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AN INVESTIGATION OF SUMMERTIME CONVECTION OVER THE UPPER CURRENT RIVER VALLEY OF SOUTHEAST MISSOURI

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WSO Columbia, MO

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UNITED STATES DEPARTMENT OF COMMERCE
Malcolm Baldrige, Secretary / National Oceanic and Atmospheric Administration
John V. Byrne, Administrator / National Weather Service
Richard E. Hallgren, Director

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1. INTRODUCTION

During the unusually dry month of July, 1983, it was discovered that thunderstorms or convective showers consistently developed over the upper Current River Valley (UCRV) when weak synoptic conditions and marginal instability prevailed. Thunderstorm development was first noted on July 13 and thunderstorm or convective shower development continued for 5 consecutive days thereafter and again on August 25 and 26 over the same area.

The UCRV would appear to be ideally located to make use of limited topography to create an environment preferential to thunderstorm development under certain synoptic conditions. Although most of the thunderstorms observed were weak and short lived, a few were quite intense and lasted several hours, as was the case on July 14, 1983 when a thunderstorm that originated over the UCRV later reached severe limits and caused property damage as it moved northwest across the Lake of the Ozarks. The thunderstorms forming over this area, then, can have significant impact on areas far from their source region and should be of interest to both aviation and public forecasters.

This paper will examine the topography of the UCRV and discuss qualitatively some of the reasons why it would be a preferred area for thunderstorm development.

The general synoptic conditions on the days of known occurrences are presented along with a means of objectively forecasting thunderstorm development over the area.

It must be stressed that the development of thunderstorms over the UCRV was discovered quite by accident and only later were the probable causes determined.

Although this paper is based on a limited amount of data, the observational evidence of a relationship between the UCRV and thunderstorm formation is quite strong. Since the conditions necessary for thunderstorm formation over the area are not that uncommon during a typical summer it is believed that the results of this preliminary investigation can be of immediate benefit to operational forecasters.

2. THE UPPER CURRENT RIVER VALLEY AND ENVIRONS

The upper Current River Valley is located in southeast Missouri and is centered approximately 100 nm SSW of St. Louis, Missouri (see Fig. 1). The Current is one of several rivers draining the south slope of the Salem Plateau and penetrates the furthest into the Plateau of any of the rivers. The upper Current Valley is bounded to the west and north by parts of the major divide of the Salem Plateau and encompasses an area of about 1500 nm^2 (see Fig. 2). The divide runs east-west from about 20 nm ESE of Salem to just north of Licking where it turns sharply south for 40 nm forming

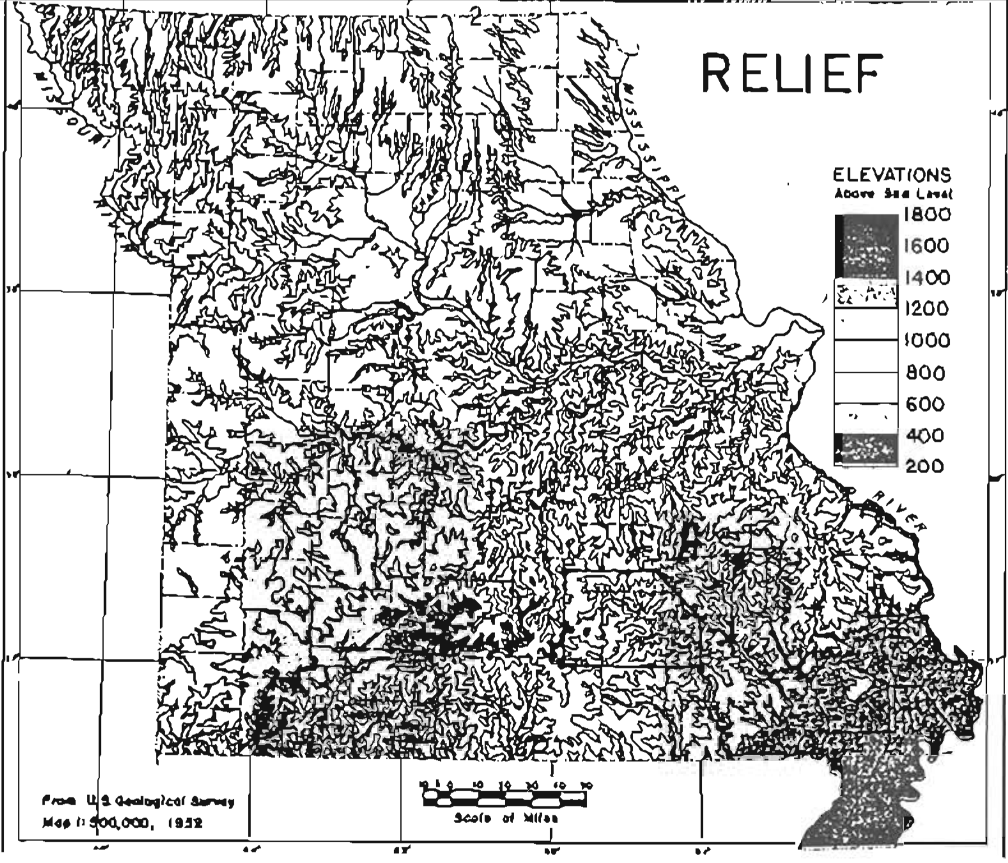


Fig. 1. The upper Current River Valley and environs are enclosed by the solid lines at A. Elevations of extreme southeast Missouri are within the 200 to 400 foot contours while the major ridges of the valley lie between the 1200 and 1400 foot contours.

Fig. 2. The upper Current River Valley. The dashed line is the major divide of the Salem Plateau, the dotted line is the other major ridgeline of the upper Current. Names mentioned in text are circled. (Map courtesy of the U.S. Geological Survey.)

nearly a right angle. The divide is relatively broad and flat in this part of the Plateau and is well cultivated. Elevations generally fall between the 1200 and 1400 foot contours with isolated peaks above 1400 feet. In contrast the adjacent valley walls are quite rugged and heavily forested (see Fig. 3).

The headwaters of the Current River begin at Pigeon Creek, northeast of Licking at an elevation of about 1400 feet. Several small tributaries feed into the Current southeast of Licking and then larger tributaries join the river as the valley widens. The largest is the Jacks Fork. All of the tributaries of the upper Current except the Jacks Fork are occasionally dry in summer. Most of the water flowing into the Current River comes from immense underground springs.

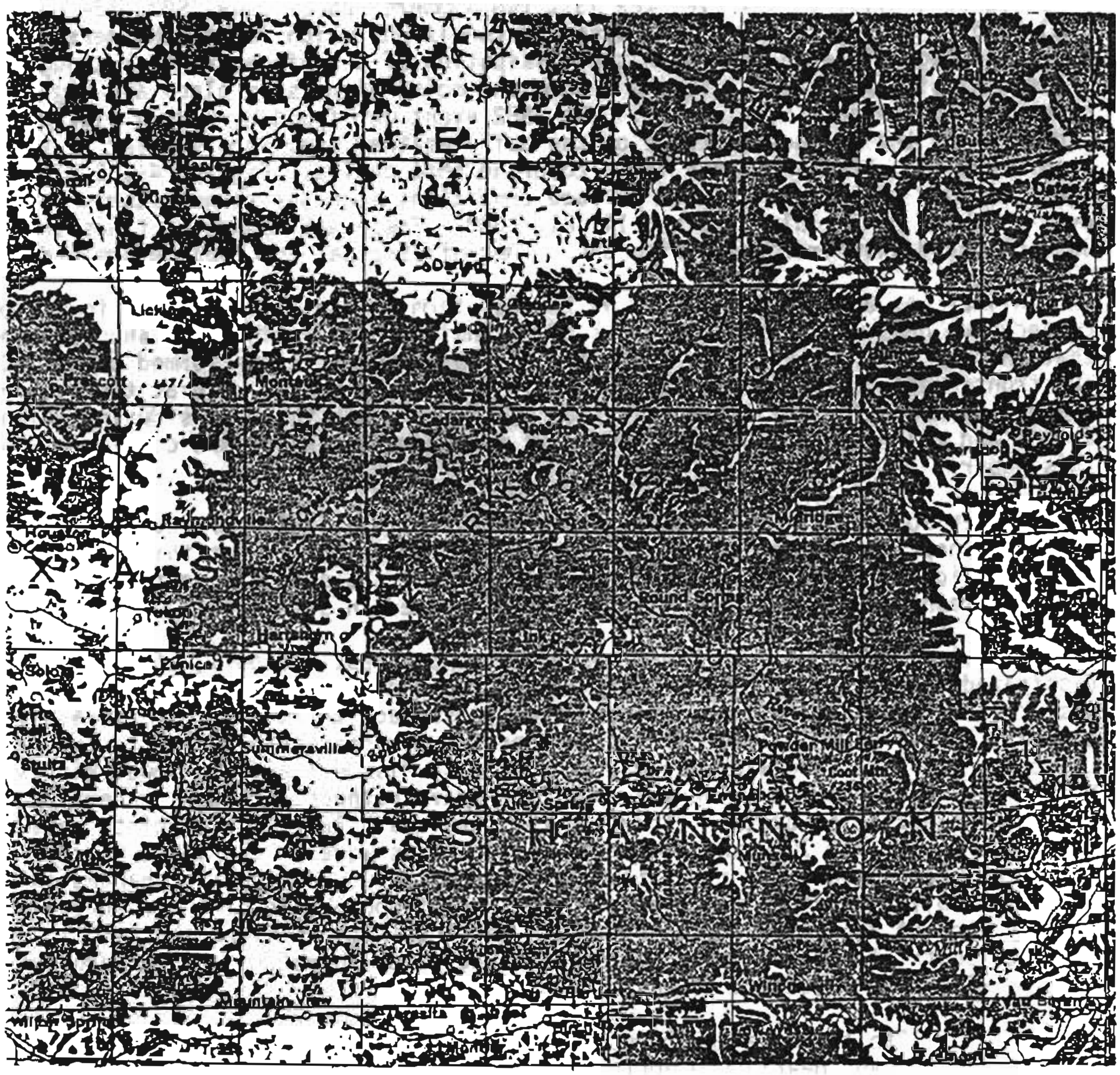


Fig. 3. Forest cover map of upper Current River Valley and environs. Dark areas are covered by trees. (Courtesy of UMC School of Forestry and the Missouri Department of Conservation.)

The valley floor drops to 500 feet about 12 nm northwest of Van Buren and is at 475 feet at Van Buren. The total fall of the upper Current then is about 1000 feet in 43 linear nm, with the steepest drops occurring in the first 30 miles of the river's course. Most of the tributaries fall 400 to 500 feet from adjacent ridges to valley floor in 10 to 20 nm. Although the valley slope is shallow in the mean there are many steep ravines and bare rock cliffs throughout the course of the upper river and its tributaries that fall several hundreds of feet in short order.

3. SYNOPTIC CONDITIONS

There have been at least 3 known episodes of thunderstorm formation over the upper Current River Valley over the last two summers; 25-27 July 1982, 13-18 July 1983, and 25-26 August 1983. The synoptic conditions which led to thunderstorm formation began in each case with the dissipation of a surface front or trough over the mid Mississippi Valley leaving a warm and moist airmass in place and high pressure generally to the east of Missouri. The 1982 event was found by simply picking a period in which the surface features on the daily weather maps were similar to the 1983 occurrence and obtaining radar films covering that period. Figures 4(a & b) and 5(a & b) show that under similar surface conditions numerous thunderstorms formed over the UCRV on 26 July 1982 and 14 July 1983. The exact number of times that the UCRV produced thunderstorms during the summer of 1982 has not been determined.

All of the episodes consisted of thunderstorm or convective shower formation on consecutive days with varying degrees of intensity and duration. It should be noted that on many other days during the summer of 1983 thunderstorms formed on the UCRV, but fronts were in the immediate vicinity. This was also the case at the beginning and end of the July 1982 and August 1983 episodes. Only those days during which fronts and major weather disturbances were far from the valley are considered in this paper.

The episode of 13-18 July 1983 was probably a relatively rare event in that the general synoptic conditions remained unchanged for so long. But this period provides considerable insight into the relationship of the synoptic weather patterns to the topography of the UCRV and will now be discussed in some detail.

On July 12, 1983 a cold front pushed into northeast Missouri, stalled and then dissipated during the morning of July 13 leaving the Current River Valley on the western edge of a high pressure ridge from the surface to 700 mb (Fig. 6a & b). Over the next 9 days no major weather system approached closer than 300 nm to the valley. Light fog and haze were widespread over southeast Missouri and the lower Mississippi Valley during the period. The sky condition over southeast Missouri generally consisted of clear skies or thin cirrus in the mornings. Surface dew points were commonly in the low to mid 70's and afternoon temperatures were in the 90's. Except for the 14th, when the air was significantly more unstable, only subtle changes in the various stability indices were noted. The lower tropospheric high pressure ridge initially east of the valley moved southeast and then west until on the 19th it was centered south of Missouri over Louisiana. The winds therefore shifted progressively with time from southeast to west.

On July 13th a single thunderstorm formed southeast of Licking around 1830Z (Fig. 7a) and moved nearly due north with the 700 mb flow. A second thunderstorm developed in approximately the same location shortly after the first one had moved off and within a few hours a string of cells stretched from southeast of Licking to near the Columbia Regional Airport (Fig. 7b). These were the only thunderstorms

MONDAY, JULY 26, 1982

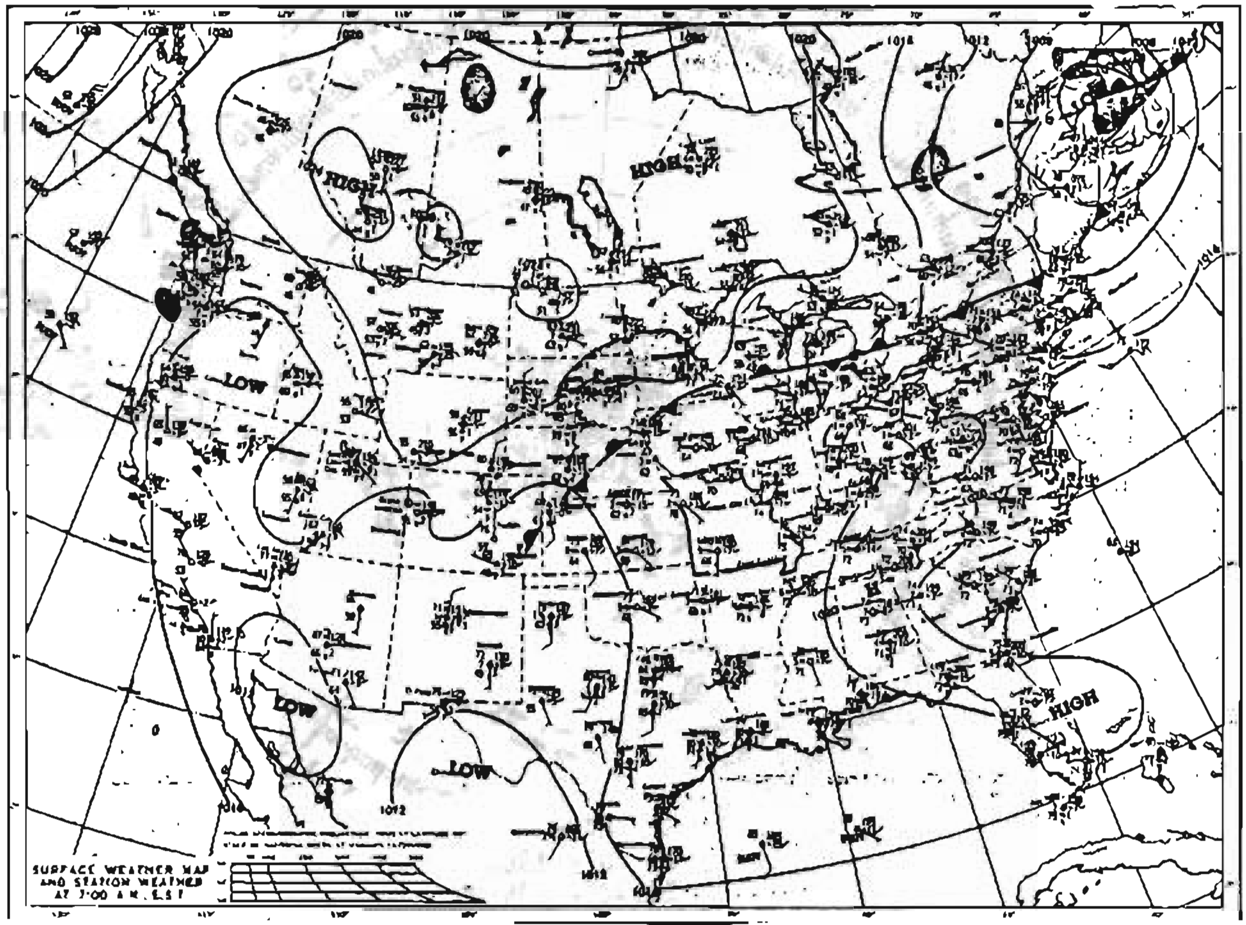


Fig. 4a. Daily Weather Map
1200Z July 26, 1982

THURSDAY, JULY 14, 1983

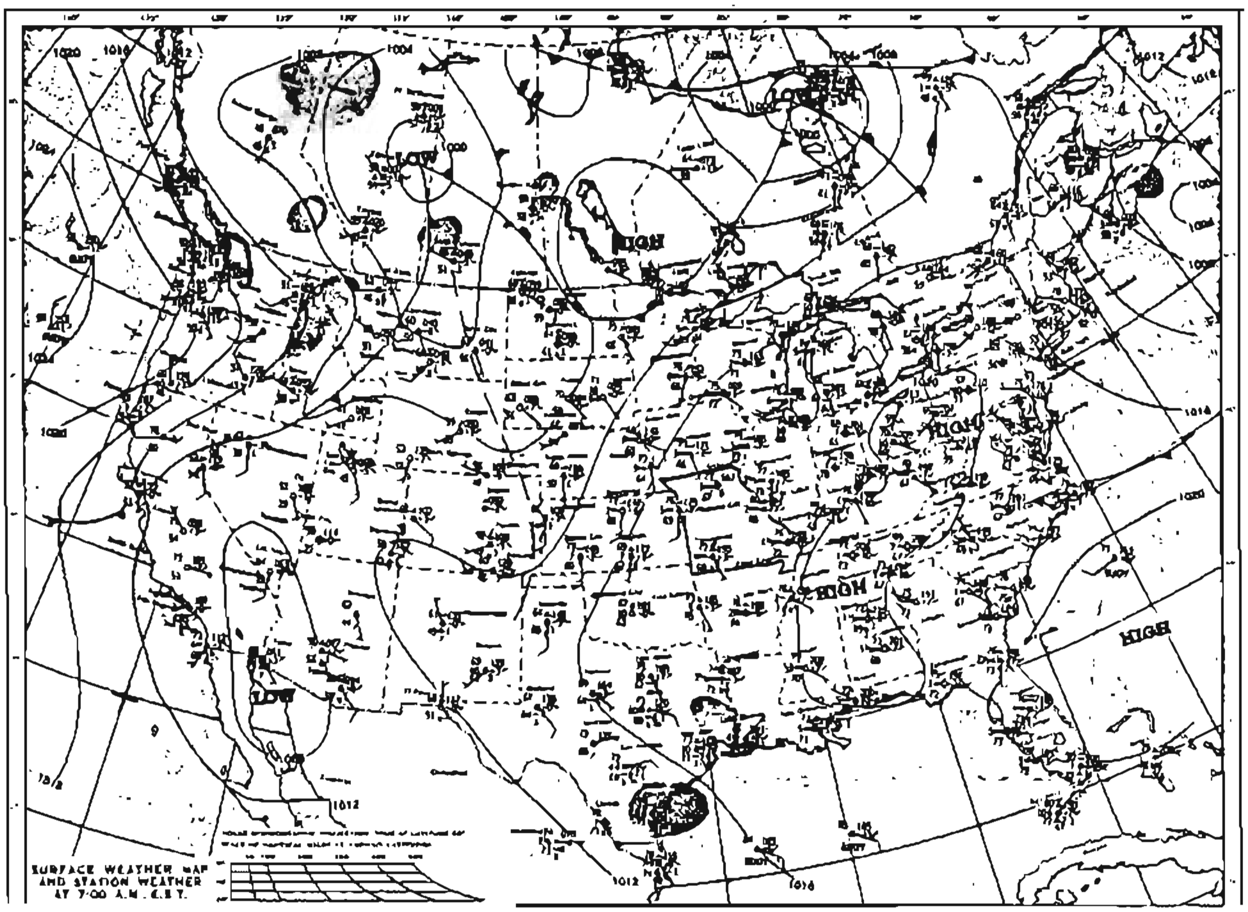


Fig. 4b. Daily Weather Map
1200Z July 14, 1983

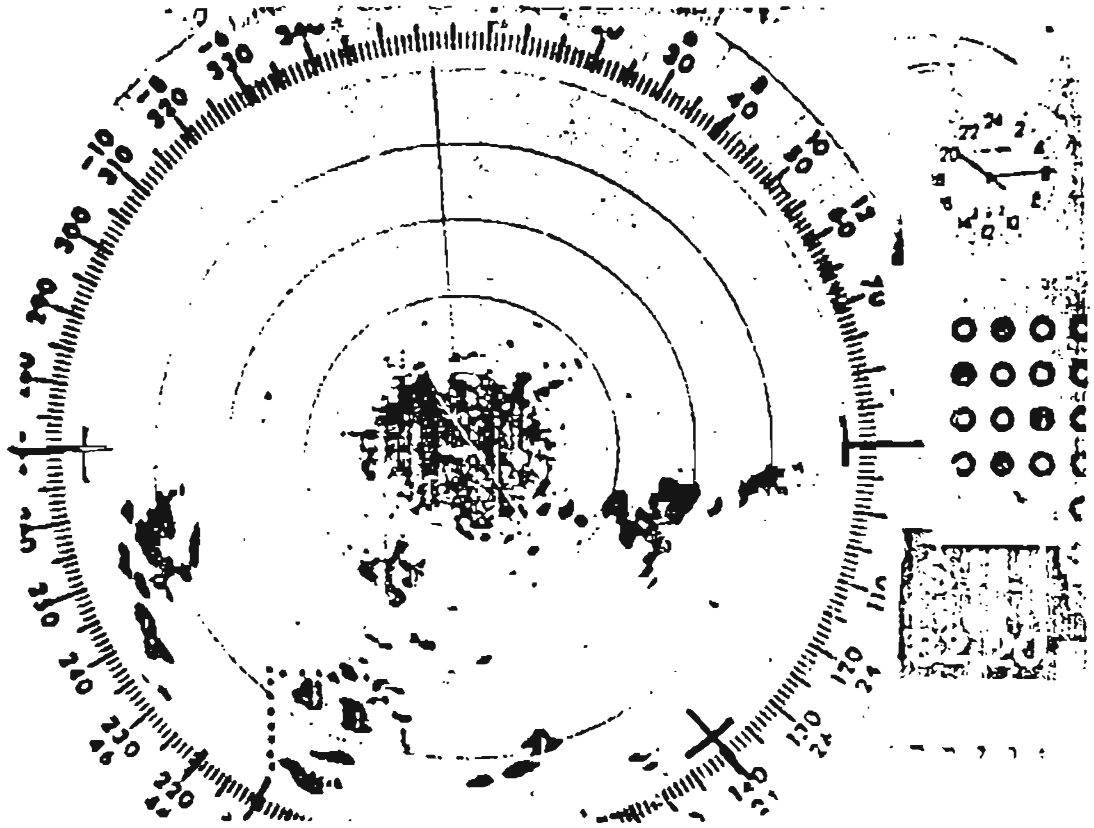


Fig. 5a. STL RADAR
26 July 1982
2014Z - 125 NM Range

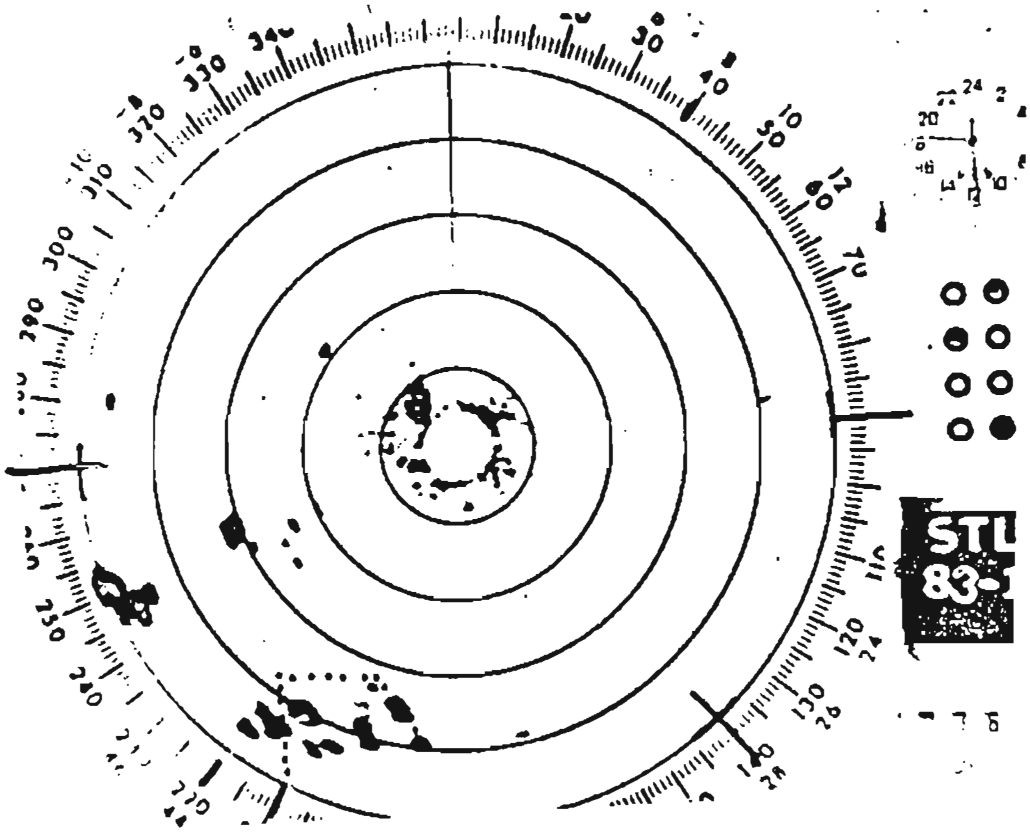
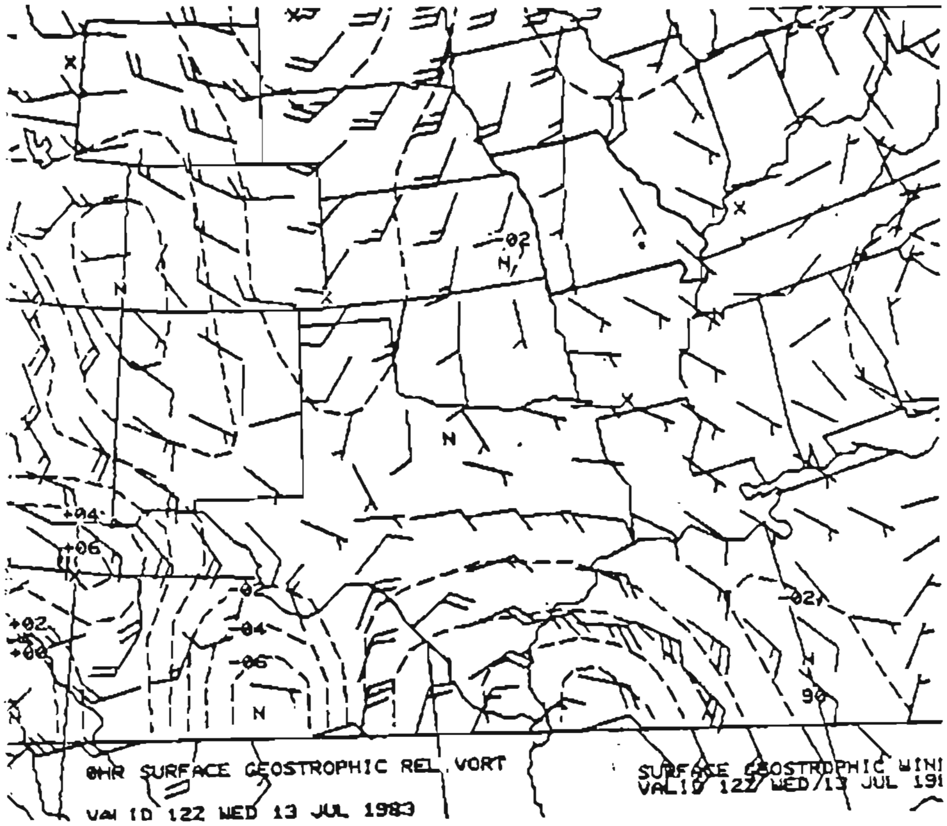


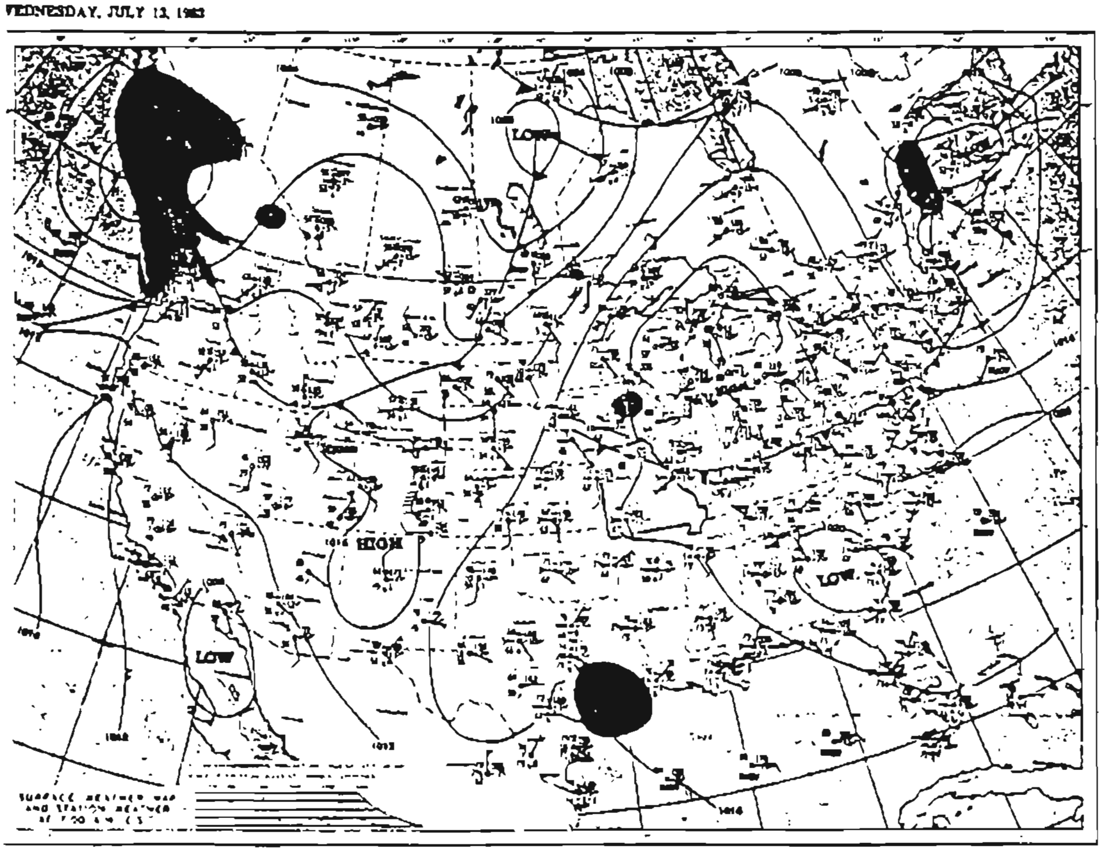
Fig. 5b. STL RADAR
14 July 1983
1830Z - 125 NM Range

Dotted line approximates the major ridgelines of the UCRV.



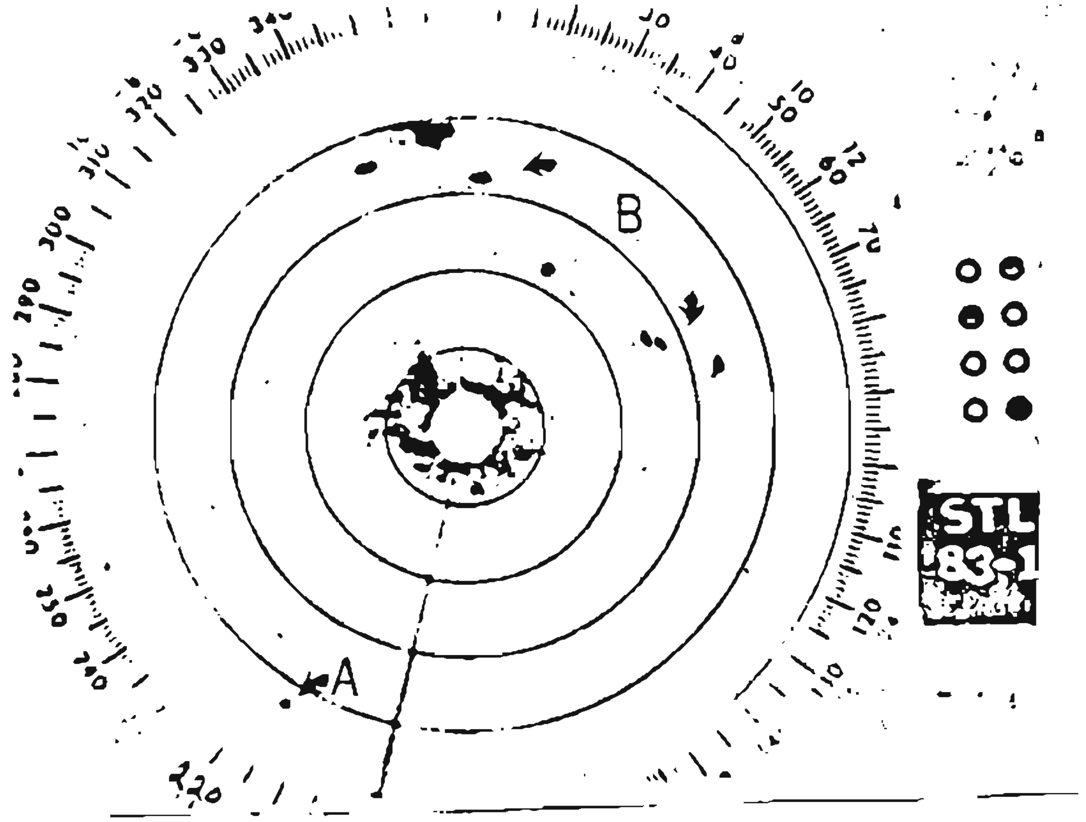
Surface geostrophic chart. 7/13/83 1200Z.

Fig. 6a.



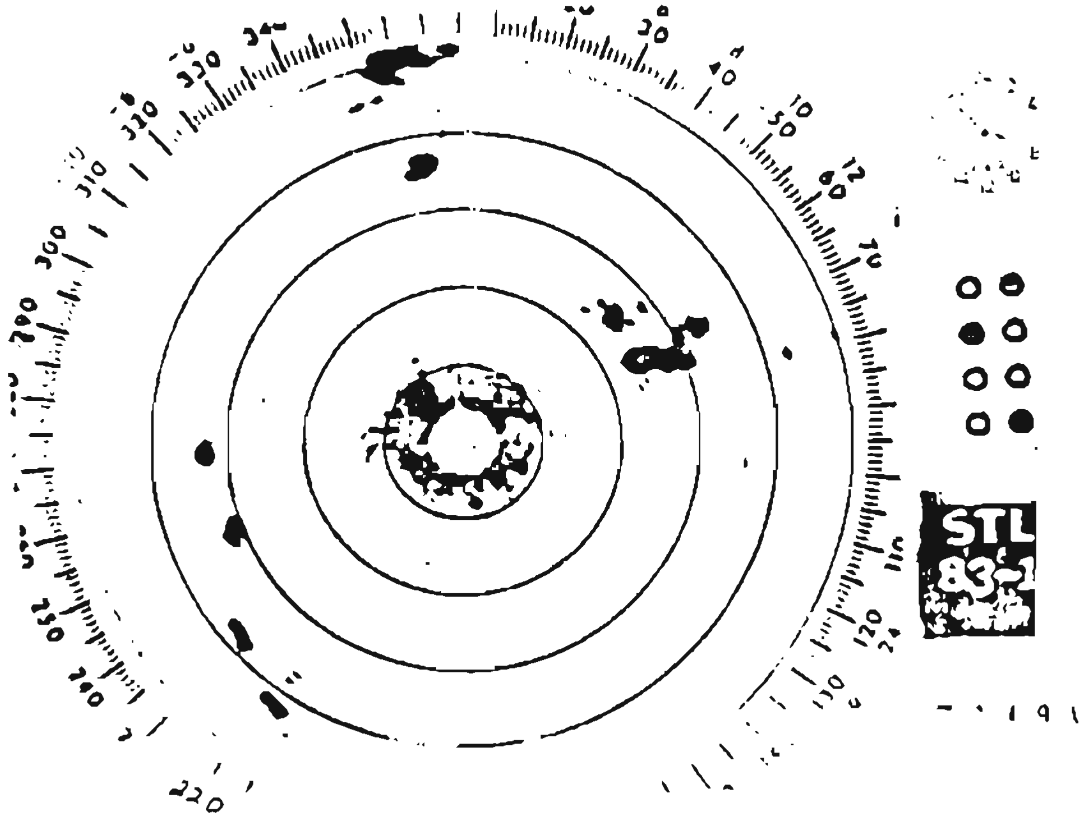
Daily weather map for 7/13/83 1200Z.

Fig. 6b.



STL radar, 7/13/83 at 1836Z, 125 NM range. Newly formed cell southeast of Licking is at A, convection along old frontal boundary is at B.

Fig. 7a.



STL radar, 7/13/83 at 2109Z, 125 NM range.
Fig. 7b.

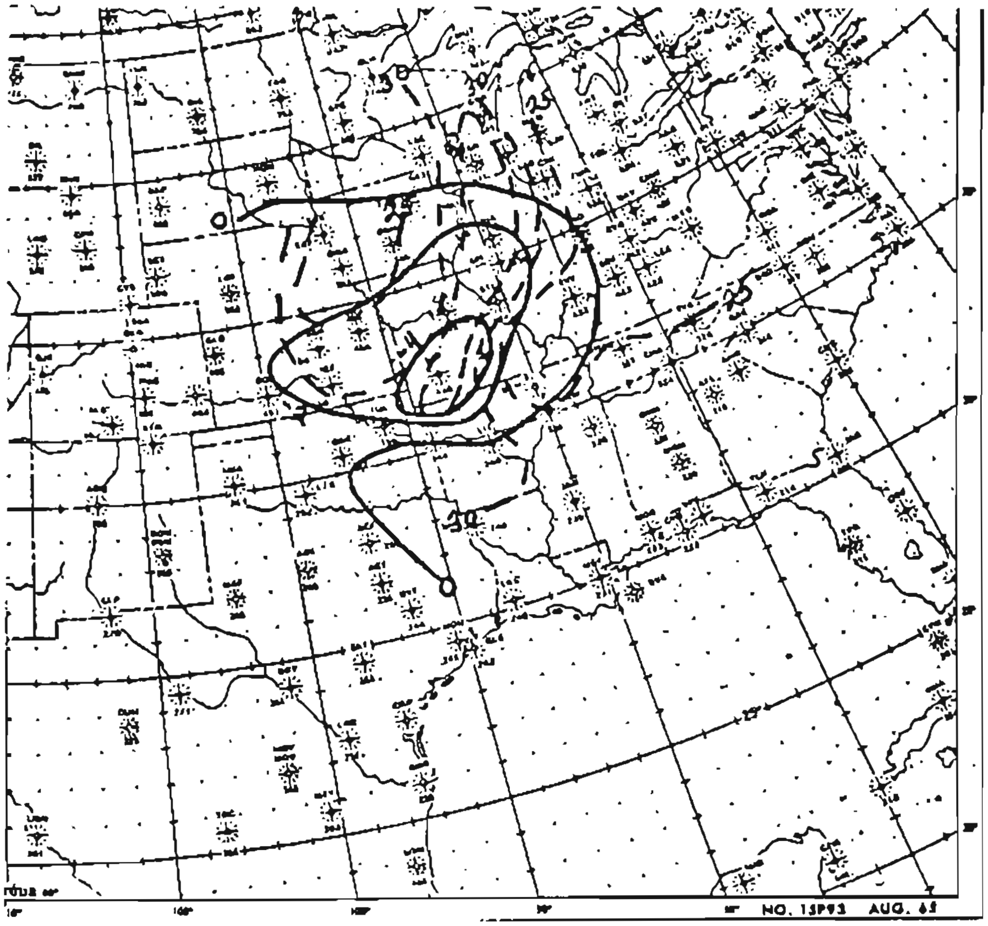
observed over Missouri that day. The film of the STL radarscope gives some idea of the relative importance of the UCRV as a thunderstorm producer. On the film the string of cells previously mentioned is clearly visible and the only other thunderstorms indicated are those along the remains of the frontal boundary in central Illinois which had retreated northward during the day.

On the 14th the air was quite unstable in a swath across central Missouri (Fig. 8a & b). The UCRV was on the extreme eastern edge of this unstable air mass. The very first convection noted on WSO Columbia's radar was a weak rainshower southeast of Licking at about 1600Z. This cell quickly dissipated and the first substantial convection developed over northwest Arkansas and southwest Missouri. By early afternoon thunderstorms were forming over the UCRV (Fig. 5a) with a south southeast surface flow prevailing. Shortly thereafter strong thunderstorms began to move northwest out of the valley (Fig. 9) and upon intersection with the more unstable air over central Missouri, intensified rapidly to the point where at 2110Z (Fig. 10a & b) one of them had nearly reached severe limits. A delayed report from Camden County indicated that the thunderstorm winds had turned over boats and docks, downed some trees and damaged outbuildings near Hurricane Deck and Lake of the Ozarks. The damage was said to have occurred between 2145Z and 2200Z. The damage path was about one quarter mile square and was caused by straight line winds indicating a possible microburst.

The thunderstorms that moved over the Lake of the Ozarks blossomed into a large ill-defined line and weakened as they moved northward. Thundershowers eventually spread as far north as the Iowa border. Strong thunderstorms continued to form over the valley into the early evening (Fig. 11).

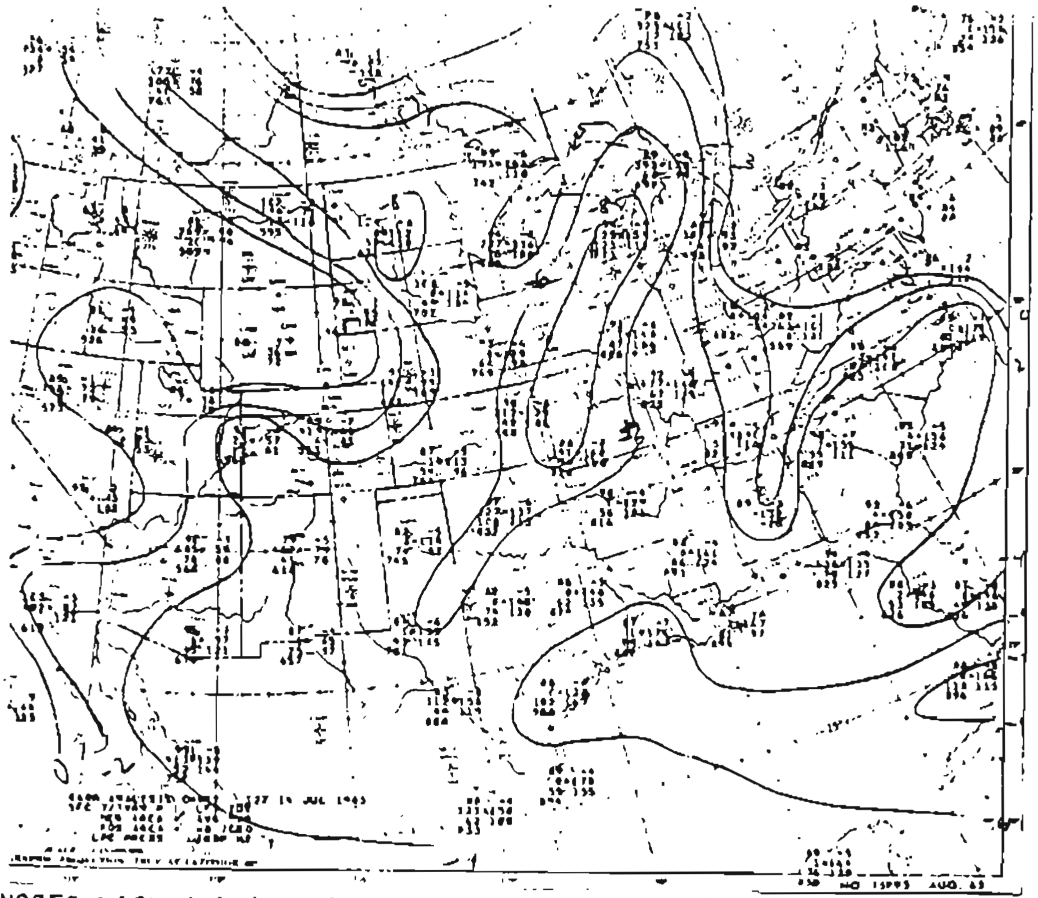
The convection on the 13th and 14th when light south to southeast surface winds prevailed stands out sharply from the other days during the period when the surface flow had a westerly component. On days with a westerly component to the surface flow the convection was generally much weaker and more random. It is expected then, that all other things being nearly equal, the wind speed and direction are the most critical elements of the dynamics of thunderstorm formation over the valley.

Lack of mesoscale and microscale observations over the UCRV precludes any attempts in this report to thoroughly document and discuss the details of the atmospheric dynamics and their interaction with local topography which causes this area to be a preferred location for convective storm development. It is felt, however, that the accumulated observational evidence on the synoptic scale coupled with radar film histories already supports the offering of at least a preliminary rationale which attempts to explain the reasons and conditions under which the valley serves as a preferred location for convective storm development.

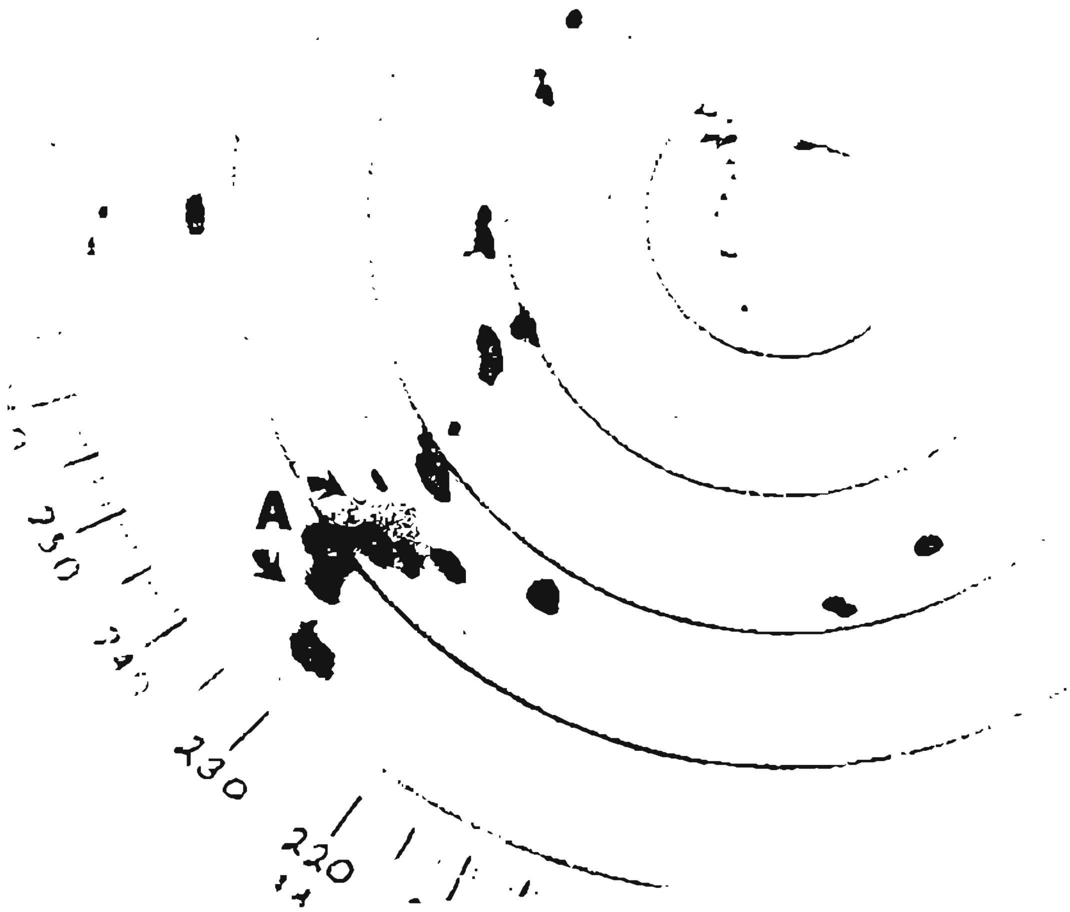


NSSFC Showalter stability index (solid line) and K-index (dashed line) 1200Z analysis for 7/14/83. Approximate valley center is marked by a small x.

Fig. 8a.

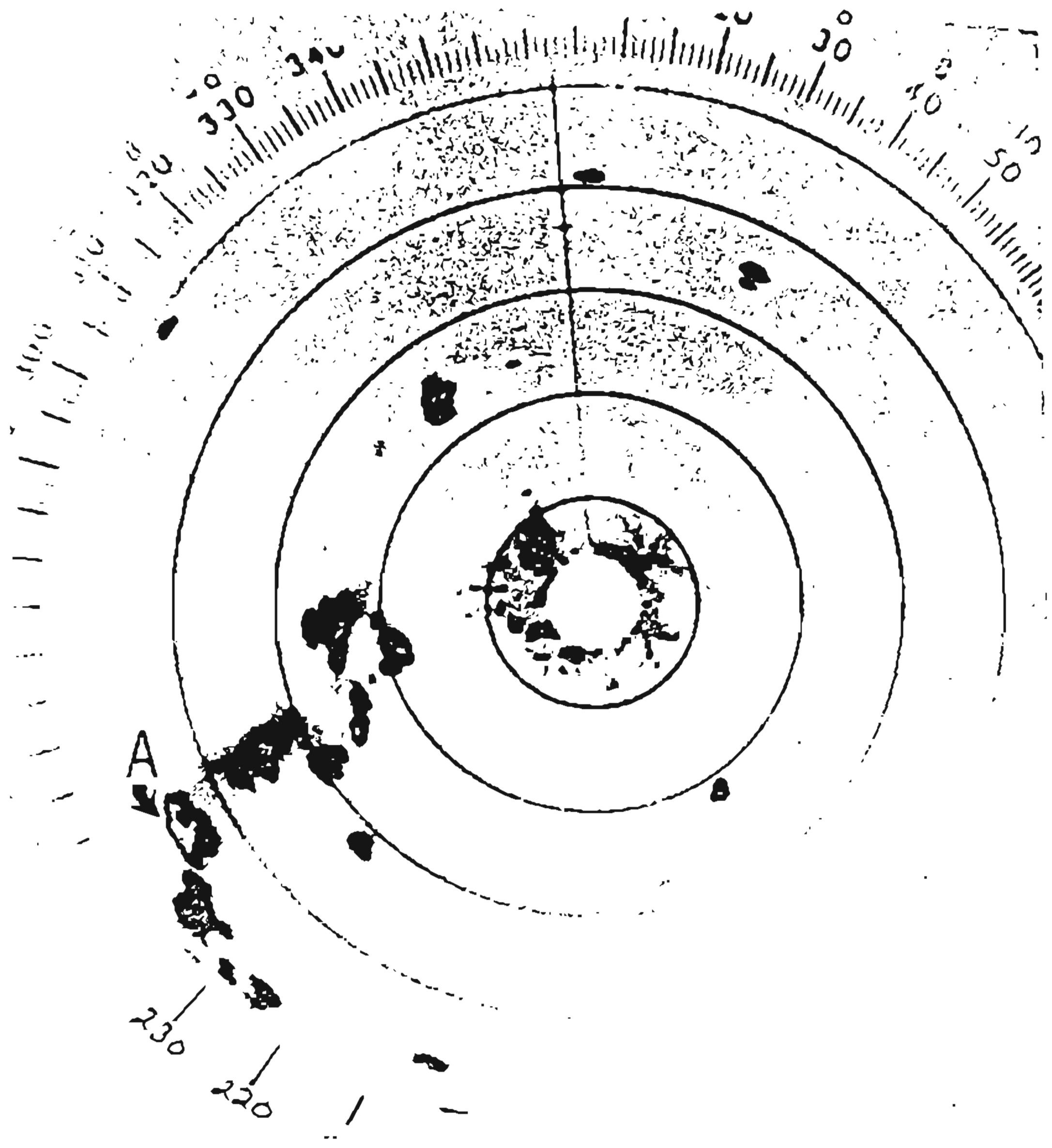


NSSFC Lifted Index 1200Z Analysis for 7/14/83.
Fig. 8b.



STL radar, 7/14/83 at 2012Z, 125 NM range. Strong Convection at A has moved northwest out of the U.C.R.V. Note that no new convection has formed over the valley at this time.

Figure 9.



STL radar, 7/14/83 at 2110Z, 125 NM range. Strong thunderstorm at A resulting form the merger of cells that formed over the U.C.R.V. caused wind damage as it moved across Lake of the Ozarks. COU radar indicated a VIP 5 height of 25K at this time.

Figure 10a.

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NNNNVJA
ZCZC STLSFSCOU
WOUS00 KCOU 142300
 STLSFSCOU

SPECIAL WEATHER STATEMENT
NATIONAL WEATHER SERVICE COLUMBIA MO
415 PM CDT THU JUL 14 1983

...VERY HEAVY THUNDERSTORMS CONTINUE OVER SOUTH CENTRAL MISSOURI...

AT 410 PM AN AREA OF VERY HEAVY THUNDERSTORMS ABOUT 15 MILES WIDE
WAS LOCATED FROM FULTON TO BELLE AND THEN CONTINUED WEST TO LINN CREEK
IN CAMDEN COUNTY. THE HEAVIEST THUNDERSTORMS WERE LOCATED JUST NORTH OF
LINN CREEK AND EAST OF TUSCUMBIA. THESE THUNDERSTORMS MAY CONTAIN
HEAVY RAIN..GUSTY WINDS AND SMALL HAIL.

THE THUNDERSTORMS WERE MOVING NORTHWEST AT 15 MILES AN HOUR AND WILL BE
MOVING OVER THE LAKE OF THE OZARKS BETWEEN 415PM AND 515PM THIS
AFTERNOON. HAGEMEYER
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Figure 10b.

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NNNN
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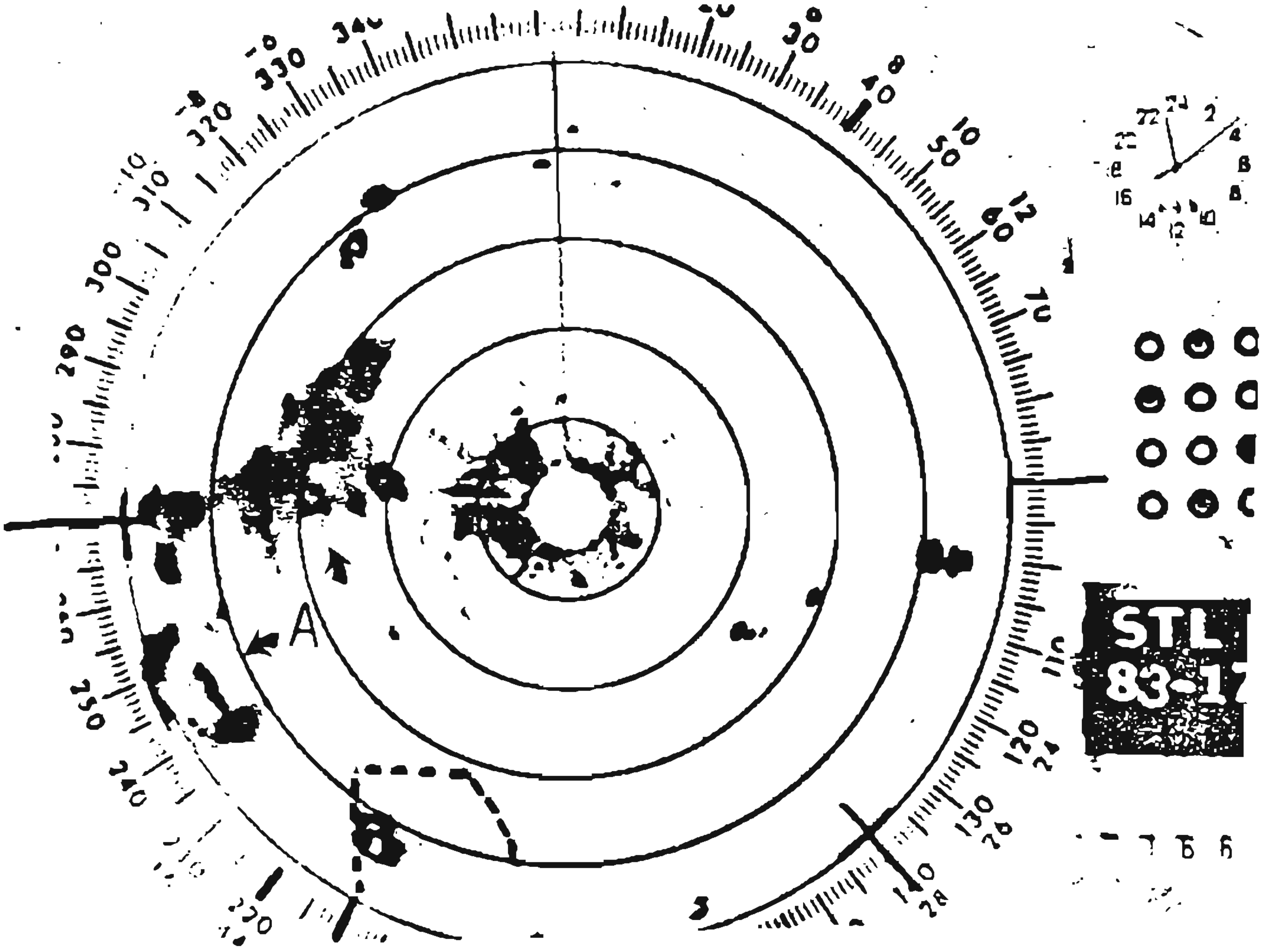
Special weather statement based on 2110Z COU radar data.



STL radar, 7/14/83 at 2308Z, 125 NM range. A strong thunderstorm has recently developed over the U.C.R.V., Thunderstorms at A are now weakening.

Figure 11.

4. INTERACTION OF THE UPPER CURRENT RIVER VALLEY WITH THE ATMOSPHERIC CONDITIONS

Considering the topography of Missouri it is clear that low level air with a trajectory over southeast Missouri and across the upper Current River Valley (southeast flow) would be forced upward some 1200 feet by the time it broke the ridgelines of the valley leading to a tendency for upward motion near the top of the valley walls. In addition to this large scale upslope motion over the general area there are several reasons for the existence of a mesoscale wind field over the valley itself. One of the most important components of this is the flow up the valley walls caused in part by surface heating and by the turning of the surface winds moving up the valley. On the microscale the ruggedness of the valley walls would cause significant mechanical turbulence in the lower levels leading to the formation of a deep mixed layer by late morning. In addition each of the countless small ravines superimposed on the valley would have their own unique circulation which would add to the overall vertical motion and turbulence over the valley.

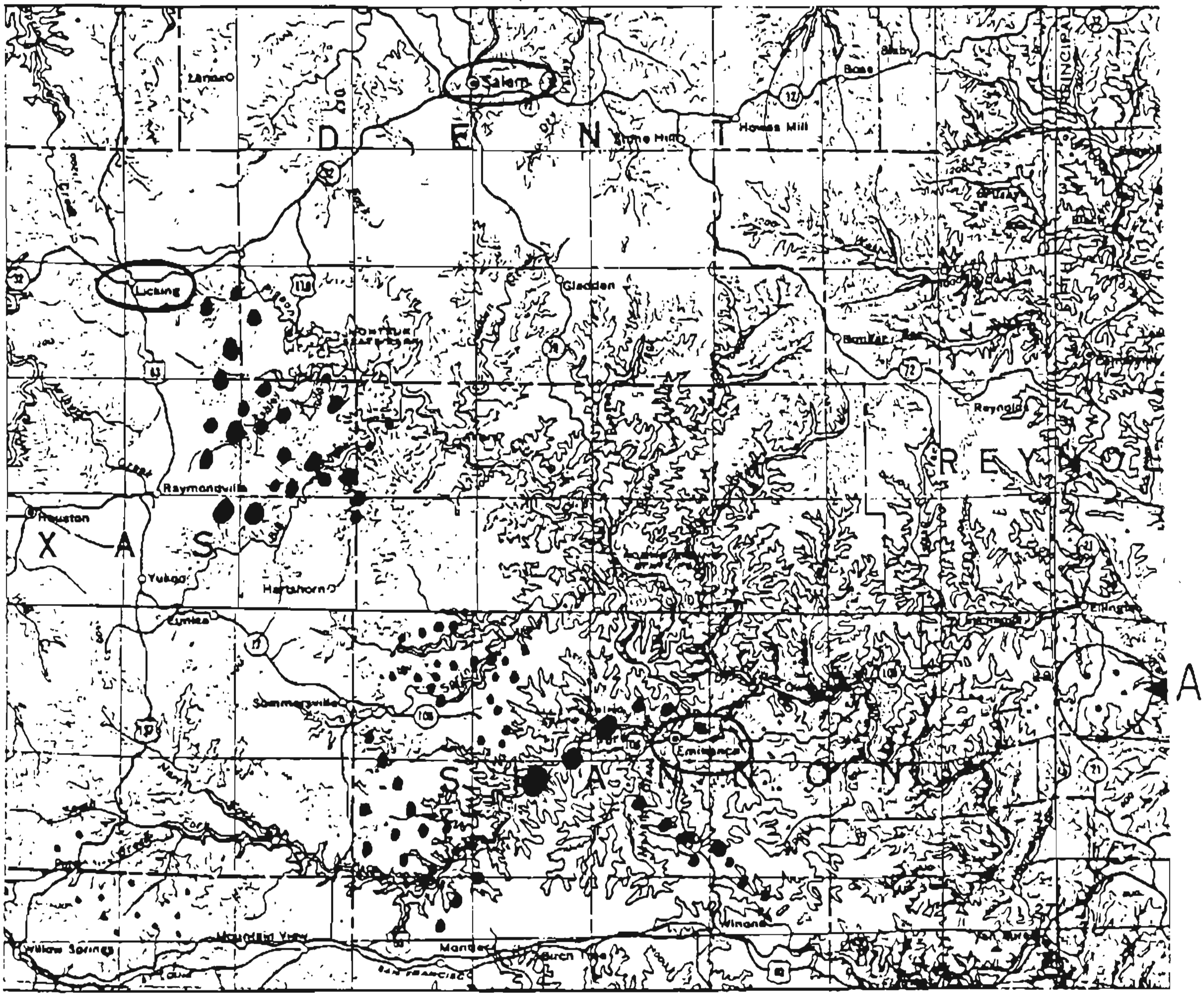
The orientation of the valley is such that a southerly flow will rapidly advect synoptic scale Gulf moisture over the area. Indeed a maritime tropical airmass is observed over the valley on days when convection is active. In addition there is an important local source of moisture present in the valley. This is transpiration from the dense forest that is estimated to cover at least 95 percent of the valley (Fig. 3).

There is also apparently an abundance of condensation nuclei available over the valley due to the dense forest which exudes considerable amounts of aerosol size particle such as terpenes and waxes. This process often manifests itself in bluish or purple haze which hangs over the valley on summer days. This fact is alluded to in virtually all literature available on the Current River.

From the above discussion one can surmise the existence of a deep and well mixed moist layer over the valley in conjunction with a circulation driven by strong and differential insolation, and modified by the terrain to provide upward motion on favorable days, and the presence of abundant condensation nuclei. All of these factors are conducive to thunderstorm development.

A fortuitous discovery of a Landsat 4 (thematic mapper) photograph of the Current River Valley provided much insight into how the valley "works." The picture was taken late in the morning of 29 August, 1982. High pressure was east of the valley at the time and the surface flow was light southeast, and significant low level moisture was lacking. The only clouds noted over ~~w~~outheast Missouri that morning where fair weather cumulus and they were concentrated along the western ridglines of the upper Current River Valley.

The arrangement of the clouds along the western valley walls suggested several areas of maximum convection and vertical motion, notably southeast of Licking and north and west of Eminence (Fig. 12). The photo left no doubt as to the upslope (up valley wall flow) nature of the low level wind over the UCRV. The apparent preference for convection to develop on the southwest side of the valley is most likely due to the orientation of the valley, where the southwest side receives several more hours of strong insolation in the morning than the northeast side. What can't be determined with available data is why on a given day the wind flow favors one side of the valley or the other; for example during the July 1982 episode the thunderstorms tended to develop on the northeast side of the valley along the ridgeline south of Salem. It may be that there is some critical wind direction and speed or insolation relationship that determines which side of the valley will be the most active but this has not been determined nor is it likely to be in the near future.



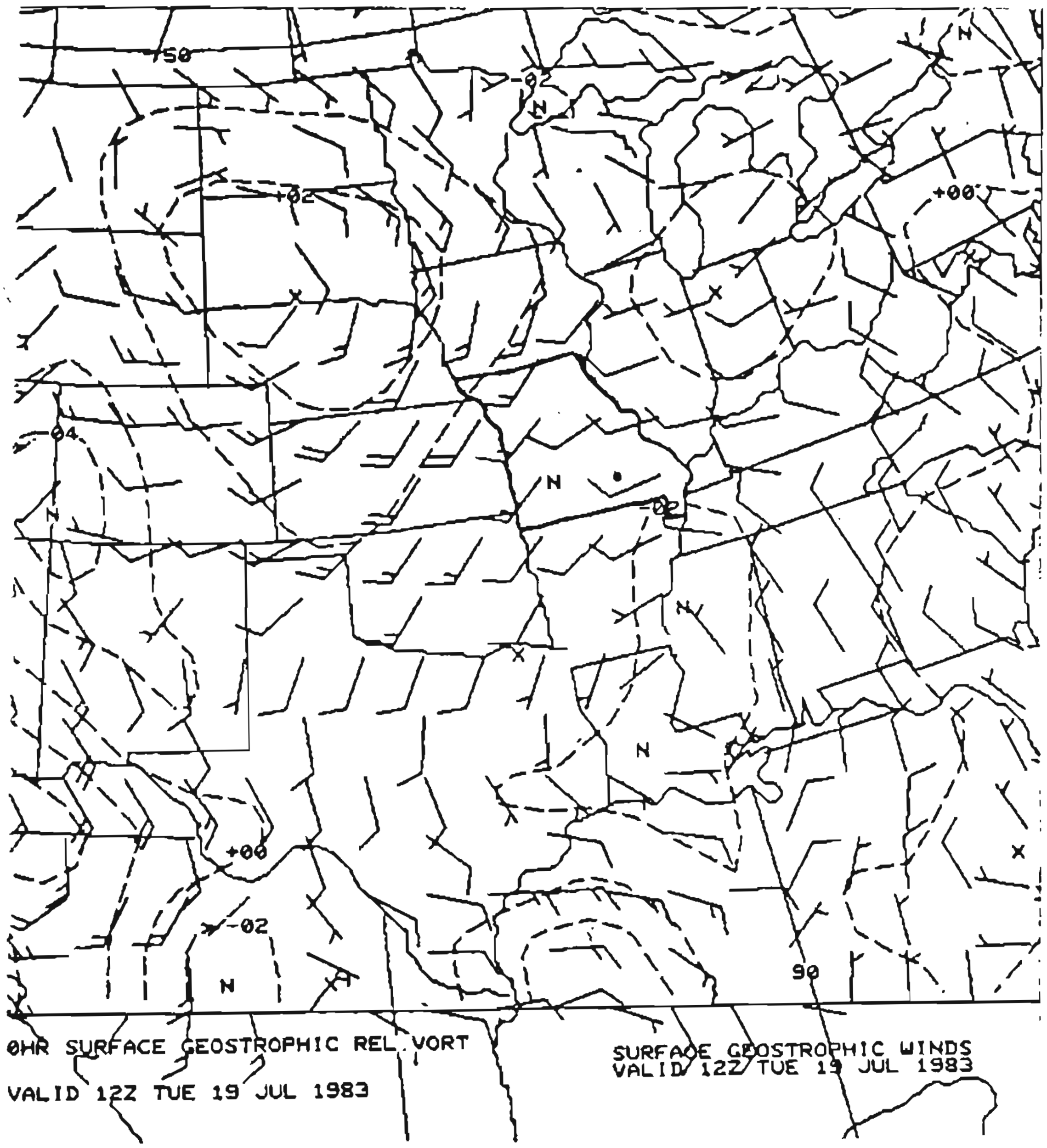
Data taken from Landsat 4 (thematic mapper) 8/29/82 (approx. 1610Z). The darkened dots are representations of the clouds observed on the Landsat photo. The cloud sizes are not relative to the map scale but are relative in size to each other. Note the total lack of clouds on the Northeast side of the valley except for a few at A.

Figure 12.

The upslope nature of the low level wind in the valley was also confirmed by radar observations, when as the synoptic scale surface winds shifted to a southwesterly direction and remained light from the 15th to 19th of July, 1983 weak convection continued on the southwest side of the valley. Realtime radar investigations (with the radar antenna stopped and slightly elevated) at WSO Columbia during the period revealed that weak convective showers were periodically forming and dissipating over the southwest side of the valley by midday, but that the more significant radar echoes did not develop until several hours later. By July 19 the surface geostrophic wind over the valley was nearly due west at 10 knots (Fig. 13) and the only significant convection noted during the day was a single rainshower that formed southeast of Licking and lasted about 45 minutes.

As long as the low level winds over the valley remain light and from a favorable direction (southeast to southwest) convective showers or thunderstorms should develop. But higher wind velocities (say around 10 knots or greater) overpower the effect of the valley leading to little if any convective development. There appears to be no preference for convection to develop on the northeast side of the valley with a southwest wind as might be expected and the southwest wind should generally result in reduced moisture in the valley.

The picture that emerges then is one of two general phases of valley activity; one phase with a south to southeast surface flow that amplifies the mesoscale and microscale wind fields up the valley walls and increases available moisture resulting in stronger, more lasting convection and the second phase with a westerly component to the synoptic scale surface wind in which the upslope flow is provided mainly by surface heating and other local effects resulting in less and weaker convection.



Surface geostrophic chart, 7/19/83 1200Z.

Figure 13.

5. OPERATIONAL CONSIDERATIONS

Having seen that convection consistently develops over the upper Current River Valley under the general conditions set forth it would be logical to want to use this new knowledge in an operational sense.

Under the synoptic conditions considered in this paper forecasters generally predict a 20 percent probability of precipitation (PoP) over much of Missouri based simply on surface heating and the stability indices. In reality the areal coverage of the thundershowers is usually much less than a 20 percent PoP would indicate. Indeed during the period of 13 July to 18 July, 1983, most of the air mass thunderstorms observed over Missouri formed south of the Missouri River and their formation was related to the terrain.

The knowledge of the UCRV system can now be used to refine forecasts for specific areas. In considering the zones in which the UCRV is located (MO. Zones 17, 18, and 21) this could often lead to the raising of PoP's there if little movement of the convection is expected or if more widespread convection is indicated in the synoptic analysis. Clearly other areas can be affected by the convection from the valley, notably the Columbia-Jefferson City area and the Lake of the Ozarks. These areas can be influenced by UCRV convection only with a south to southeast surface flow and steering wind. So depending on the circumstances the PoP's could be raised or lowered over a particular area.

Certainly the majority of cases will consist of thunderstorms not moving too far from the valley before dissipating since the synoptic conditions are generally characterized by light winds in the lower troposphere. It appears however, that the conditions leading to thunderstorms moving into the Lake of the Ozarks area or the Columbia local forecast area, while rare, are quite noticeable and stand out clearly from other days. Of course, Lake of the Ozarks (MO Zone 14) is more likely to be affected due to its proximity to the UCRV.

At this point there can be no purely objective forecast technique for predicting what areas the thunderstorms which form over the valley will affect, other than their source region of course (see Appendix A). The main problems are that the sparsity of data may well lead to incorrect interpolation (predicting movement from a source region as small as the UCRV would be very sensitive to minor errors in wind speed and direction) and the lack of exclusivity of the convection over the valley. Also predicting the lifetime of thunderstorms after they have moved out of the valley would be a highly subjective task.

In considering stability values the valley lends itself to a climatological approach but day-to-day changes have significant effect on the convection produced. Based on available data the roughly interpolated and averaged 12Z sounding on active days was stable from the surface to 850 mb and included a low-level inversion due to radiational cooling. However, the surface to 850 mb layer was conditionally unstable when considering strong surface heating. The sounding was potentially unstable from the surface to 700 mb. Stability indices derived from the averaged sounding were: Showalter -1, K 33, total totals 48 and lifted -4. The level of free convection was uniformly low on active days, averaging around 830 mb.

The Showalter index seems to be the most representative index to use in judging relative convection strength over the UCRV. The Showalter index ranged from values of plus one on some of the days with weakest convection to minus 3 on 14 July 1983 when the strongest convection occurred. The lifted indices, however, were uniformly low with little day-to-day variability noted due to the abundance of low-level moisture and strong surface heating. The advantage of the lifted index is that its analysis is readily available to forecasters and the LFM provides forecast values out to 36 hours so a threshold value for the lifted index is included in Table 1.

The final question to address is when can thunderstorms not be expected to develop over the UCRV since we would not want an attempt at mesoscale forecasting to lead to unnecessary forecasts.

Based on available data the ending of an episode such as the one from 13 to 17 July 1983 depends not so much on increased stability as on the wind direction and speed from the surface to around 700 mb. For example on 19 July 1983 the air was more unstable than on some previous days but the steering winds were northwesterly and no significant convection developed. It appears that if the wind flow across the valley at any level from the surface to 700 mb has a northerly component no significant convection will develop. The theory is that a low-level northerly wind across the valley would have a twofold effect; first, surface convergence would be at a minimum over the valley and second, the northerly flow would act to shear off with height any convection that did form thus not allowing enough lifting to realize the potential instability.

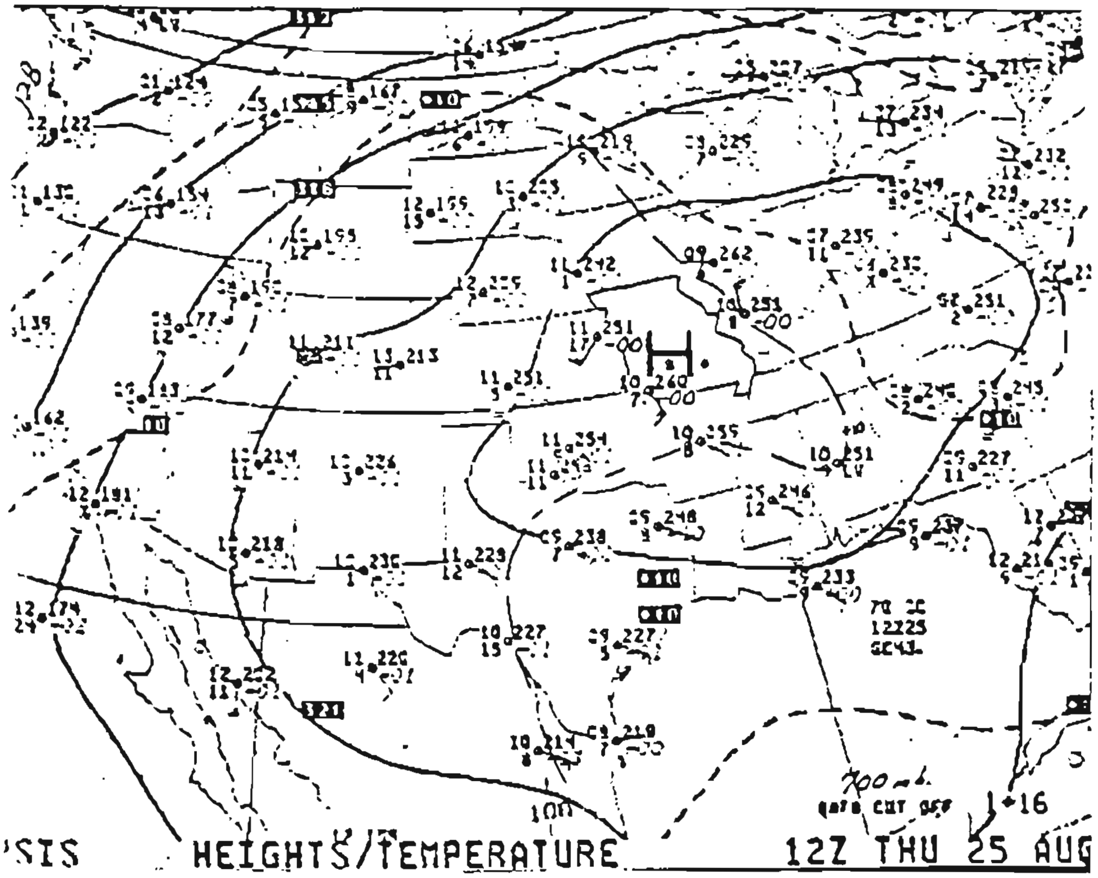
Care should be taken when high pressure aloft is centered very nearly over the valley as was the case on 25 and 26 ~~July~~ 1983. The convection that developed on these two days remained nearly stationary indicating calm winds aloft in the center of the high. The surface geostrophic winds, however, were ideal, light southeast (Fig. 14a & b).

It is believed that the surface geostrophic winds should be less than 10 kts to allow the valley system to exert its influence. Of course when the geostrophic wind exceeds 10 kts over southeast Missouri in the summer, it is usually the result of a synoptic scale system being nearby. It is also quite possible that the geostrophic winds may be favorable over the valley even when a front is nearby, but considering the valley effect in the forecast at that point might be ill-advised.

Cloud cover is generally of little concern on favorable days since it is neither thick or extensive enough to seriously reduce insolation. It is conceivable, however, that an opaque middle or high cloud layer could exist over the valley during the critical heating period and result in a disruption or reduction in the local circulation leading to reduced convective shower development or in the extreme case no development at all.

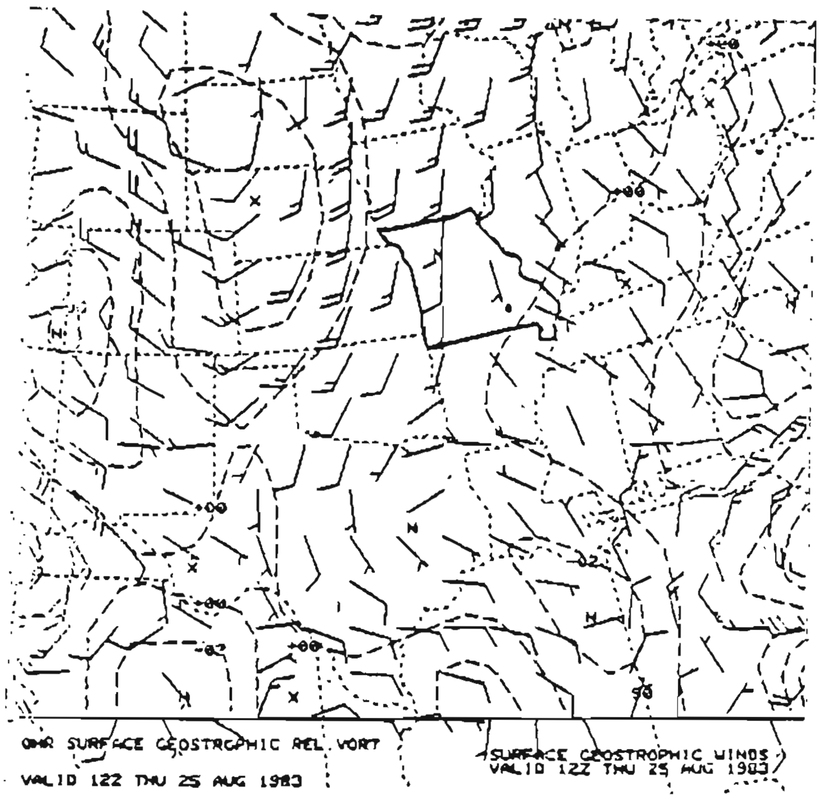
The last point is the fact that all of the cases considered in this paper began when weak fronts or troughs dissipated nearby. Although this is not considered a necessary condition for convection to form over the UCRV, is is certainly the fastest way to modify the atmosphere over the valley to a favorable state. In general, the dissipation of a front can be detected on the LFM and in the summer usually occurs overnight or in the morning. If a 12Z or 15Z surface analysis shows little indication of a front then a forecast for valley thunderstorms that afternoon could be made. Once the front has dissipated and convection is observed over the valley then persistence should be followed on subsequent afternoons until synoptic weather parameters indicate otherwise.

With regard to the synoptic conditions needed for thunderstorm formation over the valley and the limitations brought forth it is likely that the "valley effect" will only be evident from late June to early September with July and August being the optimum months. The time before and after this period is generally dominated by synoptic scale systems that rarely stagnate.



700 mb. analysis, 8/25/83 1200Z.

Figure 14a.



Surface geostrophic chart, 8/25/83 1200Z.

Figure 14b.

Concluding Remarks

The UCRV appears to be a preferred area for summertime convective storm development under weak synoptic conditions due to its unique geography. The UCRV has a history of sparse settlement and this is why little comprehensive climatological data is available over this area. Today Van Buren is the only city along the length of the Upper Current and this is, of course, in part due to the fact that the Current River is a federally protected scenic waterway. The present data network is too sparse to draw any conclusions along long term rainfall over the area and any detailed local network study would be extremely costly. The most immediate prospects for improving our knowledge about the "valley system" will come from synoptic data gathered and radar observations made over subsequent summers. It is important to understand the "valley system" since the Current River is often crowded with vacationers and canoeists during the summer months and, of course, the convective storms produced can affect many other areas. The influence of local topography in causing thunderstorms during periods of weak synoptic conditions should not be overlooked since it is felt that microscale and mesoscale processes necessarily dominate during these periods. It is not unreasonable to believe that other areas of Missouri and the midwest may have either unexpected or unobserved topographic effects significant enough to produce convective showers or storms.

ACKNOWLEDGEMENTS

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APPENDIX A

FORECAST DECISION TABLE

An attempt was made to make this forecast table as simple and objective as possible and it is to be used only under weak synoptic conditions after a detailed synoptic analysis of the 12Z data. If all answers are "yes" then afternoon thunderstorms should be forecast over the upper Current River Valley. Threshold values on the table were picked in an attempt to eliminate the isolated and weak convection from consideration since it may not be of significance in a public forecast. Clearly the intensity and coverage of thunderstorms will increase as dew points increase and stability indices decrease, etc. Specific temperature and dew point ranges from 850 mb - 500 mb are not included since a wide variability of values were noted during active days (850 temperatures as high as 21° were observed on one active day) and it is felt that when all other parameters on the table are favorable then the temperature and dew point field aloft should follow suite. The surface geostrophic chart is the most objective means of evaluating the low level wind direction over the valley, and it is felt that there should be a fetch of constant wind speed both upwind and downwind of the valley (example Fig. 6a). When considering the dissipation of a front close to the valley in the forecast (usually the first day of thunderstorm formation over the valley) it should be stressed that the synoptic and local weather conditions could change considerably between 12Z and early afternoon, notably stability values, low-level moisture and the wind field. Although this table is for thunderstorms forming over the valley, forecasters with an interest in the area are encouraged to try to predict the movement of the thunderstorms and what areas they might affect. The forecast table is of course far from perfect but it is believed that reasonably accurate forecasts can result from detailed analyses and accumulated operational experience.

TABLE 1

FORECAST DECISION TABLE FOR THUNDERSTORMS FORMING OVER THE UPPER CURRENT RIVER VALLEY DURING THE AFTERNOON

(Based on observed forecast 12Z conditions over the UCRV)

PARAMETER	VALUE	YES	NO	REMARKS AND DATA SOURCES
Low level wind Sfc. Geostrophic	$120^{\circ} \leq \omega \leq 240^{\circ}$ 5 kts or calm			(9AM), LFM progs (L2M etc.)
Sfc. Dew Points	$\geq$ 65°F 18°C			12Z SFC observations for PØ2, TBN and CGI. (Under these conditions dew points will generally rise during the day.)
Strong Surface Heating				Generally clear skies or thin cirrus over area before onset of convection (100% sunshine is ideal.) Satellite data is best source.
Stability Indices	Only one of the Showalter or lifted indices need to be checked.			
Showalter Lifted Index	$\leq$ 0 $\leq$ -4			UMN and SLO RAOB Plots; LFM (12L, 14L, etc.), FRH65, FTJ56, interpolation of UMN and SLO RAOBS is best method.
K-Index	> 25			
850 mb wind	[1] $120^{\circ} \leq \omega \leq 240^{\circ}$ calm or light and variable			1. No wind speed criteria is given for a favorable direction. 8ØA
700 mb wind	[1] $120^{\circ} \leq \omega \leq 250^{\circ}$ calm or light and variable			7ØA
500 mb wind	[1] NE-S-W or < 15 kts			5ØA

APPENDIX B

RADAR FILM HISTORY OF 26 JULY 1982

The study of the radar film of 26 July 1982 is especially instructive and interesting. Convection was occurring over the UCRV in various stages from dawn until dusk and the influence of the valley is obvious. The 26th was characterized by a southeast surface wind and an unstable atmosphere. Air mass thunderstorms formed elsewhere in southeast Missouri and southern Illinois as should be expected under these conditions.

Note: The dashed lines on the STL radarscope approximate the major ridgelines of the UCRV (reference Fig. 2 in text).

26 July 1982 STL RADARSCOPE 125 NM RANGE

<u>1117Z</u> Isolated rainshower over the Current River. The echo was apparent on the radar film from 1100-1202Z. This was an unusual occurrence since the katabatic winds would be expected to dominate at this time.

<u>1458Z</u> First echo on radarscope forms on the ridgeline south of Salem.

<u>1544Z</u> Convection continues along ridgeline south of Salem. Little movement noted.

<u>1646Z</u> & <u>1656Z</u> Convection intensifies and begins to take on an arc-like shape as it moves away from ridgeline.

<u>1711Z</u> Strong convection has consolidated into a solid arc or wedge like complex. Movement is slow to the northwest.

<u>1740Z</u> The thunderstorm complex has moved almost completely out of the UCRV and no new convection is observed forming over the valley. This particular occurrence is very similar to that of 14 July 1983 (see Fig. 9). With a southeast surface wind and unstable atmosphere the convection over the UCRV appears to occur in pulses or waves. Convection first forms and shows little movement and then organizes and moves out of the valley in a characteristic wedge or arc shaped convective complex. Whether these occurrences are due to the unique shape and geography of the UCRV remains to be seen. In any case these very strong, northwest moving thunderstorms are quite unusual. This may be the most important and potentially dangerous aspect of the UCRV system. The UCRV should be monitored closely by radar operators once convection has begun, especially if stability indices are very low and low-level winds are southeasterly.

<u>1812Z</u> Thunderstorm complex weakens and loses integrity. Several small cells forming on ridgeline south of Salem.

<u>1912Z</u> Light convection continues on ridge line south of Salem while light convection formed to the southeast has begun to spread into the UCRV.

<u>2014Z</u> Convection is increasing over the UCRV.

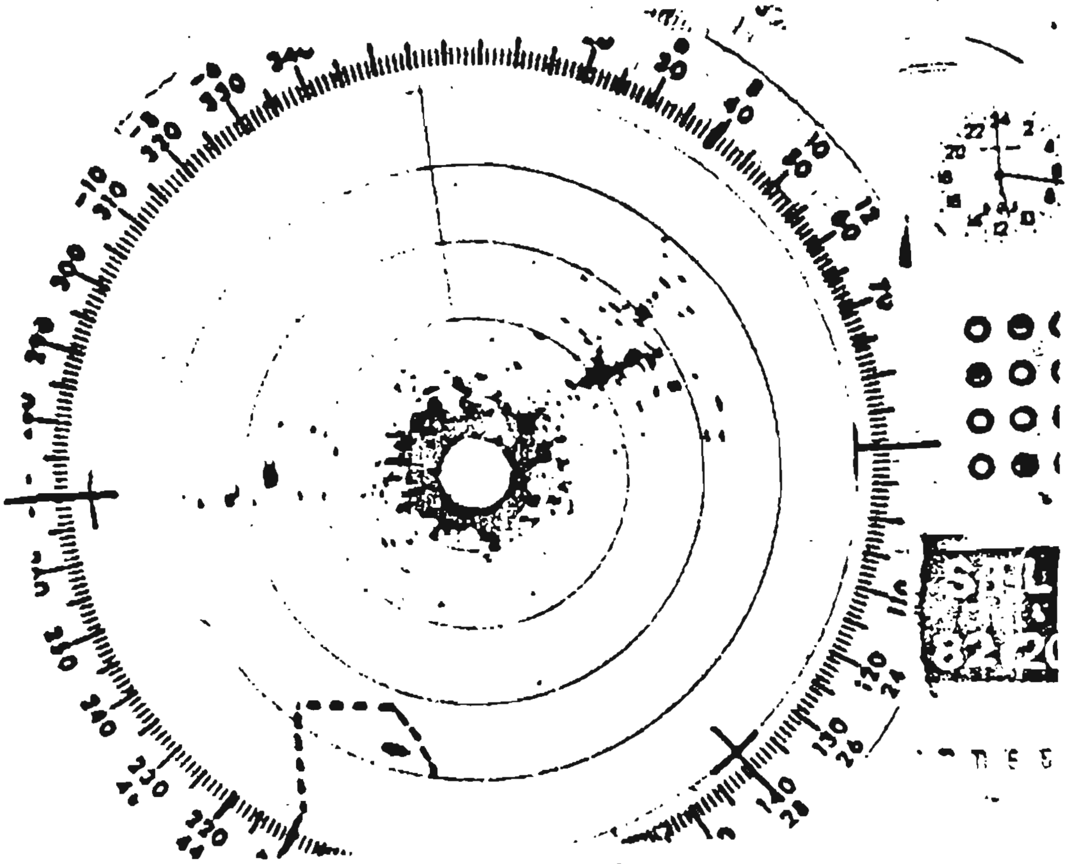
<u>2058Z</u> Numerous thunderstorms over the UCRV. Very little movement noted.

<u>2252Z</u> Convection decreases over UCRV and ceases to the southeast.

<u>2346Z</u> Convection intensifies over UCRV and virtually ceases in nearby areas.

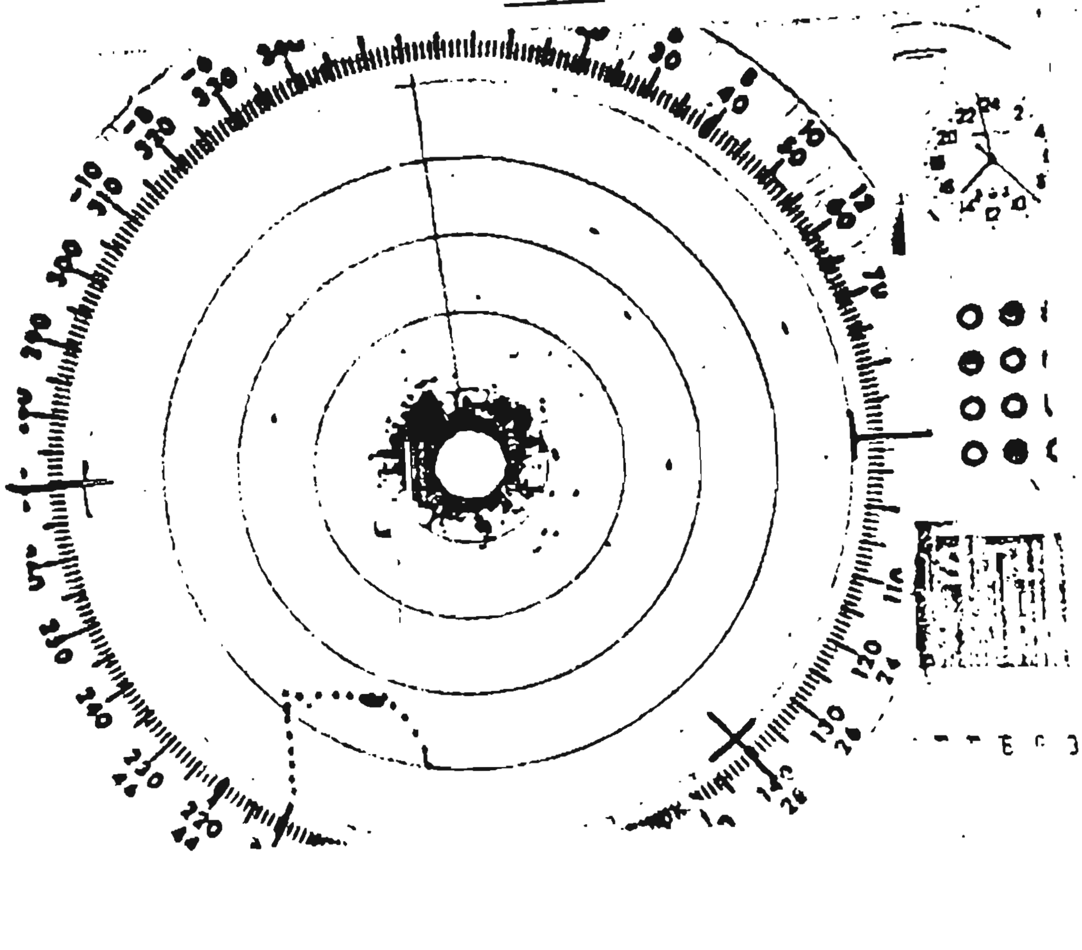
OTHER RADARSCOPE PICTURES

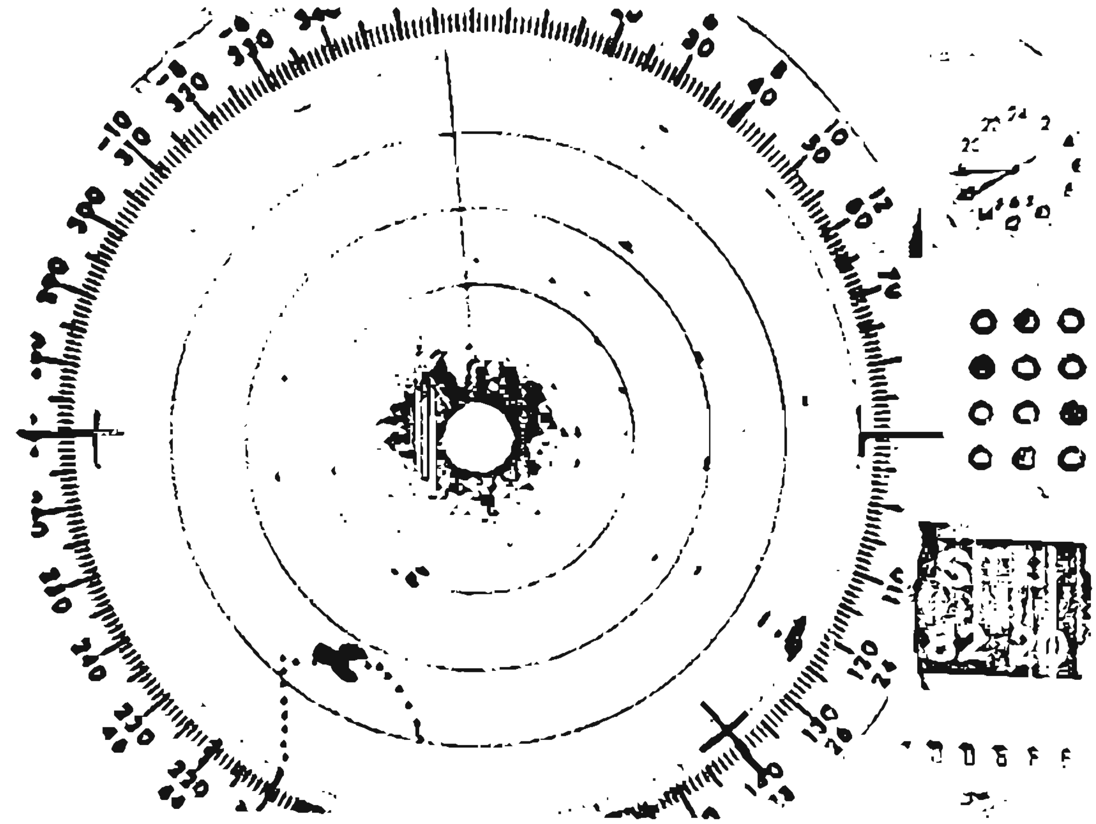
STL	25 JULY 1982	2235Z	First echoes form over the northeast side of the UCRV.
UMN	13 JULY 1983	2058Z	250 NM Range. Another view of the thunderstorms that formed over the UCRV on 7/13 (reference Fig. 7b). The only other echoes noted are those over mountainous regions of northwest Arkansas. Last cell formed over the UCRV at "A" is just south of Licking.



7/26/82 1117Z

1458Z





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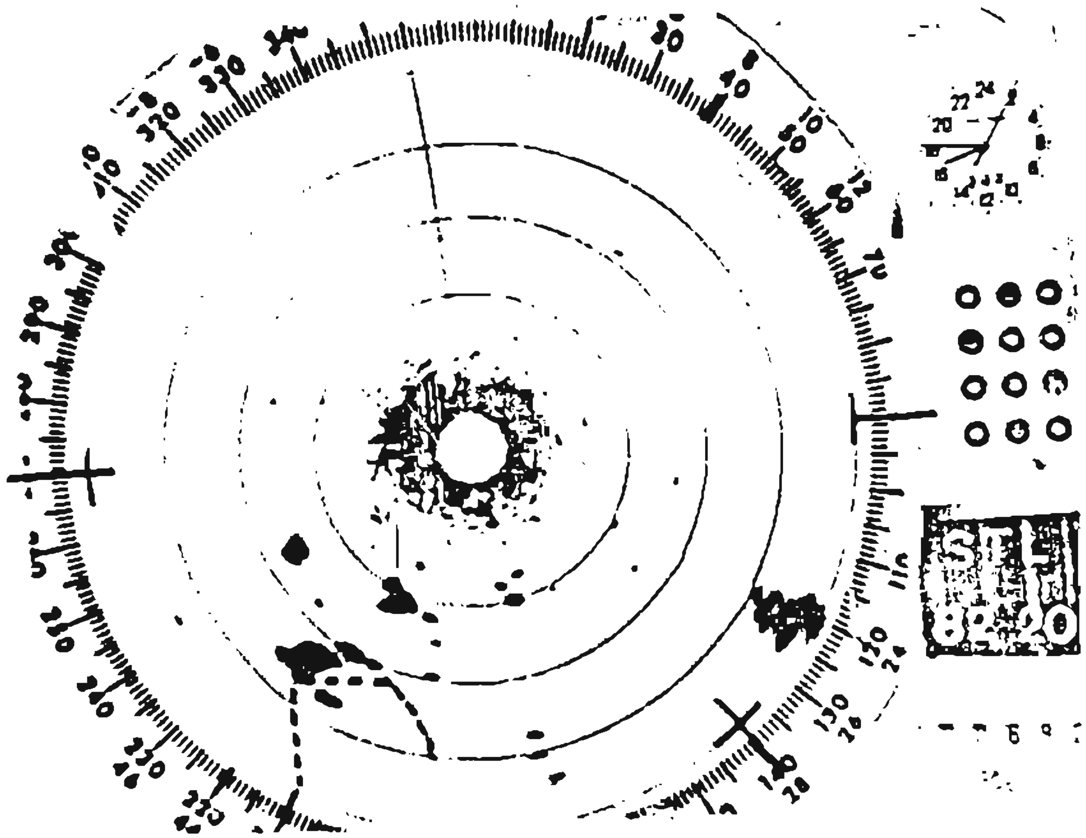

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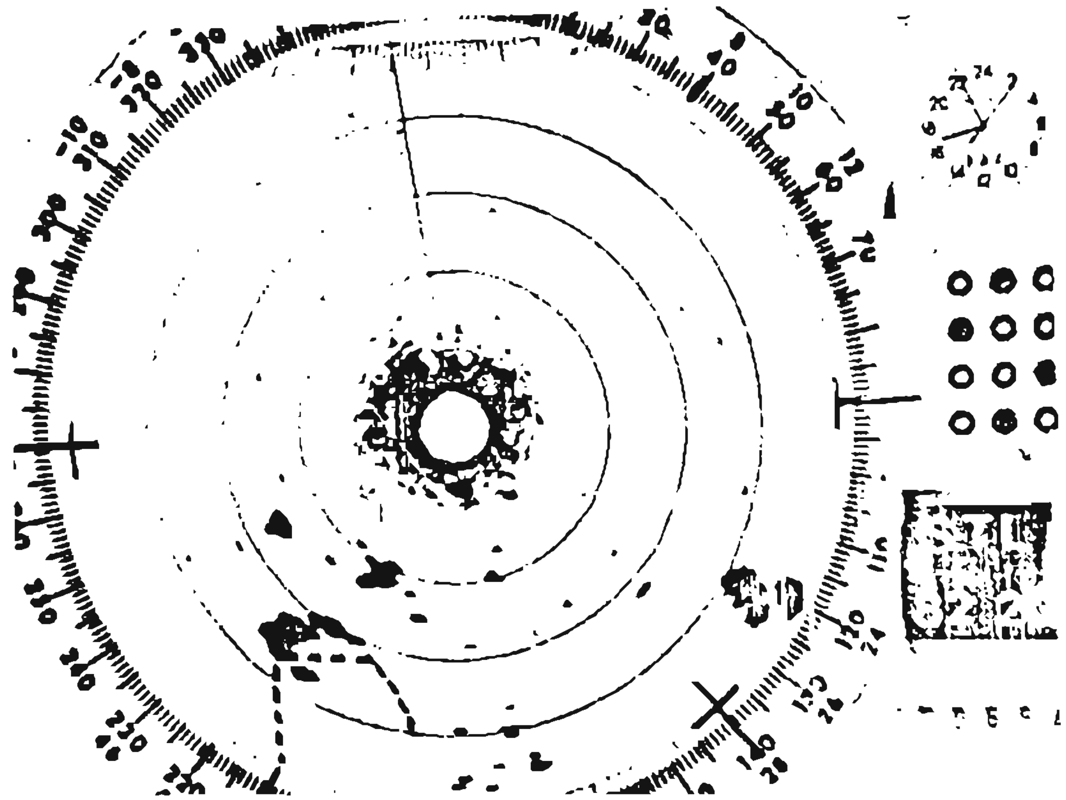
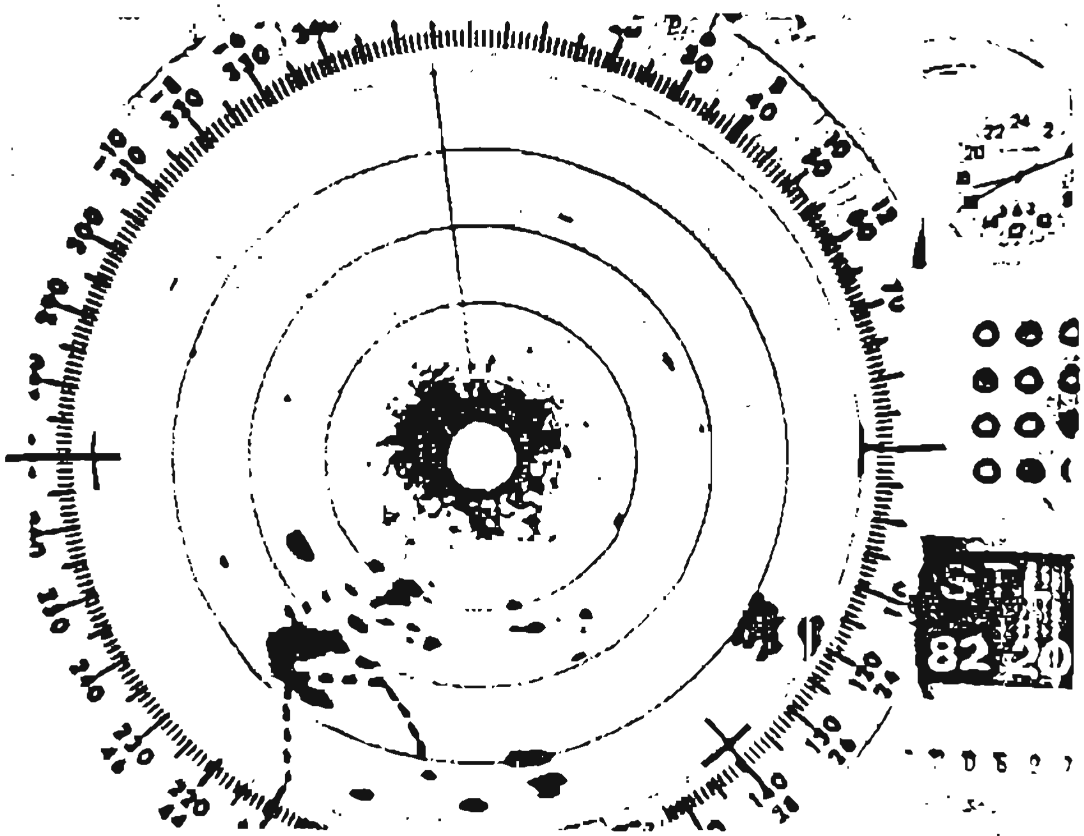
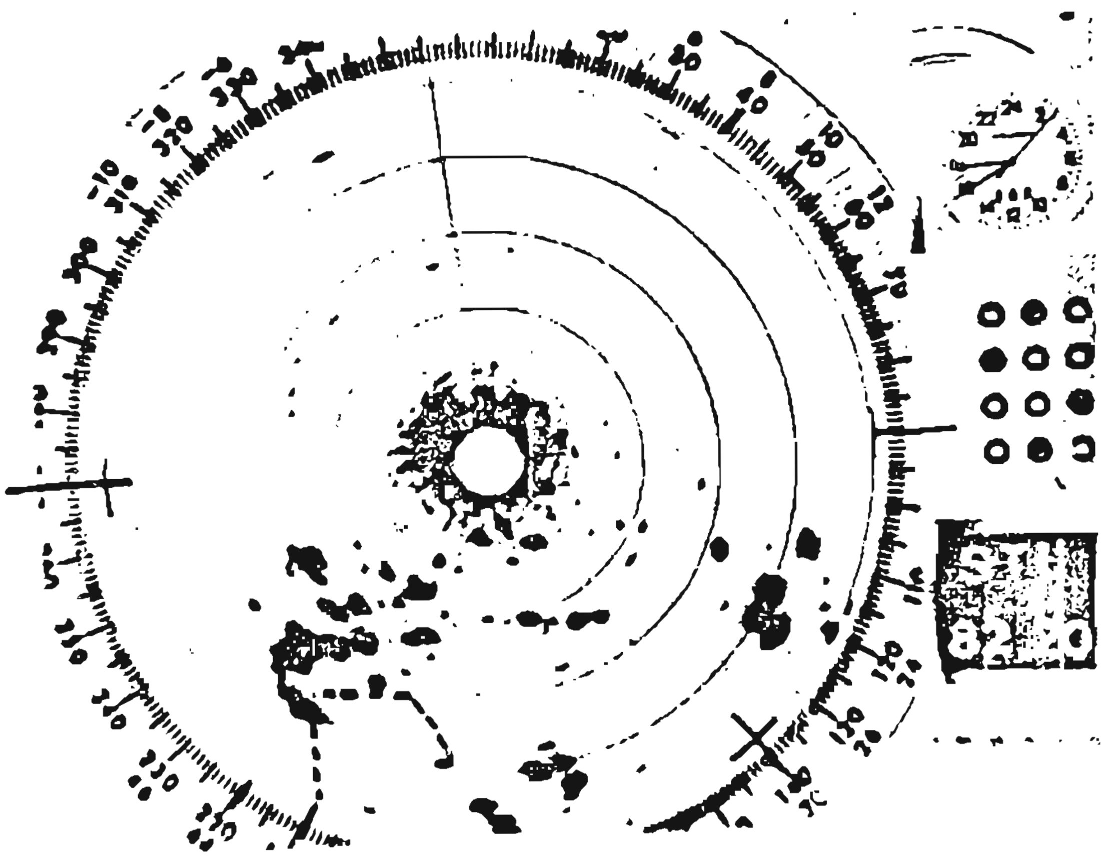


1656Z



1711Z



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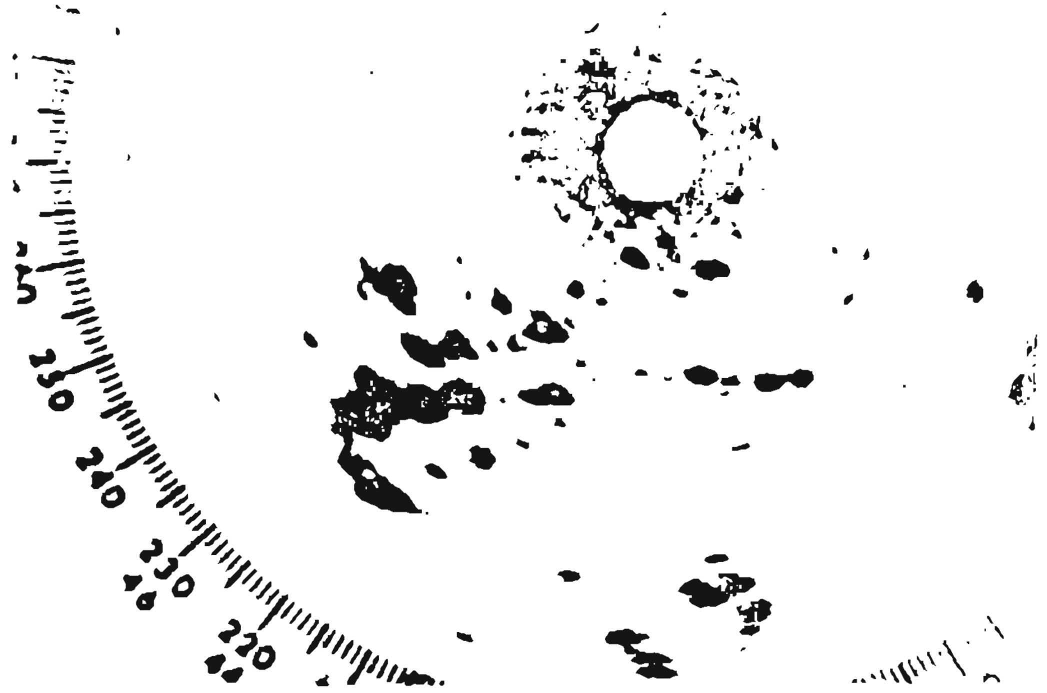

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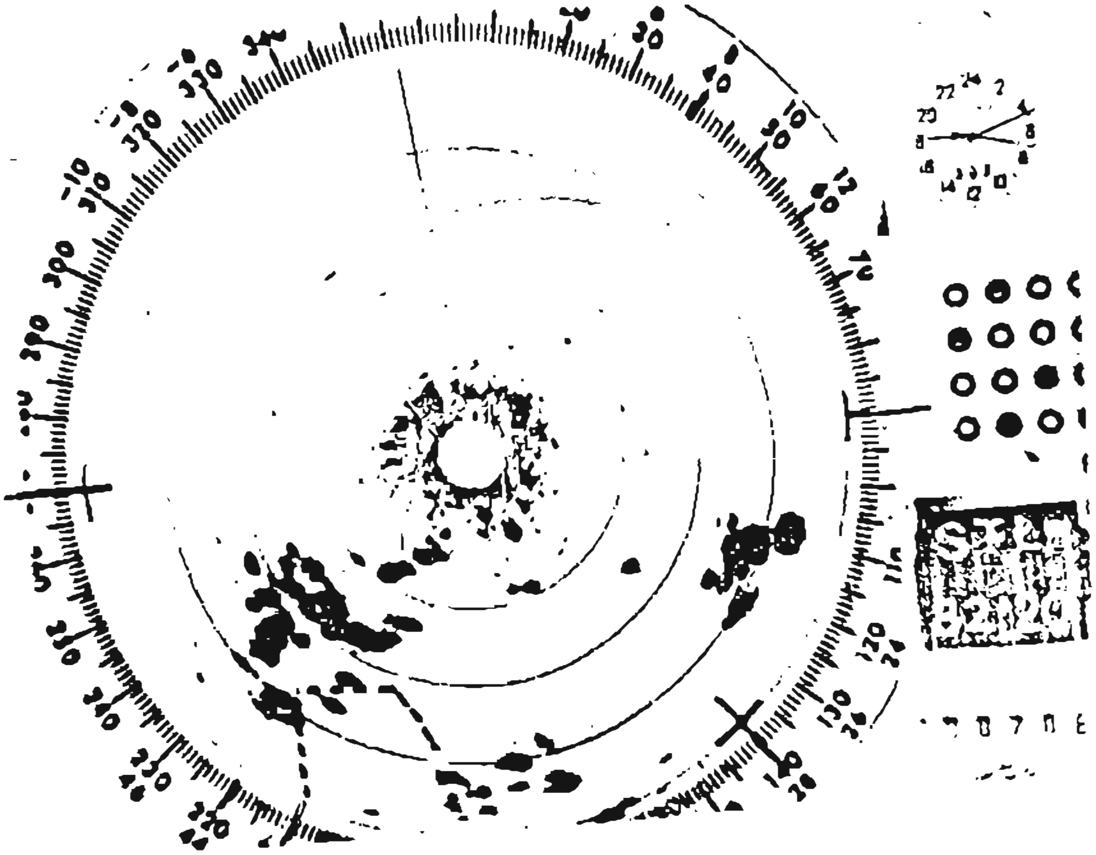
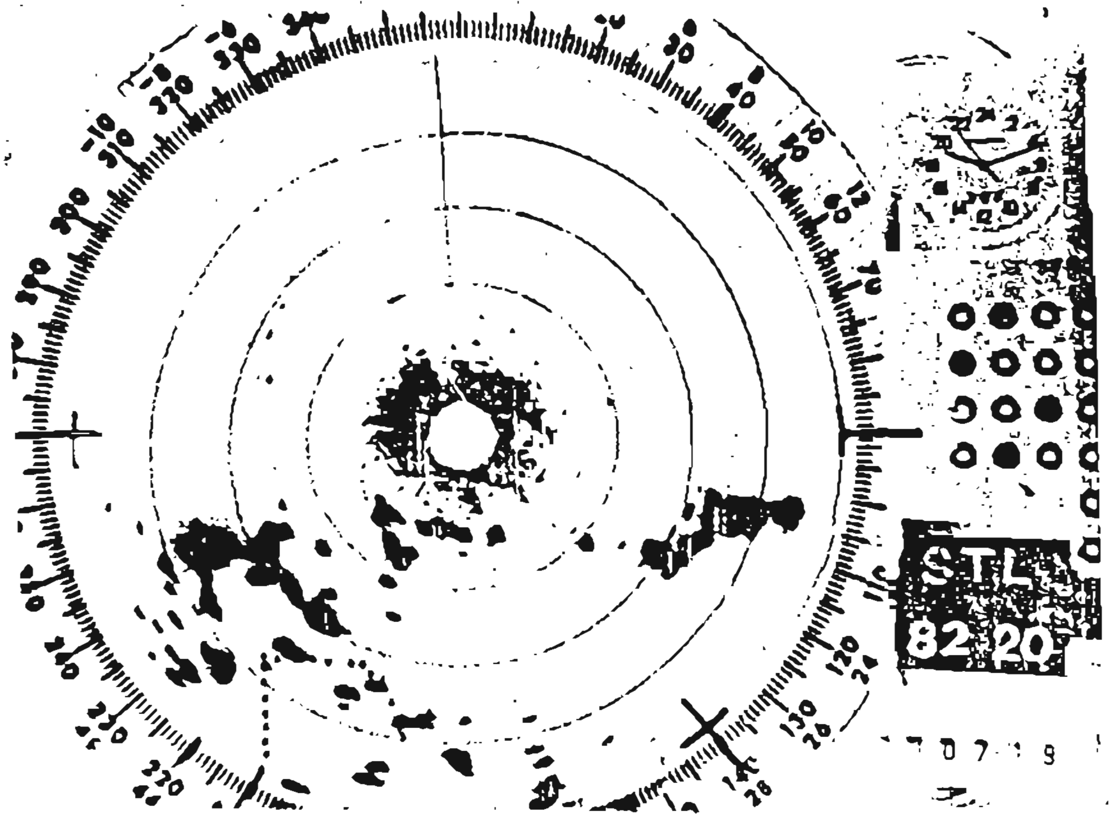


1812Z



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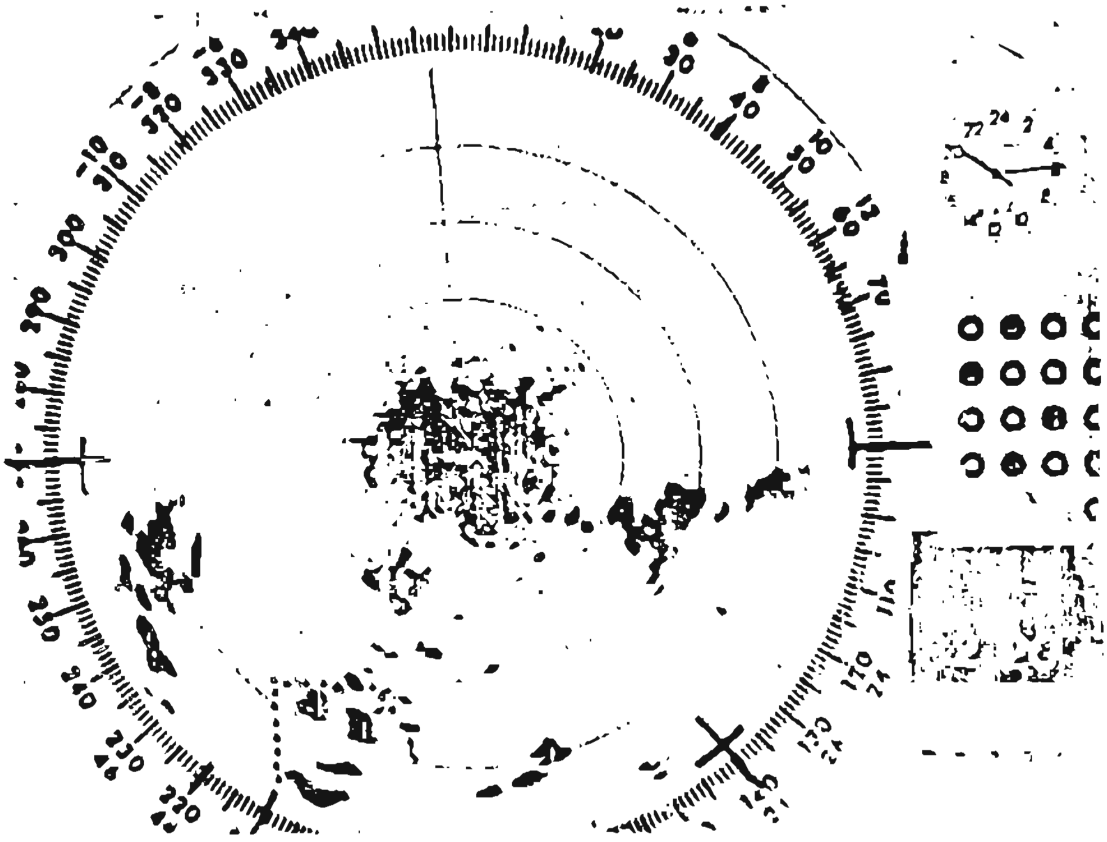

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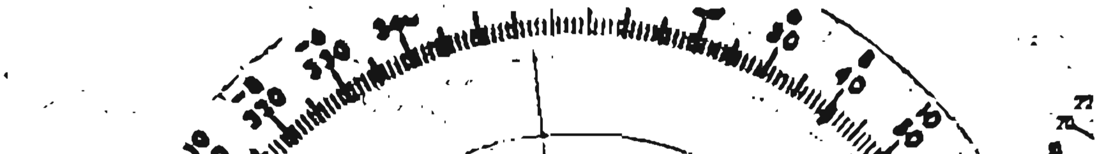

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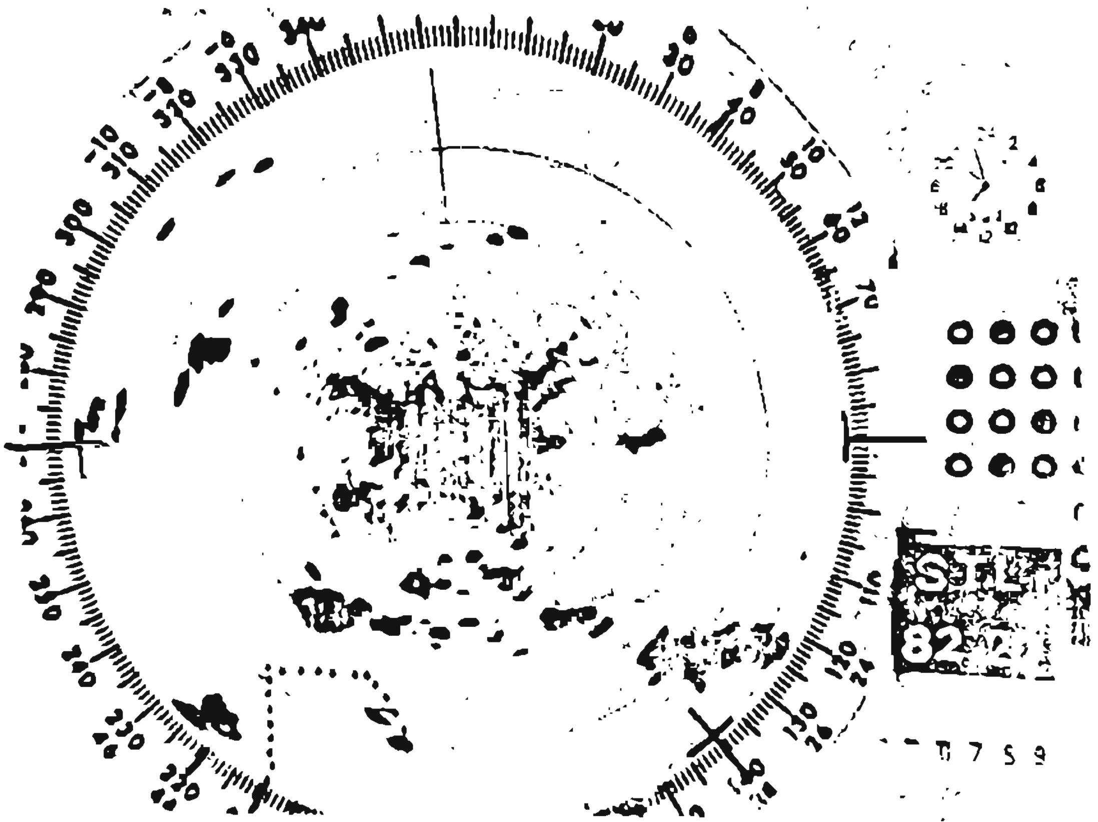
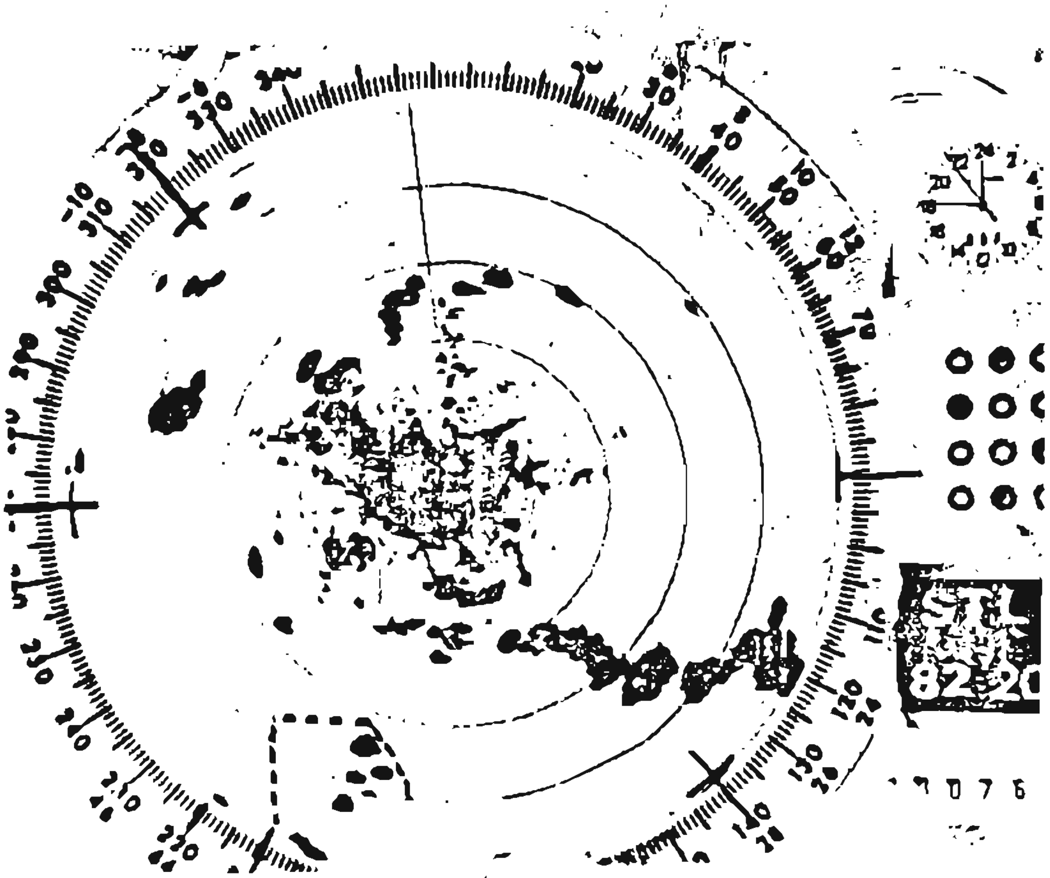
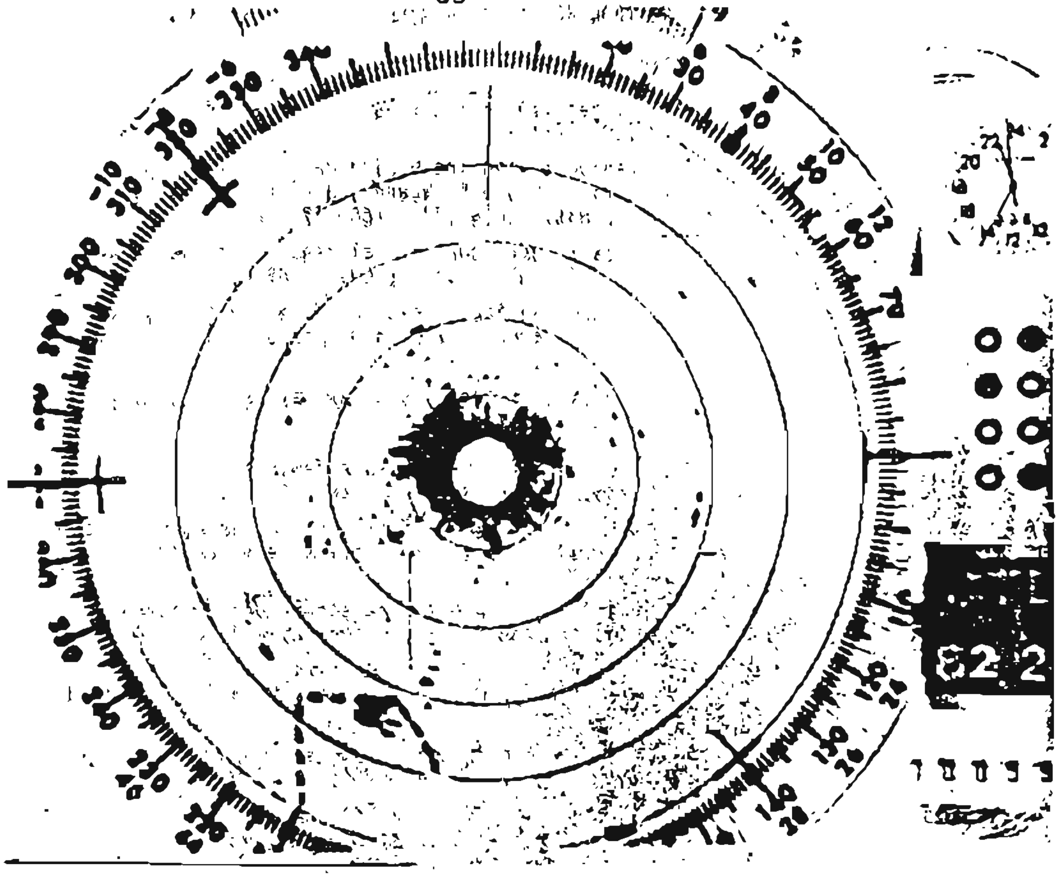


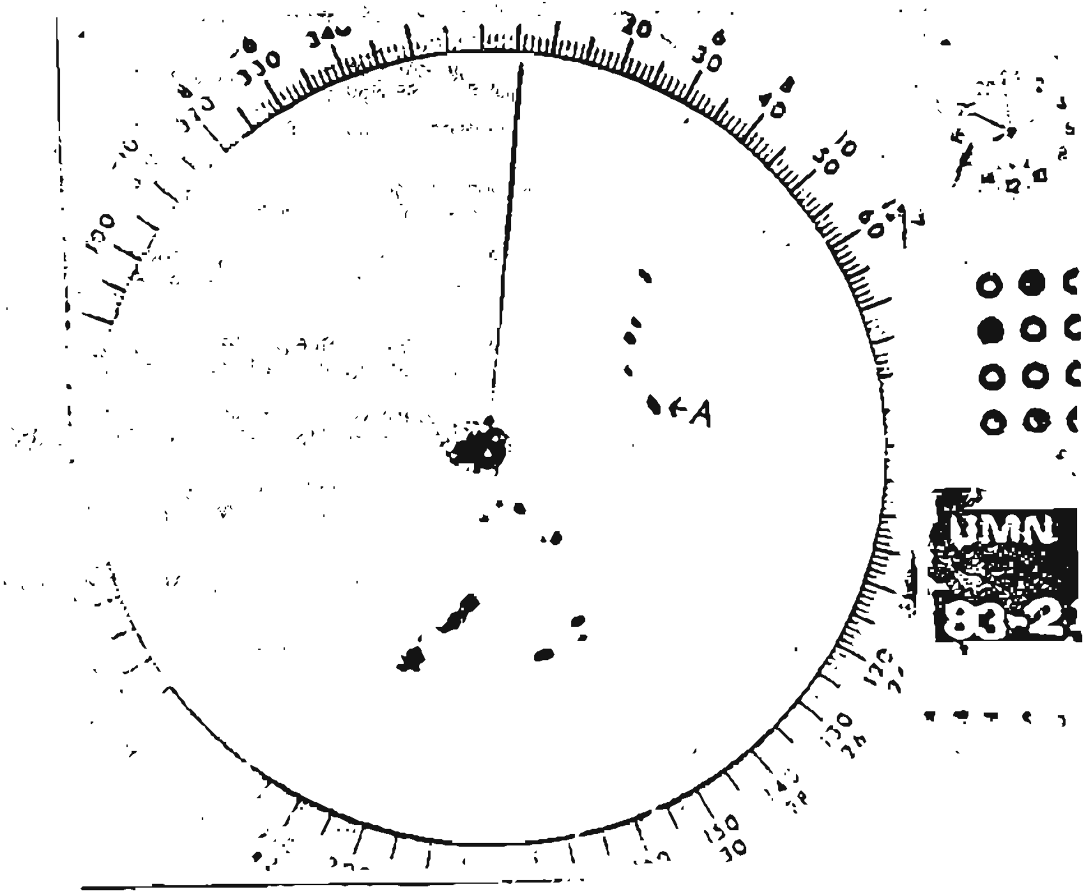
2252Z



2346Z



7/25/82 22352



UMN radar 7/13/83 2058Z

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