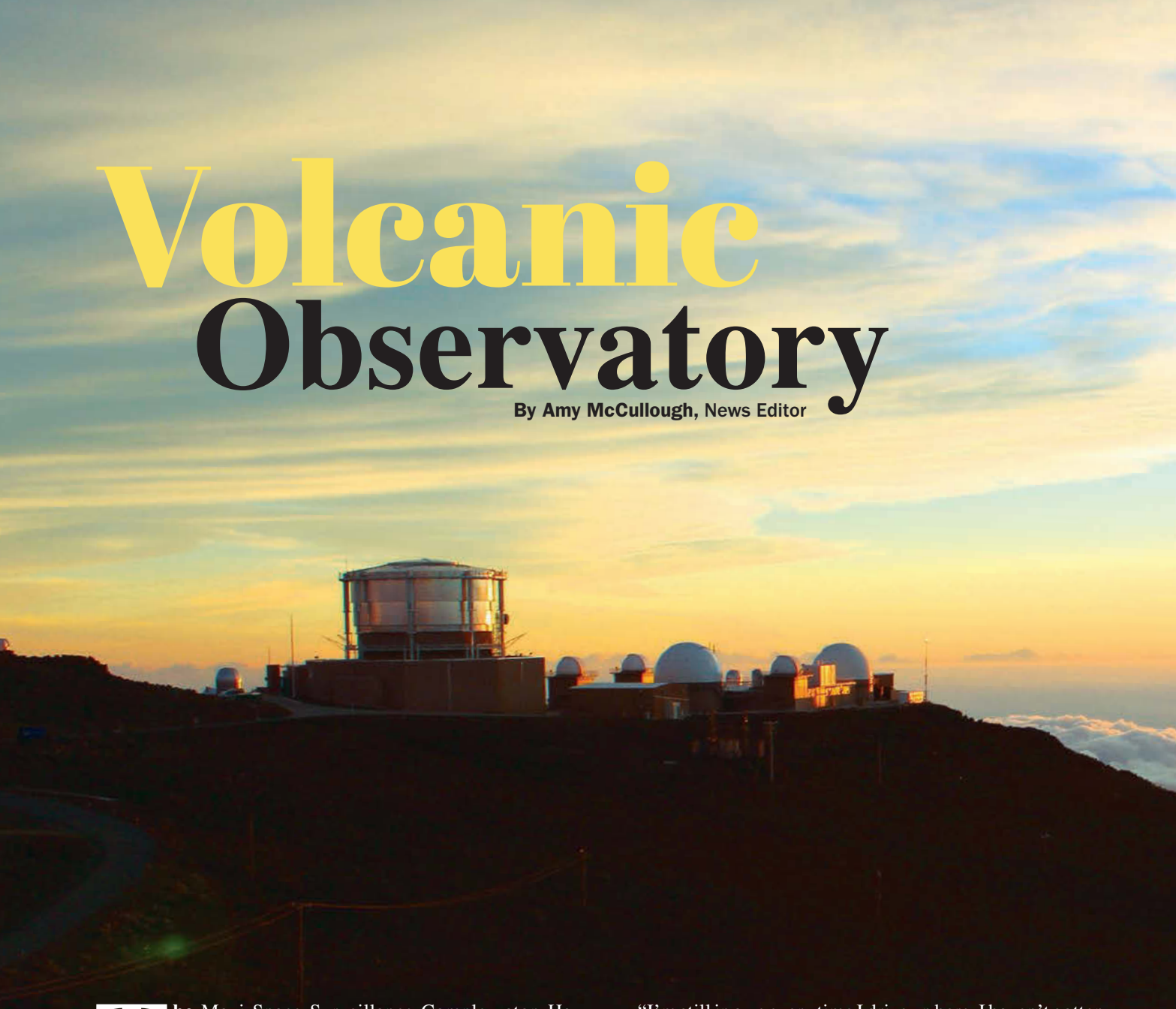
Volcanic Observatory

By Amy McCullough, News Editor



The Maui Space Surveillance Complex atop Haleakala in Hawaii is one of the best astronomical viewing sites in the world. Because it sits 10,000 feet above sea level, there is little light pollution, allowing researchers to take clear pictures of satellites and other man-made objects, such as the Hubble Space Telescope and the International Space Station.

The drive up or down Haleakala goes through different ecosystems, past palms trees, refreshing fields of lavender, eucalyptus trees, through a small town, and then free-range sheep and cattle farms. The cloud cover hovers between 7,000 and 8,000 feet, but when the clouds lift it looks as if you've arrived on another planet. One almost expects the Mars Rover to round the corner, crossing over the barren beds of red volcanic rocks.

Temperatures on top of the volcano, which last erupted in the late 1700s, also vary drastically from hour to hour, easily dropping from 70 degrees to below freezing in the same day. The weather changes so frequently, the control room has a rack of Air Force-issued cold weather parkas for workers to wear outside after sunset.

"I'm still in awe every time I drive up here. I haven't gotten used to this at all," Stacie Williams, site technical advisor, said during an *Air Force Magazine* visit to MSSC in April. "You forget how beautiful it is when you are inside working and then you walk outside and it takes your breath away."

The complex was originally built by the Advanced Research Projects Agency, the predecessor to DARPA, in the 1960s to observe missile launches from the Pacific Missile Range Facility, said Lt. Col. James Phillips, then commander of Air Force Research Laboratory's Det. 15 atop the Hawaiian mountain.

MSSC is now a state-of-the-art electro-optical facility used to track satellites and other man-made objects in space with a mission of increasing importance as the Air Force grows ever more concerned about on-orbit crowding, debris, and threats to expensive, complex satellite systems.

AFRL took ownership of the facility in 2000 and shares the location with the University of Hawaii, a collaborative of other space agencies, and Air Force Space Command, operator of three Ground-Based Electro-Optical Deep-Space Surveillance (GEODSS) systems there.

Staff photo by Amy McCullough

AFSPC and AFRL track objects in the skies from a 10,000-foot dormant volcano on Maui.

The Maui Space Surveillance Complex, run by the Air Force Research Laboratory, is located on the summit of Haleakala on Maui, Hawaii, some 10,000 feet above sea level, making it one of the best astronomical viewing locations in the world.

AFRL Commander Maj. Gen. Thomas J. Masiello said the facility provides "space situational awareness from the ground" and "cutting-edge research in terms of being able to identify, categorize, and understand what is going on in space."

The Maui center also can use lasers to illuminate satellites, then use "extremely advanced data analytics to process the images," even during the daytime, said Masiello.

LOOKING DEEP INTO THE SKY

"Space is becoming more congested and more contested and in order to really decide a course of action if something were to happen in space, we need to see it today," said Stacie Williams.

That's not an easy task because the objects AFRL observes are extremely far away and often clouded by atmospheric turbulence.

Imagers, however, can use adaptive optics taking advantage of a deformable mirror attached to the 120-ton, 3.67-meter Advanced Electro-Optical System (AEOS) telescope—the largest telescope in the Department of Defense—to remove those distorting effects, said Chief Engineer Skip Williams.

Despite its massive size, AEOS moves fairly fast, said Phillips, allowing it to accurately track objects both in low Earth orbit and geosynchronous Earth orbit (GEO).

"If I were an adversary I would attack when my enemy couldn't see me. Well, they don't have that advantage now, because we can track objects day or night," said Stacie Williams.

MSSC also uses a 1.6-meter closed tube telescope. It is more conducive to daylight imaging because there is not as much stray light that comes in, said Phillips. In addition, there is a 0.6-meter laser beam director, some other smaller telescopes, and a variety of sensor systems, including imaging systems, infrared radiometers, low-light video, and acquisition telescopes.

Capt. Robert Copley, 21st Operations Group Det. 3 commander, looks to the horizon from the complex. Copley is the sole Air Force Space Command airman on Maui.

Photo courtesy of Capt. Robert Copley

The first is used to determine the position of satellites and is invisible to the naked eye. The Air Force is adding to the complex a new laser that creates a "sodium guide star," allowing researchers to get "really clean pictures" of man-made objects in space, Skip Williams said. The laser will be used "very infrequently" for short periods of time at sunrise and sunset. It will be visible only from the 10,000-foot summit.

That point is critical for native Hawaiians who consider Haleakala a sacred site. As legend goes, the demi-god Maui, who is said to have thrown his fishing hook into the ocean and pulled out the Hawaiian islands, climbed to the top of Haleakala and snared the sun, pulling off some of its tentacles to slow it down.

LIGHT UP THE SKY

That's why AFRL is so careful to educate the community about any new developments at the site—especially lasers—in an effort to respect and honor local Hawaiian beliefs and traditions, engineer Williams added.

Workers will be able to shoot the laser into the atmosphere and create an artificial star, known as a guide star, next to an object of interest. The light from the artificial star then travels back to the AEOS telescope, enabling researchers to use adaptive optics that compensate for the turbulence in the atmosphere, getting a clearer image of space objects.

AFRL expects to use the new technology sometime this year, said Williams.

The largest telescope in the Defense Department, a 120-ton, 3.67-meter Advanced Electro-Optical System telescope. It is operated by the Air Force Research Laboratory.

Staff photo by Amy McCullough

Unlike the scientists and technicians from AFRL, Capt. Robert Copley, commander of the 21st Operations Group's Det. 3, operator of the three GEODSS systems at the site, doesn't care what an object actually looks like. He is there to watch out for stray space junk and give warnings when it could be a problem.

Copley, the lone AFSPC airman on Maui, and his team of civilian contractors are responsible for executing combat-relevant warning, intelligence, surveillance, and reconnaissance, and counterspace operations to ensure space superiority.

Haleakala is one of three GEODSS sites across the globe. The other two are in Socorro, N.M., and on the British island of Diego Garcia in the Indian Ocean. The telescopes only operate at night and track man-made objects, such as satellites, rocket bodies, and even tools lost during the early days of space exploration, all orbiting mostly in GEO. GEODSS sites are also capable of tracking objects in highly elliptical orbit, or HEO.

"We're not interested in what an object looks like. We're interested in where an object is," said Copley. "We provide time, elevation, and azimuth"—a specific compass point—to the Joint Space Operations Center at Vandenberg AFB, Calif., maintainers of a catalog of space objects, and to the National Air and Space Intelligence Center at Wright-Patterson AFB, Ohio. If there is a potential problem such as possible incoming collisions, those centers will respond.

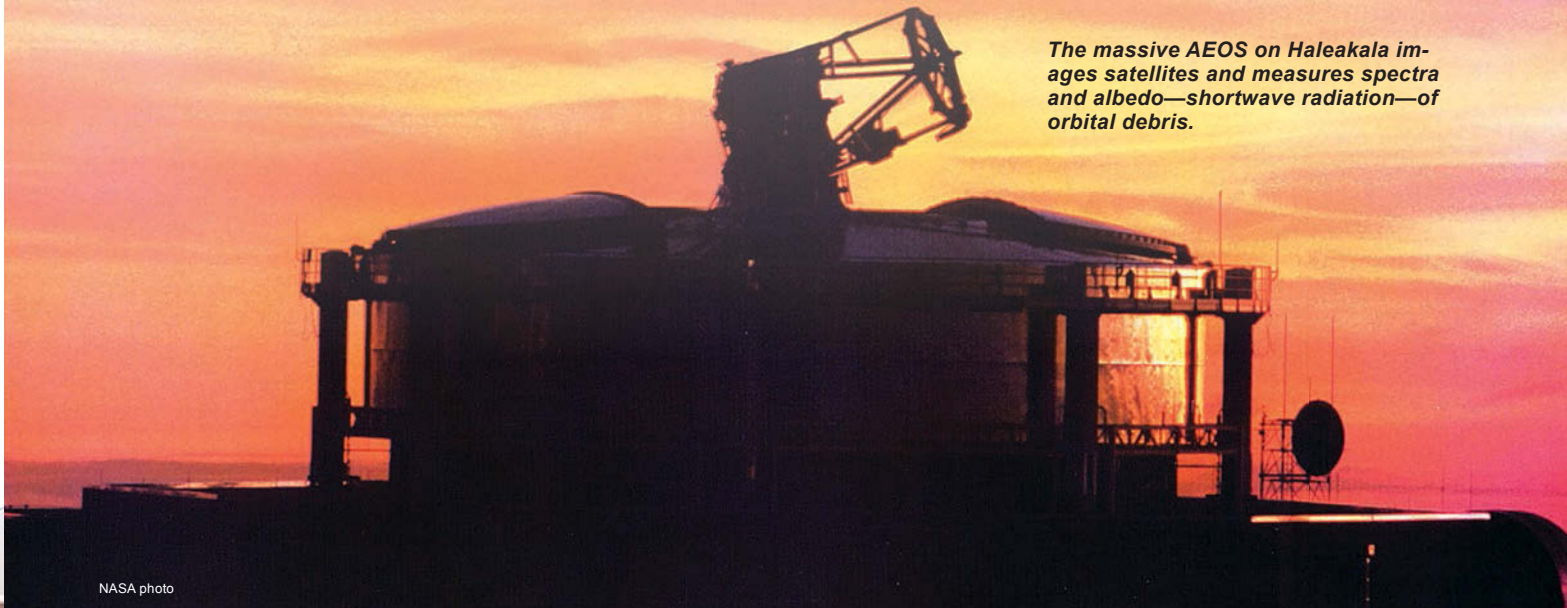
The three GEODSS telescopes are each one meter, the smallest domes on Haleakala. Despite their size, Copley referred to them as the "B-52s of space situational awareness" because of their ruggedness.

Because they are a compact system, they don't have huge motors needed to run significantly larger telescope domes. There is less materiel to sustain and less of a wind cross-section, adding to their durability, said Copley. However, the telescopes are highly capable, allowing users to see objects 10,000 times dimmer than the human eye can detect.

"There are definitely more man-made objects in orbit today because space is lucrative and there are a lot of nations wanting to become space-faring nations," said Copley. "As they do so, more and more objects end up in orbit. We hope all those objects play nice with each other, but failures do happen and we want to know what's going on in space." ✪

Photo courtesy of Capt. Robert Copley

A Ground-Based Electro-Optical Deep-Space Surveillance telescope at the complex tracks an object in space.



The massive AEOS on Haleakala images satellites and measures spectra and albedo—shortwave radiation—of orbital debris.

NASA photo