Tropical Winds

Spring 2000

News from the ARM Program for students and teachers about climate-change studies

IN THIS ISSUE

WHAT IS GLOBAL WARMING?

by Andrea Maestas, TWP Undergraduate Intern

Did you know many scientists today agree that the temperature of our Earth is rising? In fact, the majority of scientists say the Earth has warmed by one degree Fahrenheit in the last 100 years. While this may not seem like much of a change in temperature, it may be big enough to have a noticeable impact on the environment with possible changes in agriculture, forests, coastlines and oceans. These changes that our planet may be going through are called global warming.

Global warming results from an enhanced "greenhouse effect." When greenhouse gases are released into the air, they form a blanket around the Earth. These greenhouse gases include carbon dioxide, water vapor and other gases like methane and nitrous oxide. This blanket around the Earth does the same thing a blanket around your body would do: trap the heat to keep you warm. The Earth's blanket traps the sun's heat to keep it warm.

The blanket around the Earth is very important because without it, the planet would be too cold for life as we know it. The Earth is heated by the solar energy we get from the sun. While the Earth absorbs some energy from the sun, some other energy is reflected back into space. Therefore, in order to remain the same temperature, the energy being absorbed by the Earth has to be the same as what is being reflected back into space. Recent global warming actually occurs when humans cause more greenhouse gases to be in the atmosphere than what is normal and healthy. With more greenhouse gases in the atmosphere, the Earth's blanket gets thicker and traps more solar energy than what gets reflected back into space.

When people burn fossil fuels like coal, oil, and gas, lots of carbon dioxide is being released. Millions of people in the world drive cars to get around everyday. But, what people tend to forget is that each time they use an automobile, they are releasing carbon dioxide. For example, the average car releases 20 pounds of carbon dioxide for every gallon of gas burned. Industries such as steel factories and oil refineries also create a lot of air pollution. In other words, whenever you see smoke coming out of a factory's chimney, you are seeing

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Nauru99 Experience

By Tom Gillman

From June 15 to July 19, 1999, I had the privilege of sailing on board the U. S. National Oceanic and Atmospheric Administration (NOAA) Ship Ronald H. Brown as part of the Nauru99 scientific expedition in the Tropical Western Pacific. My particular role was as a representative of NOAA's *Teacher at Sea* program, but what I came away with was a heightened appreciation of the work carried on by this talented group of scientists.

Nauru99 was sponsored by the U. S. Department of Energy's (DOE) Atmospheric Radiation Measurement (ARM) Program, with NOAA and the Japan Marine Science and Technology Center (JAMSTEC) as major collaborators. The objective of Nauru99 was to further our understanding of the radiative energy exchange between the atmosphere and the Earth, and how this exchange affects long-term climatic changes, such as global warming, the greenhouse effects, El Niño, etc.

The science conducted on this mission was mind-boggling to an "outsider" like me! We had more RADARs, LIDARs, photometers and ceilometers than have probably ever been assembled in one place at one time! We even had a LIDAR that could transmit a laser forward from the bow of the ship and detect puffs of wind! But while I think time will prove that Nauru99 accomplished its scientific objectives, what many people will never be able to appreciate is the incredible amount of goodwill generated by the participants in this expedition.

I've already mentioned that the major players in this exploration came from the United States and Japan. However, we also had participants from the Max Plank Institute for Meteorology in Hamburg, Germany, Flinders University in Adelaide, Australia, and the La Vai Moana Marine Center in American Samoa. I should also mention the important role played by our new Nauruan friends, who both manage and serve as observers at the ARM site on their island. This was truly an international expedition in every sense of the word!

You are the inspiration! *Young scientists like Tepora Toliniu (foreground) and Jennifer Aicher are role models for school children. Particularly, Tepora, a native American Samoan, inspires students in the Tropical Pacific.*

You "had to be there" to see the excitement as officers, scientists and crew members of the Ron Brown and the JAMSTEC Research Vessel Mirai exchanged places for a day. And I wish you could have shared the great sense of accomplishment that we felt when we presented the Nauruan officials with the first ever comprehensive bathymetric survey of their coastal waters, and received their lavish thanks in return. Or the great sense of pride as we hosted a "Forth of July" barbecue on the fantail of the ship, with many of our new local friends in attendance.

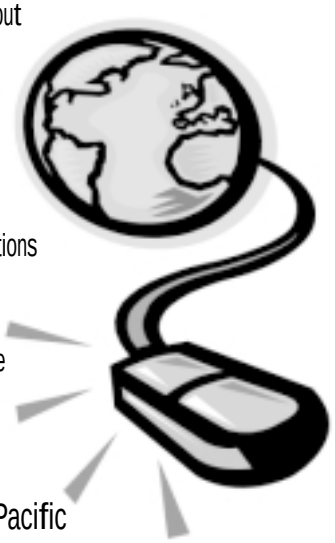
But, as a teacher, perhaps one of the highlights of the whole trip for me was watching the excitement in the eyes of the senior class of Nauru High School when they visited our ship, and were given the red carpet treatment by everyone on board! Even though these children currently study very little science or physics in their school, they were keenly interested in our scientific mission. And if you think about it, it is crucial for the next generation on islands like Nauru to be keenly aware of their marine environment and their relationship to it. These people depend on the sea for their very existence; without it, they have nothing. So if we are able to increase their awareness of the environment even a little bit, then we have performed a very valuable service indeed.

I'd like to close with one scene that I found particularly touching while the high school kids were on board. There were several young ladies among these students, and they absolutely clamored to have their picture taken with one of the two participants from the La Vai Moana Marine Center, one of whom happened to be a young American Samoan lady. Here were these young girls, who had probably never thought of becoming scientists, suddenly presented with a role model from a background very much like their own. You could literally see the sparkle in their eyes as they suddenly had their eyes opened to some opportunities, of which they had hardly dreamed! And that, my friends, is a capstone example of what made this campaign so exciting for all of us who participated!

Tom Gillman is a professor at College of Desert in Palm Desert, California, USA.

We want to hear from you!

We are committed to stay in touch with you. Please send us any comments about the contents and let us know how we can serve you and your school. If you have access to the Internet, you can send us e-mails. If you live in Manus or Nauru, you can bring your comments or questions to our observers at the ARCS research site. Of course, you can send us a letter, too. Here is the contact information.



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Global Warming
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greenhouse gases. If we humans continue to release those greenhouse gases into the air, global warming is likely to continue.

Our planet has natural ways of limiting the amount of carbon dioxide that goes back into the atmosphere. Trees are one of those natural resources. Trees are very important to us because they use carbon dioxide to make sugars and in turn release oxygen for us to breathe. With this in mind, you can understand how cutting and burning trees can be a big loss for our environment. When cut down and burned, all the carbon dioxide in a tree is released into the atmosphere. Not only do we have fewer trees to produce oxygen for us, but by destroying the trees in the forests and rain forests, we are also adding to the global warming problem.

According to many scientists' predictions, there will be changes for all types of environments if the temperature of the Earth continues to rise. Many of the beautiful plants and animals that exist today may not be able to survive because of the extremely warm temperatures. For example, fish need to live in water that is just the right temperature. If the water in the ocean gets too warm, some fish may die or have to migrate to another region. As a result, other animals like polar bears and seals that depend on fish for food may also die. Global warming could also change life on dry land. Many farmers fear that it will someday cause their crops to be harmed by the heat. There are still many things that are unknown about global warming, so scientists in many countries are conducting research to better understand global warming and its possible effects.

So, what can you do to help stop global warming? Well, there are a lot of little things that you can do that may not seem important. Encouraging your friends and family to ride their bicycles or walk to nearby destinations would be a great start. Or, if the place you want to get to is too far, try to ride a bus or subway. This way, more people get where they want to go in one trip! The key to making a difference is to release fewer greenhouse gases into the air.

Source: The U.S. Environmental Protection Agency. Global Warming Site. <http://www.epa.gov/globalwarming/index.html>.

Dr. Fairley's Corner

The ARM program relies on many people in its effort to gain a better understanding about our climate. Beginning this issue, we will be introducing you to a variety of the scientists, technicians, engineers and students whose expertise makes the program a diverse scientific endeavor. Our first guest is Dr. Bill Porch, calibration scientist at the U.S. Department of Energy's Los Alamos National Laboratory. In this interview, Bill gives some insight into his work and tells a few things about himself.

Q: How long have you been working with the ARM program and with TWPPO?

A: I've been working with the ARM Program since its beginning in about 1990 and with TWPPO since 1994.

Q: Where did you go to college?

A: In 1966 I earned my bachelor's degree at the University of Utah in Salt Lake City. In 1968 I got my master's degree at the University of Washington in Seattle, where I also earned a Ph.D. in 1971.

Q: What is "calibration"?

A: Calibration is a multi-measurement comparison between an instrument and a reference standard to make sure that the instrument measures accurately what you want to measure. An instrument can lose its accuracy over a period of time, particularly during a transportation process. Environment is another big factor. For example, an extremely humid environment, which is often the case in the Tropical Pacific region, can be very harsh on the instrument. So, you need to perform calibration periodically.

Q: What do you like most about your job?

A: Working in an active ARM and TWPPO team environment on the interesting scientific and important national problem of improving our understanding of natural and anthropogenic influences on Global Climate Change.

Q: What advice do you have for young people who are interested in environmental science?

A: Many people have a tendency to exaggerate how much we know about the environment, in our case, climate. In other words, policy makers tend to give an impression that we've done enough research on climate. Well, the truth is, like most other science fields, there is still so much about climate and weather that we don't know. Things we "think" we know all about can come back and bite us! Students should know that environmental science has almost a limitless supply of ignorance. So, I want young scientists to keep their eyes open, be creative, and always think of new ideas.

ARM/TWP Scientist Bill Porch performs calibration at the ARM Program's Southern Great Plains facility.

Los Alamos
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Classroom Activity 1:
Making Clouds

(Adapted from Climate Change and Sea Level (part 1): Physical Science by Aung, Kaluwin and Lennon)

Materials

1 liter (or larger) clear glass jar with lid (largemouth jars work best)

Ice cubes or crushed ice 

Hot water (caution: even very warm water will do). Do not use water that is hot enough to burn your skin.

Matches 

Can of aerosol spray (air freshener is suggested)

Black construction paper

Safety goggles 

Flashlight (optional)

Objective:

The objective of this activity is to investigate the conditions that must be present for clouds to form.

Materials:

- 1 liter (or larger) clear glass jar with lid (largemouth jars work best)
- Ice cubes or crushed ice
- Hot water (It does not need to be boiling; very warm water is sufficient.)
- Matches
- Can of aerosol spray (air freshener is preferred)
- Black construction paper
- Safety goggles
- Flashlight (optional)

Important points to understand:

Three things are necessary for cloud formation: water vapor, vertical movement and cooling of air, and condensation nuclei.

1) Water vapor: When liquid water is heated, it changes to a gas by a process called evaporation. The gas formed by evaporation is called *water vapor*, which exists in the atmosphere (air) but usually cannot be seen with the naked eye.
2) Vertical movement and cooling of air: When the sun heats up the Earth's surface, it also raises the temperature of the air nearby. The mass of warmer air then breaks away from the surface and starts rising (upward vertical movement). As the air mass rises higher, its temperature decreases (cools down).
3) Condensation nuclei: As the mass of warm air rises higher and its temperature gets cooler, it can hold less water vapor. In order to form droplets that compose clouds, water vapor needs to "hold on to" something. *Condensation nuclei* serve this purpose of letting water vapor "hold on to" them. Many things can serve as condensation nuclei, such as dust, pollen, salt from ocean spray, and smoke.

Preparation (for teachers):

- Before the lesson begins, discuss cloud formation with the class to determine the students' ideas on how clouds form. Ask students what they think a cloud is made of, then ask them how it forms.
- Be sure that all materials are either centrally located or already distributed to the groups of students. Perhaps the students could bring clear glass jars, such as mayonnaise jars, pickle jars, canning jars, etc., from home. The jars do not have to be the same shape, but clear glass works the best. The larger the mouth of the jar, the better the experiment.
- Depending on the students, the teacher may choose to light all matches for them to reduce the risk of accidents and the temptation for horseplay. CAUTION: Flames and aerosol cans are an explosive combination. Holding a lighted match in front of an aerosol can makes a very effective flame-thrower. Students must never have access to both the matches and the aerosol at the same time. If in the teacher's opinion, this represents too great a risk for the students, it is strongly recommended that the aerosol not be used at all. The important points of the activity can still be made using only smoke.

Procedure:

1. Fill the jar with hot water. Do not use water that is hot enough to burn your skin.
2. Pour out most of the hot water, but leave about 2 cm of water in the bottom of the jar. Hold the black paper upright or prop it up against some books behind the jar.
3. Turn the lid of the jar upside down and fill it with ice. Now place the lid on the jar as shown in Figure 1. Observe the jar for three minutes. If you have a flashlight, darken the room and shine the flashlight on the jar while you observe it. Record your observations in the Data Table (sample table is shown below), in the box marked "Control."
4. Pour the water out of the jar and repeat steps 1 and 2.
5. Prepare the lid so that you can immediately cover the mouth of the jar during the next step.
6. Move all loose papers away from the jar, put on your safety goggles, and then strike a match and drop the burning match into the jar. Cover the mouth of the jar immediately (with the ice-filled lid). Record your observations in the box marked "Match" in the Data Table. Be extremely careful with the matches.
7. Pour out the water in the jar and repeat steps 1 and 2.
8. Spray a very small amount of the aerosol in the jar and immediately cover the mouth of the jar with the ice-filled lid.
9. Observe what happens in the jar for three minutes and record your observations in the Data Table below in the box marked "Aerosol."

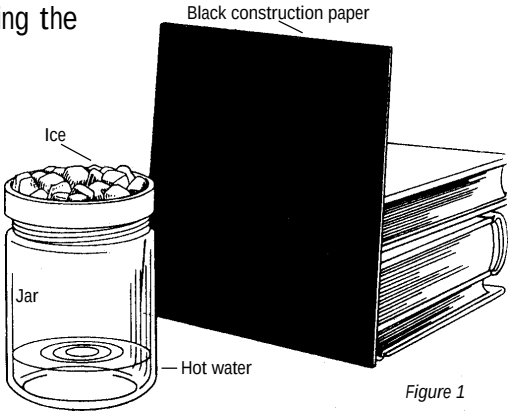

Figure 1

TRIAL	OBSERVATION
Control	
Match	
Aerosol	

?????? Questions:

1. In all the trials of this experiment, the jar contained water vapor and cooled air. Where did each come from?
2. Did a cloud form the first time you put the lid over the mouth of the jar? How about the second and third times?
3. Look up the word *aerosol* in a dictionary and write the definition here.
4. Based on the definition given in your answer to Question 3, would you classify smoke as an aerosol?
5. Based on your observations and your answers, what is the other condition besides moisture and cool air necessary for cloud formation?