# SEA ICE NOMENCLATURE

**Version 1.0**

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**Summary and Purpose of Document**

This document provides a draft of a new version of the WMO Sea Ice Nomenclature, which includes a corrected version of the WMO glossary on sea ice cover. The document describes recommendations for future ice chart preparation using the international system of sea ice symbols.

**Content**

**EXPLANATORY NOTE BY AUTHOR**

1. The quality of providing information on the ice cover state to the users is determined to a great extent by completeness and consistency of four main documents: Nomenclature (terminology), scales, system of symbols and format (code). The development of these documents should take into account:

- physical essence of a process or a phenomenon,
- limits of possible quantitative values,
- significance of information on the given characteristic for users,
- technical possibility of determining and the accuracy,
- illustrativity of the cartographic depiction of information,
- minimum (without loss of accuracy) volume of coded digital or letter-digital ice chart.

2. The "WMO Sea-Ice Nomenclature", which is currently effective, was developed by the WMO CMM WG in 1968 and published in 1970 (without scales and symbols). In 1989, it was republished in the form of Supplement No.4, where volume 3 "International system of sea-ice symbols" is presented, and Supplement No.5, presenting several supplemented and edited main sections of the Nomenclature (ice terms arranged in the subject and alphabetical orders). No international format (code) for operational provision of users and data exchange has yet been developed.

3. During the period of the development of the Nomenclature, the visual air - and shipborne observations were the main method of ice information collection, which influenced inevitably the composition and formulation of terms.

4. Along with an excessively detailed description of some ice features that are not even depicted on the ice charts (separate ice ridges, standing floes, rams, etc.), the Nomenclature does not contain a number of notions and terms that are already applied in practice of the ice services (ice cover, zone, ice drift, drift divide, etc.). An absence of these terms and notions, extremely important for investigators and navigators, leads to a possibility of different understanding of information plotted on the chart.

5. Sometimes the physical essence of a phenomenon and bounds of possible quantitative values are not taken into account. Thus, the terms 6.2 Hummocking and 6.3 Ridging are presented as different deformation processes although this is in fact a result of one process – ice pressure.

6. The extent ice surface coverage with ice hummocks and ice ridges according to Nomenclature can be expressed either in partial concentration of the area of ridges in tenths or in the quantity per nautical mile. However, the expression in tenths does not take into account the limit of the maximum possible value of hummock and ridge concentration, which is not greater than 20%.

*Some recommendations for compiling the ice charts also cause objections*.

7. In particular, we consider incorrect in principle the recommendations of the effective nomenclature on depiction of ice forms of each age stage. The ice cover of the seas presents as a rule ice breccia of different age. Only the oldest ice has at this the shape of ice fields, whereas all other ice – frozen in different periods after the onset of ice formation areas of ice-free water, fractures and leads. As a result of this recommendation, the drifting ice forms are not indicated on the ice charts at all at the present time. The aforementioned facts determine the need and the importance of developing a new version of WMO Nomenclature on Sea Ice.

***Specific features of the Draft Nomenclature***

8. The developed preliminary Draft Nomenclature consists of 11 sections including 120 terms. The successive order of the sections is given in accordance with the succession of compiling the ice charts and their coding. Whenever possible, the terms of the existing Nomenclature were preserved. These terms are followed by their number in the Nomenclature in brackets. If the term notion was edited, "ed" follows the number. Some terms that are not used for compilation of the ice charts but can

be used in the text messages are included in a description of the main term. For example, a description of landfast ice includes a description of the notions “Ice foot” and “Young coastal ice”. After such terms several Nomenclature numbers are given.

9. The Draft Nomenclature includes 22 new terms with part of them being already used during ice observations without preliminary permission (“*residual first-year ice*”, “*rough ice*”, etc.). The definitions of the main zones and their types (*landfast ice, drifting ice, individual field, iceberg waters, clear*) are given. These new terms are given by sections:

Section 1:
- *1.2 Ice cover*;
- *1.7 No observational data;*
- *1.8 Zone;*
- *1.8.1 Basic zones;*
- *1.8.2 Additional zones*.

Section 2:
- *2.4.3 Strips, patches.*

Section 3:
- *3.5.1 Residual first-year ice;*
- *3.6 Ice age composition.*

Section 5:
- *5.1 Ice floe.*

Section 6:
- *6.2.2 Rough ice;*
- *Hillocky multiyear ice;*
- *6.5 Dirty ice.*

Section 7:
- *7.4 Barrier of ice ridges;*
- *7.7 Jammed brash barrier.*

Section 9:
- *Fracture.*

Section 10:
- *10.1 Ice drift;*
- *10.1.1 Drift vector;*
- *10.1.2 Drift divide;*
- *10.5 Ice pressure;*
- *10.5.1 Zone of pressure.*

Section 11
- *11.6 Recommended place;*
- *11.7 Recommended route;*
- *11.8 Channel in ice made by a ship (vessel)*.

10. The following terms and sections were excluded (by the numbers of the existing Nomenclature):

- *2.3 Pancake ice* – the term description is given in the section of Forms;
- *3.1.1 Young coastal ice* and *3.2 Landfast ice foot* are included to the description of the main term;
- *3.1 Landfast ice* and *3.3 Anchor ice* – as a feature typical only of rivers;
- *4.2.1.1 Consolidated floating ice* - there is a term “*Ice breccia*”;
- *4.3.7.- 4.3.12 Icebergs* and their types in the section of Forms – a full description of these terms is given in the section “*Ice of land origin*”;
- *4.4.1.1 Large ice field, 4.4.1.2 Medium ice field, 4.4.1.3 Small ice field, 4.4.3 Ice belt, 4.4.4 Ice tongue, 4.4.6 Bight* – these features are described by their boundaries, hence separate terms are not needed;
- *7.1.2 very small fracture, 7.1.3 Small fracture, 7.1.4 Medium fracture, 7.1.5 Large fracture* - are either described by the boundaries or are not depicted on the ice charts;

- *7.4.1 Shore polynyas, 7.4.2 Flaw polynya, 7.4.3 Recurring polynya* – are transferred to the description of the term “Polynya”;
- *8.2.1.1 Finger rafter ice* – transferred to the description of the term “Rafted ice”, it was not taken into account that the character of rafting is not reflected on the ice charts;
- *8.2.2.1 New ridge, 8.2.2.2 Weathered ridge, 8.2.2.3 Very weathered ridge, 8.2.2.4 Aged ridge 8.2.2.5 Consolidated ridge, 8.3 Standing floe* – the types of ice ridges are not depicted on the ice charts;
- *10.1 Firn, 10.2.3 Ice stream* – a description of inland glaciers, which is not in the objectives of the Nomenclature;
- *12.4 Ice under pressure* – repetition of the term;
- *12.7 Ice port* - described by the boundary of the ice front;
- *Section 6 “Deformation processes”* is excluded. The term 6.1 Fracturing is transferred to the section “Floating ice motion processes”;
- *Section 11 “Sky and air indications”* is excluded. Data obtained as a result of such observations cannot be considered reliable at present and used for operational and research purposes;
- *Section 13 “Terms relating to submarine navigation”* is excluded – the terms in this section cannot be used in compiling the ice charts.

*Annex I to the Draft Nomenclature presents code tables, symbols and conventional designations*.

11. For coding information for attributive description of zones and ice objects, their area used code tables 1 – 8 ensuring unambiguous determination of each variable (characteristic) of ice in the zones or of ice objects and tables 9 – 18 – scales for a quantitative or qualitative assessment of these characteristics.

12. Each variable (characteristic) of ice in a zone or an ice object is coded by a two-letter identifier (code symbol). The first letter defines belonging to some or other information block (code table), and the second – a specific variable value, that is the term of the Nomenclature defining it. Then, the code figures of relative area, points of assessment or true values (size, thickness, azimuth, etc.) follow.

13. Thus, the proposed coding system clearly separates designation of the notions and quantitative characteristics and excludes the need for preserving a constant place for each variable in the attributive description of zones and the use of the term “Undetermined/unknown”. That is why the advisability of such coding system is obvious.

14. Code tables 1-8 were made on the basis of multiyear experience and have already been used for a number of years for ice information coding in the SIGRID-2 and in Shapefile formats. A letter rather than a digital designation of variables clearly separates the code symbols of the variables and their quantitative values excluding the need for preserving a constant place for each variable in the attributive description of zones and the use of the term “Undetermined/unknown”. That is why the advisability of such coding system is of no doubt.

15. However, the situation with the scales (Tables 9–18) cannot be considered as satisfactory. As indicated in the Introduction to Annex 1, the main scales (of pressure, stage of melting, snow cover thickness, size of icebergs) are presented from Supplement No. 4 of 1989 to the WMO Nomenclature. Similar to the Nomenclature itself, they are mainly intended for coding data obtained as a result of visual observations and completely do not take into account the possibilities of modern satellite remote sensing tools.

16. A scale of one of the most important ice cover characteristics “Stages of melting” can serve as an example. It reflects not the ice cover decay as a result of melting, but the external indications of the process and most of them can be determined only visually and has some other deficiencies. Similar comments can be also made for some other scales.

17. However, now only general comments can be formulated on these scales with indication of their shortcomings. For their specification or to be more exact, for the development of new versions, it is necessary to undertake special studies including joint international research.

18. Some scales, in particular of the snow thickness and sizes of icebergs, are proposed to be excluded and replaced with the indication of snow thickness in decimeters, horizontal sizes of specific glacier bergs in tens of metres and tabular bergs in hundreds of metres. Some columns of the code tables contain symbols and conventional designations.

19. Similar to the existing Nomenclature, two alternative variants of the symbols are proposed – numerical and graphical symbols. The graphical symbols are more illustrative, while the logic of their construction significantly facilitates storage. In addition, the graphical symbols allow a more compact transmission of information. One symbol can describe the age and the prevailing forms of the oldest ice while in the graphical symbol of the largest forms of breccia fields, their partial concentration, which is an important navigation characteristic, can be indicated. However, a system of numerical symbols is constantly used in the practice of the majority of national ice centres, and the users have been already accustomed to it. This determines the need for preserving two options.

20. The international format for exchange and dissemination of data on the ice situation should provide data transmission via the communication lines and storage of spatially distributed information on the ice cover characteristics and include the attributive and spatial components.
For using the received coded information for operational purposes, it is converted to a cartographic image, whereas at the ice centres, its statistical processing and calculations are performed and forecasts are developed using geo-information technologies. Annex 2 considers an order of using ice symbols presented in Annex 1 and the technology for preparing and drawing up the graphical ice charts.

21. In compliance with the currently existing International System of Sea-Ice Symbols, the forms of ice features are coded and depicted on the ice charts only by the numerical symbols. A possibility for using two variants is envisaged: indication of the forms of each ice age category or indication of the prevailing and secondary sizes of the ice fields. The principal deficiencies of the first and second variants were repeatedly pointed out. Only the oldest ice has the form of fields, whereas the ice conditions are determined not by the prevailing forms, but by the largest forms and their partial concentration. As a result, this important ice cover characteristic determining to a great extent the ice conditions of practical activity in the ice-infested seas is typically not depicted at all on the ice charts.

22. In the proposed draft, the attributes of the zones include the prevailing forms of the oldest ice and the forms of the largest breccia fields with the indication of their partial concentration. These data can be most fully and clearly depicted by using the graphical symbols. Therefore, the graphical symbols are proposed as the main variant and the numerical symbols as substituting them. The proposed drafts of the main section and annexes probably appear to be a first approximation of the final variant of the new version of the WMO Nomenclature on Sea-Ice and require further specifying, addition and editing.

**ICE TERMS ARRANGED BY SUBJECT**

## 1. Main notions and definitions

### 1.1 Floating ice

Any form of ice floating in water. The principal kinds of floating ice at the sea surface are sea ice which is formed by the freezing of sea water at the surface, lake ice and river ice formed on rivers or lakes and glacier ice (ice of land origin). The concept also includes ice that is grounded. (1. Ed.)

1.1.1 Sea ice

Ice, which has originated from the freezing of sea water. It presents the main kind of floating ice encountered at sea. (1.1.Ed.)

1.1.2 Ice of land origin

Ice formed on land or in an ice shelf, found floating in water (1.2 Ed.)

1.1.3. River, lake ice

Ice formed on a river or on a lake and which may be exported to sea. River ice fields are depicted on radar images as similar to old fields. Fresh water ice differs significantly in its mechanical and electro-magnetic characteristics from sea ice of the same age.

### 1.2 Ice cover

Floating ice covering a water area regardless of its age, concentration, mobility and other characteristics.This is the most general notion, usually requiring further specification. The ice cover boundaries are the ice edge and the coastline.

### 1.3 Fast ice

Consolidated solid ice attached to the shore, to an ice wall or to an ice front. It forms by freezing to the shore of the ice cover forming in the coastal zone or as a result of freezing of drifting ice of any age category to the shore or fast ice. Vertical movement may be observed during tidal oscillations. It can be preserved without fracturing for two or more years transforming from first-year ice to multiyear ice and even shelf ice. The fast ice width can vary from several hundreds of meters to several hundreds of kilometers. That part of fast ice presenting a narrow fringe of ice directly attached to the coast with a shallow bottom and unresponsive to tidal oscillations that remains after the fast ice has moved away is called the Ice foot. Fast ice at the initial stage of formation consisting of nilas and young ice with a width up to 100-200 m is called young coastal ice. When coding and depicting fast ice on ice charts, total concentration is not indicated as this is always equal to 10/10 in accordance with the definition (3.1, 3.1.1, 3.2 Ed.).

### 1.4 Pack ice

Any ice at the sea surface except for fast ice and stamukhas regardless of its age, form, origin and other characteristics that has a possibility of movement (drift) under the action of winds, currents and tides. As a result of the dynamic processes (drift, divergence, convergance), the total and partial concentrations of drifting ice constantly change (1.1.2 Ed.).

### 1.5 Bergy water

A large area of navigable water in which ice of land origin is present or possible at a total concentration less than 1/10. Such zones do not usually have a clearly expressed edge or boundary

with ice-free water. A characterization of ice conditions in such areas can be made both on the basis of data from direct observations, data from previous observations or from climatic data (4.2.7 Ed.).

### 1.6 Ice-free

No ice is present. If ice of any kind is present this term shall not be used (4.2.8. Ed.)

### 1.7 No observational data

Zone where observations were not conducted.

### 1.8 Zone

Part of the water area contoured on an ice chart in the form of a closed polygon within which the ice cover characteristics given for this zone are considered similar. A zone can be sub-divided into a basic zone and additional zones.

#### 1.8.1. Basic zones

Basic zones are delineated by mobility, total concentration and age categories. Such additional characteristics as hummock and ridge concentration, rafting of young ice, or stages of melting are usually included in a description of the characteristics of these basic zones. It is assumed that the boundaries of the main and additional characteristics coincide. The basic zones are subdivided into the following types: Fast ice, Drifting Ice, Bergy water, Ice-free water. On large-scale ice charts, giant and sometimes vast ice floes can be contoured and described in the basic zones.

#### 1.8.2. Additional zones

Additional zones present separate layers on an ice chart. If it is necessary to show the actual boundaries of zones of discontinuities (leads and fractures), changing hummock and ridge concentration, level ice, zones of different stages of melting or other additional characteristics, they are identified only by one characteristic.

### 1.9 Ice boundary

The demarcation between fast ice and drift ice or between different zones of drift ice. When used as a climatologic term, for describing the position of the boundary of spreading of ice of any concentration or age in any given month or a period based on the observation data for a number of years, the tem should be preceded by a word mean, median, minimum or maximum with indication of the ice cover characteristic after it. For example: “Median boundary of multiyear close ice” (4.4.9 Ed.).

#### 1.9.1 Ice edge

The demarcation between the open sea and sea ice of any kind, whether fast (fast ice edge) or drifting. The drift ice edge may be termed compacted or diffuse (4.4.8 Ed.).

##### 1.9.1.1 Ice limit

Climatological term referring to the mean, median, extreme minimum or extreme maximum extent of the ice edge in any given month or period based on observations over a number of years. Term should be preceded by the word mean, median, minimum or maximum (4.4.8.3, 4.4.8.4 Ed.).

## 2. Arrangement

### 2.1 Area of ice cover

The ratio in percent of the ice cover area to the total sea area or some geographical area at a specific moment of time. This local may be global covering an area of the seas of the entire hemisphere or some part of an ocean or a sea, for example such as Baffin Bay or the Barents Sea (4.1 Ed.).

## 2.2 Concentration

The ratio of the area of ice features to the total area of a sea part (zone) delineated on the chart, expressed in tenths. The total concentration includes all stages of development and the partial concentration includes areas of ice of specific age or arrangement which comprise only part of the total concentration. Concentrations within 0-1/10 and 9/10 – 10/10 from instrumental observations can be expressed in hundredths (4.2 Ed.).

2.2.1. Compact pack ice

Floating ice in which the concentration is 10/10 and no water is visible (4.2.1)

2.2.1.1 Consolidated ice

Floating ice in which the concentration is 10/10 and the *floes* are frozen together. (4.2.1.1)

2.2.2. Very close pack ice

Floating ice in which the concentration is 9/10 and more, but less than 10/10 (4.2.2.Ed.)

2.2.3 Close pack ice

Floating ice in which the concentration is 7/10 to 8/10, composed of *floes* mostly in contact (4.2.3).

2.2.4 Open pack ice

Floating ice in which the ice concentration is 4/10 to 6/10, with many fractures, and floes that are generally not in contact with one another (4.2.4).

2.2.5 Very open pack ice

Floating ice in which the concentration is 1/10 to 3/10 and water preponderates over ice (4.2.5.).

2.2.6 Open water

A large area of freely navigable water in which sea ice is present in concentrations less than 1/10 and ice of land origin is absent. (4.2.6)

## 2.3 Ice massif

A variable accumulation of *close* or *very close ice* covering hundreds of square kilometers which is found in the same region every summer (4.4.2).

## 2.4 Ice field

An area of floating ice of any size, which is greater than 10 km across. The characteristics, position and sizes of fields are described as separate zones. (4.4.1 Ed.)

2.4.1 Ice patch

An accumulation of floating ice less than 10 km across in ice-free water or among ice in smaller concentration.

2.4.2 Strip

A long narrow zone of floating ice, about 1 km or less in width, usually composed of small fragments detached from the main mass of ice, and run together under the influence of wind, swell or current. (4.4.5)

2.4.3 Strip, Patch

The term is applied for characterizing irregularities of the total and partial concentration in a delineated zone when it is impossible to depict the position of strips and patches on the ice chart as separate zones.

## 3. Development

### 3.1 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. (2.1)

3.1.1 Frazil ice

Fine spicules or plates of ice, suspended in water. (2.1)

3.1.2 Grease ice

A later stage of freezing than *frazil ice* when the crystals have coagulated to form a soupy layer on the surface. Grease ice reflects little light, giving the sea a matt appearance. (2.1.2)

3.1.3 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. (2.1.3)

3.1.4 Shuga

An accumulation of spongy white ice lumps, a few centimeters across; they are formed from grease ice or slush and sometimes from anchor ice rising to the surface. (2.1.4)

### 3.2 Nilas

A thin elastic crust of ice, easily bending on waves and swell and under pressure, thrusting in a pattern of interlocking 'fingers' (finger rafting). Has a matt surface and is up to 10 cm in thickness. May be subdivided into dark nilas and light nilas. (2.2)

3.2.1 Dark nilas

Nilas which is under 5 cm in thickness and is very dark in color (2.2.1)

3.2.2 Light nilas

Nilas which is more than 5 cm in thickness and rather lighter in colour than dark nilas (2.2.2)

3.2.3 Ice rind

A brittle shiny crust of ice formed on a calm surface by direct freezing, or from *grease ice*, usually in water of low salinity. Thickness to about 5 cm. Easily broken by wind or swell, commonly breaking in rectangular pieces. (2.2.3)

**3.3 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. (2.4)

3.3.1 Grey ice

Young ice 10-15 cm thick. Less elastic than nilas and breaks in swell. Usually rafts under pressure. (2.4.1)

3.3.2 Grey-white ice

Young ice 15-30 cm thick. Under pressure it is more likely to ridge than to raft. (2.4.2)

**3.4 First-year ice**

Sea ice of not more than one winter's growth, developing from young ice; thickness 30 cm - 2 m, and sometimes slightly more. May be subdivided into thin first-year ice/white ice, medium first-year ice and thick first-year ice. (2.5 Ed.)

3.4.1 Thin first year ice/white ice

First-year ice 30-70 cm thick. May be subdivided into thin first-year ice of the first stage 30 to 50 cm thick and thin first-year ice of the second stage 50 to 70 cm. (2.5.1.Ed.)

3.4.2 Medium first-year ice

First-year ice 70-120 cm thick. (2.5.2)

3.4.3 Thick first-year ice

First-year ice over 120 cm thick. (2.5.3)

**3.5 Old ice**

Sea ice which has survived at least one summer's melt; typical thickness up to 3m or more. It is subdivided into residual first-year ice, second-year ice and multi-year ice. (2.6 Ed.)

3.5.1 Residual first-year ice

First-year ice that has survived the summer’s melt and is now in the new cycle of growth. It is 30 to 180 cm thick depending on the region where it was in summer. After 1 January (in the Southern hemisphere after 1 July), this ice is called second-year ice.

3.5.2 Second-year ice

Old ice which has survived only one summer's melt; typical thickness up to 2.5 m and sometimes more. Because it is thicker than first-year ice, it stands higher out of the water. Ridged features as a result of melting during the preceding summer attain a smoothed rounded shape. In summer, numerous puddles of extended irregular shape form on its surface. Bare ice patches and puddles are usually greenish-blue. (2.6.1 Ed.)

3.5.3 Multi-year ice

Old ice up to 3 m or more thick that has survived at least two summers' melt. Hummocks are even smoother than in second-year ice and attain a look of mounds and hills. The surface of multiyear ice fields in places not subject to deformations is also hillocky due to non-uniform multiple melting. The ice is almost salt-free. Its color, where bare, is usually blue. As a result of melting, round puddles appear at its surface in summer and a well-developed drainage system is formed. (2.6.2.Ed.)

### 3.6 Age structure of ice

The observed, or model calculated age categories of ice and their partial concentrations. The sum of the partial concentrations of ice of different age should be equal to the total ice concentration in the given zone.

## 4. Ice of land origin

### 4.1 Glacier ice

Ice in, or originating from, a glacier, whether on land or floating on the sea as icebergs, bergy bits or growlers (10.2)

### 4.2 Glacier

A mass of ice predominantly of atmospheric origin, usually moving from higher to lower ground. A seaward margin of a glacier that is aground, the rock basement being at or below sea-level, is termed an ice wall. The projecting seaward extension of a glacier*, which is* usually afloat, is termed a glacier tongue. In the Antarctic, glacier tongues may extend over many tens of kilometers. (10.2.1, 10.2.2, 10.2.4 Ed.).

### 4.3 Ice shelf

A floating ice sheet of considerable thickness showing 2-50 m or more above sea-level, attached to the coast or a glacier. Usually of great horizontal extent and with a level or gently undulating surface. Nourished by annual snow accumulation at the surface and often also by the seaward extension of land glaciers. Limited areas may be aground. The seaward edge is termed an ice front. (10.3, 10.3.1 Ed.)

### 4.4 Iceberg

A massive piece of ice of varying shape, protruding more than 5 m above sea-level, which has broken away from a glacier or an ice shelf, and which may be afloat or aground. Icebergs by their external look may be subdivided into tabular, dome-shaped, sloping and rounded bergs. (10.4.2 Ed.)

4.4.1 Glacier berg

An irregularly shaped iceberg (10.4.2.1)

4.4.2 Tabular berg

Most flat-topped icebergs form by *calving* from an *ice shelf* and show horizontal banding (cf. ice island). (10.4.2.2) [Note: I've assumed that tabular berg is the term being defined rather than vice-versa]

4.4.3 Bergy bit

A large piece of floating ice of land origin, showing less than 5 m above sea-level and 100-300 $m^2$ in area (10.4.4 Ed.) [Note: it might be better to say no more than 20 metres long, rather than give an area]

4.4.4 Growler

A smaller piece of ice of land origin than a bergy bit. The color is usually white, but sometimes transparent or blue-green or nearly black, normally occupying an area of about 20 $m^2$. Growlers are distinguished with difficulty when they are surrounded by ice and also in heavy swell. (10.4.5 Ed.) [Note it might be better to say no more than 5 metres long]

**4.5 Iceberg tongue**

A major accumulation of icebergs, bergy bits and growlers projecting from the coast, held in place by grounding or joined together by fast ice (10.4.2.3 Ed.)

**4.6 Ice island**

A large piece of floating ice protruding about 5 m above sea-level, which has broken away from an Arctic ice shelf, having a thickness of 15-30 m and an area of from a few thousand square meters to 500 $km^2$ or more, and usually characterized by a regularly undulating surface which gives it a ribbed appearance from the air. (10.4.3) [Note: Antarctic use is slightly different and refers to a grounded part of a floating ice sheet which rises significantly higher than its surroundings, eg Butler Island. There are also more substantial features, eg the Lyddan Ice Rise.]

**5. Forms of floating ice**

**5.1 Ice fragment**

A general name of any relatively flat piece of sea or river ice with a size from fractions of meter up to several kilometers across.

**5.2 Floe**

Any relatively flat piece of sea ice 20 m or more across. Floes are subdivided according to horizontal extent as follows: (4.3.2)

5.2.1 Giant

Over 10 km across. (4.3.2.1)

5.2.2 Vast

2 to 10 km across (4.3.2.2)

5.2.3 Big

500 – 2000 m across (4.3.2.3)

5.2.4 Medium

100 – 500 m across (4.3.2.4)

5.2.5 Small

20 – 100 m across (4.3.2.5)

5.3 Ice cake

Any relatively flat piece of sea ice less than 20 m across (4.3.3)

5.3.1 Small ice cake

An ice cake less than 2 m across (4.3.3.1)

5.3.2 Brash ice

Accumulations of floating ice made up of fragments not more than 2 m across, the wreckage of other forms of ice as a result of melting (4.3.6 Ed.) [Note: BAS usage is normally that brash is small fragments of glacier ice. We also use the term 'porridge' to refer to a mass of fragments, often under slight pressure, through which navigation is difficult.]

**5.4 Pancake ice**

Predominantly circular plates of ice from 30 cm to 3 m in diameter, and up to about 10 cm in thickness, with raised rims due to the pieces striking against one another. It may be formed on a slight swell from grease ice, shuga or slush or as a result of the breaking of ice rind, nilas or, under heavy swell, of grey ice. (4.3.1 Ed.)

**5.5 Ice breccia**

Ice of different stages of development frozen together (4.3.5)

**6. Ice surface features**

**6.1 Level ice**

Sea ice which has not been affected by deformation (8.1)

**6.2 Deformed ice**

A general term for ice which has been squeezed together and broken up with formation of surface and underwater conglomerations. Subdivisions are rafted ice, rough ice, ridged ice, jammed brash barrier and hillocky multiyear ice (8.2 Ed.)

6.2.1 Rafted ice

Type of deformed ice formed by one piece of ice overriding another. When young ice under pressure is forced alternately over and under like thrusting fingers, the ice is termed finger rafted ice. (8.2.1, 8.2.1.1 Ed)

6.2.2 Rough ice

First-year ice subjected to fracturing and hummocking at the stage of young ice, that has formed as a result of the freezing together of pancake ice or of fragments of fresh ridges that have collapsed into fractures after the end of compaction and the onset of ice divergance. The irregularities cover significant areas where snow accumulation increases and the heat conductivity and the tangential stress coefficient significantly change. During a radar sounding, segments of rough ice are depicted by increased brightness with ice ridges being indiscernible. As a result of further growth, the irregularities at the bottom surface of rough ice are usually completely smoothed by the end of winter and the ice thickness becomes approximately equal to that of ice of the same age of quiet growth. During the period of summer melting, all small irregularities at the surface of ice fields are smoothed; hence this type of relief is typical only of first-year ice. [Note this may need further revision]

6.2.3 Hummocked ice

Sea ice piled haphazardly one piece over another, predominantly in the form of ice ridges and separate hummocks. (8.2.3.1 Ed.)

6.2.4 Hillocky multiyear ice

A qualitative assessment of the relief of multiyear ice formed as a result of non-uniform melting of initially level ice and smoothing of ice ridges and hummocks. It can be assessed as smoothed multiyear ice, moderately hillocky multiyear ice and strongly hillocky multiyear ice.

### 6.3 Bare ice

Ice without snow cover (8.5)

### 6.4 Snow-covered ice

Ice covered with snow (8.6)

### 6.5 Dirty ice

Ice that has a mineral or organic content of natural or anthropogenic origin on the surface or in its strata.

### 6.6 Frost flowers

Growth of ice crystals by condensation from the atmosphere at points on the surface of young ice. After formation sea water may be drawn through the ice into the flowers.

## 7. Separate Ice features

### 7.1 Hummock

A hillocky conglomeration of broken ice formed by pressure at the place of contact of the angle of one ice floe with anther ice floe. The underwater portion of a hummock is termed a bummock (8.2.3 Ed.)

### 7.2 Ridge

A comparatively rectilinear conglomeration of ice fragments formed by pressure at the contact line between ice floes, usually along earlier existing cracks and leads or at the boundary between ice floes of different age. In this case, isostatically unbalanced hummocks usually form on the older ice surface. Ice ridges can also form as a result of direct fracturing of ice fields of thick and even first-year and multiyear ice at very strong pressures. The underwater portion of a ridge is termed an ice keel (8.2.2, 13.5 Ed.)

### 7.3 Ridged ice belt

Fractured ice piled in the form of several parallel ridges formed at the external boundary of fast ice or on drift divides as a result of repeated pressure. (8.2.2.6 Ed.)

### 7.4 Line of ridges

A thick ice ridge on fast ice, including stamukhas, which in places may attach it to the bottom.

### 7.5 Floeberg

A massive piece of sea ice composed of a hummock, or a group of hummocks frozen together, presenting a separate floating ice fragment in ice-free water or among separate ice fragments. It may protrude up to 5 m above sea-level (4.3.4 Ed.)

### 7.6 Stamukha (Grounded hummock)

A thick hummocked grounded ice formation. Stamukhas form from floebergs and hummocked grounded ice fragments. They are distinguished by a large height (up to 10 m and more above sea level) and steep slopes. There are single grounded hummocks and lines (or chains) of grounded hummocks. Stamukhas forming at the same place from season to season are termed recurring stamukhas (3.4.2 Ed.).

### 7.7 Windrow

A compact layer of ice cake and small ice cake formed as a result of repeated hummocking and rafting. In the coastal zone and near the fast ice boundary, the windrow thickness can achieve 10-20 m. In some cases it extends down to the bottom. Windrow presents a serious obstacle for shipping.

### 7.8 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 (8.4)

## 8. Stages of melting

### 8.1 Puddle

An accumulation melt-water on ice, mainly due to melting snow, but in the more advanced stages also to the melting of ice. The initial stage consists of patches of melted snow. (9.1)

### 8.2 Flooded ice

Sea ice, usually first-year ice, flooded by a melt or river water layer. (9.5 Ed.).

### 8.3 Thaw holes

Vertical holes in sea ice formed when surface puddles melt through to the underlying water. (9.2)

### 8.4 Dried ice

Sea ice that was earlier at the flooded ice stage, from the surface of which melt-water has disappeared after the formation of cracks and thaw holes. During the period of drying, the surface whitens (9.3)

### 8.5 Rotten ice

Sea ice which has become honeycombed (laced) and which is in an advanced state of disintegration (9.4)

## 9. Opening in the ice

### 9.1 Fracturing

Any break or rupture through close ice, compact ice, consolidated ice, fast ice, or a single floe resulting from shears and deformation processes. The fracture may contain brash ice and be covered with nilas or young ice. The length may vary from a few meters to several tens of kilometers (7.1 Ed.)

9.1.1 Crack

Any fracture of fast ice, consolidated ice or a single floe with a width ranging from a few centimeters to 50 m and a length from several tens or hundreds of meters to several hundreds of kilometers. (7.1.1 Ed.)

9.1.1.1 Tide crack

A crack between fast ice subject to sea level tidal rise and fall and the fast ice foot or ice wall, or shore. (7.1.1.1 Ed.)

**9.2 Flaw**

A narrow separation zone between pack ice and fast ice filled with continuous small ice cake with some small floes, where the pieces of ice are in chaotic state; it forms when drift ice moves under the effect of a strong wind or current along the fast ice boundary. Flaws also form at drift divides. (7.1.1.2 Ed.)

**9.3 Lead**

A more than 50 m wide rectilinear or wedge-shaped crack from several kilometers to several hundreds of kilometers in length. At below freezing temperatures, new, nilas and young ice forms at the surface of leads (7.3 Ed.)

9.3.1 Shore lead

A lead between pack ice and the shore or between drift ice and an ice front. (7.3.1)

9.3.2 Flaw lead

A passage-way between pack ice and fast ice which is navigable by surface vessels (7.3.2) [Note: shore lead is used in the Antarctic]

**9.4 Fracture**

A restricted space, the length of which is comparable with the width of ice-free water, or very open broken ice among solid, very close and close ice. Diamond- or lens-shaped fractures form as a result of the shear of ice floes along the line of an earlier crack or lead. Due to cracks and leads not being rectilinear, they expand in some places and converge in other places under slight pressure. Hummocking can form a chain of fractures. This is the most stable type of fracture and can exist for several months. In the autumn-winter period, nilas and young ice and then first-year ice forms at their surface. Less stable fractures the shape and dimensions of which constantly change, are formed as a result of shears between giant and vast ice floes and by local divergance of close ice of smaller formations.

**9.5 Polynya**

A stable ice-free water space in or at the boundary of fast ice. Polynyas may contain very open broken and brash ice or be covered with new ice, nilas or young ice. A polynya is sometimes restricted by the shore from one side and is termed a shore polynya. If it is restricted by fast ice, then it is termed a flaw polynya. If it recurs in the same position every year, it is termed a recurring polynya (7.4, 7.4.1, 7.4.2, 7.4.3 Ed.) [Note: polynyas can form in the pack, eg in the Weddell Sea]

## 10. Pack ice motion processes

### 10.1 Ice drift

Displacement of ice floes and other ice features resulting from the impact of wind and currents including tidal currents and of forces transferred through the ice cover from other regions. The drift direction and velocity of a specific ice feature or ice cover area depends at any specific moment on the magnitude of the external forces, on the feature's characteristics (size, concentration and upper and lower surface roughness), on its position relative to the coastline and on the seabed relief.

10.1.1 Drift vector

A segment on a graphical or digital ice chart connecting the location of an ice cover point at successive moments of time. For subsequent analysis and calculations, the observed drift vector field is usually interpolated to regular grid points with a step size chosen as required. The vectors at the regular grid points can also be obtained by means of model calculations.

10.1.2 Drift divide

A boundary between ice massifs or zones drifting in different directions or with a different speed. Drift divide indications include increased fracturing of the ice cover, flaws, ridging belts, leads and diverging zones. One frequently observes ice floe rotation at the drift divide.

### 10.2 Shearing

Mutual displacement of ice floes resulting in their turn and deformation and formation of fractures. (5.3 Ed.)

### 10.3 Fracturing

A pressure process whereby ice is permanently deformed, and rupture occurs. Most commonly used to describe breaking across fast ice, ice breccia, compact ice and ice fields (6.1)

### 10.4 Compacting

A decrease in the separation between individual ice floes resulting in increased ice concentration (5.2 Ed.)

### 10.5 Compression of ice

A further stage of ice compacting after its concentration reaches 9-10/10. During compression of ice, rafting and hummocking usually occur and stuffed ice may be formed within the coastal zone. Within the zones where big and giant floes are predominant, compression of ice may start if total concentration is equal 7-8/10.

10.5.1 Compression zone

Zone where compression of ice is observed.

### 10.6 Diverging

The process of increasing separation between ice fields or floes, thus reducing ice concentration and/or relieving stresses in the ice (5.1)

## 11. Terms relating to surface shipping

### 11.1 Difficult area

A general expression to indicate that the severity of ice conditions prevailing in an area is such that navigation in it is difficult (12.5)

### 11.2 Easy area

A general expression to indicate that ice conditions prevailing in an area are such that navigation in it is not difficult. (12.6)

### 11.3 Ice bound

A harbor, 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. (12.2)

### 11.4 Nip

Ice is said to nip when it forcibly presses against a ship. A ship so caught, though undamaged, is said to have been nipped (12.3)

### 11.5 Beset

The situation of a ship surrounded by ice and unable to move (12.1)

### 11.6 Recommended place

A place where a ship or a group of ships is to go for transportation operations, to await an improved ice situation, to form a convoy, etc.

### 11.7 Recommended path

A route for a ship or a convoy of ships that is the most favorable in terms of ice and hydrological conditions. The navigation risks for the given type of ships should be minimized on the recommended path.

### 11.8 Channel in ice, made by ship

A band of broken ice or flaw formed by a ship passing across fast or pack ice.