Several additional groups dropped out for technical or policy reasons, including the Materials Research Society, the American Society of Mechanical Engineers, and the American Astronomical Society. The American Association for the Advancement of Science was never invited to join, says one official, "because we never sign statements like that."

The astronomers were divided up to the end. "I don't think we have any real quarrel with the [American Physical Society] position," says Peter Boyce, executive officer of the American Astronomical Society. "But we just didn't want to sign it." Why not? "We felt that it was not a good thing to do, to raise the fight again after having lost so one-sidedly and unexpectedly in the House," says Boyce. "You've got to look at the stand of the people who were on the Senate committee," Boyce explains. They had strongly endorsed the station, as had a group of 50 senators. The astronomers also were put off by the emotionalism of the debate in the House—including "comments by various people about the scientific community being naive and greedy." Furthermore, it isn't wise to kick one's benefactor in the shins, and NASA is now a bigger supporter of basic astronomy grants than NSF. In many ways, says Boyce, NASA has been "more responsive" to astronomers' requests than NSF.

To the pragmatists' argument that there was much to lose and little to gain by hammering on the senators about the space station, even Park conceded at his press conference on 9 July that, "We are not sanguine about our prospects" of changing any votes in the committee. So why did he go ahead with the protest? "We have an obligation to state our concerns as clearly and forthrightly as we can." At least one Senate aide who deals with science legislation responded favorably to the protest. "If there are concerns out there, it's good that we hear about them," he said, noting that when NSF was in trouble 3 years ago, there was silence from the scientific community.

The next indication of whether the 14 societies are making any headway in their argument—or have incurred penalties—could come as early as this week, when the Senate may take up the independent agencies bill. As the bill reaches the floor, the White House budget office may release a "Statement of Position" announcing whether it is willing to go along with the Antarctic funding plan. Meanwhile, Park clings to what seems a slender reed: that Congress will listen to his logic and eliminate the space station before it enacts a final appropriations bill this fall.

■ ELIOT MARSHALL

Greenhouse Role in Reef Stress Unproven

An interdisciplinary group nixed the idea that global warming is causing coral bleaching and pointed instead to local stresses

IN THE LATE 1980S, AS CORAL REEFS throughout the Caribbean and elsewhere fell victim to a phenomenon known as bleaching, a few scientists began sounding the alarm. The message of these scientists, who included Thomas Goreau of the Discovery Bay Laboratory in Jamaica and Raymond Hayes of Howard University, was that greenhouse warming is upon us and that the exquisitely sensitive corals, reacting to elevated water temperatures, are serving as biological sentinels (*Science,* 12 October 1990, p. 213). This caught the attention of Congress, where then Senator Lowell Weicker (R–CT) and Senator Albert Gore (D–TN) held hearings, most recently just last October. At that last hearing several investigators testified that bleaching had reached its worst point ever, and this stirred up so much concern that Congress assigned the National Science Foundation (NSF) to investigate the connection between coral bleaching and global warming.

Al Grotell

Endangered ecosystem. *Many of the world's reefs, like this one in the Atlantic, are deteriorating. Local stresses —and perhaps high temperatures—may be to blame.*

Late last month investigators at an NSF-sponsored meeting rendered their verdict. Following the Miami meeting, which brought together, for the first time, climatologists, oceanographers, and meteorologists with marine biologists, ecologists, and other reef experts, the participants issued a statement saying essentially that, yes, higher temperatures seem to be at least partly at fault but, no, greenhouse warming cannot be blamed. "While many of the recent bleaching episodes do appear to be associated with high local temperatures," the group said, "our knowledge of both coral stress responses and the detailed nature of climate change make it impossible at present to claim that coral bleaching is an early indicator of the global greenhouse effect."

Global warming might eventually wreak havoc with coral reefs around the world, the experts said, but there's no proof that it's already happening. The consensus may be somewhat illusory, however, as Goreau, Hayes, and other proponents of the greenhouse connection were not invited to attend. They could not be reached for comment.

Differences notwithstanding, there is one point on which everyone agrees: Something is clearly amiss on the world's reefs. Indeed, the participants at the Miami meeting were sufficiently worried about what they see as the deterioration of coral reefs that they unanimously endorsed an international program of intensive, long-term monitoring throughout the world to collect data on all the physical and biological factors that affect reef health. The group's recommendations will go to the sponsoring agencies—NSF, the National Oceanographic and Atmospheric Administration (NOAA), and the Environmental Protection Agency—within a few weeks.

Bleaching, which occurs when corals expel the algae that reside within their cells, thereby turning snowy white, is not a new phenomenon. Indeed, it is a fairly common response to a number of stresses, including high or low temperatures, high or low salinity, high sedimentation, fluxes of visible or ultraviolet light, or pollutants. What has caught people's attention over the past few years is the frequency, severity, and unprecedented geographic scope of some of these events, which occurred almost simultaneously at locations around the Caribbean and western Atlantic (*Science,* 27 November 1987, p. 1228).

Unless the stress is especially severe, the corals regain their algae and recover. But in

some cases they die, leaving the reefs vulnerable to erosion. During a massive bleaching episode in the tropical eastern Pacific, which has been closely linked with the near-record warm waters of the 1982–83 El Niño Southern Oscillation, Peter Glynn, a marine biologist at the University of Miami, found not only widespread mortality—up to 85% on the Panamanian reefs—but also the apparent extinction of two coral species, he told the group in Miami. (Also see *Science,* 5 July, p. 69.)

But while the culprit was fairly easy to discern in the eastern Pacific—the waters were unusually hot—that is not the case for the recent episodes in the Caribbean. They do appear to be linked to high temperatures, but the temperature anomalies are smaller and the connection more nebulous, says Glynn. Mark Eakin, NOAA's representative at the meeting, agrees: "The data are suggestive but far from statistically convincing." Good in-situ temperature records exist for only a few sites around the Caribbean, Eakin explains. "For most areas, the best we can do are satellite observations, which just give you the 'skin' temperature, and that is not necessarily what the corals feel." The rest of the data come from ships, which do take deeper measurements, but typically far from the reefs.

Using these admittedly crude measurements, various investigators, including Goreau and Hayes, have discerned a correlation between elevated water temperatures and recent episodes of bleaching in the Caribbean. But as intriguing as those findings are, says Robert Buddemeier, a reef expert at the Kansas Geological Survey, it is "extremely difficult to argue from a local scale to a regional scale to a global scale with any logic or conviction." He suspects, as do many of his colleagues at the meeting, that local high temperatures may be acting synergistically with other stresses to trigger bleaching. One possibility, he says, is that elevated nutrient levels may lower the threshold for bleaching, so that temperatures that did not bother corals 30 years ago might do so now, since waters are more polluted.

Indeed, the group concluded that the biggest threat to reef health worldwide is not global warming or transient high temperatures but rather "the cumulative effect of local perturbations" from population growth, land use, and resource exploitation, says Christopher D'Elia, director of the University of Maryland Sea Grant College and the principal organizer of the meeting. "We are quick to worry about climate change but not so quick to worry about local effects," he adds.

The reefs of Southeast Asia are especially vulnerable, said the group. Not only is rainfall high, which leads to freshwater runoff and sedimentation, but population pressures and environmental problems are rife. At this stage, however, next to nothing is known about the status of those reefs. "It is a major area of ignorance," says Buddemeier. "Finding out what is going on there ought to be a high priority."

To figure out what is happening to the world's reefs, the group recommended monitoring not just seawater temperature but such physical and chemical parameters as light, wave energy, and water quality. The more challenging problem, says Buddemeier, "is to develop the biological and ecological monitoring techniques that could be related to physical environment and could be compared among sites and over time." Such monitoring could cost millions of dollars a year, but most of it could come from redirecting and coordinating ongoing efforts, says Buddemeier, "with just a modest amount of new funds."

Collecting enough data to confirm or deny the link to global warming could take 10 to 15 years, the group estimated. In the interim, they called for "retrospective monitoring," by which they mean an attempt to discern past environmental variations and coral response from coral growth bands.

The group also urged the federal agencies to fund more research in coral physiology and adaptation, in order to predict how corals might respond to greenhouse warming. On the climate modeling side, too, improvements are needed to predict accurately just how high seawater temperatures might rise. Based on runs with two existing atmospheric models, which are still quite crude, Linda Mearns, a climatologist at the National Center for Atmospheric Research, predicted daily temperature excursions of up to 3° to 4°C, if atmospheric levels of carbon dioxide double—clearly enough to trigger bleaching. Lab experiments have shown that an increase above warm summertime temperatures of just 1° or 2°C for several weeks, or 3° or 4°C for a day or two, can induce bleaching. But how quickly the reefs might recover from such temperature-related stress, or what their ultimate fate might be, remains unknown. ■ LESLIE ROBERTS

Geographic Fission on Fusion

Cooperation in large international scientific projects often comes with a political price, and the International Thermonuclear Experimental Reactor (ITER), an ambitious attempt to build a working fusion reactor, is no exception. ITER's four international partners—the United States, Japan, Europe, and the Soviet Union—agreed last week to proceed with the reactor's 6-year, $1-billion engineering design phase. The political price was a complex arrangement to spread the work over three continents.

The design phase was scheduled to start at the beginning of this year, but bickering over the site for the work brought negotiations to a standstill. "For roughly 6 months, Japan, Europe, and the U.S. have gone to the negotiations with their own home site as their first choice, and no second choice," says a U.S. fusion physicist who spoke on condition of anonymity. That deadlock was finally broken last week when the partners accepted a plan to establish ITER centers in San Diego; Garching, Germany; and Naka, Japan (*Science*, 31 May, p. 1241).

Billed as a "compromise" between siting the activity in one country and splitting it equally between three, the new plan places most management and coordinating responsibility in San Diego. The centers in Garching and Naka will take charge of designing and building reactor component prototypes.

Attempts to internationalize the project as much as possible don't end with the site selections. While none of the site directors has yet been named, their countries of origin have been decided—and the whole scheme resembles a game of musical chairs. The director of the San Diego site will be a Soviet; the director in Garching will be an American; and the Naka director will be a European. (A Japanese will serve as chief deputy at the European site.) The partners have also set up an ITER Council—resembling a corporate board of directors—in Moscow, to be chaired by a Soviet. Sources within the fusion community say the director of the entire project, although not yet named officially, will be Paul Rebut, a Frenchman who is currently director of the Joint European Torus.

Some critics have charged that splitting the project among three sites would create serious management difficulties. "Absent any other considerations, when you're building a large project, you'd do it in one place," acknowledges Alexander Glass, leader of the U.S. engineering team. "[H]ere, we had other considerations."

■ DAVID P. HAMILTON