Climate Change:
Implications for Transport

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September 2010

Outline

1. Background
2. Recent scientific evidence
3. The stabilization challenge
4. The New Zealand context
5. Implications for New Zealand transport
   - Mitigation
   - Adaptation
6. Conclusions

Some quotes

"This is the most serious problem facing humanity in the 21st century ... this is the problem that if we don't address it will undermine and perhaps destroy civilization ... Don't be under 40 ... if we fail to solve this problem, my advice to people is not to be under 40".

Professor Tom Burke, Imperial College London (BBC interview, 2006)

"If we don't succeed, we run the risk of failure"(!)

George W Bush

Who said this and when?

"Mr President, the evidence is there. The damage is being done. ... The environmental challenge which confronts the whole world demands an equivalent response from the whole world. Every country will be affected and no one can opt out. ...

We need a realistic programme of action and an equally realistic timetable. Each country has to contribute, and those countries who are industrialised must contribute more to help those who are not. The work ahead will be long and exacting. We should embark on it hopeful of success, not fearful of failure. ...

We are not the lords, we are the Lord's creatures, the trustees of this planet, charged today with preserving life itself—preserving life with all its mystery and all its wonder.
May we all be equal to that task."

Climate change: background

1. Human-induced climate change is one of the defining issues of our time – with multiple dimensions: scientific, ethical, political, environmental, economic, international relations, food security, etc.
2. While climate change is an important issue, there are many other significant environmental issues, some with similar structural features or linked to climate change:
   - Destruction of natural habitats
   - Destruction of global fisheries
   - Loss of biodiversity
   - Loss of top soil
   - Depletion of freshwater resources
   - Toxic chemicals
   - Population growth and the total human impact

Climate change: background

3. Climate change is particularly pressing because:
   - There are long-lags and inertia in the climate system and the need to act now to avoid very significant temperature increases later this century and beyond
   - There is a risk of humanity inflicting large-scale, irreversible damage to key bio-geophysical systems, destroying countless species, submerging numerous coastal settlements and making the planet much less agreeable for human life
4. The subject area is highly complex and controversial; and characterized by *deep uncertainty* (i.e. many things are unknown and possibly unknowable), <u>but we know enough</u> ...

The scientific evidence

6. In order to assess the scientific evidence on climate change, the UNEP and WMO established the Intergovernmental Panel on Climate Change (IPCC) in 1988.
7. The IPCC has completed 4 major assessments, the most recent in 2007. These assessments involve hundreds of scientists and policy experts from around the world; each report goes through two lengthy and demanding peer review processes involving thousands of scientists and policy experts; not without errors, but authoritative on the key issues
8. The 4AR Synthesis Report, *Summary for Policy Makers*, was approved in November 2007 by virtually every government in the world

The scientific evidence

The major findings of 4AR include:

- "Warming of the climate system is unequivocal, as in now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level." (1906-2005 about 0.75°C increase)
- "Most of the observed increase in globally-averaged temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic GHG concentrations." ('very likely' means 90%+ probability) (due to burning of fossil fuels and deforestation)
- "Continued GHG emissions at or above current rates would cause further warming and induce many changes in the global climate system during the 21st century that would very likely be larger than those observed during the 20th century."

The scientific evidence

The major findings of 4AR include:

- "Anthropogenic warming could lead to some impacts that are abrupt or irreversible, depending upon the rate and magnitude of the climate change."
- Mitigation options are available – i.e. we already have the necessary technological means to reduce emissions very substantially (e.g. low-carbon transport technologies, renewable energy sources, etc.)
- The cost of mitigation is likely to be much lower than the cost of business-as-usual (doing nothing), but much depends on the discount rate adopted and the value placed on non-market impacts (e.g. loss of species) (see also the Stern Review and Garnaut Review)

The scientific evidence

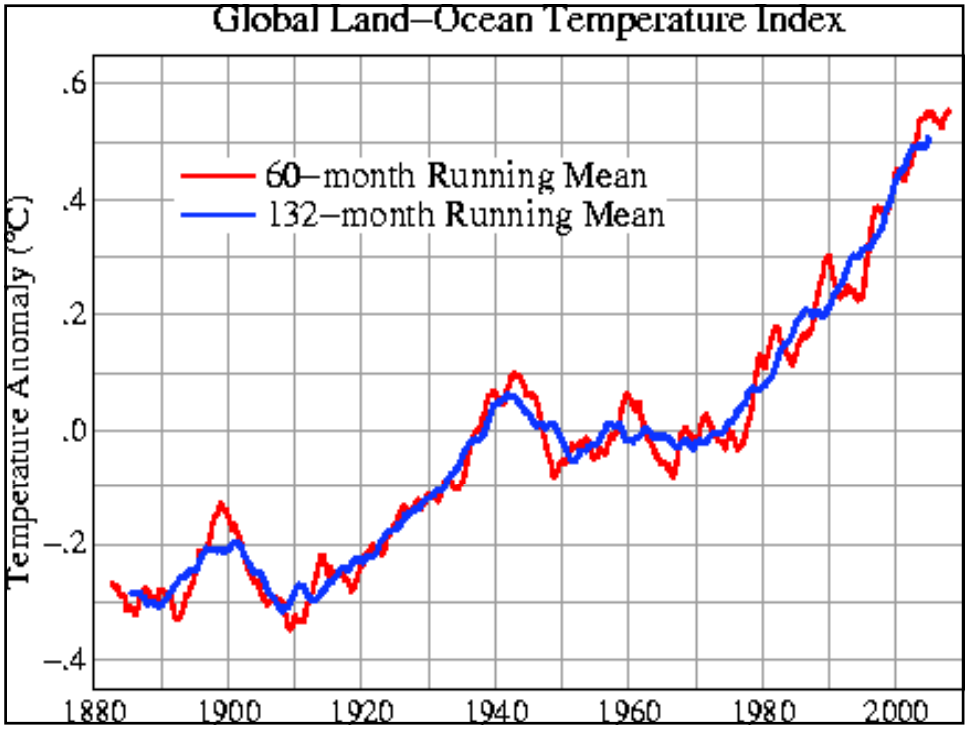
"Humanity today, collectively, must face the uncomfortable fact that industrial civilization itself has become the principal driver of global climate. If we stay our present course, using fossil fuels to feed a growing appetite for energy-intensive life styles, we will soon leave the climate of the Holocene, the world of human history. The eventual response to doubling pre-industrial atmospheric CO2 likely would be a nearly ice-free planet. ... The most difficult task, phase-out over the next 20-25 years of coal use that does not capture CO2, is herculean, yet feasible when compared with the efforts that went into World War II. The stakes, for all life on the planet, surpass those of any previous crisis. The greatest danger is continued ignorance and denial, which could make tragic consequences unavoidable".

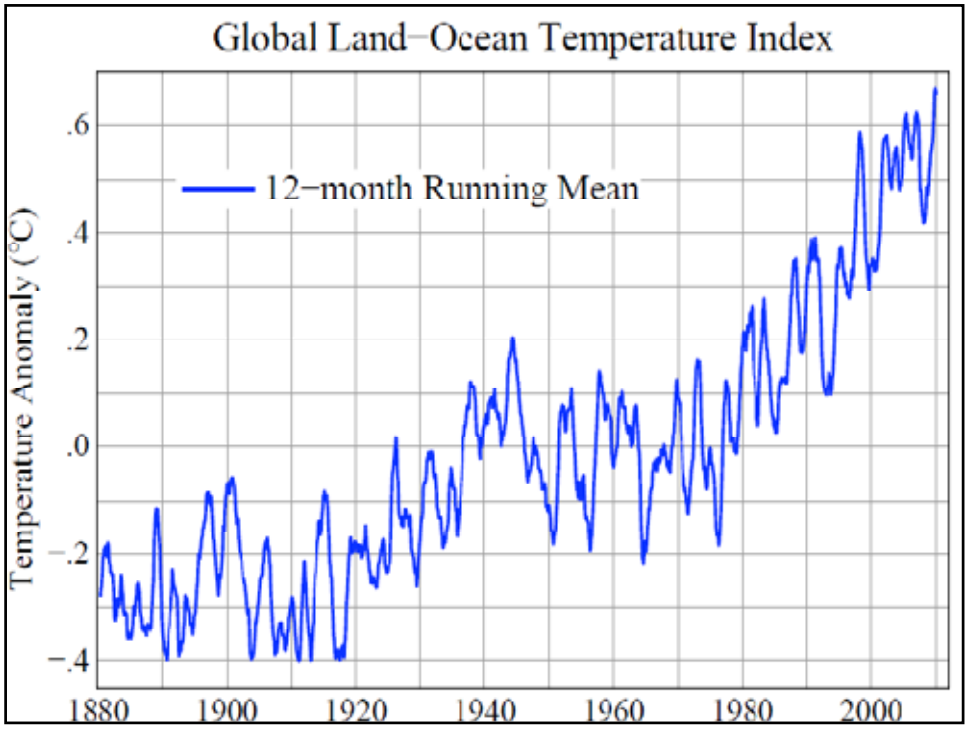
Dr Jim Hansen (head of NASA's Goddard Space Centre) et al (2008)

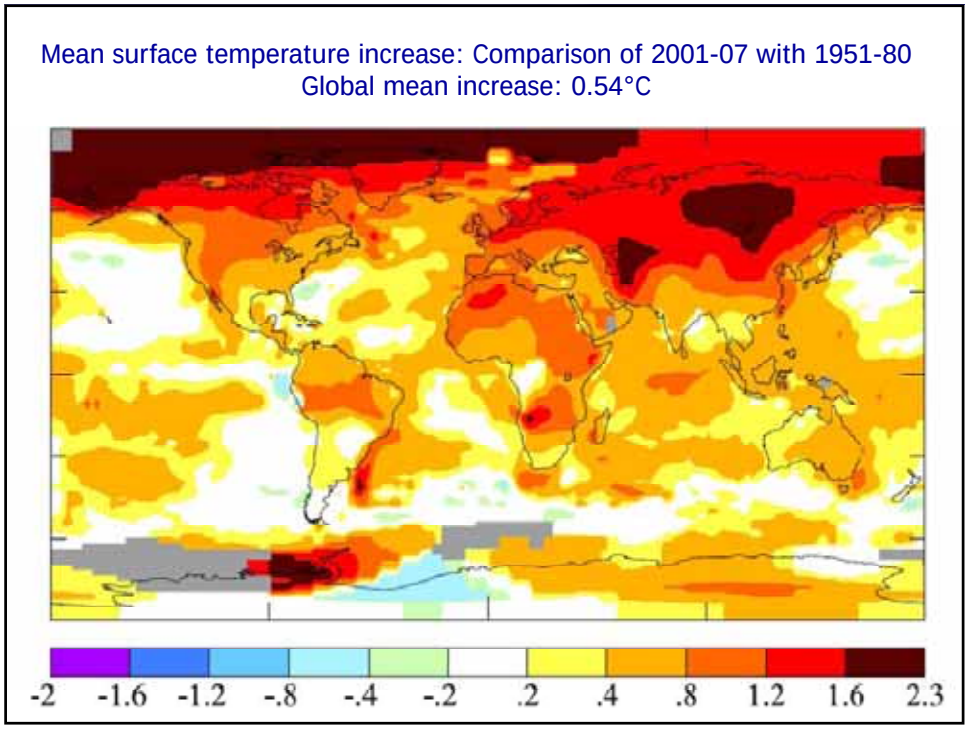
The scientific evidence

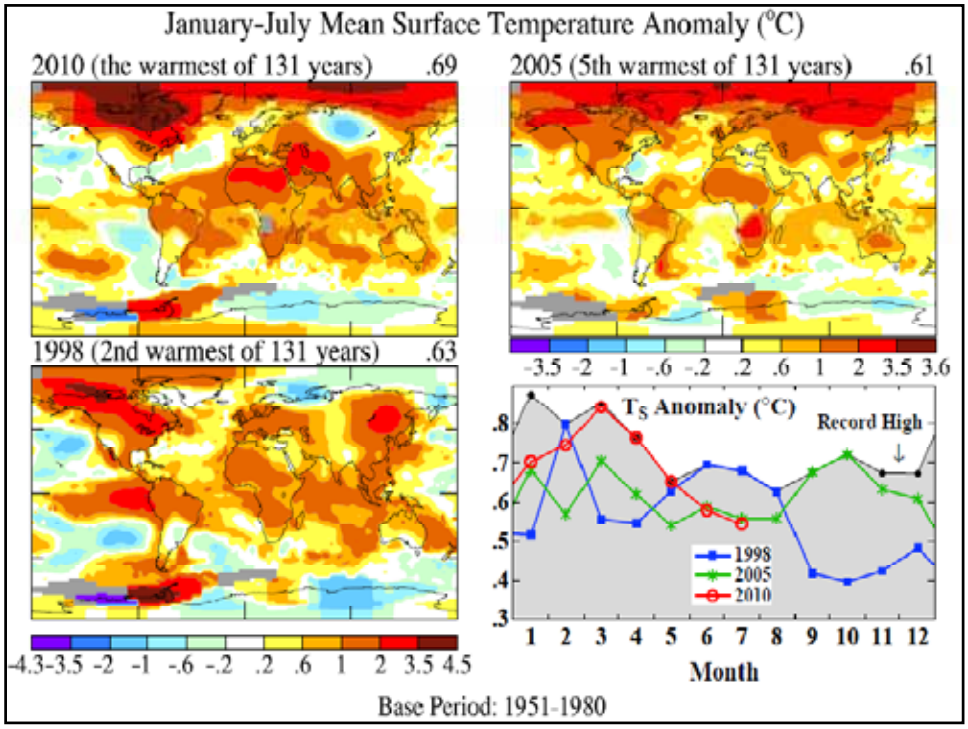
Summary

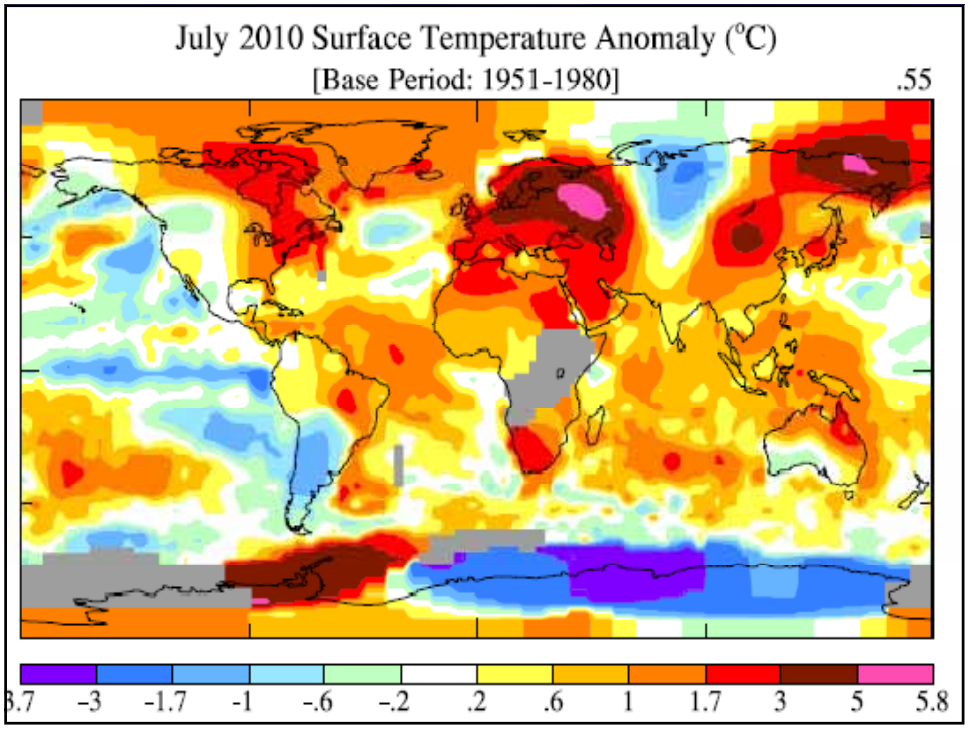
1. The planet is warming
2. The most likely explanation is the large-scale emission of GHGs by human beings
3. More warming is very likely
4. The consequences are very likely to be mainly negative; some will be irreversible




Global Land–Ocean Temperature Index
12–month Running Mean
Temperature Anomaly (°C)
.6
.4
.2
.0
–.2
–.4
1880
1900
1920
1940
1960
1980
2000


Mean surface temperature increase: Comparison of 2001-07 with 1951-80
Global mean increase: 0.54°C
-2
-1.6
-1.2
-.8
-.4
-.2
.2
.4
.8
1.2
1.6
2.3

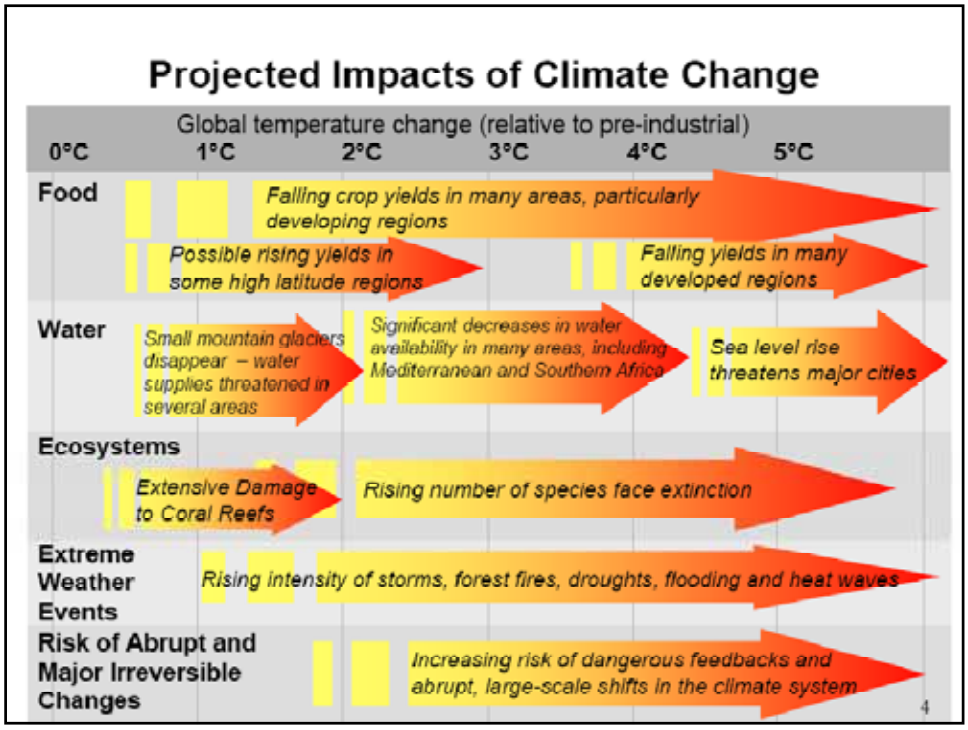

January-July Mean Surface Temperature Anomaly (°C)
2010 (the warmest of 131 years) .69
2005 (5th warmest of 131 years) .61
1998 (2nd warmest of 131 years) .63
-3.5 -2 -1 -.6 -.2 .2 .6 1 2 3.5 3.6
-4.3 -3.5 -2 -1 -.6 -.2 .2 .6 1 2 3.5 4.5
TS Anomaly (°C)
Record High
1998
2005
2010
.8
.7
.6
.5
.4
.3
1 2 3 4 5 6 7 8 9 10 11 12
Month
Base Period: 1951-1980

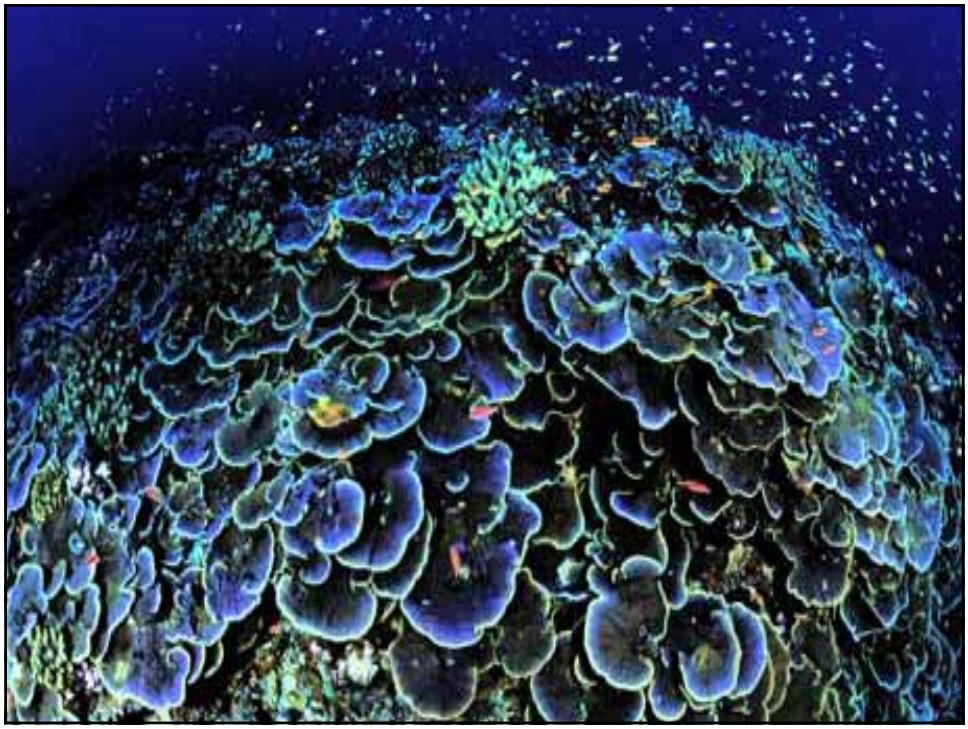

July 2010 Surface Temperature Anomaly (°C)
[Base Period: 1951-1980]
.55
-3.7 -3 -1.7 -1 -.6 -.2 .2 .6 1 1.7 3 5 5.8

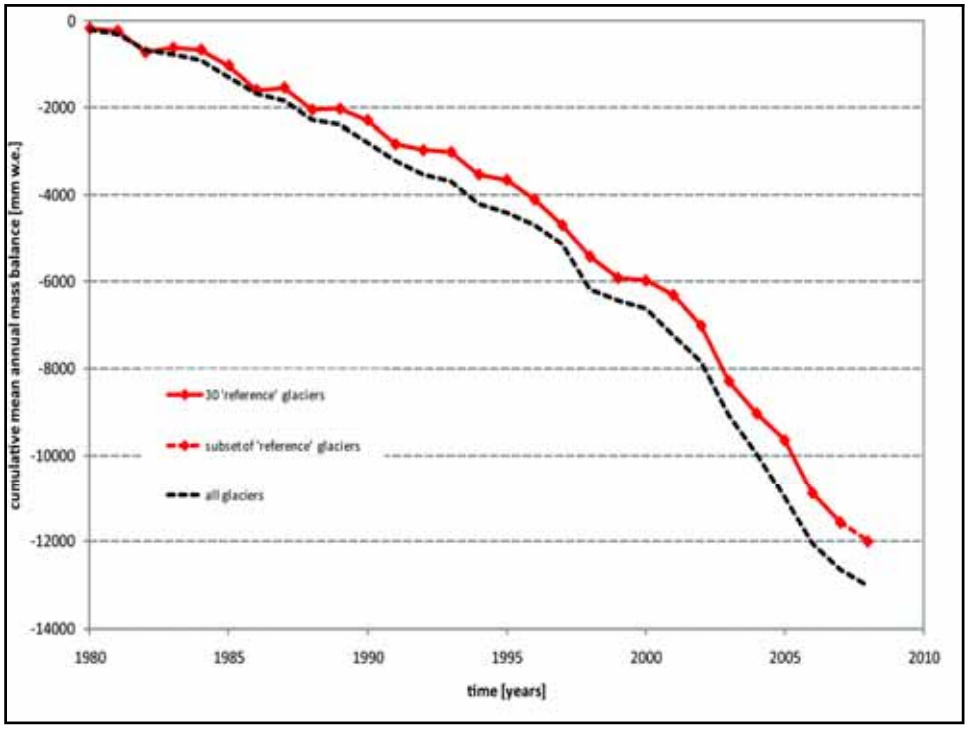
The scientific evidence

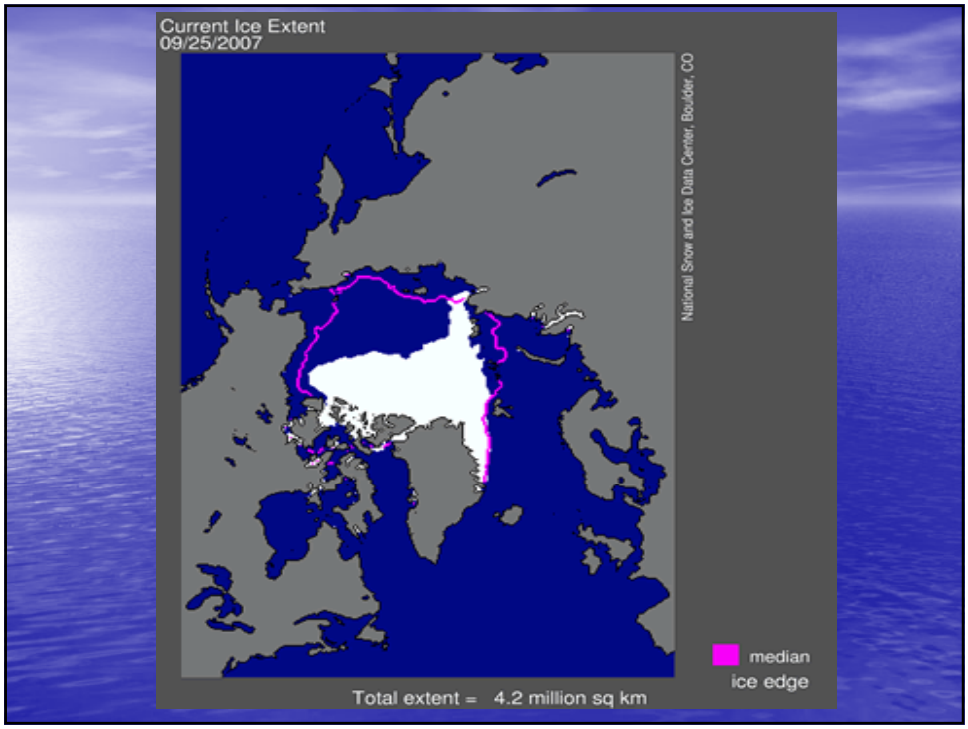
Projected impacts – depend on the magnitude of warming but likely to include:

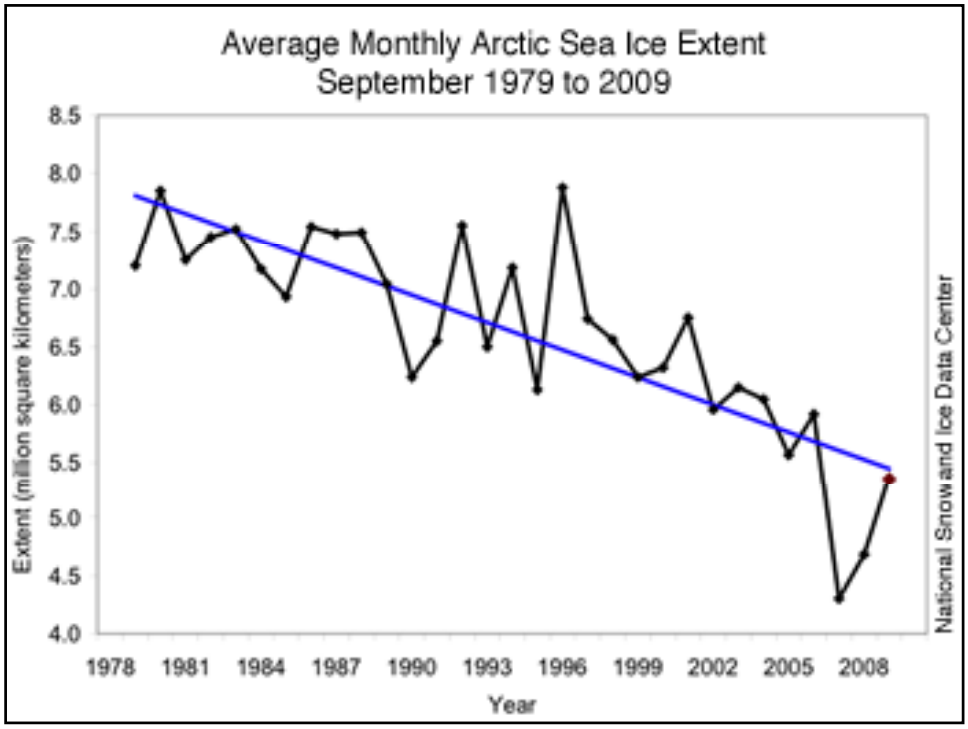
1. Ocean acidification and loss of marine biodiversity, including coral reefs
2. Loss of ice – mountain glaciers, and Greenland & West Antarctic ice sheets
3. Multi-meter sea-level rise
4. More severe droughts, storms, water shortages etc
5. Impacts on food production & security

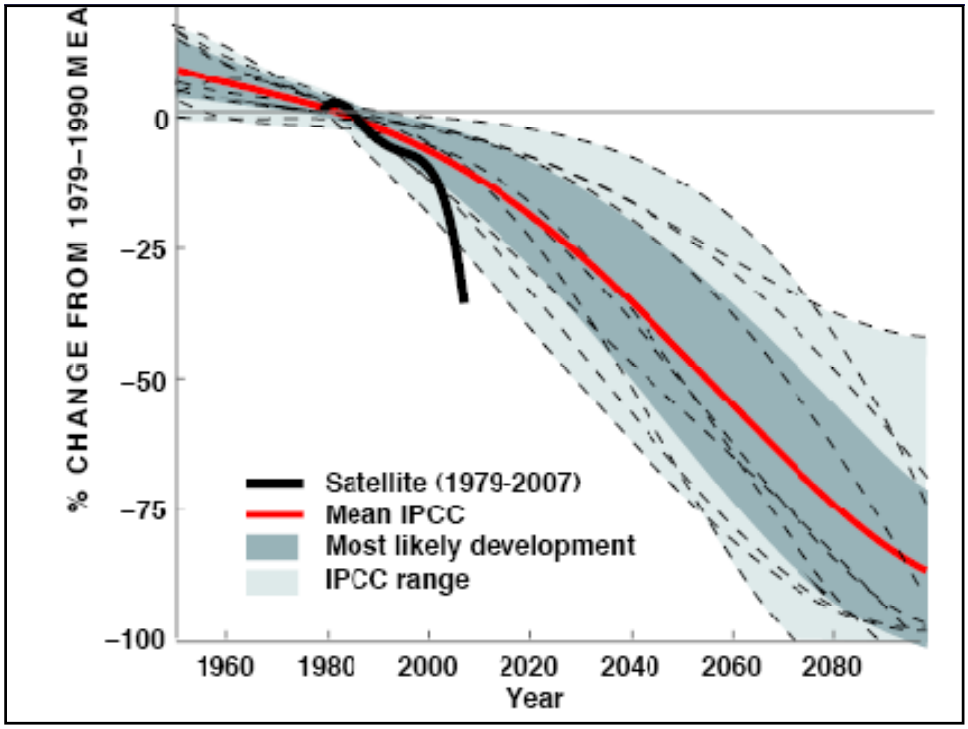


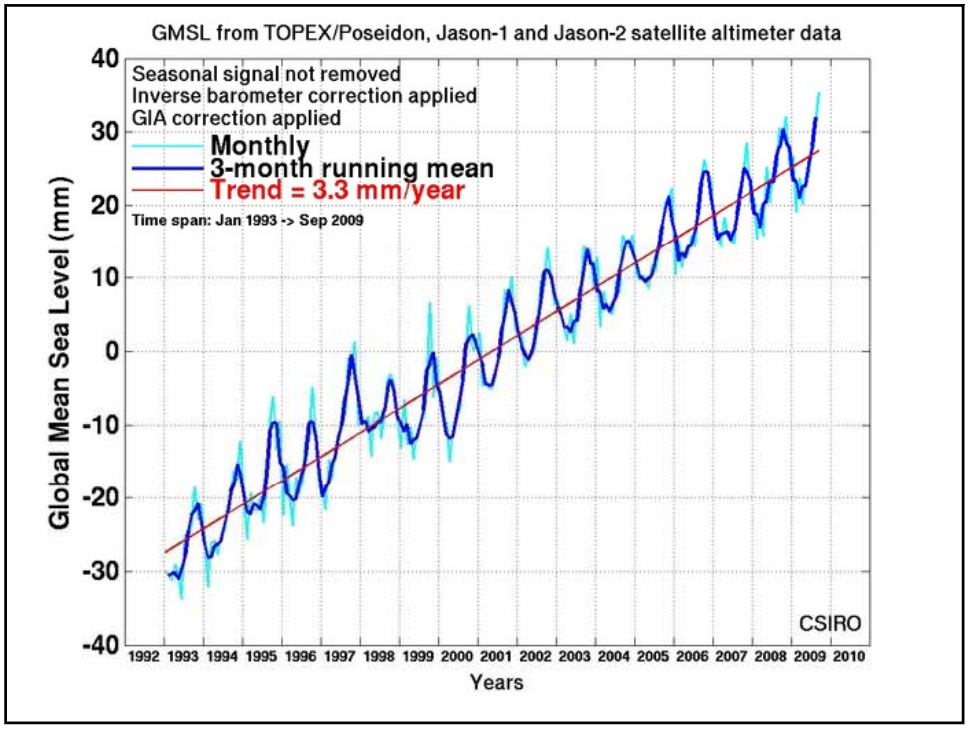



cumulative mean annual mass balance [mm w.e.]
0
-2000
-4000
-6000
-8000
-10000
-12000
-14000
1980
1985
1990
1995
2000
2005
2010
time [years]
30 'reference' glaciers
subset of 'reference' glaciers
all glaciers


Current Ice Extent
09/25/2007
National Snow and Ice Data Center, Boulder, CO
median
ice edge
Total extent = 4.2 million sq km


Average Monthly Arctic Sea Ice Extent
September 1979 to 2009
Extent (million square kilometers)
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
1978
1981
1984
1987
1990
1993
1996
1999
2002
2005
2008
Year
National Snow and Ice Data Center


% CHANGE FROM 1979–1990 MEA
0
−25
−50
−75
−100
1960
1980
2000
2020
2040
2060
2080
Year
Satellite (1979-2007)
Mean IPCC
Most likely development
IPCC range


GMSL from TOPEX/Poseidon, Jason-1 and Jason-2 satellite altimeter data
Seasonal signal not removed
Inverse barometer correction applied
GIA correction applied
Monthly
3-month running mean
Trend = 3.3 mm/year
Time span: Jan 1993 -> Sep 2009
Global Mean Sea Level (mm)
40
30
20
10
0
-10
-20
-30
-40
1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010
Years
CSIRO

The scientific evidence

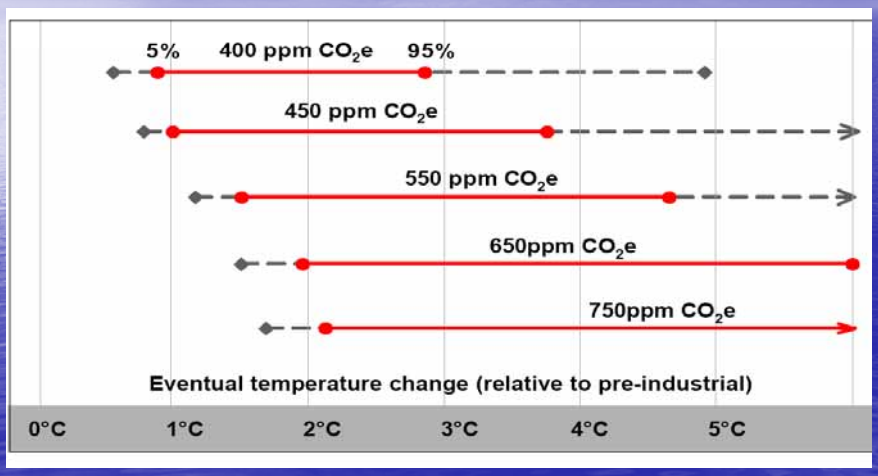
"There is strong support for the mainstream science from the leaders of the relevant science academies in all of the major economies. The outsider to climate science has no rational choice but to accept that, on the balance of probabilities, the mainstream science is right … We will delude ourselves if we think that scientific uncertainties are cause for delay. Delaying now will eliminate attractive lower-cost options … To delay is to deliberately choose to avoid effective steps to reduce the risks of climate change to acceptable levels".

Garnaut Climate Change Review (Australia) (Draft Report, 2008, pp.1-2):

What needs to be done?
The stabilization challenge

1. The global mean surface temperature has increased about 0.75°C above pre-industrial levels; another 0.5°C is in the pipeline (due to lags in the climate system)
2. The Copenhagen Accord commits the global community to avoiding a temperature increase of more than 2°C (above pre-industrial levels)
3. To have a reasonable chance of meeting this objective, CO_2 equivalent concentrations in the atmosphere will need to be stabilized at 450ppm or less (currently about 380-430ppm, depending on whether aerosols are included, and rising at 2ppm p.a.)

Stabilization targets and temperature implications (from Stern Review)

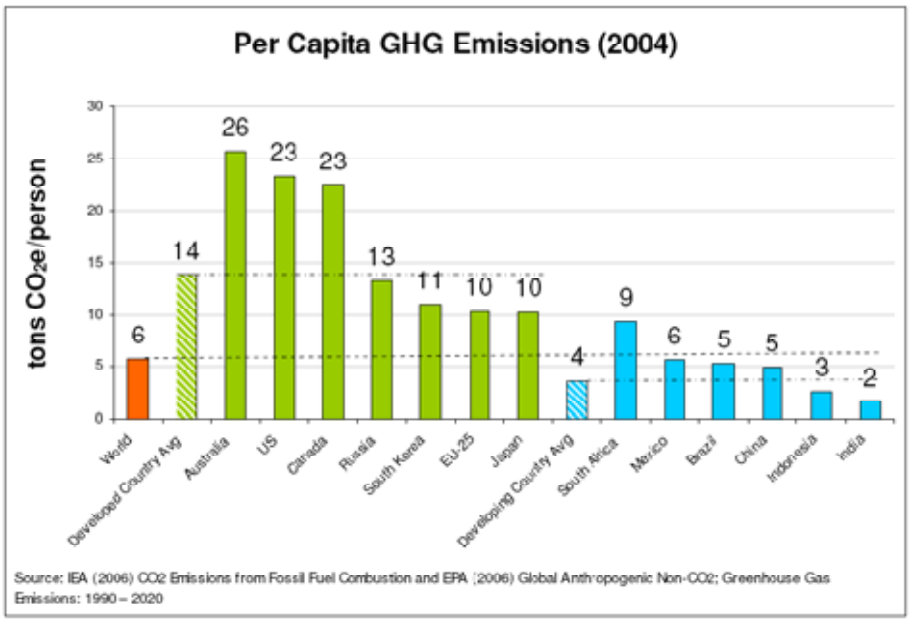


The stabilization challenge

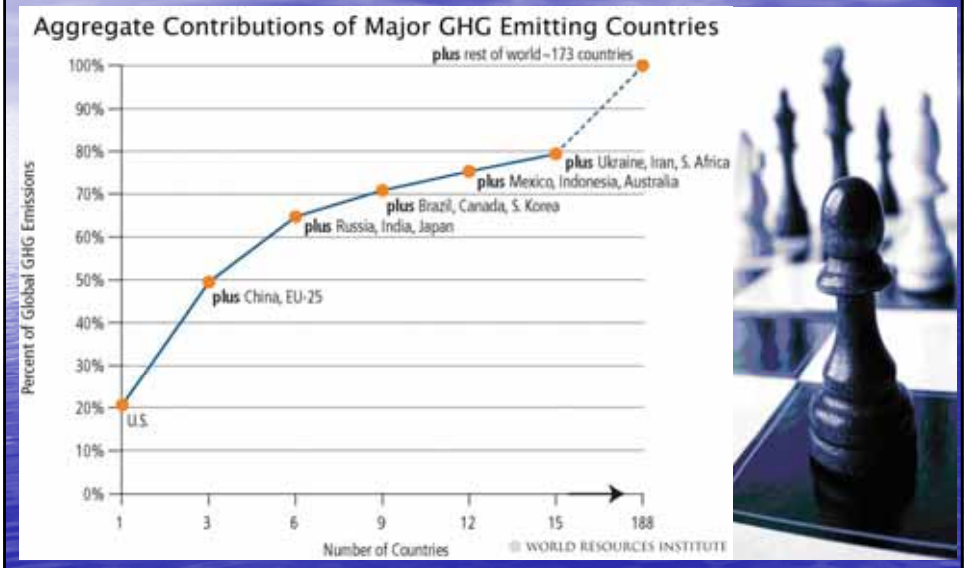
4. To achieve this target, *global* GHG emissions need to be reduced by 50-85% by 2050 and 98% by 2100.
5. Put differently, current global GHG emissions need to be reduced from about 7 tonnes per capita to less than 2 tonnes per capita by 2050 and eventually to almost zero (Australian emissions are currently about 26 tonnes per capita, NZ about 18 tonnes)
6. There is a possible alternative – namely to increase significantly the rate at which GHG emissions are absorbed by the Earth's biosphere (i.e. biosphere carbon stock management – e.g. planting trees, etc.), but this option is likely to be only a temporary fix (or geo-engineering solutions – but risks)

The stabilization challenge

7. Current international policy framework: UNFCCC and Kyoto Protocol (first commitment period, 2008-12)
8. Prospects for a new global climate deal for implementation post-2012 – key issues:
   - Domestic policy settings in the US
   - Legal forms
   - Global burden sharing
   - Financing adaptation
   - Land use/forestry
9. The longer term – post 2020?



Key Players


Aggregate Contributions of Major GHG Emitting Countries
Percent of Global GHG Emissions
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1
3
6
9
12
15
188
Number of Countries
U.S.
plus China, EU-25
plus Russia, India, Japan
plus Brazil, Canada, S. Korea
plus Mexico, Indonesia, Australia
plus Ukraine, Iran, S. Africa
plus rest of world ~173 countries
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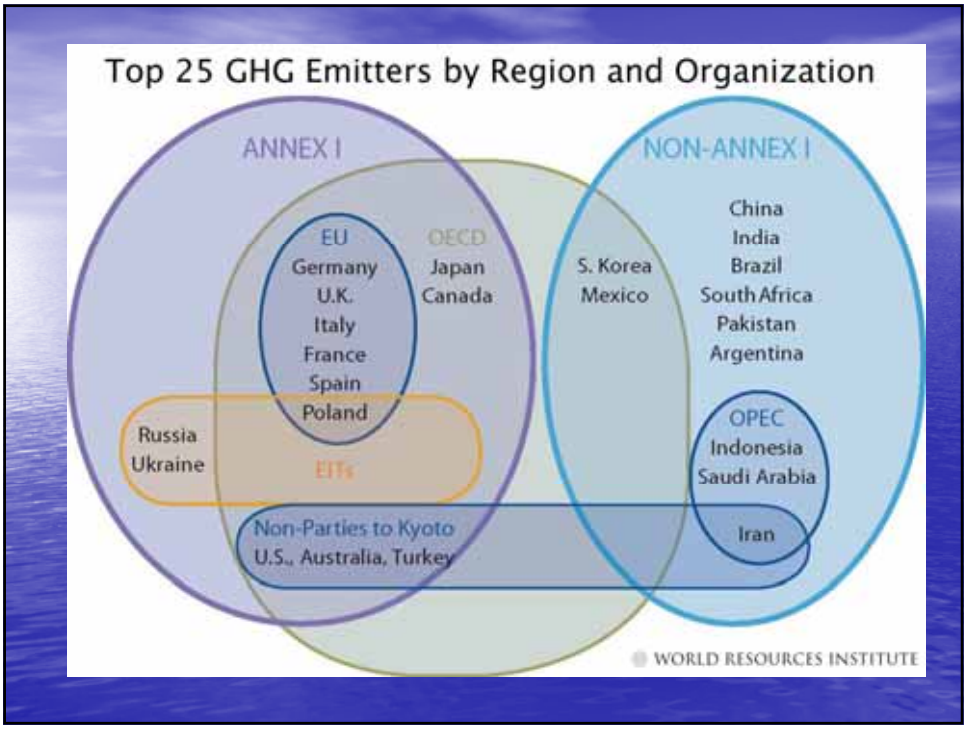
Top 25 GHG Emitters by Region and Organization
ANNEX I
NON-ANNEX I
EU
Germany
U.K.
Italy
France
Spain
Poland
OECD
Japan
Canada
S. Korea
Mexico
China
India
Brazil
South Africa
Pakistan
Argentina
Russia
Ukraine
EITs
OPEC
Indonesia
Saudi Arabia
Iran
Non-Parties to Kyoto
U.S., Australia, Turkey
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Emission paths to stabilization
(from Stern Review)

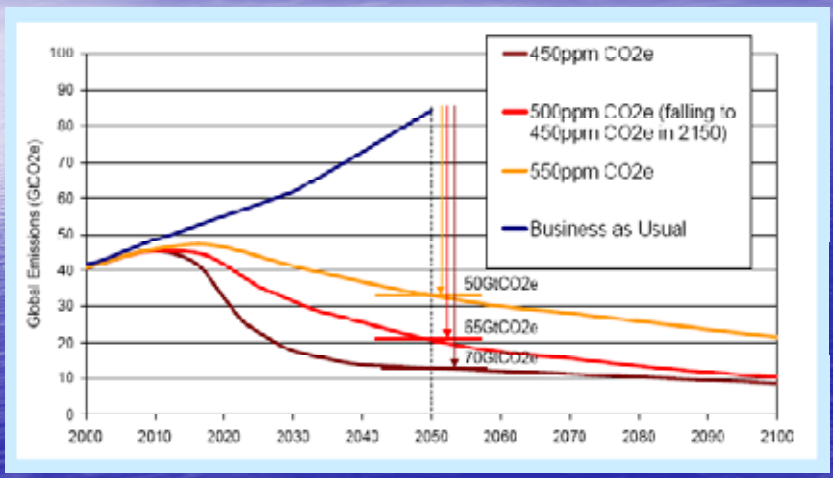
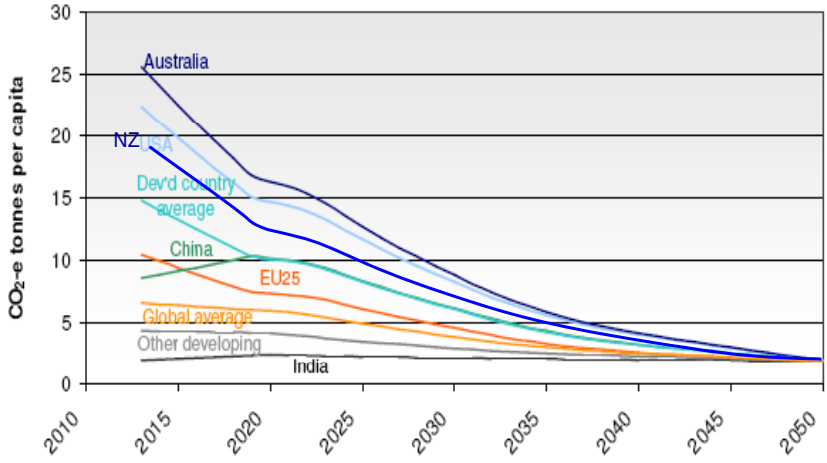
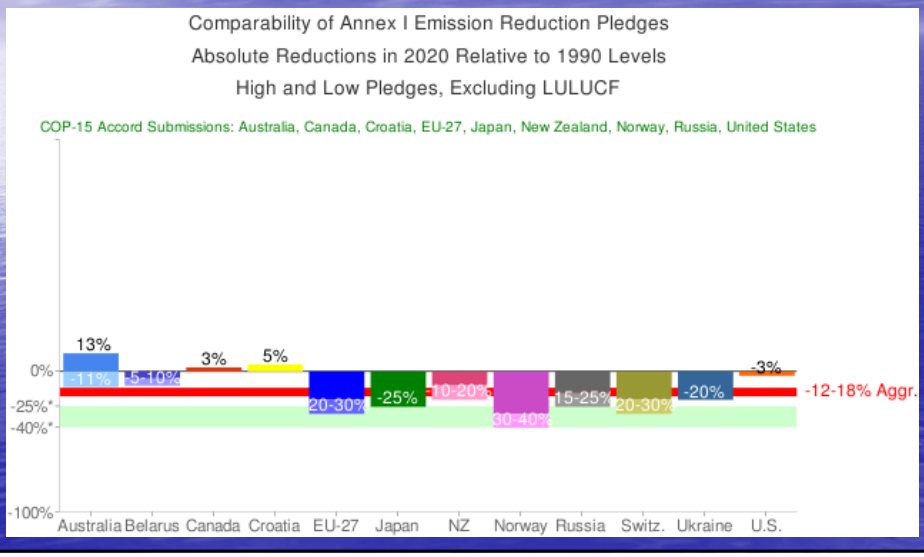


Figure 5.3 Per capita emissions entitlements for the 450 scenario



Note: The graph starts in 2012. Australia's 2012 starting value assumes Kyoto compliance, as do those for the EU25. Other countries start at their emissions level given by the no mitigation scenario in 2012.

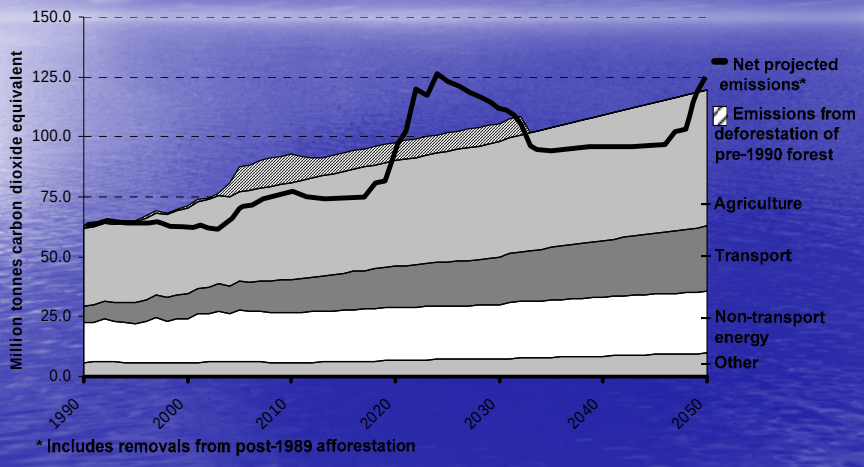
Reduction Pledges Fall Short Relative to Reductions Called for by Science



The New Zealand Context

1. GHG emissions – overall and transport
2. International commitments
3. Policy framework

New Zealand's Projected Emissions



Source: New Zealand Government

Transport emissions

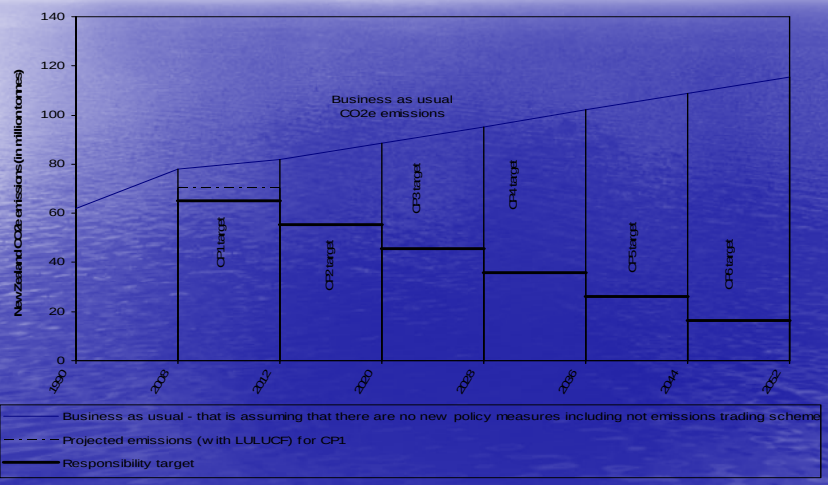
About 18% of NZ's greenhouse gas emissions

- Approx 12% is from light vehicles (private and commercial vehicles less than 3.5tonnes)
  - The average car puts out around 2.5 tonnes of CO_2/yr
- Approx 6% from heavy road, rail, domestic aviation and domestic maritime
- GHG's from the transport sector have increased significantly in recent decades

International commitments

1. Kyoto Protocol – first commitment period (2008-12): NZ to reduce gross emissions to 1990 levels during CP1
2. Post 2012: National-led government has pledged to reduce NZ's gross emissions by 10-20% below 1990 levels by 2020, and by 50% by 2050
3. These commitments have significant implications for transport emissions

Possible post-2012 *responsibility* targets for New Zealand



NZ Domestic Policy Framework

1. Basic policy stance = "ETS plus" (i.e. price on emissions plus complementary measures)
2. Weaker ETS and less "plus" under current government than Labour-led government (but also note the failure of Australia and the US to act)
3. Liquid fuels covered by ETS since 1 July 2010
4. Former NZ Energy Strategy included halving transport emissions per capita by 2040 (cf 2007 levels)

Implications for transport

1. Mitigation
   - Major decarbonization of the transport system needed over the next 2-3 decades
2. Adaptation
   - Key risks
   - Policy implications

Mitigation issues

Many challenges:

- Transport emissions are likely to increase on a business-as-usual scenario
- Behavioural change can be difficult
- Different people are motivated by different factors and require targeted policy responses
- NZ is a technology taker
- Some low-carbon options are expensive

Mitigation issues

Many options for emission reductions
(not mutually exclusive):

- Increase fuel efficiency of road fleet
- Better traffic management (e.g. congestion charges, road pricing, etc.)
- Increase reliance on public transport
- Move to alternative fuels
- Modal shift (more walking and cycling)
- Reduce travel (via improved logistics, working from home, increased housing density, etc.)
- Change urban form (land use controls)

Mitigation issues

How best to achieve change?

Many policy options:

Need a policy framework to encourage the demand for low-carbon technologies and change behaviour in a cost-effective way

- Price on carbon (emissions tax or emissions trading)
- Regulation to improve vehicle efficiency (e.g. mandatory fuel efficiency standards, etc.)
- Integrated planning of transport modes (land, air and sea) and better urban planning
- Information and education

Regulatory options

1. Voluntary agreement
2. Mandatory minimum vehicle efficiency standards
3. Corporate average fuel economy (CAFE) standard
4. Biofuels (general)
5. Renewable Transport Fuels Obligation
6. Hydrogen and fuel cell development
7. Bus operator fleet targets for alternative fuels
8. Car and cycle parking standards for new developments
9. Public procurement of alternative vehicles
10. Fuel quality standards
11. Taxi regulation
12. Railway minimum energy standards (e.g. Franchise agreements)
13. Car free housing
14. Controled parking zones (CPZ) Green badge parking permits (GBPP) I
15. High occupancy vehicle lanes/ pricing
16. Low emission zones (LEZ)
17. Speed limits/ enforcement
18. Intelligent speed adaptation (ISA)
19. Event data/ Black box recorders (cars)
20. Electronic control units in cars
21. Vehicle idling campaigns
22. Tyre pressure monitoring systems
23. Car emissions testing
24. Flexitime/ adjust opening times
25. Carbon trading (surface transport in EUETS)
26. Personal carbon trading
27. Fuel rationing/ permits
28. Domestic Tradeable Quotas DTQs
29. Carbon offsetting DTQs)
30. Stronger speed enforcement

Adaptation Issues

1. Key risks for transport infrastructure:
   - Storms – heavy precipitation events
   - Heat waves
   - Sea level rise – the evolving science
2. Policy implications:
   - Enhancing resilience and reducing vulnerability
   - Long-term planning issues – especially for long-lived infrastructure (e.g. location, design, cost, etc.)
   - Environmental implications of engineering decisions

Conclusions

1. Climate change poses huge political, social, economic and technical challenges
2. Transport is a key sector – significant decarbonization is both necessary and possible; adaptation will be increasing important, especially in the longer term
3. A sustainable transport strategy needs a combination of measures to promote low carbon fuels, low carbon vehicles and low carbon journeys and lifestyles

Former British PM, Margaret Thatcher, Speech to the United Nations General Assembly (Global Environment), 8 November, 1989

On climate change:

> "Mr President, the evidence is there. The damage is being done. ... We need a realistic programme of action and an equally realistic timetable. Each country has to contribute, and those countries who are industrialised must contribute more to help those who are not. The work ahead will be long and exacting. We should embark on it hopeful of success, not fearful of failure. ... We are not the lords, we are the Lord's creatures, the trustees of this planet, charged today with preserving life itself—preserving life with all its mystery and all its wonder. May we all be equal to that task."

Acknowledgements

1. National Climatic Data Centre (NOAA)
2. National Snow and Ice Data Center
3. The Garnaut Climate Change Review
4. Dr Jim Hansen's blog
5. The Pew Center