A New Research Paradigm:

Where Data Science Meets Community Life

Above: *scientists and residents of Kotzebue, Alaska, pose with the unmanned aerial system used in a cooperative program by both groups to study changes in Arctic sea ice. Photo by Sarah Betcher/ Farthest North Films.*

Physical oceanographer Christopher Zappa grew up on the coast north of Boston, where he developed a deep appreciation and intellectual curiosity about the sea. It follows that his work at Lamont is rooted in the oceans. Zappa studies climate physics, and more specifically how ocean waves impact the transfer of heat and mass between the ocean and the atmosphere. His work has recently taken him on an unusual journey of investigation and friendship. This past spring, Zappa and his colleagues completed the second year of a four-year project to study the seasonal variation in sea ice in the Chukchi Sea off northwestern Alaska, both with highly sophisticated technology and through the traditional knowledge of villagers in the local village of Kotzebue.

"I love the way they say good morning there," says Zappa. "Uuvlaaluataq (pronounced oov-la-lua-tuck). It means great day, good morning. Everyone greets each other with this." Zappa and his colleagues spent a few weeks in the village last year, but this spring they spent five weeks in Kotzebue during April and May.

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Above: *Lamont engineers (left to right) Scott Brown and Tej Dhakal prepare the unmanned aerial system (UAS) for flight.*
Opposite page: *(upper left) Kotzebue, Alaska, advisory council member, John Goodwin, cuts into a sea-ice core; (upper right) members of the flight team discuss UAS operations at an open house with the local community; (lower right, left to right) University of Washington graduate student Jessica Lindsay and NOAA scientist Peter Boveng survey the sea ice with LIDAR (light detection and ranging); (lower middle, left to right) University of Alaska, Fairbanks, graduate student Kate Turner and advisory council member Cyrus Harris read data after a CTD (conductivity, temperature, depth) cast; (lower left, left to right) Christopher Zappa, Alex Whiting, Cyrus Harris, Kate Turner, Jessica Lindsay, and Sarah Betcher during interviews by the local radio station in Kotzebue (photo courtesy KOTZ Radio). All photos by Sarah Betcher/Farthest North Films except as indicated.*

Kotzebue, a tiny town with a population of about 3,000, drew national focus in late 2015, when President Barack Obama came to announce federal grant programs to help residents cope with coastal erosion and high energy costs, and in some extreme cases relocate altogether. Tribal leaders told reporters that the visit was an important gesture for those who have long sought federal support to deal with such challenges.

"Alaska native traditions that have set the rhythm of life in Alaska for thousands of years are being upended by decreasing sea-ice cover and changing seasonal patterns," read a White House statement. Sea ice has been receding up and down the coast of Alaska, impacting the many local communities. The importance of village traditions and their close ties to the "rhythm of life" in their environment has inspired this first-of-its-kind study funded by the Gordon and Betty More Foundation. It has taken Zappa and his colleagues into a deep study of the melting sea ice, which involved deploying redesigned remote-sensing instruments, and has also required in-depth conversations with Kotzebue elders to enlist the wisdom and insights of the indigenous community. By integrating the native coastal community's

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observations with a powerful unmanned aerial system (UAS), Zappa anticipates developing a uniquely nuanced study of the dynamics of sea ice melting. Such an understanding will help inform and prepare Alaska's coastal communities and will ultimately gauge the role of climate change on this pattern.

"The whole project is about bridging science and traditional knowledge to understand how sea ice is changing in Kotzebue Sound and how it impacts their traditions. A lot of the traditional life of the village is spent on the ice, so the changing ice impacts what they are able to do and when," explained Zappa.

Zappa, who runs a UAS lab at Lamont, has redesigned remote-sensing instruments typically found aboard research ships or aircraft to conduct research in environments such as Kotzebue's. The drones' range and maneuverability allow his teams to fly their instruments low over sea ice across a wide area that ships can't always reach while also avoiding interference from a ship's heat and movement and significantly cutting costs. The result is unmatched data on sea ice movement and new insights into changes in the environment.

"When we fly our unmanned aerial vehicles (UAVs) we don't know what to anticipate. With this technology, we are able to send back data to our ground station. Once we see an area with interesting features we want to study, we can alter the UAV flight path and conduct high-density sampling in that specific region," said Zappa.

The overarching approach to this research project is guided in a unique way. Typically, research fieldwork begins with clearly defined objectives, specific questions to be addressed and, ideally, answered. However, the Kotzebue research began with a series of meetings with local elders of the village. From the very beginning, the local advisory council was to have a voice in setting the agenda.

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Above: *Lamont Research Professor Christopher Zappa. Photo by Sarah Betcher/ Farthest North Films.*

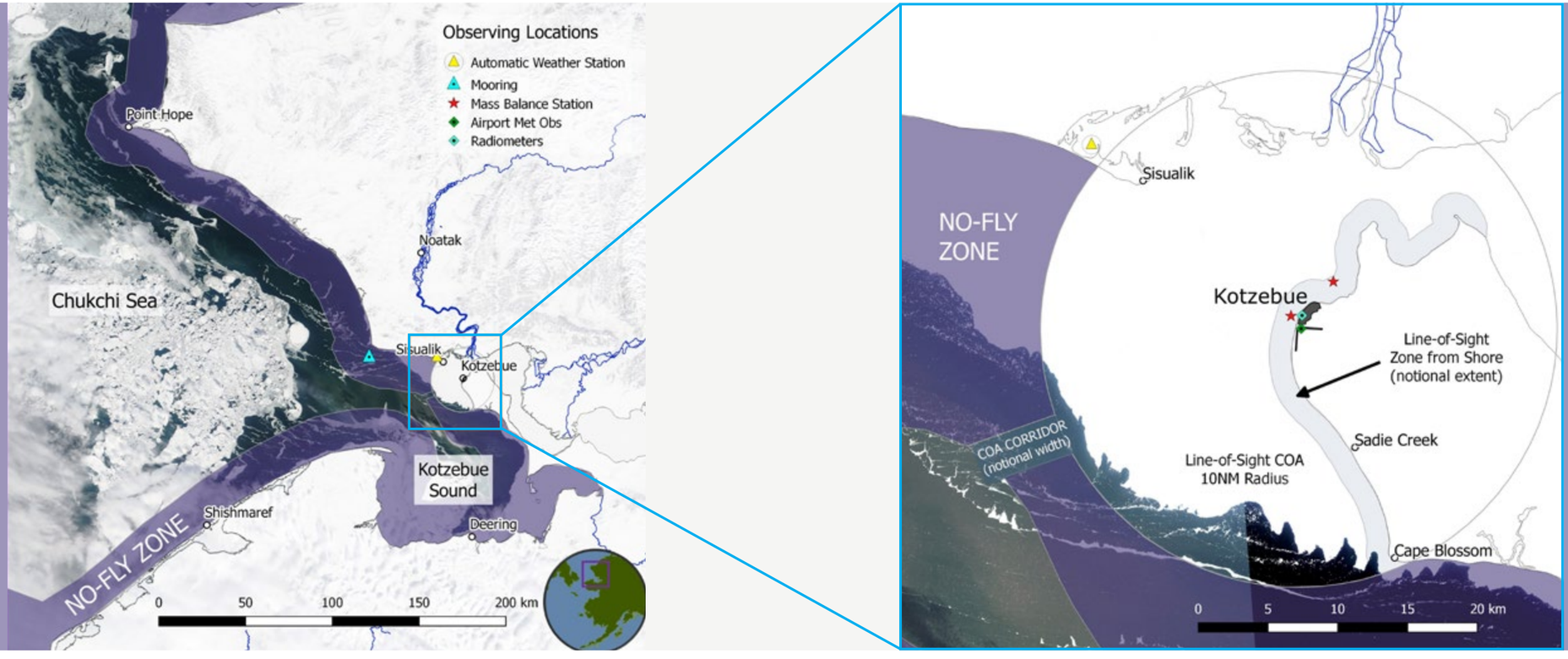
"We came up with topics based on the interests of the indigenous community. We went in with a clean slate. We formed an advisory board of elders from the community that we worked with to develop the scientific questions," said Zappa.

For the first year of the project, Zappa and his colleagues worked with Kotzebue elders to define the questions most vital to the community. Among them: which species of marine mammals and birds occupy the system west of Kotzebue prior to the ice break up within the sound, what environmental factors control marine mammal use of Kotzebue Sound, what environmental factors control the length of the bearded seal (Ugruk) hunting season in the sound, what determines the ice transport processes in the sound, what snow and ice surface properties promote ringed seal (Nutchuk) den integrity and pupping success, and what role does the sea ice play in sediment transport in the sound.

The environmental controls on the ice breakup are especially important to the community, as hunters count on stable landfast ice to enable them to travel from the beach to ice farther offshore, where they conduct their time-honored traditional hunt of ringed seals. Furthermore, the ice breakup defines the beginning of the bearded seal hunt. The bearded seal hunting season is determined both by the availability of suitable sea-ice habitat and the accessibility of this habitat from Kotzebue, which is determined in part by the development of a channel through the landfast ice created by outflow from the Noatak River. Early disintegration of the pack in the sound and delayed breakup of the shorefast ice has led to a severely shortened season in recent years. The hunting of the seals is part of the Kotzebue tradition and was once critical to the villagers' survival.

"The ice is still critical for subsistence; traditional hunts are central to the fabric of the community and something the community wants to keep going," said Zappa. Preliminary findings flesh out a pattern of melt seasons that has varied significantly. This year, Zappa observed a major anomaly in that the melt period was much earlier than usual.

"It's my first time working with an indigenous community. It's both challenging and rewarding. Challenges include incorporating a new perspective on how to do science. It's rewarding as we are accessing different perspectives. Having access to the villagers' documented history is and will be very helpful," said Zappa. "The indigenous community has a wealth of knowledge because for many generations they have always been there in Kotzebue to observe the coastal Arctic ice system. It's part of their tradition."



Below: *(left) annotated satellite image mosaic of Kotzebue Sound and the Chukchi Sea showing the no-fly zone (shaded purple) and the 10-mile radius approved for unmanned aerial system flight under a certificate of authorization (COA) from the Federal Aviation Administration; (inset) map of Alaska showing the borders of the left panel; (right) expanded view of the work area around Kotzebue; selected geographic names and multi-year observing locations are marked and labeled. Figure by Carson Witte.*