Russian iceberg observations in the Barents Sea, 1933–1990

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Seasonal variations of iceberg distribution in the Barents Sea have been studied on the basis of Russian observations for the period 1933–1990. The maximum southern distribution is observed in January and the minimum in September and October. A significant correlation coefficient of 0.5 is calculated for the relationship between the latitude of the southern ice cover expansion and the corresponding expansion of iceberg distribution. There is a general temporal trend of increased southern locations of iceberg observations during the period considered. Some analyses of iceberg dimensions in the western part of the Barents Sea are based on observations obtained in 1988–1990 under the Ice Data Acquisition Programme (IDAP) and under the Soviet-Norwegian Oceanographic Programme (SNOP).

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Background

Glaciological studies of the mass balance of the glaciers of Svalbard, Frans Josef Land and Novaja Zemlja, indicate a retreat of glaciers under the present climatic conditions. This conclusion is in accordance with the results of similar studies carried out by AARI in the Severnaja Zemlja archipelago in the late 1970s and in the early 1980s (Govorukha 1983).

Throughout the 20th century the glaciation areas of the Barents Sea archipelagos has been reduced by 8% or 3850 km^2, corresponding to an annual average volume decrease of 15.2 km^3. Koryakin (1988) also found that about 30% of the glacier reduction in the Frans Josef Land archipelago is caused by iceberg calving. Under the assumption that a similar reduction has taken place in Svalbard and Novaja Zemlja, the annual iceberg production corresponds to 4.5 km^3. The calculated volume of iceberg discharge refers entirely to the Barents Sea basin. Influx from internal sources to the Barents Sea may amount to about 9.0 km^3 a year (World Water Balance 1974).

Based on iceberg observations obtained under the Soviet-Norwegian Oceanographic Programme (SNOP) and the Ice Data Acquisition Programme (IDAP) carried out for oil companies in 1988–1990, the most typical iceberg volumes were found in the interval 8,000–11,000 m^3. Combined with the above volumetric production, the annual iceberg production in the Barents Sea area can be estimated at about 3500 icebergs. Long-term observations indicate that the occurrence of icebergs in the Barents Sea is far less than what the production rate suggests should be the case; this indicates that most of the icebergs are melting near the area of calving.

The 1899–1928 observations by Zubov (1944) indicate two areas of maximum iceberg occurrence, one covering the shallow Spitsbergenbanken between Hopen and Bjørnøya and the other covering the area between 30 and 60°E (Sentralbanken). The material of this study (Fig. 1) confirms Zubov's findings.

Materials and methods

Reconnaissance flights in the Barents Sea carried out by AARI provided data characterising icebergs from 1933 to 1990. The reconnaissance flights covered the entire Barents Sea, but they were not uniformly distributed throughout the year, being more frequent in the summer than in the winter. On the whole, however, data over this time span are available for all months of the year.

In addition to the data of airborne ice recon-

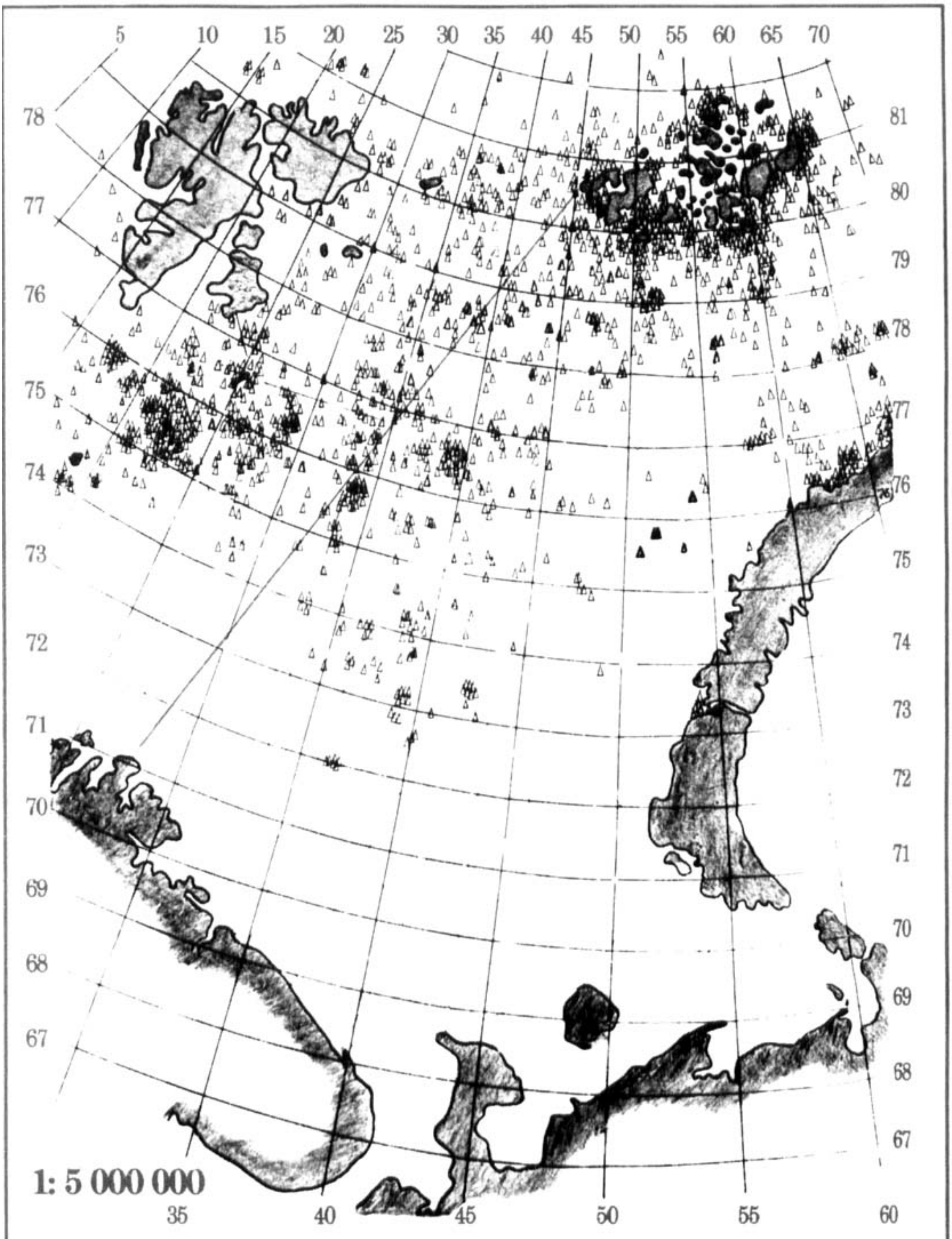

Fig. 1. Distribution of icebergs in the Barents Sea for the period 1933–1990. The conventional division line between the eastern and western part is indicated. Data about iceberg locations obtained during the visual observations from ships and aircraft ice reconnaissance flights systematically performed by AARI in the Barents Sea until 1990.

naissance flights for this time interval, data on icebergs were obtained from ice breakers, transport and fishing vessels, and research expeditions. More than 20,000 iceberg records were collected.

As the navigation and aircraft flight routes follow different and specific courses, the obtained data do not allow for the estimation of the total number of icebergs in the Barents Sea. The seasonal southern iceberg extension limit has therefore been used to illustrate long term distribution trends.

Discussion

As should be expected, we find a marked seasonal cycle in the southern extension in the iceberg distribution. This holds both for the western as well as for the eastern part of the Barents Sea (Fig. 2). The southernmost distribution is observed in January–May, and the minimum in September–October. The latitudinal difference between the maximum and minimum distribution is 4.2° in the western part of the Barents Sea and 3.3° in the eastern. The southward expansion of the iceberg distribution throughout the year is more pronounced in the western part compared with the eastern part, with great difference particularly during the freezing season (Fig. 2).

According to Vinje (1985) the occurrence of icebergs on Spitsbergenbanken shows an average maxima of 40–50 icebergs near Hopen in April and 5–10 icebergs near Bjørnøya in April–May.

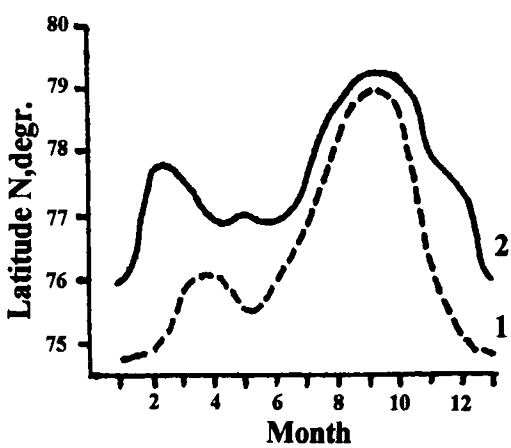

Fig. 2. The mean seasonal variation of the southern boundary of iceberg occurrence in the western (1) and eastern (2) parts of the Barent Sea for the period 1933–1990.

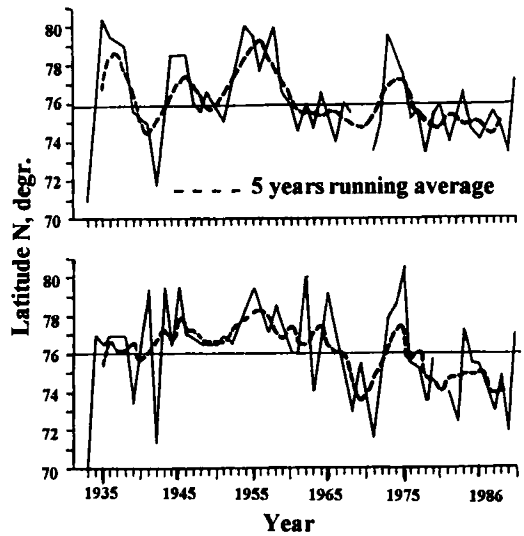

Fig. 3. The interannual variation in the southern boundary of iceberg occurrence in the western (upper) and eastern (lower) parts of the Barents Sea for the period 1933–1990.

On the average, icebergs are observed in this area between January and August only. The interannual variability of the numbers observed as well as the southern distribution during the summer period are in all probability connected with the iceberg production further north and the following preponderance of northerly and northeasterly winds.

As there exists no structured observation array covering the whole Barents Sea, the southernmost latitude of iceberg appearance has been used as a reference to illustrate the interannual changes (Fig. 3). The interrelationship between the most southern occurrence of icebergs in the western versus the eastern part is characterised by a correlation coefficient of 0.73. This indicates a syncronisim in the interannual changes of the southern boundary of iceberg appearance for the two areas. It can be mentioned that just prior to the period considered (1929), an extreme southern position of a relatively large number of icebergs was observed along the coast of North Norway and the Kola Peninsula (Vieze 1930). A previous, similar extreme event also occurred in 1881 (IDAP Report 1990).

It is possible, in a conventional way, to divide the examined period into three sub-periods characterised by specific iceberg distribution (Fig. 3). The first period came to an end in the beginning of the 1940s with anomalous southern iceberg

Table 1. Statistical characteristics of some measured dimensions of icebergs in the Barents Sea.

Statistical characteristics	Length (m)	Width (m)	Height (m)
Average	64	46	11
Mode	54	35	6.5
Standard deviation	38	33	6.5
Variance, %	62	71	58
Maximum	180	160	30
Minimum	5	5	5
Range	175	155	25
Sample size	97	38	87

location in 1933, 1939, and 1942. Later, until the beginning of the 1960s, icebergs were on a whole observed north of 76°N. With the exception of the period 1973–1975, the period 1960–1990 is characterised by more southern iceberg occurrence as compared with the long term latitudinal mean, running along 76°N. Anomalously southern positions were observed in 1971, 1978, 1982, 1987, and 1989 during the last two decades of the period considered. In general, the observation series indicates a temporal trend of increased southern iceberg appearance for the 57-year long period considered.

The interannual changes in the southern boundary of iceberg occurrence are connected with interannual changes in the distribution of sea ice. The closest relation between these indicators is observed during the cold period of the year with correlation coefficients varying between −0.4 and −0.6. (The minus occurs because decreasing latitude of iceberg observation versus increasing sea ice area have been considered). This correlation indicates that the periodical variation of the southern limit of iceberg occurrence is connected with climatic fluctuations characterised by the periodical variation of the sea ice extent in the Barents Sea. As the southern extension of sea ice is linked with the preponderance of northerly and northeasterly winds, the mentioned variation is in turn linked with the large scale atmospheric circulation and the production and availability of icebergs in the northern provenances.

In comparison with the icebergs observed along the Labrador coast or in the Antarctic, the icebergs in the Barents Sea are considered to be small. Estimations and measurement of the sizes of the Barents Sea icebergs were obtained recently under the Ice Data Acquisition Programme of the Operators Committee North (OKN) as well as under the Soviet-Norwegian Oceanographic Programme (SNOP) (IDAP Reports). The maximum sizes observed according to these reports (Tables 1 and 2) is 180 m for the length, 160 m for the width, and 30 m for the height. Dowdeswell (1989) found that the largest glaciers in the eastern part of the Svalbard archipelago produce a small quantity of large icebergs up to 600 m long. However, because of small

Table 2. Statistical characteristics of iceberg linear dimensions (m) for latitudinal intervals in the Barents sea.

	Latitudinal intervals 75–76°			76–77°			77–78°			78–79°			79–80°		
	L	B	H	L	B	H	L	B	H	L	B	H	L	B	H
Average	97	87	12	77	48	8	46	—	8	58	40	10	65	42	13
Standard deviation	52	44	6	40	13	5	40	—	6	34	21	5	32	28	7
Variance, %	54	54	47	52	28	66	89	—	70	58	54	53	49	66	56
Maximum	180	160	70	150	60	14	100	—	20	150	70	20	160	100	30
Minimum	30	30	5	30	30	5	10	—	5	5	4	5	20	15	5
Range	150	130	65	120	30	99	90	—	15	145	66	15	140	85	25
Sample size	10	7	8	8	4	7	8	1	7	32	13	31	39	11	34

L = Length, B = Breadth, H = Height.

depths these icebergs generally start to drift after having been split up into smaller pieces due to breakage and melting.

Very little data exists concerning direct measurements of iceberg draughts, and all known cases are cited in this paper. Sonar side-scanning surveys from LANCE of iceberg bottom plowing indicate maximum draughts of about 100 m outside the very long grounded glacier of Nordaustlandet (Elverhøi & Solheim 1983). Other indirect estimations suggest droughts of about 60 m near Frans Josef Land and 50 m near Svalbard for a particular year (Voyevodin 1972). The mapping of iceberg plowing is supposed to give the best overview of iceberg thicknesses.

Two methods for draught estimations were used under the SNOP cruises. The first consisted of measuring the previous depths of 90 degree tilted parts of initial tabular icebergs. A ratio between freeboard and draught was found to be 1:7, with a maximum draught of 80 m (for a tabular iceberg). The second method, using a hand-held side scanning sonar, revealed a maximum draught of 85 m (IDAP Report 1989b).

The available data on the iceberg linear dimensions allow us to draw some preliminary conclusions concerning a latitudinal dependency for the northern part of the Barents Sea, 75–80°N (Table 2). (To the south of 75°N the measurements are too sparse).

The observations suggest that the average values of the linear dimensions decrease when moving southward from 80°N to 77°N, and that they increase again when moving further south from 77°N. This latitudinal variation of the average iceberg size may be explained by melting and disintegration effects which will filter out the smaller icebergs during the general drift towards the south. It is noted that the latitudinal change in the average dimensions takes place around 77°N. Table 2 suggests accordingly that most of the minor icebergs are disintegrated during the drift from their northern provenances to about 77°N.

In general, considering a larger geographical area, observations suggest that iceberg heights increase northwards, from the Barents and Kara Seas to the Arctic Basin (Abramov in press).

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