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Tracing Magnetic Fields Across Galaxy

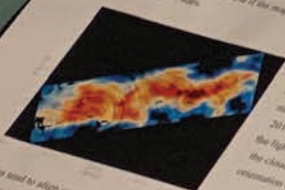


Figure 1. A magnetic field map of the Vela C core-forming region made with BLAST-ING's predecessor BLASTING (Inse et al., 2016) observing at 500 mHz. The background image shows the light emitted by the dust grains, which shows the structure of the cloud. The "streaks" (expected on top of the image) show the orientation of the magnetic field inferred from BLASTING data.

BLAST-ING is designed to make incredibly detailed maps of magnetic fields. It has been known since the 1960s that interstellar dust grains tend to align on average perpendicular to their local magnetic field. The polarization direction of the light they emit can be used to infer the net alignment of the grains. If observing the polarized light emitted by these small grains, BLAST can therefore map magnetic fields in distant star-forming regions. Because BLAST operates above 90% of the atmosphere (which absorbs most of the radiation in the far-infrared regions), it can make larger and more sensitive maps than telescopes of the same size on the ground (for example see Figure 1).

While these maps give an incredibly detailed portrait of the magnetic field, they don't directly tell us the magnetic field strength. To understand whether the magnetic field is sufficiently strong to affect the motions of the gas and possibly slow down star formation, we need to compare our observations of the magnetic field to "synthetic maps" of magnetic fields derived from computer simulations of star-forming regions such as the ones shown in Figure 2. In strong-field simulations the magnetic field shows considerably more order than in weak magnetic field simulations. Also while in weak magnetic field simulations the cloud density structures align on average parallel to the field, in strong-field simulations the low density features tend to be oriented parallel to the field, while the higher density features tend to be perpendicular to the field.

I'M MADE OF SUGAR!

WHAT AM I LOOKING AT?

LOOKING AT?
This is an earlier 3-D rendering of Vela C – a map of our galaxy's interstellar dust particles which shows the original strong magnetic fields which trapped the gas – resulting in the origin of the first stars.
Major outcome from BLAST's 2010/2012 long duration balloon launch. (BLAST is back this year with the largest payload ever launching again any day now!)

I'M MADE OF SUGAR!

TELL AN MORE.
3-D lines illustrate the orientation of our galaxy's interstellar dust particles which shows the original strong magnetic fields which trapped the gas – resulting in the origin of the first stars.

TELL ME MORE

WHAT IS THIS MADE OUT OF?

D lines were individually molded over flexible balloons for 30 days spent building the skeleton and then sealed with a clear coat of sealer to seal the magnetic field and the thermal map. The hand-painted overlay is a thermal map, showing the distribution of the galaxy's interstellar dust particles which shows the origin of the galaxy's magnetic field. The hand-painted overlay is a thermal map, showing the distribution of the galaxy's interstellar dust particles which shows the origin of the galaxy's magnetic field. The hand-painted overlay is a thermal map, showing the distribution of the galaxy's interstellar dust particles which shows the origin of the galaxy's magnetic field.

WHAT IS THIS MADE OUT OF?

Fondant (sugar clay)

The 3-D lines were individually molded over flexible helium tubes and Everclear, which evaporates quickly. After two days spent building the skeleton, I mixed fondant with water (which dissolves the sugar) and "caulk" to seam-seal the magnetic field edges. After it set for 10 hours, I transported the model in a hilarious and terrifying process, and then hand-painted the thermal map.

A SUPERGIANT THANK YOU TO BLAST, CSRF, Kujir W

MADE BY: Rose McAdoo (sous chef at LDB)

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ARCTIC SCIENCE CAKES AT: www.

MADE BY: Rose McDoo (sous chef at LDB)
SEE MORE AT: www.WhiskMeAwayCakes.com

SIKU: MIXING HIGH TECH WITH ANCIENT KNOW-HOW

An Inuktitut word for 'sea ice,' SIKU today refers to a revolutionary web platform that provides access to both indigenous traditional knowledge and current-day research compiled by communities living in Canada's Arctic zone. A story that began modestly with a few snapshots of eider ducks struggling for survival on the ice floes of Hudson Bay has evolved into an extraordinary project of fifteen years, which combines ancient knowledge with modern technologies.

by Joel Heath and
Lucassie Arragutaina

IT WAS COLDER THAN EVER that winter day of 2002, in the Qikiqtaaluk region in Nunavut, Canada. Not far from the community of Sanikiluaq, a group of Inuit with harpoons led the way over the thin, newly formed ice. A team of biologists cautiously and literally followed in their footsteps. The ice fog rising from the open water made the scene particularly dramatic.

Siku, the Inuktitut word for sea ice, is itself a metaphor of ice as the structure of connectivity and change in the North.

A large floe edge on the east side of the Belcher Islands had recently frozen over, and a group of eider ducks was struggling to keep the remaining open water from freezing. The opening was critical for them to dive through in order to access the mussels and sea urchins they relied on as food.

The ice edges were littered with carcasses of dead ducks that had frozen into the advancing ice. The Inuit leading the expedition, active hunters from the community – Simeonie Kavik, Elijah Oquaituk and Lucassie Ippak – turned to the biolo-



Puasi Ippak tests out the SIKU mobile app near Sanikiluaq.

gists and said, "This is what we've been telling you about. In the early 1990s, one of our elders noticed that there were as many dead eiders on the ice as there was gravel on the beach." The hunters and elders of Sanikiluaq had alerted the Canadian authorities at the time, but the phenomenon escaped the attention of the scientific community.

As one of the biologists on the 2002 expedition to study the eider die-offs, I had designed an underwater camera that could film the eiders as they dove under the sea ice to forage in winter. I was a Ph.D. student at the time, and spent the next two winters at the edge of the sea ice – under the guidance of Kavik and Oquaituk – collecting footage tracking eider survival methods.

The footage captured was unprecedented. After seven years of working closely with almost all the families in Sanikiluaq, the project resulted in the documentary *People of a Feather* (2011). The film, which went on to win a dozen awards, highlights the community's unique relationship with eiders, and the shared challenges of environmental change that they face.

The Inuit of the Belcher Islands are not just interested in eider ducks – their lives depend on them. While most birds,

including eiders, migrate south, the Hudson Bay eiders remain around the Belcher Islands through the winter. In the absence of caribou here, the community uses eider skins to make traditional parkas, and eider meat is critical to food security year-round.

Putting together the puzzle pieces

It was in the wake of the film's release that the Arctic Eider Society [AES] was formed in 2011. The groundwork was already well-prepared thanks to the community-driven research programs developed with the support of the Canadian government's International Polar Year (2007–2008) and to their mobilization, dating back to the early 1990s. Around the same time, the Sanikiluaq community launched a programme bringing together twenty-eight Inuit and Cree communities across Hudson Bay and James Bay, to synthesize their knowledge of environmental change. The project resulted in the 1997 publication, *Voices from the Bay*, which to this day remains a definitive source for knowledge on the region.



Elder Jimmy Iqaluit and Hunter Johnny Kurluarok review posts on the SIKU online platform as a part of developing the platform

An Inuit-driven charity, AES aims to empower local people to take charge of research, education and stewardship of their environment. The early programmes focused on assessing changes in oceanography and sea ice – training hunters and youth to use salinity and temperature profilers; establishing time-lapse monitoring stations and carrying out ice-core and water sampling.

The creation of AES's Community-Driven Research Network was given top priority. It includes Sanikiluaq (Nunavut), Inukjuak, Umiujaq, Kuujuaapik (Nunavik region of Quebec) and Chisasibi (Cree community in the Eeyou Marine Region of Quebec). Each of these neighbouring communities held a different piece of the puzzle, and by working together they could finally provide a larger picture of environmental change in the region.

Drawing academic expertise from the University of Manitoba, Carleton University and ArcticNet, as well as funding from the Nunavut General Monitoring Plan [NGMP], the Nunavik Marine Region Wildlife Board [NMRWB] and the Cree Nation of Chisasibi, the network has been able to

develop partnerships. The increased capacity has allowed the tackling of new issues, including the Northern Contaminants Program, and with funding from Polar Knowledge Canada, has facilitated expansion into new regions.

Three New Priorities:

As capacity continued to grow, the communities identified three new priorities: increasing youth engagement, helping bridge the larger-scale jurisdictional challenges faced by the region, and sharing results and coordination in near-real time.

To involve youth, the network partnered with Kativik Ilisarniliriniq, the Nunavik School Board, to develop a holistic Inuit-centred approach to training and education in the sciences. This has resulted in the Arctic Sea Ice Educational Package. Using interactive multimedia tools, it allows young people to partner with hunters, and to become directly involved in local research.

Regarding the second priority, the first-ever Hudson Bay Summit was held in 2018. It brought together twenty-seven Inuit and Cree communities from James Bay and

Hudson Bay, and representatives of ninety-seven organizations, to form the Hudson Bay Consortium – a forum for collaboration and coordinated stewardship for a region with complex inter-jurisdictional governance.

To address the third priority of sharing data in near-real time, the five communities in the network created a web platform in 2014. A simple base map and corresponding time-lines were built, with profiles for community researchers where the results of salinity profiling, ice-core sampling and contaminants-monitoring could be shared online.

Not only did this prototype platform – initially named IK-MAP – prove compelling for data management among so many collaborators, it allowed each community to use its own knowledge systems to interpret data and to see how their results fit into the bigger picture. In the past, the results of research programs would far too often end up in an academic's file cabinet down south, never to be seen again.

Today, the information is accessible to everyone, including tech-savvy Inuit youth. New features have been added, allowing photos and posts to be tagged – not just for individuals, but also for wildlife species and the Inuktitut terminology for ice types, and for measurements, remarks and observations of all kinds.

Google Street View of the Arctic Sea Ice

In 2015, AES partnered with Google Earth Outreach to develop the first-ever Google Street View of remote sea ice – mapping not only the Sanikiluaq community, but also polynyas and floe edges in winter. The platform provided new ways for northerners and southerners to explore the Arctic sea ice.

The next step was to create a social media network and mapping platform, specifically by and for the Inuit. SIKU: The Inuit Knowledge Wiki and Social Mapping Platform was born, and came to life with new funding after

In 2015, AES partnered with Google Earth Outreach to develop the first-ever Google Street View of remote sea ice – mapping not only the Sanikiluaq community, but also polynyas and floe edges in winter. The platform provided new ways for northerners and southerners to explore the Arctic sea ice.



For more information scan this QR code.

Photo: Hunters near Sanikiluaq involved in community-driven research programs

dotal by scientists can be systematically documented and quantified. The data management and permissions approach protection policy means local populations can now be in charge of managing their data and intellectual property, as well as how they choose to share it.

Joel Heath – A Canadian scientist and filmmaker, Joel Heath has spent twenty years



in the Arctic with Inuit communities, combining his expertise in ecology, sea ice dynamics and mathematical biology with Inuit knowledge. He

is Executive Director and cofounder of the Arctic Eider Society [AES], an Inuit charity based in Sanikiluaq, Nunavut, Canada.

Lucassie Arragutainaq – A cofounder and Board Member of the Arctic Eider Society [AES], Lucassie Arragutainaq (Canada) is Director of the Sanikiluaq Hunters and



Trappers Association. A coauthor of *Voices from the Bay* (1997), he is responsible for many initiatives to mobilize indigenous knowledge.

winning the 2017 Google.org Impact Challenge in Canada. *Siku*, the Inuktitut word for sea ice, is itself a metaphor of ice as the structure of connectivity and change in the North.

The platform has brought together a wide range of tools and services important to the Inuit. Profiles for each community provide local weather, tides and sea ice imagery from multiple satellites in near-real time. It was officially launched in 2019. A mobile app has also been developed to significantly expand the scope of systematically documenting indigenous knowledge and observations.

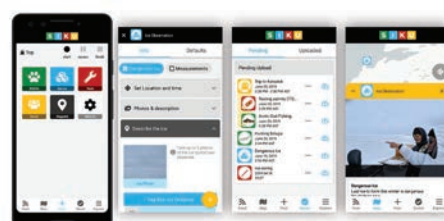
A New Era

Of course, the mobile app is no replacement for using a harpoon to check the ice or for experiential learning through elders. But

by combining the best of recent scientific approaches and centuries of indigenous knowledge, it is now possible to monitor dangerous sea ice conditions by using Inuktitut terminology to classify types of ice, as an example. It is hoped that this terminology will one day be integrated into machine learning approaches (Artificial Intelligence) enabling indigenous communities to access relevant information remotely – in real time, and in their own language.

Observations that were once typically written off by scientists as anecdotal can be systematically documented and quantified.

Young people can immerse themselves in local culture by sharing hunting stories and traditional place names. Observations that were once typically written off as anecdotal



Left: SIKU online platform showing left-side timeline and right side map windows with various features of the platform highlighted.

Above: SIKU Android App Screenshots.

Above right: SIKU Screenshot showing Ice Roughness product (Green is smooth, yellow medium, purple rough) near Cambridge Bay, Nunavut.

