# Regional Antarctic Sea Ice Extent Variation and Trends, 1980-2021

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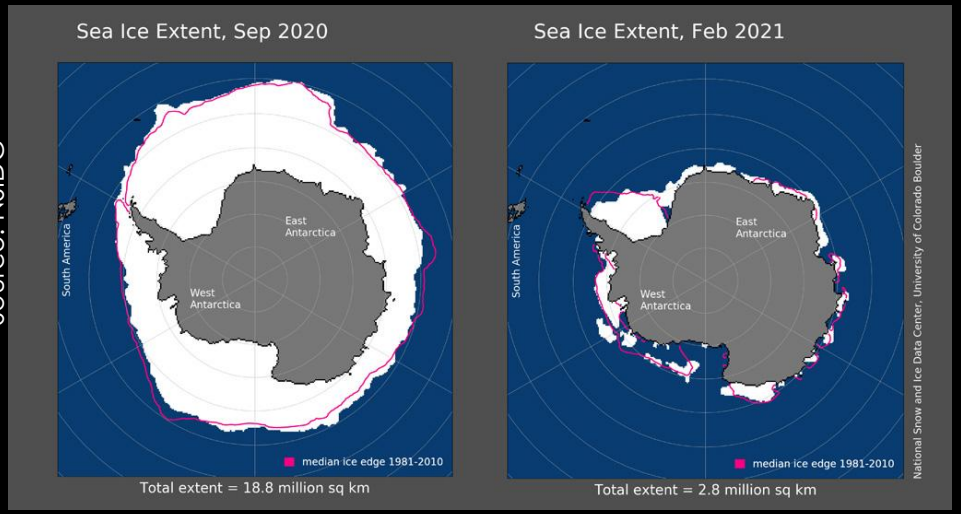
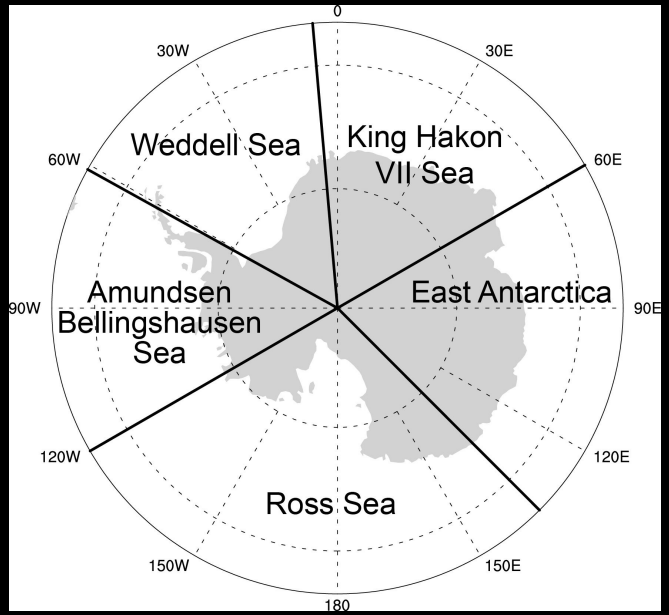
# Annual Sea Ice Extent Variation

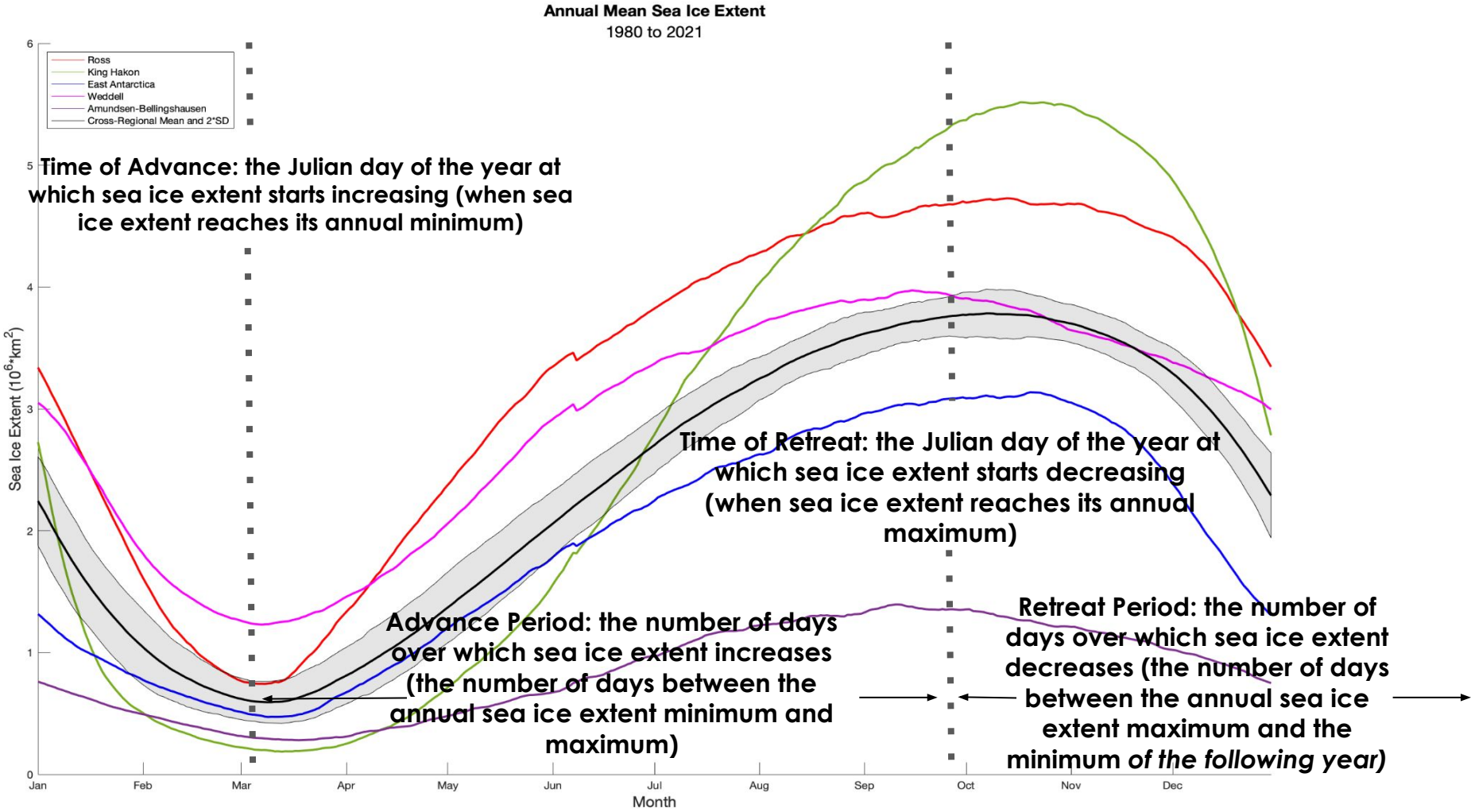
Source: NSIDC




Antarctic sea ice extent troughs at the end February and peaks in early September. We see this pattern on a continental and regional basis.

How can we analyze the annual cycle of sea ice extent within and across these five regions?...

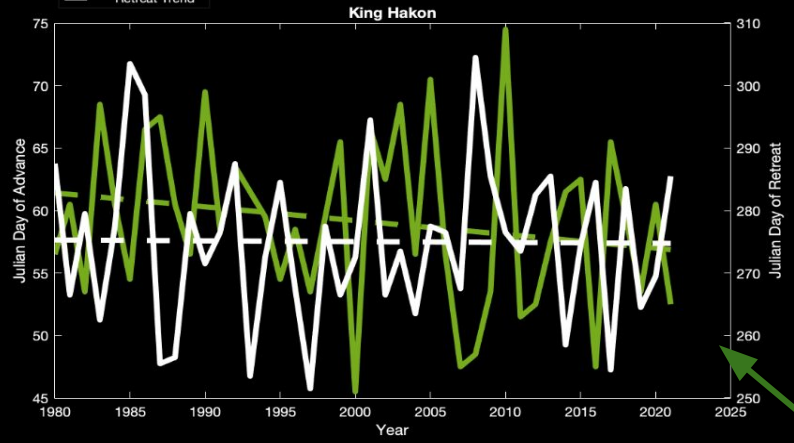


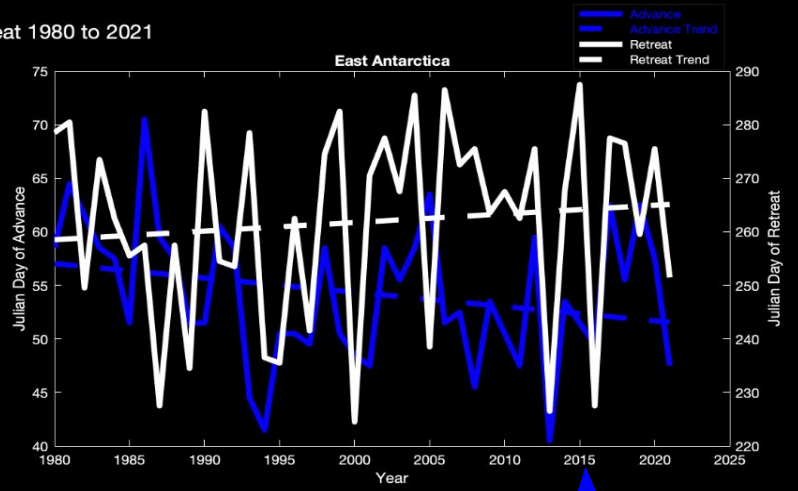

Annual Mean Sea Ice Extent
1980 to 2021
Ross
King Hakon
East Antarctica
Weddell
Amundsen-Bellingshausen
Cross-Regional Mean and 2*SD
Time of Advance: the Julian day of the year at which sea ice extent starts increasing (when sea ice extent reaches its annual minimum)
Time of Retreat: the Julian day of the year at which sea ice extent starts decreasing (when sea ice extent reaches its annual maximum)
Advance Period: the number of days over which sea ice extent increases (the number of days between the annual sea ice extent minimum and maximum)
Retreat Period: the number of days over which sea ice extent decreases (the number of days between the annual sea ice extent maximum and the minimum of the following year)
Sea Ice Extent (10^6*km^2)
Month
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
0
1
2
3
4
5
6

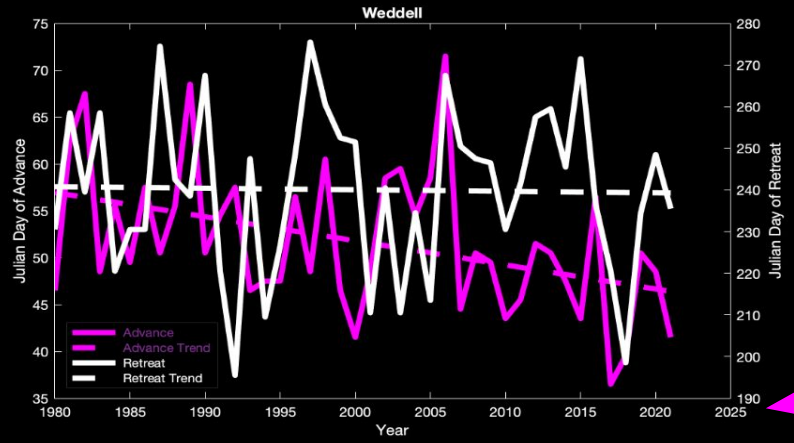
# Intra-Regional Relationships

*Analyzing time of retreat and advance, and retreat and advance periods, within the five Antarctic regions*

Time of Advance and Time of Retreat 1980 to 2021



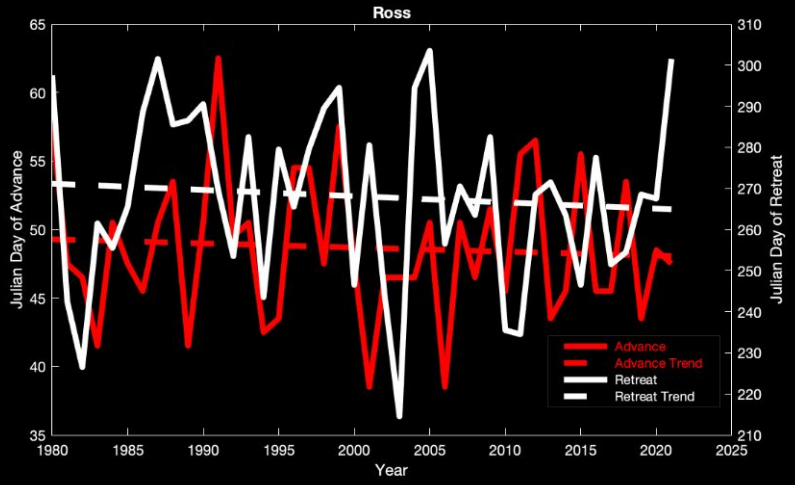



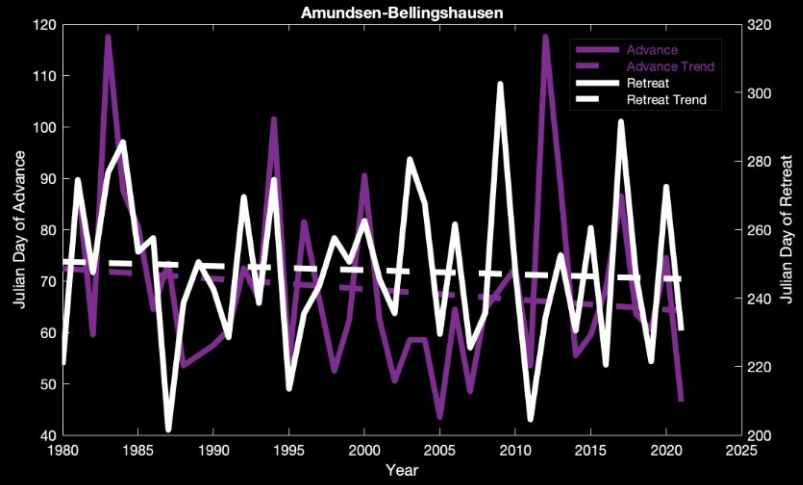

Ice is beginning to advance earlier, while time of retreat is variable. Starting around 2015, advance and retreat period remain constant.

Sea ice extent is beginning to advance earlier in the year and retreat later in the year. So, the number of days between when ice begins to advance and when ice begins to retreat is increasing–there is a longer period under growing ice.

Sea ice extent in beginning to advance earlier in the year, while time of retreat is variable–there is a longer period under growing ice.

Time of Advance and Time of Retreat 1980 to 2021




Time of advance and time of retreat remain relatively constant. Period of time over which ice is advancing remains unchanged, and the period of time over which ice is retreating remains unchanged.

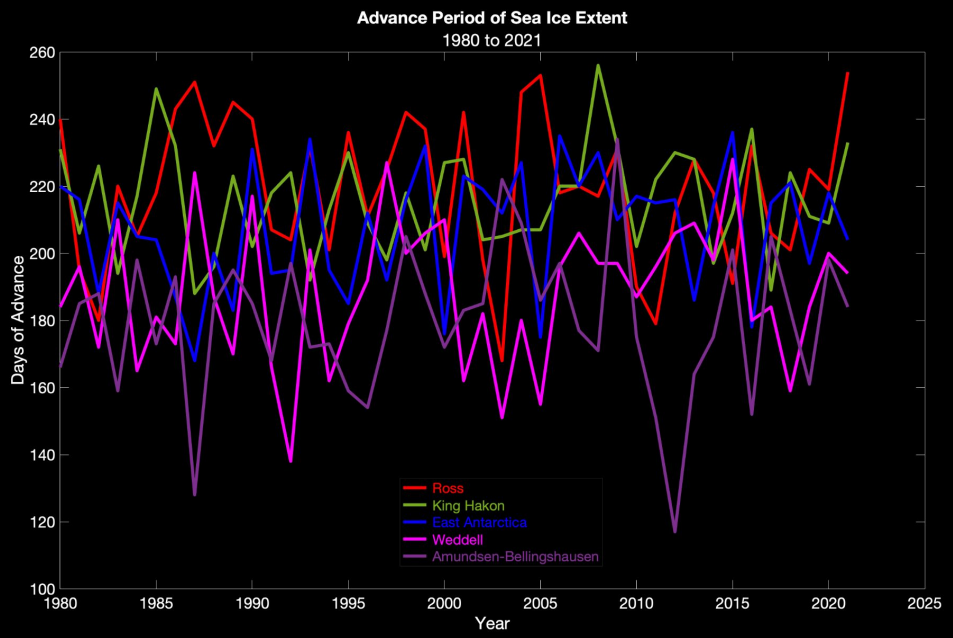
There is a small trend toward an earlier day of advance, while day of retreat remains relatively constant. There is a longer period under growing ice.

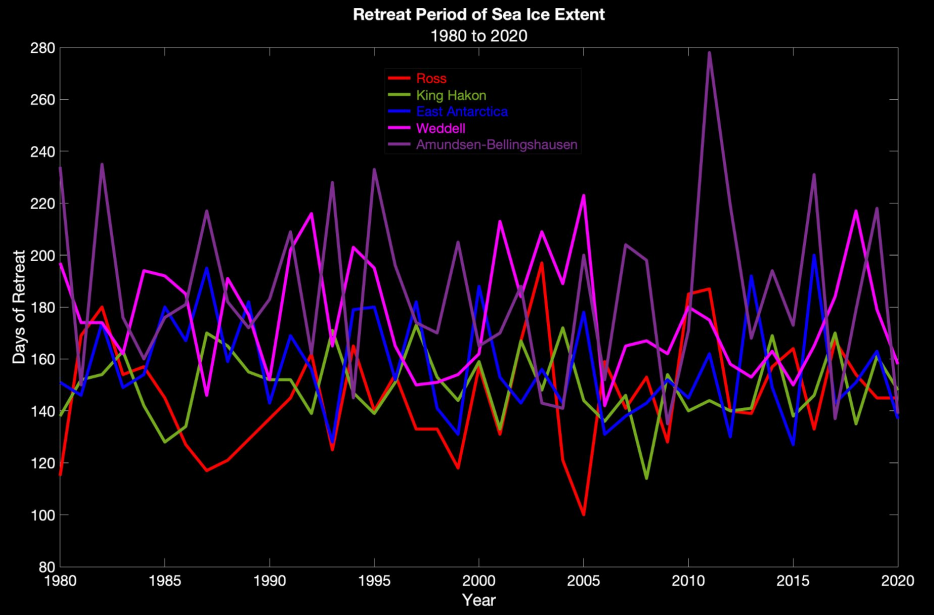
# Intra-Regional Relationships Summary

- Advance period is increasing in three regions: East Antarctica, the Weddell, and the Amundsen-Bellingshausen Seas.
- The advance and retreat period in the Ross Sea has remained relatively constant from 1980 to 2021, and constant in the King Hakon Sea since 2015.

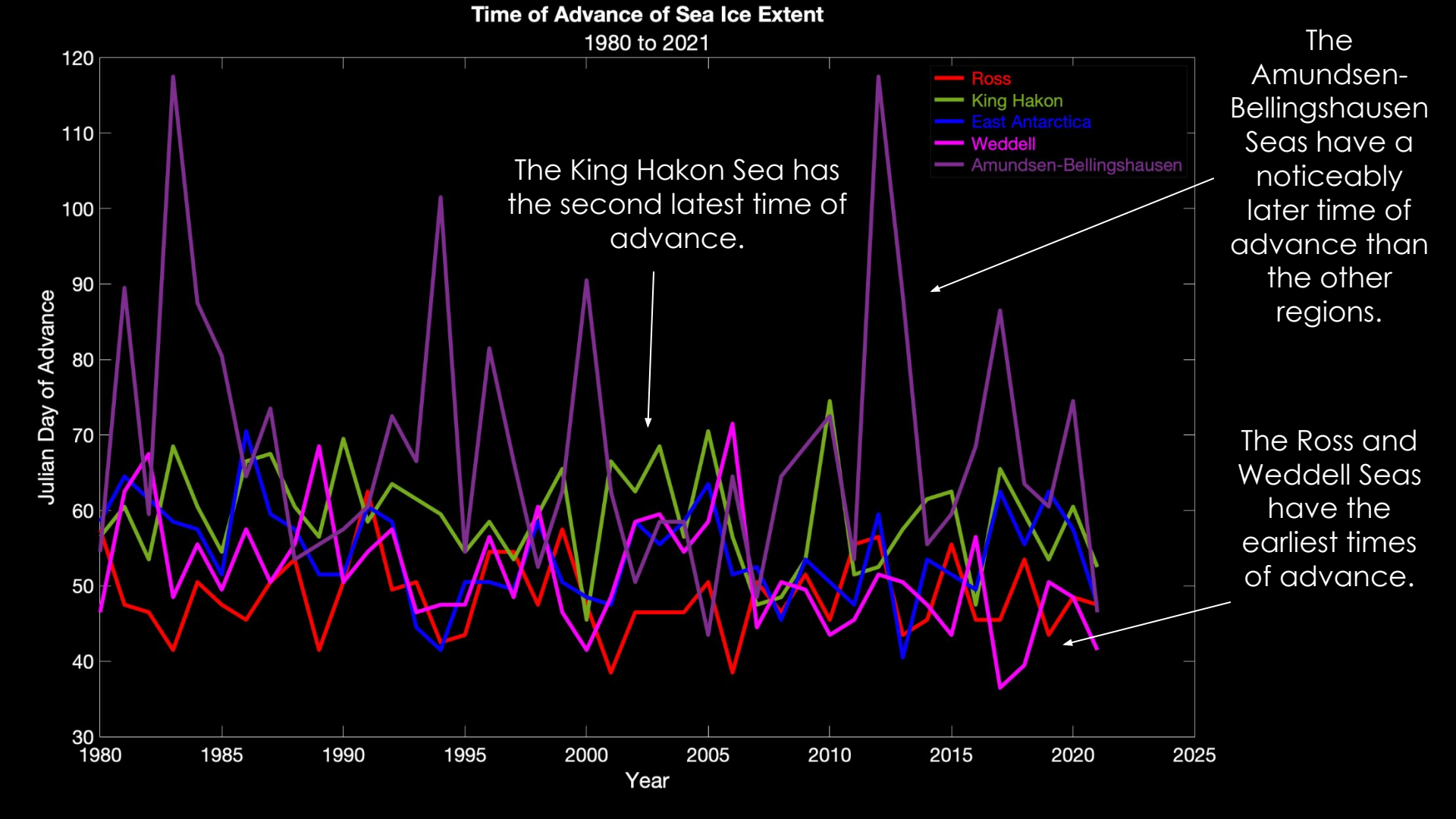
# Inter-Regional Relationships

*Analyzing time of retreat and advance, and retreat and advance periods, across the five Antarctic regions*



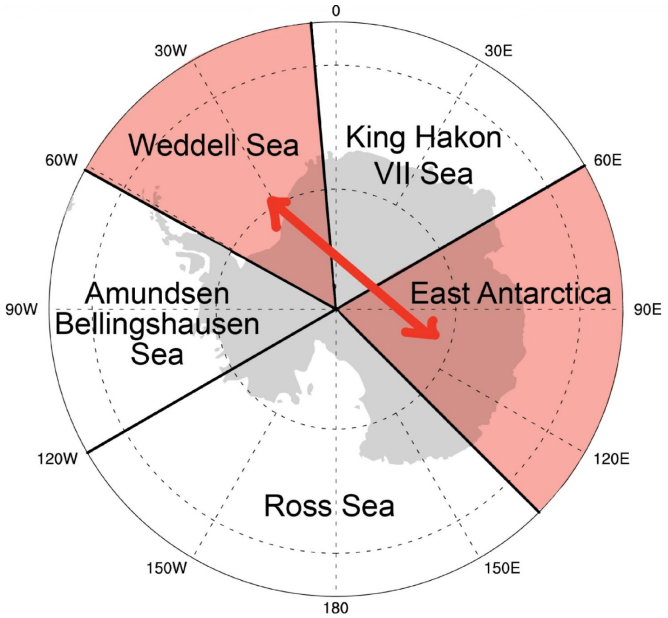

No significant correlations occurred across regions for advance and retreat periods.


Time of Advance of Sea Ice Extent
1980 to 2021
Julian Day of Advance
Year
Ross
King Hakon
East Antarctica
Weddell
Amundsen-Bellingshausen
The King Hakon Sea has the second latest time of advance.
The Amundsen-Bellingshausen Seas have a noticeably later time of advance than the other regions.
The Ross and Weddell Seas have the earliest times of advance.

# Time of Advance Correlation

Lag = 0

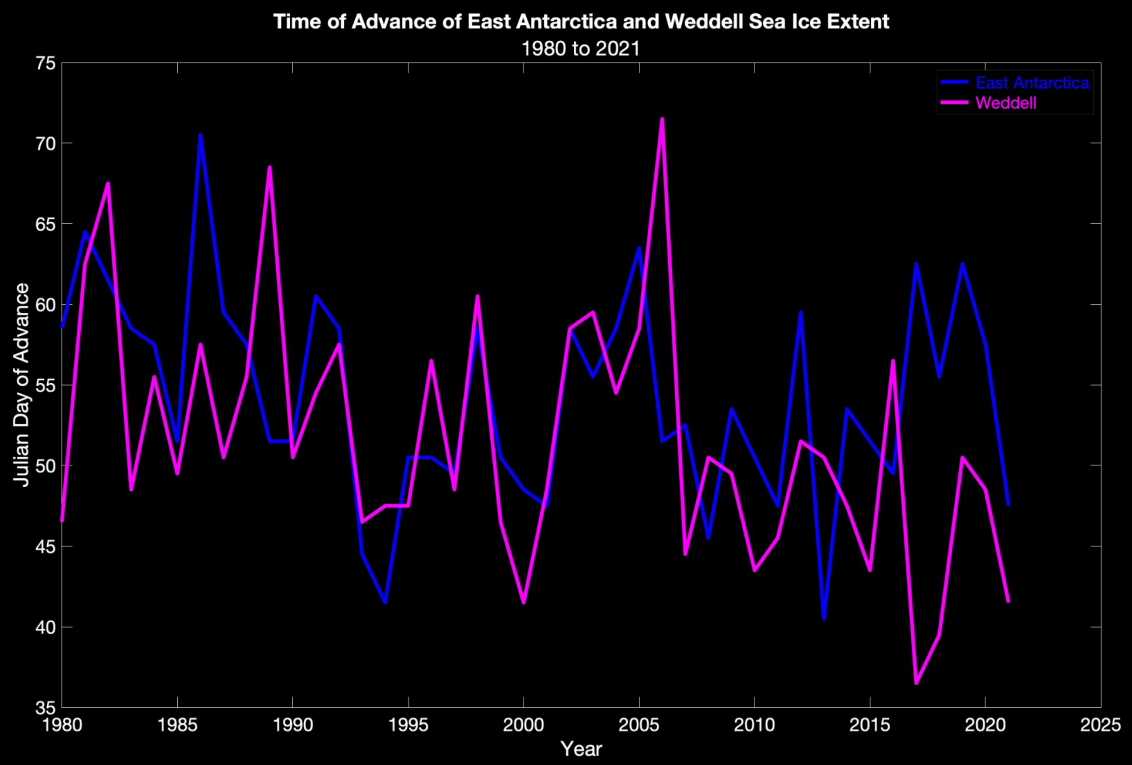
Red = Positive Correlation Coefficient



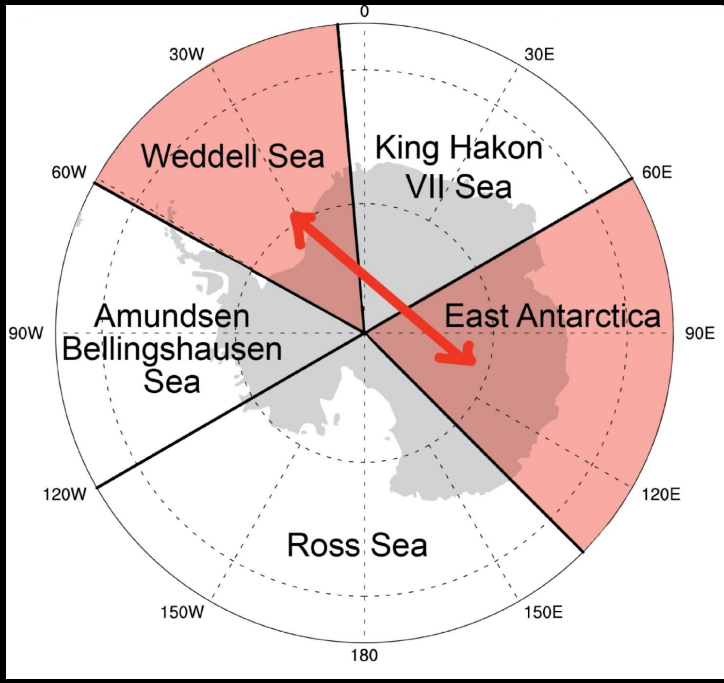

Since the Weddell Sea and East Antarctica are not adjacent to each other, this correlation must be due to larger-scale atmospheric and/or oceanic effects, rather than local-scale effects.

# Time of Advance

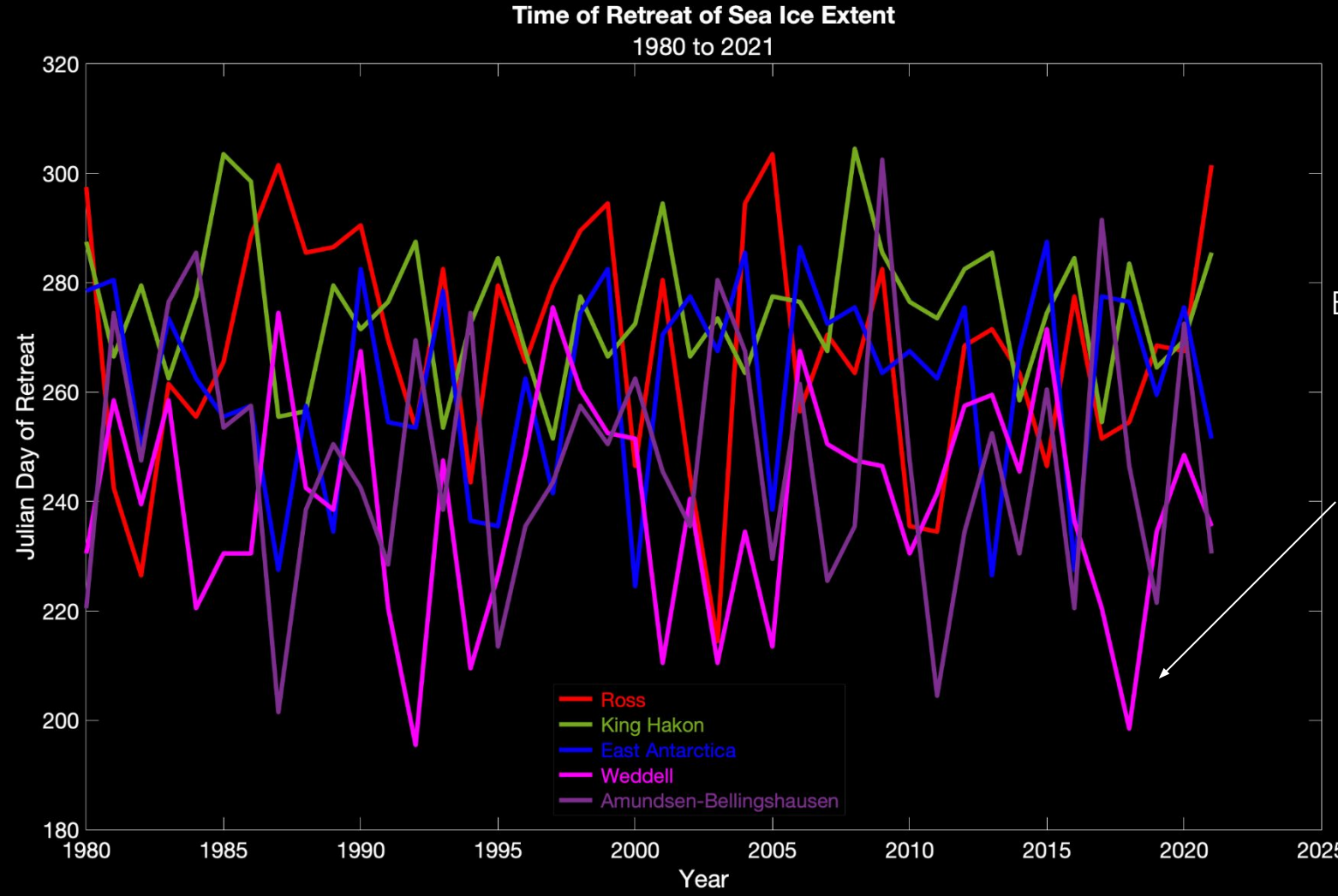
## East Antarctica & the Weddell Seas




Lag = 0




Sea ice extent in East Antarctica and the Weddell Sea tend to advance at the same time.

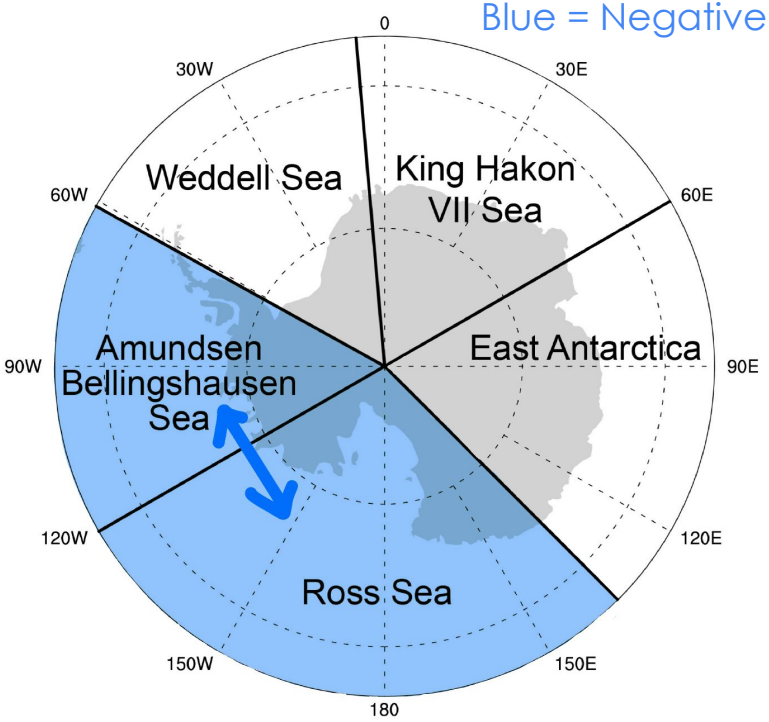


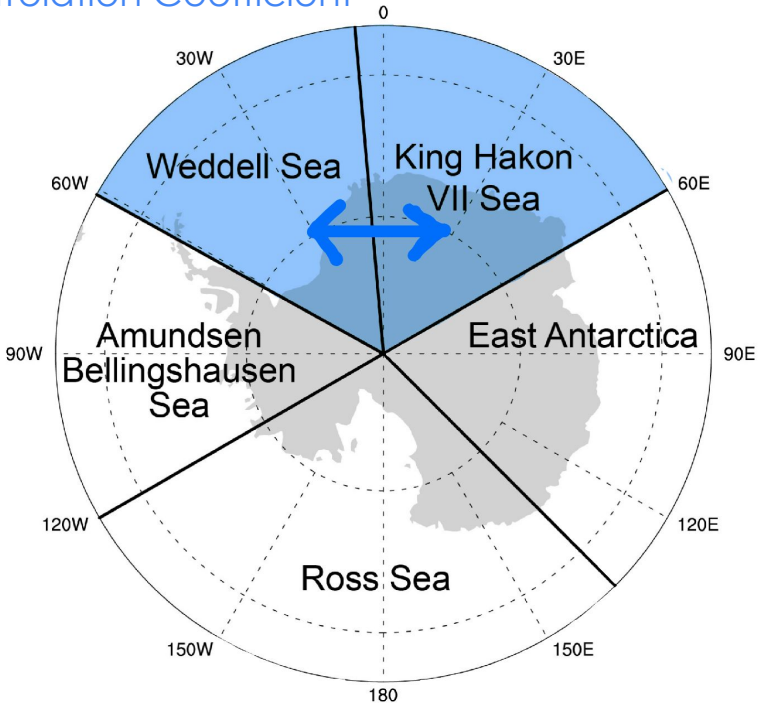

The Weddell and Bellingshausen Seas have a noticeably earlier time of retreat than the other regions.

# Time of Retreat Correlations

Lag = 0

Blue = Negative Correlation Coefficient

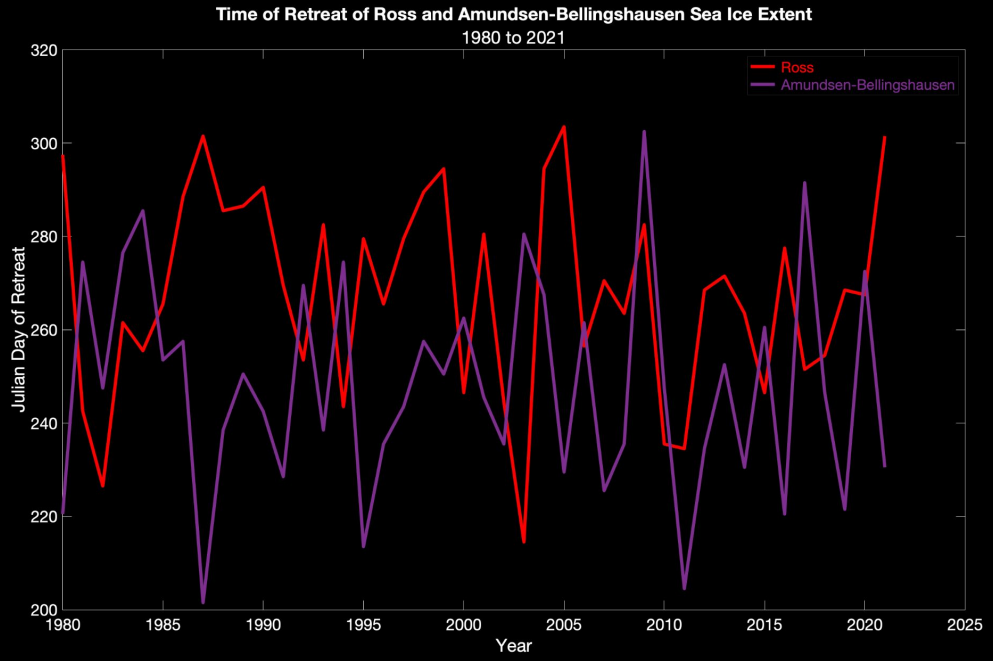


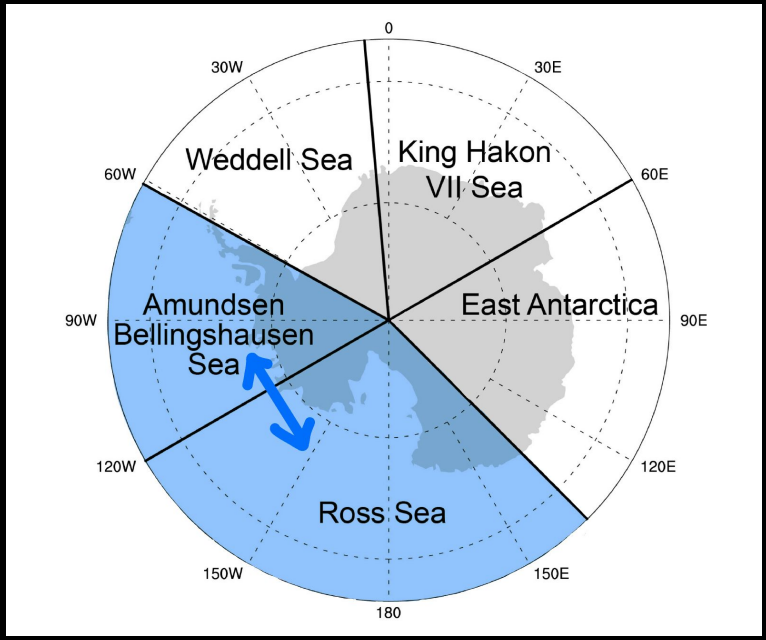

There are significant correlations between two regions adjacent to one another, implying that something is impacting these regions on the local-scale.

# Time of Retreat

## The Ross & Amundsen-Bellingshausen Seas



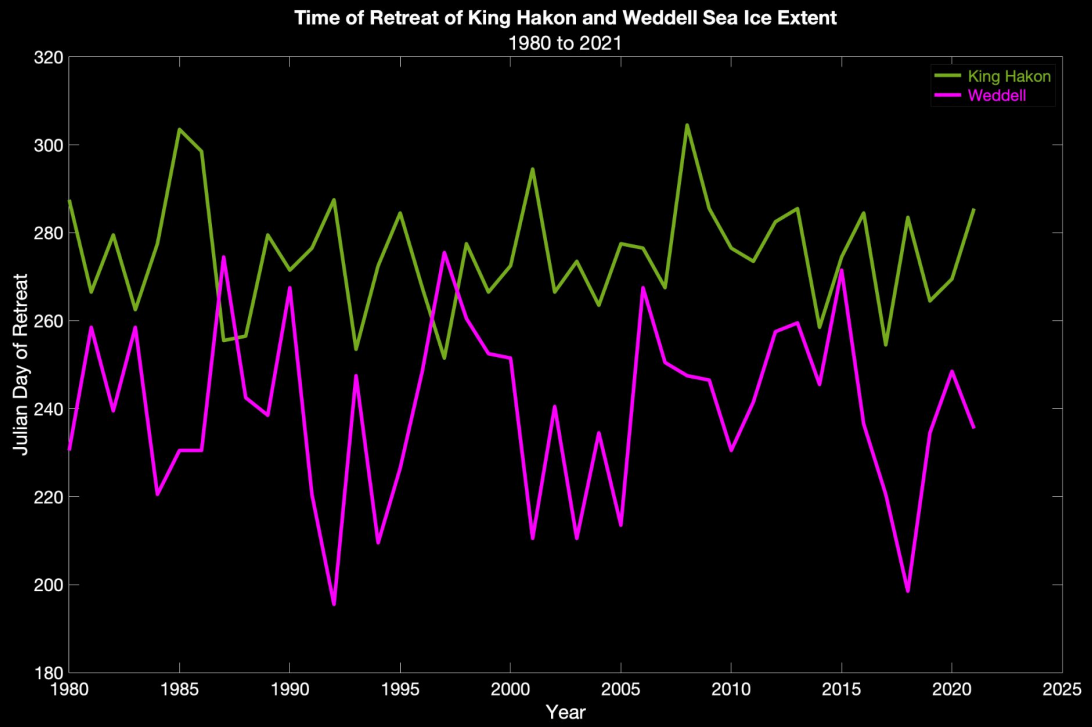

Lag = 0



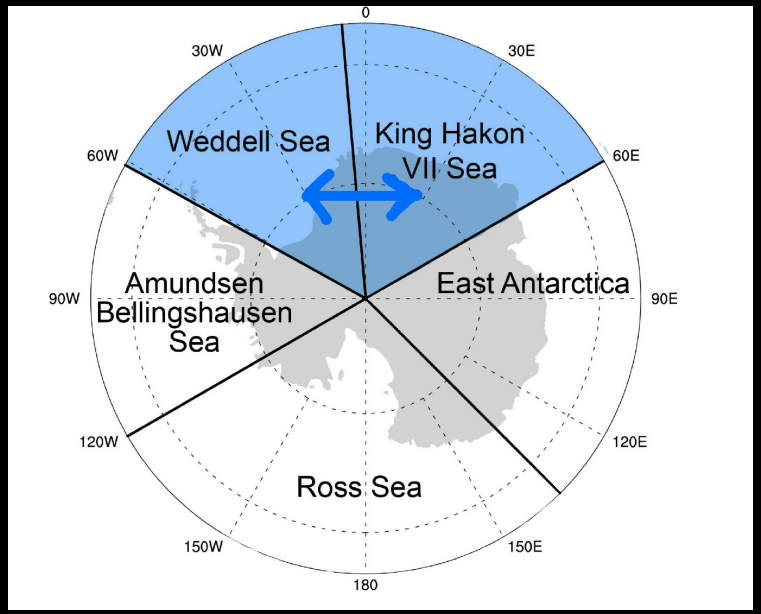

An inverse relationship between time of retreat in the Ross and Amundsen-Bellingshausen Seas is visible. As julian day of retreat becomes later in the Ross Sea, julian day of retreat becomes earlier in the Amundsen-Bellingshausen Seas (and vice versa).

# Time of Retreat

## The King Hakon & Weddell Seas




Lag = 0




An inverse relationship between time of retreat in the King Hakon and Weddell Seas is visible. As julian day of retreat becomes later in the King Hakon Sea, julian day of retreat becomes earlier in the Weddell Sea (and vice versa).

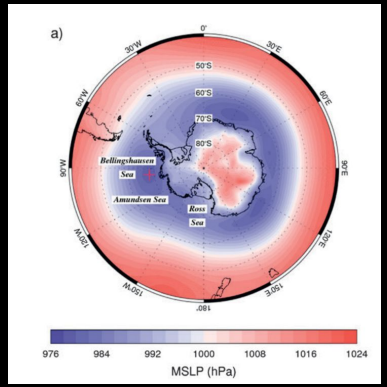
# Inter-Regional Relationships Summary

- No significant correlations were found for the retreat and advance periods across regions.
- The Weddell Sea and East Antarctica are the only regions *not in direct proximity of each other* that display a significant correlation. This implies that a large scale atmospheric and/or oceanic process can be influencing ice to advance at the same time in these regions.
- Two significant correlations were found between regions adjacent to one another, suggesting that a local-scale process is driving time of retreat to inversely vary across these regions.

# Key Results & Next Steps

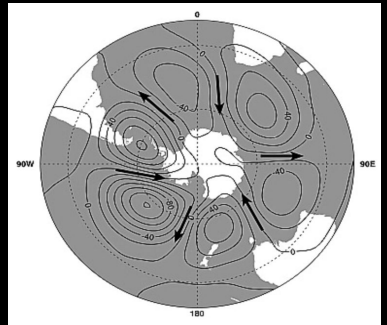
1) Time of advance in East Antarctica and the Weddell Sea is significantly and positively correlated. → ?

2) Time of retreat in the Amundsen-Bellingshausen Seas and the Ross Sea is significantly and negatively correlated. →




Raphael et al, (2016).

3) Time of retreat in the Weddell and King Hakon Seas is significantly and negatively correlated. →




Raphael, (2007).