LIDAR PROFILES OF ARCTIC PLANKTON LAYERS AND THEIR DEPENDENCE ON SEA ICE CONDITIONS

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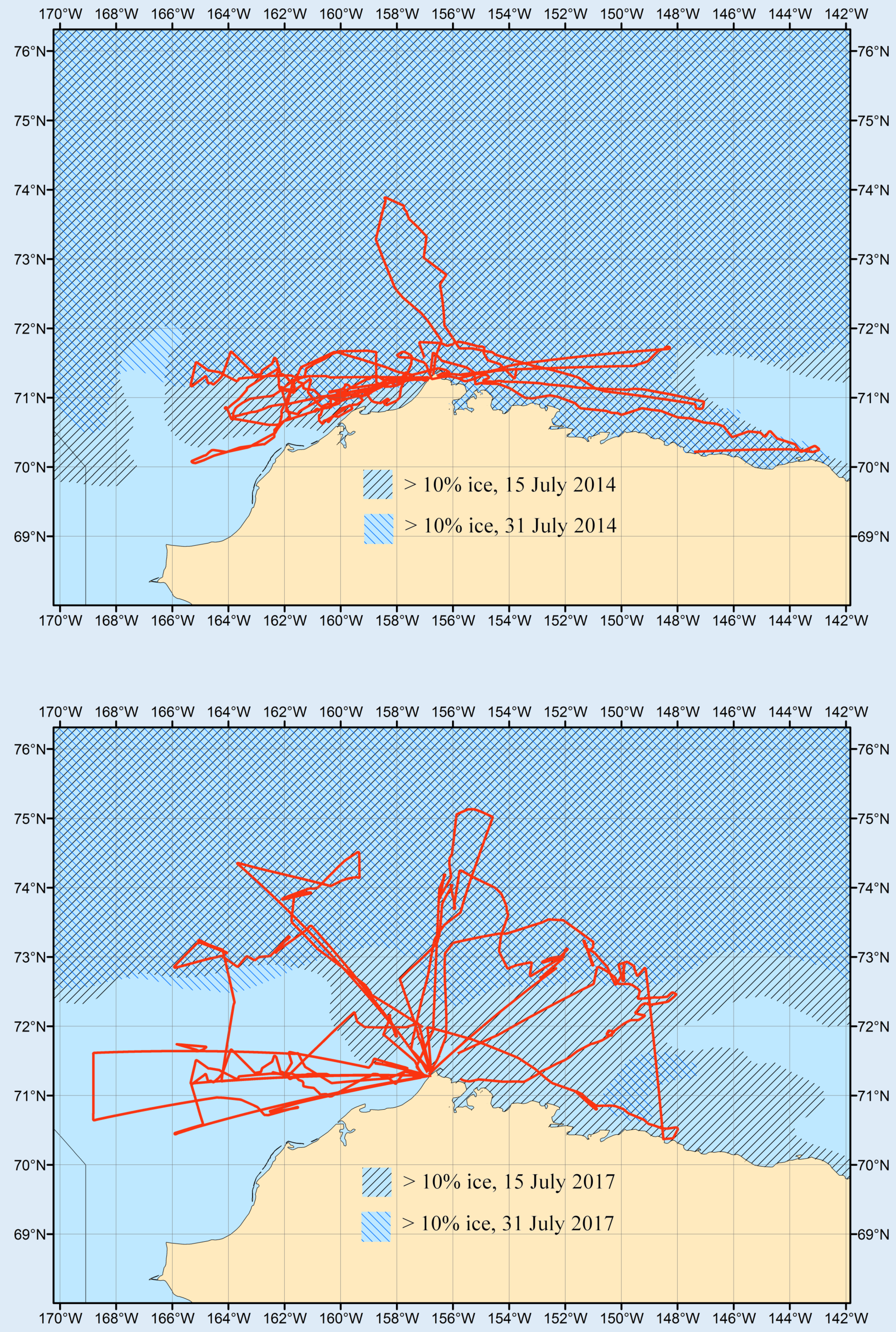
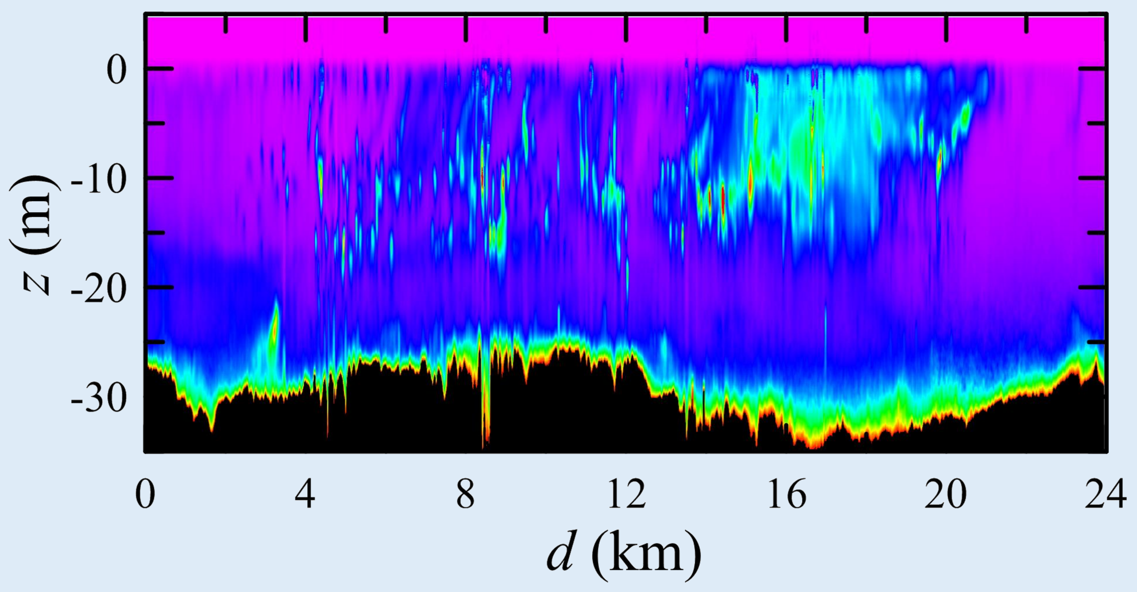
Airborne lidar surveys were used to characterize subsurface layers of phytoplankton in the Arctic Ocean during the latter half of July 2014 and again during the latter half of July 2017. The survey region included US waters in the Beaufort and Chukchi Seas. In 2014, layers were detected in open water and also in openings in pack ice where up to 90% of the surface was covered by ice. The layers in the pack ice were less prevalent, weaker, and shallower than those in open water. Layers were more prevalent in the Chukchi Sea than in the Beaufort Sea. Three quarters of the layers observed were thinner than 5 m. In 2017, ice conditions were significantly different. The ice edge was farther north at the beginning of the measurement period in 2017 and retreated faster during that period. This is likely the result of winds that were stronger and more southerly. Because the ice was farther north the second year, flights were conducted in the areas surveyed in 2014 in addition to areas near the ice edge, and more of the data were collected in open water. The layers were significantly weaker and thinner in 2017. They were slightly shallower in open water, but at about the same average depth in the ice.

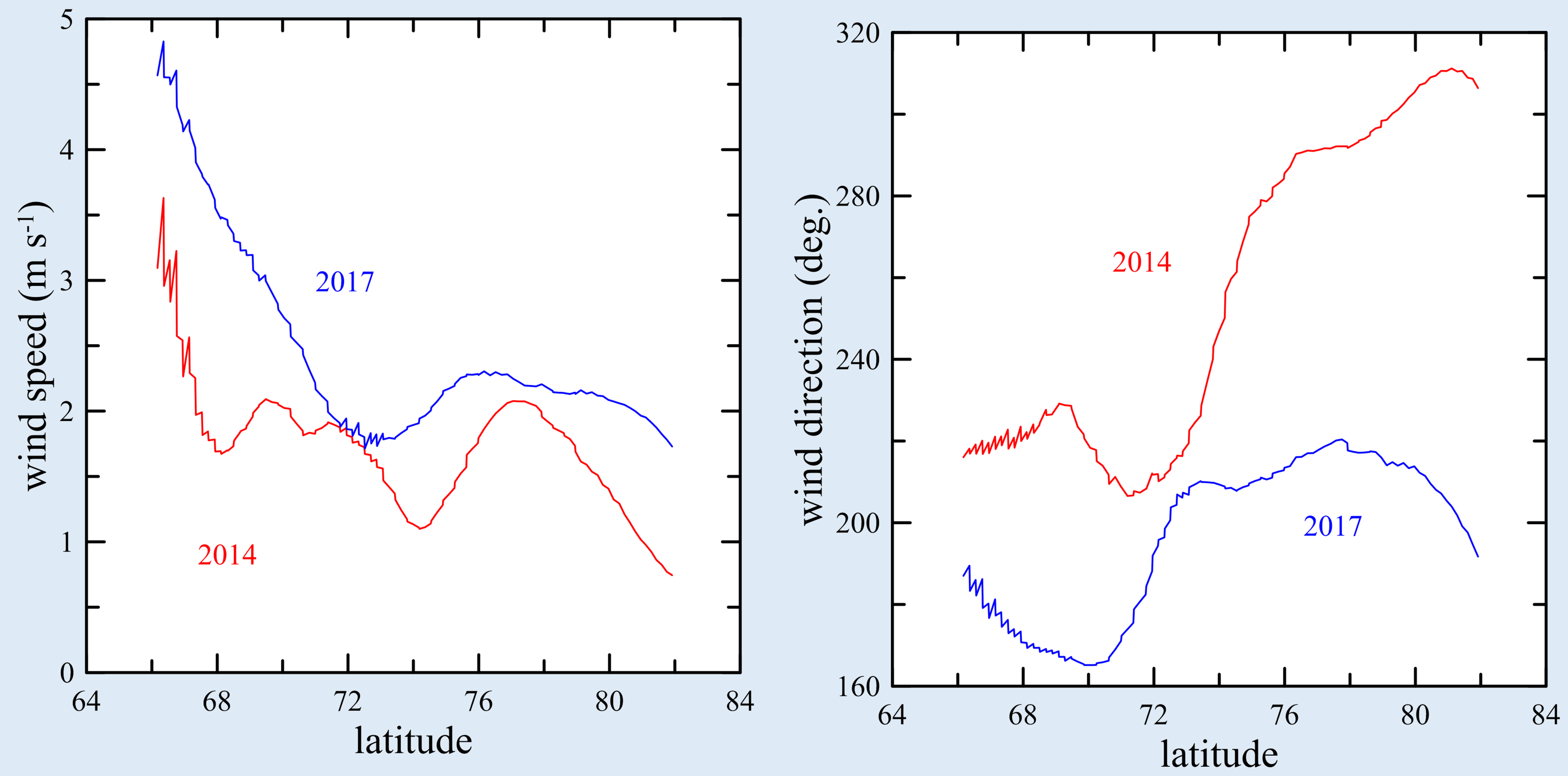
	2014: Open Water	Ice > 0.1	2017: Open Water	Ice > 0.1
Strength	27.0 ± 44.7	8.9 ± 14.0	10.7 ± 48.9	4.1 ± 5.6
median	12	5.1	2.6	2.2
depth (m)	19.6 ± 6.0	15.6 ± 6.2	18.5 ± 8.1	15.5 ± 7.0
thickness (m)	3.8 ± 1.5	3.4 ± 2.0	2.4 ± 1.6	2.8 ± 1.7



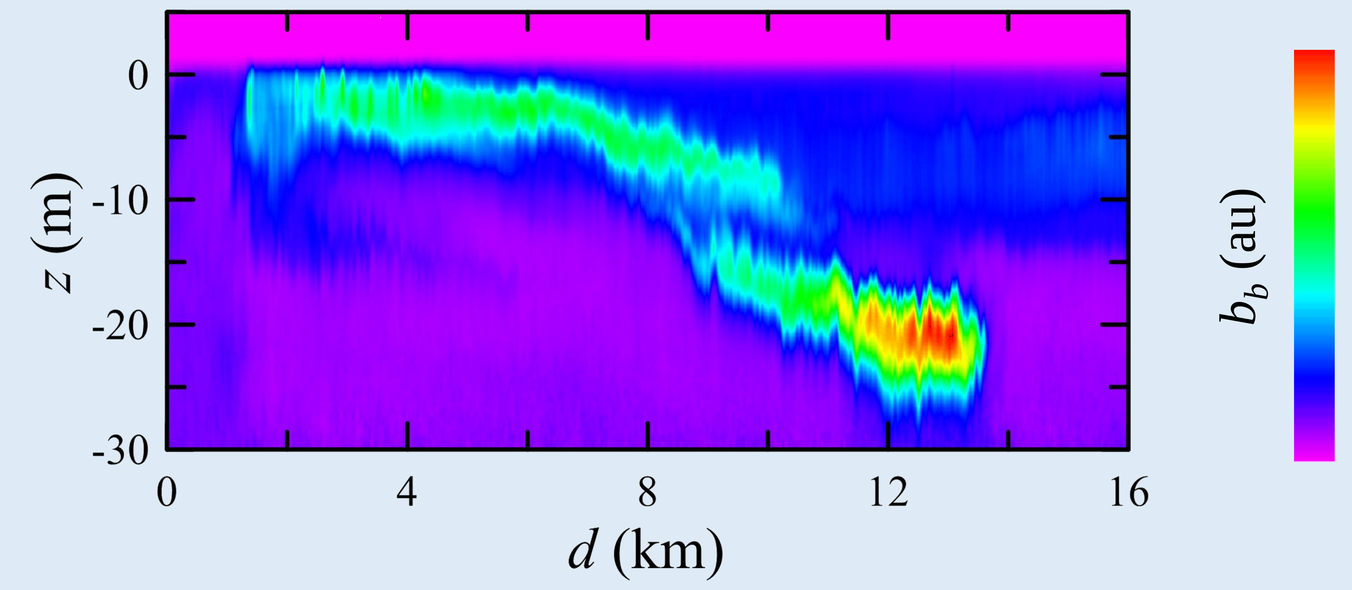
Map of all flight tracks for 2014 and 2017.



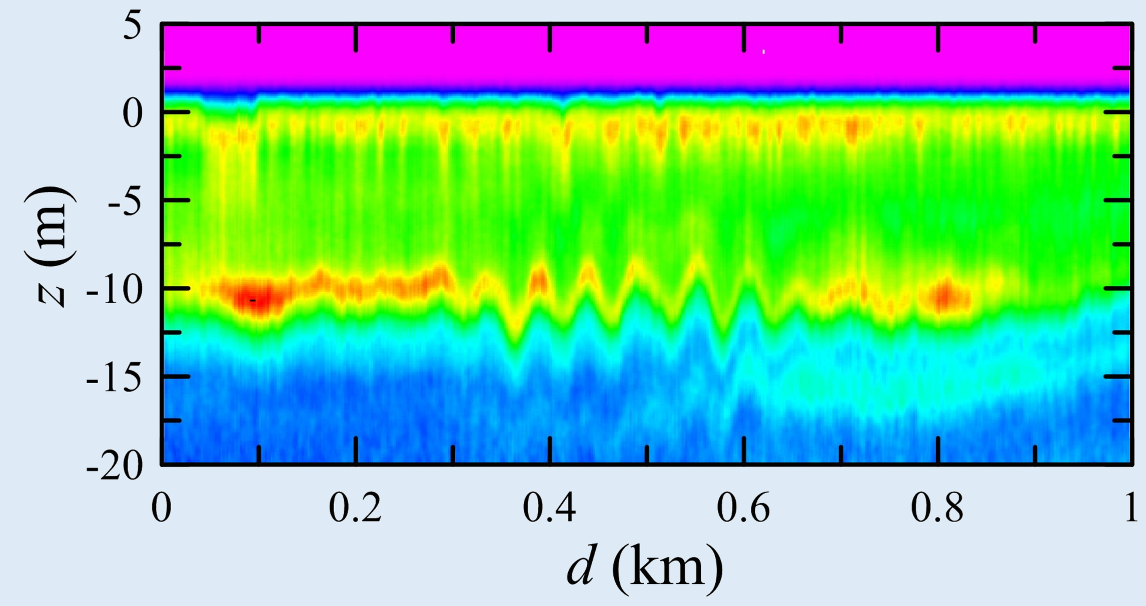
Example of lidar backscattering near feeding gray whales. Black is saturated return from bottom. Return above 20 m depth is from mud in the water, as seen in the photo below.



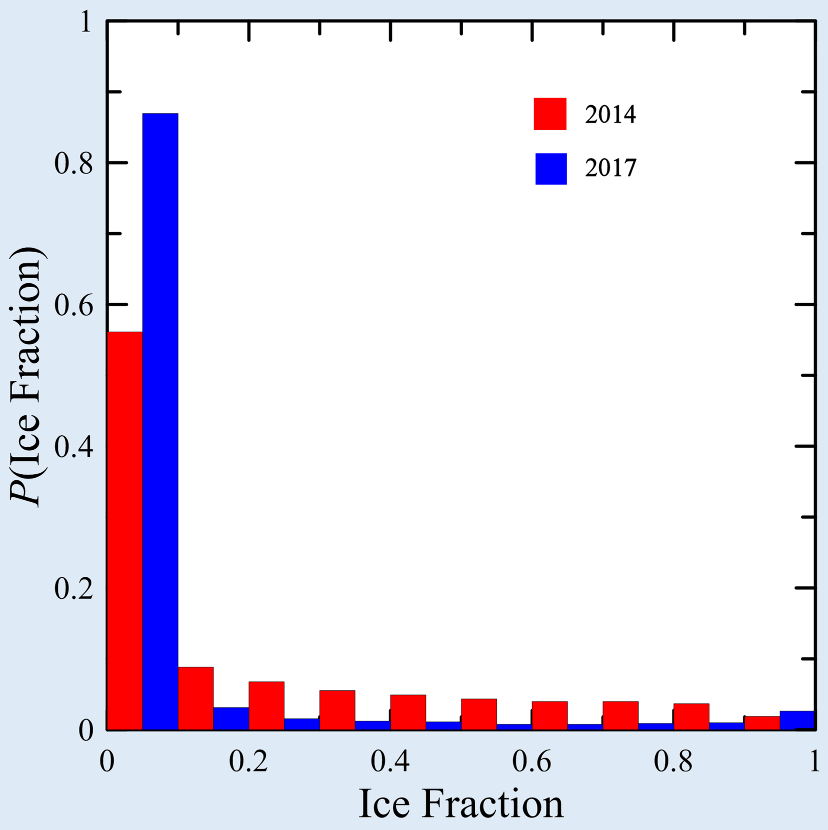
Average wind speed for 15-31 July in 2014 and 2017 between 168 and 170 W longitude from Bering Strait north. Winds were stronger and more directly out of the south in 2017, which would push the ice in the Chukchi Sea northward.



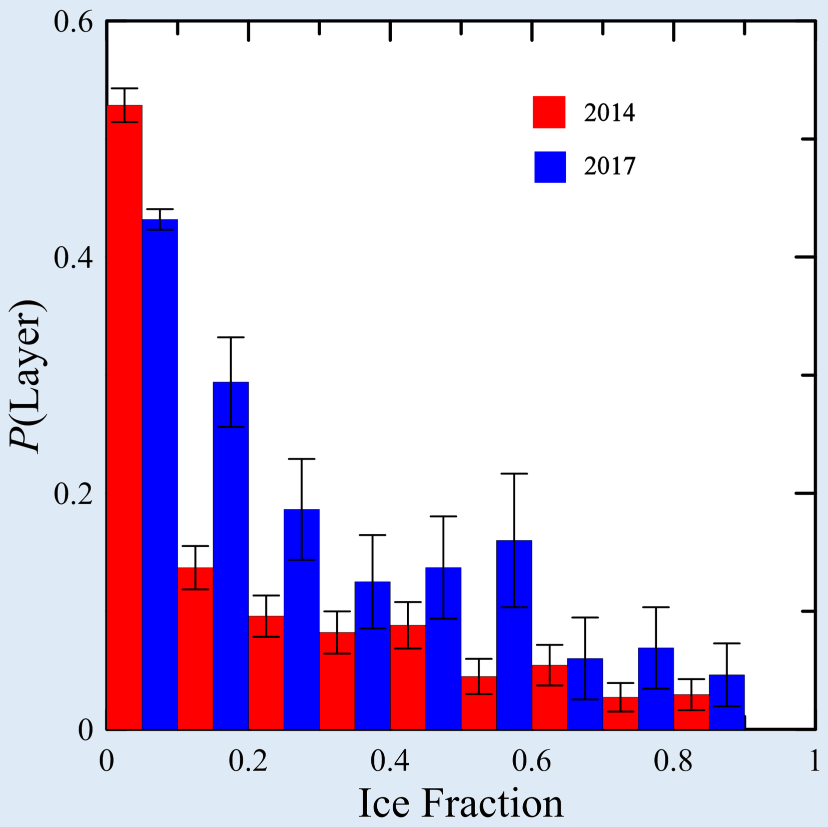
Example of lidar backscattering as a function of depth, *z*, and distance along the flight track, *d*, according to the color bar at the right. This is typical of the abrupt transition from a surface layer to a sub-surface layer.



Example of lidar backscattering (same relative color scale) showing effect of an internal wave on the iso-pycnal.



Probability, *P*, of encountering a given ice fraction in 0.1 intervals for each of the two years.



Probability, *P*, of encountering a layer at various ice concentrations for the two years. Error bars represent the standard deviation of the daily values.