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Ice Cover Deformations at Adams Island, Winter 1982 - 1983

by M. Sayed, R.M.W. Frederking and D. Bradford

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Ice cover deformations at Adams Island, winter 1982–1983

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Measurements of horizontal movements of the ice cover near Adams Island, March to June 1983, and in Eclipse Sound, December 1982 to June 1983, indicate no apparent coupling between movement direction and wind or current. Average strain rates in the plane of the ice cover were 10^{-10} s^{-1} , with a maximum of 10^{-8} s^{-1} . Similar strain rate values were obtained on Eclipse Sound. Movement rates at Eclipse Sound were of the same magnitude as those at Adams Island, but the direction was quite different. Maximum calculated and measured ice pressures were 500 and 140 kPa, respectively.

Key words: ice movements, ice pressures, Canadian Arctic Ocean, oceanography, wind.

Des mesures de mouvements horizontaux du couvert de glace près d'Adams Island, de mars à juin 1983, et dans Eclipse Sound, de décembre 1982 à juin 1983, indiquent qu'il n'y a pas de couplage apparent entre la direction du mouvement et celles du vent et du courant. Les vitesses moyennes de déformation dans le plan du couvert de glace sont 10^{-10} s^{-1} , avec une valeur maximum de 10^{-8} s^{-1} . Des valeurs semblables furent obtenues dans Eclipse Sound. Les vitesses du mouvement à Eclipse Sound étaient de la même grandeur que celles à Adams Island, mais la direction était très différente. Les valeurs maximum de pression de glace calculées et mesurées étaient de 500 et 140 kPa respectivement.

Mots clés : mouvements de glace, pression de glace, Océan Arctique canadien, océanographie, vent.

[Traduit par la revue]

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Introduction

Adams Island ($73^{\circ}44'N$, $81^{\circ}28'W$) is a natural island approximately 200 m in diameter at the intersection of Navy Board Inlet and Lancaster Sound (Fig. 1). It is about 3 km from the shore of the Borden Peninsula on Baffin Island and is surrounded by first-year landfast ice for most of the winter. A project is in hand to study ice cover interaction with the island over several seasons in an effort to improve understanding of landfast ice response to wide structures. Observations for the winters of 1981/1982 and 1982/1983 were reported earlier (Frederking *et al.* 1983, 1984). The present paper gives in greater detail the measured ice cover movement and deformation for the winter of 1982/1983. Preliminary examination of the data suggested that the local behaviour of ice at Adams Island might be affected by conditions over a larger scale. Observations for Eclipse Sound are therefore presented as well.

Visits to the Adams Island site were made in November 1982, March 1983, and April/May 1983, when markers on the ice were surveyed to determine ice movement. Ice conditions and environmental data were also documented. Monitoring of movements in Eclipse Sound, at Pond Inlet, was carried out from December 1982 to June 1983 at 2-week intervals by the Arctic Research Establishment.

Related literature on landfast ice behaviour is limited. Cooper (1974) studied movement and deformation in the Beaufort Sea, Ito and Muller (1977) conducted another study in the eastern Arctic, and Instanes (1979) has reported on landfast ice movements near Vestspitsbergen in van Mijen Fjord. Most work on ice interaction with structures or islands, however, remains proprietary, although published studies include ice interaction with the artificial island of Netserk F-40 in the Beaufort Sea (Strilchuk 1977). Landfast ice movements in the vicinity of the same island were reported by Spedding (1983), and survey techniques similar to those used in the present study

FIG. 1. Site map.

were earlier employed by Hibler *et al.* (1973) to measure pack ice deformation.

Measurements

Ice cover movements near Adams Island and near the shore at Borden Station were measured by successive surveys of arrays of prism reflectors situated on the ice. An electronic distance measuring (EDM) instrument (Wild DI-20) and a theodolite (Wild T-2) were used to measure distances and angles to the reflectors from fixed base lines on shore. The EDM instrument has an accuracy of $\pm 5 \text{ mm}$ for distances up to 1000 m; horizontal and vertical angles have an accuracy of $5''$ of arc. One array of reflectors surrounded Adams Island and another was nearly parallel to the shore at Borden Station. Positions were measured from 20 to 26 March, from 27 April to 7 May, and from 10 to 14 June, usually at 2-day intervals. In addition, some

FIG. 2. Aerial view of ice conditions, Adams Island, April 1983.

reflectors near Borden Station were surveyed every 15 min on 26 March and again on 15 June.

An Aanderaa TC-3A tide recorder provided tide readings at 15 min intervals from 20 March to 14 June. It was located 1 km north of Borden Station in 5 m of water. A current meter (Aanderaa RCM-4) installed 2 km northwest of Adams Island recorded current velocity at 10 min intervals from 16 April to 11 June. Wind and temperature were also recorded at Borden Station for the periods of observation. Ice thickness and salinity were measured at several locations from November 1982 to June 1983.

Ice cover movements on Eclipse Sound were measured near the community of Pond Inlet. These and measurements of ice thickness and salinity, air temperature, wind, and tide were carried out by the Arctic Research Establishment (Steltner 1984).

Results

Adams Island

An aerial photograph of Adams Island shows the surrounding ice conditions (Fig. 2). Throughout the period of observation (November 1982 to June 1983) first-year landfast ice and a few grounded multiyear floes covered the region. Most of the reflectors used to measure ice movement were separated from each other by numerous cracks. Ice thickness was between 0.27 and 0.60 m in November, 1.9 m in late March, and 1.7 m in early May. Measurements taken southwest of the island in an area of flat ice (station 7) and north of the island in a rough ice area (station 8) are given in Table 1. Typical temperature and salinity profiles of first-year ice are shown in Fig. 3. Grounded

TABLE 1. Ice thickness at Adams Island*

Date	Thickness, m		Freeboard, m		Snow, m	
	Stn. 7	Stn. 8	Stn. 7	Stn. 8	Stn. 7	Stn. 8
83-03-22	1.956	1.897	0.121	0.126	0.200	0.200
83-04-15	1.900	1.889	0.150	0.141	0.055	0.052
83-04-29	1.824	1.638	0.164	0.118	0.076	0.103
83-05-23	1.680	1.140	—	—	—	—

*Stations 7 and 8 are southwest and north of the island, respectively.

FIG. 3. Temperature and salinity profiles of first-year sea ice southwest of Adams Island, 15 April 1983.

FIG. 4. Ice movement array and ice movements at Adams Island, March–June 1983.

rubble accumulated round the island, mostly on the southwest side.

Coordinates of reflectors were calculated from measured distances and angles from fixed points on the island or on the shore. East was taken as the positive x -direction and north as the positive y -direction. The origin was chosen as the end of one of the base lines on Adams Island. Movement vectors of the ice cover round the island and near the Borden shore are shown in Figs. 4 and 5. All reflectors appeared to move at approximately

FIG. 5. Ice movement array and ice movements at Borden Station, March–June 1983.

similar rates and in the same direction, i.e., towards the north-northeast at average rates close to 0.1 m/day, the ice cover pressing against the southwest side of the island. Details of movement rates for a typical location (reflector S1) are shown in Fig. 6a. An example of movement rates on the other side, where ice was moving away from the island (reflector I4), is given in Fig. 6b. The abrupt change in the positions of all reflectors on 5 May 1983 is probably due to an error in measuring the horizontal angles.

Movement rates near the Borden Station shore (reflector BS1) are illustrated in Fig. 6c. All reflectors at that location, including those on grounded multiyear floes, had similar movement rates and directions and were comparable to the values measured near Adams Island. As may be seen from Fig. 5, the ice cover consistently moved away from the shore, signalling that new ice might form at the tidal crack immediately adjacent to the shore. This was corroborated by measurements of the location markers approximately 30 and 50 m offshore. These measurements were made by tape and thus had much lower accuracy than those made using the EDM instrument. It was clear, however, that as the markers moved away from the shore there was little relative movement among them, i.e., most of the movement occurred along the shoreline at the tidal crack.

Ice movements over shorter periods were surveyed by means of two reflectors at 15 min intervals on 26 March and 15 June. The record of reflector BS1 on 15 June is given in Fig. 7 and Table 2; the wind at the time was from the west at an average speed of 17.5 km/h. The tide was at a peak, with approximately 2 m difference between high- and low-water levels. The movement rate and direction fluctuated more than the values measured over longer intervals. It should be noted that displacements were relatively small in this case, and that the relative accuracy would consequently be low. For example, the coordinates of reflector BS1 could be determined to within ± 0.012 m; the measured movements varied from 0.007 to

FIG. 6. (a) Rate of movement and direction southwest of Adams Island (reflector S1); (b) rate of movement and direction north of Adams Island (reflector I4); (c) rate of movement and direction near Borden Station (reflector BS1).

FIG. 7. Movements of reflector BS1, 15 June 1983 (measurements taken for 8 h at $\frac{1}{2}$ h intervals, starting 10:50).

0.039 m. Those during a 1-day interval, however, were of the order of 0.1 m.

The daily averages of wind speed measured at Borden Station are shown in Fig. 8, the prevailing direction from the west. The wind was less frequently from the south, and no north wind was ever recorded. Peak values reached 60 km/h on 18 April. The air temperature record was obtained for only part of the above period and is shown in Fig. 9.

The tide had a semidiurnal cycle. Daily high- and low-water levels (Fig. 10) varied between 1.5 and 2.3 m. An example of

TABLE 2. Movement of reflector BS1, 15 June 1983

Time, h	X(M)	Y(M)	Displacement, m	Rate, m/day	Angle from north, deg. clockwise
10:51	-3039.156	-694.188	0.373	0.073	50.473
11:12	-3039.148	-694.195	0.011	0.729	129.804
11:45	-3039.143	-694.187	0.010	0.145	28.092
12:12	-3039.117	-694.191	0.026	1.402	99.716
12:50	-3039.085	-694.188	0.033	1.308	85.054
13:10	-3039.079	-694.184	0.007	0.447	53.368
13:40	-3039.064	-694.185	0.015	0.696	94.044
14:10	-3039.056	-694.183	0.008	0.391	74.894
14:50	-3039.044	-694.182	0.013	0.463	85.464
15:10	-3039.026	-694.188	0.019	1.534	109.500
15:40	-3039.014	-694.190	0.012	0.574	99.513
16:10	-3038.979	-694.208	0.039	1.879	116.536
16:40	-3038.979	-694.219	0.011	0.547	181.520
17:10	-3038.977	-694.251	0.032	0.000	176.208
17:35	-3038.945	-694.272	0.038	0.000	123.667
18:10	-3038.930	-694.291	0.024	1.068	142.379
18:40	-3038.910	-694.309	0.027	0.432	131.597

FIG. 8. Wind speed and direction at Borden Station.

FIG. 9. Air temperatures at Adams Island.

FIG. 10. High- and low-water level readings on tide recorder.

FIG. 11. Water current near Adams Island, 17-30 April 1983.

current speed and direction recorded in April is shown in Fig. 11; the dominant direction was to the east, and maximum speeds to the east-southeast. The recorded peak speed was 0.37 m/s. The current appeared to be dependent on tide and showed semidiurnal cycling (E. Lewis, personal communication, 1984).

Eclipse Sound

Ice movements in Eclipse Sound near the shore at Pond Inlet were monitored from December 1982 to June 1983. During this time first-year landfast ice covered the sound. The accuracy of the measurements is similar to that for Adams Island. Reflectors were placed on a line extending perpendicular to the shore for approximately 7 km. One was offset from this line so that it could be used, with other reflectors, to calculate strain.

The movement vectors are shown in Fig. 12. Total displacement varied from 4.5 to 9.0 m between 17 December 1982 and 7 June 1983. The corresponding average rate would be from 0.03 to 0.05 m/day. Measured over 2-week intervals the rates are of the same order, but they fluctuated within a larger range, with maximums reaching 0.13 m/day. Movement rates for a typical point are given in Table 3. The ice cover movement had a westerly component, and points near the shore (within 2 km) also moved to the north away from the shore, as observed on the Borden shore. Points further away from the shore moved to the south, towards the shore. There was no obvious change in movement rate as winter progressed, although ice thickness increased from approximately 0.5 m in December 1982 to 1.6 m

FIG. 12. Ice movement array and ice movements in Eclipse Sound.

TABLE 3. Ice movement in Eclipse Sound (reflector No. 1)

Date	Displacement, m	Rate, m/day	Angle from north, deg. clockwise
82-12-17	1.971	0.094	312.88
82-01-07	0.523	0.075	309.50
82-01-14	1.104	0.078	308.64
82-01-28	0.796	0.073	309.85
82-02-11	0.140	0.047	333.25
82-02-18	0.496	0.071	311.73
82-02-25	0.419	0.060	317.04
82-03-04	0.873	0.127	312.96
82-03-08	0.267	0.063	166.80
82-03-09	0.066	0.084	353.09
83-06-03	2.227	0.089	300.68
83-06-07	0.165	0.041	309.09

in June 1983. Figure 13a records the ice thickness near one of the reflectors. Air temperature and wind velocity for the same period are given in Figs. 13b and 13c. The prevailing wind for the period was from the west, although it was relatively calm (below 10 km/h) most of the time. Ice movement is apparently influenced by factors other than wind.

Analysis and discussion

Measured movements were used to calculate strains and strain rates in the ice cover. These correspond to length scales varying from 30 m to a few hundred metres. At this scale the ice cover is not flat and homogeneous but includes numerous cracks, rafted and ridged areas, and multiyear floes, some grounded.

Movements of sets of three reflectors were used to calculate average strains along the sides of triangles. These linear strains were then resolved to give the components of the strain tensor and, from the interval between measurements, the strain rate tensor. Linear strains were calculated by dividing the length change between two reflectors by an original length chosen as

FIG. 13. (a) Ice thickness in Eclipse Sound, reflector 1; (b) air temperature, Eclipse Sound; (c) wind speed and direction, Eclipse Sound.

that measured at the beginning of observations. Obviously it is impossible to define an "undeformed" state for the ice cover. The present values of strains, however, are small enough that use of different reference lengths (corresponding to the current deformed state for example) would give similar results.

Strains and strain rates calculated from reflectors S1, S2, and S3 are given in Table 4. Their magnitude and direction are plotted versus time in Fig. 14. Strains calculated for an adjacent area, using reflectors I1, S2, and S3, are shown in Fig. 15. An example of the values calculated over larger areas of the ice cover (reflectors I1, O1, and O2) is shown in Fig. 16. In spite of the apparent uniformity of movements, calculated strains showed considerable scatter. Strain rates varied from 10^{-8} to 10^{-10} s^{-1} over short time intervals (2 days), but were more consistent over longer durations of the order of 1 month.

The total strains accounting for ice cover deformation near Adams Island from March to June 1983 are shown in Fig. 17. The magnitude of the total strain change during this period is of the order of 10^{-3} . Reflectors forming nearly equilateral triangles were used in the calculations in order to obtain the best

TABLE 4. Principal strains and strain rates southwest Adams Island, reflectors S1, S2, S3

Date	Principal strain			Principal strain rate		
	Major	Minor	Angle*	Major	Minor	Angle*
83-03-20	0.000	0.000	0.00	0.000	0.000	0.00
83-03-22	0.840×10^{-4}	0.710×10^{-5}	-131.73	0.486×10^{-9}	0.411×10^{-10}	-131.73
83-03-24	0.644×10^{-4}	-0.270×10^{-3}	-56.64	-0.725×10^{-10}	-0.157×10^{-8}	-60.69
83-03-26	0.303×10^{-3}	0.449×10^{-5}	-59.10	0.316×10^{-8}	-0.329×10^{-9}	-57.80
83-04-27	0.160×10^{-2}	-0.154×10^{-2}	-119.74	0.555×10^{-9}	-0.644×10^{-9}	-121.96
83-04-29	0.162×10^{-2}	-0.158×10^{-2}	-121.58	0.568×10^{-9}	-0.663×10^{-9}	-67.16
83-05-01	0.315×10^{-2}	-0.115×10^{-2}	-122.42	0.929×10^{-8}	0.258×10^{-8}	-124.85
83-05-03	0.198×10^{-2}	-0.105×10^{-2}	-116.44	0.117×10^{-8}	-0.733×10^{-8}	-45.11
83-05-05	0.169×10^{-2}	0.474×10^{-3}	-54.80	0.110×10^{-7}	-0.390×10^{-8}	-104.84
83-05-07	0.171×10^{-2}	-0.174×10^{-2}	-113.28	0.260×10^{-8}	-0.153×10^{-7}	-103.05
83-06-14	0.365×10^{-2}	0.585×10^{-2}	-120.97	0.616×10^{-9}	-0.127×10^{-8}	-125.20

*Degrees clockwise from north.

FIG. 14. Principal strains among reflectors S1, S2, and S3.

FIG. 15. Principal strains among reflectors I1, S1, and S3.

FIG. 16. Principal strains among reflectors I1, O1, and O2.

possible accuracy. Other combinations of reflectors, not shown in Fig. 17, were also examined. The scatter of the results is similar to that discussed above. Although directions of the principal strains in Fig. 17 show some scatter, it seems that compressive strains acted along directions nearly perpendicular to the shore of the island. Tensile strains occurred in most of the ice cover except to the south where the largest ice movements against the island took place.

Strains and strain rates in Eclipse Sound at Pond Inlet are shown in Fig. 18 and Table 5. The values are of the same order as those observed near Adams Island, an unexpected development because the ice cover is not constrained by any obstacle, unlike that in the vicinity of Adams Island. The above values were calculated for the triangle connecting reflectors 0.4, 1.0, and 1.2; side lengths are of the order of 1 km. Uniaxial strains and strain rates were also calculated for the array at Eclipse Sound (Table 6). Strain was calculated from the change in the length of the imaginary line connecting two adjacent reflectors. The first point to note is that strain in a direction parallel to the

TABLE 5. Principal strains and strain rates in Eclipse Sound, reflectors 0.4, 1.0, 1.23

Date	Principal strain			Principal strain rate		
	Major	Minor	Angle*	Major	Minor	Angle*
83-01-14	0.000	0.000	0.00	0.000	0.000	0.00
83-01-28	0.370×10^{-3}	-0.478×10^{-2}	-193.35	0.306×10^{-9}	-0.395×10^{-8}	-193.35
83-02-08	0.562×10^{-3}	-0.812×10^{-2}	-193.28	0.202×10^{-9}	-0.351×10^{-8}	-193.17
83-02-11	0.565×10^{-3}	-0.877×10^{-2}	-193.83	0.527×10^{-10}	-0.257×10^{-8}	-200.97
83-02-18	0.748×10^{-3}	-0.105×10^{-1}	-193.10	0.317×10^{-9}	-0.295×10^{-8}	-189.60
83-02-25	0.775×10^{-3}	-0.121×10^{-1}	-193.41	0.503×10^{-10}	-0.254×10^{-8}	-195.65
83-03-09	0.273×10^{-1}	-0.197	-203.78	0.260×10^{-7}	-0.179×10^{-6}	-204.40
83-06-03	0.209×10^{-2}	-0.262×10^{-1}	-194.37	0.231×10^{-7}	-0.351×10^{-8}	-205.10
83-06-07	0.211×10^{-2}	-0.267×10^{-1}	-194.46	0.470×10^{-10}	-0.154×10^{-8}	-199.05

*Degrees clockwise from north.

TABLE 6. Total uniaxial strain and average strain rate data, ice movements in Eclipse Sound, winter 1982-1983

Pairs of movement stations	Relative movement, m	Distance between stations, m	Total strain change	Duration of measurements, days	Relative rate of measurements, m/day	Average strain rate, s^{-1}
0.4-1.0	1.410	1026	-13.1×10^{-4}	171	0.008	-0.89×10^{-10}
1.0-1.1	-1.430	206	69.8×10^{-4}	171	0.008	4.75×10^{-10}
1.1-1.2	-1.864	1159	16.1×10^{-4}	143	0.013	1.30×10^{-10}
1.2-1.3	-1.630	932	17.5×10^{-4}	143	0.011	1.42×10^{-10}
1.3-1.4	-1.246	983	12.7×10^{-4}	129	0.010	1.14×10^{-10}
1.4-1.5	-1.075	997	10.5×10^{-4}	129	0.008	0.95×10^{-10}
1.5-1.6	-0.897	1101	7.9×10^{-4}	129	0.007	0.71×10^{-10}
1.6-1.7	-0.758	986	6.9×10^{-4}	129	0.006	0.62×10^{-10}
1.7-1.8	-0.725	1064	6.0×10^{-4}	129	0.006	0.54×10^{-10}

shore is extensional (tensile) and that strains normal to the shore are compressive; as well, the total strain change over the measurement period was less than 10^{-3} . Another feature of the strains and movements is a decrease in their magnitude with distance from shore.

These results suggest that adopting a continuum approach to describe the overall strains and strain rates of an ice cover (100 m^2 in area) can give consistent values. This is especially true over long periods of the order of 1 month. Strains account for actual ice deformation as well as for the rearrangement and breaking of separate ice floes. Part of the compressive strains may be due to rafting or ridging and part of the tensile strains to cracking.

Movement rates of the ice cover could be used to estimate the total load on the island (Sanderson 1984). Ponter *et al.* (1983) developed a method of calculating an upper bound of the total load exerted by an ice sheet undergoing secondary creep on a structure. Considering 2 m thick columnar ice at -11°C and 5 ppt salinity, a movement rate of 0.1 m/day gives a total load of 94 MN on the 200 m width of the island (average stress of 235 kPa). A higher movement rate of 1.0 m/day may occur over short periods of less than 1 day; this gives a total load of 200 MN (average stress of 500 kPa). Bruen and Vivatrat (1984) used a different approximate method, one that gives higher upper bounds of the total loads. The conditions at Adams Island give average stresses of 370 and 800 kPa, corresponding to movement rates of 0.1 and 1.0 m/day, respectively. As discussed earlier (Frederking *et al.* 1984), estimates based on strain

measurements over small lengths (approximately 0.3 m) gave average stresses below 70 kPa and a peak value of 140 kPa. Direct stress measurements were conducted by Hamburg Ship Model Basin (HSVA) as part of the project. An array of small vibrating wire (IRAD) transducers was deployed around the southeast quadrant of the island. The results were reported by Frederking *et al.* (1984). The maximum measured stress was 370 kPa in the top 0.5 m of the ice sheet and 50 kPa below that. The peak stress averaged over the ice sheet thickness would be 140 kPa. Further discussion of these measurements is available (Frederking *et al.* 1984).

It appears that stresses calculated by means of the method proposed by Ponter *et al.* (1983) are much higher than those measured directly or obtained from measurements of strain over small length scales. The assumption of secondary creep contributes to overestimated stresses. The measured global strains were mainly less than 2% for the period March to June. The total strains in the ice are probably of the same order. According to Gold (1983), creep at such strains would be transient. He also showed that strain rate depends approximately linearly on the stress within the range of present stresses. The use of Gold's data for freshwater columnar-grained ice and correction for salinity reduces the reference stresses well below those calculated assuming secondary creep. Another factor influencing stress calculations is the reference strain rate. According to Ponter *et al.* (1983), an ice velocity of 0.1 m/day corresponds to a reference strain rate of $1.3 \times 10^{-7} \text{ s}^{-1}$. The measured strain rates were much lower, for the most part

FIG. 17. Total strain from ice sheet deformation, March–June 1983.

FIG. 18. Principal strains in Eclipse Sound among reflectors 0.4, 1, and 1.2.

ranging from 10^{-10} to 10^{-9} s^{-1} . Finally, the discrepancy between measured and calculated stresses may be partly caused by the large cracks and ridges existing in the ice sheet but not accounted for in the theory. Intuitively, such inhomogeneities would "soften" the ice sheet and reduce stresses.

Direct correlation of observed ice cover movement and deformation with wind, water current, tide, and air temperature is not obvious in the present case. Evidently the ice cover responds in a complex way to numerous factors. For example, variation in the water level with tide can change the resistance of rounded ice features to ice sheet movement. Generation of new ice at tidal cracks may also have some effect. It is probable that the behaviour of the landfast ice over a large area that includes Eclipse Sound and Navy Board Inlet should be considered in

predicting local movements at a smaller scale near Adams Island.

Summary and conclusions

Ice cover movements and deformations are described for the winter of 1982/1983 near Adams Island and in Eclipse Sound at Pond Inlet. Displacements and displacement rates were determined by means of repeated surveys of reflectors placed on the ice. The relative movements of the reflectors were used to calculate strains and strain rates over distances varying between 30 m and a few hundred metres. The intervals between measurements varied from 2 days to 1 month, although limited measurements were taken at shorter intervals of 15 min.

Movements near Adams Island proved to be north–northeast at a rate of approximately 0.1 m/day. Those in Eclipse Sound were of the same order, but to the west. Ice appeared to move away from the shoreline at both Borden Station and Pond Inlet. Strain rates were of the order of 10^{-10} s^{-1} in both locations. Strains measured using different combinations of reflectors were consistent over long periods (approximately 1 month), but showed some scatter over shorter periods.

Average (upper bound) ice stresses against the island, determined from ice movement rates, varied from 235 to 500 kPa; those determined from strain measurements or direct measurements were 70–140 kPa. The difference is attributed to the inadequacy of the upper bound method to reflect the presence of macroflaws in the ice cover.

These results are part of a larger project that includes measurements of stresses, strains at small scales, and meteorological conditions. Correlation of the various factors governing landfast ice interaction with an island still requires study.

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