

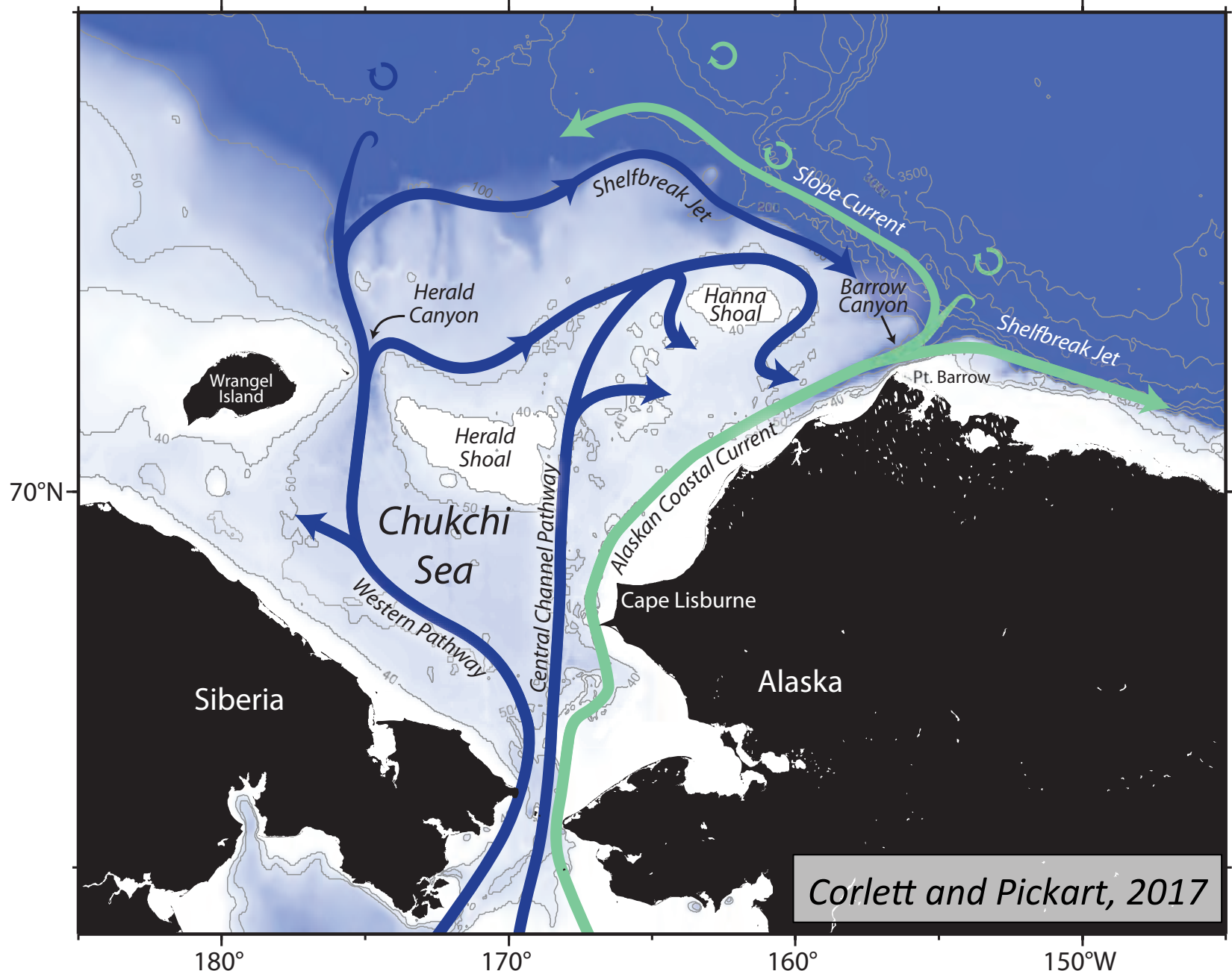


# On the nature of wind-forced upwelling in Barrow Canyon

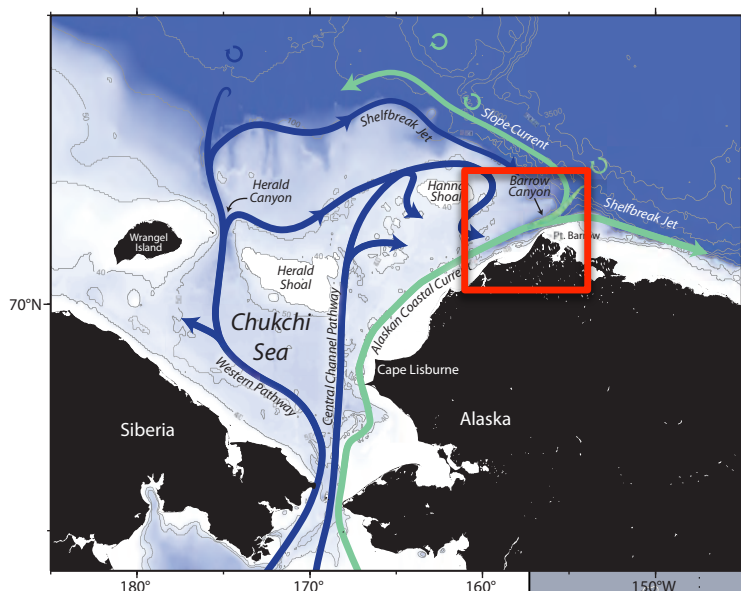
**Maria N. Pisareva,**  
*mnpisareva@gmail.com*, IO RAS, Moscow

**Robert S. Pickart, Paula S. Fratantoni,  
Thomas J. Weingartner**

# Pacific-origin waters influence the interior Arctic



# SBI mooring data at the 78 m isobath at the head of Barrow Canyon

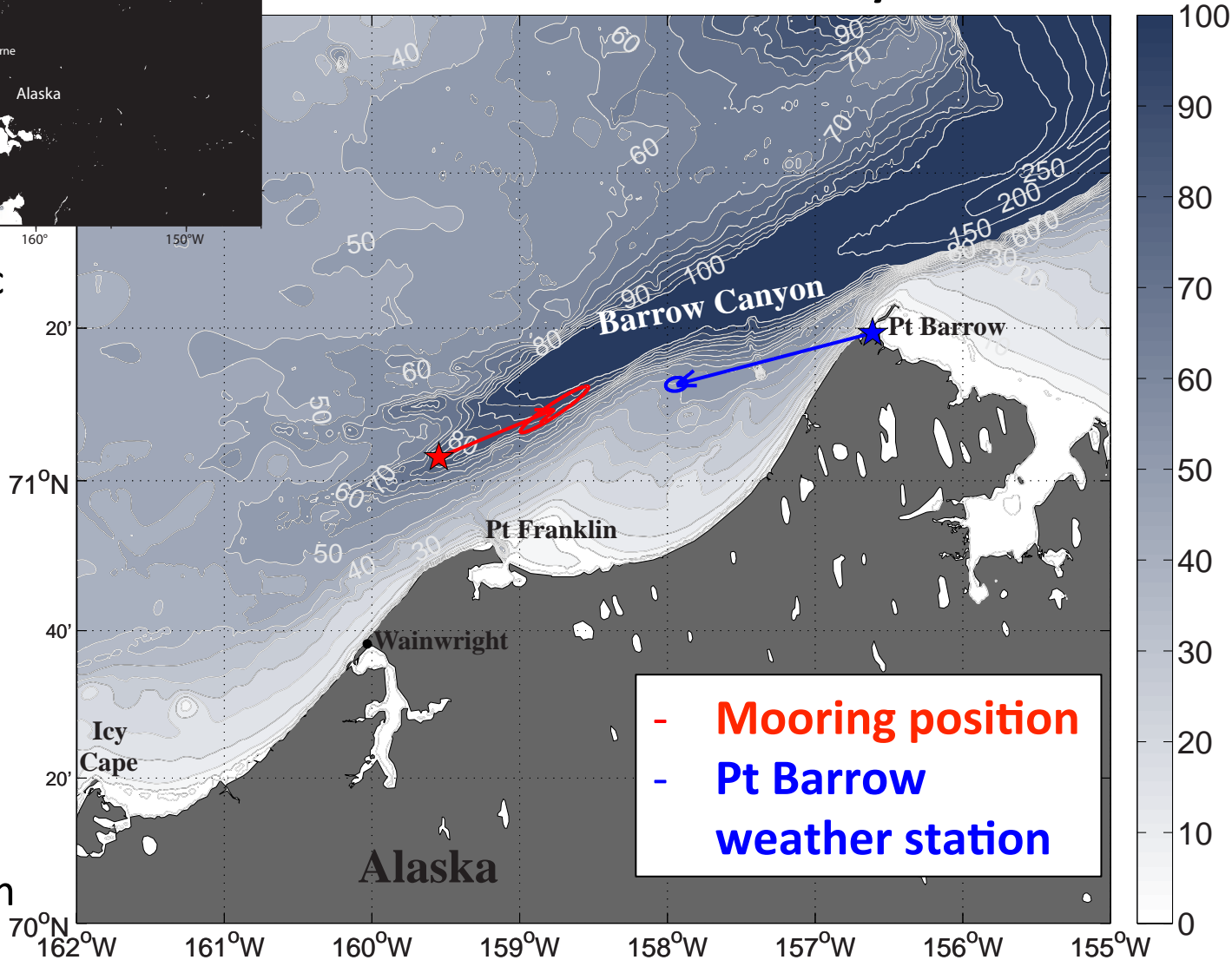


**SBI** – “Western Arctic Shelf-Basin Interactions”

**Mooring** from Aug 2002 to Sept 2004

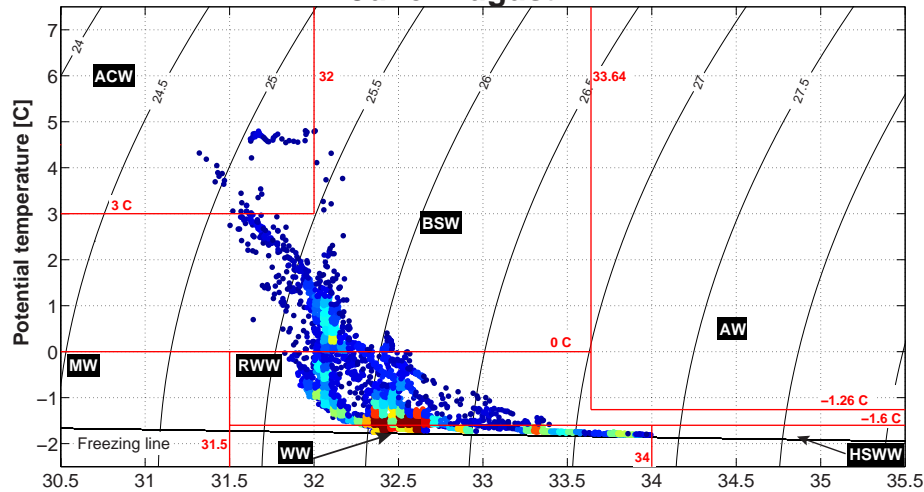
**Instruments:**

- SEACAT SBI - 67 m
- AANDERAA Recording Current Meter (ACM-7) - 64 m

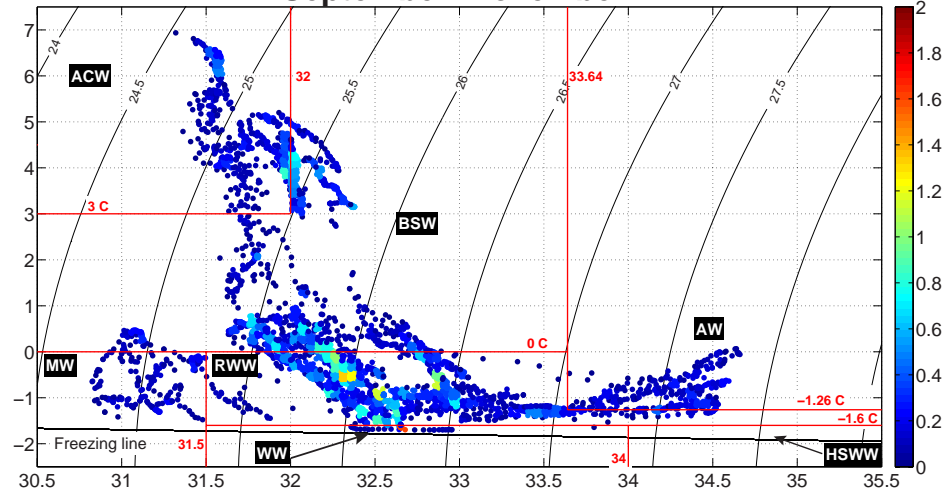


# Seasonal T/S diagrams for the water measured by the mooring

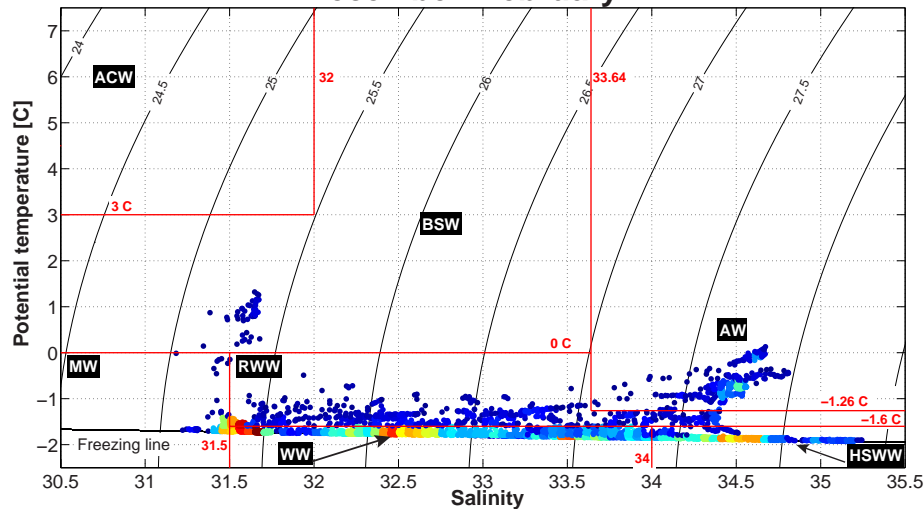
June–August



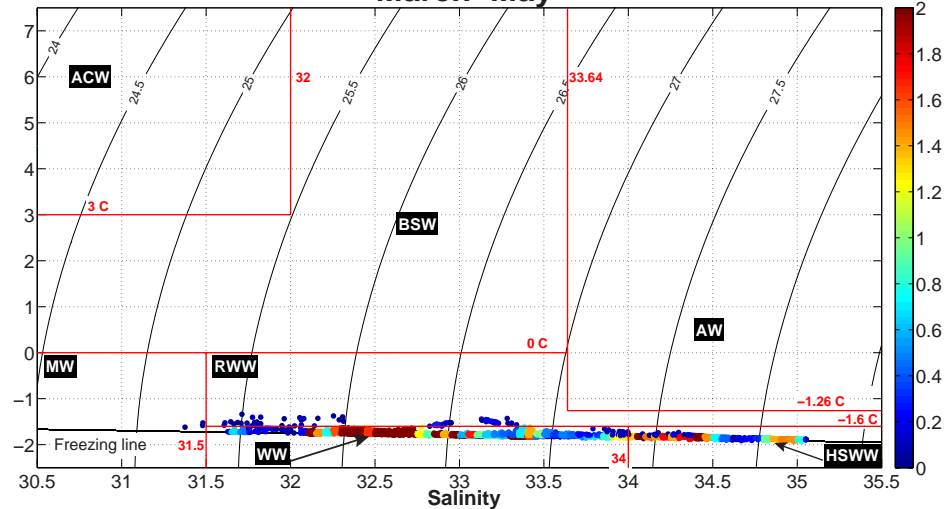
September–November



December–February



March–May

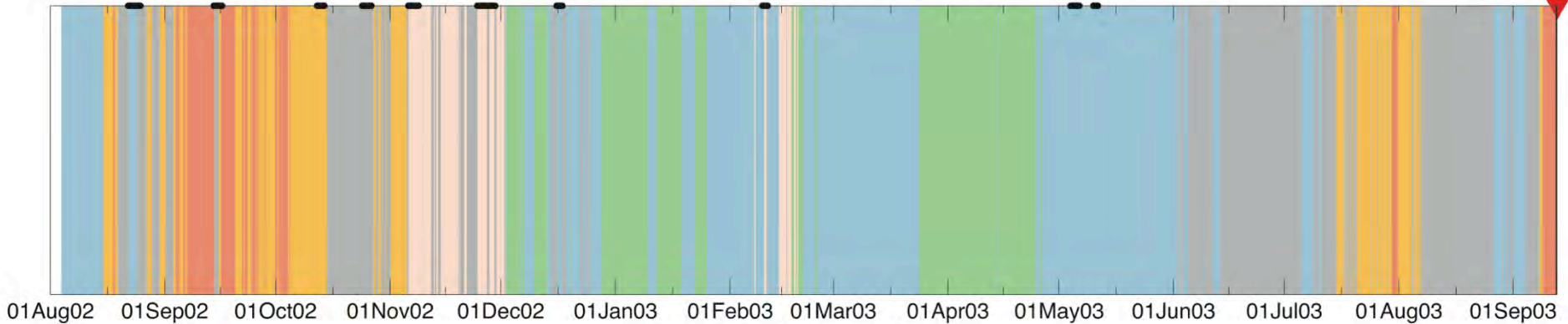


Bering Sea Water:  $> 0\text{ }^{\circ}\text{C}$ ;  $32.2 - 33$  (12.2%)  
 Alaskan Coastal Water:  $> 3\text{ }^{\circ}\text{C}$ ;  $< 32$  (3.2%)  
 Atlantic Water:  $> -1.26\text{ }^{\circ}\text{C}$ ;  $> 33.64$  (5%)

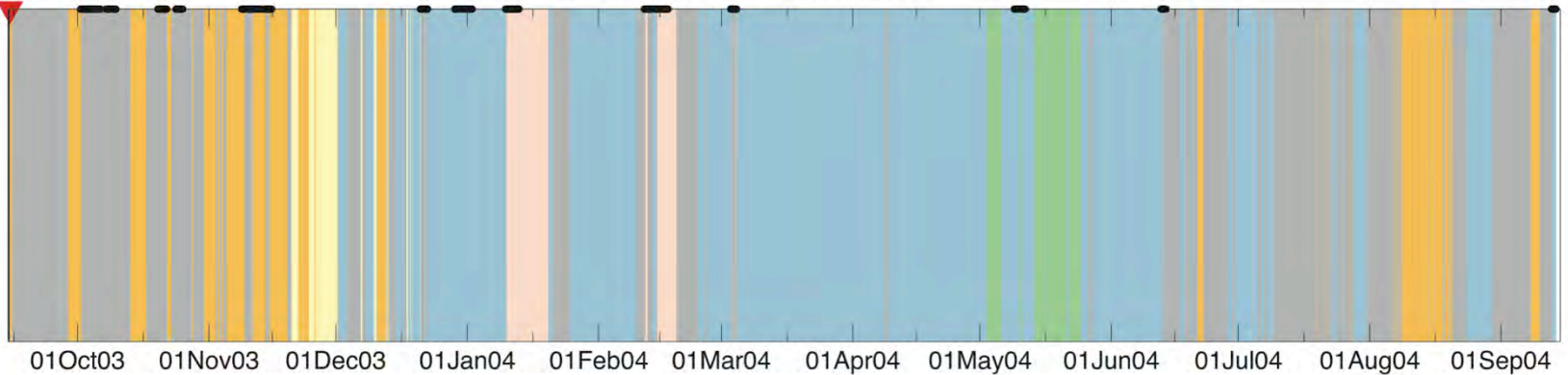
Winter Water:  $< -1.6\text{ }^{\circ}\text{C}$ ;  $< 34$  (38%)  
 Remnant Winter Water:  $-1.6 < T < 0\text{ }^{\circ}\text{C}$  (29.8%)  
 Hypersaline Water:  $< -1.6\text{ }^{\circ}\text{C}$ ;  $> 34$  (10.4%)

# Water masses at the head of Barrow Canyon

2002–2003 deployment year



2003–2004 deployment year



Bering Sea Water:  $> 0\text{ }^{\circ}\text{C}$ ; 32.2 – 33 (12.2%)

Alaskan Coastal Water:  $>3\text{ }^{\circ}\text{C}$ ;  $<32$  (3.2%)

Atlantic Water:  $>-1.26\text{ }^{\circ}\text{C}$ ;  $> 33.64$  (5%)

Winter Water:  $<-1.6\text{ }^{\circ}\text{C}$ ;  $<34$  (38%)

Remnant Winter Water:  $-1.6 < T < 0\text{ }^{\circ}\text{C}$  (29.8%)

Hypersaline Water:  $<-1.6\text{ }^{\circ}\text{C}$ ;  $>34$  (10.4%)

25 wind-driven upwelling events were identified in 2002/04 at the head of Barrow canyon from the near-bottom SBI mooring data

**Upwelling criteria:**

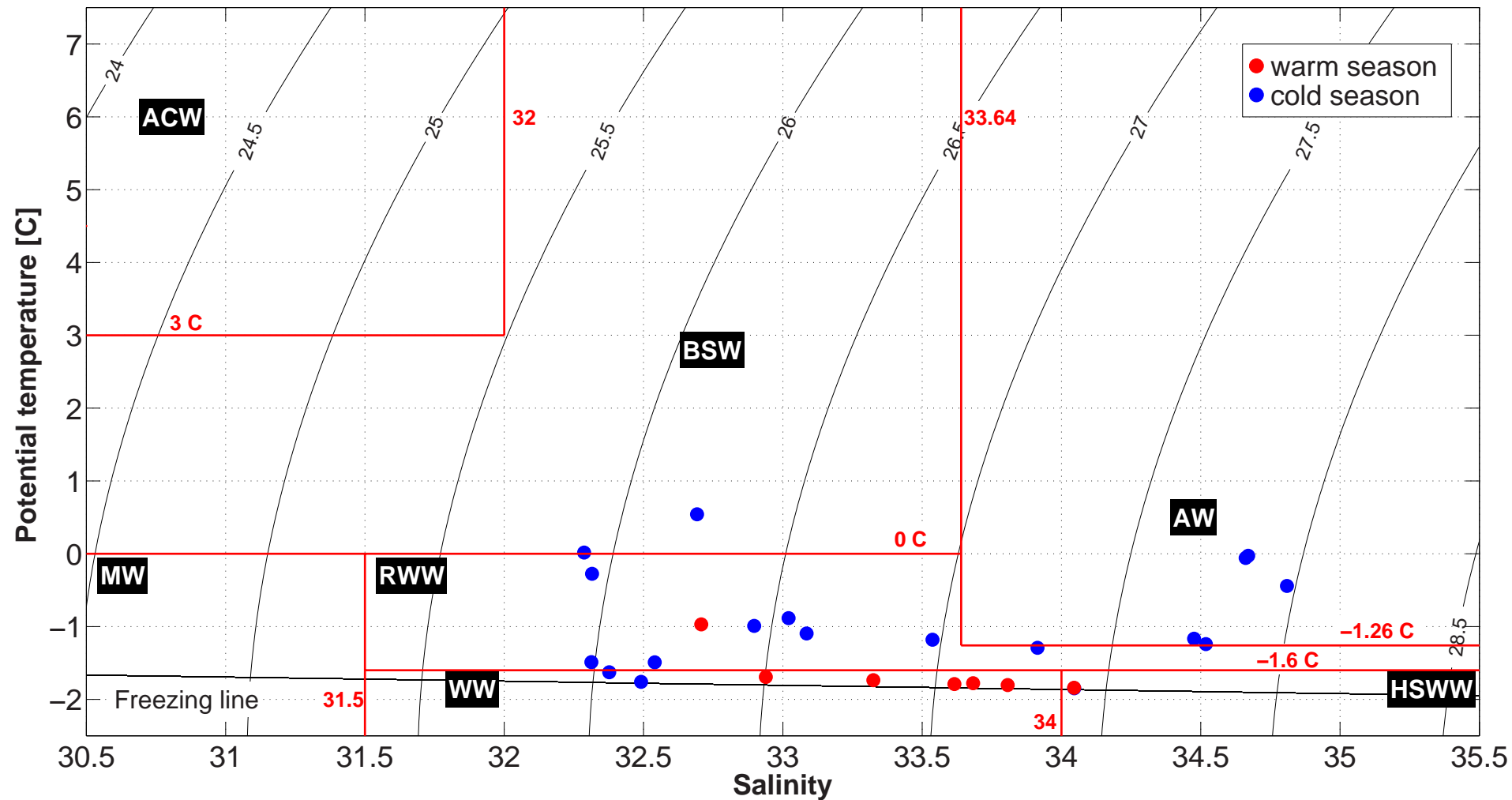
- positive potential density anomaly
- up-canyon flow
- northerly winds

**Characteristics of defined upwelling events:**

- $V$  mean  $\approx 35$  cm/s,  $V$  max = 120 cm/s;
- Av. Length = 59 h (from 23h to 135h)
- 2002/03: 11 events; 2003/04: 14 events;
- Sep – Nov: 13; Dec – Feb: 6; Mar – May: 4; Jun – Aug: 2;
- Wind-current time lag – 7h (compare to 8h at the shelfbreak [e.g. *Schulze and Pickart, 2012*])
- Current-density anomaly lag – 21h (10h at the shelfbreak)

During **warm** season – Winter Water;  
Atlantic Water – only during **cold** season.

Upwelled water



# Upwelling integral index

## Ice concentration at the mooring site and within the polynya region

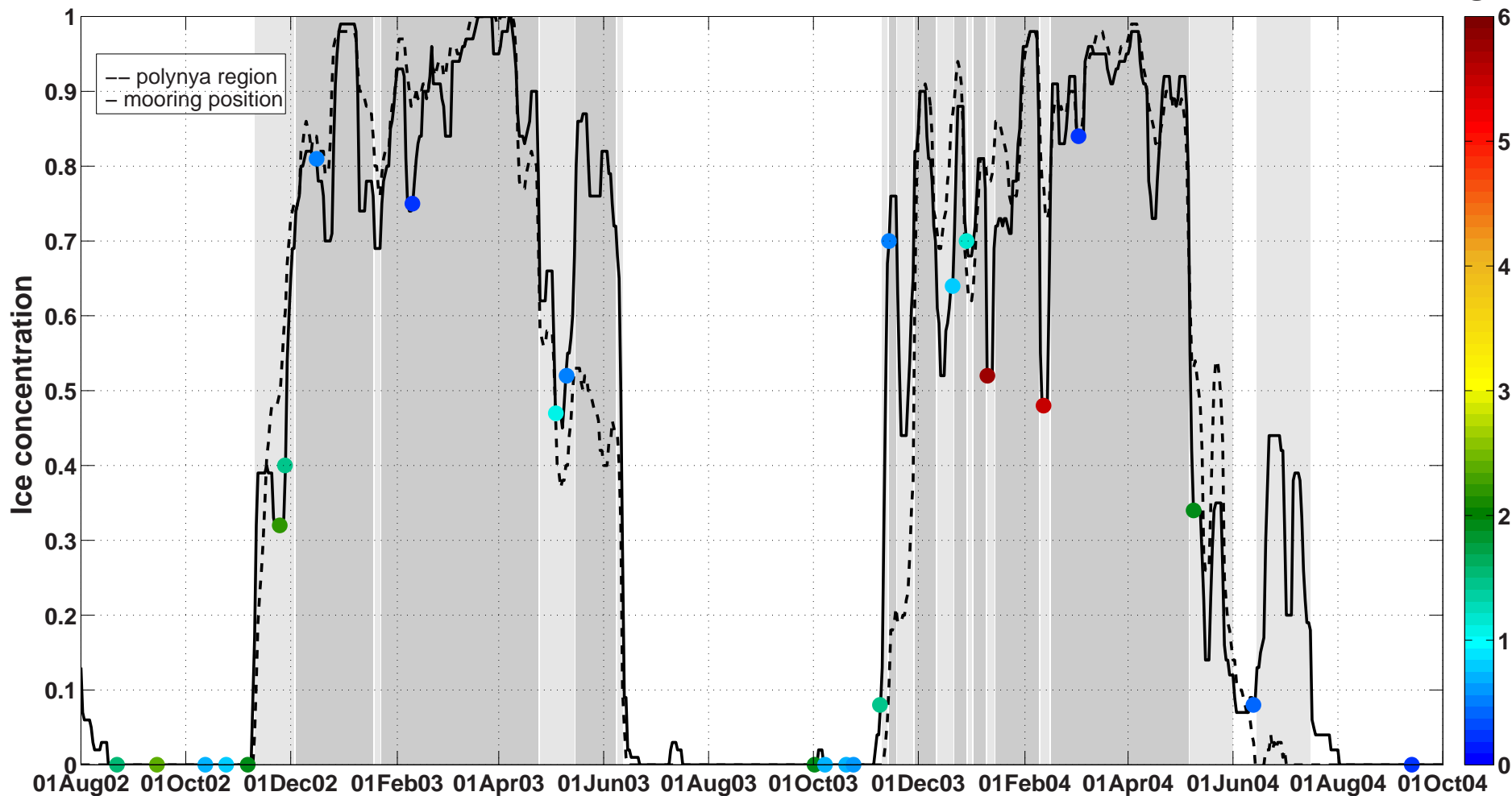
$$UI = \int_{t_s}^{t_e} \frac{\rho(t)}{\rho(t_s)} dt,$$

<10 % : 12 events

10 – 70 % : 11 events

>70 % : 2 events

AVHRR-AMSR data





# Atmospheric forcing

Warm season

Cold season

Apr – Sep 1979–2014

Oct – Mar 1979–2014

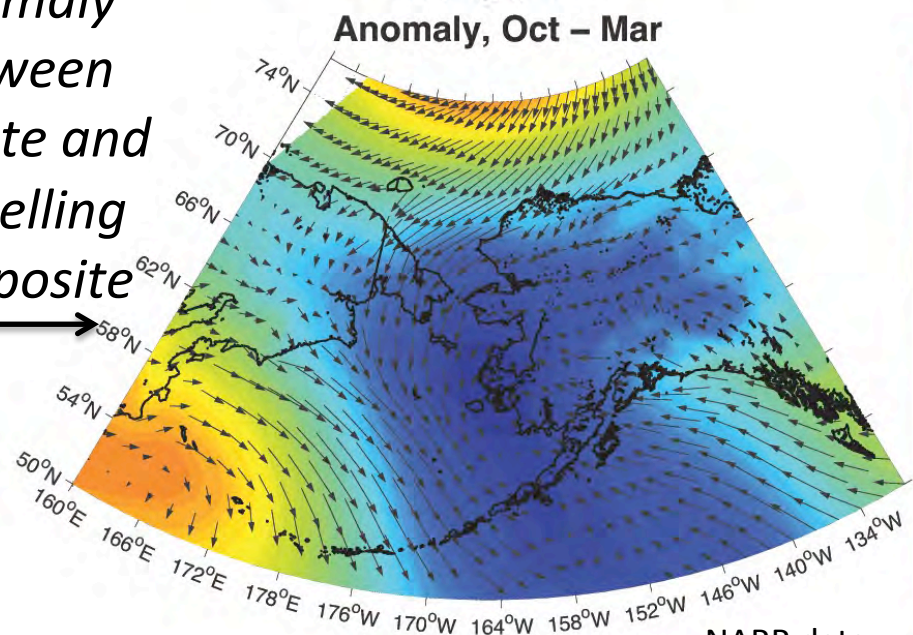
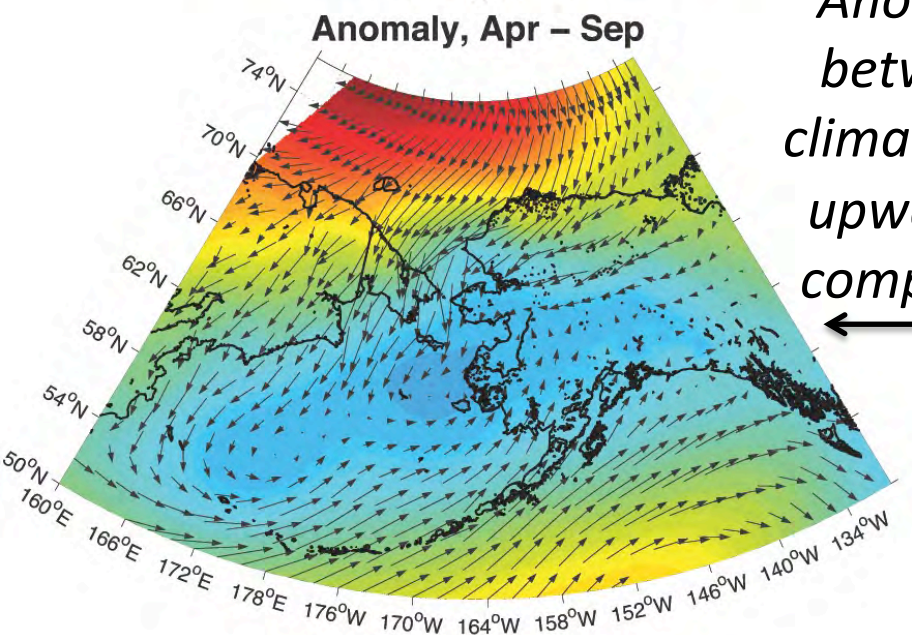
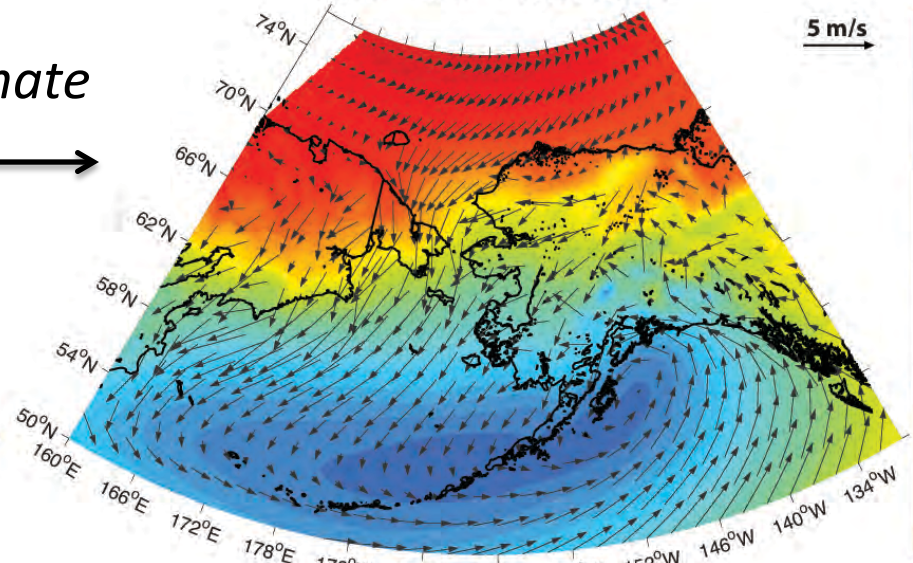
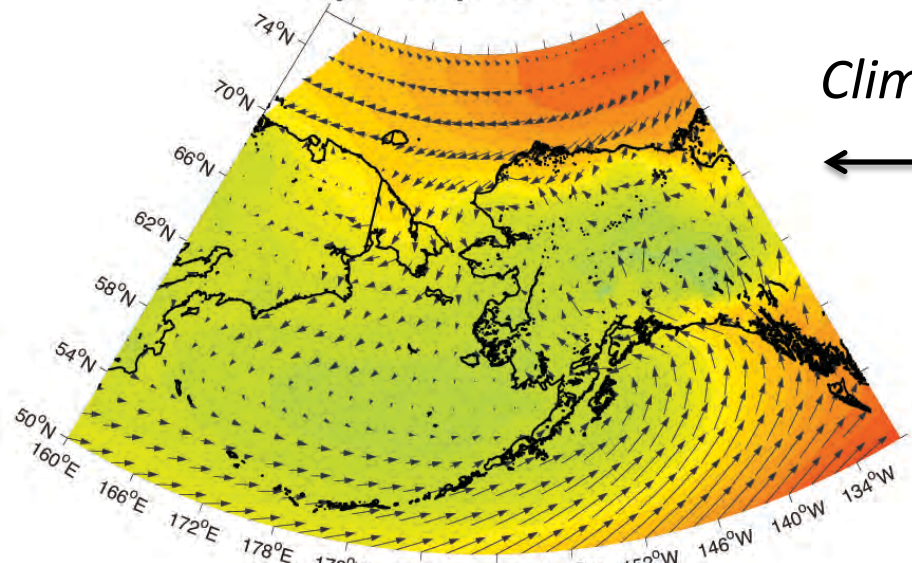
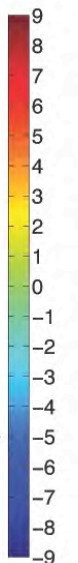
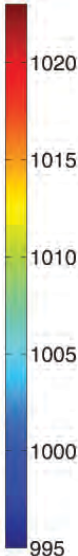
*Climate*



*Anomaly between climate and upwelling composite*

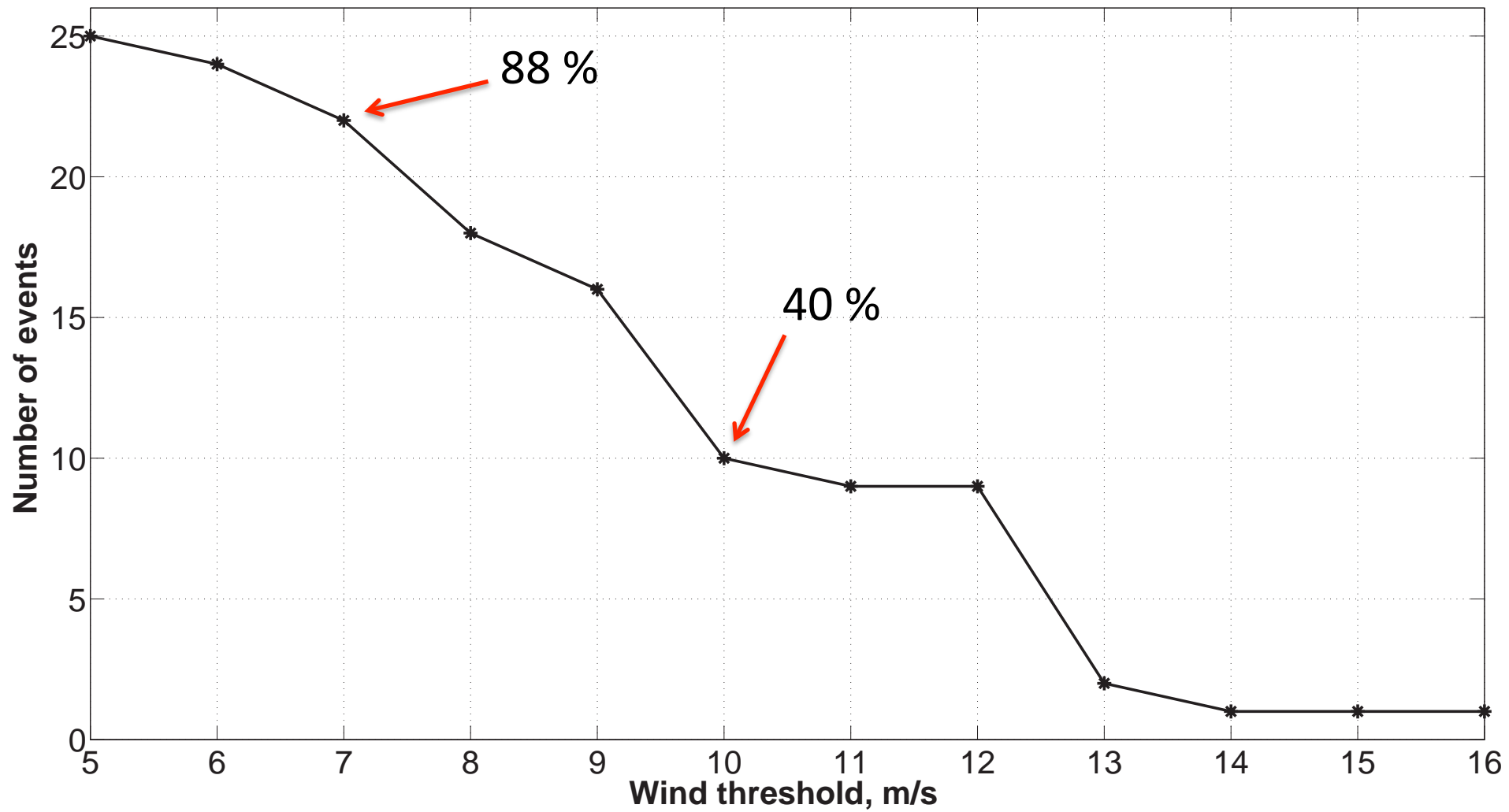


5 m/s



NARR data

# Strength of forcing versus water column response



Pt Barrow weather station data

# Time integral of the windstress at Pt. Barrow for the up-canyon wind events

$$I_w = \int_{t_s}^{t_e} \tau_a(t) dt,$$

For the up-canyon wind events with

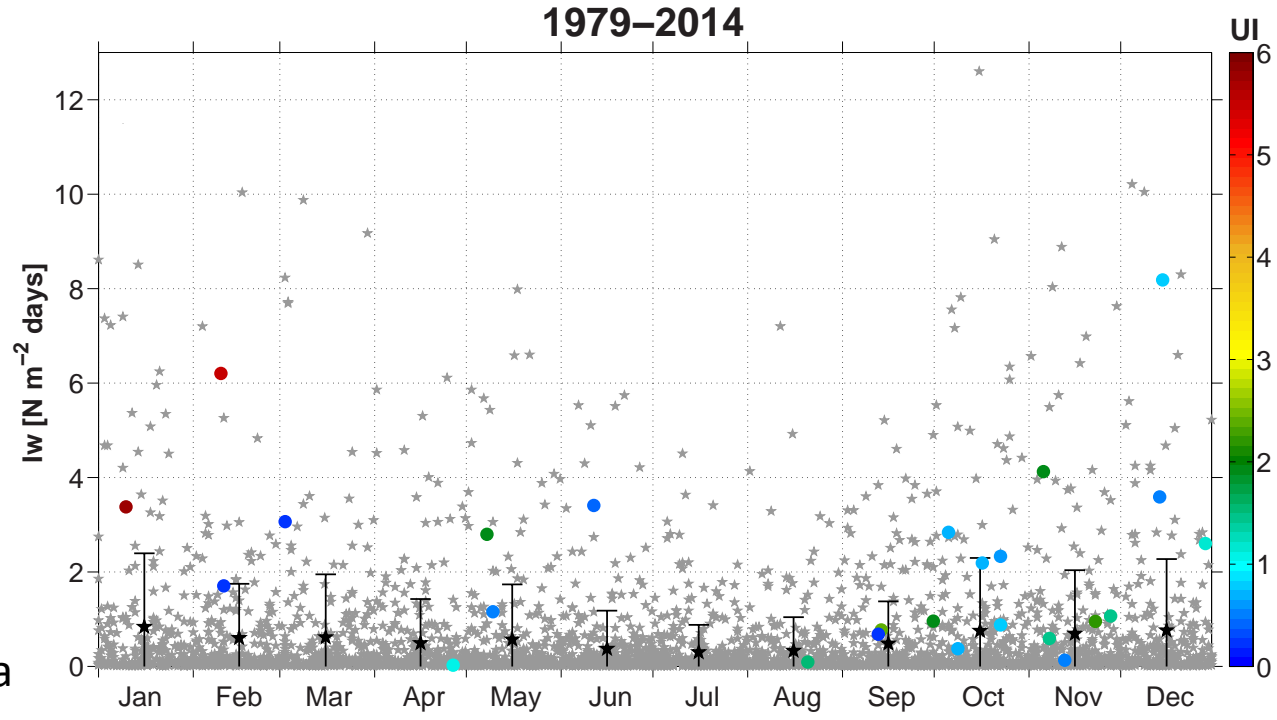
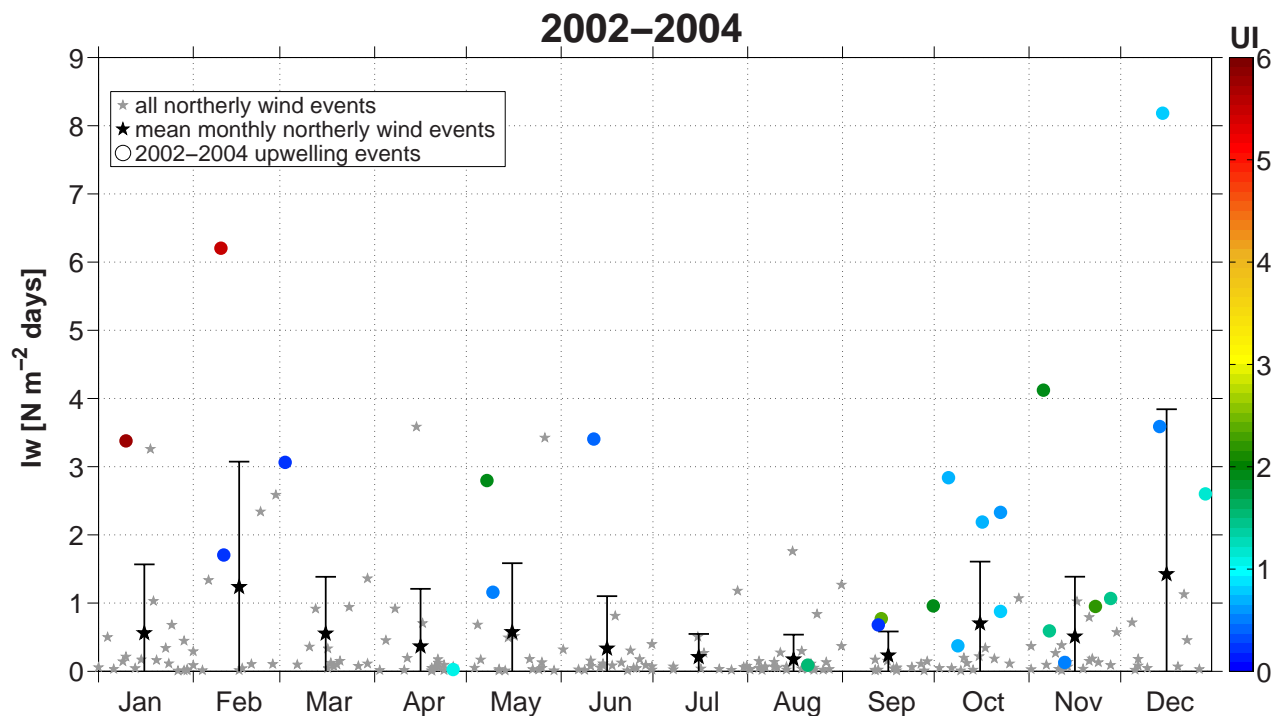
$$I_w > 2 \text{ N m}^{-2} \text{ d}$$

70% of the events resulted in upwelling

=>

~184 upwelling events at the head of Barrow Canyon over the 34-year period

Pt Barrow weather station data



# Summary

- 25 wind-driven upwelling events identified in 2002-04 at the head of Barrow Canyon
- greatest number of events occurred in fall
- AW was upwelled to the mooring site only during the “cold” season (Oct-Mar); in the “warm” season (Apr-Sep) all of the events consisted only of winter water modes
- almost all of the pronounced sudden decreases in ice concentration coincided with an upwelling event (strongest events linked to the largest ice openings)
- in the cold months primarily a deepening of the Aleutian Low drives the upwelling
- no statistical correlation between the strength of the wind forcing and the magnitude of the upwelling was found, but...
- ice and wind records could be used for assessing upwelling events at the head of Barrow Canyon in the past and future

# Thanks!

Pisareva M.N., R.S. Pickart,  
P.S. Fratantoni,  
T.J. Weingartner.  
On the nature of  
wind-forced upwelling events  
in Barrow Canyon.  
DSR I, DBO special issue,  
submitted.



*Courtesy of: Healy SUBICE 2014*