somewhat tougher than the old one, they see many weaknesses. The biggest problem, Hind says, is that there are still no deadlines for finishing any cleanups. Of some 500 cleanups started since 1980, only 13 are finished. The original House bill would have required 600 cleanup starts and 540 completions.

Another problem is that the new law does not require the EPA to expand its list of toxic-waste sites. The current list includes 800 sites; the environmental groups — including U.S. PIRG, the National Audubon Society and the National Wildlife Federation — had asked that it be expanded to 1,600. *— M. Murray*

More grounding for global warming

Have the increasing levels of carbon dioxide and other "greenhouse" gases in the atmosphere begun to warm the planet yet?

The answer to this question is urgently needed by scientists who are trying to verify climate models predicting that temperatures will rise significantly in the next century due to greenhouse gases (SN:9/14/85,p.170). These gases are thought to trap heat escaping from the earth and send it back to warm the planet. One reason scientists have been uncertain about the answer is that past estimates of global temperatures have been based almost exclusively on readings taken on land, which covers at most 30 percent of the globe.

Now, in the July 31 NATURE, climatologists P. D. Jones, Thomas M. L. Wigley and P. B. Wright present the first comprehensive estimates of global mean surface temperatures that are based on calibrated ocean data as well as on land measurements. "This is a big step forward," says James Angell at the National Oceanic and Atmospheric Administration's Air Resources Laboratory in Silver Spring, Md. Adds Murray Mitchell, also at the lab, "The importance of this study is that it confirms that we have indeed seen a general warming of the global climate over the last 100 years."

Records of air and water temperatures have been kept by ships at sea for more than a century. The problem with these marine data, however, is that different measurement techniques of varying degrees of accuracy have been used, and the methods were not always reported.

One group of researchers had attempted to correct these discrepancies by trying to remedy each source of inconsistency individually. But because so much uncertainty is involved with this approach, Jones and his colleagues at the University of East Anglia in Norwich, England, instead corrected the marine data by calibrating them to measurements from nearby spots on land.

Their new temperature estimates, based on data taken from 1861 through 1984, show a slow warming trend over that period of about 0.7°C — consistent with the temperature changes predicted by greenhouse models. The researchers also note that the three warmest years in their temperature estimates were 1980, 1981 and 1983 and that five of the nine warmest years over the entire record occurred after 1978.

In general, these estimates confirm those based solely on land measurements. The only noteworthy difference is that land data showed a slight decrease in temperature between the late 1930s and 1970s, while the addition of marine data for this period causes the temperature to level off. The lack of growth during this period has puzzled scientists for several years. Jones's group writes that these steady conditions mean either that something is compensating for the greenhouse warming or that the climate system is less sensitive to greenhouse gases than was thought. Mitchell and others, for example, think that volcanic eruptions, which occurred far less frequently in this period than in the previous decades, counteracted greenhouse warming by cooling the atmosphere.

However, Jim Hansen at NASA Goddard Institute for Space Studies in New York City thinks that neither the argument for compensating factors nor that for lower sensitivity is required. He says greenhouse warming could be obscured by natural climate fluctuations of several tenths of a degree every decade or so.

Mitchell observes that for the majority of researchers, the new temperature estimates are "another piece of the puzzle that needs to fall into place before we ask the politicians to take us more seriously than they have. As for the minority who believe that carbon dioxide changes could affect the temperature only a little bit, if at all, I think when they see these data they're going to find that they have less ammunition than they thought they did to support their conservative view."
— S. Weisburd

Photosynthetic fuel factories

Love may make the world go round, but it's photosynthetic plants that keep the machines running. All fossil fuels are the remains of ancient organic matter, and therefore of ancient photosynthetic processes. The past decade has seen a growing awareness that those remnants are running out.

According to Melvin Calvin, research may be able to sidestep the need for the eons-long geological processes that turn organic matter into oil and gas. With the development of new crops, the Nobel Prize-winning chemist says, modern plants could provide at least half of the fuel energy needs of the United States within the next 40 years.

The idea isn't new. Nearly half of Brazil's fuel comes from sugarcane, for example. But sugar juice from cane must be fermented, to concentrate the carbohydrates into higher-energy hydrocarbons. "We would much prefer . . . plants which would do the whole thing in one step — reduce all the way down to hydrocarbons," Calvin told an international symposium on grasses last week at the Smithsonian Institution in Washington, D.C.

Calvin reported in 1979 that the Amazonian copa-iba tree (*Copaifera langsdorfii*) produces diesel fuel that can go directly from the tree into a car's gas tank (SN:9/15/79,p.182). Since then, Brazilian researchers have grown an experimental plantation of the trees, which they hope to begin tapping soon. Copa-ibas grow only in the tropics, but Calvin says researchers may be able to adapt them to temperate climates or to transfer the oil-producing genes into a temperate-adapted tree.

Calvin, at the University of California at Berkeley, also works with hydrocarbon-producing temperate plants. The *Euphorbia lathyris,* or gopher plant, produces an oil-based latex as well as fermentable sugars and cellulose. After growing small crops of the plants on soil- and water-poor experimental plantations in California, Calvin and his colleagues estimate that an acre of gopher plants would produce the equivalent of 12 barrels of oil from the three components. At that level of productivity, the crop would become economically enticing if oil prices rose above $30/barrel again, Calvin says.

But the gopher plant is an annual, and while that means it can be harvested almost immediately, it also means the crop is relatively expensive and hard on the land. The Pittosporaceae family offers a few candidates for a temperate perennial oil-producer. Growing throughout the U.S. West Coast, *P. undulatum*'s grape-sized fruits are sticky with oil. And in the Philippines (at high altitudes, which bodes well for temperate adaptation), the fruits of *P. resiniferum* are so oily they are used as torches. Calvin estimates that such trees might keep producing for 10 to 15 years.

Some biologists at the meeting had misgivings about using wild lands for large-scale planting of fuel crops — and, ultimately, still coming up short on fuel. Asked Hugh Iltis of the University of Wisconsin in Madison, "After you provide fuel for the next 5 billion [people], what next?" *— L. Davis*