Sustainability Big Issues

3 Big Global Sustainability Issues

Supply of:

- **Energy**
- **Water**
- **Food**

They are interlinked and exacerbated by Climate Change

- Energy and Climate Change (John Fitzpatrick)
- Fresh Water Resources (Debbie Chapman)

This week: Unsustainable societal construct

November: Moving to a sustainable societal construct

Energy and Climate Change

Presentation Content – This Week

Unsustainable societal construct

1. **Current unsustainable energy situation**
2. **Global warming and climate change**

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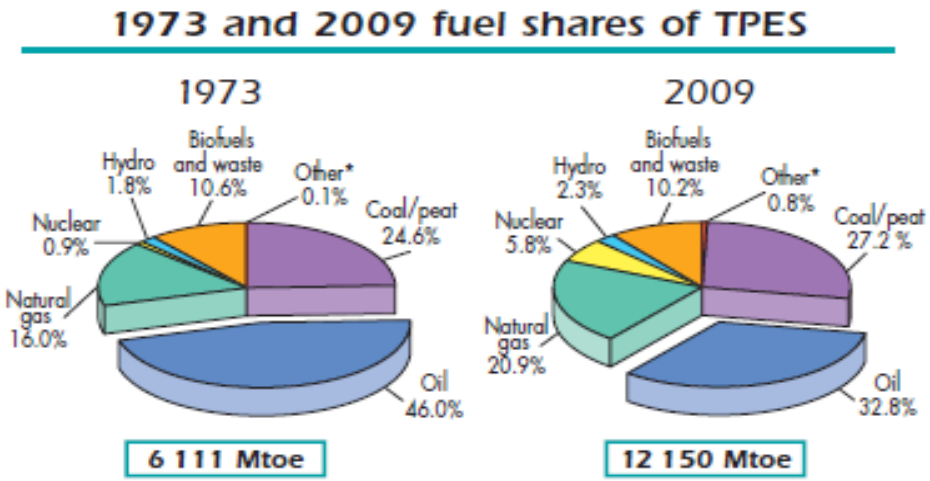
1. Our Current Unsustainable Energy Situation

Our current unsustainable energy situation

Some Energy Numbers – International Energy Agency (IEA) Data

Global Total Primary Energy Supply (TPES)



*Other includes geothermal, solar, wind, heat, etc.

86.6% fossil fuels 80.9%

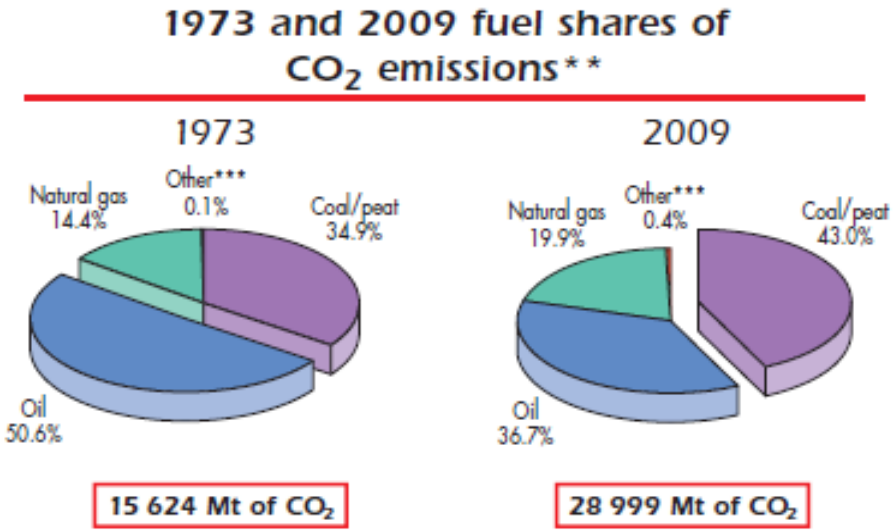
Mtoe: million tonnes of oil equivalent

Over 12 billion tonnes of oil equiv.

Really HUGE number, & nearly 81% fossil fuels

Our current unsustainable energy situation

Global CO_2 emissions from energy (IEA data)



*World includes international aviation and international marine bunkers.
**Calculated using the IEA's energy balances and the Revised 1996 IPCC Guidelines. CO_2 emissions are from fuel combustion only. ***Other includes industrial waste and non-renewable municipal waste.

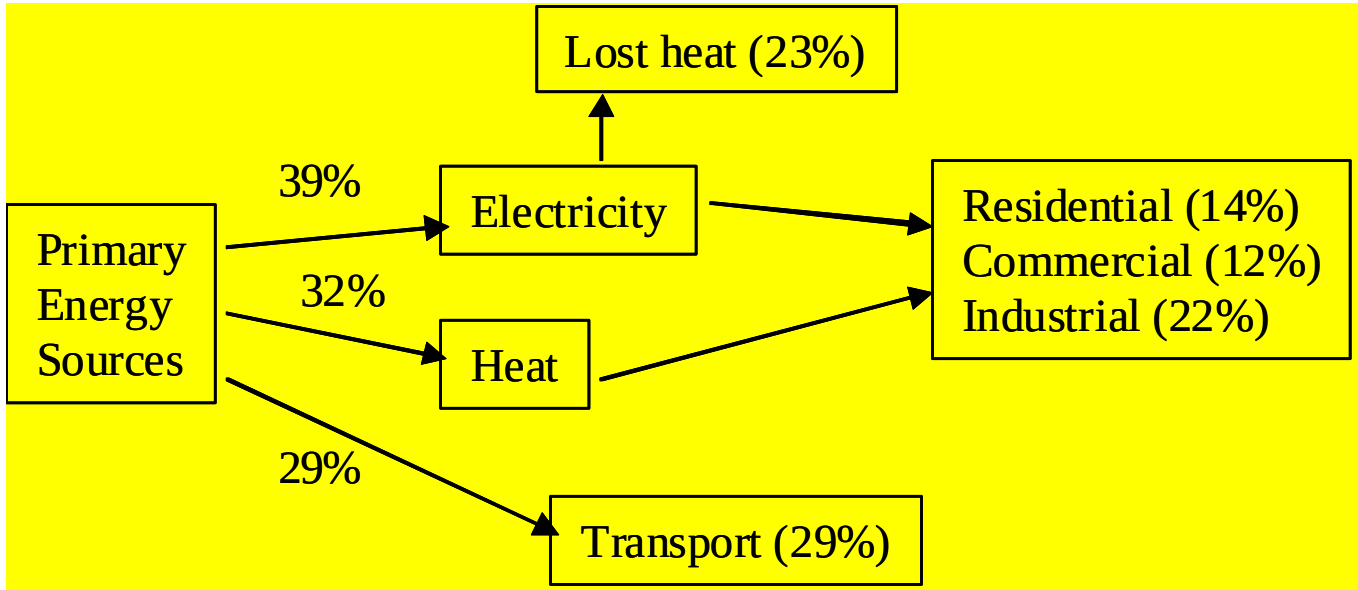
2009- 99.6% coming from fossil fuels

About **29 billion tonnes of CO_2**

Another really **HUGE** number, & nearly **all from fossil fuels**

Our current unsustainable energy situation

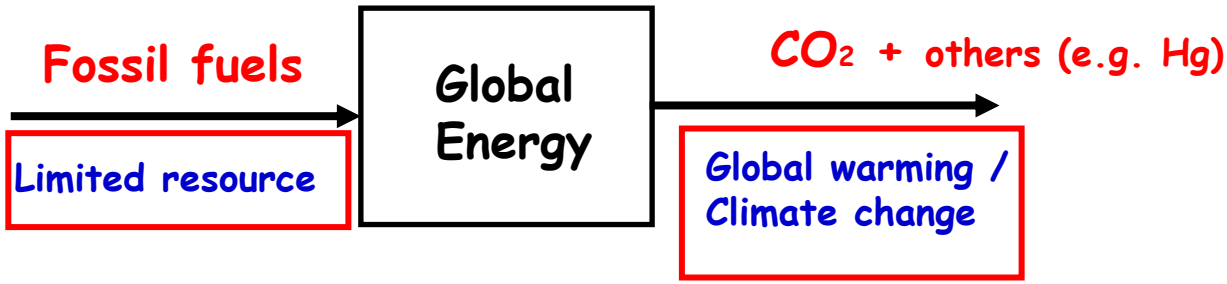
Breakdown of where primary energy goes:



81% Fossil fuels

Our current unsustainable energy situation

Our big current energy unsustainability
~ 81% fossil fuels



Our current unsustainable energy situation

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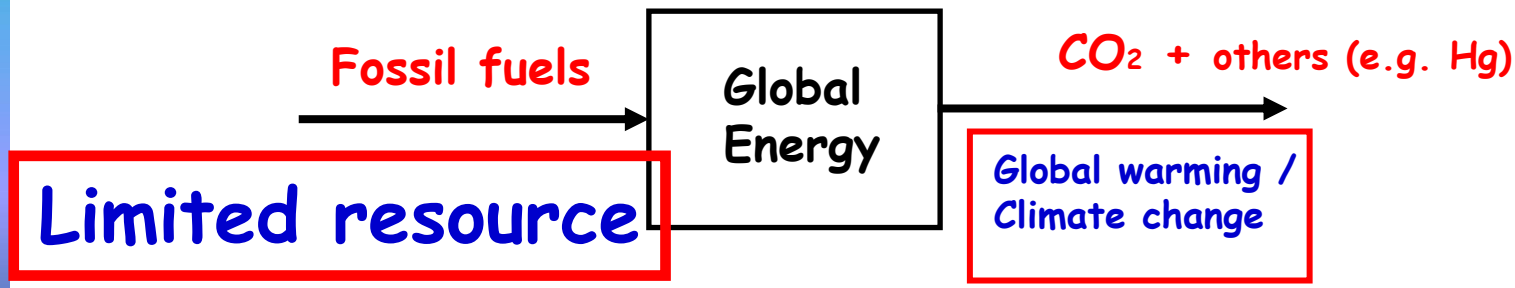


Limited Resource – Fossil fuels

billion

Region	Fossil fuel reserve (giga tonnes of oil equivalent)				Fossil fuel reserve (%)			
	Oil	Coal	Gas	Sum	Oil	Coal	Gas	Sum
North America	8	170	7	185	0.86	18.20	0.75	19.81
South America	15	13	6	34	1.61	1.39	0.64	3.64
Europe	2	40	5	47	0.21	4.28	0.54	5.03
Africa	16	34	13	63	1.71	3.64	1.39	6.75
Russia	18	152	52	222	1.93	16.27	5.57	23.77
Middle East	101	0	66	167	10.81	0.00	7.07	17.88
India	1	62	1	64	0.11	6.64	0.11	6.85
China	2	76	2	80	0.21	8.14	0.21	8.57
Australia and East Asia	2	60	10	72	0.21	6.42	1.07	7.71
Total	165	607	162	934	17.67	64.99	17.34	100.00

[*Source*: WCI (2007) and BP (2006)]

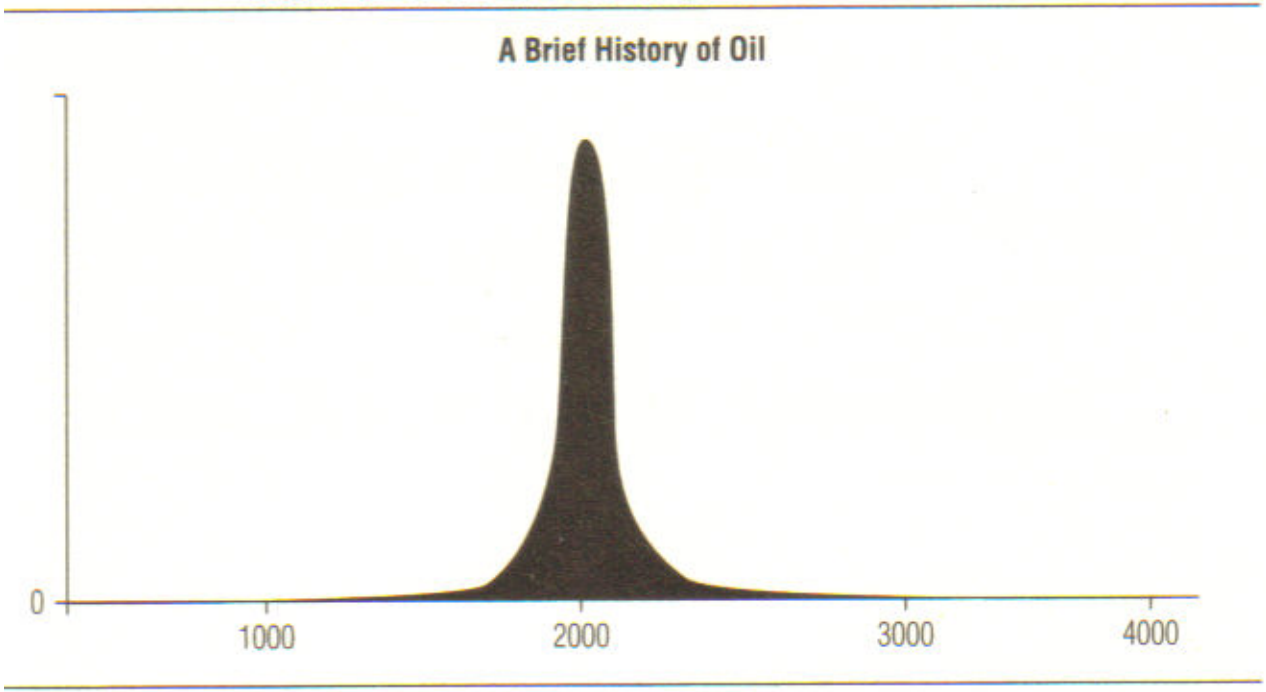
Table 1. Location of the world's main fossil fuel reserves in 2006

934 / 12*(0.81) = 100 years

Limited Resource – Fossil fuels

Fossil fuels are totally unsustainable because they are a limited resource that will be exhausted; it is only a matter of time.

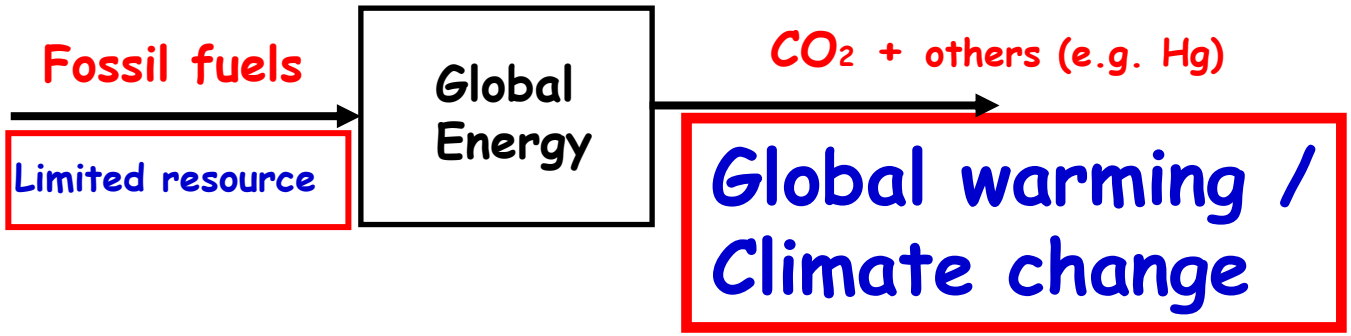
Figure 16.10
Global Oil Production on a 4,000-Year Timeline



Around 30 – 50 years of oil left

Our current unsustainable energy situation

Our big current energy unsustainability
~ 81% fossil fuels



2. Global Warming & Climate Change

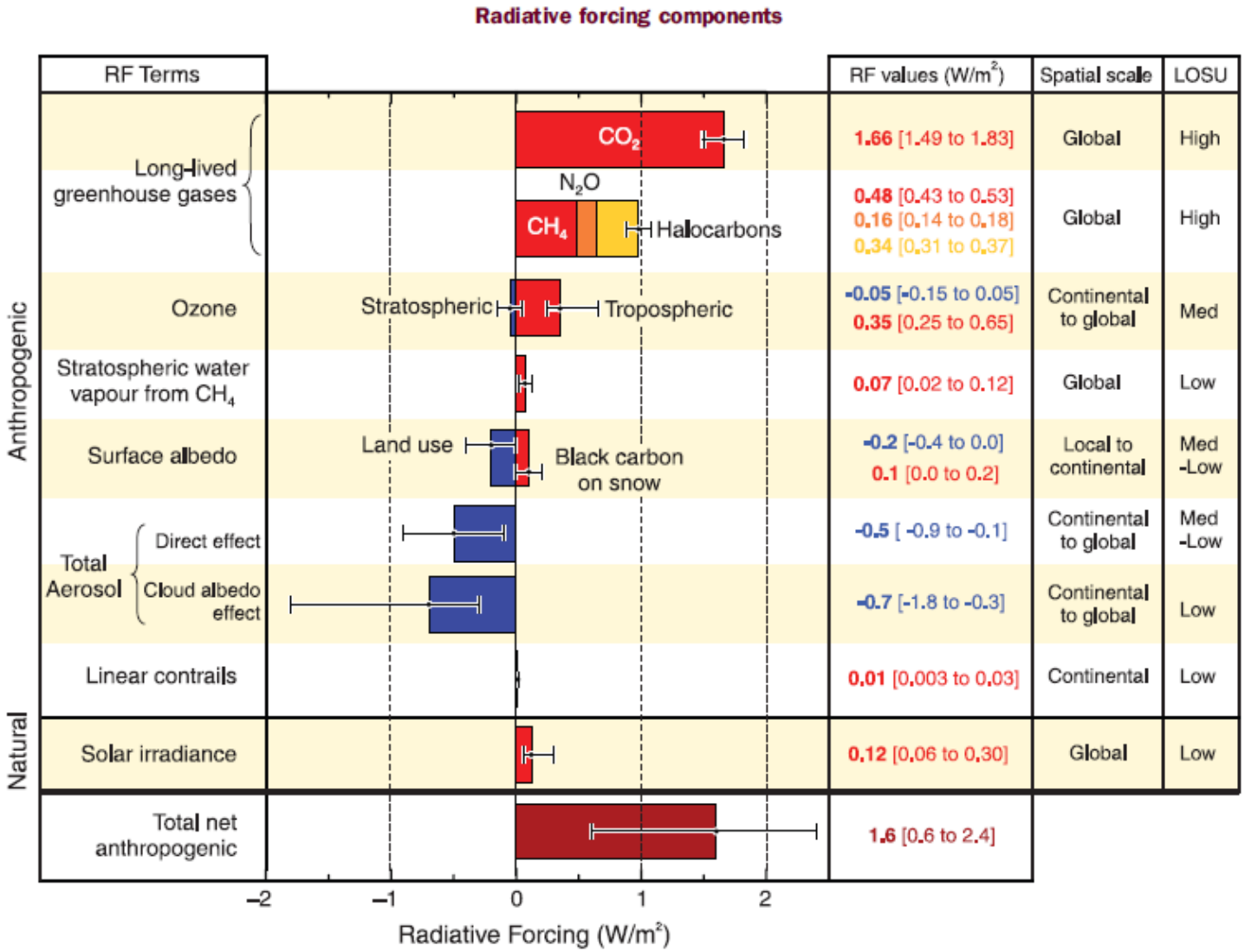
Global warming and climate change

Climate change is possibly **the big worry**, as the market still has time to react to fossil fuel resource depletion.

Global warming causes climate change, not just in terms of temperature change, but also precipitation change, rising sea levels, changes in extreme weather events.

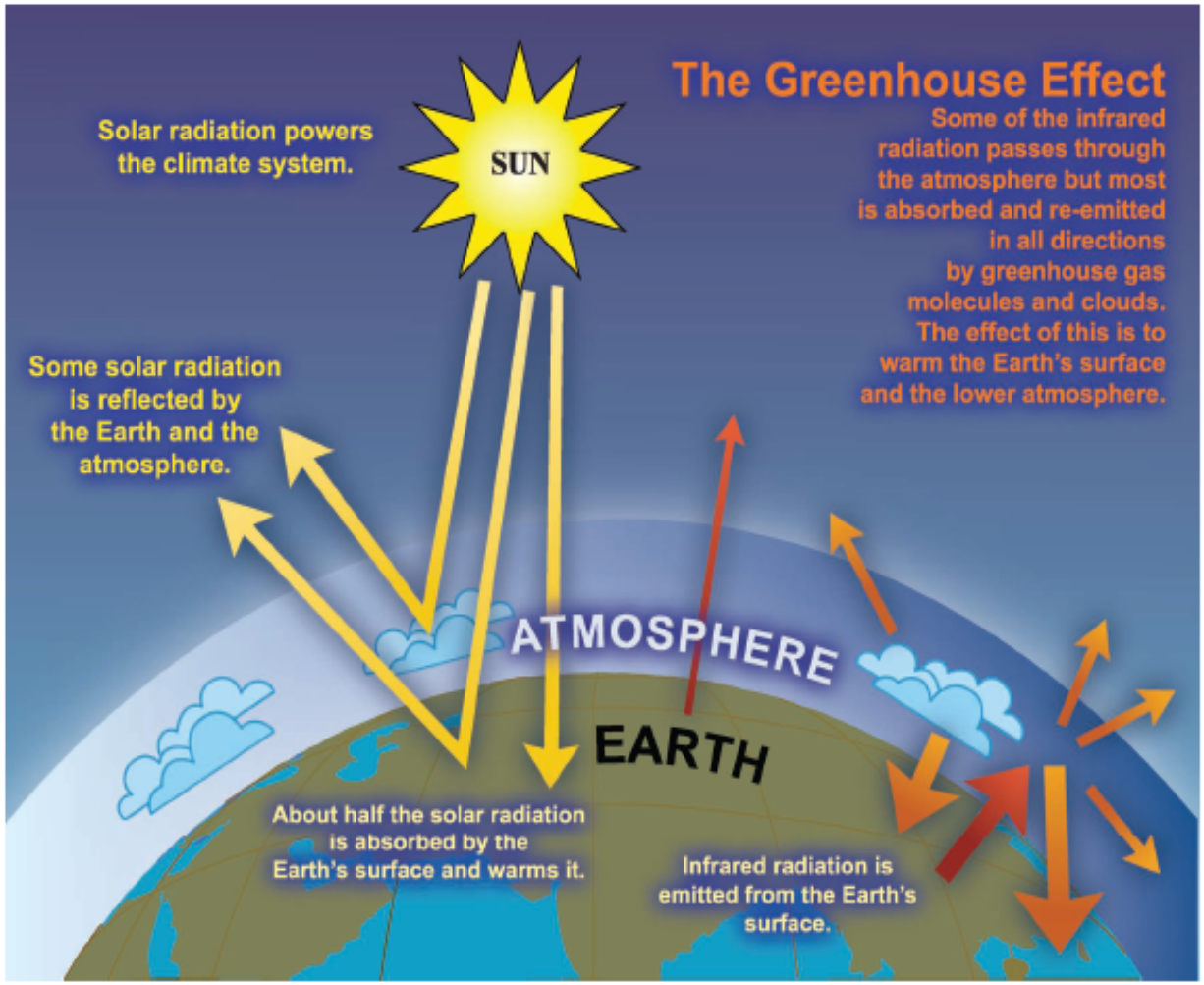
Greenhouse gases, such as CO_2, methane and nitrous oxide cause global warming through the greenhouse gas effect.

Factors contributing to global warming (IPCC)



IPCC – Intergovernmental Panel on Climate Change

Greenhouse gas effect and global warming

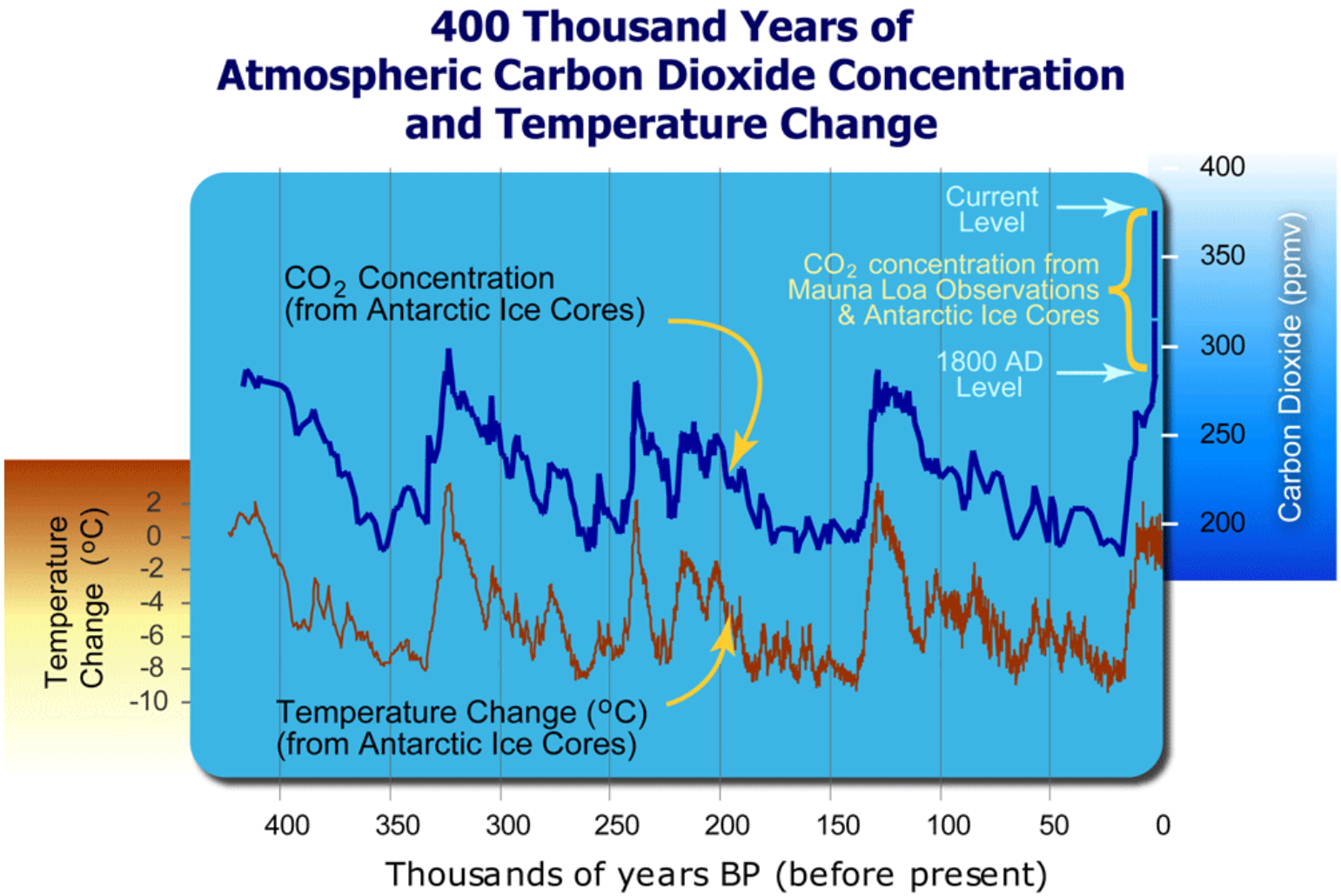


(IPCC)

CO_2 is a greenhouse gas molecule (this is well-known scientifically), thus increasing CO_2 leads to increased global average temperatures

Some evidence for CO_2 – Temperature relationship

Carbon Dioxide vs Temperature over thousands of years



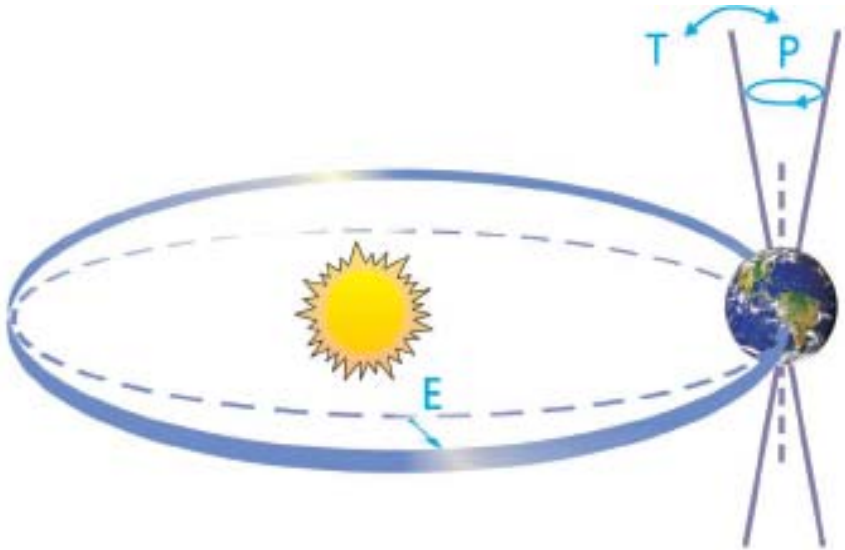
Data Source CO2: ftp://cdiac.ornl.gov/pub/trends/co2/vostok.icecore.co2
Data Source Temp: http://cdiac.esd.ornl.gov/ftp/trends/temp/vostok/vostok.1999.temp.dat

Graphic: Michael Ernst, The Woods Hole Research Center

The natural variation in temperature and CO_2

There is evidence to show over the last 700,000 years that there is a natural cycle that occurs every 100,000 years,
where CO_2 varies from 180 ppm to 300 ppm ~ change of 120 ppm
and temperature correspondingly varies by about 6 C

The reason for this is caused by the elliptical orbit of the earth around the sun which varies the intensity of solar radiation hitting earth, however the effect is greatly amplified by earth processes causing variations in greenhouse gases



FAQ 6.1, Figure 1. *Schematic of the Earth's orbital changes (Milankovitch cycles) that drive the ice age cycles. 'T' denotes changes in the tilt (or obliquity) of*

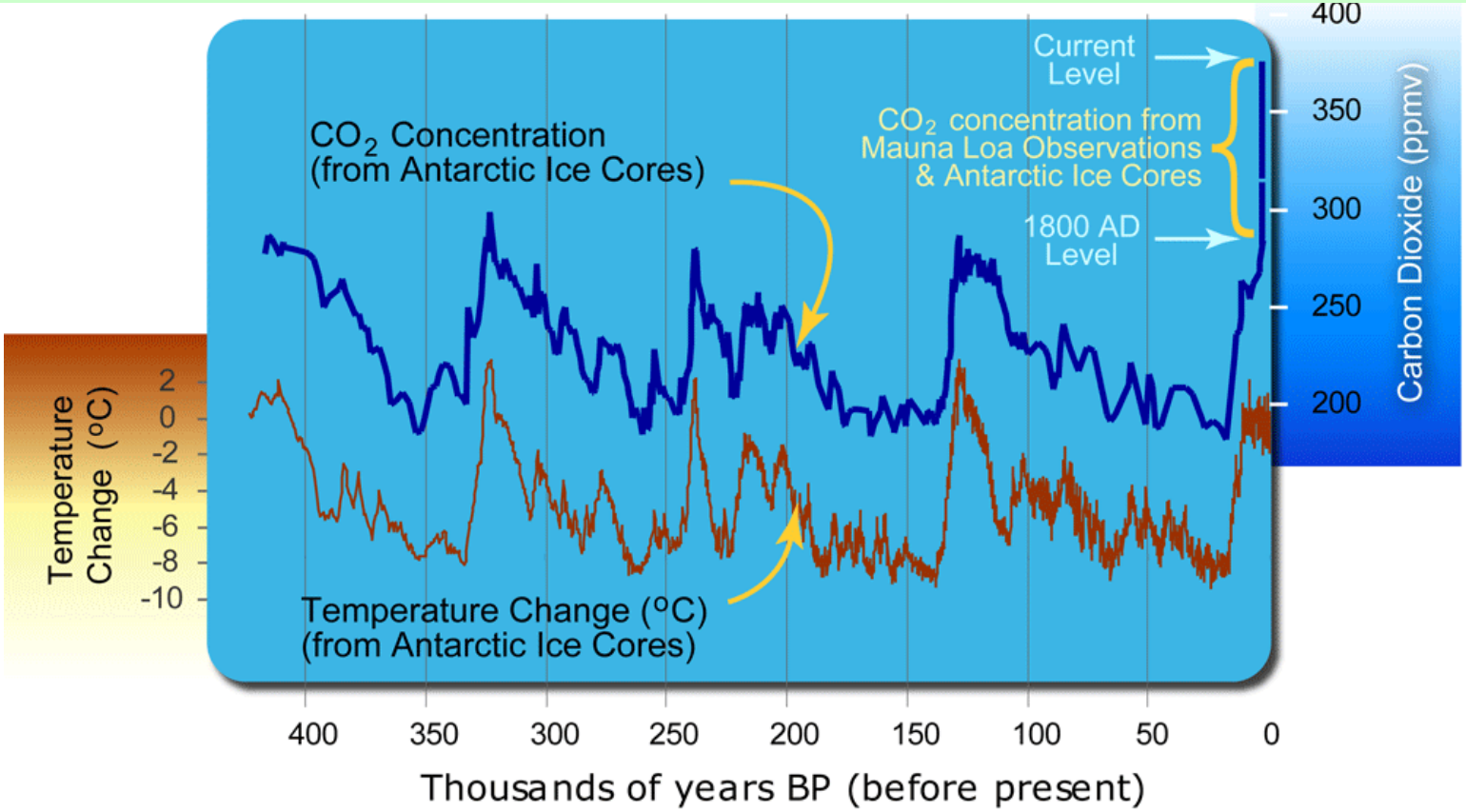
(IPCC)

The last 10,000 years before 1750

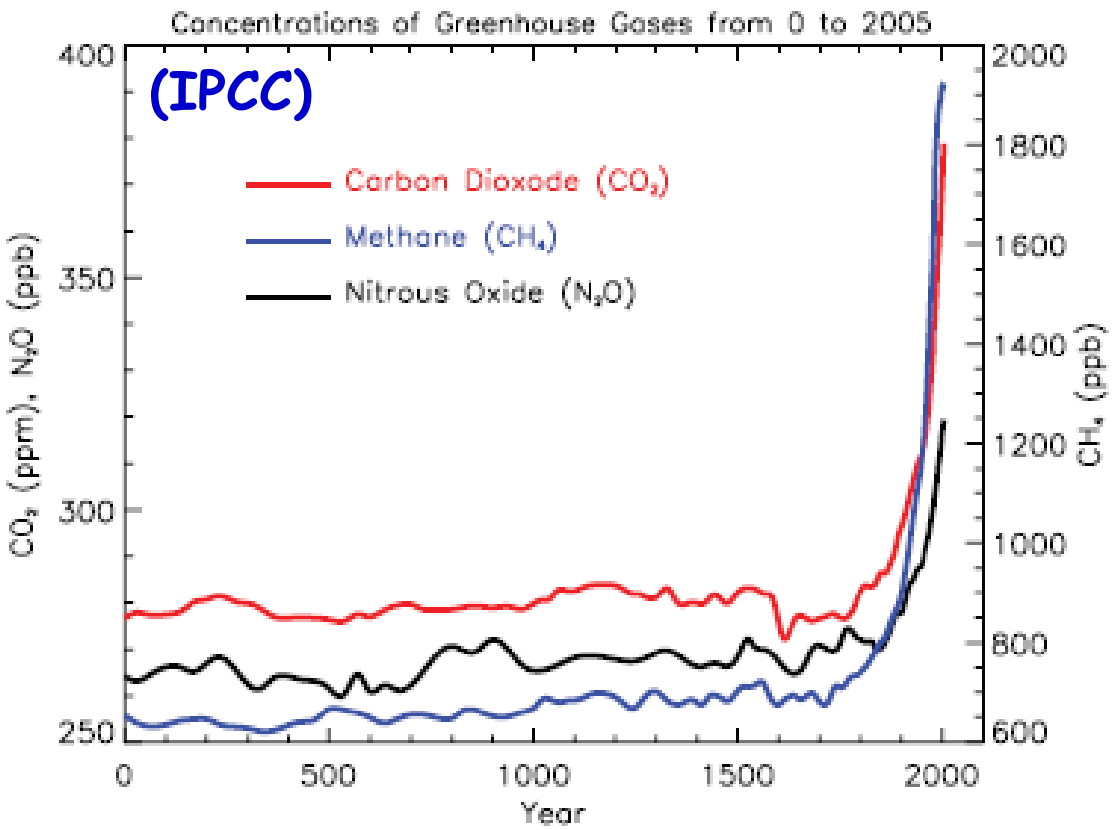
In Geological time, we are in a warm period or interglacial

Before the industrial revolution ~ 1750, Global CO_2 ~ 260 - 280 ppm and was at that level for the last 10,000 years.

Thus, we have had a nice stable climate over this period.



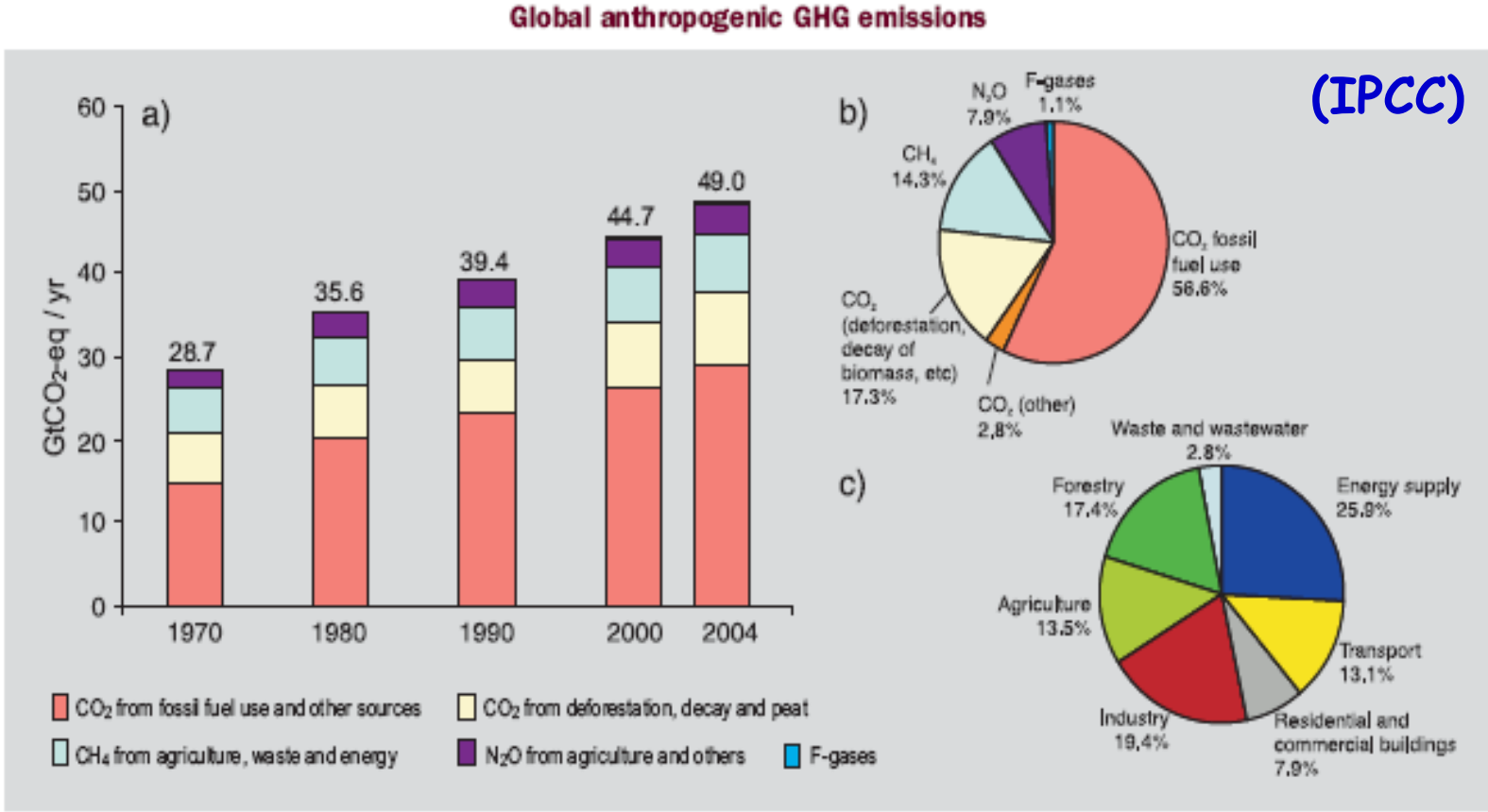
What has happened since? – Lets look at GHGs



Well, GHG concs. have greatly increased, especially CO2

We have gone from
280 ppm in 1750 to
392 ppm in 2011

What has happened since? – Lets look at GHGs



Note:

- GHG from fossil fuel combustion is not the only source.
- Methane and nitrous oxide from agriculture are significant.
- Also CO2 from burning forests.

GHGs – CO_2 equivalents - CO_2 e

CO_2 is not the only GHG, there are others,
including methane which is about 25 times stronger than CO_2
So, methane has a CO_2 e of around 25..

Kyoto protocol GHGs: CO_2, CH_4, N_2O, HFCs, PFCs & SF_6
Montreal protocol GHGs: CFCs, HCFCs & CH_3CCl_3
Other warming / cooling agents: ozone, water vapour and aerosols

In 2009: [European Environmental Agency data]

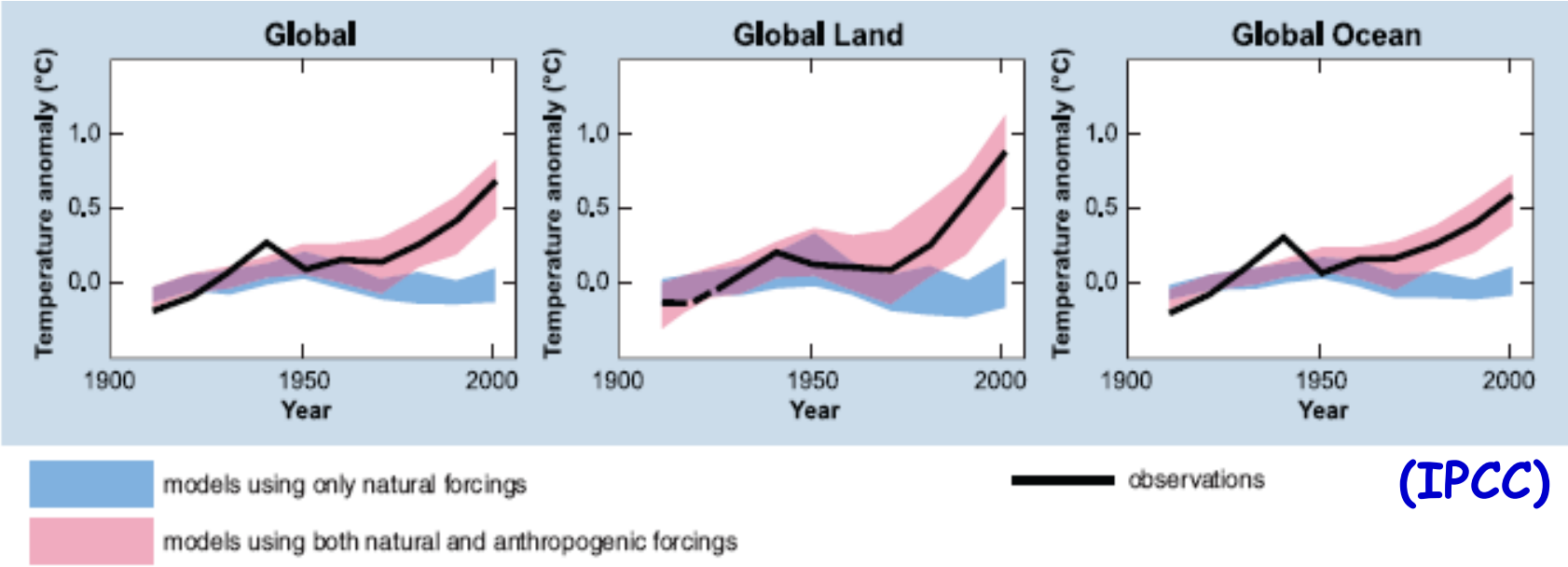
CO_2 ~ 388 ppm

CO_2 e [Kyoto protocol gases] ~ 439 ppm

CO_2 e [Kyoto + Montreal gases] ~ 461 ppm

CO_2 e [Kyoto + Montreal + Other] ~ 399 ppm

Evidence of climate change – Lets look at Temperature



(IPCC)

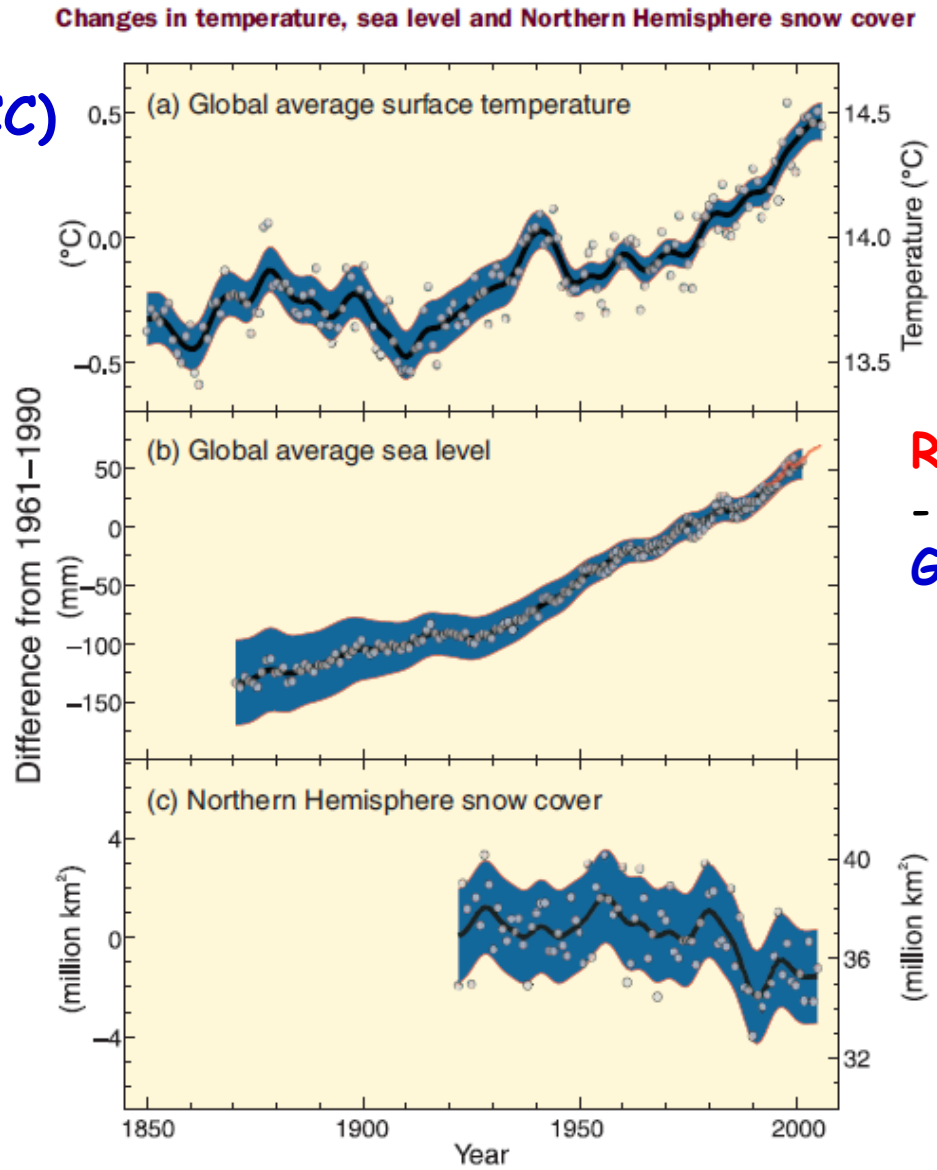
Global average temps have increased by about 0.8 C since 1750

Also, beware, there is a time lag, thus temp will increase further even if there are no more emissions.

It is reckoned that CO_2 e:
- 350 ppm gives 1 C increase
- 450 ppm gives 2 C increase

More evidence & Impacts of global warming

(IPCC)



Heat stress
- Affect on agriculture
- Biodiversity loss

Rising sea levels
- Coastal flooding

Good global warming indicator

Melting of ice / glaciers
- Affect on water supply / agriculture

Artic ice as the "canary in the coal mine"

Accelerated climate change & tipping points

One example is:

Thawing of the permafrost in Thundra & Siberia

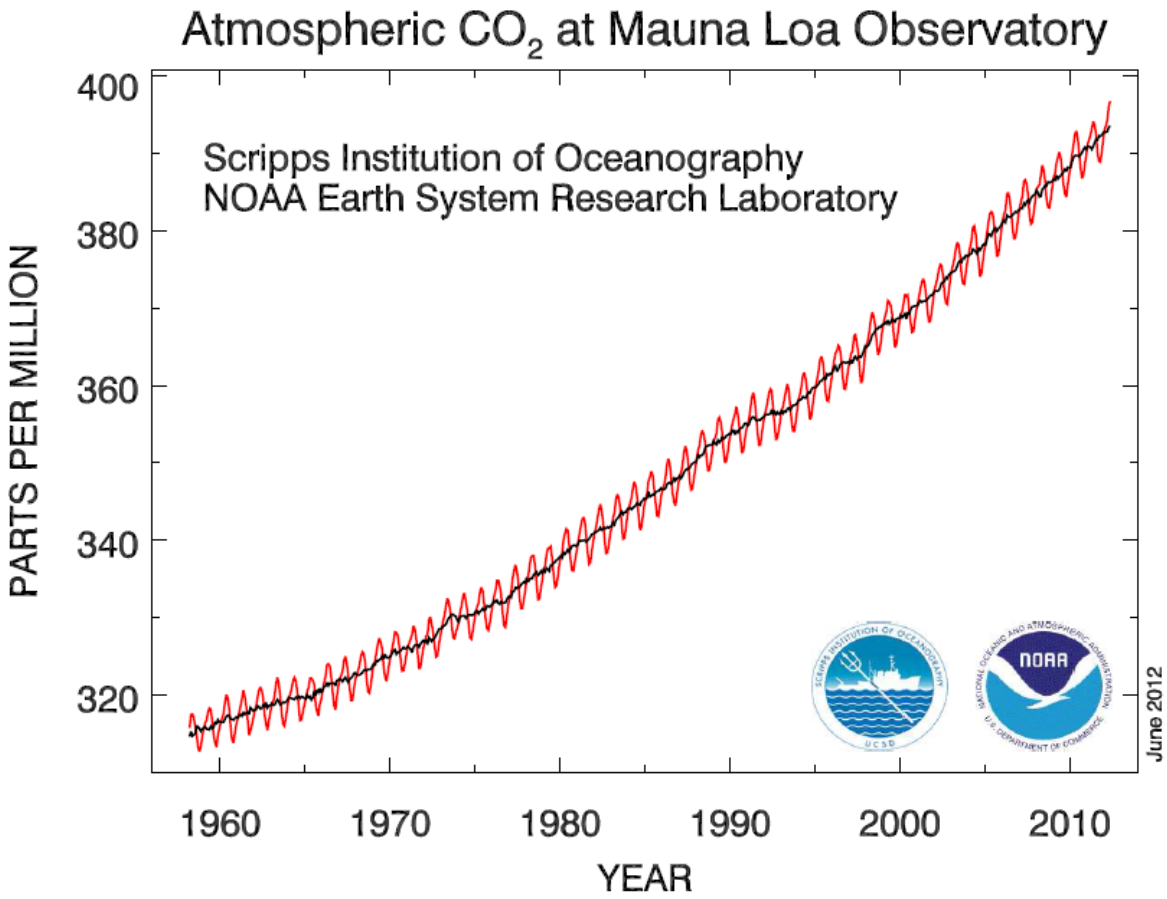
Permafrost is frozen ground that is a storehouse of frozen carbon, locked up in the form of leaves, roots and other organic matter trapped in icy soil.

When thawed, it can produce methane and CO_2,
that warms the planet, which can cause further thawing of permafrost, which leads to more methane and CO_2 release, which can cause more warming, etc….and the warming accelerates.

When the global temperature exceeds a "tipping point" temperature, then sufficient permafrost melting occurs to initiate this accelerated warming effect.

This is a real worry, because there is a lot of frozen carbon there. This has the potential to lead to accelerated global warming and climate change.

Rate of increase of global CO_2 concentration



Year	CO2 [ppm]
1960	317
2000	369.52
2001	371.13
2002	373.22
2003	375.77
2004	377.49
2005	379.80
2006	381.90
2007	383.76
2008	385.59
2009	387.38
2010	389.78
2011	391.57

Global CO_2 conc.increasing at about 2 ppm / year

What CO_2 conc. should we NOT go above ??

Many scientists have written about definitely not going above **450 ppm** or else encounter seriously dangerous climate change.

However, more recently, some renowned climate scientists, including Jim Hansen NASA, state we need to get back below **350 ppm**

Where are we now?

450 ppm

392 ppm – 2011

350 ppm

317 ppm - 1960

280 ppm - 1750

How many years to get to 450 ppm?

Overly simplified calculation:

(450 – 392) / 2 = 29 years

The year 2040

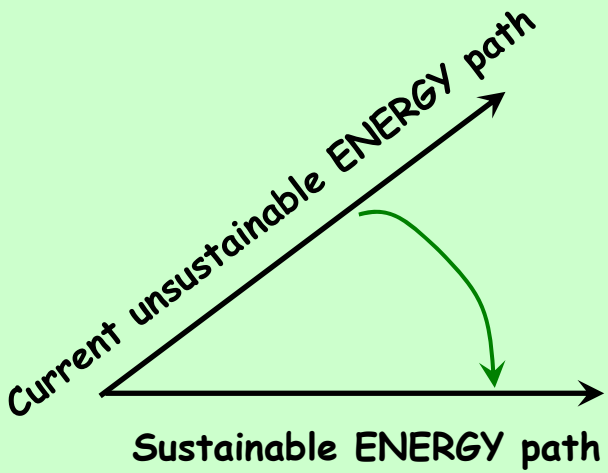
What do we need to do to avoid serious climate change?

- Well, definitely do not go above 450 ppm CO_2
- Try to get back below 350 ppm!
- Remember, we had a very nice climate for 10,000 years at 270 ppm

How do we avoid serious climate change?

- Kick the "fossil fuel habit"
- Prevent agricultural emissions of methane and nitrous oxide
- Stop burning forests

Next Time



The Move:
- How? Technological, Economic ..
- Issues & barriers
- What will happen?

Energy and Climate Change

Presentation Content – Next Time

Moving to a sustainable societal construct

3. The Move: A planned approach

4. The Move: Technological perspective

5. The Move: Economic & Social perspective

6. What will happen?