Time-lapse photos and synched weather data unlock Antarctic secrets

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A year's worth of sandblasting by intense Antarctic winds rendered the window of a camera mount almost opaque. The clear portion had been covered by an anchor strap.

In preparation for his upcoming fieldwork, Brown University research analyst Jay Dickson took 10,000 pictures of the inside of his freezer. He wasn't investigating disappearing food or making sure the light went off when he closed the door. Dickson was making sure his new camera and timer would function properly for long periods in sub-freezing temperatures.

"Everything worked great in the freezer for five weeks," Dickson said, "so hopefully it will all work in the field."

That camera's next stop: a remote Antarctic outpost, where it will left to take two-month's worth of time-lapse images of geological features in the McMurdo Dry Valleys. Dickson's trip to the Dry Valleys this December will mark his seventh field season and Antarctica, and his sixth season using automated camera stations to gather scientific data.

Those stations are giving scientists from Brown and elsewhere a view of geological change in the Dry Valleys that can't be glimpsed any other way. The cameras are not only unveiling new details about the changing climate on Earth, but also offering insight into what conditions might be like in the similar frozen deserts of Mars.

Dickson, along with Brown University geologist James Head and Joseph Levy of the University of Texas, a 2009 Brown Ph.D. graduate, describe their time-lapse technique and how it contributes to Antarctic science in this week's issue of *Eos, Transactions of the American Geophysical Union*.

Capturing climate change

The Dry Valleys stretch for about 50 miles through the Transantarctic Mountains down to the coast of the Ross Sea. Dry katabatic winds that blow down from the mountain peaks and ice cap sap the region of much of its moisture, making it the largest portion of Antarctica not covered completely by ice. Because the region is so cold and so dry, the landscape is remarkably stable. But that doesn't mean the region is entirely unchanging. Time-lapse offers a way to capture those changes.

Solar radiation . Scientists had thought that the river at the foot of the cliff had caused pieces to fall off—"calving." Time-lapse photography shows that losses are due to melting from solar radiation. Credit: Brown University

"The hunt is on for where climate change is manifesting itself," Dickson said. "That's been a challenge in Antarctica because changes there are extremely slow. Time-lapse allows us to speed that up and understand how it's working."

Time lapse made a key contribution to a paper Levy, Dickson and Head published last year investigating an ice cliff in Garwood Valley, a part of the Dry Valleys near the Antarctic coast. The ice was left behind 20,000 to 30,000 years ago when a glacier invaded the valley and later retreated. Using a variety of remote sensing techniques, the researchers were able to show that the cliff's rate of melting over the last decade was 10 times faster than the melt rate over the last 10,000 years.

But understanding the mechanism behind that melting could only be done with time lapse. By combining two months of images taken at five-minute intervals with data on solar intensity captured by a nearby weather station, the researchers showed that the primary driver of the melting process is solar radiation.

"We could see that for about four to six weeks every year, just in the middle of the day, that thing melts like crazy," Dickson said. "People thought maybe the cliff was retreating because of calving events, where the river that runs in front of it melts the bottom and causes chunks to break off. But we didn't see that in the time lapse. What we saw was this very clear melting due to solar radiation."

The ability to link the camera images to weather data is a key part of Dickson's system. He wrote software that enables camera images to be automatically synched to data from any weather station that happens to be nearby.

"That's a big part this," he said. "We have a ton of measurements of what the climate is doing in terms of temperature, humidity, sunlight, and everything else. But we're really far behind in terms of the surface response to those climate forcings. Our approach is able to link those forcings with what's happening on the surface."

Clues about Mars

Understanding Earth's climate isn't the only reason the researchers are interested in the Dry Valleys. The frigid, desiccated landscape is the closest analog on Earth to the surface of Mars. In another paper published last year, Dickson and his colleagues used time-lapse to reveal a hydrological process in the Dry Valleys that's similar to a process scientists believe may be happening on Mars.

Water tracks. The parched, salty soil on the valley floor pulls any available moisture out of the air. When the humidity spikes, the "water tracks" darken. The same process could be happening on present-day Mars. Credit: Brown University

Scientists studying Mars have noticed peculiar dark patches that appear on Martian cliff faces on a seasonal basis. Some scientists think these "recurring slope lineae" could be the signature of a flowing saltwater brine. Head and Dickson have found similar features in Antarctica, and the time-lapse system has shed light on how they form.

The camera images, synched to weather data, show that dark tracks form in certain spots on the valley floor when the humidity of the surrounding air jumps. Head and Dickson concluded that the dry, salty soil soaks up any available moisture in the air. So when the humidity spikes, these dark "water tracks" form.

"It's possible that you have a similar hydrology happening on Mars in the form of these recurring slope lineae," Dickson said.

A Challenging Environment

Dickson's time-lapse work involves much more than simply throwing a camera on a tripod for two months. Keeping the stations running in one of the harshest environments in the world isn't easy.

The cameras are housed in fiberglass enclosures about the size of a small microwave. The cameras are powered by two 12-volt car batteries. While extreme cold is generally a problem for batteries, the Antarctic summer offers a bright side: the sun never sets. So Dickson uses small solar panels to keep the batteries charged.

But the cold isn't the only problem. There are other elements that Dickson can't recreate in his freezer. Chief among them is the wind, which often blows through the Dry Valleys with hurricane force. Dickson learned the hard way what these winds can do to his installations.

"The first station I installed was completely ripped apart by the wind," he said. "One of the car batteries, we never found. So the wind can pick up a 70-pound battery with no problem."

The newest installations are held together with heavy cargo straps and bolted to large rock boxes to keep them in place. The wind also blasts the fiberglass enclosure with dust, eventually turning the clear material opaque. So Dickson has to replace the window through which the pictures are taken at the end of each field season.

Another challenge is installing these stations in extremely remote locations. The team of researchers Dickson works with is transported to the Dry Valleys by helicopter, but specific installation sites must be reached on foot.

"The pilots don't necessarily like landing in the most geologically interesting sites," he said. "So sometimes we have to hike long distances."

Those treks must be made with 70-pound car batteries strapped into backpacks. Then there's the matter of getting back to those locations in February to retrieve the data at the end of the season.

That will make for plenty of hiking come December. During this upcoming trip, Dickson is installing a total of nine cameras for four different principal investigators.

"The sites span a lot of the range of climates that occur in the Dry Valleys," he said. "My goal is eventually to cover as much of the Dry Valleys as possible and build a multiyear record of activity."

More information: *Eos, Transactions of the American Geophysical Union*, onlinelibrary.wiley.com/doi/10 … 02/2014EO46/abstract

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