

What is Global Warming?!

By **Hayanon**

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Hi. I am a mammoth. My genus existed from around 3 million years ago to 10,000 years ago. Do you know that remains of a frozen mammoth excavated in Siberia were displayed at the 2005 World Exposition in Aichi, Japan? To my delight, as many as about 7 million visitors came to see the display!

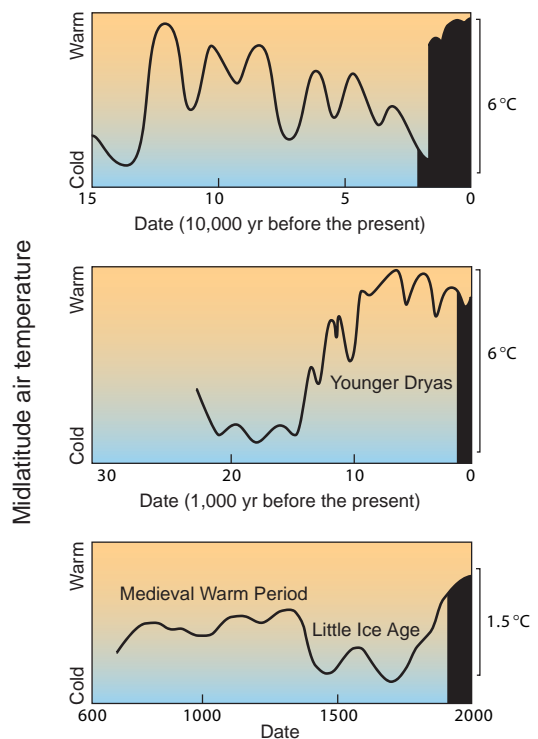
Although we resemble modern elephants, it is said that we were not their immediate ancestors. Some of our species were covered with long hair and were able to survive throughout the Ice Age.

The mammoths' territory expanded to Europe, Asia, and North America, which were connected together at that time. Then we disappeared.

Thousands of years after the extinction, people found our remains in Siberia and came to understand us.

Do you ever wonder why we died out? There seem to be two possible reasons. One is that extinction is the result of global warming. Grasslands and ponds were replaced by coniferous forests due to the temperature rise after the Ice Age. The plants we lived on were gone.

I have heard that you, humans, are responsible for the acceleration of global



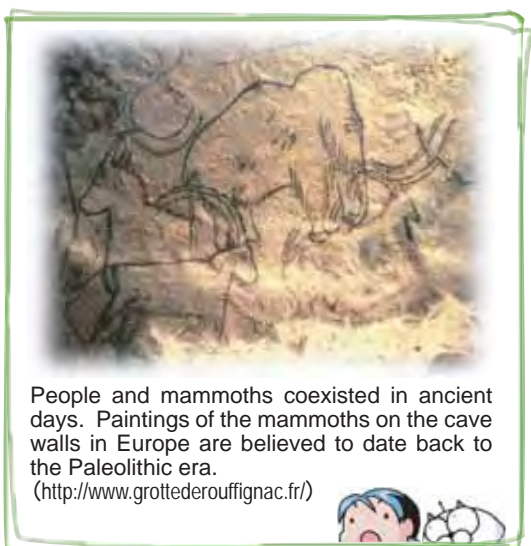
Climate Change (Adapted from "Webb, III, T. et al., in Global Change, Cambridge Univ. Press, 1985")

warming by emitting more carbon dioxide and methane. I really hope that you will not suffer from food shortages like we did. Luckily, though, global warming can be minimized by your efforts and ingenuity.

The other theory for our extinction is overhunting by humans. They sometimes act, driven only by their own desires, jumping over a line which should not be crossed. Please remember the value of all life on Earth and the preciousness of the Earth's environment.

The whole world needs to tackle the problem of global warming instead of pursuing their own interests in order to head off an irreversible crisis.

Also, if the globe keeps warming, my bed will be melted! That is really a problem. Now, I have talked enough. I am going back to sleep. Bye for now. Zzz ...



People and mammoths coexisted in ancient days. Paintings of the mammoths on the cave walls in Europe are believed to date back to the Paleolithic era.
(<http://www.grottederouffignac.fr/>)

It is a rainy day today.

Our familiar friends, science lover Mol and her robotic dog Mirubo, are stuck in the house, doing nothing but watching TV.



Mom said
summer is
coming soon
...

... but why
is it so
cold?

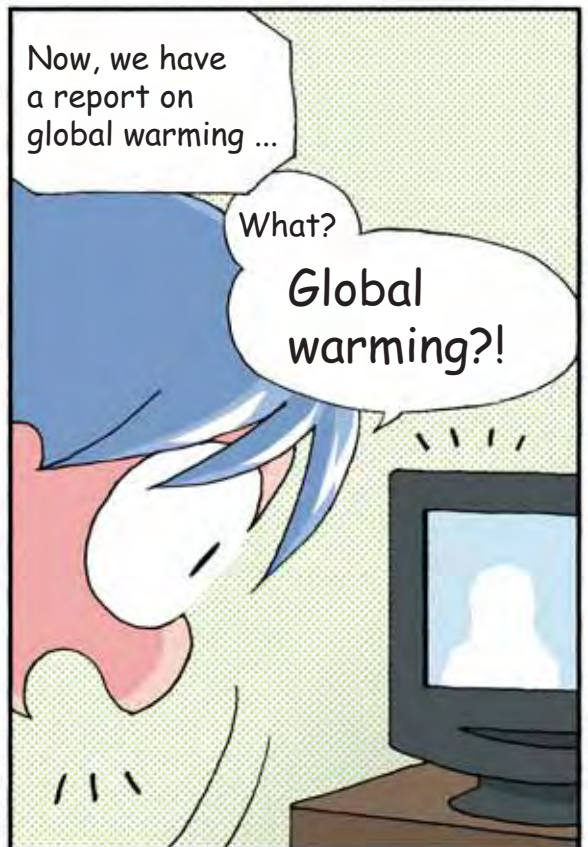
I really miss the
sunshine. Go away
rain, and hurry up
summer!

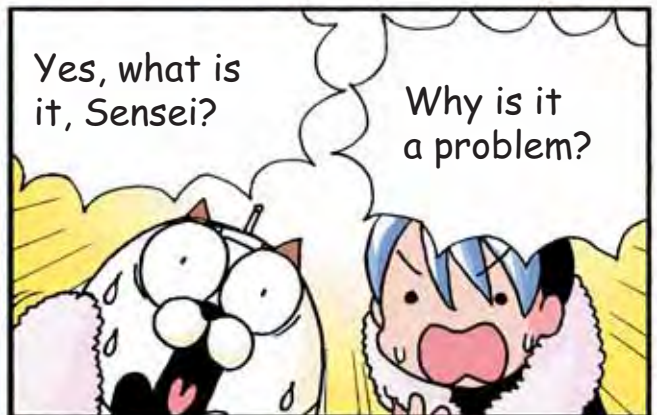


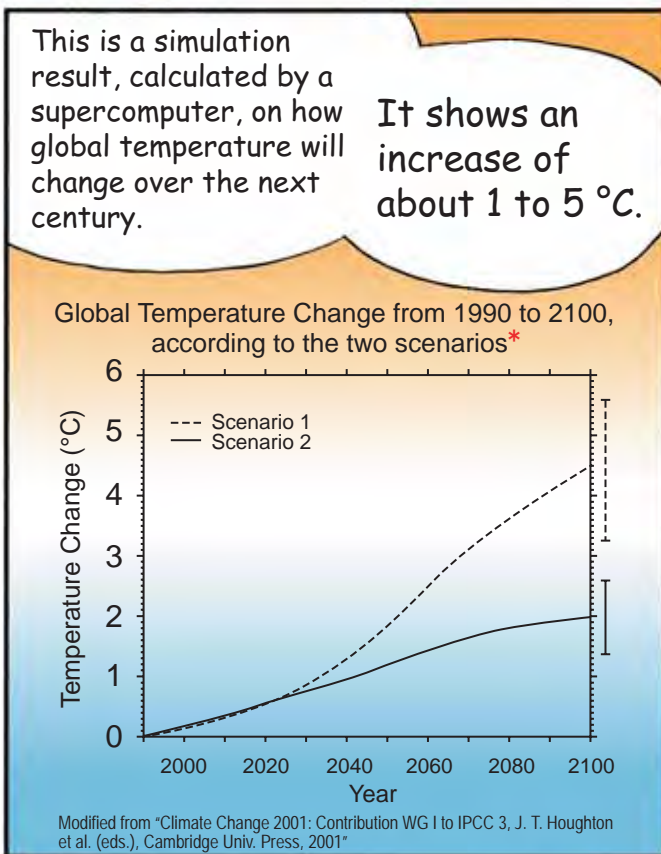
Now, we have
a report on
global warming ...

What?

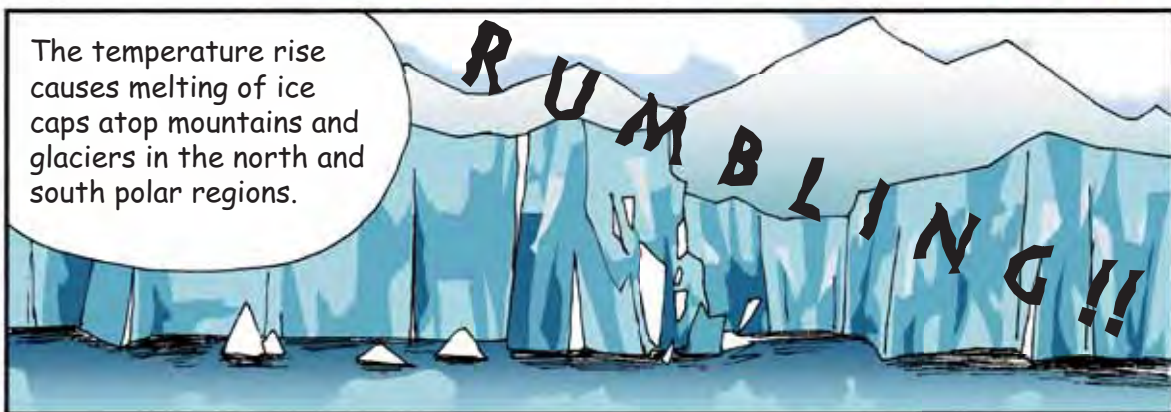
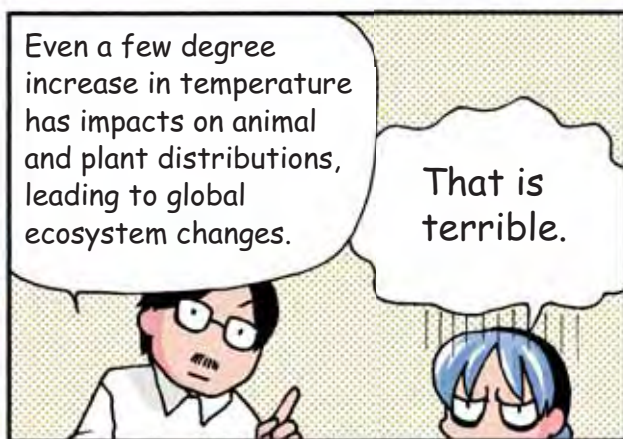
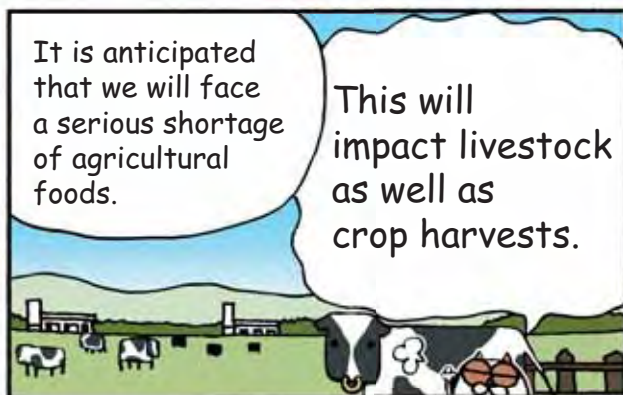
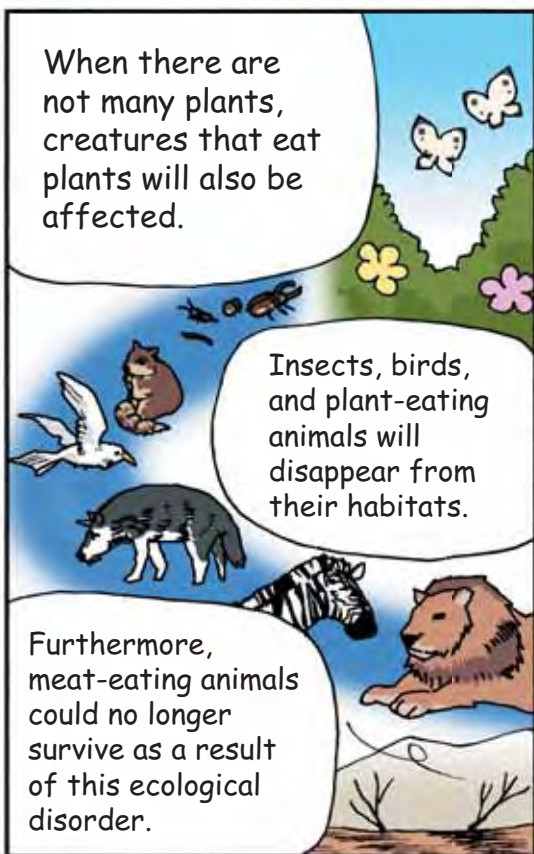
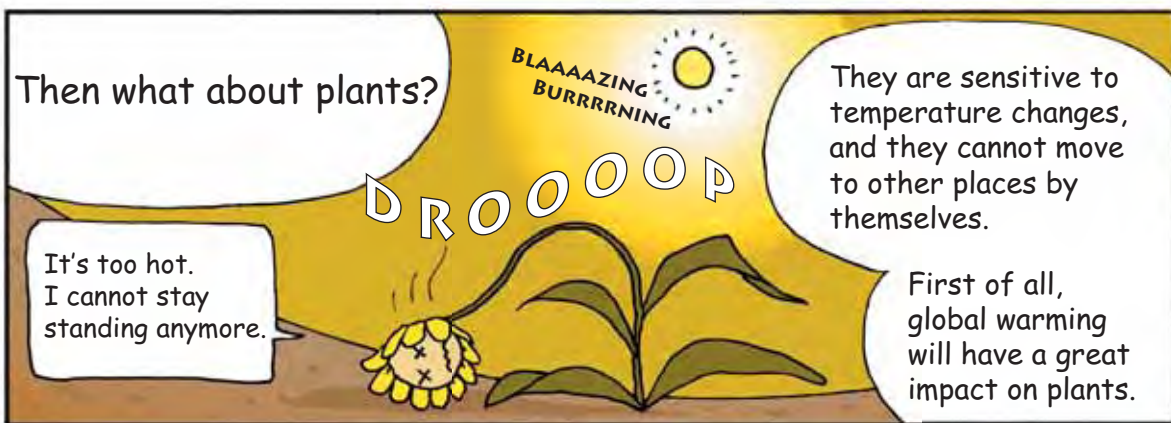
Global
warming?!

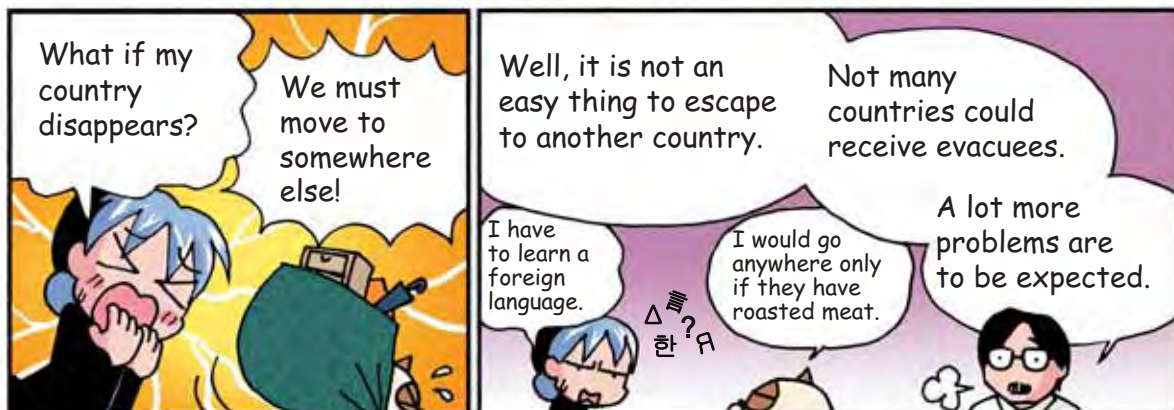
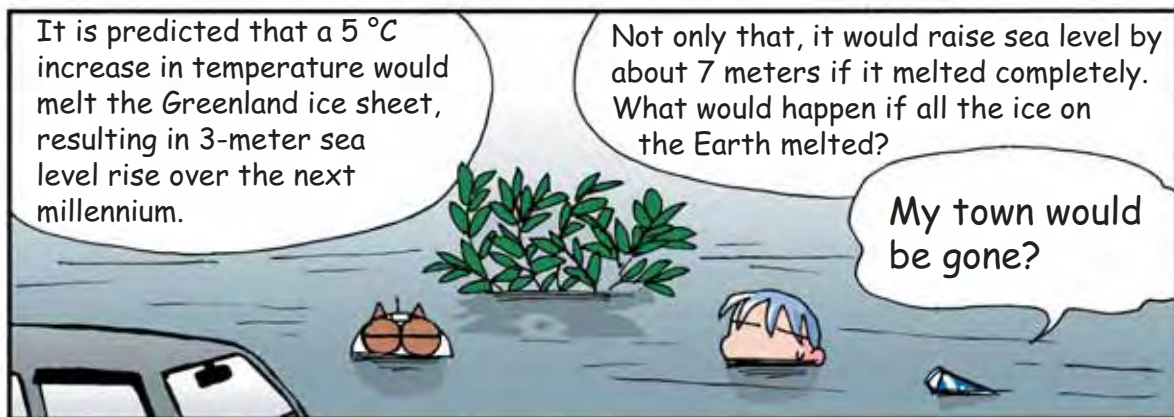


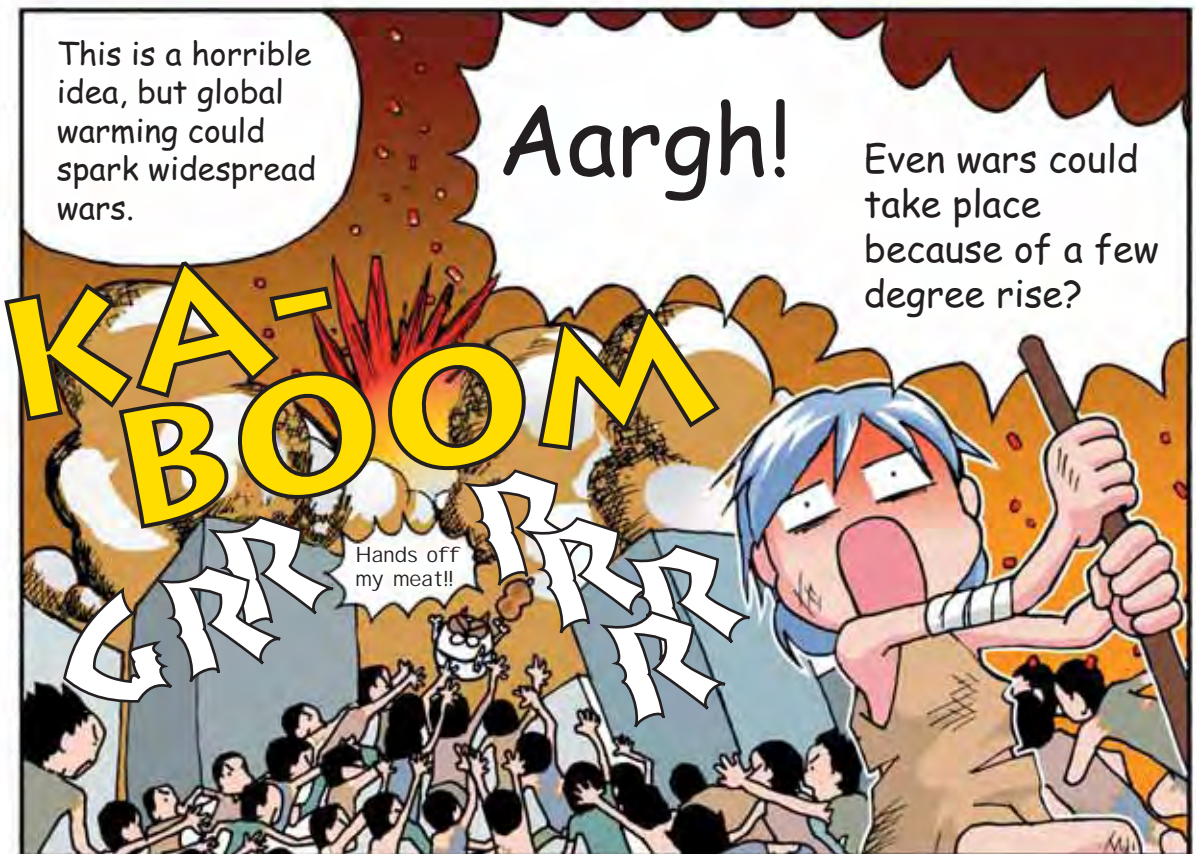
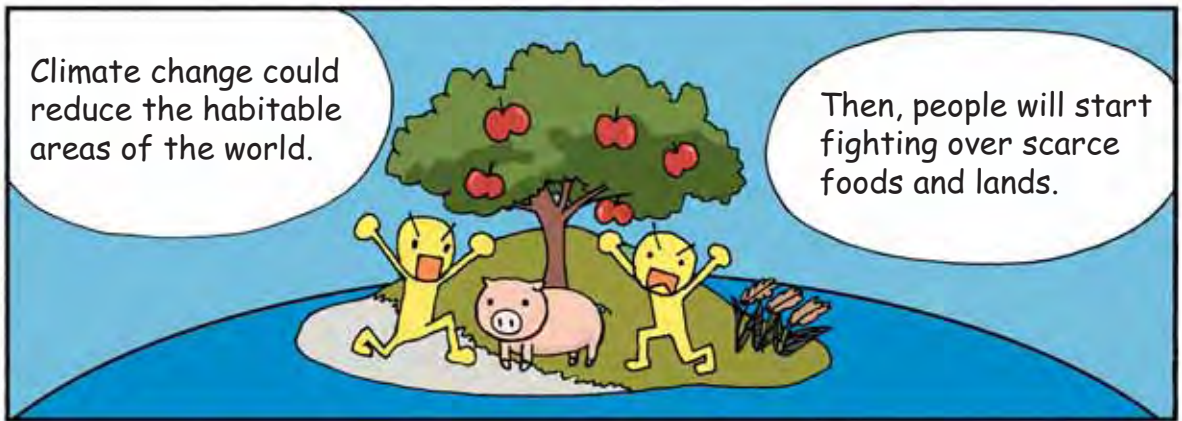


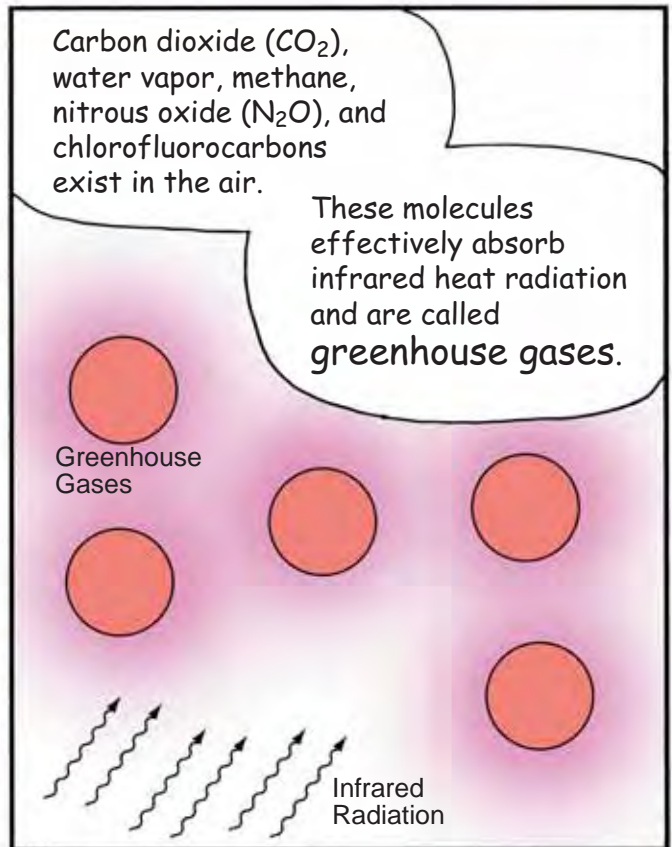
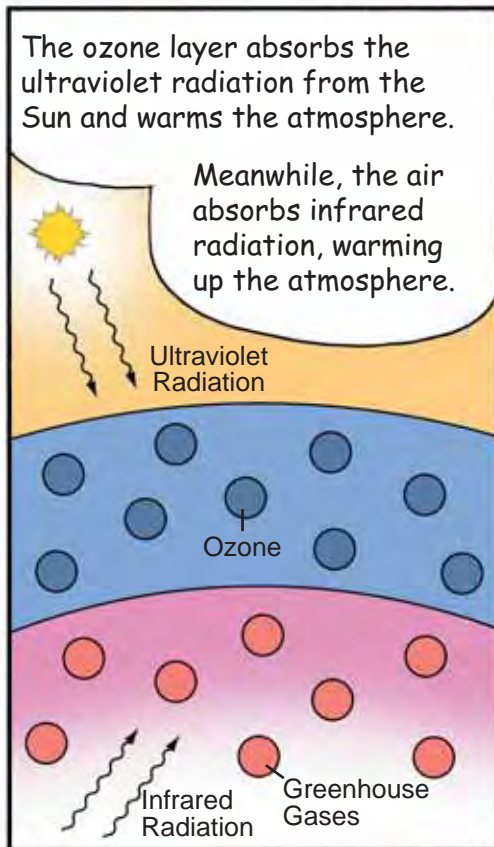
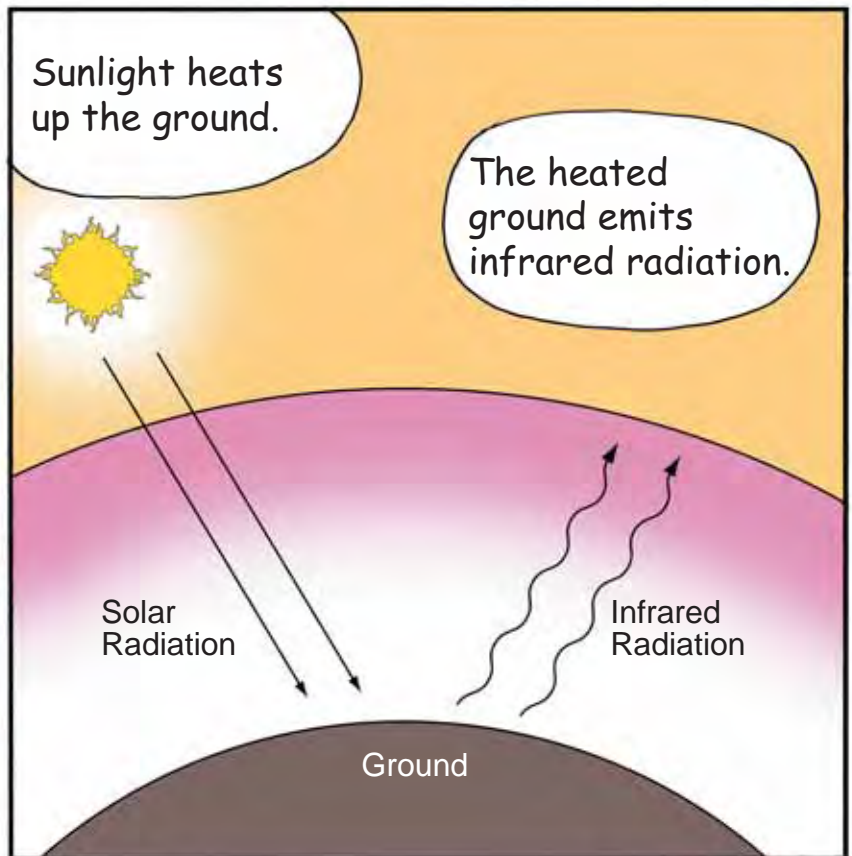


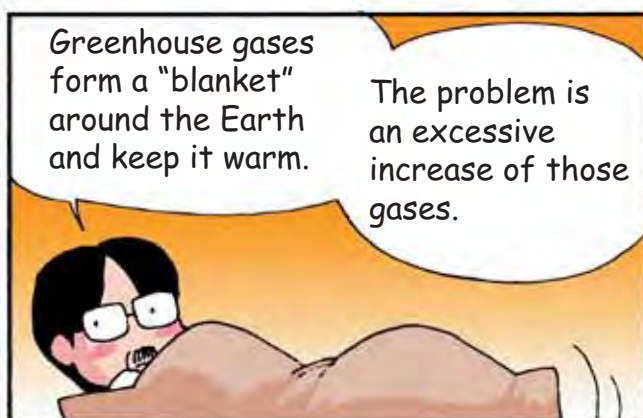
* Bars on the right show the range in the temperature in 2100 produced by two different models.
 Scenario 1: A future world of rapid economic growth with technological emphasis on fossil fuel-intensive energies.
 Scenario 2: A world with the introduction of clean and resource-efficient technologies emphasizing environmental sustainability.

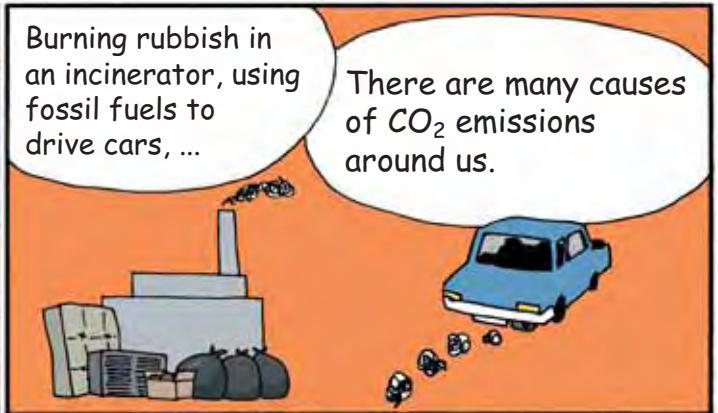
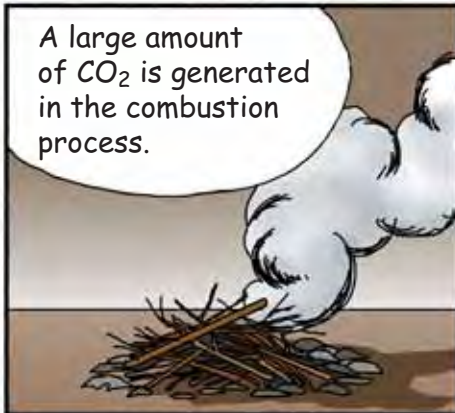


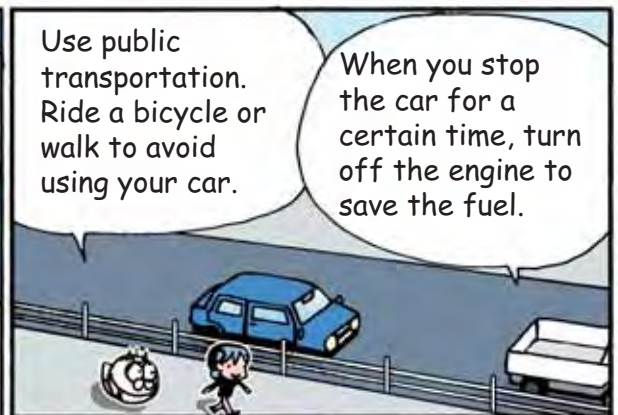
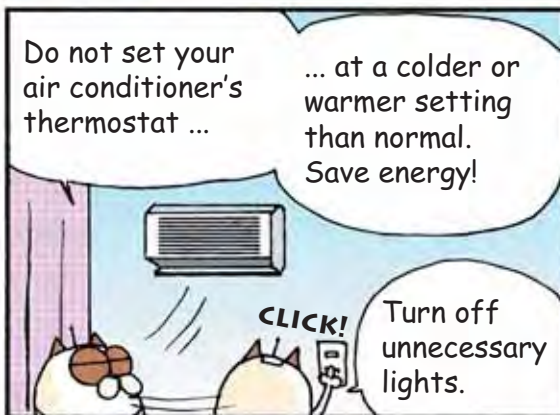


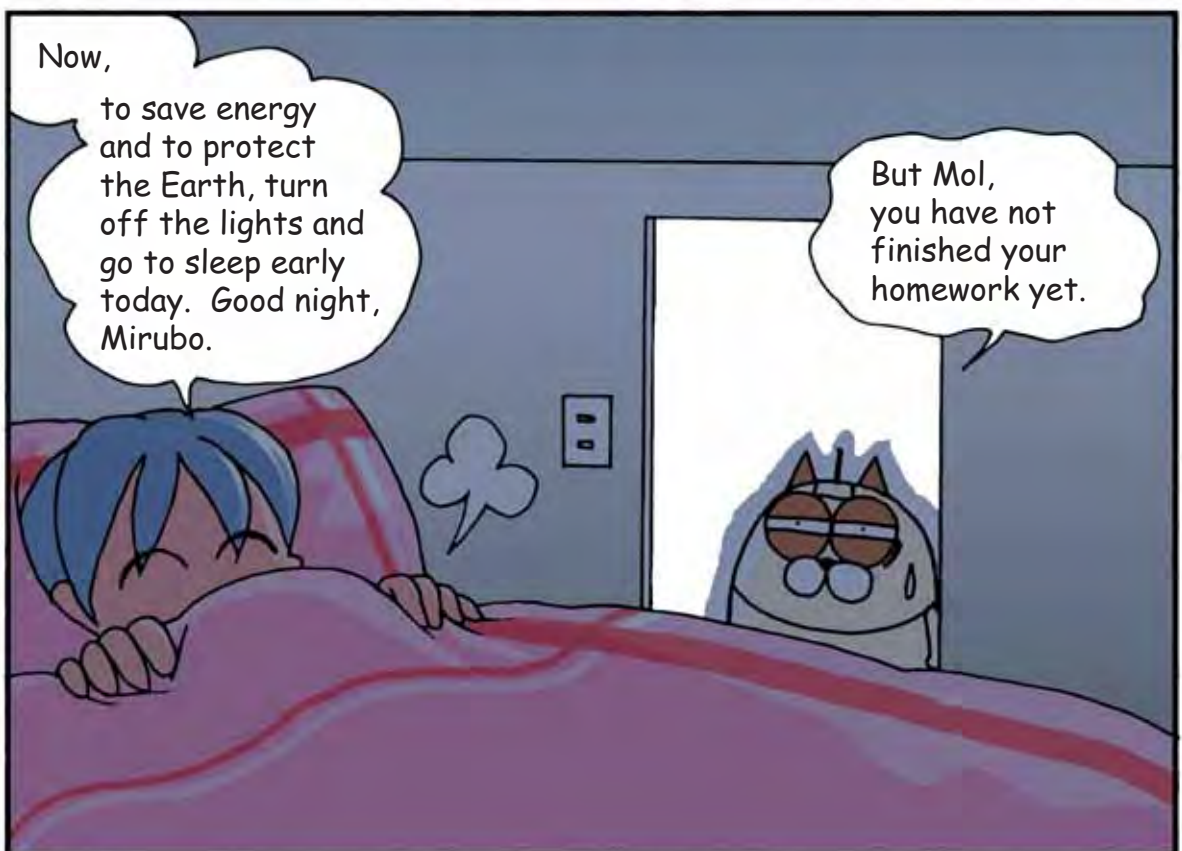
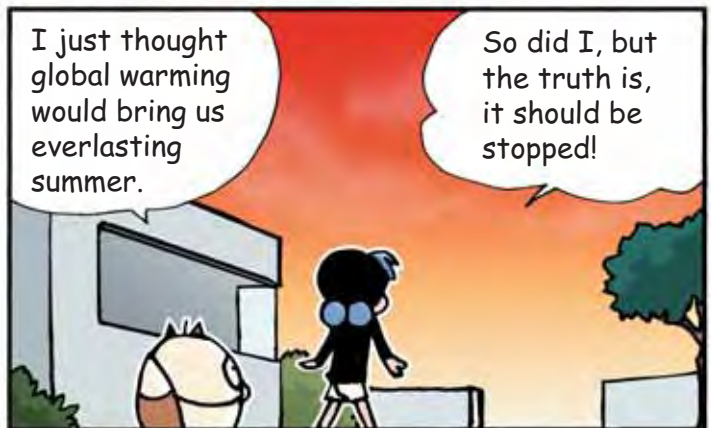
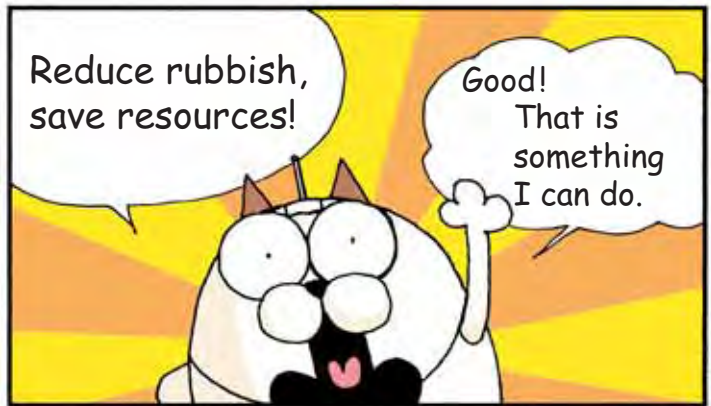












What is Global Warming?!



On TV and newspapers everyone talks about global warming. They say gasoline cars cause the problem and that the gasoline tax needs to be increased to stop it.



Gee, you are so smart, Moll! Greenhouse gases such as CO_2 and methane emitted from burning fossil fuels contribute a lot to global warming. Various measures are studied to cut those gases. The introduction of "environmental tax" on oil and coal is one of them.



When did the Earth start warming?



The Earth has gone through warm and cold climates in cycles that last thousands of years or tens of thousands of years since its birth about 4.6 billion years ago. The Earth is currently thought to be in a warm period, from the viewpoint of long-term climate changes.

However, greenhouse gas emissions including CO_2 have increased especially since the Industrial Revolution began around 1750. The recent warming trend reflects its impacts.



I know that the invention of the steam engine led to the rapid industrial development. Coal provided the power to drive the steam engines!

Thanks to inventions during this period, our life has become full of conveniences. Is that a cause of global warming?! We did not need the Industrial Revolution at all?!



Wait! I, and even TV, would not exist without those inventions.



Our present life has been established based on people's achievements of that time. They, however, never imagined we would face the crucial problem resulting from their inventions.

Chlorofluorocarbons (CFCs) are another example of what had provided us with convenience but later turned out to be harmful. CFCs, used in air

conditioners, are found to destroy the ozone layer.

In 1898, a Swedish chemist S. Arrhenius suggested that CO_2 could cause global warming. The issue then began to be discussed at the U.S. Congress in the 1980s, and soon became of worldwide concern.



What will happen if the Earth keeps warming?



Scientists make predictions based on various scenarios. They say that the temperature will rise about 1 to 5 °C in the next 100 years.



Is that all?? We can ignore that.



No. Even though the rise would not be severe enough to directly kill animals, it could cause ecological disorder. Global warming could reduce crop yields as well as plants which animals depend on.

It would also cause sea levels to rise by melting glaciers. Most parts of low-lying islands like Maldives will be submerged. The occurrence of extreme weather events such as heat waves and typhoons is estimated to increase.



That is a big problem! What can we do to avoid that?



The whole world needs to tackle global warming together. An international conference is annually held to try to reduce greenhouse gas emissions.

Every one of us is also able to contribute to stopping the problem through energy saving. Setting your air conditioner's thermostat to a moderate temperature, or turning off the engine while parking, for example. Many small things make a great difference.



I have an idea! I will use a smokeless BBQ grill from now on. That could reduce CO_2 emissions.



Well, I do not know whether that works, maybe so ...

How to Measure Greenhouse Gases

Do you know that the content of greenhouse gases such as CO_2 and methane in the air is only a tiny bit? CO_2 accounts for 0.03% of the air, and the level of methane is only 1.7 ppm (parts per million). Because they have enormous impacts on climate changes despite their low content, an accurate measurement of those gases is essential.

In 1958, a U.S. scientist C. D. Keeling and his colleagues started measurement of CO_2 as the major greenhouse gas at an observatory on the top of an about 4,000 meter-high mountain called Mauna Loa in Hawaii.

A nondispersive infrared analyzer is used for the observation. This analyzer measures CO_2 concentration by making use of the gas's nature of absorbing infrared radiation. In more detail, infrared absorption intensities are measured alternately for two gas samples; one is the air sampled from the outside and the other is a reference gas whose CO_2 abundance is known. The CO_2 concentration is derived from the difference of the absorption intensities.

While the above method provides "in-situ" analysis of CO_2 concentration, "remote" data can be obtained using an instrument named Fourier Transform Infra-Red Spectrophotometer (FTIR). CO_2 in the atmosphere absorbs sunlight at

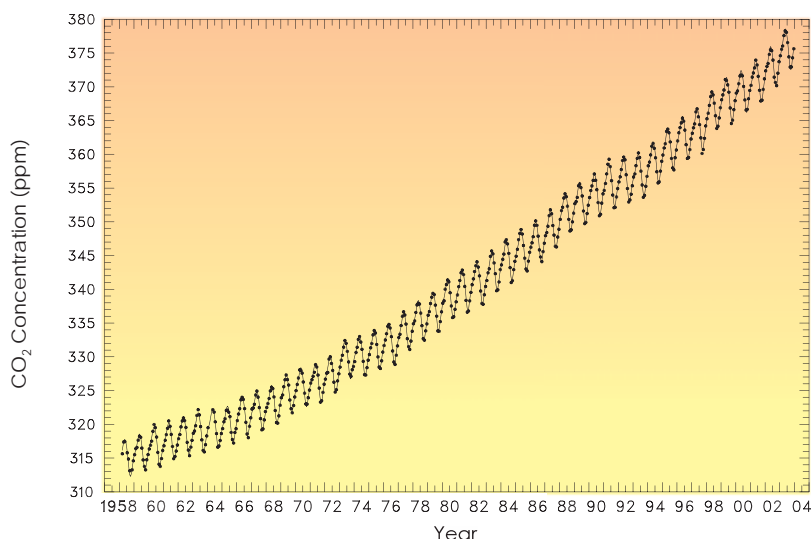


A compact FTIR measures atmospheric CO_2 concentration.

some specific infrared wavelengths determined by the molecular structure of CO_2 . Such a discrete absorption feature is called an absorption line. In the FTIR measurements from the ground, the spectrometer directly looks at the Sun, and the CO_2 concentration is derived from the intensity of the absorption lines.

There is an ongoing project to make observations of greenhouse gases in the Earth's atmosphere from space! Satellite-borne FTIR is to obtain two types of infrared spectra. One is reflected by the Earth's surface after being radiated from the Sun, and the other is radiated from Earth itself.

With the aim of studying changes in the Earth's CO_2 concentration in a broader perspective, the GOSAT satellite of Japan and the U.S. OCO satellite carrying a diffraction-grating infrared spectrometer are scheduled for launch in 2007.



CO_2 Concentration Observed at Mauna Loa, Hawaii (Source: C. D. Keeling et al., Scripps Institution of Oceanography, University of California at San Diego)

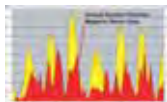
CAWSES: A SCOSTEP Program 2004–2008

Solar Influence on Climate

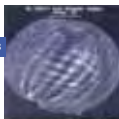


Space Weather: Science and Applications

Atmospheric Coupling Processes



Space Climatology



Climate and Weather of the Sun-Earth System (CAWSES)

CAWSES is an international program sponsored by SCOSTEP (Scientific Committee on Solar-Terrestrial Physics) and has been established with the aim of significantly enhancing our understanding of the space environment and its impacts on life and society. The main functions of CAWSES are to help coordinate international activities in observations, modeling and theory crucial to achieving this understanding, to involve scientists in both developed and developing countries, and to provide educational opportunities for students at all levels. The CAWSES office is located at Boston University, Boston, MA, USA. The four science Themes of CAWSES are shown in the figure.

<http://www.bu.edu/cawses/>

<http://www.ngdc.noaa.gov/stp/SCOSTEP/scostep.html>



Solar-Terrestrial Environment Laboratory (STEL), Nagoya University

STEL is operated under an inter-university cooperative system in Japan. Its purpose is to promote “research on the structure and dynamics of the solar-terrestrial system,” in collaboration with a number of universities and institutions both in Japan and abroad. The Laboratory consists of four research Divisions: Atmospheric Environment, Ionospheric and Magnetospheric Environment, Heliospheric Environment, and Integrated Studies. The Geospace Research Center is also affiliated to the Laboratory to coordinate and promote joint research projects. At its seven Observatories/Stations, ground-based observations of various physical and chemical entities are conducted nationwide.

<http://www.stelab.nagoya-u.ac.jp/>

はやのん Hayanon

Graduated from the Department of Physics of Ryukyu University, Hayanon, a writer and cartoonist, has contributed a number of serials in popular magazines on the basis of her strong background in science and computer games. Her consistent writing style, expressing a love for science, is well accepted.

<http://www.hayanon.jp/>

子供の科学 Kodomo no Kagaku (Science for Kids)

Kodomo no Kagaku, published by the Seibundo Shinkosha Publishing Co., Ltd. is a monthly magazine for juniors. Since the inaugural issue in 1924, the magazine has continuously promoted science education by providing various facets of science, from scientific phenomena in everyday life to cutting edge research topics.

<http://www.seibundo.net/>

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