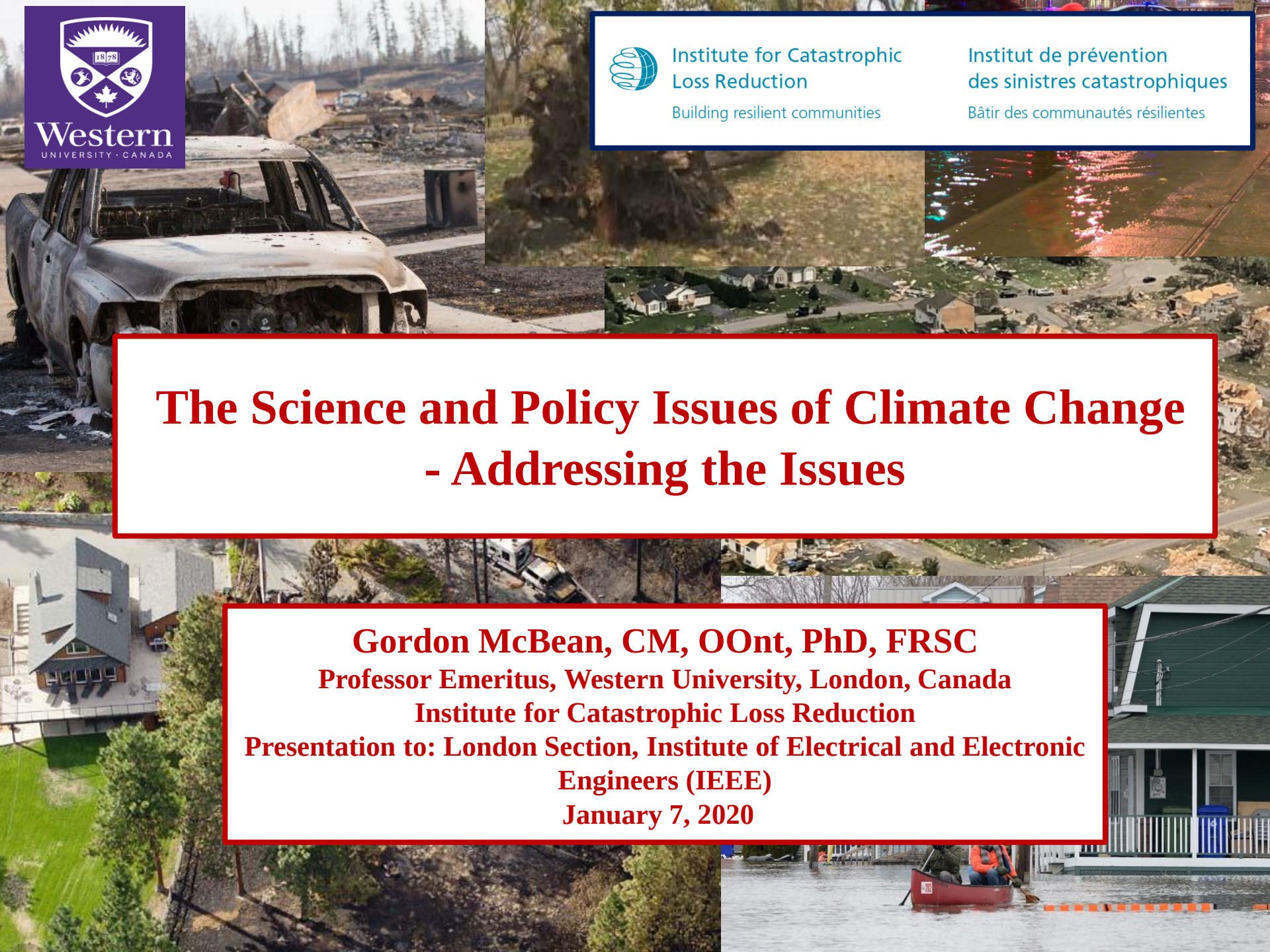

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Institute for Catastrophic Loss Reduction
Building resilient communities

Institut de prévention des sinistres catastrophiques
Bâtir des communautés résilientes

The Science and Policy Issues of Climate Change - Addressing the Issues

Gordon McBean, CM, OOnt, PhD, FRSC
Professor Emeritus, Western University, London, Canada
Institute for Catastrophic Loss Reduction

Presentation to: London Section, Institute of Electrical and Electronic Engineers (IEEE)
January 7, 2020

Climate Science

And Climate Warming

GREENHOUSE EFFECT –
Gases in atmosphere trap energy and warm the surface and lower atmosphere

Greenhouse effect warming:

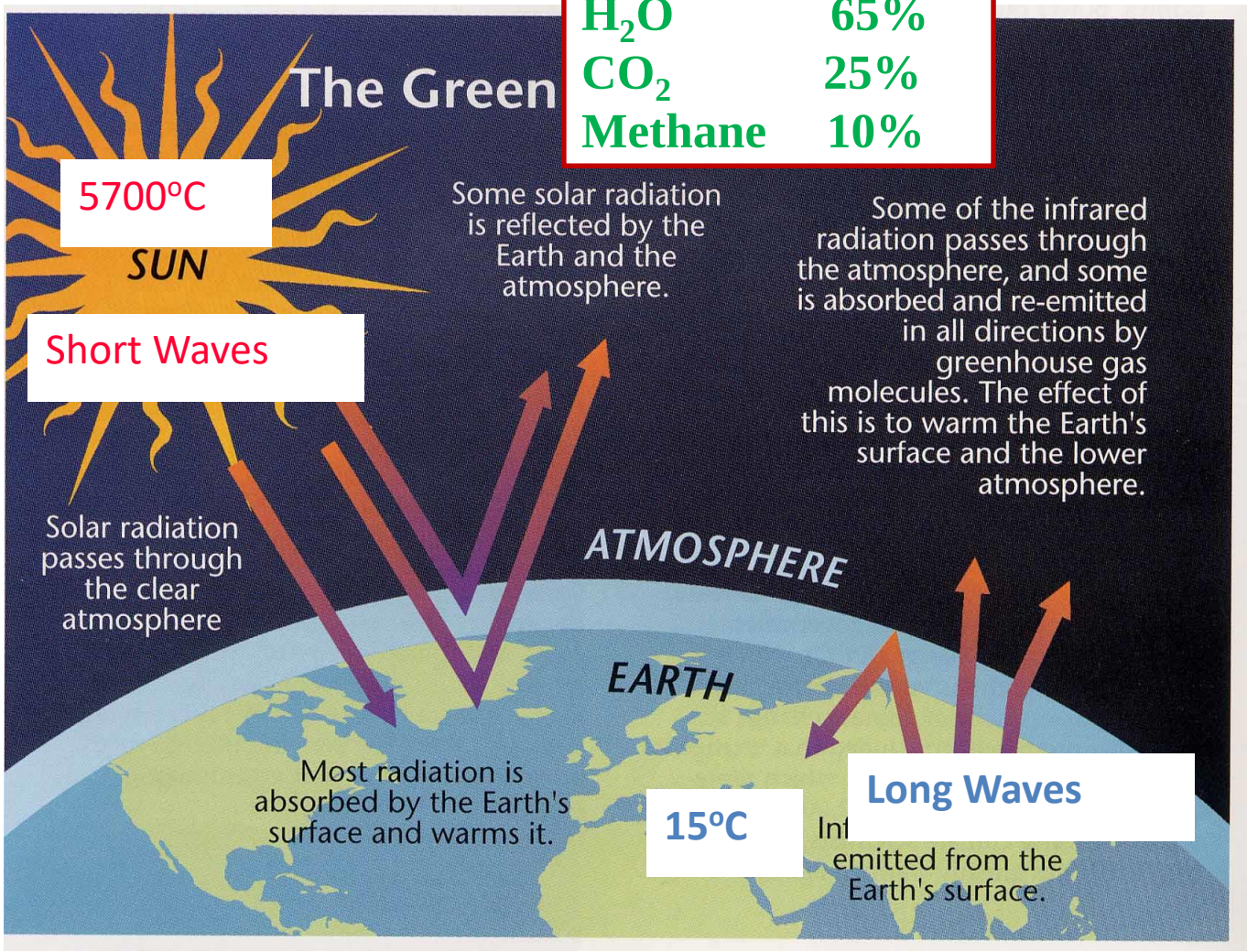
Earth +33C
0.04% CO_2
1% H_2O
1 atmos.

Venus +500C
>90% CO_2
90 atmos.

Mars +10C
>80% CO_2
0.007 atmos.

GHG effect

H_2O	65%
CO_2	25%
Methane	10%



Time scales of the greenhouse - climate system

Time scales of Greenhouse Gases

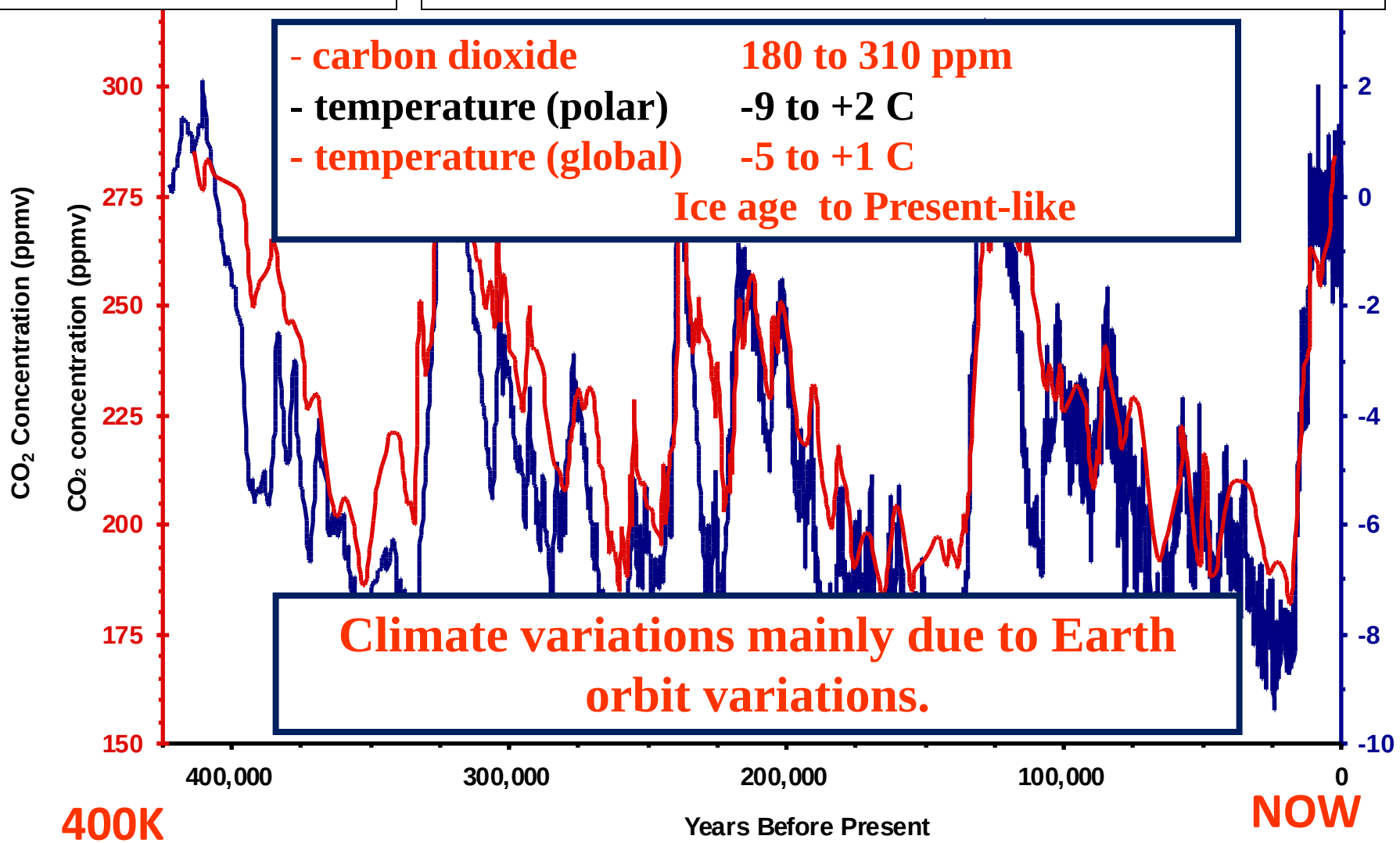
- **Water vapour** — **10 days**
  - **In and out quickly – atmosphere almost full**
- **Carbon dioxide - CO_2** — **100 years**
  - **Global mixing of greenhouse gases 2-4 y**
  - **Does not matter where it enters – also depends on last century – not just "last year"**
- **Other –methane (+ nitrous oxide)** — **10 years**
  - **Methane gas – 25 times more "potent" than CO_2**

Climate system time scales

- **Air temperature response - CO_2 injection** — **100 years**
- **Sea level response - CO_2 injection** — **100's yrs**

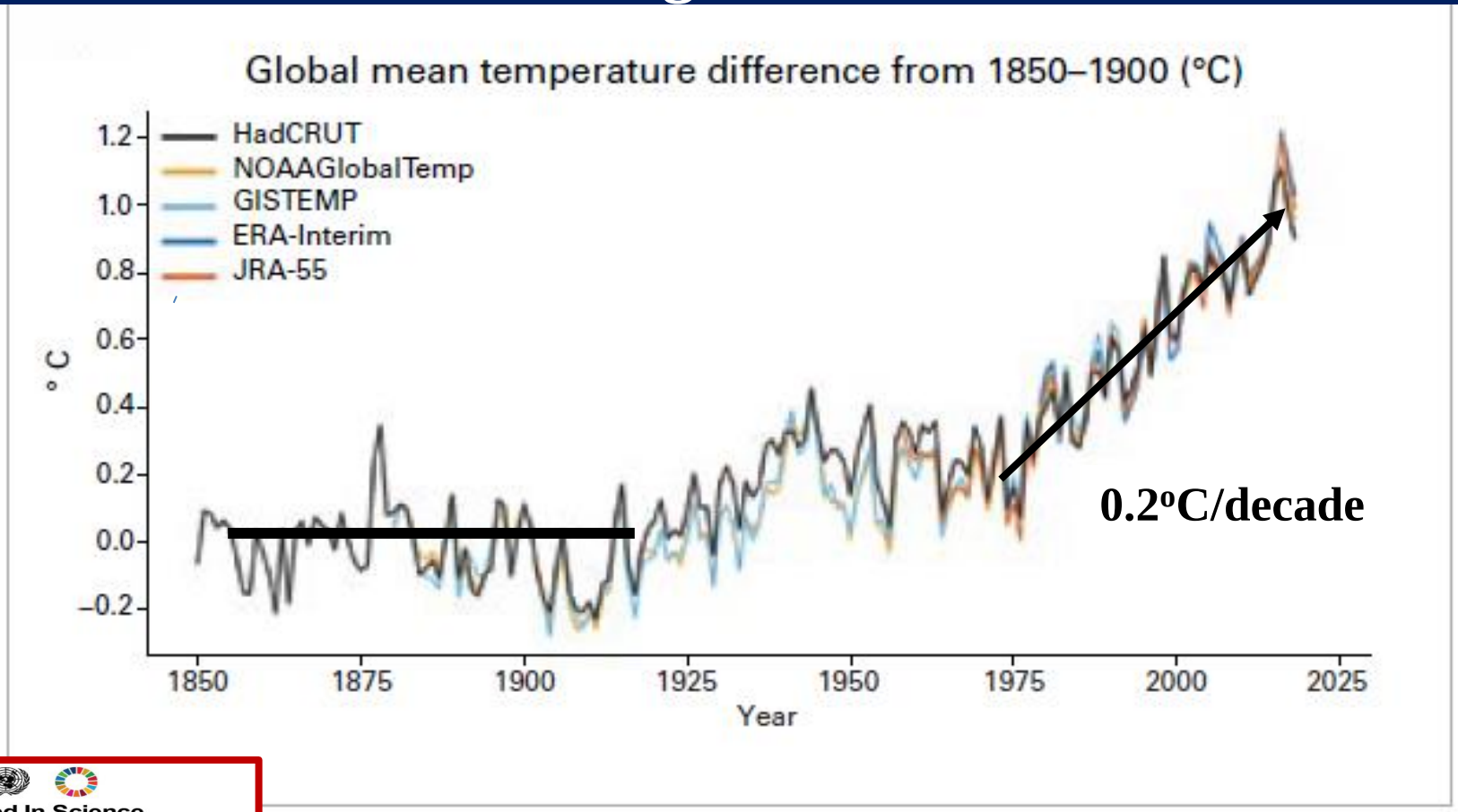
Temperature and CO_2 together.

Temperature led but a reduced greenhouse effect amplified the cooling



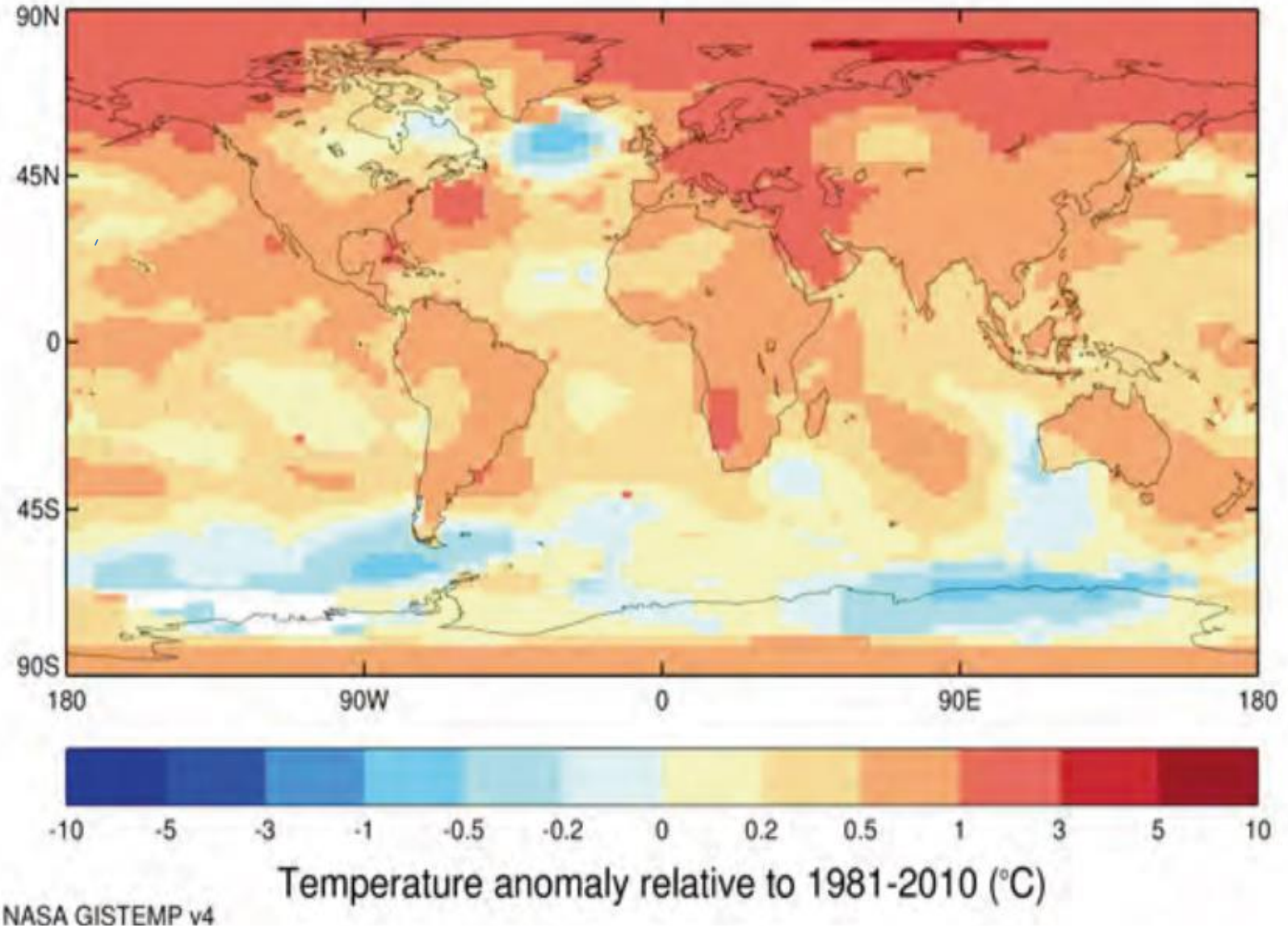
Source: Barnola, *et.al.*; Petit *et.al.* *(PAGES* / IGBP)

A Warming Climate



Climate Warming

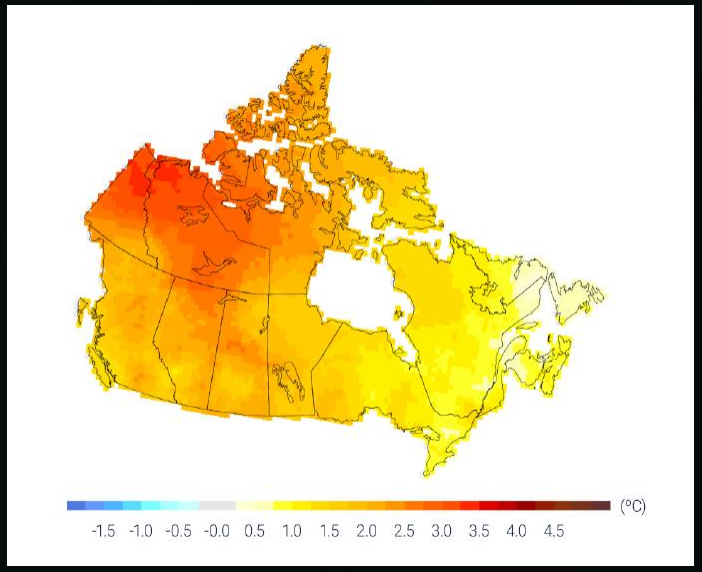
2015 - 2019
5 warmest years



Source NASA GISTEMP v4

2015-2019 five-year average temperature anomalies relative to the 1981-2010 average. Data are from NASA GISTEMP v4. Data for 2019 to June.

CHANGING CANADIAN CLIMATE - warming



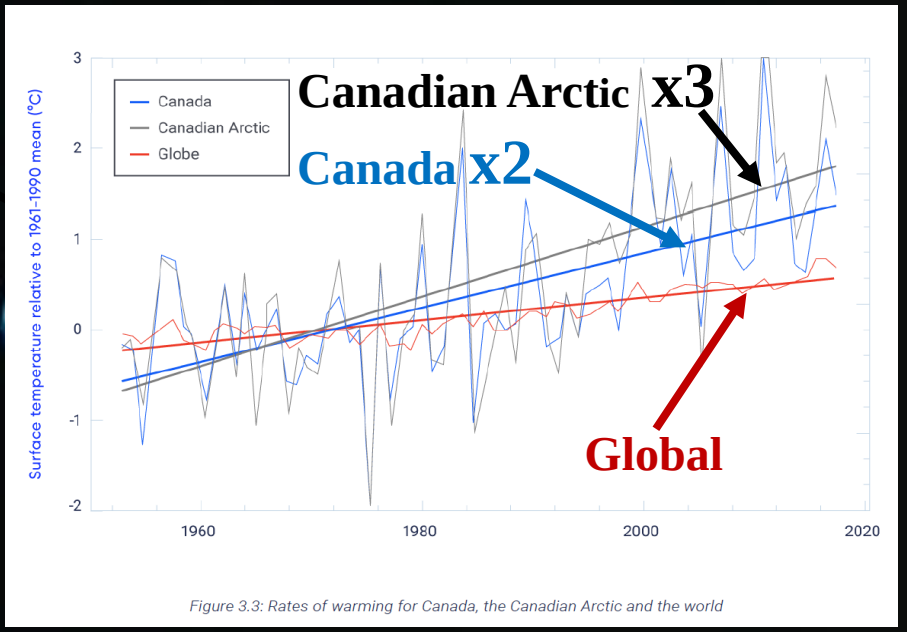
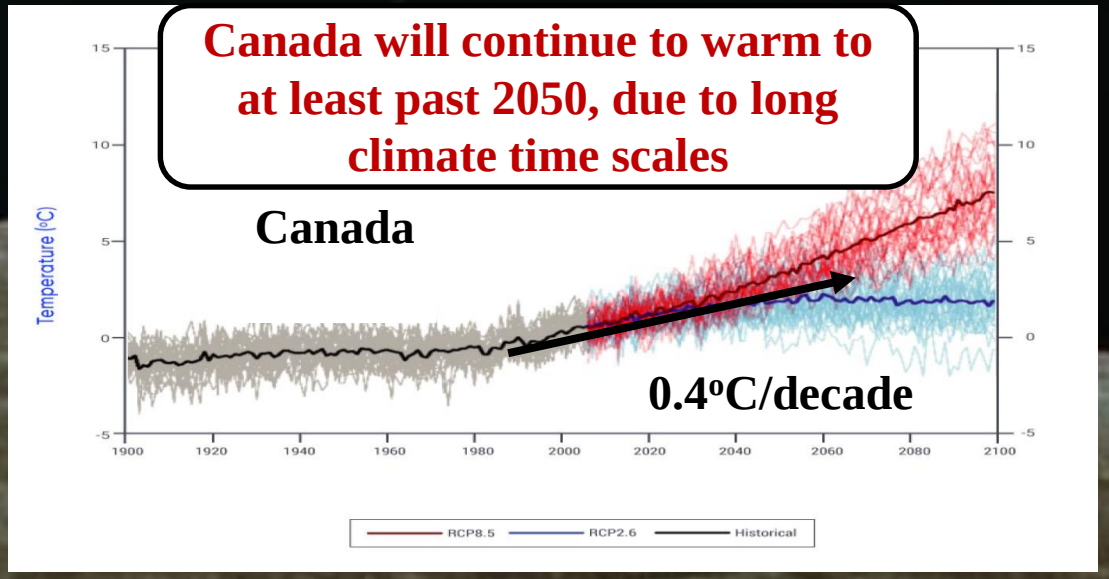
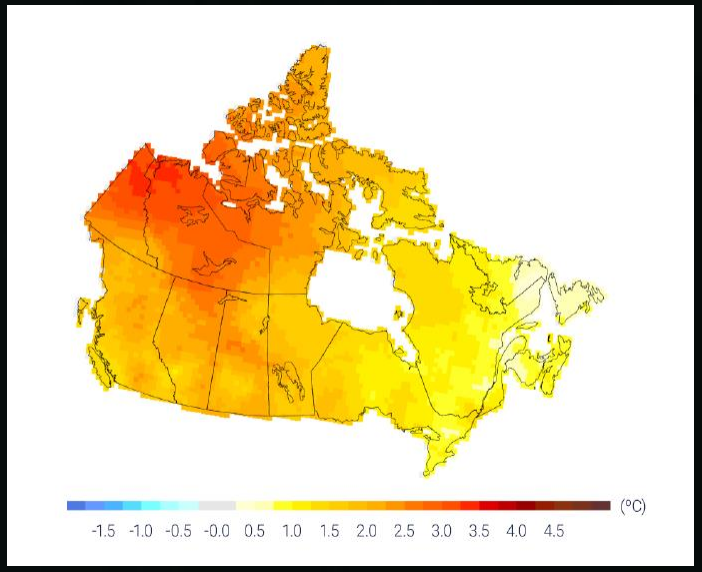
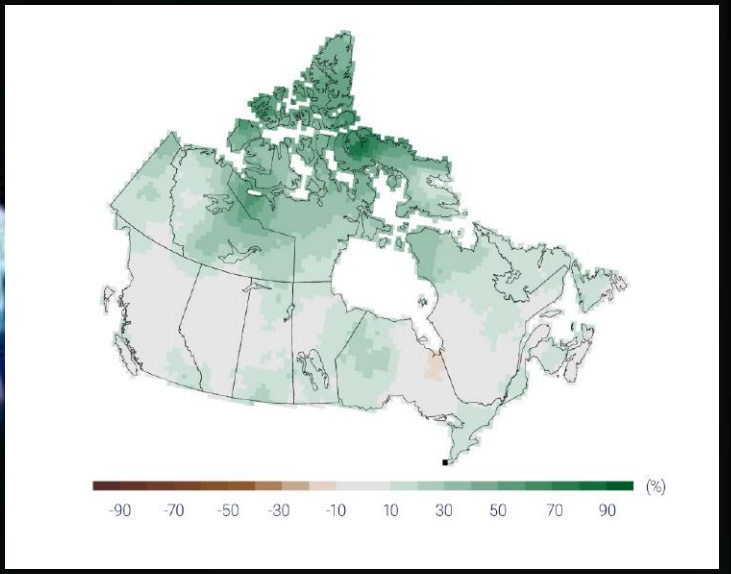


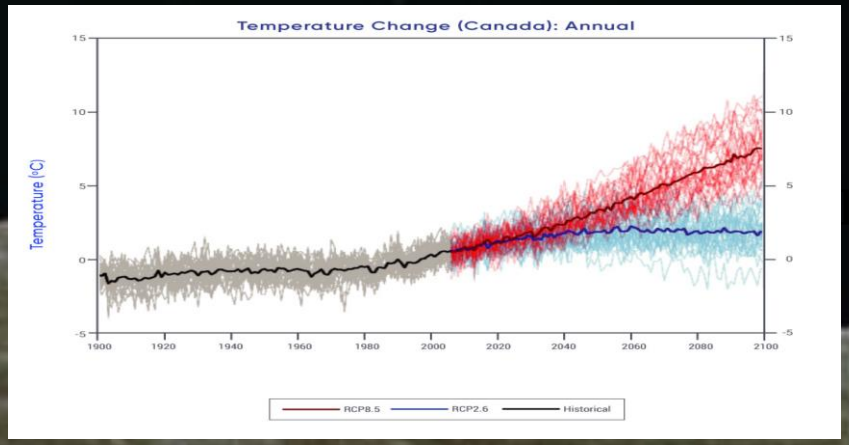
Figure 3.3: Rates of warming for Canada, the Canadian Arctic and the world

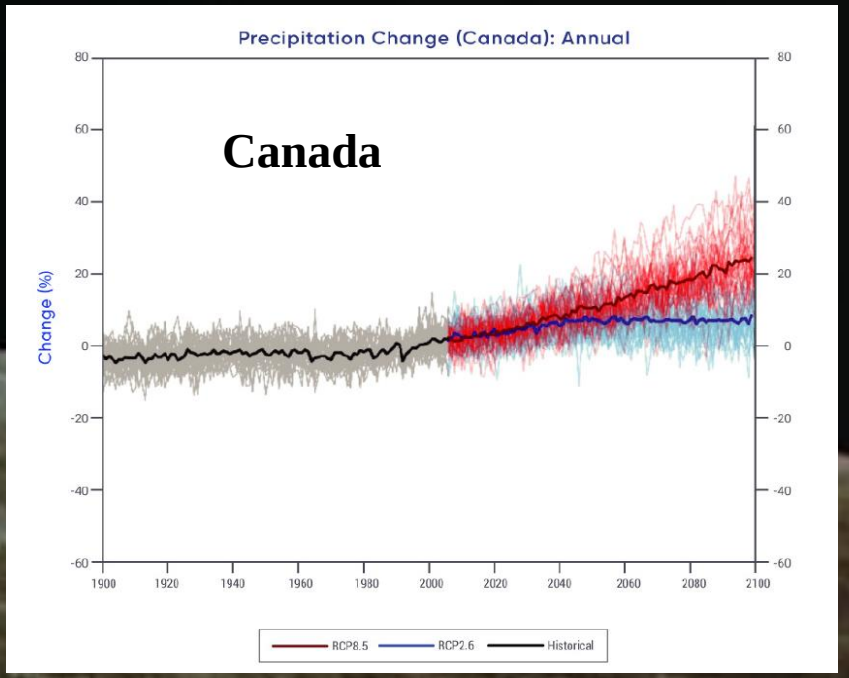


CHANGING CANADIAN CLIMATE - precipitation










Why is the climate changing?

Intergovernmental Panel on Climate Change
Climate Science Assessment

- **Established in 1988 by WMO and UNEP. Science Assessments – 1990, 1995, 2001, 2007, 2013-4, 2020**
- **Special reports – SREX (2011), 1.5C, …**
- **Policy relevant but not policy prescriptive**
- **Authors selected on basis of scientific excellence – from around the world. Extensive review process.**
- **Chapters – responsibility of lead authors**
- **Summary for Policy Makers – approved by governments in plenary**

WG	Title	Authors	Countries	Comments
I	The Physical Science Basis	259	39	54,677
II	Impacts, Adaptation & Vulnerability	309	70	50,444
III	Mitigation of Climate Change	235	57	38,315

IPCC Detecting and Attributing Climate Change

- **1st (1990):"*The observed increase* (in temperatures) *could be largely due to natural variability; alternatively this variability and other man-made factors could have offset a still larger man-made greenhouse warming.*" "*The unequivocal detection of the enhanced greenhouse effect from observations is not likely for a decade or more, when the commitment to future climate change will be considerably larger than it is today.*"**
- **2nd (1995): "*The balance of evidence suggests that there is a discernible human influence on global climate*"**
- **3rd (2001) "*There is new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities.*"**
- **4th (2007): "*Most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations.*"**

IPCC SPM 2015 Causes of Climate Change

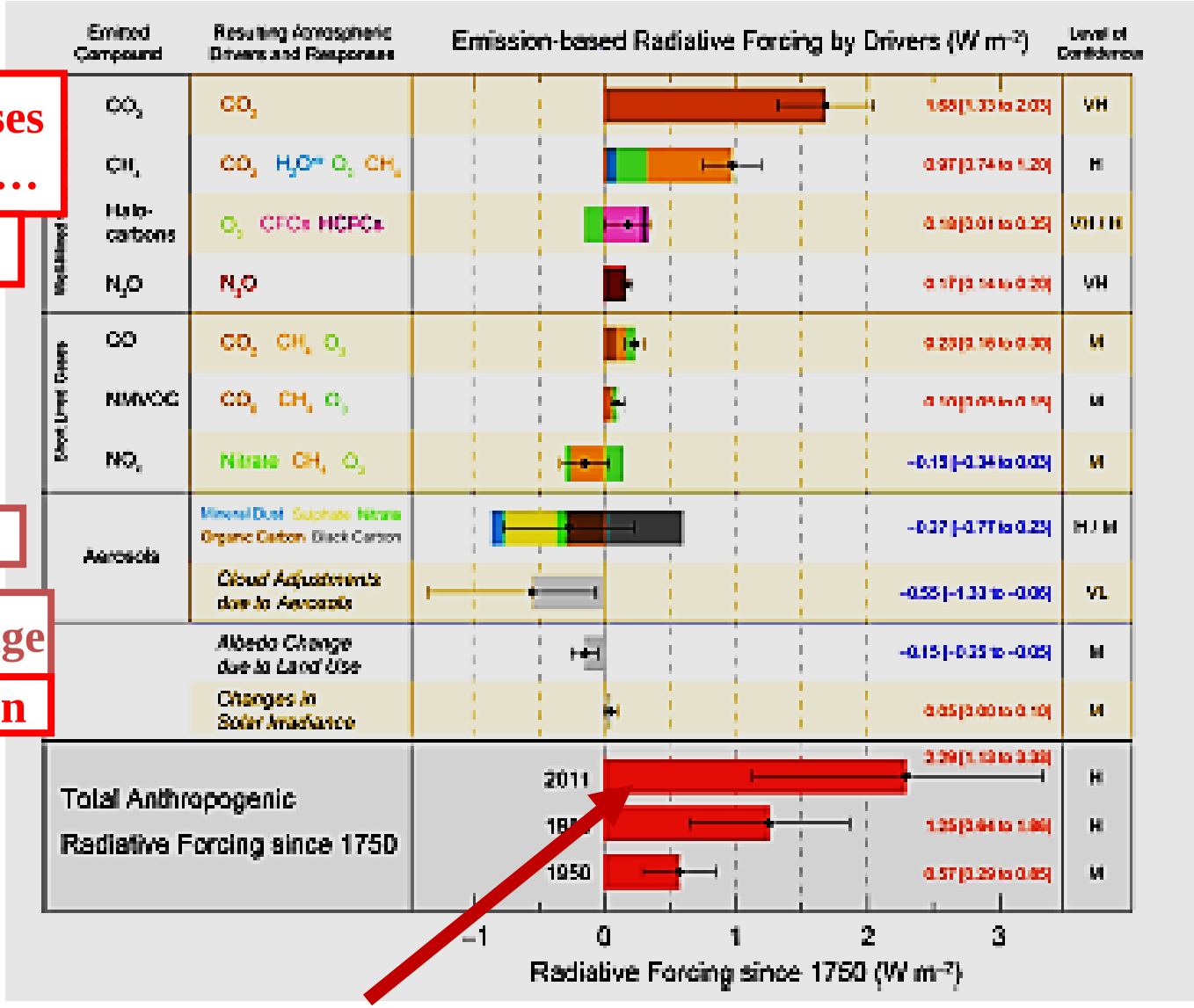
Greenhouse gases
CO_2, Methane,…

Ozone

Aerosols

Land-use change

Solar radiation

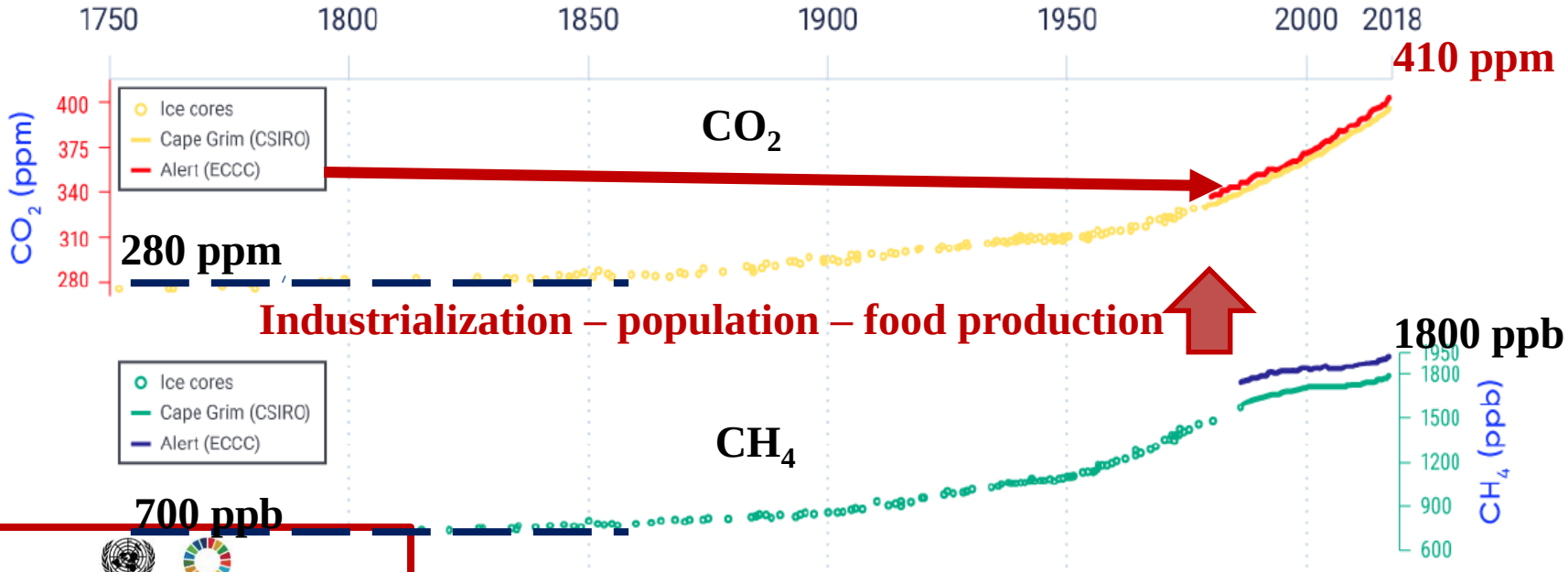


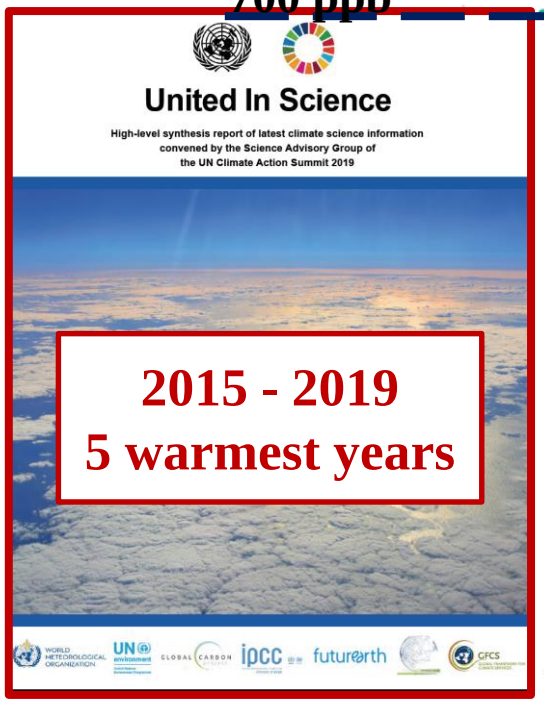
Climate Change – IPCC AR5 - 2014

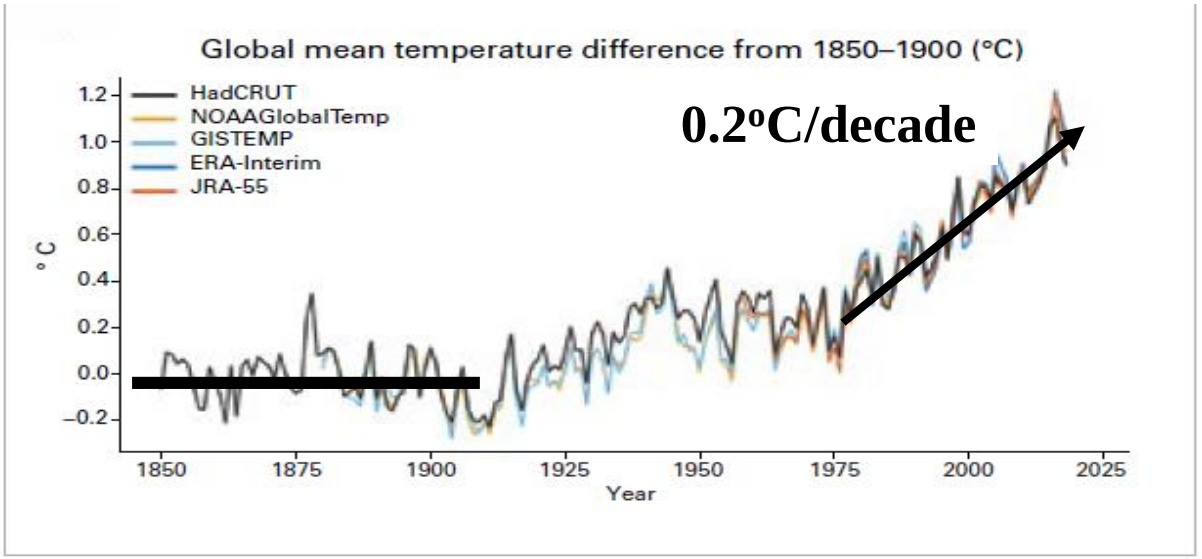
Warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia. The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, sea level has risen, and the concentrations of greenhouse gases have increased. (IPCC 2013)

Human influence has been detected in warming of the atmosphere and the ocean, in changes in the global water cycle, in reductions in snow and ice, in global mean sea level rise, and in changes in some climate extremes. This evidence for human influence has grown since AR4 (2007). It is extremely likely that human influence has been the dominant cause of the observed warming since the mid-20th century.

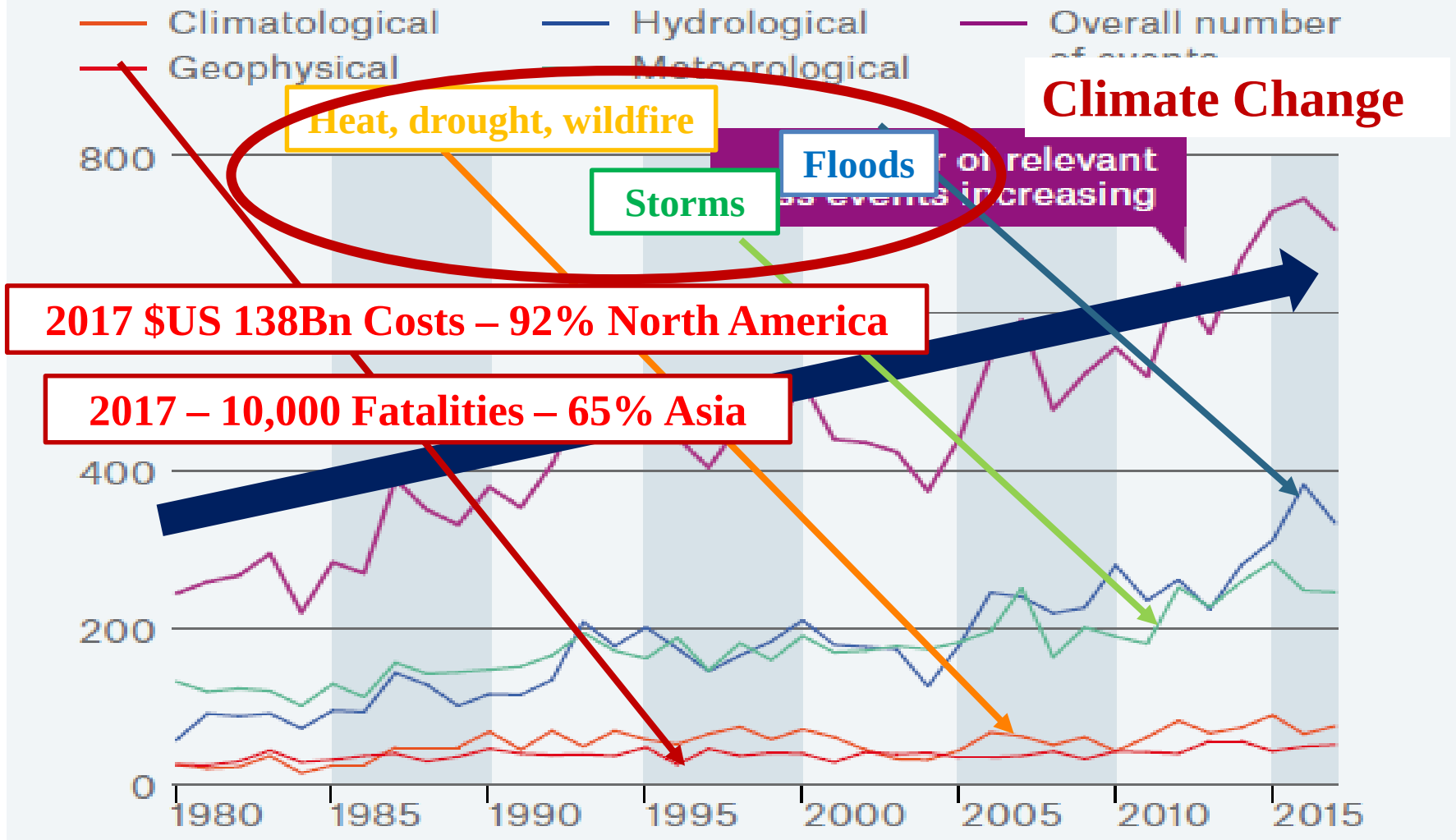
Greenhouse Gas Concentrations up and Climate Warming







IMPACTS GLOBALLY
THE NUMBER OF "NATURAL" CATASTROPHES IS INCREASING



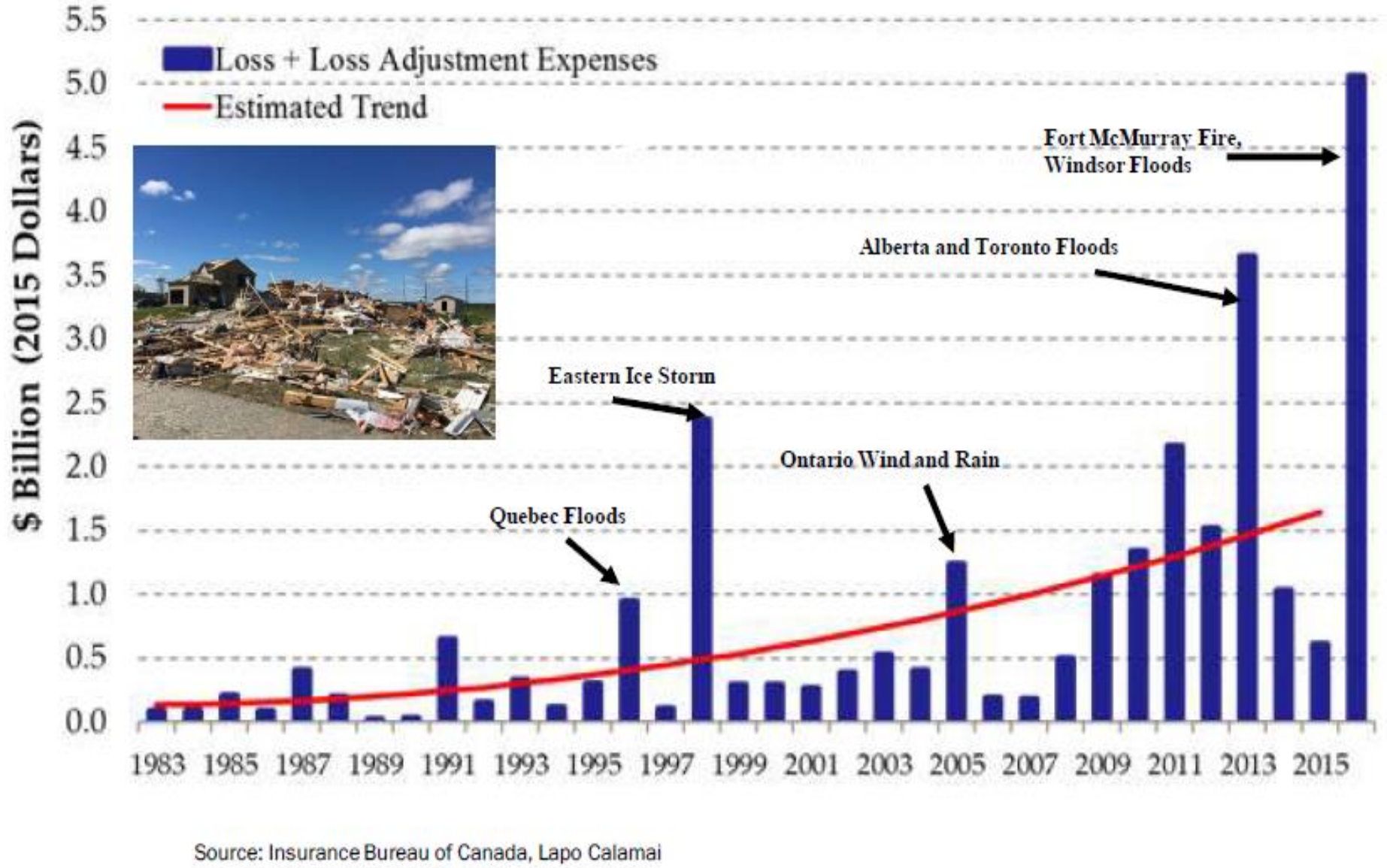
2017 $US 138Bn Costs – 92% North America

2017 – 10,000 Fatalities – 65% Asia

NatCatSERVICE, Munich Re, 2017

IMPACTS IN CANADA

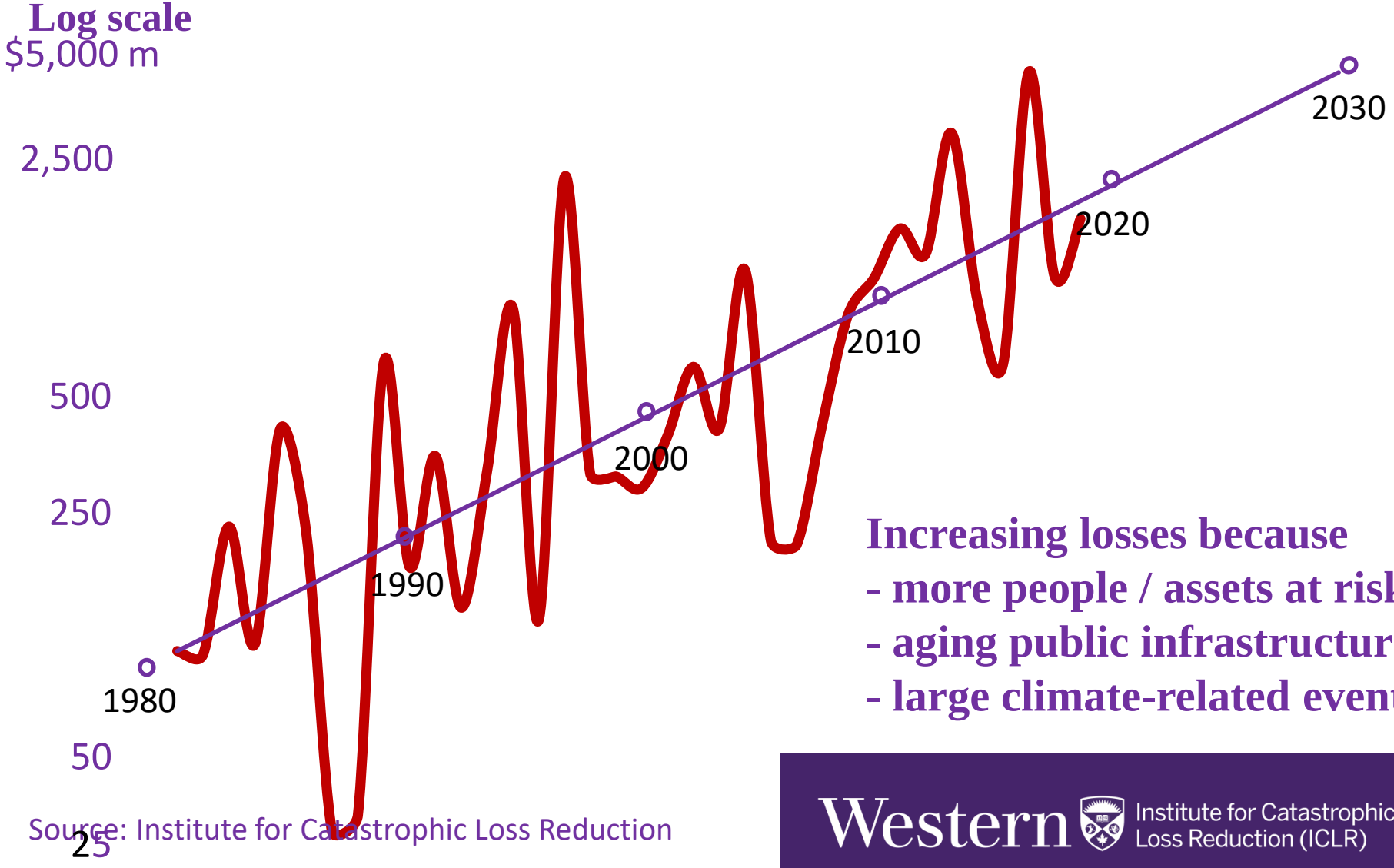
THE NUMBER OF "NATURAL" CATASTROPHES IS INCREASING



Source: Insurance Bureau of Canada, Lapo Calamai

Canadian insurance payments

Insurance claims paid, 1983 - 2018, millions of dollars, adjusted for inflation



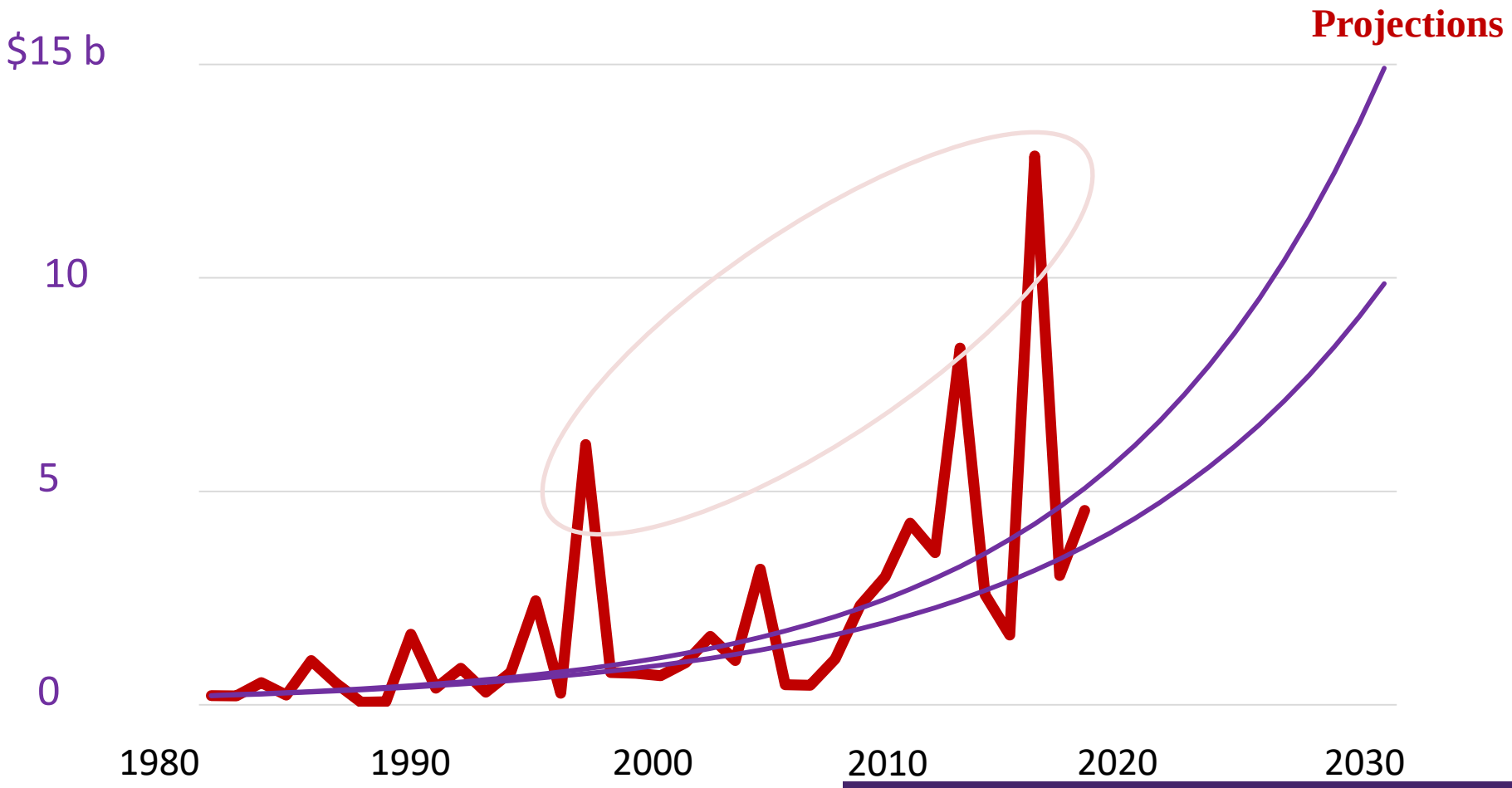
Increasing losses because
- more people / assets at risk
- aging public infrastructure
- large climate-related events

Source: Institute for Catastrophic Loss Reduction

Western | Institute for Catastrophic Loss Reduction (ICLR)

Direct damage trends in Canada

Estimated annual direct physical damage, billions of dollars, adjusted for inflation

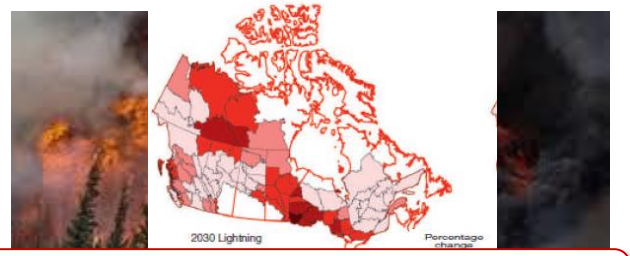


Source: Institute for Catastrophic Loss Reduction

Western Institute for Catastrophic Loss Reduction (ICLR)

10 most costly (in dollars) disasters in Canadian history for insurers and Canadians plus projections with climate change

"Today is not the end of the story. It is <u>not a return to normal life</u> and it's not yet a celebration," Alberta Premier Notley told reporters on June 1 at Fort McMurray's emergency centre as the first residents began to return. "There's still a lot of work to recover and rebuild Wood Buffalo. This will be the <u>work of years, not weeks</u>."



More than 50% Increase

A confident, athletic girl, McLean says the flood left her vulnerable, scared and hating the rivers that encircled her home.

Youth anxiety on the rise amid changing climate

By GAYLE MacDONALD

By 2050, with about twice as many heavy precipitation events, more floods are projected.

Extreme events - the unborn and children :

"Children whose mother experienced high stress (during the Quebec 1998 ice storm) scored lower on IQ and language performance tests than those whose mothers had less stress."

Freezing rain events

- increase in the number of freezing rain events of more than 4 and 6 hours by about 40% by 2050.

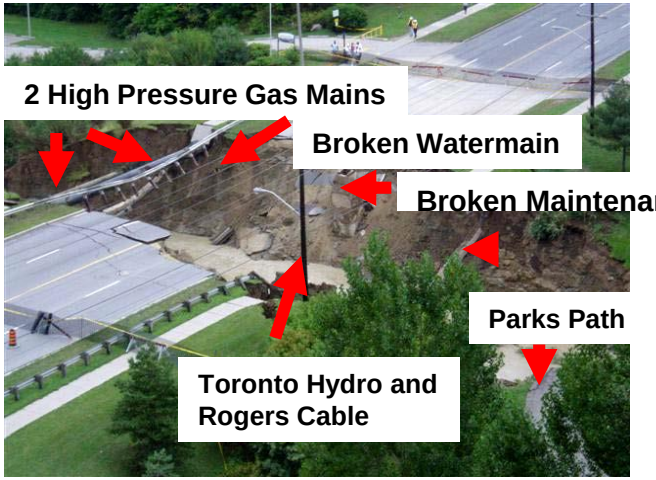
eastern Ontario and parts of Quebec.

Top 10 most costly (in dollars) disasters in Canadian history for insurers

#4: July 2013 Toronto Flood
The wind and thunderstorm event caused $943 million in insured damage. It flooded highways and streets in the Greater Toronto Area on July 8 with approximately 126 mm of rain, according to Environment Canada.

#5: Slave Lake 2011 Fire
In May 2011, a wildfire tore through the Alberta community, causing $700 million in insured damages. The mid-May fire – which was later determined to be arson – destroyed one-third of the town.

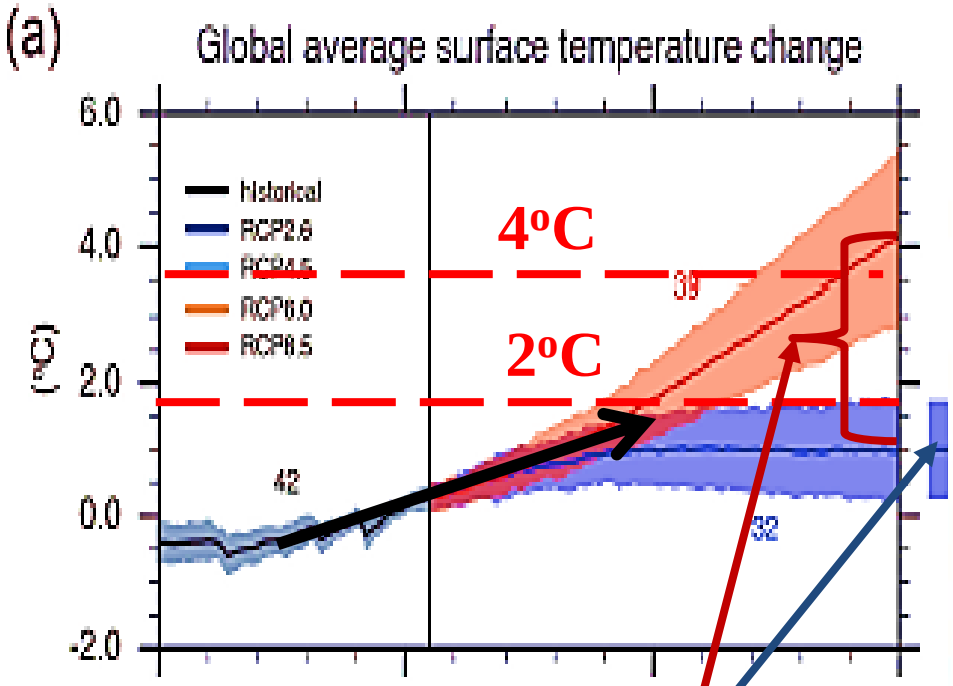
#6: August 2005 Toronto Flood
On Aug. 19, 2005, a series of severe thunderstorms approached the city from the south, affecting Kitchener to Ottawa and the northern part of Toronto. A rare tornado warning was even issued for the city.
The storm caused $590 million in insured damage.



#7: September 1991 Calgary Hailstorm
#8: August 2014 Alberta Hailstorm
#9: August 2012 Calgary-area Storm
#10: July 2010 Calgary Storm

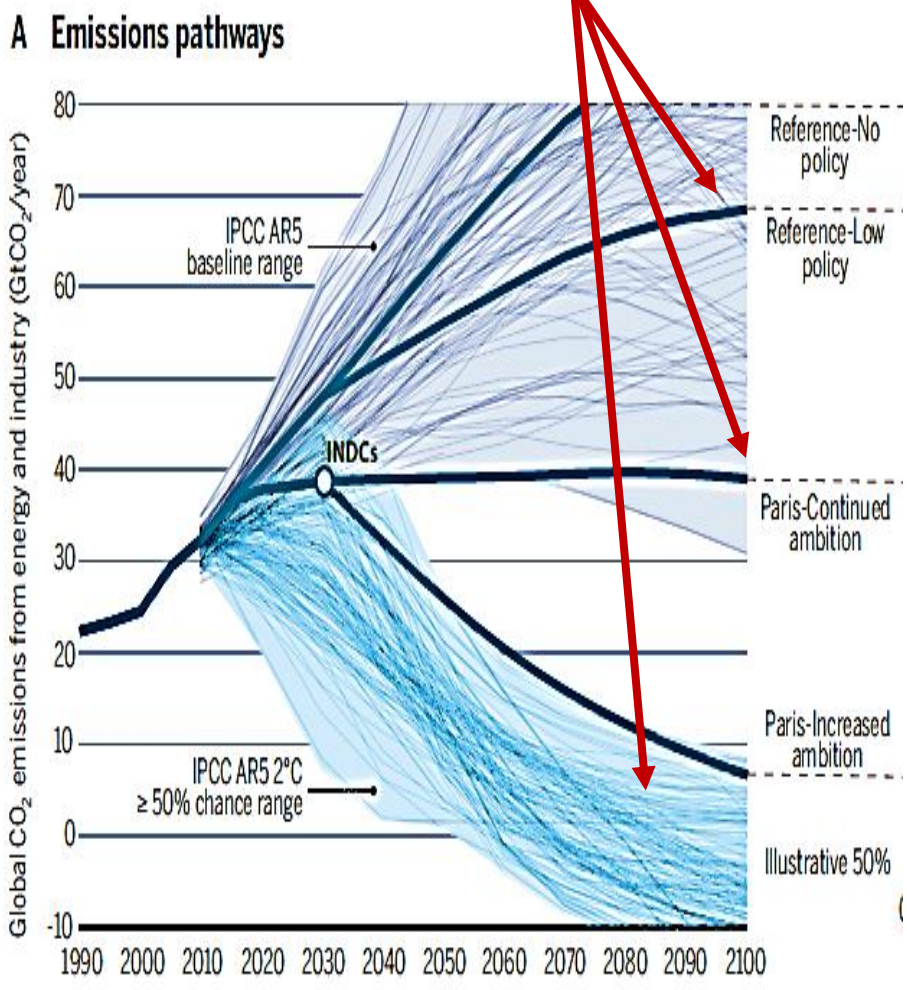
Projections of climate change

Climate Projections for future



Relative to pre-industrial T

Societal Choices

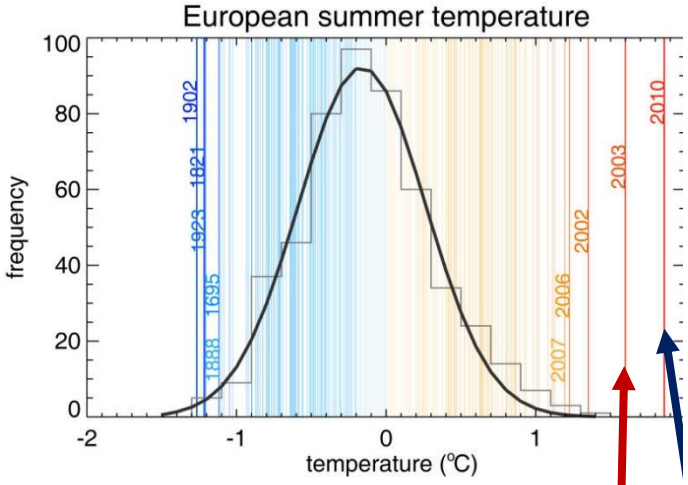


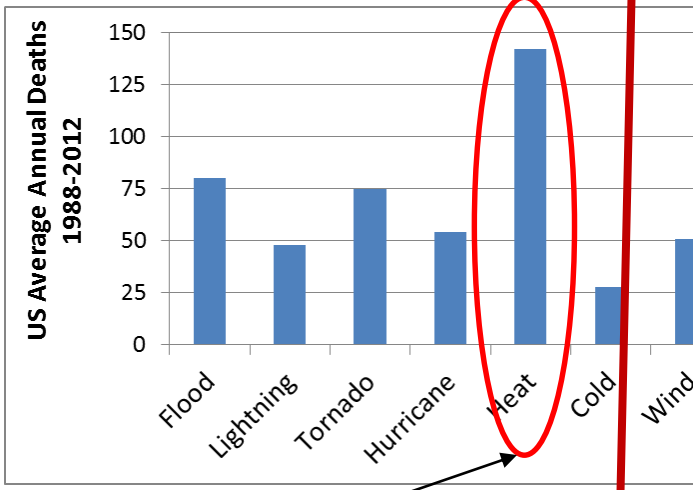
Climate Projections Uncertainties:

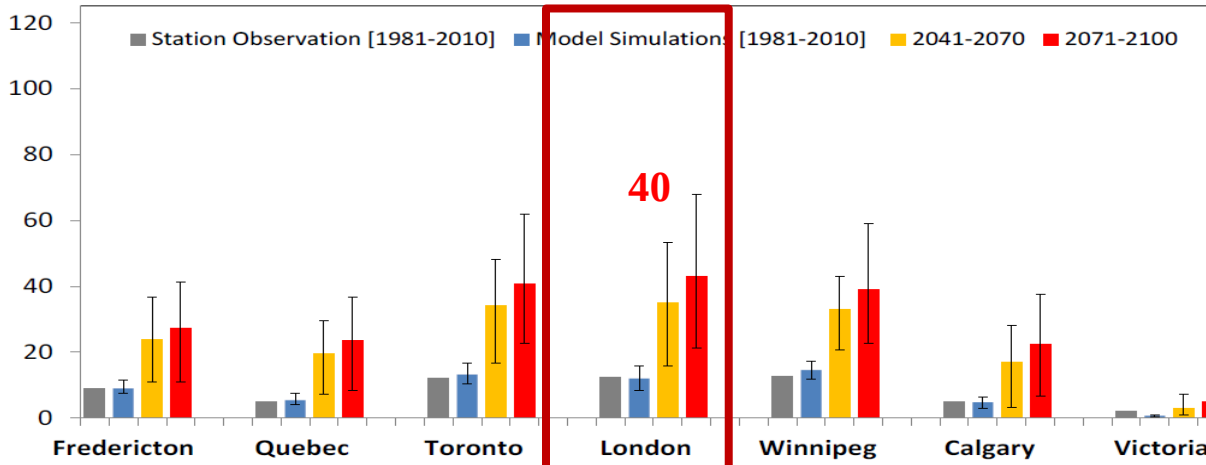
Climate Science

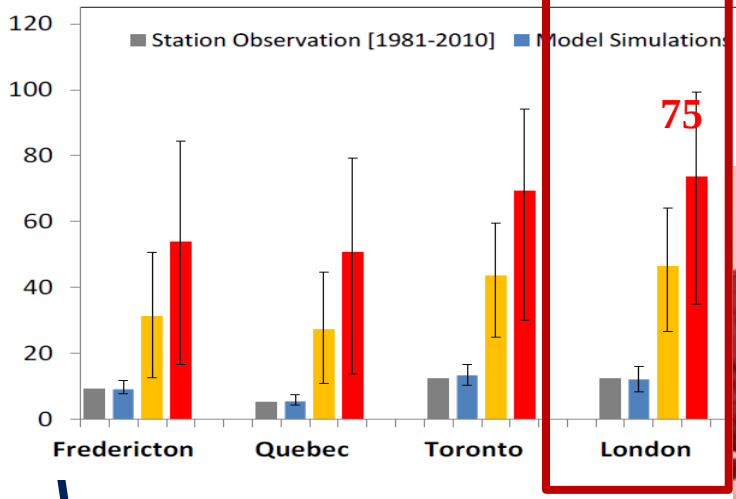
Societal choices

Heat Waves and Cities









Heat is the deadliest of weather hazards (US Data)

Russian Heat Wave: 70,000 d

European Heat Wave: 55,000 deaths

Climate Change Policy

UN Conference on Environment and Development (1992) – Rio

- **The Earth Summit**
  - **Secretary-General – M. Strong, Canada**
  - **Rio – 3-14 June 1992**
  - **172 countries – 108 heads of state or government – Mulroney+Charest, Bush, …**
- **Agenda 21**
- **Rio Declaration on Environment and Development**
- **The Statement of Forest Principles**
- **The UN Framework Convention on Climate Change**
- **UN Convention on Biological Diversity**
- **Convention to Combat Desertification**
- **Commission on Sustainable Development (1993)**

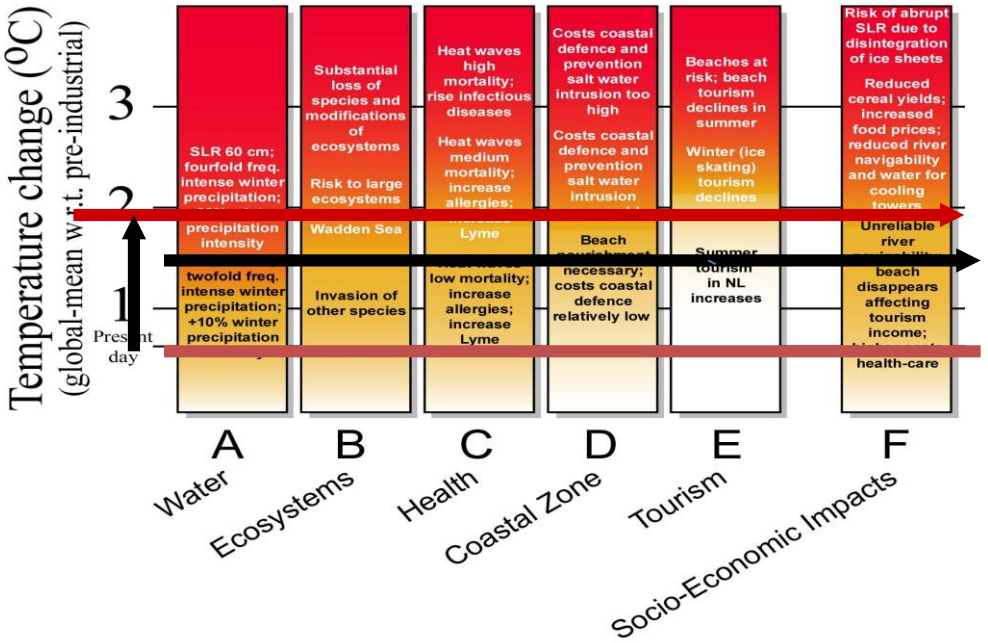
UN Framework Convention on Climate Change

- **signed by 155 nations – came into force in 1994 -signed by Mulroney, ratified by Chretien**
- **developed countries aim to reduce emissions to 1990 levels by year 2000**

Article 2

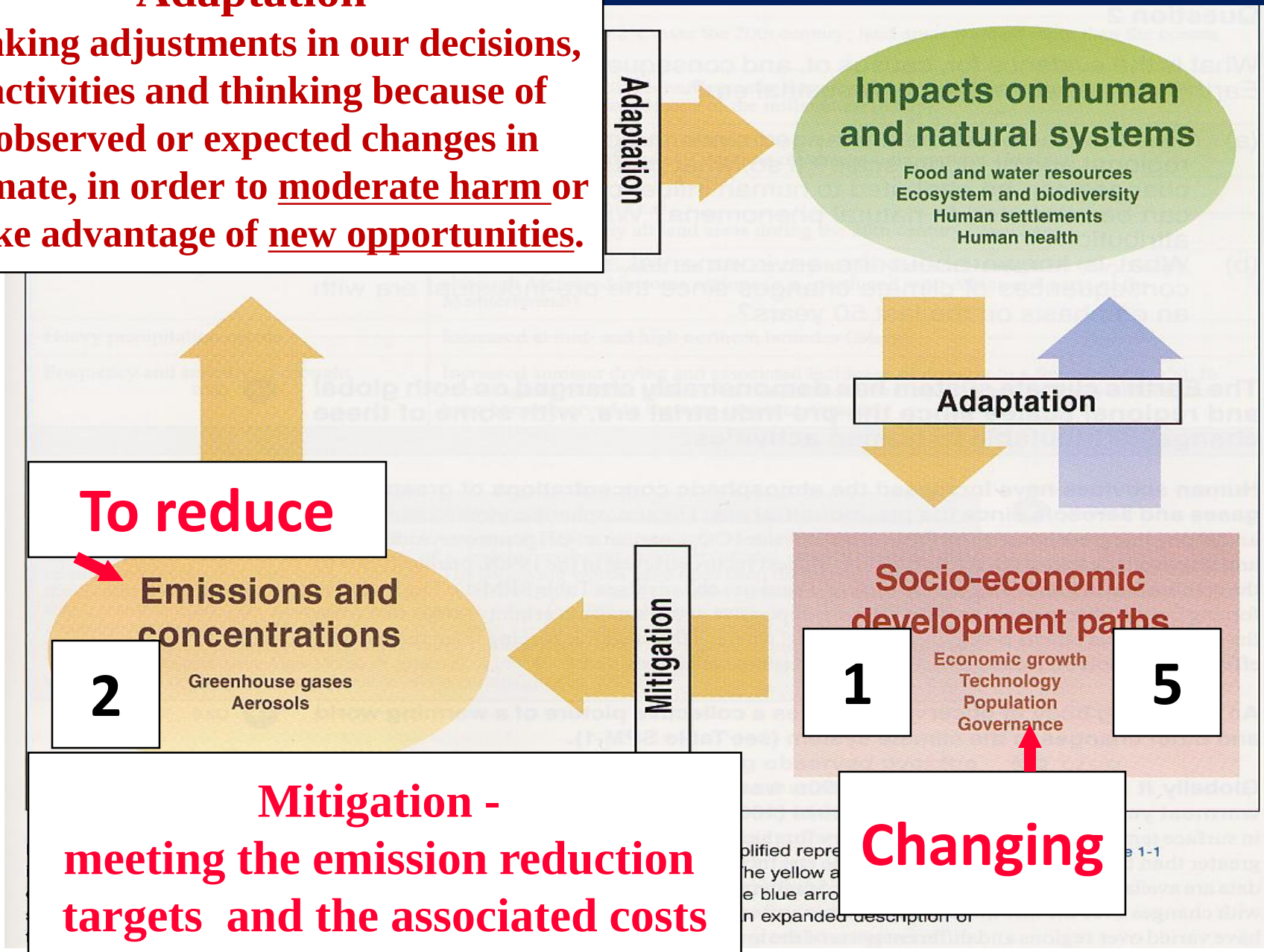
" … stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure food production is not threatened and to enable economic development to proceed in a sustainable manner."

"Dangerous" Climate Change



Addressing Climate Change

Adaptation -
making adjustments in our decisions, activities and thinking because of observed or expected changes in climate, in order to moderate harm or take advantage of new opportunities.



Mitigation -
meeting the emission reduction targets and the associated costs

GLOBAL AGENDA 2030

Climate Convention CoP21 Paris, 2015

Article 2 1. This Agreement, .. aims to strengthen the global response to .. threat of climate change, .. context of sustainable development and efforts to eradicate poverty:

(a) Holding the increase .. global average temperature to well below 2 °C above pre-industrial levels and pursuing .. Limit .. to 1.5 °C .., significantly reduce the risks and impacts of climate change; MITIGATION

(b) Increasing the ability to adapt to the adverse impacts of climate change and foster climate resilience and low greenhouse gas emissions development, in a manner that does not threaten food production; ADAPTATION

Article 4 Each Party shall prepare, communicate and maintain successive NATIONALLY DETERMINED CONTRIBUTIONS .. public registry.

Article 7 Parties hereby establish the global goal on adaptation of enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change, … sustainable development and ensuring an adequate adaptation …

Strengthening scientific knowledge on climate, including research, systematic observation of the climate system and early warning systems,

The process to formulate and implement NATIONAL ADAPTATION PLANS;

2015 Policy Agenda - 2030

Sendai Framework for Disaster Risk Reduction 2015-2030

UN World Conference on Disaster Risk Reduction 2015 Sendai Japan

Lead - S&T Major Grp

INTERNATIONAL COUNCIL FOR SCIENCE

The post-2015 development agenda, financing for development, climate change and disaster risk reduction …

Ensuring credible links, … between these processes will contribute to building resilience and achieving the global goal of eradicating poverty." **…action within and across sectors by States at local, national, regional and global levels**

Four priority areas for Disaster Risk Reduction

IRDR Integrated Research on Disaster Risk

1. **Understanding disaster risk;**
2. **Strengthening disaster risk governance to manage disaster risk;**
3. **Investing in disaster risk reduction for resilience;**
4. **Enhancing disaster preparedness for effective response, and to "Build Back Better" in recovery, rehabilitation and reconstruction.**

Sustainable Development Goals – 17 Goals with 169 Targets

All SDGs interact with one another – by design they are an integrated set of global priorities and objectives that are fundamentally interdependent.

9. Build resilient infrastructure

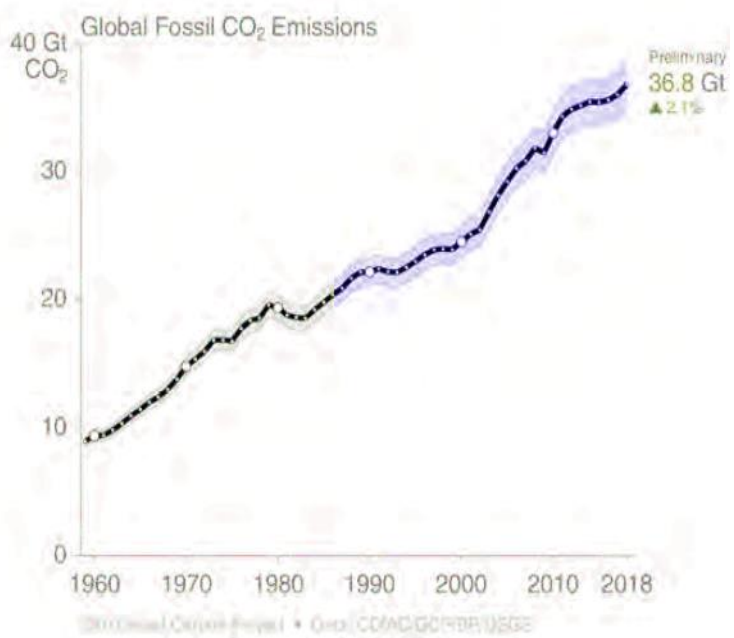
11. cities+human settlements… safe, resilient

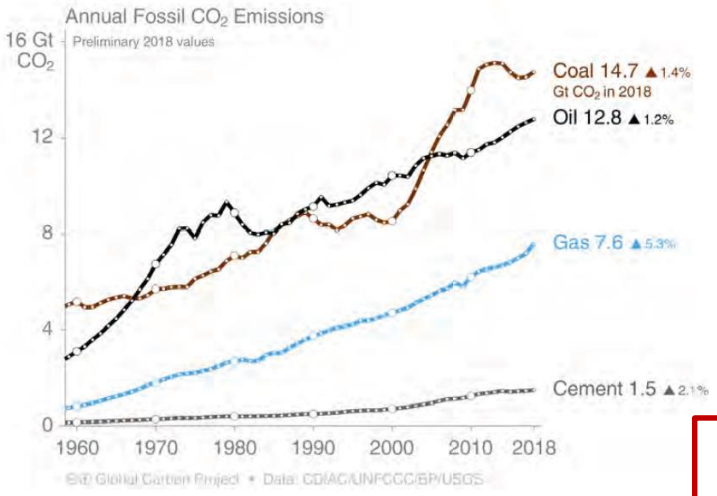
SDG 16 (good governance) and SDG 17 (means of implementation) are key to turning the potential for synergies into reality,….

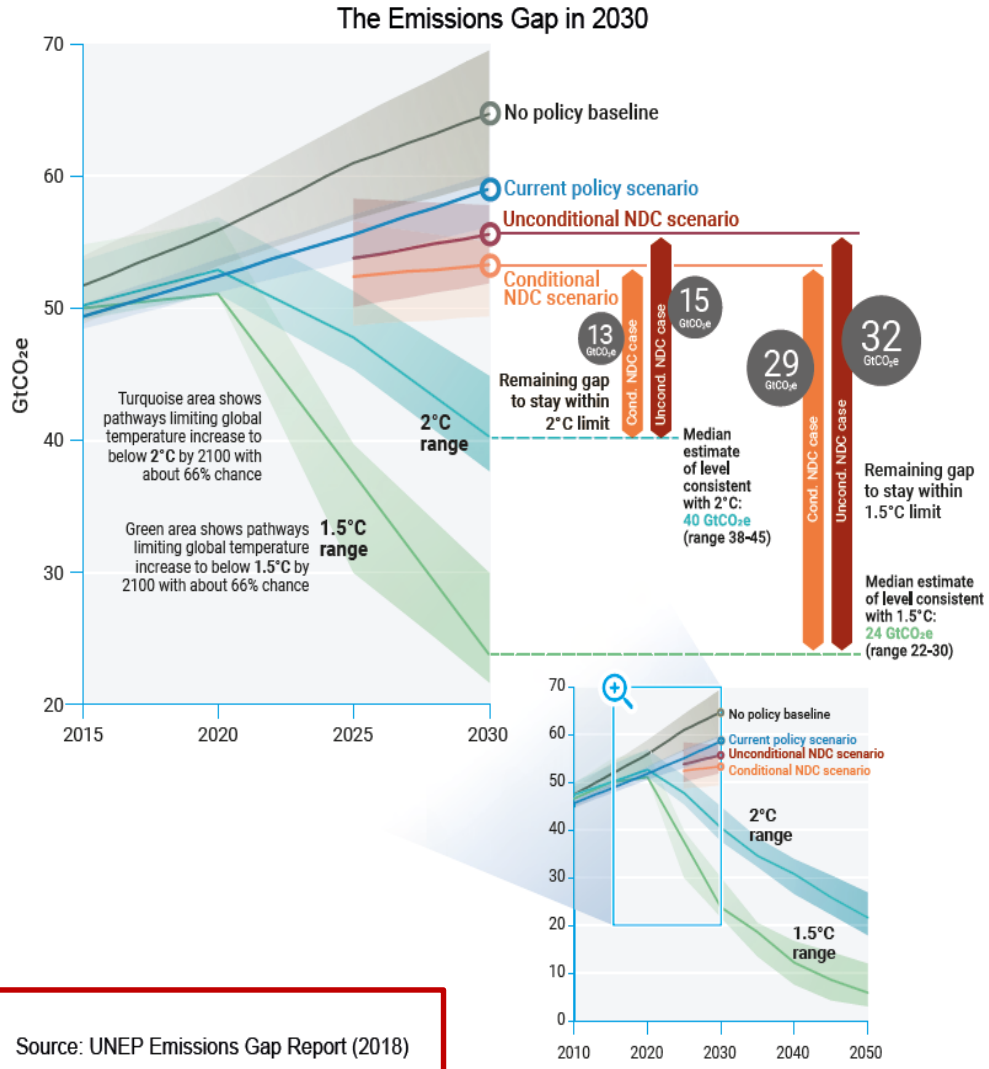
Climate Change Policy

2020

Global Fossil CO_2 Emissions



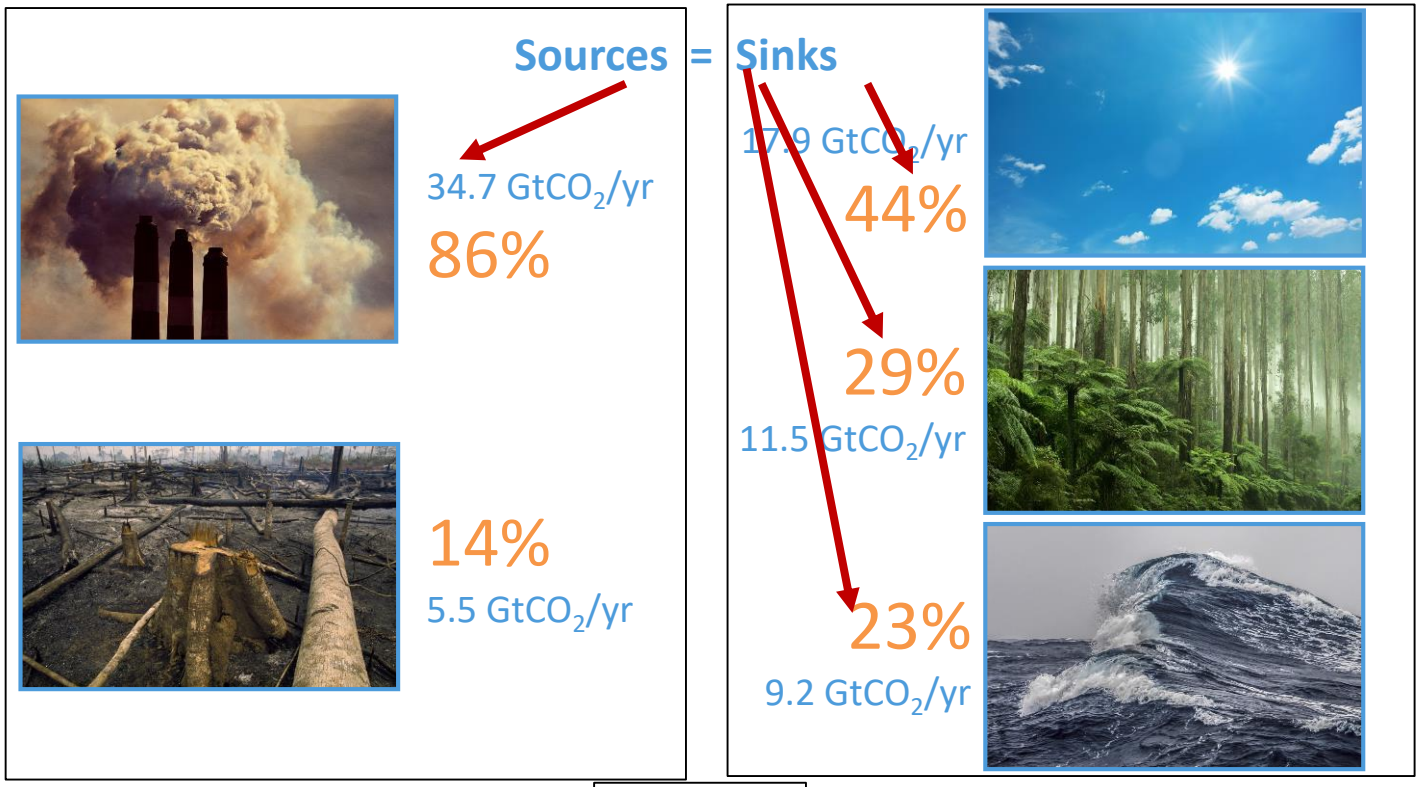




Source: UNEP Emissions Gap Report (2018)

Fate of anthropogenic CO_2 emissions (2009-2018)

Fate of anthropogenic CO_2 emissions (2009–2018)



Budget Imbalance:
(the difference between estimated sources & sinks)

4%
1.6 $GtCO_2$/yr

Source: CDIAC; NOAA-ESRL; Houghton and Nassikas 2017; Hansis et al 2015; Friedlingstein et al 2019; Global Carbon Budget 2019

Key statistics

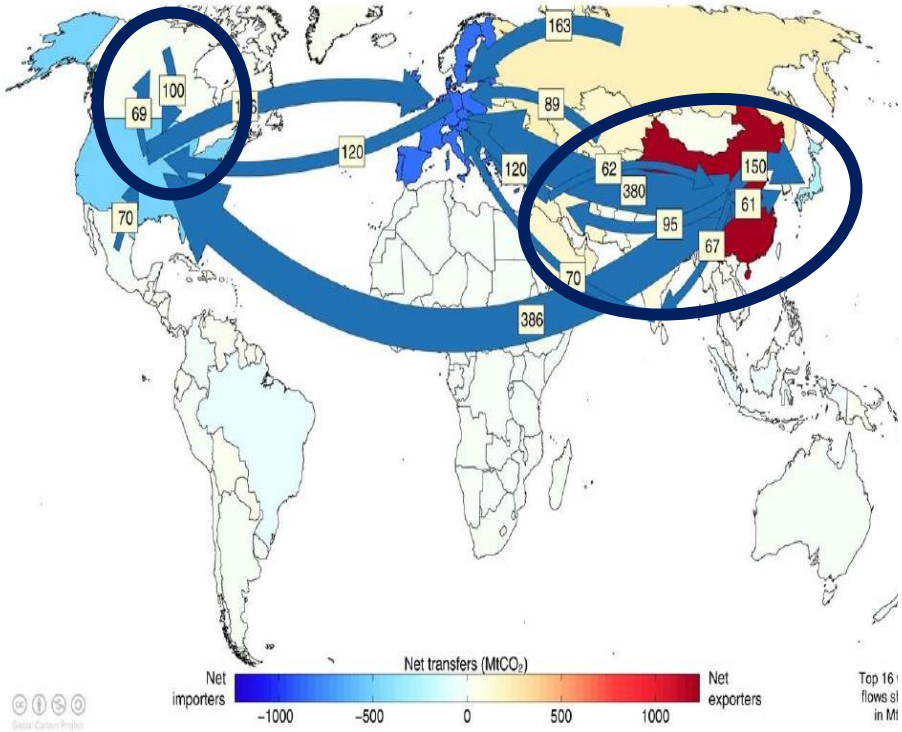
Region/Country	Emissions 2018				
	Per capita	Total		Growth 2017–18	
	tCO_2 per person	$GtCO_2$	%	$GtCO_2$	%
Global (with bunkers)	4.8	36.57	100	0.762	2.1
OECD Countries					
OECD	9.8	12.69	34.7	0.056	0.4
USA	16.6	5.42	14.8	0.146	2.8
OECD Europe	6.9	3.37	9.2	-0.070	-2.0
Japan	9.1	1.16	3.2	-0.026	-2.2
South Korea	12.9	0.66	1.8	0.018	2.8
Canada	15.3	0.57	1.6	-0.003	-0.5
Non-OECD Countries					
Non-OECD	3.6	22.65	61.9	0.692	3.2
China	7.0	10.06	27.5	0.226	2.3
India	2.0	2.65	7.3	0.197	8.0
Russia	11.7	1.71	4.7	0.064	3.9
Iran	8.8	0.72	2.0	0.034	5.0
Saudi Arabia	18.4	0.62	1.7	-0.012	-1.9
International Bunkers					
Bunkers	-	1.24	3.4	0.014	1.2

Source: CDIAC; Friedlingstein et al 2019; Global Carbon Budget 2019

Major flows from production to consumption/Major flows from extraction to consumption

Major flows from production to consumption

Flows from location of generation of emissions to location of consumption of goods and services

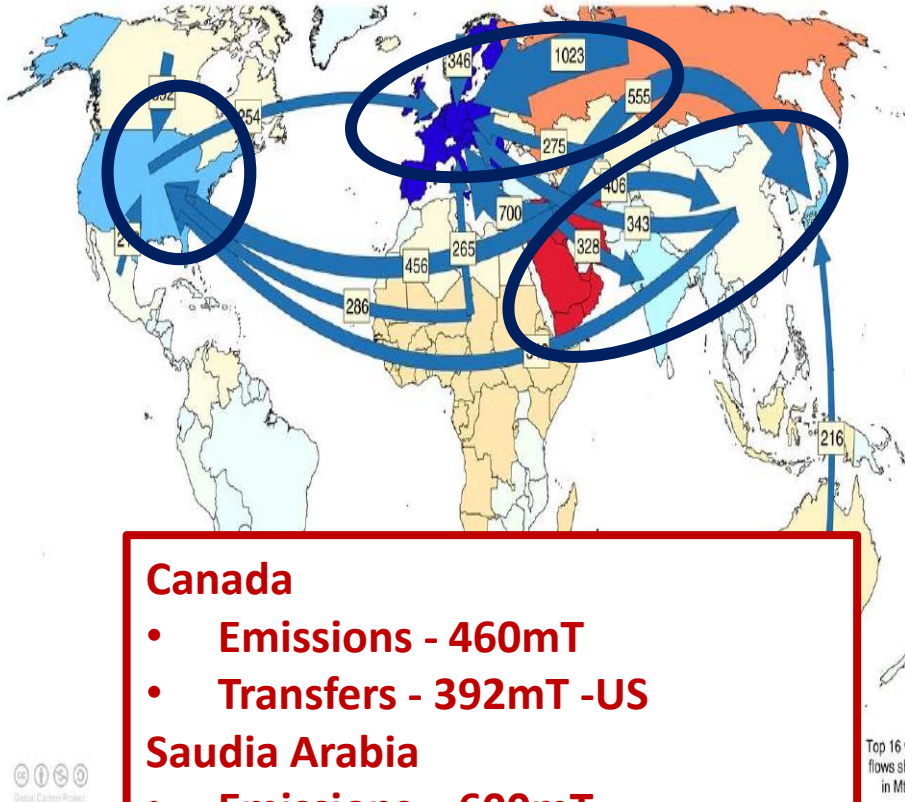


Values for 2011. EU is treated as one region. Units: $MtCO_2$

Source: Peters et al 2012

Major flows from extraction to consumption

Flows from location of fossil fuel extraction to location of consumption of goods and services



Canada

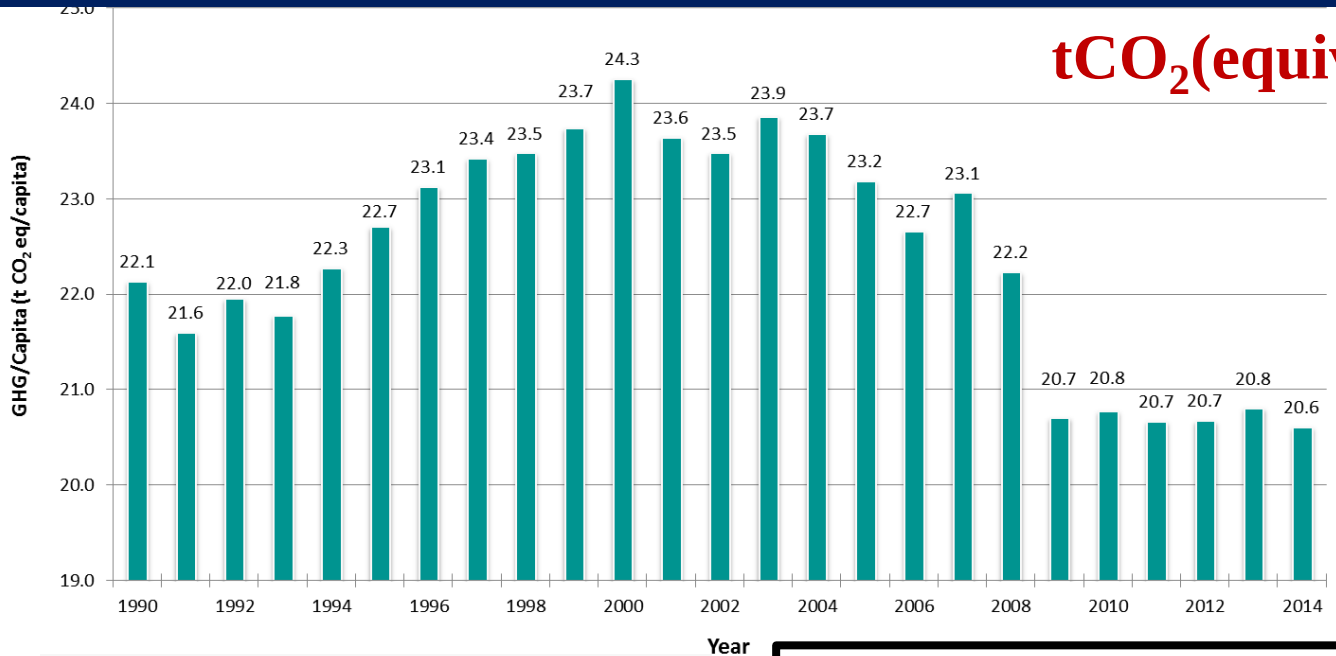
- **Emissions - 460mT**
- **Transfers - 392mT -US**

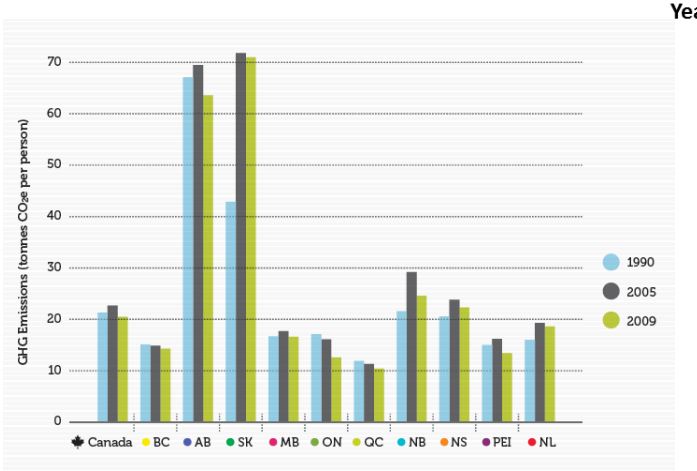
Saudia Arabia

- **Emissions – 600mT**
- **Transfers – 2,400mT –globe**
- **…**

Canadian per-capita emissions (INDC-UNFCCC)

tCO_2(equivalent)/capita



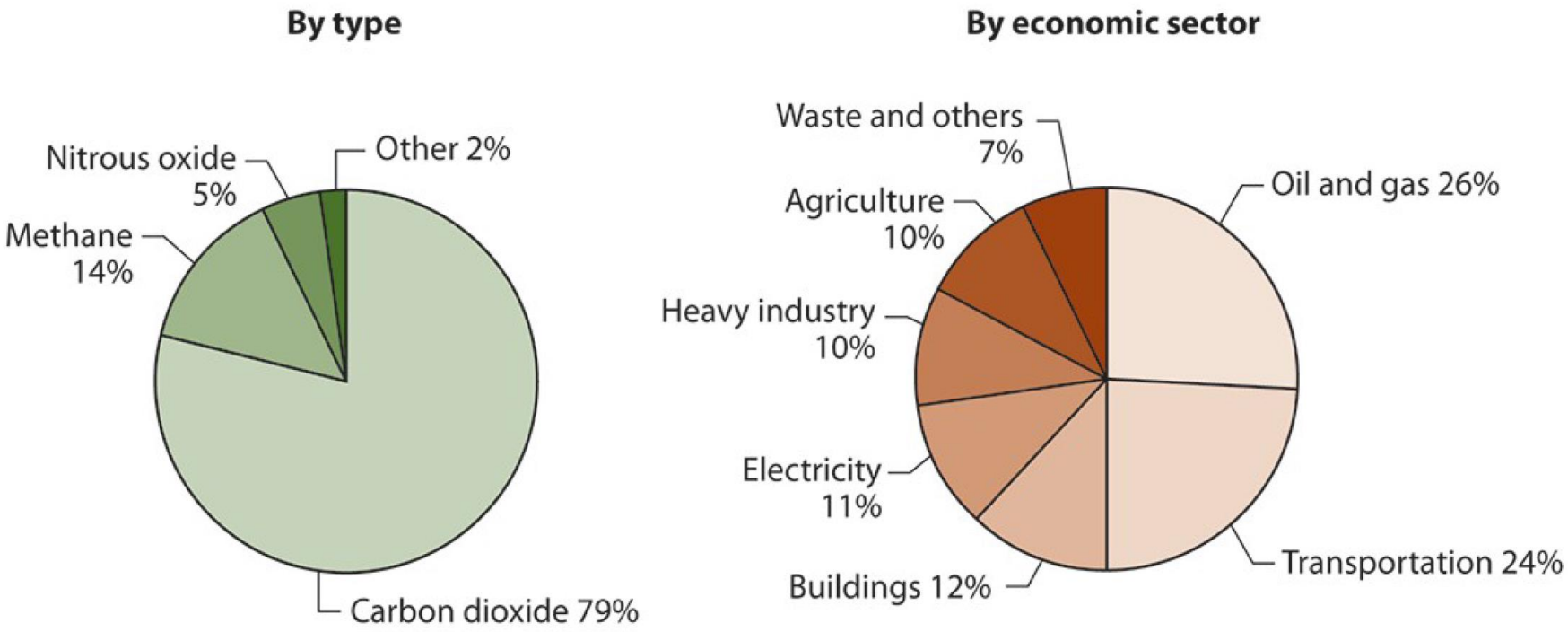


NRTEE Report (2012)

Need:

- **Clear action plans and implementation**
- **Monitoring of compliance**
- **Projections for target years**
- **Public Reporting**

Canada's greenhouse gas emissions by type and economic sector (CESD, 2017)



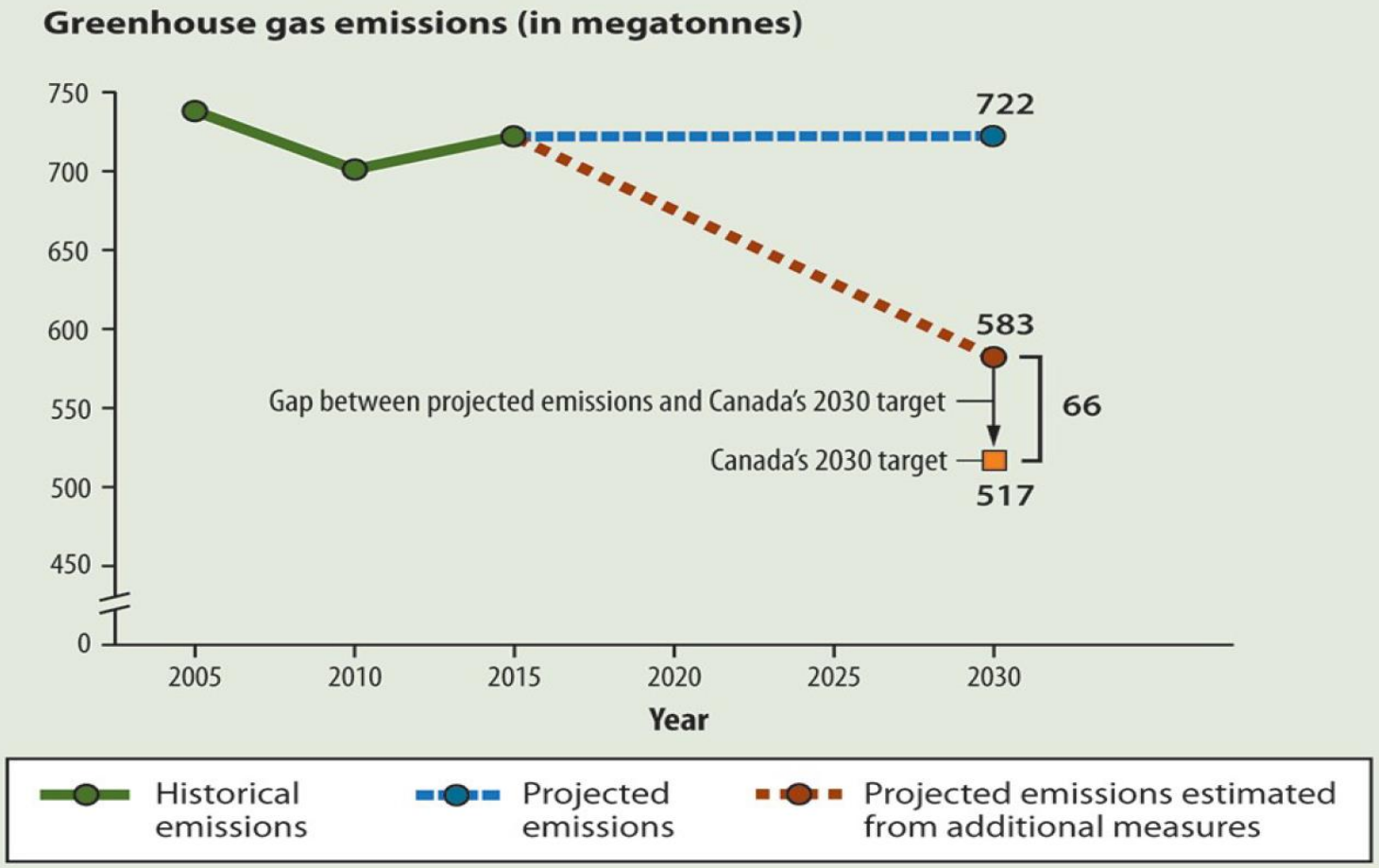
National Inventory Report 1990–2015: Greenhouse Gas Sources and Sinks in Canada, Environment and Climate Change Canada, 2017

2019 Fall Reports of the Commissioner of the Environment and Sustainable Development to the Parliament of Canada

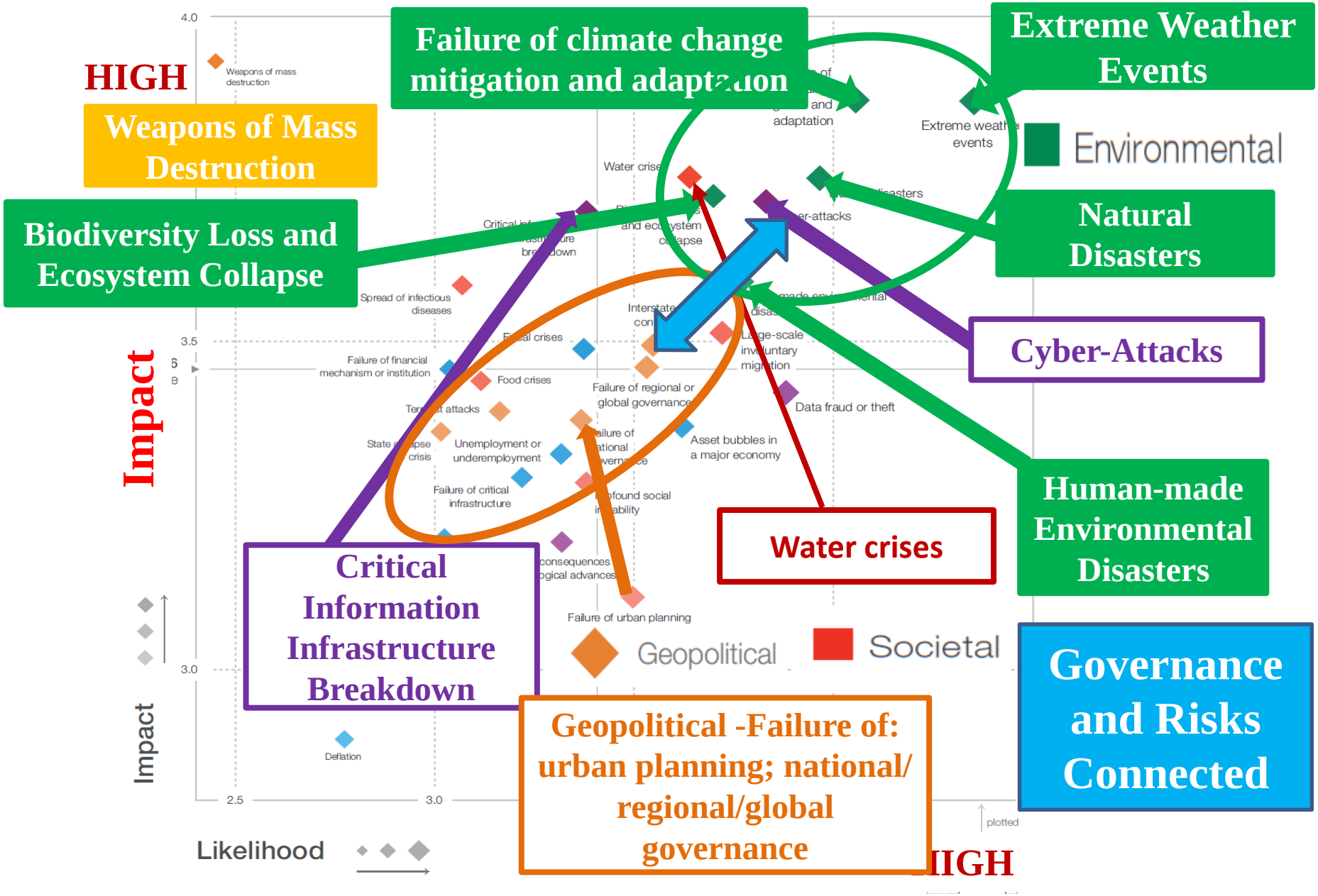
Independent Reviewer's Report

Report 1—Review of the 2018 Progress Report on the Federal Sustainable Development Strategy

- **Effective action on climate change.** The progress report stated that current and planned actions under the Pan-Canadian Framework on Clean Growth and Climate Change would enable Canada to meet or exceed its 2030 target for reducing greenhouse gas emissions. We found that this statement was not supported by the projections in the progress report or by other documentation.

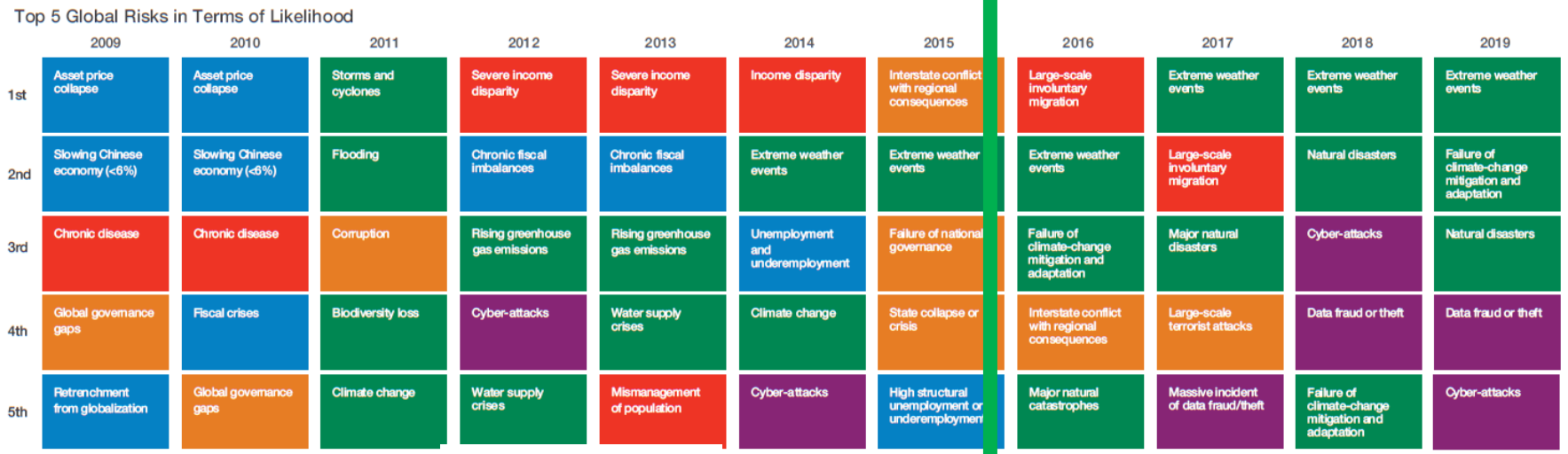


World Economic Forum - Global Risks 2019

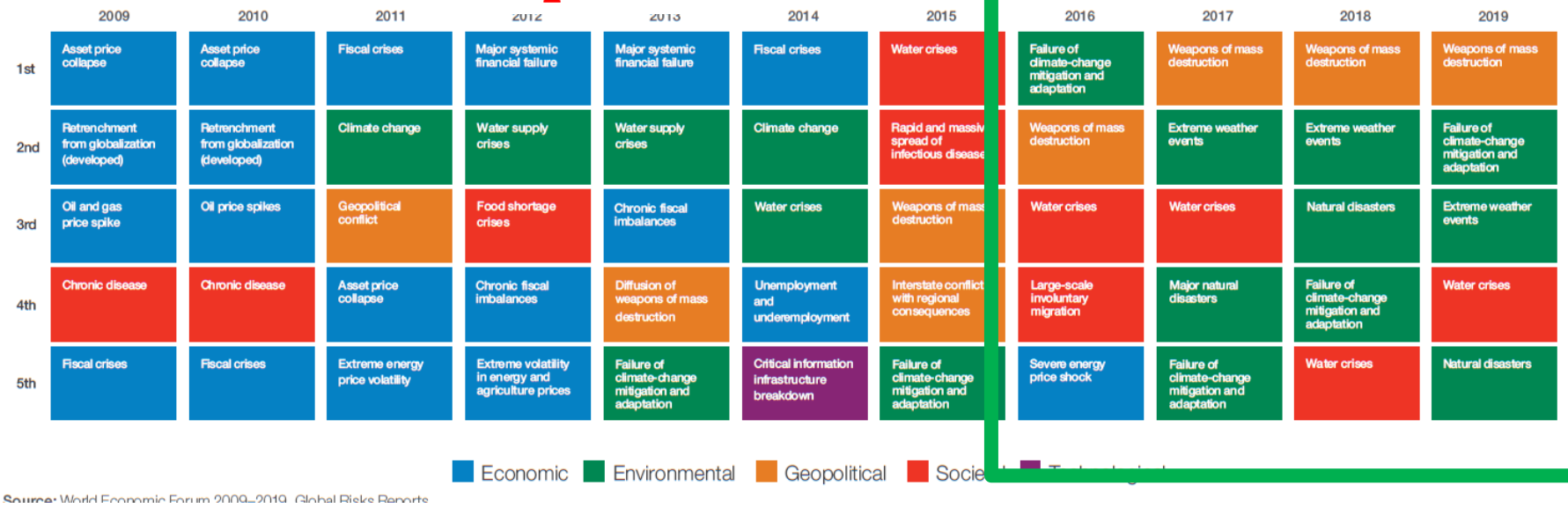


World Economic Forum - Global Risks 2019

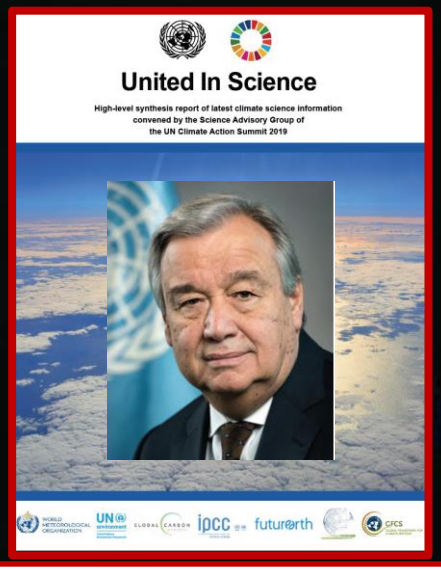
Likelihood



Impact



Source: World Economic Forum 2009–2019, Global Risks Reports



Global Energy Growth is outpacing Decarbonization

Foreword by António Guterres, United Nations Secretary-General

CLIMATE CHANGE IS THE DEFINING CHALLENGE OF OUR TIME.

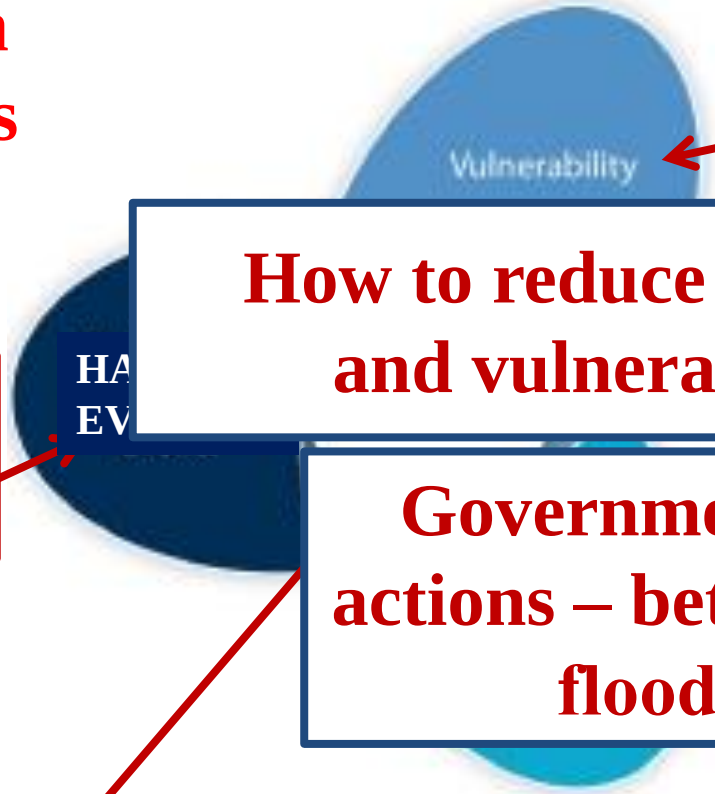
Science informs governments in their decision-making and commitments. I urge leaders to heed these facts, unite behind the science and take ambitious, urgent action to halt global heating and set a path towards a safer, more sustainable future for all.

The CLIMATE IS CHANGING WHY WON'T THE SYSTEM

Unite Behind the SCIENCE SAVE THE EARTH

CoP Madrid
Nothing agreed to!!!

Impacts from hazard events depend on:



Vulnerability: predisposition

on or be

How to reduce exposure and vulnerability?

Changing Climate Changing Hazards

Government policies and actions – better homes, not in flood plains, …

Nature and severity of event

Exposure and vulnerability are key determinants of disaster risk

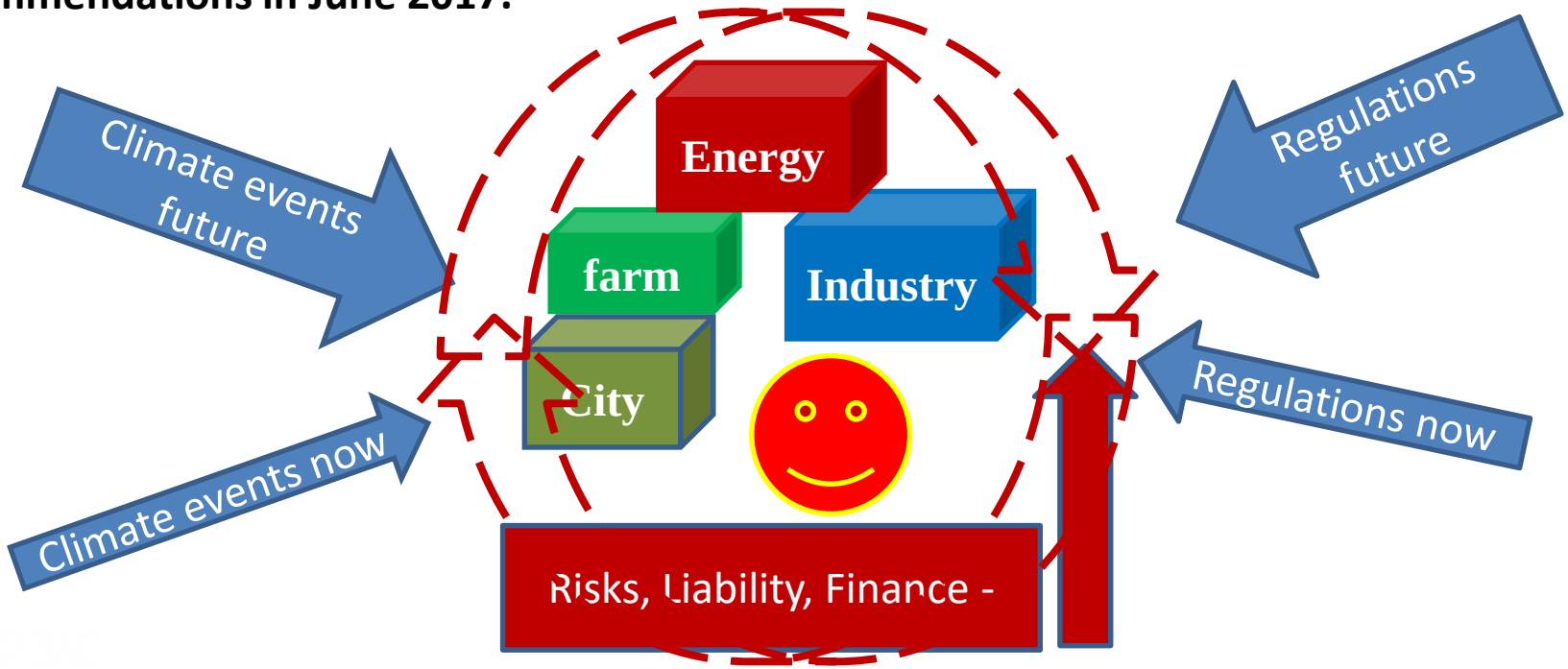
Disaster Risk: the likelihood of severe alterations in the normal functioning of a community or society due to hazard events interacting with vulnerable social conditions

Climate Disclosure, Liability and Finance

Institute for Catastrophic Loss Reduction
Institut de Prévention des Sinistres Catastrophiques

Financial Stability Board (FSB) is an international body that monitors and assesses vulnerabilities affecting the global financial system and proposes actions to address these vulnerabilities.

Following the 2008 financial crisis, FSB recognized the growing risk of climate-related issues to the global financial system and, under the leadership of its then Chairman, Mark Carney (Governor of Bank of England) and Former NYC Mayor Bloomberg, formed the industry-led Task Force on Climate-Related Financial Disclosures (TCFD) - framework for identifying, evaluating and disclosing climate-related risks. TCFD released its final recommendations in June 2017.



Climate Disclosure, Liability and Finance

ICLR is preparing a report as part of national assessment.

Institute for Catastrophic Loss Reduction
Institut de Prévention des Sinistres Catastrophiques

1. **Disclosure - Businesses and governments are increasingly expected to disclose the climate risks they face and their plans to manage their exposure. Voters, consumers, investors and other stakeholders expect to be informed.**

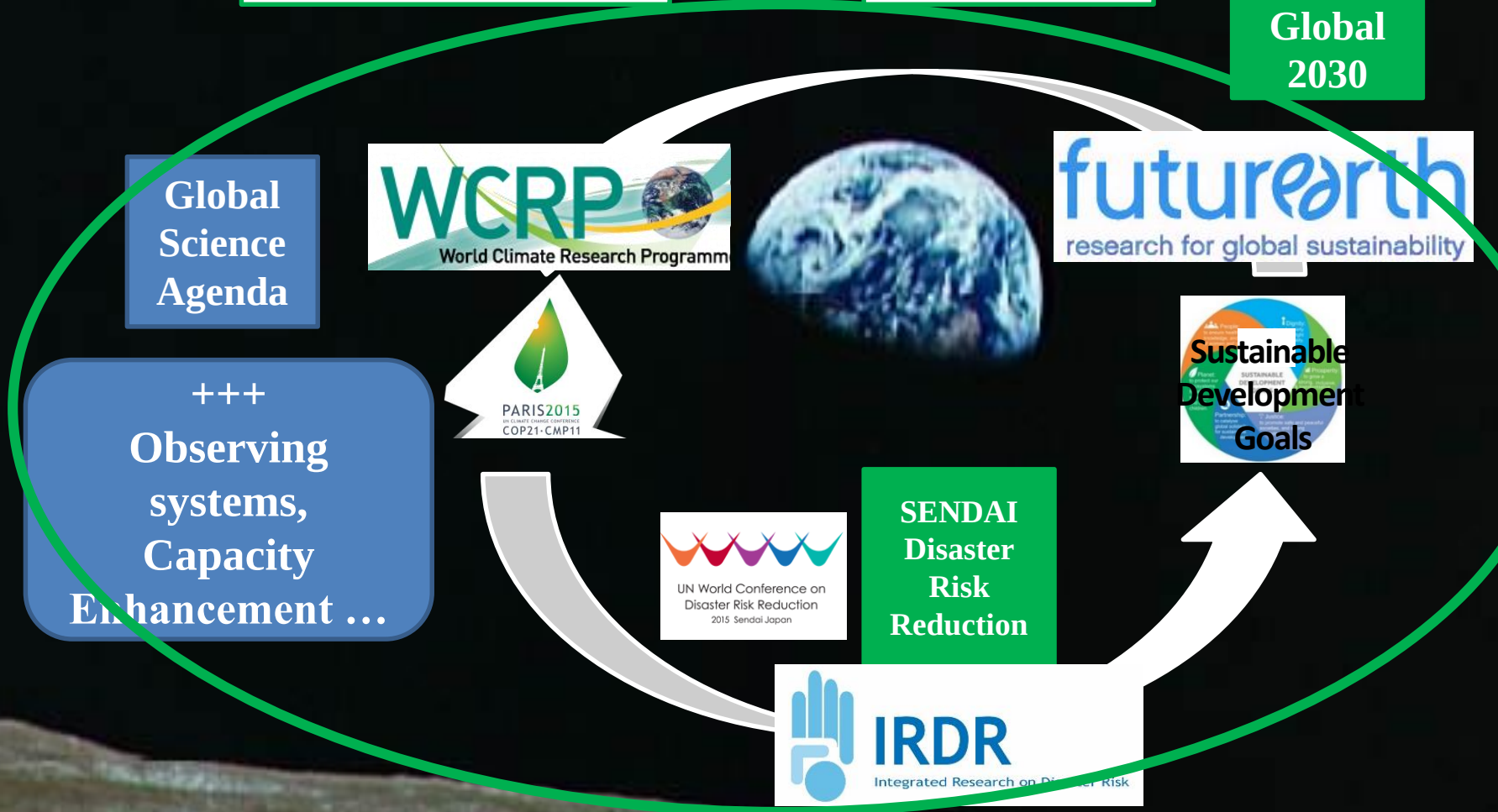
2. **Liability - Loss and damage from severe weather events is rising. In what circumstances may we expect that the courts would find anyone liable for losses and damage?**

3. **Finance - Canadians have experiencing significant losses from recent floods, fires and other extreme weather events. How will Canadians finance the cost of recovery and reconstruction from future events, investments in resilience, and the transition to a low carbon economy?**

GLOBAL AGENDA 2030

Canada is a signatory and can have a major role.
Actions across the Agenda need to be fully coordinated.

Integrated Science to Policy → **Canada's Roles**



Meeting the Climate Challenges

May 26-27, 2020
APEX Leadership Symposium

Comprehensive Actions Needed