A Spring Bloom in the Arctic Ocean

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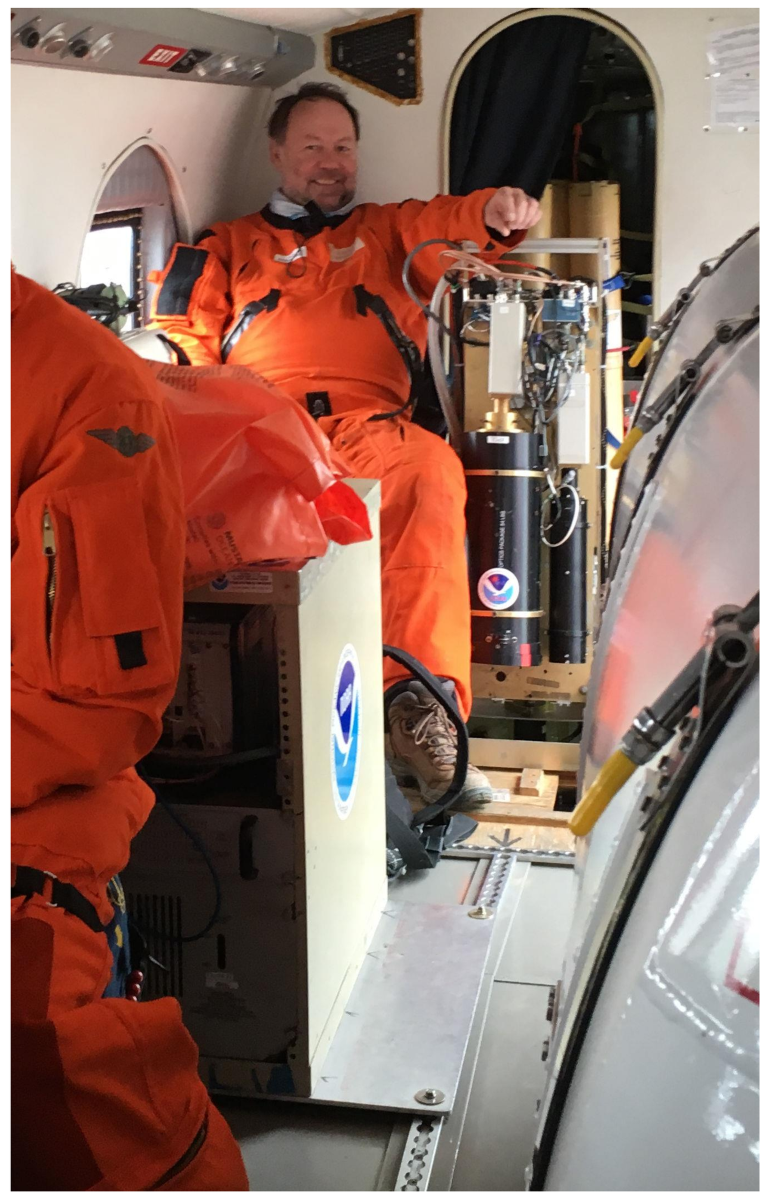
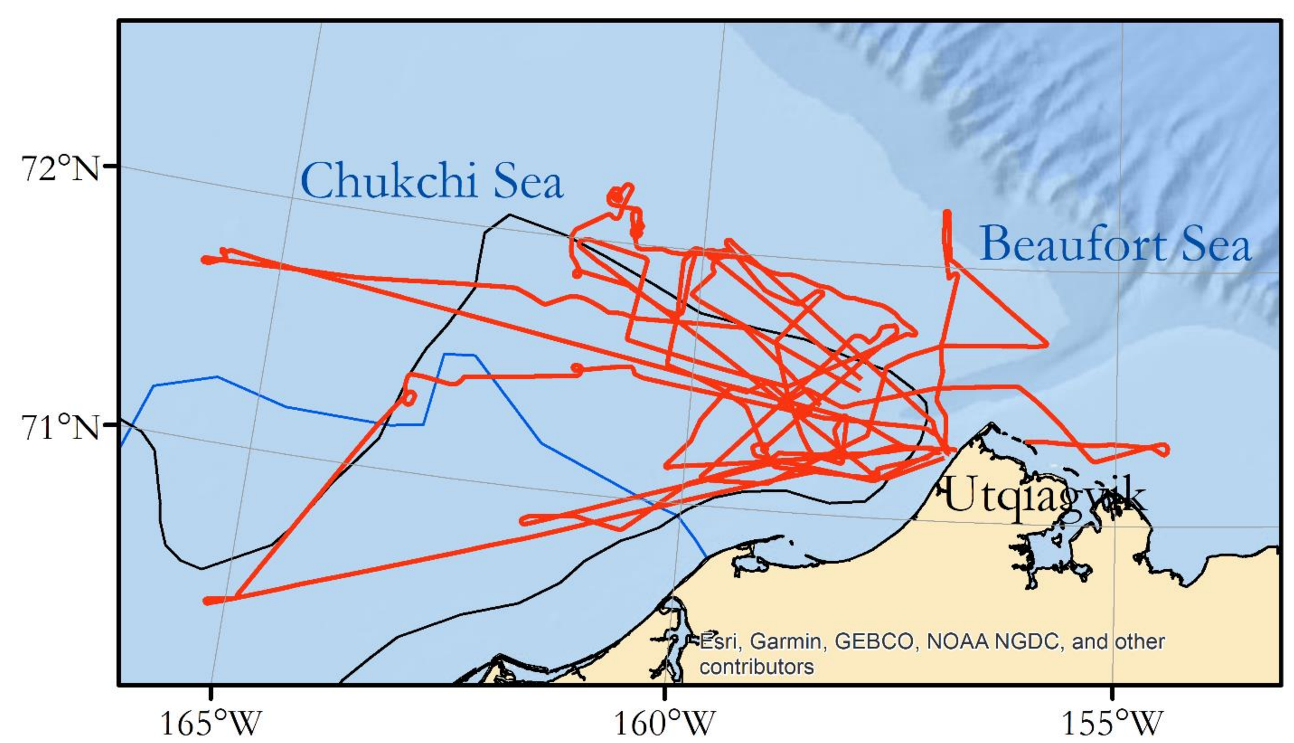


Photo of lidar optics package in rear of NOAA Twin Otter and electronics rack in front of operator (Marchbanks). Both lidar components can be identified by NOAA stickers.

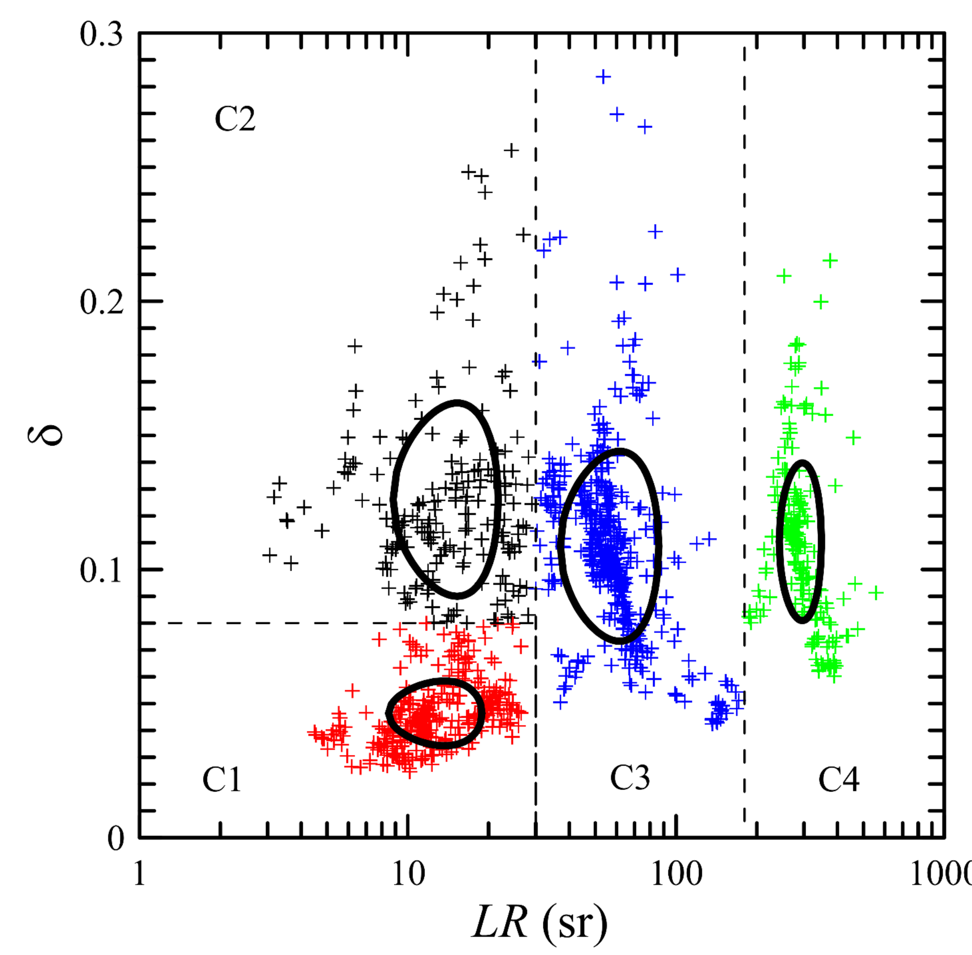
The lidar has a wavelength of 532 nm (green), a pulse length of 12 ns, a pulse energy of 100 mJ, a pulse rate of 30 Hz, a spot diameter on the surface of 5 m, and a digitization rate of 1 GHz.

BACKGROUND: In May, 2019, we measured optical properties of a spring phytoplankton bloom in the Chukchi Sea in the Arctic Ocean northwest of Alaska. The airborne lidar provided profiles of the optical attenuation, backscattering, and depolarization of the water column at the laser wavelength of 532 nm. Depolarization and the ratio of attenuation to backscattering (lidar ratio) depend strongly on the optical characteristics of the scattering particles and very weakly on their concentration.

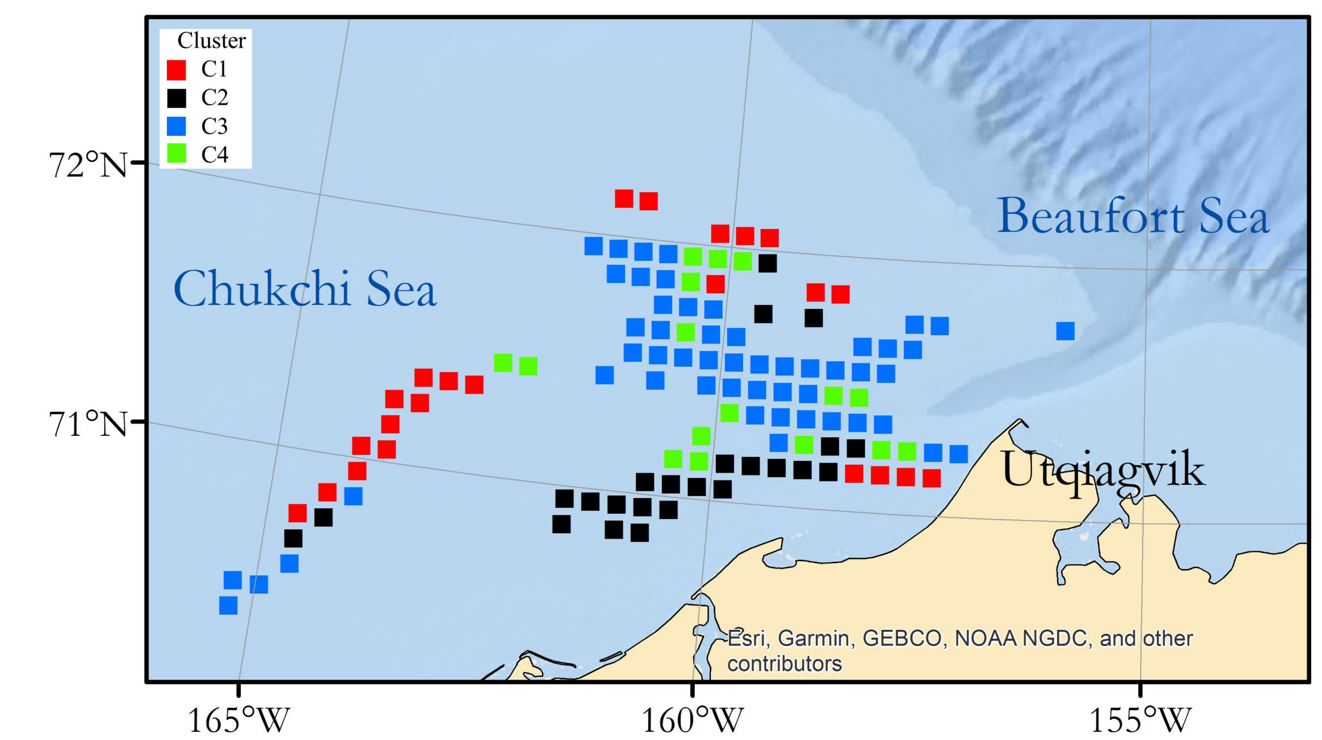


Map of the Arctic Ocean north of Alaska with the lidar flight tracks shown in red. The black line shows the position of the ice edge on May 23, 2019, in the middle of the survey. The blue line shows the position of the ice edge for a previous survey in July, 2017. Flight altitude was 300 m.

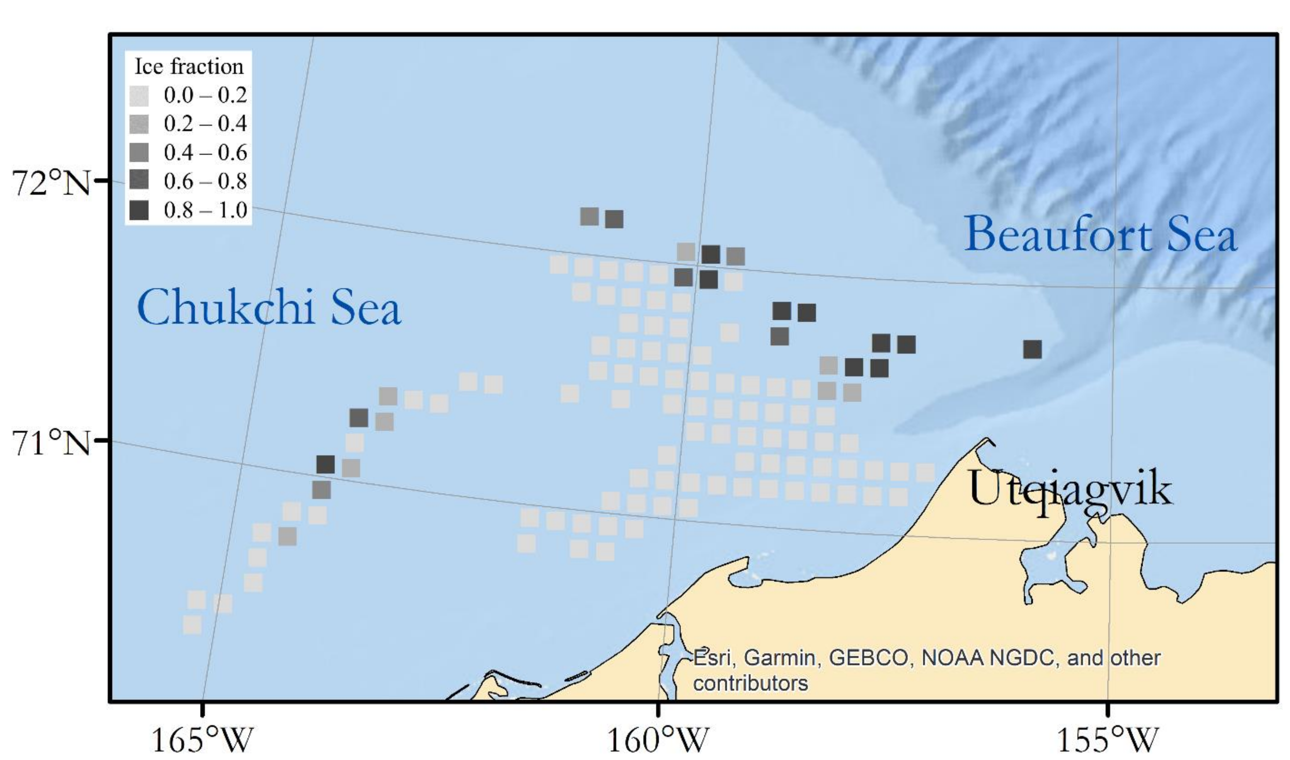
CONCLUSIONS: Both attenuation and backscattering were highest in open water and decreased with increasing ice cover, although the relationship was not strong. High values of both optical properties were observed in the pack ice up to ice fractions of 90%. Where there was complete ice cover, the lidar was not able to penetrate between floes to make the measurement. Attenuation is most closely associated with chlorophyll concentration, while backscatter is most closely associated with the concentration of particulate organic carbon, so we get two different estimates of parameters of the spring phytoplankton bloom. With the additional information from depolarization of the lidar return, we were able to determine that there were several distinct types of scattering particles in the lidar data, although we were not able to identify these particles.



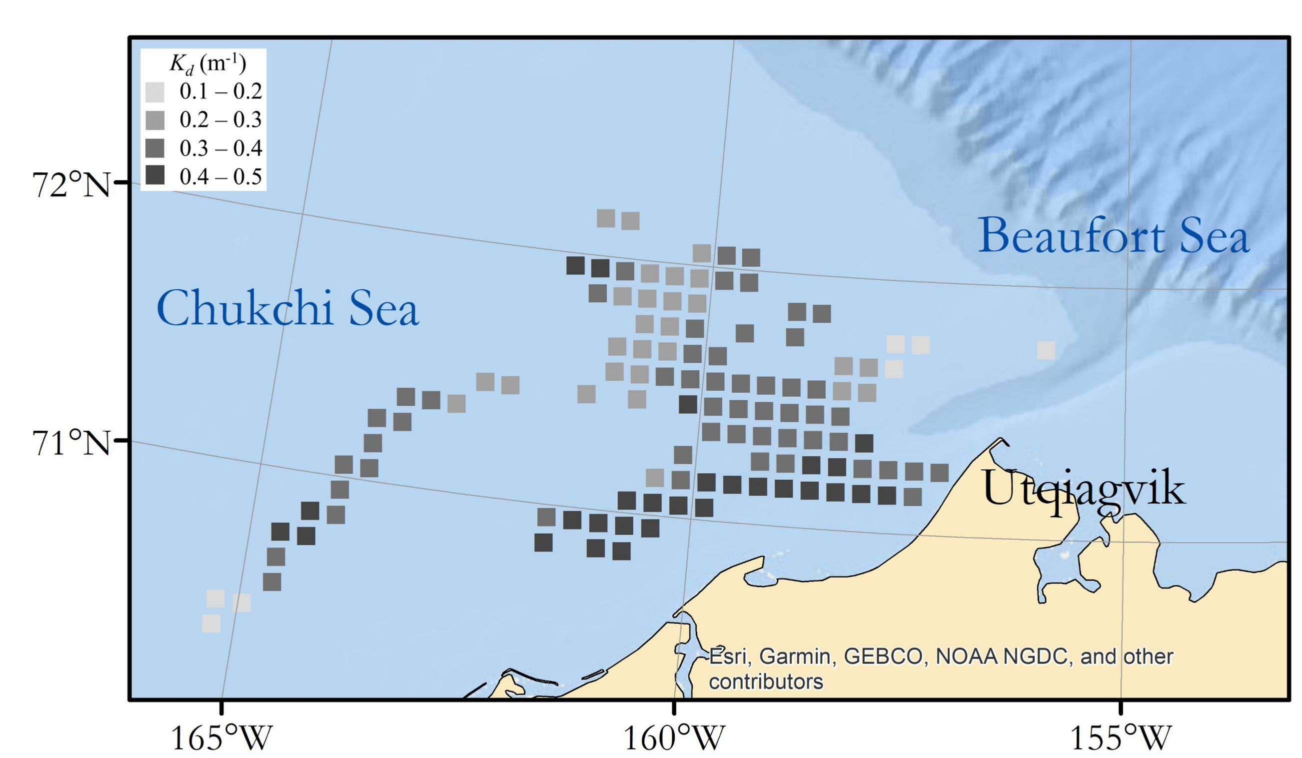
Scatter plot of depolarization ratio, δ, as a function of lidar ratio, *LR*. Each of the four clusters is plotted as a different color, the boundaries as dashed lines, and the one standard deviation contour for each is marked with a bold black line.



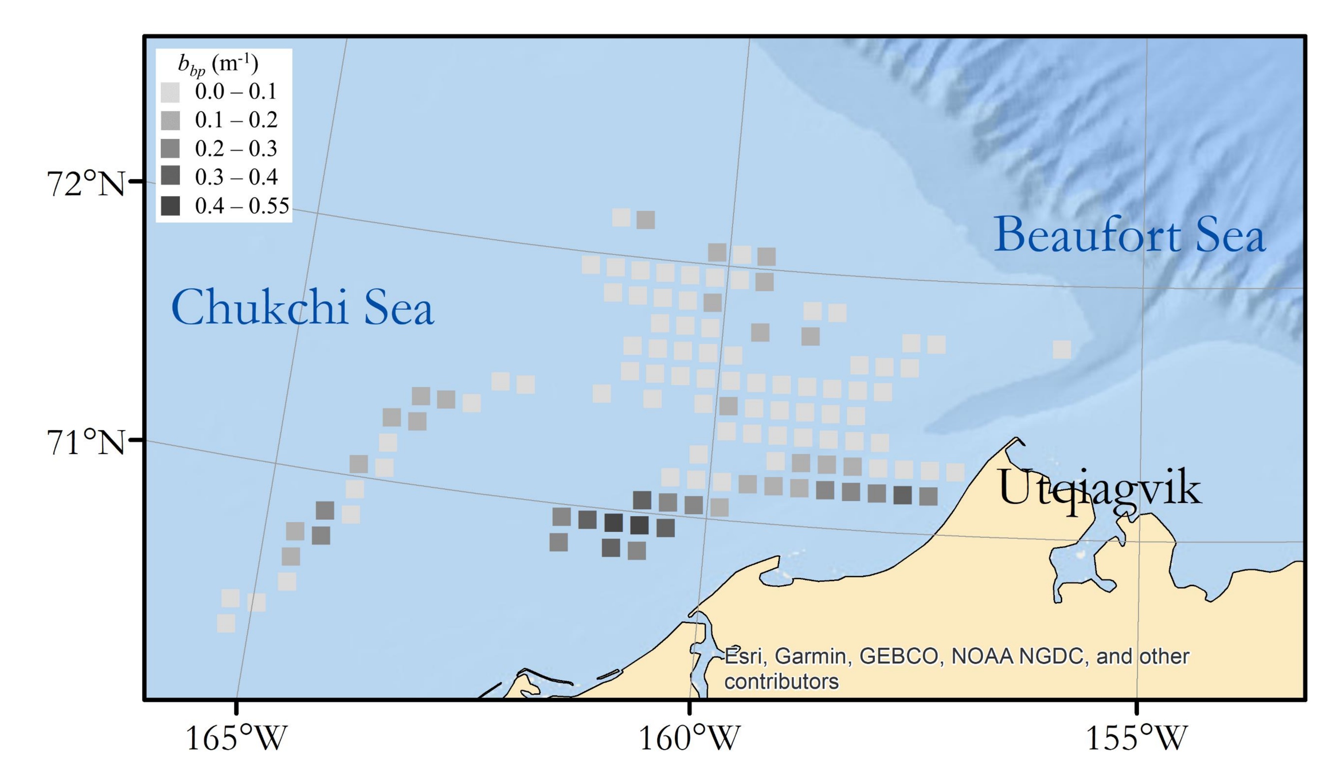
Most common cluster in each of the lidar data spatial bins. Blue (C3) is mostly in open water, red (C1) is mostly in broken ice, black (C2) is mostly along the land-fast ice near shore, and green (C4) is more scattered.



Binned ice fraction from the lidar data. Pack ice was generally to the north and west of the open water.



Binned diffuse attenuation coefficient, K_d, from the lidar data. Higher ice concentrations were correlated with lower diffuse attenuation, suggesting lower chlorophyll concentrations.



Binned particulate backscatter coefficient, b_{bp}, from the lidar data. Higher ice concentrations were correlated with lower backscattering, suggesting lower concentrations of Particulate Organic Carbon (POC).