

Changing Ocean & Ice conditions in the Northern Bering Sea

7 February 2023

North Pacific Fishery Management Council
Scientific and Statistical Committee Workshop

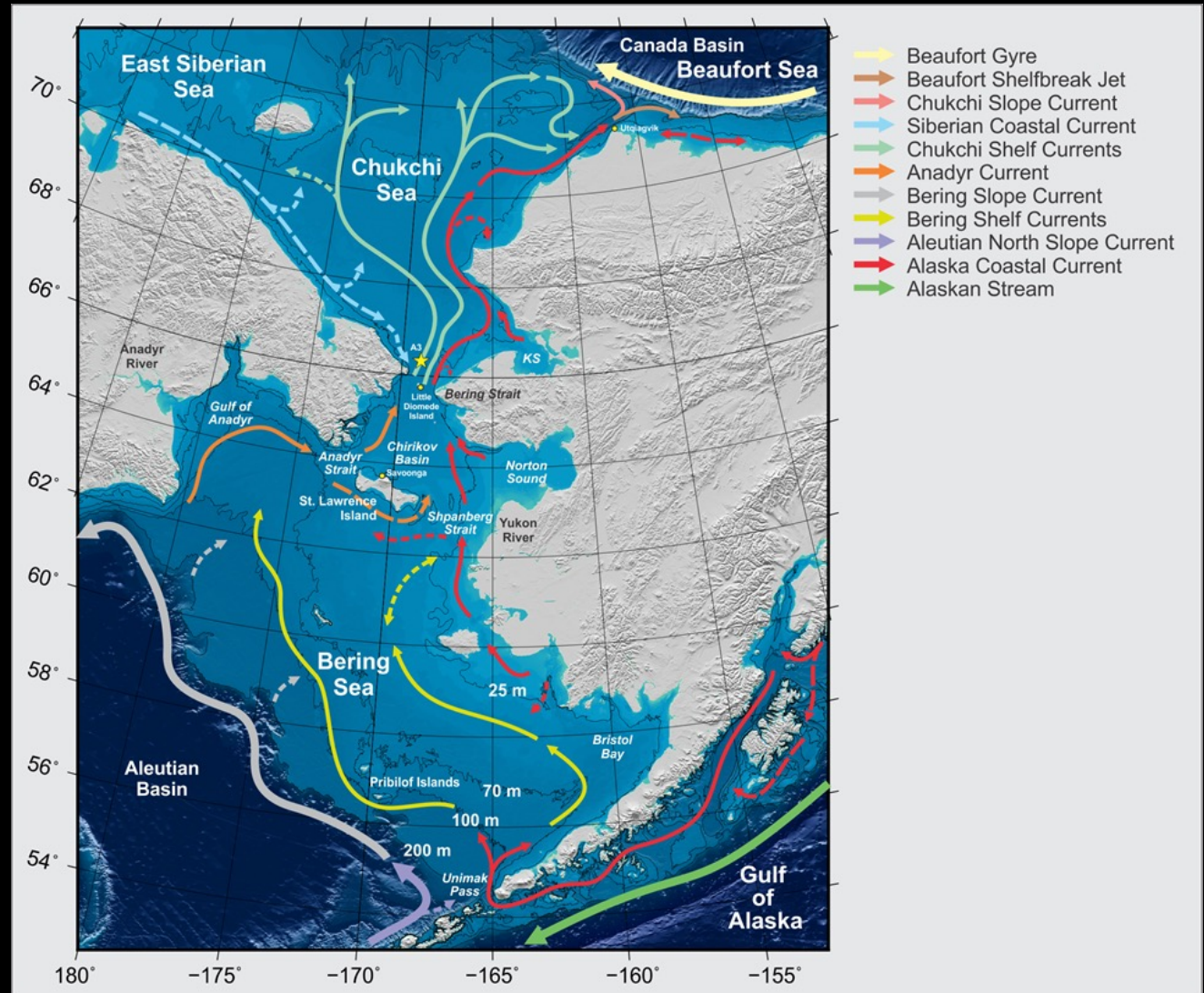
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Fisheries and
Ocean Sciences

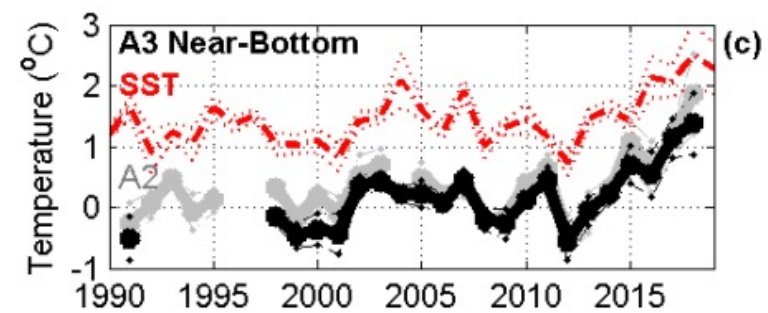
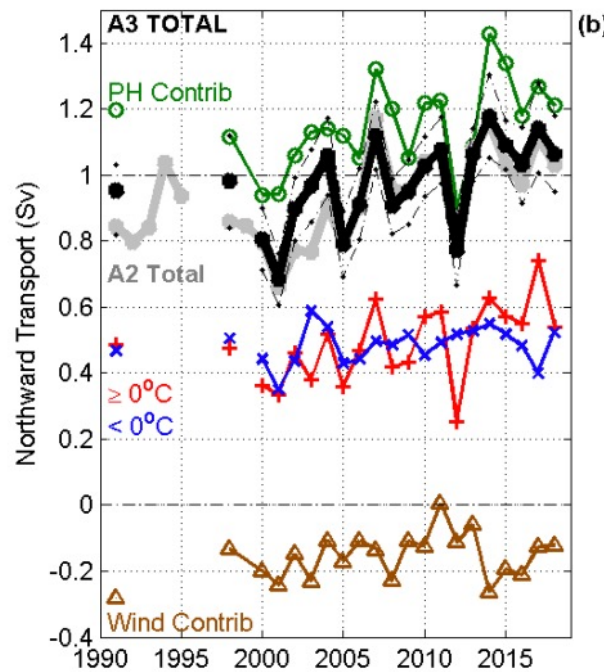
Regional Circulation

- Net Flow Northward
- Highly Responsive to Wind Speed & Direction

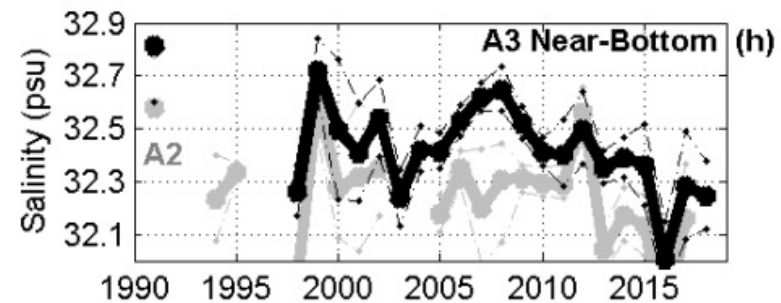


Changes In Bering Strait

Increasing Transport



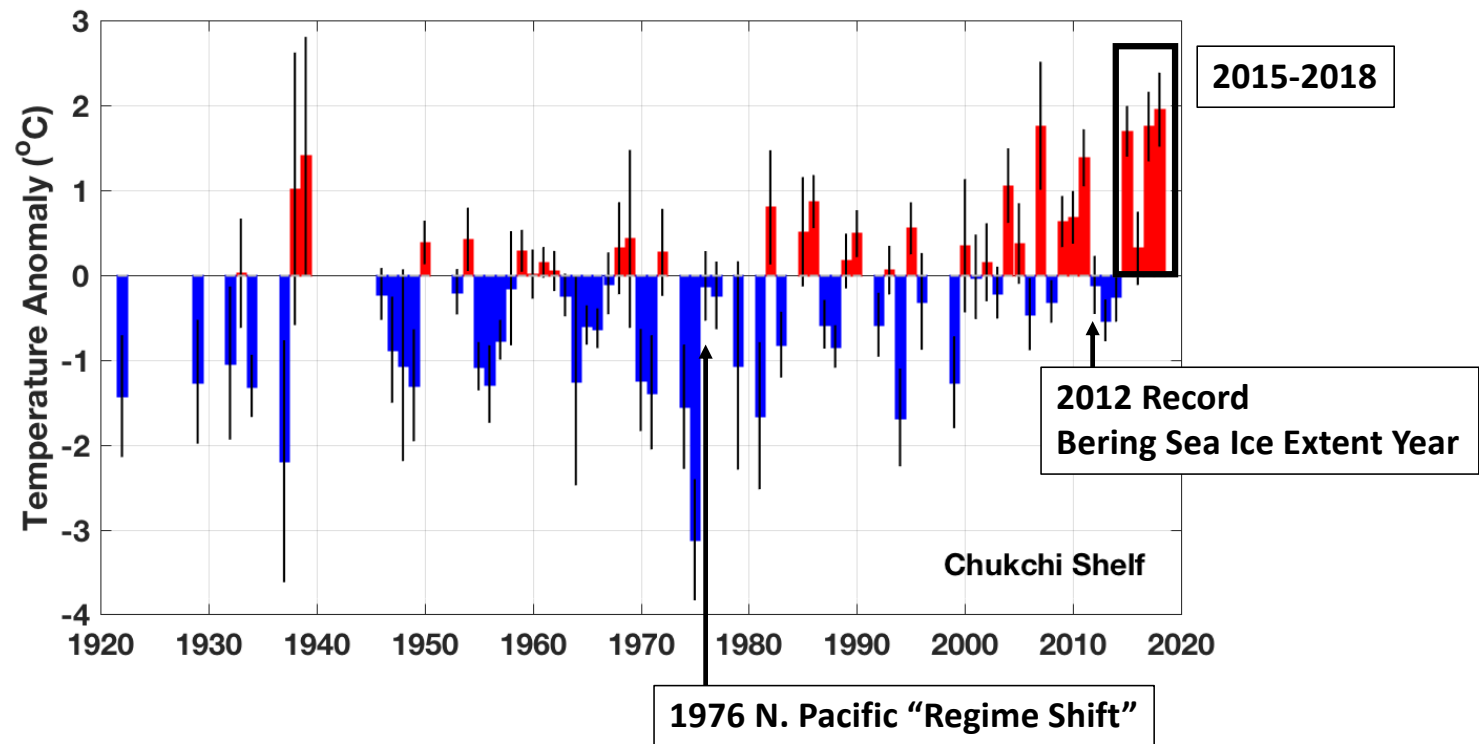
Warming



Freshening

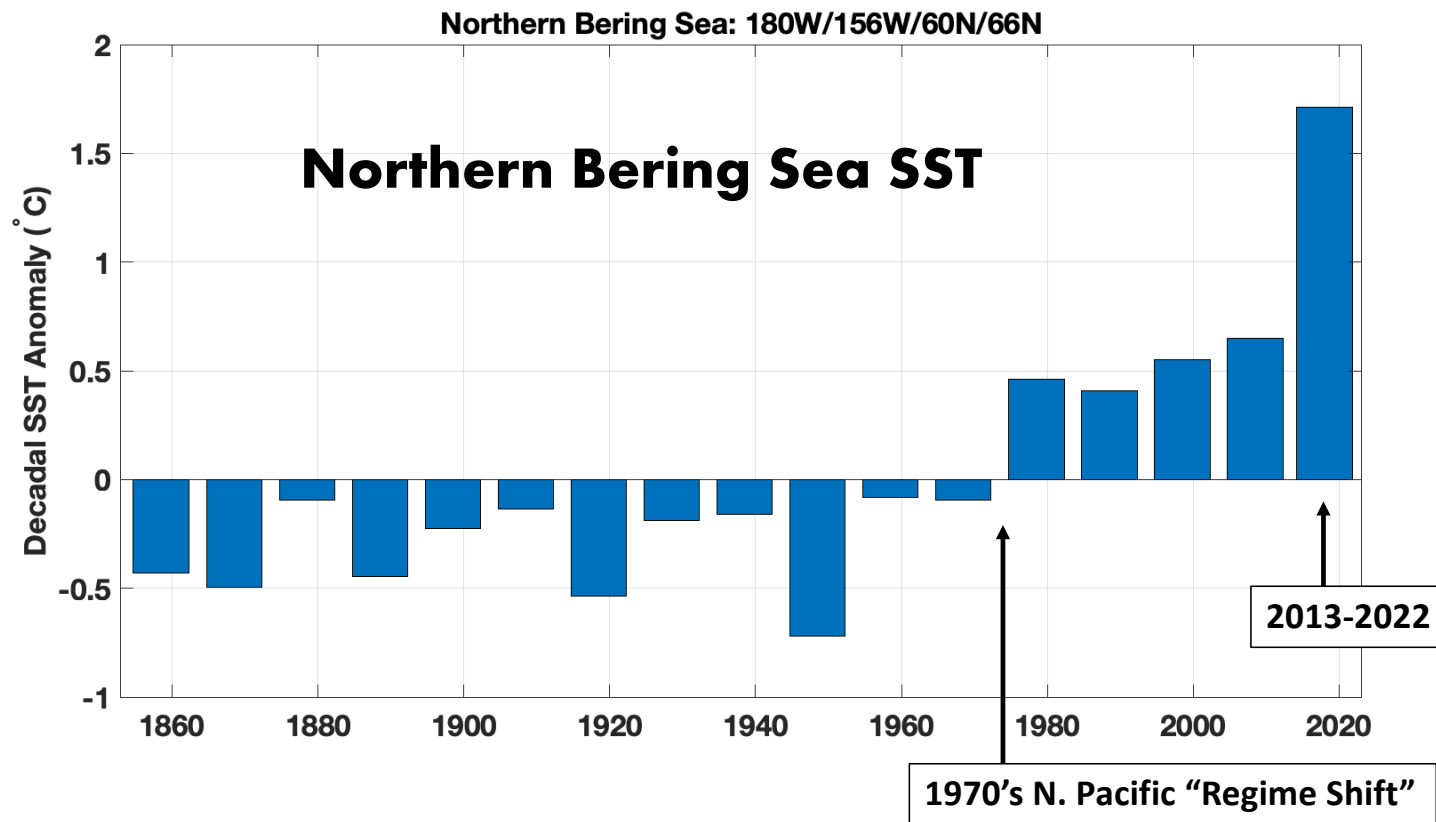
[Woodgate & Peralta-Ferriz, 2021]

1922-2018 Chukchi Shelf July to October Ocean Temperature Anomalies

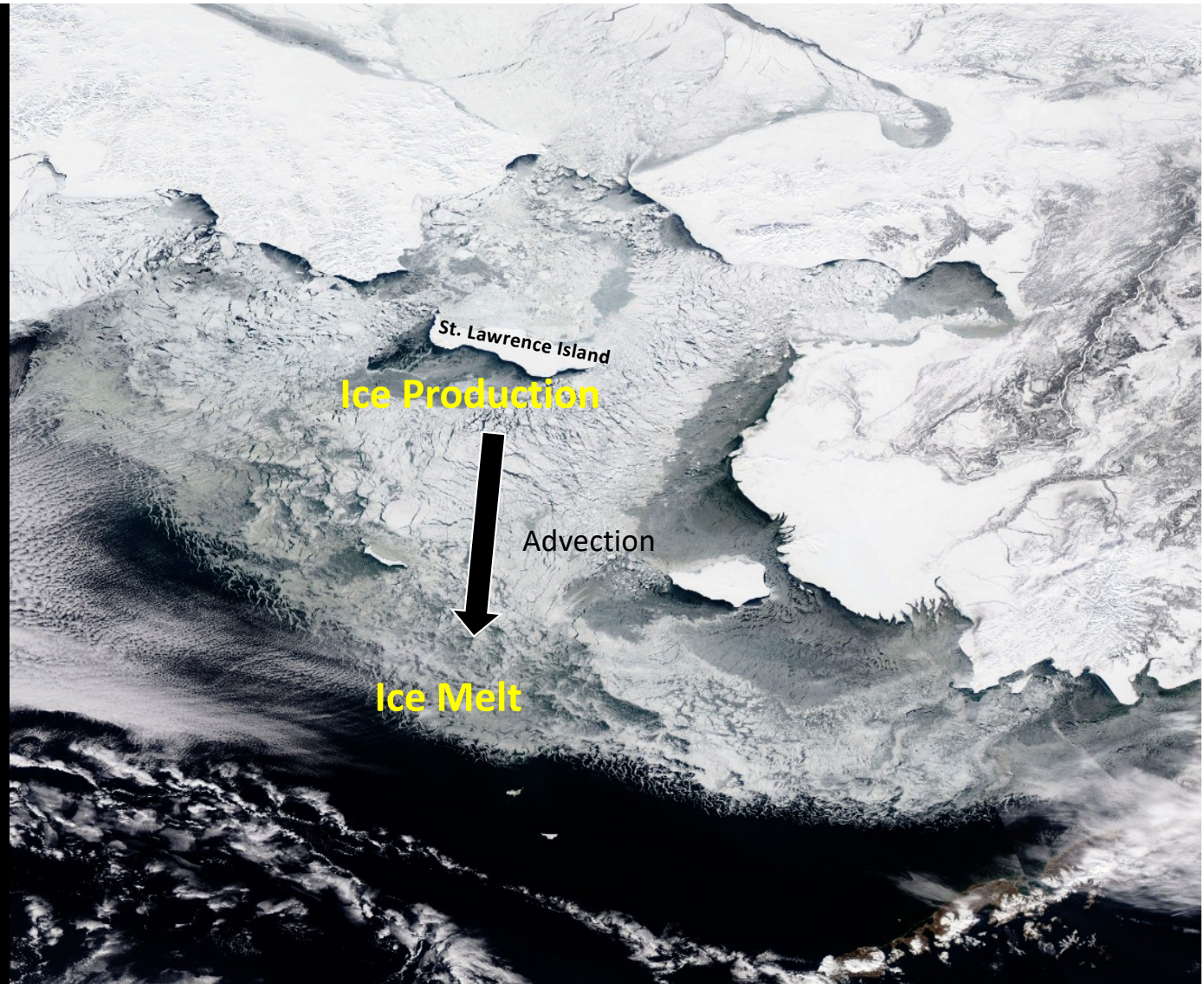


Sea Surface Temperature Anomaly

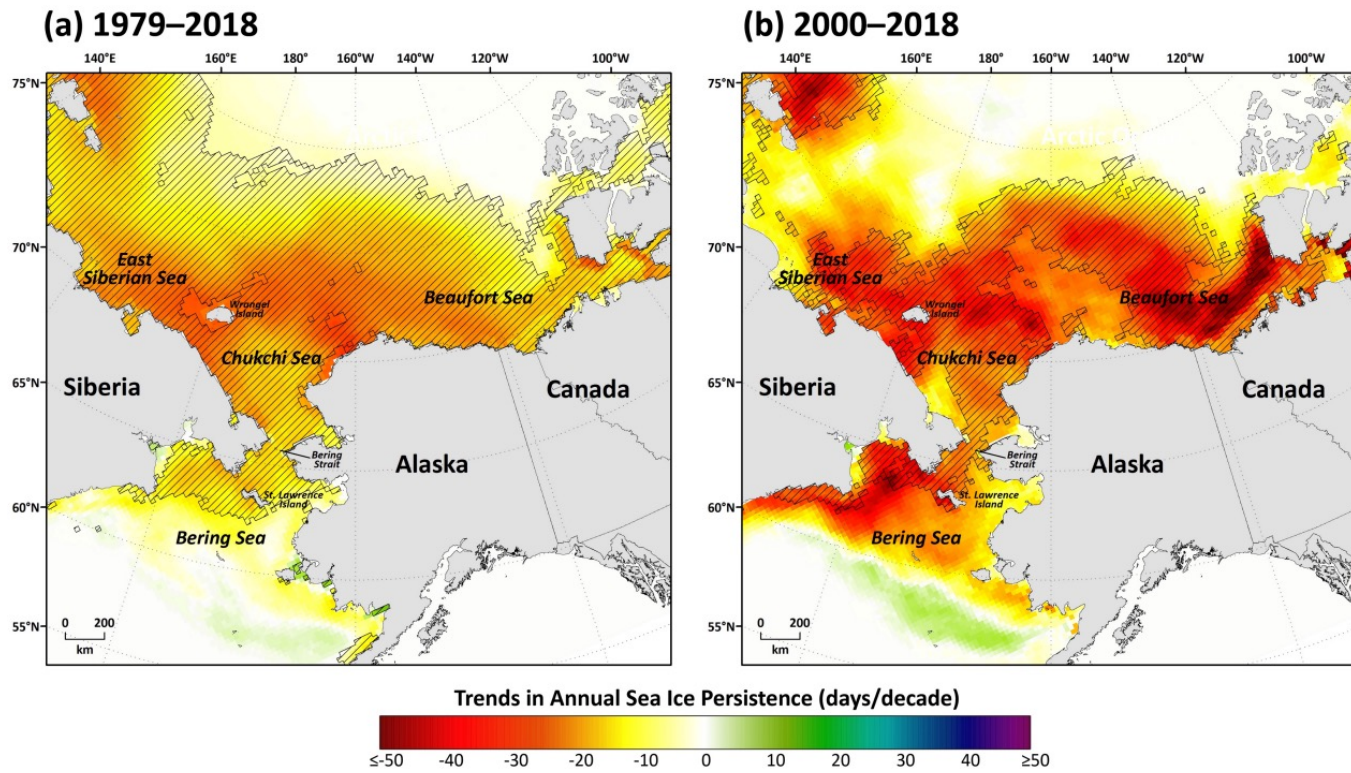
Year-round, by Decade 1854-2022



Bering Sea Ice Conveyor Belt

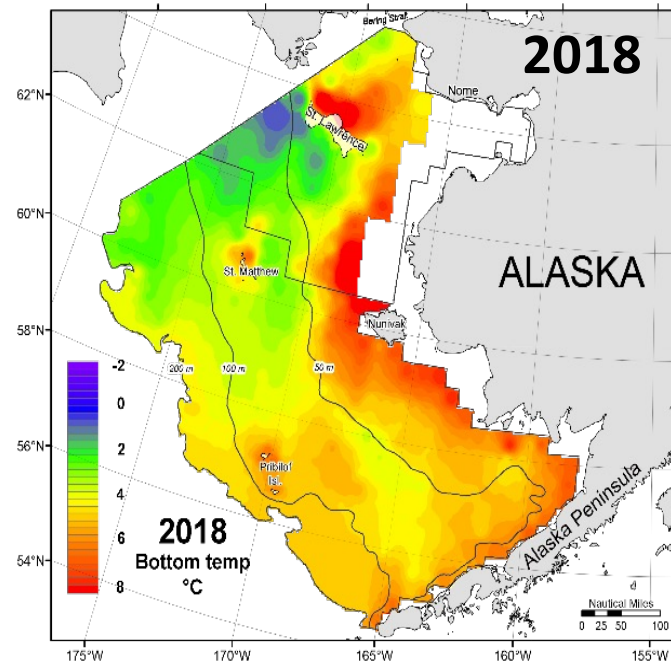
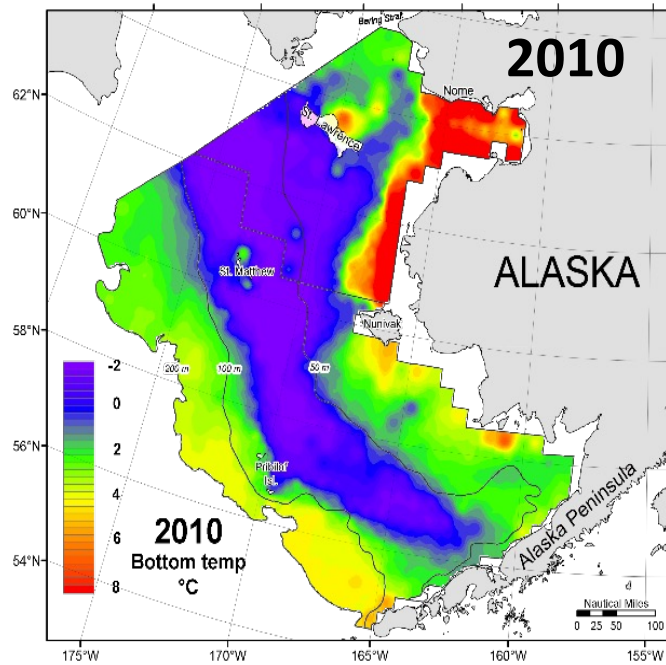


Trends in Sea Ice Persistence



[Karen Frey]

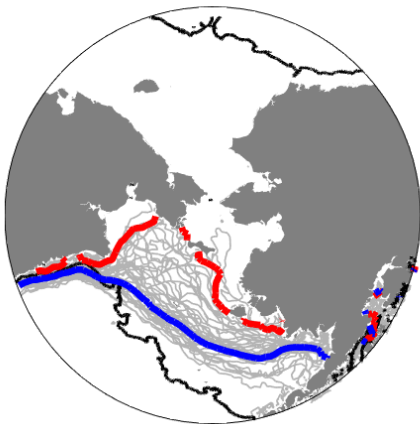
Bering Sea Cold Pool



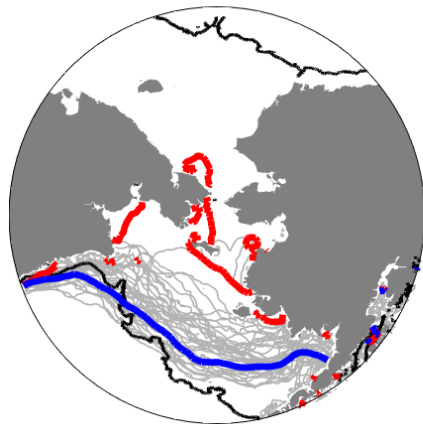
[L. Britt & NOAA AFSC RACE Division, 2018]

Winter Retreat of the Leading Ice Edge

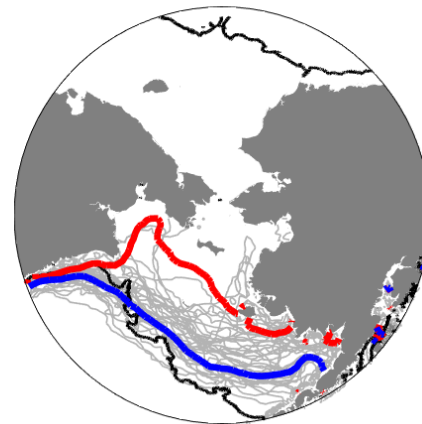
20-Jan-2018



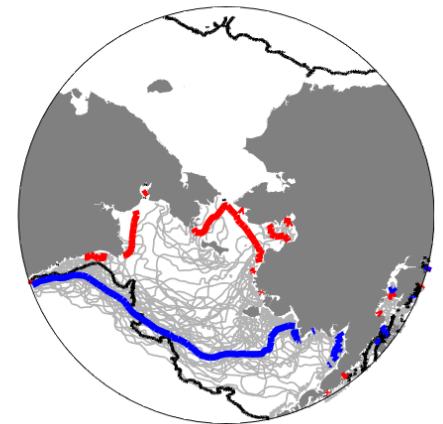
20-Feb-2018



20-Mar-2018

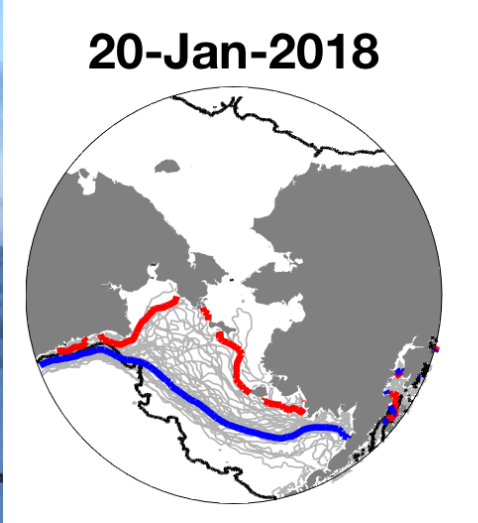


20-Apr-2018



2018 Ice Edge

1979-2019 Mean Ice Edge

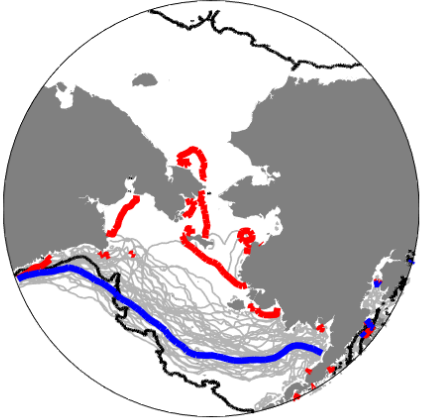


20 January 2018

Photo courtesy Opik Ahkinga

Views from Little Diomedede Island

20-Feb-2018



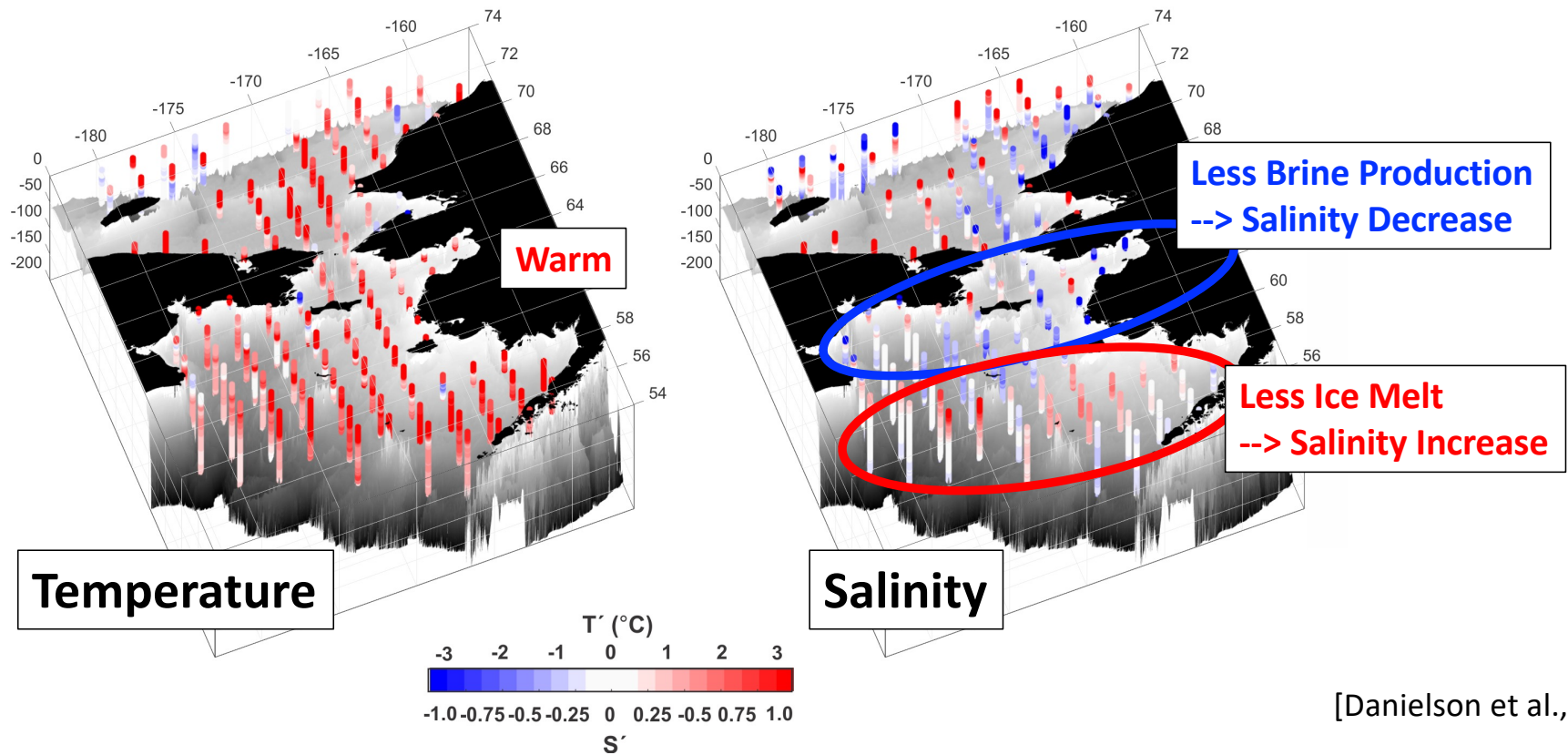
20 February 2018

Photo courtesy Frances Ozenna

Views from Little Diomedede Island

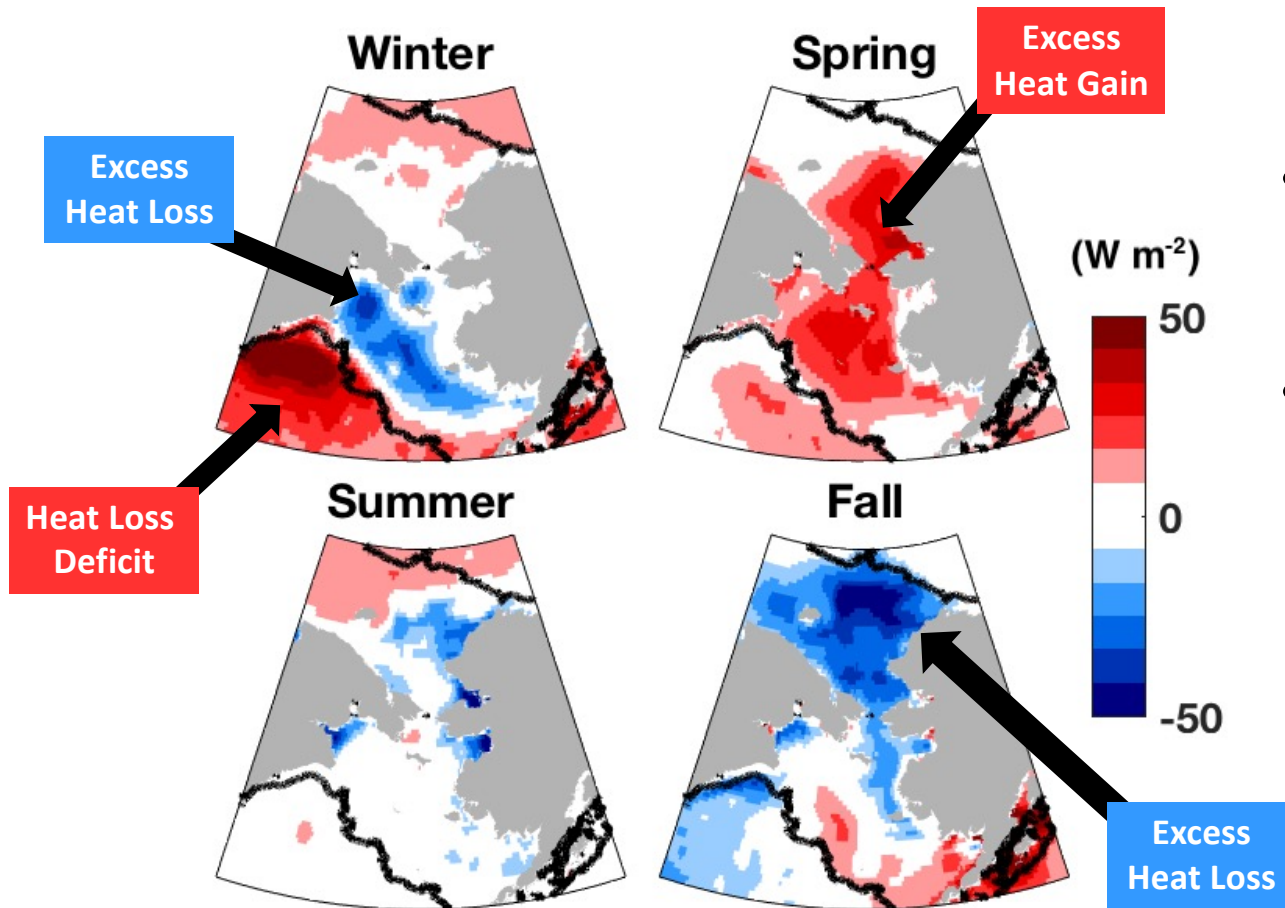
Bering-Chukchi Thermal & Haline Anomalies

2014-2018 Summer Season, Relative to Prior Period of Record



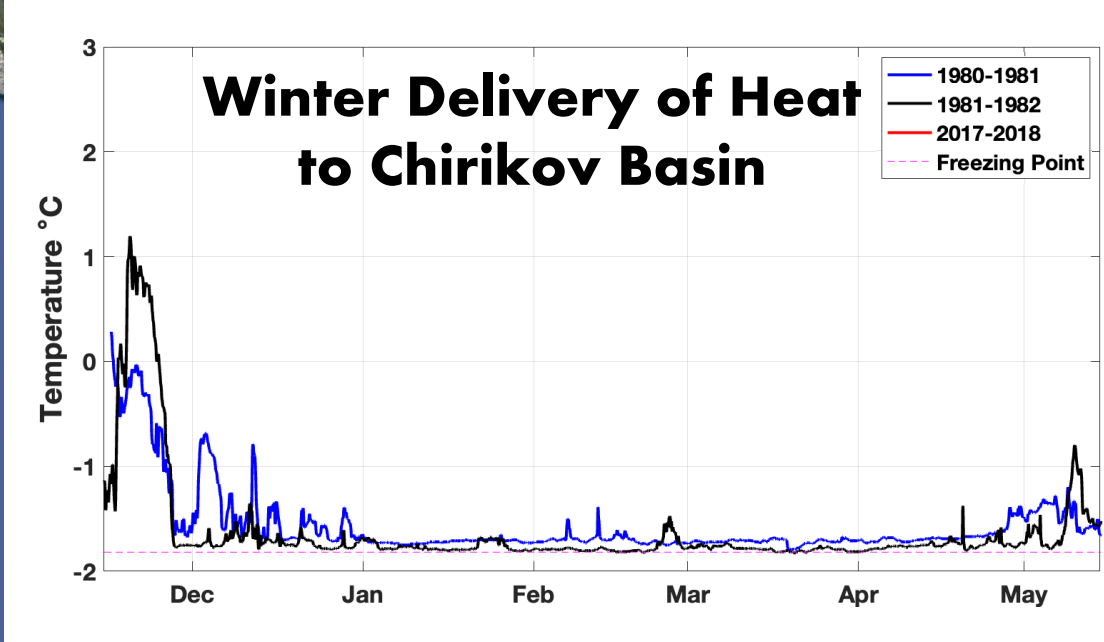
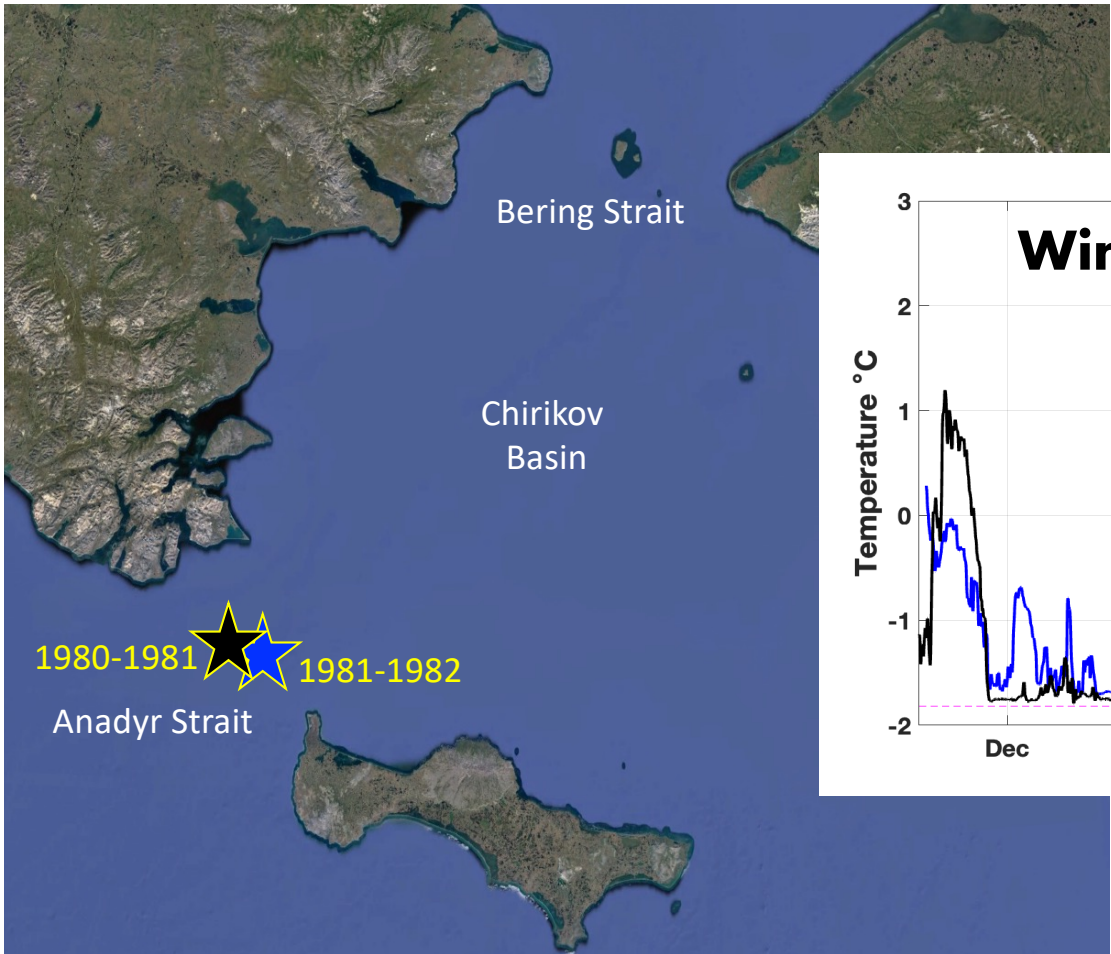
[Danielson et al., 2020]

Seasonally Changing Sea Surface Heat Fluxes

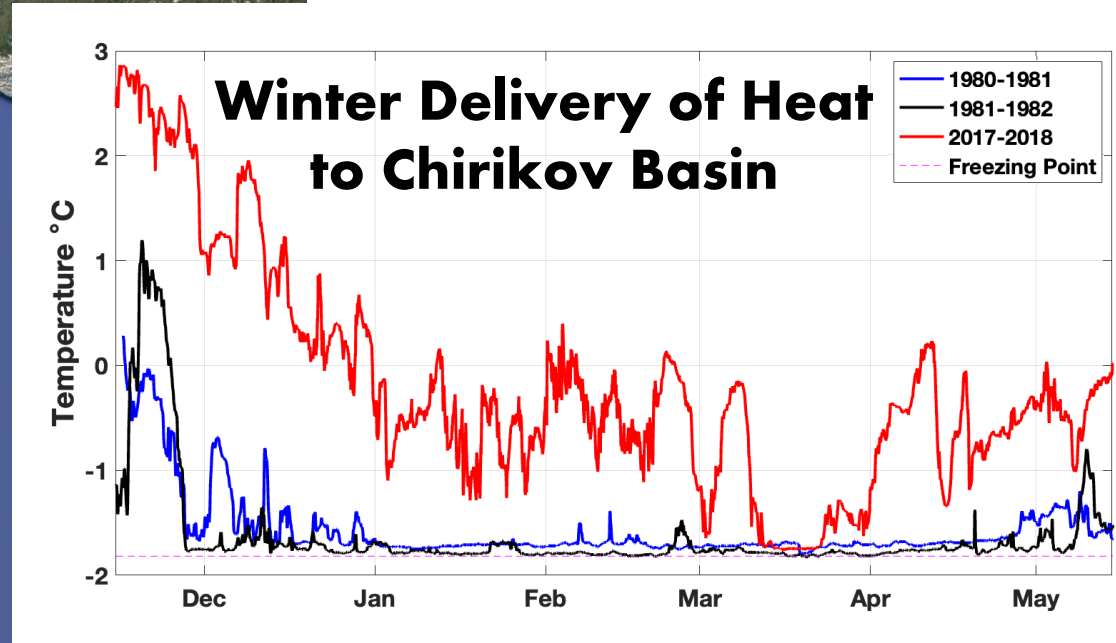
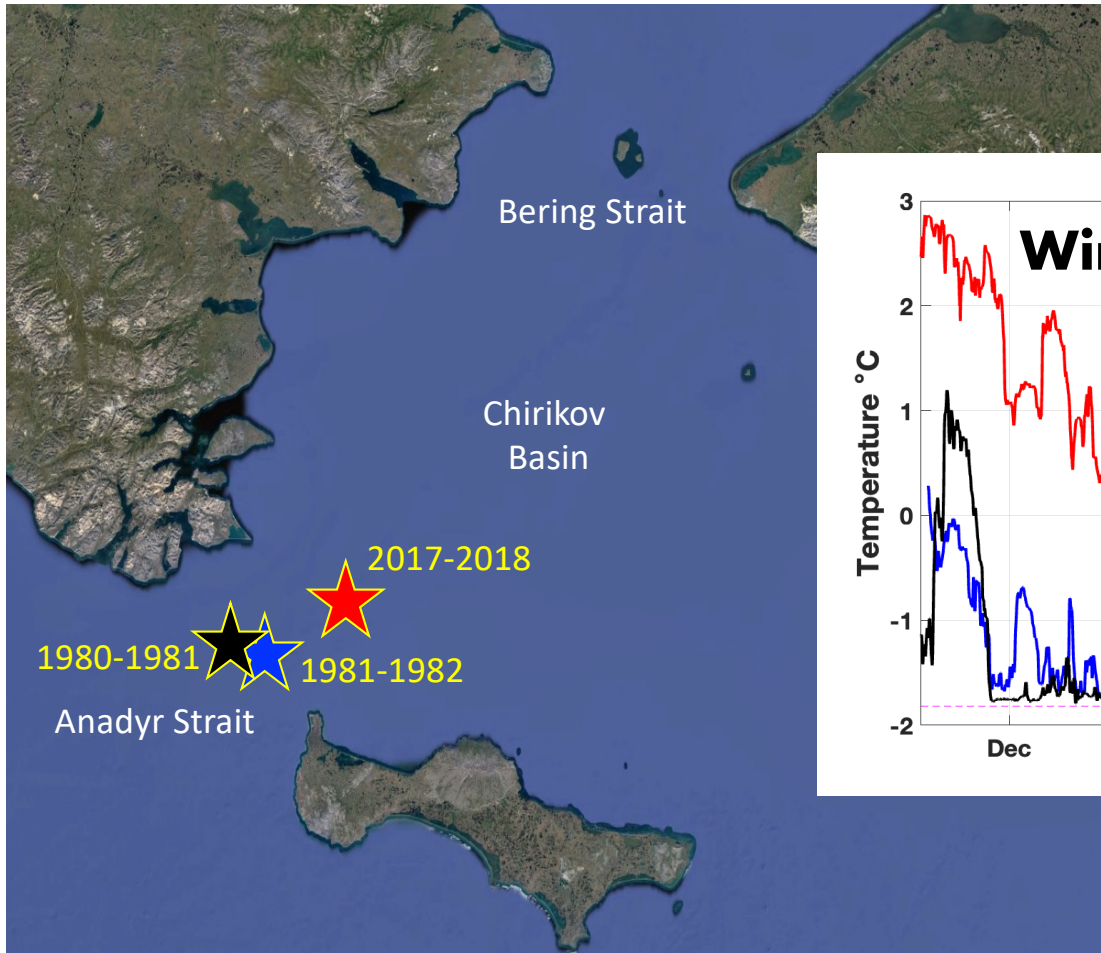


- Anomalies of 2014-2018 relative to 1979-2013
- Based on EMCWF ERA5 reanalysis

[Danielson et al., 2020]



Oceanic Heat Flux



Oceanic Heat Flux

Physical Consequences of Arctic Warming

Diminishing:

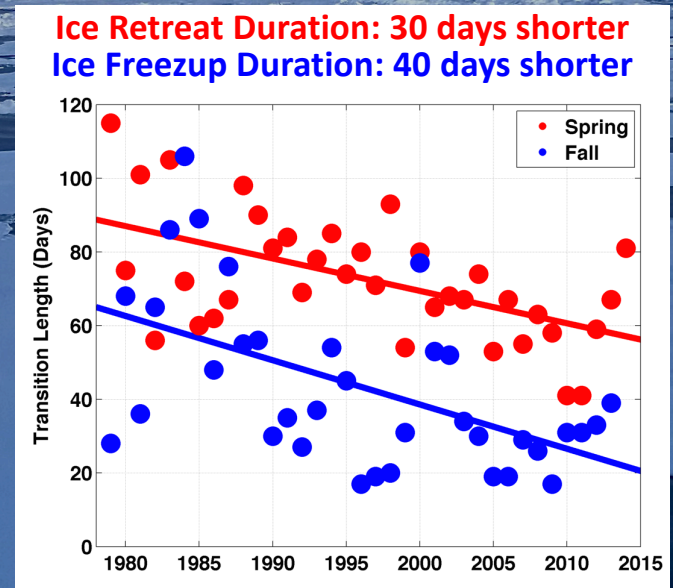
- Sea Ice Extent & Persistence
- Transition Duration to/from Open Water

Spatial/Temporal/Magnitude Alterations to:

- Locations of Sea Ice Melt
- Ocean-Atmosphere Heat Fluxes
- Stratification
- River Runoff & Timing
- Water Column Irradiance
- Wind Fields & Storm Tracks

Increasing:

- Wave Heights
- Coastal Erosion



1979 → 2015

[Danielson et al., 2017]

Observed and/or Potential Ecosystem Consequences of Arctic Warming

Spatial/Temporal/Magnitude Alterations to:

- Species distributions (microbes to fish to whales)
- Food quality
- Pelagic export & benthic deposition of organic matter

Increasing:

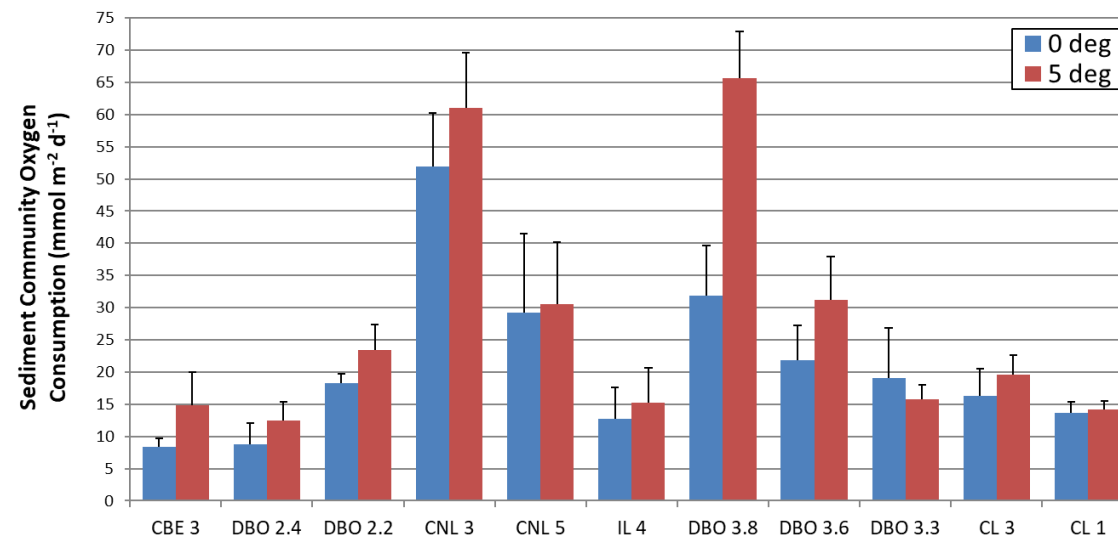
- Metabolisms
- Competition for resources
- Presence & predation by sub-Arctic species

Emergence of:

- Arctic Refugia?
- Ocean Acidification Impacts?
- Hypoxia?



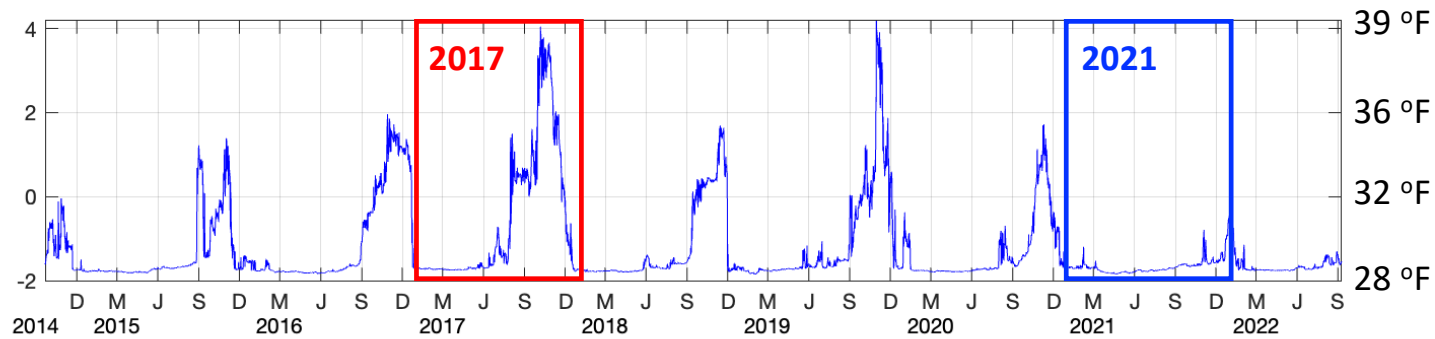
Warming Benthos



Sediment community oxygen consumption (i.e., organic carbon) was ~30% higher in the warmer treatments.

[S. Hardy, in prep.]

NE Chukchi Sea Near-seafloor temperature



“Warm Year” 2017 vs. “Less Warm Year” 2021

~1 month of $T > T_F + 5$

~4 months of $T > T_F + 2$

0 months of $T > T_F + 1$

However, many things will persist that give this region its character.

- Strong Seasonality
- Large Nutrient Flux to Chirikov Basin & Bering Strait
- "Perpetual Spring Bloom"
- Diatoms that sink rapidly to the seafloor