

a graduate student in the Deisseroth lab who spearheaded the technique. The neurons can be recorded while the animal runs in place on a ball or learns different tasks in a virtual reality environment.

Similarly, in zebrafish, whose nerve cells are visible through largely transparent flesh, the technique allows the activity of individual neurons to be monitored as a fish swims and learns to avoid certain

areas or go to others containing rewards. The technique promises to track real-time activity in major brain structures known to influence behavior, says Mehmet Fatih Yanik, a neuroscientist and engineer at the Massachusetts Institute of Technology in Cambridge. “I think it will be adopted very rapidly by other labs, including my own.”

Warranted or not, enthusiasm for the new techniques is irrepressible. “I won’t

ever stop doing this,” says Kasthuri of his electron microscopy work. “I’m going to try to convince every person I ever meet that this is the way to do this.” The young researchers clustered around Deisseroth’s posters clearly felt similar excitement: At 5 p.m. on Wednesday night, at the tail end of a weeklong conference, security had to shoo them out of the building.

—EMILY UNDERWOOD

CLIMATE CHANGE

Humans Fueled Global Warming Millennia Ago

People were already pumping greenhouse gases into the atmosphere 5000 years before the Industrial Revolution, air bubbles in Antarctic ice suggest. The new evidence—in part from an exceptional record of atmospheric methane freshly cored from the West Antarctic Ice Sheet—supports a paleoclimatologist’s provocative idea that humanity began

of previous glacial periods. But then, about 5000 years ago, methane began to rise in a way that no one could explain.

Delving into the archaeological literature, Ruddiman noted that the methane increase occurred at about the same time as people started cultivating rice in what were essentially manmade, methane-producing wetlands. The

purely natural, so lone ice cores couldn’t give Ruddiman’s hypothesis a rigorous test. Then geochemist Logan Mitchell, now at the University of Utah in Salt Lake City, and colleagues decided to compare the methane trapped over time in two ice cores: one retrieved from Greenland in the 1990s and the other from the West Antarctic Ice Sheet in late 2011—the best record so far from the Southern Hemisphere. Because air circulation tends to be confined within one hemisphere or the other, atmospheric methane produced in one is slow to spread to the other. So methane concentrations can differ between the north and south in ways that reflect the relative sizes and locations of sources.

The results, reported on page 964, show that from 2800 to 600 years ago—the period most easily tested—atmospheric methane rose 17%. Levels started out higher in the Northern Hemisphere, as they are today, but they rose in tandem so that the north-south difference remained unchanged. Natural wetlands could have driven the global rise in the Southern Hemisphere, but Mitchell and his colleagues found a need for a human source—presumably Ruddiman’s expanding rice cultivation—to drive the rise in the Northern Hemisphere.

“Fully one or the other [source] wouldn’t fit the data,” says ice-core paleoclimatologist Eric Wolff of the University of Cambridge in the United Kingdom. “They end up with a bit of both, which is probably okay. It’s reasonably persuasive.”

Ruddiman himself is encouraged. The community’s attitude “is changing slowly,” he says, adding that “it’s in the right direction.” But he notes that modelers have failed to show how natural processes on their own could have boosted methane, much less carbon dioxide, thousands of years ago. Even in the early days of global warming, he thinks, humans must have been the major force.

—RICHARD A. KERR



Closer look. An exceptionally detailed Antarctic ice-core record shows that expanding rice cultivation, plus natural forces, kicked off global warming 5000 years ago.

warming the world early, as methane bubbled out of early rice farmers’ paddies.

Paleoclimatologist William Ruddiman, now a professor emeritus at the University of Virginia in Charlottesville, proposed his early-warming hypothesis 10 years ago after studying ice core records available at the time (*Science*, 16 January 2004, p. 306). Bubbles of ancient air, trapped when fallen snow turned to ice, showed that methane levels declined as the last ice age was ending 10,000 years ago—just as they had done at the end

coincidence suggested humans were behind the rise. And 8000 years ago, another greenhouse gas, carbon dioxide, also began rising suspiciously—perhaps because early farmers were clearing forests for agriculture. Together, Ruddiman calculated, the added greenhouse gases could have warmed the world by 0.8°C, about as much as humans have warmed the world over the past century or two.

Skepticism was widespread in the paleoclimate community. Methane molecules don’t come labeled as human-generated or