COMPUTER ANIMATION OF METEOROLOGICAL DATA

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Abstract

Animation of meteorological observations of the atmosphere, and the techniques for producing the animation, are presented. First, the design of the display frame is described. This includes numerous improvements over the static display frame that continues to be used for still picture production. The use of segmented, or partial, display frames is then described. The significant value of segmented display frames is pointed out. Results of both partial and full frame displays are shown. In spite of the fundamental problem of animating data that lacks continuity both in time and in space, the results show the value of such animation in displaying the temporal and spatial history of the data.

1. Introduction

This paper is the second of two papers on the subject of computer graphics for meteorological data. The previous paper (reference 1) introduced the problem of manual plotting of meteorological data, described computer algorithms and graphics hardware for automating the work involved, and presented some of the results obtained. While the work described in this paper makes use of the same hardware and algorithms described in reference 1, this paper discusses the extension of the problem into the area of computer animation of meteorological data. The reader is referred to reference 1 for description and discussion of the hardware and basic algorithms.

Animation is normally thought of as the simulation of continuous motion by the rapid viewing of a sequence of still images, each of which displays the same object, but with a small incremental change in position from one frame to the next. In order to achieve a good simulation of motion, it is necessary to have a continuous series of these incremental changes with no discontinuities appearing in the sequence of images.

There is a fundamental problem in the animation of meteorological data, in that the data are discontinuous both in time and in space. However, since the purpose in animating these data is not to simulate continuous motion, but to display the temporal and spatial history of the data, the discontinuities do not pose a problem. Perhaps animation is not the right word to use, but we use it for lack of a better one.

2. Description of the Problem

Many measurements of the atmosphere are made almost simultaneously, all around the world, at fixed times each day. These times are called synoptic times. The main synoptic times are 00 hours (midnight) Greenwich Mean Time, 06 hours GMT, 12 hours (noon) GMT, and 18 hours GMT. In addition, numerous measurements are made asynoptically; that is, either sporadically, intermittently, or continuously in time. Some of these asynoptic data come from commercial aircraft, some from space satellites, and some from various other sources.

In the animated display of these data, the most notable features will be the sudden appearance of many observations at each of the synoptic times, their disappearance at the hours in between, and the scattered sporadic, intermittent, and continuous appearance of data from numerous sources, such as aircraft and satellites. The problem is to design an animated display of these data that gives the desired effect; that is, one that displays the temporal and geographical history of the data.

3. Design of the Display Frame

Figure 1 shows a typical frame as plotted by a modified version of the program described in reference 1. The purpose of this program is to produce, on film, a still image with considerable detail, which can be printed on a microfilm printer, and studied at some length. The noticeable changes from reference 1 are the elimination of the hour notation (e.g., 10Z) from the satellite observations, and the addition of one of several letters at the head of some wind arrows. The dot at the arrow head still indicates a land based radiosonde observation, but we now have also the letter S for ship based radiosonde, C for satellite-tracked cloud wind, and A for aircraft report.

For the purpose of careful study, images or frames like Figure 1 are satisfactory. However, for the purpose of viewing a movie that rapidly displays a sequence of different images like that of Figure 1, there are numerous problems in the design of the frame. First of all, it is too "busy." There is too much detail to be grasped when viewing a rapid sequence of such images. Secondly, the title, labels and data values will be difficult to read when projected on a screen. Third, there are far too many data values to read. Fourth, the geography will be too faint when projected on a screen. Fifth, the rapidly changing frame number, in the upper right corner, will be distracting. Six, the title has too much information.

These numerous problems have been solved by changing the design of the frame as follows. By using vector drawn characters, the latitude and longitude labels have been enlarged to make them more legible. The title has been simplified and enlarged even further, and the frame count has been removed. All data values have been eliminated, and the dot representing satellite temperature observations has been changed to an asterisk. Thus, wind information, and the location only, of the satellite temperatures, are displayed. Finally, the faint, dotted geography has been replaced by solid line geography. A typical frame of the movie now looks like Figure 2.

4. Display Files

Once the computer program has generated the many thousands of commands necessary to make the graphics hardware produce one complete frame, this set of commands (preceeded by a camera frame advance command) is written to a display file, which is then written to a magnetic tape for later processing on the graphics hardware. In order to display one image for one full second, at a projection rate of sixteen frames per second, it is only necessary to copy the display file to the magnetic tape sixteen times. This saves a great deal of computer time since it would otherwise require recomputing the thousands of commands sixteen times. Figure 3 shows several repeated frames taken right from the film itself.

A significant amount of computer time is also saved by the use of partial display frames. It is obvious that, even when the data to be displayed changes, there is much of the display frame that does not change. The frame borders, latitude and longitude labels and tic marks, and geography do not change. Therefore, the commands to generate these parts of the frame are written to a partial display file and need never be recomputed. The title changes only when the month, day, or hour changes. Thus, these commands are written to a second partial display frame. The commands for plotting the data observations are partitioned by data type. That is, commands for plotting conventional data are written to one partial display file, while commands for plotting satellite temperature data are written to another partial display file. This allows for projecting the different types of data on the screen for different lengths of time.

If each of these partial display files were plotted individually, they would result in the images shown in Figures 4 through 7. However, they are not normally plotted individually. The final display frame to be plotted is created by concatenating the commands from the partial display files into one complete display file. This is done simply by writing each partial display file sequentially to the complete display file. The resulting image is shown in Figure 8.

5. Conclusion

First, it is clear that the use of partial display frames to create a complete image is a valuable cost and time saving technique, where the images to be projected on a movie screen can be partitioned into parts, each of which changes with different frequencies. That this technique is applicable to any kind of animated film, is quite obvious.

Less obvious, however, is the value of displaying animated meteorological observations in this manner. Since the data are generally discontinuous in time and space, the animation tends to be quite jumpy. It does, however, give a good feeling for the spatial and temporal coverage of the data.

Occasionally, the animation does result in features which appear to be continuous in time, when the density and frequency of the data are sufficient. The meandering of the jet stream over North America, two instances of which are shown in Figure 9 and 10, can be readily seen when viewing the movie.

Although the animated display of meteorological data in this manner has limited value, particularly when contrasted to the costs involved in producing such a movie, it does have sufficient value to justify the cost and effort when dealing with large quantities of data.

REFERENCES

1. Computer Graphics for Meteorological Data, Ronald A. Lusen, Geophysical Fluid Dynamics Laboratory/NOAA, Princeton University, Princeton, New Jersey.

9/ 5/74 22 GMT THROUGH 9/ 6/74 3 GMT + 200 MB LEVEL

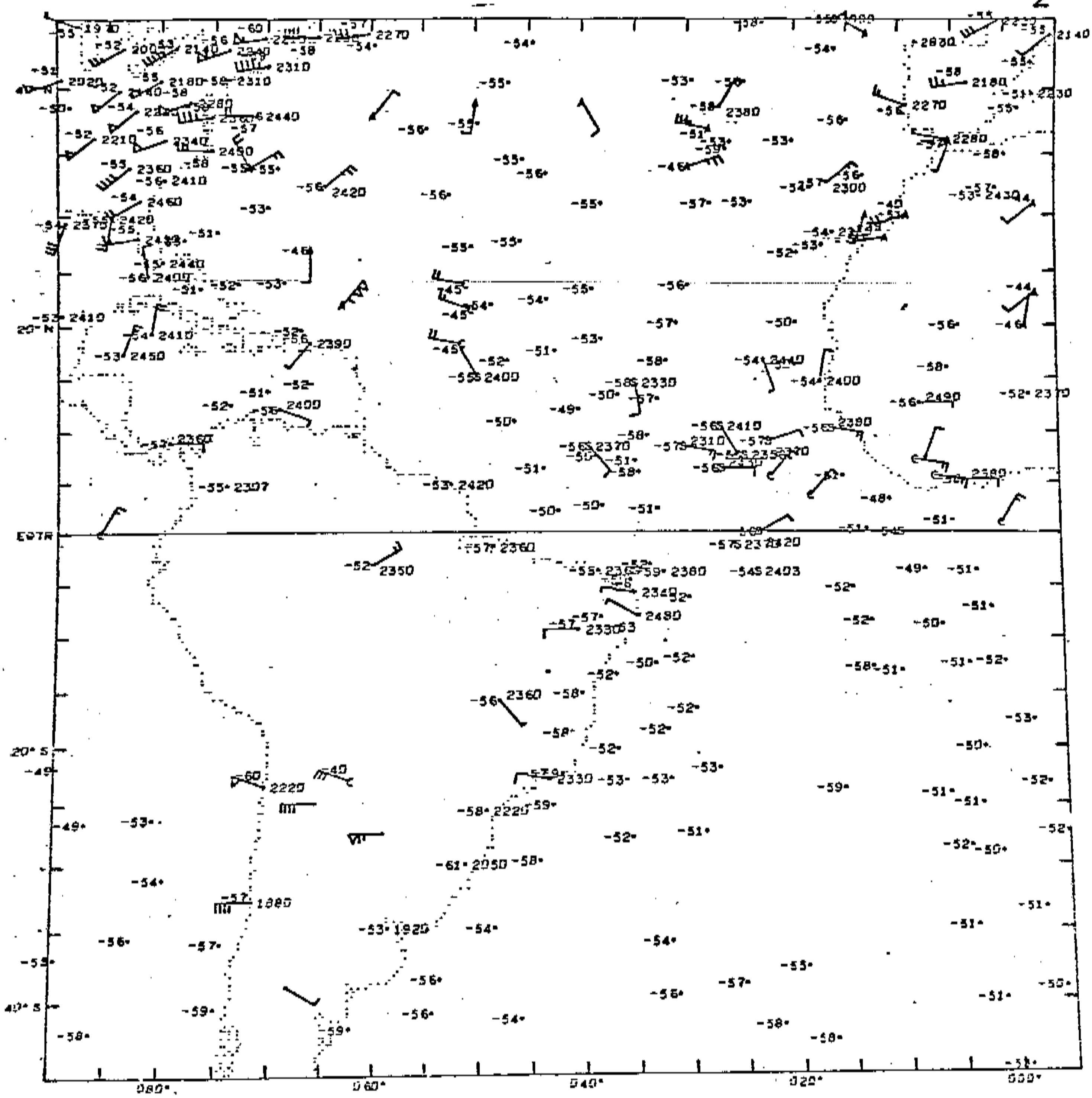

Figure 1

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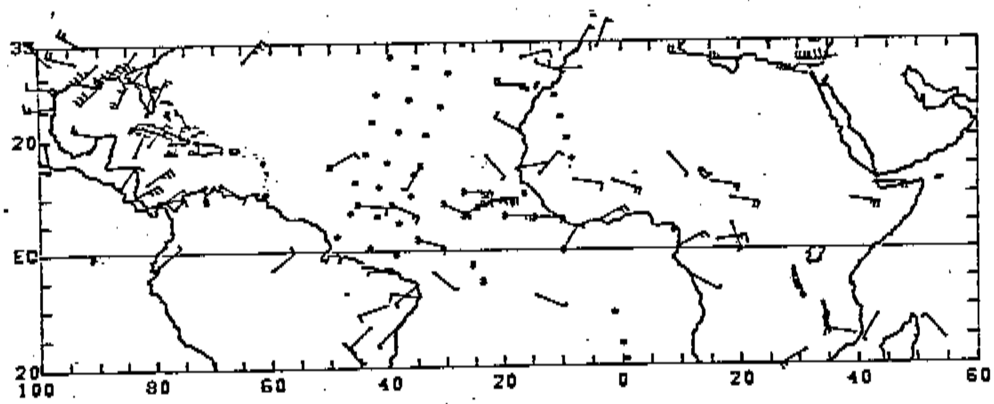
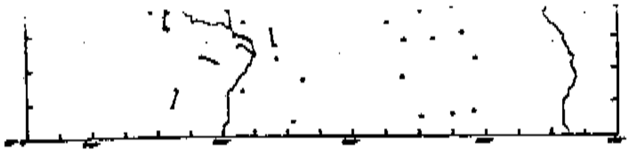


Figure 2



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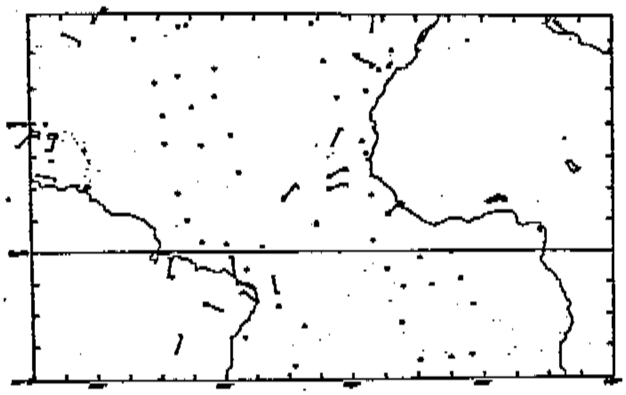

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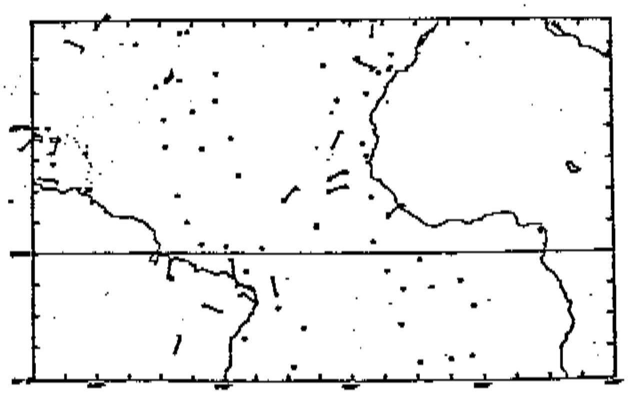

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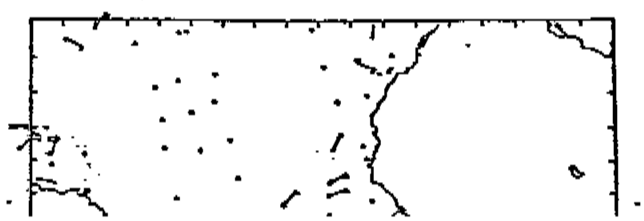


Figure 3

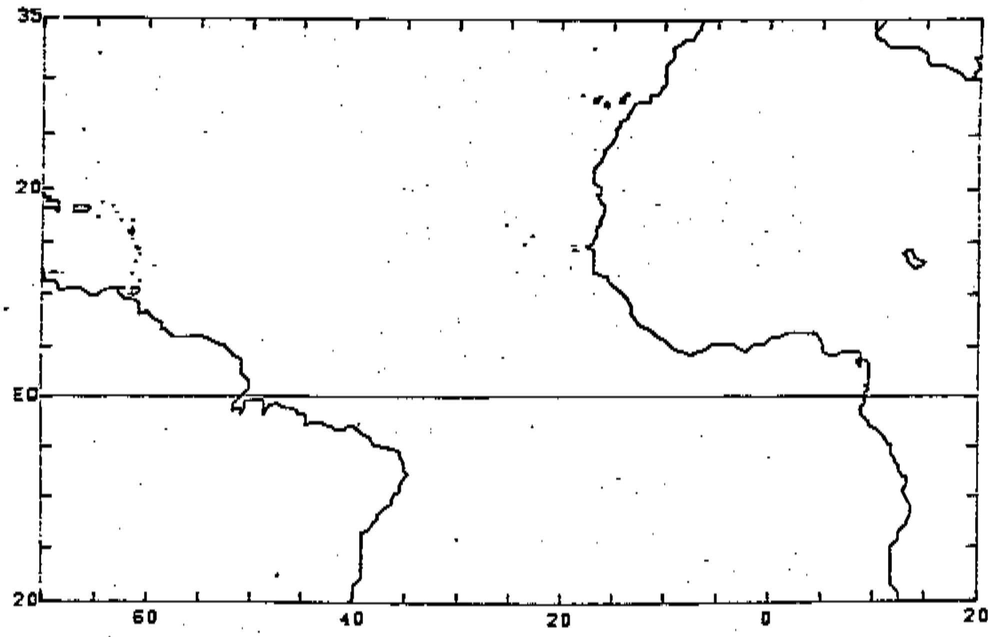


Figure 4

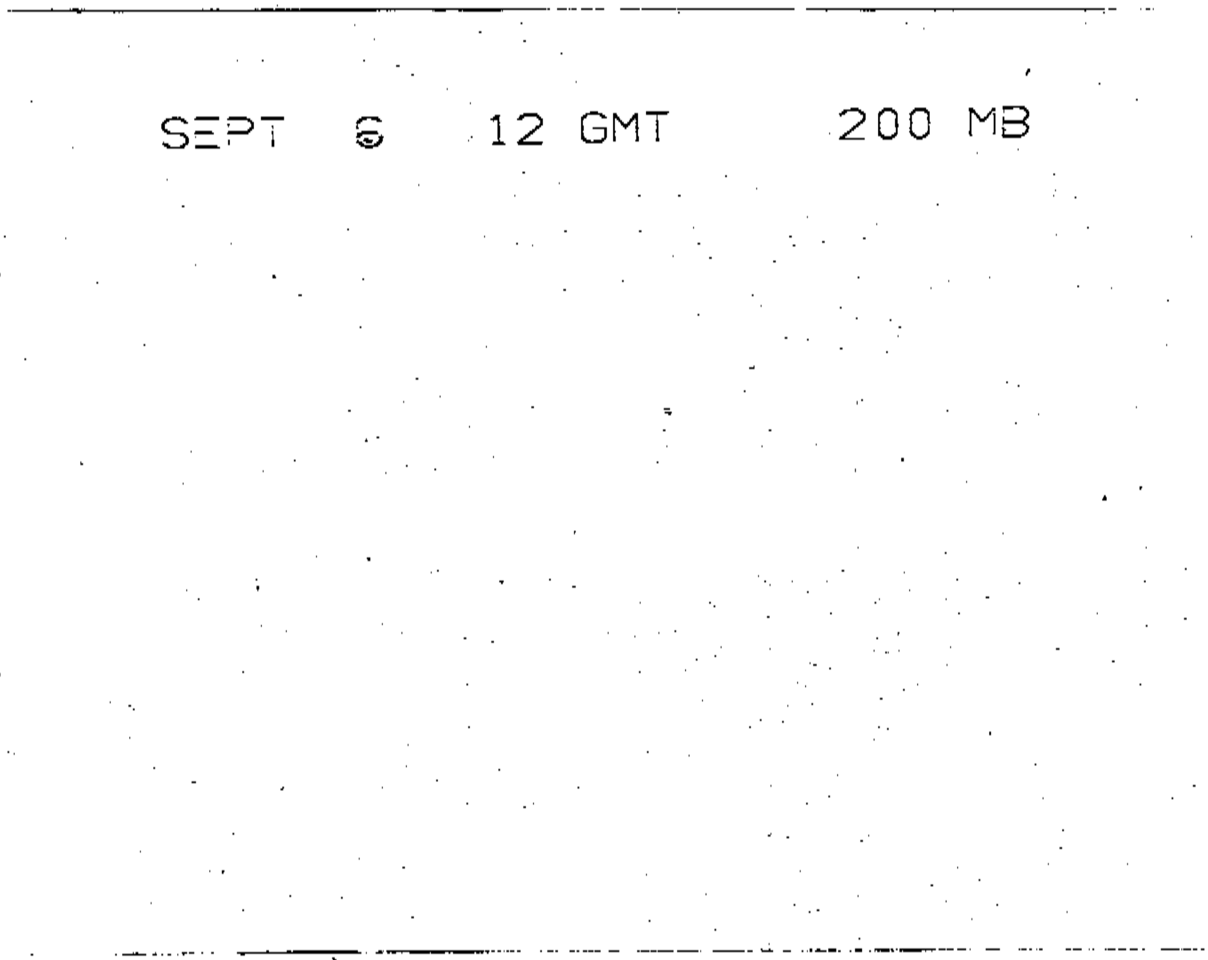
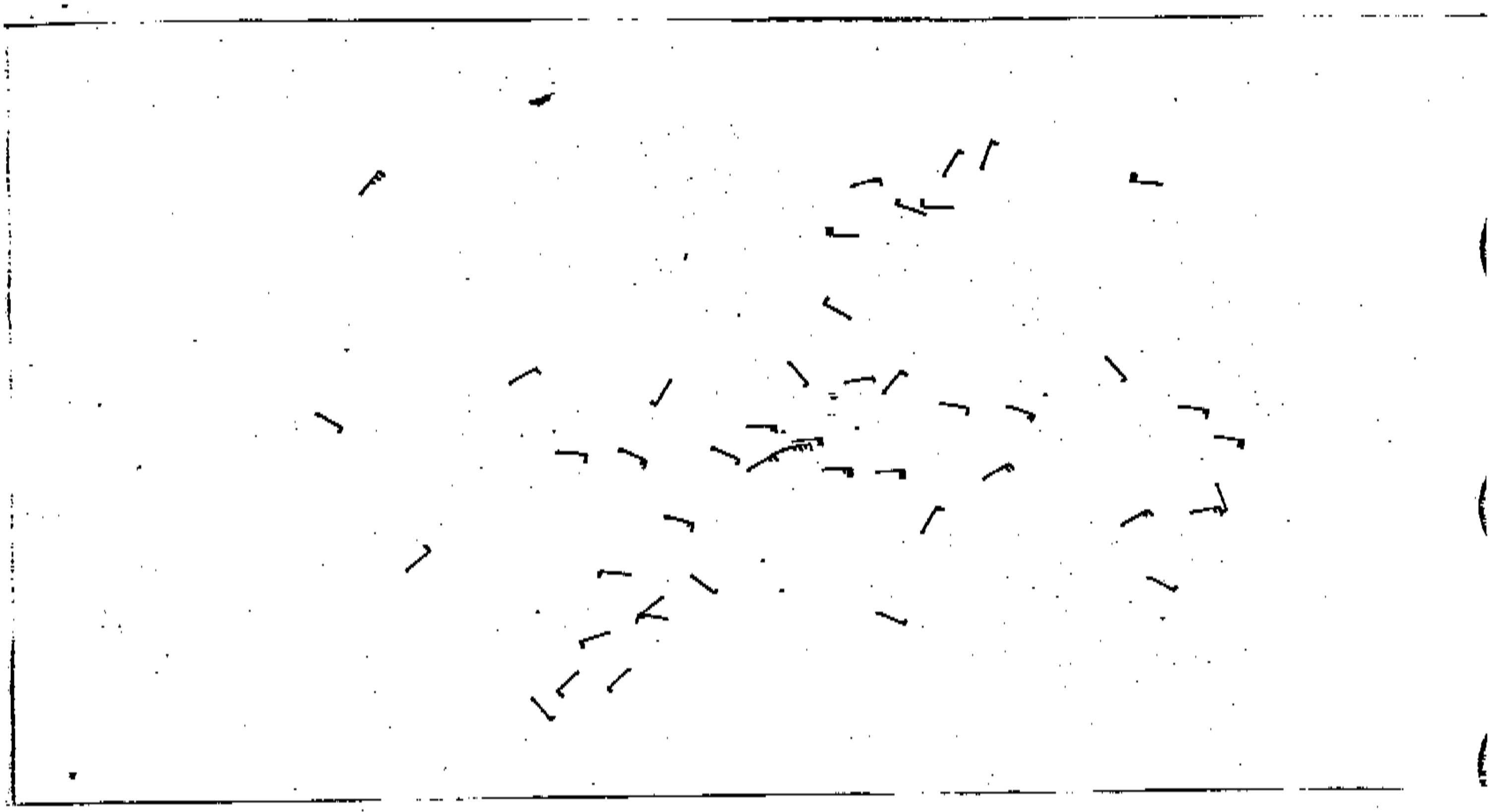


Figure 5



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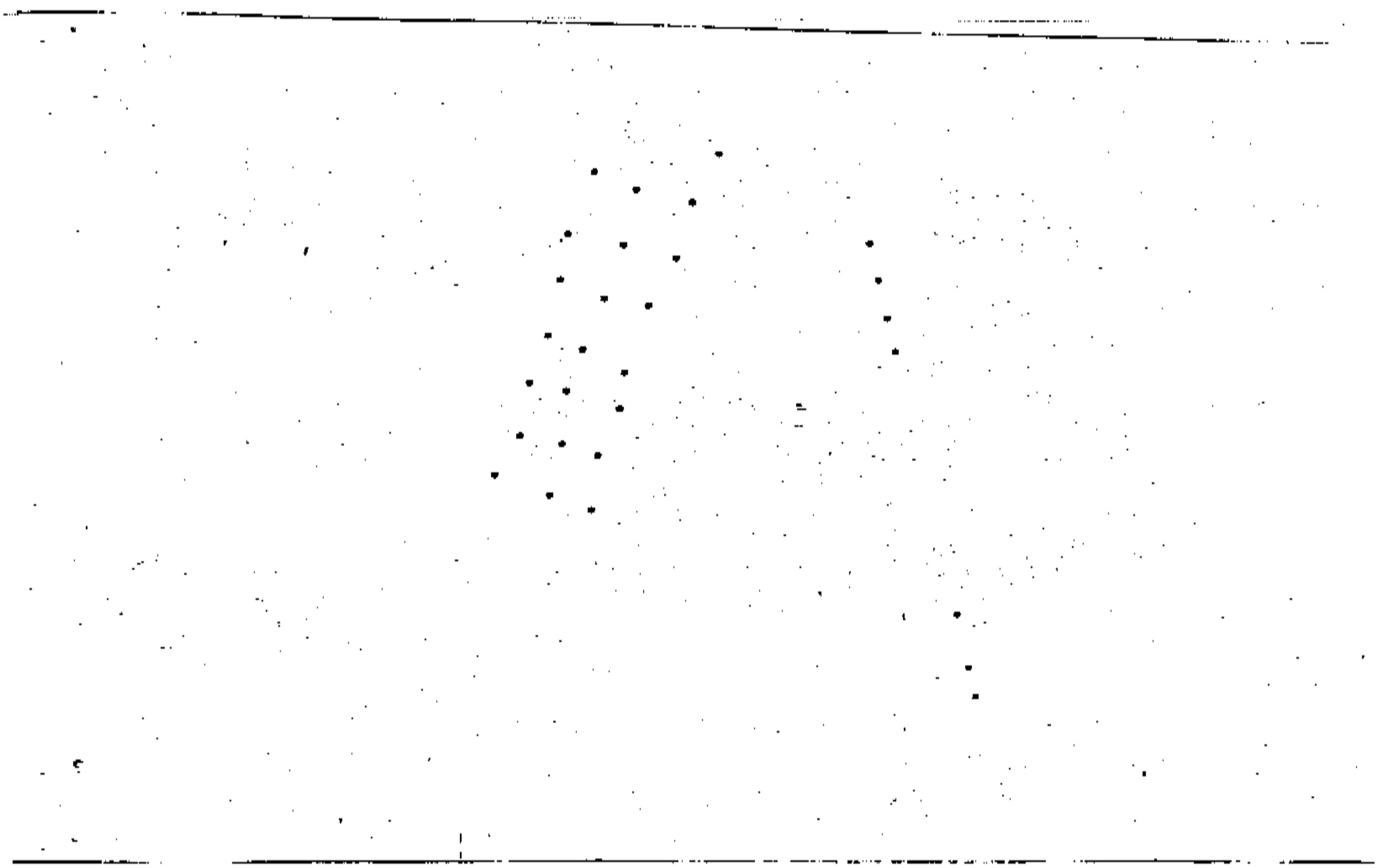

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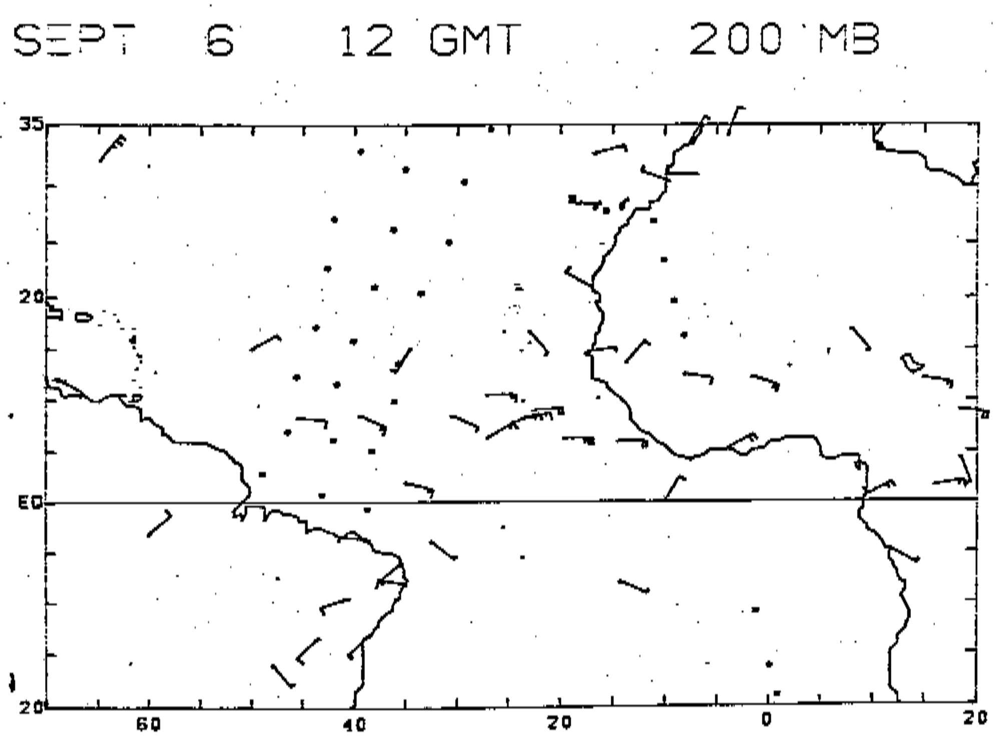

Figure 8

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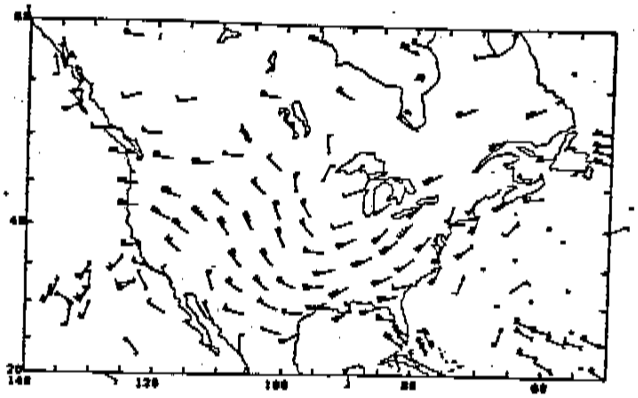

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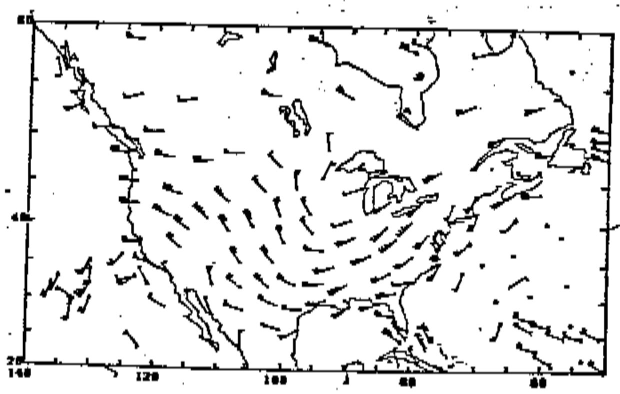

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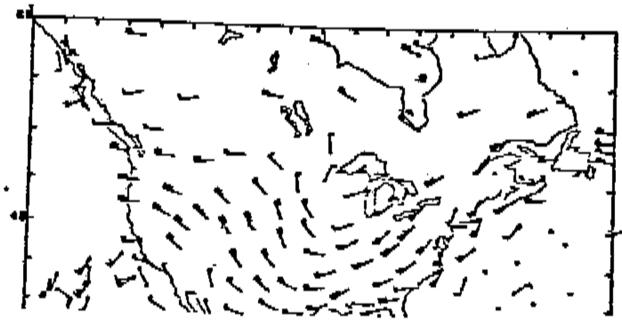
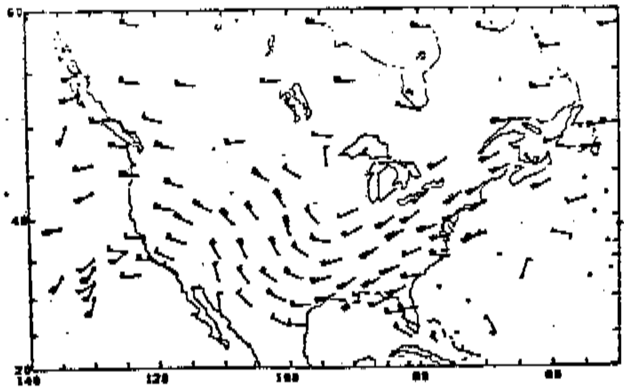


Figure 9



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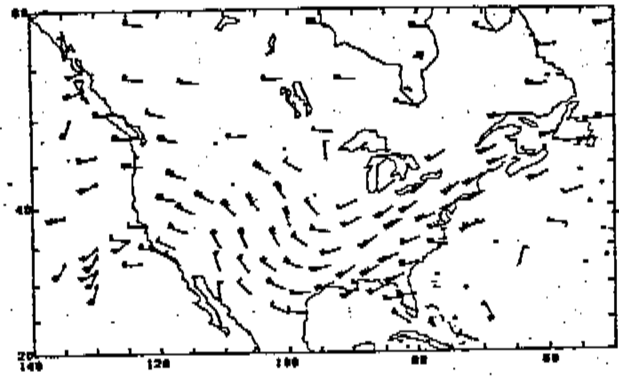

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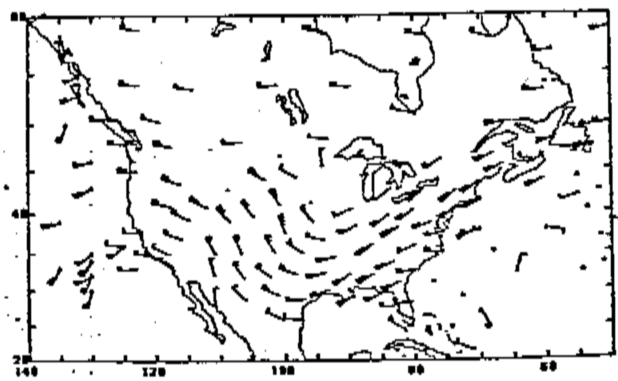

Figure 10

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