Determining Light Extinction Through Arctic Sea Ice Using a Self-Built Device

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Introduction & Research Methods

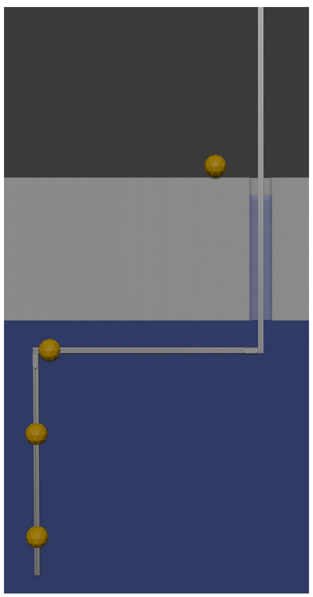
I went to Utqiagvik, Alaska in early March of 2024 with a group of other Radford University students, each with our own project. My project was focused on determining the effect ice thickness had on light intensity that was lost through the ice.

Challenges included the design of a tool that can operate through a 4-inch diameter hole in the sea ice, getting that tool back from beneath the ice, mechanical issues, and waterproofing electronics.

To collect data, we used a 4-inch-diameter ice corer to drill hole at various locations a few hundred meters from the shore. At each location, the ice thickness was measured, the tool was deployed, and each sensor took multiple readings before folding the tool and pulling it back up through the ice.

This tool was also used in a pond in SW Virginia.

Tool



Data & Calibration

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 Sensor: Surface
Gain:  1x (Low) Timing: 100 ms

[ 1349018 ms ] IR: 1697  Full: 3580  Visible: 1883  Lux: 4040.9
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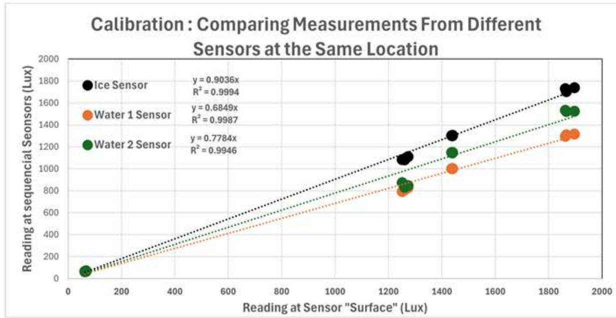
		Raw Data					Calibrated			
	Thickness (m)	Sur	Ice	Wt1	Wt2		Sur	Ice	Wt1	Wt2
278	0.67	4040.9	105.3	86.8	99.8		4040.9	116.5	126.7	128.8
		3832.0	105.1	87.4	100.0		3832.0	116.3	127.6	129.1
		3817.6	104.4	87.6	100.7		3817.6	115.5	127.9	130.0



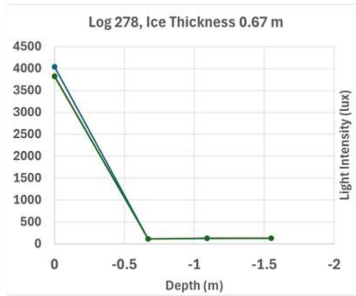
Data Analysis

Hole ID	Depth (m)	Average I_f/I_i	a (m^{-1})
278	-0.67	2.98%	-5.24
281	-0.64	3.93%	-5.06
282	-0.635	4.40%	-4.92
289	-0.66	5.02%	-4.53

$$I_f = I_i * e^{-a*d} \rightarrow a = ln\left(\frac{I_f}{I_i}\right) \div -d$$

The light coefficient α of sea ice was calculated using the equation above.

While this tool took 2 additional readings under the ice, they were comparable to the reading directly below the ice and varied too much to determine an extinction coefficient of the sea water.



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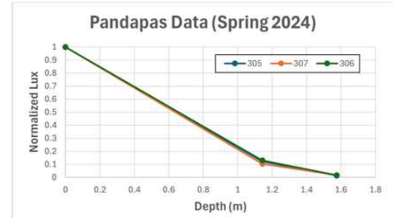
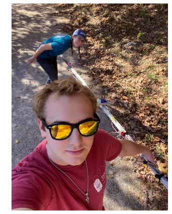
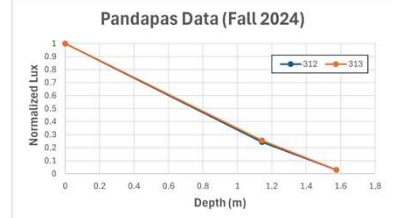
Local Comparision



Log #	Average I_1/I_i	Average I_2/I_i	a_1	a_2	$a_{1\text{->}2}$
305	12.2%	1.4%	-1.84	-2.73	-5.09
306	13.1%	1.6%	-1.78	-2.63	-4.88
307	10.3%	1.6%	-1.99	-2.63	-4.33
312	24.3%	3.0%	-1.24	-2.23	-4.88
313	25.6%	3.0%	-1.19	-2.23	-4.96





Discussion

While this tool was not able to directly measure the direct effect of ice thickness on light intensity, it was able to calculate light extinction through the sea ice. To further improve this tool, the addition of multiple sensors at smaller fixed intervals along its length would create a smother plot, allowing for the measurement of many “layers” in the ice or water.

References

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