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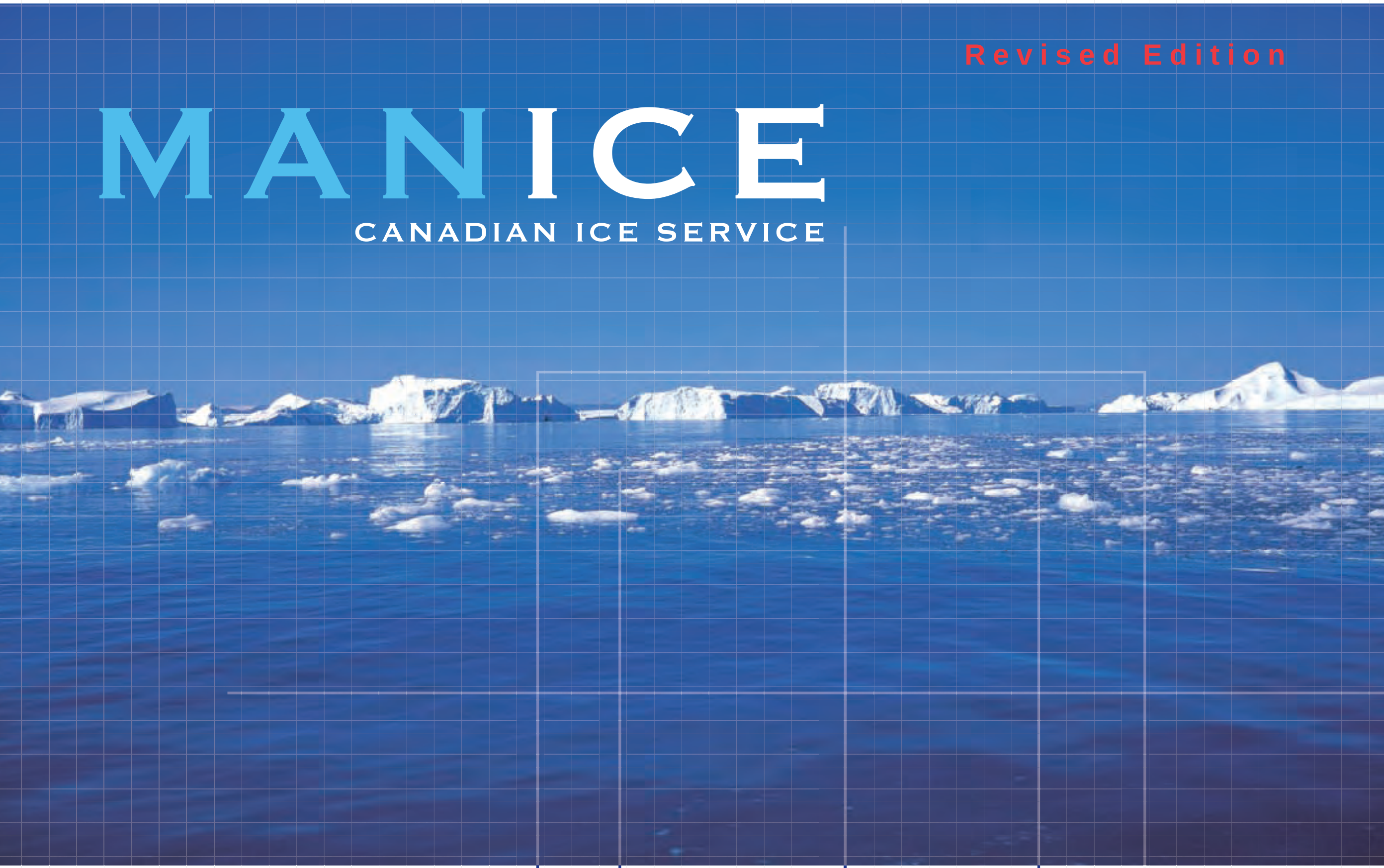
Revised Edition

MANICE

CANADIAN ICE SERVICE



MANUAL OF STANDARD PROCEDURES FOR OBSERVING AND REPORTING ICE CONDITIONS

Canada

MANICE

**Manual of Standard Procedures for
Observing and Reporting Ice Conditions**

Issuing authority:
Assistant Deputy Minister
Meteorological Service of Canada

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Meteorological Service of Canada

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2 Meteorological Service of Canada, *MANMAR*, *Manual of Marine Weather Observing*, Seventh Edition, Environment Canada, December 1996.

3 Meteorological Service of Canada, *MANTRANS*, *Meteorological Teletype Traffic*, Volume 1, First Edition, Environment Canada, Nov. 1983.

4 Meteorological Service of Canada, *SAR ICE INTERPRETATION GUIDE*, Environment Canada, 1990.

5 Meteorological Service of Canada, *SLAR USERS MANUAL*, First Edition, Environment Canada, 1991.

6 Canadian Coast Guard - Marine Communications and Traffic Services, *RADIO AIDS TO MARINE NAVIGATION*, Fisheries and Oceans Canada, 2005 (issued annually).

Forward

MANICE is the authoritative document for observing all forms of Sea, Lake and River Ice, as well as Ice of Land Origin. It describes the standard procedures of the Canadian Ice Service for observing, recording and reporting ice conditions.

MANICE has been prepared in accordance with internationally recommended terminology and symbology established by the World Meteorological Organization (WMO). It describes procedures that are completely compatible with WMO nomenclature (cf. 1), coding and observing practices, along with additional procedures, coding and symbology adapted for Canadian use or, in the case of icebergs, used in conjunction with the International Ice Patrol (IIP).

This manual has been reviewed, revised and updated by the Operations and Field Services divisions of the Canadian Ice Service. This document has been updated to reflect changes in technology, practices, colour codes and Iceberg message coding. Although amendments are required and important there were not enough significant changes to publish a completely new version of the standards manual. Therefore this edition will be considered a *revision* of version 9 published in April 2002.

Amendments and Corrections

Amendments and corrections will be issued when warranted. All holders of the manual are responsible for keeping their copies current. When amendments have been received, they should be recorded on page x (“Record of Amendments”).

Inquiries

Please direct any inquiries on the content of this manual to the Canadian Ice Service, through appropriate channels. Local changes or deviations from these instructions are not permitted unless authorized by the Assistant Deputy Minister, Meteorological Service of Canada.

Record of Amendments

AMENDMENT NO./DATE	INITIALS	DETAILS

Introduction

The information from ice observations is very important and serves many purposes and needs. Ice observations and carefully prepared records have long-range, as well as immediate value.

- Some people require up-to-the-minute information; for example, an icebreaker captain needs current ice reports and forecasts.

- Others require data having daily, monthly or long-term climatological significance; for instance, marine engineers require climatological and/or monthly data. The decision to construct a dock in a certain locality or the strengthening a vessel structure should have in order to withstand ice stress will depend on ice data obtained over a long period.

Ice observations may be made from:

- fixed-wing aircraft,
- the deck of a ship,
- a helicopter, or
- a shore base.

In each case, the perspective of the observer differs and adjustments need to be made to the observing procedures.

Since ice is a global phenomena, ice information must be freely exchanged between countries throughout the world. This requires coordination and standardization of practices and procedures and the efficient exchange of ice data. The WMO has undertaken these tasks, including promotion of further application of ice information services to shipping, marine resource activities and other human safety activities. The results have been international codes and standardized nomenclature and symbology.

To carry out resolutions and to discuss and coordinate ice activities within certain geographical areas, WMO Members are grouped in six Regional Associations, among which Region IV comprises Canada, the United States, Mexico and the Central American countries.

To meet special requirements, a Member or group of Members within a region may develop a special reporting procedure. For instance, the Great Lakes Ice Nomenclature was developed through bilateral agreement between Canada and the United States to meet the local requirements of shipping and other uses. Such codes or code changes are called "national practices".

Although international and national codes may both be used in ice reporting, ice messages for interregional broadcast must use the International Code.

This manual has been prepared with due consideration to the recommended practices and procedures set down by the World Meteorological Organization (cf. 1) and the Meteorological Service of Canada. All statements throughout this manual shall be regarded as authoritative and shall be considered by the observer to be instructions.

The word “shall” is used in this manual to indicate that instructions are mandatory and must be followed. The word "should" is used to denote a recommended practice.

An “Ice Services Specialist” (ISS) is a member of the Meteorological Service of Canada who is trained and qualified to make ice observations and reports, or a person authorized or qualified to do so by the Assistant Deputy Minister.

It is the duty of the observer to report ice conditions as they actually exist at the time of observation. He/she is responsible for keeping a close and continuous watch on the ice while on duty, and his/her records and reports shall be as complete and accurate as possible. Prompt and accurate reports are necessary for the provision of forecasts and ice-warning services, and may be the means of preventing property damage and loss of life. Delayed reports are of less value for forecasting and for operational decision-making. However, if communication or other difficulties delay or prevent distribution of reports, the observer shall continue to observe the ice and record the observations for later transmission. Before finally being transferred to the Canadian Ice Service archives, observed ice data is subjected to an analysis or review, which may reveal errors.

The observer must be competent and trained to make observations accurately and to code and chart the resulting reports for transmission as quickly as possible. He/she should realize, however, that it is neither possible nor desirable to prepare detailed instructions to cover reporting and coding of ice in all of its forms. Therefore, initiative and resourcefulness in dealing with unusual conditions are most important in observing ice.

Data held at the Canadian Ice Service in Ottawa is used in the preparation of official publications, and by both government and industry in the preparation of statistical analyses for decision-making purposes. The accuracy of the archived data determines, to a large degree, the quality of the publication or analysis; it is therefore extremely important to take suitable measures to ensure that observed data is of the highest quality consistent with reasonable cost.

This manual deals principally with procedures for the visual observation of ice from various platforms. Where appropriate, electronic aids such as airborne or satellite radar for ice data collection are referred to; however, for a much more detailed description of SLAR (Side Looking Airborne Radar) and SAR (Synthetic Aperture Radar) technical operation and image interpretation, please refer to the following documents:

- SLAR Users Manual (cf. 5), and
- SAR Ice Interpretation Guide (cf. 4).

These guides are also available from the Canadian Ice Service.

The terminology has been prepared with the needs of the international marine community in mind; it is therefore highly oriented toward terms relating to sea ice and ice of land origin found at sea. Nevertheless, many of the terms apply equally to lake ice and/or river ice, particularly those relating to floe sizes and ice-dynamic processes. A section on lake ice nomenclature has been added, and this manual is now the authoritative guide for observing all types of floating ice, including ice of land origin.

CHAPTER 1

General Terminology

- Floating Ice
- Stages of Development of Sea Ice
- Stages of Development of Lake Ice
- River Ice
- Ice of Land Origin
- Forms of Ice
- Arrangement of the Ice
- Ice Surface Features
- Stages of Melting
- Terms Related to Navigation


C-GCFR (CIS)

Photo 1.1: Fast ice forming in harbour

1.1 Floating Ice

Any form of ice found floating in water. The principal kinds of floating ice are lake ice, river ice and sea ice which form by the freezing of water at the surface and glacier ice formed on land or in an ice shelf. This term includes ice that is stranded or grounded.

Sea Ice: Any form of ice found at sea which has originated from the freezing of water

Lake Ice: Ice formed on a lake, regardless of observed locations.

River Ice: Ice formed on a river, regardless of observed location.

Ice of Land Origin: Ice formed on land or in an ice shelf, found floating in water.

1.2 Stages of Development of Sea Ice

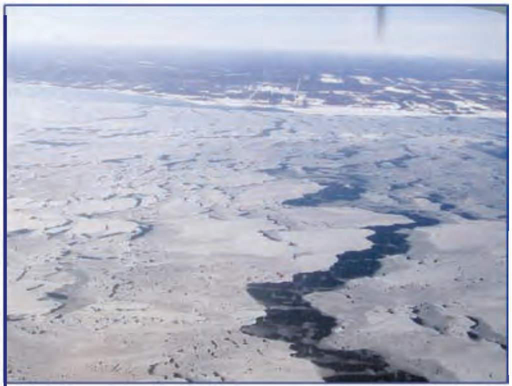
1.2.1 New Ice: A general term for recently formed ice which includes frazil ice, grease ice, slush and shuga. These types of ice are composed of ice crystals which are only weakly frozen together (if at all) and have a definite form only while they are afloat.

Frazil Ice: Fine spicules or plates of ice suspended in water.

Grease Ice: A later stage of freezing than frazil ice where the crystals have coagulated to form a soupy layer on the surface. Grease ice reflects little light, giving the water a matte appearance.

Slush: Snow which is saturated and mixed with water on land or ice surfaces or as a viscous floating mass in water after a heavy snowfall.

Shuga: An accumulation of spongy white ice lumps having a diameter of a few centimeters across; they are formed from grease ice or slush and sometimes from anchor ice rising to the surface.



C-GCFR (CIS)

Photo 1.2: Very close pack light nilas and new ice

1.2.2 Nilas: A thin elastic crust of ice, easily bending on waves and swell and under pressure growing in a pattern of interlocking “fingers” (finger rafting). Nilas has a matte surface and is up to 10 cm in thickness and may be subdivided into dark nilas and light nilas.

Dark Nilas: Nilas up to 5 cm in thickness and which is very dark in colour.

Light Nilas: Nilas which is more than 5 cm in thickness and lighter in colour than dark nilas.

Ice Rind: A brittle, shiny crust of ice formed on a quiet surface by direct freezing or from grease ice, usually in water of low salinity. It has a thickness of about 5 cm. Easily broken by wind or swell, commonly breaking into rectangular pieces.

1.2.3 Young Ice: Ice in the transition stage between nilas and first-year ice, 10-30 cm in thickness. May be subdivided into grey ice and grey-white ice.

Grey Ice: Young ice 10-15 cm thick, less elastic than nilas and breaks on swell. It usually rafts under pressure.

Grey-White Ice: Young ice 15-30 cm thick. Under pressure it is more likely to ridge than to raft.

1.2.4 First-year Ice: Sea ice of not more than one winter’s growth, developing from young ice; 30 cm or greater. It may be subdivided into thin first-year ice – sometimes referred to as white ice –, medium first-year ice and thick first-year ice.

Don Isaacs (CIS)

Photo 1.3: Container ship tracking through a large pan of thin first-year ice

Thin First-year Ice/White Ice - First Stage:	30-50 cm thick.
Thin First-year Ice/White Ice - Second Stage:	50-70 cm thick.
Medium First-year Ice:	70-120 cm thick.
Thick First-year Ice:	Greater than 120 cm thick.

1.2.5 Old Ice: Sea ice which has survived at least one summer's melt. Topographic features generally are smoother than first-year ice. It may be subdivided into second-year ice and multi-year ice.

Second-year Ice: Old ice which has survived only one summer's melt. Thicker than first-year ice, it stands higher out of the water. In contrast to multi-year ice, summer melting produces a regular pattern of numerous small puddles. Bare patches and puddles are usually greenish-blue.

Multi-year Ice: Old ice which has survived at least two summer's melt. Hummocks are smoother than on second-year ice and the ice is almost salt-free. Where bare, this ice is usually blue in colour. The melt pattern consists of large interconnecting, irregular puddles and a well-developed drainage system.

1.3 Stages of Development of Lake Ice

New Lake Ice:	Recently formed ice less than 5 cm thick.
Thin Lake Ice:	5-15 cm thick.
Medium Lake Ice:	15-30 cm thick.
Thick Lake Ice:	30-70 cm thick.
Very Thick Lake Ice:	Greater than 70 cm thick.

CIS Archives

Photo 1.4: Large pans of old ice showing secondary drainage pattern and puddling

1.4 River Ice

Because of the effect of salinity on the ice formation process, ice shall be coded as follows: ice which forms in water with a salinity of more than 24.7 parts per thousand will be coded as sea ice; otherwise the lake ice code is used. In the St. Lawrence River it is Canadian practice to use sea ice terminology down river from St. Lambert lock and lake ice terminology up river from St. Lambert lock, unless otherwise noted.

1.5 Ice of Land Origin

1.5.1 Terminology

Firn: Old snow which has recrystallized into a dense material. Unlike ordinary snow, particles are to some extent joined together; but, unlike ice, the air spaces in it still connect with each other.

Glacier Ice: Ice in or originating from a glacier, whether on land or floating on the sea as icebergs, bergy bits, growlers or ice islands.

Glacier: A mass of snow and ice continuously moving from higher to lower ground or, if afloat, continuously spreading. The principal forms of glaciers are: inland ice sheets, ice shelves, ice streams, ice caps, ice piedmonts, cirque glaciers and various types of mountain (valley) glaciers.

Ice Wall: An ice cliff forming the seaward margin of a glacier which is aground. The rock basement being at or below sea level (see “ice front”, below). The term also includes the seaward face of non-active glaciers.

Ice Stream: Part of an inland ice sheet in which the ice flows more rapidly and not necessarily in the same direction as the surrounding ice. Margins are sometimes clearly marked by a change in direction of the surface slope but may be indistinct.

Glacier Tongue: Projecting seaward extension of a glacier, usually afloat. In the Antarctic, glacier tongues may extend over many tens of kilometres.

Iceberg Tongue: A major accumulation of icebergs projecting from the coast, held in place by grounding and joined together by fast ice.

Ice Shelf: A floating ice sheet of considerable thickness showing 2 m or more above sea level, attached to the coast. They usually have great horizontal extent and a level or gently undulating surface. Ice shelf growth occurs by annual snow accumulation and also by the seaward extension of land glaciers. Limited areas may be aground. The seaward edge is termed an ice front.

Ice Front: The vertical cliff forming the seaward face of an ice shelf or other floating glacier, varying in height from 2 to 50 m or more above sea level.

Calving: The breaking away of a mass of ice from an ice wall, ice front or iceberg.

Iceberg: A massive piece of ice of greatly varying shape, protruding 5 m or more above sea level, which has broken away from a glacier and which may be afloat or aground. They may be described as tabular, domed, pinnacled, wedged, drydocked or blocky. Sizes of icebergs are classed as small, medium, large and very large.

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Photo 1.5: Pinnacled iceberg

1.5.2 Shapes of Calved Ice of Land Origin

Tabular Iceberg: A flat-topped iceberg. Most show horizontal banding.

Domed Iceberg: An iceberg which is smooth and rounded on top.

Pinnacled Iceberg: An iceberg with a central spire or pyramid, with one or more spires.

Wedged Iceberg: An iceberg which is rather flat on top and with steep vertical sides on one end, sloping to lesser sides on the other end.

Drydocked Iceberg: An iceberg which is eroded such that a U-shaped slot is formed near or at water level, with twin columns or pinnacles.

Blocky Iceberg: A flat-topped iceberg with steep vertical sides.

1.5.3 Sizes of Calved Ice of Land Origin

Growler: Piece of ice smaller than a bergy bit and floating less than 1 m above the sea surface, a growler generally appears white but sometimes transparent or blue-green in colour. Extending less than 1 m above the sea surface and normally occupying an area of about 20 sq. m., growlers are difficult to distinguish when surrounded by sea ice or in high sea state.

Bergy Bit: A piece of glacier ice, generally showing 1 to less than 5 m above sea level, with a length of 5 to less than 15 m. They normally have an area of 100-300 sq. m.

Small Iceberg: A piece of glacier ice extending 5 to 15 m above sea level and with a length of 15 to 60 m.

Medium Iceberg: A piece of glacier ice extending 16 to 45 m above sea level and with a length of 61 to 120 m.

Large Iceberg: A piece of glacier ice extending 46 to 75 m above sea level and with a length of 121 to 200 m.

Very Large Iceberg: A piece of glacier ice extending more than 75 m above sea level and with a length of more than 200 m.

Ice Island: A large piece of floating ice protruding about 5 m above sea level, which has broken away from an Arctic ice shelf. They have a thickness of 30-50 m and an area of from a few thousand square metres to 500 sq. km or more. They are usually characterized by a regularly undulating surface giving a ribbed appearance from the air.

Ice Island Fragment: Piece of an ice island that has broken away from the main mass.

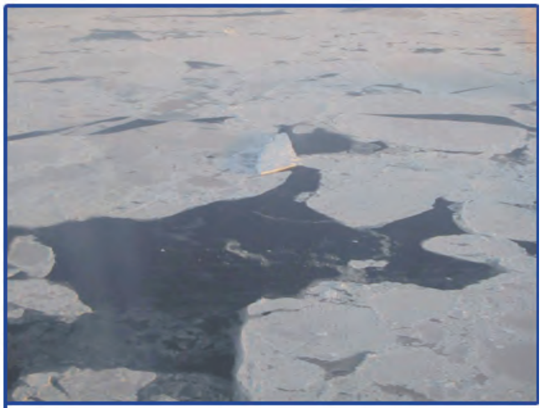

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Photo 1.6: Ice island fragment seen from the air.

1.6 Forms of Ice

1.6.1 Pancake Ice: Predominantly circular pieces of ice 30 cm to 3 m in diameter, up to 10 cm in thickness, with raised rims due to the pieces striking against one another. It may form on a slight swell from grease ice, shuga or slush or as a result of the breaking of ice rind, nilas or, under severe conditions of swell or waves, of grey ice. It also sometimes forms at some depth at an interface between water bodies of different physical characteristics where it floats to the surface. It may rapidly form over wide areas of water.

1.6.2 Ice Cake: Any relatively flat piece of ice less than 20 m across.

Small Ice Cake: An ice cake less than 2 m across.

1.6.3 Floe: Any relatively flat piece of ice 20 m or more across. Floes are subdivided according to horizontal extent as follows:

Small:	20-100 m across.
Medium:	100-500 m across.
Big:	500-2,000 m across.
Vast:	2-10 km across.
Giant:	Greater than 10 km across.

1.6.4 Floeberg: A massive piece of ice composed of a hummock or a group of hummocks, frozen together and separated from any surrounding ice. They may typically protrude up to 5 m above water level.

1.6.5 Ice Breccia: Ice pieces of different stages of development frozen together.

1.6.6 Batture Floes: Large, thick, uneven and discoloured ice floes that form on the upstream side of shoals and islets in rivers when cold weather precedes or accompanies neap tides. Composed of ice of different thicknesses formed under pressure during ebb tide, the whole mass freezing together and gradually increasing in size with each successive tide. As the range increases between the neap and spring tides, large sections of grounded ice break away and drift down river. This is a Canadian description and not part of the WMO nomenclature.

1.6.7 Brash Ice: Accumulation of floating ice made up of fragments not more than 2 m across, the wreckage of other forms of ice.

Jammed Brash Barrier: A strip or narrow belt of new, young or brash ice usually 100-5000 m across formed at the edge of either floating or fast ice or at the shore. Heavily compacted, mostly due to wind action, may extend 2 to 20 m below the surface, but does not normally have appreciable topography. Jammed brash barriers may disperse with changing winds, but can also consolidate to form a strip of unusually thick ice in comparison to the surrounding ice.

Agglomerated Brash: This term is similar to Jammed Brash Barrier but is not consolidated. This is a Canadian description and not part of the WMO nomenclature

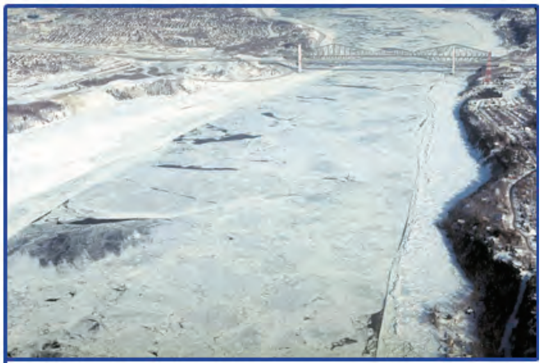

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Photo 1.7: View of Québec City bridges with nilas and grey ice mixed with thin brash moving down under the bridge. Extensive fast ice (battures) has formed on both sides of the river.

1.6.8 Fast Ice: Ice which forms and remains fast along the coast. It may be attached to the shore, to an ice wall, to an ice front, between shoals or grounded icebergs. Vertical fluctuations may be observed during changes of sea level. It may be formed "in-situ" from water or by freezing of floating ice of any age to shore and can extend a few metres or several hundred kilometres from the coast. It may be more than one year old in which case it may be prefixed with the appropriate age category (old, second-year or multi-year). If higher than 2 m above sea level, it is called an ice shelf.

Young Coastal Ice: The initial stage of fast ice formation consisting of nilas or young ice; its width varying from a few metres up to 100-200 m from the shoreline.

1.6.9 Icefoot: A narrow fringe of ice attached to the coast, unmoved by tides and remaining after the fast ice has moved away.

1.6.10 Anchor Ice: Submerged ice attached or anchored to the bottom, irrespective of the nature of its formation.

1.6.11 Grounded Ice: Floating ice which is aground in shoal water.

Stranded Ice: Ice which had been floating and has been deposited on the shore by retreating high water.

Grounded Hummock: A hummocked, grounded ice formation. There are single grounded hummocks and lines (or chains) of grounded hummocks.

1.7 Arrangement of the Ice

1.7.1 Drift Ice/Pack Ice: Term used in a wide sense to include any area of ice, other than fast ice, no matter what form it takes or how it is disposed. When concentrations are high, i.e., 7/10 or more, the term pack ice is normally used. When concentrations are 6/10 or less the term drift ice is normally used.

1.7.2 Ice Cover: The ratio of an area of ice to the total area of water surface within some large geographic locality. This locality may be global, hemispheric or prescribed by a specific oceanographic entity such as Baffin Bay or the Barents Sea.

1.7.3 Concentration: The ratio expressed in tenths describing the area of the water surface covered by ice as a fraction of the whole area. Total concentration includes all stages of development that are present; partial concentration refers to the amount of a particular stage or of a particular form of ice and represents only a part of the total.

Consolidated Ice: Floating ice in which the concentration is 10/10 and the floes are frozen together.

Compact Ice: Floating ice in which the concentration is 10/10 and no water is visible.

Very Close Pack/Drift: Floating ice in which the concentration is 9/10 to less than 10/10.

Close Pack/Drift: Floating ice in which the concentration is 7/10 to 8/10, composed of floes mostly in contact with one another.

Open Drift: Floating ice in which the concentration is 4/10 to 6/10, with many leads and polynyas. Floes generally not in contact with one another.

Very Open Drift: Ice in which the concentration is 1/10 to 3/10 and water dominates over ice.

Open Water: A large area of freely navigable water in which ice is present in concentrations less than 1/10. No ice of land origin is present.

Bergy Water: An area of freely navigable water in which ice of land origin is present. Other ice types may be present, although the total concentration of all other ice is less than 1/10.

Ice Free: No ice present. If ice of any kind is present, this term shall not be used.

1.7.4 Ice Distribution:

Ice Field: Area of floating ice, consisting of any size of floes and greater than 10 km across.

Large Ice Field: An ice field over 20 km across.

Medium Ice Field: An ice field 15-20 km across.

Small Ice Field: An ice field 10-15 km across.

Ice Patch: An area of ice less than 10 km across.

Ice Massif: A variable accumulation of pack or very close pack, covering hundreds of square kilometres and found in the same region every summer.

Belt: A large feature of pack/drift ice arrangement longer than it is wide; from 1 km to more than 100 km in width.

Tongue: A projection of the ice edge up to several kilometres in length, caused by wind or current.

Strip: Long narrow area of pack/drift ice, about 1 km or less in width, usually composed of small fragments detached from the main mass of ice, which run together under the influence of wind, swell or current.

Bight: Extensive crescent-shaped indentation in the ice edge formed by either wind or current.

Ice Jam: An accumulation of broken river ice or sea ice not moving due to some physical restriction and resisting to pressure.

1.7.5 Openings in the Ice:

Fracture: Any break or rupture through very close pack ice, compact ice, consolidated ice, fast ice or a single floe resulting from deformation processes. Fractures may contain brash ice and/or be covered with nilas and/or young ice. Their lengths may vary from a few metres to many kilometres.

Fracture Zone: An area which has a great number of fractures. Fractures are subdivided as follows:

Very Small Fracture:	1 to 50 m wide.
Small Fracture:	50 to 200 m wide.
Medium Fracture:	200 to 500 m wide.
Large Fracture:	Greater than 500 m wide.

Crack: Any fracture of fast ice, consolidated ice or a single floe which may have been followed by separation ranging from a few centimetres to 1 m.

Tide Crack: Crack at the line of junction between an immovable ice foot or ice wall and fast ice, the latter subject to rise and fall of the tide.

Flaw: A narrow separation zone between floating ice and fast ice, where the pieces of ice are in a chaotic state. Flaws form when ice shears under the effect of a strong wind or current along the fast ice boundary.

Lead: Any fracture or passageway through ice which is navigable by surface vessels.

Shore Lead: A lead between ice and the shore or between ice and an ice front.

Flaw Lead: A passageway between ice and fast ice which is navigable by surface vessels.

Polynya: Any non-linear shaped opening enclosed by ice. May contain brash ice and/or be covered with new ice, nilas or young ice; sub-mariners refer to these as skylights.

Shore Polynya: A polynya between ice and the coast or between ice and an ice front.

Flaw Polynya: A polynya between ice and fast ice.

Recurring Polynya: A polynya which recurs in the same position every year.

1.7.6 Ice Edge: The demarcation at any given time between open water and sea, lake or river ice whether fast or drifting.

Compacted Ice Edge: Clear-cut ice edge compacted by wind or current, usually on the windward side of an area of ice.

Diffuse Ice Edge: Poorly defined ice edge limiting an area of dispersed ice, usually on the leeward side of an area of ice.

Ice Limit: Climatological term referring to the extreme minimum or extreme maximum extent of the ice edge in any given month or period based on observations over a number of years. This term should be preceded by minimum or maximum.

Mean Ice Edge: Average position of the ice edge in any given month or period based on observations over a number of years. Other terms which may be used are mean maximum ice edge and mean minimum ice edge.

Median Ice Edge: The position of the ice edge where its frequency of occurrence is fifty percent.

Fast Ice Edge: The demarcation at any given time between fast ice and open water.

1.7.7 Ice Boundary: The demarcation at any given time between fast ice and floating ice or between areas of ice of different concentrations, types and/or floe sizes.

Fast Ice Boundary: The ice boundary at any given time between fast ice and the pack/drift ice.

Concentration Boundary: A line approximating the transition between two areas of floating ice with different concentrations.

1.7.8 Iceberg Limit: The limit at any given time between ice of land origin and the open sea or sea ice.

Limit of all known Ice: The limit at any given time between icebergs and/or sea-ice infested waters and ice-free waters.

Mean Iceberg Limit: Average position of the limit of icebergs at any given time based on observations over a number of years.

Median Iceberg Limit: The position where the historical or statistical frequency of occurrence of the iceberg limit is fifty percent.

Minimum Iceberg Limit: Minimum limit of icebergs based on observations over a period of years.

Maximum Iceberg Limit: Maximum limit of icebergs based on observations over a period of years.

1.8 Ice Surface Features

1.8.1 Level Ice: Ice unaffected by deformation.

1.8.2 Deformed Ice: A general term for ice which has been squeezed together and in places forced upwards and downwards. Subdivisions are rafted ice, ridged ice and hummocked ice.

Rafted Ice: Type of deformed ice formed by one piece of ice overriding another.

Finger Rafted Ice: Type of rafted ice in which floes thrust “fingers” alternately over and under the other, common in nilas.

Ridge: A line or wall of broken ice forced up by pressure. It may be fresh or weathered. The submerged volume of broken ice under a ridge, forced downwards by pressure, is termed an ice keel.

New Ridge: Ridge with sharp peaks and slope of sides usually 40 degrees or more. Fragments are visible from the air at low altitude.

CIS Archives

Photo 1.8: Coast Guard buoy tender/icebreaker escorts small freighter through thoroughly rafted grey ice.

Weathered Ridge: Ridge with peaks slightly rounded and slope of sides usually 30 to 40 degrees. Individual fragments are not discernible.

Very Weathered Ridge: Ridge with tops very rounded. Slope of sides usually 20 to 30 degrees.

Aged Ridge: Ridge which has undergone considerable weathering. These ridges are best described as undulations.

Consolidated Ridge: A ridge in which the base has frozen together.

Ridged Ice: Ice piled haphazardly one piece over another in the form of ridges or walls. Usually found in first-year ice.

Ridged Ice Zone: An area of many ridges with similar characteristics (rubble field).

Hummock: A hillock of broken ice which has been forced upwards by pressure. May be fresh or weathered. The submerged volume of broken ice under the hummock, forced downwards by pressure, is termed a bummock.

Hummocked Ice: Ice piled haphazardly one piece over another to form an uneven surface. When weathered it has the appearance of smooth hillocks.

1.8.3 Other Surface Feature Definitions:

Standing Floe: A separate floe standing vertically or inclined and enclosed by rather smooth ice.

Ram: An underwater ice projection from an ice wall, ice front, iceberg or floe. Its formation is usually due to a more intensive melting and erosion of the unsubmerged part.

Bare Ice: Ice without snow cover.

Snow-Covered Ice: Ice covered with snow.

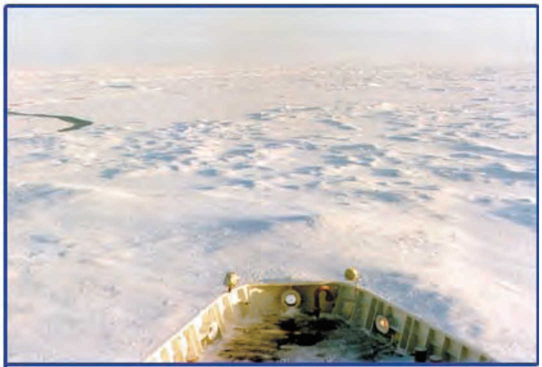
Sastrugi: Sharp, irregular ridges formed on a snow surface by wind erosion and deposition. On mobile floating ice the ridges are parallel to the direction of the prevailing wind at the time they were formed.

Snowdrift: An accumulation of wind-blown snow deposited in the lee of obstructions or heaped by wind eddies. A crescent-shaped snowdrift, with ends pointing down-wind, is called a snow barchan.

1.8.4 Ice Deformation Processes:

Fracturing: Pressure process whereby ice is permanently deformed and rupture occurs. This term is most commonly used to describe breaking across very close ice, compact ice and consolidated ice.

Hummocking: Pressure process by which ice is forced into hummocks. When the floes rotate in the process it is termed screwing.



Don Isaacs (CIS)

Photo 1.9: Embedded floes of snow-covered old ice

Ridging: The pressure process by which ice is forced into ridges.

Rafting: Pressure process whereby one piece of ice overrides another. Most common in new and young ice.

Finger Rafting: Type of rafting whereby interlocking thrusts are formed like "fingers" alternately over and under the other. This is commonly found in nilas and in grey ice.

Weathering: Processes of ablation and accumulation which gradually eliminate irregularities in an ice surface.

1.8.5 Ice Motion Processes:

Diverging: Ice fields or floes in an area that are subjected to a diverging motion, reducing ice concentration and/or relieving stresses in the ice.

Compacting: Pieces of floating ice are said to be compacting when subjected to a converging motion, which increases ice concentration and/or produces stresses which may result in ice deformation.

Shearing: An area of floating ice is subject to shear when the ice motion varies significantly in the direction normal to the motion, subjecting the ice to rotational forces. These forces may result in phenomena similar to a flaw.

1.9 Stages of Melting

Puddle: An accumulation of water on ice, mainly due to melting snow, but in the more advanced stages also to the melting of ice.

Thaw Holes: Vertical holes in ice formed when surface puddles melt through to the underlying water.

Dried Ice: Ice surface from which water has disappeared after the formation of cracks and thaw holes. During the period of drying the surface whitens.

Rotten Ice: Ice which has become honeycombed and is in an advanced state of disintegration.

Flooded Ice: Ice which has been flooded and is heavily loaded by water or water and wet snow.

CIS Archives

Photo 1.10: Vast pan of first-year ice, with extensive puddling and thaw holes

1.10 Terms Related to Navigation

1.10.1 Sky and Air Indications:

Water Sky: Dark streaks on the underside of low clouds, indicating the presence of water features in the vicinity of ice.

Ice Blink: A whitish glare on low clouds above an accumulation of distant ice.

Frost Smoke: Fog-like clouds formed by the contact of cold air with relatively warm water. These can appear over openings in the ice or leeward of the ice edge and may persist while ice is forming.

1.10.2 Terms related to Surface Shipping:

Beset: Situation in which a vessel is surrounded by ice and unable to move.

Ice-Bound: A harbour, inlet, etc., is said to be ice-bound when navigation by ships is prevented, on account of ice, except possibly with the assistance of an icebreaker.

Nip: Ice is said to nip when it forcibly presses against a ship. A vessel so caught, though undamaged, is said to have been nipped.

Ice Under Pressure: Ice in which deformation processes are actively occurring. It is a potential impediment or danger to shipping.

Difficult Area: A general qualitative expression to indicate that the relative severity of the ice conditions, prevailing in an area, are such that navigation in it is difficult.

Easy Area: A general qualitative expression to indicate that ice conditions, prevailing in an area, are such that navigation is not difficult.

Iceport: An embayment in ice, often of a temporary nature, where ships can moor alongside and unload directly onto the ice itself.

1.10.3 Terms related to Submarine Navigation:

Ice Canopy: Ice from the point of view of the submariner.

Friendly Ice: An ice canopy containing many large skylights or other features which permit a submarine to surface. There must be more than ten such features per 30 nautical miles (56 km) along the submarine’s track.

Hostile Ice: An ice canopy containing no large skylights or other features which permit a submarine to surface.

Bummock: A downward projection from the underside of the ice canopy; the submerged counterpart of a hummock.

Ice Keel: A downward-projecting ridge on the underside of the ice canopy; the submerged counterpart of a ridge. Ice keels may extend as much as 50 m below the surface.

Skylight: Thin places in the ice canopy, usually less than 1 m thick and appearing from below as relatively light, translucent patches in dark surroundings. The undersurface is normally flat. Skylights are termed large if big enough for a submarine to attempt to surface through them (120 m) or small if not.

CHAPTER 2

Ice Observations

- ❑ Aerial Ice Observations
- ❑ Shipboard Ice Observations
- ❑ Iceberg Observations
- ❑ Ice Thickness Observations


Simon Prinsenberg (DFO)

Photo 2.1: Bifurcated grey-white and thin first-year ice, medium floes, moving under the Confederation Bridge

This chapter deals with ice-observing methodology.

Ice observations are made using electronic aids such as radar, by visual observation or from a combination of both methods. These methods vary as functions of the platform from which the ice observations are made as well as what electronic aid equipment is available.

The emphasis in this chapter is on visual ice observations made from aerial- and surface-based platforms. References are made to the use of airborne radar imagery; however, the reader is referred to documents related to the interpretation of radar imagery. (cf. 4 and 5)

Ice observations are dependant on the perspective from which the ice is viewed. Ice can be observed from the aerial perspective using an aircraft or helicopter or from the surface perspective using a vessel or from shore. Each perspective has limitations on the nature and detail of ice observations which can be made and in turn drawn on an ice chart. It is important that the Ice Services Specialist (ISS) understand these limitations and what aspects of the ice can and cannot be observed from each perspective.

2.1 Aerial Ice Observations

Using aircraft as platforms from which to conduct ice reconnaissance, a nearly synoptic description of ice conditions can be obtained. Large areas of ice can be covered in a relatively short time, using the latest state-of-the-art electronic aids combined with visual observations, where weather conditions and daylight make it possible to see the ice surface.

However the limitations must be realized. As the observing distance from the aircraft increases, it becomes progressively more difficult to detect changes in the ice surface. Therefore it is necessary to determine the visibility limit, which is the maximum distance from the aircraft at which the ISS can confidently identify and locate ice features. Under normal circumstances, the visibility limit should not exceed 15nm (25 km) on each side of the aircraft. Ice observations made in the early morning or late afternoon under sunny skies allow for much easier identification of surface features away from the aircraft. In an overcast situation with snow-covered ice, a condition known as flat light will often exist. This condition eliminates shadows and causes ice-surface features to appear insignificant or even invisible. Observing limits will change as a function of altitude and the prevailing horizontal and vertical visibility.

In order to successfully perform ice-reconnaissance duties, the ISS must be able to recognize, identify and record the different characteristics and features which distinguish one ice type from another. Training and experience in ice recognition allows the ISS to identify ice types, concentrations, floe sizes and significant surface features.

Aerial observing platforms are usually stable relative to their intended track, but ground speed varies considerably with wind. For this reason, the aircraft position should be plotted on the ice chart with a dot every few minutes.

In the conduct of aerial ice reconnaissance, the ISS employs standard techniques and procedures which are designed to provide the maximum amount of useful, quality-controlled information. Discussion with the participating air crew as to the extent of flight, general area of reconnaissance, close-tactical support requirements and other particulars are routine for each flight. Attendance at pre-flight weather briefings is also normal.

C-GCFR (CIS)

Photo 2.2: A ship's track through fast ice, with open water in the background

2.1.1 Use of Electronic Aids:

The ISS has available on board the reconnaissance aircraft several useful electronic aids that can be combined, where appropriate, with visual observations. These aids may include an airborne imaging radar and an airborne radiation thermometer (ART).

Airborne Imaging Radar: An imaging radar is the most valuable ice-observing tool. It is presently the only operational source of mapped ice information when the surface becomes obscured by fog or cloud. An ISS who is fully familiar with the operation and the limitations of the radar system can effectively delineate ice edges and large leads, estimate the total ice concentrations and when used in combination with other sources of information, identify and distinguish many ice types. There are two types of imaging radars that are used for ice reconnaissance. The first type is the **Side-Looking Airborne Radar (SLAR)**, which is a real-aperture system. It differs from most other airborne radars in that the antenna is rigidly fixed to the aircraft and the energy is directed towards either side of the aircraft ground track. Scanning of the area to either side of the ground track is accomplished by the movement of the aircraft in flight. The radar returns are then processed and converted into intensity-modulated traces on cathode ray tubes. This light is used to expose film thus producing a photo radar map of the ground. The signal is also digitized and processed by on-board computers and is transmitted to ships and ground stations in digital format. It then is relayed to the Canadian Ice Service and Canadian Coast Guard Ice Operation Centres.

Imagery may be acquired at 25, 50 or 100 km swath widths on both sides of the aircraft. Generally speaking, the 100 km swath is used when wide aerial coverage is desired. If more detail is needed or the width of a channel being imaged is narrow, a 50 km swath may be specified. Unless otherwise specified, the SLAR is operated at the 100 km swath.

The second type of airborne imaging radar is the **Synthetic Aperture Radar (SAR)**. This radar forms an image by a different process. It uses a relatively short antenna to produce a wide beam. The image is built up by successive scans but the radar also makes use of the Doppler history of the surface being scanned as the aircraft moves forward. As the beam of the radar moves across the surface, changes in position are calculated and this information is used in creating the radar image. The effect is to synthesize a much longer antenna than is physically possible on the SLAR, achieving a constant resolution across the image. This factor, along with a finer resolution, distinguishes the SAR from the SLAR.

The radar image is mainly a function of the return microwave energy which is dependent on the radar system parameters and the surface characteristics. Through practice and experience, radar imagery can be interpreted by studying changes in texture, pattern and tone.

Airborne Radiation Thermometer: The ART provides a linear trace of the surface temperature along the flight track directly below the aircraft. Due to the effect of atmospheric moisture on the accuracy of the temperature reading, the system is routinely calibrated over known temperature reference targets, such as melting ice or frazil ice. Its prime application is in monitoring surface temperatures of open water bodies for determining the growth and decay of ice.

2.1.2 Ice Type Identification: The first tool the ISS should use during any visual observation is the local ice climatology. Although some ice types will look virtually identical at different times of the year, a knowledge of what ice types and features are possible in any given location will greatly simplify the identification process. The ISS should be aware of all ice information for the area from ships, shore stations and scientific parties to further support the ice types under consideration. Previous ice charts and observations should also be referred to in order to maintain the consistency of observations between flights.

Accurate aerial observations require careful examination of the ice surface for subtle features. Although some conditions are very easy to interpret, such as old ice floes in a matrix of grey ice, other conditions require more attention to details. An example of a more complicated ice condition to observe is small floes and ice cakes of old ice within a heavily ridged snow-covered area of thin first-year ice.

Surface topography is one indicator of ice type that can be used in most observing situations. For example, the surface topography of first-year ice is generally rougher than old ice. Old ice floes tend to stand out as smooth rounded areas encased by ridged and rubbled first-year ice in mixed ice-type conditions. Determining whether the ice surface is ridged or rafted will also help determine ice type, since thinner ice will tend to raft rather than ridge. Old ice floes have a higher freeboard than first-year ice and hence will appear to "stick out" of the general ice surface.

Ice colour is another indicator of ice type that can be used when lighting conditions permit and the ice surface is free of snow. Since thin ice types are more transparent, they show the darkness of the water beneath them. As the ice thickens it becomes greyer in appearance.

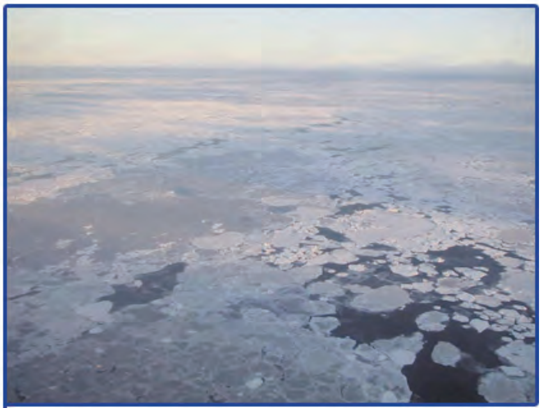

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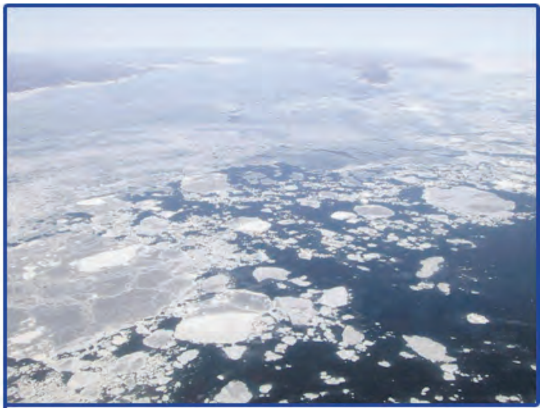
Photo 2.3: Various stages of ice development. In the foreground, grey ice and nilas mixed with small floes of thin first-year and grey-white ice. Total concentration 9/10's ice.

Beyond the thin first-year ice category, the colour differences are negligible and it is no longer possible to distinguish thicker ice types on the basis of colour alone, except for old ice floes. When ice is very thick it becomes more of a blue-white colour. The colour is most apparent during the melt period, but it can be observed at other times. To distinguish thick first-year ice from second- or multi-year ice, additional surface features (e.g. topography) need to be considered. This is because there is little difference in colour between the three types, except during the melt period. The melt ponds on thinner ice types become blue-grey, then green-blue and finally black as they continue to melt deeper and thaw holes begin to appear. Their colour remains blue on old ice types unless the floes become very deteriorated.

A complicating factor in winter ice observation is the presence of snow cover on the ice surface. This requires the ISS to pay much closer attention to the orientation and severity of the surface topography, since colour and other surface features are hidden. Visibility limits are often reduced over snow-covered ice, as it becomes difficult for the ISS to detect changes in ice colour or surface roughness.

Visual observation of ice types in summer or melt conditions requires attention to melt patterns. As the snow melts on first-year ice, it produces pools of fresh water very similar to old-ice conditions. These pools initially make the surface of old ice and thick first-year ice appear blue. Unlike first-year ice, old ice has an established drainage pattern at this point and so has fewer melt ponds with small connecting streams.



C-GCFR (CIS)

Photo 2.4: Northumberland Strait: in the background, very close pack grey ice, and in the foreground, open to very open grey-white and grey ice.

CIS Archives

Photo 2.5: Melt ponds and drainage pattern on old ice.

Despite these guidelines and even with the benefit of much experience, there will be situations where ice types cannot be identified with reasonable confidence. In all such cases, the ISS shall still make an observation to the extent possible and designate all other unknown or unidentified categories with an **X** designator. A partial observation is better than none at all.

2.1.3 Boundary Placement:

The placement of ice boundaries is just as important as the identification of ice types. These boundaries indicate differences in ice conditions that relate to total concentration, floe size, surface features or ice types.

It is important to locate ice boundaries as accurately as possible. Determining the distance from the aircraft to ice edges or other ice features requires a good deal of practice and attention to detail. When beginning a period of visual observation, an ISS should make an attempt to identify a significant land or ice feature which will be evident on radar and ask the radar ISS for the exact distance. This technique is also useful for experienced ISS when the decision is taken to fly a mission at a higher or lower than normal altitude, as it allows the ISS to quickly orient oneself.

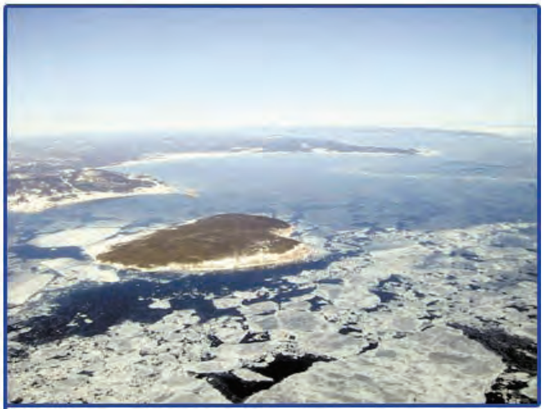
Visibility limits shall be drawn on the chart paralleling the flight track for all sections of the flight where visual observations are made.

The ISS should avoid drawing overly complex ice charts by merging areas of similar ice conditions.

2.1.4 Estimating Ice Concentration:

Observations from airborne platforms allow for a more accurate estimate of ice concentration. An ISS with weather-observing experience will find the procedure of estimating ice cover in tenths quite straightforward. In the higher concentrations (6-10 tenths), it is often easier to estimate how much of the area is ice-free rather than how much is ice-covered.

Figure 2.2 (p. 2-15) provides a visual guide to estimating ice concentrations. The ISS should use judgment in recording ice conditions to the maximum detail that their chart scale will allow.



C-GCFR (CIS)

Photo 2.6: In the Woods' Island area, very close pack grey and nilas.

2.1.5 Chart Production: In an aerial-observing situation, the data collected by visual observation, radar observation and the ART are placed on a single chart. This compilation of all data sources allows the ISS to correlate the various information sources and improve accuracy. The resulting chart is the main product of the mission; therefore its accuracy is crucial to a successful mission.

Visual observation of surface ice features is a very accurate means of determining ice type and concentration. However, estimated distances are not as accurate as radar measurements. For this reason, whenever radar and visual observations are to be correlated, edges that are distinct should be taken from radar. Ice type concentration should normally be taken from the visual chart. When available, ART data should be included as spot observations.

Figures 3.4 (p. 3-26) and 3.5 (p. 3-27) are examples of actual aerial ice charts produced from operational flights. Procedures for coding the chart are described in Chapter 3.

2.1.6 Helicopter Observations: Ice reconnaissance carried out from a helicopter provides a very good opportunity to collect detailed ice information over a fairly large area. Helicopters are used extensively on ships for ice reconnaissance and other purposes. The shipboard ISS should make every effort to accompany as many of these flights as possible.

During helicopter reconnaissance, special attention must be paid to positioning. Most of the helicopters now in use for ice reconnaissance can provide latitude and longitude information. On helicopters equipped with position display navigation systems such as GPS, the ISS can accurately record positions along any particular flight lines. Where the helicopter does not have positioning equipment on board, the ISS shall constantly dead reckon his/her position using aircraft heading, speed and elapsed time.

Prior to a flight, the shipboard ISS will normally undertake basic pre-flight planning in consultation with the ship's captain and helicopter pilot. Factors to be considered should include the specific requirements relating to the ship's area of interest, desired flight track/area of coverage, weather conditions (specifically wind speed/directions), obscuring phenomena and precipitation. Before takeoff the ISS should plot the ship's position, speed and heading on his working chart. During takeoff, he/she should make note of the time and update the ship's position if required. This information will allow the vessel to be used as a reference point on both the outbound and inbound legs.

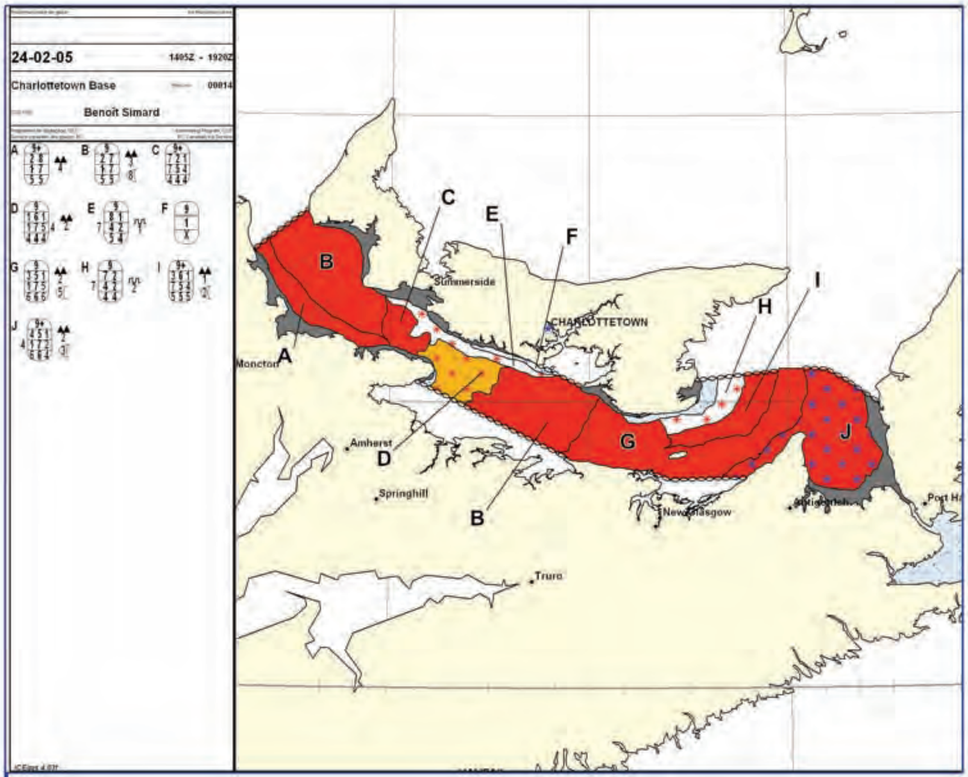


Figure 2.1: An example of an ice chart produced from a helicopter flight.

In situations where it is necessary to have daily information in nearshore waters, a shore-based helicopter reconnaissance program may be established, such as the St. Lawrence River winter ice-reconnaissance program at Quebec City or a similar ice-reconnaissance program at Charlottetown. The ISS is expected to be aware of and report all significant changes in ice cover, thickness and movement on a daily basis.

In areas normally covered by a shore-based helicopter, each day's chart should be compared to the previous day's chart to ensure consistency and accuracy. As well, the ISS should be aware of all shore-based ice information sources for potential information on fast ice thickness.

2.2 Shipboard Ice Observations

Shipboard ISS are a very important part of the ice-observation network. They provide very detailed ice observations, as well as report characteristics of the ice not collected by aerial reconnaissance methods such as snow depth, ice thickness and ice behaviour.

These detailed observations of the ice are used to make more accurate interpretations of aerial charts as well as for climatological studies. Therefore shipboard ISS should always record ice conditions to the maximum possible detail.

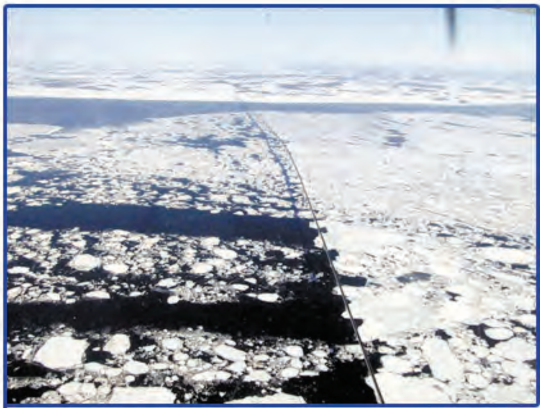


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Photo 2.7: Very close pack first-year and grey-white ice moving under Confederation Bridge.

Ice information to be collected should include, but not be limited to:

- concentration
- behaviour of the ice (i.e. movement, developing or releasing pressure)
- thickness
- topography
- ridge heights
- ridges per linear mile
- iceberg observations
- depth and surface coverage of snow
- water temperature
- melt state

Whenever possible, the ISS should disembark from the ship to the ice surface in order to measure its thickness and snow depth and to estimate or measure ridge heights.

Don Isaacs (CIS)

Photo 2.8: A shipboard perspective.

The shipboard perspective is similar to the far-range of the aerial perspective as the ice cover is viewed from an extreme angle; this, along with its slow speed, limits the geographic extent of a ship-based ice observation. The low angle perspective of a ship's deck requires special attention to maintain ice observation accuracy. Whereas an aerial observation depends primarily on surface features to determine ice types, a shipboard ISS should normally use ice thickness.


CIS Archives

Photo 2.9: Ship moving through very close pack grey-white ice and patches of nilas.

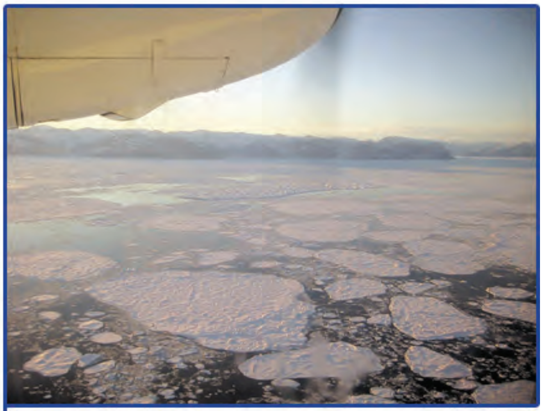
2.2.1 Use of Electronic Aids: The ISS on board the icebreaker has several electronic aids which can provide useful information and be combined with visual observations. The ISS can use the onboard marine surveillance radar to indicate the range and bearing of surface targets such as icebergs or ice edges.

As well, airborne imaging radar data (either SAR or SLAR) can be downloaded to most Coast Guard ships through the use of a downlink receiver and Ice-Vu display software. This will provide the ISS with a source of mapped ice information identical to that available to the ISS on board the ice reconnaissance aircraft. This data is mainly used for navigating the vessel through the ice, but can also help in assessing the general ice conditions in the area. In some cases accurate boundaries and features can be extracted from the imagery for the ice chart.

2.2.2 Ice Type Identification: Accurate estimates of ice thickness can be made by observing ice being turned up along the ship's hull. To help improve accuracy, any known reference point can be used such as the ship's deck rail, the sea bucket or pieces of wood tossed over the side.

To record conditions further away from the vessel, surface topography becomes more important for ice type recognition.

The identification of old ice floes from the ship perspective requires special attention to the surface topography ahead of the vessel. Old ice floes in a mixed field of ice types are often detected by observing a significant difference in freeboard between these floes and other first-year ice floes around them. In many cases there is significant rubble and ridging around these floes; this is caused by the pressure of thinner ice types against the much thicker old ice floe.



C-GCFR (CIS)

Photo 2.10: Airborne view of close pack concentration of vast floes of old ice.

The local ice climatology should also be known in order to know what ice types are normal for the area, as well as determining the normal behaviour of the ice.

The ISS should also refer to previous ice charts and imagery (if available) collected and/or generated in the days prior to the ship entering the area. This will help to maintain consistency in the observations and help in ice recognition. For example, if the presence of an ice type has been previously reported in the area, the ISS should be looking for that ice type.

2.2.3 Estimating Ice Concentration: The low observing position from the ship causes separate ice floes to lose their distinction. This can result in over-estimation of the concentration and/or floe size.

In good light conditions, the ISS shall record ice conditions to a distance of no more than 5 nm from the vessel. Experience has indicated that observations beyond 3 nm are very subjective, but this is left at the discretion of the ISS. Attempts should be made to locate an iceberg or another vessel in the 3-5 nm range from the vessel using the ship's marine radar which will help to estimate distances.

Consideration should be given to the fact that ice conditions in the immediate vicinity of the ship are not always representative of those within the accepted observation limits of 3-5 nm. However, the initial assessment of conditions in the near range serves as a good starting point or baseline and can be modified if required as the ship moves through the ice.

Whenever an ice-reconnaissance aircraft is in the area, efforts should be made to speak to the ISS on board. The ISS should try to convey as much information as possible to the aircraft, to help improve the accuracy of the aerial ice charts as they are being generated. Also, an attempt should be made to receive any charts or radar imagery that might be available. The charts or imagery will provide a better overall picture of the ice conditions and will aid in estimating the concentration from the ship perspective.

It is worth noting that aerial ice charts typically display much larger areas due to their perspective. For this reason, the vessel may find itself in a high-concentration area recorded as a low-concentration area on the aerial chart. It is likely that the ship is in a very localized area of high ice concentration, the limits of which cannot be seen by a shipboard ISS because of the visibility or extent of the ice coverage. When this happens, the ISS should look for signs in the distance to verify the differing concentration, but shall not alter the shipboard chart to comply with the aerial one. Nevertheless, this matter should be discussed with the airborne ISS, if possible.

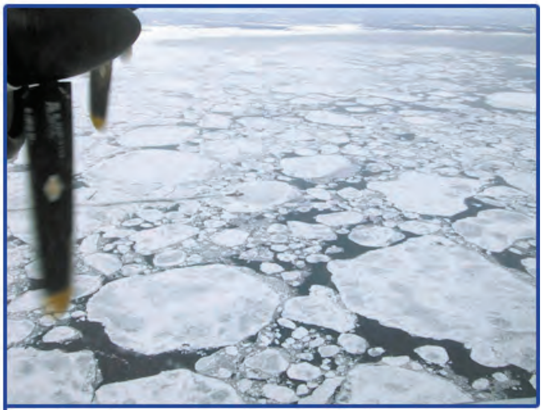


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Photo 2.11: Large pans of grey-white ice devoid of snow cover.

2.2.4 Chart Production: A daily chart of observed ice conditions shall be produced for the entire area the vessel has travelled while the ISS was on duty. The only exception is when a vessel is in ice-free waters that are not normally subject to sea-ice cover or iceberg intrusion. Data obtained from helicopter reconnaissance flights can either be merged with the daily ice-track chart or plotted as a separate observation. The shipboard charts shall be numbered consecutively from the start of the voyage.

2.2.5 Synoptic Observations:

Synoptic Observations: Individual ice observations from ships are an important part of the ice information required to prepare the daily ice analysis chart produced at the Canadian Ice Service. These observations are used to confirm interpretations of remotely sensed imagery. They also serve as a check on observed charts generated from visual aerial ice reconnaissance.

Marine weather synoptic observations are normally made every 3 hours while a vessel is in transit. The ISS will usually take 3 or 4 observations during the course of their duty day. Synoptic ice observations are taken and recorded using the WMO ice code described in MANMAR (cf. 2). It is important that these observations reach the Canadian Ice Service in a timely manner, so they can be incorporated into the daily ice analysis.

At times when the ISS is engaged in other duties or is off duty, the ship's officers should be encouraged to take, record and transmit marine weather and ice observations in accordance with the codes contained in MANMAR (cf. 2).

2.3 Iceberg Observations

Iceberg observations are acquired in several different ways from the air and from the surface. The method of reporting iceberg observations is the same for both types and the coding procedures are described in chapter 4. Iceberg observations from the air are collected by visual means as well as using airborne radar. This manual will briefly describe visual iceberg observations only. Radar detection of icebergs is dealt with in references 4 and 5 (*List of References, p. viii*).

Aerial iceberg observations are made by dedicated flights or as part of the collection of sea ice data. For dedicated iceberg flights, basic sea-ice boundaries and concentrations shall be recorded. Otherwise icebergs have a lower priority but should be reported whenever possible.

The principal objective of iceberg observations is to identify and report all icebergs that are present within the area covered. The ISS should set his/her observing limits to the extent that he/she can be certain that all icebergs have been reported with a high degree of confidence.

Visual priority flights shall not be undertaken unless visibility along 90% of the planned flight track is forecast to be 15 nm or more. The optimum altitude for visual observation is approximately 1500 feet. Fig 2.2 and 2.3 illustrate the size, shape and types of icebergs.

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Photo 2.12: Bergy Water

2.4 Ice Thickness Observations

Ice thicknesses are measured routinely at selected shore stations, ranging from the Arctic to the Great Lakes. Occasional thickness measurements are obtained from icebreakers. All thickness observations are desirable and should be obtained where and when possible.

These measurements serve to help verify aerial and shipboard observations by providing the exact WMO thickness category at the point of measurement. This data can be used to compare estimates made in the same area at the same time or during future observations. It can also be used to predict future ice thicknesses.

Chapter 6 describes the procedures for coding and reporting ice-thickness observations.

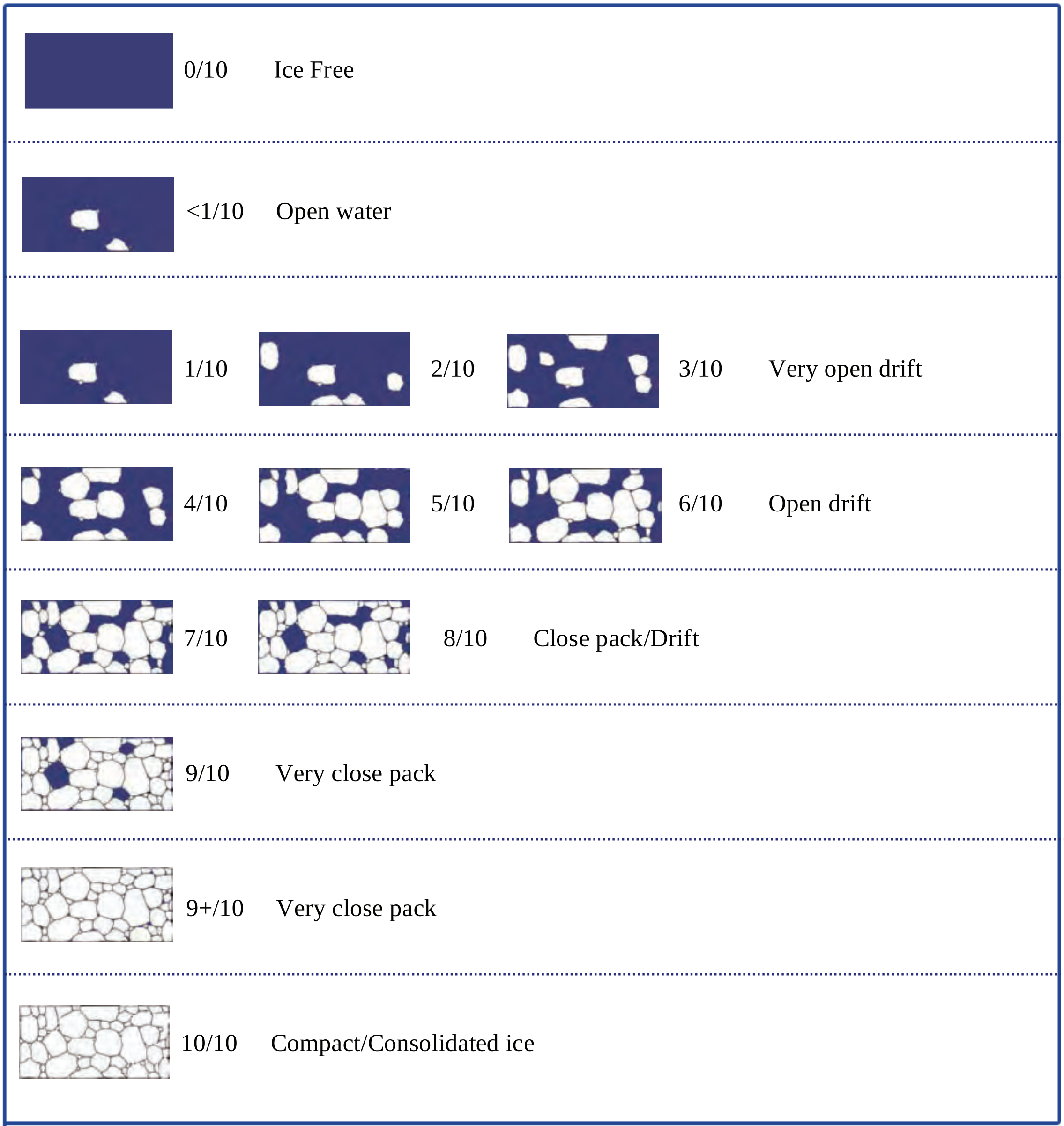


Figure 2.2: Diagram of Ice Concentrations from an Aerial Perspective

Iceberg Size	Height above sea surface (meters)	**Length** (meters)	**Weight** (Megatons)
Growler 	less than 1 m	less than 5 m	0.001
Bergy Bit 	1 m to less than 5 m	5 m to less than 15 m	0.01
Small Berg 	5 m to 15 m	15 m to 60 m	0.1
Medium Berg 	16 m to 45 m	61 m to 120 m	2.0
Large Berg 	46 m to 75 m	121 m to 200 m	10.0
Very Large Berg 	Greater than 75 m	Greater than 200 m	Greater than 10.0

Figure 2.3: Iceberg Size

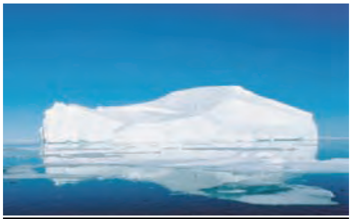
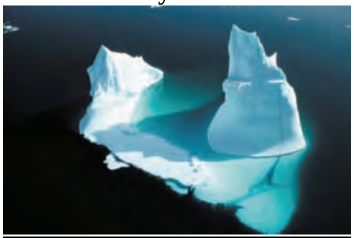
Shape	Average height to draft ratio	Shape	Average height to draft ratio
Tabular 	1:5	**Wedge** 	1:5
Non-Tabular 	1:5	**Drydock** 	1:1
Domed 	1:4	**Blocky** 	1:5
Pinnacle 	1:2		

Figure 2.4: Iceberg Shape

Photos: Masterfile ®

CHAPTER 3

Observed Ice Charts

- Preparation of Ice Charts
- Dissemination of Aerial Ice Charts
- Dissemination of Shipboard Ice Charts
- The Egg Code
- Symbols Used on Ice Charts
- Supplementary Procedures for Indicating Total Concentration
- Colour Coding Ice Charts
- Examples of the Use of the Egg Code
- Examples of Ice Charts

This chapter deals with basic procedures for preparing and transmitting ice charts. Ice 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 data on the chart is of vital importance to ice forecasters, serving as the basis for:

- ice hazard warnings
- preparation of daily ice analysis chart
- short- and long-range ice forecasts, and seasonal outlooks
- preparation of regional ice charts

3.1 Preparation of Ice Charts

Time and care are necessary to prepare ice charts. Details and precision are of the outmost importance.

3.1.1 Drawing Procedures

Ice charts are drawn directly on a computer screen using GIS (Geographic Information Systems) software. This software has been developed specifically for the Coast Guard to allow precise observation and quick transmission of data.

It is beyond the scope of this manual to describe this particular software in detail. It is sufficient to know the precision of observation is greatly increased by the use and integration of the Global Positioning System (GPS). The usefulness of the data is enhanced by the automatic verification of all coding and final preparation of charts.

Data will generally be transmitted in the form of electronic files and distributed by CIS to clients. Maps of observed data will also be produced by CIS and made publicly available.

For examples of actual ice charts see Figure 3.2 (p. 3-24), Figure 3.3 (p. 3-25), Figure 3.4 (p. 3-26) and Figure 3.5 (p. 3-27).

3.2 Dissemination of Aerial Ice Charts

Data (in the form of electronic files or charts) is of special importance to the ice forecasters and analysts and ships operating in or near the areas observed during the reconnaissance mission. Files are updated continuously while airborne and sent frequently. Partial files, rough copies and final copies of charts may be sent in-flight to the Canadian Ice Service, the appropriate Coast Guard ice offices and Coast Guard ships as necessary.

After the termination of the reconnaissance mission, the ISS will transmit the completed and corrected data to the Canadian Ice Service for distribution.

3.3 Dissemination of Shipboard Ice Charts

An ISS serving on icebreakers equipped with appropriate communication equipment should relay their ice information (even if incomplete) before 1800 UTC to CIS. Upon completion of the duty day, a second transmission is recommended. The data should be sent in the form of an electronic file via cellular phone, landline or satellite link depending on what is practical and available.

If it is not possible to transmit an electronic file, then a map could be printed and send by facsimile.

3.4 The Egg Code

The basic data concerning concentrations, stages of development (age) and form (floe size) of ice are contained in a simple oval form. A maximum of three ice types is described within the oval. This oval and the coding associated with it, are referred to as the "Egg Code". To indicate ice observations interpreted from radar imagery, the oval shall be omitted.

In the following figures and tables where ranges are shown for thickness, floe sizes or other dimensions, a report coinciding with the end point of a range shall be coded as the higher value.

Don Isaacs (CIS)

Photo 3.1: Escorting oil tanker through very close pack, heavily rafted grey ice.

The following is a summary diagram of the Egg Code. This code conforms to international convention and shall be used in coding all visual sea ice and lake ice observations without exception.

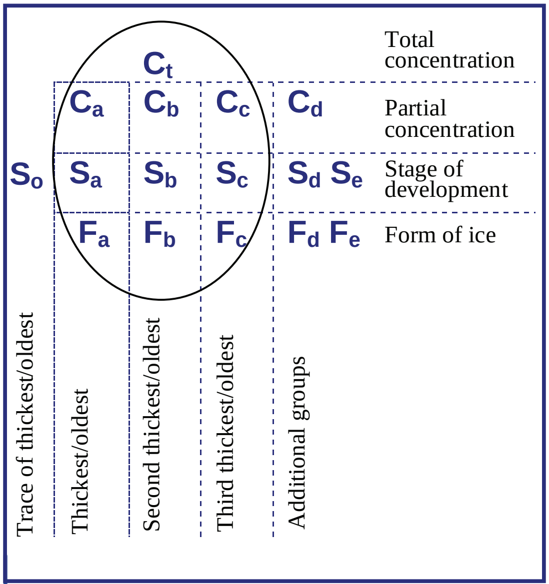


Figure 3.1: The Egg Code

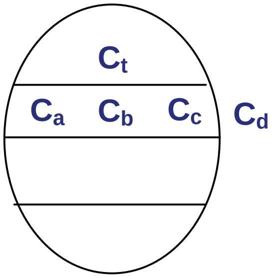
The symbols C_a C_b C_c and F_a F_b F_c correspond to S_a S_b S_c respectively.

There are some minor additions to the Egg Code symbology that are Canadian practice. In Canada, to enable the reporting of additional ice classes, especially during freeze-up and break-up, C_d S_e and F_e can be used. This should not be a common occurrence.

The following pages describe the specific details and rules for completing each level of information within the egg.

3.4.1 Concentration (C)

Total concentration (C_t) of ice in the area reported in tenths and partial concentrations of thickest (C_a), second thickest (C_b), third thickest (C_c) and fourth thickest (C_d) ice in tenths.



Notes:

1. Less than 1/10 (i.e. traces) shall not be reported within the oval except to describe open water (see Example 1, p. 3-21).

2. C_d shall only be included when S_d and S_e are reported (see Example 2, p. 3-21).

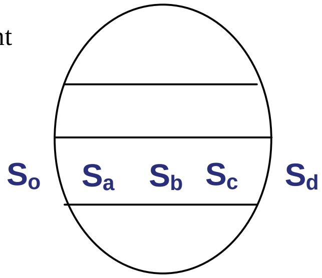
3. When S_d is used and C_d is omitted, C_d equals $C_t - (C_a+C_b+C_c)$ (see Example 3, p. 3-21).

4. When only one ice type is present, the partial concentration shall not be indicated (see Example 4, p. 3-21).

5. When one ice type is present with a trace of a thinner type, only total concentration of the major ice type shall be indicated (see Example 5, p. 3-21).

3.4.2 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 types S_d and S_e, of which the concentrations are reported by C_a C_b C_c C_d 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 as Sea or Lake depending on where it forms. In Canada, the practice is to use lake-ice coding 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. S_a, S_b and S_c shall have concentrations of at least 1/10, except when C_t is zero (see Example 1, p. 3-21).

4. Reporting of S_a, S_b and S_c should generally be restricted to a maximum of 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 6, p. 3-21).
S_d - Stage of development of the thickest remaining ice types (if more than one type remains). It is the fourth stage present after S_a, S_b and S_c.
S_e - Shall only be reported when a thinner ice type remains after S_d. Partial concentration of S_e is obtained by subtracting partial concentrations ($C_aC_bC_cC_d$) from total concentration (C_t) (see Example 2, p. 3-21).

5. When S_e is not present, S_d may be a trace of ice (see example 6, p. 3-21)

6. Concentration shall not be indicated for S_o and S_e (see Example 2, p. 3-21, and Example 6, p. 3-21).

7. Concentration shall not be indicated for S_d when S_e is not present (see Example 3, p. 3-21, and Example 5, p. 3-21).

DESCRIPTION	THICKNESS	CODE
New ice	<10 cm	1
Nilas, Ice rind	<10 cm	2
Young Ice	10-30 cm	3
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
First stage thin first-year	30-50 cm	8
Second stage thin first-year	50-70 cm	9
Medium first-year ice	70-120 cm	1•
Thick first-year ice	>120 cm	4•
Brash		-
Old ice		7•
Second-year ice		8•
Multi-year ice		9•
Ice of land origin		▲•
Undetermined or unknown		X

Table 3.1: Coding for Sea-Ice Stages of Development (S_o S_a S_b S_c S_d S_e)

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 3.2: Coding for Lake-Ice Stages of Development (S_o S_a S_b S_c S_d S_e)

Notes for Tables 3.1 and 3.2:

1. On the horizontal line giving $S_oS_aS_bS_cS_dS_e$, 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 2, 3 and 6, pp. 3-21).

2. Codes 3 and 6 shall only appear on Canadian charts if the ISS cannot confidently determine the stages of the ice in the area observed. This will happen mostly when using radar or when visibility is poor due to sun reflection, darkness, fog, snow, etc.

3. Codes 8 and 9 shall only appear when measurements have been taken.

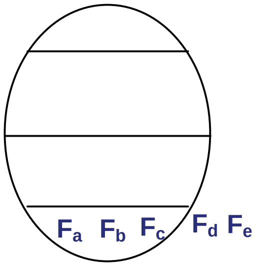
4. Codes 8• and 9• shall normally appear on Canadian charts only from 01 October to 31 December, but if the ISS is confident of the report, it may be used throughout the year, otherwise 7• is used.

5. The symbol ▲• shall only be used within the egg and when the concentration of ice of land origin is 1/10 or more.

6. The symbol **X** (meaning “undetermined”) shall be used to designate stages of development or forms of ice only if it is impossible to specify otherwise.

3.4.3 Form of Ice (F)

Floe Size corresponding to S_a S_b S_c S_d and S_e (when S_d and S_e are greater than a trace).



Notes:

1. WMO International procedures also permit reporting of F_p and F_s as the primary and secondary forms of all the ice without reference to stage of development.

2. It is Canadian practice to report $F_aF_bF_c$ as predominant floe sizes of S_a S_b S_c respectively. This makes it necessary, when only S_a and S_b are present, that F_a and F_b shall be followed by a dash (-) where F_c would normally appear (see Example 7, p. 3-21).

DESCRIPTION	WIDTH	CODE
Pancake ice		0
Small ice cake, brash ice, agglomerated brash	<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, *growlers or floebergs*		9
Undetermined, unknown or no form		**X**

Table 3.3: Coding for Form of Ice (F_a F_b F_c F_d F_e)

Notes for Table 3.3:

1. Width refers to the maximum horizontal extent.

2. At least one code 8 must be used for fast and consolidated ice. Other ice types embedded may retain their floe size (see Example 9, p. 3-22).

3. Occasionally the stage of development of fast ice cannot be determined. The area shall be blackened-in to denote fast ice (see Table 3.9, p. 3-18).

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 4, p. 3-21).

5. Floe size is not included for S_o, S_d and S_e if the concentration of these ice types is less than 1/10. Otherwise floe sizes for S_d and S_e are optional.

6. If there is a significant variation in floe sizes in an area containing only one particular ice type, the ISS may enter the applicable floe-size categories in the lowest part of the oval reserved for floe size. The largest floe-size category shall be put on the left side within the oval, followed by the other applicable floe sizes. In this case, the partial concentrations listed (C_a C_b C_c C_d) would match the partial concentration of floe sizes, instead of different ice types.

3.4.4 Coding and Symbology for Strips and Patches ∾ C

The ∾ symbol, placed at the bottom of the oval in the section reserved for Form of Ice, indicates that the ice is in strips and patches; the concentration within the strips and patches is represented by **C**. (see Example 11, p. 3-22).

When strips and patches are observed in open-water areas, the symbol shall be placed to denote the position of the strips and patches. If the ice in the strips and patches is of the same composition as that inside an adjacent ice edge, no oval is required. If the ice in the strips and patches is of a different composition, an oval shall be used with an arrow or arrow(s) to the strips-and-patches symbol(s). To avoid confusion, the strip symbol must be included with the total concentration (see Example 10, p. 3-22).

In an area where the ice is arranged in strips and patches and the ice floes are medium or greater, the floe size shall be indicated by using two ovals. The floe sizes are indicated as normal in the first oval, with the ∾ symbol placed between the first and second ovals. The ∾ symbol is repeated in the second oval beside the total concentration of the strips and patches (see Example 12a, p. 3-22).

An alternate way of reporting the same situation as above:

In an area where the ice is arranged in strips and patches and the ice floes are medium or greater, the floe sizes shall be indicated as normal. Both the total concentration and the concentration within the strips will be placed in the space reserved for C_t, with the ∾ symbol between them. When this option is used, C_a C_b C_c and possibly C_d refer to the total concentration and not the concentration within the strips. For example, C_t can be reported as **2 ∾ 9** meaning the total concentration is 2 tenths with strips of 9 tenths and the partial concentration(s) shall equal 2 tenths (see Example 12b, p. 3-22).

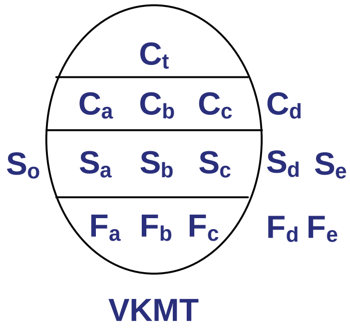
In an area of ice where some thicker ice type(s) is (are) embedded as strips and patches, these shall be indicated by the use of two ovals. The overall partial concentrations of the ice types are indicated in the first oval and the concentrations within the strips and patches are indicated in the second oval. The ∾ symbol shall be placed between the two ovals and along with the total concentration in the second oval (see Example 13, p. 3-22).

3.4.5 Coding for Brash

If 1 tenth or more of brash is present, it will always be C_a.

If brash is present, S_a will always be a dash (-), otherwise the normal table is to be used.

Brash is already indicated in the table as 1, therefore F_a = 1 confirms the dash (-) for S_a.



Four digits (**VKMT**) shall be added below the oval to indicate the thickness concentration breakdown of the brash that is present. Table 3.4 (next page) shows the thickness categories for agglomerated brash. The breakdown shall be entered going from right (**T**) to left (**V**). In the case where there is no thickness for thin but there are entries for medium, thick and very thick a zero (**0**) shall be placed in the thin column. This also holds true for medium (**M**) and thick (**K**) regardless of the combination (see Example 14, p. 3-23 to Example 17, p. 3-23).

DESCRIPTION	THICKNESS
Very Thick (**V**)	>4m
Thick (**K**)	>2-4m
Medium (**M**)	1-2m
Thin (**T**)	<1m

Table 3.4: Thickness Categories for Brash (VKMT)

Notes:

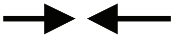
1. $C_a = V + K + M + T$
2. This is a Canadian coding procedure.
3. By convention a trace of brash is not coded.

Don Isaacs (CIS)

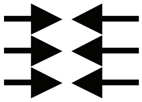
Photo 3.2: An icebreaker escorting a freighter above the Québec City bridges clearly show thick river brash ice.

3.5 Symbols Used on Ice Charts

3.5.1 Symbols for Dynamic Processes

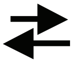
Compacting 

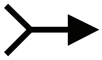
Optional



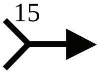
1 Slight compacting
2 Considerable compacting
3 Strong compacting

Diverging 

Shearing 

Drift 

Optional

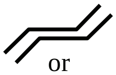
15 

(indicate drift speed in tenths of knots)
(e.g. 15 – 1.5 knots)

3.5.2 Symbols for Openings in the Ice

Crack  This symbol indicates the presence of cracks in the area.

Crack  This symbol represents a crack at a specific location.

Lead  or  The width in nautical miles may be specified.

Frozen lead  The orientation of the crosslines may be varied to distinguish them from other hatching lines.

3.5.3 Symbols for Topographical Features

Ridges/Hummocks

 $\bar{h}$ /hx or **f**  $\bar{h}$ /hx

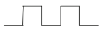
C

optional 

C

C Concentration or area coverage in tenths.
f Frequency in numbers per nautical miles (f is an alternative for C).
$\bar{h}$ Mean height expressed in decimetres and included when known.
hx Maximum height expressed in decimetres and included when known.

Rafting

 (concentration C in tenths)

C

Jammed brash barrier

3.5.4 Symbols for Ice Thickness

Thickness $\boxed{t_E}$ (t_E = thickness measured in centimetres)

Thickness t_E (dotted box) (t_E = thickness estimated in centimetres)

Examples: $\boxed{35}$ 35 (dotted box)

When more than one measurement has been taken, both mean and maximum thicknesses are reported, as shown below:

$\boxed{30/40}$

3.5.5 Coding for Stage of Melting

Stage of melting
(see Table 3.5 below for m_s)

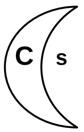
m_s

DESCRIPTION	COVERAGE	CODE
No melt		0
Few puddles	1-3/10	1
Many puddles	>3/10	2
Flooded ice		3
Few thaw holes	1-3/10	4
Many thaw holes	>3/10	5
Dried ice		6
Rotten ice		7
Few frozen puddles		8
All puddles frozen		9
Undetermined or unknown		**X**

Table 3.5: Coding for Stage of Melting (m_s)

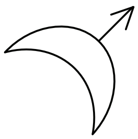
3.5.6 Coding and Symbology for Snow Cover

Snow cover



C - concentration (or area coverage) in tenths

s - snow depth, according to Table 3.6



(the orientation of the symbol with an arrow can show the direction of sastrugi)

DESCRIPTION	CODE
no snow	0
1 - 5 cm	1
6 - 10 cm	2
11 - 20 cm	3
21 - 30 cm	4
31 - 50 cm	5
51 - 75 cm	6
76 - 100 cm	7
> 100 cm	8
unknown	9

Table 3.6: Coding for Snow Depth (s)

3.5.7 Coding and Symbology for Ice of Land Origin

Triangular symbol shown:

nn
△
yy

nn= number, see following Table 3.7
yy = day of month of sighting

NUMBER	CODE
None	00
1	01
2	02
3	03
4	04
5	05
6	06
7	07
8	08
9	09
10	10
11	11
12	12
13	13
14	14
15	15
16	16
17	17
19	19

NUMBER	CODE
1 - 9	20
10 - 19	21
20 - 29	22
30 - 39	23
40 - 49	24
50 - 99	25
100 - 199	26
200 - 499	27
500 or more	28
Undetermined	99

Table 3.7: Number of Bergy Bits/Growlers or Icebergs (nn)

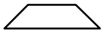
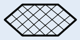
DESCRIPTION	SYMBOL	
	ONE	MANY
Growler		
Bergy bit		
Iceberg (size unspecified)		
Small iceberg		
Medium iceberg		
Large iceberg		
Very large iceberg		
Ice island		
Ice of sea origin (floeberg)		
Radar target (suspected berg)		

Table 3.8: Symbology for Ice of Land Origin

Notes:

1. Tabular iceberg indicated by adding a horizontal line through any of the symbols as shown in the following example. These symbols can be combined with a number, if exact numbers are known.
   Example:

2. For further detail on reporting ice of land origin, see Chapter 4.

3.5.8 Symbols for Defining Limits

Limit of Undercast

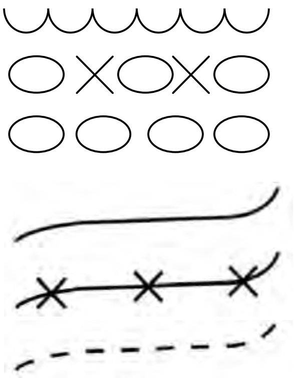
Limit of Radar Observations

Limit of Visual Observations

Observed Edge or Boundary

Ice Edge or Boundary from Radar

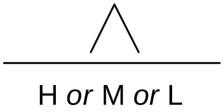
Estimated Edge or Boundary



3.5.9 Supplementary Coding for Radar Observations

Relative Roughness

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



Note:
Areas showing no radar return shall be indicated NIL ECHO.

3.6 Supplementary Procedures for Indicating Total Concentration

In order to facilitate readability of the chart, ice-covered areas may be hatched according to total ice concentration. The hatching symbology (developed by WMO) may be applied to all areas of ice concentration or only to some of them. Whenever hatching is applied, the hatching symbols as shown in Table 3.9 shall be used. No International Rules are given for the thickness of the hatching lines; the thickness may be the same throughout all hatched areas or may vary in the sense that the thickest lines are used for areas of thicker ice. It is Canadian practice not to hatch ice charts except for total concentrations less than 1/10th.

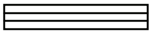
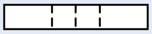
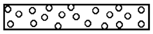
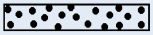
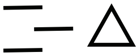
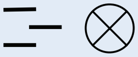
DESCRIPTION	HATCHING
Fast Ice	
10/10 Consolidated ice, Compact ice and 9-9+/10 Very close pack/drift ice	
7-8/10 Close pack/drift ice	
4-6/10 Open drift ice (Line spacing is twice that of Close pack/drift ice)	
1-3/10 Very open drift ice	
Open water (less than 1/10 sea ice, no ice of land origin)	
Bergy water (less than 1/10 sea ice may be present and total ice concentration is less than 1/10)	
Water with Radar Targets (less than 1/10 sea ice may be present and total ice concentration is less than 1/10)	
Ice free (no ice present)	

Table 3.9: WMO Symbols For the Hatching of Total Concentration of Ice

Note:
Presence of new ice can be indicated by the following symbols scattered throughout area affected:

* *
*

3.7 Colour Coding Ice Charts

3.7.1 Introduction

For several years, the Ice Service Specialists have been applying a colour code to ice information charts for the Canadian Coast Guard operations in the St. Lawrence River and the Gulf of St. Lawrence. This has proven to be quite beneficial to individuals making transportation decisions based on these information products. More recently, we have modified and expanded this colour code for application in all coastal waters of Canada, including the Arctic.

3.7.2 The Colour Code

This colour code is intended to assist navigation decisions in ice infested water. It is loosely based on the concept of a traffic light where green represents proceed, yellow represents caution and red represents danger. The objective of the colour code application is to enable a person to quickly assess general ice conditions. A ship sailing in a given area can easily assess the general ice conditions and hence qualify the difficulty or ease to either navigate through easily, or to reduce speed or to stop the ship.

However, this does not consider the other variables such as winds, currents or ship design which are important considerations in any ice navigation decision. The most detailed ice information continues to reside in the ice egg codes.

3.7.3 How to Interpret the Code

The following text is intended to assist an individual interpret the colour presentation.

Open or Bergy Water

- ❏ Areas of open water or bergy water are coloured blue.

Blue – open or bergy water

Presence of Ice

- ❏ For ice concentration of one tenth or greater, the ice type must be separated into two categories: less than 15 cm and greater than 15 cm thickness:

Ice Types Thicker than 15 cm

- ❏ The colour for a given ice area will be determined by the total concentration of the ice types thicker than 15 centimetres and is represented by the following list:

Green – from 1 to 3 tenths of ice thicker than 15 cm

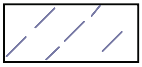
Yellow – from 4 to 6 tenths of ice thicker than 15 cm

Orange – from 7 to 8 tenths of ice thicker than 15 cm

Red – from 9 to 10 tenths of ice thicker than 15 cm

Presence of Old Ice

- The presence of old ice (multi-year ice) is indicated by the colour purple, and is represented by the following list:



Purple Dash Lines – indicates the presence of 1 to 4 tenths of old ice

Purple Background – indicates the presence of 5 tenths or more of old ice

Presence of Fast Ice

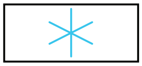
- The presence of fast ice, regardless of the thickness is always black or grey. The grey background allows seeing additional information that can be added on fast ice.

Black – fast ice regardless of thickness

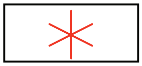
Grey – fast ice regardless of thickness

Ice Types Thinner than 15 cm – No Colour Assigned in Background

- Ice less than 15 centimetres in thickness is indicated by a star code and the colour of the stars is determined by the predominance between grey ice (10 to 15 cm) and new ice (0 to 10 cm), and is represented by the following list:



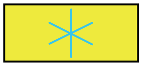
Blue Stars – predominance of ice thinner than 10 cm



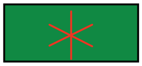
Red Stars – predominance of ice thickness between 10 and 15 cm

Ice Types Thinner than 15 cm – Colour Assigned in Background

- Secondary ice types with less than 15 centimetres in thickness are indicated by a star code and the colour of the stars is determined by the predominance between secondary grey ice (10 to 15 cm) and secondary new ice (0 to 10 cm), and is represented by the following list:



Blue Stars – predominance of secondary ice thinner than 10 cm



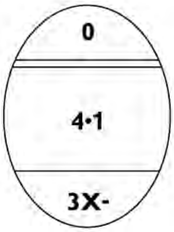
Red Stars – predominance of secondary ice thickness between 10 and 15 cm

The star code is placed over top of the background colour. In the case of 9 to 10 tenths of ice (red background) and predominance of ice thickness between 10 and 15 cm (red stars), there is only one colour which can be represented: red. The result of red stars on a red background is red.

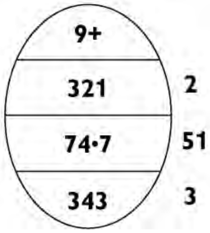
3.8 Examples of the Use of the Egg Code

3.8.1 Various Ice Type and Concentration Combinations

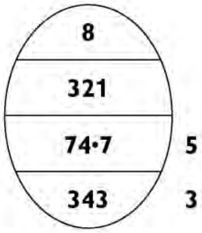
Example 1
Less than one tenth of ice to show open water. Some thick first-year in small floes; new ice is also present and has no floe form.



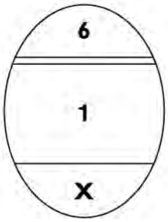
Example 2
9+/10 total ice concentration. 3/10 old ice in small floes, 2/10 thick first-year ice in medium floes, 1/10 thin first-year ice in small floes, 2/10 grey-white ice in small floes, and the remaining 2/10 is new ice with no floe form.



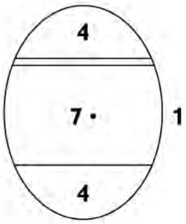
Example 3
8/10 total ice concentration. 3/10 old ice in small floes, 2/10 thick first-year ice in medium floes, 1/10 thin first-year ice in small floes and 2/10 grey-white in small floes.



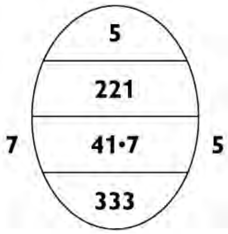
Example 4
6/10 of new ice with no floe form.



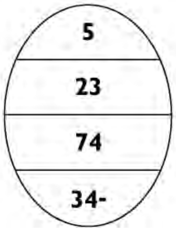
Example 5
4/10 of old ice in medium floes. New ice is also present with a concentration of less than 1/10.



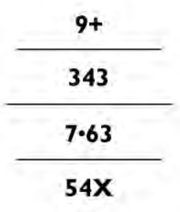
Example 6
5/10 total ice concentration. 2/10 thick first-year ice, 2/10 medium first-year ice and 1/10 thin first-year ice. All in small floes. Old ice and grey-white ice with a concentration of less than 1/10 are also present.



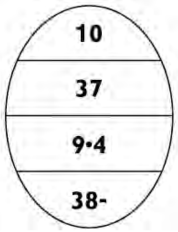
Example 7
5/10 total ice concentration. 2/10 thin first-year ice in small floes and 3/10 grey ice in medium floes.



Example 8
9+/10 total ice concentration. 3/10 old ice in big floes, 4/10 first-year ice in medium floes and 3/10 young ice with floes undetermined. Horizontal lines with no egg shell indicates that data has been interpreted from radar.

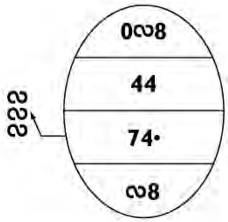


Example 9
Fast grey ice with 3/10 multi-year ice in small floes embedded.

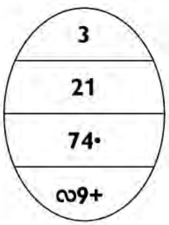


3.8.2 Strips and Patches

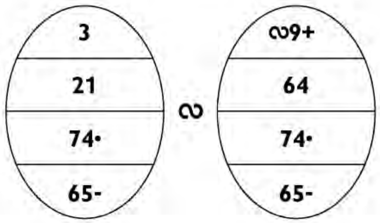
Example 10
Open water with strips and patches of old and thick first-year ice in small floes.



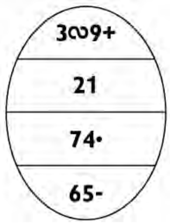
Example 11
3/10 total ice concentration. 2/10 old ice and 1/10 thick first-year ice. All ice is concentrated in strips and patches of 9+/10.



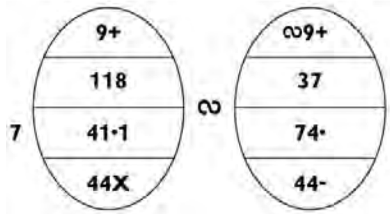
Example 12a
3/10 total ice concentration in strips and patches of 9+/10. 6/10 old ice in vast floes and 4/10 thick first-year ice in big floes. These floe sizes are significant and warrant the use of two ovals.



Example 12b
An alternate way to describe the same conditions with 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 indicated because they are significant.

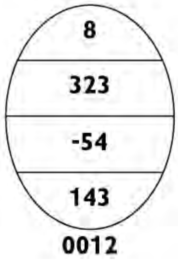


Example 13
9+/10 total ice concentration comprised of 1/10 thick first-year ice, 1/10 medium first-year ice, 8/10 new ice and old ice with a concentration of less than 1/10. The old and thick first-year ice are distributed throughout the area in strips and patches made up of 3/10 old and 7/10 thick first-year ice. All ice types in the second oval must be included in the first oval.

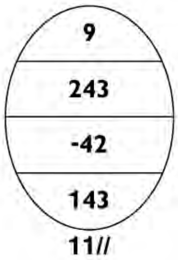


3.8.3 Brash

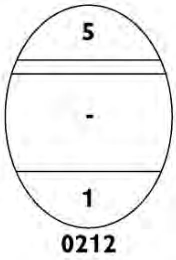
Example 14
8/10 total ice concentration. 3/10 of brash, 2/10 grey-white ice in medium floes, 3/10 grey ice in small floes and 1/10 of the brash is medium while 2/10 is thin. There is no thick or very thick brash present.



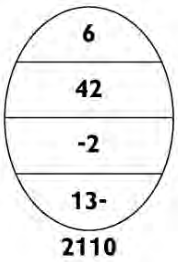
Example 15
9/10 total ice concentration. 2/10 brash (1/10 very thick brash, 1/10 thick brash and a trace of medium and thin brash), 4/10 grey ice in medium floes and 3/10 nilas in small floes.



Example 16
5/10 total ice concentration. All brash with 2/10 thick brash, 1/10 medium brash and 2/10 thin brash.



Example 17
6/10 total ice concentration. 4/10 brash (1/10 medium, 1/10 thick and 2/10 very thick) and 2/10 nilas in small floes.



3.9 Examples of Ice Charts

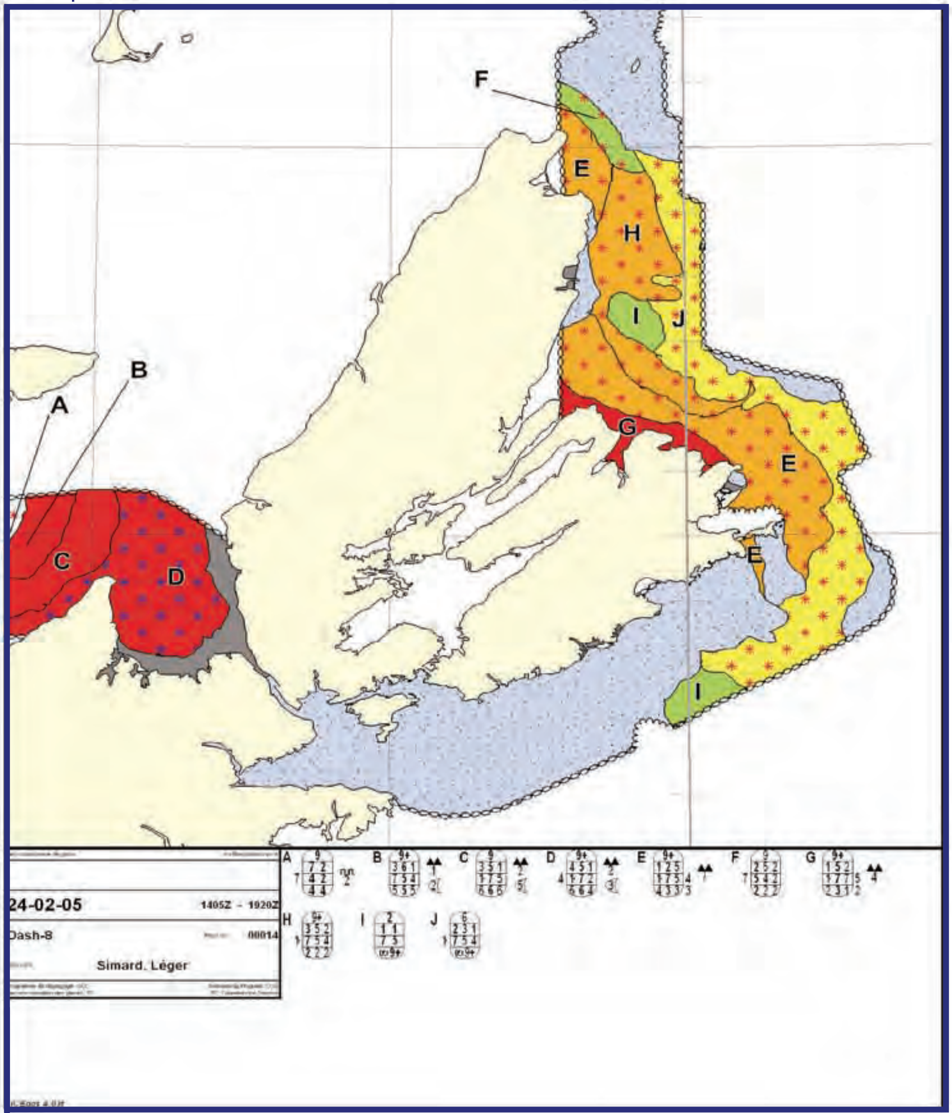


Figure 3.2: Ice Chart From a Sea-Ice Reconnaissance Flight

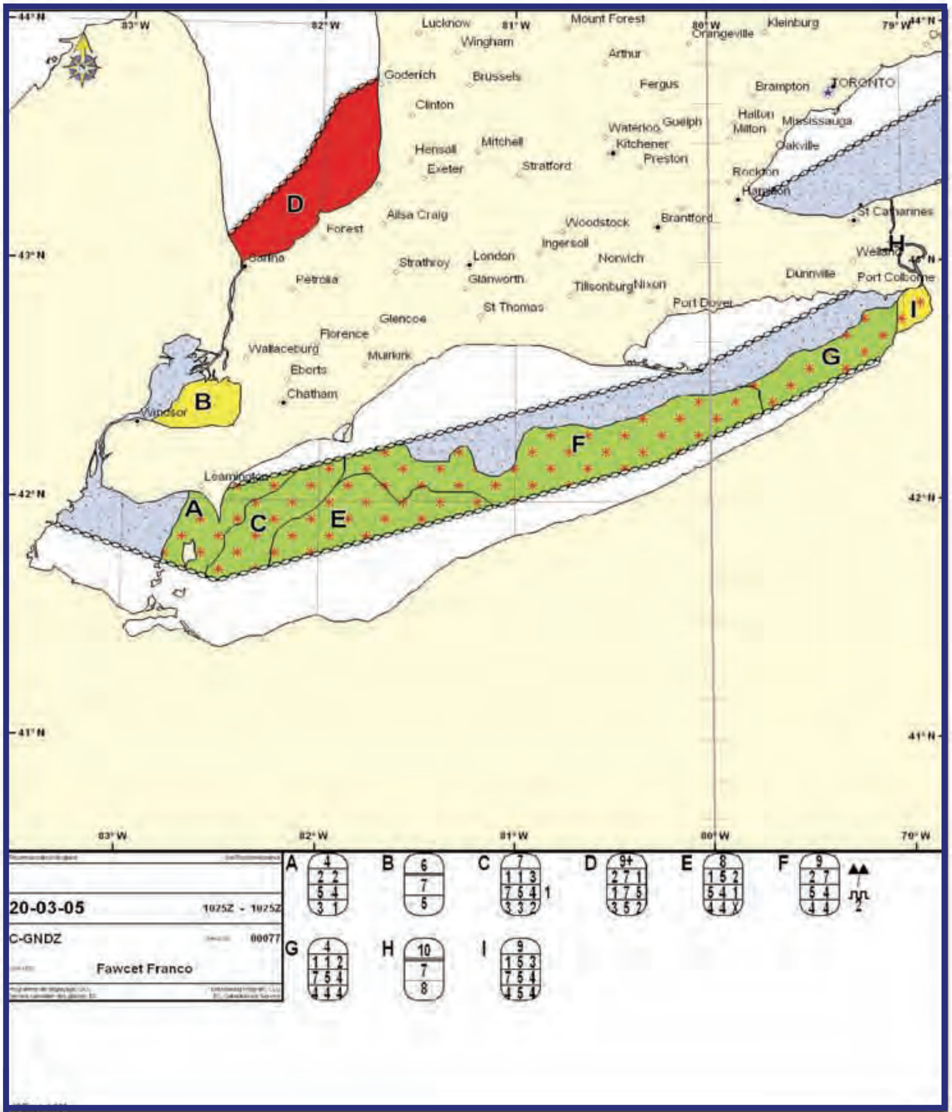


Figure 3.3: Ice Chart From a Lake-Ice Reconnaissance Flight

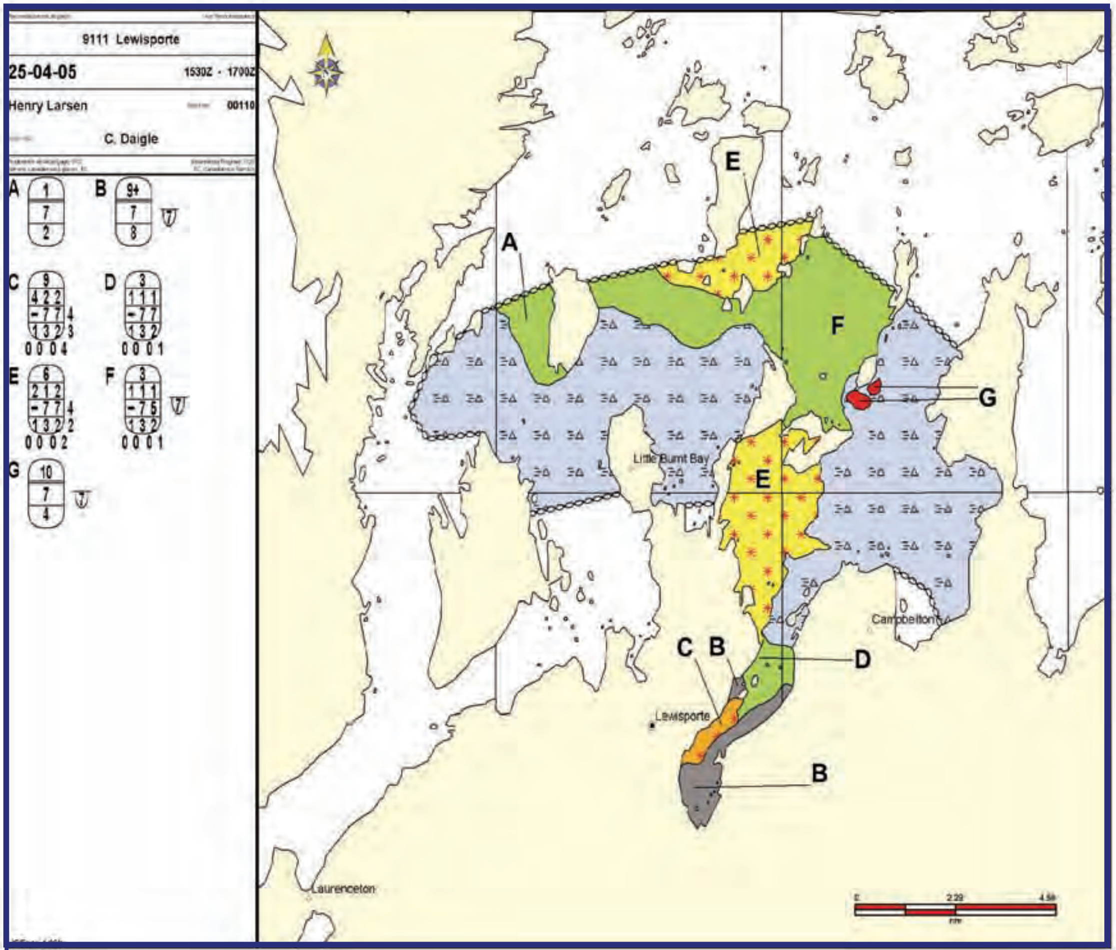


Figure 3.4: Daily Shipboard Ice Chart

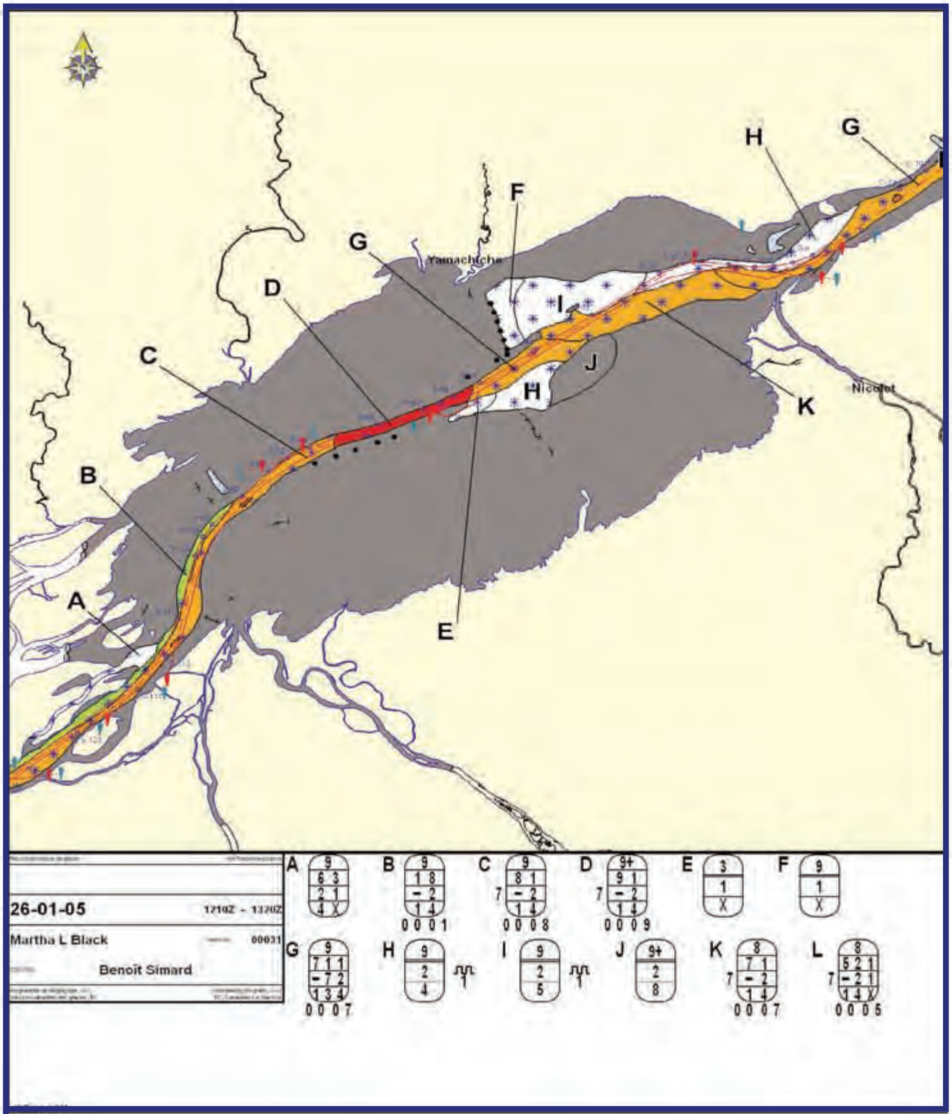


Figure 3.5: St Lawrence River Chart

CHAPTER 4

Iceberg Messages

- ❑ Iceberg Coding and Message Preparation
- ❑ Iceberg Coding Tables
- ❑ Notes on Iceberg Coding Procedures
- ❑ Examples of Iceberg Coded Reports

This chapter describes the iceberg information depicted on the observed ice chart as generated from either a ship or an aircraft in a message format.

Since Canada is in the northwestern quadrant of the globe, please note that all latitudes and longitudes are degrees N and W respectively. Also note that all times are UTC.

Yves Sivret (CIS)

Photo 4.1: Coast Guard icebreaker Henry Larsen sailing past a tall tabular iceberg.

4.1 Iceberg Coding and Message Preparation

An iceberg reporting code has been developed by the Meteorological Service of Canada and International Ice Patrol, to allow for exchange of digital iceberg information and to enable computer-assisted manipulation of volumes of iceberg observations into one complete iceberg analysis. The iceberg code follows standard coding practices and iceberg nomenclature of the WMO and supplements codes that exist in WMO. It provides for the reporting of all iceberg parameters, the area of surveillance and the factors that influence both visual and radar iceberg detection.

Listed below is the basic format for the iceberg message, with the following sections describing each component. Notes referred to in the code descriptions appear in Section 4.3 (following the Iceberg Coding Tables section).

Note:
Groups **00000** to **55555** can be repeated as often as necessary.

IBXXN CCCC YYGGgg
PPPP $P_tN_rN_rN_rN_r$ YYMMJJ

00000
$Q_cL_aL_aL_aL_a$ $L_oL_oL_oL_oL_o$ ZGGgg $1C_sAAA$ $2V_lV_lV_rV_r$ $3R_lR_lR_lR_rR_rR_r$ $4D_sD_sH_sH_s$

11111
(SSSS) $(I_dI_dI_dI_dI)$ C_lGGgg $L_aL_aL_aL_aL_a$ $L_oL_oL_oL_oL_o$ $01C_iS_iS_h$
$(1C_lLEN$ $2C_lWID$ $3C_lHEI$ $4C_lDRA$ $5C_lDIR$ $6C_lSPE)$

22222
(SSSS) C_lGGgg $L_aL_aL_aL_aL_a$ $L_oL_oL_oL_oL_o$ $N_tN_tD_{rr}$ $nnC_iS_iS_h$ ($nnC_iS_iS_h$ etc.)

33333
C_lGGgg $L_aL_aL_aL_aL_a$ $L_oL_oL_oL_oL_o$ $L_aL_aL_aL_aL_a$ $L_oL_oL_oL_oL_o$ nnnnD (nnnnD)

44444
C_lGGgg $L_aL_aL_aL_aL_a$ $L_oL_oL_oL_oL_o$ $(1m_am_am_om_o)$ $2N_tN_tN_tD$ $nnC_iS_iS_h$ ($nnC_iS_iS_h$ etc.)

55555
(SSSS) C_lGGgg $L_aL_aL_aL_aL_a$ $L_oL_oL_oL_oL_o$ $(1D_vD_vV_vV_v)$ $(2N_vN_vrr)$

REMARKS

END

Figure 4.1: Iceberg Message

4.1.1 Iceberg Message Header

IBXXN CCCC YYGGgg

PPPP $P_tN_rN_rN_rN_r$ YYMMJJ

This section is mandatory for all iceberg messages.

SYMBOL	DESCRIPTION	CODE TABLE	PAGE
IB	Indicator for an iceberg message		
XX	Nationality of iceberg message	(Note 1)	4-13
N	Figure to indicate source of iceberg message	4.16 (Note 2)	4-12 4-13
CCCC	International call sign for the location from which the iceberg message was transmitted	(Note 3)	4-13
YY	Day of month that the message was transmitted		
GG	Hour that the message was transmitted		
gg	Minute that the message was transmitted		
PPPP	4 figure or 4 letter platform identifier	(Note 4) (Note 13) (Note 26)	4-13 4-14 4-17
P_t	Platform type	4.14	4-12
$N_rN_rN_rN_r$	Consecutive iceberg message number from this platform	(Note 5)	4-13
YY	Day of the month that the message begins	(Note 6)	4-13
MM	Month of the year that the message begins	(Note 6)	4-13
JJ	Last two digits of the year that the message begins	(Note 6)	4-13

Table 4.1: Iceberg Message Header

4.1.2 Track Information

00000

$Q_cL_aL_aL_aL_a$ $L_oL_oL_oL_oL_o$ ZGGgg $1C_sAAA$ $2V_lV_lV_rV_r$ $3R_lR_lR_lR_rR_rR_r$ $4D_sD_sH_sH_s$

This section is mandatory for icebreakers and aircraft. (Note 7, p. 4-13).

SYMBOL	DESCRIPTION	CODE TABLE	PAGE
00000	Indicator that track information follows		
Q_c	Quadrant of the Globe (usually 7)	4.11	4-11
$L_aL_aL_aL_a$	Latitude in degrees and minutes at the start of each leg	(Note 8) (Note 9)	4-13 4-14
$L_oL_oL_oL_oL_o$	Longitude in degrees and minutes at the start of each leg	(Note 8) (Note 9)	4-13 4-14
Z	Time indicator		
GG	Time in hours at the start of each leg		
gg	Time in minutes at the start of each leg		
1	Indicator for general sea ice and altitude group		
C_s	Code for general sea ice distribution	4.12	4-11
AAA	Altitude of platform in hundreds of feet		
2	Indicator for visibility group		
V_lV_l	Visibility left of track in nautical miles	(Note 10)	4-14
V_rV_r	Visibility right of track in nautical miles	(Note 10)	4-14
3	Indicator for radar group		
$R_lR_lR_l$	Radar range to left of track in nautical miles	(Note 10)	4-14
$R_rR_rR_r$	Radar range to right of track in nautical miles	(Note 10)	4-14
4	Indicator for wave or swell group	(Note 11)	4-14
D_sD_s	Direction (to nearest 10 degrees) from which the predominant swell is coming		
H_sH_s	Height of predominant swell in half metres		

Table 4.2: Track Information

4.1.3 Individual Observations

11111
(SSSS) ($I_dI_dI_dI_d$I) C_lGGgg $L_aL_aL_aL_aL_a$ $L_oL_oL_oL_oL_o$ 01$C_iS_iS_h$
(1C_lLEN 2C_lWID 3C_lHEI 4C_lDRA 5C_lDIR 6C_lSPE)

SYMBOL	DESCRIPTION	CODE TABLE	PAGE
11111	Indicator that iceberg observations by individual position follows	(Note 12)	4-14
SSSS	Optional group used by Ice Operations Centres and by the offshore industry	(Note 13) (Note 26)	4-14 4-17
$I_dI_dI_dI_d$	Optional groups used by offshore industry to report consecutive iceberg number	(Note 14)	4-14
I	Optional groups used by offshore industry to indicate iceberg mobility	(Note 14)	4-14
C_l	Confidence level/Method of observation	4.13 (Note 15)	4-12 4-15
GG	Time in hours that observation was made	(Note 16)	4-15
gg	Time in minutes that observation was made		
$L_aL_aL_aL_aL_a$	Latitude of the individual observation in degrees, minutes and tenths of a minute		
$L_oL_oL_oL_oL_o$	Longitude of the individual observation in degrees, minutes and tenths of a minute		
01	Indicator for single iceberg report		
C_i	Concentration of sea ice immediately at the iceberg position	4.10 (Note 17)	4-11 4-15
S_i	Size of iceberg	4.8 (Note 18)	4-10 4-15
S_h	Shape of iceberg	4.9 (Note 18)	4-10 4-15
1C_lLEN **2C_lWID** **3C_lHEI** **4C_lDRA** **5C_lDIR** **6C_lSPE**	Optional groups to report iceberg length (**LEN**), width (**WID**), height (**HEI**) and draft (**DRA**), in whole metres, direction (**DIR**) of iceberg drift (toward) in whole degrees and speed (**SPE**) of iceberg drift in knots and tenths. The confidence level (**C_l**), indicates whether these parameters are measured (4) or estimated (5)	(Note 19)	4-15

Table 4.3: Individual Observations

4.1.4 Cluster Observations

22222

(SSSS) C_lGGgg $L_aL_aL_aL_aL_a$ $L_oL_oL_oL_oL_o$ N_tN_tDrr $nnC_iS_iS_h$ ($nnC_iS_iS_h$ etc.)

SYMBOL	DESCRIPTION	CODE TABLE	PAGE
22222	Indicator that iceberg observations by cluster follow	(Note 12) (Note 20)	4-14 4-16
SSSS	Optional group used by Ice Operations Centres and by the offshore industry	(Note 13) (Note 26)	4-14 4-17
C_l	Confidence level/Method of observation	4.13 (Note 15)	4-12 4-15
GG	Time in hours that observation was made	(Note 16)	4-15
gg	Time in minutes that observation was made		
$L_aL_aL_aL_aL_a$	Latitude of the centre of the cluster in degrees, minutes and tenths of a minute		
$L_oL_oL_oL_oL_o$	Longitude of the centre of the cluster in degrees, minutes and tenths of a minute		
N_tN_t	Total number of icebergs within the cluster, disregarding bergy bits and growlers	(Note 21)	4-16
D	Distribution of icebergs within the cluster	4.15	4-12
rr	Radius of cluster in nautical miles		
nn	Number of icebergs of each size and shape in the cluster	(Note 21)	4-16
C_i	Average concentration of sea ice in the cluster	4.10	4-11
S_i	Size of icebergs reported in the cluster	4.8 (Note 21)	4-10 4-16
S_h	Shape of icebergs reported in the cluster	4.9 (Note 21)	4-10 4-16
$nnC_iS_iS_h$	Sufficient 5 figure groups to describe the numbers of each size and shape within the cluster	(Note 21)	4-16

Table 4.4: Cluster Observations

4.1.5 Grid Observations

33333

C_lGGgg $L_aL_aL_aL_a$ $L_oL_oL_oL_o$ $L_aL_aL_aL_a$ $L_oL_oL_oL_o$ nnnnD (nnnnD)

SYMBOL	DESCRIPTION	CODE TABLE	PAGE
33333	Indicator that iceberg observations by grid follow	(Note 22)	4-16
C_l	Confidence level/Method of observation	4.13 (Note 12)	4-12 4-14
GG	Time in hours that observation was made	(Note 16)	4-15
gg	Time in minutes that observation was made		
$L_aL_aL_aL_a$	Latitude at the start point of the grid in degrees, minutes and tenths of a minute		
$L_oL_oL_oL_o$	Longitude at the start point of the grid in degrees, minutes and tenths of a minute		
$L_aL_aL_aL_a$	Latitude at the end point of the grid in degrees, minutes and tenths of a minute		
$L_oL_oL_oL_o$	Longitude at the end point of the grid in degrees, minutes and tenths of a minute		
nnnn	Number of icebergs within the grid	(Note 23)	4-16
D	Location of the grid	4.15 (Note 22)	4-12 4-16
nnnnD	Group required if both left and right of track grids reported		

Table 4.5: Grid Observations

4.1.6 Zone Observations

44444

C_lGGgg $L_aL_aL_aL_aL_a$ $L_oL_oL_oL_oL_o$ $(1m_am_am_om_o)$ $2N_tN_tN_tD$ $nnC_iS_iS_h$ $(nnC_iS_iS_h$ etc.)

SYMBOL	DESCRIPTION	CODE TABLE	PAGE
44444	Indicator that iceberg observations by zone follow	(Note 24)	4-16
C_l	Confidence level/Method of observation	4.13 (Note 15)	4-12 4-15
GG	Time in hours that observation was made	(Note 16)	4-15
gg	Time in minutes that observation was made		
$L_aL_aL_aL_aL_a$	Latitude at the southwest corner of the zone in degrees, minutes and tenths of a minute		
$L_oL_oL_oL_oL_o$	Longitude at the southwest corner of the zone in degrees, minutes and tenths of a minute		
1	Indicator for optional group to specify non-standard zone		
m_am_a	Whole minutes of latitude		
m_om_o	Whole minutes of longitude		
2	Indicator for total number of icebergs group		
$N_tN_tN_t$	Total number of icebergs disregarding bergy bits and growlers	(Note 21)	4-16
D	Distribution of icebergs within the zone	4.15	4-12
nn	Number of icebergs of each size and shape in the zone	(Note 21)	4-16
C_i	Average concentration of sea ice in the zone	4.10	4-11
S_i	Size of icebergs reported in the zone	4.8 (Note 21)	4-10 4-16
S_h	Shape of icebergs reported in the zone	4.9 (Note 21)	4-10 4-16
$nnC_iS_iS_h$	Sufficient 5 figure groups to describe the numbers of each size and shape within the zone	(Note 21)	4-16

Table 4.6: Zone Observations

4.1.7 Ship Locations

55555

(SSSS) C_lGGgg $L_aL_aL_aL_aL_a$ $L_oL_oL_oL_oL_o$ $(1D_vD_vV_vV_v)$ $(2N_vN_vrr)$

SYMBOL	DESCRIPTION
55555	Indicator that ship positions follow
SSSS	Optional ship identifier (Note 26)
C_l	Confidence level/Method of observation (Code Table 4.13)
GG	Time in hours of reported ship location
gg	Time in minutes of reported ship location
$L_aL_aL_aL_aL_a$	Latitude of reported ship/cluster centre location in degrees, minutes and tenths of a minute
$L_oL_oL_oL_oL_o$	Longitude of reported ship/cluster centre location in degrees, minutes and tenths of a minute
1	Indicator for first optional group to specify ship speed and direction
D_vD_v	Optional ship direction (01-36) in tens of degrees
V_vV_v	Optional ship speed in knots
2	Indicator for second optional group to specify a cluster of ships
N_vN_v	Total number of ships within the cluster
rr	Radius of cluster in nautical miles

Table 4.7: Ship Locations

4.1.8 Plain Language Remarks

REMARKS (Note 15, p. 4-15)

END (*Mandatory end of message)

4.2 Iceberg Coding Tables

DESCRIPTION	HEIGHT	LENGTH	CODE
Growler	<1m	<5m	1
Bergy Bit	1-<5m	5-<15m	2
Small Iceberg	5-15m	15-60m	3
Medium Iceberg	16-45m	61-120m	4
Large Iceberg	46-75m	121-200	5
Very Large Iceberg	>75m	>200m	6
Not Specified	-	-	7
Radar Target	-	-	X

Table 4.8: Size of Iceberg (S_i)

DESCRIPTION	CODE
Tabular	1
Non-Tabular	2
Domed	3
Pinnacled	4
Wedged	5
Drydocked	6
Blocky	7
Ice Island	8
Not Specified	0
Undetermined (Radar)	X

Table 4.9: Shape of Iceberg (S_h)


CIS Archives

Photo 4.2: Bergy bits and ridge remnants embedded in rotten first-year ice

DESCRIPTION	CODE
No Sea Ice	0
Trace of Sea Ice	/
1/10	1
2/10	2
3/10	3
4/10	4
5/10	5
6/10	6
7/10	7
8/10	8
9/10, 9+/10 or 10/10	9
Undetermined	X

Table 4.10: Concentration of Sea Ice (C_i)

DESCRIPTION	CODE
No Sea Ice	0
Trace of Sea Ice	/
Very Open Drift	1
Very Open Drift in strips and patches	2
Open Drift	3
Open Drift in strips and patches	4
Close Drift/Pack	5
Very Close Drift/Pack	6
Consolidated	7
Undetermined	X

Table 4.12: Distribution of Sea Ice (C_s)

LATITUDE	LONGITUDE	CODE
North	East	1
South	East	3
South	West	5
North	West	7

Table 4.11: Quadrant of the Globe (Q_c)

DESCRIPTION	CODE
Radar position with visual confirmation	1
Radar (SLAR/FLAR) only	2
Visual only	3
Measured (only used in iceberg dimension)	4
Estimated (only used in iceberg dimension)	5
Satellite – High Confidence	6
Satellite – Medium Confidence	7
Satellite – Low Confidence	8

Table 4.13: Confidence Level/Method of Observation (C_l)

Note: (Table 4.13)
A "Z" found in the Ship Locations section of older messages is treated as code 3 (see example at the end of the chapter)

DESCRIPTION	CODE
Fixed wing aircraft	1
Helicopter	2
Icebreaker including helicopter	3
Other ship	4
Oil rig	5
Shore station	6
Satellite	7

Table 4.14: Platform Type (P_t)

DESCRIPTION	CODE
Evenly (both sides of track)	1
Left of track	2
Right of track	3

Table 4.15: Iceberg Distribution (D)

DESCRIPTION	CODE
MSC/IIP	1
Icebreaker	2
Ice Operation Centre	3
Offshore Industry	4
Canadian Ice Service / IIP	5

Table 4.16: Source of Iceberg Message (N)

4.3 Notes on Iceberg Coding Procedures

1. Nationality of originator of iceberg message is indicated by **CN** for Canadian and **US** for American.

2. To facilitate turn-around of iceberg data, messages are designated by source:
   - Aerial reconnaissance by MSC and IIP
   - CCG icebreakers
   - Commercial ships, land stations and miscellaneous reports input by Ice Operations Centres
   - Offshore industry
   - Miscellaneous iceberg reports input by the Canadian Ice Service and IIP

3. When transmitted from or through a land station, **CCCC** is the four-letter identifier, but when transmitted directly from an icebreaker or an aircraft, **CCCC** becomes the four-letter or four-figure identifier of the ship or aircraft.

4. Normally a reconnaissance is conducted from one platform and the **PPPP** code for the identifier is in brackets e.g., icebreaker Henry Larsen (**CGHL**), MSC Dash-7 (**GCFR**) and US Coast Guard C130 (**1504**). Messages from Ice Operations Centres may be comprised of reports from several commercial ships and **PPPP** becomes (**SHIP**) or if the message is an assortment of reports from shore stations **PPPP** becomes (**LAND**). Messages from the offshore industry will usually include reports from rigs and supply vessels and **PPPP** is coded as (**RIGG**).

5. Consecutive iceberg message numbers shall commence January 1st each year.

6. Since reconnaissance missions may extend through two days, **YYMMJJ** refers to the date on which the mission began or in the case of a message from industry or Ice Operations Centres the date of the first sighting.

7. A track is made up of one or more legs defined by position, time and parameters. There are as many legs (lines of code) as required to describe all turning points or any change of parameters, e.g., general sea-ice description, aircraft altitude, visibility, radar range and sea state. Although complete detail is required to reproduce a plot as if it was drawn by the observer, complicated tracks should be redrawn to give a simpler track with appropriate visibility and radar ranges to outline the area of coverage. Variable parameters could be averaged to keep the message to a reasonable length. The last track line must only contain the latitude, longitude and time parameters (see example at the end of the chapter).

8. If a mission starts or ends at a shore base, the first and last position becomes the international call sign of the base. An aerial mission may start or end at any position. For example, a mission from Iqaluit to observe icebergs in Hudson Strait and then sea ice in Hudson Bay, would end iceberg reporting in western Hudson Strait. In this

same example, if the mission re-entered Hudson Strait to continue iceberg reporting, the endpoint of the first iceberg reconnaissance would be joined to this restart point by a straight line with all parameters coded as **X**'s. Track legs over stretches of land may have all parameters coded as **X**.

9. Each leg start position is, by default, the end position of any previous leg; consequently, the last line of the track is always position and time. For stationary icebreakers, these two positions are the same.

10. For icebergs, visibility or radar limits are defined by the distance from the ship or aircraft that the observer feels confident that he/she can see or get a radar return for all small icebergs. This does not preclude the observation and reporting of icebergs beyond these limits. The radar visibility must have a minimum of 2 digits and a maximum of 3 digits on either side.

11. Experienced ISS may estimate the wave or swell group visually or by radar from an aircraft or report **XXXX** for "undetermined". Icebreakers should report the group.

12. The individual-position method of iceberg and target reporting should be used in areas near the iceberg limit, areas of offshore drilling activity, the approaches to the Strait of Belle Isle and in all other areas where icebergs are evenly distributed and their numbers permit. When numbers increase or when icebergs are concentrated in small areas, a combination of cluster and individual methods can be used. When numbers become unmanageable, zones and grids should be incorporated.

13. Messages from the offshore industry and from Ice Operations Centres consist of iceberg reports from individual sources such as commercial ships, rig supply vessels, land stations, etc. If the iceberg message contains only one individual source, the message is coded with **PPPP** in the second line of the header information and is coded as the first four letters (or figures) of the call sign of the single source. However, if the iceberg message contains iceberg reports from more than one source, the optional group **SSSS** is used to indicate the call signs of the individual sources.

14. The offshore industry usually tracks icebergs through their area of interest. Icebergs entering the area are assigned a consecutive number which is maintained until the iceberg exits from the area. The optional group $\mathbf{I_dI_dI_dI}$ is used by the offshore industry to code the assigned number of the iceberg and to indicate if the iceberg is freely drifting (**D**), grounded (**G**) or is under tow (**T**).

15. The degree of confidence in an iceberg's observed position and related parameters is expressed by **C_I**. The highest confidence (**Code 1**) is a radar position with visual confirmation. There should be an attempt to consolidate visual and radar data to produce high confidence levels. Radar-only targets (**Code 2**) will not appear in areas visually searched, unless there is some doubt about the visual capability which should be expressed in the **REMARKS** section.

16. The time of observation is the time at which an individual iceberg, the centre of a cluster, the southwest corner of a zone or the start point of a grid becomes abeam of the track. Times may be rounded off to the nearest 15 minutes but they must be within the time frame of the track leg from which the observations were made.

17. The concentration of sea ice is a factor which affects iceberg drift and which provides the user with some degree of confidence in iceberg detection, especially if the detection is made by radar. There shall be an attempt to describe the ice cover to the nearest tenth immediately adjacent to the iceberg. However, when the concentration varies from side to side, the recorded concentration will be an average of the conditions around the iceberg. Open water areas or trails caused by the iceberg will be disregarded.

18. Sizes refer to the portion of the iceberg above water. If height and length of a berg in metres (m) fall into a different size classification, use the larger size. Dimensions (in kilometres) of a tabular berg or ice island may be indicated beneath the symbol. Iceberg size and shape parameters are important in the process of re-identification of icebergs and as inputs to iceberg deterioration and drift models. These parameters shall be reported along the limit of icebergs, in areas of offshore drilling activity, in the approaches to the Strait of Belle Isle and in all areas where the work load permits. When icebergs are more numerous, shape parameters should be simply tabular or non-tabular. When icebergs become too numerous, use code **7** for unspecified size and code **0** for unspecified shape. **X**'s will only be used for radar information.

19. The optional groups **(1C_ILEN 2C_IWID 3C_IHEI 4C_IDRA 5C_IDIR 6C_ISPE**) shall be used when any of the length, width, height, draft, direction and speed iceberg parameters are available. The confidence level in this group shall only be measured (**Code 4**) or estimated (**Code 5**).

20. Accurate determination of the positions and radii of clusters is essential so that the circles do not overlap other clusters, zones or grids, overlap land or extend beyond the applicable radar or visual limit. Normally observations by individual position will not be included inside a cluster. However a visually confirmed iceberg through a hole in the clouds could be included in a radar cluster and in this case the total number of icebergs reported in the cluster would not include the individual iceberg.

21. If there are no bergy bits or growlers present, **nn** equals N_tN_t for clusters or $N_tN_tN_t$ for zones. S_i is coded as **7** for not specified and S_h is coded as **0** for not specified. However, when the workload permits, the code allows specifying the numbers of different sizes and shapes within the grid or zone. For example, in a cluster free of sea ice which has 1 very large tabular iceberg, 3 medium icebergs, 5 small icebergs and 2 bergy bits which are all evenly distributed within a radius of 5 nautical miles, $N_tN_tDrr\ nnC_iS_iS_h\ nnC_iS_iS_h\ nnC_iS_iS_h\ nnC_iS_iS_h$ would be coded as: **09110 01061 03040 05030 02020**.

22. Grids are defined by the confidence level (whether radar and visual, radar only or visual only), by two positions along the track, by the visibility or radar limits as coded in the track part of the message and by the iceberg distribution (left of track, right of track or both sides of track). A visual and radar or a visual-only grid extends from the track line to the visibility limit. A radar-only grid extends from the track to the radar limit or if there is a visible limit, the grid extends from the visibility limit to the radar limit. Two lines of code are required to encode both visual and radar grids with the same endpoints. Clusters will not be reported inside grids and normally individual icebergs should be excluded. However, individual icebergs which are considered significant because of size, shape or other parameters which can assist in re-identification may be positioned inside of the grid. The time assigned to the grid associates it with the correct visibility and/or radar limits coded in the track leg, so it is essential that the time refers to the right leg. Grids will not extend beyond one track leg.

23. An accurate count of iceberg numbers in grids, clusters and zones is desired. However, when numbers are too large, report an estimate and explain in the **REMARKS** section.

24. Zones are areas usually one degree latitude by one degree longitude defined by the latitude and longitude of the southwest corner. The optional group $1m_am_am_om_o$ permits the use of nonstandard zones. Zones should not overlap other zones, grids or clusters, or extend beyond the appropriate visibility or radar limit. As with clusters and grids, individual icebergs should not normally appear in zones.

25. Factors, such as turbulence, drift angle, precipitation and sea state, which can affect radar; and variable visibilities or breaks in the undercast that affect visual capabilities shall be included.

26. The platform identifier group **PPPP**, found in the Iceberg Message Header, and the optional ship identifier group **(SSSS),** coded in the observation reports can be extended to contain up to 7 alphanumeric characters.

4.4 Examples of Iceberg Coded Reports

```
IBCN1 CYQX 082000
GCFR 10004 080302
00000
CYQX              Z1200   1XXXX   2XXXX   3XXXX   4XXXX
74800 05340       Z1220   10030   21515   35050   4XXXX
74800 04900       Z1320   10030   21515   35050   4XXXX
74855 04900       Z1340   10030   21515   35050   4XXXX
74855 05140       Z1420   16030   21515   35050   4XXXX
74855 05300       Z1440   16030   21515   35050   4XXXX
74950 05300       Z1500   10030   21515   35050   4XXXX
74950 04800       Z1600   10025   21515   35050   4XXXX
75045 04800       Z1620   10025   21515   35050   4XXXX
75045 05215       Z1655   16025   21515   35050   4XXXX
75045 05400       Z1710   16025   21515   35050   4XXXX
74925 05400       Z1730   1XXXX   2XXXX   3XXXX   4XXXX
CYQX Z1745
11111
21240   48200   51220   010XX
11400   48450   50210   01044
11415   49050   51050   01051
21425   48350   51530   010XX
31435   49010   52310   01970
31435   48590   52320   01970
21455   49380   53280   019XX
21508   50100   52180   010XX
11515   49500   51300   01041
11542   49450   49250   01054
21544   49280   49220   010XX
11623   50500   48160   01070
21630   51030   49130   010XX
11633   50570   49400   01070
11638   50530   50230   01070
21639   51040   50300   010XX
11642   50330   50480   01070
11649   50330   51260   01070
11649   50530   51260   01070
21649   51040   51260   010XX
21652   51030   51590   019XX
11656   50580   52170   01970
11700   50480   52580   01970
11718   50080   54060   01970
11722   49470   54040   01961
22222
21526   50120   50400   03103   030XX
11705   50360   53330   03105   01931   01947   01961
33333
21659   50450   52460   50450   53120   00123
11703   50450   53120   50450   54000   00123
21703   50450   53120   50450   54000   00183
44444
11633   50350   49400   11015   20081   08070
31710   50450   54230   11523   20081   08970
55555
CGHL    Z1512   49510   50030   12409
REMARKS
END
```

```
IBCN2 CGDX 181530

CGDX 30001 170799

00000

75132 05621 Z1800 10000 22020 35050 42504

75156 05540 Z2200 10000 22020 35050 42504

75200 05530 Z2300

11111

11800 51360 56220 01044

11800 51430 56080 01056

11800 51410 56040 01046

12200 51540 55570 01042

12200 51550 55550 01042

12200 51550 55540 01042

12200 51580 55500 01042

12200 51580 55450 01042

12200 51540 55280 01042

12200 51570 55270 01042

12200 52000 55270 01042

12200 52000 55310 01042

12200 52010 55360 01042

12200 52010 55420 01042

12200 52020 55390 01042

12200 52040 55360 01042

12200 52030 55440 01042

REMARKS

END
```

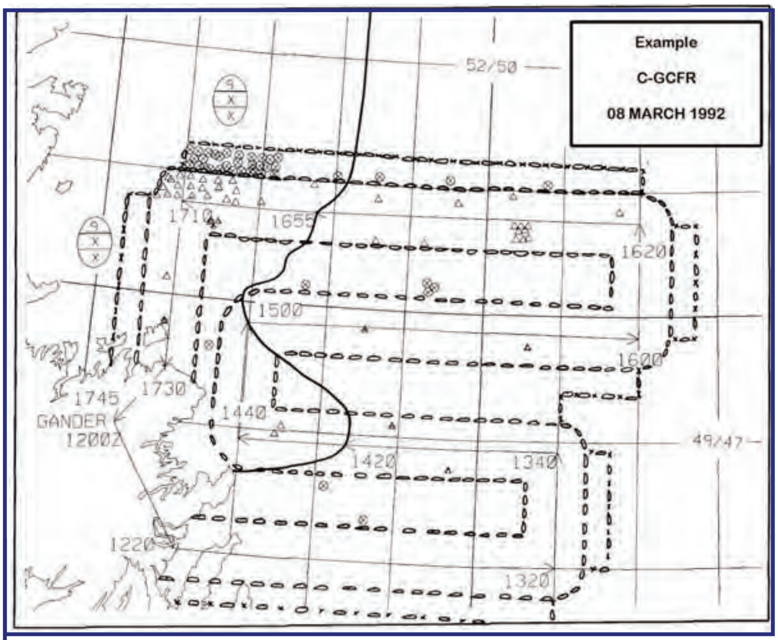


Figure 4.2: Chart Produced from an Iceberg Flight

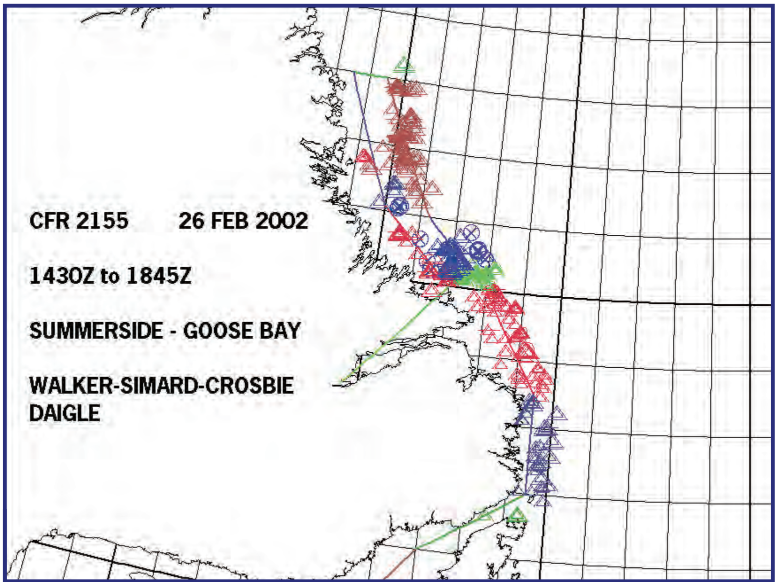


Figure 4.3: Computer Generated Chart Produced from an Iceberg Flight

CHAPTER 5

Ice Analysis Charts

- ❑ Daily Ice Analysis Charts
  - Description
  - Method of Production
  - Dissemination of Charts
  - Symbols Used on Charts

- ❑ Regional Ice Analysis Charts
  - Description
  - Method of Production
  - Dissemination of Charts
  - Symbols Used on Charts

- ❑ Image Analysis Charts
  - Description
  - Method of Production
  - Dissemination of Charts
  - Symbols Used on Charts

- ❑ Daily Iceberg Analysis Chart
  - Description
  - Method of Production
  - Dissemination of Charts
  - Symbols Used on Charts

- ❑ Colour Coding Ice Charts

- ❑ Examples of the Use of the Egg Code

- ❑ Examples of Ice Charts

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.

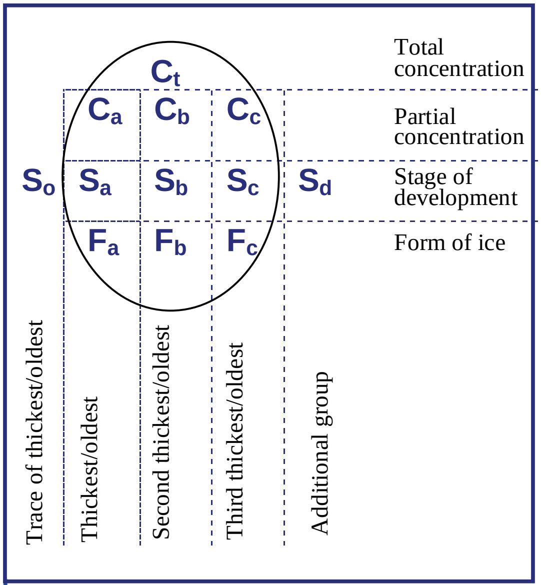
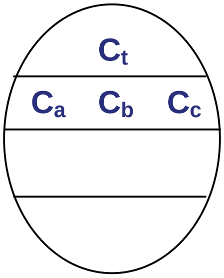


Figure 5.1: Elements of the Egg Code Used for Daily Ice Analysis Charts

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:

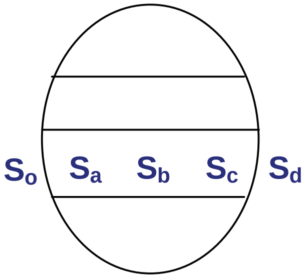
1. When only one ice type is present, the partial concentration shall not be indicated (see Example 1).

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).

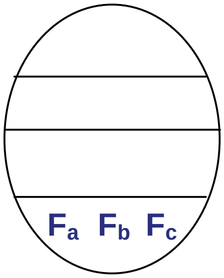
2. The symbol ▲• shall only be used within the egg when the concentration of ice of land origin is 1/10 or more (see Example 12).

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.

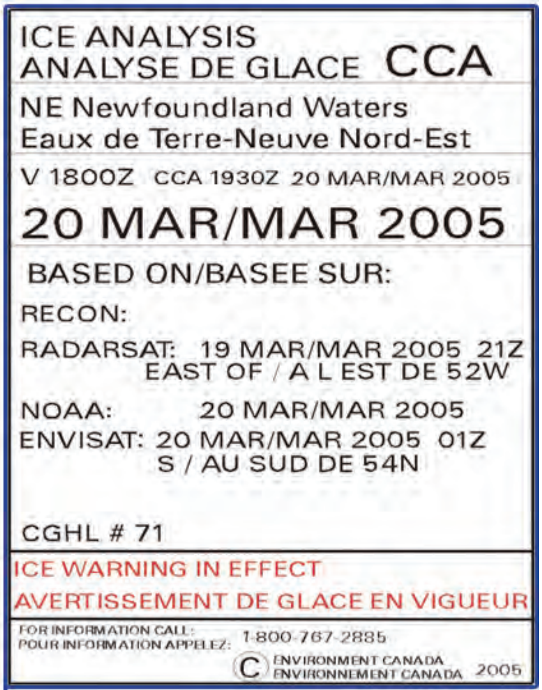


Figure 5.2: Example of Chart Legend

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.

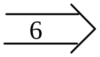
- **Data reception and integration**
  For information received from outside sources (CFR charts, CCG ship reports, etc.), a minimum of 2.5 hours before the transmission deadline is required to integrate it into the daily ice analysis chart. In most cases when the information arrives late, the forecaster 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

Drift 

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.

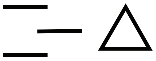
Symbols for Defining Limits

Analysed edge or boundary 

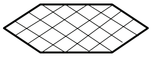
Bergy water boundary 

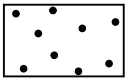
Other Symbols Used

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.

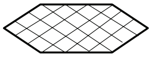
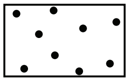
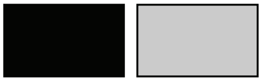
5.2.4 Symbols Used on Regional Ice Charts

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.

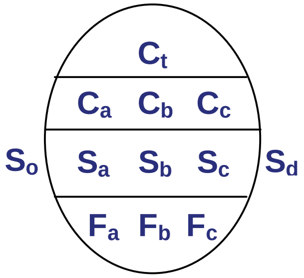
5.3.2 Method of Production

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.

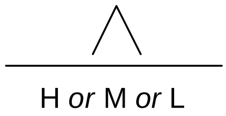
5.3.4 Symbols Used

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

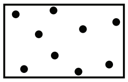


In operational areas, relative roughness will be indicated when there are coincident visual reports to support the signature analysis.

Symbols In Use On Image Analysis Charts

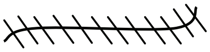
Fast ice

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



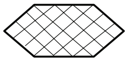
Bergy water
(less than 1/10 sea ice
may be present and
total ice concentration
is less than 1/10)

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.

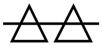
5.4.2.4 Deadlines

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:

Pattern	Name	Concentration
*	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		
(blue)	(white)	000-100-255	Ice free
	(light blue)	150-200-255	Less than one tenth (open water)
	(light green)	140-255-160	1/10 - 3/10
	(yellow)	255-255-000	4/10 - 6/10
	(orange)	255-125-007	7/10 - 8/10
	(red)	255-000-000	9/10 - 10/10
	(grey)	150-150-150	Fast ice
	? ? ?	255-255-255	Undefined ice (unknown type and amount)
Optional			
	(pink)	255-175-255	7/10 - 10/10 new ice
	(purple)	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

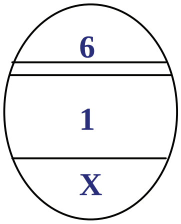
Colour	Description	Thickness
	Ice free	
	Ice of Unspecified Stage of Development (open water)	
	New Lake Ice	< 5 cm
	Thin Lake Ice	5 – 15 cm
	Medium Lake Ice	15 – 30 cm
	Thick Lake Ice	30 – 70 cm
	Very Thick Lake Ice	> 70 cm
	Fast Ice of Unspecified Stage of Development	
? ? ?	Undefined Ice	

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

5.6 Examples of the Use of the Egg Code

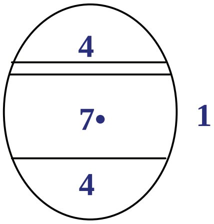
Example 1

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.



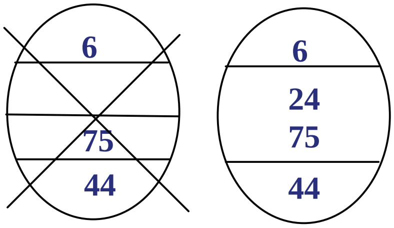
Example 2

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



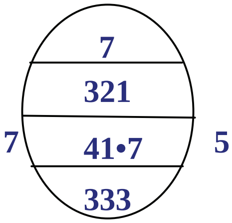
Example 3

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.



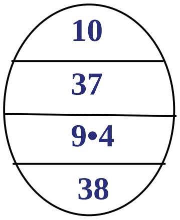
Example 4

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.



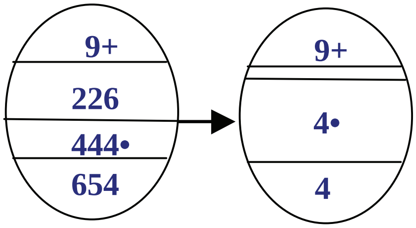
Example 5

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

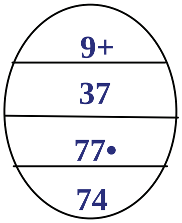


Example 6

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.

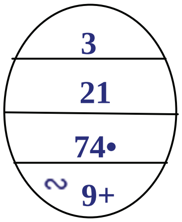


Example 7
9+/10 total ice concentration. 3/10 old ice of giant floes and 7/10 old ice of medium floes.

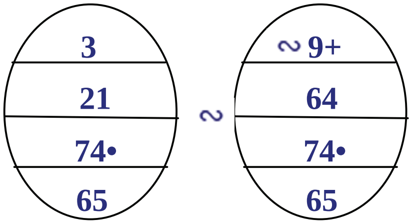


Strips and Patches

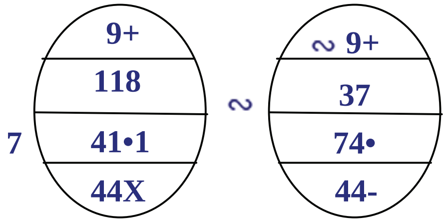
Example 8
3/10 total ice concentration. 2/10 old ice and 1/10 thick first-year ice. All ice is concentrated in strips and patches of 9+/10. Floe sizes are code 3 or less.



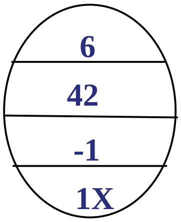
Example 9
3/10 total ice concentration in strips and patches of 9+/10. 6/10 old ice in vast floes and 4/10 thick first-year ice in big floes. These floe sizes are significant and warrant the use of two ovals.



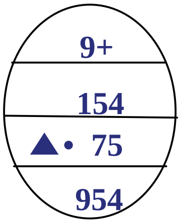
Example 10
9+/10 total ice concentration comprised of 1/10 thick first-year ice, 1/10 medium first-year ice, 8/10 new ice and old ice with a concentration of less than 1/10. The old and thick first-year ice are distributed throughout the area in strips and patches made up of 3/10 old and 7/10 thick first-year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



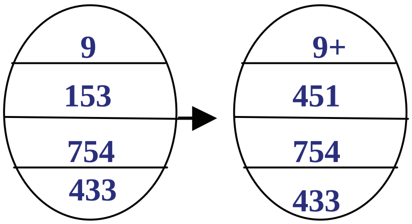
Example 11
6/10 total ice concentration. 4/10 brash and 2/10 new ice with no form.



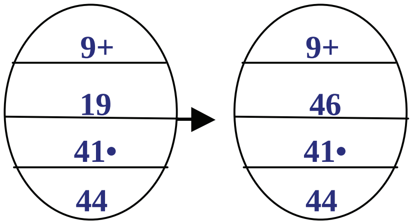
Example 12
9+/10 total ice concentration. 1/10 of ice of land origin (▲•) with floe size of 9 (icebergs). 5/10 thin first-year ice in big floes and 4/10 grey-white ice in medium floes.



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

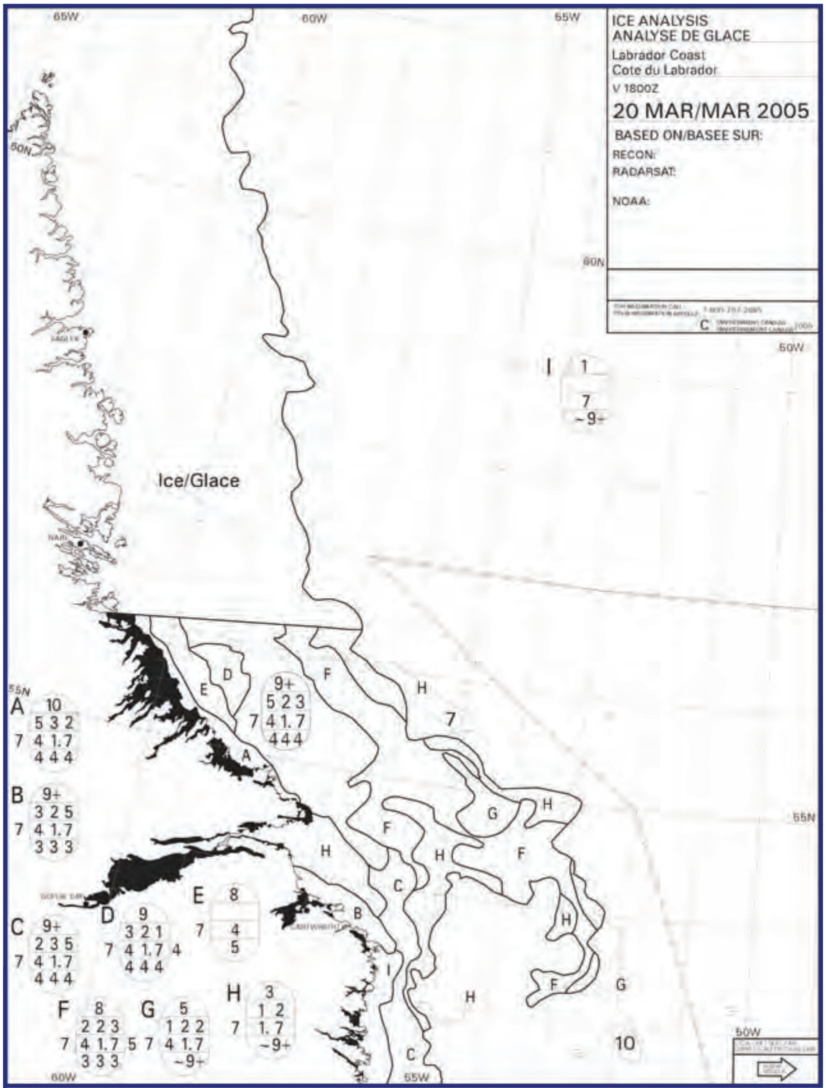


Figure 5.3: Black and White Daily Ice Chart

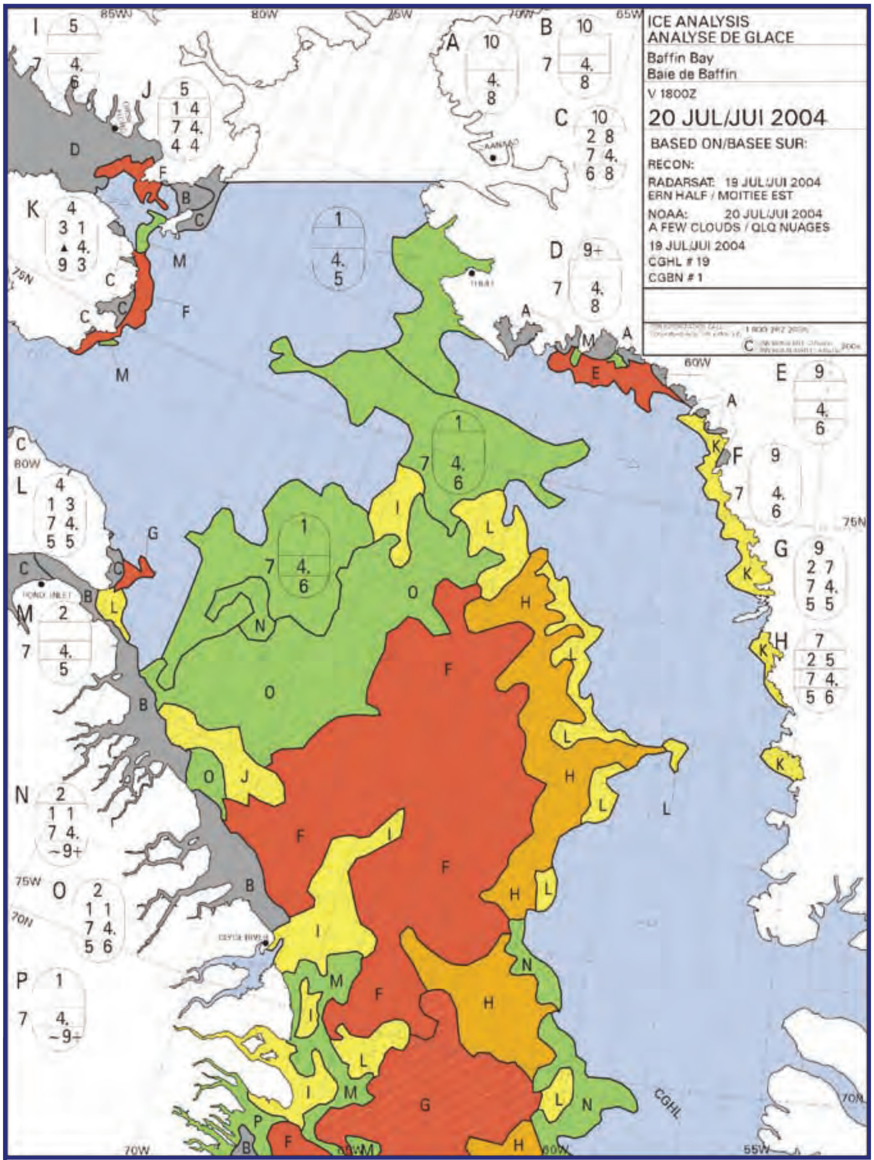


Figure 5.4: CIS/ISS Colour-Coded Daily Ice Chart

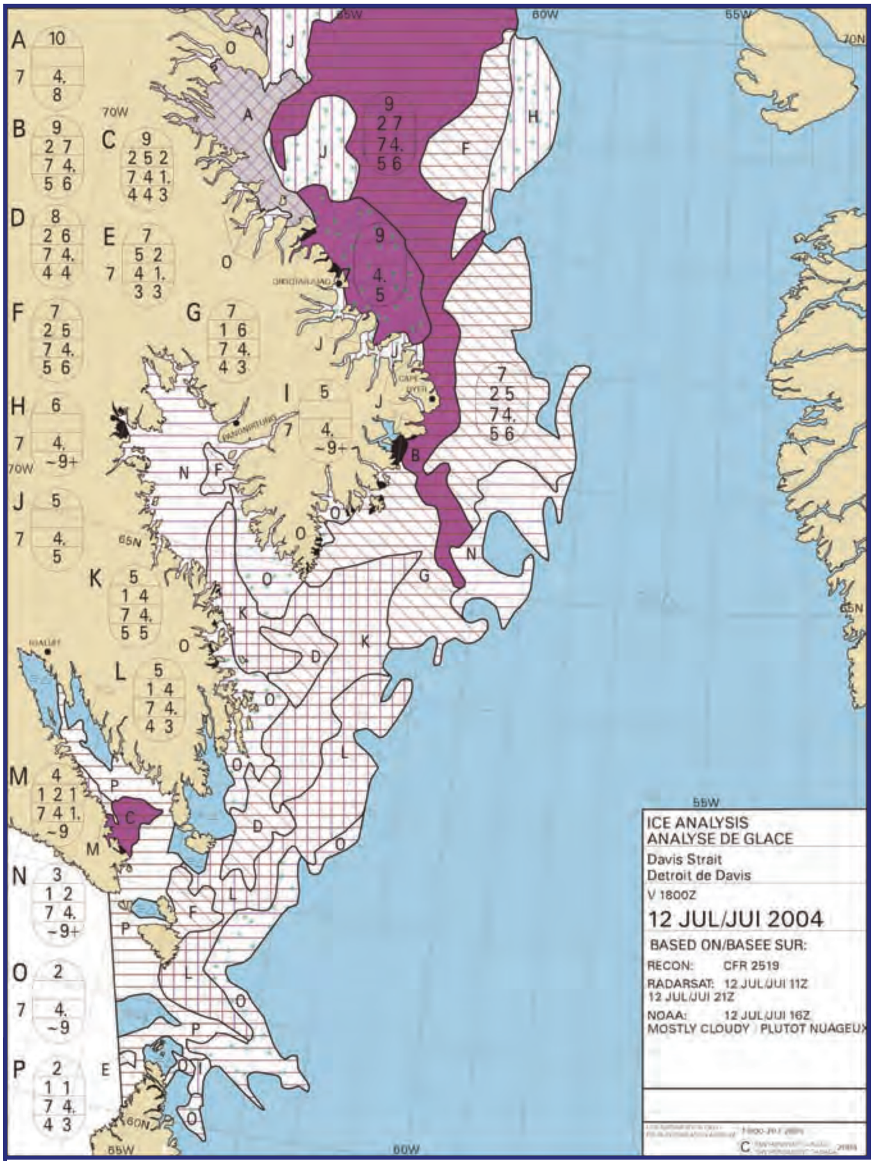


Figure 5.5: Q/A Colour-Coded Daily Ice Chart

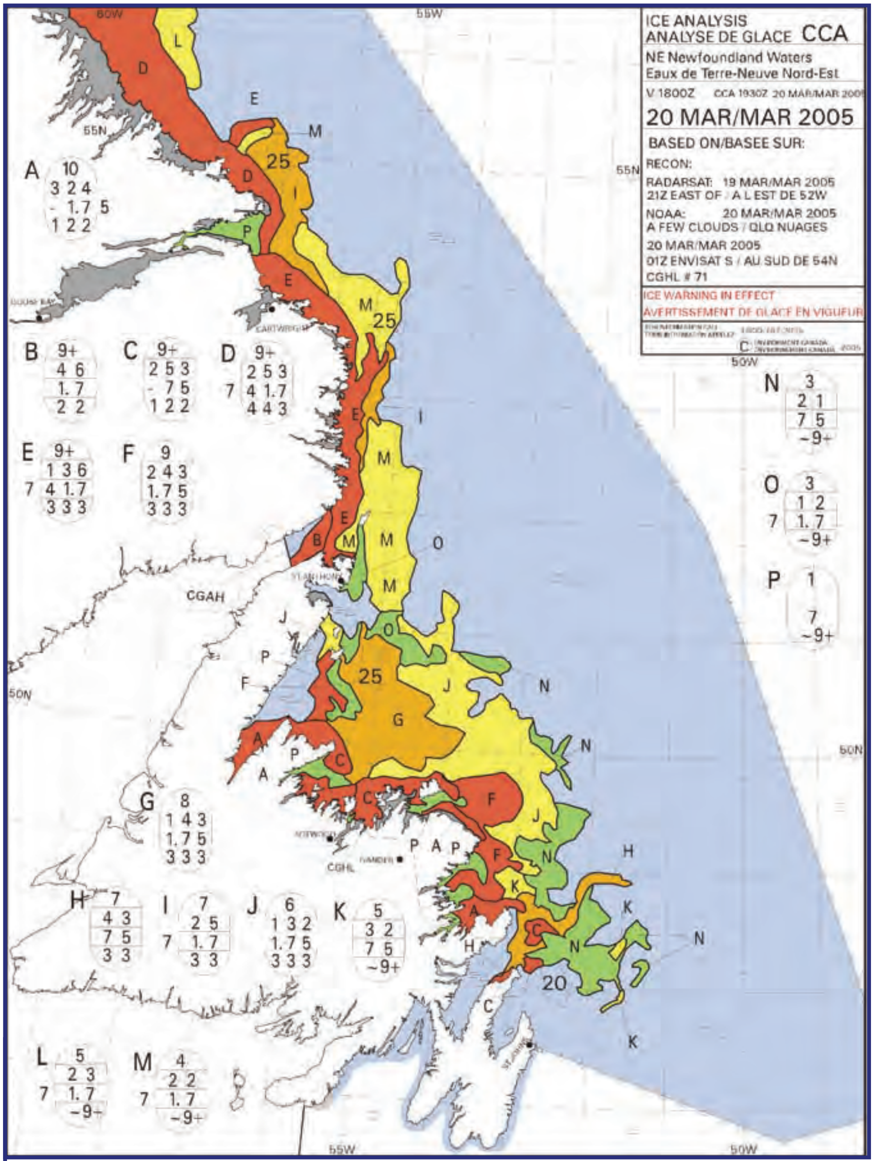


Figure 5.6: Example of Corrected/Ammended Chart

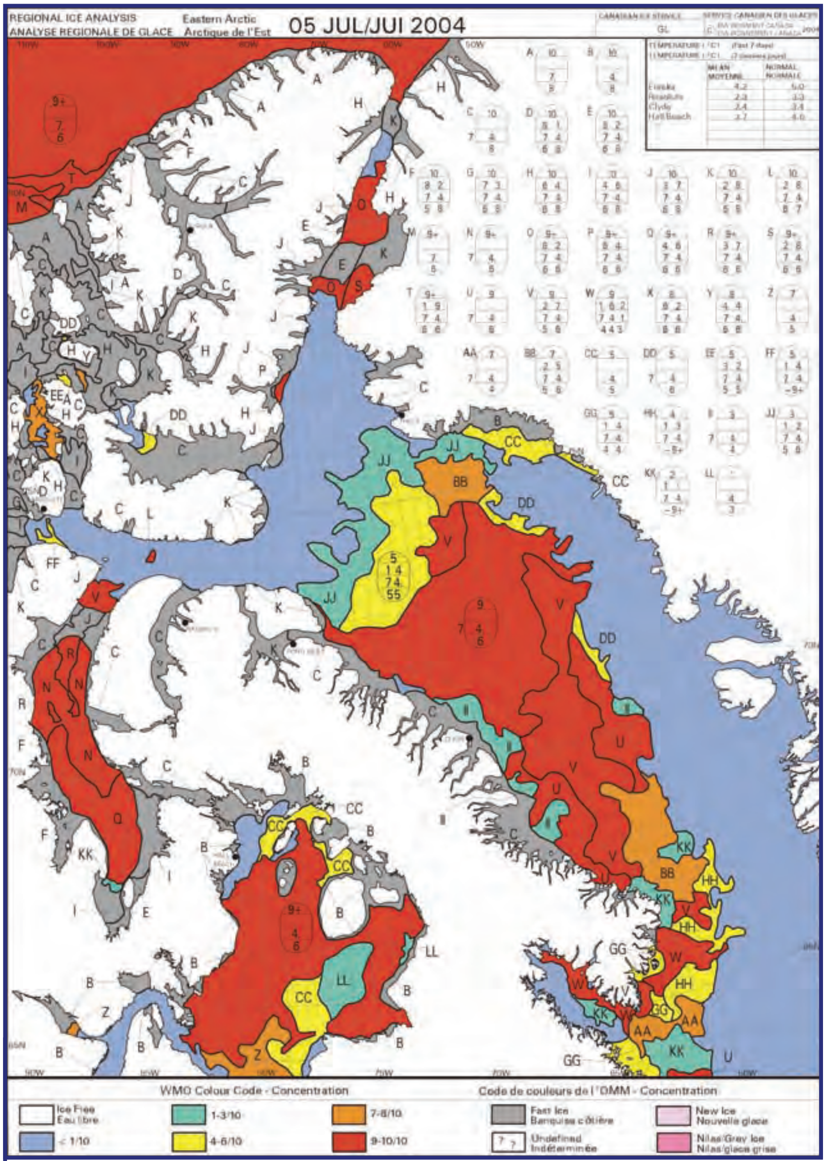


Figure 5.7: Eastern Arctic Regional Chart with WMO CT Colour Code

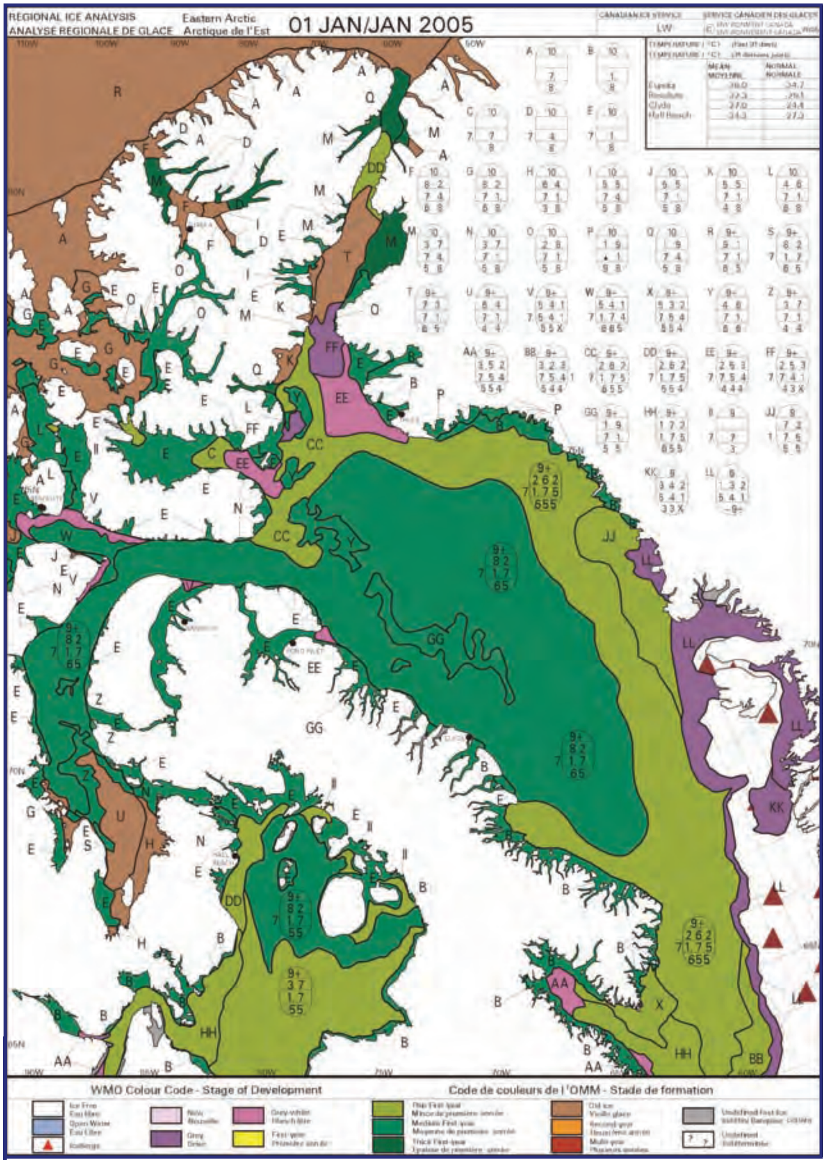


Figure 5.8: Eastern Arctic Regional Chart with WMO SD Colour Code

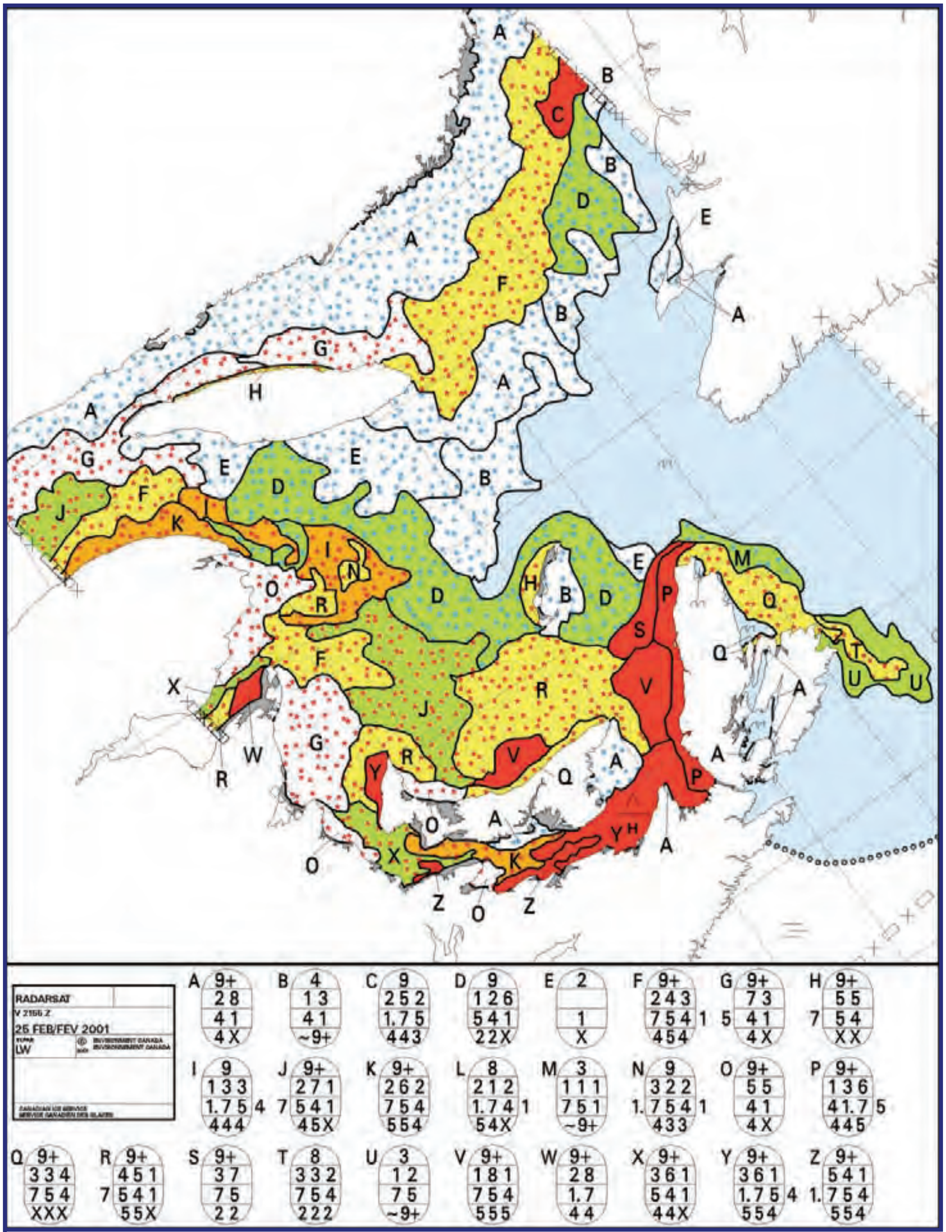


Figure 5.9: RADARSAT Image Analysis Chart

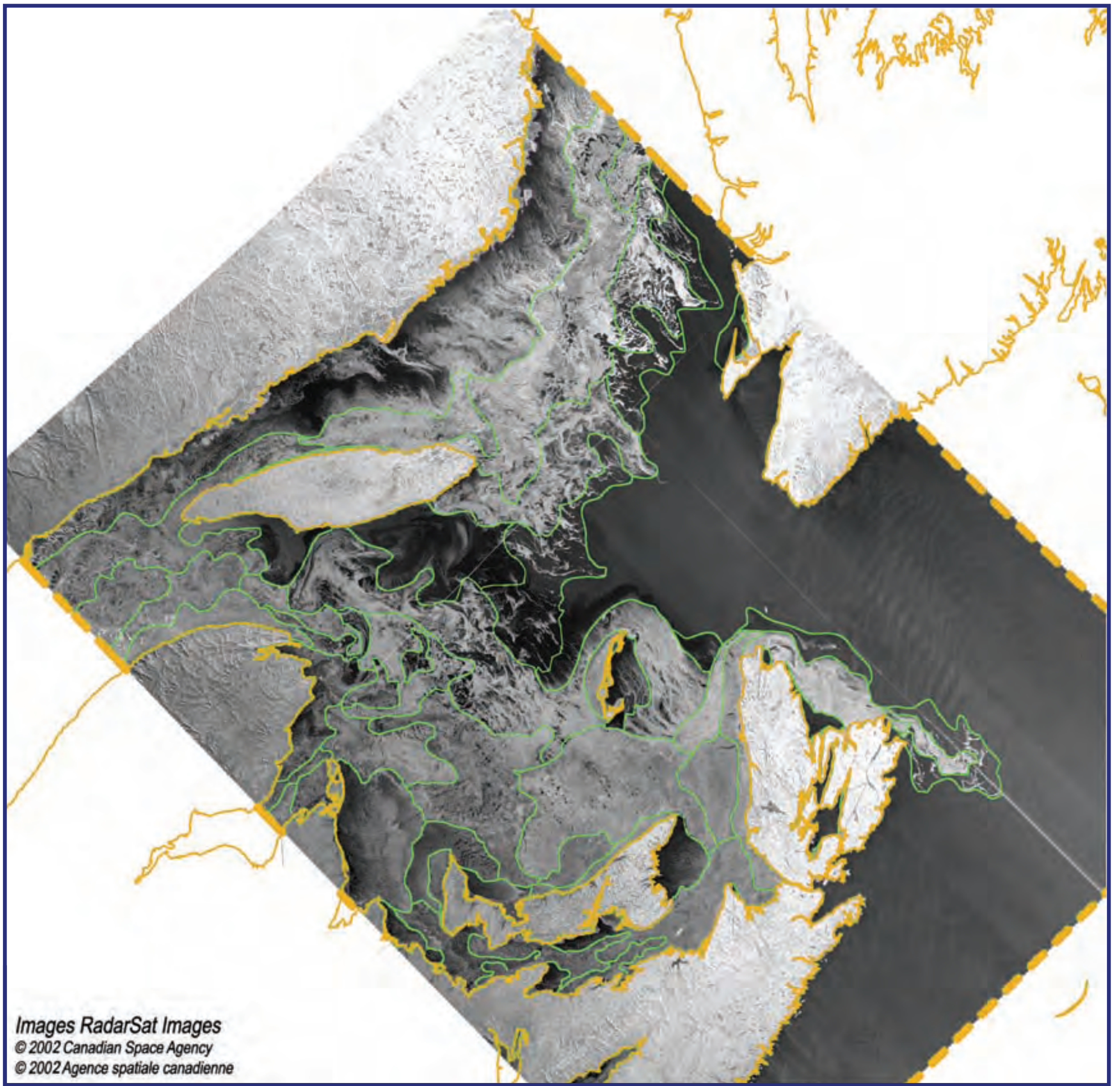


Figure 5.10: RADARSAT Image

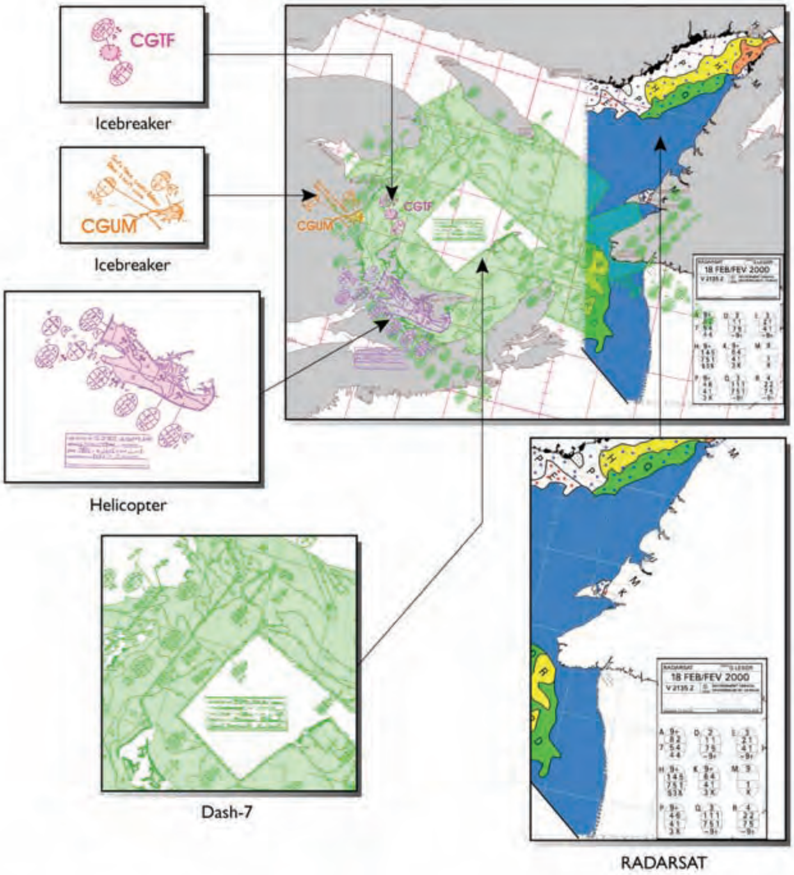


Figure 5.11: Data Sources

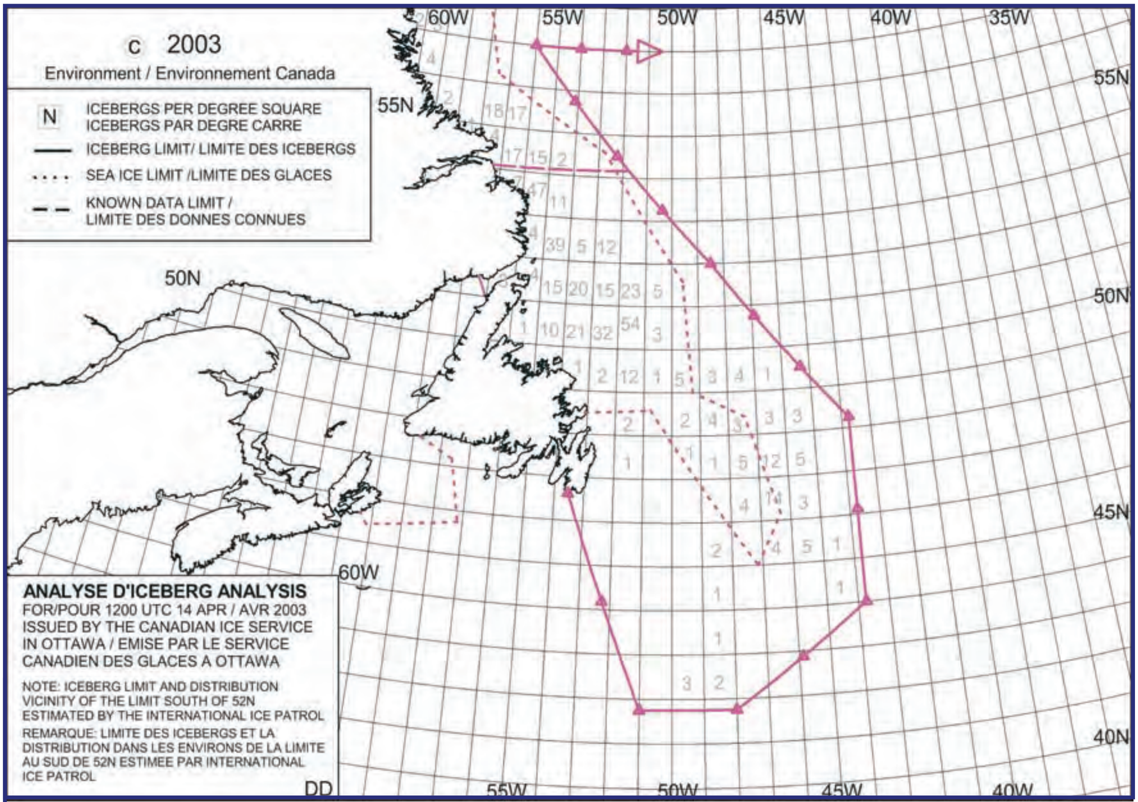


Figure 5.12: Example of a Daily Iceberg Analysis Chart

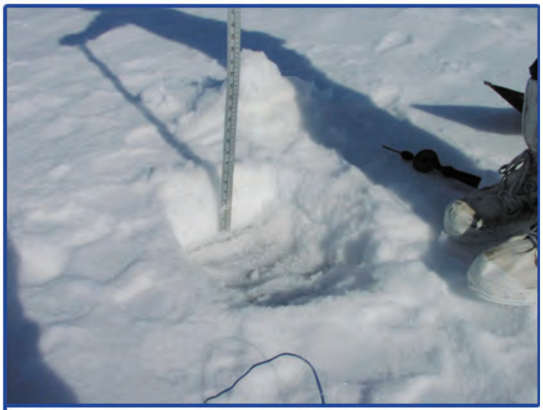
CHAPTER 6

Ice Thickness Measurements and Reports

- ❑ Weekly Ice Thickness Reports
- ❑ Ice Thickness Monthly Report
- ❑ Examples of Ice Thickness Reports

This chapter deals with the measurement and reporting of ice thickness and snow depth. The depth of snow is important to know because it has a direct bearing on the ice thickness due to it's insulating qualities. These measurements are important operationally since they provide a means to estimate the general thickness of the ice cover around the area. They are also important climatological records that users need for ice modeling, building infrastructures and, most recently, studies in climate change. Annual data summaries are produced from these measurements.

The observer shall ensure that the site selected has a depth of water greater than the maximum ice thickness expected for the year. The ice thickness and snow depth shall be measured, as near as practicable, at the same location throughout the ice season, and from one season to the next. The site should be on undeformed (level) and undisturbed ice. When the auger is used, a new hole shall be drilled for each measurement made in order to obtain the thickness of the entire ice layer. If a tidal crack is a permanent feature at the station, the site selected should be slightly seaward of the crack.



Katherine Wilson (CIS)

Photo 6.1: Snow depth measurement

6.1 Weekly Ice Thickness Reports

Weekly reports are used in near real-time as validation of fast ice growth and to estimate the rate of growth of drifting sea ice. The reports are to be forwarded to a designated collection station on the meteorological communication system, where they are to be entered on the circuit in bulletins under the heading "**ITCN01**" with the collection station's identifier. MANTRANS (cf. 3) gives a listing of **ITCN** bulletin headings, including the stations contained in the bulletins and prescribes the relays which provide the desired distribution.

The weekly ice thickness and snow depth measurements are coded as follows:

ITCN01 CXXX YYGGgg
(CXXX) $YYI_tI_tI_t$ $S_tS_tTW_fd$

SYMBOL	DESCRIPTION
ITCN01	Message identifier
CXXX	Transmission station identifier
YY	Day of month of message transmission
GG	Hour of message transmission
gg	Minute of message transmission

Table 6.1: Weekly Ice Thickness Message Heading

SYMBOL	DESCRIPTION	CODE TABLE
CXXX	Observation station identifier (if different than transmission station)	
YY	Day of month of measurement	
$I_tI_tI_t$	Ice thickness in whole centimetres	
S_tS_t	Average depth of snow in whole centimetres at measurement site	
T	Surface topography	6.3
W_f	Cracks and leads	6.4
d	Measurement method used	6.5

Table 6.2: Weekly Ice Thickness Message Body

SYMBOL	CONCENTRATION	CODE
Smooth		0
Rafted	0 - 1/10	1
	2/10 - 3/10	2
	4/10 - 10/10	3
Ridged	0 - 1/10	4
	2/10 - 3/10	5
	4/10 - 10/10	6
Hummocked	0 - 1/10	7
	2/10 - 3/10	8
	4/10 - 10/10	9

Table 6.3: Surface Topography (T)

DESCRIPTION	CODE
No cracks or leads	0
Few cracks	1
Numerous cracks	2
Few leads	3
Numerous leads	4

Table 6.4: Cracks and Leads (W_f)

DESCRIPTION	CODE
Visually	0
Ice Auger Kit	1
Hot Wire	2
Other Means	3

Table 6.5: Measurement Method Used (d)

6.2 Ice Thickness Monthly Report

Weekly ice thickness measurements are recorded on Form 0063-2317. Figure 6.1 (“Ice Thickness Form 0063-2317”, p. 6-7) shows an example of a completed form. The completed forms constitute the official record of ice thickness and snow depth reports from network stations. The Officer-In-Charge (OIC) is responsible for ensuring that each form has been carefully checked and signed by himself or his/her deputy. This signature is a certification of the accuracy and completeness of the record.

The form shall be forwarded by mail to the Canadian Ice Service at the end of each month. One copy should be retained for station files. One form should be used for each month’s observations.

The station name in full, the month and year shall be entered neatly on each sheet in the appropriate spaces provided at the top of the form.

The form has four (4) categories of information to be entered:

- measurement site
- measurements
- leads
- remarks

Table 6.6 describes the guidelines for filling the form.

ITEM #	ITEM	DESCRIPTION
1	Measurement Site	The bearing and distance from a significant landmark and report any change of the site, should a change become necessary
2a	Date of Measurement	The date (a two-figure number) when the ice measurement is taken
2b	Ice Thickness	Measured ice thickness to the nearest whole centimetre
2c	Depth of Snow	Average snow depth to the nearest whole centimetre
2d	Surface Topography	Surface features at the measurement site and seaward (Table 7.3)
2e	Cracks/Leads	The presence and orientation of cracks and leads (Table 7.4)
2f	Method Used	The method used to measure or estimate the ice thickness (Table 7.5)
2g	Transmitted by Message	Y (yes) or N (no) whether or not the weekly report was transmitted
3	Leads	The presence and when possible the location orientation, length and width (in metres or kilometres) of leads shall be noted
4	Remarks	Additional information (include the date ice first appears and the date the ice is unsafe for measurement)

Table 6.6: Ice Thickness Monthly Report

6.3 Examples of Ice Thickness Reports

Example 1

ITCN01 CYFB 072200
07112 15611

Heading
ITCN01 CYFB 072200

ITCN01	message identifier
CYFB	station identifier (Iqaluit)
072200	time of filing report for transmission was 7th day of the month at 2200UTC

Body
07112 15611

07	date of measurement was 7th day of the month
112	ice thickness is 112 centimetres
15	average depth of snow is 15 centimetres at measurement site
6	surface topography = 4/10 - 10/10 ridging
1	few cracks
1	measurement made with ice auger kit

Example 2

ITCN01 CYVN 072100\
07095 08401

Heading
ITCN01 CYVN 072100

ITCN01	message identifier
CYVN	station identifier (Cape Dyer)
072100	time of filing report for transmission was 7th day of the month at 2100UTC

Body
07095 08401

07	date of measurement was 7th day of the month
095	ice thickness is 95 centimetres
08	average depth of snow is 8 centimetres at measurement site
4	surface topography = 0 - 1/10 ridging
0	no cracks or leads
1	measurement made with ice auger kit

The above examples would be assembled into a bulletin by YFB, the designated collection station, in the following form:

ITCN01 CYFB 072230
YFB 07112 15611
YVN 07095 08401

Environment Canada Environnement Canada

ICE THICKNESS MONTHLY REPORT

Station	Bagotville (A)	Quebec
Month	December	2001

1. Measurement Site: Approximately 200 metres eastward from the wharf and some 250 metres off shore on baie de Ha Ha.

2.

Date of Measurement (a)	Ice Thickness (centimetres) (b)	Depth of Snow (centimetres) (c)	Surface Topography (d)	Cracks/ Leads (e)	Method Used (f)	Transmitteby Message (Y/N) (g)
03	nil	nil	n/a	n/a	0	N
10	3	1	0	0	0	Y
17	15	7	1	0	1	Y
23	22	10	1	1	1	Y
31	22	6	2	1	1	Y

3. Leads: A few shore leads were seen until approximately December 12. Icebreakers keep a 25 metre channel (approximately) open to navigation on the bay and along the Saguenay River throughout most of the winter season.

4. Remarks: Observations on December 03 and 10 were visual. After December 15, the ice was piling on shore due to tides and ice ridging from shore to approximately 100 metres off shore.
The bay was completely covered with ice on December 17. Several fishing huts were seen on the bay beginning approx. December 20. Relatively warmer temperatures kept the ice thickness fairly unchanged December 23-31.

Observer(s) Staff

Reporting Instructions (reference: MANICE, ninth edition, chapter 6)

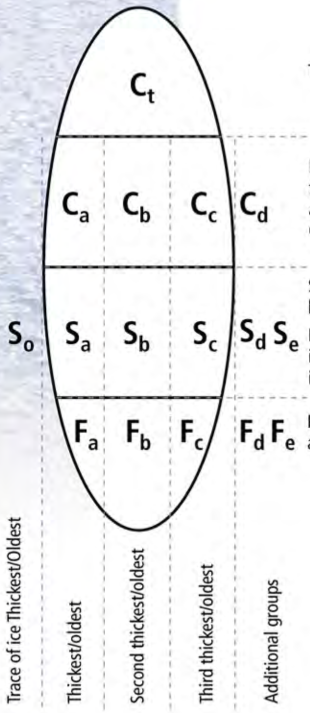
1. For "Measurement Site" note bearing and distance from a significant landmark, and report any significant change of the site. The ice thickness should be measured, as near as practicable, at the same spot throughout the ice season and from season to season.
2. "Surface Topography", "Cracks/Leads" and "Method Used" are coded according to tables 7.3, 7.4, and 7.5 in MANICE.
3. Indicate by Y/N in the final column whether or not the weekly report was transmitted.
4. In "3. Leads", when possible, include: location, length and width (metres or kilometres).
5. In "4. Remarks", indicate if this is the first/last monthly report of the season and please include complementary information such as: the date new ice first appears, date ice is unsafe for measurement, method used when (f) is coded as "Other Means", etc.
6. The original of this form should be forwarded by mail at the end of each month to:
Client Services, Canadian Ice Service, Environment Canada, 373 Sussex Drive, Ottawa ON K1A 0H3
and a copy should be retained on station files.

0063-2317

Figure 6.1: Ice Thickness Form 0063-2317

Environment Canada Environnement Canada

KEY TO ICE SYMBOLS



Total Concentration of ice, reported in tenths.

Partial concentration in tenths of thickest (C_a), second thickest (C_b) and third thickest (C_c) ice types with C_a C_b and C_c 1/10 or more. If only one thickness type is present C_a equals C_t and the second level is left blank.

Stage of development (age) of ice concentration reported by C_a C_b and C_c.

Development stage (age) of remaining ice types. S_o if reported is a trace of ice thicker/older than S_a. S_d is a thinner ice which is reported when there are four or more ice thickness types.

Predominant form of ice (floe size) corresponding to S_a S_b and S_c respectively.

Open Water

Fast Ice

Ice Free

Bergy Water

Target Water

NM/Day Ice Drift (NM: Nautical miles)

Stage of Development Sea Ice ($S_oS_aS_bS_cS_dS_e$)

Description	Thickness	Code
New	<10 cm	1
Nilas; Ice rind	<10 cm	2
Young	10-30 cm	3
Grey	10-15 cm	4
Grey-white	15-30 cm	5
First-year	≥30 cm	6
Thin first-year	30-70 cm	7
Medium first-year	70-120 cm	1•
Thick first-year ice	>120 cm	4•
Old		7•
Second-year		8•
Multi-year		9•
Ice of land origin		▲•
Undetermined, unknown		X

Form of Ice ($F_aF_bF_cF_dF_e$)

Description	Width	Code
Pancake ice		0
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
Undetermined, unknown or no form		X
Ice in strips in which concentration is **C**		ꝏ C

Stage of Development Lake Ice ($S_oS_aS_bS_cS_dS_e$)

Description	Thickness	Code
New	<5 cm	1
Thin	5-15 cm	4
Medium	15-30 cm	5
Thick	30-70 cm	7
Very thick	>70 cm	1•
Undetermined, unknown		X

Canadian Ice Service (CIS)

Client Services
373 Sussex Drive, E-3
Ottawa, Ontario
K1A 0H3

Tel.: 1 800 767 2885 (Canada) and (613) 996-1550
Fax: (613) 947-9160
Email: cis-scg.client@ec.gc.ca
Web site: http://ice-glaces.ec.gc.ca

Canada

Conversion Table

VOLUME

1 Barrel (petroleum)	=	5.615 Cubic Feet	=	158.987 Litres	=	34.972 Gallons		
1 Barrel (Imp)	=	7.224 Cubic Feet	=	204.574 Litres	=	45.000 Gallons		
1 Gallon (Imp)	=	0.161 Cubic Feet	=	4.546 Litres	=	4,546.090 Millilitres		
1 Litre	=	0.035 Cubic Feet	=	1,000.000 Millilitres	=	0.220 Gallons		
1 Metric Tonne (oil)	=	7-9 Barrels	=	~1.11 Cubic Metres	=	~250 Gallons		

AREA

1 Acre	=	0.405 Hectares	=	4,046.955 Square Metres	=	43,560.000 Square Feet	=	0.002 Square Miles
1 Hectare	=	10,000.000 Square Metres	=	2.471 Acres	=	107,636.486 Square Feet	=	0.004 Square Miles

LENGTH

1 Kilometre	=	0.540 Nautical Mile	=	0.621 Miles	=	3,280.800 Feet	=	5.400 Cable (UK/Canada)
1 Nautical Mile	=	1.852 Kilometres	=	1.151 Miles	=	6,076.116 Feet	=	1,852.000 Metres
1 Mile	=	1.609 Kilometres	=	0.869 Nautical Mile	=	5,280.000 Feet	=	1,609.344 Metres
1 Metre	=	0.547 Fathom	=	1.094 Yards	=	3.281 Feet	=	39.370 Inches
1 Foot	=	0.305 Metre	=	30.480 Centimetres	=	304.800 Millimetres	=	0.167 Fathoms
1 Fathom	=	1.829 Metres	=	6.000 Feet	=	72.000 Inches		
1 Cable (UK/Canada)	=	0.100 Nautical Mile	=	185.200 Metres	=	607.612 Feets	=	0.185 Kilometres

SPEED

1 Knot	=	1.852 Kilometre/Hour	=	1.151 Mile/Hour	=	0.514 Metre/Second	=	1.688 Foot/Second
1 Mile/Hour	=	1.609 Kilometre/Hour	=	0.869 Knot	=	0.447 Metre/Second	=	1.467 Foot/Second
1 Kilometre/Hour	=	0.540 Knot	=	0.621 Mile/Hour	=	0.278 Metre/Second	=	0.911 Foot/Second
1 Metre/Second	=	3.600 Kilometre/Hour	=	1.944 Knot	=	2.237 Mile/Hour	=	3.281 Foot/Second

MASS/WEIGHT

1 Tonne	=	1,000.000 Kilograms	=	2,204.623 Pounds	=	0.984 Long Ton (UK)
1 Long Ton (UK)	=	2,240.000 Pounds	=	1.016 Tonnes	=	1,016.047 Kilograms
1 Pound	=	0.454 Kilogram	=	16.000 Ounces	=	453.592 Grams
1 Ounce	=	0.028 Kilogram	=	0.063 Pound	=	28.350 Grams
1 Kilogram	=	2.205 Pounds	=	35.280 Ounces	=	1,000.000 Grams

POWER

1 Horsepower	=	0.735 Kilowatts	=	735.294 Joules/Sec	=	735.294 Watts