Eos

EARTH & SPACE SCIENCE NEWS

VOL. 101 | NO. 2
FEBRUARY 2020

Our Magnetic Brains

Los Angeles's Shaky Underbelly

Beavers: Nature's Firefighters

Up in Smoke

As wildfires scorch the land, scientists are using novel methods to study the damage to our air.

AGU 100
ADVANCING EARTH AND SPACE SCIENCE

Using Satellites and Supercomputers to Track Arctic Volcanoes

Conical clues of volcanic activity speckle the Aleutian Islands, a chain that spans the meeting place of the Pacific Ring of Fire and the edge of the Arctic. (The chain also spans the U.S. state of Alaska and the Far Eastern Federal District of Russia.) Scientists are now turning to advanced satellite imagery and supercomputing to measure the scale of natural hazards like volcanic eruptions and landslides in the Aleutians and across the Arctic surface over time.

When Mount Okmok in Alaska unexpectedly erupted in July 2008, satellite images informed scientists that a new 200-meter cone had grown beneath the ashy plume. But scientists suspected that topographic changes didn't stop with the eruption and its immediate aftermath.

For long-term monitoring of the eruption, Chunli Dai, a geoscientist and senior research associate at the Ohio State University, accessed an extensive collection of digital elevation models (DEMs) recently released by ArcticDEM, a joint initiative of the National Geospatial-Intelligence Agency and the National Science Foundation. With ArcticDEM, satellite images from multiple angles are processed by the Blue Waters petascale supercomputer to provide elevation measures, producing high-resolution models of the Arctic surface.

Dai first used these models to measure variations in lava thickness and estimate the volume that erupted from Tolbachik volcano in Kamchatka, Russia, in work published in *Geophysical Research Letters* in 2017 (bit.ly/measure-lava). The success of that research guided her current applications of ArcticDEM for terrain mapping.

Monitoring long-term changes in a volcanic landscape is important, said Dai. "Ashes easily can flow away by water and by rain and then cause dramatic changes after the eruption," she said. "Using this data, we can see these changes...so that's pretty new."

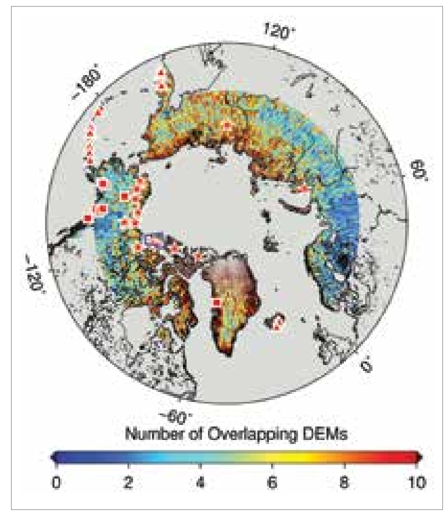
Creating time series algorithms with the ArcticDEM data set, Dai tracks elevation changes from natural events and demonstrates the algorithms' potential for monitoring the Arctic region. Her work has already shown that erosion continues years after a volcanic event, providing first-of-their-kind measurements of posteruption changes to the landscape. Dai presented this research at AGU's Fall Meeting 2019 in San Francisco, Calif. (bit.ly/DEMs-land-surface).

Elevating Measurement Methods

"This is absolutely the best resolution DEM data we have," said Hannah Dietterich, a research geophysicist at the U.S. Geological Survey's Alaska Volcano Observatory not involved in the study. "Certainly, for volcanoes in Alaska, we are excited about this."

Volcanic events have traditionally been measured by aerial surveys or drones, which are expensive and time-consuming methods for long-term study. Once a hazardous event occurs, Dietterich explained, the "before" shots in before-and-after image sets are often missing. Now ArcticDEM measurements spanning over a decade can be used to better understand and monitor changes to the Arctic surface shortly following such events, as well as years later.

For example, the volcanic eruption at Okmok resulted in a sudden 200-meter elevation gain from the new cone's formation



In this map of ArcticDEM coverage, warmer colors indicate more overlapping data sets available for time series construction. Blue and red rectangles mark mass wasting events, triangles identify volcanoes, and red stars show locations of active layer detachments and retrogressive thaw slumps, both used for studying landslides. Credit: Chunli Dai

The 2008 Okmok eruption in Alaska resulted in a new volcanic cone, as well as consistent erosion of that cone's flanks over subsequent years. The volcano's ring-shaped plume is visible in the center of this satellite image. Credit: NASA image courtesy of Jeff Schmaltz, MODIS Rapid Response Team, NASA Goddard Space Flight Center but also showed continuing erosion rates along the cone flanks of up to 15 meters each year.

Landslides and Climate

For Dai, landslides provide an even more exciting application of ArcticDEM technology. Landslides are generally unmapped, she explained, whereas "we know the locations of volcanoes, so a lot of studies have been done."

Mass redistribution maps for both the Karrat Fjord landslide in Greenland in 2017 (bit.ly/Karrat-Fjord) and the Taan Fiord landslide in Alaska in 2015 (bit.ly/Taan-landslide) show significant mass wasting captured by DEMs before and after the events.

"We're hoping that our project with this new data program [will] provide a mass wasting inventory that's really new to the community," said Dai, "and people can use it, especially for seeing the connection to global warming."

Climate change is associated with many landslides studied by Dai and her team, who focus on mass wasting caused by thawing permafrost. ArcticDEM is not currently intended for predictive modeling, but as more data are collected over time, patterns may emerge that could help inform future permafrost loss or coastal retreat in the Arctic, according to Dietterich. "It is the best available archive of data for when crises happen."

Global climate trends indicate that Arctic environments will continue to change in the coming years. "If we can measure that, then we can get the linkage between global warming and its impact on the Arctic land," said Dai.

"If we can measure [the changing Arctic environment], then we can get the linkage between global warming and its impact on the Arctic land."

By **Lara Streiff** (@laragstreiff), Science Communication Program Graduate Student, University of California, Santa Cruz

Will Melting Sea Ice Expose Marine Animals to New Diseases?

Northern sea otters are just one of many marine mammal species that can contract the phocine distemper virus (PDV), which is related to the canine distemper virus. Credit: U.S. Environmental Protection Agency

In 2004, Tracey Goldstein was trying to crack a marine mammal mystery. Goldstein, associate director of the One Health Institute at the University of California, Davis School of Veterinary Medicine, was part of a team digging for answers about why Alaska's northern sea otter populations were plummeting.

The falling number of otters was curious. Before the decline began, decreases in the killing of otters for the fur trade had actually sparked a population rebound, Goldstein said.

Researchers still don't know exactly what made the otter populations dwindle. However, Goldstein was shocked by something she and her colleagues discovered while screening the animals for a variety of diseases. Some of the animals had been exposed to the phocine distemper virus (PDV), which is pathogenic for pinnipeds and is closely related to the measles virus and the canine distemper virus.

Same Virus, Different Location

This wasn't the first time researchers identified a PDV outbreak in marine mammals. An estimated 23,000 European harbor seals were killed after they were sickened by the virus in 1988. In 2002, a second epidemic hit the northern Atlantic Ocean, killing approximately 30,000 harbor seals.

However, this was the first time a PDV outbreak was confirmed in the northern Pacific Ocean.

Northern sea otters "don't move widely," said Goldstein, so the emergence of PDV in the Alaskan population "really surprised" her and her colleagues. Researchers realized the virus was likely transmitted to the otters by some species of marine mammal that had contact with European harbor seals exposed to the virus. "Nomadic Arctic seals with circumpolar distributions (e.g., ringed and bearded, Erignathus barbatus, seals) and geographic ranges that intersect with those of harp seals, may be carriers of PDV to the North Pacific," researchers write in *Scientific Reports* (bit.ly/PDV-mammals).

This explanation presented one big problem: Contact between Arctic and sub-Arctic seal species was assumed to be impossible due to Arctic sea ice separating the species. This left the team wondering whether there could be a connection between the rapid melting of Arctic sea ice, driven by climate change, and the emergence of PDV in the otters.

Boundaries Melting Away

In an international study conducted between 2001 and 2016, Goldstein and her colleagues probed connections between virus transmission patterns and environmental factors to understand when and how PDV was introduced into the North Pacific.

"The study is ambitious in its interdisciplinary effort to summarize immunological data on prevalence of antibodies to PDV,