Climate Change and Us
An Overview

NEEC Forum

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Global warming is a real and growing phenomenon. There is no lack of data indicating this is a big problem with which the world must deal.

Some have attacked the data and have a differing opinion. While it would be nice to dismiss the science, experts agree this is a dilemma we must confront some day soon

Global warming is [redacted] no [redacted] big [redacted] deal.

[redacted] have [redacted] a [redacted] nice [redacted] day [redacted]

Outline

- What is Climate Change?
  - Natural Variability
  - Anthropogenic Effect
  - Global Warming due to anthropogenic effect?
- IPCC
- Climate Change Projections
  - Global
  - Caribbean
- Impacts of climate change
- What is the Caribbean doing
- How do we contribute?
- What's really to be done

- What is Climate Change?
  - Natural Variability
  - Anthropogenic Effect
  - Global Warming

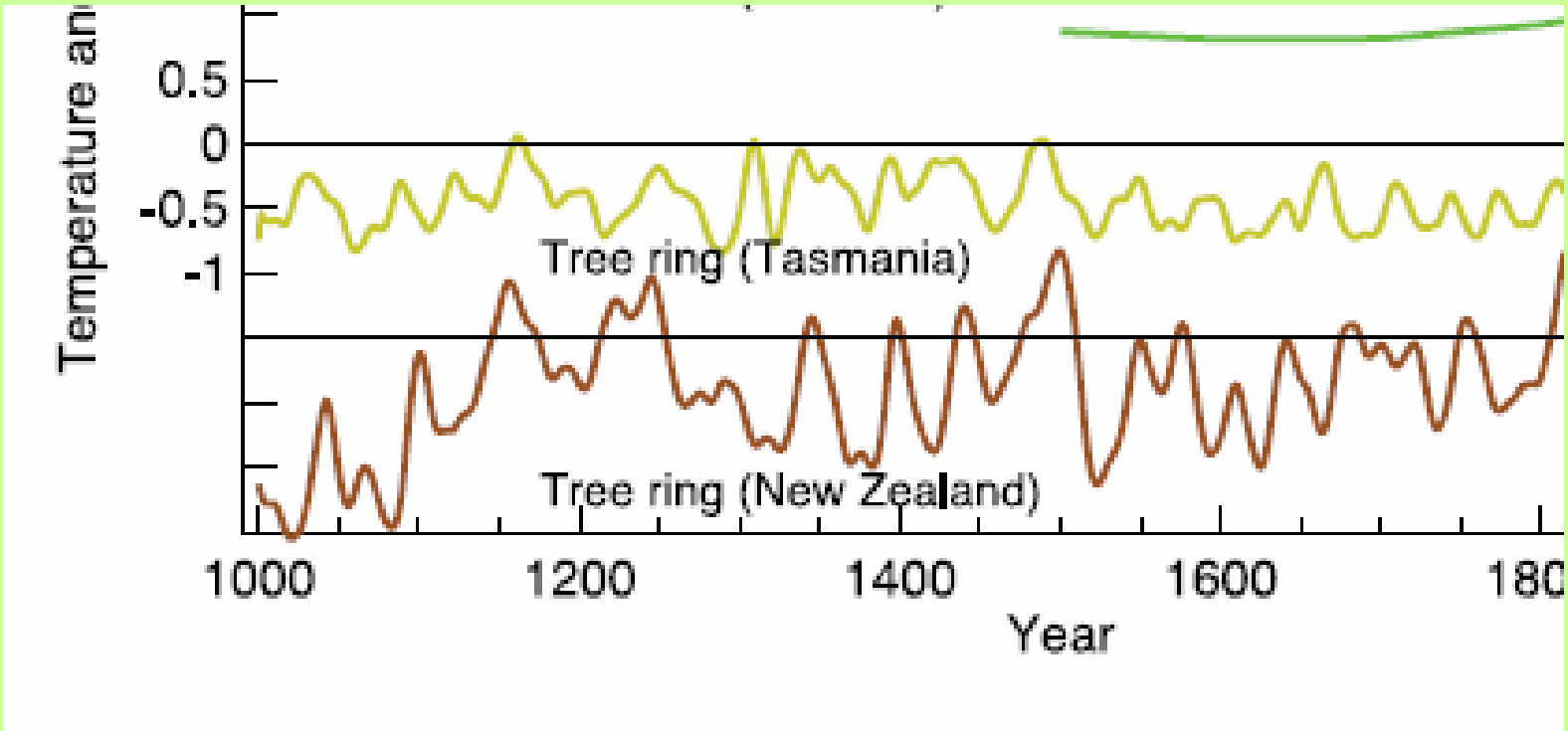
Climate

- The average weather
- Mean Statistics
- Averaging period: months to years

Climate Change

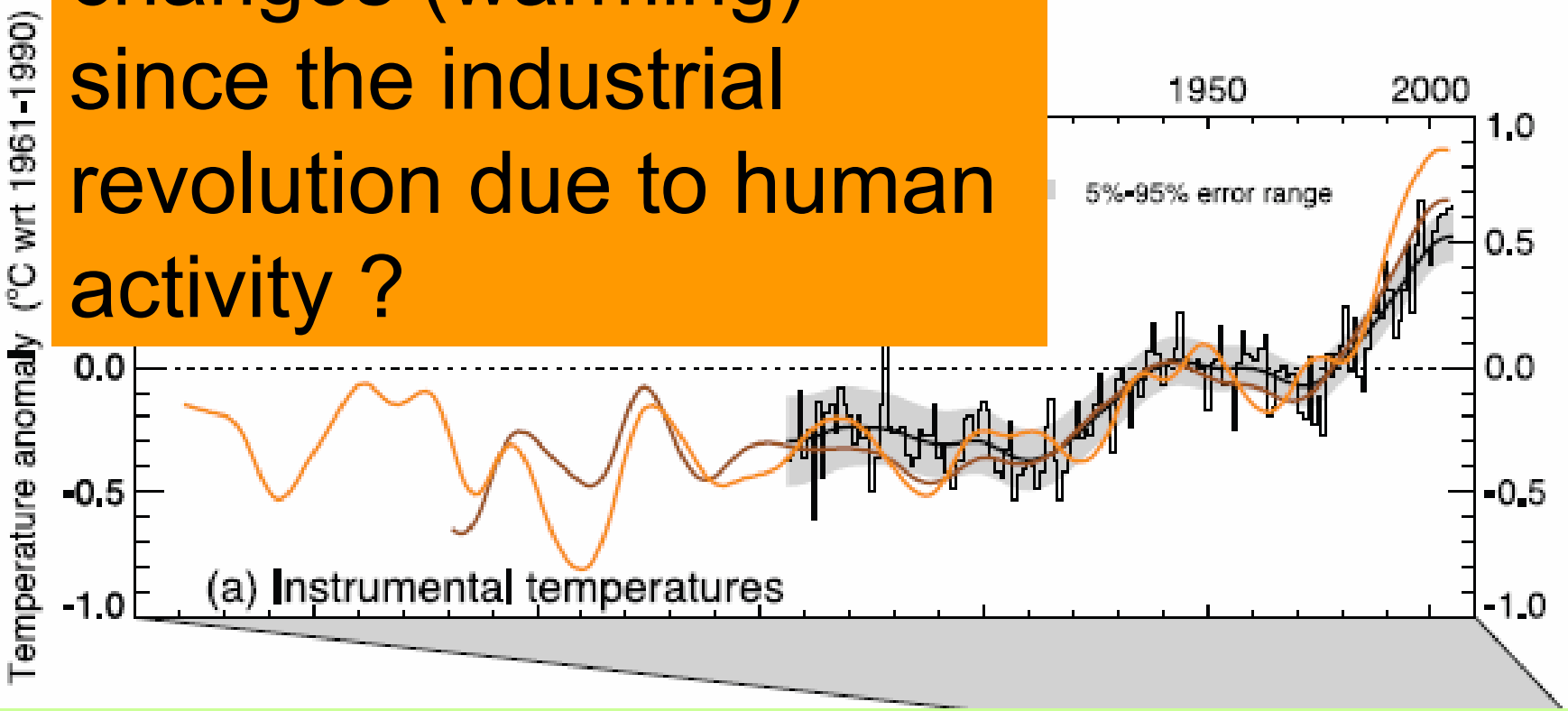
- Identified by changes in the mean
- Persists for an extended period, typically decades or longer.
- Due to
  - natural internal processes
  - *external forcings (e.g., volcanic eruptions, solar radiation changes)*
  - changes in the composition of the *atmosphere* or in *land use* due to human activity

e.g., of natural variability (temperature from tree rings) due to internal processes and external forcing
1000 to ~ 1800



Example of temperature variability since the industrial revolution~ 1750

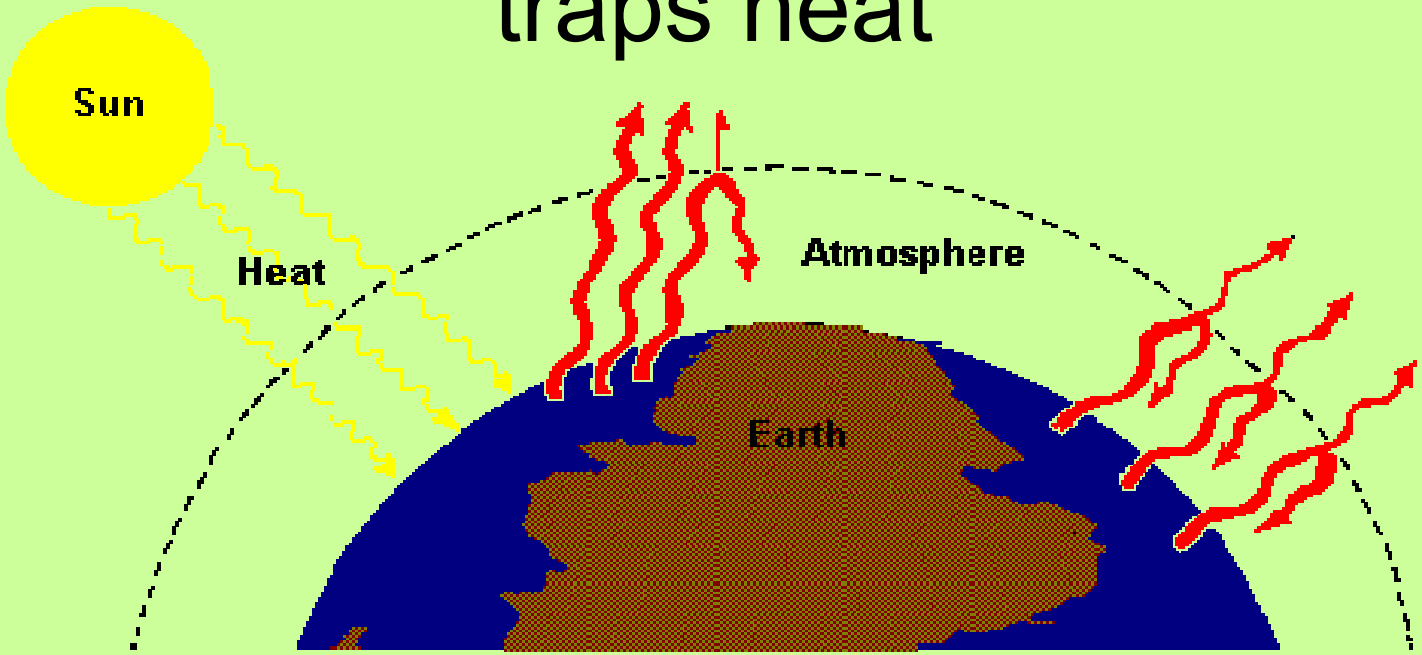
Are any of these changes (warming) since the industrial revolution due to human activity ?



How does warming occur?

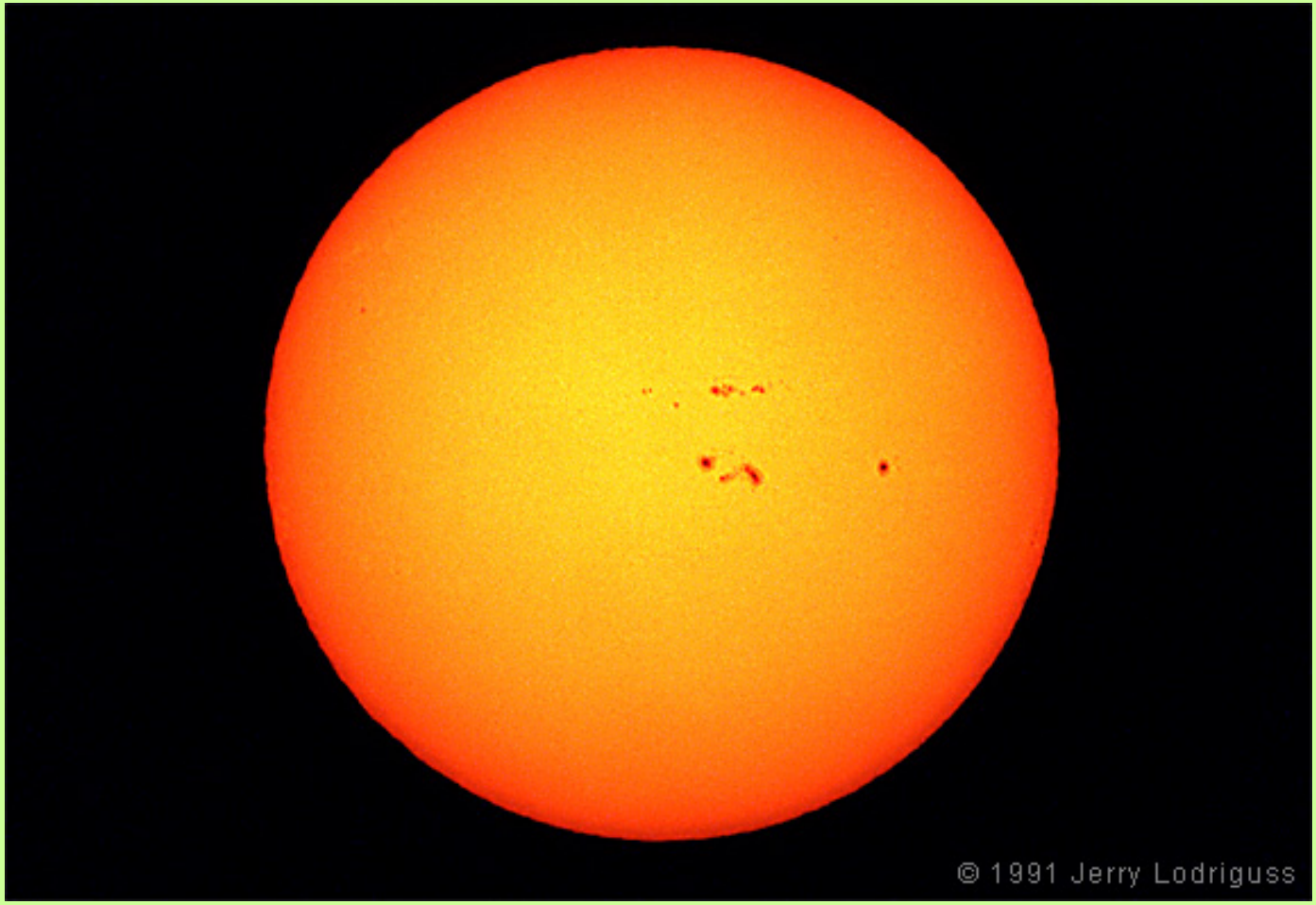
- Like warming in a greenhouse

Natural greenhouse gases (CO_2, water vapour, etc) in the atmosphere traps heat



If there were no natural atmospheric greenhouse effect the temperature of the earth would be 30º C colder.

Variations in solar radiation also effect temperature changes

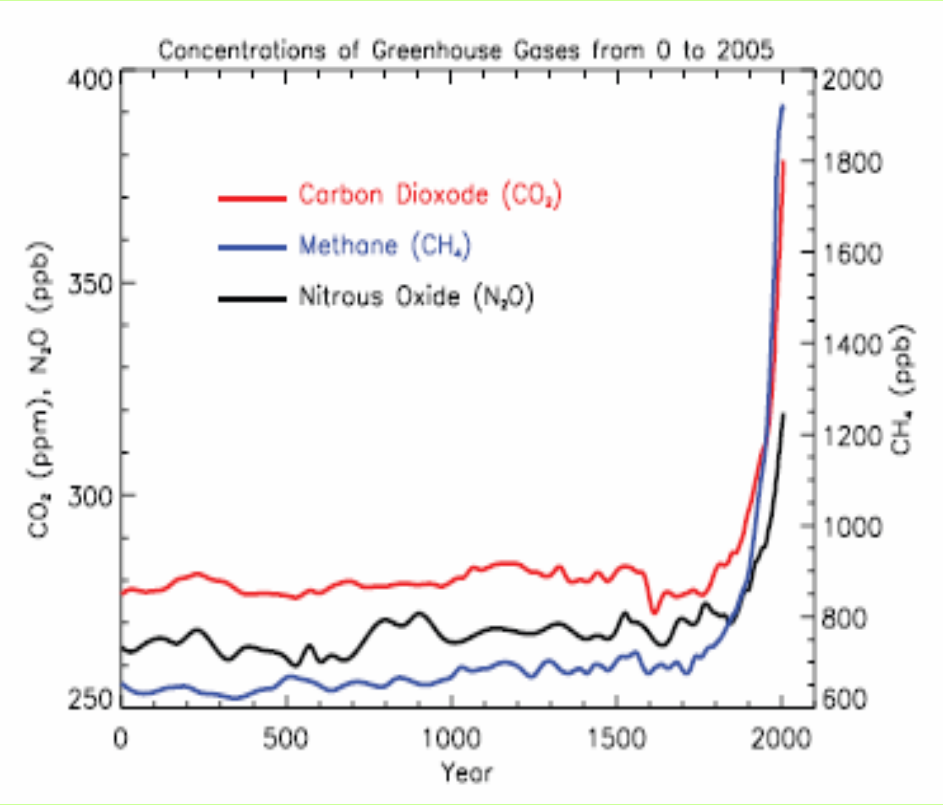


How does cooling occur?

- Blocking out the sun's radiation
  - volcanic ash
  - Aerosols (dust)

Manmade green house gases have been added to the atmosphere since the industrial revolution

- Are they making the earth warmer and, if so, what are the consequences?



Answer to the query re anthropogenic influence on climate change

- IPCC
- Climate Change Projections
  - Global
  - Caribbean
- Impacts of climate change

IPCC

Intergovernamental Panel On Climate Change

Founded 1988 by the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP)

Working Group I assesses the scientific aspects of climate change.

Working Group II assesses impacts, vulnerability and adaptation

Working Group III assesses options for mitigating climate change.

Fourth Assessment (AR4) 2007

AR4 Report of Working Group I

Climate Change 2007:
The Physical Science Basis

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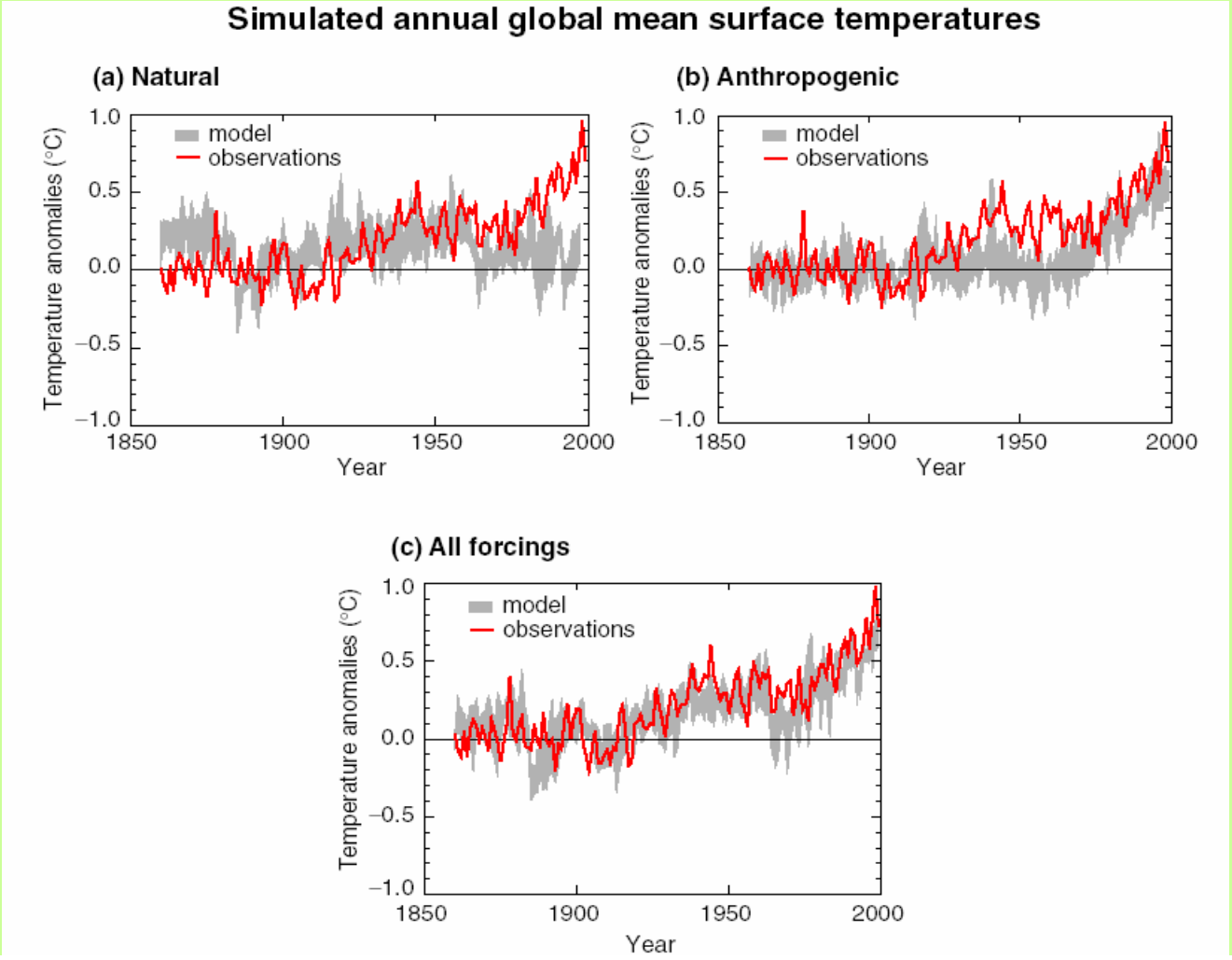
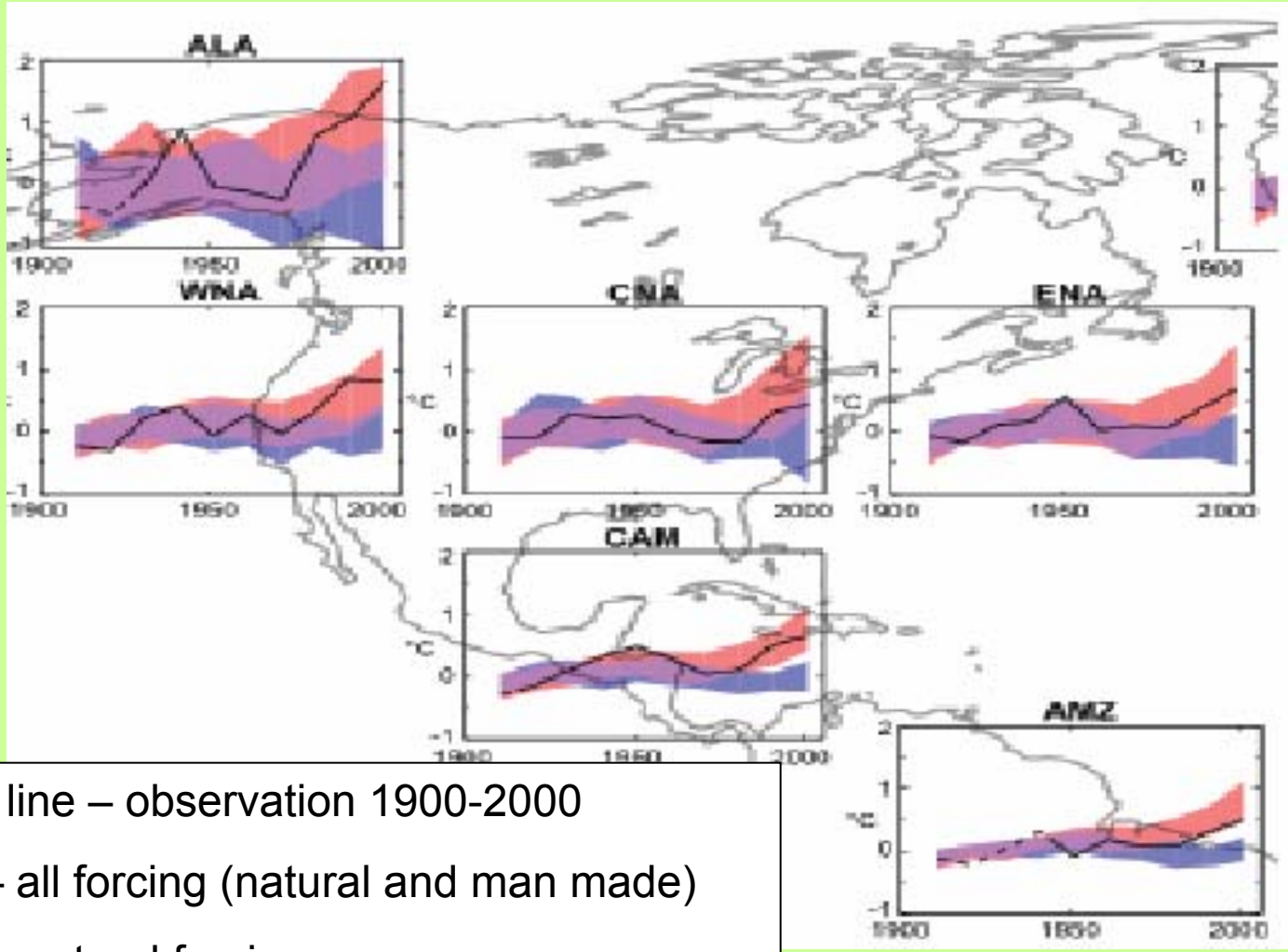
Attribution: Comparisons of models and observations of global mean temperature

Agree only when both natural and anthropogenic forcing are included IPCC 3rd assessment



Attributing climate change regionally, 4th Assessment, to anthropogenic and natural causes



Black line – observation 1900-2000

Red – all forcing (natural and man made)

Blue – natural forcing

Similarly for the rest of the world

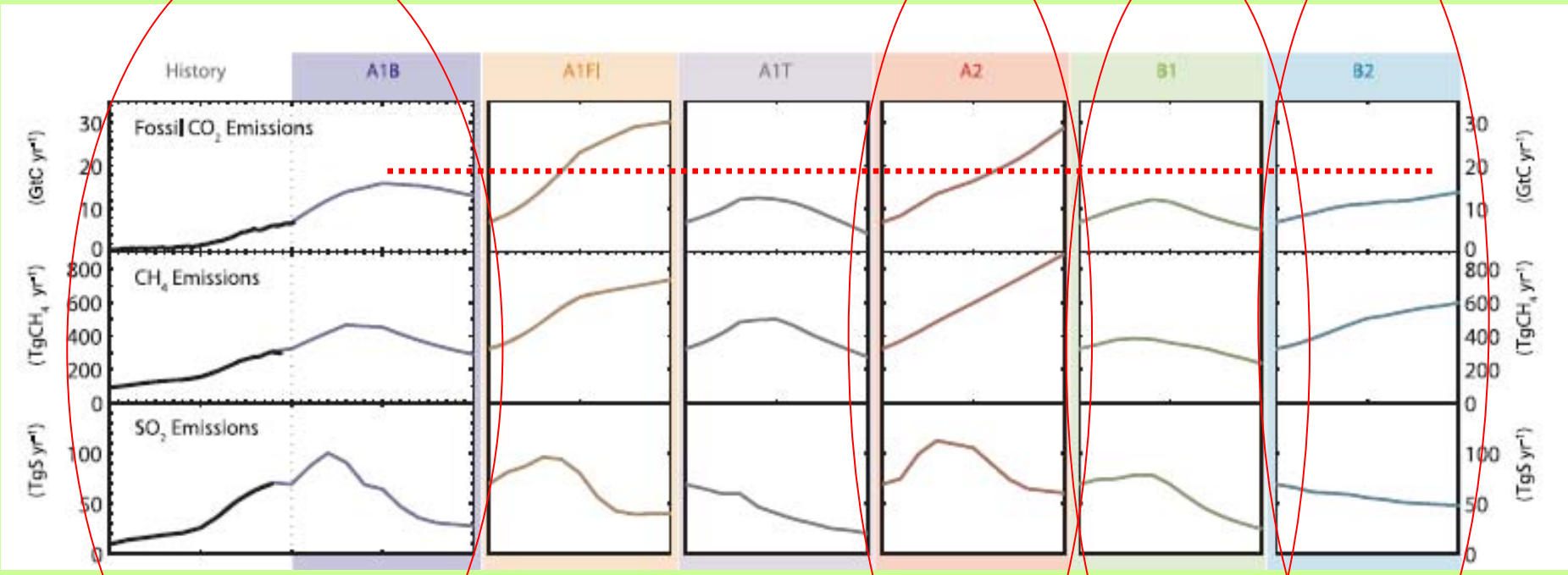
IPCC Statement

- From new estimates of the combined anthropogenic forcing due to greenhouse gases, aerosols and land surface changes, it is *extremely likely* (> 95% probability) that human activities have exerted a substantial net warming influence on climate since 1750.

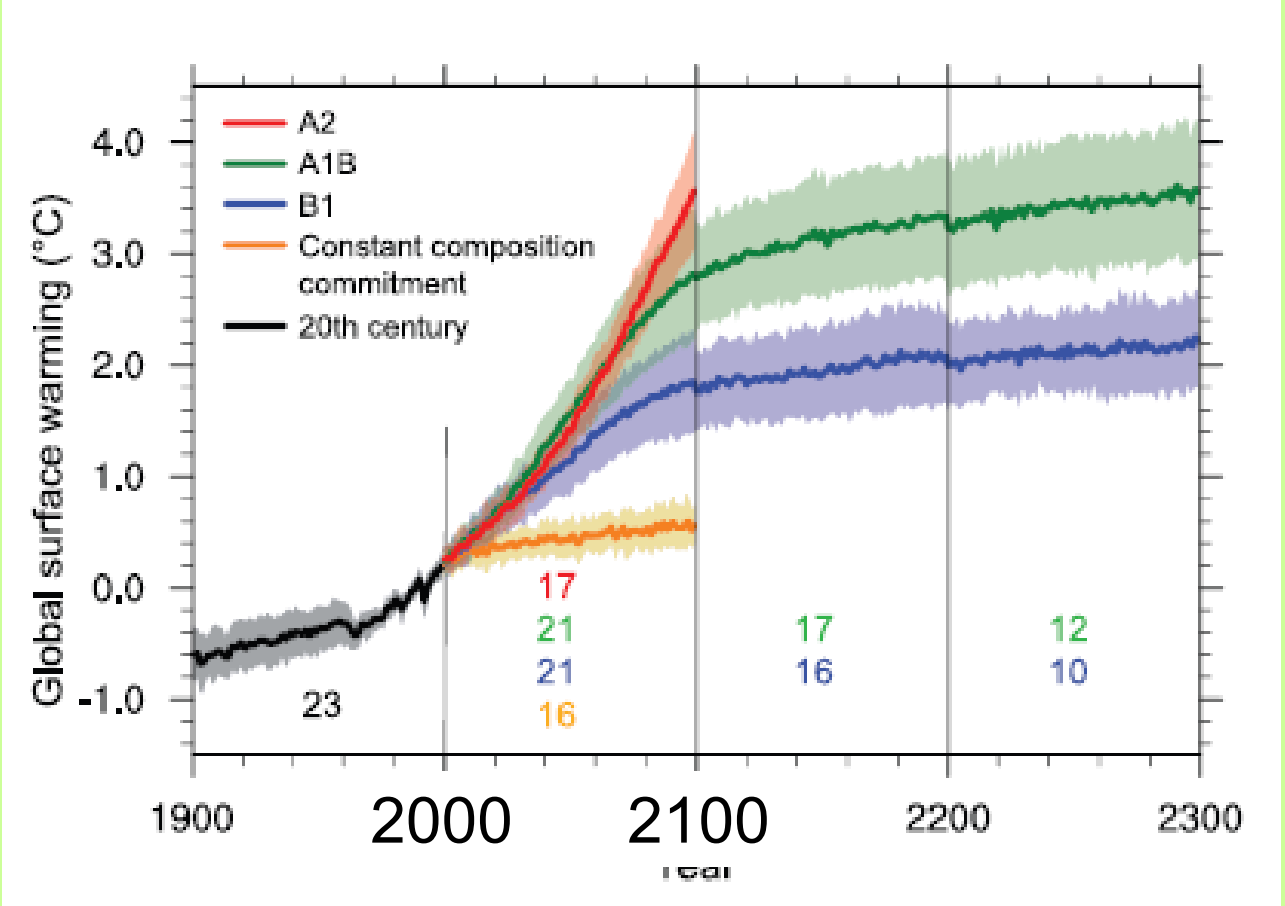
Projection of future climate depends on future emission scenario

- Called Special Report on Emission Scenarios (SRES)
- Images of the future, or alternative futures.
- Neither predictions nor forecasts.

Some SRES

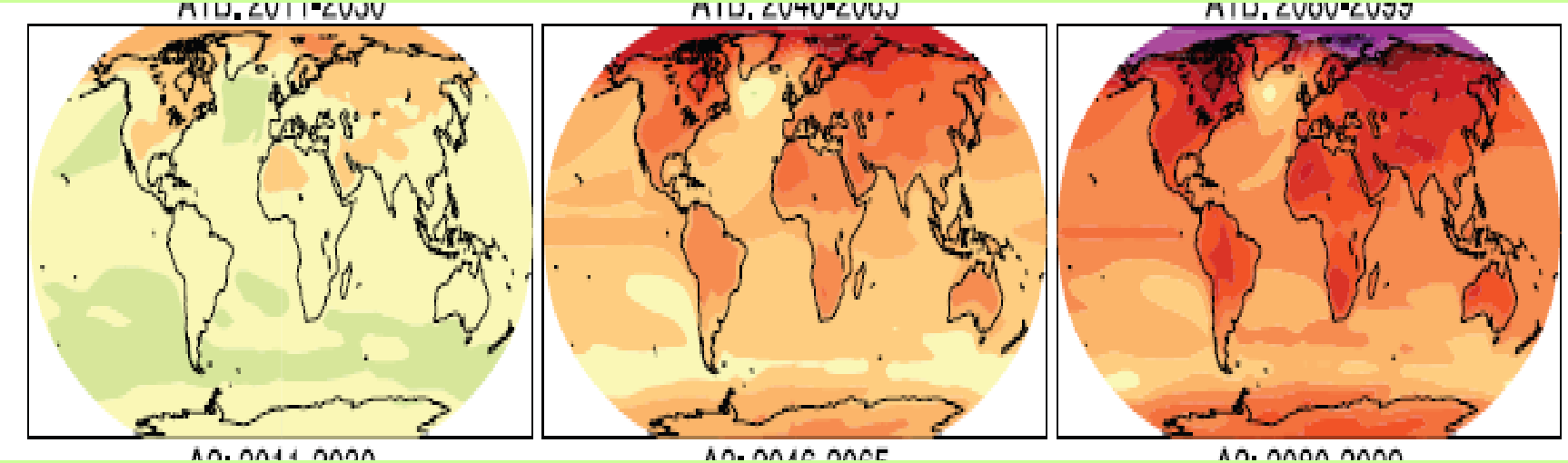

History
A1B
A1FI
A1T
A2
B1
B2
Fossil CO_2 Emissions
CH_4 Emissions
SO_2 Emissions
(GtC yr⁻¹)
(TgCH₄ yr⁻¹)
(TgS yr⁻¹)
30
20
10
0
800
600
400
200
100
50

Projects of global temperature for various SRES



Note global temperatures will rise even if we stop emission of CO_2 in 2000, i.e., now (orange), or in 2100 (blue and green) due to long lifetime and 'memory' of ocean

- regional temperature rise under A1B emission scenario
- 2011-2030 2046-2065 2080-2099



Temperature Projections for Caribbean:

- Very likely (> 90% probability) that Caribbean temperatures will increase
- Agreement of observation, global models, statistical downscaling, good physical basis
- Extent will depend on actual green house gas emissions ~ slightly below global average of 3.4ºC by end of century based on A1B

Precipitation Projection

- Likely (> 66% probability) drying in the Greater Antilles in June, July and August (JJA)
  - General Agreement between Global Models
  - A Global model run for the Caribbean show decrease in JJA (Angeles et al, 2007)
  - Some statistical runs show decreases in JJA
  - Drying trend in observed data (Neelin et al., 2006)
  - Theoretically, drying is probable in Greater Antilles (Chou and Neelin,2004)

(Present work being done at by Climate Studies Group Mona (CSGM) indicate that JJA drying is very likely)

Hurricanes

- Not enough results to make statement about the Caribbean and other hurricanes
- Human contribution to observed trend more likely than not (> 50% probability)
- Likely (>66%) that intense tropical cyclone will increase in some regions
- NOAA, 2006: Observed increases can also be explained by natural variability (as opposed to anthropogenic induced variability)

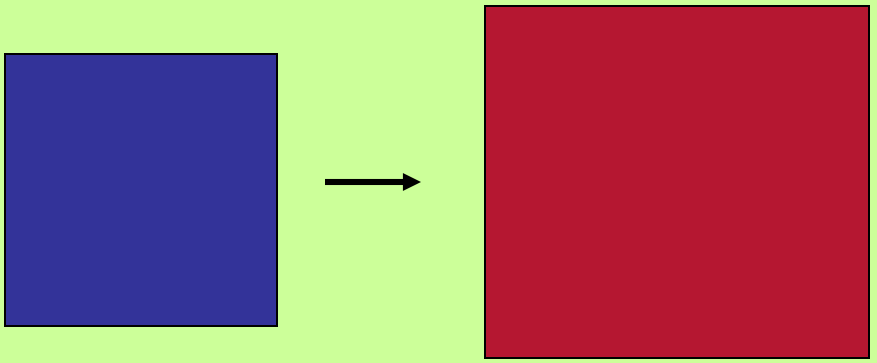
Sea Level Rise

- Observation
  - The rise in the Caribbean appears to be near the global mean (Church et al, 2004: *J. Clim*., 17, 2609-2625).
  - 1.8 $\pm$ 0.3 mm per year or 0.18m per 100year over the period 1950– 2000.
- Modelling
  - Large deviation among models
  - No regional modelling
  - Global mean rise expected: 0.2 to 0.5 m up to 2090's
- General statement: Sea level rise are likely (>66% probability) to continue to rise on average around the small islands of the Caribbean (near the global mean)

Impacts I

Sea level will rise

•Thermal expansion of ocean



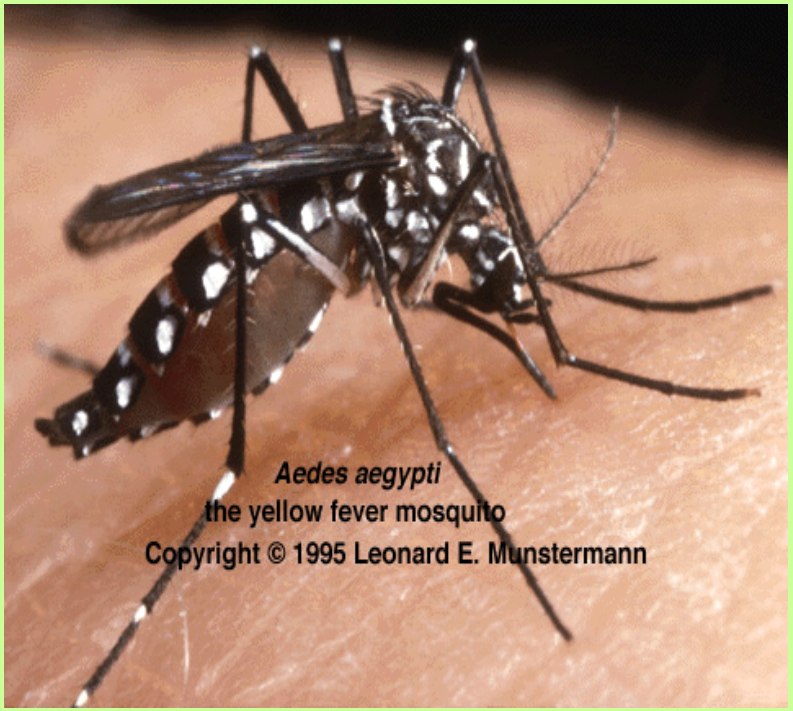
•Melting of glaciers and ice land mass, e.g., in Greenland

2 meter rise impact (Dr. 'PJ' Lyew-Ayee, Mona Informatix, UWI, Mona)

Red indicates flooding

Impact II

Dengue fever transmission will increase approximately 3-fold



•As temperature increases the time for the parasite to incubate in mosquitos decreases

•Takes less time to transmit the disease

Other Impact III

Higher sea surface temperatures will cause coral reefs to die - bleaching

Other Possible Impacts on

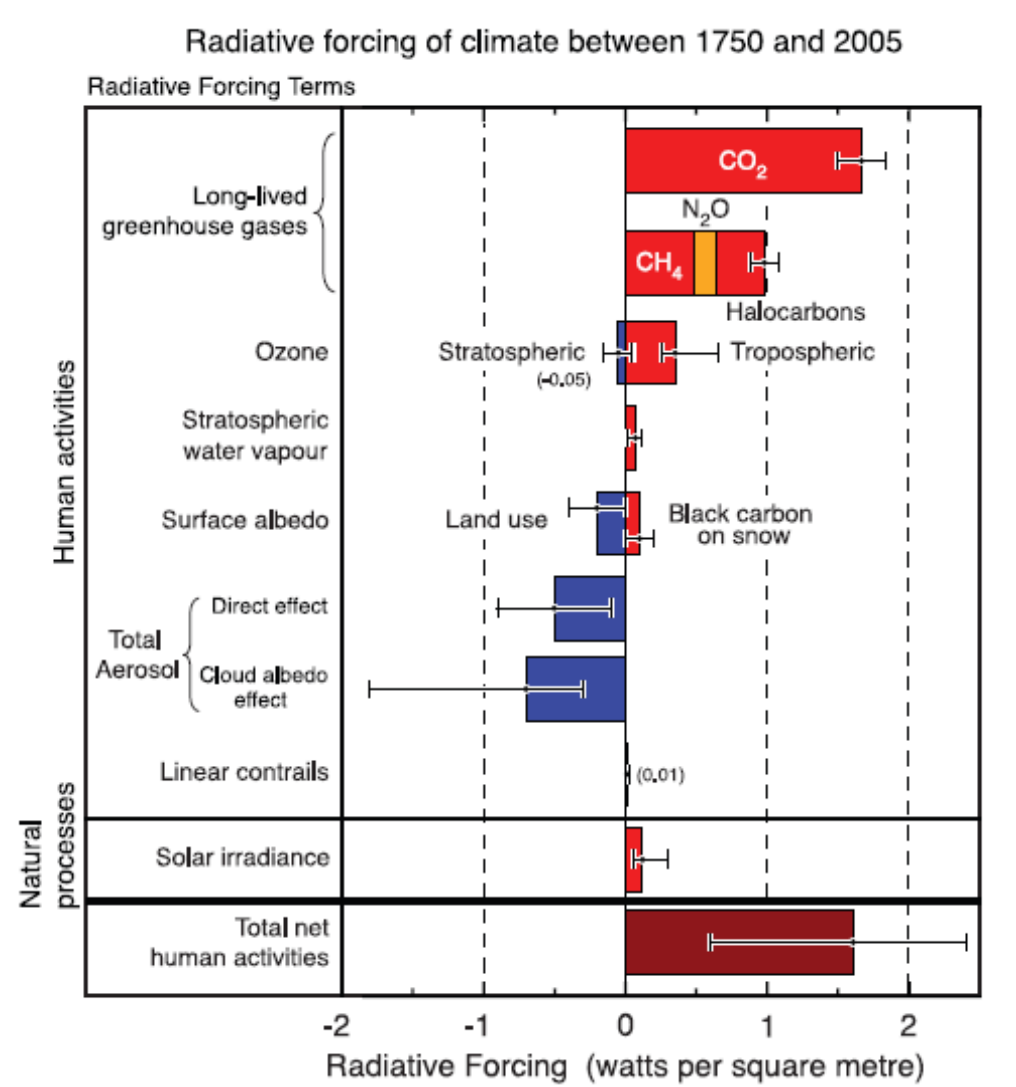
- Water resources
- Biodiversity
- Agriculture
- Tourism
- Coastal resources
- Human settlement

- What is the Caribbean doing
- How do we contribute?
- What’s really to be done

Studies of Climate Change, Impact and Adaptation and Mitigation are being done

- University of the West Indies (Climate Studies Group Mona (CSGM), Cave Hill), Inst of Meteorology, Cuba
  - Climate modelling and projections
- Millions of dollars grants from developed countries
  - Caribbean Community Climate Change Centre (CCCCC)
    - the impact of climate variability and change on all aspects of economic development
  - Community-based Climate Change Adaptation Projects
  - Assessments of Impacts and Adaptations to Climate Change (AIACC) in Human Health at UWI
- Jamaica second National communication
  - Health, coastal Resource and Human Settlement, Water and Agriculture

How do we contribute?
Look at main drivers of warming

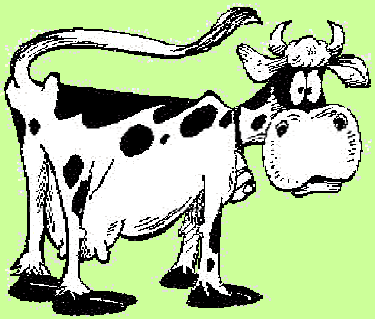


Anthropogenic Green House Gases:

- CO_2
- N_2O

Water Vapour

(very effective greenhouse gas)

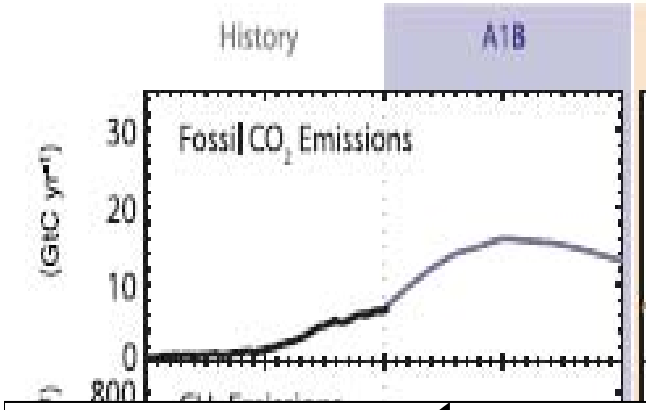


Methane

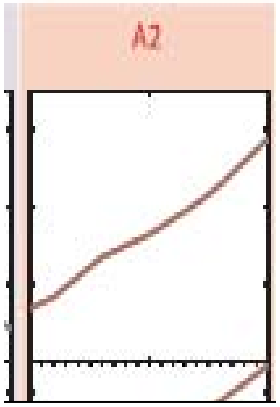
Chlorofluro-carbons CFC's

How do we get rid of the gas?

What could happen if we do not mitigate greenhouse gas emissions



What happens if we do not do this?



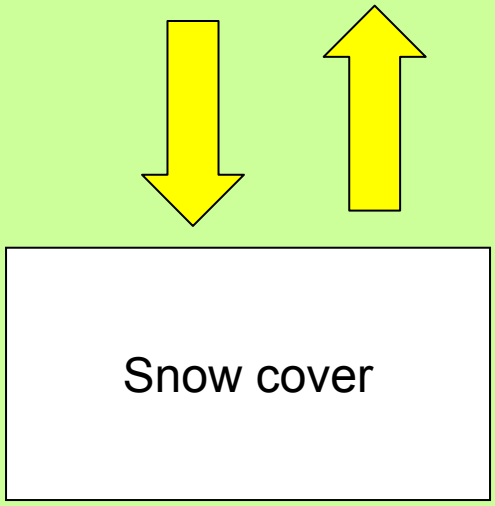
And instead do this

Tipping Points

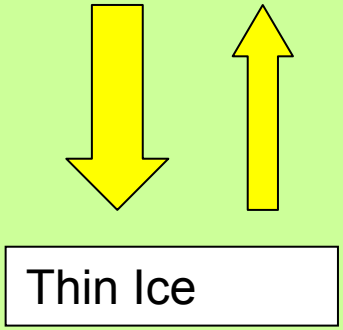
- Delicate thresholds
  - slight rise in the Earth's temperature can cause a dramatic change
  - irreversible change
  - due to positive feedback
- The following are serious concerns but are based only a few model runs and/or scientific principles

Greenland and West Antarctic Ice Sheets

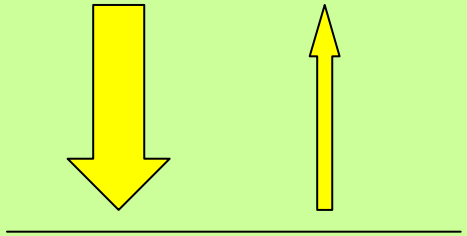
Snow reflecting sunlight →



Balance between incoming and outgoing radiation



More incoming than outgoing due to less reflection, more melt



Ice has all melted, much less reflection and surface get warmer

IPCC 4th Assessment

- A collapse of the West Antarctic Ice Sheet … has been discussed as a potential response to global warming for many years (Bindschadler, 1998; Oppenheimer, 1998; Vaughan, 2007).
- A complete collapse would cause a global sea level rise of about 5 m.
- Present understanding is insufficient for prediction of the possible speed or extent of such a collapse

Other possible tipping points

- Atlantic Meridional Overturning Circulation (MOC)
  - moderates temperatures in northern Europe
  - Caribbean would probably become very warm
  - Not yet confirmed by models
- Desertification
  - As happened to the Sahara region 4 to 6 thousand years ago (ka)

Other concern

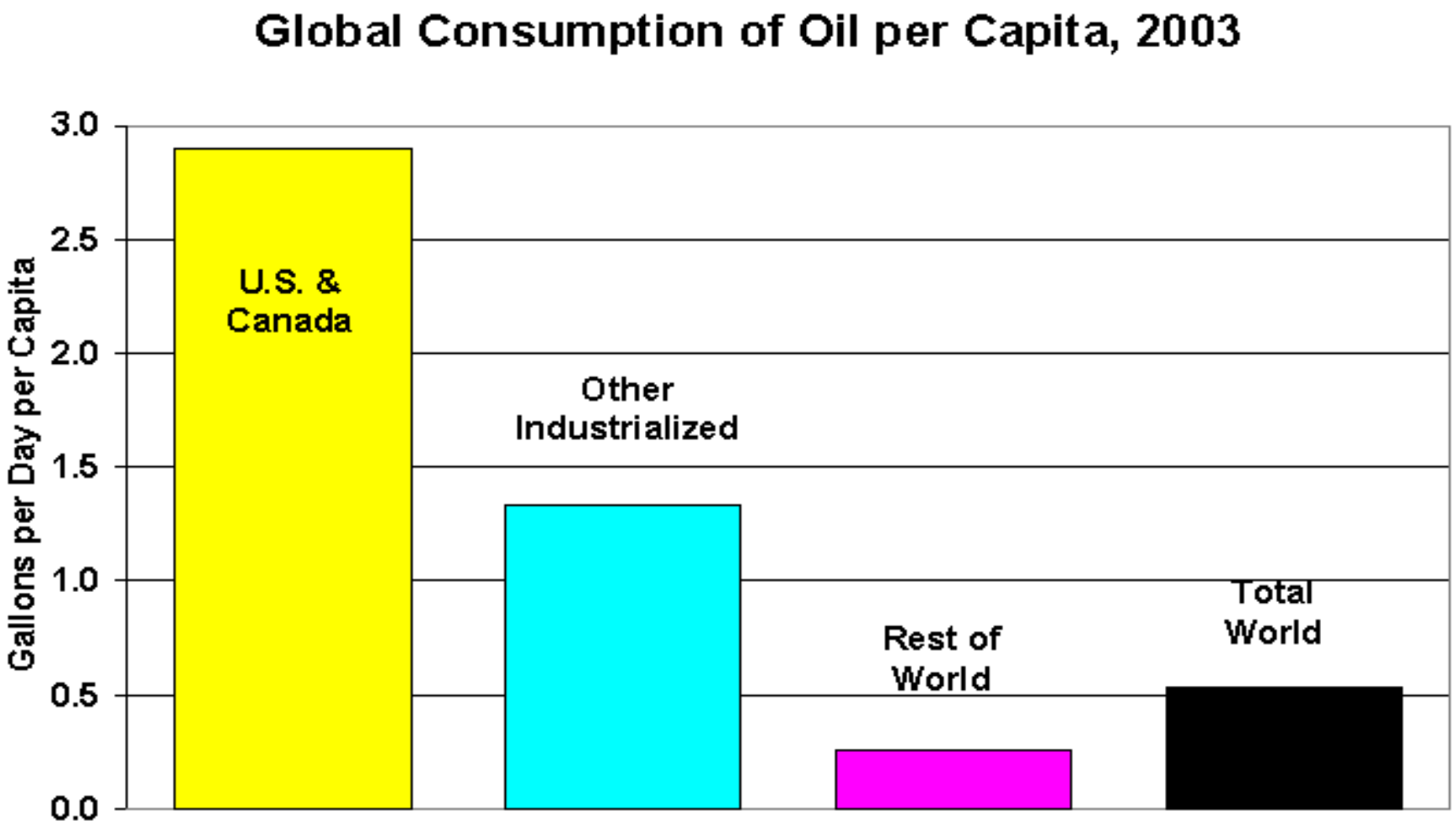
- Widespread coral bleaching that could damage the world's fisheries within three decades (Washington Post, Sunday, January 29, 2006)

Possibility of a runaway greenhouse effect thousands to millions of years from now

Earth

Venus - almost the same size as Earth. A runaway greenhouse effect makes the surface 400º C hotter than the Earth.

How do we contribute?



What's really to be done?

- USA, Canada and other industrialized countries (Europe, Australia), China and India must be persuaded to reduce greenhouse gas emission.
- Of the above, Europe is leading the way
  - England to cut by 60% by 50's.
- China has expressed concern
  - First global warming policy initiative issued on June 4
  - 3 Gorges Hydroelectric Dam (22500 MW, world's largest)
- Other countries, UN, NGO's must lobby for reduction by developed countries

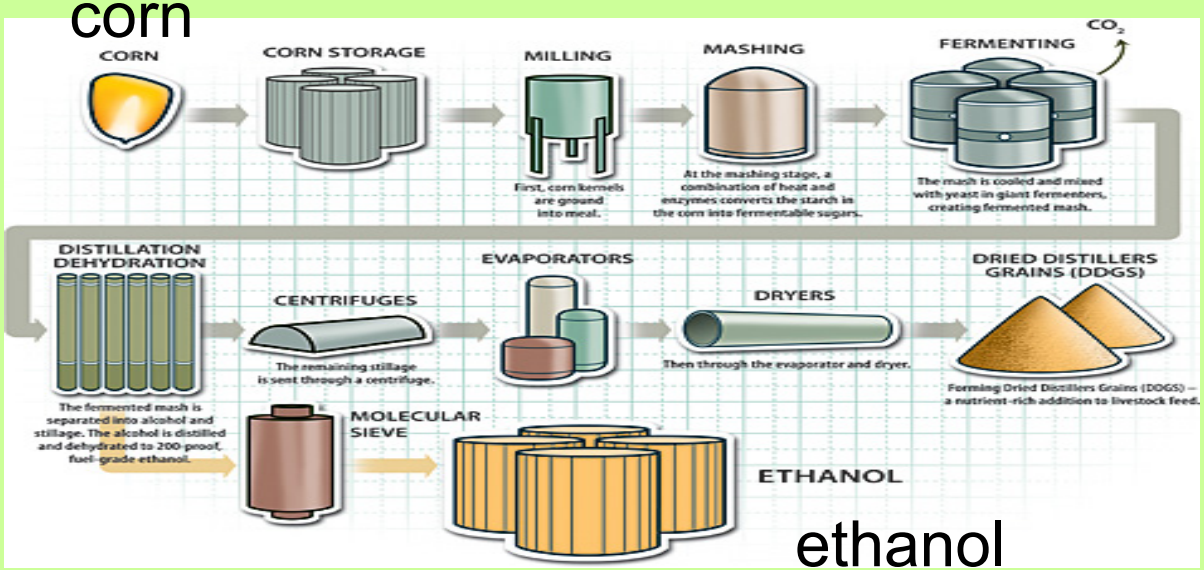
How can developed countries reduce greenhouse gas emissions?

- Alternative sources of energy that do not produce CO_2
- Billions of dollars into R&D and manufacturing. Grants/contracts to
  - Universities
  - Research Organizations (Bell Labs, British Petroleum, etc.)
- Wage war, not for oil, but on greenhouse gases

Possible New Sources of Energy for developed and developing countries

- Not ethanol from corn as Pres. Bush is advocating
- It increases the cost of food and feedstock
- Poor suffers
- Not a source of electric power

corn



ethanol

Sources: Hydroelectricity, a conventional source of energy

3 Gorges Hydroelectric Dam, China

22500 MW

World's largest

Wind, already viable as a source of electricity and used worldwide

Wigton Wind Farm, Manchester, Jamaica

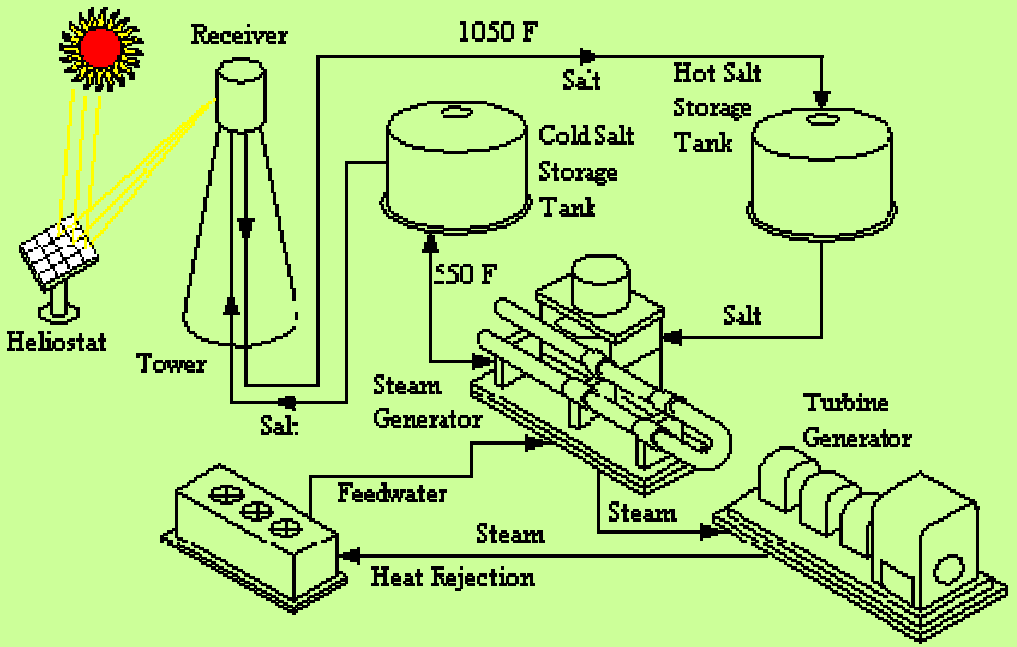
Solar Cell Power Plant – need for more R&D and usage to make cheaper

Ontario is proposing a solar farm similar to this one Amstein, Germany. The Ontario plant will be able to supply enough electricity to power up to 15,000 homes on sunny days.

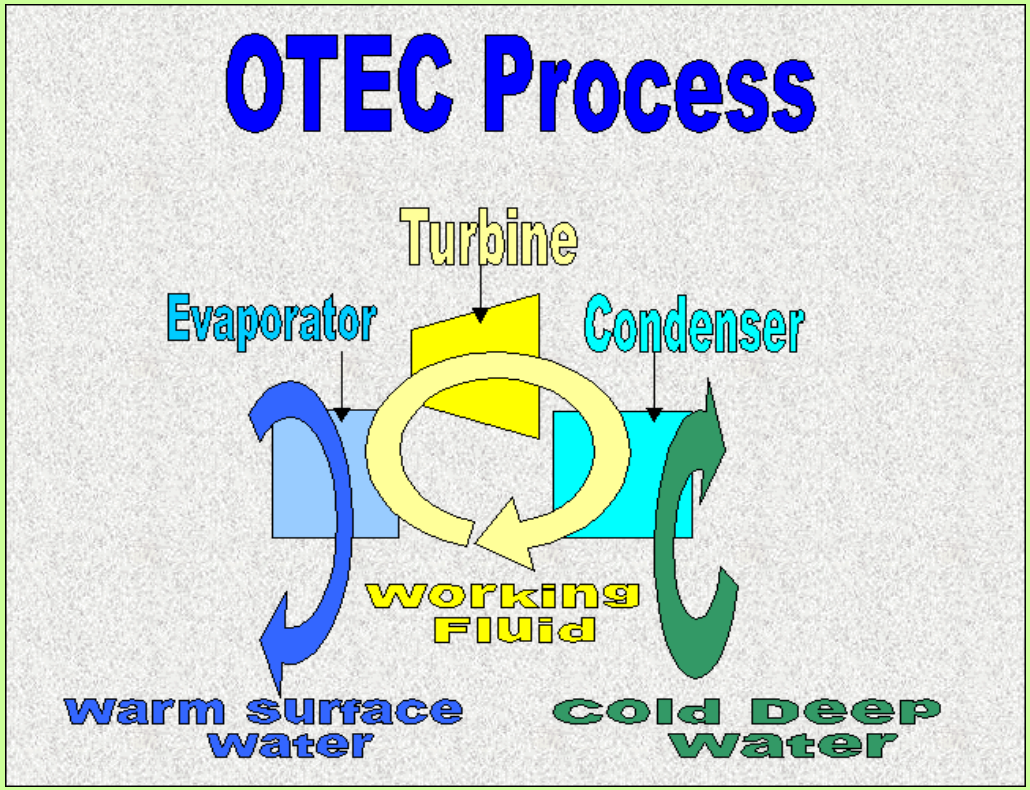
Solar thermal electric power plant

Plants constructed in Seville,Spain (Solucar) and California,USA. R&D and more usage will bring down the cost

Mirrors reflect solar radiation to a collector (receiver). Heat is used to drive a electric generator.



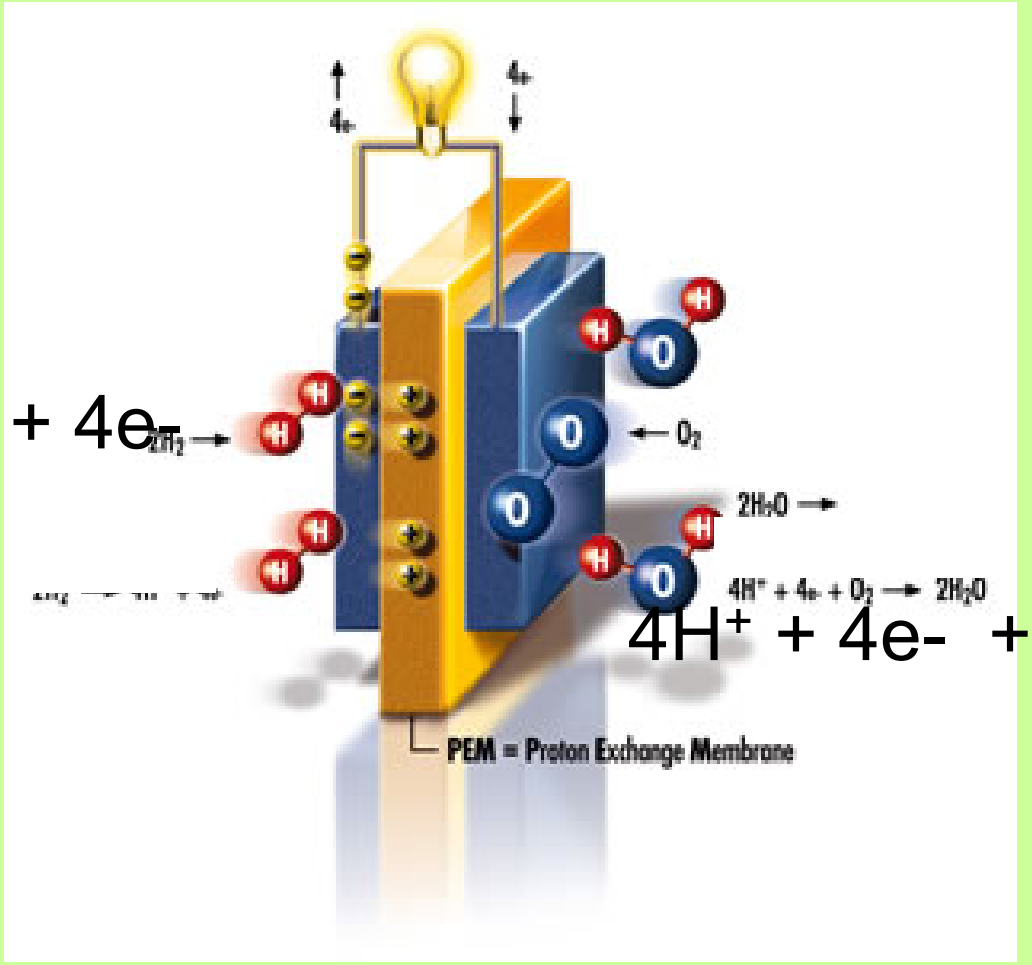
Ocean Thermal Energy Conversion (OTEC)
Produces electricity by driving a turbine using difference in temperature of warn surface and cold depth of ocean/sea
- More R&D and usage needed



View of OTEC facility at Keahole Pointe on the Kona coast of Hawaii.

Hydrogen Fuel cell to produce electricity from Hydrogen – more R&D

$2H_2 \rightarrow 4H^+ + 4e^-$



$4H^+ + 4e^- + O_2 \rightarrow 2H_2O$

Demo car running on hydrogen fuel cell

Nuclear Power Plant
R&D to make safer, smaller for smaller countries, and for safer storage of waste

In Summary

- Caribbean continue to develop adaptation strategies to climate change
  - It will all be better for the environment (‘no regrets’ adaptation)
- Continue our mitigation efforts to use more environmentally friendly sources of energy
- Do not let the millions we get for adaptation from the developed countries blind us or stop us from vigorously advocating the need for reduction of green house gases especially in the developed countries.
- Not millions $’s, but billions $’s expenditure by developed countries.

FINIS

What we must do is see the whole world as our "self"

Only then will we be worthy

of being entrusted with the World (*Earth*)

Only One who values the World as his own body

can truly rely on the World in return.

Lao Tsu, over 2000 years ago