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FOR HANDEL, SJØFART, INDUSTRI, HÅNDVERK OG FISKERI

NORGES SVALBARD- OG ISHAVS-UNDERSØKELSER
LEDER: ADOLF HOEL

SKRIFTER OM SVALBARD OG ISHAVET

Nr. 14

ROLF KJÆR AND J. E. FJELDSTAD

TIDAL OBSERVATIONS IN THE ARCTIC

WITH 8 TEXT FIGURES AND 7 TABLES

OSLO
I KOMMISJON HOS JACOB DYBWAD
1934

Results of the Norwegian expeditions to Svalbard 1906—1926 published in other series. (See Nr. 1 of this series.)

The results of the Prince of Monaco's expeditions (Mission Isachsen) in 1906 and 1907 were published under the title of 'Exploration du Nord-Ouest du Spitsberg entreprise sous les auspices de S. A. S. le Prince de Monaco par la Mission Isachsen', in Résultats des Campagnes scientifiques, Albert Ier, Prince de Monaco, Fasc. XL—XLIV. Monaco.

ISACHSEN, GUNNAR, Première Partie. Récit de voyage. Fasc. XL. 1912. Fr. 120.00.
With map: Spitsberg (Côte Nord-Ouest). Scale 1 : 100000. (2 sheets.) Charts: De la Partie Nord du Foreland à la Baie Magdalena, and Mouillages de la Côte Ouest du Spitsberg.

ISACHSEN, GUNNAR et ADOLF HOEL, Deuxième Partie. Description du champ d'opération. Fasc. XLI. 1913. Fr. 80.00.

HOEL, ADOLF, Troisième Partie. Géologie. Fasc. XLII. 1914. Fr. 100.00.

SCHETELIG, JAKOB, Quatrième Partie. Les formations primitives. Fasc. XLIII. 1912. Fr. 16.00.

RESVOLL HOLMSEN, HANNA, Cinquième Partie. Observations botaniques. Fasc. XLIV. 1913. Fr. 40.00.

A considerable part of the results of the ISACHSEN expeditions in 1909 and 1910 has been published in Videnskapsselskapets Skrifter. I. Mat.-Naturv. Klasse, Kristiania (Oslo).

ISACHSEN, GUNNAR, Rapport sur l'Expédition Isachsen au Spitsberg. 1912, No. 15. Kr. 5,40.

ALEXANDER, ANTON, Observations astronomiques. 1911, No. 19. Kr. 0,40.

GRAARUD, AAGE, Observations météorologiques. 1913, No. 1. Kr. 2,40.

HELLAND-HANSEN, BJØRN and FRIDTJOF NANSEN, The sea west of Spitsbergen. 1912, No. 12. Kr. 3,60.

ISACHSEN, GUNNAR, The hydrographic observations. 1912, No. 14. Kr. 4,20.
With chart: Waters and anchorages on the west and north coast. Publ. by the Norw. Geogr. Survey, No. 198.

HOEL, A. et O. HOLTEDAHL, Les nappes de lave, les volcans et les sources thermales dans les environs de la Baie Wood au Spitsberg. 1911, No. 8. Kr. 4,00.

GOLDSCHMIDT, V. M., Petrographische Untersuchung einiger Eruptivgesteine von Nordwestspitzbergen. 1911, No. 9. Kr. 0,80.

BACKLUND, H., Über einige Olivinknollen aus der Lava von Wood-Bay, Spitzbergen. 1911, No. 16. Kr. 0,60.

HOLTEDAHL, OLAF, Zur Kenntnis der Karbonablagerungen des westlichen Spitzbergens. I. Eine Fauna der Moskauer Stufe. 1911, No. 10. Kr. 3,00. II. Allgemeine stratigraphische und tektonische Beobachtungen. 1912, No. 23. Kr. 5,00.

HOEL, ADOLF, Observations sur la vitesse d'écoulement et sur l'ablation du Glacier Lilliehöök au Spitsberg 1907—1912. 1916, No. 4. Kr. 2,20.

VEGARD, L., L'influence du sol sur la glaciation au Spitsberg. 1912, No. 3. Kr. 0,40.

ISACHSEN, GUNNAR, Travaux topographiques. 1915, No. 7. Kr. 10,00.
With map: Spitsberg (Partie Nord-Ouest). Scale 1 : 200000 (2 sheets).

GUNNAR ISACHSEN has also published: Green Harbour, in *Norsk Geogr. Selsk. Aarb.*, Kristiania, 1912—13, Green Harbour, Spitsbergen, in *Scot. geogr. Mag.*, Edinburgh, 1915, and, Spitsbergen: Notes to accompany map, in *Geogr. Journ.*, London, 1915.

All the above publications have been collected into two volumes as Expédition Isachsen au Spitsberg 1909—1910. Résultats scientifiques. I, II. Christiania 1916.

As the result of the expeditions of ADOLF HOEL and ARVE STAXRUD 1911—1914 the following memoir has been published in Videnskapsselskapets Skrifter. I. Mat.-Naturv. Klasse.

HOEL, ADOLF, Nouvelles observations sur le district volcanique du Spitsberg du Nord. 1914, No. 9. Kr. 2,50.

The following topographical maps and charts have been published separately:

Maps:

Bear Island. 1 : 25000. 1925. Kr. 10,00.

Bear Island. 1 : 10000. (In six sheets). 1925. Kr. 30,00.

East Greenland. Eirik Raudes Land from Sofiasund to Youngsund. 1 : 200000. 1932. Kr. 5,00

Charts:

No. S. 1. Bear Island. 1 : 40000. 1932. Kr. 4,00.
„ S. 2. Bear Island Waters. 1 : 350000. 1931. Kr. 5,00.
„ S. 3. From Bellsound to Foreland Reef with the Icefjord. 1 : 200000. 1932. Kr. 5,00.
„ S. 5. Norway—Svalbard, Northern Sheet. 1 : 750000. 1933. Kr. 4,00.
„ S. 6. Norway—Svalbard, Southern Sheet. 1 : 750000. 1933. Kr. 4,00.

A preliminary edition of topographical maps (1 : 50000) covering the regions around Kings Bay, Ice Fjord, and Bell Sound, together with the map of Bear Island (1 : 25000), is published in:

Svalbard Commissioner [Kristian Sindballe], Report concerning the claims to land in Svalbard. Part I A, Text; I B, Maps; II A, Text; II B Maps. Copenhagen and Oslo 1927. Kr. 150,00.

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A. W. BRØGGERS BOKTRYKKERI A/S

CONTENTS

PREFACE

The tidal observations dealt with in this paper were carried out on the Norwegian Arctic expeditions sent out in the years 1930—1933 by *Norges Svalbard- og Ishavs-undersøkelser* in Oslo.

The observations in Bear Island 1930 and East Greenland 1933 were made by means of an automatic tide-gauge of American type (Julien P. Friez & Sons, Baltimore Md., U. S. A.), whereas the observations in Southeast Greenland 1932 consisted in staff readings only.

The results of the observations have been worked up shortly after the return of each expedition, hence the different methods used.

Oslo and Bergen, January, 1934.

Rolf Kjær and *J. E. Fjeldstad.*

Observations.

By

ROLF KJÆR

Bear Island 1930.

The tidal observations on the coast of Bear Island were carried out in connection with an hydrographic expedition sent out to the Svalbard waters on board the fishery inspection ship of the Navy, the *Michael Sars*. The expedition started from Tromsø, and reached Bear Island on the morning of June 4. Here the ice conditions were very favourable, as the island already early in the spring was ice-free.

Unsuccessful attempts were first made to erect the tide-gauge on the southeast coast, then they succeeded with some difficulty to place it in Austervåg on the northeast coast of the island (see fig. 1), not far from the Bear Island Radio Station.

The *Michael Sars* anchored off Austervåg where the coast has a steep cliff. The steep rock just inside the coal pocket still remaining from the mining period, was chosen as the most favourable site for the tide-gauge. The rock is here perfectly perpendicular, and the depth quite close to the rock is more than 4 metres at L. W. The height of the edge of the cliff, however, is about 10 metres above the sea-bottom, and the pipe system for the floater thus became too short (it has a total length of 9 metres). There is, however, at the height of abt. 4 metres above M. W. level a small bench in the rock, accessible through descending with ropes from the edge of the cliff. From this bench it would be possible to look after the recorder, if it was erected with a pipe length of 8 metres. After having landed 6 men from the *Michael Sars*, carrying with them the necessary outfit, tackles, tools, staging, and instruments, 3 strong iron bolts were fixed in the rock during the night before June 5, in order to get the pipe system and the recorder erected. A copper bolt was also fixed, to be used in connection with a proposed levelling. The fixing of the bolts by drilling holes in the rock from a lowered staging was a difficult and slow piece of work, but was finished in 14 hours.

During June 5 the pipe, floater, and recorder were put in position, but not until the evening on the following day the tide-gauge was in operation. It became evident that the holes in the lower end of the pipe were too large, causing the swell to "pump" in and out, trans-

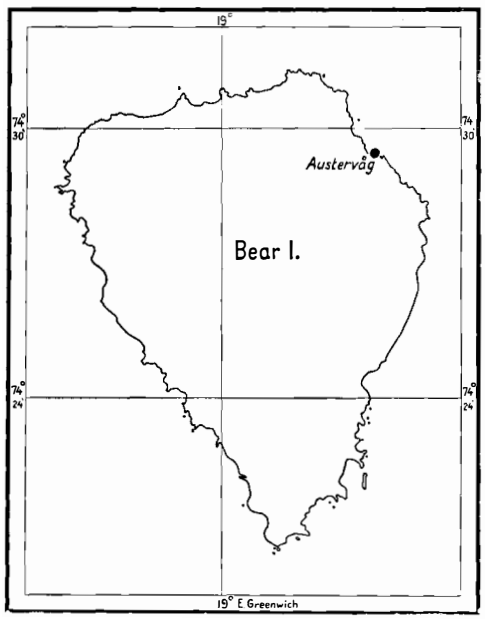


Fig. 1. Location of tidal observation point on the Bear Island coast.

ferring this motion through the pen to the records. Several experiments throughout the day and the night before June 6 were necessary to make the whole system work satisfactorily. The pipe then touched the sea-bottom with its lower end, which was closed with a wooden plug. The sea had access through 4 holes having a diameter of 1,5 millimetres.

On June 6 at 9 p. m. (21) the clockwork of the tide-gauge was started, and worked then satisfactorily for 30 days until 8 p. m. (20) on July 6.

In order to tend the tide-gauge 3 men fitted out with a tent, sleeping bags, and a supply of food for one month were put ashore from the *Michael Sars*. The ship then left Austervåg in the evening on June 6, and called at Bear Island a few times during the following 30 days, when the vessel was occupied with sounding work in the Barents Sea. Wireless telephone communication with the 3 watchmen was kept up via Bear Island Radio throughout the period. On July 6 the *Michael Sars* returned to Austervåg, where the tide-gauge was taken down, and the 3 men embarked.

That the tidal observations could be successfully carried out throughout such a long period on the open Bear Island coast is in the first instance due to most favourable weather conditions with prevailing westerly winds of moderate strength, without a heavy sea or swell. Drift-ice neither, hampered the work of the tide-gauge (see table 2).

During the stay in Austervåg a levelling was also made, as the height of the copper bolt placed next to the tide-gauge was determined by levelling to bench mark *63* of the Bear Island trigonometrical net. The foot plate of the recorder of the tide-gauge was found to be situated 2.77 metres above this copper bolt.

During the erection and taking down of the tide-gauge the total length of the copper thread was measured from the waterline of the floater to the end of the thread fixed in the rotating drum, and the average of the two measurements was 5.79 m. During the 30 days of registration it was every third day noted on the records the length of the copper thread which at a certain time was rolled up on the drum

above the footplate of the recorder (i. e. the height of the footplate above the sea-level was measured). The average of these measurements shows that the 5-line on the records corresponds to 1.16 metres copper thread rolled up on the drum above the footplate, (i. e. the footplate is 4.63 metres above the sea-level).

The geographical co-ordinates of the station in Austervåg is

74° 29′.4 Lat. N.

19° 12′.4 Long. E. Gr.

The time is Mean European Time (M. E. T.). The clock of the recorder was compared with the chronometers of the ship at the beginning and end of the observations, but no difference could be found.

Fig. 2. Tide-gauge erected in Austervåg, Bear Island.
R. Kjær phot. 6/6 1930.

Southeast Greenland, Finnsbu 1932.

The tidal observations at the Norwegian Station Finnsbu north of Skjoldungen in Southeast Greenland, was carried out in 1932 by the scientific expedition sent out on board the sealer *Veslemari*.

The expedition — which started from Ålesund — reached the Greenland coast on Aug. 16, and proceeded then to the radio, meteorological and hunting station Finnsbu at Heimenhamna (Heimen harbour) in the district of Skjoldungen, where it arrived in the morning of the 17th.

The expedition had no automatic tide-gauge at its disposal, but nevertheless they would attempt to obtain information about the tide conditions by taking ordinary staff readings through a longer period. The same day (17th) it was agreed that the two men of the station (the manager and the wireless operator) should perform the readings on the staff and make the necessary notes. It was planned to take readings every hour throughout a period of 30 days, but the men on the station found it — owing to other pressing work — impossible to do this, and a restricted programme was therefore agreed upon:

Fig. 3. Heimenhamna, Southeast Greenland, looking North.
G. Horn phot. 19/8 1932.

a. At spring tide — just to come — the sea-level should be read every hour throughout 24 hours, and these frequent readings should be repeated on the 7th, 14th, 21th, and 28th day.

b. On the intervening days the readings should be taken every second hour for a period of 18 hours, commencing at 8 a. m.

A staff, 4 metres long and divided in centimetres, was erected at the shore of Heimenhamna some 50 metres distant from the station house in Finnsbu. It was plumbed up and checked. According to information received from the hunters at Finnsbu it was thus placed that its lower end would remain below water, even at the lowermost sea-level. The hunters who had been there one year, estimated the range of tide to 3 metres. The readings started in the afternoon of Aug. 17. *Veslemari* left Finnsbu three days later and during the following weeks the expedition carried out various scientific and practical work along the coast and in the fjords of Southeast Greenland as far as the Lindenowfjord.

The vessel did not return to Finnsbu until Sept. 13. The hunters could inform the expedition that the readings of the sea-level had proceeded satisfactorily according to the plan, apart from one interruption, when the men had to make a trip to another hunting station. Smaller deviations from the schedule had occurred, when the reading time for some reason or other had not quite been kept up.

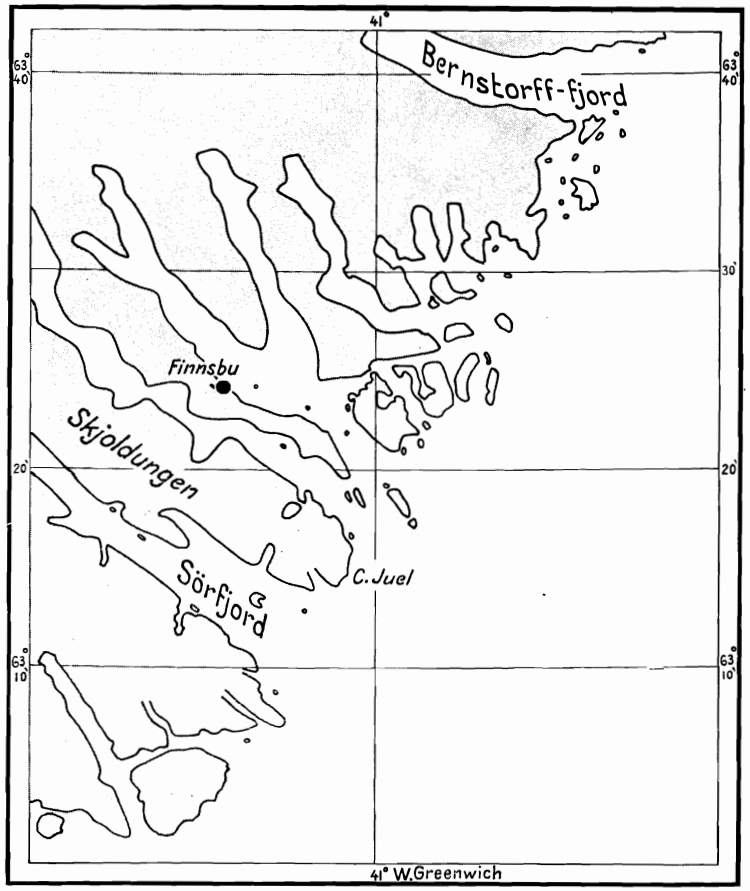
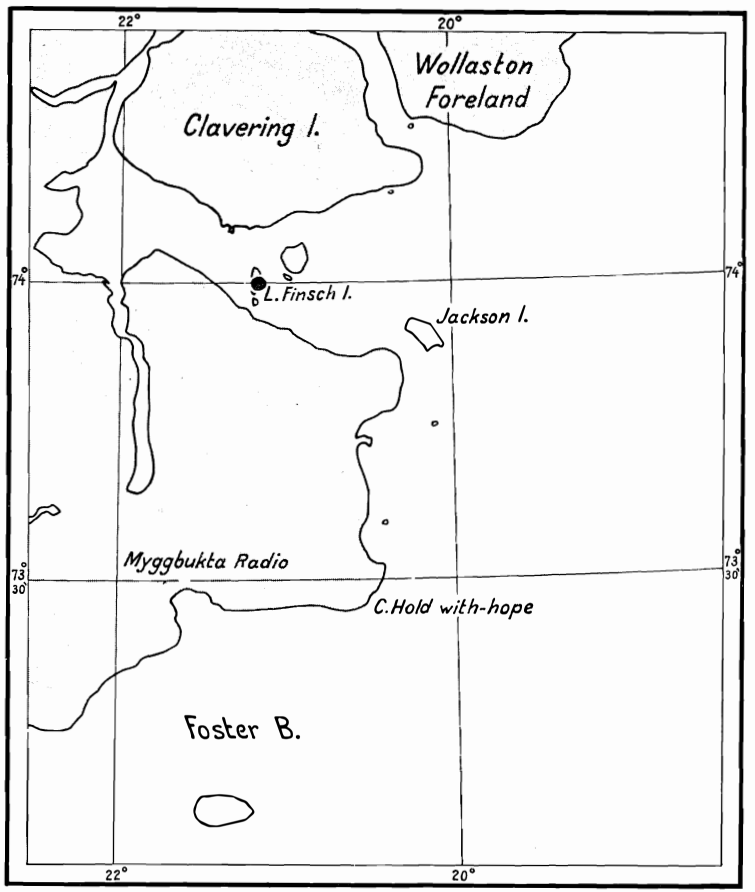


Fig. 4. Location of tidal observation point in Southeast Greenland.



Location of tidal observation point in East Greenland.

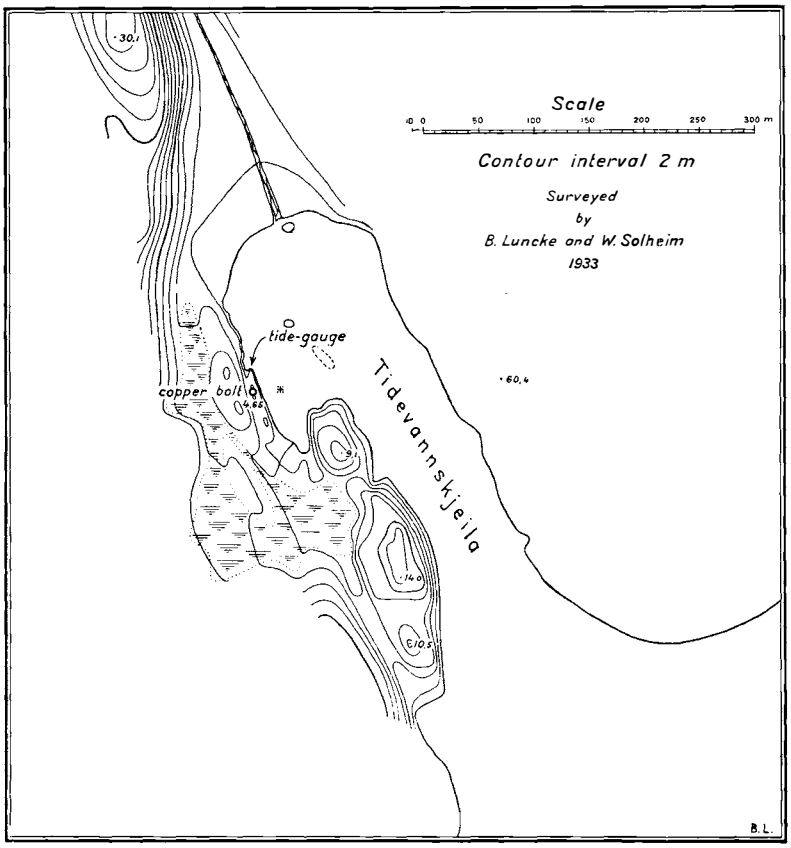


Fig. 5. Map of Tidevannskjeila (Tide Creek).

The observations were continued until the expedition left Southeast Greenland on Sept. 15.

The weather conditions in the Skjoldungen district were very stable throughout the observation period (see table 3).

The geographical co-ordinates of the observation point are:

63° 24′ Lat. N. 41° 17′ Long. W. Gr.
The time is M. E. T.

East Greenland, Vesle Finschøya (Little Finsch Island) 1933.

Since 1929 *Norges Svalbard- og Ishavs-undersøkelser* has every year sent out scientific expeditions to the coast of East Greenland between 71° and 76° Lat. N. The object of these expeditions have been of varied nature: surveying, geological, botanical, zoological, and

Fig. 6. Tidevannskjeila, Vesle Finschøya, East Greenland. Position of tide-gauge.
B. Luncke phot. 19/7 1933.

archaeological investigations have been included in the programme, but it was not until the expedition in 1933 that complete tide observations through a long period were carried out on this coast.

The ship of the expedition, the sealer *Polarbjørn* left Barentsburg on Spitsbergen on July 13, having proceeded thither from Tromsø in Norway, and reached the ice-edge off Greenland on the 16th. It pushed its way through the ice in the course of a couple of days, and was in the evening of the 18th in almost ice-free water south of Claveringøya (Clavering Island). After having investigated the coast of Vesle Finschøya in this locality, it was decided to erect the automatic tide-gauge on the south side of this island, at the head of a little sheltered bay called Tidevannskjeila (Tide-creek) (see fig. 5—6). Here there was no risk of getting the instruments damaged through drift ice, and the sea was quite smooth.

Four men were put ashore on Vesla Finschøya and during 2 days absence of the expedition vessel *Polarbjørn* they erected the tide-gauge next to a small rock, where the depth was sufficient and where the recorder was easily accessible from the shore. Iron bolts were driven into the solid rock in order to make a support for the tide-gauge, and a copper bolt was fixed in the rock some distance from the gauge. An ordinary tide-water staff divided into centimetres was placed near the tide-gauge, and when this had been started, staff readings were taken at fixed times, and noted on the records of the gauge.

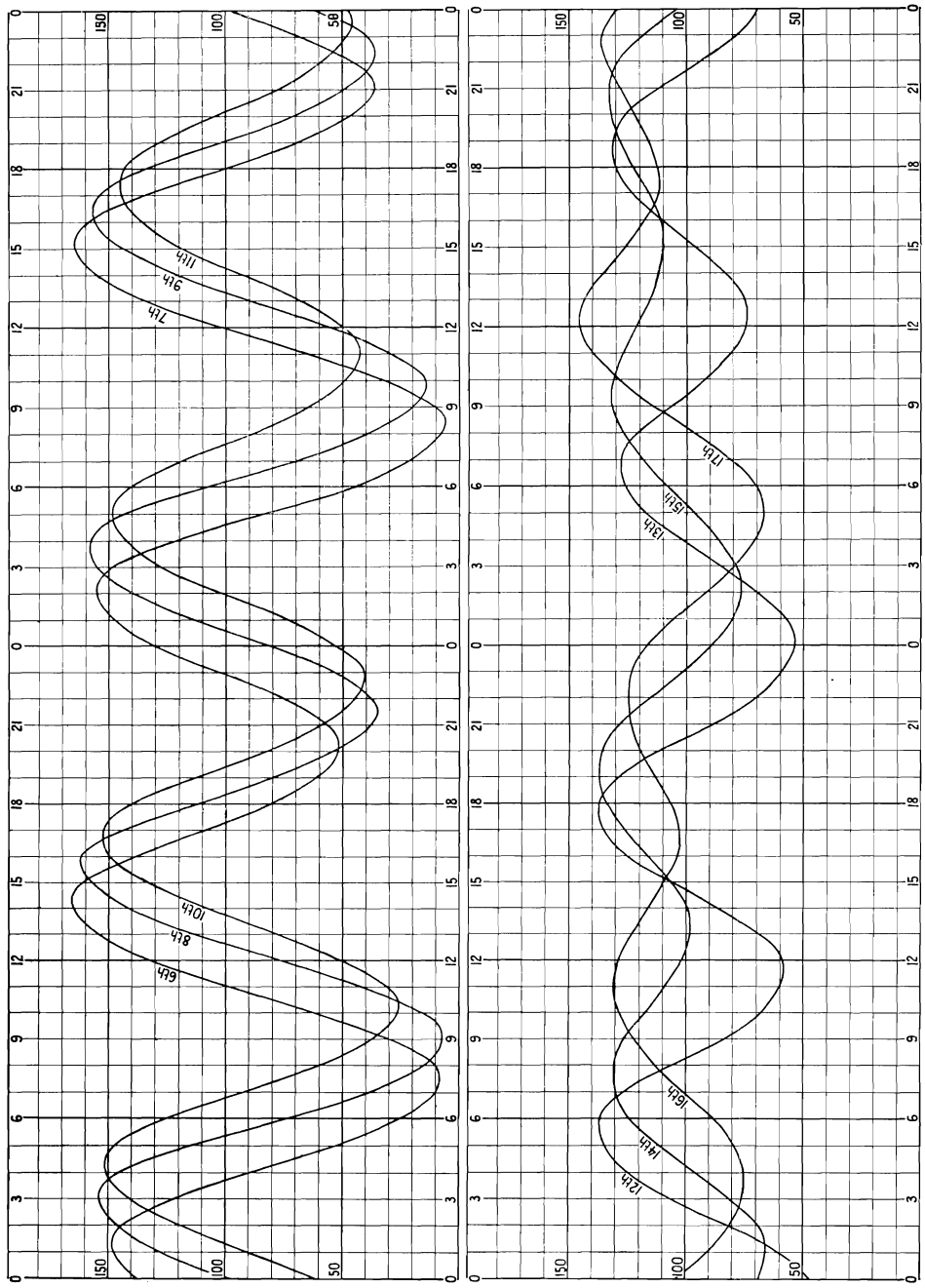


Fig. 7. Part of tidal records from Little Finsch Island, East Grenland, August 1933.

The *Polarbjørn* left Vesle Finschøya on July 20, leaving 2 men behind, who were to watch and look after the gauge. They were fitted out with tent, weapon, and the necessary stores for a period of one month. The tide-gauge then was in continuous operation for 30 days.

As the scientific and surveying work of the expedition were carried out in various localities on the coast quite far from the Claveringfjord, the vessel had only once occasion to call at the island. On Aug. 18 the *Polarbjørn* returned to Vesle Finschøya, and the tidal observations were discontinued. Men, outfit, and instruments were embarked, and a few days later the expedition left East Greenland.

On Vesle Finschøya was also carried out a levelling, wherewith the copper bolt near the tide-gauge was connected up with the gauge and the Norwegian trigonometrical net on East Greenland.

During the observation period the weather and ice conditions in the Claveringfjord were very favourable (see table 4).

The geographical co-ordinates of the observation point are:

73° 59′.4 Lat. N. 21° 08′.2 Long. W. Gr.

The time is always M. E. T., and was checked, when the observations were started and stopped, with time signals received by the radio station of the *Polarbjørn*.

Results.

By

J. E. FJELDSTAD

Bear Island 1930.

The harmonic analysis of the tidal observations from Bear Island has been performed according to the methods described by R. A. Harris in Manual of Tides (U. S. Coast and Geodetic Survey).

The hourly values of the height of the sea-level above an arbitrarily selected zero level were found by measuring the ordinates of the curve above the 5-line on the records, assuming, on the basis of the control measurements of the copper thread, that one division on the paper corresponded to one decimetre. Table 5 contains these hourly values of the height of the sea-level above the 5-line = the arbitrarily chosen zero level.

The grouping of the hourly values to component hours has been done by means of table 42 in Manual of Tides. In this way the components M_2, N_2, and O_1 have been computed. The components K_1 and S_2 were found by the method described by G. H. Darwin[1].

This method gives some uncertainty in the determination of the components in question, as it is based on the assumption that the ratio of the components K_1 and P_1 and K_2 and S_2 have their theoretical values, and also that the differences of phases are the same as in the equilibrium theory. Therefore, the amplitude and the phase of S_2 may be slightly erroneous. The component M_2, however, is nearly correct, as may be seen from a curve showing the means of the hourly ordinates.

The component O, on the other hand, is rather uncertain, as is also N.

The results are:

	Ampl.	Phase
A_0	54.9 cm	
M_2	34.2 cm	50°.5
S_2	13.0 „	83°
N_2	6.7 „	35°
K_1	5.4 „	230°
O_1	4.4 „	66°

[1] On an Apparatus for Facilitating the Reduction of Tidal Observations. — Proc. of Royal Soc. of London, Vol. LII, p. 365.

It should first be noted that the mean sea-level in the period lies 54.9 cm above the arbitrarily chosen zero level, which, according to the above statement, was 463.3 cm below the ground plate of the recorder. Therefore, the mean sea-level in the period was found at a distance of 408.4 cm below the ground plate of the recorder, and 131.4 cm below the copper bolt.

From the harmonic constants we find tidal hour M_2 $0^h.40$, and regarding the quality of the tide we obtain $\frac{S_2}{M_2} = 0.38$, while the theoretical value is 0.46, $S_2^\circ - M_2^\circ = 32°.5$ and the "age of tide" 32 hours.

Southeast Greenland, Finnsbu 1932.

Since the readings in Finnsbu (table 6) were made at irregular intervals, one has to interpolate the hourly heights of the sea-level. In order to do this, a continuous curve was drawn by means of the observed values. The drawing of this curve was facilitated by frequent readings near the times of H. W. and L. W. The tide seems to be but little disturbed by meteorological causes, and therefore, the shape of the tidal curve could be determined without difficulties, even when the observations are scanty, as during the nights when five hours of observations are lacking.

The tide curve for the lacking day, from Sept. 12 to 13 was interpolated by means of the heights on the preceding and the following day, and also by use of the heights 14.5 days earlier. The curve was then drawn such that it should fit in with the parts of the curve for the adjacent days.

Also, one could wish that the series of observations had covered one day more, as it comprises only 28 days instead of 29, which is a more proper number of days for the analysis of tidal observations.

When the curve had been completed, the hourly heights were read off, and submitted to harmonic analysis according to the methods described by Harris. The results for the principal components of the tide are:

	Ampl.		Phase
M_2.....	85.1 cm	M_2°.....	127°
S_2.....	36.6 „	S_2°.....	158°
N_2.....	15 „	N_2°.....	126°
K_1.....	13.2 „	K_1°.....	93°
O_1.....	4.4 „	O_1°.....	46°

For the sake of comparison the first 15 days were also analysed by the method of dr. Doodson[1], Tidal Institute of Liverpool, with the following results:

M_2.....	91.2 cm	$M_2°$.....	127°
S_2.....	35.6 „	$S_2°$.....	163°
N_2.....	18.4 „	$N_2°$.....	123°
K_1.....	11.7 „	$K_1°$.....	93°
O_1.....	5.5 „	$O_1°$.....	49°

The accordance between the results of the two analyses is satisfactory, and gives a check on the values of N_2 and O_1, whose determination from so short and incomplete a series of observations is difficult.

East Greenland (Vesle Finschøya) 1933.

The analysis is made by the method of Doodson.

The tidal observations cover an interval of 30 complete days from July 20 to Aug. 18, both inclusive, but the last day, Aug. 18, has been omitted because this method requires observations from 29 days.

The hourly values of the height of the sea-level in centimetres above the arbitrarily chosen zero level, which as already mentioned, corresponds with the 0-line on the records, are given in table 7. The mean sea level of the period is situated 96.7 centimetres above this arbitrarily chosen zero level, which, again, corresponded with a staff reading = 25 centimetres. In levelling from the staff to the copper bolt next to the tide-gauge, the top of the bolt was found to be situated 465 centimetres above M. W.

It should be noted that the angles given as $M_2°$, $S_2°$, etc. mean the angle usually designated by $\varkappa$, and not the angle which by Doodson is designated by g.

As the weather conditions during the period of observations were favorable and the records, therefore, are very regular, the results should be reliable. The harmonic constants which have been calculated are:

	Ampl.	Phase
M_2.....	44.9 cm	315°.3
S_2.....	19.5 „	0°
N_2.....	11.9 „	289°
K_1.....	11.8 „	75°
O_1.....	7.6 „	25°

[1] Instructions for Analysing Tidal Observations. Published by the Lords Commissioners of the Admiralty.

Comparison with results from other stations.

It may be of interest to compare the harmonic constants for Bear Island, Finnsbu and Vesle Finschøya with the known harmonic constants from adjacent places. For this purpose we shall make use of the harmonic constants for Nanortalik (west of Cape Farvel), Denmark Island (in Scoresby Sound), and Jan Mayen on the western side; Bodø and Kabelvåg (Norway) and Port Virgo (West Spitsbergen) on the eastern side of the Norwegian Sea. In table 1 we have compiled the harmonic constants for the principal components at these places together with some other quantities giving the quality of the tide. Most of these are found in Harris' *Arctic Tides*. It should be noted that Harris gives the result of two different analyses for Port Virgo, one contained in the original memoir of *Mission Scientifique pour la mesure d'un arc de méridien au Spitzberg: Mission Suédoise, Tome I. P. 25* and the other the result of an analysis by the U. S. Coast and Geodetic Survey. The results differ widely on several points, but it seems that the American analysis is erroneous as far as regards the solar component S_2, which is found to be 7.9 cm and the ratio $\frac{S_2}{M_2} = 0.19$. The Swedish analysis gives $S_2 = 14.3$ and the ratio $\frac{S_2}{M_2} = 0.35$, which is nearly equal to the ratio found at all the other stations in the northern part of the Norwegian Sea. We, therefore, adopt this value as the most probable.

A comparison of the harmonic constants shows the great resemblance of the tide at these places. The ratio $\frac{M_2}{S_2}$ varies between 0.33 and 0.44 and the ratio $\frac{N_2}{M_2}$ between 0.18 and 0.27.

The comparison of the diurnal tides reveals an interesting fact. While the diurnal component O_1 has nearly the same phase at the eastern and western side of the Norwegian Sea, we see that the component K_1 is quite different. Thus we find the cotidal hours 6.08 at Denmark Island, 6.41 at Vesle Finschøya and 7.00 at Jan Mayen. At the Norwegian side we find 12.90 for Bodø, 13.16 for Kabelvåg, 14.05 at Bear Island, and 13.62 at Port Virgo. The time difference is about 6 hours, or a quarter of a period.

Furthermore, we draw attention to the tidal hours for M_2, which give a picture of the propagation of the semidiurnal tide in the northern part of the Norwegian Sea. The cotidal line for 12^h seems to run almost parallel to the shelf from Norway to Spitsbergen and also parallel to the northern part of East Greenland.

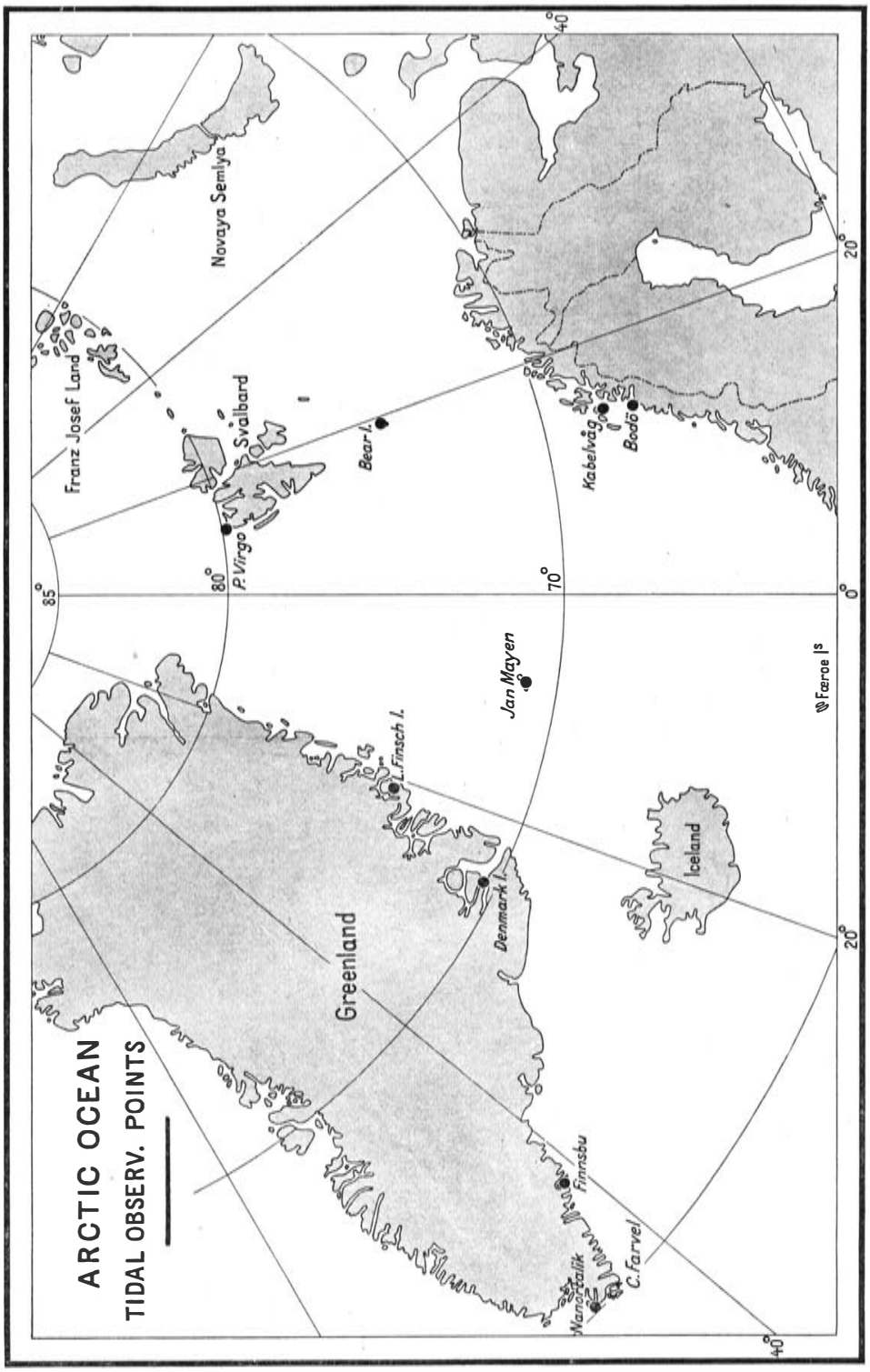


Fig. 8. Tidal observation points in the Arctic Ocean.

Table 1.

Harmonic constants, etc.

Station	Lat. N.	Long Gr.	M_2	$M_2°$	S_2	$S_2°$	N_2	$N_2°$	K_1	$K_1°$	O_1	$O_1°$	T.H. M_2	$S_2°-M_2°$	$M_2°-N_2°$	$K_1°-O_1°$	$\frac{S_2}{M_2}$	$\frac{N_2}{M_2}$	$\frac{O_1}{K_1}$	T.H. K_1	T.H. O_1
		West																			
Nanortalik	60°08′	45°16′	88.0	161°	37.5	203°	—	—	18.9	114°	11.0	74°	8.39	42°	—	40°	0.43	—	0.58	10 62	7.95
Finnsbu	63°24′	41°17′	85.1	127°	36.6	158°	15.0	126°	13.2	93°	4.4	46°	6.98	31°	1°	47°	0.43	0.18	0.33	8.95	5.82
Denmark Island ..	70°27′	26°12′	35.0	337°	16.0	28°	7.6	312°	8.7	65°	9.3	35°	0.98	51°	25°	30°	0.44	0 22	1.07	6.08	4.08
Vesle Finschøya ..	73°59′	21°03′	44.9	315°	19.5	0°	11.9	289°	11.8	75°	7.6	25°	11.92	45°	27°	50°	0.44	0.27	0.66	6.41	3.10
Jan Mayen	71°00′	8°28′	40.2	328°	13.1	18°	8.5	300°	3 4	97°	6.1	49°	11.51	50°	29°	47°	0.33	0.21	1.86	7.00	3.85
		East																			
Bodø	67°17′	14°23′	86.6	356°.5	29.9	35°	17.4	334°	10 4	208°	4.0	32°	10.91	39°	22°	176°	0.35	0.20	0 38	12.00	1.16
Kabelvåg	68°13′	14°30′	90.8	3°.5	32.9	44°	18.6	340°	10.4	212°	4.0	51°	11.15	40°	24°	158°	0.36	0.20	0.38	13.16	2.63
Bear Island	74°29′	19°12′	34.2	50°.5	13 0	83°	6.7	35°	5.4	230°	4.4	66°	0.40	33°	16°	164°	0.38	0.20	0.82	14.05	3.12
Port Virgo	79°43′	10°44′	41.4	38°.2	14.3	70°	7.6	13°	2.7	225°	1.2	12°	0.55	32°	25°	203°	0.35	0.18	0.44	13 62	0.08

Table 2.

Meteorological observations, Bear Island, June 6—July 6, 1930.

Date	M. E. T.	Pressure mb	Air temp, °C	Relat. humid. %	Sea surface °C	Wind: Direct. from	Wind: Force 0—12	Cloudiness 0—10	State of ice and sea
June 6	14	983.9	5.4	111	0.9	SWbS	4	10	High swell
„ 7	„	988.4	2.5	110	1.0	NW	4	10	
„ 8	„	1003.2	3.3	101	1.0	W	4	10*	Some swell
„ 9	„	1004.9	4.8	110	0.9	SbE	2	10*	„
„ 10	„	997.1	3.8	109	1.3	SEbE	4	8	„
„ 11	„	988.0	4.6	110	1.3	NWbN	3	10	„
„ 12	„	988.2	4.0	107	1.4	WNW	5	10	„
„ 13	„	996.4	6.3	96	1.3	WbN	2	10	„
„ 14	„	1006.0	5.8	102	1.5	WbS	3	10	„
„ 15	„	1015.7	4.1	95	1.5	WSW	4	8	„
„ 16	„	1007.4	6.5	107	1.6	SWbW	5	10	„
„ 17	„	1002.0	5.9	107	1.6	SW	5	10	„
„ 18	„	1000.5	6.0	106	1.6	WSW	5	10	„
„ 19	„	1005.0	4.1	93	1.8	WbS	5	9	„
„ 20	„	1012.8	2.2	100	2.0	NNW	4	10	„
„ 21	„	1018.7	5.1	96	1.9	NNW	3	3	„
„ 22	„	1015.3	4.5	93	2.1	WNW	3	10	„
„ 23	„	1012.0	4.6	99	2.2	NWbN	2	10	„
„ 24	„	1012.0	3.2	104	2.3	ENE	2	4	„
„ 25	„	1013.3	2.0	103	2.3	EbN	4	10	
„ 26	„	1011.9	3.5	102	2.3	EbS	4	10	
„ 27	„	1014.0	1.1	102	2.4	NEbE	2	10	Some swell
„ 28	„	1009.2	4.5	99	2.4	WNW	5	10	
„ 29	„	1009.9	4.2	107	2.4	WNW	4	10	
„ 30	„	1006.1	5.8	98	2.4	WbS	5	9	
July 1	„	1008.4	3.3	105	2.4	ENE	2	10	Some swell
„ 2	„	1012.9	7.0	96	2.4	WSW	4	10	„
„ 3	„	1003.1	12.2	106	2.5	WSW	7	10	„
„ 4	„	1004.9	9.6	102	2.5	SW	6	9	„
„ 5	„	1011.1	9.5	102	2.6	SSW	3	9	„
„ 6	„	1006.6	12.6	93	2.6	W	2	6	„

No drift-ice throughout the period

Table 3.

Meteorological observations, Finnsbu, Southeast Greenland, August 17—September 14, 1932.

Aug. 17	14	1018.0	11.5	-	-	—	-	-	
„ 18	„	1014.0	11.8	71	6.2	—	0	10*	
„ 19	„	1022.5	10.2	87	8.2	SE	1	8	
„ 20	„	1020.5	6.0	-	-	—	-	-	
„ 21	„	1017.3	8.7	67	7.2	SE	2	3	
„ 22	„	1012.2	5.8	90	6.6	ESE	1	9	
„ 23	„	1013.5	9.0	77	7.9	ESE	1	7	
„ 24	„	1008.3	9.7	82	8.3	ESE	1	3	
„ 25	„	1002.1	9.3	86	7.5	NNW	2	10*	
„ 26	„	992.4	6.7	95	8.3	NE	2	10*	
„ 27	„	993.0	10.8	76	7.6	NNW	3	10	
„ 28	„	988.9	7.5	84	6.1	SE	2	6	
„ 29	„	990.9	9.9	76	5.7	NNW	3	3	
„ 30	„	991.2	7.8	88	6.1	NW	2	10	
„ 31	„	996.2	10.9	65	5.1	NW	3	8	

No drift-ice throughout the period

Table 3 (continued).

Date	M. E. T.	Pressure mb	Air temp. °C	Relat. humid. %	Sea surface °C	Wind		Cloudiness 0—10	State of ice and sea
						Direct. from	Force 0—12		
Sept. 1	14	990.8	15.0	73	5.3	WNW	4	2	No drift-ice throughout the period
„ 2	„	1002.3	11.0	53	5.6	SE	1	1	
„ 3	„	1007.4	5.1	95	5.0	WNW	3	10*	
„ 4	„	1006.4	7.0	89	4.9	-	0	10	
„ 5	„	1007.7	7.3	81	5.2	SSW	1	1	
„ 6	„	1004.4	4.8	89	5.5	E	1	10	
„ 7	„	1006.6	7.8	73	4.7	-	0	0	
„ 8	„	1000.5	5.0	93	4.6	NW	1	10*	
„ 9	„	999.5	7.2	75	4.6	N	4	7	
„ 10	„	1003.5	6.0	72	4.4	E	3	9	
„ 11	„	1003.0	7.8	66	4.3	WNW	6	0	
„ 12	„	1009.6	5.6	25	4.4	NNW	3	2	
„ 13	„	1004.5	3.0	69	4.0	NW	5	3	
„ 14	„	999.7	6.7	47	3.8	WNW	1	10	

Table 4.

Meteorological observations, Myggbukta Radio, East Greenland, July 19—August 17, 1933.

July 19	14	1010.9	4.2	90	No Observations	ESE	4	3	Occasionally some drift-ice in the Clavering fjord
„ 20	„	1010.6	7.6	47		ENE	5	3	
„ 21	„	1014.1	7.6	84		SE	4	1	
„ 22	„	1011.5	8.0	80		SE^{b}E	3	0	
„ 23	„	1020.4	10.0	72		SSE	3	7	
„ 24	„	1015.3	6.4	83		SE^{b}E	4	7	
„ 25	„	1011.1	10.0	75		ESE	3	8	
„ 26	„	1013.2	11.4	59		SSE	4	9	
„ 27	„	1013.6	7.7	80		SE^{b}E	3	0	
„ 28	„	1009.5	10.6	72		NW	3	9	
„ 29	„	1007.4	4.6	80		SSE	3	9	
„ 30	„	1003.1	5.6	80		W	2	10	
„ 31	„	1008.3	4.0	83		S	4	10	
Aug. 1	„	1002.2	2.0	85		SE^{b}E	4	3	
„ 2	„	1005.4	2.0	85		ESE	3	3	
„ 3	„	1008.5	8.0	95		SE^{b}S	3	10	
„ 4	„	1016.5	4.0	75		SE^{b}E	4	1	
„ 5	„	1015.3	1.0	85		SE	3	3	
„ 6	„	1008.4	4.0	85		E^{b}S	2	1	
„ 7	„	1009.3	1.0	85		E^{b}S	4	10	
„ 8	„	1009.0	2.0	85		ESE	4	8	
„ 9	„	1011.0	5.0	75		E^{b}S	3	1	
„ 10	„	1008.8	15.0	45		W^{b}N	2	0	
„ 11	„	1005.1	5.0	85		E	2	0	
„ 12	„	1004.1	5.0	75		ESE	3	3	
„ 13	„	1002.7	11.0	45		NW^{b}W	3	1	
„ 14	„	995.3	14.0	45		NW^{b}W	4	8	
„ 15	„	996.5	4.0	75		SE	2	1	
„ 16	„	999.4	8.0	65		E	3	1	
„ 17	„	992.8	9.0	65		WNW	5	10	

Table 5. *Hourly values in centimetres of height of sea-level referred to an arbitrarily selected zero level. Bear Island, 74° 29′ N, 19° 12′ E Gr.*

1930	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
June 6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	90	97	96
„ 7	89	77	67	54	46	42	46	57	72	89	98	99	89	74	59	40	24	13	11	23	44	69	83	88
„ 8	83	73	60	46	34	24	22	26	40	61	79	90	90	79	64	46	30	16	9	11	27	51	76	92
„ 9	96	91	78	64	49	39	31	30	36	50	71	89	98	94	81	67	48	31	20	16	22	38	64	84
„ 10	96	94	88	71	57	42	33	28	28	36	53	74	91	97	93	78	62	44	32	24	24	33	53	78
„ 11	99	103	101	91	72	56	41	32	28	31	41	66	87	99	101	92	76	61	44	37	33	36	50	74
„ 12	94	110	111	103	89	71	56	42	33	30	34	49	71	92	100	98	86	68	53	40	32	32	38	54
„ 13	80	100	110	106	94	78	61	46	33	29	29	38	58	80	96	100	93	80	66	52	42	38	42	51
„ 14	71	93	104	109	102	89	72	57	42	32	30	30	40	61	80	92	91	82	69	56	42	34	32	36
„ 15	46	63	82	92	92	86	70	53	39	29	19	16	21	37	54	71	79	77	69	57	46	38	33	37
„ 16	43	58	76	87	94	92	82	70	58	46	34	27	26	31	47	66	78	83	80	72	63	54	48	44
„ 17	48	56	69	82	91	93	89	79	67	54	42	32	28	28	36	50	66	74	76	71	63	53	47	40
„ 18	34	42	50	63	76	83	88	83	76	67	57	47	39	33	32	38	52	67	76	77	74	69	62	56
„ 19	52	50	52	59	68	78	84	86	81	71	61	49	37	29	23	27	37	50	64	71	72	70	64	58
„ 20	50	46	43	46	52	61	69	74	76	74	67	54	42	29	17	11	13	23	38	51	62	64	61	56
„ 21	48	41	37	36	37	42	54	64	71	73	69	61	48	37	26	16	12	17	30	46	61	67	68	64
„ 22	57	47	39	33	31	32	38	47	59	67	69	67	57	43	31	19	10	7	13	30	49	63	71	72
„ 23	68	59	47	38	31	27	30	37	50	64	71	72	67	53	40	26	13	7	8	18	39	60	76	80
„ 24	78	69	58	44	33	24	21	22	33	48	64	74	78	71	58	41	26	11	4	6	17	41	66	80
„ 25	86	83	71	57	41	28	18	13	17	33	53	71	81	82	72	54	39	23	11	7	10	28	53	78
„ 26	91	93	87	71	53	38	23	14	12	19	38	62	82	94	92	78	60	40	24	11	8	13	32	61
„ 27	86	98	97	87	70	49	31	17	10	8	19	43	70	90	97	91	72	54	36	20	10	9	19	41
„ 28	68	94	101	97	82	63	42	27	11	3	3	12	41	71	93	97	90	74	54	37	21	11	13	23
„ 29	49	78	100	103	97	80	59	39	22	7	1	3	21	52	79	98	98	89	72	54	40	29	22	27
„ 30	42	70	92	106	108	98	81	62	42	26	10	2	4	24	56	81	97	97	86	69	52	41	32	29
July 1	32	44	68	89	102	102	92	74	56	39	21	8	2	6	27	56	80	90	88	77	63	50	40	32
„ 2	32	36	54	68	84	94	94	83	69	52	37	18	7	0	1	21	48	70	80	78	71	61	51	42
„ 3	38	37	40	50	69	84	93	93	86	71	56	39	23	12	9	11	30	54	73	82	81	74	64	54
„ 4	46	40	38	40	47	61	74	84	86	80	69	57	40	26	11	8	13	32	52	70	76	76	70	62
„ 5	54	44	39	37	38	44	58	70	79	80	76	67	56	41	29	19	13	17	32	53	68	76	77	73
„ 6	66	60	50	42	38	38	42	54	67	77	81	78	70	59	44	32	22	17	20	36	47	-	-	-

Table 6.

Staff readings.

Height of sea-level in centimetres above an arbitrarily selected level. Finnsbu, East Greenland, 63° 24′ N, 41° 17′ W Gr.

Date	Hour M. E. T.	Height m	Date	Hour M. E. T.	Height m	Date	Hour M. E. T.	Height m
1932			*1932*			*1932*		
Aug. 17	21 00	2.60	Aug. 20	23 00	2.27	Aug. 23	18 31	0.68
„ 17	23 00	2.08	„ 21	0 05	2.03	„ 23	19 19	0.75
„ 18	1 07	0.79	„ 21	1 40	1.37	„ 23	21 26	1.27
„ 18	2 05	0.25	„ 21	7 38	0 93	„ 23	22 33	1.57
„ 18	3 01	—0.04	„ 21	10 47	2.15	„ 23	23 41	1.79
„ 18	3 55	—0.03	„ 21	11 58	2.05	„ 23	-	* 1 84
„ 18	7 43	1.83	„ 21	13 38	1.45	„ 24	0 31	1 82
„ 18	11 05	1.93	„ 21	14 31	1.02	„ 24	1 46	1.70
„ 18	11 58	1.50	„ 21	16 00	0.42	„ 24	7 36	0.71
„ 18	13 05	0 85	„ 21	16 29	0.29	„ 24	10 43	1.52
„ 18	13 43	0.48	„ 21	17 01	0.24	„ 24	11 41	1.73
„ 18	15 06	—0.03	„ 21	17 30	0.26	„ 24	12 20	1.84
„ 18	16 52	0.25	„ 21	18 13	0.41	„ 24	13 00	1.87
„ 18	19 12	1.64	„ 21	19 55	1.04	„ 24	13 41	1.86
„ 18	22 55	2.39[1]	„ 21	20 58	1.56	„ 24	15 37	1.57
„ 19	0 03	1.85	„ 21	22 01	1.97	„ 24	16 38	1.32
„ 19	0 57	1.28	„ 21	22 25	2.09	„ 24	18 42	0.93
„ 19	2 06	0.58	„ 21	-	* 2.20	„ 24	19 20	0.95
„ 19	4 14	0.02	„ 21	22 26	2.17	„ 24	22 15	1.33
„ 19	5 03	0.19	„ 22	0 25	2.02	„ 24	23 45	1.59
„ 19	6 02	0.60	„ 22	1 46	1.52	„ 25	0 48	1.71
„ 19	12 05	1.80	„ 22	7 37	0 82	„ 25	1 45	1.71
„ 19	13 38	0.88	„ 22	10 39	2.05	„ 25	7 35	0.90
„ 19	16 00	—0.07[2]	„ 22	11 21	2.13	„ 25	10 37	1.32
„ 19	16 07	—0.13[2]	„ 22	11 44	2.13	„ 25	12 28	1.70
„ 19	19 02	1.07	„ 22	12 22	2.06	„ 25	12 52	1.77
„ 19	21 58	2.39	„ 22	13 10	1.90	„ 25	13 38	1.87
„ 19	22 30	2.47	„ 22	14 21	1.47	„ 25	14 12	1.88
„ 19	23 01	2.30	„ 22	15 57	0.93	„ 25	15 41	1.83
„ 20	0 31	1.83	„ 22	16 40	0.63	„ 25	16 37	1.73
„ 20	2 16	0.69	„ 22	17 18	0.53	„ 25	18 37	1.40
„ 20	3 10	0.21	„ 22	17 53	0.53	„ 25	20 21	1.21
„ 20	8 02	1.40	„ 22	18 39	0.63	„ 25	21 44	1.27
„ 20	10 42	2.21	„ 22	18 56	0.66	„ 25	22 45	1.36
„ 20	-	* 2.22	„ 22	19 55	0.97	„ 26	0 27	1.59
„ 20	11 31	2.07	„ 22	21 37	1.61	„ 26	2 40	1.73
„ 20	12 16	1.79	„ 22	22 43	1.93	„ 26	7 38	1.13
„ 20	12 55	1.50	„ 22	23 15	2.04	„ 26	10 40	1.18
„ 20	13 54	0.96	„ 23	0 11	2.02	„ 26	13 13	1.65
„ 20	14 56	0 46	„ 23	1 39	1.74	„ 26	14 45	1.93
„ 20	15 28	0.23	„ 23	7 37	0.71	„ 26	15 32	2.00
„ 20	15 55	0.12	„ 23	11 20	1.90	„ 26	17 25	1.98
„ 20	16 30	0.06	„ 23	-	* 2.09	„ 26	18 46	1.80
„ 20	17 05	0.09	„ 23	12 33	2.07	„ 26	20 01	1.59
„ 20	17 31	0.19	„ 23	13 37	1.89	„ 26	22 20	1.45
„ 20	18 44	0.66	„ 23	14 20	1.62	„ 27	0 51	1.50
„ 20	20 14	1.47	„ 23	16 11	1.05	„ 27	1 38	1.61
„ 20	21 27	2.04	„ 23	17 09	0 80	„ 27	7 36	1.57
„ 20	22 03	2.26	„ 23	17 41	0.71	„ 27	10 37	1.11
„ 20	22 26	2.30	„ 23	18 09	0.69	„ 27	12 15	1.22

[1] Decreased about 30 cm.

[2] Uncertain. * Maximum.

Table 6 (continued).

Date	Hour M. E. T.	Height m	Date	Hour M. E. T.	Height m	Date	Hour M. E. T.	Height m
1932			*1932*			*1932*		
Aug. 27	13 43	1.61	Aug. 31	20 20	2.93	Sept. 3	22 06	2.83
„ 27	14 12	1.65	„ 31	20 39	2.90	„ 3	22 39	2 72
„ 27	14 35	1.71	„ 31	21 30	2.67	„ 4	1 43	0.94
„ 27	15 18	1.92	„ 31	22 43	2.05	„ 4	7 32	1.43
„ 27	-	* 2.21	Sept. 1	0 11	1.10	„ 4	-	* 2.71
„ 27	16 05	2.07	„ 1	1 41	0.34	„ 4	10 32	2 68
„ 27	18 41	2.11	„ 1	2 58	0.27	„ 4	10 41	2 65
„ 27	20 15	1.27	„ 1	7 37	2.32	„ 4	13 31	1.34
„ 27	21 11	1.14	„ 1	10 38	2.16	„ 4	14 26	0.76
„ 28	1 05	1.16	„ 1	12 05	1.27	„ 4	15 55	0.05
„ 28	1 58	1.28	„ 1	13 03	0.71	„ 4	16 35	0.00
„ 28	11 43	1.06	„ 1	13 40	0.40	„ 4	16 58	0.01
„ 28	12 39	0.99	„ 1	14 50	0.23	„ 4	18 33	0.66
„ 28	13 41	1.19	„ 1	15 14	0.30	„ 5	1 35	1.40
„ 28	16 40	2.22	„ 1	16 42	0.95	„ 5	7 27	0.94
„ 28	17 58	2.36	„ 1	18 41	2 30	„ 5	10 36	2.55
„ 28	18 41	2.39	„ 1	19 06	2.53	„ 5	-	* 2.59
„ 28	20 25	2.03	„ 1	19 48	2 87	„ 5	11 25	2.56
„ 28	22 15	1.38	„ 1	20 02	2.93	„ 5	13 26	1.83
„ 28	23 43	0.94	„ 1	20 24	3 01	„ 5	15 38	0.58
„ 29	0 43	0.85	„ 1	20 37	3.07	„ 5	16 33	0.25
„ 29	1 38	0.90	„ 1	20 53	3.03	„ 5	16 56	0.20
„ 29	7 41	2.02	„ 1	22 05	2.70	„ 5	18 02	0 25
„ 29	11 16	0.93	„ 1	23 05	2.13	„ 5	18 32	0.43
„ 29	12 59	0.74	„ 2	0 14	1.34	„ 5	22 42	2.49
„ 29	13 38	0.83	„ 2	1 06	0.74	„ 6	1 38	1.76
„ 29	15 45	1.58	„ 2	1 31	0.48	„ 6	7 33	0.71
„ 29	16 40	1.97	„ 2	2 20	0.15	„ 6	8 00	0.94
„ 29	18 40	2.57	„ 2	2 51	0.06	„ 6	11 52	2.42
„ 29	20 07	2.48	„ 2	7 27	2.28	„ 6	12 19	2.43
„ 29	23 17	1.16	„ 2	10 30	2.48	„ 6	12 57	2.30
„ 30	0 23	0.75	„ 2	11 58	1.60	„ 6	13 28	2.14
„ 30	1 40	0.70	„ 2	13 28	0.59	„ 6	14 51	1.55
„ 30	7 40	2.28	„ 2	14 23	0.12	„ 6	16 29	0.80
„ 30	10 40	1.30	„ 2	14 39	0.03	„ 6	17 30	0.50
„ 30	12 01	0.74	„ 2	15 01	0.01	„ 6	17 58	0.48
„ 30	13 42	0.46	„ 2	15 36	0.00	„ 6	18 32	0.49
„ 30	15 12	0.91	„ 2	16 37	0.26	„ 6	20 50	1.24
„ 30	16 44	1.70	„ 2	17 54	1.12	„ 6	21 40	1.60
„ 30	18 43	2.61	„ 2	18 31	1.57	„ 6	23 36	2.17
„ 30	19 25	2.73	„ 2	20 10	2.75	„ 7	1 45	2.00
„ 30	19 58	2.76	„ 2	21 20	2.90	„ 7	7 33	0.55
„ 30	22 02	2.02	„ 2	21 44	2.88	„ 7	10 35	1.77
„ 31	2 10	0.50	„ 2	22 10	2.77	„ 7	12 02	2.17
„ 31	7 40	2.48	„ 2	23 33	2.11	„ 7	-	* 2.23
„ 31	8 07	2.51	„ 3	1 43	0.48	„ 7	12 48	2.22
„ 31	12 11	0.78	„ 3	7 30	1.91	„ 7	13 40	1.65
„ 31	13 04	0.41	„ 3	10 32	2.65	„ 7	17 48	0.84
„ 31	13 37	0.31	„ 3	12 23	1.70	„ 7	18 36	0.73
„ 31	14 14	0.29	„ 3	13 28	0.91	„ 8	1 52	1.85
„ 31	14 55	0.42	„ 3	14 17	0.40	„ 8	13 49	1.94
„ 31	16 40	1.28	„ 3	15 19	0.00	„ 8	15 38	1.92
„ 31	18 32	2.47	„ 3	15 52	−0.10	„ 8	16 35	1.75
„ 31	18 41	2.53	„ 3	16 16	−0.05	„ 8	18 31	1.27
„ 31	19 08	2.73	„ 3	16 30	0.00	„ 8	19 10	1.14
„ 31	19 49	2.86	„ 3	18 31	1.10	„ 8	20 14	1.02
„ 31	19 52	2.91	„ 3	21 15	2.70	„ 8	22 11	1.17
„ 31	19 58	2.92	„ 3	21 40	2.80	„ 8	23 42	1.47

Table 6 (continued).

Date	Hour M. E. T.	Height m	Date	Hour M. E. T.	Height m	Date	Hour M. E. T.	Height m
1932			*1932*			*1932*		
Sept. 9	1 40	1.82	Sept. 10	15 14	1.87	Sept. 12	10 35	0.94
„ 9	7 33	1.05	„ 10	15 29	1.92	„ 12	11 13	0.75
„ 9	8 16	0.99	„ 10	16 21	2.11	„ 12	11 43	0.57
„ 9	10 36	1.09	„ 10	16 35	2.16	„ 12	12 12	0.48
„ 9	11 57	1.42	„ 10	17 26	2.20	„ 12	13 06	0.46
„ 9	13 14	1.76	„ 10	-	* 2.23	„ 12	13 33	0.52
„ 9	13 42	1.88	„ 10	17 57	2.20	„ 12	15 09	1.05
„ 9	14 51	2 08	„ 10	18 37	2.10	„ 12	15 39	1.38
„ 9	15 15	2.12	„ 10	21 28	1.27	„ 12	17 43	2.29
„ 9	-	* 2.14	„ 10	22 11	1.03	„ 13	17 38	1.65
„ 9	15 56	2.12	„ 10	22 51	0.88	„ 13	19 50	2.63
„ 9	16 38	2.10	„ 10	23 26	0.80	„ 13	22 06	2.08
„ 9	18 00	1.88	„ 11	1 55	1.08	„ 14	2 05	0.43
„ 9	19 56	1.48	„ 11	7 35	0.72	„ 14	3 30	0.74
„ 9	21 16	1.07	„ 11	10 38	0.85	„ 14	11 25	1.94
„ 9	22 16	0.96	„ 11	13 38	0 98	„ 14	13 30	0.40
„ 9	22 46	0 96	„ 11	15 38	1.73	„ 14	16 33	1.22
„ 10	1 36	1.40	„ 11	22 29	1.09	„ 14	18 33	2 38
„ 10	7 33	1.31	„ 11	23 28	0.75	„ 14	19 30	2.77
„ 10	10 57	0 84	„ 12	1 35	0.50	„ 14	20 43	2.83
„ 10	11 28	0 86	„ 12	7 33	2.02	„ 14	21 17	2.67
„ 10	13 30	1.32	„ 12	8 58	1.62	„ 15	1 10	0.50

Table 7. *Hourly values in centimetres of height of sea-level referred to an arbitrarily selected zero level, Vesle Finschøya, East Greenland. 73° 59′ N, 29° 08′ W Gr.*

1933	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
July 20	133	126	109	89	72	60	55	57	70	92	114	132	144	147	138	127	109	96	87	84	88	101	116	126
„ 21	131	129	114	91	66	48	38	37	50	70	94	118	132	139	138	125	105	89	76	70	73	86	104	121
„ 22	128	131	125	104	79	55	37	30	34	51	74	103	126	141	147	142	124	100	82	70	65	72	88	108
„ 23	127	136	138	125	98	68	43	29	26	38	63	93	118	135	146	144	128	92	78	62	54	56	72	92
„ 24	113	118	134	129	108	79	47	28	19	22	39	66	98	125	141	149	143	122	97	72	57	51	58	76
„ 25	102	127	137	139	127	99	65	38	23	21	35	61	93	123	143	155	153	132	103	77	62	55	61	76
„ 26	102	127	141	147	144	123	87	57	37	28	32	52	80	107	133	149	155	148	124	93	68	53	48	59
„ 27	79	105	127	138	140	130	102	69	44	29	26	38	61	91	117	138	148	147	132	102	77	59	48	50
„ 28	64	90	116	133	143	142	126	100	69	52	41	41	56	76	104	125	139	146	139	122	93	69	54	46
„ 29	54	70	94	116	131	138	136	118	92	69	57	50	57	72	94	118	136	145	148	136	113	88	68	57
„ 30	54	63	79	104	122	134	137	135	118	97	79	68	65	68	83	102	120	133	139	138	126	104	80	64
„ 31	54	51	54	70	93	109	125	133	132	120	103	89	78	74	75	88	104	119	127	131	128	114	94	75
Aug. 1	60	49	46	52	66	85	104	118	126	129	122	112	101	91	86	86	93	105	119	130	135	135	128	114
„ 2	90	75	62	56	56	66	85	103	120	129	135	133	122	108	96	87	84	87	97	108	121	128	128	124
„ 3	109	89	69	55	44	43	56	72	95	116	134	144	144	134	118	103	87	79	78	86	99	117	127	132
„ 4	129	114	91	65	43	29	27	38	59	87	114	133	145	147	133	112	91	72	64	64	74	93	114	128
„ 5	134	130	114	83	52	28	13	11	26	51	83	116	138	154	156	139	114	87	68	56	56	70	94	121
„ 6	137	147	145	123	91	53	26	11	10	29	61	98	131	155	166	162	138	108	81	62	52	56	74	102
„ 7	130	147	155	148	123	82	45	22	7	9	32	63	100	132	154	164	158	134	101	68	46	36	43	68
„ 8	98	128	147	154	145	115	74	38	16	8	14	42	76	115	141	158	163	144	114	79	55	38	37	54
„ 9	81	114	139	156	157	142	108	69	49	21	14	30	56	89	121	143	156	155	144	102	70	50	37	38
„ 10	62	92	121	142	151	148	126	92	60	38	27	30	50	78	107	132	150	153	139	114	83	59	45	41
„ 11	52	72	101	126	142	148	141	120	89	65	49	43	49	66	92	118	135	144	144	129	104	78	59	48
„ 12	47	61	82	106	124	134	136	127	106	84	67	60	59	70	87	107	128	135	137	129	113	88	69	60
„ 13	55	58	72	86	104	118	126	128	120	107	92	81	75	74	83	96	111	124	130	132	125	112	94	78
„ 14	69	66	68	81	96	111	124	130	131	127	118	110	103	98	99	105	117	127	135	137	136	129	117	102
„ 15	90	81	77	79	86	97	108	120	127	132	132	127	122	115	113	110	111	116	124	128	133	134	129	117
„ 16	104	93	83	76	75	79	88	102	113	123	129	131	128	124	115	109	105	103	106	114	121	124	125	125
„ 17	116	104	92	79	69	67	70	82	97	114	128	140	145	144	134	125	119	112	113	116	123	128	134	135
„ 18	130	122	104	88	71	59	57	61	75	94	113	128	137	139	133	118	102	88	82	81	90	101	115	124

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