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AN ANALYSIS OF SELECTED AIRBORNE SEA ICE OBSERVATIONS PROJECT BIRDSEYE (1968-1971)

by

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ABSTRACT: From 1968 to 1971, over 12,000 visual observations of arctic sea ice were collected during an airborne arctic ice program, Project BIRDSEYE, under the auspices of the Naval Oceanographic Office. To have these data in an easily accessible form, the data were all stored on one computer magnetic tape. A computer program, written to decode the data which were grouped by tracks, obtained various information from each observation, such as the position, the time, the concentration, forms, and stages of development of the ice, the height and extent of ridging, the orientation of the water feature, the stage of melting, and the number of growlers, bergy bits, and icebergs. Statistical computations were then performed for each of the above categories of information. To make the data pictorially presentable, the observations were divided into four seasonal periods, from which the observations were grouped into 5° sections (i.e., 5° latitude by 5° longitude). Polar projection charts for each period were constructed to display the percentage probabilities, concentrations, and number of observations of two ice categories within each section. After examination of the charts, it was found that the data were too sparse over the whole arctic region to develop any definitive prediction scheme. However, in those limited portions of the Arctic where many tracks, taken at the same time of year, were flown, the data may be very useful in predicting various ice characteristics.

I. INTRODUCTION

This report describes a method of compilation used to make visual ice data collected during Project BIRDSEYE, an arctic ice program conducted by the Naval Oceanographic Office (NAVOCEANO) since 1962, readily accessible and adaptable to its scientific commitments. The BIRDSEYE data used here were gathered during the years 1968-1971, inclusive, by ice observers aboard a U. S. Navy aircraft on missions over the Arctic Ocean and marginal sea ice zones. This four year period was used because the format of reporting remained the same during this time. However, this was not the case prior to this period since the format changed significantly several times. This four year compilation is one of the first consolidations of BIRDSEYE data over any significant time span, and it is hoped that this endeavor, through its procedure and results, will yield more meaningful ideas to serve as a base for future consideration and examination.

II. PROCEDURE

The first task in the compilation of the BIRDSEYE data was to assemble the data in the most efficient manner possible. Due to the immense amount of data, which amounted to approximately 12,000 visual observations taken at 5-minute intervals, a procedure for minimizing storage space and facilitating access to the data had to be developed. Consequently, all four years of data were put on one standard computer magnetic tape.

The data were originally recorded on NAVOCEANO 3930/7 forms in a World Meteorological Organization (WMO) "numerical spot ice aerial" coded format. From these forms, arranged according to the tracks of the missions, the data were transferred to computer input cards via standard key-punch machines (Figure 1). Then, with the data on computer cards, a simple FORTRAN computer program was written to transfer the card images onto the magnetic tape such that each year of data comprised one file on the tape (i.e., the first file contained 1968 data, the second file contained 1969 data, etc.). As a result, four years of BIRDSEYE data were stored on one magnetic tape from which the data could be easily obtained.

Next, a computer program was written to decode the data on the tape in order to print out the data in an easily readable tabular form grouped by tracks (Figure 2). From each track, the following information for each observation was obtained: quadrant of the globe, latitude, longitude, year, month, day, hour, total concentration of the ice observed, primary ice form, concentration of the primary ice form, primary stage of ice development, concentration of the primary stage, secondary ice form, concentration of the secondary ice form, secondary stage of ice development, concentration of the secondary stage, extent of the ridging, height of the ridging, orientation of the water feature, stage of ice melting, number of growlers and bergy bits, and number of icebergs. All these decoded data were then stored on another magnetic tape for easy manipulation.

With these decoded data now on tape, a more usable form of presentation had to be developed. Therefore, after the information of each track was printed out, another computer program was used to calculate and print out simple statistical information (Figure 3). The statistics computed were the average total concentration (in oktas) of the ice, the number of observations for each category of information, and the percentage probability of occurrence of: each stage of ice development observed along with its average concentration, the extent and maximum height of the ridging, the orientation of the water feature, the stage of melting, the number of growlers and bergy bits, and the number of icebergs. After each set of statistics, an alphabetic key of the codes and abbreviations used was presented.

Finally, a way to make these data pictorially presentable was considered. As a result, instead of having the data arranged by tracks, it was decided to use a computer program to divide all four years of data into four periods (i.e., September-October-November, December-January-February, March-April-May, June-July-August), and then group the data of each period into 5° sections (i.e., 5° longitude in width and 5° latitude in height) (Figure 4) from 55° to 90°N latitude and from 0° to 180°W longitude as well as from 0° to 180°E longitude with yet another program. Thus, the major portions of the Arctic Ocean and its marginal seas surveyed by Project BIRDSEYE could now be presented pictorially.

III. RESULTS AND CONCLUSIONS

Now that all four years of data were sorted into the 5° sections by periods, it was possible to graphically display the information through polar projection charts. In order to get an initial idea of the significance of the data sorted into sections, it was decided to make charts for two categories of ice.

The ice categories chosen for these charts were (1) NONE (open water and/or nilas, 0-10 cm thick) and (2) OLD ICE (second-year ice or older), when each of these was the primary (i.e., predominant) stage of development. So, for each of the four seasons, two charts were constructed: one for NONE and one for OLD ICE. The information given within each section for all four years on each chart was: (1) the number of observations from all tracks for the appropriate ice category; (2) the average concentration (in oktas) of the ice category: and (3) the probability (in percent) of finding the ice category in question within the particular area at a particular period of the year. After this information was entered in each section (Figure 5), a coded grid was drawn upon each of the charts in order to better see the percentage probabilities and to determine if some sort of pattern might emerge (Figure 6).

After the eight coded charts were constructed, they were put through extensive scrutiny. As a result, the charts revealed several interesting features such as a pattern of seasonal progression of the ice, various anomalies, and a curious lack of old ice along the upper northwest and northeast coasts of Greenland. However, the accuracy and reliability of the results were subject to question because some of the sections contained only one or two observations, whereas other sections contained as many as eighty or ninety observations. Initially, it was thought that the low observation count sections were not very reliable and that the high observation count sections were definitely reliable. The latter conclusion, however, was soon found to be erroneous when, after plotting some of the tracks, it was discovered that many of the high observation counts from several sections were taken on exactly the same day from the same month of the same year.

Finally, it was concluded that trying to develop a definitive prediction scheme, based only on these available data, would be futile. The main problem was that the data were too sparse when taken as a whole over the arctic region. However, these data may be very useful in predicting various ice characteristics in those limited portions of the Arctic where many tracks, taken at the same time of year, were flown (e.g., the Denmark Strait area). Consideration will now be given as to further utilization of the data, while, in the meantime, the raw original BIRDSEYE data will be stored in an easily accessible form on tape.

ACKNOWLEDGMENT

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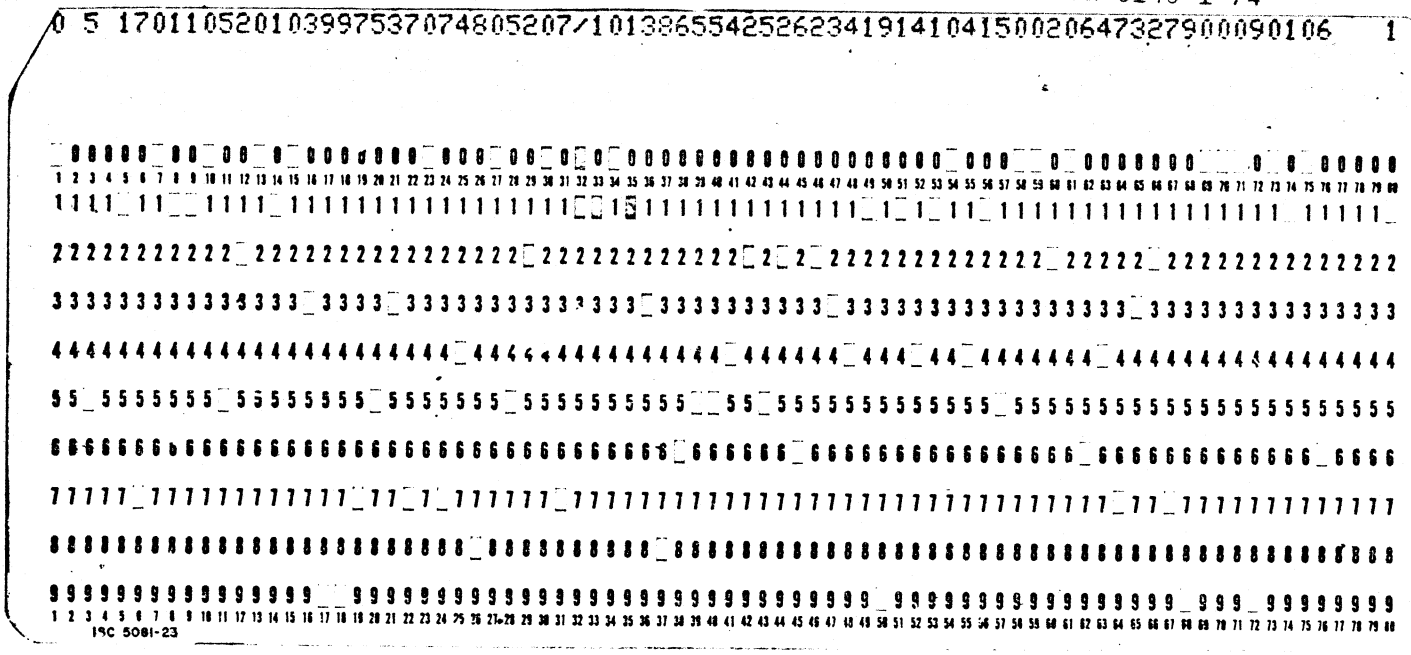

COLUMN(S)	DESCRIPTION	COLUMN(S)	DESCRIPTION
1	Always "0"	46	Concentration of Stage
2-3	Flight	47	Always "3"
4-5	Track	48	Tertiary Form
6-7	Year	49	Concentration of Form
8-9	Month	50	Tertiary Stage of Devel.
10-11	Day	51	Concentration of Stage
12-15	Hour	52	Always "4"
16	Always "3"	53	Quaternary Form
17-18	Always "99" for Card No. 1	54	Concentration of Form
	And "88" for Card No. 2	55	Quaternary Stage of Devel.
19-20	Latitude (Degrees)	56	Concentration of Stage
21	Latitude (Minutes (10ths))	57	Always "5"
22	Quadrant	58	Quintary Form
23-25	Longitude (Degrees)	59	Concentration of Form
26	Longitude (Minutes (10ths))	60	Quintary Stage of Devel.
27-28	Day	61	Concentration of Stage
29-30	Hour	62	Always "6"
31	Visibility	63	Primary Topography
32	Always "/"	64	Secondary Topography
33-34	Minutes	65	Extent of Ridging
35-36	Altitude	66	Height of Ridging
37	Total Concentration	67	Always "7"
38	Primary Form	68	Type of Ice Opening
39	Concentration of Form	69	Orientation of Water Feature
40	Primary Stage of Devel.	70	Extent of Fast Ice
41	Concentration of Stage	71	Stage of Melting
42	Always "2"	72	Always "9"
43	Secondary Form	73-74	No. of Growlers and Bergy Bits
44	Concentration of Form	75-76	No. of Ice Bergs
45	Secondary Stage of Devel.	77-80	Card No.

FIGURE 1 — DECODING TABLE FOR ICE DATA CARDS

BE 5- 3 1971

LAT	Q	LONG	YR	MO	DA	TIME	CT	FM 1	CF1	ST 1	CS1	FM 2	CF2	ST 2	CS2	EX RIDG	HT RIDG	ORIEN	ST MELT	GR-BGBT	IC BERG
83.9	7	44.0	71	6	18	20	8	BRBL	6	OLD	4	LG	2	THIK	3	40	5	NONE	NONE		
84.0	7	42.3	71	6	18	25	8	BRBL	6	OLD	4	LG	2	THIK	3	50	7	NONE	NONE		
84.1	7	40.7	71	6	18	30	8	BRBL	8	OLD	4	NONE	0	THIK	2	50	6	NONE	NONE		
84.1	7	58.3	71	6	18	35	8	BRBL	6	OLD	5	LG	2	THIK	2	50	6	N-S	NONE		
84.1	7	36.2	71	6	18	40	8	BRBL	6	OLD	4	LG	1	THIN	3	40	4	NONE	NONE		
84.1	7	33.8	71	6	18	45	8	BRBL	6	OLD	4	LG	1	THIK	2	40	6	N-S	FP		
84.0	7	31.5	71	6	18	50	8	BRBL	7	THIK	4	LG	1	OLD	3	40	4	NONE	FP		
83.8	7	29.5	71	6	18	55	8	BRBL	7	OLD	4	LG	1	THIK	3	40	4	NONE	FP		
83.7	7	27.6	71	6	18	100	8	BRBL	7	OLD	4	LG	1	THIK	3	40	4	N-S	FP		
83.6	7	26.0	71	6	18	105	8	LG	3	OLD	6	BRBL	3	THIK	2	40	5	NONE	FP		
83.5	7	24.5	71	6	18	110	8	LG	3	OLD	6	BRBL	3	THIK	2	40	5	NONE	FP		
83.4	7	22.7	71	6	18	115	8	LG	3	OLD	6	BRBL	2	THIK	2	40	4	NONE	FP		
83.3	7	21.0	71	6	18	120	8	LG	2	OLD	6	BRBL	2	THIK	2	40	4	NONE	FP		
83.2	7	19.2	71	6	18	125	8	LG	3	OLD	6	BRBL	2	THIK	2	30	4	NONE	FP		
83.1	7	17.7	71	6	18	130	8	LG	3	OLD	6	BRBL	2	THIK	2	10-20	3	NONE	FP		
82.9	7	16.1	71	6	18	135	8	LG	2	OLD	6	LG	2	THIK	1	10-20	4	NONE	FP		
82.8	7	14.7	71	6	18	140	9	LG	2	OLD	6	LG	2	THIK	2	10-20	4	NONE	FP		
82.6	7	12.8	71	6	18	145	8	LG	2	OLD	6	BRBL	2	THIK	2	30	3	NONE	FP		
82.5	7	11.0	71	6	18	150	8	LG	2	OLD	5	LG	2	THIK	2	30	3	E-W	FP		
82.3	7	9.6	71	6	18	155	8	LG	2	OLD	5	LG	2	THIK	2	10-20	4	NONE	FP		
82.1	7	8.2	71	6	18	200	8	LG	2	OLD	3	LG	2	THIK	3	40	2	NONE	FP		
81.9	7	6.8	71	6	18	205	8	BRBL	4	OLD	4	LG	2	THIK	3	40	2	NONE	FP		
81.8	7	5.5	71	6	18	210	8	BRBL	4	THIK	4	LG	2	OLD	3	40	2	NONE	FP		
81.5	7	4.9	71	6	18	215	9	BRBL	5	THIK	5	LG	3	OLD	3	40	2	NONE	FP		
81.3	7	5.8	71	6	18	220	8	BRBL	5	OLD	5	LG	3	THIK	3	40	2	NONE	FP		
81.1	7	6.7	71	6	18	225	8	BRBL	4	OLD	4	LG	2	THIK	3	40	2	NONE	FP		
80.9	7	7.3	71	6	18	230	8	BRBL	4	OLD	4	LG	2	THIK	3	40	2	NONE	FP		
80.6	7	8.5	71	6	18	235	8	LG	3	OLD	3	BRBL	3	THIK	3	30	2	NONE	FP		
80.4	7	9.3	71	6	18	240	7	BRBL	3	OLD	3	BRBL	2	THIK	3	30	2	NONE	FP		
80.2	7	10.2	71	6	18	245	6	BRBL	2	OLD	3	BRBL	2	THIK	3	30	2	NONE	FP		
80.0	7	11.0	71	6	18	250	7	BRBL	3	THIK	4	LG	2	OLD	3	30	3	NONE	MPFTH		
79.7	7	11.9	71	6	18	255	7	BRBL	3	THIK	4	LG	2	OLD	3	30	3	NONE	FP		
79.5	7	12.4	71	6	18	300	7	BRBL	3	THIK	4	LG	2	OLD	3	30	3	NONE	FP		
79.6	7	11.4	71	6	18	305	8	BRBL	3	OLD	4	LG	2	THIK	2	40	3	NONE	FP		
79.7	7	10.3	71	6	18	310	9	LG	3	OLD	4	BRBL	3	THIK	3	40	3	NONE	FP		
79.7	7	9.0	71	6	18	315	7	BRBL	4	OLD	4	LG	3	THIK	2	40	3	NONE	FP		
79.7	7	7.5	71	6	18	320															
79.7	7	6.6	71	6	18	323	7	BRBL	4	OLD	4	LG	2	THIK	2	40	3	NONE	FP		
79.7	7	6.0	71	6	18	325	6	BRBL	3	OLD	3	BRBL	2	THIK	2			NONE	FP		
79.7	7	4.5	71	6	18	330	2	BRBL	1	OLD	1	BRBL	1	THIK	1			NONE	FP		
79.6	7	2.9	71	6	18	335	6	BRBL	4	OLD	3	LG	1	THIK	2			NONE	FP		
79.2	7	4.5	71	6	18	340	6	BRBL	3	THIK	4	LG	2	OLD	1	10-20	0-1	NONE	FP		
79.1	7	4.6	71	6	18	345	6	BRBL	3	THIK	4	LG	2	OLD	1	10-20	2	NONE	FP		
78.9	7	5.3	71	6	18	350	6	BRBL	3	THIK	4	LG	2	THIN	2	10-20	2	NONE	FP		
78.7	7	5.8	71	6	18	355	6	BRBL	3	THIK	4	LG	2	THIN	2	30	2	NONE	FP		
78.5	7	6.3	71	6	18	400	6	BRBL	3	THIK	4	LG	2	THIN	2	30	2	NONE	FP		
78.3	7	6.9	71	6	18	405	6	LG	3			BRBL	2					NONE	FP		
78.1	7	7.5	71	6	18	410															
77.8	7	8.2	71	6	18	415	6	LG	3			BRBL	2					NONE	FP		
77.5	7	8.8	71	6	18	420	8	LG	3	OLD	4	BRBL	3	THIK	2	10-20	3	NONE	FP		
77.3	7	9.4	71	6	18	425	0	BRBL	0	OLD	0					10-20	3	NONE	FP		
77.0	7	9.8	71	6	18	430	6	LG	2	OLD	2	BRBL	2	THIK	2	10-20	3	NONE	FP		
77.0	7	8.9	71	6	18	435	6	LG	2	OLD	2	BRBL	2	THIK	2	10-20	3	NONE	FP		
77.0	7	7.8	71	6	18	440	6	LG	2	OLD	2	BRBL	2	THIN	2	10-20	2	NONE	FP		
77.0	7	6.4	71	6	18	445	5	BRBL	2	THIK	2	BRBL	2	THIN	2	10-20	3	NONE	FP		
77.0	7	5.0	71	6	18	450	5	BRBL	2	THIK	2	BRBL	2	THIN	2	10-20	3	NONE	FP		
77.0	7	3.7	71	6	18	455	3	LG	1	THIK	1	BRBL	1	THIK	1	10-20	2	NONE	NONE		
77.0	7	2.3	71	6	18	500	3	LG	1	THIK	1	BRBL	1	THIK	1	10-20	2	NONE	NONE		
77.0	7	1.0	71	6	18	505	0	BRBL	0	THIK	0					0	0-1	NONE	NONE		

FIGURE 2 - A SAMPLE TRACK OF ICE DATA

TOTAL CONCENTRATION= 6.8

OBS.= 57

PRIMARY FORM

OBS.= 57	NONE =	.0	NEW =	.0	BRBL =	61.4	LG =	38.6	FAST =	.0
CONCEN.=		.0		.0		2.4		.9		.0

PRIMARY STAGE OF DEVELOPMENT

OBS.= 55	NONE =	.0	NEW =	.0	THIN =	.0	THIK =	29.1	OLD =	70.9
CONCEN.=		.0		.0		.0		.9		2.9

SECONDARY FORM

OBS.= 55	NONE =	1.8	NEW =	.0	BRBL =	41.8	LG =	56.4	FAST =	.0
CONCEN.=		.0		.0		.9		1.1		.0

SECONDARY STAGE OF DEVELOPMENT

OBS.= 53	NONE =	.0	NEW =	.0	THIN =	13.2	THIK =	71.7	OLD =	15.1
CONCEN.=		.0		.0		.3		1.6		.4

EXTENT OF RIDGING (PCT.)

OBS.= 52	0 =	1.9	10-20=	30.8	30 =	21.2	40 =	40.4	50 =	5.8
	60 =	.0	70 =	.0	80 =	.0	90 =	.0	100 =	.0

MAXIMUM HT. OF RIDGING (M.)

OBS.= 52	0-1 =	3.8	2 =	32.7	3 =	30.8	4 =	19.2	5 =	5.8
	6 =	5.8	7 =	1.9	8 =	.0	9 =	.0	GE10 =	.0

ORIENTATION OF WATER FEATURE

OBS.= 57	NONE =	93.0	N-S =	5.3	NE-SW=	.0	E-W =	1.8	SE-W =	.0
	PSN =	.0	PSE =	.0	PSS =	.0	PSW =	.0		

STAGE OF MELTING

OBS.= 57	NONE =	14.0	FP =	84.2	MP =	.0	MPFTH=	1.8	MPMTH=	.0
	THWOP=	.0	DIC =	.0	ROTIC=	.0	FIC =	.0	BIC =	.0

GROWLERS & BERGY BITS

OBS.= 0	0 =	.0	1 =	.0	2 =	.0	3 =	.0	4 =	.0
	5 =	.0	6 =	.0	7 =	.0	8 =	.0	9 =	.0
	10 =	.0	11 =	.0	12 =	.0	13 =	.0	14 =	.0
	15 =	.0	16 =	.0	17 =	.0	18 =	.0	19 =	.0
	20 =	.0	21-50=	.0	51-1H=	.0	1012H=	.0	2015H=	.0
	GT500=	.0								

ICE BERGS

OBS.= 0	0 =	.0	1 =	.0	2 =	.0	3 =	.0	4 =	.0
	5 =	.0	6 =	.0	7 =	.0	8 =	.0	9 =	.0
	10 =	.0	11 =	.0	12 =	.0	13 =	.0	14 =	.0
	15 =	.0	16 =	.0	17 =	.0	18 =	.0	19 =	.0
	20 =	.0	21-50=	.0	51-1H=	.0	1012H=	.0	2015H=	.0
	GT500=	.0								

BIC = BRASH ICE BRBL = BRASH & BLOCK ICE(SMALL & MEDIUM ICE FLOES) CF1,CF2 = CONCEN. OF PRIMARY,SECONDARY ICE FORM
CS1,CS2 = CONCEN. OF PRIMARY,SECONDARY STAGE OF ICE DEVELOPMENT CT = TOTAL CONCEN. OF ICE DIC = DRIED ICE
EX RIDG = EXTENT OF RIDGING FIC = FLOODED ICE FM1,FM2 = PRIMARY,SECONDARY ICE FORM FP = FEW PUDDLES GE = GREATER OR EQAL TO GR-BGBT= GROWLERS & BERGY BITS GT = GREATER THAN H = HUNDRED(1012H=101-200) HT RIDG = HEIGHT OF RIDGING
LG = LARGE ICE(BIG,VAST,GIANT, ICE FLOES) MP = MANY PUDDLES MPFTH = MANY PUDDLES WITH FEW THAWING HOLES MPMTH = MANY PUDDLES WITH MANY THAWING HOLES NEW(FM1,FM2) = NEW & PANCAKE ICE(0-10 CM) NEW(ST1,ST2) = FRAZIL,SLUSH,RIND,NILAS(0-10 CM)
OLD = SECOND-YR & MULTI-YR ICE ORIEN = ORIENTATION OF WATER FEATURE PSE,PSN,PSS,PSW = PARALLELS SHORE TO E,N,S,W
Q = QUADRANT ROTIC = ROTTEN ICE ST1,ST2 = PRIMARY,SECONDARY STAGE OF DEVELOPMENT ST MELT = STAGE OF MELTING
THIK = MEDIUM & THICK 1ST YR ICE(GT 70 CM.) THIN = GRAY,WHITE,THIN 1ST YR ICE(10-70 CM.) THWOP = THAWING HOLES W/O PUDDLES

FIGURE 3 - ICE DATA STATISTICS FOR THE SAMPLE TRACK

```
      140.0
      145.0
      150.0
      155.0
      160.0
      165.0
      170.0
      175.0
65.0    .0
         5.0
        10.0
            68.7  7   14.6   68  6   4   725   6   THIK  3   OLD   2
            68.8  7   13.9   68  6   4   730
            68.8  7   13.2   68  6   4   735   6   THIK  4   OLD   2
            68.9  7   12.5   68  6   4   740
            69.4  7   13.9   68  6   9  1625   4   OLD   3   THIK  1
            69.4  7   13.3   68  6   9  1630   3   OLD   3
            69.2  7   12.9   68  6   9  1635   0
            68.2  7   14.7   68  6   9  1700   0   NONE  0
            67.6  7   14.8   68  6   9  1710   4   OLD   2   OLD   1
            67.1  7   14.7   68  6   9  1720

            PRIMARY   STAGE OF DEVELOPMENT
                OBS.=  6   NONE=  16.7   THIN=   .0   THIK=  33.3   OLD=  50.0
                       CONC.=        .0         .0          3.5         2.7

            SECONDARY STAGE OF DEVELOPMENT
                OBS.=  4   NONE=   .0   THIN=   .0   THIK=  25.0   OLD=  75.0
                       CONC.=        .0         .0          1.0         1.7
      15.0
            68.1  7   17.7   68  6   2  1640   5   OLD   3   OLD   1
            67.9  7   19.3   68  6   2  1650   9   OLD   7   THIK  1
            68.2  7   20.0   68  6   4   645   5
            68.5  7   19.4   68  6   4   650   7
            68.7  7   16.1   68  6   4   715   6   OLD   3   THIK  3
            68.7  7   15.3   68  6   4   720
            70.0  7   18.9   68  6   9  1550   2   OLD   2   NONE  0
            69.9  7   17.4   68  6   9  1555   4   OLD   3   OLD   1
            66.7  7   19.6   68  6   9  1810   0   NONE  0
            69.1  7   19.4   70  6  10  1615   0   NONE  0
            69.0  7   19.9   70  6  10  1620   4   OLD   2   THIK  2
            68.6  7   19.4   69  7  21  1310   0   NONE  0
            69.1  7   18.5   69  7  21  1325
            69.3  7   18.2   69  7  21  1330   0   NONE  0
            69.6  7   17.6   69  7  21  1340
            69.9  7   18.0   69  7  21  1345   0   NONE  0
            70.0  7   18.5   69  7  21  1350
            69.3  7   19.2   69  7  25  2100

            PRIMARY   STAGE OF DEVELOPMENT
                OBS.= 11   NONE=  45.5   THIN=   .0   THIK=   .0   OLD=  54.5
                       CONC.=        .0         .0           .0         3.3

            SECONDARY STAGE OF DEVELOPMENT
                OBS.=  6   NONE=  16.7   THIN=   .0   THIK=  50.0   OLD=  33.3
                       CONC.=        .0         .0          2.0         1.0
      20.0
```

FIGURE 4 - TWO SAMPLE 5° SECTIONS OF ICE DATA

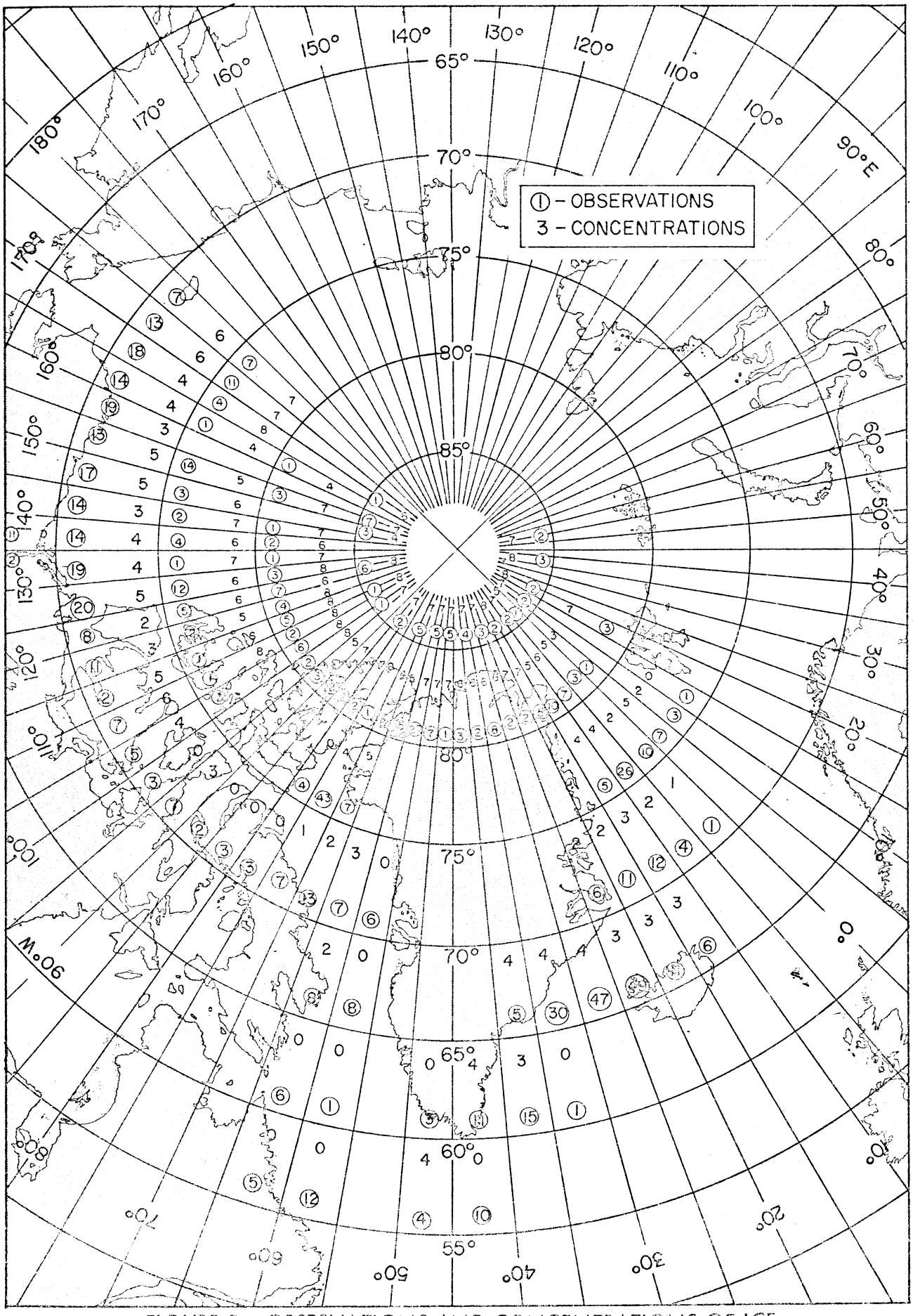

FIGURE 5 – OBSERVATIONS AND CONCENTRATIONS OF ICE
(JUNE–JULY–AUGUST/OLD ICE/PRIMARY STAGE)

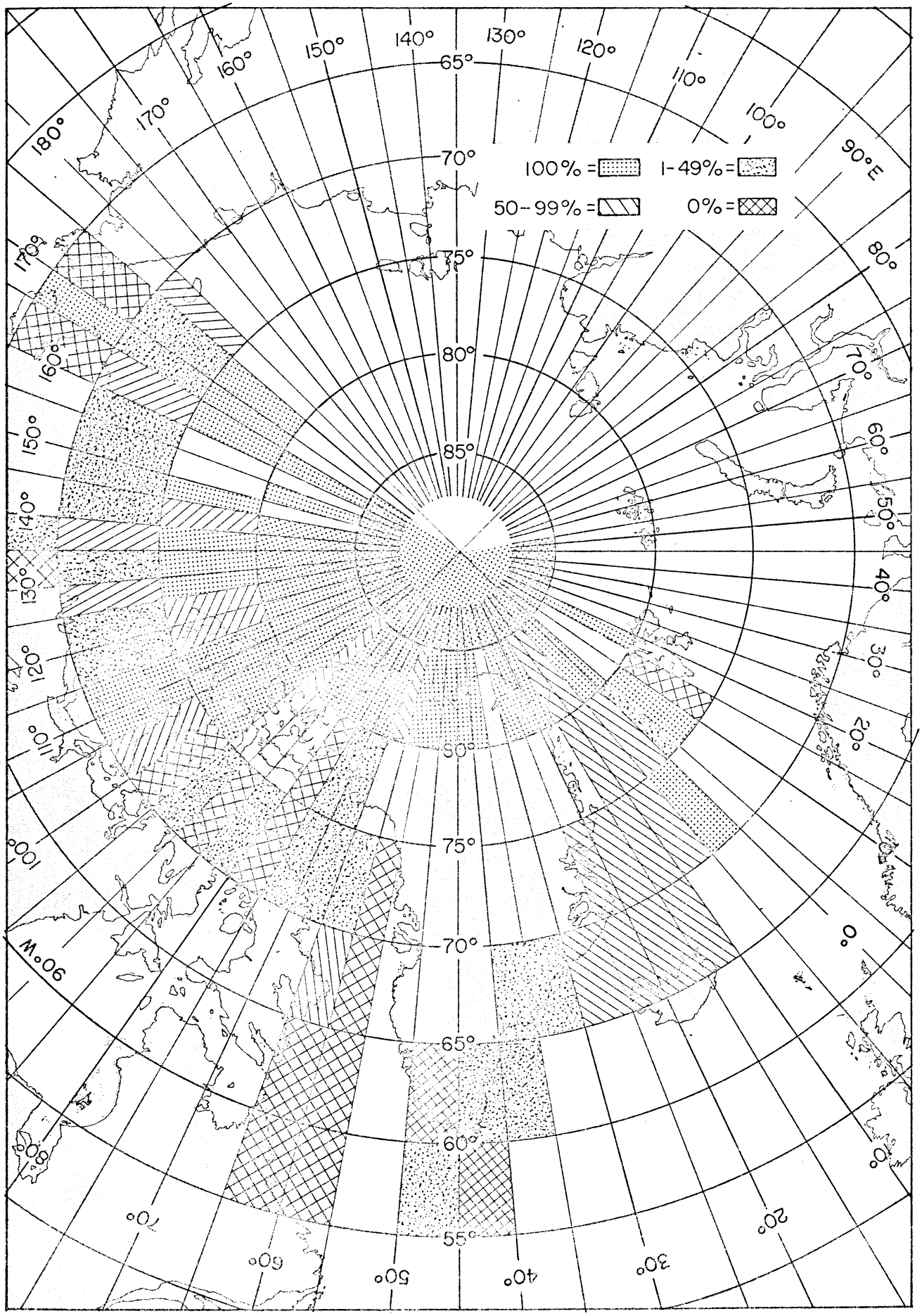

FIGURE 6 - PERCENTAGE PROBABILITY OF ICE
(JUNE-JULY-AUGUST/OLD ICE/PRIMARY STAGE)

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