San Diego, CA – Galapagos Islands, Ecuador

Jennifer Richards, NOAA Teacher at Sea

www.ogp.noaa.gov/epic
Jennifer.Richards@noaa.gov

NOAA Ship R/V Ronald H. Brown
September 4 - October 6, 2001

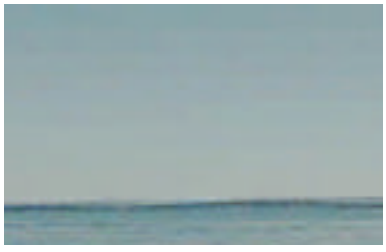

Table of Contents

Tuesday, September 4, 2001 3
Wednesday, September 5, 2001 4
Thursday, September 6, 2001 6
Friday, September 7, 2001 8
Saturday, September 8, 2001 10
Sunday, September 9, 2001 13
Monday, September 10, 2001 16
Tuesday, September 11, 2001 18
Wednesday, September 12, 2001 19
Thursday, September 13, 2001 23
Friday, September 14, 2001 25
Saturday, September 15, 2001 27
Sunday, September 16, 2001 30
Monday, September 17, 2001 32
Tuesday, September 18, 2001 34
Wednesday, September 19, 2001 35
Thursday, September 20, 2001 37
Friday, September 21, 2001 39
Saturday, September 22, 2001 41
Sunday, September 23, 2001 44
Monday, September 24, 2001 46
Tuesday, September 25, 2001 47
Wednesday, September 26, 2001 50
Thursday, September 27, 2001 51
Friday, September 28, 2001 54
Saturday, September 29, 2001 56
Sunday, September 30, 2001 58
Monday, October 1, 2001 59
Tuesday, October 2, 2001 61
Wednesday, October 3, 2001 62
Thursday, October 4, 2001 64
Friday, October 5, 2001 66
Saturday, October 6, 2001 70
Index 72

TUESDAY, SEPTEMBER 4, 2001

Location: San Diego, California

Latitude: 32.7°N

Longitude: 117.2° W

Temperature: 75° F

Seas: Since we are still at port in a protected harbor, there is no swell. The water is extremely calm.

Travel Log: Tomorrow the ship departs San Diego, California for its big adventure! I saw the ship for the first time this morning, and had the opportunity to meet Captain Dreves and Chris Fairall, the Chief Scientist. At 274 feet long, the ship certainly isn't small, but it is docked at the Naval Station and is surrounded by huge gray navy ships, dwarfing the Ronald H. Brown. Some of my students had asked if the captain has a white beard, smokes a pipe, and has a peg leg or a patch on his eye. The answer is "no" to all of those questions (sorry to disappoint you). I'll be sure to take his picture as soon as I unpack my camera.

The pre-trip hoopla was pretty exciting and tiring. A reporter from the Navy Compass and a cameraman from KUSI, a local television station, came to the ship to interview the captain, Chris, and me. The weatherman at KUSI did a nice 2.5 minute piece about the cruise on the evening news in which he spoke about the importance of the research being conducted, and the Teacher at Sea (me!). Dr. John Kermond from NOAA gave me a tour of the ship, which Captain Dreves described very eloquently as "an industrial workplace with an enhanced chance of drowning." On the inside, it has laboratory areas, a mess hall, small library, lounge with a television, lots of staterooms, and a lot of industrial areas filled with heavy equipment and people with dirty shirts. There's something for everyone!

This afternoon John Kermond came up to my school (Guajome Park Academy in Vista, California) so I could say goodbye to my students. They wanted to know if I'm going to miss them, so let me put it in writing right here- YES! I really enjoy spending my days with my 9th and 10th grade Earth Science and Math students, and I will miss getting to see them every day.

Finally, I made it home to get my suitcase and say goodbye to my dog and cat, Birch and Hobbes. Birch knew something was going on- he gets nervous when suitcases leave the house and he's not invited. Then back to the ship for a photo shoot with the San Diego Union-Tribune newspaper. What a busy day! I'm definitely not used to being in the spotlight like this, and I felt pretty awkward with cameras on me the whole day, but I survived.

Once things settled down, my husband, Rob came to the ship to see me. John and I gave him the tour, and I was very happy to see him before my big departure. Although the ship doesn't leave until tomorrow morning, I thought I would spend the night here so I can get used to its layout before it gets too wobbly in the ocean.

My first adventure on the ship went something like this: I was getting ready for bed and put my sneakers in a drawer in my stateroom. When it was time to visit the head (bathroom) I found that it had been locked from the inside. Since I share a head with another room, I thought someone was using it. After waiting a while, and realizing that the only way in was to go through my neighbor's room, I went to get my shoes on. Now, you need to understand that I received at least a half-dozen emails prior to getting on the ship telling me to bring shoes that cover my whole feet, because anything else will not be allowed outside of the stateroom. Well, when I went to get my shoes on, so that I could walk down the hall to the neighbor's stateroom, so that I could get into the bathroom, I realize the drawer had locked!! Without shoes, I couldn't leave my room, and I couldn't unlock the head! So I poked my head out of my room until someone walked by and I asked for help. The Chief Scientist showed me how to unlock the head with a penny, but we had no luck unlocking my shoes.

Question of the Day: The name of the ship I am on is the "R/V Ronald H. Brown." This question has two parts: 1) What does R/V stand for, and 2) Who was Ronald H. Brown?

WEDNESDAY, SEPTEMBER 5, 2001

Location: San Diego, California

Latitude: 32.7°N

Longitude: 117.2° W

Temperature: 75° F

Seas: Since we are still at port in a protected harbor, there is no swell. The water is extremely calm.

Science Log: Research has not yet started. The scientific crew was notified in a ship briefing that they are not allowed to gather and record data until the ship leaves Mexican waters.

Travel Log: This morning, my husband Rob and John Kermond from NOAA came to watch the ship depart. Rob brought me an extra pair of shoes since mine were still stuck in the drawer. Then I realized the drawer had a special latch that had to be pushed in, and my shoes weren't locked in after all! Dork mistake #1.

There was a lot of activity around the ship as the crew and scientists rushed to tie everything down- from computers to bottles and flasks, to heavy equipment and cranes on deck. Everything on the ship must be securely locked or tied down or bolted to something prior to departure, since the movement of the ship could cause things to start flying.

Finally, the big departure at 10am. We sailed for an hour up to the fueling dock at Point Loma, where we docked for another 5 hours. It was evening before we were out at sea.

As soon as the ship left the protected harbor, I was very aware of the swaying, and knew I would need something to prevent me from getting seasick. Some people wore special wristbands that use acupuncture to suppress seasickness. Other people wore a patch behind their ear that releases medication into their bodies. I chose an over-the-counter medication called Meclizine. It works well, but puts me to sleep.

I started reading the "Voyage of the Beagle" which is Charles Darwin's journal of his 5-year voyage in the 1830s to the Galapagos Islands and all over the world. You may recall that Darwin developed the theories of evolution, natural selection, and survival of the fittest that we still believe today. Did you know that Darwin was seasick during the entire voyage??!! How miserable that must have been. During the 5-year journey, he was only on the ship for 18 months, and never more than 45 days at a time (I'll be on this ship for 31 days). He was 20 years old when he left Britain on

the HMS Beagle, and 25 years old when he returned home, only a few years younger than me, and not too much older than my high school students. It's pretty inspiring to think of someone so young contributing so much to the scientific community. I'll fill you in on more Darwin stuff as I keep reading his journals.

Question of the day: One of today's photos shows a "marine layer" (see photo descriptions below). What causes the marine layer to sit over coastal land in San Diego?

Photo Descriptions: Today's photos focus on the beautiful scenery of San Diego harbor. You'll see pictures of a variety of ocean vessels, the picturesque Coronado bridge, and the "marine layer" off the coast. The marine layer is an area of the San Diego coast that is fogged in, even when the sky above the water and the sky further inland is perfectly clear and sunny.

THURSDAY, SEPTEMBER 6, 2001

Latitude: 30^{o} 21.2 N

Longitude: 116^{o} 01.7 W

Seas:		
	Sea wave height:	less than 1 foot
	Swell wave height:	2-3 feet
	Visibility:	10-12 miles
	Cloud cover:	8/8 (100%)
	Water Temp:	21.4^{o}C

Science Log: Since we are not in international waters yet, the scientists are not permitted to collect or record data. Many of them are spending their time calibrating equipment or working on papers that they would be writing if they were in their offices at home.

Travel Log: I have had the chance to meet a number of scientists and crew members on the ship, and each one of them really amazes me. Everyone on this ship is either a "crew member" or part of the "scientific party." All the crew members report to Captain Dreves. They run the ship, repair and maintain the ship, and make sure we are happy and healthy. Besides the Captain, there are four additional uniformed NOAA Officers, and approximately 20

un-uniformed crew members. It takes 7 people to keep the engine in good shape, 3 stewards in the kitchen, and the remainder are deck hands. The officers are assigned to the ship for 2 year commissions, and during that time they spend 11 months out of the year on the ship, out at sea. The crew is on the ship forever, unless they want to quit and get a new job. It's so interesting to talk with them, and to realize how unique their lives are.

Everyone in the scientific party (including me) reports to the Chief Scientist, Chris Fairall. There are research groups here from:

- Environmental Technology Laboratory in Boulder, Colorado
- University of Washington Applied Physics Laboratory
- Colorado State University Department of Atmospheric Science
- University of California at Santa Barbara
- Universidad Nacional Autonoma de Mexico

and a few others that are working in partnership with each of the groups above.

Each of the research groups has their own equipment on the ship and their own research to focus on, but they have to work together to coordinate data collection efforts. And since they are sharing bunks with their coworkers (2 people per room) they have to be able to get along with each other in tight quarters, which may get challenging towards the end of the cruise. Can you imagine being stuck on a ship with your best friend for a month, with no way to escape? After a whole month you may need a break from each other.

The big excitement for the day was the fire drill and abandon ship drill. It's kind of scary to think we might need to do these things for real, although this is a top-notch ship with a top-notch crew, so I'm sure we'll be fine. The abandon ship whistle consists of 6 short horn blows, followed by one long horn. We can remember this by saying "get-your-butt-off-the-damn-ship nnnnoooowwwwww!" Seven short, one long. We all have to grab a long sleeve shirt, long pants, and a hat to protect us from sun exposure as we drift around in the ocean. We also have a life preserver and a "gumby suit" to protect us from the water chill until help arrives. The man overboard drill will be later in the cruise and consists of 3 long horn blows – "maaaan over booaarrd."

Question of the day: The scientists on board are not allowed to collect and record data until we are out of Mexican waters. How far off-shore is the boundary between Mexican waters and International waters?

Photo Descriptions: Today's photos show you an overview of my stateroom. They are pretty small, but efficiently laid out. Each stateroom has 2 bunks, lots of drawers, an area that can be converted into a desk, a sink, 2 life preservers and 2 gumby suits, and an inside door leading to a head. The most important thing in the stateroom is our bunk card, which tells each of us exactly where to go in case of fire, abandon ship signal, or man overboard signal.

FRIDAY, SEPTEMBER 7, 2001

Latitude: 24° 3.063 N

Longitude: 112° 11.4 W

Temperature: 26.1°C

Seas:

Sea wave height:	3-4 feet
Swell wave height:	4-6 feet
Visibility:	10 miles
Cloud cover:	3/8
Water Temp:	27.7°C

Science Log: Research has not yet started. The scientific crew was notified in a ship briefing that they are not allowed to gather and record data until the ship leaves Mexican waters.

Each day during this trip I will highlight one of the research groups on the ship and introduce you to the science they are doing. Today I met with the group from the University of California at Santa Barbara- Dr. Carter Ohlmann and Dave Menzies. These guys are studying the variations in ocean radiant heating, or in simpler terms, the amount of light in the ocean at different depths.

Imagine a nice clear swimming pool. The sun's heat energy can penetrate all the way to the bottom of the pool because the water is so clear. Whatever heat energy hits the pool will be dispersed throughout the water somewhat evenly. Makes sense, right?

Now imagine that the pool has a layer of scum and algae at the top. Face it, you just haven't done a very good job at cleaning the pool, and your allowance just isn't big enough to make the job worthwhile. Now, the sun's heat energy can't pass all the way to the bottom of the pool because the scum is blocking the light. The very top of the pool water is going to capture almost all of the sun's heat energy, and the bottom layers of water will be darker and colder.

The ocean has lots of "stuff" in it, right? Fish, whales, coral, seaweed… All plants, whether in the ocean or on land, contain a substance called "chlorophyll." Chlorophyll is the substance that makes plants green. If you can detect chlorophyll in the ocean, you are detecting plant material-mostly in the form of algae. If the water appears green, it has a lot of algae, if it appears mostly blue with a little green, it has a little algae. Dr. Ohlmann and Mr. Menzies have special piece of equipment, called an SPMR, that can measure the exact "color" of the ocean. The water and chlorophyll in the ocean absorb and reflect solar energy, or light, and these scientists want to know how much of the sun's heat energy is being absorbed and reflected at various depths in the ocean. In other words, how does the sun heat the ocean?

Aren't there satellites that can accomplish the same task as what is being done on the ship? Well, there is a NASA satellite in space called "SeaWiFS" (Sea viewing Wide Field-of-view Sensor) that measures different wavelengths of light being reflected from the surface of the ocean, and it can determine how much blue and green is there. Remember, the more green that is present, the more algae that is present. But satellites are viewing the ocean from so far away, and they have to make lots of adjustments for the amount of light in the atmosphere. If it's cloudy or foggy, it can be impossible for the satellite to see the ocean. Since Dr. Ohlmann and Mr. Menzies are right here at sea level, they can measure the amount of green and blue in the water at the surface, and at various depths in the ocean. For comparison, they also measure the light near sea level, by installing sensors on a large tower on the bow of the ship.

Why does anyone care about all this? There are lots of scientists around the world who try to model different aspects of climate. The computer models make certain assumptions about how heat circulates between the ocean and the atmosphere. Since any large body of water can have a profound affect on the land nearby, it is important that the climate models be accurate. The data being collected and analyzed by Dr. Ohlmann and Mr. Menzies will improve the accuracy of air-sea heat exchange in climate computer models.

Travel Log: You may have noticed from the sea data above that the wave height is larger today than it was yesterday. A satellite image on the bridge shows hurricane Henrietta in the area, which accounts for the swell we feel. The ship is rocking quite a bit, making it difficult to walk around too much, but I seem to have acquired my "sea legs" and the rocking isn't making me sick. Hmmm, in a cartoon drawing, what would sea legs look like? Let me know if you have any ideas.

There's not a lot of entertainment on the ship. If the weather is nice you can go out on deck and watch the flying fish. A lot of people have books and computers to play with when their shift ends. The only form of organized entertainment are the movies shown each night in the lounge. Just make sure you bundle up, because the lounge, and most indoor areas of the ship, are freezing! The air conditioning inside the ship keeps the temperature very low so that the millions of dollars of electronics equipment on board is safe from heat damage.

Question of the day: What is the difference between sea wave height and swell wave height?

Photo Descriptions: Today's photos show Dr. Ohlmann and Mr. Menzies at work in the ship's lab. The rocket-looking device they are holding is the SPMR mentioned in the Science Log above. The tower at the bow of the ship contains sensors that will measure the wavelength of light in the atmosphere at sea level. The large apparatus with the long cylinders is a CTD, which measures the conductivity (salinity), temperature, and depth of water samples.

SATURDAY, SEPTEMBER 8, 2001

Latitude: 19° 57.1N

Longitude: 108° 21.4W

Temperature: 30.0°C

Seas:

Sea wave height:	2-3 feet
Swell wave height:	3-4 feet
Visibility:	10-12 miles

Cloud cover: 4/8
Water Temp: 29.4°C

Science Log: Today I met with the radar scientists from Colorado State University (Ft. Collins, Colorado). These guys are meteorologists who are studying the internal structure of storms over tropical oceans. As radar scientists, they rely primarily on radar systems for obtaining data. They are using pretty sophisticated equipment and software for their research, and have been spending the last several days just getting everything set up.

Although all four members of this group - Dr. Rob Cifelli, Dr. Walt Petersen, Mr. Bob Bowie and Dr. Dennis Boccippio - are very nice guys with a great sense of humor, from my perspective, they are somewhat the villains on the ship. These guys are hoping we will encounter storms- lots of them- the bigger, the better. Have any of you seen the movie "The Perfect Storm?"

Here's some background information that will help you understand the research this group is working on. Storms on land and storms on the ocean tend to be about the same size vertically, but the way they function internally is quite different. On land, storms can be generated over pretty short periods of time, and can run themselves out pretty quickly. A lot of people in the mid-west are familiar with the daily rain storms that hit during summer afternoons- suddenly coming out of nowhere, and then disappearing as fast as they arrived. This is because land is full of heat pockets. You could have rivers, farms, asphalt and concrete highways, homes, and forests, and they all heat and cool at different rates. The differences in the rate of heating cause pressure gradients, which can lead to volatile weather conditions.

The ocean does not contain heat pockets the way the land does, and therefore, the air above the ocean heats more slowly. Pressure gradients in the air above the ocean are not as steep, so when storms are generated over the ocean, they grow slowly over long periods of time, and can become quite large. Do you remember hearing in the news about hurricanes? The weathermen will track hurricanes for many days to see where it is moving and how large it is getting. This is an example of an ocean storm growing slowly to a very large size.

If we can understand how storms form and behave in a certain area, it will help us understand the climate in that area. If you want to learn about the climate of San Diego, California, for example, it's not very hard. You can visit the library and find all sorts of documents about the climate and typical weather conditions. There have been weather stations in San Diego

for at least a hundred years, and there is plenty of data that has been collected. There aren't too many surprises.

But what do we really know about climate over the oceans? Not a whole lot. Storms heat the atmosphere and affect the climate. NASA and NASDA (the Japanese Space Agency) have a satellite called TRMM (Tropical Rainfall Measuring Mission) provides data about storms from very far away, but we don't have oceans full of weather stations to show us exactly what's going on at the surface and in the troposphere. Plus, TRMM can only measure what it sees from the sky- the tops of storms. You have to be on the ocean to see the rest of the storm. And since the satellite passes over each location on earth only twice a day, the data can be up to 12 hours old. When's the last time you heard of a storm that hadn't changed in 12 hours?

How do the atmosphere and the ocean interact? How are storms in the tropics different from storms in the mid-latitude regions? What impact does the tropical ocean water have on the air above it? What impact does it have on storms that form over it? That's where this group from Colorado State University comes into the picture. The R/V Ronald H. Brown is equipped with a Doppler Radar system that uses microwaves to echo off of condensed water, ice crystals, and hail. It can create 3D profiles of storms within 150 km of the ship. A satellite can only see the top of the storm, but the radar system on the ship can see the internal structure of it. And if we happen to be in the middle of a big storm, the radar can see everything going on around us for the duration of the storm (not just once every 12 hours, like the TRMM satellite). Unfortunately, hurricane Henrietta was too far away to effectively measure with the radar. These guys will also be launching weather balloons from the ship to gather additional atmospheric data in the sky above us.

What can the world hope to learn from the research being done by this group? Well, if we have a better understanding of how storms are behaving in the tropics, we will have a better understanding of the factors affecting ocean climate. Since events such as El Nino originate in the tropical area of the Pacific Ocean, this research may help us better understand what causes seasonal climate changes and El Nino, and provide better forecasting of such events.

Travel Log: The air temperature is getting much warmer each day, and you can definitely tell we're in the tropics. One of my students, Kalen, asked if I had seen any wildlife? Excellent question. I forgot to mention earlier that I saw a bunch of flying fish! They were really cool- almost looked like birds jumping out of the ocean, flying 10 or 20 feet, then diving back in. You could see them just about any time you looked for them during the last

couple days. We also passed a huge school of at least a hundred porpoises, about a mile away. I'm hoping we'll see some more a little closer so I can get some pictures for you.

Have you ever heard of sailors seeing a green flash at sunset? Captain Dreves announced last night that the conditions were good to see it, so I ran out on deck. After staring at the horizon a couple minutes I saw what looked like neon green flashes of lightning, only for a second. I waited and waited and finally the sun dipped below the horizon, but I'm not sure if I saw it. I'm not sure if what I saw was THE green flash, or if my eyes were getting strained from staring at the sunset too long. I told Captain Dreves "well, I guess I have 3 and a half more weeks to see it again" and he said "I was at sea 30 years before I saw my first one." Oh, well.

Question of the day: What causes the green flash that sailors sometimes see at sunset?

Photo Descriptions: Today's photos show some of the equipment that the group from Colorado State University are using for their research. Dr. Rob Cifelli and Dr. Walt Peterson are working on the computer to establish the radar settings they will be using to collect data. Bob Bowie is standing at the radar station that controls the Doppler Radar unit on the ship. Dr. Dennis Boccippio inflates a weather balloon, which you see aloft in a separate picture. Finally, all four members of the CSU team pause for a picture.

SUNDAY, SEPTEMBER 9, 2001

Latitude: 16° 39.3 N

Longitude: 103° 17.0 W

Temperature: 31.3°C

Seas:		
	Sea wave height:	1-2 feet
	Swell wave height:	2-3 feet
	Visibility:	10 miles
	Cloud cover:	5/8
	Water Temp:	29.7°C

Science Log: Today I met with Dr. Mike Gregg, a Physical Oceanographer from the Applied Physics Laboratory (APL) at the University of Washington (UW). He is accompanied by 7 additional scientists, comprising the largest group on the ship. The team is composed of the following members:

Dr. David Winkel - Physical Oceanographer
Mr. Jack Miller - Electrical Engineer
Mr. Earl Krause - Oceanography Technician
Mr. John Mickett and Mr. Glenn Carter - Ph.D. graduate students
Mr. Arthur Bartlett and Mr. Paul Aguilar - Engineers

All 8 members of the UW team are working together to gather data about the microstructure of the ocean. They want to understand turbulence in the ocean- in other words, they are interested in finding out how the ocean mixes.

"Coupled global models"- this is a term that is very important to understand the research being conducted on this cruise. It refers to the relationship between the oceans and the atmosphere over the entire planet. Computer models make assumptions about these relationships, which are used to predict short-term and long-term climate. These models exist today, but Dr. Gregg hopes to improve the accuracy of the numbers being input into these models, in order to improve climate-forecasting abilities. Better data input into the models will produce more accurate the climate forecasts.

There are very complex relationships between the oceans and the atmosphere. For example, as the wind blows over the ocean, it transfers energy to the water. You can see this energy in the form of waves. In addition, the moon has a tremendous impact on tides, and as tides rise and fall, energy transfers occur between the atmosphere and the ocean. You can see that energy is constantly being circulated between the oceans and the atmosphere. If you recall from your Physical Science classes in middle school, heat is a form of energy. What happens to the energy, or heat, from waves once the wave has broken and no longer exists? How does that heat energy travel through the ocean? How is the heat energy transfer different in the Eastern Pacific, where there is a warm pool of surface water, compared to the heat energy transfer in inland lakes, or in other parts of the world's oceans? This is what Dr. Gregg and his team of scientists are trying to find out.

The World Meteorological Organization (WMO) set up the framework for a program called CLIVAR (Climate Variability). Through CLIVAR, scientists from around the world are working together to improve climate forecasting models. This program reaches across international boundaries and includes dozens of countries that wish to improve the climate forecasting abilities using coupled global models. In the United States, the

National Science Foundation (NSF) has agreed to participate in CLIVAR, and are funding Dr. Gregg's research as part of that program.

The key piece of equipment being used in this research is called a Modular Microstructure Profiler (MMP). The MMP will be dropped in a free-fall while loosely tethered to the ship behind the ship using Kevlar lines while it is slowed to approximately 2 knots. It will measure small-scale turbulence, on the scale of centimeters, in the upper 300 meters of the ocean. The Kevlar line will allow the device to remain far enough away from the ship to prevent the ship movements from interfering with the MMP's measurements. Dr. Gregg has 3 MMP's so that one is available to be deployed 24 hours a day while the other two are undergoing repairs and data processing. The eight members of this team will be working 12 hour shifts, around the clock deploying the MMPs and using the winch to bring them back on the ship.

Travel Log: You know, after 5 days on the ship, I am still amazed that I am here. When I was in junior high school, I actually thought of aiming for a career with NOAA. I've always loved the oceans, always loved boats, and always loved science. What better way to put it all together than to join the NOAA Corps. I'm not sure what happened, but NOAA faded from my list of career choices in high school. It's so incredible to finally have a NOAA experience, to participate in a research cruise, and to meet such unique people.

I have found that maintaining sanity on the ship requires keeping a schedule. Here's my schedule (since I'm sure the world is just dying to know!!): I spend the mornings with one of the research groups or one of the crew groups to find out what they are doing and how it will make the world a better place. I take pictures of them at work, and make lots and lots of notes. Walking around with my paper, pen and camera I feel like a reporter all the time, like some kind of Lois Lane on the high seas. Lunch is from 1130-1230, and is a nice chance to chat with people. After lunch, I visit the bridge and collect the data that you see at the top of my daily log-location, atmospheric and water data. Usually at that time the bridge is occupied by the two female officers on the ship. I'll introduce you to them some other day. Finally, I go to the computer to review the day's pictures, translate my scribbled notes and type up my daily log. I also read the email that arrived that morning (we send and receive email twice a day-10am and 6pm) and respond to each one of them. Once I've sent off my logs and pictures to be posted on the web site, it's time for dinner. After dinner, I have 2 1/2 hours to write lesson plans, read, catch up on logs, or hang out on deck to watch the sunset. Every night at 8pm there is a movie in the lounge. No matter how bad it is, I can't help watching. For some

reason, watching the movie always removes any hint of seasickness I might be feeling. After the movie, it's finally time for bed.

My favorite time of day is definitely when I get a chance to sit out on deck and watch the sunset while reading Charles Darwin's "Voyage of the Beagle." It is so amazingly beautiful and peaceful here, and while I don't think I'm ready to make a permanent move onto the ship, I sure wish I had a button at home that I could push to be instantly transported to this exact spot (with my husband, Rob, of course).

Question of the day: When Charles Darwin was asked to join the HMS Beagle on its voyage to South America, he was in school at Cambridge studying to enter what profession?

Photo Descriptions: Today's photos include a couple members of the team from the Applied Physics Laboratory at the University of Washington. Dr. Mike Gregg is shown in one picture standing next the Modular Microstructure Profiler (MMP), and in another picture, Mr. Paul Aguilar catches up on some highly-intellectual reading. Since I've written in my log about the ocean sunsets, I included a picture of one, but I'm sure you can imagine that the picture just doesn't do it justice. Of course, none of these logs and photos would be possible without a good onboard computer network, so you'll see a picture of Mr. Larry Loewen, our computer guy. And finally, a shot to remind you of what ship I am on- an ax painted with the ship's name "Ronald H. Brown."

MONDAY, SEPTEMBER 10, 2001

Latitude: 13° 25.1 N

Longitude: 100° 58.4 W

Temperature: 26.1°C

Seas:		
	Sea wave height:	6-8 feet
	Swell wave height:	--
	Visibility:	0.5 - 1 mile
	Cloud cover:	8/8
	Water Temp:	29.6°C

Science Log: A lot of the scientists got very little work done today because the cloud cover was interfering with their instruments. The radar group from Colorado State University was in good spirits because they had a real opportunity to test their equipment during stormy conditions. They are still working out some of the bugs so that when we reach international water, they will be able to work efficiently.

Travel Log: This was the first day in a week that I felt somewhat seasick. I would like to take this opportunity to thank the makers of Meclizine for making a darn good product. We are in the middle of a storm, as you can see from the higher waves and lower visibility reported above. It certainly could be worse- I mean, the waves are only 8 feet, but it's still an adjustment for my body since the trip has been so nice up until now. I saw a satellite image of this part of the world and you can see a huge storm brewing. I encourage you to search the internet for current weather images (try a Yahoo search of "NCAR RAP") and find our latitude and longitude on the map. It looks pretty impressive. It could easily develop into a tropical storm, but hopefully not until it has passed us a little. So what does it feel like to be in a storm? Well, the boat is rocking a LOT, and I've been losing my balance all day. I went outside to take some pictures, and was drenched in the few minutes I was there. The deck has about an inch of water sloshing around. And there's no view of the sunset on the deck after dinner tonight.

Question of the day: What are the two factors that are used when classifying a storm as a tropical depression, tropical storm, or hurricane?

Photo Descriptions: Although not the most exciting pictures you've ever seen, I included 5 shots relating to the storm we are in. You'll see several pictures of the bow of the ship and the low visibility. At all times, there is someone on the bridge on lookout for "objects" in the water (boats, buoys, etc.) During low visibility conditions this job is even more important, since the Captain would have very little time to react if something was spotted. Of course, there is always the radar system, but it doesn't catch everything. Finally, a picture of the Doppler radar dome, taken prior to the storm. This Doppler radar provides crucial data about the weather conditions around the ship.

TUESDAY, SEPTEMBER 11, 2001

Latitude: 12° 06.3 N

Longitude: 95° 49.7 W

Temperature: 26.5 ° C

Seas:

Sea wave height:	2-3 feet
Swell wave height:	4-5 feet
Visibility:	10 miles
Cloud cover:	6/8
Water Temp:	29.7°C

Special note: The storm we hit yesterday is now called "Hurricane Ivo"

Research Objective for the day: Install sensors on the buoy at 10N, 95W. Download data from the buoy into the ship's system for analysis.

Science Log: Today is the first day that official operations take place. We reached the first buoy at 10N, 95W around 4pm, and the zodiac sent several people out to it for maintenance. Divers installed sensors on the under-water portion. They also downloaded the data from the buoy for analysis.

There are lots of buoys in the ocean. Mr. John Stanley (who I will introduce you to later in the week) is in charge of the buoy work on this cruise. He'll installing some, repairing some, and doing general maintenance.

One neat thing about the buoys is that the anchors that keep them in place develop their own ecosystem. All sorts of stuff grows on the anchor line, and stuff that eats the stuff on the line hangs out in the area. And the stuff that eats the stuff that grows on the line is also there. You get the picture. This means that whenever we reach buoys, people on the ship start reaching for their fishing gear. Although we didn't see any today, I've been told that there are often white-tip sharks in the area, and things can get pretty exciting (especially with a diver in the area). Today Pat, one of the crew, caught a pretty good-sized yellow-tail tuna. It was cool, until it started bleeding all over the deck. That's when I decided I should go look at something else.

Travel Log: This has been a quiet day. Most people on the ship are in some kind of shock after hearing of the terrorist activities on the east coast. I know I speak for everyone on board when I say that all of our thoughts are with the thousands and millions of people who have been affected by the attacks on the World Trade Center and the Pentagon. I tried for hours to reach my family in the Washington, D.C. area, but was never able to get a connection. Inmarsat-M phone calls must first connect with a satellite operator (challenge #1), and then connect with land (challenge #2). To those of you reading this who have family or friends on the ship, please remember that in an event like this, email is a reliable way to communicate. Our computer guy, Larry, connects with the satellite twice a day – 10:00 am and 6:00 pm. We are now in Mountain Standard Time, one hour later than when we started, 6 hours off of Greenwich Mean Time (GMT).

Today marks the one-week anniversary of when I arrived on the ship. In some ways, it feels like it went quickly, but at the same time, I feel like I've been here forever. One of my students, Melissa, asked if it was hard to be away from home. To be honest, I try not to think about it. I miss my husband, Rob, and we email regularly, but I try not to remind myself that I won't be home for another month. Certainly on a tragic day like this, all I can think about is how far away from home I am.

Question of the day: Why is cloud cover measured in 8ths (example 1/8, 7/8, etc.)

Photo Descriptions: Today's pictures include the following: the zodiac at the buoy, fishing off the stern of the boat, Pat's fish, a close-up of a buoy on the ship (will be installed later on the trip), and Captain Dreves keeping a close eye on the buoy operations.

WEDNESDAY, SEPTEMBER 12, 2001

Latitude: 9° 56.5 N

Longitude: 95° 2.5 W

Temperature: 31.2° C

Seas: Sea wave height: 2-3 feet

Swell wave height:	4-5 feet
Visibility:	10 miles
Cloud cover:	5/8
Water Temp:	29.3°C

Research Objective for the day: Begin taking measurements with the Lidar (ETL), the MMP (UW), weather balloons (CSU), and the SPMR (UCSB). Every group on the ship is in full swing, and will continue their operations for the next 18 days.

Science Log: Today I met with part of the group from NOAA's Environmental Technology Laboratory in Boulder, Colorado. There are three sets of instruments being used by this team, and today I will introduce you to the researchers associated with two of those groups- the lidar group and the kaband group.

Ms. Janet Intrieri, an Atmospheric Scientist, and Dr. Raul Alvarez, a Physicist, have been working long hours each day on the Mini MOPA Lidar. This is the most labor-intensive piece of equipment on the ship, requiring constant watch and intervention to keep it running properly. It is also probably the fanciest piece of equipment on the ship, using CO_2 lasers and an intricate network of lenses and mirrors to measure wind velocity and water vapor in the atmosphere. The really cool thing about the lidar is that it can measure these things at various altitudes simultaneously, up to 6-8 kilometers in range. Without the lidar, scientists could measure a specific point in the atmosphere using planes, satellites, or weather balloons, but the lidar allows Ms. Intrieri and Dr. Alvarez to see everything in a horizontal column of the sky at the same time.

How does lidar work? Lidar (which stands for Light Detection and Ranging, similar to the term Radar as used for radio waves) is a remote sensing technique that allows measurements of atmospheric conditions using laser light. The typical lidar system emits a short pulse of laser light that travels through the atmosphere. As this pulse of light goes through the atmosphere, it can interact or scatter off of various components in that atmosphere. These components can include dust, clouds, water vapor, pollutants, and even the air molecules themselves. When the light scatters off of these things, a small part of that scattered light is going back toward the receiver part of the lidar which is usually composed of a telescope (to collect as much of this light as possible) and a detector that converts the light signals into electronic signals that can be input to a computer.

How the signals that are collected are processed depends on what atmospheric properties are being measured. For information on the total

amount of light scattering due to dust and clouds, we can simply look at the strength of the return signal as a function of time (which is proportional to the distance that the pulse has traveled). To gather information about the amount of water vapor in the atmosphere, one technique is to transmit two laser pulses that are at different wavelengths. One of the wavelengths is selected so that it is not affected by the water vapor, while the other is selected so that it is partially absorbed by water vapor. (Each different chemical that we might try to measure has a different absorption of light that will determine which wavelengths and types of laser must be used.) Now, as the laser pulses go through the atmosphere and as the scattered light returns to the receiver, one of the signals is attenuated (reduced) more than the other because it is being absorbed by the water vapor. The amount of water vapor that must have been in the atmosphere to cause a particular amount of signal reduction can then be calculated.

Another thing that can be measured with lidar is the wind velocity. To do this, we rely on the Doppler Effect. This effect states that as the light scatters off of the particles in the atmosphere, the frequency of the light may be shifted if the particles are moving. If they are moving towards the lidar, the frequency will be shifted up while the frequency will be shifted down for particles moving away. Since the frequency of light is extremely high and the Doppler frequency shift is very small, we need to bring the signal (light) frequency down to a manageable level. We can do this by a process called mixing. In essence, the light signal is shone onto a detector along with a small sample of laser light that is at the same frequency as the original pulse that was sent into the atmosphere. When these two beams interfere with each other, the result is a signal on the detector that is the difference in the two light frequencies. At this point, this difference signal tells us the speed of the wind, but not the direction of the wind. A shift of a few megahertz (MHz)(depending on the laser wavelength) could be due to a wind either towards or away from the lidar at a meter per second (m/s). To resolve this uncertainty, the transmitted laser pulse is shifted by a fixed amount of 10 megahertz. Now, when the atmospheric light signal and the laser sample are mixed, the shift in frequency will be offset by the 10 MHz signal. (As an example, let's suppose that the Doppler shift due to the wind is 2 MHz. Then, the first example without a 10 MHz offset will give you simply a resultant 2 MHz signal for either a +1 m/s or -1 m/s wind, while the 10 MHz offset makes the resultant 12 MHz for a wind toward the lidar and 8 MHz for a wind away from the lidar.)

An additional piece of equipment being used by ETL is the Ka-band radar, operated by Ms. Michelle Ryan. Ms. Ryan uses Ka-band radar to study the clouds- water droplet size, condensation, and the changes between liquid, gas, and solid water. She also uses radiometers to study liquid water and

vapor in a column from the ship to the sky. Her equipment complements the lidar by providing information about what's going on above the cloud base (the lidar focuses on everything between the ocean surface and the clouds).

Thank you very much to Dr. Alvarez for translating enormously complex physics into what you just read about how the lidar works. If you read it through a couple times, it really makes sense! And they say laser physics is complex.

Travel Log: People always wonder what the food is like on the ship. Well, there is lots of it, and it's better than what you would expect. In fact, I've heard some of the scientists challenging each other to see who can gain the most weight on the trip- just an excuse to try a little of everything on the buffet line, and dessert twice. There's always a salad bar, a couple meat entrees, a couple meatless entrees, and several vegetables. One night we even had crab legs and steak! We eat during designated meal times in the mess hall, and since there are more people on the ship than there are seats in the mess, they try to get you to "eat it and beat it." The most dangerous part of the mess is the freezer stocked with Haagen Daas ice cream, but I am challenging myself to avoid it until the last night on the ship. There are three stewards on the ship that do all the cooking and kitchen stuff. They're really nice and friendly.

Question of the day: How much money did the U.S. spend last year on scientific research? What percent of the total budget does it represent? (Please cite your source when you send your answer)

Photo Descriptions: Since today's science log focused on the Lidar operated by NOAA Environmental Technology Laboratory (ETL), that's what is highlighted in today's pictures. You'll see the ETL lab on the ship- a large container that traveled via tractor-trailer, plane, and barge to get onto the ship. There are two "vans" like this on the ship, which is where this group of ETL scientists spends most of their time. Inside the van, you'll see Ms. Intieri at the computer controls, Dr. Alvarez tweaking the lenses in the Lidar, and in another picture, Dr. Alvarez pouring liquid nitrogen into the Lidar to keep the optics cool. Finally, you'll see Ms. Ryan standing next to the kaband radar (looks like a large drum in the photo).

THURSDAY, SEPTEMBER 13, 2001

Latitude: 10° 1.2 N

Longitude: 94° 57.8 W

Temperature: 30.0° C

Seas:

Sea wave height:	1-2 feet
Swell wave height:	4-5 feet
Visibility:	8-10 miles
Cloud cover:	4/8
Water Temp:	29.4°C

Science Log: Today I met with the remaining part of the NOAA ETL group- Dr. Chris Fairall, Dr. Frank Bradley, and Mr. Sergio Pezoa. Dr. Fairall is the Chief Scientist on the ship, so he is not only responsible for his equipment and research, but he coordinates all the other scientists on-board to make sure everyone is able to get the data they need. Sometimes this is difficult, since one group may need the ship to stand still for a couple hours to take stationary data, while another group may need the ship to be moving 1-2 knots into the wind. Dr. Fairall is responsible for the entire scientific party on the ship. Dr. Bradley is an Australian Physicist, and it's been interesting to hear that his family in Australia is responding to the recent terrorist activities in exactly the same manner as the families of the Americans on the ship. Mr. Pezoa is an Engineer, and helps keep the equipment functioning properly.

What kind of research is Dr. Fairall leading? Well, they are studying air-sea turbulent fluxes. Imagine heating two different materials- a metal bar, and a pot of water. The metal bar will heat through molecular processes- the molecules are excited and collide, producing heat, and transferring it down the bar. In the pot of water, however, convection occurs as the fluid is allowed to circulate in the pot. The hot water closest to the heat source rises, and the cooler water replaces it. The ocean heats like the pot of water- warm and cool water mix and circulate, and at the same time, the air is doing the same thing. How are the air and the water interacting with each other? All of the researchers on this ship are asking essentially the same question, but using different methods to answer it. Dr. Fairall is looking at the heat flux, water vapor flux, and carbon dioxide flux between the ocean and atmosphere.

There are two key pieces of equipment being used by these researchers. First, I'll talk about the sonic anemometer, which measures heat flux. It is a pretty simple looking instrument with 6 prongs that measures the motion of air along the x, y and z planes. Each prong can either send or receive a sound signal to the prong opposite it. The speed of sound changes depending on the medium in which it is flowing. So, when the air between the two prongs moves fast, the speed of sound is different from when the air is moving more slowly. By measuring the amount of time it takes the prong to bounce off its mate and return, you can determine the speed of sound. From the difference in time for opposing directions, you can determine the speed of the air (wind). You can determine the temperature of the air, since the speed of sound equals a constant times the square root of the temperature (Kelvin).

The second piece of equipment used by this group is the "Carbon Dioxide, Water Gas Analyzer" (finally a simple name that really tells you what it does!). This analyzer has a light source, and a light sensor. The light is activated and sent through 3 individual filters. One filter allows only the wavelength of light that is absorbed by carbon dioxide to pass through. One filter allows only the wavelength of light that is absorbed by water vapor to pass. The third filter allows a wavelength that is not absorbed, and is used as a reference. The difference between the amount of light received by the sensor and the amount of light that originated from the light source tells you how much carbon dioxide and water vapor are in the air.

There are additional, more simple pieces of equipment that are measuring, for example, sea water temperature, rainfall, solar radiation and IR radiation from the sky. All of Dr. Fairall's equipment is mounted on the bow of the ship, and there are so many wires and cables that connect them with the computers in the lab. The data is all digitally and automatically recorded by the computer, using redundant systems. They have at least two of everything, so that if a computer or circuit or panel is damaged or inoperable, they can quickly swap it with a new one. This is a unique aspect of ship research- you can't just run out to Radio Shack when something breaks. You have to anticipate any and all problems, and be prepared accordingly. Most of the time, the members of this group are monitoring the data and equipment, backing up data multiple times to tapes and CDs, and making any necessary repairs.

Just like with the other research groups I have introduced you to, Dr. Fairall's research will help climate modeling become more refined and accurate.

Travel Log: Today we had a fire drill and an abandon ship drill. The ship is required to do these drills weekly, and they are an effective reminder that we are at sea, essentially in the middle of nowhere. I first told you about these drills last Thursday - ah, ha, I see a pattern perhaps- next Thursday I'll be ready. It's a little un-nerving because the Captain gets on the intercom and gives the details on the location of the fire, and instructs everyone to muster at either the primary or alternate muster station. The scientific crew musters together, while many of the crew members have fire-fighting duties. The crew not only keeps the ship running and functioning, but they will put their lives on the line in case of emergency. I really have a lot of respect for them and all they do.

Question of the day: How many miles per hour are in one knot?

Photo Descriptions: Today's photos focus on the fire drill and the abandon ship drill that I told you about in my travel log. There are a couple shots of the firefighters at work. In another picture you see several people standing around with life preservers on. When we have an abandon ship drill, we have to grab our survival gear (life preserver, "gumby" suit, long pants, long-sleeved shirt, and a hat) and report to our muster station, where we wait for further instructions. I've also included a picture of the auto-inflating life rafts. There are 8 on the ship, but we only need 4 to accommodate everyone on the ship (in case one side of the ship falls over and the life rafts on that side cannot be accessed). Finally, there is a picture of Dr. Fairall (with Dr. Bradley in the background) holding the sonic anemometer.

FRIDAY, SEPTEMBER 14, 2001

Latitude: 9° 55.6 N

Longitude: 95° 1.2 W

Temperature: 30.2° C

Seas:		
	Sea wave height:	1-2 feet
	Swell wave height:	3-4 feet
	Visibility:	10 miles
	Cloud cover:	5/8
	Water Temp:	29.4°C

Science Log: There is one research study that involves the ship, but there are no scientists on the ship representing it. What I am referring to are the airplanes that take off from Huatulco, Mexico, fly to the ship's vicinity, and drop radiosondes from the sky. It's a really neat thing. There are two types of planes used for this purpose. The P-3s, operated by NOAA, were formerly Navy planes that have been converted into hurricane chasers, equipped with Doppler radar systems. The C-130s were also military planes that have been retrofitted for scientific use, and are operated by the National Science Foundation (NSF) and the National Center for Atmospheric Research (NCAR).

The flights began yesterday, but today the C-130 flew close to the ship at a low altitude, so we were able to see it. Kind of neat to see some sign of human life beyond the confines of this ship! There will be approximately 10 flights over the next 16 days, and they will be flying in a grid pattern over our general vicinity. While the ship's scientists collect lots and lots of data at 10N, 95W, the planes will collect similar data, but over a larger area. The radiosondes that are dropped from the planes measure temperature, wind, and humidity every 20 meters as they fall from the sky. When they hit the ocean they measure water speed and current. They relay the data via radio signal before becoming debris on the ocean floor.

The Teacher at Sea for the next leg of this cruise, from the Galapagos Islands to Chile, is Mrs. Jane Temoshok. She'll be visiting Huatulco to fly in one of these planes and to tour the facility. Hopefully, she'll get some good pictures of the planes up close.

Travel Log: In the travel log I've been telling you about non-scientific stuff that is happening on the ship. The last several days, the main non-scientific activity has involved conversations about the recent terrorist activities in New York and Washington, D.C. Remember that we don't have television reception here, so most of our information has come from emails from family and friends, and the news articles that Larry (computer guy) downloads when he is uploading our email. We are all comparing notes to try to get as full a picture as possible about what happened, who did it, and how the U.S. will respond. We joined the country in a moment of silence at noon.

On the subject of sad things…. We've noticed a number of birds on the ship lately. These are not shore birds, that you might expect to see on a ship, but land birds. The sad part is that they somehow got blown here, or got off track, and they'll probably die here, since there is no fresh water or food for them.

Question of the day: There is a special name for people who cross the equator- what is it?

Photo Descriptions: The coolest picture you'll see today is the C-130 aircraft flying near the ship. While the aircraft will be in our general vicinity for the next several weeks, today provided a unique opportunity to see it at a low altitude. I'm also sending a picture of myself, so that you can connect a face with the author of all the daily logs you have been reading. There's a picture of John Mickett, from the University of Washington manning the winch that deploys the MMP, which is shown in another picture just before it is hoisted onto the deck. Finally, a picture of Captain Dreves on the bridge. My students were so curious about what he looks like, and I know they'll be disappointed that he doesn't have a peg leg, hook arm, or even a patch on his eye. The parrot that normally sits on his shoulder was sleeping, and we thought it best not to wake him for the photo.

SATURDAY, SEPTEMBER 15, 2001

Latitude: 9° 55.8 N

Longitude: 94° 59.2 W

Temperature: 29.9° C

Seas:

Sea wave height:	1-2 feet
Swell wave height:	3-4 feet
Visibility:	10 miles
Cloud cover:	6/8
Water Temp:	29.9°C

Science Log: Today I met with our Marine Ecologist on the ship, Dr. Amparo Martinez, from Universidad Nacional Autonoma de Mexico in Mexico City, Mexico. Dr. Martinez is studying the processes between the ocean and the atmosphere regarding the formation of aerosols. She is studying aerosols that are created by natural photochemical processes, and those created biogenically, by living organisms.

What is an aerosol? An aerosol is any airborne particle. Although we don't see it, we are surrounded by airborne particles all the time. If there were no aerosols, there would be no clouds, since water vapor requires nuclei,

or aerosols, to cling to before it can condense. Aerosols scatter solar radiation and influence the radiative balance of the Earth. This is a major mechanisms linking the global biosphere and climate.

What happens to sunlight when it reaches the Earth's atmosphere? Well, some of it is reflected back into space by clouds. Some is scattered by aerosols in the atmosphere, and bounced in all directions. A relatively small percent of incoming solar radiation actually hits the Earth. If we can understand the nature of the aerosols in the atmosphere, their size and composition, we will have yet another piece of the "climate puzzle" and will be able to forecast climate more accurately.

How does Dr. Martinez study aerosols? She is actually looking at a chemical compound called DMS (dimethylsulfide), which contributes approximately 40% of the total sulfur burden of the atmosphere (aerosols). Plankton in the ocean are a major source of DMS, in addition to photochemical processes. Dr. Martinez studies DMS in the ocean, and in the air to obtain a vertical profile of aerosols from 15 meters above sea level, to 100 meters below.

In the ocean, she uses a CTD (measures conductivity, temperature and depth of water) to obtain water samples from various depths in the ocean, down to 100 meters. This is deeper than any scuba diver could ever go, so it's good that we have a CTD to do the job for us. She uses filters to separate the biological material in the water (i.e. plankton) from the water, and she measures the amount of DMS in both using a gas chromatograph (GC). This helps her determine how much DMS is coming from biological sources compared to chemical sources. In the air, Dr. Martinez has a sensor on the tower that is mounted on the bow of the ship. The sensor is able to measure different types of aerosols and sends the data to a computer in the lab.

You may have noticed that all of the scientists on the ship are conducting research that will help with climate modeling. Did you know that our models are unable to predict present-day climate? We can forecast weather to some degree, but climate is a mystery. How can we predict El Nino, seasonal variations in climate, or long-term variations in climate, when our models can't even show us what we are presently experiencing? We have a long way to go before fully understanding how the interactions between the oceans and the atmosphere affect climate on Earth. It is increasingly recognized that in order to understand climate, we need to understand all the pieces that contribute to the climate puzzle. Dr. Martinez is contributing to the biological and ecological pieces of the puzzle, while the other scientists on the ship are contributing to the chemical and physical pieces.

Travel Log: Today there was a pod of at least 20 pilot whales swimming with the ship. They were playing within 20 feet of the ship for over an hour! We've seen quite a bit of wildlife on this trip so far. There were two beautiful egrets on the tower yesterday, but they have since disappeared. Land is approximately 300 miles from here (a 24-hr journey by ship), but I guess the birds have attempted to fly home. I was not thrilled to hear that my roommate recently saw a large spider with thick legs and a bright orange body. And the stateroom next door said they saw a large spider with a somewhat transparent body. My husband, Rob, will probably laugh when he reads this because he knows I am very uncomfortable (ok, maybe "scared" is a better word) being around anything with more than 4 legs, or less than 2.

This started an interesting conversation over lunch, which you may want to continue in your classroom or at home. If this ship is transporting a few stowaway critters, which would not be unusual, what impact could that have on the ecology of the Galapagos Islands? What could the Ecuadorian government do to prevent the introduction of non-native species? I don't know how you would quarantine an entire ship, so what do you do? Look at Britain as an example of how foot-and-mouth disease has spread so quickly, killing so many animals. What precautions have they, and the rest of the world, taken to keep this disease from spreading further?

Question of the day: How many statute miles are in one nautical mile? (a statute mile is a regular road mile)

Photo Descriptions: Today's pictures include two of Dr. Amparo Martinez- in one picture she is making repairs to the gas chromatograph (GC) in the laboratory, and in the other, she is filtering water samples to separate the biological material from the water. The equipment she uses to collect air samples is mounted on the tower shown in one of the photographs. It's necessary to elevate the equipment so that the ship's emissions do not contaminate her samples. Dr. Chris Fairall, the Chief Scientist on the ship, is shown in one photo overseeing operations on the stern. Finally, there's another picture of me (Jennifer Richards)- this time I am standing in front of some buoy anchors. Later in the cruise we will be deploying a buoy, which is connected with several miles of cable to the anchor on the ocean floor.

SUNDAY, SEPTEMBER 16, 2001

Latitude: 9° 59.2 N

Longitude: 94° 59.2 W

Temperature: 27.5° C

Seas:

Sea wave height:	1 foot
Swell wave height:	3-4 feet
Visibility:	8 miles
Cloud cover:	7/8
Water Temp:	29.5°C

Science Log: We will be at this location in the ocean for a total of 18 days. This is the main data-gathering time for everyone on the ship. The operations continue 24 hours a day, and are very repetitive. The pictures you'll see today show you some of the typical activities going on. There are weather balloons deployed by the radar group from Colorado State University 10 times a day. We receive a signal from them for up to 2 hours after being launched, and they reach an altitude of 12 miles before we lose them. There is an incessant beeping in the lab as the computer acknowledges that it is receiving data. The threatened punishment for anyone who gets out of line would be to lock them in this room with the computer volume turned as high as it goes.

Another 'round the clock activity on the ship is the deployment of the MMPs by the University of Washington group. The reel the MMP out, and pull it back in, over and over, 24 hours a day.

Finally, there are CTD casts a couple times during the day and night. The CTD goes to 1000 meters deep (the theoretical limit for scuba divers is 99 meters) to collect water samples that are used by the University of California at Santa Barbara group and by Universidad Nacional Autonoma de Mexico.

Travel Log: We had engine problems this morning, which I don't think are a big deal, but it reminds me of a story. Since my students love stories, I thought I'd share it (Kalen- this one's for you!). A year and a half ago my husband and I were on vacation in Fiji doing some scuba diving. The boat reminded me a lot of the Millennium Falcon from Star Wars- a big, clumsy hunk-of-junk. As a third-world country, their boats were

maintained about as well as the potholes in Manhattan. There were about 20 passengers on the boat and two crew members, both no older than 18. As we sailed, one of the crew guys drove the boat, while the other banged on equipment in the engine room with large wrenches- literally banged on them non-stop. Well, actually he did stop every few minutes- to pour more transmission fluid into the transmission. We went through gallons of the stuff before our afternoon trip had ended. Unfortunately, the trip didn't end at a dock- it ended when the engine finally died and we were stranded in a murky, olive green river in the jungle. The guy who had been driving the boat was no longer preoccupied with his duties (you can't drive if the boat won't move), so he swam to shore, avoiding any sea serpents that surely lived in the water, walked to the road, hitchhiked to a phone, and called a buddy for help. After several hours of desperately wanting to get off the darn boat and on to something clean and familiar, another boat showed up with a rope, and towed us to shore. I share this story with you because I am so happy to be on a good 'ole American vessel, where I am confident we won't have to swim to shore for help.

Tonight we are having a barbeque on the stern. I'll give you a full report tomorrow.

Question of the day: What is the main function of the World Meteorological Organization (WMO)?

Photo Descriptions: Remember when I told you several days ago about the flying fish? Well, one flew right onto the ship and died. Although it is sad to see a dead animal, it seemed like a good time to show you what they look like up close. They actually have wing-like structures that fan out while they fly.

The rest of today's pictures show miscellaneous things going on here- a picture of me launching a weather balloon, a picture of Jack Miller from the University of Washington deploying the MMP, a picture of Sergio Pezoa from NOAA ETL risking life and limb to do research (not really), and a picture of John Mickett from the University of Washington as he tows the MMP back to the ship.

MONDAY, SEPTEMBER 17, 2001

Latitude: 9° 58.8 N

Longitude: 95° 00.1 W

Temperature: 29.5°C

Seas:

Sea wave height:	2-3 feet
Swell wave height:	3-4 feet
Visibility:	10 miles
Cloud cover:	8/8
Water Temp:	29.5°C

Science Log: I got a chance to look at some weather balloon data from Dr. Rob Cifelli. It's really neat- this particular weather balloon traveled to 16 km altitude, where it probably increased 5 times in size before the air pressure finally popped it. The data I saw showed temperature, pressure, dew point, wind speed and direction for the entire troposphere. It's neat to see the data behaving the way the textbooks say it should. I'll be working on a lesson plan that incorporates these data and graphs so you can see them.

Travel Log: Today I met with Joe, the ship's doctor. He's a super nice guy and we talked for hours about life as a medical officer at sea, a medical officer at a federal prison, and the state of medical affairs in the U.S. today. Of course, the part of that discussion that you would be most interested in is the "at sea" part. I was surprised to learn that only 2 of NOAA's 16 ships have a medical officer on board. The others have EMTs, but no formal medical facilities. The primary reason for this is that the Ronald H. Brown travels all over the world, primarily beyond reach of U.S. Coast Guard helicopters. Since the helicopters typically have a range of approximately 200 miles, ships that spend most of their time beyond this distance (such as the Ronald H. Brown) have a medical officer. Most NOAA ships hug the coasts, so in case of emergency a helicopter could come rescue the patient and fly them to appropriate medical facilities on land.

The first thing I wanted to know was what would happen if there were a medical emergency on this ship? Well, the clinic on the Ronald H. Brown was designed right from the start to be a clinic, rather than being a converted broom closet, so we are pretty lucky to have all the necessary life-saving equipment that we would need. Joe has all the equipment necessary to stabilize a heart attack patient- EKG, oxygen, defibrillator,

IV, medication, etc. All NOAA ships have access to the Medical Advisory System (MAS) which allows communication 24 hours a day with a doctor who has all the necessary references to walk you through any medical procedure. Once the patient is stabilized, the ship would sail to the closest port and the patient would be transported to the nearest U.S. medical facility.

I was afraid to ask Joe about the worst medical emergency he's encountered on the ship, but relieved to hear it was just a fish hook stuck in someone's hand. It was a really big hook, and it was really deep in the hand, but the patient was OK. During the first couple days of each cruise Joe sees a lot of seasick patients, but that's pretty easy to treat. Several years ago, on a different ship with a different medical officer, a group of people were swimming in the ocean and a woman's leg was bit off by a shark. She is alive today, but swimming is now prohibited on all NOAA ships.

In addition to being the ship's medical officer, Joe does sanitation inspections of the ship's kitchen, handles all workplace safety issues, and ensures that the ship is complying with all environmental federal and international maritime agreements. Being at sea would be a pretty miserable place to get food poisoning, so I'm glad to hear that it's not a real concern. As for maritime agreements, there are lots of regulations about what can be disposed of at sea (i.e. sewage and human waste, incinerated paper products), and what types of waste must remain on the ship until we reach port (plastics, recyclables, etc.).

The best part about getting sick at sea? Joe makes house calls.

Question of the day: How many shark attacks were reported last year in the world?

Photo Descriptions: Today you'll see two pictures of the ship's Medical Officer, Joe, in the clinic. I'm also sending some pictures of the BBQ served out on the stern last night, showing Dr. Dave Winkel, the kitchen stewards at the smoky grill, and tables of crew and scientists enjoying the feast. Wonderful place for a picnic, don't you think?

TUESDAY, SEPTEMBER 18, 2001

Latitude: 9° 55.0 N

Longitude: 95° 1.2 W

Temperature: 28.1° C

Seas:

Sea wave height:	1-2 feet
Swell wave height:	3-4 feet
Visibility:	8-10 miles
Cloud cover:	8/8
Water Temp:	29.4°C

Science Log: Today I caught up once again with Dr. Carter Ohlmann and Mr. Dave Menzies from the University of California at Santa Barbara. They have been doing CTD casts every day to obtain water samples to 300 meters deep. Once the CTD returns to the surface, they fill their bottles with the water and filter out the chlorophyll. They add acetone to the filters which now contain the chlorophyll, and freeze them overnight to dissolve the filter paper and release the chlorophyll into suspension. Tomorrow, they will measure the amount of green and blue wavelengths reflected from the samples, to determine the approximate amount of chlorophyll present.

Travel Log: There are so many things about being on this ship that have become very normal, and I have to remind myself that to people who aren't on the ship, these things are unique and potentially interesting. An example of that is the light situation at night. A few times I have gone out on deck at night to hang out, but it is completely pitch dark, and kind of creepy. I mean, here you are on a moving object, but you can hardly see your hand in front of your face. The little that you do see is moving, and you're constantly wondering if you passed a little fog, or if that was a shadow of a nearby person. Am I standing next to someone and have no idea? On any other moving object (car, train, plane) there are some form of lights projected from the ship to illuminate the surrounding area (car headlights, for example). On a ship it's almost the exact opposite- they keep the ship as dark as possible at night so that the bridge can get good night vision. Of course we have a few lights on the ship to make us visible to other vessels, but there is a whole routine we go through at night to keep things dark. All the portholes are closed, so that interior lights don't escape to the outside. On the top level of the ship, where my stateroom is, the interior hall lights are changed to red. All computer screens in the bridge have red filters

placed on top. If you go out on deck with even the smallest flashlight, it ruins the night vision for anyone in the bridge. Everything has to be as dark as possible so that the crew in the bridge can see as far as possible into the darkness and identify any objects that could be crash hazards- small boats, buoys, etc. Of course, the nice side affect of all this is that you get an amazing view of the stars. If we weren't sitting on a moving and rocking object, this would be a fantastic place to bring a telescope.

Question of the day: Why are red lights used in darkrooms and for night vision? Why not blue, yellow, or some other color?

Photo Descriptions: Today's pictures show the group from the University of California at Santa Barbara- Dr. Carter Ohlmann and Dave Menzies- as they collect and process samples from the CTD. In addition, you'll see one of the land birds that has somehow made its way to the ship (cute, eh?).

WEDNESDAY, SEPTEMBER 19, 2001

Latitude: 9° 55.8 N

Longitude: 95° 0.7 W

Temperature: 29.9° C

Seas:

Sea wave height:	2-3 feet
Swell wave height:	3-4 feet
Visibility:	8-10 miles
Cloud cover:	5/8
Water Temp:	29.4°C

Science Log: Today I checked in with the University of Washington group. They have been deploying their MMP 24 hours a day, with each person working 12 hour shifts. I've been told that in a few days they should have enough data to start doing some analysis. At this stage, they are still checking the data for validity. I'll be sure to let you know what kinds of results they are getting.

Travel Log: Today was the first live web feed from the ship. We had a number of schools participating from around the country, as well as several NOAA offices and my husband looking on. Thank you to all the teachers who have been enthusiastically following this trip, and for making the live feed a success.

Here is the list of the live video broadcast participants:

- My classes at Guajome Park Academy in Vista, CA
- Jane Temoshok's class at Lyles-Crouch Traditional Academy in Alexandria, VA
- Susan Carty's class at Stetson Middle School in PA
- Laurie Bricker's classes at Sligo Middle School in MD
- Carl Hazen's class at Bedminster School in NJ
- Gay Byer's class at Northley Middle School in PA
- Mike Stern's class at Westhoff Independent School District in TX
- Plainfield Elementary School in New Hampshire
- Science Center in Fort Wayne, IN
- NOAA's Office of Global Programs
- Admiral Fields at NOAA's Office of Marine and Aviation Operations
- NOAA Research Public Relation Offices
- National Science Foundation (NSF) Division of Atmospheric Sciences

We'll be doing this twice more over the next couple weeks, and I promise next time I will model the gumby survival suit for you!

I had a very interesting conversation today with Captain Dreves about water sources on the ship. We get water 3 ways while at sea. If there was a fire on the ship, we would pump ocean water into the hydrants to fight it. Drinking water is manufactured on the ship using two different methods- an evaporation plant and reverse osmosis- both methods separate the salt and particulates out of salt water. The ship can generate 4500 gallons per day using these methods, which is quite astounding to me. Why do we have such a water problem in California if water can be desalinated so easily? Well, you need engine power to run the evaporator and reverse osmosis systems, which works well for us since we have the engine running 24/7. And since we are always moving, the salt and particulate waste is evenly distributed in the ocean behind us. If we were a stationary land facility, there would be significant impacts on the coastal environment.

Question of the day: If you wanted to be a Mate on a ship, what organization would issue you a "Mate's License?"

Photo Descriptions: Today I am sending more MMP pictures. If you recall, the MMP is the key piece of equipment being used by the University of Washington Applied Physics Laboratory. In one picture, you'll see me standing next to one of the MMPs in its crate. You'll also see a picture of Jack Miller and Paul Aguilar working to deploy it. I also thought you might enjoy some whale pictures.

THURSDAY, SEPTEMBER 20, 2001

Latitude: 9° 56.1 N

Longitude: 95° 0.1 W

Temperature: 26.9° C

Seas:

Sea wave height:	2-3 feet
Swell wave height:	3-4 feet
Visibility:	8-10 miles
Cloud cover:	6/8
Water Temp:	29.5°C

Science Log: Today I saw some of the data plots being created by the University of Washington scientists. While they haven't discovered any "ah ha!!" data, they gave me some plots of data that follow a textbook-type pattern of temperature, salinity and density to 300 meters deep in the ocean. There is not a significant amount of ocean layer mixing showing up in the data, primarily due to the calm weather we have been experiencing. The bridge got a whether report today indicating that we may hit a severe storm in the next 24 hours. If so, it will be interesting to compare the stratification data during a storm event to the data collected under calm conditions.

Travel Log: Well, I just learned that some of the crew have been laughing at me behind my back, and I must take this opportunity to print a retraction to something I wrote previously. When I referred to the engine (singular), I should have referred to engines (multiple). "Do you really think this entire ship is powered by a single engine?" they asked me. Duh, I don't know. So today I asked the lead engineer, Mike Gowan, for a tour of the engine room (while crew nearby taunted me by saying "why, so you can see THE

engine?" snicker snicker). So here I am, ready to redeem myself for my previous error, which I fear will not soon be forgotten.

First thing you see when you enter the engine room are two rows of huge burly men with tattered shirts and big oars in their hands, rowing as fast as they can.

Just kidding.

It takes 7 people to operate and maintain the equipment in the engine room- that's over one-third of the crew. The Ronald H. Brown operates off of 6 diesel generator engines (yes 6, not 1!).

- Three engines are V8 1000 horsepower, and they are primarily used for ship services- lights, computer power, research equipment power, etc. If needed, these three engines can also be used for ship propulsion.

- There are three V16 2000 horsepower engines, which are used only for propulsion.

There are two buses that distribute power from the engines. The "ship service bus " distributes power to the ship's services, and the "propulsion bus" distributes propulsion power.

The ship does not use a rudder for steering. Instead, it uses two Z-drive propulsion motors (stern thrusters), and a bow thruster. The Z-drive motors operate 360 degrees, allowing thrust in all directions. If you recall one of the basic laws of physics says that "any action must create in an equal and opposite reaction." If you push or thrust water away from the ship on the left side, the ship will move to the right. If you push water forward from the bow, the ship will move backwards. By controlling the amount of force being thrusted, and the exact angle at which it is thrusted (remember, the Z-drive motors operate in a full 360 degrees circle), you can precisely control where the ship moves. This is not a common feature on ships, but it allows us to maintain an exact position in the ocean, like a helicopter maintaining an exact position in the sky. Cool, huh?

The engine room is really loud and really hot. I was only there for 15-20 minutes, but I was pretty uncomfortable by the end of the tour. Even with ear protection, it was still very loud, and impossible to talk to anyone. Can you imagine working all day in an environment like that?

The most unexpected part about my tour was the computer automated controls. There was a whole room with nothing but buttons. lights, and computer screens. It makes complete sense that they would be computer controlled, but I guess on the ship I expected something more old-fashioned. The computers can control most every aspect of the engines. If you want, you can set them on automatic settings so that engines will start and stop automatically, based on the power requirements from whoever is driving ship from the bridge. Mr. Gowan doesn't use these auto functions, so that he can keep an eye on what the engines are doing and control them most appropriately.

While touring the engine room I also got to check out the evaporator and the reverse osmosis systems, used to generate desalinated water. Check yesterday's log for more information about these systems.

Question of the day: How many documented cases of ocean piracy were reported last year?

Photo Descriptions: Today I am showing you pictures of the engine room. One picture shows Mike Gowan at the computer controls. In another picture, you see the large yellow propulsion engines. There is also a picture of the smaller ship service engine. One picture shows large silver round things- that is the evaporator. Finally, a picture of the bow thruster. You can see that it is round at the bottom, reminding you that it works in a full 360 degree circle.

FRIDAY, SEPTEMBER 21, 2001

Latitude: 9° 55.0 N

Longitude: 95° 0.8 W

Temperature: 26.3° C

Seas:		
	Sea wave height:	1-2 feet
	Swell wave height:	3-4 feet
	Visibility:	8-10 miles
	Cloud cover:	8/8
	Water Temp:	29.3°C

Science Log: I have been making the rounds among the science groups and asking if any significant discoveries have been made on this cruise yet, or at least if there have been any "oh, wow!!" moments as they review their data. Unfortunately, science is not a very fast process, and they have all said that it will probably be years before the data is fully analyzed and interpreted. So, will the scientific research on this cruise revolutionize the climate forecasting models? Possibly. Will it happen during the next couple weeks? Probably not, but I promise you'll be the first to know.

Meanwhile, we are still on station at 10N, 95W and the 24-hour operations continue. Today's pictures focus on the CTD deployments. The CTD is a series of bottles in a circular pattern that are lowered into the ocean. For our purposes, the CTD is lowered to 300 meters, but they can go as far as the ocean floor (approximately 3800 meters at this location). A large winch lowers the cable to 300 meters, and as it lifts the CTD up to the surface, it pauses at designated intervals to capture a water sample. Dr. Carter Ohlmann sits at a computer, reading the depth of the CTD, and at the right times, he pushes a button to close one of the bottles on the CTD. When the instrument reaches the surface, each bottle contains water from different depths, and both Dr. Ohlmann (University of California) and Dr. Martinez (Mexico) use the samples for their research.

Travel Log: Dr. Amparo Martinez, one of the scientists on the ship, is from Mexico. One of the crew members asked her to teach him a little Spanish, and of course she said yes. When another crew member heard about this, he asked if he could be included. Again, she said yes without hesitation. Then, those two guys made a flyer and posted it in the mess – "Spanish Classes Monday, Wednesday and Friday at 7:30 in the library." At this point, Amparo was getting a little nervous about what she's gotten herself into, and sure enough, there were about 15 people in class. That's one-third of the ship! So we are all hoping to learn a little bit of Spanish to help us when we get to the Galapagos Islands. Yo soy gringa.

Question of the day: What is the Intertropical Convergence Zone (ITCZ)?

Photo Descriptions: Today I am sending several pictures of the CTD as it is lowered into the ocean, and one artsy-looking picture of it actually under water. Once the water samples are obtained, they are almost immediately filtered to separate the water from the chlorophyll and particulates, so I've included a picture of the various samples being filtered. There's also a picture of Dr. Martinez teaching us some Spanish.

SATURDAY, SEPTEMBER 22, 2001

Latitude: 9° 54.2 N

Longitude: 95° 1.2 W

Temperature: 26.8° C

Seas:

Sea wave height:	2-3 feet
Swell wave height:	3-4 feet
Visibility:	6-8 miles
Cloud cover:	7/8
Water Temp:	29.3°C

Science Log: I met with the radar group from Colorado State University to see what kind of results they have obtained from their data so far. Apparently, it was pretty good timing, because they had just finished creating a movie file that shows an animated version of the data they've collected over the last week. The data is collected by the radar 24 hours a day, so over the course of a week there is quite a lot of data generated. Of course, one week of data isn't enough to make remarkable discoveries with, but it's a start.

One of the things Dr. Rob Cifelli, Dr. Walt Petersen, and Dr. Dennis Boccippio are looking at is the lightning potential in the area, and how it compares with other parts of the world. We have had some spectacular lightning shows during the trip, and the data collected by this team has shown that the clouds in this area are more electrified than clouds in the western Pacific Ocean.

What is an "electrified" cloud? It's a cloud that is ready to produce lightning. Let's look at cloud growth and dynamics to understand how a cloud becomes electrified.

As air moves in updrafts and rises into the sky, what happens to the air temperature? It decreases, of course. The warm tropical air, full of water vapor, rises to the point where condensation occurs and a cloud is formed. If the drafts are strong enough, the air will eventually cool to the freezing point and colder. In this part of the world (10N, 95W) the altitude where the air temperature reaches 0 degrees Celsius is approximately 5 kilometers. Beyond this point the air temperature continues to decrease. When the moisture in the air hits the freezing point, it doesn't all

instantaneously turn into ice crystals. There are complex physics that keep some of the water in liquid form, and some of it turns into ice. As the liquid water at this altitude bumps into existing ice crystals, the water freezes to the ice, forming a coating of rime. As the ice grows by this riming process, it can eventually produce particles called graupel (baby hail).

The part of the atmosphere where the temperature is between the freezing point and -40 degrees Celsius is called the "mixed phase" layer. Below -40 degrees any liquid water will spontaneously freeze. The air in the mixed phase layer contains both water and ice. This is the region of the cloud where electric charge is separated and lightning is produced. To have an active mixed phase layer, the cloud updrafts have to lift raindrops above the freezing level high enough and fast enough so the drops don't all freeze right away and they can interact with ice crystals that are already there. After raindrops are lofted into the mixed phase region and interact with the ice particles, graupel forms and descends. As the graupel falls it bumps into small ice crystals which are either moving up or moving down slower than the graupel. Most atmospheric scientists think that the collisions of graupel with small ice crystals in the presence of liquid water separates charge and produces cloud electrification. An electrified cloud that produces lightning is one that contains an active mixed phase layer (lots of collisions between ice and liquid water above the freezing level).

How do you measure the amount of ice crystals in the clouds, so that you know whether a mixed phase layer is present? That's where the radar technicalities come into play. The radar sends out a certain amount of energy, and receives a fraction of that energy back. Water reflects more of the radar signal than ice. When your power return is greater than 30 dBZ above the freezing level, you can be pretty sure you are detecting large ice (graupel) in the cloud. By measuring the amount of time it took for the signal to bounce off the cloud and return to the radar, you can determine how far away that part of the cloud is.

From the data collected on this research cruise so far, the CSU team has been able to infer that the clouds in the tropical eastern Pacific Ocean have a more active mixed phase process relative to other regions in the Pacific, meaning there is more liquid water lifted above the freezing level and it's there long enough to interact with ice before freezing. This, in turn, allows the charge to separate, and voilá! lightning is produced.

Is this information anything new and exciting? Well, yes! Satellite images have been used for a while to view the tops of clouds, and observers on the ground can view the bottoms of clouds, but you have to know the internal

structure of the cloud to understand what type of weather it will produce. If you don't know the temperature and phase of the water in the cloud, you can't expect to accurately predict how it formed, how it dissipates, and how it is interacting with the rest of the atmosphere. Answers to all of these questions are necessary for climate modeling. Most atmospheric scientists believe that electrified clouds produce a different response on the surrounding atmosphere compared to non-electrical clouds.

So, to summarize the discovery (based on preliminary data)... the clouds in this area appear to be more electrified than clouds in the western Pacific Ocean.

Ready for the quiz?

- What temperature range contains water in both the liquid and solid form (mixed phase)?

  Answer: 0^{o}C to approximately -40^{o}C

- A cloud is electrified when it contains what phase(s) of water?

  Answer: solid (ice) and liquid (water)

- True or False. The greater the amount of water and ice in the cloud above the freezing level, the more lightning it can produce.

  Answer: True

Travel Log: This was our 11th day on station at 10N, 95W. All the research activities are taking place here, and we have 7 more days before we continue our journey to the Galapagos. I sense some boredom in a lot of people- the exact same work just repeats over and over, 24 hours a day, with little break. Some of us are looking ahead to our arrival at the town of Puerto Ayora, on the island of Santa Cruz, in the Galapagos Islands. There's definitely a lot of excitement about seeing unique wildlife, volcanic landforms, and exploring new territory.

Question of the day: How many statute miles is it from Quito, Ecuador (where most of us will be flying through to get home) to Puerto Ayora, Isla Santa Cruz, Galapagos Islands (where the ship will be docked)?

Photo Descriptions: Today I am sending a picture of me with a storm brewing in the background, and one of me on the stern deck. There are also a couple pictures of a warbler that made its way to the ship a few days ago.

Today is a special day- not only am I sending photographs of ship and research stuff, but I am also including a diagram created by Dr. Walt

Petersen from Colorado State University that shows the internal structure of a cloud in this area. The diagram uses cloud data obtained over the last few weeks on this cruise. You can see from the legend on the right that everything colored yellow or red is returning at least 30 dBZ Below approximately 5 kilometers these values mean large raindrops (especially the red areas). Above approximately 5 kilometers these values suggest the presence of large ice (graupel). The higher the 30 dBZ line extends above the cloud level, the stronger the cloud updrafts and the more vigorous the storm.

SUNDAY, SEPTEMBER 23, 2001

Latitude: 9° 55.9 N

Longitude: 95° 0.2 W

Temperature: 25.0° C

Seas:		
	Sea wave height:	3-4 feet
	Swell wave height:	5-6 feet
	Visibility:	2-3 miles
	Cloud cover:	8/8
	Water Temp:	29.1°C

Science Log: Today's science log is inspired by the storm that we are right in the middle of. I learned today that there are 11 pieces of equipment on the ship that all measure rainfall quantities, and all 11 of them yield different results! I had no idea that measuring rainfall could be so difficult! Since many of the researchers on this cruise are looking at clouds and raindrops, it is worth discussing the problems with measuring rainfall.

The first challenge is in determining what type of equipment to use for measuring rainfall. There are three basic types of rain measuring devices used on the R/V Ronald H. Brown.

1) There are 9 simple rain gauges that just collect water in a calibrated tube as it falls.

2) There are 4 disdrometers (including one optical) which measure the raindrop size and distribution to calculate rain rate. These devices are used in conjunction with an anemometer (measures wind speed) to calculate and compensate for the effects of wind-driven rain on the measurements obtained.

3) Finally, there are 2 optical rain gauges, which uses an electric pulse to determine the vertical momentum of an impacting raindrop to determine raindrop diameter. These devices are used in conjunction with an anemometer (measures wind speed) to calculate and compensate for the effects of wind-driven rain on the measurements obtained.

The next challenge in trying to measure rainfall is in deciding where to place the equipment. Rain rarely falls straight from the sky- there is usually some amount of wind in the air that pushes the rain in one direction or another. When wind is significant, a rain gauge on one side of the ship may record significant rainfall, while a gauge on the other side may record nothing. What if the wind is blowing and the rain only hits the side of the rain gauges, without actually entering it? How do you make sure that sea spray is not included in the rainfall measurements?

As it turns out, the Ronald H. Brown has all of these different types of rain measurement devices placed around the ship in an effort to record accurate data. Each device will report different results, and it is very difficult to determine which one is closest to correct. Who knew that counting raindrops could be so difficult and scientific?? Why is any of this important? Well, if we are trying to understand climate better, and all of the complex variables that affect climate, we need to know what the current conditions are like. You can't predict rainfall amounts 10 years from now if you don't know how much rain falls this year.

Travel Log: A nice large storm decided to form today, with the ship right smack dab in the middle of it all. Hurricane Julliet is in the area, but apparently the "disturbance" we are feeling is a completely new storm that brewed overnight. Before I heard any rain I could tell we were in a storm because most of the night I was being rocked back and forth in bed. I don't know how anyone can sleep through that! I sleep on the top bunk, which makes it worse, because I am constantly thinking about falling out of bed. Many of the operations were cancelled for parts of the day due to lightning very close to the ship. Exciting, huh?

Question of the day: What is graupel?

Photo Descriptions: Rainy, stormy day. Hopefully, today's pictures give you a glimpse of the conditions we are experiencing. Did you know the bridge has windshield wipers? Cool. Poor John Shanley was about the only one working outside today in between lightning storms.

MONDAY, SEPTEMBER 24, 2001

Latitude: 9° 55.6 N

Longitude: 94° 59.3 W

Temperature: 26.7° C

Seas:

Sea wave height:	2-3 feet
Swell wave height:	5-7 feet
Visibility:	8 miles
Cloud cover:	8/8
Water Temp:	29.0°C

Science Log: Today I caught up with Dr. Chris Fairall from NOAA's Environmental Technology Laboratory in Boulder, Colorado. If you recall, he is studying the heat flux between the atmosphere and the oceans. Dr. Fairall measures a number of parameters to calculate heat flux, and has obtained some surprising data over the last couple weeks. In fact, if he didn't have three different instruments reporting the exact same results, he never would have believed it. Want to know what he found? It turns out that the amount of sunlight that reaches the ocean surface is amazingly low on stormy days (like yesterday), that he's never seen anything like it! In fact, the sunlight measured during yesterday's storm was lower than what he's measured in Alaska in the dead of winter! Here are some numbers to help put this into perspective.

Normal day in the eastern Pacific Ocean:	280 watts/m^2
Normal overcast day in the eastern Pacific Ocean:	100 watts/m^2
When we were in the middle of Hurricane Ivo:	28 watts/m^2
Yesterday, while near Hurricane Juliet:	3.7 watts/m^2

The really interesting part of this is that you could see just fine yesterday with your eyes. I mean, it was a little darker than normal because of the stormy clouds, but your eyes didn't tell you "hey, there's no light today". And yet, that's what the instruments measured. Why is this happening? Well, the sunlight was absorbed somewhere between the time it left the sun and the time it reached the earth's surface.

Travel Log: I'd like to introduce you to the exercise room today. When you're not working, eating or sleeping, there is not much else to do while at sea. The TV lounge shows movies twice an evening, but after 18 days at sea, 36 movies have been shown (many of them have been quite bad, I might add), and you just need a little something else to do. So there's the exercise room, which most people seem to be taking advantage of. It has weight machines, stationary bicycles, and a treadmill, all surrounded by gas cylinders used for the research. Hence, it is an "exercise/storage area," but my favorite part is that there is a CD player in the room. This is the only place on the ship where I can play the CDs I brought with me without being confined to headphones. I try to make a date with the treadmill once in a while, and I am not too proud to admit that I have flown right off the thing at least once as the ship rocked, the treadmill rocked, but I tried to keep walking straight. An exercise for the mind as well as the body.

Question of the day: Professional mariners in the private sector are employed through the Merchant Marines. The Merchant Marine Academy trains people to become professional mariners. What are their admission requirements?

Photo Descriptions: Today's pictures include one of Dr. Frank Bradley on the tower located on the bow of the ship. Dr. Bradley works with Dr. Chris Fairall, and routinely climbs the tower to check his instruments located on top. The data from all that equipment is processed by a number of computers, and the cables in their work area would almost certainly make the fire marshal nervous. There are also a few pictures of the exercise room, and you can see the gas tank storage in the background of one shot.

TUESDAY, SEPTEMBER 25, 2001

Latitude: 9° 53.4 N

Longitude: 95° 3.3 W

Temperature: 29.8° C

Seas:

Sea wave height:	2-3 feet
Swell wave height:	4-5 feet
Visibility:	10-12 miles
Cloud cover:	6/8
Water Temp:	29.2°C

Science Log: Today I checked in with Dr. Amparo Martinez, our Mexican scientist. Amparo is measuring the amount of aerosols in the atmosphere, and she uses a gas chromatograph (GC) to obtain a lot of her data. Amparo has been up until 3:00 or 4:00 am many nights trying to get the GC to work properly. She has lots of tools, and lots of experience working with GCs, but just isn't successful in getting this one to behave. Today's message for you is the importance of careful planning when you are a scientist at sea. Amparo bought a new GC to use for this cruise, so that her colleagues could continue to use the one in the lab for their own research. Once she received approval from the university to purchase this expensive piece of equipment, it took forever to actually get the money. As soon as she had the money available, she bought the GC. She spent a day in Mexico unpacking it to make sure all the parts were in the box, then promptly shipped it to the U.S. to be loaded on the ship. All of her equipment entered the U.S. in New York, where it had to pass customs inspections before continuing its trip to Seattle. Well, for some reason it took 2 whole weeks for her equipment to get through New York, and it arrived in Seattle the day before the ship departed. Keep in mind that once the ship departs, you can't run out to your favorite electronics store for spare parts and tools. Amparo's original plan was to spend a full week in Seattle setting up the GC, calibrating it, and testing it, which would give her plenty of time to remedy any problems. As it turned out, she had less than 24 hours, and wouldn't you know it, the thing has problems. Poor Amparo has been pulling her hair out trying to get this thing to work, with no luck.

There's another lesson here. Be creative with your solutions. Scientists encounter problems all the time, and they have to find solutions. There is no 1-800-technical-support line to call when *you* are the expert in your field. Science is almost like a game- you encounter problems, and you want to find the most efficient and appropriate way to solve them. Since Amparo can't analyze her gas samples while on the ship, she will have to wait until she gets home. But during that time she is concerned that the amount of gas in her samples may change, which would invalidate her data. This is why it is very handy for scientists to have "standard" samples that can be used as reference. A standard is something with precisely known contents similar to what you are studying, and they can be used as

controls in an experiment. Each day, as Amparo prepares her sample vials, she includes a vial of her standard and stores them all together. Every minute between now and when the samples are finally analyzed, 4-5 weeks from now, the standard will be right there with her samples. If her samples undergo pressure and temperature changes while flying home, so will her standard. If small amounts of gasses escape her sample vials, they will also escape from the standard. Since she knows exactly how much of the different gasses are in her standard, she can calculate loss and changes when she analyzes it, and apply those same calculations to her standards. In the end, she will have valid data, even though the GC on the ship was never operational. See how easy that was?

Science is a lot more than numbers and flasks. It requires a range of problem-solving skills, flexibility, teamwork and patience. These things all put together keep a scientist's job interesting!! It's a great career for people who are good thinkers. But if you decide instead that you would rather be an accountant for the Universidad Nacional Autonoma de Mexico, please process money requests quickly so that Amparo can buy the equipment she needs!

Travel Log: Well, I am really bummed that the live webcast scheduled for today didn't work. We had all sorts of technical problems, and after an hour and a half of trying to fix it, we finally figured we had lost our audience. I had some really neat things to show you all! Instead of making you wait until next week, I thought I would at least answer one question (my favorite one). Meghan from Mrs. Byer's class at Northley Middle School in Pennsylvania asked "Have you ever had any interference from sea creatures when using the MMP?" Since I wasn't sure of the answer, I asked Dr. Mike Gregg from the University of Washington, who is in charge of the research that uses the MMPs. I was surprised to learn that yes, they do get interference from sea creatures. In fact, he even showed me a piece of cable that had fish teeth marks all over it! On other cruises he has had cables with shark teeth marks on it, and one time, a shark chomped on the line so hard that it broke, and the MMP sunk to the ocean floor where it still lies today! I thought it was a cool story, but Dr. Gregg was upset that such an expensive piece of equipment had been lost.

Question of the day: What is the process for becoming a NOAA officer? What are the prerequisites?

Photo Descriptions: Today we had beautiful weather, which was such a nice change from the stormy conditions we had experienced the last several days. We even had a small flock of sea birds flying around the ship. So today's pictures focus on the birds and the sunshine that made us all smile.

WEDNESDAY, SEPTEMBER 26, 2001

Latitude: 9° 55.7 N

Longitude: 95° 0.2 W

Temperature: 27.9° C

Seas:

Sea wave height:	2-3 feet
Swell wave height:	3-4 feet
Visibility:	8-10 miles
Cloud cover:	8/8
Water Temp:	29.0°C

Science Log: Today I checked in with the lidar folks from NOAA's Environmental Technology Laboratory in Boulder, Colorado. My roommate, Janet Intrieri, is one of two people working with the lidar to collect data about winds, clouds, and moisture in the air. Unfortunately, the data being collected is so sophisticated that Ms. Intrieri and her coworker, Dr. Raul Alvarez won't have reportable results for years to come. I can tell you that Ms. Intrieri and Dr. Alvarez are up at all hours of the night and day collecting data, making adjustments to the equipment, and archiving data. On many occasions she wakes up to go to work only a couple hours after I go to sleep. The lidar is definitely the most labor-intensive piece of equipment on the ship, and through my roommate's comings and goings it is very clear to me that only a truly dedicated scientist could successfully gather all the necessary data with the lidar to make the trip from Boulder worthwhile.

Travel Log: After reading my logs over the last 3 weeks, are you convinced yet that you are ready to pursue a career as a NOAA officer? You can travel the world, put your interest in science and engineering to use, and live a truly unique and interesting life. Of course, you also have to be willing to spend half of your adult life at sea away from family. But you also never have to deal with sitting in traffic, going grocery shopping, or being trapped in a cubicle until you hit retirement.

I think it is finally time that I introduce you to the 5 NOAA officers on the Ronald H. Brown. I'll introduce you to the female officers, both ensigns, today, and the others tomorrow.

Ensign Cathy Martin- Cathy is the Navigation Officer on the ship. As an Ensign, she is new to the NOAA corps, and this is her first assignment since her initial 3-month training. When Cathy finishes her 2 years of ship service in January 2002, she will be transferred to NOAA's Aircraft Operations Center in Tampa, Florida, where she will begin a career as a pilot. NOAA operates aircraft for scientific research purposes, and it is the NOAA officers that fly the planes. Cool, huh? Cathy will fly planes for marine mammal surveys, aerial photography, snow surveys, atmospheric chemistry studies, hurricane research... you name it, they do it.

Ensign Jenn Pralgo- The newest officer on the ship, Jenn is still in the training phase of her career. Just like all NOAA officers, she completed 3 months of training at the Merchant Marine Academy in Kings Point, Long Island, New York. Her goal is to learn as much as she can so that she can qualify to be an Officer of the Deck (OOD). In addition to their other duties, all officers are the OOD on the bridge for 4-8 hours a day. The OOD is responsible for the operations of the ship during their shift. The Captain is on call 24 hours a day, but it's the other officers who man the bridge under normal operating conditions. When Jenn completes her 2 years at sea, she will have a land assignment for 2-3 years, and return to sea for another 2. She can expect this pattern to continue for the duration of her career with NOAA.

Question of the day: NOAA is one of the 7 uniformed services in the U.S. government. Can you name the other 6?

Photo Descriptions: Today I am sending photos of each officer on the ship (except the Captain, whose pictures have been posted several times previously). On special occasions they wear their uniforms, but for day to day work they usually wear t-shirts with the Ronald H. Brown picture and call sign.

THURSDAY, SEPTEMBER 27, 2001

Latitude: 9° 59.8 N

Longitude: 94° 59.7 W

Temperature: 25.8° C

Seas:

Sea wave height:	2-3 feet
Swell wave height:	3-5 feet
Visibility:	8 miles
Cloud cover:	8/8
Water Temp:	28.8°C

Science Log: Test question... which researcher on the ship is looking at chlorophyll in the ocean? That's right, Dr. Carter Ohlmann from the University of California at Santa Barbara. If you recall, he collects water samples obtained by the CTD at various depths (to 300 meters) and looks at the amount of chlorophyll. He correlates that with the amount of sunlight that is detected at those same depths, which is measured by the SPMR. The greater the amount of chlorophyll, the less light than can penetrate to depths below. The more thermal energy that is trapped above the phytoplankton (which contains the chlorophyll), the warmer the upper layers should be, and the cooler the lower layers. What Dr. Ohlmann is trying to do is quantify the relationship between chlorophyll and light penetration in the ocean.

Once Dr. Ohlmann arrives home to Santa Barbara, California, biological oceanographers will enter the picture by analyzing nutrient concentrations in the same water samples collected by the CTD on this cruise. Those scientists will try to correlate the nutrients with the light and chlorophyll data Dr. Ohlmann is analyzing. In the end, they hope to have better input values for climate modelers, and will gain better understanding of the carbon cycle as it relates to photosynthesis in the ocean.

As with most scientists on the ship, Dr. Ohlmann will be spending the next several years analyzing the data he is collecting on this cruise. I was lucky enough, however, to get a sneak preview of some of his data. He showed me two plots of chlorophyll in the ocean to 100 meters at two very close locations. It was interesting to see that one graph showed 400% more chlorophyll than the other where the graphs peaked, around 45 meters deep. Were there currents moving a pocket of high nutrient water into our vicinity? How large is this pocket? What caused it to exist? Or is the high nutrient water "normal" and the low nutrient water the odd-ball? There are a lot of questions to be answered. The way the ocean mixes is important to understand if we hope to forecast climate.

Travel Log: Today I will introduce you to the remaining three officers on the ship and tell you a little about each of their responsibilities.

Captain, Commanding Officer (CO) Don Dreves- As you probably expect, the Captain is the one person who is in charge of everything and everyone on the ship. He is responsible for the safety of the ship and everyone on board, and for operating the ship in accordance will all pertinent regulations. The Captain must delegate a lot of responsibilities to the other officers, but ultimately it's his butt on the line. The average NOAA officer can expect to reach the rank of Captain after approximately 23-25 years of service.

Commander, Executive Officer (XO) George White- The XO is second in command, almost like a "Vice Captain." He would be in charge of the ship in the event that the Captain was unable to do so. The XO's main responsibilities on the ship include the administration of the vessel, all human resources issues (ex. payroll, benefits, grievances), and keeping people happy and comfortable. The ship's crew all have very specialized talents and training, and it can be very difficult to replace people when they leave. If the XO can keep everyone happy, his ship administration duties will be that much easier. The XO makes all arrangements with the ports that the ship visits, to make sure that everyone on the ship has the proper clearances to enter the country, make sure that there is a place for the ship to dock, makes arrangements for equipment and personnel to be transported on and off the ship, etc. The average NOAA officer can expect to reach the rank of Commander after approximately 16-19 years of service.

Lieutenant Robert Kamphaus- Robert is the Operations Officer on the ship. As such, he is responsible for helping the scientific party prepare and complete their missions. Robert coordinates with the chief scientist on each cruise many months ahead of the actual cruise dates and conveys the ships characteristics, features, and limitations. He also makes sure that the Cruise Instructions (drafted by the chief scientist) are realistic and feasible. At this point in time, Robert is not only working with the scientific party that is currently on the ship, but he is working with the scientists that will be on the Galapagos-Chile cruise, the Chile-Panama cruise, and even some scientists who will be boarding the ship next spring when the Ronald H. Brown travels to Brazil, Barbados, and the U.S. Virgin Islands.

Question of the day: If you wanted to pursue a career as a NOAA officer, what would NOAA train you to do?

Photo Descriptions: Today we had another fire drill and abandon ship drill, but this time it was a little more exciting- we had to actually don our gumby suits! So here are a few pictures of yours truly and the people I will be sharing a life raft with in the event we have to abandon ship. And I'd like to point out that it takes an enormous amount of self-confidence to publish a picture like this of myself on the web!

Just in case you were worried that we are all working too hard, I thought I would ease your concerns by including a couple pictures of my shipmates in the movie lounge. These pictures were taken just before we watched "The Wizard of Oz", played to the Pink Floyd CD "Dark Side of the Moon." Very groovy experience. If you want to try this at home, start the CD when the MGM lion growls for the third time.

FRIDAY, SEPTEMBER 28, 2001

Latitude: 9° 57.4 N

Longitude: 94° 56.8 W

Temperature: 25.8° C

Seas:

Sea wave height:	2-3 feet
Swell wave height:	3-4 feet
Visibility:	8 miles
Cloud cover:	7/8
Water Temp:	28.7°C

Science Log: I previously mentioned that there are other aspects to the EPIC program aside from the research being conducted aboard the Ronald H. Brown. Although rarely visible to us on the ship, there are C-130 and P-3 aircraft flying out of Huatulco, Mexico in a grid pattern dropping sondes to collect atmospheric and oceanic data as they fall to the ocean floor. Another piece of this program is the National Science Foundation (NSF) vessel New Horizon. We were barely able to see them today off in the distance, but they have been in our general vicinity for much of the cruise, making butterfly patterns in the ocean to gather ocean cross-sections of data. Whereas the researchers on the Ronald H. Brown are gathering intensive

data about this particular spot (10N, 95W), the New Horizon is gathering a limited amount of data, but for a much larger area.

Travel Log: Today is my second annual 28th birthday. I could write an entire book about my fear of any age over, and including, 29, but I'll spare you from reading it here.

I received really cool electronic birthday cards from Mrs. Byer's Honors Science class at Northley Middle School in Pennsylvania - thank you so much!!!

The biggest surprise of all was when the computer guy, Larry, asked me to help him do some stuff on the computer while he was on the bridge in the radar room connecting to the satellite, 4 floors up- "Jennifer, all you have to do is click here when I call you. That way, I won't have to run up and down the stairs to do it myself." Sounded innocent enough. Well, when I clicked there, I was treated to a video of my husband, Rob, wishing me happy birthday and sending his greetings. It was so cool to see and hear him!! But then, there was more. The screen said "La Jolla Passers-by" and the next video was of two complete strangers in La Jolla, California wishing me happy birthday! Apparently, they saw Rob being taped and decided to get in on the action themselves. Very, very funny. And there was still more- the next video was of my parents in Virginia singing me happy birthday, an annual tradition usually limited to a telephone call! I must say, if this is a true reflection of NOAA as an organization, they sure do a great job of keeping people happy while at sea! To my NOAA contacts in Maryland- Jennifer Hammond and John Kermond- thanks a million times over for tracking down my loved ones and sitting them in front of the camera!!!

The birthday celebration continued into the evening, and I was so surprised when Richard, the chief steward, brought me a birthday cake as I finished my dinner! Everyone in the mess sang, and it was very cool. The rest of my 2nd annual 28th birthday celebration will have to wait until I get home. I told my husband to exercise his vocal cords so he can sing to me

when I call tonight. Sound romantic? Don't worry, I'm sure it won't be- he's pretty much tone deaf (and still in denial).

Question of the day: Twenty-nine years ago I was born near Oxon Hill, Maryland. How many miles am I from my birthplace?

Photo Descriptions: Today I am sending more CTD pictures. The CTD is the largest object that is submerged in water for the research being conducted on the ship, and it's always kind of cool to watch it rise out of the ocean, with water pouring off its sides, until it finally comes to a rest on the ship's deck. If you make a little book out of the pictures I am sending today, and you flip the pages really fast, it will be just like you're here with me on the ship watching!

SATURDAY, SEPTEMBER 29, 2001

Latitude: 9° 54.9 N

Longitude: 95° 1.0 W

Temperature: 28.0° C

Seas:		
	Sea wave height:	3-4 feet
	Swell wave height:	4-6 feet
	Visibility:	8-10 miles
	Cloud cover:	7/8
	Water Temp:	28.7°C

Science Log: A few evenings ago we had a science seminar in the library. I was asked to share the work I have done on the cruise with the scientific party and crew, and they seemed impressed with the lesson plans and daily logs. Now they understand why I am constantly hogging the computer! Following my brief presentation and show-and-tell, we all enjoyed lectures by Dr. Rob Cifelli from Colorado State University, and Ms. Michelle Ryan from NOAA's Environmental Technology Laboratory in Boulder, Colorado. They are both working with radar to collect meteorological data, but their radar systems vary enough to allow them to collect different types of data. I told you a few days ago about some of the results obtained by Dr. Cifelli regarding the internal structure of clouds

and cloud electrification, so today I'll bring you up to date on what Ms. Ryan is learning about atmospheric conditions in the eastern Pacific Ocean with her ka-band radar and radiometers. As expected, the amount of water vapor in the air is much larger here than in non-tropical places in the world. We have a lot of evaporation, and a large body of water. Ms. Ryan found it interesting that there have been so many small, low cumulus clouds with a clearly defined base. This is data she has not typically seen anywhere else. What does it mean? I got a familiar answer- it will be years before all the data is quality-checked, reviewed, processed, analyzed, correlated with data collected by other scientists on the ship, and finally ready for conclusions worthy of publication. So I guess we'll just all have to check back in with these scientists in a few years.

Travel Log: Today we have had some eerie scenery, in my opinion. The swell is unusually large, and everyone on the ship is walking like a drunken sailor (in the words of the XO) as our center of balance constantly, and sometimes dramatically, changes. We have sun above us, with nice cumulus clouds in three directions, and a large dark gray mass in the other. There is definitely a storm nearby, and we are feeling the effects. If you stand out on deck and watch the water moving it's almost creepy how dark and tall the waves are, and we are seeing white-caps for the first time on the trip. Hopefully it will pass soon.

Question of the day: Some of my students are interested in science, but are not sure which area of science they would like to pursue in college. List as many different scientific disciplines as you can (ex. meteorology, oceanography, etc.)

Photo Descriptions: Today I am sending a variety of pictures highlighting the ship, its crew, and food. So many students have asked about the food on the ship, so I'm sending a picture of the buffet line in the mess, some people enjoying mealtime, and Richard, the chief steward (head cook), who does a fantastic job of mixing simple ingredients into really yummy stuff. Of course, I also have to show off my birthday cake from last night. Richard made dozens of them so everyone had their own. Isn't that sweet? You can probably tell from the photo how happy and surprised I was about the whole thing!

The last picture being sent today shows Michelle Ryan and one of her radiometers.

SUNDAY, SEPTEMBER 30, 2001

Latitude: 9° 54.4 N

Longitude: 95° 1.9 W

Temperature: 28.0° C

Seas:

Sea wave height:	3-4 feet
Swell wave height:	4-6 feet
Visibility:	8-10 miles
Cloud cover:	6/8
Water Temp:	28.5°C

Science Log: OK, I realize this is pretty late, but I was just revisiting the Cruise Instructions, written by our Chief Scientist, Dr. Chris Fairall, and I found a nice big-picture overview of the research being conducted on this cruise. I thought it might help put things in perspective, so here it is, taken directly from that document:

> NOAA Ship *Ronald H. Brown* (RHB) will participate in the Eastern Pacific Investigation of Climate Processes in the Coupled Ocean-Atmosphere System (EPIC) to study several aspects of the Inter-Tropical Convergence Zone (ITCZ) the Atmospheric Boundary Layer (ABL)/Cold Tongue and the Stratocumulus region during the EPIC 2001 field program. The RHB will be equipped with a suite of instruments for measurements of atmospheric and oceanographic processes. The emphasis will be on observations of precipitating systems, clouds, and atmospheric boundary layer structure and their coupling to oceanic mixed layer structure through the sea surface temperature field.

On the first leg of the cruise, the ship will operate predominantly in the ITCZ region near the TAO buoy at 95 W 10 N for joint measurements with the *R/V New Horizon* and the NCAR C-130 and the NOAA P-3 research aircraft. The RHB will make a transect of the cold tongue region from 10 N to 10 S along the 95 W TAO buoy line with a diversion to the Galapagos Islands to exchange personnel.

Travel Log: Today is a landmark day. This is the last of 18 straight days that we will be sitting at 10N, 95W, and while it's a perfectly fine spot in the ocean,

most everyone on the ship has agreed that it's time to move on. There's plenty of, uh, fish in the sea, and it's time we go visit some new ones.

We are still feeling the effects of a large tropical depression in the area, which is causing a pretty large swell. Of course, this is nothing compared to REALLY bad conditions, but the ship is rocking much more than usual, and enough to cause a little seasickness. I am really looking forward to sleeping in a bed that doesn't sway all night! I'm starting to count the days until we hit land.

Question of the day: Quito is the capital of Ecuador. Name 3 U.S. cities that are located on the same line of longitude as Quito.

Photo Descriptions: Just a reminder of the many activities happening on the ship. There are 2 pictures of a weather balloon ready to be launched by Janet Intrieri (helping out the CSU team). There's a picture of Carter Ohlmann and Dave Menzies from UCSB getting the SPMR ready to deploy. I'm also sending pictures of some of the crew relaxing on the stern, and one of a deck getting spruced up with touch-up paint (a never-ending job).

MONDAY, OCTOBER 1, 2001

Latitude: 8° 19.0 N

Longitude: 94° 56.6 W

Temperature: 24.3° C

Seas:		
	Sea wave height:	1-2 feet
	Swell wave height:	3-5 feet
	Visibility:	2-4 miles
	Cloud cover:	8/8
	Water Temp:	28.4°C

Science Log: We have finally departed the operations center at 10N, 95W! In the concise, yet brilliant, words of Homer Simpson…woo hoo! We are all excited about moving on, and a lot of the data gathering on the ship has been reduced or eliminated, giving many (but not all) scientists a much-

needed break. Finally, the 8 team members from the University of Washington can do something besides standing at the winch, deploying and pulling the MMP for 24 hours a day!

As a follow-up to yesterday's cruise overview, taken from the Cruise Instructions, I am sharing with you today the cruise objectives that relate to leg 1 of this cruise. This may help put all the information I provided over the last 26 days into perspective.

(a) mechanisms governing temperature and salinity field evolution across the oceanic cold tongue through the ITCZ

(b) atmospheric planetary boundary layer structure and evolution from the equator through the ITCZ, primarily in the southerly monsoonal regime; and

(c) the processes determining the existence, character and strength of deep convection in the northeast Pacific ITCZ.

Objective II. To observe and understand the dynamic, radiative and microphysical properties of the extensive boundary layer cloud decks in the southeasterly tradewind and cross-equatorial flow regime and their interactions with the ocean below.

If you look at each science log I've written, you can relate all of the research being conducted to at least one of the objectives listed above. Although the objectives are written in fairly technical terms, I am reprinting them here to give you a big-picture view of what's going on here on the Ronald H. Brown EPIC cruise.

Travel Log: Today there was a 20-30 feet long, 3 feet diameter, log floating near the ship. This is a perfect example of why there is someone on watch 24 hours a day in the bridge. Some objects, like debris floating in the water, just isn't large enough to show up on the ship's radar. The log was big enough that, had we hit it, it could have done some real damage. There is SCUBA equipment on the ship, and a couple divers would have been sent down to inspect the hull. Of course, since we didn't hit it, everything is OK.

Question of the day: The water temperature at 10N, 95W is approximately 29 degrees Celsius. Is the water temperature in the Galapagos Islands warmer or cooler? Why?

Photo Descriptions: One of the operations that will continue through the end of the trip is the lidar. So today I am sending pictures of the lidar, graphic

representation of lidar results, Janet Intrieri making adjustments to the lidar on the roof of the van, and a handmade scientific instrument called "lidar man." He's a split personality guy, composed of "worker guy" on one side and "party guy" on the other. Yes, I'm serious. He is actually a dessicator, whose purpose is to keep moisture away from the equipment (like those little packets that are often in the boxes when you buy new shoes). When Janet and Raul are working, the worker guy side of the dessicator keeps them company. When the work is done, the party guy side comes out to play. Who ever said scientists don't know how to have fun?!

TUESDAY, OCTOBER 2, 2001

Latitude: 5° 4.9 N

Longitude: 94° 50.0 W

Temperature: 26.9° C

Seas:

Sea wave height:	1-2 feet
Swell wave height:	2-4 feet
Visibility:	6-8 miles
Cloud cover:	8/8
Water Temp:	27.2°C

Science Log: The focus of this last week of the cruise is the TAO buoys. The only research group that I haven't talked about yet is Mr. John Shanley from NOAA's Pacific Marine Environmental Laboratory in Seattle, Washington. His entire job on the ship is the buoy work. While on land he builds the equipment that will be mounted on the buoys to collect oceanographic and atmospheric data, and he spends approximately 3 months a year at sea installing the equipment, deploying buoys, etc.

We are now making progress toward the Galapagos Islands, but there will be stops at 5 buoys along the way that require maintenance or replacement. We stopped at one buoy yesterday to replace a sensor that had stopped working. Two or three guys from the ship used the rescue boat to get out to the buoy- the swell looked enormous compared to their little 20 foot boat. It's amazing to watch John Shanley climbing the buoy

and bouncing all over the place- I'm surprised he's able to hang on as well as he does!

According to Larry Bennett, one of the crew members who went out to the buoy in the rescue boat, they found a tupperware container with a note inside, duct-taped to the buoy! The bummer of it is that they were so preoccupied with their jobs, that they forgot to bring the container with them! Isn't that neat to be in the middle of the ocean and get a note from someone? I heard that on a previous cruise John got a note on a buoy from a friend on another ship that had been in the area. The note had a photograph of the guy holding a huge fish, and a challenge to John to catch something bigger. The XO said there have been times when even a case of beer has been left at the buoy for the next passing ship.

On the subject of buoys, I was fascinated to learn about "mail buoys." You leave your outgoing mail on them, and your incoming mail will be waiting for you there. Pretty neat system, huh? The US Postal Service really goes out of their way to do a great job!

Travel Log: The Ronald H. Brown is 6 decks tall. The laundry room is 5 decks below my stateroom. There are 11 stairs between each deck. This means that every time I do laundry- put my clothes in the washing machine, put them in the dryer, take them back to my room- I walk up and down 165 stairs. I'm thinking of starting a new diet fad- "The Laundry Diet." The cleaner your clothes, the more weight you lose!

Question of the day: What is the call sign of the NOAA ship Ronald H. Brown?

Photo Descriptions: Today I am sending buoy-related pictures. The rescue boat is used to transport John Shanley and crew to the buoy for repairs. In one picture you can see some replacement TAO buoys on the deck of the ship.

P.S. If you even halfway believe the story about the mail buoys, don't admit it to anyone on the ship or you'll surely be picked on for the rest of the cruise. Luckily, we were all too smart to fall for it.

WEDNESDAY, OCTOBER 3, 2001

Latitude: 2^{o} 2.43 N

Longitude: 95° 20.7 W

Temperature: 23.2° C

Seas:

Sea wave height:	3-4 feet
Swell wave height:	4-6 feet
Visibility:	8 miles
Cloud cover:	7/8
Water Temp:	25.7°C

Science Log: Today was a pretty exciting one. I started it by reading an entire 350-page book from midnight to 4:30 am. My roommate's alarm clock went off at 5:00 am and I was still wide awake. I decided I might as well be productive, so I worked on some lesson plans. Then it was time to prep for the last live video feed from the ship, which was broadcast from the bridge. Right after that the C-130 flew over and I got some good video of it. All afternoon was spent watching John Shanley and the crew readying one of the TAO buoys and deploying it. See what I mean? Exciting day!

I was surprised at the amount of effort that went into deploying the buoy. It's not just a matter of dropping something into the water. Because we're on a moving platform, moving any large object is quite tricky. There were so many cables and people around, it looked like a float in the Macy's Thanksgiving Day parade! There were sensors on a cable hanging from the bottom of the buoy at good100 feet. After the cable was lowered into the water, the ship's crane and a half-dozen crew members fought to get the buoy in the water. Then there was 3 miles of cable to spool out into the water, and at the end of the cable are the anchors. By the time the anchors were dropped, the buoy had drifted quite a way out to sea. As the anchors fell, they pulled the buoy back to the ship. Dr. John Kermond from NOAA had told me about all this before my trip, and said it was his dream to surf the buoy as it races across the ocean to the anchor. I think it sounds like fun!

Travel Log: Today was the last live web feed for leg 1 of the cruise, but don't worry, Mrs. Temoshok will be doing the same thing on leg 2, from the Galapagos Islands to Arica, Chile. The highlight of today's broadcast was showing you all a weather balloon and sonde, and my fabulous demonstration putting on the gumby suit.

Here is the list of the live video broadcast participants:

- My classes at Guajome Park Academy in Vista, CA

- Jane Temoshok's class at Lyles-Crouch Traditional Academy in Alexandria, VA
- Instituto Mexico de Huatulco, Professoras Zimbron Carranza and Zimbon
- Gay Byer's class at Northley Middle School in PA
- Mike Stern's class at Westhoff Independent School District in TX
- Plainfield Elementary School in New Hampshire
- Science Center in Fort Wayne, IN
- NOAA's Office of Global Programs
- Admiral Fields at NOAA's Office of Marine and Aviation Operations
- NOAA Research Public Relation Offices
- National Science Foundation (NSF) Division of Atmospheric Sciences

Question of the day: When I return home to California I will be flying from Quito, Ecuador to Miami, Florida to Los Angeles, California, and finally to San Diego, California. Approximately how many frequent flyer miles will I rack up?

Photo Descriptions: The TAO buoy! Lots of pictures of the buoy as it was prepared for deployment, and lowered into the ocean.

THURSDAY, OCTOBER 4, 2001

Latitude: 0° 1.1 S

Longitude: 94° 56.5 W

Temperature: 19.8° C

Seas:		
	Sea wave height:	2-4 feet
	Swell wave height:	3-5 feet
	Visibility:	3-5 miles
	Cloud cover:	8/8
	Water Temp:	18.3°C

Science Log: We have now entered the "cold tongue" region. If you look at the water temperature today (18.3° C or 64.9° F) and compare it to the water temperature over the course of this trip (highest on September 15 at 29.9° C or 85.8° F) you'll notice that it is significantly cooler all of a sudden.

The *question of the day* from October 1 can be answered right here. Why is the water temperature here at the equator suddenly so much cooler than in the areas surrounding the equator?

Remember the coriolis effect, which results from the earth spinning. At the equator, winds and ocean currents move westward. The surface waters are moving towards Indonesia, and when they get there they submerse deeper in the ocean and cycle back to the east. When they reach the eastern boundaries of the Pacific Ocean, they upwell. This means that the cold deep water rises to the surface, and starts traveling west again. So in this part of the ocean, the eastern Pacific, we have very cool water rising from the deep ocean. This water brings a lot of nutrients with it, allowing for good fishing off the west coast of Ecuador. The cool water also causes the air temperature to drop and today we've experienced the coolest air temperature on the entire trip- 19.8° C (67.6° F) compared to a high of 31.3° C (88.3° F) recorded September 9 off the coast of Baja California, Mexico. It's really neat to actually experience something that the textbooks tell you about, and to realize that the textbook authors were right!

A little bit of trivia for you… Dr. Dennis Boccippio, one of the radar scientists working with the group from Colorado State University, apparently had a little too much time on his hands the other day. He actually took the time to use his radar data to calculate that over an 18-day period on this cruise, 28 **billion tons** of rain fell within a 300 km x 300 km area centered over the ship! That's an incredible amount of water, don't you think?!

Travel Log: Today we reached the equator and installed a buoy. Rumor has it that there may be some sort of initiation tonight for those of us who have never crossed the equator via ship (I guess it doesn't count if you fly across- darn!). If the rumor is true, I will certainly let you know how it goes.

Everyone is getting excited about reaching land in 2 days. Now that we have left the operations station at 10N, 95W many groups have started packing their equipment. The labs are starting to look pretty empty. What happens to the equipment once it is all packed? Well, there are two choices- you can try to ship it all from Ecuador to the U.S., which will involve several months of sitting in customs lines and waiting to be inspected, or you can leave it on the ship until the ship reaches the next U.S. port, Charleston, South Carolina. From there, the equipment will be loaded on to trucks to be transported to the scientists in their labs, all on the west coast. Although the ship won't arrive in the U.S. until December,

it is still faster to transport it this way, leaving it on the ship, rather than deal with customs issues.

Question of the day: What is a "pollywog"? You may have to search a little, but give me the definition that relates to the ocean.

Photo Descriptions: While we're doing buoy operations this is prime opportunity for good fishing. So I am sending you pictures of the crew and scientific party fishing, and some of the mahi they caught. Nice looking fish, eh? The picture of the fishermen and their prized mahi shows (from left to right) John Shanley (buoy guy), Janet Intrieri (lidar gal), Bruce Cowden (crew-Chief Bosun), Pat McManus (crew- engine guy) and Paul Aguilar (University of Washington).

FRIDAY, OCTOBER 5, 2001

Latitude: 1° 3.2 S

Longitude: 93° 6.7 W

Temperature: 19.0° C

Seas:		
	Sea wave height:	1-2 feet
	Swell wave height:	3-4 feet
	Visibility:	10 miles
	Cloud cover:	3/8
	Water Temp:	17.0° C

Science Log: I am going to get a little ahead of myself on today's science log by telling you about what I hope to see on the Galapagos Islands. I feel like Charles Darwin has prepped me well and I am so excited about the unique animals that are waiting for me. It fascinates me to think that at age 29 I will be visiting the same place Darwin visited at age 26, and that his observations on the Galapagos Islands lead to a revolution in the scientific community-the theory of evolution. I would like to read you some quotes from Darwin's journal "Voyage of the Beagle" about his visit to the Galapagos Islands exactly 166 years ago in September and October of 1835. I find it so amazing to read the journal and see foreshadowing of the theory of

evolution which he developed in the Origin of Species, published 24 years after his visit.

Excerpts from "Journal of Researches into the Geology and Natural History of the various countries visited by the H.M.S. Beagle, under the command of Captain Fitzroy, R.N. from 1832 to 1836" by Charles Darwin Esq., M.A. F.R.S. Secretary to the Geological Society.

- Considering that these islands are placed directly under the equator, the climate is far from being excessively hot; a circumstance which, perhaps, is chiefly owing to the singularly low temperature of the surrounding sea.

- Nothing could be less inviting than the first appearance. A broken field of black basaltic lava is every where covered by a stunted brushwood, which shows little signs of life… such wretched-looking little weeds would have better become an arctic, than an equatorial Flora.

- The natural history of this archipelago is very remarkable: it seems to be a little world within itself; the greater number of its inhabitants, both vegetable and animal, being found nowhere else.

- …the birds are strangers to man. So tame and unsuspecting were they, that they did not even understand what was meant by stones being thrown at them…

- …many of the islands possess trees and plants which do not occur on the others…Unfortunately, I was not aware of these facts till my collection was nearly completed: it never occurred to me, that the productions of islands only a few miles apart, and placed under the same physical conditions, would be dissimilar.

- …I must describe more in detail the tameness of the birds…A gun here is almost superfluous; for with the muzzle of one I pushed a hawk off the branch of a tree.

Regarding the tortoise

- …there are many wild pigs and goats, but the main article of animal food is derived from the tortoise. Their numbers in this island have of course been greatly reduced… It is said that

formerly single vessels have taken away as many as 700 of these animals.

- In my collections from these islands, Mr Gould considers that there are twenty-six different species of land birds. With the exception of one, al probably are undescribed kinds, which inhabit this archipelago, and no other part of the world.

- The inhabitants, when walking in the lower district, and overcome with thirst, often take advantage of this circumstance, by killing a tortoise, and if the bladder is full, drinking its contents.

- …the instant I passed, it would draw in its head and legs, and uttering a deep hiss fall to the ground with a heavy sound, as if struck dead. I frequently got on their backs, and then, upon giving a few raps on the hinder part of the shell, they would rise up and walk away; but I found it very difficult to keep my balance.

Regarding the aquatic lizards

- It is a hideous-looking creature, of a dirty black colour, stupid and sluggish in its movements… A seaman on board sank one, with a heavy weight attached to it, thinking thus to kill it directly; but when an hour afterwards he drew up the line, the lizard was quite active.

- …when frightened it will not enter the water…One day I carried one to a deep pool left by the retiring tide, and threw it in several times as far as I was able. It invariably returned in a direct line to the spot where I stood…I several times caught this same lizard, by driving it down to a point, and though possessed of such perfect powers of diving and swimming, nothing would induce it to enter the water; and so often as I threw it in, it returned in the manner above described. Perhaps this singular piece of apparent stupidity may be accounted for by the circumstance, that this reptile has no enemy whatever on shore, whereas at sea it must often fall prey to the numerous sharks.

Regarding the terrestrial lizards

- The lizards, like their brothers the sea-kind, are ugly animals; and from their low facial angle have a singularly stupid appearance.

- The inhabit burrows; which they sometimes excavate between fragments of lava, but more generally on level patches of the soft volcanic sandstone…I watched one for a long time, till half its body was buried; I then walked up and pulled it by the tail; at this is was greatly astonished, and soon shuffled up to see what was the matter; and then stared at me in the face, as much to say, 'What made you pull my tail?'

- The little birds are aware how harmless these creatures are: I have seen one of the thick-billed finches picking at one end of a piece of cactus, whilst a lizard was eating at the other; and afterwards the little bird with the utmost indifference hopped on the back of the reptile.

Travel Log: Well, there were no initiation rites last night to mark our crossing the equator. I guess everyone is just preoccupied with last minutes plans for our arrival in the Galapagos Islands.

The weather today is even cooler than yesterday. John Mickett from the University of Washington is hoping to find a t-shirt in the Galapagos that says "I froze my butt off at the equator!" I'd buy one.

A lot of activity on the ship today as people burn CDs of data, make backup tapes, pack research equipment and personal belongings, and plan for our shore visit. A bunch of people are going SCUBA diving, and I am bummed that I didn't bring my c-card or gear. That's OK, as long as I get a chance to go swimming with the marine iguanas. And maybe some penguins. Oh, and some turtles and sea lions, too. That's not too much to ask, is it?

Question of the day: How many people live in the Galapagos Islands?

In an unprecedented move, I am going to give you an answer to yesterday's question of the day. A pollywog, according to the Captain and seafaring tradition, is "an unworthy, slimy intruder to the realm of King Neptune," or someone who has never crossed the equator via ship. By the way, a "shellback" is the term for someone who has crossed the equator via ship- that's me!

Photo Descriptions: Today I am sending a couple pictures taken at the equator buoy- one of me, and one of Glenn Carter and Dave Winkel from the University of Washington. As hard as we looked, we just couldn't see the line marking the equator in the water (kidding- ha!). Notice how overcast it is,

a side effect of the suddenly cooler temperatures. I am also sending some more buoy pictures today. You'll see some buoy parts on the deck in various stages of assembly, the rescue boat going out to a buoy for repairs, and Ensign Jenn Pralgo overseeing buoy deployment from the bridge.

SATURDAY, OCTOBER 6, 2001

Latitude: 0.5° S

Longitude: 91.5° W

Science Log: As you can probably guess, this is a big packing day for all the scientists. There are a lot of equipment and personal belongings that will start their journey home today. We have to get that all done so we will have plenty of time to explore the Galapagos Islands as soon as we arrive!

Travel Log: Today is my last day on the ship. We are scheduled to arrive at Puerto Ayora, on the island of Santa Cruz, in the Galapagos Islands, Ecuador at 8 am. What happens next? Well, I will be meeting Mrs. Jane Temoshok, the teacher on Leg 2 of this cruise to Arica, Chile. She and I will tour the islands with Mike Patterson, the head of NOAA's Office of Global Programs (the sponsor of the Teacher at Sea Program) and Dr. John Kermond, a cruise coordinator and public relations guy who is never seen without a video camera in his hands.

Some of you may recall that our original plan was to travel to the island of San Cristobal to watch the pilot-less aerosonde airplanes takeoff. From what little I know about them so far, these planes fly for a full 24 hours on a pre-programmed flight path to collect atmospheric data. Then they land, and are sent on another mission. This data is used in conjunction with the data collected on the ship and by the C-130 and P-3 planes (which flew over the ocean while the ship was on station at 10N, 95W) to gain a better understanding of atmospheric conditions in the eastern Pacific Ocean. Eventually, all of this data will help improve the ability to forecast climate. Well, as it turns out, the aerosondes have still not arrived in the Galapagos and the decision was made to abort that project. The operations center on San Cristobal is being closed so there won't be anything for Jane and I to visit there.

After our impromptu explorations of the islands we will return to the ship, anchored in Academy Bay off the island of Santa Cruz to send Mrs. Temoshok off on her ship-board adventure to Chile. The following day, October 10, I depart for Quito, the capital of Ecuador, where I will fly to Miami and back home to San Diego, California.

So I will sign off for now and email this to Jennifer Hammond, the web master at the NOAA offices in Maryland, while I still have internet access. I hope you have enjoyed reading my journals and getting a glimpse at ship life the last 33 days on our cruise from San Diego to the Galapagos Islands. I've really enjoyed receiving email from so many of you- please feel free to keep writing with any questions or comments you may have.

Adios!

Question of the day: What is the elevation of Quito, Ecuador? What is the elevation of the highest city in the United States?

Photo Descriptions: Today's pictures include a few of tropical clouds (afterall, clouds are such a large focus of the research on the ship), a silhouette shot of the Doppler radar dome, view from the stern, and the various scientific and ship equipment on deck.

INDEX

abandon ship drill 7, 8, 25, 54
aircraft
  C-130 ..... 26, 27, 54, 58, 63, 70
  P-3 ..... 54, 58, 70
bird 69
buoy 18, 19, 29, 58, 61, 62, 63, 64, 65, 66, 69
carbon cycle 52
chlorophyll 9, 34, 40, 52
climate model 9, 24, 28, 43, 52
cloud 17, 19, 22, 41, 42, 43, 44, 57, 60
Colorado State University 7, 11, 12, 13, 17, 20, 30, 41, 42, 44, 56, 59, 65
Darwin, Charles 5, 16, 66, 67
El Nino 12, 28
equator 27, 60, 65, 67, 69
fire drill 7, 25, 54
fish 10, 12, 18, 19, 31, 33, 49, 59, 62, 65, 66
Galapagos Islands, Ecuador 5, 26, 29, 40, 43, 58, 60, 61, 63, 66, 69, 70, 71
gumby suit 7, 8, 25, 36, 54, 63
Huatulco, Mexico 26, 54, 64
hurricane 10, 12, 17, 26, 51
lidar 20, 21, 22, 50, 60, 66
man overboard drill 7, 8
Modular Microstructure Profiler (MMP) 15, 16, 20, 27, 30, 31, 35, 37, 49, 60
NASA (National Aeronautical and Space Agency) 9, 12
NCAR (National Center for Atmospheric Research) 17, 26, 58
New Horizon 54, 58
NOAA (National Oceanic and Atmospheric Administration) 1, 3, 5, 6, 15, 20, 22, 23, 26, 31, 32, 33, 36, 46, 49, 50, 51, 53, 55, 56, 58, 61, 62, 63, 64, 70, 71
NOAA Corps Officer 32, 33, 49, 50, 51, 53
NOAA Environmental Technology Laboratory 7, 20, 21, 22, 23, 31, 46, 50, 56
NOAA Office of Global Programs 36, 64, 70
NOAA Pacific Marine Environmental Laboratory 61
NSF (National Science Foundation) 15, 26, 36, 54, 64
ocean characteristics
  conductivity 10, 28
  density 37
  depth 10, 28, 40
  salinity 10, 37, 60
photosynthesis 52
pollywog 66, 69
radar 11, 12, 13, 17, 21, 22, 26, 30, 41, 42, 55, 56, 60, 65, 71

Ronald H. Brown 1, 3, 4, 12, 16, 32, 38, 44, 45, 51, 53, 54, 58, 60, 62
San Diego, California..... 3, 4, 6, 11, 64, 70, 71
satellite 9, 10, 12, 17, 19, 55
  SeaWiFS (Sea viewing Wide Field-of-view Sensor)..... 9
  TRMM (Tropical Rainfall Measuring Mission) 12
shark..... 33, 49
shellback 69
Ship
  bridge 6, 10, 15, 17, 27, 34, 37, 39, 46, 51, 55, 60, 63, 69
  engine..... 7, 30, 36, 37, 38, 39, 66
  exercise room..... 47, 55
  mess hall..... 3, 22, 40, 55, 57
SPMR..... 9, 10, 20, 52, 59
stateroom..... 4, 8, 29, 34, 62
storm 11, 12, 17, 18, 37, 43, 44, 45, 46, 57
Universidad Nacional Autonoma de Mexico..... 7, 27, 30, 49
University of California at Santa Barbara..... 7, 8, 20, 30, 34, 35, 40, 52, 59
University of Washington Applied Physics Laboratory7, 14, 16, 20, 27, 30, 31, 35, 37, 49, 60, 66, 69
weather balloon..... 13, 31, 32, 59, 63
whale 9, 29, 37