Climate Education Update

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

SPRING2002

The Return of EL Niño

Will Warm Water Wreak Havoc When Winds Won't Blow?

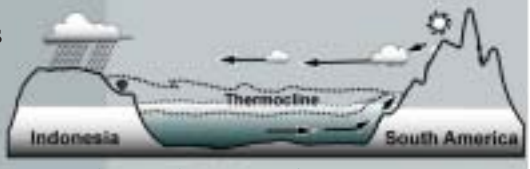
Carrie Talus, *ARM graduate research assistant*

Well, it looks like the next El Niño is coming. Right now many scientists are observing warming over the Tropical Pacific, and this has led to predictions of the next El Niño. El Niño is known to scientists as the El Niño-Southern Oscillation, or ENSO, and is a complicated chain of events that begins in the Pacific Ocean and then spreads to affect the weather around the entire world. What is the El-Niño Southern Oscillation, you ask? The El-Niño Southern Oscillation is the result of a cyclic warming and cooling of the surface ocean of the central and eastern Pacific.

In normal, non-El Niño conditions the central and eastern Pacific region of the ocean is normally colder than its equatorial location would suggest. This condition exists because of the influence of trade winds blowing to the west, a cold ocean current flowing up the coast of Chile, and upwelling of cold deep water off the coast of Peru. The trade winds blow toward the west across the tropical Pacific and these winds pile up warm surface water in the west Pacific. The sea-surface temperatures are much colder near South America because of an upwelling of cold water from deeper levels. This cold water is extremely nutrient rich, leading to high levels of primary productivity, a rich ecosystem, and major fisheries off the coast of Peru.

During an El Niño event, the trade winds weaken in the central and western Pacific for unknown reasons. This weakening causes western Pacific waters to cool, and a warming in the eastern Pacific. The warm, still surface waters in the east Pacific reduce the efficiency of the cold nutrient-rich upwelling, which results in an even larger increase in sea surface temperatures and a dramatic decline in productivity that severely impacts marine life and commercial fisheries in this area. The warming waters in the east Pacific cause huge thunderstorms and floods in the Peru area, while the cooler water temperatures in the west Pacific cause problems such as droughts in Indonesia and Australia. *(continued on page 2)*

In this issue:



Normal non-El Niño conditions.

El Niño conditions.

The National Science Digital Library Focusing on ARM Data Images for Education

Christopher Klaus, *Atmospheric Visualization Collection Principle Investigator*

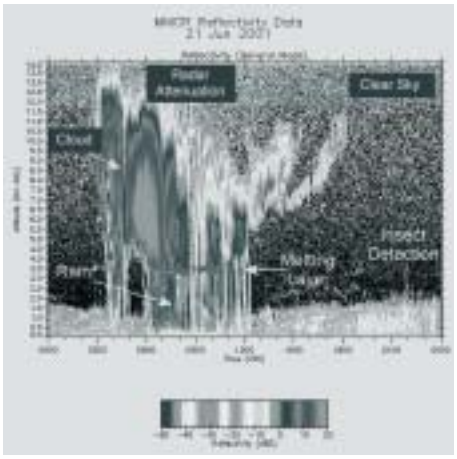
As part of the National Science Foundation's National Science Digital Library (NSDL) effort to develop high quality educational material, the Atmospheric Visualization Collection (AVC) is developing lesson plans with data images basedon the ARM Southern Great Plains (SGP) data.

Students investigating Skewt plots.

These lesson plans and online activities are currently being class tested. As shown above middle school students explore how to interpret Skewt plots. Other lesson plans and online activities cover wind chill, air pressure, drawing contour plots, severe weather indices, various cloud related topics, snowflake formation, lighting safety, the greenhouse effect, radiation budget, and a temperature climate model. These lesson plans and the ability to share your lesson plans are available in our lesson plan sandbox at *http://avc.comm.nsdlib.org/cgi-bin/wiki.pl*. To make educational access to the SGP data easier, the AVC has developed a geophysical focus area interface at *http://www.nsdl.arm.gov/Visualization/geophysical_focus_areas.htm*, which describes areas of ARM interest as shown in the next image.

ARM Geophysical Focus Areas.

This interface allows access to data images with educational oriented descriptions, such as the Millimeter Cloud Radar (MMCR), which has an annotated image shown below as part of description. Our hope is this site will make it easier for teachers to produce their own lesson plans from the ARM data.



Millimeter Cloud Radar image.

(continued from page 1)

The El Niño event occurs irregularly, every 2 to 7 years, lasts 6 – 18 months, and causes large changes in heat and moisture in the atmosphere. This event interferes with the jet stream winds and causes many unexpected weather patterns around the world.

To make things more complicated, the upcoming El Niño event may be dominated by a stronger event called the Pacific Decadal Oscillation (PDO). The PDO is a longer-term ocean-temperature fluctuation that oscillates or switches every 20 – 30 years, and scientists now see data that shows the PDO is switching to a "cool" phase that is associated with a La Niña-like pattern. So, the strength and severity of this next El Niño event will depend on how much the PDO affects the Pacific Ocean's temperatures and circulation.

Climate Change Research Opportunities for Students

Information from this article from Jeff Gaffney, *Argonne National Laboratory*

If you are a U.S. high school or college student and are interested in participating in climate change research, the Department of Energy's (DOE) Office of Biological and Environmental Research Global Change Education Program (GCEP) offers educational opportunities to college students through the Summer Undergraduate Research Experience (SURE).

Students who become a part of the SURE program may work in such fields as atmospheric sciences, ecology, global carbon cycles, climatology, and terrestrial processes. They will interact with mentors from research programs such as the Atmospheric Radiation Measurement (ARM) Program, as well as the Atmospheric Chemistry Program, the Environmental Meteorology Program, the Terrestrial Carbon Processes effort, and the Program for Ecosystem Research.

The SURE program accepts undergraduate students in their sophomore or junior years, but exceptions are sometimes made for outstanding freshman students. Students participate in a 10-week summer program, where the first week is an orientation, and then they travel to various National Laboratories or universities to conduct global change research with their mentor. At the end of the summer, the students gather for a final workshop to share their research experiences with one another and to find out what is happening at the various National Laboratories in Global Change Research.

Students at the 2000 Global Change Education Program Orientation.

Jeff Gaffney, at Argonne National Laboratory in Illinois, is the Chief Scientist for the SURE program. He says that the SURE program "allows undergraduates to determine if they really enjoy the challenges of research before they enter graduate school, and helps them focus on the best places to obtain the quality educational experiences in their various disciplines that they will need if we are to obtain the answers to complex global issues."

One of the past undergraduates in the program, Ms. Shelby Winiecki, worked with the ARM Program with Dr. William Porch of Los Alamos National Laboratory. Her work on the cloud trails over Nauru resulted in a presentation at an ARM meeting. Her work is summarized in a poster presentation that can be found at *http://www.atmos.anl.gov/GCEP/2000posters/winiecki.pdf*. Shelby has gone on to graduate and is working towards obtaining her Ph.D. at the University of Chicago in Geophysical Sciences.

You can find out more about the SURE program at *http://www.atmos.anl.gov/GCEP/sure.html* and how to apply for the summer of 2003 at *https://www.orau.gov/gcep/undergraduate/login.asp*.

Activity ~ Make Your Own El Niño!

Purpose: Hands on demonstration of the El Niño effect, trade winds, and upwelling.

Materials:

- Clear plastic container (approx.18"x4"x4")
- Water
- Mineral oil
- Hair dryer
- Blue food coloring
- Red oil-based paint - optional
- Paper sheet map showing the Pacific Ocean

Preparation: Fill the tray with water to within 1" of the top. Add blue food coloring to the water until it is a nice "ocean blue". Some food coloring will settle to the bottom, which is fine because this will show ocean upwelling. Pour some mineral oil in a bowl and mix in some red oil-based paint until the oil is evenly colored. If you do not have oil-based paint, it does not affect the outcome. Gently pour the oil over the surface of the water. It's okay if it mixes a bit because it will separate out again. Put the container on the paper and mark East, Indonesia, and West, South America at either end. Plug in hair dryer, being careful to keep it away from any water spills.

Explanation: The liquids in the plastic container represent a slice across the Pacific Ocean in the vicinity of the equator. The oil (possibly colored red) represents the warm layer of surface water that has been heated by the sun. The blue water represents the colder water below the surface warm layer. Where the two layers meet is the thermocline. The hairdryer is about to represent the trade winds.

Action 1: The teacher turns on the hairdryer (no heat needed) and directs the wind across the surface of the oil-topped water from the East to the West. Ask the class to describe what effect this has on the "warm" and "cold" water.

Notes to Teacher: Notice that the warm water piles up in the West as it is blown by the trade winds, which is the normal condition for the equatorial Pacific Ocean. Discuss the location of the warm water on the globe. Discuss what will happen to the air above the warm water in terms of how much moisture the air can hold. You may notice that the sediment of the blue food dye moves upwards towards the surface at the east end. This movement is ocean upwelling that brings nutrient-rich bottom waters to the surface. Plankton feed on the nutrients, and in turn fish feed on the plankton, so these areas tend to be rich in fish and other sea life.

Action 2: Now the teacher turns off the "trade winds" and asks the class to describe what happened when the trade winds stop. *(continued on back)*

(continued from front)

Notes to Teacher: You may need to do this several times to observe the motion. The warm water pulses across the ocean from West to East, this pulse of water is the ocean's warm water part of the El Niño condition. In the real ocean, the water also deflects up and down the coastline of South and North America. Note that in your model the "upwelling" previously seen while the trade winds were blowing is no longer present, so no nutrient rich water surfaces to feed marine life. Now a thick layer of warm water (oil) covers the surface in the East, this cuts off the nutrient-rich cold water from upwelling to the surface.

This lesson was created by NASA Education.

For another classroom lesson on El Niño, see the ARM webpage at *http://www.arm.gov/docs/education/tlessons.html*

Critical Thinking Question

Which has the greater capacity to store heat - the oceans or the atmosphere?

Without a doubt, the oceans play an important role in storing heat. When the earth's surface cools or is heated by the sun, the temperature change is greater - and faster - over the land than over the oceans. Because it is a fluid, the ocean diffuses the effects of a temperature change for great distances by vertical mixing and convective movements of the water. The solid land cannot do this, so the heat from the sun penetrates only the thin, upper crust. One consequence of the ocean's ability to absorb more heat is that when an area of ocean becomes warmer or cooler than usual, it takes much longer for that area to revert to "nornal" than it would for a land area. This also explains why coastal climates tend to be less extreme than inland climates, with smaller day-night and winter-summer differences.

We want to hear from you!

Please send us any comments or let us know how we can serve you and your school by either sending us an email or writing a letter. If you live in Manus or Nauru, you can also bring your comments to our observers at the ARCS research site. We are happy to hear from you anytime!

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ARM Education News Briefs

• During April and May 2002, the ARM Education team will be conducting Teacher Workshops on curriculum implementation in the Tropical Western Pacific areas of Manus, Nauru, and Port Moresby. This year's workshops will include collaboration with the Wildlife Conservation Society of Papua New Guinea, and the Roger Williams Park Zoo's Tree Kangaroo Project.

• In October 2001, we held a community meeting in Atqasuk, Alaska, to bring awareness of the ARM Program to the community, and to hear from community members and especially Elders about climate change phenomena that have been occurring in the area.

Laura Marsh, Science Programs Specialist, at Atqasuk Community Meeting.

• After meeting with the North Slope Borough School District, Iñupiat History, Language, and Culture Commission, and community members, we are working to start the "Elders in the Classroom" project. To bring in more traditional Elder knowledge and culture, ARM will fund Elders and translators to speak about weather, climate, and climate change in the classroom.

• We are creating a Climate Change Educational Museum Kiosk for the Iñupiat Heritage Center in Barrow, Alaska. This kiosk will give information on climate change in the Arctic from the perspective of both the western scientist and the traditional Iñupiat Elder.

• In October 2001, we team led a Teacher Workshop at Barrow High School, which included teaching hands-on climate related lessons and taking the teachers on field trips to the ARM site, the NWS site, and the NOAA site.

Weather balloon launch assisted by teacher participating in ARM Teacher Workshop.

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