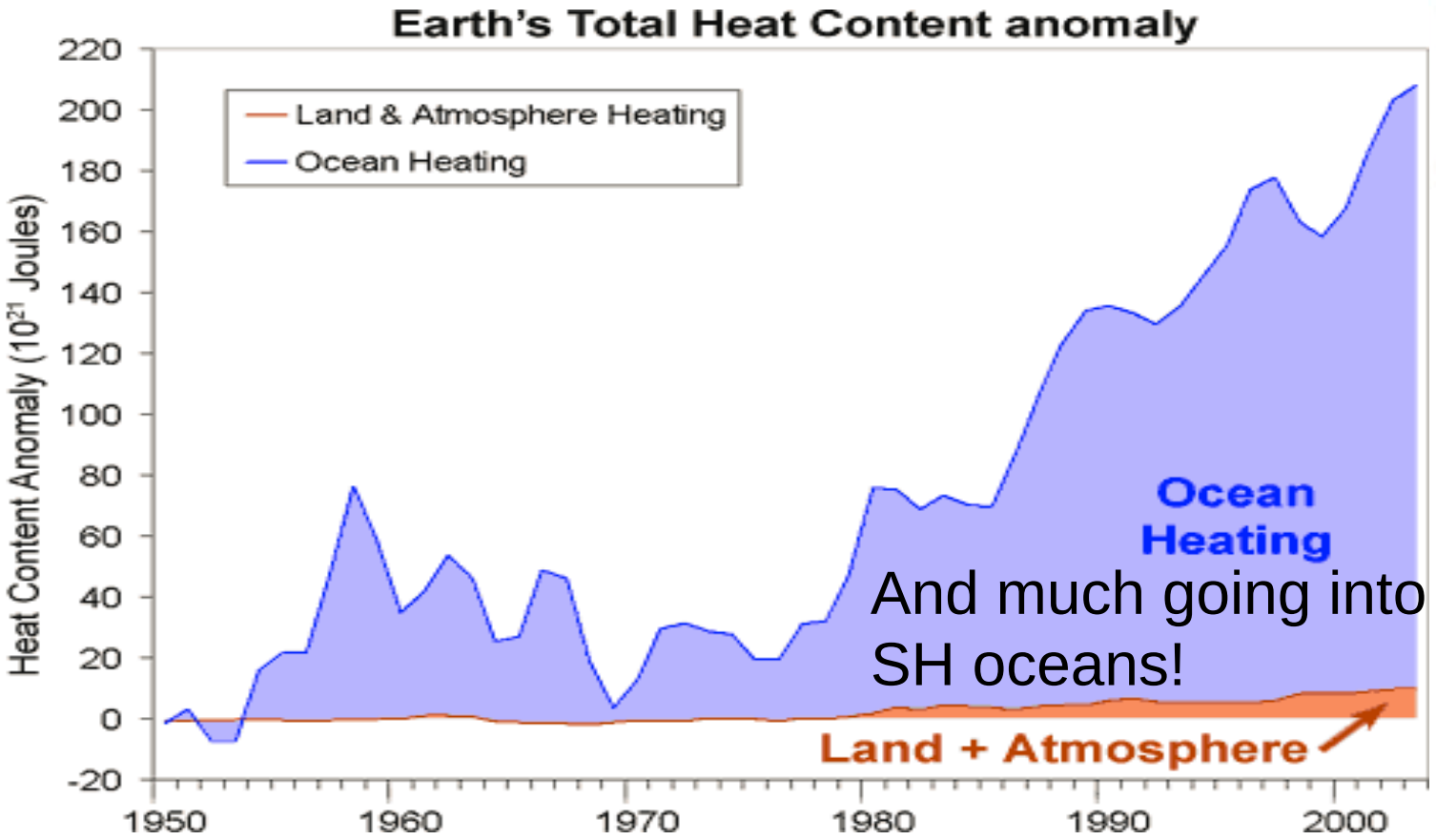
Auckland



- 140 - year change about 1.5°C

Our changing climate





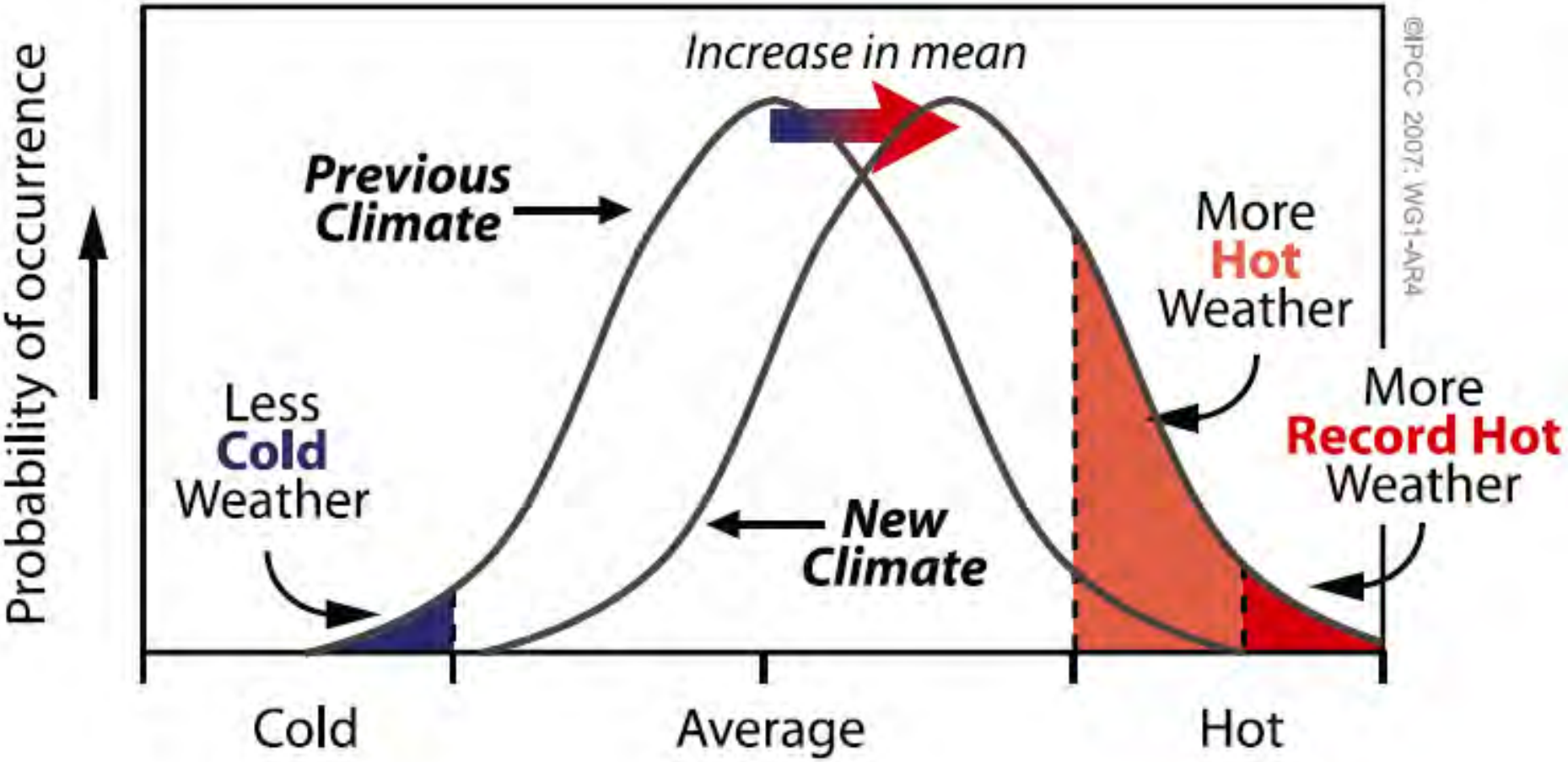
And much going into the SH oceans!

- More than 90% of the energy accumulating in the climate system between 1971 and 2010 has accumulated in the ocean;
- Land temperatures remain at historic highs while ocean temperatures continue to climb.

Our changing climate

LIVING IN A WARMER WORLD

How a changing climate will affect our lives



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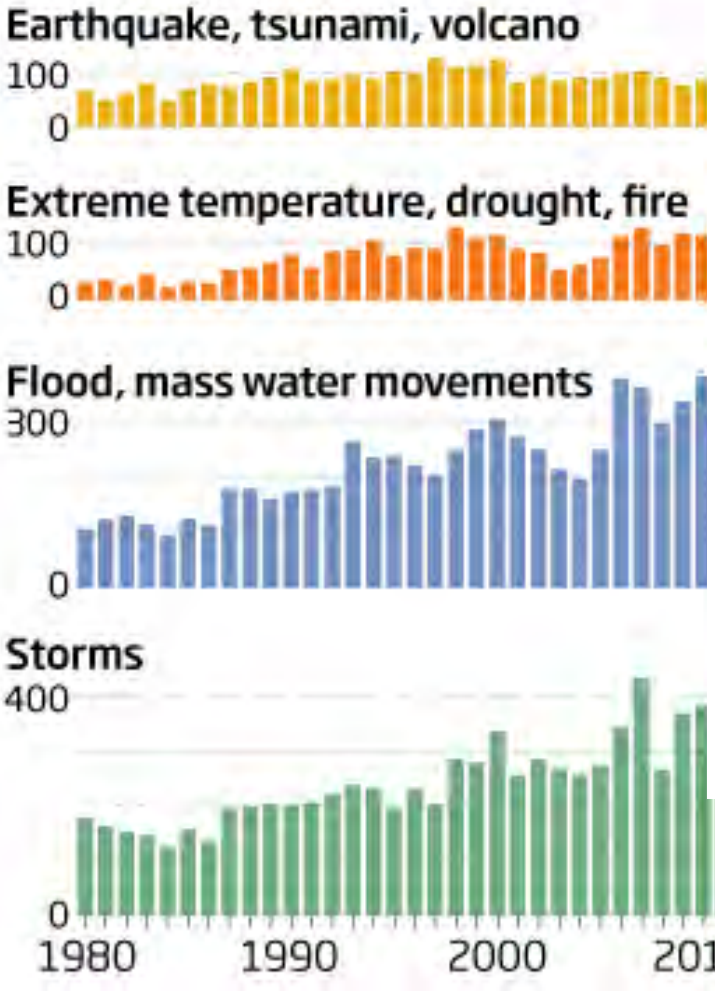
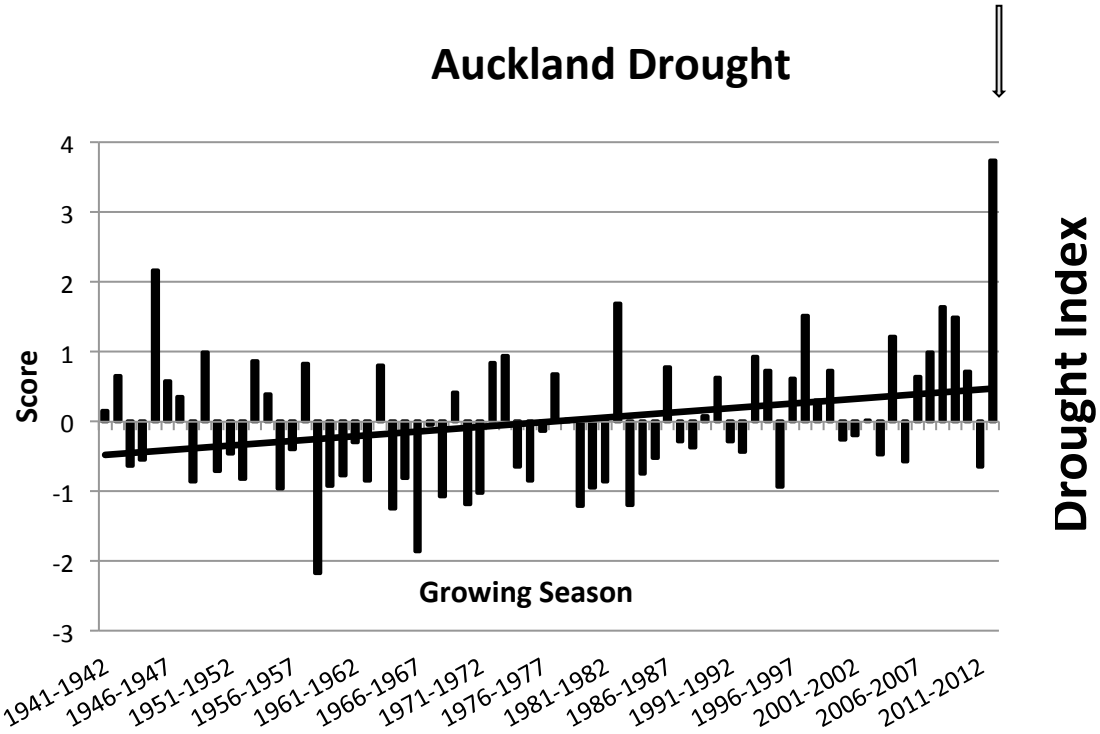
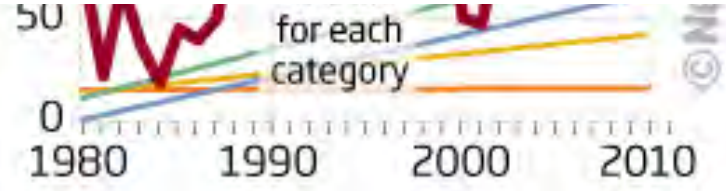
Our changing climate

LIVING IN A WARMER WORLD

Natural disasters are more frequent than 30 years ago – and are costing us more







2012/13 the most severe!

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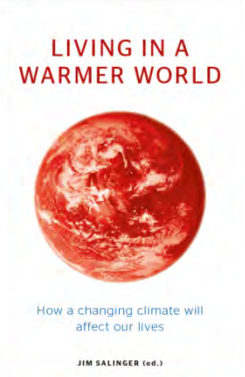
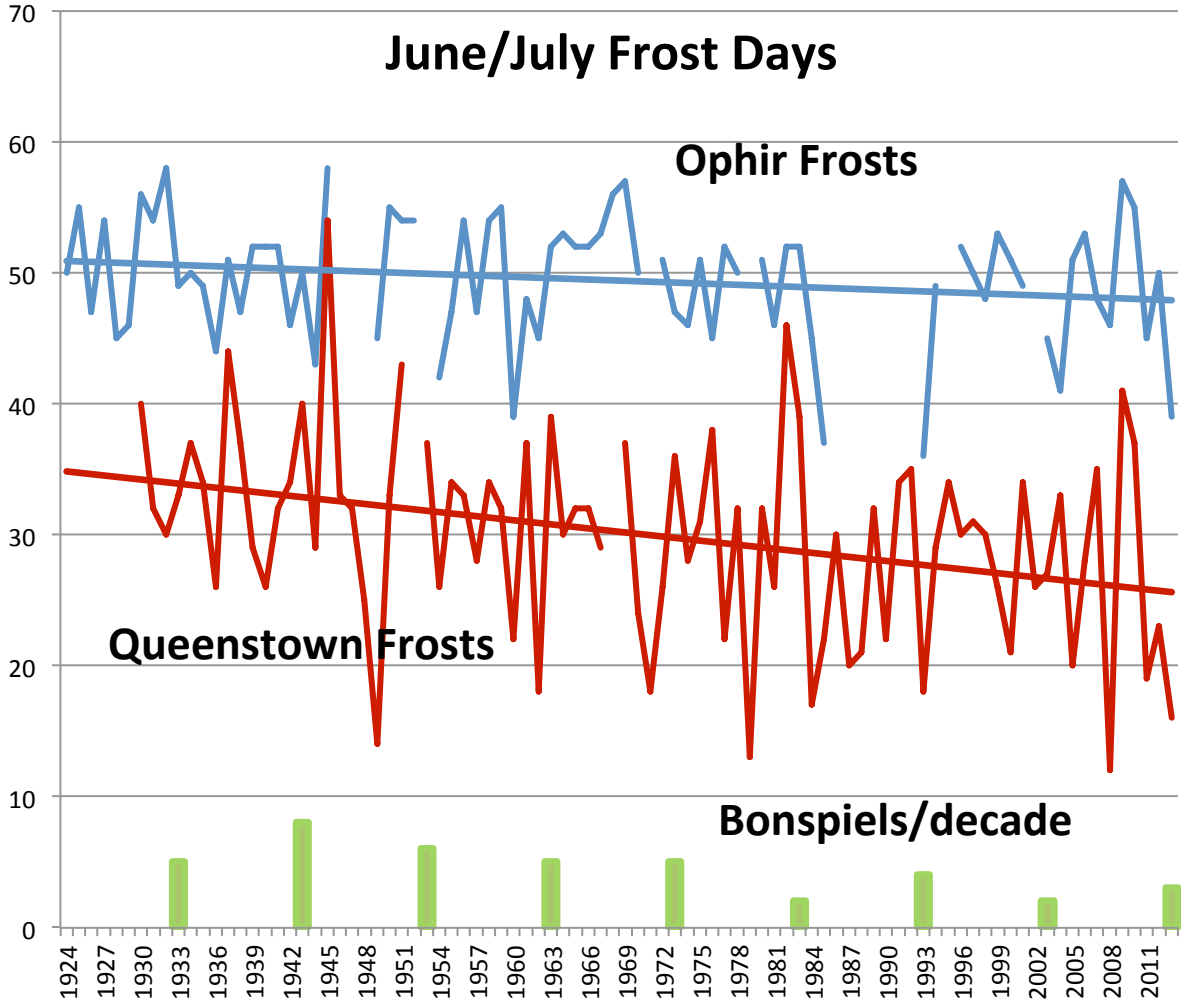


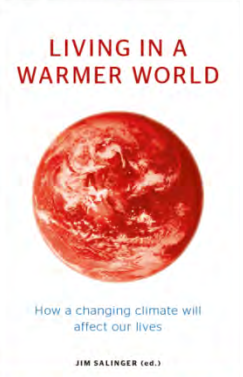


- Bonspiels require a minimum of 13 cm of ice on the Idaburn Dam;
- Records from the 1880s show a trend from 8/ decade to 2-3/ decade now.

Our changing climate

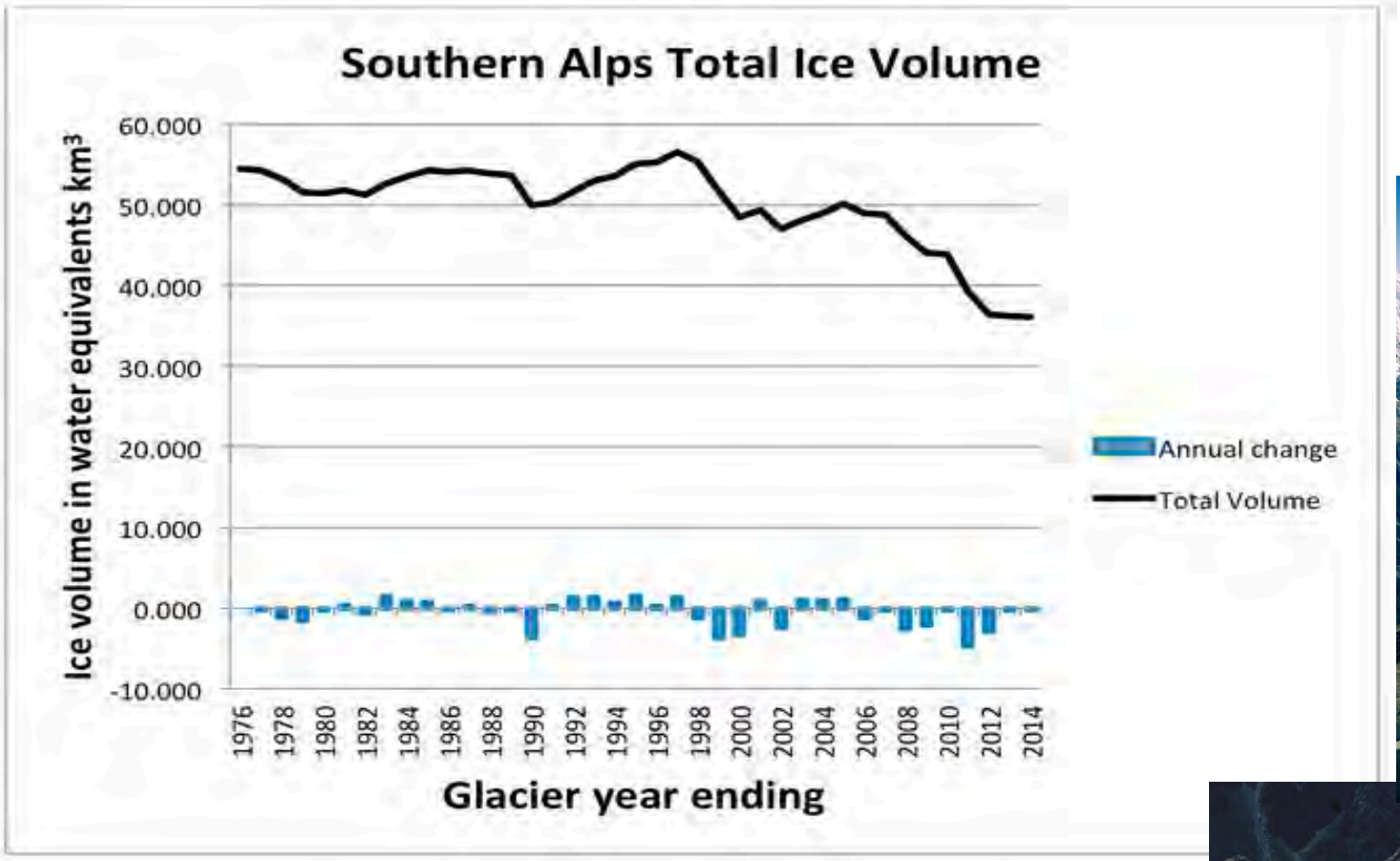
Source: adapted from Anthony Cramp, Flickr, CC-BY-2.0.

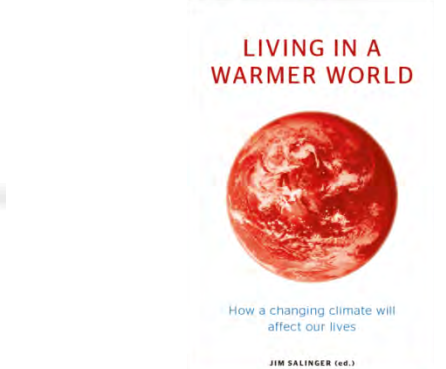
Figure 4.2 The Franz Josef Glacier has both retreated and thinned since 1865. Lines and shading showing the extent of the glacier in 1865 have been added.

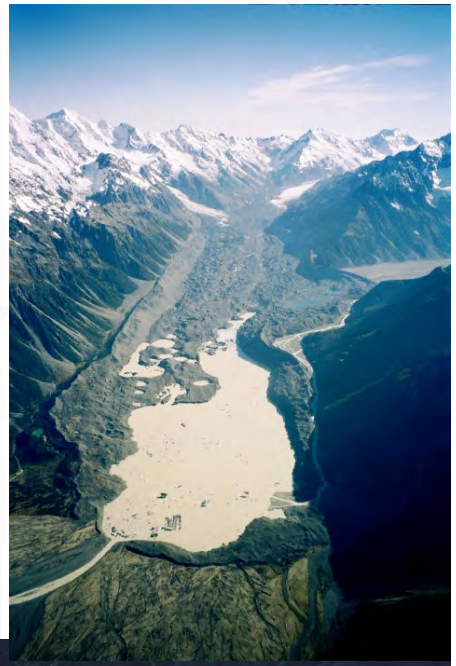


Source: Jan Wright, PCE 2014

Our changing climate



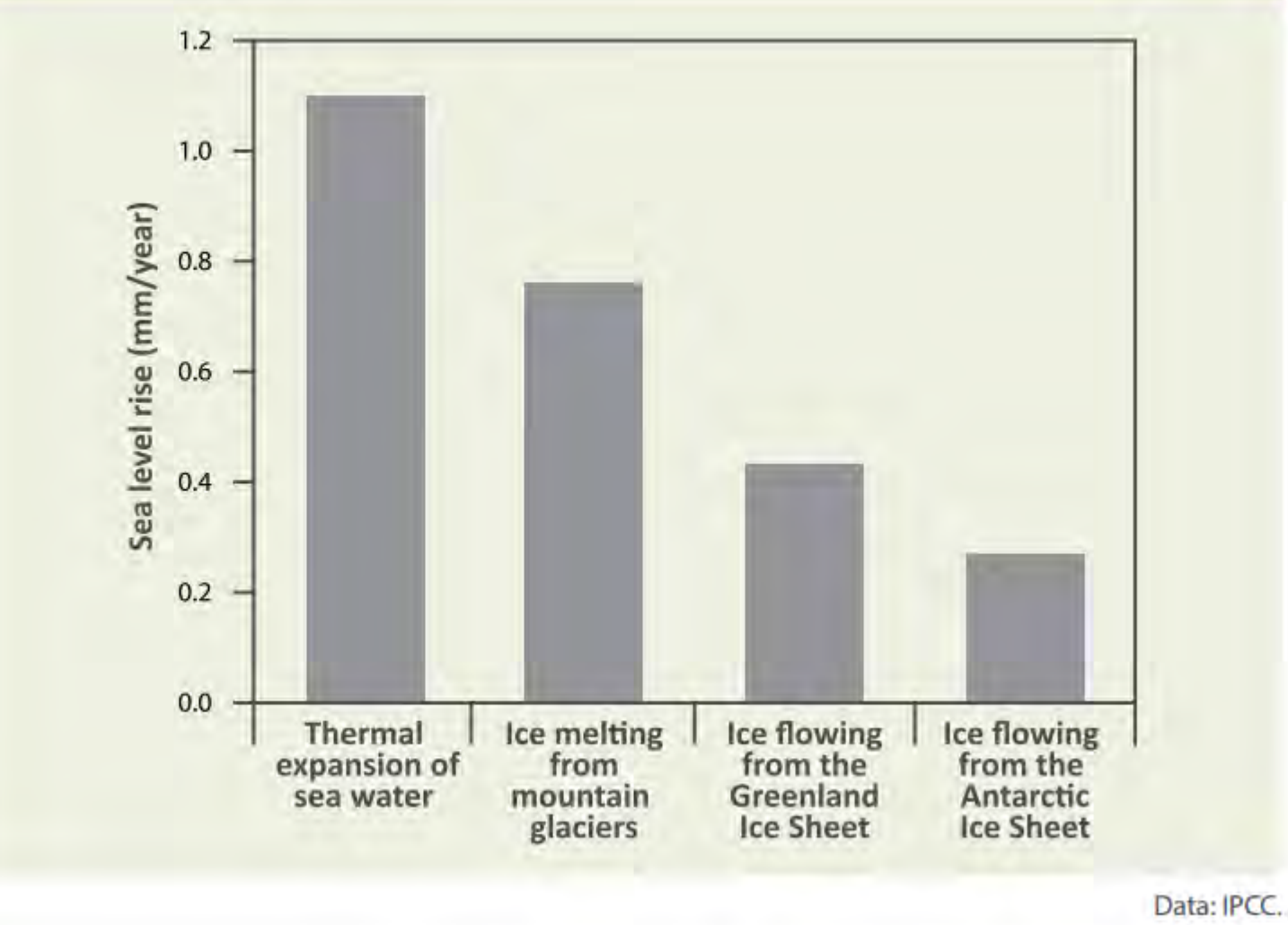




Ice volume changes Southern Alps (water equivalents) km^3:

- 34% reduction 1976 - 2014: 54.5 to 36.1 km^3;
- 1890s 100 to 170 km^3 ~ 20% of 1890s;
- + 2 deg C reduced to ~ 15 km^3; 10 % of 1890s!

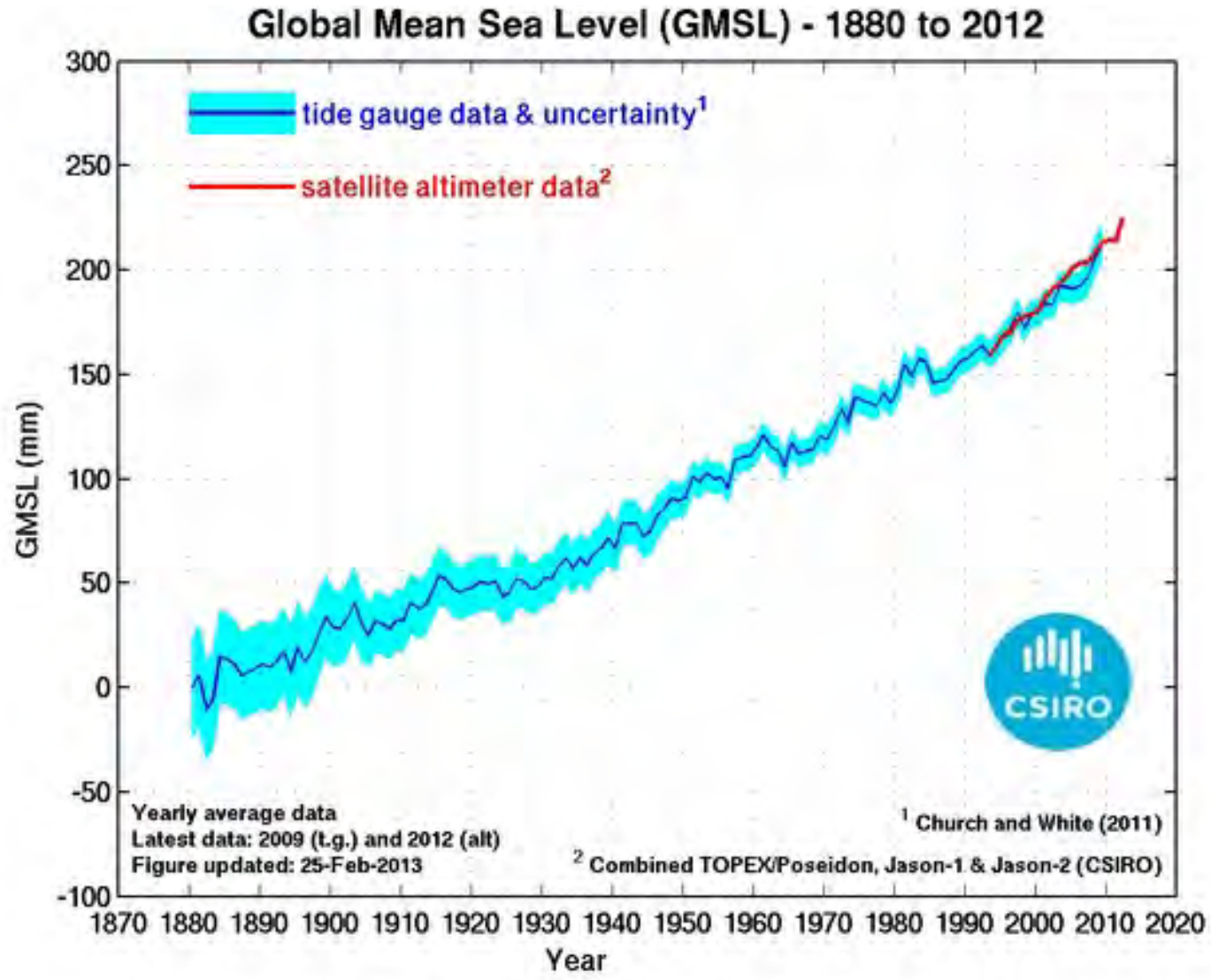
Our changing climate



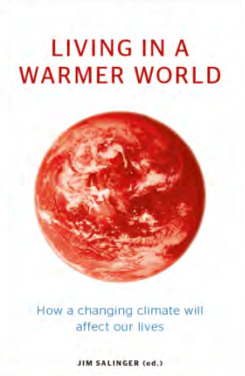
Source: PCE 2014

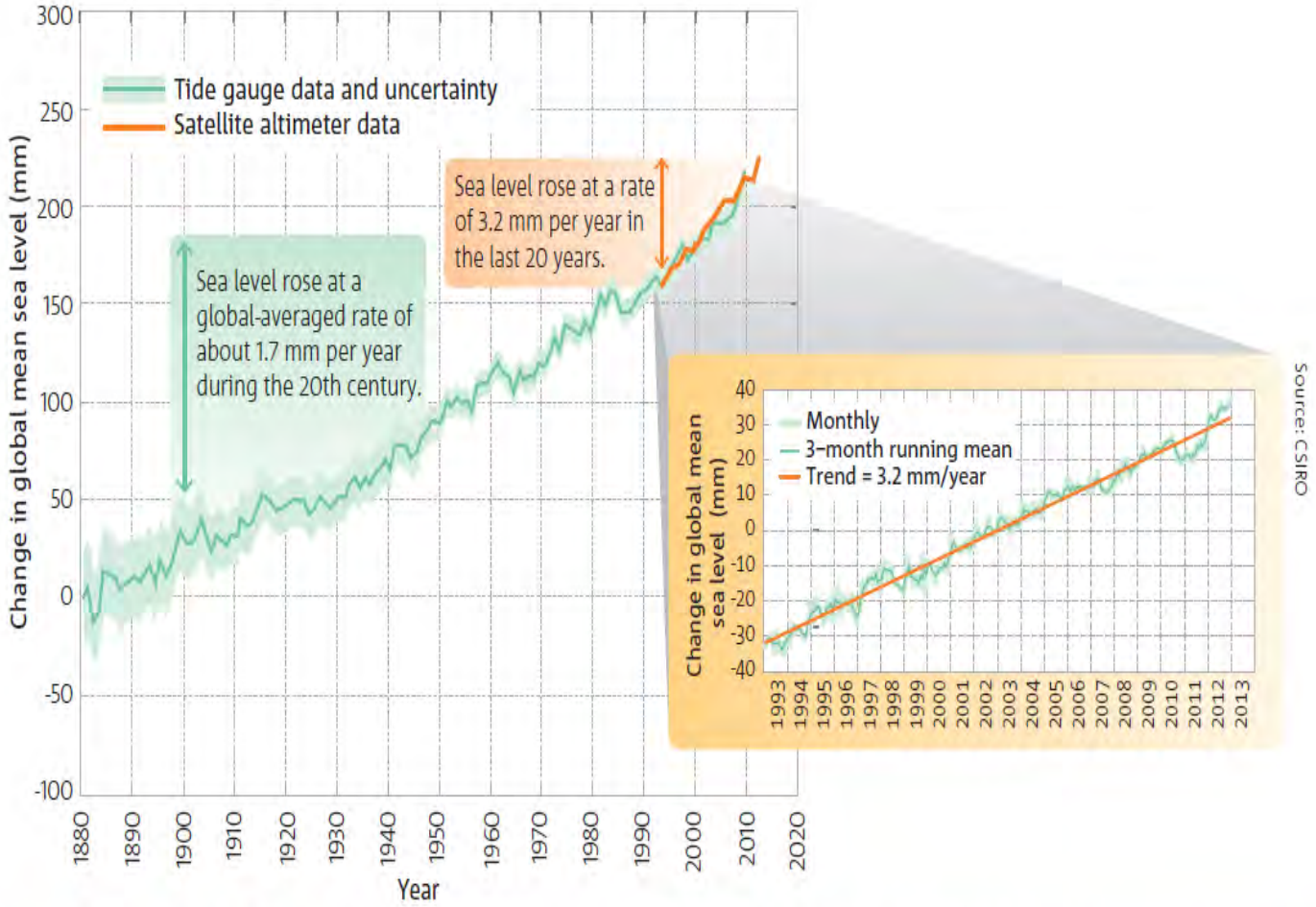
Contributions to Sea Level Rise

Our changing climate



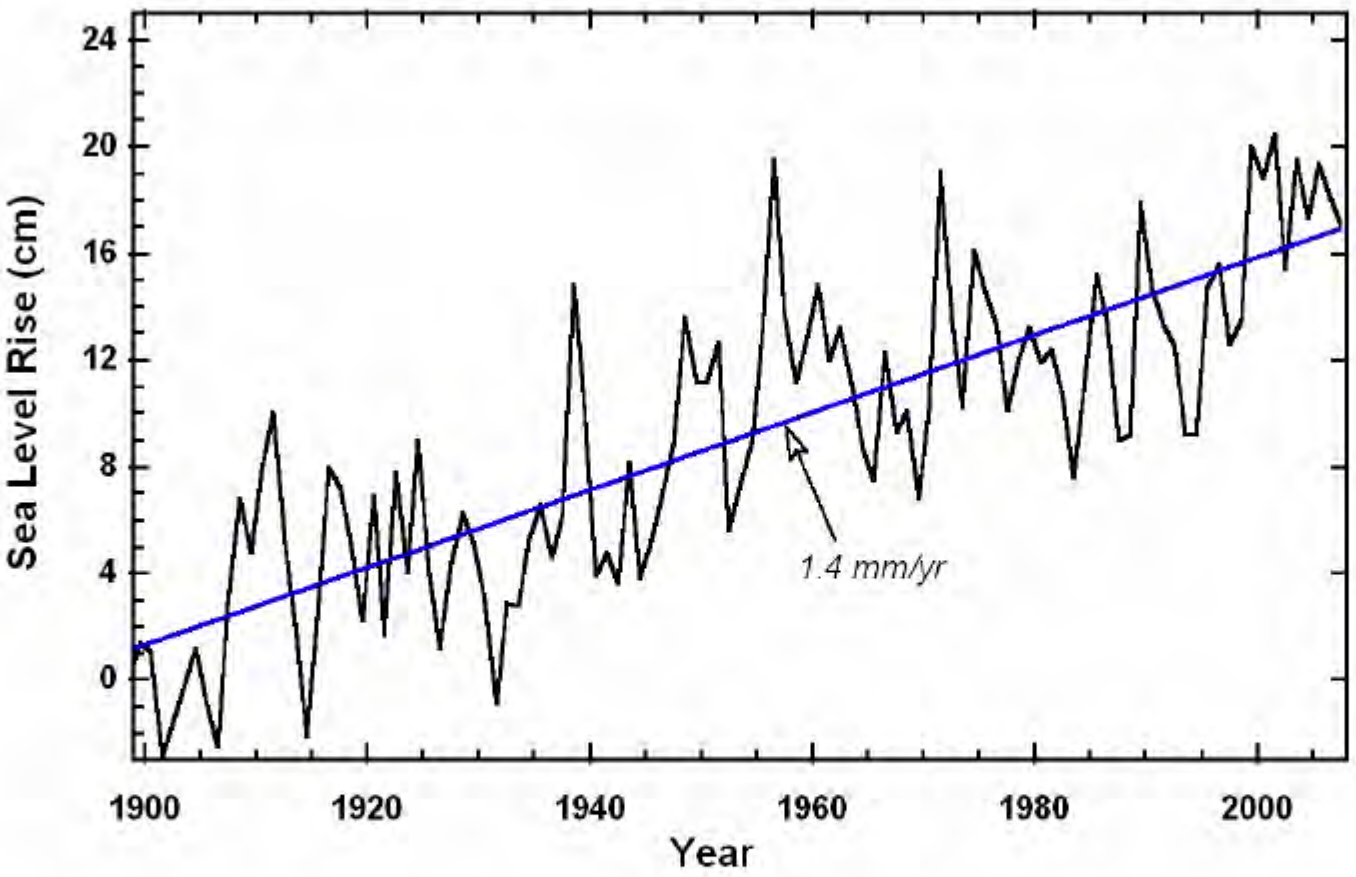
Our changing climate



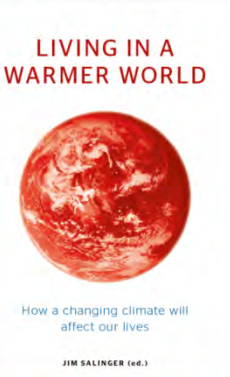


- Sea level has been fairly stable over the last few millennia;
- It has risen 225 mm since 1880; the rate is increasing in the last decades.

Our changing climate

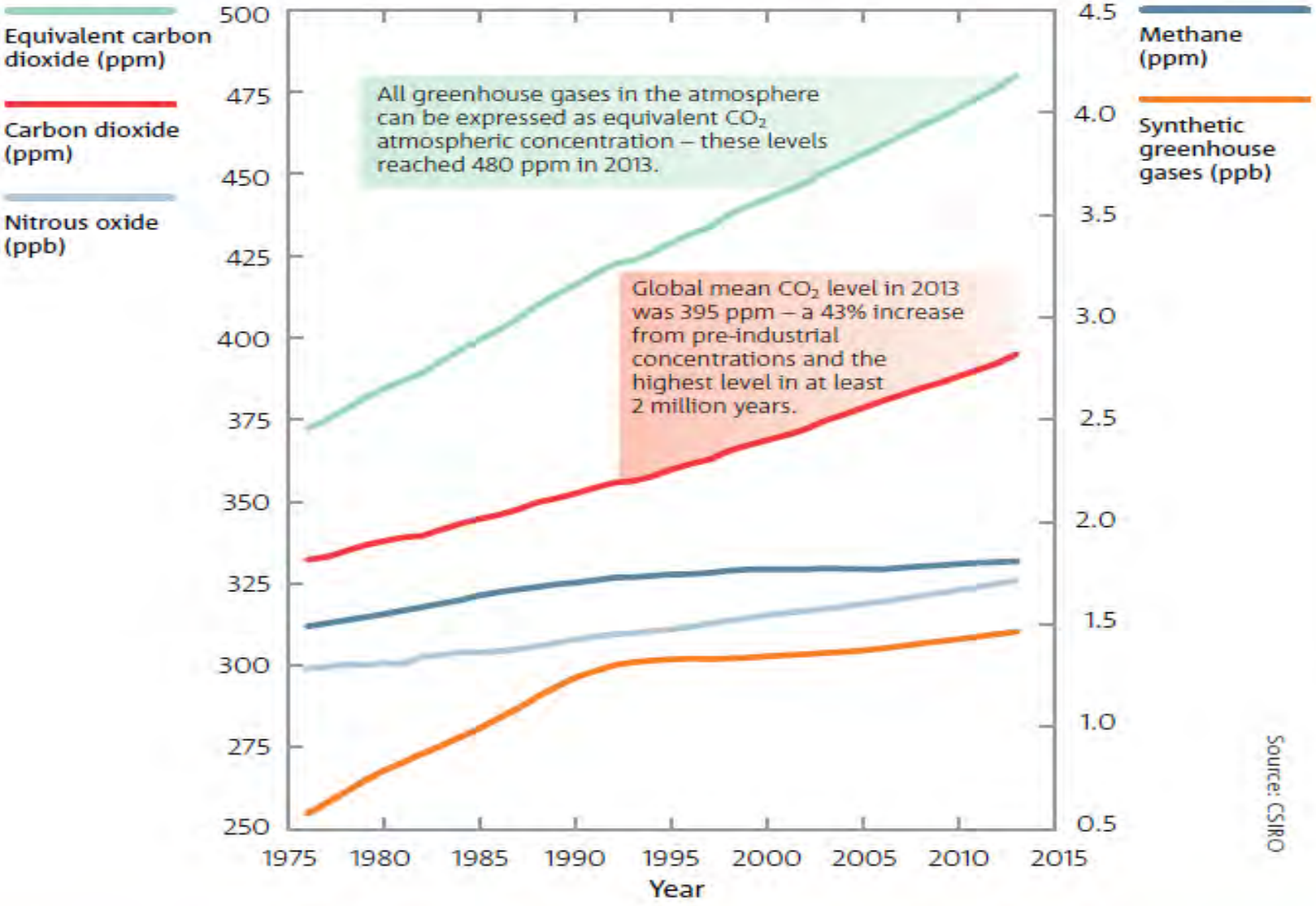


The rise in annual mean sea level (black line) recorded at the Port of Auckland (Waitemata) gauge over the period 1899 to 2007 relative to the mean level around 1900. The long term linear trend of 1.4 mm/yr is shown by the straight blue line.



Port of Auckland tide gauge

Our changing climate

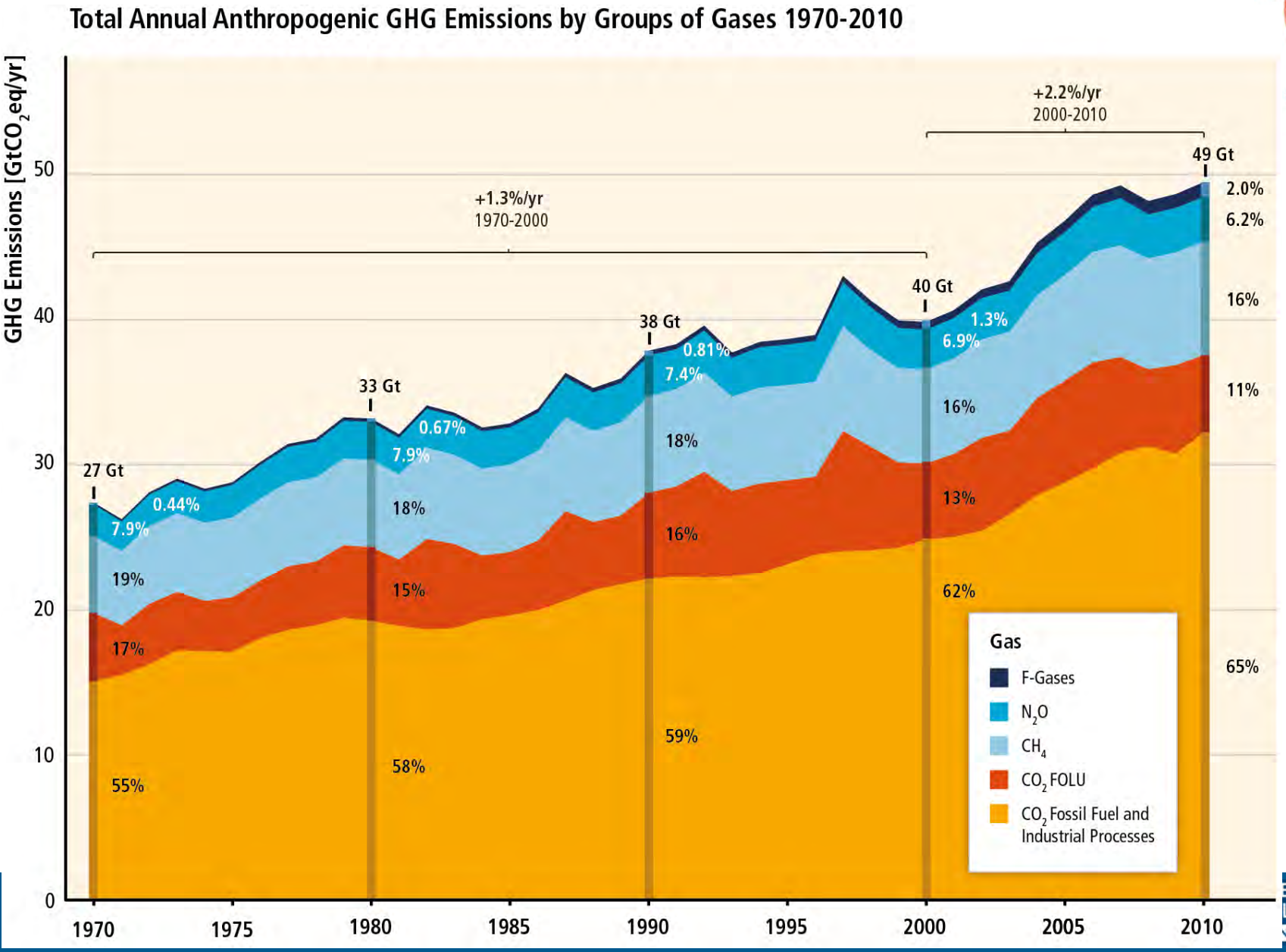


Our changing climate

LIVING IN A WARMER WORLD

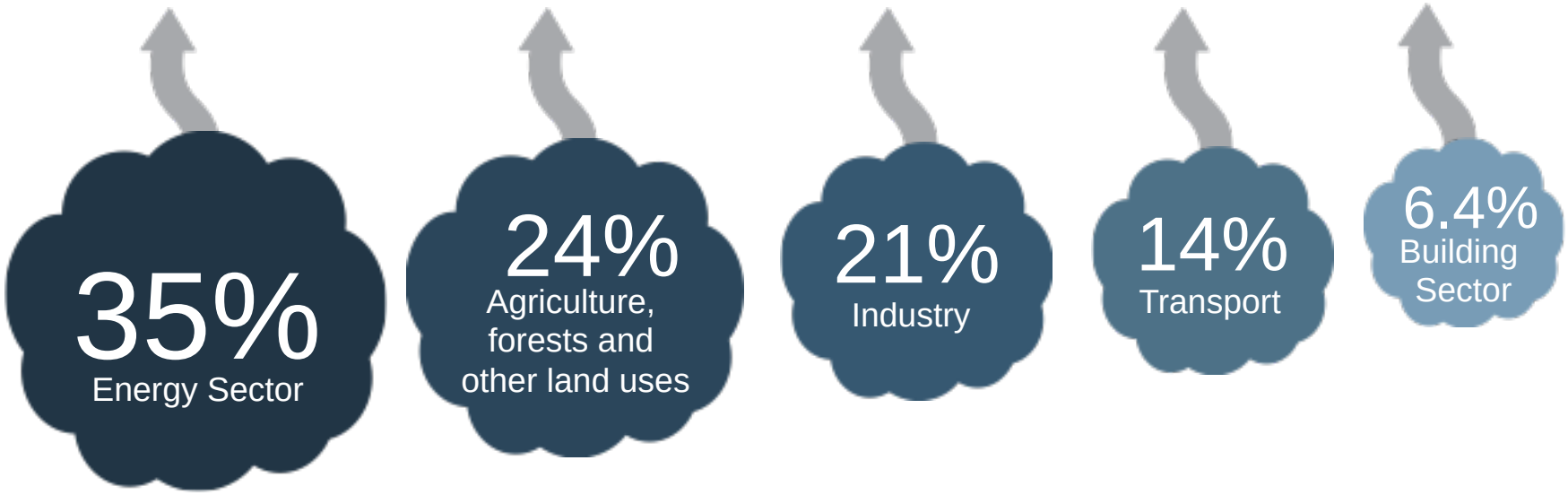
How a changing climate will affect our lives

JIM SALINGER (ed.)



Our changing climate

2010 GHG emissions



Energy production remains the primary driver of GHG emissions

AR5 WGIII SPM

Our changing climate

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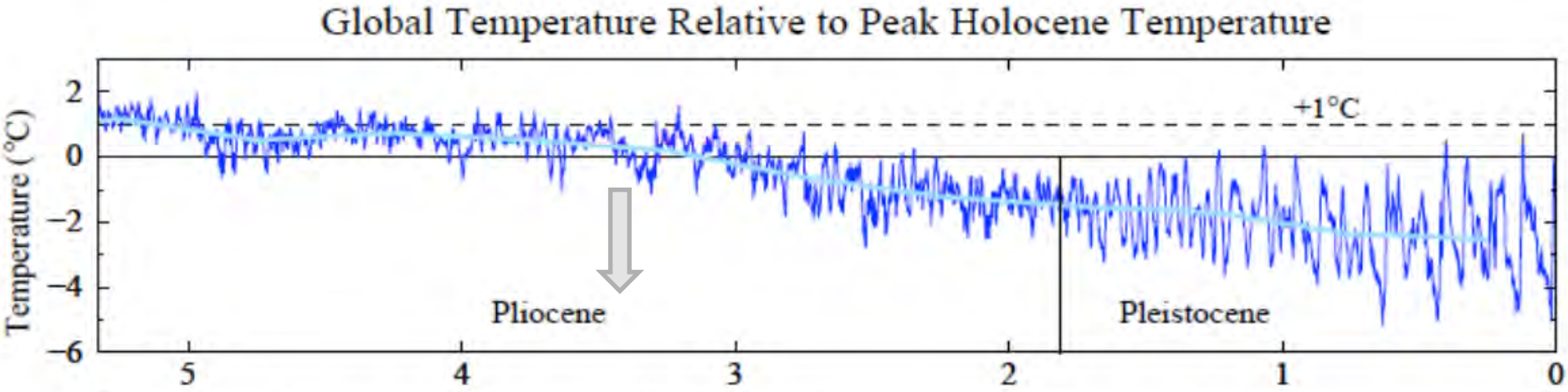
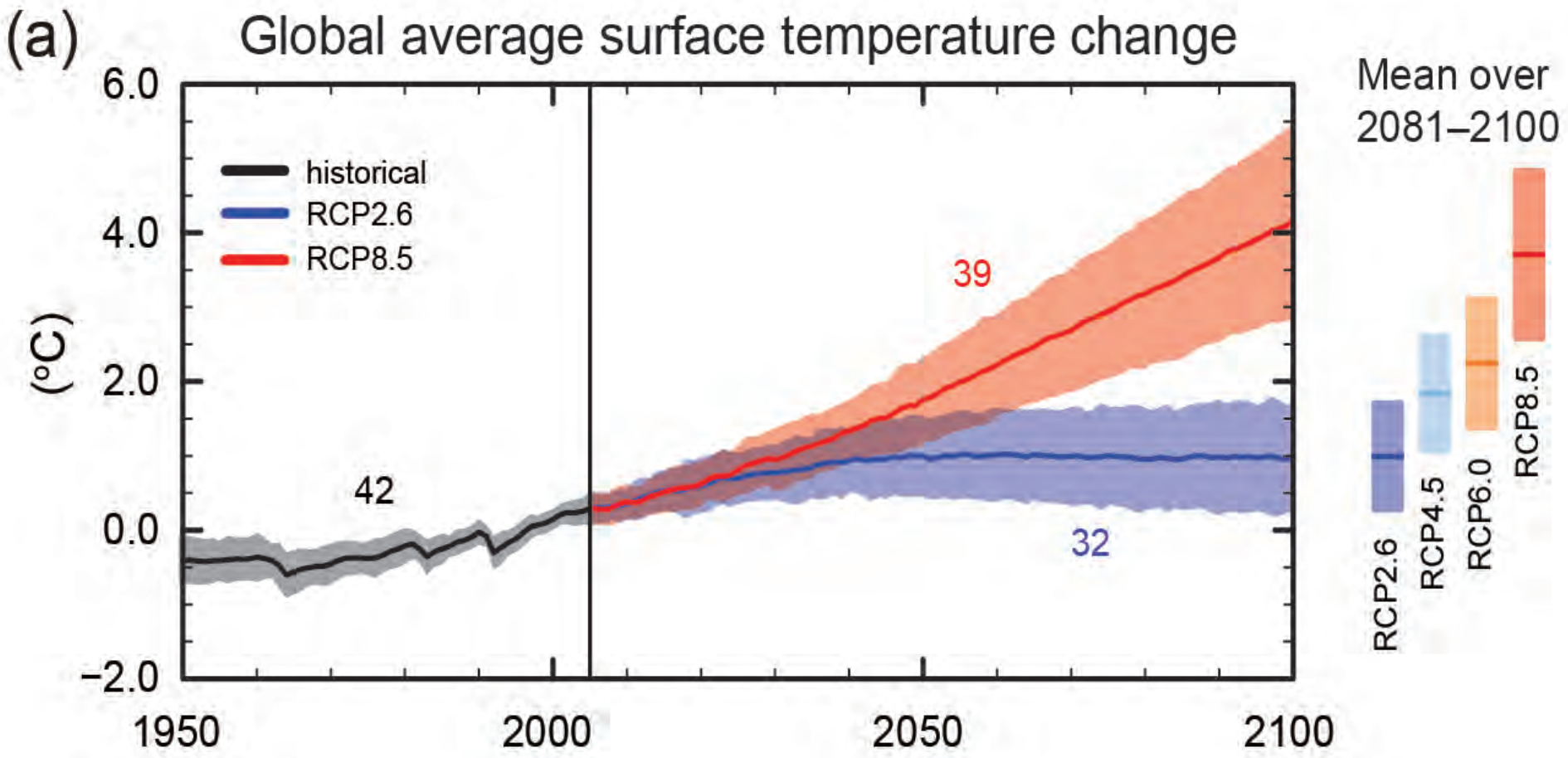


- The Mid-Pliocene (about 3.3 to 3.0 Ma) is the most recent time in Earth's history when mean global temperatures were substantially warmer for a sustained period, at about 2 to 3°C above 1971-2000;
- Atmospheric CO_2 concentrations estimated to be between 360 to 400 ppm);
- Sea level were in the order of 10 metres above modern levels.

Future projections

LIVING IN A WARMER WORLD

How a changing climate will affect our lives



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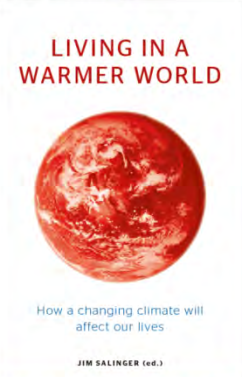
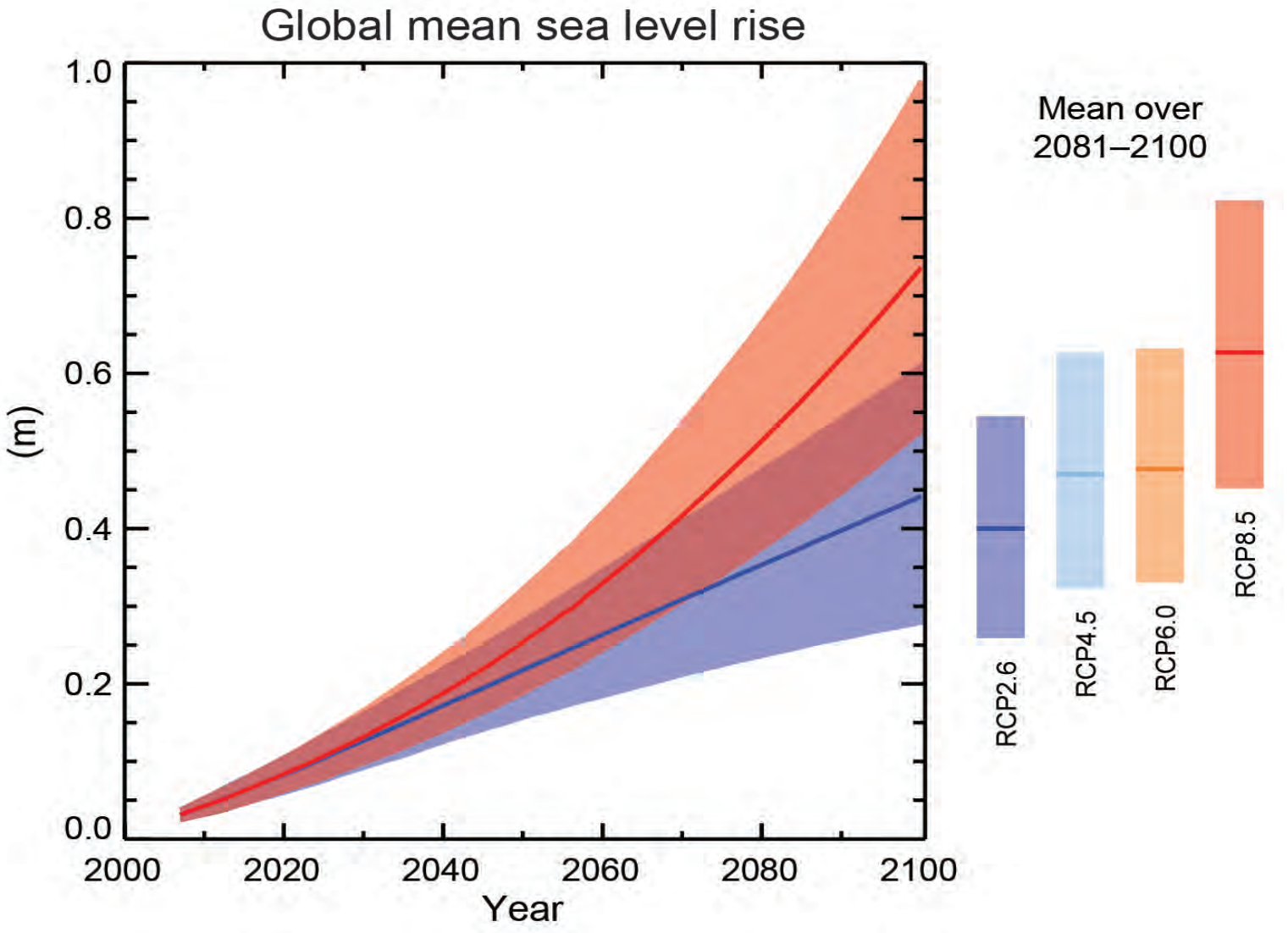
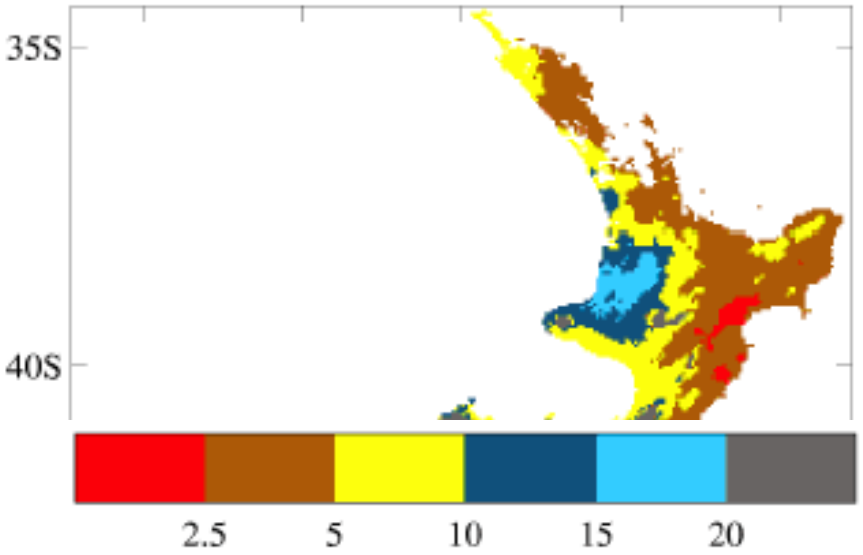
Future projections



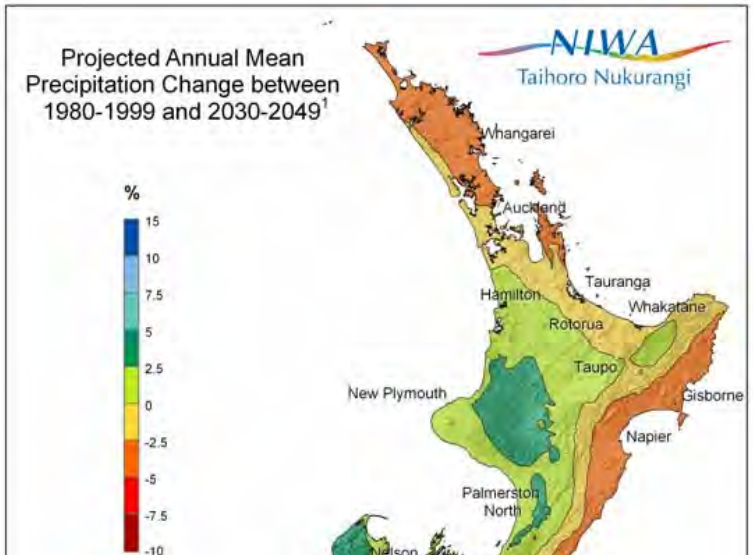


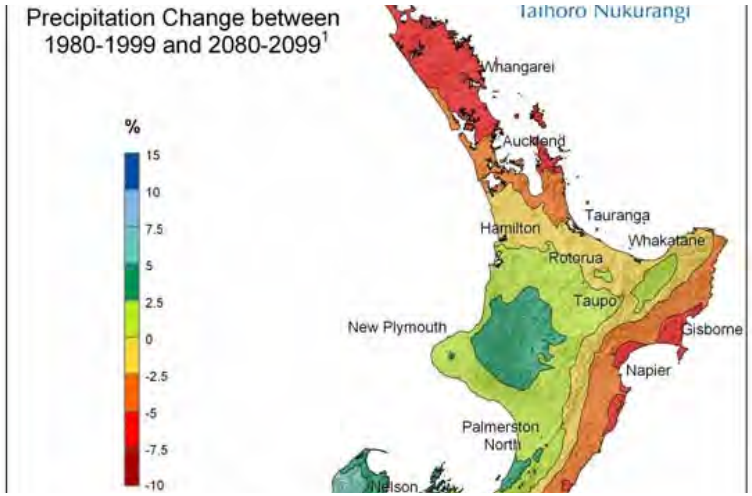
Future projections



2080's drought frequency (years)
For present 1-in-20 year event

- By 2030s about 1°C warmer, less frost, and drier;
- By 2090s about 2°C hotter, drier, more hot days;
- More westerlies;
- Becomes more droughty.





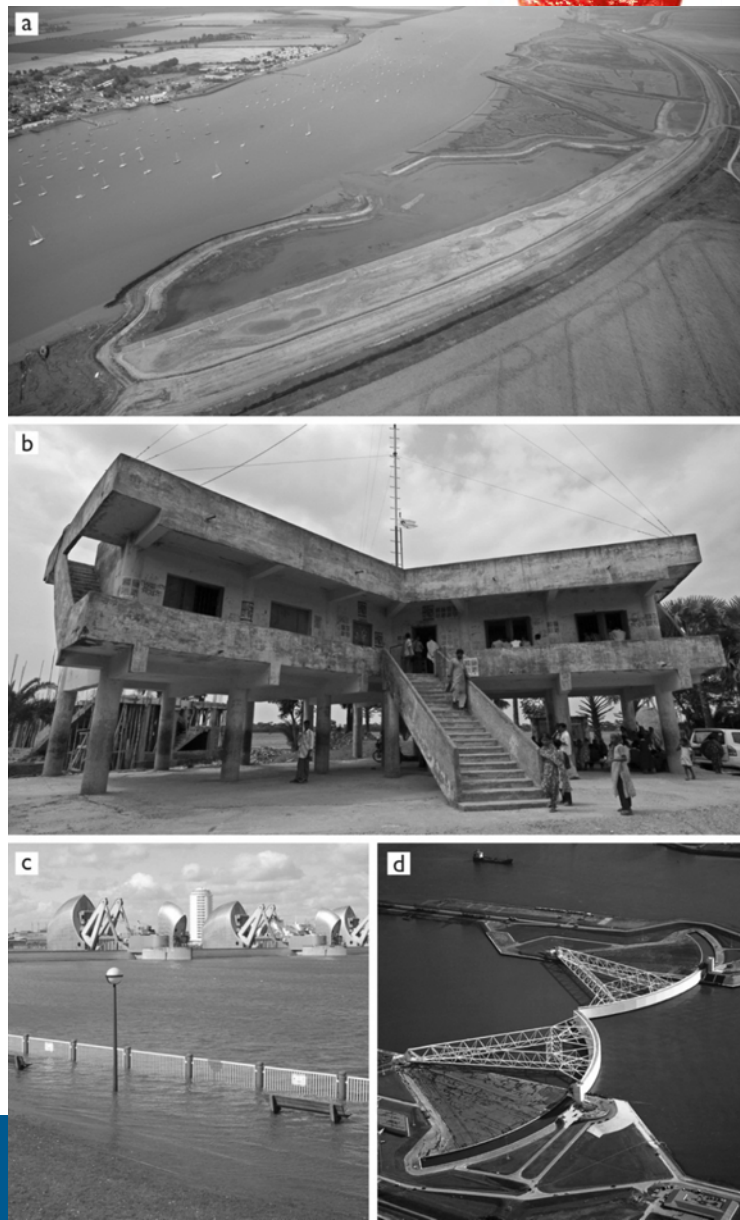
Impacts:coasts

LIVING IN A WARMER WORLD

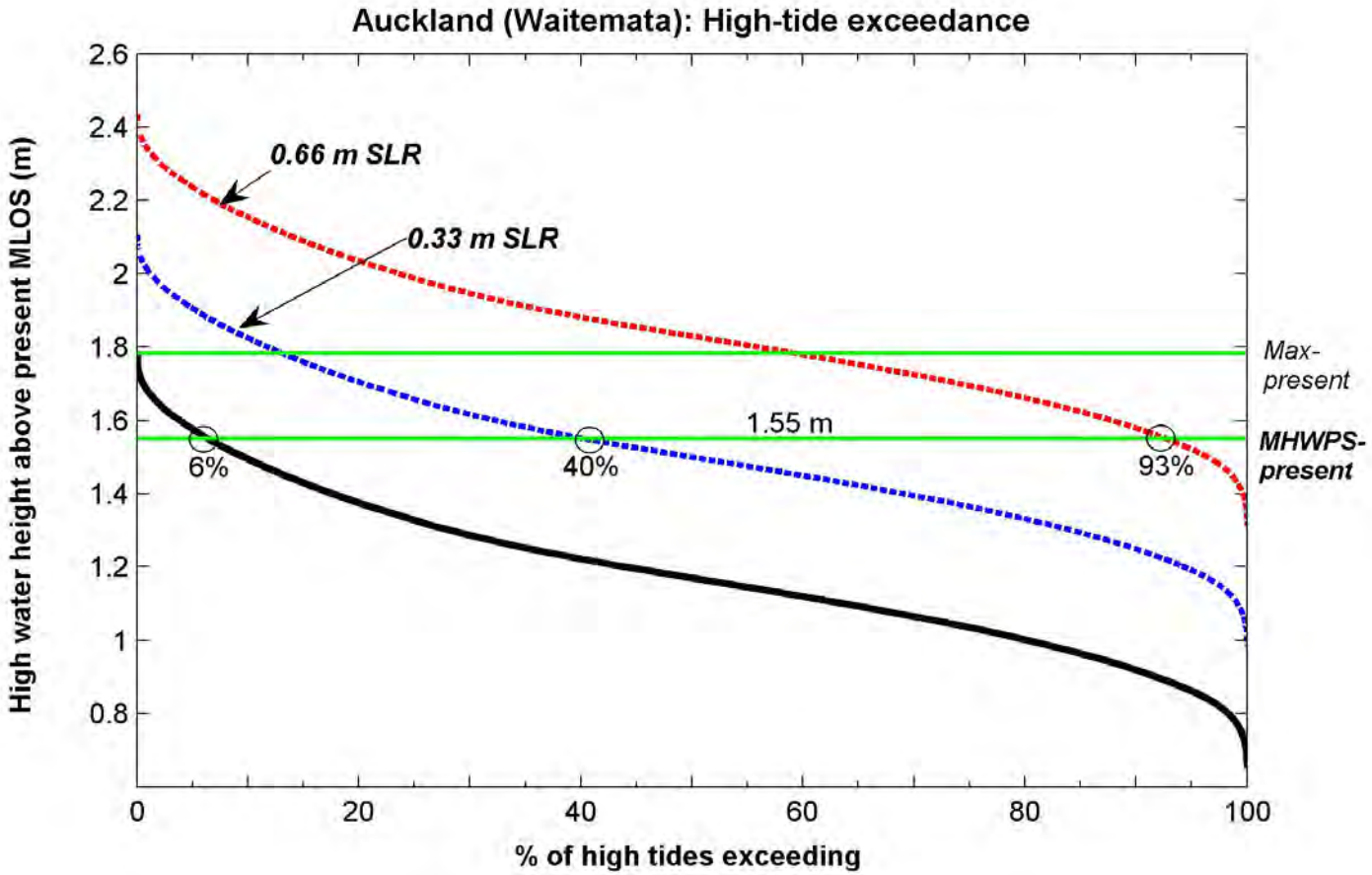
- Sea level is expected to rise between 50 - 120 cm by 2100, then continue;
- Humanity is faced with three adaptations:
  - retreat: abandoning coasts or islands;
  - accommodate: changing infrastructure, plan appropriate use of coastal zones, storm-surge shelters;
  - protect: extending barriers or dykes.

The British Government in the 1990s commissioned a survey of all coastlines and decided where to retreat and where to protect;

- **12 of NZ's 15 largest towns and cities are near or at sea level!**



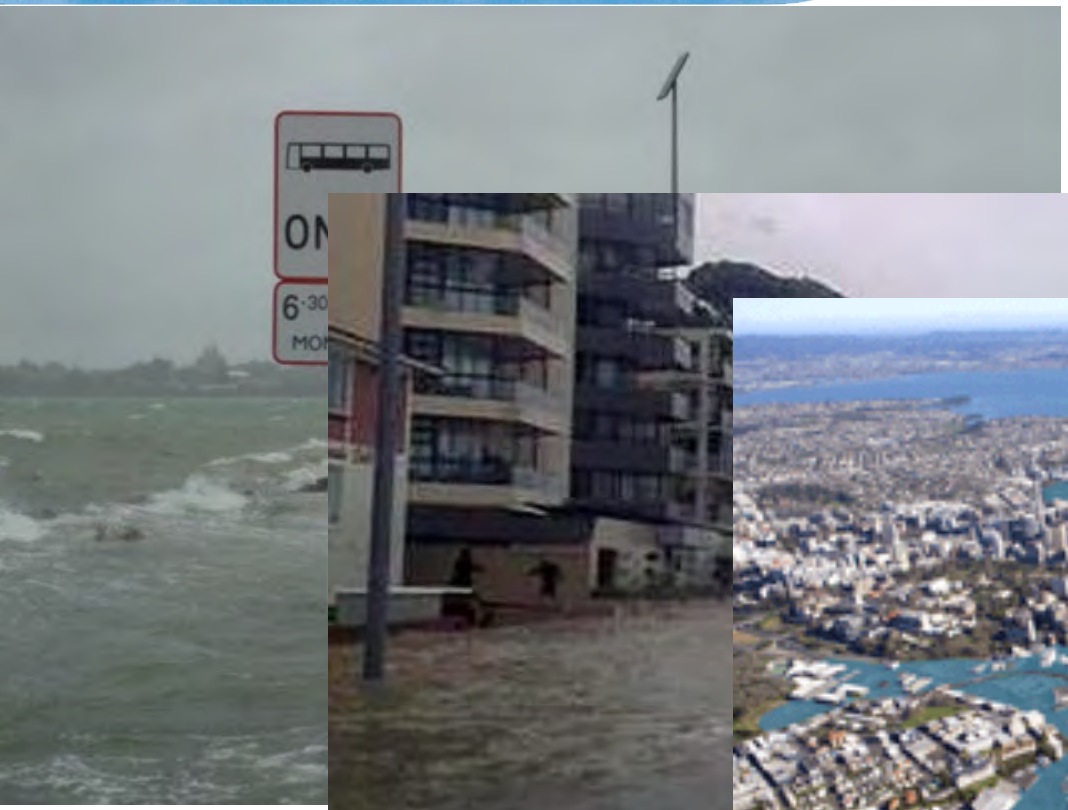
Impacts: coasts



High tide exceedance curves based on a simulation of 100 years of tides at the Port of Auckland (Waitemata Harbour) for the present day relative to mean level of the sea (MLOS - black line) and for a 0.33 m rise in sea level (blue line) and a 0.66 m rise in sea level (red line).

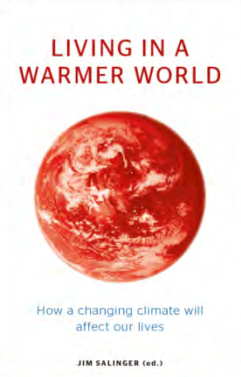
Impacts: coasts

23 January 2011

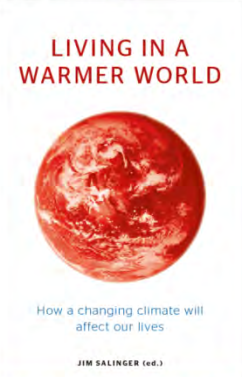


17 April 2014

3 metre rise

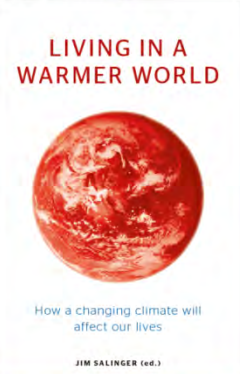


Impacts: coasts



Climate change impacts on Mean High Water Spring and 1% Annual Exceedance Probability water levels Auckland harbour frontage determined for the 2150s red (continuous line along coast) and orange (land areas below contour) relative to the present day.

Impacts: infrastructure



Duration – Frequency for Manukau (Auckland) for 2080s, for mid-range emissions temperature scenarios

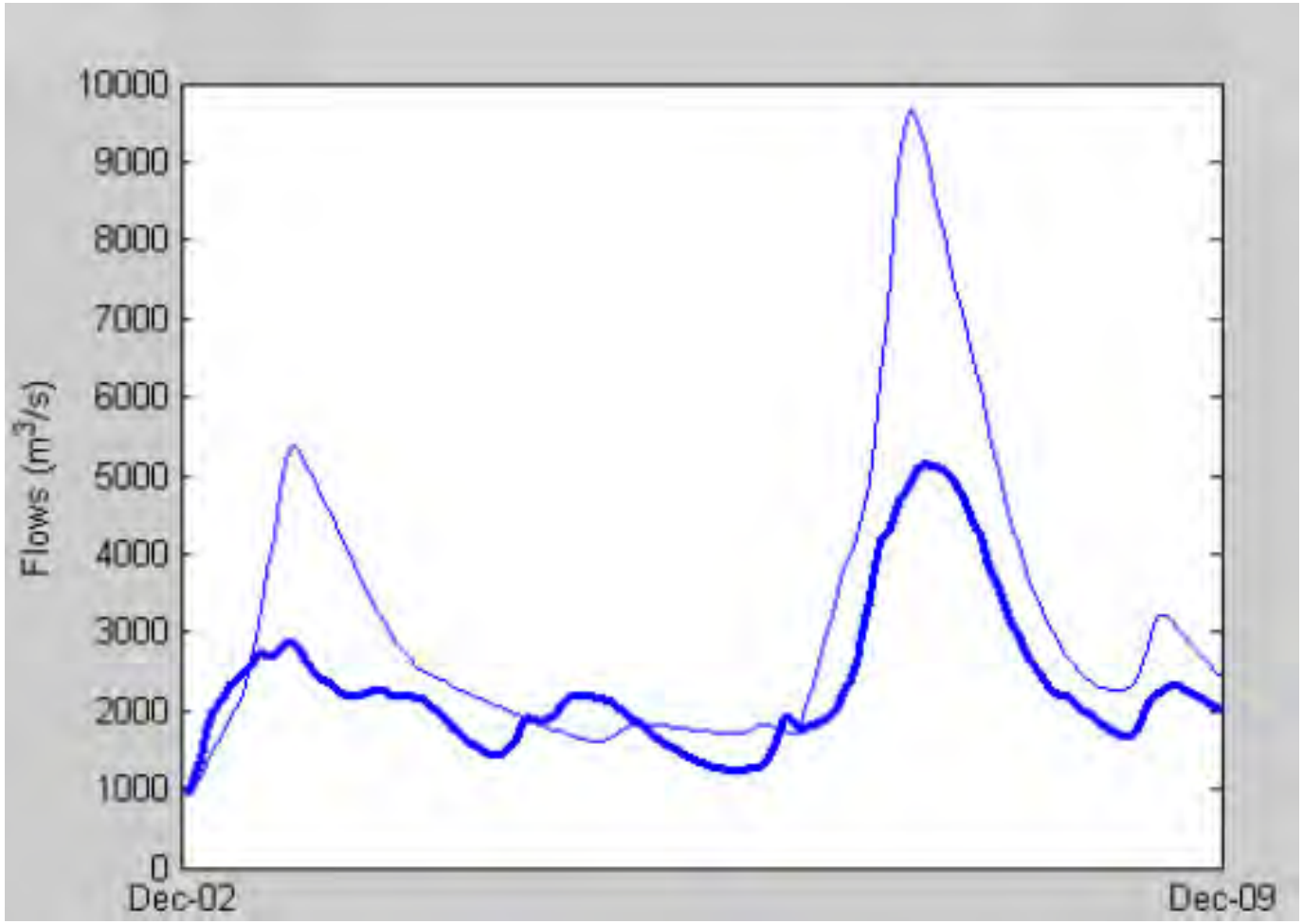
Pakuranga

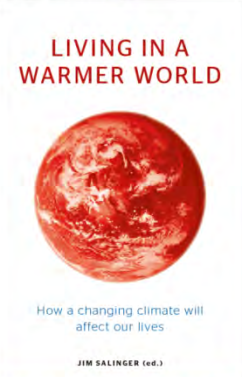
ARI (y)	10m	20m	30m	60m	2h	6h	12h	24h	48h	72 h
2	71	49	40	27	18	8	5	3	2	1
5	92	63	52	**37**	24	11	7	4	2	2
10	106	73	60	43	29	13	8	4	3	2
20	119	82	67	49	33	15	9	5	3	2
50	136	94	77	58	39	18	10	5	3	3
60	140	96	79	59	40	18	11	5	3	3
80	145	100	82	61	41	19	11	6	3	3
100	149	102	84	63	43	19	11	6	3	3

E.g. a 1-hour 20-year event at Pakuranga of **37** mm/hour is expected to have a recurrence interval of about 5 years by the 2080s – frequency quadruples on today!

Engineering Quality Standards (EQS) which outlines the functional requirements and design standards - design rainfall intensity curves on which the design of stormwater infrastructure and road drainage works relies.

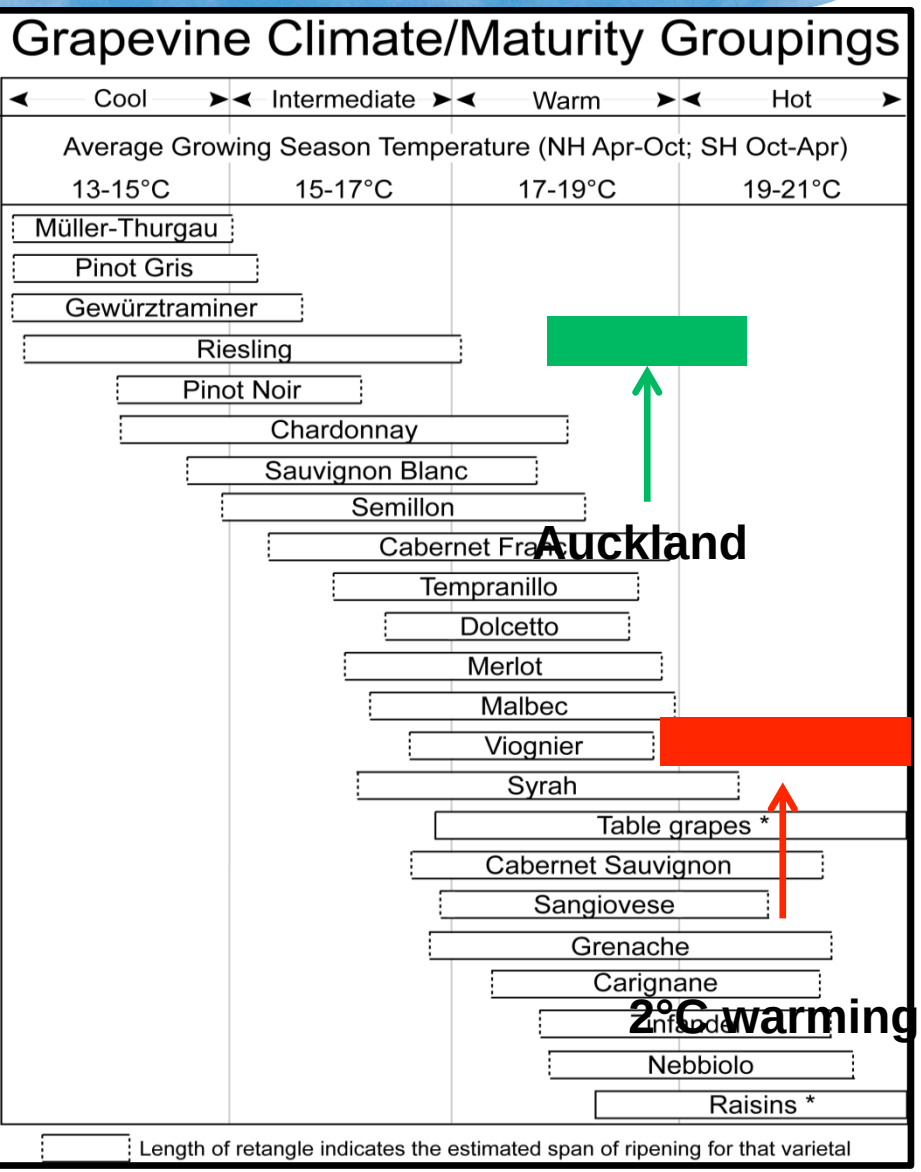
Impacts: infrastructure

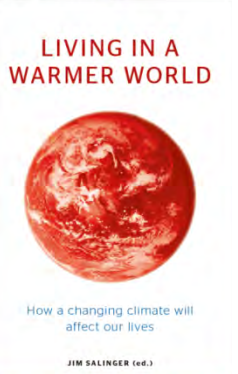




Example of present day (bold) and 2080s flood flow (Westport)

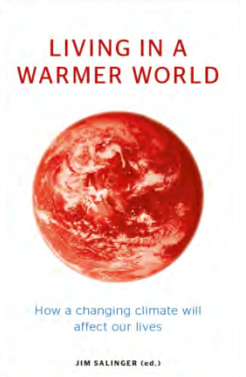
Agriculture: Wine



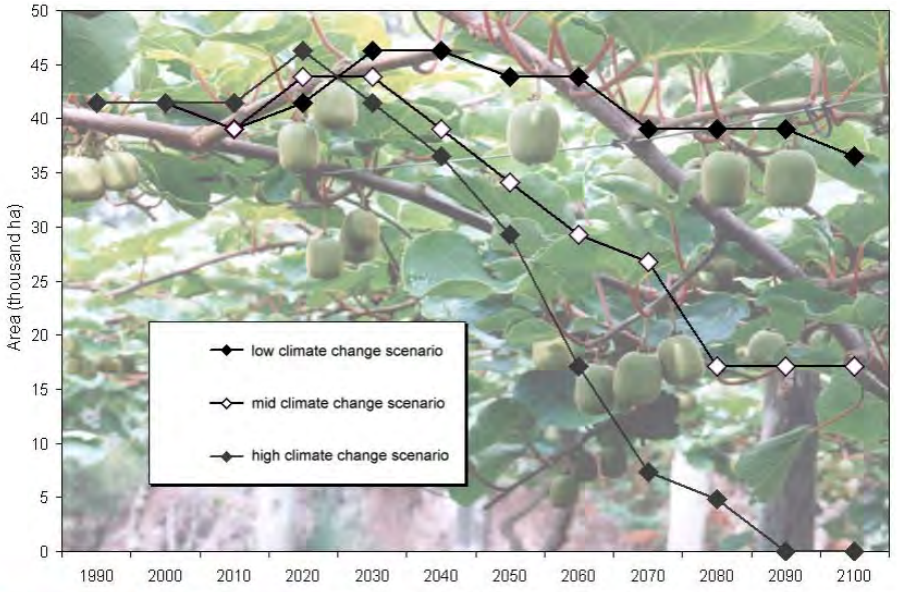


- Wine production limited to 13 – 21°C growing season;
- Outside this range wine growth is possible, but quality poor;
- Auckland with 2°C warming is 19 - 21°C for the growing season;
- Wine styles will be Grenache through to raisins;
- Warmer climate brings more pest and disease pressure.

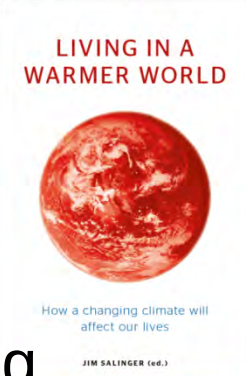
Agriculture: Crops



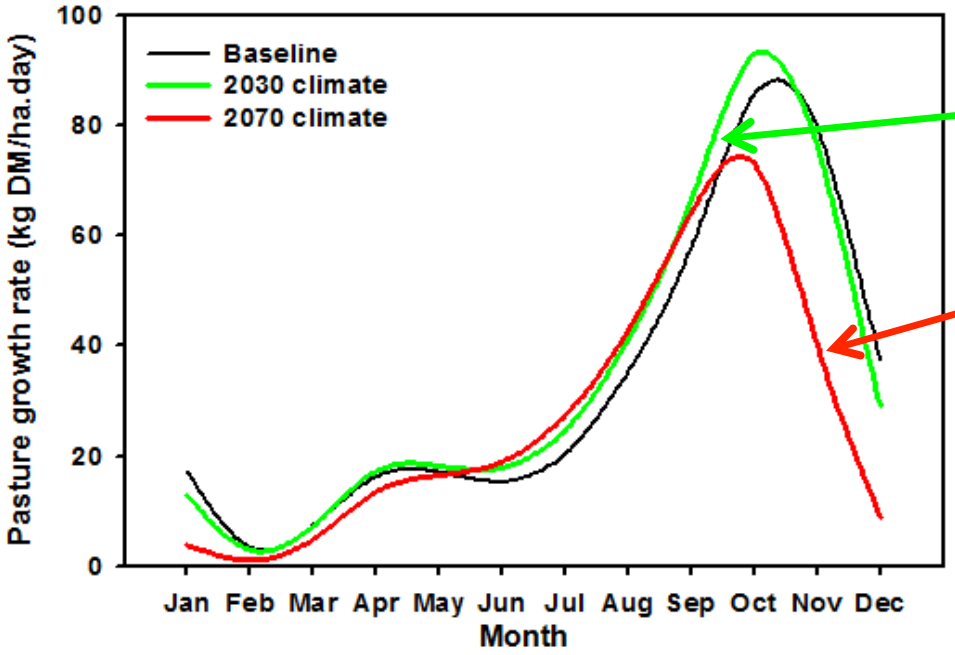
- Hayward kiwifruit production may become uneconomic in Auckland over the next 50 years, due to a lack of winter chilling;
- Sub-tropical crops such as avocados and citrus will benefit from a trend towards warmer average conditions;
- Some tropical fruit crops can presently be grown in localised micro-climates in Auckland but it is likely that opportunities for these crops will increase.



Agriculture



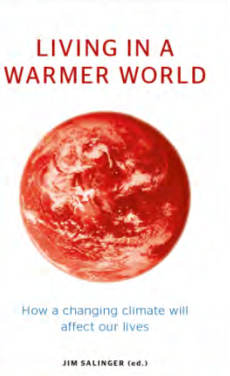
Pasture production SE Australia



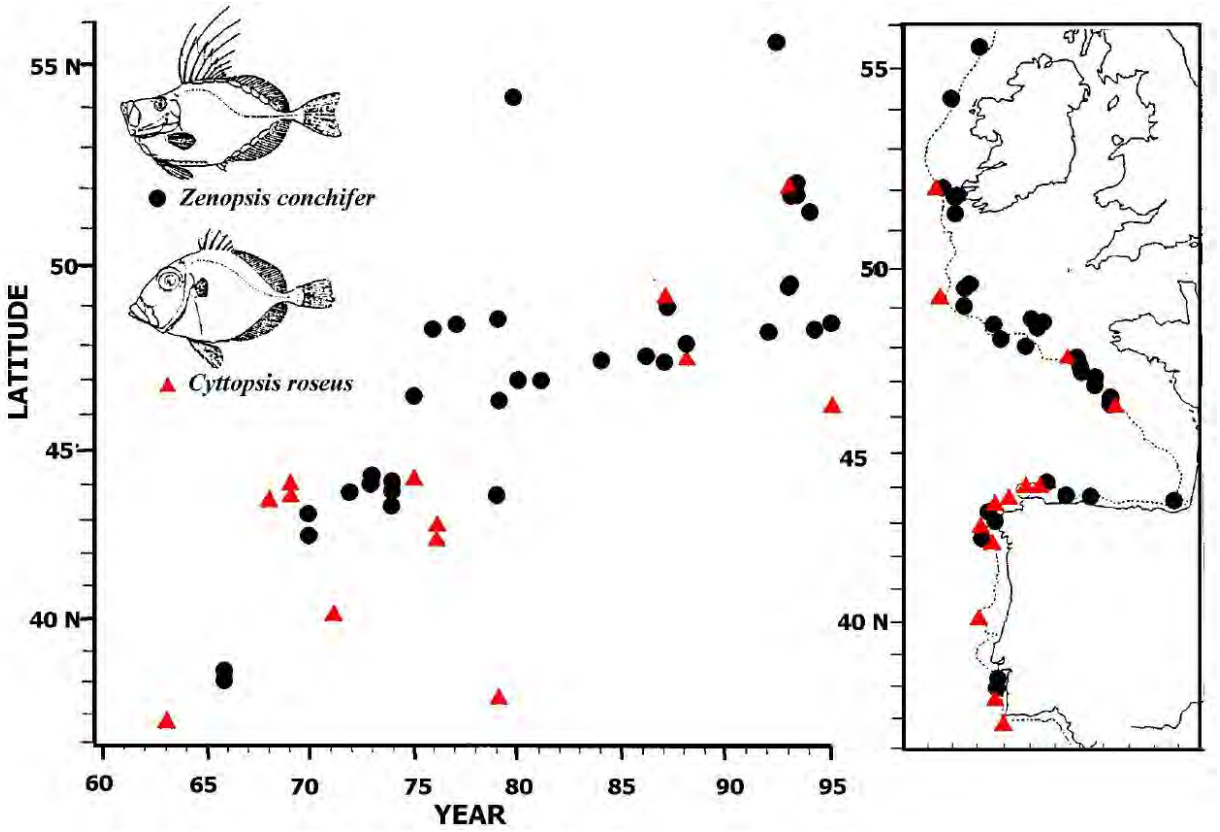
- For pastures, warming produces little change in lower rainfall temperate regions;
- With more warming yield lowers quite dramatically;
- Less productive subtropical grasses more dominant (paspalum, kikuyu);
- Several pest plants, such as lantana, could become a serious pest.

Fisheries


CAPE RODNEY
CUVIER ISLAND
RED MERCURY ISLAND
MURIWAI
AUCKLAND
THE ALDERMEN ISLANDS
PORT WAIKATO
HOMUNGA POINT


LIVING IN A WARMER WORLD
How a changing climate will affect our lives
JIM SALINGER (ed.)

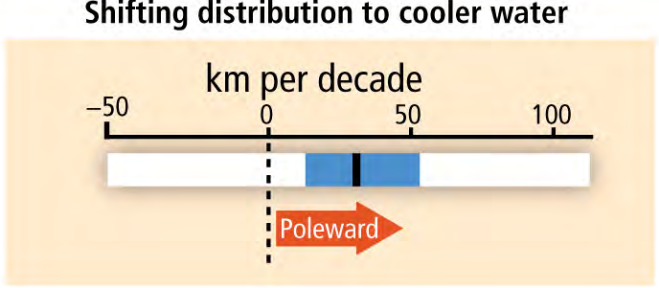
Fisheries

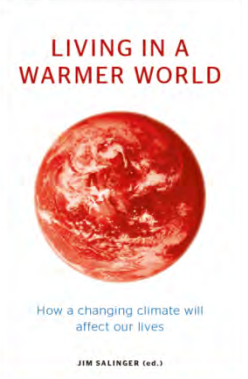


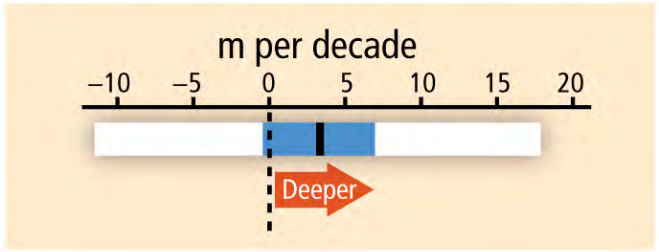
- Fish are moving poleward, life cycles changing with warming;
- Oceans are becoming more acidic;
- Climate warming only one of several pressures on fisheries.

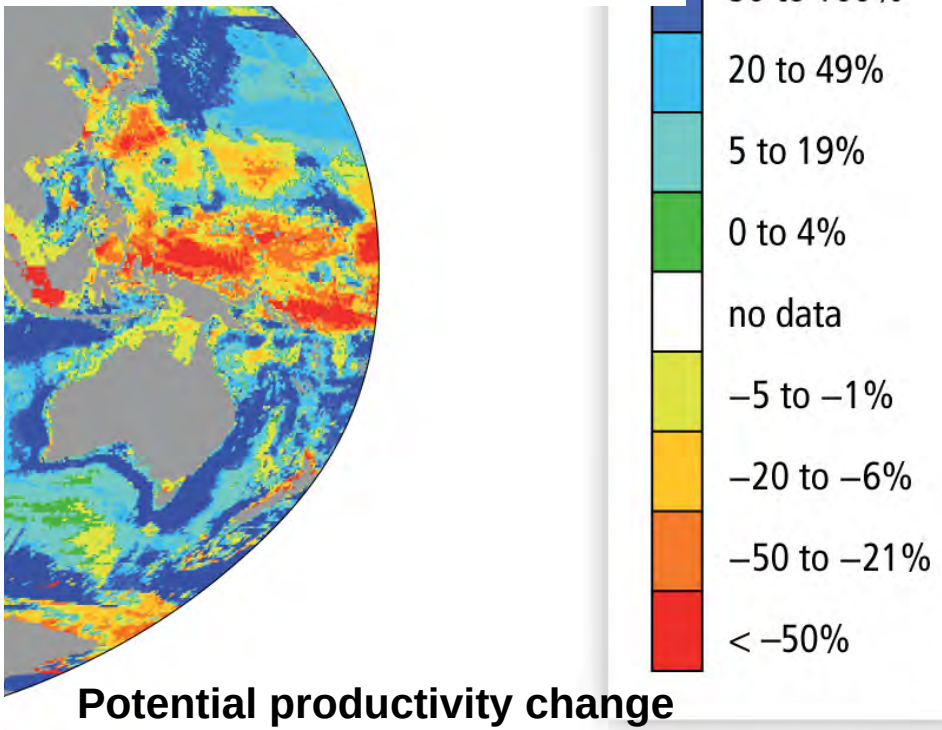
Fisheries

- Rising ocean temperatures and ocean acidification are altering marine life;
- Local fisheries will migrate south;
- Shell fisheries may be threatened as seas become more acidic;
- Reducing fishing pressure a triple win – more resilient populations and marine life.



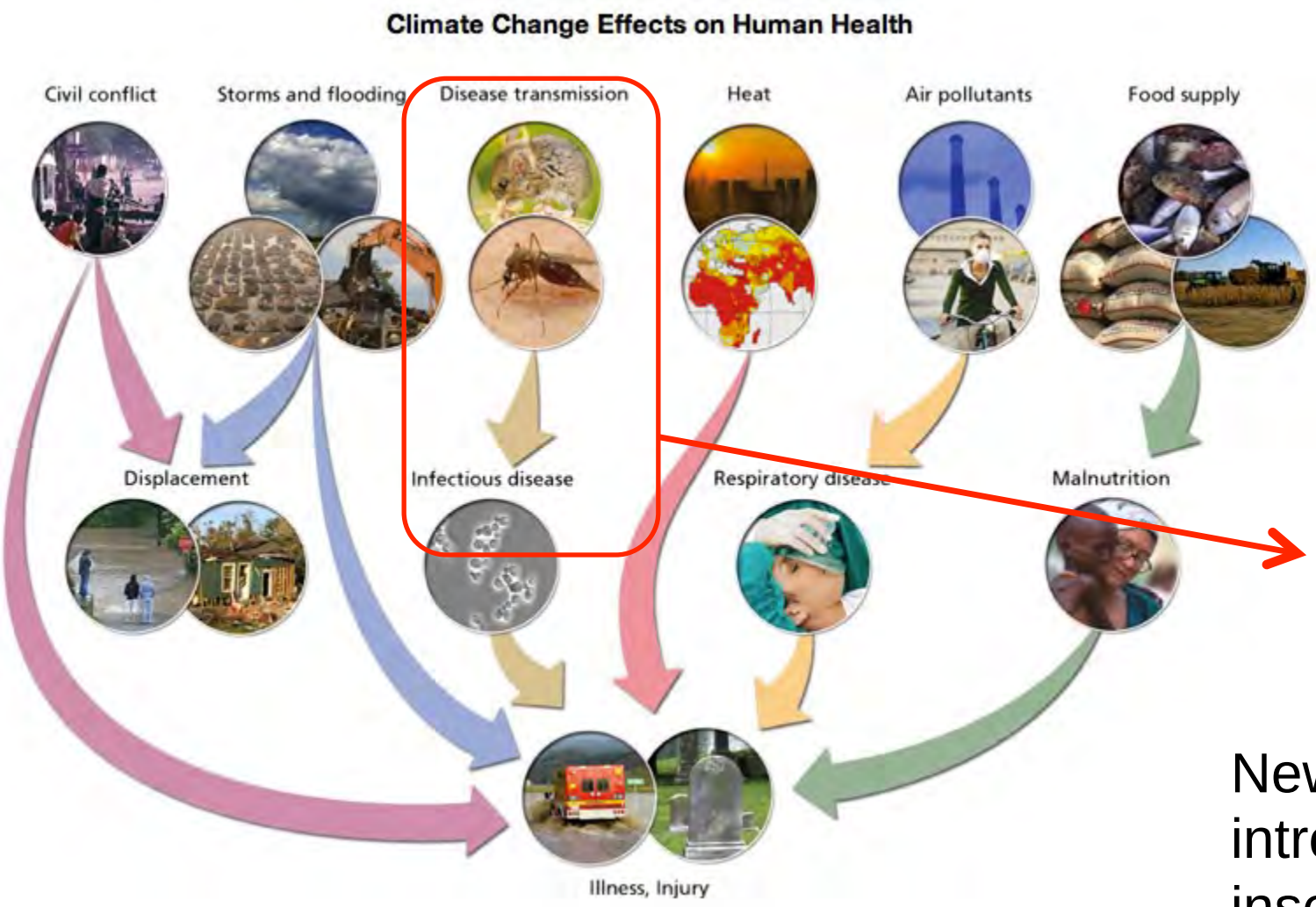






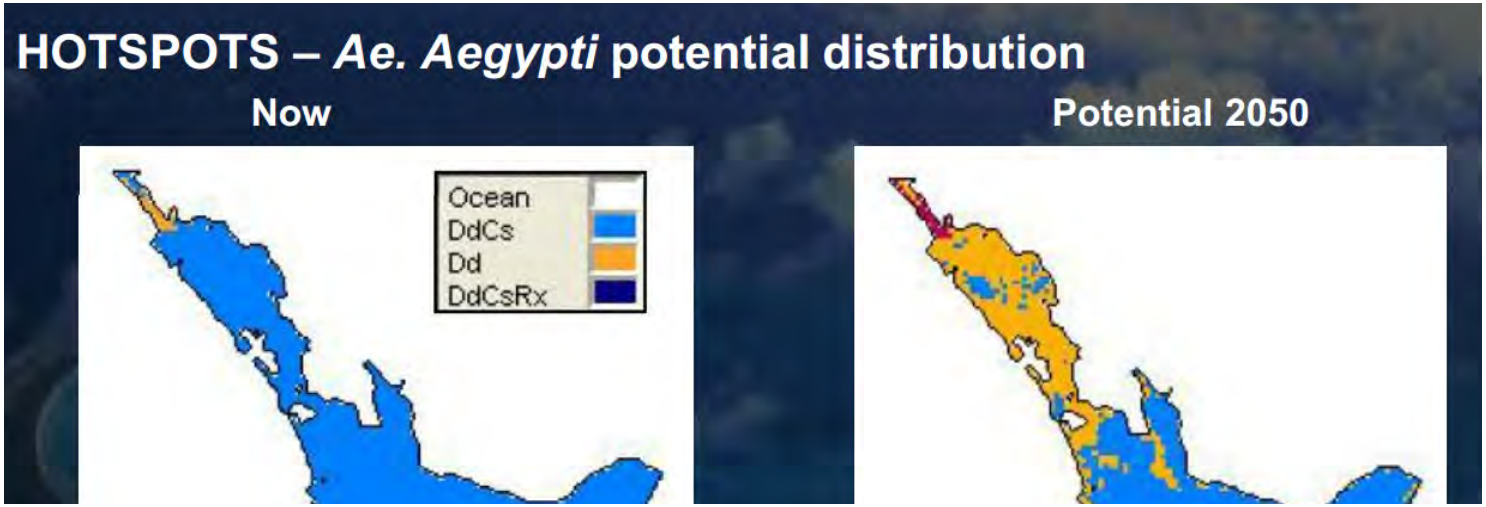
Potential productivity change

Health



New diseases introduced by insect vectors – e.g. dengue

Health



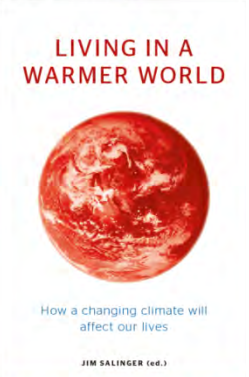
Temperature increase

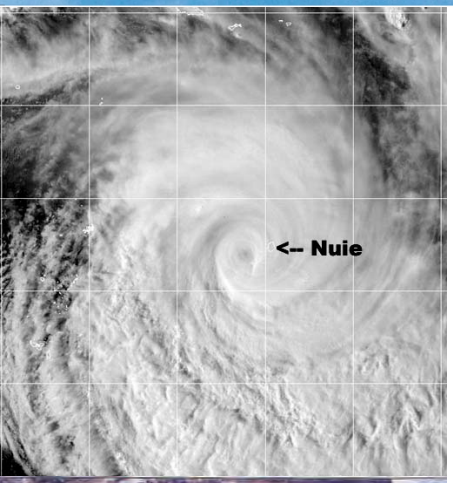
- Increases biting activity;
- Increases reproductive rate therefore abundance;
- Extends or intensifies transmission season – impacts age groups exposed;
- EIP – 7 days at 32°C, 21 days at 13°C

Rainfall changes

- Increased rainfall can increase mosquito abundance;
- Decreased rainfall can also increase abundance through water storage behaviours.

Pacific climate change

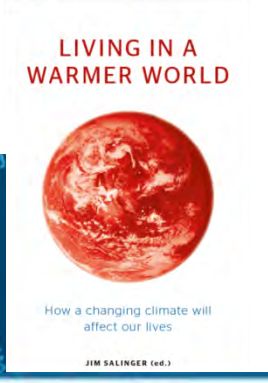




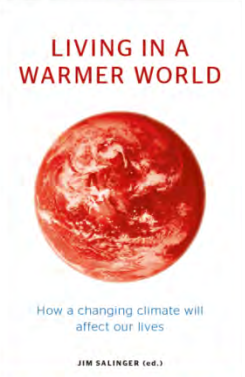
- Cyclone Heta on Tonga, Niue, and American Samoa was estimated at $150 million dollars (2004 USD);
- Heta precipitated a massive relief and clean-up operation that lasted throughout 2004;
- New Zealand's 20,000-strong Niuean population (mainly in Auckland) raised funds and providing volunteers to help in Niue;
- The Pacific is Auckland’s front yard – disasters in the Pacific impact.

Pacific climate change

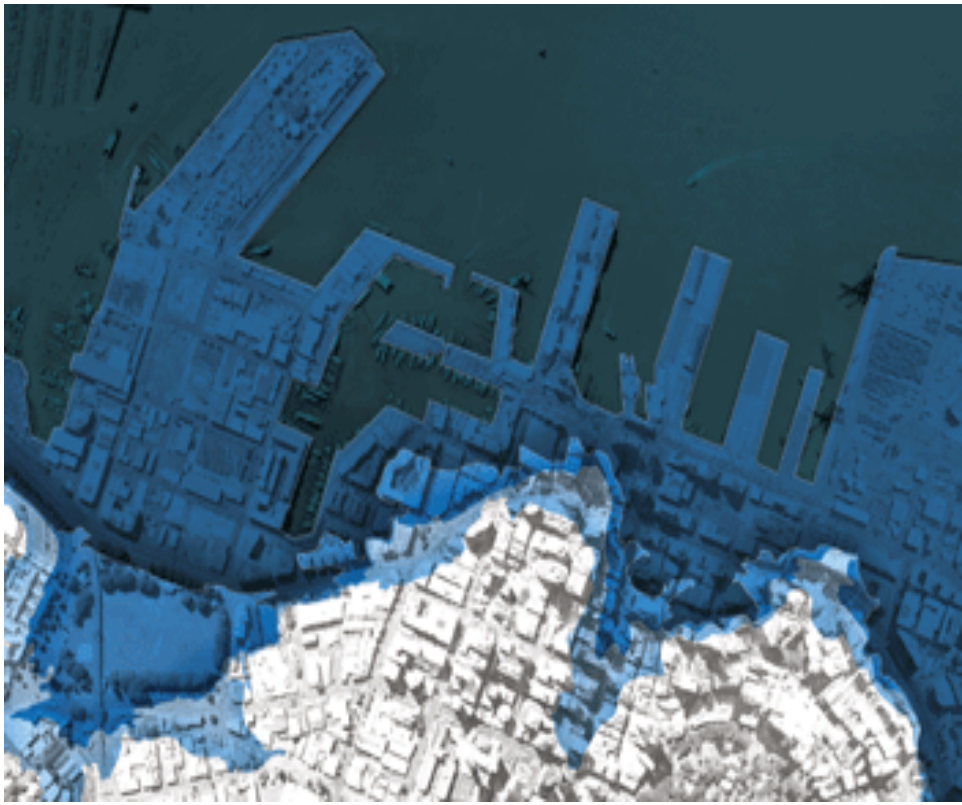
- Pacific communities very connected to homelands;
- Auckland Pacific communities need to be strong to assist build resilience;
- Build resilience and allow people to stay in their homes, but the risk of displacement and relocation is a Pacific reality;
- Planning for response when movement is unavoidable;
- The Pacific is Auckland's front yard – building capacity now is high priority.



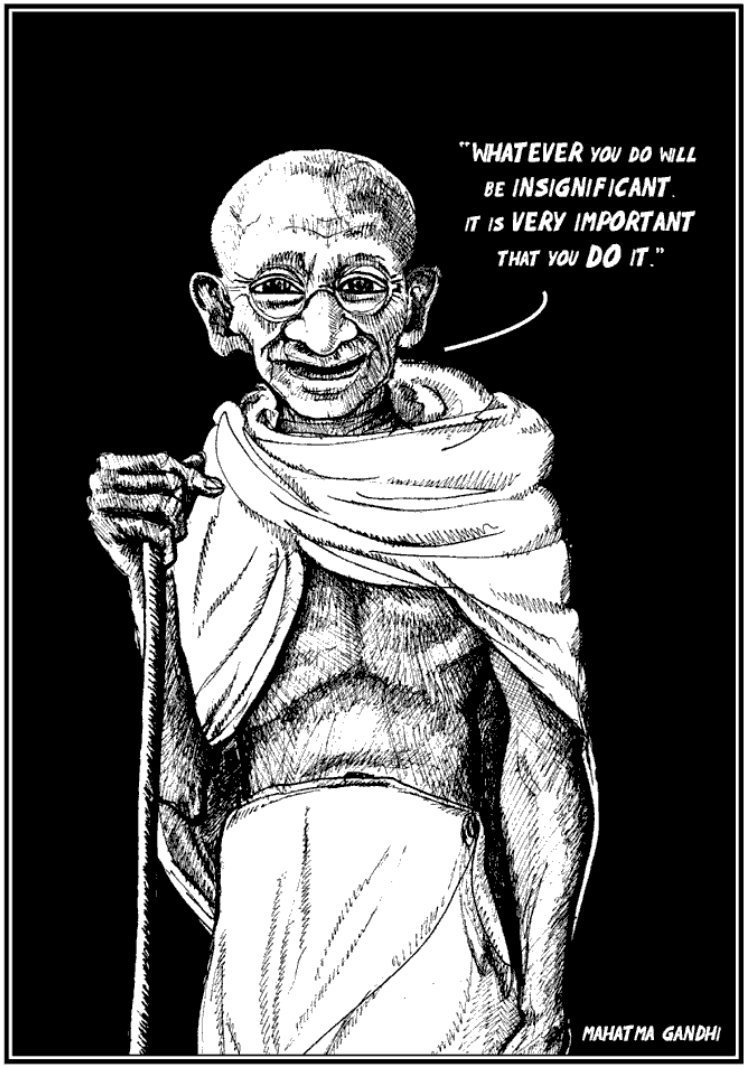
Concluding remarks

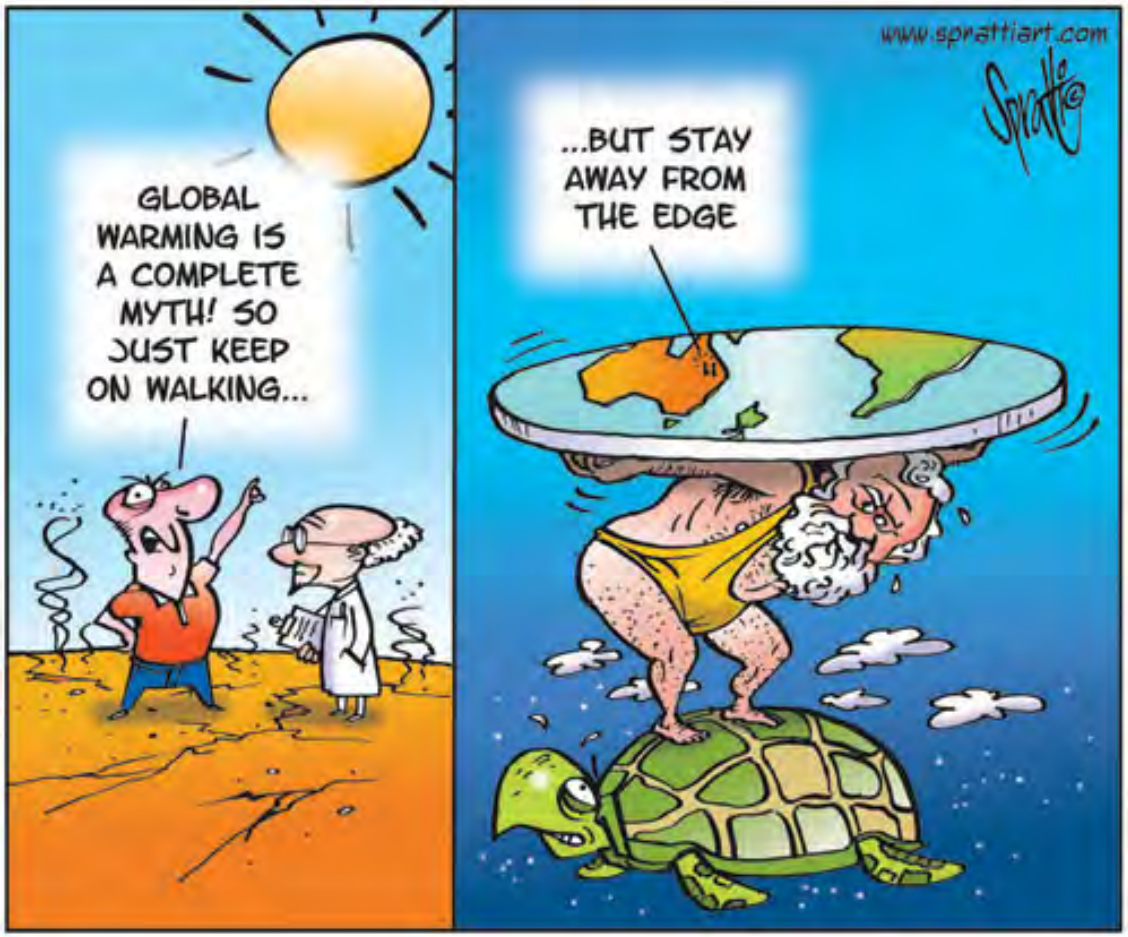


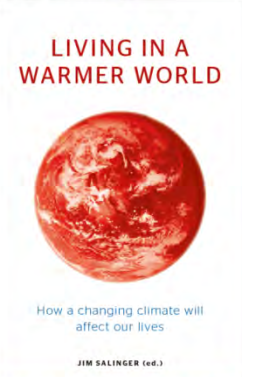
- Increases in greenhouse gases are causing the climate system to warm;
- Observations show unequivocal warming of the climate system;
- Auckland temperatures have warmed about 1°C in the last 100 years;
- Sea level rise from 1899 to 2014 is in the order of 18 cm;
- Temperatures are projected to increase 2°C or more by 2100;
- Sea levels keep rising.



Concluding remarks







Concluding remarks

"In my personal value frame, it is already a few decades too late for having implemented some policy measures against such risks…..

beyond a few degrees Celsius of warming —it is likely that many 'dangerous' thresholds will be exceeded…..

uncertainty is no longer a responsible justification for delay."

Stephen H Schneider