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ARCTIC TIDES

By ROLLIN A. HARRIS
COAST AND GEODETIC SURVEY

WASHINGTON
GOVERNMENT PRINTING OFFICE
1911

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ARCTIC TIDES

By ROLLIN A. HARRIS

COAST AND GEODETIC SURVEY

CORRECTIVE NOTE TO ARCTIC TIDES.

Recent explorations have shown that Peary Channel, mentioned upon page 95, and shown upon the chart of cotidal lines as separating the extreme northern portion of Greenland from Greenland proper, does not exist; also, that Crocker Land, mentioned upon pages 92, 95, if existent, does not lie in the position indicated upon this chart.

September 14, 1915.

WASHINGTON

GOVERNMENT PRINTING OFFICE

1911

National Oceanic and Atmospheric Administration

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PREFACE.

In preparing this paper one of the principal aims has been to bring together in one form or another practically all available results pertaining to tides in Arctic waters. Although the quality of the results varies widely, the advantages of having all important tidal evidence in one publication are self-evident.

In connection with the work, numerous harmonic analyses have been made, and considerable labor has been expended unifying nonharmonic results taken from various sources. Harmonic analyses thus recently made are for the following stations: Cape Bryant, Cape Sheridan, Polaris Bay, Fort Conger, Point Aldrich, Van Rensselaer Harbor, Port Foulke, Port Kennedy, Northumberland Sound, Winter Harbor, Flaxman Island, Treurenberg, and Port Virgo.

The remarkably accurate tidal observations along the northern coast of Grant Land and Greenland made by the recent expedition of Robert E. Peary, U. S. N., are published in considerable detail. The tidal observations at Flaxman Island and vicinity made by the expedition under Messrs. Mikkelsen and Leffingwell to the northern coast of Alaska, although not so extensive as those of the Peary expedition, are nevertheless of great value and are likewise published in considerable detail.

Undoubtedly many explorers have neglected their opportunities for observing and recording Arctic tides because the amount of rise and fall is generally inconsiderable, and because the possible bearing of this phenomenon upon polar problems was not fully realized. At the present time observations are especially desired in the following regions or localities: The outer coasts of Prince Patrick Island and Banks Land, the coasts of Mackenzie Province, the northwestern coast of Alaska, Wrangell Island, and the Arctic coasts of Siberia.

The Russian Government has recently made tidal observations in Taimur Bay and on one of the New Siberian Islands; but, unfortunately for this discussion, the results are not as yet at hand.

R. A. H.

WASHINGTON, *October, 1910.*

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ARCTIC TIDES.

CHAPTER I.

RECENT OBSERVATIONS TAKEN ON THE NORTHERN COASTS OF GRANT LAND, GREENLAND, AND ALASKA.

Previous to his departure for explorations in the north polar regions in 1908, Civil Engineer R. E. Peary, U. S. Navy, was ordered by the Secretary of the Navy to report for duty in the Coast and Geodetic Survey, and by direction of the President the Superintendent instructed him to make tidal observations at various points on the Grant Land and Greenland shores of the polar sea (see H. Rept. No. 791, 61st Cong., 2d sess.). The observations given below (pp 10–30) were made by the Peary Polar Expedition of 1908–9 in pursuance of these instructions. The object was to secure observations along the northern coasts of Grant Land and Greenland at a sufficient number of places for determining the tides in that region, it being the belief that such observations might throw light upon the possible existence of a "considerable land mass in the unknown area of the Arctic Ocean."

Systematic tidal and meteorological observations were carried on day and night at Cape Sheridan, Point Aldrich (near Cape Columbia), Cape Bryant, Cape Morris Jesup, and Fort Conger. The amount of record secured is given below in remarks relating to the several stations at which observations were carried on.

TIME USED.

Throughout this expedition the kind of time used was Intercolonial, or sixtieth meridian. The watches of the tide observers were compared with chronometer, Bliss, No. 2998. This chronometer was compared with Greenwich mean time before and after the expedition, with the following results:

July 3, 1908, fast, G. M. T.	0 min. 25.8 sec.
Predicted daily rate, losing	0.2 sec.
October 7, 1909, fast, G. M. T.	17 min. 12.9 sec.
Average daily rate, 461 days, gaining	2.2 sec.

The observers at Cape Sheridan made frequent comparisons between watch and chronometer.

The watch used in making the Cape Columbia and Cape Morris Jesup observations read "very close" (or within a minute) to chronometer time upon the return of the observing parties to the ship.

The watch used at Fort Conger lost, according to chronometer, 1 minute 35 seconds between June 7 and June 30.

As a check upon the reliability of the time corrections, may be mentioned the value of $M_2°$ for Fort Conger, derived from MacMillan's observations taken in comparison with the value obtained from the long series of observations obtained by the Greely expedition. (See table of harmonic constants, pp. 40–43.) A comparison between lunitidal intervals at Fort Conger for the same two series affords another check. (See table of lunitidal intervals, pp. 50–67.) A comparison between the values of $M_2°$ for Cape Sheridan as derived from the Peary expeditions of 1905–6 and 1908–9 (pp. 40–43) affords still another check, but as no time notes were given in connection with the earlier observations there is a small uncertainty in the time relations.

Because of the frequency of the readings, it was a simple matter to take the time corrections into account. The tabulations published below therefore show the heights for the exact hours, true time.

BENCH MARKS AND TIDE STAVES—RECORD SECURED.

Cape Sheridan.—The bench mark at Cape Sheridan is the top of a driven iron pipe. The pipe is surrounded by a biscuit tin planted in a mound of gravel. The zero of the tide staff was 11 feet 5 inches below the top of the pipe. The staff was located 275 feet true north from the bench mark. It was held in a vertical position by means of stones placed around it.

An igloo was built over the staff. A well hole through the ice and surrounding the staff enabled the observer to read with great accuracy the elevation of the water's surface. Heat was supplied by means of an oil stove. A similar arrangement obtained at Point Aldrich and Cape Bryant.

Observations were commenced on November 12, 1908, and continued to June 30, 1909. The record consists of hourly staff readings and intermediate readings taken every ten minutes during most of the time. The total loss of hourly readings amounts to 31 hours. Hourly readings of the barometer and thermometer are also given.

Point Aldrich, Cape Columbia.—The bench mark at Point Aldrich, Cape Columbia, is the top of a three-fourths inch pipe driven into the crushed rock at the foot of Independence Bluff. The staff was 77 feet 9 inches south 8° west (magnetic) from the bench mark. Repeated sights taken throughout the month showed the staff to have remained stable with reference to the bench mark, its zero being 8.37 feet below the bench mark. A cairn containing records was built over the bench mark.

The tide staff was firmly fastened to two large boxes filled with rocks and resting upon the bottom. The depth of water was 9 feet and the thickness of the ice 3 feet 4 inches. The bottom was hard and sandy. Old pack ice, evidently resting upon the bottom, lay a short distance seaward. It was noted by the observer that "a sudden rise and fall seemed always to follow a phenomenal cracking of the ice foot."

Observations were commenced on November 16 and continued to December 14, 1908. The record consists of hourly staff readings throughout this period, generally supplemented by more frequent readings. Hourly readings of the barometer and thermometer are also given.

Cape Bryant.—The bench mark at Cape Bryant is the top of a driven pipe. The pipe is surrounded by a biscuit tin planted in a mound of dirt. The zero of the

tide staff was 11 feet below the top of the pipe. The tide staff bore due north from the bench mark, distance 52 feet.

Observations were commenced on January 15 and continued to February 13, 1909. The record consists of hourly staff readings throughout this period and intermediate readings taken every ten minutes during most of the time. Hourly readings of the barometer and thermometer are also given.

Cape Morris Jesup.—Observations at Cape Morris Jesup were commenced on May 13 and continued to May 23, 1909. The record consists of hourly staff readings, generally supplemented by more frequent readings. The total loss of hourly readings amounts to 5 hours. Hourly readings of the barometer and thermometer are also given.

Fort Conger.—The bench mark at Fort Conger is the top of an iron pipe driven into the ground. The pipe is surrounded by a brick pier and is situated between the remains of the old house at Fort Conger and the shore line. The zero of the tide staff was 25 feet 9¼ inches below the top of the pipe. The staff was fastened to an iron rod driven into the mud.

Observations were commenced on June 10 and continued to June 25, 1909. The record consists of hourly staff readings throughout this period and intermediate readings taken every ten minutes during most of the time. Hourly readings of the barometer and thermometer are also given.

The staff zero was in every case kept at a fixed height throughout the observation period. At Cape Columbia, Cape Morris Jesup, and Fort Conger the staves were not once knocked down.

The principal results of harmonic analyses of these observations are given in the next chapter. The more complete results for Cape Sheridan are, however, given below. All constants from recent analyses have been cleared of the disturbing effects due to other components by means of rules and tables given on pages 545–557, 573, 587, and 588, Coast and Geodetic Survey Report for 1897, and pages 504 and 506–519, Report for 1907 (Manual of Tides, Parts II and V). The values of the intervals and ranges obtained from tabulating the high and low waters will be found in the table of intervals, ranges, tidal hours, etc. (Chap. III, pp. 50, 51).

Results of harmonic analysis of hourly ordinates for Cape Sheridan (191½ days, beginning 0h. November 13, 1908).

	H.	*κ.*		*H.*	*κ.*
	Feet.	°		*Feet.*	°
K_1....	0.1550	298.1	P_1.....	0.0528	295.8
K_2....	0.1039	348.0	Q_1.....	0.0130	265.1
L_2....	0.0255	329.6	S_2.....	0.3780	351.6
M_2....	0.8086	303.5	S_4.....	0.0044	133.4
M_4....	0.0124	358.2	T_2....	0.0354	43.3
M_6....	0.0076	180.0	μ_2.....	0.0165	235.0
N_2....	0.1417	274.9	ν_2.....	0.0326	283.6
O_1 ...	0.0882	278.3			

The observed times and heights of the high and low waters are given in tabular form following the table of hourly heights.

Hourly heights of the tide at Cape Sheridan, Point Aldrich, Cape Bryant, Cape Morris Jesup, and Fort Conger.

[Sixtieth meridian time. Brackets indicate interpolated values.]

CAPE SHERIDAN, GRANT LAND.

Hour.	November, 1908.													
	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
0	.....	3.01	2.83	2.79	2.20	1.44	1.22	0.95	1.21	1.54	1.58	2.00	2.18	2.44
1	.....	3.12	3.10	3.04	2.35	[1.54]	1.17	0.76	0.96	1.09	1.14	1.50	1.75	2.04
2	.....	3.00	3.25	3.14	2.45	1.66	1.17	0.72	0.76	0.74	0.66	[0.98]	1.17	[1.52]
3	.....	2.60	3.02	3.14	2.50	1.82	1.28	0.78	0.70	0.51	0.31	0.44	0.64	0.88
4	.....	2.12	2.68	3.06	2.43	1.90	1.37	0.99	0.89	0.58	0.22	0.13	0.20	0.31
5	.....	1.61	2.30	2.73	2.34	1.94	1.47	1.19	1.18	0.82	0.35	0.14	0.02	−0.08
6	.....	1.22	1.96	2.45	2.15	1.88	1.54	1.36	1.46	1.07	0.74	0.47	0.24	−0.09
7	1.05	1.01	1.74	2.18	1.91	1.83	1.57	1.54	1.74	1.52	1.05	0.96	0.64	0.23
8	1.25	1.04	1.60	2.00	1.75	1.67	1.51	1.60	1.96	1.84	1.60	1.45	1.18	0.71
9	1.68	1.24	1.70	1.88	1.55	1.49	1.36	1.61	2.06	2.03	1.97	1.85	1.70	1.23
10	2.12	1.65	1.88	1.94	1.38	1.30	1.16	1.46	1.94	2.07	2.19	2.21	2.12	1.74
11	2.56	1.98	2.26	2.11	1.38	1.20	0.96	1.18	1.70	1.81	2.09	2.24	2.33	2.10
Noon.	2.87	2.36	2.50	2.34	1.41	1.16	0.78	0.89	1.32	1.41	1.77	2.06	2.25	2.18
13	3.00	2.57	2.79	2.52	1.55	1.20	0.68	0.70	0.96	1.00	1.31	1.60	1.91	1.94
14	2.91	2.63	2.90	2.64	1.69	1.33	0.71	0.58	0.75	0.65	0.87	1.00	1.37	1.40
15	2.63	2.54	2.94	2.72	1.82	1.46	0.81	0.70	0.71	0.47	0.54	0.62	0.86	0.94
16	2.20	2.35	2.86	2.68	1.91	1.64	1.03	0.80	0.85	0.53	0.44	0.37	0.49	0.43
17	1.81	2.02	2.65	2.57	1.95	1.86	1.24	1.06	1.16	0.79	0.61	0.42	0.37	0.18
18	1.53	1.83	2.40	2.51	1.92	2.00	1.50	1.48	1.56	1.15	1.01	0.76	0.59	0.20
19	1.43	1.63	2.22	2.36	1.84	2.00	1.66	1.77	1.93	1.59	1.54	1.22	1.03	0.54
20	1.60	1.71	2.12	2.20	1.75	1.92	1.71	2.00	2.21	1.98	2.10	1.81	1.59	1.06
21	1.90	1.91	2.16	2.04	1.64	1.74	1.73	1.97	2.35	2.20	2.39	2.26	2.13	1.67
22	2.30	2.18	2.31	2.00	1.54	1.56	1.45	1.78	2.22	2.20	2.48	2.51	2.49	2.13
23	2.68	2.53	2.57	2.02	1.46	1.36	1.22	1.53	1.93	1.94	2.34	2.48	2.62	2.33

Hour.	November, 1908—Continued.					December, 1908.								
	26.	27.	28.	29.	30.	1.	2.	3.	4.	5.	6.	7.	8.	9.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
0	2.38	3.49	3.68	3.57	3.11	2.49	2.13	1.88	1.96	2.37	3.03	3.41	3.94	3.91
1	2.17	3.45	3.75	3.81	3.38	2.73	2.24	1.89	1.73	2.05	2.58	2.79	3.42	3.50
2	1.68	3.09	3.58	3.79	3.47	2.96	2.43	1.97	1.70	1.83	2.16	2.21	2.83	2.91
3	1.11	2.58	3.29	3.69	3.47	3.09	2.64	2.19	1.85	1.84	1.91	1.76	2.18	2.29
4	[0.99]	1.98	2.70	3.26	3.29	3.09	2.79	2.47	2.11	2.02	1.91	1.58	1.76	1.75
5	0.87	1.46	2.17	2.84	2.94	3.02	2.89	2.63	2.41	2.30	2.16	1.67	1.70	1.45
6	0.68	1.08	1.73	2.39	2.56	2.78	2.89	2.76	2.75	2.69	2.71	2.06	1.92	1.56
7	0.91	1.04	1.51	2.02	2.20	2.52	2.76	2.83	3.03	3.15	[3.11]	2.57	2.34	1.94
8	1.33	1.32	1.55	1.89	1.96	2.19	2.52	2.78	3.14	3.41	3.48	3.08	2.82	2.47
9	1.84	1.82	1.81	1.93	1.78	1.94	2.25	2.52	3.06	3.62	3.79	3.58	3.27	2.97
10	2.34	2.37	2.27	2.25	1.88	1.80	1.94	2.25	2.79	3.54	3.88	3.77	3.68	3.41
11	2.81	2.79	2.85	2.58	2.04	1.79	1.76	1.96	2.42	3.22	3.68	3.79	3.86	3.77
Noon.	3.06	3.15	3.12	2.95	2.38	1.96	1.68	1.71	2.10	2.78	3.26	3.49	3.74	3.87
13	3.01	3.33	3.41	3.28	2.66	2.19	1.78	1.59	1.80	2.30	2.80	3.03	3.35	3.66
14	2.68	3.20	3.43	3.50	2.90	2.48	2.01	1.72	1.66	2.06	2.31	2.53	2.83	3.23
15	2.20	2.81	3.27	3.50	3.14	2.73	2.33	1.97	1.78	2.04	2.02	2.15	2.33	2.70
16	1.72	2.35	2.90	3.32	3.15	2.98	2.63	2.29	2.08	2.22	1.97	1.98	1.94	2.28
17	1.38	1.96	2.55	2.98	2.96	3.07	2.89	2.64	2.52	2.59	2.26	2.14	1.90	2.08
18	1.24	1.68	2.26	2.67	2.76	2.98	3.10	2.95	3.05	3.00	2.76	2.60	2.14	2.15
19	1.43	1.70	2.11	2.38	2.53	2.85	3.02	3.17	3.35	3.57	3.34	3.11	2.56	2.52
20	1.86	1.99	2.17	2.31	2.31	2.61	2.88	3.20	3.59	4.04	3.80	3.73	3.15	3.05
21	2.36	2.44	2.47	2.36	2.17	2.37	2.60	3.03	3.55	4.15	4.09	4.11	3.68	3.60
22	2.84	2.91	2.85	2.55	2.18	2.18	2.26	2.71	3.25	3.97	4.11	4.29	4.02	4.07
23	3.31	3.35	3.22	2.85	2.29	2.10	2.06	2.27	2.87	3.51	3.86	4.22	4.11	4.34

Hourly heights of the tide at Cape Sheridan, Point Aldrich, Cape Bryant, Cape Morris Jesup, and Fort Conger—Continued.

[Sixtieth meridian time. Brackets indicate interpolated values.]

CAPE SHERIDAN, GRANT LAND—Continued.

Hour.	December, 1908—Continued.													
	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
0	4.34	4.08	3.73	3.69	3.28	2.76	2.27	2.04	1.78	1.96	2.25	2.59	3.12	3.29
1	4.06	3.97	3.85	3.83	3.53	3.03	2.44	2.11	1.70	1.75	1.91	2.16	2.61	2.81
2	3.56	3.60	3.69	3.80	3.65	3.21	2.64	2.28	1.80	1.66	1.74	1.80	2.14	2.16
3	2.99	3.08	3.32	3.53	3.53	3.17	2.78	2.44	1.95	1.79	1.74	1.63	1.77	1.70
4	2.40	2.50	2.74	3.13	3.25	3.03	2.88	2.54	2.12	1.98	1.79	1.58	1.61	1.29
5	1.96	2.04	2.23	2.62	2.84	2.72	2.77	2.58	2.28	2.20	1.98	1.83	1.68	1.18
6	1.81	1.67	1.84	2.25	2.45	2.46	2.58	2.53	2.43	2.40	2.29	2.22	1.98	1.36
7	2.08	1.68	1.72	1.93	2.17	2.16	2.38	2.45	2.51	2.60	2.61	2.58	2.42	1.80
8	2.44	1.92	1.85	1.95	2.05	1.97	2.19	2.29	2.45	2.72	2.85	2.93	2.85	2.33
9	2.88	2.37	2.16	2.09	2.05	1.81	2.01	2.09	2.30	2.68	2.97	3.19	3.27	2.82
10	3.31	2.76	2.57	2.41	2.39	1.82	1.92	1.84	2.08	2.52	2.84	3.21	3.46	3.05
11	3.71	3.17	2.99	2.73	2.61	1.98	1.94	1.76	1.90	2.21	2.65	3.08	3.38	3.31
Noon.	3.95	3.46	3.28	3.09	2.88	2.21	2.03	1.76	1.79	1.98	2.33	2.83	3.11	3.18
13	3.90	3.57	3.55	3.39	3.02	2.43	2.20	1.81	1.78	1.83	2.08	2.47	2.69	2.79
14	3.57	3.49	3.55	3.44	3.21	2.63	2.41	1.94	1.83	1.83	1.89	2.16	2.27	2.29
15	3.08	3.16	3.36	3.38	3.32	2.82	2.62	2.13	1.94	1.92	1.87	2.00	1.96	1.86
16	2.58	2.72	3.02	3.16	3.25	2.91	2.83	2.38	2.22	2.17	2.00	2.06	1.81	1.58
17	2.23	2.27	2.59	2.87	3.11	2.81	2.88	2.59	2.52	2.43	2.31	2.29	1.91	1.55
18	2.17	2.02	2.42	2.65	2.83	2.64	2.85	2.69	2.80	2.79	2.70	2.68	2.27	1.80
19	2.31	2.09	2.26	2.40	2.60	2.42	2.72	2.69	2.95	3.06	3.13	3.11	2.77	2.29
20	2.67	2.33	2.39	2.37	2.44	2.25	2.56	2.53	2.93	3.22	3.39	3.48	3.24	2.81
21	3.13	2.51	2.63	2.44	2.37	2.11	2.40	2.39	2.78	3.19	3.48	3.70	3.60	3.28
22	3.60	3.09	3.03	2.69	2.45	2.07	2.20	2.19	2.57	2.99	3.32	3.71	3.73	3.63
23	3.94	3.51	3.39	2.99	2.61	2.18	2.12	1.96	2.27	2.64	3.06	3.54	3.58	3.75

Hour.	December, 1908—Continued.								January, 1909.					
	24.	25.	26.	27.	28.	29.	30.	31.	1.	2.	3.	4.	5.	6.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
0	3.48	3.96	4.12	3.80	3.88	3.21	2.79	2.20	1.91	2.19	2.50	2.73	3.14	3.30
1	3.06	3.93	4.05	3.93	4.09	3.55	3.15	2.48	1.99	2.04	2.18	2.30	2.70	2.79
2	2.51	3.28	3.66	3.74	4.22	3.79	3.46	2.80	2.30	2.11	2.12	1.99	2.22	2.28
3	1.84	2.77	3.18	3.34	4.00	3.75	3.59	3.06	2.50	2.33	2.15	1.83	1.83	1.80
4	1.34	2.15	2.49	2.82	3.50	3.57	3.61	3.20	2.79	2.59	2.30	1.91	1.77	1.45
5	1.00	1.74	1.82	2.19	2.99	3.19	3.42	3.18	2.98	2.89	2.56	2.10	1.82	1.37
6	1.07	1.59	1.45	1.66	2.35	2.69	3.07	3.00	3.02	3.04	2.80	2.40	2.08	1.49
7	1.40	1.71	1.41	1.47	2.00	2.17	2.68	2.80	3.01	3.17	3.10	2.70	2.50	1.85
8	1.89	2.25	1.69	1.56	1.85	1.93	2.35	2.48	2.75	3.20	3.28	3.04	2.81	2.34
9	2.46	2.76	2.14	1.85	1.91	1.90	2.10	2.17	2.53	3.08	3.39	3.27	3.28	2.78
10	2.92	3.39	2.62	2.33	2.24	2.06	2.03	1.97	2.34	2.85	3.24	3.40	3.51	3.10
11	3.24	3.80	3.11	2.94	2.65	2.37	2.10	1.86	2.16	2.57	3.00	3.30	3.49	3.21
Noon.	3.30	3.94	3.53	3.52	3.08	2.75	2.41	2.00	2.06	2.34	2.62	3.00	3.21	3.03
13	3.09	3.91	3.71	3.95	3.49	3.13	2.78	2.20	2.11	2.15	2.33	2.60	2.82	2.73
14	2.64	3.56	3.51	4.07	3.77	3.49	3.07	2.50	2.30	2.21	2.20	2.25	2.41	2.25
15	2.16	3.02	3.09	3.81	3.75	3.69	3.37	2.78	2.60	2.42	2.22	2.09	2.12	1.93
16	1.78	2.50	2.49	3.39	3.48	3.68	3.45	3.02	2.88	2.75	2.38	2.10	1.92	1.60
17	1.53	2.18	2.05	2.99	3.00	3.36	3.49	3.19	3.24	3.10	2.72	2.37	2.01	1.48
18	1.71	2.07	1.80	2.64	2.60	3.04	3.30	3.21	3.37	3.40	3.10	2.79	2.33	1.62
19	2.04	2.20	1.75	2.39	2.33	2.72	3.07	3.06	3.44	3.65	3.48	3.23	2.79	2.00
20	2.65	2.59	2.01	2.37	2.17	2.51	2.76	2.83	3.40	3.78	3.70	3.65	3.34	2.63
21	3.18	3.11	2.50	2.62	2.14	2.37	2.42	2.52	3.19	3.75	3.78	3.89	3.70	3.14
22	3.72	3.66	3.04	3.06	2.31	2.28	2.16	2.15	2.84	3.49	3.59	3.90	3.85	3.40
23	4.02	4.05	3.50	3.44	2.77	2.49	2.12	1.96	2.50	2.89	3.18	3.68	3.72	3.39

Hourly heights of the tide at Cape Sheridan, Point Aldrich, Cape Bryant, Cape Morris Jesup, and Fort Conger—Continued.

[Sixtieth meridian time. Brackets indicate interpolated values.]

CAPE SHERIDAN, GRANT LAND—Continued.

Hour.	January, 1909—Continued.													
	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
0	3.19	3.31	4.03	3.29	3.29	2.89	2.58	2.45	2.01	1.86	2.05	2.09	2.12	2.52
1	2.80	3.08	3.89	3.32	3.52	3.07	2.99	2.71	2.19	2.00	2.00	1.84	1.83	2.02
2	2.32	2.72	3.50	3.17	3.45	3.15	3.12	2.90	2.46	2.24	2.14	1.80	1.59	1.62
3	1.72	2.21	2.98	2.69	3.22	3.00	3.12	3.01	2.70	2.41	2.32	1.85	1.49	1.40
4	1.22	1.75	2.36	2.18	2.69	2.70	2.91	2.96	2.71	2.53	2.58	2.05	1.59	1.42
5	0.90	1.30	1.81	1.62	2.23	2.26	2.50	2.75	2.68	2.60	2.75	2.21	1.79	1.61
6	0.89	1.14	1.45	1.12	1.79	1.76	2.16	2.39	2.46	2.51	2.91	2.45	2.10	[1.98]
7	1.20	1.40	1.40	1.01	1.49	1.39	1.84	2.04	2.21	2.42	2.92	2.60	2.40	[2.34]
8	1.70	1.88	1.69	1.12	1.46	1.20	1.59	1.79	1.96	2.17	2.81	2.62	2.58	[2.68]
9	2.16	2.34	2.10	1.61	1.68	1.40	1.69	1.70	1.80	2.05	2.71	2.54	2.70	2.99
10	2.59	2.79	2.67	2.11	2.04	1.68	1.81	1.68	1.75	1.94	2.58	2.40	2.69	3.13
11	2.90	3.21	3.11	2.61	2.54	2.09	2.21	1.87	1.82	1.95	2.31	2.27	2.59	3.04
Noon.	2.93	3.50	3.33	2.90	2.86	2.43	2.52	2.09	1.99	2.04	2.21	2.09	2.30	2.80
13	2.69	3.60	3.39	3.19	3.13	2.79	2.82	2.34	2.20	2.17	2.17	1.88	2.01	2.41
14	2.29	3.43	3.15	3.17	3.11	2.98	3.09	2.64	2.46	2.30	2.30	1.90	1.77	2.07
15	1.90	2.92	2.73	2.92	2.99	3.04	3.24	2.84	2.68	2.54	2.49	2.00	1.65	1.90
16	1.49	2.42	2.30	2.41	2.70	2.84	3.15	2.89	2.83	2.75	2.69	2.21	1.81	1.94
17	1.29	2.03	1.93	2.06	2.33	2.50	2.94	2.81	2.90	2.93	2.92	2.49	2.14	2.17
18	1.18	1.93	1.62	1.70	1.90	2.08	2.63	2.54	2.79	3.06	3.10	2.78	2.60	2.52
19	1.50	2.12	1.55	1.65	1.64	1.81	2.32	2.32	2.64	3.05	3.19	3.06	2.90	3.00
20	1.97	2.50	1.81	1.77	1.63	1.68	2.07	2.11	2.42	2.94	3.13	3.23	3.25	3.41
21	2.64	3.05	2.26	2.15	1.81	1.77	1.99	1.88	2.21	2.72	2.93	3.19	3.34	3.71
22	3.18	3.53	2.73	2.55	2.11	1.96	2.02	1.80	2.01	2.50	2.62	3.00	3.22	3.80
23	3.41	3.85	3.16	2.93	2.48	2.28	2.20	1.81	1.85	2.22	2.30	2.56	2.94	3.64

Hour.	January, 1909—Continued.											February, 1909.		
	21.	22.	23.	24.	25.	26.	27.	28.	29.	30.	31.	1.	2.	3.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
0	3.20	3.30	3.53	3.33	3.52	3.67	3.34	2.83	1.77	1.32	1.50	2.32	2.66	3.16
1	2.74	2.74	3.26	3.28	3.70	3.88	3.70	3.21	2.08	1.53	1.54	2.07	2.31	2.71
2	2.29	2.23	2.69	2.84	3.54	3.93	3.93	3.52	2.31	1.78	1.67	2.00	2.09	2.29
3	1.85	1.63	2.00	2.17	3.03	3.80	3.86	3.70	2.56	2.03	1.88	2.00	2.03	1.98
4	1.53	1.14	1.33	1.42	2.39	3.31	3.65	3.57	2.64	2.27	2.04	2.22	2.16	1.86
5	1.58	0.90	0.91	0.79	1.75	2.67	3.18	3.25	2.51	2.40	2.24	2.40	2.31	1.93
6	1.75	1.04	0.80	0.40	[1.32]	1.96	2.58	2.81	2.21	2.35	2.39	2.58	2.51	2.14
7	2.16	1.46	1.05	0.39	1.04	1.53	2.03	2.33	1.86	2.14	2.47	2.85	2.80	2.46
8	2.66	1.95	1.47	0.86	1.19	1.42	1.76	1.84	1.49	1.93	2.45	2.95	3.11	2.85
9	3.08	2.48	2.03	1.40	1.66	1.70	1.79	1.74	1.24	1.75	2.29	2.99	3.34	3.18
10	3.34	2.93	2.57	2.04	2.19	2.27	2.07	1.71	1.12	1.53	2.16	2.92	3.29	3.37
11	3.39	3.18	3.01	2.64	2.80	2.76	2.52	1.98	1.19	1.46	2.07	2.75	3.27	3.33
Noon.	3.16	3.20	3.28	3.02	3.35	3.27	3.09	2.33	1.41	1.52	1.96	2.51	3.01	3.14
13	2.81	2.86	3.14	3.16	3.68	3.75	3.49	2.71	1.78	1.69	1.94	2.36	2.68	2.80
14	2.36	2.38	2.71	2.99	3.72	3.99	3.85	3.03	2.05	1.92	1.98	2.23	2.46	2.38
15	1.90	1.84	2.08	2.49	3.42	3.93	3.96	3.29	2.41	2.20	2.24	2.25	2.30	2.08
16	1.63	1.40	1.50	1.94	2.86	3.54	3.85	3.33	2.62	2.51	2.53	2.48	2.34	1.90
17	1.61	1.29	1.12	1.43	2.26	2.88	3.44	3.20	2.68	2.64	2.80	2.81	2.55	2.04
18	1.90	1.42	0.99	1.10	1.80	2.28	2.89	2.80	2.57	2.76	3.11	3.12	2.90	2.36
19	2.38	1.87	1.16	1.10	1.59	1.96	2.44	2.32	2.27	2.66	3.28	3.37	3.26	2.79
20	2.94	2.40	1.62	1.45	1.65	1.88	2.12	1.91	1.89	2.49	3.22	3.54	3.58	3.23
21	3.39	2.95	2.14	2.07	2.02	2.01	1.94	1.62	1.56	2.17	3.15	3.60	3.80	3.54
22	3.64	3.39	2.68	2.66	2.57	2.38	2.16	1.49	1.36	1.91	2.86	3.37	3.80	3.72
23	3.61	3.60	3.09	3.20	3.25	2.86	2.44	1.56	1.28	1.67	2.64	3.01	3.59	3.53

Hourly heights of the tide at Cape Sheridan, Point Aldrich, Cape Bryant, Cape Morris Jesup, and Fort Conger—Continued.

[Sixtieth meridian time. Brackets indicate interpolated values.]

CAPE SHERIDAN, GRANT LAND—Continued.

Hour.	February, 1909—Continued.													
	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
0	3.25	3.23	3.71	3.68	4.08	3.47	3.00	3.02	2.42	2.56	1.91	1.90	2.28	2.79
1	2.81	2.84	3.38	3.58	4.03	3.55	3.20	3.35	2.76	2.83	2.12	2.00	2.26	2.59
2	2.27	2.24	2.91	3.17	3.77	3.38	3.19	3.43	2.96	3.07	2.34	2.12	2.33	2.48
3	1.81	1.75	2.29	2.62	3.29	2.91	2.94	3.32	2.92	3.17	2.50	2.30	2.46	2.49
4	1.52	1.29	1.74	2.05	2.69	2.34	2.47	2.97	2.76	3.09	2.59	2.41	2.69	2.62
5	1.46	1.04	1.47	1.55	2.07	1.78	1.95	2.50	2.37	[2.88]	2.52	2.54	2.90	2.78
6	1.68	1.12	1.40	1.38	1.70	1.29	1.40	1.98	1.97	2.62	2.32	2.59	3.07	2.99
7	2.00	1.45	1.60	1.55	1.61	1.10	1.14	1.62	1.63	2.30	2.07	2.53	3.19	3.21
8	2.44	1.95	2.09	1.96	1.94	1.23	1.12	1.51	1.47	2.10	1.86	2.40	3.19	3.43
9	2.84	2.45	2.52	2.50	2.36	1.55	1.45	1.65	1.52	2.00	1.69	2.29	3.12	3.52
10	3.19	2.88	3.02	2.98	2.96	2.05	1.97	1.92	1.81	2.08	1.70	2.27	3.01	3.43
11	3.26	3.13	3.42	3.52	3.31	2.53	2.52	2.32	2.17	2.26	1.80	2.27	2.95	3.22
Noon.	3.16	3.18	3.52	3.82	3.68	2.97	2.96	2.71	2.68	2.51	2.00	2.30	2.81	3.04
13	2.79	2.96	3.39	3.81	3.87	3.24	3.28	3.06	2.98	2.75	2.24	2.36	2.72	2.84
14	2.36	2.59	2.95	3.58	3.68	3.23	3.36	3.28	3.19	3.01	2.53	2.44	2.78	2.66
15	1.95	2.06	2.41	3.07	3.22	2.88	3.17	3.20	3.29	3.14	2.71	2.79	3.00	2.65
16	1.63	1.65	1.92	2.61	2.62	2.36	2.81	2.95	3.17	3.05	2.83	3.01	3.26	2.72
17	1.59	1.50	1.51	2.15	2.00	1.88	2.37	2.46	2.89	2.97	2.80	3.17	3.54	3.04
18	1.80	1.60	1.47	1.92	1.71	1.48	2.04	2.13	2.56	2.72	2.71	3.21	3.71	3.34
19	2.16	1.96	1.66	1.99	1.62	1.30	1.74	1.69	2.21	2.38	2.52	3.18	3.77	3.62
20	2.68	2.45	2.15	2.29	1.86	1.38	1.68	1.50	1.98	2.08	2.29	3.08	3.81	3.85
21	3.12	3.00	2.66	2.78	2.26	1.64	1.79	1.48	1.95	1.83	2.15	2.91	3.65	3.89
22	3.39	3.46	3.21	3.38	2.70	2.07	2.16	1.66	2.02	1.71	1.94	2.67	3.47	3.71
23	3.42	3.72	3.53	3.87	3.14	2.53	2.64	2.04	2.30	1.77	1.83	2.41	3.14	3.40

Hour.	February, 1909—Continued.											March, 1909.		
	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.	28.	1.	2.	3.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
0	2.99	3.25	4.04	4.29	4.44	4.15	3.94	2.75	2.12	2.02	1.71	1.57	1.60	1.93
1	2.55	2.70	3.54	3.92	4.20	4.19	4.20	3.14	2.58	2.38	1.92	1.62	1.39	1.66
2	2.17	2.23	2.91	3.33	3.69	3.89	4.11	3.27	2.91	2.68	2.14	1.74	1.36	1.45
3	1.95	1.82	2.32	2.49	2.91	3.30	3.70	3.12	2.99	2.87	2.29	1.90	1.44	1.36
4	1.91	1.62	1.90	1.83	2.21	2.58	3.02	2.69	2.74	2.88	2.39	2.02	1.55	1.40
5	2.14	1.70	1.80	1.48	1.61	1.84	2.31	2.10	2.34	2.67	2.36	2.17	1.73	1.55
6	2.43	2.04	2.03	1.45	1.39	1.36	1.61	1.44	1.87	2.41	2.28	2.18	1.94	1.85
7	2.76	2.52	2.44	1.82	1.52	1.31	1.28	1.00	1.47	2.12	2.10	2.27	2.13	2.17
8	3.09	2.96	2.99	2.34	2.06	1.69	1.25	0.87	1.18	1.87	1.89	2.19	2.29	2.43
9	3.32	3.39	3.49	3.01	2.63	2.27	1.63	0.99	1.10	1.71	1.73	2.08	2.30	2.61
10	3.35	3.67	3.99	3.59	3.31	2.97	2.20	1.40	1.29	1.71	1.64	2.03	2.24	2.65
11	3.23	3.74	4.19	4.08	3.95	3.63	2.87	1.95	1.75	1.88	1.62	1.90	2.06	2.58
Noon.	2.98	3.47	4.07	4.18	4.32	4.16	3.35	2.53	2.28	2.20	1.80	1.81	1.87	2.41
13	2.58	3.10	3.65	3.98	4.28	4.39	3.76	2.99	2.75	2.54	1.94	1.77	1.70	2.12
14	2.30	2.59	2.93	3.38	3.80	4.19	3.86	3.29	3.07	2.85	2.20	1.89	1.65	1.90
15	2.05	2.25	2.57	2.66	3.14	3.65	3.54	3.24	3.17	3.03	2.43	2.07	1.69	1.79
16	2.10	2.07	2.19	2.03	2.47	2.94	2.87	2.92	3.07	3.07	2.60	2.26	1.83	1.87
17	2.35	2.19	2.03	1.71	1.90	2.23	2.21	2.36	2.73	2.96	2.67	2.40	2.04	2.14
18	2.69	2.54	2.19	1.72	1.60	1.74	1.54	1.75	2.28	2.66	2.57	2.46	2.27	2.44
19	3.11	3.02	2.61	2.08	1.65	1.52	1.14	1.27	1.92	2.31	2.38	2.48	2.48	2.74
20	3.47	3.55	3.15	2.64	2.02	1.68	0.93	0.99	1.45	1.98	2.17	2.42	2.62	3.04
21	3.77	3.99	3.73	3.25	2.61	2.19	1.15	0.98	1.35	1.75	2.00	2.31	2.57	3.19
22	3.83	4.29	4.14	3.83	3.23	2.79	1.67	1.22	1.41	1.57	1.79	2.13	2.45	3.18
23	3.68	4.33	4.40	4.28	3.82	3.38	2.22	1.58	1.66	1.58	1.60	1.84	2.22	2.97

Hourly heights of the tide at Cape Sheridan, Point Aldrich, Cape Bryant, Cape Morris Jesup, and Fort Conger—Continued.

[Sixtieth meridian time. Brackets indicate interpolated values.]

CAPE SHERIDAN, GRANT LAND—Continued.

Hour.	March, 1909—Continued.													
	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
0	2.56	2.76	2.74	2.78	3.15	3.14	2.95	2.86	2.54	2.16	1.68	1.19	1.28	1.38
1	2.24	2.32	2.30	2.44	2.89	3.02	3.05	3.03	2.78	2.49	2.01	1.44	1.42	1.38
2	1.88	1.78	1.76	1.95	2.44	2.56	2.74	2.84	2.77	2.63	2.20	1.66	1.55	1.47
3	1.62	1.34	1.25	1.45	1.85	2.07	2.30	2.47	2.52	2.49	2.23	1.78	1.74	1.58
4	1.58	1.15	0.90	0.91	1.33	1.45	[1.71]	1.87	2.07	2.18	2.08	1.78	1.84	[1.76]
5	1.65	1.15	0.77	0.69	0.92	0.91	1.17	1.27	1.56	1.73	1.81	1.69	1.87	1.93
6	1.92	1.42	0.90	0.76	0.87	0.67	0.90	0.87	1.13	1.31	1.35	1.43	1.81	2.08
7	2.26	1.75	1.19	1.13	1.08	0.78	0.79	0.76	0.89	1.01	0.95	1.19	1.70	2.12
8	2.64	2.14	1.65	1.66	1.48	1.18	1.08	0.90	0.92	0.88	0.80	1.08	1.58	2.05
9	2.91	2.46	2.09	2.18	2.00	1.70	1.51	1.23	1.16	1.01	0.83	1.04	1.45	1.96
10	3.05	2.73	2.51	2.67	2.59	2.26	2.07	1.70	1.61	1.32	1.01	1.09	1.37	1.86
11	3.04	2.82	2.70	2.98	3.00	2.75	2.66	2.28	2.14	1.77	1.36	1.27	1.31	1.77
Noon.	2.82	2.66	2.61	3.02	3.19	3.07	3.01	2.75	2.62	2.19	1.70	1.60	1.45	1.72
13	2.39	2.30	2.28	2.82	3.00	3.03	3.17	2.98	2.90	2.52	2.02	1.92	1.65	1.70
14	2.03	1.84	1.85	2.34	2.58	2.68	2.93	2.90	2.94	2.61	2.22	2.10	1.93	1.79
15	1.75	1.41	1.32	1.81	2.00	2.09	2.46	2.52	2.72	2.55	2.24	2.27	2.09	1.96
16	1.64	1.20	0.88	1.29	1.44	1.46	1.89	2.00	2.31	2.25	2.09	2.22	2.20	2.13
17	1.80	1.23	0.70	0.97	1.03	0.96	1.35	1.46	1.79	1.92	1.81	2.15	2.21	2.31
18	2.08	1.44	0.89	1.04	0.85	0.69	0.95	1.01	1.32	1.49	1.48	2.00	2.22	2.43
19	2.42	1.82	1.26	1.30	1.01	0.75	0.81	0.80	1.00	1.10	1.17	1.78	2.16	2.53
20	2.81	2.25	1.76	1.81	1.45	1.11	1.00	0.78	0.85	0.82	0.82	1.51	1.99	2.51
21	3.06	2.65	2.29	2.36	1.97	1.64	1.38	1.11	1.00	0.78	0.70	1.26	1.77	2.37
22	3.20	2.94	2.70	2.82	2.53	2.20	1.90	1.54	1.34	1.00	0.74	1.18	1.57	2.14
23	3.10	2.96	2.89	3.12	2.98	2.74	2.45	2.08	1.77	1.34	0.93	1.17	1.41	1.85

Hour.	March, 1909—Continued.													
	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.	28.	29.	30.	31.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
0	1.57	1.83	2.26	2.91	3.10	3.31	3.37	3.27	2.75	2.48	2.26	2.28	1.37	1.10
1	1.39	1.45	1.76	2.34	2.63	3.00	3.33	3.50	3.10	2.94	2.67	2.44	1.47	1.05
2	1.28	1.15	1.27	1.70	2.01	2.40	2.90	3.30	3.14	3.14	[2.92]	2.60	1.55	1.12
3	1.33	1.00	0.93	[1.17]	1.26	1.68	2.26	2.80	2.88	3.16	3.00	2.71	1.65	1.19
4	1.49	1.06	0.85	0.78	0.63	0.98	1.53	2.15	2.39	2.83	2.90	2.70	1.75	[1.29]
5	1.72	1.27	1.00	0.78	0.39	0.47	0.88	1.44	1.76	2.42	2.69	2.69	1.84	1.40
6	2.03	1.61	1.36	1.08	0.50	0.39	0.54	[0.91]	1.32	1.93	2.42	2.54	1.90	1.60
7	2.28	1.99	1.85	1.57	0.98	0.68	0.63	0.74	0.98	1.55	2.17	2.34	1.87	1.79
8	2.44	2.36	2.35	2.12	1.60	1.30	1.09	0.98	0.97	1.38	2.00	2.13	1.78	1.87
9	2.46	2.53	2.80	2.68	2.22	1.99	1.77	1.54	1.27	1.43	1.96	1.98	1.65	1.84
10	2.36	2.53	2.98	3.12	2.88	2.73	2.44	2.20	1.77	1.76	2.10	1.92	1.53	1.72
11	2.21	2.33	2.89	3.25	3.24	3.29	3.15	2.88	2.40	2.19	2.42	1.95	1.45	1.58
Noon.	2.02	2.05	2.60	3.00	3.20	3.49	3.58	3.39	2.95	2.62	2.82	2.05	1.43	1.44
13	1.87	1.66	2.11	2.59	2.91	3.33	3.71	3.64	3.30	3.10	3.20	2.19	1.47	1.32
14	1.74	1.35	1.60	1.80	2.16	2.83	3.45	3.52	3.42	3.30	3.47	2.38	1.56	1.31
15	1.78	1.21	1.18	1.20	1.45	1.98	2.78	3.08	3.18	3.28	3.56	2.49	1.69	1.38
16	1.89	1.24	1.06	0.84	0.76	1.25	1.97	2.35	2.74	3.02	3.45	2.56	1.84	1.53
17	2.12	1.48	1.25	0.75	0.40	0.55	[1.25]	1.61	2.18	2.59	3.24	2.52	1.93	1.73
18	2.34	1.92	1.56	0.97	0.42	0.38	0.79	0.99	1.60	2.11	2.95	2.38	2.01	1.93
19	2.58	2.27	2.07	1.46	0.80	0.55	0.69	0.69	1.09	1.65	2.58	2.18	1.95	2.09
20	2.72	2.64	2.58	2.07	1.46	1.06	1.02	0.77	0.93	1.39	2.29	1.92	1.85	2.18
21	2.74	2.90	3.05	2.65	2.16	1.70	1.58	1.13	1.08	1.35	2.05	1.62	1.67	2.12
22	2.55	2.90	3.30	3.10	2.80	2.43	2.21	1.70	1.54	1.53	1.99	1.40	1.48	1.96
23	2.24	2.67	3.24	3.26	3.23	3.04	2.85	2.27	2.05	1.86	2.10	1.28	1.30	1.73

Hourly heights of the tide at Cape Sheridan, Point Aldrich, Cape Bryant, Cape Morris Jesup, and Fort Conger—Continued.

[Sixtieth meridian time. Brackets indicate interpolated values.]

CAPE SHERIDAN, GRANT LAND—Continued.

Hour.	April, 1909.												
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
0	1.46	2.01	2.51	2.96	3.51	3.60	3.60	3.58	3.50	3.46	2.93	2.52	2.12
1	1.25	1.62	2.11	2.48	3.14	3.23	3.32	3.53	3.58	3.62	3.18	2.77	2.37
2	1.10	1.34	1.68	1.88	2.59	2.71	2.80	3.12	3.37	3.56	3.21	2.90	2.54
3	1.10	1.20	1.35	1.54	2.04	2.09	2.19	2.58	2.88	3.22	3.00	2.92	2.67
4	1.22	1.23	1.29	1.29	1.62	1.63	1.67	1.93	2.36	2.74	2.61	2.63	2.62
5	1.43	1.46	1.47	1.29	1.53	1.40	1.41	1.58	1.93	2.25	2.22	2.31	2.49
6	1.73	1.76	1.76	1.58	1.77	1.51	1.25	1.38	1.72	1.91	1.89	1.98	2.29
7	2.00	2.14	2.23	2.04	2.14	1.91	1.54	1.53	1.60	1.79	1.63	1.75	2.07
8	2.22	2.46	2.65	2.53	2.72	2.52	2.02	1.95	1.91	1.93	1.60	1.68	1.90
9	2.30	2.70	3.00	2.97	3.17	2.96	2.67	2.45	2.36	2.31	1.84	1.74	1.88
10	2.26	2.75	3.20	3.27	3.60	3.44	3.08	3.05	2.88	2.78	2.22	1.97	1.98
11	2.11	2.58	3.14	3.43	3.78	3.76	3.49	3.51	3.39	3.28	2.66	2.30	2.14
Noon.	1.88	2.29	2.91	3.21	3.68	3.80	3.61	3.73	3.77	3.69	3.04	2.71	2.42
13	1.66	1.94	2.52	2.75	3.26	3.47	3.47	3.70	3.89	3.83	3.30	3.03	2.71
14	1.43	1.63	2.05	2.25	2.69	2.89	2.99	3.33	3.69	3.74	3.37	3.14	2.89
15	1.37	1.47	1.68	1.81	2.09	2.23	2.39	2.79	3.19	3.35	3.24	3.10	3.00
16	1.48	1.47	1.50	1.48	1.59	1.64	1.74	2.18	2.59	2.86	2.82	2.84	2.93
17	1.68	1.60	1.64	1.47	1.45	1.30	1.26	1.61	2.01	2.30	2.36	2.52	2.73
18	2.00	1.90	1.93	1.78	1.58	1.30	1.10	1.31	1.59	1.80	1.91	2.17	2.49
19	2.27	2.29	2.37	2.19	1.98	1.59	1.26	1.33	1.43	1.53	1.50	1.86	2.26
20	2.49	2.66	2.77	2.77	2.44	2.07	1.71	1.63	1.59	1.51	1.34	1.60	2.00
21	2.59	2.98	3.17	3.24	2.92	2.60	2.30	2.11	2.00	1.73	1.40	1.50	1.79
22	2.52	2.99	3.30	3.60	3.47	3.14	2.82	2.66	2.53	2.10	1.70	1.59	1.63
23	2.32	2.82	3.31	3.67	3.68	3.50	3.33	3.12	3.05	2.55	2.09	1.83	1.68

Hour.	April, 1909—Continued.												
	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
0	1.82	2.11	2.37	2.29	2.25	2.64	3.04	3.32	3.44	3.10	2.76	2.36	2.22
1	2.04	2.16	2.22	1.92	1.75	2.05	2.52	2.89	3.28	3.19	2.97	2.65	2.51
2	2.26	[2.27]	2.16	1.61	1.33	1.44	1.85	2.27	2.79	2.92	2.93	2.77	2.72
3	2.45	2.44	2.28	1.59	1.12	0.98	1.21	1.56	2.13	2.41	2.57	2.68	2.81
4	2.57	2.67	2.49	1.78	1.10	0.81	0.80	0.96	1.47	1.79	2.05	2.38	2.67
5	2.58	2.91	2.76	2.11	1.41	0.97	0.75	0.68	0.97	1.21	1.54	1.98	2.40
6	2.45	3.08	3.09	2.50	1.85	1.40	1.09	0.79	0.83	0.87	1.10	1.62	2.11
7	2.36	3.10	3.27	2.84	2.44	1.99	1.62	1.27	1.09	0.85	0.93	1.40	1.87
8	2.25	3.05	3.33	3.14	2.88	2.60	2.27	1.91	1.63	1.24	1.09	1.31	1.75
9	2.12	2.96	3.26	3.19	3.20	3.11	2.88	2.61	2.25	1.82	1.45	1.50	1.75
10	2.10	2.85	3.02	3.11	3.22	3.36	3.37	3.18	2.88	2.44	1.96	1.85	1.88
11	2.08	2.76	2.73	2.89	2.99	3.30	3.59	3.58	3.42	3.02	2.45	2.29	2.21
Noon.	2.26	2.70	2.46	2.65	2.53	2.94	3.42	3.65	3.66	3.42	2.86	2.73	2.56
13	2.43	2.65	2.28	2.01	2.01	2.37	2.87	3.26	3.56	3.53	3.17	3.04	2.82
14	2.66	2.70	2.18	1.66	1.49	1.71	2.14	2.56	3.05	3.22	3.10	3.19	3.02
15	2.80	2.91	2.23	1.50	1.17	1.07	1.37	1.81	2.34	2.73	2.77	3.10	3.03
16	2.90	3.07	2.41	1.64	1.09	0.79	0.78	1.14	1.57	2.03	2.20	2.77	2.93
17	2.94	3.27	2.74	1.93	1.27	0.82	0.56	0.68	0.91	1.34	1.68	2.30	2.66
18	2.87	3.43	2.95	2.27	1.67	1.12	0.71	0.59	0.60	0.87	1.23	1.83	2.36
19	2.73	3.53	3.19	2.66	2.18	1.62	1.14	0.94	0.64	0.70	0.89	1.47	2.05
20	2.58	3.45	3.31	3.00	2.68	2.25	1.73	1.46	1.09	0.90	0.78	1.28	1.80
21	2.43	3.26	3.22	3.18	3.10	2.84	2.41	2.09	1.64	1.31	1.03	1.30	1.65
22	2.24	3.03	2.98	3.05	3.27	3.22	3.01	2.73	2.24	1.88	1.43	1.57	1.68
23	2.11	2.67	2.66	2.74	3.08	3.33	3.34	3.24	2.75	2.37	1.88	1.92	1.83

Hourly heights of the tide at Cape Sheridan, Point Aldrich, Cape Bryant, Cape Morris Jesup, and Fort Conger—Continued.

[Sixtieth meridian time. Brackets indicate interpolated values.]

CAPE SHERIDAN, GRANT LAND—Continued.

Hour.	April, 1909—Continued.				May, 1909.								
	27.	28.	29.	30.	1.	2.	3.	4.	5.	6.	7.	8.	9.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
0	2.05	1.80	1.65	1.55	1.53	1.98	2.29	2.44	3.25	3.51	2.96	2.80	2.72
1	2.28	1.91	1.71	1.43	1.27	1.57	1.88	2.01	2.83	3.18	2.75	2.77	2.85
2	2.47	2.08	1.79	1.38	1.08	1.24	1.37	1.50	2.27	2.67	2.27	2.47	2.71
3	2.61	2.24	1.88	1.41	1.09	1.14	1.03	1.09	1.72	2.15	1.67	1.94	2.32
4	2.67	2.35	2.02	1.61	1.24	1.23	0.97	0.89	1.40	1.81	1.17	1.42	1.89
5	2.57	2.46	2.21	1.85	1.53	1.49	1.12	1.01	1.30	1.67	0.84	1.06	1.46
6	2.44	2.42	2.39	2.09	1.86	1.86	1.47	1.39	1.59	1.69	0.80	0.92	1.22
7	2.29	2.38	2.50	2.31	2.18	2.28	1.94	1.88	2.00	2.07	1.14	1.10	1.19
8	2.16	2.30	2.50	2.43	2.43	2.67	2.35	2.39	2.57	2.45	1.59	1.49	1.44
9	2.02	2.17	2.37	2.36	2.50	2.91	2.67	2.83	3.04	2.98	2.10	1.94	1.86
10	1.98	2.04	2.17	2.15	2.40	2.90	2.77	3.12	3.41	3.37	2.60	2.49	2.35
11	2.09	1.94	1.98	1.90	2.13	2.66	2.64	3.16	3.53	3.57	2.94	2.93	2.84
Noon.	2.34	1.99	1.88	1.66	1.78	2.32	2.30	2.91	3.38	3.46	3.10	3.17	3.14
13	2.54	2.10	1.83	1.44	1.47	1.93	1.83	2.47	2.94	3.10	2.92	3.14	3.23
14	2.72	2.26	1.84	1.35	1.22	1.58	1.32	1.90	2.39	2.55	2.48	2.81	3.08
15	2.81	2.39	1.94	1.35	1.15	1.26	0.88	1.40	1.80	1.90	1.87	2.32	2.70
16	2.81	2.52	2.07	1.54	1.25	1.18	0.73	1.09	1.33	1.26	1.25	1.74	2.17
17	2.74	2.58	2.19	1.74	1.52	1.35	0.80	1.08	1.18	0.87	0.72	1.17	1.61
18	2.60	2.53	2.32	1.98	1.84	1.71	1.17	1.38	1.32	0.75	0.55	0.79	1.12
19	2.36	2.44	2.41	2.20	2.15	2.13	1.63	1.84	1.69	1.05	0.64	0.70	0.93
20	2.13	2.28	2.43	2.29	2.40	2.51	2.11	2.34	2.22	1.48	1.05	0.97	1.00
21	1.89	2.09	2.30	2.26	2.54	2.72	2.54	2.86	2.78	2.03	1.57	1.41	1.28
22	1.78	1.88	2.07	2.11	2.51	2.79	2.77	3.29	3.24	2.48	2.10	1.95	1.68
23	1.72	1.70	1.78	1.88	2.32	2.64	2.73	3.47	3.53	2.78	2.58	2.38	2.09

Hour.	May, 1909—Continued.												
	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
0	2.46	2.23	1.69	1.69	1.29	1.20	1.44	2.04	2.12	2.57	3.00	3.06	3.09
1	2.71	2.50	1.93	1.89	1.38	1.10	1.16	1.59	1.58	2.01	2.57	2.86	3.09
2	2.74	2.65	2.17	2.15	1.58	1.18	1.09	1.27	1.05	1.45	1.97	2.39	2.76
3	2.54	2.55	2.33	2.37	1.82	1.43	1.22	1.21	0.72	0.94	1.35	1.82	2.23
4	2.11	2.32	2.30	2.50	2.06	1.74	1.53	1.38	0.74	0.72	0.90	1.29	1.71
5	1.72	2.00	2.12	2.50	2.30	2.08	1.97	1.80	1.08	0.85	0.76	0.91	1.26
6	1.45	1.69	1.85	2.39	2.40	2.37	2.44	2.30	1.59	1.30	1.04	0.89	1.07
7	1.29	1.47	1.63	2.21	2.36	2.52	2.80	2.77	2.19	1.90	1.53	1.28	1.18
8	1.41	1.40	1.50	2.04	2.20	2.57	3.00	3.17	2.69	2.47	2.14	1.83	1.53
9	1.66	1.53	1.48	1.83	1.98	2.36	2.97	3.26	3.10	2.98	2.70	2.44	2.04
10	2.06	1.81	1.60	1.72	1.76	2.07	2.72	3.14	3.19	3.29	3.14	2.96	2.58
11	2.48	2.14	1.85	1.74	1.60	1.72	2.34	2.76	2.95	3.31	3.36	3.37	3.04
Noon.	2.86	2.48	2.16	1.86	1.51	1.41	1.92	2.31	2.49	3.04	3.27	3.47	3.32
13	3.06	2.69	2.44	2.04	1.59	1.30	1.50	1.77	1.84	2.44	2.87	3.28	3.31
14	3.08	2.79	2.63	2.25	1.72	1.35	1.34	1.28	1.28	1.75	2.18	2.79	2.94
15	2.82	2.71	2.72	2.37	1.89	1.50	1.33	1.01	0.82	1.07	1.45	2.08	2.50
16	2.41	2.49	2.67	2.45	2.06	1.71	1.56	1.05	0.61	0.64	0.86	1.43	1.80
17	1.91	2.11	2.50	2.43	2.23	1.98	1.85	1.31	0.75	0.57	0.54	0.91	1.24
18	1.46	1.70	2.26	2.36	2.34	2.24	2.10	1.73	1.13	0.86	0.59	0.68	0.78
19	1.11	1.32	1.97	2.18	2.34	2.45	2.61	2.17	1.65	1.32	0.89	0.90	0.70
20	1.02	1.12	1.70	1.92	2.20	2.53	2.91	2.54	2.16	1.85	1.40	1.26	0.91
21	1.18	1.06	1.53	1.65	1.98	2.41	2.96	2.82	2.64	2.45	2.00	1.79	1.33
22	1.50	1.18	1.45	1.42	1.70	2.15	2.80	2.84	2.94	2.91	2.55	2.33	1.85
23	1.86	1.44	1.54	1.30	1.42	1.77	2.47	2.58	2.92	3.11	2.98	2.81	2.31

Hourly heights of the tide at Cape Sheridan, Point Aldrich, Cape Bryant, Cape Morris Jesup, and Fort Conger—Continued.

[Sixtieth meridian time. Brackets indicate interpolated values.]

CAPE SHERIDAN, GRANT LAND—Continued.

Hour.	May, 1909—Continued.									June, 1909.			
	23.	24.	25.	26.	27.	28.	29.	30.	31.	1.	2.	3.	4.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
0	2.70	2.85	2.93	2.45	2.24	2.30	2.32	2.27	2.43	2.71	2.93	3.14	3.32
1	2.85	3.10	3.21	2.70	2.42	2.43	2.30	2.11	2.17	2.39	2.53	2.71	2.94
2	2.77	3.20	3.39	2.90	2.62	2.61	2.43	2.10	2.01	2.08	2.17	2.30	2.42
3	2.46	3.06	3.41	3.02	2.78	2.82	2.59	2.23	2.06	1.98	1.91	1.96	2.02
4	2.01	2.78	3.25	3.01	2.92	3.01	2.77	2.46	2.29	2.13	1.94	1.82	1.75
5	1.60	2.40	2.97	2.86	3.00	3.14	2.99	2.75	2.66	2.42	2.19	1.91	1.75
6	1.25	2.06	2.67	2.66	2.90	3.24	3.15	3.02	2.99	2.83	2.57	2.22	2.08
7	1.15	1.88	2.46	2.46	2.77	3.22	3.28	3.24	3.27	3.23	3.06	2.71	2.45
8	1.37	1.91	2.33	2.26	2.60	3.13	3.22	3.34	3.44	3.52	3.40	3.18	2.97
9	1.83	2.17	2.40	2.14	2.49	2.94	3.05	3.25	3.43	3.66	3.71	3.54	3.48
10	2.34	2.52	2.57	2.15	2.41	2.75	2.81	3.02	3.29	3.62	3.77	3.73	3.78
11	2.84	2.93	2.85	2.31	2.43	2.63	2.56	2.74	3.01	3.35	3.59	3.68	3.88
Noon.	3.20	3.27	3.16	2.58	2.53	2.60	2.41	2.45	2.64	2.93	3.22	3.34	3.70
13	3.34	3.60	3.45	2.85	2.69	2.62	2.28	2.19	2.30	2.44	2.71	2.87	3.31
14	3.26	3.69	3.60	3.08	2.87	2.74	2.31	2.08	2.02	2.03	2.19	2.28	2.76
15	2.92	3.54	3.56	3.14	3.04	2.91	2.40	2.09	1.93	1.78	1.80	1.76	2.20
16	2.44	3.20	3.35	3.09	3.18	3.10	2.55	2.28	2.04	1.79	1.64	1.40	1.70
17	1.91	2.78	3.06	2.94	3.20	3.25	2.80	2.54	2.28	2.00	1.75	1.37	1.52
18	1.44	2.30	2.64	2.72	3.09	3.29	2.99	2.83	2.65	2.35	2.07	1.61	1.57
19	1.17	1.96	2.26	2.44	2.90	3.22	3.09	3.09	2.97	2.75	2.48	2.01	1.94
20	1.25	1.84	2.04	2.16	2.70	3.08	3.06	3.18	3.21	3.09	2.91	2.50	2.42
21	1.55	1.99	1.90	1.96	2.51	2.86	2.94	3.12	3.33	3.38	3.31	2.97	2.92
22	2.00	2.26	2.00	1.95	2.35	2.65	2.73	2.96	3.25	3.44	3.50	3.34	3.42
23	2.47	2.62	2.18	2.04	2.26	2.43	2.49	2.72	3.05	3.28	3.46	3.48	3.64

Hour.	June, 1909—Continued.												
	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
0	3.62	3.76	3.81	3.38	2.99	2.59	2.44	2.15	1.93	1.96	2.60	.....	2.92
1	3.36	3.63	3.88	3.61	3.28	2.93	2.76	2.39	2.02	1.84	2.30	.....	2.44
2	2.99	3.28	3.66	3.62	3.44	3.22	3.08	2.63	2.24	1.88	2.12	.....	1.98
3	2.59	2.80	3.25	3.35	3.36	3.40	3.41	2.83	2.55	2.10	2.18	.....	1.64
4	2.06	2.37	2.75	2.94	3.10	3.35	3.51	3.10	2.88	2.43	2.46	.....	1.58
5	1.89	2.07	2.35	2.57	2.80	3.16	3.43	3.29	3.24	2.80	2.91	.....	1.77
6	2.06	1.98	2.09	2.26	2.46	2.79	3.26	3.28	3.41	3.22	3.38	.....	2.19
7	2.38	2.24	2.15	2.15	2.19	2.46	2.98	3.14	3.42	3.51	3.78	.....	2.71
8	.....	2.64	2.46	2.26	2.08	2.25	2.77	2.84	3.24	3.57	3.98	.....	3.21
9	3.36	3.14	2.88	2.54	2.18	2.19	2.55	2.58	2.97	3.46	3.97	.....	3.58
10	3.75	3.65	3.30	3.00	2.45	2.31	2.39	2.29	2.62	3.05	3.76	.....	3.72
11	3.93	3.98	3.71	3.54	2.87	2.55	2.46	2.10	2.27	2.58	3.34	.....	3.59
Noon.	3.94	4.16	3.95	3.77	3.21	2.85	2.63	2.09	2.06	2.28	2.81	.....	3.24
13	3.69	4.06	4.04	3.94	3.48	3.15	2.90	2.16	1.97	1.99	2.35	.....	2.69
14	3.22	3.70	3.83	3.91	3.60	3.40	3.12	2.42	2.08	1.88	2.00	.....	2.17
15	2.64	3.25	3.40	3.64	3.55	3.57	3.29	2.72	2.28	1.97	1.88	.....	1.67
16	2.10	2.60	2.85	3.22	3.30	3.51	3.38	2.88	2.54	2.20	1.96	.....	1.33
17	1.63	2.10	2.28	2.73	2.93	3.30	3.35	3.04	2.79	2.55	2.22	.....	1.36
18	1.50	1.80	1.87	2.23	2.49	2.96	3.18	3.08	2.98	2.94	[2.71]	.....	1.64
19	1.73	1.81	1.68	1.88	2.09	2.60	2.92	2.98	3.08	3.28	.....	.....	2.08
20	2.17	2.12	1.79	1.76	1.81	2.31	2.63	2.79	3.03	3.49	.....	2.85	2.55
21	2.66	2.61	2.09	1.93	1.79	2.08	2.34	2.48	2.88	3.53	.....	3.19	3.01
22	3.17	3.08	2.53	2.23	1.95	2.06	2.08	2.23	2.60	3.33	.....	3.37	3.35
23	3.56	3.50	3.00	2.60	2.25	2.20	2.08	2.01	2.27	2.99	.....	3.26	3.49

Hourly heights of the tide at Cape Sheridan, Point Aldrich, Cape Bryant, Cape Morris Jesup, and Fort Conger—Continued.

[Sixtieth meridian time. Brackets indicate interpolated values.]

CAPE SHERIDAN, GRANT LAND—Continued.

Hour.	June, 1909—Continued.												
	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.	28.	29.	30.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
0	3.30	3.47	3.59	3.69	3.37	2.95	2.80	2.72	2.25	2.16	2.00	2.18	2.61
1	2.94	3.22	3.56	3.75	3.57	3.20	3.22	2.91	2.49	2.28	2.06	2.11	2.37
2	2.42	2.78	3.24	3.62	3.57	3.35	3.45	3.16	2.74	2.45	2.17	2.19	2.29
3	1.96	2.28	2.77	3.26	3.36	3.34	3.51	3.31	2.93	2.69	2.38	2.34	2.33
4	1.69	1.86	2.31	2.84	3.00	3.12	3.41	3.36	3.05	2.93	2.65	2.59	2.56
5	1.70	1.65	1.98	2.49	2.61	2.80	3.16	3.23	3.04	3.07	2.88	2.89	2.87
6	2.04	1.79	1.91	2.26	2.29	2.46	2.87	3.05	2.98	3.11	3.01	3.19	3.21
7	2.52	2.19	2.11	2.23	2.14	2.21	2.63	2.82	2.80	3.01	3.02	3.37	3.49
8	3.01	2.72	2.54	2.49	2.20	2.15	2.45	2.61	2.57	2.84	2.92	3.48	3.61
9	3.48	3.26	3.08	2.89	2.49	2.26	2.41	2.41	2.36	2.61	2.75	3.34	3.56
10	3.76	3.66	3.54	3.33	2.83	2.55	2.56	2.37	2.21	2.38	2.51	3.11	3.31
11	3.84	3.88	3.90	3.70	3.22	2.89	2.84	2.43	2.18	2.19	2.23	2.81	2.99
Noon.	3.64	3.86	4.04	3.95	3.60	3.22	3.10	2.62	2.27	2.12	2.03	2.51	2.63
13	3.25	3.59	3.97	4.01	3.77	3.47	3.36	2.85	2.43	2.17	1.93	2.29	2.28
14	2.65	3.13	3.66	3.84	3.75	3.58	3.56	3.09	2.62	2.28	1.99	2.19	2.04
15	2.05	2.53	3.15	3.47	3.50	3.57	3.60	3.23	2.78	2.45	2.14	2.25	1.91
16	1.56	2.02	2.57	2.96	3.10	3.34	3.45	3.25	2.91	2.66	2.33	2.40	2.04
17	1.33	1.56	2.10	2.43	2.62	2.95	3.20	3.11	2.95	2.81	2.54	2.65	2.27
18	1.45	1.43	1.79	2.00	2.20	2.53	2.82	2.88	2.81	2.86	2.71	2.92	2.55
19	1.79	1.63	1.79	1.79	1.84	2.19	2.46	2.57	2.65	2.80	2.79	3.18	2.84
20	2.27	2.04	2.07	1.93	1.72	1.99	2.20	2.27	2.42	2.65	2.79	3.28	3.08
21	2.74	2.49	2.48	2.24	1.94	2.03	2.14	2.08	2.18	2.42	2.69	3.29	3.21
22	3.21	2.97	2.92	2.67	2.30	2.25	2.20	2.02	2.07	2.21	2.55	3.11	3.22
23	3.48	3.39	3.38	3.06	2.66	2.54	2.43	2.12	2.06	2.06	2.33	2.86	3.02

Hourly heights of the tide at Cape Sheridan, Point Aldrich, Cape Bryant, Cape Morris Jesup, and Fort Conger—Continued.

[Sixtieth meridian time. Brackets indicate interpolated values.]

POINT ALDRICH, CAPE COLUMBIA, GRANT LAND.

Hour.	November, 1908.														
	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.	28.	29.	30.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
0	[3.74]	3.48	3.09	2.81	2.86	3.00	2.86	3.03	3.15	3.35	3.32	3.58	4.07	4.27	4.11
1	[3.84]	3.60	3.14	2.83	2.86	2.89	2.68	2.83	2.86	3.05	3.02	3.40	3.91	4.24	4.13
2	[3.90]	3.64	3.20	2.95	2.91	2.87	2.60	2.67	2.67	2.75	2.69	3.16	3.72	4.07	4.04
3	[3.87]	3.72	3.25	3.01	3.05	2.93	2.67	2.59	2.53	2.52	2.43	2.81	3.39	3.87	3.80
4	[3.80]	3.66	3.28	3.12	3.19	3.06	2.74	2.64	2.53	2.43	2.26	2.61	3.10	3.56	3.56
5	[3.71]	3.54	3.21	3.18	3.33	3.22	2.92	2.81	2.62	2.47	2.22	2.49	2.94	3.39	3.35
6	[3.62]	3.44	3.12	3.13	3.42	3.33	3.12	3.02	2.84	2.63	[2.35]	2.51	2.85	3.24	3.15
7	[3.52]	3.29	3.04	3.07	3.39	3.38	3.27	3.21	3.04	2.85	[2.59]	2.67	2.90	3.07	3.06
8	[3.40]	3.17	2.88	2.91	3.30	3.30	3.32	3.27	3.22	2.99	2.77	2.89	3.02	3.28	3.01
9	[3.28]	3.08	2.77	2.85	3.21	3.25	3.27	3.31	3.25	3.14	2.95	3.11	3.21	3.46	3.12
10	[3.25]	3.05	2.68	2.72	3.06	3.04	3.14	3.16	3.22	3.08	2.90	3.24	3.40	3.59	3.12
11	3.31	3.03	2.58	2.60	2.96	2.85	2.98	2.96	3.07	3.01	2.95	3.30	3.50	3.67	3.22
Noon.	3.40	3.11	2.59	2.55	2.80	2.69	2.86	2.78	2.87	2.83	2.88	3.25	3.49	3.74	3.34
13	3.45	3.15	2.66	2.60	2.77	2.62	2.64	2.58	2.66	2.62	2.65	3.12	3.43	3.75	3.38
14	3.49	3.20	2.74	2.66	2.83	2.64	2.63	2.51	2.55	2.41	2.43	2.94	3.29	3.59	3.43
15	[3.47]	3.25	2.86	2.81	2.99	2.76	2.75	2.54	2.51	2.31	2.25	2.77	3.12	3.50	3.37
16	3.41	3.29	3.00	2.96	3.20	2.94	2.91	2.73	2.60	2.34	2.27	2.70	2.98	3.34	3.27
17	3.33	3.31	3.05	3.08	3.37	3.18	3.20	2.97	2.87	2.50	2.41	2.72	2.94	3.21	3.18
18	3.30	3.40	3.06	3.20	3.56	3.54	3.44	3.24	3.20	2.77	2.62	2.81	3.01	3.20	3.08
19	3.27	3.22	3.06	3.23	3.64	3.50	3.69	3.57	3.45	3.10	2.95	3.17	3.19	3.25	3.03
20	3.27	3.12	3.05	3.22	3.61	3.55	3.77	3.72	3.74	3.45	3.29	3.53	3.48	3.41	3.09
21	3.29	3.01	2.92	3.11	3.50	3.47	3.69	3.74	3.88	3.58	3.58	3.78	3.75	3.65	3.22
22	3.33	3.06	2.87	2.92	3.34	3.35	3.51	3.68	3.78	3.67	3.76	4.02	4.02	3.80	3.41
23	3.41	3.06	2.82	2.88	3.15	3.06	3.28	3.42	3.62	3.53	3.73	4.12	4.22	4.06	3.55

Hour.	December, 1908.													
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
0	3.70	3.40	3.04	2.95	3.08	3.47	3.41	3.94	3.91	4.39	4.28	4.23	4.42	4.22
1	3.76	3.49	3.16	2.99	3.06	3.34	3.29	3.65	3.58	4.12	4.08	4.10	4.22	4.21
2	3.80	3.62	3.30	3.11	3.16	3.29	3.11	3.42	3.29	3.79	3.79	3.85	4.12	4.08
3	3.70	3.60	3.41	3.23	3.28	3.39	3.12	3.24	3.10	3.53	3.48	3.60	3.82	3.91
4	3.59	3.54	3.42	3.42	3.45	3.54	3.17	3.22	3.00	3.36	3.22	3.30	3.59	3.67
5	3.41	3.46	3.40	3.53	3.60	3.68	3.35	3.32	3.06	3.30	3.10	3.08	3.40	3.49
6	3.20	3.26	3.32	3.48	3.73	3.91	3.57	3.54	3.24	3.44	3.11	3.10	3.30	3.28
7	3.04	3.08	3.15	3.39	3.72	3.99	3.72	3.74	3.50	3.63	3.21	3.13	3.25	3.24
8	2.89	2.95	2.96	3.24	3.69	4.00	3.85	3.89	3.70	3.81	3.41	3.27	3.29	3.19
9	2.88	2.83	2.83	3.07	3.62	3.91	3.85	3.91	3.84	3.96	3.60	3.46	3.48	3.33
10	2.91	2.78	2.68	2.92	3.40	3.72	3.71	3.84	3.84	4.03	3.69	3.60	3.56	3.53
11	3.00	2.77	2.60	2.82	3.21	3.47	3.53	3.72	3.78	3.98	3.76	3.71	3.73	[3.65]
Noon.	3.22	2.86	2.65	2.76	3.10	3.32	3.35	3.52	3.63	3.86	3.69	3.71	3.76	[3.73]
13	3.26	3.00	2.74	2.82	3.06	3.20	3.19	3.27	3.46	3.71	3.55	3.70	3.72	[3.78]
14	3.34	3.16	2.97	2.97	3.22	3.19	3.15	3.11	3.30	3.44	3.43	3.57	3.67	[3.72]
15	3.37	3.28	3.16	3.21	3.45	3.36	3.24	3.08	3.16	3.31	3.26	3.44	3.66	[3.66]
16	3.35	3.34	3.30	3.43	3.82	3.56	3.43	3.17	3.24	3.31	3.13	3.29	3.37	[3.56]
17	3.28	3.37	3.40	3.65	4.01	3.81	3.78	3.42	3.41	3.37	3.09	3.24	3.35	[3.47]
18	3.19	3.31	3.41	3.74	4.21	4.12	4.13	3.76	3.73	3.54	3.23	3.35	3.36	[3.40]
19	3.10	3.19	3.40	3.75	4.32	4.29	4.45	4.06	4.05	3.85	3.47	3.49	3.39	[3.43]
20	3.05	3.09	3.28	3.70	4.27	4.38	4.62	4.32	4.34	4.07	3.80	3.71	3.56	[3.55]
21	3.08	3.02	3.18	3.54	4.15	4.32	4.59	4.43	4.60	4.35	4.06	4.04	3.81	[3.75]
22	3.13	2.99	3.03	3.39	3.96	4.09	4.43	4.37	4.68	4.46	4.25	4.22	3.95	[3.90]
23	3.24	2.99	2.95	3.21	3.61	3.79	4.11	4.19	4.58	4.41	4.30	4.32	4.19	[4.15]

Hourly heights of the tide at Cape Sheridan, Point Aldrich, Cape Bryant, Cape Morris Jesup, and Fort Conger—Continued.

[Sixtieth meridian time. Brackets indicate interpolated values.]

CAPE BRYANT, NORTH GREENLAND.

Hour.	January, 1909.													
	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.	28.	29.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
0	4.89	5.17	5.22	5.42	5.46	5.94	5.87	5.81	5.40	5.42	5.74	5.66	5.49	4.77
1	4.82	4.98	4.95	5.12	5.31	5.72	5.74	5.84	5.50	5.63	5.93	5.78	5.53	4.75
2	4.80	4.86	4.70	4.83	4.95	5.53	5.56	5.68	5.43	5.78	6.13	5.96	5.66	4.83
3	4.85	4.84	4.59	4.56	4.64	5.17	5.12	5.45	5.21	5.77	6.24	6.13	5.83	4.91
4	4.89	4.88	4.59	4.37	4.38	4.78	4.68	4.91	4.92	5.54	6.14	6.17	5.89	4.97
5	4.97	4.95	4.63	4.31	4.28	4.53	4.27	4.53	4.44	5.25	5.94	6.06	5.89	5.01
6	5.04	5.13	4.72	4.42	4.30	4.39	4.03	4.13	3.97	4.82	5.59	5.95	5.79	4.95
7	5.07	5.26	4.90	4.59	4.45	4.43	4.05	3.96	3.68	4.48	5.20	5.61	5.69	4.90
8	5.03	5.38	5.05	4.75	4.73	4.67	4.18	3.97	3.66	4.35	4.95	5.34	5.43	4.87
9	5.10	5.48	5.23	5.09	5.12	5.02	4.49	4.16	3.80	4.36	4.85	5.17	5.24	4.82
10	5.15	5.55	5.39	5.38	5.47	5.37	4.91	4.50	4.11	4.52	4.92	5.16	5.16	4.72
11	5.20	5.57	5.49	5.56	5.72	5.70	5.38	4.97	4.52	4.91	5.11	5.27	5.17	4.66
Noon.	5.27	5.59	5.51	5.66	5.86	5.96	5.74	5.44	4.99	5.33	5.44	5.49	5.27	4.69
13	5.28	5.56	5.48	5.63	5.86	6.10	5.97	5.77	5.39	5.81	5.86	5.76	5.43	4.80
14	5.29	5.53	5.47	5.51	5.76	6.05	6.00	5.87	5.70	6.23	6.32	6.14	5.63	4.95
15	5.40	5.53	5.43	5.38	5.64	5.85	5.77	5.78	5.75	6.42	6.59	6.46	5.86	5.14
16	5.51	5.59	5.43	5.29	5.57	5.63	5.55	5.54	5.67	6.36	6.62	6.64	6.04	5.35
17	5.62	5.68	5.48	5.31	5.53	5.41	5.40	5.27	5.44	6.20	6.46	6.60	6.10	5.49
18	5.68	5.71	5.54	5.38	5.53	5.30	5.21	5.04	5.14	5.91	6.22	6.41	5.99	5.48
19	5.78	5.81	5.67	5.50	5.60	5.31	5.18	4.87	4.98	5.74	5.95	6.16	5.74	5.42
20	5.80	5.81	5.79	5.67	5.76	5.42	5.25	4.79	4.88	5.45	5.76	6.02	5.51	5.24
21	5.71	5.72	5.83	5.77	5.97	5.61	5.39	4.89	4.91	5.39	5.57	5.76	5.34	5.06
22	5.58	5.55	5.72	5.74	6.08	5.82	5.56	4.98	5.03	5.44	5.51	5.58	5.10	4.97
23	5.43	5.35	5.56	5.65	6.07	5.90	5.74	5.18	5.20	5.59	5.58	5.46	4.88	4.76

Hour.	January, 1909—Continued.		February, 1909.												
	30.	31.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
0	4.59	4.86	5.57	5.71	6.01	5.99	5.82	6.12	5.90	6.22	5.72	5.40	5.50	4.99	5.27
1	4.52	4.69	5.34	5.55	5.91	5.85	5.71	6.09	5.98	6.32	5.89	5.57	5.67	5.13	5.35
2	4.56	4.60	5.10	5.35	5.64	5.65	5.55	5.86	5.90	6.36	5.95	5.70	5.82	5.31	5.48
3	4.61	4.59	4.99	5.18	5.34	5.31	5.21	5.56	5.73	6.22	5.87	5.72	5.89	5.44	5.62
4	4.70	4.66	4.97	5.08	5.11	4.97	4.84	5.28	5.40	5.90	5.61	5.66	5.81	5.53	5.71
5	4.83	4.72	4.96	4.98	4.97	4.70	4.49	4.93	5.10	5.54	5.26	5.45	5.76	5.43	[5.73]
6	4.92	4.81	5.06	5.06	4.90	4.58	4.29	4.64	4.80	5.24	5.01	5.17	5.57	5.22	[5.63]
7	4.95	4.99	5.23	5.25	4.98	4.70	4.27	4.55	4.68	4.96	4.72	4.86	5.27	5.17	[5.47]
8	4.98	5.16	5.49	5.54	5.21	4.89	4.45	4.62	4.74	4.87	4.56	4.67	5.08	5.02	[5.32]
9	5.02	5.24	5.72	5.84	5.53	5.20	4.73	4.82	4.93	4.96	4.53	4.63	5.01	4.96	[5.19]
10	5.11	5.35	5.88	6.10	5.86	5.52	5.10	5.14	5.21	5.12	4.67	4.82	5.02	4.92	[5.12]
11	5.09	5.45	5.88	6.30	6.12	5.77	5.48	5.54	5.62	5.45	4.94	5.09	5.12	4.99	[5.13]
Noon.	5.07	5.50	6.00	6.36	6.29	6.10	5.81	5.85	6.04	5.83	5.33	5.42	5.32	5.19	[5.28]
13	5.03	5.54	5.94	6.34	6.28	6.20	6.01	6.16	6.37	6.22	5.69	5.71	5.57	5.60	[5.52]
14	5.09	5.51	5.89	6.24	6.19	6.14	6.08	6.20	6.54	6.45	5.97	5.97	5.81	5.81	[5.75]
15	5.24	5.56	5.80	6.09	6.05	5.96	5.93	6.05	6.46	6.45	6.06	6.09	5.98	6.00	[5.98]
16	5.41	5.62	5.79	5.99	5.88	5.70	5.64	5.75	6.33	6.24	5.87	6.06	5.98	6.08	[6.14]
17	5.47	5.71	5.85	5.91	5.71	5.53	5.57	5.47	6.05	5.95	5.67	5.95	5.84	6.01	[6.15]
18	5.51	5.83	5.88	5.96	5.69	5.40	5.41	5.27	5.78	5.64	5.48	5.75	5.65	5.87	[6.02]
19	5.54	5.89	5.98	6.03	5.77	5.39	5.38	5.13	5.65	5.46	5.36	5.62	5.42	5.67	[5.78]
20	5.52	5.90	6.08	6.14	5.84	5.50	5.44	5.19	5.51	5.32	5.08	5.39	5.19	5.48	[5.48]
21	5.35	5.83	6.10	6.23	5.98	5.64	5.60	5.31	5.59	5.29	4.96	5.20	4.99	5.38	[5.22]
22	5.18	5.77	6.07	6.29	6.08	5.79	5.81	5.50	5.79	5.40	4.99	5.21	4.88	5.29	[5.04]
23	5.05	5.66	5.90	6.16	6.08	5.85	5.99	5.69	6.03	5.55	5.17	5.31	4.88	5.21	[4.96]

Hourly heights of the tide at Cape Sheridan, Point Aldrich, Cape Bryant, Cape Morris Jesup, and Fort Conger—Continued.

[Sixtieth meridian time. Brackets indicate interpolated values.]

CAPE MORRIS JESUP, PEARY LAND.

Hour.	May, 1909.									
	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
0	.....	3.60	3.51	3.51	3.91	3.74	3.61	3.76	3.77	3.96
1	.....	3.58	3.50	3.53	3.88	3.72	3.58	3.70	3.70	3.89
2	3.74	3.60	3.55	3.57	3.91	3.72	3.56	3.70	3.68	3.87
3	3.76	3.60	3.60	3.64	3.97	3.73	3.59	3.70	3.69	3.83
4	3.77	3.62	3.62	3.74	4.08	3.80	3.71	3.76	3.74	3.83
5	3.77	3.62	3.64	3.80	4.19	3.92	3.85	3.88	3.84	3.88
6	3.78	3.62	3.65	3.86	4.26	4.01	4.00	4.04	4.00	3.99
7	[3.79]	3.62	3.66	3.91	4.32	4.10	4.14	4.20	4.16	4.13
8	3.84	3.64	3.66	3.93	4.30	4.11	4.24	4.33	4.35	4.32
9	3.94	3.67	3.63	3.90	4.30	4.12	4.28	4.49	4.50	4.50
10	4.03	[3.72]	3.65	3.89	4.29	4.04	4.24	4.49	4.64	4.59
11	4.15	[3.79]	[3.68]	3.85	4.16	3.91	4.17	4.42	4.61	4.63
Noon.	4.26	3.87	3.73	3.86	4.06	3.79	4.08	4.29	4.53	4.58
13	4.31	3.94	3.76	3.92	3.95	3.68	3.90	4.13	4.41	4.48
14	4.36	4.01	3.81	3.94	3.95	3.58	3.77	3.95	4.24	4.34
15	4.33	4.03	3.87	3.99	3.90	3.55	3.64	3.79	4.04	4.17
16	4.27	4.04	3.90	4.03	4.00	3.54	3.59	3.66	3.89	[3.99]
17	4.15	3.98	3.92	4.07	3.99	3.58	3.61	3.63	3.78	3.81
18	4.05	3.91	3.88	4.10	4.04	3.64	3.64	3.60	3.77	3.68
19	3.92	3.84	3.84	4.12	4.08	3.70	3.75	3.67	3.78	3.67
20	3.79	3.77	3.77	4.10	4.07	3.74	3.81	3.74	3.82	3.68
21	3.70	3.66	3.69	4.07	4.06	3.75	3.83	3.87	3.91	3.71
22	3.64	3.58	3.58	3.98	4.04	3.72	3.88	3.83	3.93	3.76
23	3.60	3.52	3.53	3.93	3.87	3.68	3.83	3.80	3.97	3.78

Hourly heights of the tide at Cape Sheridan, Point Aldrich, Cape Bryant, Cape Morris Jesup, and Fort Conger—Continued.

[Sixtieth meridian time. Brackets indicate interpolated values.]

FORT CONGER, GRANT LAND.

Hour.	June, 1909.														
	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
0	2.28	2.17	2.59	3.38	4.67	5.51	6.11	6.53	6.28	5.90	5.20	4.28	3.41	3.08	2.72
1	2.81	2.25	2.21	2.54	3.60	4.49	5.29	6.25	6.53	6.54	6.13	5.31	4.28	3.87	3.22
2	3.58	2.68	2.13	1.97	2.64	3.25	4.10	5.20	5.92	6.47	6.47	5.97	5.09	4.67	3.82
3	4.41	3.26	2.50	1.75	1.91	2.14	2.76	3.93	4.78	5.68	6.20	6.02	5.57	5.28	4.45
4	5.06	4.01	3.14	2.03	1.80	1.52	1.67	2.56	3.43	4.48	5.35	5.51	5.50	5.48	4.86
5	5.44	4.72	3.95	2.83	2.23	1.48	1.09	1.49	2.07	3.19	4.17	4.65	4.96	5.23	4.99
6	5.41	5.18	4.78	3.69	3.05	2.03	1.19	1.08	1.17	2.05	2.98	3.60	4.11	4.65	4.77
7	4.97	5.25	5.31	4.56	4.16	2.95	1.95	1.39	1.00	1.42	1.99	2.56	3.13	3.90	4.31
8	4.24	4.92	5.45	5.22	5.08	4.02	2.95	2.28	1.57	1.53	1.61	1.81	2.30	3.07	3.66
9	3.41	4.30	5.12	5.44	5.65	4.97	4.11	3.31	2.49	2.17	1.82	1.58	1.73	2.40	2.95
10	2.63	3.44	4.40	5.10	5.74	5.54	5.13	4.46	3.63	3.13	2.51	1.93	1.74	2.06	2.32
11	2.12	2.59	3.48	4.30	5.29	5.53	5.58	5.32	4.70	4.28	3.45	2.63	2.14	2.13	2.00
Noon.	2.00	1.91	2.60	3.34	4.38	4.97	5.48	5.71	5.47	5.25	4.48	3.52	2.81	2.58	2.02
13	2.19	1.60	1.86	2.36	3.27	3.93	4.79	5.49	5.65	5.79	5.27	4.39	3.59	3.21	2.38
14	2.63	1.72	1.54	1.59	2.16	2.66	3.65	4.66	5.22	5.72	5.62	5.01	4.35	3.91	2.93
15	3.26	2.24	1.60	1.13	1.41	1.59	2.34	3.43	4.23	5.05	5.40	5.13	4.83	4.44	3.56
16	3.91	2.94	2.08	1.28	1.09	0.83	1.19	2.14	2.95	4.02	4.64	4.76	4.88	4.70	4.11
17	4.45	3.69	2.80	1.91	1.26	0.67	0.58	1.06	1.71	2.80	3.57	3.99	4.46	4.58	4.33
18	4.74	4.39	3.61	2.89	1.96	1.04	0.62	0.56	0.87	1.74	2.45	2.95	3.74	4.11	[4.22]
19	4.65	4.82	4.42	3.93	3.08	1.96	1.25	0.77	0.68	1.13	1.59	2.16	2.95	3.51	[3.90]
20	4.19	4.87	5.02	4.96	4.35	3.19	2.31	1.68	1.15	1.13	1.27	1.51	2.28	2.93	[3.45]
21	3.57	4.52	5.22	5.73	5.40	4.52	3.66	2.66	2.05	1.76	1.53	1.44	1.92	2.49	[3.05]
22	2.96	3.96	4.89	5.92	6.04	5.62	5.07	4.01	3.29	2.74	2.25	1.86	1.94	2.30	[2.70]
23	2.42	3.25	4.18	5.51	6.10	6.23	6.08	5.40	4.70	3.95	3.21	2.57	2.38	2.39	[2.50]

High and low waters at Cape Sheridan, Point Aldrich, Cape Bryant, Cape Morris Jesup, and Fort Conger.

[Sixtieth meridian time. Brackets indicate interpolated values.]

CAPE SHERDIAN.

Date.	Forenoon tides.				Afternoon tides.			
	Time of—		Height of—		Time of—		Height of—	
	H. W.	L. W.	H. W.	L. W.	H. W.	L. W.	H. W.	L. W.
1908.	*h. m.*	*h. m.*	*Feet.*	*Feet.*	*h. m.*	*h. m.*	*Feet.*	*Feet.*
Nov. 12	-----	----	----	---	13 05	18 46	3.0	1.4
13	0 55	7 25	3.1	1.0	13 50	19 14	2.6	1.6
14	1 58	8 06	3.3	1.6	14 50	20 18	3.0	2.1
15	3 05	9 15	3.2	1.9	15 20	22 00	2.7	2.0
16	2 54	10 48	2.5	1.4	17 12	23 25	2.0	1.5
17	5 00	-----	1.9	---	18 40	12 00	2.0	1.2
18	6 37	1 13	1.6	1.2	19 40	13 15	1.8	0.7
19	8 14	2 28	1.6	0.6	20 25	14 05	2.0	0.6
20	8 56	2 44	2.1	0.7	21 11	14 46	2.4	0.7

High and low waters at Cape Sheridan, Point Aldrich, Cape Bryant, Cape Morris Jesup, and Fort Conger—Continued.

(Sixtieth meridian time. Brackets indicate interpolated values.)

CAPE SHERIDAN—Continued.

Date.		Forenoon tides.				Afternoon tides.			
		Time of—		Height of—		Time of—		Height of—	
		H. W.	L. W.	H. W.	L. W.	H. W.	L. W.	H. W.	L. W.
1908.		*h. m.*	*h. m.*	*Feet.*	*Feet.*	*h. m.*	*h. m.*	*Feet.*	*Feet.*
Nov.	21	9 36	3 19	2.1	0.5	21 29	15 21	2.3	0.5
	22	10 11	4 01	2.2	0.2	21 56	15 51	2.5	0.4
	23	10 36	4 30	2.3	0.1	22 26	16 11	2.6	0.3
	24	11 11	5 01	2.4	0.0	22 53	17 01	2.6	0.4
	25	11 46	5 31	2.2	—0.1	23 32	17 26	2.4	0.1
	26	.....	5 56	...	0.7	12 26	18 01	3.1	1.2
	27	0 23	6 33	3.5	1.0	13 07	18 23	3.3	1.6
	28	0 47	7 21	3.8	1.5	13 41	19 08	3.5	2.1
	29	1 31	8 11	3.9	1.9	14 27	20 10	3.5	2.3
	30	2 21	9 16	3.5	1.8	15 36	21 31	3.2	2.2
Dec.	1	3 29	10 32	3.1	1.8	16 57	23 17	3.1	2.1
	2	5 17	11 47	2.9	1.7	18 21	.....	3.1	...
	3	6 39	0 29	2.8	1.9	19 37	12 57	3.2	1.6
	4	7 57	1 36	3.1	1.7	20 14	14 08	3.6	1.7
	5	9 07	2 17	3.7	1.8	21 03	14 42	4.2	2.0
	6	9 47	3 33	3.9	1.9	21 37	15 39	4.1	1.9
	7	10 25	4 10	3.9	1.6	22 13	16 00	4.3	2.0
	8	11 13	4 37	3.9	1.7	22 50	16 43	4.1	1.9
	9	11 41	5 07	3.9	1.5	23 27	17 17	4.4	2.1
	10	.....	5 51	...	1.8	12 27	18 00	4.0	2.2
	11	0 00	6 33	4.1	1.6	12 57	18 23	3.6	2.0
	12	0 57	7 02	3.8	1.7	13 32	19 02	3.6	2.2
	13	1 21	7 31	3.9	1.9	14 02	19 58	3.5	2.4
	14	1 58	8 24	3.6	2.0	15 00	21 01	3.3	2.4
	15	2 27	9 25	3.2	1.8	15 58	21 47	2.9	2.1
	16	4 01	10 27	2.9	1.9	17 10	23 55	2.9	2.0
	17	5 01	11 37	2.6	1.7	18 18	.....	2.7	...
	18	7 02	1 02	2.5	1.7	19 18	12 50	3.0	1.8
	19	8 21	1 48	2.8	1.7	20 30	13 48	3.2	1.8
	20	8 52	2 41	3.0	1.7	20 52	14 45	3.5	1.9
	21	9 40	3 30	3.2	1.6	21 35	15 28	3.8	2.0
	22	10 10	4 12	3.5	1.6	21 55	16 07	3.7	1.8
	23	10 59	4 54	3.3	1.2	22 44	16 29	3.7	1.5
	24	11 45	5 27	3.3	1.0	23 44	17 05	4.2	1.6
	25	†12 09	5 59	4.0	1.6	23 55	18 03	4.2	2.1
	26	.....	6 35	...	1.4	12 54	18 29	3.7	1.7
	27	0 54	7 14	3.9	1.5	13.49	19 39	4.1	2.4
	28	1 43	8 13	4.2	1.8	14 24	20 26	3.8	2.1
	29	2 25	8 41	3.8	1.9	15 18	21 49	3.7	2.3
	30	3 20	9 59	3.6	2.0	16 19	22 55	3.5	2.1
	31	4 19	10 49	3.2	1.9	17 29	23 44	3.2	1.9

†Afternoon tide.

High and low waters at Cape Sheridan, Point Aldrich, Cape Bryant, Cape Morris Jesup, and Fort Conger—Continued.

[Sixtieth meridian time. Brackets indicate interpolated values.]

CAPE SHERIDAN—Continued.

Date.		Forenoon tides.				Afternoon tides.			
		Time of—		Height of—		Time of—		Height of—	
		H. W.	L. W.	H. W.	L. W.	H. W.	L. W.	H. W.	L. W.
1909.		*h. m.*	*h. m.*	*Feet.*	*Feet.*	*h. m.*	*h. m.*	*Feet.*	*Feet.*
Jan.	1	5 49	.....	3.1	...	18 55	12 13	3.5	2.0
	2	7 24	1 12	3.2	2.0	20 04	13 24	3.8	2.1
	3	8 47	2 06	3.4	2.1	20 40	14 35	3.8	2.2
	4	9 50	3 24	3.4	1.9	21 23	15 23	4.0	2.1
	5	10 20	4 13	3.5	1.8	22 00	16 15	3.8	1.9
	6	10 45	4 58	3.2	1.4	22 30	16 54	3.4	1.5
	7	11 36	5 26	3.0	0.8	23 13	17 25	3.4	1.2
	8	†12 43	5 52	3.6	1.1	23 59	17 45	4.0	1.9
	9	.....	6 36	...	1.3	12 39	18 41	3.4	1.5
	10	0 36	6 58	3.4	1.0	13 31	18 51	3.2	1.6
	11	1 25	7 38	3.5	1.4	13 40	19 36	3.1	1.6
	12	1 40	7 56	3.2	1.2	14 41	20 12	3.1	1.7
	13	2 32	8 27	3.2	1.6	15 02	21 15	3.2	2.0
	14	3 10	9 22	3.0	1.6	16 02	22 16	3.0	1.8
	15	4 02	10 02	2.8	1.8	16 47	23 26	2.9	1.8
	16	4 52	10 32	2.6	1.9	18 32	.....	3.1	...
	17	6 35	0 47	2.9	2.0	19 07	12 45	3.2	2.2
	18	7 47	1 57	2.6	1.8	20 22	13 42	3.2	1.9
	19	9 33	3 03	2.7	1.5	21 05	14 53	3.4	1.7
	20	10 06	3 30	3.2	1.4	21 43	15 20	3.8	1.9
	21	10 35	4 38	3.4	1.5	22.28	16 33	3.7	1.5
	22	11 31	5 18	3.2	0.9	23 23	16 58	3.6	1.3
	23	.....	5 49	...	0.8	12 05	17 57	3.3	1.0
	24	0 08	6 30	3.4	0.3	12 54	18 16	3.2	1.1
	25	0 59	7 00	3.7	1.1	13 35	19 19	3.8	1.5
	26	1 53	7 49	4.0	1.4	14 15	19 59	4.0	1.8
	27	2 19	8 29	3.9	1.7	14 57	20 58	4.0	2.0
	28	3 03	9 23	3.7	1.6	15 40	22 13	3.4	1.5
	29	3 43	10 11	2.7	1.1	16 43	23 07	2.7	1.3
	30	4 58	11 18	2.4	1.4	18 00	.....	2.8	...
	31	7 03	0 23	2.5	1.5	19 20	12 34	3.3	1.9
Feb.	1	8 17	2 18	3.1	2.0	20 24	14 14	3.6	2.2
	2	9 49	2 54	3.4	2.0	21 24	15 24	3.8	2.3
	3	10 24	4 02	3.4	1.9	21 59	15 59	3.7	1.9
	4	10 59	4 44	3.3	1.5	22 39	16 45	3.4	1.6
	5	11 34	5 19	3.2	1.0	23 34	17 05	3.8	1.5
	6	11 54	5 44	3.5	1.4	.....	17 45	...	1.4
	7	0 08	6 06	3.7	1.4	12 34	18 24	3.9	1.9
	8	0 19	6 44	4.1	1.6	12 59	18 44	3.9	1.6
	9	0 49	7 04	3.6	1.1	13 24	19 10	3.3	1.3
	10	1 19	7 36	3.2	1.1	13 40	19 52	3.4	1.6
	11	1 54	8 04	3.5	1.5	14 14	20 34	3.3	1.5
	12	2 24	8 19	3.0	1.4	14 49	20 55	3.3	1.9
	13	2 59	8 59	3.2	2.0	15 17	22 12	3.2	1.7
	14	4 11	9 41	2.6	1.6	16 22	23 11	2.8	1.8
	15	5 47	10 22	2.6	2.2	18 02	.....	3.2	...

†Afternoon tide.

High and low waters at Cape Sheridan, Point Aldrich, Cape Bryant, Cape Morris Jesup, and Fort Conger—Continued.

[Sixtieth meridian time. Brackets indicate interpolated values.]

CAPE SHERIDAN—Continued.

Date.	Forenoon tides.				Afternoon tides.			
	Time of—		Height of—		Time of—		Height of—	
	H. W.	L. W.	H. W.	L. W.	H. W.	L. W.	H. W.	L. W.
1909.	*h. m.*	*h. m.*	*Feet.*	*Feet.*	*h. m.*	*h. m.*	*Feet.*	*Feet.*
Feb. 16	7 42	0 42	3.2	2.2	19 22	13 09	3.8	2.7
17	8 57	2 27	3.5	2.5	20 41	14 49	3.9	2.6
18	9 43	3 33	3.4	1.9	21 52	15 22	3.8	2.0
19	10 32	4 12	3.8	1.6	22 32	16 07	4.3	2.1
20	11 02	4 45	4.2	1.8	23 12	16 52	4.4	2.0
21	11 51	5 32	4.2	1.4	23 53	17 25	4.4	1.7
22	.. ..	6 13	...	1.4	12 29	18 29	4.4	1.6
23	0 39	6 44	4.2	1.3	13 00	19 11	4.4	1.5
24	1 21	7 33	4.2	1.2	13 39	19 50	3.9	1.0
25	1 52	8 02	3.3	0.8	14 23	20 37	3.3	0.9
26	2 38	8 49	3.0	1.1	14 57	21 02	3.2	1.4
27	3 29	9 29	2.9	1.7	15 47	22 37	3.1	1.5
28	4 20	10 25	2.4	1.6	16 58	.. ..	2.7	...
Mar. 1	6 25	0 00	2.2	1.6	18 46	12 31	2.5	1.7
2	8 46	1 46	2.3	1.4	20 11	14 13	2.6	1.7
3	9 51	3 16	2.6	1.4	21 26	15 06	3.2	1.8
4	10 21	3 51	3.1	1.5	22 06	15 53	3.2	1.6
5	10 51	4 26	2.8	1.1	22 31	16 27	3.0	1.2
6	11 11	4 54	2.7	0.8	23 10	16 54	2.9	0.7
7	11 41	5 18	3.0	0.7	23 33	17 21	3.2	1.0
8	.. ..	5 42	...	0.8	12 00	18 00	3.2	0.8
9	0 05	6 06	3.1	0.7	12 30	18 25	3.1	0.7
10	0 45	6 45	3.1	0.8	12 55	19 00	3.2	0.8
11	1 05	6 55	3.0	0.8	13 10	19 25	3.0	0.8
12	1 25	7 30	2.8	0.8	13 35	20 00	3.0	0.8
13	2 05	8 00	2.6	0.9	14 05	20 40	2.6	0.8
14	2 40	8 20	2.2	0.8	14 35	21 15	2.3	0.7
15	3 35	8 50	1.8	1.0	15 27	22 26	2.3	1.1
16	4 40	10 50	1.9	1.3	17 20	.. ..	2.2	...
17	6 50	0 25	2.1	1.4	19 20	12 25	2.5	1.7
18	8 35	2 10	2.5	1.3	20 34	14 25	2.8	1.7
19	9 25	3 20	2.6	1.0	21 35	15 20	2.9	1.2
20	10 10	3 50	3.0	0.8	22 20	16 00	3.3	1.1
21	10 50	4 35	3.2	0.7	23 00	16 45	3.3	0.8
22	11 30	5 15	3.3	0.4	23 40	17 25	3.3	0.4
23	.. ..	5 40	...	0.4	12 05	18 05	3.5	0.4
24	0 25	6 19	3.4	0.5	12 50	18 40	3.7	0.7
25	1 00	6 54	3.5	0.7	13 15	19 17	3.7	0.7
26	1 41	7 35	3.2	0.9	13 50	20 07	3.4	0.9
27	2 25	8 10	3.2	1.4	14 20	20 42	3.3	1.3
28	3 05	8 40	3.0	1.9	14 55	21 50	3.6	2.0
29	3 50	10 00	2.7	1.9	16 10	23 00	2.6	1.3
30	6 05	11 35	1.9	1.4	18 05	.. ..	2.0	...
31	8 17	1 00	1.9	1.0	19 58	13 40	2.2	1.3

High and low waters at Cape Sheridan, Point Aldrich, Cape Bryant, Cape Morris Jesup, and Fort Conger—Continued.

[Sixtieth meridian time. Brackets indicate interpolated values.]

CAPE SHERIDAN—Continued.

Date.	Forenoon tides.				Afternoon tides.			
	Time of—		Height of—		Time of—		Height of—	
	H. W.	L. W.	H. W.	L. W.	H. W.	L. W.	H. W.	L. W.
1909.	*h. m.*	*h. m.*	*Feet.*	*Feet.*	*h. m.*	*h. m.*	*Feet.*	*Feet.*
Apr. 1	9 10	2 30	2.3	1.1	21 00	15 05	2.6	1.4
2	9 45	3 20	2.7	1.2	21 30	15 35	3.0	1.4
3	10 13	3 40	3.2	1.3	22 15	16 08	3.3	1.5
4	10 52	4 35	3.4	1.3	22 56	16 34	3.7	1.4
5	11 10	4 50	3.8	1.5	23 15	17 02	3.7	1.4
6	11 34	5 09	3.8	1.4	23 39	17 29	3.6	1.3
7	11 59	5 59	3.6	1.3	.. ..	17 59	...	1.1
8	0 19	6 09	3.6	1.4	12 19	18 29	3.8	1.3
9	0 44	6 43	3.6	1.6	12 54	19 04	3.9	1.4
10	1 12	6 54	3.6	1.8	13 07	19 39	3.8	1.5
11	1 39	7 30	3.2	1.6	13 49	20 14	3.4	1.3
12	2 12	8 04	3.0	1.7	14 19	20 59	3.1	1.5
13	3 14	8 49	2.7	1.9	14 59	22 18	3.0	1.6
14	4 39	10 14	2.6	2.1	16 39	23 49	3.0	2.1
15	6 59	.. ..	3.1	...	18 59	13 15	3.5	2.6
16	8 00	1 49	3.3	2.1	20 09	14 14	3.3	2.2
17	8 59	2 45	3.2	1.6	21 14	15 00	3.2	1.5
18	9 39	3 34	3.2	1.1	21 59	15 49	3.3	1.1
19	10 24	3 59	3.4	0.8	22 49	16 24	3.3	0.8
20	11 04	4 39	3.6	0.7	23 18	17 13	3.4	0.5
21	11 44	5 14	3.7	0.6	.. ..	17 49	...	0.6
22	0 02	5 55	3.4	0.8	12 19	18 24	3.7	0.6
23	0 44	6 35	3.2	0.8	12 49	18 54	3.5	0.7
24	1 25	6 59	3.0	0.9	13 24	19 54	3.2	0.8
25	1 59	7 49	2.8	1.3	14 14	20 24	3.2	1.2
26	2 49	8 34	2.8	1.7	14 39	21 19	3.0	1.6
27	3 54	9 39	2.7	2.0	15 34	22 53	2.8	1.7
28	5 29	11 19	2.5	2.0	17 14	23 54	2.6	1.6
29	7 29	.. ..	2.5	...	19 37	13 24	2.4	1.8
30	8 09	2 04	2.4	1.4	20 14	14 24	2.3	1.3
May 1	8 54	2 29	2.5	1.1	21 19	14 57	2.6	1.2
2	9 28	3 08	2.9	1.1	21 48	15 48	2.8	1.2
3	9 58	3 48	2.8	1.0	22 23	16 03	2.8	0.7
4	10 43	4 08	3.2	0.9	22 53	16 33	3.5	1.1
5	10 53	4 48	3.5	1.3	23 23	17 01	3.6	1.2
6	11 06	5 23	3.6	1.6	23 58	17 48	2.9	0.7
7	.. ..	5 38	...	0.8	12 03	18 09	3.1	0.5
8	0 23	5 59	2.8	0.9	12 23	18 43	3.2	0.7
9	0 53	6 38	2.8	1.2	12 53	19 18	3.2	0.9
10	1 38	7 12	2.8	1.3	13 26	19 58	3.1	1.0
11	2 08	7 55	2.7	1.4	14 04	20 48	2.8	1.1
12	3 18	8 38	2.3	1.5	15 00	21 57	2.7	1.4
13	4 37	10 23	2.5	1.7	16 25	23 31	2.5	1.3
14	6 04	11 55	2.4	1.5	18 18	.. ..	2.3	...
15	7 31	1 10	2.6	1.1	19 58	13 19	2.6	1.3

High and low waters at Cape Sheridan, Point Aldrich, Cape Bryant, Cape Morris Jesup, and Fort Conger—Continued.

[Sixtieth meridian time. Brackets indicate interpolated values.]

CAPE SHERIDAN—Continued.

Date.	Forenoon tides.				Afternoon tides.			
	Time of—		Height of—		Time of—		Height of—	
	H. W.	L. W.	H. W.	L. W.	H. W.	L. W.	H. W.	L. W.
1909.	*h. m.*	*h. m.*	*Feet.*	*Feet.*	*h. m.*	*h. m.*	*Feet.*	*Feet.*
May 16	8 25	1 56	3.0	1.1	20 47	14 24	3.0	1.3
17	8 51	2 43	3.3	1.2	21 38	15 32	2.9	1.0
18	9 43	3 23	3.2	0.7	22 24	16 05	3.0	0.6
19	10 38	4 13	3.4	0.7	23 13	16 40	3.1	0.6
20	11 10	4 53	3.4	0.8	23 43	17 23	3.1	0.5
21	11 49	5 35	3.5	0.8	.. ..	18 04	...	0.7
22	0 31	6 05	3.2	1.1	12 21	18 48	3.4	0.7
23	1 08	6 53	2.8	1.2	13 03	19 23	3.4	1.1
24	1 59	7 18	3.2	1.9	14 00	20 00	3.7	1.8
25	2 38	8 13	3.4	2.3	14 18	21 16	3.6	1.9
26	3 28	9 34	3.0	2.1	15 08	21 39	3.2	1.9
27	4 55	10 28	3.0	2.4	16 38	23 17	3.2	2.2
28	6 28	.. ..	3.2	...	17 53	12 05	3.3	2.6
29	7 06	0 36	3.3	2.3	19 14	13 25	3.1	2.3
30	8 08	1 28	3.4	2.1	20 10	14 21	3.2	2.0
31	8 32	2 17	3.5	2.0	21 02	15 02	3.3	1.9
June 1	9 17	2 57	3.7	2.0	21 43	15 31	3.4	1.7
2	9 43	3 27	3.8	1.9	22 17	15 59	3.5	1.6
3	10 19	4 16	3.8	1.8	22 52	16 37	3.5	1.3
4	10 52	4 37	3.9	1.7	23 22	17 13	3.7	1.5
5	11 31	5 13	4.0	1.9	.. ..	17 52	...	1.5
6	0 07	5 48	3.8	2.0	12 09	18 31	4.2	1.8
7	0 42	6 15	3.9	2.1	12 47	19 11	4.0	1.7
8	1 29	6 53	3.7	2.2	13 22	19 46	4.0	1.8
9	2 11	8 05	3.5	2.1	14 12	20 38	3.6	1.8
10	3 17	8 46	3.4	2.2	15 11	21 37	3.6	2.0
11	4 07	10 12	3.5	2.4	16 02	22 39	3.4	2.0
12	5 27	11 57	3.3	2.1	17 43	.. ..	3.1	...
13	6 32	0 02	3.4	1.9	19 03	12 59	3.1	2.0
14	7 42	1 12	3.6	1.8	20 37	14 12	3.6	1.9
15	8 27	2 13	4.0	2.1	[21 25]	15 01	[3.5]	1.9
16	[9 15]	[3 00]	[3.9]	[1.9]	22 06	[15 45]	3.4	[1.6]
17	10 03	3 45	3.7	1.6	22 57	16 22	3.5	1.3
18	10 43	4 27	3.9	1.7	23 30	17 04	3.5	1.3
19	11 26	5 11	3.9	1.6	.. ..	17 47	...	1.4
20	0 17	5 52	3.6	1.9	12 05	18 34	4.0	1.7
21	0 42	6 37	3.8	2.2	12 55	19 12	4.0	1.8
22	1 27	7 20	3.6	2.1	13 17	19 52	3.8	1.7
23	2 19	7 53	3.4	2.1	14 17	20 16	3.6	2.0
24	2 52	8 37	3.5	2.4	14 47	21 02	3.6	2.1
25	3 32	9 56	3.4	2.4	15 37	21 53	3.3	2.0
26	4 31	10 42	3.1	2.2	16 45	22 36	2.9	2.1
27	5 46	.. ..	3.1	...	18 01	12 11	2.9	2.1
28	6 36	0 06	3.0	2.0	19 28	13 11	2.8	1.9
29	7 59	1 04	3.5	2.1	20 26	14 11	3.3	2.2
30	8 11	2 09	3.6	2.3	21 31	14 51	3.2	1.9

High and low waters at Cape Sheridan, Point Aldrich, Cape Bryant, Cape Morris Jesup, and Fort Conger—Continued.

[Sixtieth meridian time. Brackets indicate interpolated values.]

POINT ALDRICH.

Date.		Forenoon tides.				Afternoon tides.			
		Time of—		Height of—		Time of—		Height of—	
		H. W.	L. W.	H. W.	L. W.	H. W.	L. W.	H. W.	L. W.
1908.		*h. m.*	*h. m.*	*Feet.*	*Feet.*	*h. m.*	*h. m.*	*Feet.*	*Feet.*
Nov.	16	.....	.....	....	....	14 10	19 30	3.50	3.26
	17	3 00	10 30	3.72	3.03	17 20	22 15	3.36	3.04
	18	3 50	11 25	3.28	2.57	18 25	23 45	3.07	2.80
	19	5 05	12 00	3.17	2.56	19 20	.. ..	3.25	....
	20	6 15	0 20	3.42	2.85	19 10	12 50	3.65	2.76
	21	6 55	1 50	3.38	2.86	20 00	13 20	3.57	2.61
	22	8 00	2 10	3.32	2.60	20 00	13 40	3.78	2.62
	23	8 25	3 15	3.31	2.58	20 45	14 20	3.74	2.51
	24	8 55	3 35	3.27	2.51	21 05	14 45	3.88	2.51
	25	9 20	4 10	3.15	2.42	21 55	15 20	3.67	2.30
	26	10 00	4 45	2.98	2.21	22 25	15 25	3.80	2.23
	27	11 05	5 25	3.31	2.47	23 05	16 20	4.12	2.70
	28	11 30	6 05	3.51	2.85	.. ..	16 50	....	2.94
	29	0 10	6 55	4.28	3.07	12 35	17 55	3.76	3.20
	30	0 25	8 05	4.15	3.01	13 40	18 55	3.42	3.03
Dec.	1	1 50	8 50	3.80	2.87	15 10	20 10	3.38	3.05
	2	2 40	10 15	3.63	2.75	16 45	22 20	3.37	2.98
	3	4 05	11 20	3.47	2.61	18 00	23 40	3.42	2.91
	4	5 20	.. ..	3.52	....	18 40	12 05	3.76	2.75
	5	6 50	0 35	3.75	3.06	19 15	12 40	4.31	3.06
	6	7 40	1 45	4.01	3.28	20 10	13 30	4.38	3.17
	7	8 30	2 40	3.86	3.09	20 30	13 50	4.64	3.14
	8	9 10	3 40	3.94	3.20	21 00	14 50	4.43	3.08
	9	9 45	4 15	3.87	2.99	21 55	15 15	4.70	3.14
	10	10 05	4 55	4.05	3.30	22 30	15 50	4.51	3.27
	11	11 00	5 40	3.76	3.06	23 05	16 50	4.32	3.08
	12	11 55	6 00	3.74	3.06	23 55	17 00	4.41	3.25
	13	.. ..	6 35	....	3.19	12 20	17 45	3.79	3.33
	14	0 20	7 30	4.23	3.20	.. ..	.. ..	....	....

High and low waters at Cape Sheridan, Point Aldrich, Cape Bryant, Cape Morris Jesup, and Fort Conger—Continued.

[Sixtieth meridian time. Brackets indicate interpolated values.]

CAPE BRYANT.

Date.		Forenoon tides.				Afternoon tides.			
		Time of—		Height of—		Time of—		Height of—	
		H. W.	L. W.	H. W.	L. W.	H. W.	L. W.	H. W.	L. W.
1909.		*h. m.*	*h. m.*	*Feet.*	*Feet.*	*h. m.*	*h. m.*	*Feet.*	*Feet.*
Jan.	16	(*)	1 37	(*)	4.78	19 52	(*)	5.80	(*)
	17	11 52	2 42	5.58	4.82	19 50	14 22	5.82	5.50
	18	11 52	3 42	5.52	4.58	20 52	15 42	5.83	5.42
	19	†12 15	4 52	5.65	4.30	21 22	16 25	5.78	5.29
	20	†12 22	5 22	5.90	4.26	22 22	17 32	6.10	5.51
	21	†13 12	6 12	6.10	4.37	23 02	18 32	5.91	5.28
	22	.. ..	6 22	....	4.00	13 42	18 52	6.00	5.18
	23	0 42	7 32	5.88	3.92	13 47	20 08	5.88	4.78
	24	1 12	7 32	5.51	3.62	14 42	20 10	5.80	4.85
	25	2 32	8 30	5.81	4.32	15 12	21 12	6.43	5.38
	26	3 02	8 57	6.24	4.85	15 42	21 50	6.64	5.50
	27	3 40	9 42	6.18	5.14	16 18	23 18	6.66	5.45
	28	4 22	10 32	5.93	5.14	16 52	.. ..	6.11	....
	29	4 42	0 42	5.01	4.74	17 22	‡10 52	5.52	4.66
	30	(*)	1 12	(*)	4.51	19 02	(*)	5.54	(*)
	31	(*)	2 32	(*)	4.58	19 32	(*)	5.92	(*)
Feb.	1	11 57	4 42	6.00	4.93	20 52	15 30	6.14	5.77
	2	†12 12	5 12	6.37	4.97	22 12	17 08	6.30	5.91
	3	†12 32	6 02	6.33	4.90	22 32	17 42	6.08	5.68
	4	†13 02	5 57	6.20	4.58	23 22	18 27	5.87	5.37
	5	.. ..	6 37	....	4.26	13 56	18 42	6.08	5.37
	6	0 22	7 12	6.15	4.54	13 42	19 20	6.22	5.12
	7	1 02	7 06	5.98	4.68	14 12	20 07	6.55	5.50
	8	1 40	8 12	6.37	4.87	14 32	20 30	6.48	5.29
	9	1 51	8 31	5.95	4.51	14 51	21 21	6.06	4.92
	10	2 47	8 41	5.75	4.62	15 11	21 31	6.10	5.19
	11	3 21	9 26	5.90	4.99	15 41	22 31	6.00	4.85
	12	4 06	9 57	5.53	4.92	16 11	22 51	6.08	5.21

CAPE MORRIS JESUP.

1909.									
May	13	.. ..	.. ..	....	....	14 03	.. ..	4.36	....
	14	4 43	0 39	3.63	3.56	15 34	‡6 26	4.04	3.61
	15	7 28	0 12	3.67	3.48	16 29	‡9 19	3.92	3.64
	16	7 47	19	3.94	3.50	18 49	‡11 27	4.13	3.84
	17	7 53	1 14	4.33	3.86	19 19	14 48	4.08	3.92
	18	8 24	1 48	4.15	3.68	20 49	15 19	3.76	3.51
	19	8 59	1 49	4.30	3.56	21 58	16 23	3.87	3.58
	20	9 29	2 34	4.52	3.68	21 08	17 29	3.86	3.59
	21	10 34	2 24	4.64	3.68	23 54	18 04	3.97	3.75
	22	11 10	3 38	4.66	3.81	23 18	18 48	3.79	3.66

* Tide becomes diurnal. † Afternoon tide. ‡ Forenoon tide.

High and low waters at Cape Sheridan, Point Aldrich, Cape Bryant, Cape Morris Jesup, and Fort Conger—Continued.

[Sixtieth meridian time. Brackets indicate interpolated values.]

FORT CONGER.

Date.	Forenoon tides.				Afternoon tides.			
	Time of—		Height of—		Time of—		Height of—	
	H. W.	L. W.	H. W.	L. W.	H. W.	L. W.	H. W.	L. W.
1909.	*h. m.*	*h. m.*	*Feet.*	*Feet.*	*h. m.*	*h. m.*	*Feet.*	*Feet.*
June 10	.. ..	.. ..	....	....	.. ..	22 55	....	2.05
11	5 35	11 55	5.47	2.00	18 15	.. ..	4.80	....
12	6 35	0 10	5.30	2.14	19 40	13 10	4.89	1.60
13	7 55	1 40	5.46	2.11	20 55	14 20	5.24	1.48
14	9 00	2 55	5.44	1.75	21 50	15 20	5.94	1.12
15	9 45	3 45	5.78	1.75	22 35	16 15	6.16	1.07
16	10 35	4 35	5.62	1.42	23 25	16 55	6.28	0.65
17	11 20	5 20	5.62	1.03	.. ..	17 35	....	0.52
18	0 10	6 00	6.55	1.08	12 15	18 05	5.75	0.56
19	0 55	6 45	6.53	0.98	12 55	19 00	5.66	0.66
20	1 35	7 15	6.62	1.40	13 25	19 25	5.83	1.05
21	2 00	8 05	6.47	1.59	14 05	20 05	5.63	1.25
22	2 35	8 55	6.09	1.56	14 45	20 40	5.15	1.38
23	3 25	9 30	5.61	1.70	15 35	21 20	4.93	1.87
24	4 00	10 15	5.49	2.03	16 10	22 05	4.70	2.30
25	4 55	11 20	4.99	1.95	.. ..	.. ..	....	....

TIDE WORK UNDERTAKEN BY MIKKELSEN AND LEFFINGWELL.

The intention of Messrs. Mikkelsen and Leffingwell when they set out upon their expedition, in 1906, was to proceed to Banks Land and there establish a base from which to explore Beaufort Sea. They succeeded in reaching Flaxman Island, which thus became the headquarters of the expedition. In the fall and early winter systematic tidal observations were carried on at this island. A few tides were observed near the mouths of the Shaviovei and Aichilei rivers and will be found in the table headed "Short series of tide observations and results" (pp. 76, 77). The former station is near Pole Point, a short distance west of Flaxman Island; the latter is near Icy Point, or a little west of the international boundary.

The time notes in the records show that the observers used practically true one hundred and fiftieth meridian time.

The tide staves were situated upon the south, or inner, side of Flaxman Island.

The record consists of hourly staff readings from October 21 to December 18, 1906, supplemented by quarter-hourly readings near the times of high and low waters, and of somewhat incomplete observations extending from December 18 to December 31.

Brief statements concerning the tidal work of this expedition are given on pages 111, 136, and 437 of Mikkelsen's book entitled "Conquering the Arctic Ice."

Regular observations upon the direction and force of the wind were made along with the tidal work, but these have not as yet been discussed.

Hourly heights of the tide at Flaxman Island, Alaska.

[One hundred and fiftieth meridian time. Brackets indicate interpolated values.]

Hour.	October, 1906.											November, 1906.			
	21.	22.	23.	24.	25.	26.	27.	28.	29.	30.	31.	1.	2.	3.	4.
	Cm.	*Cm.*	*Cm.*	*Cm.*	*Cm.*	*Cm.*	*Cm.*	*Cm.*	*Cm.*	*Cm.*	*Cm.*	*Cm.*	*Cm.*	*Cm.*	*Cm.*
0	86	58	50	57	64	69	67	71	71	64	58	55	73	85	85
1	90	62	55	60	66	70	65	69	68	62	55	54	72	83	87
2	94	67	60	65	68	70	64	66	64	56	50	52	70	82	86
3	91	68	63	68	71	70	63	64	60	54	45	48	66	81	81
4	85	63	62	70	74	72	65	64	57	50	39	42	61	79	75
5	76	61	62	70	74	74	68	65	56	46	38	38	56	76	70
6	70	57	59	70	76	75	71	67	57	46	36	38	54	75	67
7	66	50	56	68	75	76	72	68	60	47	34	37	54	74	62
8	65	48	52	65	74	76	74	72	62	50	39	40	55	70	58
9	63	46	50	63	73	75	76	73	66	53	42	46	59	72	59
10	63	46	50	62	71	73	73	72	68	54	46	50	65	76	60
11	66	48	51	61	69	72	70	70	66	55	49	54	70	81	62
Noon.	68	50	53	62	68	70	70	68	64	55	50	56	74	82	64
13	68	54	58	63	70	68	68	65	61	52	46	58	75	84	68
14	72	54	59	66	71	68	66	62	56	48	42	54	74	86	65
15	68	56	59	68	71	70	64	60	55	43	38	50	71	81	62
16	66	54	60	69	73	71	67	60	53	39	35	47	68	77	59
17	60	54	59	70	74	72	68	61	54	38	32	45	63	74	59
18	56	50	57	69	76	74	70	65	55	38	32	43	62	71	53
19	51	45	55	67	76	76	73	68	56	41	35	46	64	70	48
20	50	42	53	66	74	76	77	69	60	46	40	51	66	71	47
21	50	40	52	64	74	75	79	72	66	50	46	56	67	74	50
22	55	42	51	63	71	73	75	72	68	55	53	62	73	78	54
23	56	46	54	63	70	71	74	72	65	58	56	69	80	81	57

Hour.	November, 1906—Continued.														
	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.
	Cm.	*Cm.*	*Cm.*	*Cm.*	*Cm.*	*Cm.*	*Cm.*	*Cm.*	*Cm.*	*Cm.*	*Cm.*	*Cm.*	*Cm.*	*Cm.*	*Cm.*
0	62	60	60	52	35	28	28	13	24	47	56	57	63	65	65
1	66	65	62	52	37	30	25	10	21	45	50	56	65	67	69
2	68	65	62	55	39	32	22	5	18	40	46	50	60	65	71
3	64	65	65	55	41	34	20	—1	16	36	41	44	55	62	69
4	62	63	66	56	43	35	22	—1	16	33	37	40	50	56	64
5	59	60	66	55	43	36	25	6	17	32	32	35	43	50	59
6	56	60	60	54	41	40	26	9	20	32	32	32	39	45	53
7	50	55	57	52	39	40	28	10	24	36	34	32	38	41	48
8	48	54	57	48	37	40	26	12	26	40	37	35	39	40	46
9	47	54	54	45	37	38	28	15	30	44	38	40	43	42	45
10	50	55	51	43	34	35	26	15	32	47	43	44	48	45	46
11	52	55	52	45	34	32	21	13	32	48	46	48	52	49	50
Noon.	55	58	56	45	34	31	19	10	29	48	44	49	55	51	53
13	58	59	55	45	32	31	16	9	27	44	41	48	55	55	55
14	58	64	55	45	34	31	14	6	24	40	38	44	52	54	54
15	56	64	58	44	34	30	13	5	23	36	33	40	48	51	54
16	53	60	60	46	36	30	14	6	22	35	28	35	44	47	49
17	51	60	55	45	36	33	15	10	25	34	27	32	40	44	44
18	48	55	53	45	38	35	18	12	30	35	30	32	37	41	40
19	47	53	51	42	38	34	20	16	34	40	33	33	37	39	37
20	47	52	49	40	35	36	22	21	40	46	38	34	40	41	35
21	49	52	48	37	33	36	22	24	44	51	45	47	44	45	36
22	50	53	47	36	33	32	20	27	48	54	52	54	53	50	38
23	55	56	50	35	31	30	16	26	48	56	56	60	59	58	43

Hourly heights of the tide at Flaxman Island, Alaska—Continued.

[One hundred and fiftieth meridian time. Brackets indicate interpolated values.]

Hour.	November, 1906—Continued.											December, 1906.		
	20.	21.	22.	23.	24.	25.	26.	27.	28.	29.	30.	1.	2.	3.
	Cm.	*Cm.*	*Cm.*	*Cm.*	*Cm.*	*Cm.*	*Cm.*	*Cm.*	*Cm.*	*Cm.*	*Cm.*	*Cm.*	*Cm.*	*Cm.*
0	49	49	55	60	43	47	53	60	62	55	70	80	84	66
1	54	54	58	62	44	45	50	56	58	53	70	81	85	68
2	58	58	64	62	45	44	48	52	54	49	66	81	82	68
3	58	61	67	62	45	44	47	48	50	45	64	76	[76]	64
4	54	60	70	64	46	46	47	48	46	40	60	75	70	58
5	51	57	68	64	46	49	48	46	44	38	58	74	65	53
6	47	56	66	63	46	51	50	48	45	39	56	74	62	48
7	42	52	[65]	62	48	53	52	50	46	40	58	66	60	43
8	39	48	[63]	58	47	54	54	54	48	42	62	65	58	40
9	40	46	[62]	55	44	54	55	56	52	46	65	69	59	42
10	41	45	[62]	53	41	52	56	56	54	50	68	72	62	43
11	42	48	[66]	50	39	51	55	56	52	52	70	76	63	45
Noon.	45	51	[70]	47	38	49	51	53	49	52	72	80	65	48
13	48	52	[72]	46	37	48	49	50	46	48	69	80	66	49
14	50	56	74	46	39	46	46	46	44	46	67	76	64	48
15	51	57	76	48	40	46	45	45	41	44	64	74	58	44
16	49	58	75	49	42	48	46	44	37	42	61	72	56	42
17	46	56	75	51	45	53	50	46	37	41	58	68	52	39
18	43	56	74	53	48	54	54	50	39	43	56	68	51	36
19	40	52	70	51	51	55	57	53	43	48	58	69	50	35
20	40	50	67	50	52	58	60	58	48	54	64	70	51	36
21	41	49	64	49	51	59	62	62	51	60	69	75	53	38
22	43	49	60	46	50	58	62	62	54	65	75	79	58	40
23	46	52	58	42	48	56	62	65	55	69	80	82	63	45

Hour.	December, 1906—Continued.													
	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.
	Cm.	*Cm.*	*Cm.*	*Cm.*	*Cm.*	*Cm.*	*Cm.*	*Cm.*	*Cm.*	*Cm.*	*Cm.*	*Cm.*	*Cm.*	*Cm.*
0	52	59	60	66	65	52	41	45	60	68	65	70	73	84
1	56	65	65	70	67	54	39	45	58	64	62	68	69	85
2	57	66	66	72	68	54	40	44	56	60	58	63	67	84
3	55	65	66	74	70	55	44	42	54	56	50	57	65	81
4	52	64	64	73	71	56	46	45	54	52	45	51	64	74
5	48	61	62	72	70	56	48	47	57	53	44	47	62	68
6	45	59	61	71	65	56	50	48	60	54	44	46	61	64
7	42	56	59	69	64	54	50	49	62	55	46	47	62	60
8	40	54	57	67	63	52	48	50	64	58	50	52	63	60
9	40	54	56	66	61	49	46	50	66	60	53	56	64	61
10	41	52	55	65	58	48	45	50	64	58	55	59	67	64
11	45	56	58	66	56	44	44	48	60	58	58	61	72	67
Noon.	52	59	59	68	56	41	43	45	59	55	55	62	73	70
13	56	60	61	68	58	41	44	44	57	52	51	60	72	71
14	57	60	63	71	60	43	44	43	54	46	47	55	68	67
15	56	58	64	74	60	44	46	42	52	45	44	53	65	63
16	54	56	64	74	61	45	46	44	55	44	42	50	62	61
17	50	54	63	74	62	46	50	50	57	44	41	47	58	54
18	46	50	62	72	62	48	50	54	59	48	44	47	55	49
19	44	50	61	70	60	49	52	59	64	54	48	52	56	48
20	45	48	59	67	58	48	58	64	69	59	54	58	60	48
21	46	48	60	66	55	45	55	66	72	63	60	64	66	51
22	49	51	61	63	52	44	50	64	72	67	67	71	72	57
23	53	56	62	64	52	42	47	62	71	68	70	74	79	63

High and low waters at Flaxman Island, Alaska.

[One hundred and fiftieth meridian time.]

Date.	Forenoon tides.				Afternoon tides.			
	Time of—		Height of—		Time of—		Height of—	
	H. W.	L. W.	H. W.	L. W.	H. W.	L. W.	H. W.	L. W.
1906.	*h. m.*	*h. m.*	*Cms.*	*Cms.*	*h. m.*	*h. m.*	*Cms.*	*Cms.*
Oct. 21	2 15	9 30	94	63	14 15	20 45	73	49
22	2 30	9 00	68	46	15 15	21 15	56	40
23	3 30	9 30	63	50	16 00	22 00	60	51
24	5 00	10 50	70	61	17 15	22 30	70	63
25	6 20	11 50	76	68	18 30	23 45	76	69
26	7 40	.. ..	77	..	19 15	13 45	76	67
27	9 00	2 00	76	64	20 45	15 00	80	64
28	9 00	3 00	73	63	21 15	15 15	72	59
29	9 45	4 30	69	56	21 30	16 00	68	53
30	11 30	5 30	55	46	23 30	16 45	58	38
31	11 45	7 00	51	34	23 00	17 30	56	31
Nov. 1	.. ..	7 00	..	37	12 45	18 00	58	43
2	0 30	7 00	74	53	13 30	18 00	76	62
3	0 15	8 00	85	70	14 00	19 00	86	70
4	1 00	8 00	87	58	13 00	19 30	68	47
5	2 00	8 15	68	47	14 00	19 15	58	46
6	2 00	8 15	64	53	14 30	20 30	65	52
7	4 35	11 04	67	51	16 00	21 30	60	47
8	3 45	10 00	56	43	16 00	23 15	46	34
9	4 45	10 30	44	34	18 45	.. ..	39	..
10	6 30	0 15	40	28	18 00	‡11 45	35	30
11	9 00	3 00	28	20	20 30	15 00	23	13
12	9 30	3 20	15	—01	22 00	14 45	27	05
13	10 45	4 00	32	16	22 45	15 45	48	22
14	11 15	5 15	48	32	22 45	16 45	57	34
15	11 00	5 45	46	31	23 45	17 00	57	27
16	12 00	6 45	49	32	.. ..	17 45	..	32
17	0 45	7 15	65	37	12 30	18 30	56	36
18	1 00	7 15	67	40	13 00	18 45	55	39
19	2 00	8 30	71	45	13 30	20 00	56	35
20	2 30	8 30	59	38	14 45	20 15	51	39
21	3 15	9 45	61	45	16 00	22 00	58	49
22	4 00	[9 45]	70	[57]	15 00	22 30	76	58
23	5 00	†13 00	64	46	18 00	23 00	53	42
24	5 00	.. ..	46	..	20 00	13 00	52	37
25	8 45	2 30	55	44	21 00	14 30	59	45
26	9 45	3 30	56	47	22 30	15 00	62	45
27	10 45	5 00	56	46	22 45	16 15	66	44
28	10 00	5 00	54	44	22 45	16 30	55	36
29	11 30	5 00	53	38	.. ..	17 15	..	40
30	0 30	6 00	70	56	‡11 45	18 00	73	56

† Afternoon tide. ‡ Forenoon tide.

High and low waters at Flaxman Island, Alaska—Continued.

[One hundred and fiftieth meridian time.]

Date.	Forenoon tides.				Afternoon tides.			
	Time of—		Height of—		Time of—		Height of—	
	H. W.	L. W.	H. W.	L. W.	H. W.	L. W.	H. W.	L. W.
1906.	*h. m.*	*h. m.*	*Cms.*	*Cms.*	*h. m.*	*h. m.*	*Cms.*	*Cms.*
Dec. 1	1 45	7 30	82	64	13 00	18 15	80	68
2	0 30	8 15	85	58	13 00	18 30	66	48
3	1 45	8 00	69	40	13 00	19 30	49	35
4	1 45	8 30	58	39	14 15	19 30	57	44
5	2 15	10 00	67	52	14 00	20 15	60	48
6	2 15	9 30	66	55	15 15	20 30	64	59
7	3 00	9 45	74	65	15 30	22 00	75	63
8	4 00	11 45	71	56	17 30	23 45	62	52
9	5 45	.. ..	57	..	18 30	12 30	49	41
10	6 45	1 15	50	39	20 00	12 15	58	43
11	9 15	3 00	50	42	21 00	15 00	66	42
12	9 15	3 30	66	54	21 00	15 00	72	52
13	9 15	3 45	60	52	22 45	16 30	68	44
14	11 00	5 45	58	44	23 30	16 45	70	41
15	11 45	5 45	62	45	23 30	17 30	75	47
16	11 45	5 30	73	61	.. ..	18 00	..	55
17	0 30	7 30	86	60	13 00	19 30	71	48

METEOROLOGY, NORTHERN COASTS OF GRANT LAND AND GREENLAND.

Regular hourly observations of the thermometer and barometer were carried on day and night by the tide observers at Cape Sheridan, Point Aldrich, Cape Bryant, Cape Morris Jesup, and Fort Conger. Owing to the existence of chronometer and watch corrections, the mean values given in the table below do not pertain to the hours exactly. The approximate amounts, whereby the apparent or given hours are in retard of the true hours for the various months, are indicated beneath the line of the mean values. This item is probably one of little consequence.

In addition to the mean hourly values a brief résumé concerning the temperature and air pressure is added, which is practically the same as that given in an appendix to Peary's book entitled "The North Pole."

Temperature of the air and atmospheric pressure at Cape Sheridan, Point Aldrich, Cape Bryant, Cape Morris Jesup, and Fort Conger, during specified periods, 1908 and 1909.

TEMPERATURE OF THE AIR.

Hour.	CAPE SHERIDAN.								POINT ALDRICH.	CAPE BRYANT.	CAPE MORRIS JESUP.	FORT CONGER.
	Nov. 14-30, 1908.	Dec., 1908.	Jan., 1909.	Feb., 1909.	Mar., 1909.	Apr., 1909.	May, 1909.	June, 1909.	Nov. 17-Dec. 13, 1908.	Jan. 16-Feb. 12, 1909.	May 17-22, 1909.	June 11-25, 1909.
	°	°	°	°	°	°	°	°	°	°	°	°
0	−23.4	−29.2	−31.1	−31.6	−21.4	−20.6	+14.9	+28.7	−31.4	−36.1	+25.7	+32.2
1	−23.5	−29.1	−31.6	−31.2	−21.2	−19.4	+14.3	+28.8	−31.6	−36.5	+26.0	+31.7
2	−23.9	−29.2	−31.5	−31.7	−21.2	−20.5	+15.4	+29.0	−30.7	−37.5	+26.7	+31.9
3	−23.5	−29.0	−31.6	−31.7	−21.2	−18.8	+15.7	+29.1	−30.5	−36.5	+27.0	+33.3
4	−23.1	−29.3	−31.5	−31.3	−20.8	−18.1	+17.7	+29.3	−31.9	−37.1	+28.5	+33.3
5	−23.3	−29.0	−31.5	−31.9	−21.0	−17.3	+17.5	+30.0	−31.5	−37.2	+27.7	+34.9
6	−23.5	−29.0	−30.7	−32.6	−20.8	−16.2	+18.5	+31.0	−31.1	−37.5	+27.3	+34.5
7	−23.9	−29.4	−30.5	−31.5	−20.4	−14.3	+19.6	+31.3	−31.2	−37.5	+27.0	+34.6
8	−23.9	−29.6	−30.6	−31.4	−21.0	−12.6	+19.4	+32.6	−30.7	−37.4	+27.0	+34.6
9	−24.2	−30.2	−30.6	−31.8	−20.1	−11.1	+20.6	+34.0	−31.3	−37.9	+26.7	+34.7
10	−24.9	−29.7	−30.3	−31.5	−19.4	−10.8	+19.7	+33.7	−31.6	−38.0	+28.3	+34.7
11	−24.0	−29.5	−30.1	−31.3	−19.9	−11.4	+19.2	+33.9	−31.9	−37.8	+27.7	+34.8
Noon.	−23.4	−29.1	−29.9	−31.9	−19.7	−13.0	+20.1	+33.8	−32.1	−37.5	+28.2	+36.6
13	−24.0	−28.9	−29.2	−33.0	−19.4	−13.6	+20.0	+33.7	−32.0	−37.0	+27.8	+35.5
14	−24.1	−28.5	−29.7	−33.0	−19.5	−13.7	+19.6	+34.1	−32.3	−35.9	+28.5	+36.1
15	−24.0	−29.0	−30.2	−33.0	−19.3	−13.0	+20.5	+33.5	−32.9	−35.2	+30.2	+35.3
16	−24.0	−29.2	−30.2	−32.4	−20.3	−12.5	+19.9	+32.8	−32.8	−35.4	+32.3	+36.5
17	−24.1	−29.4	−30.7	−32.3	−21.5	−12.8	+19.3	+32.1	−31.8	−35.2	+31.3	+37.6
18	−24.6	−29.2	−30.1	−31.1	−21.8	−14.8	+19.9	+32.2	−32.1	−35.4	+30.7	+36.2
19	−24.1	−29.1	−30.6	−30.6	−22.6	−15.8	+17.3	+31.7	−32.9	−35.8	+30.2	+34.7
20	−24.4	−29.3	−31.0	−30.7	−22.7	−16.9	+15.6	+31.0	−33.6	−36.0	+29.3	+33.8
21	−24.5	−29.1	−30.8	−31.0	−22.0	−18.7	+16.9	+30.2	−34.3	−36.3	+26.2	+33.0
22	−24.5	−29.1	−30.6	−30.9	−21.9	−19.4	+14.3	+30.1	−32.8	−36.6	+24.7	+33.4
23	−24.4	−29.0	−30.2	−31.4	−21.9	−20.1	+16.0	+29.6	−32.1	−36.8	+25.2	+32.6
Means.	−23.96	−29.22	−30.61	−31.71	−20.87	−15.63	+18.00	+31.51	−31.96	−36.68	+27.92	+34.44
Time cor.	−4m.	−2m.	−6m.	−7m.	−10m.	−11m.	−12m.	−13m.	−6m.	−8m.	−12m.	−12m.

Temperature of the air and atmospheric pressure at Cape Sheridan, Point Aldrich, Cape Bryant, Cape Morris Jesup, and Fort Conger, during specified periods, 1908 and 1909—Continued.

ATMOSPHERIC PRESSURE.

[Uncorrected barometric readings.]

Hour.	CAPE SHERIDAN.								POINT ALDRICH.	CAPE BRYANT.	CAPE MORRIS JESUP.	FORT CONGER.
	Nov. 13–30, 1908.	Dec., 1908.	Jan., 1909.	Feb., 1909.	Mar., 1909.	Apr., 1909.	May, 1909.	June, 1909.	Nov. 17–Dec. 13, 1908.	Jan. 16–Feb. 4, 1909.	May 14–22, 1909.	June 11–25, 1909.
	°	°	°	°	°	°	°	°	°	°	°	°
0	29.885	29.741	29.755	29.760	30.273	30.006	30.104	29.782	29.999	29.972	30.472	30.000
1	29.881	29.749	29.747	29.760	30.272	29.998	30.098	29.785	29.999	29.974	30.467	29.989
2	29.886	29.752	29.747	29.750	30.274	30.000	30.098	29.786	29.999	29.976	30.471	29.933
3	29.891	29.751	29.749	29.745	30.275	30.004	30.097	29.792	29.997	29.980	30.467	30.003
4	29.896	29.754	29.761	29.749	30.276	29.998	30.099	29.797	29.999	29.972	30.471	30.005
5	29.907	29.754	29.756	29.757	30.280	29.996	30.101	29.799	30.001	29.970	30.476	30.000
6	29.906	29.757	29.760	29.767	30.284	29.998	30.107	29.804	30.005	29.972	30.475	30.014
7	29.897	29.759	29.753	29.763	30.289	29.996	30.112	29.808	30.004	29.979	30.484	30.020
8	29.897	29.758	29.754	29.769	30.285	29.986	30.119	29.814	30.003	29.974	30.481	30.026
9	29.901	29.758	29.756	29.765	30.284	29.980	30.126	29.813	30.004	29.970	30.479	30.027
10	29.888	29.752	29.749	29.768	30.283	29.978	30.124	29.815	30.002	29.967	30.475	30.027
11	29.893	29.738	29.748	29.762	30.279	29.977	30.122	29.813	30.000	29.964	30.477	30.020
Noon.	29.892	29.735	29.747	29.770	30.278	29.976	30.116	29.810	29.999	29.969	30.469	30.019
13	29.891	29.731	29.744	29.769	30.275	29.975	30.116	29.810	30.000	29.972	30.494	30.016
14	29.889	29.738	29.742	29.766	30.275	29.981	30.110	29.818	30.000	29.976	30.480	30.019
15	29.894	29.738	29.747	29.767	30.275	29.983	30.108	29.821	29.998	29.972	30.482	30.016
16	29.899	29.739	29.752	29.779	30.282	29.984	30.103	29.820	29.993	29.975	30.471	30.021
17	29.909	29.742	29.762	29.783	30.285	29.985	30.104	29.816	29.998	29.980	30.469	30.029
18	29.910	29.744	29.760	29.792	30.289	29.988	30.100	29.812	29.997	29.983	30.463	30.029
19	29.908	29.739	29.761	29.802	30.291	29.993	30.101	29.807	29.991	29.980	30.454	30.027
20	29.911	29.737	29.758	29.795	30.295	29.994	30.095	29.804	29.990	29.982	30.453	30.011
21	29.909	29.739	29.754	29.802	30.292	29.998	30.092	29.801	29.992	29.988	30.452	30.014
22	29.912	29.739	29.744	29.796	30.287	30.007	30.086	29.791	29.990	29.988	30.447	30.013
23	29.919	29.738	29.744	29.789	30.279	30.010	30.082	29.788	29.988	29.982	30.429	30.020
Means.	29.899	29.745	29.752	29.772	30.282	29.991	30.105	29.804	29.998	29.976	30.469	30.013
Time cor.	−4m.	−2m.	−6m.	−7m.	−10m.	−11m.	−12m.	−13m.	−6m.	−8m.	−12m.	−12m.

Temperature of the air and atmospheric pressure at Cape Sheridan, Point Aldrich, Cape Bryant, Cape Morris Jesup, and Fort Conger, during specified periods, 1908 and 1909—Continued.

RÉSUMÉ OF TEMPERATURES.

Station and date.	Maximum.	Minimum.	Mean.
CAPE SHERIDAN.	°	°	°
November 14–30, 1908	− 7	−39	−23.96
December, 1908	− 5	−53	−29.22
January, 1909	− 6	−49	−30.61
February, 1909	− 7	−49	−31.71
March, 1909	+13	−52	−20.87
April, 1909	+13	−37	−15.63
May, 1909	+46	−15	+18.00
June, 1909	+52	+15	+31.51
November 17 to December 13, 1908	− 7	−39	−25.75
January 16 to February 12, 1909	−21	−48	−35.48
May 17 to May 22, 1909	+37	+12	+22.97
June 11 to June 25, 1909	+50	+25	+34.17
POINT ALDRICH NEAR CAPE COLUMBIA.			
November 17 to December 13, 1908	−14	−46	−31.96
CAPE BRYANT.			
January 16 to February 12, 1909	−12	−55	−36.68
CAPE MORRIS JESUP.	°	°	°
May 17 to May 22, 1909	+35	+16	+27.92
FORT CONGER.			
June 11 to June 25, 1909	+54	+28	+34.44
June 11 to June 25, 1882*	+44.4	+26.7	+34.883
June 11 to June 25, 1883*	+39.6	+26.4	+33.393
Observations made in 1875–76 and 1881–1883 (Greely's Report, Vol. II, p. 230):			
December			−28.10
January			−38.24
February			−40.13
March			−28.10
April			−13.55
May			+14.08
June			+32.65

* Greely's Report, Vol. II, pp. 196, 197, 220, 221. Hourly readings used.

From these values we see that from November 17 to December 13, 1908, the average temperature at Point Aldrich was 6.21 degrees lower than the temperature at Cape Sheridan for the same period; that from January 16 to February 12, 1909, the average temperature at Cape Bryant was 1.20 degrees lower than that at Cape Sheridan; that from May 17 to May 22, 1909, the average temperature at Cape Morris Jesup was 4.95 degrees higher than that at Cape Sheridan; and that from June 11 to June 25, 1909, the average temperature at Fort Conger was practically the same as that at Cape Sheridan during this period.

RÉSUMÉ OF BAROMETER READINGS.

Station and date.	Maximum.	Minimum.	Mean.
CAPE SHERIDAN.	°	°	°
November 13–30, 1908	30.42	28.96	29.899
December, 1908	30.27	29.28	29.745
January, 1909	30.42	29.18	29.752
February, 1909	30.59	29.03	29.772
March, 1909	30.89	29.69	30.282
April, 1909	30.58	29.20	29.991
May, 1909	30.60	29.39	30.105
June, 1909	30.21	29.37	29.804
November 17 to December 13, 1908	30.42	29.26	29.866
January 16 to February 4, 1909	30.40	29.18	29.691
May 14 to May 22, 1909	30.52	30.04	30.304
June 11 to June 25, 1909	30.10	29.47	29.834
POINT ALDRICH.			
November 17 to December 13, 1908	30.51	29.35	29.998
CAPE BRYANT.			
January 16 to February 4, 1909	30.10	29.83	29.976
CAPE MORRIS JESUP.	°	°	°
May 14 to May 22, 1909	30.70	30.24	30.469
FORT CONGER.			
June 11 to June 25, 1909	30.19	29.74	30.013
June 11 to June 25, 1882 *	30.129	29.416	29.817
June 11 to June 25, 1883 *	30.218	29.590	29.949
Observations made in 1881–1883 (Greely's Report, Vol. II, p. 166):			
December			29.922
January			29.796
February			29.672
March			29.893
April			30.099
May			30.066
June			29.878

* Greely's Report, Vol. II, pp. 122, 123, 146, 147. Hourly readings are reduced to sea level.

The above tabulation shows that during the month the average fluctuation of the barometer at Cape Sheridan amounts to 1.2 inches, being greatest in February and least in June.

An inspection of the monthly means shows that the barometer at Cape Sheridan is lowest for the months of December and January, or about January 1, and highest about April 1, the range of the fluctuation being about 0.5 inch. These results agree well with those obtained by Greely at Fort Conger and illustrated by a diagram on page 166, Vol. II, of his Report.

From the tabulation made according to hours of the day, there is seen to be a diurnal fluctuation at Cape Sheridan amounting to a little more than one one-hundredth of an inch. The minima of this fluctuation are fairly well defined from November to April and occur at about 2 o'clock both a. m. and p. m.

CHAPTER II.

HARMONIC CONSTANTS FOR ARCTIC SEAS.

The following table contains the principal harmonic constants for all stations north of the sixtieth parallel where such constants are at present available to the writer. The stations are arranged in the order of their longitude. The significance of these constants will be considered in Chapter IV.

For want of space in the body of the table, the harmonics of M_2 and the diurnal component P_1 are, when known, given in the footnotes. A few other components can in some cases be obtained from the published values to which reference is made in the notes.

In this table are also given quantities which show the character of the tide at the various stations, the mean range of tide as computed from the harmonic constants, and the high-water tidal hours. Of these quantities, S_2/M_2 denotes the ratio of the principal solar to the principal lunar tide; N_2/M_2 measures the parallactic or parallax inequality in the amplitude of the tide; $S_2° - M_2°$ and $M_2° - N_2°$ denote ages of the phase and parallax inequalities expressed in degrees; $K_1 + O_1$ is very nearly equal to the average tropic amplitude of the diurnal wave; and $K_1° - O_1°$ denotes the age of the diurnal wave expressed in degrees. The tidal hours are the component hours increased by the longitude of the station if the latter is west and diminished if it is east, the longitude being expressed in hours.

At the end of the table is a supplementary set of values for several stations. The values given earlier in the table are to be preferred to these for various reasons which may be gathered from the footnotes.

Table of harmonic constants, tidal hours, etc.

No.	Station.	Geographic position.			M_2.	$M_2°$.		S_2.	$S_2°$.	N_2.	$N_2°$.	K_1.
		Latitude.	Longitude.									
			Arc.	Time.		Degrees.	Lunar hours.					
		° ′	° ′			°						
		North.	*West.*	*h. m.*	*Ft.*		*h.*	*Ft.*	°	*Ft.*	°	*Ft.*
1	Jan Mayen Island	71 00	8 28	0 34	1.32	328.3	10.94	0.43	18	0.28	300	0.11
2	Nennortalik	60 08	45 16	3 01	2.88	161.0	5.37	1.24	203	.....	.....	0.62
3	Godthaab	64 12	51 44	3 27	4.46	193.0	6.43	1.54	229	0.86	188	0.69
4	Cape Bryant	82 21	55 30	3 42	0.42	4.1	0.14	0.23	47	0.08	350	0.32
5	Cape Sheridan	82 27	61 21	4 05	0.81	303.5	10.12	0.38	352	0.14	275	0.16
6	Polaris Bay	81 36	61 41	4 07	1.80	351.8	11.73	0.83	33	0.35	326	0.40
7	Fort Conger, Discovery Harbor	81 44	64 44	4 19	1.96	335.0	11.17	0.89	19	0.38	309	0.28
8	Port Burwell, Ungava Bay	60 25	64 46	4 19	7.12	263.0	8.77	2.33	305	.....	.....	0.48
9	Kingua Fiord	66 36	67 20	4 29	7.43	158.7	5.30	2.67	202	1.20	144	0.27
10	Point Aldrich, Cape Columbia	83 05	69 35	4 38	0.38	229.9	7.66	0.16	284	0.06	194	0.17
11	Ashe Inlet	62 33	70 35	4 42	11.00	234.0	7.80	3.98	296	.....	.....	0.52
12	Van Rensselaer Harbor	78 37	70 53	4 44	3.37	333.5	11.12	1.49	12	0.70	303	0.85
13	Stupart Bay	61 35	71 32	4 46	9.02	227.0	7.57	3.05	289	.....	.....	0.47
14	Port Foulke	78 18	73 00	4 52	3.64	321.8	10.73	1.52	5	0.67	293	1.05
15	Port Boncherville, Nottingham Island	62 12	77 28	5 10	4.74	260.0	8.67	1.77	321	.....	.....	0.22
16	Port Laperrière, Digges Island	62 34	78 01	5 12	3.09	257.0	8.57	1.24	316	.....	.....	0.14
17	Port Leopold, Barrow Strait	73 50	90 20	6 01	2.00	338.0	11.27	0.64	29	0.42	306	0.90
18	Beechey Island	74 43	91 54	6 08	2.00	347.0	11.57	0.69	34	0.43	315	0.90
19	Port Kennedy, Bellot Strait	72 01	94 15	6 17	1.80	356.2	11.87	0.60	49	0.28	299	1.18
20	Northumberland Sound, Penny Strait	76 52	97 00	6 28	0.66	359.9	12.00	0.23	32	0.13	342	0.31
21	Winter Harbor	74 47	111 00	7 24	1.21	33.5	1.12	0.71	83	0.17	355	0.22
22	Kokinhenic Island	60 18	145 03	9 40	1.12	11.9	0.40	0.28	51	0.26	348	0.41
23	Pete Dahl Slough	60 23	145 24	9 42	3.52	12.7	0.42	1.05	46	0.64	358	1.57
24	Orca, Prince William Sound	60 35	145 41	9 43	4.52	357.7	11.92	1.61	40	0.88	335	1.53
25	Flaxman Island	70 11	145 50	9 43	0.22	354.3	11.81	0.09	37	0.03	331	0.08
26	Orca, Cape Whitshed	60 28	145 55	9 44	4.42	8.4	0.28	1.56	44	0.80	344	1.51
27	Camp April	60 32	146 00	9 44	4.54	356.0	11.87	1.53	32	0.91	331	1.47
28	Valdez Arm	61 07	146 27	9 46	4.51	353.7	11.79	1.52	25	0.86	327	1.66
29	Rocky Point	60 57	146 42	9 47	4.46	358.8	11.96	1.50	52	.....	.....	1.55

1. Hourly gauge readings published in Die Internationale Polarforschung, 1882–83, Vol. I, III Theil, pp. 4–9. Series of hourly values analyzed: Apr. 28 to Aug. 10, 1883; 104½ days. M_4=0.004 ft., $M_4°$=358°; M_6=0.017 ft., $M_6°$=270°. Analysis made in Coast and Geodetic Survey Office.

2. Harmonic constants published in Danske Konebaadsexpedition til Grønlands Østkyst, 1883–85, Observations Météorologiques et Nautiques, Flux et reflux de la mer à quelques points de la Côte Est du Gronland, p. 42; also in Proc. Roy. Soc., Vol. 45 (1888–89), p. 569.

3. Harmonic constants published in Observations Internationales Polaires, 1882–83. Expédition Danoise, Tome II, 1, II, p 3; also in Proc. Roy. Soc., Vol. 45 (1888–89), p. 569. Series of values analyzed: July 16 to Aug. 31, 1883; 6 weeks.

4. Hourly and other staff readings made by Ross G. Marvin of the 1908–9 Peary Expedition. Series of hourly values analyzed: Jan. 16 to Feb. 13, 1909; 29 days. M_4=0.018 ft., $M_4°$=320°; M_6=0.008 ft., $M_6°$=274°. Analysis made in Coast and Geodetic Survey Office.

5. Hourly and other staff readings made by D. B. Macmillan and Jack Barnes, of the Peary Expedition, 1908–9. Series of hourly values analyzed: Nov. 13, 1908, to May 23, 1909; 191½ days. M_4=0.012 ft., $M_4°$=358°; M_6=0.008 ft., $M_6°$=180°; P_1=0.053 ft., $P_1°$=296°. Analysis made in Coast and Geodetic Survey Office.

6. Hourly gauge readings published in Scientific Results of the U. S. Arctic Expedition, Vol. 1, pp.21–35. Series of hourly values analyzed: Dec. 3, 1871, to Feb. 27, 1872; 87 days, and March 6 to May 31, 1872; 87 days. M_4=0.017 ft., $M_4°$=31°; M_6=0.006 ft., $M_6°$=118°. Analyses made in Coast and Geodetic Survey Office.

7. Harmonic constants published in Report on the Proceedings of the U. S. Expedition to Lady Franklin Bay, Vol. II, p. 697. Series of hourly staff readings analyzed: Aug. 20, 1881, to Aug. 25, 1882. M_4=0.018 ft., $M_4°$=322°; P_1=0.077 ft., $P_1°$=233°.

8. Harmonic constants published in Proc. Roy. Soc., Vol. 45 (1888–89), p. 570. Bi-hourly heights observed. Length of series analyzed, 2 weeks, 1885.

9. Harmonic constants published in Die Internationale Polarforschung, 1882–83, Proc. Roy. Soc., Vol. 45 (1888–89), p. 569. Hourly values from bi-hourly and other readings were analyzed: July 22 to Sept. 8, 1883; 41 days.

10. Hourly and other staff readings made by D. B. Macmillan, of the Peary Expedition. Series of hourly values analyzed: Nov. 16 to Dec. 12, 1908; 29 days. M_4=0.009 ft., $M_4°$=285°; M_6=0.004 ft., $M_6°$=184°. Analysis made in Coast and Geodetic Survey Office.

11. Harmonic constants published in Proc. Roy. Soc., Vol. 45 (1888–89), p. 570. Bi-hourly and other heights observed. Length of series analyzed, 1 month, 1886.

12. Hourly gauge readings published in Smithsonian Contributions to Knowledge (1860), Tidal Observations in the Arctic Seas, pp. 6–36. Two series of hourly values analyzed: Oct. 19 to Dec. 15, 1853, and May 7 to July 3, 1854; each 58 days in length. M_4=0.058 ft., $M_4°$=185°; M_6=0.039 ft., $M_6°$=142°. Analyses made in Coast and Geodetic Survey Office.

13. Harmonic constants published in Proc. Roy. Soc., Vol. 45 (1888–89), p. 570. Bi-hourly and other heights observed. Length of series analyzed, 2 weeks, 1886.

Table of harmonic constants, tidal hours, etc.

$K_1°$.	O_1.	$O_1°$.	S_2/M_2.	N_2/M_2.	O_1/K_1.	K_1+O_1.	$S_2°-M_2°$.	$M_2°-N_2°$.	$K_1°-O_1°$.	Mean range of tide.	Tidal hour. Semidiurnal. M_2.	Tidal hour. Semidiurnal. M_2 & harmonics.	Tidal hour. Diurnal. K.	Tidal hour. Diurnal. O.	No.
°	*Ft.*	°				*Ft.*	°	°	°						
97	0.20	49	0.33	0.21	1.86	0.30	50	29	47	2.84	11.51	11.53	7.00	3.85	1
114	0.36	74	0.43	.....	0.58	0.98	42	.....	40	.....	8.39	.....	10.62	7.95	2
127	0.30	81	0.35	0.19	0.44	0.99	36	5	46	9.5	9.88	.....	11.92	8.85	3
286	0.14	262	0.55	0.19	0.44	0.46	43	14	25	0.98	3.84	3.62	22.77	21.15	4
298	0.09	278	0.47	0.17	0.56	0.25	48	29	20	1.79	2.20	2.24	23.95	22.63	5
246	0.15	209	0.46	0.19	0.38	0.55	41	26	37	3.93	3.84	3.88	20.51	18.04	6
222	0.09	199	0.45	0.19	0.32	0.37	44	26	23	4.3	3.49	3.49	19.12	17.59	7
114	0.19	157	0.33	.....	0.40	0.67	42	.....	−43	15.12	1.09	.....	11.92	14.79	8
32	0.09	47	0.36	0.16	0.33	0.36	43	15	−15	15.9	9.78	.....	6.62	7.61	9
311	0.11	281	0.44	0.16	0.65	0.28	54	36	30	0.83	12.31	12.25	1.36	23.36	10
108	0.21	349	0.36	.....	0.40	0.73	62	.....	119	23.54	12.50	.....	11.90	3.97	11
193	0.42	150	0.44	0.21	0.49	1.27	38	30	43	7.32	3.85	3.72	17.60	14.73	12
103	0.31	6	0.34	.....	0.66	0.78	62	.....	97	19.21	12.34	.....	11.64	5.17	13
187	0.41	145	0.42	0.18	0.39	1.46	43	29	42	7.91	3.60	3.60	17.33	14.53	14
91	0.25	17	0.37	.....	1.14	0.47	61	.....	74	10.16	1.84	.....	11.24	6.30	15
64	0.04	126	0.40	.....	0.29	0.18	59	.....	−62	6.66	1.77	.....	9.47	13.60	16
216	0.44	164	0.32	0.21	0.49	1.34	51	32	52	4.31	5.30	5.27	20.43	16.96	17
243	0.49	162	0.35	0.22	0.54	1.39	47	32	81	4.33	5.70	5.66	22.33	16.93	18
245	0.58	178	0.33	0.15	0.49	1.76	53	58	67	3.84	6.16	5.95	22.62	18.15	19
274	0.15	213	0.34	0.20	0.48	0.46	32	18	61	1.43	6.47	6.50	24.74	20.67	20
267	0.10	130	0.59	0.14	0.45	0.32	49	38	138	2.73	8.52	8.52	1.20	16.07	21
157	0.34	178	0.25	0.23	0.83	0.75	39	24	−21	2.45	10.07	9.89	20.14	21.54	22
137	0.84	121	0.30	0.18	0.54	2.41	33	15	16	7.73	10.12	9.87	18.83	17.77	23
130	0.98	115	0.36	0.19	0.64	2.51	42	23	15	9.88	9.64	9.79	18.39	17.39	24
7	0.09	45	0.43	0.14	1.14	0.17	43	23	−38	0 48	9.53	9.43	10.25	12.72	25
130	1.06	118	0.35	0.18	0.70	2.57	36	24	12	9.85	10.01	9.79	18.40	17.60	26
124	0.98	110	0.34	0.20	0.67	2.45	36	25	14	9.73	9.60	9.65	18.00	17.06	27
123	0.97	111	0.34	0.19	0.58	2.63	31	27	12	9.66	9.56	9.58	17.97	17.17	28
117	1.05	124	0.34	.....	0.68	2.60	53	.....	− 7	.....	9.74	9.68	17.58	18.05	29

14. Hourly or high-and-low water readings published in Smithsonian Contributions to Knowledge, 196, Physical Observations in the Arctic Seas, pp. 118–129. Two series of hourly values analyzed: Nov. 22 to Dec. 20, 1860, and June 7 to July 5, 1861, each 29 days in length. Analyses made in Coast and Geodetic Survey Office.

15. Harmonic constants published in Proc. Roy. Soc., Vol. 45 (1888–89), p. 570. Bi-hourly and other heights observed. Length of series analyzed, 1 month, 1886.

16. Ibid., Vol. 45 (1888–89), p. 570. Bi-hourly and other heights observed. Length of series analyzed, 2 weeks, 1886.

17. Ibid., Vol. 39 (1885), pp. 174, 175; 194, 195. Nov. 1, 1848, to July 31, 1849. M_4=0.015 ft., $M_4°$=202°; P_1=0.216 ft., $P_1°$=218°.

18. Ibid., Vol. 39, pp. 174, 175; 194, 195, Nov. 2, 1858, to Feb. 28, 1859. M_4=0.024 ft.; $M_4°$=268°; P_1=0.215 ft.; $P_1°$=222°.

19. Hourly gauge readings published in Phil. Trans., Vol. 165 (1875), pp. 340–345. Series of hourly values analyzed: July 1 to 29, 1859; 29 days. M_4=0.094 ft.; $M_4°$=214°; M_6=0.060 ft.; $M_4°$=164°. Analysis made in Coast and Geodetic Survey Office.

20. High and low waters published in the Phil. Trans. Royal Soc., Vol. 165 (1875), pp. 318–320. Series used: May 27 to June 24, 1853; 29 days. Analysis made in Coast and Geodetic Survey Office according to a method described on pp. 569–572, Report of Superintendent for 1897 (Manual, Pt. II), and pp. 494, 495, Report for 1907 (Manual, Pt. V).

21. Ranges of tide published in Capt. Parry's Journal of a Voyage for the Discovery of the North-West Passage, etc. (London, 1821). Series used: May 5 to June 2, 1820; 29 days. Analysis made in Coast and Geodetic Survey Office according to a method described on pp. 569–572, Report of Superintendent for 1897 (Manual, Pt. II), and pp. 494, 495, Report for 1907 (Manual, Pt. V).

22. Staff readings by Coast and Geodetic Survey. Series of hourly values analyzed: June 10 to July 8, 1898; 29 days. M_4=0.319 ft.; $M_4°$=13°; M_6=0.052 ft.; $M_6°$=346°. Analysis made in Coast and Geodetic Survey Office.

23. Staff readings by Coast and Geodetic Survey. Series of hourly values analyzed: Aug. 26 to Sept. 24, 1898; 29 days. M_4=0.188 ft., $M_4°$=296°; M_6=0.084 ft., $M_6°$=355°. Analysis made in Coast and Geodetic Survey Office.

24. Staff readings by Coast and Geodetic Survey. Series of hourly values analyzed: May 24 to June 21, 1898; 29 days. M_4=0.0167 ft., $M_4°$=138°; M_6=0.087 ft., $M_6°$=30°. Analysis made in Coast and Geodetic Survey Office.

25. Hourly and other staff readings by Anglo-American Expedition, under Ejnar Mikkelsen and Ernest de K. Leffingwell. Series of hourly values analyzed: Oct. 21 to Dec. 12, 1906; 58 days. M_4=0.007 ft., $M_4°$=274°; M_6=0.004 ft., $M_6°$=141°. Analysis made in Coast and Geodetic Survey Office.

26. Staff readings by Coast and Geodetic Survey. Series of hourly values analyzed: July 1 to July 29, 1899; 29 days. M_4=0.363 ft., $M_4°$=231°; M_6=0.143 ft., $M_6°$=11°. Analysis made in Coast and Geodetic Survey Office.

27. Staff readings by Coast and Geodetic Survey. Series of hourly values analyzed: May 22 to June 19, 1900; 29 days. M_4=0.061 ft., $M_4°$=138°; M_6=0.023 ft., $M_6°$=129°. Analysis made in Coast and Geodetic Survey Office.

28. Staff readings by Coast and Geodetic Survey. Series of hourly values analyzed: Aug. 9 to Sept. 6, 1901; 29 days. M_4=0.090 ft., $M_4°$=141°; M_6=0.029 ft., $M_6°$=190°. Analysis made in Coast and Geodetic Survey Office.

29. Hourly staff readings by Coast and Geodetic Survey. Series of hourly values analyzed: June 22 to July 20, 1902; 29 days. Analysis made in Coast and Geodetic Survey Office.

Table of harmonic constants, tidal hours, etc.—Continued.

No.	Station.	Geographic position.			M_2.	$M_2°$.		S_2.	$S_2°$.	N_2.	$N_2°$.	K_1.
		Latitude.	Longitude. Arc.	Longitude. Time.		Degrees.	Lunar hours.					
		° ′	° ′	h. m.	Ft.	°	h.	Ft.	°	Ft.	°	Ft.
		North.	West.									
1	Point Barrow (Ooglaamie)	71 18	156 40	10 27	0.17	336.2	11.21	0.07	16	0.03	312	0.05
2	St. Michael	63 29	162 02	10 48	0.55	235.4	7.85	0.12	338	0.18	178	1.35
3	Point Clarence	65 14	166 24	11 06	0.47	213.4	7.11	0.03	346	0.14	133	0.25
4	Pitlekaj	67 03	173 30	11 34	0.08	4.1	0.14	0.03	60	0.02	334	0.04
		North.	East.									
5	Teplitz Bay	81 47	57 56	3 52	0.51	178.0	5.93	0.21	229	0.10	155	0.10
6	Cape Flora	79 57	49 59	3 20	0.43	278.8	9.30	0.14	333	0.08	245	0.22
7	Port Ekaterininskoi	69 13	33 27	2 14	3.77	192.0	6.40	1.15	237	0.82	162	0.46
8	Vardö	70 20	31 06	2 04	3.29	163.5	5.45	0.92	208	0.72	130	0.38
9	Hangö	59 49	22 58	1 32	0.43	217.0	7.23	0.15	244	0.07	191	0.22
10	Ratan	64 00	20 55	1 24	0.08	13.0	0.43	0.05	2	.....	.....	0.45
11	Björn	60 38	17 58	1 12	0.23	74.0	2.47	0.14	145	.....	.....	0.20
12	Draghallan	62 20	17 28	1 10	0.23	38.0	1.27	0.11	118	.....	.....	0.18
13	Treurenberg	80 00	16 52	1 07	0.92	98.5	3.28	0.35	150	0.23	71	0.24
14	Mossel Bay	79 53	16 04	1 04	1.15	74.5	2.48	0.43	121	0.22	42	0.23
15	Fineide	67 17	15 30	1 02	1.74	57.0	1.90	0.50	106	0.34	36	0.26
16	Kabelvaag	68 13	14 30	0 58	2.98	3.5	0.12	1.08	44	0.61	340	0.34
17	Bodoe	67 17	14 23	0 58	2.84	356.5	11.88	0.98	35	0.57	334	0.34
18	Port Virgo	79 43	10 44	0 43	1.36	38.2	1.27	0.26	70	0.25	13	0.09
19	Bergen	60 24	5 18	0 21	1.44	297.5	9.92	0.52	334	0.28	270	0.11
		North.	West.									
20	Cape Sheridan	82 27	61 21	4 05	0.77	301.2	10.04	0.37	347	0.14	280	0.17
21	Fort Conger	81 44	64 45	4 19	1.96	334.5	11.15	0.84	16	.....	.....	.....
		North.	East.									
22	Teplitz Bay	81 47	57 59	3 52	0.47	168.4	5.61	0.17	230	.....	.....	0.09
23	Treurenberg*	80 00	16 52	1 07	1.07	43.0	1.43	0.20	99	0.30	81	0.55
24	Treurenberg*	80 00	16 52	1 07	0.92	64.6	2.15	0.33	117	0.21	34	0.27
25	Port Virgo*	79 43	10 44	0 43	1.36	15.0	0.50	0.47	68	0.26	344	0.07

1. Half-hourly readings published in Report of the International Polar Expedition to Point Barrow, Alaska, pp. 679-682. Series of hourly values analyzed: Feb. 26 to June 10, 1883; 104½ days. M_4=0.003 ft., $M_4°$=319°; M_6=0.003 ft., $M_6°$=106°. Analysis made in Coast and Geodetic Survey Office.

2. Automatic record by Coast and Geodetic Survey. Three series of hourly values analyzed: May 15 to July 10, 1891; 58 days. July 16 to Aug. 13, 1898; 29 days; and July 1 to Aug. 27, 1899; 58 days. M_4=0.042 ft., $M_4°$=150°; M_6=0.018 ft., $M_6°$=266°. Analyses made in Coast and Geodetic Survey Office.

3. Automatic gauge records by Coast and Geodetic Survey. Series of hourly values analyzed: Aug. 26 to Sept. 23, 1900; 29 days. M_4=0.097 ft., $M_4°$=301°; M_6=0.028 ft., $M_6°$=212°. Analysis made in Coast and Geodetic Survey Office.

4. Hourly gauge readings published in Vega-expeditionens vetenskapliga arbeten, Bd. 5. Series of hourly values analyzed: Dec. 7, 1878 (European date) to June 7, 1879; 162½ days. M_4=0.0049 ft., $M_4°$=144°; M_6=0.0088 ft., $M_6°$=3°. Analysis made in Coast and Goedetic Survey Office.

5. Harmonic constants published in The Ziegler Polar Expedition, Scientific Results, p. 575. Series of hourly values analyzed: April 1 to May 28, 1904; 58 days. M_4=0.005 ft., $M_4°$=357°; M_6=0.004, $M_6°$=264°.

6. Ibid., p. 574. Series of hourly values analyzed: May 21 to Sept. 2, 1904; 104½ days. M_4=0.006 ft., $M_4°$=189°; M_6=0.008 ft., $M_6°$=162°.

7. Harmonic constants published in annual tide tables for the year 1910, issued by the Russian Hydrographic Office, St. Petersburg. P_1=0.16 ft., $P_1°$=280°.

8. Harmonic constants published in Resultater af Vandstands-Observationer paa den Norske Kyst, Hefte VI (1904). Series used: 369 days beginning June 1, 1881, and 369 days beginning April 1, 1891. M_4=0.039 ft., $M_4°$=202°; P_1=0.115 ft., $P_1°$=282°.

9. Harmonic constants published in Untersuchungen zur Kenntnis der Wasserbewegungen und der Wasserumsetzung in den Finland Umgebenden Meeren, by Rolf Witting (Helsingfors, 1908), p. 205. Hourly observations. Period analzyed, 1 year. 1903. M_4=0.023 ft., $M_4°$=128°; P_1=0.14 ft., $P_1°$=122°.

10. Ibid., p. 206. Observations taken at 7 a. m., 2 p. m., and 9 p. m. Period analyzed, 2 years, 1904 and 1905. P_1=0.15 ft., $P_1°$=346°.

11. Ibid., p. 206. Observations taken at 7 a. m., 2 p. m., and 9 p. m. Period analyzed, 2 years, 1904 and 1905. P_1=019 ft., $P_1°$=231°.

12. Ibid., p. 206. Observations taken at 7 a. m., 2 p. m., and 9 p. m. Period analyzed, 2 years, 1904 and 1905. P_1=0.10 ft., $P_1°$=158°.

13. Hourly gauge readings published in Missions Scientifiques pour la mesure d'un are de méridien au Spitzberg. Mission suédoise Tome I, Section V, pp. 34 to 37. Series of hourly values analyzed: Mar. 30 to June 12, 1900; 104½ days. M_4=0.032 ft., $M_4°$=127°; M_6=0.038 ft., $M_6°$=61°. Analysis made in Coast and Geodetic Survey Office.

Table of harmonic constants, tidal hours, etc.—Continued.

$K_1°$.	O_1.	$O_1°$.	$\frac{S_2}{M_2}$.	$\frac{N_2}{M_2}$.	$\frac{O_1}{K_1}$.	K_1+O_1.	$S_2°-M_2°$.	$M_2°-N_2°$.	$K_1°-O_1°$.	Mean range of tide.	Tidal hour. Semidiurnal. M_2.	Tidal hour. Semidiurnal. M_2 & harmonics.	Tidal hour. Diurnal. K.	Tidal hour. Diurnal. O.	No.
°	*Ft.*	°				*Ft.*	°	°	°						
347	0.05	20	0.40	0.17	0.97	0.11	40	25	327	0.36	9.65	9.67	9.55	11.76	1
297	0.76	247	0.22	0.32	0.56	2.11	103	57	50	1.16	6.65	6.65	6.62	3.28	2
115	0.12	287	0.06	0.30	0.48	0.37	133	80	−172	1.04	6.21	5.06	18.77	6.23	3
233	0.04	243	0.38	0.19	1.10	0.08	56	30	350	0.20	11.71	11.74	3.10	3.79	4
26	0.04	49	0.41	0.19	0.42	0.14	51	23	336	1.10	2.06	2.11	21.85	23.42	5
30	0.07	47	0.83	0.19	0.33	0.30	54	34	343	0.95	5.97	6.02	22.66	23.82	6
280	.....	.....	0.31	0.22	.....	.....	45	30	.....	7.98	4.17	.....	16.44	.....	7
286	0.10	92	0.28	0.22	0.26	0.48	44	34	−166	6.94	3.38	.....	17.00	4.06	8
6	0.41	39	0.35	0.16	1.84	0.63	27	26	− 33	0.98	5.70	5.85	22.87	1.07	9
7	0.36	320	0.62	.....	0.80	0.81	− 11	.....	47	.....	11.04	.....	23.07	19.94	10
139	0.18	53	0.61	.....	0.90	0.38	71	.....	86	0.55	1.27	.....	8.07	2.33	11
123	0.11	169	0.48	.....	0.61	0.29	80	.....	− 46	0.54	12.10	.....	7.03	10.10	12
270	0.07	70	0.38	0.25	0.29	0.31	52	27	−160	1.92	2.16	2.24	16.88	3.54	13
65	0.09	239	0.37	0.18	0.39	0.32	46	32	−174	2.45	1.41	.....	3.26	14.86	14
250	0.08	102	0.29	0.20	0.31	0.34	49	21	148	3.75	12.87	12.82	15.64	5.77	15
212	0.13	54	0.36	0.20	0.38	0.47	40	24	158	6.39	11.15	11.04	13.16	2.63	16
208	0.13	32	0.35	0.20	0.38	0.47	39	22	176	6.09	10.91	10.75	12.90	1.16	17
215	0.04	12	0.19	0.18	0.44	0.13	32	25	−157	2.87	12.55	12.56	13.62	0.08	18
170	0.10	18	0.36	0.19	0.91	0.21	36	28	152	3.08	9.57	.....	10.98	0.85	19
294	0.09	284	0.49	0.18	0.53	0.26	46	21	11	1.72	2.13	2.24	23.68	23.01	20
.....	.....	.....	0.43	.....	.....	.....	42	.....	.....	.....	3.47	.....	.....	.....	21
11	0.05	354	0.36	.....	0.56	0.14	62	.....	17	1.14	1.74	.....	20.86	19.73	22
219	0.20	41	0.18	0.28	0.36	0.75	56	−38	178	.....	12.31	.....	13.48	1.61	23
255	0.09	138	0.36	0.23	0.33	0.36	52	31	117	.....	1.03	.....	15.88	8.09	24
216	0.03	338	0.35	0.19	0.39	0.11	53	31	−122	.....	11.78	.....	13.68	21.81	25

14. Harmonic constants published in Bihang till Kongl. Svenska Vetenskaps-Akademiens Handlinger, Vol. 15, Part I, No. II (1889–90), also in Mission Scientifique, p. 22. Series analyzed: 38 days beginning Oct. 20, 1872, and 66 days beginning Feb. 18, 1873. $K_1°$ and $O_1°$ should be altered by 180°. Cf. a remark upon p. 560, Proc. Roy. Soc., Vol. 45 (1889). The observations as published begin at midnight, and the ζ's refer to this hour, as is explicitly stated. But the V_0+u must have been taken for noon in order to give the κ's as there published, where $\kappa=\zeta+V_0+u$. Hence epochs of diurnals must be altered by 180°.

15. Harmonic constants published in Bihang till Kongl. Svenska Vetenskaps-Akademiens Handlinger, Vol. 15 (1889–90). Series used: 369 days beginning June 1, 1896, and 350 days beginning Dec. 1, 1897. $M_4=0.039$ ft., $M_4°=61°$; $M_6=0.039$ ft., $M_6°=179°$; $P_1=0.074$ ft., $P_1°=236°$.

16. Ibid. Series used: 369 days beginning Dec. 1, 1884, and 369 days beginning Feb. 7, 1889. $M_4=0.141$ ft., $M_4°=323°$; $P_1=0.090$ ft., $P_1°=202°$.

17. Ibid. Series used: 369 days beginning June 1, 1896, and 369 days beginning Jan. 1, 1900. $M_4=0.162$ ft., $M_4°=292°$; $P_1=0.095$ ft., $P_1°=194°$.

18. Hourly gauge readings published in Missions Scientifiques pour la mesure d'un arc dé meridien au Spitzberg; Mission suédoise Tome I, Section V, pp. 56, 57. Series of hourly values analyzed: June 9 to July 7, 1897; 29 days. $M_4=0.006$ ft., $M_4°=168°$; $M_6=0.016$ ft., $M_6°=107°$. Analysis made in Coast and Geodetic Survey Office.

19. Harmonic constants published in Resultater of Vandstands-Observationer paa den Norska Kyst, Hefte VI (1904). Series used: 369 days beginning Dec. 27, 1884, and 369 days beginning Dec. 1, 1893. $P_1=0.036$ ft., $P_1°=152°$.

20. Hourly and other staff readings made by Ross G. Marvin, of the Peary Expedition, 1905–6. Series of hourly values analyzed: Nov. 4 to Dec. 2, 1905; 29 days. $M_4=0.019$ ft., $M_4°=325°$; $M_6=0.012$ ft., $M_6°=208°$. Analysis made in Coast and Geodetic Survey Office.

21. Hourly and other staff readings made by D. B. Macmillan, of the Peary Expedition, 1908–9. Series of hourly values analyzed: June 11 to 25, 1909; 15 days. $M_4=0.012$ ft., $M_4°=320°$. Analysis made in Coast and Geodetic Survey Office.

22. Harmonic constants published in Osservazioni Scientifiche eseguite durante la Spedizione Polare di S. A. R. Luigi Amedeo di Savoia Duca degli Abruzzi (Milan, 1903, pp. 167, 177), also in Scientific Results of the Ziegler Polar Expedition, 1903–1905, p. 575. Sept. 19 to Oct. 17, 1899; March 16 to April 3, 1900; and June 3 to 27, 1900.

23. Harmonic constants published in Missions Scientifiques pour la mesure d'un arc de méridien au Spitzberg; Mission suédoise Tome I, Section V., p. 25. Aug. 23 to Sept. 13, 1899.

24. Ibid., p. 22. March 29 to July 12, 1900.

25. Ibid., p. 54. June 8 to July 12, 1897.

* These epochs or angles for Treurenberg, as well as those for Port Virgo, are evidently erroneous.

CHAPTER III.

NONHARMONIC TIDAL QUANTITIES, AND THE SET OF THE CURRENTS.

REMARKS ON NONHARMONIC METHODS OF REDUCING OBSERVATIONS.

In computing the lunitidal intervals, the times of high and low water are supposed to be referred to the local times of the transit of the moon across the meridian of the place. But in making the observations, time other than local is frequently used, especially the time pertaining to some standard or particular meridian whose west longitude in hours may here be denoted by S.

The transits used in the tabulations may belong to any meridian. Let the west longitude of this meridian expressed in hours be denoted by E, the initial of the word "ephemeris."

In rare instances, the times of the transits across the given meridian, E, are expressed in time belonging to some other meridian whose west longitude, in hours, may be denoted by T.

L denotes the west longitude of the station expressed in hours.

When concerned with east longitudes, write the minus sign before the values of S, E, T, and L.

The correction to change observation time into local time is $S-L$, and the correction to the lunitidal intervals, due to the motion of the moon in her orbit while passing from the meridian E to the meridian L, is $0.035\ (E-L)$. The entire interval correction (unless the transits are expressed in other than E-meridian time), is

$$S-L+0.035\ (E-L). \tag{1}$$

If the transits across the E-meridian are given in T-meridian time, they are reduced to E-meridian time by adding $T-E$; the above interval correction will be increased by $E-T$. For the general case the entire interval correction thus becomes

$$S-L+0.035\ (E-L)+E-T. \tag{2}$$

In order to obtain directly an independent determination of the lunitidal interval, observations should be continued at least a fortnight or semilunation. By using multiples of this period, the accuracy of the determination will, of course, be increased. When only a few high and low waters have been observed, a correction must be applied to the intervals to allow for this circumstance. This is easily done if the station in question is located near a station whose tides are well known and for which observations or predictions can be procured covering the period of the given observations.

When such is not the case, the principal correction to the interval can be obtained by means of tables given on pages 375 and 376, Coast and Geodetic Survey Report for 1897, or from the same tables given in the Introduction to the annual Tide Tables published by the Survey; but before using these we must make some estimate of the age of the tide and of the values of the mean, spring, and neap ranges.

The age of tidal inequality is the time by which its appearance follows the occurrence of the corresponding inequality in the tide-producing forces.

In harmonic notation, the respective ages of the phase, "parallactic," and diurnal inequalities are

$$\frac{S_2{}^\circ - M_2{}^\circ}{s_2 - m_2},\ \frac{M_2{}^\circ - N_2{}^\circ}{m_2 - n_2},\ \frac{K_1{}^\circ - O_1{}^\circ}{k_1 - o_1}, \tag{3}$$

or—

$$0.984\ (S_2{}^\circ - M_2{}^\circ),\ 1.837\ (M_2{}^\circ - N_2{}^\circ),\ 0.911\ (K_1{}^\circ - O_1{}^\circ), \tag{4}$$

mean solar hours.

If high water heights are tabulated with reference to the transit of the moon across a given meridian, they evidently belong on an average to a time a constant number of hours, HWI (uncorrected), after the moon's transit. If ranges—that is, both high and low waters—are tabulated, they belong to a time $\frac{1}{2}$ (HWI+LWI) after the moon's transit. Similar remarks apply when lunitidal intervals are tabulated for the purpose of ascertaining the age "from the times," i. e., from the positions of the lunitidal intervals when they take their mean values.

The age as determined by tabulating with reference to the transits of the moon must, if expressed in degrees, be corrected by the known change in the astronomical argument which takes place during the actual time which elapses between the lunar transit and the high waters or ranges used.

Consequently, in order to have an age properly determined, its value must relate to the tide and not to the associated transit.

If local times and local transits are used throughout and if both high and low water heights are used, the expression, in solar hours, for age of the phase inequality, or, as it is commonly called, the age of the tide, is

$$\text{age} = \frac{24 \times 60}{48.8}\left\{\begin{matrix}\text{hour of transit}\\ \text{for max. range}\end{matrix}\right\} + \tfrac{1}{2}\ (\text{HWI}+\text{LWI}) \tag{5}$$

$$= \frac{30}{s_2 - m_2}\left\{\begin{matrix}\text{hour of transit}\\ \text{for max. range}\end{matrix}\right\} + \tfrac{1}{2}\ (\text{HWI}+\text{LWI}) = \frac{2\alpha\ \text{(of Airy)}}{s_2 - m_2}$$

$$= \frac{\alpha_1\text{(of Ferrel)}^*}{s_2 - m_2} = \frac{S_2{}^\circ - M_2{}^\circ}{s_2 - m_2} = \frac{S_2{}^\circ - M_2{}^\circ}{1.0159} = 0.984\ (S_2{}^\circ - M_2{}^\circ) \tag{6}$$

To correct the age when the transits used are across the meridian E and expressed in T meridian time add $T-E$ hours to the observed "hour of transit for maximum range," or

$$\frac{30}{s_2 - m_2}\,(T-E) \tag{7}$$

hours to the uncorrected age. The high and low water intervals may be corrected by means of formula (2).

When the series is short, say less than about six months in length, the age should be increased by a number of hours equal to

$$-\frac{1}{2\,(s_2 - m_2)}\ \text{(equation of time in minutes)},\dagger \tag{8}$$

* I. e., Ferrel's α_1 corrected for lunitidal intervals when necessary.

† The "equation" added to apparent times gives mean time.

$s_2 - m_2$ being twice the hourly rate of separation between moon and sun. Or the numerators of (6) should be increased by an angle equal to

$$-0.5 \text{ (equation of time in minutes)} \tag{9}$$

since the "speed" of the inequality is $s_2 - m_2 = 1.0159$ degrees per hour. If the "hour of transit" refer to apparent time, the need for this correction will disappear. In computing HWI and LWI, however, either mean or apparent time should be used for both transits and tides.

On account of the moon's variation, the (solar) daily retardation of the moon at the time of syzygy is 49.9 minutes and at the time of quadrature 47.6; that is, the daily separation of moon and mean sun is not quite uniform, and so in place of 48.8 in formula (5) these values should be substituted if syzygies alone or quadratures alone are used. Generally, both syzygies and quadratures are used, thus making the consideration of the moon's variation unnecessary.

If solstitial and equinoctial tides be separately considered, it should be borne in mind that the daily retardation of the moon upon the mean sun is increased by one-twelfth part of its mean value for $\left\{\begin{matrix}\text{solstitial springs}\\ \text{equinoctial neaps}\end{matrix}\right\}$ and decreased by one-twelfth part for $\left\{\begin{matrix}\text{equinoctial springs}\\ \text{solstitial neaps}\end{matrix}\right\}$. That is, the age in the former case will be one-twelfth part less than its mean value, while in the latter case it will be one-twelfth part greater than its mean value. Here $\frac{1}{12} = 1 - \cos\omega$, where ω is the obliquity of the ecliptic.*

All the foregoing statements imply the assumption that the maximum or minimum tidal effect on range follows the maximum or minimum value of the slowly varying tidal forces by a lag, or interval of time, constant for a given station. This assumption can be strictly true only where the semidiurnal portion of the lunar and solar tide waves, if it were possible to so decompose the tide wave into two parts, are, at all times, respectively similar to the waves or curves which represent the corresponding semidiurnal tidal forces.

The amount by which the M_2-wave is accelerated by the S_2-wave is the angle (in M_2-degrees) whose tangent is †

$$\frac{\frac{S_2}{M_2}\frac{s_2}{m_2}\sin\left[\arg S_2 - S_2^\circ - (\arg M_2 - M_2^\circ)\right]}{1 + \frac{S_2}{M_2}\frac{s_2^2}{m_2^2}\cos\left[\arg S_2 - S_2^\circ - (\arg M_2 - M_2^\circ)\right]}. \tag{10}$$

Here $s_2 = 30°$, $m_2 = 28°.9841042$; $s_2 - m_2 = 1.01590$; $s_2/m_2 = 1.03505$; and $s_2^2/m_2^2 = 1.07133$. $S_2^\circ - M_2^\circ =$ age of tide in hours $\times (s_2 - m_2)$.

* Cf. Coast and Geodetic Survey Report, 1897, p. 500 (Manual, Pt. II), Airy: Tides and Waves, Art. 541.

† Coast and Geodetic Survey Report, 1894, p. 131, eq. (7); p. 169, eq. (157); Table I; pp. 190–193 (Manual, Pt. III).

At the times of full and change the astronomical arguments of S_2 and M_2 are equal, and the amount, in solar minutes of time, whereby the interval then exceeds the mean interval or the spring interval, is,

$$2\times 1.035 \tan^{1} \frac{1.035 \frac{S_2}{M_2} \sin [S_2^\circ - M_2^\circ]}{1+1.0713 \frac{S_2}{M_2} \cos [S_2^\circ - M_2^\circ]}; \tag{11}$$

and so, where the age is not too great,

$$122.765 \frac{\frac{S_2}{M_2} \sin [1.0159 \text{ (age in hours)} = S_2^\circ - M_2^\circ]}{1+1.0713 \frac{S_2}{M_2} \cos [1.0159 \text{ (age in hours)} = S_2^\circ - M_2^\circ]}. \tag{12}$$

The number $122.765 = 2 \frac{180}{\pi} \left(\frac{s_2}{m_2}\right)^2$. The ratio $\frac{S_2}{M_2}$ is nearly equal to $\frac{Sg-Np}{Sg+Np}$ where Sg and Np denote spring and neap ranges. Its theoretical value, judged from the tidal forces, is 0.46531. The actual value from observation is generally somewhat less. See table given on pages 40 to 43.

To take account of the effect of the moon's variation, M_2 in formulas (11) and (12) should be replaced by $M_2+\mu_2$. This amounts to multiplying (11) or (12) by a factor approximately equal to 0.983. The "speed" of the lunar forces at syzygy is (0.9992) m_2; a value sufficiently near to that of m_2 for the present purpose.

Computation for the required quantity, viz., the excess of the full-and-change interval over the mean interval, can be avoided by making use of Table 24, page 254, Coast and Geodetic Survey Report for 1894 (Manual, Pt. III).

The ratio of the solar tide to the lunar tide as determined "from heights" is $\frac{Sg-Np}{Sg+Np}$.

Using Airy's notation,* and supposing the period of the lunar tide to differ but slightly from that of the solar, the amount by which the lunar tide is retarded by the solar is $2\,\theta - 2\,\lambda$ where

$$\tan\,(2\,\theta - 2\,\lambda) = -\frac{S''\sin\,(2\,\overline{m-s} - 2\,\alpha)}{M'' + S''\cos\,(2\,\overline{m-s} - 2\,\alpha)}. \tag{13}$$

Here θ denotes the hour-angle of the moon to the west of the meridian at the time of high water; λ denotes the lunitidal interval expressed in lunar degrees; $m-s$ is "the excess of the sun's hour angle above the moon's at the instant of computation for tide." S''/M'' here denotes the amplitude ratio of the solar to the lunar tide as inferred from the observed angle $2\,\theta - 2\,\lambda$.

The numerical value of the right-hand member becomes a maximum when $\cos\,(2\,\overline{m-s} - 2\,\alpha)$ equals $-\frac{S''}{M''}$. Substituting this value for cosine and $\sqrt{1-\frac{S''^2}{M''^2}}$ for sine in (13), it becomes

$$\tan\,(2\,\theta - 2\,\lambda) = \frac{S''}{\sqrt{M''^2 - S''^2}}; \tag{14}$$

and so

$$\sin\,(2\,\theta - 2\,\lambda) = \frac{S''}{M''}. \tag{15}$$

* Tides and Waves, Arts. 44, 457, 535, and 541.

The range of fluctuation in interval is 2 $(2\ \theta - 2\ \lambda)$ degrees of a semidaily wave, or $2\ \theta - 2\ \lambda$ of a daily. The range, x, expressed in minutes of time, $= 4\ (2\ \theta - 2\ \lambda)$ or $\frac{S''}{M''} = \sin \frac{x}{4}$. This is the ratio as determined "from times." (See footnote to table, pp. 51, 53.)

Laplace used $A\frac{L}{r^3} \div A'\frac{L'}{r'^3}$ to denote the ratio of the solar to the lunar tide, the tides being so reduced as to refer to mean parallax and zero declination.* S. Houghton denotes this ratio by S/M.†

Whewell uses h/h' to denote the ratio of the solar to the lunar tide. Both sun and moon are supposed to take their various distances and declinations,‡ or the tides are supposed to be so reduced by suitable tables (empirical or theoretical) as to correspond to mean distances and declinations of these bodies. However, since the declinations of sun and moon do not, in the long run, differ much from each other, this distinction in the ratio can generally be ignored.

Whether this ratio is derived from the times or the heights of the tides will have to be gathered from the context of the memoirs in which it has been given.

Before the mathematical developments underlying the harmonic analysis were carried out, the diurnal wave was but imperfectly understood, and so little will be given here in reference to older nonharmonic determinations. It may, however, be said that Whewell pointed out a way for determining it when high and low waters are given § and L. F. Pourtales, of the United States Coast Survey, devised a graphical process for its determination from a tide curve or marigram.‖

CORRECTING OBSERVED RANGES AND INTERVALS.

The intervals are first of all corrected for the kind of time used and the meridian of the transits by means of formula (1) or (2).

The mean ranges of tide and the mean lunitidal intervals for short series of observations were reduced or corrected in the following manner. Let $(S_2)_{,}$ denote the S_2 at a near-by station where a harmonic analysis has already been carried out, and let $(S_2)_{,,}$ denote the unknown S_2 at the place where only a few observations

* Laplace: Mécanique céleste, Bk. 13, p. 171. Coast and Geodetic Survey Report, 1897, p. 435 (Manual, Pt. I).

† Phil. Trans. Roy. Soc. of London, Vol. 156 (1866), p. 641.

‡ Ibid., Vol. 124 (1834), p. 35; Vol. 126 (1836), pp. 2, 3.

§ Phil. Trans., 1837, pp. 227, 228; Report Coast and Geodetic Survey, 1897, p. 441 (Manual, Pt. I).

‖ Smithsonian Contributions to Knowledge, Tidal Observations in Arctic Seas (1860), p. 78; Smithsonian Contributions to Knowledge, Vol. 15, Physical Observations (1865), p. 159; Report Coast and Geodetic Survey, 1897, p. 453 (Manual, Pt. I).

are available. A similar distinction may be made for the mean ranges of tide $(Mn)_{//}$ and $(Mn)_{/}$; also for other quantities. Then

$$\text{True } (Mn)_{//} = \frac{\text{observed } (Mn)_{//} - 2\,k\,p\,(S_2)_{//}}{q} \tag{16}$$

where

$$(S_2)_{//} = \frac{(Mn)_{//}}{(Mn)_{/}}\,(S_2)_{/}. \tag{17}$$

$$\text{True HWI} = \text{observed HWI} - \frac{j}{q}\left(\frac{S_2}{M_2}\right)_{/}. \tag{18}$$

Here k denotes the average value of the coefficient, during the observation period, of S_2 given in column 3, Table 24, page 254, Coast and Geodetic Survey Report for 1894 (Manual, Pt. III); j denotes the average value of the coefficient of S_2/M_2 during the observation period given in column 2 of the same table. The symbols p and q are defined in connection with tables given on pages 375, 376, Coast and Geodetic Survey Report for 1897 (Manual, Pt. I), also in introduction to the annual Tide Tables. The results will indicate whether or not a second approximation is required.

The results from either long or short series of observations have been corrected for the longitude of the moon's node by means of Tables 6 and 14, pages 209–213, 247, Coast and Geodetic Survey Report for 1894 (Manual, Pt. III).

COLLECTION OF INTERVALS, RANGES, ETC.

In preparing the accompanying table of intervals, ranges, tidal hours, etc., the aim has been to bring together, chiefly from various published sources, such intervals and ranges as are available, and to deduce from them the mean ranges of the semidaily tide and the mean tidal hours. These are the quantities required in the construction of cotidal maps. The values from the Admiralty Tide Tables are, for convenience, given in a section of the table by themselves.

Where the dates of the observations are known, the published ranges are given in the first line, and the ranges, corrected for the longitude of the moon's node, in the second line. This correction is small and is made by means of Table 14, page 247, Coast and Geodetic Survey Report for 1894 (Manual, Pt. III). Such corrected ranges are bracketed in this table, as are also the mean ranges of tide inferred from spring ranges and the mean lunitidal intervals inferred from the full-and-change intervals. Ranges not obtained from published results are supposed to have been properly corrected although accompanied by dates of observation. In short, the brackets in this table signify that the values inclosed have been derived from published quantities through inference or correction.

Rules for inferring the mean lunitidal interval from the full-and-change interval are given on pages 46 and 47. Remarks pertaining to other nonharmonic quantities and to the kinds of time used are given on pages 44 to 46.

When a mean range has been inferred from a spring range, it has been done by means of the factor *mean range ÷ spring range* at a principal station not too remote and which factor has been computed or estimated from the harmonic constants.

This table and the one next following it comprises the territory north of the sixtieth parallel.

Table of intervals, ranges, tidal hours, etc.

No.	Station.	Latitude.	Longitude.		Lunitidal interval.			Range of phase fluctuation.	Range of tide.		
			Arc.	Time.	Mean HWI.	Mean LWI.	HW full and change.	x	Mean (Mn.).	Spring (Sg.).	Neap (Np.).
		North. ° ′	*West.* ° ′	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*Min.*	*Ft.*	*Ft.*	*Ft.*
1	Jan Mayen	71 00	8 28	0 34	11 21	5 05	11 37	78	2.95 [2.88]	3.74 [3.67]	2.17 [2.10]
2	Frederiksdal	60 00	44 40	2 59	‡6 00	12 12	.....	.....	..... [7.10]	9.68 [9.53]	4.64 [4.49]
3	.....do	.....	.....	.....	6 08	12 23	.....	.....	7.10	.....	.....
4	Tasinsarsik kitdlek (à Angmagsalik).	65 37	37 16	2 29	§4 06	.....	.....	.....	.....	.....	.....
5	Isortup nua	65 05	cir. 40 00	2 40	§3 55	.....	.....	.....	.....	.....	.....
6	Putulik (à Pikiutdlek)	65 00	cir. 40 00	2 40	§4 18	.....	.....	.....	.....	.....	.....
7	Nuerniagartek	64 49	cir. 40 45	2 43	§3 50	.....	.....	.....	.....	.....	.....
8	Kiatak (à Umivik)	64 19	cir. 41 00	2 44	§3 56	.....	.....	.....	.....	.....	.....
9	Karra akungnak	61 48	cir. 42 10	2 49	§4 06	.....	.....	.....	.....	.....	.....
10	Inugsuit	61 41	cir. 42 12	2 49	§4 34	.....	.....	.....	.....	.....	.....
11	Kehertatsiak	60 10	cir. 43 04	2 52	§4 21	.....	.....	.....	.....	.....	.....
12	Nunatsuk	60 04	cir. 43 05	2 52	§4 42	.....	.....	.....	.....	.....	.....
13	Kumah (à Ipek)	59 55	cir. 43 10	2 53	§4 50	.....	.....	.....	.....	.....	.....
14	Cape Morris Jesup	83 40	33 35	2 14	10 49	4 33	.....	.....	0.38	.....	.....
15	Cape Bryant	82 21	55 30	3 42	0 03	6 22	.....	.....	1.07	.....	.....
16	Cape Sheridan	82 27	61 21	4 05	10 30	4 09	.....	.....	1.78	.....	.....
17	.....do	82 27	61 21	4 05	10 31	4 14	.....	.....	1.76	.....	.....
18	Fort Conger	81 44	64 45	4 19	11 35	5 15	.....	.....	4.06	.....	.....
19	Point Aldrich, Cape Columbia	83 05	69 35	4 38	7 58	1 50	.....	.....	0.84	.....	.....
20	Black Horn Cliffs	82 12	57 30	3 50	12 37	6 18	.....	.....	1.3 [1.27]	.....	.....
21	Five miles southwest of Repulse Harbor.	82 03	59 30	3 58	12 06	6 10	.....	.....	2.7 [2.63]	.....	.....
22	Cape Sumner	81 55	60 45	4 03	12 15	5 42	.....	.....	3.4 [3.32]	.....	.....
23	Cape Beechey	81 52	63 00	4 12	11 38	5 24	.....	.....	3.7 [3.61]	.....	.....

1. Die Internationale Polarforschung, 1882–1883. Die Österreichische Polarstation Jan Mayen. Beobachtungs-Ergebnisse Vol. I, Vienna, 1886. Discussed by A. Böbrik.
2. Philosophical Transactions of the Royal Society of London, Vol. 156, I (1866). Observations by Missionary M. A. Asboe.
3. From observations published in Philosophical Transactions of the Royal Society of London, Vol. 156, I (1866).
4–13. Danske Konebaads expedition til Grønlands Østkyst, 1883–85. Observations météorologiques et nautiques. Flux et reflux de la mer à Nennortalik et à quelques points de la côte est du Grönland, p. 45.
14–19. Observations taken by members of the Peary polar expeditions.
20–23. International Polar Expedition. Report on United States Expedition to Lady Franklin Bay, Grinnell Land, Vol. II, by A. W. Greely, Washington, 1888, pp. 695–698.

Table of intervals, ranges, tidal hours, etc.

Ratio $\frac{\text{solar tide.}}{\text{lunar tide.}}$		Age.		Tidal hour full and change.	Tidal hour mean.	Station used for comparison.	Date, length of series, etc.	No.
From times.	From heights.	From times.	From heights.					
		h.	h.					
*0.334	†0.308	45.6	48.0	11.79	11.53	.....	Apr. 27 to Aug. 4, 1883	1
.....	0.360	.....	.....	.....	8.78	Nennortalik	Aug. 22, 1863, to Aug. 21, 1864; only springs and neaps treated.	2
.....	.....	.....	.....	.....	8.91	.....	Aug. 22, 1863, to Aug. 21, 1864; 279 highs and 279 lows.	3
.....	.....	.....	.....	.....	§6.44	.....	79 observations	4
.....	.....	.....	.....	.....	§6.45	.....	1 observation	5
.....	.....	.....	.....	.....	§6.82	.....	2 observations	6
.....	.....	.....	.....	.....	§6.42	.....	5 observations	7
.....	.....	.....	.....	.....	§6.21	.....	1 observation	8
.....	.....	.....	.....	.....	§6.78	.....	11 observations	9
.....	.....	.....	.....	.....	§7.23	.....	3 observations	10
.....	.....	.....	.....	.....	§7.07	.....	13 observations	11
.....	.....	.....	.....	.....	§7.41	.....	3 observations	12
.....	.....	.....	.....	.....	§7.55	.....	5 observations	13
.....	.....	.....	.....	.....	12.68	.....	May 13-22 1909; 19 highs and 18 lows	14
.....	.....	.....	.....	.....	3.75	.....	Jan. 16 to Feb. 13, 1909; 51 highs and 52 lows.	15
.....	.....	.....	.....	.....	2.23	.....	Nov. 4 to Dec. 2, 1905; 56 highs and 56 lows.	16
.....	.....	.....	.....	.....	2.24	.....	Nov. 13, 1908, to June 21, 1909; 426 highs 426 lows.	17
.....	.....	.....	.....	.....	3.51	.....	June 11-25, 1909; 28 highs and 28 lows	18
.....	.....	.....	.....	.....	12.35	.....	Nov. 16 to Dec. 14, 1908; 54 highs and 54 lows.	19
.....	.....	.....	.....	.....	4.02	Fort Conger	1883; 2 highs and 1 low	20
.....	.....	.....	.....	.....	3.66	do	do	21
.....	.....	.....	.....	.....	3.89	do	do	22
.....	.....	.....	.....	.....	3.44	do	1883; 5 highs and 4 lows	23

*$=\sin\left(\frac{z}{4}\right)$.

†$=\frac{Sg-Np}{Sg+Np}$, or a practically equivalent ratio.

‡The value 2h. 53½m., given on pp. 640, 641, Philosophical Transactions of the Royal Society of London, Vol. 156, I (1866), refers to half-tide level and not to high water. . . . *applying to this ±3h. 06m. or one-fourth of a tidal period*, we obtain as intervals 6h. 00m. and 12h. 12m. The necessity for doing this was overlooked in the discussion of the Fort Conger tides referred to below. (Report on United States expedition to Lady Franklin Bay, Vol. II, p. 698 and chart facing p. 700.) The same is doubtless true concerning the chart opposite p. 86 of Bessels's discussion; also concerning Berghaus's cotidal chart for the world. This wrong interpretation has accordingly introduced an error of 3 hours into these cotidal charts in the vicinity of Cape Farewell.

§There was doubtless some defect in the process whereby the lunitidal intervals were obtained, as the results appear to be erroneous.

Rough values of the establishments around southern Greenland are shown upon the chart accompanying Macdougall's translation of the narrative of Capt. W. A. Graah's expedition to the east coast of Greenland.

Table of intervals, ranges, tidal hours, etc.—Continued.

No.	Station.	Latitude.	Longitude.		Lunitidal interval.			Range of phase fluctuation.	Range of tide.		
			Arc.	Time.	Mean HWI.	Mean LWI.	HW full and change.	x	Mean (Mn.).	Spring (Sg.).	Neap (Np.).
		North. ° ′	*West.* ° ′	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*Min.*	*Ft.*	*Ft.*	*Ft.*
1	Distant Cape	81 42	64 00	4 16	11 33	5 19	.....	.....	4.3 [4.19]	.....	.....
2	Cape Baird	81 32	64 30	4 18	11 23	5 12	.....	.....	3.8 [3.71]	.....	.....
3	Cape Cracroft	81 22	64 30	4 18	11 27	5 22	.....	.....	4.8 [4.68]	.....	.....
4	Between Carl Ritter Bay and Cape Lawrence.	80 42	68 00	4 32	11 06	.....	.....	.....	.....	.....	.....
5	Eleven miles northeast of Cape Lawrence.	80 30	68 18	4 33	11 00	.....	.....	.....	.....	14?	.....
6	Seven miles northeast of Cape Lawrence.	80 24	68 36	4 34	11 00	.....	.....	.....	.....	.....	.....
7	One mile west southwest of Cape Lawrence.	80 18	69 18	4 37	11 12	.....	.....	.....	.....	14?	.....
8	Two miles south of Cape Norton Shaw.	79 54	71 06	4 44	11 18	.....	.....	.....	.....	.....	.....
9	Cape John Barrow	79 48	71 06	4 44	11 54	.....	.....	.....	.....	.....	.....
10	Three miles northeast of Cape Louis Napoleon.	79 42	71 36	4 46	11 42	.....	.....	.....	.....	.....	.....
11	Camp Clay, 4 miles northwest of Cape Sabine.	78 48	74 12	4 57	10 54	.....	.....	.....	.....	.....	.....
12	Eskimo Point	78 36	75 00	5 00	11 00	.....	.....	.....	.....	.....	.....
13	Cape Sheridan	82 27	61 22	4 05	[9 41]	.....	10 12	.....	..... [2.05]	2.6 [2.65]	1.3 [1.35]
14	Polaris Bay	81 36	61 41	4 07	12 14	5 58	.....	117½	3.86 [3.88]	5.40 [5.42]	1.99 [2.01]
15	Fort Conger	81 44	64 44	4 19	11 33	5 20	.....	.....	4.36 [4.28]	6.01 [5.93]	2.37 [2.29]
16	Bellot Harbor	81 45	65 00	4 20	[11 06]	.....	11 34	.....	[4.80]	6.2	2.3
17	Ananito Harbor, Cumberland Gulf.	66 20	66 56	4 28	5 18	11 34	.....	112	14.70 [15.07]	20.83 [21.20]	7.57 [8.94]
18	Van Rensselaer Harbor	78 37	70 53	4 44	11 43	17 48 5 23	11 52	112½	7.9 [8.03]	10.8 [10.9]	4.9 [5.0]
19	Port Foulke	78 18	73 00	4 52	11 14	17 20 4 55	11 24	85½	7.7 [7.78]	9.9 [10.0]	5.0 [5.1]
20	Ooglet	68 24	81 36	5 25	[10 44]	.....	11 15	.....	.....	.....	.....
21	South end of Igloolik	69 20	81 37	5 26	[6 59]	.....	7 30	.....	.....	.....	.....
22	Igloolik	69 21	81 37	5 26	6 57	0 44	.....	.....	4.64	.....	.....
23	Winter Island	66 11	83 10	5 33	[11 40]	.....	12 11	.....	[12.1]	15.7	3.1

1-12. International Polar Expedition. Report on United States Expedition to Lady Franklin Bay, Grinnell Land, Vol. II, by A. W. Greely, Washington, 1888, pp. 695-698.

13. Transactions of the Royal Irish Academy Vol. XXX (1895). Observations made on board H. M. S. *Alert*. Also, from Narrative of a Voyage to the Polar Sea during 1875-76 in H. M. S. *Alert* and *Discovery*, Capt. Sir G. S. Nares.

14. Scientific Results of the United States Arctic Expedition, steamer *Polaris*, C. F. Hall commanding, Vol. I, Physical Observations by E. Bessels, Washington, 1876.

15. International Polar Expedition. Report on United States Expedition to Lady Franklin Bay, Grinnell Land, Vol. II, by A. W. Greely; Washington, 1888.

16. Narrative of a Voyage to the Polar Sea during 1875-76 in H. M. S. *Alert* and *Discovery*, Capt. Sir G. S. Nares.

Table of intervals, ranges, tidal hours, etc.—Continued.

Ratio $\frac{\text{solar tide.}}{\text{lunar tide.}}$		Age.		Tidal hour full and change.	Tidal hour mean.	Station used for comparison.	Date, length of series, etc.	No.
From times.	From heights.	From times.	From heights.					
		h.	*h.*					
.....	.....	.....	.....	.....	3.43	Fort Conger	1883; 9 highs and 7 lows.....	1
.....	.....	.....	.....	.....	3.30	.....do.....	1883; 5 highs and 4 lows.....	2
.....	.....	.....	.....	.....	3.36	.....do.....	1883; 4 highs and 4 lows.....	3
.....	.....	.....	.....	.....	3.26	.....do.....	1883. Generally only 1 or 2 tides observed. Not simultaneous with Fort Conger observations.	4
.....	.....	.....	.....	.....	3.18	.....do.....		5
.....	.....	.....	.....	.....	3.20	.....do.....		6
.....	.....	.....	.....	.....	3.44	.....do.....		7
.....	.....	.....	.....	.....	3.65	.....do.....		8
.....	.....	.....	.....	.....	4.23	.....do.....		9
.....	.....	.....	.....	.....	4.07	.....do.....		10
.....	.....	.....	.....	.....	3.48	.....do.....		11
.....	.....	.....	.....	.....	3.63	.....do.....		12
.....	0.458	.....	.....	1.94	1.45	Cape Sheridan....	1875, 1876, 41 days; only springs and neaps treated.	13
*0.491	†0.461	38.9	40.9	.....	3.94	Polaris Bay.....	Nov. 6, 1871, to June 6, 1872; nearly continuous.	14
*0.474	†0.434	51.1	46.4	.....	3.48	Fort Conger.....	Aug. 20, 1881, to July 1, 1883; 1,315 highs and 1,315 lows.	15
.....	.....	.....	.....	3.51	3.06	.....do.....	1875–76; 6 months; only springs and neaps treated.	16
*0.469	†0.467	47.9	50.9	.....	9.59	Kingua Fiord.....	Jan. 13 to Apr. 26, 1878; 88 highs and 94 lows.	17
*0.471	†0.376	32.5	44.3	4.19	4.05	Port Foulke.....	1853–1855; 480 highs and 485 lows.....	18
*0.364	†0.329	34.1	35.9	.....	3.72	.....do.....	Nov. 17 to Dec. 23, 1860, and June 6 to July 12, 1861.	19
.....	.....	.....	.....	4.28	3.78	Nottingham Island	.....	20
.....	.....	.....	.....	0.68	0.18	.....do.....	.....	21
.....	.....	.....	.....	.....	12.15	.....	Nov. 18, 1822, to Apr. 19, 1823; 293 highs and 294 lows.	22
.....	.....	.....	.....	5.32	4.82	Nottingham Island	1822.....	23

$*=\sin\left(\frac{x}{4}\right)$. $\dagger=\frac{Sg-Np}{Sg+Np}$.

17. Professional Paper No. XI, U. S. Signal Service. Meteorological and Physical Observations on the East Coast of British America. O. T. Sherman, Washington, 1883.
18. Smithsonian Contributions to Knowledge. Physical Observations in the Arctic Seas. By E. K. Kane. Washington, 1859–60. *See also Ibid.*, Vol. XV, by I. I. Hayes, Washington, 1867.
19. Smithsonian Contributions to Knowledge, Vol. XV. Physical Observations in the Arctic Seas. By I. I. Hayes. Washington, 1867.
20, 21, 23. Parry's Second Voyage. Journal, 1821–1823. From charts at back of volume, and p. 247.
22. From observations published in Supplement to Appendix of Captain Parry's First Voyage. London, 1874.

Table of intervals, ranges, tidal hours, etc.—Continued.

No.	Station.	Latitude.	Longitude.		Lunitidal interval.			Range of phase fluctuation.	Range of tide.		
			Arc.	Time.	Mean HWI.	Mean LWI.	HW full and change.	x	Mean (Mn.).	Spring (Sg.).	Neap (Np.).
		North. ° ′	*West.* ° ′	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*Min.*	*Ft.*	*Ft.*	*Ft.*
1	Winter Island	66 11	83 10	5 33	12 02	6 00	.....	.....	9 68	.....	.....
2	Cape Welsford	65 28	84 40	5 39	[11 44]	.....	12 15	.....	[12.8]	16.6	.....
3	York Bay, Southampton Island	65 28	85 16	5 41	[11 49]	.....	12 20	.....	[13.8]	cir. 18	.....
4	Near head of Repulse Bay	66 31	86 30	5 46	[10 44]	.....	11 15	.....	.....	.....	.....
5	Douglas Harbor, Wagner Strait	65 40	89 10	5 57	[5 29]	.....	6 00	.....	14½ [14.86]	.....	.....
6	Port Bowen	73 14	88 55	5 56	11 37	5 29	.....	.....	3.36	.....	.....
7	Fullerton Harbor	63 59	89 06	5 56	[2 19]	.....	2 50	.....	[12.3]	16	6
8	Port Leopold	73 50	90 20	6 01	11 06	.....	.....	.....	4.40 [4.31]	5.94 [5.85]	2.91 [2.82]
9	Refuge Cove, Wellington Channel	75 31	92 10	6 09	11 58	6 01	.....	.....	[4.5]	5.7	1.3
10	.....do	75 31	92 10	6 09	11 58	6 00	.....	.....	4.18	.....	.....
11	Port Kennedy, Bellot Strait	72 01	94 12	6 17	[12 16]	.....	12 40	.....	[5.8]	7½	.....
12	.....do	72 01	94 12	6 17	11 23	.....	.....	147	[3.15]	4.00	1.67
13	.....do	72 01	94 12	6 17	12 10	6 06	.....	.....	3.58	.....	.....
14	Assistance Harbor	74 37	94 15	6 17	0 06	6 19	.....	.....	3.07	.....	.....
15	Table Island	77 14	95 08	6 21	11 39	5 59	.....	.....	.....	.....	.....
16	Penny Strait	76 52	97 00	6 28	0 07	6 35	.....	103	[1.41]	1.79	0.97
17	.....do	76 52	97 00	6 28	0 02	6 24	.....	.....	1.48	.....	.....
18	Byam Martin Island	75 10	103 34	6 54	[11 29]	.....	cir. 12 00	.....	.....	.....	.....
19	Cambridge Bay, Dease Strait, Victoria Land.	69 06	105 25	7 02	[11 06]	.....	11 30	.....	[1.8]	2.3	0.6
20	Southeast coast of Melville Island	74 58	107 04	7 08	[1 22]	.....	cir. 1 45	.....	[3.9]	cir. 5	.....
21	Winter Harbor, Melville Island	74 47	110 48	7 23	1 06	7 19	.....	.....	2.63	.....	.....

1. From observations published in Supplement to Appendix of Captain Parry's First Voyage. London, 1874.
2-4. Parry's Second Voyage. Journal, 1821-1823, pp. 40, 42, and 54.
5. Henry Ellis, Gent.: A Voyage to Hudson's Bay by the *Dobbs Galley* and *California* in the years 1746-47, p. 255.
6. From observations published in Journal of Captain Parry's Third Voyage for the Discovery of the North-West Passage, 1824-25.
7. Capt. J. E. Bernier: Report on Dominion Government Expedition to the Arctic Seas and Hudson Strait. Note on map.
8. Philosophical Transactions of the Royal Society of London, Vol. 153 (1863). Observations on board H. M. S. *Investigator*, Sir J. C. Ross. The interval 4h. 54m. given on p. 260 is 6 lunar hours in error. See also Philosophical Transactions, Vol. 156 (1866), p. 654.
9. Philosophical Transactions of the Royal Society of London, Vol. 165 (1875). Observations on board H. M. S. *Assistance*, Capt. Sir E. Belcher.
10. From observations published in Philosophical Transactions of the Royal Society of London, Vol. 165 (1875).
11. Captain McClintock: Franklin and his discoveries. Map at the back of volume.
12. Philosophical Transactions of the Royal Society of London, Vol. 165 (1875). Observations on board yacht *Fox*, Admiral McClintock.

Table of intervals, ranges, tidal hours, etc.—Continued.

Ratio $\frac{\text{solar tide.}}{\text{lunar tide.}}$		Age.		Tidal hour full and change.	Tidal hour mean.	Station used for comparison.	Date, length of series, etc.	No.
From times.	From heights.	From times.	From heights.					
		h.	*h.*					
.....	.....	.....	.....	.....	5.17	.....	Oct. 11, 1821 to May 15, 1822; 411 highs and 410 lows.	1
.....	.....	.....	.....	5.49	4.99	Nottingham Island	Aug. 16, 1821	2
.....	.....	.....	.....	5.60	5.10	.....do	Aug. 17, 1821	3
.....	.....	.....	.....	4.63	4.13	.....do	.....	4
.....	.....	.....	.....	11.74	11.24	.....do	July, 1747	5
.....	.....	.....	.....	.....	5.16	.....	Apr. 17 to June 17, 1825; 119 highs and 120 lows.	6
.....	.....	.....	.....	8.67	8.17	Nottingham Island	.....	7
.....	0.364	.....	.....	.....	4.74	Port Leopold	Oct. 25, 1848, to Aug. 6, 1849; only springs and neaps treated.	8
0.63	0.621	.....	.....	.....	5.71	.....do	Sept. 17 to Oct. 11, 1853	9
.....	.....	.....	.....	.....	5.70	.....	Sept. 17 to Oct. 11, 1853; 49 highs and 48 lows.	10
.....	.....	.....	.....	6.52	6.13	Bellot Strait	*About 1858	11
0.549	0.412	.....	.....	.....	5.28	.....do	July 5–27, 1859	12
.....	.....	.....	.....	.....	6.04	.....	July 5–27, 1859; 45 highs and 45 lows	13
.....	.....	.....	.....	.....	6.38	.....	Oct. 1, 1850, to Apr. 12, 1851; 360 highs and 361 lows.	14
.....	.....	.....	.....	.....	5.61	Beechey Island	Aug. 28–31, 1852	15
0.421	0.297	.....	.....	.....	6.58	Port Leopold	May 27 to July 7, 1853; springs and neaps only treated.	16
.....	.....	.....	.....	.....	6.50	.....	May 27 to July 7, 1853: 81 highs and 81 lows.	17
.....	.....	.....	.....	6.51	6.01	Nottingham Island	Aug. 28, 1819	18
.....	.....	.....	.....	6.14	5.75	Bellot Strait	.....	19
.....	.....	.....	.....	8.82	8.45	Beechey Island	Sept. 2, 1819	20
.....	.....	.....	.....	.....	8.45	.....	May 4 to July 19, 1820; 118 highs and 117 lows.	21

13. From observations published in Philosophical Transactions of the Royal Society, London, Vol. 165 (1875).
14. From observations published in Peter Sutherland's Journal of a Voyage in Baffins Bay and Barrow Straits, 1850–51. H. M. S. *Lady Franklin* and *Sophia*.
15. Accounts and Papers. Arctic Expeditions, 1854–55, Vol. 35, pp. 118, 119.
16. Philosophical Transactions Royal Society of London, Vol. 165 (1875). Observations on board H. M. S. *Assistance*, Capt. Sir E. Belcher.
17. From observations published in Philosophical Transactions Royal Society, London, Vol. 165 (1875).
18. Parry's First Voyage, pp. 62, 63.
19. Capt. Richard Collinson: Journal of H. M. S. *Enterprise*, 1850–55, p. 291.
20. Parry's First Voyage, p. 69.
21. From observations published in Captain Parry's First Voyage for Discovery of the North-West Passage from 1819 to 1823.

* Under date of August 21, 1858, it is remarked by McClintock (Franklin and his Discoveries) that the night tides in Bellot Strait are "much higher" than the day tides. This rule is true for the summer season, as the harmonic constants show. Cf. Coast and Geodetic Survey Reports, 1894, p. 177; 1897, p. 406 (Manual, Pts. III and I).

Table of intervals, ranges, tidal hours, etc.—Continued.

No.	Station.	Latitude.	Longitude.		Lunitidal interval.			Range of phase fluctuation.	Range of tide.		
			Arc.	Time.	Mean HWI.	Mean LWI.	HW full and change.	x	Mean (Mn.).	Spring (Sg.).	Neap (Np.).
		North. ° ′	*West.* ° ′	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*Min.*	*Ft.*	*Ft.*	*Ft.*
1	Prince of Wales Strait	72 50	117 45	7 51	.....	.....	.....	.....	[2.3]	cir. 3	0
2	Bay of Mercy, Banks Land	74 06	117 54	7 52	.....	.....	.....	.....	[1.6]	2	.....
3	Flaxman Island	70 11	145 50	9 43	12 09	5 58	.....	.....	0.51	.....	.....
4	Kayak Island, Controller Bay	59 59	144 20	9 37	12 19	6 02	.....	.....	7.69	.....	.....
5	Wingham Island, Controller Bay	60 05	144 20	9 37	12 20	6 06	.....	.....	7.74	.....	.....
6	Kokinhenic Island	60 18	145 03	9 40	0 20	6 33	.....	.....	2.59	.....	.....
7	Eyak River	60 28	145 39	9 43	0 18	7 04	.....	.....	8.20	.....	.....
8	Camp Denson	60 28	146 24	9 46	12 24	5 49	.....	.....	9.44	.....	.....
9	Port Etches	60 20	146 30	9 46	12 16	6 03	.....	.....	8.97	.....	.....
10	Jacks Bay	61 02	146 35	9 46	12 10	6 00	.....	.....	9.56	.....	.....
11	Snug Corner Cove	60 44	146 36	9 46	12 18	5 54	.....	.....	9.48	.....	.....
12	Rocky Point	60 57	146 42	9 47	12 19	5 57	.....	.....	9.39	.....	.....
13	Smith Island	60 31	147 18	9 49	.....	.....	.....	.....	9.26	.....	.....
14	Hanning Bay	59 57	147 38	9 51	12 15	5 59	.....	.....	9.20	.....	.....
15	Drier Bay	60 22	147 40	9 51	12 16	5 55	.....	.....	9.20	.....	.....
16	Bay of Isles, Harvester Island	60 22	147 42	9 51	.....	.....	.....	.....	9.60	.....	.....
17	Boat Extreme	71 03	154 26	10 18	.....	.....	.....	.....	1.25	.....	.....
18	Elson Bay	71 21	156 16	10 25	[0 38]	.....	1 00	.....	0.58 [0.59]	.....	.....
19	Point Barrow	71 24	156 20	10 25	[11 38]	.....	Noon.	.....	[0.9]	cir. 1.2	.....
20	Northwest coast of Alaska	70 24	160 44	10 43	[11 38]	.....	12 00	.....	.....	.....	.....
21	Black Point	63 33	161 05	10 44	8 51	2 48	.....	.....	*2.4	.....	.....
22	Reindeer Cove	64 32	161 22	10 45	10 01	3 32	.....	.....	*2.4	.....	.....
23	Chamisso Island	66 23	161 46	10 47	[4 31]	.....	4 47	.....	[3.97]	5(?)	4(?)

1–2. Capt. R. McClure: The Discovery of the North-West Passage, by H. M. S. *Investigator*. Edited by Commander Sherard Osborn, pp. 197, 241.
3. Observations taken by Mikkelsen and Leffingwell expedition.
4–16, 21, 22. Observations by Coast and Geodetic Survey.

Table of intervals, ranges, tidal hours, etc.—Continued.

Ratio solar tide. / lunar tide.		Age.		Tidal hour full and change.	Tidal hour mean.	Station used for comparison.	Date, length of series, etc.	No.
From times.	From heights.	From times.	From heights.					
		h.	*h.*					
						Beechey Island		1
			50			do	10 months, 1851–1852	2
					9.46		Oct. 21 to Dec. 17, 1906; 112 highs and 112 lows.	3
					9.52		June 1 to Sept. 24, 1909; 224 highs and 224 lows.	4
					9.54		Aug. 13 to Sept. 10, 1903; 56 highs and 56 lows.	5
					9.99	Kodiak	June 10 to July 8, 1898; 56 highs and 56 lows.	6
					10.01	do	Oct. 1–15, 1898; 28 highs and 28 lows	7
					9.75		July 23 to Oct. 2, 1900; 66 highs and 66 lows.	8
					9.62		July 4 to Sept. 28, 1902; 167 highs and 167 lows.	9
					9.50		May 16 to June 26, 1902; 80 highs and 80 lows.	10
					9.65		June 1 to July 28, 1903; 112 highs and 112 lows.	11
					9.68		June 21 to July 21, 1902; 58 highs and 59 lows.	12
						Kodiak	June 15 to Aug. 3, 1905; 42 highs and 41 lows.	13
					9.69		Aug. 23 to Oct. 9, 1905; 93 highs and 92 lows.	14
					9.70	Kodiak	July 1 to Sept. 30, 1907; 57 highs and 50 lows.	15
							Aug. 4 to Sept. 17, 1908; 52 highs and 72 lows.	16
								17
				11.38	11.03	Point Barrow	9 months in about 1854	18
				10.01	9.66	do		19
				10.31	9.96	do		20
					7.28		July 16 to 23, 1900; 13 highs and 14 lows	21
					8.43		Aug. 13 to 18, 1900; 10 highs and 10 lows	22
				3.41	3.16	Kodiak		23

17. Thomas Simpson: Narrative of the discoveries on the North coast of America, London, 1843, p. 167.
18. Accounts and Papers, Navy, Vol. 42, 1854, p. 162.
19. Simpson: l. c., p. 161.
20, 23. From British Admiralty Chart 593.
* Approximate range for equatorial tides; tropic tides diurnal.

Table of intervals, ranges, tidal hours, etc.—Continued.

No.	Station.	Latitude.	Longitude.		Lunitidal interval.			Range of phase fluctuation.	Range of tide.		
			Arc.	Time.	Mean HWI.	Mean LWI.	HW full and change.	x	Mean (Mn.).	Spring (Sg.).	Neap rise.
		North. ° ′	*West.* ° ′	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*Min.*	*Ft.*	*Ft.*	*Ft.*
1	Northwest coast of Alaska	69 33	163 05	10 52	[7 17]	.....	7 39	.....	.....	.....	.....
2	Topkok	64 33	163 55	12 37	7 57	.....	.....	.....	*1.3	.....	.....
3	Kwiklok, Yukon River Delta	62 34	164 51	10 59	.....	.....	.....	.....	1.4	.....	.....
4	Avogon	62 37	164 51	10 59	3 04	10 53	.....	.....	1.39	.....	.....
5	Kripniyuk	62 20	165 19	11 01	.....	.....	.....	.....	3.8	.....	.....
6	Nome	64 30	165 26	11 02	1 38	8 26	.....	.....	*1.0	.....	.....
7	Sledge Island	64 29	166 12	11 05	2 37	8 50	.....	.....	0.8	.....	.....
8	Clarence Point	65 17	166 48	11 07	[6 01]	.....	6 16	.....	[0.8]	1	.....
9	Nunivak Island	60 04	167 15	11 09	7 20	0 47	.....	.....	3.0	.....	.....
10	South coast of St. Lawrence Island	63 15	170 07	11 20	[5 39]	.....	5 55	.....	[1.3]	1¾	1
		North.	*East.*								
11	Petropaulovsk	53 00	158 43	10 35	[3 14]	.....	3 30	.....	[5.15]	6.6	2.2
12	Golchikha, Yenisei River	71 42	83 32	5 34	[11 55]	.....	Cir. 0 00	.....	[1.1]	1½	1
13	Port Dickson	73 32	80 50	5 23	[1 30]	.....	2 00	.....	[1.2]	1.6	.....
14	Cape Yam Sale near Kham	66 55	71 40	4 47	[0 30]	.....	1 00	.....	.....	.....	.....
	SHETLAND ISLES.										
15	Fair Isle	59 53	1 38	0 07	[10 41]	.....	11 00	.....	[3.9]	5	3
16	Sumburgh Head	59 51	1 17	0 05	[9 26]	.....	9 45	.....	.....	.....	.....
17	Scalloway Head	60 08	1 16	0 05	[9 11]	.....	9 30	.....	[4.5]	5¾	4½
18	Hillswick Head	60 27	1 30	0 06	[9 26]	.....	9 45	.....	[5.0]	6½	5
19	Lerwick Bay of Heogan	60 09	1 08	0 05	[10 46]	.....	11 05	.....	[4.5]	5¾	4½
20	Balta, Unst	60 45	0 47	0 03	[9 26]	.....	9 45	.....	[5.0]	6½	4½
	NORWAY.										
21	Bergen	60 24	5 19	0 21	[10 06]	.....	10 25	.....	[3.1]	4	.....
22	Rundo	62 25	5 35	0 22	[10 15]	.....	10 34	.....	[4.3]	5½	.....
23	Valderhaug	62 30	6 09	0 25	[9 55]	.....	10 15	.....	.....	.....	.....
24	Lepso-rev	62 35	6 15	0 25	[10 40]	.....	11 00	.....	[4.6]	6	.....
25	Romsdals Islands	62 40	6 10	0 25	[10 25]	.....	10 45	.....	[4.6]	6	.....

2-7, 9. Observations made by Coast and Geodetic Survey.
11. Capt. F. W. Beechy, R. N.: Narrative of Voyage to the Pacific and Bering Strait, Pt. II, London, 1831, p. 651.

Table of intervals, ranges, tidal hours, etc.—Continued.

Ratio $\frac{\text{solar tide.}}{\text{lunar tide.}}$		Age.		Tidal hour full and change.	Tidal hour mean.	Station used for comparison.	Date, length of series, etc.	No.
From times.	From heights.	From times.	From heights.					
		h.	*h.*					
.....	.....	.....	.....	6.26	5.91	Point Barrow.....	B. A. Chart 593.....	1
.....	.....	.....	.....	.....	8.30	.....	From equatorial tides. July 17 to 18, 1900; 2 highs and 2 lows.	2
.....	.....	.....	.....	.....	.....	.....	Aug. 7 to Sept. 10, 1898; 60 highs and 64 lows.	3
.....	.....	.....	.....	.....	1.94	.....	July 14 to Aug. 12, 1899; 56 highs and 56 lows.	4
.....	.....	.....	.....	.....	.....	.....	Aug. 29 to Sept. 7, 1898; 17 highs and 17 lows.	5
.....	.....	.....	.....	.....	0.61	.....	From equatorial tides. Aug. 12–26, 1900; 4 highs and 4 lows.	6
.....	.....	.....	.....	.....	1.61	.....	Aug. 9–22, 1900; 24 highs and 24 lows....	7
.....	.....	.....	.....	5.17	4.92	Kodiak.....	B. A. Chart 593.....	8
.....	.....	.....	.....	.....	6.24	Sitka.....	Aug. 27 to Sept. 12, 1902; 26 highs and 20 lows.	9
.....	.....	.....	.....	5.05	4.80	Kodiak.....	B. A. Chart 593.....	10
.....	.....	.....	.....	4.80	4.55	.....do.....	B. A. Chart 1040.....	11
.....	.....	.....	.....	6.43	5.95	Teplitz Bay.....	B. A. Chart 2963.....	12
.....	.....	.....	.....	8.55	8.07	.....do.....	Gen. Hyd. Bureau, St. Petersburg; obs. in 1894.	13
.....	.....	.....	.....	8.18	7.70	.....do.....	Gen. Hyd. Bureau, St. Petersburg; obs. in 1896.	14
.....	.....	.....	.....	10.75	10.44	Bodö.....	From Admiralty Tide Tables for 1909; values corrected by means of tables for 1910.	15
.....	.....	.....	.....	9.50	9.19	.....do.....	.....do.....	16
.....	.....	.....	.....	9.26	8.95	.....do.....	.....do.....	17
.....	.....	.....	.....	9.52	9.21	.....do.....	.....do.....	18
.....	.....	.....	.....	10.80	10.49	.....do.....	.....do.....	19
.....	.....	.....	.....	9.47	9.16	.....do.....	.....do.....	20
.....	.....	.....	.....	9.71	9.41	.....do.....	.....do.....	21
.....	.....	.....	.....	9.84	9.53	.....do.....	.....do.....	22
.....	.....	.....	.....	9.49	9.16	.....do.....	.....do.....	23
.....	.....	.....	.....	10.21	9.89	.....do.....	.....do.....	24
.....	.....	.....	.....	9.97	9.64	.....do.....	.....do.....	25

* Approximate range for equatorial tides; tropic tides diurnal.

Table of intervals, ranges, tidal hours, etc.—Continued.

No.	Station.	Latitude.	Longitude.		Lunitidal interval.			Range of phase fluctuation.	Range of tide.		
			Arc.	Time.	Mean HWI.	Mean LWI.	HW full and change.	x	Mean (Mn.).	Spring (Sg.).	Neap rise.
	NORWAY—continued.	*North.* ° ′	*East.* ° ′	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*Min.*	*Ft.*	*Ft.*	*Ft.*
1	Christianasund	63 07	7 45	0 31	[10 24]	.....	10 44	.....	[5.4]	7	.....
2	Ramso Fiord	63 34	7 52	0 31	[10 38]	.....	10 58	.....	[5.0]	6½	.....
3	Trondhjem Bay	63 36	10 22	0 41	[10 52]	.....	11 12	.....	[6.6]	8½	.....
4	Villa, Svee Fiord	64 25	10 32	0 42	[11 00]	.....	11 20	.....	[6.2]	8	.....
5	Træn Islands	66 31	12 02	0 48	[11 25]	.....	11 45	.....	[5.4]	7	.....
6	Værö, Lofoten Islands	67 40	12 40	0 51	[12 36]	.....	0 31	.....	[7.4]	9½	7½
7	Kabelvaag	68 12	14 30	0 58	[12 09]	.....	0 04	.....	[5.4]	7	.....
8	Tromsö	69 39	18 58	1 16	[0 53]	.....	1 14	.....	[6.2]	8	.....
9	Andenæs	69 19	16 18	1 05	[0 24]	.....	0 45	.....	[6.5]	8½	5
10	Hammerfest	70 40	23 41	1 35	[0 53]	.....	1 10	.....	[7.3]	9	7½
11	Vardö	70 22	31 06	2 04	[5 24]	.....	5 41	.....	[5.2]	6½	.....
12	Vadsö	70 04	29 45	1 59	[6 13]	.....	6 30	.....	[5.6]	7	.....
	FÆROE ISLANDS.										
13	Fuglo Fiord	62 19	6 18	0 25	[10 56]	.....	11 15	.....	[5.0]	6	4½
14	Klaksvig	62 14	6 35	0 26	[8 49]	.....	9 08	.....	[3.5]	4½	2¾
15	Nolsö Fiord	61 59	6 42	0 27	[3 41]	.....	4 00	.....	[5.0]	6	4½
16	Vestmanhavn	62 09	7 09	0 29	[6 50]	.....	7 09	.....	[5.0]	6	4½
17	Myggenæs Fiord	62 06	7 30	0 30	[8 41]	.....	9 00	.....	[7.4]	9	7½
18	Eide Fiord	62 18	7 05	0 28	[10 41]	.....	11 00	.....	[7.4]	9	7½
19	Sandsvaag	61 50	6 47	0 27	[6 01]	.....	6 20	.....	[5.6]	7¼	4½
20	Trangjisvaag Sydero	61 33	6 49	0 27	[5 43]	.....	6 02	.....	[3.3]	4¼	.....
	ICELAND.	*North.*	*West.*								
21	Vestmannaeyjar	63 26	20 15	1 21	[4 26]	.....	4 50	.....	[8.4]	11	.....
22	Reykjavik	64 08	21 50	1 27	[4 34]	.....	4 58	.....	[10.6]	14	8¾
23	Hvammsvig	64 20	21 40	1 27	[5 16]	.....	5 40	.....	[11.0]	14½	8
24	Grundar Fiord	64 56	23 15	1 33	[5 21]	.....	5 45	.....	[9.9]	13	.....
25	Stykkisholm	65 05	23 25	1 34	[5 12]	.....	5 36	.....	[9.1]	12	9
26	Patrix Fiord	65 35	24 00	1 36	[5 44]	.....	6 08	.....	[7.6]	10	5
27	Sudereyre	65 37	23 48	1 35	[5 38]	.....	6 02	.....	[7.6]	10	.....
28	Bildal, Arnar Fiord	65 42	23 35	1 34	[5 59]	.....	6 23	.....	[7.6]	10	.....
29	Dyra Fiord	65 54	23 27	1 34	[6 06]	.....	6 30	.....	[8.4]	11	6
30	Flateyre, Onundar Fiord	66 03	23 30	1 34	[6 21]	.....	6 45	.....	[8.4]	11	6
31	Skutils Fiord	66 07	23 02	1 32	[6 40]	.....	7 04	.....	[6.8]	9	.....
32	Skagestrand	65 51	20 18	1 21	[8 18]	.....	8 42	.....	[3.4]	4½	.....
33	Akureyre Eyla Fiord	65 40	18 00	1 12	[9 19]	.....	9 43	.....	[4.2]	5½	.....
34	Thorshaven	66 11	15 18	1 01	[10 09]	.....	10 33	.....	[3.6]	4¾	.....
35	Vapna Fiord	65 50	14 35	0 58	[11 29]	.....	11 53	.....	[3.8]	5	3½
36	Seidis Fiord, Aldan	65 20	13 40	0 55	[0 06]	.....	0 30	.....	[4.0]	5¼	3¾
37	Eske Fiord	65 05	14 00	0 56	[0 58]	.....	1 22	.....	[6.8]	9	5
38	Diupavag Beru Fiord	64 40	14 13	0 57	[2 23]	.....	2 47	.....	[5.7]	7½	5
39	Myra Bay	64 03	16 05	1 04	[4 13]	.....	4 37	.....	.....	.....	.....
40	Horne Fiord	64 13	15 18	1 01	[5 10]	.....	5 34	.....	[3.8]	5	.....
	LAPLAND.	*North.*	*East.*								
41	Vorlema River	69 47	30 50	2 03	[6 13]	.....	6 30	.....	[8.1]	10	.....
42	Pechenga Gulf, entrance	69 41	31 24	2 06	[5 58]	.....	6 15	.....	[4.8]	6	.....

Table of intervals, ranges, tidal hours, etc.—Continued.

Ratio $\frac{\text{solar tide.}}{\text{lunar tide.}}$		Age.		Tidal hour full and change.	Tidal hour mean.	Station used for comparison.	Date, length of series, etc.	No.
From times.	From heights.	From times.	From heights.					
		h.	*h.*					
.....	.....	.....	.....	9.85	9.53	Bodö	From Admiralty Tide Tables for 1909; values corrected by means of tables for 1910.	1
.....	.....	.....	.....	10.08	9.75	.....do.....	.....do.....	2
.....	.....	.....	.....	10.14	9.82	.....do.....	.....do.....	3
.....	.....	.....	.....	10.25	9.93?	.....do.....	.....do.....	4
.....	.....	.....	.....	10.55	10.23	.....do.....	.....do.....	5
.....	.....	.....	.....	11.65	11.32	.....do.....	.....do.....	6
.....	.....	.....	.....	11.10	10.77	Kabelvaag.....	.....do.....	7
.....	.....	.....	.....	11.92	11.58	.....do.....	.....do.....	8
.....	.....	.....	.....	11.64	11.30	.....do.....	.....do.....	9
.....	.....	.....	.....	11.55	11.27	Vardö.....	.....do.....	10
.....	.....	.....	.....	3.42	3.15	.....do.....	.....do.....	11
.....	.....	.....	.....	4.30	4.02	.....do.....	.....do.....	12
.....	.....	.....	.....	11.29	10.98	Bodö.....	.....do.....	13
.....	.....	.....	.....	9.26	8.95	.....do.....	.....do.....	14
.....	.....	.....	.....	4.32	4.01	.....do.....	.....do.....	15
.....	.....	.....	.....	7.39	7.08	.....do.....	.....do.....	16
.....	.....	.....	.....	9.20	8.89	.....do.....	.....do.....	17
.....	.....	.....	.....	11.10	10.79	.....do.....	.....do.....	18
.....	.....	.....	.....	6.57	6.26	.....do.....	.....do.....	19
.....	.....	.....	.....	6.28	5.97	.....do.....	.....do.....	20
.....	.....	.....	.....	6.02	5.63	Jan Mayen & Nennortalik.	.....do.....	21
.....	.....	.....	.....	6.25	5.86	.....do.....	.....do.....	22
.....	.....	.....	.....	6.92	6.54	.....do.....	.....do.....	23
.....	.....	.....	.....	7.12	6.73	.....do.....	.....do.....	24
.....	.....	.....	.....	6.98	6.59	.....do.....	.....do.....	25
.....	.....	.....	.....	7.53	7.14	.....do.....	.....do.....	26
.....	.....	.....	.....	7.41	7.03	.....do.....	.....do.....	27
.....	.....	.....	.....	7.74	7.35	.....do.....	.....do.....	28
.....	.....	.....	.....	7.85	7.46	.....do.....	.....do.....	29
.....	.....	.....	.....	8.09	7.70	.....do.....	.....do.....	30
.....	.....	.....	.....	8.36	7.97	.....do.....	.....do.....	31
.....	.....	.....	.....	9.76	9.37	.....do.....	.....do.....	32
.....	.....	.....	.....	10.59	10.20	.....do.....	.....do.....	33
.....	.....	.....	.....	11.21	10.82	.....do.....	.....do.....	34
.....	.....	.....	.....	12.45	12.06	.....do.....	.....do.....	35
.....	.....	.....	.....	1.40	1.01	.....do.....	.....do.....	36
.....	.....	.....	.....	2.25	1.87	.....do.....	.....do.....	37
.....	.....	.....	.....	3.64	3.25	.....do.....	.....do.....	38
.....	.....	.....	.....	5.53	5.14	.....do.....	.....do.....	39
.....	.....	.....	.....	6.40	6.01	.....do.....	.....do.....	40
.....	.....	.....	.....	4.23	3.96	Vardö.....	.....do.....	41
.....	.....	.....	.....	3.94	3.66	.....do.....	.....do.....	42

Table of intervals, ranges, tidal hours, etc.—Continued.

No.	Station.	Latitude.	Longitude.		Lunitidal interval.			Range of phase fluctuation.	Range of tide.		
			Arc.	Time.	Mean HWI.	Mean LWI.	HW full and change.	x	Mean (Mn.).	Spring (Sg.).	Neap rise.
		North. ° ′	*East.* ° ′	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*Min.*	*Ft.*	*Ft.*	*Ft.*
	LAPLAND—continued.										
1	Vaida Bay	69 57	31 55	2 08	[5 33]	.....	5 50	.....	[7.3]	9	6½
2	Tzuip Navolok Bay	69 45	33 10	2 13	[6 13]	.....	6 30	.....	[8.9]	11	.....
3	Ozerko Bay (N. Zemli)	69 43	32 07	2 08	[6 59]	.....	7 16	.....	[8.1]	10	7
4	Port Ekaterininskoi	69 12	33 28	2 14	[6 56]	.....	7 13	.....	[8.9]	11	7½
5	Roslyakova Bay	69 03	33 12	2 13	[6 43]	.....	7 00	.....	[7.3]	9	.....
6	Kola road	68 53	33 00	2 12	[6 57]	.....	7 14	.....	[6.1]	7½	.....
7	Kildin Strait	69 19	34 22	2 17	[6 53]	.....	7 10	.....	[8.9]	11	.....
8	Teriberskaya Bay	69 16	35 08	2 21	[7 03]	.....	7 20	.....	[10.5]	13	.....
9	Gavrilova	69 15	35 44	2 23	[7 08]	.....	7 25	.....	[9.7]	12	.....
10	Oleni Russki road	69 04	36 24	2 26	[7 13]	.....	7 30	.....	[9.7]	12	.....
11	Sem (Seven) River	68 49	37 21	2 29	[8 03]	.....	8 20	.....	[9.7]	12	.....
12	Vostochni Bay	68 19	38 31	2 34	[9 05]	.....	9 22	.....	[9.7]	12	.....
13	Svyatoi Nos	68 10	39 48	2 39	[9 13]	.....	9 30	.....	[11.3]	14	.....
	WHITE SEA.										
14	Turna Bay	67 48	40 41	2 43	[9 37]	.....	9 54	.....	[12.1]	15	.....
15	Trek Island	67 06	41 26	2 46	[10 31]	.....	10 48	.....	[16.1]	20	.....
16	Sosnovetz	66 29	40 43	2 43	[11 27]	.....	11 44	.....	[14.5]	18	.....
17	Tetrina	66 04	38 17	2 33	[3 00]	.....	3 17	.....	[5.6]	7	.....
18	Kuzomen	66 17	36 55	2 28	[3 13]	.....	3 30	.....	[4.8]	6	.....
19	Sosnovaya	65 03	35 54	2 24	[2 23]	.....	2 40	.....	[4.8]	6	.....
20	Kandalaksha	67 08	32 26	2 10	[2 51]	.....	3 08	.....	[5.0]	6¼	.....
21	Kovda Bay	66 43	32 57	2 12	[3 08]	.....	3 25	.....	[4.8]	6	.....
22	Keret River, Gulf of Kandalak	66 17	33 34	2 14	[2 51]	.....	3 08	.....	[4.8]	6	.....
23	Kalgalaksha	65 45	34 43	2 19	[6 33]	.....	6 50	.....	[5.6]	7	.....
24	Kem River	64 56	34 39	2 19	[5 06]	.....	5 23	.....	[3.2]	4	.....
25	Suma	64 23	35 27	2 22	[6 13]	.....	6 30	.....	[4.4]	5½	.....
26	Onega River, entrance	63 56	38 00	2 32	[8 55]	.....	9 12	.....	[7.7]	9½	7½
27	Cape Orlov Lyetni, Gulf of Onega	67 12	41 22	2 45	[5 01]	.....	5 18	.....	[3.2]	4	.....
28	Solovetz road	65 01	35 42	2 23	[5 38]	.....	5 55	.....	[3.2?]	4	.....
29	Zhizhginsk Island	65 12	36 51	2 27	[4 58]	.....	5 15	.....	[3.2]	4	.....
30	Gribanikha Point	64 48	38 29	2 34	[4 33]	.....	4 50	.....	[2.4]	3	.....
31	Nikolskoi Channel	64 35	39 47	2 39	[5 08]	.....	5 25	.....	[2.4]	3	.....
32	Arkhangel	64 32	40 33	2 42	[7 11]	.....	7 28	.....	[2.0]	2½	1
33	Dvina bar	64 54	40 13	2 41	[5 33]	.....	5 50	.....	[2.8]	3½	.....
34	Moudyugski Island	64 55	40 17	2 41	[5 33]	.....	5 50	.....	[2.8]	3½	.....
35	Nikolskaya Spit	65 02	40 07	2 40	[5 43]	.....	6 00	.....	[1.6]	2	.....
36	Keretz Point, Gulf of Arkhangel	65 20	39 45	2 39	[4 13]	.....	4 30	.....	[4.4]	5½	.....
37	Intzi Point	65 58	40 43	2 43	[11 38]	.....	11 55	.....	[12.9]	16	.....
38	Cape Voronov	66 31	42 21	2 49	[11 03]	.....	11 20	.....	[13.7]	17	.....
39	Morzhovetz Island	66 46	42 30	2 50	[11 03]	.....	11 20	.....	[13.7]	17	.....
40	Kuloi River	66 14	43 47	2 55	[0 58]	.....	1 15	.....	[16.1]	20	.....
41	Mezen town	65 52	44 17	2 57	[1 51]	.....	2 08	.....	[14.5]	18	.....
42	Cape Konushin	67 10	43 48	2 55	[11 37]	.....	11 54	.....	[12.1]	15	.....
43	Lütke ledge	67 10	42 52	2 51	[11 28]	.....	11 45	.....	[12.1]	15	.....
44	Cape Kanin	68 39	43 30	2 54	[10 16]	.....	10 33	.....	[5.6]	7	.....
45	Kolquev-i-Vaskina	68 42	48 30	3 14	[1 57]	.....	2 14	.....	[7.3]	9	.....
46	Indigskaya Bay	67 43	48 55	3 16	[4 38]	.....	4 55	.....	[5.2]	6½	.....

Table of intervals, ranges, tidal hours, etc.—Continued.

Ratio solar tide / lunar tide.		Age.		Tidal hour full and change.	Tidal hour mean.	Station used for comparison.	Date, length of series, etc.	No.
From times.	From heights.	From times.	From heights.					
		h.	*h.*					
.....	.....	.....	.....	3.50	3.22	Vardö	From Admiralty Tide Tables for 1909; values corrected by means of tables for 1910.	1
.....	.....	.....	.....	4.06	3.79	.....do.....	.....do.....	2
.....	.....	.....	.....	4.89	4.61	.....do.....	.....do.....	3
.....	.....	.....	.....	4.74	4.47	.....do.....	.....do.....	4
.....	.....	.....	.....	4.55	4.27	.....do.....	.....do.....	5
.....	.....	.....	.....	4.79	4.52	.....do.....	.....do.....	6
.....	.....	.....	.....	4.64	4.37	.....do.....	.....do.....	7
.....	.....	.....	.....	4.74	4.46	.....do.....	.....do.....	8
.....	.....	.....	.....	4.78	4.51	.....do.....	.....do.....	9
.....	.....	.....	.....	4.81	4.54	.....do.....	.....do.....	10
.....	.....	.....	.....	5.57	5.29	.....do.....	.....do.....	11
.....	.....	.....	.....	6.48	6.21	.....do.....	.....do.....	12
.....	.....	.....	.....	6.53	6.25	.....do.....	.....do.....	13
.....	.....	.....	.....	6.85	6.57	.....do.....	.....do.....	14
.....	.....	.....	.....	7.67	7.39	.....do.....	.....do.....	15
.....	.....	.....	.....	8.62	8.35	.....do.....	.....do.....	16
.....	.....	.....	.....	0.62	0.35	.....do.....	.....do.....	17
.....	.....	.....	.....	0.91	0.64	.....do.....	.....do.....	18
.....	.....	.....	.....	0.18	11.90	.....do.....	.....do.....	19
.....	.....	.....	.....	0.86	0.59	.....do.....	.....do.....	20
.....	.....	.....	.....	1.10	0.83	.....do.....	.....do.....	21
.....	.....	.....	.....	0.79	0.52	.....do.....	.....do.....	22
.....	.....	.....	.....	4.28	4.01	.....do.....	.....do.....	23
.....	.....	.....	.....	2.88	2.61	.....do.....	.....do.....	24
.....	.....	.....	.....	3.91	3.64	.....do.....	.....do.....	25
.....	.....	.....	.....	6.36	6.08	.....do.....	.....do.....	26
.....	.....	.....	.....	2.37	2.10	.....do.....	.....do.....	27
.....	.....	.....	.....	3.33	3.06	.....do.....	.....do.....	28
.....	.....	.....	.....	2.62	2.35	.....do.....	.....do.....	29
.....	.....	.....	.....	2.10	1.83	.....do.....	.....do.....	30
.....	.....	.....	.....	2.58	2.31	.....do.....	.....do.....	31
.....	.....	.....	.....	4.51	4.24	.....do.....	.....do.....	32
.....	.....	.....	.....	2.95	2.68	.....do.....	.....do.....	33
.....	.....	.....	.....	2.95	2.68	.....do.....	.....do.....	34
.....	.....	.....	.....	3.13	2.86	.....do.....	.....do.....	35
.....	.....	.....	.....	1.70	1.42	.....do.....	.....do.....	36
.....	.....	.....	.....	8.80	8.52	.....do.....	.....do.....	37
.....	.....	.....	.....	8.12	7.86	.....do.....	.....do.....	38
.....	.....	.....	.....	8.13	7.84	.....do.....	.....do.....	39
.....	.....	.....	.....	10.29	10.02	.....do.....	.....do.....	40
.....	.....	.....	.....	11.11	10.84	.....do.....	.....do.....	41
.....	.....	.....	.....	8.58	8.31	.....do.....	.....do.....	42
.....	.....	.....	.....	8.50	8.23	.....do.....	.....do.....	43
.....	.....	.....	.....	7.29	7.02	.....do.....	.....do.....	44
.....	.....	.....	.....	10.92	10.65	.....do.....	.....do.....	45
.....	.....	.....	.....	1.48	1.21	.....do.....	.....do.....	46

Table of intervals, ranges, tidal hours, etc.—Continued.

No.	Station.	Latitude.	Longitude.		Lunitidal interval.			Range of phase fluctuation.	Range of tide.		
			Arc.	Time.	Mean HWI.	Mean LWI.	HW full and change.	x	Mean (Mn.).	Spring (Sg.).	Neap rise.
		North. ° ′	*East.* ° ′	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*Min.*	*Ft.*	*Ft.*	*Ft.*
	WHITE SEA—*continued.*										
1	Bolvanskaya Bay	68 20	55 00	3 40	[6 40]	.....	6 57	.....	[2.4]	3	.....
2	Varandei Island	68 42	57 16	3 49	[4 28]	.....	4 45	.....	[3.2]	4	.....
3	Golchika, Yenisei River	71 43	83 45	5 35	[5 43]	.....	0 00	.....	[1.2]	1½	1
	NOVAYA ZEMLYA.										
4	Novaya Zemlya, W. C.	.....	.....	.....	.....	.....	.....	.....	[2.3?]	3?	.....
5	Mali Karmakul	72 23	52 43	3 31	.....	.....	.....	.....	[2.3]	3	.....
6	Menshikova Cape	70 43	57 43	3 51	[4 03]	.....	4 28	.....	[1.7]	2¼	.....
7	Matochkin Shar	73 18	53 57	3 36	[9 05]	.....	9 30?	.....	[2.7]	3½	.....
	SPITZBERGEN, ETC.										
8	Bell Sound, Recherche Bay	77 38	14 58	1 00	[0 59]	.....	1 06	.....	[5.9]	7	.....
9	Advent anchorage	78 16	15 45	1 03	[0 38]	.....	0 45	.....	[5.0]	6	.....
10	Danes Island, South Gat	79 42	11 05	0 44	[0 17]	.....	0 24	.....	[4.6]	5½	.....
	HUDSON STRAIT.	*North.*	*West.*								
11	Port Burwell	60 22	64 46	4 19	[8 54]	.....	9 25	.....	[14.6]	19	14¼
12	Kôksoak River entrance, Ungava Bay.	58 33	68 05	4 33	[8 21]	.....	8 52	.....	[29.6]	38½	.....
13	Stupart Bay	61 35	71 32	4 46	[7 40]	.....	8 11	.....	[18.5]	24	18
14	Aske Inlet	62 30	70 38	4 42	[8 01]	.....	8 32	.....	[23.1]	30	22
15	Nottingham Island, Port de Boucherville.	63 12	77 25	5 10	[8 59]	.....	9 30	.....	[10.0]	13	9½
16	Digges Island	62 37	78 10	5 13	[8 22]	.....	8 53	.....	.....	8½	6¼
	HUDSON BAY.	*North.*	*West.*								
17	Marble Island	62 42	91 10	6 05	[3 39]	.....	4 10	.....	[9.2]	12	9
18	Fury and Hecla Strait, Melville Peninsula.	69 21	81 49	5 27	[6 29]	.....	7 00	.....	[6.2]	8	.....
	DAVIS STRAIT.										
19	Frobisher Bay, northwest arm	63 45	68 40	4 35	.....	.....	.....	.....	[34.6?]	45?	.....
20	Kingua Fiord, Cumberland Sound.	66 36	67 19	4 29	[5 38]	.....	6 00	.....	[15.4]	20	.....
	ARCTIC REGIONS, GREENLAND, WEST COAST.										
21	Nennortalik	60 02	45 10	3 01	[5 34]	.....	6 00	.....	[6.2]	8¼	.....
22	Julianshaab	60 43	46 01	3 04	[4 40]	.....	5 06	.....	[5.2]	7	5
23	Arsuk	61 10	48 33	3 14	[5 59]	.....	6 25	.....	[9.0]	12	9
24	Frederickshaab	62 00	49 43	3 19	[5 56]	.....	6 22	.....	[6.7]	9	5
25	Godthaab	64 10	51 35	3 27	[6 42]	.....	7 00	.....	[9.3]	12	.....
26	Holsteinborg	66 56	53 42	3 35	[6 12]	.....	6 30	.....	[7.7]	10	.....
27	Whalefish Island	69 02	53 10	3 33	[7 57]	.....	8 15	.....	[5.8]	7½	.....
28	Godthavn	69 12	53 20	3 34	[8 42]	.....	9 00	.....	[5.8]	7½	.....
29	Upernivik	72 47	56 03	3 44	[10 42]	.....	11 00	.....	[6.2]	8	.....
30	North Star Bay	76 30	68 50	4 35	[10 42]	.....	11 08	.....	[5.6]	7½	.....
31	Wolstenholm Sound	76 30	68 50	4 35	[10 42]	.....	11 08	.....	[5.6]	7½	.....

Table of intervals, ranges, tidal hours, etc.—Continued.

Ratio solar tide / lunar tide.		Age.		Tidal hour full and change.	Tidal hour mean.	Station used for comparison.	Date, length of series, etc.	No.
From times.	From heights.	From times.	From heights.					
		h.	*h.*					
.....	.....	.....	.....	3.05	2.77	Vardö	From Admiralty Tide Tables for 1909; values corrected by means of tables for 1910.	1
.....	.....	.....	.....	0.77	0.50	.....do.....	.....do.....	2
.....	.....	.....	.....	0.21	11.94	.....do.....	.....do.....	3
.....	.....	.....	.....	.....	.....	Cape Flora.....	.....do.....	4
.....	.....	.....	.....	.....	.....	.....do.....	.....do.....	5
.....	.....	.....	.....	0.47	0.06	.....do.....	.....do.....	6
.....	.....	.....	.....	5.58	5.18	.....do.....	.....do.....	7
.....	.....	.....	.....	0.06	11.95	Port Virgo.....	.....do.....	8
.....	.....	.....	.....	11.68	11.56	.....do.....	.....do.....	9
.....	.....	.....	.....	11.65	11.54	.....do.....	.....do.....	10
.....	.....	.....	.....	1.42	0.92	Nottingham Island	.....do.....	11
.....	.....	.....	.....	1.10	0.60	.....do.....	.....do.....	12
.....	.....	.....	.....	0.67	0.17	.....do.....	.....do.....	13
.....	.....	.....	.....	0.94	0.44	.....do.....	.....do.....	14
.....	.....	.....	.....	2.35	1.85	.....do.....	.....do.....	15
.....	.....	.....	.....	1.80	1.30	.....do.....	.....do.....	16
.....	.....	.....	.....	10.11	9.61	.....do.....	.....do.....	17
.....	.....	.....	.....	12.21	11.71	.....do.....	.....do.....	18
.....	.....	.....	.....	.....	.....	Kingua Fiord.....	.....do.....	19
.....	.....	.....	.....	10.28	9.93	.....do.....	.....do.....	20
.....	.....	.....	.....	8.81	8.40	Nennortalik.....	.....do.....	21
.....	.....	.....	.....	8.00	7.58	.....do.....	.....do.....	22
.....	.....	.....	.....	9.43	9.01	.....do.....	.....do.....	23
.....	.....	.....	.....	9.47	9.05	.....do.....	.....do.....	24
.....	.....	.....	.....	10.21	9.92	Godthaab.....	.....do.....	25
.....	.....	.....	.....	9.86	9.57	.....do.....	.....do.....	26
.....	.....	.....	.....	11.52	11.23	.....do.....	.....do.....	27
.....	.....	.....	.....	12.24	11.90	.....do.....	.....do.....	28
.....	.....	.....	.....	2.36	2.07	.....do.....	.....do.....	29
.....	.....	.....	.....	3.34	2.92	Port Foulke.....	.....do.....	30
.....	.....	.....	.....	3 36	2.94	.....do.....	.....do.....	31

Table of intervals, ranges, tidal hours, etc.—Continued.

No.	Station.	Latitude.	Longitude.		Lunitidal intervals.			Range of phase fluctuation.	Range of tide.		
			Arc.	Time.	Mean. HWI.	Mean. LWI.	HW full and change.	x	Mean (Mn.).	Spring (Sg.).	Neap rise.
		North. ° ′	*West.* ° ′	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*Min.*	*Ft.*	*Ft.*	*Ft.*
	SMITH SOUND AND NORTHWARD.										
1	Port Foulke	78 18	72 40	4 51	[10 48]	.....	11 14	.....	[7.4]	10	7½
2	Rensselaer Harbor	78 38	70 40	4 43	[11 26]	.....	11 52	.....	[8.0]	10¾	7¾
3	Thank God Harbor	81 37	61 40	4 07	[12 10]	.....	0 13	.....	[4.1]	5½	3¾
4	Discovery Harbor	81 45	64 45	4 19	[11 07]	.....	11 35	.....	[4.8]	6½	4¼
5	Cape Sheridan	82 25	61 30	4 06	[10 07]	.....	10 37	.....	[1.8]	2½	.....
	BARROW STRAIT.										
6	Port Leopold	73 48	90 20	6 01	[12 12]	.....	0 10	.....	[3.9]	5	.....
7	Beechey Island	74 43	91 34	6 08	[0 07]	.....	0 30	.....	[3.9]	5	.....
8	Griffiths Island	74 30	95 30	6 22	[12 17]	.....	0 15	.....	[2.9]	3¾	2¾
	MELVILLE ISLAND.										
9	Dealy Island, Bridport Inlet	74 56	108 49	7 15	[1 25]	.....	1 48	.....	[3.1]	4	.....
10	Winter Harbor	74 47	110 48	7 23	[1 07]	.....	1 30	.....	[2.3]	3	2
	BANKS ISLAND.										
11	Bay of Mercy	74 07	118 15	7 53	[0 26]	.....	0 49	.....	[1.6]	2	1¼
12	Prince of Wales Strait	73 00	116 00	7 44	.....	.....	.....	.....	[2.3]	3	.....
	BERING SEA AND STRAIT.										
13	St. Paul Island, Pribiloff Islands	57 08	170 18	11 21	[4 01]	.....	4 17	.....	[3.5]	4½	2½
14	St. Matthew Island	60 20	172 25	11 30	[4 18]	.....	4 34	.....	[3.5]	4½	2½
		North.	*East.*								
15	Nikolski, Bering Island	55 12	165 59	11 04	[3 49]	.....	4 04¾	.....	[2.5]	3½	.....
16	Anadyr Bay	64 43	178 20	11 53	[3 44]	.....	4 00	.....	[7.0?]	9?	.....
		North.	*West.*								
17	St. Lawrence	65 38	171 00	11 20	[7 59]	.....	8 15	.....	[2.7]	3½	.....
18	Good-news Bay	59 02	161 45	10 47	[5 59]	.....	6 15	.....	[10.5]	13½	.....
19	St. Michael Bay	63 29	162 02	10 48	[7 39]	.....	7 55	.....	[1.2]	1½	.....
20	Golovnin Bay	64 32	163 00	10 52	[10 55]	.....	11 11	.....	[2.1]	2⅓	.....
21	Port Clarence	65 13	166 24	11 06	[6 00]	.....	6 16	.....	[1.6]	2	.....
	ARCTIC SEA.										
22	Chamisso Island	66 15	161 45	10 47	[4 31]	.....	4 47	.....	[3.9]	5	
23	Point Barrow	71 18	156 40	10 27	[11 16]	.....	11 38	.....	[0.4]	½	.....
24	Herschel Island	69 35	139 00	9 16	[5 32]	.....	6 03	.....	[1.7]	2½	.....

Table of intervals, ranges, tidal hours, etc.—Continued.

Ratio solar tide / lunar tide.		Age.		Tidal hour full and change.	Tidal hour mean.	Station used for comparison.	Date, length of series, etc.	No.
From times.	From heights.	From times.	From heights.					
		h.	*h.*					
.....	.....	.....	.....	3.70	3.28	Port Foulke	From Admiralty Tide Tables for 1909; values corrected by means of tables for 1910.	1
.....	.....	.....	.....	4.18	3.76	.....do.....	.....do.....	2
.....	.....	.....	.....	4.33	3.87	Fort Conger.....	.....do.....	3
.....	.....	.....	.....	3.51	3.06	.....do.....	.....do.....	4
.....	.....	.....	.....	2.36	1.87	Cape Sheridan....	.....do.....	5
.....	.....	.....	.....	6.18	5.80	Port Leopold.....	.....do.....	6
.....	.....	.....	.....	6.62	6.25	Beechey Island....	.....do.....	7
.....	.....	.....	.....	6.61	6.24	.....do.....	.....do.....	8
.....	.....	.....	.....	8.99	8.62	.....do.....	.....do.....	9
.....	.....	.....	.....	8.83	8.46	.....do.....	.....do.....	10
.....	.....	.....	.....	8.67	8.30	.....do.....	.....do.....	11
.....	.....	.....	.....	.....	.....	.....	.....	12
.....	.....	.....	.....	4.79	4.53	Kodiak.....	.....do.....	13
.....	.....	.....	.....	4.91	4.65	.....do.....	.....do.....	14
.....	.....	.....	.....	4.88	4.62	.....do.....	.....do.....	15
.....	.....	.....	.....	3.98	3.72	.....do.....	.....do.....	16
.....	.....	.....	.....	8.64	8.38	.....do.....	.....do.....	17
.....	.....	.....	.....	4.82	4.56	.....do.....	.....do.....	18
.....	.....	.....	.....	6.45	6.19	.....do.....	.....do.....	19
.....	.....	.....	.....	9.67	9.41	.....do.....	.....do.....	20
.....	.....	.....	.....	5.16	4.90	.....do.....	.....do.....	21
.....	.....	.....	.....	3.41	3.15	.....do.....	.....do.....	22
.....	.....	.....	.....	9.69	9.34	Point Barrow.....	.....do.....	23
.....	.....	.....	.....	3.11	2.61	Flaxman Island...	.....do.....	24

*Short series of tide observations, and results.**

No.	Station.	Latitude and longitude.	Date.	Moon's transits Greenwich meridian Gr. civil time.	Time of— High water.	Time of— Low water.
		° ′		h. m.	h. m.	h. m.
1	Cape Philip Broke	74 56 N.	July 24, 1870	8 39	21 13	.....
		17 39 W.		(21 04)		
			July 25, 1870	.....	9 14	3 15
				(22 48)		
2	Cape Börgen	75 26 N.	July 27, 1870	11 15	11 16	.....
		17 59 W.	.....do.....	(23 42)	23 26	30 30
			July 28, 1870	12 10	12 30	18 00
			July 29, 1870	(0 37)	1 00	.....
				(15 52)		
3	Pendulum Island	74 37 N.	Aug. 28, 1869	4 13	2 38	8 46
		18 29 W.	.....do.....	(16 36)	14 56	20 58
			Aug. 29, 1869	4 58	3 05	.....
4	Jackson Island	73 54 N.	Aug. 1, 1870	(3 14)	13 31	.....
		20 00 W.		15 39		
			Aug. 2, 1870	(4 04)	2 26	19 48
				16 29		
5	Cape Broer Ruys	73 28 N.	Aug. 3, 1870	17 20	.....	21 24
		20 30 W.	Aug. 4, 1870	(5 46)	3 29	.....
6	Eleanor Bay	73 27 N.	Aug. 13, 1870	1 28	.....	6 00
		25 03 W.				
				20 33		
7	Nukarbik	63 24 N.	Apr. 12, 1870	(9 00)	4 00	.....
		42 02 W.				
				(23 24)		
8	Reykjavik, Iceland	64 12 N.	July 13, 1836	11 50	4 55	10 30
		21 50 W.	.....	.....	16 50	.....
				17 11		
			July 21, 1836	(5 34)	10 25	4 40
				17 57	.....	16 00
9	About 25 miles off coast	cir. 62 40 N	Apr. 12, 1870	9 00	16 00	.....
		cir. 41 42 W.				
10	Near Scott Inlet	71 18 N.	Sept. 3, 1820	9 01	.....	.....
		70 55 W.				15 00
11	River Clyde	70 22 N.	Sept. 7, 1820	.....	.....	.....
		68 26 W.		13 00		

1–7. Observations published by E. Bessels in United States Arctic Expedition Steamer *Polaris*, Vol. I, Physical Observations' p. 86. These were made during the second German expedition under Captain Koldewey.

8. Paul Gaimard: Voyage en Islande et au Gröenland, 1835 et 1836, *La Recherche*. Physique, by Victor Lottin, 2e Partie, pp. 540, 541.

9. Koldewey: The German Arctic Expedition of 1869–70, p. 143. Observations made by *Hansa* crew on floe.

10, 11. Parry's First Voyage, pp. 274, 288.

Short series of tide observations, and results.

Uncorrected lunitidal interval.		Intervals corrected for transits, kind of time used and time of month.	Height of—		Ranges corrected for phase, time of month, time of year, and longitude of moon's node.	Tidal hour.	Observation time.	Station used for comparison.	No.
High water.	Low water.		High water.	Low water.					
12 34			Range.				Local	Jan Mayen	1
12 10	6 11	11 25							
12 22	6 11	5 14	2.66		3.94	12.18			
12 28							do	do	2
12 11	6 48		2.06						
12 48	5 50		2.54						
12 50		12 06							
		5 54							
12 34.2	6 19.0		2.30		2.06	12.89			
10 46	4 33		2.85				do	do	3
10 43	4 22		2.49						
10 29		11 31							
10 39.3	4 27.5	5 19	2.67		2.95	12.35			
10 17							do	do	4
10 47	4 09	11 01							
10 32.0		4 46	3.22		2.52	11.97			
	4 04						do	do	5
10 09		10 46							
		4 41	3.04		2.98	11.77			
	4 32	4 32				† 11.05	do	do	6
7 27		6 43	2.00		2.65	9.29	do	do	7
5 31	11 06		15.7	7.0			do	Jan Mayen and Godthaab.	8
5 00			17.3						
4 51	11 29		15.9	7.4					
	10 26	5 14		7.5					
		11 07							
5 07.3	11 00.3		16.3	7.3	10.0	6.50			
7 00							do		9
	5 59	6 25				†4.93	do	Godthaab	10
1 02		0 34				5.12	do	do	11

* Short series of tide observations are given and reduced in this table. The leading object of the table is the same as that of the preceding, viz., the determination of the mean ranges of the tide and the mean tidal hours, quantities required in the construction of cotidal maps. Means of correcting for transits and kind of time used are given on page 44, while the corrections for time of month on the interval and range are explained on pages 48, 49. Local mean time was commonly used prior to about 1885.

† Tidal hour inferred from LWI.

Short series of tide observations, and results—Continued.

No.	Station.	Latitude and longitude.	Date.	Moon's transits Greenwich meridian Gr. civil time.	Time of— High water.	Time of— Low water.
				h. m.	*h. m.*	*h. m.*
				22 46		
1	Fury and Hecla Strait, Cape North-East	69 43 N.	Aug. 31, 1822	(11 10)	6 20	.....
				23 33		
		82 40 W.	.....	.....	18 15	12 40
			Sept. 1, 1822	(11 56)	6 40	.....
						12 50
			Sept. 2, 1822	0 19		
				(12 42)	19 30	13 30
			Sept. 3, 1822	1 06	8 00	.....
				4 20		
2	Fox Channel, west side	67 12 N.	July 10, 1822	(16 43)	16 00	.....
		81 25 W.	July 11, 1822	5 06		
				(17 30)	.....	23 30
3	York Bay, west side	65 28 N.	Aug. 17, 1821	2 53	.....	8 43
		85 16 W.				
				(19 03)		
4	Repulse Bay, near head of	66 31 N.	Aug. 22, 1821	.....	cir. 7 10	.....
		86 30 W.				
5	Liddon Island, east end of	69 46 N.	Sept. 3, 1822	(13 30)	19 00	.....
		83 03 W.				
6	Montreal Island	67 50 N.	Aug. 2, 1833	1 06	11 40	.....
		96 15 W.				
7	Southeast of Byam Martin Island	75 10 N.	Aug. 28, 1819	(5 20)	17 30	.....
		103 34 W.	.....	17 47		
8	Southeast coast of Melville Island	74 58 N.	Sept. 2, 1819	(10 26)	.....	19 00
		107 04 W.				
9	Table Island	77 14 N.	Aug. 28, 1852	(11 14)		
		95 08 W.	.....	23 38	.....	17 15
			Aug. 29, 1852	.....	.....	6 00
				(12 01)		
			Aug. 30, 1852	0 24		
				(12 46)	.....	19 00
			Aug. 31, 1852	1 08	.....	.....
				(13 29)	13 00	.....
10	Dealy Island	74 57 N.	June 21, 1853	(12 17)	13 48	.....
		109 00 W.	July 6, 1853	(12 08)	13 59	.....
			July 20, 1853	(12 04)	13 38	.....
11	East of Dease Strait	68 07 N.	Aug. 1–5, 1839	.....	.....	.....
		103 37 W.				
12	Mouth of Ellice River	68 02 N.	July 31, 1839	.....	.....	.....
		104 15 W.				
13	Cape Alexander, east end of Dease Strait	68 53 N.	July 26, 1839	23 44	12 00	.....
		106 24 W.				

1–5. Parry's Second Voyage.
6. A selection of Papers on Arctic Geography and Ethnology (London, 1875), p. 149. Back's Second Voyage.
7–8. Parry's First Voyage.

Short series of tide observations, and results—Continued.

Uncorrected lunitidal interval.		Intervals corrected for transits, kind of time used and time of month.	Height of—		Ranges corrected for phase, time of month, time of year, and longitude of moon's node.	Tidal hour.	Observation time.	Station used for comparison.	No.
High water.	Low water.		High water.	Low water.					
			Rise.	Fall.					
7 34							Local	Port Leopold	1
7 05	1 30			5.83					
7 07			5.17						
.....	0 54			7.00					
6 48	0 48		8.75						
6 54	.....	6 30							
7 06	1 04	0 28	.....	.....	5.5	11.79			
11 40							do	do	2
.....	6 00	12 10	.....	.....	.....	5.18			
.....	5 50	6 00	.....	.....	.....	*5.48	do	do	3
12 07	.....	11 55	.....	.....	.....	5.28	do	do	4
5 30	.....	5 20	.....	.....	.....	10.68	do	do	5
			Range.						
10 34	.....	10 24	1.0		0.8	4.47	do	Beechey Island	6
12 10	.....	0 05	.....	.....	.....	7 00	do	do	7
.....	8 34	7 45	.....	.....	.....	*8 63	do	do	8
							do	Flaxman Island	9
.....	6 01								
.....	6 22								
.....	6 14								
.....	.....	11 42							
		5 34							
11 52	.....	.....	.....	.....	.....	5.65			
1 31	.....	0 52	4.08		2.90		do	Winter Harbor	10
1 51	.....	0 58	3.58		3.32				
1 34	.....	0 49	4.00		2.73				
1 39	.....	0 53	3.89		2.98	8.12			
.....	.....	.....	1½ to 2				.....	.....	11
.....	.....	.....	2½(?)				.....	.....	12
12 16	.....	11 33	Rise cir. 2	.....	.....	6.25	do	Flaxman Island	13

9. Accounts and papers, Arctic Expeditions, 1854-55, Vol. 35, pp. 118-120.
10. Geo. F. McDougall: The Eventful Voyage of H. M. Discovery Ship *Resolute* to the Arctic Regions, etc., p. 496 (London, 1857)
11-13. Simpson: Narrative of the Discoveries on the North Coast of America.
*Tidal hour from LWI.

Short series of tide observations, and results—Continued.

No.	Station.	Latitude and longitude.	Date.	Moon's transits Greenwich meridian Gr. civil time.	Time of— High water.	Time of— Low water.
		° ′		h. m.	h. m.	h. m.
1	Dease Strait	68 56 N. 106 40 W.	Aug. 23, 1838	.....	.....	.....
2	East of Demarcation Point	69 35 N. 141 00 W.	Aug. 11, 1837	(7 14)	16 00	.....
			.....	19 43		
			Aug. 12, 1837	(8 14)	4 00	.....
3	Point Griffin	69 57? N. 142 30 W.	July 16, 1837	(10 34)	12 00	.....
4	Camden Bay	70 05 N. 145 30 W.	July 17, 1837	(11 40)	13 00	.....
			July 18, 1837	0 13		
				(12 45)	13 30	.....
			July 19, 1837	1 17	1 00	.....
				(13 46)	14 00	.....
				(18 43)		
5	Cape Halkett	70 48 N. 151 56 W.	July 26, 1837	7 07	6 00	.....
6	Cape George Simpson	70 59 N. 154 21 W.	July 28, 1837	8 48	10 00	.....
7	Seven miles from Cape Krusensten	68 32 N. 113 53 W.	Aug. 6, 1826	14 08	21 00	.....
8	Chantry Island	68 45 N. 114 23 W.	Aug. 5, 1826	13 18	20 30	.....
9	Between Cape Hope and Cape Bexley	68 57 N. 115 48 W.	Aug. 4, 1826	12 29	21 00	.....
10	Stapylton Bay	68 52 N. 116 03 W.	Aug. 3, 1826	11 39	20 30	.....
11	Point Wise	69 03 N. 119 00 W.	Aug. 1, 1826	9 58	17 30	.....
12	3 miles from Buchanan River	69 24 N. 120 03 W.	July 30, 1826	8 17	17 00	.....
13	Cape Lyon	69 46 N. 122 51 W.	July 27, 1826	5 55	11 50	.....
14	West of Horton River	69 50 N. 125 55 W.	July 20, 1826	0 34	16 15	.....
				(13 00)		
			July 21, 1826	1 25	5 00	.....
15	Point Fitton	70 11 N. 126 14 W.	July 20, 1826	0 34	4 00	.....
				23 40		
16	Near Cape Bathurst	70 33 N. 127 21 W.	July 19, 1826	(12 07)	1 30	.....
				22 42		

1–6. Simpson: Narrative of the Discoveries on the North Coast of America.
7–16. Franklin's Second Expedition to the Polar Sea, London, 1828.

Short series of tide observations, and results—Continued.

Uncorrected lunitidal interval.		Intervals corrected for transits, kind of time used and time of month.	Height of—		Ranges corrected for phase, time of month, time of year, and longitude of moon's node.	Tidal hour.	Observation time.	Station used for comparison.	No.
High water.	Low water.		High water.	Low water.					
			Range.						
.....	.....	.....	3						1
8 46	.....	.....	Rise 0.50	.....	.....		Local	Flaxman Island.....	2
8 17	.....	7 42	.....	.....	0.74	*4.84			
1 26	.....	0 25	.....	.....	.....	9.90	.....do.....	.....do.....	3
1 20	.....	.....	Rise 0.92				.....do.....	.....do.....	4
0 45	.....	.....	Rise 0.88						
−0 17	.....	.....	Rise 0.50						
0 14	.....	.....	Rise 0.67	.....	0.55	9.64			
0 30	.....	−0 04	Rise 0.74						
11 17	.....	11 25	.....	.....	.....	9.20	.....do.....	.....do.....	5
1 12	.....	12 18	Rise 0.83	.....	1.05	10.17	.....do.....	.....do.....	6
6 52	.....	7 00	.....	.....	.....	2.36	.....do.....	.....do.....	7
7 12	.....	7 05	.....	.....	.....	2.48	.....do.....	.....do.....	8
8 31	.....	8 08	.....	.....	.....	3.58	.....do.....	.....do.....	9
8 51	.....	8 11	.....	.....	.....	3.64	.....do.....	.....do.....	10
7 32	.....	6 18	.....	.....	.....	2.02	.....do.....	.....do.....	11
8 43	.....	7 20	.....	.....	.....	3.08	.....do.....	.....do.....	12
5 55	.....	6 21	.....	.....	.....	2.32	.....do.....	.....do.....	13
3 15	.....	.....	.....	.....	.....	.....	.....do.....	.....do.....	14
3 35									
3 25	.....	3 10	.....	.....	.....	11.45			
3 26	.....	3 00	.....	.....	.....	11.32	.....do.....	.....do.....	15
1 50	.....	1 10	.....	.....	.....	9.62	.....do.....	.....do.....	16

* See p. 80.

Short series of tide observations, and results—Continued.

No.	Station.	Latitude and longitude.	Date.	Moon's transits Greenwich meridian Gr. civil time.	Time of— High water.	Time of— Low water.
		° ′		h. m.	h. m.	h. m.
1	Point Sir P. Maitland	70 08 N.	July 18,1826	(11 11)	3 15	.....
		127 45 W.				
				(7 14)		
2	Browell Cove	70 00 N.	July 14,1826	19 43	19 00	.....
		130 20 W.				
3	Atkinson Island	69 55 N.	July 13,1826	18 46	19 00	.....
		130 43 W.				
4	Bay between Points Toker and Warren	69 43 N.	July 10,1826	16 11	17 00	.....
		131 58 W.	July 12,1826	17 52	18 48	.....
5	Point Toker	69 38 N.	July 9,1826	15 23	16 25	.....
		132 18 W.				
6	Garry Island	69 29 N.	Aug. 16,1825	(1 26)	13 00	.....
		135 41 W.		13 52		
7	Point Sabine	69 05 N.	July 12,1826	17 00	1 30?	.....
		137 25 W.				
8	West of Flaxman Island	70 16 N.	Aug. 7,1826	14 58	.....	21 30
		147 38 W.	Aug. 8,1826	(3 24)	2 30	.....
				15 49		
			Aug. 9,1826	(4 16)	.....	.....
				16 42	15 15	.....
9	Backs Inlet	67 55 N.	July 19,1849	11 40	cir. 12 50	.....
		115 50 W.				
10	Point Pearce	69 40 N.	Aug. 16,1848	1 01	8 00	.....
		122 30? W.				
				19 52		
11	Cape Maitland	70 08 N.	Aug. 10,1848	(8 17)	1 00	.....
		127 45? W.				
12	Point Atkinson	69 55 N.	Aug. 6,1848	(5 12)	cir. 6 45	.....
		130 43? W.				
13	West of Point Atkinson	69 55 N.	Aug. 5,1848	(4 28)	.....	11 30
		130 43? W.				
14	Near Cape Dalhousie	70 15 N.	Aug. 4,1850	(21 06)	.....	17 45
		129 10 W.	Aug. 5,1850	9 37	0 00	.....
15	Western horn of M'Kinley Bay	69 57 N.	July 30,1850	(16 46)	.....	23 00
		130 40 W.	July 31,1850	5 08	1 45	11 30
				(17 32)	17 00	.....
16	Hoopers Island	69 42 N.	Aug. 26,1850	2 22	cir. 3 00	.....
		134 50 W.				

1–8. Franklin's second expedition to the Polar Sea, London, 1828.
9–13. Sir John Richardson: Arctic searching expedition, New York, 1852, pp. 312, 169, 159, 154; or London, 1851, pp. 279, 264, 259, 253.
14–16. Reports on the Arctic Expeditions, 1852; Commander Pullen to the Secretary of the Admiralty, pp. 40 38, and 51.

Short series of tide observations, and results —Continued.

Uncorrected lunitidal interval.		Intervals corrected for transits, kind of time used and time of month.	Height of—		Ranges corrected for phase, time of month, time of year, and longitude of moon's node.	Tidal hour.	Observation time.	Station used for comparison.	No.
High water.	Low water.		High water.	Low water.					
4 33	.....	3 40	.....	.....	.....	12.06	Local	Flaxman Island	1
11 46	.....	11 02	.....	.....	.....	7.35	.....do.....	.....do.....	2
0 14	.....	0 10	.....	.....	.....	8.89	.....do.....	.....do.....	3
0 49	.....	.....	.....	.....	.....	.....	.....do	.....do.....	4
0 56	.....	1 30	.....	.....	.....	10.25			
1 02	.....	1 25	.....	.....	.....	10.19	.....do.....	.....do.....	5
11 34	.....	11 25	.....	.....	.....	8.08	.....do.....	.....do.....	6
8 30?	.....	9 10	.....	.....	.....	6.02	.....do	.....do.....	7
.....	6 32	.....	.....	.....	.....	.....	.....do.....	.....do.....	8
11 32									
.....	.....	11 40				9.11			
		6 56							
10 59									
11 16									
1 10	.....	0 27	Rise 0.83	.....	.....	8.15	.....do.....	.....do.....	9
6 59	.....	6 40	.....	.....	.....	2.61	.....do.....	.....do.....	10
5 08	.....	3 55	.....	.....	.....	12.30	.....do.....	.....do.....	11
1 33	.....	2 19	.....	.....	.....	10.95	.....do.....	.....do.....	12
.....	7 02	7 45	.....	.....	.....	*10.21	.....do.....	.....do.....	13
.....	9 09	1 44	.....	.....	.....	.....	.....do.....	.....do.....	14
2 54		7 59	Rise 0.96	.....	1.11	10.29			
.....	6 14	.....	.....	.....	.....	.....	.....do.....	.....do.....	15
†8 59	6 22	0 10	.....	Fall 1.33	.....	8.88			
11 52		7 01	Rise 0.75	.....	1.3	‡9.48			
	6 18								
0 38	.....	0 46	.....	.....	.....	9.72	.....do.....	.....do.....	16

* Tidal hour inferred from LWI.
† This interval rejected.
‡ From LWI.

Short series of tide observations, and results—Continued.

No.	Station.	Latitude and longitude.	Date.	Moon's transits Greenwich meridian Gr. civil time.	Time of— High water.	Time of— Low water.
		° ′		h. m.	h. m.	h. m.
1	Whale Island, eastern end of	69 09 N.	July 15,1789	5 31	cir. 6 00	.....
		134 30 W.				
2	Herschel Island	69 34 N.	Sept. 14,1908	3 07	15 20	9 00
		138 50 W.		(15 32)		19 00
			Sept. 15,1908	3 58	15 00	8 00
				(16 23)		19 00
			Sept. 16,1908	4 49	17 00	10 00
				(17 15)		
			Sept. 17,1908	5 40	19 00	11 30
			Sept. 19,1908	(19 48)		
			Sept. 20,1908	8 12	10 00	
				(20 37)		
			Sept. 21,1908	9 00	11 20	
				(21 23)		
			Sept. 22,1908	9 46	12 00	
				(22 08)		19 00
			Sept. 23,1908	10 30	12 00	8 00
				(22 52)		19 00
			Sept. 24,1908	11 13	13 00	8 00
						19 00
3	Aichilei River, Beaufort Bay, near Turner River	69 54 N.	Nov. 7,1906	4 20		11 00
		142 00 W.		(16 44)	16 00	21 00
			Nov. 8,1906	5 08		11 30
4	Shaviovei River, west from Flaxman Island	70 10 N.	Dec. 11,1906	7 52	.....	.....
		147 00 W.		(20 17)	21 30	
			Dec. 12,1906	8 43	8 50	3 26
				(21 10)	21 30	14 55
			Dec. 13,1906	9 38	10 05	4 30
				(22 06)	23 15	15 00
			Dec. 14,1906	10 36	10 15	4 43
				(23 06)		16 05
			Dec 15,1906	11 38	0 00	6 05
					11 40	17 15
			Dec. 16,1906	0 09	0 20	7 00

1. Mackenzie: Voyage to the Frozen and Pacific Oceans.
2. Letter from S/Sergt. F. J. Fitzgerald, R. N. W. Police, to Superintendent U. S. Coast and Geodetic Survey. The given low water readings seem to indicate that the exact low water height was not recorded when it fell below zero of the staff.
3. Observations made by Leffingwell and Storkersen.
4. Doctor Howe and Christopher Thuesen of the Mikkelsen-Leffingwell expedition.

Short series of tide observations, and results—Continued.

Uncorrected luni-tidal interval.		Intervals corrected for transits, kind of time used and time of month.	Height of—		Ranges corrected for phase, time of month, time of year, and longitude of moon's node.	Tidal hour.	Observation time.	Station used for comparison.	No.
High water.	Low water.		High water.	Low water.					
0 29	.....	1 00	.....	.....	.....	9.93	Local	Flaxman Island	1
12 13	5 53	.....	0.4	0.0	.....	.....	.....do.*	.....do.....	2
	3 28			0.0					
11 02	4 02		0.3						
12 11	5 11		0.8	0.3					
13 20	5 50		1.2	0.7					
14 12			1.0						
14 43			1.2						
14 37			1.0						
	9 14			0.0					
13 52	9 52		0.5	0.0					
	8 30			0.0					
14 08	9 08	0 25	0.5	0.0					
	7 47	6 16	.....	0.0					
13 22.0	6 30.2				0.80	9.60			
.....	6 40	.....	.....	1.80	.....	.....	150th West.....	.....do.....	3
11 40	4 16	0 32	2.07	1.77					
	6 22	7 03		1.61	0.42	9.98			
.....	.....	.....	.....	.....	.....	.....	.....do	.....do.....	4
1 13			2.30						
0 07	7 09		2.26	1.87					
0 20	6 12		2.56	1.87					
0 27	7 20		2.20	1.84					
1 09	5 22		2.43	1.64					
—0 21	6 37		2.10	1.67					
	5 29			1.57					
0 54	6 59		2.53	1.77					
0 02	5 37		2.33	1.80					
0 11	6 51		2.92	2.13					
		12 13							
0 26.9	6 24.0	5 45	2.43	1.80	0.55	9.61			

* Assumed.

Short series of tide observations, and results—Continued.

No.	Station.	Latitude and longitude.	Date.	Moon's transits Greenwich meridian Gr. civil time.	Time of— High water.	Time of— Low water.
		° ′		h. m.	h. m.	h. m.
1	Bennett Island	76 41 N. 149 05 E.	July 30,1881	(2 43)	19 25	13 25
				15 04		
			July 31,1881	(3 25)	8 10	1 25
				15 47	19 55	14 10
			Aug. 1,1881	(4 09)	8 05	1 55
				16 32	20 25	14 25
			Aug. 2,1881	(4 55)	8 25	2 40
				17 19	21 15	14 55
			Aug. 3,1881	(5 45)	9 13	3 15
				18 11	22 25	15 40
			Aug. 4,1881	(6 38)	10 25	3 55
				19 06	22 25	16 26
			Aug. 5,1881	(7 36)	11 05	4 25
				20 06	23 55	16 55
			Aug. 6,1881	(8 36)	11 56	5 25
2	Cape Flora, Franz Josef Land *	79 56 N. 49 41 E.	Aug. 26,1895	(4 4	.....	.....
				17 14	13 05	
			Sept. 3,1895	(11 29)		
				23 50		16 28
			Sept. 4,1895		9 47	
				(12 09)	22 45	16 35
			Sept. 5,1895	0 29		
				(12 48)		16 07

1. Geo. W. De Long: The Voyage of the Jeannette, Vol. II.
2. F. G. Jackson: A Thousand Days in the Arctic, p. 912. Observer, A. B. Armitage.

Short series of tide observations, and results—Continued.

Uncorrected lunitidal interval.		Intervals corrected for transits, kind of time used and time of month.	Height of—		Ranges corrected for phase, time of month, time of year, and longitude of moon's node.	Tidal hour.	Observation time.	Station used for comparison.	No.
High water.	Low water.		High water.	Low water.					
4 21	10 42	.....	2.67	0.29	.....	.....	Local time, European date.	Teplitz Bay and Point Barrow combined.	1
4 45	10 21		2.75	0.46					
4 08	10 45		2.83	0.61					
3 56	10 08		2.82	0.58					
3 53	10 16		2.92	0.58					
3 30	10 08		3.00	0.79					
3 56	10 00		2.94	0.94					
3 28	9 56		3.08	1.02					
4 14	9 55		2.98	1.17					
3 47	9 44		3.06	1.32					
3 19	9 48		2.83	1.40					
3 29	9 19		3.00	1.38					
3 49	9 19		2.75	1.50					
3 20	9 19	4 43	3.11	1.68					
		10 51							
3 51.1	9 58.6		2.91	0.98	2.50	6.62			
.....	.....	.....	.....	.....	.....	.....	Local†	Cape Flora	2
8 18			1.60						
	4 59			0.81					
9 57			1.57						
10 36	4 26		1.58	0.42					
	3 19	9 28		0.62					
		4 06							
9 37.0	4 14.7		1.58	0.62	0.88	5.83			

* Flood from west.

† Assumed.

ERRONEOUS TIDAL DATA NEAR MERIDIAN 141° W.

On page 178 of his Narrative of the Discoveries on the North Coast of America, etc., Thomas Simpson says: "It was high water about 4 o'clock, both p. m. and a. m.; rise of the tide six inches." This quotation refers to August 11 and 12, 1837, the locality of observation being a short distance east from Demarcation Point.

In the table given on pages 68 to 79 it will be seen that these observed times of the tide give IV.84 as the tidal hour.

In the same table it will be noticed that observations taken by Leffingwell on November 7 and 8, 1906, a few miles west of Demarcation Point give IX.98 as the tidal hour. This value agrees well with the tidal hour for Herschel Island, IX.60, obtained from observations taken by the Royal Mounted Police in September, 1908.

These recent values show that the time of the tide in the vicinity of Demarcation Point does not differ materially from the time, wherever observed, for the coast line extending from Point Barrow to and beyond the mouths of the Mackenzie River. There are, therefore, no indications from the tide of the existence of an island lying off the Alaskan coast and which I indicated upon a map first published in the National Geographic Magazine (Vol. 15, 1904, p. 256). In inferring its existence, great weight was given to the above-quoted statement of Simpson's, which embraced the only definite information available at the time. It now turns out to be erroneous. Perhaps "4 o'clock" is a misprint for "9 o'clock," a time in fair accord with the facts. Such a mistake could easily have occurred on account of the similarity, in some manuscript forms, of the figures "4" and "9."

DIRECTION OF TIDAL STREAMS, AND OF APPARENT WAVE PROGRESSION.

The direction of flood stream generally coincides with the direction of wave propagation or of apparent progression of the time of tide. The flood stream at any given point may be defined as the stream whose maximum velocity falls on the rising tide and does not occur later than the time of local high water. The direction of the flood stream can therefore be ascertained by making tidal and current observations at any given station, whereas the direction of tidal progression can be ascertained with certainty only by knowing the times of tide at two or more stations situated a moderate distance apart.

In the following table, entitled "Tidal streams," the directions are generally those in which flood streams set, or are supposed to set, and are not necessarily the directions of apparent wave progression. In several instances the observers, or the authorities cited, have doubtless mistaken the flood for the ebb, and vice versâ.

QUOTATIONS RELATING TO THE DIRECTION OF THE FLOOD STREAM AT POINT BARROW.

(71° 23′ 33″ N., 156° 20′ W.) "The configuration of Point Barrow afforded me a decisive opportunity of ascertaining the direction of the flood and ebb tides. Both were equally strong: the former coming from the south-west, and sweeping round the point; the latter retiring in the reverse direction. When we arrived, the morning tide had just turned, and the fall was fourteen inches. The moon being

then three days old, the time of high-water at full and change will be noon. The afternoon tide was still rising when we took our departure at 1 P. M., and I could not help remarking that the velocity of both ebb and flow was far greater than the inconsiderable rise and fall would have led me to expect."*

(Boat Extreme, 71° 03′ 24″ N., 154° 26½′ W.) "Mr. Dease had observed a pretty regular semi-diurnal tide, which rose on an average fifteen inches, and came along the reefs from the *north*-west. This coincides with my own remarks at Point Barrow, except that there the tide flows from the *south*-west, because such is the trending of the land to Behring's Straits. There can, therefore, remain no doubt that this western part of the Arctic Sea receives its tides from the Pacific."*

(Elson's Bay.) "The tides have been registered hourly for nine months, and the result is that the flood makes from the west, and the mean rise and fall in Elson's Bay is seven inches. The time of high water at full and change is 1 p. m.; but great irregularities occur from the wind, the rise being scarcely perceptible with fresh E. and N. E. breezes, when with S. W. gales it amounts to 3½ feet."† [The substance of this note appears upon United States Hydrographic Office Chart, No. 1189.]

(Ooglaamie.) "Flood tides came from the southward and westward and there was a prevailing current setting to the northeast. The ebb current slackened but did not reverse this current.

"The daily rise and fall of tide is quite small, being about 6 or 7 inches, but during the series of observations [Feb. 26 to June 17, 1883] the level of the sea varied more than 3 feet."‡

For results of tidal analysis of these observations, see table given on pages 40 to 43.

As mentioned elsewhere in this paper, a few current observations taken by Collinson on July 25 and 26, 1851, also seem to indicate that the flood stream comes from the west.

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* Thos. Simpson: Discoveries on the North Coast of America, 1836–1839, pp. 161, 162, 167, 168.

† Accounts and Papers, Navy, Vol. 42, 1854, p. 162.

‡ Lieut. P. H. Ray: Report of the International Polar Expedition to Point Barrow, Alaska, p. 678, and map opposite p. 28.

Tidal streams.

No.	Locality or station.	Latitude.	Longitude.	Flood.	
				Direction.	Velocity.
		° ′ *North.*	° ′ *West.*		
1	Southeast coast of Melville Island	74 58	107 04	Not clear, southward (?)	
2	Southeast coast of Byam Martin Island	75 09	103 45	do	
3	Cape Welsford	65 28	84 40	Westerly	
4	Winter Island			Southward	2 to 3 knots at springs.
5	About 3 miles northeasterly from Adderley bluff, west side of Fox Channel.	66 40	82 30	do	
6	Fox Channel, west side	66 54	81 45		
7	do	cir. 67 05		South-southwesterly	
8	do	67 12		Southerly	
9	do	68 05		do	
10	do	68 53		do	
11	Narrows, Fury and Hecla Strait			Easterly	
12	East of Demarcation Point			Not ascertained	
13	Western part of Barter Island			Eastward (?)	
14	West of Barter Island	70 07	145 27	Westward (?)	
15	East Flaxman Island	70 16	147 38	Not clear	
16	Near Cape Bathurst	70 33	127 21	Westward	
17	Cape Lyon	69 46	122 51	do	
18	7 miles from Cape Krusenstern	68 32	113 53	Northwest	3 knots
19	Camden Bay			Apparently eastward	
20	Point Barrow	71 24	156 20	Northeast	
21	Boat extreme, east of Point Barrow	71 03	154 26	Southeast	
22	Point Barrow to Coppermine River			Eastward	
23	Cape Alexander, east of Dease Strait			do	
24	East of Dease Strait	68 07	103 37	Westward	
25	Near Point Barrow				
26	McClure Strait			Easterly	
27	North of Penny Strait			Westerly	
28	Dease Strait, off Cambridge Bay	69 06	105 25	Not clear	
29	Between Griffith and Cornwallis Islands			Northwest	
30	West coast of Baring Land			Eastward	
31	Point Barrow			East	
32	Table Island, north of Grinnell Land			Westward	2 knots
33	Northern part of Wellington Channel			Southerly (?)	
34	Prince of Wales Strait			Northeasterly (?)	
35	Bellot Strait			East	
36	Between Mackenzie and Coppermine rivers			Eastward	
37	Bay of Mercy, Banks Land			West	
38	Cape Flora, Franz Josef Land	*North.* 79 56	*East.* 49 41	Eastward	2½ knots at springs.

Tidal streams.

Ebb.		Current.		Remarks.	No.
Direction.	Velocity.	Direction.	Velocity.		
				Parry's First Voyage, p. 60	1
				Ibid., pp. 62-63	2
				Parry's Second Voyage, p. 40	3
				Ibid., p. 247	4
				Ibid., p. 250	5
Northeasterly				Ibid., p. 253	6
North-northeast				Ibid., p. 257	7
				Ibid., p. 263	8
		Southerly		Ibid., chart at end of volume	9
				do	10
Westerly		Easterly (strong)		Ibid., pp. 319, 336, 337	11
				Franklin's Second Expedition to the Polar Sea, p. 138.	12
				Ibid., p. 147	13
				Ibid., p. 150	14
				Ibid., p. 153	15
				Ibid., p. 284	16
				do	17
				do	18
				Simpson: Discoveries on the North Coast of America, p. 123.	19
				Ibid, p. 161	20
				Ibid., p. 167	21
				Ibid., pp. 288, 289	22
				Ibid., p. 357	23
				Ibid., p. 363	24
		Northerly and easterly.		Collinson: Journal of H. M. S. Enterprise, pp. 138-142.	25
				Ibid., map, opposite p. 255	26
				do	27
		Easterly		Ibid., p. 291	28
Southeast				Reports on the Arctic Expeditions, 1852, p. 116	29
		Eastward		Arctic Expeditions in Search of Franklin, 1852-53, pp. 59, 60.	30
				Accounts and Papers, Navy, Vol. 42, 1854, p. 162	31
Eastward	2 knots			Accounts and Papers, Arctic Expedition, 1854-5, Vol. 35, pp. 118-120. Belcher: The Last of the Arctic Voyages, Vol. I, p. 105.	32
				Belcher: The Last of the Arctic Voyages, Vol. II, p. 219.	33
		Uncertain		McClure: The Discoveries of the North-West Passage, p. 197. Richardson: The Polar Regions, p. 231	34
West		East	Nearly 6 knots with tide.	McClintock: Franklin and his Discoveries, pp. 181-183. Richardson: The Polar Regions, pp. 196, 230	35
				Richardson: The Polar Regions, p. 230	36
				Osborn quoted in the Threshold of the Unknown Region, Markham, p. 222.	37
Westward	2½ knots at springs.			Jackson: A Thousand Days in the Arctic, p. 912. Stream turns 20 minutes before high water or low water.	38

NONTIDAL OR DRIFT CURRENTS IN THE ARCTIC REGIONS.

NOTES.

The voyages of the *Jeannette* and the *Fram*, and the sledge journey of Mikkelsen and Leffingwell, appear to establish beyond all reasonable doubt the existence of a broad west-going offshore current or drift which extends from the mouth of the Mackenzie River westward, north of Point Barrow, New Siberia, Franz Josef Land, and the Spitzbergen Islands, and finally emerges from the Arctic as the principal constituent of the current which passes between Greenland and Iceland, around Cape Farewell, and up the eastern shore of Baffin Bay. Peterman's map of 1865 (see Fig. 1) indicates that the currents north of Alaska flow westward. Collinson found the set of the current, not far from the shore, to be eastward around Point Barrow.

The general set of the waters through the Arctic Archipelago is easterly and southerly into Baffin Bay. This east-going drift was noticed by McClure as far west as Baring Land, and Collinson observed it in Dease Strait. Captain Bernier states that "the general output runs to the eastward" in McClure Strait. Further eastward the set is very pronounced, especially in Bellot, Fury and Hecla, and Hudson straits. McClure found large quantities of drift wood in the Prince of Wales Strait, which probably came from the Mackenzie River; but Amundsen found the quantity of driftwood much greater to the west of the mouth of the river than to the east of it. The fact that a cask set adrift in 1900 off Cape Bathurst was picked up on the northern coast of Norway in 1908 seems to indicate that the dividing point between the west-going and east-going currents may lie at times as far east as Cape Bathurst.

The easterly set north of Grant Land and Greenland, observed by Peary, forms a second constituent of the current flowing southward along the eastern coast of Greenland.

The direction toward which the wind blows is often in general accord with that taken by the drifting ice and surface water. The small evaporation in high latitudes and the influx of large rivers necessitate a permanent discharge of fresh water from the Arctic into the Atlantic Ocean. The lighter water remaining near the surface produces a southward downward slope and so southerly-flowing superficial streams; it also necessitates a slow northerly-flowing undercurrent.

According to Buchan's chart, the region of highest barometer for the Arctic waters is in the vicinity of Cape Bathurst, while the region for lowest barometer lies close to Cape Farewell.

The prevailing winds at Point Barrow are from east-northeast. During the drifting of the *Fram*, the wind was from the east rather than from the west. The prevailing winds east of Greenland are from the northeast. The winds through the American Archipelago are, as a rule, from the north or northwest. Peary found westerly winds north of Grant Land and Greenland.

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George F. McDougall: The Eventful Voyage of H. M. Discovery Ship *Resolute* to the Arctic Regions, etc., pages 360, 361, and chart opposite page 1 (London, 1857).

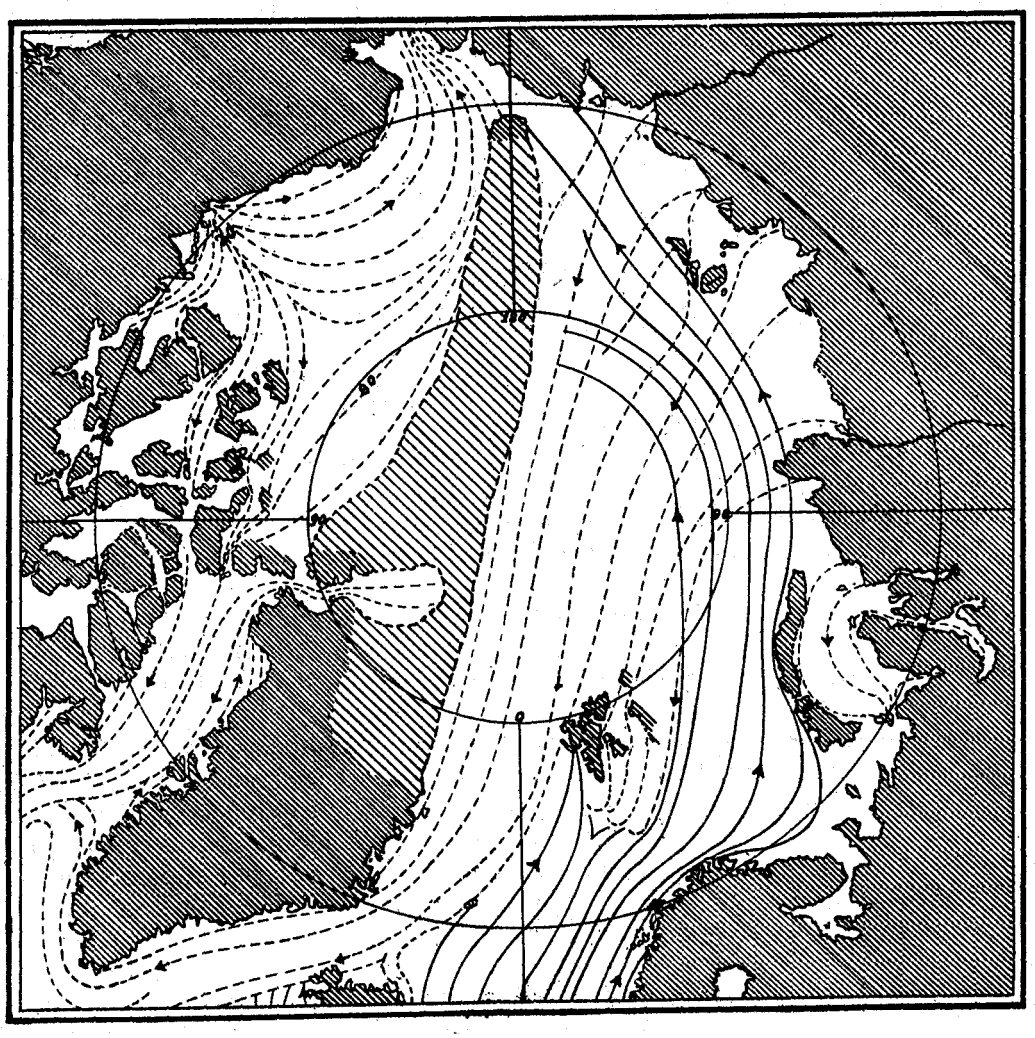

FIG. 1.

John Richardson: The Polar Regions, pages 230–236 (Edinburgh, 1861).

Clements R. Markham: The Threshold of the Unknown Region, page 223 (London, 1873).

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The Geographical Journal, Vol. 33 (1909), page 443.

A. Petermann: Der Nordpol und Südpol, Mittheilungen aus Justus Perthes' Geographischer Anstalt, etc., 1865, pages 146–160. Also, Ibid., Ergänzungsband VI, 1869–71, Plate I, following page 118. Figure 1 of the present paper was taken from these two sources.

Charts of the Arctic Regions published by the British Admiralty and the United States Hydrographic Office. Particularly Admiralty Charts Nos. 2443 (1859), 593 (1909); U. S. H. O. Charts Nos. 318, 1531 (1896.)

CHAPTER IV.

DISCUSSION AND SIGNIFICATION OF RESULTS.

COTIDAL CHARTS.

The cotidal chart accompanying this paper shows the Greenwich lunar time of the occurrence of mean high water. In its construction the mean or corrected establishment has been used. This is generally about twenty minutes less than the establishment referred to the day of full and change. It also differs slightly from the establishment or interval obtained from the M_2 – tide alone. The side of the line upon which a Roman numeral is written indicates the direction in which the wave appears to progress. Changes in the time or hour of the tide in going from place to place are spoken of as "progressions," although in many instances the character of the tide has little resemblance to a wave progressing at the rate due to depth; that is, at the rate $\sqrt{g\,h}$ where h denotes the depth expressed in feet.

The Arabic numerals scattered over the cotidal chart indicate the mean ranges of the tide expressed in feet or in feet and tenths of feet, somewhat in accordance with the probable accuracy of the determination. These values are supposed to refer to the actual or observable mean ranges of tide and not to the strictly semidiurnal tide alone; that is, they include small effects due to the existence of diurnal components and harmonics of the semidiurnals. If the diurnal wave is so large that only one high water and one low water occur daily when the moon is near extreme declination, the diurnal components are omitted from the computation of the mean semidaily range of tide, and the resulting ranges are bracketed on the chart.

In the descriptions of the semidaily tides given beyond, the ranges used have, for convenience, generally been those shown upon the chart; and so for theoretical purposes a slight allowance would have to be made for this fact. The use of the word "semidiurnal" will be confined to regular waves having periods of about one-half day each. The context will generally show whether or not it is necessary to discriminate between the words "semidaily" and "semidiurnal."

Cotidal charts for all portions of the world are given in the Coast and Geodetic Survey Report for 1904 (Manual, Pt. IV B). Some modifications have been made in the cotidal charts shown on pages 533–536, Popular Science Monthly, Vol. 74 (1909).

IMPERFECT EQUILIBRIUM TIDES.

The dimensions of the oceans are such that they can not assume equilibrium forms in a half-day period. The dominating semidiurnal tides in almost all localities are due directly or indirectly to wave motions or oscillations where the inertia of the water plays an important part. There are a few land-locked portions of the sea where approximate equilibrium tides predominate—especially along those coasts which lie farthest from large openings. Examples of this are the eastern half of the Mediterranean Sea, the western portion of the Gulf of Mexico, and the southwestern corner of the Caribbean Sea.

For the monthly and fortnightly disturbances, the entire ocean is in approximate equilibrium with the forces acting upon it.

The predominating diurnal tides in several instances show a tendency to obey the equilibrium theory, not only in those bodies or arms of water which are largely surrounded by land, but also in extended gulfs or bays. The western portion of the Atlantic Ocean obeys, in a measure, the equilibrium theory in the production of its diurnal tides.*

The Arctic Ocean being nearly surrounded by land would, if everywhere of suffient depth, certainly obey the equilibrium theory in reference to its diurnal tides. As a matter of fact, observations indicate that the diurnal tides in certain parts of the Arctic Ocean are largely equilibrium tides produced in this ocean; while those found in other parts of the Arctic are propagated into it from the northern extremities of the Atlantic Ocean.

The manner in which these Atlantic diurnal tides are formed is somewhat uncertain, but they probably originate through the action of tidal forces upon the waters of certain portions of the ocean which are partially surrounded by land, and in accordance with the following statements which relate to a mode of producing imperfect equilibrium tides:

Consider a large bay which happens to be somewhat parabolic or V-like in form. Suppose the ocean or sea of which it is a branch to be so extensive that equilibrium tides in the main body are impossible. It is required to show how an approximate equilibrium surface may exist in the bay and its approaches at any given instant.

By hypothesis, the ocean of which the bay forms a part can not at any time be in equilibrium with gravity and the tidal forces. At the time when the forces act strongest towards the head of the bay they are capable of holding its waters on a slope (could they attain to this condition), thus producing high water over the bay. The horizontal oscillatory movements of the ocean may be largely lost or dissipated and still set up the assumed surface slope of the bay; because an ocean disturbance, or pulse, of long front, advancing towards the bay will, upon entering, experience lateral reflections which tend to destroy the oscillatory movement and to heap up the water in the focus or axis of the bay, thus making an imperfect equilibrium tide possible. The nearer the head of the bay, the nearer will the slope of its surface approach the slope which the tidal forces are capable of directly maintaining for the given time. At the mouth of the bay the surface is not tilted in accordance with the forces and there the range of the tide may be supposed to be comparatively small.

On account of the small diurnal fluctuation in the slope of an equilibrium surface, no considerable diurnal tide can arise in this manner unless the distance from the head of the bay to the main body of the ocean is considerable.

The principal bays or embayments where imperfect equilibrium tides formed in this manner either dominate or seriously modify those produced otherwise are probably the following: The northern angles or portions of the north Atlantic Ocean, the southeastern corner of the Pacific Ocean, Bay of Panama and approaches(?), Gulf of Alaska, Ross Sea, Bay of Bengal, and the Arabian Sea.

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*Coast and Geodetic Survey Report, 1900, pp. 554, 555, 660, 661.

High water produced in this manner occurs at about the time when the direction of the tide-producing forces coincides with the axis of the bay and are acting toward its head.*

AMPHIDROMIC REGIONS.

The position of several no-tide points and the surrounding amphidromic regions are shown upon the chart of cotidal lines and also in the table here given:

Location of amphidromic region.	Position of no-tide point.	
	Latitude (N.).	Longitude (W.).
	° ′	° ′
Between Shetland and Faroe	61 39	5 25
Between Faroe and Iceland	63 06	10 18
Off coast of Peary Land	83 45	50 30
Fox channel	68 09	79 00
Norton Sound	63 53	163 41

From each of these points cotidal lines radiate and the tidal hours are numbered progressively from I to XII. Most of these regions have been pointed out and briefly explained in the Coast and Geodetic Survey Report for 1904, pages 332–338, 379, 388, and 395 (Manual, Pt. IV B).

There are possibilities for still other amphidromic regions where the geography is conjectural. A narrow gulf having regular sides and a closed end, and a depth such that its length is more than $\frac{1}{4}\lambda$, may constitute or possess an amphidromic region; e. g., Norton Sound. If v denote the velocity of the tidal current expressed in feet per second, then the horizontal deflecting force due to the earth's rotation is

$$0.000\,145\,842\, v \cos \theta \tag{19}$$

poundals, where θ denotes colatitude. This force divided by g gives

$$0.000\,004\,533\,18\, v \cos \theta. \tag{20}$$

It acts towards the right in the Northern Hemisphere and towards the left in the Southern. This is the gradient or transverse slope of a narrow stream, arising from the earth's deflecting force.

Now the maximum velocity across the nodal line of a gulf rectangular in outline is

$$A'\sqrt{\frac{g}{h}} \tag{21}$$

where A' denotes the amplitude or semirange of the tide at the head of the gulf, and h the half-tide level depth of the water.†

The range of tide at either end of the nodal line due to the earth's rotation is

$$0.000\,004\,533\, v \cos \theta \times \text{length of nodal line or width of gulf.} \tag{22}$$

The maximum velocity of the tidal current for a progressive wave is $A'\sqrt{\frac{g}{h}}$

* For the magnitude and direction of the tide-producing forces see Coast and Geodetic Survey Report, 1900, pp. 547, 548, and Fig. 1 (Manual, Pt. IV A).

† Coast and Geodetic Survey Report, 1907, p. 277 (Manual, Pt. V).

where A' denotes its average amplitude. Such a wave is generally due to openings at or near the head of the gulf; but its amplitude can not generally be determined with much accuracy from geographical considerations alone. It is, therefore, sometimes difficult to see in advance whether or not progressive waves will prevent the occurrence of amphidromic regions even where the soundings and shore lines are well known.

In straits or channels the amplitude of the progressive wave is generally sufficiently great for preventing the occurrence of amphidromic regions. An exception occurs when a strait connects two bodies whose tides are in opposite phases, that is, whose tidal hours differ by six. The oscillation in the strait is then stationary or nearly stationary; and would, but for the deflecting force, or the presence of progressive waves, possess a nodal line crossing the strait somewhat nearer to the body having the smaller tide than to the other body. But the presence of the deflecting force or of certain progressive waves may produce an amphidromic region in the strait or channel, and this will be characterized by a no-tide point instead of by a nodal line.

The flood velocity in a progressive wave attains its maximum value at the time of local high water. If such a wave pass between two shore lines of considerable length but not too far asunder, the range of tide will be greater upon the right side than upon the left, supposing the observer to be facing the direction in which the wave is propagated. The reverse of this will be the case in the Southern Hemisphere.

This explains why the range of tide is greater upon the western coast of Spitzbergen than upon the eastern coast of northern Greenland. It also partially explains why the range of tide is greater along the coast of Norway than along the eastern coast of Greenland to the northward of Iceland. It is practically certain that to the northward of Davis Strait the range of tide is considerably greater along the Greenland coast of Baffin Bay than along Baffin Island, which constitutes the western coast. The cotidal lines must spread apart upon the eastern coast and crowd together upon the western. The openings near the head of the bay have been assumed to prevent the occurrence of a no-tide point and an amphidromic region. But the meager tidal information for Scott Inlet and River Clyde, p. 69, on the coast of Baffin Island, indicates the necessity for a no-tide point situated, say, between Cumberland Peninsula and Disko Island. This matter could be settled by procuring observations in Home Bay.

The amphidromic region off Peary Land deserves special consideration. The stationary oscillation in Smith Sound, Kane Basin, and Robeson Channel extends along the coast of Peary Land, the trend of which is about the same as that of Robeson Channel. The deflecting force of the earth's rotation gives the moving water a tendency to crowd towards the coast of Peary Land on the northeasterly-going stream and a tendency to leave this coast on the stream going southwesterly. It is therefore possible for this motion to sustain a considerable transverse slope if once such a slope could have originated. That is, the force due to slope or pressure gradient urging the water away from or towards the coast at any given instant may, for a certain form of surface, approximately balance the deflecting force tending to pile it up along, or withdraw it from, the coast.

As already stated, the water surface partakes of a transverse slope in a stream not too wide and having banks along both sides. Cases like this are not difficult to understand. But where there is only one bank, as in the present instance, it is not so easy to see how the transverse deflecting force can cause a transverse slope, although it is easy to see how it could aid in sustaining such slope. The velocity, and so the deflecting force, will be considerable even where the stationary wave from the strait joins the practically tideless sea, say at Cape Payer.

The stationary wave is accompanied by a small dependent progressive wave due to irregularities in shore line, depth, and cross section of the stationary tidal streams. The fluctuation in the surface level produced by this progressive wave may be such that the instantaneous transverse slope of the surface will, for a portion of the coast concerned, agree with that implied in the deflecting force connected with the stationary oscillation. Where this is the case the deflecting force will cause the resultant tide to exceed in size what the progressive wave alone would have been in the absence of such force; but where the reverse is the case the tide will be reduced by the action of this force.

Regardless of the existence of any deflecting force, the range of tide can not suddenly decrease to zero as one passes from a strait having a good rise-and-fall into a practically tideless sea.

NECESSITY FOR A TRACT OF LAND, AN ARCHIPELAGO, OR AN AREA OF SHALLOW WATER IN THE ARCTIC OCEAN.

Since Nansen's discovery of ocean depths along the track of the *Fram* it has been quite generally assumed that deep water covers all or nearly all of the unknown Arctic territory situated to the northward of the known land masses. That such is not the case can be conclusively proven. But there is difficulty in showing with certainty whether land or very shallow water is responsible for certain observed phenomena.

The following are a few well-established facts which show at once the necessity for land or shoals:

(1) At Point Barrow the flood stream comes from the west and not from the north, as the hypothesis of an extended and deep polar basin implies.

(2) The range of the semidaily tide at Bennett Island is 2.5 feet, while it is only 0.4 foot at Point Barrow and 0.5 foot at Flaxman Island.

(3) The observed tidal hours and ranges of tide show that the semidaily tide is not propagated to the Alaskan coast directly across a deep and uninterrupted polar basin.

The tides along the northern coast of Alaska could not, under the hypothesis of an uninterrupted deep basin, differ materially in time from those occurring upon the northern coast of Bennett Island. For, while the distance from the Spitzbergen Islands and northeastern Greenland to the Alaskan coast somewhat exceeds that to Bennett Island, the shoals around this island greatly exceed any likely to occur off the Alaskan coast. Notwithstanding the shoals around Bennett Island, the observed tidal hour at Rudder Point, the island's southern extremity, is VI.6, while the tidal hour at Flaxman Island is IX.5.

The semidiurnal tides produced by the tide-producing forces acting upon the waters of the Arctic Ocean are small because these forces vanish at the Pole. For a deep sea circular in form, with center at the Pole, the theoretical equilibrium semidiurnal tide would agree with that known as the "uncorrected" equilibrium tide. At the margin of a zone having a radius of 10° the theoretical range amounts to 0.05 foot, and for one having a 20° radius to 0.2 foot. These are negligible quantities when compared with 2.5 feet, the range of the semidaily tide at Rudder Point, Bennett Island, showing that this tide must be transmitted from the Atlantic Ocean. If the deep-basin hypothesis were correct, there could be no reasonable doubt that since the tides at Bennett Island are derived from a propagation directly across a deep polar basin so must be the tide along the northern coast of Alaska. The observed tidal hours show this to be impossible.

(4) The observed ranges of the diurnal tides at Teplitz Bay, Bennett Island, Pitlekaj, Point Barrow, and Flaxman Island have less than one-half of their theoretical equilibrium values based upon the assumption of an uninterrupted and deep polar basin.

The equilibrium theory should apply especially well to the diurnal tide in a body like the Arctic Ocean if its bed consists mainly of a single deep basin; and the ranges of the diurnal tide should exceed their equilibrium values wherever the tide has progressed from deep water over extensive shallow-water belts along the coasts. But, as already stated, the observed ranges of the diurnal tide are surprisingly small.

SHAPE AND SIZE OF HYPOTHETICAL LAND.

From various indications it will be assumed that the land in question is trapezoidal in form and that it contains nearly half a million square statute miles.

One corner has been placed to the northward of Bennett Island. This appears to be necessitated by the direction and velocity of the *Jeannette* during the last five months of her drifting; also by the diminution in the range of the semidaily tide from 2.5 feet at Bennett Island to 0.2 foot at Pitlekaj, 0.4 foot at Point Barrow, and 0.5 foot at Flaxman Island. The small range of the diurnal tide at Bennett Island indicates the existence of a large tract of land lying between this island and the Arctic Archipelago of America.

Another corner has been placed to the northward of Point Barrow. This assumption assists in explaining the eastward set of the flood tide at Point Barrow; also the westward drifting of the ice, well off the Alaskan coast, observed by Mikkelsen and Leffingwell.*

From this corner the coast line is assumed to trend in an easterly direction nearly to Banks Land, thus forming the northern boundary of Beaufort Sea. Such a boundary is indicated by the westward drifting just mentioned, by the age of the ice in Beaufort Sea, by the probable course taken by a cask set adrift off Cape Bathurst and picked up on the northern coast of Norway, also by the magnitude of the range of the diurnal tide at Point Barrow and Flaxman Island.

Another corner has been placed to the northwest of Banks Land. But whether the unknown land approaches nearest to the known lands at Banks Land, Prince

* It is interesting to note here that in 1865 Petermann inferred the offshore currents north of Alaska to flow westerly. (See Fig. 1, and pp. 84, 85.)

Patrick Island, or at some point farther eastward seems to be an open question. The fact that the time of tide, as shown upon the cotidal chart, is but little later at the mouths of the Mackenzie River than in McClure Strait indicates that the tide in the former locality is not greatly influenced by the tide coming from the latter. This may indicate that the polar land approaches nearer to Banks Land than to Prince Patrick Island. The indications just noted in reference to the northern boundary of Beaufort Sea also apply to this corner of the trapezoid which forms the eastern terminus of this boundary.

Another corner has been placed northwest of Grant Land. This is indicated by the discovery of Crocker Land by Peary; by a shoaling north of the eighty-fifth parallel observed by Peary, viz., 310 fathoms in latitude 85° 23′ N.; by the eastward progression and range of the semidaily tide wave at Cape Columbia; and perhaps by the eastward drift encountered by Peary in 1902 and 1906.†

The coast line next the Pole is somewhat uncertain in position. The fact that the range of the semidaily tide is 0.4 foot at Cape Morris Jesup, 2.9 feet at Port Virgo, 1.9 feet at Treurenberg, 2.5 feet at Mossel Bay, 1.1 feet at Teplitz Bay, and 2.5 feet at Bennett Island indicates that the Arctic basin traversed by Nansen is limited on the side nearest the Pole; the small size of the diurnal tide at Teplitz Bay is a further indication.

SEMIDAILY TIDES IN ARCTIC WATERS.

These tides are derived almost entirely from the tides generated in the North Atlantic Ocean. This is best illustrated by the accompanying chart showing cotidal lines and the average amount of rise and fall. Wherever ranges are given to tenths of a foot, it is safe to say that the time and height of the tide are fairly well known from observation. On the other hand, the greater the distance from such points the greater, as a rule, will be the room for conjecture.

The semidaily tides consist chiefly of two fairly distinct branches which may, for convenience, be spoken of as the Greenland Sea branch and the Baffin Bay branch.

From the northern end of the North Atlantic tidal system where the range is large (the mean range at Reykjavik being 10 feet) a disturbance sets out through Denmark Strait. Another disturbance, coming chiefly from the loop of the North Atlantic system off southwestern Europe, passes up the outer coast of Ireland, Scotland, and Norway.

The tide in Greenland Sea is a resultant of these two disturbances; it is nearly simultaneous over this entire sea, and has at Jan Mayen a mean range of 2.9 feet. The tide proceeds from thence both northward across the deep waters of the Arctic Ocean to Bennett Island and eastward across the shallow Barents Sea to the coast lying south of Nova Zembla. The tides of Kara Sea, the Gulf of Obi, and the Yenisei River probably result from the wave passing north of Franz Josef Land, as shown upon the cotidal chart.

From Bennett Island to the northwestern coast of Alaska the depths are fairly well known; but to the northward of the track of the *Jeannette* no soundings have

† See appendix to Peary's book "The North Pole," entitled "Summary of Bathymetrical, Tidal, and Meteorological Observations."

been made. There is, therefore, a possibility that the tides at Bennett Island and those occurring at Point Barrow may not be connected in the manner shown upon the chart.

It is a remarkable fact, now thoroughly established, that the tidal hour for the northern coast of Alaska is very nearly IX½. It is also known that the tidal hour increases in going eastward from Beaufort Sea to Dolphin and Union Strait.

The range of tide increases from 0.4 foot at Point Barrow to 0.5 foot at Flaxman Island and 0.8 foot at Herschel Island. This fact, taken in connection with the probable rapid change in the tidal hour between Icy Cape and Point Barrow and the slow change occurring eastward from Point Barrow, seems to indicate the existence of a stationary wave about $\frac{1}{4}\lambda$ in length, extending from Banks Land to Point Barrow. This would imply an average depth for Beaufort Sea of 450 fathoms. The depths found by Mikkelsen and Leffingwell north of the parallel 71° 20′ were 339 fathoms, with no bottom. The observations of the set of the current off Point Barrow taken by Collinson on July 25 and July 26, 1851, indicate that the maximum of the east-going stream occurs about 2½ hours before the time of high water for the northern coast of Alaska.

Combining the values at Point Barrow with those at Flaxman Island we have, from the table given on pages 40 to 43,

$$S_2{}^\circ - M_2{}^\circ = 41\tfrac{1}{2}^\circ,\ S_2/M_2 = 0.40\tfrac{1}{2},\ M_2{}^\circ - N_2{}^\circ = 24^\circ,\ N_2/M_2 = 0.15\tfrac{1}{2}.$$

The corresponding quantities for Teplitz Bay, Treurenberg, and Mossel Bay combined are 50°, 0.39, 27°, 0.21. This shows that by whatever route the Greenland Sea branch of the semidaily tide reaches the northern coast of Alaska, it must be combined with a branch or source having a considerably smaller age. Such a tide is probably formed by the transverse action of the tidal forces upon the waters of Beaufort Sea. If so it would be an imperfect equilibrium tide of small age, the range depending upon the width of the Beaufort Sea. If the width is 6½ degrees of a great circle, the theoretical equilibrium value of the M_2– range would be for the latitude of Beaufort Sea, say 72½° N., about 0.08 foot. A wave of this range having zero as age could well accelerate a wave having a range of 0.3 or 0.4 foot, and an age of, say, 60 or 65 hours, as much as 10° or 12°; and so lessen the age by this amount. If the range of the tide produced in Beaufort Sea, or coming from other sources where the ages are small, be greater than this, the age of the observed or resultant tide will be lessened still more. The theoretical equilibrium value of the ratio S_2/M_2 is 0.46531. This, which may be regarded as the ratio for the tides originating in Beaufort Sea proper, will, when combined with the above value for northern Spitzbergen, give very nearly the value for Point Barrow and Flaxman Island.

For Winter Harbor, Melville Island, we have

$$S_2{}^\circ - M_2{}^\circ = 49^\circ,\ S_2/M_2 = 0.59,\ M_2{}^\circ - N_2{}^\circ = 38^\circ,\ N_2/M_2 = 0.14.$$

The age, 49° or 48 hours, agrees well with that found by McClure in the Bay of Mercy, viz., about 50 hours. Suppose now that a portion of the tide in Beaufort Sea comes from the east through McClure Strait. The phase age of this portion will not be much in excess of 50 hours. Consequently, one will not have to assume an age as

great as 60 or 65 hours as the age of the derived tide in Beaufort Sea; nor that the portion of the tide generated in this sea shall exceed 0.08 foot. But, as elsewhere noted, the early tide in the vicinity of the mouth of the Mackenzie River indicates strongly that no great portion of the tide in the Beaufort Sea comes from the east through McClure Strait.

The parallax age being somewhat less for Point Barrow and Flaxman Island than for the northern coasts of Spitzbergen and Franz Josef Land and Winter Harbor, gives a further indication that a portion of the Beaufort Sea tide originates in its own waters.

However this may be, too great weight should not be attached to "ages" where the range of tide is small and where shoals and islands abound, and especially where the tide may be partly equilibrium and partly oscillatory in character.

The following are some of the places at which the observed age of the phase inequality is negative:* Port Eads, Tampico, Ponce (P. R.), Colon, Montevideo, Dutch Harbor and vicinity, Batavia and stations in Java Sea, certain stations in Celebes Sea, Wellington (New Zealand), Port Chalmers (New Zealand), Cooktown (Australia), Cairns Harbor (Australia), Christiania, Oscarsborg, Arendal, and Copenhagen. At most of these places the range of tide is small and the ratio S_2/M_2 considerably different from the theoretical ratio 0.46531.

In only a few cases has it appeared possible to explain negative ages or very great positive ones. Consequently in a deep sea like the Arctic Ocean, known to contain extensive shoals and islands, the existence of a tide wave of sufficiently small age to account for the fact that the age of the resultant or observed tide at Point Barrow and Flaxman Island is even less than the age of the tide at Mossel Bay, Treurenberg, or Teplitz Bay, may be difficult to account for but need not surprise us.

The Baffin Bay branch covers a much smaller area than does the Greenland Sea branch, but the amount of the rise and fall is, in general, much greater. The tide in Baffin Bay and its approaches consists largely of a stationary wave. The nodal line is obscured by the deflecting force due to earth's rotation, and by the progressions to the northwest into Lancaster and Jones sounds.

The wave progressing through Lancaster Sound produces the tides in the Gulf of Boothia (at the head of which they are said to be considerable), in Victoria Strait, Dease Strait, in Melville Sound, and in McClure Strait. Statements are conflicting as to the direction of the progression through McClure Strait, and although McClure observed the tide in the Bay of Mercy and in the Prince of Wales Strait the lunitidal intervals were probably not determined. But the known time and range of tide in Melville Sound, when compared with these quantities for the coast lying east of the Mackenzie River, make it highly probable that the apparent progression through McClure Strait into Beaufort Sea is westerly. At any rate, Capt. J. E. Bernier, commander of the *Arctic*, states that the flood runs westward at Winter Harbor and Cape Providence on Melville Island.

If a tided body communicate by means of a strait with a body having little or no tide, there will generally be some progression from the former into the latter; but,

*Coast and Geodetic Survey Reports, 1900, pp. 664–667; 1904, pp. 342–351 (Manual, Pts. IV A, IV B).

in so far as a stationary wave is produced in the strait, the direction of the flood stream in the strait will be in the opposite direction. For, the flood stream corresponds to a rising tide, and motion in the strait is from the tideless towards the tided body when the water in the strait is rising.* This may explain the discrepant statements concerning the tides in McClure Strait and other channels leading out from Melville Sound.

From Barrow Strait and Melville Sound the progression is probably northward, although a few indications to the contrary are contained in the table given on pages 82 and 83. Some reasons for this conclusion will appear in connection with the explanation of the tides north of Grant Land.

The progression through Jones Sound is westward, as shown by observations made at Table Island.

While there is some delay or progression in passing from the northern end of Baffin Bay into Kane Basin, the oscillation in Robeson Channel is practically a stationary one, connecting a tided and tideless body. The tidal hour of the tided body (Kane Basin) being III½, it follows that the greatest northward velocity in Robeson Channel should occur 3 hours later or at VI½. This would tend to cause a piling up of the waters upon the northwestern coast of Greenland at VI½ o'clock. On account of the narrowness of the channel this effect is there not very apparent, but farther to the northeast the tide is, as explained on page 89, partially caused by the crowding of the stream against the coast at VI½ o'clock and the withdrawing tendency which is greatest at about XII½ o'clock. The amphidromic region northwest of Peary Land is somewhat analogous to those lying off the eastern coast of Argentina where waves progressing northward along the shore are compounded with a wave of small range coming from the deep offshore water.†

The range of tide diminishes rapidly in going from the northern end of Robeson Channel, where it is about 3 feet, to Cape Morris Jesup, where it is only 0.38 foot. The rapid change in the tidal hour along the coast, necessitating an amphidromic region as just noted, agrees well with the assumption of deep water to the north.

The tides in Peary Channel, as shown upon the cotidal map, are of course only conjectural.

The range of tide diminishes from 1.4 feet in Penny Strait and about 3 feet at the southern end of Byam Martin Channel to 0.8 foot at Cape Columbia. There can be no doubt of the direction of the wave progression, because the tide at Cape Columbia occurs 2 hours earlier than at Cape Sheridan. Considering the great distance from Penny Strait and Byam Martin Channel to Cape Columbia it appears highly probable that a channel of only moderate width exists north of the known Arctic Archipelago and northwest of Grant Land. For, if the Arctic Ocean proper washes these shores with no land to the northward, it is difficult to see how the tide at Point Aldrich now known to come from the west could have a range as great as 0.8 of a foot, which is the observed value. Crocker Land, seen by Peary, and a sounding of 310 fathoms taken by his party in latitude 85° 23′ indicate the approximate limits of the hypothetical channel.

* See Coast and Geodetic Survey Report, 1900, p. 683 (Manual, Pt. IV A).

† United States Coast and Geodetic Survey Report, 1904, p. 392 and Fig. 29 (Manual, Pt. IV B).

At Point Aldrich, Cape Columbia, we have from the table given on pages 40 to 43

$$S_2^\circ - M_2^\circ = 54^\circ, S_2/M_2 = 0.44, M_2^\circ - N_2^\circ = 36^\circ, N_2/M_2 = 0.16.$$

For four stations near the head of Baffin Bay at which harmonic constants are available, viz., Van Rensselaer Harbor, Port Foulke, Port Leopold, and Beechey Island the average values are

$$S_2^\circ - M_2^\circ = 45^\circ, S_2/M_2 = 0.38, M_2^\circ - N_2^\circ = 31^\circ, N_2/M_2 = 0.20\tfrac{1}{2}.$$

The difference in phase age between these stations and Point Aldrich is about 9°, or a little less than 9 lunar hours. The difference in parallax age is about 5°, or about 9 lunar hours. The tidal hour for Point Aldrich is XII.26 and the average tidal hour for the four stations at the head of the bay is IV.57, the difference being 7.69 lunar hours, which is not very different from 9. Hence it is practically certain that the tides at Point Aldrich come from the tides at the head of Baffin Bay by way of Lancaster and Jones Sounds.

For Fort Conger and Polaris Bay combined we have

$$S_2^\circ - M_2^\circ = 0.42\tfrac{1}{2}^\circ, S_2/M_2 = 0.45\tfrac{1}{2}, M_2^\circ - N_2^\circ = 26^\circ, N_2/M_2 = 0.19.$$

The stationary character of the wave in Robeson Channel increases the difficulty of accounting for the ages of the tide at these two stations.

The fact that the age of the phase inequality is essentially the same at Port Foulke, Van Rensselaer Harbor, Polaris Bay, Fort Conger, Cape Sheridan, and Cape Bryant goes to establish the nearly stationary character of the tide from the northern end of Baffin Bay to the Arctic Ocean.

Peary's observations show that the progression of the semidaily tide is from west to east along the northern coast of Grant Land and Greenland, and that the mean range of tide is only 0.38 foot at Cape Morris Jesup. In consequence of these facts, the following conclusion, which has been quite generally held for the past thirty years, turns out to be incorrect, viz., that because the time of the tide at Cape Sheridan is earlier than the time of the tide in Kane Basin the tide at Cape Sheridan must come from the Atlantic Ocean by way of northeastern Greenland.*

It is thus seen that the existence of early tides at Cape Sheridan does not prove the insularity of Greenland, as had been claimed by some. The sledge journeys of Peary, however, dispelled all doubts on this subject, which had been a question of long standing.

DIURNAL TIDES IN ARCTIC WATERS.

Information is too meager to enable one to construct reliable cotidal lines representing the K_1 – and O_1 – waves in the Arctic Ocean and nearby waters. The diurnal tides in the North Atlantic Ocean are mainly imperfect equilibrium tides, the imperfections being due to the values of the free periods of this body and numerous defects

* Cf. E. Bessels: Scientific Results of the United States Arctic Expedition, steamer *Polaris*, C. F. Hall, commanding, Vol. I, p. 86 (Washington, 1876).

G. S. Nares: Narrative of a Voyage to the Polar Sea, 1875–76, Vol. 2, p. 356, appendix by S. Houghton. London, 1878.

A. W. Greely: Report on the Proceedings of the United States Expedition to Lady Franklin Bay, Vol. 2, p. 699 (App. No. 140, by A. Christie). Washington, 1888.

in its boundary. Because the western portion of this body of water is more nearly landlocked than the eastern, the equilibrium theory applies better to American than to African or European ports.*

The question of the possibility of equilibrium tides in corners or angles of an ocean irrespective of the dimensions of such body, has been considered on page 87. From this it appears that diurnal tides of considerable size might be expected to exist between Labrador and southern Greenland. As a matter of fact, diurnal tides originating here progress northward and westward, and constitute the predominating diurnal tides throughout the known Arctic Archipelago.

The apparent progression of the K_1 – and O_1 – waves can be seen from the following values taken from the table given on pages 40 to 43:

Station.	K_1.		O_1.	
	Tidal hour.	Amplitude.	Tidal hour.	Amplitude.
		Feet.		*Feet.*
Nennortalik	10.62	0.62	7.95	0.36
Godthaab	11.92	0.69	8.85	0.30
Kingua Fiord	6.62	0.27	7.61	0.09
Port Leopold	20.43	0.90	16.96	0.44
Beechey Island	22.33	0.90	16.93	0.49
Port Kennedy, Bellot Strait	22.63	1.18	18.18	0.58
Northumberland Sound	24.74	0.31	21.34	0.15
Winter Harbor	25.20	0.22	16.07	0.10
Port Foulke	17.31	1.05	14.51	0.41
Van Rensselaer Harbor	17.60	0.85	14.73	0.42
Fort Conger	19.12	0.28	17.59	0.09
Polaris Bay	20.55	0.40	18.08	0.15
Cape Bryant	22.77	0.32	21.15	0.14
Cape Sheridan	23.95	0.16	22.63	0.09
Point Aldrich	25.39	0.17	23.37	0.11
Cape Morris Jesup	cir. 27	.....	cir. 26	.....

Upon comparing these hours with the tidal hours for the semidaily wave, as shown in the tables given on pages 40 to 43 or upon the chart of cotidal lines, it will be seen that about the same time is required by the diurnal as by the semidiurnal wave in passing from southern Greenland to Melville Island, Penny Strait, or Port Foulke. This indicates the progressive character of both kinds of waves over most of these routes. The ages of the diurnal tide in this region—i. e., the values of $K_1^\circ - O_1^\circ$—are somewhat irregular or anomalous and so in several cases of doubtful significance in connection with the progression here considered.

A progressive wave controls the diurnal tide as far north as Polaris Bay and Fort Conger and probably as far to the northeast as Cape Morris Jesup. At this place the series of observations is not sufficiently long for separating the O_1 from the K_1; but the value of $K_1 + O_1$ is about 0.4 foot and the tidal hour of the diurnal wave is about XXVI or XXVII.

The diurnal tides at Cape Bryant, Cape Sheridan, and Point Aldrich show by their tidal hours, ages, and amplitude ratios that they are influenced by diurnal

* Coast and Geodetic Survey Report for 1900, pp. 554, 555, 660, 661 (Manual, Pt. IV A).

tides from the north, as will be noted presently. However the ratio O_1/K_1 shows that the tide at Cape Bryant comes chiefly from Robeson Channel rather than from the Arctic.

Whether the Arctic Ocean is assumed to be a deep uninterrupted body of water or a body of water somewhat annular in form—*i. e.*, an ocean surrounding a mass of land by broad and deep channels—the times and ranges of the equilibrium diurnal tides along the known or outer shores will be nearly the same under either assumption. For this reason, great care must be exercised in drawing conclusions from the observed values of K_1 and O_1.

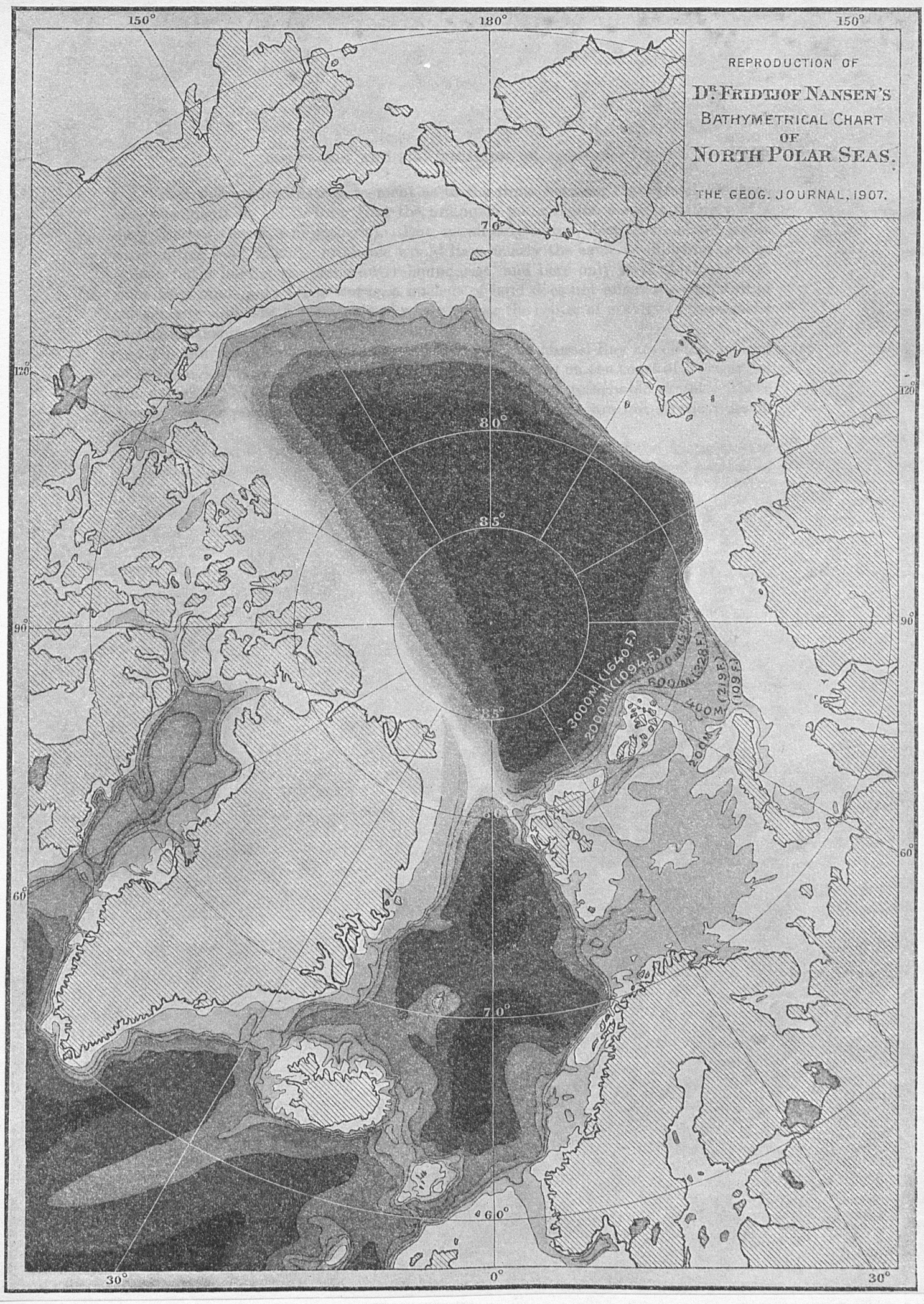
The diurnal tidal forces at the North Pole have an intensity of 0.000 000 044 66g for K_1 and of 0.000 000 031 75g for O_1. They may be represented by arrows radiating from the Pole; and if the time interval be one component hour the angle between adjacent arrows will be 15°. For a small, deep polar basin the cotidal lines will radiate from the Pole, the zero hour line coinciding with the terrestrial meridian to which the times are referred.

The arrows representing tidal forces in high latitudes differ but little from those at the Pole itself. The no-tide point of a body of water of moderate dimensions in any latitude which obeys the equilibrium theory coincides with the center of gravity of the surface of the body. Hence, for a body of water near the pole the tidal hour of any place upon it is very nearly determined by first connecting this place with the center of gravity of the surface and then noting what meridian is parallel to this line. The amplitudes of K_1 and O_1 will be very nearly equal to the above numerical coefficients of g multiplied by the distance, expressed in feet, from the no-tide point to the given station.

If the boundaries of the equilibrating body are supposed to follow Nansen's assumed 200-meter curve from off Point Barrow to Nova Zembla, to pass thence through Franz Josef Land and Northern Spitzbergen Islands, and to follow the northern coasts of Greenland, Grant Land, the Arctic Archipelago, and Alaska, the position of the center of gravity of the surface thus defined will be 85° N. and 162° W. (See Fig. 2.)

The theoretical values for K_1 and O_1, computed in the above manner and upon this assumption of deep water, are given here together with the observed values.

Station.	Tidal hour.			Amplitude.			
	K_1 or O_1 computed.	K_1 observed.	O_1 observed.	K_1 computed.	K_1 observed.	O_1 computed.	O_1 observed.
				Feet.	*Feet.*	*Feet.*	*Feet.*
Cape Morris Jesup	0.70	cir. 3	cir. 2	0.17	.....	0.12	.....
Cape Bryant	1.84	22.77	21.15	0.17	0.32	0.12	0.14
Cape Sheridan	2.15	23.95	22.63	0.15	0.16	0.11	0.09
Point Aldrich	2.30	1.39	23.37	0.14	0.17	0.10	0.11
Flaxman Island	9.40	10.25	12.72	0.24	0.08	0.17	0.09
Point Barrow	10.32	9.55	11.76	0.22	0.05	0.16	0.05
Bennett Island (Rudder Point)	15.42	.....	.....	0.17	.....	0.12	.....
Teplitz Bay	21.12	21.85	23.42	0.20	0.10	0.14	0.04
Treurenberg	22.84	16.88	3.54	0.25	0.24	0.18	0.07
Mossel Bay	22.89	14.86	3.26	0.25	0.23	0.18	0.09


REPRODUCTION OF
Dr. FRIDTJOF NANSEN'S
BATHYMETRICAL CHART
OF
NORTH POLAR SEAS.
THE GEOG. JOURNAL, 1907.
150°
180°
150°
70°
120°
120°
80°
85°
90°
90°
85°
3000 M. (1640 F.)
2000 M. (1094 F.)
1000 M. (547 F.)
600 M. (328 F.)
400 M. (219 F.)
200 M. (109 F.)
60°
60°
70°
60°
30°
0°
30°

From this approximate agreement as to the times between theory and observation one might be led to infer that the unknown polar region consists entirely of a deep ocean (Nansen's hypothesis). But, as already noted, deep channels of water surrounding land, islands, or shoals would have nearly the same equilibrium tide as a deep basin having the same outer boundaries, and here only have tidal observations been made. In other words, a nucleus of land does not affect the equilibrium tides in any sufficiently deep body of water, unless the center of gravity of the water's surface be displaced because of this land.

The diurnal tides at Port Virgo, Treurenberg, and Mossel Bay are closely related to those at Vardö, Fineide, Kabelvaag, Bodö, and Bergen on the coast of Norway, as the values of $K_1° - O_1°$ and O_1/K_1 establish beyond all reasonable doubt. These diurnal waves progress in a northeasterly direction and so are not Arctic tides in origin.

The K_1 and O_1 at Teplitz Bay are largely equilibrium tides of the Arctic Ocean. A derived wave sets out in a southerly direction, producing the principal portion of the diurnal tides at Cape Flora.

The observations at Bennett Island are too few for enabling one to separate the K_1- and O_1- waves. The observed tidal hour of the diurnal wave is about XVII and the observed tropic range is 0.3 foot; that is, about one-half of the value computed on the assumption of an extended polar basin. This tidal hour shows that the Bennett Island diurnal wave does not consist entirely of the diurnal wave transmitted from the vicinity of Teplitz Bay, where the K_1- hour is XXI.85 and the O_1- hour is XXIII.42. It indicates, rather, that the diurnal tides at Bennett Island originate in the near-by deep portion of the Arctic Ocean lying between Bennett Island, Franz Josef Land, and Grant Land. The small range of the diurnal wave at Bennett Island does not appear to be reconcilable with the hypothesis of an uninterrupted broad and deep basin extending from this island to the Arctic Archipelago of America. The small range of the diurnal tide at Pitlekaj is a further strong argument, if not a positive proof, against the hypothesis of generally deep water between the Arctic coast of eastern Siberia and the Arctic Archipelago.

As already noted, the diurnal tide occurs at Point Barrow about one hour earlier than at Flaxman Island, indicating that one portion of this wave comes from the west. The ratio O_1/K_1 is 0.97 for Point Barrow, 1.14 for Flaxman Island, and 1.10 for Pitlekaj; the corresponding ratio between the forces is 0.711. The value of $K_1° - O_1°$ is $-33°$ for Point Barrow, $-38°$ for Flaxman Island, and $-24°$ for Teplitz Bay. For Winter Harbor, Melville Island, $O_1/K_1 = 0.45$, $K_1° - O_1° = 138°$.

Upon the hypothesis that the northern coast of Beaufort Sea lies 6½ degrees away from its southern or Alaskan coast, there would be implied an equilibrium diurnal tide having at Flaxman Island a tropic range of 0.2 foot and XI as the tidal hour. The equilibrium tide at Point Barrow would, upon this hypothesis, be much smaller than that at Flaxman Island.

The range of the semidaily tide being 2.5 feet at Bennett Island and 0.4 foot at Point Barrow would seem to make reasonable the assumption that a 0.3-foot diurnal tide at the former place may become a 0.1-foot diurnal tide at the latter. Assuming an average depth of 70 fathoms, the time required for the transmission of a wave over 15° of a great circle, which is about the distance from Bennett Island to Point Barrow, is 13 hours. This added to XVII will give VI as the tidal hour of the small derived tide at Point Barrow. VI combined with the time of the equilibrium portion already mentioned will make the diurnal tidal hour somewhat less than XI. The acceleration is probably chiefly in the K_1- wave, because the ratio O_1/K_1 is known to be small for the northern coasts of Spitzbergen Islands and Franz Josef Land. This may help to explain why the tidal hour of the K_1- wave is less than that of the O_1- wave at Point Barrow and Flaxman Island; that is, why the age of the diurnal tide is there negative.

There remains to be considered a portion of the diurnal wave coming from the east through McClure Strait. The tidal hours for K_1 and O_1 at Winter Harbor are XXV.20 and XVI.07, the latter probably being unreliable. Adding, say, four hours to the former, we have XXIX or V as the K_1- tidal hour for northern Alaska. At Winter Harbor the ratio O_1/K_1 is small in comparison with its theoretical value 0.711. This, also, may help to explain the acceleration in K_1, and so the negative age, for the northern coast of Alaska.

The small amplitudes of K_1 and O_1 observed at Point Barrow, Flaxman Island, and Pitlekaj prove that the unknown lands or shoals seriously interfere with and obstruct the diurnal tides in the Arctic Ocean. For greater reason the semidaily tides must be obstructed by the same obstacle.

The observed diurnal tides at Point Aldrich agree fairly well with their theoretical values (based upon the deep-water assumption) in both time and amplitude, as is shown in the above table.

The fact that the diurnal tides at Cape Sheridan are a trifle smaller than at Point Aldrich proves that not all of the diurnal tide at Point Aldrich is transmitted through Robeson Channel, although a portion of it probably is. Whatever part is so transmitted would go to making the resultant or observed tide at Point Aldrich earlier than the computed equilibrium tide. The reverse would probably be true for any diurnal tide which may be transmitted westerly and northwesterly from Lancaster and Jones sounds around the northern coast of Grant Land to Point Aldrich. However, the diurnal tide from this source is probably negligible. The value of $K_1° - O_1°$ at Point Aldrich agrees well with that at Fort Conger and Polaris Bay, indicating Robeson Channel influence; but the ratio O_1/K_1 is almost twice as great at Point Aldrich as at the places just named, indicating deep-water influence to the north. It seems to be practically certain that the observed diurnal tide at Point Aldrich consists partly of an equilibrium tide from the deep waters to the northward and partly of a tide transmitted up through Robeson Channel. It would thus follow that the equilibrium portion of the tide, whatever may be the geography

of the Arctic Ocean, must be later than the observed resultant tide and smaller in amplitude; its tidal hour may be as great as IV or V. But the existence of a large tract of land northwestward from Grant Land would doubtless reduce the size of the equilibrium tides at Point Aldrich and those occurring along the coast line farther westward, where no observations have been taken; for, the size of the equilibrating body of water would then be materially reduced, while the openings leading away from it, remaining the same as before, could the more readily reduce the size of the equilibrium portion of the tide. The land distribution shown upon the cotidal chart would imply a diurnal tidal hour of about IV or V.

The fact that the diurnal tide at Point Aldrich is larger than the diurnal tide at Point Barrow and Flaxman Island indicates that a larger deep basin of water exists north of Greenland and Grant Land than north of Alaska.

The diurnal tide at Cape Morris Jesup is a little later than the diurnal tide at Point Aldrich. The fact that it is quite as large, notwithstanding its proximity to the opening between Peary Land and Spitzbergen Islands shows that it must come largely through Robeson Channel viâ Cape Bryant. This appears reasonable from the fact that the diurnal range diminishes in going from Cape Bryant to Cape Morris Jesup, while the time becomes several hours later.

The manner in which the diurnal tide from Baffin Bay joins the diurnal tide of the Arctic Ocean can be seen upon comparing the tidal hours for stations along the Arctic coast with the tidal hour at Fort Conger. Peary's observations show that the diurnal tide at Cape Bryant, Cape Sheridan, Point Aldrich, and Cape Morris Jesup follows that at Fort Conger by respective intervals of 3½, 5, 6, and 8 hours. The ratio O_1/K_1 is 0.32 at Fort Conger, 0.44 at Cape Bryant, 0.56 at Cape Sheridan, and 0.65 at Point Aldrich.

At Teplitz Bay the ratio O_1/K_1 approaches more nearly to the ratio between the corresponding forces than is the case at Cape Flora.

CONCERNING NANSEN'S HYPOTHESIS THAT DEEP WATER EXTENDS CONTINUOUSLY FROM SPITZBERGEN TO ALASKA.

The semidaily tidal hour for Cape Morris Jesup is XII.68 and for Port Virgo XII.56. The direct distance from a point midway between these two stations to Flaxman Island is 26½°. The distance following a more circuitous route, which about coincides with the line of assumed deepest water measures 28° or 29°, the assumed average depth in this case is greater than 3,000 meters, or 1,640 fathoms. (See Fig. 2.)

The rate of wave propagation in depths of 1,640 fathoms is 344 nautical miles per lunar hour, or about 5.7°. The required time of transmission can not, therefore, be greater than $28\frac{1}{2} \div 5.7 = 5$ lunar hours. This added to XII.6 gives V.6 as the tidal hour for the northern coast of Alaska. Observation makes it out to be IX.5 instead. A greater average depth would give a still greater discrepancy. The rather sudden termination of this assumed basin off the northern coast of Alaska also adds to the discrepancy by accelerating the times of the tides.

The flood tide at Point Barrow would, according to Nansen's hypothesis, have to come from the north, and not from the west as observation has established.

With a deep polar basin extending from Franz Josef Land to Alaska, the range of tide along the Alaskan coast could hardly differ much from that found at Teplitz Bay and Bennett Island, whereas observation shows it to be scarcely one-half as great. The very small semidaily tide found at Pitlekaj does not favor the hypothesis in question.

Large diurnal equilibrium tides would, under the hypothesis in question, be set up between Franz Josef Land and the northern coast of Alaska, the length of the basin being 28°. The tidal hour at these two ends would be −III, or XXI, and IX. The equilibrium amplitude of the diurnal tides for a polar basin 28°, or 10,214,400 feet, long would be 0.22 foot for the K_1−wave and 0.16 foot for the O_1−wave. The estimated times of the equilibrium tides agree fairly well with the observed times as can be seen from the observed tidal hours for Teplitz Bay, Point Barrow, and Flaxman Island. But the fact that the diurnal tide reaches Point Barrow nearly an hour earlier than it reaches Flaxman Island can not be accounted for by Nansen's hypothesis. The observed amplitudes of the K_1− and O_1−waves at these three places average only 0.08 and 0.06, respectively, or about one-third of their equilibrium values. This fact alone disproves the hypothesis.

Nansen's hypothesis necessitates diurnal tides at Pitlekaj of at least the size of the theoretical values at Flaxman Island. Observation shows that at Pitlekaj $K_1=0.04$ foot and $O_1=0.04$ foot, which values are about one-fifth or one-fourth of what might have been expected from the equilibrium theory.

Regarding the hypothetical Arctic basin extending from Franz Josef Land to the northern coast of Alaska as five component hours in length, or 5/24 λ, λ denoting wave length for given depth and period, the equilibrium amplitude should be increased by the factor 1.17 on account of wave motion.* This may, however, be about offset by the yielding of the solid earth which the diurnal tides at Lake Superior put in evidence.

The shelving edges would increase the range of the equilibrium tides while broken boundaries would diminish it.

If Doctor Nansen's hypothesis were correct, there can be no doubt that at Flaxman Island the ratio O_1/K_1 would approach 0.711, and $K_1°-O_1°$ would be a small angle and probably positive. Observation shows that $O_1/K_1=1.14$, and $K_1°-O_1°=-38°$. The corresponding quantities for Point Barrow are 0.97 and −33°. For Duluth, Lake Superior, $O_1/K_1=0.719$ and $K_1°-O_1°=1°.7$.

The diurnal tidal hour at Bennett Island would, according to Nansen's hypothesis, be XVI and for Cape Columbia IV hours. The distance from Bennett Island to the northern coast of Prince Patrick Island, Isachsen Land, Axel Heiberg Island, and Grant Land is 19°. The computed and observed times are in fair agreement for Bennett Island, but the discrepancy is significant for Cape Columbia.

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* Cf. p. 268, Coast and Geodetic Survey Report for 1907 (Manual, Pt. V).

The theoretical amplitudes of K_1 and O_1 for a polar basin 19° across are 0.151 and 0.110 foot, respectively. These computed amplitudes suit the amplitudes at Cape Columbia very well. They are, however, about twice as great as those observed at Bennett Island.

The shoals north of Bennett Island probably aid in increasing the range of the semidaily tide to 2.5 feet; this range measures only 1.1 feet at Teplitz Bay. The same shoaling doubtless increases the range of the diurnal wave somewhat. Yet, as already noted, the observed diurnal range is much smaller than the equilibrium value.

The decided westward drift observed by Mikkelsen and Leffingwell off the northern coast of Alaska is alone strong evidence against Nansen's hypothesis of an unobstructed polar basin.

The westerly direction taken by the *Jeannette*, especially during the last five months of her drifting, does not suggest unobstructed deep water to the northward of eastern Siberia.

The time required by casks deposited off Point Barrow and off Cape Bathurst to reach their destinations on the northeastern coast of Iceland and the northern coast of Norway, viz., about five and one-half and eight and one-fourth years, respectively, while not disproving, certainly do not favor the hypothesis in question.

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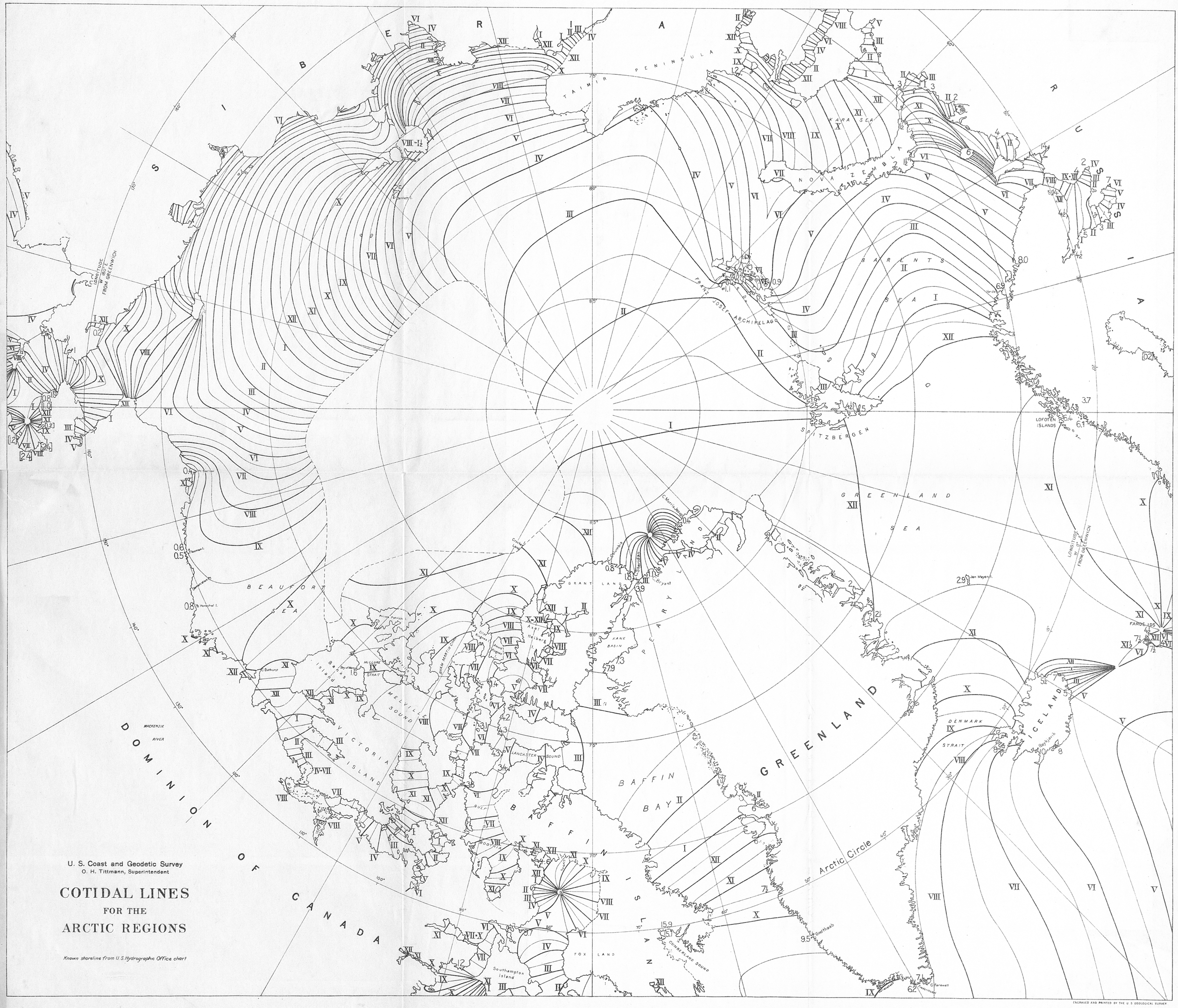

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