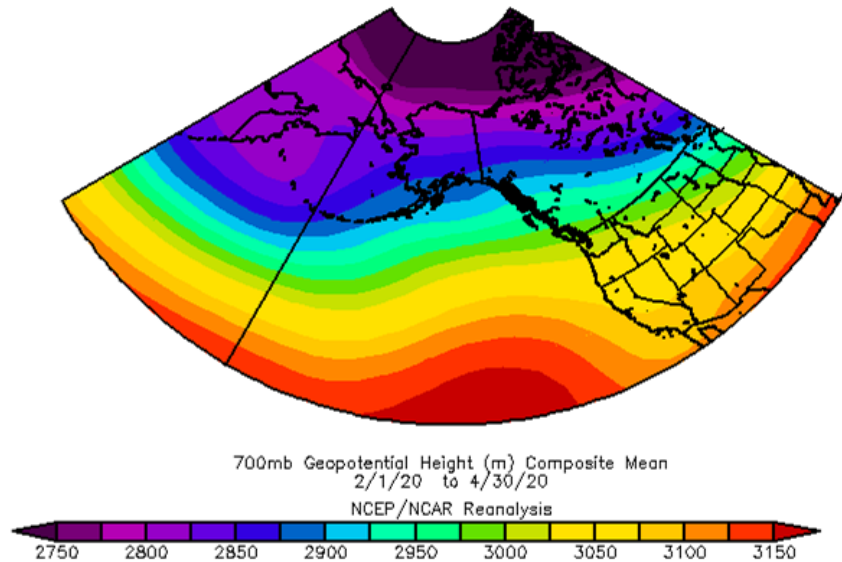


ECOSYSTEM STATUS REPORT

Climate and Oceanography Update

Elizabeth Siddon
Bridget Ferriss
Ivonne Ortiz
Stephani Zador

NPFMC Groundfish Plan Teams
September 8, 2020





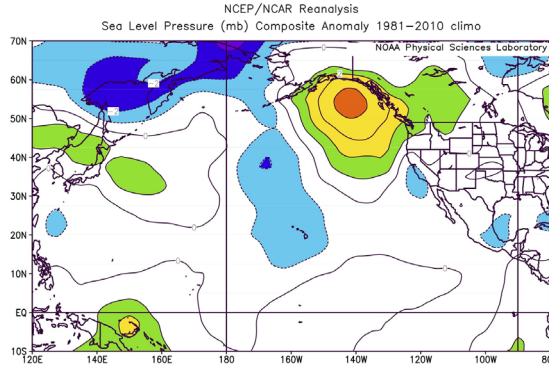
⚓ 2020 climate and oceanography

⚓ 2021 sea surface temperature forecasts

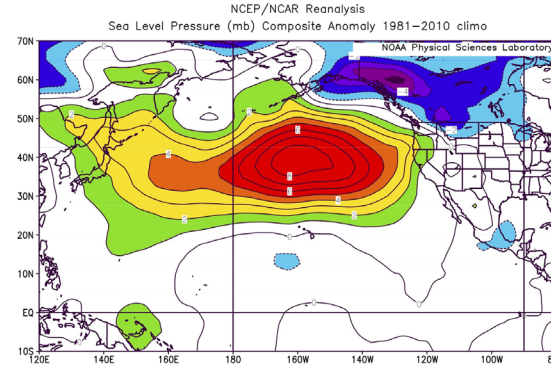
Sea Level Pressure Anomalies

Bond

Positive in central GOA; warm SSTs and upwelling-favorable winds.



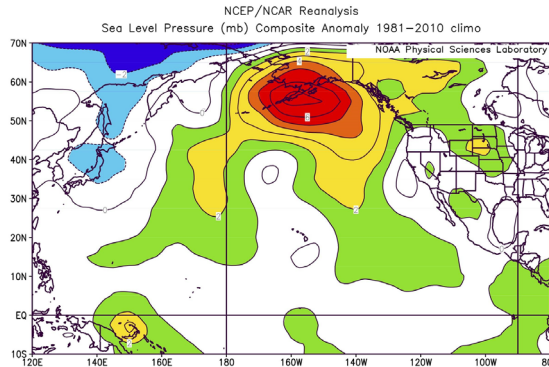
Autumn 2019



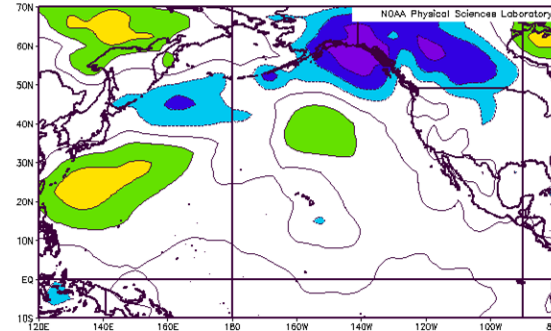
Winter 2019/20

Large positive anomaly; suppressed storminess; equatorward transport.

Positive SLP continued; westerly winds in CGOA; upwelling-favorable in EGOA; southerly wind in EBS.

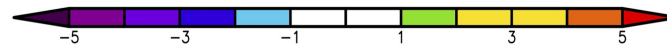


Spring 2020



Summer 2020

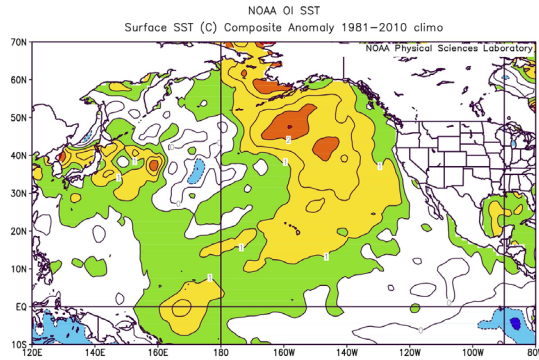
Low pressure over GOA; northerly winds brought warm/dry air from mainland to W&C GOA.



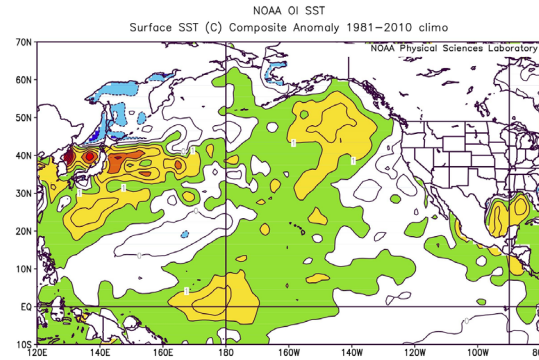
From the NCEP/NCAR Reanalysis project

Sea Surface Temperature Anomalies

Warmer than normal across the region (EBS and WGOA); moderate temps in EGOA due to upwelling.

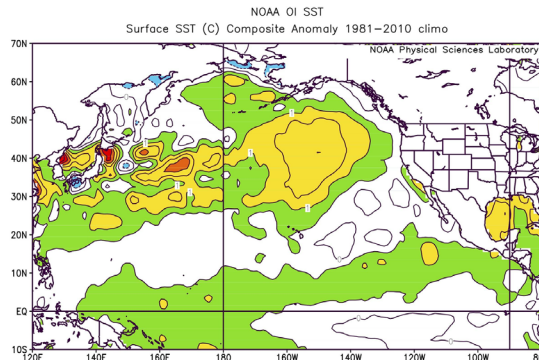


Autumn 2019

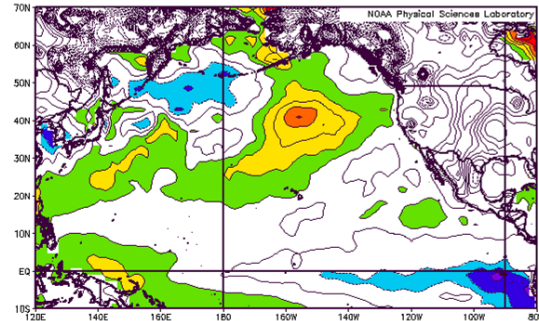


Winter 2019/20

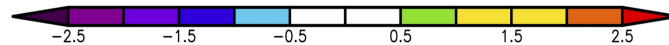
Warm across region; Increased SSTs in SEBS and rapid ice retreat. Weak El Niño faded.



Spring 2020



Summer 2020



Bond

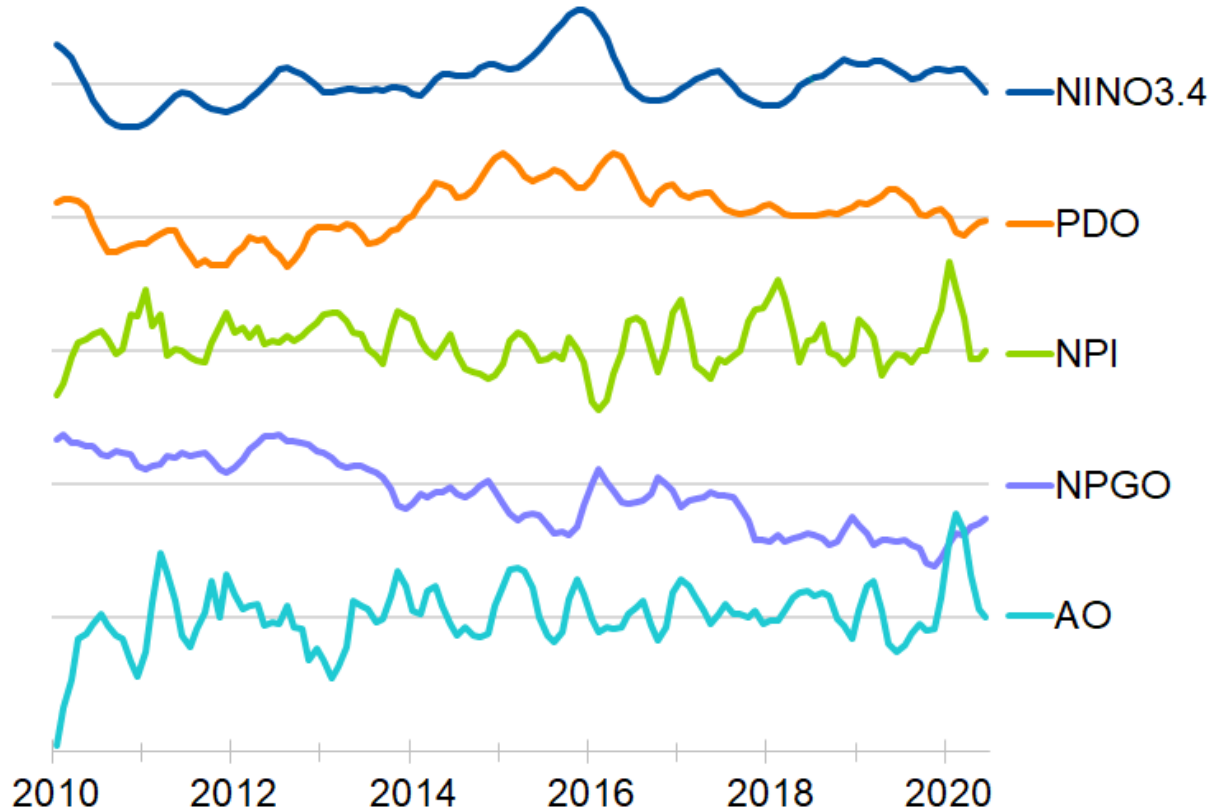
Moderation of warmth in GOA; considerable cooling in EBS. A weak El Niño developed.

Warmth east of dateline; cooling west of dateline. Negative anomalies in WAI. La Niña?

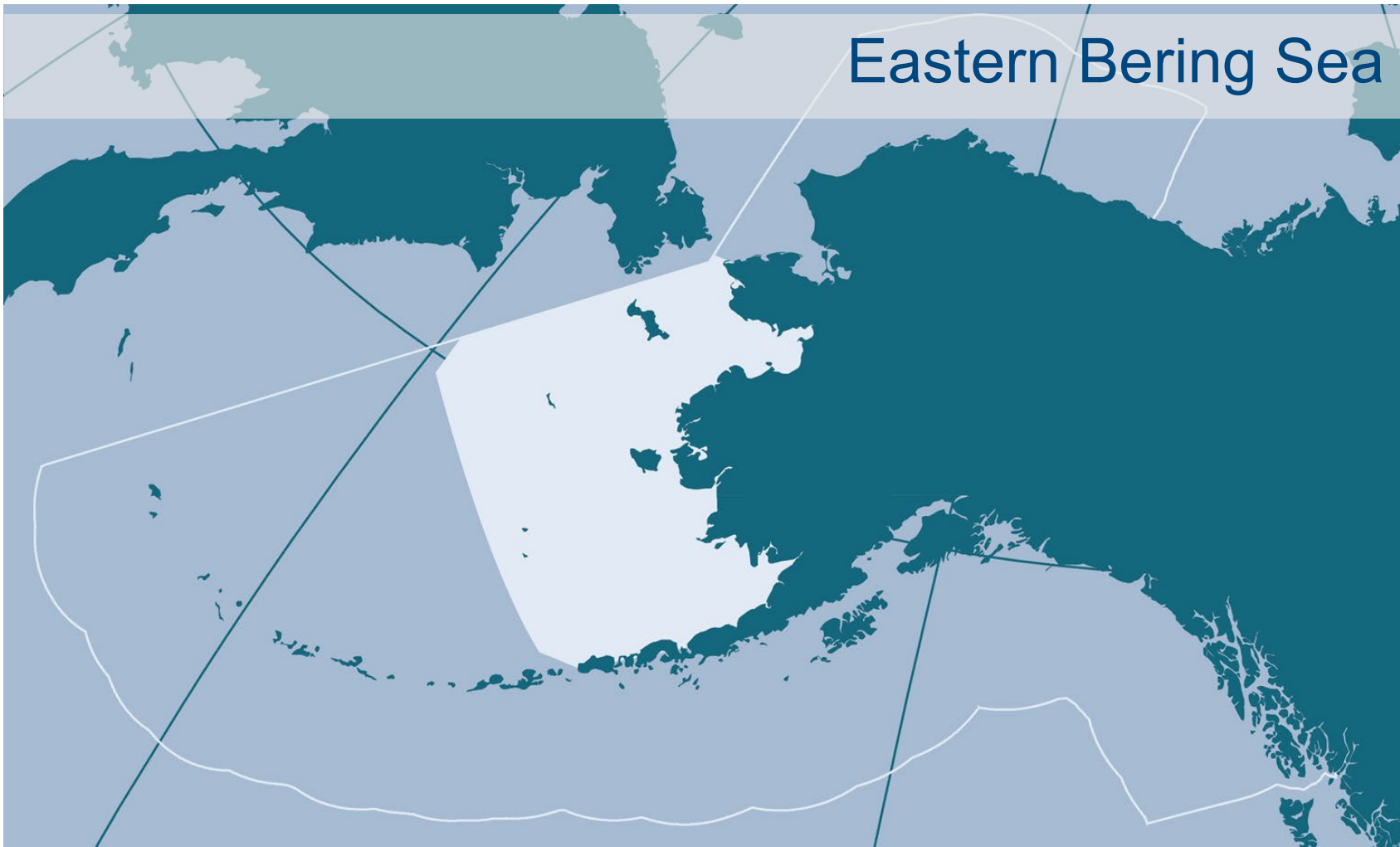
Climate Indices

Bond

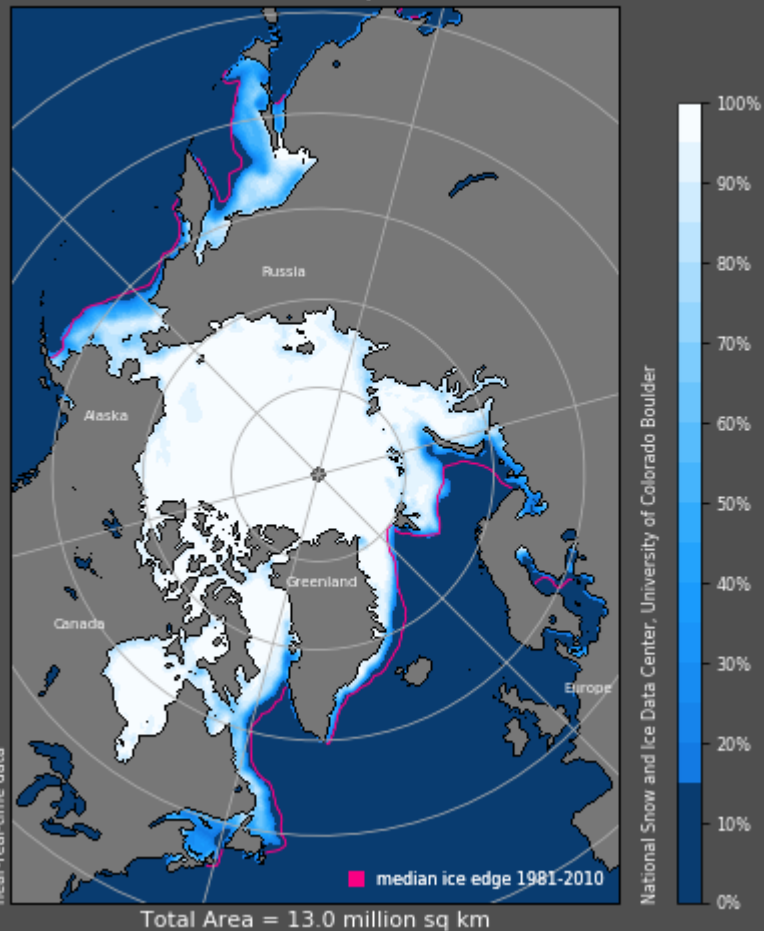
- NINO3.4 - Weak El Niño conditions.
- PDO declined (cooling along west coast, warming in North Pacific), then increased to neutral.
- NPI spike correlates with a weak Aleutian Low. Currently in a neutral state.
- NPGO remains negative; high SLP over GOA.
- AO spike resulted in coldest winter since 1988/89. Currently near neutral.



Eastern Bering Sea



Sea Ice Concentration, Mar 2020



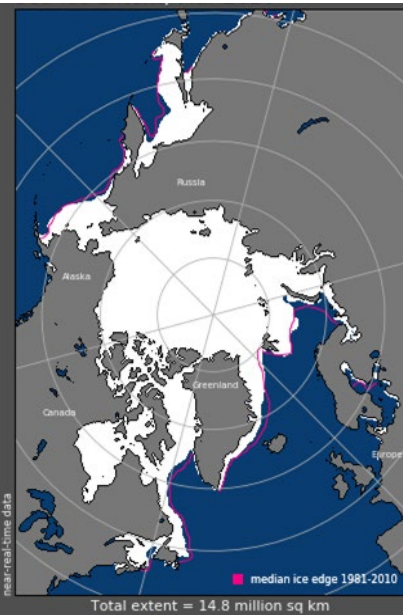
Arctic Sea Ice Extent

National Snow and Ice Data Center

March 2018

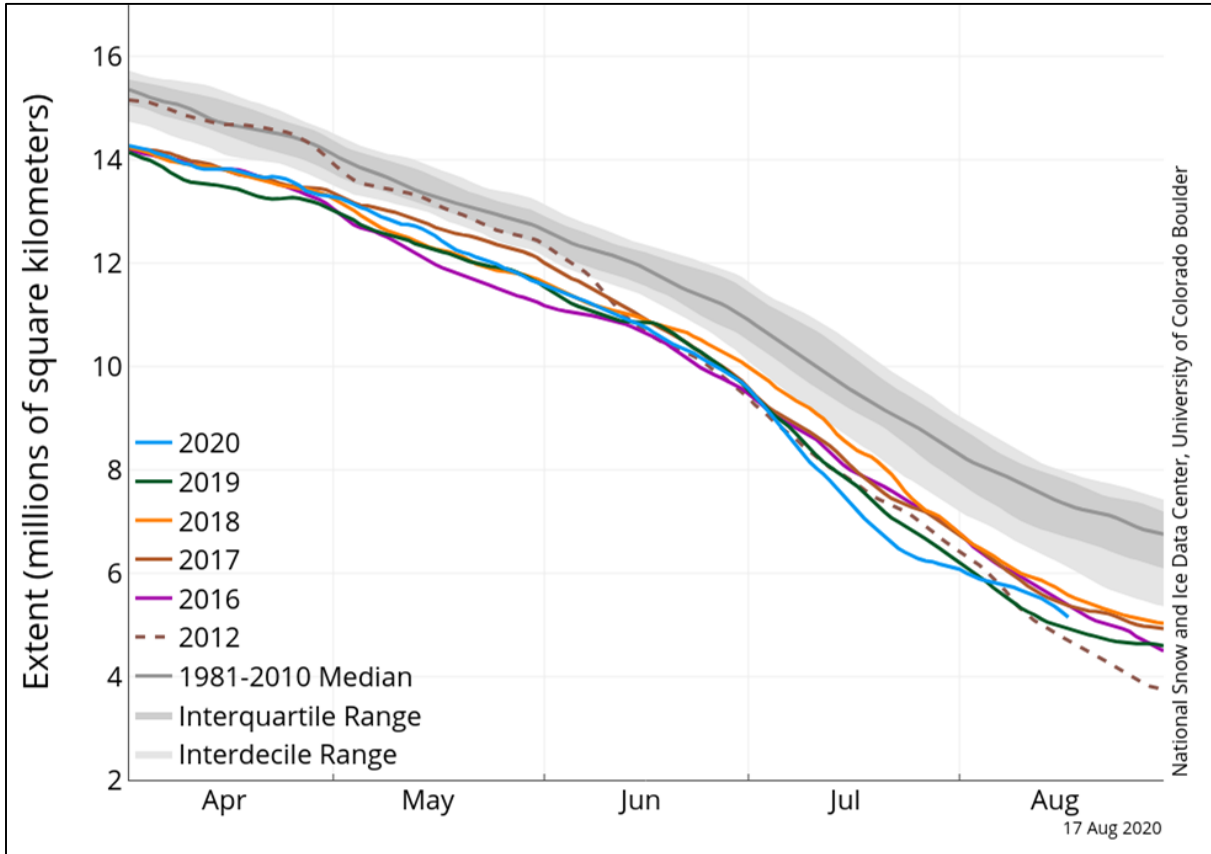
March 2019

March 2020



Arctic Sea Ice Extent

National Snow and Ice Data Center

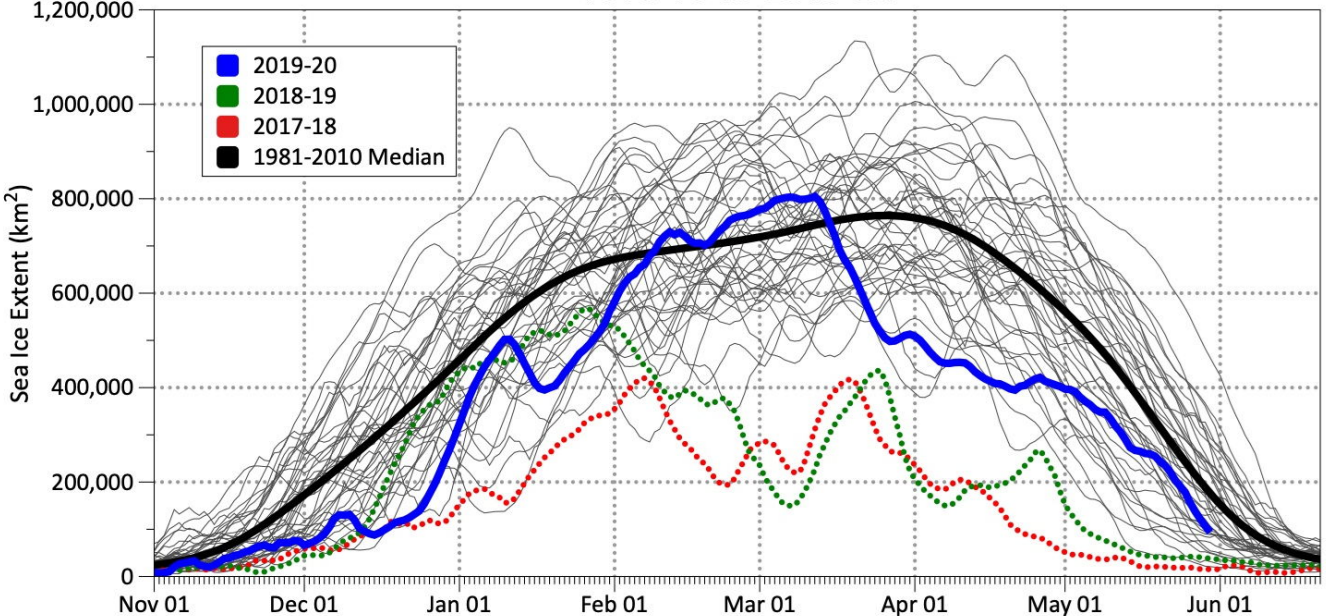


- Past 5 years all had lower-than-median ice extent in spring.
- 2020 had near-normal spatial extent of ice.
- 2020 ice retreated similarly to previous warm years, especially after June.

Bering Sea Ice Extent

Thoman

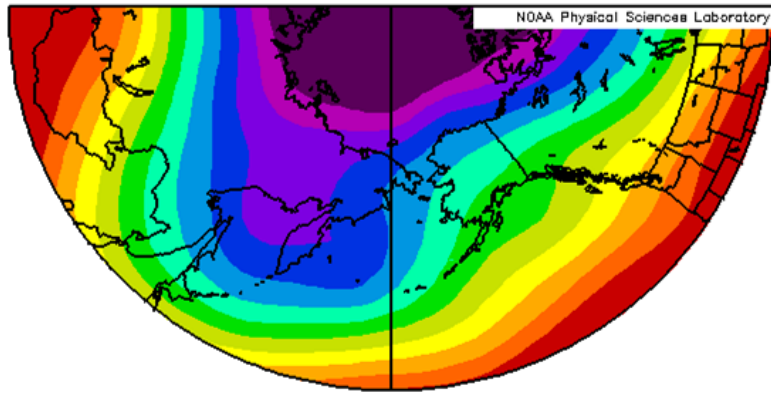
Bering Sea Daily Ice Extent 1978-79 to 2019-20



- Residual warmth delayed freeze-up into winter.
- Cooling in late winter resulted in a rapid build-up of sea ice.
- Exceeded median in Feb/March.
- Southerly (warm) winds in spring promoted rapid ice retreat.

Spring Conditions in EBS Overland

Jet stream

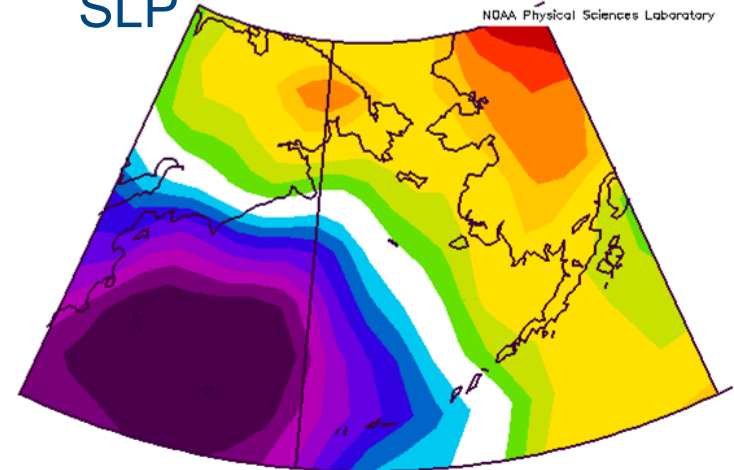


March to May 2020

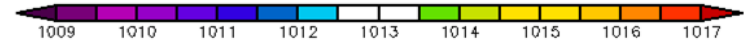


- The jet stream was located very far south (over Japan).
- Sea ice extent was typical until south winds in spring deteriorated it.

SLP



March to May 2020

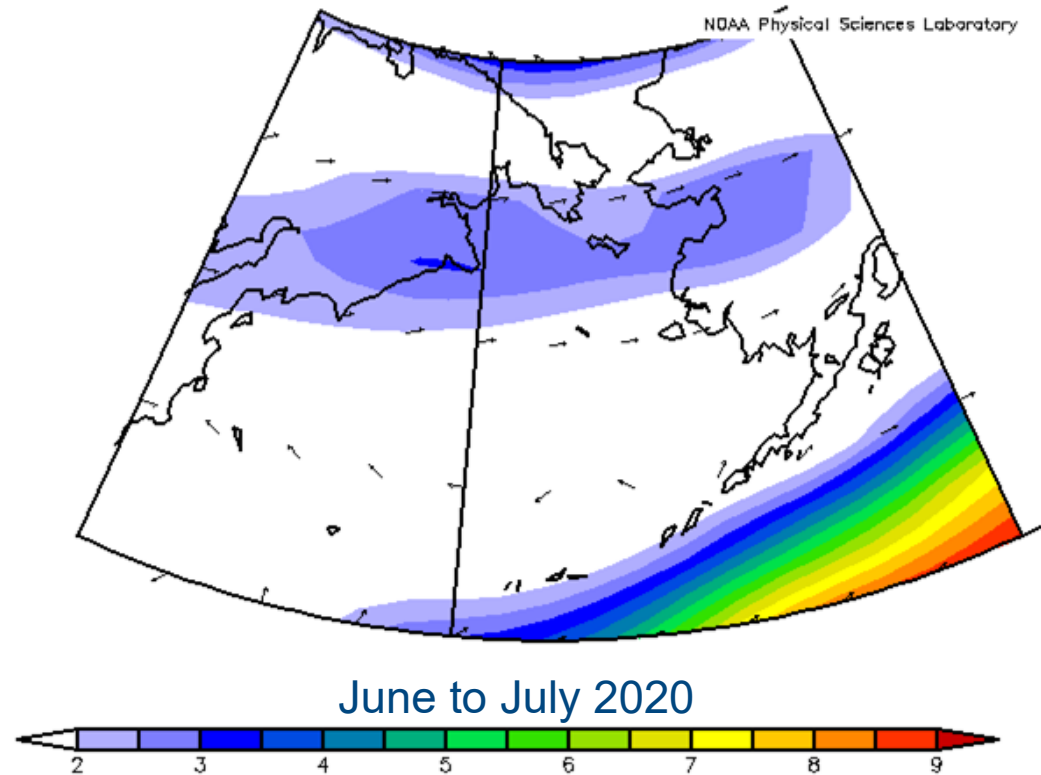


- Low pressure (purple) brought south winds over the EBS;
- Warm temperatures to the NBS.

Summer Conditions in EBS

Overland

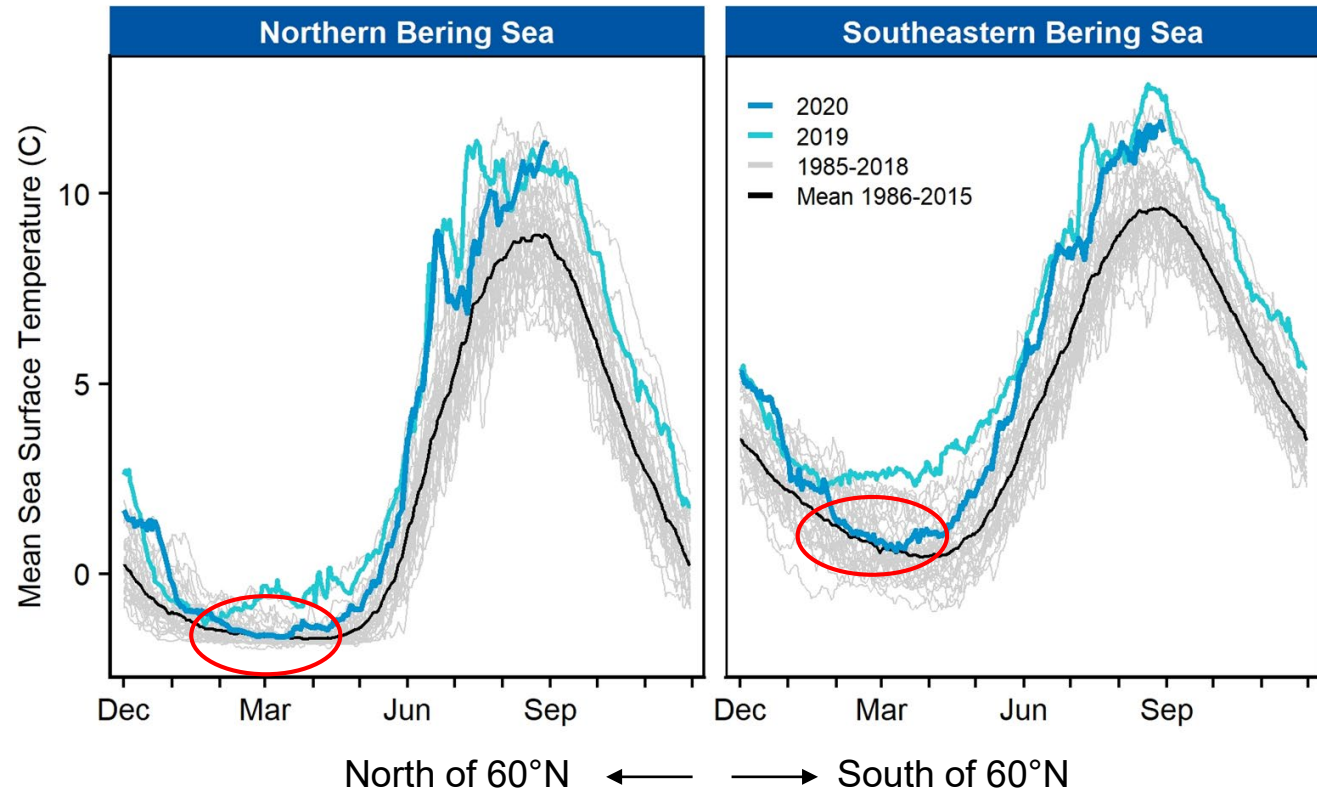
- Summer winds were light in the SEBS.
- The NBS had west winds in the summer.



EBS Sea Surface Temperature

Watson

- 2020 late winter temperatures were closer to the long-term mean.

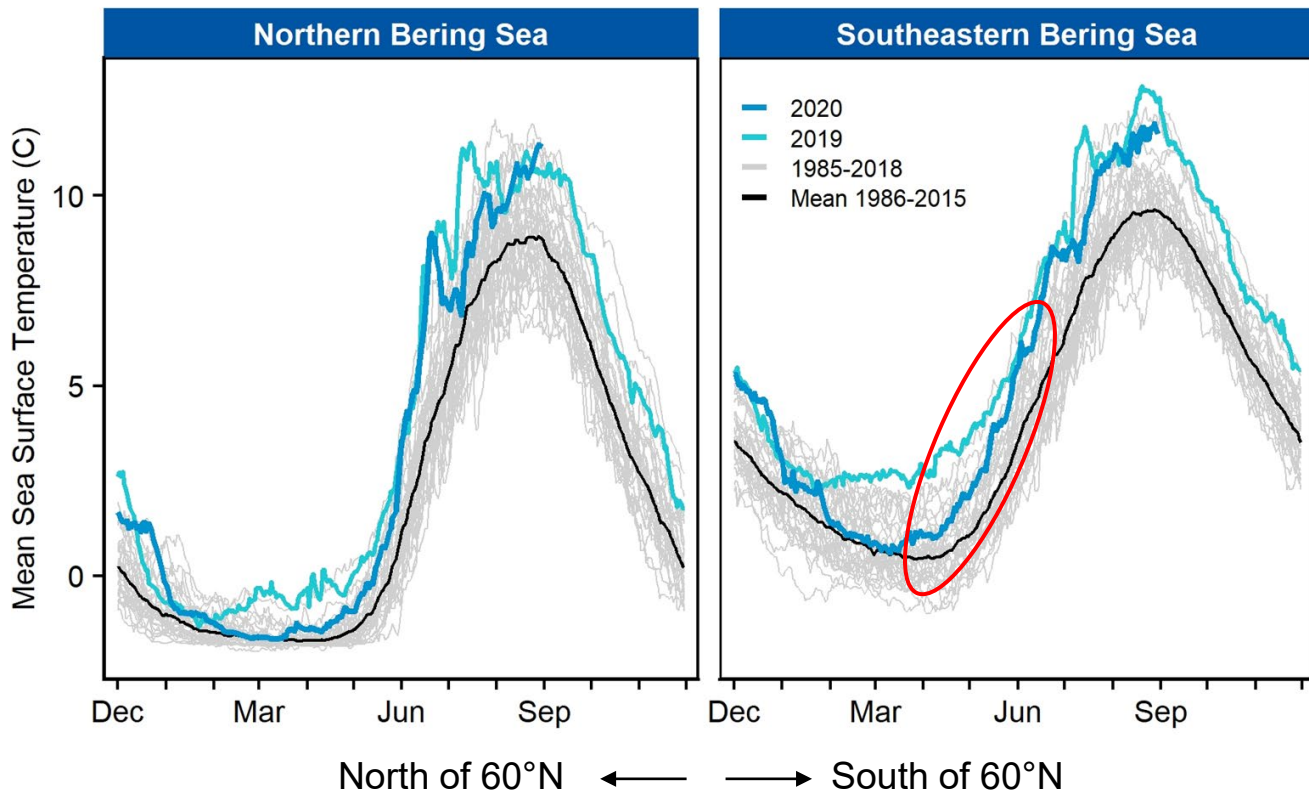


North of 60°N ← → South of 60°N

EBS Sea Surface Temperature

Watson

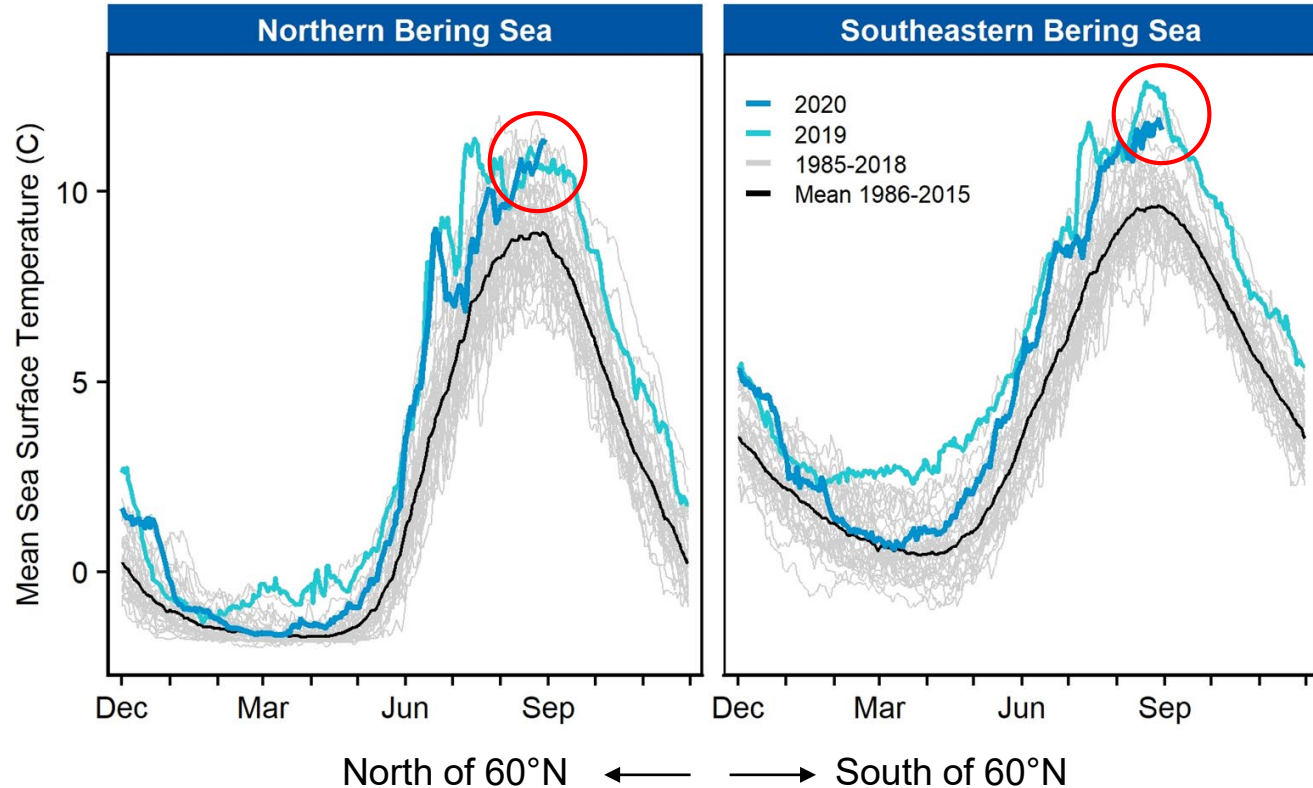
- 2020 late winter temperatures were closer to the long-term mean.
- Above-average temperatures returned in spring and summer, especially over the southeastern shelf.



EBS Sea Surface Temperature

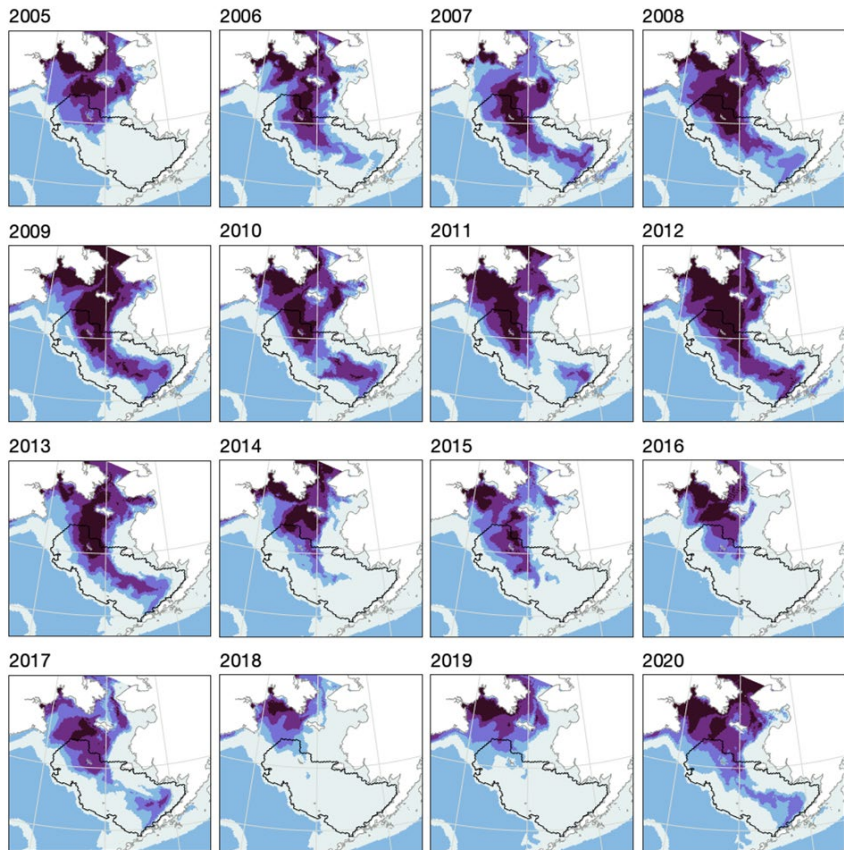
Watson

- 2020 late winter temperatures were closer to the long-term mean.
- Above-average temperatures returned in spring and summer, especially over the southeastern shelf.
- Current temperatures remain above average, similar to those observed in 2019.

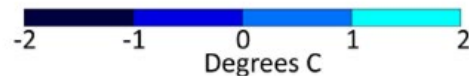
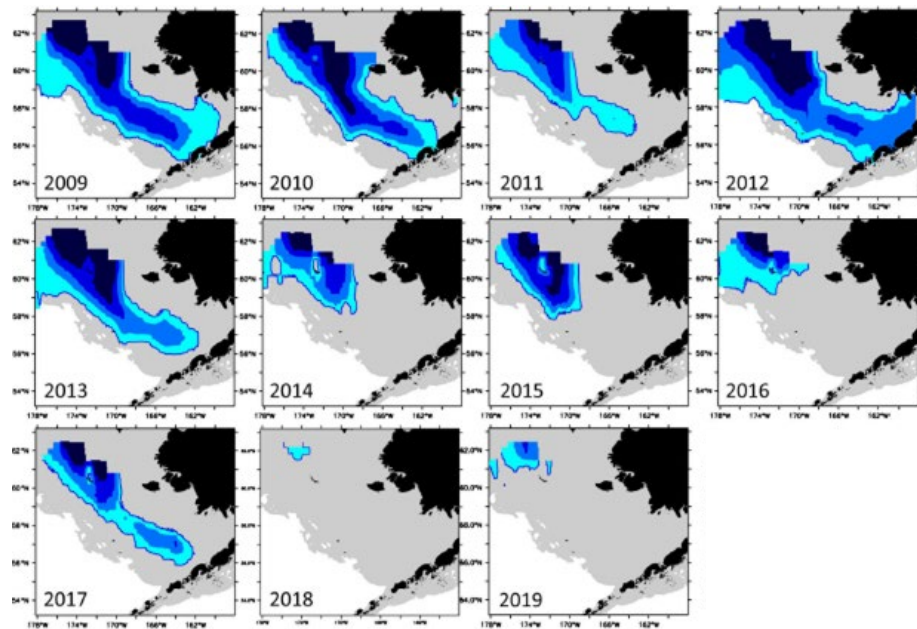
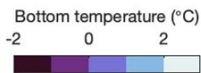


EBS Bottom Temperatures and Cold Pool Extent

Kearney, Aydin, Britt, Ladd

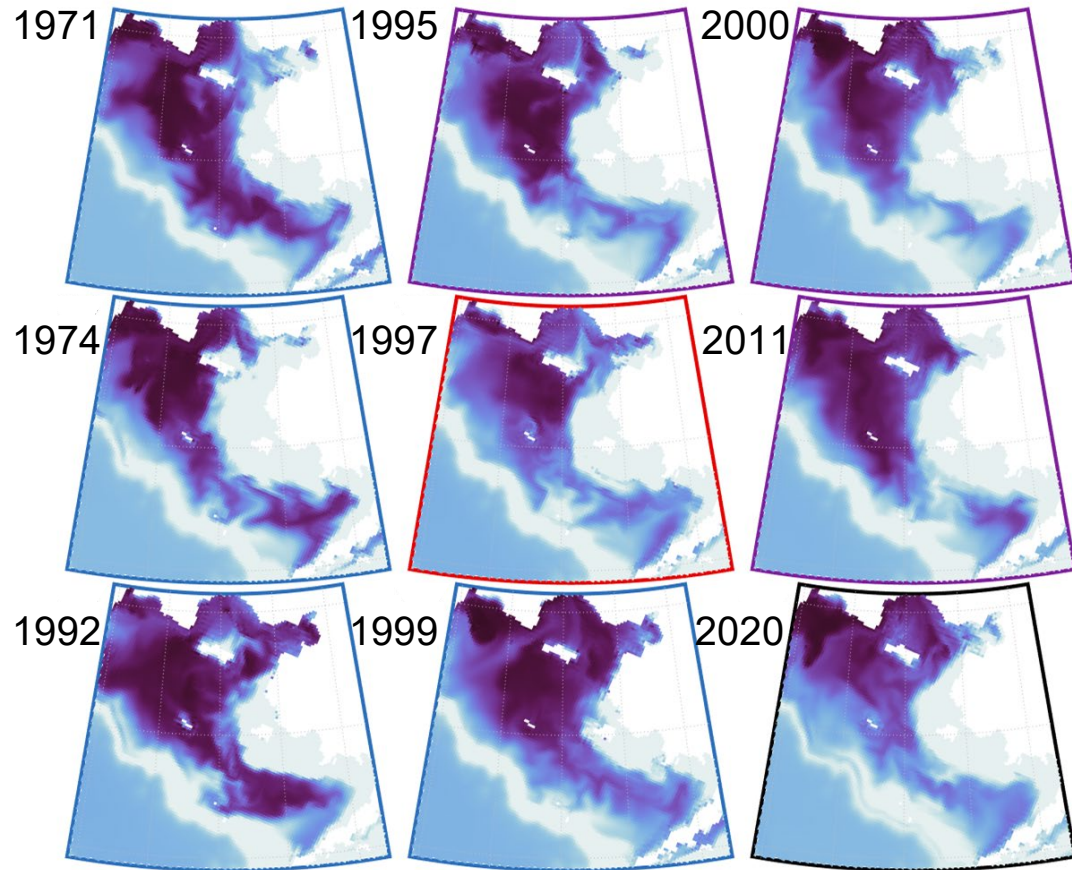


Bering 10K ROMS hindcast

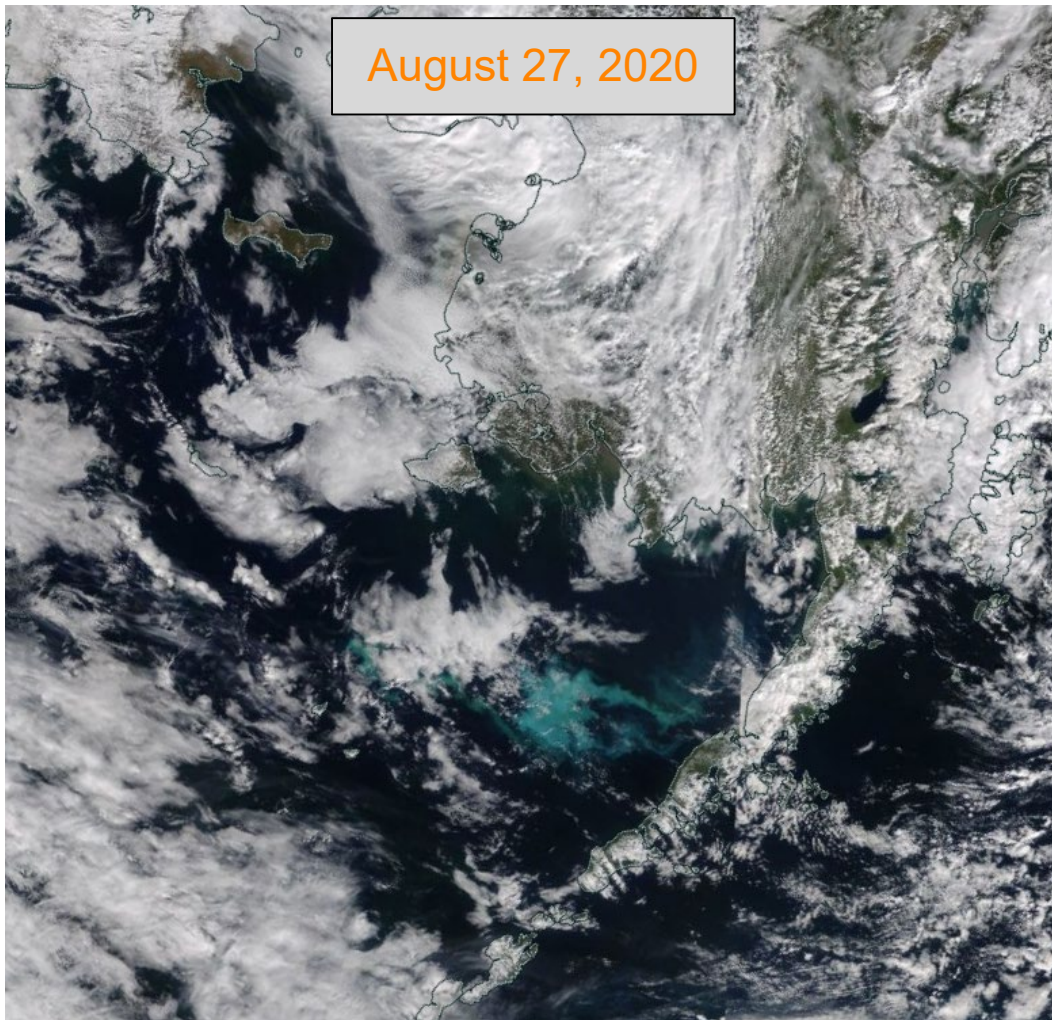


EBS Bottom Temperatures and Cold Pool Extent

Kearney, Aydin, Britt, Ladd



- 2020 was an average year.
- Slightly above average $<2^{\circ}$ water and slightly below average $<0^{\circ}$ water.
- Spatially, 2020 clusters with 1995, 1997, 2000, and 2011.
- 2020 most closely resembles 1997.

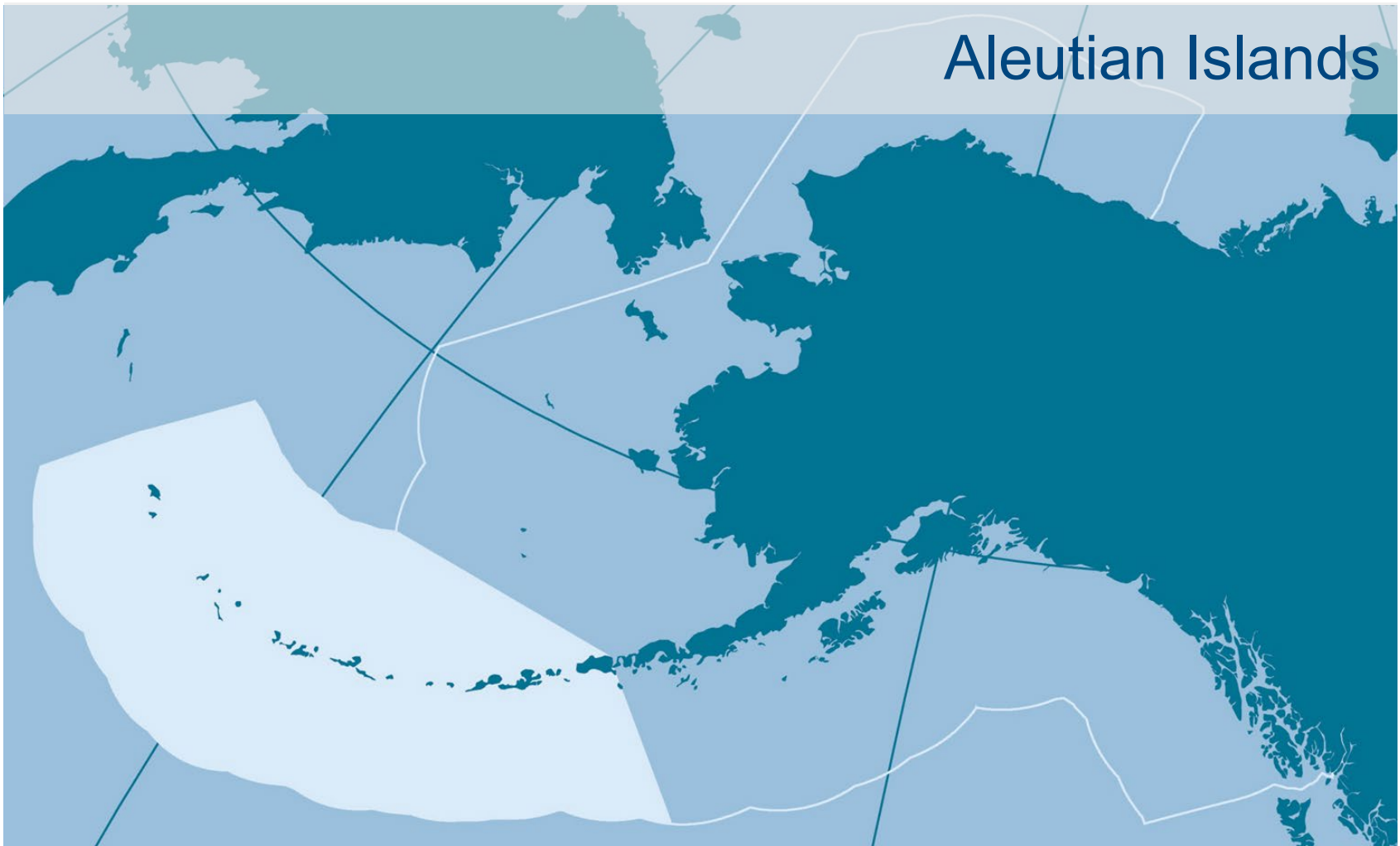


Coccolithophore Bloom

Ladd

- A coccolithophore bloom started in mid-August.
- Blooms typically peak in September (stay tuned...).
- A large bloom occurred in 1997, associated with a die-off of short-tailed shearwaters.
- Thought to reduce foraging success for visual predators.

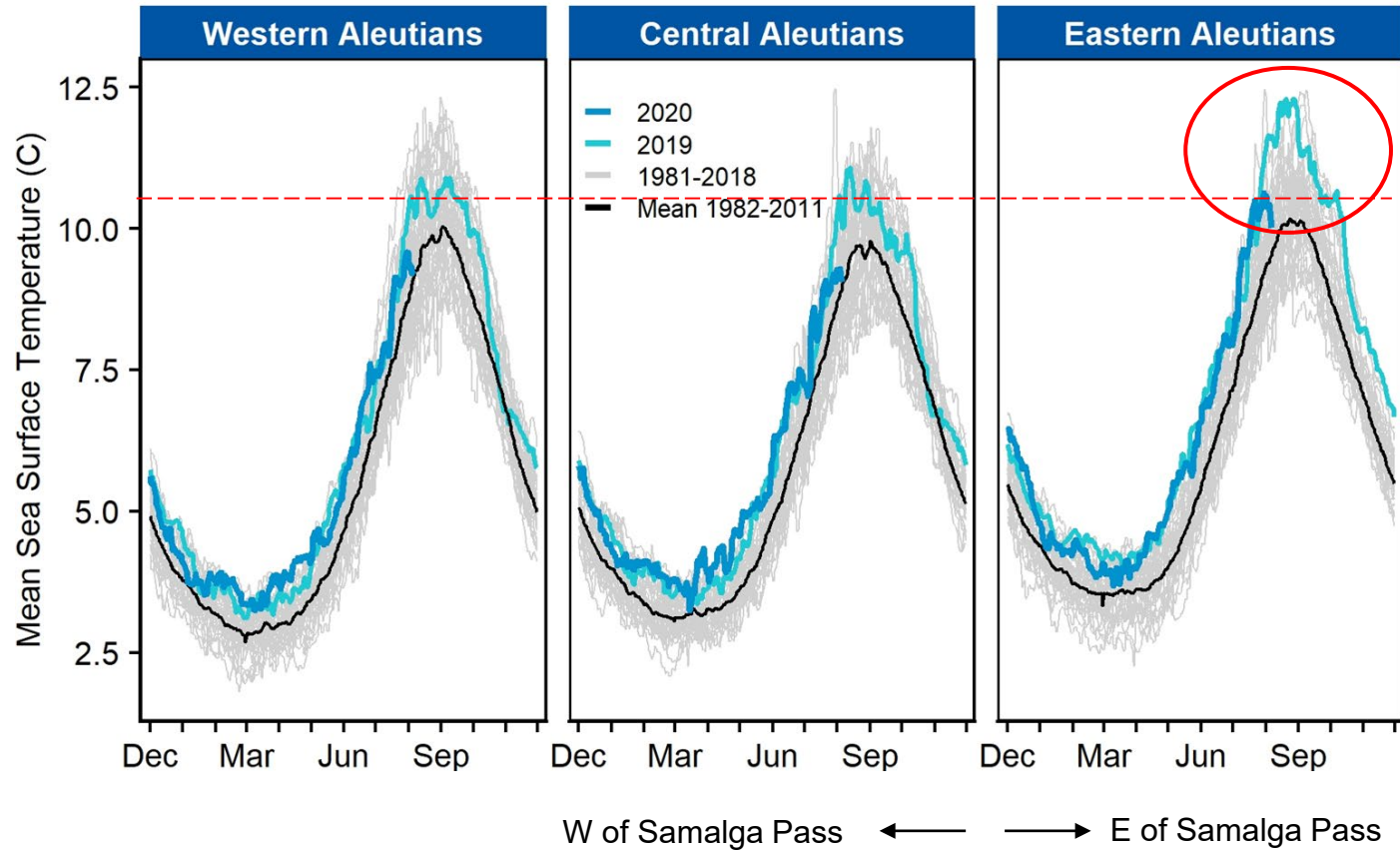
Aleutian Islands



AI Sea Surface Temperature

Watson

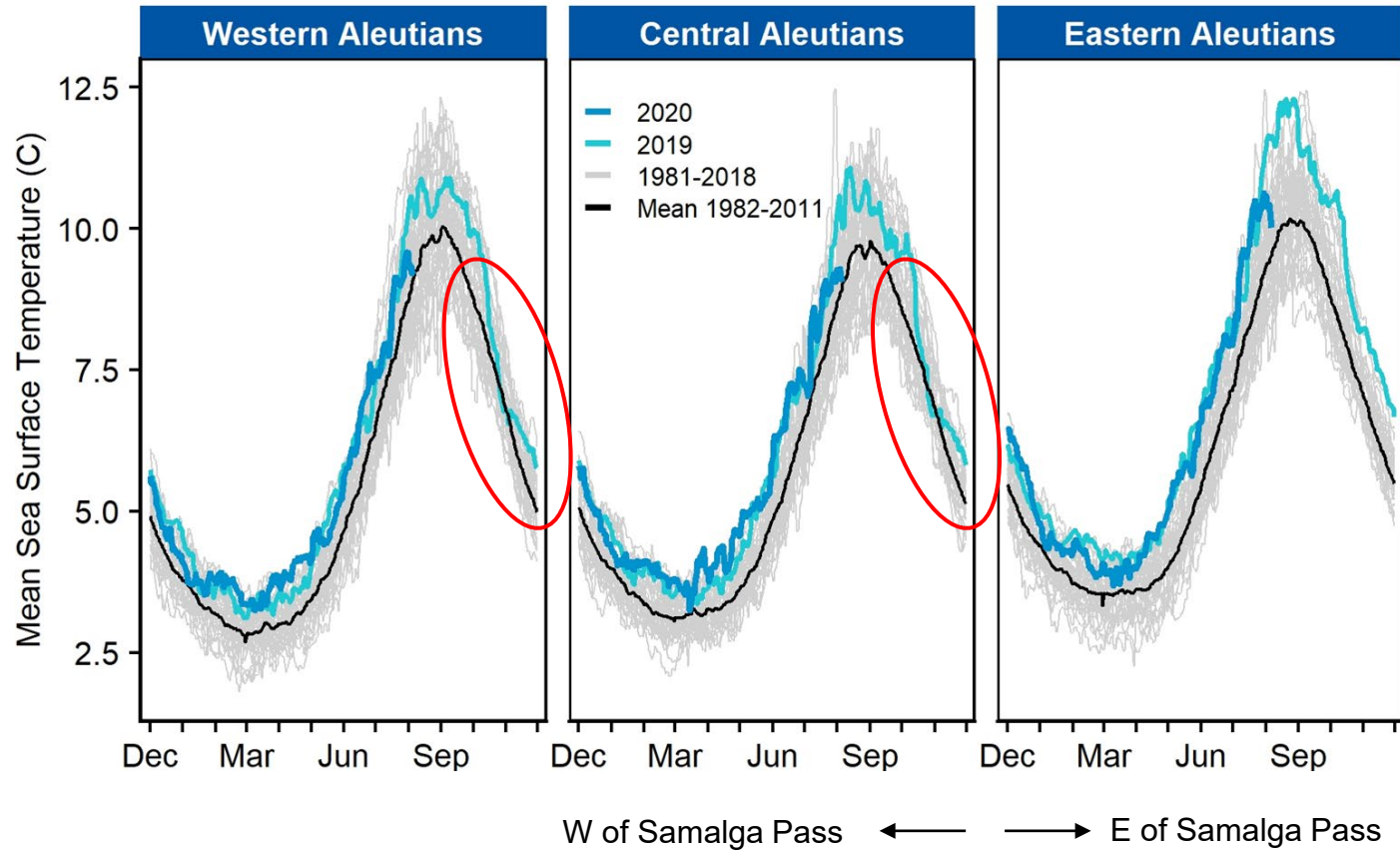
- 2019 summer was very warm in EAI.



AI Sea Surface Temperature

Watson

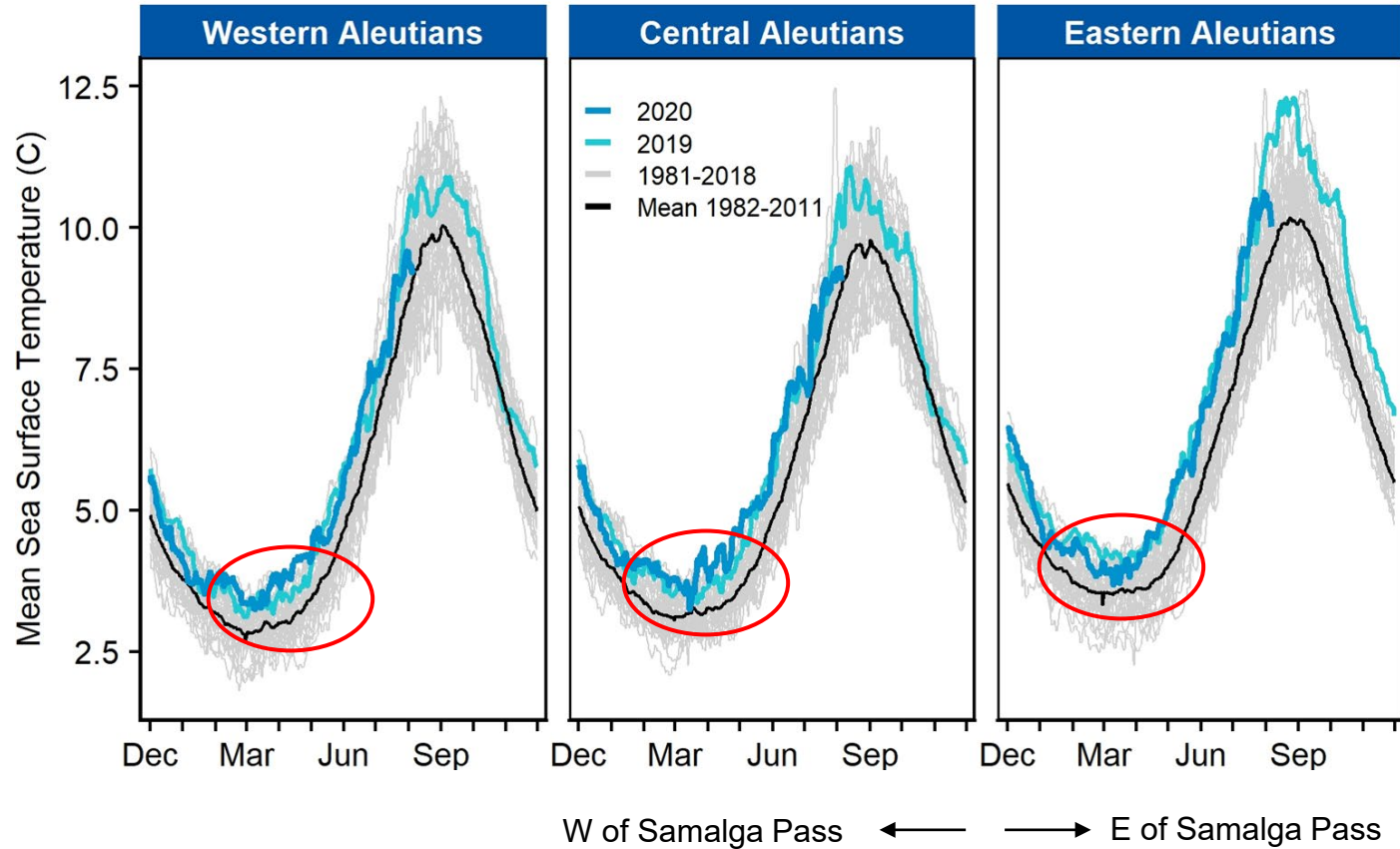
- 2019 summer was very warm in EAI.
- 2019 fall was close to the long-term mean in W&C AI.



AI Sea Surface Temperature

Watson

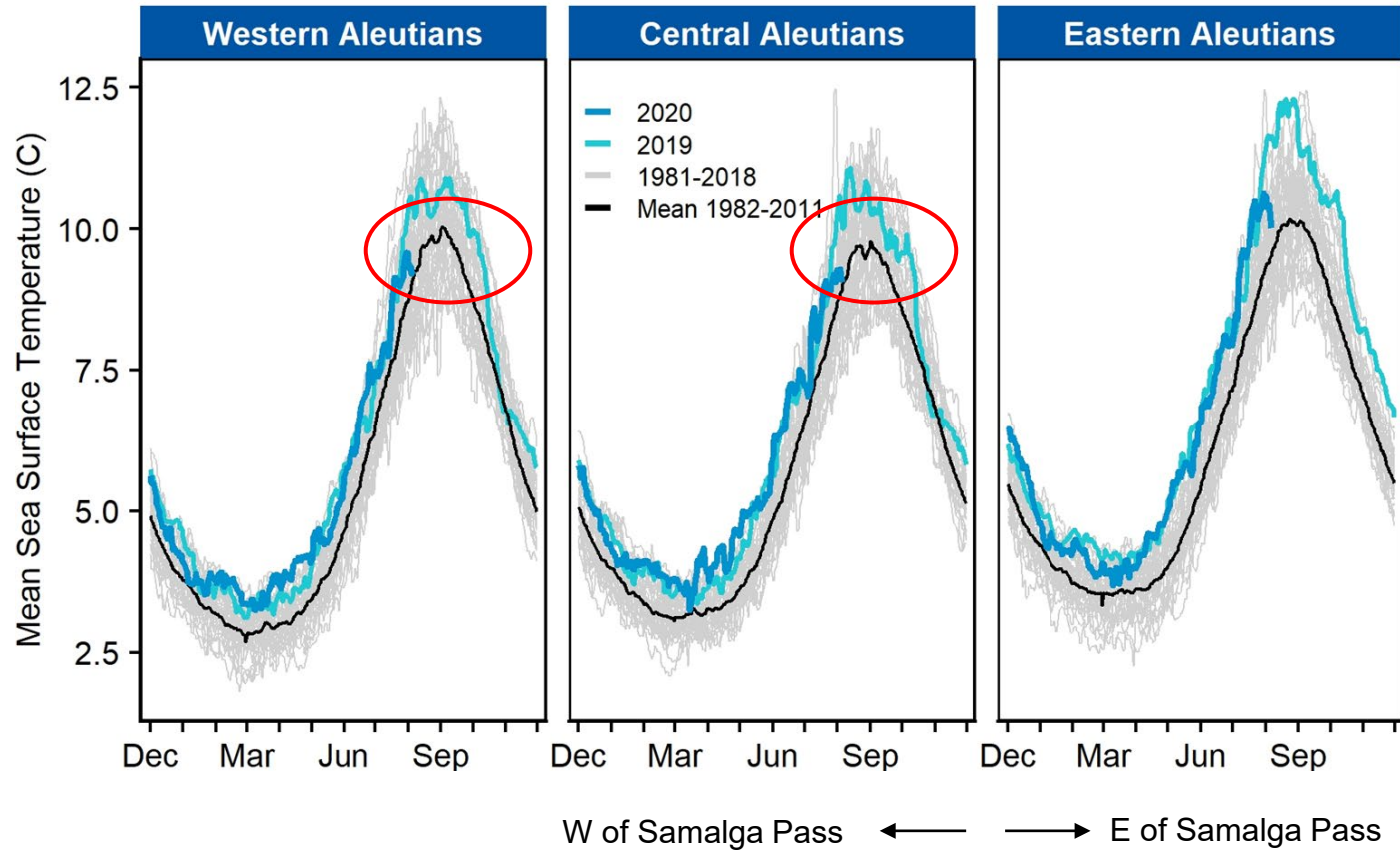
- 2019 summer was very warm in EAI.
- 2019 fall was close to the long-term mean in W&C AI.
- 2020 late winter and spring were warm in W&C AI; cooler than 2019 in EAI, but above the mean.



AI Sea Surface Temperature

Watson

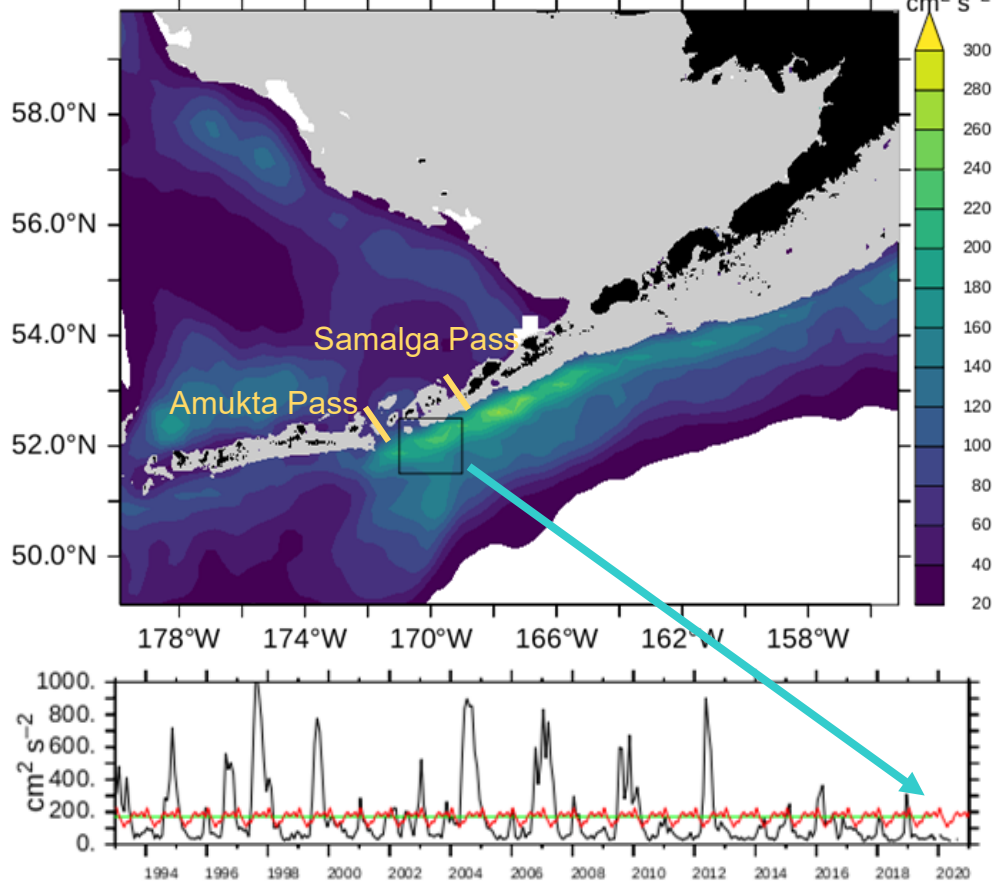
- 2019 summer was very warm in EAI.
- 2019 fall was close to the long-term mean in W&C AI.
- 2020 late winter and spring were warm in W&C AI; cooler than 2019 in EAI, but above the mean.
- W&C AI expected to cool through summer 2020.



Eddies in the Eastern Aleutians

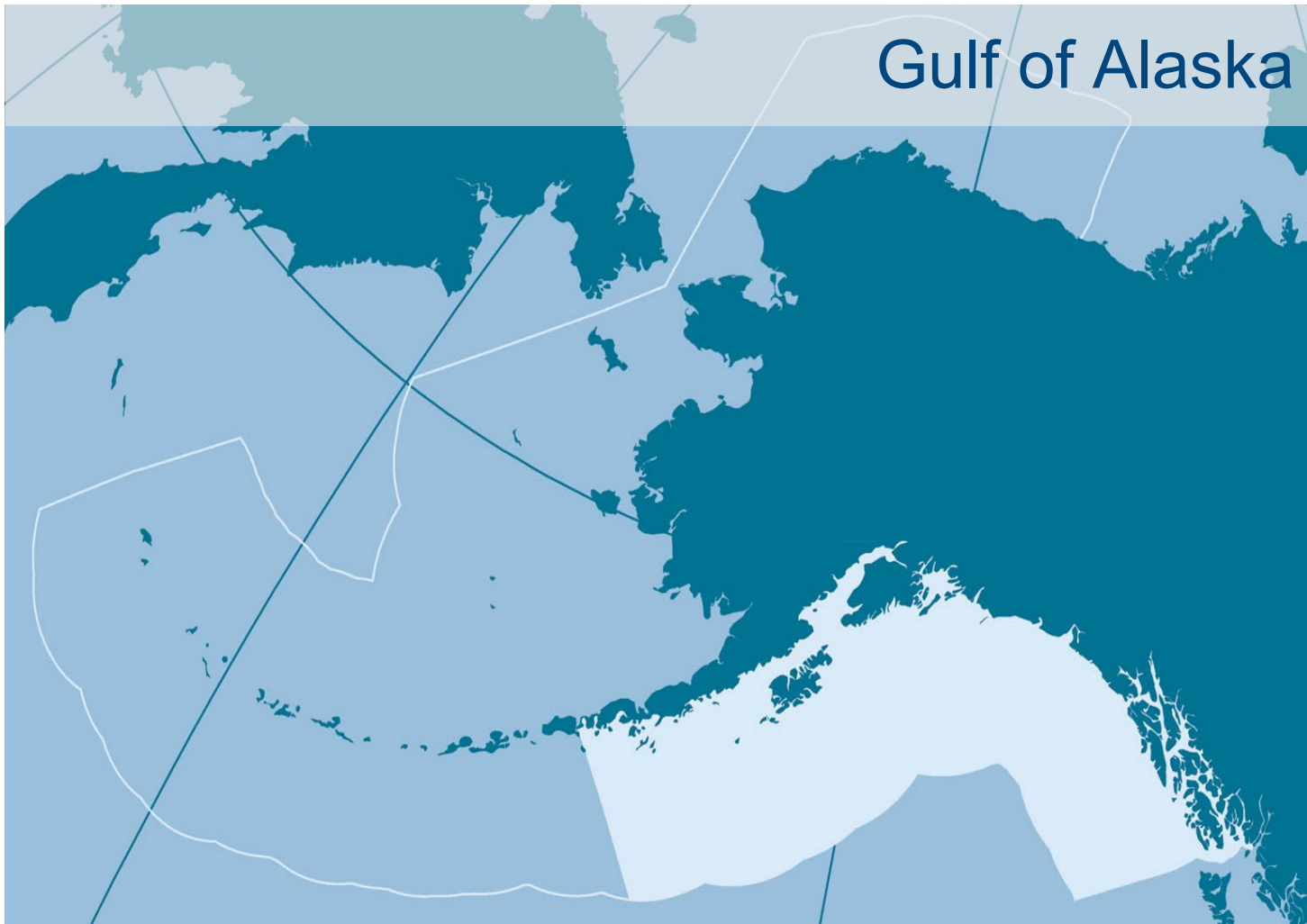
Ladd

Average Eddy Kinetic Energy (EKE) Jan 1993 - Dec 2020



- EKE low since 2012.
- Different from WGOA where EKE was high in 2020.
- Influences flow through Amukta Pass.
- Sustained below-average transport of heat, salt, and nutrient fluxes to the Bering Sea, and Bering Slope & Aleutian North Slope Currents.

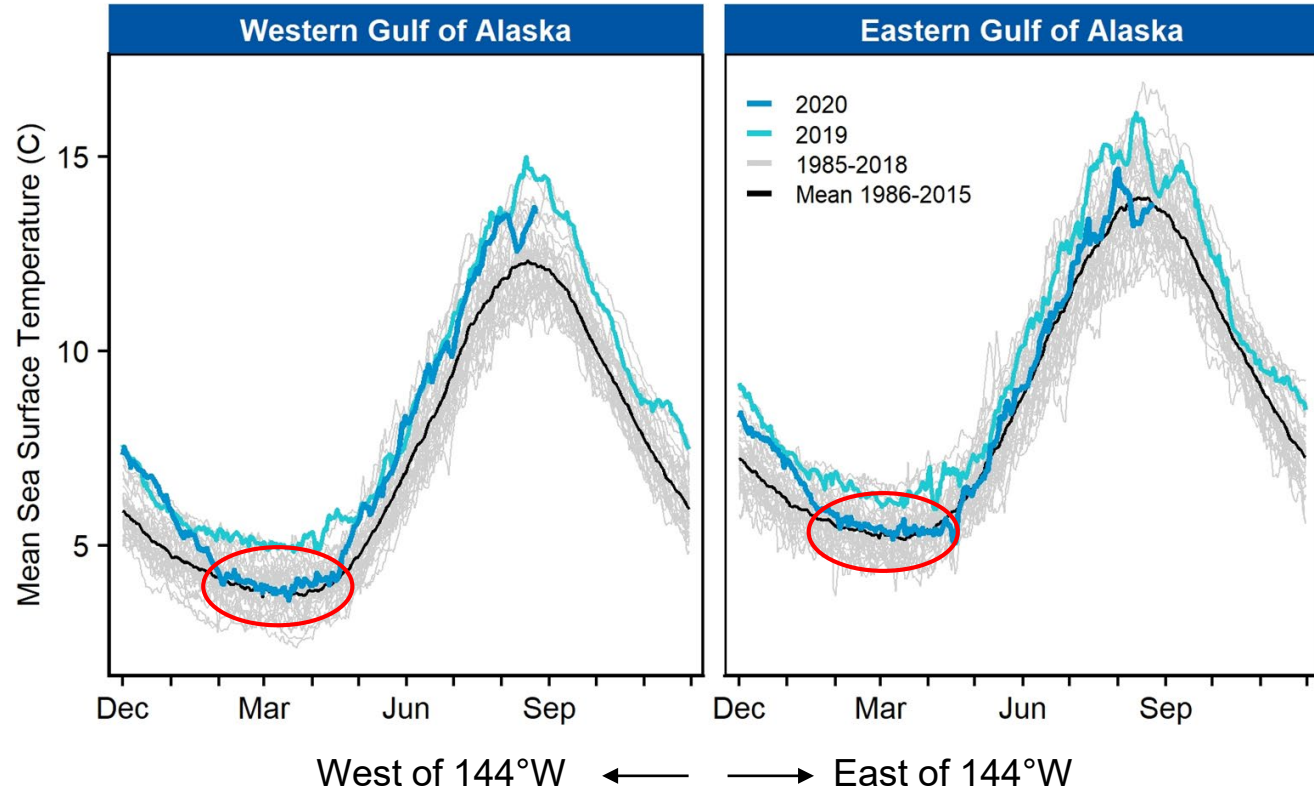
Gulf of Alaska



GOA Sea Surface Temperature

Watson

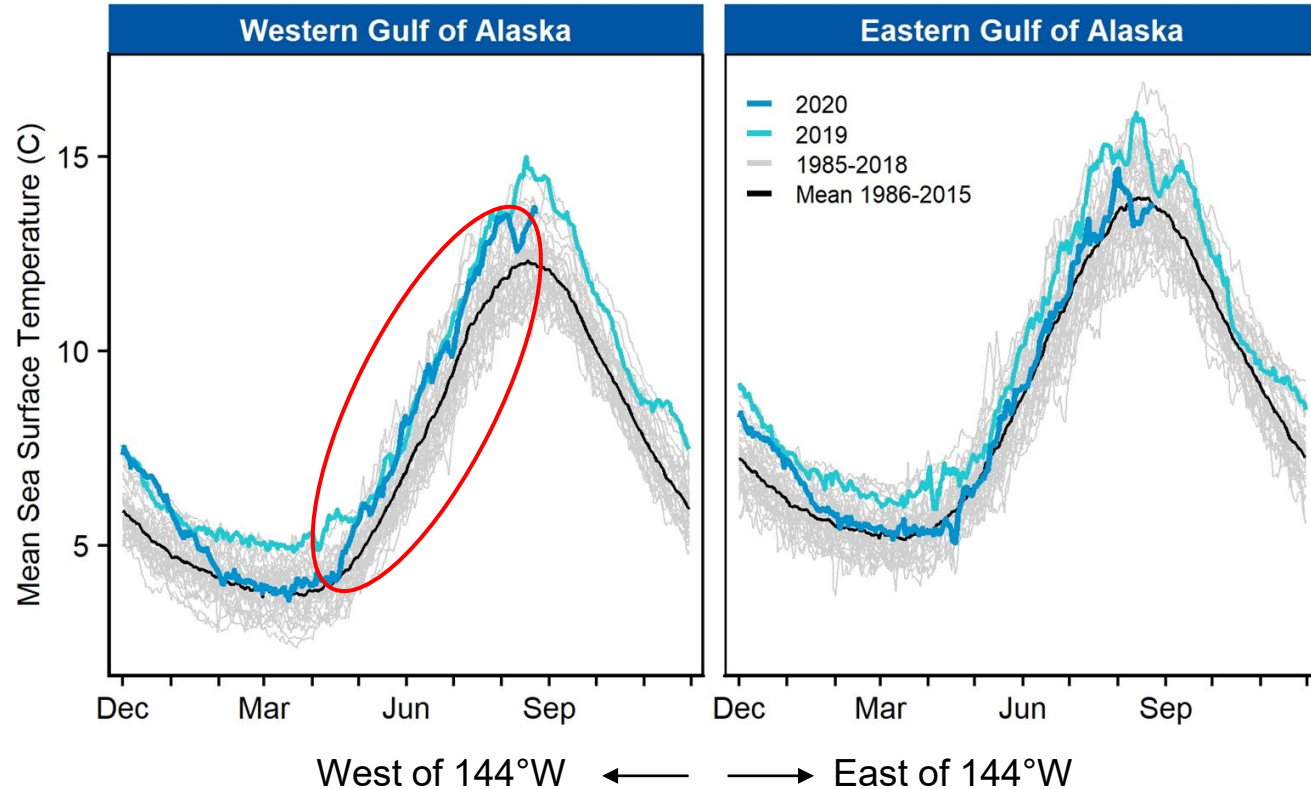
- 2020 late winter temperatures cooled to the long-term mean through April.



GOA Sea Surface Temperature

Watson

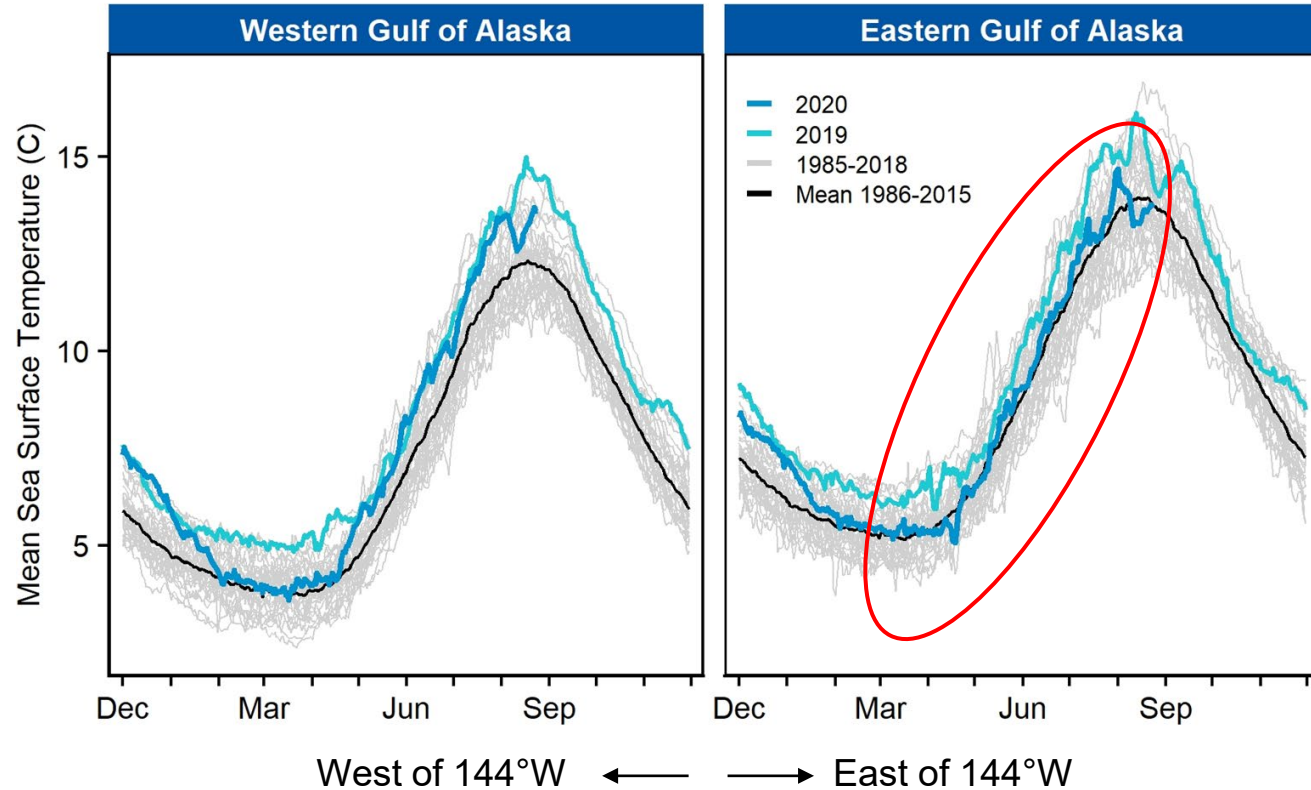
- 2020 late winter temperatures cooled to the long-term mean through April.
- WGOA then warmed above the mean, near the MHW threshold, for much of summer.



GOA Sea Surface Temperature

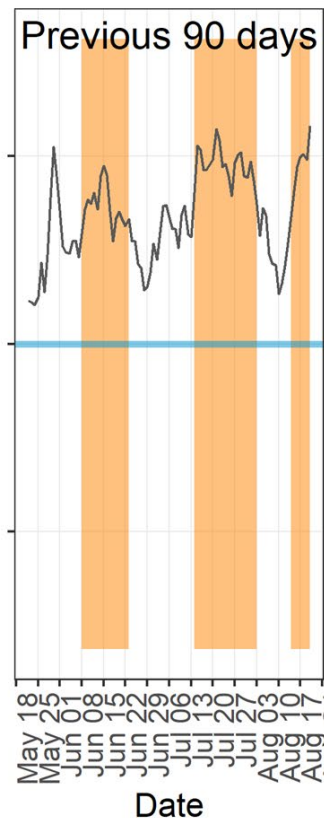
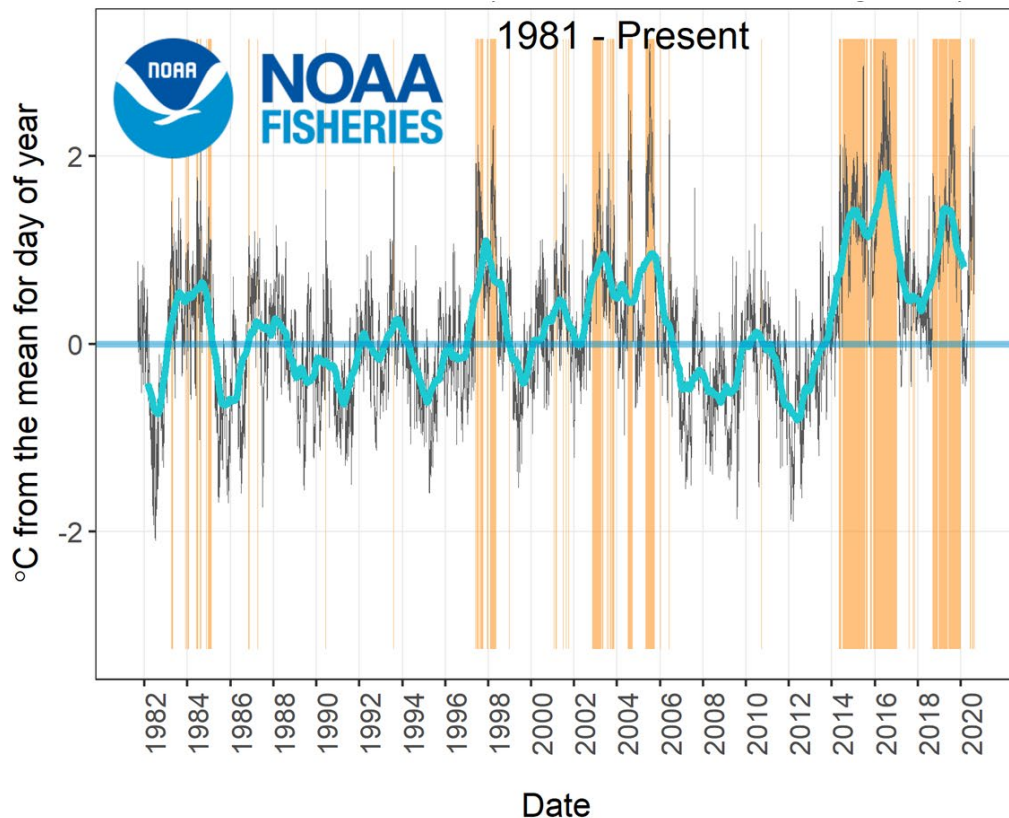
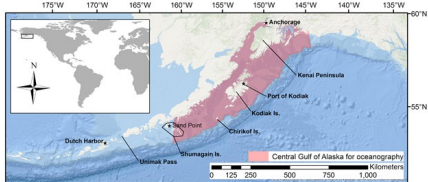
Watson

- 2020 late winter temperatures cooled to the long-term mean through April.
- WGOA then warmed above the mean, near the MHW threshold, for much of summer.
- EGOA temperatures remained near-normal through present.



Western Gulf of Alaska Marine Heatwave Index

Barbeaux



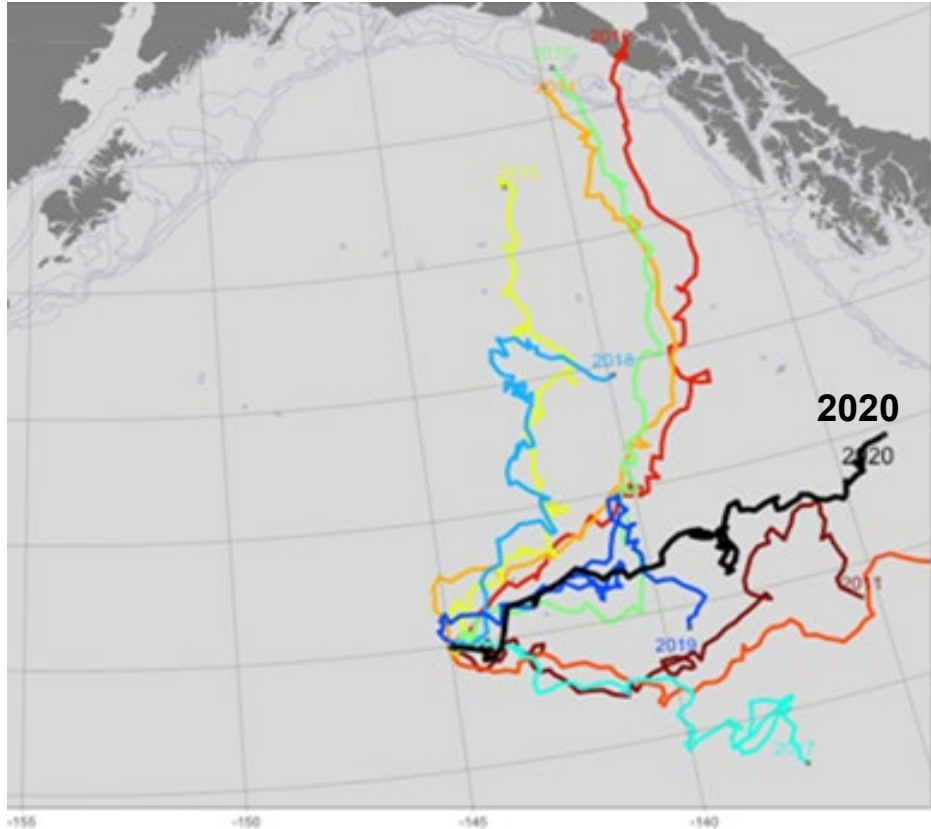
- Heatwave ended Dec. 23, 2019.
- Summer 2020 temperatures oscillated around heatwave threshold.
- 3 periods of heatwave status, including current conditions.

A. Hobday algorithm,
through August 21, 2020

GOA Ocean Surface Currents

Papa Trajectory Index

Stockhausen

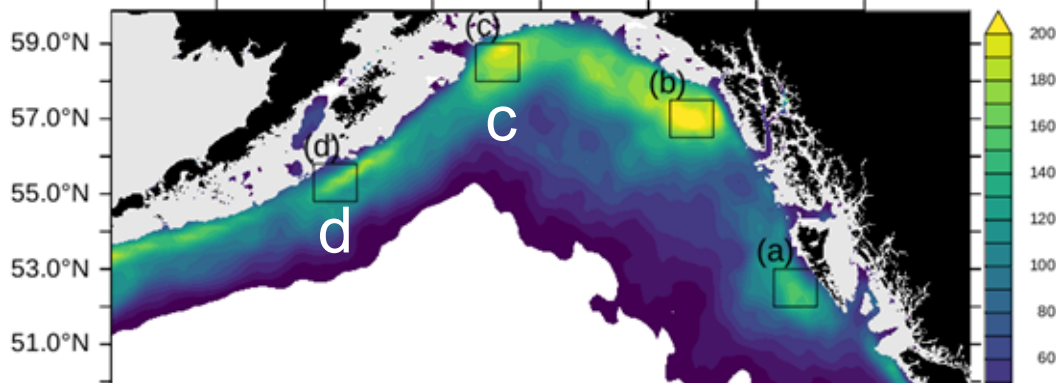


- Simulated surface drifter released from Ocean Station Papa on Dec 1 for 90 days.
- 2020 PTI extended further south and east than the long-term mean.
- 2020 PTI similar to 2013.
- Reflects surface winds associated with the large high pressure system in the GOA in Winter 2019/20.

Eddies in the Gulf of Alaska

Ladd

Average Eddy Kinetic Energy (EKE) Jan 1993 - Dec 2020

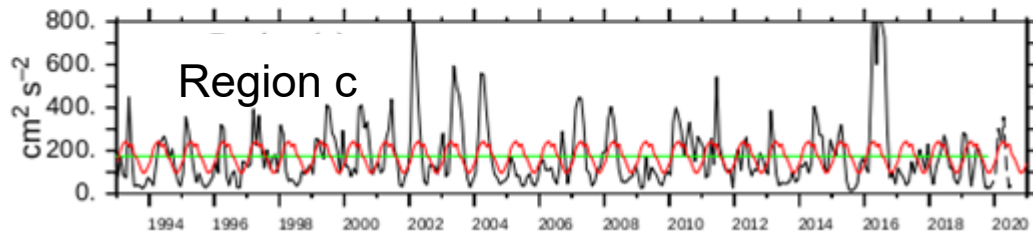
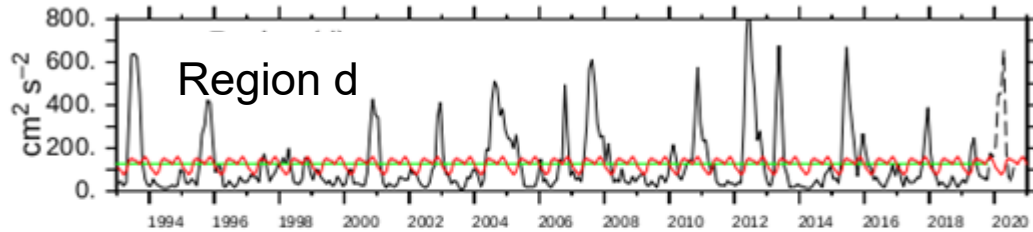


2020 Seasonal EKE cycle for Regions c and d:

- Above average in spring.
- Below average in summer.

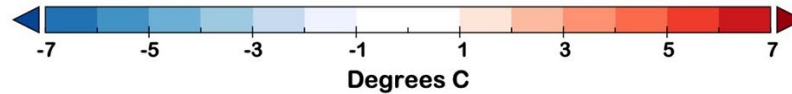
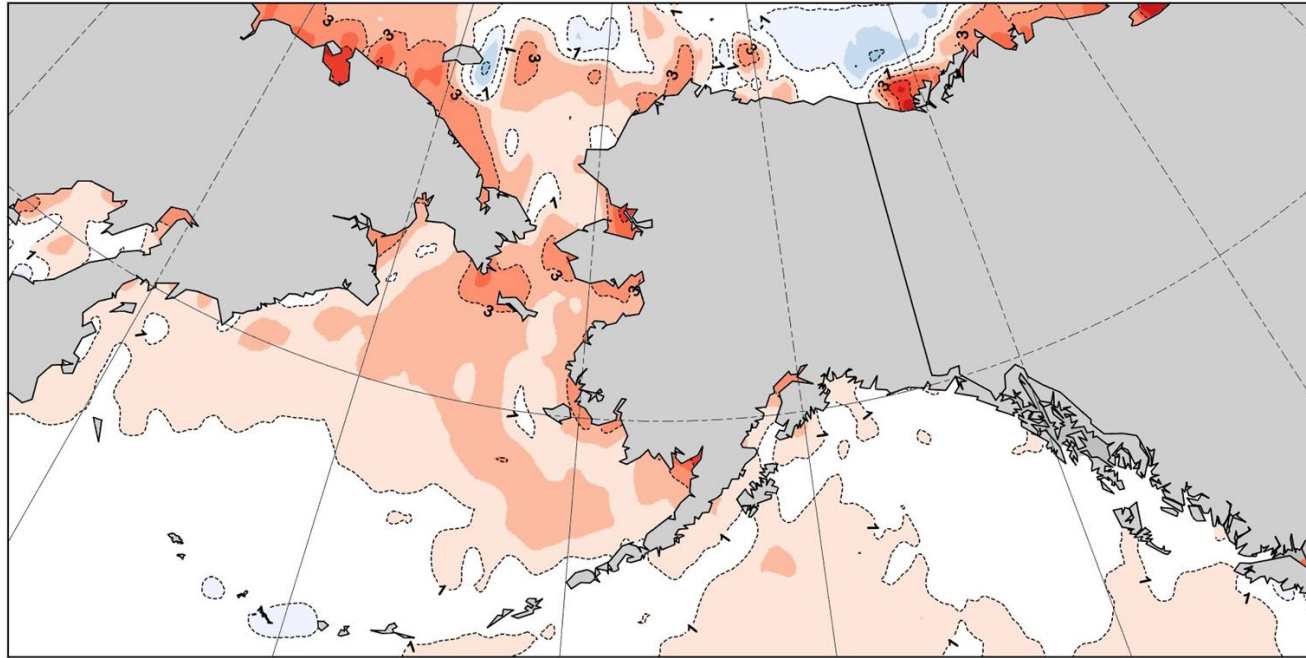
Potential implications for Region d in spring 2020:

- Stronger cross-shelf transport of heat, salinity, and nutrients.
- Higher off-shelf phytoplankton biomass.
- Enhanced settlement success for arrowtooth flounder.



Sea Surface Temperature Departure from Normal

August 28-September 3, 2020



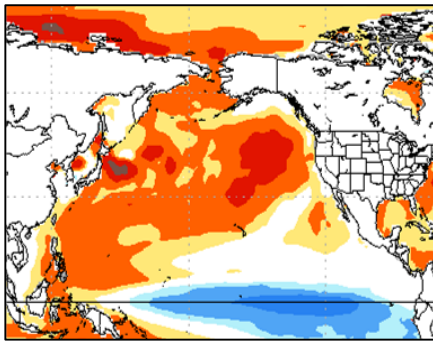
OISSTv2.1 courtesy of NOAA/PSL/ESRL

2021 Sea Surface Temperature Forecasts

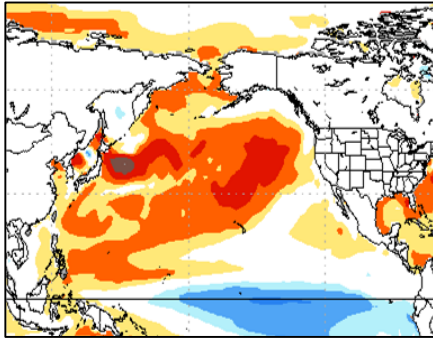
SST Projections from the National Multi-Model Ensemble

Bond

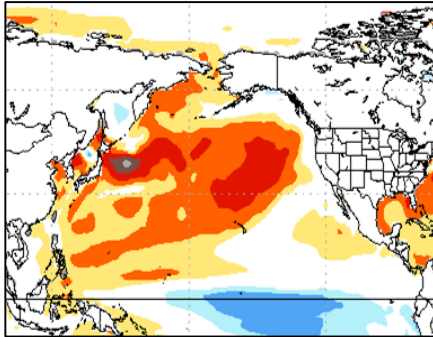
Oct - Dec
2020



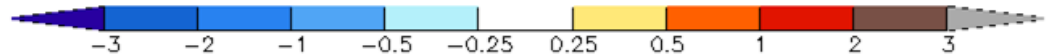
Dec 20 -
Feb 21



Feb -
April
2021



- **TOP:** continued warmth in Bering Sea with delayed sea ice; warmth for AI; near-normal SSTs in GOA (an end of the current MHW?).
- **MIDDLE:** similar spatial pattern, but decreased magnitude of anomalies.
- **BOTTOM:** near-normal temps along coast, moderate warmth in EBS, slight warmth in C&W AI.
- Possible La Niña; weakens by Spring 2021.



SOUTHEAST ALASKA:



AS CLOSE AS YOU CAN GET TO ACTUALLY LIVING UNDERWATER.

Story Maps coming soon...



2019 Second Year of Record Low Sea Ice in the Bering Sea

Ecosystem Check-In

Alaska Fisheries Science Center | September 4, 2020

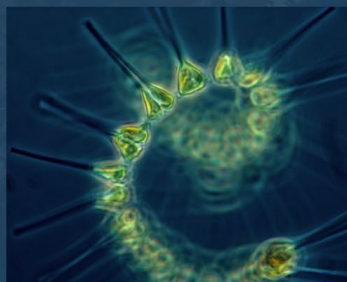


Gulf of Alaska 2019: It's All About the Food

Ecosystem Response to Warm Ocean Temperatures

Alaska Fisheries Science Center | September 4, 2020

A late phytoplankton bloom (rapid growth of the tiny algae that are the base of the marine food chain) occurred in the spring of 2019.



Microscopic view of diatom cells connected by organic threads to form a chain (*thalassiosira*)

