



Meteorological Conditions During the MOSAiC Expedition: Normal or Unusual?

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1. MOSAiC Expedition

Multidisciplinary drifting Observatory for the Study of Arctic Change (MOSAiC)

- MOSAiC was the largest polar research expedition ever conducted
- The German icebreaker *Polarstern* drifted with sea ice across the Arctic from October 2019 to September 2020 (Fig 1)
- MOSAiC scientists made observations of the Arctic atmosphere, ocean, ice, biogeochemistry and ecosystems

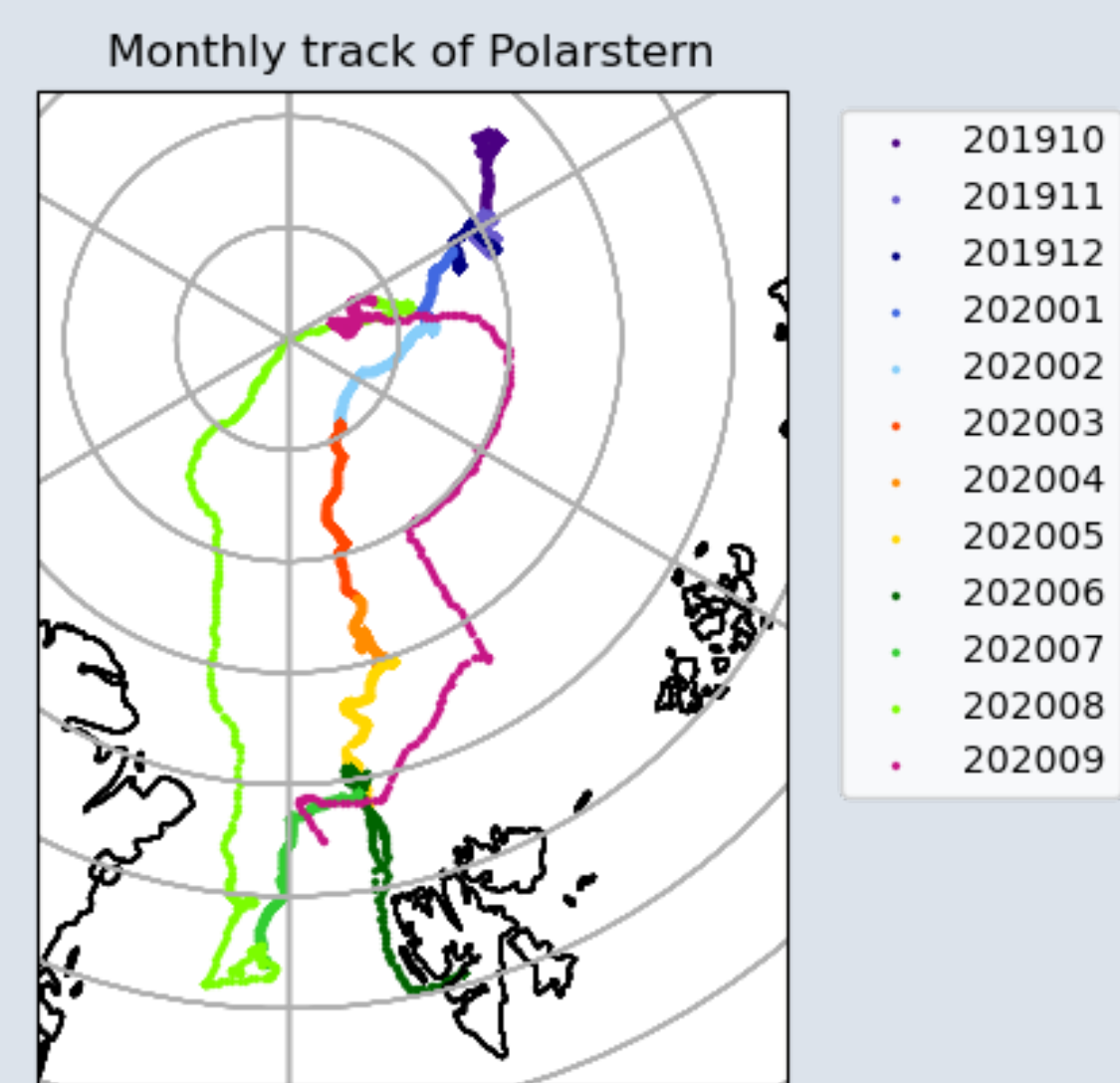


Figure 1: Track of the *Polarstern* as it drifted across the Arctic Ocean from October 2019 to September 2020

2. MOSAiC Year Meteorology

We want to determine how typical or atypical the weather was during the year-long MOSAiC expedition

- Extract ERA5 reanalysis near surface meteorological data (2 m air temperature, mean sea level pressure (MSLP) and 10 m winds on this poster) along the *Polarstern* track for the MOSAiC year (Figure 1)
- Compare this to ERA5 reanalysis data from 1979 to 2019
 - 24 h running median MOSAiC values to long-term median, 5th, 25th, 75th and 95th percentiles and min/max values from 1979-2019 (Figure 2)
 - Monthly distribution (median, 25th and 75th percentiles, min/max) for MOSAiC-year and 1979-2019 (Figure 3)
 - Monthly ranking of MOSAiC year data (Figure 4)
- Identify all cyclones that impacted *Polarstern* using ERA5 MSLP and Crawford and Serreze (2016) cyclone tracking algorithm
- Compare the MOSAiC-year cyclones to all cyclones impacting the same drift track from 1979-2019
 - MOSAiC year monthly cyclone count to 1979-2019 median, 25th and 75th percentile and min/max monthly counts (Figure 5a)
 - Cyclone intensity: Central pressure and depth (median, 25th and 75th percentile and min/max) (Figure 5b and 5d)
 - Percent of monthly MOSAiC-year cyclones that were strong, normal or weak compared to 1979-2019 period (Figure 5c and 5e)

References

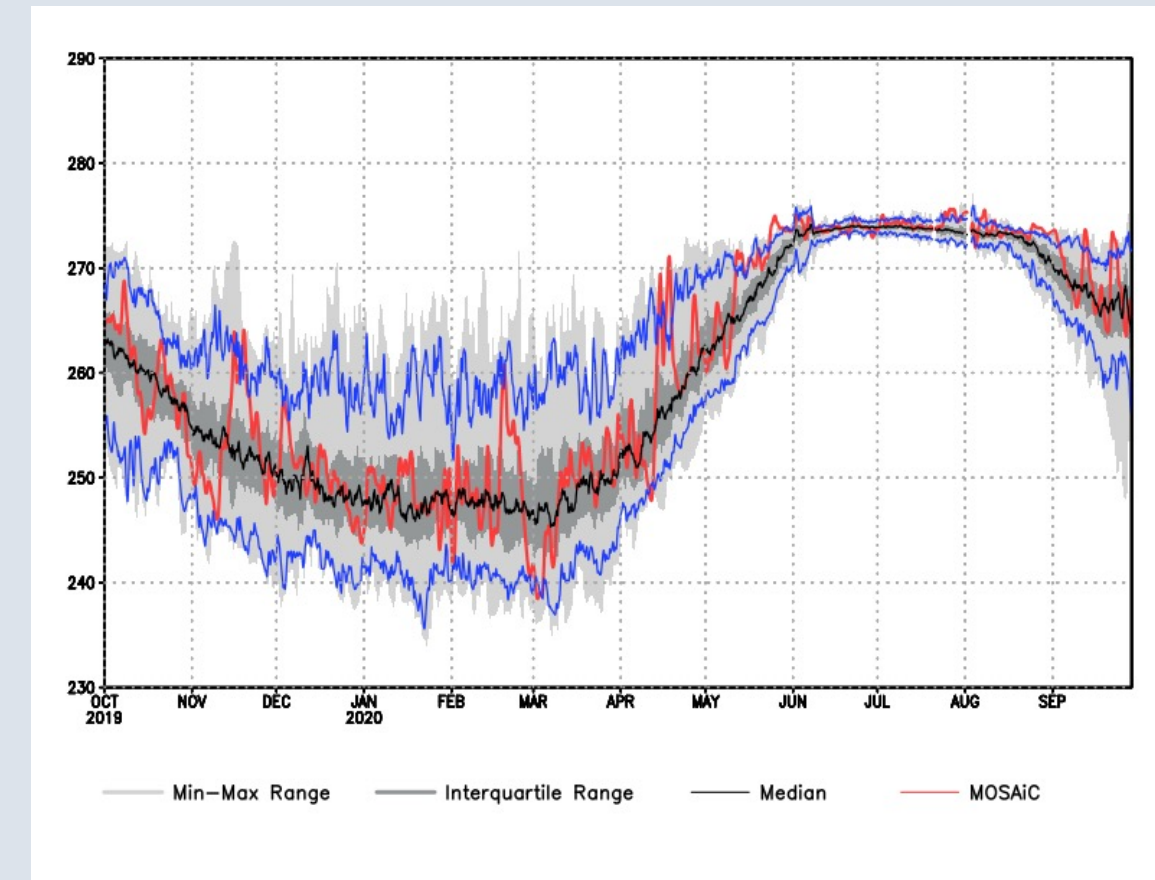
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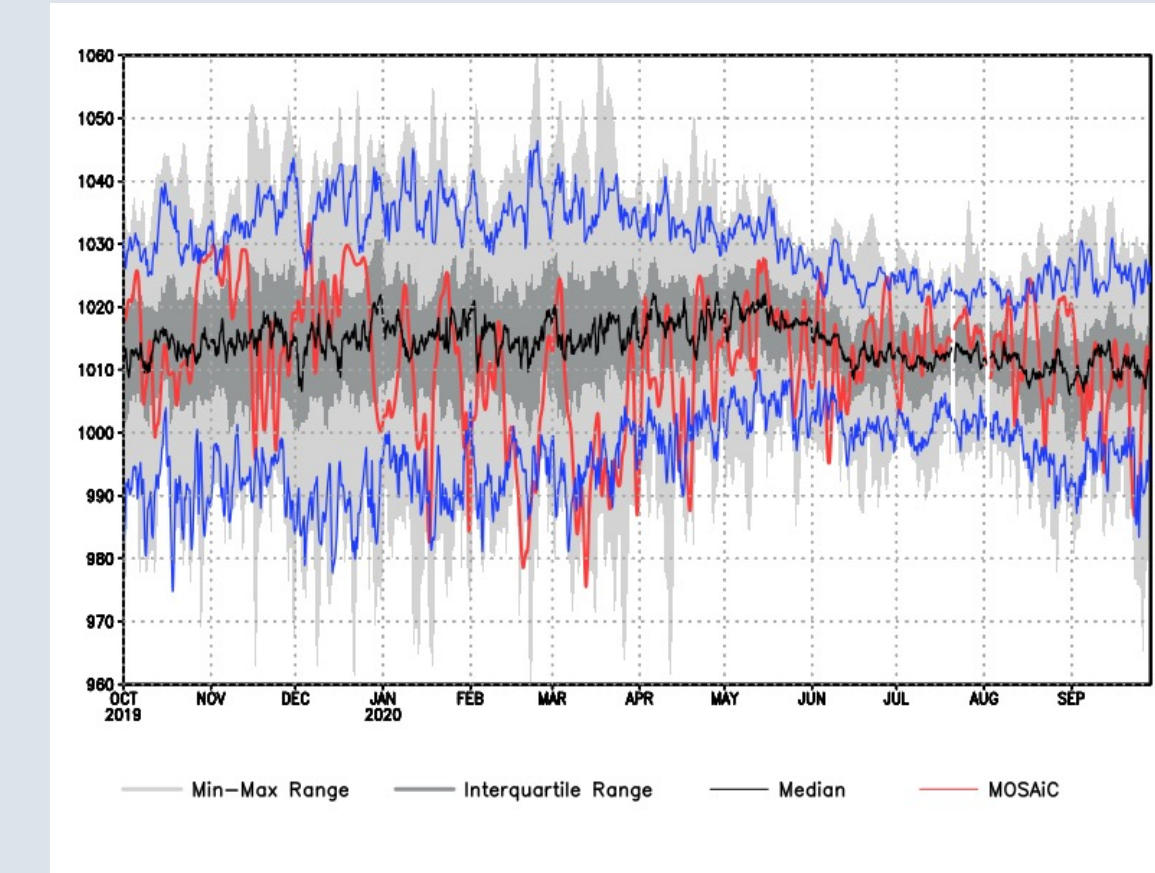
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3. Annual Time Series

a. 2 m Air Temperature (K)



b. Mean Sea Level Pressure (hPa)



c. 10 m Wind Speed (m/s)

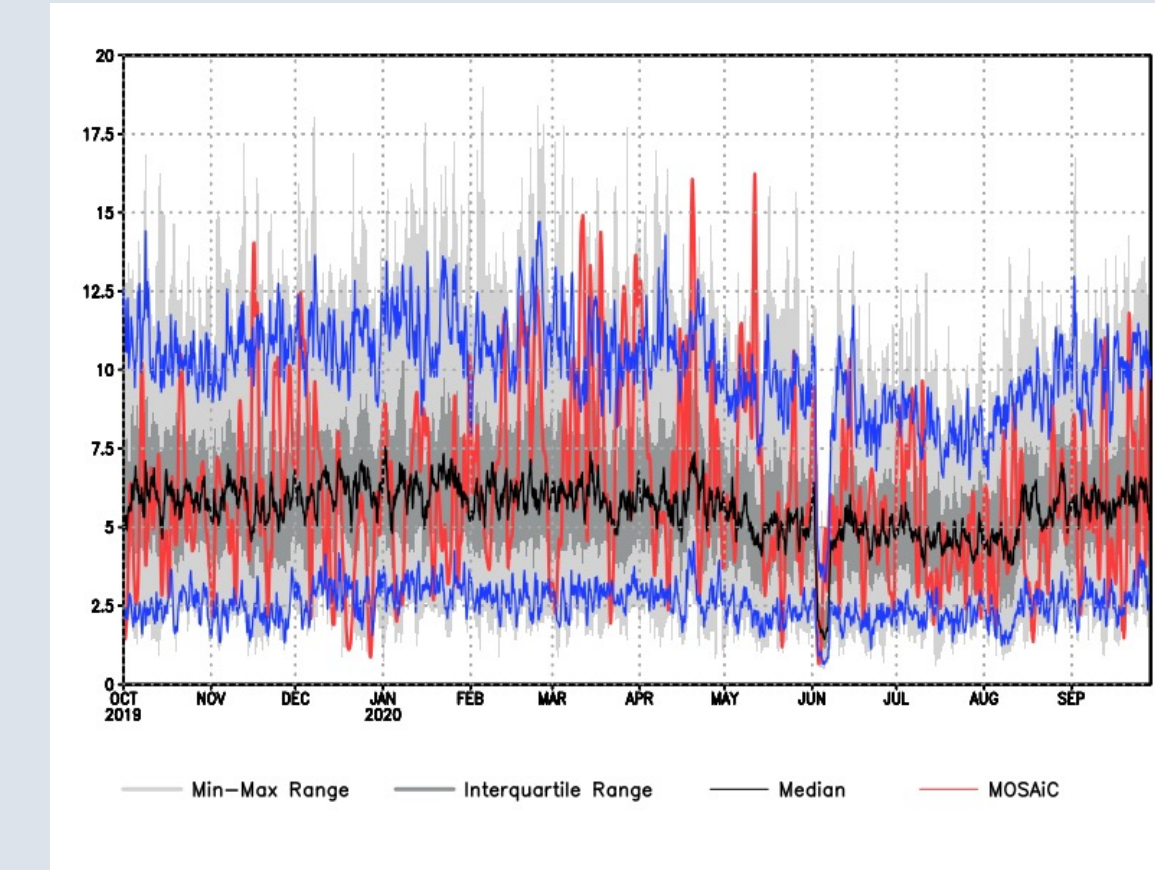
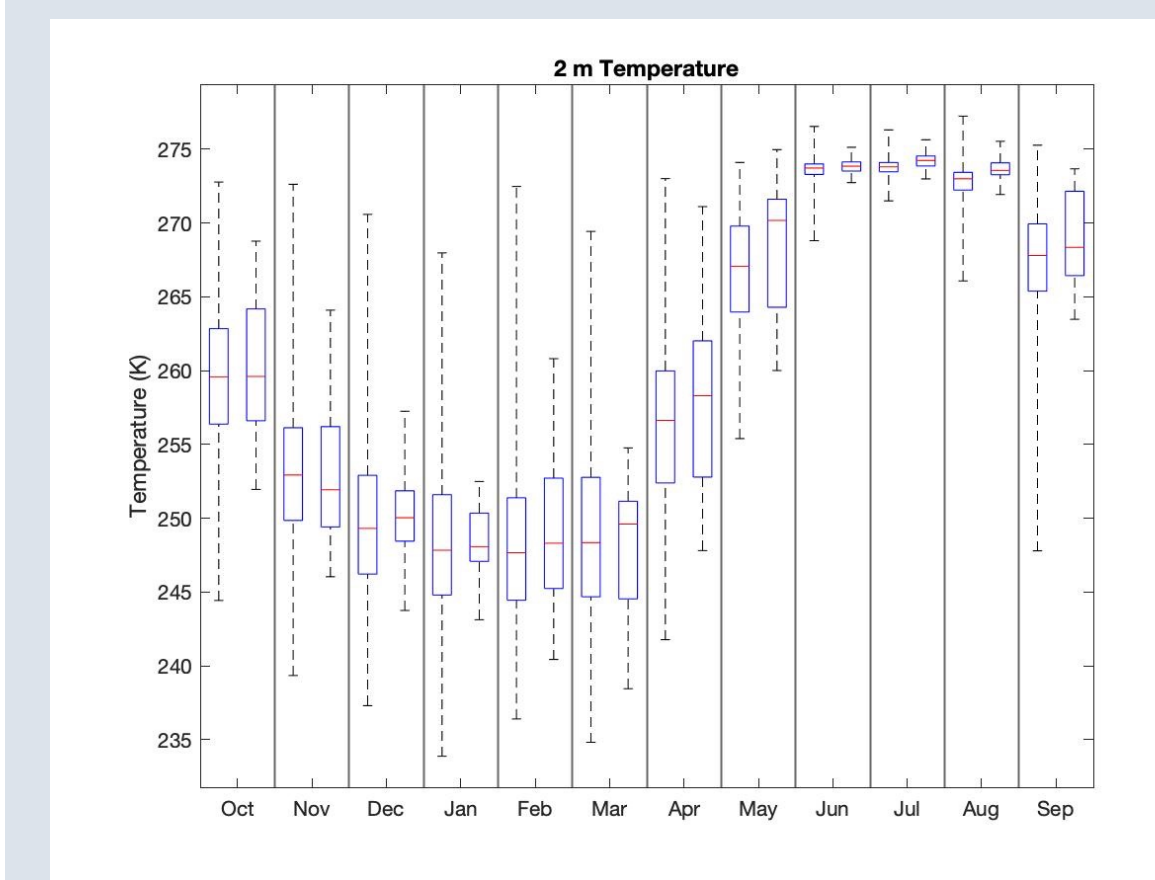


Figure 2: Annual time series of (a) 2 m air temperature, (b) mean sea level pressure and (c) 10 m wind speed based on ERA5 data from 4 grid points surrounding the *Polarstern* position. MOSAiC year 24 h running median (red line), 1979-2019 median (black line), interquartile range (dark gray shading), 5th and 95th percentiles (blue lines) and min/max range (light gray shading).

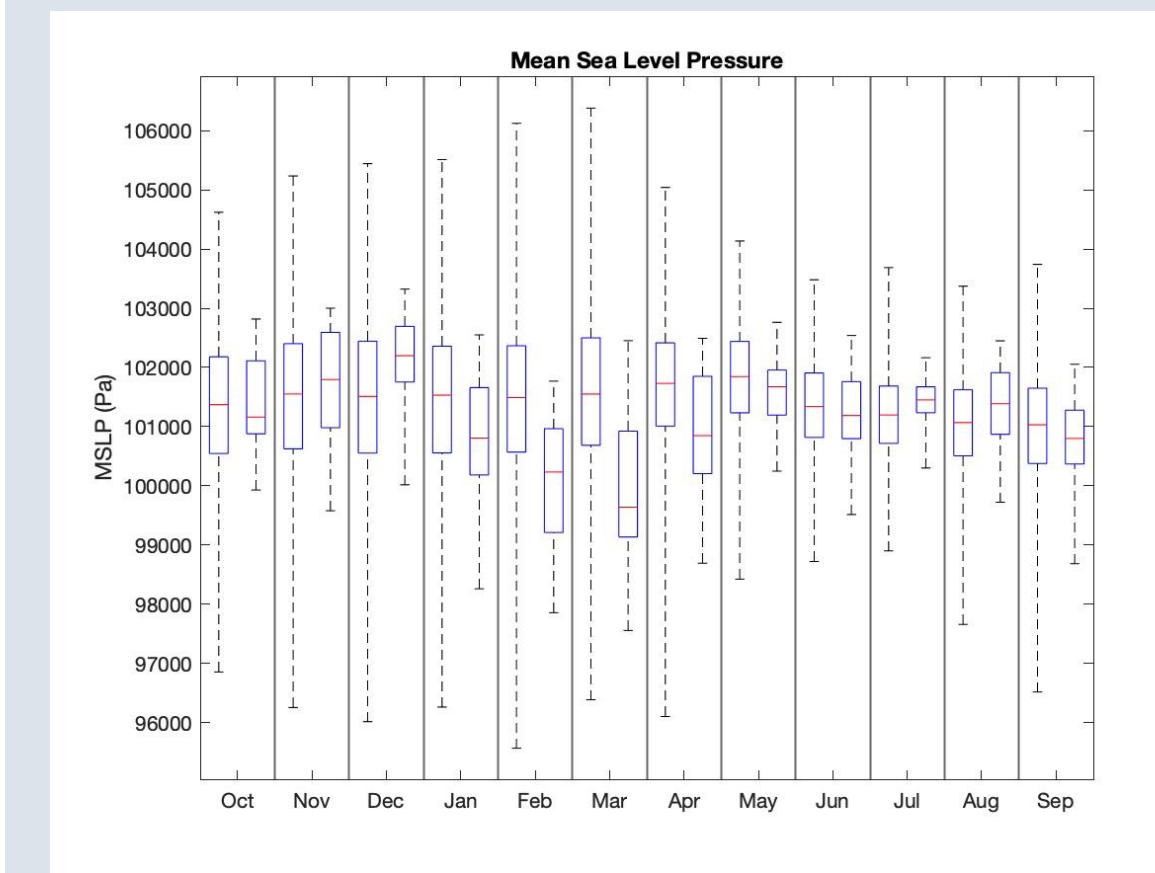
- During the MOSAiC year temperature, pressure and wind speed was often within the interquartile range of the 1979-2019 period
- There were several warm events (mid-November, early December, mid-February, mid-April and mid-May)
- Unusually cold conditions were infrequent but did occur in early November and early March
- The summer melt season was almost 1 month longer than in the 1979-2019 period with daily median temperature near the melting point from late May until early September
- MSLP was frequently below the 25th percentile from January to April
- MSLP was anomalously low for most of March, associated with increased cyclone frequency (see section 6)
- Extended periods of anomalously strong winds occurred from mid-November to mid-December, late February, most of March and mid-April

4. Monthly Comparison

a. 2 m Air Temperature (K)



b. Mean Sea Level Pressure (Pa)



c. 10 m Wind Speed (m/s)

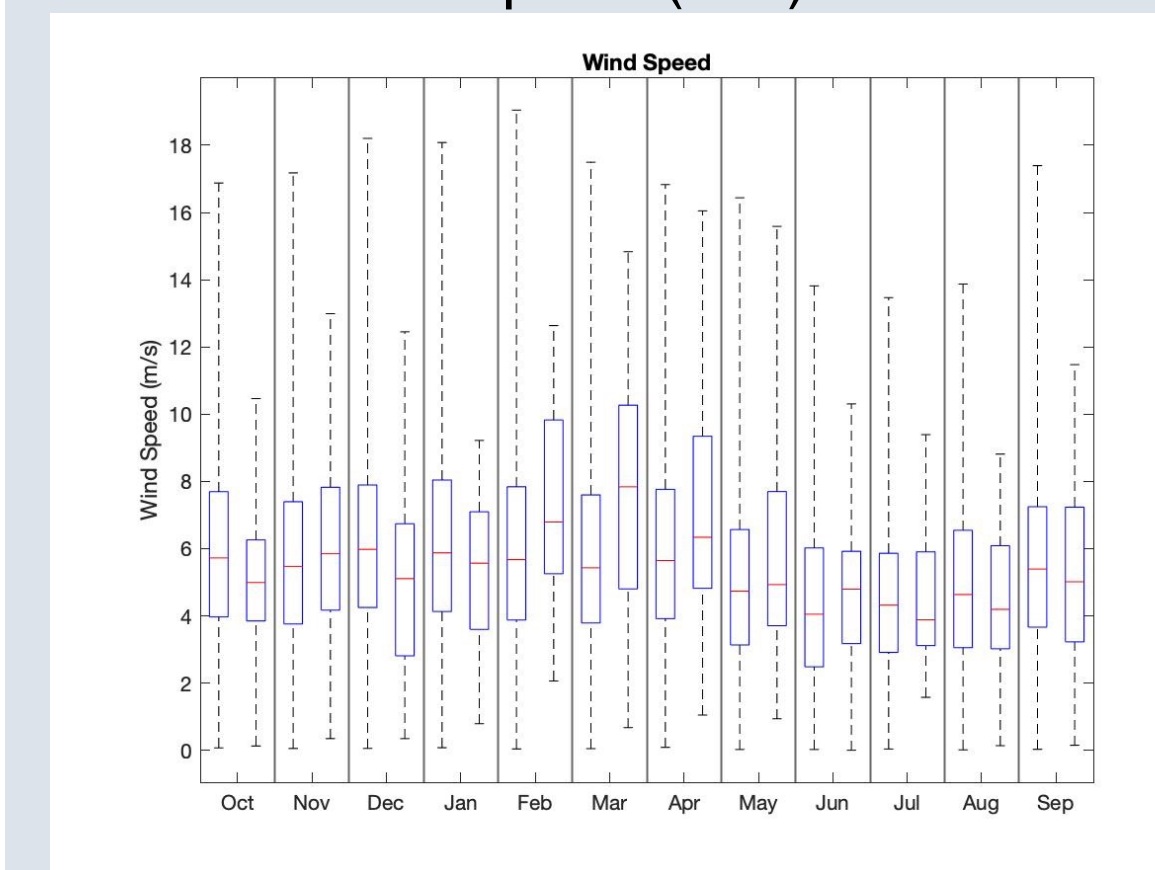
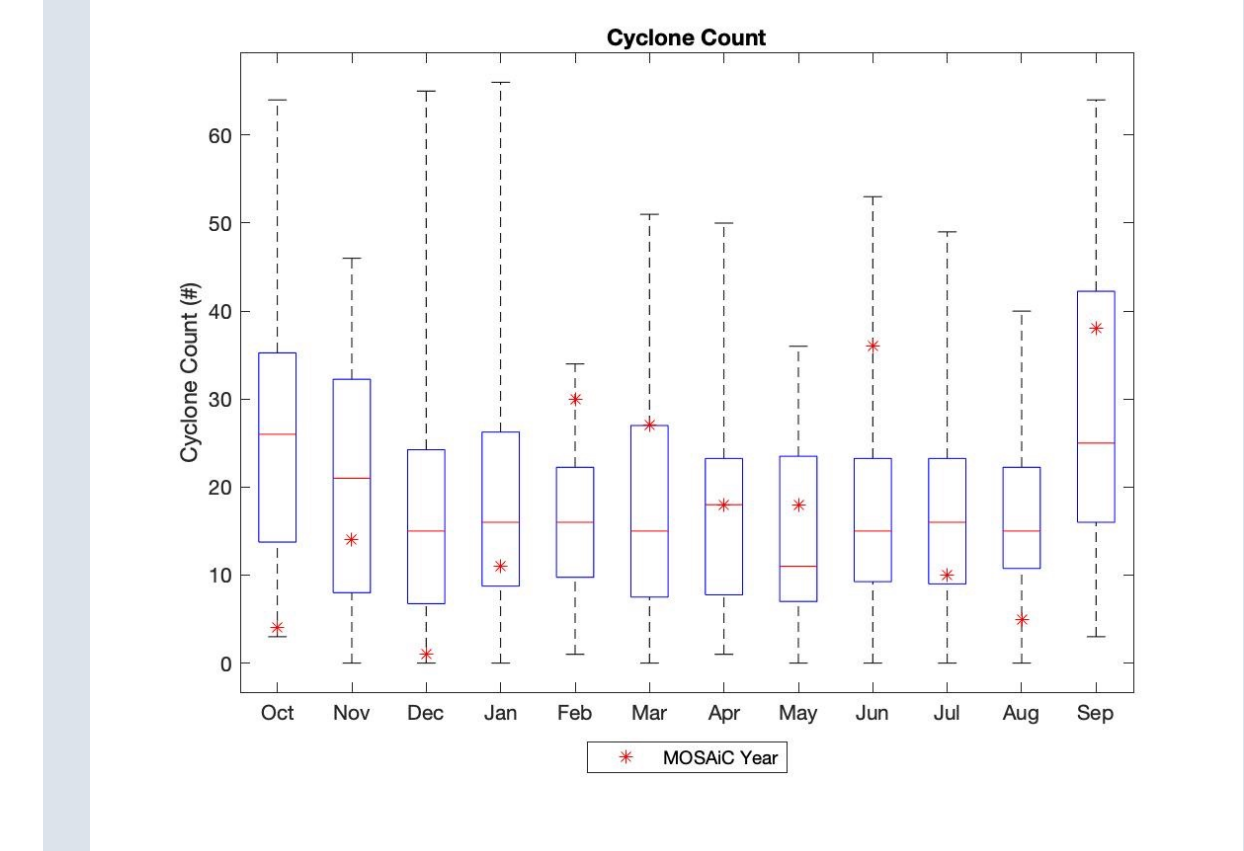


Figure 3: Monthly median (red line), 25th and 75th percentile (box) and minimum and maximum (whiskers) for the 1979-2019 period (left box) and the MOSAiC year (right box) for (a) 2 m air temperature, (b) mean sea level pressure and (c) 10 m wind speed.

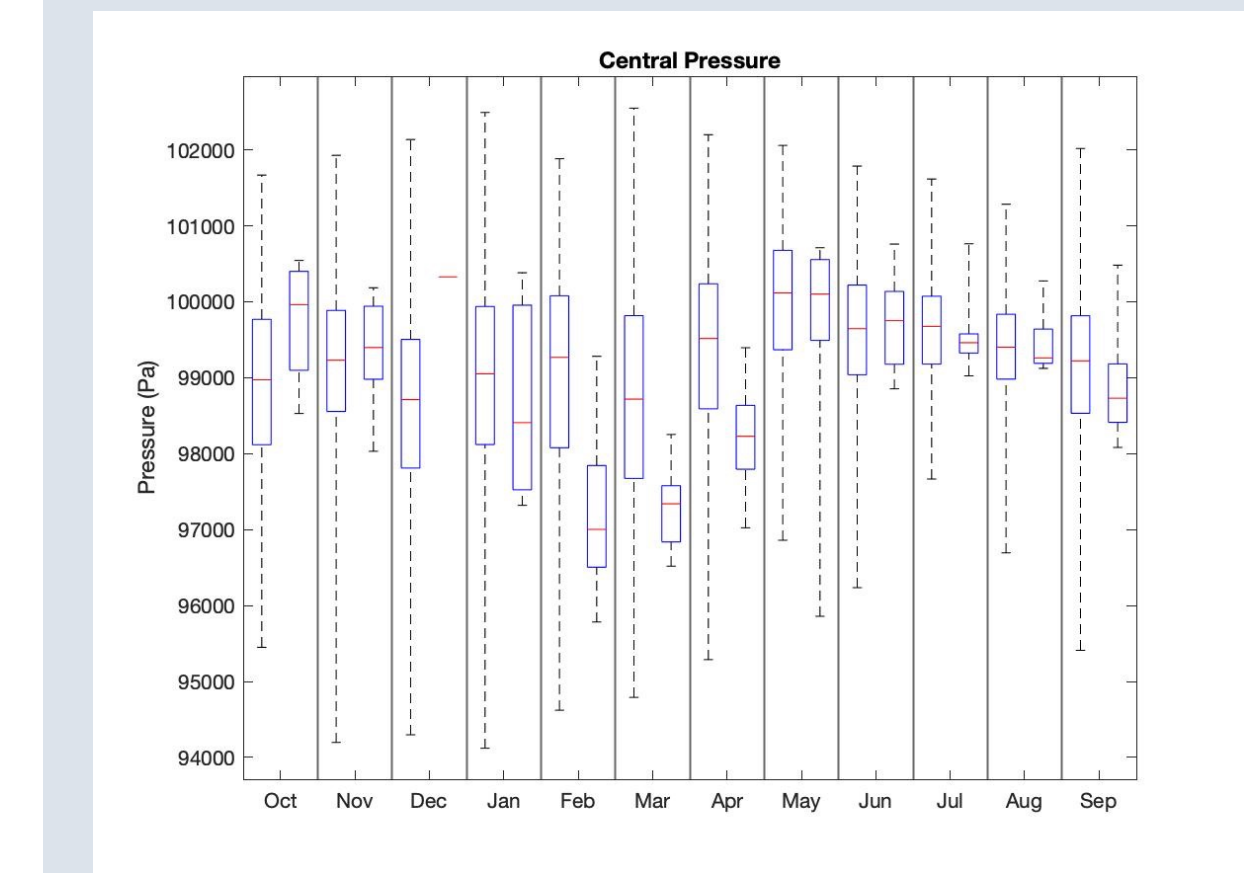
- Median monthly temperatures during the MOSAiC year were similar to the 1979-2019 period for most months except for May, July and August when the MOSAiC monthly median temperature was near or above the 1979-2019 75th percentile
- From October to January of the MOSAiC year the coldest temperatures were notably warmer than in the 1979-2019 period, while December and January had notably lower high temperatures compared to 1979-2019
- The MOSAiC February to April monthly median MSLP was below the long-term 25th percentile for these months
- MOSAiC monthly median wind speed was much larger than the 1979-2019 monthly median wind speed for February to April, with the March 2020 monthly median wind speed larger than the long term 75th percentile wind speed for this month

6. Monthly Cyclone Statistics

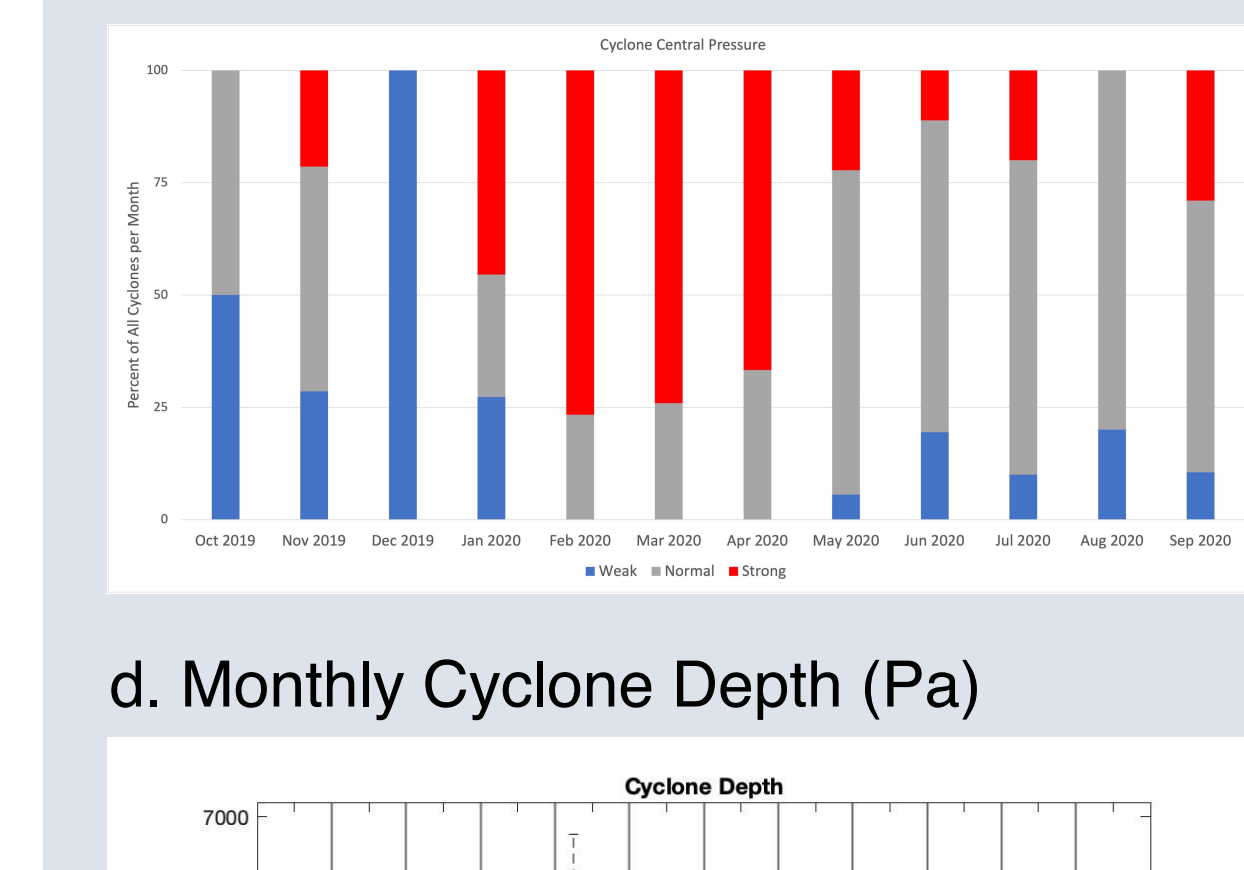
a. Monthly Cyclone Counts



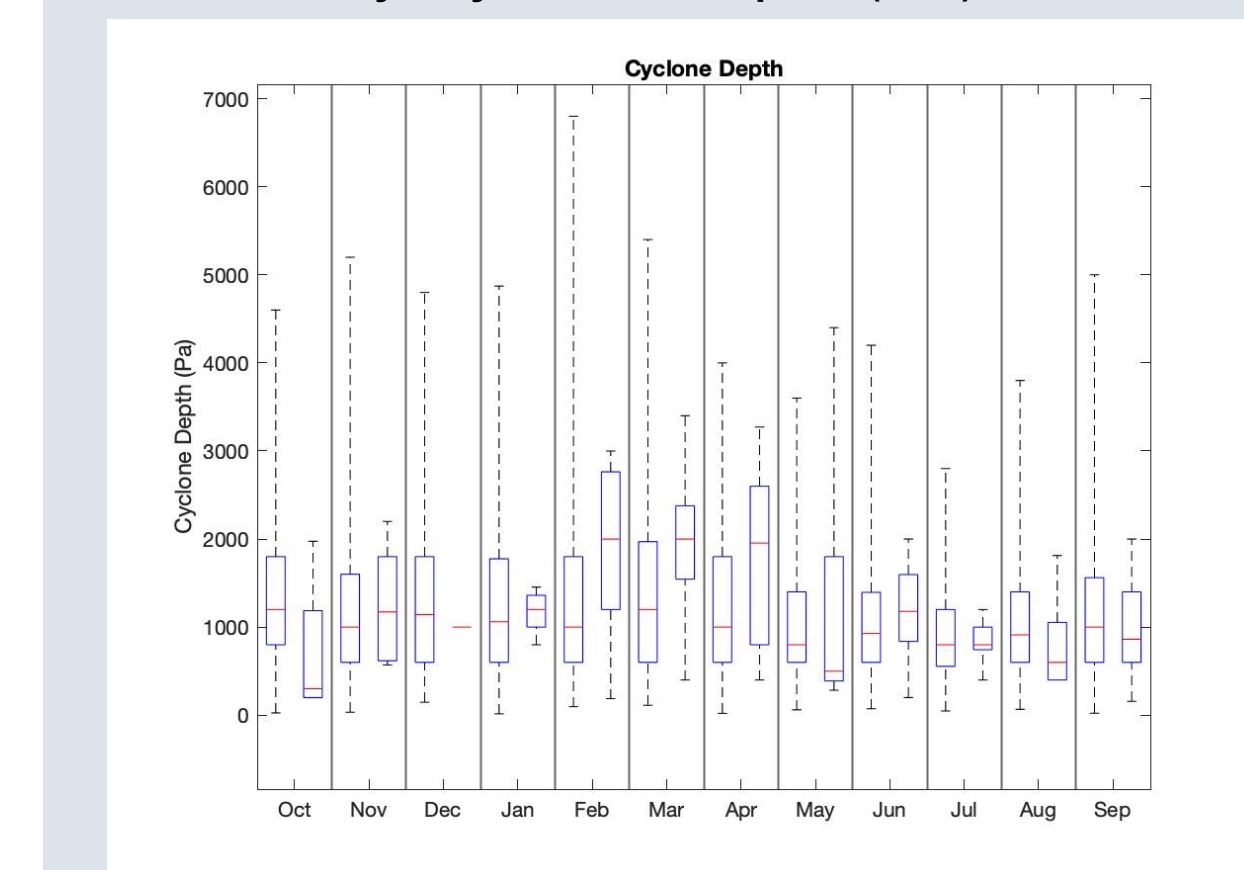
b. Monthly Cyclone Cent. Pressure (Pa)



c. Cent. Pressure: strong - normal - weak



d. Monthly Cyclone Depth (Pa)



e. Depth: strong - normal - weak

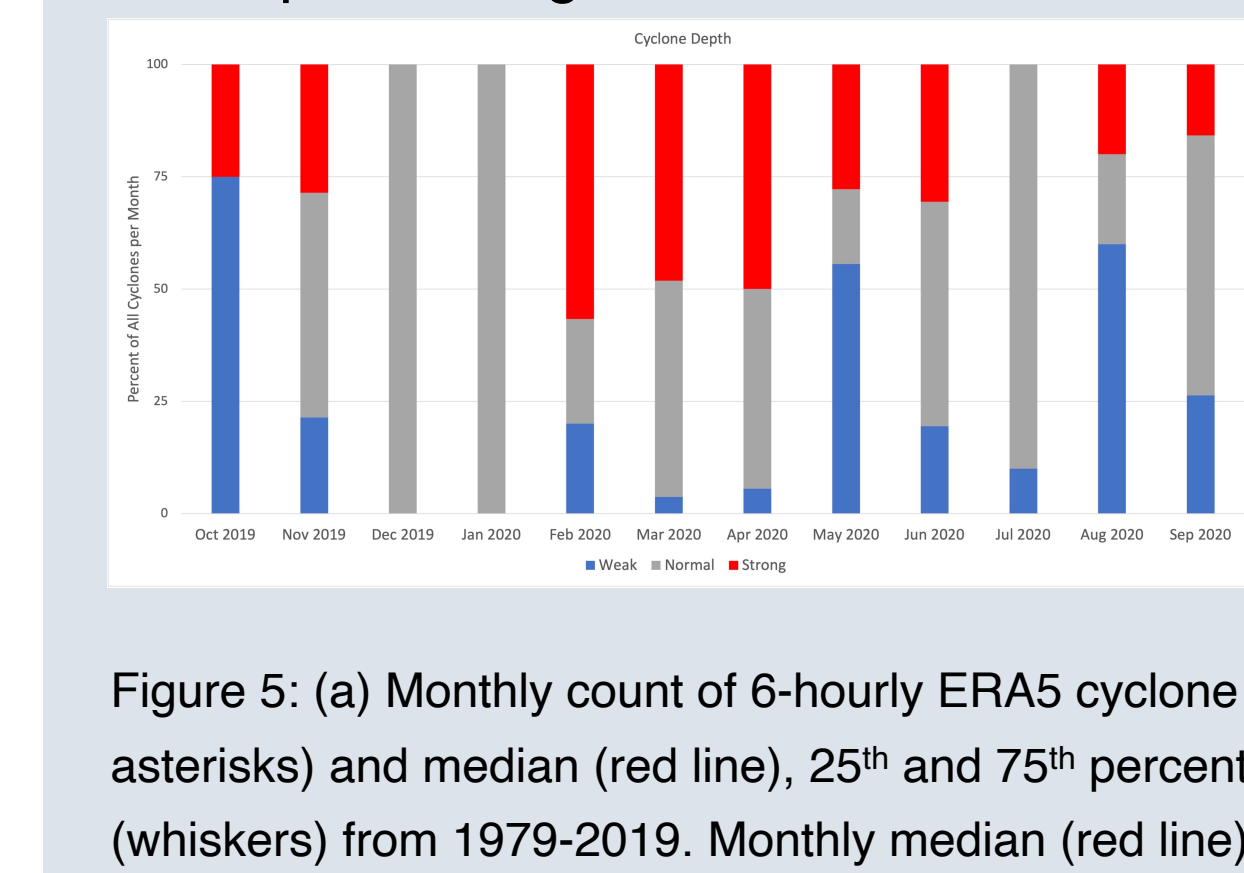


Figure 5: (a) Monthly count of 6-hourly ERA5 cyclone occurrence for the MOSAiC year (red asterisks) and median (red line), 25th and 75th percentiles (box), and minimum and maximum (whiskers) from 1979-2019. Monthly median (red line), 25th and 75th percentile (box) and minimum and maximum (whiskers) of (b) cyclone central pressure and (d) cyclone depth for the 1979-2019 period (left box) and the MOSAiC year (right box). Frequency of occurrence (%) of weak (blue), normal (gray) and strong (red) cyclones based on (c) cyclone central pressure and (e) cyclone depth.

The MOSAiC year late winter and spring had more and stronger storms than the 1979-2019 period associated with a record positive AO

Cyclone Counts

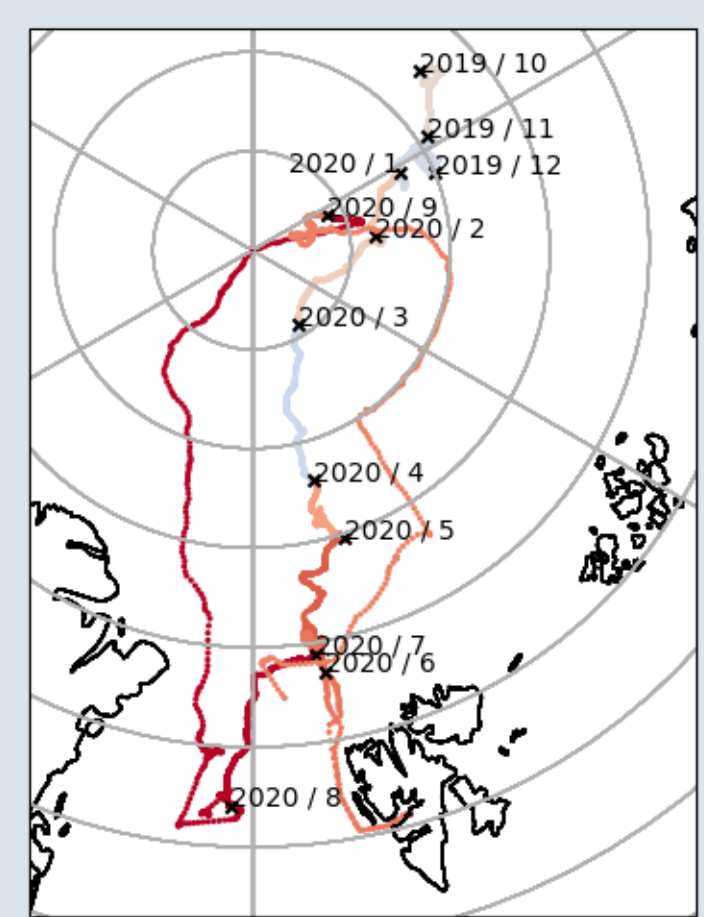
- Monthly cyclone counts were above the long-term median from February through June 2020 (excluding April 2020) and above the 75th percentile monthly cyclone counts in February and March 2020
- There were also high monthly cyclone counts in September 2020
- Monthly cyclone counts were near or below the 25th percentile for October and December 2019 and January, July and August 2020

Cyclone intensity

- Cyclone intensity was relatively normal for much of MOSAiC year aside from late winter to early spring
- More than 50% of cyclones were classified as strong from February to April 2020
- Cyclone central MSLP was below the long term median from January to April 2020 and below long-term 25th percentile from February to April 2020. Cyclone depth had similar monthly distributions as central MSLP

5. MOSAiC Daily and Monthly Ranking

Monthly Sfc. T Ranking



Monthly MSLP Ranking

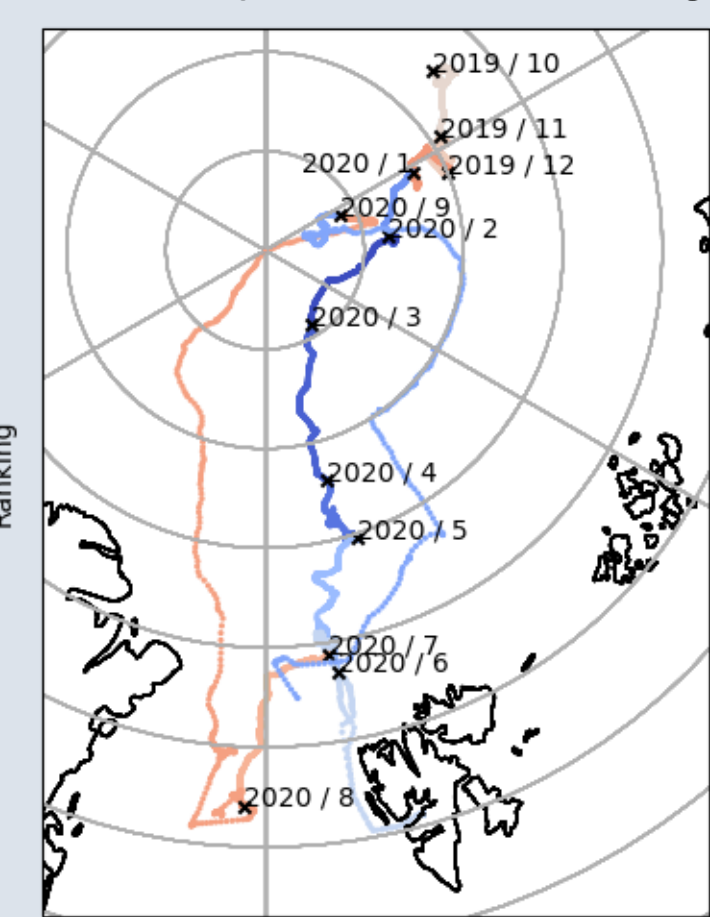


Figure 4: Ranking of monthly MOSAiC year temperature (left) and MSLP (right) at the location of the *Polarstern* relative to 1979-2020 ERA5 record. Dark red (blue) indicate MOSAiC year ranked highest (lowest) during the 41 year period.

Monthly ranking (Figure 4)

- July and August 2020 were the warmest Julys and Augusts since 1979
- May 2020 ranked as 6th warmest May since 1979
- March 2020 MSLP ranked 5th lowest for all Marchs since 1979

Daily ranking (not shown)

- Several days in November 2019 ranked from 2nd to 6th warmest of the 1979-2019 period
- The first five days of March 2020 ranked within the five coldest of the 1979-2019 period
- Two days in April 2020 had record high temperatures for those days and two additional days had the 2nd highest daily temperatures of 1979-2019 period.
- There were 6 daily record high temperatures in the last half of May 2020 including the highest all time May temperature

Acknowledgments

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