Environment

Ironing away a greenhouse wrinkle

An unusual strategy for slowing global greenhouse warming – fertilizing the Antarctic Ocean with iron – has received mixed reviews from scientists exploring its feasibility. While one group suggests that fertilization won't do the trick, others say their initial research indicates it might appreciably slow carbon dioxide buildup in the atmosphere, although they caution that scientists must still address many basic questions about the strategy, including its potential to alter the ocean ecosystem.

Oceanographers at the Moss Landing (Calif.) Marine Laboratories suggested last year that the Antarctic Ocean's unusually low concentrations of single-celled plants called phytoplankton result from an iron deficiency that keeps these organisms from making full use of the rich supplies of available nutrients. If so, the team theorized, fertilizing the waters with iron could enhance phytoplankton photosynthesis – an effect that would pull large amounts of carbon dioxide from the atmosphere, helping to counteract the buildup of this greenhouse gas.

Now a thumbs-down response comes from Tsung-Hung Peng of the Oak Ridge (Tenn.) National Laboratory and Wallace S. Broecker of Columbia University's Lamont-Doherty Geological Observatory in Palisades, N.Y. Using a computer model of the world's oceans, these researchers found that currents bring water to the region too slowly for the fertilization scheme to make a significant difference. If their model is correct, a century's worth of iron fertilization would reduce the global concentration of atmospheric carbon dioxide to a level only 5 to 15 percent below what it would be without fertilization, they say. "Even if iron fertilization worked perfectly, it would not significantly reduce the atmospheric CO_2 content," they assert in the Jan. 17 NATURE.

Jorge L. Sarmiento, a mathematical modeler at Princeton (N.J.) University, argues that a 15 percent reduction would represent a significant effect, dramatically slowing the rise in carbon dioxide. What's more, he told SCIENCE NEWS, his computer simulations indicate that fertilization would lower carbon dioxide levels by about double the amount calculated by Peng and Broecker.

Nonetheless, he says, "it's very unlikely that iron fertilization will have practical applications." For one thing, oceanographers don't know whether an iron deficiency really limits the Antarctic phytoplankton population; indeed, that theory runs counter to traditional thinking about the region's ecology. And even if the strategy could lower carbon dioxide levels, its cost might be prohibitive; once begun, the treatments would have to continue forever. Moreover, scientists express concern that fertilization could disrupt aquatic ecosystems – a threat that hasn't escaped environmentalists, who vehemently oppose the strategy. Environmentalists and other critics also worry that the fertilization prospect might derail crucial attempts to control the world's use of fossil fuels, the source of most carbon dioxide pollution.

"This is not to be viewed as a fix-it or cure-all to the CO_2 problem," says Oskar R. Zaborsky, director of the National Research Council's board on biology. Even if fertilization worked, he says, it could not replace other actions such as energy conservation.

He says scientists are proceeding with caution on the iron question: "No one is suggesting initiating a treatment process at this time." Researchers are planning ship-board and laboratory experiments and are even discussing a small-scale field study in which they would fertilize about 400 square kilometers of the Antarctic Ocean. Ecologists and biologists say an experiment of this size would not harm the aquatic system, Zaborsky adds.

Space Sciences

Why three planets radio the sun

When the solar wind, a continuous outpouring of electrically charged particles from the sun, collides at supersonic speed with the magnetic field of a planet, it creates a shock wave on the sunward side. This in turn triggers the emission of radio waves that radiate back toward the sun. The widths of the arc-shaped shock waves responsible for the radio signals from the solar system's inner three planets – Mercury, Venus and Earth – vary widely. The signals themselves, however, are quite similar, according to a new analysis of spacecraft data more than 10 years old.

Earth and Mercury owe their shock waves to magnetic fields generated by the dynamo at each planet's spinning core, says Chris T. Russell of the University of California, Los Angeles. He and two graduate students coauthored the analysis, which appears in the December GEOPHYSICAL RESEARCH LETTERS. The width of Earth's shock wave is about 10 times the planet's diameter. Owing to Mercury's roughly 50 percent smaller size and weaker magnetic field, its shock wave is only 5 percent as big as Earth's.

Venus, nearly Earth's twin in size, derives its weak magnetic field from a far different mechanism: the collision of the solar wind and that planet's upper atmosphere. The resulting shock wave is only about 10 percent as wide as Earth's.

Sunward-radiating radio waves spawned by these vastly different-sized shock waves share a number of common properties, the space physicists found. For instance, all radiate at extremely low frequencies – about 1 to 3 cycles per second. They also leave the shock wave around each planet at approximately the same range of angles. And the amplitudes or strengths of the radio signals – which naturally decrease with distance – appear comparable when measured at about the same distance from their source.

The new analysis also appears to have answered a long-standing question about which type of solar wind particles trigger the radio waves: negatively charged electrons or positively charged particles such as protons (ionized hydrogen atoms).

Previous studies, including one by Russell himself, had suggested that the solar wind ions took a "left-handed" spiral around the planetary magnetic field lines that captured them – a sign that the ions were positively charged. But in the new report, Russell's team concludes that the spiraling only *appeared* left-handed owing to the spacecrafts' motion relative to the solar wind. By analyzing the spiral's direction with respect to the flowing solar wind, they have now determined that it's actually right-handed, Russell says. This indicates the radio waves are really spawned by electrons, his team now reports.

An asteroid's offspring

Three classes of meteorites, all made of basalt but differing in other mineralogical details, may come from three asteroids that originally formed a single large asteroid. The three meteorite types – the eucrites, howardites and diogenites – came from an asteroid big enough for its surface rock to melt, possibly from the heat of radioactive elements inside it, concludes a team headed by Dale P. Cruikshank of NASA's Ames Research Center in Mountain View, Calif., in the January ICARUS.

The team suggests that a "parent" asteroid shattered in a collision with another such chunk, forming three smaller asteroids now known as 3551, 3908 and 4055, whose orbits carry them near Earth. Cruikshank's group found the similarity between the meteorite classes and the three asteroids by comparing laboratory studies of the meteorites with infrared spectral measurements and other observations of the asteroids, made with NASA's Infrared Telescope Facility on Mauna Kea, Hawaii.