

Sea State and Boundary Layer Physics

The Emerging Arctic Ocean

Jim Thomson: We talk about the emerging Arctic. An Arctic that now has more open water. That has less sea ice. And an Arctic that potentially has quite a bit bigger role for waves to play.

Narrator: October 2015. The western Arctic Ocean. The fall freeze-up in the Beaufort and Chukchi seas is closely observed and measured during a 42-day research cruise aboard the *R/V Sikuliaq*.

Thomson: We're up here on an ice floe in the Arctic Ocean conducting the Sea State and Boundary Layer Physics Experiment. It's fall right now and there's ice growing all around us....

Narrator: Jim Thomson of APL-UW served as chief scientist, heading up the sea state team drawn from nearly 20 major research universities and laboratories. The focus is on helping the Navy understand and forecast the presence or absence of sea ice in the Arctic.

Thomson: Our big question was: in the fall when the ice starts to recover and advance to the south again, what are the waves doing in that system? And what are the storms doing in that system? Do they matter?

We are standing on the Arctic Ocean right now at about 74 degrees north and this piece of ice we're on is about six inches thick.

Narrator: Sea state scientists employed a variety of sensors to gather data from the surface and from below the ice. Other data were gathered from space-based platforms, from balloons, aircraft overflights, and autonomous aerial systems.

Guy Williams: We're flying this fixed wing. It's doing an autonomous grid over the surface of the ice and we're hoping that it will match up with the AUV under the ice.

Narrator: The *Sikuliaq* took the team to the marginal ice zone, where ice begins to form in open water. It often forms as pancake ice, once seen mostly in the Antarctic, but now described by Jim Thomson as the dominant icing process — the new normal — in the Arctic.

Thomson: So, is the freeze-up a different thing now? And indeed that's what we saw. We saw pancake ice everywhere. Throughout the entire trip, we saw pancake ice.

Narrator: The focus now is waves and how they interact with the newly-forming ice.

Thomson: When we go out to the ice edge, we expect to see something else come into play. We expect to see a mechanical process — the waves coming into the ice edge and those waves can break up the floes. They can change the size of the floes as they do that. They can flex them and weaken the ice.

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Thomson: One of the most dramatic events we sampled was on October 12th. It really lasted a few days.

The main portion of the Beaufort was still open water at that point. And a strong easterly wind event came through that built large waves — waves that got to almost five meters in height. And the winds were something like up to thirty knots. And these waves were coming into the newly forming ice and making pancake ice.

We saw this happening so we quickly made a plan. And we put out this long array of buoys. We put out a total of 16 different types of wave measurement buoys.

Thomson: So what we thought we were going to do was put these buoys out and they would measure the waves for awhile until the ice slowly started to mature enough so that it damped the waves. And the pancakes would start to lock together and then the waves wouldn't be able to penetrate further into the ice pack and that would be the end of the event. But that's not what happened. What happened is the ice went away. Almost all the ice melted — really unexpected by everyone on board the ship.

There was a very warm layer of water 20 meters down beneath the surface. And these waves coming in were enough to drive additional mixing and bring that warm water up from the subsurface and that warm water melted the ice and changed that balance happening at the surface.

Thomson: And so, the waves can win the battle. But the ice will always win the war. By the time we get to December, late fall in the Arctic, there will be ice cover everywhere. But it's not simply a steady progression of the polar ice cap southward in the fall. It's a much more complicated process.

Narrator: The sea state cruise brought back physical ice samples, imagery, CTD measurements, and more — a massive data set assembled by the sea state team, data that will shed light in the years to come on the autumn ice advance and the role of waves in the Arctic Ocean.

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