Image captions/credits on Page 2.

supplemental datasheet

Okeanos Explorer METOC Supplemental Datasheet #1 for Cruise 12.02

This Supplement provides data that can be analyzed using techniques developed in the lesson, "Tools for Classroom Explorers – The Okeanos Explorer Atlas" to reveal additional information or discoveries.

Focus

Meteorological and oceanographic (METOC) data, navigation data, and exploration activities during the NOAA Ship *Okeanos Explorer* Gulf of Mexico 2012 Expedition

Grade Level

5-6 (Physical Science/Earth Science)

Focus Question

How can data from the *Okeanos Explorer* Atlas be used to study ship movements, oceanographic and meteorological conditions, and exploration activities involved with the NOAA Ship *Okeanos Explorer* Gulf of Mexico 2012 Expedition?

Learning Objectives

- Students will use the *Okeanos Explorer* Atlas to obtain information about position and movement of the NOAA Ship *Okeanos Explorer*.
- Students will calculate average velocity using information about geographic location at two different times, and interpret discrepancies between calculated average velocity and measured velocity.
- Students will interpret graphs to describe how salinity and temperature vary with depth based on measurements made during the Gulf of Mexico 2012 Expedition, and compare patterns of variability with historic data from the same geographic area.

Materials

- Copies of the *Okeanos Explorer Atlas User's Guide*, one copy for each student group
- Computers with Internet access

Background for the Gulf of Mexico 2012 Expedition

On August 13, 2008, the NOAA Ship *Okeanos Explorer* was commissioned as "America's Ship for Ocean Exploration;" the only U.S. ship whose sole assignment is to systematically explore our largely unknown ocean for the purposes of discovery and the advancement of knowledge. To

fulfill its mission, the *Okeanos Explorer* has specialized capabilities for finding new and unusual features in unexplored parts of Earth's ocean, and for gathering key information that will support more detailed investigations by subsequent expeditions. These capabilities include:

- Underwater mapping using multibeam sonar capable of producing high resolution maps of the seafloor to depths of 6,000 meters;
- Underwater robots (remotely operated vehicles, or ROVs) that can investigate anomalies as deep as 4,000 meters; and
- Advanced broadband satellite communication and telepresence.

Capability for broadband telecommunications provides the foundation for telepresence: technologies that allow people to observe and interact with events at a remote location. This allows live images to be transmitted from the seafloor to scientists ashore, classrooms, newsrooms and living rooms, and opens new educational opportunities, which are a major part of the *Okeanos Explorer's* mission for the advancement of knowledge. In this way, scientific expertise can be brought to the exploration team as soon as discoveries are made, and at a fraction of the cost of traditional oceanographic expeditions.

The purpose of the Gulf of Mexico 2012 Expedition is to explore unknown and poorly known ocean areas in the Gulf of Mexico. Specifically, the northern West Florida Escarpment, the DeSoto Canyon in the northeastern Gulf, the vicinity of the Deepwater Horizon or Macondo Well, and deepwater shipwrecks (Figures 1 – 5). A major objective of the expedition is to use the *Okeanos Explorer's* state-of-the-art ocean exploration capabilities to investigate the diversity and distribution of deep-sea habitats and marine life in the target areas. Even after extensive investigations following the Deepwater Horizon blowout event in 2010, much of the Mississippi Canyon area where the event occurred remains unexplored. Throughout the deep Gulf of Mexico the situation is much the same: the ecology and even the basic distribution of seeps and deep-sea ecosystems remain poorly understood.

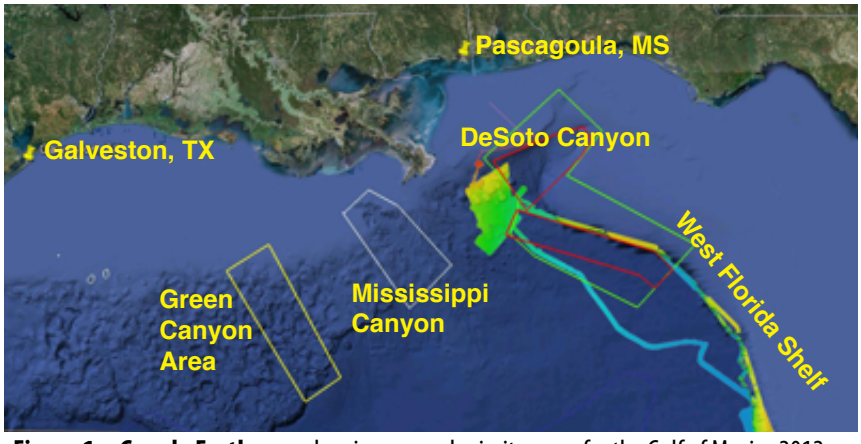

Figure 1 – Google Earth map showing general priority areas for the Gulf of Mexico 2012 Expedition.

Images from Page 1 top to bottom:
Backdeck: Bobby Mohr, Tom Kok, and Jeff Williams discuss 'the plan' on the back deck. Image courtesy of the NOAA *Okeanos Explorer* Program.
http://oceanexplorer.noaa.gov/okeanos/explorations/ex1202/logs/hires/mar21-2-hires.jpg

Anchor resting on the top of the Site 15429 wreck. *Lophelia* coral is also visible.
After a great first marine archaeology dive on March 27, everyone was excited about exploring a second target. Site 15429 was initially located in 2009 with the National Institute for Undersea Science and Technology's (NIUST) *Eagle Ray* autonomous underwater vehicle (AUV). The data showed a potential vessel resting on the seafloor. The remotely operated vehicle (ROV) dive confirmed what several members of the Science Team expected. The wreck appears to be a hotspot for *Lophelia* coral. It was a great day for both the marine archaeologists and the biologists. Image courtesy of NOAA *Okeanos Explorer* Program.
http://oceanexplorer.noaa.gov/okeanos/explorations/ex1202/logs/hires/mar29_hires.jpg

Image of gridded bathymetry shown as a wireframe and draped over gridded backscatter data. Ever since the Team on Leg I of the Gulf of Mexico expedition mapped the DeSoto Canyon area in early March 2012, there was lots of speculation about one specific seafloor feature in approximately 400 meters of water. Not only did the feature seem to be the one spot of significant relief in an otherwise fairly flat area, but it also showed up in the backscatter data as a very 'hard' target. Image courtesy of NOAA *Okeanos Explorer* Program.
http://oceanexplorer.noaa.gov/okeanos/explorations/ex1202/logs/hires/mar28_update_hires.jpg

Through the power of technology, scientists on the ship and on shore are able to view and learn about the complex ecosystems in the Gulf of Mexico. Deep-sea corals flourish in the dark depths of the Gulf of Mexico, providing foundations that attract lush communities of other animals, including brittle stars, anemones, crabs, and fish. This diversity of life on the seafloor may be out of sight, but it is has been squarely on the minds of scientists seeking to determine the short- and long-term ecological impacts of the Deepwater Horizon oil spill. Image courtesy of the NOAA *Okeanos Explorer* Program.
http://oceanexplorer.noaa.gov/okeanos/explorations/ex1202/logs/hires/mar24-2-hires.jpg

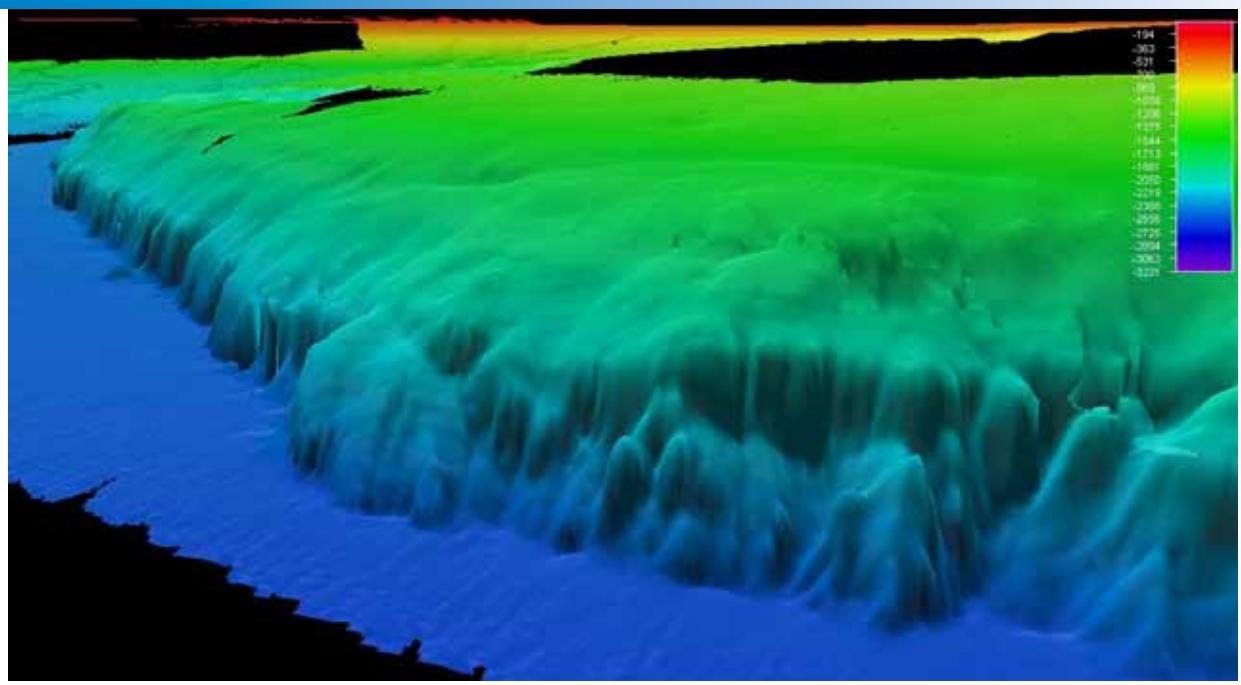

Figure 2 – Bathymetry of the West Florida Escarpment. The base of the escarpment (2,600 meters depth) is shown in blue with the upper rim more than 600 meters above. The expedition will identify at least four dive sites that cover the diverse soft sedimented and hard carbonate rock bottom between 2,300 and 400 meters to explore the physical structure of the seafloor and biodiversity on soft and hard bottom habitats (Multibeam data from EX1105, EX1106, and this expedition, EX1202). Image courtesy of the NOAA *Okeanos Explorer* Program. [*http://oceanexplorer.noaa.gov/okeanos/explorations/ex1202/background/hires/science-1-hires.jpg*]

Figure 3 – Bamboo corals (with an attached crinoid) on a scarp wall in the DeSoto Canyon area (2,055 meters depth). Image courtesy of the NOAA *Okeanos Explorer* Program. [*http://oceanexplorer.noaa.gov/okeanos/explorations/ex1202/background/hires/science-3-hires.jpg*]

This is the latest in a series of expeditions sponsored by NOAA's Office of Exploration and Research (OER) to explore deep-sea organisms and ecosystems in the Gulf of Mexico. Between 2001 and 2010, OER sponsored 12 such expeditions. The *Lophelia* II 2010: Oil Seeps and Deep Reefs Expedition was particularly significant, since it took place less than six months following the April 20, 2010 blowout at the Deepwater Horizon wellhead. Results from this expedition published in the Proceedings of the National Academy of Sciences (http://www.pnas.org/content/early/2012/03/23/1118029109.full.pdf) suggest that the Deepwater Horizon oil spill did have an impact on a nearby community of deep-water corals.

Figure 4 – Corals and associated animals living with them in the vicinity of the Deepwater Horizon oil spill (within 11 kilometers) as captured by a time-lapse camera image. Image courtesy of C. Fisher and T. Shank, Woods Hole Oceanographic Institution. [*http://oceanexplorer.noaa.gov/okeanos/explorations/ex1202/background/science/media/science-2-600.jpg*]

The Gulf of Mexico 2011 Expedition (http://oceanexplorer.noaa.gov/okeanos/explorations/ex1105/welcome.html) demonstrated that the *Okeanos Explorer's* deepwater multibeam sonar system can be used to map the location of gaseous seeps, and this capability will be used to search for hydrocarbon seeps in all of the areas to be explored. While much of the exploration of deepwater ecosystems in the Gulf of Mexico has been driven by their association with hydrocarbon seeps that may indicate the presence of undiscovered petroleum deposits, these are also unique biological communities whose importance is presently unknown. (For more about hydrocarbon seeps and their associated ecosystems, please see Lessons from the Deep: Exploring the Gulf of Mexico's Deep-Sea Ecosystems Education Materials Collection; http://oceanexplorer.noaa.gov/edu/guide/welcome.html.)

Seafloor habitats associated with hydrocarbon seeps will be explored using the Institute for Exploration's *Little Hercules* remotely operated vehicle (ROV) and the NOAA *Seirios* camera platform. Using the ship's telepresence capabilities, live images from the seafloor and other science data will flow over satellite and high-speed Internet pathways to scientists standing watches ashore in Exploration Command Centers (ECCs). During some portions of the expedition, live-internet

connections will allow people from around the world to witness explorations as they unfold hundreds to thousands of meters below the ocean surface. For more information about the Gulf of Mexico 2012 Expedition, please see background essays linked from http://oceanexplorer.noaa.gov/okeanos/explorations/ex1202/welcome.html. For more information about *Little Hercules*, *Seirios*, multibeam sonar and telepresence, please see http://oceanexplorer.noaa.gov/okeanos/explorations/ex1103/background/edu/purpose.html, and http://oceanexplorer.noaa.gov/okeanos/explorations/ex1103/background/seirios/seirios.html.

In addition to deepwater habitats and hydrocarbon seeps, the Expedition will also investigate some of the Gulf of Mexico's more than 4,000 shipwrecks, which are important cultural resources that span several centuries of human history. These wrecks often contain important clues about the societies to which they once belonged:

> *"For several millennia, ships were the most sophisticated machines on earth. They have shaped history by expanding trade and waging war, spreading ideas (and sometimes plague), and discovering and colonizing new lands. At the same time, the crews of these ships lived in closed societies, with traditions, beliefs, vocabularies, and hierarchies that set them apart from those on shore. When one of these ships met with disaster at sea or sank as a result of war, its remains literally became a time capsule, preserving clues to the story of our past."* (http://www.gomr.boemre.gov/homepg/regulate/environ/archaeological/shipwrecks.html).

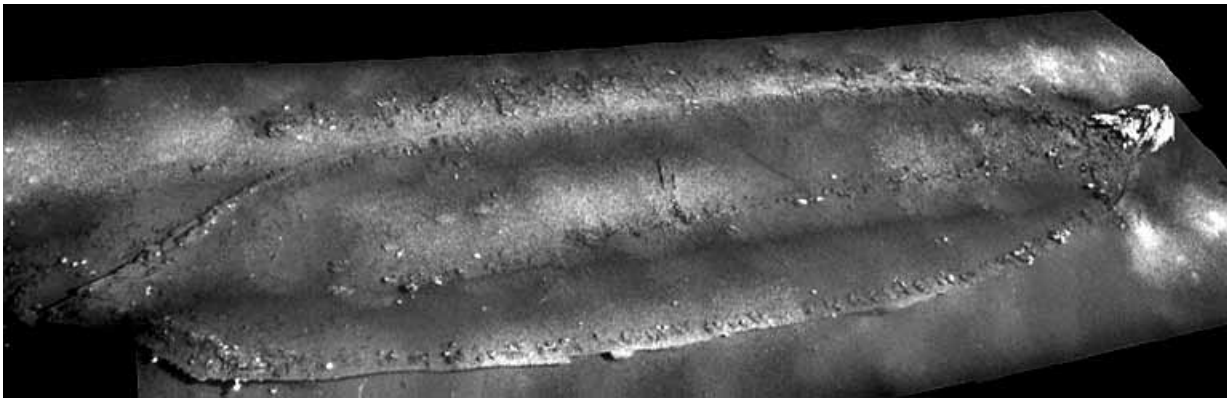

Figure 5 – Mosaic of the Ewing Bank Wreck at 621 meters depth in the Gulf of Mexico. This three-dimensional perspective of the Ewing Bank Wreck was produced by "draping" the photo mosaic over the multibeam bathymetry. The photos and multibeam data were collected with the C-Surveyor autonomous underwater vehicle. Image courtesy of C & C Technologies, Inc.; video courtesy of *Lophelia* II 2009: Deepwater Coral Expedition: Reefs, Rigs, and Wrecks Exploration. [*http://oceanexplorer.noaa.gov/okeanos/explorations/ex1202/background/hires/science-4-hires.jpg*]

Many such wrecks have been discovered by surveys that use sonar to detect promising sites for oil and gas exploration. While the locations of these wrecks are reported to the Bureau of Ocean Energy Management (the federal agency responsible for protecting natural and cultural resources) their exact identity usually cannot be confirmed without visual information from divers or remotely

operated vehicles. Several possible wreck locations have been previously reported in the planned survey area for the Gulf of Mexico 2012 Expedition, and some of these will be visually explored with *Little Hercules* and *Seirios*. For more information about Gulf of Mexico shipwrecks, please see "Deep Wrecks 2009" (http://oceanexplorer.noaa.gov/explorations/09lophelia/background/deepwrecks/deepwrecks.html).

Procedure

For this Worksheet, you will use the *Okeanos Explorer* Atlas to find information about the movement and activities of the NOAA Ship *Okeanos Explorer* during the Gulf of Mexico 2012 Expedition. If you are not already familiar with the *Okeanos Explorer* Atlas, use the *Okeanos Explorer* Atlas User's Guide to get acquainted. Try the Zoom and Navigation tools, and open the various Data Layers to see what kinds of information they contain. If you get stuck, you can always re-launch the Atlas to start over. Once you feel comfortable with how the Atlas works, move on to the following questions:

1. Where was the *Okeanos Explorer* on March 21, 2012 at 21:55:21? What does 21:55:21 mean? What does GMT mean?

2. Describe the ship's velocity from the Ship Observations for 03/21/12 at 21:55:21.

3. Based on the ship's location on 03/22/12 at 21:55:23, how far had the ship travelled in 24 hours?

4. What was the ship's Speed Over Ground on 03/21/12 at 21:55:21? What was the ship's Speed Over Ground on 03/22/12 at 21:55:23?

5. Based on your answer to Question 3, what was the ship's average speed between 03/21/12 at 21:55:21 and 03/22/12 at 21:55:23?

6. How does the average speed calculated in Question 5 compare to the speeds you listed in Question 4? How can you explain any differences? [HINT: Look at the Daily Update for March 22, 2012]

7. Why was a backup plan needed at 0330 on 03/22/12?

8. On March 20, and March 22, 2012, CTD data were recorded at 12:33:00 and 12:55:28, respectively. How do water temperatures measured at these times compare to historical data?

9. On March 24, 2012, CTD data were recorded during ROV dive #4 at 12:16:49. How did salinity vary between depths of 1,000 m and 2,000 m?

10. How far was the location in Question 8 from the Deepwater Horizon Wellhead? [HINT: Expand "Additional Data and Tools"]

Answers to Questions for METOC Data Worksheet #1 for Cruise 12.02

1. On March 21, 2012 at 21:55:21, the *Okeanos Explorer* was located at 26.99° North latitude, 84.98° West longitude. "21:55:21" means the time is 21 hours, 55 minutes, 21 seconds since midnight on the previous day. GMT means Greenwich Mean Time, which is also called coordinated universal time (abbreviated UTC), "zulu time," or "world time."

2. The ship's velocity from the Ship Observations for 03/21/12 at 21:55:21 was 7.45 kn on a course of 67.6°.

3. The ship's location on 03/22/12 at 21:55:23was 26.5N, 84.76W. Students may find the distance between the two positions by zooming into the ship track, using a ruler to measure the distance between the two points, and calculating the distance from the Scale Bar. The result should be about 50 km. An alternative method is to use an online calculator to find the distance between two points whose latitude and longitude are known. By this method, the distance is 58.76 km.

4. The ship's Speed Over Ground on 03/21/12 at 21:55:21was 7.45 kn. On 03/22/12 at 21:55:23, the ship's Speed Over Ground was 8.54 kn.

5. Based the answer to Question 3, the ship's average speed between 03/21/12 at 21:55:21 and 03/22/12 at 21:55:23 was about 2 kn.

6. The difference between the average speed calculated in Question 5 compared to the speeds listed in Question 4 are the result of ROV diving operations on 03/22/12 during which the ship was nearly stopped.

7. A backup plan was needed at 0330 on 03/22/12 because bad weather prevented the ROV dive originally planned.

8. Water temperatures measured by CTD March 22, 2012, CTD data were higher than historical temperatures near the surface down to about 200 - 250 m, and about the same at deeper depths.

9. Salinity data measured by the CTD during ROV dive #4 were almost constant at slightly less than 35 psu between depths of 1,000 m and 2,000 m.

10. The location in Question 8 is about 438 km from the Deepwater Horizon Wellhead.