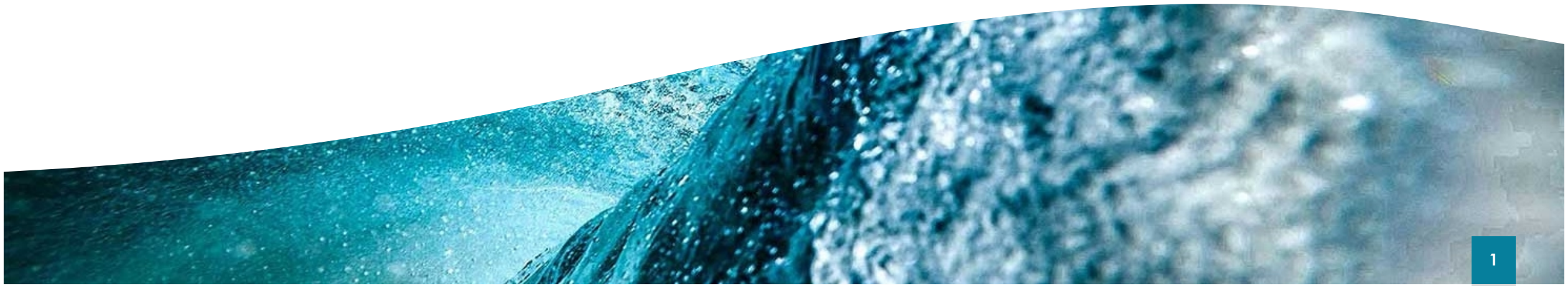
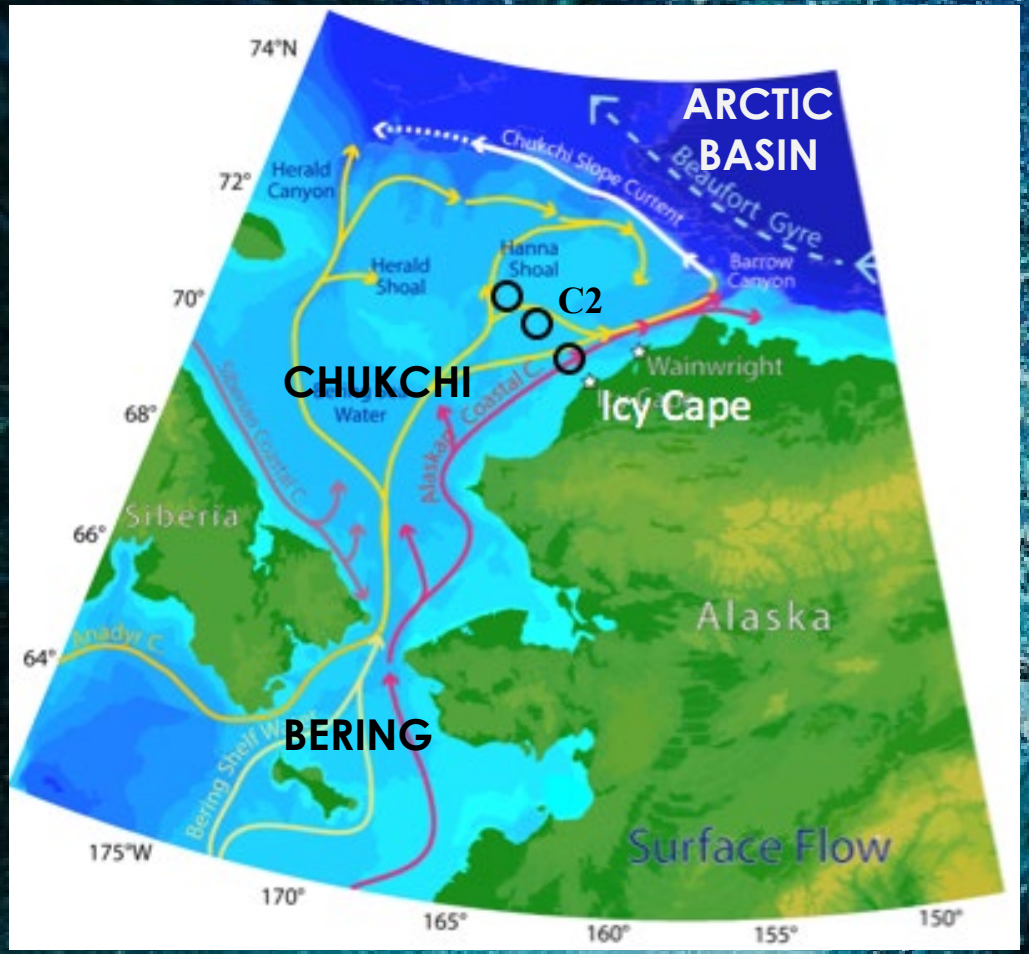
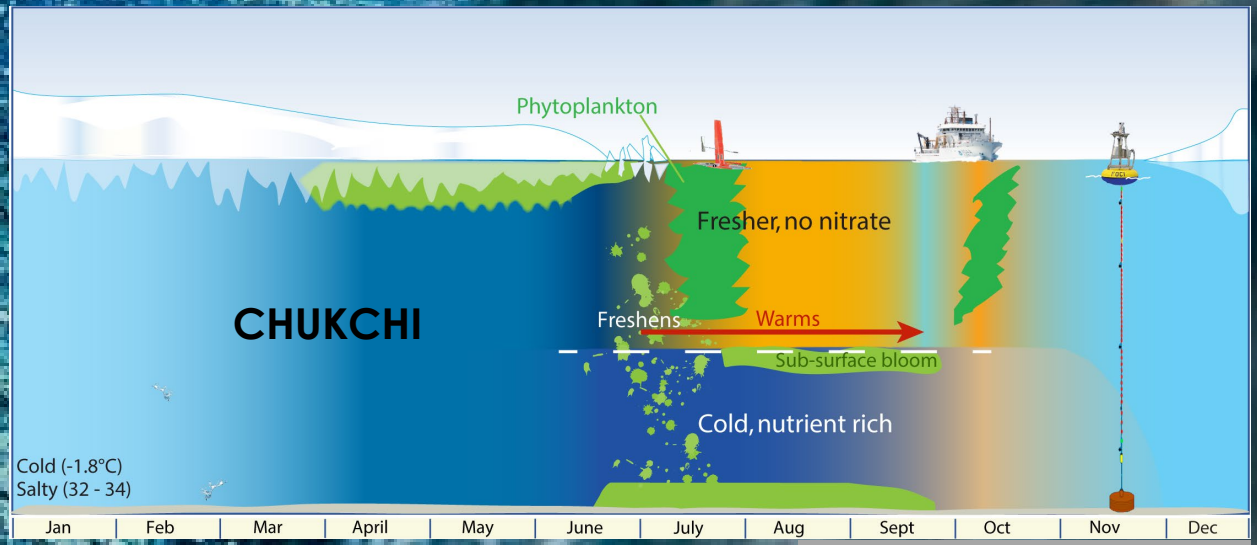
Stratification, nutrients, and water mass structure in the Chukchi Sea

Carol Ladd, Calvin Mordy, and Phyllis Stabeno



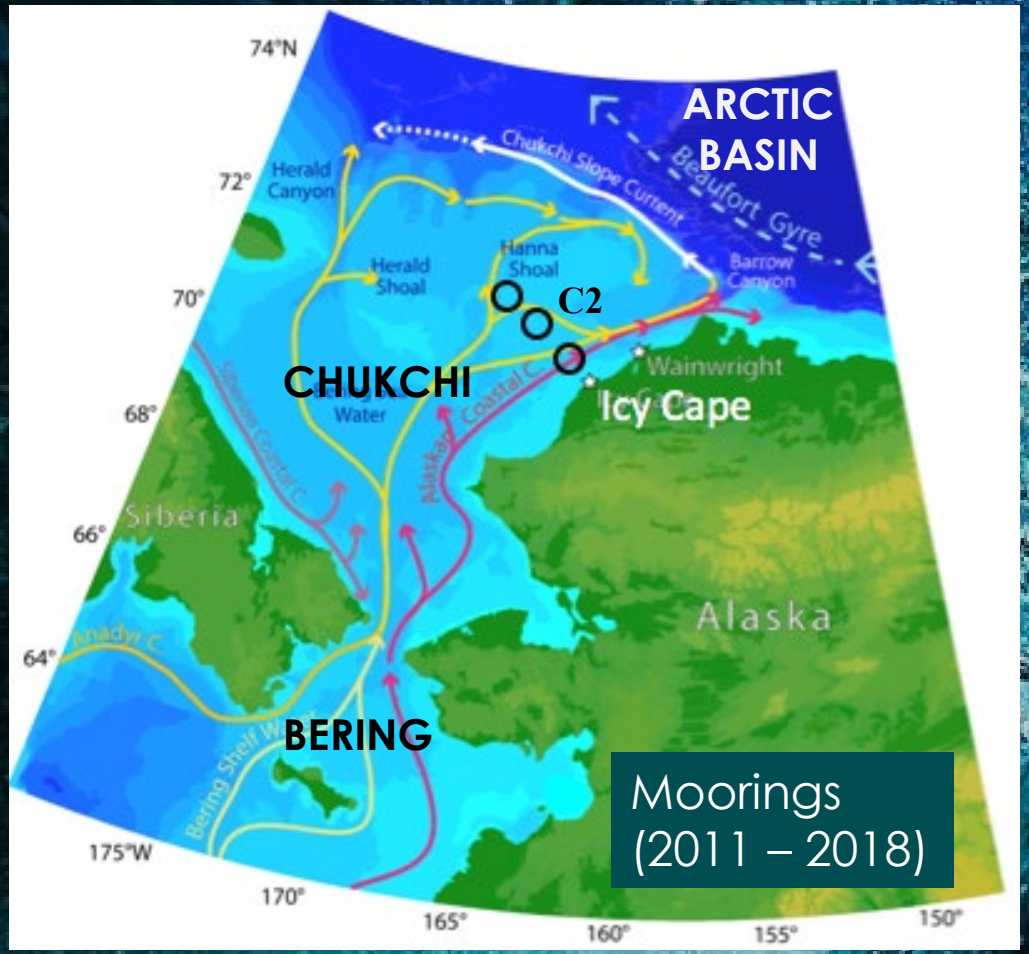


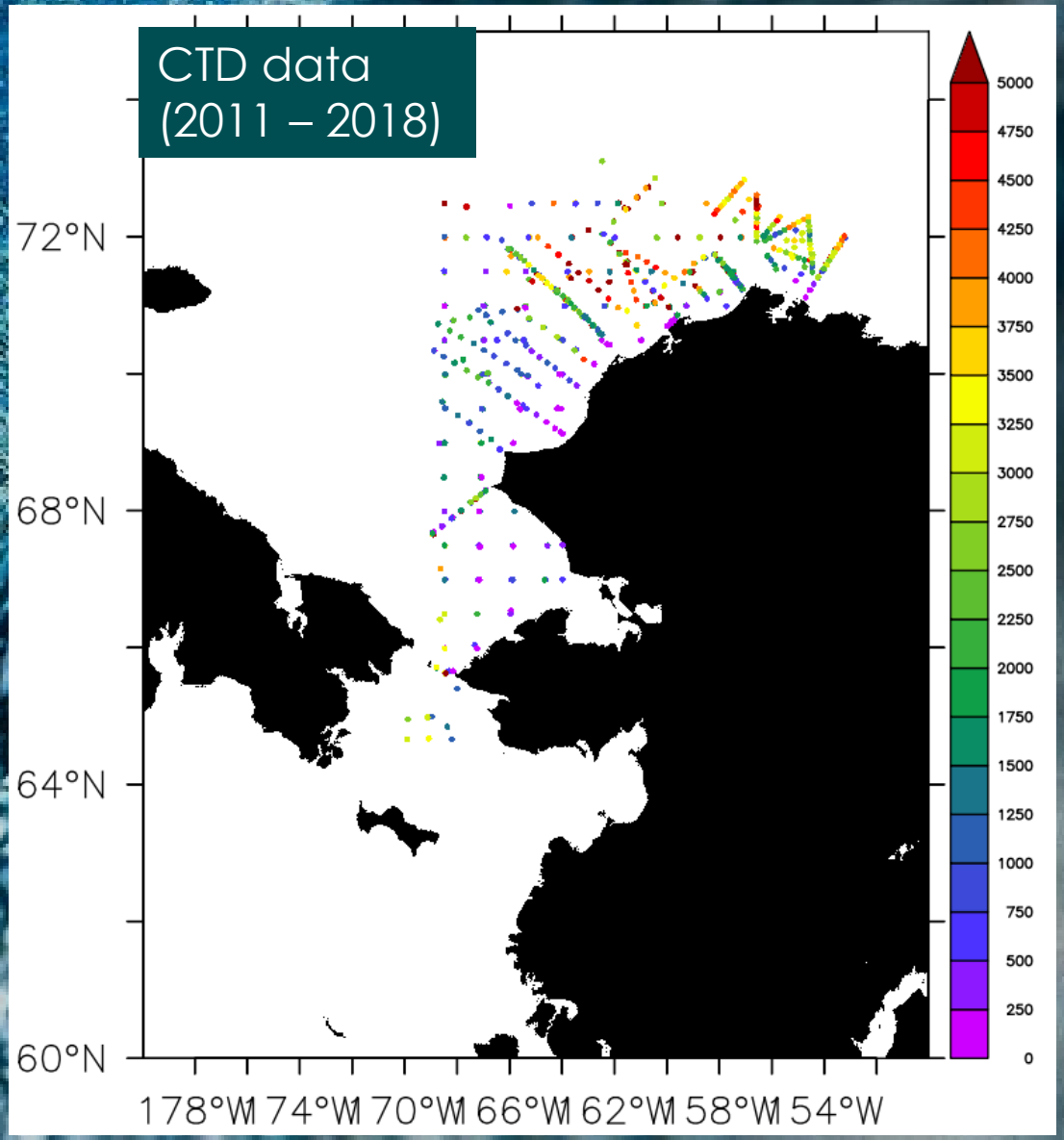


Stabeno et al. 2019

Chukchi Sea

Advective (Bering Strait inflow) vs. local processes (sea ice, winds, solar heating)



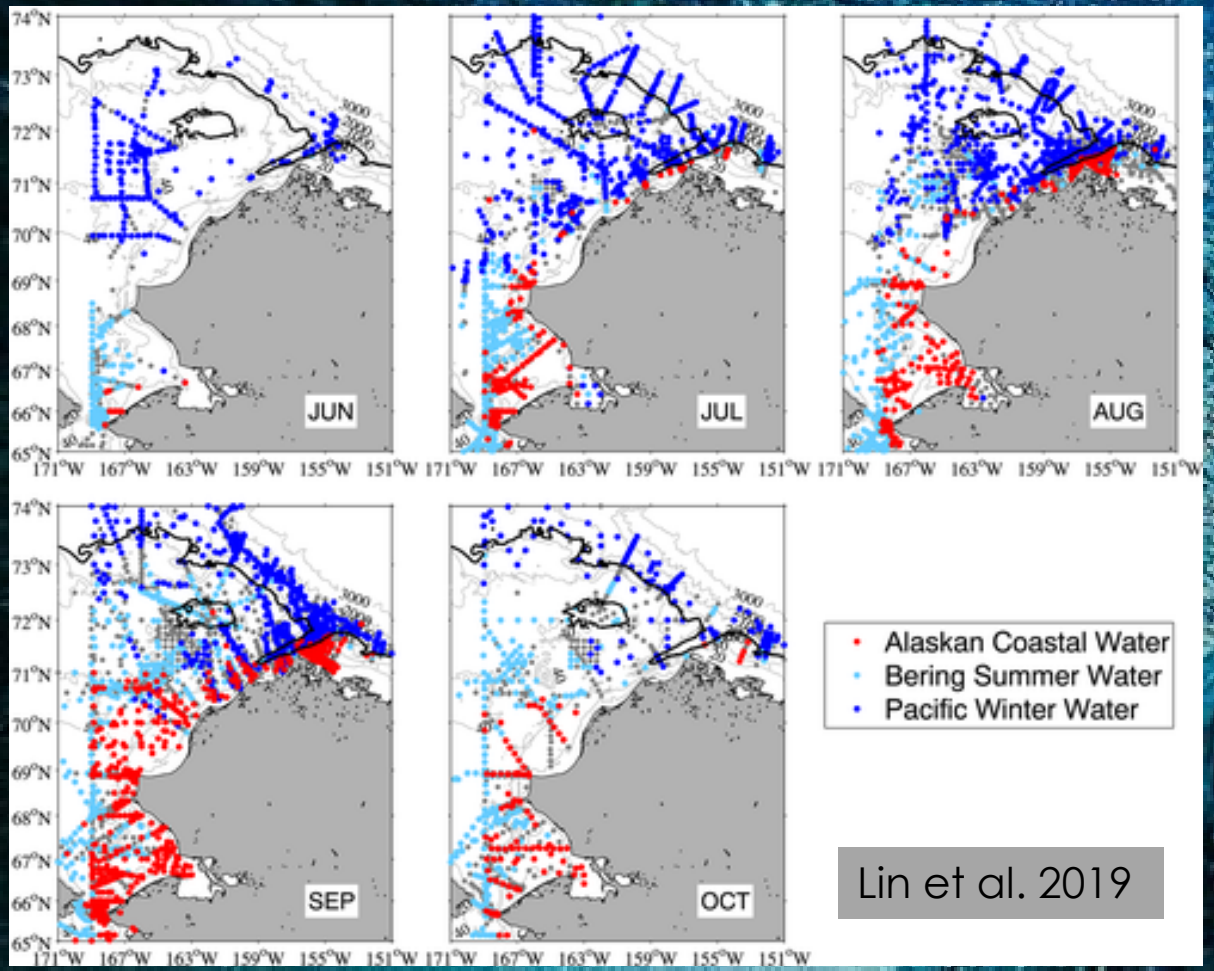


Methods

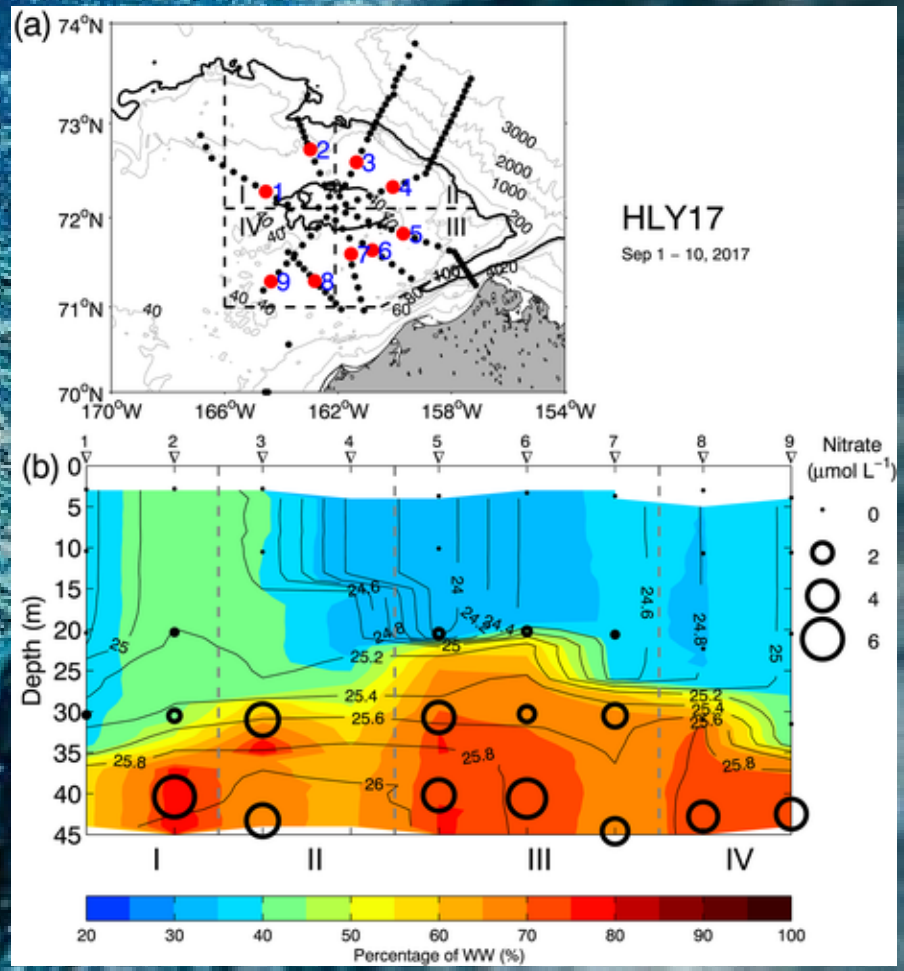
Cruises from 2011-2018, Moorings, Stratification index

- Nutrient supply to euphotic zone
- Trends in primary production (Hill et al., 2018)
- Phytoplankton community composition (Neeley et al., 2018)
- Zooplankton distributions (Sigler et al., 2016)
- Pelagic fishes/jellyfish (Sigler et al., 2016)
- Sea bird distributions (Gall et al., 2013)
- Harmful Algal Blooms (ongoing research, Anderson (WHOI), Lefebvre (NOAA))
- Carbon pump (CO_2 outgassing to atmosphere) (Hauri et al., 2013)

Stratification & Water masses



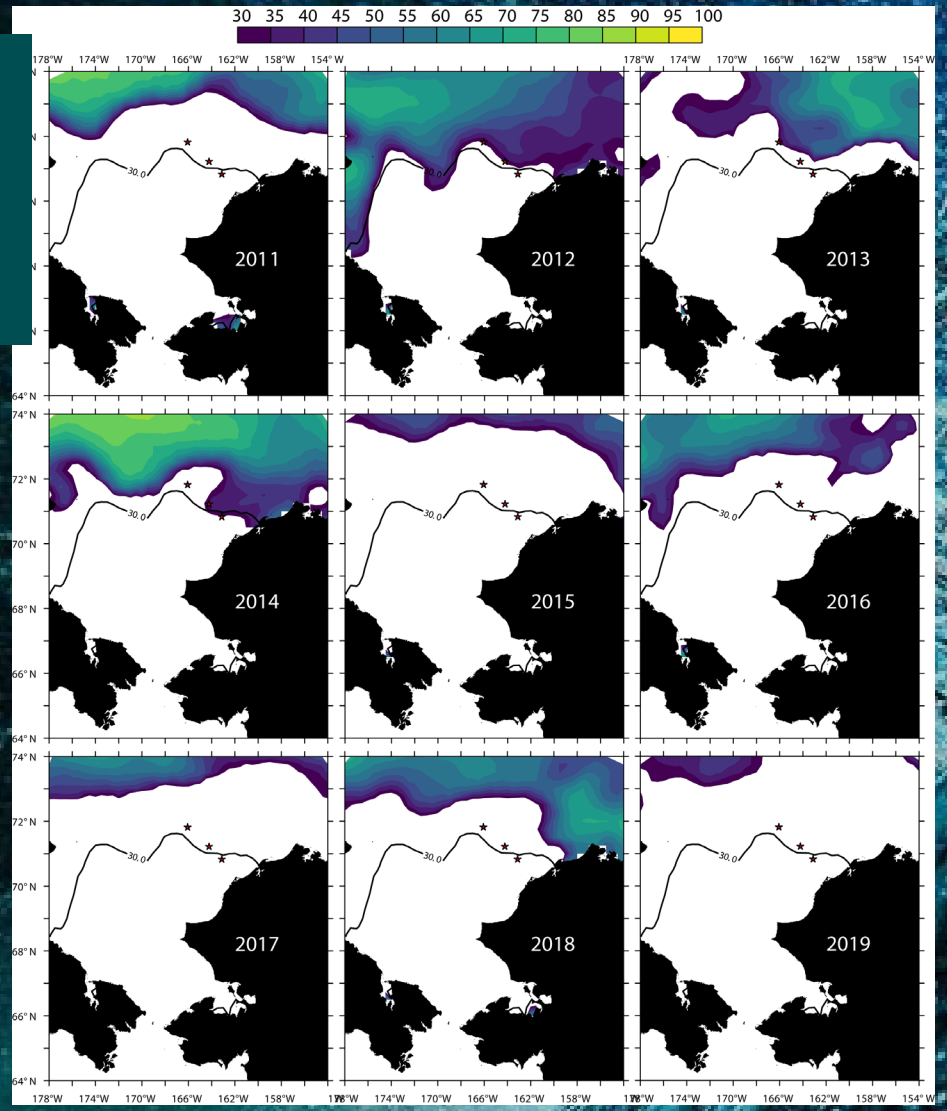
Lin et al. 2019



Advective (Lin et al. 2019)

Winter Water (high nutrients) formed in winter is pushed off the shelf during Summer

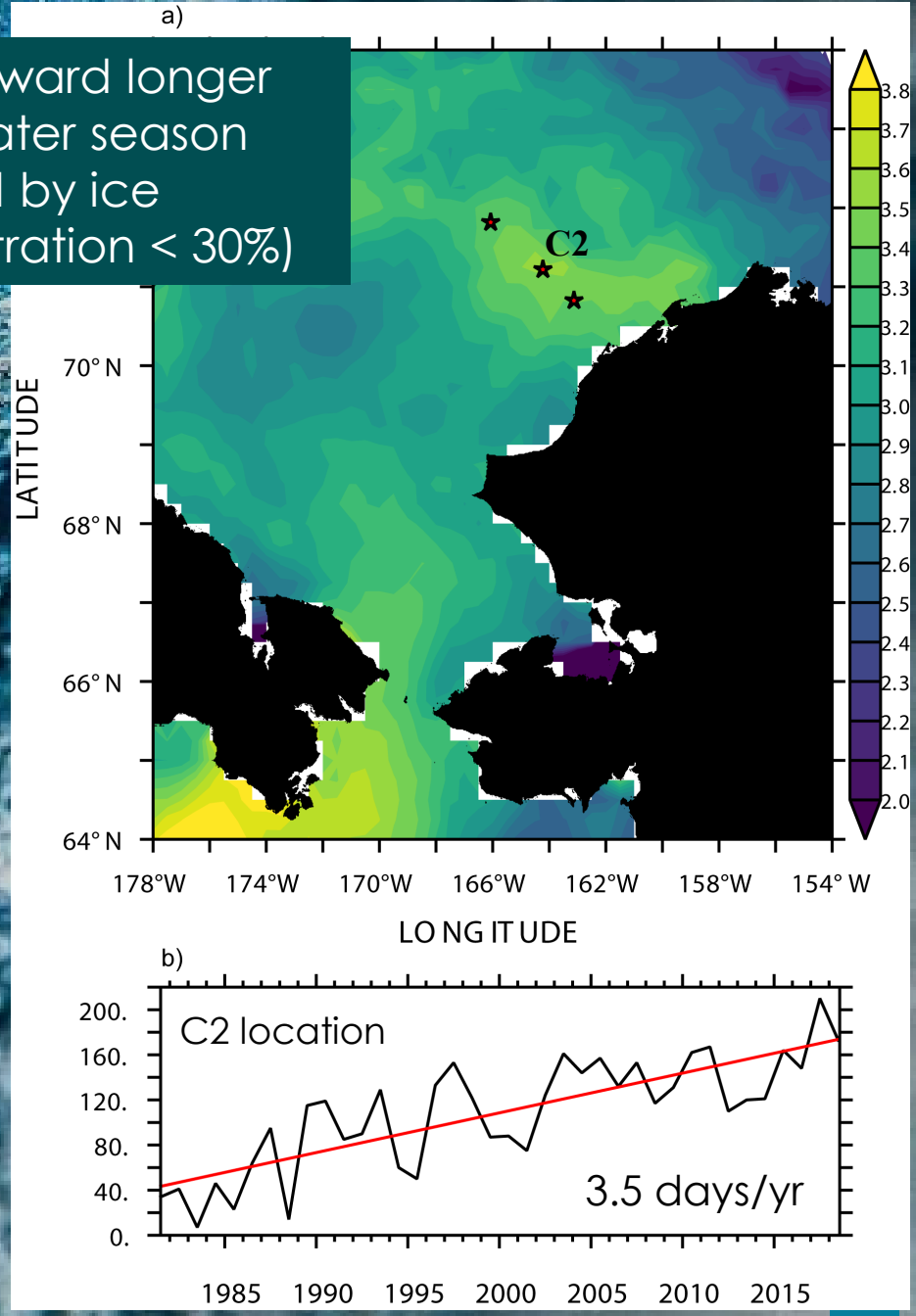
Black contour: 30% ice mean 1982-2010



Ice Concentration

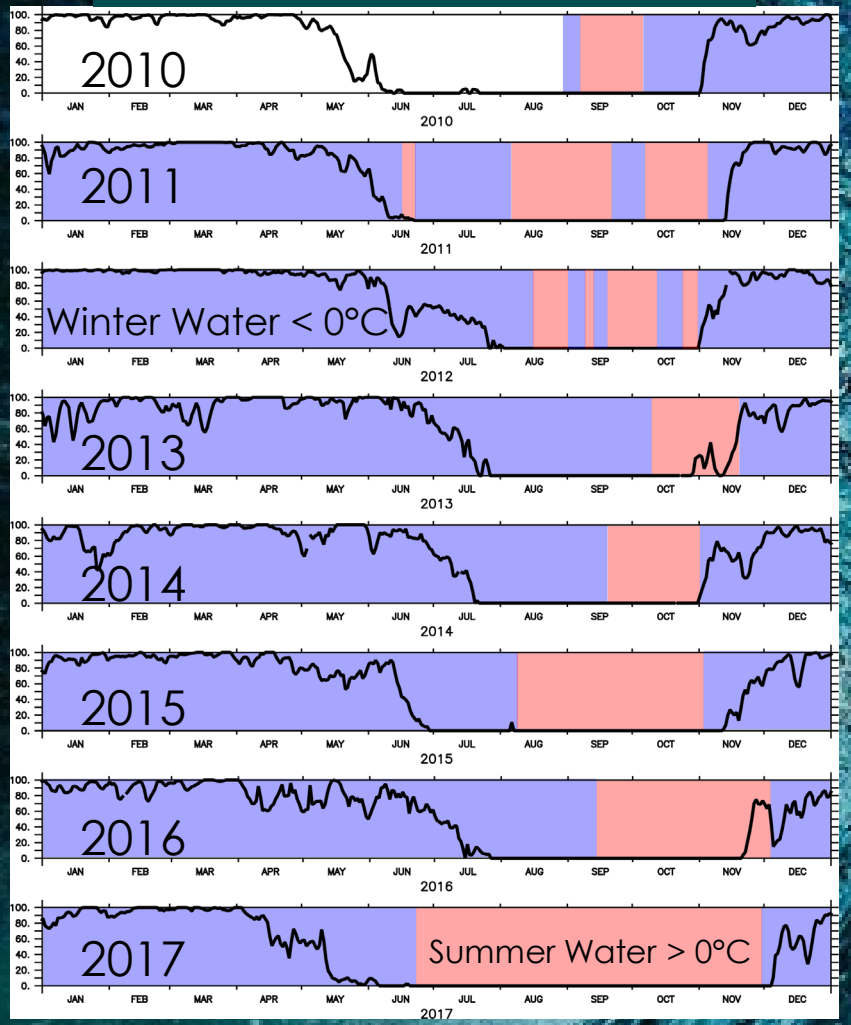
15 July

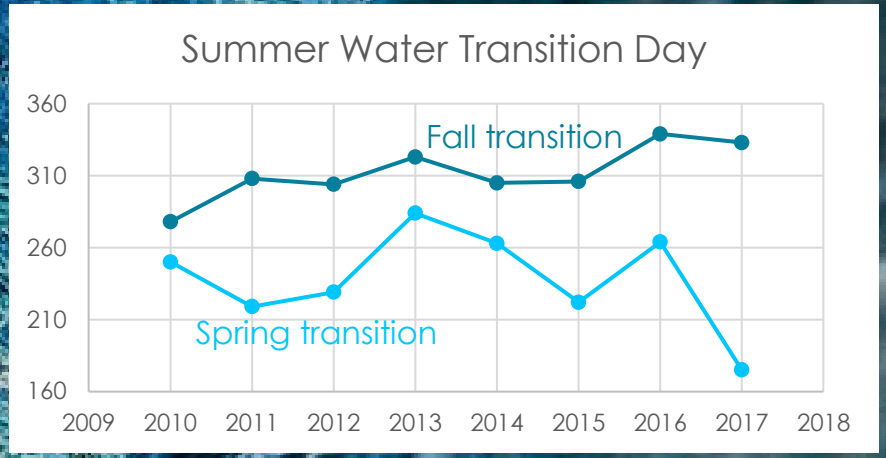
Trend toward longer open water season (defined by ice concentration < 30%)

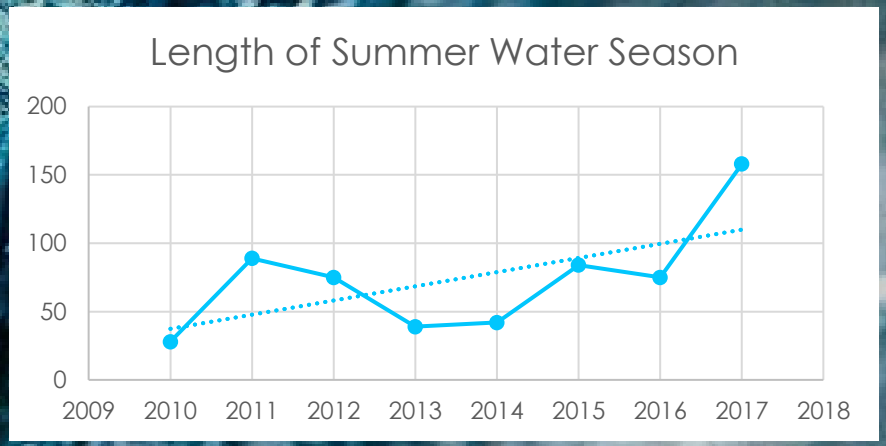


Seasonal Cycle

Ice Concentration at C2
And bottom water masses

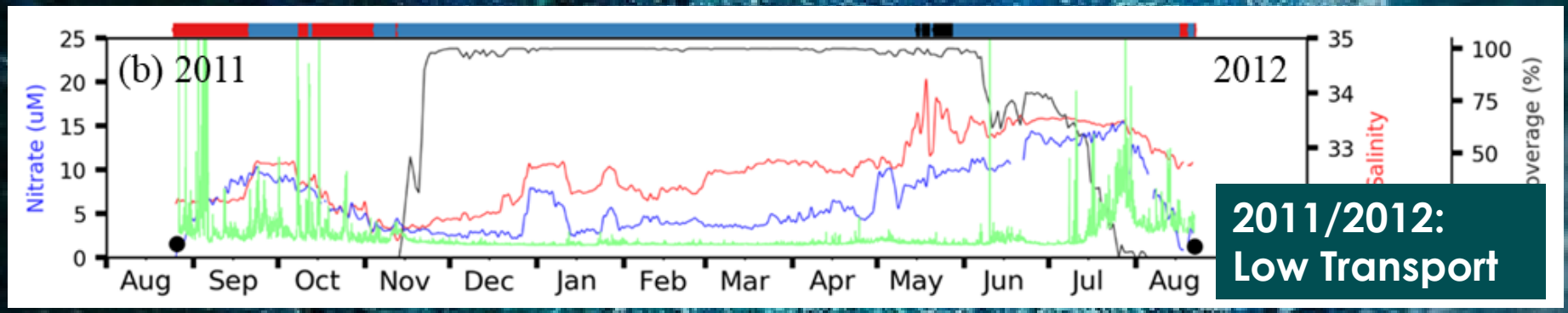






Water mass transitions are correlated with ice retreat/advance dates

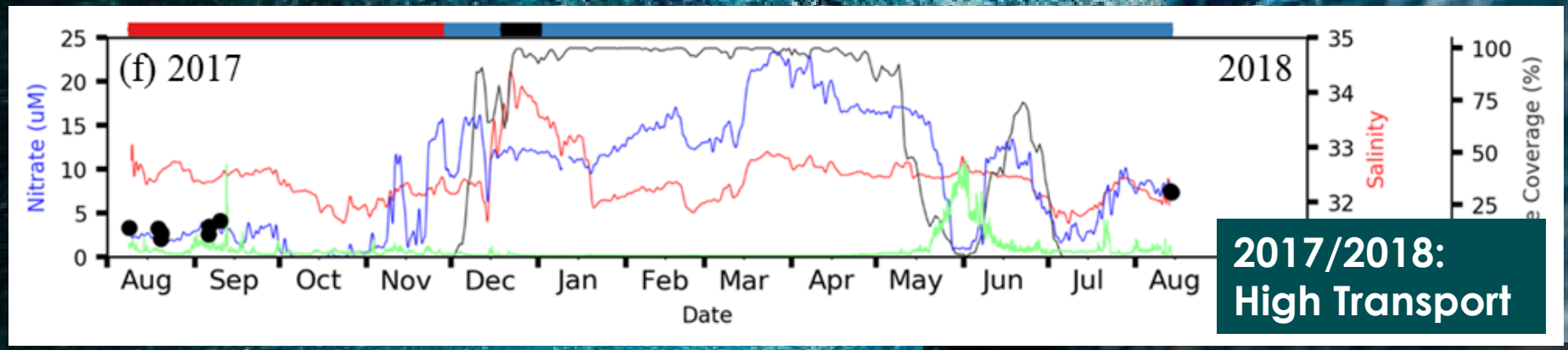
2017: transition to open water and Summer Water > 1 month earlier than average (2017 also exhibited strongest spring transport in record)



- Ice extent (black),
- nitrate (blue),
- salinity (red),
- chl fluorescence (green)

2011/2012: Low Transport

Summer Water **Winter Water**

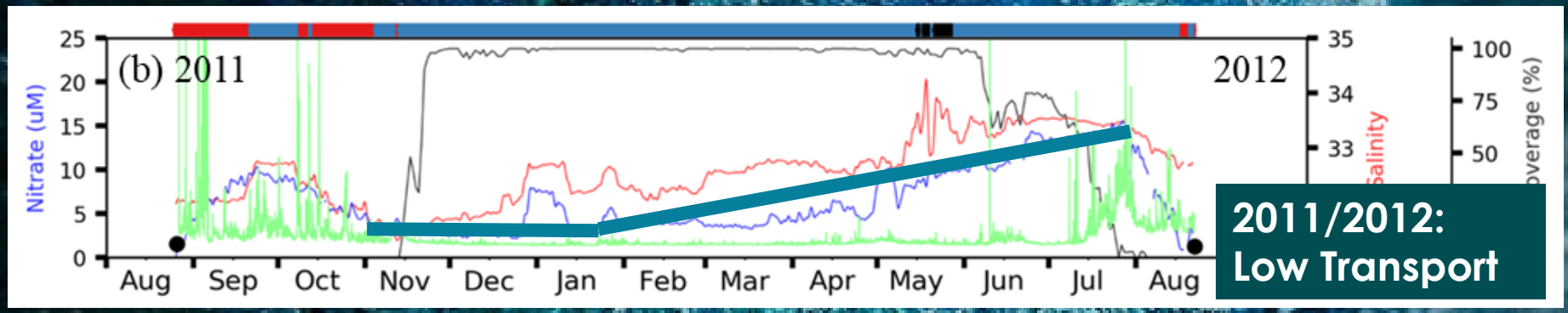


2017/2018: High Transport

Seasonal Cycle

Mordy et al., 2019

- Nitrate is low in Summer Water and newly ventilated Winter Water
- Replenished in Winter Water over the winter (via transport from Bering Strait)
- Used during spring bloom (prior to Summer Water transition)



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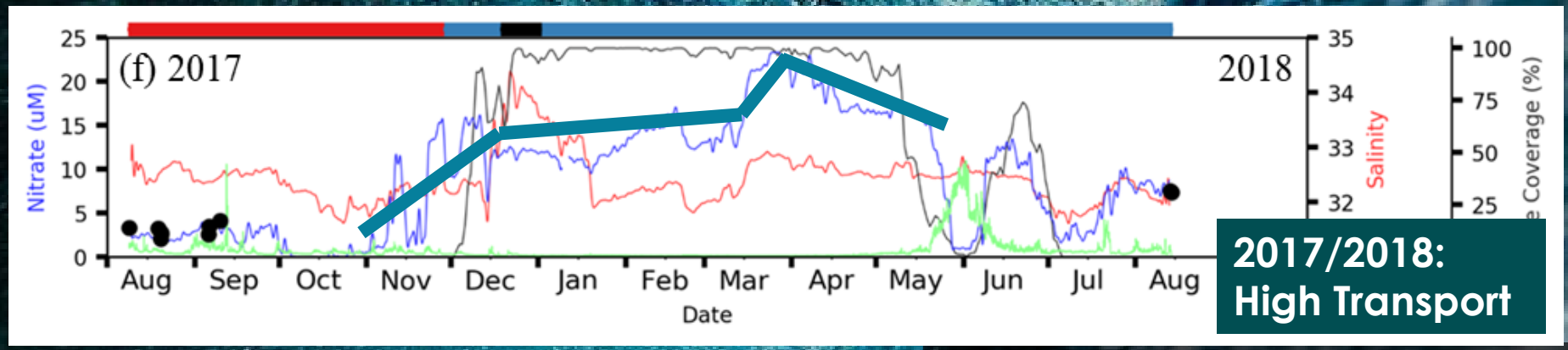

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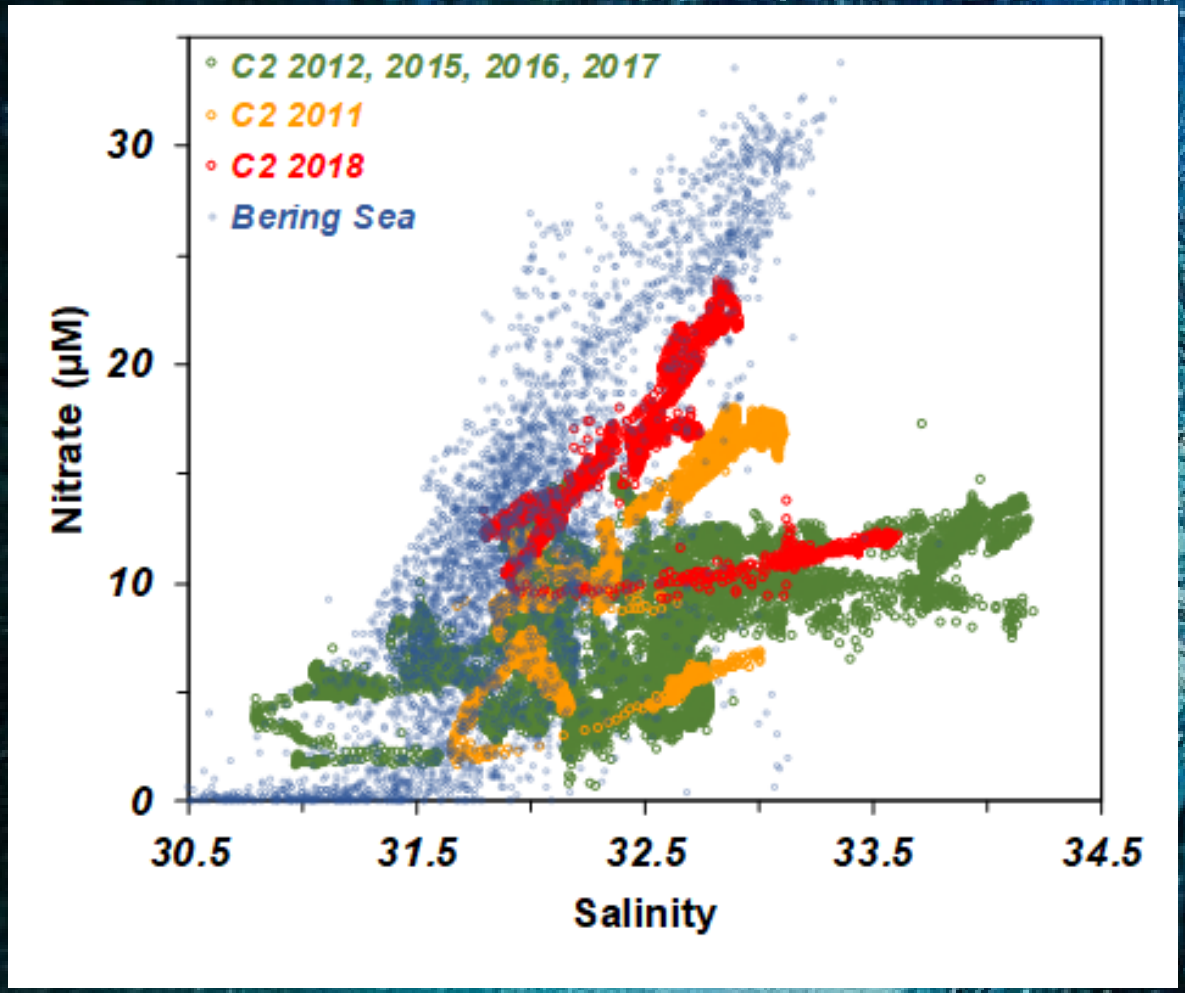


	SON	OND	NDJ	DJF	JFM	FMA	MAM
2017 – 2018	1.1	1.0	0.8	0.7	0.9	0.9	0.5
2016 – 2017	0.5	0.5	0.6	0.5	0.6	0.4	0.5
2015 – 2016	0.5	0.0	0.0	-0.1	0.1	0.1	0.2
2014 – 2015	0.4	0.1	0.1	0.1	0.3	0.2	0.3
2013 – 2014	0.5	0.5	0.1	-0.1	-0.1	0.2	0.5
2012 – 2013	0.4	0.4	0.1	-0.2	-0.2	0.0	0.3
2011 – 2012	0.1	0.0	0.0	0.0	0.1	0.0	0.1
2010 – 2011	0.2	-0.1	0.2	0.6	0.9	0.6	0.4

Scale

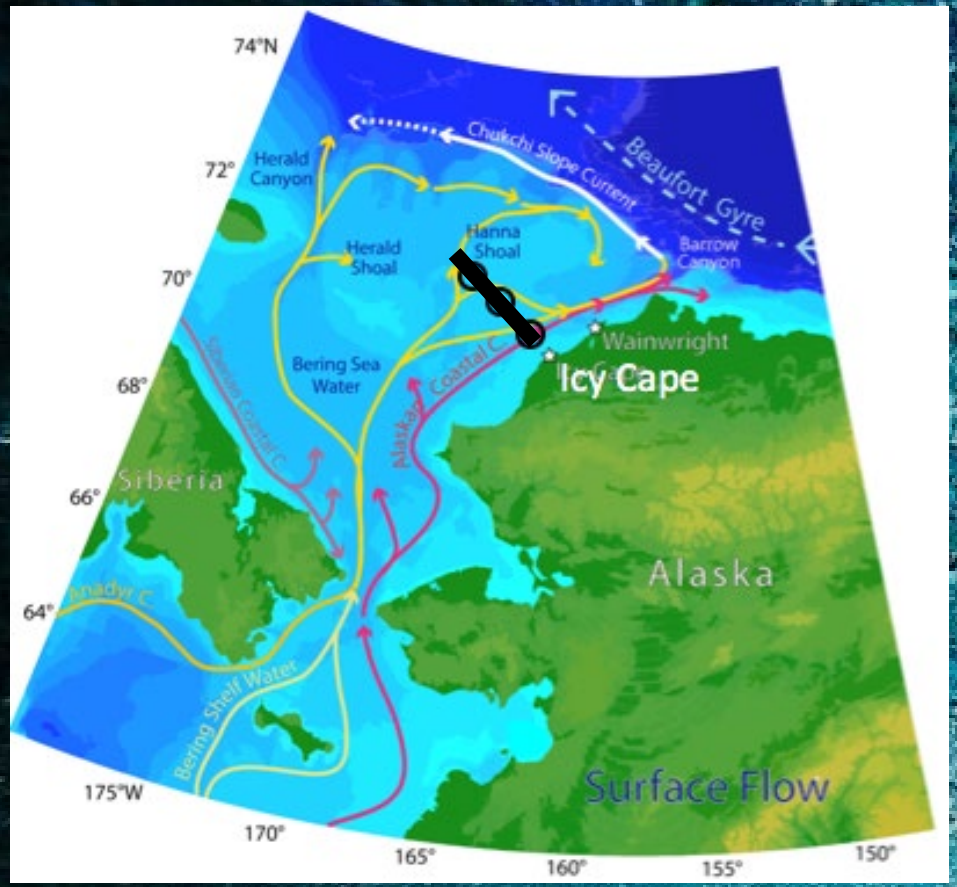
-1 -0.5 0.0 0.5 1 (Sv)

Nitrate and Transport

Mordy et al., 2019

High Transport corresponds with Bering Sea nutrient signature at C2:

2011 & 2018

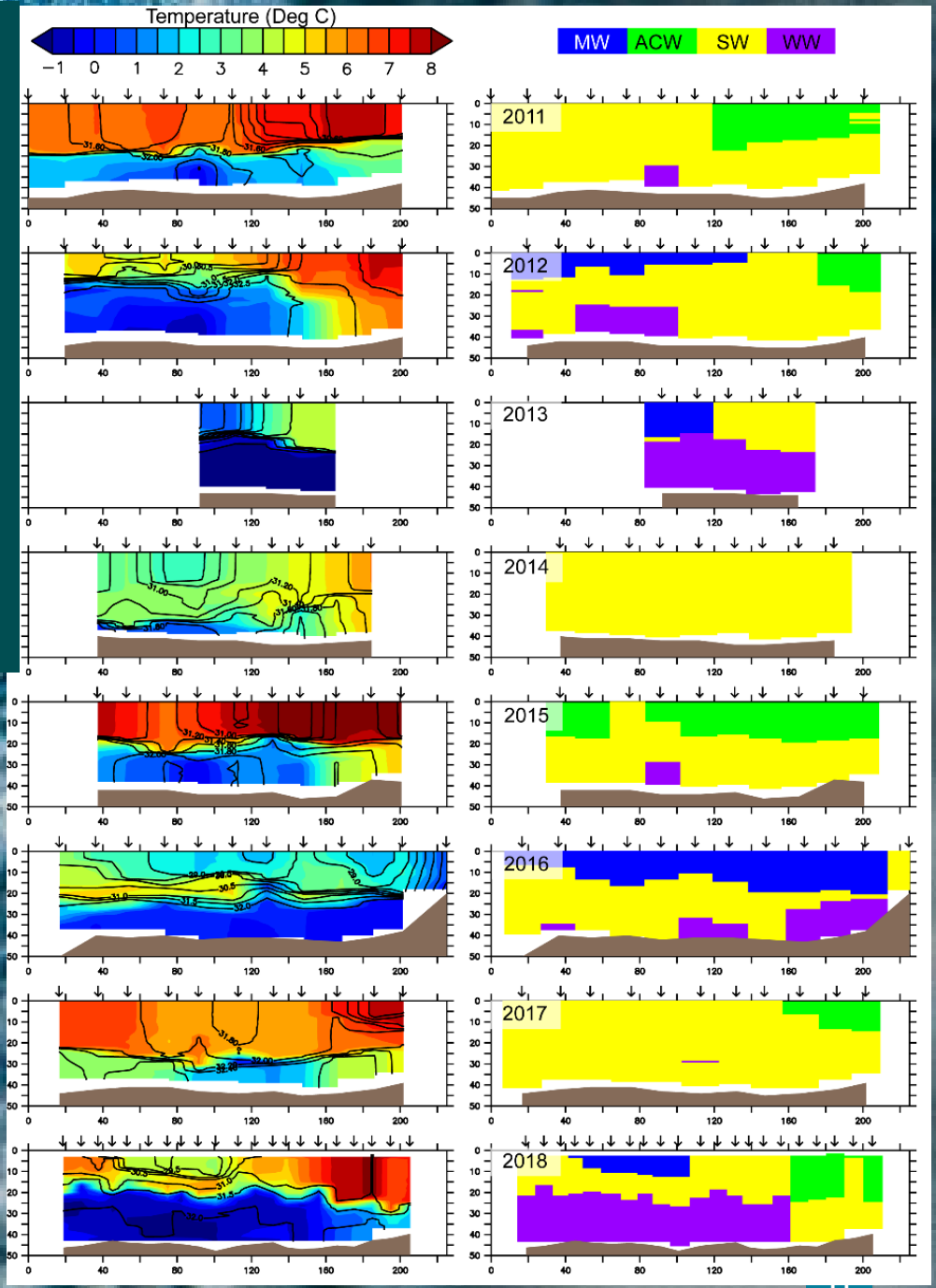


Icy Cape CTD transects:

In 2012, 2013, 2018, MW and WW tend to co-occur.

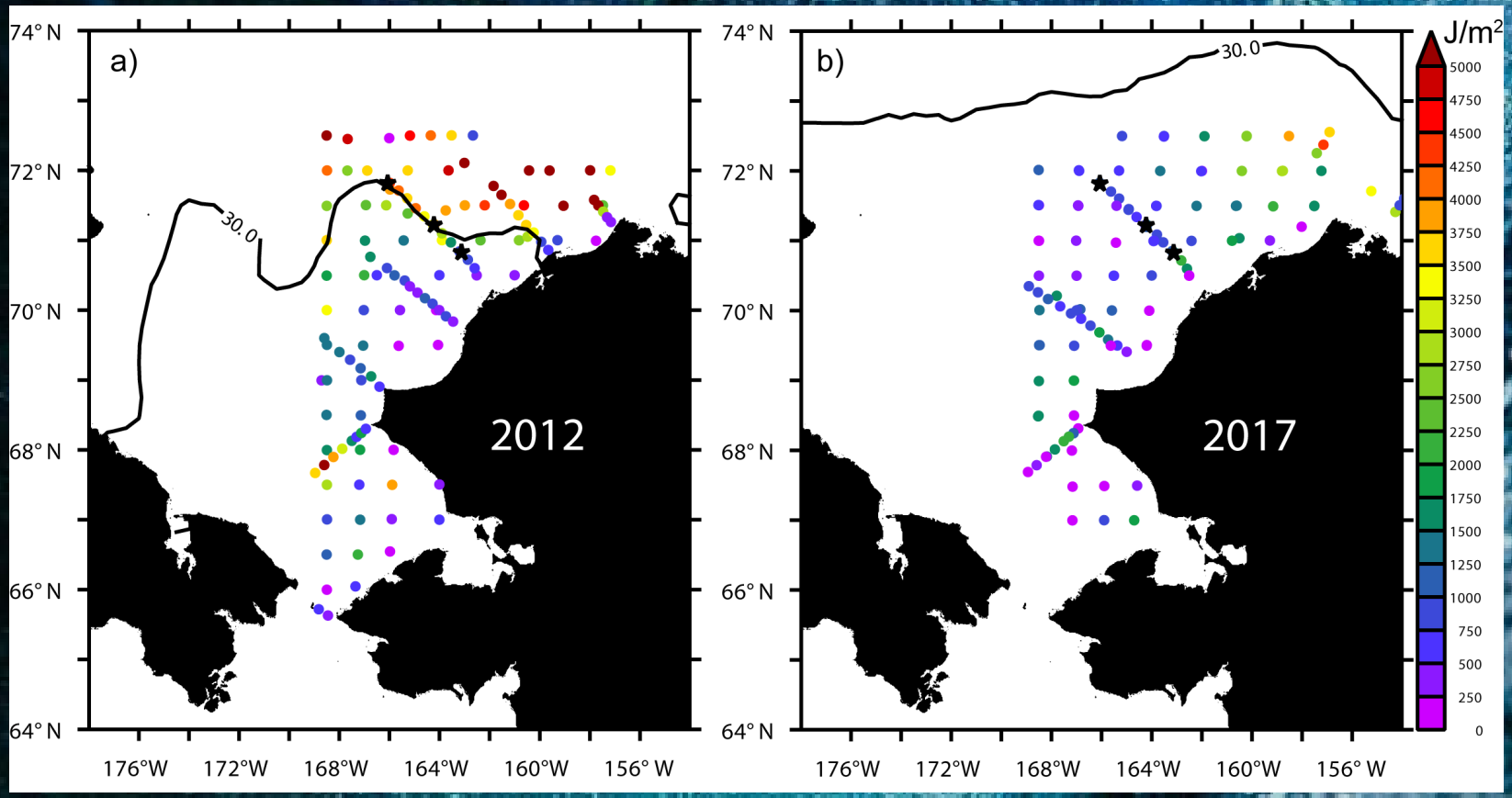
Those years also tend to have higher stratification.

WW < 0°C
SW > 0°C
MW < 30 psu
ACW > 7°C



Interannual Variability

Icy Cape line



Stratification Strength in Aug/Sep (color)

30% Ice concentration contour on July 15

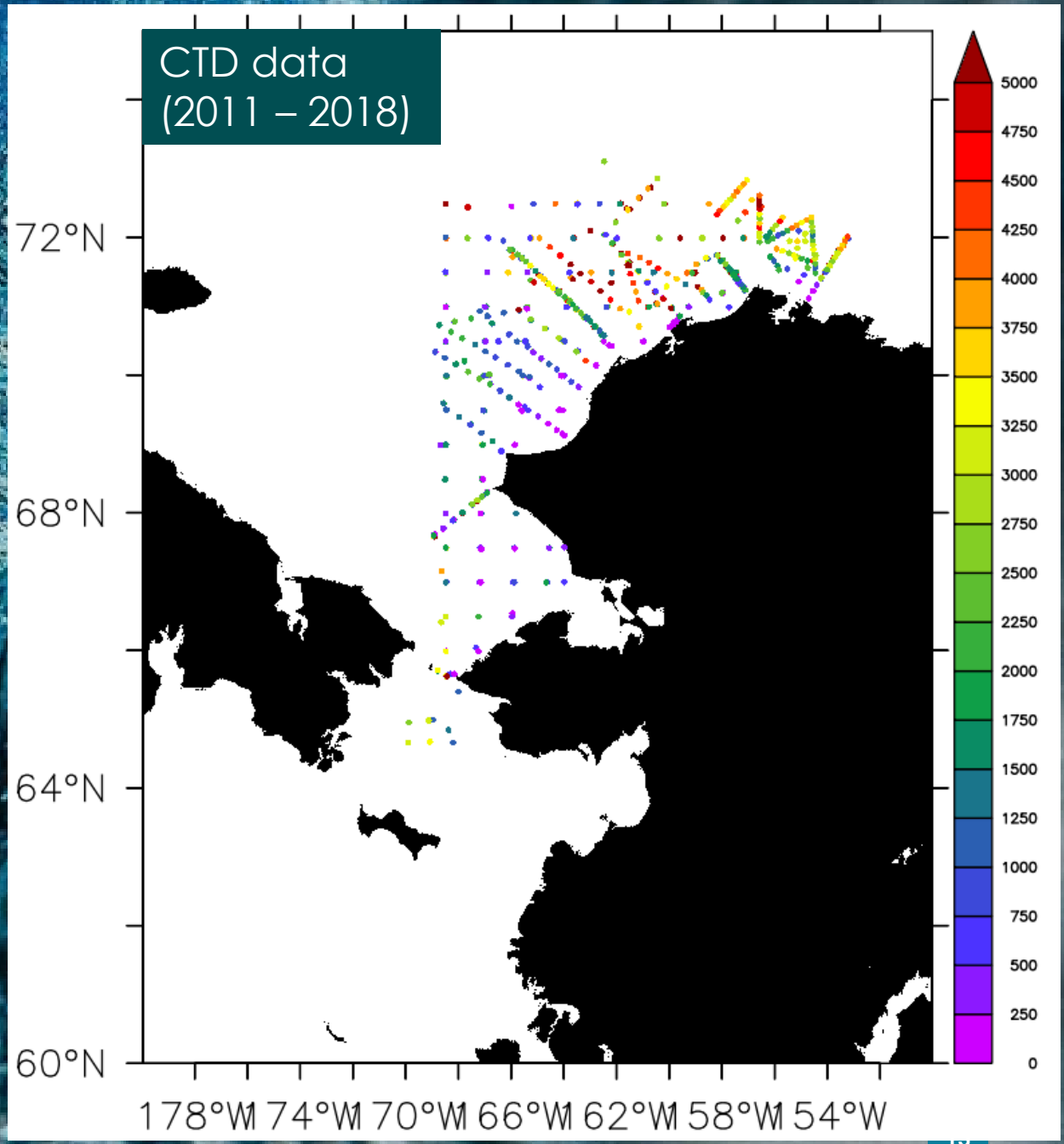
Summer Stratification (Aug/Sep)

And 15 July Sea Ice 30% contour

Summer Stratification

Regression Model:

- **Wind speed (negative correlation)**
- **Day of Year (non-linear: increases until Sep 12 then decreases)**
- **Days since ice > 30% (negative correlation)**
- **Year (decreasing trend)**



Summary and Conclusions

Interannual Variability:

- Spring transition earlier, fall transition later, open water season increasing by 3.5 days/year
- Over 2011 – 2018, summer stratification is most influenced by day of year and wind speed
- Interannual trend toward weaker stratification (likely due to earlier ice retreat)
- Nitrate content in Winter Water is influenced by transport (strongest transport and highest nutrient concentrations in 2011 and 2018)

Summary and Conclusions

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- Nitrate content in Winter Water is influenced by transport (strongest transport and highest nutrient concentrations in 2011 and 2018)

- **Interplay between advective and local processes is complicated and important drivers (transport, ice, winds) are not independent.**


THANK YOU
NOAA
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE
NORTH PACIFIC RESEARCH BOARD
Arctic Program