Death watch for climate probe

GRACE’s demise will leave gap before follow-on can launch

By Paul Voosen

A sentinel of Earth’s climate is going dark. The Gravity Recovery and Climate Experiment (GRACE) has monitored minute shifts in Earth’s gravity to reveal the unexpectedly rapid melt of polar ice sheets and the drawdown of underground aquifers. But it has run a decade beyond its planned life, and one of its tandem satellites, GRACE-2, is nearly out of fuel. GRACE will soon make its final science run, NASA announced last week.

Scientists had hoped GRACE would operate until its successor, the $550 million GRACE Follow-on (GRACE-FO) mission, reached orbit. But troubles with a planned Russian booster delayed GRACE-FO’s launch to next year at the earliest, on a U.S. rocket. Meanwhile, GRACE-2’s battery, which stores solar power while the satellite is in Earth’s shadow, has deteriorated rapidly, forcing the satellite to burn through fuel. Engineers turned off an accelerometer last year to save power, but the satellite’s data have continued to degrade.

On 3 September, scientists lost contact with GRACE-2 after another battery cell failed; the next day its computer malfunctioned. Four days of feverish work followed before engineers could reboot the satellite. NASA has now put GRACE-2 on standby until mid-October, when it will orbit in full sun along the terminator, the line between night and day, until early November—its final planned science collection.

However small, the gap between GRACE and GRACE-FO will make it hard to stitch their data together into a seamless whole, says Eric Rignot, a glaciologist at NASA’s Jet Propulsion Laboratory in Pasadena, California. “It would be an impossible task to fill the gap,” he says. A joint U.S.-German effort, GRACE has provided an unprecedented view of the planet’s water and ice since its launch in 2002. Flying 220 kilometers apart, the twin satellites constantly monitor their separation, down to microns, by swapping microwave pulses. When they approach a more massive feature, like an ice sheet, its extra gravity tugs a little bit more on the first satellite—briefly widening the distance between the pair—before the second satellite catches up. The changes in distance can be translated into mass.

The exquisite mass measurements revolutionized climate science, showing, for example, that melting polar ice sheets contribute more to sea level rise than the demise of mountain glaciers. Greenland, GRACE found, is losing 280 gigatons of ice a year on average, and Antarctica is shedding 120 gigatons—rates that both seem to be accelerating. Much can still be done with GRACE’s archival data, says Isabella Velicogna, a geophysicist at the University of California, Irvine. For example, Velicogna and her colleagues recently used GRACE to observe a counterintuitive effect of ice loss in Greenland and Antarctica. The meltwater adds to sea level rise. But the lost ice also means lost gravity. As a result, sea levels near the ice sheets are actually dropping while ocean levels half a world away are goosed. Oceanographers predicted the dynamic, but GRACE confirmed it.

The impending data gap is unfortunate, but it was never a sure bet that GRACE would hold out, Velicogna says. And GRACE-FO promises a bonus. It will measure the distance between the two satellites not just with microwaves, but also with a laser range finder, providing even finer mass resolution—and a sharper eye on a changing Earth.

Embryo edit makes human ‘knockout’

CRISPR inactivation of gene allows developmental study

By Gretchen Vogel

F or the first time, scientists have used gene-editing techniques on human embryos to probe how they develop. The work suggests that a protein called OCT4 is active earlier in human embryos than in those of mice. But biologists say the study is more important as a proof of principle; previous human embryo-editing research has focused instead on correcting faulty genes.

The new experiments, published this week in Nature, are also a first test of the United Kingdom’s carefully crafted embryo-editing research regulations, which require that researchers undergo a review by a government authority and receive a license before moving forward. Kathy Niakan, a developmental biologist at the Francis Crick Institute in London, applied in 2015 to use the CRISPR editing technique on human embryos to learn more about the genes active in early development. The researchers planned to focus first on OCT4, known as a marker for pluripotent stem cells—cells that can become all tissues in the body.

Niakan’s group used CRISPR to “knock out,” or deactivate, the gene that codes for OCT4 in 37 single-cell human embryos left over after in vitro fertilization treatments and donated by couples. Mouse embryos lacking the protein form mostly placental cells; the cells destined to become the fetus don’t appear. But in the human embryo knockouts, placental cells also failed to form, indicating that in humans OCT4 plays a role in the development of both cell types.

Niakan’s work shows that “you can [CRISPR] effectively enough and efficiently enough” to study development, says Janet Rossant, a developmental biologist at The Hospital for Sick Children and the University of Toronto in Canada. Researchers have relied on mouse models to understand early mammalian development, she adds, but to understand human development and how it can go wrong, the real thing may be best.