Explanation of the objectives of the symposium

(Summary : Translated by Secretariat)
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1. Current Situation

(1) Mechanism of global warming (more accurately, climate warming)

The incoming solar light energy turns into thermal energy. This thermal energy will be absorbed by the CO_2 and methane existing in the atmosphere. This process will rise the temperature of the atmosphere, and we will live in a warm environment.

In the last 200 years, global mean temperatures have been rising and the appreciation rate has also been escalating.

Although the balance of incoming light energy and outgoing thermal energy has not changed much, the temperature in the stratosphere, has been lowering.

Global warming does not mean temperature rise of the earth itself but that of the earth's surface and the troposphere. Therefore we should better call it climate warming.

The main cause of global warming is CO_2 concentration in the atmosphere due to mass consumption of fossil fuels. Intergovernmental Panel on Climate Change (IPCC) stated in its report that the net effect of human activity has been one of global warming causes.

(2) The Industrial Revolution was the turning point

Since the Industrial Revolution, we have been almost totally dependent on fossil fuels including coal and oil, and developed an artificial system apart from the natural circulation. Only 200 years later from the revolution, we have consumed fossil fuels massively, increased CO_2 concentration and greenhouse effect, and caused global warming. If the present behavior continues, human society will collapse.

(3) CO_2 emissions, accumulation in the atmosphere and its concentration

Since the Industrial Revolution, 2 trillion tons of CO_2 has been emitted, 60% of which has been absorbed by vegetation and the sea. The remaining 800 billion tons of CO_2 has accumulated in the atmosphere.

CO_2 concentration increased from 280 ppm before the revolution to a present 380 ppm by 100 ppm. The increase by 1 ppm is equal to 8 billion tons of CO_2 accumulation.

(4) Global energy demand and prospect of CO_2 emission

According to *World Energy Outlook 2006* published by the International Energy Agency (IEA), there

will be a 50% increase in world energy demand by 2030. 70% of the demand will come from developing countries and the rest 30% from China.

Increase of production in energy intensive industry such as steel and cement and wider use of automobiles have accelerated this trend.

From progress of electrification and increase of coal fired power plants, CO_2 emissions will increase by 55%, from 28 billion tons (2004) to 40 billion tons (2030).

2. Where should we start looking at the greenhouse gas concentration?

If we keep a level double that of the Industrial Revolution, mean surface temperature rise will be in the range of 2 to 4.5℃, although best estimate is about 3℃. Temperature rise up to 2℃ would be safe without serious hazardous impacts. Needless to say, we should keep CO_2 equivalent concentration as low as possible.

3. Global Warming Mitigation Strategies

Although energy saving and shift to low CO_2-emitting fuels are effective, CO_2 emissions will increase as long as we depend on fossil fuels. In addition to development in CO_2 capture and storage, we should promote renewable energy such as solar, wind and biomass energy. To achieve this, we should set a high target for the expansion of renewable energy use and apply financial incentives such as feed-in tariff and investment tax reduction.

Translated by Secretariat

Toward the Mitigation of Global Warming

February 14, 2008

Director, IGES Kansai Research Center
Yutaka Suzuki

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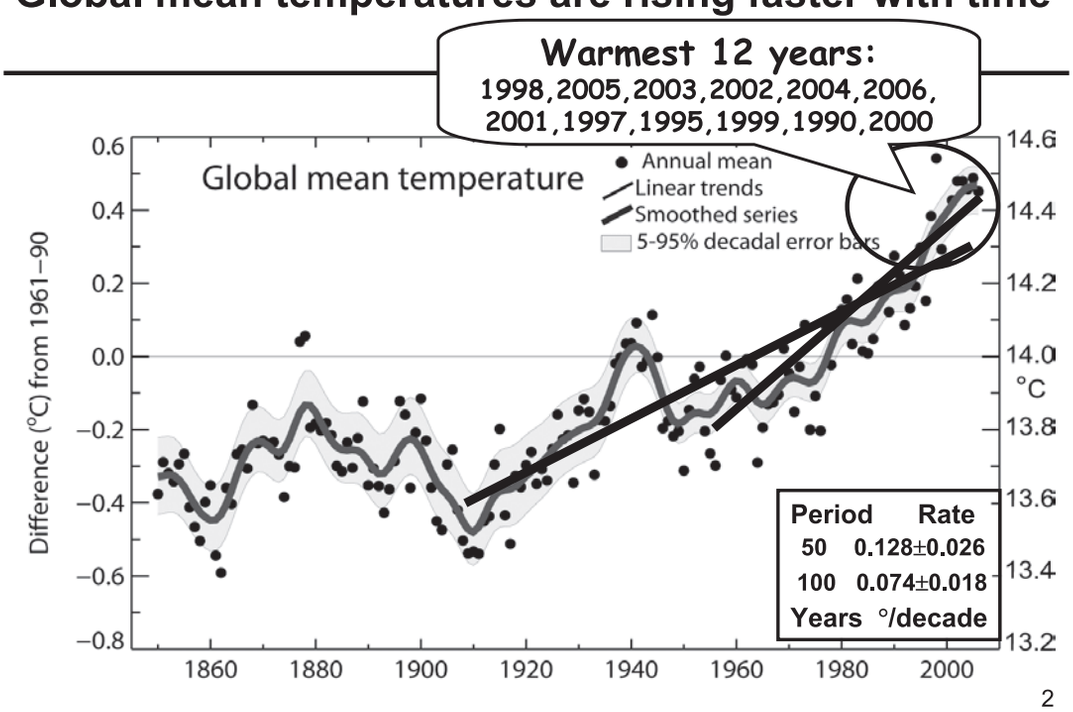
Global mean temperatures are rising faster with time



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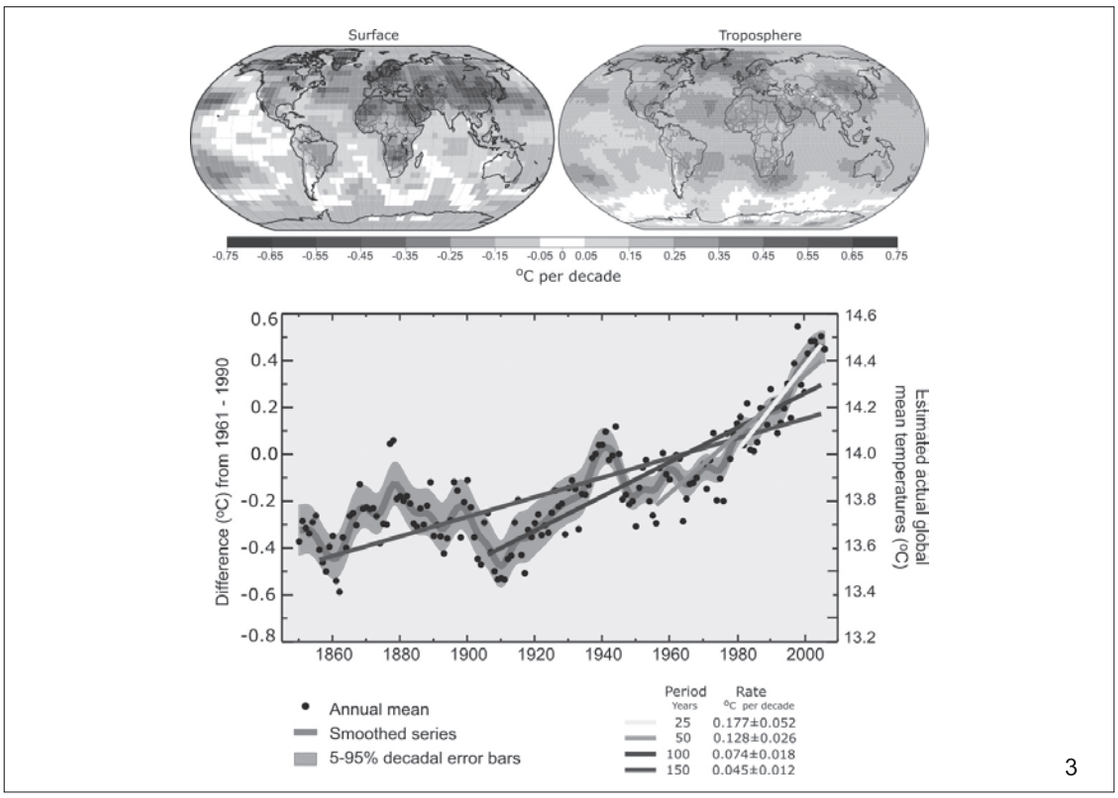
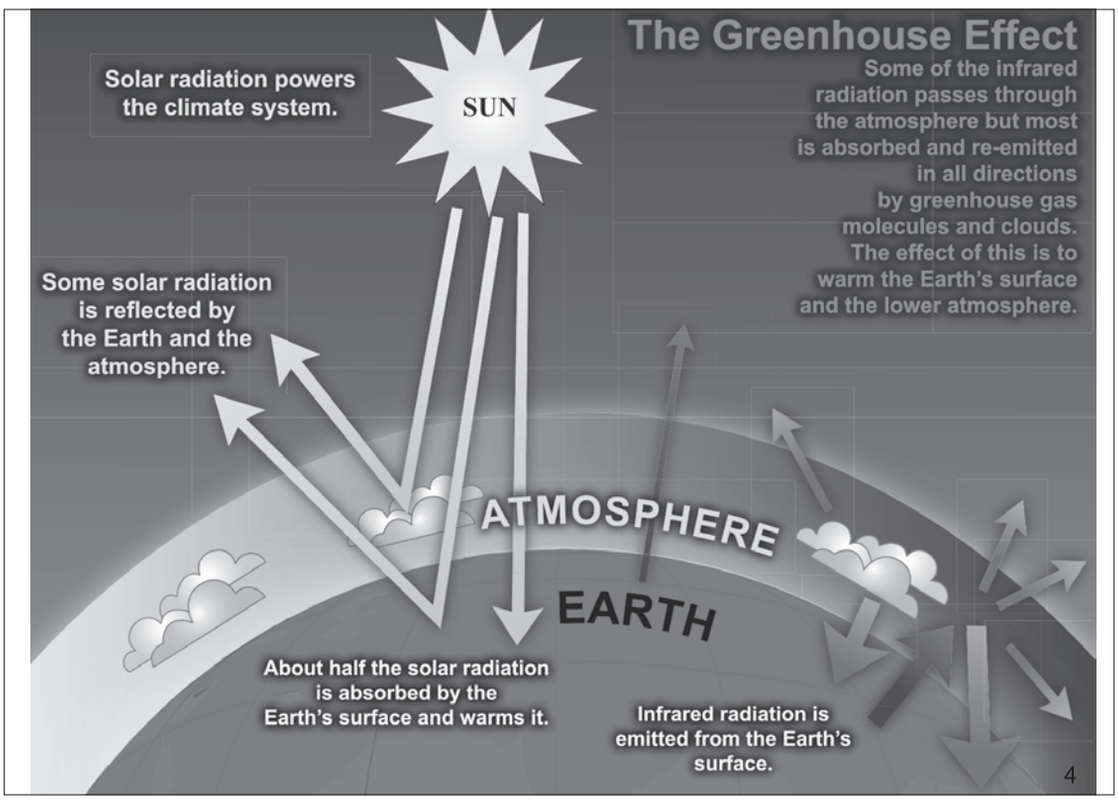

Surface
Troposphere
-0.75 -0.65 -0.55 -0.45 -0.35 -0.25 -0.15 -0.05 0 0.05 0.15 0.25 0.35 0.45 0.55 0.65 0.75
°C per decade
Difference (°C) from 1961 - 1990
Estimated actual global mean temperatures (°C)
0.6 0.4 0.2 0.0 -0.2 -0.4 -0.6 -0.8
14.6 14.4 14.2 14.0 13.8 13.6 13.4 13.2
1860 1880 1900 1920 1940 1960 1980 2000
Annual mean
Smoothed series
5-95% decadal error bars
Period Years
Rate °C per decade
25 0.177±0.052
50 0.128±0.026
100 0.074±0.018
150 0.045±0.012

3


The Greenhouse Effect
Some of the infrared radiation passes through the atmosphere but most is absorbed and re-emitted in all directions by greenhouse gas molecules and clouds. The effect of this is to warm the Earth's surface and the lower atmosphere.
Solar radiation powers the climate system.
SUN
Some solar radiation is reflected by the Earth and the atmosphere.
ATMOSPHERE
EARTH
About half the solar radiation is absorbed by the Earth's surface and warms it.
Infrared radiation is emitted from the Earth's surface.

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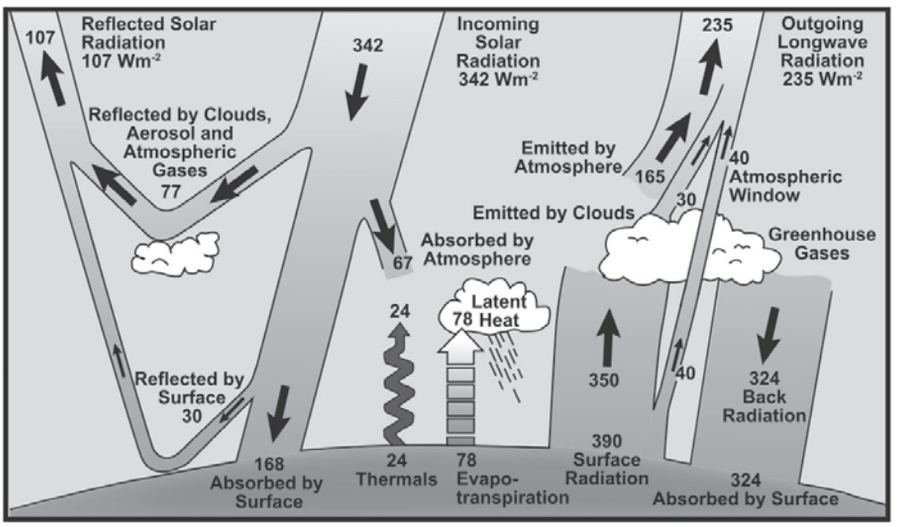
The Earth's Annual and Global Mean Energy Balance



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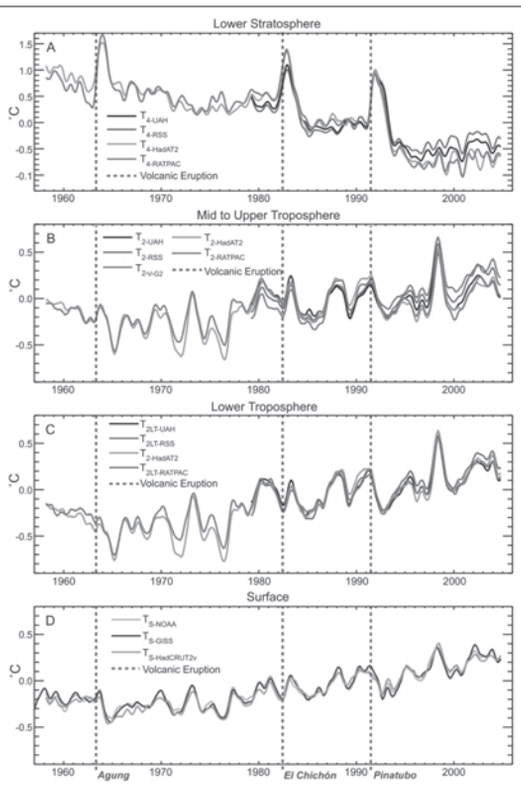

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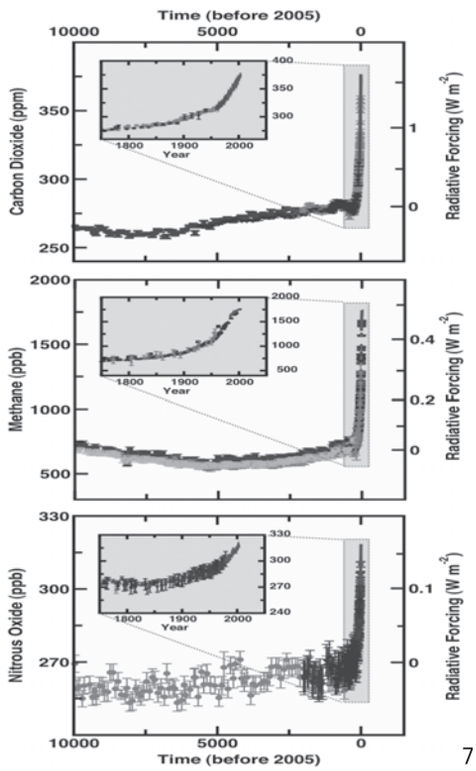
Human and Natural Drivers of Climate Change

CO_2, CH_4 and N_2O Concentrations

- far exceed pre-industrial values
- increased markedly since 1750 due to human activities

Relatively little variation before the industrial era



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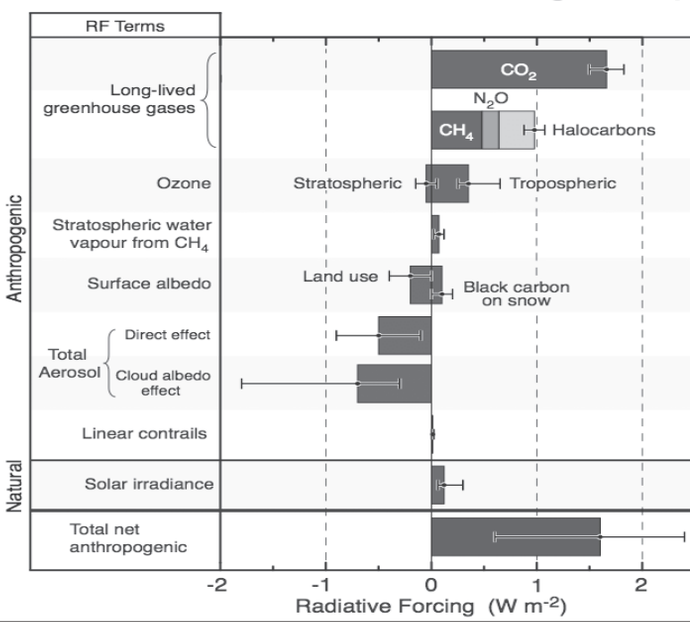
Global-average radiative forcing estimates and ranges

Radiative Forcing Components

	RF Terms	RF values ($W m^{-2}$)	Spatial scale	LOSU
Anthropogenic	Long-lived greenhouse gases	**1.66** [1.49 to 1.83]	Global	High
		0.48 [0.43 to 0.53] **0.16** [0.14 to 0.18] **0.34** [0.31 to 0.37]	Global	High
	Ozone	**-0.05** [-0.15 to 0.05] **0.35** [0.25 to 0.65]	Continental to global	Med
	Stratospheric water vapour from CH_4	**0.07** [0.02 to 0.12]	Global	Low
	Surface albedo	**-0.2** [-0.4 to 0.0] **0.1** [0.0 to 0.2]	Local to continental	Med - Low
	Total Aerosol: Direct effect	**-0.5** [-0.9 to -0.1]	Continental to global	Med - Low
	Total Aerosol: Cloud albedo effect	**-0.7** [-1.8 to -0.3]	Continental to global	Low
	Linear contrails	**0.01** [0.003 to 0.03]	Continental	Low
Natural	Solar irradiance	**0.12** [0.06 to 0.30]	Global	Low
	Total net anthropogenic	**1.6** [0.6 to 2.4]		



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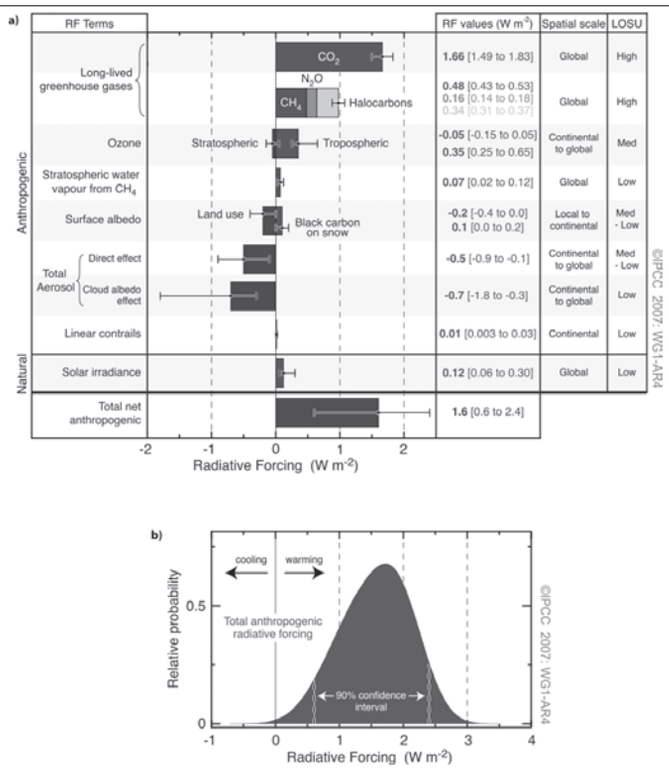

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Human and Natural Drivers of Climate Change

The understanding of anthropogenic warming and cooling influences on climate has improved since the Third Assessment Report (TAR), leading to *very high confidence* that the globally averaged net effect of human activities since 1750 has been one of warming, with a radiative forcing of +1.6 [+0.6 to +2.4] W m^{-2}.

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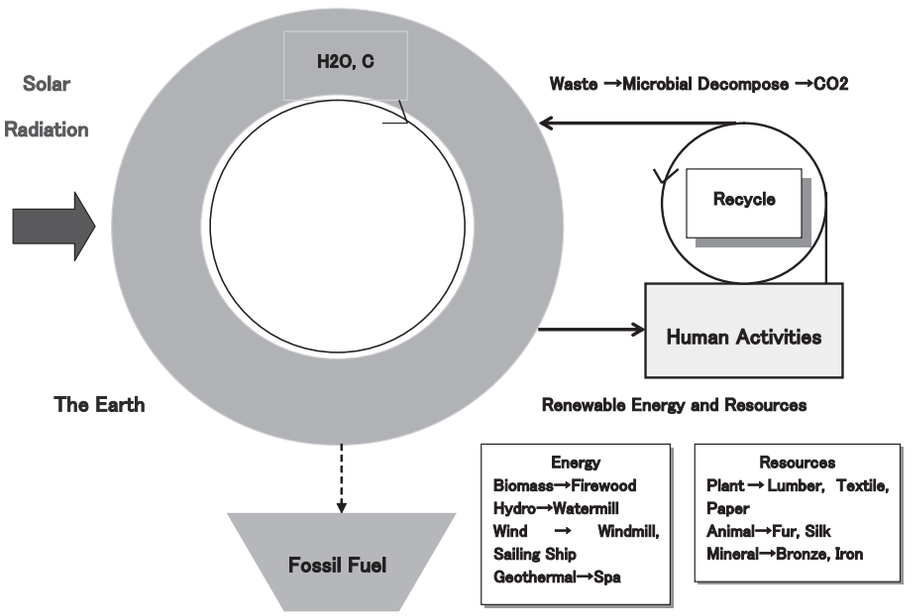
Before the Industrial Revolution (Turn of the 18th Century)



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Looking back the human behavior from the perspective of energy and materials cycle

Turning point of human behavior

The Industrial Revolution

UK in the second half of the 18th century

France and USA in the 19th century, then Germany and Japan

Invention and development

1712 Thomas Newcomen Steam engine

1769 James Watt Efficient steam engine,

The beginning of extensive coal use

1804 Richard Trevithick Steam locomotive

1814 George Stephenson Steam locomotive for railways

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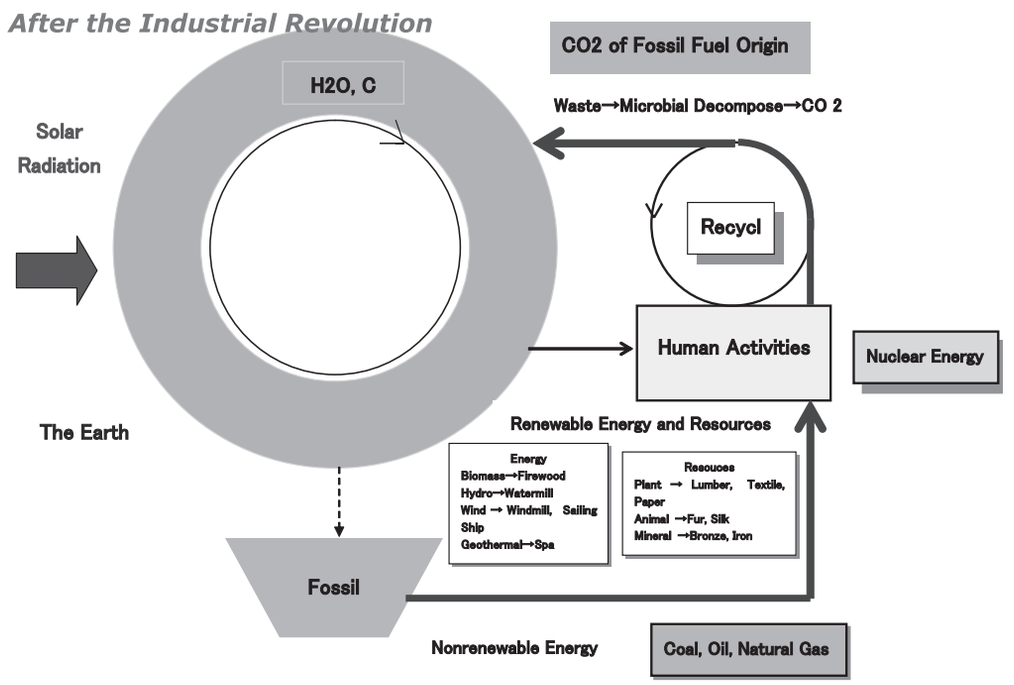

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Change of the human behavior from the perspective of energy and material cycle

Before the Industrial Revolution

- Development of human society is basically depend on the natural energy and material circulating system on the earth

From the Industrial Revolution to the present

- Mostly dependent on fossil fuel
- Mass-consumption of natural resources accumulated on the earth
- Humankind grow by developing artificial system apart from natural circulation

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Change of the human behavior in the perspective of energy and material cycle (Continued)

Present status, only 200 years after the Industrial Revolution

- **Mass-consumption of fossil fuel → Increase of CO2 concentration in the atmosphere → Increase of the Greenhouse Effect → Global Warming**

  →Crisis of human society (sea level rise, collapse of agricultural production system)

- **If we continue the present behavior, human society will be ruined**

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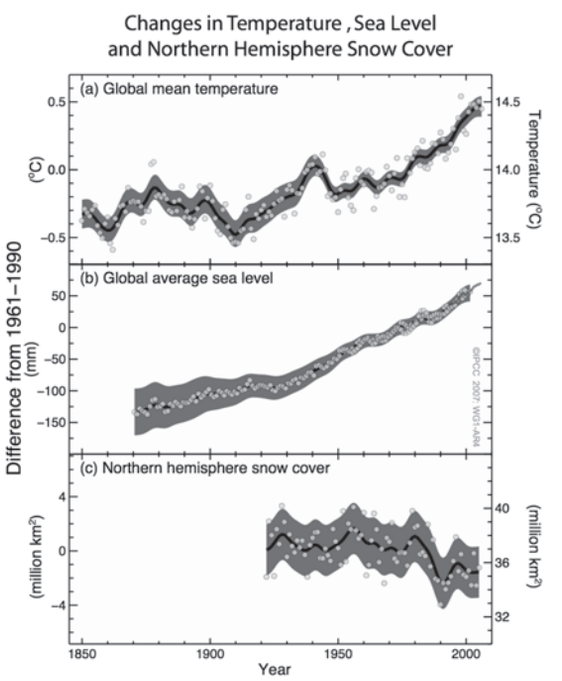
Direct Observations of Recent Climate Change

Global mean temperature

Global average sea level

Northern hemisphere Snow cover



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CO_2 emission, accumulation and increase of concentration in the atmosphere

- 2005 CO_2 concentration 380ppm
  CO_2equivalent concentration including other greenhouse gases 440ppm
- Total amount of CO_2 emission into the atmosphere reaches 2 trillion tons, over 200 years after the Industrial Revolution
  - 60% is absorbed by vegetation and the sea
  - Residual 800 billion tons is accumulated in the atmosphere
  - Increase of 100ppm from 280ppm around the Industrial Revolution to the present 380ppm
- 8 billion ton of CO_2 accumulated in the atmosphere = Increase of 1ppm
- At present, about half of CO_2 is accumulating in the atmosphere

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World Energy Demand and CO_2 Emission Outlook IEA [World Energy Outlook 2006]

- World energy demand
  - Increase of over 50% until 2030 (average annual increase 1.6%)
  - 70% of demand increase came from developing countries, and 30% from China only
    Increase of the share of energy intensive industries (steel and cement etc.) and wider use of automobiles
- CO_2 emission
  - 55% increase until 2030 (average annual increase 1.7%)
    Progress of electrification and increase coal fired power plant
  - 26 billion tons in 2004 ➔ 40 billion tons in 2030
  - The China will surpass the USA until 2010

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Where should we stop the increase in greenhouse gas concentration

- **How high will average surface temperature be, when radiative forcing is sustained at a doubling of pre-industrial revolution level 550ppm**
  (Experiment using climate model = estimation of the equilibrium climate sensitivity)
- **Equilibrium Climate Sensitivity**
  - **Best estimate about 3 ℃**
  - **likely 2~4.5℃**
- **Temperature rise up to 2℃ would be safe without serious hazardous impacts**
- **Keep CO2 equivalent concentration as low as possible than 550ppm**

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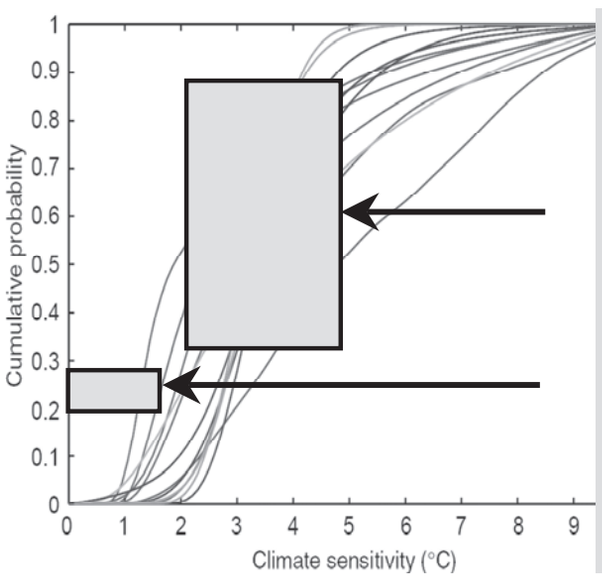
Equilibrium Climate Sensitivity

Surface warming following a sustained doubling of CO2 concentrations



Best estimate 3° C;

likely 2-4.5° C;

very unlikely less than 1.5° C;

higher values not ruled out

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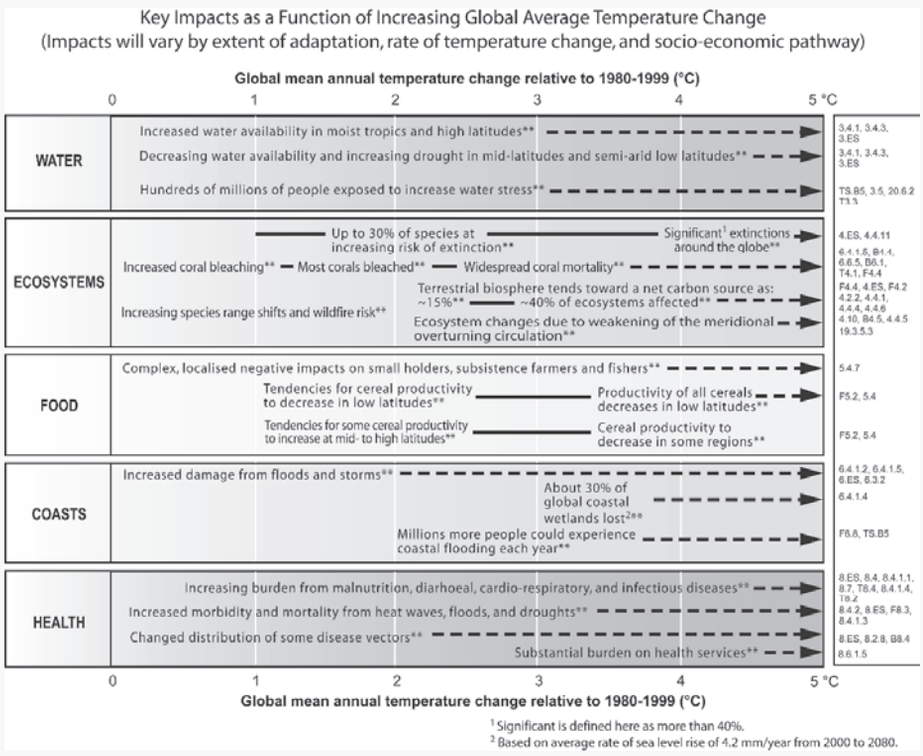
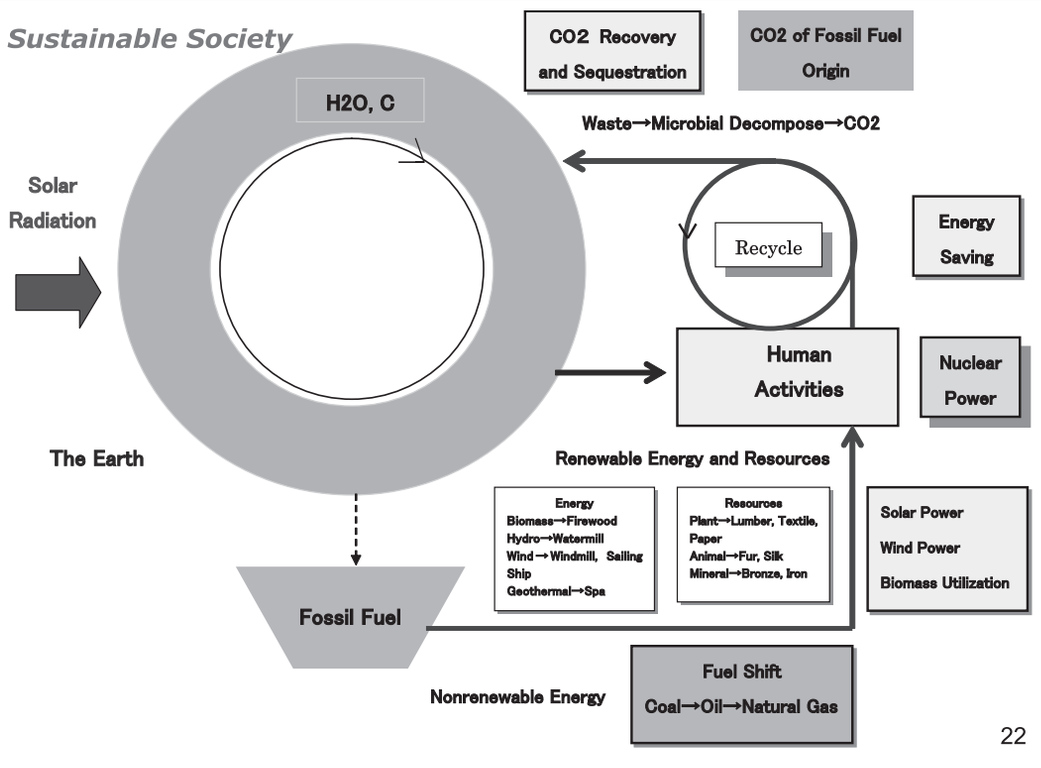

Key Impacts as a Function of Increasing Global Average Temperature Change
(Impacts will vary by extent of adaptation, rate of temperature change, and socio-economic pathway)
Global mean annual temperature change relative to 1980-1999 (°C)
0
1
2
3
4
5 °C
WATER
Increased water availability in moist tropics and high latitudes**
Decreasing water availability and increasing drought in mid-latitudes and semi-arid low latitudes**
Hundreds of millions of people exposed to increase water stress**
3.4.1, 3.4.3, 3.ES
3.4.1, 3.4.3, 3.ES
TS.B5, 3.5, 20.6.2 T3.3
ECOSYSTEMS
Up to 30% of species at increasing risk of extinction**
Significant[1] extinctions around the globe**
Increased coral bleaching**
Most corals bleached**
Widespread coral mortality**
Increasing species range shifts and wildfire risk**
Terrestrial biosphere tends toward a net carbon source as: ~15%** ~40% of ecosystems affected**
Ecosystem changes due to weakening of the meridional overturning circulation**
4.ES, 4.4.11
6.4.1.5, B4.4, 6.6.5, B6.1, T4.1, F4.4
F4.4, 4.ES, F4.2 4.2.2, 4.4.1, 4.4.4, 4.4.6 4.10, B4.5, 4.4.5 19.3.5.3
FOOD
Complex, localised negative impacts on small holders, subsistence farmers and fishers**
Tendencies for cereal productivity to decrease in low latitudes**
Productivity of all cereals decreases in low latitudes**
Tendencies for some cereal productivity to increase at mid- to high latitudes**
Cereal productivity to decrease in some regions**
5.4.7
F5.2, 5.4
F5.2, 5.4
COASTS
Increased damage from floods and storms**
About 30% of global coastal wetlands lost[2]**
Millions more people could experience coastal flooding each year**
6.4.1.2, 6.4.1.5, 6.ES, 6.3.2
6.4.1.4
F6.8, TS.B5
HEALTH
Increasing burden from malnutrition, diarhoeal, cardio-respiratory, and infectious diseases**
Increased morbidity and mortality from heat waves, floods, and droughts**
Changed distribution of some disease vectors**
Substantial burden on health services**
8.ES, 8.4, 8.4.1.1, 8.7, T8.4, 8.4.1.4, 18.2
8.4.2, 8.ES, F8.3, 8.4.1.3
8.ES, 8.2.8, B8.4
8.6.1.5
0
1
2
3
4
5 °C
Global mean annual temperature change relative to 1980-1999 (°C)
[1] Significant is defined here as more than 40%.
[2] Based on average rate of sea level rise of 4.2 mm/year from 2000 to 2080.


Sustainable Society
CO2 Recovery and Sequestration
CO2 of Fossil Fuel Origin
H2O, C
Waste→Microbial Decompose→CO2
Solar Radiation
Recycle
Energy Saving
Human Activities
Nuclear Power
The Earth
Renewable Energy and Resources
Energy
Biomass→Firewood
Hydro→Watermill
Wind→Windmill, Sailing Ship
Geothermal→Spa
Resources
Plant→Lumber, Textile, Paper
Animal→Fur, Silk
Mineral→Bronze, Iron
Solar Power
Wind Power
Biomass Utilization
Fossil Fuel
Fuel Shift
Coal→Oil→Natural Gas
Nonrenewable Energy
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Global Warming Mitigation Strategies

- Energy saving and resource saving (including reuse and recycle)

- Shift to the fossil fuels less CO_2 emission
  Coal (CO_2 emitted per unit of Calorie =1) → Oil(0.8) → Natural gas (0.6)

- CO_2 capture and storage (CCS)
  CO_2 emitted from smokestack and automobiles is a new type of hazardous waste which endanger the sustainability of human society, though it is not directly harmful to our health

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Global Warming Mitigation Strategies (Continued)

"De-carbonization"

- Enhanced use of CO_2 emission free renewable energies (solar, wind, hydro power, biomass, geothermal energy etc.)

- Enhanced use of renewable resource (biomass, especially non-food stuff cellulose materials

- Safety use of nuclear power

- R&D and application of innovative energy technologies

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Necessity of feed-in policy to enhance renewable energy use

- Fossil fuel is a high quality energy refined in nature. Renewable energies are unstable and difficult to store. Therefore, they are uncompetitive to fossil fuel.
  Exception: Sites with natural advantage, such as hydro power with suitable geography for dam construction, wind power with stable and strong wind, geothermal power with suitable underground structure etc.
- Setting of high usage goal and application of economic incentives (feed-in tariff, investment tax reduction, low interest finance etc.)
- Introduction of really effective CO2 emission reduction policy such as CO2 Emission Trade system
- Legal responsibility for enhanced use of renewable energy
  Law of RPS, implementation to public facilities, urban and regional development, obliged use of bio-fuel

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The Stern Review "The Economics of Climate Change" October 2006 Report to Prime Minister and Chancellor of the Exchequer of the UK

Considering national balance, historical responsibilities and CO2 emission per capita, economically wealthy countries are responsible to reduce their emission 60-80% from the emission level of 1990

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