

**In 1881, a land speculator named Charles Dana Wilber wrote a book called *The Great Valleys and Prairies of Nebraska and the Northwest*, in which he, stumping for western settlement, coined a phrase: “Rain follows the plow.”**

**T**HE PHRASE CAPTURED A POPULAR THEORY—that homesteading and farming could change the climate of the arid West, increasing rainfall and turning the Great American Desert, as it was known, into a verdant paradise.

The idea, though lyric, turned out to be false. But scientists—as well as farmers, water managers, and urban planners—remained intrigued by the notion that soil and rain are somehow linked. Now two scientists using comprehensive satellite data and sophisticated statistical techniques have proved that the two elements do influence each other—but in an unexpected way.

The research, published in May 2016 in the

journal *Science*, finds, as expected, that damp soil in the western United States indicates a higher probability of rain the next day. But surprisingly, the opposite is true in the eastern United States, where dry soil today means rain is more likely tomorrow.

“People have looked at this link between soil moisture and rainfall for a long time,” says Guido Salvucci, a College of Arts & Sciences professor of earth and environment and coauthor of the *Science* paper. “But we felt like scientists didn’t necessarily use the right statistical techniques, and they also didn’t have as high quality and long a data set as we had. So we revisited it.”

Samuel Tuttle (GRS’11, ’15),

► Researchers Guido Salvucci (left) and Samuel Tuttle used satellite data and statistics to probe the link between soil moisture and future rainfall.

a postdoctoral research scientist in civil and environmental engineering at the University of New Hampshire, began the work as a PhD candidate under Salvucci. After completing a project examining soil moisture data from NASA’s *Aqua* satellite, Tuttle decided to take the work one step further.

“We had this nice satellite data set of soil moisture, nine years long, every day from 2002 to 2011,” says Tuttle. He decided to use the data in a new way, “to

Damp soil in the western United States indicates a higher probability of rain the next day. But the opposite is true in the eastern US, where dry soil means rain is more likely tomorrow.

# When Earth Speaks to Sky

Research connects soil moisture to next-day rainfall / BY BARBARA MORAN







diagnose the relationship between soil moisture on one day and rainfall on the next day.”

In the past, scientists had found a connection: it seemed that wet soil led to a higher probability of rain the next day. But Tuttle and Salvucci were skeptical. After all, rain can fall for many reasons: because moist air moved in from the ocean, or because a storm blew in from the mountains, or because of seasonal variations.

To figure out the effect of soil—and soil alone—on rainfall, Tuttle and Salvucci had to use a statistical technique called Granger causality, which cancels out every other factor. The results surprised them.

As other scientists had speculated, damp soil did predict a higher probability of rain the next day, but only in the arid West. The scientists aren’t exactly sure why this is the case, but they have some suspicions. “There are two main things you need to get rain,” says Tuttle. “You need water—moisture—and you need energy to lift that moisture into the air so it can condense into clouds.”

The West has solar energy to spare, says Tuttle, which heats the air into rising thermals that can lift water. “So, when you do get that moisture in the soil, that moisture can then evaporate, rise, and condense into clouds and rain.”

On the East Coast, with cooler and damper air, things are different. “It’s always humid in North Carolina,” says Salvucci. “But if you actually get drier soils for a few days, that’s when you get the thermals, which can then take that humid air, lift it up, and give you clouds.”

The researchers’ findings contribute to our overall understanding of weather, climate, and drought, and they may serve as a good check on climate change models. But here’s the real question: Can we use this information to summon rain when we want it, or make it go away? Unfortunately, no.

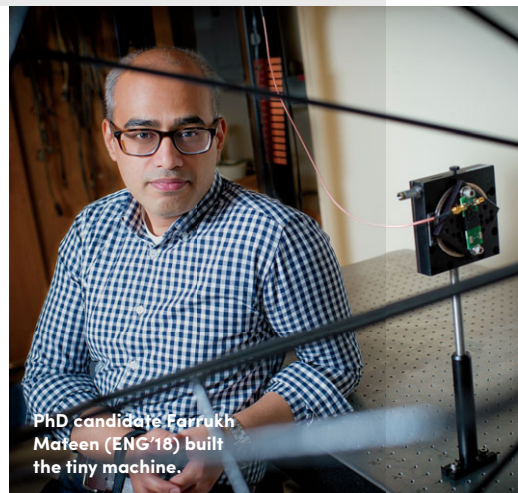
“One of my neighbors said, ‘Hey, I’m going to send my kids out into the backyard to pour water on the ground, because we’re in the East, so that way we’ll have a nice dry summer,’” recalls Salvucci. “But no, I don’t think so.”

## IN PROGRESS

### Menstrual Cycle Linked to Fertility? How Two Regions of the Brain Communicate.

#### MICROMACHINES GO WIRELESS

Miniscule machines are at work all around us. Accelerometers in our cars, for example, sense a collision and tell the airbags to inflate. The machines are attached to, or very close to, a power source. For broader applications, like wireless brain implants, scientists need power from a distance. BU researchers have built a tiny micromechanical device and turned it on and off using one nanowatt of power—or a billionth of a watt—from three feet away. In later tests, the device achieved an impressive degree of efficiency.



PhD candidate Farrukh Mateen (ENG '18) built the tiny machine.

#### DOES WEED HELP YOU SLEEP? PROBABLY NOT.

Daily marijuana users report more sleep disturbance than those who use marijuana less often or not at all, countering the perception that the drug helps people sleep, according to a School of Public Health study. The study, which surveyed 98 marijuana users, found a lack of difference in the sleep characteristics of nondaily users (those who smoked on at least one day in the past month and up to five days per week), compared to nonusers. Daytime sleepiness did not differ among heavy users, lighter users, and nonusers.

#### FERTILITY FINDINGS

Short menstrual cycles and early or late onset of menstruation are associated with reduced fertility. The findings are the latest from an ongoing, SPH-led internet-based study of more than 2,100 women trying to conceive. It found that women who had cycles of 26 days or fewer had reduced chances of becoming pregnant. The average cycle among participants was 29 days. Women who started menstruating at younger than 12 years old, or at ages 15 and older, also had reduced fertility, compared with those who started at ages 12 to 13.



Howard Eichenbaum

#### MIND MAPPING

The human brain contains circuitry that retrieves memories appropriate for the situation you’re in. New work conducted in the lab of Howard Eichenbaum, director of the Center for Memory & Brain, suggests that this circuitry supports a complex dialogue between two brain structures. By revealing the details of the communications between brain regions to access appropriate memories, the findings may give clinical researchers clues about which communication channels may be impaired in brain disorders that disrupt memory.