Probabilistic Model for Drifting Ice Ridges of the Sakhalin Offshore

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ABSTRACT
This paper proposes the probabilistic model of ice ridge based on field data on measuring profiles for drifting ice ridges on the north-eastern Sakhalin offshore.

KEY WORDS: ice ridge, sail height, keel draft, probabilistic model, Monte-Carlo.

INTRODUCTION
Ice ridges may occupy major part of ice cover. Basically, the size of such part depends on ice cover dynamics. For example, maximum ridging frequency in some areas of the north-eastern Sakhalin offshore noted for high dynamics may reach 5 points by April-May, with the average ridging frequency of 3 points (Surkov, 1997b).

Ice ridges are the most common ridging features in ice cover. Cross profiles of real ice ridges are intricate and have various configurations. Therefore, simplified ice ridge geometry models are used to solve various scientific and engineering problems such as development of mathematical sea ice models and ice drift models, analysis of ice ridge interaction with hydraulic structures and sea bottom, etc. Ice ridge morphologies vary with the regions, which should be taken into account in developing ice ridge geometry models. Thus, for the same ice ridge geometry models, ridge sizes and ridge size ratios may vary for different regions. Besides, various ridge geometries may be used. Generally, rectilinear and prismatic ice ridge is assumed with triangular or trapezoidal cross section (Timokhov and Heisin, 1987).

Basic limitation to available ice ridge models is that ice ridges having dimensions of expressed probabilistic nature are described from deterministic viewpoint. Sizes of such models are the arithmetic means of the observed values. No one model gives mean square deviations and other statistic sampling parameters, probably due to very high values, which means that errors inherent in models describing real ice ridges remain unknown.

Currently, probabilistic methods find their application in almost all technical and scientific trends. They ensure more accurate description of various systems and, consequently, more accurate forecast of their behavior. Besides, they lead to considerable reduction of the cost of projected facilities (Augusti et al, 1984). Available deterministic models for ice ridges no longer meet the needs of scientists dealing with the development of mathematical ice cover models and designers working at hydraulic structure designs. Therefore, this paper proposes the probabilistic model based on field data on measuring profiles for drifting ice ridges on the north-eastern Sakhalin offshore.

DEFINITIONS
The paper uses the following definitions describing ice ridges:
- "Ice ridge" is a long ice feature made of piled-up ice rubble and blocks which is formed due to ice floe compression at the contact line.
- "Sail" is the upper part of an ice ridge – from the sea level and higher.
- "Keel" is the underwater part of an ice ridge - from the sea level and lower.
- "Sail height" is a vertical distance from the sail top to the sea level.
- "Keel draft" is a vertical distance from the lowest point of a keel to the sea level.
- "Ice draft" is a distance from any bottom surface point of ice cover to the sea level.

The above definitions resemble those used by other authors, however, some of the terms differ. For example, some authors use the term "ice ridge" for long ice feature made of piled-up ice rubble on the upper ice cover surface. However, the results of field ice ridge study on the north-eastern Sakhalin offshore indicated possible existence of underwater keel associated with complete (or next complete) absence of above-water (surface) ice ridge.

More and more papers use the term "sail" to denote the upper (above-water) part of ice ridges. This paper also uses the term "sail". It allows to eliminate confusion and to distinguish between the upper part of an ice ridge and the whole ice ridge, e.g. when considering thickness. Also, the important point is that position of a sail (from the sea level and higher) is specified in the definition of sail. For example, the paper (Beketsky et al, 1997) uses the term "sail" for the upper part of ice ridge – in some cases from the sea level to the uppermost point and in other cases from top of level ice surface to the uppermost point. The same may hold true for the definition of an ice ridge keel.