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Variations in Satellite Derived Sea Ice and Snow Coverage in the Arctic

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Introduction

This work is an investigation on the variations of satellite derived sea ice and snow cover extents in the Arctic region from 1979-2012. The NASA Making Earth System Data Records for Use in Research Environments (MEaSUREs) Hemisphere Snow and Ice Earth System Data Record is examined in order to find variations of Northern Hemispheric sea ice and snow cover extents and impacts each extent may have not only on one another as well as the changing atmospheric conditions over the study period. Extent patterns and extreme circumstances defined by this study are identified in order for future studies to examine the atmospheric conditions.

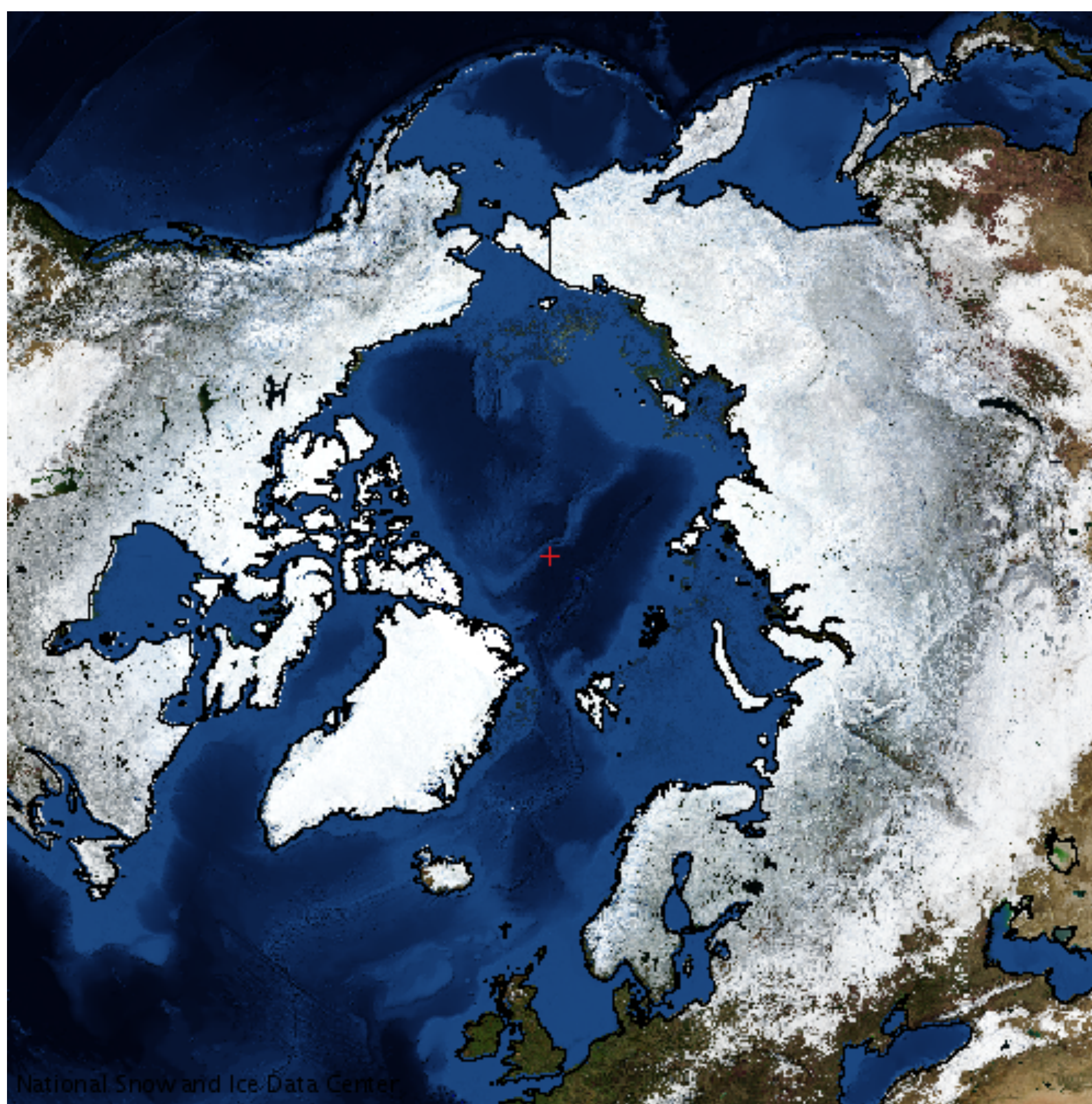


Figure 1. Spatial Map of the Northern Hemisphere
<https://nsidc.org/>

Methods

The MEaSUREs cryospheric dataset is gridded to the EASE-II grid, enabling straightforward evaluations of snow and sea ice coverage in a uniform manner that heretofore has not been available. Therefore, total areal extent of land snow and sea ice, or “cryototal” has been calculated between 1979 and 2012 (Figure 1). Areas not included in the cryototal values included fresh water lakes as well as the Greenland Ice Sheet. The annual cryototal is predominately driven by the snow cover in the winter period and the sea ice cover in the summer period, even though there are variations in the both extents throughout the year.

Results

Through the examination of the 33 year study period of sea ice and snow cover extents in the Northern Hemisphere, it appears that the extent values seem to be very constant, despite the knowledge that these conditions have been considerably changing over the years (Figure 2). This is mainly due to the fact that solar radiation, ocean currents and geographic regions make it very difficult for dramatic changes in magnitude, positive or negative, in either snow or sea ice extents to occur. Even the smallest changes in sea ice and snow cover amounts can have significant impacts on the Earth’s energy balance. The maximum cryototal extents are determined by taking the maximum daily/weekly area between the 1 January and 1 June. The maximum cryototal extent is approximately 62 million km², occurring in late January through February during the study period. The snow coverage maximum extent is around 47 million km² and the sea ice extent would be just under 16 million km². The maximum area for both sea ice and snow cover has not changed significantly over the time period, however, for both parameters the date of maximum extent occurrence has been observed later in the year over the study period. With a later date of maximum extent, the length of the snow or ice cover season would be expected to be longer (Figure 3). On the contrary, the length of season appears almost constant.

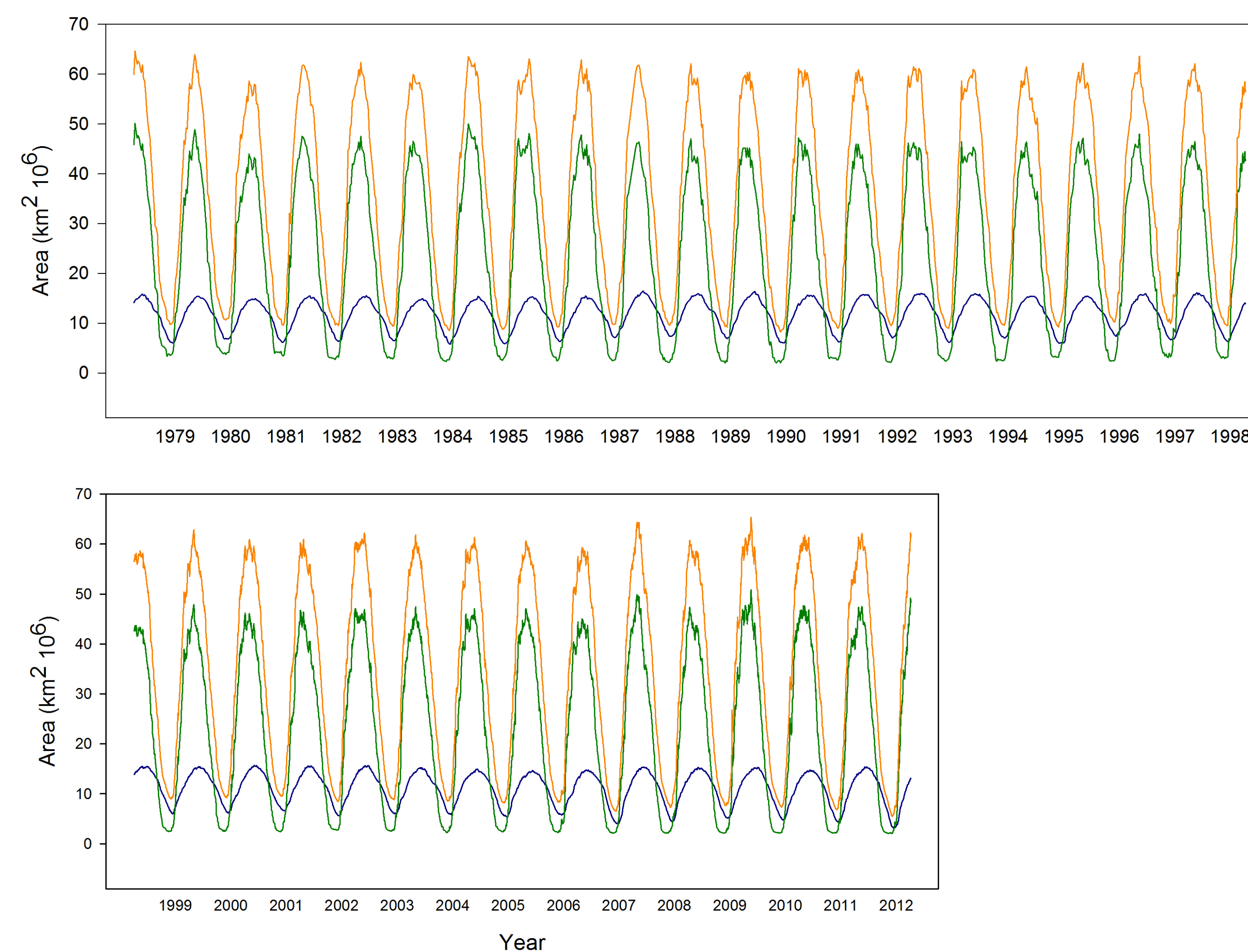


Figure 2. Area of coverage for cryototal (orange), snow cover (green), and sea ice (blue)

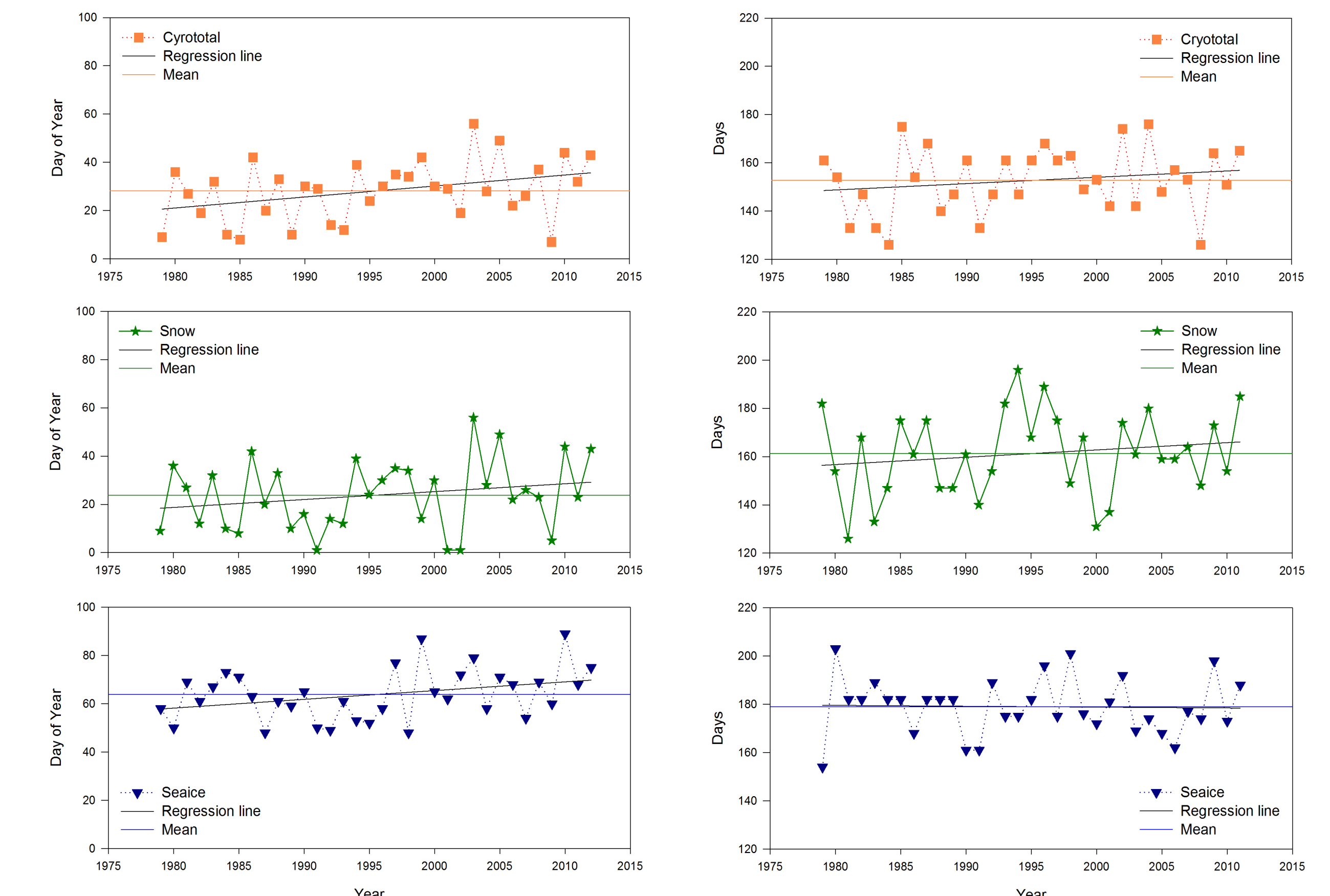


Figure 3. Date of maximum cryototal area coverage (top left), date of maximum snow cover area coverage (middle left), date of maximum sea ice area coverage (bottom left), length of cryototal season (top right), length of snow cover season (middle right), and length of sea ice season (bottom right)

Conclusion

Conditions on Earth are continuing to change, which will have a major impact on how humans continue to inhabit the planet. This study is an opportunity to gain a better understanding of the changing climate and its impacts on how the Northern Hemisphere sea ice and snow cover extents might be varying. By studying how the Arctic has already changed from 1979 to 2012, researchers can now begin to find the effect certain atmospheric conditions are having on the sea ice and snow cover extents. Differences in the date of maximum area and season length are only some of the variables that will be studied in order to better comprehend the modifications occurring on the Earth. The alterations already seen will be used in future studies to connect the impact the Arctic has on the Earth. In the future, plans to examine the extremes in sea ice and snow cover extents to see the atmospheric conditions associated with these extremes from variables including temperature anomalies and changing Arctic oscillations.

Acknowledgments

I would like to thank my advisor, Dr. Anderson, for his assistance on this project.

References & Data Sources

NASA MEaSUREs Northern Hemisphere Snow and Ice Earth System Data Record. [1979-2012]. Boulder, Colorado USA: National Snow and Ice Data Center