Start of a Northern Hemisphere Sea Ice Climatology

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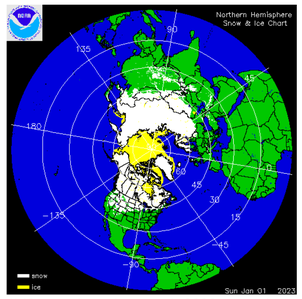
Introduction:

This project aims to create a series of climatological sea ice products for the United States National Ice Center (USNIC) using the USNIC's in-house IMS Data, or Interactive Multisensor Snow and Ice Mapping System Data. This project uses 17 years' worth of IMS data at a 4km resolution. The finalized products are to be published to the USNIC website in the future.

Background:

USNIC: The US National Ice Center, or USNIC, is tri-agency organization made up of NOAA, the U.S. Navy, and the U.S. Coast Guard. The USNIC produces daily, weekly, and monthly sea ice products that are used for navigation in Arctic waters. Products show information such as location, extent, and concentration of sea ice.

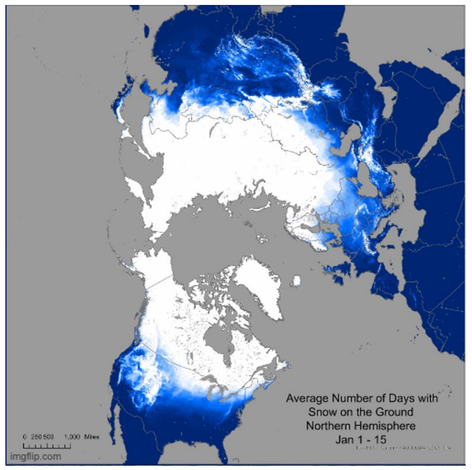
IMS Data: IMS data, or Interactive Multisensor Snow and Ice Mapping System data, is a type of data produced by the USNIC. IMS charts, created using a combination of products such as satellite imagery, radar, and ground station data, are daily snow and sea ice cover charts in 24km, 4km, and 1km resolutions. For this project, 4km daily IMS charts from 2006-2022 were used.



IMS chart from January 1, 2023, taken from USNIC website.

Project Motivation:

- Snow climatology already exists from a previous internship.
- IMS data of the Northern Hemisphere, including both snow and sea ice data, is increasing in longevity.
- Research and Department of Defense requests for a sea ice climatology product.



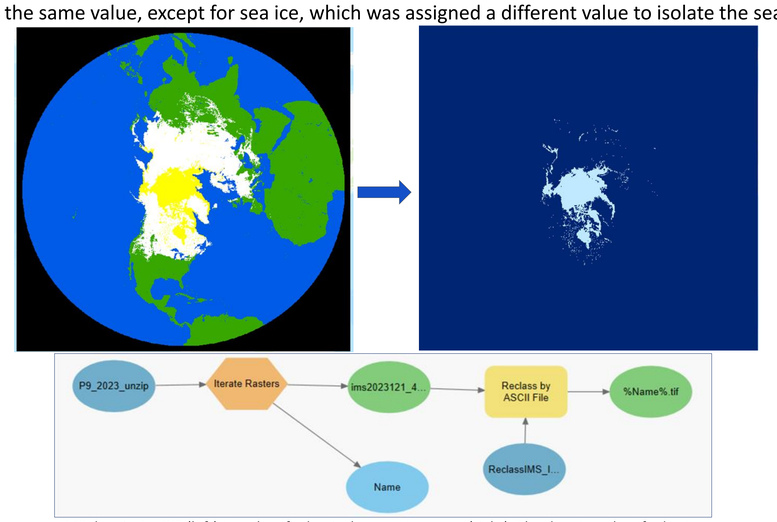
Average Snow Cover map from previous intern Anna Jensen's project.

Project Goals:

- Cumulative and average charts of days with sea ice cover
- Combined cumulative and average charts of days with snow and sea ice cover
- Departure from Normal charts
- Automate process to allow for easy addition of new data to the charts each year

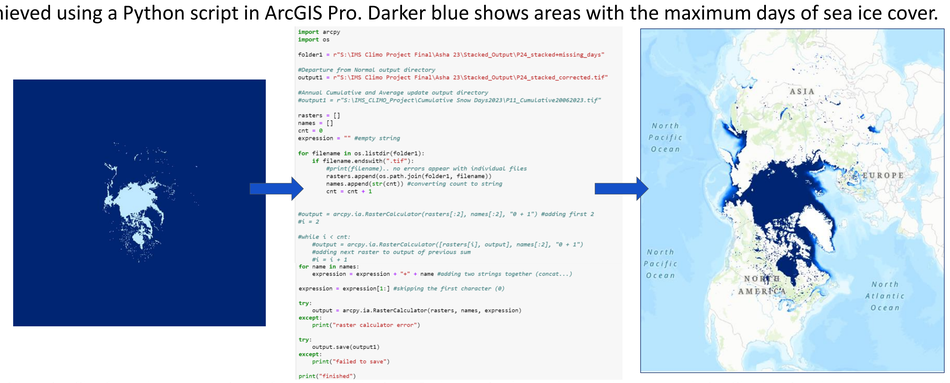
Workflow:

1. Sort and Reclassify Data: IMS data was sorted into half-month periods of 15-16 days of data. For example, period 1 includes January 1-15. Once the data was sorted, the files were reclassified using ModelBuilder on ArcGIS Pro. IMS data originally has 4 values of data: land, water, snow, and sea ice. Reclassifying the data meant changing all values into the same value, except for sea ice, which was assigned a different value to isolate the sea ice data.



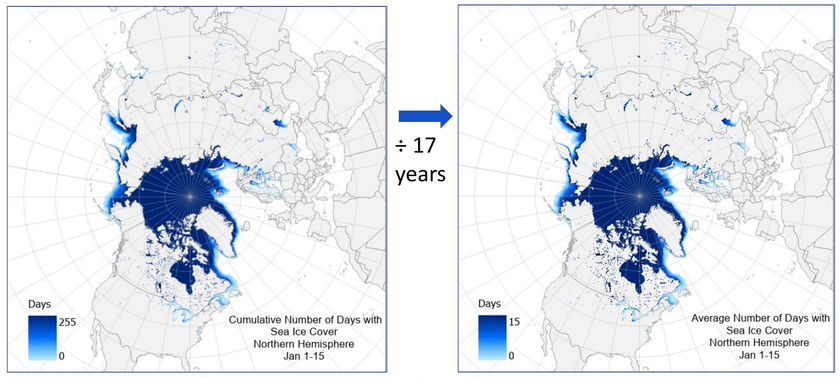
IMS data in ArcGIS (left) is reclassified to isolate sea ice cover (right). The data is reclassified using ModelBuilder in ArcGIS Pro (bottom).

2. Stack Rasters to Produce Cumulative Rasters: All files from the same period over all 17 years were added together, or stacked, to create one large cumulative sea ice cover file for each period. This stacking was achieved using a Python script in ArcGIS Pro. Darker blue shows areas with the maximum days of sea ice cover.



All sea ice files from the same period (left) are stacked using a Python script (center) to produce a cumulative file showing the total number of days of sea ice cover in the Northern Hemisphere for all 17 years over each period (right).

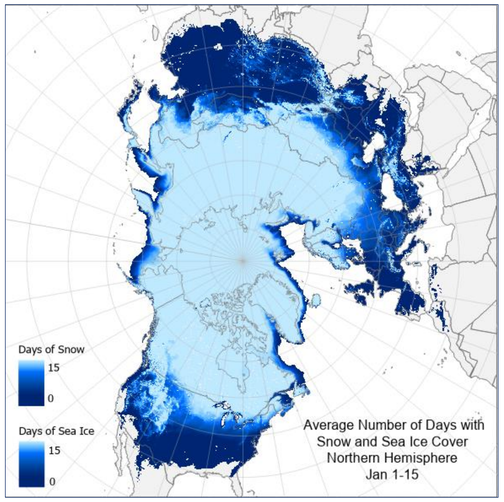
3. Divide Cumulative Files into Average Files: The cumulative files contain all 17 years of data for one period. These cumulative files were then divided by the number of years (17) to produce a map showing the average number of days of sea ice cover for each period. Both the cumulative and average maps are goals of the project.



The cumulative sea ice cover files are divided by the number of years of data. This leaves the average number of days of sea ice cover for each period. The above example shows January 1-15, which has a maximum of 15 days of sea ice cover on average and a minimum of 0 days of sea ice cover on average.

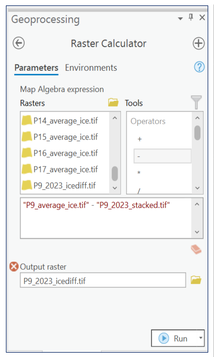
Future Work:

Combined Snow and Ice Charts: The goal of this product is to show both snow cover (over land) and sea ice cover (over water) on the same map. This can be achieved by stacking together the sea ice and snow files.

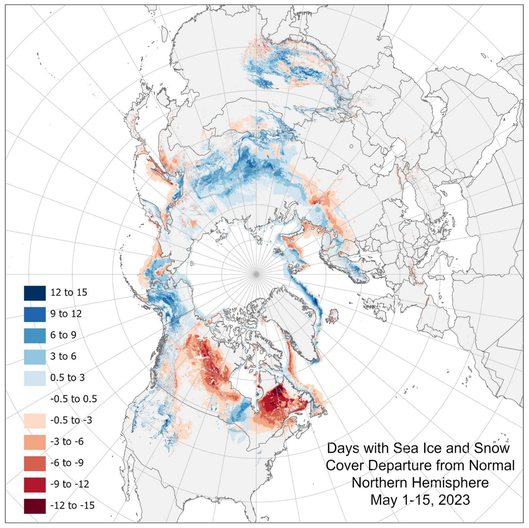


An example of a combined snow and ice cover map showing the average cover from January 1-15 from 2006 to 2022.

Departure from Normal Charts: The goal of this product is to compare recent snow and sea ice cover data to the average, to show areas with more (blue) or less (red) cover than average. This was achieved by subtracting the current data from the average data in the Raster Calculator on ArcGIS Pro.



Raster Calculator used to create the Departure from Normal map.



An example of a Departure from Normal chart for snow and sea ice cover comparing data from May 1-15, 2023 to the average for May 1-15 from 2006 to 2022.

Automation Process: The final goal of this project is to create an automation process to easily update the products as new IMS data is recorded. Cumulative and average snow and sea ice cover charts will be updated yearly, and Departure from Normal charts will be updated at the end of each period. Once the automation process is complete, regularly updated charts will be available on the USNIC website.

Acknowledgments:

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