Global Change Researches

JAMSTEC

JAMSTEC in our daily lives!

J boxes represent JAMSTEC' s scientific results, delivered to the world

Government, Ministries

JAMSTEC provides data about disasters at the government's request

Check the latest JAMSTEC activities on the internet!

Web

Schools, Lectures

Now, I'm at a special lecture by an JAMSTEC scientist

Ahchoo

I've already taken my hay fever medicine

GO!

OFF

News

Science Programs

power-saving planning

sakura front

Family

I'm planning a cherry-blossom viewing!

Information provided by JAMSTEC appears in the media

Shop

The amount of the stock depends on weather in winter

My winter favorite is Oden

Shop

Industries

Safety first

Factories use seasonal forecasts. JAMSTEC contributes to improve it.

Increase production for this summer! It's going to be hot!

Companies, Local governments

Seasonal prediction is useful!

Typhoon projection

Hmm. How global warming will affect Typhoons?

Construction

Lot of useful information for disaster mitigation in urban design

Weather derivatives cover business losses…

Insurance

Weather and ocean current predictions are important for fisheries

Fishery

Ships make use of ocean current prediction for safety

Transport

Want to know more?

Research activities of JAMSTEC are on the next page!

Farmers in Australia plan production based on the seasonal prediction

Agriculture

Working hard on various publicity works

We sometimes ask pilots to report wild fires and sea ice conditions

Global-scale observations

Culturing plankton on the ship to check their productivity!

Wow. Is this a Monsoon?

Observed data is transferred via satellites, or collected by scientists themselves

Presentation in conferences

Data and samples from our research vessels!

Breeding sampled organisms

Analyzing atmospheric samples, too!

Hmm. The deep ocean is getting warmer too…

Data Analysis

Analyzing samples

Linking observational and modeling studies

ジャムステック JAMSTEC

Listening to a talk in a conference… Difficult…

Heated discussions sometimes…

Observed data and this huge computer are used for future prediction

Earth Simulator

Projected climate change

… WE … PREDICT FUTURE CLIMATE…

Global Warming and Typhoons

A typhoon is a cyclone that forms and develops over a tropical ocean. Because typhoons are accompanied by strong winds and intense precipitation, serious damage can occur when they approach or pass over land. The energy source of a typhoon is the condensation of water vapor in cumulonimbus clouds near its center. Because oceans warmed by global warming will supply more water vapor, there is concern that typhoons may become larger, more intense, and more damaging in the future.

Cloud Modeling

Clouds strongly affect climate through precipitation and radiative processes. Physical processes in clouds range from microphysical processes at the millimeter scale to dynamical processes at the kilometer scale. Because treating all these processes explicitly is difficult, better models of cloud processes for climate studies are being developed.

Climate Changes in the Stratosphere

Increasing concentrations of greenhouse gases cause warming in the troposphere and at the same time cooling in the stratosphere, which overlies the troposphere from 10 to 50km altitude. These climate changes are associated with changes in large-scale circulation from the troposphere to the stratosphere, which in turn affect ozone and methane distributions and the surface climate.

Permafrost Thawing and Environmental Changes

Global warming has been accompanied by thawing of the permafrost near the land surface. Increased thawing modifies the ground water condition and changes the topography (shape of the surface). Major degradation of the boreal forest (called "taiga") and enlargement of lakes (called "alas") can be expected, and consequently the water and carbon cycles at the land surface may change drastically. As a result, we expect increasing emissions of methane, a greenhouse gas, from the wetlands formed by this melting, are expected to further affect climate.

Application of Satellite Data

Satellite data are used to study winds over the sea surface and phytoplankton in the ocean, as well as to detect seasonal and interannual changes in terrestrial vegetation. Aerosol and concentrations of various trace gases in the atmosphere are also estimated on the basis of satellite data.

How changes in Ice Sheets effect Global Sea Level

Continental-scale ice masses (ice sheets) cover Greenland and Antarctica today and are known to have existed over North America and Europe about 20,000 years ago. Entire melting of the current Greenland and Antarctic ice sheets would lead a 70m rise in global sea level; the melting of ice sheets caused by global warming would contribute to considerable sea level rise, even though it is a small fraction of the ice volume.

Madden-Julian Oscillation

The Madden-Julian Oscillation (MJO) is the dominant intraseasonal (30–60 day) atmospheric variation in the tropics. It is usually observed as a large collection of clouds, which occurs primarily over the Indian Ocean and propagates eastward along the Equator. The MJO strongly affects the climate both in the tropics and at higher latitudes through its interaction with El Niño, monsoons, tropical cyclones, and other atmospheric phenomena.

Asian Monsoon

The Asian monsoon is a seasonally reversing atmospheric circulation pattern, caused by surface temperature contrast between the Asian continent and surrounding oceans. Various atmospheric, oceanic, and terrestrial processes, and their complex interactions generate variability within the seasonal monsoon and year-to-year variations of the monsoon, all of which have large impacts on our socio-economic activities. We are conducting research aimed at deepening our understanding of these processes and improving prediction skill of the monsoon.

Air Pollution and its impact on climate change

Ozone and aerosol particles (e.g. PM2.5) have been recognized as harmful to human health and vegetation, and ozone is also an important greenhouse gas because its impact on radiative forcing is similar to that of CO_2, especially around megacities. Aerosols can reflect and absorb both long- and short-wavelength radiation and can also change cloud distribution patterns.

Terrestrial Ecosystems

Ecosystems that are composed of forests, grasslands, etc, and extensively cover the terrestrial areas of the earth are rapidly varying due to climate change and human impacts. Such ecosystem change primarily appears as changes in the productivity of the vegetation, and subsequently affects the atmospheric CO_2 concentration that affects global climate. The resulting changes in species and decrease of habitat could also possibly pose threats to human society.

Arctic Sea-Ice Reduction

Due to global warming, Arctic sea ice has been decreasing significantly since the late 20th century. Climate models indicate that by the mid 21st century, the Arctic Ocean will be ice free at the end of summer. Such sea ice reductions will affect not only the Arctic environment but also the global climate and human activities.

Radiosonde

A radiosonde is an atmospheric sounding measurement instrument that usually carries sensors for temperature, humidity, pressure, and wind. It is usually launched attached to a balloon filled with hydrogen or helium gas.

Wind Profiler

A wind profiler provides vertical profiles of horizontal and vertical wind velocities by measuring backscatter from turbulence in the atmosphere.

Doppler Radar

Doppler radar measures the distribution and intensity of precipitation by means of reflected radio waves, and makes use of the Doppler effect to detect the motion of precipitation.

Earth Simulator

The Earth Simulator is a highly parallel vector supercomputer used to run models of complex, large-scale global phenomena, such as climate change, earthquakes, and changes in the earth's interior.

Automatic Weather Station

Water, energy, and carbon cycles vary widely on the surface of land masses and strongly affect climate change. To improve our understanding of such land surface processes, automatic weather stations have been set up at many points from tropical to Arctic regions.

El Niño

El Niño is a well known phenomenon, occurring once every few years, in which the sea surface temperature in the eastern equatorial Pacific Ocean becomes warmer than usual. Various processes in the ocean and atmosphere, each operating at different spatial and temporal scales within the Pacific are responsible for occurrence, evolution, and termination of this phenomenon. In addition, El Niño is also affected by interactions with the Atlantic Ocean and by mid-latitude variations. Research is underway with the aim of improving our understanding of El Niños and our ability to predict its occurrence.

Oceanographic Research Vessel Mirai

The Oceanographic Research Vessel Mirai delivers excellent navigational performance and resistance to ice. The vessel is used to conduct long-term observational studies over wide areas and to conduct oceanographic surveys primarily in the subtropic and subarctic regions of the Arctic, Pacific, and Indian Oceans. It is hoped that Mirai will serve as an advanced international station for ocean-based, marine-Earth research and as a base for transmitting various types of marine and Earth data.

Observation Tower

These towers are equipped with meteorological sensors for measuring air temperature, humidity, wind, precipitation, fluxes, and other variables. They are also used for monitoring the surrounding forest landscape, and ecological surveys of the forest and soil near the tower have been conducted.

Plankton Net

Plankton nets of various sizes and shapes are towed from research vessels to collect zooplankton living at depths ranging from the surface to the deep ocean.

Ocean Glider

Ocean gliders travel horizontally and vertically in water just like an air glider under the control of commands from a satellite and observe various ocean parameters such as temperature and salinity.

Research Aircraft

Research aircraft carry a wide variety of scientific payloads, such as remote sensing instruments, in-situ sensors, and sounding systems. These aircraft can quickly reach a target and investigate a wide area in a short time.

Polar Ocean Profiling System

The Polar Ocean Profiling System (POPS) can monitor not only meteorological data (air temperatures and barometric pressure) and sea ice motion but also ocean temperature and salinity profiles down to 600 m depth in the Arctic Ocean by using an Argo float mounted on the cable tethered from ice platform. POPS observation data shows recent Arctic Ocean warming and freshening due to rapid sea-ice reduction and global warming.

Argo float

Argo is a global array of more than 3,500 free-drifting profiling floats, aiming to understand the seasonal and inter-annual changes in the ocean. The Argo floats observe temperature and salinity down to a depth of 2000m, sending high-quality data to us via satellites. The Argo floats are deployed in the global ocean in collaboration with more than 30 countries, and the observed data are opened to the public in real time. The Argo data are very useful for many kinds of fields such as global climate research, weather forecast and industrial activities.

TRITON Buoys

TRITON buoys stay at the surface to collect oceanic and atmospheric data to study El Niño in the Pacific Ocean and Indian Ocean Dipole phenomena in the Indian Oceans. The buoys are deployed by JAMSTEC in collaboration with various countries in the tropics as part of an observing system.

CO_2 Buoy

To monitor the spatial and temporal variations of surface CO_2 in the global ocean, we developed a compact drifting buoy system for measuring sea surface CO_2 levels. The CO_2 data transmitted by the buoy will contribute to our ability to forecast climate change.

Wave Glider

A wave glider (WG) can measure surface meteorological and oceanic parameters near sea surface. The WG is powered completely by wave energy, so is environmentally friendly. Also, the WG can be controlled by satellite at any time.

Ocean Acidification

When atmospheric carbon dioxide is absorbed into sea water, it reacts with H_2O to form hydrogen ions. This makes the sea water more acidic, which can be measured as a decrease in pH. This process, called as ocean acidification, is another serious concern related to increasing atmospheric carbon dioxide. If ocean acidification continues, carbonate tests (shells) of marine organisms may dissolve or simply not form at all in the future. Further monitoring studies are required to understand how marine organisms and ecosystems will be affected by acidification, especially in the areas where acidificaiton is happening fastest, such as the Arctic Ocean.

Phytoplankton

Similar to plants on land, phytoplankton grow by absorbing light and carrying on photosynthesis, which consumes CO_2. They are the base of the marine food chain.

Zooplankton

Zooplankton feed on both phytoplankton and other zooplankton. In turn, many fish, including commercially important species, feed on zooplankton. They are thus important links in the marine food.

Ocean Water Sampling System

A sampling system is used to collect water samples at specified depths down to 6000m. The system is coupled with a Conductivity Temperature Depth profiler (CTD) system that provides detailed profiles of temperature, salinity, dissolved oxygen, and other variables.

Ocean Current Forecast

Ocean currents change position and magnitude over periods ranging from several days to several months. Sometimes ocean currents meander over distances of several hundred kilometers, and large eddies separate from these meanders. Predicting such variations is important for detailed investigation of climate variations and dispersion of marine biochemicals.

Marine Ecosystems

Spatial and temporal changes in the amount (biomass) of plankton and their species diversity, and the relationship between these changes and the global environment, are studied by means of shipboard and satellite-based observations. Because plankton are the base of marine ecosystems, changes in their biomass, distribution, and species composition influence not only the ecology of fish, sea birds, and marine mammals, but also CO_2 absorption into the ocean, which in turn affects global warming.

Primary Productivity Profiler

The primary productivity profiler is an observation buoy equipped with a fast-repetition-rate fluorometer, a CTD, an oxygen sensor, and an optical sensor. The profiler is supported by an underwater winch that moves it up and down periodically over the course of one year, so that seasonal variability in biological activity in the upper ocean can be observed.

Greenhouse Gases and the Carbon Cycle in the Ocean

Increases in atmospheric levels of greenhouse gases such as CO_2, which cause global warming, have become the subject of public concern. The amount of CO_2 in the ocean is about 60 times that in atmosphere, and therefore observation of the variability in CO_2 air-sea exchange and in the biogeochemical and physical cycles of CO_2 in the ocean is important.

Piston Corer

A piston corer, a long tube with a heavy weight, is inserted into the seafloor to recover cores of soft marine sediments, which are used to study past climate change.

Sediment Trap

A sediment trap automatically collects settling particles (marine snow) periodically over the course of a year. Carbon dioxide and various materials taken up by marine creature are transported to the ocean interior by marine snow.

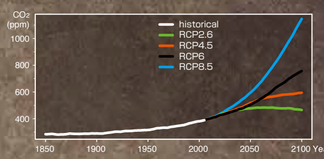
AUV (Autonomous Underwater Vehicle)

The next generation of deep-sea cruising autonomous underwater vehicle will be able to automatically collect oceanographic data (such as salinity, water temperature, dissolved oxygen and pH), which are required to clarify the mechanisms of global warming over extensive areas.

Ocean Circulation and Climate

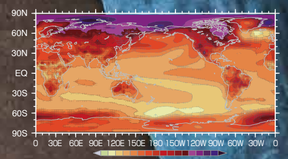
Recent observational surveys have revealed that the deepest waters of the major oceans have warmed during recent decades. The magnitude of this bottom-water warming was about 0.005C in the Pacific Ocean over the period from 1985 to 1999. The bottom-water warming has been shown to link to climate changes at sea surface via a fast teleconnection on multidecadal time scales. This implies that the deepest waters can play an essential role in determining the fate of the recent global changes. Better understanding of changes in oceanic properties from surface to bottom is thus required.

JAMSTEC has investigated the responses of the atmosphere, ocean, and land to regional and global climate change. However, we do not completely understand how high atmospheric CO_2 concentrations will affect air-sea interactions such as the El Niño–Southern Oscillation and the Arctic Oscillation, typhoons, and monsoon systems or how they will affect carbon cycles on land and in the ocean. Further sentinel and modeling studies are necessary to improve our understanding of the mechanism of global changes in the Anthropocene, and the efforts of the JAMSTEC will help to inform policies for mitigation of and adaptation to global warming.



CO_2 concentrations estimated by the earth system model

Using the earth system model, MIROC-ESM, the CO_2 concentrations are estimated from anthropogenic CO_2 emissions and uptake by biosphere. For the future emissions and land-use scenarios, four representative scenarios (RCPs) in the IPCC 5th assessment report are used.



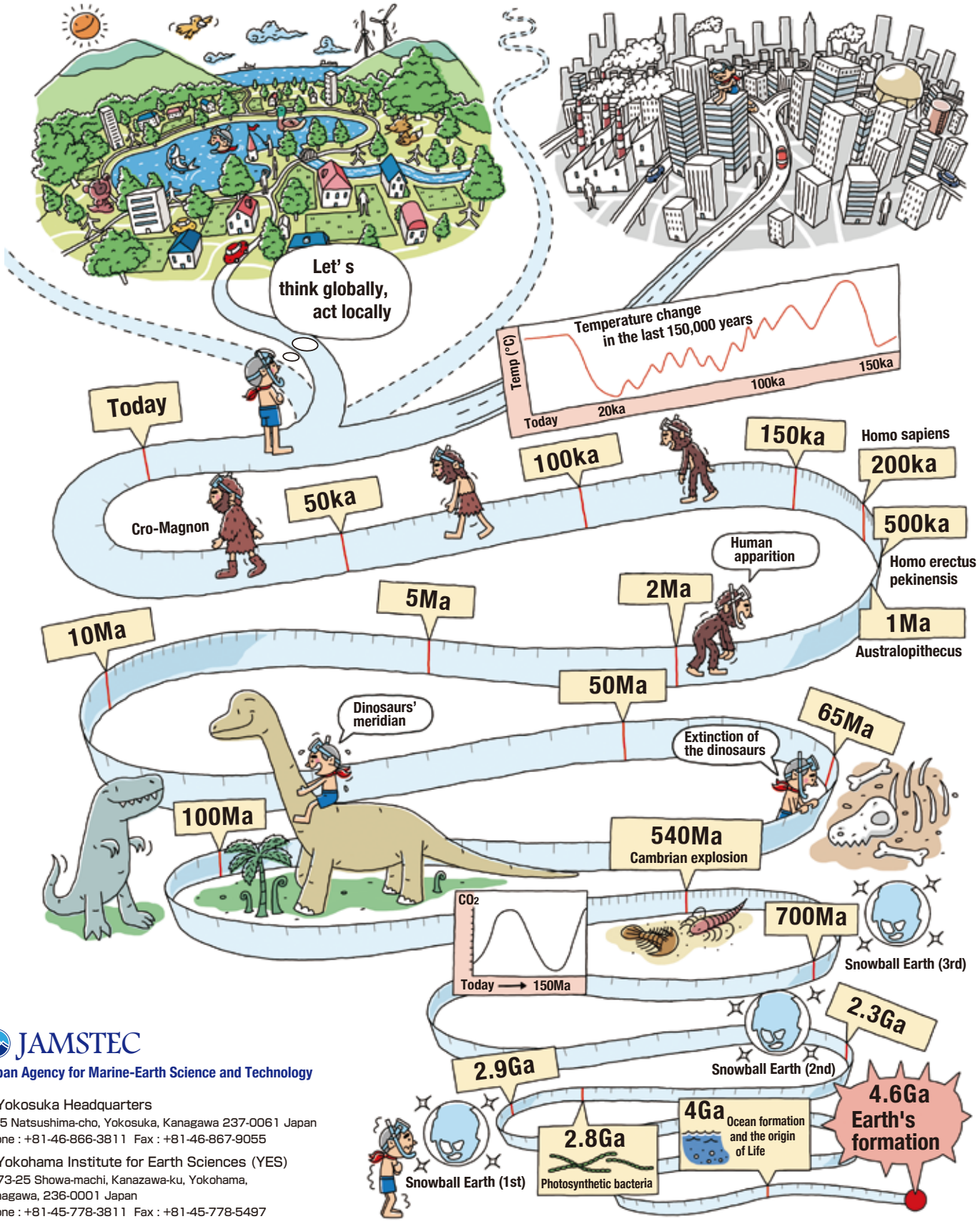
Projection of surface temperature anomaly in 2100AD

This projection is computed using our earth system model, MIROC-ESM, which considers processes within and between the atmosphere, ocean, land, and biosphere. In the wide range of estimated atmospheric CO_2 concentration, here the 538ppm in 2100AD was used (RCP4.5 in the left panel).

Global changes in the Anthropocene

JAMSTEC's Challenge

Looking back on the Earth's very long history, we learn that during the recent 100 year human-dominated epoch, called the Anthropocene, global change has progressed very rapidly compared with most previous episodes of global change. We are continuing observational and modeling studies of the atmosphere, ocean, land, ecosystems, and their interactions, in order to understand global change in the Anthropocene.



ka = 1000 years ago Ma = 1000,000 years ago Ga = 1000,000,000 years ago

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