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Sea surface temperature (SST) is one of the foundational metrics often used to describe the Bering Sea environment. Combined with sea ice extent, SST and several other simple metrics (e.g., cold pool extent) are often distilled into single annual or seasonal values used to describe the environment as relatively warm, average, or cold. We did a deeper dive on the intra- and inter-annual dynamics of SST in the north and southeastern Bering Sea, with the hopes that more detail may help to identify mechanisms or critical periods through which SST has the greatest impacts on Bering Sea ecosystems and fisheries. Specifically, we explored SST throughout the annual sea ice cycle and examined the cumulative SST within each year to better understand the annual thermal exposure experienced by the system. We also explored finer scale temporal dynamics (ie., daily data) in the context of marine heatwaves.

*Methods*

Satellite SST data (source: NOAA Coral Reef Watch Program) were accessed via the NOAA CoastWatch West Coast Node ERDDAP server (<https://coastwatch.pfeg.noaa.gov/erddap/griddap/NOAA_DHW.html>). Daily data were averaged within the southeastern (south of 60 ̊N) and northern (60 ̊N – 65.75 ̊N) Bering Sea shelf (10 m – 200 m depth). Detailed methods are online (github.com/jordanwatson/EcosystemStatusReports/tree/master/SST). We defined the annual cycle in the Bering Sea to begin on 1 Sept. of each year and end on 31 Aug. of the following year in order to most closely align with the seasonal sea ice cycle. Seasons were defined as fall (Sept – Nov), winter (Dec – Feb), spring (Mar – May), and summer (Jun – Aug), starting on 1 Sept. 1985 and ending on 31 Aug. 2020.

Marine heatwave calculations were performed using the heatwaveR package (Schlegel and Smit 2018) with the earliest complete 30-yr period as the baseline (1 Sept 1985 – 31 Aug 2014).

*Description of the indicators*

Sea ice dynamics in the Bering Sea drive a unique and tortuous pattern of thermal exposure for the system throughout the year. The cumulative annual SST (ie., the sum of daily SST throughout the year) is one metric by which to evaluate the amount of thermal exposure a system has throughout the year. Stark inter-annual differences in cumulative totals across years are clearly illustrated in the form of anomalies (**Fig. 1**). The warm stanza of the early 2000s and the recent warm years have far exceeded one standard deviation (horizontal dashed line) above average, with several years exceeding this common threshold several fold.

Within each year, the cumulative exposure can be deconstructed into seasonal cumulative SSTs, which illustrate the formation of sea ice during the winter and spring (negative cumulative total values) and subsequent warming during summer and fall (**Fig.** 2). In the Northern Bering Sea, predominantly negative SST in the winter and spring served to reduce the total cumulative SST in the earlier years, whereas more recently, there was negligible negative forcing from these seasons. Meanwhile, along the southeastern Bering Sea shelf, spring appears to have undergone much more variable inter-annual contributions to the cumulative SST, with a greater positive contribution in the recent warm years.

We consider marine heatwaves to occur when SST exceeds a particular threshold for five or more days. That threshold is the 90th percentile of temperatures for a particular day of the year based on a 30-year baseline (Hobday et al., 2016). The intensity of a heatwave can be further characterized by examining the difference between the 90th percentile threshold for a given day and the baseline (“normal”) temperature for that day. If the threshold is exceeded, the event is characterized as: *moderate*, *strong* (2 times the difference between then threshold and normal), *severe* (3 times the difference between the threshold and normal), or *extreme* (>=4 times the difference) (Hobday et al., 2018). In 2020-2021, conditions have cooled dramatically from the intense heatwave conditions of the several years prior (**Fig. 3**). While much of the winter of 2021 hovered near the marine heatwave threshold, temperatures only scarcely crossed this threshold. Thus, while temperatures were still warmer than the 30-year average, they rarely exceeded the actual heatwave threshold.

SST Trends

While much of 2020-2021 was cooler than the previous year in both regions, several periods of warmer than average temperatures still occurred. Notably, Feb-April in the SEBS was substantially warmer than the previous year and the 30-yr average (**Fig. 4**). The timing of this warm period may be relevant for larval fish that hatch during this period. Meanwhile, temperatures closer to average than last year during the summer could support more productive prey bases for foraging young-of-the-year.

SST Time Series Trends

Trend analysis removed seasonality and noise from the SST time series (Edullantes, 2019) to better illustrate the long term trends in the SST data (**Fig. 5**). Trends are compared to the mean (±1 SD) from a 30-yr baseline (1985–2014) and demonstrate that both the northern and southeastern Bering Sea are experiencing a persistent warm stanza. However, the magnitude of the recent stanza has cooled somewhat relevant to recent years.

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