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Dale G. Rogers, et al

Third Weather Wing
Offutt Air Force Base, Nebraska

April 1972

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Dale G. Rogers
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13. ABSTRACT

This paper presents a summary of thermal parameters as predictors of precipitation type at Ellsworth AFB, SD. The material presented in this paper may be used in the preparation of an objective forecast when the input data is extracted from current observations and prognostic facsimile charts. The Rapid City, SD, radiosonde data (0000Z and 1200Z) are correlated against precipitation type that occurred at Ellsworth AFB, SD. Thermal parameter combinations used in this study are: 1000-850 mb thickness, 850-700 mb thickness, 1000-500 mb thickness; surface, 850 mb and 700 mb temperatures; 850 mb wind direction.

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14. KEY WORDS	LINK A ROLE	LINK A WT	LINK B ROLE	LINK B WT	LINK C ROLE	LINK C WT
Thermal parameters						
Predictors of precipitation type						
Ellsworth AFB, SD						
Precipitation type						
Snow						
Rain						
Sleet						
Snow showers						
Freezing precipitation						
Mixed rain and snow						

1b

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THERMAL PARAMETERS AS A PREDICTOR OF PRECIPITATION TYPE FOR ELLSWORTH AFB, SD

Introduction

The prediction of precipitation type is a problem frequently encountered by forecasters. The thermal parameters provided in this paper are presented as an aid to the forecaster for the determination of the precipitation type. The material in this report is designed to be used in conjunction with the facsimile maps, charts and prognostic charts, and the local radiosonde data. The user should be familiar with the techniques and procedures set forth by the papers listed in the Selected References of this paper.

DATA

The data presented were extracted from the computer correlation printout of liquid and frozen precipitation types as observed at Ellsworth AFB, South Dakota, and the radiosonde data from Rapid City, South Dakota. The period of record for the data presented in this report is from 1 June 1957 through 31 March 1966.

The six precipitation types reported in this paper are:

1. Snow and snow showers
2. Snow showers only
3. Freezing rain and drizzle
4. Sleet
5. Mixed rain and snow
6. Liquid precipitation

As many as seven surface observations have been plotted against a radiosonde run. . These seven observations may occur from three hours before radiosonde time until three hours after radiosonde time.

ELLSWORTH AFB, SOUTH DAKOTA

% Probability (Snow vs Rain)	1000–850mb Thickness Decameters	850–700mb Thickness Decameters	1000–500mb Thickness Decameters	Surface Temp. C	850mb Temp. C	700mb Temp. C
90	131	153	537	31	-2	-9
75			540	34	-1	-6
50	132	154	542	36	0	-4
25	133		546	37	+1	-3
10	134	156	549	40	+2	0

SUMMARY OF THERMAL PARAMETERS
AS PREDICTORS OF THE PROBABILITY
OF
SNOW VS RAIN

Thickness (decameters)	Snow	Freezing Precipitation	Sleet	Liquid Precipitation	Mixed Rain and Snow	Snow Showers
115	0	0	0	0	0	0
116	0	0	0	0	0	0
117	0	0	0	0	0	0
118	0	0	0	0	0	0
119	46	0	0	0	0	1
120	54	0	0	0	0	1
121	54	0	0	0	0	2
122	79	0	0	0	0	6
123	171	0	0	0	0	14
124	233	1	0	0	0	16
125	250	0	0	0	0	23
126	259	0	0	0	0	30
127	259	3	0	0	0	28
128	246	12	2	0	0	48
129	339	20	0	1	1	44
130	321	13	1	14	3	75
131	369	14	7	32	12	101
132	139	1	0	99	31	46
133	55	1	4	183	11	25
134	13	0	0	121	5	6
135	13	1	1	178	2	2
136	2	0	0	177	0	2
137	2	0	0	104	0	1
138	3	0	0	162	0	3
139	0	0	0	104	0	0
140	0	0	0	81	0	0
141	0	0	0	87	0	0
142	0	0	0	78	0	0
143	0	0	0	46	0	0
144	0	0	0	36	0	0
145	0	0	0	30	0	0
146	0	0	0	22	0	0
147	0	0	0	15	0	0
148	0	0	0	4	0	0
149	0	0	0	1	0	0
150	0	0	0	0	0	0

Table 1. 1000-850 mb thickness, decameters, versus precipitation type reported in surface observations at Ellsworth AFB, SD, within three hours of radiosonde time. The number in the snow column includes occurrences of snow and snow showers. As many as seven observations may be reported for each radiosonde time with precipitation within plus or minus three hours of the radiosonde time. Upper air data taken from Rapid City radiosonde. Period of record 1 June 1957 through 31 March 1966.

Thickness (decameters)	Snow	Freezing Precipitation	Sleet	Liquid Precipitation	Mixed Rain and Snow	Snow Showers
140	0	0	0	0	0	0
1	34	0	0	0	0	1
2	25	0	0	0	0	4
3	57	0	0	0	0	5
4	67	0	0	0	0	3
145	88	0	0	0	0	3
6	127	0	0	0	0	15
7	220	0	0	0	0	19
8	262	0	0	0	0	58
9	310	2	0	0	1	58
150	419	5	2	6	1	61
1	470	16	0	4	1	80
2	378	5	0	10	7	70
3	224	2	1	59	24	47
4	113	11	0	91	13	26
155	76	8	11	130	13	16
6	13	9	1	135	1	3
7	11	7	0	181	2	2
8	7	1	0	133	0	2
9	4	0	0	162	1	1
160	0	0	0	135	0	0
1	0	0	0	113	0	0
2	0	0	0	114	0	0
3	0	0	0	83	0	0
4	0	0	0	68	0	0
165	0	0	0	48	0	0
6	0	0	0	43	0	0
7	0	0	0	30	0	0
8	0	0	0	17	0	0
9	0	0	0	11	0	0
170	0	0	0	2	0	0
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	0	0	0	0	0	0
4	0	0	0	0	0	0
175	0	0	0	0	0	0

Table 2. 850-700 mb thickness, decameters, versus precipitation type reported in surface observations at Ellsworth AFB, SD, within three hours of radiosonde time. The number in the snow column includes occurrences of snow and snow showers. As many as seven observations may be reported for each radiosonde time with precipitation within plus or minus three hours of the radiosonde time. Upper air data taken from Rapid City radiosonde. Period of record 1 June 1957 through 31 March 1966.

Thickness (decameters)	Snow	Freezing Precipitation	Sleet	Liquid Precipitation	Mixed Rain and Snow	Snow Showers
516	84	0	0	0	0	2
517	53	0	0	0	0	8
518	66	0	0	0	0	7
519	52	0	0	0	0	7
520	49	0	0	0	0	9
521	79	0	0	0	0	15
522	69	2	0	0	0	20
523	117	0	0	0	0	18
524	57	0	0	0	0	13
525	146	2	0	0	1	26
526	158	1	0	0	0	25
527	146	0	0	0	0	30
528	121	1	0	0	0	23
529	109	0	0	0	0	16
530	145	2	0	1	0	24
531	112	4	2	0	1	12
532	103	6	0	0	0	17
533	126	0	0	1	4	17
534	112	2	0	2	3	19
535	76	4	0	5	2	14
536	78	3	0	2	2	29
537	82	3	0	11	2	26
538	71	3	1	13	2	4
539	72	1	0	11	1	11
540	40	0	0	13	8	9
541	41	1	0	26	4	5
542	25	0	0	21	5	7
543	27	4	0	21	0	2
544	22	1	0	36	3	3
545	16	13	0	21	4	3
546	9	7	7	42	1	4
547	19	0	0	26	13	5
548	22	5	1	49	0	7
549	6	0	1	45	6	1
550	6	0	3	1202	1	2

Table 3. 1000-500 mb thickness, decameters, versus precipitation type reported in surface observations at Ellsworth AFB, SD, within three hours of radiosonde time. The number in the snow column includes occurrences of snow and snow showers. As many as seven observations may be reported for each radiosonde time with precipitation within plus or minus three hours of the radiosonde time. Upper air data taken from Rapid City radiosonde. Period of record 1 June 1957 through 31 March 1966.

Temperature (°F)	Snow	Freezing Precipitation	Sleet	Liquid Precipitation	Mixed, Rain and Snow	Snow Showers
0	289	0	0	0	0	10
1	40	0	0	0	0	0
2	30	0	0	0	0	3
3	36	0	0	0	0	0
4	61	0	0	0	0	7
5	81	0	0	0	0	9
6	52	1	0	0	0	8
7	67	0	0	0	0	8
8	77	0	0	0	0	3
9	69	0	0	0	0	4
10	107	0	0	0	0	10
11	82	1	0	0	0	6
12	64	0	0	0	0	5
13	74	0	0	0	0	7
14	15	0	0	0	0	0
15	46	3	0	0	0	3
16	63	1	0	0	0	10
17	100	0	0	0	0	6
18	76	2	0	0	0	13
19	81	0	0	0	0	12
20	54	3	0	0	0	13
21	75	1	0	0	0	6
22	65	4	0	0	1	15
23	75	4	0	0	0	23
24	65	9	2	0	0	11
25	91	0	0	0	0	25
26	135	10	0	0	0	14
27	78	9	0	4	0	16
28	105	9	0	1	0	22
29	80	7	0	9	0	24
30	106	1	1	1	1	21
31	130	0	0	10	3	31
32	96	0	0	2	6	31
33	53	0	0	20	9	17
34	63	0	3	22	3	23
35	32	0	0	39	7	17
36	37	0	7	32	7	13
37	15	0	0	45	3	9
38	17	0	0	60	9	3
39	5	1	0	39	4	3
40	13	0	0	68	7	4
+40	7	0	2	1223	5	9

Table 4. Surface temperature versus precipitation type reported in surface observations three hours before radiosonde time until three hours after radiosonde time at Ellsworth AFB, SD. The number in the snow column includes snow and snow showers. Upper air data taken from Rapid City radiosonde. Period of record 1 June 1957 through 31 March 1966.

Temperature (°C)	Snow	Freezing Precipitation	Sleet	Liquid Precipitation	Mixed Rain and Snow	Snow Showers
-20	240	0	0	0	0	10
-19	34	0	0	0	0	6
-18	70	0	0	0	0	5
-17	61	0	0	0	0	5
-16	93	0	0	0	0	9
-15	132	0	0	0	0	6
-14	73	0	0	0	0	4
-13	144	1	0	0	0	8
-12	191	0	0	0	0	11
-11	131	0	0	0	0	20
-10	167	2	0	0	0	26
-9	111	4	2	0	1	32
-8	179	4	0	0	0	13
-7	168	5	0	1	0	25
-6	221	11	0	4	0	30
-5	164	5	0	0	0	37
-4	193	13	0	4	2	39
-3	195	13	0	13	5	48
-2	197	0	1	8	16	53
-1	90	4	7	45	8	34
0	60	0	3	67	12	20
1	30	3	1	98	9	15
2	10	0	0	75	2	4
3	13	0	0	88	3	4
4	1	0	1	48	4	2
5	10	0	0	86	1	3
6	0	0	0	91	0	0
7	3	0	0	65	0	0
8	2	0	0	75	0	0
9	1	0	0	88	0	0
10	4	0	0	75	1	4
11	3	1	0	50	0	3
12	1	0	0	60	0	1
13	0	0	0	71	0	0
14	0	0	0	47	0	0
15	0	0	0	49	0	0
16	0	0	0	50	0	0
17	0	0	0	42	0	0
18	0	0	0	38	0	0
19	0	0	0	24	0	0
20	0	0	0	33	0	0

Table 5. 850 mb temperature versus precipitation type reported in surface observations three hours before radiosonde time until three hours after radiosonde time at Ellsworth AFB, SD. The number in the snow column includes snow and snow showers. Upper air data taken from Rapid City radiosonde. Period of record: 1 June 1957 through 31 March 1966.

Temperature (°C)	Snow	Freezing Precipitation	Sleet	Liquid Precipitation	Mixed Rain and Snow	Snow Showers
-29	0	0	0	0	0	0
8	4	0	0	0	0	1
7	1	0	0	0	0	0
6	16	0	0	0	0	1
-25	16	0	0	0	0	1
4	16	0	0	0	0	7
3	25	0	0	0	0	0
2	19	0	0	0	0	5
1	52	0	0	0	0	2
-20	56	0	0	0	0	12
9	103	0	0	0	0	12
8	126	0	0	0	0	13
7	146	0	0	0	0	37
6	176	0	0	0	0	42
-15	179	0	0	0	1	24
4	177	1	0	1	1	53
3	236	2	0	0	0	35
2	300	4	2	1	3	48
1	194	1	0	0	2	28
-10	213	0	0	17	9	26
-9	193	3	0	27	3	25
-8	155	14	0	30	2	19
-7	134	0	1	34	8	27
-6	123	4	0	55	10	23
-5	101	7	1	65	11	17
-4	51	7	0	73	5	3
-3	24	1	0	82	0	3
-2	16	7	0	88	3	2
-1	16	5	8	89	5	6
0	12	7	0	123	1	2
+1	3	3	0	88	0	0
+2	1	0	3	148	0	0
+3	0	0	0	85	0	0
+4	0	0	0	79	0	0
+5	0	0	0	61	0	0
+6	0	0	0	86	0	0
+7	0	0	0	83	0	0
+8	0	0	0	61	0	0
+9	0	0	0	39	0	0
+10	0	0	0	37	0	0
+11+	[illegible]	0	0	105	0	0

Table 6. 700 mb temperature versus precipitation type reported in surface observations three hours before radiosonde time until three hours after radiosonde time at Ellsworth AFB, SD. The number in the snow column includes snow and snow showers. Upper air data taken from Rapid City radiosonde. Period of record: 1 June 1957 through 31 March 1966.

Wind Direction (Degrees/10)	Snow	Freezing Precipitation	Sleet	Liquid Precipitation	Mixed Rain and Snow	Snow Showers
0	46	8	0	20	0	6
1	110	1	8	84	16	22
2	70	0	0	58	3	5
3	43	1	0	24	3	3
4	28	0	0	37	0	2
5	21	0	0	41	2	7
6	34	0	0	33	2	2
7	34	3	0	23	0	5
8	25	0	0	41	0	0
9	13	0	0	27	0	0
10	71	1	0	47	2	14
11	31	0	3	65	0	6
12	39	1	0	58	1	1
13	41	2	0	55	2	8
14	59	6	0	80	0	8
15	53	1	0	47	4	3
16	62	0	0	59	3	10
17	62	1	0	43	0	5
18	56	4	0	25	0	8
19	35	1	1	28	0	5
20	29	7	0	21	2	2
21	19	0	0	18	0	0
22	7	0	0	6	0	0
23	33	0	0	6	2	4
24	17	3	0	12	0	1
25	28	2	0	6	0	0
26	27	0	0	13	0	6
27	26	0	0	13	1	5
28	14	0	0	8	0	6
29	32	0	0	20	0	12
30	38	0	0	23	0	12
31	66	2	0	30	0	21
32	262	2	2	73	7	64
33	456	0	0	127	6	99
34	405	7	0	105	9	71
35	314	9	1	122	4	31
36	149	1	0	50	0	10

Table 7. 850 mb Wind Direction, degrees, versus precipitation type reported in surface observations at Ellsworth AFB, SD, within three hours of radiosonde time. The number in the snow column includes occurrences of snow and snow showers. As many as seven observations may be reported for each radiosonde time with precipitation within plus or minus three hours of the radiosonde time. Upper air data taken from Rapid City radiosonde. Period of record: 1 June 1957 through 31 March 1966.

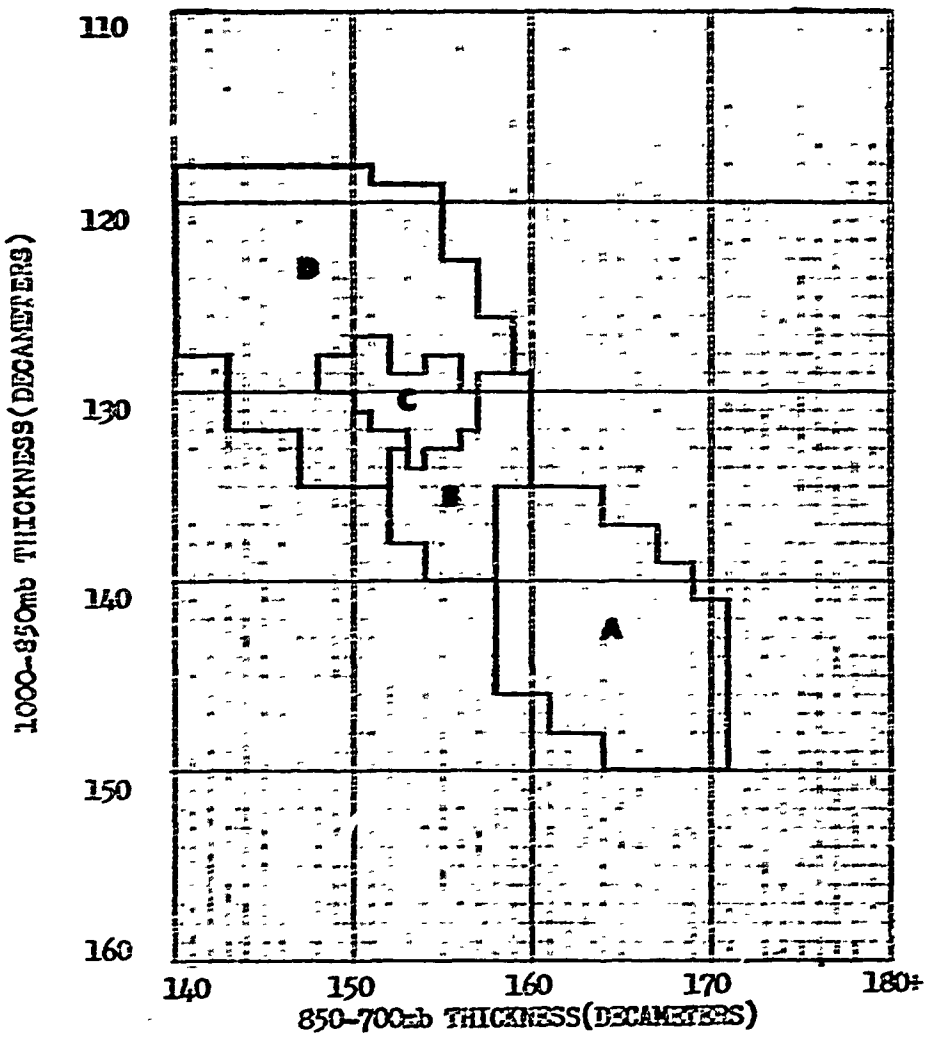

Figure 1. Graph and table for delineating the type of precipitation at Ellsworth AFB, South Dakota. Ordinate of graph is 1000-850 mb thickness in decameters, and abscissa is 850-700 mb thickness in decameters.

AREA		A	B	C	D
Liquid Precipitation	#	803	603	135	28
	%	100	86.2	9.6	1.3
Mixed, Rain and Snow	#	0	15	27	22
	%	0	2.1	1.9	1.0
Snow	#	0	57	1010	1840
	%	0	8.2	72.3	83.9
Snow Showers	#	0	19	153	302
	%	0	2.7	10.9	13.7
Sleet	#	0	5	10	0
	%	0	.7	.7	0
Freezing Precipitation	#	0	1	64	1
	%	0	.1	4.6	.1

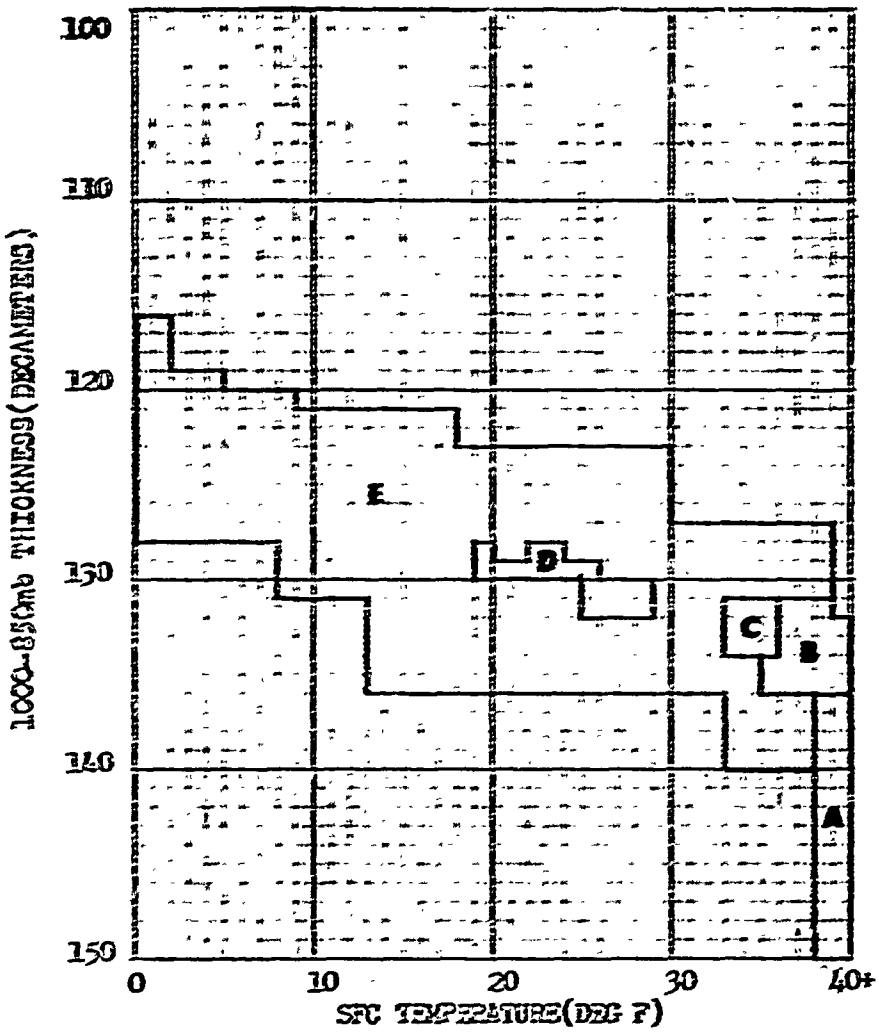

Figure 2. Graph and table for delineating the type of precipitation at Ellsworth AFB, South Dakota. Ordinate of graph is 1000-850 mb thickness in decameters and abscissa is surface temperature in degrees Fahrenheit.

AREA		A	B	C	D	E
Liquid Precipitation	#	509	930	107	13	16
	%	100	89.8	28.6	1.7	.7
Mixed, Rain and Snow	#	0	26	26	1	12
	%	0	2.5	6.9	.1	.5
Snow	#	0	51	169	589	2098
	%	0	4.9	45.2	75.9	87.3
Snow Showers	#	0	26	62	117	269
	%	0	2.5	16.6	15.1	11.2
Sleet	#	0	2	10	2	1
	%	0	.2	2.7	.2	<.1
Freezing Precipitation	#	0	1	0	55	10
	%	0	.1	0	7.1	.4

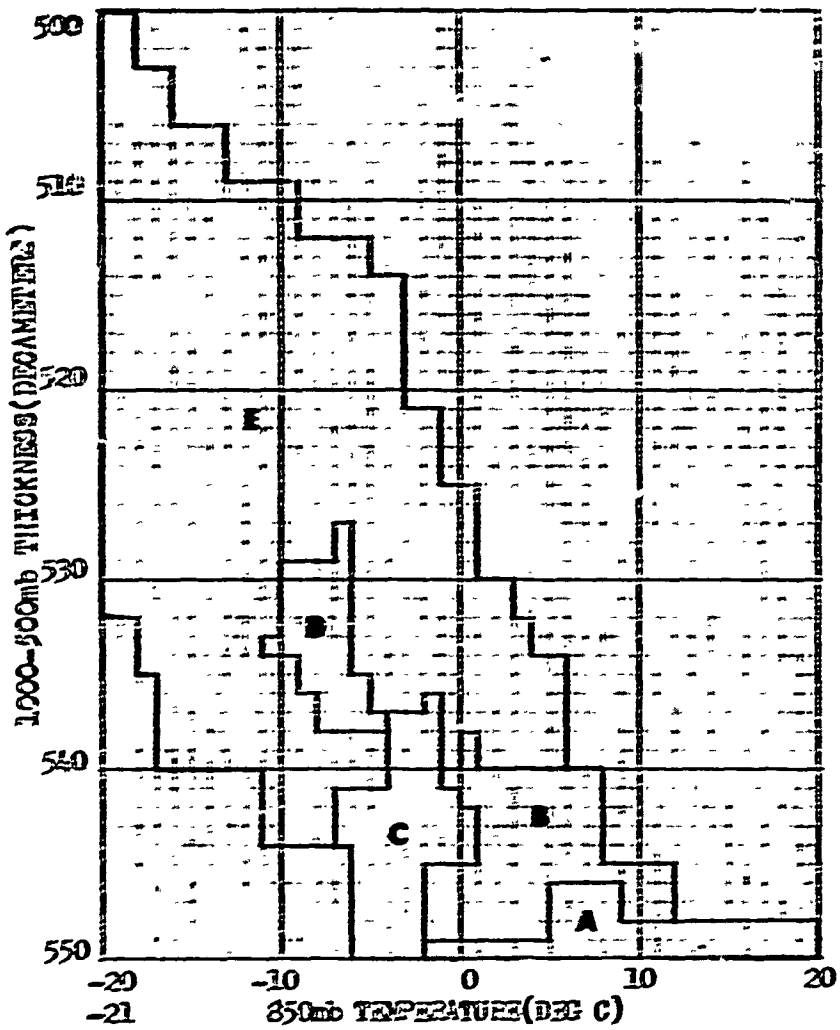

Figure 3. Graph and table for delineating the type of precipitation at Ellsworth AFB, South Dakota. Ordinate of graph is 1000-500 mb thickness in decameters, and abscissa is 850 mb temperature in degrees Centigrade.

AREA		A	B	C	D	E
Liquid Precipitation	#	1240	214	81	3	26
	%	98.8	68.2	19.6	.7	1.0
Mixed, Rain and Snow	#	1	21	25	0	17
	%	<.1	6.7	6.0	0	.6
Snow	#	9	49	231	356	2255
	%	.7	15.6	55.8	85.8	83.9
Snow Showers	#	2	20	39	29	384
	%	.2	6.4	9.4	7.0	14.3
Sleet	#	3	9	1	2	0
	%	.2	2.9	.2	.5	0
Freezing Precipitation	#	0	1	37	25	3
	%	0	.3	8.9	6.0	.1

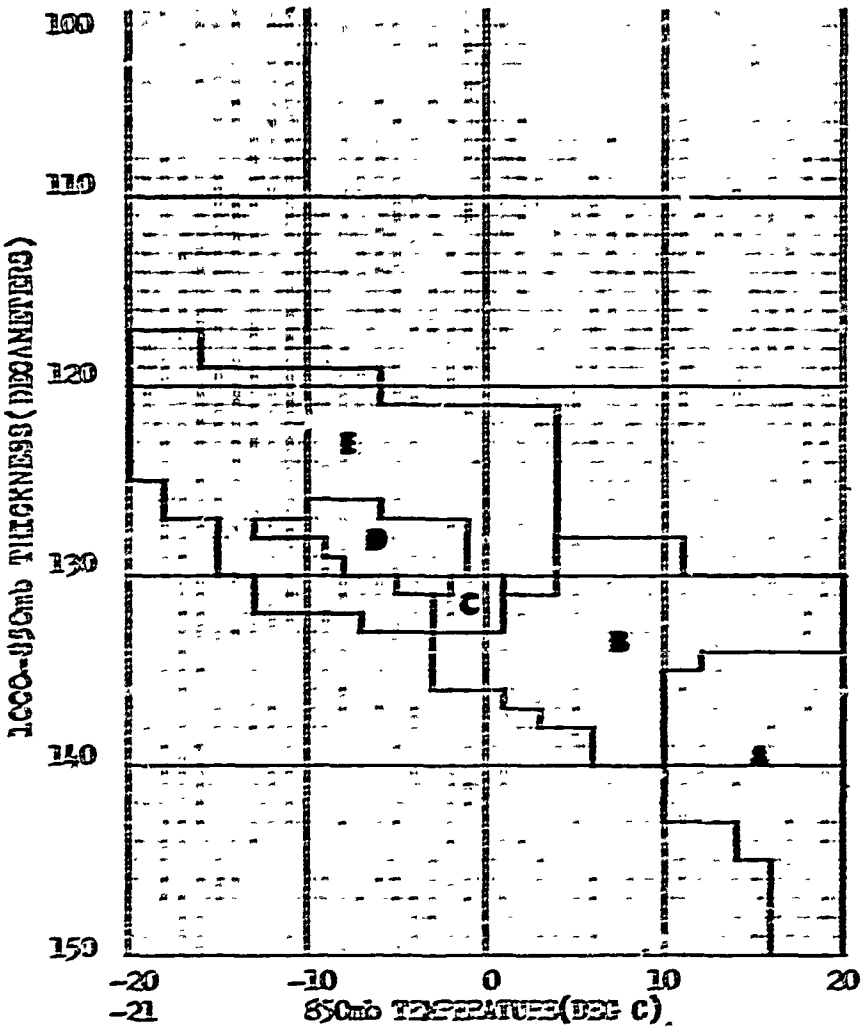

Figure 4. Graph and table for delineating the type of precipitation at Ellsworth AFB, South Dakota. Ordinate is 1000-850 mb thickness in decameters, and abscissa is 850 mb temperatures in degrees Centigrade.

AREA		A	B	C	D	E
Liquid Precipitation	#	631	708	218	18	0
	%	99.7	88.7	36.6	1.1	0
Mixed, Rain and Snow	#	0	11	43	11	0
	%	0	1.4	7.2	.7	0
Snow	#	1	57	232	1342	1274
	%	.2	7.1	38.0	79.8	91.5
Snow Showers	#	1	20	87	247	119
	%	.2	2.5	14.6	14.7	8.5
Sleet	#	0	1	11	3	0
	%	0	.1	1.9	.2	0
Freezing Precipitation	#	0	1	4	60	1
	%	0	.1	.7	3.6	<.1

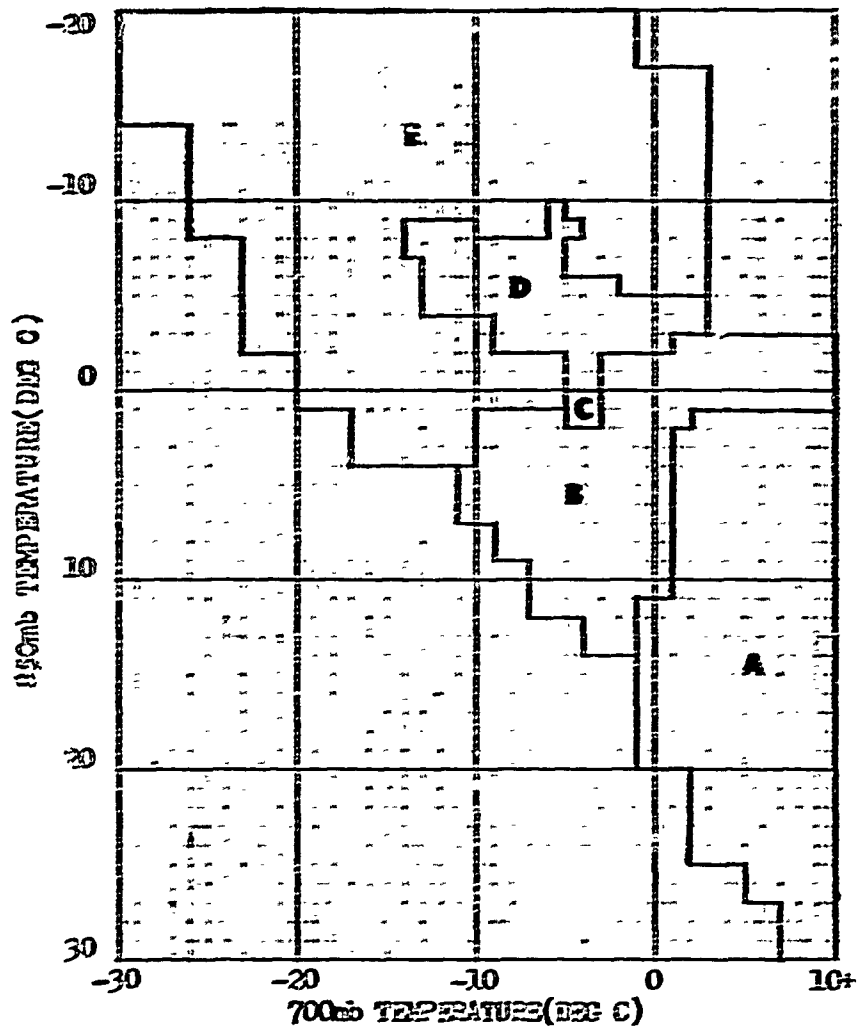

Figure 5. Graph and table for delineating the type of precipitation at Ellsworth AFB, South Dakota. Ordinate of graph is 850 mb temperature in degrees Centigrade, and abscissa is 700 mb temperature in degrees Centigrade.

AREA		A	B	C	D	E
Liquid Precipitation	#	875	574	41	23	44
	%	100	78.2	67.2	2.5	1.8
Mixed, Rain and Snow	#	0	22	5	11	26
	%	0	3.0	8.2	1.2	1.0
Snow	#	0	92	11	732	2074
	%	0	12.5	18.0	79.7	83.0
Snow Showers	#	0	33	1	87	353
	%	0	4.5	1.6	9.6	14.1
Sleet	#	0	12	0	2	1
	%	0	1.6	0	.2	<.1
Freezing Precipitation	#	0	1	3	61	1
	%	0	.1	4.9	6.7	<.1

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