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WEATHER BUREAU CENTRAL REGION
KANSAS CITY, MISSOURI 64106

Technical Attachment
News and Views, March 21, 1969

THE SNOW, THE COLD, AND THE FLOOD POTENTIAL
UPPER MIDWEST, WINTER AND SPRING 1968-1969

Photo Credits

The cover photo, showing a train entering Wendell Cut in Western Minnesota, is used by courtesy of the Soo Line. During the worst of the winter, the railroad used special equipment almost continuously to keep this part of the line open.

Figure 1-A showing the Waters Building in Rochester, Minnesota is provided by courtesy of Post-Bulletin newspaper in Rochester.

Figure 1-B is an Omaha World-Herald photo showing a five-car smashup on Interstate 80 east of Waco, Nebraska.

Figures 1-C and 1-D are Weather Bureau photos. Figure 1-C shows conditions near Sioux City, Iowa and Figure 1-D shows the observational site at Dickinson, North Dakota.

A RESUME'

OF THE

HEAVY SNOWFALL AND PERSISTENT COLD

OF THE

WINTER OF 1968-1969 IN THE UPPER MIDWEST

AND THE

FLOOD SITUATION RESULTING THEREFROM

1. Introduction

The past winter was an extraordinary one, weatherwise, for most residents of the Upper Midwest. There were numerous heavy snowstorms in various sections of the area during the winter and more especially within the 75-day period beginning in mid-December and running through February.

Some of these heavy snowstorms were widespread. A number of them were accompanied by strong winds and much drifting and blowing of snow resulting in blizzard or near blizzard conditions. Several were interspersed with ice storms in some localities.

One of the cumulative effects of the numerous heavy snowstorms, accompanied by persistently below normal temperatures, has been the development of an unusually deep mantle of snow with a very high water content over much of the area. This has resulted in the imminence of severe flooding on many streams in the area of the Upper and Central Midwest as the spring snowmelt period begins to come to the area.

The following sections and the accompanying figures and table point up the nature of the past winter's weather in the Upper Midwest and the seriousness of the flood situation that exists and is even now rapidly unfolding from the snowmelt.

Fig. 1-A

Fig. 1-B

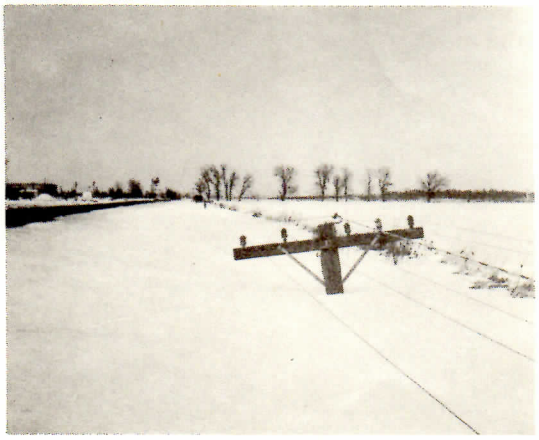


Fig. 1-C

Fig. 1-D

2. A REVIEW OF THE WEATHER

December 1968

"The most anomalous feature of the December circulation in the North American area was the strong blocking ridge over the Aleutian Islands which replaced the Bering Sea low of November... The mid Pacific trough of November moved eastward and intensified at lower latitudes, the ridge in the Rockies decreased and the mid United States trough broadened eastward.... In response to blocking, the axis of maximum 700 mb westerlies for December was south of normal over the Eastern Pacific and across North America (Fig. 2a). Most storms therefore traveled southern routes (Fig. 2g) (over the U.S. mainland), were accompanied by snow, and followed by cold. This was especially true after mid December when blocking suddenly became pronounced. In accord with blocking over North America, height and temperature anomalies were predominately negative in the United States (Fig. 2d)....resulting in a stormy month.... Nearly all of the northern half and parts of the southern half of the country received more than normal December (snow) accumulations."[1] (Fig. 2j) Some of the reports are listed below:

Office	December Snowfall
Sioux Falls, South Dakota	41.1
Minneapolis, Minnesota	28.7
Huron, South Dakota	26.0

Winter in the Plains States started abruptly on December 10, 1968, as a storm moved out of the southwest in Kansas, through Eastern Nebraska, across Northwest Iowa and Southeast Minnesota and into Central Wisconsin leaving a broad belt of heavy snow to the northwest of this track by December 14. There was a nearly identical repeat of this storm December 17-19 and a third nearly identical storm track occurred December 20-23. The major storm of December 20-23 deposited as much as 24 inches of snow and was attended by high winds and blizzard conditions (Fig. 2m). Two late December storms, December 26-28 and 29-31 added to the snow cover and allowed the cold to spread further south and east (Fig. 2g). By the end of December 1968, the southern edge of the heavy snow area covered the northern two-thirds of Iowa, East and Central Nebraska, and North-Central Kansas (Fig. 2j).

January 1969

"Blocking which had become strong in the Western Hemisphere during December increased further during January 1969. The Aleutian ridge continued to build (Fig. 2b). The unusual circulation pattern over the hemisphere....

was related to strong contrast of temperature in the United States. Confluence between Arctic air from Canada and Alaska and subtropical air from the Eastern Pacific led to a....frigid Pacific Northwest and Northern Rockies. Temperatures averaged more than 5°F below normal over the Northern Plains (Fig. 2e), the Mississippi Valley and parts of the Southeast.... Sheridan, Wyoming, had 16 consecutive subfreezing days and 19 days in which the minimum temperature was reported below zero, compared to a normal of six. Daily low temperature records were also established during the last week of January....at Williston, North Dakota.... Storms frequently formed in the lee of the Rockies and followed paths toward the Great Lakes (Fig. 2h), leading to fairly extensive areas of heavy precipitation in the Northern Mississippi Valley and parts of the Midwest (Fig. 2e). Much of this precipitation was in the form of freezing rain. Several cities from Central Nebraska (and Kansas) to Northern Indiana reported glazing conditions on 7 to 11 (January) days.

....Many (offices) from the West Coast to the Great Lakes reported the snowiest January of record and dozens more had near records (Fig. 2k). Some of these are listed below:

Office	January Snowfall	Remarks
Huron, South Dakota	13.1"	Second snowiest January of record.
Duluth, Minnesota	46.8"	Snowiest month of record.

....Goodland, Kansas, reported 14 days of fog, a new record for any month. Omaha, Nebraska, had only 22 percent possible sunshine, the least for any January since 1911. Topeka, Kansas, and Huron, South Dakota, set new records for the most cloudy days in January with 22 each."[2]

The January 1969 storms occurring on January 5-7, 7-9, 14-18, 20-24 and 26-31 (Fig. 2h) added significantly to the already heavy snow cover. By the end of January 1969 a four-inch or greater snow cover extended southward over all of Wisconsin except the Southeast, over West and North Iowa, and extreme Northwest Missouri and East and Central Nebraska, and extreme North-Central and Northeast Kansas. A 10-inch or greater snow cover extended southward through Central Wisconsin, Northwest Iowa, Northeast Nebraska and Eastern South Dakota and 20 inches or more covered Minnesota, extreme East South Dakota, Northwest Iowa, extreme Northeast Nebraska and Northern Wisconsin (Fig. 2k).

Below normal temperatures and lack of sunshine resulted in very little melting and a continuation of the heavy snow cover.

February 1969

In February 1969 the strong positive 700 mb height anomalies over the Aleutian Islands in January were replaced by strong negative anomalies and a major trough developed from a low in the Bering Sea southeastward through the Gulf of Alaska to the west coast of the United States. (Fig. 2c) Anomalies increased to well above normal over Central and Eastern Canada with a dominate ridge in Central Canada and the Great Basin. The 700 mb height anomalies continued low across southern United States to a much below normal area in the vicinity of Bermuda. In the mean, there was a weak 700 mb trough in the lee of the Rockies and a deep trough south from New England. The major storm track over the Central Plains was displaced to the south (Fig. 2i) with weak low centers tracking from the west into the Central Rockies and then southeastward into the Southern Plains and Lower Mississippi Valley before moving eastward. A weaker storm track moved across Southwest Canada into Southern Manitoba then southeastward across Upper Michigan and Lake Huron.

Mean temperatures over the Northern and Central Plains for February 1969 averaged slightly above normal (Fig. 2f), which was due to warmer minimum temperatures caused by extensive cloudiness and a lack of nighttime radiation.

Recurring snow again increased the already critical snow pack on February 14-15, 19-21 and 25-28 primarily over the Eastern Dakotas and Eastern Nebraska, extreme Western Minnesota and Northwest Iowa (Fig. 21).

March 1969

The critical snow pack continued with only slight erosion through March 14 with the first significant warming and subsequent melting beginning on March 15, 1969. Temperatures climbed into the 50's and 60's over much of the snow pack on March 17 and 18, 1969, ahead of a turn to colder on March 19 and 20, 1969.

WINTER WEATHER WARNING WORKLOAD (CENTRAL REGION)

The percentage of the time "Winter Weather Warnings" were valid in the Central Region varied from 60% in December 1968 (80% of the last 20 days), 70% in January 1969 (95% of the last 18 days) and 55% in February 1969. The types of winter weather warnings and the number of warning days per type per month in the Central Region are shown below:

Warning	December 1968	January 1969	February 1969
Blizzard	7 days	9 days	none
Heavy Snow	15 days	15 days	13 days

Warning	December 1968	January 1969	February 1969
Ice Storm	12 days	19 days	6 days
Cold Wave	10 days	9 days	none
Travelers	18 days	21 days	16 days

The following table shows the issuance distribution of National Winter Weather Bulletins by Central Region Weather Coordinating Centers:

WCC	December 1968	January 1969	February 1969	Total
Denver	23	4	11	38
Kansas City	28	38	18	84
Chicago	15	23	2	40
TOTAL....	66	65	31	162

MAJOR (KEY) WINTER STORM OF DECEMBER 20-23, 1968 (FIGS. 2m & 2q)

An intense storm system organized over Southwest United States on December 20 and by 6 a.m., Saturday, December 21, the center of the low pressure was located in West Central New Mexico. Its movement was east-northeast 35 to 40 kts. until it reached the northeast portion of the Texas Panhandle about 3 p.m. on Saturday. The storm moved northeast about 25 kts. along the remainder of the track and reached the north portion of Lower Michigan by 6 a.m. on Monday, December 23 (Fig. 2g).

The actual track of the storm was somewhat west of NMC guidance prognoses until 6 a.m., December 22; however, from that time through 6 a.m., December 23, NMC prognostic guidance charts predicted the storm track very well. Even the predicted values of central pressures of low centers were practically identical to those that occurred. Heavy snow guidance issued by A&FD beginning at 6 p.m., December 20 and continuing throughout the storm's track was also accurate and timely. Central Region FP Offices commented very favorably on the quality of guidance issued during most of this storm.

A Heavy Snow Watch (Fig. 2m) was issued for portions of Southern Wyoming and West and Central Colorado at 4 a.m., Friday, December 20, and changed to Heavy Snow Warning for West and Central Colorado at 9 a.m. the same day. The Watch and Warning for this area did not verify. At 4 p.m., Friday, December 20, a Heavy Snow Watch was issued for Southwest Kansas for Friday night and for most of the state Saturday. At 10 p.m., Friday, December 20, the Heavy Snow Watch was extended into East and Central Nebraska for Saturday. At 10 a.m. Saturday, December 21, a Heavy Snow Watch was issued for South Dakota for "this afternoon" and for Southeast North Dakota and Southern Minnesota for "late tonight". Lead times for the Heavy Snow Watch are defined as the time between the issuance of the

Watch and the release time of the subsequent Heavy Snow Warning. Lead times for the Watch varied from 8 hours in Colorado to 36 hours for portions of Nebraska, South Dakota and Minnesota.

The Heavy Snow Watches were changed to Heavy Snow Warnings (Fig. 2m) about 4 to 8 hours prior to the occurrence of heavy snow. Subsequent blizzard warnings were issued with a 2-hour lead time at Goodland, Kansas, (in the area where blizzard conditions developed) and with a 6 to 12-hour lead time in the storm area further northeastward.

Heavy snows (4 inches or more - Fig. 2m) occurred from Northwest and North-Central Kansas over most of Nebraska, Eastern South Dakota, Northwest Iowa, most of Minnesota, Northern Wisconsin, Upper Michigan and the northern portion of Lower Michigan.

Heaviest snows (10 inches or more - Fig. 2m) occurred over South-Central and Northeast Nebraska, extreme East South Dakota, Northwest Iowa, Southern and Northeast Minnesota, Northern and West-Central Wisconsin, portions of Upper Michigan and the extreme northern portion of Lower Michigan. Much of the same area affected by the December 20-23 storm received earlier heavy snows on December 11-14 and December 18 and 19, 1968. Very little melting occurred between the storms; therefore, total snow depth accumulations ranged upwards to over two feet over portions of South-Central and Northeast Nebraska (Fig. 2t), extreme Southeast South Dakota and portions of Northeast Minnesota and Northwest Wisconsin.

Very strong winds occurred during and following the December 20-23 heavy snow which resulted in blizzard conditions over the storm area, which is approximately outlined by the 4 inches or more accumulation line (Fig. 2m). Reports of 4 to 12-foot drifts were common throughout the blizzard area.

Cold Arctic air spread over the Northern and Central Plains and the Northern Mississippi Valley following the storm passage and strong winds (30-60 mph) were reported to the west and north of the low pressure center as it moved northeast. Minimum temperatures of around 5 to 15°F were recorded during the storm. By using the reported winds of 30 mph, and an average temperature of 10°F, a Wind Chill Index of -33°F can be calculated.

Most schools in the storm area were forced to close a day early for the holiday season and remained closed into mid January. Traffic was paralyzed for several days throughout the heavy snow area. In fact, many rural roads (secondary) were never open during January or February. Thousands of motorists were inconvenienced and one report listed 1200 automobiles stranded in the Grand Island, Nebraska, area alone during the December 20-23 storm. Although the storm occurred during heavy pre-holiday travel, most persons were apparently aware of warnings and the potential danger involved. Many automobile accidents occurred but only

minor injuries resulted. Two Northeast Nebraska farmers and one Northwest Iowa farmer and three Northeast Nebraska teenagers were frozen to death. A third adult in Northeast Nebraska is still missing as of March 15, 1969, (Fig. 2q). In Minnesota a snow plow operator was killed by a train during the storm when visibility was reported as poor. A number of deaths, throughout the snow stricken area, were attributed to heart attacks apparently resulting from shoveling snow or other storm related outside activities.

In general, the storm was handled exceptionally well by all Weather Bureau forecast and service echelons and the comments in area newspapers pertaining to warnings for this storm were favorable. The overall aspects of the storm were quite severe. It was described in many areas as one of worst on record (Figs. 2m, 2q and 2r). Northeast Nebraska, Northwest Iowa and portions of Central and Southern Minnesota and Wisconsin continued to have blowing and drifting conditions, especially in rural areas, through most of January.

The term "Watch" (Heavy Snow) was used extensively and seemed to serve the purpose for which it was intended; i.e., an early alert to the public of potential danger. MIC's/OIC's have expressed favorable public understanding and reaction of the relatively new "Watch" concept for winter storms.

All Central Region WBO's maintained continuous operation during the storm and no observations or forecast issuances were missed. A number of employees were stranded and/or voluntarily remained on duty longer than their normal 8-hour shift when relief personnel were not able to report for work or where only one person was scheduled for duty or at limited-hour offices. Employees remained on continuous duty at several Weather Bureau Offices for periods of 10 to 15 hours upwards to over 40 hours, prepared a large number of extra broadcasts and special statements, and provided other service activities involving the public's safety and welfare.

ECONOMIC LOSS

The accumulative economic loss directly related to adverse weather conditions over the Central and Northern Plains and the Upper Mississippi Valley accrued during the 1968-69 winter season has not been completely determined and probably cannot be until the snow melts and flood potential is over; however, estimates are staggering; e.g., nearly every community and/or county government has expended money for snow removal as much as five and six times their normal expenditures (Figs. 2m and 2s). In addition, the prolonged requirement for such extended effort has resulted in numerous equipment failures and/or total equipment loss from excessive use. Several state governments have nearly exhausted emergency funds and

many cities and counties have expended funds for snow removal originally planned for road construction and improvement. Local and county governments are also faced with a huge road repair task after the snow melts. City streets and county roads are dotted with large potholes.

Farm marketing was at a standstill in many areas for 4 to 8 weeks resulting in a huge loss of income to rural areas (Fig. 2p). Milk producers alone dumped hundreds of thousands of pounds of milk in Southwest Minnesota because of excessive age and lack of adequate storage caused by their inability to reach the processor. One Minnesota milk processor reported receiving only 2% of their normal milk supply in one 5-day period. Train service was also severely hampered and many rail lines had to be plowed daily because of continued drifting. Trains in some areas of Eastern Dakotas and Minnesota did not operate for over 30 days.

As far as livestock people are concerned, the 1968-69 winter has been one of the worst. The following is a quote from "The Omaha Market" in the Nebraska Cattleman of March 1969:

> "Death losses, injuries, labor and feed requirements have all been high. At the same time rates of gain have generally varied from nothing to minus amounts.
>
> "Unhappily the situation promises to get worse before it gets better. The advent of warm weather which will erase some of the ice and snow cover will only serve to replace these elements with more and deeper mud.
>
> "Numerous feedlots are located on the level lands of flood plains and these feeders have the added worry of possible flooding as the spring moves in.
>
> "From the market standpoint, mud, particularly on fat cattle, has been a growing consideration and one that has materially affected prices."

Wildlife has suffered tremendously as a result of the deep snow. It is estimated that 600,000 deer were stranded in deep snow in Northern Minnesota and volunteers were called to help alleviate the critical situation. The pheasant populations also suffered when heavy snow covered the feed supply.

REFERENCES

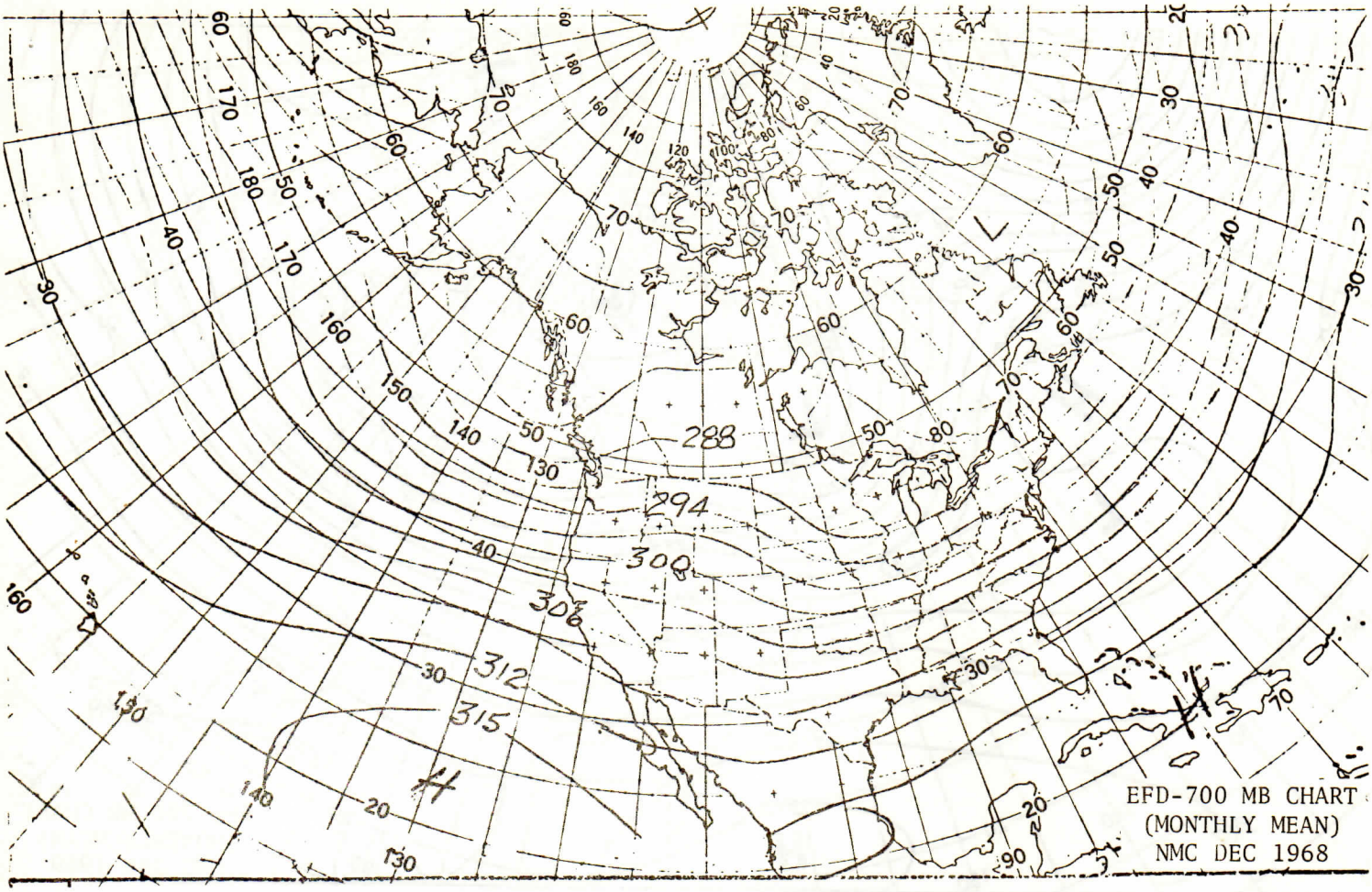
1. Green, Raymond A., Extended Forecast Division, Weather Bureau, ESSA, Suitland, Maryland. The Weather and Circulation of December 1968 - Strong Blocking Over the Western Hemisphere and Cold in the United States.

2. Wagner, James, Extended Forecast Division, Weather Bureau, ESSA, Suitland, Maryland. The Weather and Circulation of January 1969 - Continued Strong High-Latitude Blocking and Flood-Producing Rains in California.

DESCRIPTION OF FIGURES ATTACHED TO PART 2

Figure

2a December 1968 Mean Circulation
2b January 1969 Mean Circulation
2c February 1969 Mean Circulation
2d December 1968 Departure from Normal Charts
2e January 1969 Departure from Normal Charts
2f February 1969 Departure from Normal Charts
2g December 1968 Storm Tracks
2h January 1969 Storm Tracks
2i February 1969 Storm Tracks
2j December 1968 Snow Accumulation (Progressive)
2k January 1969 Snow Accumulation
2l February 1969 Snow Accumulation
2m Winter Storm, December 20-23, 1968
2n "Minneapolis Star" - Snow Depths
2o "Minneapolis Star" - Consolation Prize
2p "Minneapolis Star" - Rural Snow Problem
2q "Lincoln Star" - December 20-23, 1968, Winter Storm
2r "Cuming County Democrat" - West Point, Nebraska, Snowfall
2s "Daily Plainsman" - South Dakota, February 20-21 Snowfall
2t "Daily Plainsman" - Governor Farrar - South Dakota State Expenditures



EFD-700 MB CHART
(MONTHLY MEAN)
NMC DEC 1968

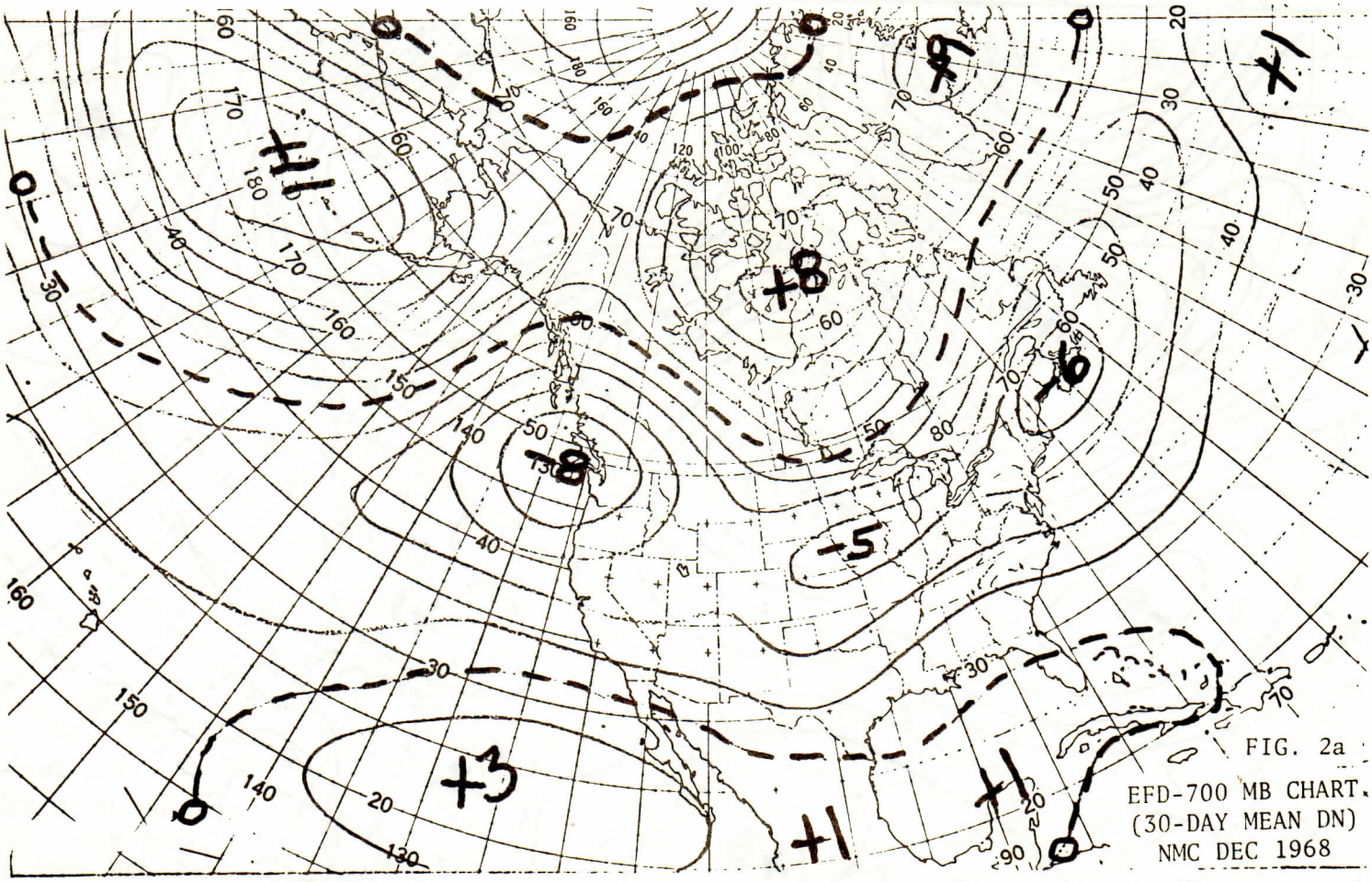
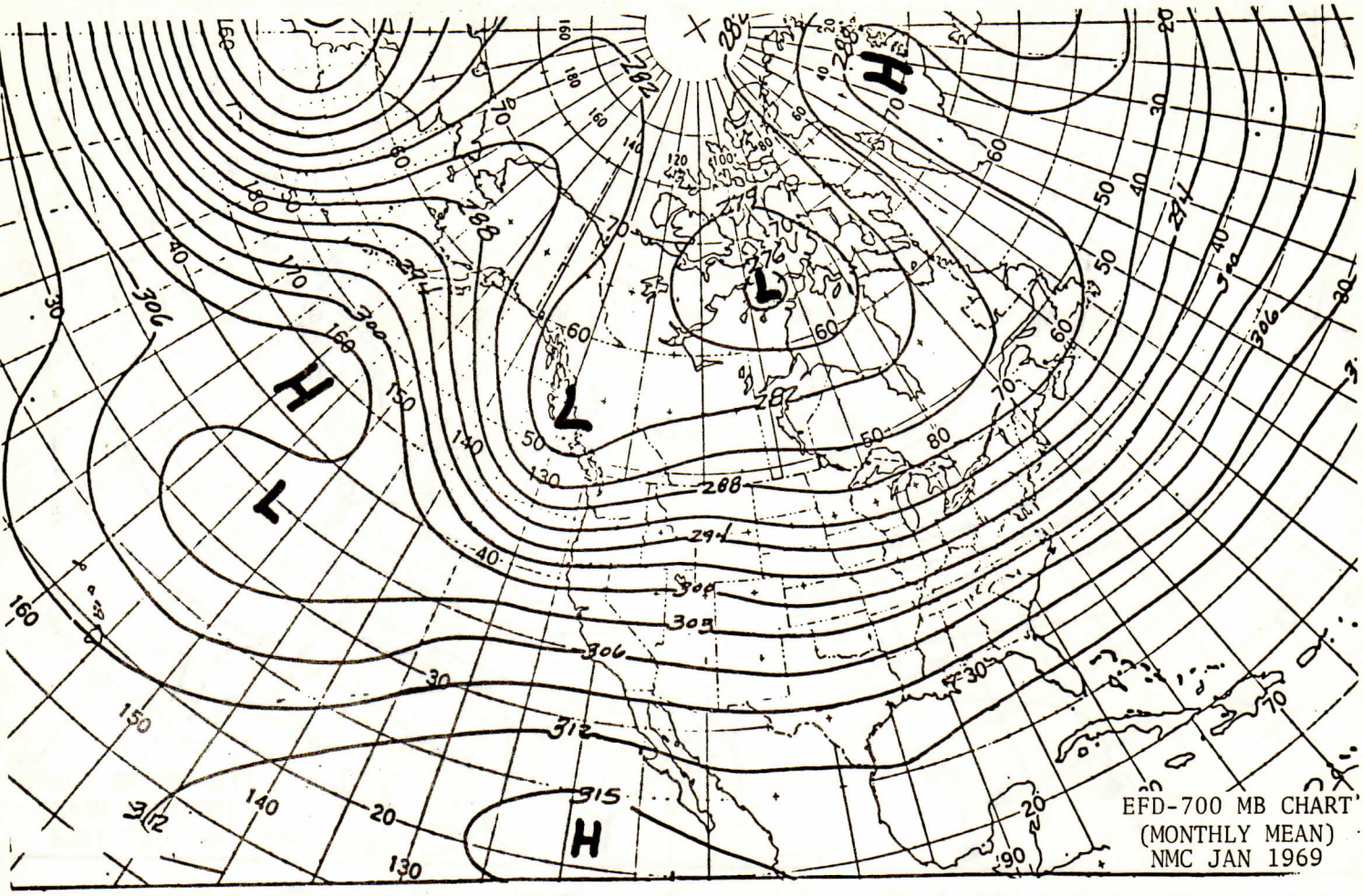
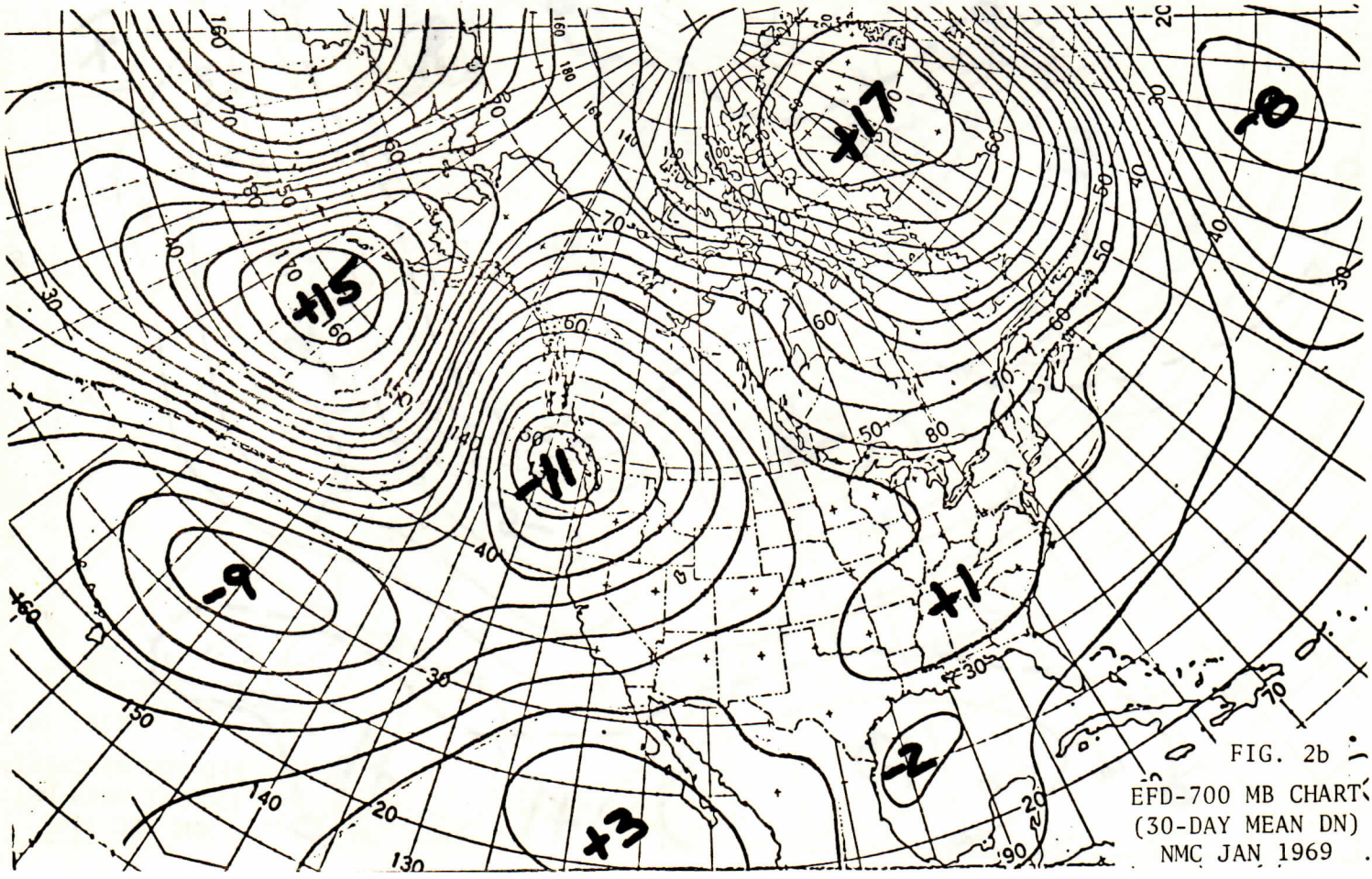


FIG. 2a

EFD-700 MB CHART.
(30-DAY MEAN DN)
NMC DEC 1968


EFD-700 MB CHART
(MONTHLY MEAN)
NMC JAN 1969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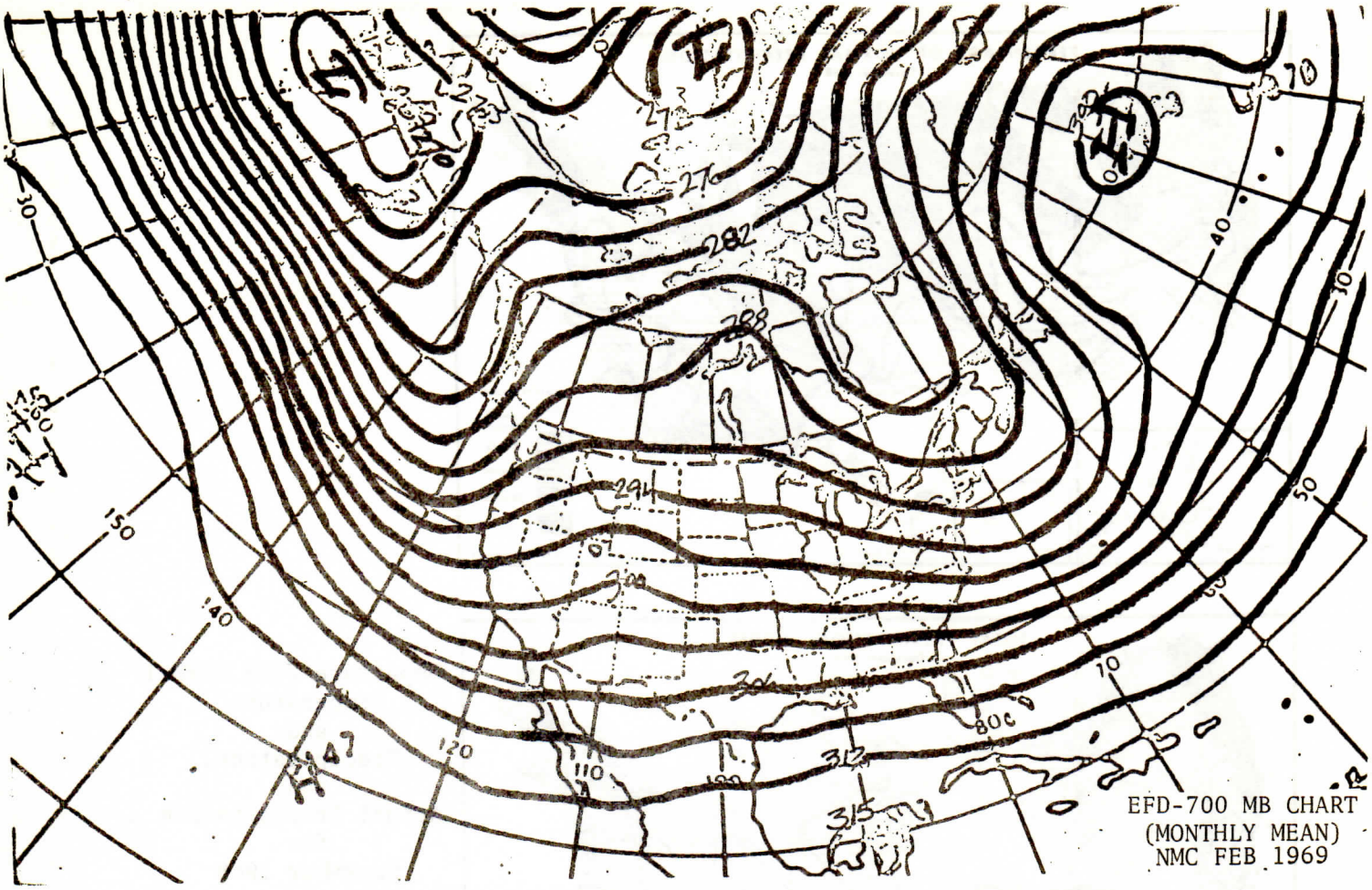
(30-DAY MEAN DN)
NMC JAN 1969

FIG. 2b



EFD-700 MB CHART
(MONTHLY MEAN)
NMC FEB 1969

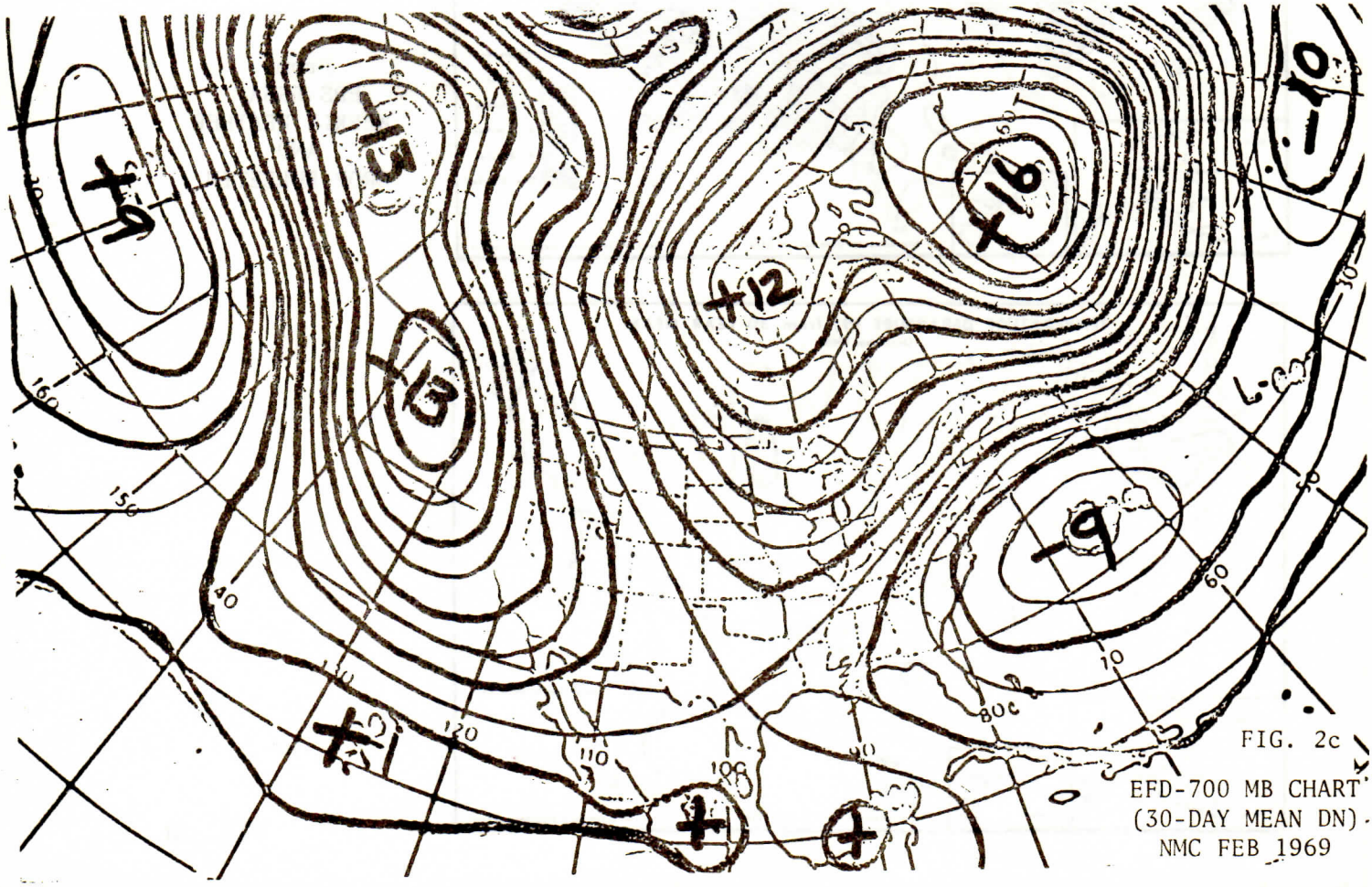
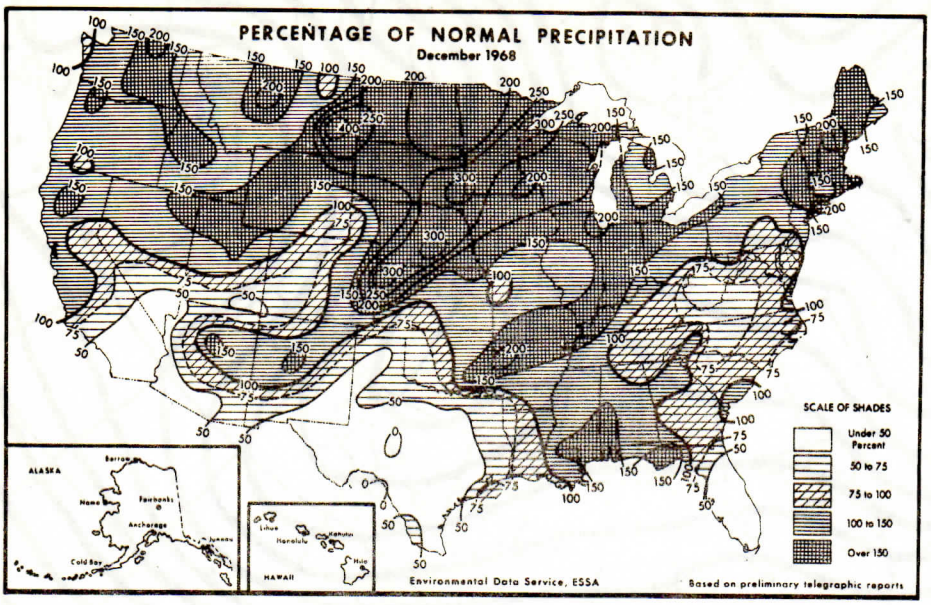
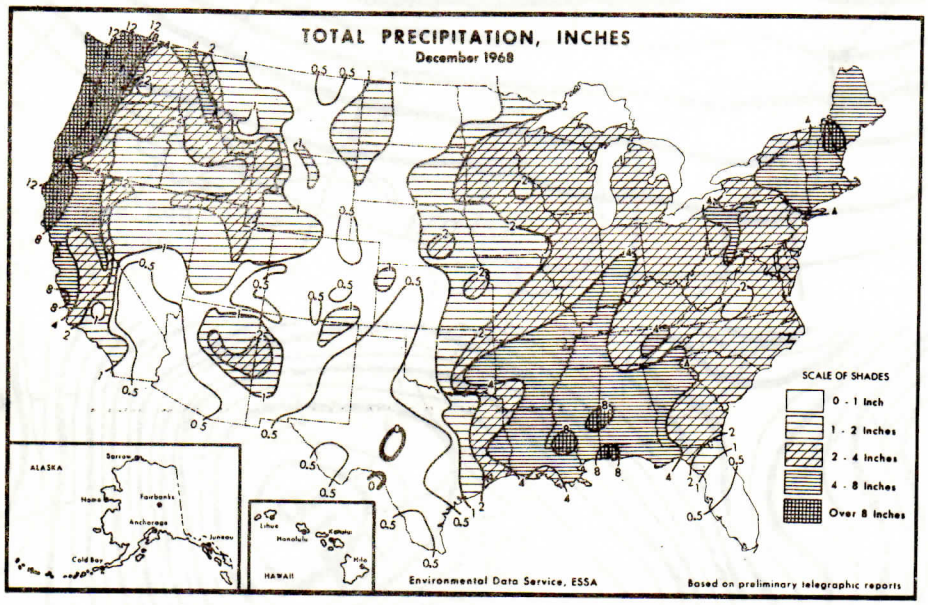


FIG. 2c

EFD-700 MB CHART
(30-DAY MEAN DN)
NMC FEB 1969





Departure from Normal Temperature and Precipitation, and Actual Precipitation for December 1968

From EDS-ESSA WEEKLY WEATHER AND CROP BULLETIN

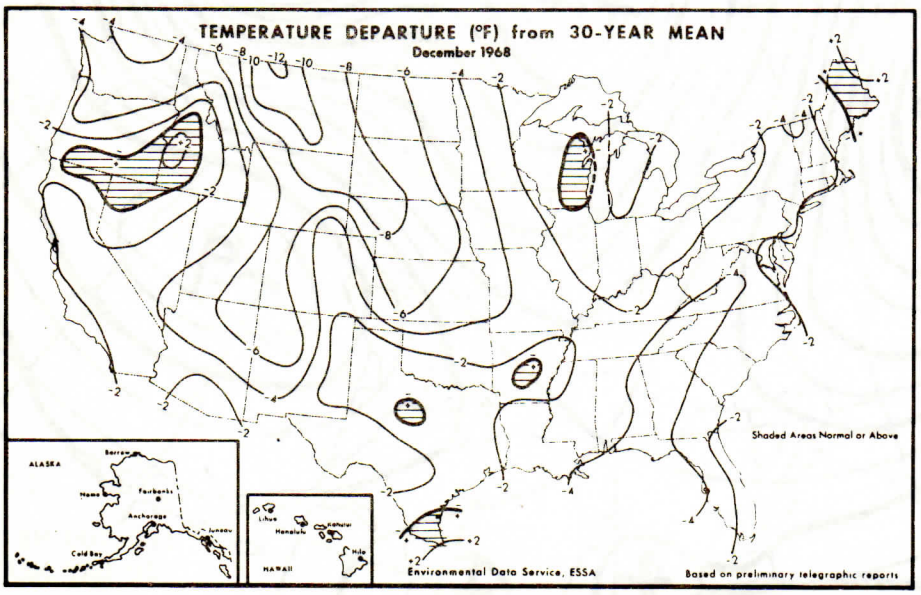
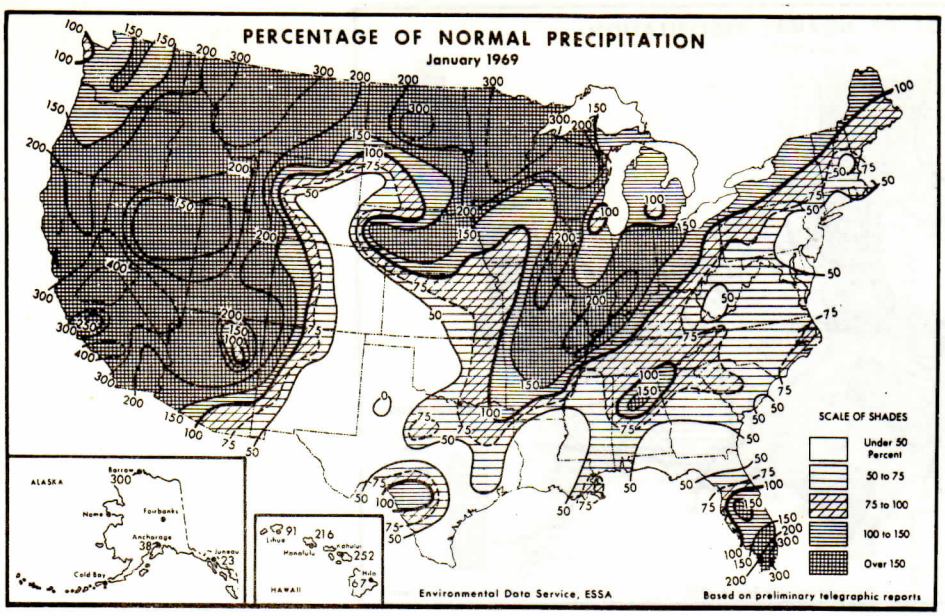
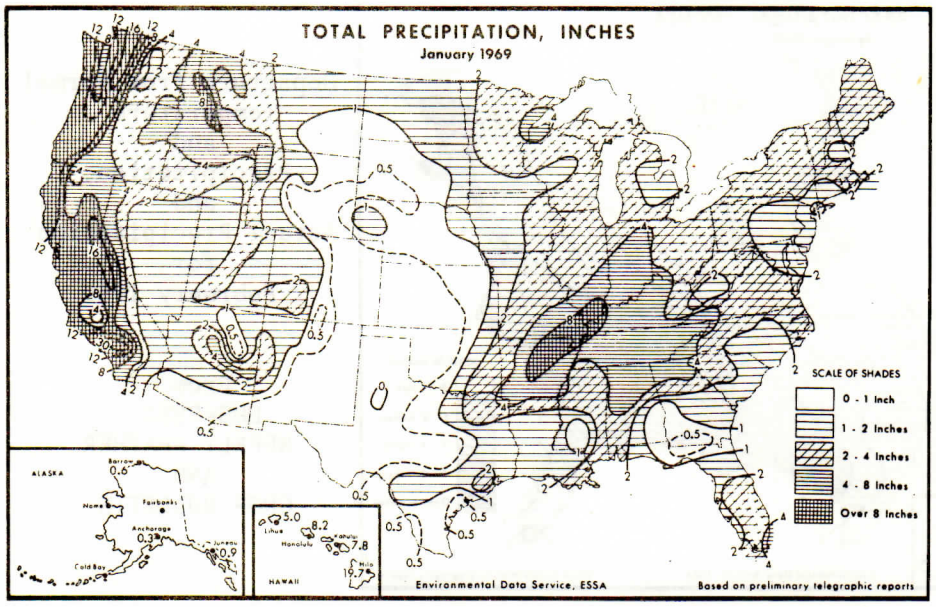


FIG. 2d





Departure from Normal
Temperature
and
Precipitation,
and
Actual Precipitation
for
January 1969

From
EDS-ESSA
WEEKLY WEATHER
AND
CROP BULLETIN

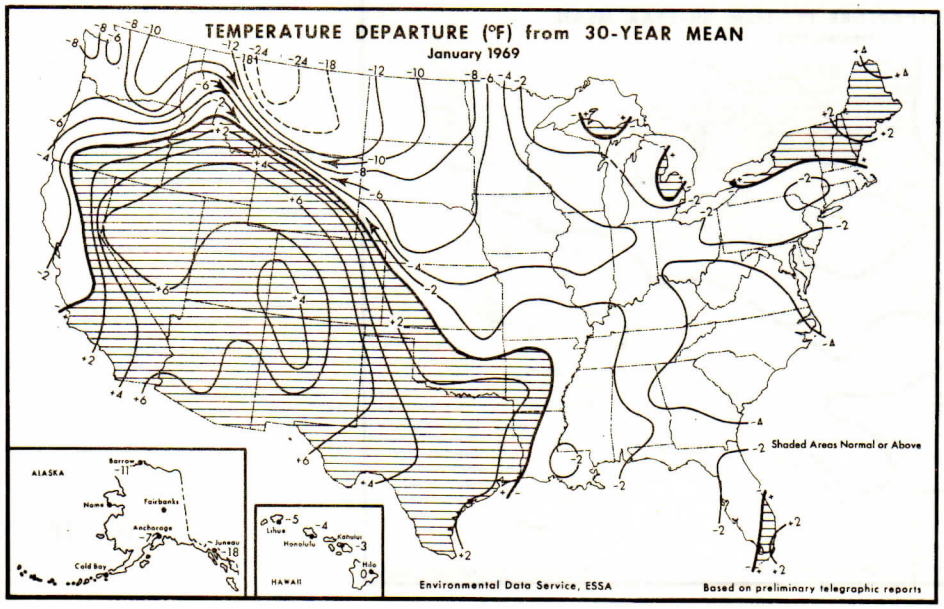
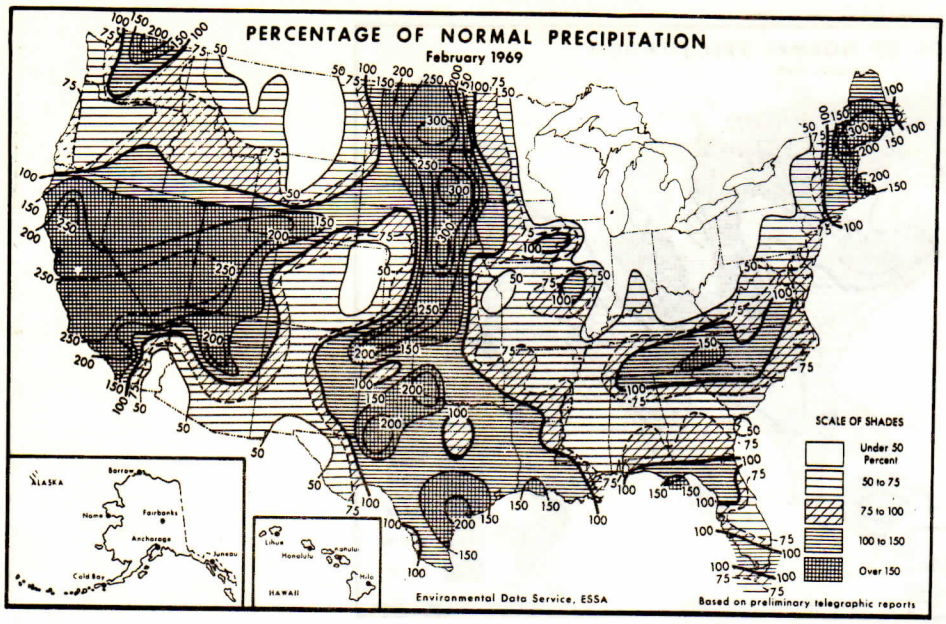
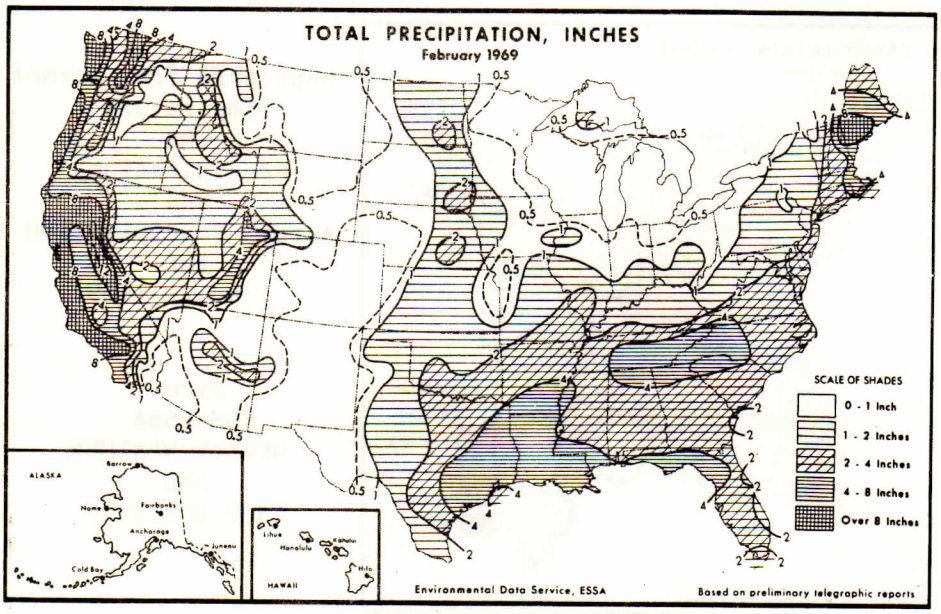


FIG. 2e





Departure from Normal
Temperature
and
Precipitation,
and
Actual Precipitation
for
February 1969

From
EDS-ESSA
WEEKLY WEATHER
AND
CROP BULLETIN

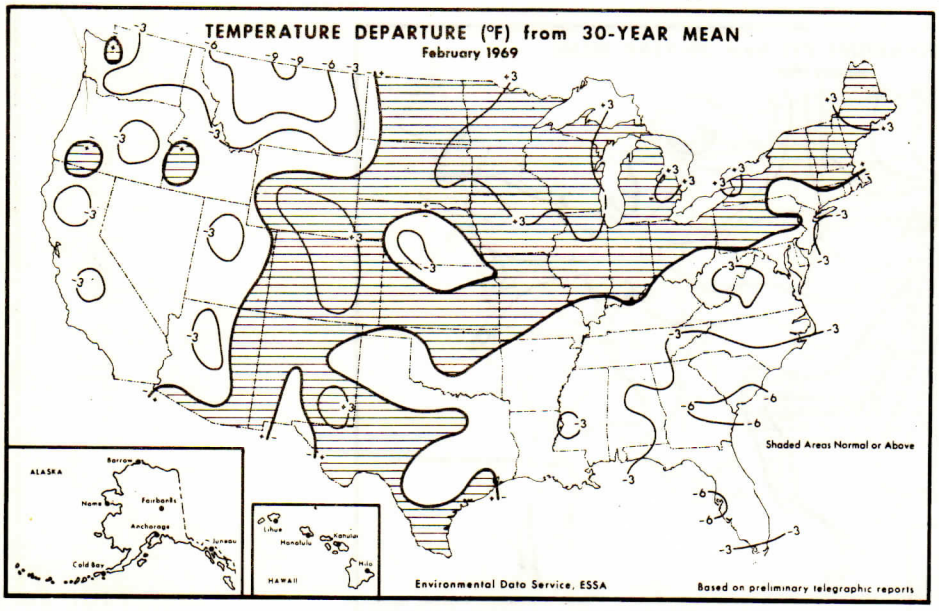


FIG. 2f

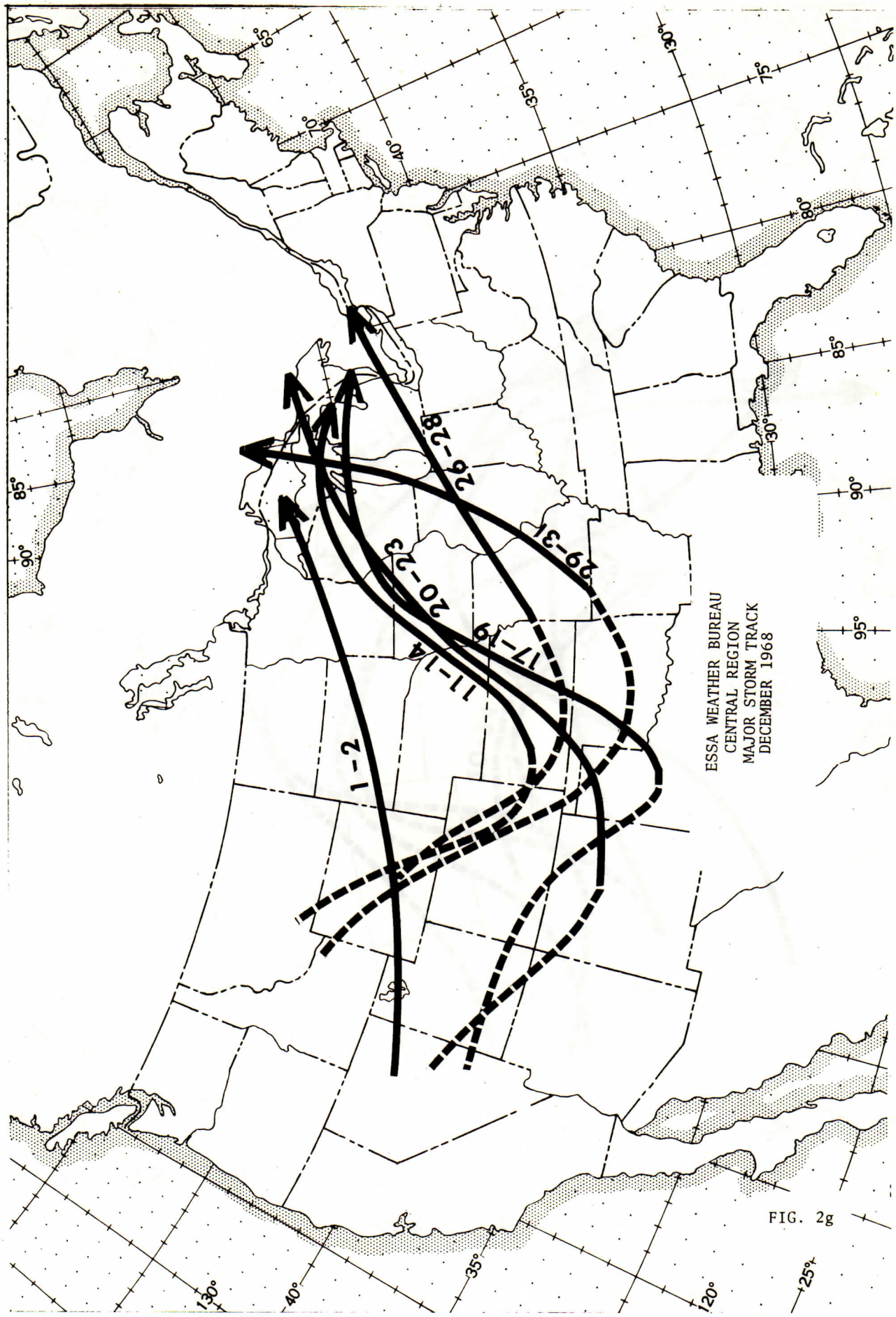
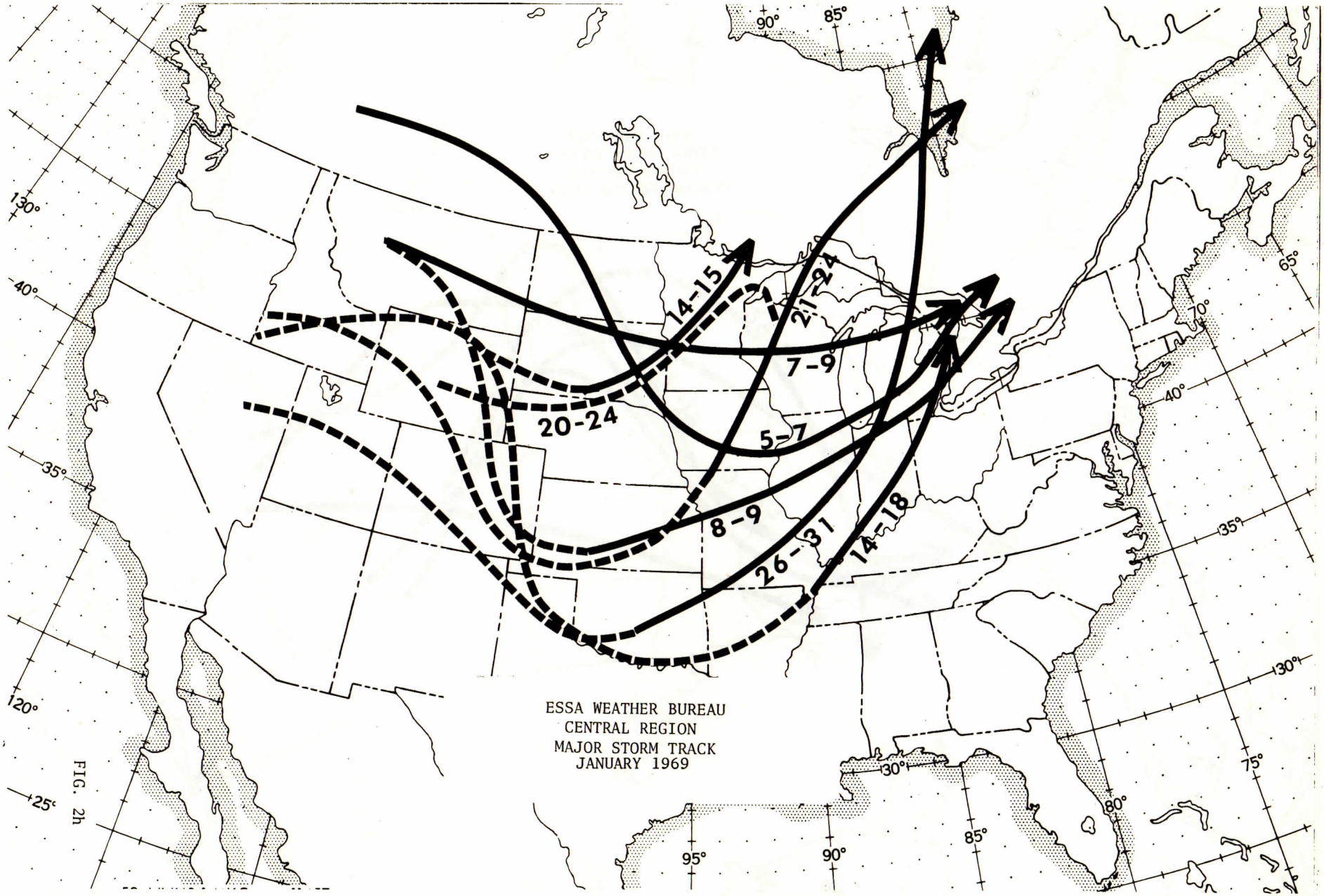

ESSA WEATHER BUREAU
CENTRAL REGION
MAJOR STORM TRACK
DECEMBER 1968
1-2
11-14
17-19
20-23
26-28
29-31

FIG. 2g



ESSA WEATHER BUREAU
CENTRAL REGION
MAJOR STORM TRACK
JANUARY 1969

FIG. 2h

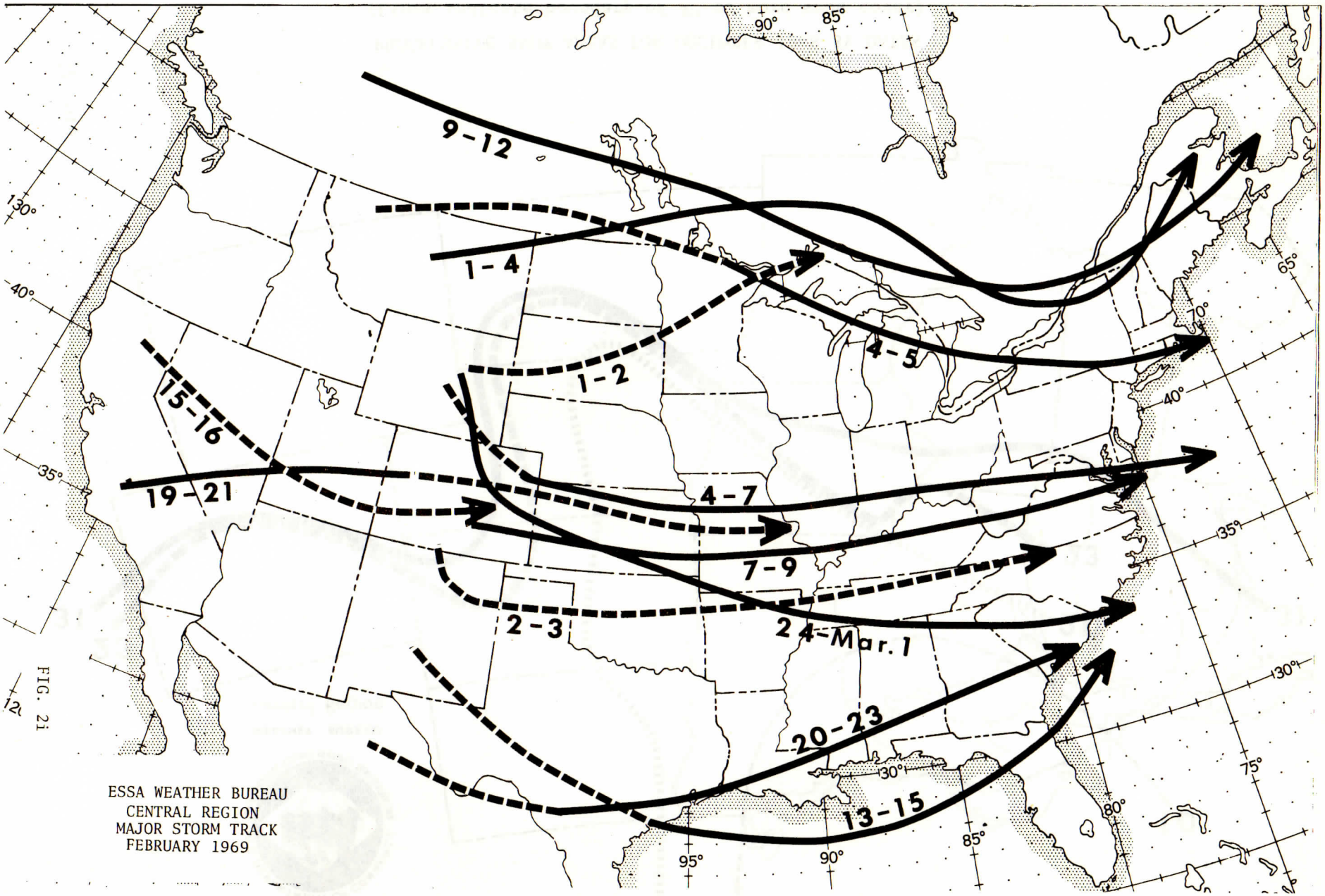
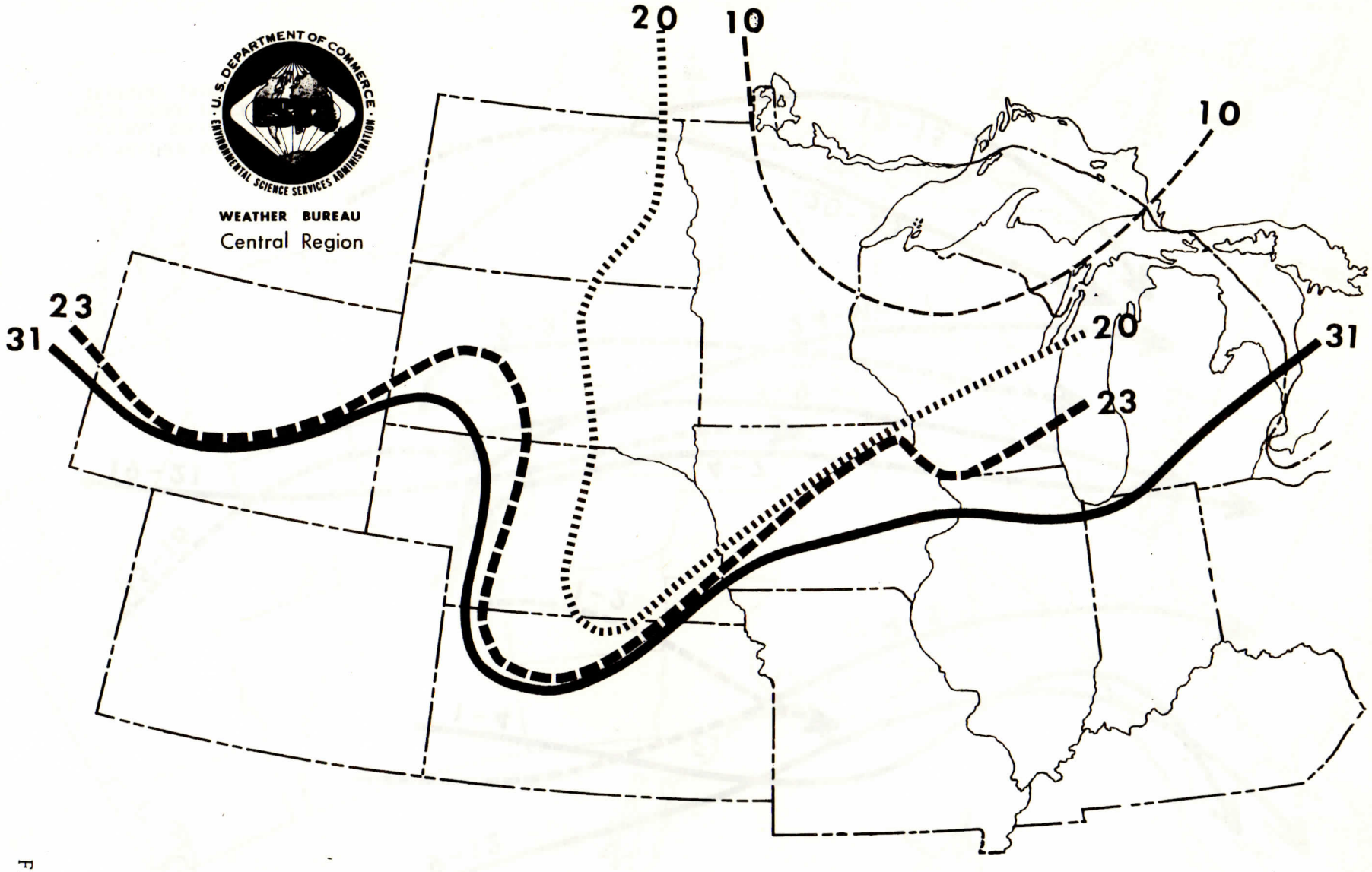


FIG. 2i

ESSA WEATHER BUREAU
CENTRAL REGION
MAJOR STORM TRACK
FEBRUARY 1969



WEATHER BUREAU
Central Region

FIG. 2j

PROGRESSIVE SNOW AREAS FOR DECEMBER 1968 BY DATES
(Lines indicate boundary of 4" or more snow cover)

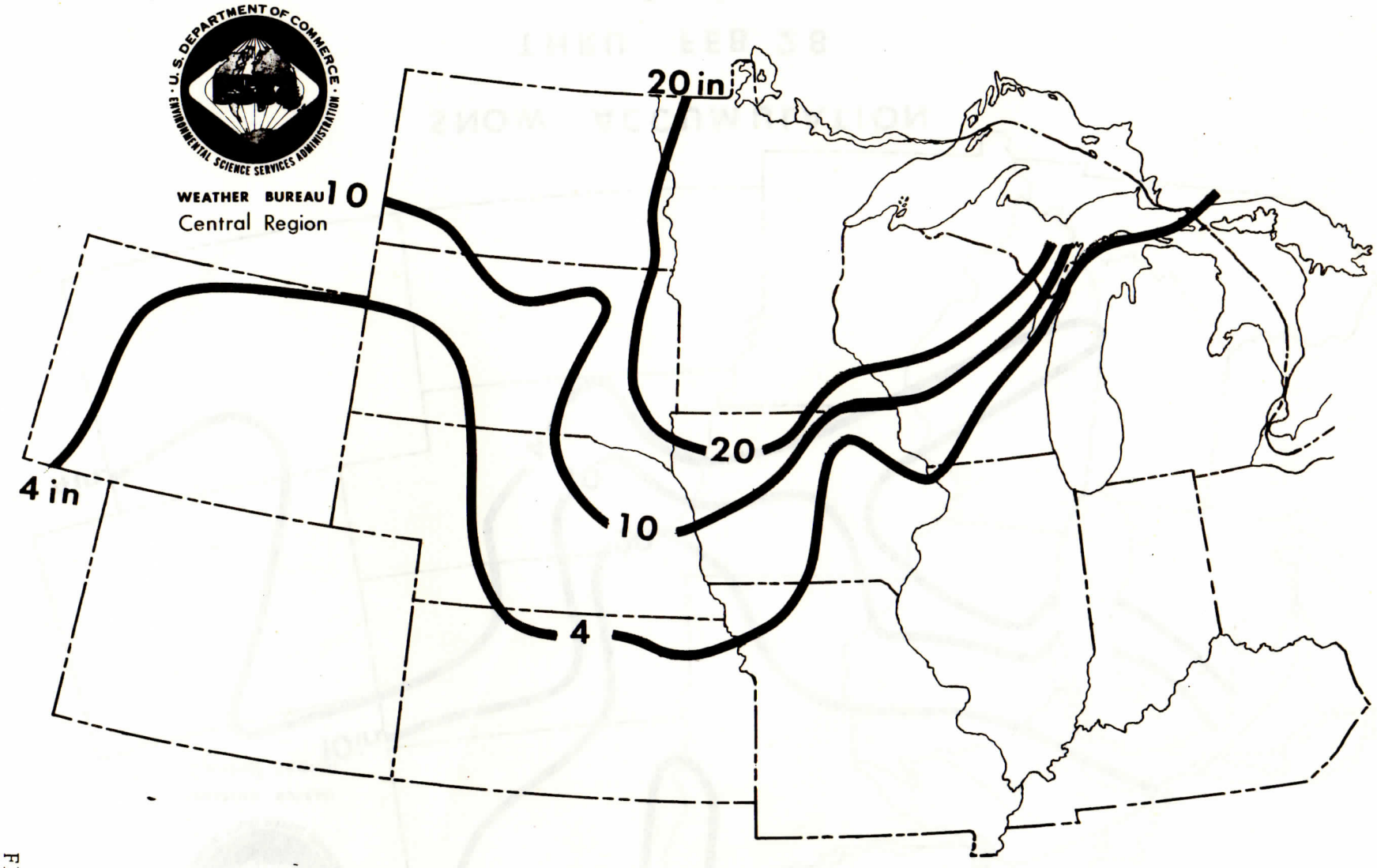
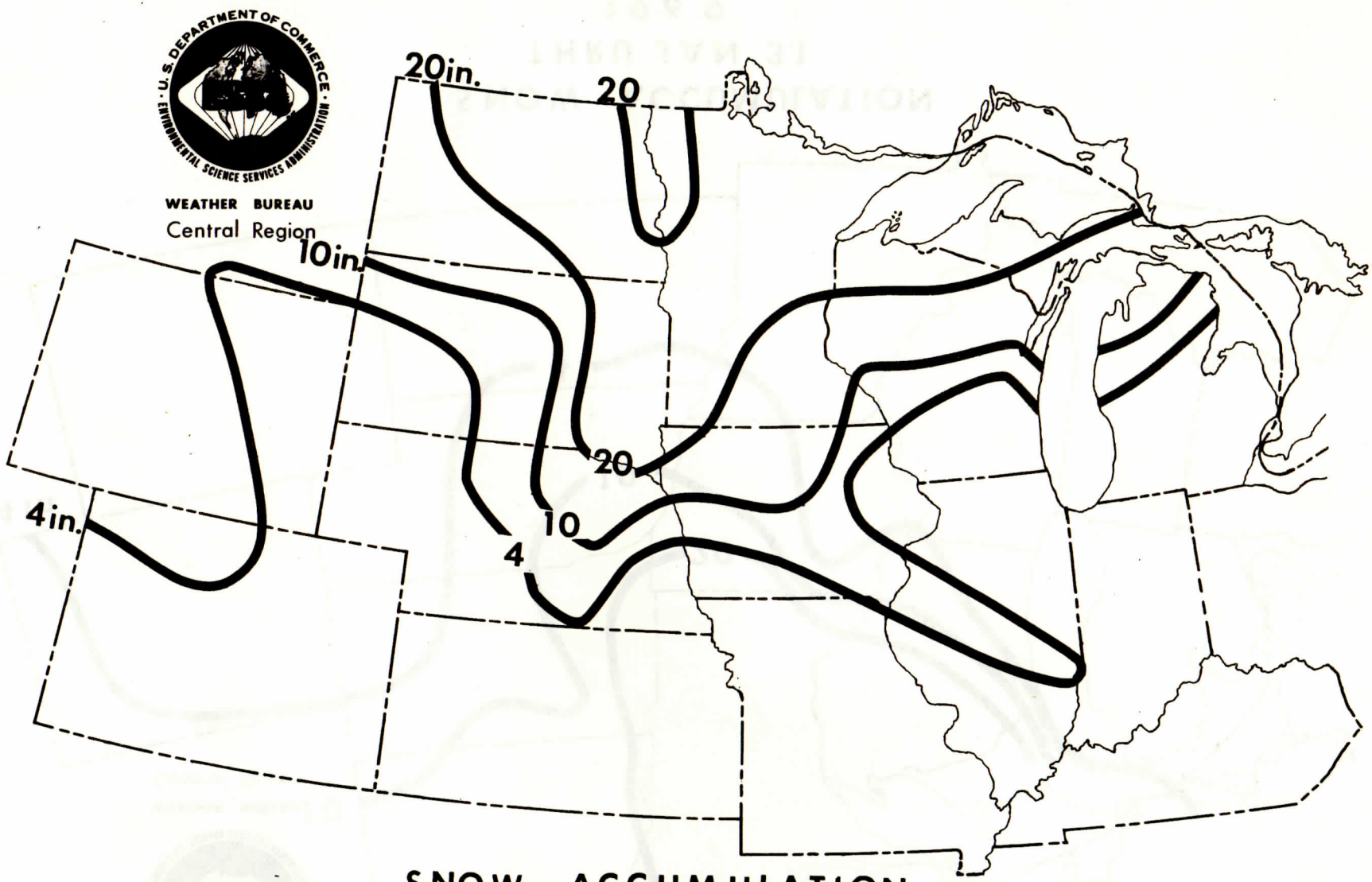


FIG. 2k

SNOW ACCUMULATION
THRU JAN 31
1969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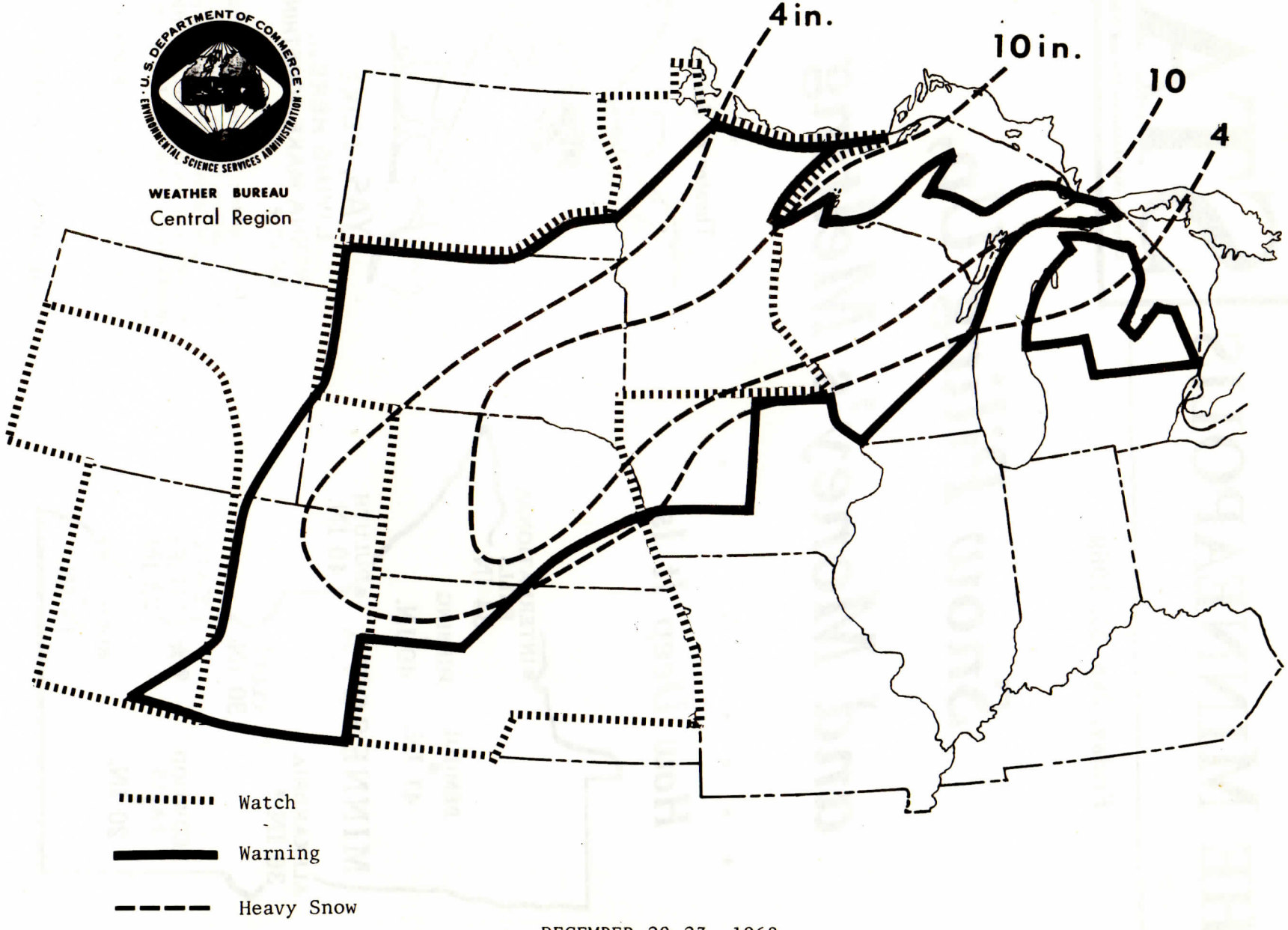
10
4
SNOW ACCUMULATION
THRU FEB 28
1969

FIG. 21



DECEMBER 20-23, 1968

FIG. 2m

THE MINNEAPOLIS STAR

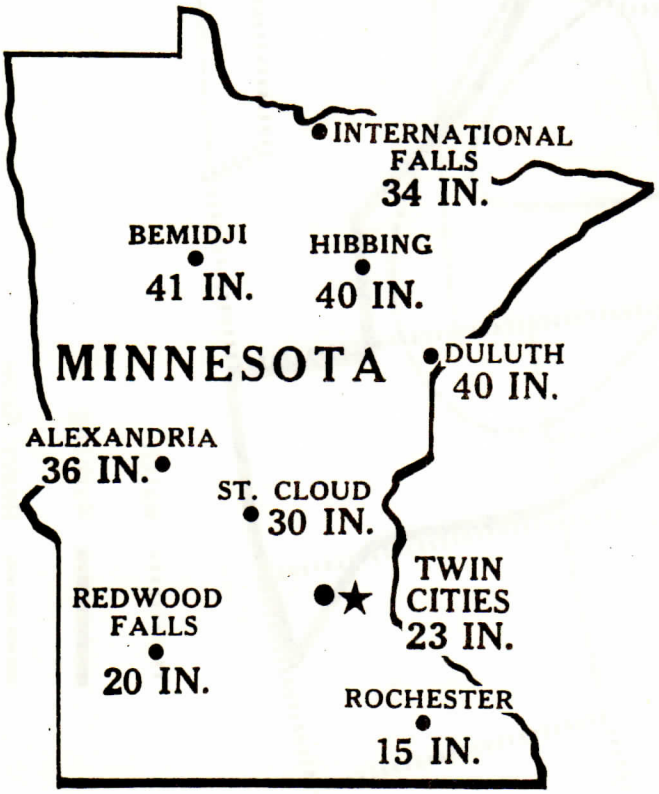
Friday, Jan. 31, 1969

Copyright 1969 Minneapolis Star and Tribune Company

Snow Piling Up, and Money's Melting

★ ★ ★ ★ ★ ★ ★ ★

How Deep It Is



★

Theater of Seasons

To the Editor: The enclosed illustrates the frustrations felt by natives in the "Theater of Seasons," when our cup runneth over as it has this winter. The artist's qualifications include 600 feet of uphill driveway.

Excelsior —Stewart R. Reamer.

THE MINNEAPOLIS STAR

Saturday, Feb. 1, 1969

FIG. 2n

Snow

Snow, Snow, Snow, Snow, Snow, Snow, Snow, Snow, Snow,
Snow, Snow, Snow, Snow, Snow, Snow, Snow, Snow, Snow,
Snow, Snow, Snow, Snow, Snow, Snow, Snow, Snow, Snow,
Snow, Snow, Snow, Snow, Snow, Snow, Snow, Snow, Snow,
Snow, Snow, Snow, Snow, Snow, Snow, Snow, Snow, Snow,
Snow, Snow, Snow, Snow, Snow, Snow, Snow, Snow, Snow,
Snow, Snow, Snow, Snow, Snow, Snow, Snow, Snow, Snow, Snow, Snow, Snow, Snow, Snow

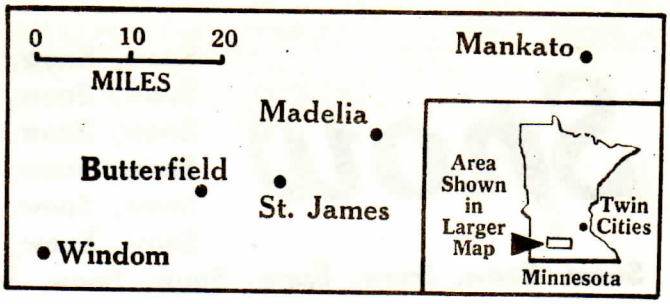
CONSOLATION PRIZE!

Fri., Jan. 31, 1969 THE MINNEAPOLIS STAR

FIG. 2o

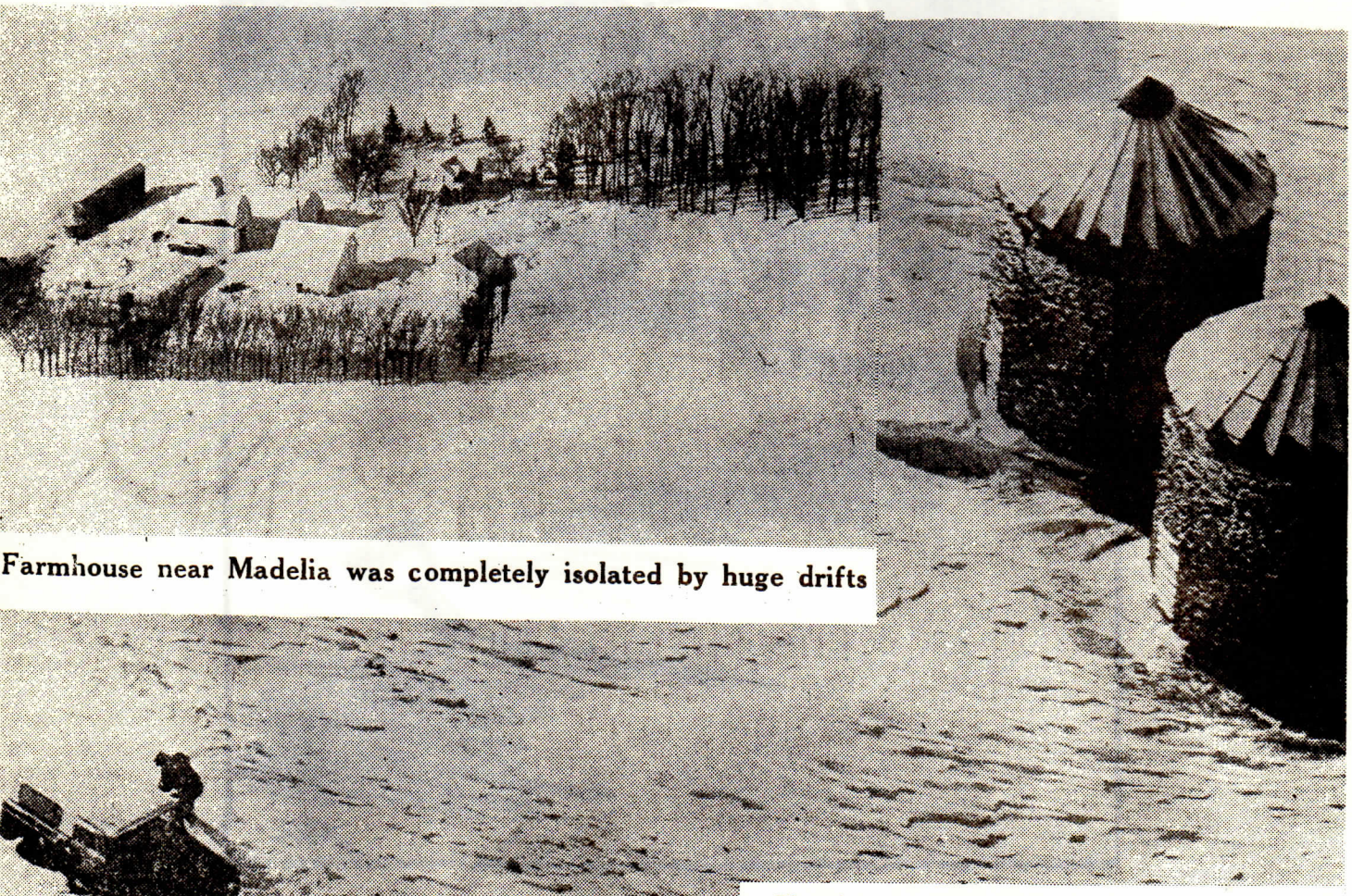
THE MINNEAPOLIS STAR

FRIDAY, JANUARY 31, 1969



Thursday was still a snowmobile-type day for transportation in southwestern Minnesota as drifts continued to hold many farm families captive in their houses while plows attempted to force their way through the drifts and open roads.

While the main roads in the Windom, Mountain Lake and St. James areas were open to travel, many secondary and township roads were still completely covered with drifts in many cases. Farmers have plowed out their private roads only to be stymied by the still unplowed secondary roads. Numerous stalled cars were visible, almost completely covered by large drifts. Many farm houses in the area, except for a few tracks to and from the barns, showed no signs of life. Plows were out in force Thursday. If the weather remains clear, roads could be opened over the weekend.



Farmhouse near Madelia was completely isolated by huge drifts

Motorist who abandoned his four-wheel drive vehicle during drifting earlier in the week, struggled to dig the vehicle out of deep snow drifts on a lonely county road between Madelia and St. James.

FIG. 2p

Minneapolis Star Air Photos by Charles Bjorgen

The Lincoln Star Monday, December 23, 1968

Hundreds Stranded In Snow-Bound State

By The Associated Press

Winter unleashed its fury across Nebraska Sunday leaving drifts as high as 12 feet in some spots and hundreds of stranded travelers.

At least four persons were reported missing Sunday night.

Mr. and Mrs. Daniel Frerichs of Gothenburg were reported missing after they failed to arrive at a Kearney hospital from a trip from Gothenburg. Mrs. Frerichs, who is pregnant, had been scheduled to enter the hospital for treatment.

Also reported missing was Steve Terry of Inavale who failed to reach his home on a scheduled trip from Hastings.

Hunter Missing

David Kennedy, a hunter in the Alma area also was reported missing.

The conditions were such that late Sunday Lt. Gov. John Everroad, acting in the absence of Gov. Norbert Tiemann, authorized the use of National Guard troops in the York area to help free stranded motorists.

Men of Company C of the 67th Support Battalion of the 67th Infantry Brigade, stationed at York, relieved weary volunteer firemen, sheriff's deputies and state patrolmen, who had fought the snow, wind and cold all day in freeing more than 200 travelers from their snow-stalled autos.

Maj. Gen. Lyle A. Welch, adjutant general of the Nebraska National Guard and State Civil Defense Director, said Sunday night that some 280 persons had been evacuated to the National Guard Armory in York.

He said he understood the travelers were being provided with lodging in homes in York.

York Fire Chief Bob Lundy said emergency field hospital equipment had been set up in York.

State troopers early Monday were traveling to the York area to assist in the evacuation of a train reported stranded about a mile west of York with 150 persons aboard.

Two snow plows and a grader were reported stalled in high drifts Sunday night as they attempted to open a road to the home of a physician on the outskirts of York.

The State Patrol reported early Monday that snow plows were operating in the York area, where an unknown number of vehicles were believed still stranded.

The operator of a service station and restaurant on Interstate 80 near Hampton reported Sunday night between 150 and 200 persons were stranded at his establishment and "they're still coming in."

Everroad said Sunday night that a state helicopter had been requested to help in the search for the hunter reported lost in the Alma area. But he said there was no possibility of using the craft until daylight or until winds died down.

Lincoln Blockade

The State Patrol set up blockades on all roads west out of Lincoln Sunday evening. Early Monday morning, the Patrol reported all roads west and north of Lincoln remained closed.

A spokesman said roads east and south were open, but he said driving conditions were hazardous.

Lincoln police reported about 10 streets in the city closed Sunday night. The Municipal Airport road was reported impassable, as was Pioneers from 56th to 70th.

Police said early Monday that 15 autos were stuck near 70th and A.

At Columbus police reported putting National Guard vehicles into special use. At least one Guard half-track and a jeep were being used in that city where 15 inches of snow was being whipped Sunday night by winds up to 50 miles an hour.

Several major cities were reported isolated by the drifts. Included were Holdrege, Kearney, Norfolk, Hastings, Grand Island, Norfolk, Fremont, North Platte, Columbus and York.

Transportation Halted

Transportation came to a near halt. The Greyhound Bus dispatcher in Omaha Sunday night reported 15 buses halted around the state. However, he said all passengers were safe and had shelter.

Airline service was reported completely disrupted with visibility cut considerably by blowing snow. Frontier Airlines spokesmen in Omaha Sunday night declined to say when normal service would be resumed.

The Union Pacific Railroad at North Platte said only passenger trains were moving east out of the city, and some of these were as much as 10 hours late. The huge automated switching yard for freight trains was idle.

Other reports from around the state late Sunday included:

Norfolk — City plowing equipment and state snow removal equipment were taken out of operation because of strong winds that gusted over 60 miles an hour.

Kearney — All roads closed in the Kearney area where the temperature dropped to 12 degrees and the wind chill index registered minus 38.

Columbus — Several Columbus industries announced that Monday morning openings for business would be delayed.

Milford — Drifts of four to five feet reported at the Interstate exit. There also were reports that stalled vehicles had blocked the exit to traffic.

Superior — Seventeen inches of snow reported on the ground with traffic at a standstill.

Grand Island — Police Sunday night reported the city isolated. All city streets also reported blocked.

FIG. 2q

West Point, Nebraska

CUMING COUNTY DEMOCRAT
Thursday, December 26, 1968

WEATHER REPORT

Frank Strehle, Jr.
Observer

	Max.	Min.	Prec.
Dec. 18	32	26	.00
Dec. 19	22	19	15"
Dec. 20	19	9	.00
Dec. 21	23	9	.00
Dec. 22	27	13	10"
Dec. 23	15	8	1"

HEAVY SNOW, STRONG WINDS PLAGUE AREA—

West Point Has 26 Inches

Yes! this is Nebraska and that accounts for the 26 inches of snow that hit West Point the past weekend.

The city received a total of 15 inches Wednesday and Thursday, Dec. 18 and 19 & another 11 inches added Saturday night and Sunday, Dec. 21.

Many social events were cancelled including morning church services and Christmas programs.

Snow cleaning crews worked at late hours Friday night on Main Street and had to repeat their efforts to rid the streets of snow again early Monday morning as a result of the all day blizzard Sunday.

Four crews of the Cuming County Public Power District were called Sunday to restore lights to residents in the northeast section of the county.

Lights were out in that area from two to five hours and all customers had electricity by dark Sunday evening.

The four CCPPD crews were stranded at farm places for Sunday night.

Phone Company

According to J. P. Coughlin, Northwestern Bell Telephone manager, several phones were out last Wednesday and Thursday due to ice condition.

The area effected was northeast and east of West Point.

Mr. Coughlin also reported the office lines weare tied up and slow dialing resulted on Sunday and Monday due to the tremendous number of calls placed which arose from emergencies of the blizzard Sunday.

Traffic was at a crawling pace on Monday but everything was restored to normal Tuesday and West Point stores again had bread for sale.

FIG. 2r

THE DAILY PLAINSMAN

WEATHER
SNOW
Low 24; High 27

The Great Home Newspaper of the Dakota Great Plains

HURON, SOUTH DAKOTA, 57350, FRIDAY, FEBRUARY 21, 1969

S.D. Again Clogged By Heavy Snowfall

Another in a series of snowstorms swept across South Dakota Thursday and Friday dumping nine inches of new snow over the Huron area and causing cancellation of many community and sporting events.

But, the South Dakota State High School Wrestling Tournament, scheduled to begin here this morning, was still on as 40 of the 52 participating schools were able to make it to the Fair City.

THE SNOWFALL, which began early Thursday morning, had reached a total of 9 inches by 1 p. m. Friday at Huron, bringing the city's total snowfall for the winter to 57.9 inches, the total for February to 15.9 inches and placing the current snow depth at 25 inches.

And, it appears the snow will continue into Saturday with problems mounting with a chance of occasional freezing drizzle tonight.

The wrestling tournament is about the only major event that hasn't been postponed.

SEVERAL CLASS B basketball district tournaments were postponed Thursday night including District 6 at Faulkton, 9 at Clear Lake, 10 at Brookings, 11 at Lake Preston, 14 at Chamberlain and 17 at Madison. All involved CSD schools.

Weather and road conditions caused school closings Friday at Miller, Forestburg, Hitchcock, Erwin, Tulare, Estelline, Hayti, Doland, Alpena, Redfield, Lake Preston and Huron public and parochial schools. For the first time this winter, schools were closed in Sioux Falls Friday because of weather conditions. Classes were held at Huron College Friday.

TRAFFIC ON HIGHWAYS was brought to a halt in the eastern and central sections of South Dakota by the state's latest snow storm. Several cars were reported stalled on main highways near De Smet, blocking traffic in all directions. Blocked roads were also reported at Miller and Wessington Springs.

The highway maintenance division reported many highways blocked and most heavy with snow in the eastern and central parts of the state.

Three inches of new snow fell in the northeast. Highways 212 and 81 were reported blocked in Codington County, all roads were blocked in Brookings County, Highways 34 and 13 were blocked in Moody County. Heavy drifting was reported on Highways 77 and 212 in Deuel County with no travel advised.

THE EAST CENTRAL portion of the state reported 4-8 inches of new snow with roads impassable in Beadle, Kingsbury, Miner and Sanborn counties while Highway 81 in northern Lake County was open and Highways 34 and 19 heavy with snow.

FIG. 2s

THE DAILY PLAINSMAN, Huron, South Dakota

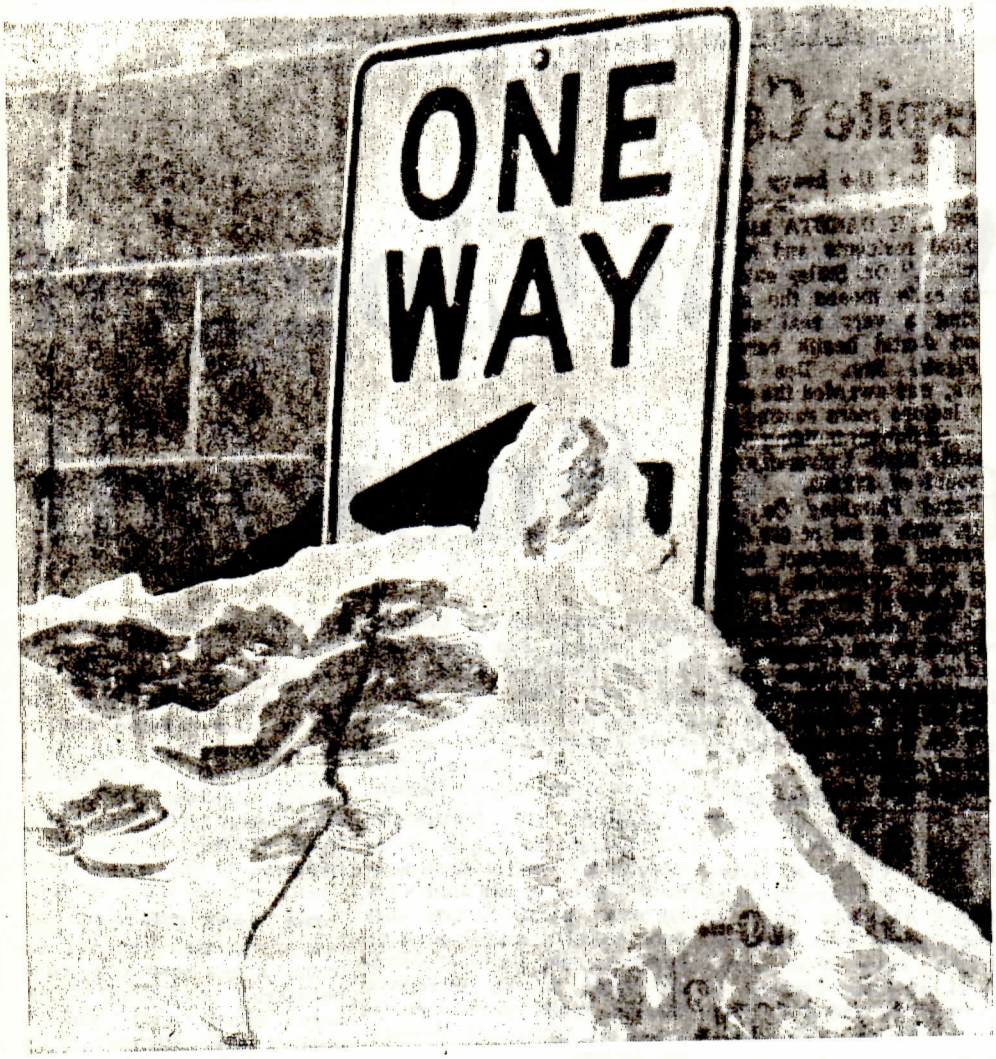
THURSDAY, FEBRUARY 20, 1969

More Snow Cash Asked By Farrar

PIERRE (AP) — Gov. Frank Farrar said Friday that state emergency funds have been used in snow removal operations at the rate of about $3,000 a day and he hopes the Legislature will provide some additional funds soon.

THE GOVERNOR said he hopes the lawmakers will add between $100,000 and $250,000 to the fund. "If this snow continues we could be forced to spend $10,000 a day," he said. About $50,000 remains in the emergency fund, he said.

Speaking at a news conference, Farrar said that most local resources have been exhausted and the state must help. He said he now is seeking equipment from outside South Dakota to provide additional support.



THERE'S ONLY ONE WAY the weather scene in Central South Dakota can turn and that's for the better as the snowfall since last November inches closer to the all-time record of 77.7 inches recorded in 1961-62. Another in a series of snowfalls dumped more than 9.2 inches of new snow on Huron last Thursday and Friday, pushing the total for February to 15.5 inches and for the year 57.6 inches.

(Plainsman Photo)

Another Mild Day In Store

Mild temperatures and a minimal chance of precipitation are expected in the Huron area today, after a snow storm which dumped 9.1 inches of snow on Huron Thursday and Friday.

Temperatures should range from a high today in the mid-30s with a low tonight in the lower 20s. Huron area precipitation probability is 10 per cent or less tonight and Monday, but there is a possibility of light snow in other sections of the state.

The storm Thursday and Friday brought Huron's total snowfall for the season to 58 inches and the February snow total to 15.5 inches. Sioux Falls and Brookings surpassed previous season record snow totals during the Thursday and Friday snow storm. Sioux Falls had received more than 84 inches of snow by Friday afternoon, topping the previous season record of 79.8 onches, and Brookings had received more than 56 inches by Friday afternoon, surpassing the city's previous seasonal record snowfall of 53 inches.

FIG. 2t

3. Climatology of the Winter's Weather

Summary - The winter has been one of the worst on record in terms of continued cold weather, persistent cloudiness, long duration of snow cover, and the volume of snow with high water content remaining on the ground in early March. As shown in Figure 3a, very large areas received more than double the normal precipitation for the five-month period of October through February. Most of the winter's snow remained on the ground in early March.

Introduction - Nearly all winters in this area include blizzards, heavy snows, occasional icing, drifting winds, and bitter cold. But blizzards are usually short-lived, cold spells normally give way to sunshine, snows slowly evaporate or melt, and winds ordinarily blow dust as often as snow. In the drier areas from Kansas to the Dakotas, considerable sunshine and low humidity bring the not unpleasant "dry cold" of the area. In other words, most winters are endurable and people dream of a "White Christmas". But in 1968-1969, the "White Christmas" was followed by a white New Year's Day and a "white" Washington's Birthday and eventually by a "white" St. Patrick's Day with plenty of white still around at the middle of March.

Temperature & Cloudiness: Cold weather in this area usually results from dry Canadian air masses. Winter days may be short but have substantial sunshine, - half of the possible hours in many seasons. This winter the more northerly location of storm tracks and the unusual temperature gradients in the area produced cold weather, abundant precipitation, and unusual cloudiness. Sunshine was about half the normal quantity or about ¼ the possible hours. Air masses were more humid than usual so that the cold, moist atmosphere and lack of sun reduced evaporation from the snow-covered soil.

Temperatures for December and January averaged 5° to 10° below normal but without much variability. February averages were mostly near normal with night-time minimums above normal but day-time maximum temperatures near or a little below normal. March brought another abnormally cold spell with temperature averages 10° to 15° below normal during the first half-month.

Wind: While blizzard or near-blizzard conditions did occur, the monthly wind averages were not particularly high, - just a little above normal. More unusual was the abundance of snow available for drifting and the lack of warm spells to glaze or settle the snow and to diminish its drifting.

Highway snowplows were in daily use for weeks, sometimes for new snows but just as often for old snow that would not stay in place. Roadside snow banks became higher and "cuts" became deeper until rotary plows had to be imported from areas usually more snowy than this one.

Precipitation and Snow Cover: Hydrologically, the winter began back in October when precipitation two and three times the normal occurred over eastern Kansas, eatern Nebraska, and most of Iowa and Minnesota. November was relatively dry but the soil remained wet until freeze-up. Heavy snows began December 10 and were repeated two weeks later while light to moderate snowfalls occurred at frequent intervals during December, January, February and the first week of March. Once established, the snow blanket gradually increased so that very large areas have had a continuous snow cover for more than 90 days. Because of the cold, cloudy weather most of the snow has remained; probably 75-85% of the winter's precipitation was still present in the snow pack of early March.

The pattern of snow depth in early March is shown in Figure 3a. The pattern is approximate and based on preliminary data. Depths within the 20-inch line run up as high as 35-40 inches and the water content of the snow ranges from 4 to 8 inches or more.

Compared with normal, the seasonal precipitation from October through February shows more than double the normal totals over northeastern Nebraska, the eastern ¼ of South Dakota, most of central and southwestern Minnesota, plus the northwestern corner of Iowa.

Soil Freezing: Because the snow cover was established early in the season, soil frost under the snow cover is probably less deep than usual which may allow greater infiltration rates than normal.

Warming Patterns: The heavy snow cover with its unusual "heat sink" capacity plus the unusual surface condition (albedo, heat insulation, etc.) will certainly affect the rate of warming in the snow pack area. However, we should note that with normal cloudiness the insolation rate by April 1 is 380-420 langlies per day; more than 2/3 the normal rate during June. The normal rise in daily mean temperature in early April is approximately 0.5°F per day. By April 1 the normal daily mean temperature at Sioux Falls, S.D. is 38° and the normal daily maximum is 47°.

Figure 3a

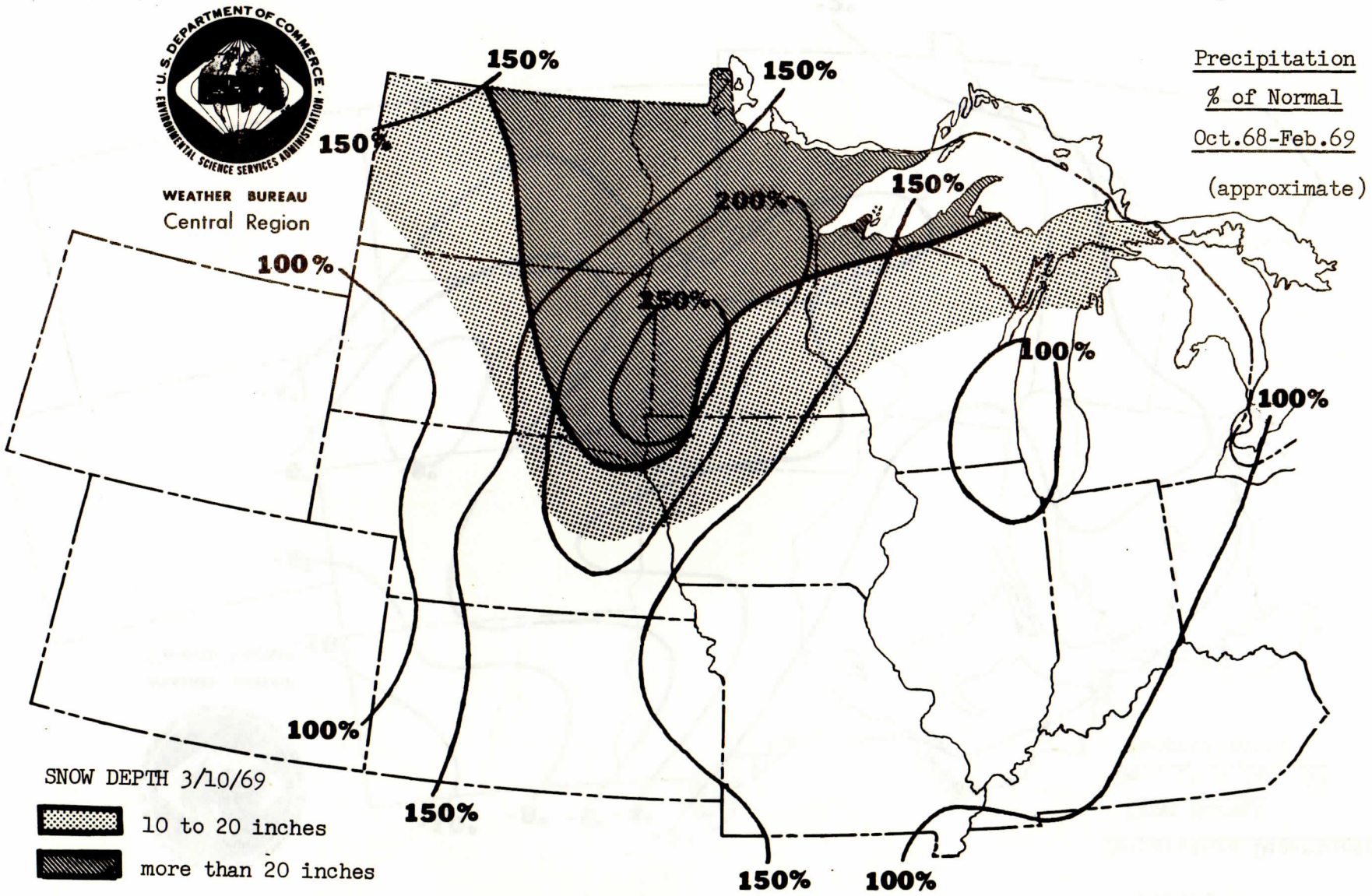
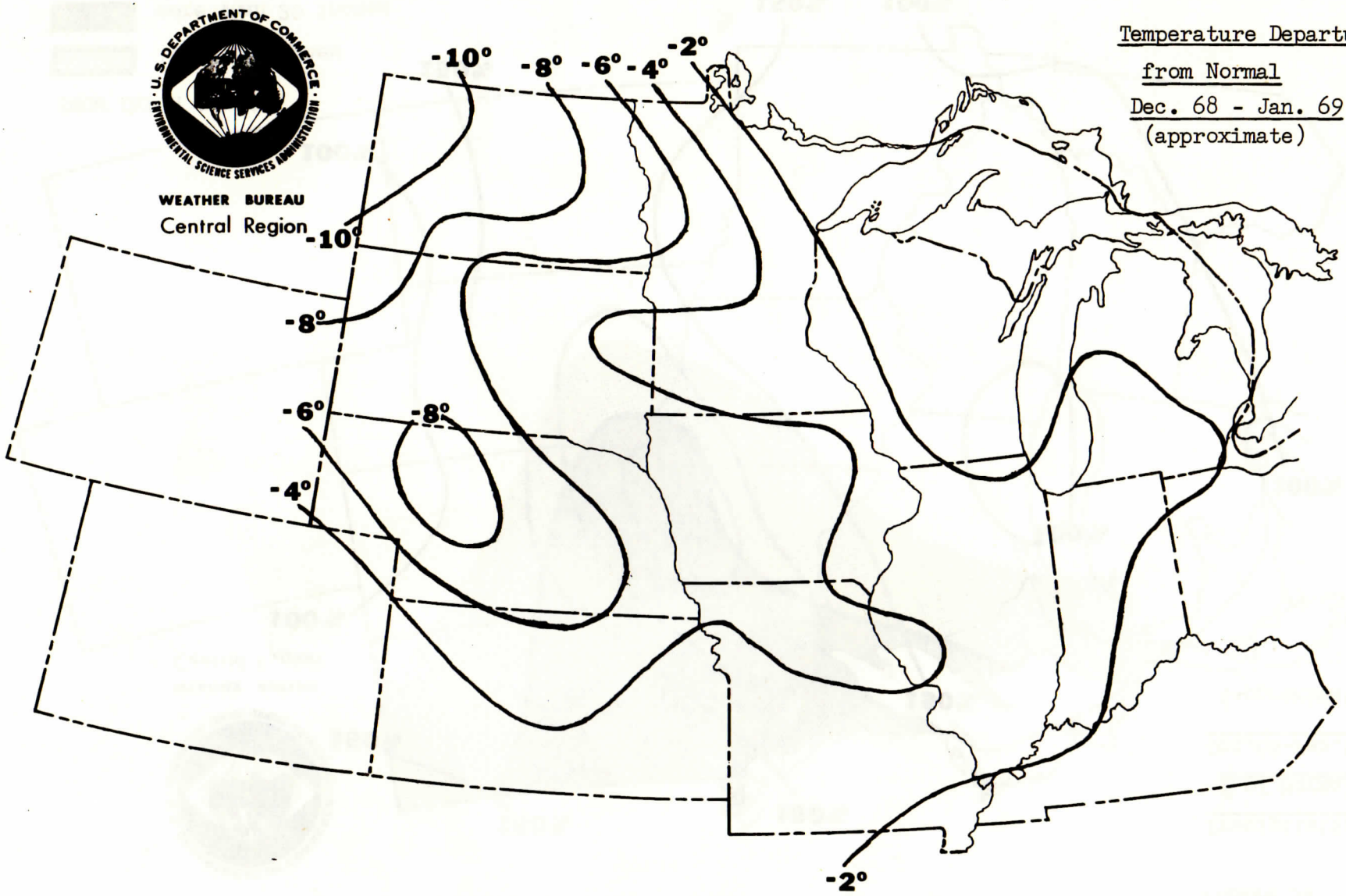

U.S. DEPARTMENT OF COMMERCE · ENVIRONMENTAL SCIENCE SERVICES ADMINISTRATION
WEATHER BUREAU
Central Region
Precipitation
% of Normal
Oct.68-Feb.69
(approximate)
150%
150%
150%
150%
200%
250%
100%
100%
100%
100%
150%
150%
100%
SNOW DEPTH 3/10/69
10 to 20 inches
more than 20 inches

Figure 3b

Temperature Departures from Normal
Dec. 68 - Jan. 69
(approximate)



4. The Flood Outlook - March 20

The water content of the current snowpack in the Upper Midwest is so great as to make serious flooding from snowmelt runoff inevitable. This large area with a very definite snowmelt flood threat includes North Dakota, Minnesota, Eastern South Dakota, Northern Iowa, Western Wisconsin, and much of Eastern and Northern Nebraska.

The levels that will be reached on most streams in this large area will be well over flood stage when the flow from the snowmelt reaches its peak. Depending on the additional precipitation that falls before and during the period of melt and the rate of melt, the situation on many of these watersheds is such that near-record or even record-breaking floods on their streams could result.

The ESSA Weather Bureau issued its first outlook of the season on February 11. Possible flood crests were given in general terms by comparison with previous floods which resulted from the water equivalents shown on Figures 4a and 4b, the 1952 and 1965 floods. Similar general outlooks were issued on February 20 and 27 and on March 6. On March 13 and 20, the outlooks furnished crest stage forecasts for river stations in the Upper Mississippi, Missouri, and Red River of the North Basins. See the attached outlooks for March 13 and 20. Since the daily pattern of temperature and precipitation during the spring breakup period was not known at those times, certain assumptions were made in order to estimate the flood potential of the snow cover. With the period of breakup in progress, weekly statements will be issued, and during the critical period, more frequent forecasts and statements will be furnished as conditions warrant. Normal values of temperature and precipitation will be replaced by observed values and those indicated by short range weather forecasts until the snow is depleted.

The following are the basic assumptions:

1. Melt proceeds at a moderate rate.

2. Much slower melt rates would give lower crests and, conversely, much faster melt rates would give higher crests.

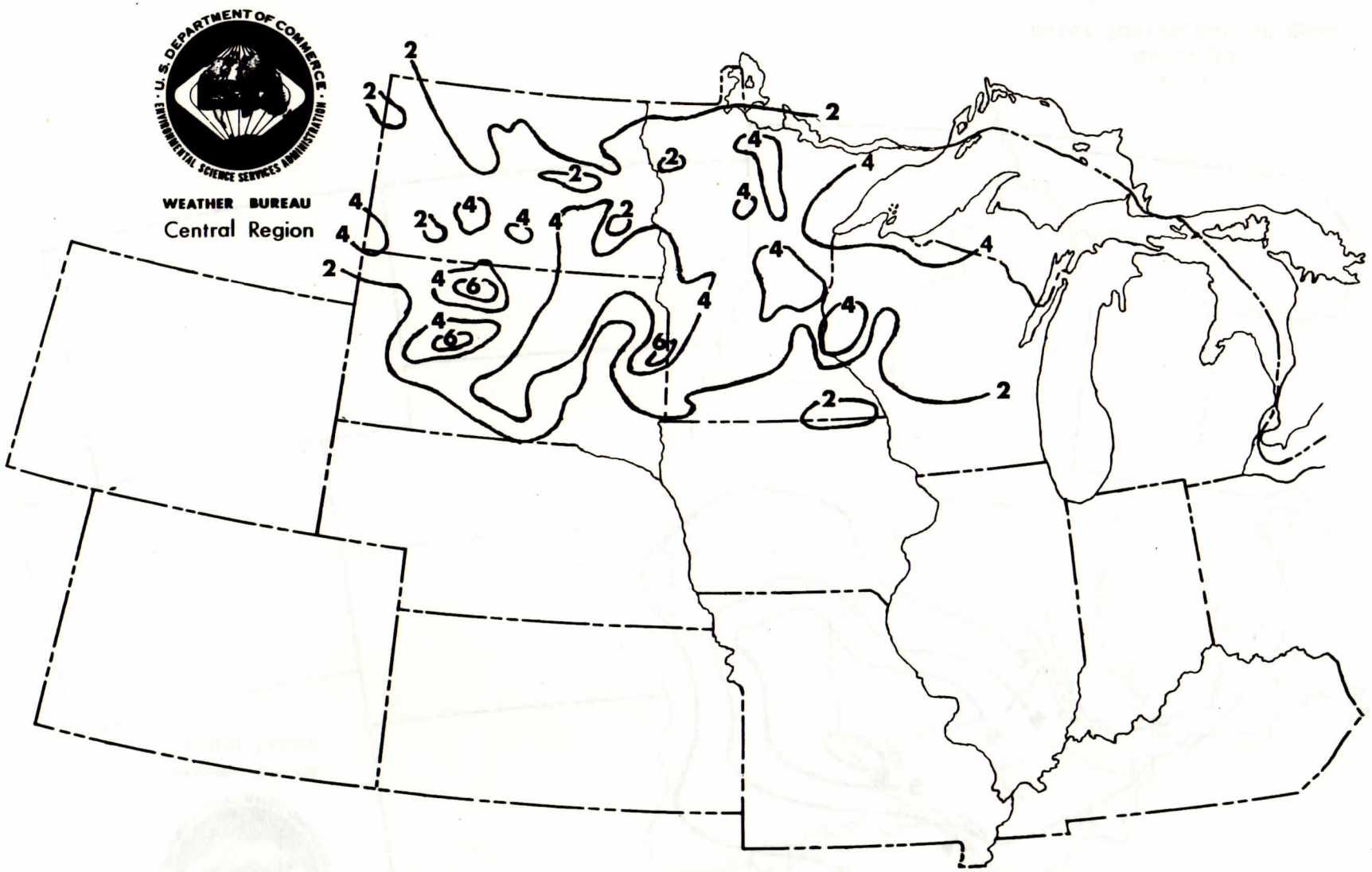
3. Melting is not accompanied by rainfall. Warm rains during the melt period would, of course, result in higher crests.

4. Crests could be augmented 3 to 5 feet by ice jams at those points frequently subjected to severe ice action.

A comparison of the March 14, 1969, water equivalent data, Figure 4c, is made with that of 1952 and 1965. It is obvious that the current

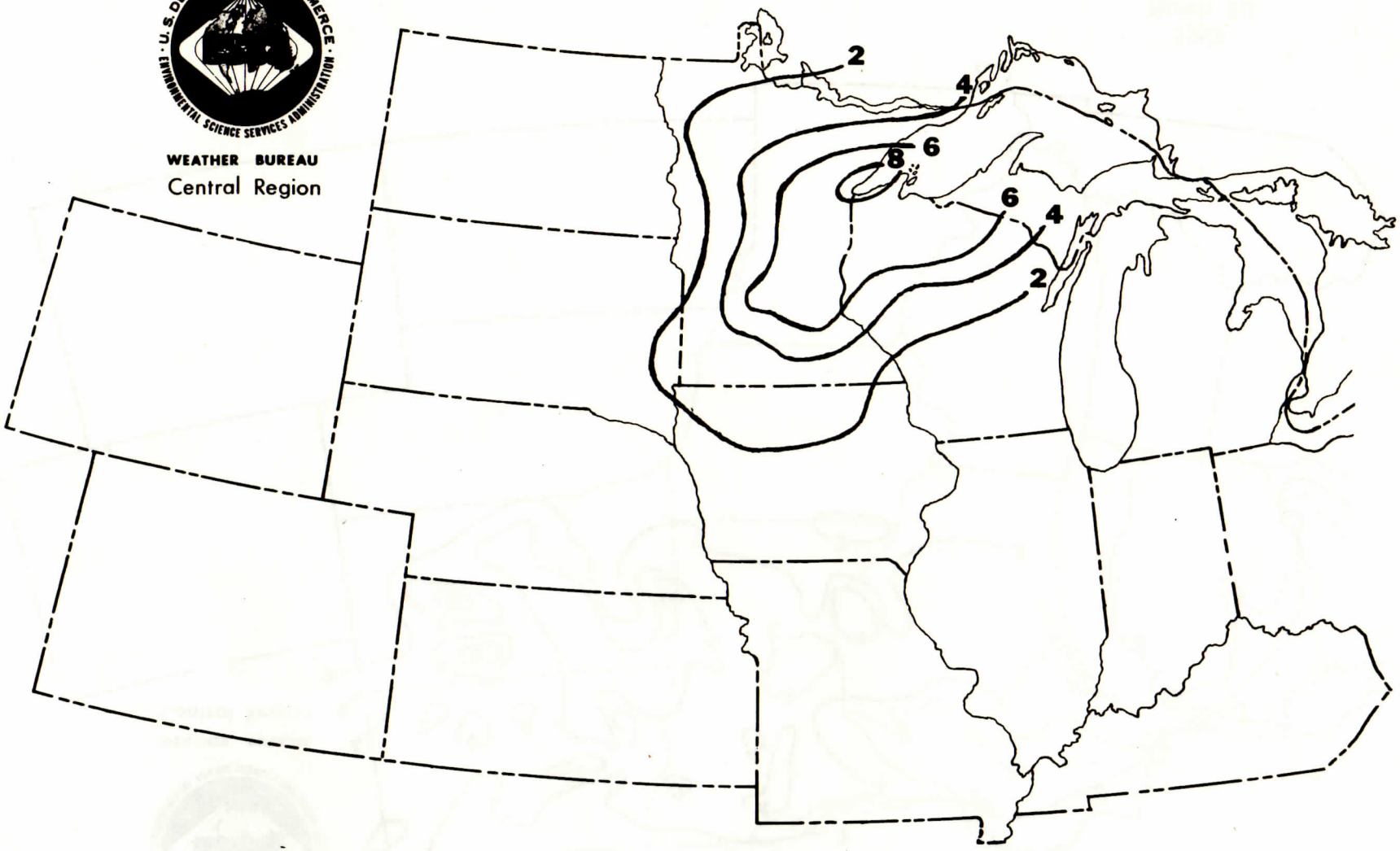
water content of the snowpack available for melt is equal to, or in many cases even greater than, that which led to previous record flood events. The 10-inch water equivalent center in Eastern South Dakota and Southwest Minnesota may result in record floods on Missouri and Mississippi River tributaries in that area. The normal spring breakup time in the critical areas is the last week in March.

Additional Weather Bureau personnel are being temporarily transferred into the critical areas to aid in data collection and in the handling of the flood situation as it develops.



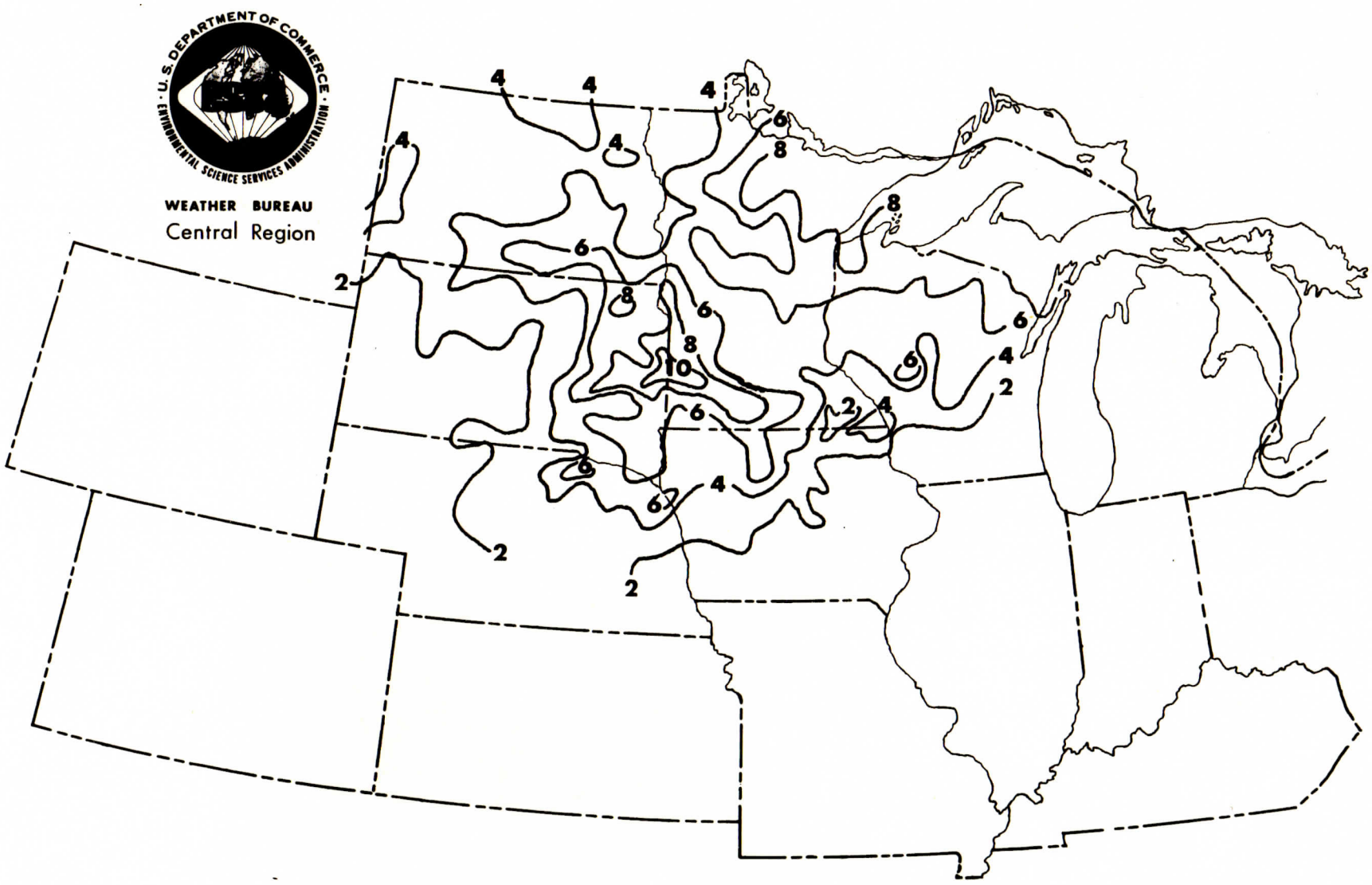
1952
March 20
Water Equivalent of Snow

Figure 4a



1965
March 30
Water Equivalent of Snow

Figure 4b



1969
March 14
Water Equivalent of Snow

Figure 4c

MARCH 13, 1969
ESSA WEATHER BUREAU
1969 SPRING SNOWMELT FLOOD OUTLOOK

LISTED BELOW IS THE 1969 SPRING SNOWMELT FLOOD OUTLOOK FOR RIVER STATIONS IN THE MISSISSIPPI...MISSOURI... AND RED RIVER OF THE NORTH BASINS. SINCE THE DAILY PATTERN OF TEMPERATURE AND PRECIPITATION DURING

TWO CREST OUTLOOKS ARE SHOWN FOR EACH RIVER STATION IN THE TABLE. THE FIRST IS BASED ON WATER EQUIVALENT OF SNOW MEASUREMENTS AS OF MARCH 8. THE SECOND IS BASED ON THE WATER EQUIVALENT OF SNOW WHICH WOULD RESULT IF THE MARCH 8 SNOWPACK IS AUGMENTED BY NORMAL MARCH PRECIPITATION FOR THE PARTICULAR RIVER BASIN OR SUB-BASIN.

RED RIVER OF THE NORTH DRAINAGE BASIN

FARGO RIVER DISTRICT

REFER TO LEAD PARAGRAPH.

WAHPETON	10	17.0	18.0	15.0	041252	17.0	1897
RED R.							
FARGO	17	36.0	38.0	30.6	041565	40.1	1897
SHEYENNE RIVER							
WEST FARGO ND	16.5	20.5	22.5	21.1	032366		
RED R.							
HALSTAD	24	38.0	39.5	35.4	032766	38.5	1897
RED LAKE R.							
CROOKSTON	15	17.0	21.0	25.8	041265		
RED R.							
GRAND FORKS	28	43.0	46.0	45.6	051260	50.2	1897
RED R.							
OSLO		31.5	34.5				
DRAYTON	32	38.5	41.0	41.6	051250		
PEMBINA	42	46.0	49.5	52.9	051450	51.3	1897
EMERSON	81.5	84.0	87.5	90.9	051350		

MISSOURI RIVER DRAINAGE BASIN

HELENA RIVER DISTRICT

REFER TO LEAD PARAGRAPH.

MILK RIVER							
HAVRE, MT	14	15.0	17.0	18.5	040352		
MALTA, MT	19.5	23.0	23.5	23.1	041152		
GLASGOW, MT		80.5	81.5	81.3	1952		
NASHUA, MT	20	30.0	31.5	31.4	041852		

MISSOURI RIVER DRAINAGE BASIN(CONTINUED)

BISMARCK RIVER DISTRICT

REFER TO LEAD PARAGRAPH.

LITTLE MISSOURI R.							
ALZADA, MONT.	9.5	8.0	10.0	16.1	061848		
CAMP CROOK,N.D.	11	9.0	11.0	13.1	032862		
MARMOUTH, N.D.	18	11.0	14.0	23.4	033152		
MEDORA, N.D.	17	12.0	14.0	20.5	032347		
WATFORD CITY	20	9.0	12.0	24.0	032547		
KNIFE RIVER							
HAZEN	21	23.0	25.0	27.0	062466		
HEART RIVER							
MANDAN	17	13.0	17.0	25.8	040452		
CANNONBALL RIVER							
BRIEN	8	13.5	16.0	22.3	041950		
JAMES RIVER							
JAMESTOWN	12	12.0	14.0	15.8	051350		
LA MOURE	8.2	14.0	16.0	15.3	051650		

SIOUX CITY RIVER DISTRICT

REFER TO LEAD PARAGRAPH.

GRAND RIVER							
WAKPALA, SD	17	14.0	17.0	22.8	041850		
MOREAU RIVER							
WHITEHORSE, SD	21	19.0	21.0	26.2*	1947		
CHEYENNE RIVER							
EAGLE BUTTE, ND	16	9.0	12.0	18.9	051320		
BAD RIVER							
FT. PIERRE, SD	16	15.0	19.0	29.6	061867	32.9	07 05
WHITE RIVER							
OACOMA, SD	15	8.0	12.0	17.6	033150		
NIOBRARA R.							
VERDEL		7.5	8.5	10.1	032760		
BRAZILE CR.							
NIOBRARA		12.5	14.0	20.0	061757		
JAMES RIVER							
COLUMBIA, ND	11	17.0	18.0	16.9	052450		
STRATFORD, SD	14	18.0	19.5	18.1	041952		
ASHTON, SD	13	20.0	21.0	19.6	042452		
HURON, SD	11	20.0	21.0	15.8	040162	19.8	4/1881
FORESTBURG, SD	12	18.0	19.0	16.4	033162	18.0	03//20
SCOTLAND	13	20.0	22.0	18.7	040362		
VERMILLION RIVER							
VERMILLION, SD		22.0	24.0	20.0	040262		
BIG SIOUX RIVER							
BROOKINGS, SD	9	14.0	14.5	13.0	032962		
SKUNK CREEK							
SIOUX FALLS, SD	10	15.0	17.0	17.8	061757		
BIG SIOUX RIVER							
SIOUX FALLS, SD							
WESTERN AV.	10	16.0	18.0				
BRANDON, SD		21.0	22.0	19.9	033062		
SPLIT ROCK CREEK							
CORSON, SD	8.5	18.0	20.0				

SIOUX CITY RIVER DISTRICT(CONTINUED)

ROCK RIVER				
ROCK RAPIDS, IA	9	15.0	16.5	
ROCK VALLEY, IA	11	16.5	17.5	16.9 032062 17.0 ////97
BIG SIOUX RIVER				
HAWARDEN	15	22.0	23.0	
AKRON, IA	16	22.0	23.0	22.1 033162
HIWAY 77	99	110.0	112.0	
PERRY CREEK				
SIOUX CITY, IA	19	12.0	16.0	25.5 070744
MISSOURI RIVER				
SIOUX CITY, IA	16	12.0	15.5	24.3 041452
FLOYD RIVER				
ALTON, IA	12	17.5	18.0	18.4 032862
W.FORK FLOYD R.				
MAURICE, IA	13	15.0	15.5	
FLOYD RIVER				
MERRILL,IA.	12	14.0	15.0	18.0 060853
JAMES, IA	16	21.0	22.0	25.3 060853

OMAHA RIVER DISTRICT

REFER TO LEAD PARAGRAPH.

MISSOURI R.				
DECATUR, NB	13	12.0	14.0	
BLAIR, NB	19	17.0	20.0	
OMAHA, NB	19	18.0	22.0	30.2 041852
LITTLE SIOUX R.				
SPENCER, IA.	10	14.0	15.0	17.2 040765
GILLETTE GROVE	12	17.0	18.0	18.7 040765
LINN GROVE	12	20.0	21.0	22.4 040765
PETERSON	15	20.0	21.0	22.0 040665
MILL CREEK				
CHEROKEE	9.5	11.0	12.0	13.4 040665
LITTLE SIOUX R.				
CHEROKEE	17	24.0	25.0	27.2 040665
CORRECTIONVILLE	19	24.5	26.0	26.0 040765 29.3 062391
KENNEBEC	25	26.0	27.0	26.6 040865
MAPLE R.				
MAPLETON	12	14.0	15.0	22.1 061250
LITTLE SIOUX R.				
TURIN	25	25.5	27.0	27.0 040865
WEST FORK DITCH				
HOLLY SPRINGS	18	22.0	23.0	22.5 032862
SOLDIER R.				
PISGAH	28	13.0	23.0	28.2 061250
BOYER R.				
LOGAN	19	23.0	25.0	25.2 030165
L.PAPILLION CR.				
IRVINGTON,NEBR	17	10.0	15.0	
BIG PAPILLION				
FT. CROOK	19	15.0	19.0	
MIDDLE LOUP R.				
ST PAUL		5.5	6.5	
NORTH LOUP R.				
ST. PAUL	5.5	6.5	7.0	10.7 062347 14.6 060696
LOUP RIVER				
COLUMBUS	11(WIRE WT)	10.0	12.0	14.4 081466 (WIRE WGT)
CEDAR CR.				
FULLERTON		7.0	9.0	14.9 81366

OMAHA RIVER DISTRICT (CONTINUED)

MUD CREEK						
SWEETWATER	15	17.5	19.0	23.2	62247	
PLATTE R.						
GRAND ISLAND	3.5	4.0	5.0	6.2	032760	
WOOD R.						
RIVERDALE, NB	8.5	12.0	13.0	19.8	062247	
GIBBON, NEBR.		16.0	17.0	16.8	061567	
ALDA	10	11.5	12.5	12.2	061667	
GRAND ISLAND		5.0	6.0	5.8	06 67	
PLATTE R.						
DUNCAN, NEBR.	7	5.0	6.0			6.5 062305
NORTH BEND	6	6.0	7.0	8.0	032960	8.2 021352
SALT CREEK						
ROCA	19	14.0	19.0	26.0	050850	
LINCOLN USGS	20.5	12.5	16.5	26.2	060251	
WAHOO CREEK						
ITHACA	19	19.0	21.0	23.2	080259	
SALT CREEK						
ASHLAND	16	14.0	17.0	19.8	062563	
PLATTE R.						
LOUISVILLE	9	10.0	12.0	12.5	033060	

NORFOLK RIVER DISTRICT

REFER TO LEAD PARAGRAPH.

ELKHORN RIVER						
NELIGH, NB	10	9.0	10.0	12.5	62347	
NORFOLK, NB	6.5	7.0	9.0	12.3	22848	
N.FORK ELKHORN						
PIERCE, NB	12	14.5	15.5	15.2	32862	
ELKHORN RIVER						
PILGER, NB	12	7.0	10.0			
WESTPOINT, NB	12	10.0	11.0			
LOGAN CREEK						
UEHLING, NB	18	15.0	19.0	20.6	060540	
ELKHORN RIVER						
WINSLOW, NB	14	14.0	17.0	14.3	62160	
WATERLOO, NB	15	15.0	17.0	17.1	032962	

KANSAS CITY RIVER DISTRICT

REFER TO LEAD PARAGRAPH.

MISSOURI RIVER						
NEBRASKA CITY	18	21.0	26.0	27.7	041852	
BROWNVILLE, NB	892	897.0	900.0			
RULO, NB	17	20.5	24.0	25.6	042252	
ST. JOSEPH, NB	17	21.0	24.5	26.8	042252	27.2 4/1881
ATCHISON, KN	22	24.0	27.5	32.5	042352	
LEAVENWORTH, MO	19	21.0	24.0	27.6	042352	
KANSAS CITY, MO	22	21.0	27.0	36.2	071451	38.0 6/1844
SIBLEY, MO	22	24.5	29.5	35.6	071551	
NAPOLEON MO	17	19.0	23.0	28.6	071551	34.1 6/1844
LEXINGTON, MO	22	25.0	29.0	33.3	071551	33.9 6/1844
WAVERLY, MO	18	23.0	26.5	28.2	071451	
MIAMI, MO	18	23.0	27.0	29.0	071651	
GLASGOW, MO	25	26.0	30.5	36.7	071851	
BOONVILLE, MO	21	22.0	26.5	32.8	071751	
JEFFERSON CITY	23	22.5	25.5	34.2	071851	38.1 6/1844
WEEPING WATER CR.						
UNION,NEBR	22	15.0	23.0			

KANSAS CITY RIVER DISTRICT(CONTINUED)

W.NISHNABOTNA R.					
RANDOLPH, IA.	19	22.0	23.0	21.9	050950
E.NISHNABOTNA R.					
ATLANTIC, IA.	16	18.0	20.0		
RED OAK, IA.	14	16.0	19.0		
NISHNABOTNA R.					
HAMBURG, IA.	18	26.0	27.0		
LITTLE NEMAHA R.					
AUBURN, NEBR.	22	15.0	23.0	27.6	050950
TARKIO R.					
FAIRFAX, MO.	17	10.0	19.0	22.3	070729
NEMAHA R.					
FALLS CITY,BR.	20	10.0	25.0	28.9	062965
NODAWAY R.					
CLARINDA, IA.	14	14.0	21.0	25.3	061347
BURLINGTON JCT	18	10.0	16.0	19.0	061447
PLATTE R.					
AGENCY, MO.	20	10.0	23.0		
KANSAS RIVER					
KANSAS CITY 23RD ST		22.0	28.0		

TOPEKA RIVER DISTRICT

REFER TO LEAD PARAGRAPH.

LINCOLN CR.						
SEWARD, NEBR.	15	18.5	20.0	20.5	061757	
BIG BLUE R.						
SEWARD, NEBR.	18	19.5	22.0	22.3	061667	
W.FK.BIG BLUE R.						
DORCHESTER,NEBR	15	20.0	23.0	24.8	071050	
BIG BLUE R.						
CRETE, NEBR.	18	27.0	30.0	29.8	061667	
TURKEY CR.						
WILBER, NEBR.	11	15.0	15.5	14.9	032860	
BIG BLUE R.						
BEATRICE,NEBR.	16	25.0	29.5	28.3	060451	
BARNESTON	18	25.0	30.0	34.3	060941	
MARYSVILLE,KANS.	35	35.0	40.0	45.4	060941	
LITTLE BLUE R.						
DEWEESE,NEBR.	8	11.0	14.0	14.6	061757	(WIRE WGT)
FAIRBURY	10	10.0	15.0	15.8	032060	
MILL CREEK						
WASHINGTON	18	12.0	22.0	36.0	060841	
LITTLE BLUE R.						
HANOVER,KANS.	14	14.0	21.0	25.0	061041	
BIG BLUE R.						
BLUE RAPIDS	1101	1105.0	1113.0	1120.2	061041	

UPPER MISSISSIPPI RIVER DRAINAGE BASIN

MINNEAPOLIS RIVER DISTRICT

REFER TO LEAD PARAGRAPH.

MISSISSIPPI R.						
LIBBY, MINN.	13	18.5	19.0	20.0	051750	
AITKIN, MINN.	15	20.0	21.0	19.5	052050	
FT. RIPLEY	10	15.0	16.0	13.6	041665	
CROW R.						
ROCKFORD	10	14.5	16.5	19.3	041565	
RUM R.						
ST. FRANCIS	8.5	11.0	12.5	11.5	041965	
MISSISSIPPI R.						
MINNEAPOLIS	16	18.0	20.5	20.0	041665	
MINNESOTA R.						
MONTEVIDEO	14	21.0	22.0	20.0	041052	
YELLOW MEDICINE						
GRANITE FALLS	6	12.0	13.0	12.4	061757	
REDWOOD R.						
MARSHALL	7	7.0	8.5	11.1	040651	
REDWOOD FALLS	6	12.0	13.0	15.9	061857	
COTTONWOOD R.						
NEW ULM	11	16.0	17.5	16.9	070947	
BLUE EARTH R.						
RAPIDAN	12	14.5	17.5	15.0	1951	20.9 1915
LE SUEUR R.						
RAPIDAN	15	15.0	17.0	22.7	052260	
MINNESOTA R.						
MANKATO	19	29.0	32.0	29.1	040965	29.9 042681
JORDAN	20	32.0	34.5	34.4	041265	
MISSISSIPPI R.						
ST. PAUL	14	22.5	25.5	26.0	041665	
ST. CROIX R.						
STILLWATER	87	92.0	95.0	94.1	04//65	
MISSISSIPPI R.						
RED WING	14	17.5	19.0	20.0	041865	
CHIPPEWA R.						
EAU CLAIRE	773	75.0	77.0	79.6	040267	
DURAND	11	14.0	15.5	17.0	040267	18.4 091284
ZUMBRO R.						
THEILMAN	38	42.0	46.0	45.8	040765	
MISSISSIPPI R.						
WINONA	13	19.0	21.0	20.8	041965	
TREMPELEAU R.						
DODGE	7	9.0	10.0	10.4	040456	
BLACK R.						
NEILLSVILLE	18	11.0	12.5	16.5	////52	
GALESVILLE	12	12.5	13.0	14.3	091138	
MISSISSIPPI R.						
LA CROSSE	12	16.5	18.0	17.9	042165	
ROOT R.						
HOUSTON	15	18.0	19.5	19.5	030265	
HOKAH	47	48.5	51.0	50.8	03//65	
WISCONSIN R.						
MERRILL	11	13.0	14.0	18.3	083141	
WISCONSIN RPDS	12	9.0	11.0	14.1	032435	
PORTAGE	17	16.0	18.0	20.5	09143A	
MUSCODA	9	7.5	9.5	11.5	091638	
KICKAPOO R.						
LA FARGE	12	12.5	13.0	12.9	030850	
STEUBEN	8	11.5	13.5	12.3	032861	
MISSISSIPPI R.						
DAM 10 TW	15	21.0	24.5	23.7	042465	

MINNEAPOLIS RIVER DISTRICT(CONTINUED)

MOLINE RIVER DISTRICT

REFER TO LEAD PARAGRAPH.

TURKEY R.							
GARBER	17	21.5	26.5	26.0	030165	28.1	022322
MISSISSIPPI R.							
DUBUQUE	17	25.0	27.5	26.8	042665		
MAQUOKETA R.							
MAQUOKETA, IA.	13	14.0	19.0	21.0	092265	24.7	062644
MISSISSIPPI R.							
CLINTON, IA.	16	23.0	25.5	24.9	042865		
WAPSIPINICON R.							
INDEPENDENCE	12	11.0	15.0	21.1	071868		
DEWITT, IA.	10	10.0	11.5	12.0	072568	12.1	062744
MISSISSIPPI R.							
LE CLAIRE	10	16.0	19.0	17.8	042865		
DAVENPORT	15	20.5	23.5	22.5	042865		
MUSCATINE	16	23.0	26.0	24.8	042865		
KEITHSBURG	12	19.0	21.0	20.4	042765		
BURLINGTON	15	19.5	22.0	21.0	043065		
KEOKUK	16	20.5	23.0	22.1	050165		

DES MOINES RIVER DISTRICT

REFER TO LEAD PARAGRAPH.

CEDAR R.							
AUSTIN	15	18.0	21.5	18.9	030165		
CHARLES CITY	12	13.5	17.0	21.6	030265		
JANESVILLE	11	11.0	13.0	16.3	032861		
WINNEBAGO R.							
MASON CITY	7	12.5	14.5	15.7	033033		
SHELL ROCK R.							
MARBLE ROCK	4	8.5	9.0	11.8	032861		
SHELL ROCK	12	13.5	15.0	16.3	032861		
W.FK.CEDAR R.							
FINCHFORD	12	13.5	15.5	17.3	062751		
BLACK HAWK CR.							
HUDSON	12	8.0	15.0	16.9	033160		
CEDAR R.							
WATERLOO	15	16.0	20.0	21.9	032961		
CEDAR RAPIDS	13	12.5	17.0	19.7	033161	20.1	031829
IOWA R.							
MARSHALLTOWN	13	16.5	18.0	17.7	060418		
WAPELLO	10	13.0	16.5	17.3	041365		
SKUNK R.							
AMES(BLO SQUAW)	10	12.5	14.0	13.2	033060		
OSKALOOSA	15	17.5	21.0	25.8	05//44		
NORTH SKUNK R.							
SIGOURNEY	16	10.0	20.0	25.3	033160		
SKUNK R.							
BRIGHTON	14	12.5	19.0				
AUGUSTA	15	8.0	18.0	25.0	040360		
W.FK.DES MOINES							
JACKSON		21.0	22.0	18.6	040665		
ESTHERVILLE		17.5	19.0	15.6	041065		
HUMBOLDT	8	19.0	20.0	13.9	040865		
E.FK.DES MOINES							
DAKOTA CITY	20	23.5	25.0	24.0	062154		
DES MOINES R.							
FT. DODGE	10	22.0	25.0	19.6	062347		

DES MOINES RIVER DISTRICT(CONTINUED)

BOONE R.						
WEBSTER CITY	10	17.0	19.5	18.6	062254	
DES MOINES R.						
BOONE	12	25.0	28.5	25.4	062254	
DES MOINES 2DAV	23	29.5	32.0	30.2	062454	
DES MOINES SE14	23	30.0	31.5	29.8	041165	
N. RACCOON R.						
JEFFERSON	10	18.0	21.0	22.3	061347	
S. RACCOON R.						
REDFIELD	14	10.0	17.0	29.0	070258	
RACCOON R.						
VAN METER	13	17.5	20.5	21.8	070358	
DES MOINES SW18	12	17.5	19.0			
MIDDLE R.						
INDIANOLA	19	8.0	20.0	28.3	061347	
SOUTH R.						
ACKWORTH	19	5.5	17.5	25.5	031765	
DES MOINES R.						
TRACY	14	16.0		26.5	061447	
OTTUMWA	10	11.0		20.2	060727	
KEOSAUQUA	15	11.0		19.4	041165	27.9 ////03

ST. LOUIS RIVER DISTRICT

REFER TO LEAD PARAGRAPH.

MISSISSIPPI R.						
GREGORY LANDING	15	21.0	24.0	22.7	050165	
QUINCY, ILL.	17	23.0	26.0	24.8	042865	
HANNIBAL, MO.	16	23.0	25.5	24.6	050165	
LOUISIANA, MO.	15	21.0	23.0	22.6	062247	
MISSOURI RIVER						
GASCONADE, MO	22	24.0	28.5	35.4	071951	38.6 6/1844
HERMANN, MO	21	22.5	26.5	33.3	071951	35.5 6/1844
ST.CHARLES, MO	25	26.0	30.0	37.3	072051	40.1 6/1844

4-11

MARCH 20, 1969
ESSA WEATHER BUREAU
1969 SPRING SNOWMELT FLOOD OUTLOOK

WARM DRY WEATHER HAS PREVAILED OVER THE EXTENSIVE HEAVY SNOW COVER IN THE DRAINAGE BASINS OF THE RED RIVER OF THE NORTH, UPPER MISSISSIPPI AND MISSOURI RIVERS. WARMING HAS DIMINISHED SOME OF THE SNOW DEPTHS IN THE MORE NORTHERN AREAS . BUT WATER CONTENTS HAVE NOT CHANGED SIGNIFICANTLY IN THE BULK OF THE GREAT SNOW PACK , WITH THE EXCEPTION OF TRIBUTARY STREAMS ALONG THE FRINGES . HERE FLOODS HAVE BEEN IN PROGRESS FOR THE PAST SEVERAL DAYS ESPECIALLY IN NEBRASKA AND IOWA. FLOOD OUTLOOKS WERE REPLACED WITH FLOOD FORECASTS UTILIZING THE OBSERVED PATTERN OF TEMPERATURE AUGMENTED BY SHORT RANGE WEATHER FORECASTS. STREAMS COVERED BY THESE FORECASTS INCLUDE THE BIG BLUE BASIN, THE LOUP ELKHORN AND LOWER PLATTE BASINS IN NEBRASKA, AS WELL AS THE LITTLE SIOUX NISHNABOTNA, CEDAR, SKUNK AND LOWER RACCOON BASINS OF IOWA.

THOUSANDS OF ACRES ARE UNDER WATER IN PARTS OF NEBRASKA, AS WELL AS NUMEROUS HIGHWAYS, AND REPORTS HAVE BEEN RECEIVED OF BRIDGES BEING WASHED OUT. SOME EVACUATION OF PEOPLE HAS TAKEN PLACE IN PARTS OF NEBRASKA NO MONTANA. ICE ACTION IS PARTICULARLY SEVERE IN A NUMBER OF STREAMS.

IN THOSE AREAS WHERE SNOWMELT FLOODS ARE NOT OCCURRING THE SPRING FLOOD OUTLOOK RELEASED MARCH 13 REMAINS ESSENTIALLY UNCHANGED, EXCEPT WHERE INDICATED BELOW. THE FIRST OR LOWER CREST VALUES OF THIS OUTLOOK NOW ARE BASED ON THE MOST RECENT MEASUREMENTS OF SNOW DEPTH AND WATER EQUIVALENT, AND CURRENT ASSESSMENTS OF SOIL CONDITIONS OR RUNOFF POTENTIAL. THE SECOND OR HIGHER FIGURE INCLUDES APPROXIMATELY ONE AND A HALF INCHES OF ADDITIONAL PRECIPITATION FROM NOW UNTIL THE NORMAL DATE OF SNOW DISAPPEARANCE. ALSO SEVERAL ADDITIONAL OUTLOOKS APPEAR IN THE TABLE BELOW WHICH WERE NOT AVAILABLE AT THE TIME OF THE MARCH 13 RELEASE THESE ARE IN THE ST.LOUIS, SIOUX CITY AND FARGO RIVER DISTRICT AREAS OF RESPONSIBILITY.

AMENDED OUTLOOKS.....

STREAM AND STATION	FLOOD STAGE	CREST OUTLOOK W.E. PRES. SNOW COVER	CREST OUTLOOK W.E.+ 1.50 IN. PCPN	PREVIOUS RECENT STAGE DATE	RECORDS ALL-TIME STAGE DATE
BISMARCK RIVER DISTRICT OFFICE					
LITTLE MISSOURI RIVER					
CAMP CROOK,N.D.	11	10.0	12.0		
MARMOUTH,N.D.	18	13.0	16.0		
MEDORA, N.D.	17	14.0	16.0		
WATFORD CITY	20	14.0	17.0		
KNIFE RIVER					
HAZEN, N.D.	21	24.0	26.0		
HEART RIVER					
MANDAN, N.D.	17	15.0	19.0		
CANNONBALL RIVER					
BRIEN	8	15.0	18.0		

SIOUX CITY RIVER DISTRICT OFFICE

GRAND RIVER							
WAKPALA, S.D.	17	15.0	18.0				
MOREAU RIVER							
WHITEHORSE,S.D.	21	21.0	23.0				
FT.PIERRE	16	16.0	20.0				
WHITE RIVER							
OACOMA	15	9.0	14.0				

ADDITIONAL OUTLOOKS.....

ST.LOUIS RIVER DISTRICT OFFICE

MISSISSIPPI RIVER							
CLARKSVILLE,MO.	25	31.0	32.5	32.2	050265	32.5	062247
WINFIELD, MO.	26	31.5	33.0	32.7	050265	33.6	062447
GRAFTON, ILL.	18	23.5	27.0	28.7	070247	32.1	1844
ALTON, ILL.	21	23.5	28.0	34.4	052443	36.9	1844
ST. LOUIS, MO.	30	28.5	33.0	40.3	072151	41.4	1844
CHESTER, ILL.	27	28.5	32.5	39.3	072351	39.8	1844
CAPE GIRARDEAU	32	33.0	36.5	42.4	052743	42.5	1844

FARGO RIVER DISTRICT OFFICE

ROSEAU RIVER					
ROSEAU, MINN.	1046.0	1047.0	1047.5	040366	
TWO RIVERS RIVER					
HALLOCK, MINN.	803.5	807.5	806.2	1967	

THE ASSUMPTIONS UNDER WHICH THIS OUTLOOK AND THAT OF MARCH 13 HAVE BEEN PREPARED ARE INTEGRAL, INSEPARABLE PARTS OF THE OUTLOOK AND ARE REPEATED HERE FOR EMPHASIS.

SINCE THE DAILY PATTERN OF TEMPERATURE AND PRECIPITATION DURING THE SPRING BREAKUP PERIOD IS NOT KNOWN AT THIS TIME CERTAIN ASSUMPTIONS MUST BE MADE IN ORDER TO ESTIMATE THE FLOOD POTENTIAL OF THE SNOW COVER. AS THE PERIOD OF BREAKUP APPROACHES...AND DURING THAT CRITICAL PERIOD...ASSUMED VALUES OF TEMPERATURE AND PRECIPITATION ARE REPLACED BY OBSERVED VALUES AND THOSE ACHIEVED BY SHORT RANGE WEATHER FORECASTS UNTIL THE SNOW IS DEPLETED.

FOLLOWING ARE THE BASIC ASSUMPTIONS...

1. MELTING PROCEEDS AT A MODERATE RATE.
2. MUCH SLOWER PROTRACTED MELT RATES WOULD GIVE LOWER CRESTS THAN THOSE INDICATED BELOW.
3. MUCH FASTER MELT RATES WOULD GIVE HIGHER CRESTS THAN THOSE INDICATED BELOW.
4. MELTING IS NOT ACCOMPANIED BY RAINFALL. WARM RAINS DURING THE MELTING PERIOD OF COURSE WOULD RESULT IN HIGHER CRESTS.
5. CRESTS COULD BE AUGMENTED 3 TO 5 FEET BY ICE JAMS AT THOSE POINTS FREQUENTLY SUBJECT TO SEVERE ICE ACTION.

AS A POINT OF INTEREST HALF TO ONE INCH RAINS HAVE FALLEN IN PARTS OF NORTHEAST NEBRASKA, SOUTHEAST SOUTH DAKOTA, AND NORTHWEST IOWA AT THE DEADLINE TIME OF THE WRITING OF THIS STATEMENT , FURTHER INCREASING THE FLOOD POTENTIAL IN THE AFFECTED AREAS.

THE WEATHER BUREAU IS WATCHING CONDITIONS CLOSELY. AS REQUIRED BY SUBSEQUENT METEOROLOGIC EVENTS, UPDATED REVISIONS FOR ANY PARTICULAR RIVER POINT OR GROUP OF POINTS WILL BE ISSUED MARCH 27 OR SOONER IF CONDITIONS WARRANT.

PREPARED IN THE RIVER FORECAST CENTER ESSA WEATHER BUREAU, KANSAS CITY MISSOURI. CREDIT LINE SHOULD BE REMOVED BY LOCAL OFFICES FOR NEWS RELEASE PURPOSES.

The Weather Outlook For the Break-Up Period

The general circulation pattern during January, February and the first half of March has favored a generally cool temperature regime over most of the United States with wetter than normal conditions in the southern part of the country and drier than normal to the north. The pattern has been one in which the axis of the jet stream has been stronger than normal and displaced well to the south of the normal latitude. This means that the storm track has also been displaced well to the south, hence rainfall has been confined primarily to the southern states. Thus the large snow cover currently existing over the North central portion of the country has had little opportunity to melt and has remained essentially without change in water content since it was initially deposited mostly in December. Therefore, the forecast problem involved is to anticipate the change in circulation regime which would result in a warming trend to substantially above freezing temperatures and possibly also to an increase in precipitation. This problem will be briefly discussed from the standpoint of (a) its climatological aspects (b) long range forecast (30 day) considerations and (c) shorter term (4 day) forecasts.

a. Climatological Considerations

As a first approximation in estimating the beginning and rate of snow melt, it was necessary to assume normal distribution temperature and precipitation. The march of average daily mean temperatures for Sioux Falls, South Dakota, which lies in a rather strategic position with respect to the snow pack, is depicted in fig. 5a. Assuming that a daily mean temperature of 35° is a significant one for inducing snow melt and the temperature distribution follows the normal march, fig. 5a would suggest onset of appreciable melting about March 27. Fig. 5a also includes lines showing the temperature distribution if the mean daily temperature followed an annual course 3.5° and 8° above and below normal respectively. The significance of these numbers lies in the consideration that 25% of the cases are included within 3.5, of the normal and 50% of the cases within 8° of the normal curve. This would suggest that, under the assumptions made, the date of beginning of significant melting would have roughly a 25% probability of occurring between March 20 and April 2 and a 50% probability of occurring between March 8 and March 11.

Since the observed temperatures cannot be expected to follow the smooth curves depicted in fig. 5a but will fluctuate over a considerable range, the probabilities defined above are at most a very rough approximation, and need to be sharpened by use of short and long range forecasts.

b. 30 Day Forecast

The only forecast problem considered in this brief summary will be the one which presented itself on March 15. For a week preceding that date the temperature had averaged markedly below normal permitting little or no thawing. The 30 day Outlook for mid-March to mid-April (fig. 5b) suggested that temperatures would be increasing somewhat but still remain in the below normal class (Fig. 5c). Also precipitation was indicated as being light or moderate. Moderate precipitation during this season of the year ranges from approximately 1 to 2 inches over the area in question.

c. Short term forecasts

In support of the snow-melt flood effort, Weather Bureau Headquarters authorized special 4 day forecasts to be prepared at NMC each day and transmitted over a special facsimile circuit to Kansas City. These consisted of daily charts of mean daily temperature and 24 hour precipitation in excess of .25 inch out four days in advance and were prepared by the Extended Forecast Division based on special runs of the PE model for a 108 hour period. These proved very useful in addition to the routinely prepared 5 and 30 day forecasts.

The special 4 day temperature forecast of this type which was received on March 15 has been entered on fig. 5d as a dashed line. This suggested a change in regime with rapidly rising temperatures and, although the peak values were forecast about 4° too low, the trend was quite accurately delineated. It is noted that the temperature reached 35° on March 18 which was sufficient to initiate melting and indeed resulted in some flooding though mainly to the south of Sioux Falls along the southern boundary of the snow field.

In order to assess, in a preliminary manner, the accuracy of the special forecasts based on PE model, the third day temperature forecasts have been superimposed (dashed line) on the observed values (solid line) in fig. 5e. In general, the forecast trends appear to be reasonably good, though the extremes tend to be somewhat underestimated. However, in view of the 3 day range, this is considered to be a very useful product.

The latest 4 day forecast available, namely that received on March 20, has also been entered on fig. 5d as a dashed line. It indicates a daily mean value near 32 degrees for the succeeding two days, followed by an upward trend to 36° and 35° on March 23 and March 24 respectively. Thus, a relatively slow melting rate is suggested in the Sioux Falls area for the first day or two followed by a return to more critical conditions thereafter.

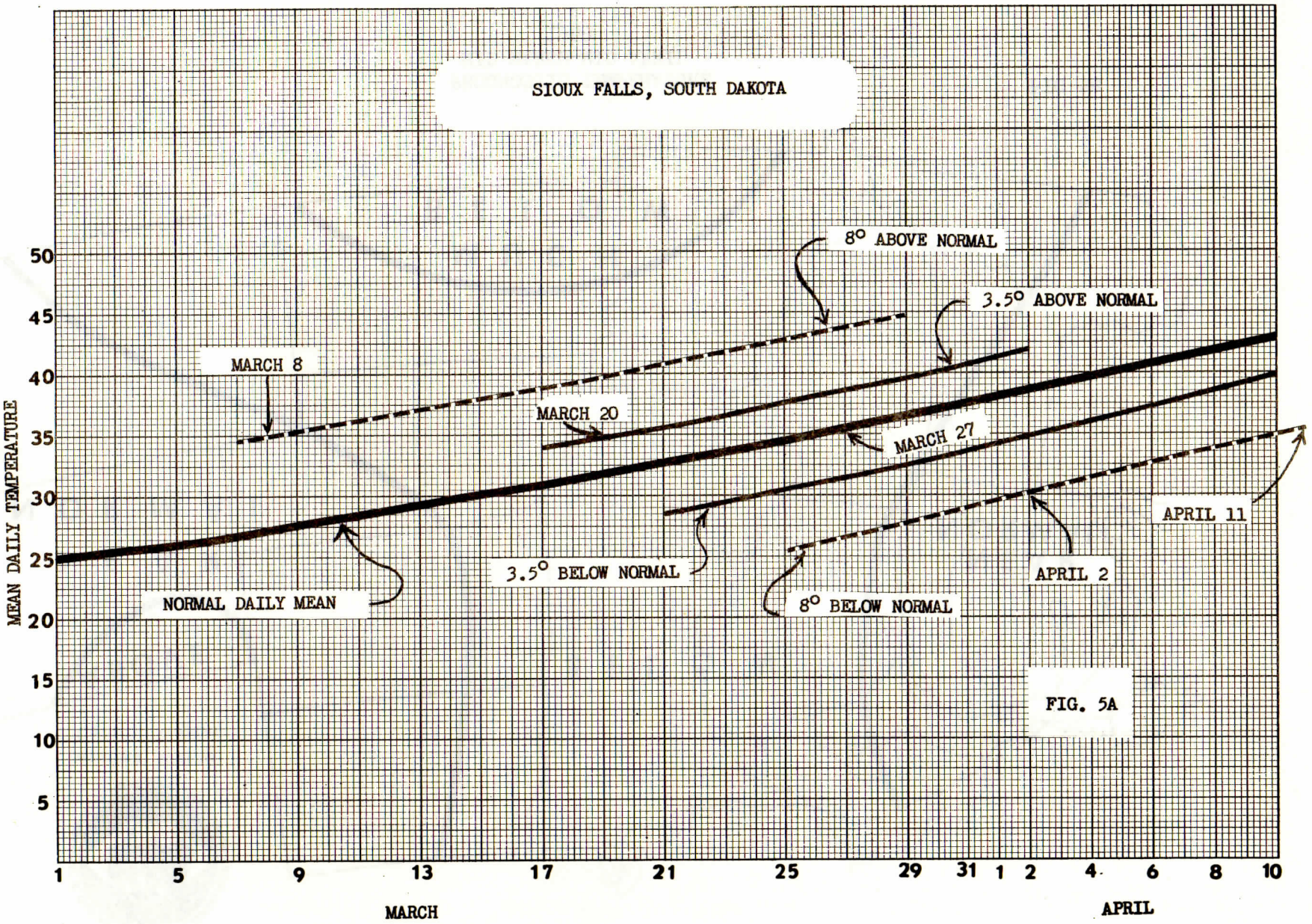
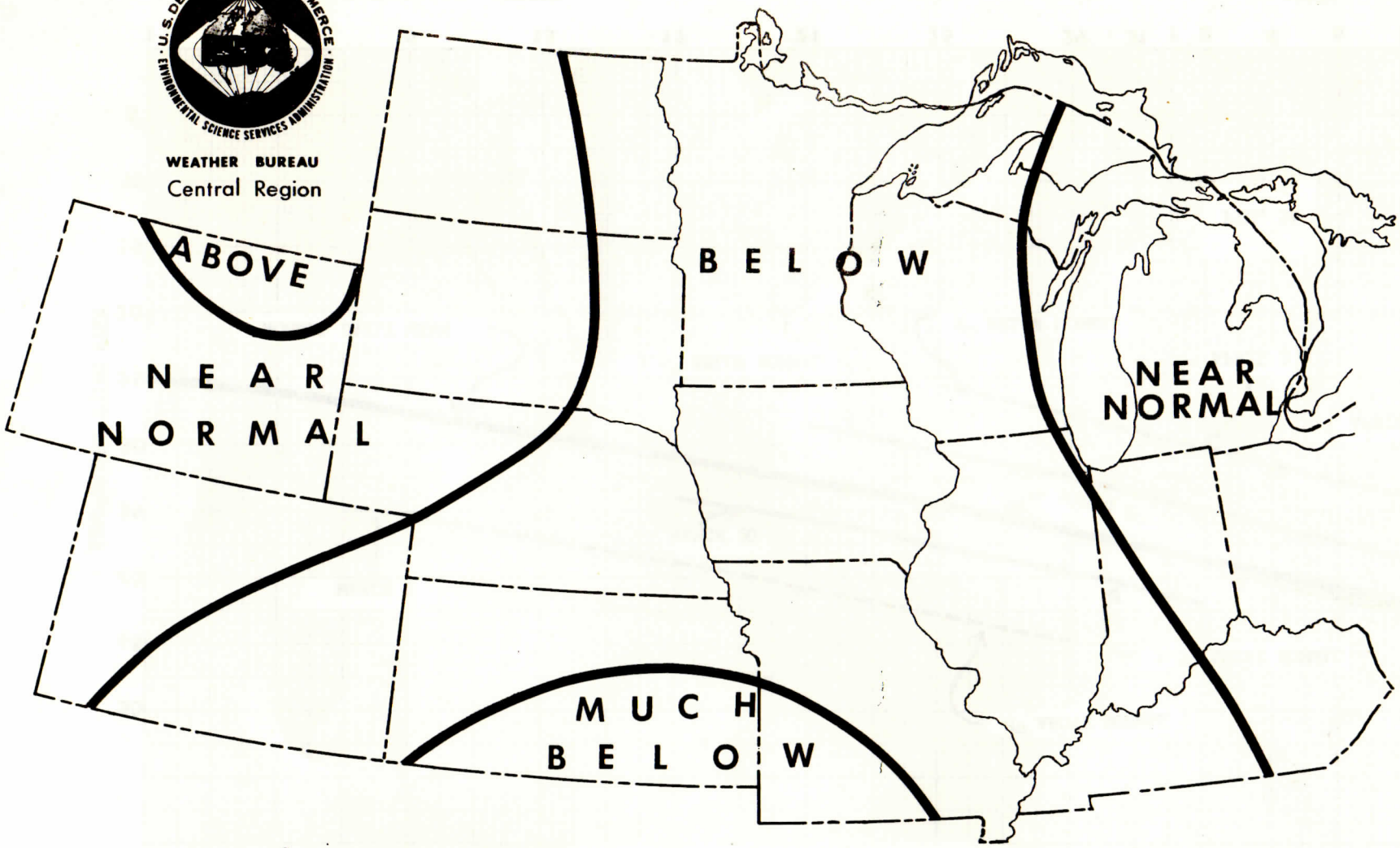
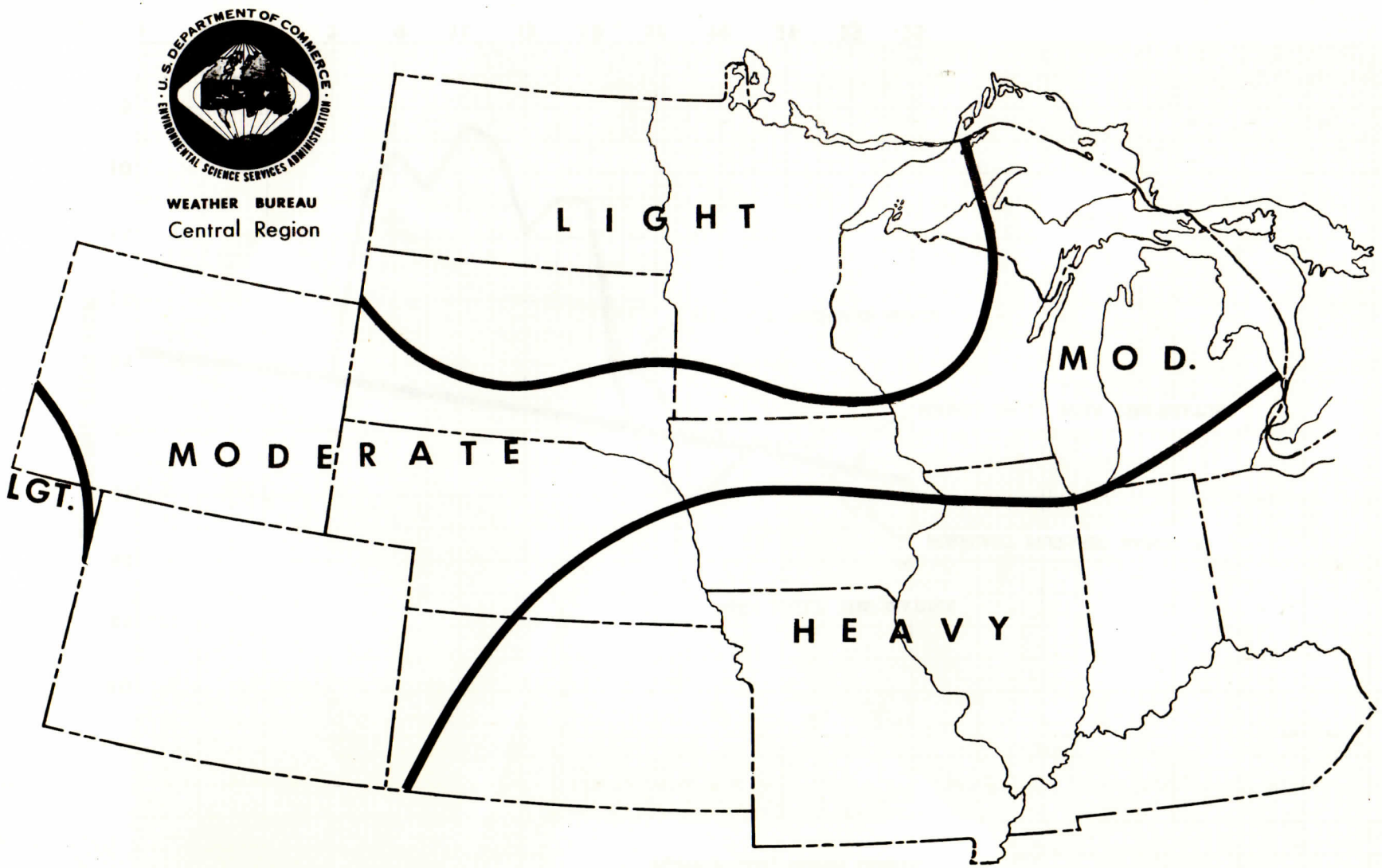

SIOUX FALLS, SOUTH DAKOTA
MEAN DAILY TEMPERATURE
50
45
40
35
30
25
20
15
10
5
8° ABOVE NORMAL
3.5° ABOVE NORMAL
MARCH 8
MARCH 20
MARCH 27
APRIL 11
APRIL 2
3.5° BELOW NORMAL
8° BELOW NORMAL
NORMAL DAILY MEAN
1
5
9
13
17
21
25
29
31
1
2
4
6
8
10
MARCH
APRIL

FIG. 5A



PROGNOSTIC TEMPERATURE
MID MARCH-MID APRIL
1969

FIG 5B



PROGNOSTIC PRECIPITATION
MIC MARCH-MID APRIL
1969

FIG 5C

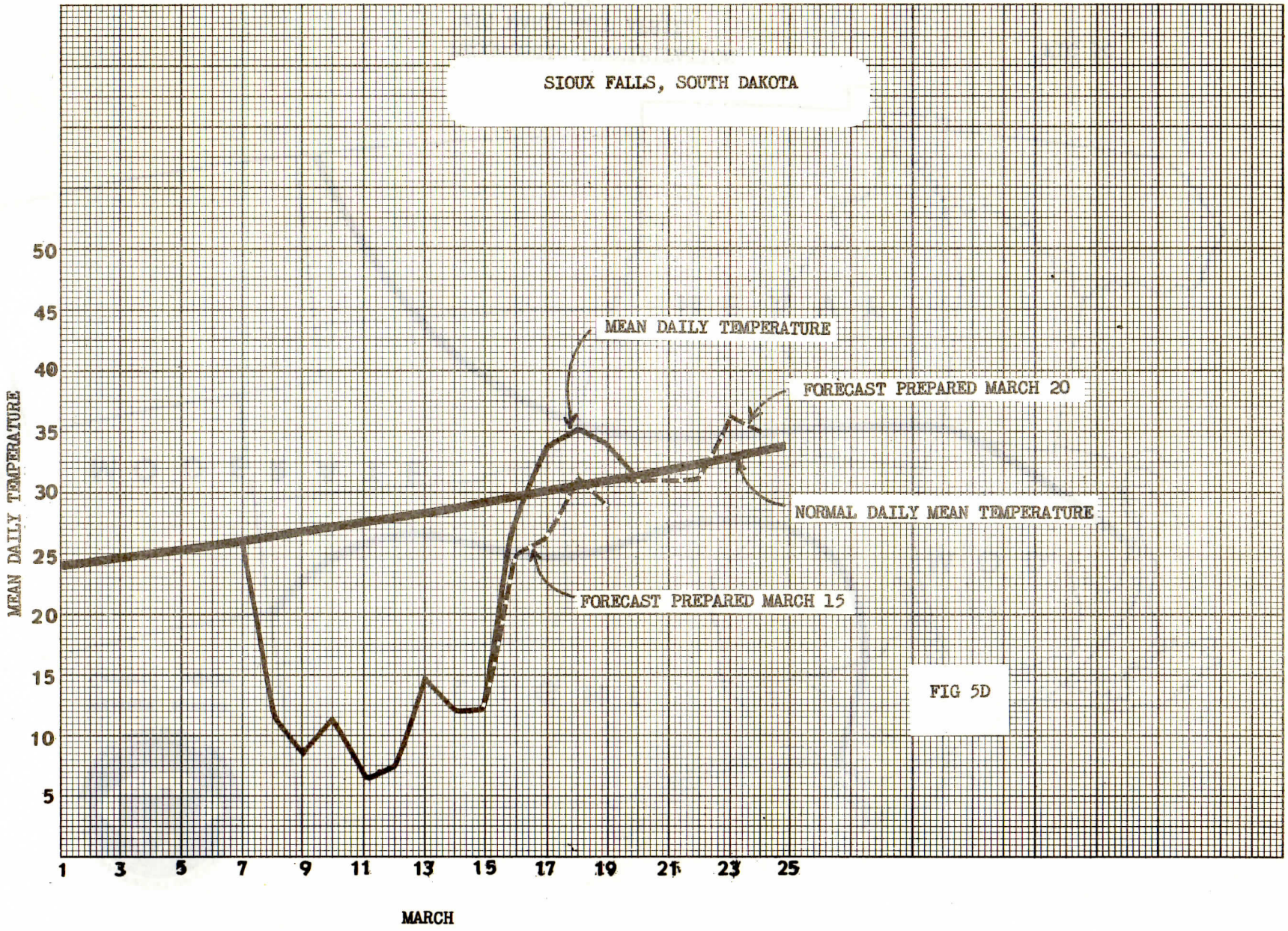

SIOUX FALLS, SOUTH DAKOTA
MEAN DAILY TEMPERATURE
FORECAST PREPARED MARCH 20
NORMAL DAILY MEAN TEMPERATURE
FORECAST PREPARED MARCH 15
MEAN DAILY TEMPERATURE
50
45
40
35
30
25
20
15
10
5
1
3
5
7
9
11
13
15
17
19
21
23
25
MARCH

FIG 5D

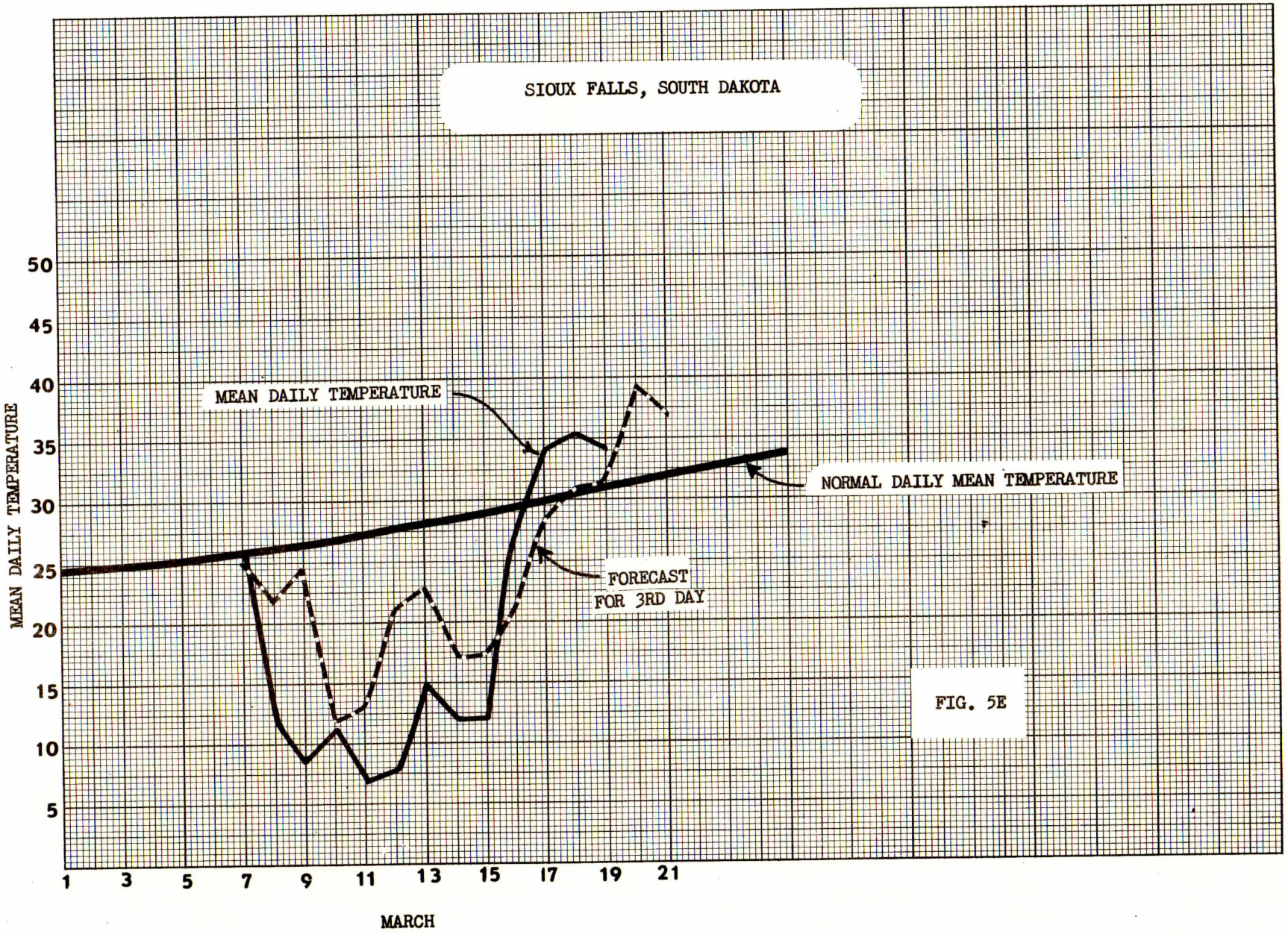

SIOUX FALLS, SOUTH DAKOTA
MEAN DAILY TEMPERATURE
NORMAL DAILY MEAN TEMPERATURE
FORECAST
FOR 3RD DAY
MEAN DAILY TEMPERATURE
50
45
40
35
30
25
20
15
10
5
1
3
5
7
9
11
13
15
17
19
21
MARCH

FIG. 5E

Acknowledgments

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