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REPORT ON THE WISCONSIN PARTICIPATION IN THE AUGUST-SEPTEMBER 1975 DST

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I. INTRODUCTION

The Space Science and Engineering Center (SSEC) of the University of Wisconsin participated in the August-September 1975 Data Systems Test (DST) from August 16 - September 21. Winds were derived from cloud motions using SMS-1 image data. Four data sets were produced each day. Out of a possible 142 data sets during this period, a total of 135 were produced, making an operational reporting reliability of 95%. For these 135 data sets, an average of 1046 vectors were produced for each data set, making a grand total of 141,216 wind vectors for the five week operation.

This report is intended as a summary of the operations at Wisconsin during this DST. It will cover the system used during this DST and how it differed from previous DSTs. It will cover the training and operational procedures used during this DST. Finally in the appendix will be the entire list of the number of winds produced for each time period of the DST.

II. SYSTEM CONFIGURATION FOR AUGUST-SEPTEMBER DST

The cloud motions were measured on the McIDAS (Man-computer Interactive Data Access System). This is an image storage, display, and processing system consisting of data archive, data access, video display, operator console, and computer control sections. Central to the system is a computer which controls the display section, operator console, and computer peripherals. Data enters the system from an antenna on the roof which receives the stretched SMS data. This data can either be archived on a special slant track recorder, or used in real time. The real time ingestion of data is done by using a data interface box which converts the incoming visible and IR data into 8 bit bytes, averages the elements in a line to produce equivalent 1/2, 1, 1-1/2, 2, 3, and 4 mile resolution data, packs the data into 24 bit words, and then puts the data directly onto the digital disk in real time. The data is then reformatted by the computer into standard analog TV format and is transferred to an analog video refresh disk. The registration of images is done by using a predictive navigation system. This predictive navigation is capable of predicting the position of every pixel 24 hours in advance within an accuracy of approximately one pixel. This predictive navigation and ingestion system is capable of producing aligned sequences of images in real time so that when the satellite finishes sending the images, they are immediately ready for cloud wind tracking.

Control of the McIDAS hardware and execution of the scientist's commands are achieved through a body of special software. The operator commands the computer through a keyboard using a language requiring no knowledge of programming. Through this software it is possible by simple key-ins to enhance an image, magnify it, combine adjacent images into loops of any length, vary loop speed by up to a factor of 30, locate and track clouds in TV, image, or earth coordinates, and display the results as a vector plot superimposed on the original image. Two independent heads on the analog disk allow double looping of infrared and visible images, with instant single key transfer from one to the other, or interlacing of the two images.

Tracking may be done by either of two primary methods: cursor tracking of the cloud to the nearest TV line and element (pixel tracking), and image match tracking of the cloud to better than TV line-element resolution (correlation tracking). Pixel tracking has been facilitated by the addition of a function called the velocity cursor. The operator positions a cursor over the cloud to be tracked using a joy stick. The velocity cursor function then automatically displaces the cursor from one picture to the next according to the position of a second joy stick. The displacement is linear within the TV line-element coordinate system, and constant from one picture to the next. The velocity cursor can be used by itself for single pixel tracking, or it can be used in conjunction with the correlation tracking. Correlation tracking requires the operator to roughly track the cloud by placing the cloud within a box for each pixture in a set. The computer then performs a correlation analysis to align the brightness field and "fine tune" the operator's tracking. Correlation tracking is the more accurate, but it requires well-defined clouds moving in a single layer flow pattern. Single pixel tracking using the velocity cursor can be invoked by the operator for tracking clouds in multi-layer flow patterns, or for matching the motion of the cursor to the motion of a pattern if individual clouds cannot be tracked.

The heights of the clouds are determined using both the visible and infrared data. The visible data is used to determine the emissivity of the cloud. The infrared blackbody temperature data is then corrected for emissivity to determine the cloud top temperature. Standard atmosphere soundings corrected for the latitude and date are then used to determine the height of the cloud. For cloud tracking using only infrared images where there is no emissivity data, the blackbody temperature of the cloud is used. The cloud height function can be requested independently of the wind calculation if desired by the operator, or it can be invoked automatically by the wind computation. The operator can also specify the height if desired.

Quality control can be applied to the derived wind measurements in several ways. The measurement can be made twice using three images. Wind measurements which do not agree within an operator set residual criteria are flagged to be in error. The height measurement also is made twice. Other quality control routines available include the best match occurrence on the matrix boundary. If during correlation, the best match of the two images occurs on the boundary of the data matrix, the data is flagged. This check is routinely used for all correlation computations. A final quality control check which is performed is the plotting of the derived wind vectors over the cloud pictures. The displayed vectors are color coded according to the height of the cloud. The operator can mark any vectors he feels which are in error. For the DST there was no conventional data comparison or large scale plot of wind vectors.

III. SYSTEM DIFFERENCES FROM PREVIOUS DST EXPERIMENTS

The August-September 1975 DST was the third in which Wisconsin participated. The first was 28 Oct.-2 Nov. 1974, the second was 25 Jan.-11 Feb. 1975, and the third was 15 Aug.-21 Sept. 1975. The basic framework of the McIDAS and the wind tracking software has been the same for all three DST experiment. However there have been significant advances between the DSTs which has advanced the McIDAS from a research tool to a tool which is capable of real time operational processing of data in a FGGE framework.

A. October 1974 DST

Any cloud tracking system has the basic components of a data ingestion system, image production system, image alignment system, cloud tracking system, cloud height determination, quality control system of derived measurements, and finally an operating system which ties together systems into a functional unit.

By October 1974, Wisconsin had developed the basic components of a cloud tracking system in the McIDAS. The satellite data was ingested onto a slant track digital recorder which was capable of recording 10^{11} bits on one tape (almost a full day of full resolution, while earth SMS images). The data was then read off the slant track tape onto a digital disk. The digital disk then transferred the image to an analog TV refresh disk. The images were aligned using an orbit model navigation system. This navigation system required a series of pictures of a single landmark over a period of a day to define the attitude of the spacecraft. These landmark images were read off the tape, the navigation was performed, and then the images which were to be used for cloud tracking were read off. Three visible images, and one IR image were used during the October 1974 DST. All the cloud tracking was done with the visible images. The cloud heights were determined using only the one IR image. The height was automatically determined with no operator intervention. There was no height checking. The displayed vectors did not contain any height information, so there was no height quality control in the system.

There were two sets of winds produced each day during the October 1974 DST. The earth was divided into 12 sectors for display on the TV screen. It took approximately six hours to load the images, 1 hour to navigate, and five hours to process the winds. Approximately 500 vectors per data set were produced using a single terminal. The loading time prevented a full set of 3 IR images from being loaded. The data times were 12 Z and 18 Z because of the need for a visible landmark for each image. This single landmark was used for both the north-south alignment and the east-west alignment of the images. The north-south variation of the image is caused by the motions of the spacecraft and are quite regular and definable. The east-west motions are under the control of the ground station and is changed many times a day, forcing the necessity for the landmark in each image. The alignment accuracy was quite good. Errors caused by alignment errors were on the order of 10 cm/sec.

The primary purpose of the October 1974 DST was the check out the basic system components of the Wisconsin cloud tracking system. The test showed that the basic navigation and alignment system worked very well. The Man-computer Interactive concept was demonstrated as an efficient method of processing satellite image data to produce quantitative results. Analysis of these winds by NMC's Data Assimilation Branch showed the satellite-derived winds to be as accurate as radiosonde winds, but the winds produced during the October 1974 DST had height assignment errors on some of the wind vectors. The ability to produce meaningful wind vectors in areas of multiple cloud layers was noted as being an advantage of the Wisconsin System.

B. January 1975 DST

The January 1975 DST was a two week test from 24 Jan-6 Feb. The original aim of this DST was to process sufficient data for model impact studies at NASA/GISS. Four wind sets per day for two weeks was desired. Because of the loading time problem and the use of the McIDAS at Wisconsin by other scientific users, only one time, 18 Z, was processed in real time. The 6 Z winds were produced during March 1975. The other two time never were produced for the full two week period except for 3 days of data which was produced in July 1975 as a training exercise for the August-September 1975 DST.

For the 18 Z set which was processed in real time the data ingestion, navigation, and loading and cloud tracking was done basically the same as during the October 1974 DST. Since the NMC analysis report had not yet been published at this time, the height assignment problem of the October 1974 data was still in the 18 Z data of the January DST. For the 18 Z data, an average of approximately 1000 vectors per data set was produced. A global comparison of the cloud derived winds for this 18 Z data set with radiosonde data showed an average 5 m/sec difference between the cloud observation and the radiosonde. The same analysis applied to radiosonde vs. radiosonde showed also a 5 m/sec difference. This difference is caused by atmospheric variability and is consistent with studies of differences between simultaneously launched balloons.

The 6 Z data set had several major system advances accomplished prior to the processing of the data. The NMC analysis of the October DST data was released. The wind vector display was changed so that the displayed vectors were color coded to height, making it easier for the operator to spot a vector with an erroneous height assignment. The second advance dealt with the alignment and the requirements for landmark data. The 6 Z data had only IR images available. The SMS infrared images have a pixel size of 2 x 4 mi at the subsatellite point.

Landmarks are very difficult to measure precisely in the IR because of the poor temperature contrast between land-water boundaries at some times during the night. Hence IR only landmark data had problems with large granularity and poor contrast. To get around this problem a system was developed to determine the east-west image shift from the line documentation of the image, and extrapolate the north-south image shift from visible landmark images measurements made on the previous days data. Hence it became possible to align a sequence of images accurately without making landmark measurements on all the images in the sequence. The error caused by the misalignment of images was only 10 cm/sec for this 0600 Z set which had no landmark measurements at all during the sequences which were used to compute the winds. An average of 700 winds per data set were produced for this 0600 Z data set.

C. August-September 1975 DST

The August-September DST was to be a one month test with four data sets per day produced in a real time operational environment mode. To accomplish this, several advances were made to the McIDAS system. The first was to expand the system into a two terminal unit with both terminals working without interference from the other. Both terminals ran off the same Datacraft computer. The second major advance was to reduce the loading time to the real time rate of the satellite transmission. This was done by ingesting the data directly onto digital disk in a navigated form. Three more digital disks were purchased making 40 megabytes available. A data interface box was made which takes the input digital data from the satellite receiver, converts the 6 bit visible data into 8 bit by left justification, converts the 9 bit IR data into 8 bit bytes by truncating the grid bit, averages the elements along a line to produce equivalent 1/2, 1, 1-1/2, 2, 3, and 4 mile resolution data, packs the data into 24 bit words and then presents the word to the computer for direct placement on the digital disk. This "byte mangler" interface box made possible the real time ingestion of data without placing much load on the computer. The computer is free to do other tasks such as loading the TV frames. A predictive navigation system was used for the ingestion. A single landmark data segment was ingested and placed on disk 8 times during the daylight hours (the landmark were designated by an operator), and a predictive navigation was put in the system for the next 24 hours of ingestion. With the predictive navigation system, the "byte mangler," and the digital disk capacity, it was possible to ingest, align, and load the images during the time that the satellite was sending the images. When the satellite finished sending the images, the data was ready to use with no further preprocessing. The registration error due to misalignment averaged approximately 40 cm/sec for this predictive navigation process. The ingestion and loading processes were made easier for the operator by the addition of a macro expander to the system which made possible the initiation of a sequence of McIDAS commands. With a single 3 letter command, the operator could initiate the entire ingestion and loading sequence.

IV. AUGUST-SEPTEMBER 1975 OPERATIONS

A. Training of Operators

The Space Science Center did not have sufficient staff to man a 24 hr/day operation, so temporary help was hired to work as "wind getters" for the DST. Four shifts/day with 2 people per shift required a total of 12 operators working on a rotating shift basis. Ten new people were hired as operators for the DST. These new people were all meteorologists with at least a BS degree. Some were graduate students and others were recent Wisconsin graduates still located in the Madison area. While all the new people had good meteorological backgrounds, none had any experience with satellite meteorology or cloud tracking. Two training courses were conducted. One group had two weeks of training on McIDAS operation, satellite meteorology, cloud tracking, McIDAS hardware and software construction, and practice "wind getting." From this group of people, team leaders, were selected for the DST. The second group was trained for one week in McIDAS operation, satellite meteorology, cloud tracking, and practice wind getting. Because of the push to get the new hardware working on the McIDAS, the practice wind getting sessions were minimal especially for the second group, but all the operators were able to pick up sufficient knowledge to track clouds proficiently. The operators were instructed to make measurements which would describe the meteorology of the situation with as many levels as possible. The operators were given general guidelines of what to track and what not to track, but no hard and fast "style" was imposed on the operators. They were instructed to use their own judgement as to what would produce the best results for a given situation.

B. DST Operations

The DST cloud tracking operations used equivalent 3 mi resolution data with the earth divided into 12 sectors. Fig. 1 shows the approximate coverage of each sector. One operator produced winds on sectors 1-7 and the other operator worked on sectors 8-12. The northern hemisphere sectors were displaced slightly south of the equator so that the ITCZ would be in the center of the TV screen, making it easier for the operator to determine the flow into and out of the ITCZ. The data were ingested in four swaths with sectors 1, 2, 3 being in swath 1, etc. There is a slight gap in the data between swaths. The ingestion program was changed during the DST so that when one swath finished, the next would start up without loosing data between swaths. There was a gap between swaths 3 and 4 for the entire DST. This was caused by the loss of one digital disk platter during the DST, which restricted room to only 450 lines of swath 4 on the disk, rather than the normal 500.

The operating schedule for each shift started with the ingestion of the satellite data onto the disk. There was an overlap of shifts so that

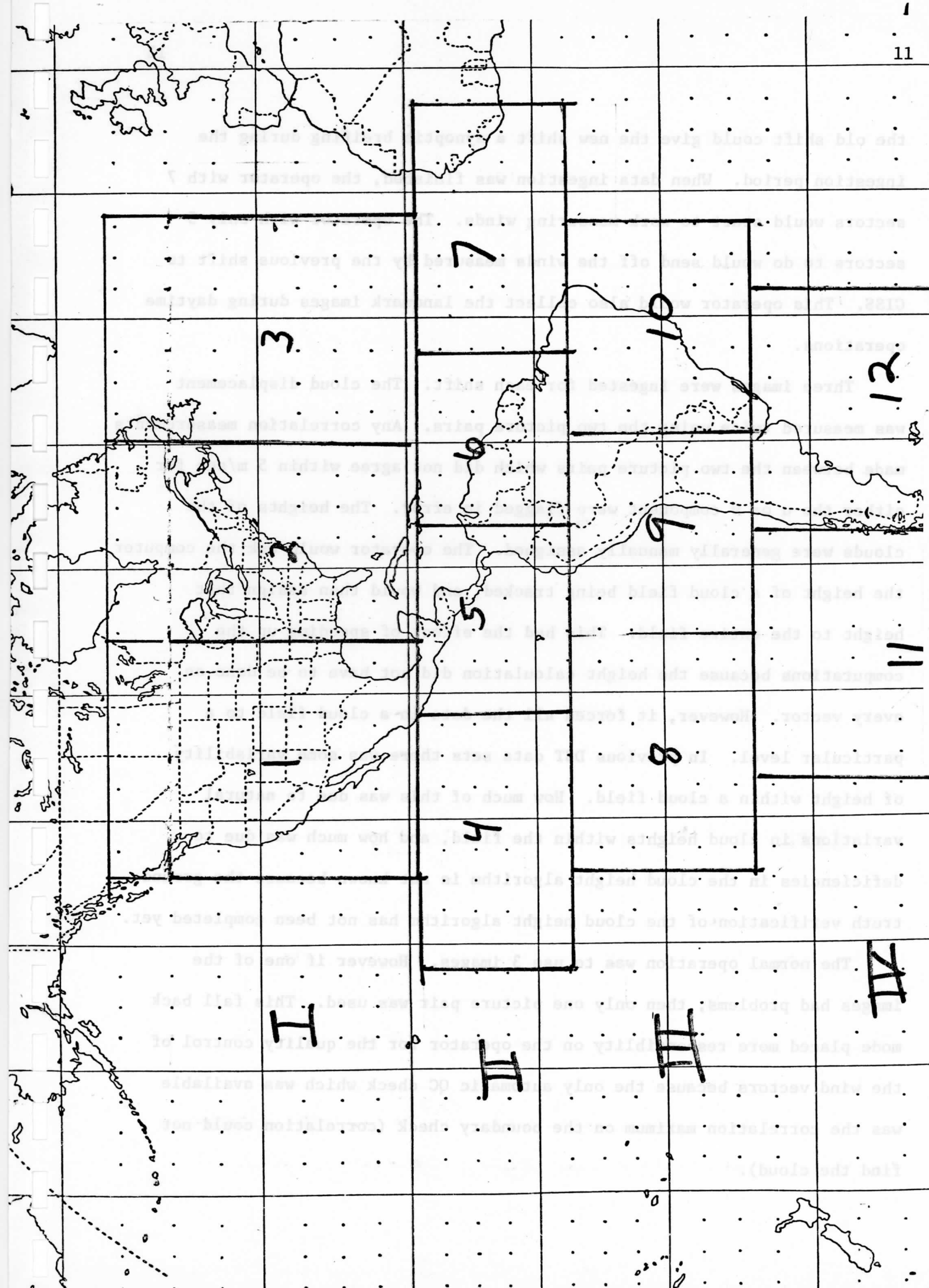

Figure 1. Approximate Coverage of Sectors During August-September 1975 DST

the old shift could give the new shift a synoptic breifing during the ingestion period. When data ingestion was finished, the operator with 7 sectors would start to work measuring winds. The operator with only 5 sectors to do would send off the winds measured by the previous shift to GISS. This operator would also collect the landmark images during daytime operations.

Three images were ingested for each shift. The cloud displacement was measured twice using the two picture pairs. Any correlation measurements made between the two picture pairs which did not agree within 5 m/sec for either the u or v component were flagged in error. The heights of the clouds were generally manually assigned. The operator would ask the computer the height of a cloud field being tracked, and would then assign that height to the entire field. This had the effect of speeding up the computations because the height calculation did not have to be done on every vector. However, it forced all the data in a cloud field to a particular level. In previous DST data sets there was some variability of height within a cloud field. How much of this was due to natural variations in cloud heights within the field, and how much was due to deficiencies in the cloud height algorithm is not known because the ground truth verification of the cloud height algorithm has not been completed yet.

The normal operation was to use 3 images. However if one of the images had problems, then only one picture pair was used. This fall back mode placed more responsiblity on the operator for the quality control of the wind vectors because the only automatic QC check which was available was the correlation maximum on the boundary check (correlation could not find the cloud).

Appendix 1 lists the days, times, and number of winds produced during the August-September DST. Figs. 2, 3, and 4 show a typical wind set. This data was from 25 August, 2000 Z.

V. AREAS WHICH COULD USE IMPROVEMENT

The August-September 1975 DST was very successful in terms of operational gathering of large numbers of wind vectors from cloud motions. Over 4,000 vectors/day were gathered during the five week DST period. As Figs. 2, 3, and 4 show, there is a fairly good distribution of wind measurements. The McIDAS was able to perform in an operational environment in the production of the data sets. However all was not perfect, and there are several areas which still could be improved for operational use of the McIDAS for wind production.

One area is back up capability. During the DST we were able to weather two major failures without severely impacting our operations. The first failure was due to loss of one of the eight digital disk platters. The digital disks were delivered the week before the DST started, and were not operational until the day before the DST started. One of the disk platters still had a hardware error in it which was causing computer halts. This platter was disabled and we ran the DST with only 7 platters. This used up our reserve disk space and limited our flexibility in data collection, but we were still able to operate with the only real impact being a small gap of missing data in the southern hemisphere. The second major failure was the loss of one of the computer memory core cards. By rearranging the core cards we were able to gracefully degrade from 65K of core to 56K. With 65K we can run two wind programs plus other smaller programs such as the wind transmission to GISS, all at the same time

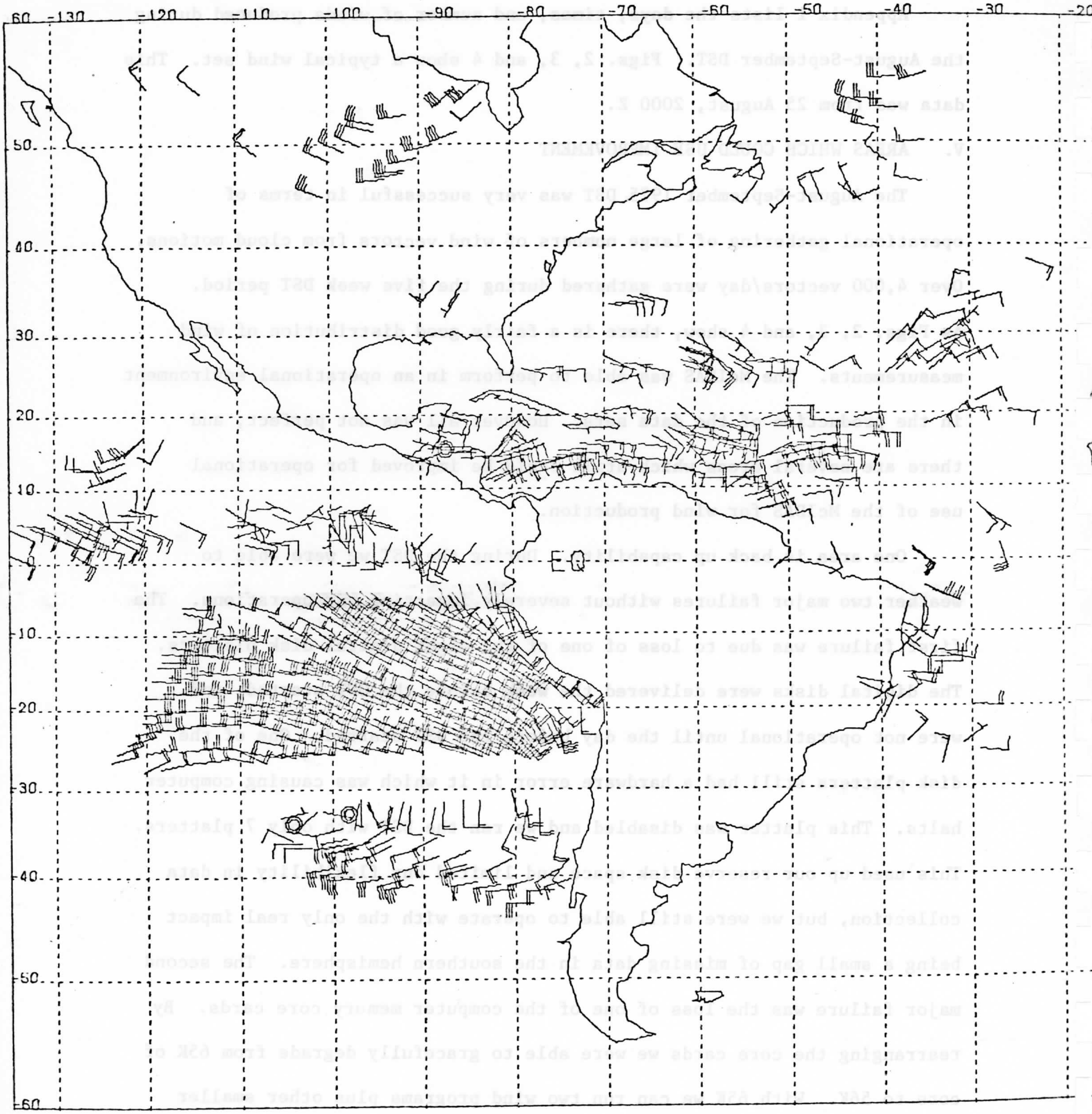

Figure 2. Low Level Winds (900-700 mb) for Aug. 25, 1975 at 20 Z. This is a typical example of the wind sets produced at Wisconsin during the Aug.-Sept. 1975 DST

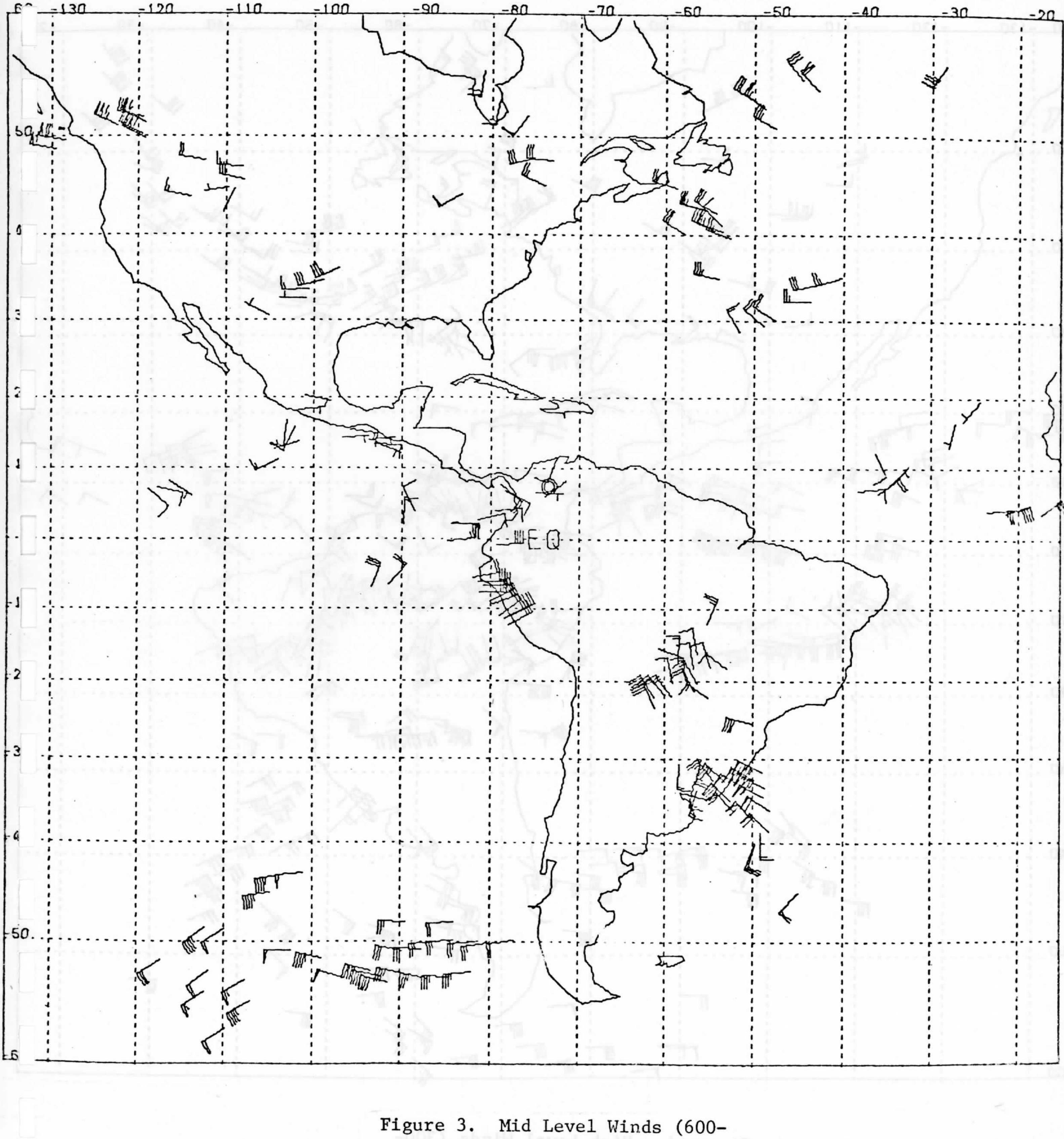

Figure 3. Mid Level Winds (600-400 mb) for Aug. 25, 1975 at 20 Z. This is a typical example of the wind sets produced at Wisconsin during the Aug.-Sept. 1975 DST.

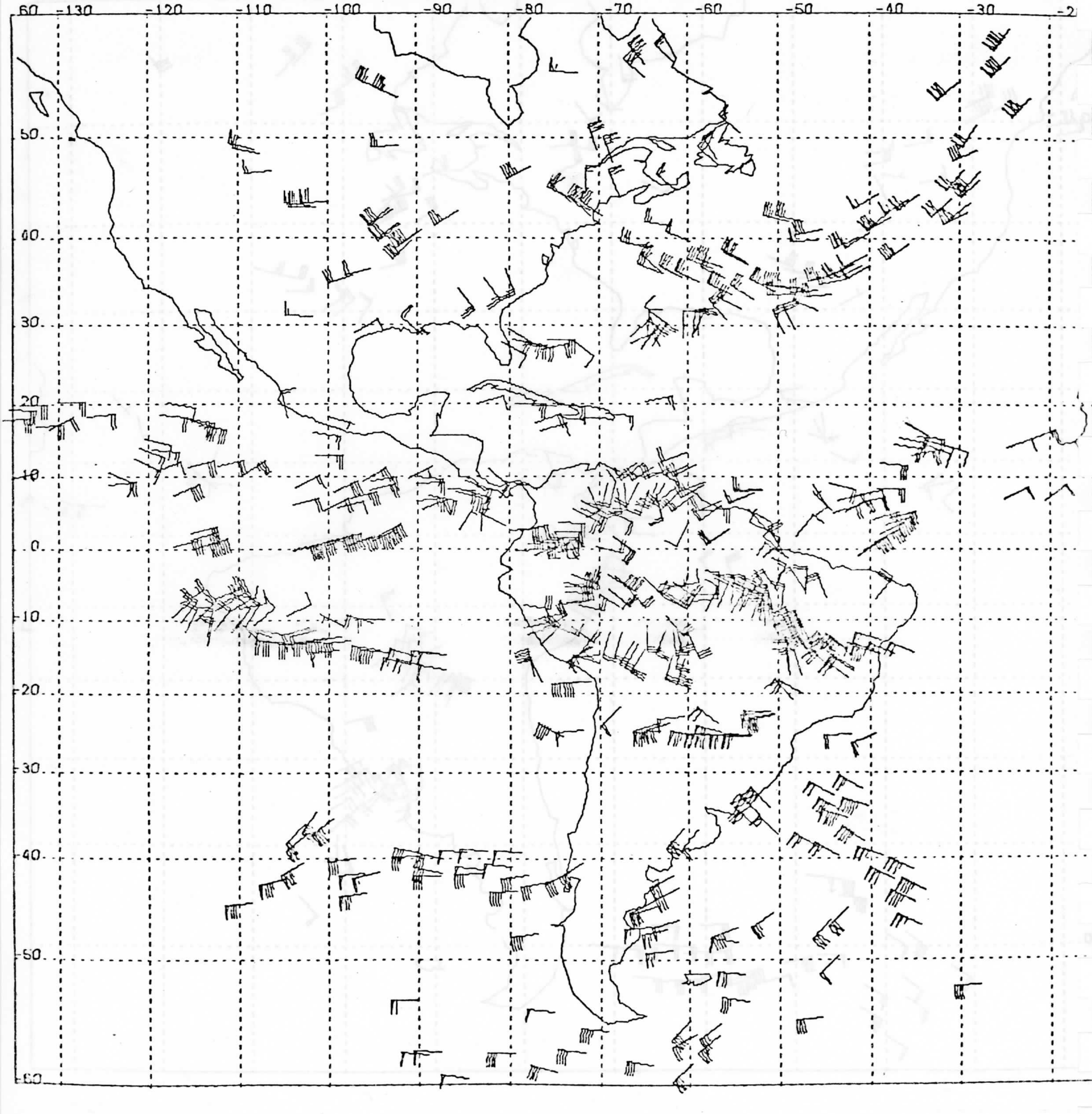

Figure 4. High Level Winds (300-200 mb) for Aug. 25, 1975 at 20 Z. This is a typical example of the wind sets produced at Wisconsin during the Aug.-Sept. 1975 DST.

without interference. With 56K of core, both wind programs would still fit, but the smaller programs would not. Consequently one of the operators had to stop measuring winds in order to transmit the winds to GISS. This was annoying. If we had lost any more computer or disk capacity, the DST operations would have halted. Having reserve capabilities is very important for any future operational use of the McIDAS. We did have a back up for the analog disk used for the TV refresh, but we did not have to use it during the DST..

During the DST there were seven full time periods when no data was processed. The last five of these took place during the end of the DST when three entire system regeneration operations were required. The cause of these failures was found during the last failure. The digital disk with programs on it had dirty heads. The system had been on a three month preventive maintenance schedule, but a shorter time between preventive maintenance was actually required.

The only other hardware failure was on 27 August when the power supply on the DMS satellite receiver was causing noise pulses which resulted in bad lines in the received image. Replacing the power supply cured the major problem of bad lines, but there were still some bad lines in the images. The SMS-1 has a very noisy signal. The full resolution data shows considerable salt and pepper in the images. When these noise bits happen during the line documentation, the entire line can be lost. On a typical image, there were at least four bad lines. This was annoying, though it did not seriously impact the cloud tracking. The problem however deserves investigation into how to improve the situation.

While there were relatively few failures in the cloud tracking operations at the Univ. of Wisconsin, not all the winds produced reached their final destination at NMC. The Univ. of Wisconsin produced the winds, transmitted them the NASA/GISS, who reformatted them and merged them with sounder data, and then trasmitted them to NMC. Due to several problems along the way, not all the winds made it to the other end. One of the problems was outages on the 360/95 at GISS during some of the scheduled transmission times. The modem at GISS which was used to receive the Wisconsin winds was also used by Suitland. If we missed our regular transmission, then Suitland got the modem and we were further delayed. Often the collect bin at GISS was dumped before our wind set got in, resulting in a missed set for transmission to NESS. At the end of the DST, these missed sets were sent to NESS.

The actual operations of the wind set production was not perfect, and some days had more problems than others, resulting in an uneven distribution of the number of winds produced. One of the problems was computer halts, especially during the data ingestion periods. This would result in portions of an image being missed. The cause of the halts appears to be in the Datacraft operating software. An updated version of the operating software will be installed on the McIDAS after the DST completion, which should solve this problem.

Another problem was the operator waiting for the computer to complete wind calculations. The computer took approximately two seconds to calculate a wind vector, but the trained operator could generally select cloud tracers faster than that, except in difficult cloud fields. The bottleneck in the operations appears to be the time required to retrieve the digital data from the digital disks for the correlation computation. The IO access time could be improved by a new design of the disk controller, so that data from the four disks could be collected in parallel rather than serially as is now done.

Other improvements which would aid the operational ability of the McIDAS to track clouds include off-line ingestion of the satellite data, improvements in the cloud height system by the addition of current synoptic data for the temperature to height conversion, quality control developments for single picture pair automatic QC, objective field analysis, and display of the entire wind field. The predictive navigation system also could use some refinements to try to remove some of the uncertainties associated with it. The August-September 1975 DST demonstrated the operational capability of the McIDAS, but further improvements could make it even better at operations.

APPENDIX I

Number of Winds Produced by Each Shift During the August-September 1975 DST

This appendix lists the number of winds produced by each shift. The day is the Julian date. The wind time is the time attached to each wind. For some shifts, there are two or more times of winds, for example on August 18 there are winds for 02:15 and 02:30 Z. These two winds sets were transmitted separately to GISS. The sum of the wind sets produced by each shift is listed under the total for shift column. Generally the total for the shift is the same as the total for the bin collection at GISS. However if the Wisconsin wind sets were an hour or more late, such as August 19, 21:00 Z, the data was shifted at GISS into the next bin.

DAY	DATE	WIND TIME	NUMBER OF WINDS	TOTAL FOR SHIFT	TOTAL FOR BIN	BIN	COMMENTS
228	Aug. 16	14:00 Z	429	429	429	C	
228	Aug. 16	20:30	1014	1014	1014	D	
229	Aug. 17	02:30	589	589	589	A	
229	Aug. 17	08:00	1029	1029	1029	B	
229	Aug. 17	14:00	858	858	858	C	
229	Aug. 17	20:30	843	843	843	D	
230	Aug. 18	02:15	255				
230	Aug. 18	02:30	733	1028	1028	A	765 good 773 sent
230	Aug. 18	08:30	1002	1002	1002	B	813 good 1002 sent
230	Aug. 18	14:00	1058	1058	1058	C	
230	Aug. 18	19:45	260				
230	Aug. 18	20:00	1039	1299	1299	D	
231	Aug. 19	02:00	927				
231	Aug. 19	02:00	139	1066	1066	A	
231	Aug. 19	08:00	170				
231	Aug. 19	08:00	1050	1220	1220	B	
231	Aug. 19	14:00	929	929	929	C	
231	Aug. 19	21:00	649	649	0	D	
232	Aug. 20	02:00	963	963	1612	A	
232	Aug. 20	08:15	525	525	525	B	
232	Aug. 20	13:45	585				
232	Aug. 20	14:00	467	1052	1052	C	
232	Aug. 20	19:45	1148	1148	1148	D	
233	Aug. 21	02:00	964	964	964	A	
233	Aug. 21	07:45	145				
233	Aug. 21	08:00	908	1053	1053	B	
233	Aug. 21	14:00	779	779	779	C	
233	Aug. 21	20:00	817	817	817	D	
234	Aug. 22	02:00	1071	1071	1071	A	
234	Aug. 22	08:00	1036	1036	1036	B	
234	Aug. 22	14:00	619				
234	Aug. 22	14:30	249	868	868	C	
234	Aug. 22	20:00	642				not transmitted in time
234	Aug. 22	20:30	197	839	839	D	

DAY	DATE	WIND TIME	NUMBER OF WINDS	TOTAL FOR SHIFT	TOTAL FOR BIN	BIN	COMMENTS
235	Aug. 23	02:00 Z	871	871	871	A	
235	Aug. 23	08:00	6	6	6	B	wrote over tape
235	Aug. 23	14:30	675	675	675	C	
235	Aug. 23	20:00	1119	1119	1119	D	
236	Aug. 24	02:30	984	984	984	A	
236	Aug. 24	08:00	828	828	828	B	
236	Aug. 24	14:00	723				
236	Aug. 24	14:15	163	886	886	C	
236	Aug. 24	20:00	1188	1188	1188	D	
237	Aug. 25	02:00	1339	1339	1339	A	
237	Aug. 25	08:00	1086	1086	1086	B	
237	Aug. 25	13:45	670				
237	Aug. 25	14:00	403	1073	1073	C	
237	Aug. 25	20:00	1475	1475	1475	D	
238	Aug. 26	02:00	675	675	675	A	
238	Aug. 26	08:00	781				
238	Aug. 26	08:15	260	1041	1041	B	
238	Aug. 26	14:30	609		609	C	
238	Aug. 26	15:00	210	819			
238	Aug. 26	21:00	1095	1095	210	D	
239	Aug. 27	02:00	0	0	1095	A	equipment failure
239	Aug. 27	08:00	1226	1226	1226	B	
239	Aug. 27	14:00	1154	1154	1154.	C	
239	Aug. 27	20:00	1221	1221	1221	D	
240	Aug. 28	02:00	803	803	803	A	
240	Aug. 28	08:00	1263	1263	1263	B	
240	Aug. 28	14:00	1297	1297	1297	C	
240	Aug. 28	20:00	1360	1360	1360	D	
241	Aug. 29	02:00	766	766	766	A	
241	Aug. 29	08:00	1283	1283	1283	B	
241	Aug. 29	14:00	833	833	833	C	
241	Aug. 29	20:00	778				
241	Aug. 29	20:00	690	1468	1468	D	

DAY	DATE	WIND TIME	NUMBER OF WINDS	TOTAL FOR SHIFT	TOTAL FOR BIN	BIN	COMMENTS
242	Aug. 30	02:00 Z	605				
242	Aug. 30	02:30	517	1122	1122	A	
242	Aug. 30	08:00	1480	1480	1480	B	
242	Aug. 30	14:00	833	833	833	C	
242	Aug. 30	20:00	536				
242	Aug. 30	20:30	301	837	837	D	
243	Aug. 31	02:30	978	978	978	A	
243	Aug. 31	08:00	1655	1655	1655	B	
243	Aug. 31	13:45	35				
243	Aug. 31	14:00	415				
243	Aug. 31	14:30	375	825	825	C	
243	Aug. 31	20:00	1157	1157	1157	D	
244	Sept. 1	02:00	1206	1206	1206	A	
244	Sept. 1	08:00	758	758	758	B	
244	Sept. 1	14:00	771				
244	Sept. 1	13:45	149	920	920	C	
244	Sept. 1	20:00	1056	1056	1056	D	
245	Sept. 2	02:00	1253	1253	1253	A	
245	Sept. 2	08:00	720	720	720	B	
245	Sept. 2	14:00	1139	1139	1139	C	
245	Sept. 2	20:00	951				
245	Sept. 2	20:00	164	1115	1115	D	
246	Sept. 3	02:00	829	829	829	A	
246	Sept. 3	07:45	213				
246	Sept. 3	08:00	646	859	859	B	
246	Sept. 3	15:00	783				
246	Sept. 3	15:15	244	1027	0	C	
246	Sept. 3	20:15	1861	1861	2888	D	
247	Sept. 4	02:00	1101	1101	1101	A	
247	Sept. 4	08:00	362				
247	Sept. 4	08:30	388	750	750	B	
247	Sept. 4	14:00	897				
247	Sept. 4	14:30	347	1244	1244	C	
247	Sept. 4	19:45	151				
247	Sept. 4	20:00	565				
247	Sept. 4	20:30	475	1191	1191	D	

DAY	DATE	WIND TIME	NUMBER OF WINDS	TOTAL FOR SHIFT	TOTAL FOR BIN	BIN	COMMENTS
248	Sept. 5	02:00 Z	1212	1212	1212	A	
248	Sept. 5	08:00	810				
248	Sept. 5	08:30	193	1003	1003	B	
248	Sept. 5	13:45	118				
248	Sept. 5	14:00	518				
248	Sept. 5	14:00	656	1292	1292	C	
248	Sept. 5	21:00	926	926	0	D	
249	Sept. 6	02:30	702	702	1628	A	
249	Sept. 6	08:30	1039	1039	1039	B	
249	Sept. 6	14:30	337		337	C	
249	Sept. 6	15:45	484	821			
249	Sept. 6	20:30	920	920	1404	D	
250	Sept. 7	02:00	338				
250	Sept. 7	02:30	596	934	934	A	
250	Sept. 7	08:00	1194	1194	1194	B	
250	Sept. 7	13:45	91				
250	Sept. 7	14:00	559	650	650	C	
250	Sept. 7	20:00	831				
250	Sept. 7	19:45	397	1228	1228	D	
251	Sept. 8	02:00	911	911	911	A	
251	Sept. 8	08:00	1353	1353	1353	B	
251	Sept. 8	14:00	834	834	834	C	
251	Sept. 8	20:00	565				
251	Sept. 8	20:00	535	1100	1100	D	
252	Sept. 9	02:00	945	945	945	A	
252	Sept. 9	08:00	1101				
252	Sept. 9	08:00	235	1336	1336	B	
252	Sept. 9	14:00	714				
252	Sept. 9	14:15	53	767	767	C	
252	Sept. 9	20:00	1078				
252	Sept. 9	20:00	88	1166	1166	D	
253	Sept. 10	02:00	48				
253	Sept. 10	02:15	896				
253	Sept. 10	02:30	248	1192	1192	A	

DAY	DATE	WIND TIME	NUMBER OF WINDS	TOTAL FOR SHIFT	TOTAL FOR BIN	BIN	COMMENTS
253	Sept. 10	08:00 Z	1116	1116	1116	B	
253	Sept. 10	14:00	1103	1103	1103	C	
253	Sept. 10	20:00	0	0	0	D	equipment down
254	Sept. 11	02:00	0	0	0	A	equipment down
254	Sept. 11	08:45	1497	1497	1497	B	
254	Sept. 11	14:00	1126	1126	1126	C	
254	Sept. 11	20:00	1196	1196	1196	D	
255	Sept. 12	02:00	765	765	765	A	
255	Sept. 12	08:00	470				
255	Sept. 12	07:45	1092	1562	1562	B	
255	Sept. 12	14:00	194				
255	Sept. 12	13:45	766	960	960	C	
255	Sept. 12	20:00	1026	1026	1026	D	
256	Sept. 13	02:00	945	945	945	A	
256	Sept. 13	10:00	674	674	0	B	
256	Sept. 13	14:00	1023	1023	1697	C	
256	Sept. 13	20:00	750	750	750	D	
257	Sept. 14	02:00	850	850	850	A	
257	Sept. 14	08:00	1176	1176	1176	B	
257	Sept. 14	14:00	780	780	780	C	
257	Sept. 14	20:00	824	824	824	D	
258	Sept. 15	02:00	924				
258	Sept. 15	01:45	148	1090	1090	A	
258	Sept. 15	08:00	365	365	365	B	equipment failed
258	Sept. 15	14:00	0	0	0	C	equipment down
258	Sept. 15	20:15	595				
258	Sept. 15	20:30	184	779	779	D	
259	Sept. 16	02:00	985	985	985	A	
259	Sept. 16	08:00	1117	1117	1117	B	
259	Sept. 16	13:45	214				
259	Sept. 16	14:00	886	1100	1100	C	
259	Sept. 16	20:00	1018	1018	1018	D	
260	Sept. 17	02:30	720				
260	Sept. 17	02:30	44	764	764	A	

DAY	DATE	WIND TIME	NUMBER OF WINDS	TOTAL FOR SHIFT	TOTAL FOR BIN	BIN	COMMENTS
260	Sept. 17	07:30 Z	857	857	857	B	
260	Sept. 17	14:00	1055	1055	1055	C	
260	Sept. 17	20:00	1053	1053	1053	D	
261	Sept. 18	01:45	411				
261	Sept. 18	02:00	584	995	995	A	
261	Sept. 18	08:00	0	0	0	B	equipment down
261	Sept. 18	14:00	0	0	0	C	equipment down
261	Sept. 18	20:45	1637	1637	1637	D	
262	Sept. 19	01:45	485				
262	Sept. 19	02:00	79	564	564	A	wrote over tape
262	Sept. 19	08:00	485				
262	Sept. 19	08:00	134				
262	Sept. 19	08:15	37	656	656	B	
262	Sept. 19	14:00	901	901	901	C	
262	Sept. 19	20:00	1040	1040	1040	D	
263	Sept. 20	01:45	487				
263	Sept. 20	02:00	150	637	637	A	
263	Sept. 20	08:00	722	722	722	B	
263	Sept. 20	13:45	635	635	635	C	
263	Sept. 20	20:00	1027				
263	Sept. 20	20:30	375				
263	Sept. 20	20:15	371	1773	1773	D	20:15 set improperly flagged; they were not transmitted
264	Sept. 21	02:00	617				
264	Sept. 21	01:45	672	1289	1289	A	
264	Sept. 21	07:30	933	933	933	B	
264	Sept. 21	14:00	1161	1161	1161	C	
264	Sept. 21	20:00	1511	1511	1511	D	

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