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The official newsletter of the Schools of the Pacific Rainfall Climate Experiment

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Climate Models: The Basics

August 1, 2012
By Michael Klatt

Meteorologists and climatologists like to play with models. Does that mean we like to build toy airplanes? Well, not exactly. A *model* is just a simplified version of something else. A model airplane, for example, is meant to look like the airplane it represents, but it is not the real thing. Scientists like to use models of the things they study in cases where using the real thing is not practical or could even be dangerous. Scientists who study the atmosphere make many observations (like the rainfall measurements from our SPaRCE participants). However, the atmosphere is so vast that it is impossible to make all the observations needed. In some cases, what is studied can be difficult to find and dangerous to be around—like tornadoes! So, atmospheric models are very important.

The atmospheric models are like your math homework, especially if you're studying algebra or calculus. Unlike an airplane model made out of wood or plastic, you can't touch an atmospheric model

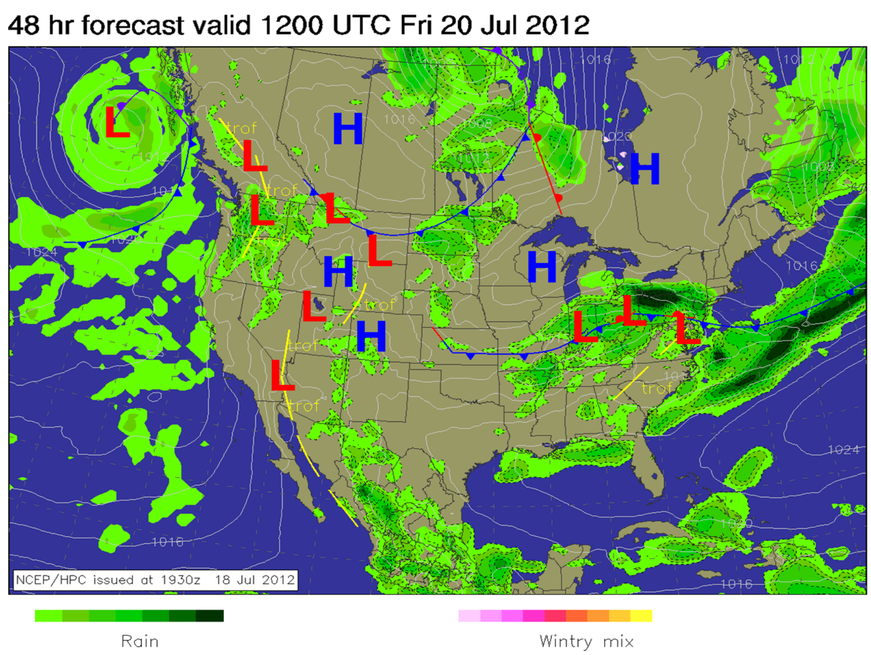

Figure 1: A computer forecast for North America showing major weather systems and areas of rainfall (green shading). From http://weather.rap.ucar.edu/model.

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(but you can still play with it!) Atmospheric scientists are interested in things like atmospheric pressure and temperature, or rainfall amounts, or wind speed and direction. These are all numbers—*data*—that describe the atmosphere, and math is used to describe numbers. Our observations, or what we already know—the *input data*—are fed into the model, which is basically a computer program. Then the computer does the math for us (a single forecast might require billions of calculations!) and tells us what we want to know—the *output data*. This is just a sequence of numbers, but with computer graphics, these numbers are turned into images that people can easily understand (see Figure 1).

One of the main uses for atmospheric models is *forecasting*—making predictions about the future. It's impossible to make observations of the future, but by observing the current weather, we can predict how the atmosphere will change. You don't need to be a meteorologist to do this, and most of us have our own built-in atmospheric model based on our personal experiences. If you see a rain shower moving your way, you can predict that it will be raining where you are in a few minutes. Based on your experience, you know that the rain will temporarily bring cooler temperatures and perhaps a change in the wind. In an atmospheric model, "experience" represents the combined knowledge of many scientists and is expressed as mathematical formulas. Keep in mind that no forecast is perfect, not even one produced by a computer.

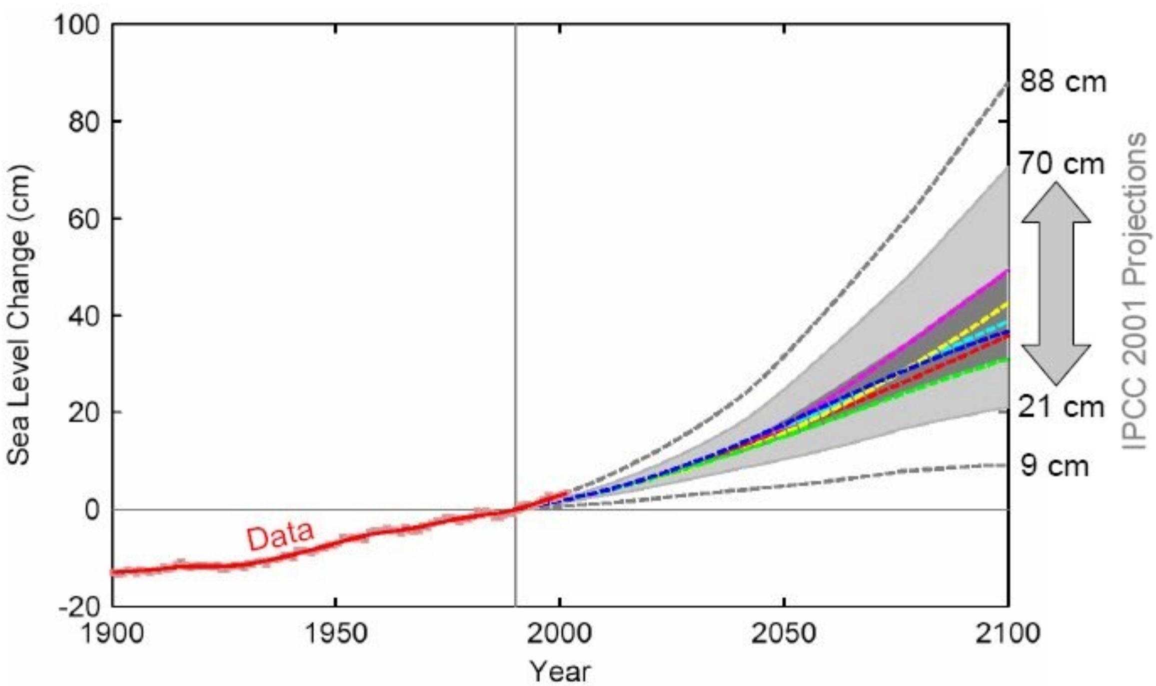

Figure 2: Observed ("Data") and predicted global sea level changes. Predictions for the 21st Century are from the MAGICC climate model for different CO2 emissions scenarios. From http://www.realclimate.org/index.php/archives/2007/03/the-ipcc-sea-level-numbers/.

A *climate model* is a forecast model designed to predict what the climate will be like in the future. Some people ask, "How can we predict the climate in 100 years if we can't even predict the weather in 10 days?" The answer is the difference between weather and climate. Climate describes what the weather is like *on average*. Weather can be highly variable and difficult to predict from day to day, especially outside of the tropics. However, over a longer period of time—a season, a year, a decade—the weather tends to follow the same pattern. For example, I do not know what the day-to-day weather will be like here in Oklahoma in January 2013, but I'm confident that it will be cooler than it is in July 2012 (I

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certainly hope so!) To use another example, if you predict that one coin toss will give you "heads" (the coin's "weather") you will be wrong half the time. But if you predict that 100 coin tosses will give you 50 "heads" (the coin's "climate") you will be right more than 90% of the time.

I'm not saying that climate models are 90% accurate in their predictions (or that weather forecasts are wrong half the time). In fact, we can't really know how accurate they are until the time period they are predicting for has passed, which can be 100 years or more in some cases. One way we can judge the accuracy of our climate predictions before a century has passed is to use more than one model. Imagine you ask somebody what time it is, and he looks at his watch and tells you. But you don't know if his watch is wrong, so you ask a second person. He might give you a different answer, and now you *really* don't know what time it is, so you ask a third person. If he agrees with the first person, you might conclude that the second person was wrong and the other two are right. Even if all three agree, first make sure they didn't set their watches using the same broken clock across the street! In an *ensemble forecast*, many climate models are run with the same input data and the predictions are compared. The more the predictions agree the more confidence we have in them.

Climate models also allow us to do experiments that would be impossible to do with the real atmosphere. Climate models must account for CO2 in the atmosphere in order to make accurate predictions. However, we cannot predict how much CO2 there will be in the future because this relies as much on human behavior and technology as it does on atmospheric science. What if world leaders decide to limit CO2 levels to 450 PPM (parts per million)? What if renewable energy technology allows us to reduce CO2 levels back to 350 PPM over the next 50 years? With climate models we can try to answer these "what if" questions. A different set of input data is created for each possibility, or *scenario*, that we want to examine, and then the model produces a forecast for each scenario so that we can see how changes in CO2 levels affect our predictions. This is similar to the ensemble forecasting described above, but this time we're changing our input data, not the model we're using.

Dr. Jule Charney (1917-1981), meteorologist and one of the pioneers of atmospheric computer modeling at Princeton University in the 1950s.

Figure 2 shows global average sea level rise predictions for the year 2100 for different scenarios, three of which are summarized in the following table:

SCENARIO	SEA LEVEL RISE (cm)
B1	18 to 38
A1B	21 to 48
A1F1	26 to 59

If we're predicting one thing—average sea level rise—why are there so many numbers? Each scenario ("B1", "A1B", "A1F1") is for a different level of CO2 and other greenhouse gasses. Because we can't predict what fossil fuel emissions will be like in the future, we have to consider all of the possibilities. For each scenario, the ensemble forecast shows us two things: the total range of all the predictions made by all the models, and how well the models agree. For example, if fossil fuel emissions in the future match the "A1F1" scenario, different models predict a sea level rise ranging from 26 cm to 59 cm. We don't know which prediction is the most accurate beforehand, so again, we have to consider all of the possibilities. The range for the A1F1 predictions is 33 cm, which is more than for the other two scenarios, so the models do not agree as well and we might not have as much confidence in this prediction as we do for the others.

I hope you now have an understanding of the basics of climate prediction. This is an important topic for everybody, not just scientists. In the next issue of the newsletter I will describe some research I am doing and show some climate predictions for tropical Pacific rainfall.

Radioactive Bluefin tuna crossed the Pacific to U.S.

May 30, 2012

Across the vast Pacific, the mighty bluefin tuna carried radioactive contamination that leaked from Japan's crippled nuclear plant to the shores of the United States 6,000 miles away — the first time a huge migrating fish has been shown to carry radioactivity such a distance.

The levels of radioactive cesium were 10 times higher than the amount measured in tuna off the California coast in previous years. But even so, that's still far below safe-to-eat limits set by the U.S. and Japanese governments.

Previously, smaller fish and plankton were found with elevated levels of radiation in Japanese waters after a magnitude-9 earthquake in March 2011 triggered a tsunami that badly damaged the Fukushima Dai-ichi reactors.

But scientists did not expect the nuclear fallout to linger in huge fish that sail the world because such fish can metabolize and shed radioactive substances.

One of the largest and speediest fish, Pacific bluefin tuna can grow to 10 feet and weigh more than 1,000 pounds. They spawn off the Japan coast and swim east at breakneck speed to school in waters off California and the tip of Baja California, Mexico.

Five months after the Fukushima disaster, Nicholas Fisher of Stony Brook University in New York and a team decided to test Pacific bluefin that were caught off the coast of San Diego. To their surprise, tissue samples from all 15 tuna captured contained levels of two radioactive substances — ceisum-134 and cesium-137 — that were higher than in previous catches.

To rule out the possibility that the radiation was carried by ocean currents or deposited in the sea through the atmosphere, the team also analyzed yellowfin tuna, found in the eastern Pacific, and bluefin that migrated to Southern California before the nuclear crisis. They found no trace of cesium-134 and only background levels of cesium-137 left over from nuclear weapons testing in the 1960s.

The results "are unequivocal. Fukushima was the source," said Ken Buesseler of the Woods Hole Oceanographic Institution, who had no role in the research.

Bluefin tuna absorbed radioactive cesium from swimming in contaminated waters and feeding on contaminated prey such as krill and squid, the scientists said. As the predators made the journey east, they shed some of the radiation through metabolism and as they grew larger. Even so, they weren't able to completely flush out all the contamination from their system.

The real test of how radioactivity affects tuna populations comes this summer when researchers planned to repeat the study with a larger number of samples. Bluefin tuna that journeyed last year were exposed to radiation for about a month. The upcoming travelers have been swimming in radioactive waters for a longer period. How this will affect concentrations of contamination remains to be seen. They also want to track the movements of other migratory species including sea turtles, sharks and seabirds.

Reprinted From: **Tehran Times**
(http://tehrantimes.com/science/98382-radioactive-bluefin-tuna-crossed-the-pacific-to-us-)

Pacific Islands Aiming For Energy Self-Sufficiency

A renewable energy project in Tokelau, supported by UNDP, converts solar-generated power to electricity.

(Photo: UN/Ariane Rummery)

May 14, 2012

By: Phil Mercer

Citizens on the South Pacific island atolls of Tokelau are to become the first in the region to rely entirely on renewable energy. Officials say a hybrid system of solar energy and coconut oil will be supplying enough power for every resident on Tokelau by the end of the year. The pledge comes after 20 small island nations announced new plans to reduce their dependence on fossil fuels at a conference organized by the United Nations in Barbados.

Tokelau officials say the atolls will stop using imported fossil fuels and become self-sufficient in energy later this year.

It is estimated that oil imports account for up to 30 percent of national income in some isolated parts of the Pacific.

The use of coconut biofuel and solar panels will save Tokelau about $1 million each year, and will provide far more electricity than the population currently needs.

Nileema Noble from the United Nations Development Program says Tokelau is making a bold statement about sustainability.

"We here have a tiny nation of people - 1,400 people - telling the world essentially you know what, get on with it," said Noble. "Move away the discourse away from the small island states being vulnerable to one which says we can do things for ourselves, we can take action and, of course, have overcome enormous barriers of distance and isolation to make this happen."

The tiny New Zealand administered territory is among several small Pacific island nations that are threatened by rising sea levels and want to become carbon neutral.

The island nations of Samoa and Tuvalu are aiming to get all of their electricity from renewable sources by 2020. The Cook Islands plans to start converting to solar panels and wind turbines, while most houses in the South Pacific archipelago will begin to use solar water heaters. The changes are in part funded by grants from Japan and New Zealand.

East Timor's government has promised that no households in the capital, Dili, would be using firewood for cooking by 2015 and said 50 percent of the country's electricity would be from renewable sources by the end of the decade.

The push for energy efficiency was a focus of a U.N.-sponsored energy forum in Barbados. It brought together more than 100 heads of state, ministers and campaigners from 39 countries across the Caribbean and Africa, as well as the Pacific and Indian Oceans. Twenty small island nations signed a statement calling for access to modern and affordable sources of renewable power that would protect the environment and boost economic growth.

Reprinted From: Voice of America News / Asia (http://www.voanews.com/content/pacific_islands_aiming_for_energy_self_sufficiency/666302.html)

Source: Voice of America

Japan commits up to 500 million US dollars for Pacific

May 28, 2012

Japan has committed to providing up to 500 million USD to the Pacific region over the next three years at the sixth Pacific Islands Leaders Meeting in Okinawa, Japan. The amount is similar to that pledged in 2009 at the last three-yearly PALM meeting.

Leaders from 15 Pacific Island countries participated along with the United States which was invited for the first time.

The leaders discussed ways to enhance cooperation with particular focus on response to natural disasters, climate change, sustainable development and human security.

Japan's Prime Minister Yoshihiko Noda announced an initiative to improve the Pacific Tsunami Warning and Mitigation System and referred to a pilot programme for developing a catastrophe-risk insurance in cooperation with the World Bank for Forum Island Countries.

Japanese Prime Minister Yoshihiko Noda (C) gives the opening speech of the 6th Pacific Islands Leaders Meeting in Nago city, Japan's southern Okinawa prefecture, on May 26. Japan pledged aid worth up to half a billion dollars to Pacific island nations

The leaders reaffirmed that climate change poses one of the greatest threats to the Pacific and Mr Noda spoke of Japan's commitment to supporting Pacific countries' efforts in addressing environmental issues.

He also announced his plan to introduce, on a bilateral basis, a new type of multiple-entry visa for short-term Forum Island country travelers.

Reprinted from: (http://www.rnzi.com/pages/news.php?op=read&id=68499)
Source: Radio New Zealand International

Crossing of Venus historic sight for Pacific

June 4, 2012

More than 240 years ago the planet Venus led British mariner James Cook into the Pacific Ocean to set up an observatory in Tahiti.

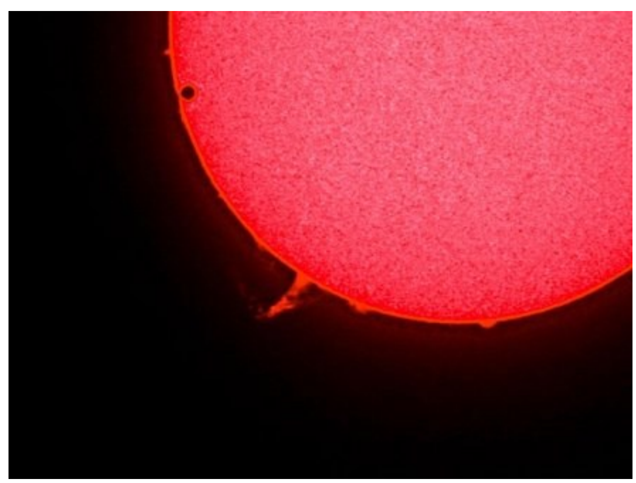
Wednesday's transit, one of the rarest astronomical events in the solar system, will not happen again for more than a century.

It occurs when the planet crosses the sun.

Historically, it was important because it enabled the distance between the earth and sun to be measured.

Professor Fred Watson from the Australian Astronomical Observatory says it is important to Australia, because it is why Captain Cook sailed south for Britain, carrying astronomers, but also on the lookout for territory.

Professor Watson said: "It happens in pairs, actually, separated by eight years and then the next one's more than a century away.



This prize-winning image of the 2004 transit was taken in the north dome of Sydney Observatory through a special filter that only transmits the red light of hydrogen atoms. [Sydney Observatory]

"But of course its transit, historically, is why we speak English in Australia, rather than French, because it's why Captain Cook went to Tahiti in 1769 and then on to explore the coast of New South Wales."

Reprinted from: (http://www.radioaustralia.net.au/international/2012-06-04/crossing-of-venus-historic-sight-for-pacific/955052)
Source: Radio New Zealand International

SPaRCE would like to welcome the following schools to our program...

Ohwa International Christian Academy
Sasina Primary School
Kosrae High School
Waikea High School
Woodford International School
Onesua Presbyterian College
Highland Lutheran International School
Baluan Primary School
Tafea College
College of Micronesia (Yap Campus)
WELCOME!

Contribute to the Newsletter!

Put Your Story in the SPaRCE Newsletter!

In order to get to know our schools and participants a bit better, please send us items to be published in the SPaRCE newsletter.

Here is a list of ideas:

- Accounts of extreme weather events
- School history
- Pictures of students taking measurements
- Activities using SPaRCE data
- Songs or poems about weather
- Any other interesting facts about your school or culture.

Ask A Meteorologist!

Do You Have Questions?
We Want To Answer Them!

If you or your students have any questions relating to science or weather please send them to us here at SPaRCE. Once we receive a question we will publish the question and an answer in the next newsletter.

Activities Page

Beach Word Search

T	V	P	C	E	S	G	T	V	C	A	R	A
T	A	O	B	P	W	Q	N	P	D	K	Z	D
R	F	C	E	A	I	D	W	I	I	N	R	U
S	E	S	I	I	M	R	O	T	L	A	A	L
D	T	W	V	L	S	A	E	C	U	I	S	S
U	N	I	E	M	U	O	I	G	E	E	A	U
O	U	M	C	H	I	B	E	N	V	A	E	S
L	S	M	B	X	T	F	J	A	N	I	N	O
C	Q	I	N	Z	I	R	W	Y	K	X	T	B
F	B	N	R	L	Q	U	K	W	A	T	E	R
F	G	G	F	V	H	S	I	F	R	A	T	S
B	B	E	A	C	H	B	A	L	L	V	P	G
N	L	L	L	E	H	S	A	E	S	R	C	J

BEACH BALL
BOAT
CLOUDS
KITE
LIFEGUARD
OCEAN
PAIL
SAILING
SAND
SEASHELL
SKY
STARFISH
SUN
SURFBOARD
SWIMMING
SWIMSUIT
WATER
WAVES

http://www.puzzles.ca/wordsearch/kids_beach.html

Joke Section

What's the difference between weather and climate?
You can't weather a tree, but you can cli-mate.

What bow can't be tied?
A rainbow

When does it rain money?
When there's change in the weather

EnchantedLearning.com

http://www.enchantedlearning.com/jokes/topics/weather.shtml

Sudoku

Complete the grid such that every row, every column, and the nine 3x3 blocks contain the digits from 1 to 9.

				8				
3								9
	9	5	3		2	7	6	
		1	8	7	4	5		
	4						7	
		8	9	2	1	6		
	2	7	6		8	9	4	
8								6
				5				

Puzzles devised by © Kevin Stone
www.brainbashers.com

Puzzlers

1. How can you throw a ball as hard as you can and have it come back to you, even if it doesn't bounce off anything? There is nothing attached to it, and no one else catches or throws it back to you.
2. You heard me before, Yet you hear me again. Then I die, Until you call me again. What am I?

Look for answers in the next newsletter!

Previous newsletter puzzle answers:

Puzzler Answers

1) Keep the first bulb switched on for a few minutes. It gets warm, right? So all you have to do then is ... switch it off, switch another one on, walk into the room with bulbs, touch them and tell which one was switched on as the first one (the warm one) and the others can be easily identified .

2) The man who drew a ship on the map of the Atlantic Ocean was a television weather forecaster who was sending a message to his wife to pick him up after work because he had no other means of transportation. This happened in the early days of Irish television weather service before cellphones.

Sudoku

9	4	2	5	8	1	6	7	3
6	3	5	7	2	4	1	8	9
7	8	1	3	9	6	2	4	5
1	5	7	6	3	8	9	2	4
4	9	8	1	7	2	3	5	6
3	2	6	4	5	9	8	1	7
8	1	4	9	6	5	7	3	2
2	7	9	8	4	3	5	6	1
5	6	3	2	1	7	4	9	8

Word Search

W	E	W	W	J	Q	F	H	W	S	T	S	O	H	N	E	C	M
F	A	C	M	G	I	C	H	T	U	I	P	C	X	Z	O	Y	I
R	R	V	I	K	C	I	E	S	U	D	L	E	S	L	N	L	W
E	Z	E	E	P	N	A	V	T	D	E	A	A	D	I	A	Y	S
I	G	I	V	O	M	I	N	J	G	T	S	N	A	G	I	G	W
C	K	J	G	I	B	I	R	I	O	D	H	R	L	I	A	R	E
A	H	U	S	C	R	W	M	D	A	H	N	U	O	M	K	E	T
L	C	N	E	Z	W	E	L	C	E	R	P	I	O	O	V	B	Q
G	K	O	A	H	K	B	G	S	Z	C	D	B	P	P	J	E	X
Z	Y	I	N	D	I	U	Q	I	L	C	G	P	W	J	K	C	L
S	W	C	F	H	Y	A	J	L	W	C	R	G	T	A	Q	I	K
K	Z	G	G	W	R	Y	X	E	L	T	T	O	B	Y	R	T	P
P	I	R	D	X	S	S	J	U	U	T	Y	M	V	K	U	N	E

Classroom Science Focus: Making your own Anemometer

An anemometer is a device that tells you how fast the wind is blowing. A real anemometer will be able to accurately measure how fast the wind is blowing. However, yours will give you an approximation of the wind speed.

Materials:

- 5 three ounce paper cups
- 2 Straight plastic straws
- 1 Straight push pin
- 1 Pencil with eraser (larger the eraser, the better)
- Paper hole punch
- 1 small stapler
- 1 pad of paper
- 1 marker
- Scissors
- Ruler

Experiment:

1. Using the paper punch, punch one hole in each cup, about a half inch below the rim.
2. With the fifth cup, punch a hole in the bottom center it. Next, punch four equally spaced holes about a quarter inch below the rim. This will be referred to as the 4-hole cup.
3. Take one of the four cups and push a straw through the hole. Fold the end of the straw, and staple it to the side of the cup across from the hole. Repeat this process for another 1-hole cup and the second straw.
4. Slide one cup and straw assembly through two opposite holes in the cup with four holes. Push another 1-hole cup onto the end of the straw just pushed through the 4-hole cup. Bend the straw and staple it to the 1-hole cup, making certain that the cup faces in the opposite direction from the first cup. Repeat this procedure for the remaining 1-hole cup.
5. Align the four cups so that their open ends face in the same direction (either clockwise or counterclockwise) around the center cup. Push the straight pin through the two straws where they intersect. Push the eraser end of the pencil through the bottom hole in the center cup. Push the pin into the end of the pencil eraser as far as it will go.
6. Take the anemometer outside. Your anemometer should rotate with the wind. It need not be pointed into the wind to spin. Make a small, yet visible mark on one of the cups. By seeing the mark as the anemometer spins, you will be able to count the revolutions.
7. Record the number of times that cup makes a complete revolution (a complete circle) around the vertical-axis (pencil) in a minute. This number will be the revolutions per minute or RPM.
8. Record your results on this data collection sheet. Try this at different times in a day or on different days.

Explanation:

An anemometer is a device for measuring wind speed, and is one instrument used in a weather station. The term is derived from the Greek word anemos, meaning wind.

The simplest type of anemometer is the cup anemometer, invented (1846) by Dr. John Thomas Romney Robinson, of Armagh Observatory. It consisted of four hemispherical cups each mounted on one end of four horizontal arms, which in turn were mounted at equal angles to each other on a vertical shaft. The air flow past the cups in any horizontal direction turned the cups in a manner that was proportional to the wind speed. Therefore, counting the turns of the cups over a set time period produced the average wind speed for a wide range of speeds. On an anemometer with four cups it is easy to see that since the cups are arranged symmetrically on the end of the arms, the wind always has the hollow of one cup presented to it and is blowing on the back of the cup on the opposite end of the cross.

You can watch more on how to build your own Anemometer on **Youtube**:

http://www.youtube.com/watch?feature=player_embedded&v=SZpXGPMvJNo

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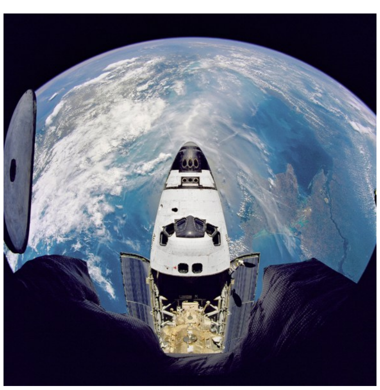

ENSO Discussion

Issued by the Climate Prediction Center/NCEP, 9 August 2012

ENSO Alert System Status: El Niño Watch

Synopsis: El Niño conditions are likely to develop during August or September 2012.

ENSO-neutral conditions continued during July 2012 despite above-average sea surface temperatures (SST) across the eastern Pacific Ocean. Reflecting this warmth, most of the weekly Niño index values remained near or greater than +0.5°C. The oceanic heat content anomalies (average temperature in the upper 300m of the ocean) also remained elevated during the month, consistent with a large region of above-average temperatures at depth across the equatorial Pacific. Although sub-surface and surface temperatures were above average, many aspects of the tropical atmosphere were inconsistent with El Niño conditions. Upper-level and low-level trade winds were near average along the equator, while tropical convection remained enhanced over Indonesia. However, convection increased near and just west of the International Date Line, which may eventually reflect a progression towards El Niño. The lack of a clear atmospheric response to the positive oceanic anomalies indicates ongoing ENSO-neutral conditions.

Nearly all of the dynamical models favor the onset of El Niño beginning in July- September 2012. As in previous months, several statistical models predict ENSO-neutral conditions through the remainder of the year, but the average statistical forecast of Niño-3.4 increased compared to last month. Supported by model forecasts and the continued warmth across the Pacific Ocean, there is increased confidence for a weak-to-moderate El Niño during the Northern Hemisphere fall and winter 2012-13. El Niño conditions are likely to develop during August or September 2012 (see CPC/IRI consensus forecast).

This discussion is a consolidated effort of the National Oceanic and Atmospheric Administration (NOAA), NOAA's National Weather Service, and their funded institutions. Oceanic and atmospheric conditions are updated weekly on the Climate Prediction Center web site (El Niño/La Niña Current Conditions and Expert Discussions). Forecasts for the evolution of El Niño/La Niña are updated monthly in the Forecast Forum section of CPC's Climate Diagnostics Bulletin. The next ENSO Diagnostics Discussion is scheduled for 5 July 2012. To receive an e-mail notification when the monthly ENSO Diagnostic Discussions are released, please send an e-mail message to: ncep.list.enso-update@noaa.gov.

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