NOAA Teacher at Sea
Scott Donnelly
Onboard NOAA Ship McARTHUR II
April 20 – 27, 2008

NOAA Teacher At Sea: Scott Donnelly
NOAA Ship McARTHUR II
Mission: Biological and Chemical Characterization of Central Oregon Coast
Date: Wednesday, April 23, 2008

Weather Data from the Bridge
Sunrise: 0619 Sunset: 2011

	WIND	SEAS	PRECIPITATION
AM	SE 20-25, G30 kts, becoming SW	Waves 4ft, SW Swell 5ft @ 7 seconds	Rain showers possible
PM	E 10-15 kts, becoming NW	Waves 2ft, SW Swell 4ft @ 7 seconds	Same

Legend: G = gusts, kts = knots

Science and Technology Log
My fourth (0100 to 0500, 1am to 5am) and fifth (1300 to 1700, 1pm to 5pm) 4-hour shifts are postponed due to the continued inclement weather. Seas are turbulent (combined seas 16 feet) and the winds blow non-stop (30 knots with gusts near 40 knots) from all directions it seems. Standing on deck both port and starboard, the howling wind throws sharp sea spray darts at my unprotected face. For a seasoned mariner these conditions are probably routine, if not prosaic. But for a newbie like me, with a little more than 48 hours of sea time experience, they are impressive and awe-inspiring, especially so given that I'm watching it all from in the midst of the storm and not from the relative safety of the shore as I've done at times in San Diego. I climb the stairs to the ship's bridge to watch and videotape this grand spectacle. The captain is calm and seems unimpressed with the temperamental, chaotic happenings outside. As I make my way to the bridge's front

Low resolution radar image of the storm system that postponed cruise operations

viewing window he says to me, “Crummy weather isn’t it.” Without thinking, I nod my head in agreement.

Also, a gale warning remains in effect until 1400 (2pm) this afternoon. A gale force wind has sustained surface speeds greater than 34 knots (39mph).

CTD deployment and biological sampling with the nets are postponed until the weather subsides and is more conducive to on deck activity. If the weather cooperates and the night forecast is accurate, the plan is to resume water sampling with the CTD and collection of marine organisms around 2000 (8pm) tonight. In the meantime the CTD has been securely fastened to the fantail deck. The coordinates for today’s postponed longitudinal sampling (constant latitude, changes in longitude) are 43^{O}07’N, 124^{O}29’W to 125^{O}15’W.

With the postponement in work activity in today’s log I’ll discuss a number of topics. In the following paragraphs I’ll discuss some of the nautical terms used in marine weather conditions as found in today’s forecast (see beginning of log, top) and what a low pressure system is. In yesterday’s log I described what a bongo net is and how it works. Today I’ll talk about the marine organisms that a bongo net collects and also describe the other three zooplankton nets used on this cruise- the Manta, ring, and HAB nets. Let’s begin with nautical terms used in marine weather forecasts.

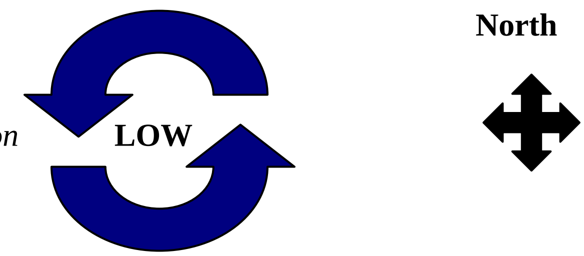
Winds are identified with respect to the direction from which the wind originates. Surface water currents on the other hand are identified with respect to the direction they are flowing. So for example, today’s morning forecasted southeast (SE) winds originate from the southeast and blow toward the northwest (NW) since in general winds travel in a straight line path when not disrupted. Conversely, today’s forecasted morning southwest (SW) swells are traveling in the southwest direction. Marine wind and ship speeds are measured in terms of knots (kts). One knot (one nautical mile per hour, nm/hr) equals 1.15 statuary (or land) miles per hour, mph. Today’s forecasted morning wind speed of 25kts then equals 29mph, with morning gusts (G) forecasted at 30kts or 35mph and subsiding by mid-afternoon.

What is a swell? A swell is a mature wind wave of a given wavelength (distance between successive wave crests, i.e. the highest point of a wave) that forms orderly undulations seen on the ocean surface. Swells are described with respect to their height and period. Wave height is self-explanatory. What about wave period? Notice in the weather forecast that a wave period is defined in terms of time (typically seconds). Let’s use a hypothetical situation to explain a wave period. Suppose you are standing on deck, looking out across the vast sea, and a wave passes across your line of sight. Seven seconds later another wave crosses your line of sight, which remains unchanged. Seven seconds later another wave passes; your line of sight is still unchanged. The wave period then is the time elapsed for successive waves to pass a fixed point. In general, the longer the period, the calmer the sea.

Since my arrival in Oregon on Friday, April 18 a low pressure system has been positioned off the Oregon coast bringing clouds and precipitation. Today’s stormy seas are a result of a low pressure system. The winds and clouds in a low pressure system rotate in a counter-clockwise direction when viewed from satellites above. So if the winds blow from the southeast (SE) and are sustained, this indicates that the northern region of the low pressure system is south of the observer.

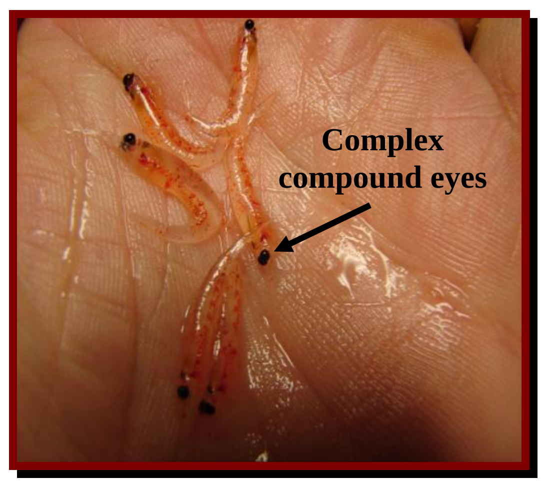
A change in winds from the SE to the E and then NW as forecasted from AM to PM indicates that the storm system is moving in a northeast direction onto land.

Counter-clockwise rotation



In yesterday's log I wrote briefly about how a bongo net is deployed and its function. So what marine organisms are collected in a bongo net? On this cruise at the depths the bongo net is deployed, it's mostly a thumb-sized, shrimplike crustacean called krill. Krill are an important and central component of the oceans' food chains and webs. In the northeastern Pacific the predominant species of krill is *Euphausia pacifica*. They are prolific consumers of microscopic marine organisms too small to see with the naked eye. But they too are consumed in enormous quantities by seabirds, squid, fishes, whales, and more recently, humans.

Dense krill "soup"



Euphausia pacifica

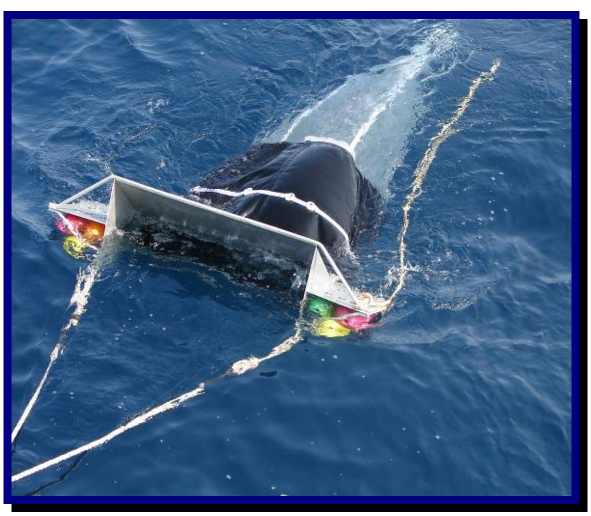
As seen in the upper right photo *Euphausia pacifica* krill have red "spots" along the entire length of their transparent, tubular bodies. These "spots" are photophores (light emitting organs) that emit blue light when a krill is agitated. During the 0100 to 0500 shift when it's relatively dark on deck, one can see the blue emitted light from individual krill (but not all simultaneously) when the detached cod end of the bongo net is shaken. The emission of light from living organisms is called bioluminescence.

Remember the scene in the 2003 Academy Award winning, computer-animated family film *Finding Nemo* when Nemo's iconic clownfish father, Marlin, and his absent-minded blue tang friend Dory descend into the pitch-black deep water to find the scuba mask dropped when Marlin's colorful, curious son Nemo was captured by the scuba diver. Dory is mesmerized by a glowing light that suddenly appears. Both eventually escape becoming a meal for a deep water fish that uses bioluminescence to attract and then eat unsuspecting prey.

A sub-category of bioluminescence is chemiluminescence, which refers to the emission of visible light on account of a chemical reaction. In the krill's photophores is a creatively named molecule called luciferin, which combines with its complementary enzyme called luciferase, to emit blue light. Of all the known bioluminescence in the natural, biological world, an overwhelming majority is found in marine organisms, especially those found in deep water where light from the sun does not penetrate.

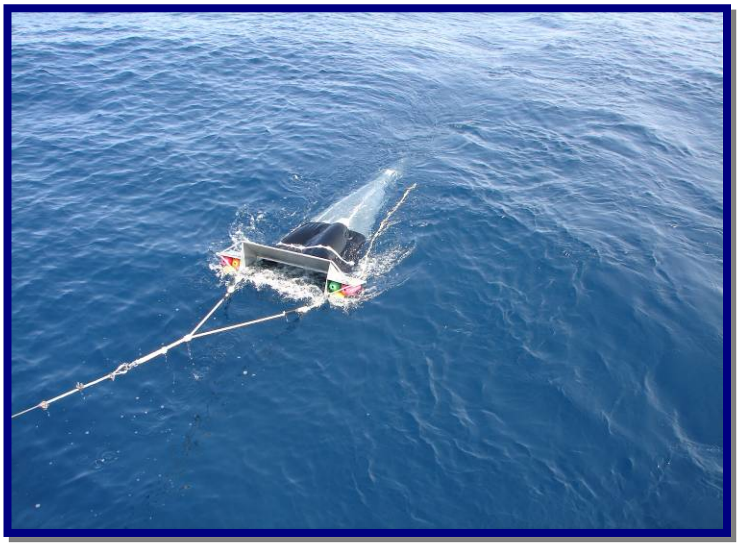
In yesterday's log I wrote briefly about the function of a bongo net in collecting marine organisms (zooplankton) in a horizontal water column below the ocean's surface. How are the nearly weightless, free-floating zooplankton found at the ocean's surface and a few inches below collected? In the following paragraphs I'll answer this question and also describe the nets used to collect marine organisms in a water column vertical (or perpendicular) to the surface.

A Manta net (also called a Neuston net) collects zooplankton at and a few inches below the ocean's surface. Like a bongo net it too collects marine organisms found in a horizontal column of seawater. This requires the ship to be moving forward. Since a Manta net collects marine organisms at the surface and a few inches below, weights are not attached to the Manta net's metal rectangular frame which also serves as its mouth. Floats are permanently attached to the right and left of the net's mouth. A rotary flowmeter is suspended in the net's mouth so the water volume can be determined. Like a bongo net the biomass density (number of organisms per volume water) then can be estimated. For our cruise the Manta net was deployed starboard once every shift for a total of ten minutes for each cast. The photos below show a Manta net in action.



Manta net in action

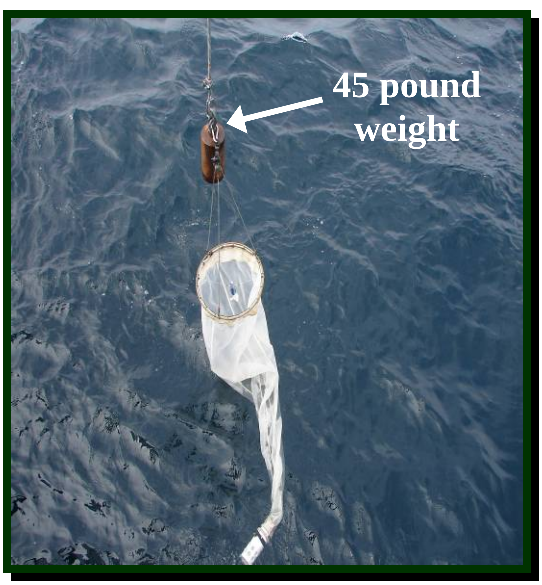
NOAA TAS Scott Donnelly (green helmet) retrieving a Manta net



Manta net skimming the surface for zooplankton

Two other nets used on this cruise are a ring net and a HAB (Harmful Algal Bloom) net, both of which are used to collect samples in a column of water vertical or perpendicular to the ocean surface. Consequently, the ship must not be moving and the net weighted for vertical sampling of a water column to occur since the nets themselves are not dense enough to sink.

Deployment and retrieval of both nets are simple enough. Basically, the net is attached to a winch cable and a weight, is slowly lowered into the water to the desired depth and kept there for the desired time before it's slowly lifted upward through the water, brought alongside the ship and suspended, washed with seawater, lifted onto the ship's deck, and the collected sample removed from the cod end. The organisms collected represent those found in the vertical column of water through which the net ascended. On account of their small, compact size and weight, both the ring and HAB nets can be managed with one person, thereby freeing the other to take care of other sampling tasks.



Ring net deployment

HAB net deployment as seen from above

What is Harmful Algal Bloom (HAB)? HAB is caused by the elevated levels of toxins produced by certain marine algae that proliferate when seawater conditions are favorable for increased rates of reproduction. The microscopic algae are consumed by the ocean's voracious eaters called phytoplankton. One of the toxins released by these certain marine algae is domoic acid, which accumulates in the phytoplankton that consume the algae. The phytoplankton are eaten by shellfish and fish such as anchovies and sardines. Domoic acid is poisonous to the shellfish and other fish thereby increasing mortality rates. If the toxin levels are elevated, massive die-offs occur, beaches are closed, and the sale and human consumption of shellfish, etc. are prohibited. The biological, social, and economic impacts are painful.

Personal Log

In spite of the ship's constant pitching and rolling in these unsettled, stormy seas, I slept well Tuesday night, taking two hour catnaps, waking for ten minutes or so, and then falling back to sleep for another two hours or so before waking after midnight to get ready for the 1am shift. About mid-morning I made a visit to the bridge where ship operations are carried out. According to ship's radar the low pressure system and local squalls causing the inclement weather shows signs of letting up.

Almost three full days on the ship and I have shown no indications or symptoms of sea sickness in spite of the constantly changing seas. According to the NOAA crew I've earned my sea legs and it's not likely that I'll get sea sick. So much for all the tablets of Dramamine I brought.

I took some memorable video from the bridge (both inside and outside) of the ship's bow rising and falling between waves, some of them smashing violently into the McARTHUR's bow on both the port (left) and starboard (right) sides, sending seawater spray up to the bridge window and all about the bow's deck. I felt like a true mariner.

Still no sightings of whales, orca, or the Black Pearl of *Pirates of the Caribbean* film fame.