Potential aerobic MTBE biodegradation

Microbial degradation of the gasoline additive methyl *tert*-butyl ether (MTBE) may be more widespread than previously thought, according to researchers at the U.S. Geological Survey (USGS) in Columbia, SC. In the February 15 issue of *ES&T* (**2001,** *35* (4), 658–662), Paul M. Bradley and colleagues report that the potential for MTBE biodegradation in surface water systems is high, even at sites with no history of MTBE exposure.

The majority of MTBE monitoring studies have focused on anaerobic groundwater systems, in which MTBE degrades slowly and incompletely, if at all. "MTBE is now the second most common contaminant in groundwater systems throughout the United States. However, the environmental fate of MTBE in surface water systems has received less attention," says Bradley. "Based on our previous experience with chlorinated ethenes, which are considered recalcitrant in groundwater but degrade very effectively in surface water, we asked whether the same is true for MTBE," he says. Evidence so far suggests that it is.

The USGS scientists collected stream and lake bed sediments from 11 sites throughout the United States (see map). Some of these sites had groundwater contamination from MTBE and other gasoline components such as benzene, toluene, ethene, and xylene (BTEX); others harbored chlorinated solvents but had no known MTBE contamination, and some had no known contamination. In simple aerobic microcosm experiments, the researchers added ^{14}C-radiolabeled MTBE to each of the sediments and monitored the conversion to $^{14}CO_2$ by headspace gas chromatography. After 50 days, a 15–66% conversion of radiolabeled MTBE to $^{14}CO_2$ due to microbial degradation was observed. Losses did not differ significantly among the various sediment types, suggesting that they all had some innate ability to degrade MTBE under aerobic conditions.

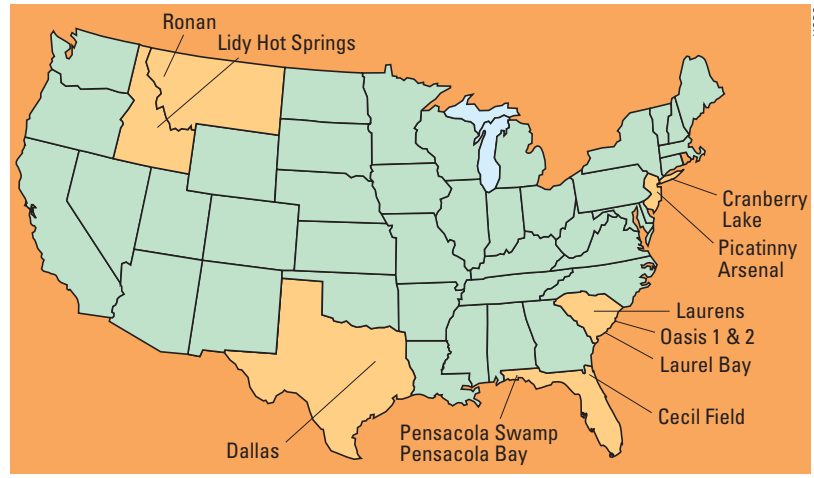
"This definitely differs from the picture that you see anaerobically," says microbiologist Joseph Suflita of the University of Oklahoma. "In any case, aerobic or anaerobic, degradation of MTBE is not a particularly fast process.

It is unclear whether MTBE is more likely to be found under anaerobic or aerobic conditions. MTBE is primarily associated with gasoline spills, "which to a bacterial population presents a smorgasbord," says Bradley. "The bacteria consume the oxygen, and the system tends to go anaerobic," he says. What makes things complicated is that MTBE is very soluble in water, whereas other gasoline components like BTEX are only marginally soluble. "It's not uncommon to see MTBE move out in front of an anaerobic plume. But how much MTBE actually makes it into the aerobic part of the system and how much remains in the anaerobic part is uncertain," he says.

"There are a number of people studying how to introduce oxygen into these anaerobic plumes. The problem is that it is resource-intensive. When it's economically not feasible, we are more or less limited to the natural capacity of the system to degrade MTBE," adds Bradley.

"We certainly don't see widespread biodegradation of MTBE," says Joseph Salanitro of Equilon Enterprises in Houston, TX, who believes that natural microbial populations will never be sufficient to clean up MTBE from gasoline spills. "You cannot sustain indigenous microbial populations on MTBE, like you can on benzene, because microbes do not grow well on MTBE. We have observed that aquifer bioaugmentation with specific cultures of high MTBE-degrading activity can control the advance of MTBE plumes," he says.

"The rate of MTBE degradation is really what is important," says Marc Deshusses of the University of



USGS scientists find great potential for MTBE biodegradation at 11 sample collection sites.

California–Riverside. "This study suggests that there is a potential for MTBE natural attenuation, but it's a question of how much MTBE is out there, how many microbes are there, how active they are, and how quickly you want to remediate the site," he says.

Although some researchers are skeptical that uncontaminated sediments contain microbes capable of degrading MTBE, Deshusses says it doesn't surprise him all that much. "MTBE hasn't been around that long in the environment, so the fact that it is biodegradable is not a result of evolution. It means that nature has a mechanism to degrade MTBE that was meant to do something else in the first place. We need to find the natural substrate for the MTBE-degrading enzymes," he emphasizes. "If this substance is found, you could then stimulate the enzymatic activity in situ."
—BRITT E. ERICKSON

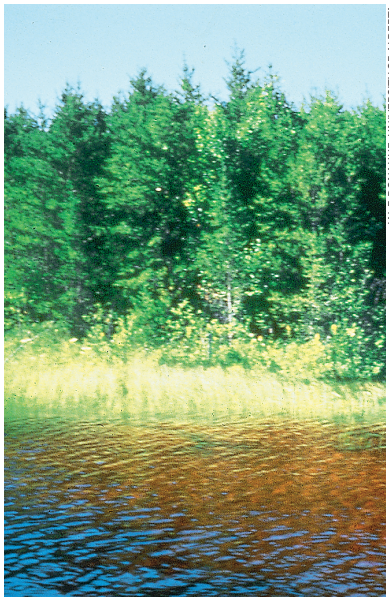
Drought and methylmercury loss

By stripping Canada's boreal lakes of their natural UV-light protection, drought and acid rain may help rid them of methylmercury, some scientists believe. But the situation is complicated because the increased UV penetration alters these lakes' plant and animal communities.

Drought and acid rain reduce the amount of UV-absorbing dissolved organic carbon (DOC) in lakes, says Dave Schindler, an aquatic ecologist at the University of Alberta. DOC is the decayed remains of plants and strongly absorbs UV light when flushed into lakes by rainfall, Schindler explains.

Over the past 30 years, prolonged droughts in Canada's northern boreal forest have kept DOC locked up in soil, robbing lakes of their natural sunscreen, Schindler told researchers at the Canadian Conference for Fisheries Research in January. Drought also boosts levels of sulfate deposited by acid rain, which dissolves DOC, he says. When wet soils dry out, their sulfur is oxidized and gets washed into lakes when rain returns (*Environ. Sci. Technol.* **1999,** *33* (17), 352A–353A).

As the amount of DOC in the water column decreases, sunlight penetrates farther, often doubling the depth of the warmest top layer of water. The effect of lowering levels of DOC on UV penetration is 10 times greater than that caused by destruction of stratospheric ozone, Schindler says.



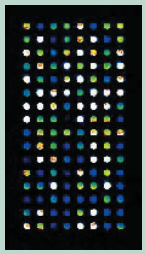
W. F. DONAHUE, UNIVERSITY OF ALBERTA

The yellow dissolved organic carbon was flushed into this boreal lake by a rainstorm.

Without protection from UV light, microscopic plants and animals at the base of the food chain are less likely to survive and reproduce because of damage to their DNA. Such declines could have an impact on the recycling of nutrients, Schindler says.

Government Watch

New era for environmental safety assessment



With the goal of identifying toxic substances more quickly, the National Institute for Environmental Health Sciences (NIEHS) established the National Center for Toxicogenomics in December. The center expects to slash the time and money needed to test potential carcinogens from $2–3 million over a two- to three-year period to under $500 within a few days, says NIEHS Director Kenneth Olden.

The National Center for Toxicogenomics intends to capitalize on recent advances in technology for studying the human genome. The "workhorses" of the new center, according to Richard Paules, director of Toxicological Gene Expression Studies for the NIEHS Microarray Center, will be the Human ToxChips developed by NIEHS scientists to compare genes that are activated by exposure to chemicals with genes that are active under normal conditions (*Environ. Sci. Technol.* 2000, *34* (11), 244A).

"Toxicogenomics represents a new era in safety assessment for environmental protection," Olden says, noting that most human diseases are now believed to be caused by gene–environment interactions. By "clearly demonstrating the links between specific toxicants and human disease, we'll … give regulators and legislators improved tools for designing pollution control laws," adds the new center's director, Raymond Tennant.

The center will also study the

Continued on Page 99A

DOC loss also has a profound effect on mercury cycling in lakes, says Patricia Sellers, a biogeochemist with the Centre for Indigenous Environmental Resources in Manitoba. Toxic methylmercury is broken down by sunlight, she explains. As more sunlight penetrates the water column, the rate of photodegradation of methylmercury increases, Sellers says.

This could be good news for fish and the predators that eat them, says David Krabbenhoft, a geochemist with the U.S. Geological Survey in Madison, WI. Methylmercury breaks down to gaseous elemental mercury, roughly 15% of which evaporates to the atmosphere, while the remaining 85% gets reoxidized to toxic inorganic mercury, he finds. The inorganic mercury fraction can be remethylated at a rate of 1–2% per day.

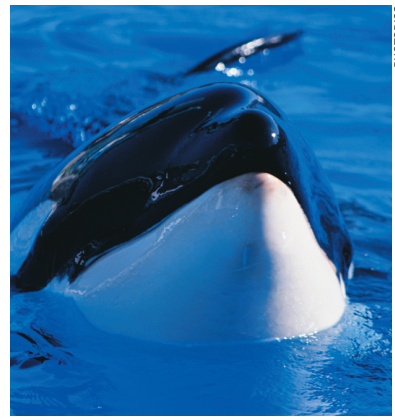
"If DOC declines and everything else stays the same, photodegradation should decrease the amount of methylmercury in the water column of lakes," Krabbenhoft says. But scientists don't know what happens to the elemental mercury that evaporates into the atmosphere. If it is redeposited at higher, cooler latitudes, photodegradation could just be dispersing the problem, he cautions.

From a global perspective, the loss of DOC from temperate lakes is an environmental concern, according to Schindler. Additional mercury deposition caused by loss of DOC further south could push mercury levels in indigenous people over the minimum threshold for health effects, he says. —JANET PELLEY

EPA to make PBT screening available

The U.S. EPA is set to launch a Web site this summer that uses a combination of modeling and databases to assess compounds for persistence, bioaccumulation, and toxicity (PBT), in a move that should dramatically increase the availability of PBT screening. The screening tool, called the PBT Profiler, is currently undergoing independent peer review, according to program manager Bill Waugh at EPA's Office of Pollution Prevention and Toxics in Washington, DC.

The PBT Profiler finds pollution prevention opportunities by identifying chemicals that may create problems in the environment, says Waugh. To protect business information, the Web site will be secure, and all information will remain confidential and private, he adds.



PHOTODISC

PBT chemicals accumulate in top predators like killer whales.

The EPA screening tool uses a collection of computer models. First, a quantitative structure–activity relationship model estimates important chemical properties, such as vapor pressure and water solubility, atmospheric oxidation rates, and biodegradation potential. Overall persistence is estimated by sending these data to a multimedia environmental fate model that determines where the chemical will accumulate and for how long. Bioaccumulation potential and aquatic toxicity are estimated using programs developed by Syracuse Research Corp., in Syracuse, NY.

Chemical company giants, such as DuPont, Procter & Gamble, and Dow Chemical are already using their own similar screening programs for existing chemicals. Now these companies are screening new compounds at their development stage to determine whether they are PBT chemicals. "We are trying to get R&D researchers to use this as they think about the implications of their developments," notes DuPont engineer Lynn Ann Dekleva. PBT screening at this stage marks the start of a new level of acceptance for such analysis, she adds. Screening results should not be considered exact, but they are useful in creating relative rankings or to target toxicity testing, says Dekleva.

The scientists also note that although there is broad agreement over what to measure to determine persistence and bioaccumulation, such a consensus does not exist for estimates of toxicity.

Linking iron with carbon sequestration

For the first time, scientists have quantified the link between atmospheric deposition of iron in particulate matter and biological activity in oceans, an important step in understanding how carbon flows between the atmosphere and oceans. The approach may help scientists follow how this relationship shifts in response to climate change.

Iron, together with nitrogen, phosphorus, and silicate, is an essential nutrient for microscopic phytoplankton, which remove as much CO_2 from the atmosphere as all terrestrial vegetation. Although researchers have known for years that some ocean areas have iron deficiencies, "nobody actually calculated out what this relationship might look like and took a stab at identifying those regions where it really does matter," says David Erickson, of Oak Ridge National Laboratory and primary author of the study, which he presented at the American Geophysical Union meeting in December.

To determine the correlation between iron deposition and biological activity, Erickson and his colleagues merged images of ocean surface chlorophyll concentrations from the U.S. National Aeronautics and Space Administration's (NASA's) OrbView-2 satellite with dust depo-

sition data derived from a satellite-based, three-dimensional atmospheric transport model. The model, which calculates where dust travels and falls by identifying the major sources of wind-blown dust such as deserts, was used to simulate atmospheric circulation patterns between 1995 and 1998. Because the model incorporates actual data on weather patterns from satellite weather observations, its global dust deposition estimates are more accurate than previous estimates, which typically use simulated circulation data.

"For every month and for every 2° by 2.5° latitude and longitude, we calculated a correlation coefficient," Erickson says. They found that the southern hemisphere, as well as a smaller region in the western North Pacific, exhibited significantly higher average correlation coefficients than those computed for areas in the northern hemisphere.

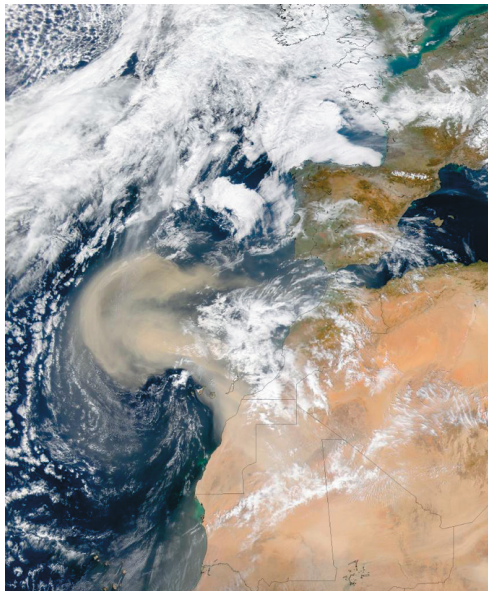
This finding is consistent with prevailing scientific thought that atmospheric iron deposition may play a role in iron-limited ocean surface biogeochemical cycles. The northern oceans are much smaller than those found in the southern hemisphere and have more surrounding landmasses from which they can receive inputs of iron through upwelling and from rivers emptying into coastal areas. Iron sources in the southern hemisphere are more limited.

Following the regional changes in the correlations may flag how the global carbon cycle is being affected by climate change. Climate change models suggest that the shape and location of deserts will change as CO_2 levels rise, Erickson says, which could affect where dust enters the atmosphere and is transported. Ultimately, these variations could alter the supply of iron to various ocean regions and affect their ocean biology.

Scientists could use these findings to determine whether adding more iron at particular iron-deficient locations could enhance phytoplankton growth, sequestering more carbon from the atmosphere in ocean sediments and organic pools in the water column.

This concept for sequestering carbon is currently receiving a lot of "hype", says Michael Behrenfeld, a NASA researcher and coauthor of the study, but he cautions against such an approach. "The total biomass produced by adding iron isn't equal to carbon sequestration because there are a lot of processes involved in the degradation of that carbon," he says. "It's not understood how ecosystems respond over a long period of time, so it's fairly naïve to think that you can make a manipulation like that and the only outcome is that you're going to suck up CO_2."

For now, Erickson says that the calculations could help guide field experiments. "If somebody wanted to go out and actually measure the chemistry, physics, and biology of the surface ocean, they could look at these maps and calculations to determine some of the most interesting places to go." —KRIS CHRISTEN



NASA/GODDARD SPACE FLIGHT CENTER

Intense sandstorms and rising warm air currents can lift dust laced with iron 15,000 feet above the Sahara Desert and carry it out across the Atlantic, often as far as the Caribbean.

Government Watch

proteins that cells express in response to exposure to potentially toxic substances, or functional proteomics.

Export credit still a race to the bottom?

The latest meetings held by the Organization for Economic Cooperation and Development on export credit agencies (ECAs) produced "a glimmer of hope" that some kind of agreement on common environmental guidelines can be reached by the G8 (Group of Eight industrialized nations) economic summit in June, but much work remains, according to sources close to the negotiations.

ECAs are publicly funded financial institutions that subsidize the goods and services of domestic companies, making it easier for them to export their products. These banks are now the single largest public financiers of large-scale infrastructure projects in the developing world and account for 8% of world exports, says Bruce Rich of Environmental Defense, a nonprofit organization linking science, economics, and law. Despite this influence, few ECAs have guidelines and safeguards in place to assess the environmental impacts of the projects they fund (*Environ. Sci. Technol.* 1999, *33* (15), 306A).

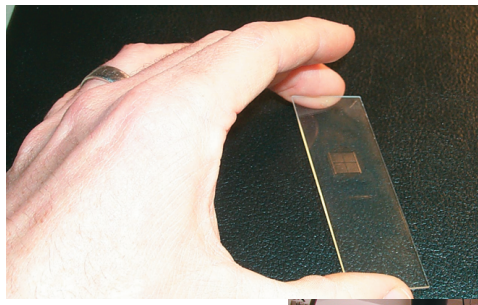
Ironically, the U.S. Export–Import Bank has been leading the push toward stricter environmental standards, whereas various European Union countries, which tend to be more protectionist on other international environmental concerns, such as global warming and the transfer of genetically modified organisms, remain staunchly resistant to implementing common environmental guidelines and adding more transparency to their lending practices.

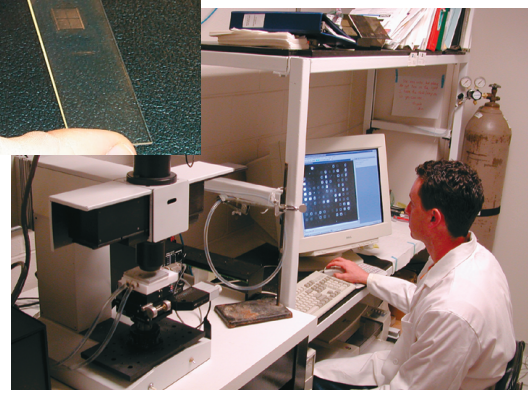
The Export–Import Bank, which adopted stringent guidelines back in 1992, has seen no loss of business beyond the Three Gorges Dam

Continued on Page 101A

News from the American Geophysical Union meeting

Biogeosciences made its formal debut at the AGU's 2000 Fall Meeting in San Francisco. The field itself is not new, as several chemists already call themselves biogeochemists, and biogeosciences has long been represented at AGU meetings, only under various other headings. This was the first time that AGU officially included biogeosciences as a separate section in its meeting program, reflecting growing recognition of the importance of biology in the geophysical sciences.





JOHN KELLY, NORTHWESTERN UNIVERSITY

John Kelly investigates microbial populations in sediments using DNA microarrays.

Given the biotechnology field's rapid growth, it shouldn't be too surprising that a talk on DNA microarrays was presented at the meeting. What are DNA microarrays doing in a geophysical world? As described by John Kelly, a postdoc in David Stahl's lab at Northwestern University, DNA microarrays offer a unique way to examine the impact of heavy metals on microbial populations. In particular, Stahl's group is characterizing microbial populations in lake sediment located near a zinc smelter in Lake DePue, IL.

In collaboration with the project, Bradley Jackson isolated and characterized several zinc-resistant anaerobic bacteria from the Lake DePue sediments. Comparative sequencing of ribosomal RNA (16S rRNA) revealed that these bacteria are affiliated with several novel groups of organisms that have not been previously isolated or described. "Using these sequences, we can then develop DNA microarrays containing probes targeting these novel groups," says Kelly. The arrays rapidly identify selected sections of DNA, providing evidence that a microbe is present.

The arrays from Stahl's lab are still in the developmental stage and haven't been field-tested yet, but they could offer a means of identifying hundreds or thousands of different microbial populations simultaneously, says Kelly. Eventually, they could allow for monitoring strategies with extensive coverage of microbial diversity.

Along similar lines, Khal Spencer of the University of Hawaii–Manoa is investigating the impacts of heavy metals on coral reefs. At the AGU meeting, he presented new evidence suggesting that the health of coral reefs should not be used as an indicator of water quality, especially in the case of lead contamination. Spencer and colleagues examined the transport and uptake of anthropogenic lead in juvenile fish otoliths, coral, and bay water samples from a reef community in Oahu. Nearly identical $^{206}Pb/^{204}Pb$ isotopic trends were observed in the otoliths and water samples, suggesting that they were in isotopic equilibrium with dissolved lead. The lead isotopic ratios observed in coral, however, did not follow the same trend as the water samples. Rather, the coral lead signatures were similar to those observed for particulate matter discharged from an urban watershed.

Low $^{206}Pb/^{204}Pb$ compositions are indicative of urban stream particulate matter; whereas high $^{206}Pb/^{204}Pb$ compositions are found in the ocean, reflecting lead derived from anthropogenic aerosols and natural eolian dusts, says Spencer. On the basis of their lead isotope measurements, "The uptake of lead by corals appears to be coming from sedimentary particles rather than dissolved lead," he concludes. As a result, the composition of lead in corals should not be used to assess lead concentrations in surrounding waters. —BRITT E. ERICKSON

PHOTODISC

The health of coral reefs may not reflect the quality of surrounding waters.

Green chemistry and beyond at Pacifichem

The American Chemical Society's takeover of the Green Chemistry Institute was arguably the most significant environmentally oriented announcement made at the Pacifichem meeting held in Waikiki Beach, HI, in December. The institute's acting director, Dennis Hjeresen, senior program manager for Los Alamos National Laboratory's Environmental Programs, vowed to facilitate the organization's international work in the spirit of the organization's founder, Joseph Breen, now that the organization is affiliated with ACS. The institute recently opened chapters in India, Australia, Estonia, and Italy.

Here is a selection of some of the other noteworthy environmental technology research presented at Pacifichem:

Korean researchers are building a pilot-scale reactor to evaluate the ability of bacteria to remove CO_2 and NO_x from the flue gas of a coal-fired power plant, says Jin-Suk Lee of the Korea Institute of Energy Research. Lee's team has shown that the *Chlorella KR1* bacteria can be maintained in a photobioreactor with actual flue gases and can take up 98 grams of CO_2/in^2. But the researchers are still trying to iron out some kinks in the process, such as how to keep the bacteria active in the cooler winter months. Lee said that his group has made considerable progress in their efforts to reuse the bacteria as a protein supplement for animal feed.

Japan's Gas Lift Advanced Dissolution (GLAD) technology for sequestering carbon may require too much energy to make its use economically feasible, according to M. Kuriyagawa of Japan's National Institute for Resources and Environment. The technology calls for injecting CO_2 gas into the ocean at depths of around 400 m (*Environ. Sci. Technol.* **2000,** *34* (19), 4140–4145) and is meant to work in conjunction with a 1000-MW power plant. But Kuriyagawa acknowledged that Japanese scientists still haven't worked out exactly how much energy the system will require. He also told attendees that Japan is increasing its use of geothermal power.

Scientists at Germany's Forschungzentrum Karlsruhe are developing a method to use CO_2 as a solvent for metal sludge recycling, reported Eckhard Dinjus, a professor at the school's Institute for Technical Chemistry. Because pilot-scale tests showed that the method produces "good results" for degreasing parts used for cutting processes, the German researchers are now demonstrating the process in a machining plant, Dinjus said. The Karlsruhe researchers are also investigating the use of CO_2 for a number of pharmaceutical industry processes, and they have developed a high-pressure reactor that they expect will enable them to synthesize complicated organic compounds using CO_2, Dinjus says.

Membranes with rougher surfaces are more likely to be associated with the fouling that can shut down drinking water treatment plants, said Colin Hobbs, a graduate student at the University of Central Florida. Both Hobbs and Menachem Elimelech of Yale University presented research conducted with data and source water from plants using membranes to treat water with different characteristics. The studies showed that surface roughness is a better predictor of the fouling that can shut down membrane treatment systems than two other widely studied membrane properties, zeta potential and hydrophobicity. Hobbs anticipates that this finding may prove universal even though drinking water characteristics vary considerably throughout the world, and he is currently working with membrane manufacturers to help them refine their designs.

Government Watch

project in China, says Dan Renberg, a member of the bank's board of directors. But the U.S. bank and nongovernmental organizations remain concerned about a potential "race to the bottom" as a consequence of what they perceive as an uneven playing field, with companies shopping around to secure the best deals without having to be concerned about possible adverse environmental impacts.

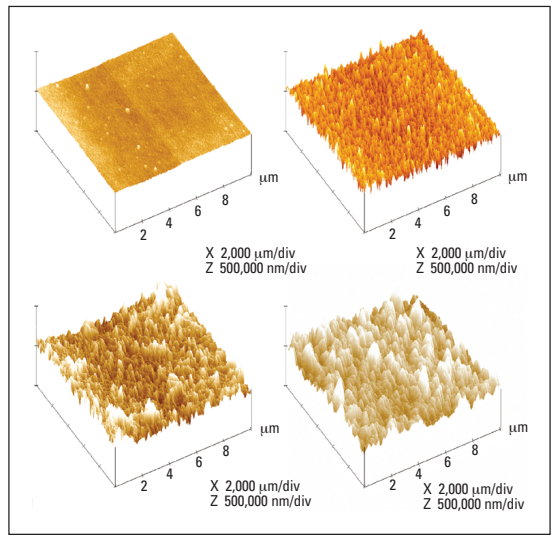
Worldwide coral reef protection

The United Nations Environment Programme (UNEP) announced in December that it has formed a new Coral Reef Unit that will implement "practical" strategies to protect coral reefs, one of the most endangered ecosystems in the world. Massive bleaching and death of coral have been linked to global climate change, and 58% of the world's reefs are threatened by overfishing, coastal development, and polluted runoff, the United Nations indicates.

UNEP's Coral Reef Unit will be a lead participant in the International Coral Reef Action Network (ICRAN), a U.N.-funded partnership of conservation and science organizations. Beginning this year, ICRAN will train local reef managers to apply conservation practices such as fishing limits and marine reserves, in combination with economic development, according to Arthur Dahl, director of UNEP's Coral Reef Unit.

The U.N. action came as a Clinton administration panel found that 27% of the world's coral reefs have been lost and 60% could be gone by 2030 if current trends continue. In December, the administration announced a final plan to establish a coral reef wilderness in the Florida Keys and approval by the International Maritime Organization for the first "no anchoring" zones around U.S. coral reefs in the Gulf of Mexico.

Oxygenated diesel gas can cut particulate emissions by 41% and decrease NO_x by 5%, according to Irshad Ahmed of Pure Energy Corp., the New York City-based company that developed the oxygenated blend of diesel and ethanol for use in the heavy-duty compression-ignition engines found in trucks and buses. Demonstration testing in 30 Chicago buses, which is expected to be completed this month, will show that the fuel also cuts CO emissions, Ahmed said. In addition, the fuel is readily biodegradable, reduces engine wear, and improves cold-temperature performance. Although the new fuel contains 16–20% less sulfur than "base diesel", it does not meet the new sulfur levels for diesel that the U.S. EPA announced in December. Ahmed says that the sulfur ruling will not impact his company's ability to sell the oxygenated diesel because the fuel will meet the agency's more stringent particulate matter emissions requirements. EPA registered the fuel in December, and Pure Energy is preparing to commercialize it.



UNIVERSITY OF CENTRAL FLORIDA AND YALE UNIVERSITY

New analyses show that membranes with rougher surfaces (as shown in these images made with atomic force microscopy) are more likely to become fouled when used to treat source waters with either high organic content or high colloidal content.

Researchers at Canada's Trent University are developing software for assessing the potential environmental fate of otherwise untested chemicals, according to Don Mackay of the university's Canadian Environmental Modeling Center, who has published research about his models in *ES&T* (**2000,** *34,* (4) 699–703). Other researchers are also trying to build software to project a chemical's likelihood of being persistent, bioaccumulative, or toxic. The version of the Canadian software demonstrated at Pacifichem required quite a bit of data input, but its method of evaluating a substance's potential for long-range transport sets it apart. The program is expected to debut in January 2002.

The popularity of microscale chemistry is growing in China, where more than 1000 schools and universities are now using this waste-avoiding method in chemistry education, according to Ning-Hua Zhou of the HangZhou Teachers College. He says that microscale chemistry "is very important to the Chinese because it helps students appreciate how important it is to protect the environment." The Chinese Chemical Society established the Chinese Microscale Chemistry Center in 1999, and Zhou said the organization's next major challenge is to change the mindset of chemical technicians. In a companion session, Robert Silberman of the State University of New York–Cortland reported that using microscale chemistry reduces the costs associated with conducting the experiments for an undergraduate chemistry class by an order of magnitude.

Glaze to chair EPA's Science Advisory Board

Congratulations to *ES&T*'s very own Bill Glaze, who was appointed to serve as chair of the U.S. EPA's Science Advisory Board (SAB) in January. Glaze is currently a professor of environmental sciences and engineering in the School of Public Health at the University of North Carolina–Chapel Hill. In addition to being the editor of *ES&T*, a position that he has held for 13 years, Glaze has served on several advisory committees, including the National Academy of Science's Committee on Drinking Water Activities and the U.S. Department of Energy's Environmental Management Science Committee. Glaze began his extensive history with the SAB in 1982 as a consultant to the Environmental Engineering Committee, and shortly thereafter, he moved up through the ranks, becoming the first chair of the SAB's Drinking Water Committee in 1989.

Annual emissions of smog-causing nitrogen oxide (NO_x) in the United States have increased by 3.5 million tons since 1970, according to Environmental Defense, a nonprofit organization. Over the same period, Clean Air Act regulations slashed airborne pollution of lead by 98% and particulate matter by 71%. Large diesel-powered trucks and buses, nonroad engines, and power plants are responsible for 53% of NO_x emissions. The report recommends that EPA impose nationwide, year-round cuts in NO_x emissions from power plants. *Building on 30 Years of Clean Air Act Success: The Case for Reducing NO_x Air Pollution* can be found at www.environmentaldefense.org/programs/GRAP/CAAReport.pdf.

As much as one-third of the nitrogen found in coastal streams flowing into U.S. estuaries comes from rain and airborne particles, according to a study by the U.S. Geological Survey, the National Oceanographic and Atmospheric Administration, and Texas A&M University's Blackland Research Center. The study, which looks at watersheds draining into 40 major estuaries, also confirms that much of the nitrogen comes from nonatmospheric sources such as agricultural runoff and municipal and industrial wastewater. For more information, go to http://water.usgs.gov/nawqa/sparrow/coast/agu_sparrow.html.

"Climate changes in this century may have serious implications for U.S. water resources," concludes a report from the nonprofit Pacific Institute and the U.S. Department of the Interior. According to the report, the buildup of anthropogenic greenhouse gases over the past century has increased the average temperature 0.67 °C in the United States. "This has already resulted in substantial thawing of the permafrost in the Alaska Arctic and unprecedented melting of mountain glaciers, an increase in sea level of 10–20 cm, and an alteration of water runoff patterns." *Water: The Potential Consequences of Climate Variability and Change for the Water Resources of the United States* is available at www.pacinst.org/naw.html.

PHOTODISC

Demographics, environment, and natural resources will be the most important drivers shaping global conflicts in 2015, according to a report released this month by the National Intelligence Council. *Global Trends 2015: A Dialogue About the Future With Nongovernment Experts* predicts that "water scarcities and allocation will pose significant challenges to governments in the Middle East, Sub-Saharan Africa, South Asia, and northern China," and that "regional tensions over water will be heightened by 2015." The report also prognosticates that "biotechnology will drive medical breakthroughs that will enable the world's wealthiest people to improve their health and increase their longevity dramatically." For a copy, go to www.cia.gov/cia/publications/globaltrends2015.

The ecological condition of rivers, lakes, and wetlands in Bulgaria, Estonia, Hungary, Slovakia, and Turkey is equal to or better than that found in comparable water bodies in the European Union (EU), according to a study by the World Wide Fund for Nature. Consequently, these countries may have fewer difficulties than expected in complying with the EU's Water Framework Directive (*Environ. Sci. Technol.* **2000,** *34* (17), 375A). *Water and Wetland Index: Results for Five Accession Countries* can be accessed at www.panda.org/europe/freshwater.

As much as one-third of Europe's soil is suffering from degradation due to competing economic interests from agriculture, households, industry, transport, and tourism, concludes a report by the European Environment Agency and the United Nations Environment Programme. Primary problems include irreversible losses from erosion and the paving over of many surfaces, contamination, and soil acidification. *Down to Earth: Soil Degradation and Sustainable Development in Europe* recommends a Europe-wide soil monitoring and assessment system as a first step toward framework legislation to protect soils. For more information, go to http://themes.eea.eu.int/binary/e/envissue15.pdf.

The quality of the world's forests is decreasing in tandem with the ever-shrinking quantity of forest land, according to a report from the nonprofit World Resources Institute. Although forested areas in developed countries continue to increase slightly, clearance for agriculture, development, and logging are reducing forest acreage by at least 140,000 km^2 every year. *Pilot Analysis of Global Ecosystems: Forest Ecosystems* argues that commercial forestry leads to significant changes in the ecology of forests because trees tend to be younger, smaller, and more uniform in species composition. The report is available at www.wri.org/wr2000/forests_page.html.

The U.S. government should establish an ocean exploration program, initially for a 10-year period, with an annual budget of $75 million, concludes the President's Panel for Ocean Exploration in its report, *Discovering Earth's Final Frontier: A U.S. Strategy for Ocean Exploration*. The report lays out the first U.S. national plan for an ocean exploration program, the centerpiece of which is "circumnavigation, from pole to pole," says Marcia McNutt of the Monterey Bay Aquarium Research Institute, who chaired the