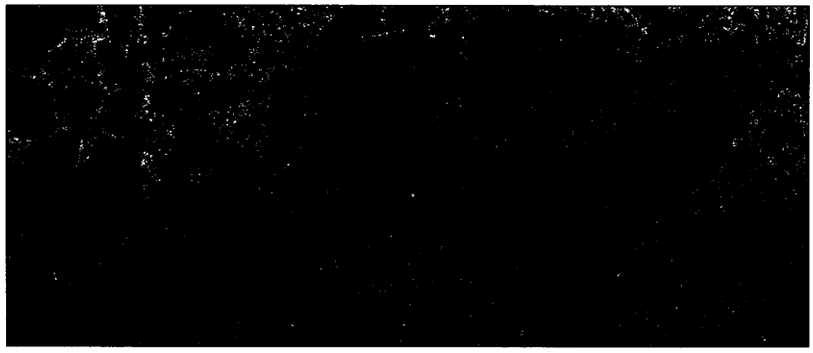
In a paper on page 1132 of this issue of *Science*, marine geochemist Wallace Broecker of Columbia University's Lamont-Doherty Earth Observatory in Palisades, New York, and his colleagues argue that the renewal of deep waters by sinking surface waters near Antarctica has slowed to only one-third of its flow a century or two ago, while deep water formation in the North Atlantic—the site of the other river—remains high. "The whole concept that deep water circulation could have changed that much is mind-boggling," says Broecker, who adds that, far from being a onetime event, the slowdown may recur in a 1500-year cycle.



Less deep water? Freezing of Antarctica's Weddell Sea, seen here in a radar image (45 kilometers across), helps send water into the abyss, but the process may have slowed.

CREDIT: JPL/NASA

This huge, climate-altering change in the oceans—if it's real—would greatly complicate attempts to understand how the ocean and climate are responding to another influence on climate, the buildup of greenhouse gases in the atmosphere. "It's a really interesting and provocative idea," says ocean circulation modeler Jorge Sarmiento of Princeton University, "but I'm very uneasy about the calculations. I find the paper more of a stimulation to further work than what I could accept as proven fact."

Directly measuring the flow of surface waters into the deep sea is impractical. Instead, researchers examine easily measured, indestructible "tags," some natural and some manmade, that join surface water before it becomes denser and sinks into the abyss. One tracer, the sum of the phosphate and oxygen in seawater, should remain constant as water sinks into the deep sea. In data collected by other researchers, Broecker found that this tracer, called PO_4^*, is high in newly formed deep water near Antarctica and relatively low in newly formed deep water in the northern Atlantic. Throughout the deep Indian and Pacific oceans it is at intermediate levels, suggesting to Broecker that these deep ocean basins have received about equal amounts of water from each source during the past 800 years or so.

Another tag, radioactive carbon-14, also supports equal roles for the two deep-water source regions over the last millennium, according to Broecker's analysis. Surface water heading down absorbs carbon dioxide, including carbon-14 formed in the atmosphere by cosmic rays, and carries it along toward the bottom. Broecker analyzed carbon-14's distribution throughout the world ocean and concluded that about 15 million cubic meters of water per second (15 Sverdrups) has been sinking into the deep sea at each source during the past 800 years.

But tracers that gauge deep water formation over decades rather than centuries seem to show that the southern source is now much smaller than the northern one. Physical oceanographers have long believed that the principal southern source of deep water, in the Weddell Sea, now supplies no more than 5 Sverdrups, judging by heat and salt content. And Broecker finds further evidence in a new study of water in the Southern Ocean, near Antarctica, by physical oceanographer Alejandro Orsi of Texas A&M University, College Station, and his colleagues. They looked at the distribution of the pollutant chlorofluorocarbon-11 (CFC-11), which first entered the environment a few decades ago. To Broecker, the study implies that the southern source has generated only 4 Sverdrups of new deep water during the past few decades. In the north, on the other hand, other CFC-11 studies support 15 Sverdrups, says Broecker.

Why should the sinking of seawater into the deep sea have slowed recently in the south? Broecker doesn't know, but he sees a parallel between the apparent recent slowdown and more drastic variations in ocean circulation during a sharp cold snap 11,000 years ago. As recorded in Atlantic sediments, deep water formation in the north slowed or halted. Because warm water normally flows northward to replace the sinking surface water, the shutdown chilled much of the Northern Hemisphere; meanwhile water began sinking faster in the south, warming the region. Something similar might have happened in the 500-year Little Ice Age, which ended around 1880, says Broecker. Since then, deep water formation in the south would have slowed. And because some suspect that the Little Ice Age is only the latest swing in a 1500-year climate cycle (*Science*, 27 February 1998, p. 1304), further changes could be in store.

Broecker's ideas are "always interesting," says marine geochemist Richard Gammon of the University of Washington, Seattle, "and he's right often enough that people have to pay attention." Physical oceanographer Arnold Gordon of Lamont is certainly paying attention. However, he and Orsi don't think Broecker has the evidence to back up his claim. By their reckoning, true deep water formation is currently equal north and south at about 5 Sverdrups. In his accounting of deep water formation, they say, Broecker includes waters that never get very deep or are picked up by new deep water as it sinks.

Broecker isn't worried about the cautious reception. "I don't expect people to accept at face value what I say." The important thing is that "the Little Ice Age is going to get more attention," he adds. "If I'm right, it has enormous consequences." Sorting natural climate oscillations from anthropogenic greenhouse warming would become more difficult. The ocean might lose some of its ability to draw off greenhouse gases and stash them away in the depths. And future change could become even harder to predict. As Sarmiento says: "It's a very interesting speculation; it's also disconcerting. If we want to understand the next 100 years or 200 years, we really need to understand what is going on with long-term cycles."

–RICHARD A. KERR

AIDS

European Vaccine Effort Faces Chinese Puzzle

PARIS—During an international AIDS meeting here last week, a group of researchers quietly met to plan a 3-year, $9.2 million European Union–backed effort to develop an AIDS vaccine. The new initiative, called EuroVac, is expected to begin on 1 January and will mark the first time the EU has attempted to pull Europe's top AIDS researchers together into a unified vaccine drive. Yet though the contracts between the EU and the researchers are still being negotiated, the initiative has already become tangled in international AIDS vaccine politics. Some members of the EuroVac scientific team were surprised to learn last week that one of the project's potential ambitions—to test vaccine candidates in China, where the AIDS virus is spreading rapidly—may duplicate similar efforts under way by virologist David Ho, director of the Aaron Diamond AIDS Research Center in New York City.

The EuroVac project, which is co-chaired by virologists Jaap Goudsmit at the Universi-

ty of Amsterdam and Marc Girard at the Pasteur Institute in Paris, will begin with phase I trials to compare the ability of several different vaccine preparations to elicit immune responses against HIV. The European team will test how well two different types of genetically engineered vaccinia viruses—one called MVA and the other NYVAC—serve as noninfectious vectors to present four key HIV proteins to the immune system. In each case, this "prime" will be followed by a "boost" vaccine preparation consisting of HIV's envelope protein, the main component of its outer coat.

In addition, the trials will mix and match proteins from two major clades, or subtypes, of HIV: clade B, which predominates in North America and Europe, and clade C, which now accounts for about 40% of new HIV infections in the world and is particularly rampant in China and India. The mix-and-match strategy should eventually allow researchers to determine whether a vaccine against clade B would also be effective against clade C and vice versa, once they are tested in full-fledged efficacy trials. "EuroVac is quite innovative," says team member Giuseppe Pantaleo, an immunologist at the Vaudois Hospital Center in Lausanne, Switzerland. "For the first time we will be comparing MVA and NYVAC with four major viral proteins, and it's the first time we will be trying to get cross-clade immune responses."

But it is EuroVac's plans to test a clade C vaccine that have provoked the sparring over turf. The clade C HIV on which the vaccine is based was provided by Hans Wolf, a virologist at the University of Regensburg in Germany, who obtained the viral strain from colleagues in China. In the meantime, Ho, who has his own contacts in China, has prepared a clade C vaccine using a somewhat different strategy, which uses both an MVA vaccine and a "naked DNA" preparation that delivers HIV genes directly to the body. Ho has been quietly talking with Chinese health authorities about testing his vaccine in China and has also been discussing funding with the New York–based International AIDS Vaccine Initiative (IAVI)—a private organization funded by numerous major foundations as well as the World Bank and the British government.

Wolf and Ho learned of each other's efforts only fairly recently. Wolf argues that the efforts are duplicative and criticizes IAVI for funding what he sees as a competitive study. "I would have nothing against it if someone like David joined in our trial," Wolf told *Science*. "But now IAVI is running around the world and putting money into a competing thing; this is irresponsible." Ho counters that "it is not unusual that multiple groups pursue the same objective" and adds that the differences between the two vaccine strategies might argue for comparing their effectiveness in parallel clinical trials. An opportunity to resolve this conflict may be at hand, however: Later this month, a Beijing meeting co-sponsored by IAVI will bring together representatives of the Chinese ministry of health, NIH, and IAVI, as well as one or two members of the EuroVac team.

Viral immunologist Wayne Koff, IAVI's vice president for research and development, says that the clade C vaccines developed by EuroVac and Ho are only two of a number of possible preparations that could go into preliminary clinical trials in China, where more than 400,000 people are estimated to be infected with HIV. IAVI's basic strategy—to accelerate development of the most effective vaccine candidates—could well mean that it would end up funding a "head-to-head" comparison of the two vaccines. But whether either vaccine will ultimately end up a finalist, he adds, it "is too early to say."

Team Europe. Virologists Jaap Goudsmit (top) and Marc Girard are co-chairing the EU's first concerted AIDS vaccine effort.

–MICHAEL BALTER

CREDITS: (TOP TO BOTTOM) CHARANIS CHIU/HONG KONG ASTRONOMICAL SOCIETY; MICHAEL GLUCK; ALAIN BUU/GAMMA LIAISON

ScienceScope

Leonid Fever Meteor watchers are planning an all-nighter for 17 November, when Earth will plow through the debris left behind by Comet Tempel-Tuttle. The comet zipped through the solar system last year, and astronomers expect rare Leonid meteor storms this year and next. While last year's crop of Leonids provided some spectacular fireballs, they fell short of a first-class storm. This time, experts say the fireworks should have more pop.

That prospect has researchers dispersing to far-flung locales to observe the storm. For instance, Peter Brown, an astronomer at the University of Western Ontario, is leading an expedition to the Canary Islands funded primarily by the U.S. Air Force, which hopes to glean insights into how to better protect its satellites. Other prime sites include Europe and West Africa, says Donald Yeomans, an astronomer at the Jet Propulsion Laboratory in Pasadena, California, who predicts peak meteor watching will occur at 01:48 Universal Time on 18 November.

Nobel Switch French research minister Claude Allègre is lucky that France has so many talented physicists. When Nobel laureate Claude Cohen-Tannoudji resigned on 13 October from the nation's National Science Council, it took Allègre just 2 weeks to find another Nobel-winning replacement. Last week, the minister named physicist Georges Charpak of the CERN accelerator center near Geneva to fill the empty slot.

But Allègre may need to do more than pull Nobelists out of a hat to end grumbling on the 27-member council, which prime minister Lionel Jospin created in 1998 to advise the government on research priorities. Allègre "confused [meetings of] the National Science Council with a press conference," Cohen-Tannoudji groused to the French daily *Le Figaro* after quitting. "He came to expound on decisions that he had already made."

Allègre can expect a somewhat more sympathetic ear from Charpak. Last month, Charpak was one of six Nobelists who signed a letter supporting the minister's overall research strategy.

Correction Last week's ScienceScope item "Upwardly Mobile" overstated the U.S. gross domestic product. It is $8.8 trillion.

Contributors: Jeffrey Mervis, David Malakoff, Andrew Lawler, Michael Balter