CASE STUDY
ALASKA CENTER FOR CLIMATE ASSESSMENT AND POLICY, UNIVERSITY OF ALASKA FAIRBANKS
FAIRBANKS, ALASKA, USA

The Historical Arctic Sea Ice Atlas

It has been more than twenty years since three bright minds came together at the International Arctic Research Center of the University of Alaska at Fairbanks to create a unique historical atlas of Arctic sea ice development.

Today, this atlas covers almost two centuries reaching back as far as 1850, offering a comprehensive timeseries of the Northern circumpolar ice shield. Spatial and temporal analysis eases discovery of patterns and assessing changes. This provides valuable historical context for Arctic ecosystem researchers as well as the general public. Its Web frontend relies on the rasdaman datacube engine as its backend.

„Our overall experience with rasdaman is very, very, very positive. The data model is a perfect match for the multidimensional Big Data that we have."

Bruce Crevensten
Technical Lead
International Arctic Research Center
University of Alaska Fairbanks

The idea was born in early 2000: Compiling all sorts of sea ice data in Northern Alaska –from whaling-ship logbooks to satellite imagery – to show how sea ice concentration has changed over the decades. „This was our vision", says Dr. John Walsh, Professor at the University of Alaska Fairbanks (UAF) International Arctic Research Center, and winner of the Mohn Award 2022 for his leading role in establishing a common understanding of how sea ice dynamics links intimately with ongoing changes throughout the Arctic system.

rasdaman
raster data manager

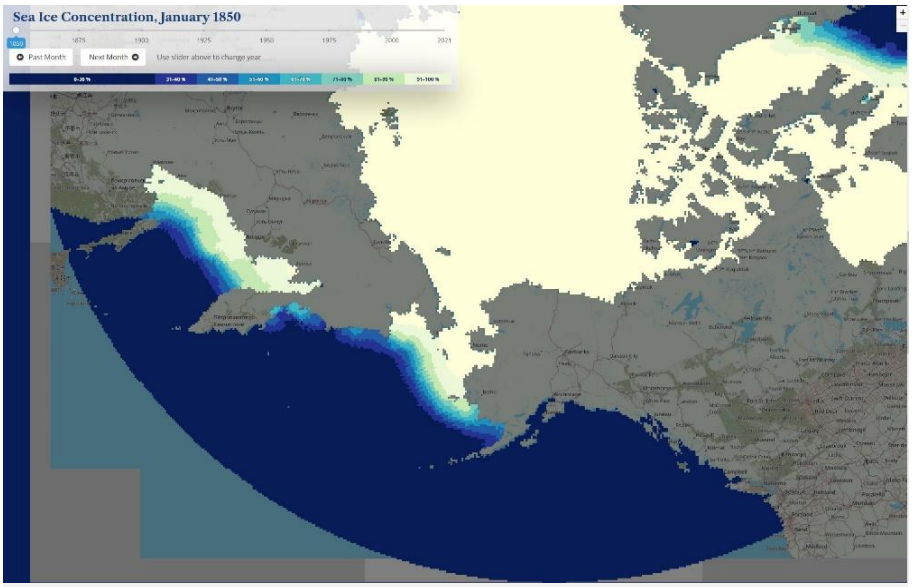
Walsh did not keep his vision for himself, but shared the idea with two fellow campaigners at UAF, Bruce Crevensten and Bill Chapman.

Ultimately Walsh convinced both to join the Scenarios Network for Alaska and Arctic Planning (SNAP) which works with University researchers, agencies at all levels, and residents of Northern communities to create climate data products tailored to regions and communities in Alaska and Western Canada.

Crevensten had a strong interest in high-performance scientific computing. He joined SNAP in 2011 and soon became Technical Lead of the project. Software expert Chapman has earned great merits with his meticulous work of transcribing and digitizing all the paper charts.

Together this team took the long way from idea to implementation.

„Choosing a location and a year of interest and see what the sea ice looked like: where was it found most often, and least often, throughout the year? These were questions driving us", Crevensten remembers from the early days. So they started out to design their unique new service.



North polar sea ice concentration in January 1850.

A Unique Service

The result is truly impressive. The web-based atlas shows historical sea ice data collected around Alaska from the mid-1800s through day. Available data have been compiled for display on an interactive map. The atlas gives users the opportunity to view sea ice data from multiple sources in a single view, and allows experiencing long-time-series-analytics at its best. By moving a slider visitors can explore changes in sea ice cover over 170 years in real-time.

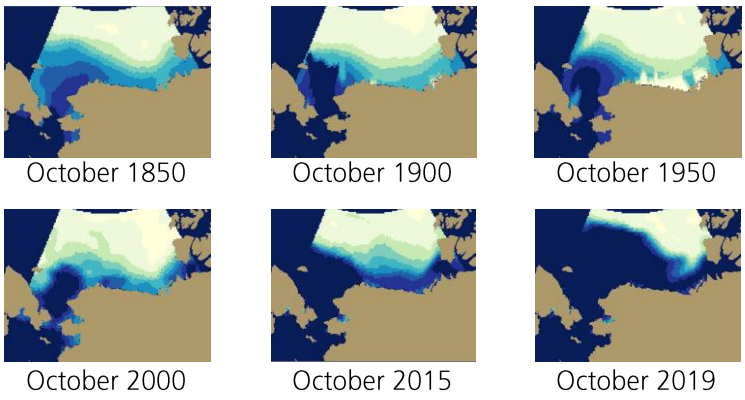
„rasdaman is very, very powerful. And we're also very, very grateful to the rasdaman developer community. It was really fantastic to have the help of the contributors."

Dr. John Walsh
Chief Scientist
International Arctic Research Center
University of Alaska Fairbanks

Challenging Ground Work

In the early phases the team brought together diverse historical databases. Atlas data begin in 1950 with observations extrapolated from ship logbooks in the Beaufort, Chukchi, and Bering seas.

A truly exceptional challenge consisted of evaluating the whaling ship logs. Those were essentially "spot reports" from a ship in a particular location where sea ice was sighted and documented.



Change of sea ice shield 1850 – 2019, visualized through the Historical Sea Ice Web tool running on the rasdaman datacube engine as backend.

"We plotted the reports and pencilled in the ice boundary based primarily on the whaling ship reports for a particular month. So we essentially drew our ice chart for those months when whaling was active", Walsh remembers.

They transcribed the information onto a common chart for each month and created different regional maps under one master map covering the entire Arctic. Gaps in log book data were filled with estimates.

Later the team started adding aircraft reports. "If a plane flies over the ice you get a lot more information than you could expect from a ship or a coastal observer", says Walsh.

The aerial survey era began in the 1930s when airborne observations increasingly augmented what was available from ships and from ground.

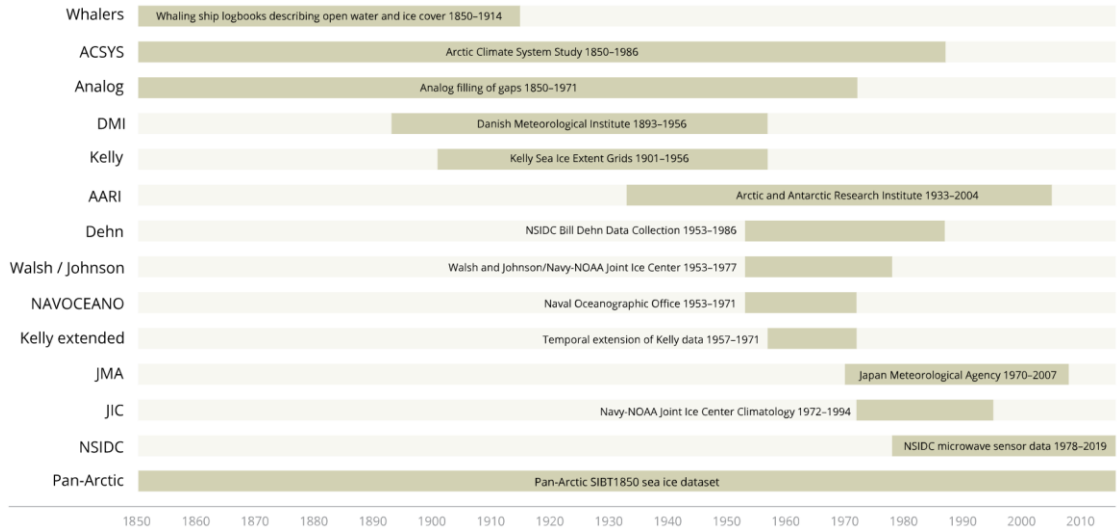
More than fifty years later satellite imagery was added to the plot. Starting in 1979 satellites like Landsat provide consistent coverage of the whole Arctic, with a complete map essentially every day.

All these observing tools come in different formats, conventions, and encodings, each with its individual characteristics.

Adding More Heterogeneity

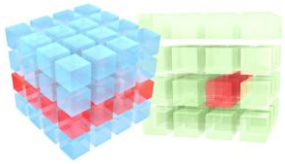
„Sea ice is an interesting variable in the sense that it covers many nations and territories", Walsh explains. Historically, he details, tracking the charting has been done regionally different by the various nations. Also charting conventions and interpretation of ice concentration have changed over time.

The data set collected, there-



Data sources for the Historical Sea Ice Atlas from 1850 onwards.

fore, initially was a huge fragmented hodgepodge. No guidance, no rules existed on how to homogenize them correctly. Walsh adds, "Putting together the existing pieces into a comprehensive database that would let us tie it into the global mate picture: That was our real motivation."



Datacubes

All these massively heterogeneous data coming from different sources had to be integrated into a single, coherent data collection. The rasdaman datacube engine played a substantial role because its architecture ensures not only fast and easy access on arbitrary-size datacubes, but additionally eases the process of homogenization during database import.

"Usually our work begins by using Python code to do some amount of data preprocessing and to get the data set into a consistent raster datacube format", Crevensten explains.

„rasdaman gives us both maps via the WMS protocol and point queries via the WCS protocol. It's great because it solves our team's challenges with it so far."

Bruce Crevensten
Technical Lead
International Arctic Research Center
University of Alaska Fairbanks

The OGC standards, especially the WCPS datacube language, increase interoperability and allow for a seamless process integration at a stellar performance.

In fact,, rasdaman acts as enabler: standing up and operating a service is made easier by pushing technicalities "behind the curtain".

In the atlas, a number of different Web technologies is combined for visualization and interaction with the datacubes served by the rasdaman backend.

The Big Picture

With SNAP, the Fairbanks International Arctic Research Center uses a wide trum of data to help Northern communities envision future climate scenarios.

Several climate tools are offered, an important one being the Historical Sea Ice Atlas. As it stands, this atlas is not only attracting ers, but a much wider range of communities – even ance companies and shipping industries are extremely interested in the continuity of the sea routes.

Get in Touch

The Sea ice Atlas team welcomes email communication via nlfresco@alaska.edu

About rasdaman

With rasdaman, actionable spatio-temporal datacubes have been pioneered, documented by patents and publications. The innovative datacube query language enables „any query, any time, on any volume". Rasdaman is standing out through its flexibility, scalability and performance, security, and the consequent support of open datacube standards being the official OGC datacube reference implementation and the EU INSPIRE Good Practice Its technological lead has been acknowledged by a series of high-ranking national and international innovation awards. The technology is continuously being advanced by rasdaman GmbH and Jacobs University and defines the state of the art in datacubes in science and engineering.