Natural and Man Made Drivers for the Greenhouse Effect on Planet Earth

CONTENTS

Summary

Computer climate models indicate that there will be continued steady increase in average temperature at sea level, due to greenhouse gas emissions, unless mitigating measures such as alternative greenhouse gas benign
energy sources are phased in more quickly than they are at present.

Current long term climate forecasting computer models are based on radiative forcing as a primary mechanism. Radiative forcing is the term used to describe the instantaneous warming effect from greenhouse
gases and is measured in watts per square metre. These computer models forecast 2 to 6 °C increase over the next 100 years.

The IPCC's summary report indicates that greenhouse gases were about 13 times more effective than solar radiation for increasing global temperatures.

Because climate modeling is non linear, due to positive and negative feedback mechanisms that are inherently present in climate systems, there is uncertainty about the predictions that these models can be expected to make.

If the models are forced to match historic temperature increases during the process of calibration, there is no guarantee that future temperature increase predictions using these models will be accurate.

This paper will concentrate on the evidence for natural and man made factors contributing to the increase in the concentration of greenhouse gases and increase in the earth's average atmospheric temperature.

The importance of albedo in determining earth surface and air temperature will be examined.
The albedo effect for planet earth is currently 31%.

The effect of anthropogenic (manmade) carbon dioxide emissions compared to what natural systems can absorb will be examined. The effect of long terms natural carbon dioxide cycles will be compared to man made carbon dioxide releases.

Currently the earth's atmosphere contains 381 ppm of carbon dioxide and this value is 100 ppm above pre industrial revolution values.

During the last two decades, 1 ppm of carbon dioxide was added to the atmosphere on average every year.

The rate of change of carbon dioxide increase from anthropogenic (manmade) activity, is greater than at any time in the planets past, when compared to natural variations which are determined from ice core records.

Details on how historical ice cores taken from Greenland and the Antarctic can be used to show the relationship between air temperature and carbon dioxide concentration in the atmosphere.
The latest data from the Antarctica Vostok Ice Cores will be examined in detail.
The issue of whether temperature increases preceded carbon dioxide increase or vice versa will be examined from the ice core records.

Accelerated anthropogenic (manmade) climate change has already had an effect on degradation and extinction levels for flora and fauna as well increasing the intensity of weather extremes.
Computer models predict temperature increases of five to 100 times the rate that nature has taken to increase temperature by 5 °C between 15,000 and 5,000 years ago.

Because of the positive feedback effect due to reduced albedo, the greenhouse effect has probably entered the early stages of a non linear growth phase as evidenced by the recent accelerating meltdown of Greenland and Antarctic ice sheets.

World wide there are not enough countries agreeing to reduce greenhouse gas emissions to meet the Kyoto protocol targets. The recent reports by IPCC and Stern Review indicate that there is a urgent need to mitigate anthropogenic (manmade) greenhouse gas emissions.

Ref: - http://www.ipcc.ch/

The statistical confidence level is greater than 90%, that global warming is due to increased anthropogenic (human) greenhouse gas concentrations in the atmosphere.

The fourth IPCC report indicates, that if we don't act within the next decade, the overall costs will be equivalent to losing 5 to 20% of global GDP.

Therefore it is prudent to consider implementing the measures for reducing greenhouse gas emissions detailed in this paper and err on the side of caution in relation to the matter of climate change.

Background

Carbon Sources

Carbon dioxide is released naturally into the atmosphere by animal respiration and decay of plants and animals. These processes account for about 38% of carbon dioxide emissions.

CO_2 is expelled from the oceans at the tropics and absorbed in the high latitudes at the rate of 90 Gigatons per year (57%) through the action of ocean currents.
The manmade burning of fossil fuels and cement production and land clearing contribute another 5 % to carbon dioxide emissions.

Carbon Sinks

Plants and trees on average absorb approximately (40%) and ocean surfaces absorb 60% of the current atmospheric carbon dioxide.
Currently the carbon sinks are not in balance with the amount of CO_2 released from carbon sources.
Currently 7 billion tonnes of CO_2 is released by man's activity on earth.
4 billion tons are absorbed by vegetation and phytoplankton in the oceans and 3 billion tons are left as surplus.

National Comparison of CO_2 emissions

Australia produces about 1.5 per cent of the world's greenhouse gases with 0.33% of the world's population. This is very high relative to other developed countries, considering the size of our population and economy.
This is because our industrial base is centred on the use of fossil fuels such as coal oil and gas.

The preceeding Liberal Federal Government did not ratify the Kyoto protocol that was negotiated in Japan in 1997.
The incoming new Labor government has agreed to ratify the Kyoto Protocol and will legislate to reduce greenhouse gas emissions by 60 % compared to 2000 levels by 2050.

USA currently generates 25% of carbon dioxide emissions with 5% of the world's population.
The Bush Republican government did not show any willingness to legislate for greenhouse gas emissions reductions on the grounds that economic growth could be effected adversely.
The recently elected Obama lead Democratic Party, has indicated that it will establish binding Carbon dioxide emissions caps.
The current US policy of voluntary greenhouse gas emission reduction has been a failure, except in California where renewable energy sources such as wind turbines and very energy efficient domestic dwelling construction is mandated by legislation. California plans to install one millions solar roof panels and reduce by 20% energy use in public buildings by 2015.

The current increased economic activity world wide and especially in the economic powerhouses of India and China has negated any energy efficiency gains achieved in the West.
Greenhouse emissions from China between 2000 and 2030 will equate to the increase from the entire industrialised world, because of 7 to 9% economic growth projections for GDP.

India's greenhouse emissions could rise up to 70% by 2025 compared to 2005 levels.

Albedo Effect

The term albedo defines the percentage of solar energy reflected back into space by a surface on planet earth.

The Sun shines on the earth's surface and emits 341 watts of energy per square metre.

The earth's climate system constantly adjusts in a way that maintains a balance between the energy that reaches the earth from the sun and the energy that reflects from earth back into space.
This is referred to as the "radiation budget".
Energy is returned back into space by the means of reflection (albedo) and the process of emission.

The emitted infrared radiation is of longwave variety that returns from the earth's surface.
Clouds absorb and reemit a portion of this radiation back into space, and portion back to the earth's surface.

Forests, grasslands, ocean surfaces, ice caps, sea ice, deserts, and cities all absorb, reflect, and radiate radiation differently.
Sunlight falling on a white glacial surface, strongly reflects back into space, resulting in minimal heating of the surface and lower atmosphere.
Polar ice reflects 90% of the sunlight back into space, the ocean absorbs 90% of the energy it receives.

Sunlight falling on a dark desert soil is strongly absorbed and contributes to heating of the earth's surface and lower atmosphere.
20% of the incident sunlight is reflected by vegetation and dark soil back into space.

Higher clouds have a warming effect as they stop the infrared radiation from escaping into space. Low clouds act to cool the earth, deep convective clouds are neutral to warming or cooling of the atmosphere.

Cloud cover affects albedo by warming the atmosphere; this reduces the amount of solar radiation reaching the earth's surface. The nett average effect with the current earth's cloud composition is for cooling.

Currently clouds reflect 17% of solar radiation back into space. If the earth becomes cloudier, as some climate models predict, more radiation will be reflected back and less will reach the surface.
The result would be negative feedback in reducing the greenhouse effect due to increasing carbon dioxide in the atmosphere.

Overall the current reflectivity of sunlight or the albedo effect on the earth is 31%.
A drop in the albedo of 0.01 would have a major influence on climate. It would equal the effect of doubling the amount of carbon dioxide in the atmosphere.
This is equivalent to retaining 3.4 watts of energy for every square metre of surface area.

The earth's albedo has reduced by 0.0027 or 0.9 watts of energy per square metre between 2000 and 2004. The cause for this reduction was probably due to reduction in aerosol pollution content in the atmosphere especially in Europe.

Ref http://earthobservatory.nasa.gov/Library/Clouds/

Greenhouse gas effect

Venus is too hot, Mars is too cold, and Earth is just right the saying goes, when comparisons are made about habitability potential on these planets.
Venus has a runaway greenhouse effect that has resulted in the surface temperatures to be 500 degrees centigrade where it is not possible for life as we know it to evolve.
Mars is too small to maintain a thick atmosphere, most of the radiation from the sun is reflected back to space, it is too cold for life to evolve as we know it on planet earth.

The earth's surface and lower atmosphere temperature is related to many factors, including changes in the eccentricity of earth's orbit around the sun, planet tilt angle changes due to precession, changes in solar activity and cosmic rays, gas content of the atmosphere, and the nature of ocean currents such as the Gulf Stream.

There has been good correlation between solar activity and air temperature increase or decrease up to 1980.
After 1980 the temperature and solar activity graphs diverge and do not correlate.

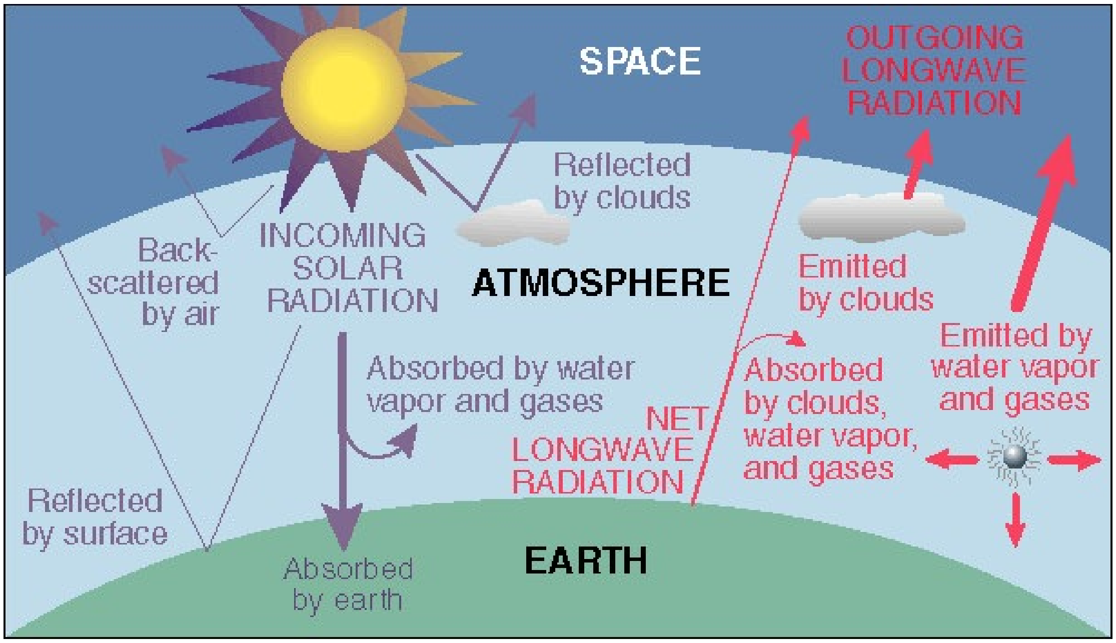
CO_2 is relatively transparent to visible light from the sun, but it is relatively opaque to infrared radiation which radiated from the earth's surface back towards space.
The atmosphere acts as an insulating blanket of just the right thickness, trapping sufficient solar energy to keep the global average temperature in a pleasant range on earth so that life as we know it could evolve and adapt to natural changes in climate conditions.

Without this layer of atmospheric gas, the average earth surface temperature would be only about -73 C and life as we know it would not have evolved.

Approximately 30% of the solar radiation striking the earth's atmosphere is re-emitted as long-wave infrared radiation, which is absorbed by greenhouse gas molecules such as carbon dioxide and water vapour in the atmosphere and is reflected back to the surface as heat.

The earth has an equilibrium temperature of about 300 Kelvin. At this temperature, the wavelength of the emitted radiation is in the infrared range.

Trapping of infrared radiation causes the Earth's surface and lower atmospheric layers to warm to a higher temperature than would otherwise be the case, resulting in the so called greenhouse effect.



The figure above shows how the greenhouse effect works

Ref http://zebu.uoregon.edu/1998/es202/l13.html

In the Tropics, solar radiation is accumulating and in the Polar Regions radiation is lost into space.
CO_2 is expelled from the oceans at the tropics and absorbed in the high latitudes at the rate of 90 Gigatons per year through the action of ocean currents.

If only a radiation and convection atmospheric forcing climate model is considered, without reference to effect of oceans, the tropics would keep on heating up and the Polar Regions cooling without a limit.

30 $^{\circ}$C represents a practical upper limit to surface temperature over oceans.
At this temperature, evaporation dominates the energy exchange between the ocean and the atmosphere. A reduction in nett longwave radiation at the earth's surface due to enhanced greenhouse gas
concentrations is compensated by increased evaporation without an increase in surface temperature.

Man made activity has enhanced CO_2 emissions in addition to what has been released naturally in the biosphere and the oceans.
Man made contributions to carbon mass is less than 4 per cent of the natural annual emissions from the biosphere and the oceans annually.
For each tonne of coal that is burned, 2 tonnes of CO_2 is released into the atmosphere.

Currently 7 billion tonnes of CO_2 is released by man's activity on earth.
4 billion tons are absorbed by vegetation and phytoplankton in the oceans
3 billion tons are left as surplus
This load is increasing each year because of the reduced amount of carbon sinks due to de-forestation, accelerated use of fossil fuels and the reduced capacity of oceans to absorb more carbon dioxide.

Based on blackbody radiation analysis, CO_2 absorbs infrared radiation in three narrow bands of frequencies. These are at the 2.7, 4.3 and 15 micrometre wavelengths which are within the black body radiation curve.
This means that most of the heat producing radiation escapes CO_2 at other wavelengths.
The most potent greenhouse effect from CO_2 released into the atmosphere was when the CO_2 concentration was between 0 and 100 ppm. Even if the current CO_2 level of 381 ppm is doubled, it would according to blackbody radiation theory, have a marginal effect to increasing the greenhouse atmospheric warming on planet earth as the greenhouse gas absorbing frequencies are already saturated.

See Figure “Radiation Emission to Space “below for details.

Up until mid 2005, atmospheric satellite temperature records showed no atmospheric warming.
When the data was reviewed and corrected for satellite orbit drift and shielding variations, it was found that the earth’s atmosphere has been warming and agreed with computer model predictions.

These measurements contradict what is expected in theory from black body radiation curve as detailed in “Radiation Emission Space” analysis detailed in the figure below.

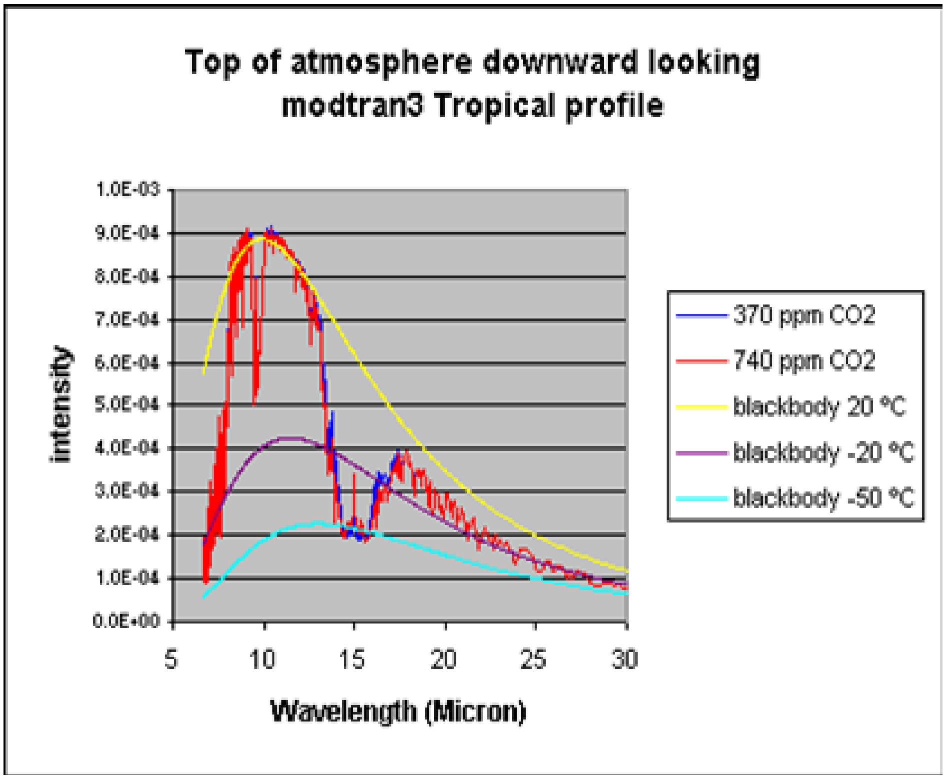
Ref:- Science 2005 , 309 pages 1548-1551, pages 1551-1556, pages1556-1559

More than 25 years of satellite data was examined and the results show that each hemisphere's jet stream has moved toward the pole by about 1 degree of latitude, or 70 miles.
According to John Wallace, a professor at the University of Washington and a co-author of the study:
"The jet streams mark the edge of the tropics, so if they are moving poleward that means the tropics are getting wider.
If the tropics move another 2 to 3 degrees poleward, very dry areas such as the Sahara Desert could move further toward the pole by hundreds of miles."

The researchers found that the troposphere was warming faster in the vicinity of 30 degrees north latitude which crosses the southern United States, Southern China and north Africa and around 30 degrees
south latitude which crosses southern Australia, South Africa and southern South America.
The troposphere is the layer from the Earth's surface to about 7.5 miles in altitude, the part of the atmosphere in which most weather occurs.

The new research suggests that faster subtropical warming of the troposphere will occur, which would move the jet streams, resulting in a shift mid-latitude storm tracks in the poleward direction.
This could reduce winter precipitation in regions such as southern Europe, including the Alps, and Southern Australia.
The response of the stratosphere is very different. The stratosphere is characterised by a radiative balance between absorption of solar radiation, mainly due to ozone, and emission of infrared radiation due to carbon dioxide.
An increase in the carbon dioxide concentration therefore leads to an increase of emission, and thus to a cooling of the stratosphere.

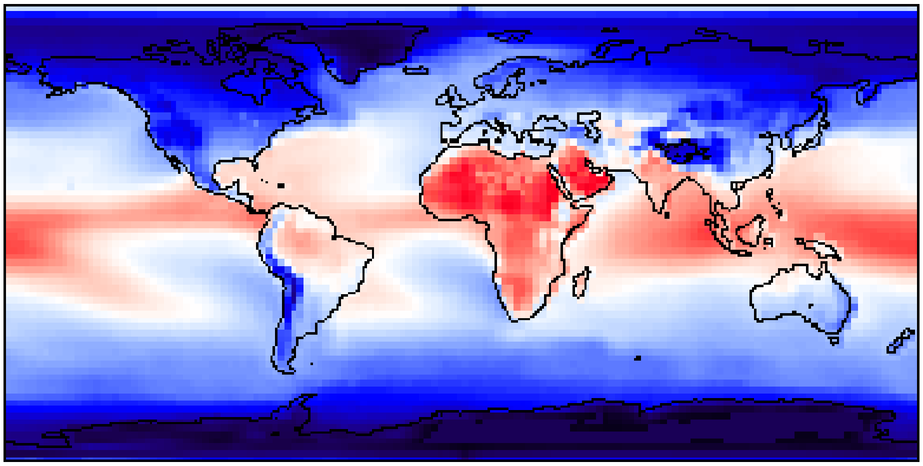
Radiation emission to space



Ref "Facts About Climate Change", William Kininmonth Australasian Climate Research Melbourne Australia
Ref www.lavoisier.com.au/papers/articles/kininmonthlaunch.html

Decomposing organic matter releases more and more methane and carbon dioxide from the thawing Arctic permafrost.
There are potentially between 200 and 800 gigatons available to be released if all the permafrost is allowed to thaw.

Contributing factors countering the greenhouse effect include, volcanic activity and acid rain pollutants, resulting in dust and aerosol content increase in the atmosphere and sunlight dimming effect due to vapour trails from jet aeroplanes.



The map above shows an Infrared Map of the Earth. Red areas represent regions of high heat retention in the atmosphere.
This occurs in the equatorial band because that is where the atmosphere retains the highest water vapor content.

Ref http://zebu.uoregon.edu/1998/es202/l13.html

Parameters effecting Greenhouse effect

The following table shows the change in parameter and feedback effect on global warming.

Parameter change	Effect on Global Warming
More Carbon Dioxide	positive
More Methane	positive
More Nitrous Oxide	positive
More Chlorofluorocarbons	positive
More Clouds	Negative feedback
More Water Vapour	positive
Reduced area Sea Ice, Ice Sheets and glaciers	positive
Reduced Acreage Of Vegetation trees	Positive feedback
Poleward Ocean Currents	Negative
Reduced Aerosols	positive
Volcanos	Negative or positive

The well known medieval age warming period (not man made) has had a lagging effect, which could be contributing to current carbon dioxide increases.
This is due to the fact that it takes a long time for atmospheric temperature change to be transferred to the oceans, which releases more carbon dioxide at a much later period in time (around 800 years).

Long term climate forecasting computer models based on radiation forcing as a primary mechanism, forecast an average 2 to 6 °C increase over the next 100 years.
Local temperature increases at the poles will be even greater.

The larger than expected increase will be due to the positive feed back, because of the reduced albedo.
Factors contributing to this will be the reduction in the quantity of aerosol pollutants from sulphur rich fuels,
thawing of permafrost, reduction in forest carbon sinks and the saturation of oceans as a heat and carbon dioxide sink.

The temperature increase due to CO_2 release is currently masked to some extent by the aerosol effect from pollutant emissions such as dust and sulphates that permeate the atmosphere due to unfiltered industrial
smoke stack pollution and motor vehicle exhausts.
Cleaner industrial and vehicle emissions will reduce the cooling effect due to presence of aerosols and take away the masking effect on the greenhouse effect that currently exists.
There has also been the latent lagging effect from large volcanic eruptions such as Krakatoa Tambora and Mount Pinatubo that generated large amounts of minute aerosol particles.
These particles rose into the stratosphere where the projection of sunlight was reduced.
The extinction of dinosaurs 65 million years ago was attributed to a large asteroid impact that shrouded the earth in a blanket of dust and aerosols blocking out solar radiation causing a temporary continuous winter.

The current interglacial period is the longest on record and past data indicates that the time following interglacial period, is accompanied by initial temperature increase followed by an abrupt temperature decreases over a short period of time.
As a consequence, there is a major concern that non linear positive feedback mechanisms may cause an uncontrolled sudden shift in world weather patterns over and above the changes that are occurring currently.
The rate of change in the global weather systems is approaching a limit, where flora and fauna is not able to adapt by mutation and natural selection through evolutionary means.
As a result the species affected simply become extinct.

Atmospheric Greenhouse Gas Concentration changes since 1750

Air sampling from bubbles inside ice cores taken from Greenland and Antarctic can be used compare CO_2 and other greenhouse gas concentration prior to the commencement of the industrial revolution.

The results are shown in the following table.

Greenhouse Gas Concentrations			
Gas	Year (1750)	Present	% Increase
Carbon Dioxide	280 ppm	381 ppm	29
Nitrous Oxide	280 ppb	360 ppb	11
Methane	0.7 ppm	1.7 ppm	143

Note:
ppm denotes parts per million
ppb denotes parts per billion

Refer to the following web link for details on how atmospheric Carbon Dioxide statistical trending is calculated and graphical data is presented over a timeline.

Ref:- http://www.esrl.noaa.gov/gmd/ccgg/trends/

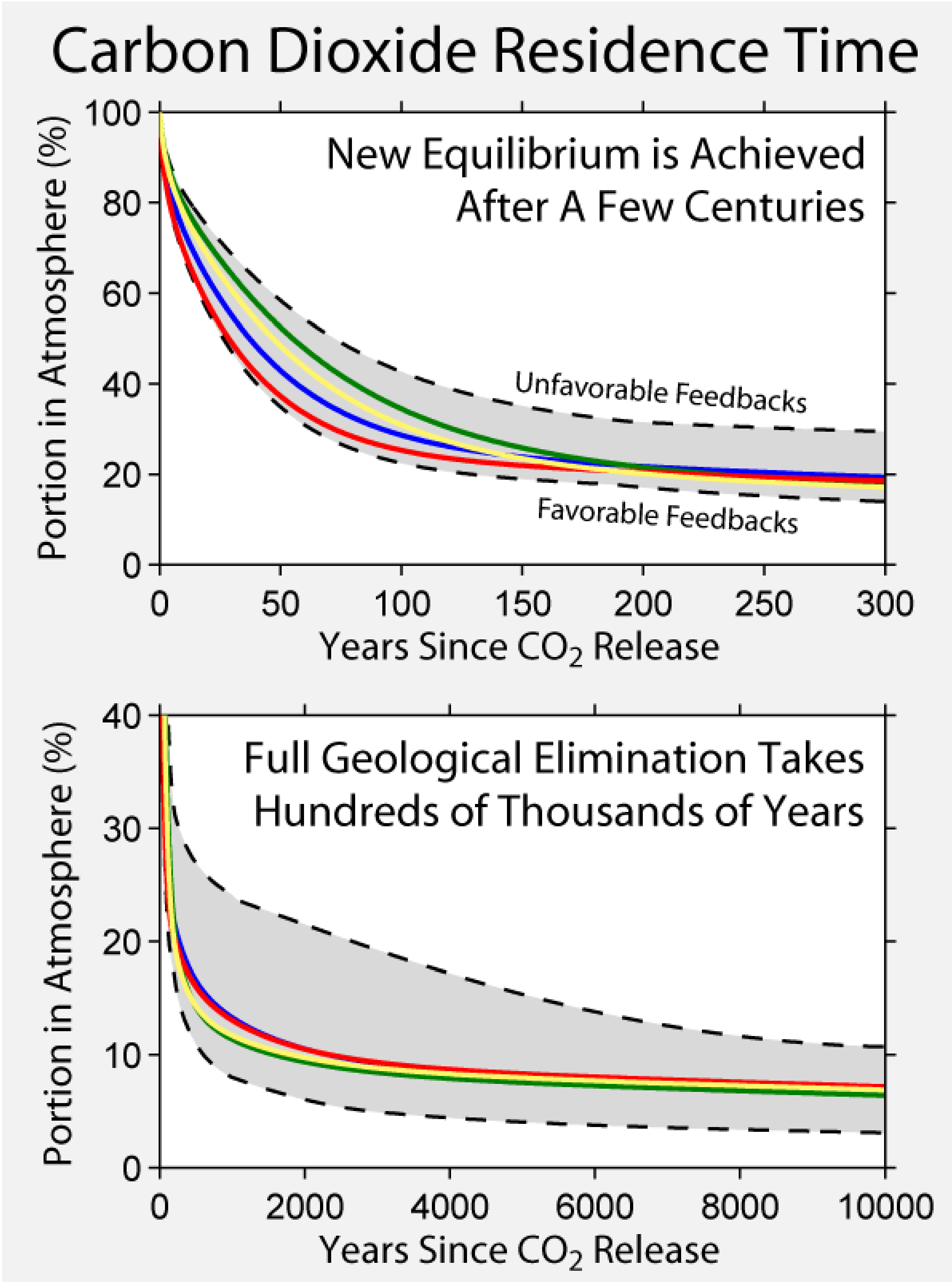
The methane gas rate increase is about 10 ppb per year. However, since 1 methane molecule is equivalent to 25 CO_2 molecules, (the equivalent growth rate in terms of CO_2 is 2.5 ppm).
This means that methane will eventually be a significant greenhouse gas in our atmosphere.

Methane is a byproduct from agricultural processes, and from the thawing of permafrost areas in the Arctic tundra. The mean atmospheric lifetime of methane in the atmosphere is 8 years.

Atmospheric Greenhouse Gas Residence Time

Residence time is defined as the time a gas persists in the atmosphere.
The lifetime of CO_2 in the atmosphere is the least understood aspect in the global warming issue.

The effect of CO_2 uptake in the oceans, the biosphere and uptake into carbonate rocks (such as limestone) has to be taken into account.
It can be expected that 15 to 30% of excess CO_2 released by man made activity currently, will remain in the atmosphere after 200 years.
3 to 7% of CO_2 added to the atmosphere today will remain in the atmosphere for 100,000 due to the slow uptake into carbonate rocks.
For more details, the Carbon Dioxide Residence Time is detailed graphically below.



Ref:- http://www.globalwarmingart.com/wiki/Image:Carbon_Dioxide_Residence_Time_png

The mean average lifetime of Nitrous oxide is 150 years before photochemical and chemical processes destroy N_2O in the stratosphere. N_2O pollution in the atmosphere has stabilised recently,because of improved motor vehicle emission controls (catalytic converters etc)

Stratospheric ozone layer depleting gas, Chlorofluorocarbon (CFC -11 and CFC -12) is also a greenhouse gas. It is expected that phasing out the use of CFC will reduce concentrations in the atmosphere within 40 years. The latent release of CFC gases from refrigerators and air conditioners in land fills, is increasing current atmospheric concentrations.

Current projections are that by 2016, 440 ppm of CO_2 will be present in the atmosphere.

Long Term CO_2 and Temperature Variations Before Present (BP)

The 1999 ice core (Data1) from Vostok in Antarctica extended the historical record of temperature variations and atmospheric concentrations of CO_2, methane and other greenhouse gases to 420,000 years before present (BP).

The ice cores were drilled to over 3,600 metres in depth.

See Antarctica Ice Core Data1 Figure below for details.

The data from the ices cores shows a high correlation between green house gas concentrations and temperature variations over a period of 420,000 years and through four glacial cycles.

It is difficult to precisely date the air and water (ice) samples, it is still unknown whether greenhouse concentration increases precede and cause temperature increases, or vice versa, or whether they increase synchronously.

It's also unknown how much of the historical temperature changes have been due to greenhouse concentrations, and how much has been due to increase in solar radiation (orbit change), or perhaps long-term shifts in ocean current circulation.

The CO_2 concentration rises vertically at the end of the time series in the figure below. The increase appears vertical because of the large time scale, it occurs over the past 150 years, which corresponds to the age of fossil fuels.

(the modern industrial age). There hasn't been a corresponding increase in temperature during this time period. This is probably due to the action of the oceans to function as a heat sink, and thereby delay the increase in atmospheric temperatures.

The current interglacial period is also unique in that the maximum temperature has not increased above +2 $^\circ$C relative to the mid-20th century benchmark (0 $^\circ$C) for very long period of time. It can be inferred that

the +2 $^\circ$C threshold must be exceeded for some period of time in order to initiate a new glacial phase. Or maybe the threshold is +1 $^\circ$C, but for a longer period of time. The present average temperature increase is about +0.8 $^\circ$C.

Recent peak temperatures have been in the +1.4 $^\circ$C to +1.6 $^\circ$C range.

The ice core graph (Data 2) time period roughly corresponds to the time since the last glacial maximum, when temperatures and CO_2 concentrations were at there lowest levels.

It shows how temperature and CO_2 levels rose, reached a plateau at the beginning of the present Holocene interglacial phase, and then rose again to above +2 $^{\circ}C$ over the plateau around 8,000 years ago.

There was a mini ice age in Northern Europe 11000 BP, in the period known as the Younger Dryas.

See Antarctica Ice Core Data2 Figure below for details

The ice core graph (Data 3) includes the Industrial Revolution which began in the mid 1800's. The start of the Industrial Revolution marked the beginning of the large-scale use of fossil fuels.

The small dip in temperature in the early 1800's was caused by volcanic eruptions which reduced the amount of sunlight reaching the Earth's surface. CO_2 inflection points are visible at around 1860, 1950 and 1975.

The data after 1958 used annual air measurements, not ice cores, and is therefore of higher quality.

See Antarctica Ice Core Data3 Figure below for details

The ice core graph (Data 4) illustrates the most recent data set of actual air measurements.

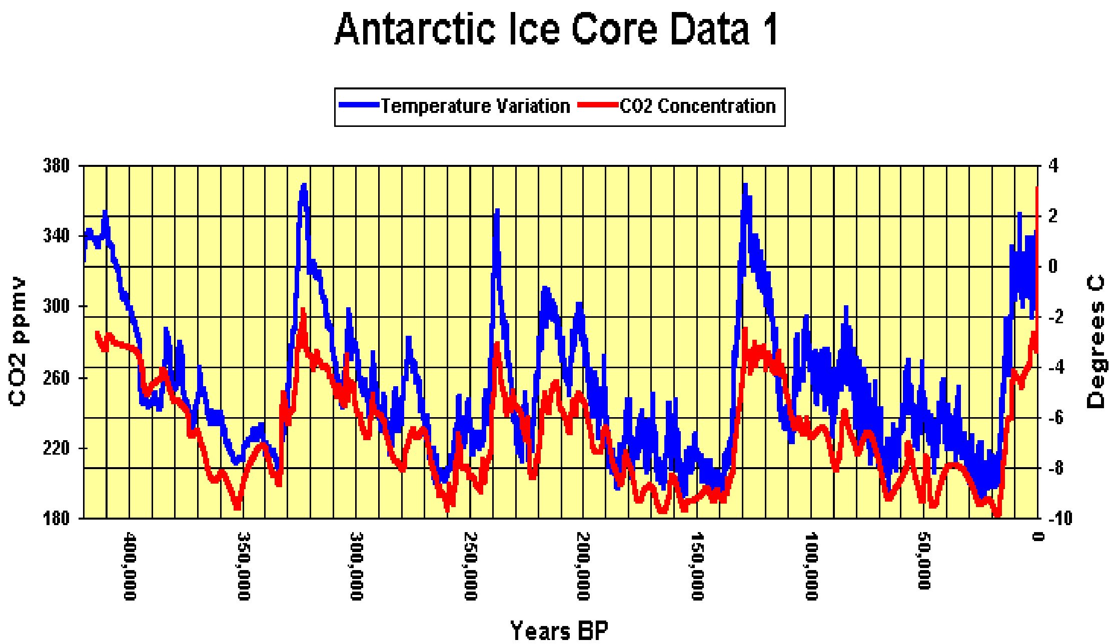
It shows how temperatures and CO_2 concentrations have increased in recent times.

A linear trend line fitted to the temperature data would indicate that the critical +2 $^{\circ}C$ level would be reached in about 40 years, assuming the future trend is linear.

Recent research indicates that the trend is probably exponential. Or it may be that peak temperatures are more important than mean temperatures.

In either of these cases the +2 $^{\circ}C$ threshold would be reached much sooner.

See Antarctica Ice Core Data4 Figure below for details


Antarctic Ice Core Data 1
Temperature Variation
CO2 Concentration
CO2 ppmv
Degrees C
Years BP
380
340
300
260
220
180
4
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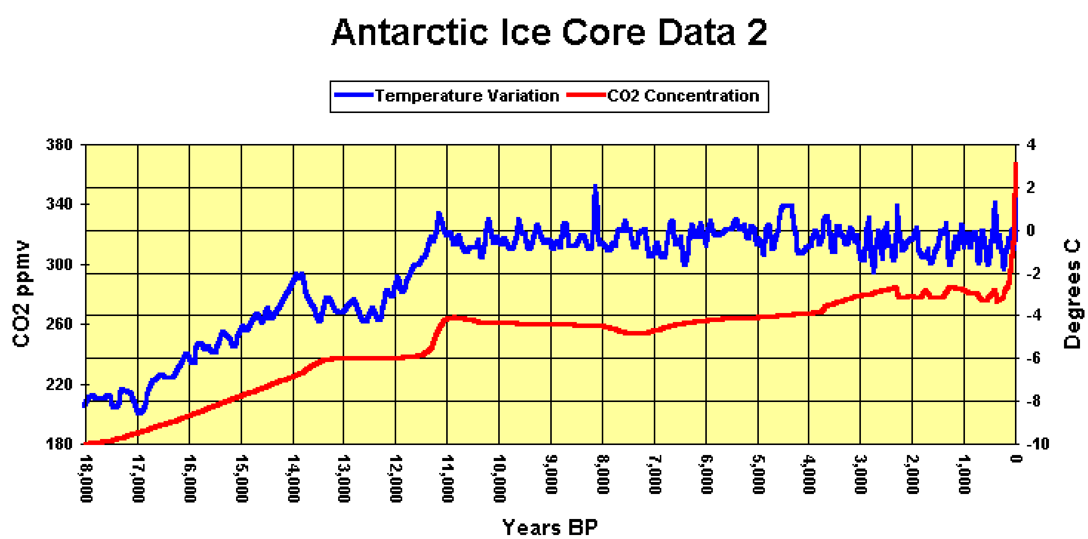
Antarctic Ice Core Data 2
Temperature Variation
CO2 Concentration
CO2 ppmv
Degrees C
Years BP
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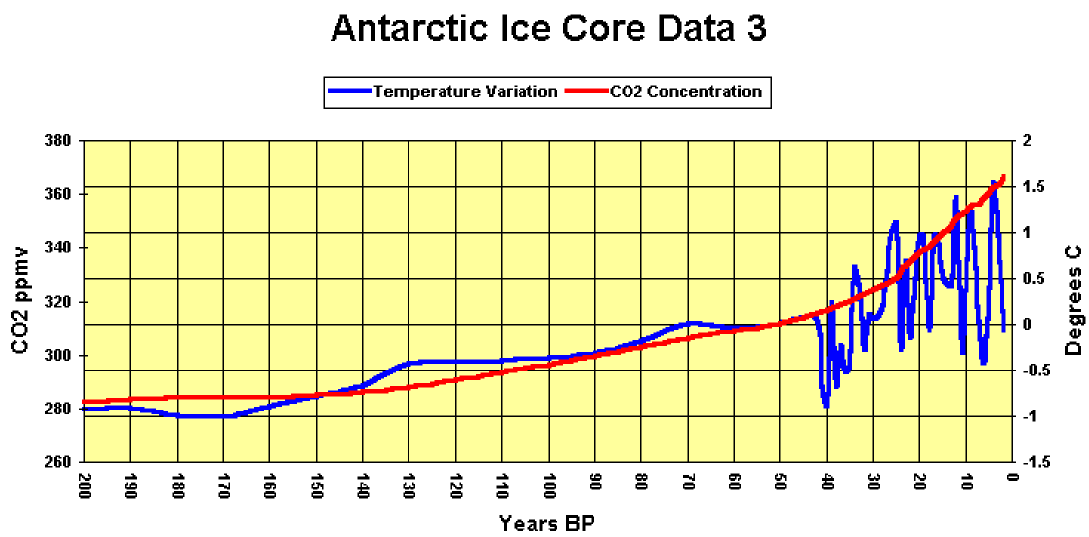
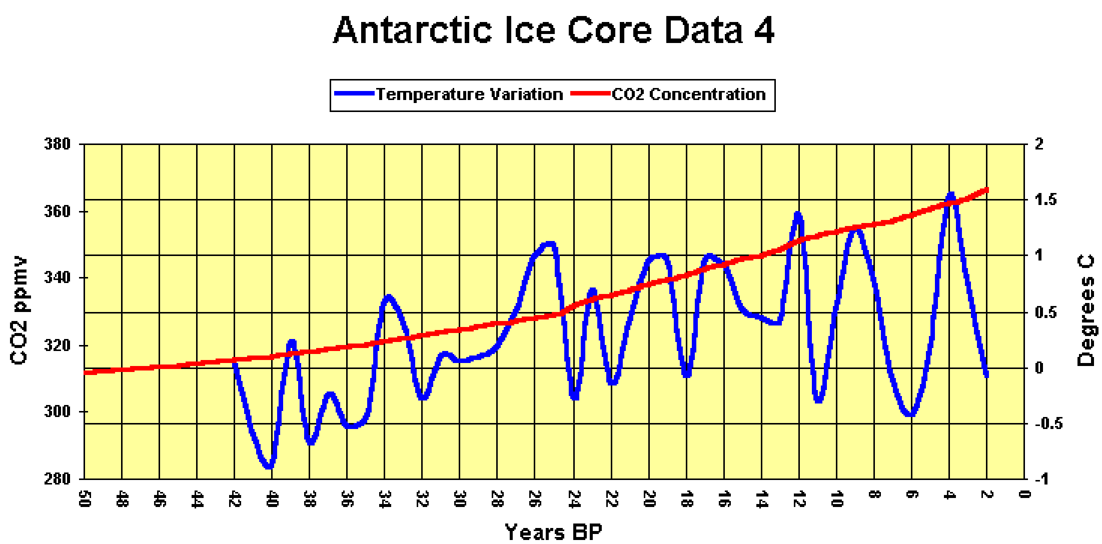




Note: BP refers to Before Present

Ref http://www.daviesand.com/Choices/Precautionary_Planning/New_Data/

Ref http://www.daviesand.com/Choices/Precautionary_Planning/Closer_Look/index.html

Recent Geological past Temperature and Sea Level Variations

Temperature and the resulting climate has varied naturally since the formation of earth.
The average air temperature at sea level has risen and fallen by up to 12 °C since life has evolved on earth.

The most recent northern hemisphere ice sheet started to melt 14,700 years ago and as a result the sea level rose by 130 metres.
Land in Europe, around Scandinavia has risen 340 metres due to the rebound effect in the mantle and crust over the last 14,700 years

The melting of the ice sheets caused the West Antarctic ice sheet to be lifted from the bedrock due to the buoyancy from rising sea level.
7,600 years ago about two thirds of the West Antarctic ice sheet collapsed and produced another 6 metre rise in sea level.
This event was probably the origin of the Sumarian Babylonian and biblical great flood.

Global cooling has occurred between 1300 to 500 BC.

There was a period of global warming around 500 BC which resulted in the earth surface air temperature increasing by 5 °C more than its is today.

Changes in the Atlantic Ocean Gulf Stream flow rate, caused the Medieval warm period between 900 and 1300 AD which allowed the Vikings to colonize Greenland for 300 years.

Volcanic eruptions in 1280 AD on Iceland and a change in ocean currents resulted in the Little Ice Age.
The little Ice Age started around 1560 and ended in 1850 AD.

Human activity has increased on average, the earth surface temperature by 0.8 °C above 32 °C earth average air temperature over the past 100 years.

Computer model projections indicate that average air temperature will rise by between 2 and 6 °C over the next 100 years.
This rate is five to 100 times the rate that nature has taken to increase temperature by 5 °C between 15,000 and 5,000 years ago.
These models underestimate natural long term changes in natural CO_2 cycles that are affected by solar radiation and ocean current circulation that lead to major and mini ice ages.
eg The poleward movement of heat energy is underestimated by 20% by most computer models compared to satellite observations.
The magnitude of the error is up to five times the expected radiation forcing from doubling CO_2 concentrations.

In addition, non linear fluid dynamics systems such as the interaction between the atmosphere and the oceans are very sensitive to initial conditions.
Because the models are non linear, errors in the initial conditions in the models lead to large errors in projected outcomes, such as air temperature.

The heat island effect from cities due to concrete and asphalt acting as heat sink needs to be taken into account, in climate models when calculating average temperature increases at the earth’s surface.
Atmospheric air temperature increases will be overestimated if cities are used as a basis for taking measurements.

Ref The Past is the Key to the Present: Greenhouse and Icehouse over time by Professor Ian Plimer School of Earth Sciences The University of Melbourne.

Ref www.lavoisier.com.au/papers/articles/kininmonthlaunch.html

Glaciers and Ice Sheets

The ratio of oxygen (18 and 16) isotopes in seawater can be used to track the proportion of the world's seawater that is locked up in glaciers and ice sheets.

Water molecules containing the heavier isotope tend to condense and fall as precipitation more readily than molecules containing the lighter isotope.

The water that evaporates from warm oceans and falls as snow on the ice sheets and glaciers is relatively depleted of heavy oxygen.

The larger the ice sheet grow, the higher the proportion of oxygen 18 is present in the seawater and hence in the ocean floor sediments which have calcium carbonate rich single cell marine organisms.

Ocean floor cores, containing single cell marine organisms preserved in calcium carbonate can be used to measure the variation in oxygen isotopes (oxygen 18 and oxygen 16)
and in the amount of ice locked up in glaciers and ice sheets in the past.

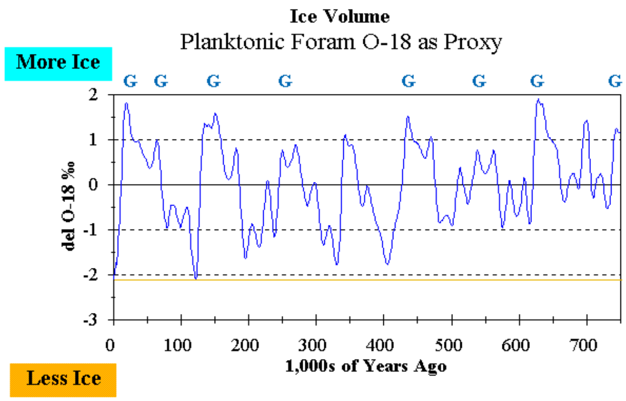
Ref Scientific American January 1990 "What Drives Glacial Cycles ?" page 44

This information can be used to obtain a profile of ice volume over time.

In the 1950's Harold Urey produced the first complete record for the waxing and waning of past ice ages.
See figure below for details.

Over the past 800,000 years the global ice volume has peaked every 100,000 years matching the period of eccentricity variation of the earth's orbit

Isotopes in ocean sediment layers allow reconstruction of past ice sheet growth and decay



16 August 2006 7

Ref “Facts About Climate Change”, William Kininmonth Australasian Climate Research Melbourne Australia

The Greenland ice sheet is currently melting at the rate of 237 cubic kilometers per year, compared to 90 cubic kilometers per year in 1996.
Most of this meltwater originates from ice at around the elevation of sea level.
If the whole of the Greenland ice sheet melted, the sea level would rise by 7 metres. This would be enough to inundate most of the pacific islands and most of Bangladesh.
The Antarctic holds enough ice to raise sea levels by 65 metres if it all melted.

The High plateau ice sheet areas will remain intact within Greenland and Antarctica as the temperature will never reach melting point. It is not possible for the bulk of the ice sheets to melt any time soon.

The Nature of Mini Ice Ages

Even when there is a general global warming trend, it is possible for local ice age events to occur.

In the past there have been snap freezing events such as during the period when mammoths became extinct around 11000 years ago.
Frozen mammoths exhumed recently from the Siberian permafrost were physiologically intact, complete with stomach contents to such an extent that the pollen could be used to identify plant species at the time the animal died.
Mini ice ages in Europe can be caused by reduced flow in Gulf Stream due to fresh water dilution of salt water from glacier and ice sheet meltdown or due to major volcanic eruptions.
The salt water dilution causes the Gulf Stream water conveyor to slow down or to stop altogether, preventing warm water from the tropics reaching the North Atlantic reducing average air temperatures by 5 deg C.
The net result is colder water and air temperatures. The colder temperatures deepen and continue despite high greenhouse gas concentrations left over from the previous interglacial phases.

This occurred during the retreat of the North American ice sheet after the last ice age about 11000 years ago when there was cold spell known as the Younger Dryas. It was caused by meltwater from Lake Agassiz that flowed into the St Lawrence River which diluted the salinity of the North Atlantic.
The water density was reduced to such an extent that the Atlantic conveyor was shut down, stopping warm water from flowing northward.
Europe remained chilled for 1000 years until the meltwater channel was blocked by ice flows near Lake Superior.
The Atlantic conveyor was reactivated and Europe warmed up again.

Currently the gulf stream has slowed down by 30 % due to freshwater dilution from glacier and ice sheet meltdown since 1957.

Ref Scientific American January 1990 “What Drives Glacial Cycles?” page 48

Consequences of Unchecked Natural and Man Made Global Warming

Ecosystem stress from global warming include:-

- 4 million acres of white spruce trees are dead or dying from an infestation of pine beetles in the Kenai Peninsula Alaska.
  Similar damage is taking place in Canadian Rocky Mountains and in Northern USA.

  This damage has been caused by more favorable breeding conditions for the beetles after they survived a series of warmer winters and summers.

- More severe bushfires feeding back more carbon dioxide into the atmosphere.
- Species migration in both latitudinal and uphill direction as temperature increases and finally extinction as suitable land runs out. Over the past 100 years studies have shown that in the Sierra Nevada,
  the tree line has moved 30 metres uphill.
  In the Northern Hemisphere butterflies have shifted their home range northward by 30 to 250 kilometres.

- Habitat destruction such as reduced see ice cover for Arctic Polar Bears.
  The arctic ice sheet is currently 50% thinner and 25% smaller than it was 30 years ago.
  There will be no Arctic polar ice by 2060, if the current trend of global warming continues unabated.

- Global warming is reducing the area covered by sea ice around the Antarctic, this means that less nutrients falls into the water leading to reduced phytoplankton blooms, and fewer krill. Penguin and whale food supply, as a result is compromised resulting in reduced population numbers. In addition, the increased concentration of carbonic acid in the oceans due to dissolved
  carbon dioxide is threatening plankton and coral reefs in general.

- General increase in species extinction due to loss of habitat.
- More coral bleaching incidents in the Pacific Ocean, in conjunction with El Nino events due to higher ocean temperatures.
- Rising stream and river temperatures caused by global warming could drive trout and salmon from many U.S. waterways and elsewhere.

The study which included eight species of fish (four species of trout - brook, cutthroat, rainbow and brown - and four species of salmon - pink, coho, chinook and chum) suggests that the cold water
habitat required by these species could shrink by more than 40 percent over the next century if steps are not taken to curb emissions of greenhouse gases.

Reference :- http://www.ens-newswire.com/ens/may2002/2002-05-22-06.asp

Human Health Consequences:-

- More heat stroke and heart attack deaths during heat waves
- Spread of tropical diseases such as malaria dengue fever, yellow fever, encephalitis
- Reduction in the availability and increased cost of fresh fruit and vegetables.

Weather consequences from global warming include:-

The warming of the oceans will drive weather systems with more energy.
Cold and hot weather extremes can be expected to increase due to the greenhouse effect.
This will result in increased droughts for temperate climate regions as well more severe storms, cyclones and hurricanes with larger accompanying tidal storm surges.
The intensity of El Nino effect in the South Pacific will increase the severity of droughts in Eastern Australia and Indonesia. Recent data seems to indicate that La Nina periods are shorter than they were 10 years ago . La Nina are periods when cooling of the Southern Pacific water occurs around eastern Australia and when rainfall typically intensifies.
This phenomenon will add to the probability of extensive droughts occurring on the Australian Eastern seaboard because the El Nino periods will endure for longer periods of time.
For instance in Australia, overall rainfall has reduced by 25% and there has been up to a 60 % reduction in river flows as a consequence.
The downward trend in rainfall and river flows has been most pronounced in the Perth area of WA.
This in combination with over allocation of water for irrigation has resulted in the current fresh water supply crisis in Australia.
There is now a need to recycle water and build desalination plants in order to make up the fresh water supply shortfall for the urban and rural environment.

***Effect on low lying Coastal communities from global warming include*:-**

Sea level rise due to polar ice melt and ocean water expansion due to temperature rise will force low lying communities to higher ground. There are already problems with sea level rise in the Maldives and some Pacific Islands.
This will add pressure on land resources, food production as well as increase the death toll from tidal storm surges.
There will be a need address the issue of environmental refugees.

Ref Time Magazine April 3, 2006

Measures for Reducing Greenhouse Gas Emissions

- *Promote Energy conservation :-*

    - Insulate existing and new homes
    - use energy efficient electrical household appliances and compact energy efficient fluorescent light bulbs
    - Install solar hot water heaters
    - Promote energy efficient home designs.

- *Power generation from the salt gradient in Solar Ponds*

One way to harness solar energy is through the use of solar ponds. Solar ponds are large-scale energy collectors with integral heat storage for supplying thermal energy.
Convection is suppressed by presence of a salt concentration gradient which increases with depth.
Because convection is suppressed, the trapped (solar) energy can be collected from the pond by using a heat exchanger from the hot brine obtained from the storage zone.
It can be used for various applications, such as process heating, water desalination, refrigeration and power generation.

The largest solar pond in the world is located at Bhuj in India.
The Bhuj Solar Pond is a research, development, and demonstration project. The construction of the 6000 m^2 pond started in 1987 at Kutch Dairy,
Bhuj as a collaborative effort between Gujarat Energy Development Agency, Gujarat Dairy Development Corporation Limited.
The solar pond is 100 m long and 60 m wide and has a depth of 3.5 m and uses 4000 tonnes of common salt.
This facility has been supplying heat for the Kutch Dairy since 1993.

Pilot solar pond plants have been setup in Ein Bokek in Israel and Alice Springs in Australia

Typically in the Australian context, pumps are used to lower the water table in locations where soil has been contaminated by salt, due to irrigation channel seepage or due to lack of tree cover.
The salty water could be pumped into large lakes which take advantage of the storage zone and is separate from the high salt content zone in the lakes in order to offset the cost of the land rehabilitation process.

Solar ponds could be constructed at locations where there is low cost salt and bittern, good supply of sea water or water for filling and flushing, high solar radiation, and availability of land at low cost.

Other naturally high salt concentration locations such as salt pans in South Australia and Western Australia could also be considered to create solar ponds if a regular supply of water could be guaranteed (build pipeline from the coast).

- *Promote Hybrid motor vehicles (gasoline and electric combination)*

  Batteries are used to run an electric motor which runs the vehicle either in parallel or in series with a gasoline combustion engine. The battery is recharged by regenerative braking and while the combustion engine is running.
  The driver can switch between hybrid and fully electric.
  Even though these cars are more expensive to purchase and to maintain, there is up to a 40% increase in fuel efficiency.

- *Develop Hydrogen Fuel Cell vehicles*

  A platinum catalyst splits electrons from hydrogen fuel which can be used to create a electrical circuit to drive the electric motor.
  The hydrogen protons move to the cathode through the electrolyte and react with oxygen from the air intake, and the electrons returning in the external electric circuit that drives the electric motor.
  This electrochemical reaction produces water and heat as byproducts.

If a plasma is used to plate a very thin film, the amount of platinum used is reduced by a factor of five.

It is also possible to produce hydrogen by photosynthetic processes from green algae. The algae absorb sunlight and they split water and produce hydrogen from the water.
Using light and electron microscope, the finest details of the algae's physical make-up can be identified.
By using nuclear magnetic resonance the structure of individual molecules can be probed.
This is helping to identify mutant strains of algae that are particularly good at converting sunlight into hydrogen.
The current process under laboratory conditions is about 2% efficiency, 7% efficiency is needed for this process to be economically viable.

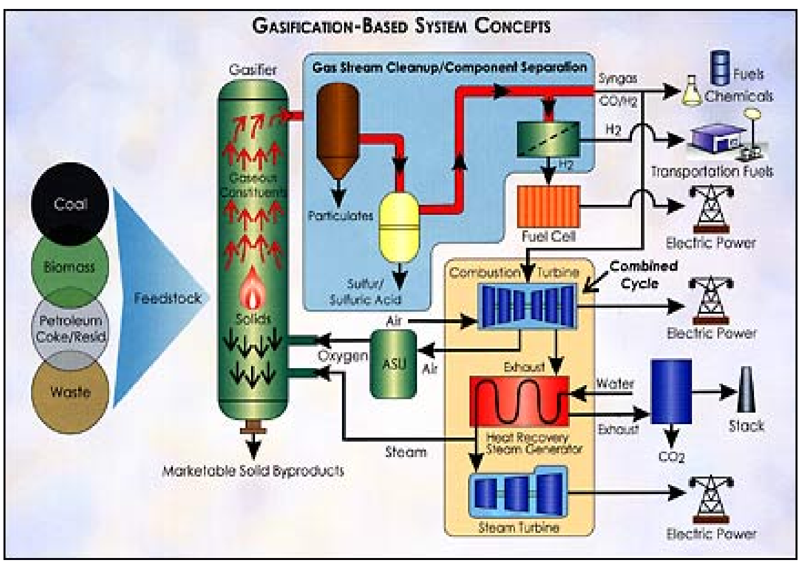
During the last three years a fleet of buses in Perth have been powered by hydrogen as a temporary measure which comes from the local oil refinery , but the side product is carbon dioxide which is released during processing.

The fuel cells used have proven to be very expensive to run.

Ref :-

ABC TV Series Catalyst 05/ 10 / 07

- *Develop Coal gasification technology for coal fired power stations*



The heart of gasification-based systems is the gasifier. A gasifier converts hydrocarbon feedstock into gaseous components by applying heat under pressure in the presence of steam.

A gasifier differs from a combustor in that the amount of air or oxygen available inside the gasifier is carefully controlled so that only a relatively small portion of the fuel burns completely.
This "partial oxidation" process provides the heat. Rather than burning, most of the carbon-containing feedstock is chemically broken apart by the gasifier's heat and pressure, setting into motion chemical reactions that produce "syngas."
Syngas is primarily hydrogen, carbon monoxide and other gaseous constituents, the proportions of which can vary depending upon the conditions in the gasifier and the type of feedstock.

Higher efficiencies mean that less fuel is used to generate the rated power, resulting in better economics (which can mean lower costs to ratepayers) and the release of less greenhouse gases (a 60%-efficient gasification power
plant can cut the release of carbon dioxide by 40% compared to a typical coal combustion plant).

Another advantage of gasification-based energy systems is that when oxygen is used in the gasifier (rather than air), the carbon dioxide produced by the process is in a concentrated gas stream, making it easier and less
expensive to separate and capture. Once the carbon dioxide is captured, it can be sequestered - that is, prevented from escaping to the atmosphere, where it could otherwise potentially contribute to the "greenhouse effect."

Ref : http://www.fe.doe.gov/programs/powersystems/gasification/howgasificationworks.html

- Restrict vehicle use with a congestion tax and provide incentive for industry to transition to alternative to fossil fuel use by imposing a carbon tax

- Promote and use more public transport infrastructure, build more transit busways, use natural gas buses and extend heavy and light rail network

- Promote re-cycling more waste materials such as paper ,cardboard and plastics

- *Set up a market system for trading carbon credits*

After an agreed cap for carbon emissions has been determined, polluters are issued with emission permits for free or by auction. The permit allows the polluter to emit a certain tonnage of carbon dioxide.
If the caped emission is exceeded, additional permits need to be purchased from the carbon Exchange market through a carbon broker.
If the carbon emissions are within Kyoto agreed limits, the surplus can be traded to companies that exceed agreed emission caps.

One of the possible trading systems involves the issuing of carbon credits for afforestation and reforestation activities since 1990 or other technologies such as geosequestration, solar energy, wind turbines etc
that does not add carbon dioxide to the atmosphere.

For instance, farmers currently have little incentive to plant trees to arrest salinity, erosion or soil acidification.
In order to create incentives, a carbon broker can offer up front to pay the farmer to plant trees.
In return, credits are sold to a carbon emitter such as a coal fired power generation company as an offset for its excessive carbon emissions.

The price of carbon in the New South Wales carbon market has halved to $6 a tonne in less than a month due to instability in the market as a result of the federal governments delay in setting new national carbon trading scheme.

140 staff and 100 contractors from the Sydney company "Easy Being Green" have been given there termination notices.
This company distributes low energy light globes and other efficiency devices in return for carbon credit certificates.

Ref ABC Stateline 14/09/07.

- *Bio Mass as Source of Energy*

  It is possible to recycle methane from landfills which are currently leaking into the atmosphere and contributing to global warming.
  Power plants can be built on landfill sites and sewerage farms to capture methane gas.
  Sugar cane fibre, timber , paper and grass can also be used as an energy source.
  Sustainable Bioenergy could meet up to 30% of Australia's energy needs if it was fully developed.

- Preservation of existing forests and rainforests and Increase acreage for new forest plantations

- *Consideration given to using nuclear energy instead of coal fired power stations*

  The safety of new generation nuclear power plants has improved with developments in technology in the last 30 years. Inherently this technology is greenhouse gas free except for the energy required to build the power station, mine the uranium and finally decommission the plant.
  Nuclear power generation produces 3.3 grams of carbon dioxide per kilowatt hour compared to 400 grams for natural gas and 700 grams for coal.
  High cost and long lead time for construction may mean that this possible bridging technology to renewable energy sources is not feasible.

- *Promote natural gas*.

  Australia has abundant natural gas supplies located at North West Shelf, Gippsland Basin and Cooper Basin in Central Australia.
  Natural gas produces about 1/3 less carbon dioxide than petroleum and 45% less carbon dioxide than coal.
  Currently in Australia about 60% of supplies are used for household heating, 30% water heating and 10% for cooking.
  There is great potential for using natural gas to produce electricity more efficiently because waste heat can be reused to generate even more power.

- *Renewables (Solar energy , Hydro power, Wind turbines and Wave power)*

  Solar, wind and wave power generation are renewable and currently under utilized energy sources worldwide.

  Germany, Japan and USA are currently world leaders in large scale industrial and rooftop solar power generation.
  In Australia currently solar panels are most extensively used to supply power for remote telecommunications systems.
  There is great potential to build large scale solar thermal power plants, which contain a large array of mirrors (Heliostats) that track the sun and reflect the rays onto the receiver on top of a central tower.
  Alternatively large arrays of parallel rows of parabolic glass mirror troughs or the Dish System with receivers lining the focus can be used for commercial solar thermal power stations.

  Hydro power is greenhouse gas benign, but can result in the loss of prime agricultural land, loss of archeological sites and loss of endangered flora and fauna habitat.
  In Australia the current extensive drought is limiting how much hydropower can be generated.
  Currently 5% of electrical power generation in Australia originates from hydro power and 1% from all remaining renewable energy sources.

Large scale wind turbines require wind speed of 2.5 to 4 metres per second for effective operation. Wind turbines are difficult to set up for baseload power supply, because of wind speed intermittency.
Spain and Germany are the world leaders in the amount of energy generated by wind turbines.
Large scale wind turbine farms are most feasible in Victoria and South Australia where wind speed is adequate for long periods of time.

Generating energy from wave power is most feasible in Australia, Western Europe and America where average power availability in kw / metre is greatest.
The most promising design so far is the so called Oscillating Water Column.
Rising and falling motion of waves pushes a jet of water inside a narrow chamber similar to a blowhole.
This forces a high speed airflow through a turbine which drives a electrical generator.

- *Provide incentives for transitioning to a Hydrogen fuel cell economy*.

  One way of obtaining hydrogen economically is to extract it from natural gas. This process produces significantly less greenhouse gases than traditional fossil fuels.
  Since Australia has very large supplies of natural gas, the process of hydrogen gas extraction from natural gas should be encouraged.

- *Power from hot rocks deep below the earth's surface*

  Cold water is pumped under high pressure down a wellhead to 3 to 5 km below the earths surface into hot rock. Super heated steam is collected from a return production well, which drives steam
  turbines at the earth's surface. A geological survey is currently near completion in Australia, which will determine the most feasible locations where this technique could be used to generate power.
  The most promising location is the Cooper Basin in South Australia where there are currently plans to build a 40 megawatt power generating station. The economics of these power stations is driven
  by the length of transmission lines which need to be built to the nearest towns and cities and the depth the wells need to drilled into the bedrock.

- Geothermal power from hot springs, boiling mud and geysers near volcanic areas

- *Increase the use of micro power generation within individual households*

  Micro power generation means that each household is independent of the power grid.
  Solar energy panels , wind mills and flowing water in streams where possible could be used to generate power on a small scale within each household.

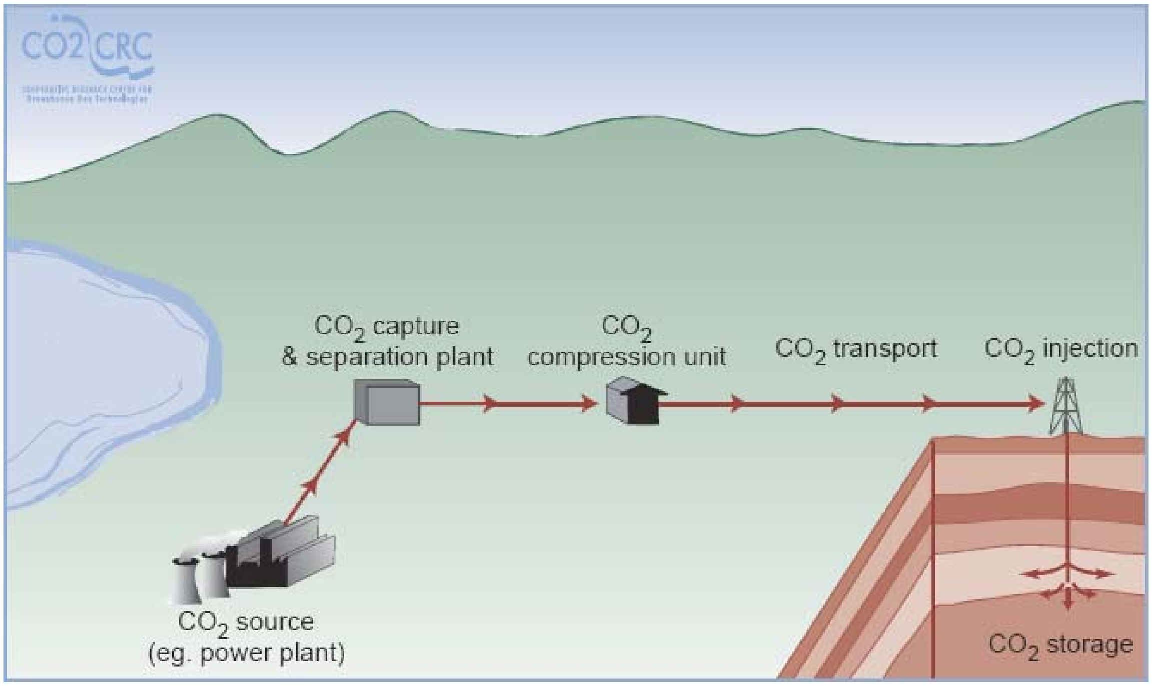
- *Develop Geosequestration technologies*.

This involves:-

- Capturing of CO_2 at the power plant or industrial facility
- Compressing the CO_2
- Transporting the CO_2 gas by pipeline
- Injecting the gas deep underground in a geological reservoir
- Storing the CO_2 in a geological reservoir (old oil and gas underground reservoirs).

The design of existing coal fired power stations will need to be modified to include CO_2 separation and capturing plants. The imposition of a carbon tax would provide incentives for this process to occur.
This technology is used in Norway where CO_2 is separated from North Sea natural gas by the geosequestration process. The CO_2 is stored in underground reservoirs or it can be stored under oceans in large ponds.

Geosequestration Process Details



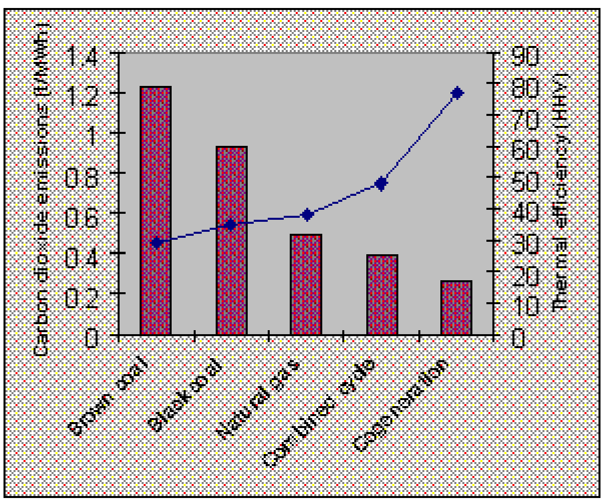
Reference www.co2crc.com.au

Currently slash and burn agriculture results in waste that is burned or left to decay, releasing CO_2.
The use of “Biochar” or charcoal made from agricultural waste that is burned inside kilns, sequesters carbon for centuries and increases soil fertility.
It would be possible to reduce CO_2 emissions by 8ppm in a period of about fifty years.

Reference www.sciamEarth3.com page 67

- <u>Cogeneration- the Combined Heat and Electrical Power Generation</u>

Conventional power plants emit heat, created as a by-product of electricity generation into the environment through cooling towers, flue gas, or by other means.
Cogeneration is the simultaneous production of extra electricity from waste heat, usually using natural gas as a fuel.
These systems compete with electricity provided from large-scale power stations, with the advantage that extensive high voltage transmission networks are not required, because the plants are located near the end user.
Cogeneration achieves greater efficiencies, between 50 and 70 % compared to 33% for traditional generation methods because waste heat is harnessed with the resultant reduction of up to 50% in CO_2 emissions.
Australia has been relatively slow in the adoption of this technology compared to European countries such as England, Germany, the Netherlands, Denmark and Finland.
Denmark currently obtains about 55% of its energy from cogeneration and waste heat recovery.



Electricity Generation Efficiencies

Ref:- http://www.aph.gov.au/LIBRARY/Pubs/RN/1998-99/99rn21.htm

Conclusion

Politicizing climatology and science in general has to be avoided at all costs. Powerful vested interest groups have tried to lobby governments in an effort to maintain the status quo.

A conservative approach is needed, when man made and natural causes are considered in the current greenhouse warming situation on planet earth, and the government response that is needed for policy changes
that encourage the reduction in greenhouse gas emissions.

Since 1976 there has been a 0.4 $^{\circ}$ C increase in average temperature on the earth's surface, in line with carbon dioxide concentration increases.
There may have been long term natural climate variation which also contributed to this temperature increase.

Current long term climate forecasting computer models are based on radiation forcing as a primary mechanism. These models forecast 2 to 6 $^{\circ}$C increase over the next 100 years.

The statistical confidence level is greater than 90%, that global warming is due to increased anthropogenic (man made) greenhouse gas concentrations in the atmosphere.

The rate of change of carbon dioxide increase from anthropogenic (manmade) activity, is greater than at any time in the planets past, when compared to natural variations using ice core records.

The IPCC's summary report showed that greenhouse gases were about 13 times more effective than solar radiation for increasing global temperatures.

The fourth IPCC report concludes that if we don't act within the next decade, the overall costs will be equivalent to losing 5 to 20% of global GDP.

It is prudent to consider implementing the measures for reducing greenhouse gas emissions detailed in this paper and err on the side of caution in relation to the issue of climate change.
There is great need to transition towards sustainable renewable energy sources within the next 5 to 10 years in order to cap the growth of greenhouse gas emissions.
This is possible if incentives are provided for ETS (emissions trading scheme) or a carbon tax is legislated by the Federal Government.

The Australian Labor Federal Government has agreed to establish national emissions trading system by 2012.
Australia has committed to 60% reduction of CO_2 emissions by 2050 relative to 2000.
The Australian Greens have set an emission reduction target of 30% below 1990 levels by 2020 and 80% by 2050.

The European Union has committed to 20% reduction from 1990 levels by 2020 and 60-80% reduction by 2050.
China has committed to 20% reduction below 2005 by 2010.
Developing countries would need to keep 2020 emissions to what they were in 2005 in order to meet the targeted stabilizing level of 450 ppm of CO_2 in the atmosphere

The current economic downturn may delay the implementation of the agreed carbon emission reduction targets.