Climate Change : Facts and Future Scenarios

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FOA/MAF 6th Annual Forest Biosecurity Workshop
8-9th March 2007

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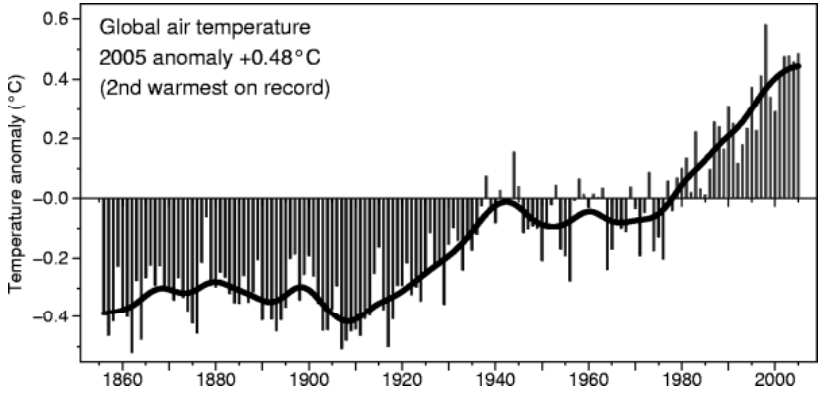
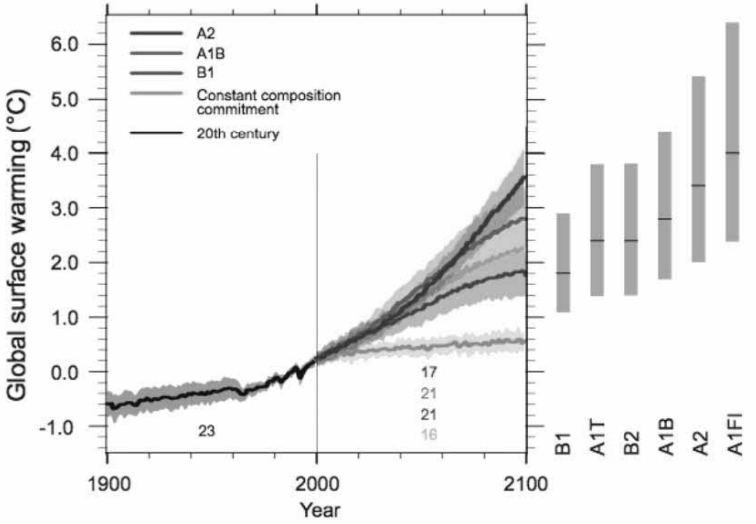
Outline

Facts
- Trends in temperature
- Greenhouse gases

Future scenarios
- Trends
- Climate Impacts





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Facts : The warming of the climate system is unequivocal

Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air temperatures, widespread melting of snow and ice, and rising global mean sea level

Most of the observed increase in globally averaged temperatures since the mid-20th century is *very likely* due to the increase in greenhouse gas concentrations

Very likely => 90% likelihood

IPCC AR4

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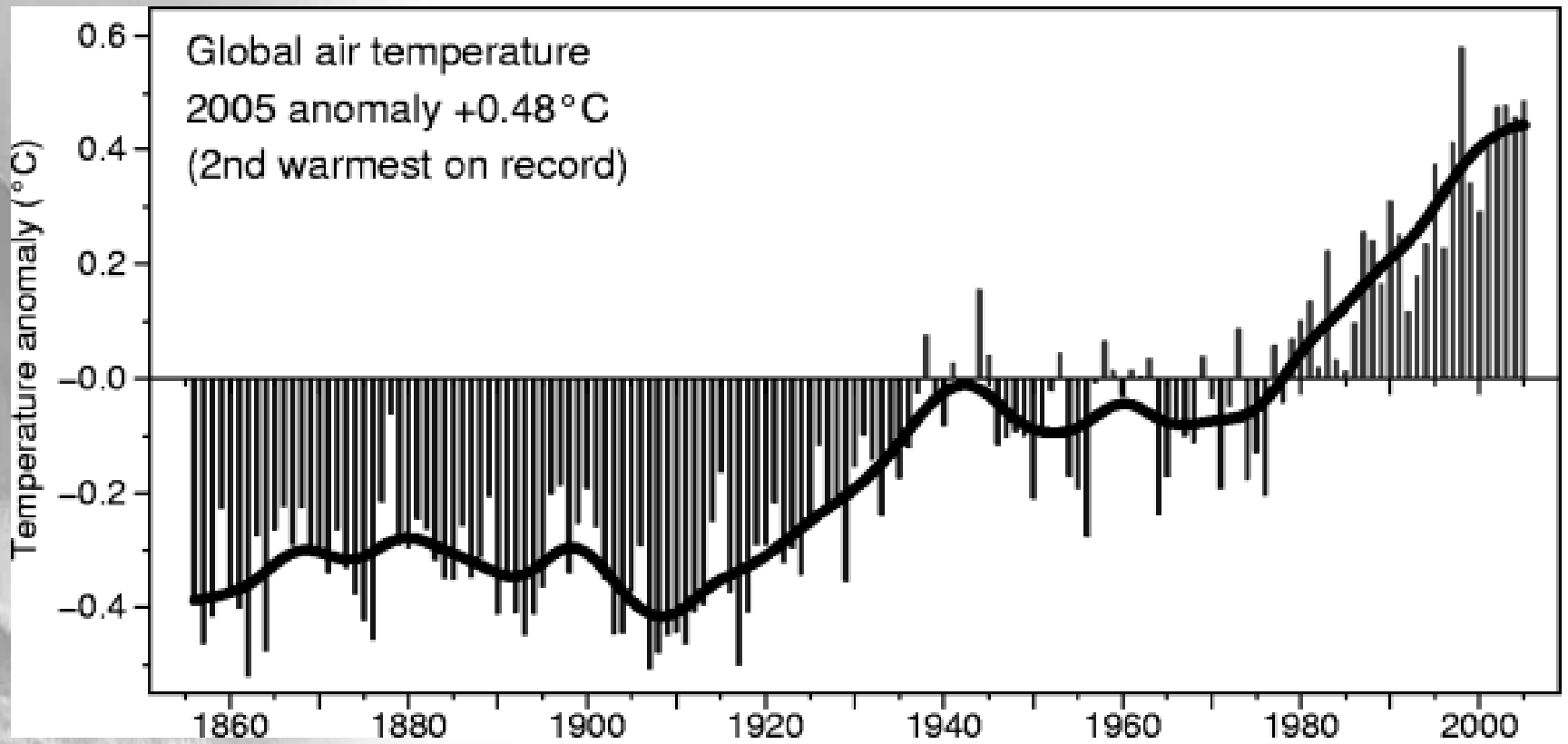
Facts : Global mean surface temperatures keep warming



- Global temperatures have increased by some 0.7°C over the 20th century
- 19 out of 20 warmest years on record occurred since 1980
- 1998 and 2005 were the two warmest years on record

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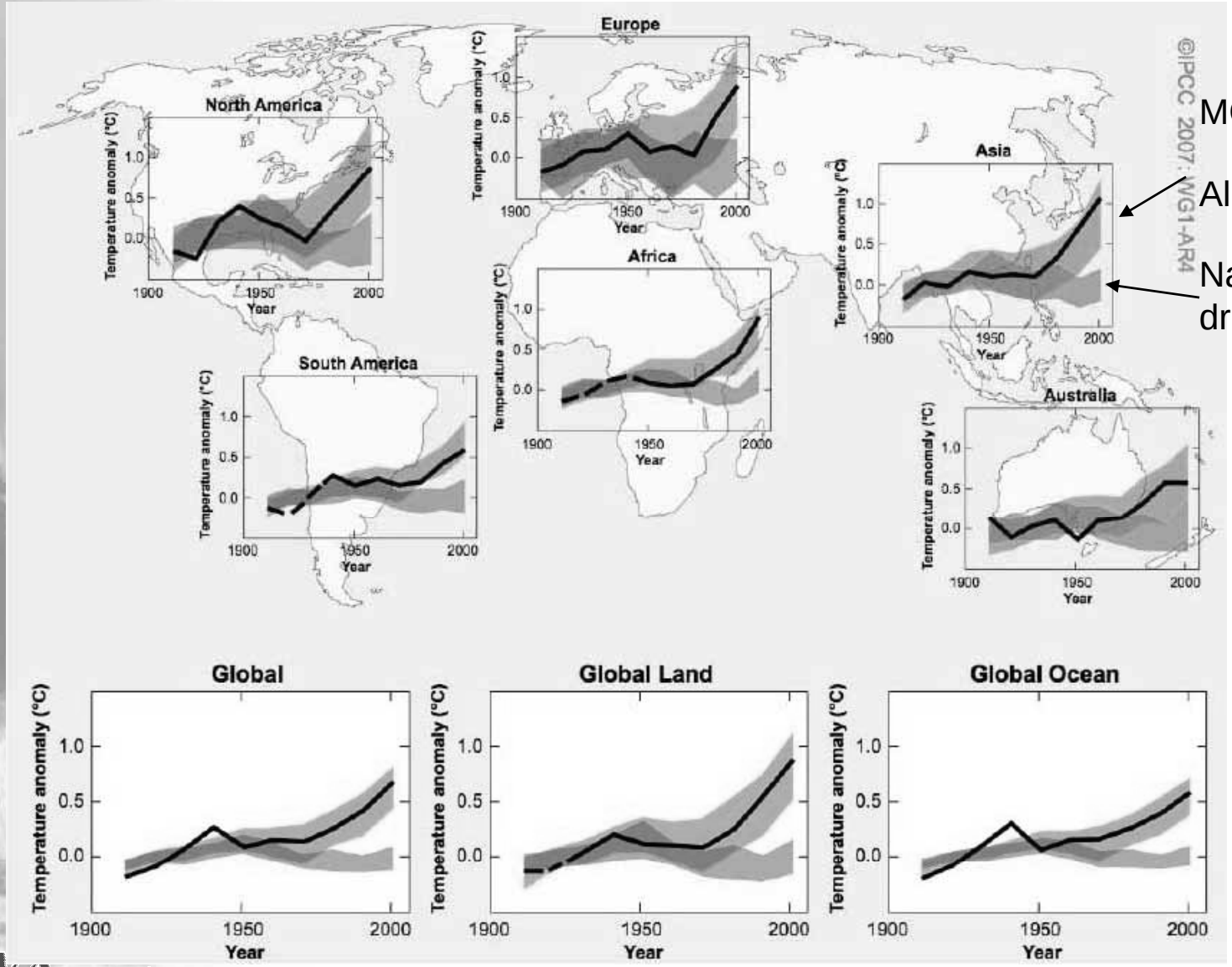
UK Met Office, Hadley Centre, 2006

Facts : All continental regions have warmed except Antarctica



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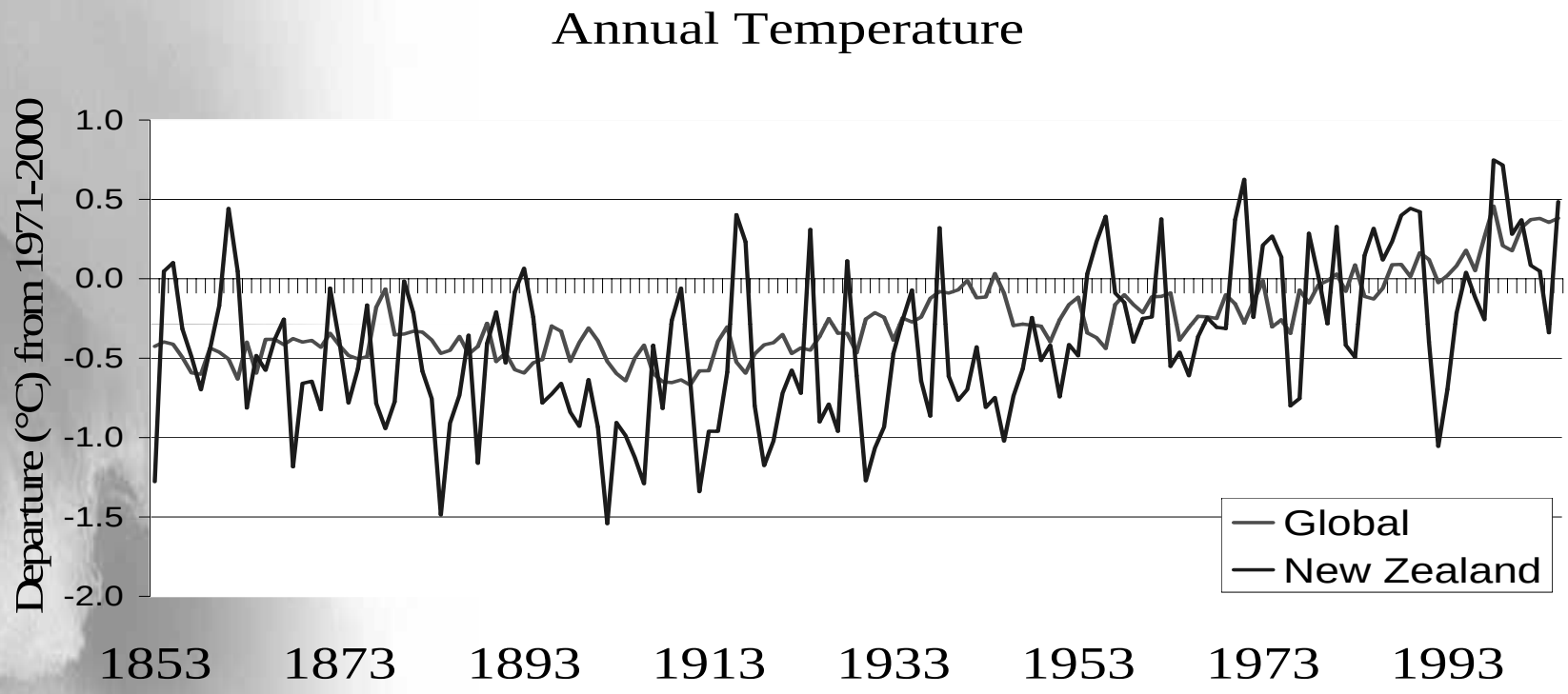
Facts : New Zealand temperatures have warmed



- New Zealand temperatures have increased by some 0.9°C since the 20th century
- 1998 and 1999 were the two warmest years on record

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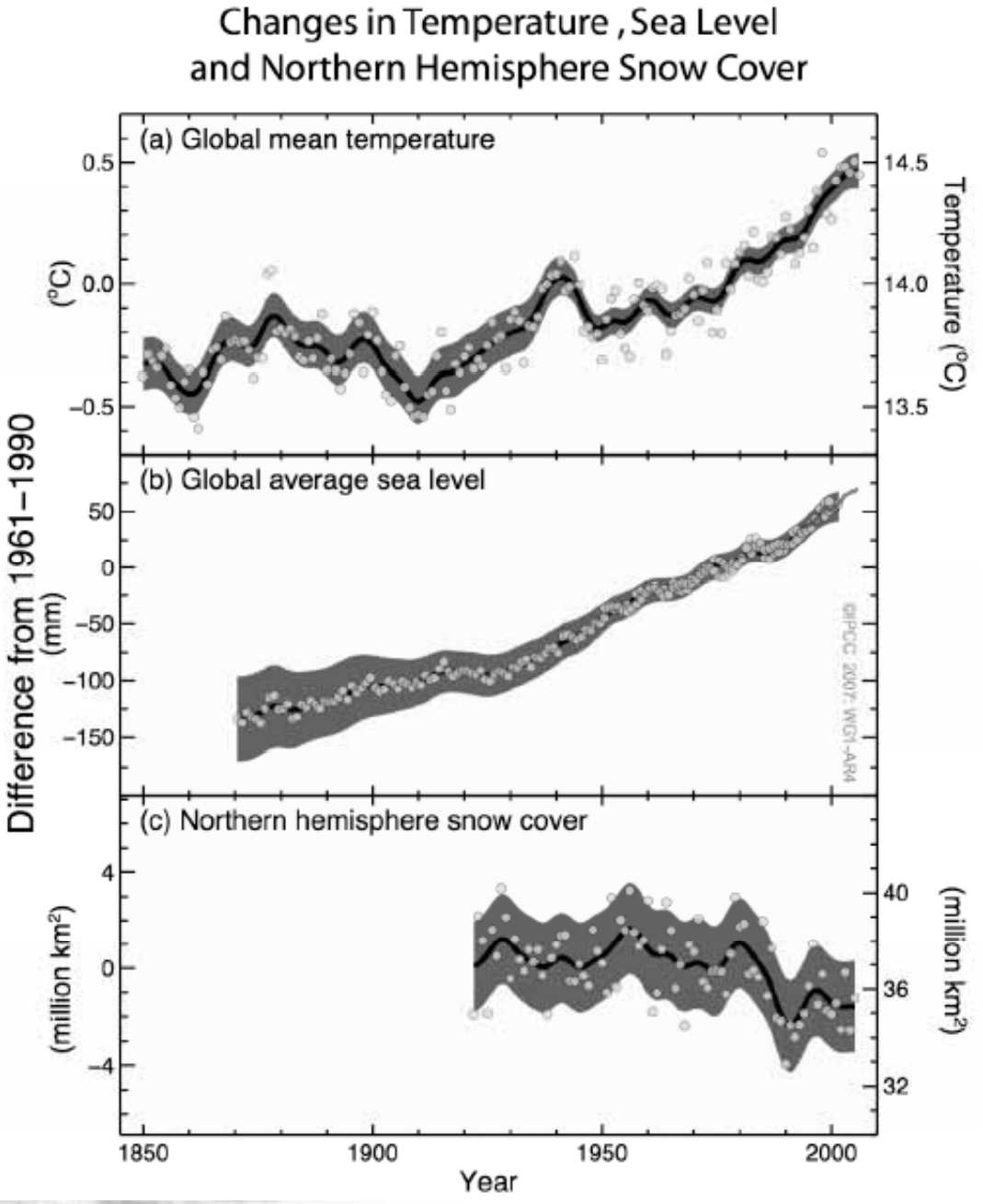

Facts : Unequivocal warming

- Atmosphere, oceans, ice, land
- Richer more compelling story

• 100-yr temperature trend +0.74°C/century

- Last 50 years is double that
- 11 of last 12 years warmest on record
- Heat island effect negligible
- Satellite record reconciled with balloons & surface measurements

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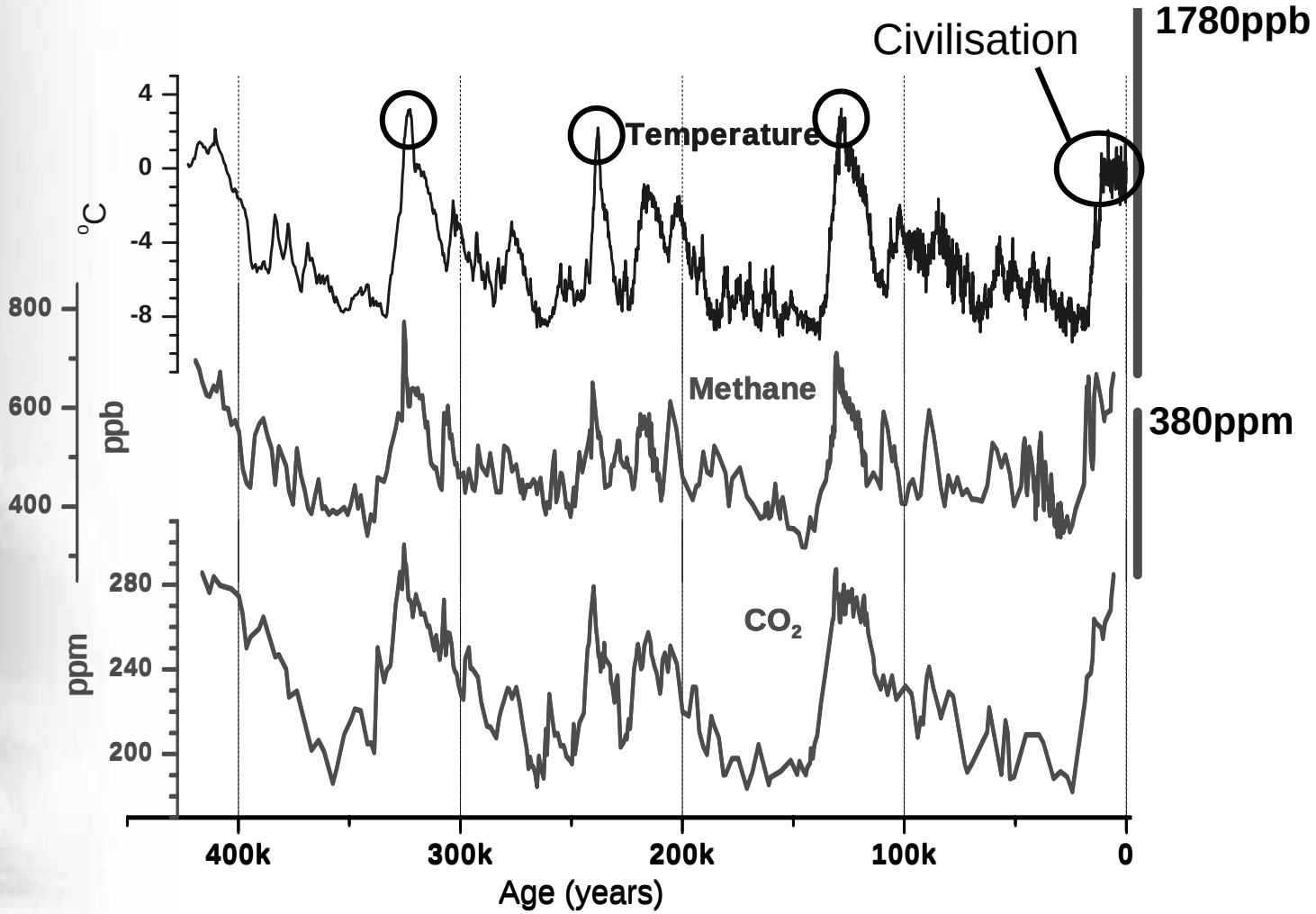
Facts : Greenhouse gases far exceed pre-industrial going back 650,000 yrs



Source: Petit et al., Nature, 1999, Berger & Loutre, QSR, 1991

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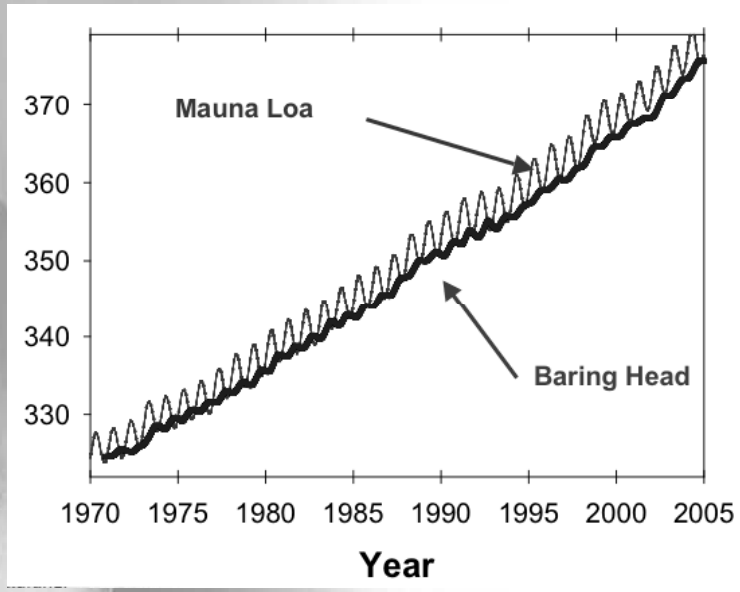
Facts : Human activities dominant cause of increases



Carbon dioxide, ppm

- Since 1750
  - carbon dioxide increase 35%, now 380 ppm
  - methane increase 150%, now 1780 ppb
  - Nitrous oxide increase 18%, now 319 ppb
- Human activities now emit annually ~7,000,000,000 tonnes (7 ppm) of carbon dioxide - about half of this stays in the atmosphere
- About ¾ anthropogenic CO_2 emissions in last 20 years from fossil fuel burning
- It is virtually certain that human activities have been the dominant cause of increases in greenhouse gases and aerosols in the past 250 years

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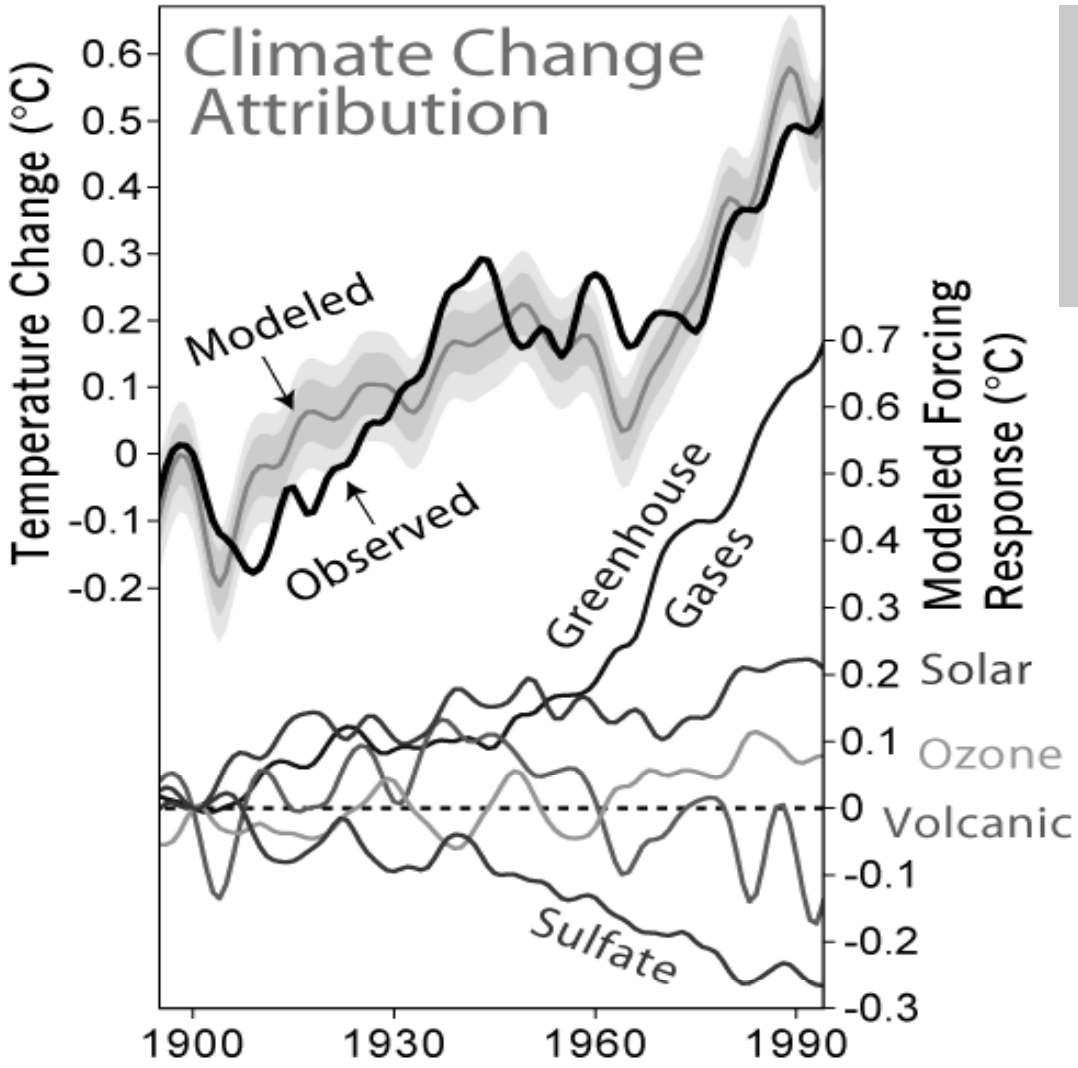
Facts : Human activities are effecting climate



"There is *very high confidence* that the globally averaged net effect of human activities since 1750 has been one of warming

IPCC AR4 (Assessment Report 4) 2007

- To explain early 20th century warming requires:
  - solar changes,
  - less volcanic activity
- To explain warming in the late 20th century requires:
  - greenhouse gases
- Solar and volcanic effects explain much of the variability prior to 1850

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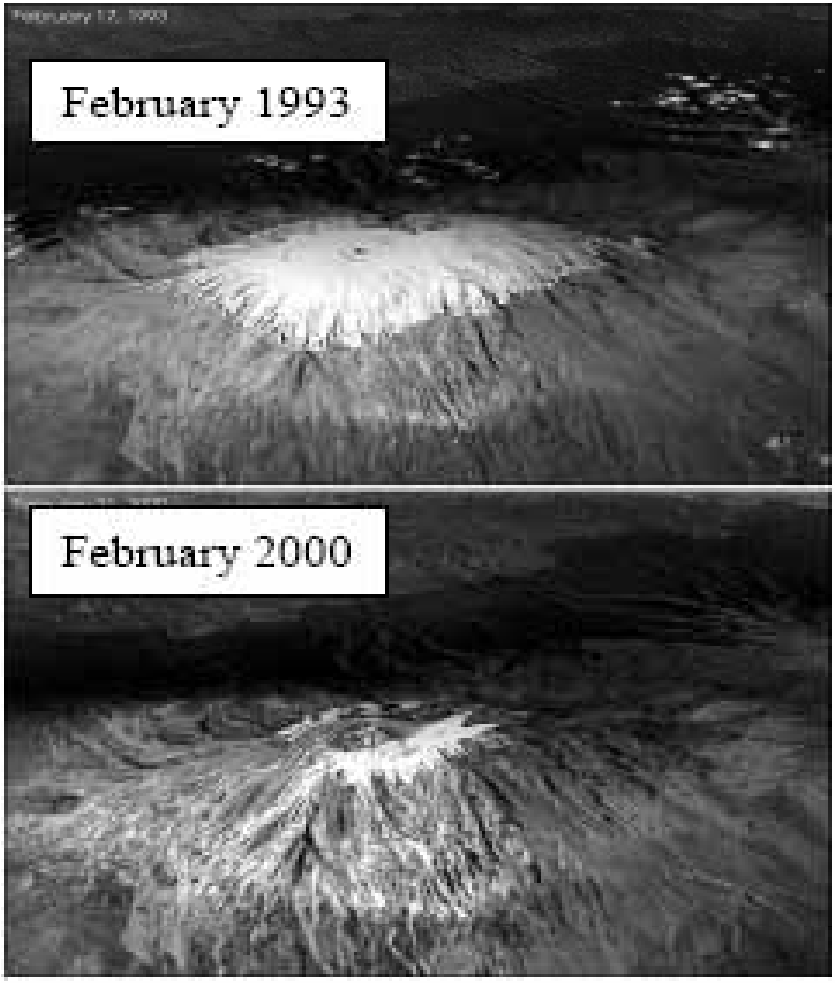
Source: www.wikipedia.org, based on Meehl et al. (2004). *J. Climate*

Facts : The amount of ice on Earth is decreasing

- There has been widespread loss of mountain glaciers since the end of the 19th century
- The rate of mass loss from glaciers and the Greenland ice sheet is increasing
- The recession of glaciers during last century is larger than at any time over the last 5,000 years, being particularly fast in the 1930s, 1940s and after 1990
- Arctic and Antarctic ice shelves several thousand years old have started to collapse due to warming



Mt Kilimanjaro

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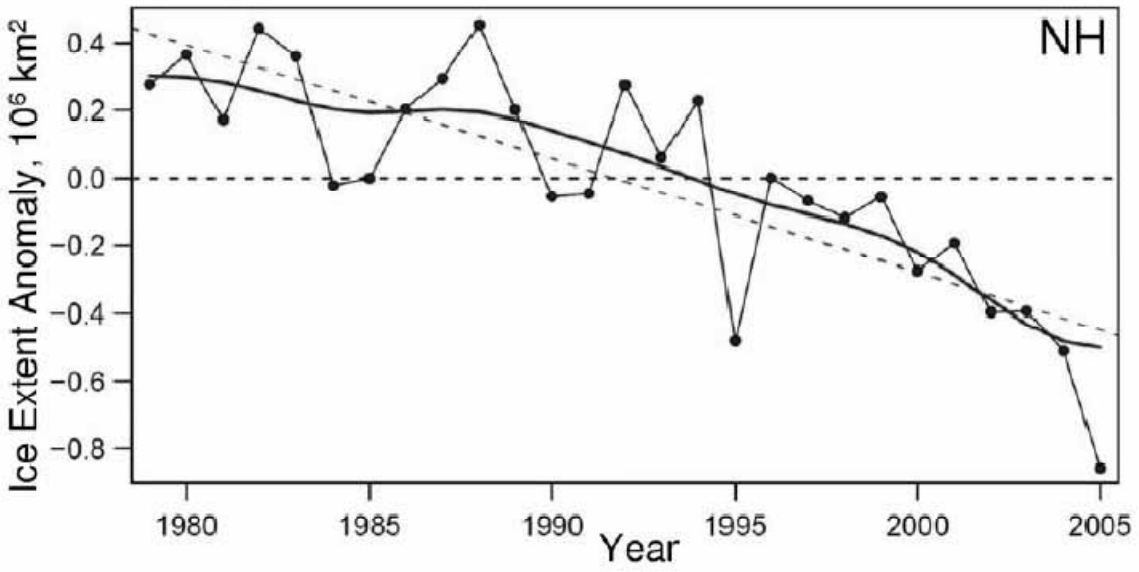
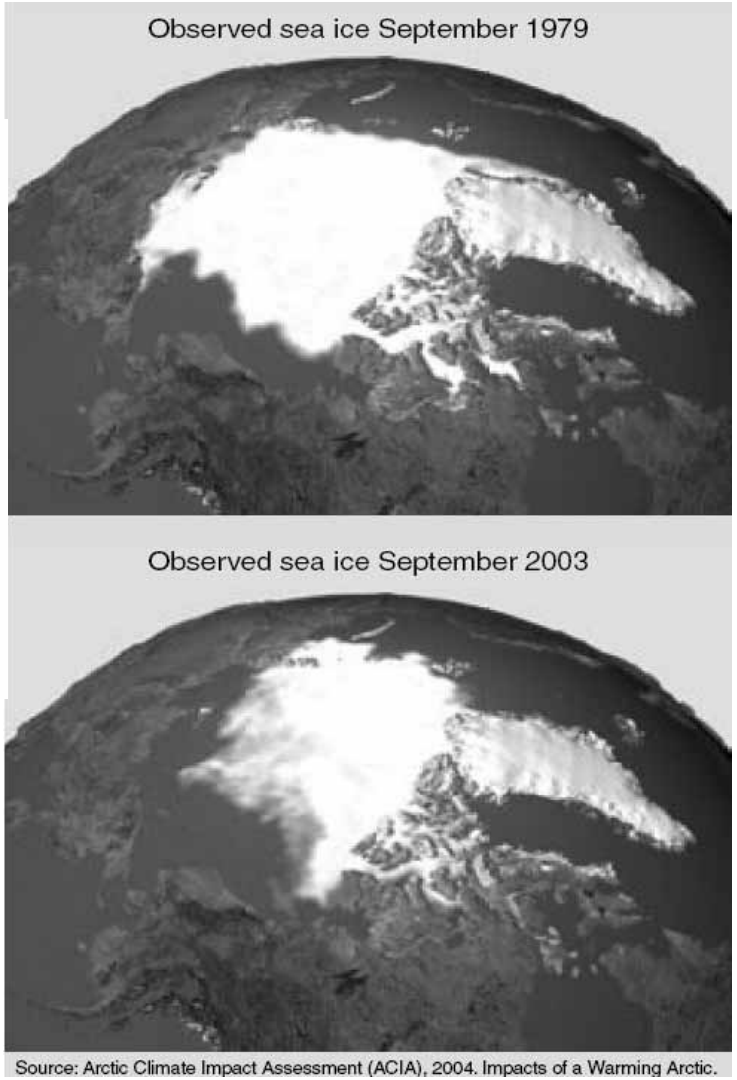
Facts : Arctic sea ice is declining





Source: Arctic Climate Impact Assessment (ACIA), 2004. Impacts of a Warming Arctic.

- Arctic sea ice extent has declined from 7.2 to 5.2 million sqkm since 1979
- Annual averaged Arctic sea ice has shrunk by 2.7% per decade since 1978, with summer minimum by 7.4% per decade

Source: U.S. National Snow & Ice Data Center (NSIDC)

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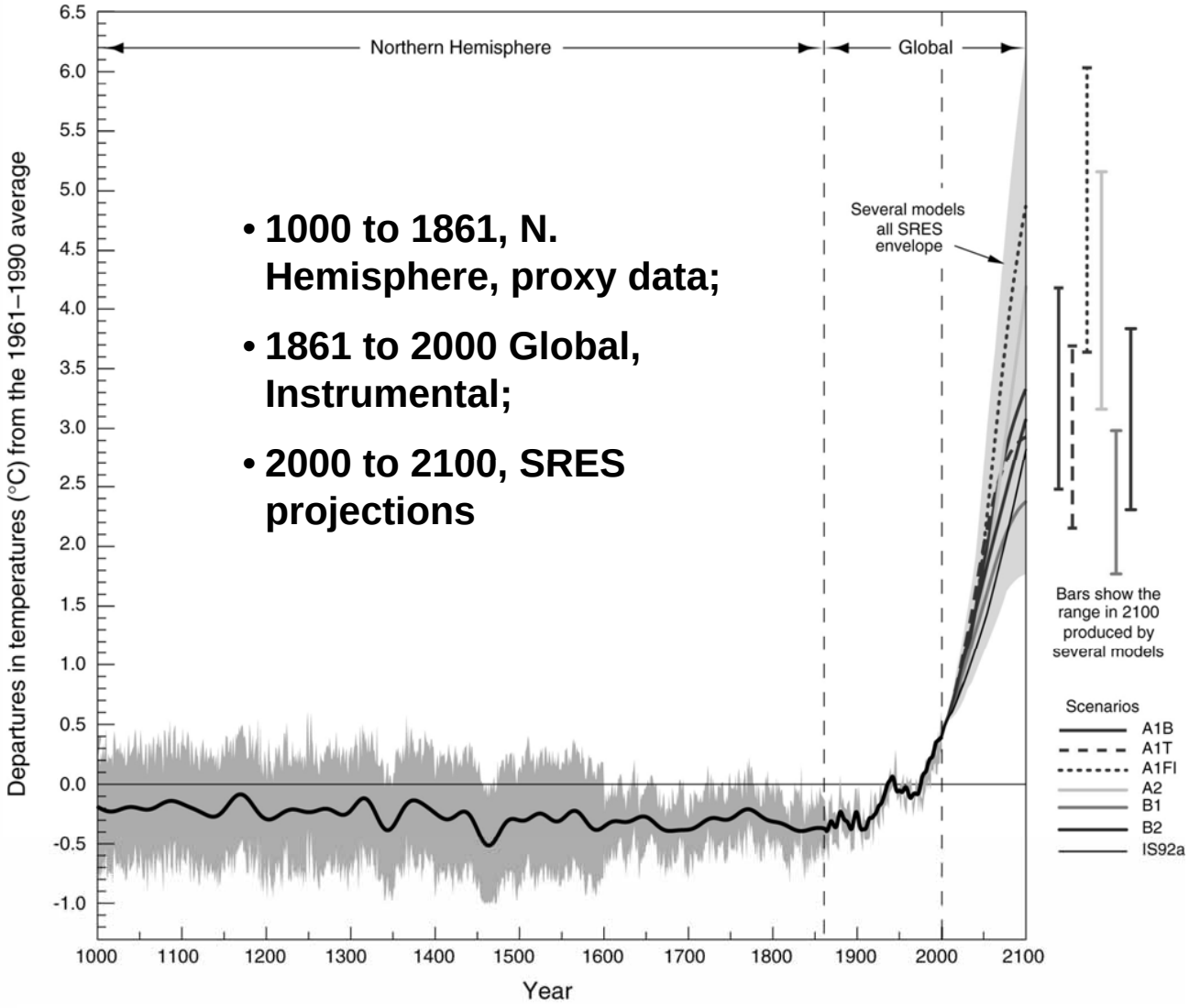
Future climate: projections

If current climate science is even only roughly correct, then the projected rate of warming during the 21st century is very likely to be without precedent during at least the last 10,000 years

IPCC, 2001



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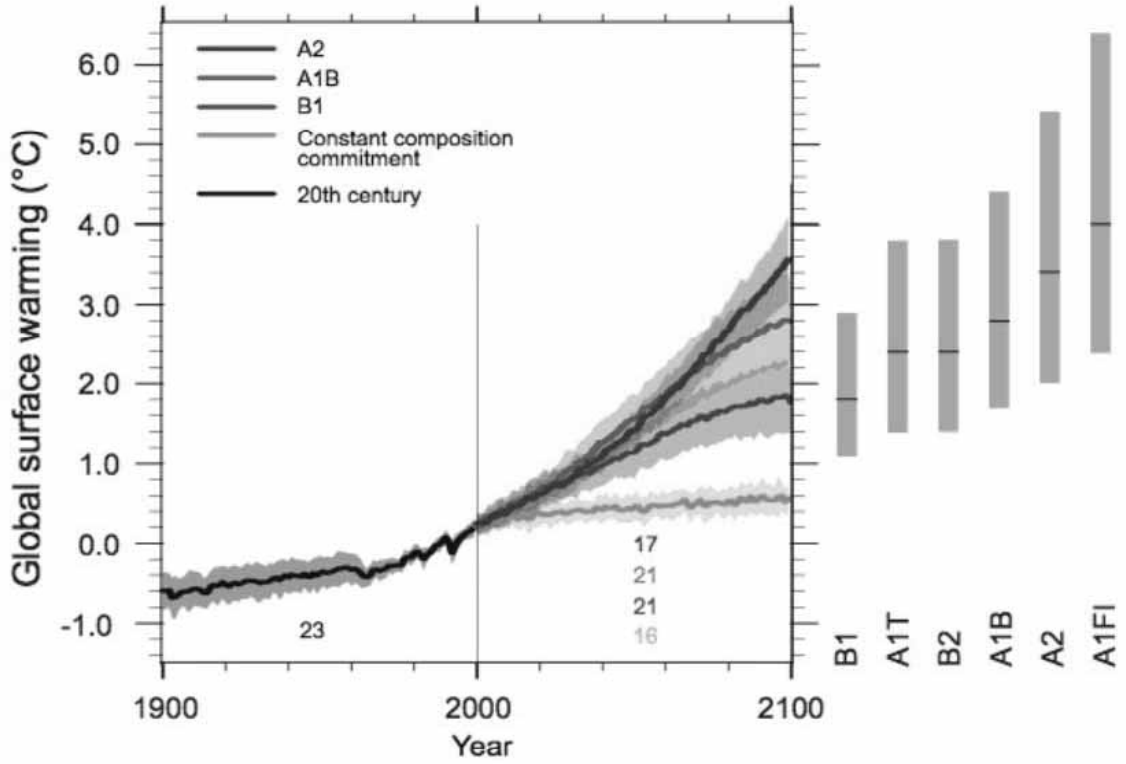
Future Climate: Global



• Globally averaged surface temperature sensitivity is **projected to be 2 – 4.5°C** – with the most likely value of about 3°C

• The middle and upper end of the projections are without precedent in at least the last 10,000 years

At 2100, B1=600; A1T 700, B2 800, A1B 850, A2 1250, A1F1 1550 ppm CO_2e

(Presently about 430 ppm CO_2e)

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Future Scenarios : New Zealand

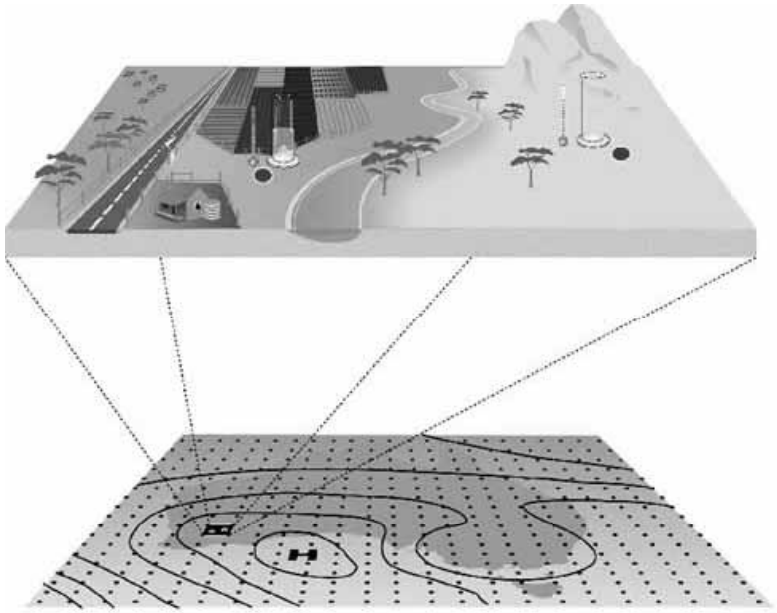
Climate scenarios produced by downscaling from larger climate models

- "Zoom in" to way below grid scale

Two techniques:

- Run a high-resolution climate model over location of interest, "forced" by General Circulation Model
- Use statistical relationships to calculate local detail

Very important for New Zealand



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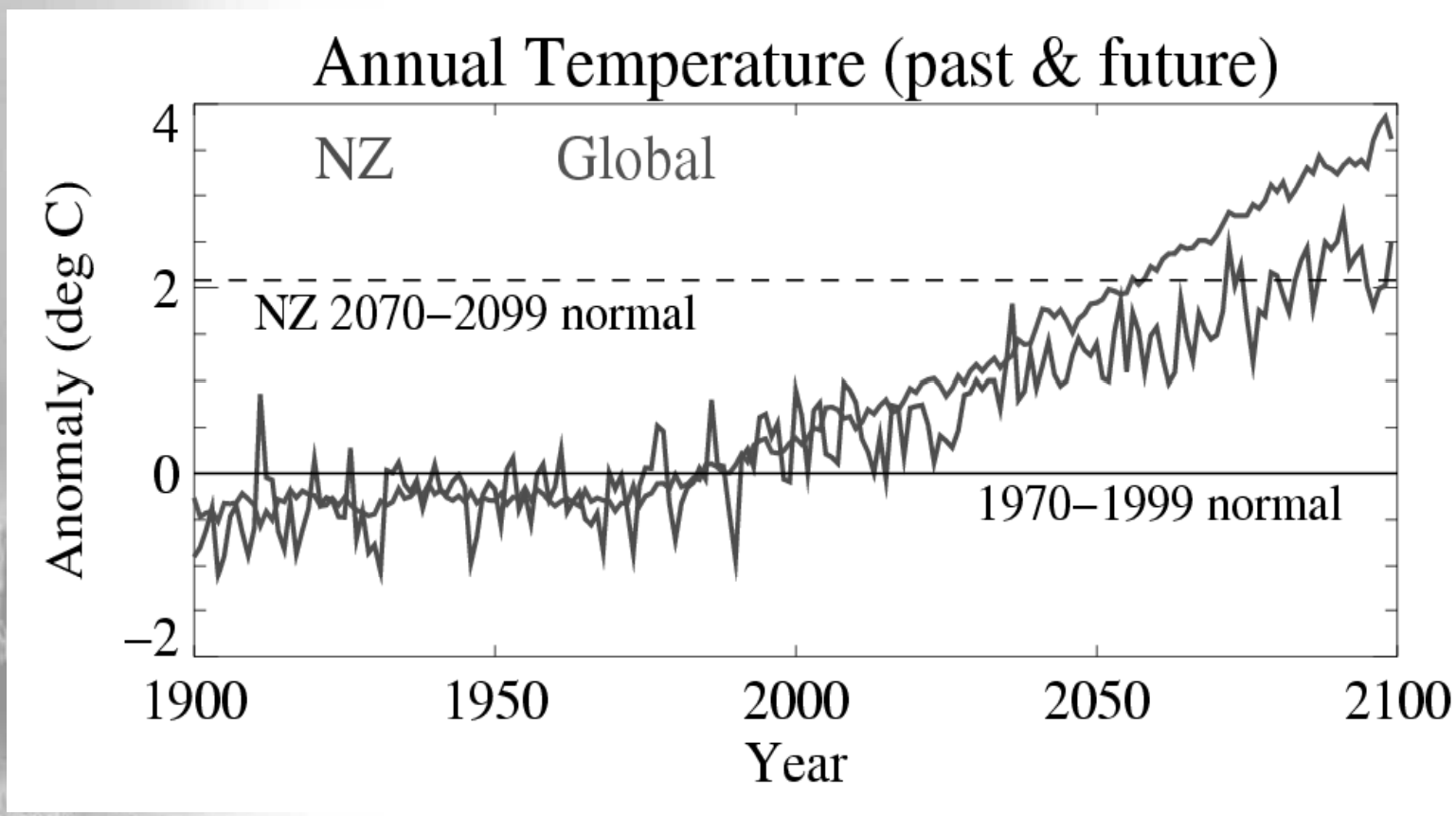
Future Scenarios : New Zealand



- 0.1 to 1.4°C warmer by 2030s, 0.2 to 4.0°C by 2080s
- NIWA prepared climate change scenarios which can be found at:

http://www.climatechange.govt.nz/resources/local-govt/preparing-for-climate-change-jul04/

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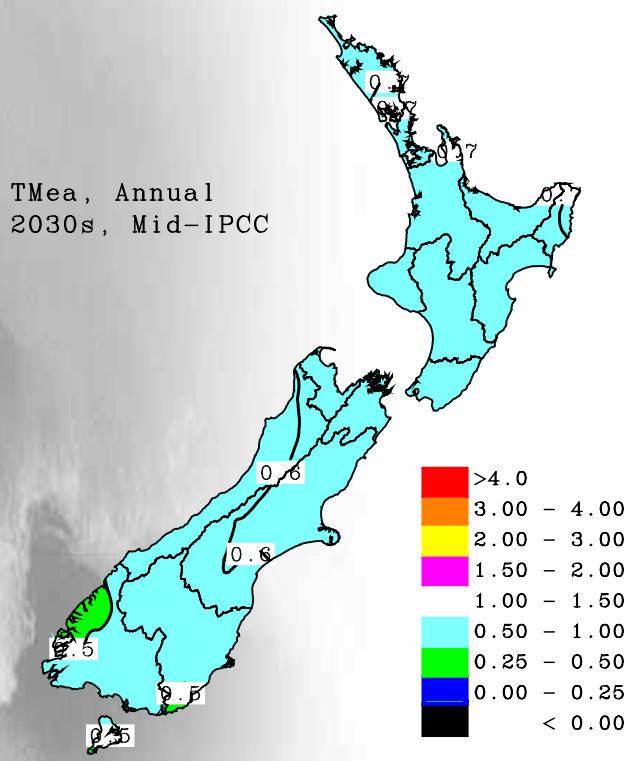
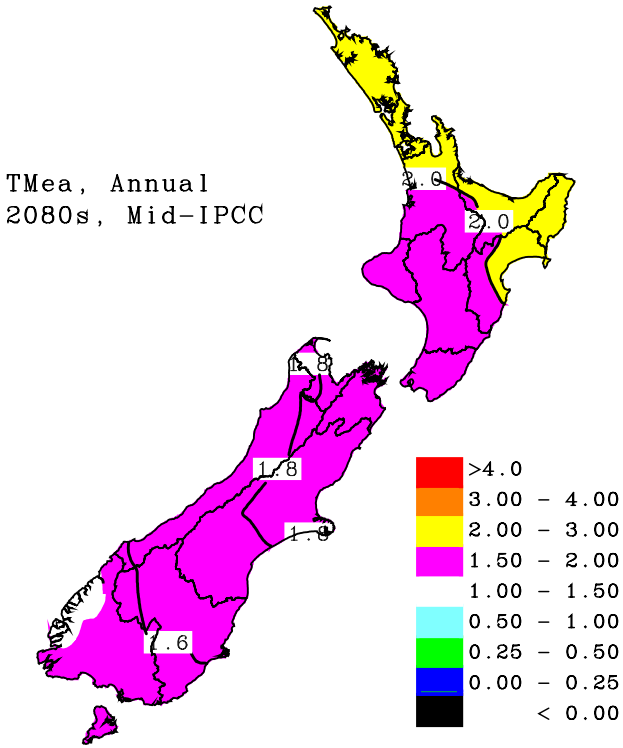
Future Scenarios : Temperature





- Report gives New Zealand warming scenarios for the full IPCC range of global warming for regional council areas

http://www.climatechange.govt.nz/resources/local-govt/preparing-for-climate-change-jul04/

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Future Scenarios : Temperature 2030s & 2080s

Northland	0.2 to 1.3	0.6 to 4.0
Auckland	0.2 to 1.3	0.6 to 3.8
Waikato	0.1 to 1.4	0.4 to 3.8
Bay of Plenty	0.2 to 1.3	0.5 to 3.8
Taranaki	0.1 to 1.3	0.4 to 3.7
Manawatu-Wanganui	0.1 to 1.3	0.3 to 3.8
Hawkes Bay	0.2 to 1.4	0.5 to 3.8
Gisborne	0.2 to 1.4	0.6 to 3.8
Wellington	0.1 to 1.3	0.5 to 3.6
Nelson	0.1 to 1.3	0.4 to 3.5
Marlborough	0.1 to 1.4	0.4 to 3.5
West Coast	0.1 to 1.2	0.2 to 3.5
Canterbury	0.2 to 1.4	0.5 to 3.4
Otago	0.1 to 1.3	0.4 to 3.1
Southland	0.1 to 1.3	0.2 to 3.2

Annual warming

°C

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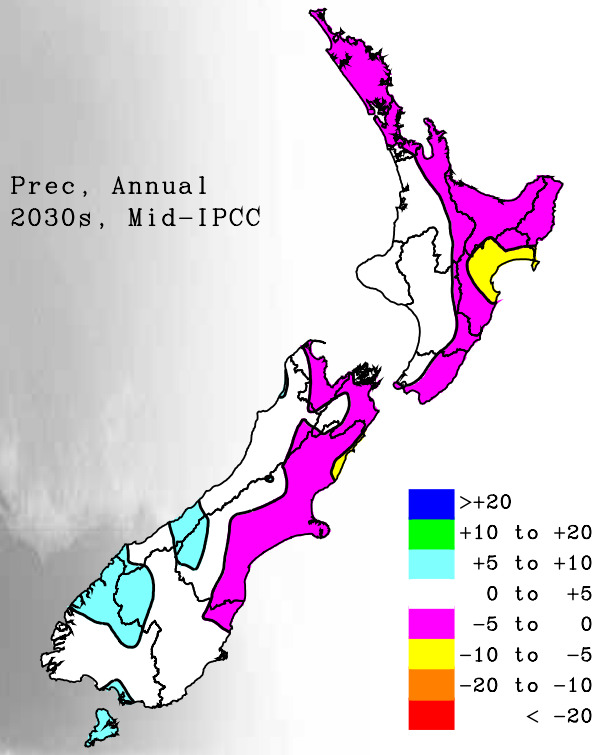
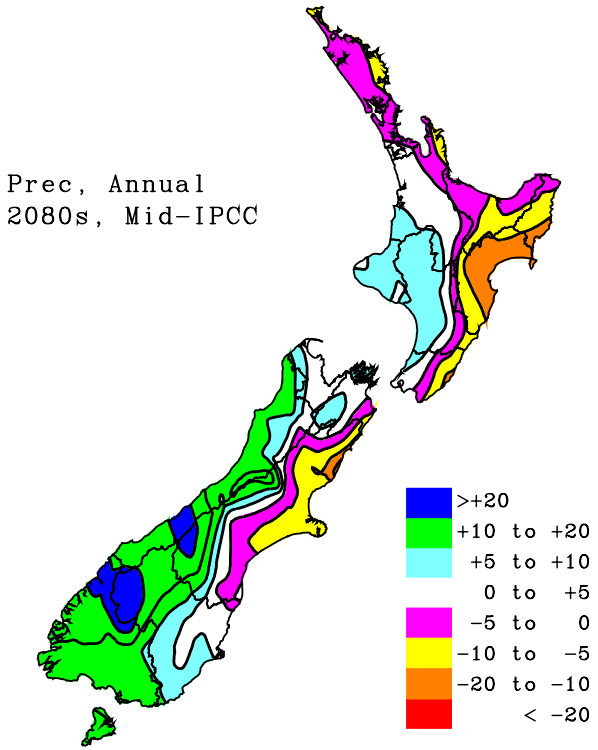
Future Scenarios : Rainfall





- Wetter in the west, drier in the east
- Westerly winds strengthen (~10% 2030s, ~ 20% 2080s)

http://www.climatechange.govt.nz/resources/local-govt/preparing-for-climate-change-jul04/

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Future Scenarios : Rainfall 2030s & 2080s

Northland Kaitaia	-5 to +3	-11 to -1
Auckland Mangere	-4 to +3	-8 to +7
Taupo	-5 to + 3	-6 to +10
Bay of Plenty Tauranga	-9 to +2	-15 to +2
Taranaki New Plymouth	-4 to +9	0 to +22
Manawatu-Wanganui Wanganui	-4 to + 11	0 to +26
Hawkes Bay Napier	-19 to +1	-32 to +3
Gisborne Gisborne	-27 to 0	-31 to +4
Wellington Paraparaumu	-4 to +10	+1 to +26
Nelson Nelson	-7 to +2	-7 to +4
Marlborough Blenheim	-5 to +3	-4 to +5
West Coast Hokitika	-4 to +14	+1 to +40
Canterbury Christchurch	-10 to +1	-17 to +4
Otago Dunedin	-2 to +6	+2 to +14
Southland Invercargill	-2 to +15	+1 to +37

Percent change

Annual total

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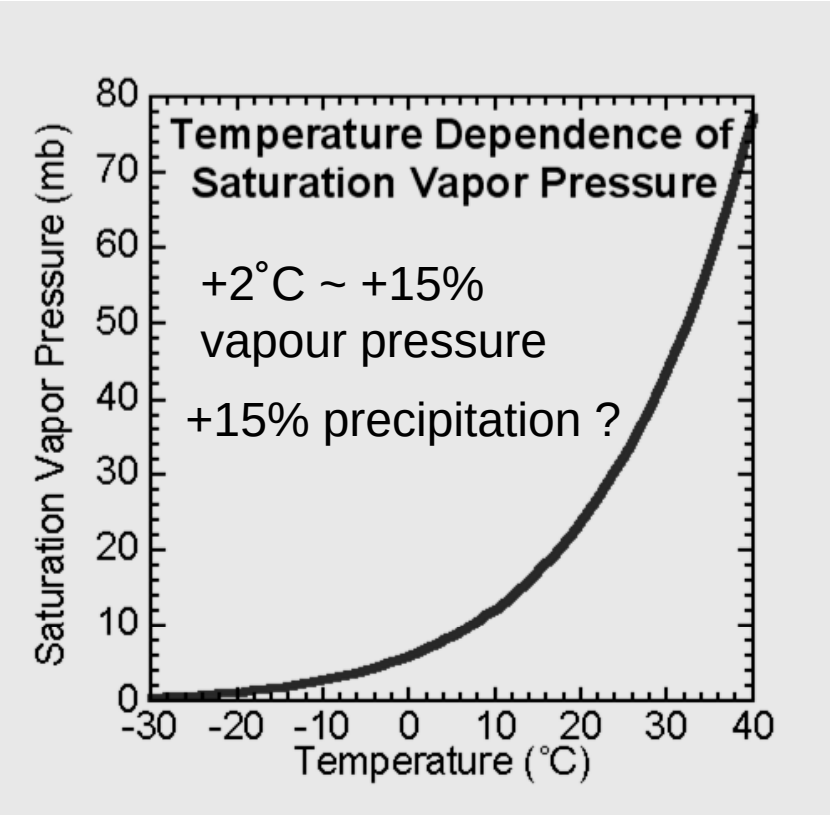
Future Scenarios : High Intensity Rainfall

Extremes – high intensity rainfall



The predicted average recurrence interval (years) for high intensity rainfall is likely to reduce in the 2080s

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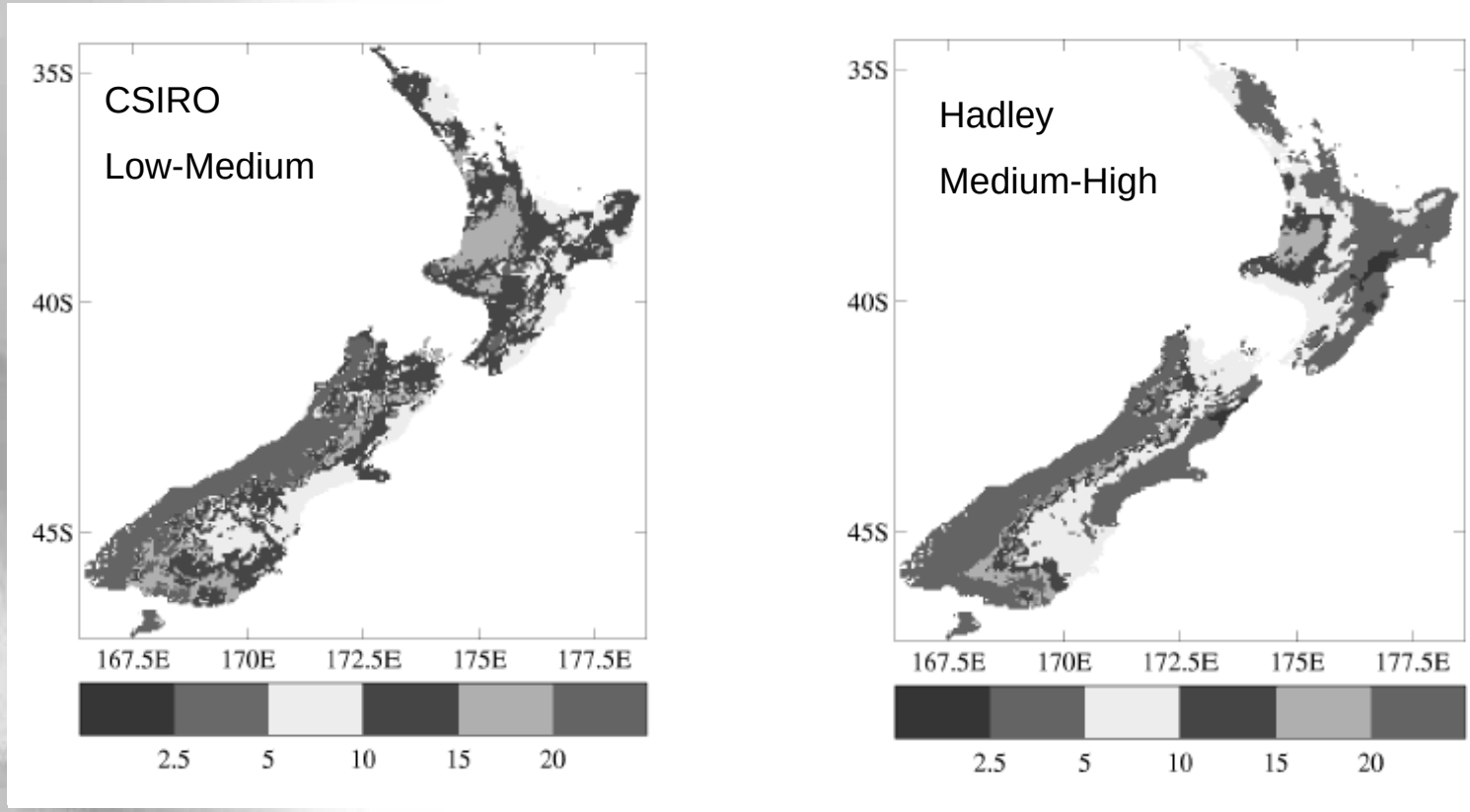
Future Scenarios : Drought



Predicted average recurrence interval (years) in 2080s for driest conditions that currently occur on average once every 20 years

~ 1 in 20 year drought reduces to 1 in 5 in brown areas

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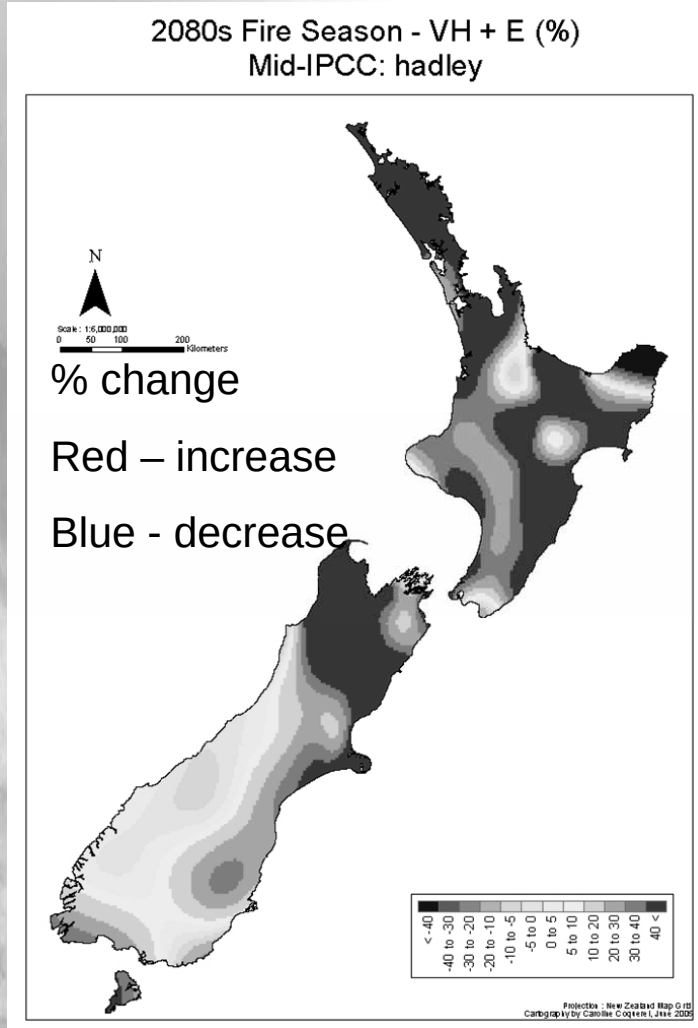
www.climatechange.govt.nz/resources/reports/drought-risk-may05/drought-risk-climate-change-may05.pdf

Future Scenarios : Fire Risk



- **Applied climate scenarios to fire weather indices**
- **For 2080s many more days of Very High + Extreme fire danger occurred in the Bay of Plenty, eastern areas of both islands, Wellington and Nelson**
- **Stations in the west and south show no change**
- **Fire season length extended**

http://nrfa.fire.org.nz/research/_docs/FR_NIWA_ReportFinalMay2005.pdf

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Future Scenarios : 2080s summary

- 2°C warmer
- Fewer frosts
- More evaporation
- Enhancement of mid- latitude westerlies
- Modest increase in west , decrease in east in rainfall
- Very heavy rain more frequent
- Drought frequency and fire risk increases in eastern New Zealand
- More El Niño-like ?
- Sea Level ~+30 cm (5 - 70)

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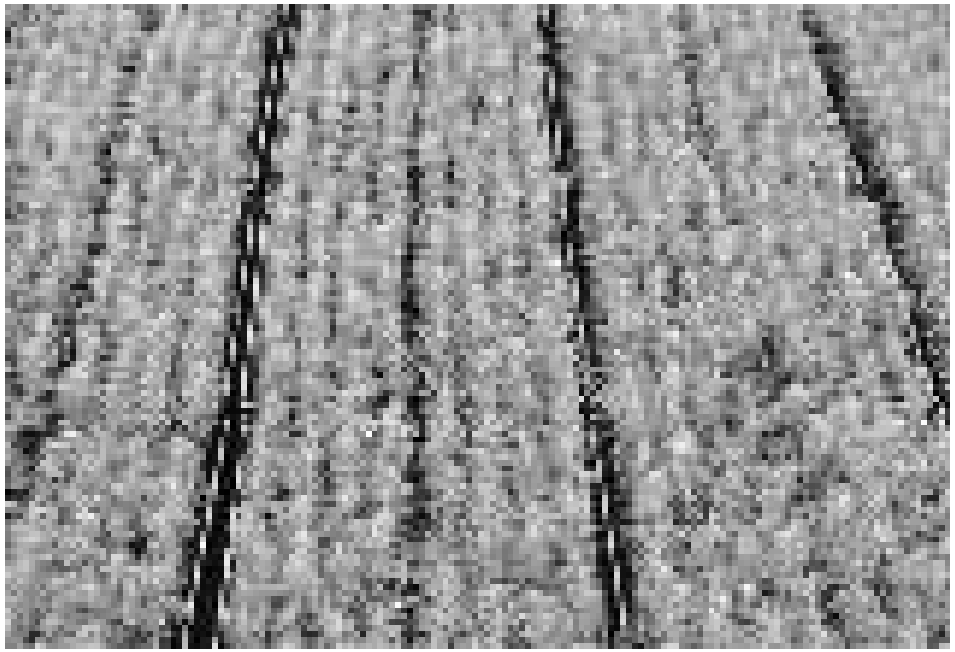
Forests : Some Impacts

- Plantation forests are likely to benefit in the south and west from higher CO_2 and rainfall with moderate temperature increases
- East coast areas of the North Island are likely to have growth reductions with lower rainfall
- Warmer temperatures change potential for pest and diseases



Summary

- **Evidence is overwhelming of widespread warming in the climate system**
- **New Zealand climate has warmed by 0.9°C**
- **The principal cause is increasing greenhouse gases from human activities**
- **NZ climate scenarios made on the full IPCC range of global warming**
- **NZ climate expected to warm 0.1 to 1.4°C by 2030s, 0.2 – 4.0 °C by 2080s**
- **Rainfall increases in the west, decreases in the east**
- **More droughts likely in the north and east**
- **Fire risk increases in many areas of the North Island, and north and east of the South Island**
- **Impacts likely on forests**

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