Climate Change in the Arctic Region from 1948 to 2018

Matt Rechenberg & Heike Hartmann, Department of Geography, Geology, and the Environment, Slippery Rock University

Introduction

The last three decades show successively warmer temperatures at Earth's surface while the Northern Hemisphere has experienced its warmest 30-year period in the past 1400 years (IPPC 2014). Air and ocean warming results in greater induced stress on Arctic sea ice which has continued to decrease in recent years (Rothrock 1999). In this study we analyzed and interpreted Arctic region air and sea surface temperatures (SST) and ice data to see if we can verify and quantify a warming trend.

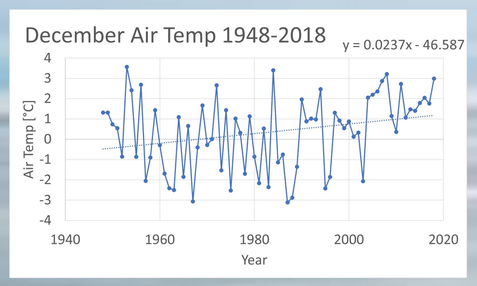
Materials

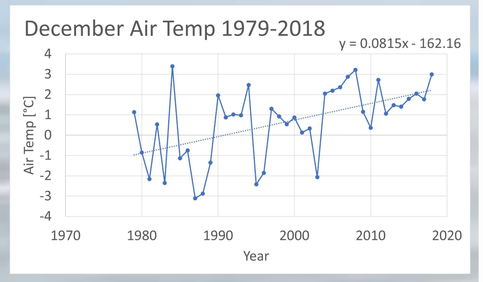
- COBE-SST2 and Sea-Ice
- NCEP/NCAR Reanalysis 1

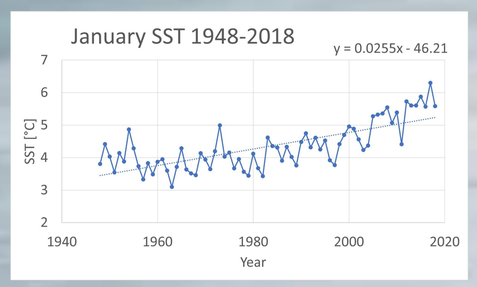
Provided by the NOAA/OAR/ESRL PSL and used for the period from 1948 to 2018.

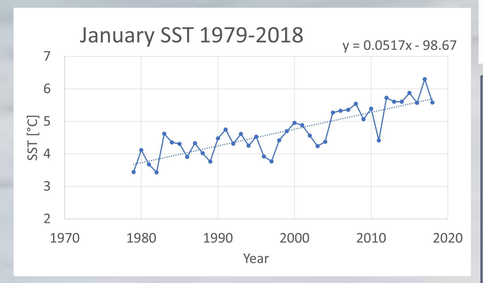
Methods

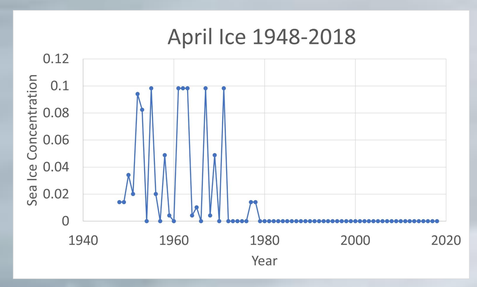
The COBE-SST2 and Sea Ice dataset was regridded to match the spatial resolution of NCEP/NCAR Reanalysis at 2.5°. In ArcMap, eight raster sea-ice concentration layers were created using a North Pole orthographic projection to display the changes over time. The changes were observed over two separate time periods, from 1948-2018 and from 1979-2018. One cell experiencing significant change was chosen to further analyze: the grid cell centered on 72.5° North and 22.5° West. For this grid cell, a time series of air temperature, SST, and ice concentration was extracted and analyzed in Excel.

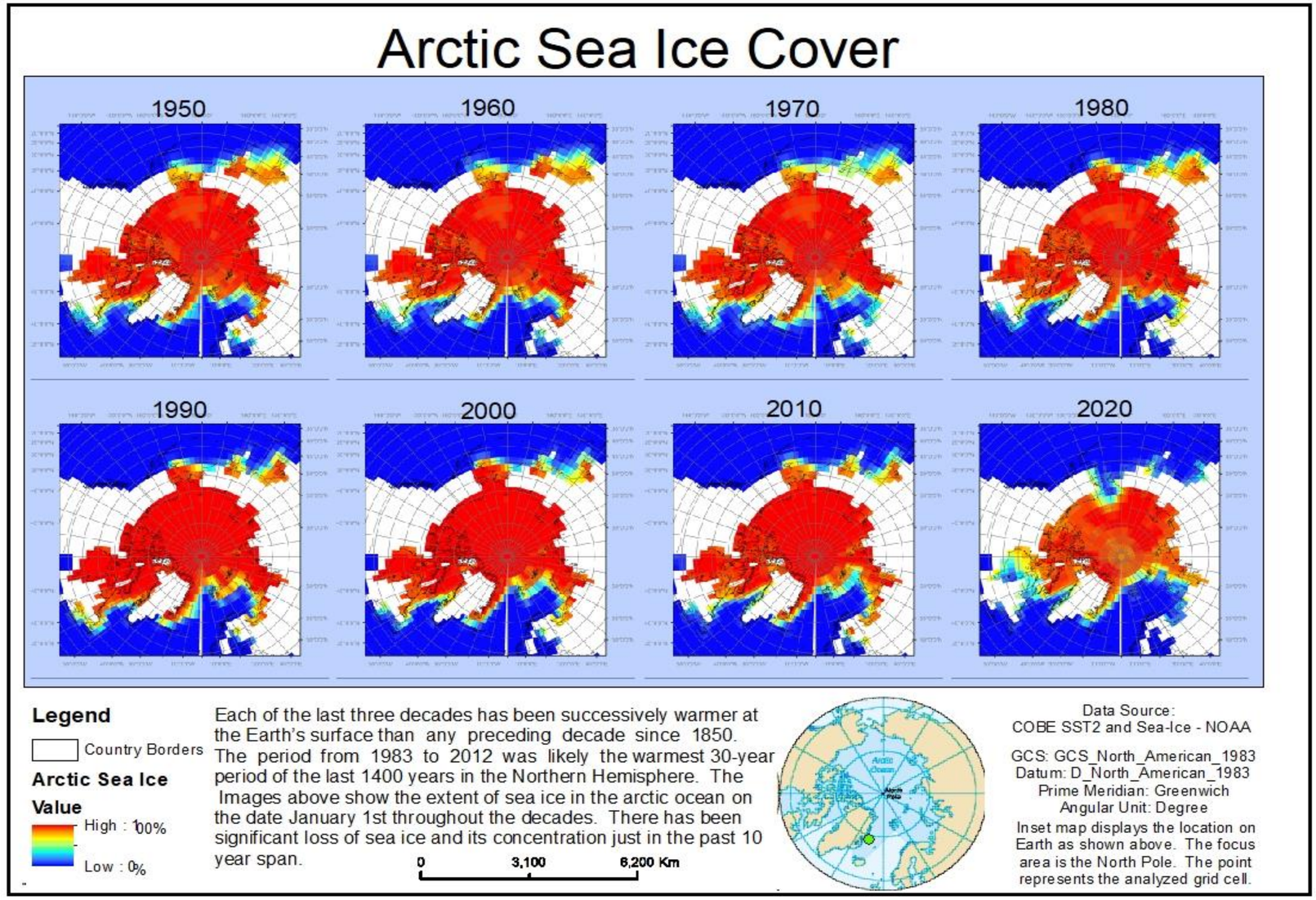












Results

The average monthly air temperature and SST show an increase over time with the strongest trend occurring in winter months between 1979 and 2018. During this period, January SST has increased by 0.5°C per 10 years and December air temperature has increased by 0.8°C per 10 years. Increasing trends in air temperature and SST have been observed in all months. Sea-ice concentration has decreased between 1948 and 1980 and since 1980 there has been no ice existent in this grid cell at all. April shows the most apparent decline in sea ice concentration while from June to October generally no ice has been present in this grid cell.

Discussion

The Greenland Sea typically sees its minimum ice extent in September and its maximum in March (Parkinson 1999). In our study, the month showing the strongest decrease was April. This is likely due to an increase in global, regional, and local air and water temperatures which causes shorter springs and longer summers (Land Trust Aliance 2015). Therefore, greater melting occurs directly after the maximum ice extent in early spring. This warming does not only affect the ice extent but also the ice thickness. Rothrock et al. (1999) found that the average ice thickness across the Arctic Sea is over a meter thinner than two to four decades prior. About 33-38% of the observed decline in Arctic sea ice in September from 1953 to 2006 is attributed to greenhouse gas forcing, growing to 47-57% from 1979 to 2006 (Stroeve et al. 2007). A continual rise in global temperatures will cause sea-ice to melt and contribute to rising ocean levels, ocean currents to alter, ocean acidity to increase, ecosystems to change as we know them, among others with extensive effects on the environment and ourselves.

References

- Intergovernmental Panel on Climate Change (IPCC) (2014). Climate Change 2014 Synthesis Report: Summary for Policymakers. Retrieved March 30, 2021, from http://www.ipcc.ch/pdf/assessmentreport/ar5/syr/AR5_SYR_FINAL_SPM.pdf
- Parkinson, C. L., Cavalieri, D. J., Gloersen, P., Zwally, H. J., & Comiso, J. C. (1999). Arctic sea ice extents, areas, and trends, 1978–1996. *Journal of Geophysical Research: Oceans*, *104*(C9), 20837-20856.
- Rothrock, D. A., Yu, Y., & Maykut, G. A. (1999). Thinning of the Arctic sea-ice cover. *Geophysical Research Letters*, *26*(23), 3469-3472.
- Land Trust Alliance. (2015, July 04). Climate Impacts on Shifting Seasons. Retrieved March 30, 2021, from https://climatechange.lta.org/climate-impacts/
- Stroeve, J., Holland, M. M., Meier, W., Scambos, T., & Serreze, M. (2007). Arctic sea ice decline: Faster than forecast. *Geophysical Research Letters*, *34*, L09501.