TUCSON, ARIZ., LIKE THE rest of our planet, lies 93 million miles from the sun. But on this late spring morning, with the temperature already above 100 and still rising, it felt as if the city occupied its own special orbit somewhere in the vicinity of Mercury. The heat didn't stop Jack Erickson's astronomy club students, though. Nine of them were out here — during their summer break, no less — on the sere grounds of Empire High School, setting up a telescope in excessively broad daylight.

"Mr. Erickson, we're still having the same problem," said Julie VanVoorhis, who will be a senior in the fall. She was in the shade of a portico, working on a laptop that was wired to a camera on the telescope a few feet away. Erickson, a 46-year-old science teacher at nearby Cienega High School, tweaked the telescope's knobs, trying to center the sun's image on a blue circle on the laptop's screen. But the image kept drifting. One student helpfully suggested that sunlight reflecting from Erickson's shaved head might be interfering with the equipment.

"Is it still drifting down?" Erickson asked, ignoring the joke. It was.

This was a test run for Erickson and his students, the third of several throughout the summer. They were preparing for a singular moment on Aug. 21, when the moon will glide between Earth and the sun, darkening the daytime sky for about two and a half minutes. The total solar eclipse will allow them — and professional astronomers — to glimpse a feature of the sun that is otherwise almost impossible to see: its blazing atmosphere, or corona.

Compared with the sun itself, the corona is so faint that it can be seen only during a total eclipse, or with a specialized instrument called a coronagraph, which uses an opaque disk to block the sun's surface and reveal the corona — essentially creating an artificial eclipse. But coronagraphs invariably hide a large part of the corona as well, specifically a region between 450,000 and 900,000 miles from the center of the sun, a gap that makes it impossible for astronomers to understand the workings of the corona as a whole. A total eclipse outdoes even the best coronagraphs; the moon, by an extraordinary celestial coincidence, blocks the sun almost perfectly. NASA has funded 11 different studies of the eclipse, including a plan to send a pair of modified bombers aloft to chase the moon's shadow over Missouri and Illinois.

Why such interest in the corona? The sun's atmosphere is the locale for unimaginably powerful phenomena like solar flares — titanic eruptions caused by the explosive discharge of energy from the sun's magnetic field. Solar flares sometimes release blobs of gas called coronal mass ejections. Containing as much energy as thousands of nuclear bombs, the electrically charged blobs can hurtle through space at more than a million miles per hour.

If one of those blobs happens to head our way, "it causes conniptions," says Hugh Hudson, a solar physicist at the University of California, Berkeley. "It damages satellites; it causes currents that disrupt power plants." In March 1989, a powerful solar storm disturbed Earth's magnetic field and created electrical currents in the ground that knocked out Quebec's power grid. "We call all that stuff 'space weather,'" Hudson says. "And the sun's magnetic field is doing all that. So any knowledge you get of the magnetic field in any shape or form is good. There are still huge unsolved problems about how these things start."

Eclipses open a window onto the corona and its turbulence, but the window stays open only briefly. Even the two retrofitted WB-57 bombers that NASA plans to fly during the eclipse won't be able to keep up. Each bomber's camera will capture barely more than three and a half minutes of the eclipse — about a minute more than ground observers will witness.

A few years ago, Hudson started thinking about ways to extend that time. In 2011, he and four colleagues began recruiting observers across the country to collaborate on a movie of the eclipse. So far more than 1,000 people have agreed to take snapshots of the eclipse with digital cameras. By combining thousands of images from coast to coast, the astronomers will make the longest film of the corona ever made.

While the "megamovie" will give astronomers a great number of images per second to pore over, the quality of those images will vary widely. To address that shortcoming, the astronomer Matt Penn at the National Solar Observatory in Tucson organized a different project that relies on volunteers working in groups with identical telescopes and cameras. Penn and other astronomers have recruited more than 70 groups of amateurs — including Erickson and his students — for the Citizen CATE Experiment (CATE stands for Continental-America Telescopic Eclipse). "We have a wide range of people, from high school students to retired colleagues of mine," Penn says. "We have tribal high schools in Wyoming and students from a historically black university in South Carolina."

Citizen CATE's teams will fan out in roughly 50-mile intervals along the 2,500-mile-long path of the eclipse. "Many of them will be in little towns," Penn says. "Some will be in farmers' fields." Because Tucson isn't on the eclipse's path, Erickson's crew — one of the largest, with 13 members — will head to Pawnee City, Neb., with a population just over 800. Daystar Filters, Celestron and other manufacturers donated most of the telescopes and mounts, and each team will keep the gear when the experiment ends. NASA, the National Science Foundation and other groups are also providing funds.

These two movies will help astronomers gain a better understanding of the structure and evolution of solar flares and the sun's magnetic field because they've never before been able to follow continuous changes in the corona for so long. They may also provide clues to another vexing puzzle: Whereas the corona's temperature is two million degrees, the surface of the sun is only 6,000 degrees. The sun's atmosphere, in other words, is more than 300 times hotter than the surface of the sun itself. It's as if the steam rising off your morning coffee were hotter than a blast furnace. The physics of this phenomenon is a mystery.

This summer's eclipse is an unusually accessible one. Given that oceans cover 70 percent of Earth's surface, many eclipses aren't visible from land at all. "Unless you have a fleet of 60 boats and can station them properly, you're going to have a hard time getting data from most eclipses," Penn says. "The moon doesn't care what part of the Earth its shadow passes over. Statistically this is a rare occurrence that we have so much access to the path."

Penn will be in Weiser, Idaho, a small town on the Oregon border, for the total eclipse, his third; Hudson will watch his fourth total eclipse from Corvallis, Ore. "I'll have a couple of smartphones, but I don't plan to fuss around too much," Hudson says. "If it's clear, I just want to see it. I've never seen a good one." Penn, meanwhile, will follow the same steps everyone else in the Citizen CATE Experiment will: make sure the telescope's tripod is pointing north; start the recording software; and then, once the moon has completely covered the sun, remove a protective filter from the telescope lens. Finally, he'll take off his protective glasses and look up.

"It will be something you'll always remember," he says. "It will be really stunning. It's just different. I mean, the sun doesn't go away in the sky. So there's that whole primal thing. But then the corona itself is just a really beautiful object."

But all that was still weeks away, and Erickson and his teenagers needed more practice. After one daytime session, Erickson, his daughter Ella and two other students were back at it. They had set up their telescope outside Erickson's classroom on the Cienega High School campus. It was night; the sun was gone, but the day's heat still lingered.

They were trying to focus their telescope on the moon, which was just four days shy of full. (The full moon has about the same brightness as the sun's corona.) They spent a frustrating two hours trying to figure out why the telescope's motor wasn't keeping the instrument aligned with the moon. Sometime around 10 p.m., Erickson discovered the problem.

"We had the wrong wire plugged into this motor," he said. "The motor was trying to track up and down when we were thinking it was trying to track left and right." He sighed. "That's why we're out here."

Assuming everything goes smoothly when they're in Pawnee City, what will they do when the eclipse ends?

"Matt told us, before we start celebrating, we need to back everything up on a flash drive and upload it to a National Solar Observatory server," he said. "I don't know how people in Pawnee City celebrate, but we'll definitely breathe a sigh of relief and find some fun." ◆

Illustrations by Geoff McFetridge