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*Illinois Cooperative Project
in Climatology*

FOURTH PROGRESS REPORT

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ILLINOIS STATE WATER SURVEY
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CONTENTS

	Page
Introduction.....	1
Station card punching and exchange.....	2
Weather card research projects.....	2
Daily summary cards (1009 and No. 3).....	3
Estimation of missing precipitation data.....	3
Monthly estimates of mid-day dew point temperatures..	3
Daily values of selected weather conditions.....	3
Daily precipitation values and temperatures at	
Urbana	3
Frequency of growing season dry periods at	
Carbondale	4
Studies of 3- to 60-month precipitation amounts.....	4
Average temperatures and precipitation in north-	
eastern Illinois	4
Climatology of selected weather conditions.....	4
Dates of occurrence of hail and thunderstorms in	
Illinois	4
Hourly summary cards (No. 1).....	5
Climatology of diurnal variations of selected	
weather conditions in Illinois.....	5
Monthly average dew point, wet bulb, and dry bulb	
temperatures	5
Studies utilizing special card decks.....	5
Radar squall line climatology.....	5
Radar analysis of severe thunderstorms.....	5
Measurements of rain-drop sizes.....	6
Analysis of data from raingage networks.....	6
References	7

ILLINOIS COOPERATIVE PROJECT IN CLIMATOLOGY

A Cooperative Project of the State Water Survey
Division and the United States Weather Bureau

FOURTH PROGRESS REPORT
SEPTEMBER 1, 1957 - DECEMBER 31, 1962

Stanley A. Changnon, Jr.

INTRODUCTION

This report discusses activities relating to the Illinois Cooperative Project in Climatology from September 1, 1957, through December 31, 1962. This project is a cooperative effort of the Illinois State Water Survey and the U. S. Weather Bureau; the project agreement was signed in December 1954. Three progress reports were prepared previously during the active phase of the project.

By August 1, 1957, the Water Survey had terminated the editing and card punching of most of the continuous Illinois historical weather records that dated from 1948 back to 1901. The Water Survey also had completed the reproduction of all these punched cards in order to supply a complete duplicate deck of cards to the Weather Bureau. Complete details on the 59 station-records entered on punch cards and the cards furnished the Weather Bureau up to August 31, 1957, can be found in the first three reports.^{1,2,3} By August 31, 1957, the Water Survey had supplied the Weather Bureau with approximately one million of the duplicate cards containing Illinois weather data.

This report deals primarily with the card exchange and the card research projects which have taken place in the period from September 1, 1957, through December 31, 1962. Brief descriptions are presented of the more major research projects which have been performed using cards punched by the Water Survey and those received from the Weather Bureau in partial fulfillment of the Bureau's role in the cooperative agreement.

STATION CARD PUNCHING AND EXCHANGE

Daily summary cards (1009 or No. 3) of 56 Illinois stations for 1956 and 1957 were requested and obtained from the Weather Bureau in 1958. The three stations for which 1956-1957 cards were not obtained are Chicago, Mt. Carroll, and Effingham. Thus, cards to complete the 1949-1957 period have been furnished by the Weather Bureau for most of the 59 stations for which the State Water Survey punched the 1901-1948 daily data.

Since August 1957, no additional punching of Illinois historical weather data on cards has been accomplished; consequently, no further cards have been furnished to the Weather Bureau by the State Water Survey.

The only active phase of the Illinois Cooperative Project in Climatology during the 1958-1962 period has been that concerned with research involving use of the punch card data.

The Water Survey would be remiss if mention was not made of the values that have been derived from the Illinois Cooperative Project in Climatology. The experience gained during the 1954-1957 period in use of punch cards for data storage and analysis has permitted much more extensive research within the organization. Machine analysis techniques are now employed in almost all of the meteorological research programs, both large and small, and in many of the other studies of water resources. To this end, the State Water Survey now has several IBM machines located in its own facilities and also has an IBM program supervisor and several machine operators.

WEATHER CARD RESEARCH PROJECTS

As previously indicated, many research projects utilizing the cards punched in Illinois, or those obtained from the Weather Bureau in exchange under the cooperative agreement, were minor tasks and no effort is made in this report to describe them. The major research studies are described herein with a brief reference to the type of cards used, the stations and periods of record employed, and the primary purpose of the research. Brief mention also is made of certain other weather research projects of the State Water Survey in which the punch card data were used, although these projects were not a part of the Illinois Cooperative Project

in Climatology. The studies are listed according to type of record represented by the basic data cards (hourly, daily, or special).

DAILY SUMMARY CARDS (1009 and No. 3)

Estimations of Missing Precipitation Data. The State Water Survey's primary interest in the weather data on punch cards concerns precipitation and the research relating to these data. To this end, 39 of the 55 cooperative sub-stations with punched card data for the 1901-1955 period were found to contain days with missing precipitation values. A total of 10,850 missing values were located in the punched cards of the 39 stations and each of these missing values was estimated using a method described in the Third Progress Report.³ Thus, the precipitation records for all Illinois stations were made complete for the 1901-1955 period.

Monthly Estimates of Mid-Day Dew Point Temperatures. From the No. 3 cards for Chicago, Moline, Springfield, and Peoria for the 1901-1948 period of record, estimates of mid-day dew point temperatures were made. These estimates were calculated on a digital computer from the 1230 CST relative humidity card values, the maximum daily temperatures, and conversion factors. From these daily estimates, monthly average temperatures were computed, and mean monthly values were calculated as the final analytical step. These values are being used in performing evaporation studies still in progress.

Daily Values of Selected Weather Conditions. Average daily values for Illinois of the percent of possible sunshine, maximum temperature, mid-day relative humidity, and evening sea level pressure were desired for use in a singularity analysis. The No. 3 card data for the 1901-1948 period at Chicago, Moline, Springfield, and Peoria were employed to compute mean daily values for each condition. The means of each station were combined to obtain an estimate of the statewide average for these four weather conditions. These data were summarized in a research report entitled "Singularities in Severe Weather Events in Illinois."⁴

Daily Precipitation Values and Temperatures at Urbana. The average daily maximum, minimum, and mean temperatures at Urbana were computed using the 1009 cards for Urbana in the period of 1903-1955. The Urbana records for 1889-1902 were also entered on daily summary cards. The individual daily temperatures were sorted by date and ranked in order to develop a frequency distribution for their occurrence. The daily precipitation values were also sorted to develop a frequency distribution by intensity intervals. The results were published in "Summary of Weather Conditions at Champaign-Urbana, Illinois,"⁵ a State Water Survey bulletin.

Frequency of Growing Season Dry Periods at Carbondale. The Carbondale 1009 cards for the period of May 16-September 15 (the primary growing season) in each year from 1910 through 1957 were analyzed to determine dry period frequencies. Dry was defined by daily precipitation amounts of 0.10 inch or less, 0.25 inch or less, and 1.00 inch or less. For each of these definition levels, the number of 7-day and longer, 14-day and longer, and 21-day and longer "dry" periods in the growing season were machine computed. The resulting frequencies were used in designing an evapotranspiration suppression field project which was to be performed cooperatively by the Water Survey and Southern Illinois University in Carbondale.

Studies of 3- to 60-Month Precipitation Amounts. Using the daily summary cards for 61 stations in Illinois, monthly summary precipitation cards were prepared for the 1906-1955 period. These monthly cards were used to machine compute running totals for periods of 3, 6, 12, 18, 24, 30, 36, 42, 48, and 60 months. For each duration the values were ranked and sorted, and the results were used in a study of precipitation droughts in Illinois.⁶ The final results of this study are to be presented in a forthcoming bulletin of the State Water Survey entitled "Drought Climatology of Illinois."⁷

Average Temperatures and Precipitation in Northeastern Illinois. To obtain averages of mean temperatures, maximum temperatures, minimum temperatures, heating and cooling degree days, snowfall, and precipitation, these data in the daily summary cards (No. 3 and 1009) for Aurora, Chicago, Waukegan, Kankakee, Marengo, Joliet, and Sycamore were summarized into monthly summary cards. Average monthly, seasonal, and annual values were machine computed from these monthly cards. The period of record was 1931-1957. These results and other climatological data for northeastern Illinois were supplied to the Northeastern Illinois Metropolitan Area Planning Commission.

Climatology of Selected Weather Conditions. Using the daily summary cards (1009 and No. 3) for 22 stations located throughout Illinois, the monthly and annual average and extreme numbers of days with sleet; freezing rain-drizzle; snowfalls of 0.1, 1.0, and 3.0 inches; and snow cover of 1.0 and 3.0 inches were determined. These values were computed from the card records during the 1901-1955 period. The average annual snowfall values also were determined for these 22 stations. The results of this machine analysis project were summarized and published in part in "Water Resources and Climate."⁸

Dates of Occurrence of Hail and Thunderstorms in Illinois. All occurrences of thunder and hail entered in the daily summary cards of 61 stations for the 1925-1957 period were sorted and grouped by date and then listed. From these listings, daily, monthly, seasonal, and annual frequencies of occurrence of the thunder days with and

without hail, and the hail days with and without thunder were determined. The daily frequencies of hail days and thunder days during the 1925-1957 period were used in the study of singularities.⁴

The card data for the 1951-1957 period also were employed in a study of the relation between hail and thunderstorm days. These results have been reported in a technical paper "Areal Frequencies of Hail and Thunderstorm Days in Illinois."⁹

HOURLY SUMMARY CARDS (No. 1)

Climatology of Diurnal Variations of Selected Weather Conditions in Illinois. From the No. 1 hourly cards for Moline, Evansville, and Springfield for the period of 1948-1955, various climatological statistics pertaining to the diurnal variations in the occurrence of hail, sleet, freezing rain-drizzle, thunder, smoke, and fog have been machine computed. Monthly and annual averages and extremes by hour and by day have been calculated to obtain a climatological measure of these conditions which can often affect human and industrial activities. The results of this analysis will be published in a forthcoming State Water Survey report.

Monthly Average Dew Point, Wet Bulb, and Dry Bulb Temperatures. Using the No. 1 hourly cards for Chicago, St. Louis, and Rantoul for the period from 1948 through 1955, the average of these three temperatures were calculated for each month based on: 1) the hours from 0800 to 1700 CST in each month, and 2) all hours during each month. These data were used in an evaluation of design criteria for industrial cooling towers in Illinois.¹⁰

STUDIES UTILIZING SPECIAL CARD DECKS

Radar Squall Line Climatology. In performing a climatological study of squall lines depicted by 3-cm radar, half-hourly measurements of many line components were entered on IBM cards using measurements taken from radar scope film. More than 400 precipitation lines in the Illinois area of the Middle West were measured and the data entered on this radar deck, totaling approximately 6000 cards. Some of the results of this study were reported in two papers presented at the Eighth Weather Radar Conference.^{11,12} Further findings were published in a report to the U. S. Air Force entitled "Studies of Radar-Depicted Precipitation Lines."¹³

Radar Analysis of Severe Thunderstorms. A study of the radar reflectivity characteristics of severe thunderstorms in central Illinois employed data entered on punch cards and the machine analysis

of these cards. In this study, data were collected on echo occurrence and intensity in each of 618 6-by-6-mile grid squares depicted on the PPI. Echo measurements at each of six different altitudes (antenna tilts) were obtained once every nine minutes, and all echo-intensity-altitude measurements in each square were recorded on punched cards.¹⁴ Ground observations of hail, lightning, rainfall, and wind were obtained from a network of 1100 cooperative observers, and these data were also entered on punch cards referencing their time of occurrence and location. Among the ensuing analyses performed were 1) a count of the echo frequency and intensity per grid square, 2) a temporal comparison of echo-height-intensity per grid square with severe surface weather, and 3) a study of reflectivity or intensity height profiles for the radar-depicted echoes. More than 127,000 research cards were punched in performing this study. This project also utilized No. 5 cards from Columbia, Rantoul, and Peoria in performing an analysis of atmospheric moisture content and stability on selected hail dates in the 1956-1960 period. Further descriptions of the card utilization in this study can be found in two project reports.^{14, 15}

Measurements of Rain-Drop Sizes. An investigation of the rain-drop size distribution found in different climates has utilized punch cards as the basic means of data storage and analysis. Special cameras developed by the State Water Survey have been located in many different climatic regions including Illinois, Florida, North Carolina, New Jersey, New Mexico, Oregon, Alaska, Majuro Island, and Java to collect adequate samples of the rain-drop size distributions particular to these various locations. The measurements of the drop sizes depicted on film are entered into IBM cards directly from the photographic record. Since 1957 approximately 505,000 cards have been punched for this project. The analysis of the drop-size distributions by rain types, synoptic types, rainfall rates, and other meteorological conditions is accomplished using a digital computer.¹⁶

Analysis of Data from Raingage Networks. For several years in Illinois the State Water Survey has operated five dense raingage networks comprising a total of 142 raingages of which 103 are recording raingages. The precipitation data are analyzed in various ways to satisfy different research programs, but the basic analysis has involved the transcription of certain data into punch cards. For each network, all precipitation periods are analyzed separately, and the individual gage amounts with the beginning and ending times of the precipitation are entered on punch cards. Approximately 40,000 precipitation-period cards have been punched. Results from analyses of raingage network data have appeared in several reports.^{17, 18, 19, 20}

Recently the State Water Survey obtained a chart reading device, an Oscar F, to transcribe rainfall amounts for varying increments of time from the recording raingage charts into punch cards. This equipment will enable many more new analyses of the chart data.

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