

# Using Satellite Data to Forecast Bleaching Events

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NOAA Coral Reef Watch

## Satellite Imagery Worksheet

The main condition that is linked to coral bleaching is unusually high water temperature. Your assignment is to use satellite data to investigate whether this condition occurred in the Caribbean during early Fall 2005. You will be assigned to one of four locations:

- Bermuda, located at 32.0°N/64.5°W
- Lee Stocking Island (Bahamas), located at 23.5°N/76.5°W
- west coast of Puerto Rico, located at 18.0°N/67.5°W
- US Virgin Islands, located at 18.0°N/65.0°W

### A. What were the local conditions at your reef on September 2<sup>nd</sup>, 2005?

Find your reef on the Sea Surface Temperature figure. This map shows the temperature of the ocean waters, measured from some of NOAA's satellites. The data are broken up into squares that are 50 km on a side.

#### **1. What was the temperature at your reef on that day?**

Now find your reef on the Coral Reef HotSpot figure. This map shows temperature anomalies. In this case, the anomaly is the temperature above the warmest monthly mean for each location. If your area is white, temperatures are less than the average for the warmest month. Warm colors indicate the number of degrees above the average for the warmest month.

#### **2. Was your site unusually warm? If so, what was the anomaly?**

### B. How hot was the whole late Summer / early Fall season?

Find your reef in the Sea Surface Temperature (SST) Time Series figure. These graphs give the yearly temperature pattern for each of the four reef sites, measured by NOAA satellites. **Note** that both 2004 and 2005 are plotted on the same graph.

The SST for the site is shown in dark blue. The dashed light-blue line shows the average temperature for the warmest month. One degree above that is the threshold temperature for coral bleaching, shown as the solid light-blue line. When the temperature at the reef exceeds this threshold, the corals are thermally stressed.

- 3. Based on the 2005 temperature graph for your site, answer these questions:**
- a. **What was the highest temperature?**

- b. **How long did the temperature stay at or above the bleaching threshold?**

The solid red line at the bottom of the graph shows the Degree Heating Weeks (DHW) for that site throughout the year. The DHWs show the accumulation of thermal stress the corals have seen in the last 3 months—how hot the water has been for how long.

This is a good measure of how stressed the corals are.

- 4. How high did the DHWs get?**

The dashed red lines show two DHW bleaching thresholds. When the value gets above 4, we expect to see significant coral bleaching. Values above 8 indicate that we expect severe coral bleaching, and some coral mortality as a result.

- 5. Do you expect that there was coral bleaching at your reef site in 2005? How severe?**

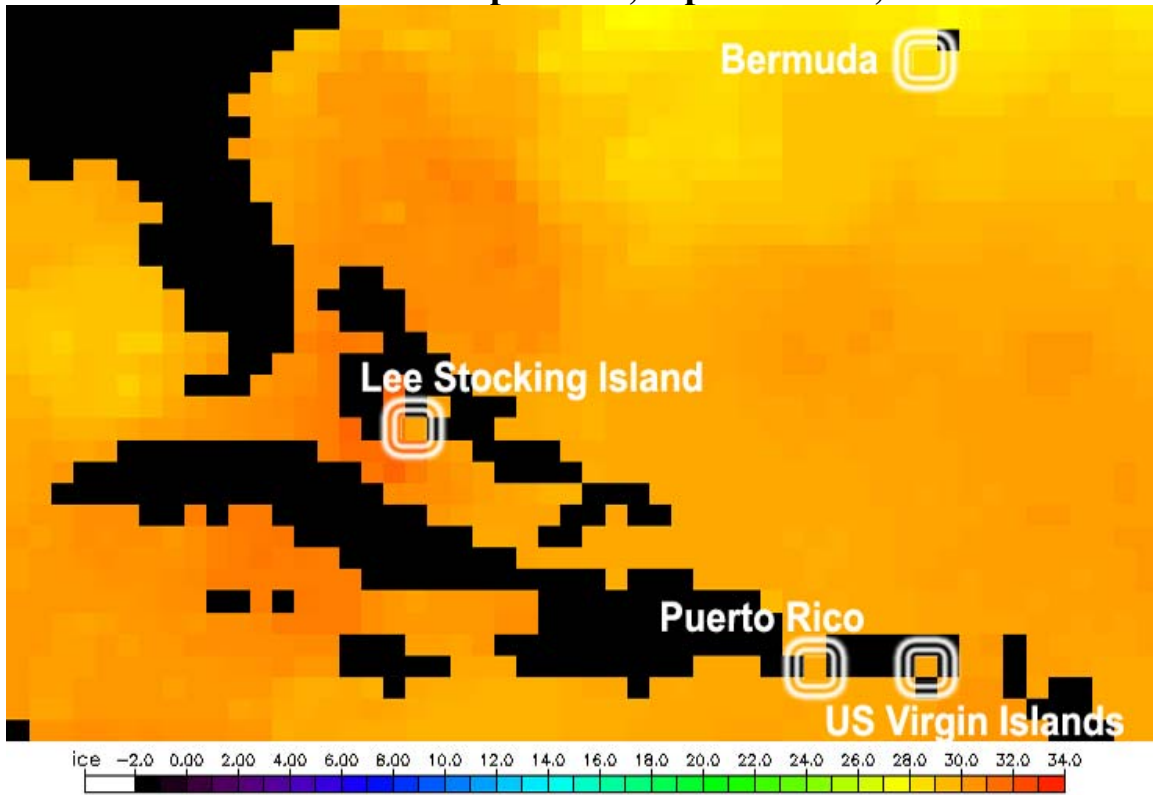
**C. How stressed was your reef site compared to other reefs in the Caribbean region?**

Find your reef on the Maximum Degree Heating Weeks (DHW) figure. DHWs measure the accumulated thermal stress on the reef. The figure shows the maximum DHW values experienced during 2005.

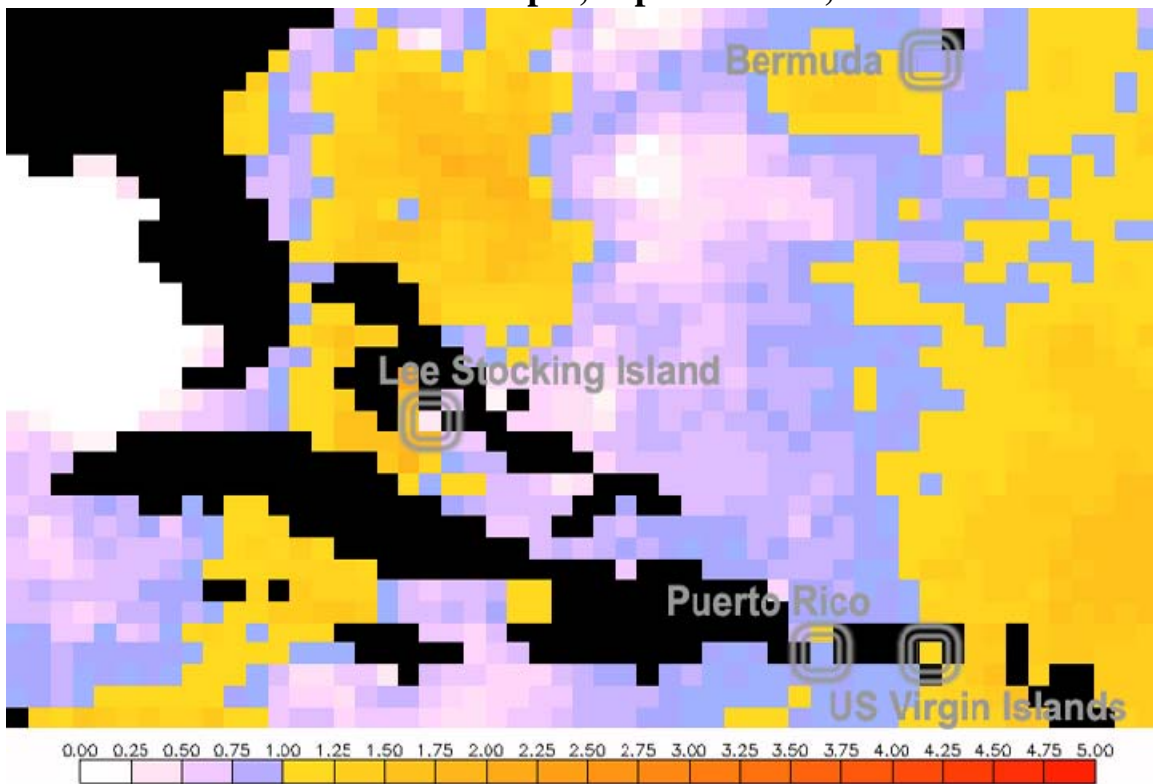
- 6. How did the thermal stress at your site compare to the stress experienced by the other three reefs highlighted in this exercise?**

- 7. How severe was the bleaching at your site compared to the other three reefs?**

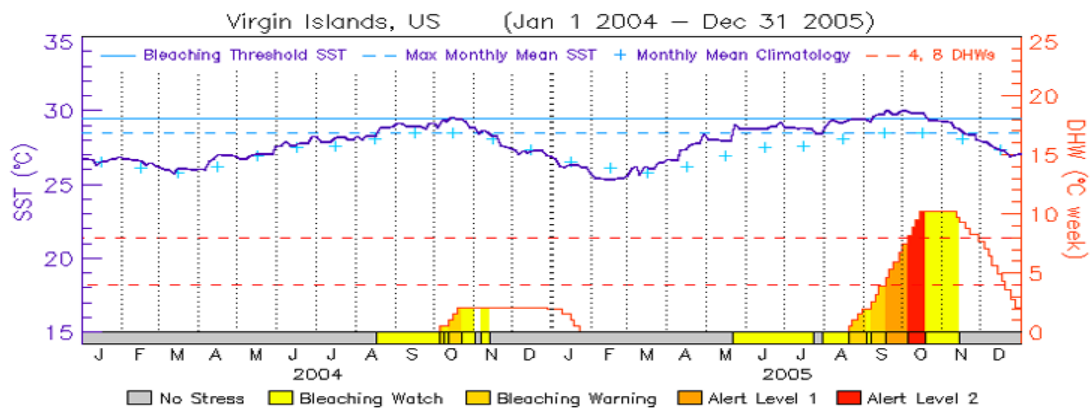
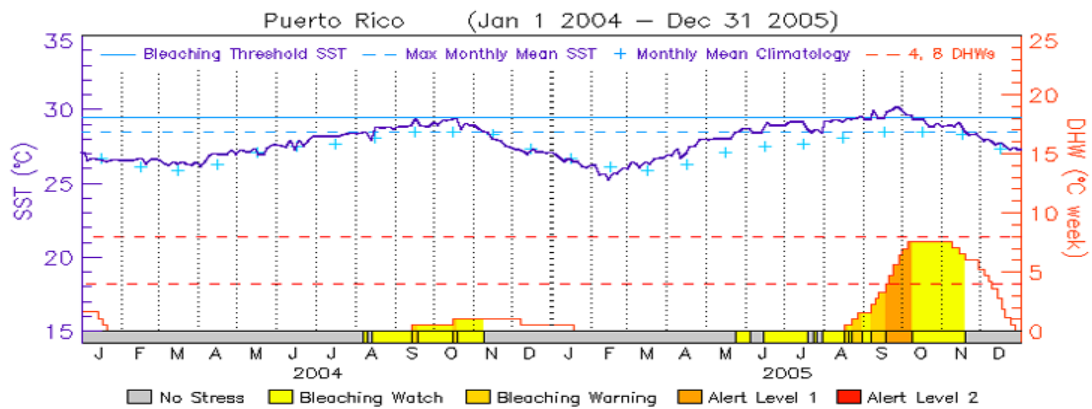
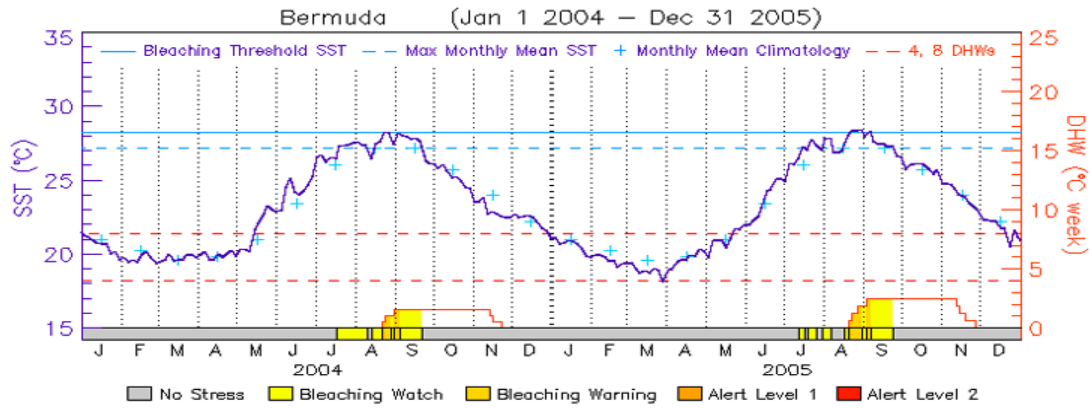
Sea Surface Temperature, September 2<sup>nd</sup>, 2005



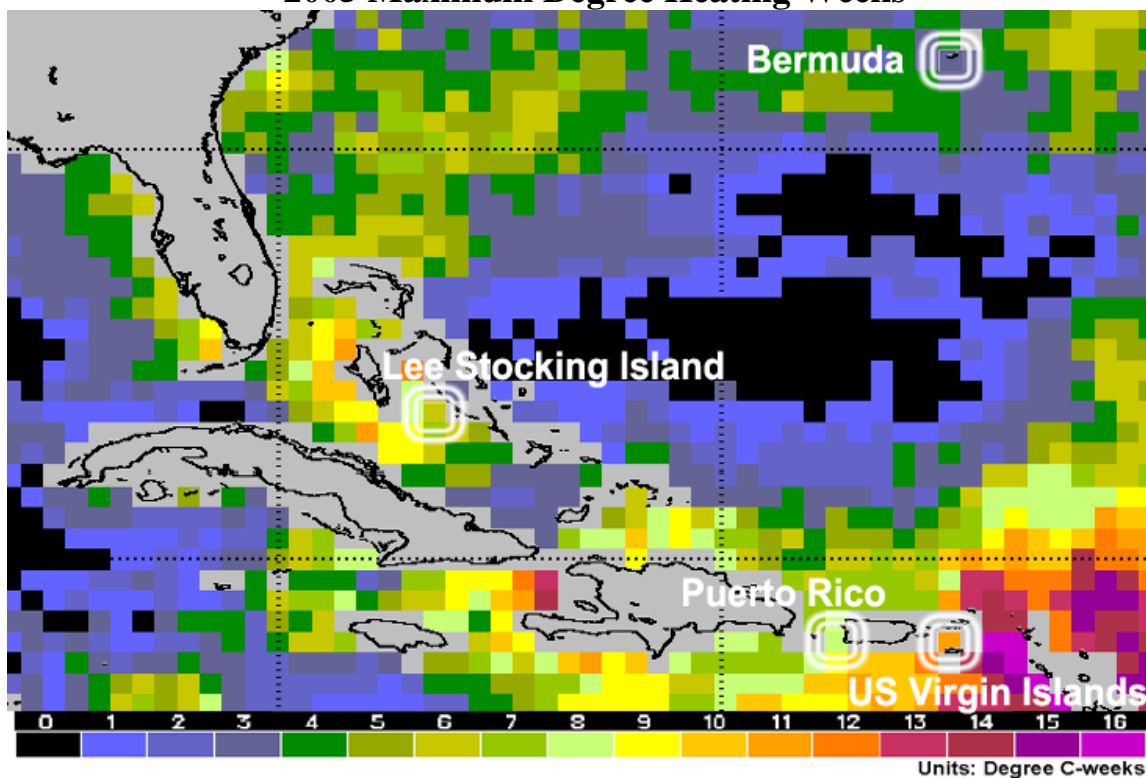
Coral Reef Hotspot, September 2<sup>nd</sup>, 2005



Sea Surface Temperature Time Series



## 2005 Maximum Degree Heating Weeks



### Satellite Imagery Resources Online

Current and past Sea Surface Temperatures, Coral Bleaching HotSpots, Degree Heating Weeks and time series can be found at:

<http://coralreefwatch.noaa.gov/satellite/>

Sea Surface Temperature images (NOAA Coral Reef Watch)

[http://www.osdpd.noaa.gov/PSB/EPS/SST/sst\\_50km.html](http://www.osdpd.noaa.gov/PSB/EPS/SST/sst_50km.html)

Sea Surface Temperature time series are found at:

[http://coralreefwatch.noaa.gov/satellite/current/sst\\_series\\_24reefs.html](http://coralreefwatch.noaa.gov/satellite/current/sst_series_24reefs.html)

Maximum DHW image, plus more on the 2005 Caribbean bleaching event:

<http://coralreefwatch.noaa.gov/caribbean2005/>

NOAA Coral Reef Watch education resources:

<http://coralreefwatch.noaa.gov/satellite/education/index.html>

All of NOAA's coral reef educational resources:

<http://coralreef.noaa.gov/outreach/welcome.html>

## Satellite Imagery Worksheet—ANSWERS

### A. What were the local conditions at your reef on September 2<sup>nd</sup>, 2005?

1. What was the temperature at your reef on that day?  
B: 28°C; LSI: 30°C; PR: 29°C; USVI: 29°C
2. Was your site unusually warm? If so, what was the anomaly?  
B: +0.75°C; LSI: +0.25°C; PR: +0.75°C; USVI: +1°C

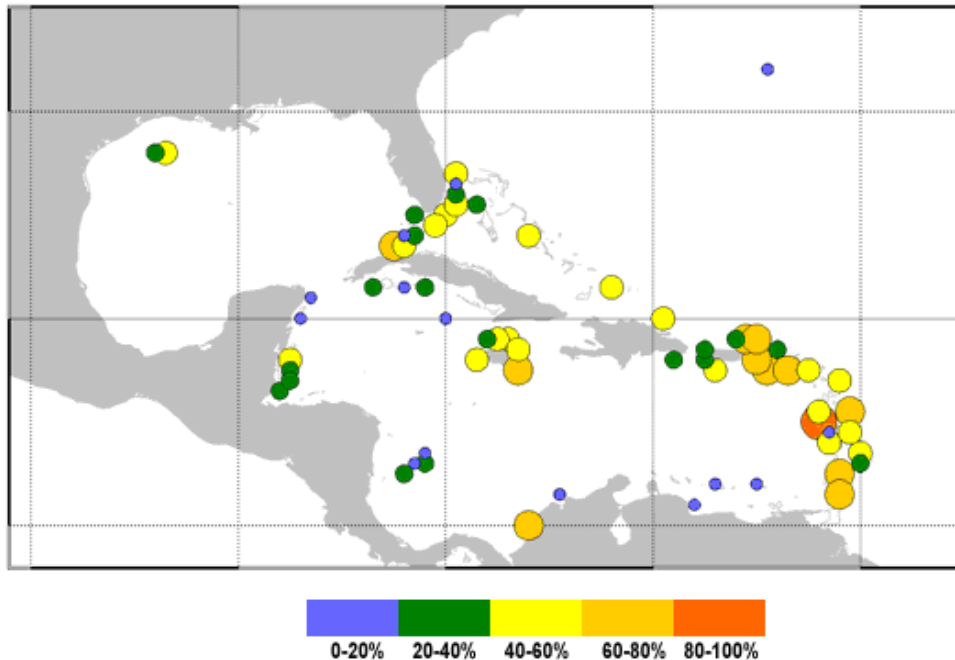
### B. How hot was the whole late Summer / early Fall season?

- 3a. What was the highest temperature?  
B: 28.5°C; LSI: 31°C; PR: 30.5°C; USVI: 30°C
- 3b. How long did the temperature stay at or above the bleaching threshold?  
B: about a month; LSI: 1 month, then a decrease, then another month; PR: 2 months; USVI: 3½ months
4. How high did the DHWs get?  
B: 3 DHW; LSI: 6 DHW; PR: 8 DHW; USVI: 11 DHW
5. Do you expect that there was coral bleaching at your reef site in 2005? How severe?  
B: mild, if any; LSI: moderate; PR: severe; USVI: very severe

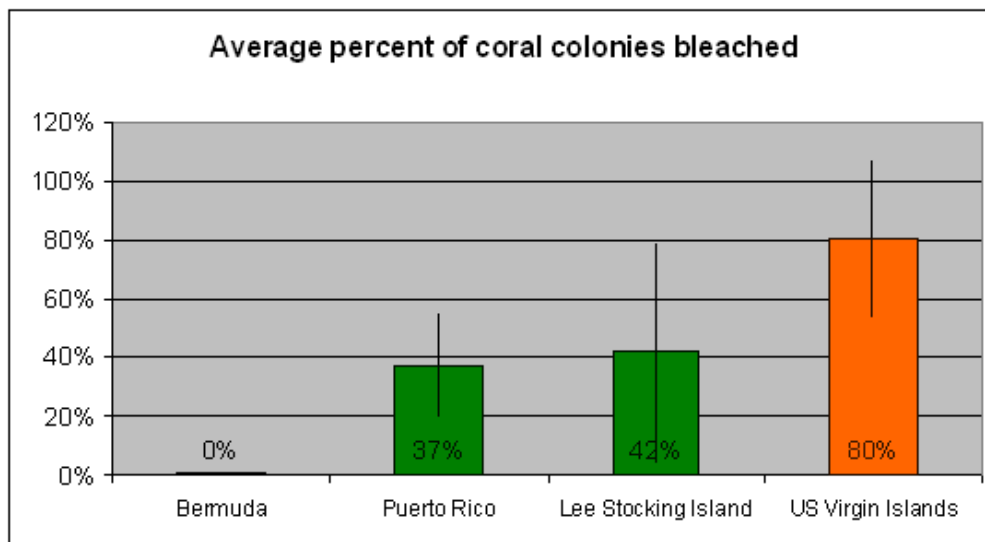
### C. How stressed was your reef site compared to other reefs in the Caribbean region?

6. How did the thermal stress at your site compare to the stress experienced by the other three reefs highlighted in this exercise?  
B < LSI < PR < USVI or B < LSI = PR < USVI
7. How severe was the bleaching at your site compared to the other three reefs?  
B < LSI < PR < USVI or B < LSI = PR < USVI

## So how bad was the bleaching, really?



Regional observations from over 1500 on-site surveys conducted during the 2005 bleaching event. Each dot represents the average percentage of the coral colonies bleached at that location.



Bleaching surveys within 50 km of the four sites in this exercise. As expected, the bleaching was worst in the US Virgin Islands, where about 80% of the coral colonies were bleached. Puerto Rico had 37% of colonies bleached; LSI had 42%. Note that there is a lot of variability in the data (shown by the error bars); Puerto Rico and the Lee Stocking Island were statistically identical. In Bermuda the bleaching was very light: less than 1% of coral colonies bleached.

**Thermal stress: B < LSI < PR < USVI**

**Actual bleaching data: B < LSI = PR < USVI**