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:

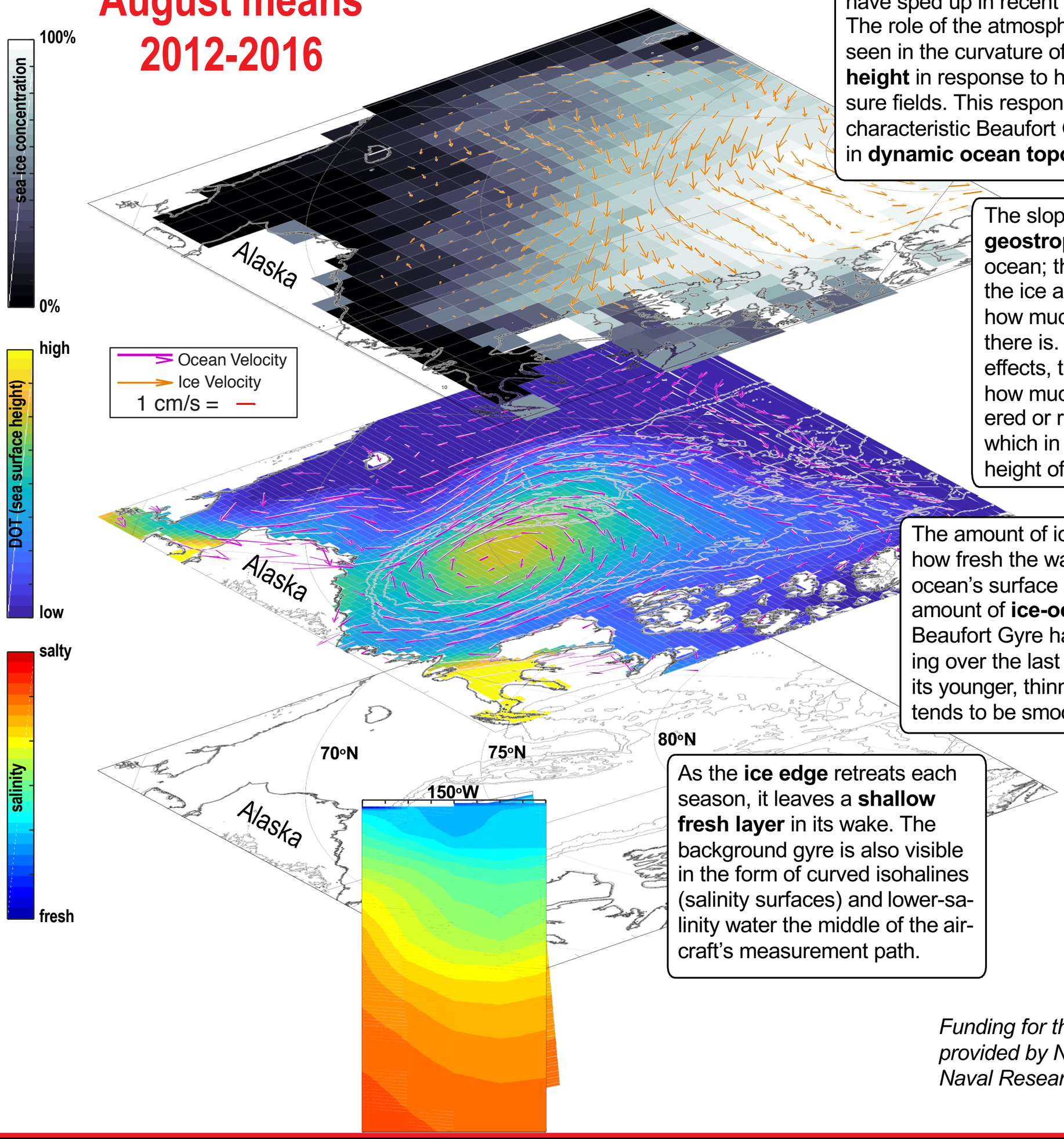
- ice edge retreat leads to local surface freshening from melt, aligned with ice edge position instead of latitude
- an accelerated ocean affects the strength and direction of ice-ocean stress and how the Beaufort Gyre accumulates or releases freshwater
- long-term changes in ice thickness and ocean 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.

August means 2012-2016

Ice

Ocean



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 the middle of the aircraft's measurement path.

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

This basin-scale view:

- complements in-situ observations and local knowledge
- relates regional change to large-scale and global climate processes

Satellite and airborne tools:

- increase observation access and frequency in space and time
- provide continuous sampling to monitor change

The basis of this work, including co-authorship and descriptions of all datasets and their processing, may be found in:
Dewey, S.R., Morison, J.H. and Zhang, J., 2017. An Edge-Referenced Surface Fresh Layer in the Beaufort Sea Seasonal Ice Zone. Journal of Physical Oceanography, 47(5), pp.1125-1144. doi:10.1175/JPO-D-16-0158.1
Dewey, S., Morison, J., Kwok, R., Dickinson, S., Morison, D. & Andersen, R.,2018. Arctic ice-ocean coupling and gyre equilibration observed with remote sensing. Geophysical Research Letters, 45. doi:10.1002/2017GL076229
Dewey, S., Morison, J., Kwok, R., Dickinson, S., & Morison, D., 2019 (in prep). Revisiting Empirically-Derived Western Arctic Ice-Ocean Stress Coefficients in the Age of Satellite Remote Sensing.