

## P1.42 AN EARTH SCIENCE HANDS-ON ACTIVITY BASED ON HURRICANE KATRINA

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### 1. INTRODUCTION

According to the 2006 United Nations Newsletter, natural disasters claimed more than 600,000 lives and affected more than 2.4 billion people. Undeniably, these natural hazards impact societies around the globe. Disasters related to these hazards commonly lead to property damage, loss of lives, and displacement of people and impart significant economic hardships to countries, states, municipalities, etc. Additionally, in developing countries, natural disasters lead to increased impoverishment as development is stunted. However, these natural disasters associated with geologic, atmospheric, and human processes also serve as stimuli for educating the public about types and causes of disasters and disaster preparedness. Education is an important key to mitigating the impact of natural disasters. Additionally, natural disasters lead to heightened awareness of the earth sciences.

To increase K-12 teacher and university student awareness of natural disasters and to stimulate interest in our oceanography and meteorology courses we have focused on developing a series of education modules and websites centered on natural disasters (see Resource section below). Our most recent efforts focus on the relationship between sea surface temperatures and the evolution of Hurricane Katrina.

Because of the considerable destruction of lives and property, Katrina received intense media scrutiny leading to heightened public awareness of hurricanes and natural disasters in general (Fig. 1). We chose to capitalize on this amplified interest by developing a learning activity for our

general education students that might result in additional nontraditional geology/geography majors at California State University, Los Angeles.

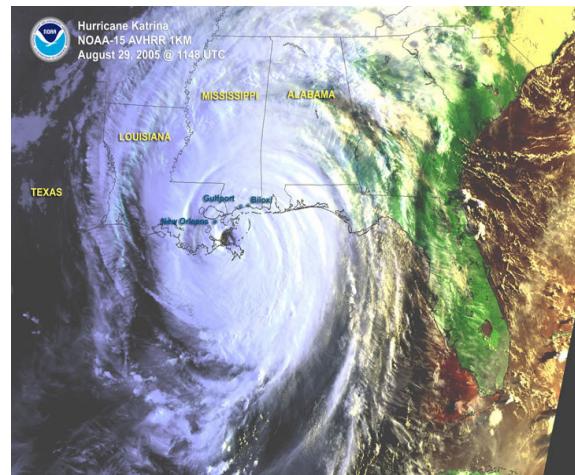


Fig. 1. GOES image of Hurricane Katrina as it made landfall, leaving a path of destruction. Image from NASA.

### 2. CALIFORNIA STATE UNIVERSITY, LOS ANGELES

California State University, Los Angeles, an urban university situated in east Los Angeles, totals 20,034 students and 15,294 full time equivalent students. Approximately 60% of all students are women. A single, working Latina approximately 28 years old requiring about 6 years to complete the degree represents the average student on our mostly commuter campus. Latinos form 43.5% of the student population, African American 7.9%, Asians 22%, and whites 12.7%.

About 80% of students at our top 10 feeder high schools are Latino. Consequently, we hope to reach these students by distributing our activity through conferences/workshops to K-12

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teachers for adoption in classrooms and to promote our departments.

### 3. HURRICANE KATRINA—SUMMARY

The December 20, 2005 National Hurricane Center Report on Hurricane Katrina (see Resource section below), which was updated on August 10, 2006, indicates Katrina was the costliest and one of the five deadliest hurricanes to strike the United States. Katrina first evolved as a tropical storm on August 24, 2005 and as a hurricane on August 25 over the central Bahamas. On August 28<sup>th</sup> Katrina intensified from a category 3 to 5 hurricane in a span of 12 hours. Katrina subsequently deteriorated to a category 3 hurricane as it made a final landfall over the Louisiana-Mississippi border on August 29<sup>th</sup>. Storm surge associated with the hurricane reached about 24-28 feet along the Mississippi coast and inundated areas up to 12 miles inland along bays and rivers. In the New Orleans area, the storm surge varied from 5 to 19 feet depending on the location. This storm surge resulted in the overtopping and erosion on the backside of levees leading to their failures. Table 1 shows the casualties and damage associated with Katrina.

Hurricane Katrina Statistics				
Date	Min. Pressure (Mb)	Max. Winds (Mph)	Direct + Indirect Fatalities	U.S. Economic Losses (Billion \$)
9/25-9/29	902	175	1833	81

Table 1. Hurricane Katrina statistics from the National Hurricane Center.

### 4. THE ACTIVITY

The activity traces the path of Hurricane Katrina as it moves from the Atlantic Ocean into the Gulf of Mexico and finally crosses the Mississippi/Louisiana coastline. Learning objectives tied to the activity are shown in Table 2. After successfully completing the activity students should be familiar with Gulf Coast geography and the use of a hurricane tracking chart, possess improved knowledge of hurricane evolution, hurricane intensity scales, and of natural disasters in general. Questions

designed for the activity address math and science critical thinking skills.

Materials required for the activity are minimal, common, and inexpensive and include the following:

1. Colored pencils
2. Saffir-Simpson Scale (Table 3)
3. Hurricane tracking data from the National Hurricane Center (Table 4).
4. Map of sea surface heights in the Gulf of Mexico for the period of Hurricane Katrina and NOAA Atlantic Tracking Chart (Fig.2).
5. Question set accompanying activity (Table 5).

#### LEARNING OBJECTIVES

- Increase geographic literacy
- Enhance student knowledge of hurricane structure and development
- Enhance student knowledge of sea surface temperature effects on hurricane development
- Increase awareness of natural disasters
- Improve knowledge of the Saffir-Simpson scale

Table 2. Learning objectives for the Hurricane Katrina exercise.

Completing the activity requires that students accomplish the following:

1. On a tracking chart of the west central Atlantic Ocean and the Gulf of Mexico, plot the positions of Hurricane Katrina using coordinates derived from data generated from the National Hurricane Center.
2. Record the date and time alongside each position.
3. Connect each coordinate point with using coloring pencils to show the hurricane track and strength. Use a blue color pencil to mark the trace of the storm when the hurricane strength was above 74 mph and a red one when the hurricane reached wind speeds of 155

mph or above (category 5). Use the Saffir-Simpson scale (Table 3) to determine the category rating for the hurricane.

- Establish the relationship between hurricane strength and sea surface temperatures.
- Complete the question set related to the activity.

Saffir-Simpson Hurricane Scale				
Category	Wind speed	Storm surge		
	Mph (kph)	Ft (m)		
5	≥156 (≥250)	>18 (>5.5)	Emily, Katrina, Rita, Wilma	
4	131–155 (210–249)	13–18 (4.0–5.5)	Dennis	
3	111–130 (178–209)	9–12 (2.7–3.7)	Maria, Beta	
2	96–110 (154–177)	6–8 (1.8–2.4)	1	
1	74–95 (119–153)	4–5 (1.2–1.5)	7	
Additional classifications				
Tropical storm	39–73 (63–117)	0–3 (0–0.9)	12	
Tropical depression	0–38 (0–62)	0	3	

Table 3. Saffir-Simpson scale along with some 2005 major hurricanes tied to scale.

Sample Hurricane Katrina Tracking Data			
Date	Latitude (N)	Longitude (W)	Wind Speed (mph)
9/25 5 am	24.0	76.4	35
11 am	24.7	76.7	40
5 pm	25.6	77.2	45
11 pm	26.0	78.0	50

Table 4. Sample tracking data derived from the National Hurricane Center.

### SAMPLE QUESTIONS

- When did the greatest increase in wind speeds occur? (Sat. am) (Sat pm) (Sun am) (Sun pm)
- Using Figure 3 (not shown), about what were sea surface temperatures in the region where the Hurricane reached category 5? (26°C) (28°C) (30°C)
- If all conditions were favorable for hurricane development, what would increasing sea surface temperatures do to the wind speed and strength of the storm? (increase) (decrease) (stay the same)
- How long did residents and emergency managers have between the time Hurricane Katrina strengthened to category 5 and landfall?

Table 5. Sample question for the exercise designed to establish relationship between hurricane strength and sea surface temperatures and to improve student critical thinking skills.

Ultimately, through the learning activity, students will see that Hurricane Katrina rapidly intensified into a category 5 hurricane on August 28<sup>th</sup> as it traversed the warm Gulf waters of the Loop Current. The warm waters are indicated by the higher sea height anomaly (SHA) in Fig. 2. Areas of the Loop Current and associated eddies are associated with sea surface temperatures greater than 26°C, one of the conditions needed for hurricane development. Ongoing research will shed more light on the relationship of warm waters and hurricane intensifications. Figure 2 is similar to the tracking map students generate as part of this exercise.

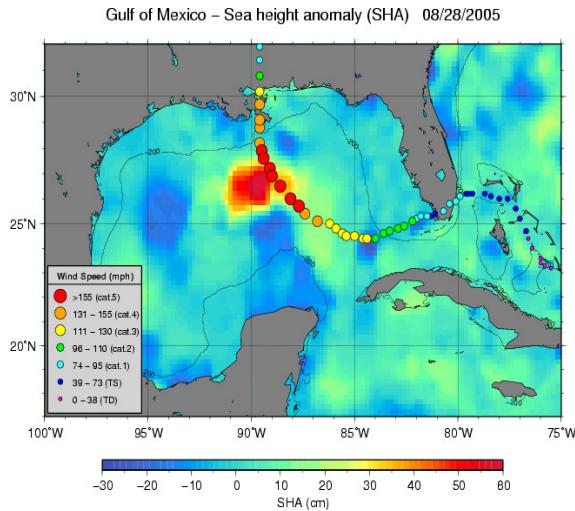


Fig. 2. Sea height anomalies on August 28, 2005 shown on Gulf tracking map. The dots represent the path of Hurricane Katrina. Warm colors represent greater anomalies. Note that hurricane intensification to category 5 occurred as Katrina passed through a warm current loop. Figure from NASA.

## 5. DISSEMINATION PLANS AND PRELIMINARY ASSESSMENT

We plan to disseminate our activity through conferences, usage in our classrooms, and our internet site. In summer of 2006 we presented a preliminary version of the module at the annual meeting of the Satellites in Education conference. Conference attendees ranged from professionals to mostly K-12 teachers. We also plan to seek outlets and feedback for the activity through presentations at conferences similar to that of the annual AMS conference. CSULA students enrolled in the general education meteorology course will complete the activity as part of their laboratory experience. Furthermore, undergraduate students planning careers as K-12 teachers and who are enrolled in our popular Physical Science courses will also complete the activity. Our internet site also contains links to the activity for downloading.

Preliminary assessments of the activity are promising. Attendees completing evaluations of our presentation of the module at the Satellites in Education conference rated the activity favorably. Figure 3 shows the ratings for the presentation and related comments.

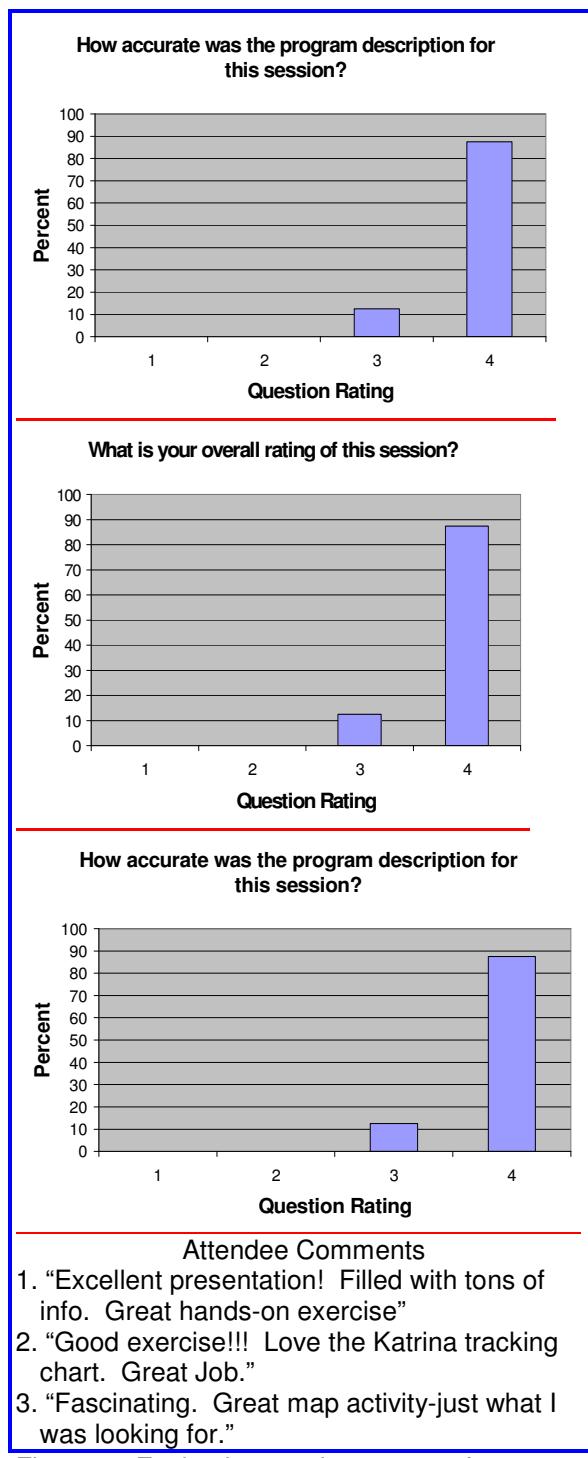


Figure 3. Evaluations and comments from presentation of activity at the annual meeting of the 2006 Satellites and Education conference. For question ratings: 4-excellent 3-good 2-fair 1-poor.

Anecdotally, CSULA students have responded well to the activity, indicating that they have learned more about hurricanes by completing the assignment. Development of an assessment tool for the activity is planned for Winter 2007.

## **6. RESOURCES**

Below is a sampling of the internet resources used by the authors for this report. Many other resources are available.

[http://instructional1.calstatela.edu/sladoch/Geog101/naturalhazards\\_home.html](http://instructional1.calstatela.edu/sladoch/Geog101/naturalhazards_home.html) Natural Disaster websites developed by authors. Website for downloading activity presented in this paper.

<http://www.nhc.noaa.gov> National Hurricane Center website containing report on Hurricane Katrina and a wealth of information on current and past hurricanes.

<http://sealevel.jpl.nasa.gov/newsroom/features/200509-1.html> News brief on sea height anomalies associated with Hurricane Katrina.

<http://www.un.org/apps/news/story.asp?NewsID=20207> United Nations news brief on natural disasters.

[http://www.nasa.gov/vision/earth/lookingatearth/h2005\\_katrina.html](http://www.nasa.gov/vision/earth/lookingatearth/h2005_katrina.html) NASA satellite data show many interesting features about the structure of Hurricane Katrina, measurements of internal winds, and damage along the Gulf coast. Some spectacular graphics can be found on the NASA website.

## **7. Acknowledgements**

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