CHAPTER 5

Ice Analysis Charts

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This chapter deals with basic procedures for preparing and transmitting various chart products from the Canadian Ice Service (CIS), operations division. These charts are of importance to a variety of users for many purposes such as strategic planning, climate studies and or tactical vessel management. These products use different variations of the Egg Code described in Chapter 3. In some cases, scale and map area restrict and limit the use of the complete code.

5.1 Daily Ice Analysis Charts

5.1.1 Description

These charts are of importance to icebreaker captains, commercial shipping interests and fishing vessels, to assist them in finding the easiest passage through the ice or to avoid the ice when feasible to do so. The charts are meant to provide ice information for strategic planning for their activities during the next 24 hours.

Please note that there are significant differences between daily ice analysis charts and observed and image analysis charts:

- **Frequency**

Daily ice analysis charts are done on a daily basis during the season, whereas image analysis charts are done when images arrive for a particular operational area. Observed charts are generated whenever ice conditions are encountered either from ships, helicopters or aircraft.

- **Detail**

The other significant difference resides in the amount of detail on each chart. Observed and image analysis charts have more latitude regarding the amount of detail and information that can be placed on the product. Daily ice analysis charts will have less detail pertaining to ice areas and egg definitions. Consequently, daily ice analysis charts have a more generalized look compared to observed and image analysis charts.

5.1.2 Method of Production

Daily ice analysis charts are computer-generated with the use of mapping and image analysis software. The system allows the forecaster to draw lines and place eggs, symbols, drift arrows, and ship positions.

The forecaster will use a variety of data sources such as NOAA AVHRR, GOES, SSMI, QUIKSCAT, ENVISAT and particularly RADARSAT, as well as the image analysis charts from these data. The field observation charts from ships, helicopter and aircraft provide ground truthing (See Figure 5.13). However on days when no data is available, or when the image analysis does not coincide with the valid time of the daily ice analysis chart (1800 UTC), the ice model from CIS can be used to advance ice to the valid time.

The Egg Code

There are some limitations on the use of the Egg Code for daily analysis charts. Later in this chapter, we will specifically outline the significant differences. For a complete version of the Egg Code, please see Chapter 3.

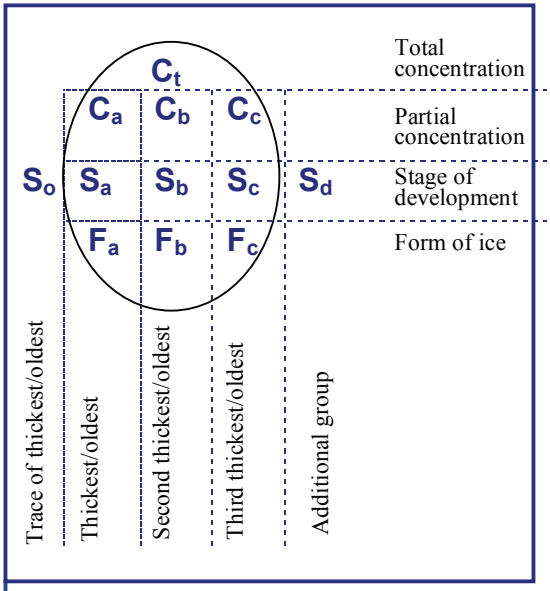
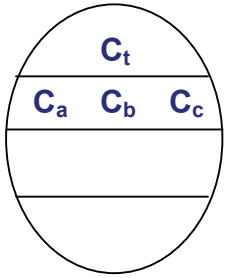


Figure 5.1: Elements of the Egg Code Used for Daily Ice Analysis Charts

Note:
The symbols C_a C_b C_c and F_a F_b F_c correspond to S_a S_b S_c respectively.

Concentration (C)

Total concentration (C_t) of ice in the area indicated in tenths and partial concentrations of thickest (C_a), second thickest (C_b) and third thickest (C_c). Note that C_d which appears on observation/SAR image analysis charts, will not be indicated on daily ice analysis charts from the Canadian Ice Service.



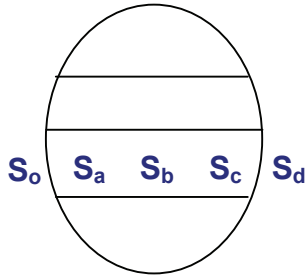
Notes:
1. When only one ice type is present, the partial concentration shall not be indicated (see Example 1).

2. When only a trace of thinner ice is present with thicker ice, only the concentration of the thicker ice is indicated inside the egg; the thinner ice type will show as S_d (see Example 2).

3. When 2 or 3 ice types are present with more than 1/10 concentration, the partial concentration for each type will show inside the egg (see Example 3).

Stage of Development (S)

Stage of development of thickest (S_o), second thickest (S_a), third thickest (S_b) and fourth thickest (S_c) ice and the thinner ice type S_d, of which the concentrations are reported by C_a C_b C_c respectively.



Notes:
1. Reference to thicker ice should be understood to mean older ice and conversely, thinner ice to mean younger ice types.

2. Ice is designated Sea or Lake depending on where it forms. In Canada, the practice is to use the Lake Ice code to report ice in the Great Lakes and the St. Lawrence Seaway. Elsewhere, including the St. Lawrence River east of Montreal, Sea Ice coding is used for stages of development.

3. Reporting of S_a S_b and S_c should generally be restricted to three significant classes. In exceptional cases further classes may be reported as follows:

S_o - stage of ice development thicker than S_a, but having a concentration less than 1/10 (see Example 4).

S_d - stage of development of the thickest remaining ice types. It is the fourth stage present after S_a, S_b and S_c. Partial concentration must be at least 1/10 (see Example 4), except during the freeze-up period when a trace of new ice may be present (see Example 2).

S_e - this stage of development will not appear on a daily ice analysis chart.

DESCRIPTION	THICKNESS	CODE
New ice	<10 cm	1
Grey ice	10-15 cm	4
Grey-white ice	15-30 cm	5
First Year ice	> 30 cm	6
Thin first-year ice	30-70 cm	7
Medium first-year ice	70-120 cm	1•
Thick first-year ice	> 120 cm	4•
Old ice		7•
Second-year ice		8•
Multi-year ice		9•
Ice of land origin		▲•
Brash		-

Table 5.1: Coding for Sea-Ice Stages of Development (S_o S_a S_b S_c S_d)

DESCRIPTION	THICKNESS	CODE
New lake ice	<5 cm	1
Thin lake ice	5-15 cm	4
Medium lake ice	15-30 cm	5
Thick lake ice	30-70 cm	7
Very thick lake ice	>70 cm	1•

Table 5.2: Coding for Lake Ice Stages of Development (S_o S_a S_b S_c S_d)

Notes for Tables 5.1 and 5.2:

1. On the horizontal line giving **$S_oS_aS_bS_cS_d$** only one dot (•) shall be placed to indicate the distinction between classes of ice. Every coded figure to the left of the (•) is understood to have the (•) as part of its code (see Examples 4 and 5).

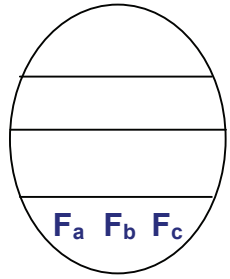
2. The symbol ▲• shall only be used within the egg when the concentration of ice of land origin is 1/10 or more (see Example 12).

3. Code 8• and 9• shall normally appear on CIS daily ice analysis charts from 01 October to 31 December.

4. Brash ice (-), when present, will always appear as **S_a** (see Example 11).

Form of Ice (F)

Floe Size corresponding to **S_a S_b S_c**



DESCRIPTION	WIDTH	CODE
Small ice cake, brash ice	<2 m	1
Ice cake	2-20 m	2
Small floe	20-100 m	3
Medium floe	100-500 m	4
Big floe	500-2000 m	5
Vast floe	2 -10 km	6
Giant floe	> 10 km	7
Fast ice		8
Icebergs		9
No form		**X**

Table 5.3: Coding for Form of Ice (F_a F_b F_c)

Notes for Table 5.3:

1. Width refers to the maximum horizontal extent.

2. At least one code **8** must be used for fast and consolidated ice. When significant ice types are present and it is important to maintain their floe size, the younger ice type will be coded as fast ice (see Example 5).

3. Occasionally the stage of development of fast ice cannot be determined. The area shall be blackened-in to denote fast ice. Also when the area in question is very small or difficult to place a label, it can be blackened-in.

   For areas with a trace of old, second or multi-year ice embedded in fast ice, the area will be shaded-in in grey with an attached label or egg.

4. New sea ice does not have a definite form, therefore, when this stage of development occurs as S_a S_b or S_c the symbol **X** shall be used to designate floe size (See Example 1).

5. When an area of ice has one particular ice type but varying floe sizes, the basic rule will be to represent the ice type that has the predominant concentration and use the corresponding floe size (see Example 6). An exception would be when there are a few giant old floes in a field of medium size old floes (see Example 7).

6. Pancake floe size (**Code 0**) will not appear on CIS charts. Since pancake ice floes implies new ice, the standard floe size when dealing with new ice at CIS is always **X**.

Coding and Symbology for Strips and Patches ∾ C

The symbol ∾, placed at the bottom of the egg in Form of Ice section, indicates that the ice is in strips and patches and that the concentration within the strips and patches is represented by **C** (see Example 8).

In an area in which the ice is arranged in strips and patches and the ice floes are medium (**Code 4**) or greater, the floe size may be indicated by using two eggs. The floe sizes are indicated as normal in the first egg with the ∾ symbol placed between the first and second eggs. The ∾ symbol is repeated in the second egg beside the total concentration of the strips and patches (see Example 9).

In an area of ice in which some first-year or thicker ice type(s) is/are embedded as strips and patches, the strips and patches shall be indicated by the use of two eggs. The overall partial concentrations of the ice types are indicated in the first egg and the concentration within the strips and patches are indicated in the second egg. The ∾ symbol shall be placed between the two eggs and along with the total concentration in the second egg (see Example 10). Double eggs will be indicated with a leader line to the polygon in question.

Where there are isolated strips and patches of ice, of less than 1/10 concentration, located outside the main ice areas, the strip (∾) symbol will be placed in the area of these strips. Usually these symbols are used to indicate ice in the final stage of melt. It should be noted that the strip (∾) symbol is not allowed on the Great Lakes charts.

5.1.2.1 Defining Polygons

The parsing of ice areas can be done in one of two ways:

1) By various ice types;
2) By concentration.

Note that solid lines will be used to separate areas of different ice type/concentration (no dash lines).

1) Ice Type

Mandatory boundaries are required between areas of predominant new, grey, grey-white, first-year and old ice.

Please note that ice codes 2 (nilas ice, ice rind) and X (undetermined or unknown) will not be used on daily ice analysis charts from CIS.

For old ice, (7•, 8• and 9•) boundaries are required between areas with concentrations of:

- No old ice
- Trace of old ice
- 1 - 3/10
- 4 - 6/10
- 7 - 8/10
- 9 - 9+/10.

Old ice (7•, 8• and 9•) with a concentration of 4 tenths or more will be considered predominant.

When two ice types are present in equal concentration, the older/thicker type is considered predominant.

When three or more types are present in equal concentrations, the second oldest is considered predominant.

2) Total Concentration

In the case of total concentration, mandatory boundaries, shown as solid lines are required between areas of:

Open water/bergy water:	< 1 tenth
Very open drift:	1 to 3 tenths
Open drift:	4 to 6 tenths
Close pack:	7 to 8 tenths
Very close pack:	9 to 9+ tenths
Compact or consolidated:	10 tenths

The total concentration is the first determining factor in defining ice boundaries. Partial concentrations of new ice are ignored when first-year or thicker ice is present.

5.1.2.2 Floe Size

Mandatory boundaries must also be placed between areas of predominantly medium floes or larger (**Code 4**) and areas of predominantly small floes or smaller (**Code 3**) when 6 tenths of thin first-year or thicker/older ice are present.

5.1.2.3 Discretionary Boundary

Discretionary boundaries can be used when sufficient data or knowledge of the ice regime has been verified by up-to-date reconnaissance flight, reports or satellite information. These boundaries are to be maintained on subsequent charts only if there is sufficient knowledge of the location, as provided by these data sources.

Discretionary boundaries should only be used in operationally sensitive areas, namely:

Great Lakes:	shipping routes
Gulf of St. Lawrence:	shipping routes
Newfoundland:	coastal waterway to Botwood
Arctic:	shipping routes

Ice type to consider:
When considering the use of a discretionary boundary, only first-year and old ice are considered, provided there is sufficient knowledge to supply this additional detail. The exception would be in the Great Lakes, where thick or very thick lake ice and areas of ridging should be considered for discretionary boundaries.

Ice concentration of ice to consider:
Total ice concentration must be at least “close pack” (7-8 tenths of ice). New ice is ignored when evaluating the total concentration.

Variance of the concentration to consider:
A discretionary boundary may be used if the partial concentration of the first-year or thicker (thick or very thick lake ice) ice varies by at least 3 tenths in a definable area within a mandatory polygon (see Examples 13 and 14).

5.1.2.4 Valid Time

Daily analysis charts generated at the Canadian Ice Service has a valid time of 1800 UTC. The chart thus represents ice conditions at 1800 UTC.

5.1.2.5 Corrections and Amendments

When a correction or amendment is made to the chart, the abbreviation CCA or AAA will appear next to "ICE ANALYSIS/ANALYSE DE GLACES" at the top of the legend.

- A correction is required if an error appears on a chart (examples: $\mathbf{C_t}$ indicated 5/10, but should have read 8/10; the ice drift is missing; wrong date for an image in the legend).

- An amendment is warranted when a significant change in ice conditions in a certain area occurs (examples: $\mathbf{C_t}$ was put as 5/10 but a report indicated that the concentration was 9+/10; ice is reported in an area shown as open water).

For an example of a corrected/amended chart, please see Figure 5.6, page 5-34.

5.1.2.6 Chart Legend

The legend is used on the daily ice analysis charts to describe the region, the valid time and date, what information the chart is based on and any warnings in effect.

The information on the source data is to give the client an idea of what was used to prepare the chart, to give a general level of confidence. Only sources that made a significant contribution to the analysis will be indicated. Where possible, the time and the area covered by that source will be given.

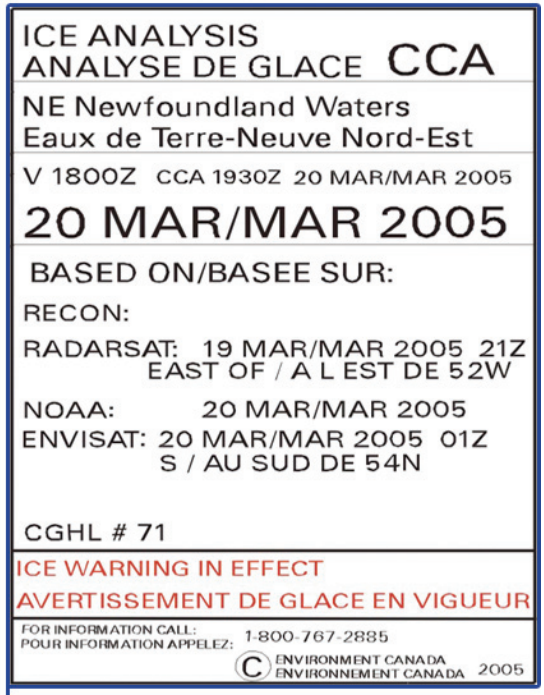


Figure 5.2: Example of Chart Legend

At the bottom of the legend, other types of information can be indicated such as the latest chart received from a particular coast guard ship.

When an ice warning is in effect, there will be a notice on the legend to alert clients to refer to the companion ice bulletin to get more information about the warning. Although the chart is valid for 1800Z today, warnings that could be in effect anytime from 18Z today up to tomorrow at 00Z will be indicated on the legend.

5.1.2.7 Deadlines

Deadlines may vary from chart to chart, and from season to season.

- **Transmission**
  At least one chart should be made ready for transmission from CIS at 1600 Eastern Standard Time (or Daylight Saving Time). However, in consultation with the CCG Ice Operations Centre(s), priorities regarding which chart to send out first will be determined on a daily basis, to ensure that the most operationally sensitive chart is first selected for transmission.

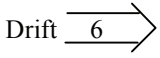
- **Data reception and integration**
  For information received from outside sources (CFR charts, CCG ship reports, etc.), a minimum of 2.5 hours before the transmission deadline is required to integrate it into the daily ice analysis chart. In most cases when the information arrives late, the forecaster will endeavour to integrate the information, especially if it is operationally sensitive. However, this may cause a delay in the delivery of the chart. The decision to process the information or not, for use in the chart, will be at the discretion of the forecaster in consultation with CCG ice operations office.

5.1.3 Dissemination of Charts

Daily ice analysis ice charts are disseminated electronically via a product delivery system. Clients will receive products via e-mail, fax or the internet. ISS and CCG clients have a special customized delivery system set up.

5.1.4 Symbols Used on Daily Ice Analysis Charts

Symbols for Dynamic Process



The arrow symbol represents the drift direction. The number represents the drift speed in nautical miles per day.

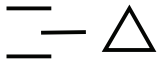
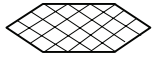
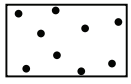
Note:
The drift arrow gives the direction and the number of nautical miles that ice, within 10 nm of the centre of the arrow, is expected to travel over the next 24 hours. Due to the influence of currents and winds, there can be large differences in the direction and speed of the ice even over areas within close proximity. This drift does not take into account the effect of land on the drift. When the arrow points towards land, there may be an increase in ice concentration and ice pressure along the coast.

Symbols for Defining Limits

Analysed edge or boundary 

Bergy water boundary 

Other Symbols Used

Ship reports	CGTF I5Z	Used to indicate the latest position and time of a Coast Guard ship (during last 24 hrs).
Bergy water		Symbol used to indicate bergy water conditions.
Ice-free		Symbol used to indicate ice-free conditions.
Ice island or Ice island fragment		Symbol used to indicate ice island or fragments.
Open water		Stipple pattern used to indicate open water areas (less than 1/10).
Fast ice		Blackened area representing fast ice.
Strips and patches		Symbol used to indicate strips and patches of ice outside the ice edge.

Note:
Some symbols may be displaced and have a leader line pointing to its actual location.

5.2 Regional Ice Charts

5.2.1 Description

Regional ice analysis charts represent ice conditions on a specific date. They are prepared weekly, bimonthly or monthly, depending on the season and the region. They provide information on ice conditions for planning marine activities up to several weeks ahead.

Regional ice charts are produced for:

- the Canadian Arctic (Eastern, Western and Hudson Bay),
- the Great Lakes, and
- the East Coast of Canada.

Regional ice charts are the main climatological product issued by CIS, and are part of the national archives. Data from the charts is also used by the Canadian Meteorological Centre (CMC) in its meteorological models.

5.2.2 Method of Production

These charts show generalized ice conditions; they incorporate all available data, usually within three days of the valid date. The main data sources are satellite images. The daily ice analysis chart will be referenced; however, using all the detail would make the chart too cluttered, so small areas may be merged.

Defining Polygons

Mandatory boundaries are drawn:

- **Concentration:**
  where the total concentration varies from the following categories:
  - open water or bergy water
  - 1 to 3 tenths
  - 4 to 6 tenths
  - 7 to 8 tenths
  - 9 to 9+ tenths
  - 10/10 or consolidated

- **Stage of development:**
  where the stage of development of the predominant ice type varies from new ice, grey ice, grey-white ice, first-year ice, and old ice (see Table 5.1):
  - when two ice types have the same concentration, the oldest/thickest is considered predominant;
  - when more than two types have same concentration, the second oldest is considered predominant;

  where the concentration of old ice varies from the following categories:
  - no old ice
  - trace of old ice
  - 1 to 3 tenths
  - 4 to 6 tenths
  - 7 to 8 tenths
  - 9 to 9+ tenths
  - 10/10 or consolidated

❑ **Form of ice:**
between areas of predominant floe size 3 or smaller and size 4 or greater, where there are 6 tenths or more of first-year ice or thicker.

Discretionary boundaries may be used for:

❑ **Concentration:**
If there is any first-year ice or thicker in an area of 7 tenths or more total concentration (ignoring new ice), may separate areas of first-year ice or thicker that vary by 3 tenths or more.

❑ **Stage of development:**
- Second-year 8• and multi-year 9• will be used from October 1 to December 31; however, these ice types may be carried throughout the winter when established, especially for consolidated ice in the high Arctic.
- Brash may be used.
- S_d is generally not used except:
  - during freeze-up when a trace of new ice is present;
  - when remaining ice type concentration is 1/10 or more.
- S_o used only when the trace of ice is significant (usually first-year or thicker).
- Only small areas of fast ice should be shaded. As the ice area grows, the shading should be replaced with an egg to show ice thickness and stage of development.
- New ice of various concentrations may be grouped together.

❑ **Form of ice:**
- Normally each ice type will have only one predominate floe size; however, more than one floe size may be used if the ice is significant (first-year ice or thicker). For example, a few giant floes in a field of medium floes.
- When significant ice types are present within fast ice it is important to maintain their floe sizes, report floe size for the significant ice (usually old ice) and younger forms of ice as code 8.
- When overall concentration of ice in a polygon is 1 to 6 tenths and ice is not evenly distributed, the strip symbol may be used in the form of ice area.

5.2.3 Dissemination of Charts

Regional ice charts are disseminated electronically via a product delivery system. Clients can receive charts via e-mail or though the Internet.

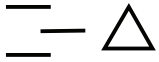
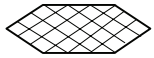
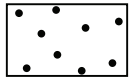
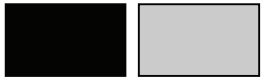
5.2.4 Symbols Used on Regional Ice Charts

Symbols for Defining Limits

Analysed edge or boundary 

Bergy water boundary 

Other Symbols Used

Bergy water		Symbol used to indicate bergy water conditions.
Ice-free		Symbol used to indicate ice-free conditions.
Ice island or Ice island fragment		Symbol used to indicate ice island or fragments.
Open water		Stipple pattern used to indicate open water areas (less than 1/10).
Fast ice		Black or grey area representing fast ice.

Note:
Strips and patches (∾) will not be used outside of the eggs.

5.3 Image Analysis Charts

5.3.1 Description

Image analysis charts are tailored products that provide a visual interpretation of the ice conditions primarily from radar imagery that may come from a variety of platforms such as on the ERS, RADARSAT or ENVISAT satellites. The Canadian Ice Service (CIS) receives approximately 3,600 RADARSAT images and 12,000 NOAA AVHRR images per year. Operationally significant images are analyzed and the image analysis chart is issued in near-real time (within 4 hours) of data reception at CIS. The international standard for coding ice information, the Egg Code, is used with some minor modifications. The modifications will be dealt with in the method of production section below, a complete description of the Egg Code can be found in Chapter 3.

This product is primarily intended for the Canadian Coast Guard ice offices and icebreakers to assist them with decision making on ship routings and escorts. The product is used as well by Ice Forecasters to supplement the daily ice analysis and regional analysis charts. Grid-point ice data from the analysis is provided to the Canadian Meteorological Centre weather models, and to ice models at the Canadian Ice Service (CIS) and the Maurice Lamontagne Institute.

The accuracy of an analysis is affected by the spatial resolution of the source data and the processing quality. Here are a few examples:

- ERS2 – pixel resolution is 25 m;
- RADARSAT ScanSAR Wide – pixel resolution is 100m;
- ScanSAR Narrow – pixel resolution is 50 m;
- NOAA AVHRR resolution is approximately 1 km at nadir.

In addition to being able to resolve different ice features, the absolute positional accuracy of the data (geo-coding) will be affected by the accuracy of the satellite orbit information. The Canadian Space Agency estimates that the geometric accuracy of a feature such as an ice edge will be within 630 m for 100 m resolution imagery.

5.3.2 Method of Production

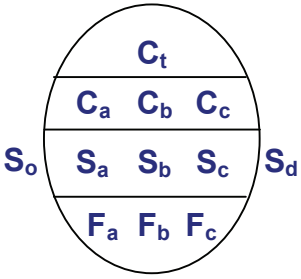
This chart is a visual interpretation of the SAR imagery by an experienced analyst using a digital image display and vector-drawing tools. The analysis of the ice regime seen on the SAR image is actually a composite of ice signature recognition and support data. Support data sources include the prevailing environmental conditions, ice climatology and coincident ice reconnaissance charts from ships, aircraft or helicopters. SAR analysis charts are tailored to meet the user's requirements. The scale of the chart is not fixed. It will be tailored to the client's geographic area of interest, constrained by the footprint and resolution of the sensor and the need to ensure that the information presented using the Egg Code is clear, and readable and is

issued in a timely fashion. Image analysis charts are issued and archived in digital format, in near-real time, usually within 4 hours of data reception at CIS.

Defining Polygons

Analysts extract ice concentration, ice type and ice topography from the images, based on tone, texture and spatial context of the ice features (resolution). The extraction of accurate information requires an understanding of ice forms and remote-sensing signatures, as well as access to the meteorological conditions and historic patterns of ice in a specific region. Accuracy may be diminished by poorly processed imagery, artifacts within the imagery or by the effects of moisture on/in the ice.

The Egg Code



Areas of different ice conditions are described using elements of the Egg Code on a variable scaled chart. Principally, this code describes the ice in terms of:

- C_t the total ice concentration expressed to the nearest tenth
- C_a, C_b, C_c the partial concentrations of up to four main ice types present, to the nearest tenth plus a trace amount. C_d is not shown but its value is apparent from the total concentration values.
- S_o, S_a, S_b, S_c, S_d the stage of development of sea ice and lake ice. See Table 3.1 and 3.2

Note: S_e is not used. **X** may be coded when ice type is undeterminable.

- F_a, F_b, F_c the form of the three main ice types present (pancake, brash, small, medium, big, vast, giant floes, strips and patches, or **X**- indeterminable) depending on the image resolution. See Table 3.3.

Note: F_d and F_e are not used.

- **Brash ice** is not coded using the observed **VKMT** standard. Brash is coded only when there are coincident visual reports to support the signature analysis. If brash is present it will always be indicated as C_a. If present S_a will always be a dash (-) and F_a=1.

Mandatory Boundaries (solid lines) are drawn when:

- **Concentration:**
  where the total concentration varies from the following categories:
  - open water or bergy water
  - 1 to 3 tenths
  - 4 to 6 tenths
  - 7 to 8 tenths
  - 9 to 9+ tenths
  - 10/10 or consolidated

- **Stage of development:**
  - the stage of development of the predominant ice type present changes in any way;
  - mandatory boundaries are required between 6/10 and 7/10ths and between 8/10ths and 9/10ths of old ice.

- **Form of ice:**
  the form of the predominant ice type present changes in any way

Discretionary Boundary lines are drawn for any changes within the Egg Code which could impact on tactical ice operations. For example an area of heavily ridged ice may be separated from level ice.

Estimated Ice Edge Boundaries are used when the analyst may be in doubt about the positional accuracy of the edge because of poor image quality or signature ambiguity.

5.3.3 Dissemination of Charts

The image analysis chart product is available for distribution in near-real time or from the archive in raster or grid point format. Delivery methods include the Internet at the CIS Web site and by subscription service via ftp, email or fax.

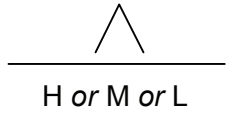
5.3.4 Symbols Used

Topographical Features

The resolution and imaging mode of the sensor directly affects the analyst's ability to detect surface features. Not all topographical features are analyzed. Below is an accounting of the topographical symbology presently in use.

Relative Roughness

Light	up to 1/10	L
Medium	2/10 - 3/10	M
Heavy	4/10 - 10/10	H

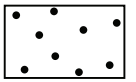


In operational areas, relative roughness will be indicated when there are coincident visual reports to support the signature analysis.

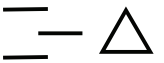
Symbols In Use On Image Analysis Charts

Fast ice

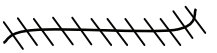
Open water
(less than 1/10 sea ice,
no ice of land origin)



Bergy water
(less than 1/10 sea ice
may be present and
total ice concentration
is less than 1/10)

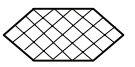


Crack
(symbol indicating
presence of crack
at a specific location)



Strips

Ice island



Ice-free (no ice present)

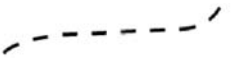
Symbols for Defining Limits

Limit of radar
observation

Limit of undercast
for AVHRR

Limit of bergy water

Estimated ice edge



Ice edge boundary

5.4 Daily Iceberg Analysis Chart

5.4.1 Description

These charts are important to shipping and fishing vessels as well as the tourism industry to assist them in determining the limit of all known icebergs on Canada's east coast.

5.4.2 Method of Production

Iceberg analysis charts are generated with the use of mapping software (GIS). The system allows the forecaster to model the position of icebergs and targets that were visually or remotely sited up to 40 days prior. The forecaster can use reports from ships, land stations, and radar satellites, but mostly relies on dedicated iceberg flights using fixed wing aircraft. The individual iceberg information is entered into the modelling database, where currents, wind and water temperature and other factors are applied to estimate the iceberg position and size at the time of the chart valid time.

5.4.2.1 Valid Time

The Iceberg Analysis charts have a valid time of 1200 UTC. The chart represents the iceberg conditions at 1200 UTC on the date that it is issued.

5.4.2.2 Corrections and Amendments

If a correction is warranted, then the chart is re-issued but with the same valid time as the original. There would be nothing on the chart to indicate that it is a correction. Amendments are not issued. If an iceberg is sited outside the iceberg limit, then a bulletin is issued to notify mariners. The chart will not be re-issued.

5.4.2.3 Chart Legend

A legend is used on the daily iceberg analysis charts to detail the valid date and time of the chart. When the International Ice Patrol (IIP) is in operation, there is a note that the iceberg limit and the distribution of icebergs in the vicinity of the limit south of 52N is estimated by the IIP. The initials of the forecaster who produced the chart will be in the bottom right corner of the legend.

5.4.2.4 Deadlines

The transmission deadline is 1700 UTC.

5.4.3 Dissemination of Charts

Daily iceberg analysis charts are disseminated electronically via a product delivery system. Clients may receive the chart via e-mail, fax or the internet.

5.4.4 Symbols used on the Daily Iceberg Analysis Charts

Iceberg Limit
Known icebergs in the Atlantic located landward (north and west) of the iceberg limit.

Iceberg Limit in the Gulf of St Lawrence
Known icebergs in the Gulf of St Lawrence are located east of this line.

Sea Ice Limit
Landward of this line is the location of sea ice of any concentration.
Exception: Sea ice in the Gulf of St Lawrence is not usually depicted on the iceberg chart.

Known Data Limit
This line depicts the iceberg coverage of the most recent dedicated iceberg flight. This limit is moved southward with the icebergs as they drift. South of this line there is more confidence in the position and number of icebergs than to the north.

N

This number represents the number of icebergs within that degree square. Growlers and/or bergy bits are not included in the count but may be present anywhere within the limit.

5.4.5 Area of Coverage

The iceberg analysis chart covers icebergs located in waters east and southeast of Newfoundland and Labrador, as well as in the Gulf of St Lawrence. There are two chart extents. The northern extent is used most of the year and shows icebergs between about 45N and 61N. The southern extent is used when the International Ice Patrol (IIP) is in operation. It shows icebergs that are between about 40N and 57N. On rare occasions when the iceberg limit is south of 40N, then a text message on the chart will describe the latitude and longitude of the points not seen on the chart.

5.4.6 Notes on the Role of the International Ice Patrol (IIP)

The IIP was established after the sinking of the Titanic to monitor and report icebergs for Atlantic shipping. While CIS monitors icebergs year-round, IIP usually begins operations when icebergs cross 48ºN latitude. This is usually in the late spring. When IIP is in operation they are responsible for determining the iceberg limit south of 52N. At this time CIS uses the same iceberg limit as IIP for the daily iceberg chart and maintains the limit north of 52N.

5.5 Colour Coding Ice Charts

Colours are used to enhance ice charts for presentations and briefings. The codes allow users to make a quick assessment of the general ice conditions and to visually follow trends. It is important to remember that the colours alone cannot be used for navigation decisions and that more detailed ice information is contained within the Egg Code. There are four colour codes in use at CIS, since each code displays the ice in different ways.

5.5.1 Standard CIS Colour Code or ISS Colour Code

The Standard CIS Colour code is intended to assist navigation decisions in ice infested waters. It represents the severity of the ice conditions and is somewhat similar to a traffic light. Colours are used to identify ice concentrations of significant ice.

- Blue and Green represent relatively easy conditions
- Yellow and Orange indicate caution is needed
- Red and Purple indicate the more dangerous ice conditions

5.5.1.1 Colours used in Standard CIS Colour Code

Total amount of ice thicker than 15 cm (grey-white ice or thicker)

(white) less than 1/10 of ice >15 cm but at least 1 tenth of thinner ice types present

(green) 1 to 3 tenths of ice >15 cm

(yellow) 4 to 6 tenths of ice >15 cm

(orange) 7 to 8 tenths of ice >15 cm

(red) 9 to 10 tenths of ice >15 cm

(purple) 5 to 10 tenths old ice (takes precedence over the other colours)

If there are other ice types present, the following symbols would be added to the above colours

* (blue star) 1/10 or more of new ice (less than 10 cm). Would not be visible if equal or greater amount of grey ice is present.

* (red star) 1/10 or more of grey ice (10 to 15 cm). Would not be visible if there was also 9 tenths of ice grey-white or thicker.

/// (purple diagonal dashed lines) 1 to 4 tenths old ice. Would be visible in addition to blue or red stars.

In addition, the following colours are used:

(light blue) open or bergy water (less than 1/10 total ice of any thickness)

(grey or black) areas of land fast ice of any thickness

5.5.2 Internal Quality Assurance (QA) Colour Code

The QA colour code is used internally to help identify total concentration and thickest ice types within the polygons. Colour is used to identify the stages of ice development and patterns are used to identify ice concentration.

5.5.2.1 Colours used in Internal QA Colour Code

The pattern of the predominant ice colour is determined by the total concentration of the ice. Total concentration is calculated by adding the partial concentrations. The exception is when first year ice or older is present, any new ice is not included in the calculation of the total concentration.

	horizontal lines	1 to 3 tenths total concentration
	vertical lines	4 to 6 tenths total concentration
	diagonal lines	7 to 8 tenths
	solid colour	9 to 9+ tenths
	hatched white background	10 tenth compacted ice
	hatched grey background	10 tenths land fast ice that is coded with an egg

The colour of the predominant ice displays the most common type of ice present. Again, new ice is ignored if first year ice or greater (or older or thicker) is present. The other exception is that old ice is considered predominant if there are 4 tenths or more present.

 (yellow) New ice

 (orange) Grey ice

 (blue) Grey-white ice

 (pink) Thin first-year ice

 (red) Medium first-year ice or combined all stages of first-year ice

 (purple) Thick first-year ice

 (brown) Old ice

The second pattern and colour will be the determined by the partial concentration of the second most common ice type. The rules for determining this ice type are:

- New ice is ignored if first year or thicker ice is present
- When any old ice is present, it will be used as the second ice type.
- When 2 ice types have the same concentration, the oldest will be used.
- When 3 ice types have the same concentration, the middle will be used.

The patterns and colours used for the second ice type are:

*	stars	less than 1 tenth concentration
	horizontal lines	1 to 3 tenths concentration
	vertical lines	4 or 5 or 6 tenths concentration

 (yellow) New ice

 (orange) Grey ice

 (blue) Grey-white ice

 (pink) Thin first-year ice

 (red) Medium first-year ice or combined all stages of first-year ice

 (purple) Thick first-year ice

 (green) Old ice (colour changes from what it is as a predominant colour so that it is more visible)

In addition, other colours that may be seen on the charts are:

 (light blue) Open water (less than 1/10 sea ice, no ice of land origin)

 (medium blue) Bergy water (less than 1/10 sea ice, and less than 1/10 iceberg concentration).

 (white) Ice free (no ice of land or sea origin). No data or area not described

 (black) Small areas of land fast ice of any thickness.

5.5.3 WMO Colour Code for Concentration

The WMO colour code for total concentration is an international code that is intended for use when the stage of development is relatively uniform, but concentrations are highly variable (e.g. arctic summer). The legend for the use of the colour code is included on the chart. No colours are used to indicate differences in the ice stage of development.

Colour		RGB colour model	Total concentration
alternate	Used at CIS		
		000-100-255	Ice free
		150-200-255	Less than one tenth (open water)
		140-255-160	1/10 - 3/10
		255-255-000	4/10 - 6/10
		255-125-007	7/10 - 8/10
		255-000-000	9/10 - 10/10
		150-150-150	Fast ice
	? ? ?	255-255-255	Undefined ice (unknown type and amount)
Optional			
		255-175-255	7/10 - 10/10 new ice
		255-100-255	9/10 - 10/10 nilas or grey ice (mainly on leads)
Areas of No Information are annotated accordingly			

Table 5.4: WMO Total Concentration Colour Code

Colour	Description
	Ice free
	< 1 Tenth Ice
	1-3 Tenths Ice
	4-6 Tenths Ice
	7-8 Tenths Ice
	9-10 Tenths Ice
	Fast Ice of Unspecified Stage of Development
? ? ?	Undefined Ice
Areas of No Information are annotated accordingly	

Table 5.5: WMO Total Concentration Colour Code for Lake Ice

5.5.4 WMO Colour Code for Stage of Development

The WMO colour code for stage of development is an international code that is intended for use when the concentration is relatively uniform, but the stage of development is highly variable (e.g. Atlantic winter). The legend for the use of the colour code is included on the chart. No colours are used to indicate differences in the concentration of the ice.

Colour		RGB colour model	Stage of development (SoD)
alternate	Used at CIS		
		000-100-255	Ice Free
		150-200-255	<1/10 Ice (Open Water)
		240-210-250	New Ice
		135-060-215	Grey Ice
		220-080-235	Grey-White Ice
		255-255-000	First-Year Ice
		155-210-000	Thin First Year Ice
		000-200-020	Medium First Year Ice
		000-120-000	Thick First Year Ice
		180-100-050	Old Ice
		255-120-010	Second-Year Ice
		200-000-000	Multi-Year Ice
		150-150-150	Fast Ice of Unspecified SoD
	? ? ?	255-255-255	Ice of Undefined SoD
	▲ ▲ ▲	255-255-255	Drifting Ice of Land Origin (Icebergs)

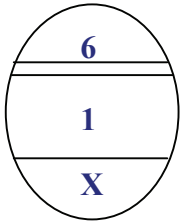
Table 5.6: WMO Stage of Development Colour Code

Colour	Description	Thickness
	Ice free	
	Ice of Unspecified Stage of Development (open water)	
	New Lake Ice	< 5 cm
	Thin Lake Ice	5 – 15 cm
	Medium Lake Ice	15 – 30 cm
	Thick Lake Ice	30 – 70 cm
	Very Thick Lake Ice	> 70 cm
	Fast Ice of Unspecified Stage of Development	
? ? ?	Undefined Ice	

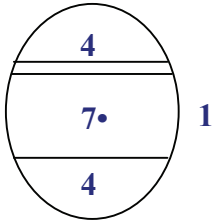
Table 5.7: WMO Stage of Development Colour Code – Lake Ice

5.6 Examples of the Use of the Egg Code

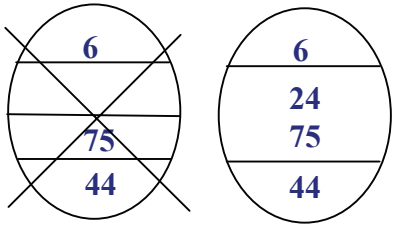
Example 1
6/10 of new ice with no form. Note that there is no partial concentration when only one ice type is represented in the egg.



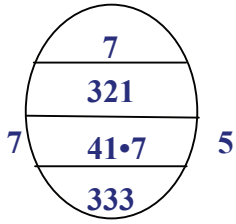
Example 2
4/10 of old ice in medium floes. New ice is also present with a concentration of less than 1/10.



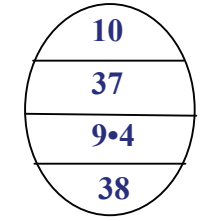
Example 3
6/10 total ice concentration. 2/10 thin first-year ice and 4/10 grey-white ice in medium floes. If more than one ice type is present, the partial concentration of each ice type must be indicated.



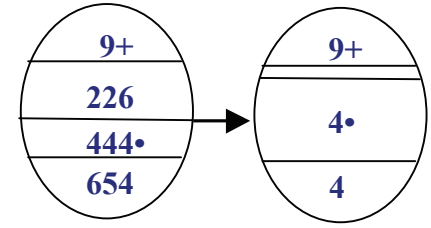
Example 4
7/10 total ice concentration. 3/10 thick first-year ice, 2/10 medium first-year ice and 1/10 thin first-year ice. All in small floes. Old ice with a concentration of less than 1/10 and 1/10 grey-white ice are also present.



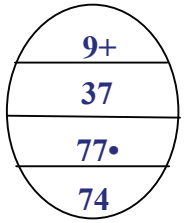
Example 5
Fast grey ice with 3/10 multi-year ice in small floes embedded.



Example 6
9+/10 total ice concentration. 2/10 thick first-year ice of vast floes, 2/10 thick first-year ice in big floes and 6/10 thick first-year ice of medium floes. Since 6/10 of the thick first-year ice has medium size floes, it represents the predominant floe size and will be indicated as such in the egg on the CIS chart.

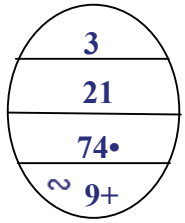


Example 7
9+/10 total ice concentration. 3/10 old ice of giant floes and 7/10 old ice of medium floes.

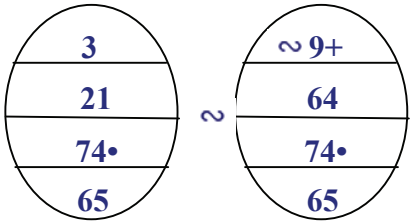


Strips and Patches

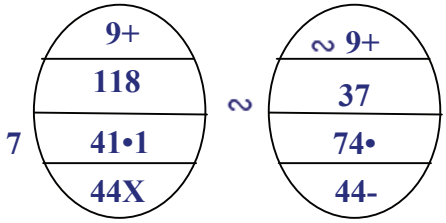
Example 8
3/10 total ice concentration. 2/10 old ice and 1/10 thick first-year ice. All ice is concentrated in strips and patches of 9+/10. Floe sizes are code 3 or less.



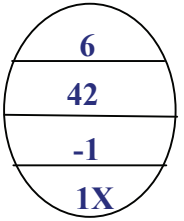
Example 9
3/10 total ice concentration in strips and patches of 9+/10. 6/10 old ice in vast floes and 4/10 thick first-year ice in big floes. These floe sizes are significant and warrant the use of two ovals.



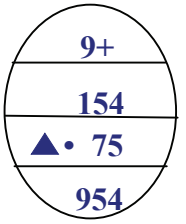
Example 10
9+/10 total ice concentration comprised of 1/10 thick first-year ice, 1/10 medium first-year ice, 8/10 new ice and old ice with a concentration of less than 1/10. The old and thick first-year ice are distributed throughout the area in strips and patches made up of 3/10 old and 7/10 thick first-year ice. All ice types in the second oval must be included in the first oval.



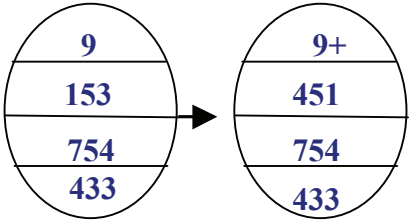
Example 11
6/10 total ice concentration. 4/10 brash and 2/10 new ice with no form.



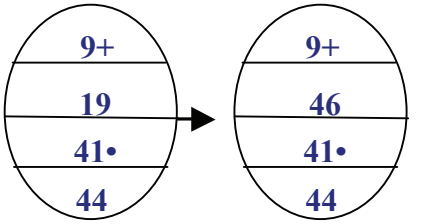
Example 12
9+/10 total ice concentration. 1/10 of ice of land origin (▲•) with floe size of 9 (icebergs). 5/10 thin first-year ice in big floes and 4/10 grey-white ice in medium floes.



Example 13
A discretionary boundary could be placed between these two eggs since the concentration of thin first-year ice varies by at least 3 tenths.



Example 14
A discretionary boundary could be placed between these two eggs since the partial concentrations of thick and medium first-year ice varies by at least 3 tenths.



5.7 Examples of Ice Charts

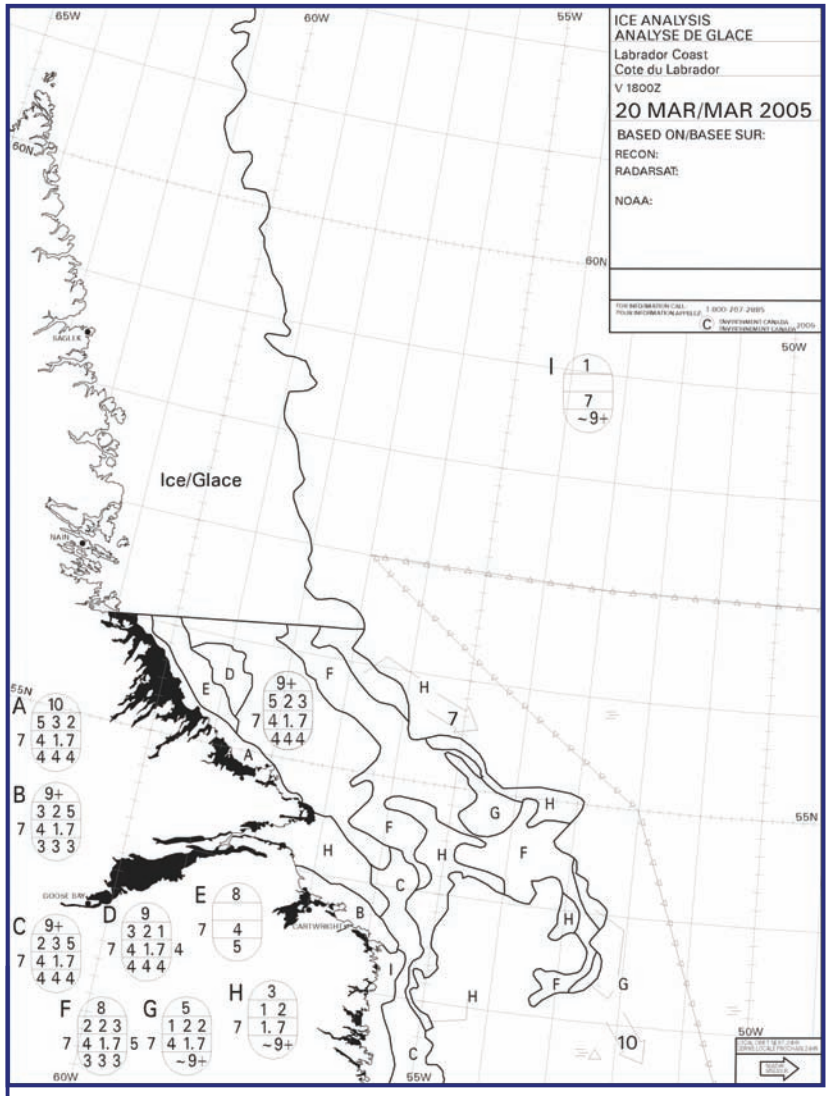


Figure 5.3: Black and White Daily Ice Chart

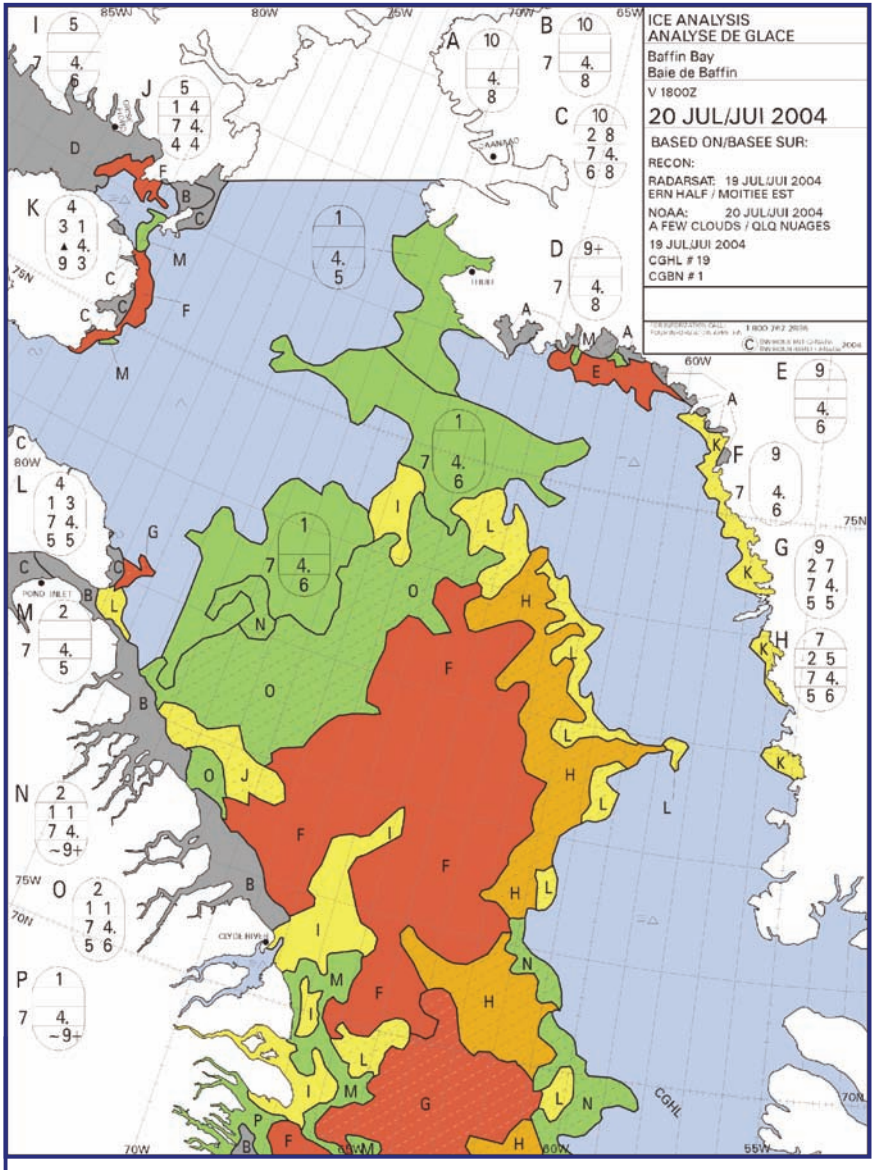


Figure 5.4: CIS/ISS Colour-Coded Daily Ice Chart

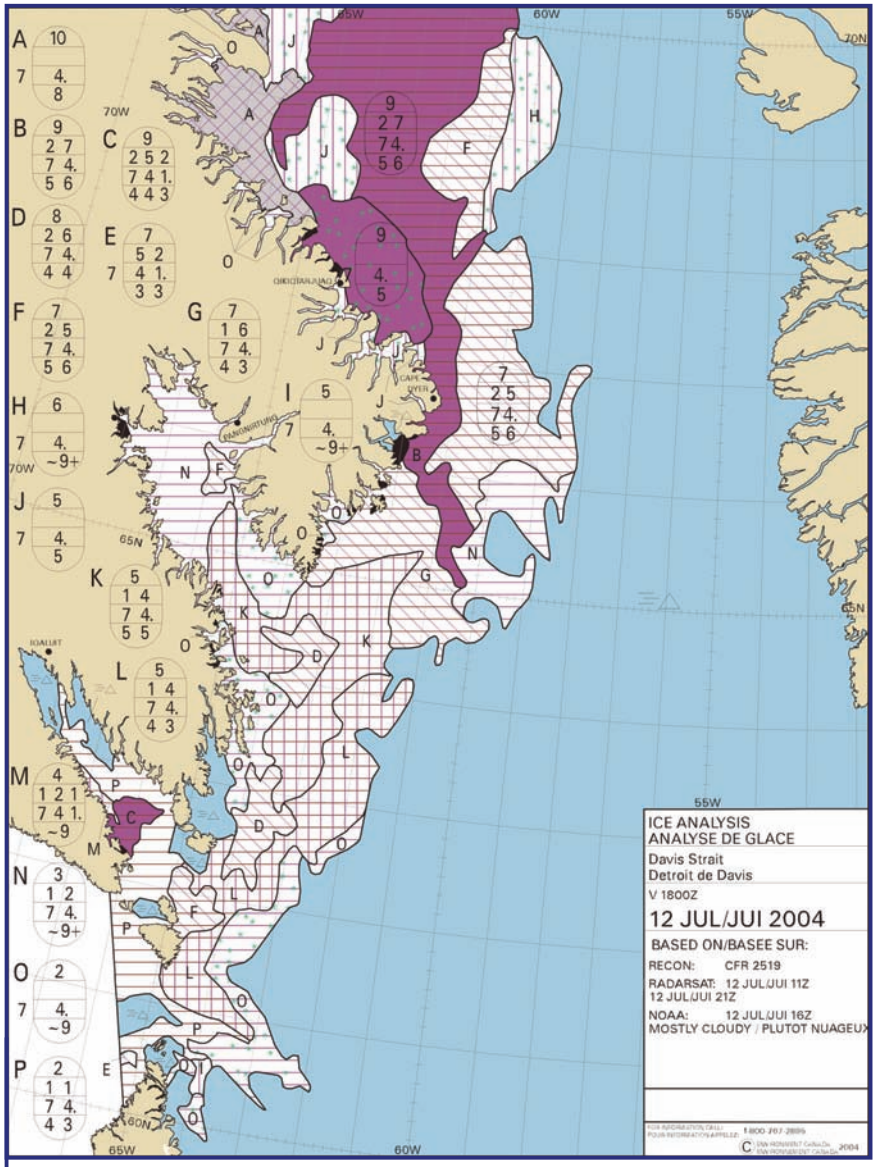


Figure 5.5: Q/A Colour-Coded Daily Ice Chart

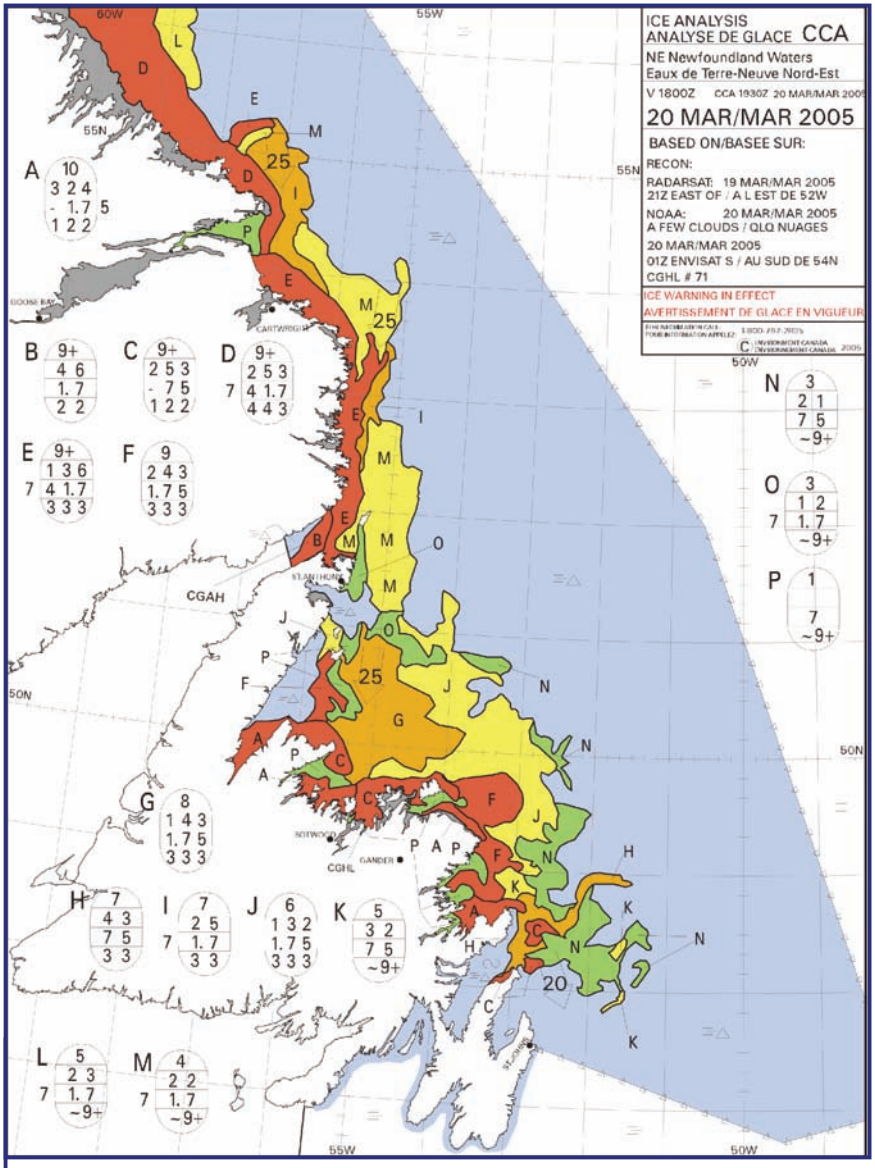


Figure 5.6: Example of Corrected/Ammended Chart

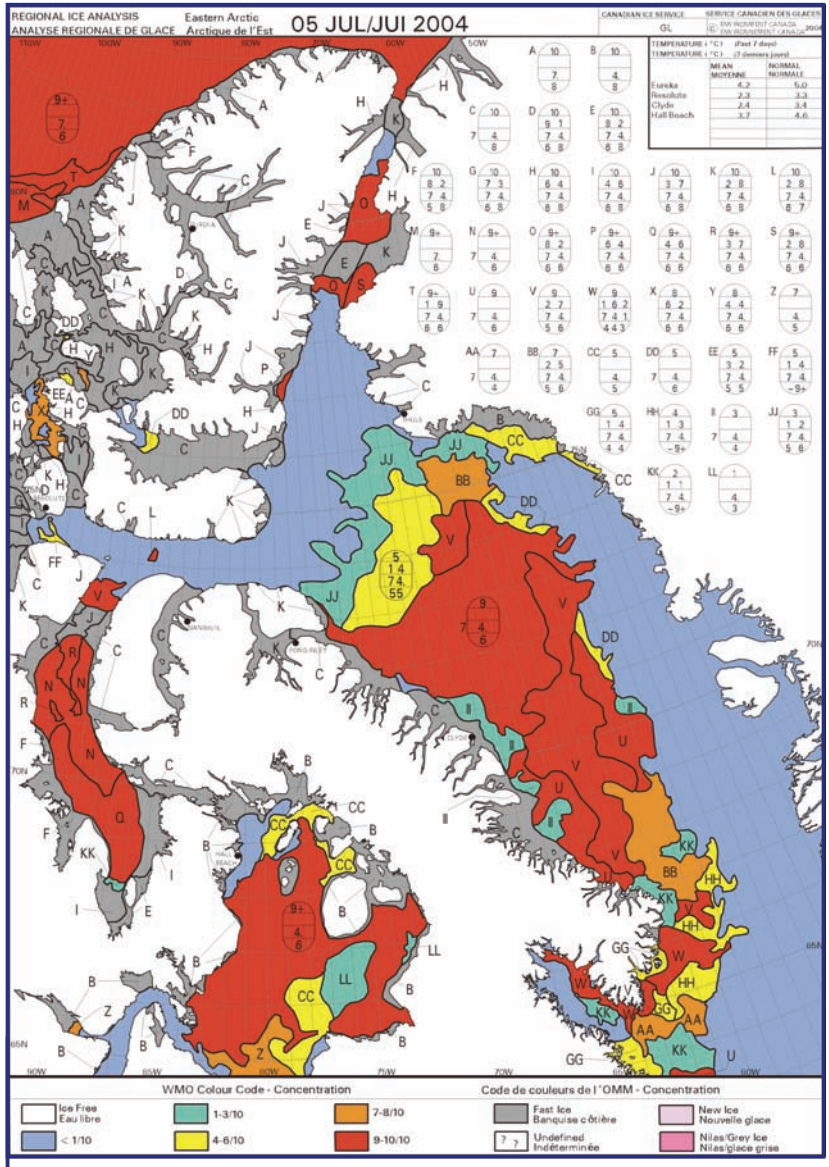


Figure 5.7: Eastern Arctic Regional Chart with WMO CT Colour Code

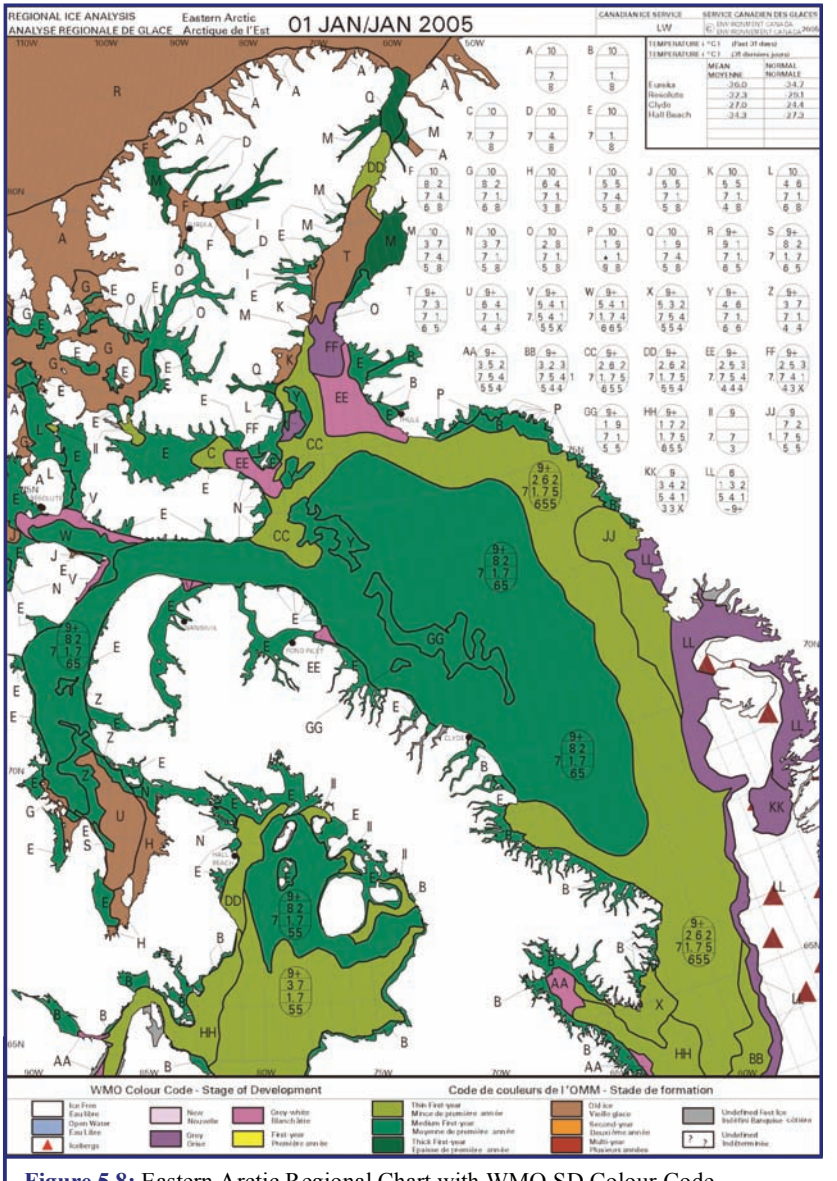


Figure 5.8: Eastern Arctic Regional Chart with WMO SD Colour Code

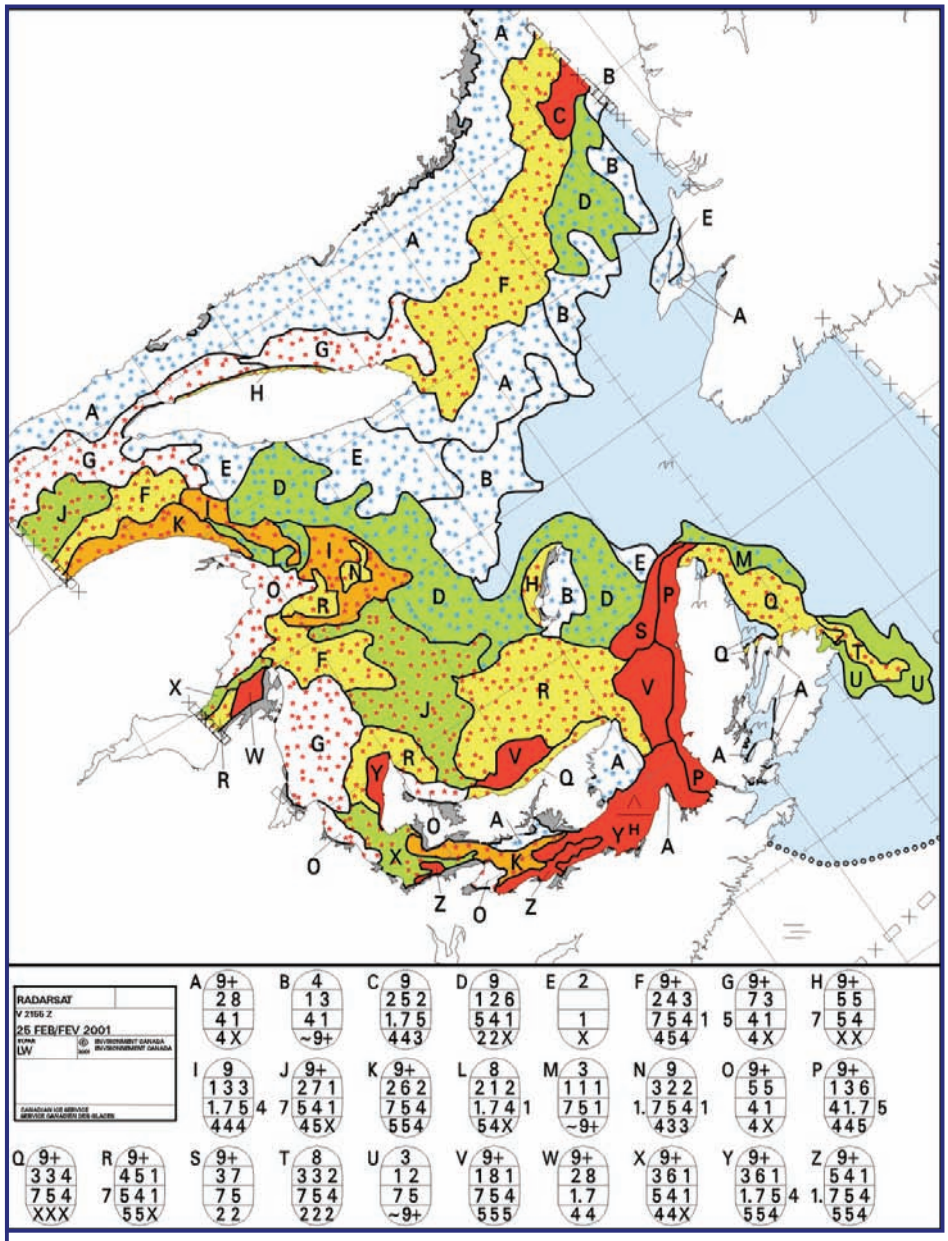


Figure 5.9: RADARSAT Image Analysis Chart

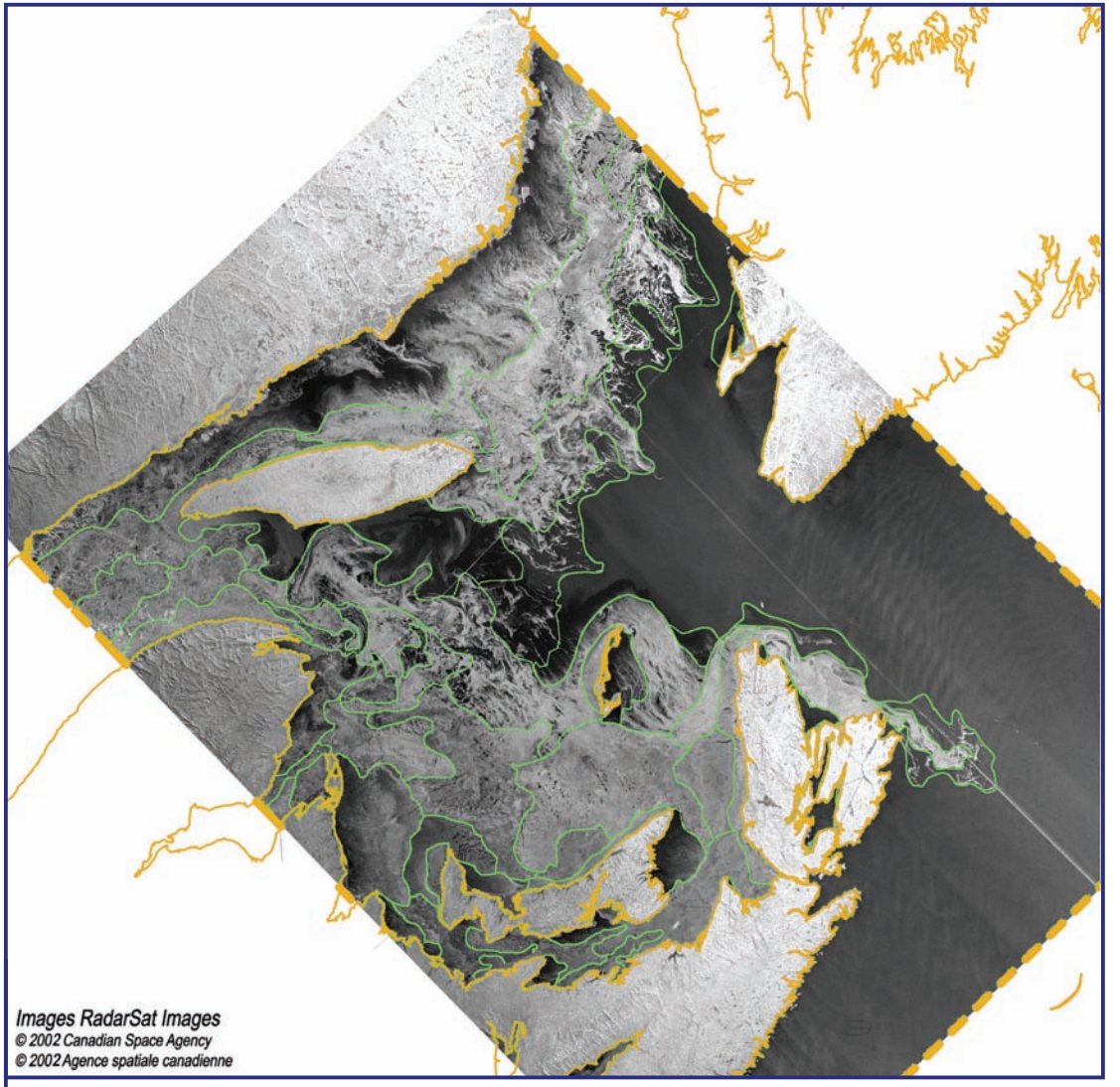


Figure 5.10: RADARSAT Image

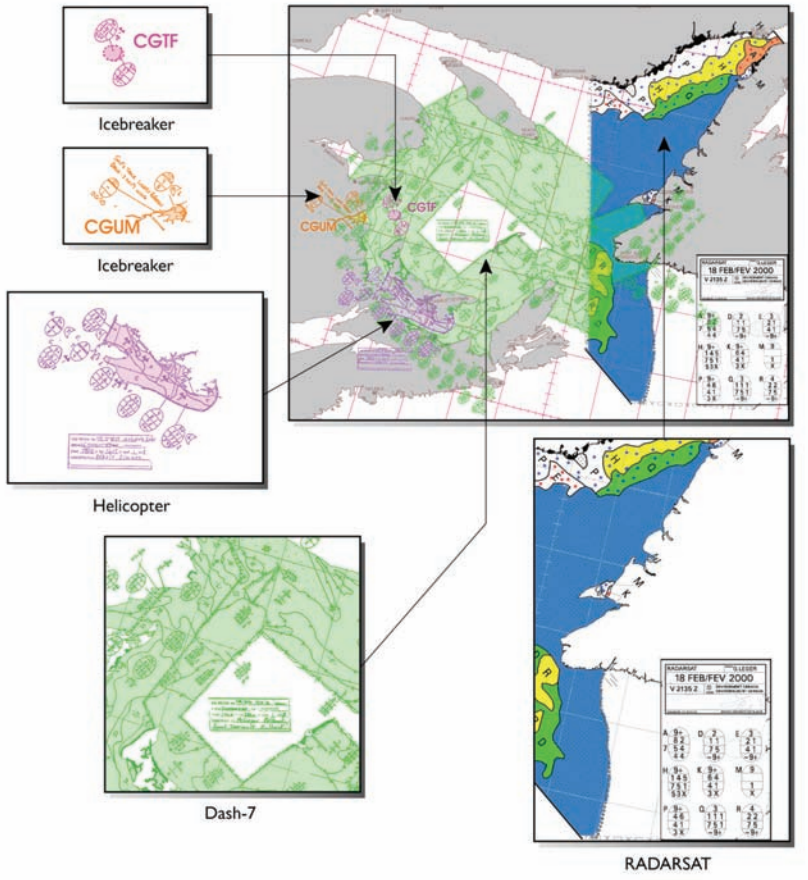


Figure 5.11: Data Sources

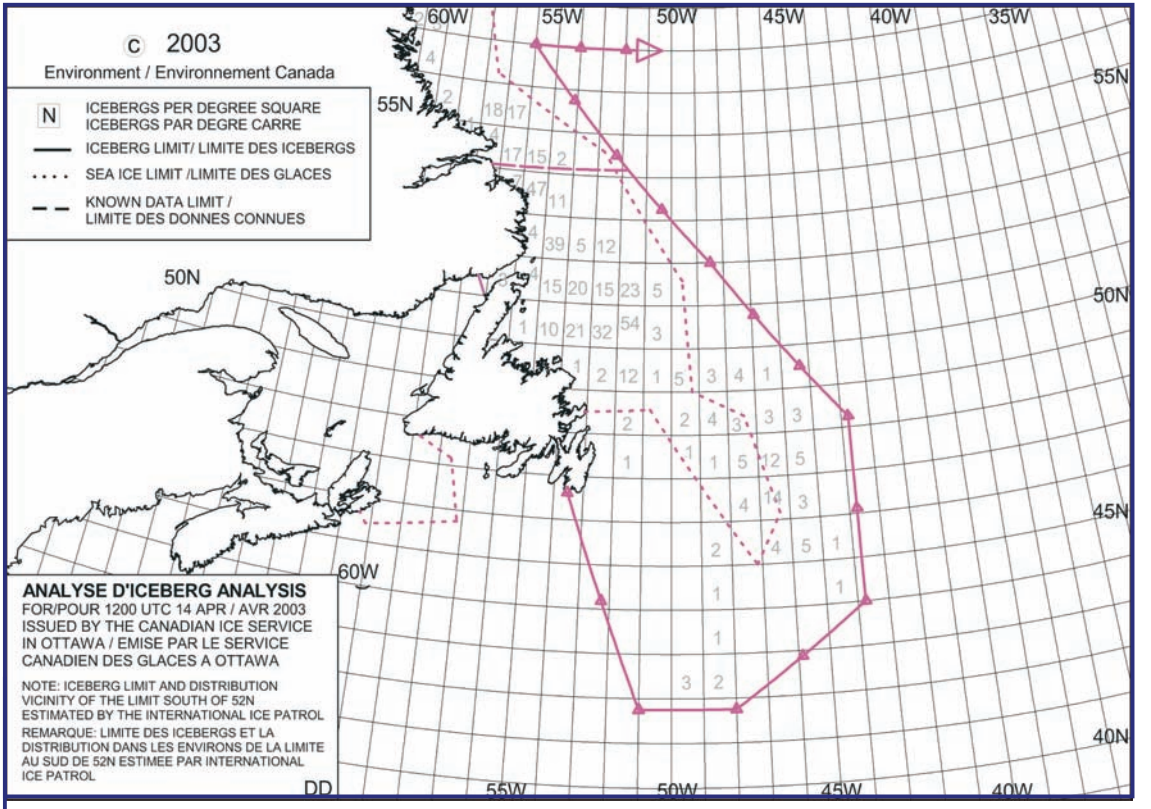


Figure 5.12: Example of a Daily Iceberg Analysis Chart