



Glosten

PROJECT MEMORANDUM

Status Update – Ice Environment Study

25 September 2020

TO: Chris Chuhran, Leidos
FROM: Peter Soles, Glosten
JOB/FILE NO. 19136.01

Progress Update

An exhaustive research effort on the availability of current and archived sea ice data for the Antarctic region was completed. The desired data will inform a proper analysis of PC4 and PC3 classed vessels, in terms of assessing their ability to access three geographic areas of interest near the Antarctic continent (Pine Island Bay, Thwaites Ice Tongue, and the central Weddell Sea) across a range of dates bounding the primary operating season.

Because IACS Polar Class Rules define PC4 vessels as suitable for “year-round operation in thick first-year ice which may include old ice inclusions” and PC3 vessels as suitable for “year-round operation in second year ice which may include old ice inclusions,” the requisite ice data for completing the analysis is not sea ice extent, concentration, or freeboard, but rather stages of development (SoD). Unfortunately, most sea ice SoD data on ice charts distributed by the US National Ice Service (NIC), Canadian Ice Service, and other agencies is limited to Primary SoD. Primary SoD shows only *primary* SoD in a given area – i.e. the ice type in greatest concentration. Thus, it is possible that within an area where the Primary SoD is first year ice, for example, secondary or tertiary second year SoD ice may also be present, which would preclude the operation of PC4 vessels. Furthermore, Primary SoD data, as shown on ice charts, does not distinguish between second year ice and multi-year ice – a distinction that is necessary to evaluate the operability of PC3 vessels in polar regions. For this reason, research focused primarily on seeking to understand the availability and quality of complete sea ice SoD data for the Antarctic region, as found on World Meteorology Organization (WMO) Egg Codes or in SIGRID-3 shapefiles (code), the underlying metadata used to generate ice charts.

In conducting this research, discussions were held with ice scientists at the US National Snow & Ice Data Center (NSIDC). Datasets on sea ice Primary SoD for the Antarctic were obtained, as well as beta samples of some new sea ice data products under development at NSIDC, expected for release in October of this year.

The functionality of the Polar View application, a remote sensing expert with the British Antarctic Survey, was explored.

Inquiries were sent to NIC requesting clarification on the availability and quality (consistency of metadata) of SIGRID-3 shapefiles for the Antarctic region, and whether the underlying data distinguishes between second year ice and multi-year ice.

Key Findings

It was determined that published WMO Egg Codes are not available for the Antarctic region as they are for many areas of the Arctic. Additionally, we learned that while there are NIC Antarctic shapefiles containing SIGRID-3 level of detail on sea ice SoD, it appears that NSIDC is no longer distributing any recent datasets and that the metadata in these shapefiles does not distinguish between second year and multi-year ice, and thus would not provide a detailed picture of the ice regime for a given place and time. More granularity on partial concentrations by ice type (SoD) would still be desirable to properly conduct the desired analysis on PC4 and PC3 vessel operability.

NSIDC is nearing completion of a new sea ice data product called G10033, which is expected to ‘go live’ sometime in October 2020. The G10033 product will show partial concentrations by ice type for both the Arctic and Antarctic regions, though the granularity on sea ice SoD will not be as fine as that of SIGRID-3 shapefiles. The table below illustrates the correspondence between the G10033 and SIGRID-3 data.

Table 1 – Comparison between G10033 and SIGRID

Ice concentration by type (EASE-Grid)	Stage of development in source data (SIGRID)
Total ice concentration (all types)	Total ice concentration (all types)
Multiyear ice	Old ice 2nd year ice Multi-year ice
First-year ice	First year ice (FYI) Thin FYI Thin FYI _ stage1 Thin FYI _ stage2 Medium FYI Thick FYI
Thin ice	New ice Nilas, ice rind Young ice Gray ice Gray-white ice
Fast ice	Ice form (landfast ice is the only form)

The G10033 product is attractive because the outputs are simple image files, similar to published NIC ice charts, but with more detailed information on sea ice SoD (see sample image below).

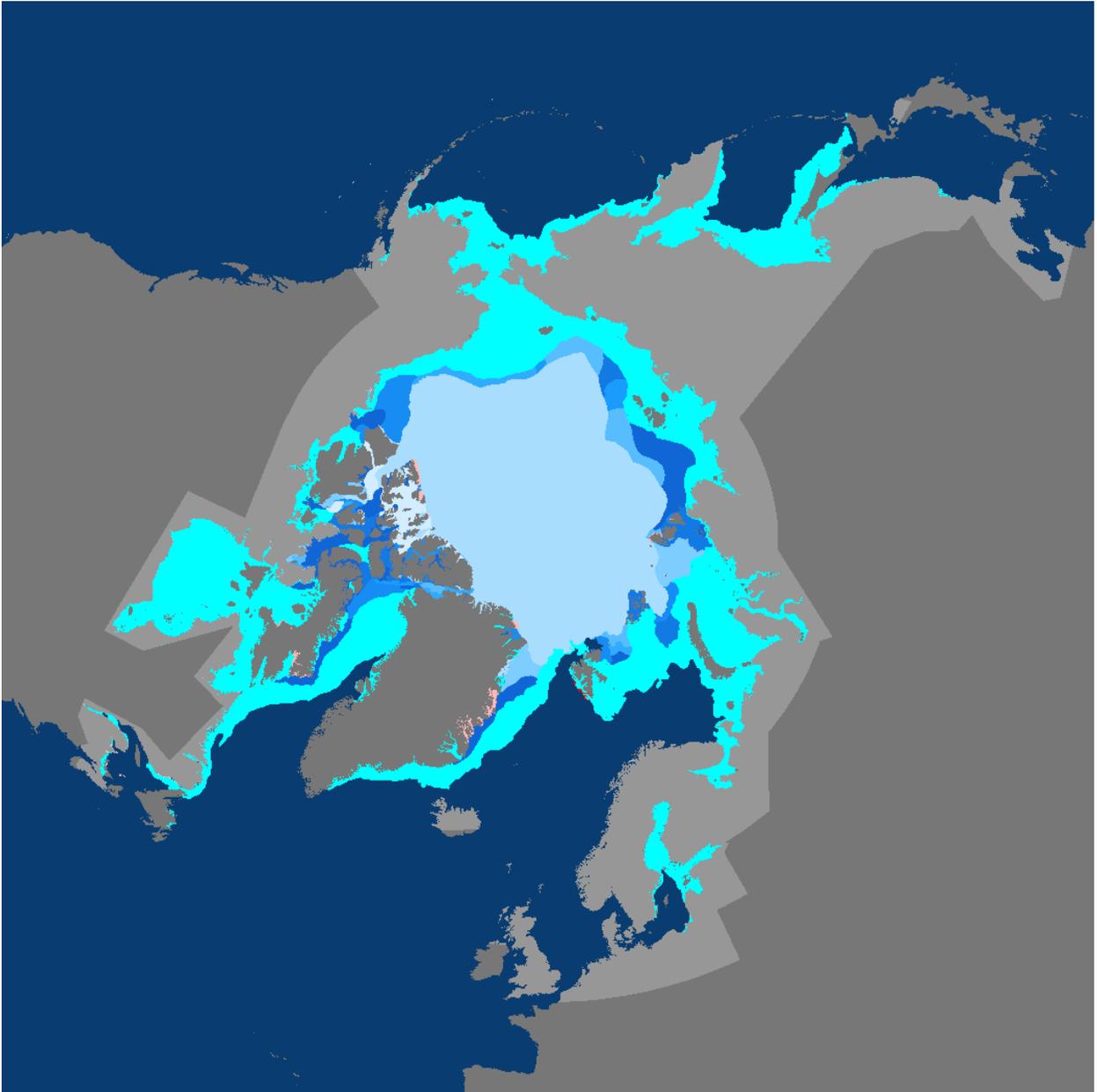


Figure 1 Sample output from G10033 product (beta) for the Arctic region.

The G10033 product appears to afford an efficient means for evaluating PC4 and PC3 operability in the identified areas of interest. In an 8 September 2020 email exchange, Ms. Florence Fetterer of NSIDC stated:

“2nd year ice is the thinnest in our Multiyear category. If you do an analysis using our G10033 product for the earliest that *any* ice in our Multiyear category is present in Pine Island Bay, for example, it will tell you the earliest date that a PC-4 icebreaker would be ‘prohibited’ from going in, because 2nd year, or older ice, is there. And, if you do an analysis for the earliest that *any* ice in our First-year ice category is present in Pine Island Bay, it will be conservative, because it will tell you that Thick FY ice, or any thinner FY type, is there.”

This approach merits consideration given the uncertainties in working with SIGRID-3 shapefiles.

Evaluation of the Polar View application confirmed that the sea ice SoD filter (data overlay) is generated from the published NIC ice charts, which means it too is limited to Primary SoD only. Additionally, the Polar View ‘custom date’ search function limits the user to datasets no older than 30 days, which is of limited value for evaluating historical average ice concentrations around the shoulder seasons of the primary operating timeframe for science missions.

Polar View appears to have been designed for accessing a broad range of recent/real-time sea ice data (much of it from remote sensing satellites) and to support the use of the Polar Operational Limit Assessment Risk Indexing System (POLARIS) in the field. POLARIS is an accepted methodology, recommended in the text of the IMO Polar Code Advisory, for making real-time navigational decisions in an ice environment.

? Question for NSF: Does NSF have access to additional datasets that should be considered for this analysis?

Next Steps

Next steps for this study include:

- A ‘roundtable’ discussion with the Leidos/NSF to determine the desired path to completing the PC4 vs. PC3 operational assessment – i.e. to wait for the release of the new G10033 product from NSIDC, or to pursue obtaining and processing NIC Antarctic SIGRID-3 shapefiles.

? Question for NSF: Does NSF have access to both archived and recent SIGRID-3 shapefiles no longer available through NSIDC?

- Continue researching the Polar View application and its potential utility for this design effort. There may be more complete information following the 21st Meeting of the International Ice Charting Working Group, which concluded on 25 September 2020 and included a presentation on Polar View.
- Continue corresponding with NIC to gain clarification on the data granularity in Antarctic SIGRID-3 shapefiles. Can Thick First Year Ice and Second Year Ice Data be extracted, or is the data muddled in broader categories?