Seasonal variation of water masses in the Chukchi Sea: results of DBO pilot study in 2010

Motoyo Itoh (JAMSTEC), Kevin Arrigo (Stanford), Svein Vagle (IOS), Jianfeng He (PRIC), Carin Ashjian (WHOI) and Robert Pickart (WHOI)
Pacific Water pathways into the Arctic Basins

Pacific Water transports heat, fresh water and nutrient into the Arctic basins.
Southern Chukchi Sea Transect

- Healy, US (July)
- SWL, Canada (July)
- Mirai (hotspot station only), Japan (Sep)
Temperature and Salinity section in July by SWL

SWL (19 July)
Mirai (2 Sep)
Surface Temperature (AMSR-E weekly)

SWL (July 16-21)

Mirai (Sep 2-9)

SWL (19 July)
Mirai (2 Sep)
Barrow Canyon Transect

- Healy, US (July 12-13)
- SWL, Canada (July 19-21)
- Xuelong, China (July 25)
- Annika Marie, US (Aug 24-25)
- Healy, US (Sep 7-8)
- Mirai, Japan (Sep 28-29)

6 cruises by 4 nations
Temperature Sections

PSW: Pacific Summer Water
PWW: Pacific Winter Water

12-13 Jul Healy SWL 25 Jul Xuelong
24-25 Aug 7-8 Sep 28-29 Sep Healy Mirai Annika Marie
Heat content is maximum in early September.

Heat content in 25 July is smaller than that in 12-13 July possibly due to upwelling favorable wind.

Heat content decrease drastically from 7-8 Sep to 28-29 Sep due to cooling.
Alon - canyon winds  Summer 2010

Along-canyon winds (m/s)  July - September

Healy  JU  MARIE
SwL  Xuelong  ANNIKA  MARIE
Healy  Sep  MIRAI

Downwelling-favorable

Upwelling-favorable

Courtesy R. Pickart
Heat content is maximum in early September.

Heat content in 25 July is smaller than that in 12-13 July possibly due to upwelling favorable wind.

Heat content drastically decrease from 7-8 Sep to 28-29 Sep due to cooling.
Salinity Sections

PSW: Pacific Summer Water
PWW: Pacific Winter Water

Melt Water  PSW  PWW
12-13 Jul  Healy

19-21 Jul  Healy

25 Jul  Xuelong

24-25 Aug  Annika Marie

7-8 Sep  Healy

28-29 Sep  Mirai

Distance (km)

Depth (m)

Color Scale:

34
33
32
31
30
29

Distance (km)

Distance (km)

Distance (km)
Velocity Section

Positive: downwelling
Negative: upwelling

12-13 Jul 19-21 Jul Healy SWL Xuelong 25 Jul
24-25 Aug Annika Marie 7-8 Sep Healy 28-29 Sep Mirai
Averaged volume transport of 4 repeat observations is 1.3 Sv. Annual averaged Bering Strait inflow is 0.8 Sv (Woodgate et al., 2005). Volume transport is maximum in 12-13 July, when down-welling favorable wind.
Heat flux through 0-30km from the coast is dominant. Heat flux maximum is observed in early September. Heat flux drastically decrease from 7-8 Sep to 28-29 Sep.
Heat Flux through the canyon

- **Total 8.6 TW**
  - 0-30m 7.7 TW

- **Total 13.2 TW**
  - 0-30m 10.8 TW

- **Total 16.5 TW**
  - 0-30m 11.0 TW

- **Total 1.6 TW**
  - 0-30m 3.8 TW

60-80% of heat flux is maintained in 0-30m.

It is difficult to know water properties of 0-30m by mooring. Information of 0-30m is a big merit of repeat hydrography.
Surface Temperature (AMSR-E weekly)

Healy (July 8-15)

SWL (July 16-22)

Xuelong (July 23-30)

Annika Marie (Aug 19-26)

Healy (Sep 2-9)

Mirai (Sep 24-30)
Surface Temperature (AMSR-E weekly)  

Resolution 12km

Healy (July 8-15)  

SWL (July 16-22)  

Xuelong (July 23-30)

---

Surface temperature derived from Microwave Satellite is too coarse to capture warm Pacific Summer Water plume through the canyon.

---

Annika Marie (Aug 19-26)  

Healy (Sep 2-9)  

Mirai (Sep 24-30)
Total fresh water flux from July to September (3 months) is 800 km$^3$.

Annual fresh water flux through the Bering Strait is 1200 km$^3$/yr (Woodgate et al., 2005).
Fresh Water Flux

Half of fresh water flux is maintained in 0-30m.
Summary of preliminary results of physical oceanographic analysis

- Repeat hydography is successfully capturing seasonal variation of the Pacific Water.
- Averaged volume transport through the Barrow Canyon is 1.3 Sv (1.0-1.7 Sv)
- Seasonal variation of heat content and heat flux is large. 8.6TW (July), 13.2 TW(Aug), 16.5 TW (early Sep) and 1.6 TW (end of Sep)
- Fresh water flux from July to September (3 months) is 800 km³.
Repeat Hydrography

- High resolution (vertically and horizontally)
- Information of 0-30m
- Seasonal variation (summer, autumn)
Repeat Hydrography

- High resolution (vertically and horizontally)
- Information of 0-30m
- Seasonal variation (summer, autumn)

Mooring Station

- Seasonal variation (including winter)
- Long term monitoring

Satellite observation

- Overview of whole Chukchi Sea