

*“For those who also have interest in these critically important systems, I ... ask you to join the global effort to conserve our planet’s coral reef systems”.*  
**Monique Barbut, CEO,  
Global Environment Facility**

2005 and 1998 were the two most damaging years for coral reefs in recorded history; they were also the world’s hottest years since records started in 1880. About 16% of the world’s reefs were effectively lost in the Indian Ocean and Western Pacific in 1998, and in 2005, massive coral losses occurred in the Caribbean; all due to coral bleaching.

- Coral bleaching and mortality in the Wider Caribbean was more severe in 2005 than during the 1987, 1995 and 1997/98 mass bleaching events.
- In 2005, live hard coral cover at some sites in U.S. Virgin Islands declined by an average of 51.5%;
- More than half of the coral colonies in Florida, Puerto Rico, the Cayman Islands, St. Maarten, Saba, St. Eustatius, Guadeloupe, Martinique, St. Barthelemy, Barbados, Jamaica and Cuba bleached during 2005;
- Coral mortality was very severe in the Lesser Antilles; e.g. there was 17% to 20% coral mortality on Barbados, 11% and 30% in the French West Indies, 18% on St. Eustatius, and 73% of all *Colpophyllia* and *Diploria* coral colonies died on Trinidad and Tobago;
- 2005 broke all records for hurricane activity in the wider Caribbean with 26 tropical storms including 13 hurricanes.
- Many of these caused considerable damage to coral reefs; e.g. Hurricanes Emily and Wilma reduced coral cover from 24% to 10% around Cozumel, Mexico;
- Many bleached corals subsequently succumbed to coral diseases, which increased mortality.

This book, *Status of Caribbean Coral Reefs after Bleaching and Hurricanes in 2005*, documents the devastating effects on coral reefs of the Caribbean and Atlantic basins during the hottest year on record for the Northern Hemisphere. Abnormally high sea surface temperatures resulted in coral bleaching and mortality throughout the region and there was record hurricane activity, including some particularly damaging storms. This is a report from 80 coral reef scientists and managers documenting what happened to their coral reefs due to the warming and storms of 2005.

## 2005 HOTSPOTS AND MASSIVE CORAL BLEACHING

In 2005, large areas of particularly warm surface waters developed in the Caribbean and Tropical Atlantic. These were tracked using satellite images as HotSpots and the resultant maps were distributed throughout the world by the National Oceanic and Atmospheric Administration (NOAA), USA via the Internet. This was the first time that a bleaching event could be followed in real time.

The first HotSpots appeared in May, 2005 and rapidly expanded to cover the northern Caribbean, Gulf of Mexico and the mid-Atlantic by August. The HotSpots expanded and intensified until October, before winter conditions cooled the waters in November and December. Abnormally warm waters bathed the Lesser and Greater Antilles for 4 to 6 months, and coral bleaching and mortality was reported throughout Caribbean under these HotSpots.

In the Southern Hemisphere, minor coral bleaching was seen in March in Brazil, whereas the first Caribbean bleaching was in June in Colombia in the south, and Puerto Rico in the north.

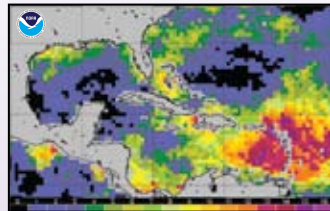
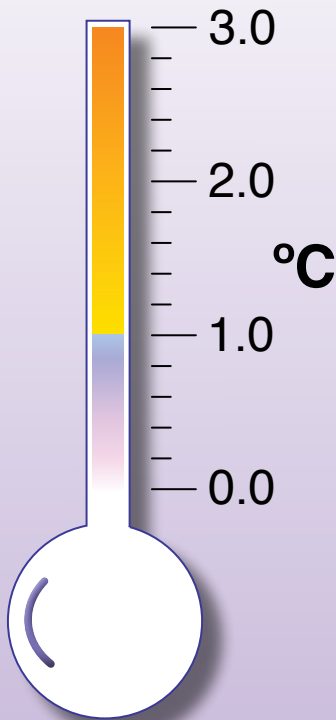
By July, the bleaching was extensive with 25% and 45% of coral colonies in Belize, Mexico and the U.S. Virgin Islands being stressed and bleached. In some places, such as the U.S. Virgin Islands, the eventual coral mortality was the worst ever seen; coral cover at some sites declining by an average of 51.5% due to bleaching and subsequent disease.

By August 50% to 95% of coral colonies had bleached in Florida, Puerto Rico, the Cayman Islands, the northern Dutch Antilles (St. Maarten, Saba, St. Eustatius), the French West Indies (Guadeloupe, Martinique, St. Barthelemy), Barbados and the north coasts of Jamaica and Cuba. Some countries reported the worst bleaching ever seen.

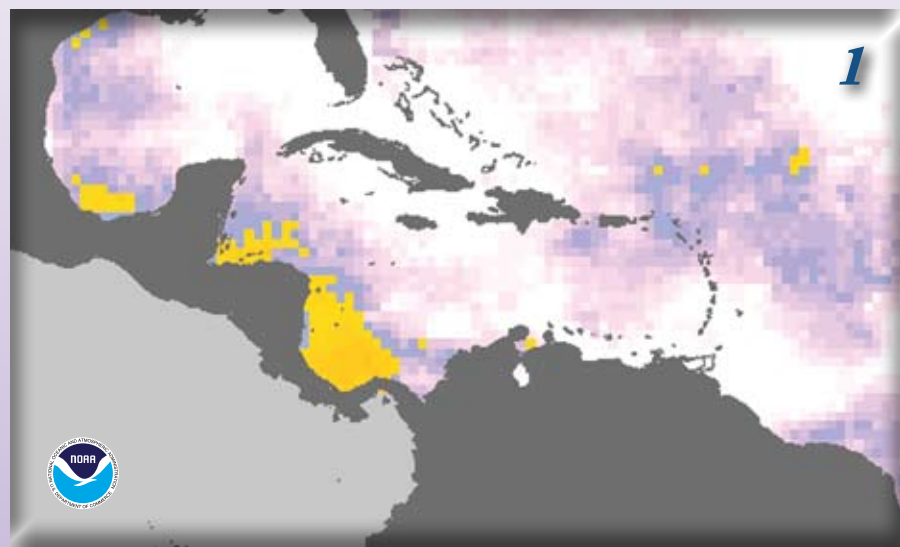
While there was coral bleaching in the Florida Keys in 2005, the passage of hurricanes Katrina, Rita and Wilma cooled the waters by mixing in deeper, cooler waters. This relieved warm water bleaching stresses and most corals recovered

1992 and 2002 were critical years for the world's environment; the United Nations Conference on Environment and Development (UNCED), Rio de Janeiro in 1992 signed Agenda 21, formed the Convention on Biological Diversity and strengthened the Global Environment Facility (GEF) to support the global environment. The World Summit on Sustainable Development in 2002 in Johannesburg reaffirmed UNCED goals and urged all countries, especially small island developing states, to better manage coasts and coral reefs and create representative networks of marine protected areas.

### HotSpot



*1. The first large HotSpots were evident in July 2005 near Central America and as a developing warm region in the central Atlantic Ocean. Coral bleaching was reported in Belize.*



16 July 2005



20 August 2005

Coral mortality on Barbados was the most severe ever seen with 17% to 20% coral losses; similar losses in the French West Indies ranged between 11% and 30%; there was 18% coral mortality in St. Eustatius, in the northern Dutch Antilles; and 73% of all *Colpophyllia* and *Diploria* coral colonies died on Trinidad and Tobago.

By September, up to 68% of corals had bleached on the south coast of Jamaica, the Dominican Republic and throughout the Greater Antilles, however there was minimal mortality in Bahamas, Bermuda, Cayman Islands, Cuba, Jamaica and Turks and Caicos. Some sites in the Dominican Republic, however, suffered up to 38% mortality.

There was minimal bleaching mortality on the Mesoamerican Reef system, largely because many storms cooled sea temperatures; however, Hurricanes Emily and Wilma damaged some reefs, decreasing coral cover from 24% to 10%, especially around Cozumel in Mexico.

Coral bleaching continued in the Lesser Antilles in October. For example, the bleaching was the most severe for 25 years in Trinidad and Tobago with 85% to 100% of corals bleached. In many areas of the Caribbean there were increasing reports of lethal coral diseases striking the bleached and stressed corals.

By November, minor bleaching also affected Venezuela, Guatemala and the Dutch islands of Bonaire and Curacao, affecting 14% to 25% of corals, however, coral mortality in Colombia and Venezuela was negligible.

There was an increased prevalence of coral diseases affecting the bleached corals. More diseased corals were reported

**2. By mid-August, HotSpots with temperatures 2°C to 3°C above the normal summer maximum covered much of the Northern Caribbean including Florida, the Flower Garden Banks in the Gulf of Mexico and Cuba, The large HotSpot in the Atlantic covered the Lesser Antilles and a small HotSpot developed near Colombia. Bleaching was reported in all of these regions.**

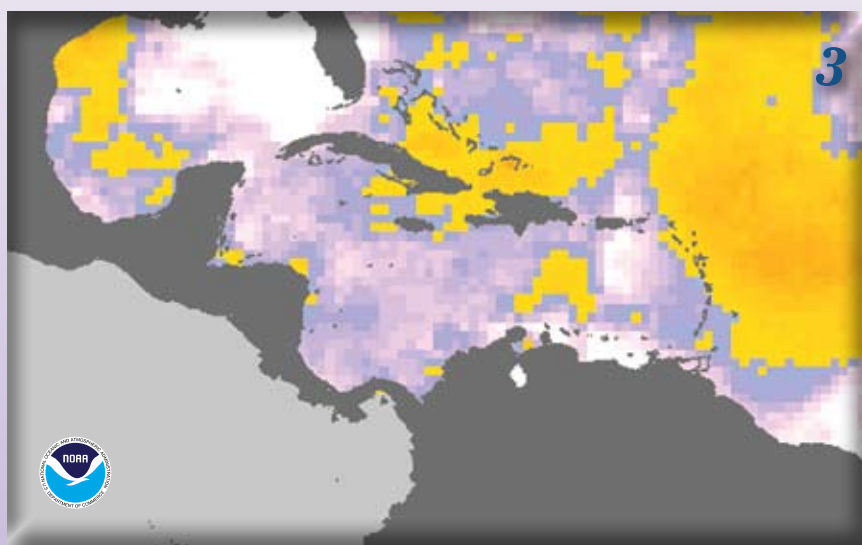
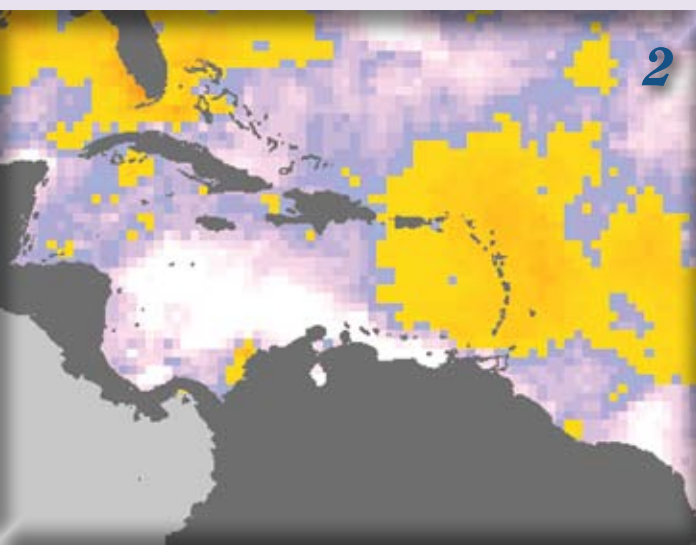
from many islands of the Lesser Antilles, particularly French West Indies. Infection rates were higher on Guadeloupe, St. Barthelemy, Martinique and Trinidad and Tobago. Secondary diseases killed many bleached colonies of *Montastraea*, *Colpophyllia*, *Diploria* and *Porites* on the U.S. Virgin Islands.

The waters started to cool with the onset of winter in November and December and many of the bleached corals that had not succumbed to bleaching or disease started to recover. However, bleaching persisted into mid 2006 in Guadeloupe, Martinique, Barbados and Trinidad and Tobago, and continued into 2007 in St. Barthelemy. Reefs in these countries showed few signs of recovery, with between 14% and 33% of colonies still bleached during 2006.

The corals vulnerable to bleaching were similar across the Caribbean, particularly: *Acropora palmata* and *A. cervicornis*, *Agaricia*, *Montastraea*, *Colpophyllia*, *Diploria*, *Siderastrea*, *Porites*, the hydrozoan *Palythoa* and the hydrocoral *Millepora*, which has nearly disappeared from the French West Indies.



**3. Two major HotSpots covered Puerto Rico, the Virgin Islands and the Lesser Antilles in early September. The August HotSpot over the Gulf of Mexico and Florida had been 'blown away' by hurricanes, especially Katrina. More reports of major coral bleaching were received from all the sites with HotSpots.**



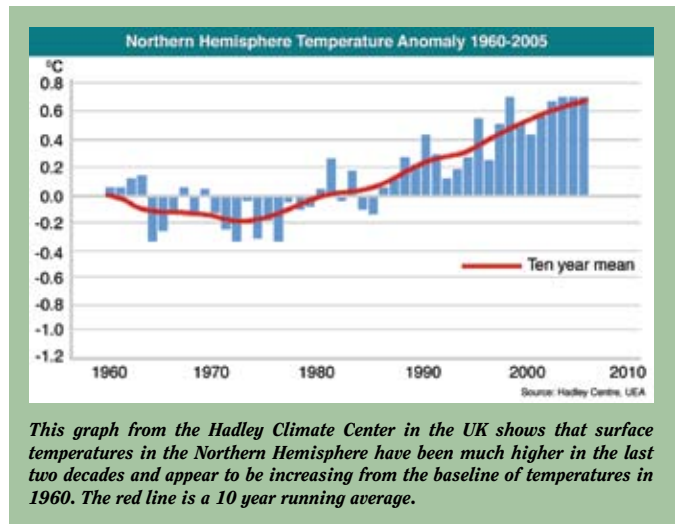
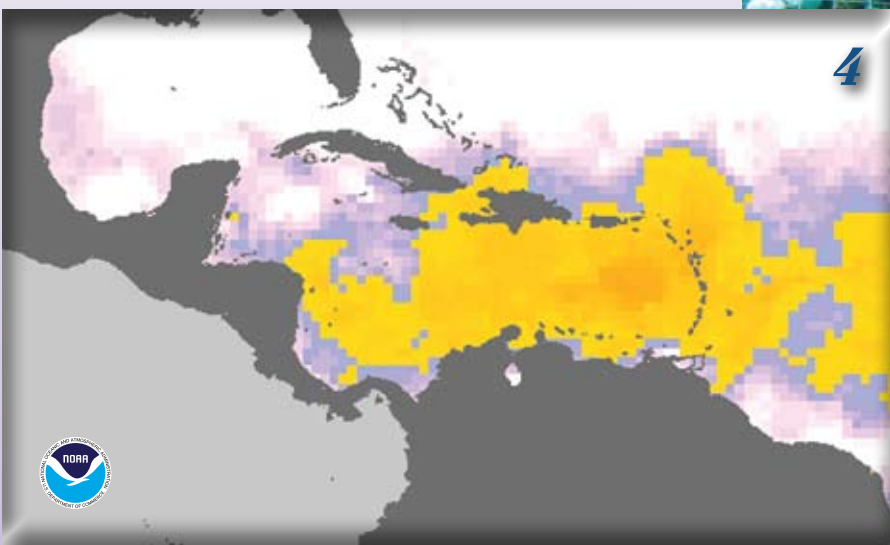
## 2005 AND HURRICANES

The 2005 hurricane year broke all records with 26 named storms, including 13 hurricanes. These included Hurricanes 'Dennis' that struck Grenada, Cuba and Florida; 'Emily' hit Mexico; 'Katrina' caused massive damage around New Orleans; 'Rita' struck Texas and Louisiana; 'Wilma' caused massive damage in Mexico, especially around Cozumel; and 'Zeta' formed in December. Many of these hurricanes caused considerable damage to the reefs via wave action and runoff of muddy, polluted freshwater.

The effects were not all bad. Some hurricanes reduced thermal stress by mixing deeper cooler waters into surface waters. None of these hurricanes, however, passed through the Lesser Antilles to cool the largest and most persistent of the HotSpots.



*4. The peak of HotSpot activity was in October with a massive HotSpot covering most of the central and eastern Caribbean, while Hurricanes had helped cool the waters of the Northern Caribbean. However, no hurricanes passed through the large HotSpot area over the Lesser Antilles. This HotSpot caused the most severe coral bleaching in the Lesser Antilles and Southern Tropical America.*

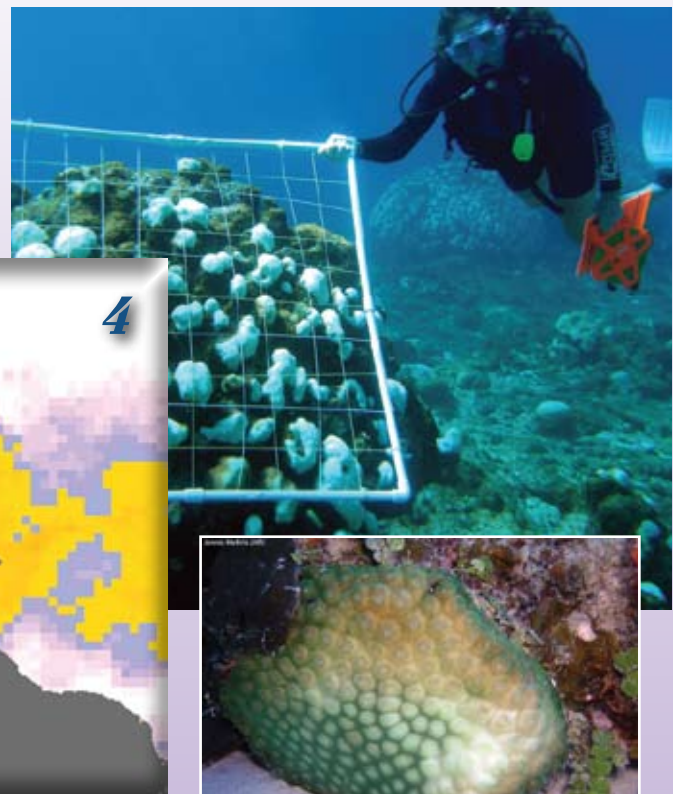


*This graph from the Hadley Climate Center in the UK shows that surface temperatures in the Northern Hemisphere have been much higher in the last two decades and appear to be increasing from the baseline of temperatures in 1960. The red line is a 10 year running average.*

1994 and 2008 are notable years for coral reef conservation; the International Coral Reef Initiative (ICRI) was proposed in 1994 and then developed the internationally agreed 'Framework for Action' and 'Call to Action', which included the formation of the Global Coral Reef Monitoring Network in 1996. ICRI has declared 2008 as the International Year of the Reef (IYOR) to focus world attention on the threats to, and value of, coral reefs and seek global solutions.



[www.iyor.org](http://www.iyor.org)



## IMPLICATIONS OF 2005 FOR CORAL MANAGERS

Unfortunately, direct management of coral reefs cannot prevent coral bleaching and mortality from climate change. However, effective management can promote more rapid recovery in the future, especially if bleaching becomes more frequent. The major target for management is to reduce direct human damage to reefs so as to encourage the natural adaptation mechanisms to build up reef resilience.

Experience from the massive climate-related destruction of reefs in 1998 shows that reefs that were actively managed to control pollution, sedimentation and over-fishing stresses recovered more rapidly from bleaching damage. Moreover, the mass bleaching event of 1998 demonstrated that some reefs are more resistant or resilient than others; these reefs should be protected within marine protected areas.

Another emphasis for coral reef managers is to directly engage with local communities, inform them what is happening and bring them on board to find solutions to conserve their coral reefs.

## THE FUTURE OF CARIBBEAN CORAL REEFS

Unfortunately, the future is not encouraging for coral reefs in the wider Caribbean. Severe coral bleaching is predicted to become a more frequent event by 2030, and an annual event by 2100, if the current rate of greenhouse gas emissions is not reversed.

Predictions from the 2007 reports of the Intergovernmental Panel on Climate Change (IPCC) indicate that the extreme warming of 2005 will not be an isolated event. It will probably happen more often and more severely in the future when the world warms by 1.8 to 4.0°C by the year 2100.

In addition to warming, increasing acidity of the seawater with the solution of more CO<sub>2</sub> will slow the growth of hard corals trying to recover from bleaching and other disturbances.

Another predicted climate change consequence is that there will be an increase in the frequency of more damaging hurricanes in the Caribbean. Hurricanes develop over warm waters in the tropical North Atlantic and warmer surface waters will probably fuel increases in tropical storm strength. Those storms that pass over coral reefs will cause significant damage to the reefs and the communities that depend upon them.

The world is committed to increased warming due to past greenhouse gas emissions and the predicted emissions in the near future. The consensus of scientific opinion is that atmospheric CO<sub>2</sub> levels should not exceed double the pre-industrial levels (e.g. 480 ppm) if coral reefs are to persist in something resembling their current form. Dramatic reductions in greenhouse gas emissions in the next 20 to 50 years will be necessary to ensure that robust and healthy coral reefs can provide food, protection and enjoyment for future generations.



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*“Coral reefs are much more than a pretty picture,  
they're an important asset. Developing countries need  
support not only to mitigate future deterioration  
of their coral reefs, but also to adapt to a sustainable use  
of the diminishing returns these reefs are likely to provide”*

*Katherine Sierra,*

*Vice President of Sustainable Development  
at the World Bank*

*“This book describes the critical state of coral reefs  
in the Wider Caribbean and why they are among the world's  
most threatened.”*

*Billy Causey, Southeast Regional Director,  
National Marine Sanctuary Program of USA, Florida*

