Physical Changes in Air-Ice-Ocean Interaction in the Western Arctic
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Observations from airborne and satellite remote sensing can show how the western Arctic air-ice-ocean system has evolved in recent decades:
- ice edge retreat leads to local surface freshening from melt, aligned with ice edge position instead of latitude
- an accelerated ocean affects the strength and direction of ice-ocean stress and how the Beaufort Gyre accumulates or releases freshwater
- long-term changes in ice thickness and ocean salinity affect ice-ocean drag

Tools such as ocean measurement probes dropped from U.S. Coast Guard C130 Hercules aircraft (far left) and remote sensing of sea surface height and ice motion from satellites such as CryoSat-2 (left) provide much information about the ice-covered ocean without the need for in-situ measurements from ships or buoys.

Wind inputs momentum to the ice and surface ocean, and both the ice and ocean have sped up in recent decades. The role of the atmosphere can also be seen in the curvature of the sea surface height in response to hemispheric pressure fields. This response creates the characteristic Beaufort Gyre dome, visible in dynamic ocean topography (DOT).

The slope of this DOT creates geostrophic currents in the ocean; the relative speeds of the ice and ocean determine how much ice-ocean drag there is. Together with Coriolis effects, this drag determines how much freshwater is gathered or released from the gyre, which in turn feeds back to the height of the dome.

The amount of ice roughness and how fresh the water is at the ocean’s surface determines the amount of ice-ocean drag. The Beaufort Gyre has been freshening over the last few decades, and its younger, thinning ice cover tends to be smoother.

As the ice edge retreats each season, it leaves a shallow fresh layer in its wake. The background gyre is also visible in the form of curved isohalines (salinity surfaces) and lower-salinity water in the middle of the aircraft’s measurement path.

Funding for this work was generously provided by NASA and the Office of Naval Research

The basis of this work, including co-authorship and descriptions of all datasets and their processing, may be found in: