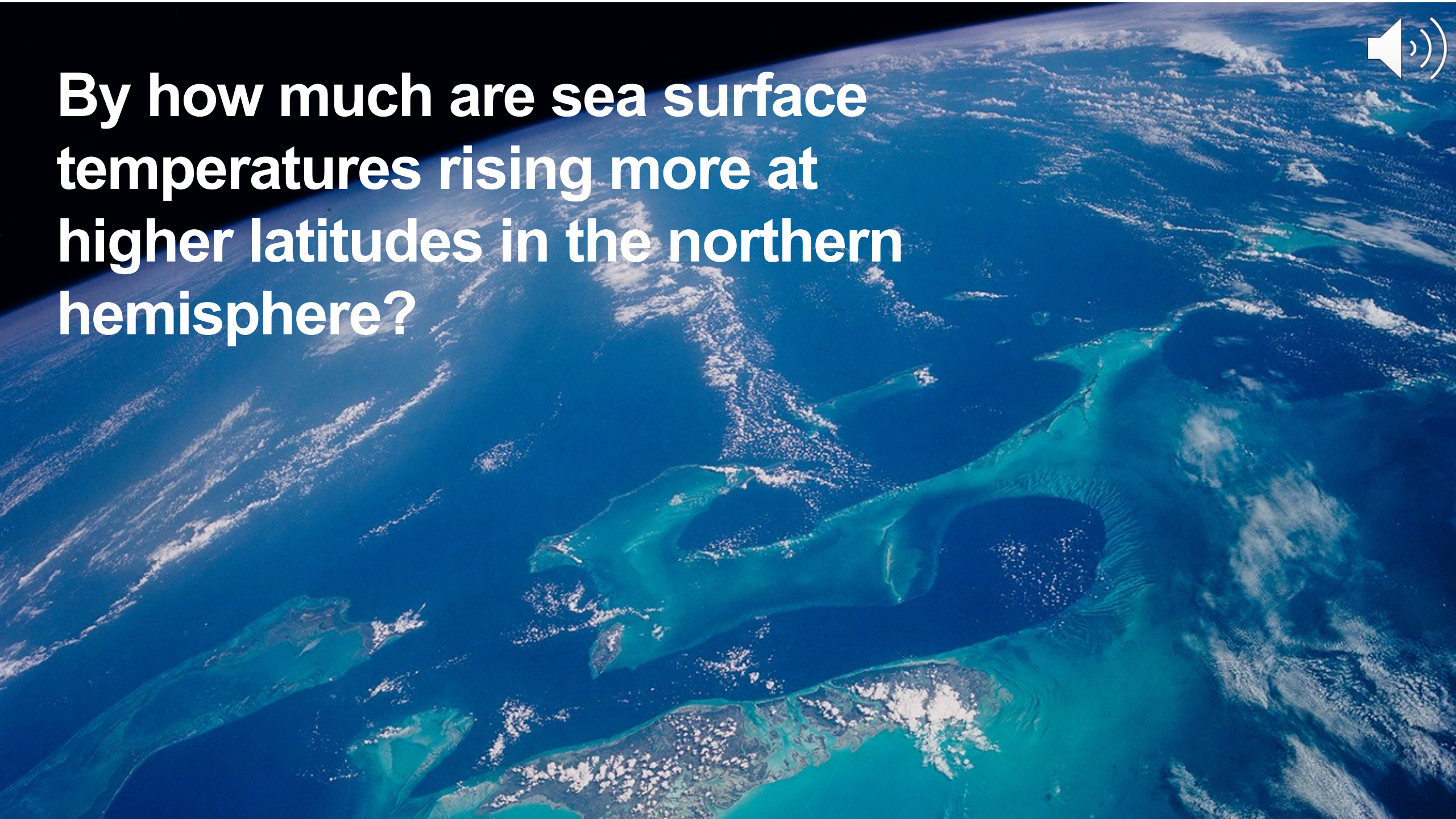


By how much are sea surface temperatures rising more at higher latitudes in the northern hemisphere?

Introduction

&

Literature review

1. IPCC, 2021

Research Questions

Primary research question : By how much are sea surface temperatures rising in high latitudes relative to lower latitudes within the northern hemisphere?

Sub research question: What factors are contributing to intensified high latitude sea surface temperature change?

Main features of the data and manipulations

- The Hadley center dataset measures sea surface temperature (SST) in Celsius (°C) and is geometrically plotted through the dimensions of longitude, latitude and time.
- The dataset calculates SST using anomalies.
- Data has been transformed and time series of differing latitude bands have been extracted for further investigation and analysis.

1. Rayner *et al.,* 2003
2. Kennedy *et al*., 2011

Results:

Sea surface temperatures are influenced by latitude

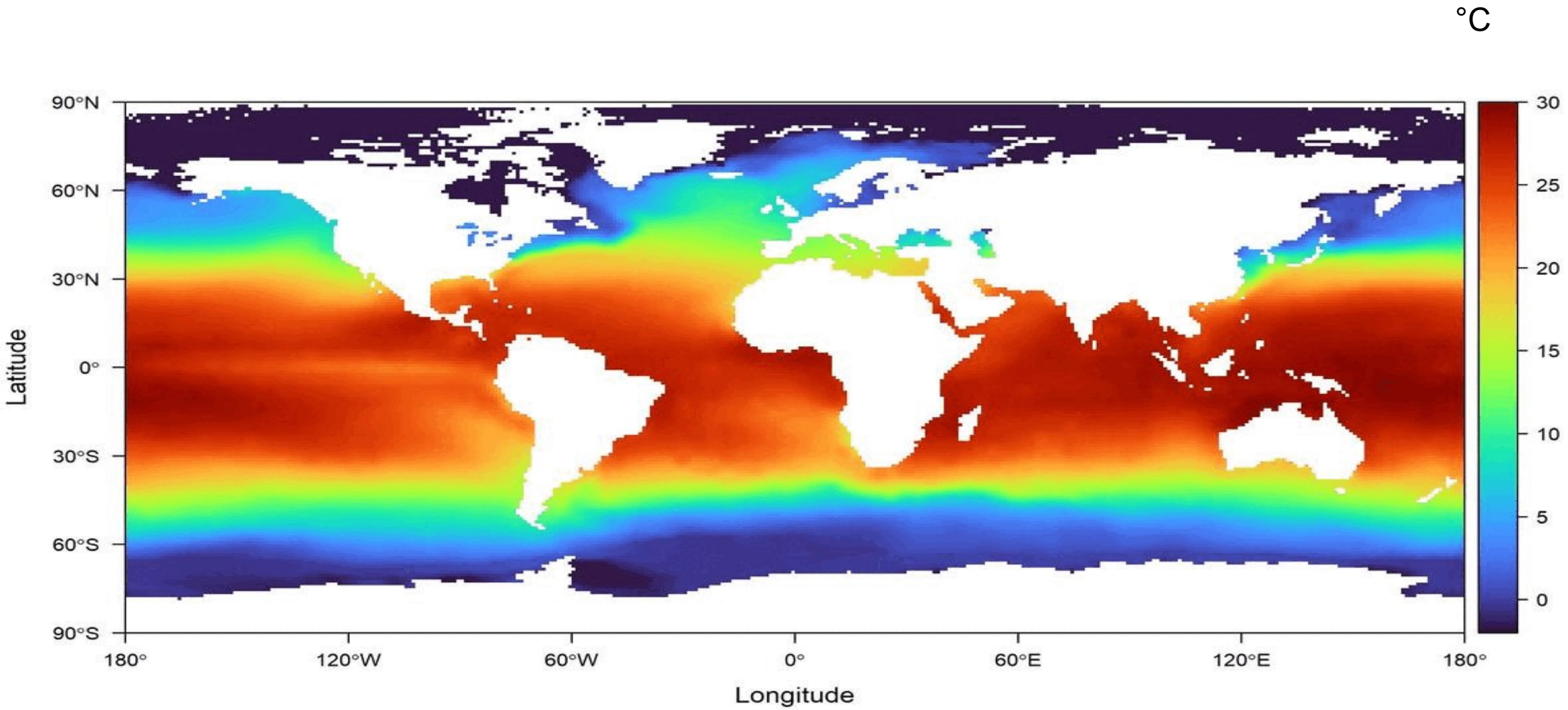


Figure 1: Global time-mean SST from 1870-2022

Globally sea surface temperatures have risen between 1870 and 2020

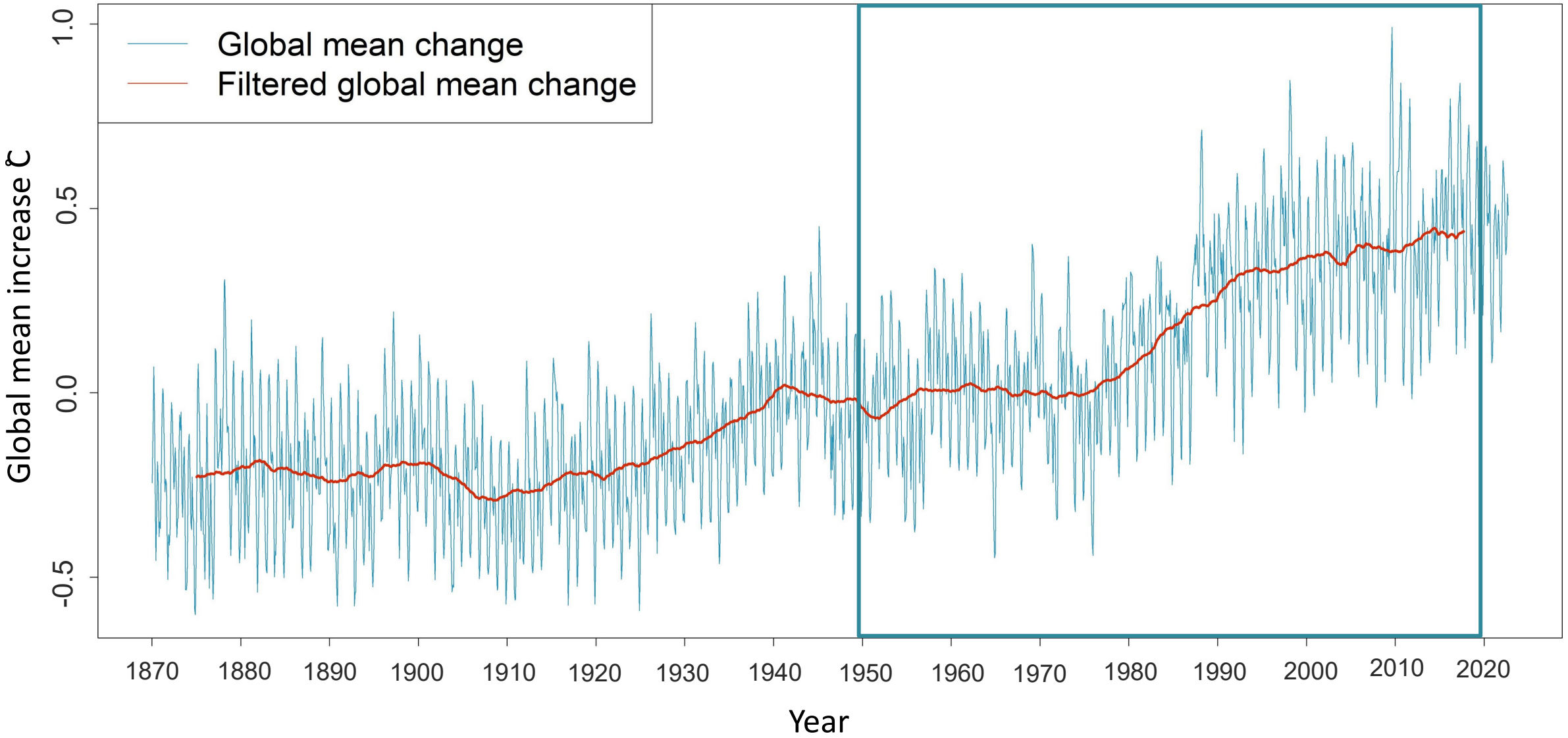
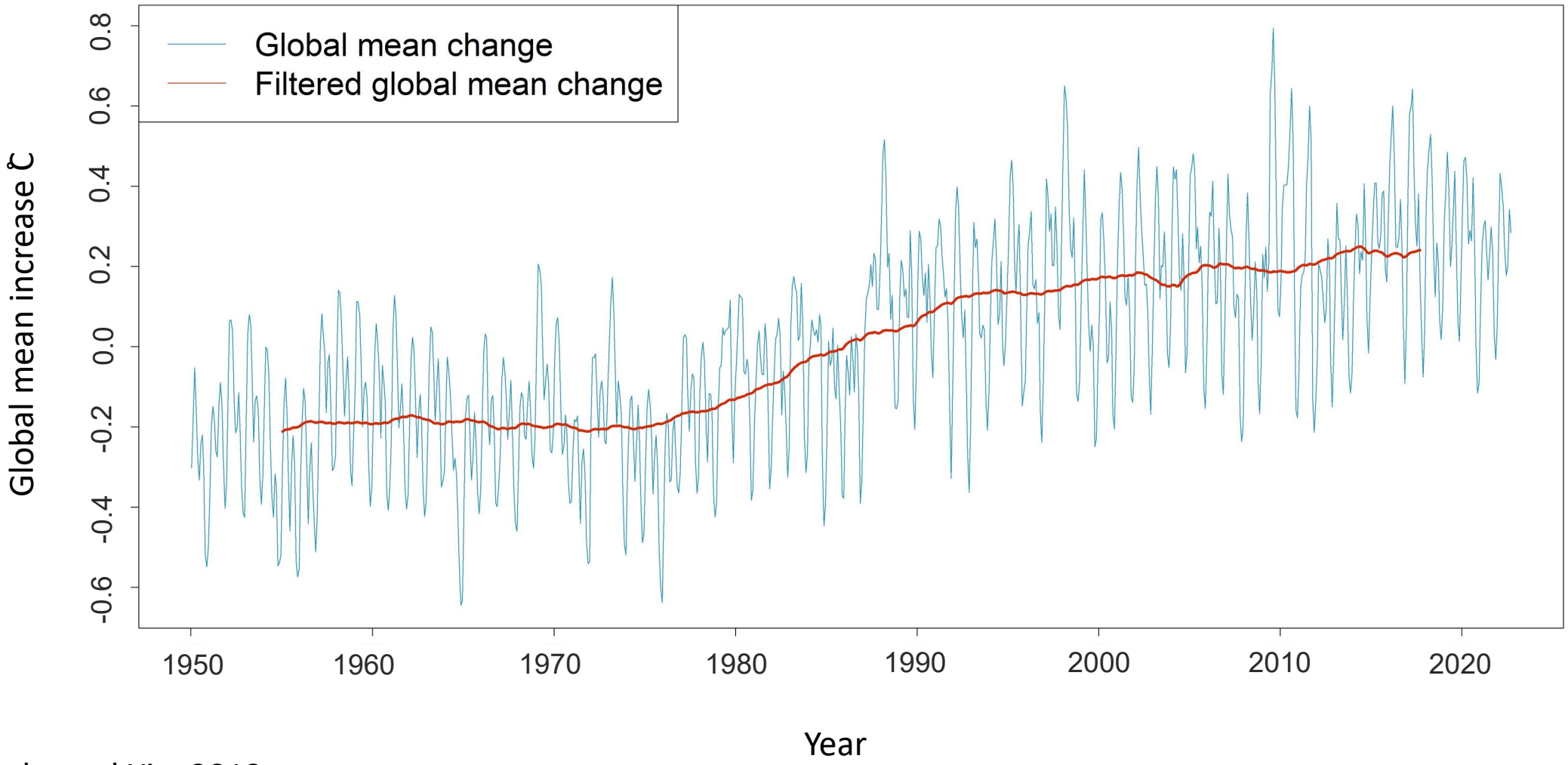


Figure 2: Global mean SST from 1870-2020 with box car filtered global mean. Data from the HadSST dataset

IPCC, 2021

Between 1950 and 2020 Sea surface temperatures increase.



1. Kosaka and Xie, 2013
2. Dai et al, 2015

Figure 3: Global mean SST since 1950-2020 and the filtered global mean

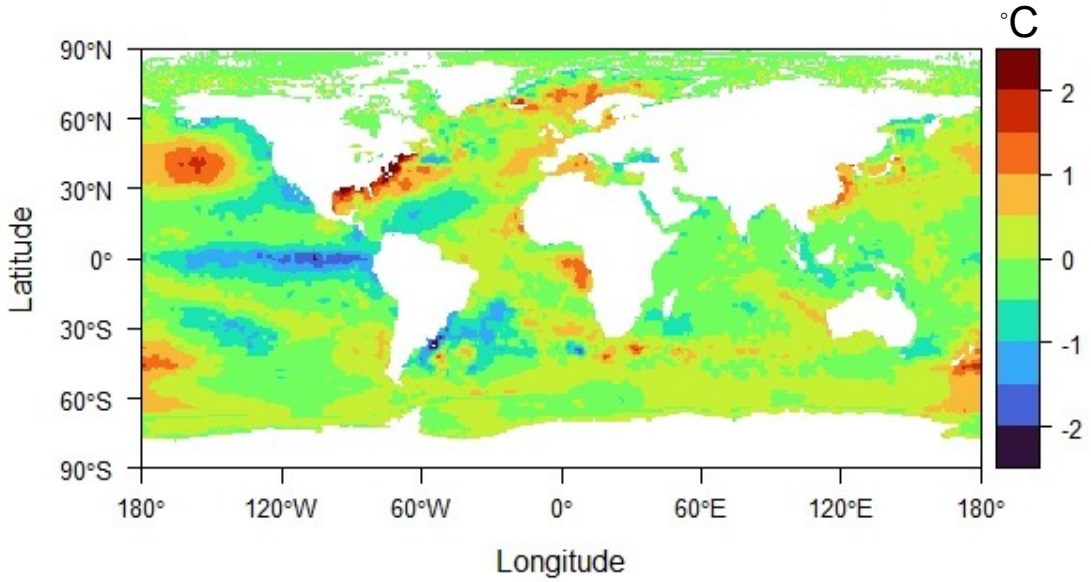


Figure 4: Anomaly time-mean of SST from January 1950

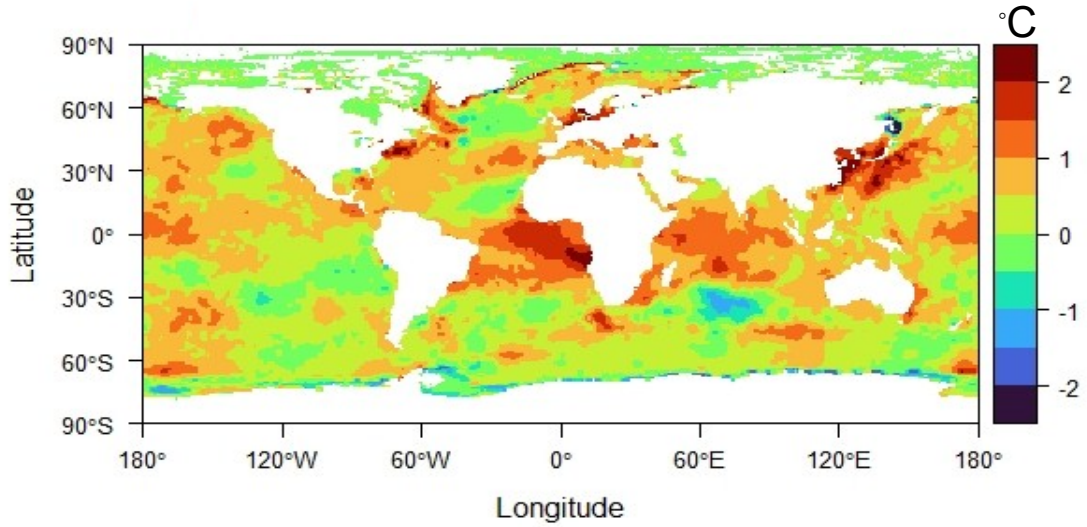


Figure 5: Anomaly time-mean of SST from January 2020

Relative to the global mean (1870-2022), temperature anomalies in *2020, compared to 1950,* are more common and occurred over a range of spatial scales.

- Increase in quantity of warming anomalies in 2020
- Non-uniform increase globally
- Majority of globe has warmed

The differences in SSTs between the 1950s and 2010s vary by latitude

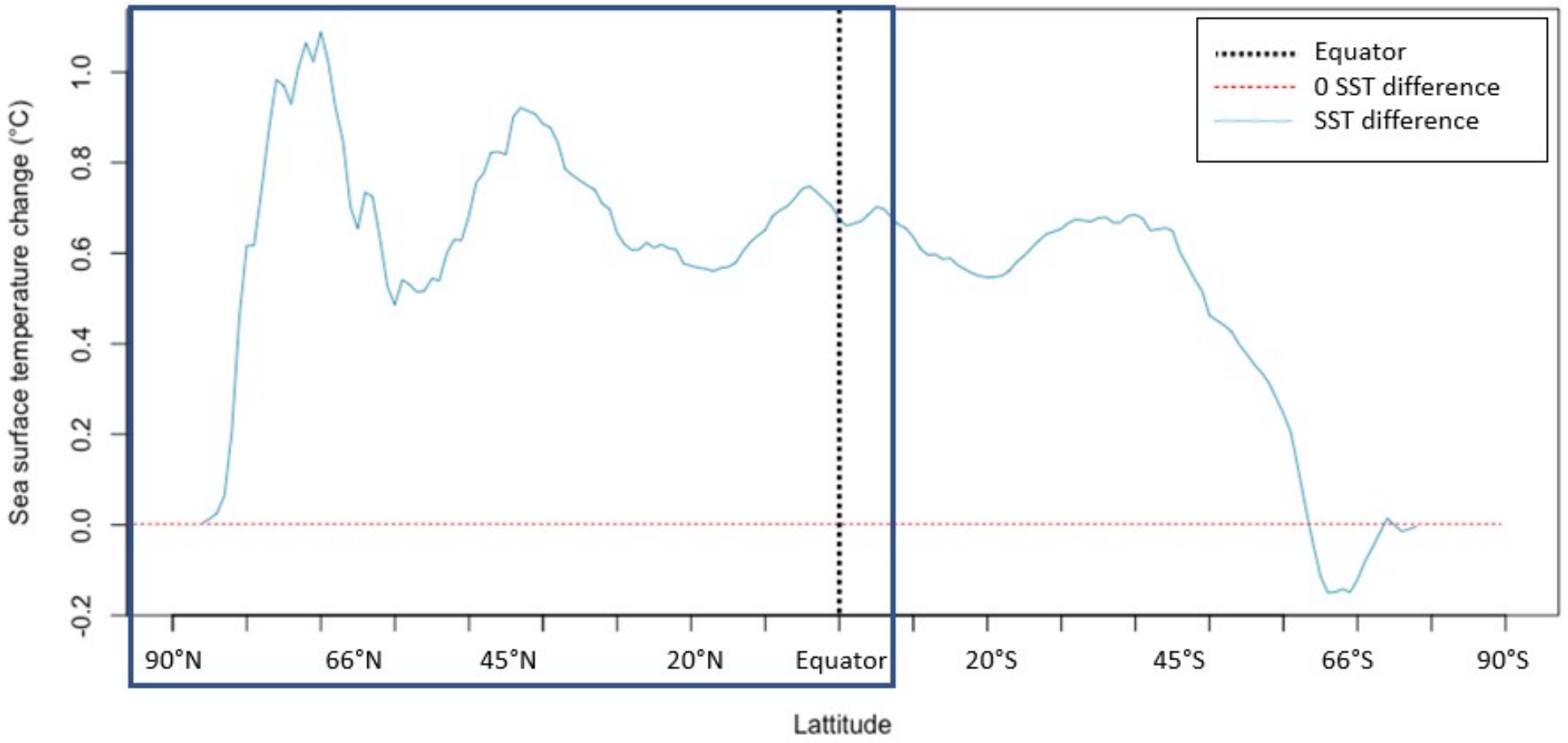


Figure 6: Change in SST between 1950-1960 and 2010-2020

SST difference changes by latitude in the northern hemisphere

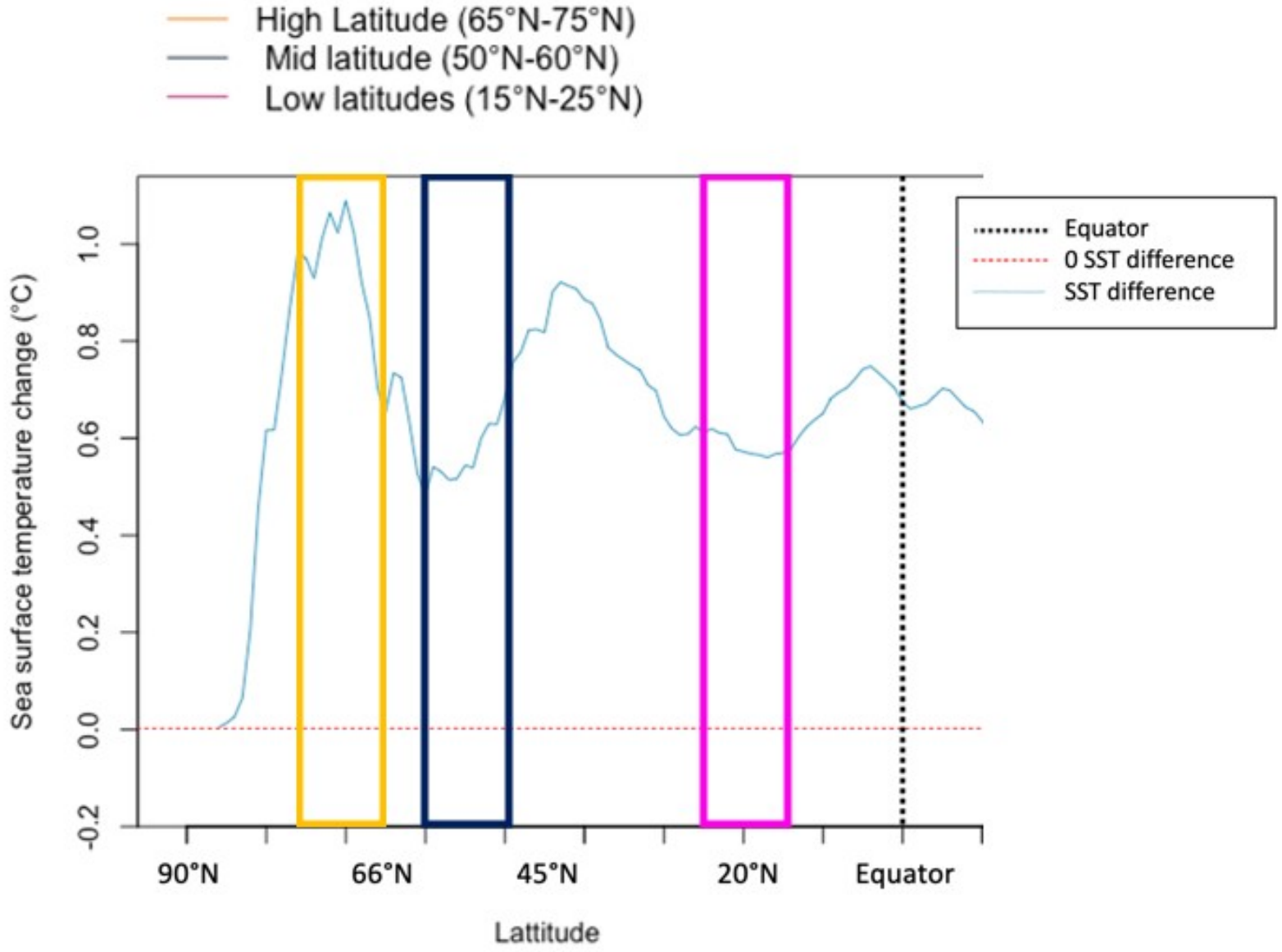


Figure 7: SST change across high, middle and low latitudes in the northern hemisphere.

SST difference changes by latitude

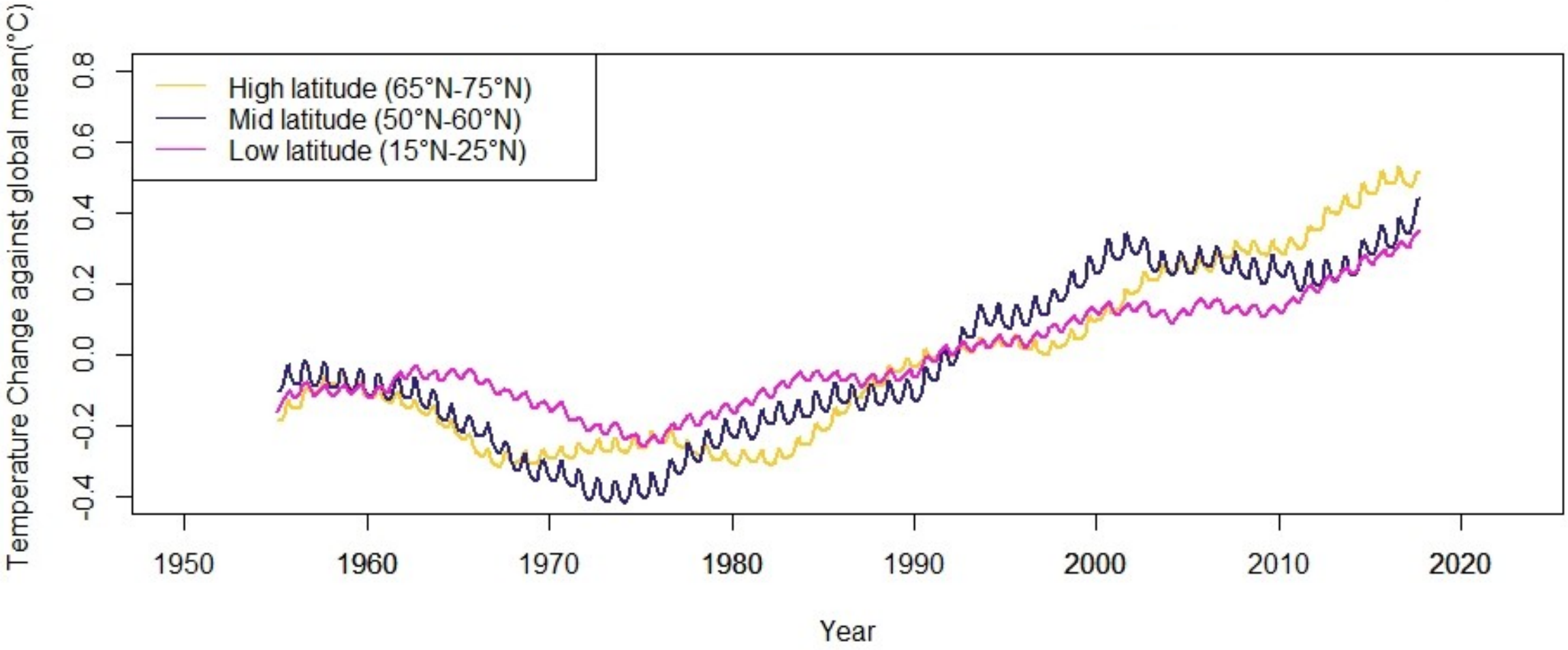


Figure 8: SST change between 1950-2020, separated across high, middle and low latitudes in the northern hemisphere.

Role of latitude in SST change

	High latitude (70°N)	Mid latitude (55°N)	Low latitude (20°N)
Surface temperature (°C)	5.306513	9.741602	27.03751
Sd	2.043171	1.956868	1.534445
Total change (°C)	0.8140894	0.4341274	0.6647101
Residual standard error (1 on 871 df)	1.818	2.577	0.6639
Multiple R-squared	0.01942	0.006636	0.05993
F-statistic	17.25	5.81	55.53
p-value	3.602e-05	0.01606	2.221e-13

Table 1: Statistical outputs from latitude points

- Between 1950 and 2020, SST rose by 0.15°C more at 70°N than at 20°N
- The largest difference between latitudes was between 55°N and 70°N with 0.35 °C more warming at 70°N

Discussion

Primary research question : By how much are sea surface temperatures rising in high latitudes relative to lower latitudes within the northern hemisphere?

Sub research question:

What factors are contributing to intensified high latitude sea surface temperature change?

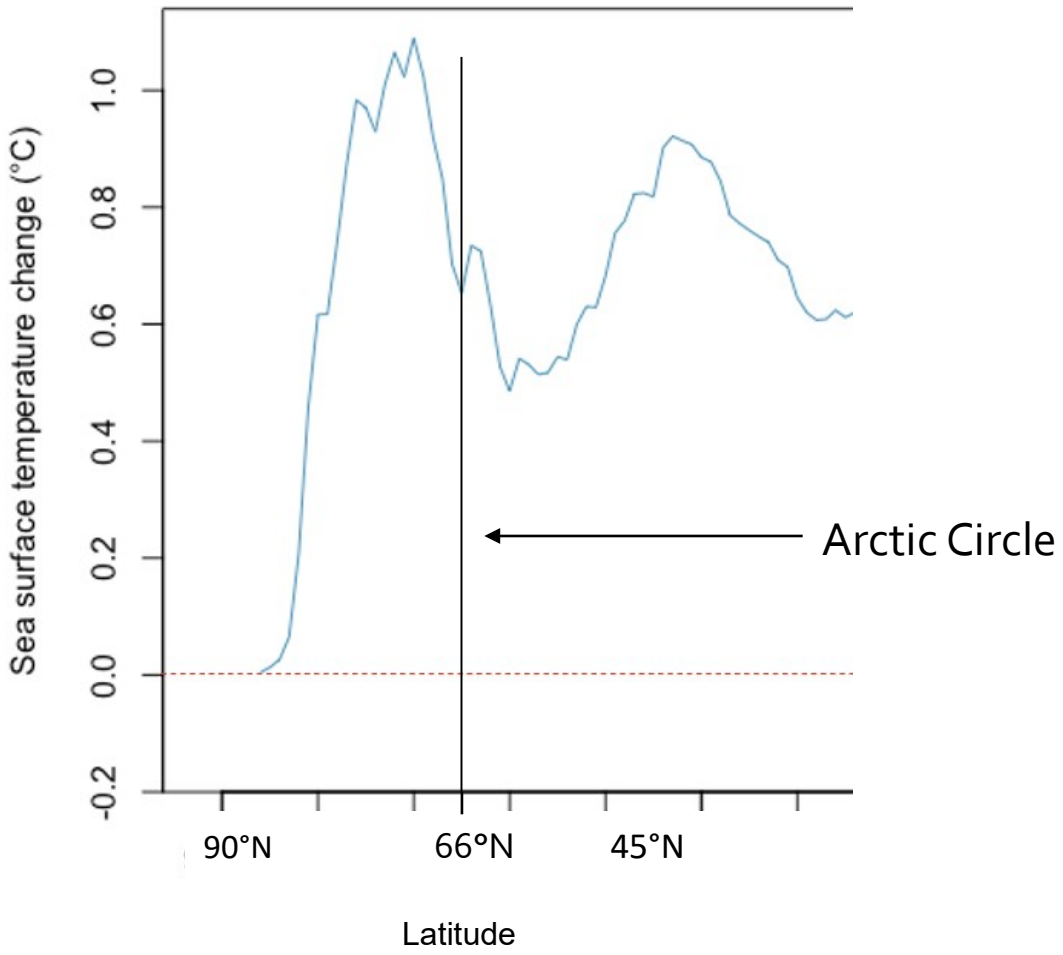


Figure 9: Snapshot of temperature change 1950-2010

1. Carvalho & Wang 2020

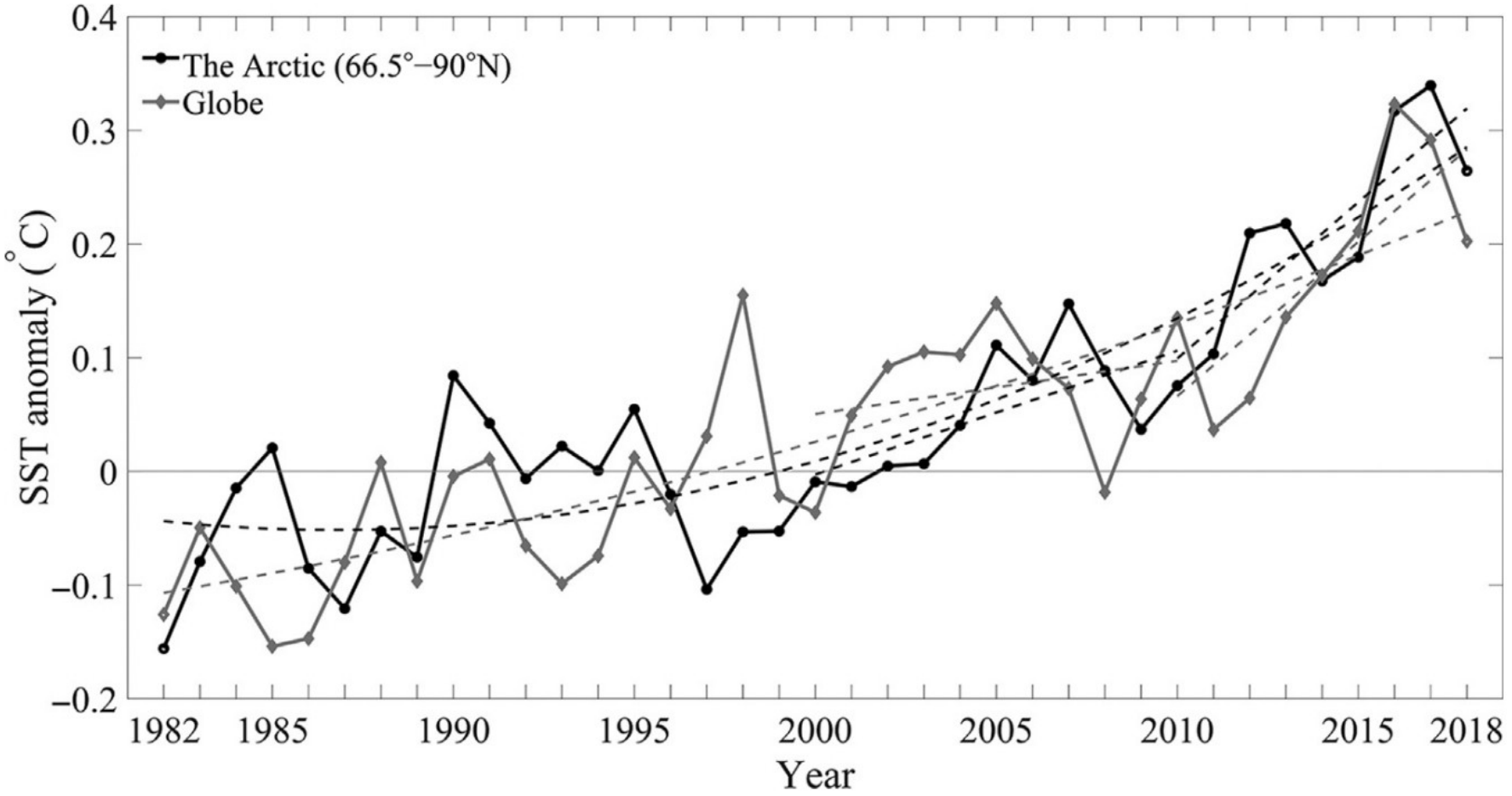


Figure 10: The anomalies of annual mean SST relative to 1982-2010 means in the Arctic and globe during 1982-2018 (Dashed lines are the fittings) (Chen et al, 2019)

Limitations

- Interpolation issues
- Points vs set of data
- Correlation not equal to causation
- Strength of seasonal variability- limits of box car

1. Rayner et al., 2003
2. Kennedy et al., 2011

Conclusion

1. Sea surface temperatures at high latitudes are rising by between 0.15°C and 0.35°C more than lower latitudes in the northern hemisphere
2. However, cannot be statistically proven due to HADISST limitations
3. This change can be attributed to Arctic Amplification and oscillations in the Northern Hemisphere
4. In the future, further research into effect of atmospheric cells on SST would expand scope

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