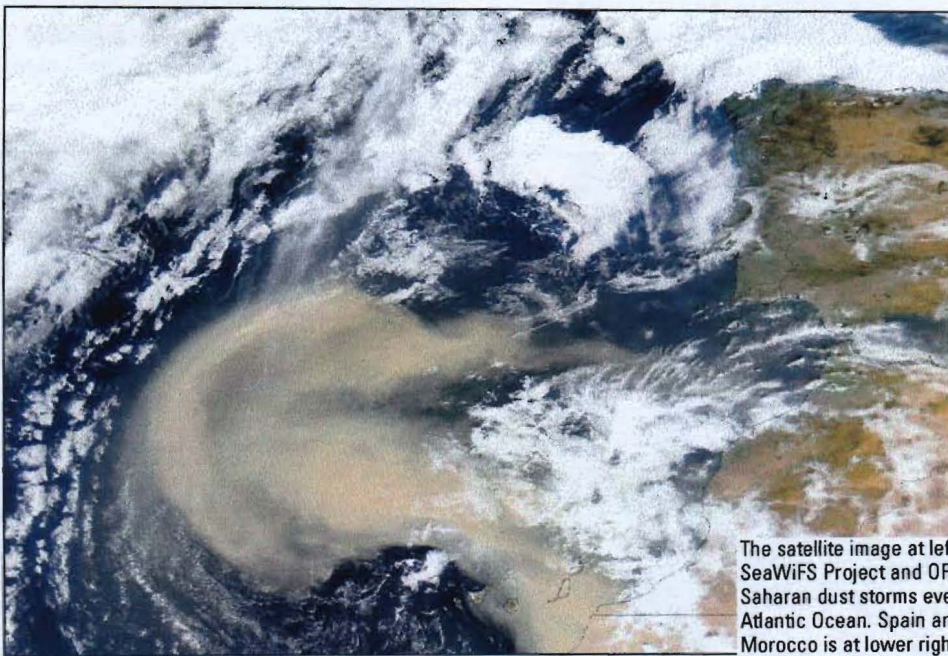


African Dust Causes Widespread Environmental Distress

Atmospheric transport of dust from North Africa to the western Atlantic Ocean region may be responsible for a number of environmental hazards, including the demise of Caribbean corals, red tides, amphibian diseases, increased occurrence of asthma in humans, and decrease of oxygen (eutrophication) in estuaries. Outbreaks of other unexplained environmental changes also might be attributable to the influx of African dust. Studies of satellite images suggest that hundreds of millions of tons of dust are transported annually across the Atlantic Ocean at high altitudes from the expanding Sahara Desert in Africa to the Caribbean Sea and southeastern United States.

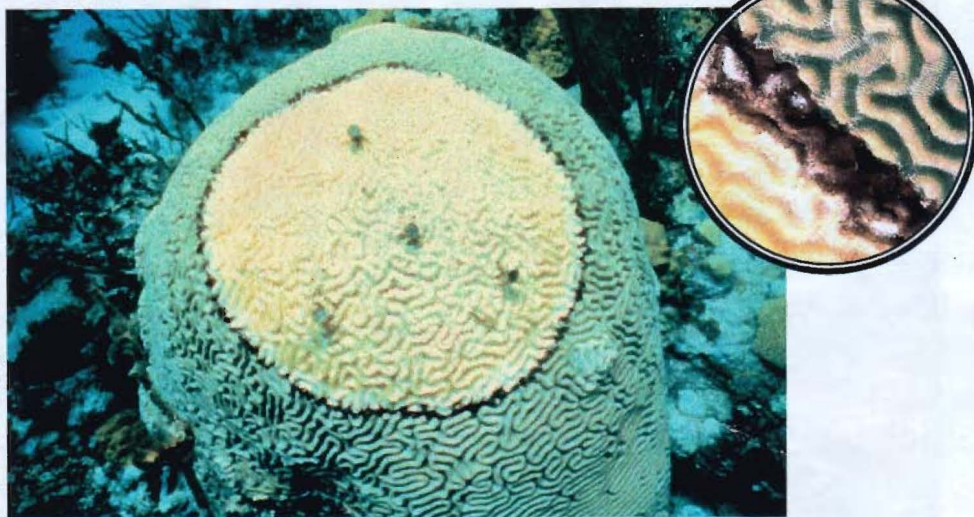


The satellite image at left, acquired by NASA/Goddard Spaceflight Center's SeaWiFS Project and ORBIMAGE on February 26, 2000, shows one of the largest Saharan dust storms ever observed by SeaWiFS as it moves out over the eastern Atlantic Ocean. Spain and Portugal are at upper right, Morocco is at lower right.

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Results of research on the composition of dust at many locations indicate a

long history of influx of African dust from across the Atlantic Ocean. Scientists of the U.S. Geological Survey's (USGS) Coastal and Marine Geology Program and Biological Resources Division, in cooperation with scientists at the University of Miami, Duke University, University of South Carolina Aiken, and the University of South Florida, conducted this work. This dust is known to play a positive role in maintaining rain forests and ecosystems of the Amazon River region. Recently, other studies concluded that dust transported from Asia provides essential nutrients for the rain forests of Hawaii.



Brain coral infected with black band disease. The band of tissue-killing bacterial slime radiates outward like a ringworm at a rate of up to 1 cm per day during summer warm-water conditions. The white area in the center is dead tissue-free coral skeleton. The dead skeleton will be attacked by boring algae, boring sponges, boring clams and parrot fish which will gnaw away the skeleton. Together these organisms remove about 1 cm (1/2 inch) per year. This means that in 100 years, a 1-meter high coral head will be completely consumed and converted to sediment. Black band disease on brain corals was first reported in Bermuda in the early 1970s, but became rampant in other species in the Florida Keys, and elsewhere, beginning in 1985.

African dust has been distinguished from other types of dust, such as volcanic, in soils and crusts from Barbados, San Salvador, the Bahamas, and the Florida Keys. A similar origin is suggested for soils and crusts in Bermuda. Pre-Colombian pottery from the eastern Bahamas contains chemical elements in ratios unique to dust from Africa, but definitely foreign to the region. For the most part, agriculture in the Bahamas depends on accumulation of African dust to form the red soils often referred to as pineapple loam.

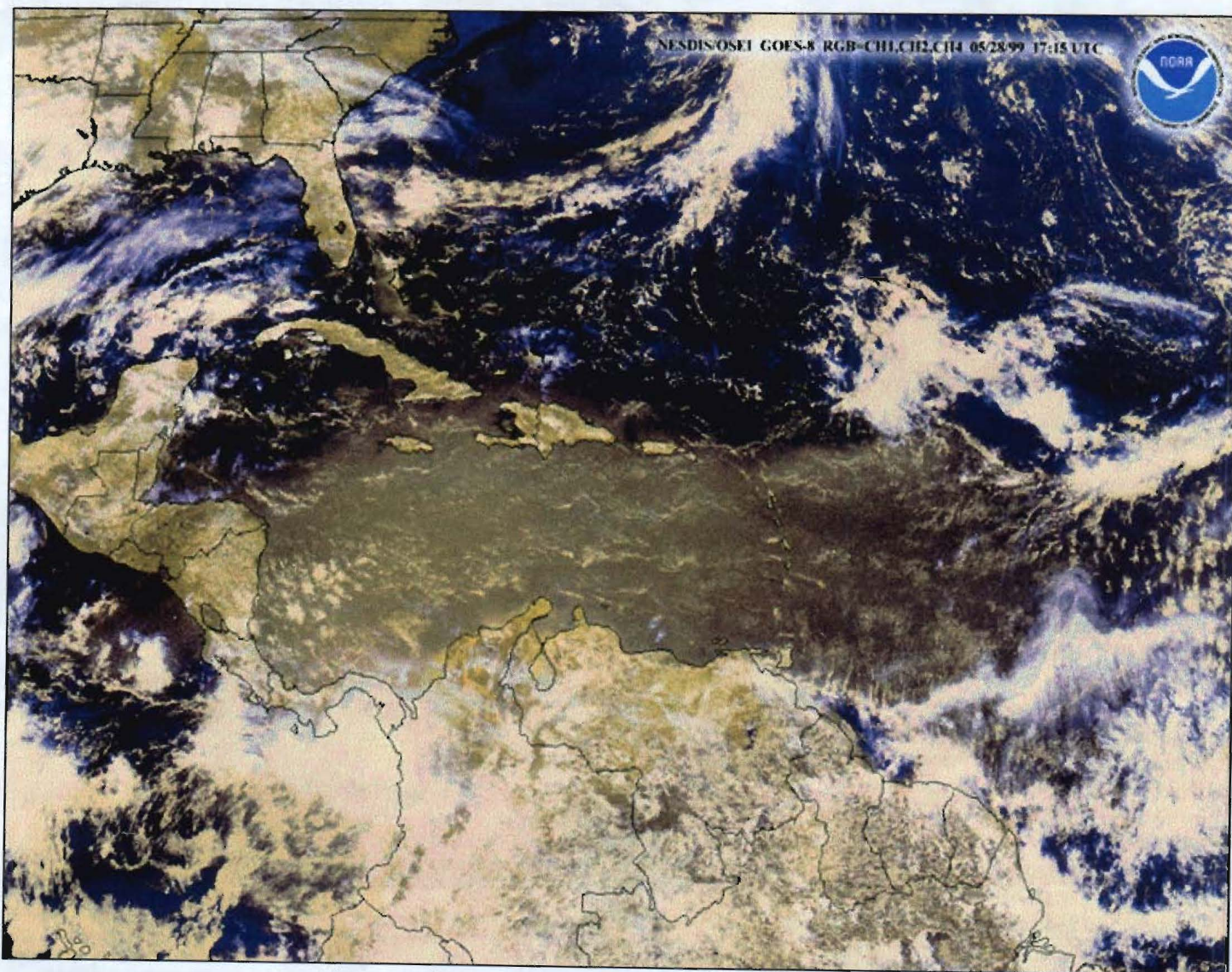
USGS scientists have monitored coral reef vitality for nearly 40 years, and have

observed that Caribbean coral reefs have been in a state of decline since the mid-1970s. Moreover, a number of other marine species, including the grazing sea urchin, *Diadema*, and sea fans, have experienced widespread and sudden demise roughly coincident with the deaths of coral populations. Environmental scientists have suspected that a pathogen was somehow released into the environment and spread across the Caribbean; however, the source of the pathogen remained elusive.

New studies at the University of South Carolina Aiken have identified several species of a soil fungus, *Aspergillus*,

in African dust samples collected in the Caribbean, and there appears to be a correlation between increased amounts of dust and outbreaks of disease.

Atmospheric distribution of African dust containing pathogens could be the cause of the 1983 Caribbean-wide near extinction of reef-building staghorn corals and a particular sea urchin, vital to the continuing health of coral reefs. Various rapidly moving fungal infections of unknown origin recently decimated frog populations in Central America and Australia. Lung infections caused by several species of *Aspergillus* are a leading cause of mortality in AIDS victims. Also,



May 28, 1999 satellite image of southeast United States, Central America, and the Amazon region of South America showing a huge African dust cloud over the Caribbean. Hundreds of million tons of dust are deposited annually in this region. In June and July these dust clouds move farther north where they impact the Florida Keys, the Gulf of Mexico, the eastern United States, and the Bahamas.

many people without severe illness also reportedly suffer from lung infections caused by *Aspergillus*. As long ago as 1846, Darwin noted the ill medical effects of African dust while cruising near the Canary Islands.

In addition to hosting spores, African dust itself is composed of chemical elements such as iron, phosphorous, and sulfates, which have been proven to stimulate phytoplankton growth in tropical waters. Collaborators at the University of South Florida suspect that iron delivered with the dust stimulates a chain reaction leading to the bloom of microscopic

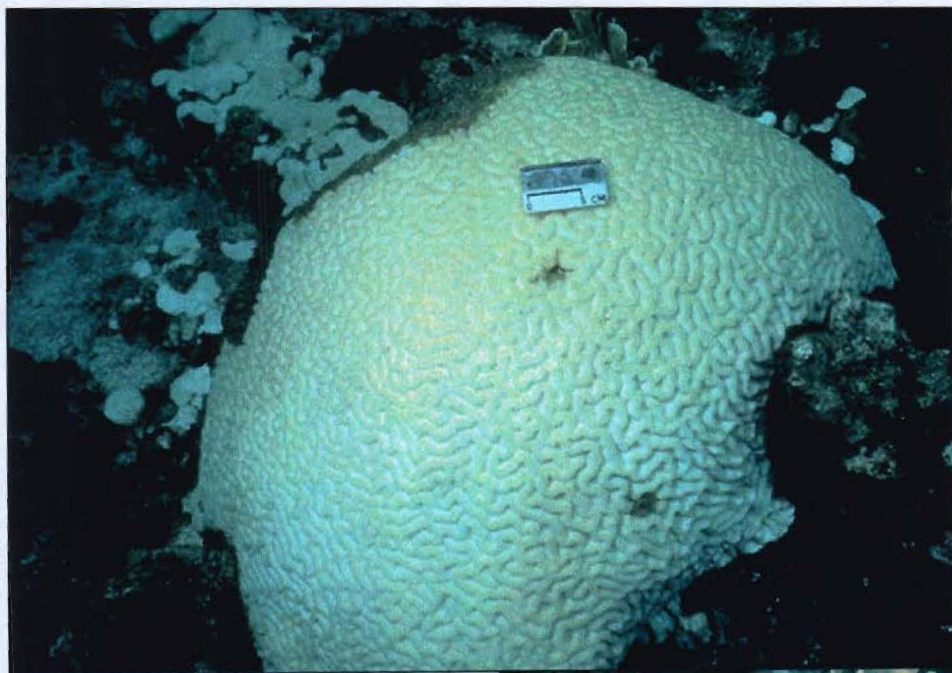
organisms that cause red tides.

It has long been known that dust is transported from remote areas of the world, but the environmental impact of this dust is only now becoming more clearly understood.

Caribbean coral diseases were first reported in the 1970s, but these early reports received little attention until the late 1980s. In 1983, the herbivorous urchin *Diadema* experienced mass mortality throughout the Caribbean, and within three months the population was decimated. The effect of this die-off was immedi-

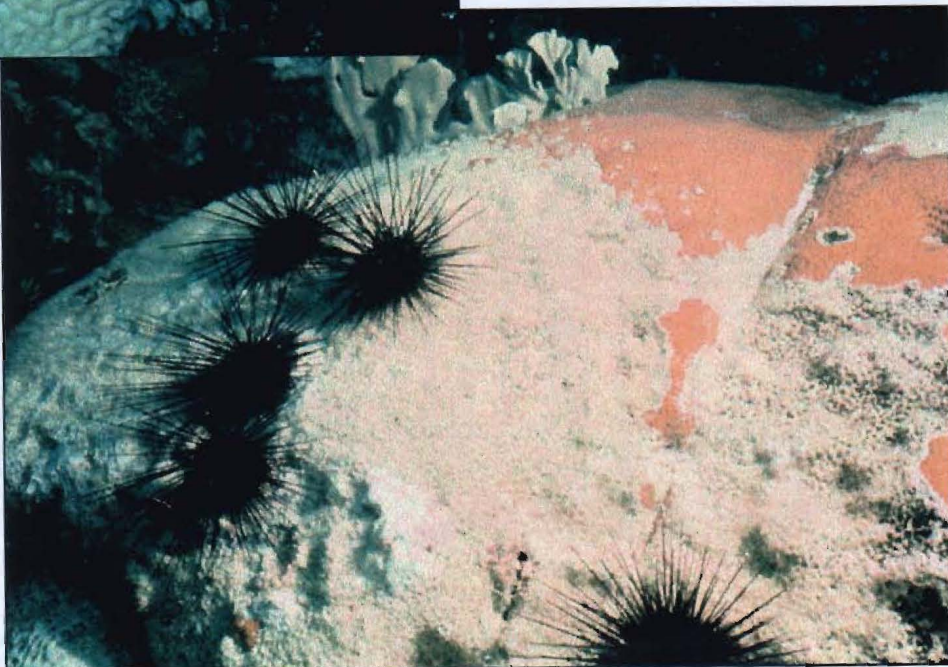
ate and obvious. Algae normally grazed by *Diadema* from dead coral surfaces proliferated, interfering with coral growth and with competition for recruitment space for new coral.

Almost at the same time, two important Caribbean reef-building coral species also experienced mass mortality. In the absence of *Diadema*, coral surfaces soon were overgrown by algae. In 1987, a second major disease event struck Caribbean populations of coral and sponges resulting in bleaching of coral surfaces. Bleaching, along with black-band disease, proliferated in the 1980s, and accelerated in 1997-1998.



This brain coral has expelled the symbiotic algal cells that give it color, leaving it snow white. The condition, called bleaching, is associated with warm water conditions, especially during the years of maximum dust transport. That dust alone causes bleaching is unproven.

Underwater photograph of the urchin *Diadema* on a dead coral head taken before 1983. In the summer of 1983 most of these urchins died throughout the Caribbean. Notice how the *Diadema* have kept the surface of this dead coral free of algae. Today, without the browsing of these algae-eating urchins, dead coral surfaces such as this are coated with mats of fleshy algae. Such growth of fleshy algae retard the establishment of coral larvae.



Each event coincided with increases in warm water associated with El Niño weather patterns and peaks in African dust production and transport. The years of highest cumulative dust flux occurred 1983 and 1987, based on data recorded in Barbados where aerosols have been collected since 1965. Indeed, fungal spores and bacteria had been identified in air

over the Atlantic Ocean during the 1950s. On October 14 and 15, 1989, large African desert locusts were transported in dust clouds to Trinidad. It is not surprising that African dust would contain soil fungus spores, because the dust is derived from the desertification of grasslands in the Sahel region of northern Africa.

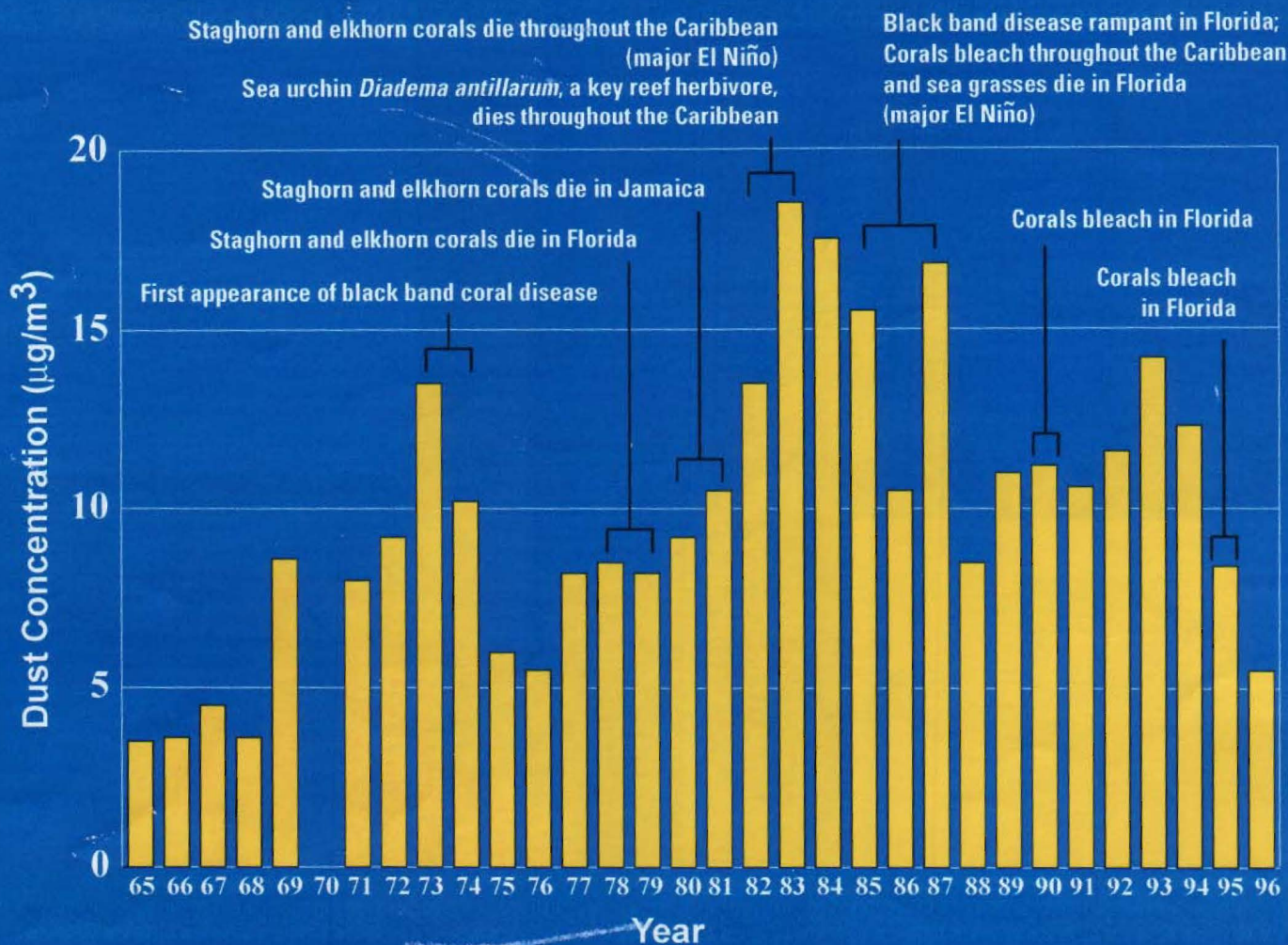
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Learn more on the Web:
http://coastal.er.usgs.gov/african_dust/

Barbados Mineral Dust (Annual Average: 1965-1996) and Benchmark Caribbean Events



This graph, courtesy of Dr. Joe Prospero, University of Miami, shows the overall increase in African dust reaching the island of Barbados since 1965. Barbados is situated in the Windward Islands, which are hidden beneath the cloud of dust shown in the satellite image on the second page. Notice the peak years for the dust deposition were 1983 and 1987. These were also the years of extensive environmental change on Caribbean coral reefs.