Circulation, hydrography and ice retreat around Hanna Shoal in Summer 2012

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Objectives and Methods

Numerical models (Winsor and Chapman, 2004; Spall, 2008) predict that the mean circulation is clockwise around Hanna Shoal in the northeast Chukchi Sea. We present the first observational corroboration of these model predictions based on results from data collected from the USCGC Healy cruise HLY1201 between 9 - 25 August 2012. The data included vertical profiles of temperature and salinity collected at 72 hydrographic stations surrounding Hanna Shoal and within Barrow Canyon (Figure 1) and underway measurements from the Healy's meteorological sensors and mounted acoustic Doppler current profiler (ADCP).

Results

A. Hanna Shoal Hydrography (Figs.1, 2)

►The bottom waters consisted of cold ($\theta < -1.5$ °C), salty ($S > 32.3$) dense water formed the previous winter. The densest water ($\theta < -1.7$ °C and $S \sim 33.4$) was trapped along transect I and transect V of the Shoal.

►Dense bottom waters were separated from surface waters derived from ice melt ($\theta > -1$ °C and $S < 30$) by a strong halocline at ~20 m depth.

►A ~10 m thick layer of moderately warm (> -0.5 °C) and salty Bering Shelf Water was observed along transect I of the Shoal wedged between the halocline and the surface layer.

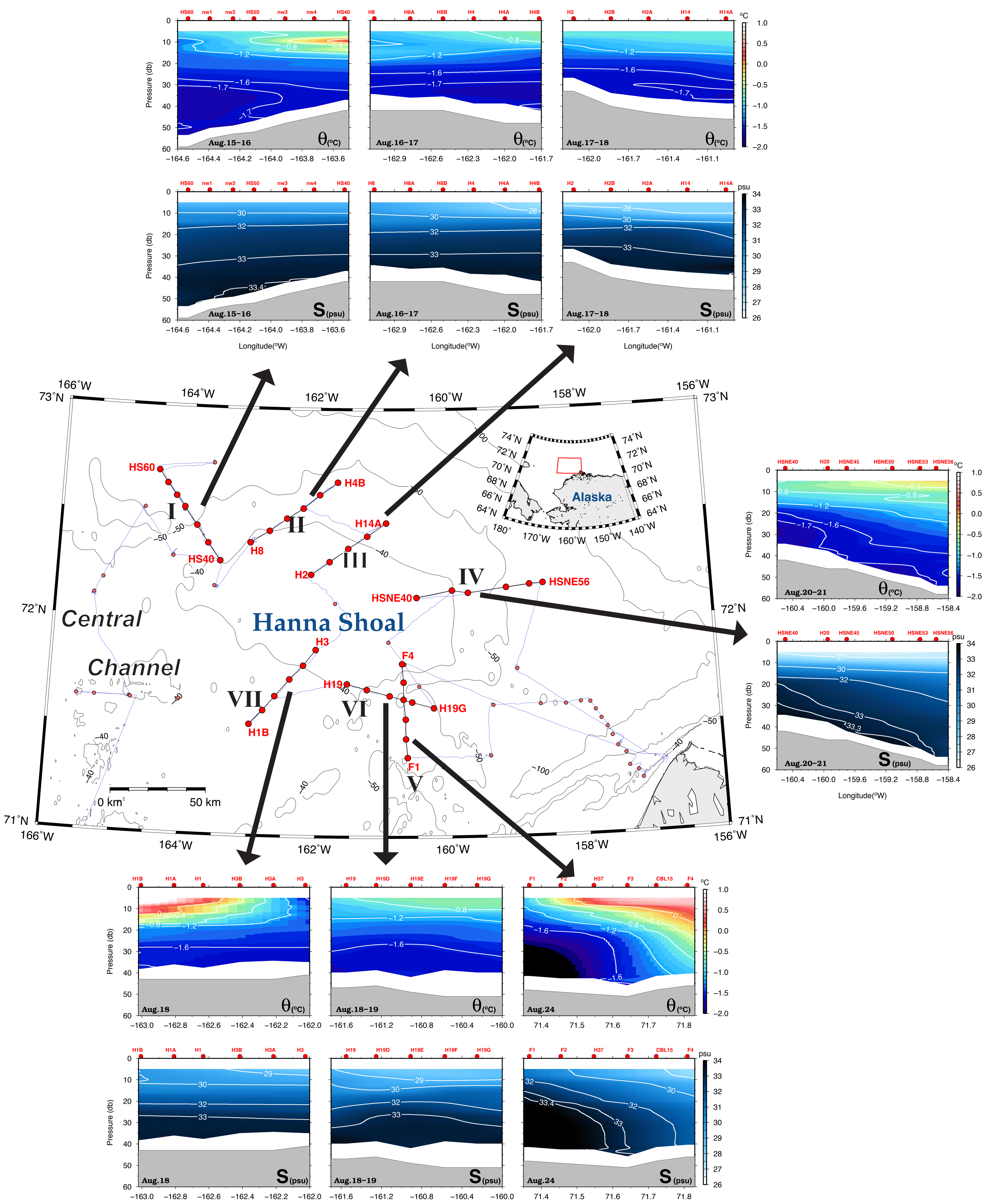

Figure 1, map of the hydrographic stations (red dots) on HLY1201 cruise, the ship track is shown in blue line. Seven selected CTD transects around Hanna Shoal are highlighted surrounding the map and show potential temperature (θ) and salinity (S). The time of each section is shown in the lower left corner of each panel.

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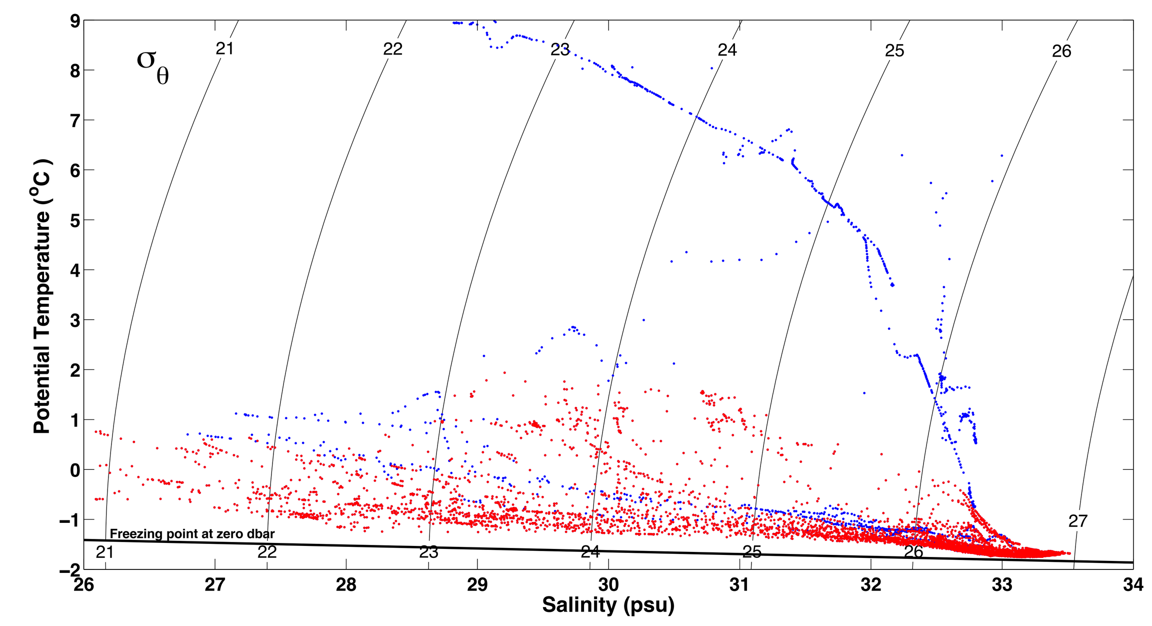

Figure.2, T-S diagram of the hydrographic stations in Figure 1. Measurements west of 158 °W (surrounding Hanna Shoal) are in red, whereas measurements east of 158 °W (in Barrow Canyon) are in blue. The warmest waters in this figure are associated with Alaskan Coastal Water, which was not encountered outside of the canyon.

B. Circulation and ice retreat (Figs.3 and 4)

►The ADCP data indicated a clockwise flow of 15 - 30 cm s^{-1} around the northern side of the Shoal. The transport between the 40 and 55 m isobaths in this region is ~0.2 Sv. The source waters for this flow likely include water flowing eastward from Herald Valley in the western Chukchi Sea and northward through the Central Channel southwest of Hanna Shoal.

►East of the Shoal the flow was southwestward and confined to the Shoal's flank.

►Farther to the east the flow was more variable but tended southeastward.

►Ice retreat commenced on the northwest side of the Shoal in the form of a narrow tongue, likely associated with the arrival of the Bering Shelf Water.

►The circulation was apparently uncorrelated with the winds, which were primarily from the north over most of the cruise. This suggests that the flow is primarily forced by the large-scale pressure field between the Bering Sea and Arctic Ocean.

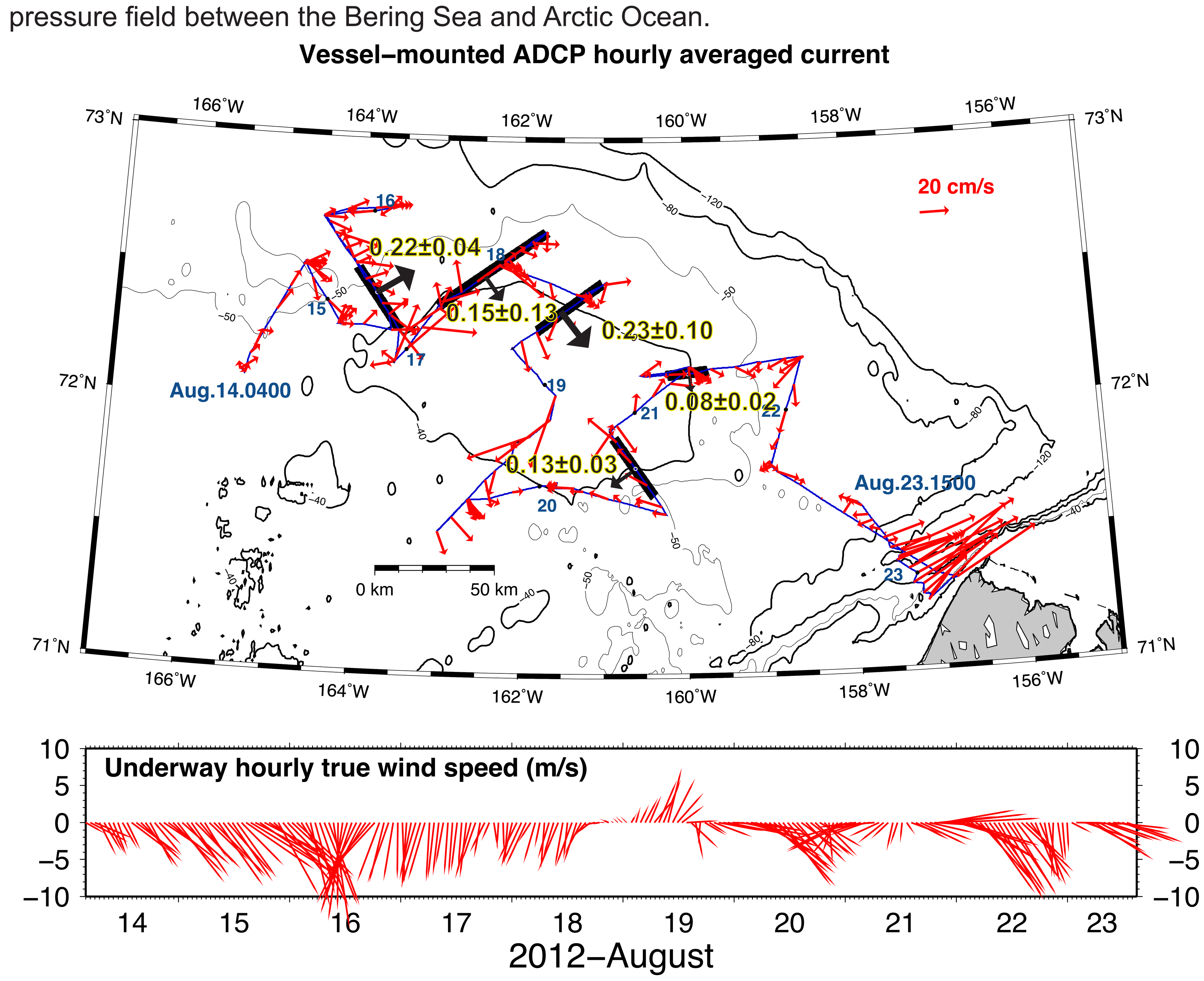

Figure 3, upper panel, underway vessel-mounted ADCP hourly and vertically averaged current measurements from 14 August 0400 UTC to 23 August 1500 UTC. Numbers in blue indicate the beginning date of each transect. The thick black line and arrow represents the transect and the estimated volume transport between the surface- and bottommost ADCP depths at 40 or 50m. Transports are given in black in units of Sverdrups, where 1 Sv = 10^6 m^3 s^{-1}. Lower panel contains the underway wind measurements.

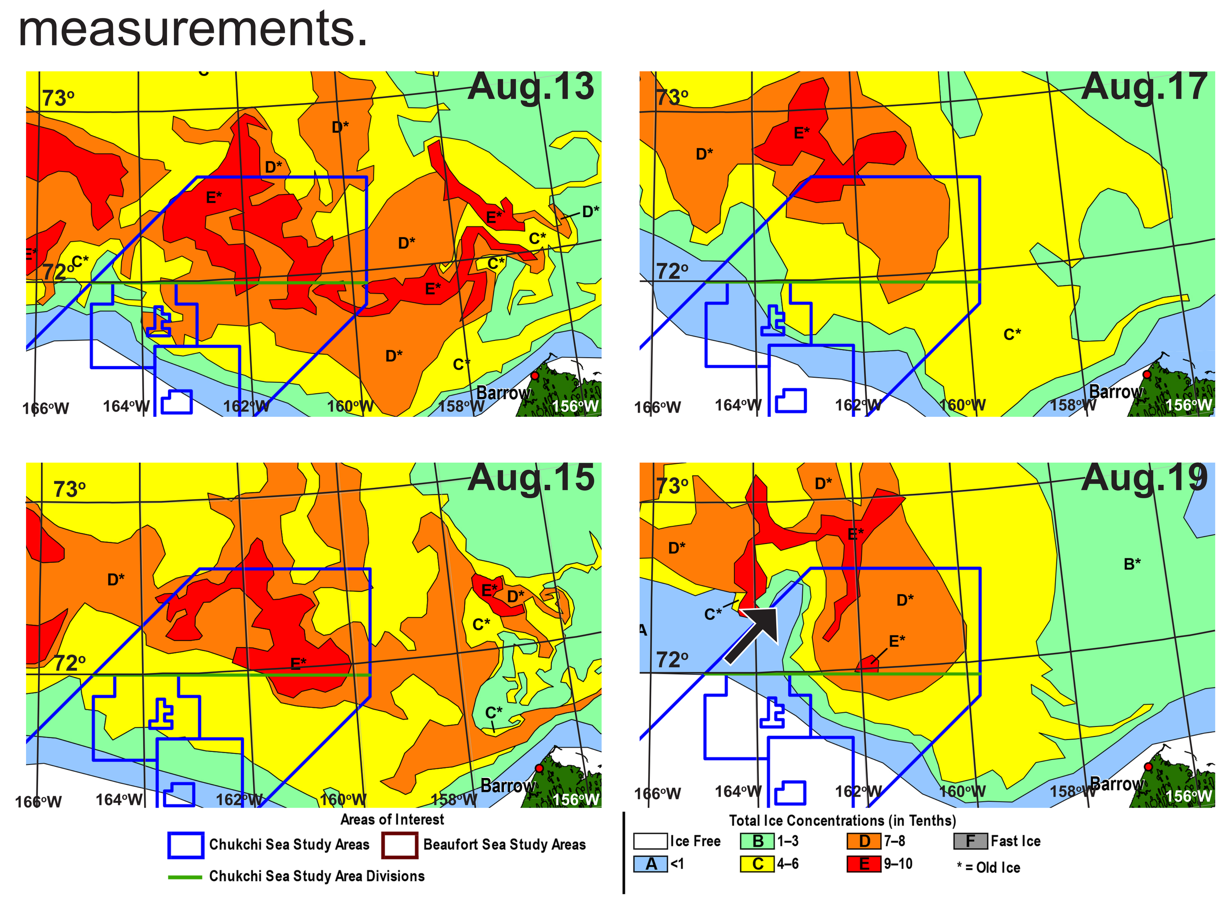

Figure 4, map of sea ice in the region between 71-73°N and 157-166°W on13-19 August showing the evolution of ice retreat. Note the preferential erosion of ice (indicated by the arrow) in the area near transect I in Figure 1. The retreat of ice here suggests that this was due to warm water advection along the northwest side of Hanna Shoal (transect I).

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