WOODS HOLE OCEANOGRAPHIC INSTITUTION

Seasonal to Mesoscale Variability of Water Masses in Barrow Canyon, Chukchi Sea

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1 - INTRODUCTION

Barrow Canyon (BC) is one of the primary conduits by which Pacific-origin water exits the Chukchi Sea into the Canada Basin. As such, it is an ideal location to monitor the different water masses through the year. At the same time, the canyon is an energetic environment where mixing and entrainment can occur, modifying the pacific-origin waters. As part of the Distributed Biological Observatory (DBO) program, a transect across the canyon was occupied 24 times between 2010-2013 by international ships of opportunity passing through the region during summer and early-fall (Fig 1).

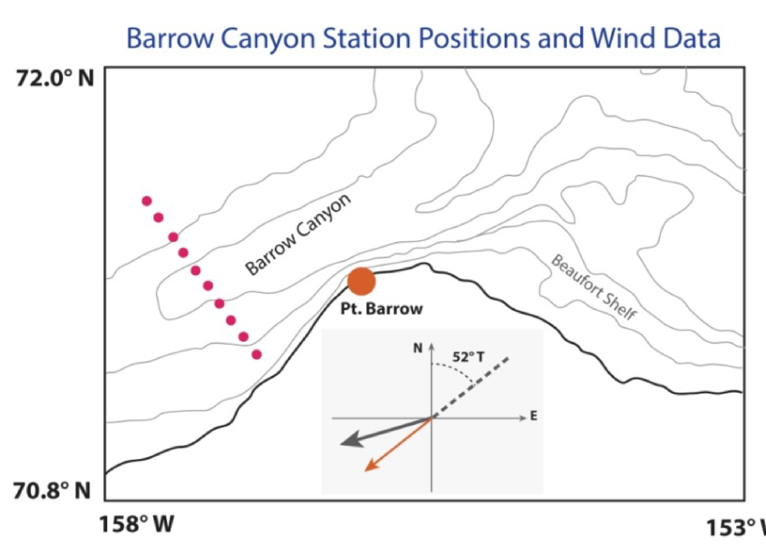

Figure 1. Map of study area. BC station positions are indicated by red circles, the Point Barrow weather station is the orange circle, and the grey vector represents the along-canyon component of the wind.

2 - DATA COVERAGE

The 24 occupations of the BC DBO transect were distributed in time as shown in Fig 2 below. The relatively even distribution both seasonally and inter-annually reduces any sampling bias .

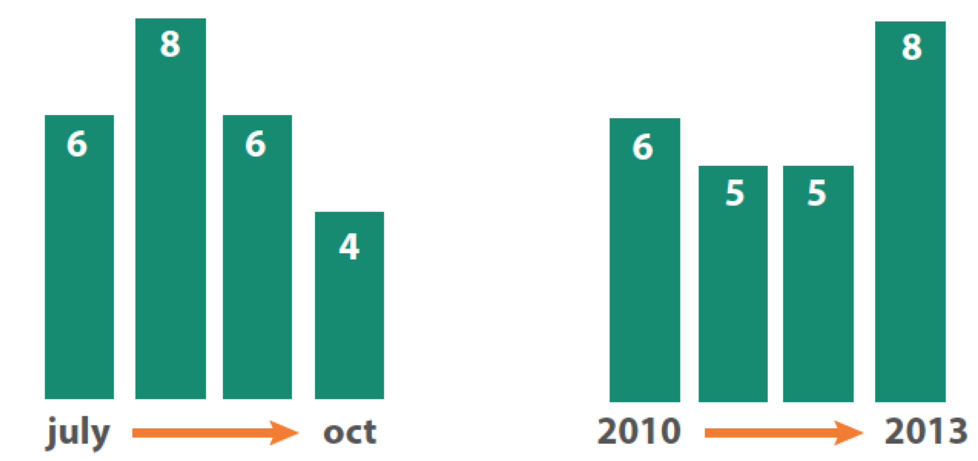

Figure 2. Distribution of transect occupations as a function of month (left panel) and year (right panel).

3 - OBJECTIVES

The main objectives of this study are:

- Quantify the seasonal evolution of the water masses
- Determine the nature of the mesoscale variability.
- Investigate atmospheric forcing of upwelling events

4 - SEASONAL EVOLUTION OF WATER MASSES

A volumetric T/S plot using all of the data (Fig 3 - left panel) shows the presence of six water masses through the summer. The dominant water mass found in the canyon is Pacific winter water. The seasonal evolution of these water masses (Fig 3 - right panel) reveals that Alaskan Coastal water is most prevalent in August and September before cooling in October. Nearly all of the newly-ventilated Pacific winter water flows through the canyon in August, while Atlantic water is found predominantly in September.

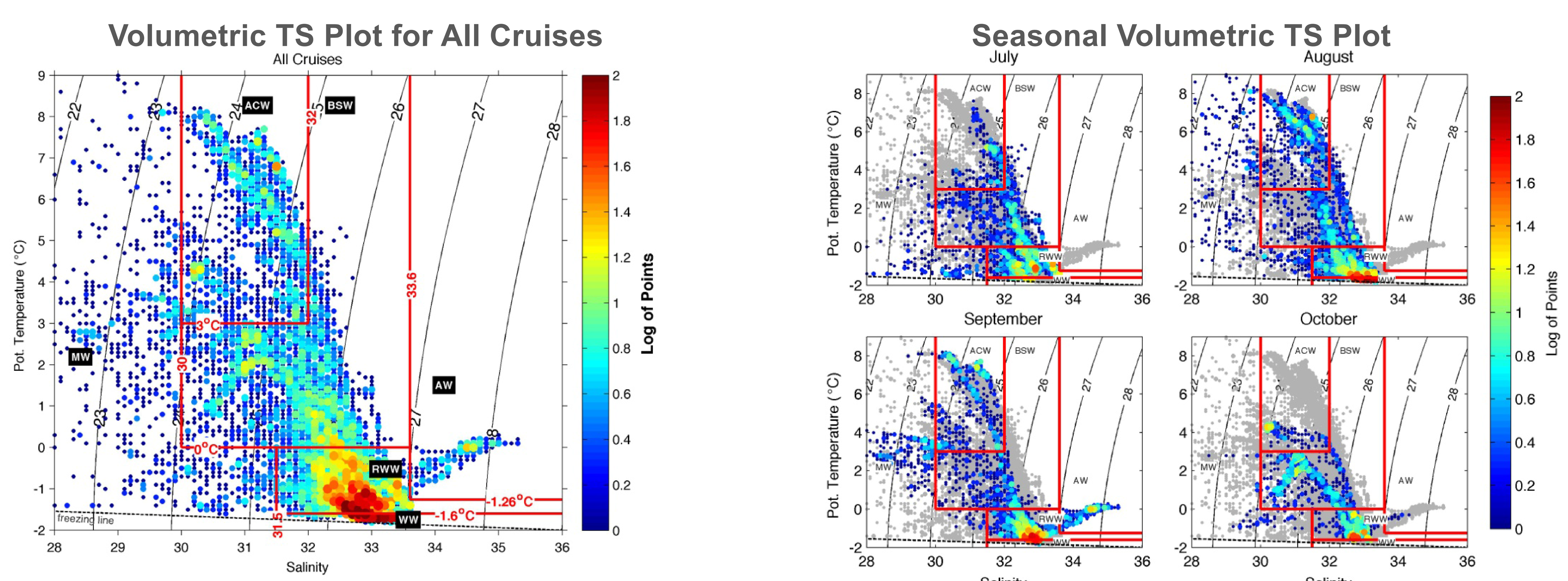

Figure 3. (left panel) Volumetric TS plot for all occupations of the BC transect. Water masses shown are: Alaskan Coastal Water (ACW), Bering Summer Water (BSW), Remnant Winter Water (RWW), newly-ventilated Winter Water (WW), Atlantic Water (AW), and Melt Water (MW). (right panel) Monthly evolution of water masses in BC.

5 - UPWELLING EVENTS

The primary mesoscale variability in the canyon is associated with wind-driven upwelling events. These events, which occur predominantly in September, are characterized by elevated isopycnals along the eastern flank of the canyon (Fig 4). The upwelled water includes Atlantic Water, as evidenced by the TS diagram in the right panel of Fig 5. The comparison between upwelling and non-forced conditions (Fig 5) also indicates a lack of Alaskan Coastal water during the wind events.

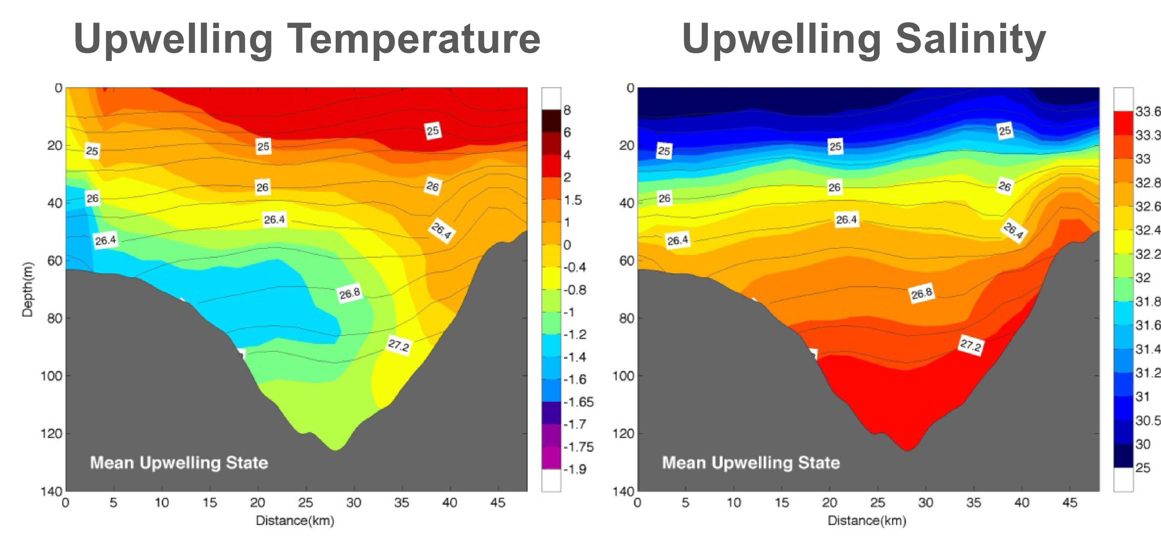

Figure 4. Composite vertical sections during times of upwelling. (left panel) Mean potential temperature (color) overlain by potential density (contours). (right panel) Mean salinity (color) overlain by potential density (contours).

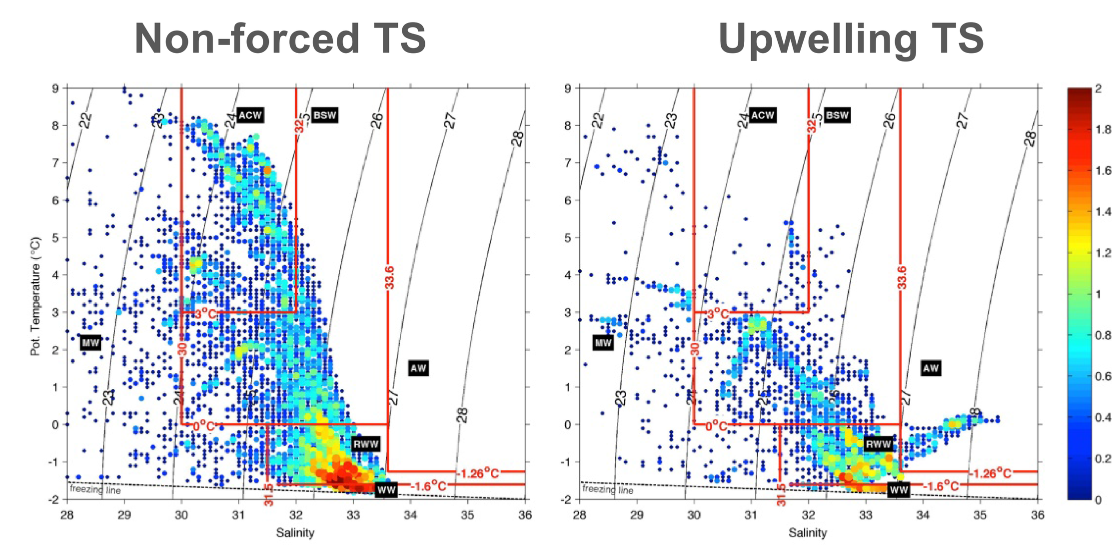

Figure 5. Volumetric TS plot for all non-forced sections (left panel) and for all upwelling sections (right panel).

6 - ATMOSPHERIC FORCING

The role of atmospheric forcing was investigated using NARR fields and data from the nearby Pt. Barrow weather station. Two atmospheric centers of action, the Beaufort High (BH) and Aleutian Low (AL), are known to influence upwelling in the region. In the days preceding an upwelling section, the Aleutian Low was significantly deeper and extended farther to the northeast than for the non-forced occupations (Fig 6).

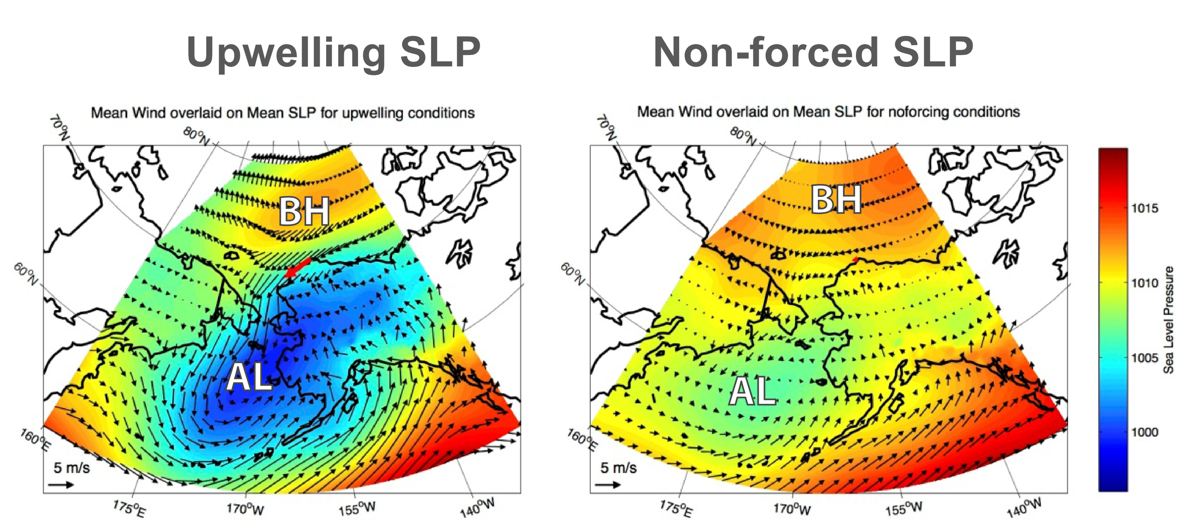

Figure 6. Composite sea level pressure fields during the 3-day period preceding upwelling events (left panel) and for the same period during non-forced events (right panel).

7 - STORM TRACKING

In order to better understand the impact of low pressure systems on the frequency and intensity of upwelling in BC, we tracked the centers of all storms in the area during the study period. Two dominant “modes” of tracks were revealed, which together account for 70% of all storms (Fig 7). The mode 1 storms progressed into the northern Bering Sea, while the mode 2 storms followed a more zonal track into the Gulf of Alaska. We hypothesize that mode 1 storms lead to upwelling in BC.

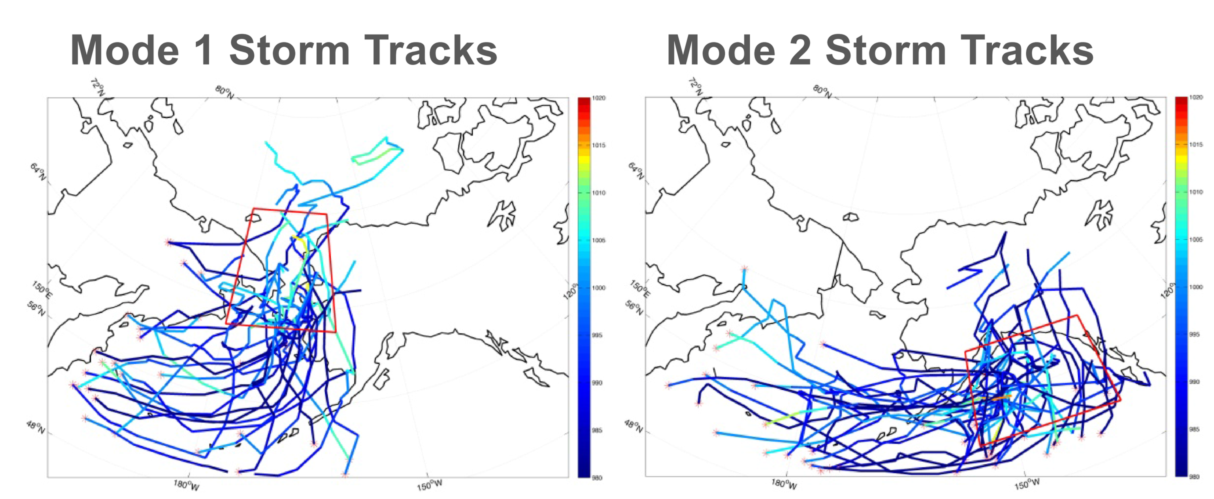

Figure 7. The two dominant types of storm tracks during the study period.

8 - CONCLUSIONS

- There is pronounced seasonal variability in the water masses passing through Barrow Canyon, with Pacific Winter Water being the most prevalent water mass throughout the summer.
- All upwelling events were characterized by the presence of Atlantic water in the deep part of the canyon and decreased amounts of Alaskan Coastal water.
- The strongest upwelling events occurred in September.
- Upwelling is associated with a deepened Aleutian Low that extends farther to the northeast, likely associated with a preferred storm track that progresses into the Bering Sea.

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