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A Preliminary Examination of Mesoscale Wind Fields and Transport Determined from a Network of Wind Towers

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SILVER SPRING,
MARYLAND
November 1970

ENVIRONMENTAL RESEARCH LABORATORIES

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PREFACE

In accordance with the letter of agreement of July 24, 1969 with the U. S. Atomic Energy Commission, Division of Reactor Development and Technology, Environmental and Sanitary Engineering Branch, the Air Resources Laboratories have continued their study of atmospheric transport and diffusion in the planetary boundary layer, micrometeorology, diffusion climatology, and the application of this work to the disposal of radioactive waste gases into the atmosphere. The research is technically administered and supervised through the Air Resources Environmental Laboratory of the Air Resources Laboratories.

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Techniques have been developed to utilize wind data from a network of stations for the purpose of studying mesoscale flow patterns and transport. These techniques are suitable for operational use. Technical problems of data collection and reduction from this type of network are discussed. Hourly averaged wind data for the year 1969 from a network of 21 stations over the upper Snake River Plain of southeastern Idaho have been selected for examination. Six hourly wind field plots and computed trajectories of "particles" released once an hour are plotted for the entire data sample. Spatial variations in the flow patterns indicate that transport defined by a wind field is somewhat more reliable than transport defined by the wind at a single station applied over an area of more than a few miles.

1. INTRODUCTION

At the present time operational estimates of the dilution of a pollutant, introduced into the atmosphere from a single source, involve the wind at the source as the transporting velocity. The primary reason for this practice is that in most cases this is the only wind direction and speed available to the individual making the estimate. However, if the transport is over more than a few miles there are strong indications that the practice is not always valid. Graphs exist which allow estimates of diffusion parameters for travel distances of over a thousand kilometers, but this should not necessarily be taken to infer that the travel was over a straight course, especially for long distances.

The problem simply stated is, at any given time, to what extent may the wind speed and direction at a single location be used to represent the wind conditions over an area? Obviously the answer to this question will depend greatly on the size of the area. For a small scale situation (within a few kilometers from the source) a time averaged velocity is used as the transporting velocity over the entire area of concern. For a large scale situation (more than a few hundred kilometers) the transporting velocity generally has a striking spatial variation. This means that for transport in the mesoscale (between a few kilometers and a few hundred kilometers) the small scale approach can become invalid.

In an attempt to determine where the small scale approach breaks down, wind data from a randomly spaced collection of 21 stations within an area of 12,420 kilometers² (4800 miles²) has been recorded since the beginning of 1969. Plots of the wind data at the stations along with wind vectors objectively interpolated to a regular grid allow a synoptic view of the wind patterns. The horizontal variability of the wind is readily apparent from a plot of this type. This type of data presentation should be acceptable and interesting to the meteorologist because he is familiar with the format. However, subjective estimation of transport is extremely difficult for rapidly changing situations in the wind fields. For this reason the wind data has been used to construct and plot trajectories of hypothetical material introduced into the flow.

When either the wind field plots or the trajectory plots are examined, the question of statistical representativeness usually arises. How often does an observed situation happen? In order to help answer this question, both wind field and trajectory plots for the entire year of 1969 have been

produced for observation (the process is relatively inexpensive). These plots are presented here not only for the benefit of interested personnel at the National Reactor Testing Station, but also for persons working in mesoscale transport and diffusion, who may not have seen data of this type and extent and for this scale. More refined and quantitative analyses of these data are in progress, but it seems appropriate to present the techniques, the problems and this assembly of information for examination.

2. DESCRIPTION OF THE AREA

The National Reactor Testing Station (NRTS) of the Atomic Energy Commission, is located along the western edge of the upper Snake River Plain in southeastern Idaho. The scale of concern in this work is shown by an outline of the computational grid (rectangular box in southeastern Idaho) on a map of the western United States in figure 1. The NRTS is represented by the black area within the computational grid. The size of the grid shown is 85.7 kilometers wide and 129.6 kilometers long. The circles on the map indicate the locations of the routine upper air sounding stations. This figure shows that the scale of concern in this work is about an order of magnitude smaller than the generally accepted synoptic scale.

The topography of the area is shown in a qualitative sense in figure 2. The solid line which forms the rectangular box encloses the area in which the data is collected. The irregular border shown encloses the NRTS. However, because of the nature of the terrain, the area of wind field and trajectory computations are bounded on the left by the dashed line. The portion of the upper Snake River Plain, within the computational grid, is

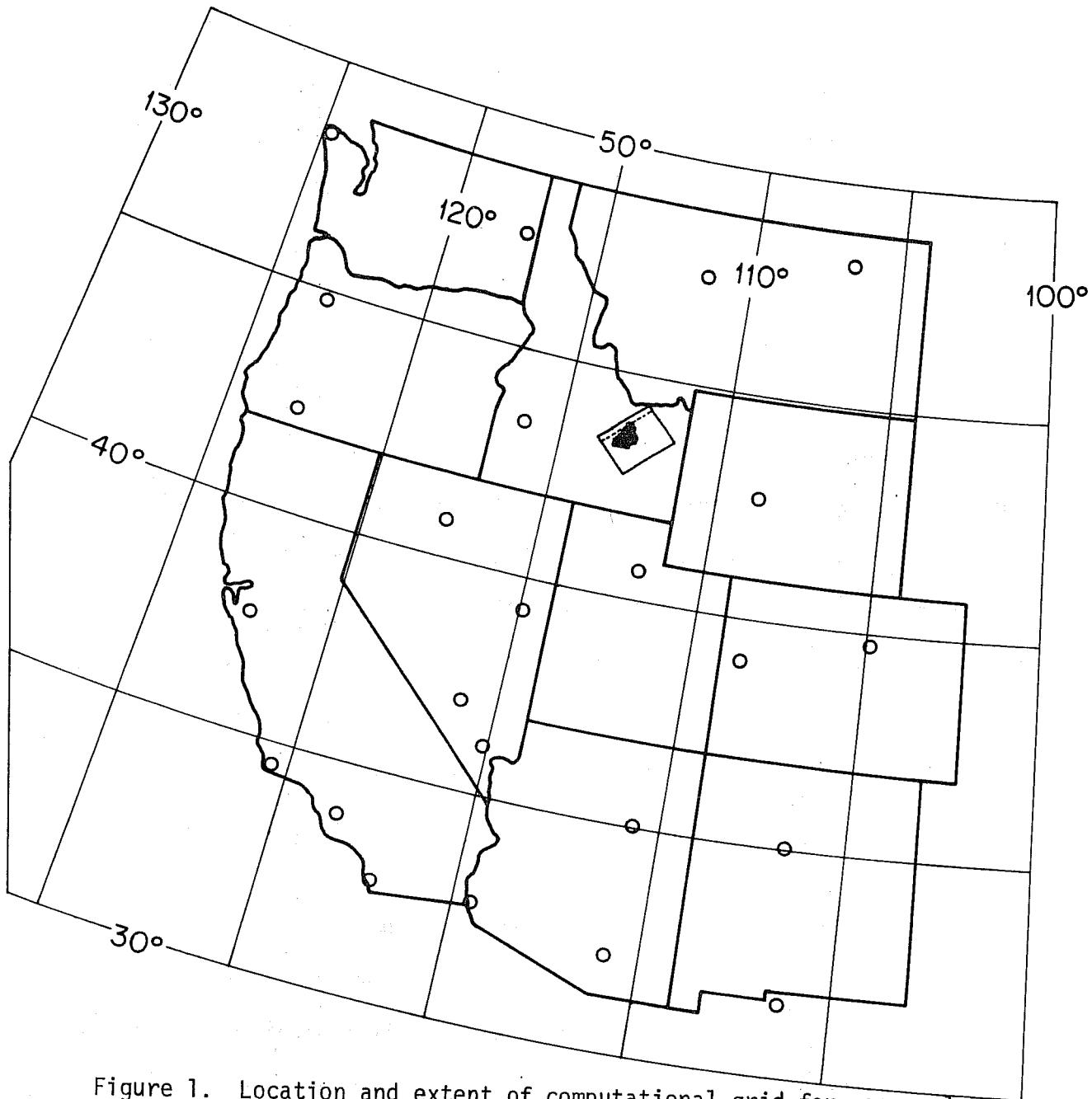


Figure 1. Location and extent of computational grid for mesoscale wind observations. The solid border encompasses all the observation locations but no calculations are carried out northwest of the dashed line. The solid black area represents the geographical extent of the National Reactor Testing Station.

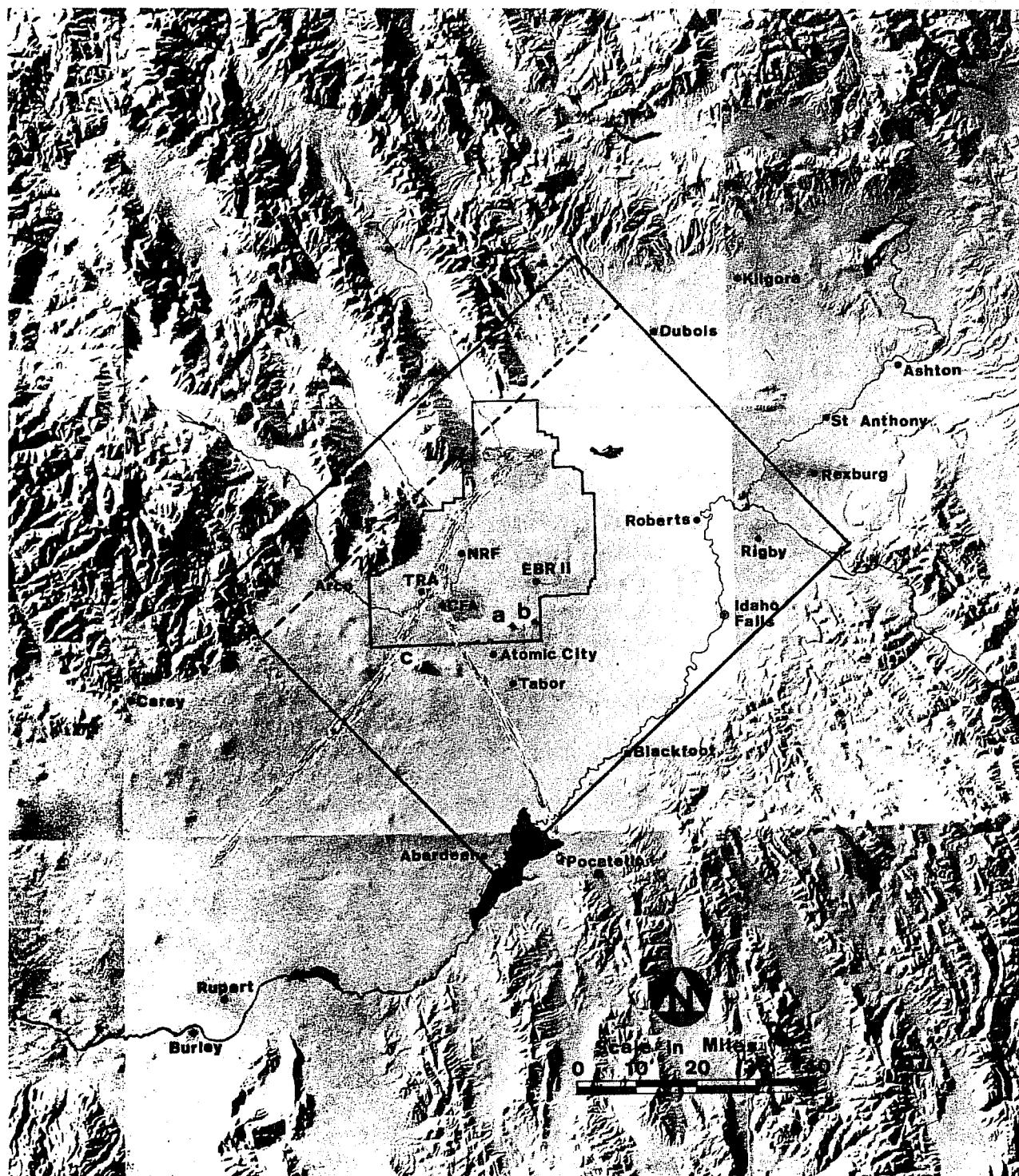


Figure 2. Relief map of the upper Snake River Plain in southeastern Idaho.

bounded by fairly rugged mountains to the northwest and southeast. The boundaries formed by these mountains prompted the rotation of the grid 49° from North. The mean elevation of the plain is about 1520 meters MSL and the mountain tops are about 24 to 31 hundred meters MSL. The relatively flat expanse of the plain is broken by three buttes. Two of them, identified by the letters A and B in figure 2, are five miles apart in the southeast portion of the test site. Both of these buttes rise about 460 meters above the floor of the plain. The third butte, identified by the letter C in figure 2, is somewhat larger and has a relative height of about 610 meters. It is located about 5 kilometers south of the southern boundary of the NRTS. Other topographic features to note are the three valleys almost perpendicular to the northwest boundary of the computational grid.

3. DATA COLLECTION

The station locations for data collection are shown in figure 3. The station locations within the boundaries of the NRTS were established years ago by the needs of the AEC. The others were placed more in accordance with the needs of the present study. Each station consists of a tower, wind direction and speed measuring equipment and a recorder. Three of the stations also have temperature sensing equipment. Table 1 contains information pertaining to the type of data measured, and the height of the measurements. We note from table 1 that the stations IET, CFA, GRD3 and EBR2 will provide information about the distribution of wind and temperature in the vertical. The data from the stations HOWE and HAMR is recorded by telemetry on paper tape as instantaneous speed and direction

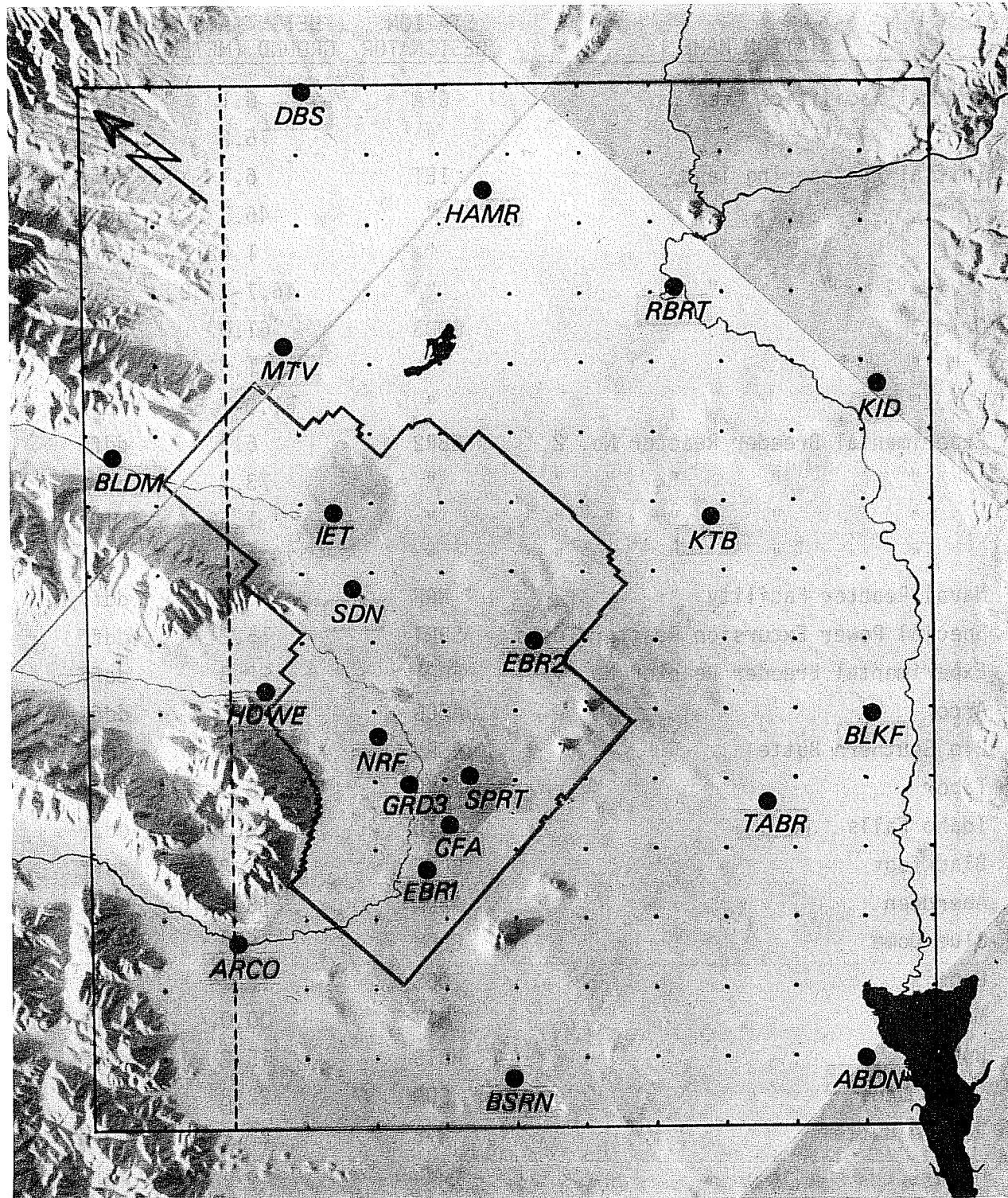


Figure 3. Station locations within the computational grid. The separation of the grid points is 8.57 kilometers (5.33 miles)

Table 1. Data obtained from stations. Symbols used are ddff - direction and speed, TT - temperature and ΔT - temperature difference.

STATION NAME	STATION DESIGNATOR	HEIGHT ABOVE GROUND (METERS)	DATA
Central Facilities Area	CFA	6.1	ddff
" " "	"	76.2	ddff
Initial Engineering Test	IET	6.1	ddff
" " "	"	46.7	ddff
" " "	"	1.52	TT
" " "	"	46.7-1.52	ΔT
Grid 3	GRD3	61.0	ddff
" "	"	1.52	TT
" "	"	61.0-1.52	ΔT
Experimental Breeder Reactor No. 2	EBR2	6.1	ddff
" " " " "	"	73.2	ddff
" " " " "	"	1.52	TT
" " " " "	"	73.2-1.52	ΔT
Naval Reactor Facility	NRF	15.2	ddff
Special Power Excursion Reactor Tests	SPRT	15.2	ddff
Experimental Breeder Reactor No. 1	EBR1	22.8	ddff
Arco	ARCO	15.2	ddff
Big Southern Butte	BSRN	15.2	ddff
Tabor	TABR	15.2	ddff
Idaho Falls	KID	22.8	ddff
Blackfoot	BLKF	15.2	ddff
Aberdeen	ABDN	15.2	ddff
Blue Dome	BLDM	15.2	ddff
Dubois	DBS	15.2	ddff
Monteview	MTV	30.0	ddff
Roberts	RBTS	15.2	ddff
Sand Dunes	SDN	22.8	ddff
Kettle Butte	KTB	22.8	ddff
Howe	HOWE	6.1	ddff
Hamer	HAMR	30.0	ddff

readings approximately two minutes apart. The speed and direction data from the other stations are recorded as ink traces on a strip chart. The charts require changing about twice a month. This is accomplished at a number of the off-site stations by off-site individuals and organizations.

4. DATA REDUCTION

The wind direction and speed data from the two telemetered stations are averaged over one hour in a vector sense and the results punched on cards. The data which is recorded on strip charts is averaged subjectively over a one hour period and recorded on forms for key punching. The averaging serves to eliminate higher frequency fluctuations which would contribute more to the diffusion of material than its transport. Also, an averaging period smaller than one hour was rejected in part because of a need for economy in the manual reduction of the data.

A test case was selected, during the initial phase of this work, in which a comparison was made of trajectories constructed by ten minute and one hour averaged data. There was no significant difference in the trajectories, however there were fewer stations in the grid than now and wind patterns and changes in the patterns have been observed since that test case, which indicate that it did not represent a very severe test. The one hour average is most certainly too long for a phenomenon like a frontal passage. In this situation the wind at a given station during the hour may blow from one direction for 15 to 30 minutes at $7 \text{ meters/sec}^{-1}$ or greater, then shift almost instantaneously 100 to 180° for the rest of the hour with the speed remaining above $7 \text{ meters/sec}^{-1}$. This condition occurs, however, only a small percentage of the time. Direction changes

of more than 90° during an averaging hour were marked for future reference by adding 500 to the recorded average direction.

After the data had been punched on cards it was transferred to magnetic tape or disc storage for easier handling in the steps to follow. During this transferring process the data was edited for completeness by checking both speed and direction entries for special codes indicating when data was missing, and the cause of the trouble. An hourly inventory of all the wind data was then printed. A sample of one page of this inventory is shown in figure 4. This type of inventory helps in deciding whether the data over a certain period is complete enough for a particular type of analysis. A monthly summary of the amount of missing data and the reasons for it are also printed. A sample of this summary is shown in figure 5. Each of the reasons for failure has a special code which is picked up by the logic of the program.

5. ERROR CHECKING AND CORRECTION

The handling of the data between the time the ink dries on the strip chart and the numerical values are stored on magnetic tape or disc, introduces errors of various types. An attempt to uncover some of the more flagrant of these errors is made by subjecting the data to some automated error checking. The first test is made by checking all the stations for wind speeds greater than 22.3 meters/sec⁻¹. The station name, speed and direction, and time of occurrence are printed out for use in checking the punch cards and the data forms. For all the stations, the data for the year 1969 had 57 distinct occurrences of hourly average winds 22.3 meters/sec⁻¹ or greater. Fourteen of these cases, however, resulted from

Figure 4. Sample page of hourly wind data inventory. 1 - data available, 0 - data missing.

	NUMBER OF HOURS DURING MONTH - 9YEAR 69 OF SYSTEMS FAILURE AND CAUSE.																							
	CFA	CFA	TAN	TAN	GD3	EB2	EB2	NRF	SPT	EB1	ACO	BSN	TBR	KID	BFT	ABN	BDM	DBS	MTV	RBT	SDN	KTB	HWE	HMR
TIME ADJUSTMENT	0	0	0	0	0	0	0	3	0	1	0	0	0	0	0	0	0	0	0	3	0	0	0	0
CALIBRATION	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SENSOR FAILURE	0	0	183	0	0	0	0	0	0	0	0	5	0	111	0	0	0	0	0	0	0	0	0	0
OUT CF PAPER	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	82	0	65	6	0	10	0	0	0
REORDER FAILURE	0	0	0	0	62	0	56	0	142	22	0	49	205	186	0	0	0	0	0	0	0	0	0	0
POWER CUTAGE	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NOT INKING	0	0	0	0	0	32	0	0	0	304	0	0	27	0	46	0	125	0	113	0	0	0	0	0
WEATHER, ETC.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OTHER	0	0	4	0	16	66	12	0	41	22	0	0	0	0	0	0	0	0	0	0	1	0	720	720

	PERCENTAGE OF OPERATION FOR THIS MONTH																							
	100	100	74	100	89	86	90	100	74	50	100	92	67	55	82	100	73	98	84	98	99	100	0	0

Figure 5. Sample page of monthly summary of wind data inventory.

illegible figures, keypunch errors and recording errors. Every one of these errors resulted in a gross distortion of the data and were corrected in the stored information.

Another extremely important type of error encountered in the data resulted from the incorrect direction orientation of some of the wind vanes. Whether the cause of this problem was electronic, mechanical, human, or a combination of all three was not determined, but occasionally an orientation check at each station would uncover varying degrees of error at several of the stations. Since there was no way to determine when the orientation had changed since it was last checked, a scheme was devised to test the orientation of the stations from the data they had reported.

The test is based on the premise that under relatively strong wind conditions (greater than $6.7 \text{ meters/sec}^{-1}$) stations which are fairly close together should be reporting less than a 30° spread in their wind direction. This allows for a $\pm 15^\circ$ tolerance for the subjective averaging of the strip chart data. Six groups of four stations each were selected for this type of checking. For each hour, during which all four stations reported a wind greater than $6.7 \text{ meters/sec}^{-1}$, an average wind direction was computed. The average direction was then recomputed not including the station which had the largest deviation from the average. The deviation was then recomputed for all four stations. The station names, the three station average speed and direction, the direction and speed for each station, and the deviations from the three station average were then printed out for examination. The monthly averages of the deviations were also printed out. Generally if an orientation error persisted through a month the average

deviation was quite representative of the amount of correction needed, as determined from an actual orientation check. The printout of the individual hourly results proved valuable in discovering a station at which an orientation error occurred only when the wind had a direction from south through west. This was an indication of faulty equipment.

This technique has the disadvantage of requiring strong winds at all four stations. During a month which has only a few hours meeting this requirement it would be very risky to use the results to correct the directions at a station for the whole month. Before corrections were made they were checked against maintenance records on some of the strip charts. The corrections to the wind direction data for the year 1969 are shown in table 2. These corrections were added algebraically to the original wind direction data.

6. RANDOM TO GRID ANALYSIS

For convenience in numerical computations involving the data from these randomly spaced wind stations an objective interpolation scheme was applied to obtain wind components on a regularly spaced grid. The technique involved using a weighted average of the velocity components from several of the stations nearest to each of the grid points. This approach has been discussed previously (ERLTM-ARL 9, 1968; Shepherd 1968; ERLTM-ARL 14, 1969). For the data presented here the interpolation scheme may be represented as

$$\bar{u}_{i,j} = \frac{\sum_{k=1}^N \frac{u_k}{r_k^2}}{\sum_{k=1}^N \frac{1}{r_k^2}} \quad \text{and} \quad \bar{v}_{i,j} = \frac{\sum_{k=1}^N \frac{v_k}{r_k^2}}{\sum_{k=1}^N \frac{1}{r_k^2}} \quad (1)$$

Table 2. Direction corrections for orientation errors. The corrections are in degrees and apply from the previous date time group to the date time group directly on the left.

Station	CFA	IET	GRD3	EBR2	NRF	SPRT	EBR1	ARCO	BSRN	TABR	KID	BLKF	ABDN	BLDM	DBS	MTV	RBRT	SDN	KTB
Time	250'	150'		240'															
Date																			
0100 01/01/69																			
2400 01/05/69	-50																10		
2300 01/06/69	-50																10		
1800 01/21/69	-50																10		
2400 01/31/69	-50																10		
1200 02/04/69	-50																10		
0100 03/01/69																	10		
0100 04/01/69																	10		
0100 05/01/69																	10		
1000 05/09/69																	10		
0100 07/01/69																	10		
1000 09/20/69																	10		
2400 09/30/69																	10		
1200 10/02/69																	10		
2400 10/31/69																	10		
1200 11/05/69																	10		
1600 12/05/69																	10		
2400 12/31/69																	10		

*Correction in southwest quadrant only

where $\bar{u}_{i,j}$ and $\bar{v}_{i,j}$ are the cross valley (x) and up valley (y) components of the wind obtained at point (i,j) on the grid, u_k and v_k are the x and y components at a wind station a distance of r_k away from the grid point (i,j) , and N is the number of stations in the average. In all the analyses shown in this work the minimum number of stations used in the average at any grid point was required to be three regardless of their distance away. If there were more than three stations within a radius of 17.16 kilometers (two grid units), they were also used in the average. Since the station locations are fixed and usually many hours of data are available for analysis, a table, for each grid point, of the ten closest stations and their distances from the grid point in ascending order is established and stored before the interpolation process begins. Then as the wind is available for analysis the list of stations for each grid point is scanned and the first three stations with available data are selected. If the next station in the list has data available and is less than the specified distance of 17.16 kilometers from the grid point, it is also used in the average. Each station in the list is checked like this until one is encountered which lies outside the limiting distance. This method is applied at every grid point including the boundaries. Thus for some grid points the method is an interpolation and for others it is an extrapolation. There are methods of random to grid wind interpolation schemes which involve as a weighting factor the angle which the wind direction at the station makes with the line connecting the station and the grid point, (Endlich and Mancuso 1968). This approach, however, seems more applicable to large scale measurements.

The wind components, once obtained at the grid points, are now ready for use in various types of analyses. However, they may also be used to enhance the appearance of a plot of the raw data for visual observation. A plot package has been developed in which the hourly averaged data may be displayed at any time interval in a fashion which allows the wind fields to be scanned by a person just as he would scan a series of synoptic weather maps. In Appendix A the wind fields are presented at six hour intervals for the entire year of 1969. The definitions of the symbols used in the plots are shown in table 3.

7. TRANSPORT

Another use of the wind components at the grid points is to provide an indication of the transport by the wind over the grid. The variation of the wind field over the grid, which is observed in the wind field plots, should be convincing evidence that advection of material for more than a few hours or a distance of 10 to 20 miles with the wind measured at the source can many times be misleading (see, for example, the map series on page A-41). The improved horizontal resolution in the data by measurements spaced over the grid should obviously produce a better representation of atmospheric transport. It should be kept in mind, however, that the transport, represented by the wind measurements from these towers, is restricted to an atmospheric layer in which these measurements are representative.

The height of this layer will depend entirely on vertical variation in the direction and speed of the wind. The nature of the vertical variation or shear in the wind speed and direction will depend on the roughness of the surface, the atmospheric temperature profile and to some

Table 3. Definitions of symbols used in wind field plots.

Symbols at Wind Stations		Symbols at Grid Points	
Symbol	Definition	Symbol	Definition
Standard Shaft and barb	Wind direction and speed (Each barb represents 10 mph)	→	Wind speed and direction. (Distance between grid points represents 25 mph)
*	A direction change of 90° or greater during the averaging hour	↗	$2 < V < 5$ mph
+	Missing data	-	$ V < 2$ mph
0	Calm		Calm

extent the large scale motion and weather pattern moving through the area. The wind variation with height at the NRTS has been observed under several conditions and is found to range from the classical logarithmic profile to a profile which showed a 150 degree direction shear between 6 and 9 meters above the ground. The latter case, however, has been observed under a very special set of conditions at a single location.

During the initial phase of this work an attempt was made to adjust the wind speeds from all the towers to a common height by use of a climatologically established logarithmic profile. It was found, however, that application of this adjustment at stations where the winds were known at two levels produced inconsistent results. Thus, for the purpose of this report, the winds at each station were not adjusted for height above ground before the random to grid process was performed.

In order to depict transport by the winds over the grid, the trajectories of a series of "particles", released sequentially from a selected spot on the grid, are constructed using the hourly averaged data interpolated to the regular grid. The technique for constructing the trajectories involves an interpolation of the velocity components from the grid points to the "particle" positions and an iterative scheme for advecting the particles. A linear interpolation in time is used between hourly averaged wind fields. The time interval used between each advection step was 10 minutes. (A five minute advection step produced no significant difference in a test set of trajectories. A reduction of the grid spacing also produced no significant difference in the trajectories.) Comparisons

of these trajectories constructed with tower winds are being made with simultaneous trajectories of constant density balloons. Results of these comparisons will be reported later.

The scheme for graphical representation of the trajectories is depicted in figure 6. This series of trajectories indicates the paths of 12 "particles" released one hour apart from a location in the southern part of the NRTS. The release time for the first "particle" is shown at the top of the diagram. The numbers at the ends of the trajectories indicate the order in which they were released. The letters along the trajectories indicate the locations of the "particles" at hourly intervals after release. The letter A occurs one hour after release, the letter B two hours, and so on. Like letters may be used to approximate a plume center line. The second column of table 4 may be used to determine position times for the release shown in figure 6. The dots on the diagram represent a few population centers in the area and may be used as reference points. The identification of these locations is shown in figure 7.

In Appendix B the display format shown in figure 6 is used to show the trajectories for a continuous hourly release of particles for the period 0100 January 1, 1969 through 2400 December 30, 1969. Note that two plots are used to show the transport for each twenty-four hour period. The first plot depicts the trajectories for a series of releases from 0100 through 1200 with advection continuing to 2400 if there are any particles left within the grid boundaries. The second plot depicts the trajectories for a series of releases from 1300 the same day through 2400 with advection continuing, if necessary, to 1200 the next day. The overlap

CPP RLSE 1300 06/29/69 TO 2400 06/29/69

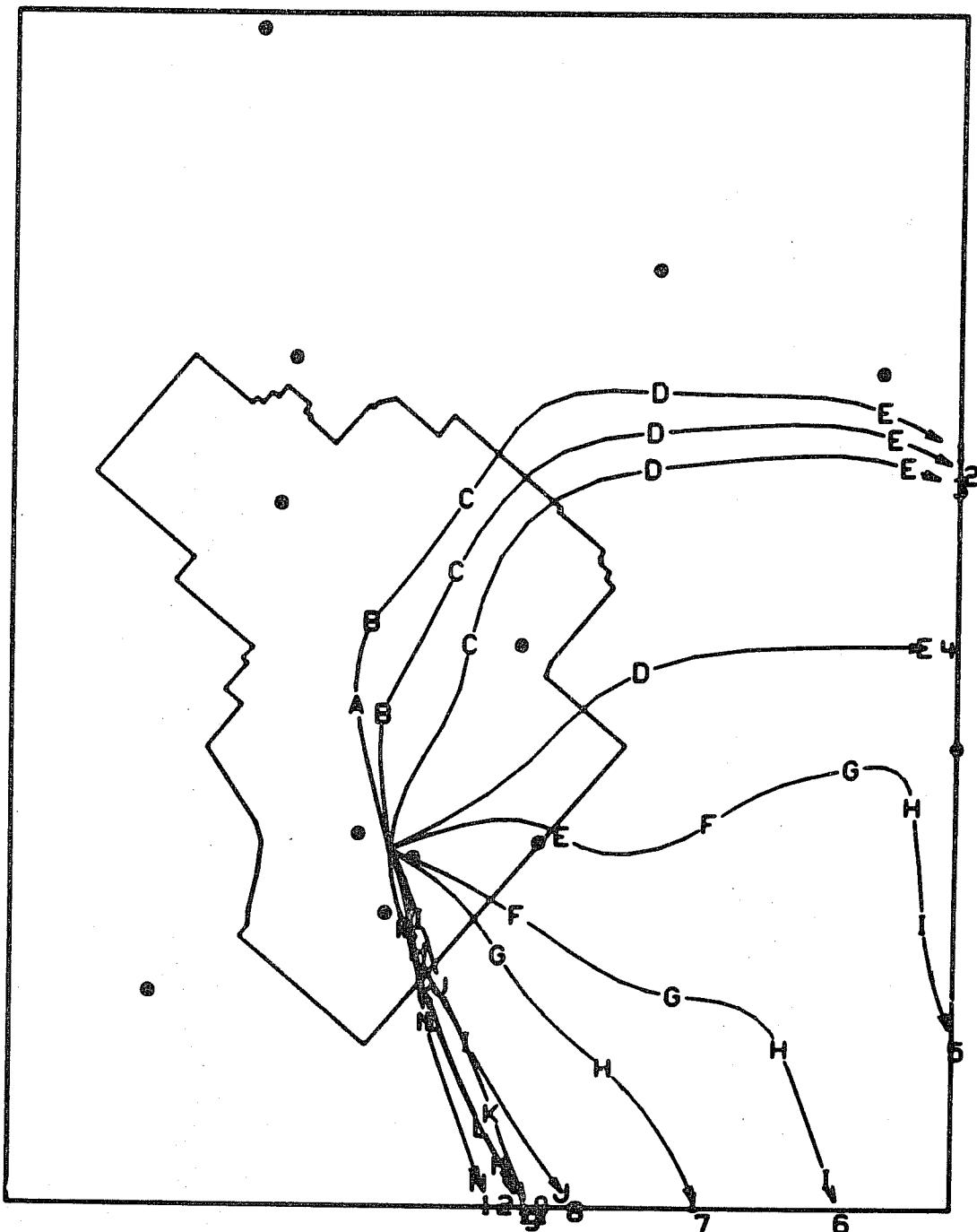


Figure 6. Trajectories of hypothetical particles serially released, one hour apart, into a time series of objectively interpolated wind fields. The release time for the first particle is 1300 MST 06/29/69.

Table 4. Symbols for Particle Trajectories*.

Release Duration 0100 - 1200 MST	Release Duration 1300 - 2400 MST
1 1:00	1 13:00
2 A 2:00	2 A 14:00
3 B 3:00	3 B 15:00
4 C 4:00	4 C 16:00
5 D 5:00	5 D 17:00
6 E 6:00	6 E 18:00
7 F 7:00	7 F 19:00
8 G 8:00	8 G 20:00
9 H 9:00	9 H 21:00
10 I 10:00	10 I 22:00
11 J 11:00	11 J 23:00
12 K 12:00	12 K 24:00
L 13:00	L 1:00
M 14:00	M 2:00
N 15:00	N 3:00
O 16:00	O 4:00
P 17:00	P 5:00
Q 18:00	Q 6:00
R 19:00	R 7:00
S 20:00	S 8:00
T 21:00	T 9:00
U 22:00	U 10:00
V 23:00	V 11:00
W 24:00	W 12:00

* The particle numbers appear opposite their release times. The hourly particle position is indicated by the appropriate letter-time combination.

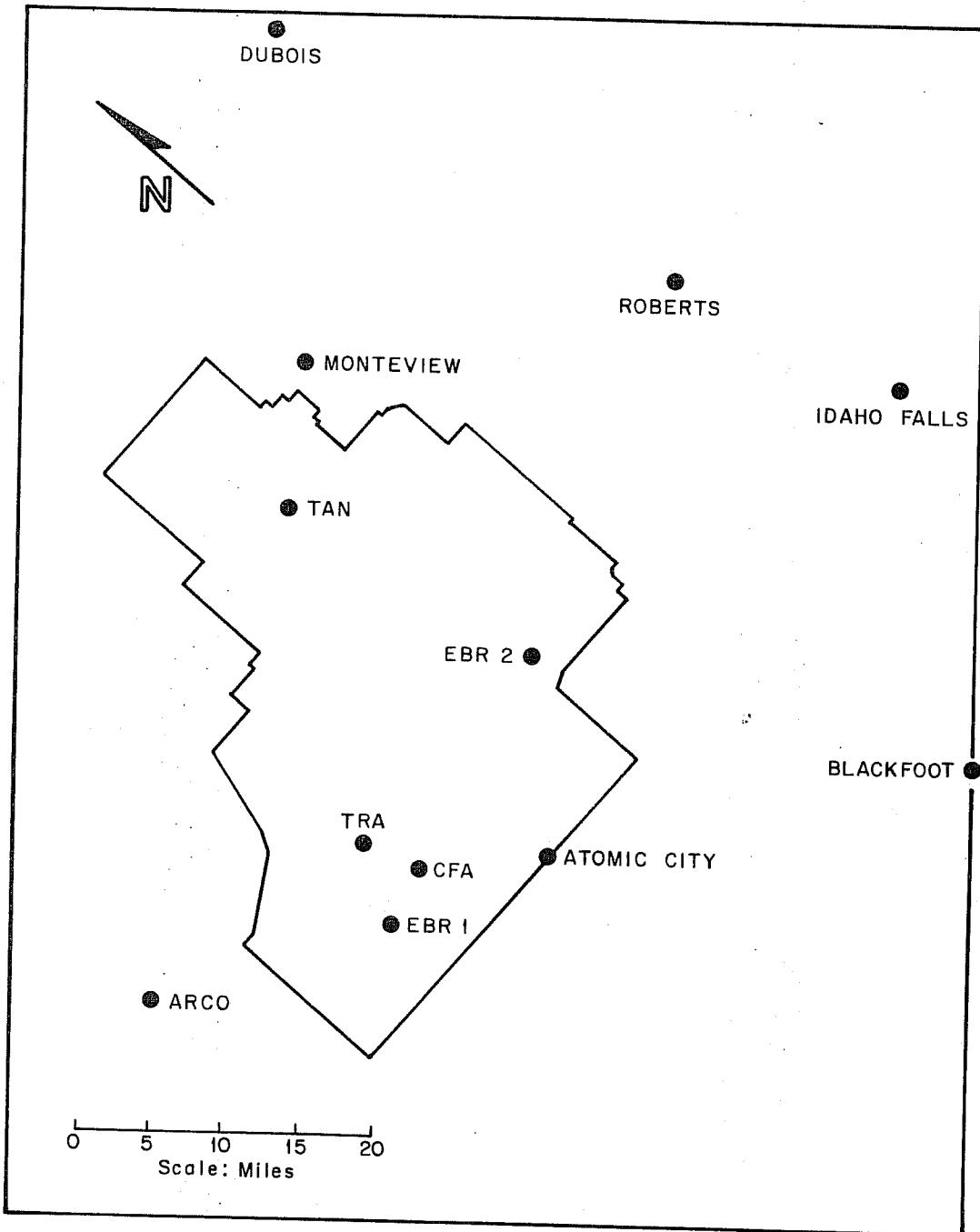


Figure 7. Location of several population centers within the computational grid.

allows one to estimate the continued transport of the last few particles, which might be left on the grid, from the first trajectory of the next plot. Thus one may observe the transport continuously for as long a period of time as his data sample provides.

8. DISCUSSION

Any project which involves gathering data on a routine and continuous basis is plagued with the problems of quality control. When sensors are exposed to the elements on a year round basis and recorders run continuously year after year, maintenance of equipment becomes one of the most important factors in the quality and quantity of data obtained. The reduction of the data after it is obtained is also an important area in which problems can arise. For example, the separate averaging of speed and direction can occasionally yield somewhat different results than an average of the velocity vector. This occurs when there are strong variations in speed and direction at the same time. Unfortunately there seems to be no economical way to obtain a vector average from speed and direction traces on a strip chart. The answer seems to lie in recording the data by telemetry on magnetic tape with strip charts as a backup system only. In this way the averaging interval may be varied to suit the experimenter and vector averaging is easily accomplished. Also, the tedious task of reading strip charts is eliminated.

In spite of the problems involved in obtaining the data included in this report and some of the inherent uncertainties, it certainly can be considered a statistically representative sample for investigating the validity of applying a single point wind over the entire area of concern.

The windfield plots in Appendix A provide a look at both the time and space variation of the winds over the area. The plots are arranged such that six hour variation may be seen from horizontal scanning and twenty-four hour variation may be seen by scanning the plots vertically. The map times used were chosen to be as representative as possible of four distinct flow regimes and to avoid transition periods. These plots may be used as a first step toward familiarization with the flow patterns of an area on this scale, in a manner similar to a meteorologist's familiarization with the routine plots and synoptic analyses of meteorological data on a continental or hemispheric scale. The technique for producing this type of presentation is general and can be applied to any area where data is available. It is currently being used by other offices for some data in the Los Angeles basin and an area near the Salt Lake Valley. For detailed studies in meso-meteorology, synoptic charts may be used in conjunction with this data.

Regardless of the meteorological significance of this type of data, it does provide a more sound basis for estimating the frequency of transport from source to receptor than only the wind record at the source. In a reactor siting study, data from a collection of stations may be used to study the transport from any location within the area covered by the network of stations. For example, diagrams such as those in Appendix B can be obtained for any spot within the computational grid. The inexpensive reproduction of the diagrams has reduced their legibility, impairing detailed analysis of many of the individual cases. This situation was difficult to avoid; the use of computer produced, CRT plots on 35 mm film was the only economical means of assembling so many graphs. In any case,

the transport patterns are quite evident and provide an indication of the frequency and duration of transport to the various population centers. If more detail is required, selected plots may be reproduced on a larger scale (for example, figure 6).

The trajectories shown in the diagrams would be most representative during the hours between sunset and sunrise. This would be the time during which material would be trapped in the inversion layer and subject to the least amount of dispersion by the atmosphere. A more accurate picture of the stability conditions may be obtained from the tower temperatures, but for present purposes the high correlation between darkness and inversion in a desert climate should be sufficient. One should also keep in mind that, if two consecutive trajectories pass on both sides of a population center, under continuous release conditions, material would have passed over the population center. More sophisticated and automated techniques than estimation from these diagrams, are now being used to determine quantitative estimates of transport frequency to specific locations. The diagrams, however, have provided a first look at the variations in a year's worth of transport patterns. They provide the basis from which a climatology of transport may be developed.

9. ACKNOWLEDGEMENTS

The establishment of the offsite network of wind stations was accomplished by Messrs. C. R. Dickson, F. E. White and G. E. Start. Mr. G. Young has had the primary responsibility for maintaining the equipment. Mr. D. Sharp has serviced the equipment and monitored the disposition of the data sent in from offsite stations, as well as the data extraction by students

at Ricks College at Rexburg, Idaho. Mr. H. Boen provided computer programming assistance in the card-to-tape phase of the data handling.

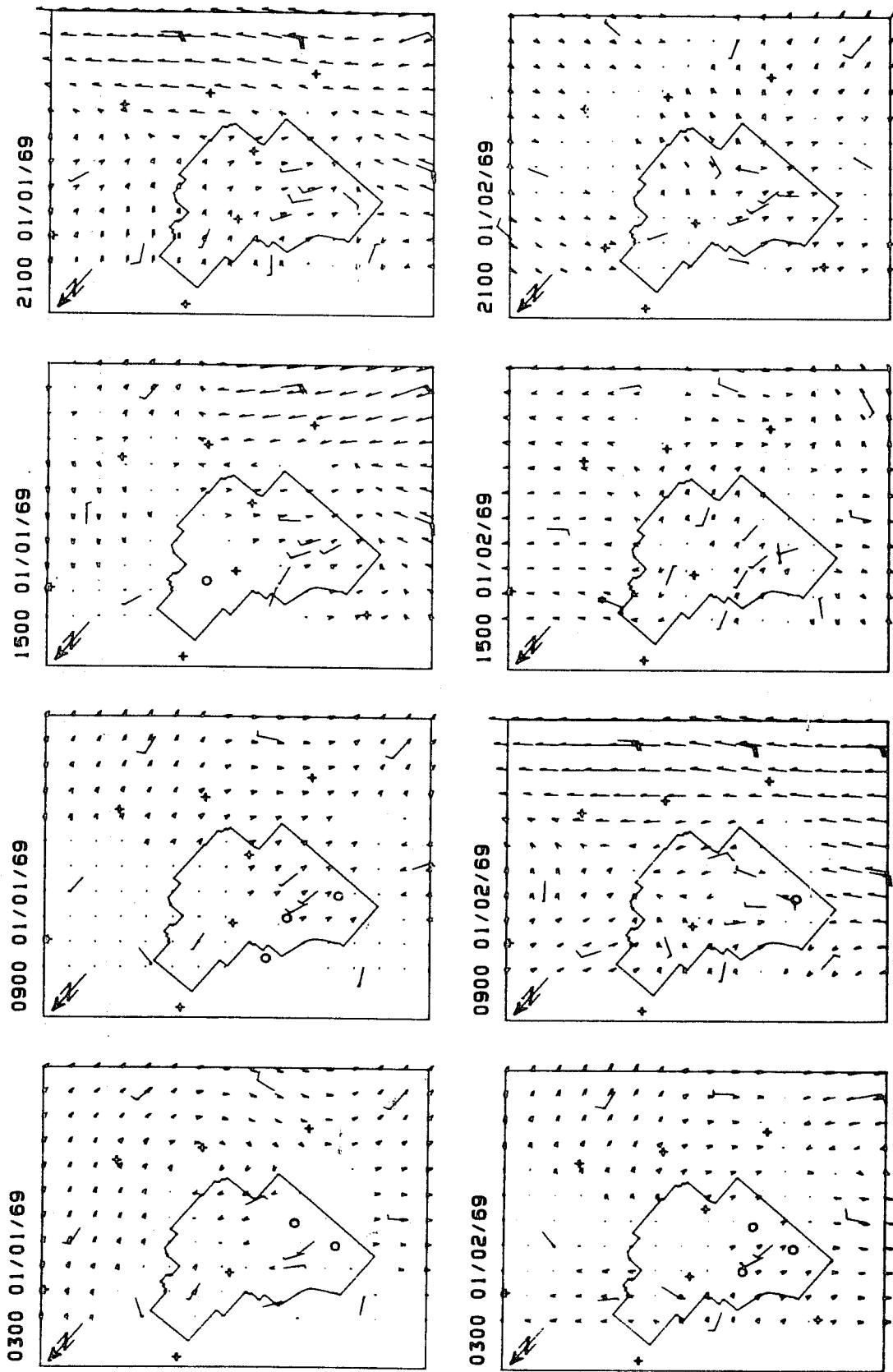
10. REFERENCES

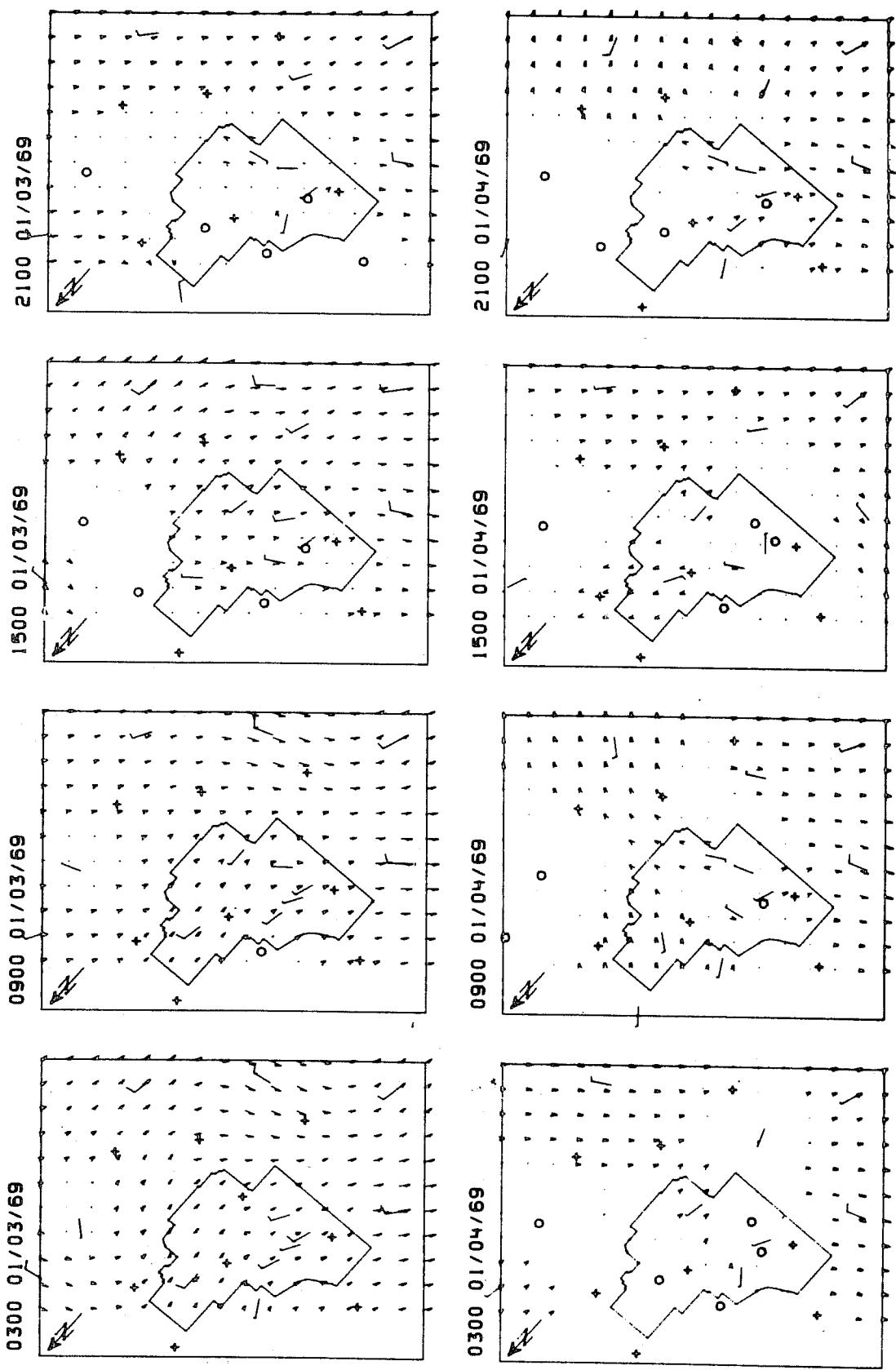
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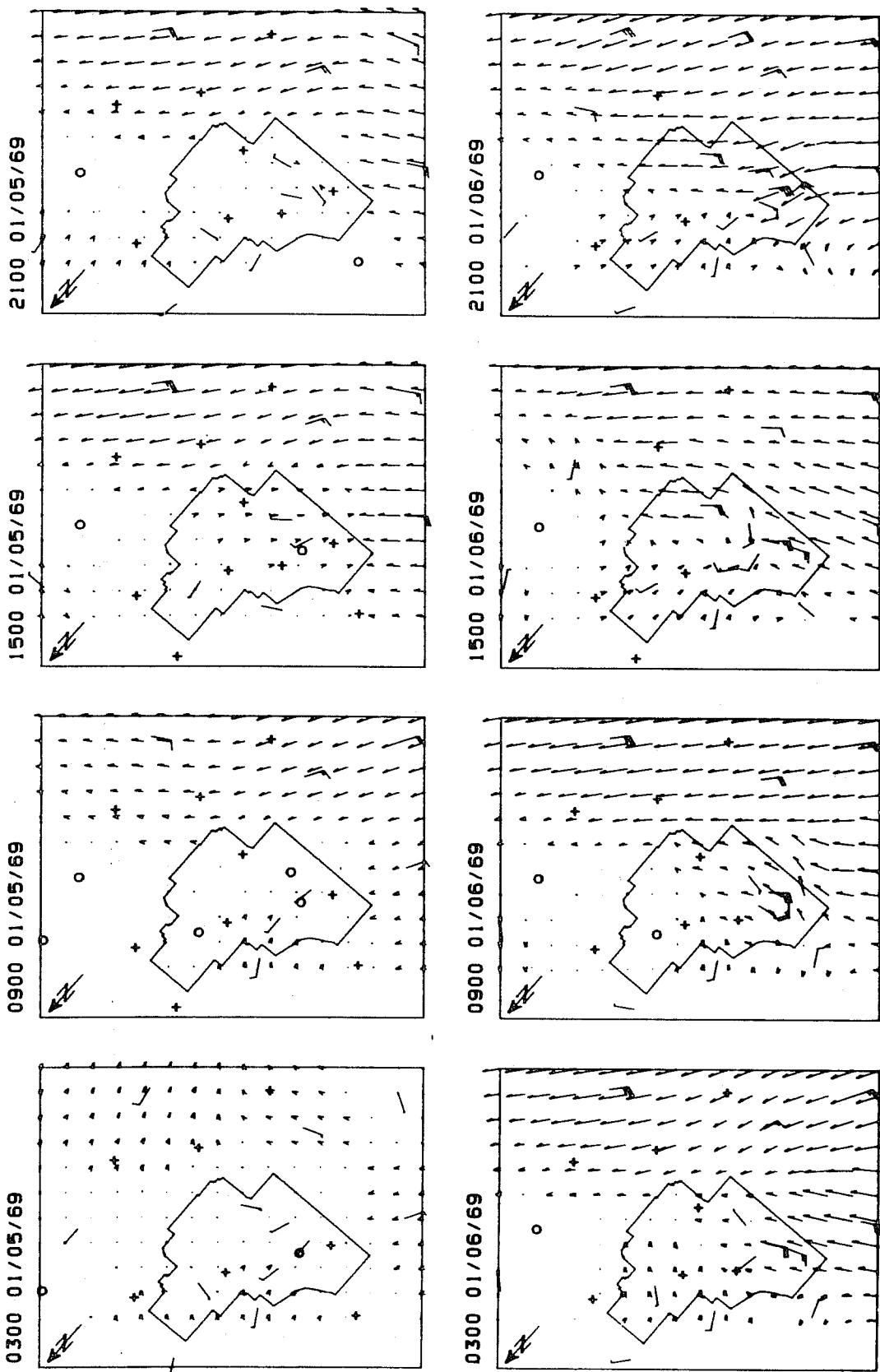
APPENDIX A

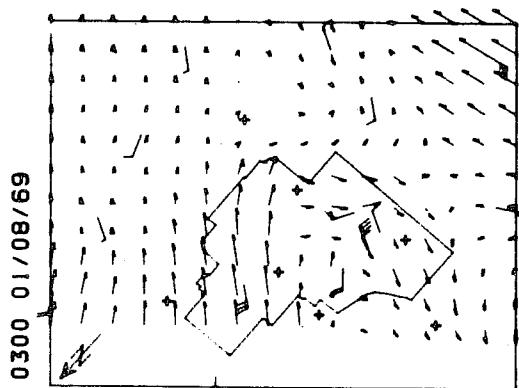
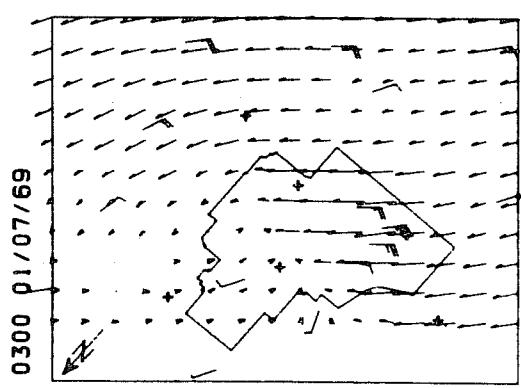
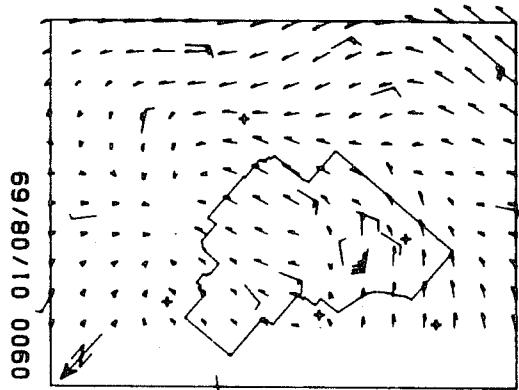
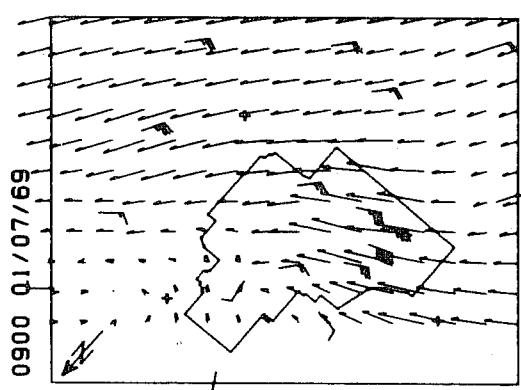
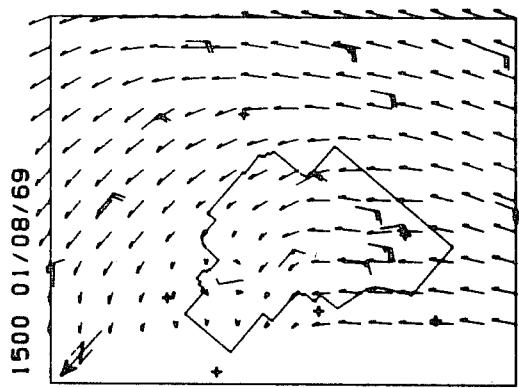
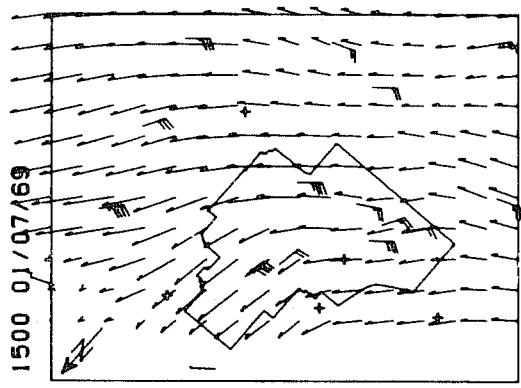
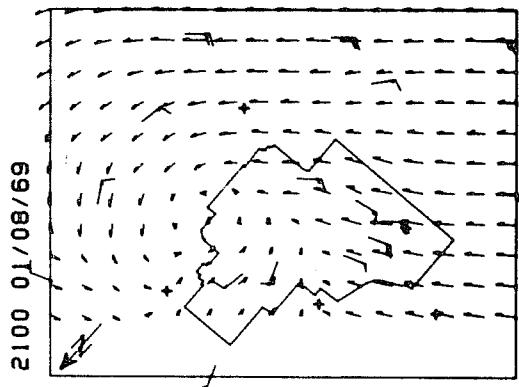
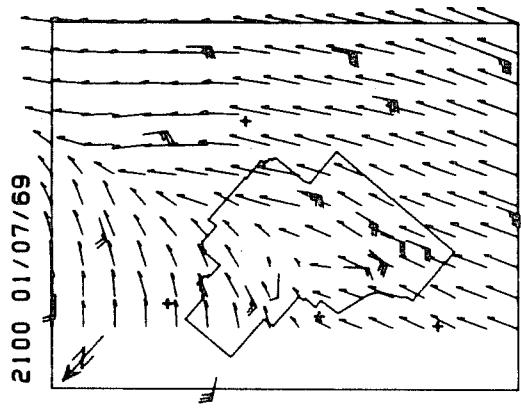
Wind field plots for the upper Snake River Plain.

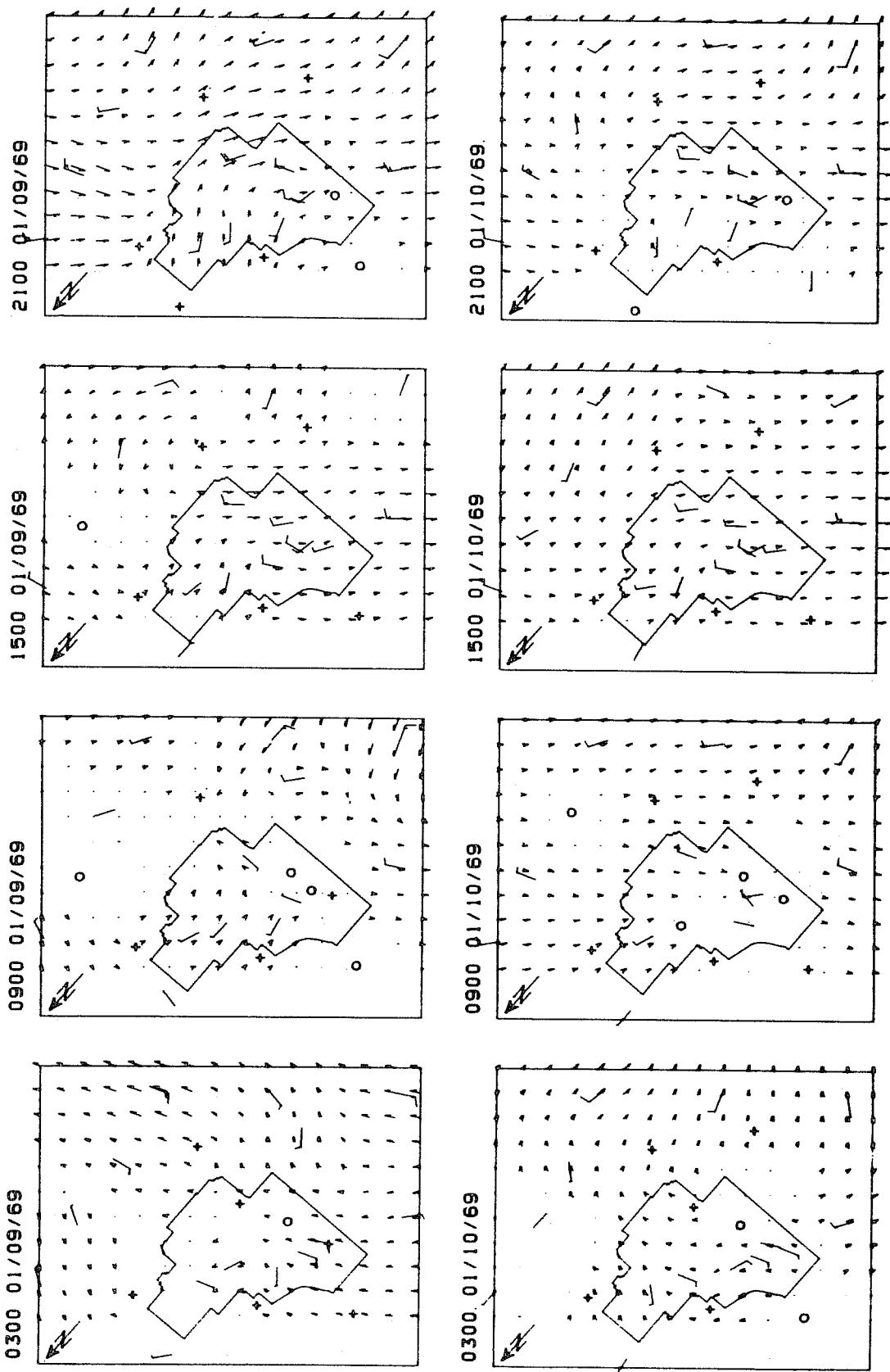
Times are Mountain Standard.

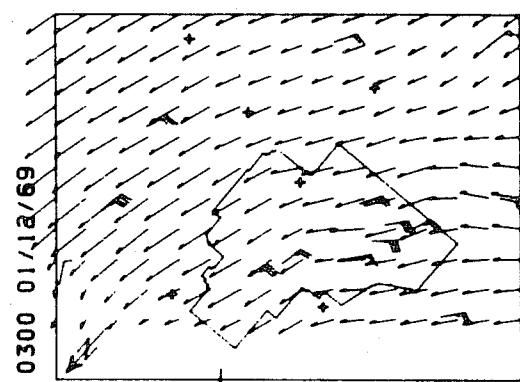
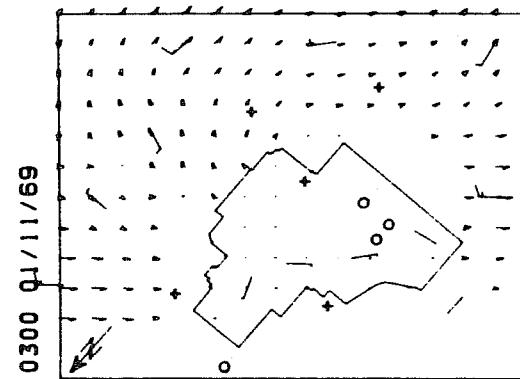
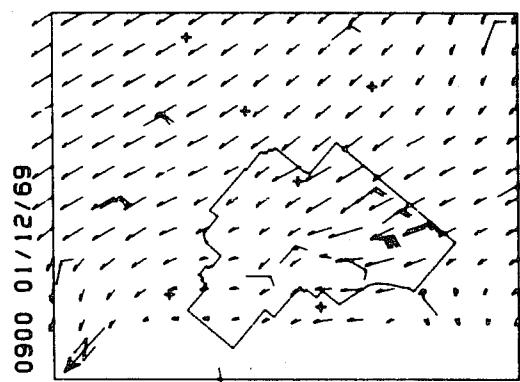
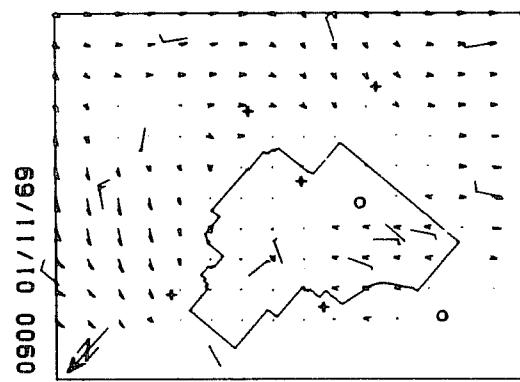
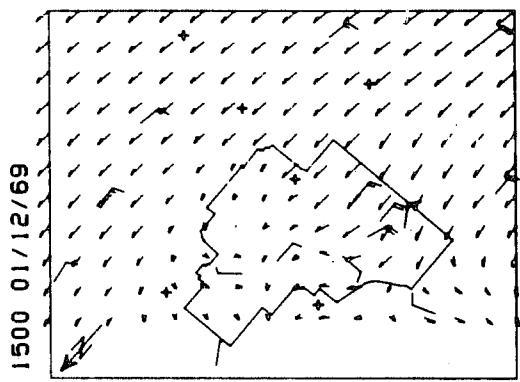
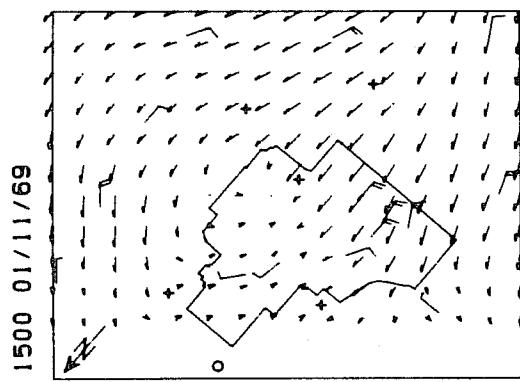
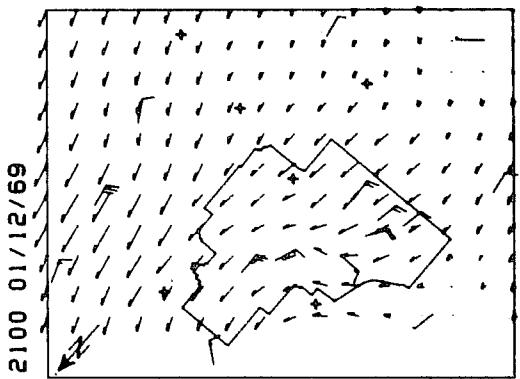
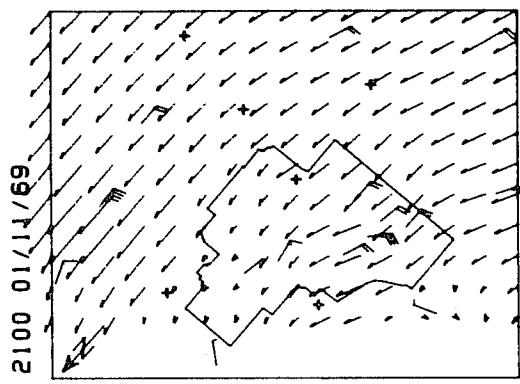


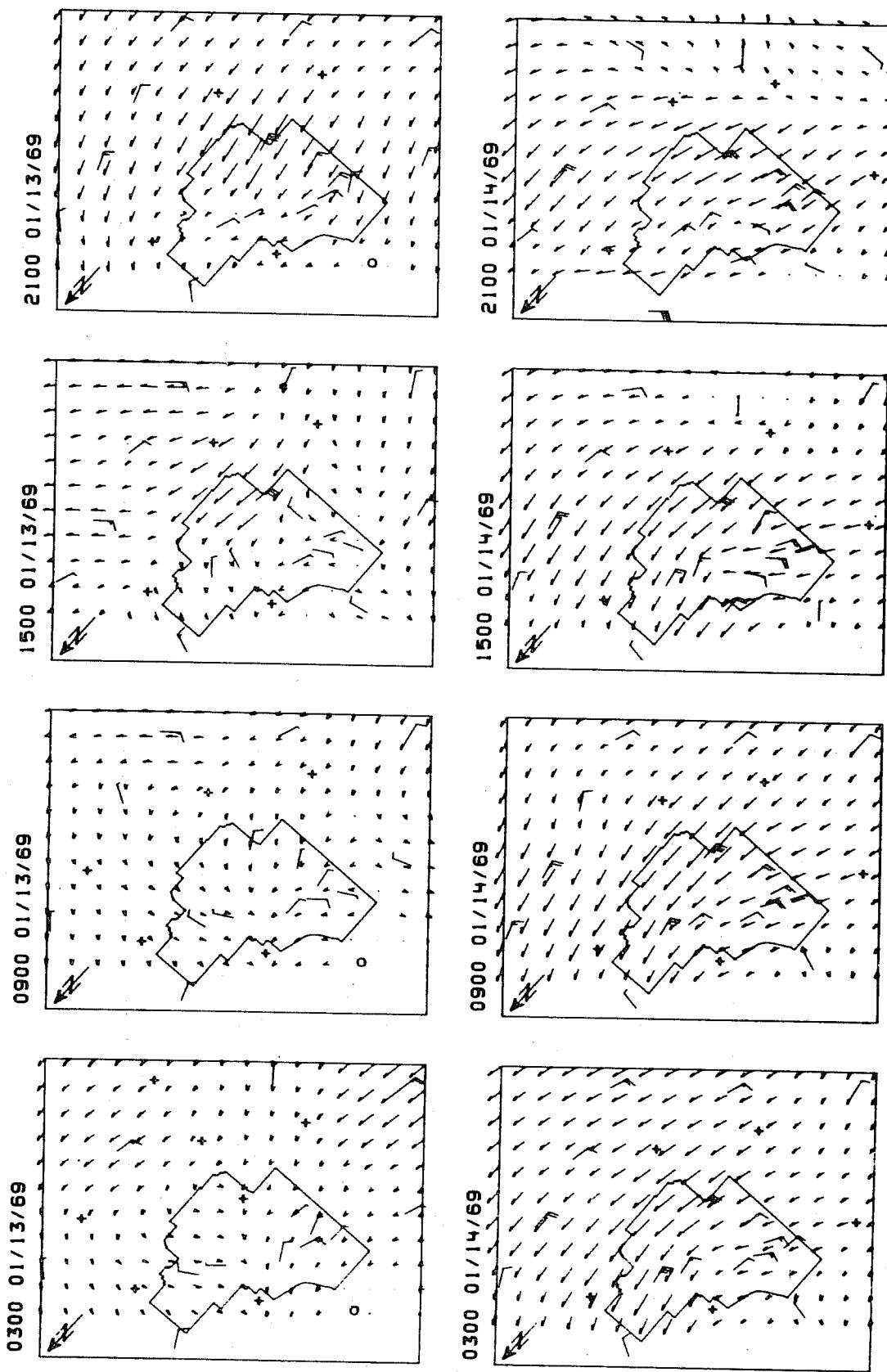


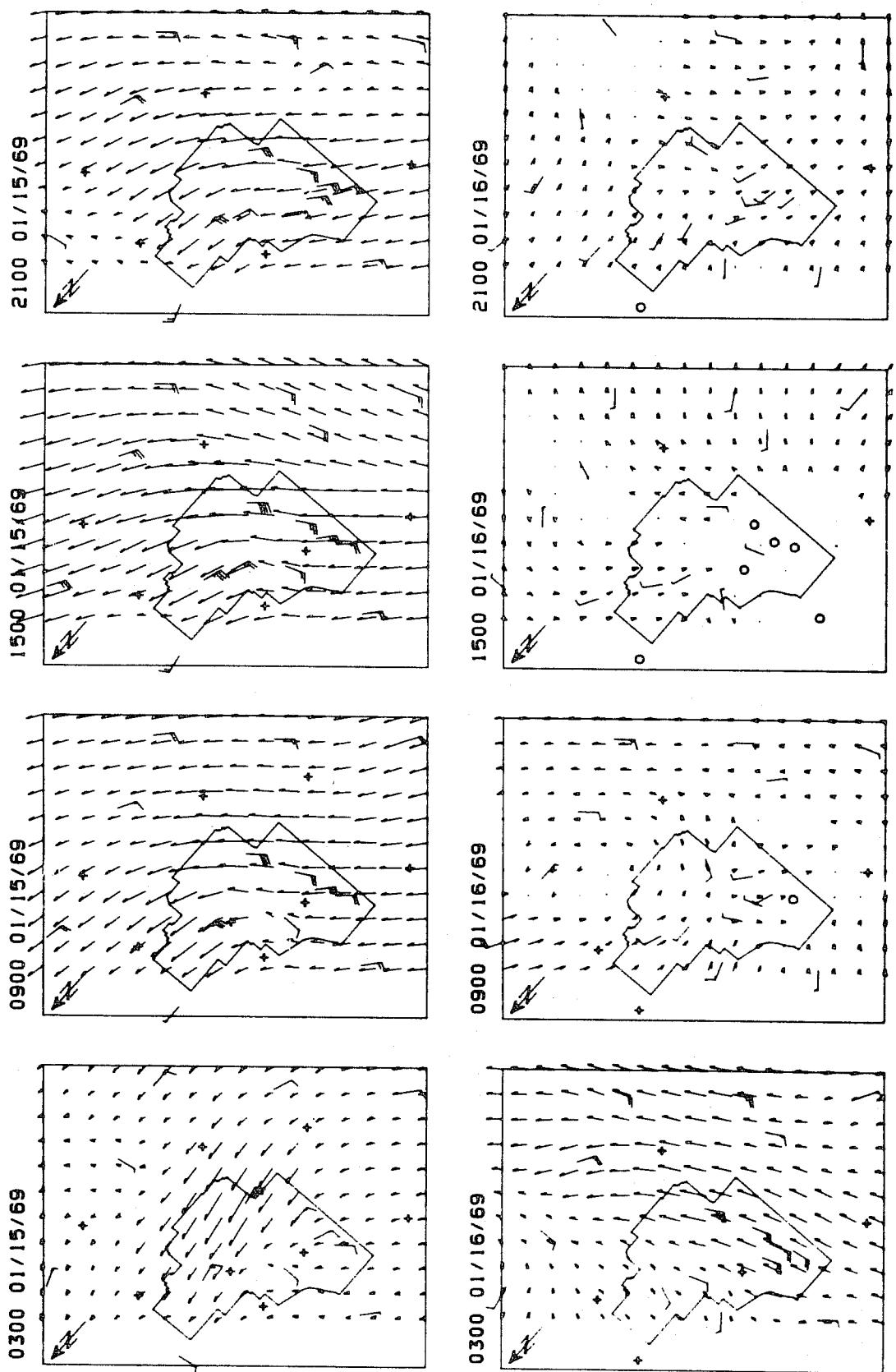


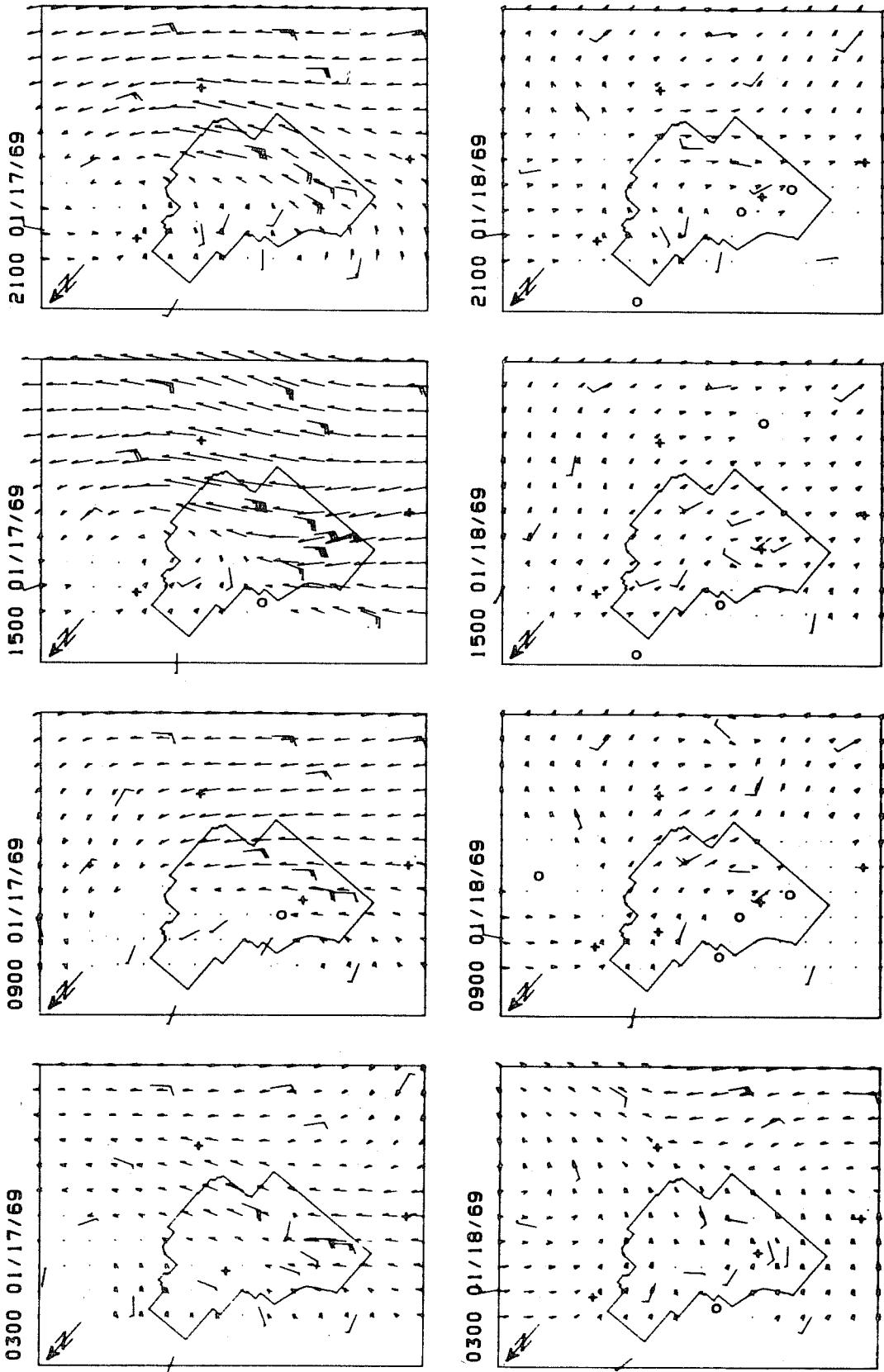


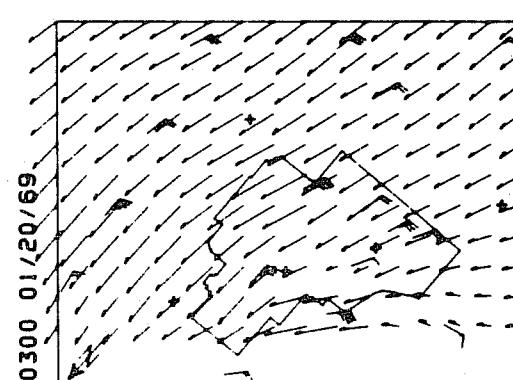
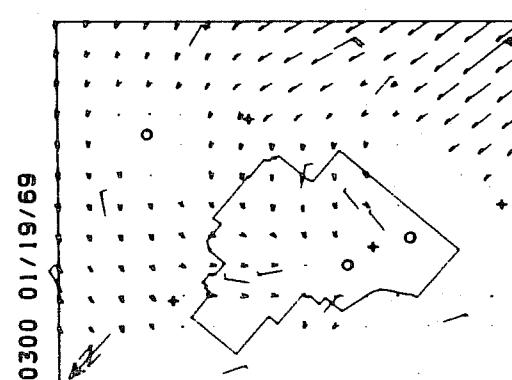
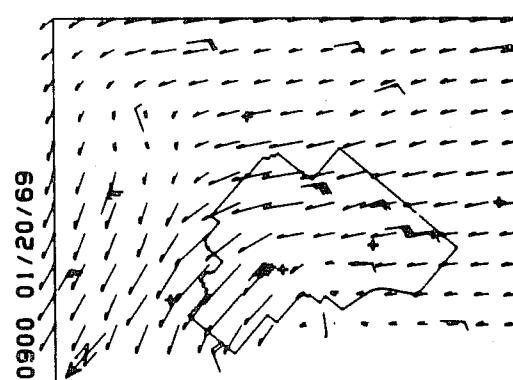
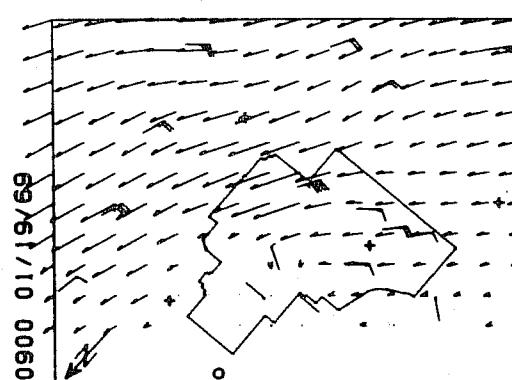
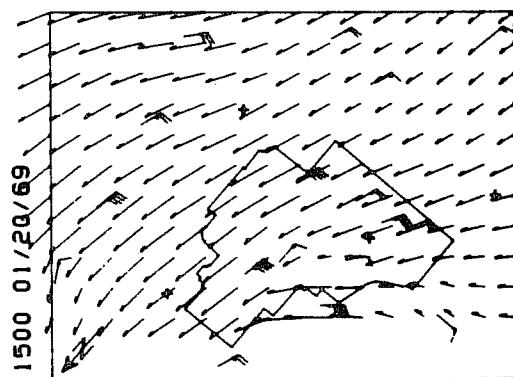
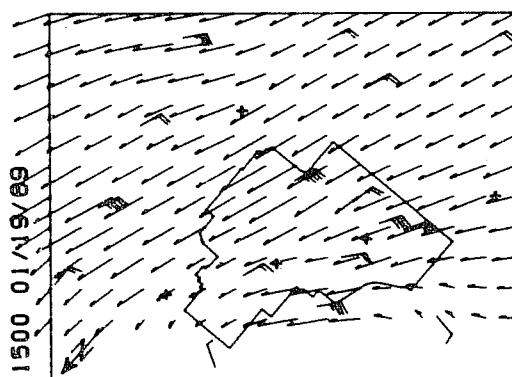
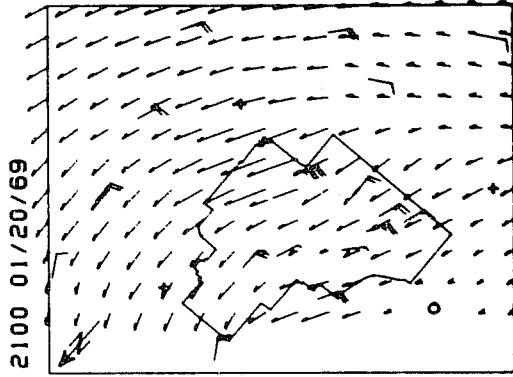
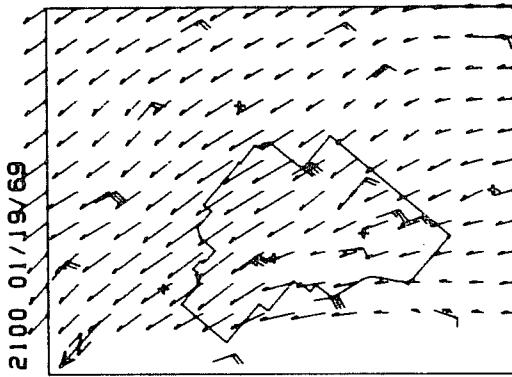


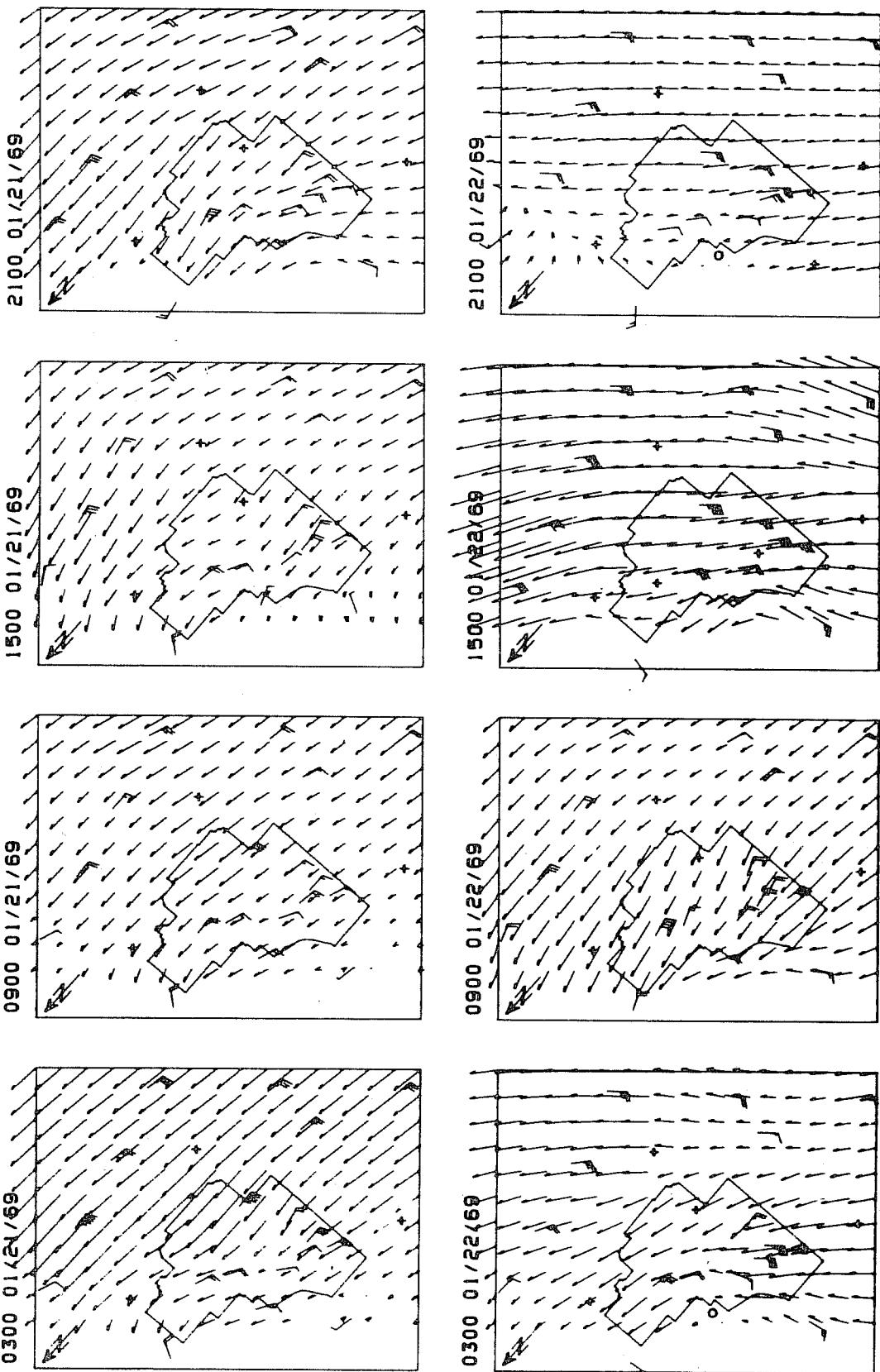


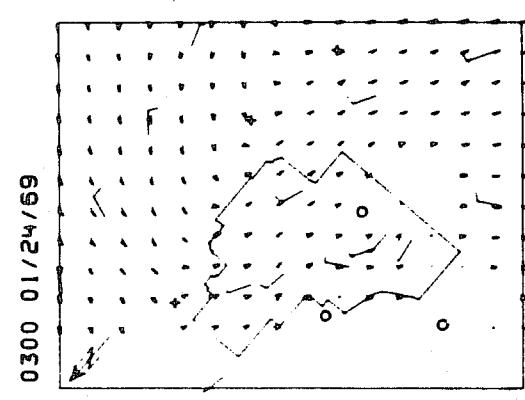
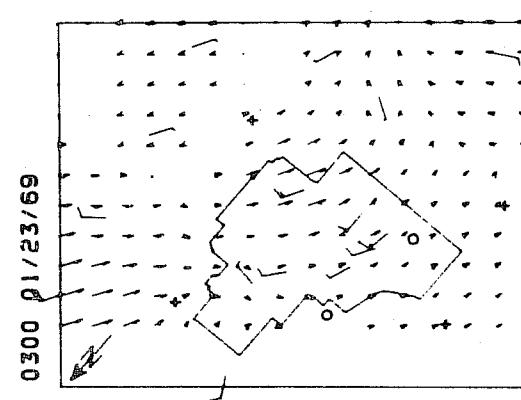
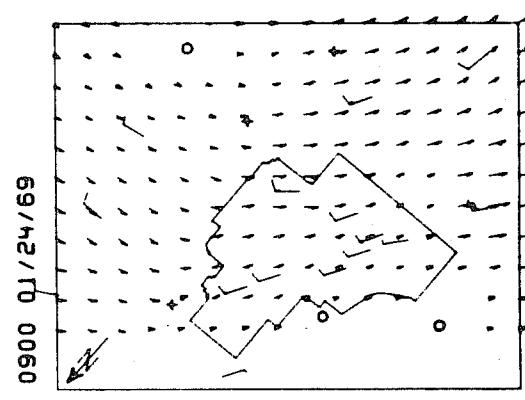
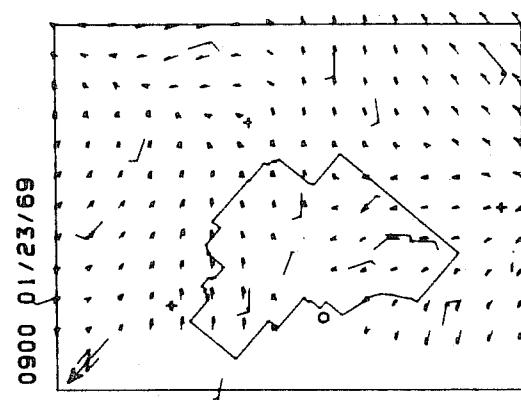
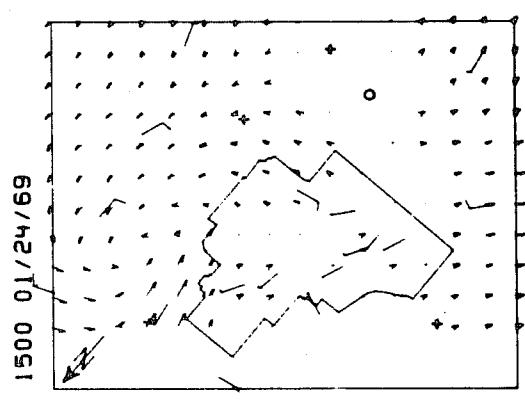
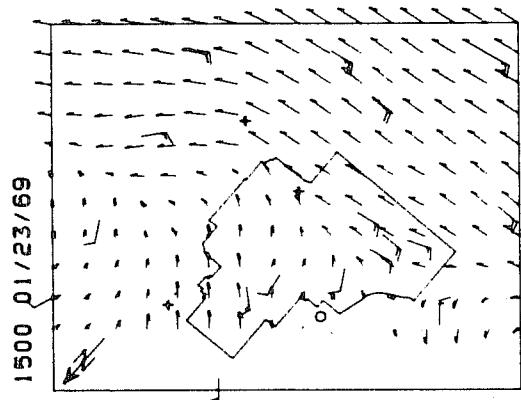
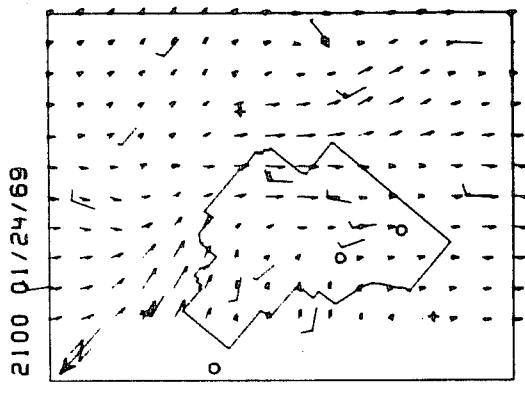
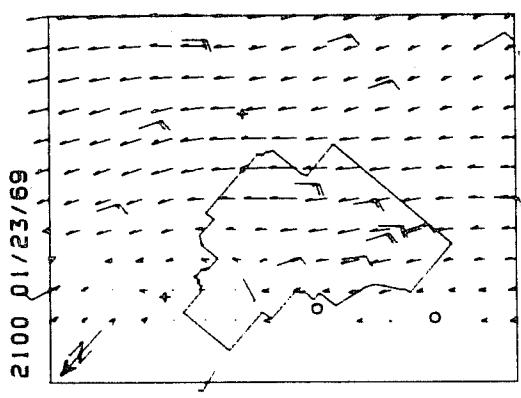


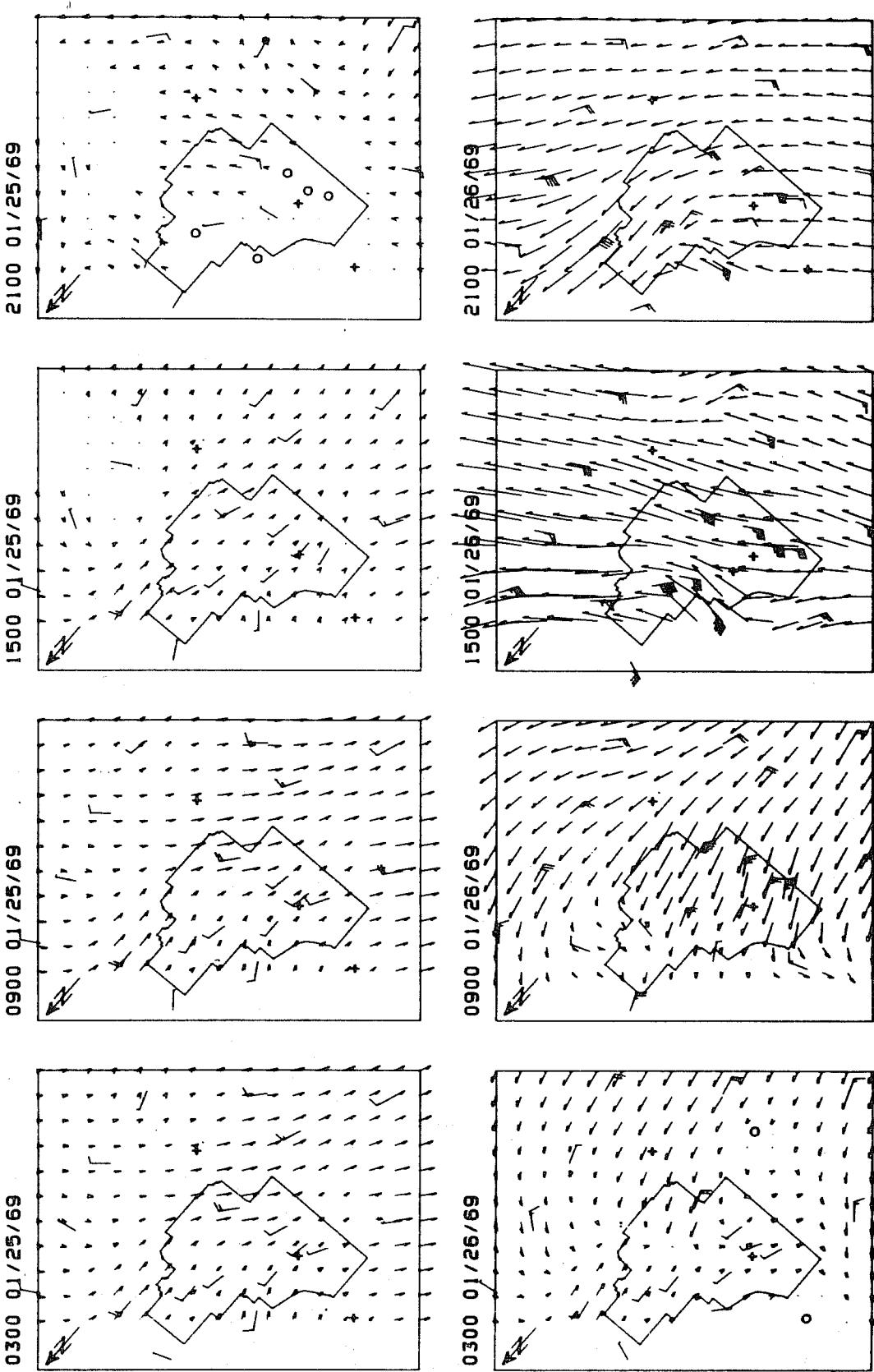


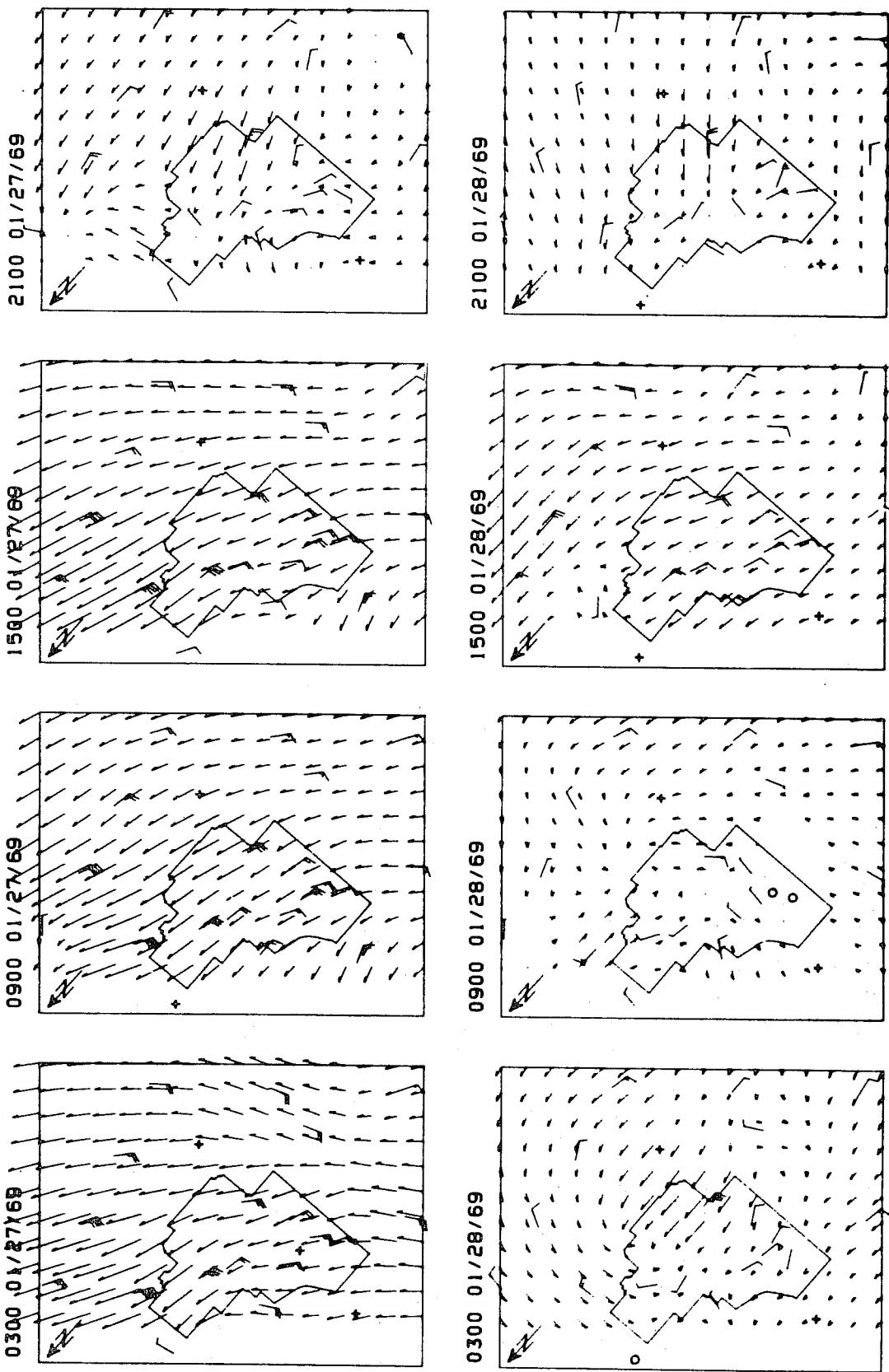


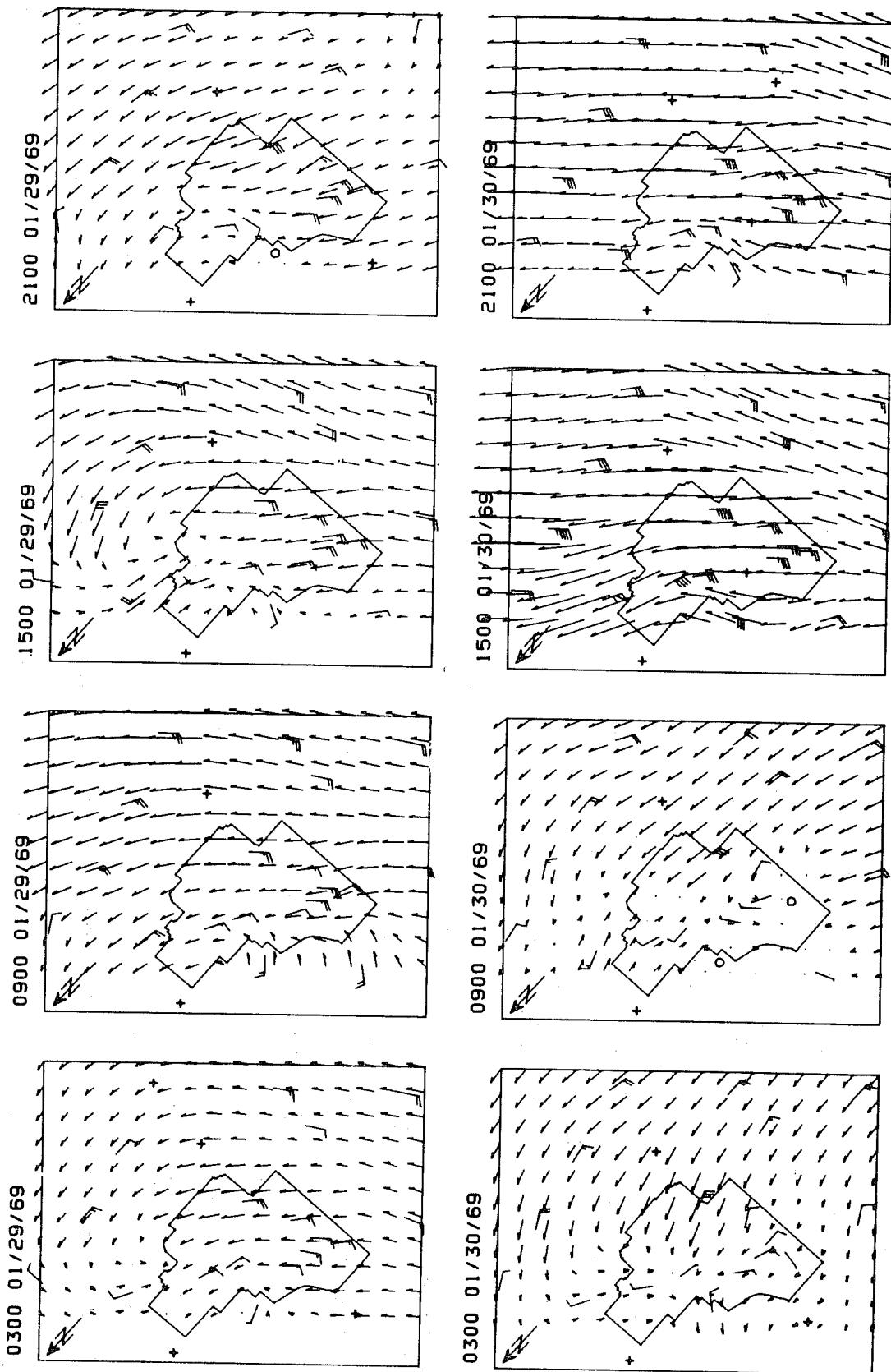


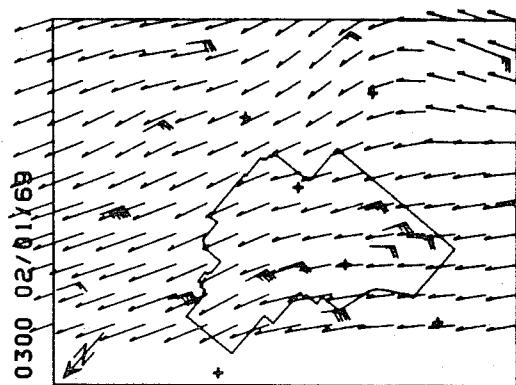
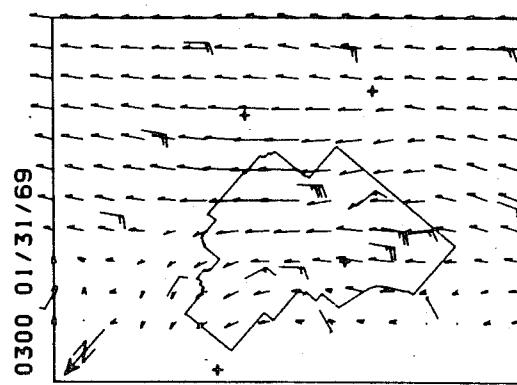
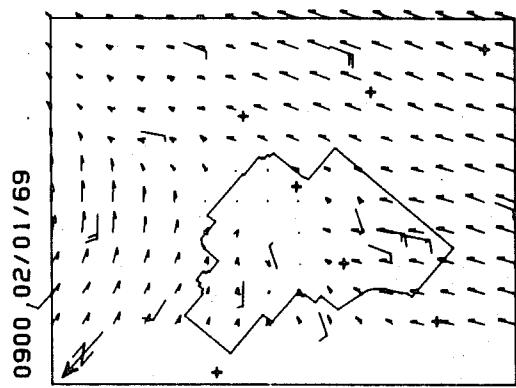
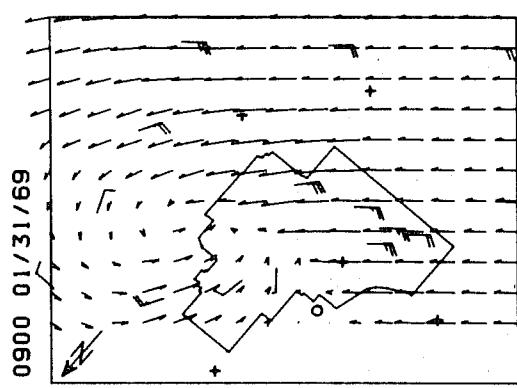
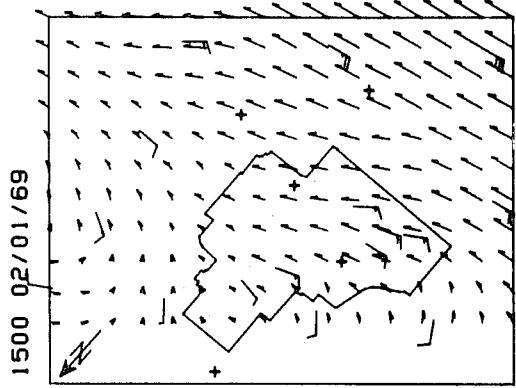
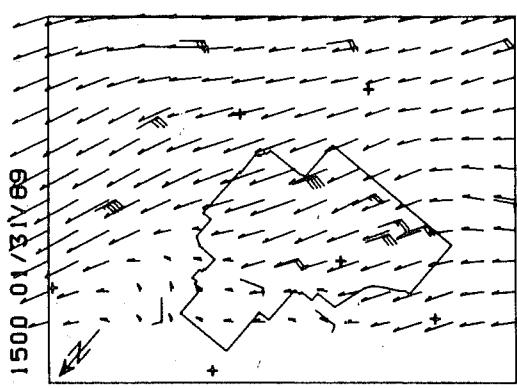
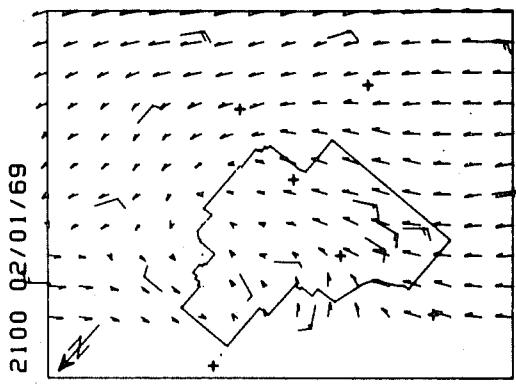
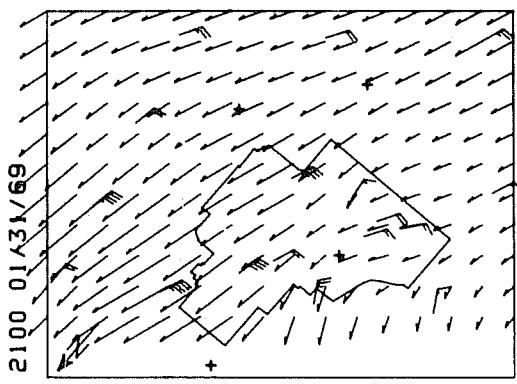


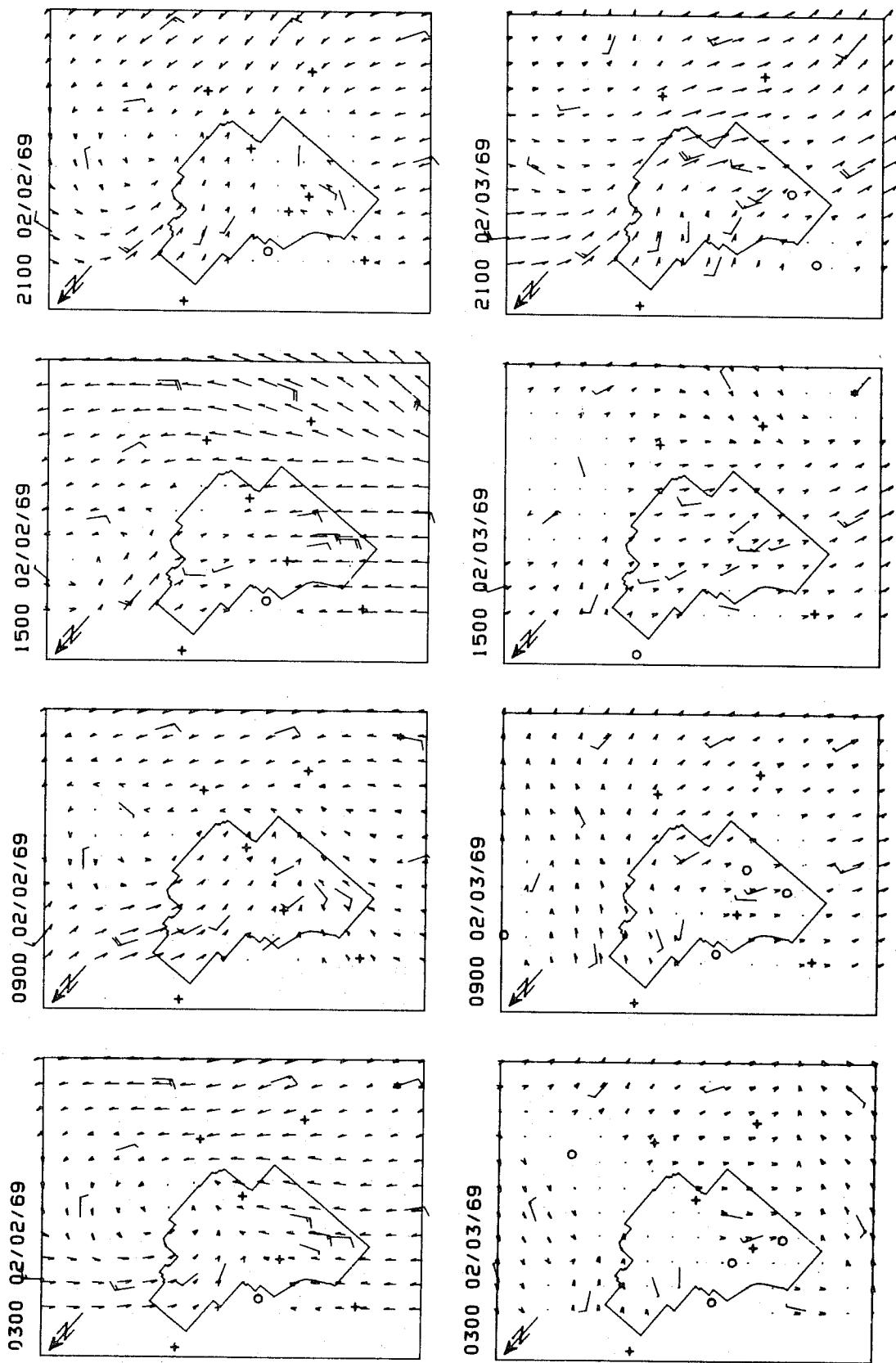


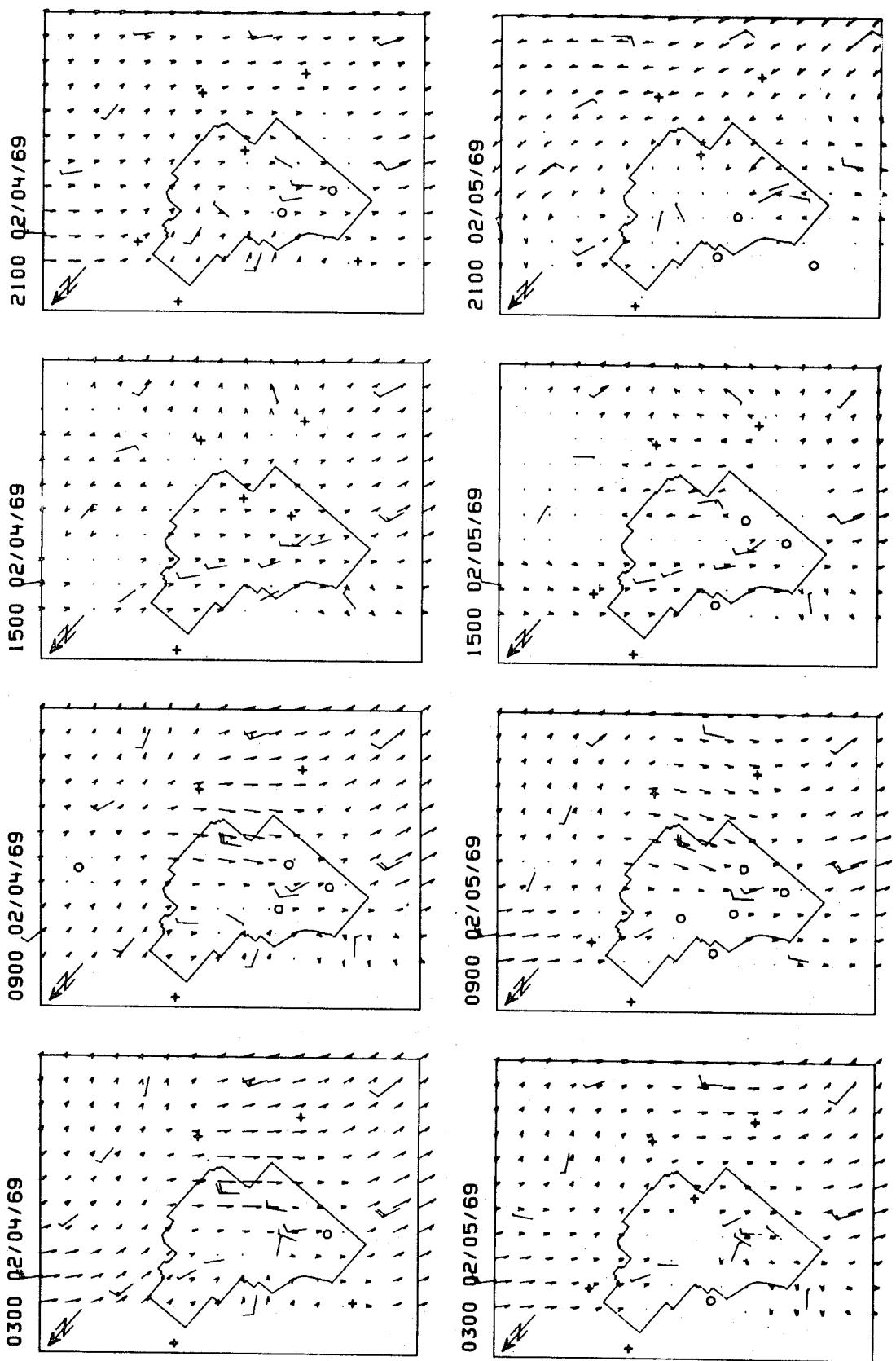


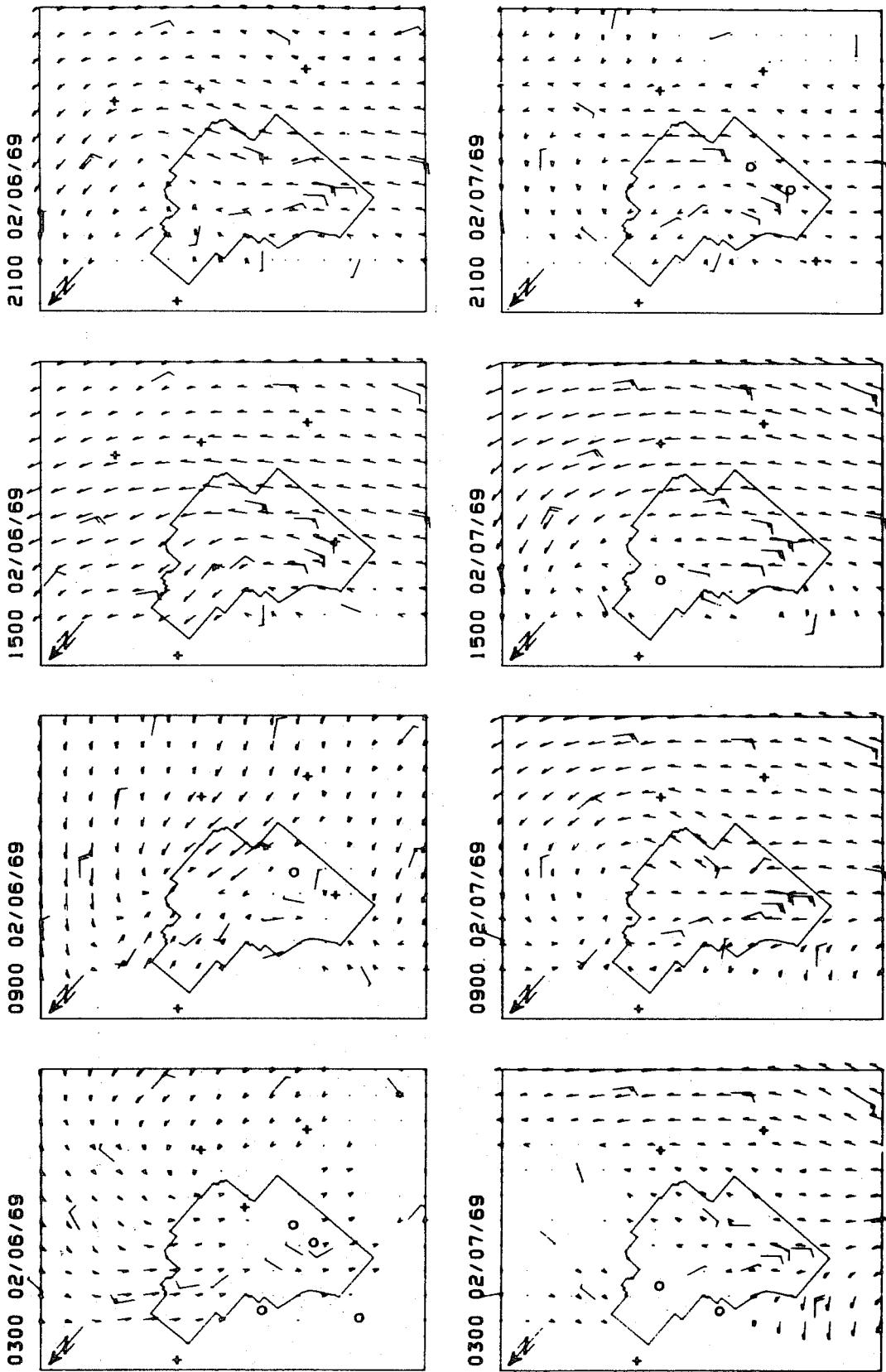


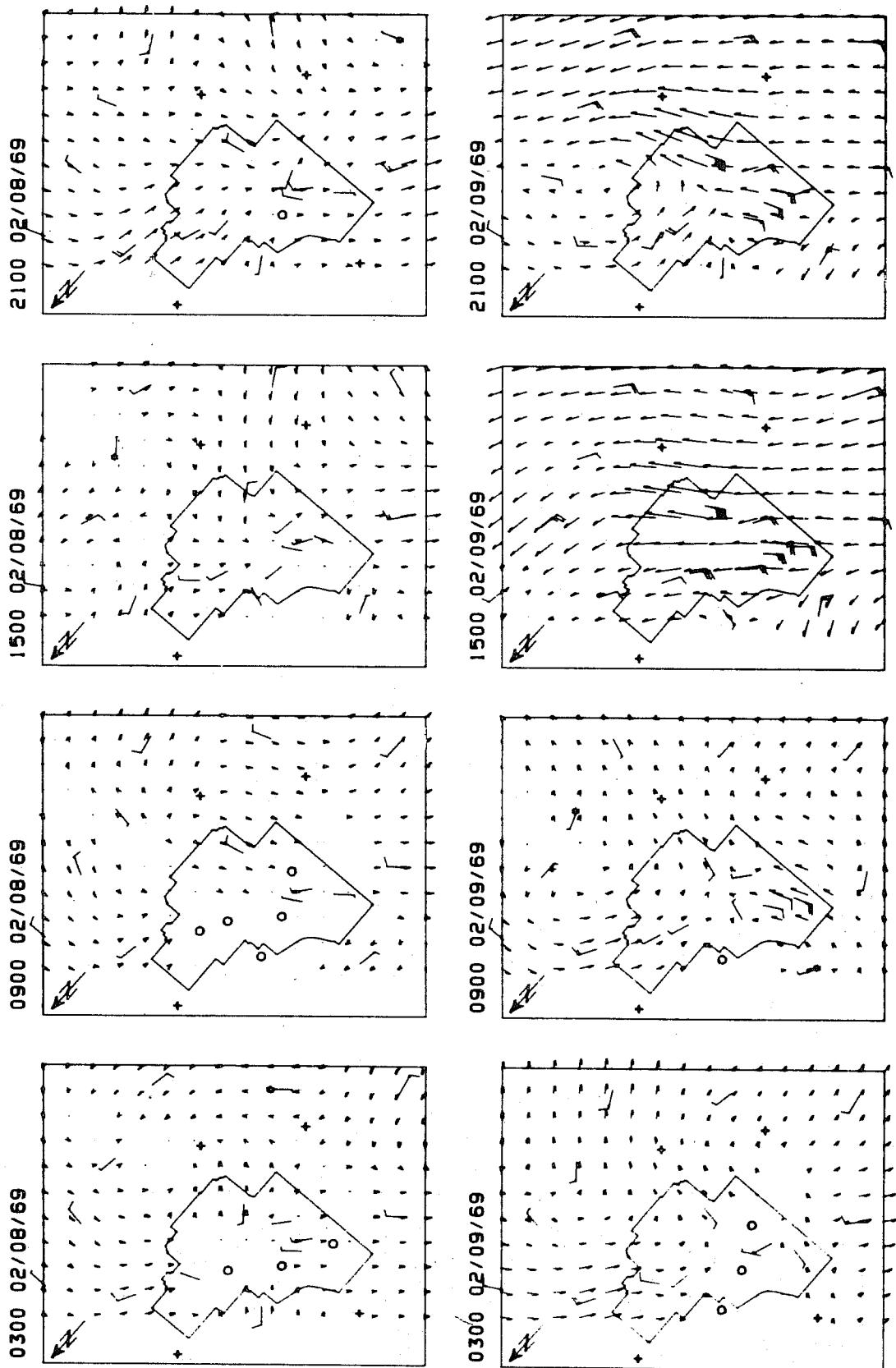


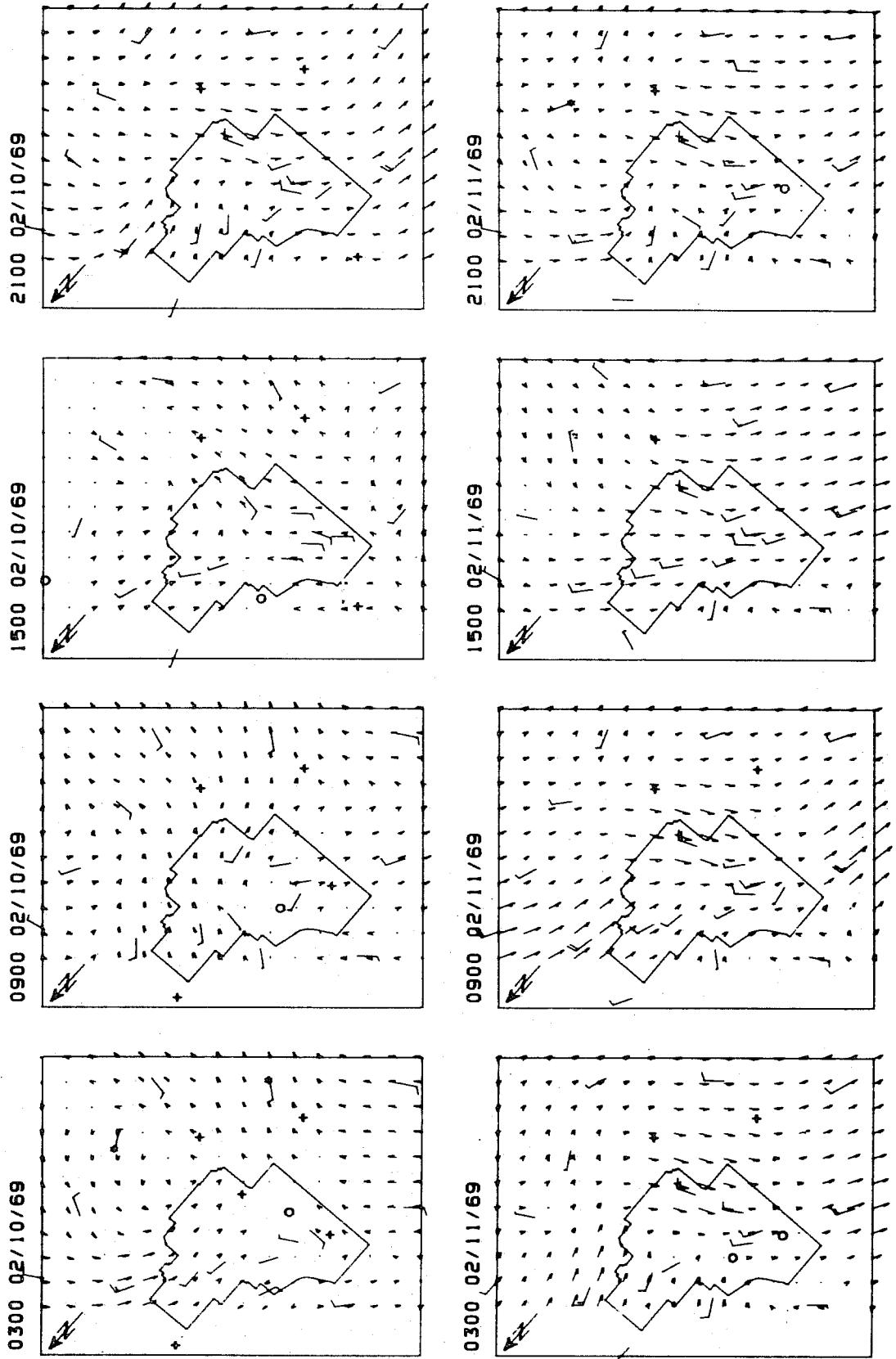


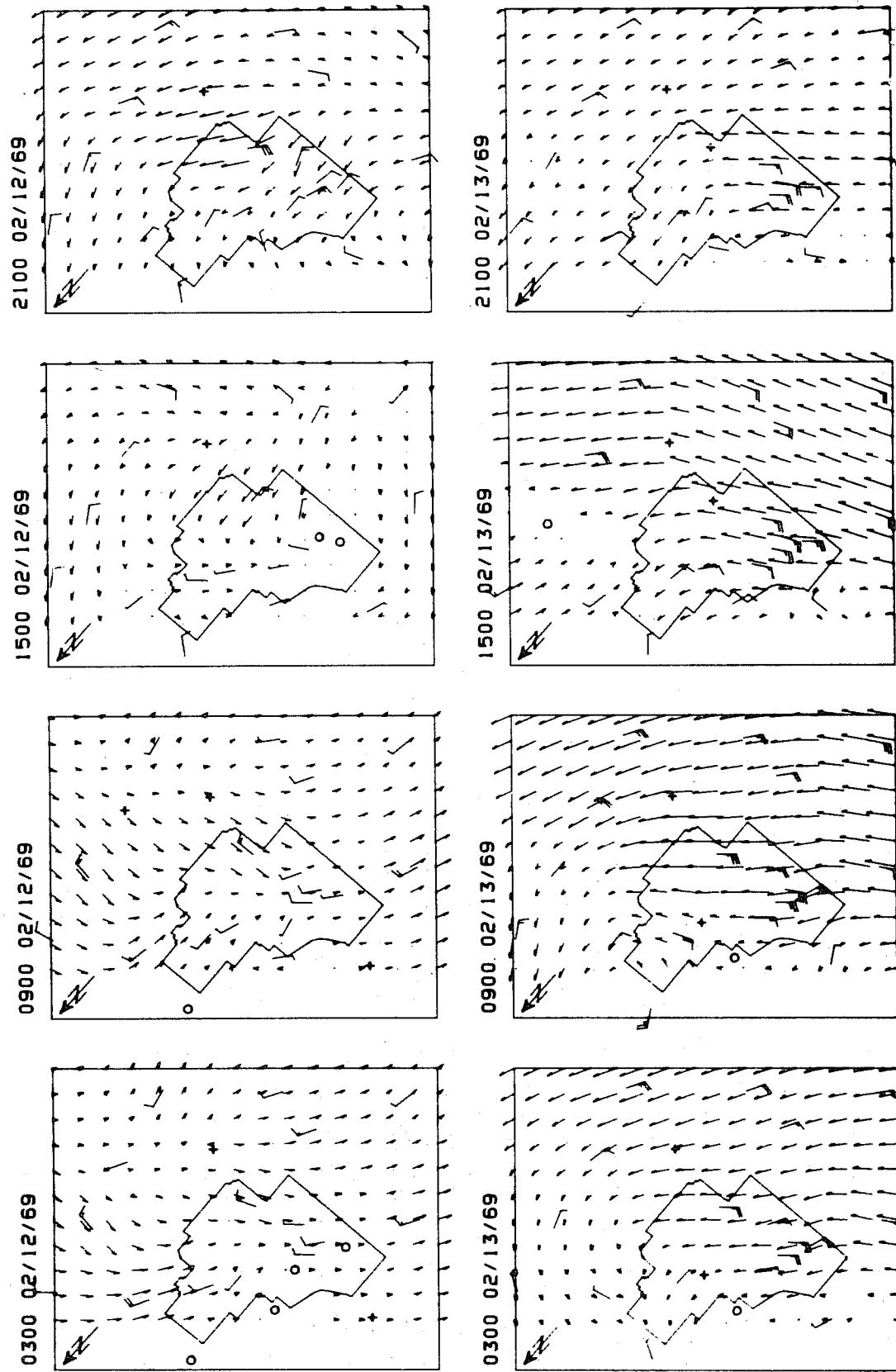


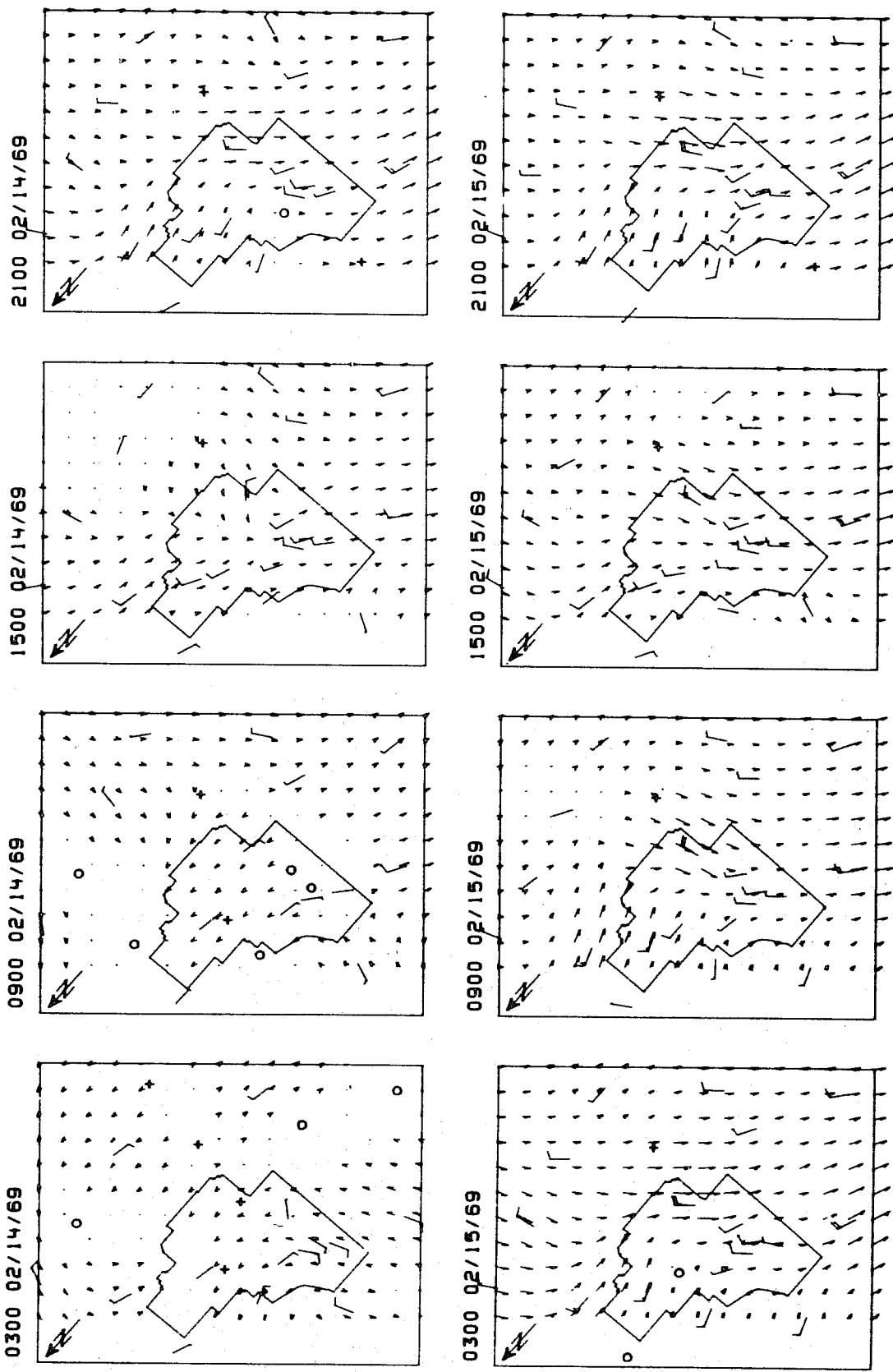


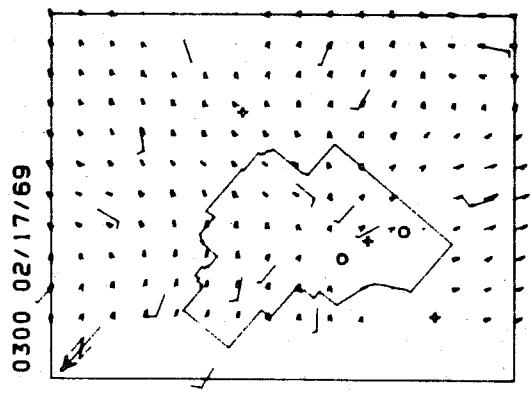
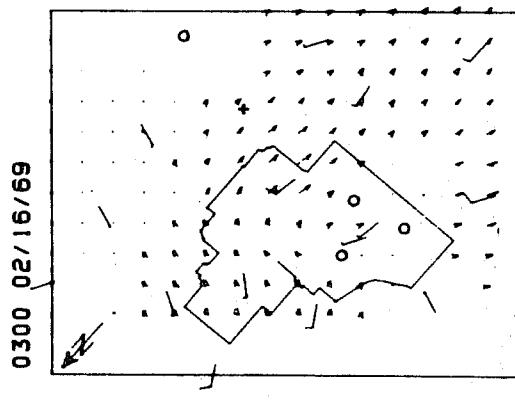
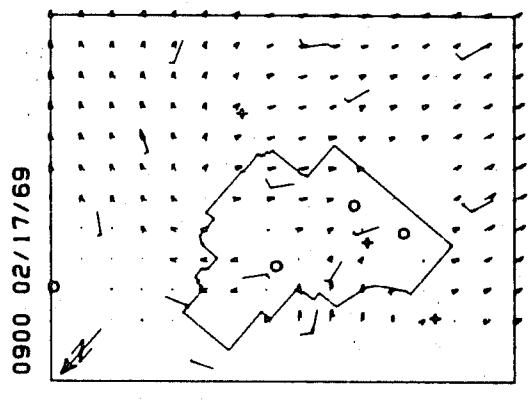
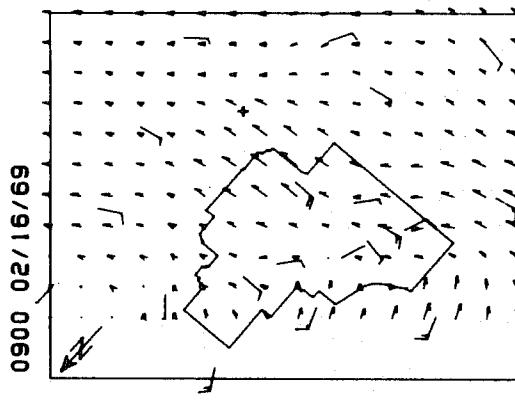
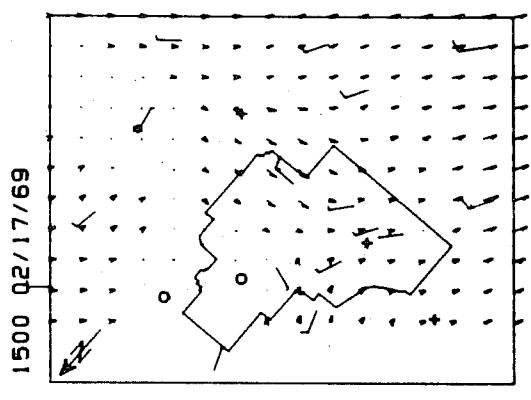
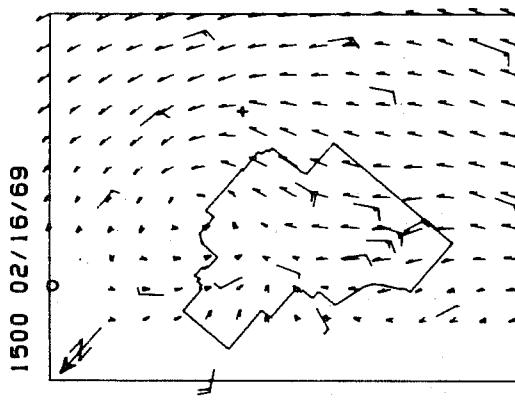
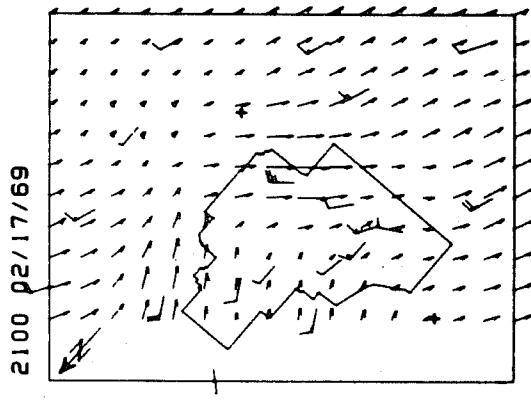
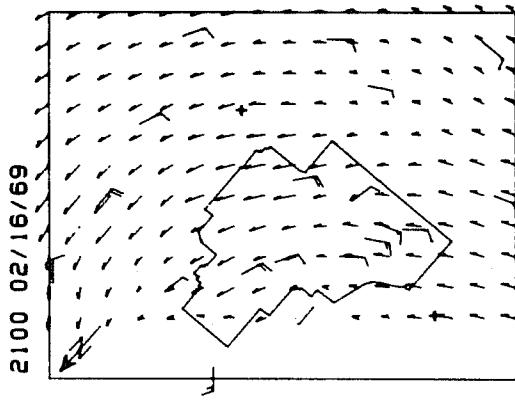


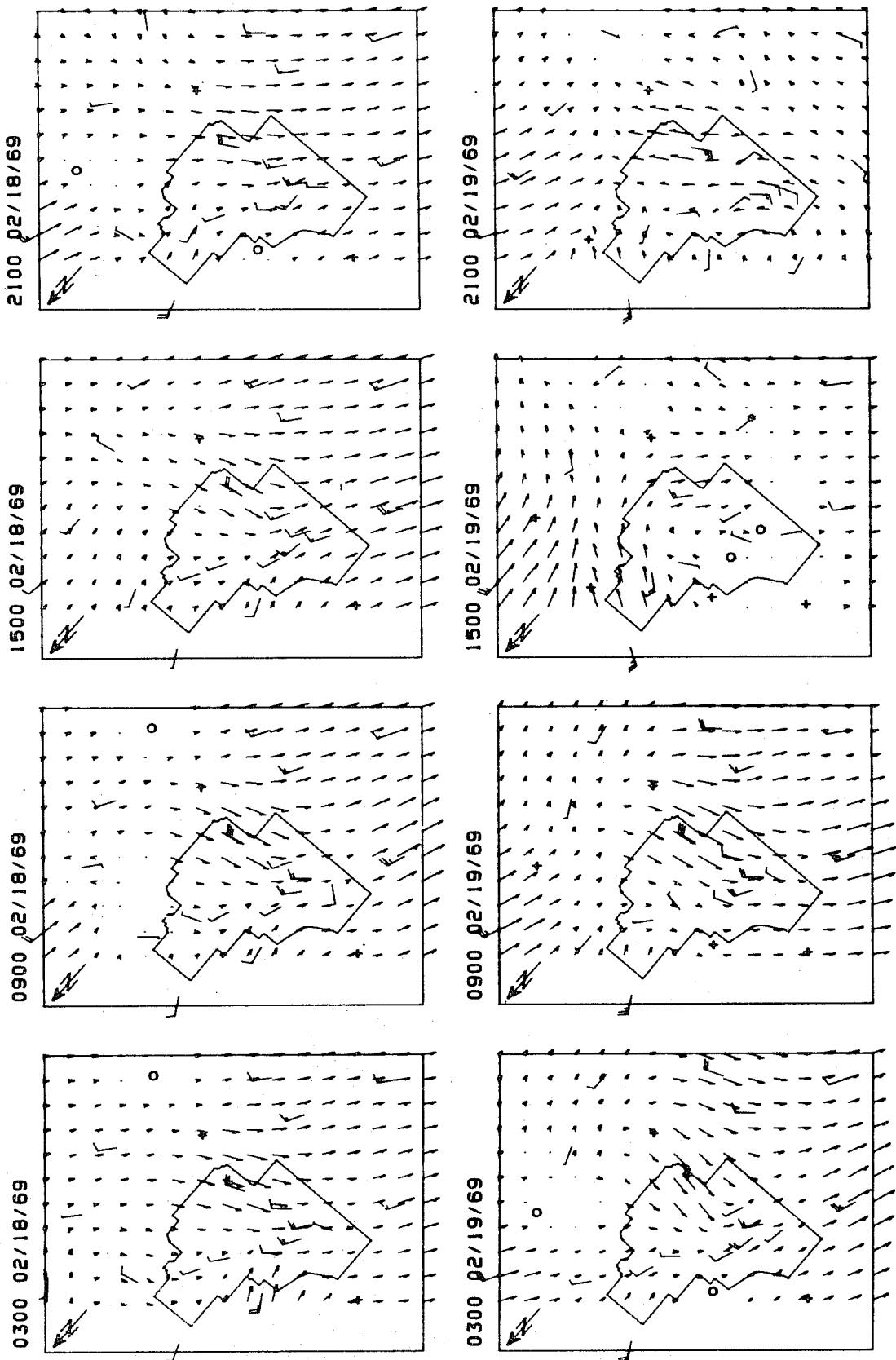


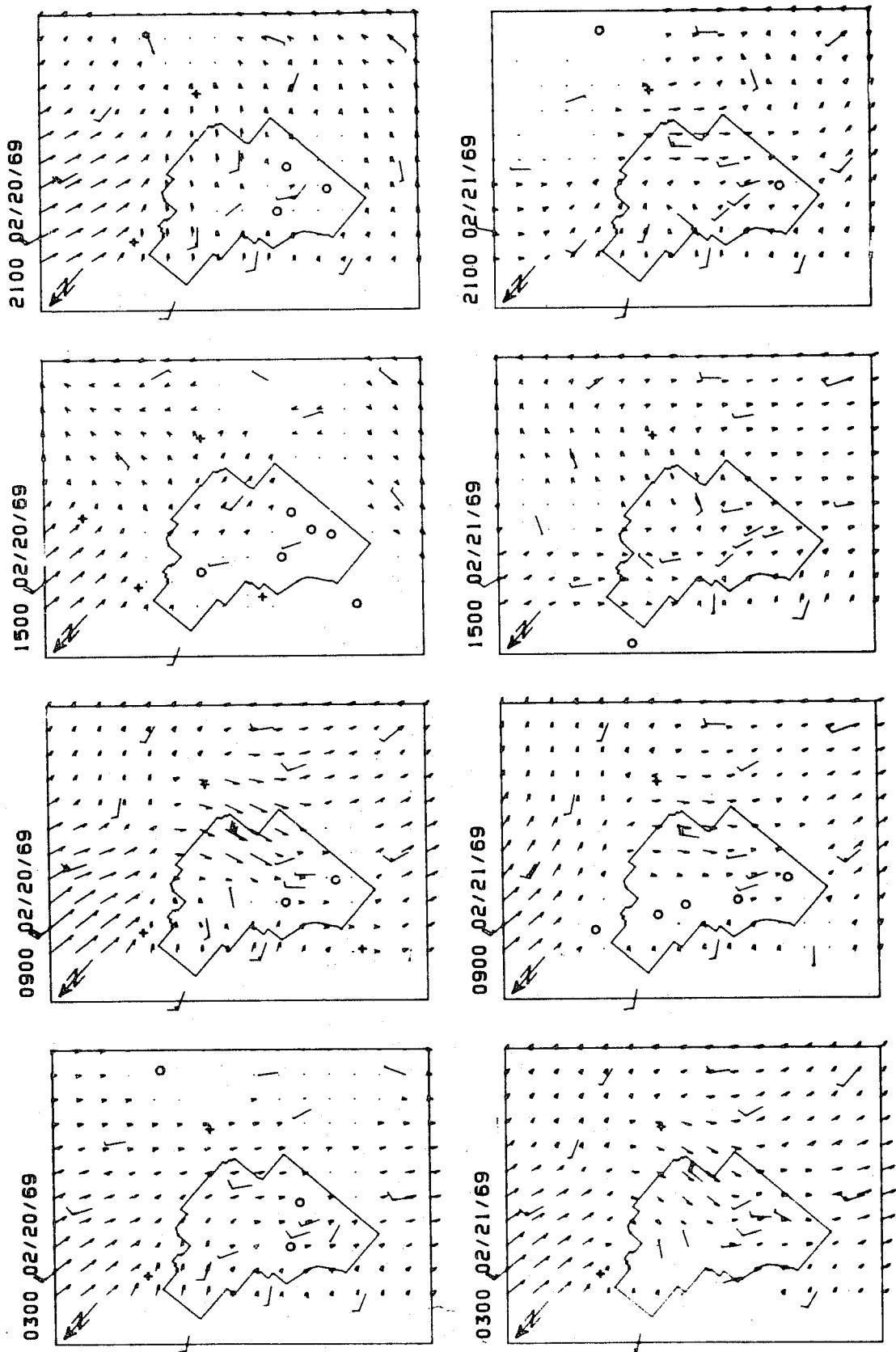


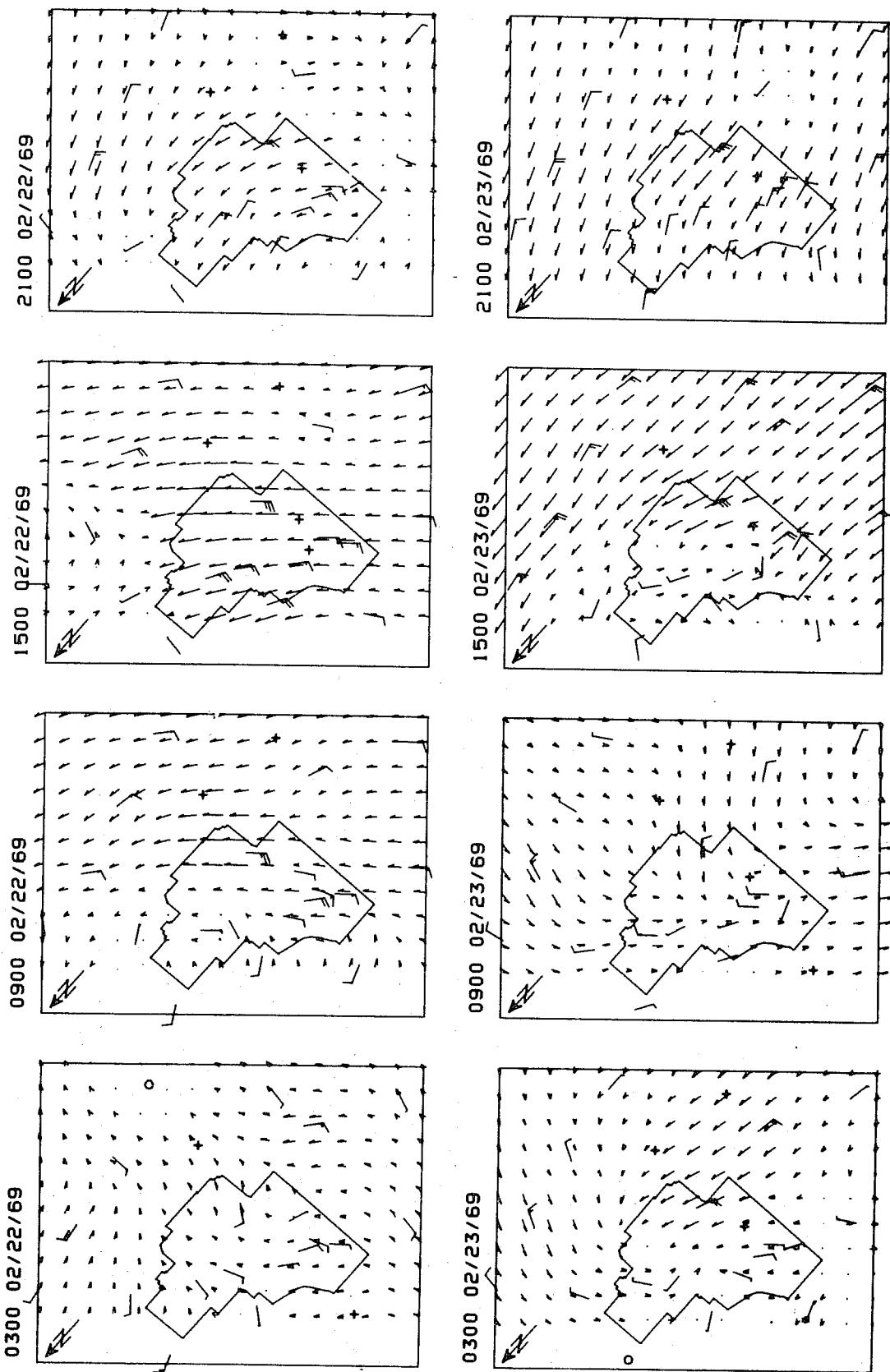


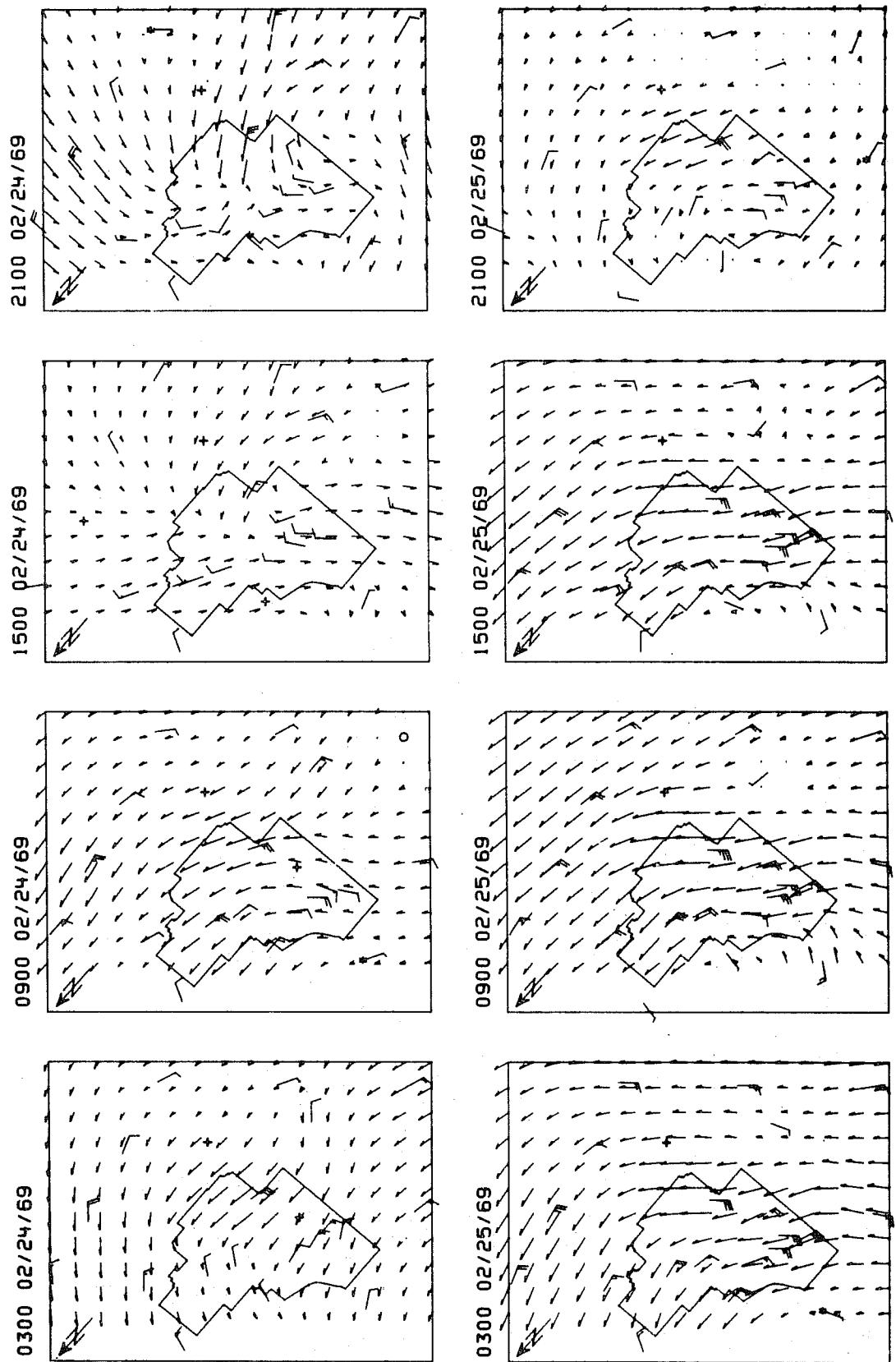


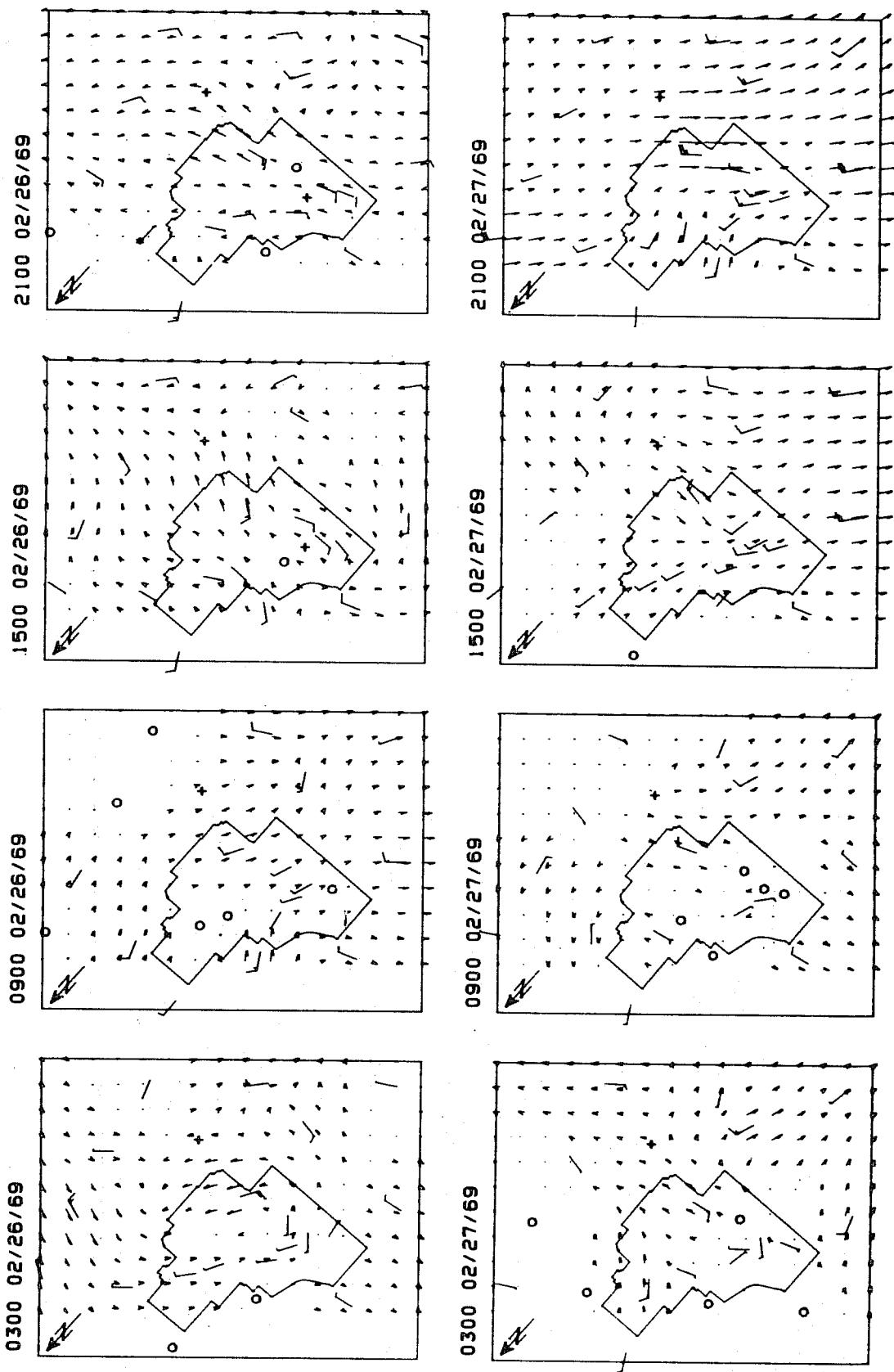


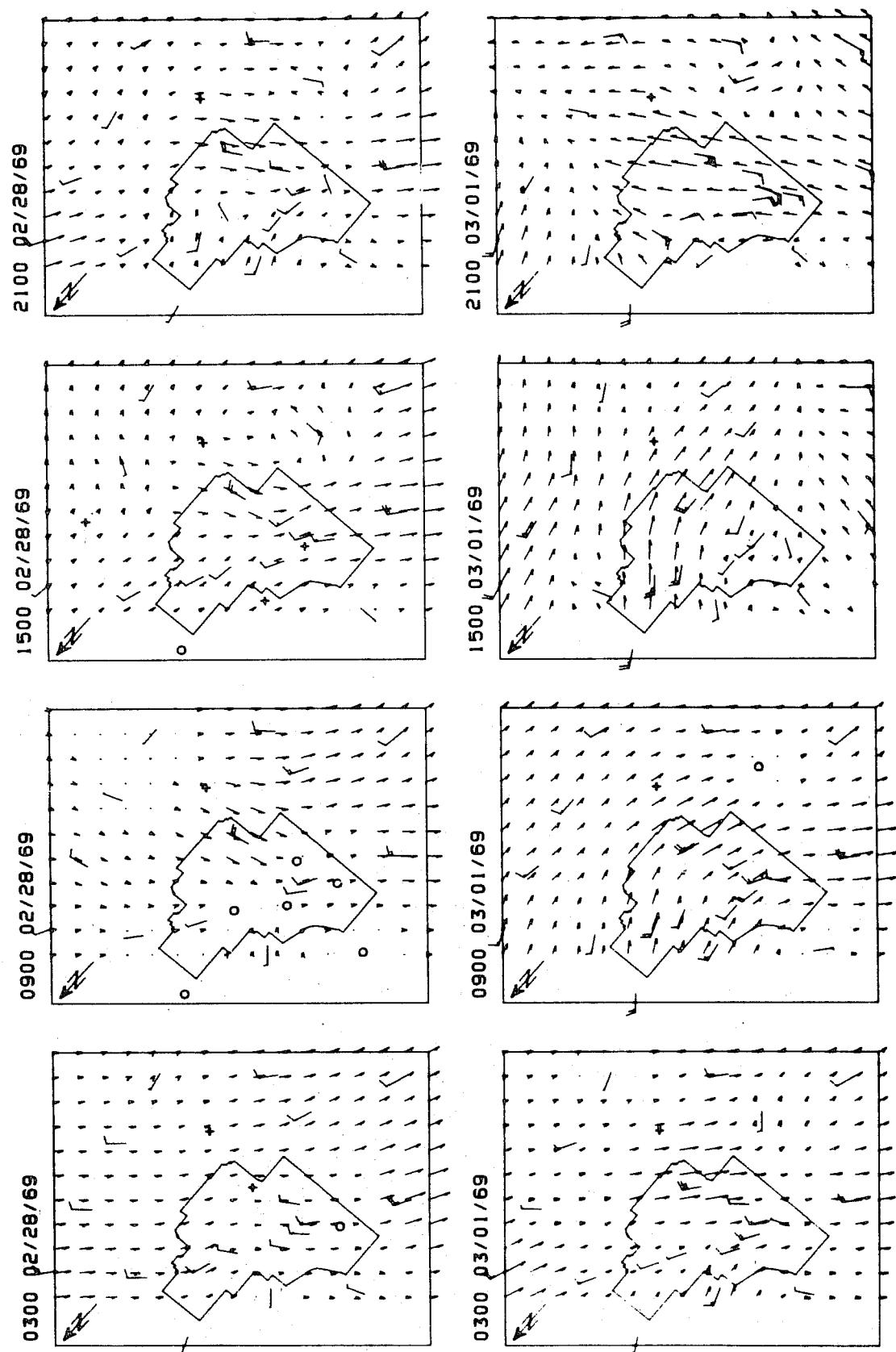


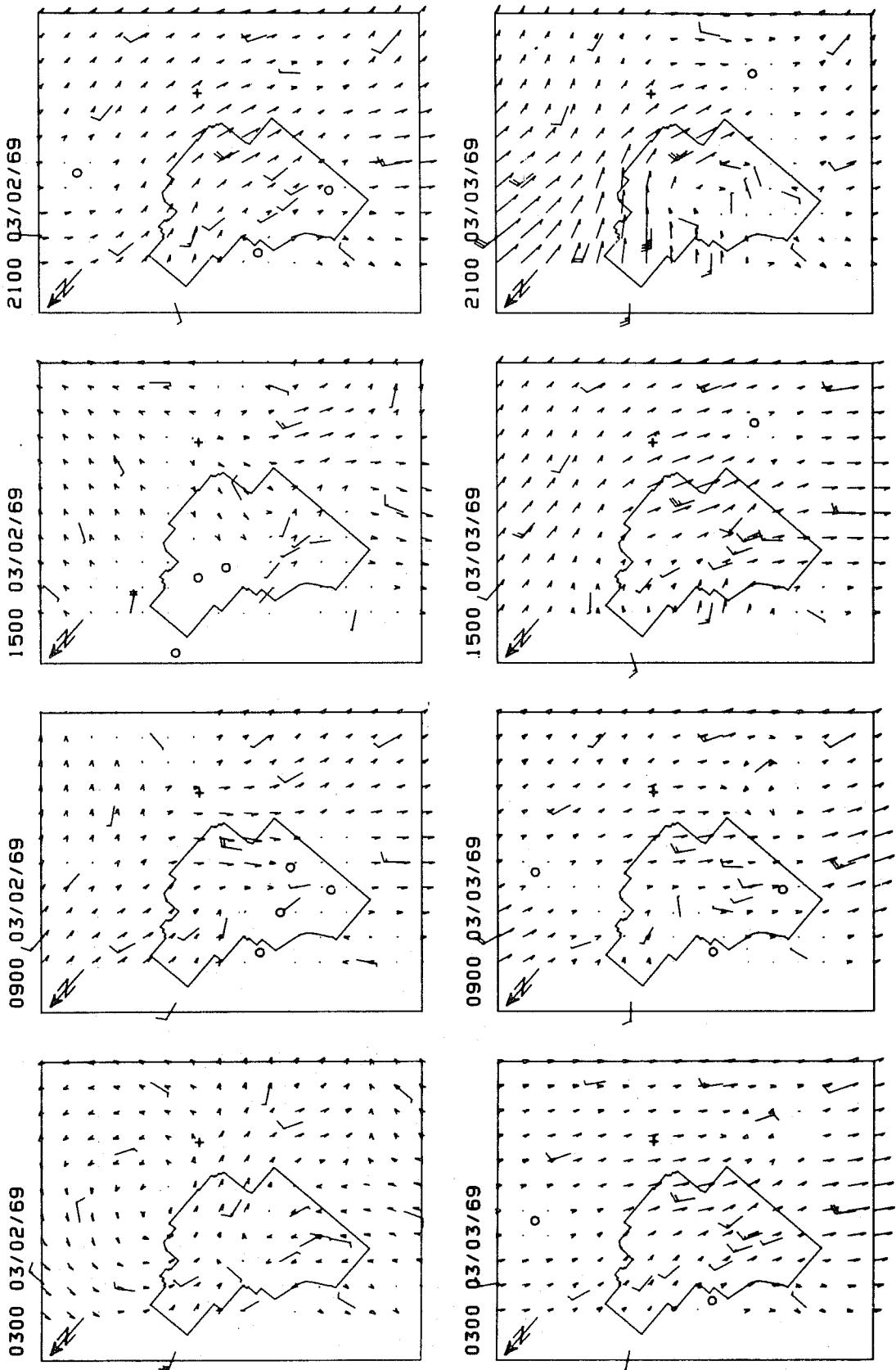


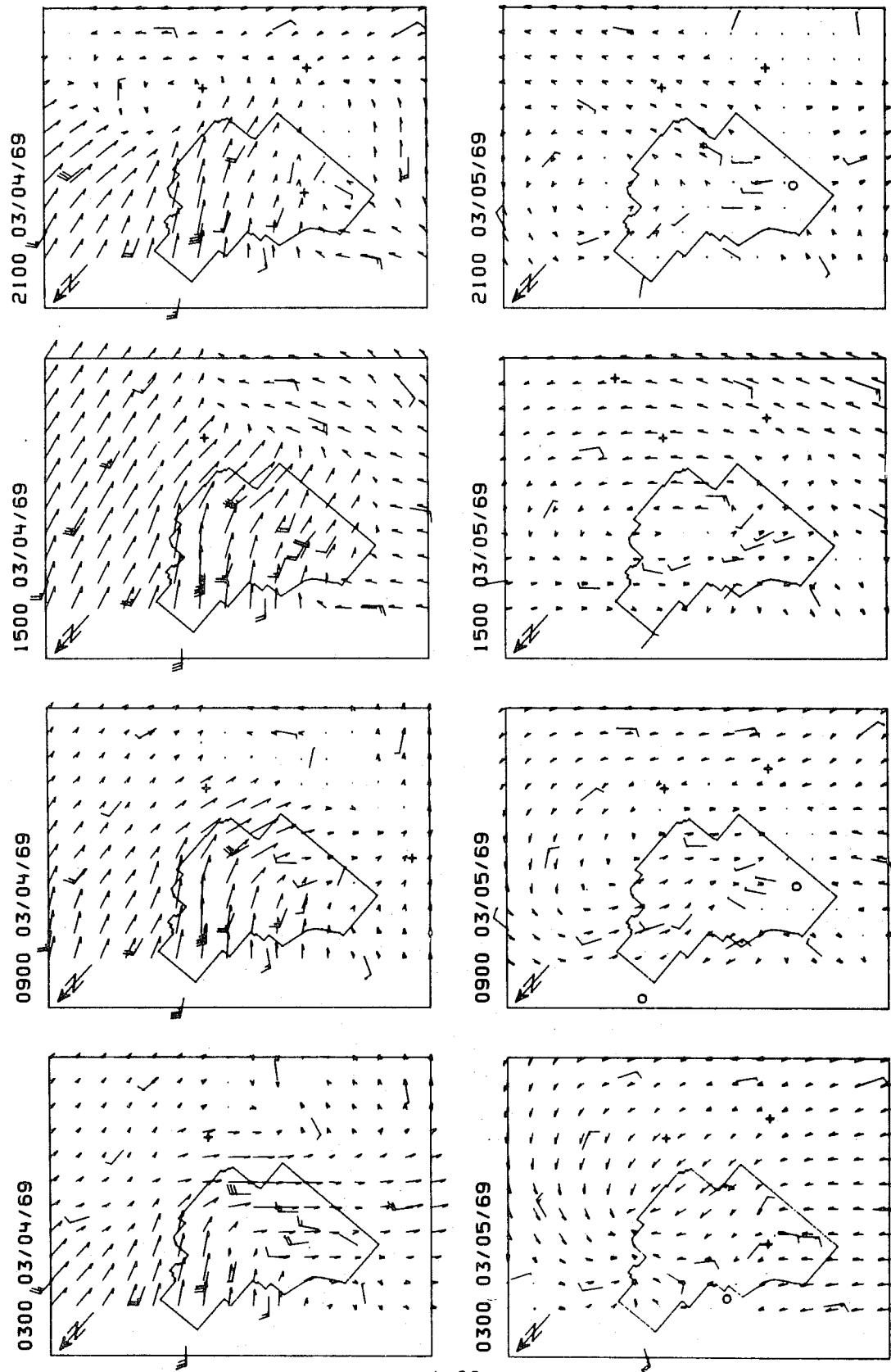


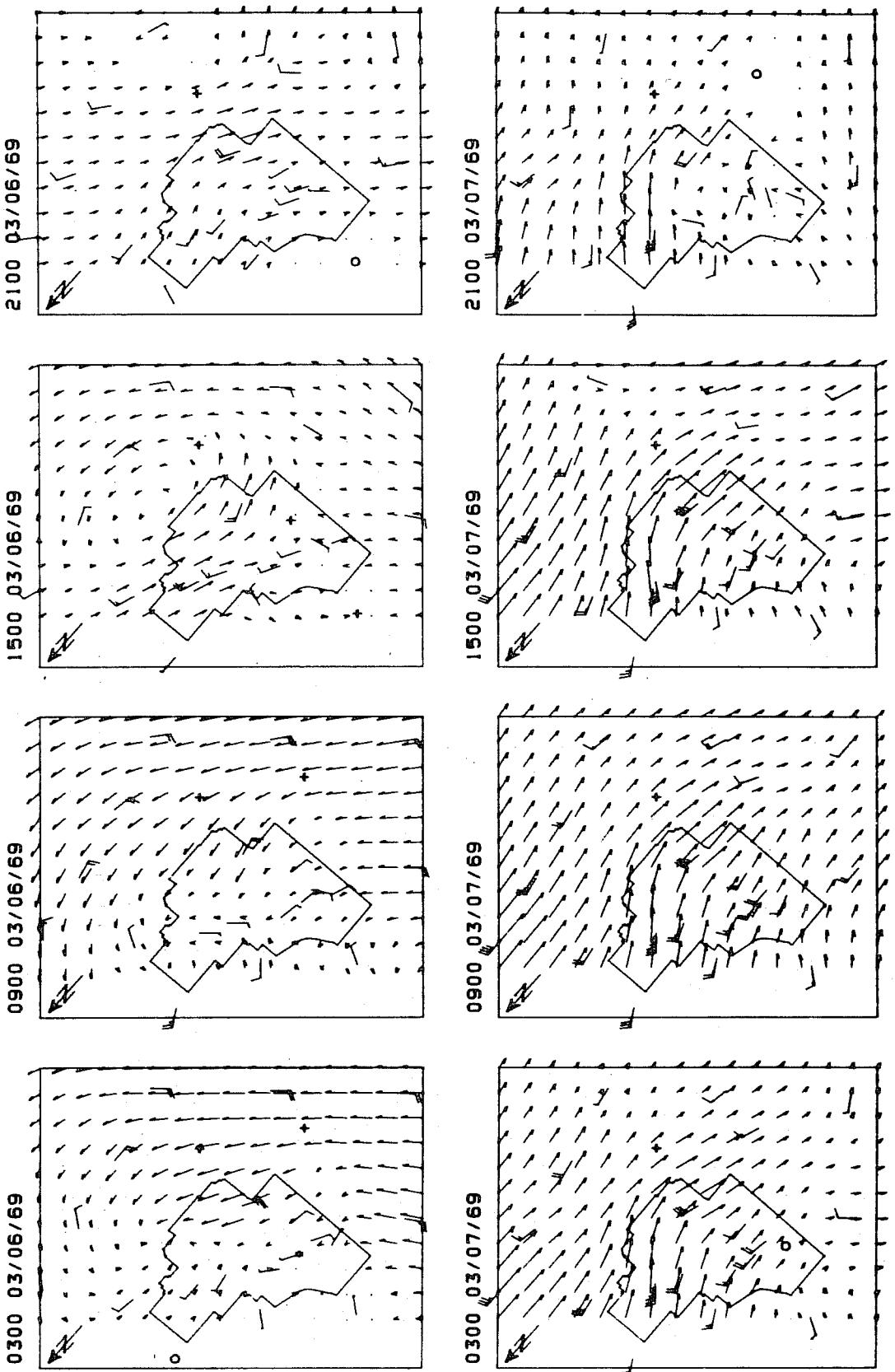


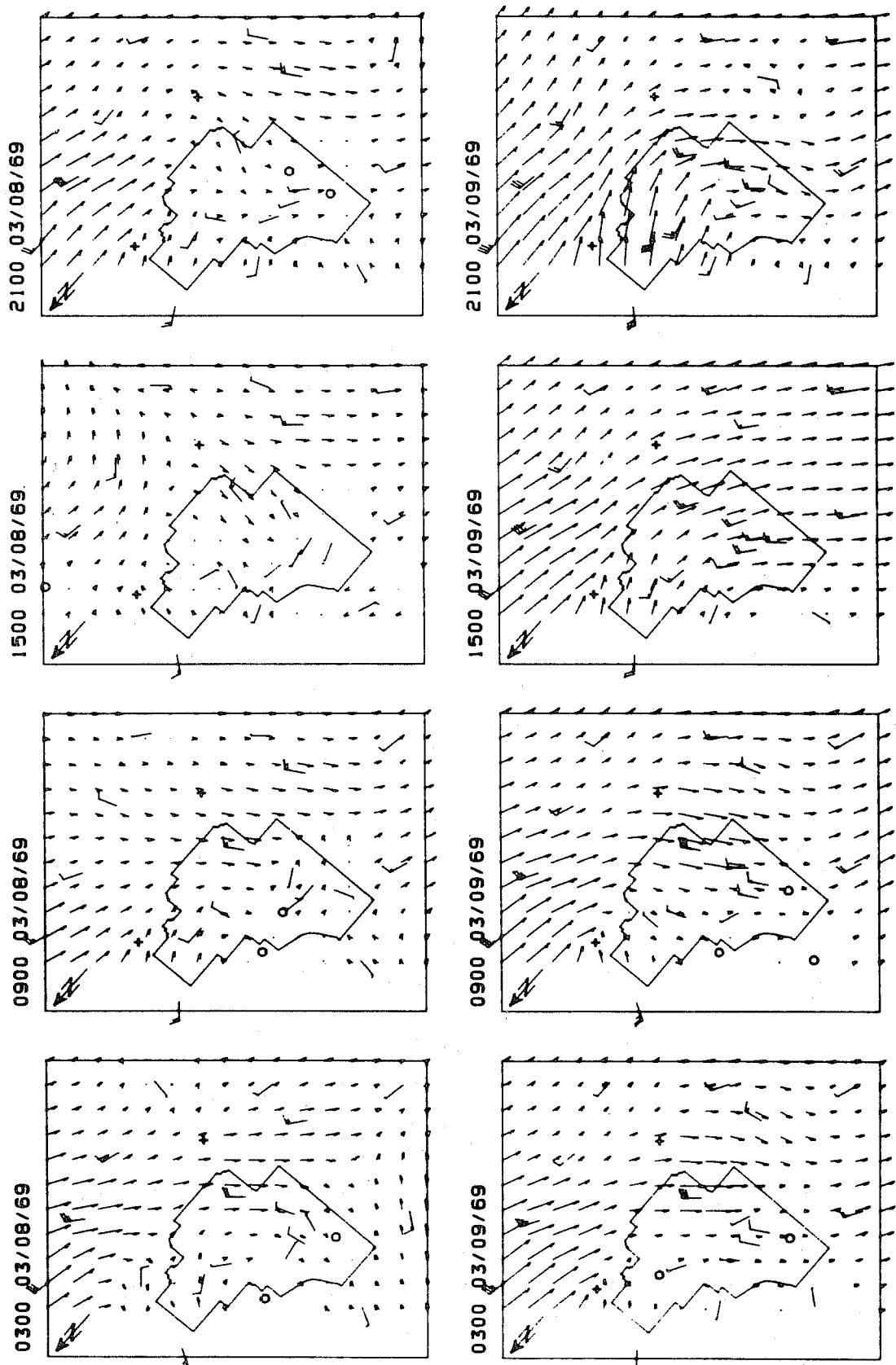


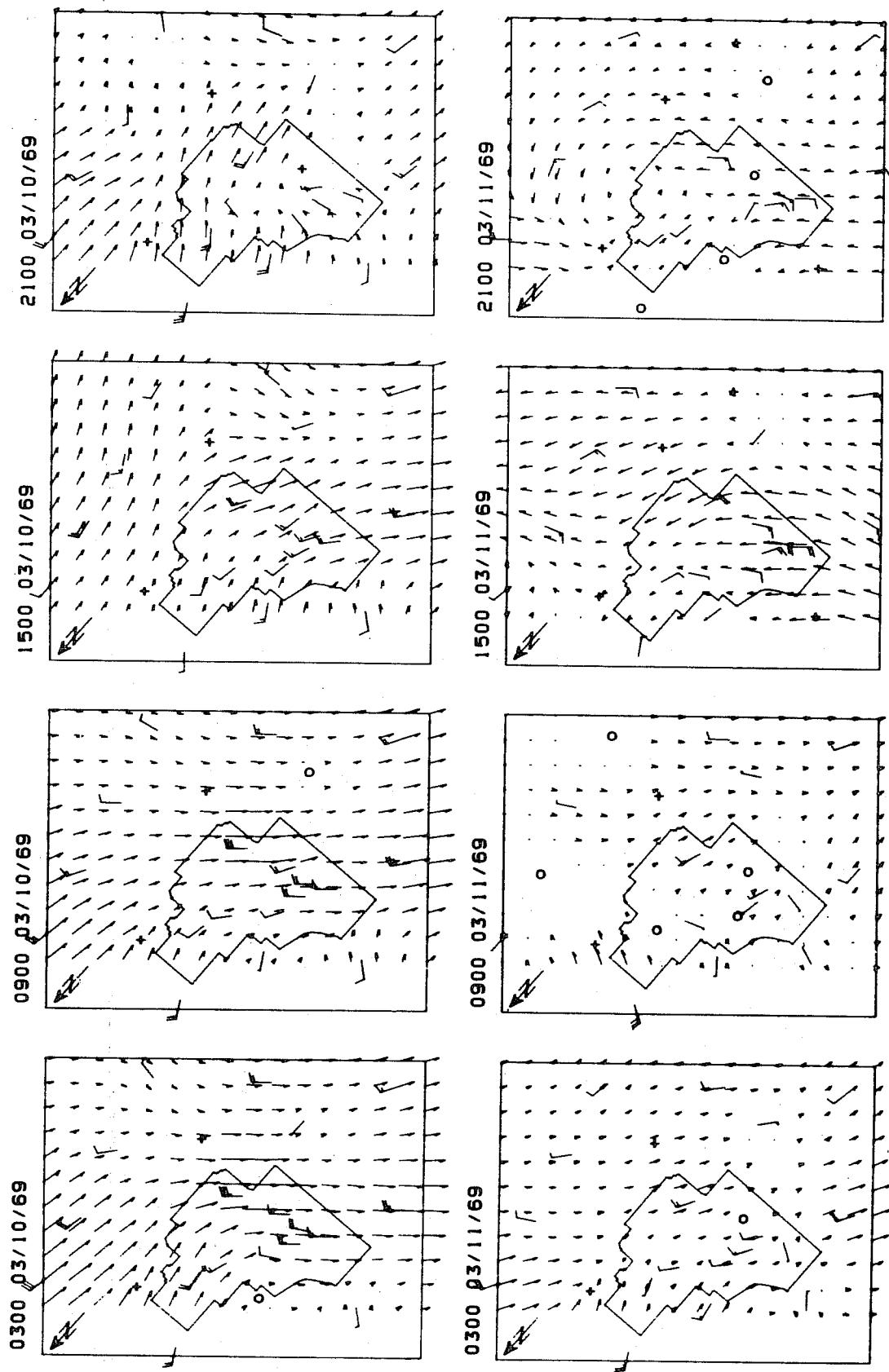


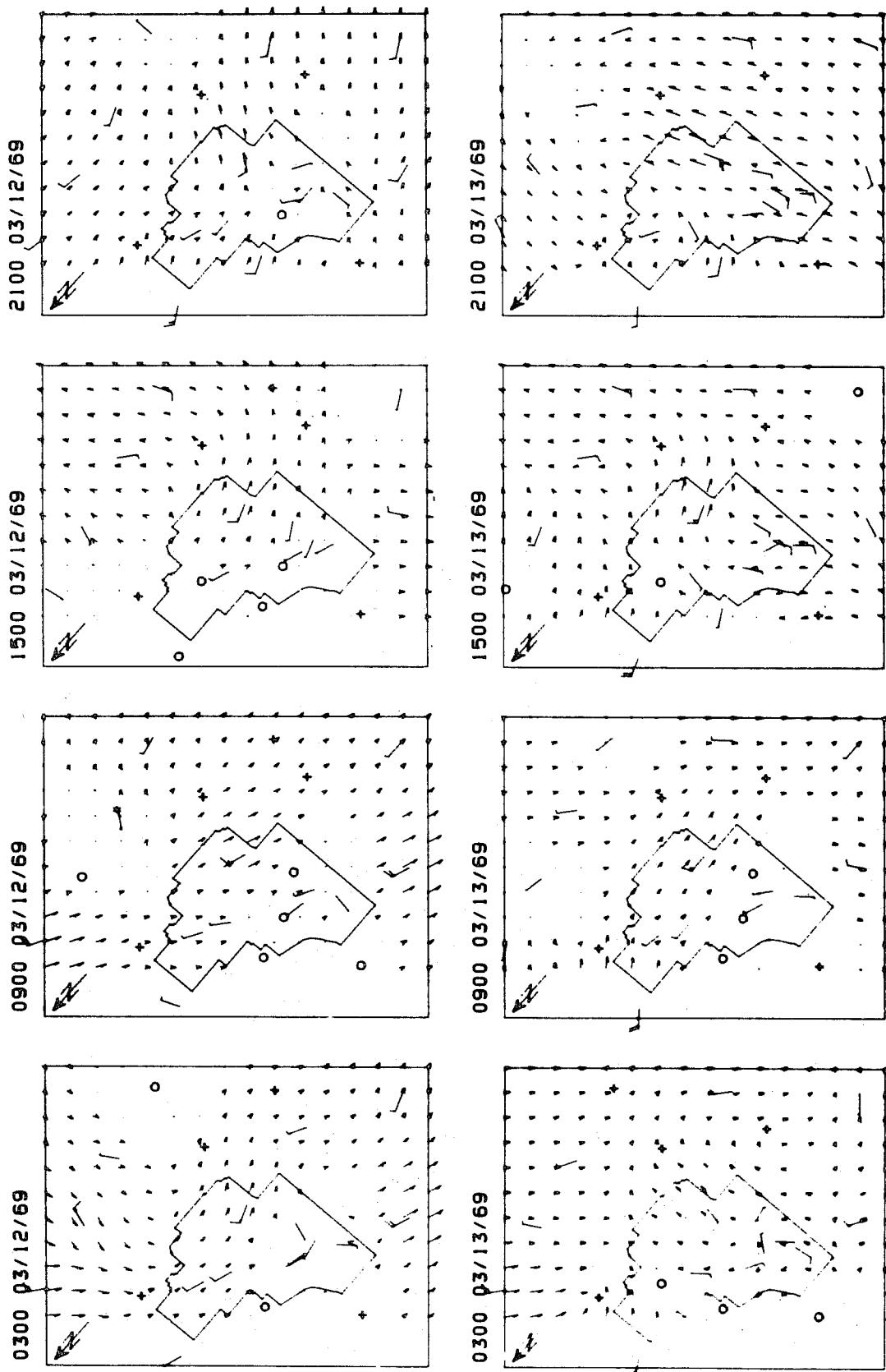


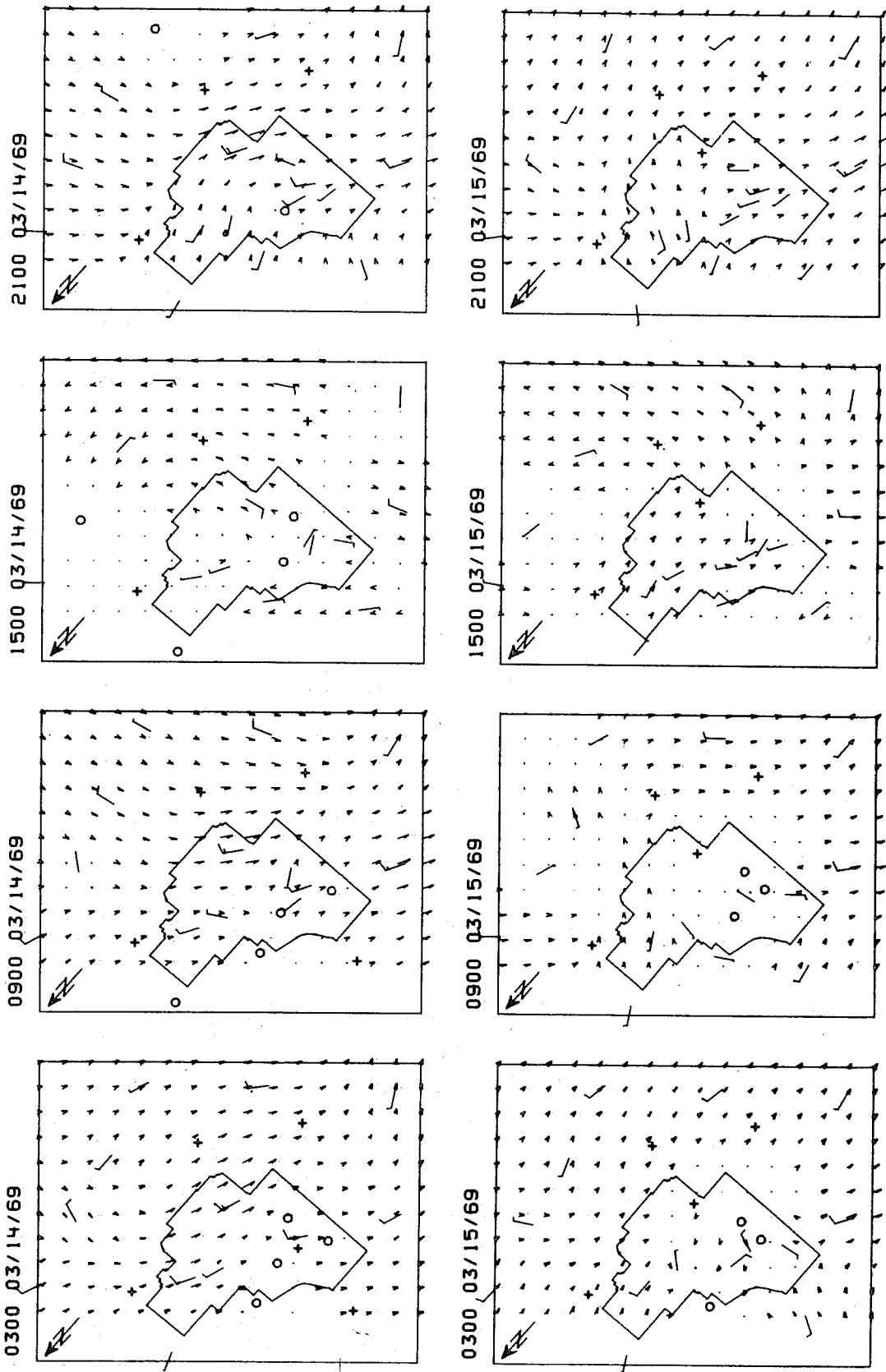


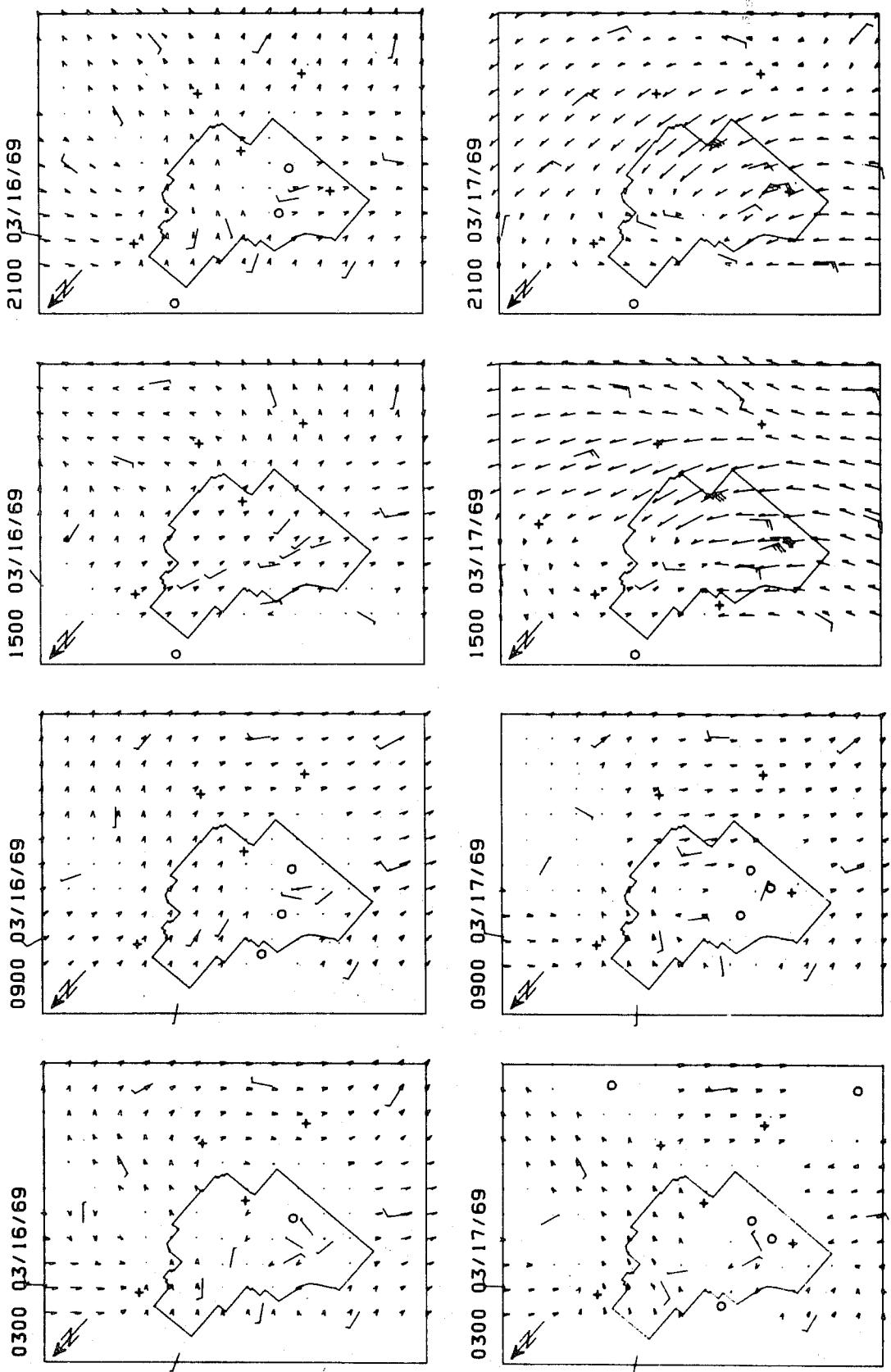


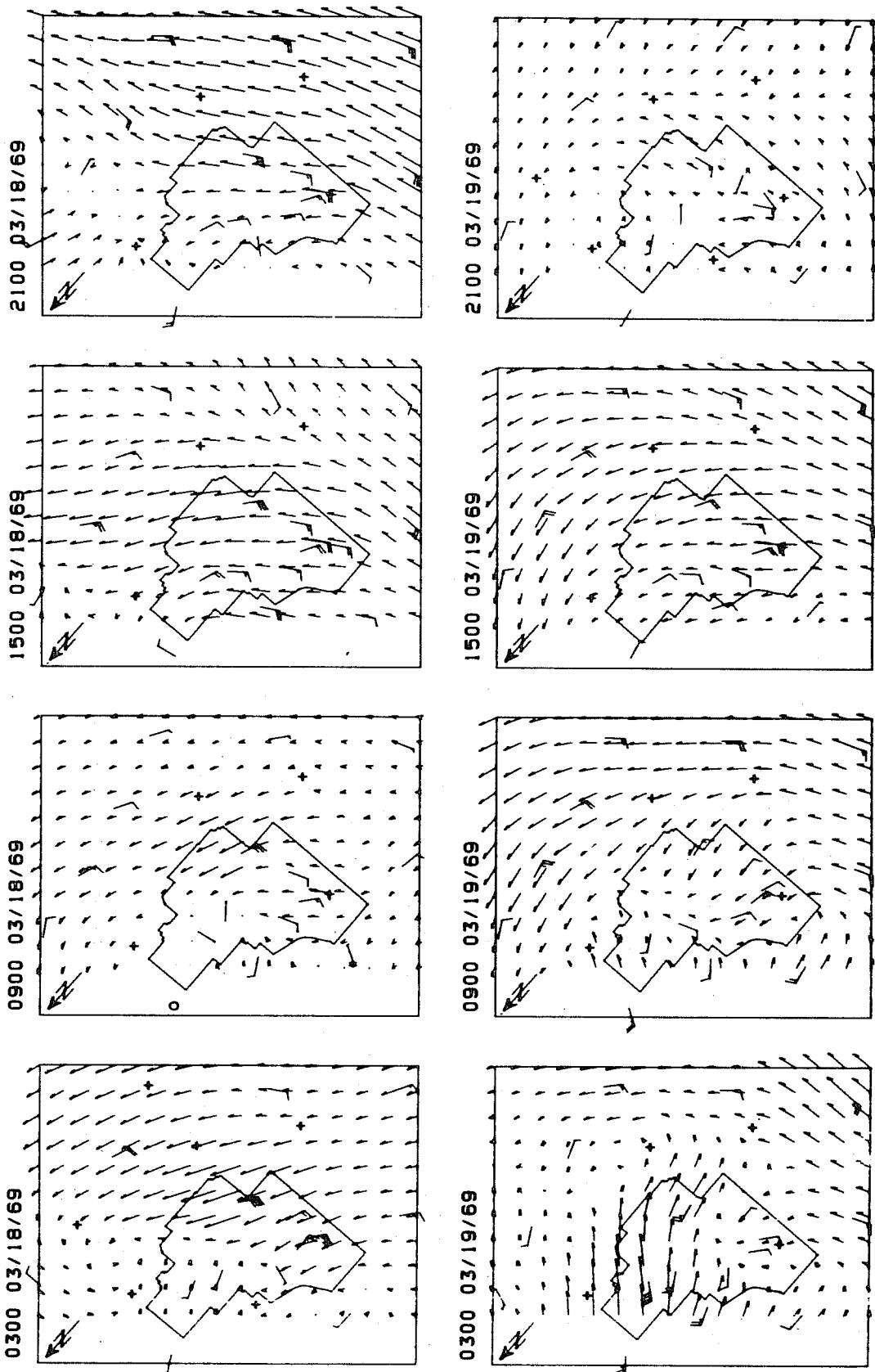


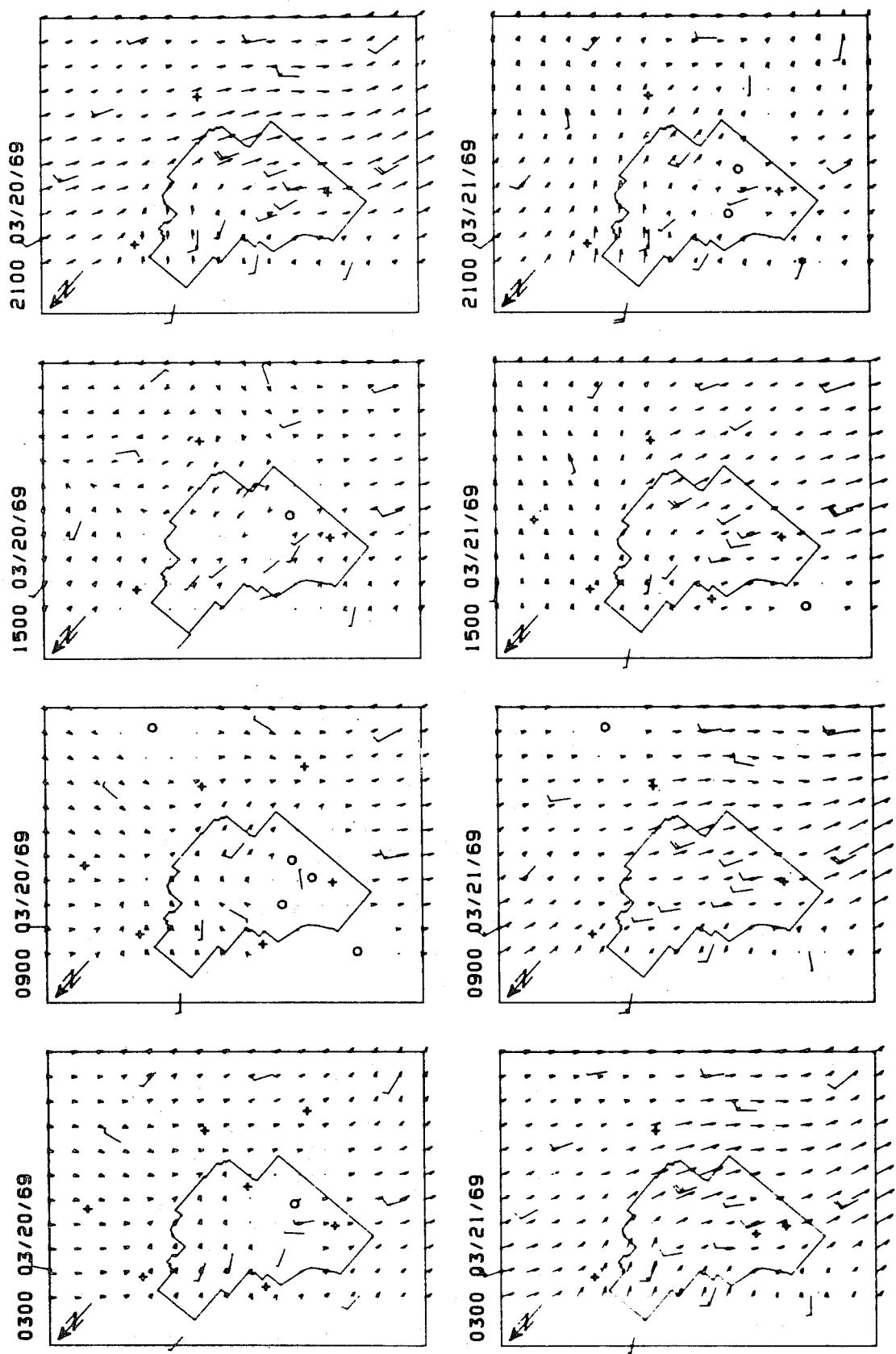


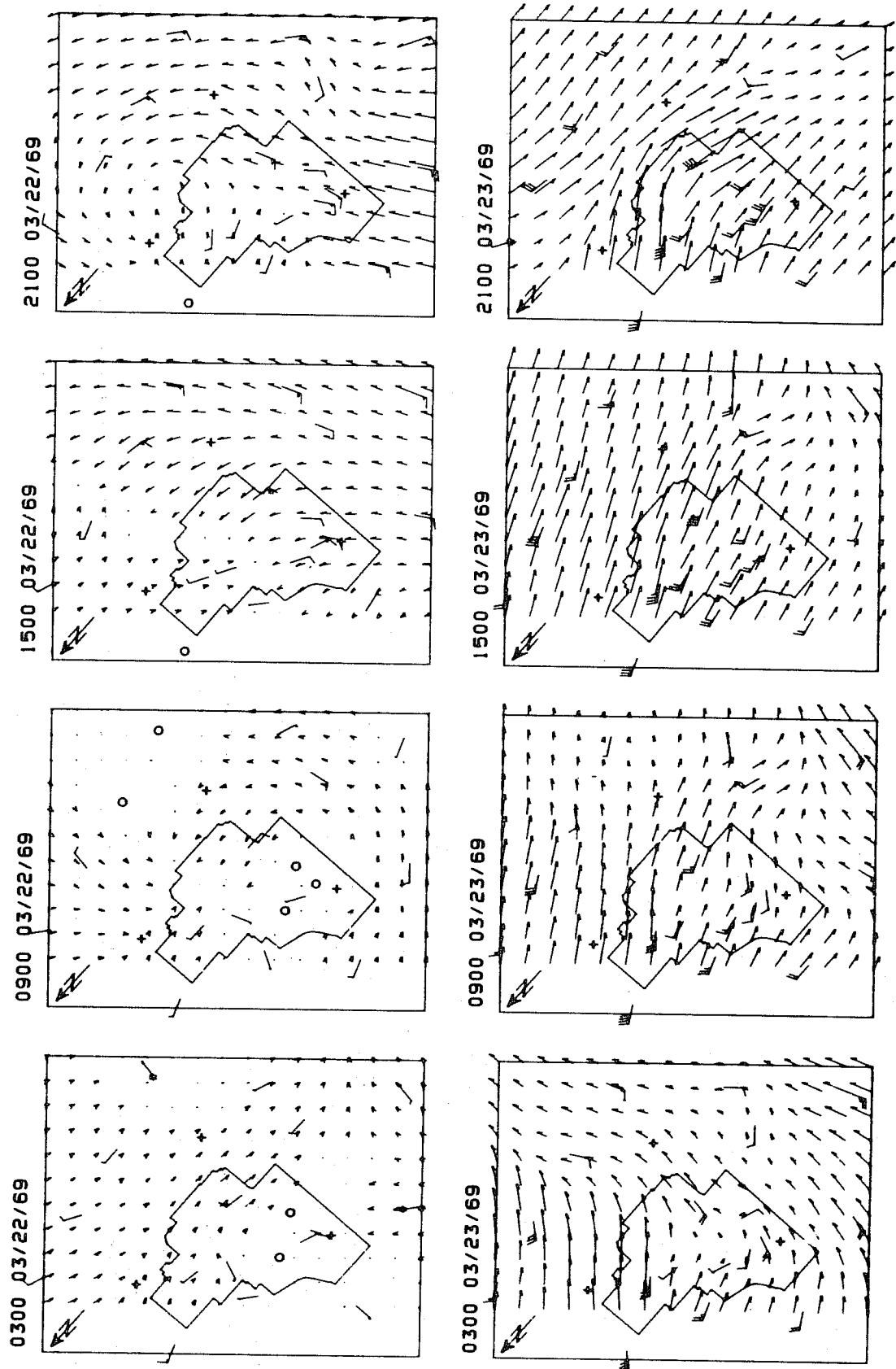


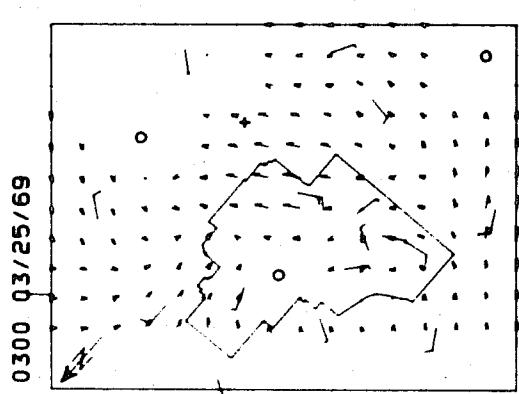
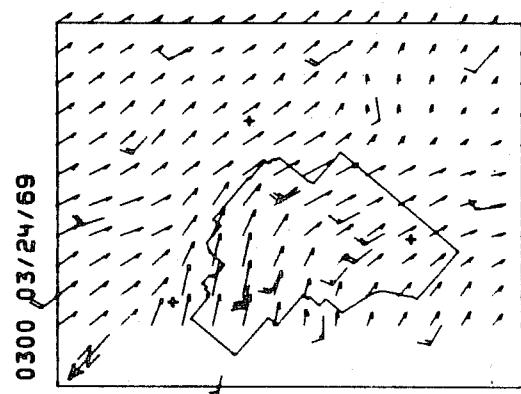
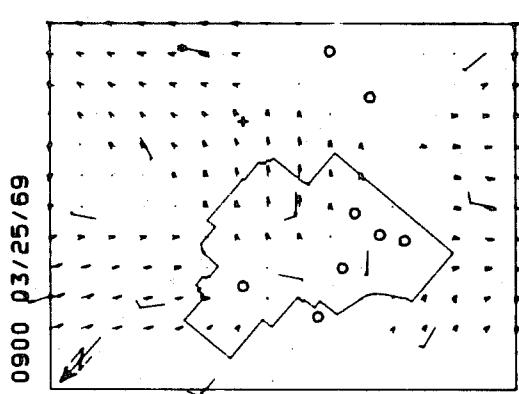
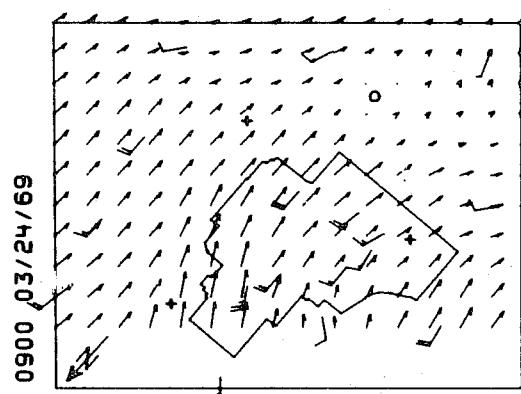
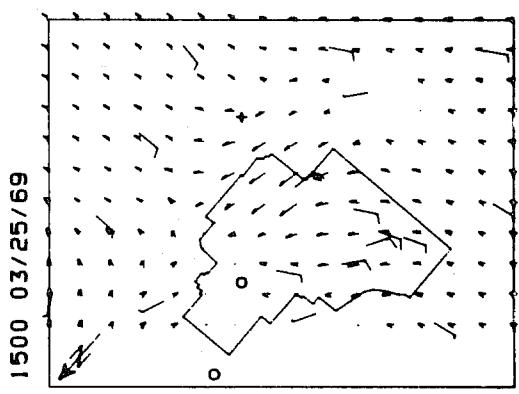
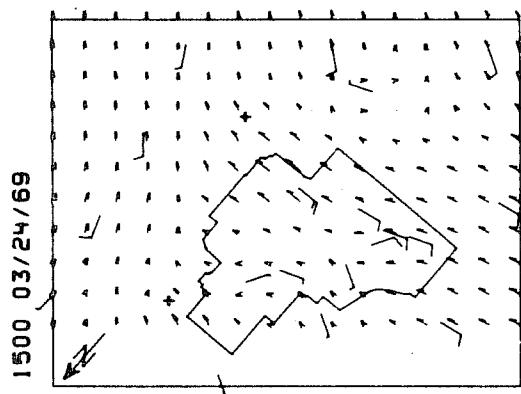
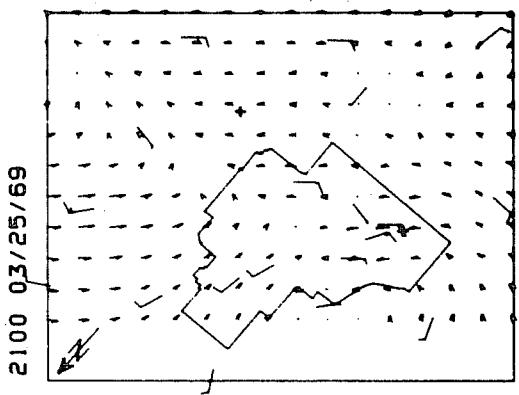
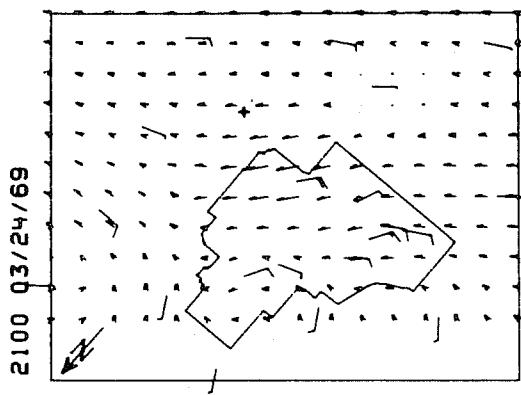


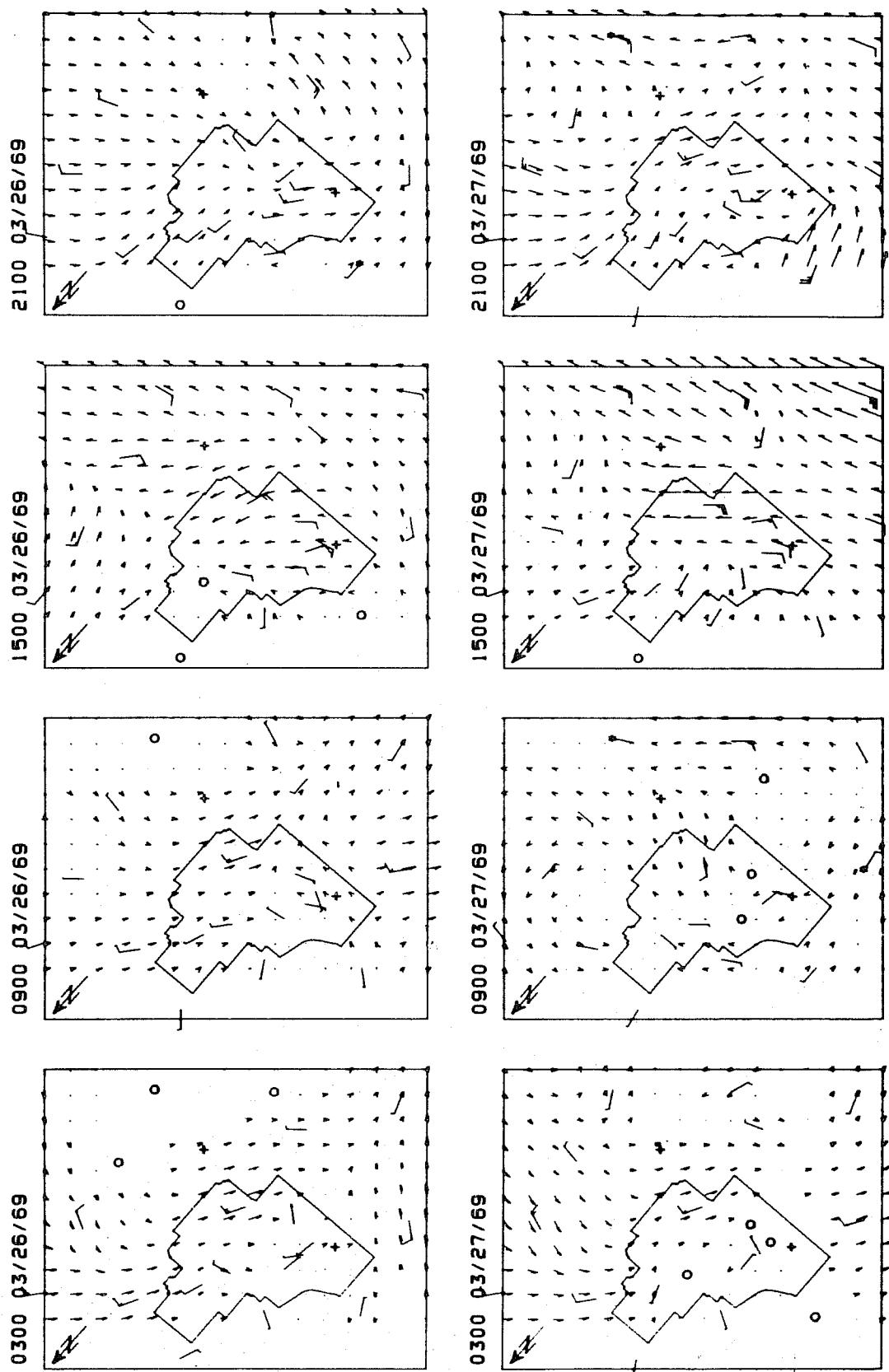


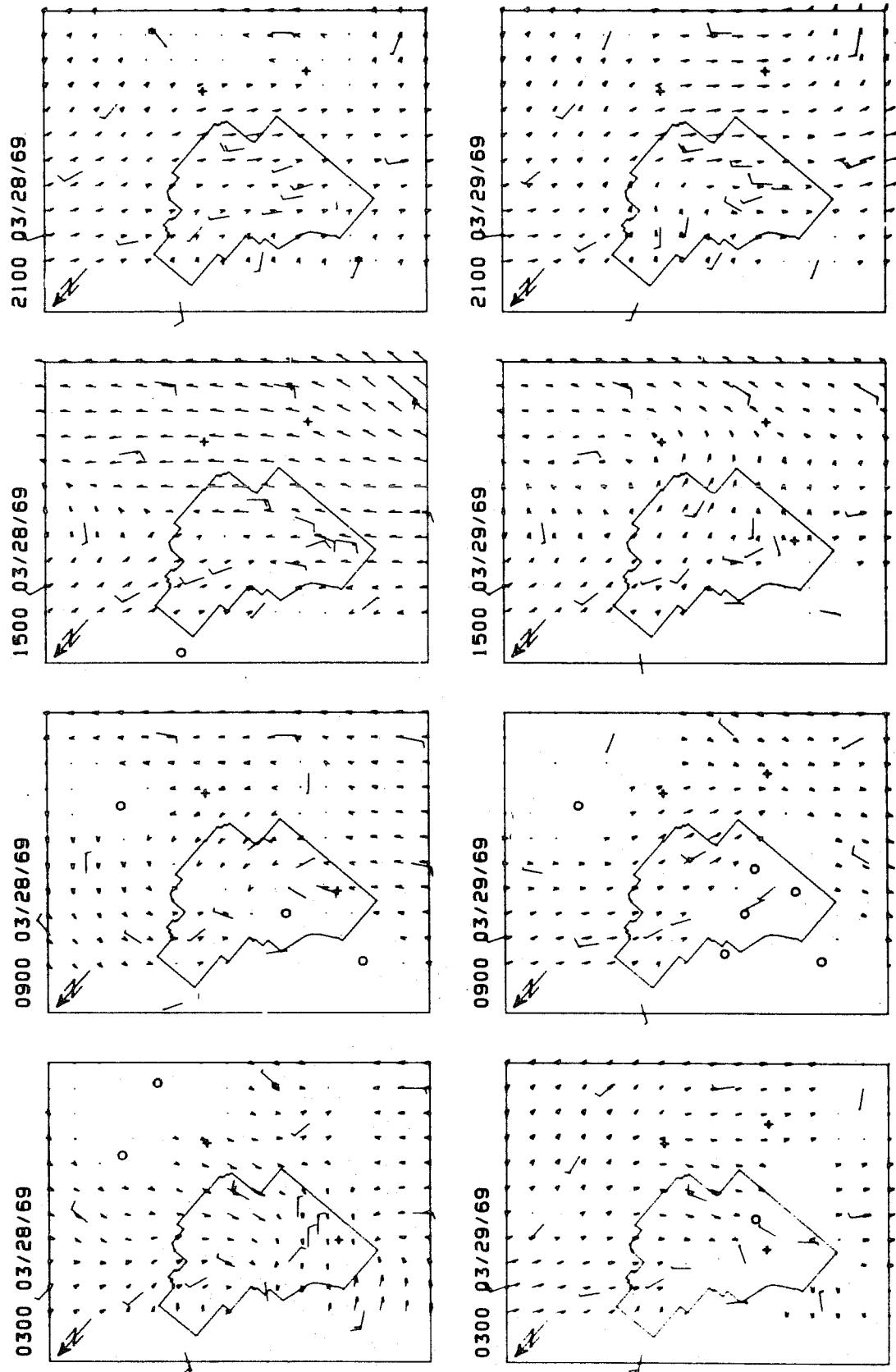


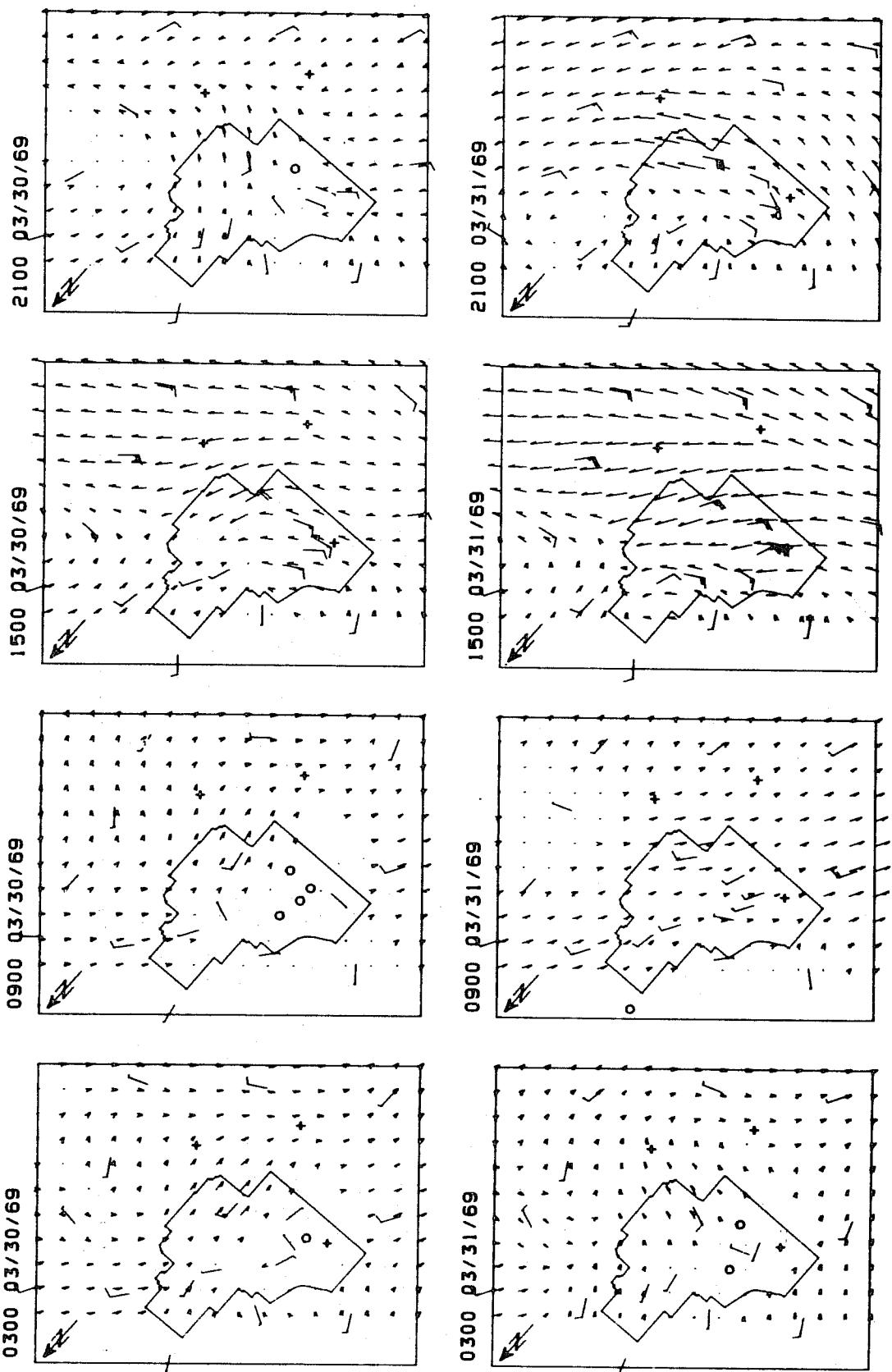


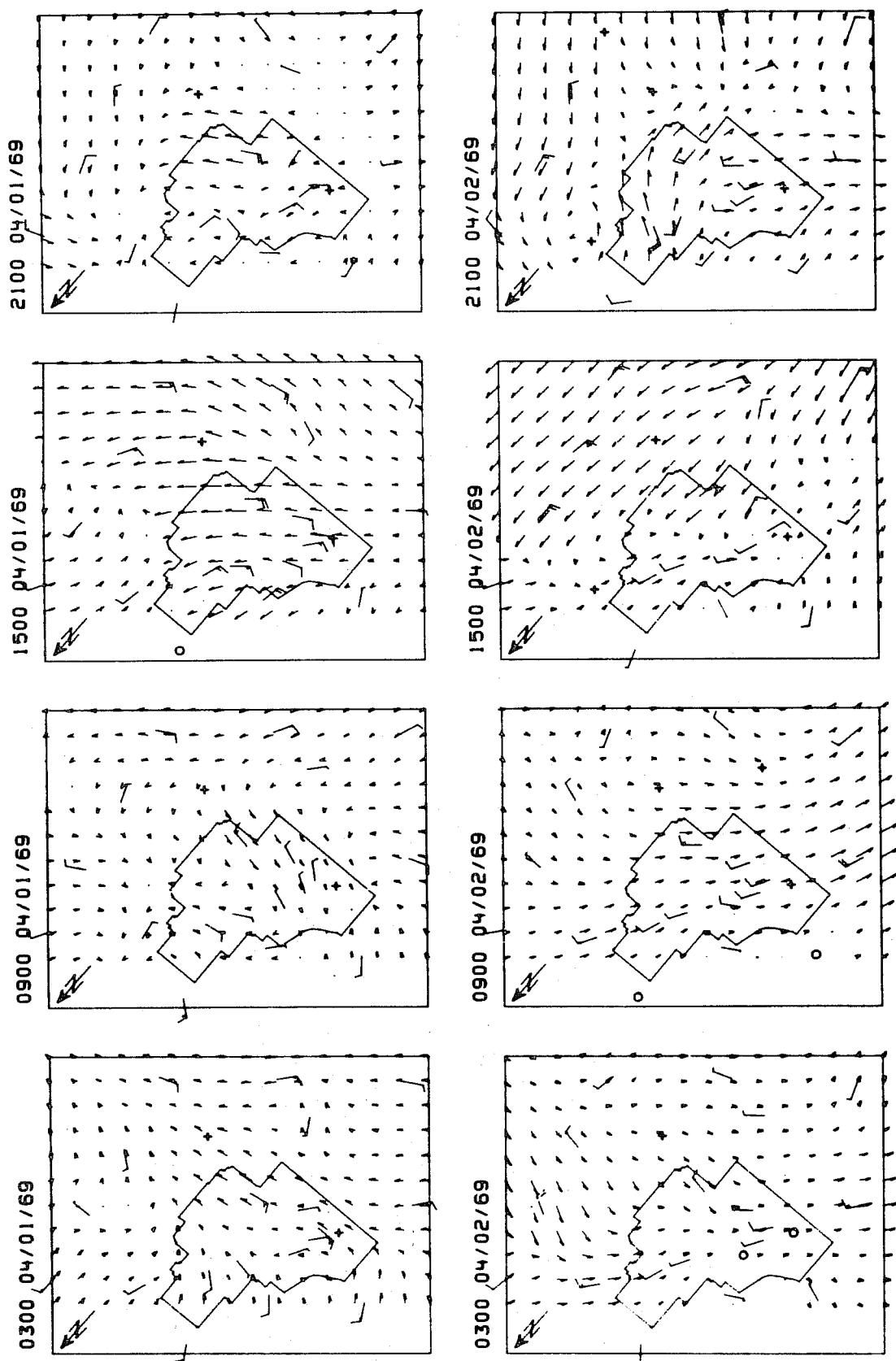


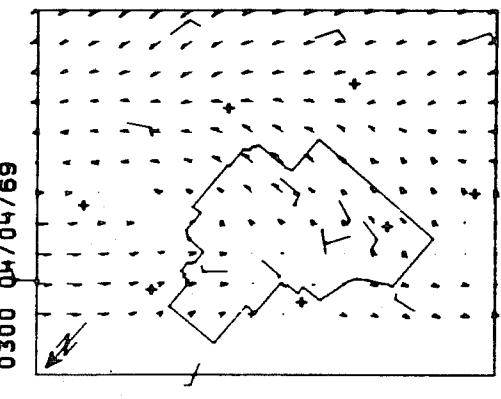
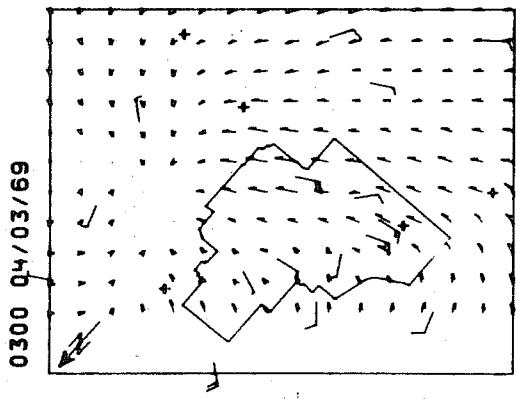
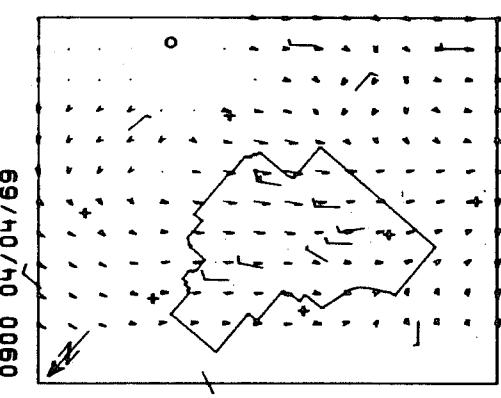
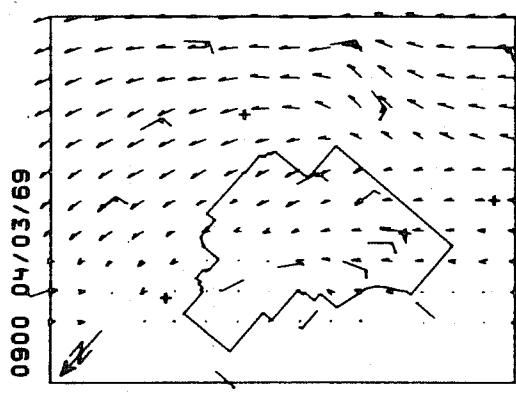
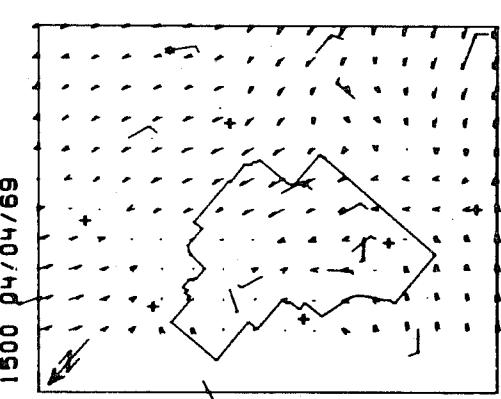
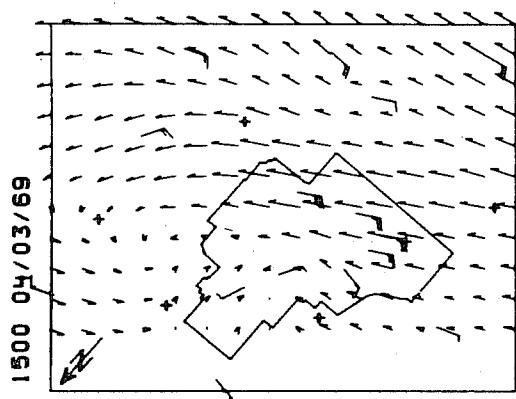
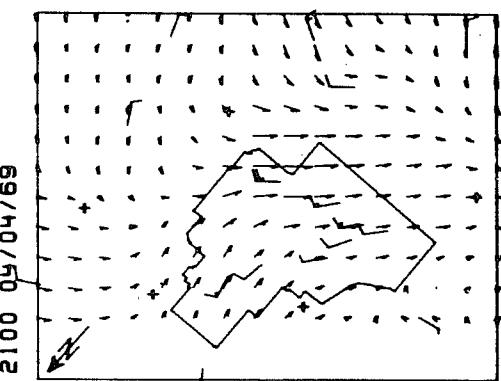
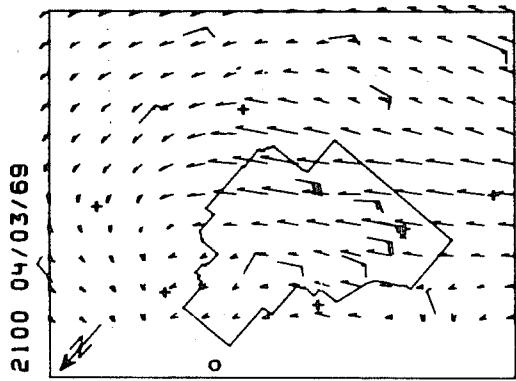


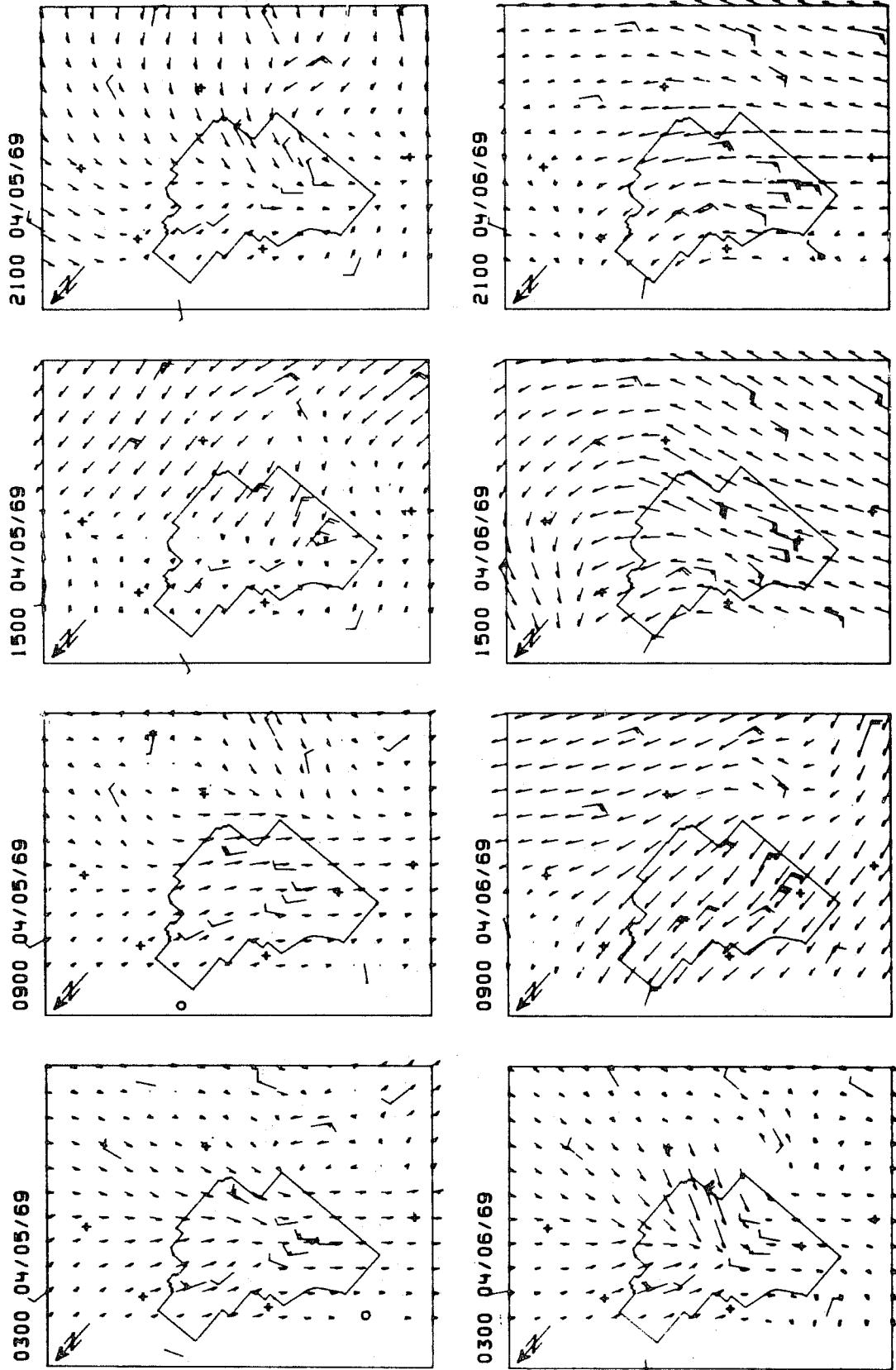


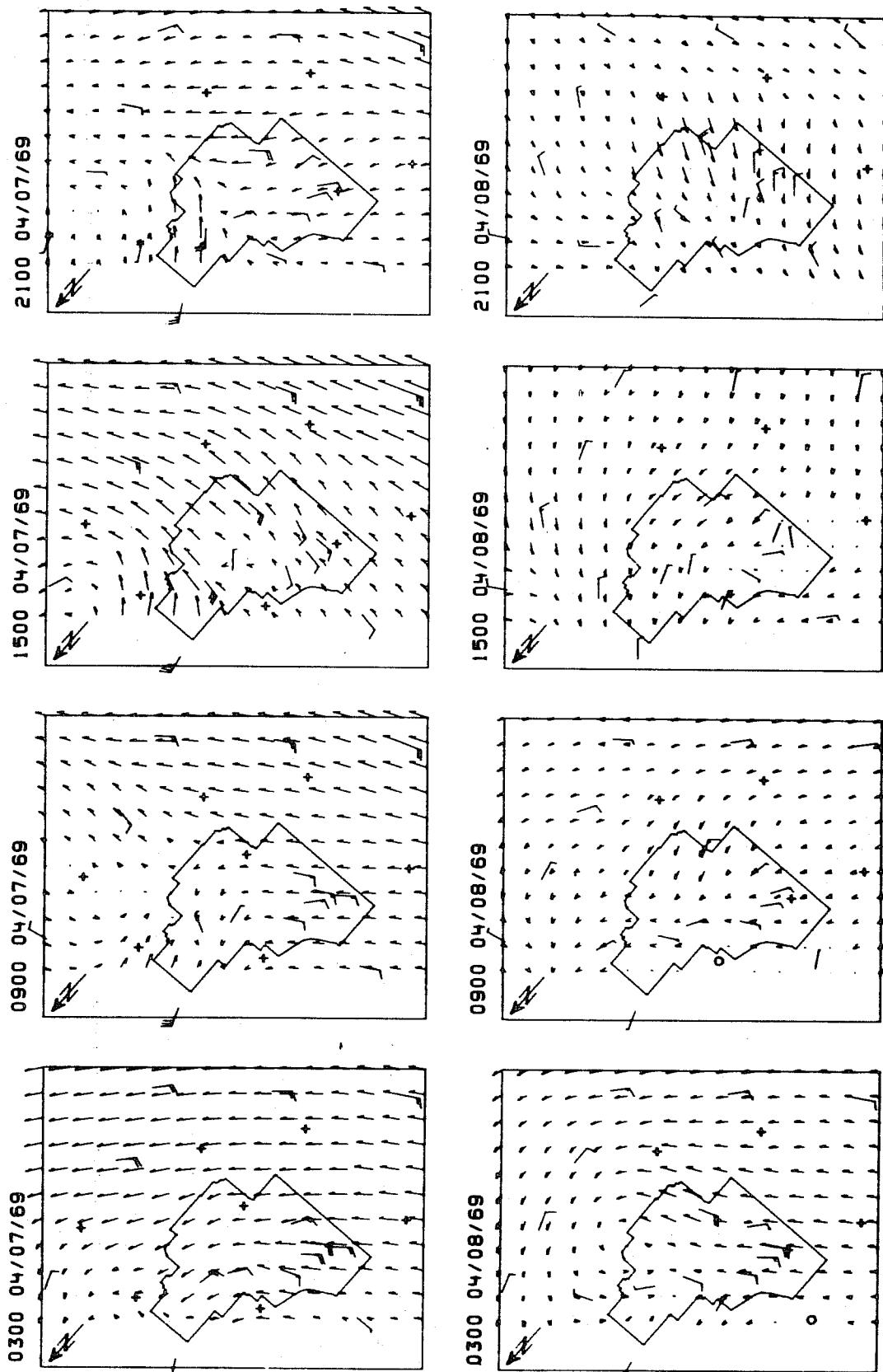


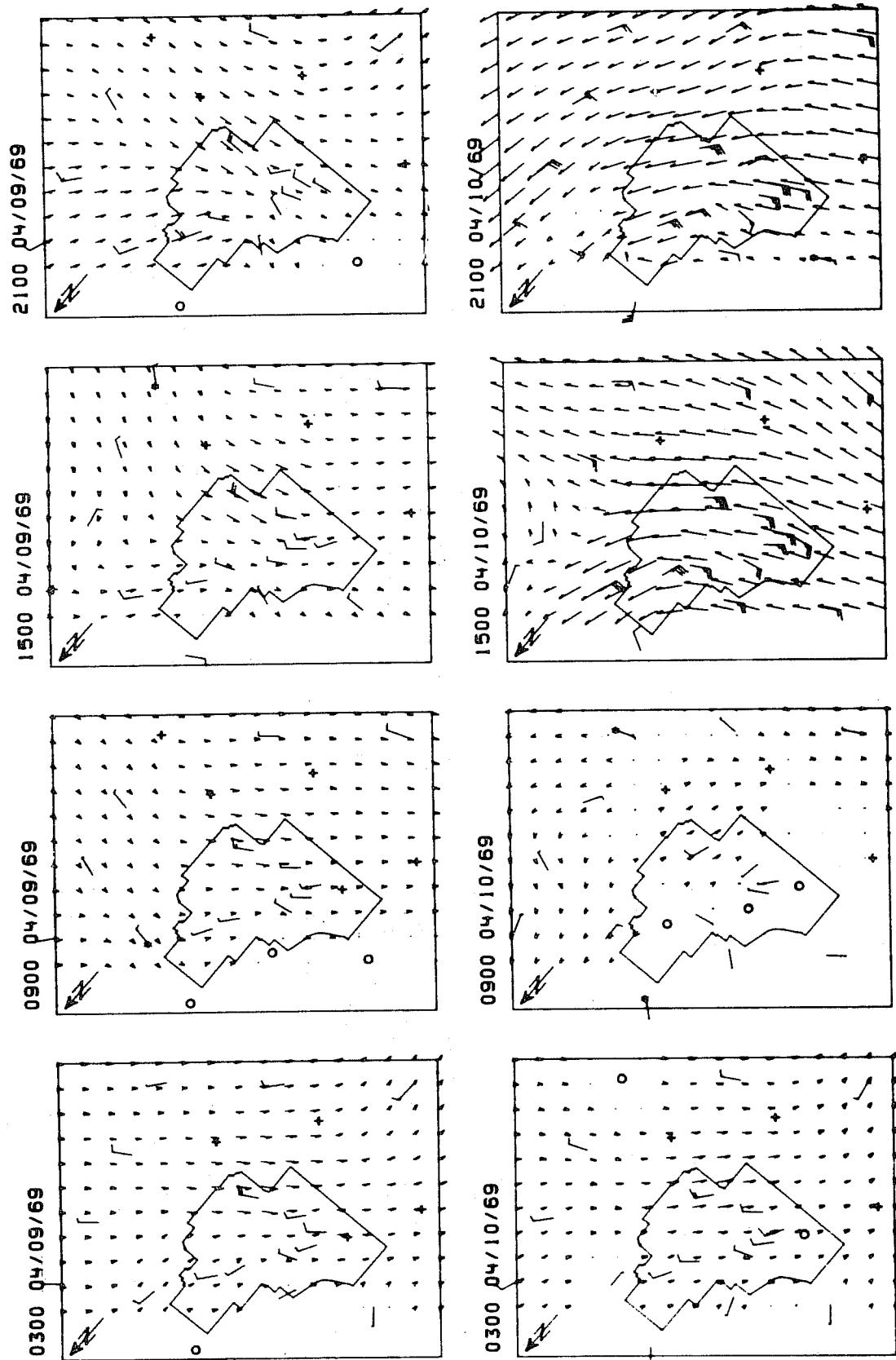


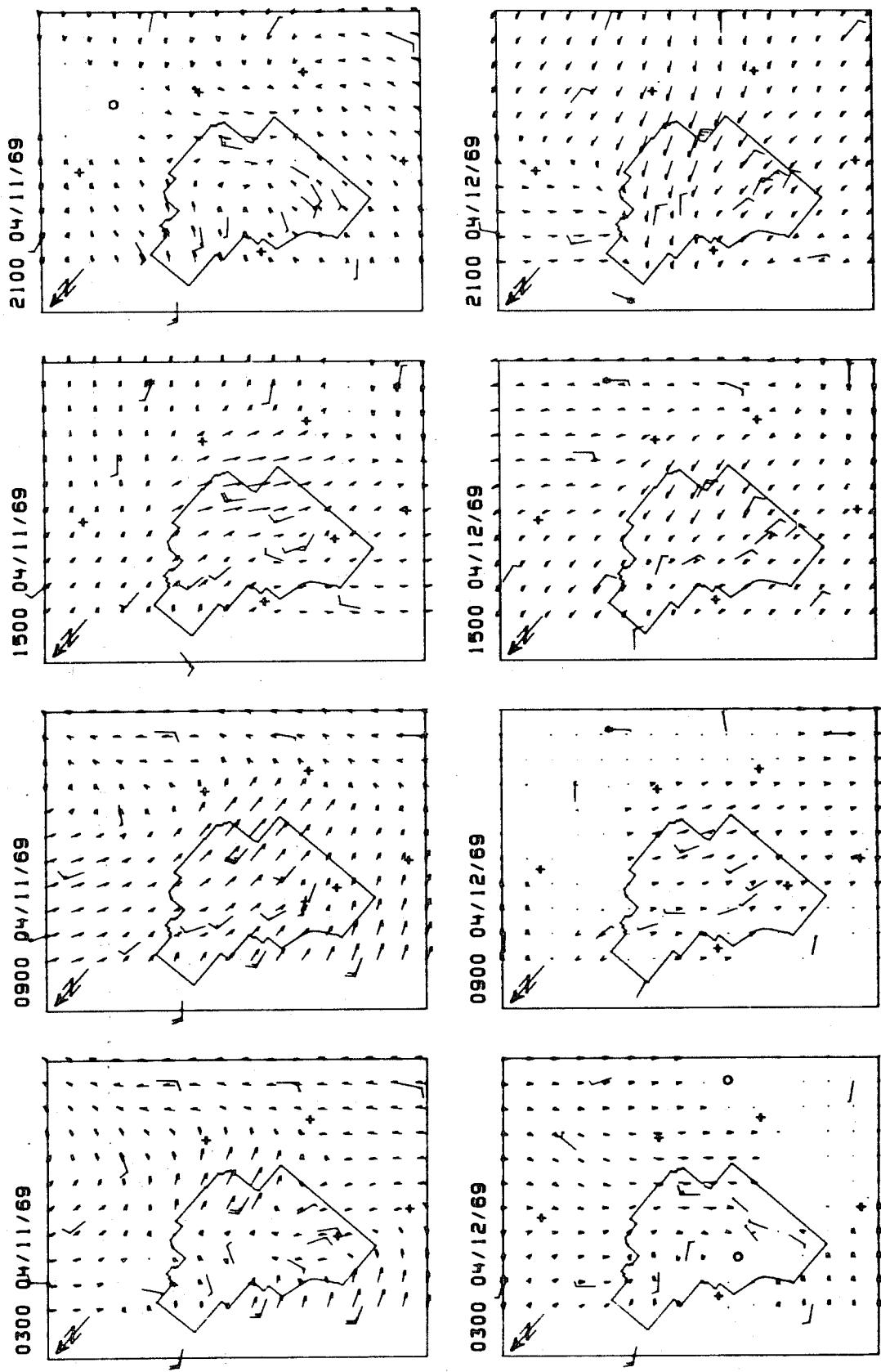


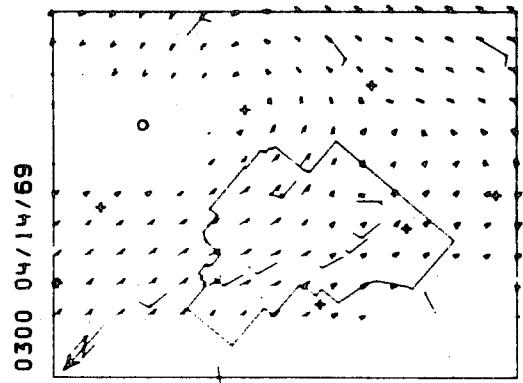
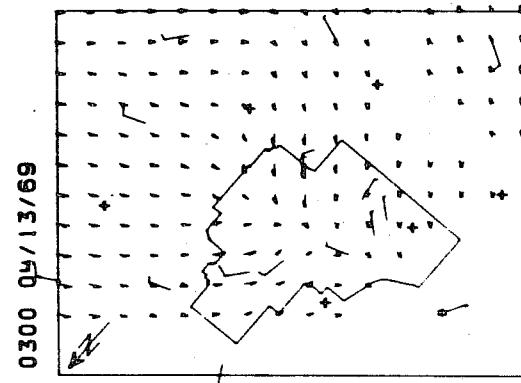
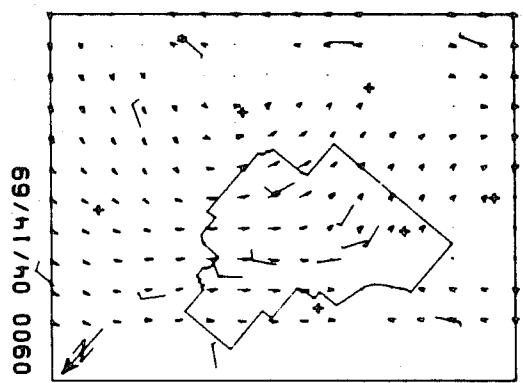
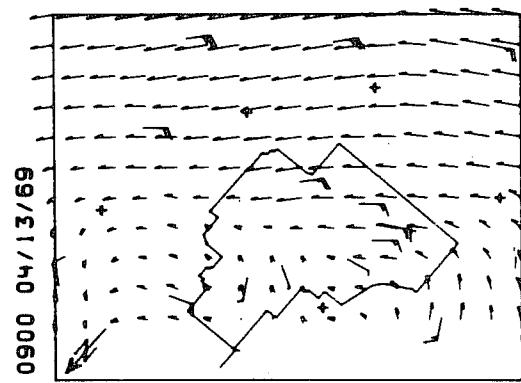
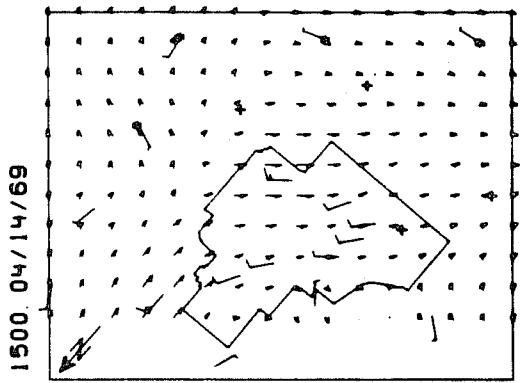
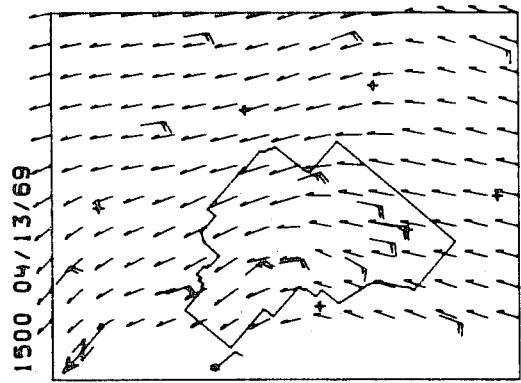
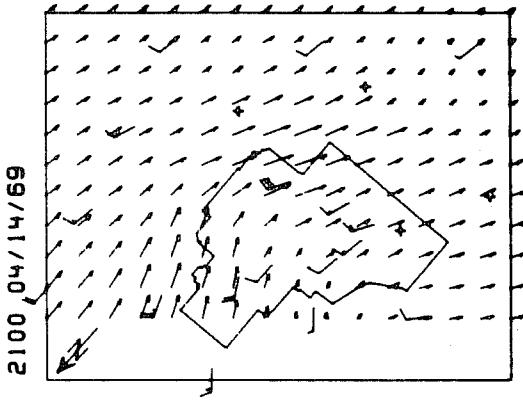
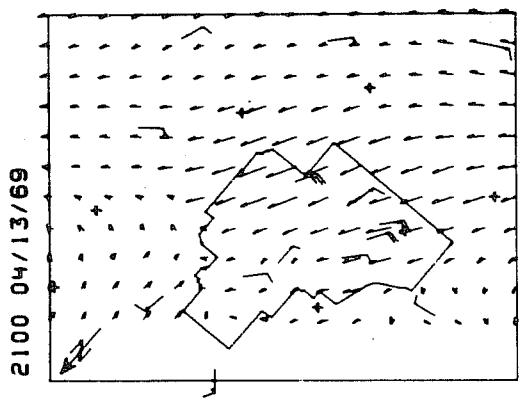


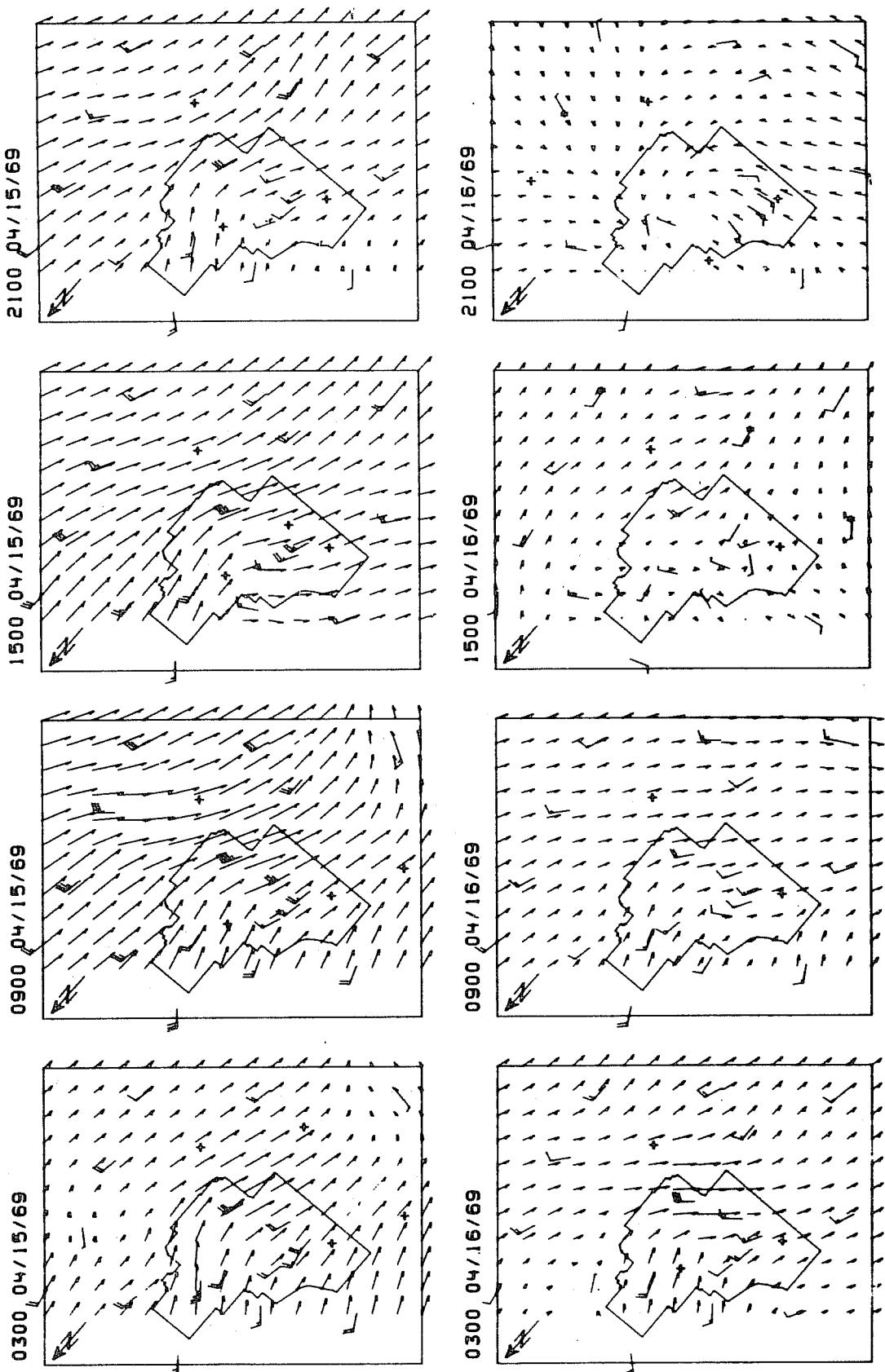


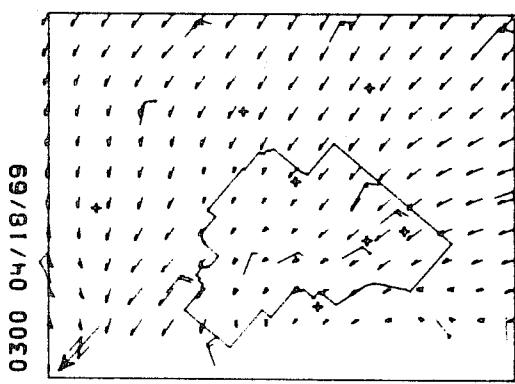
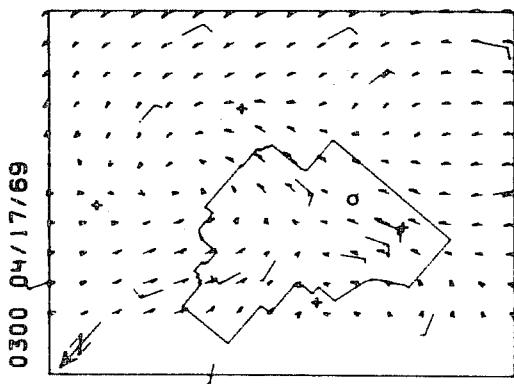
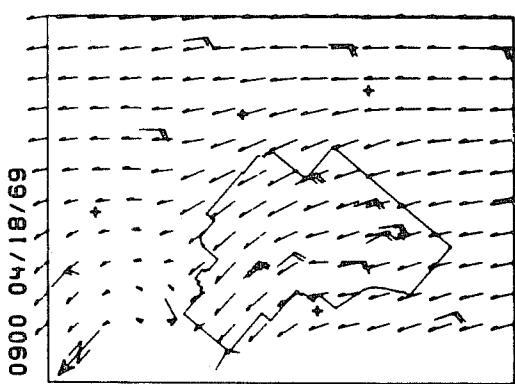
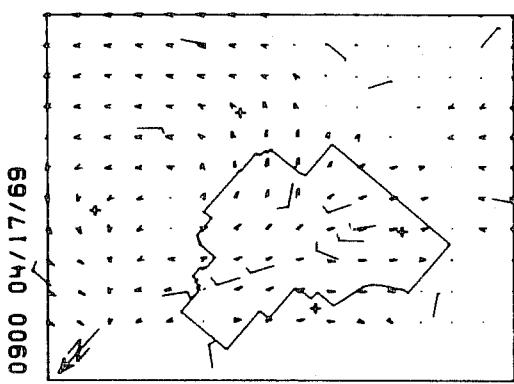
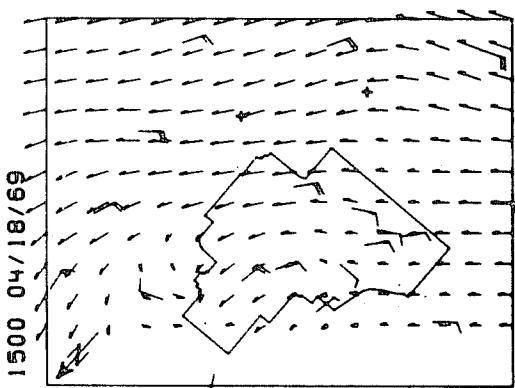
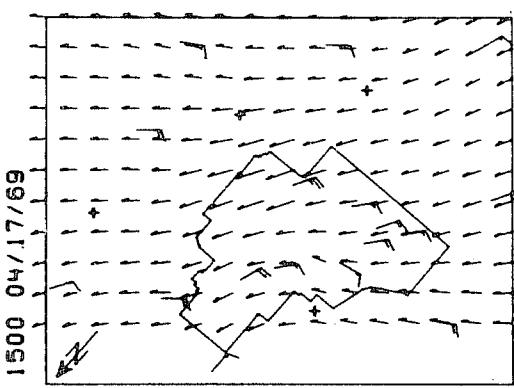
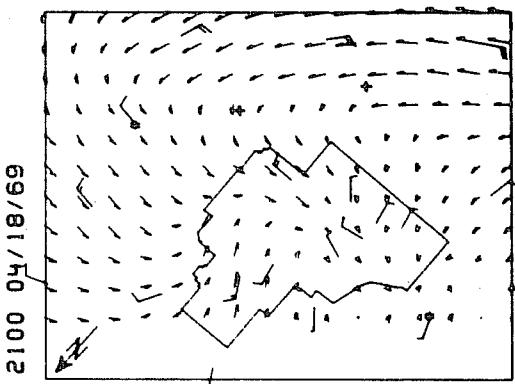
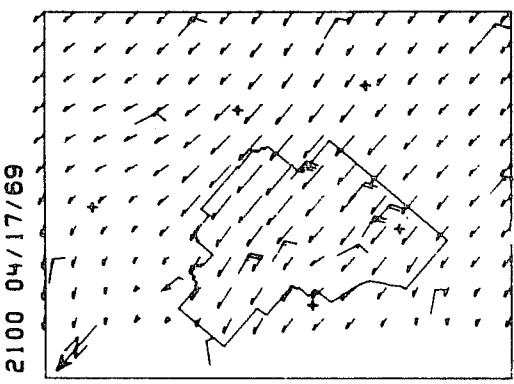


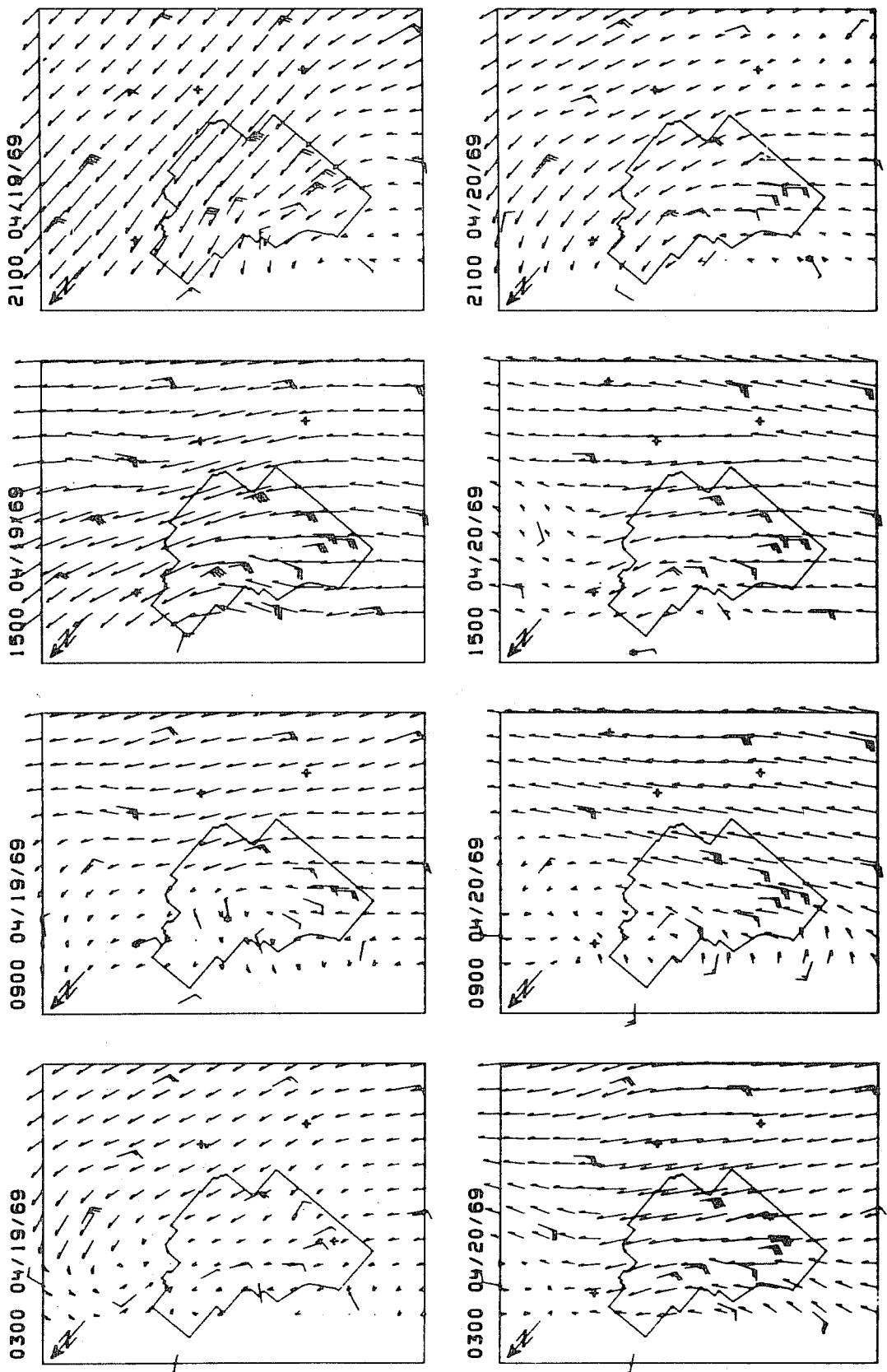


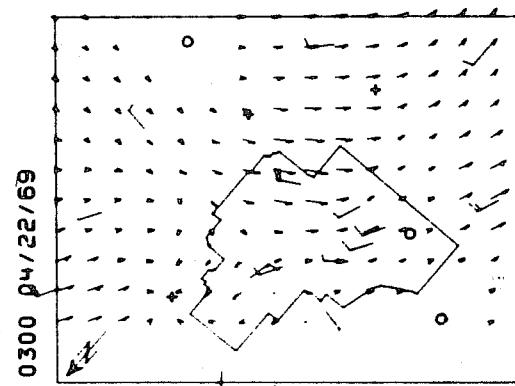
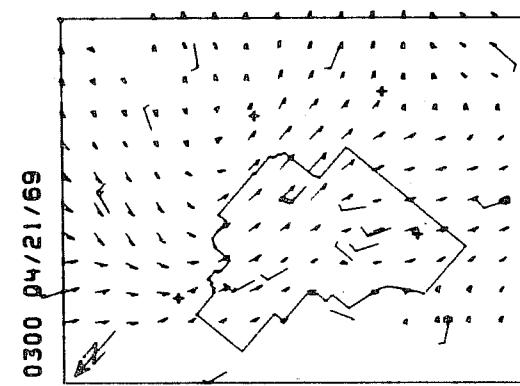
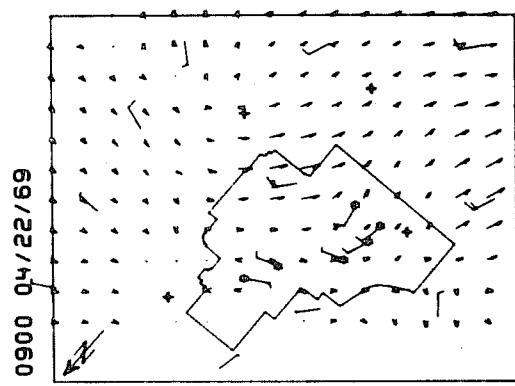
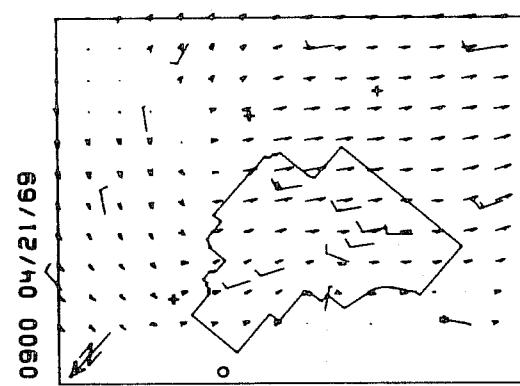
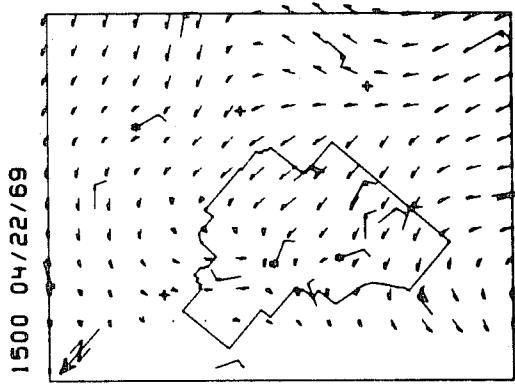
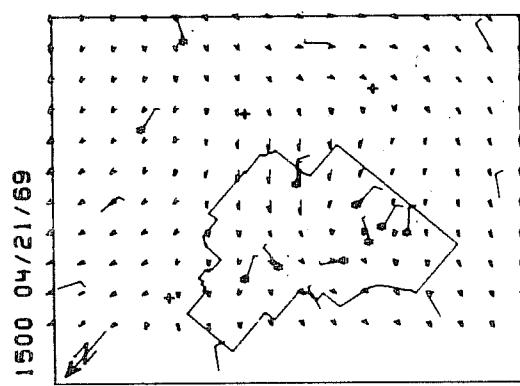
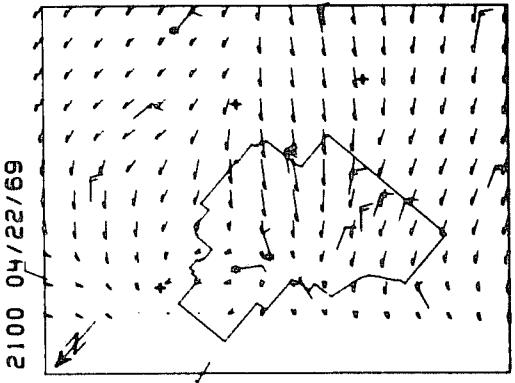
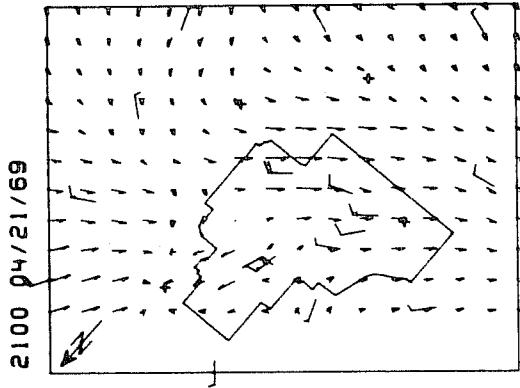


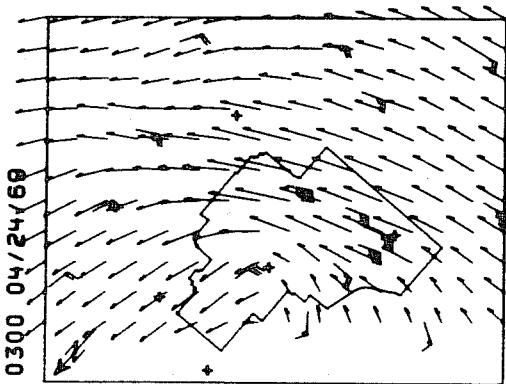
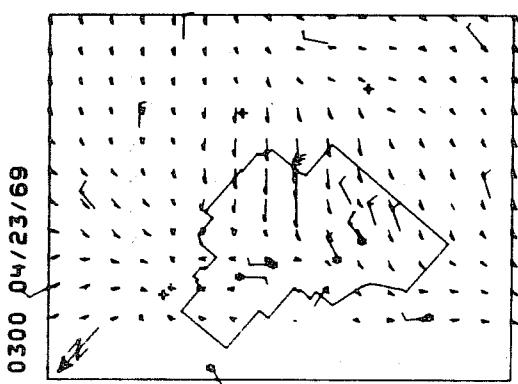
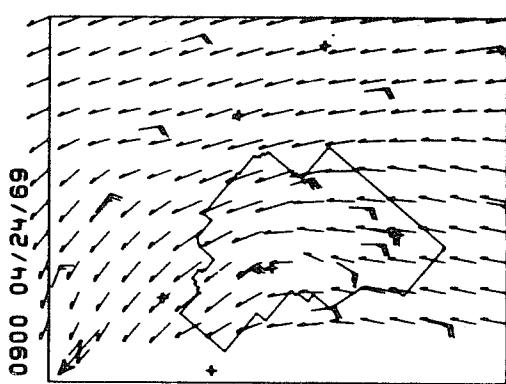
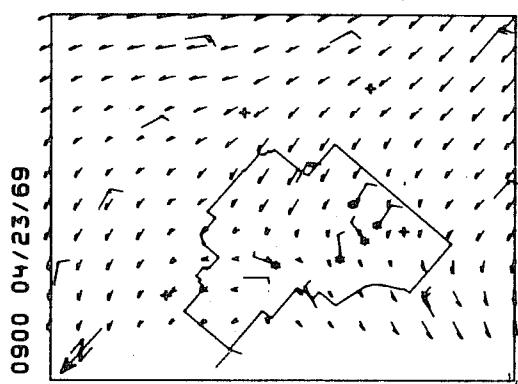
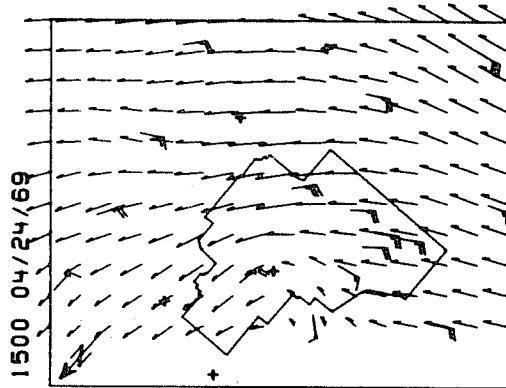
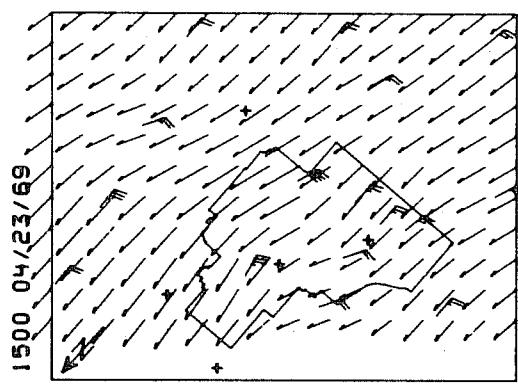
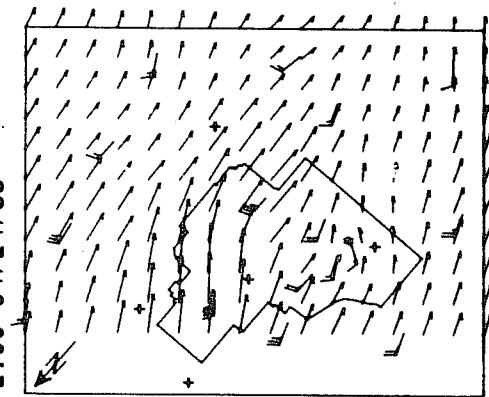
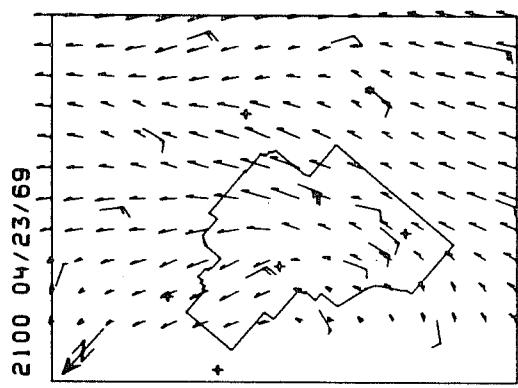


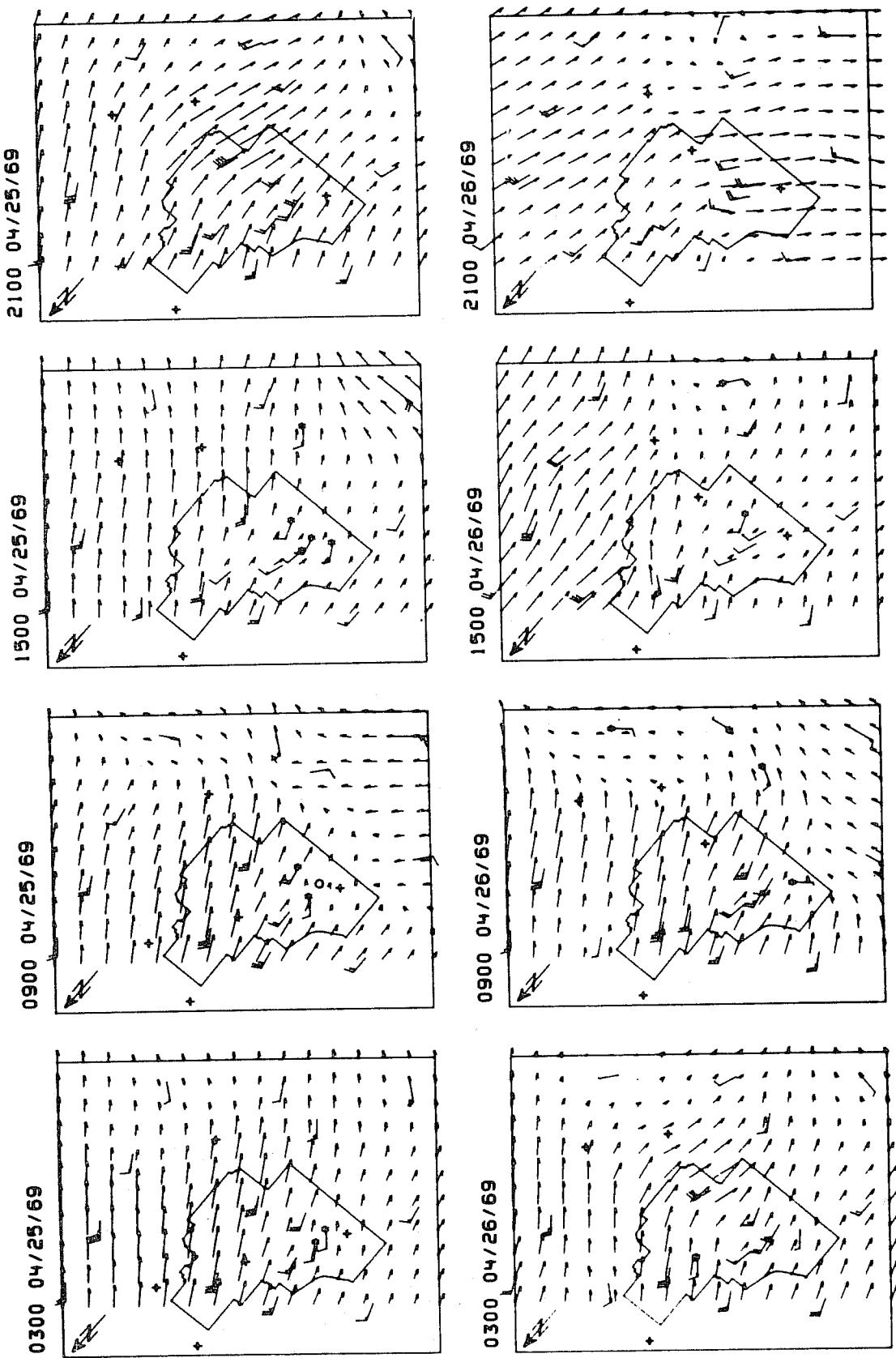


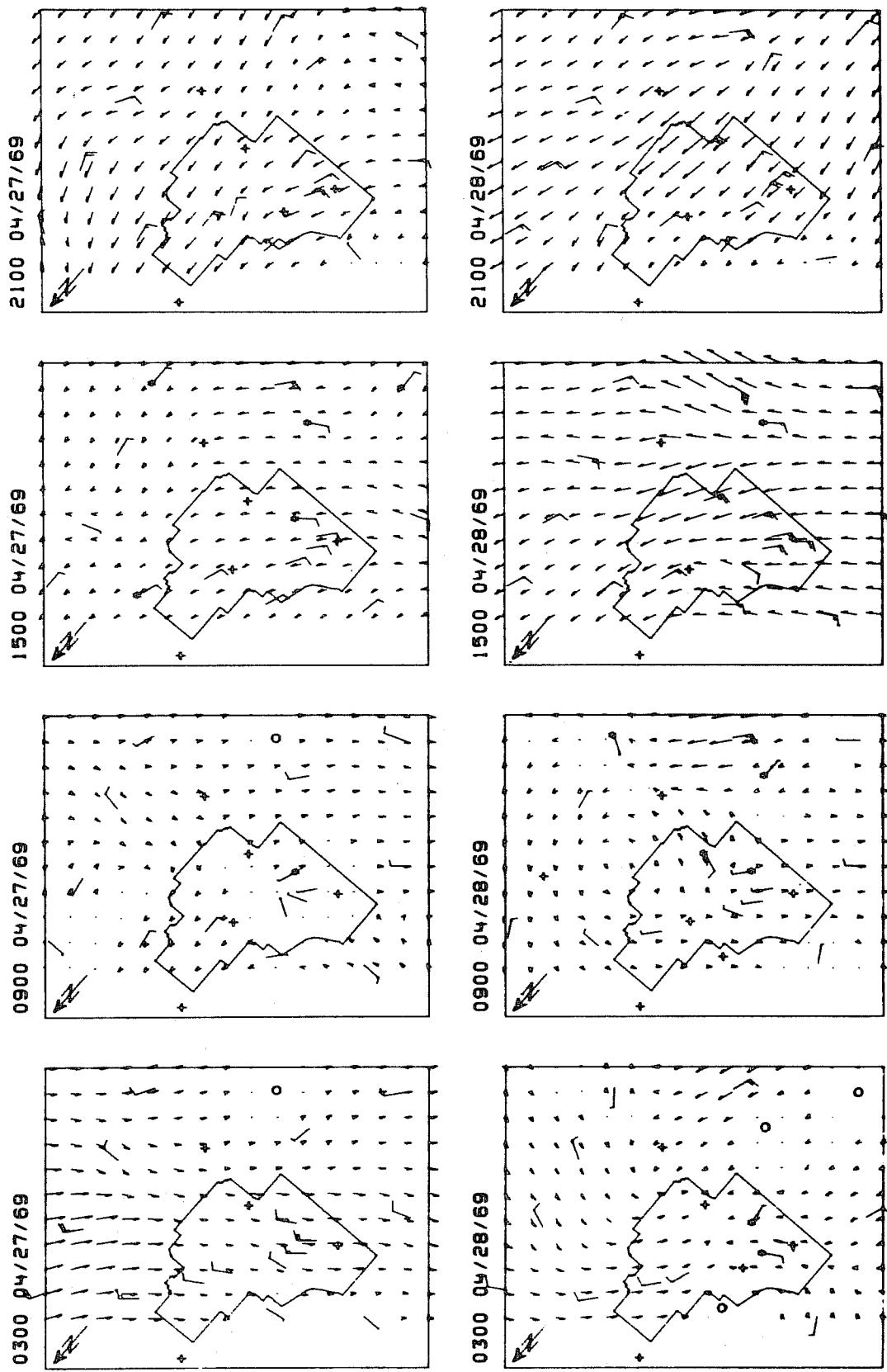


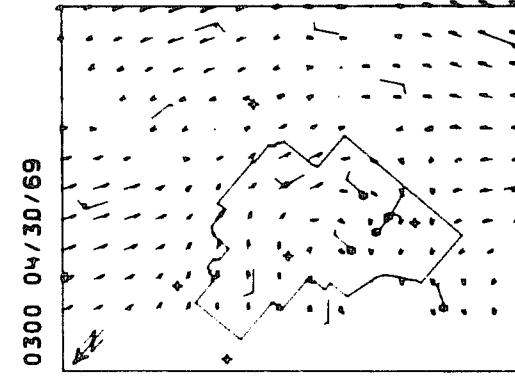
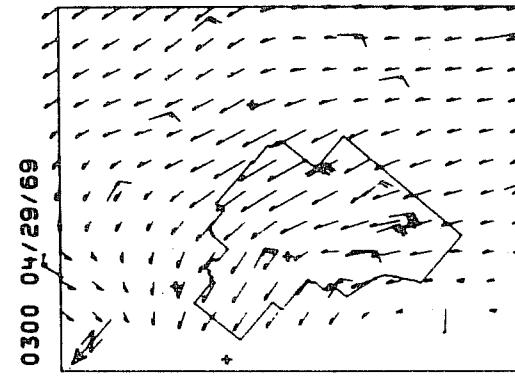
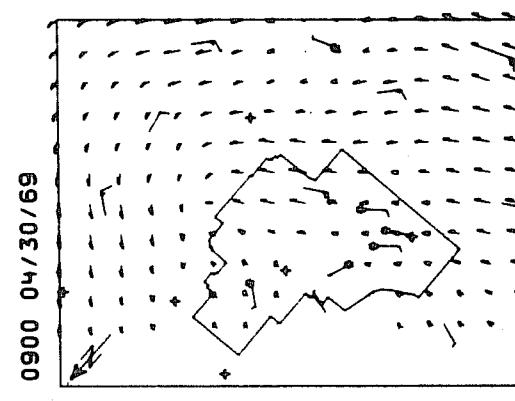
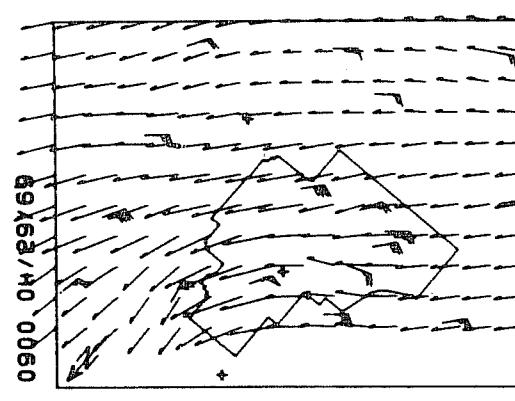
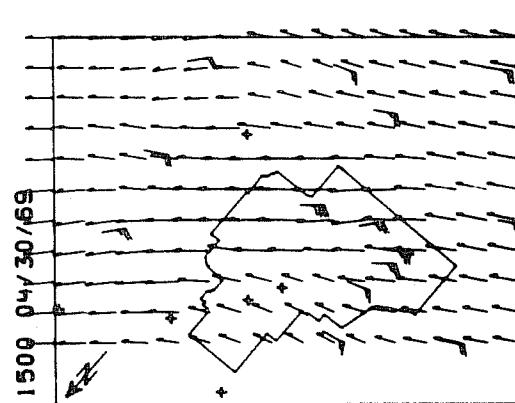
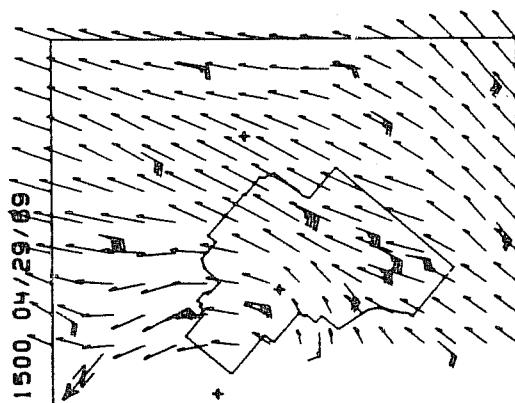
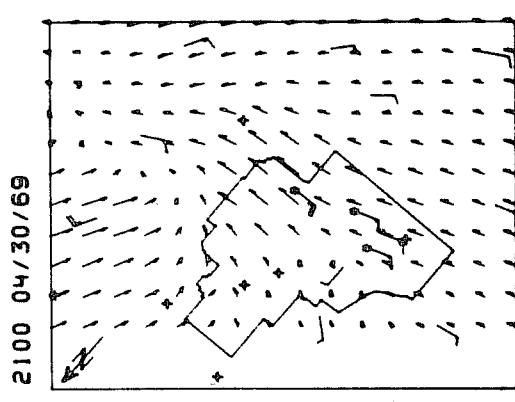
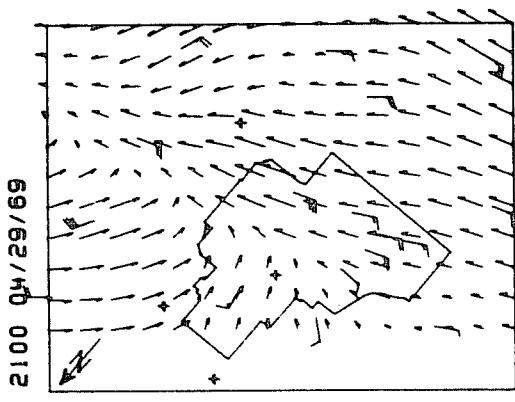


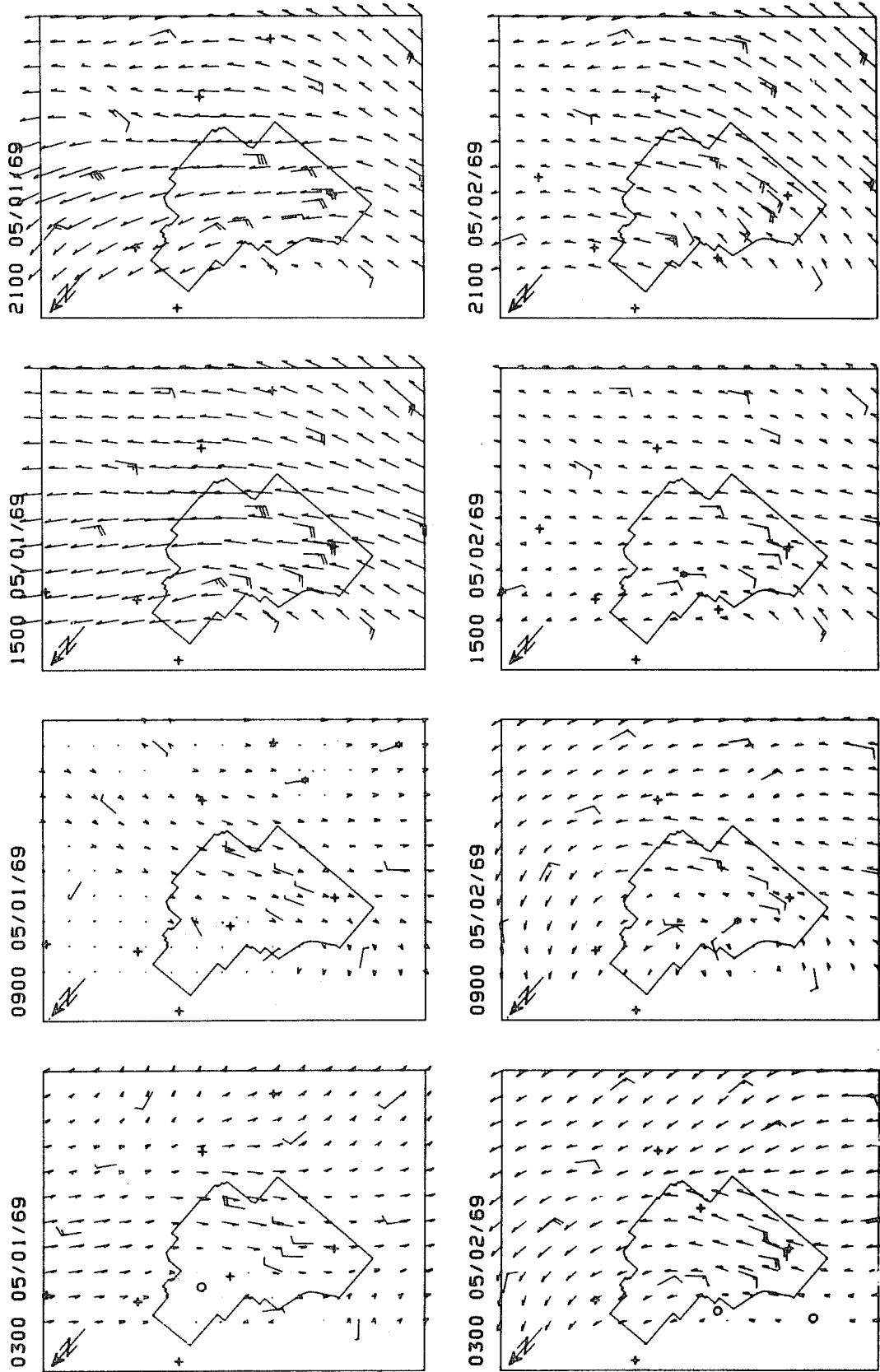


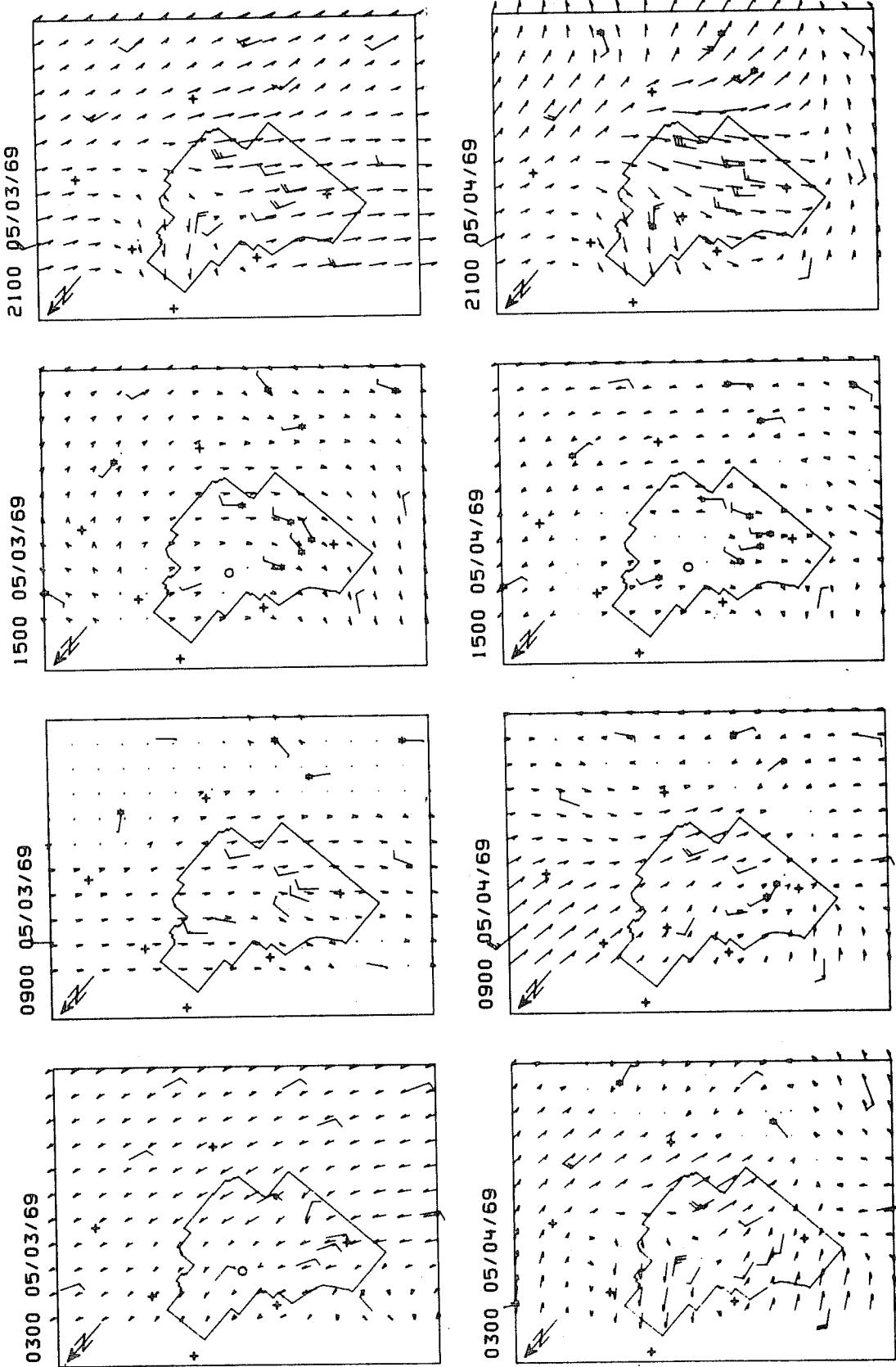


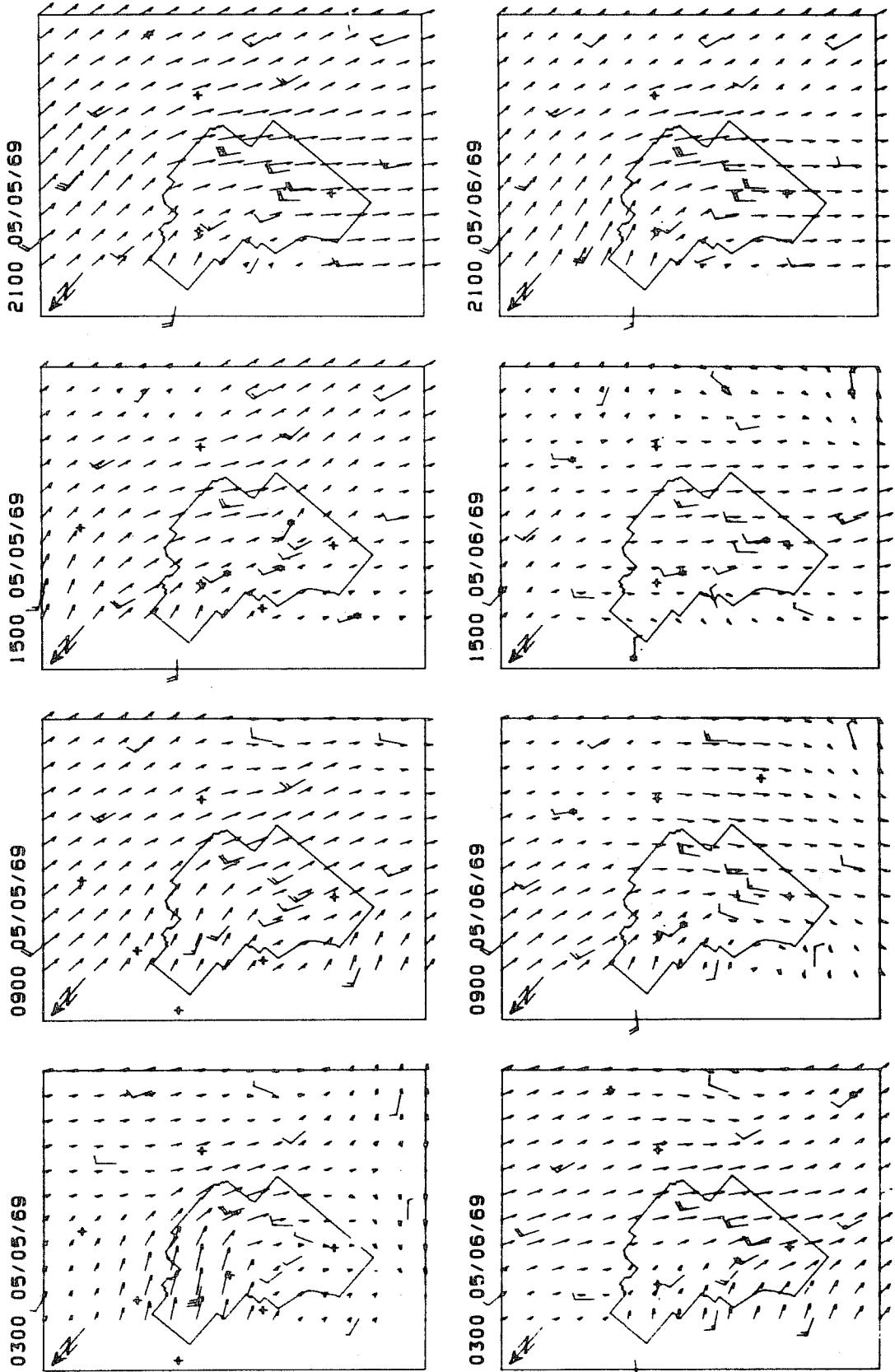


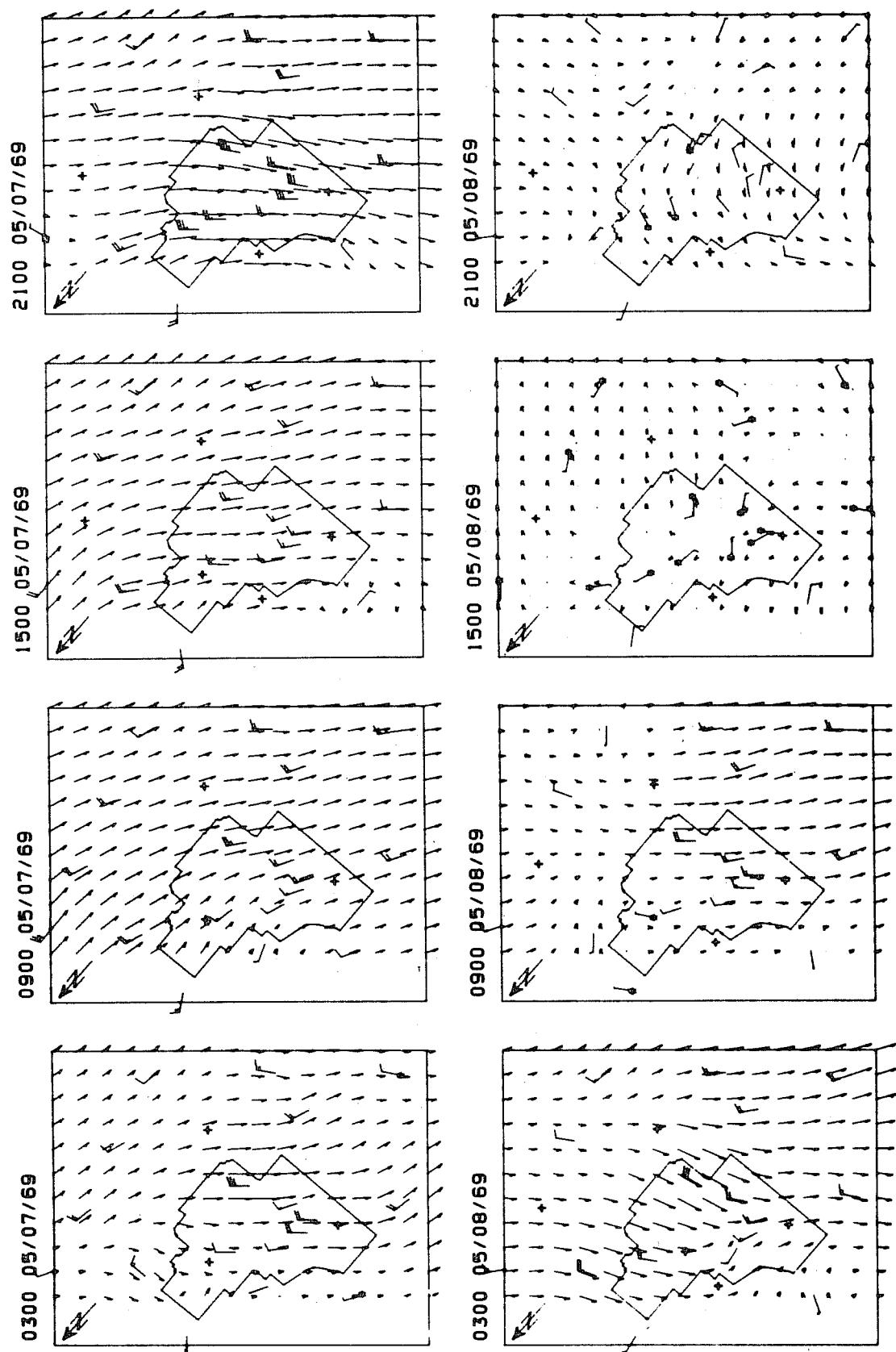


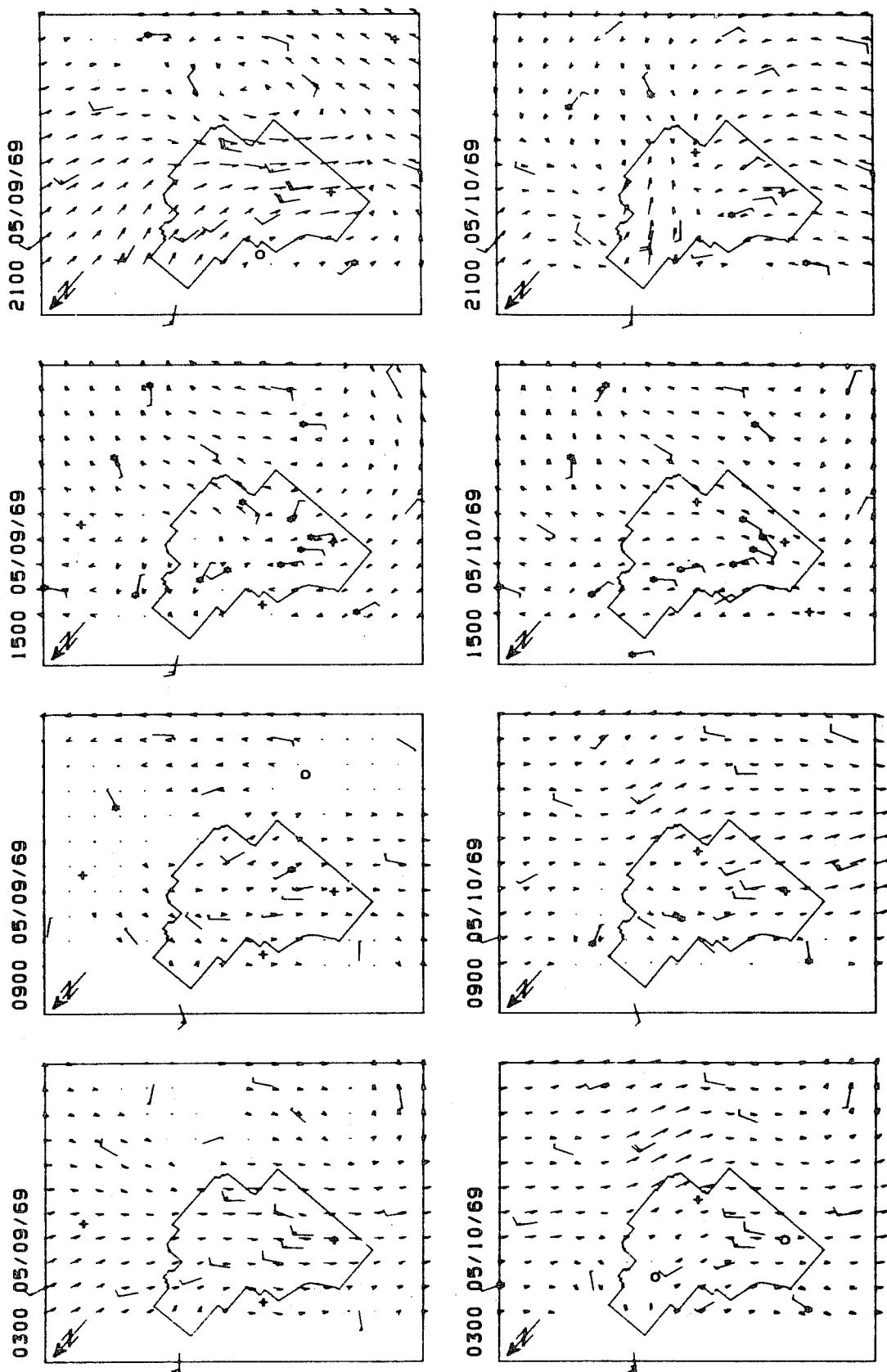


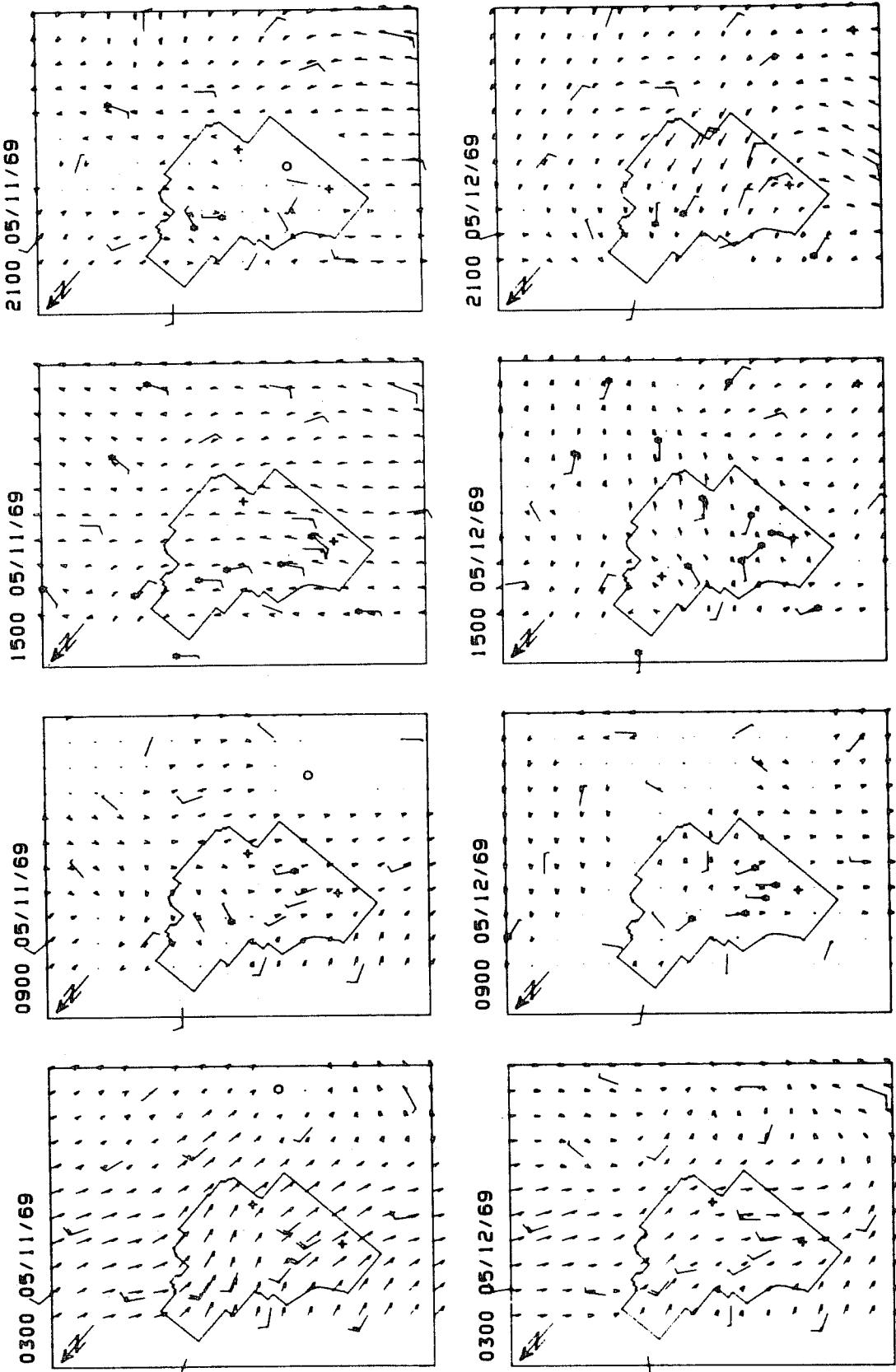


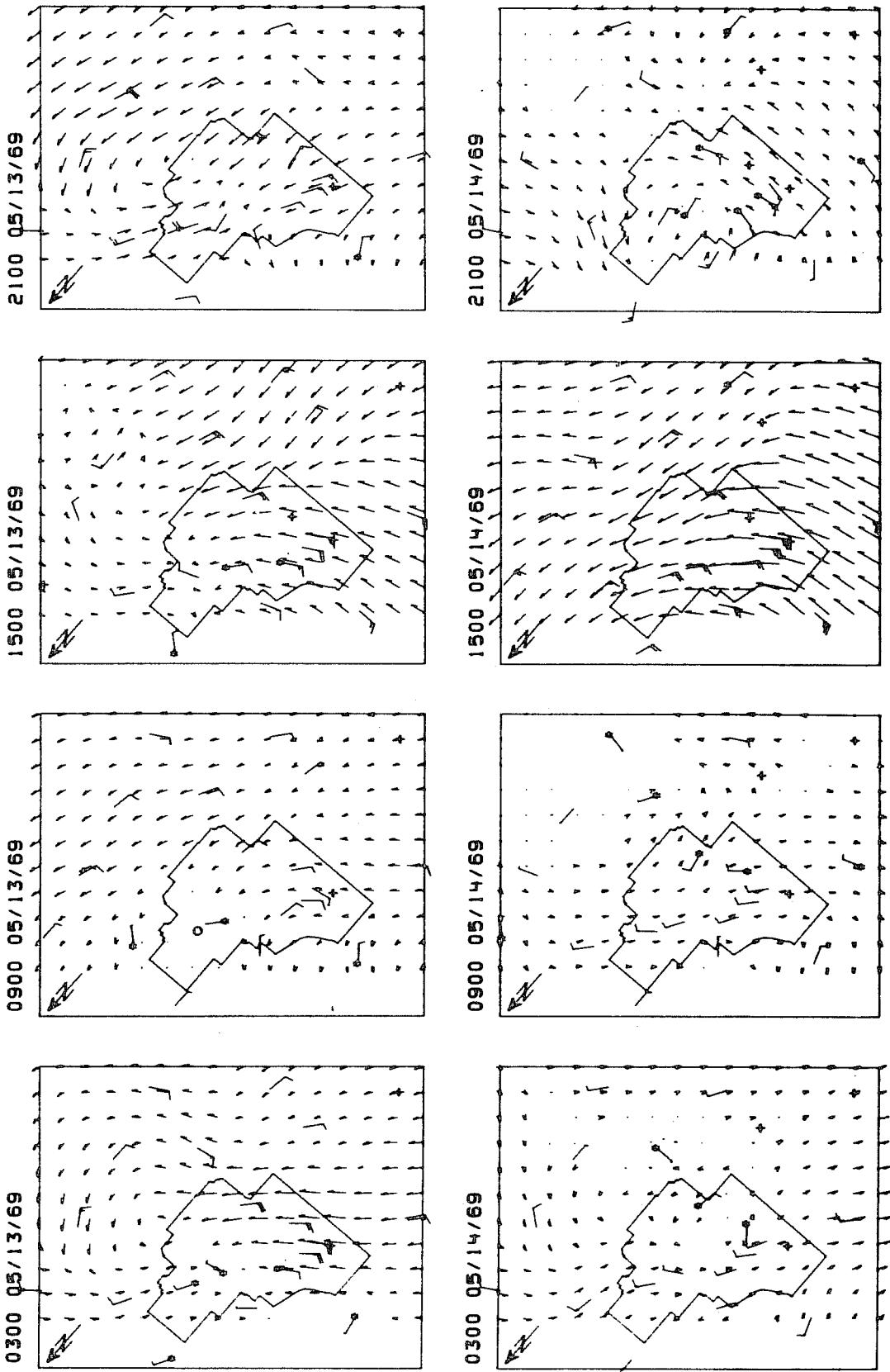


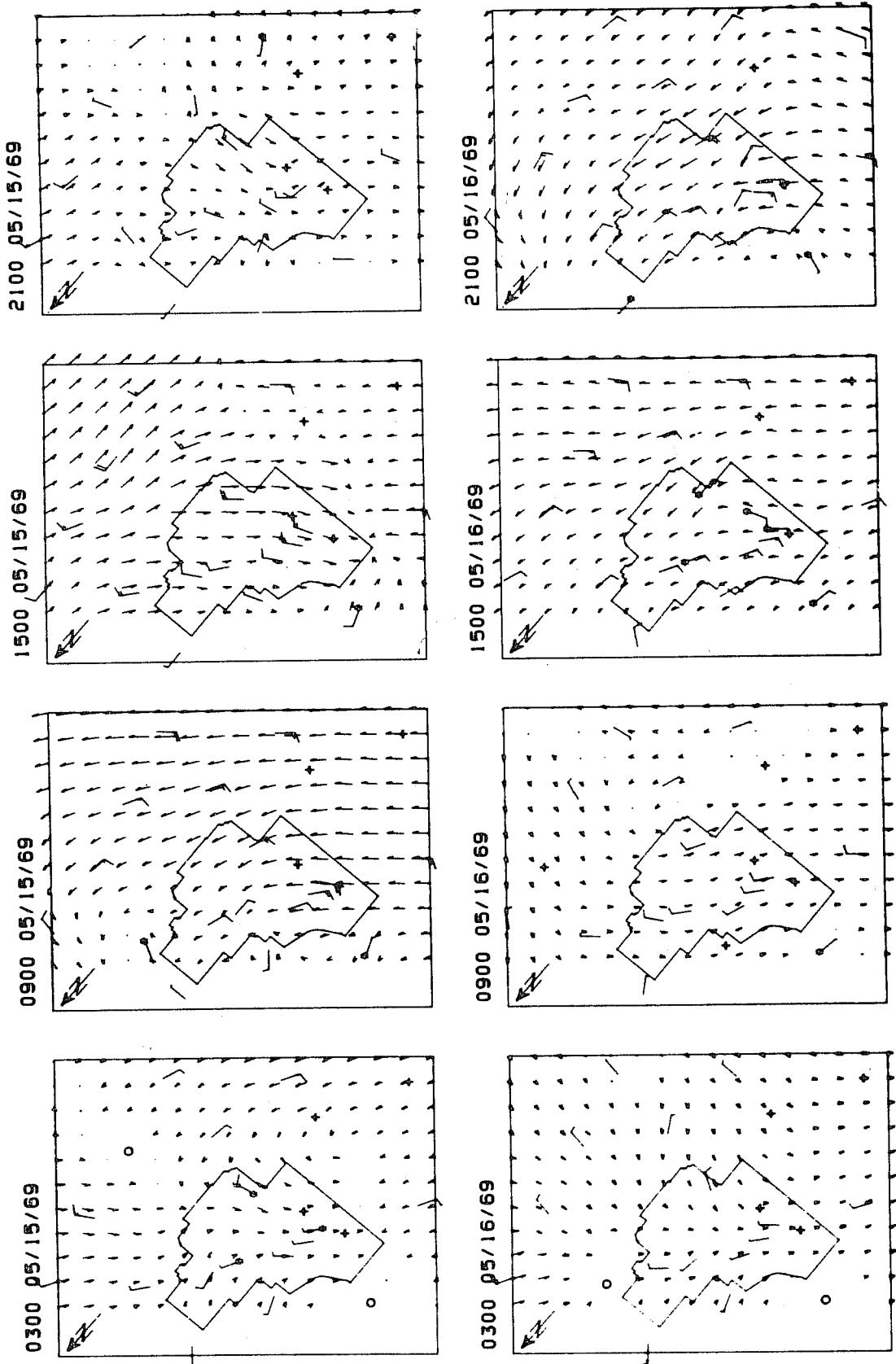


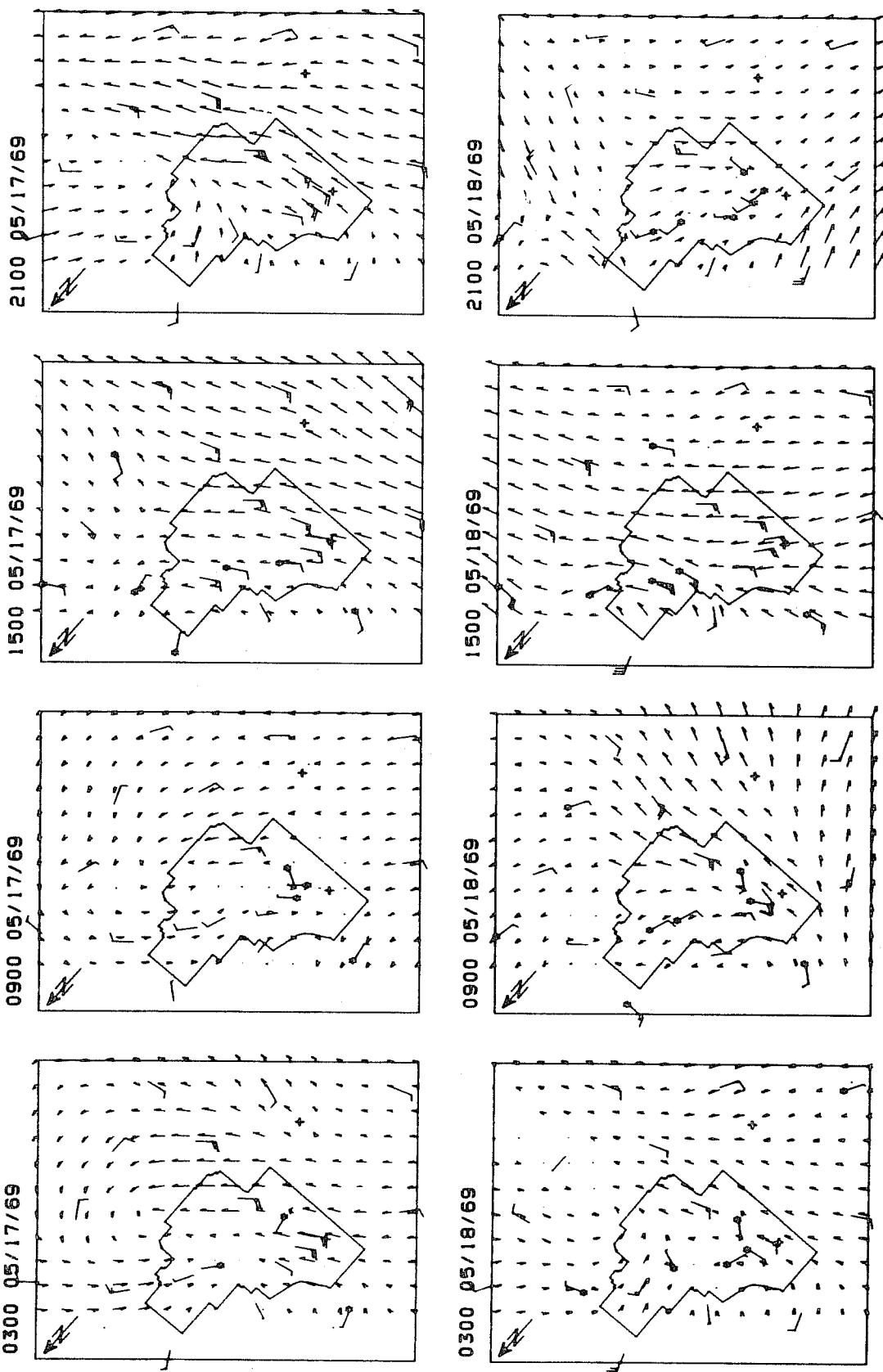


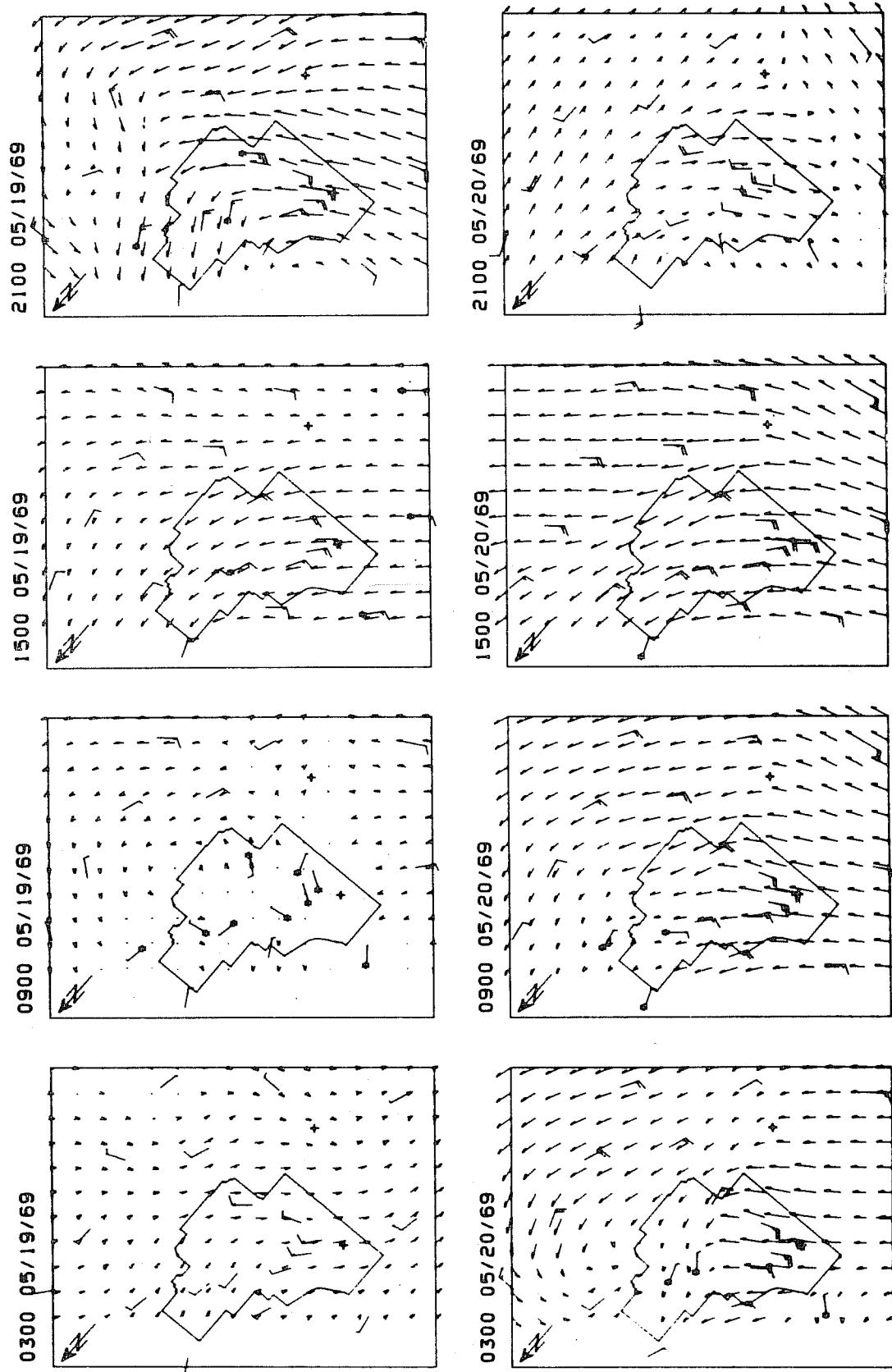


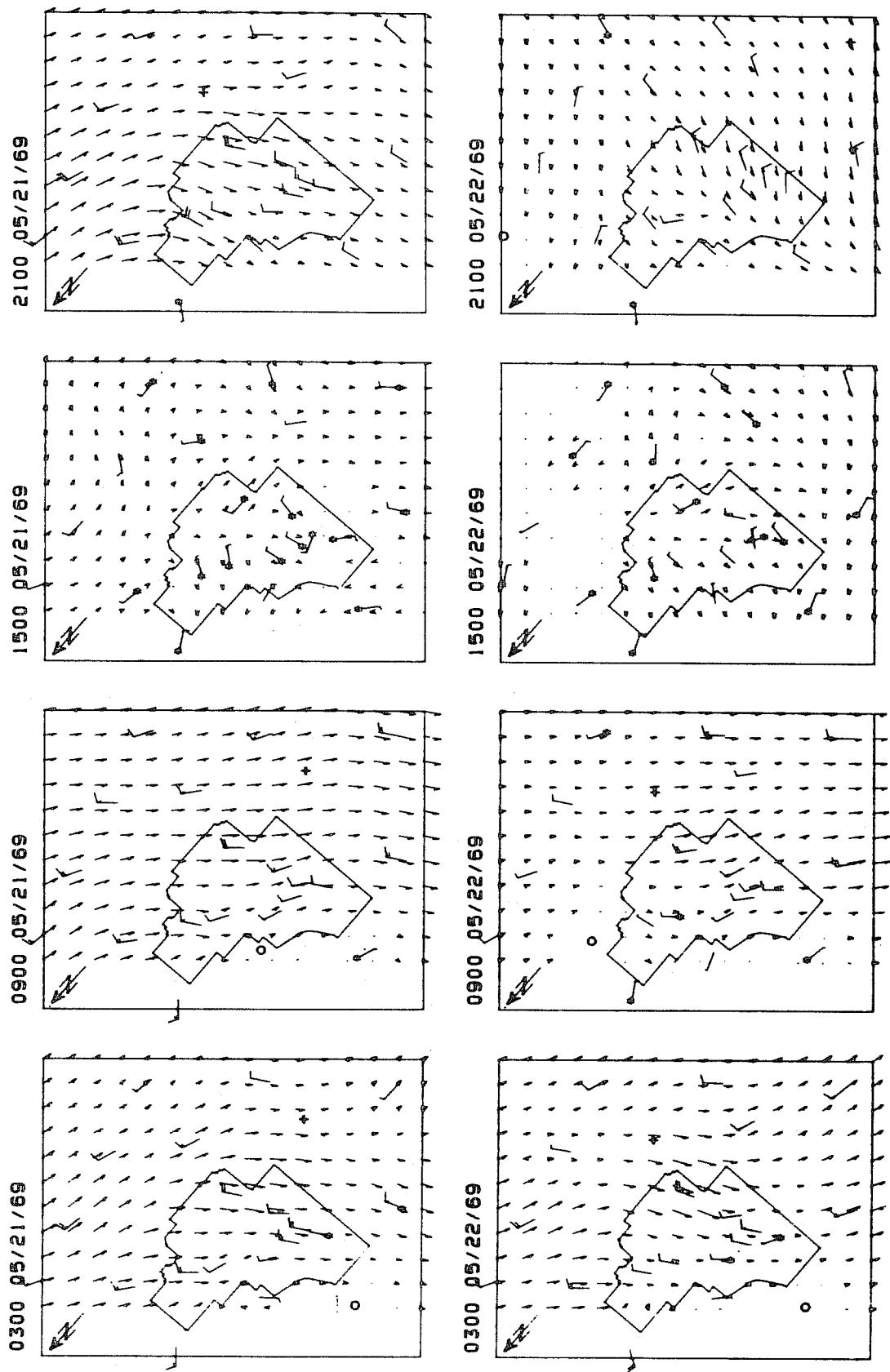


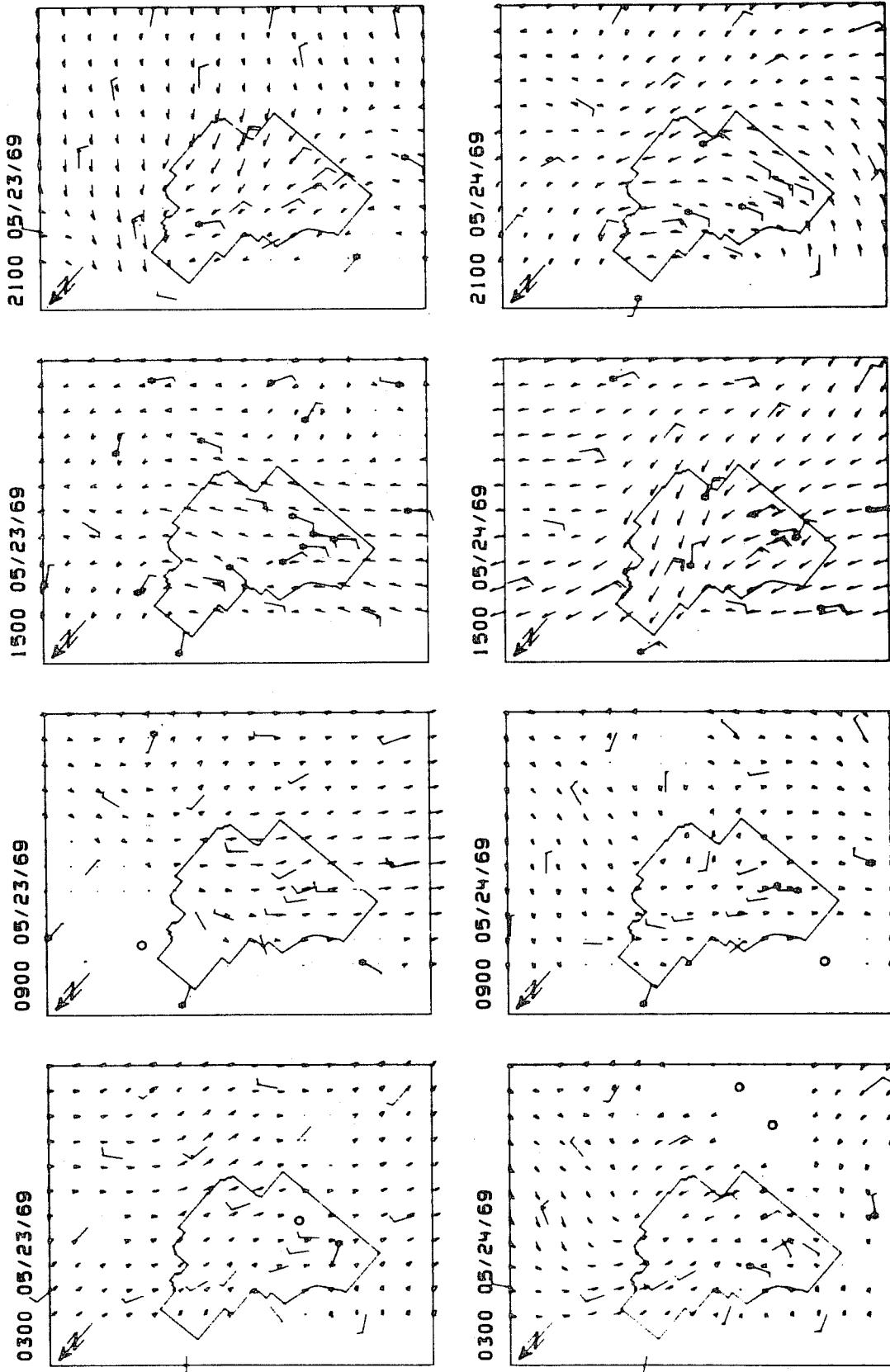


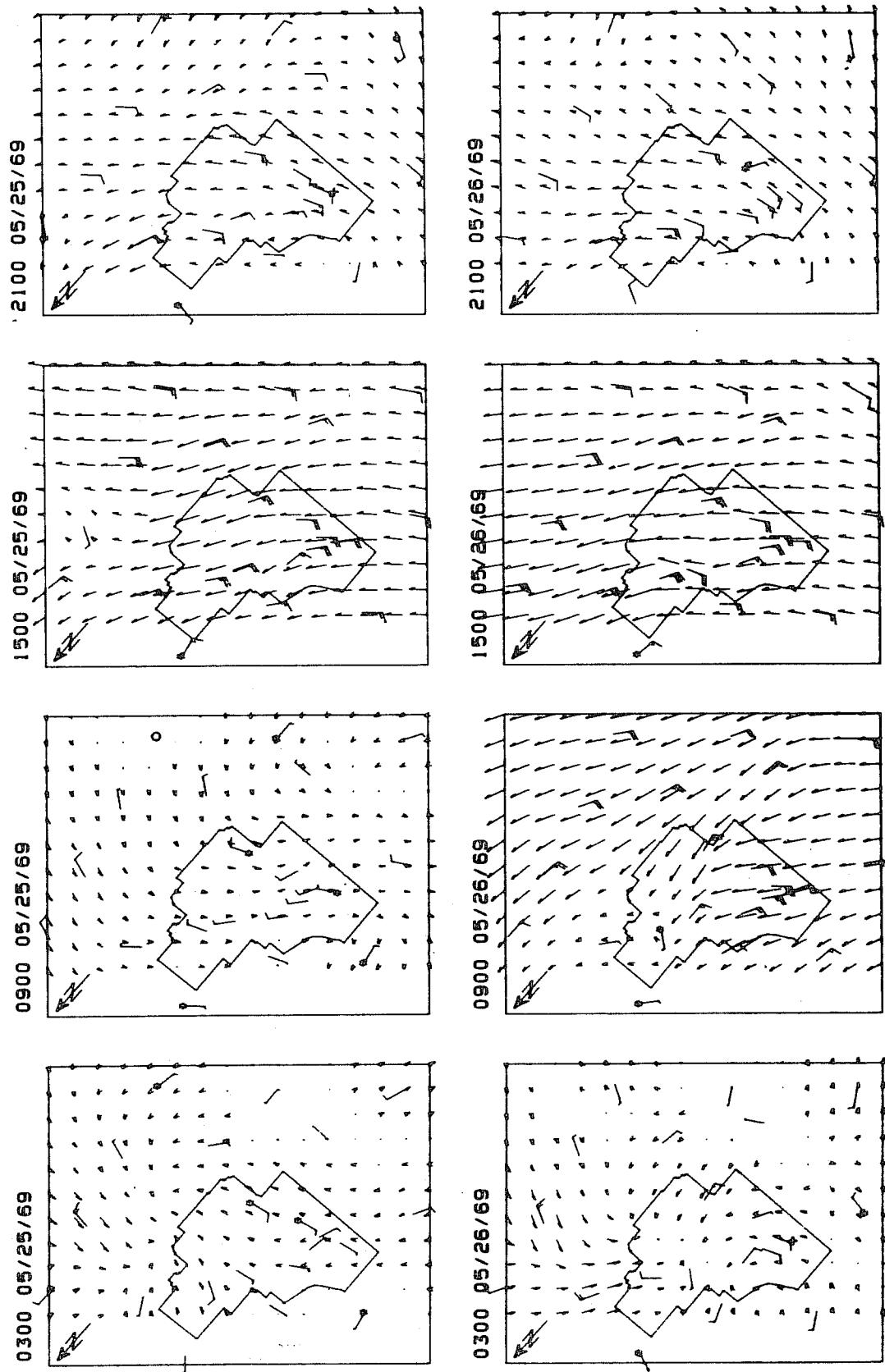


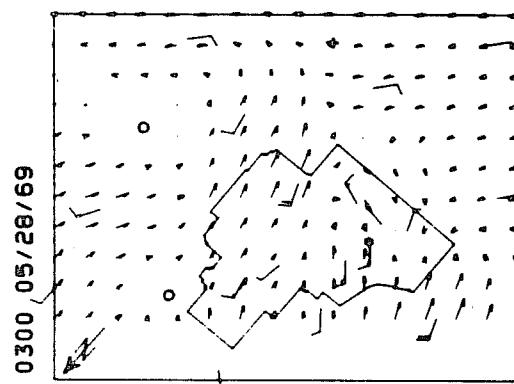
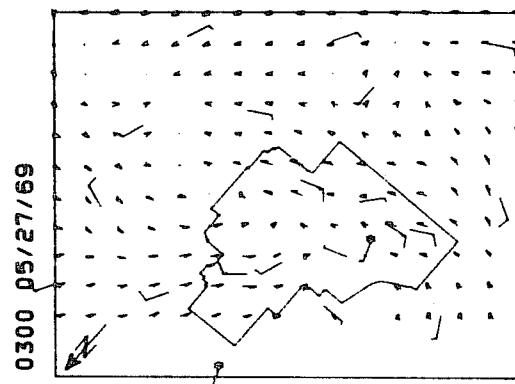
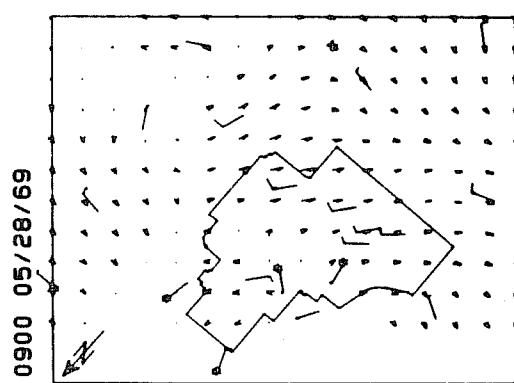
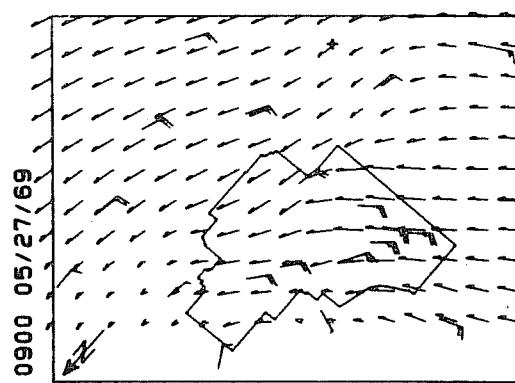
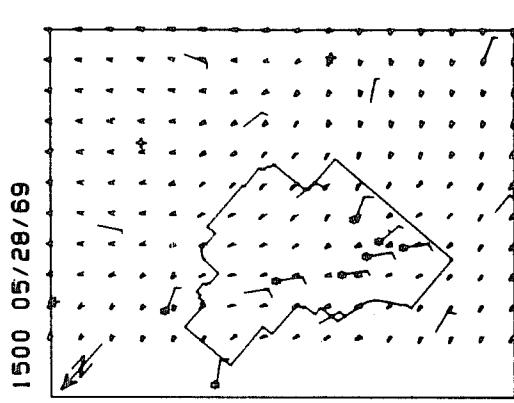
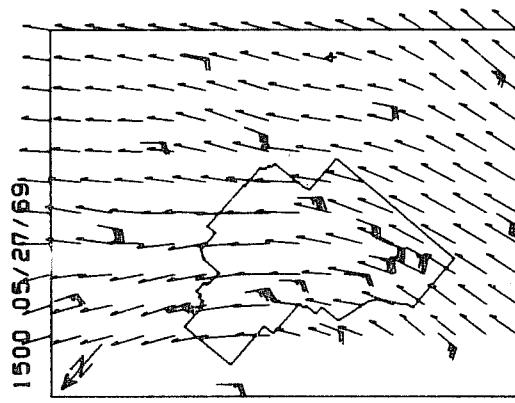
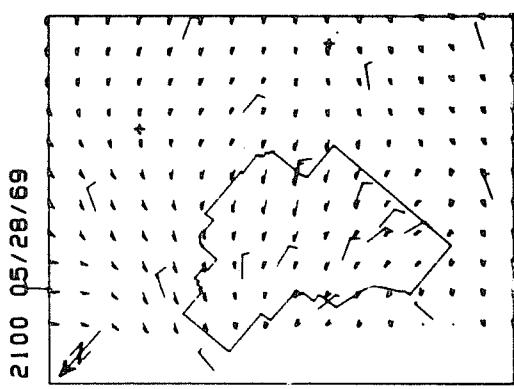
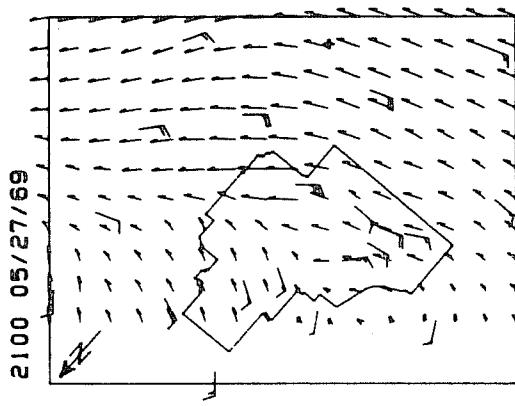


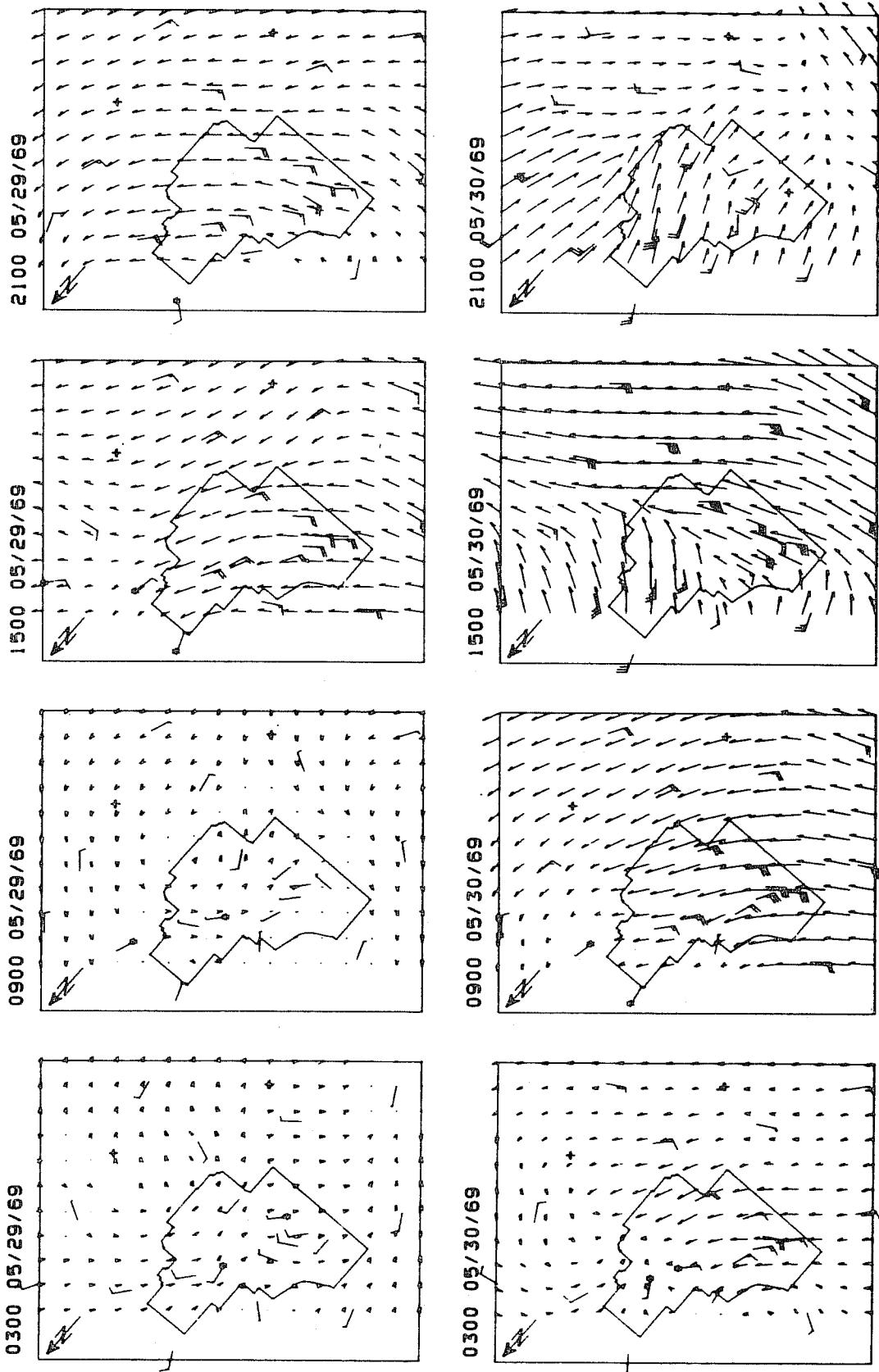


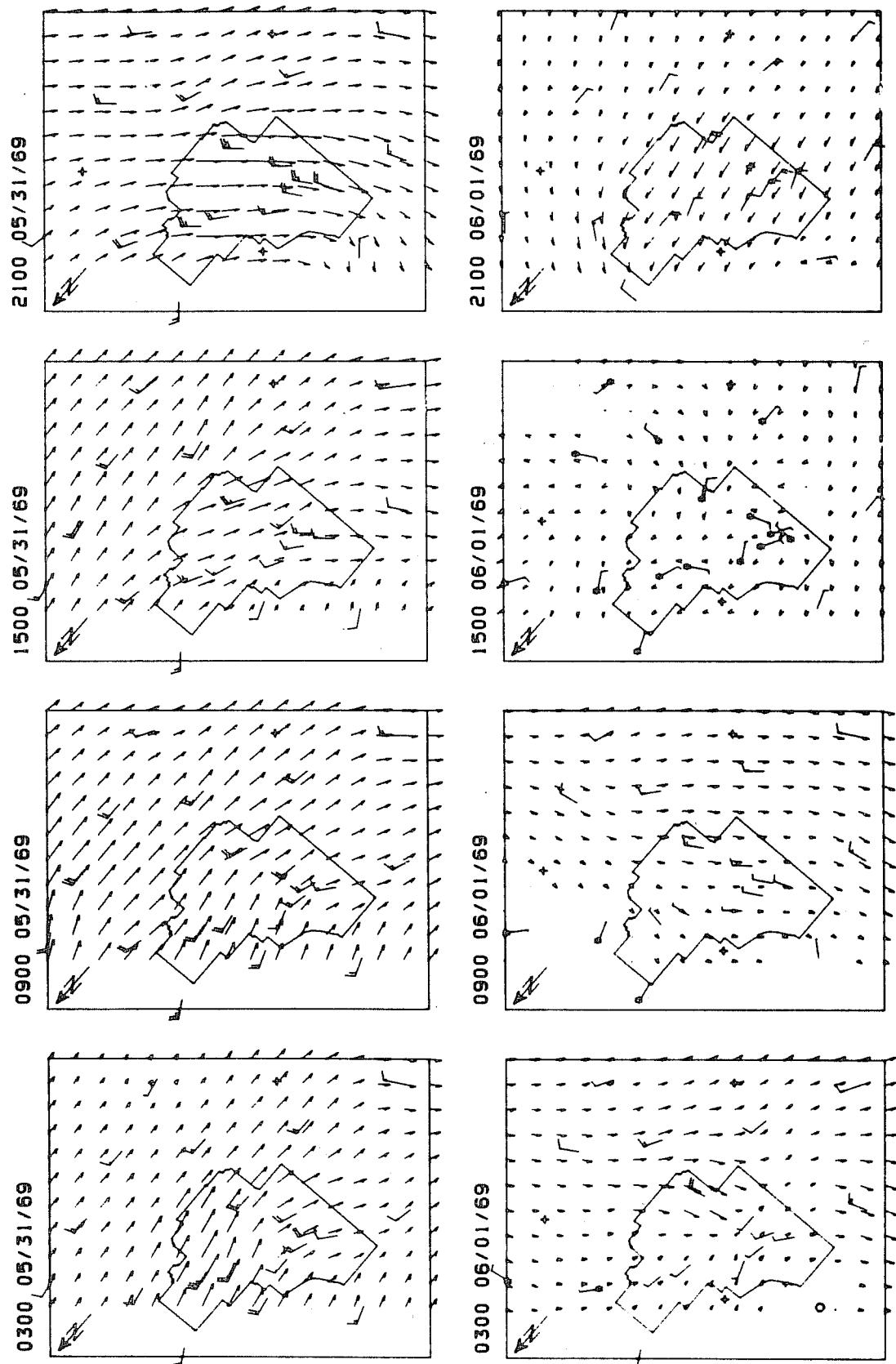


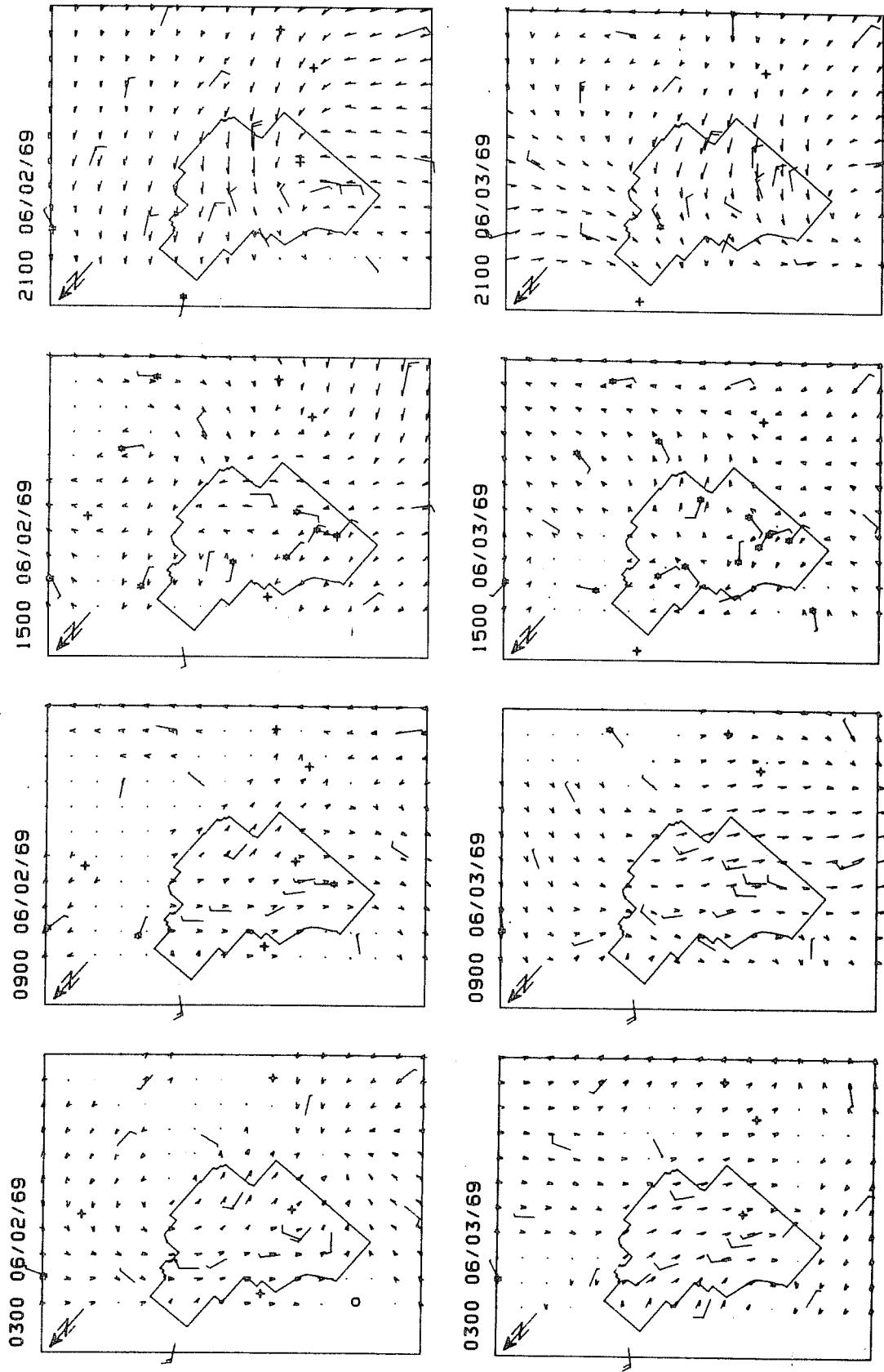


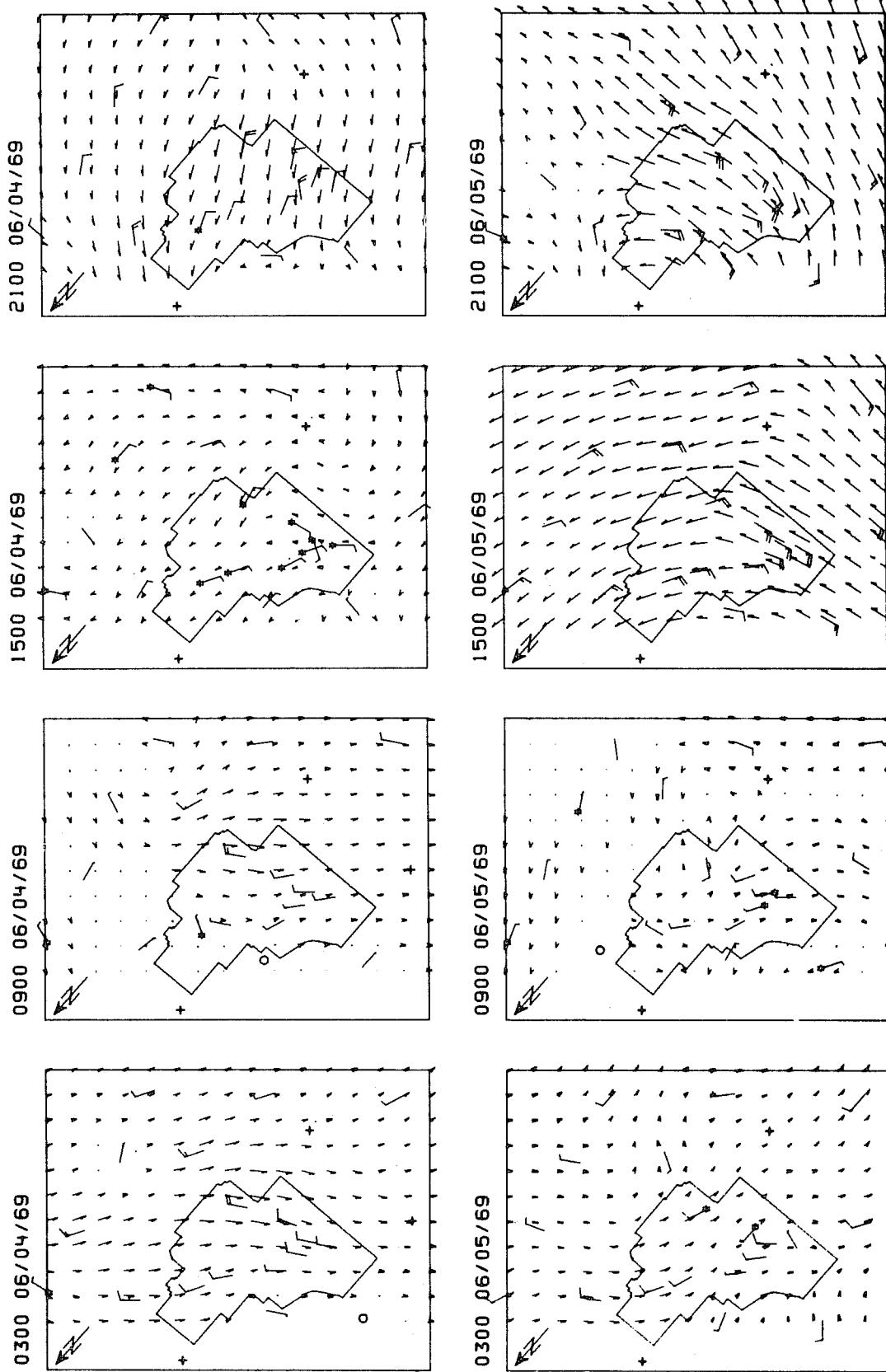


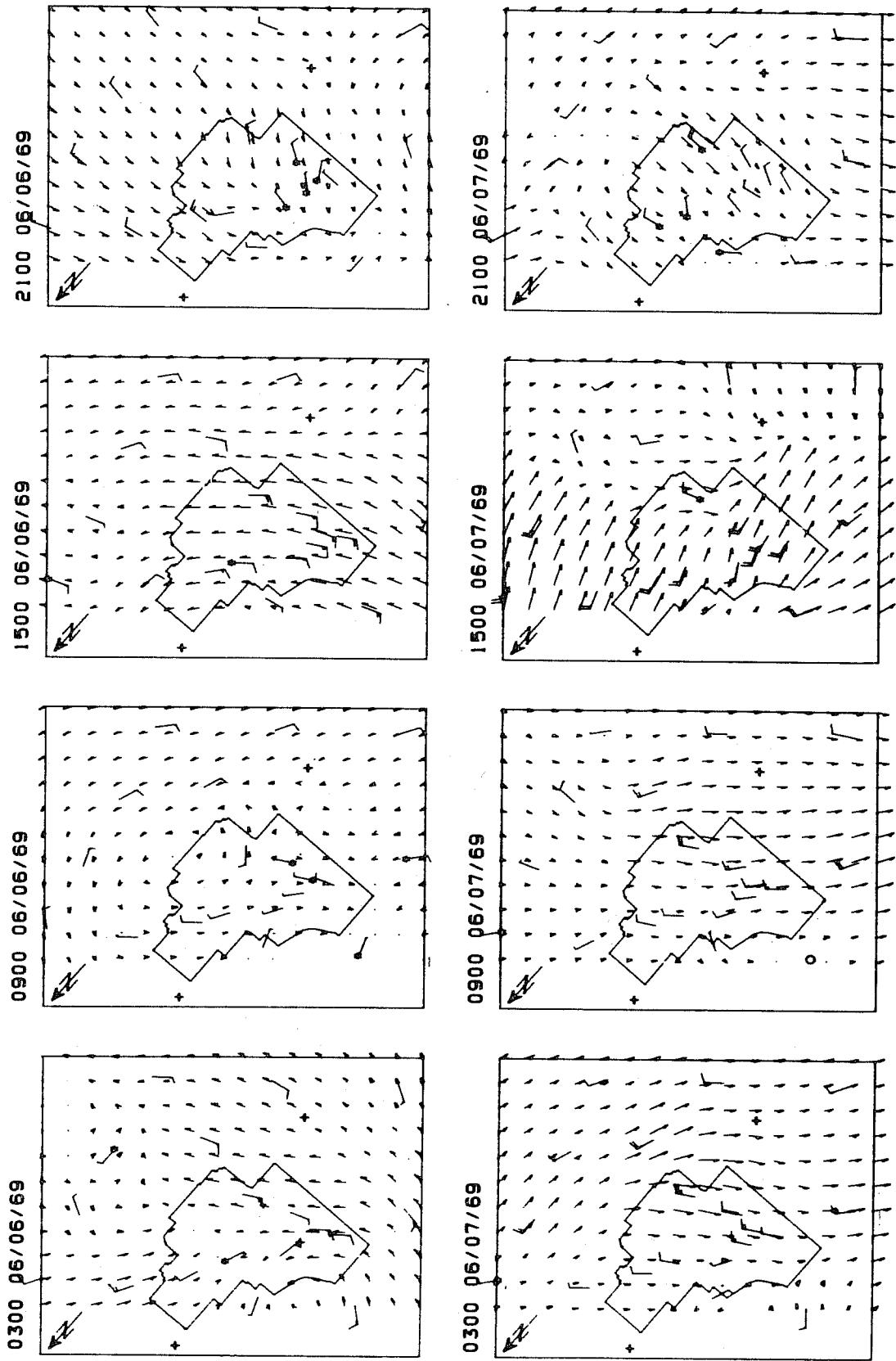


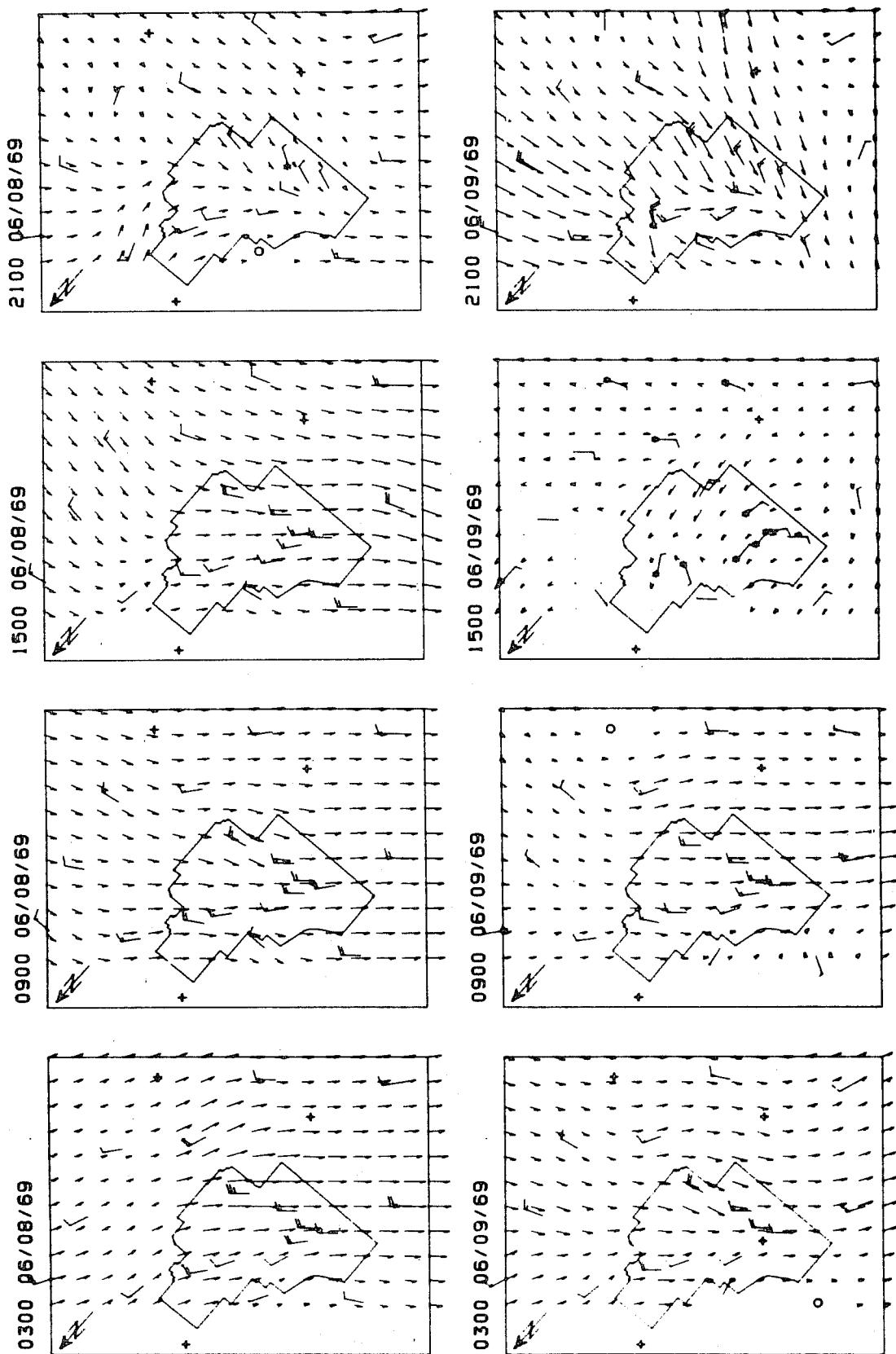


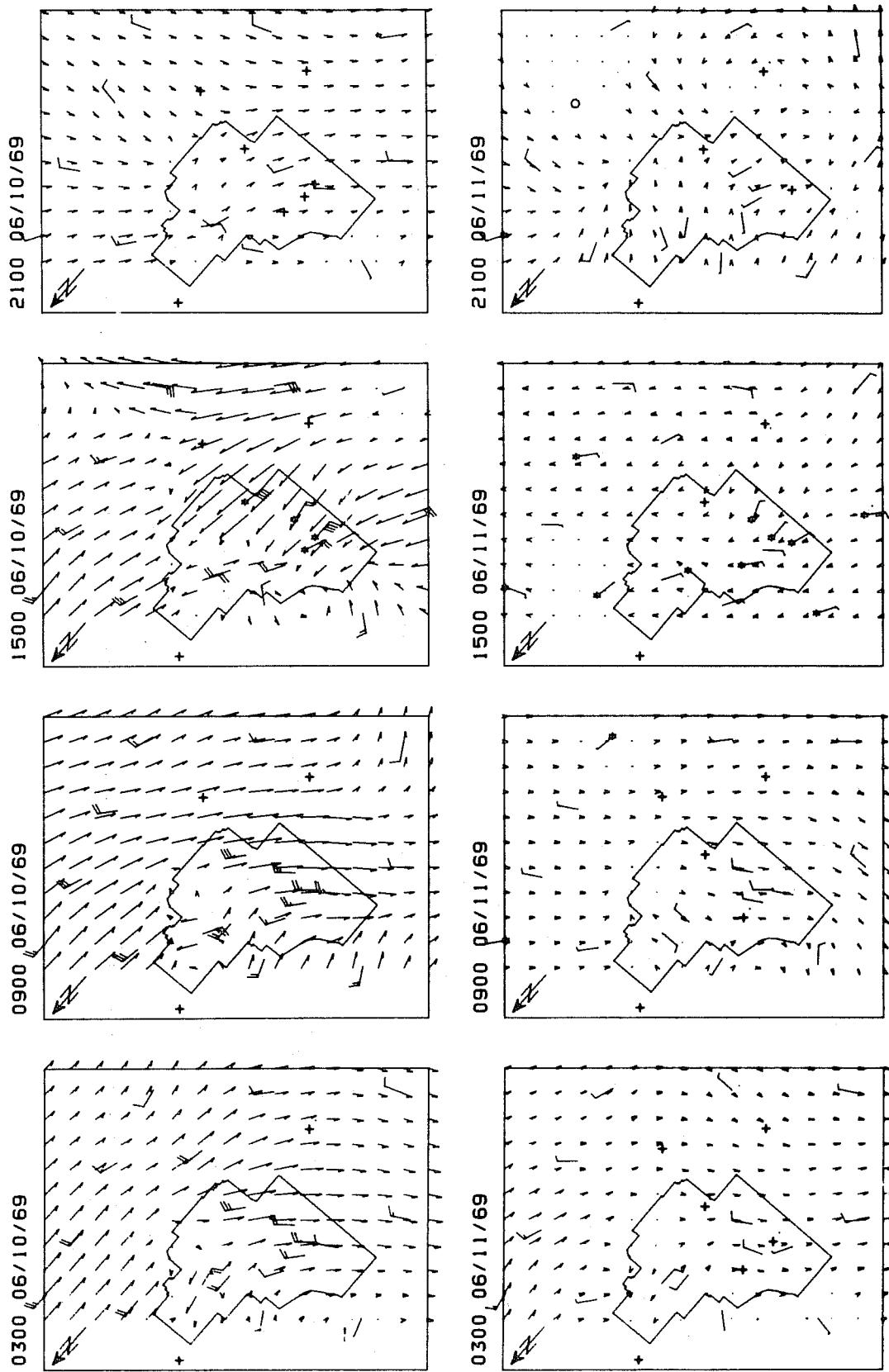


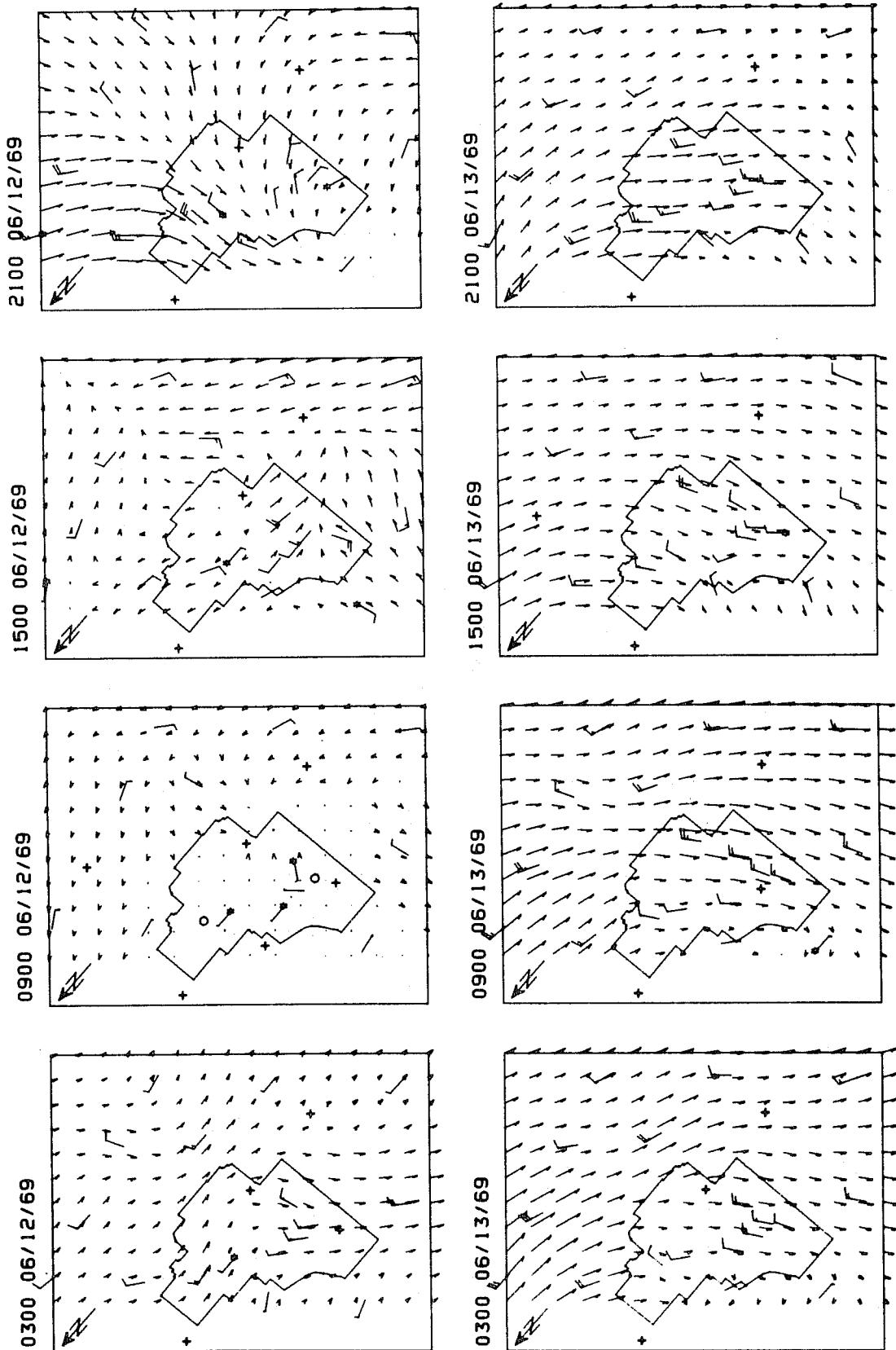


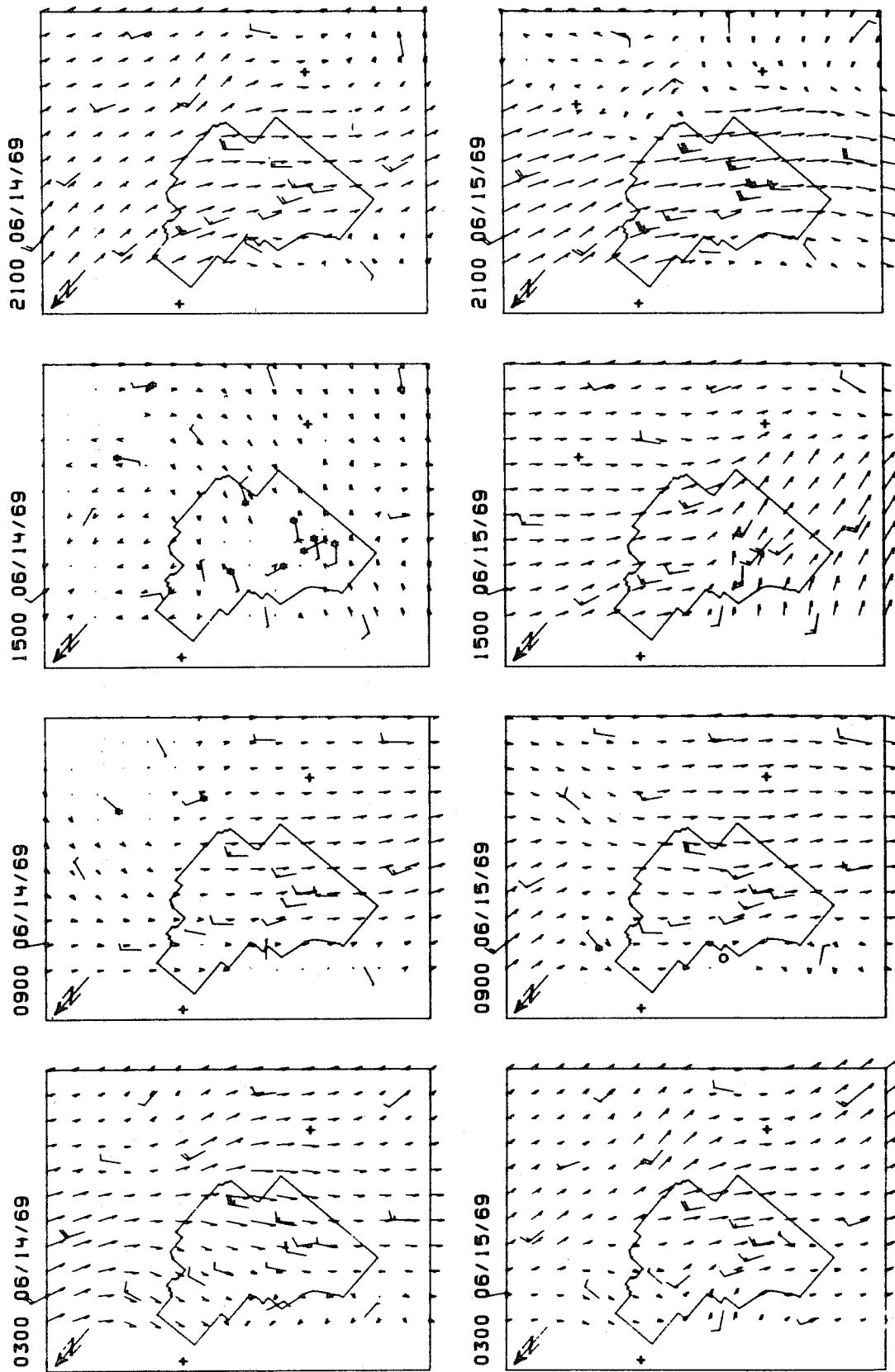


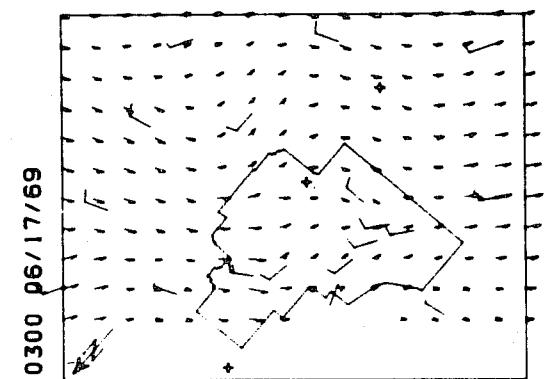
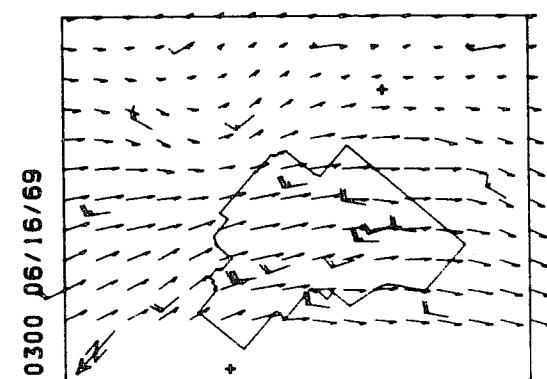
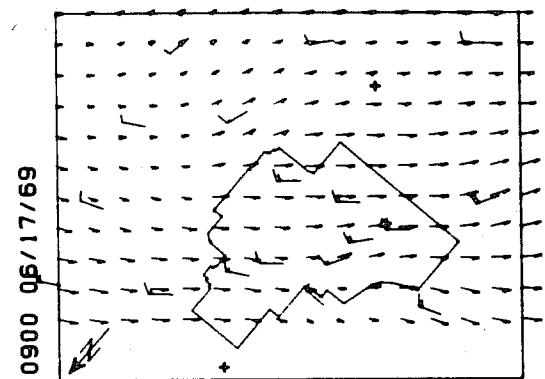
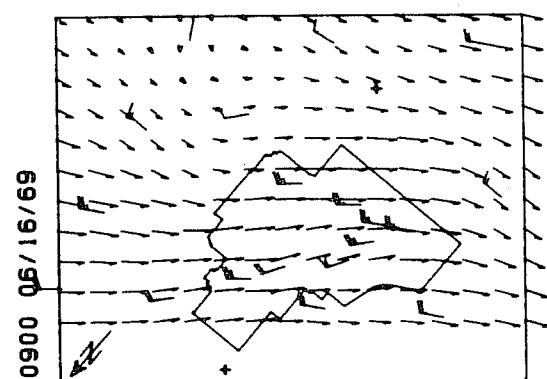
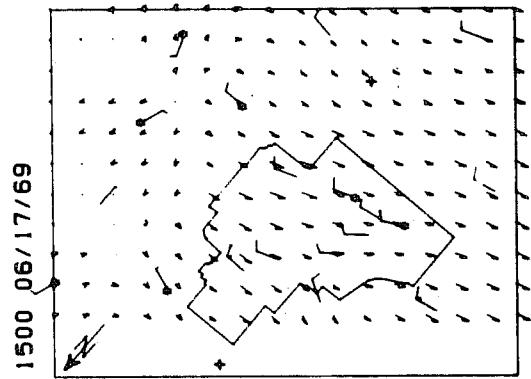
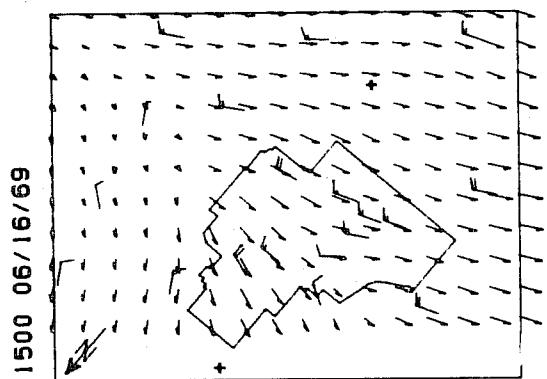
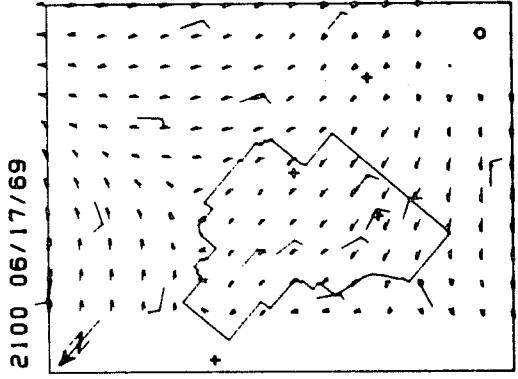
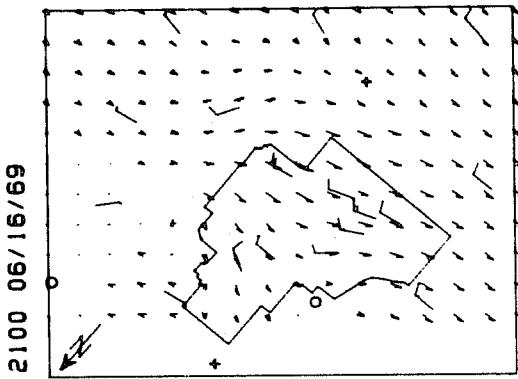












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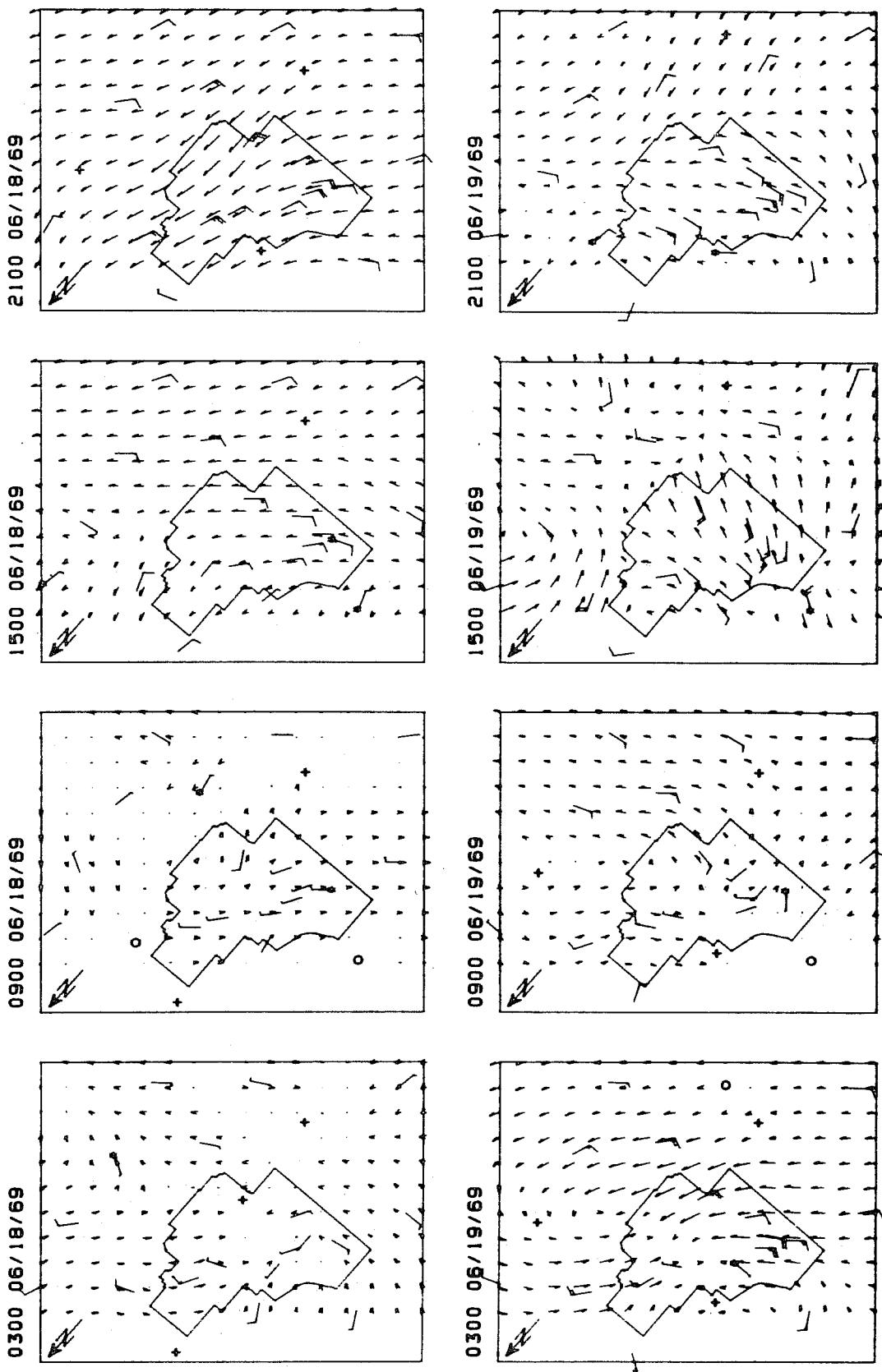
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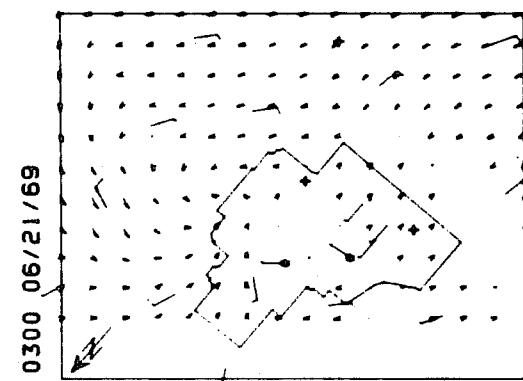
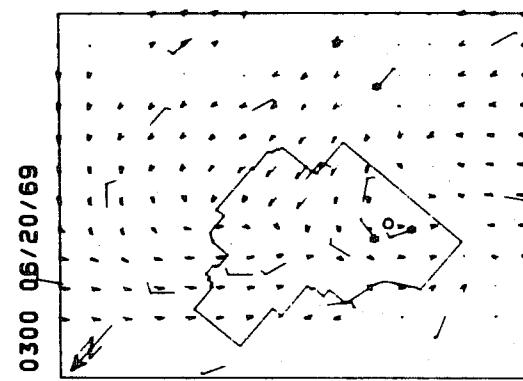
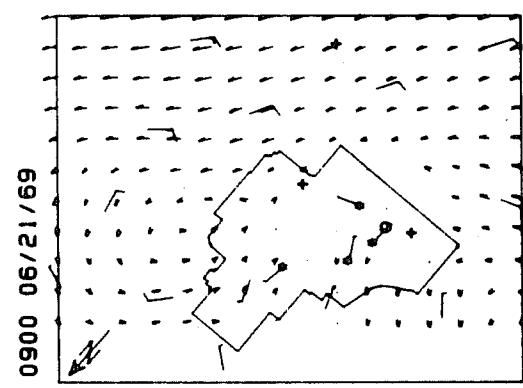
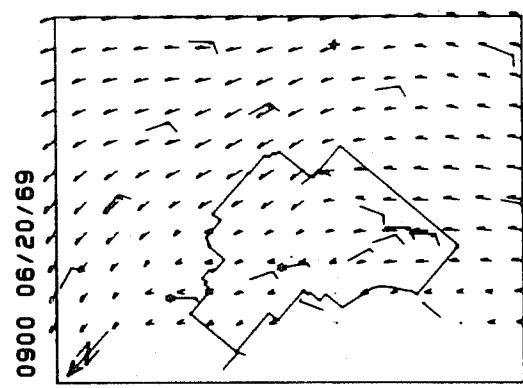
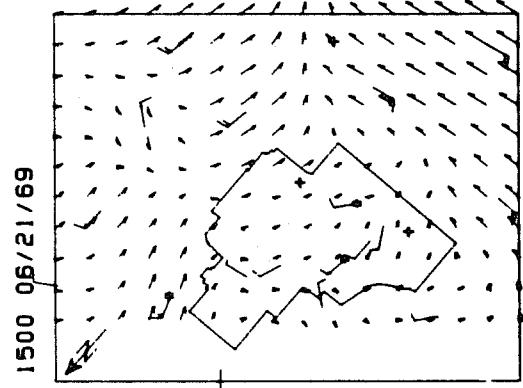
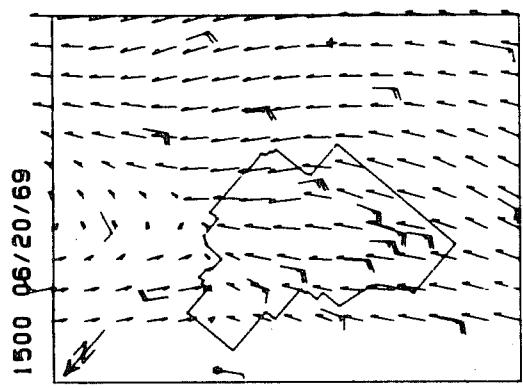
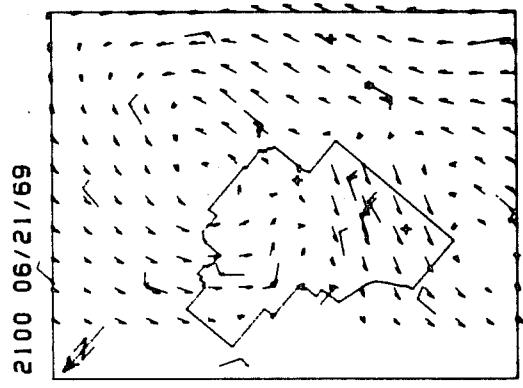
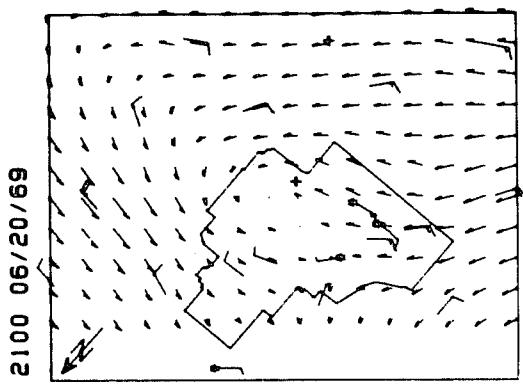
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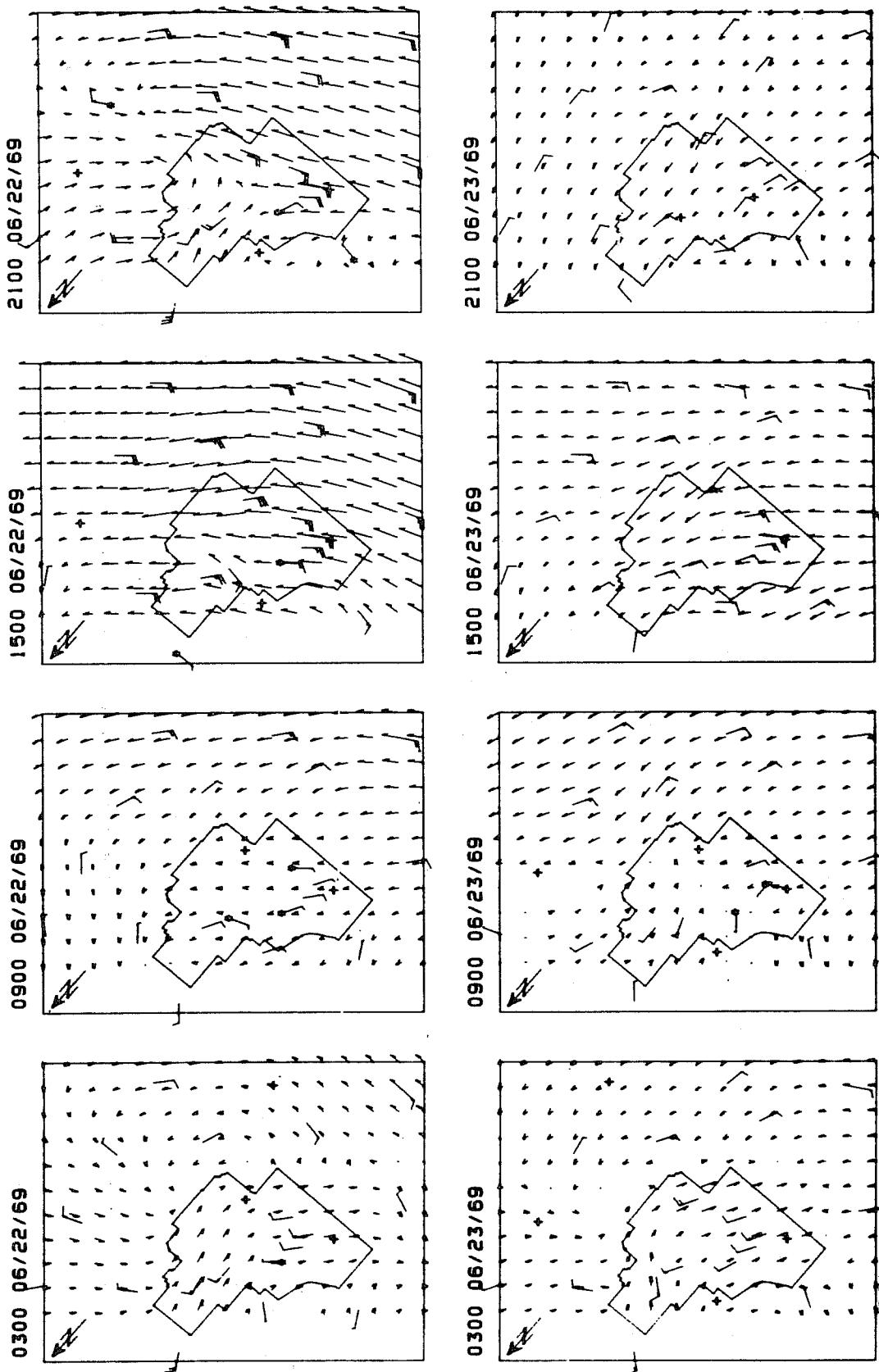
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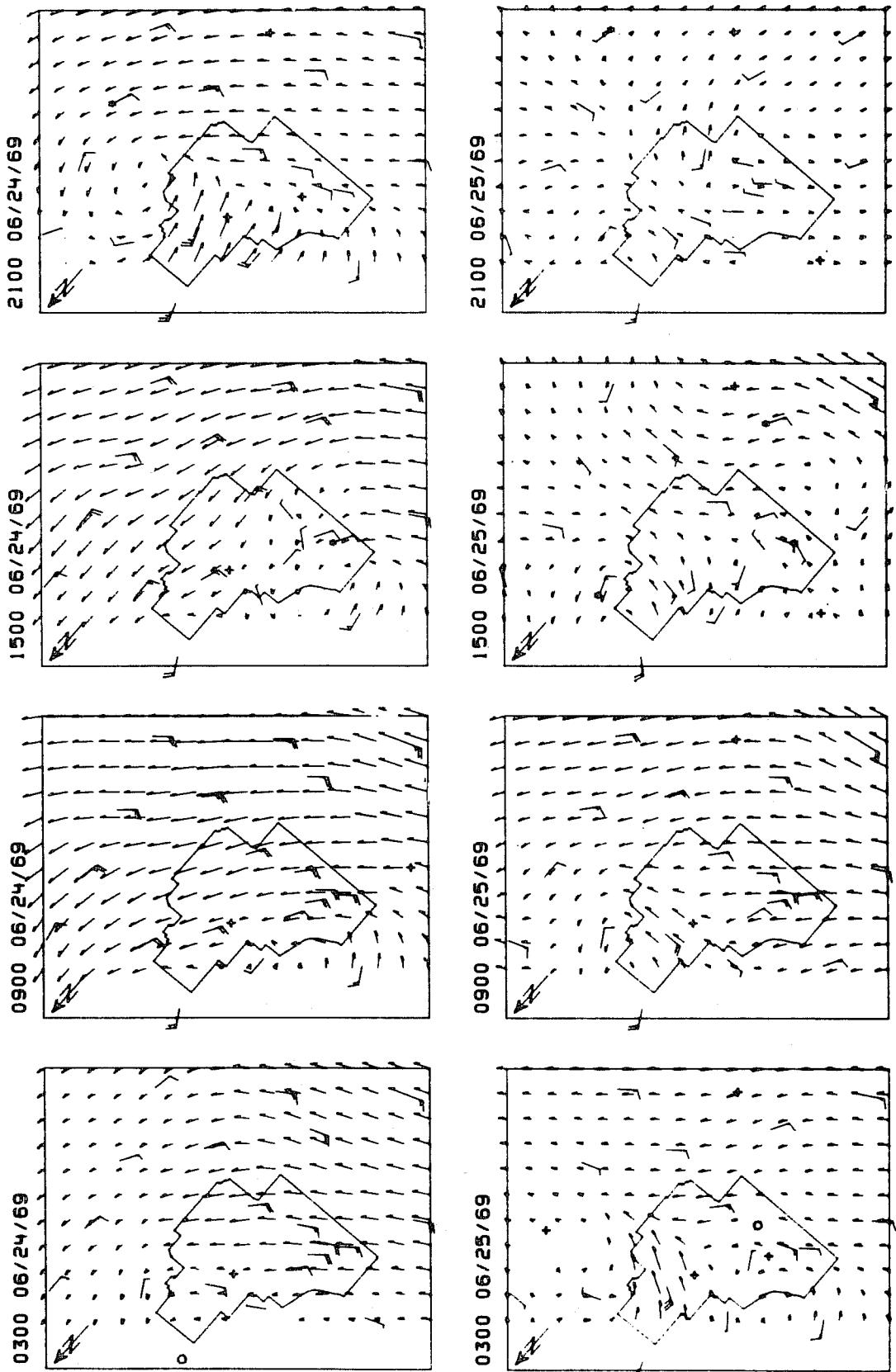
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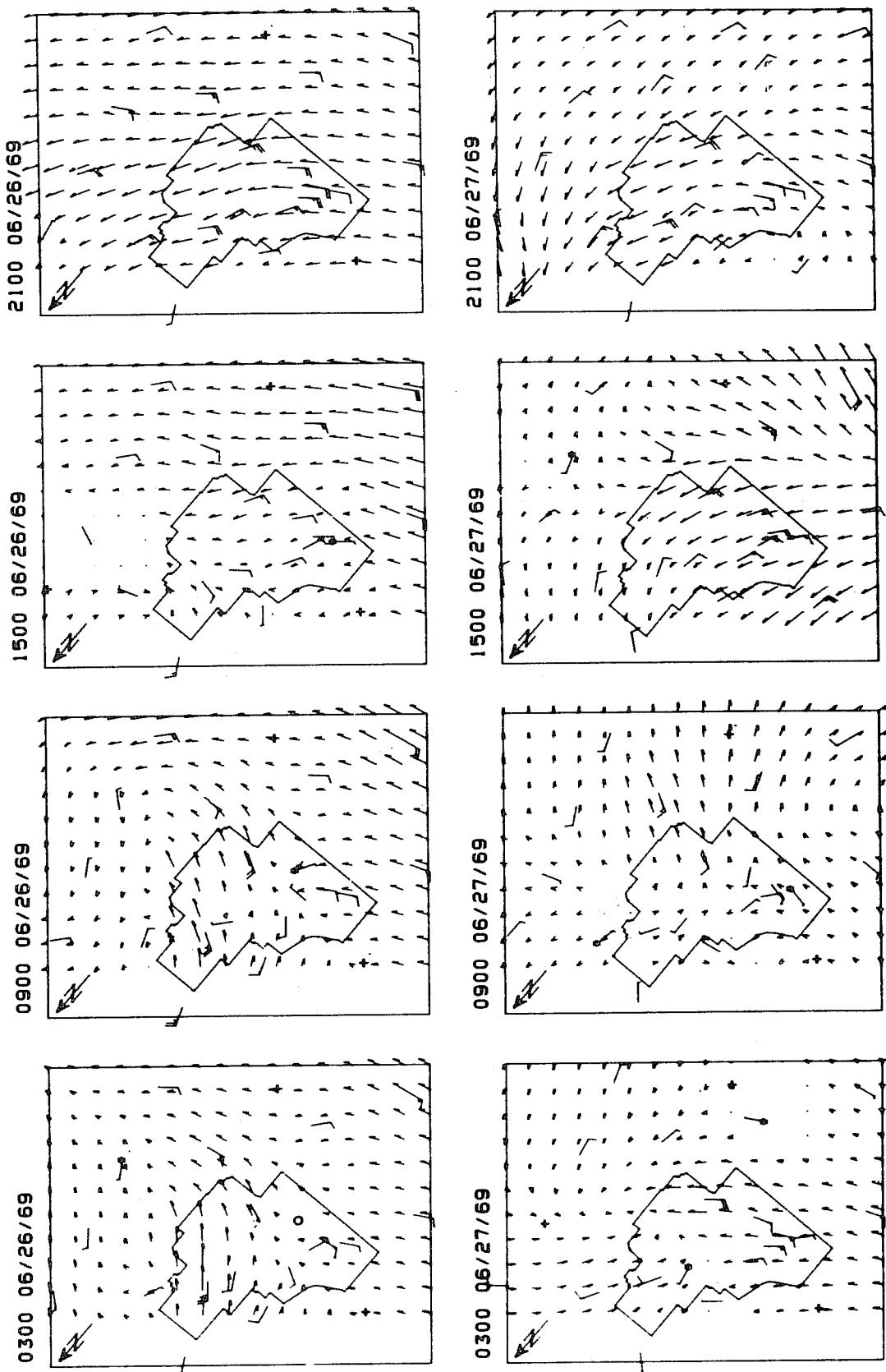
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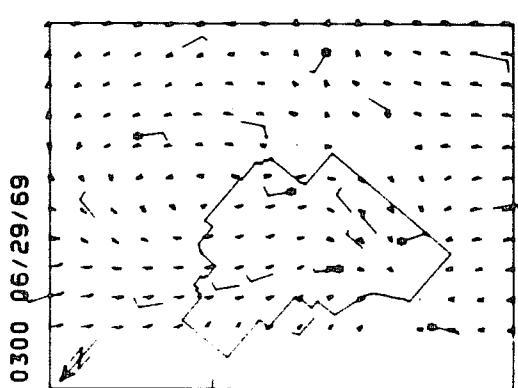
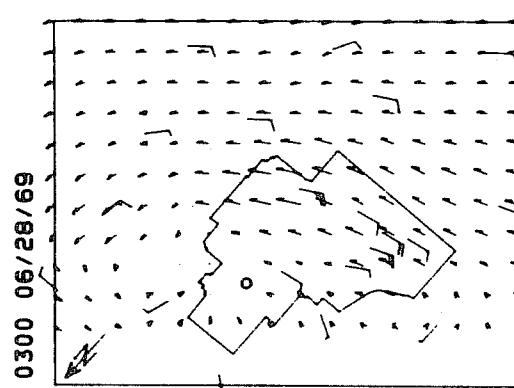
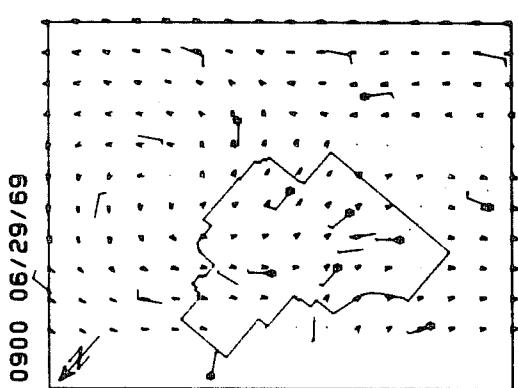
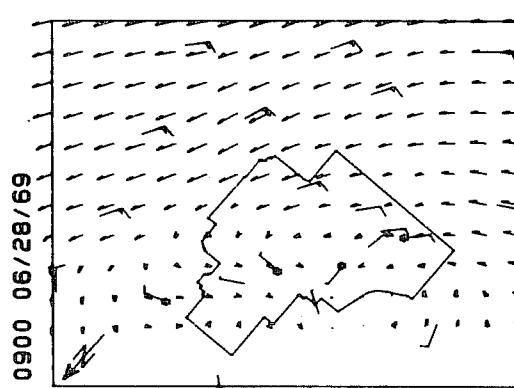
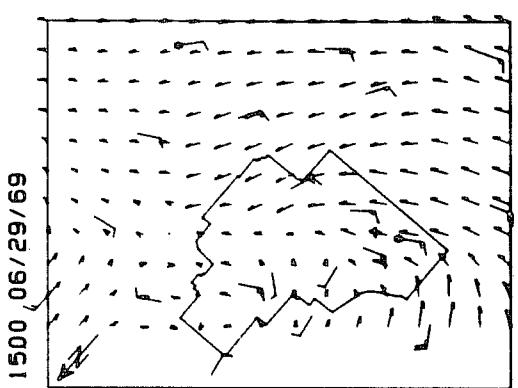
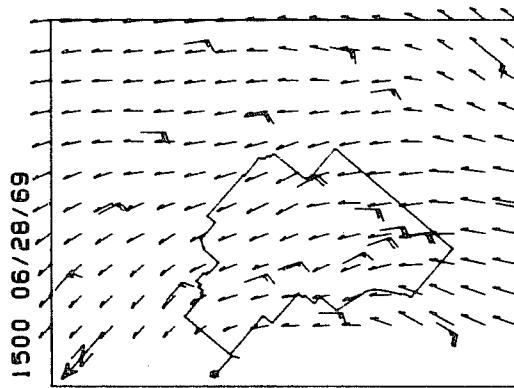
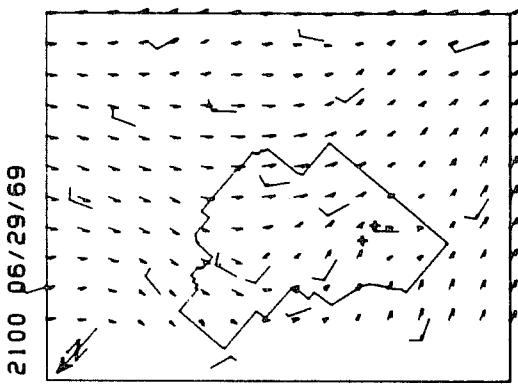
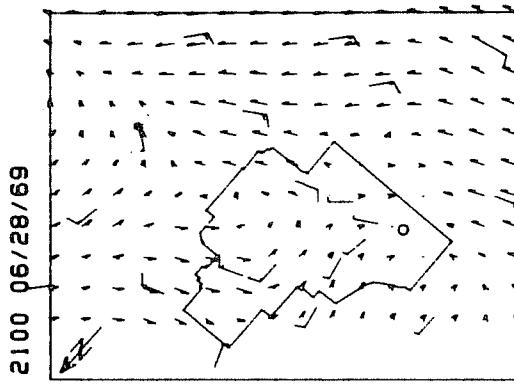


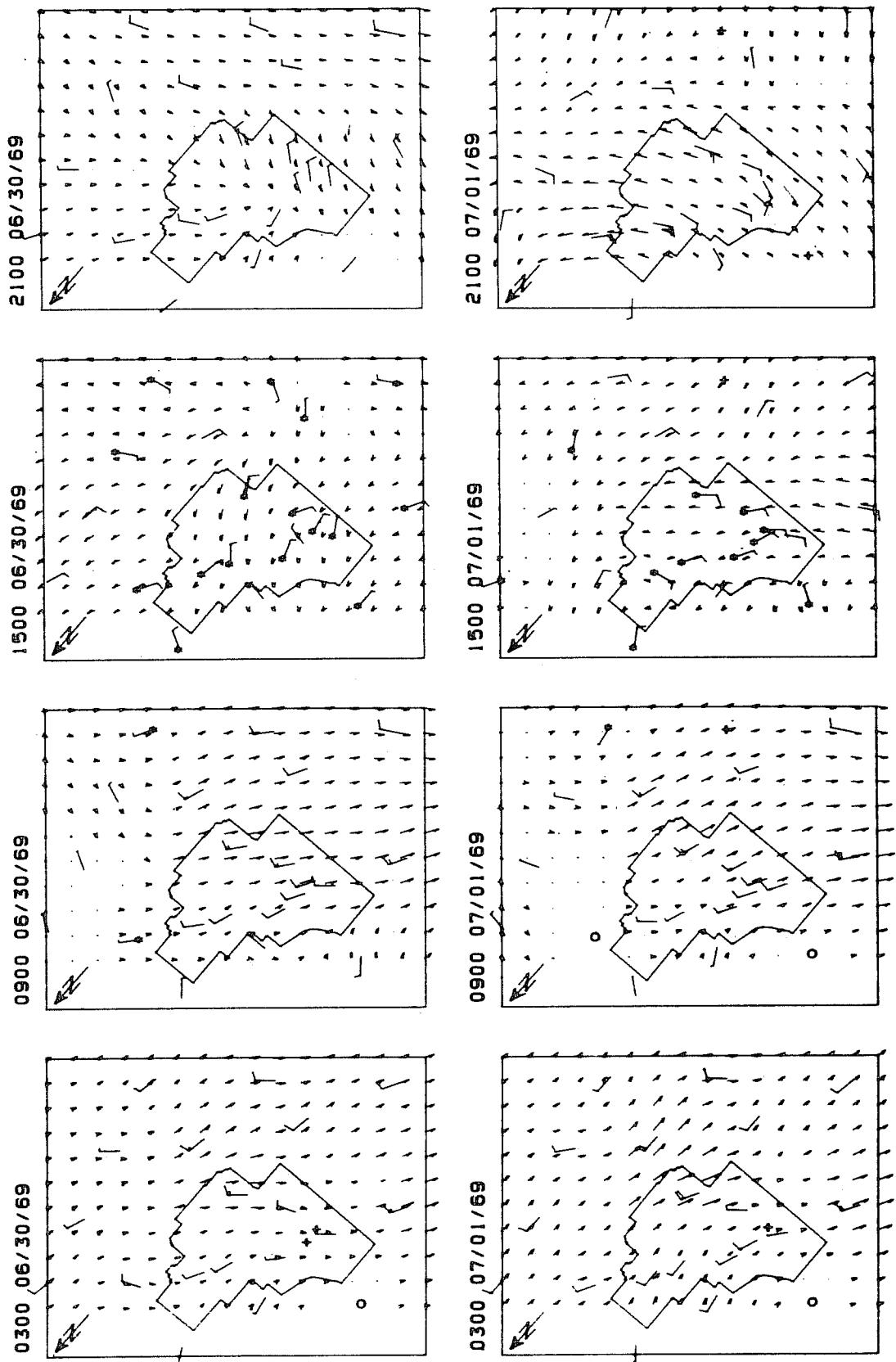


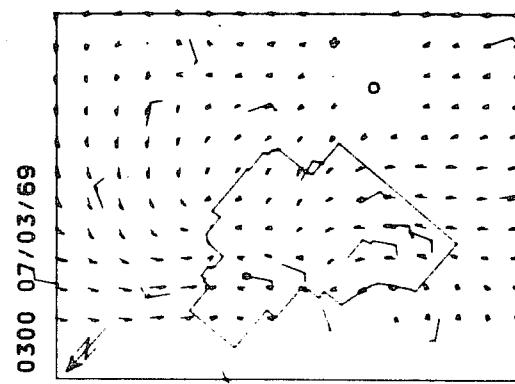
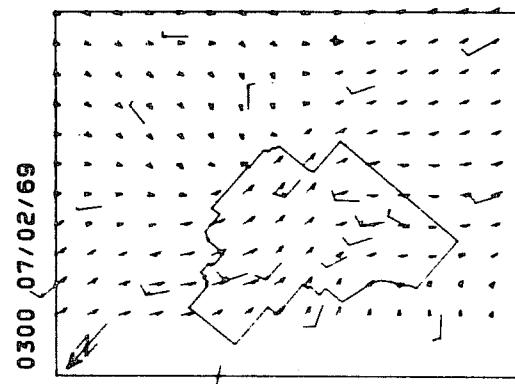
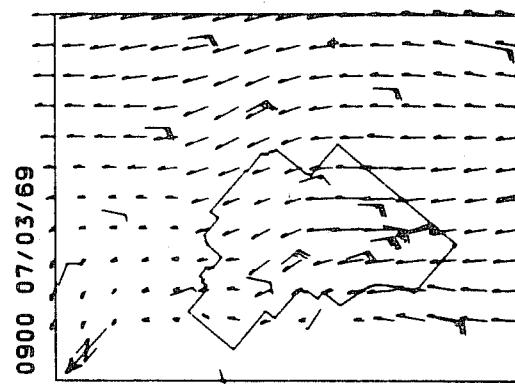
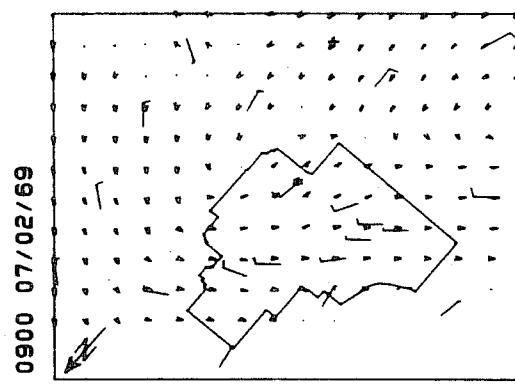
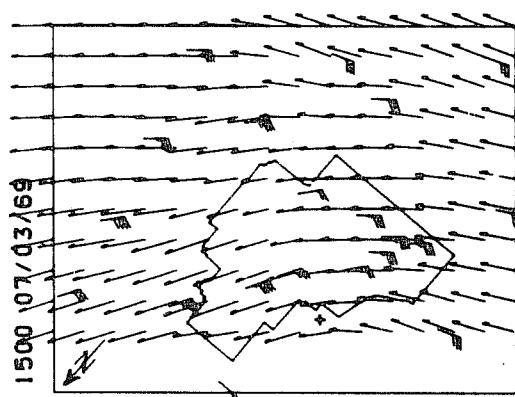
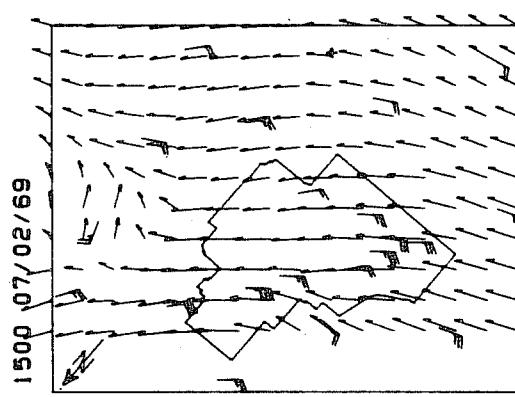
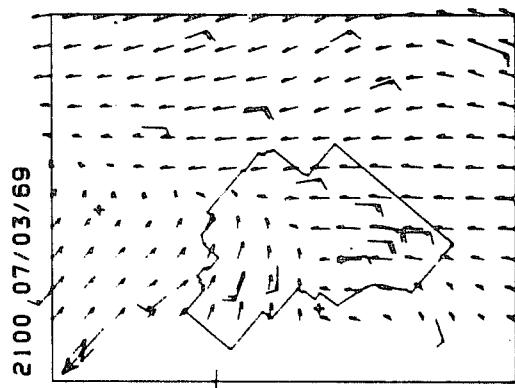
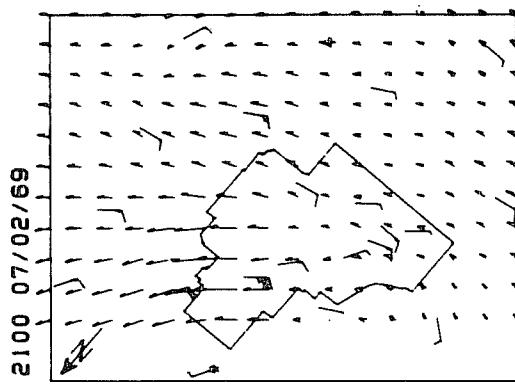


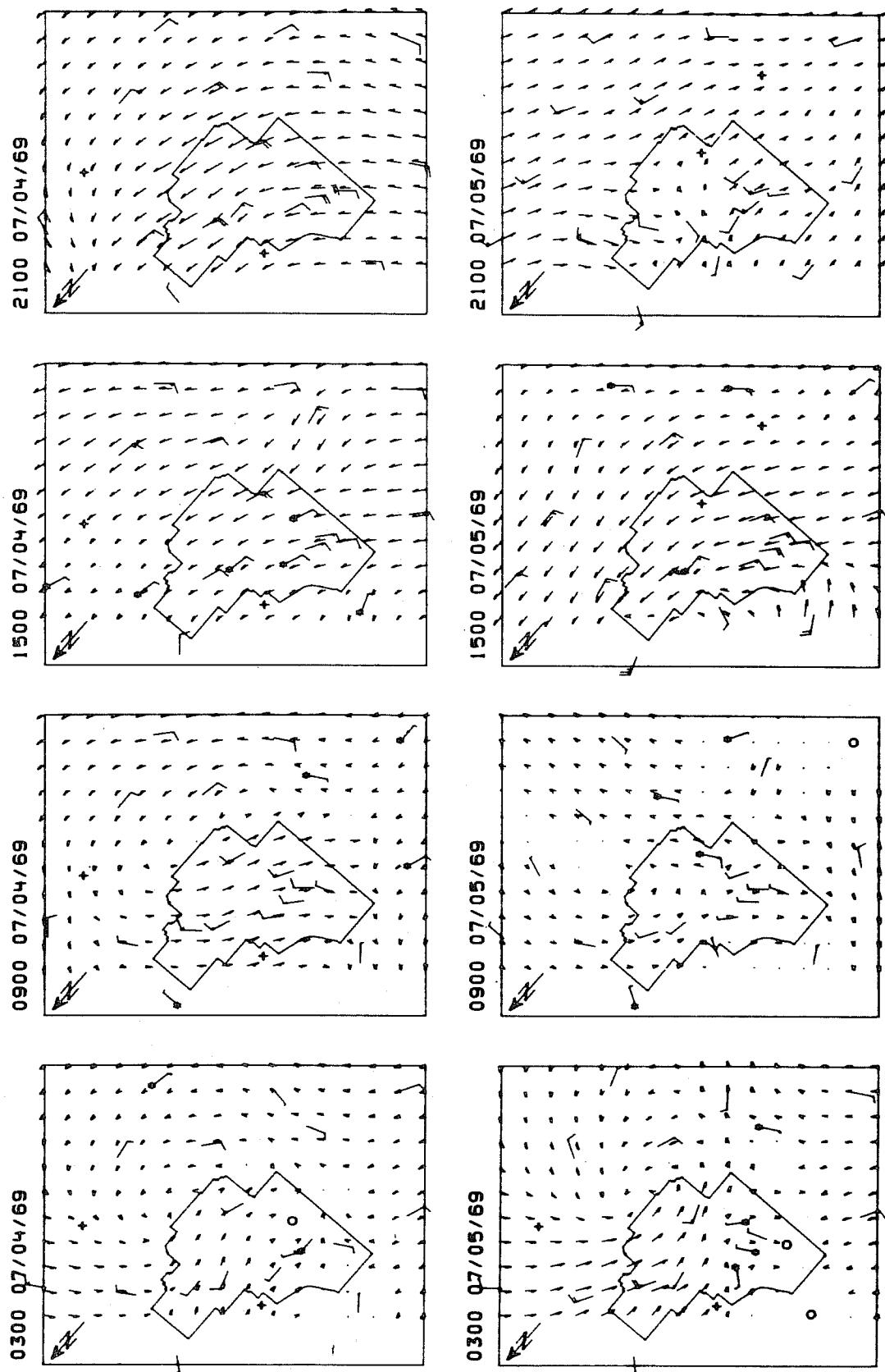


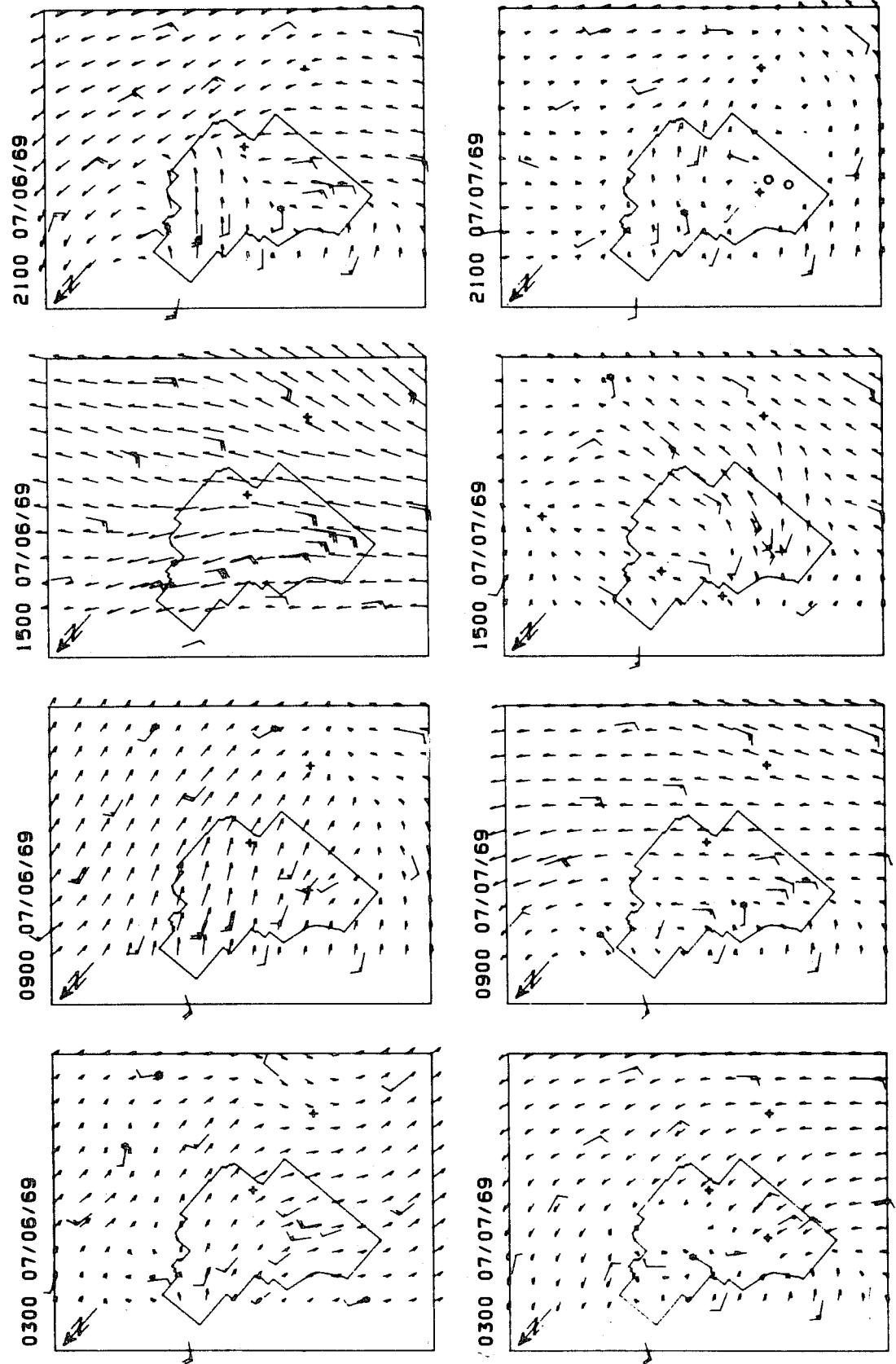


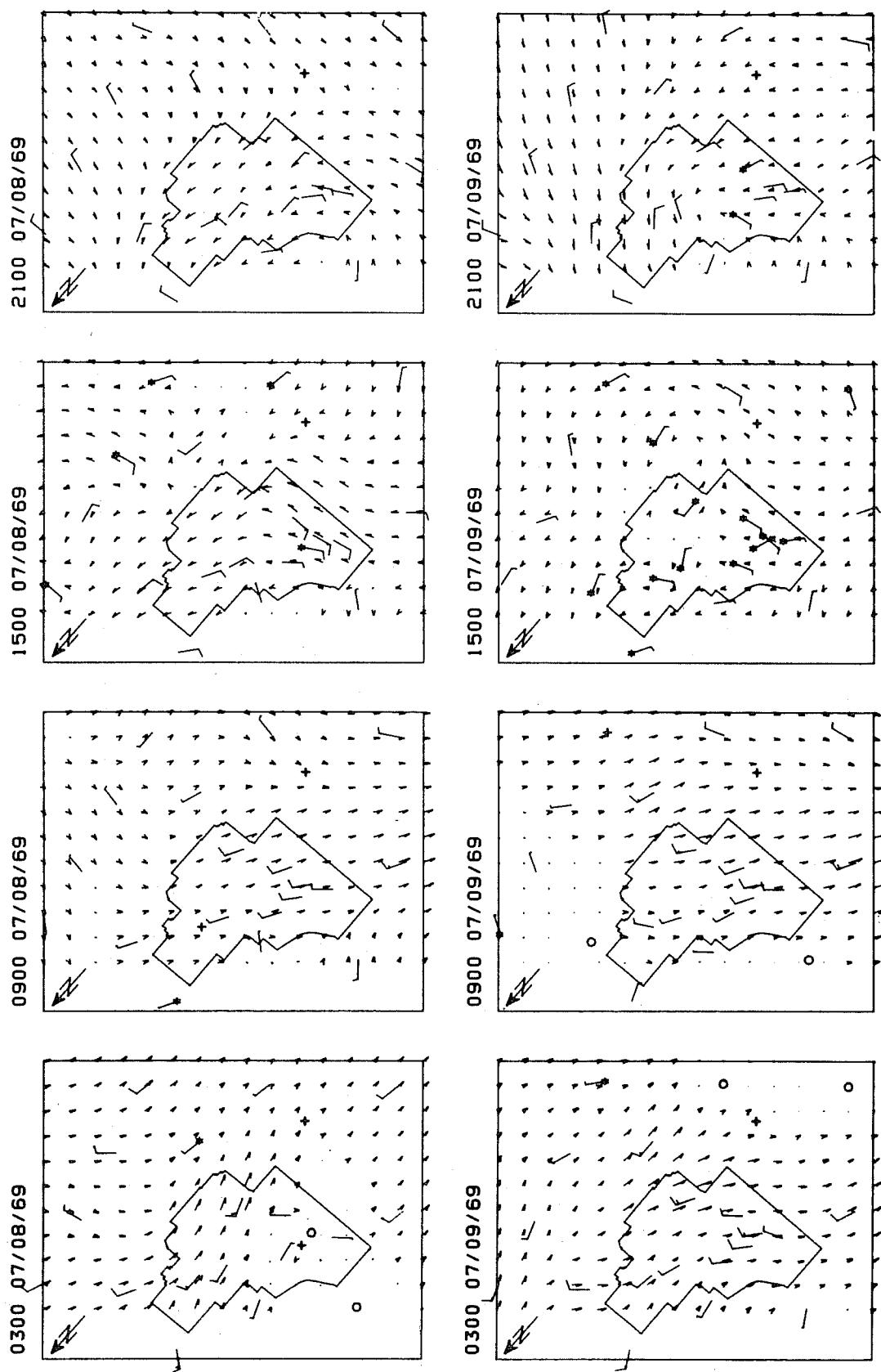


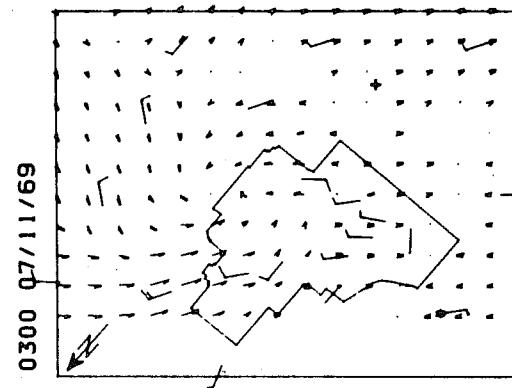
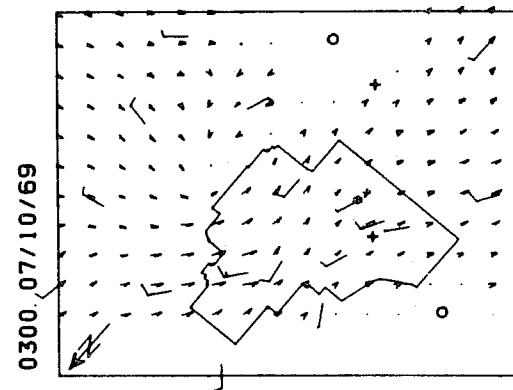
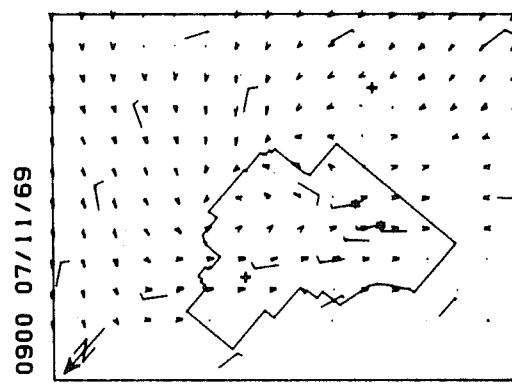
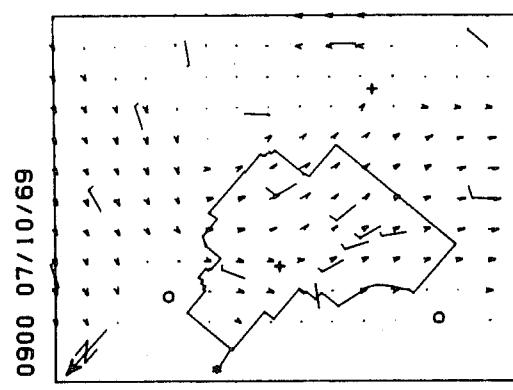
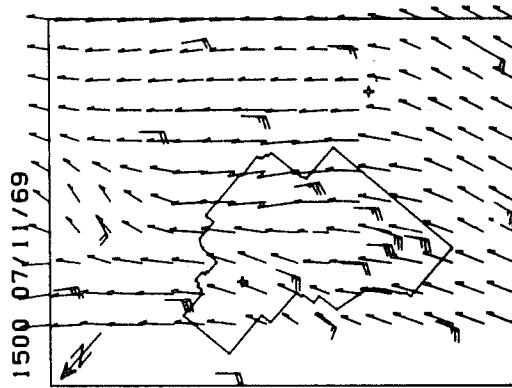
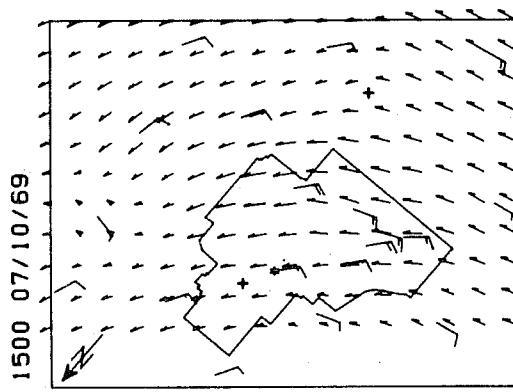
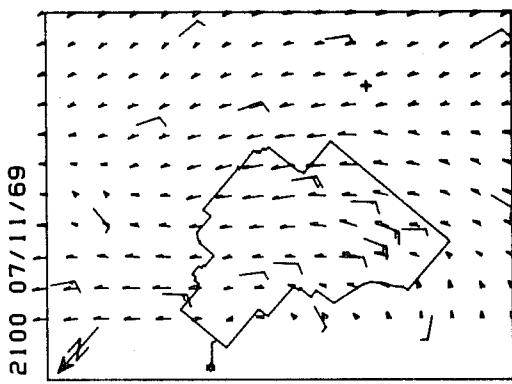
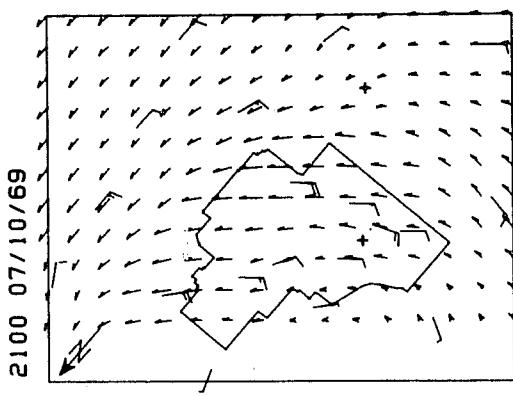


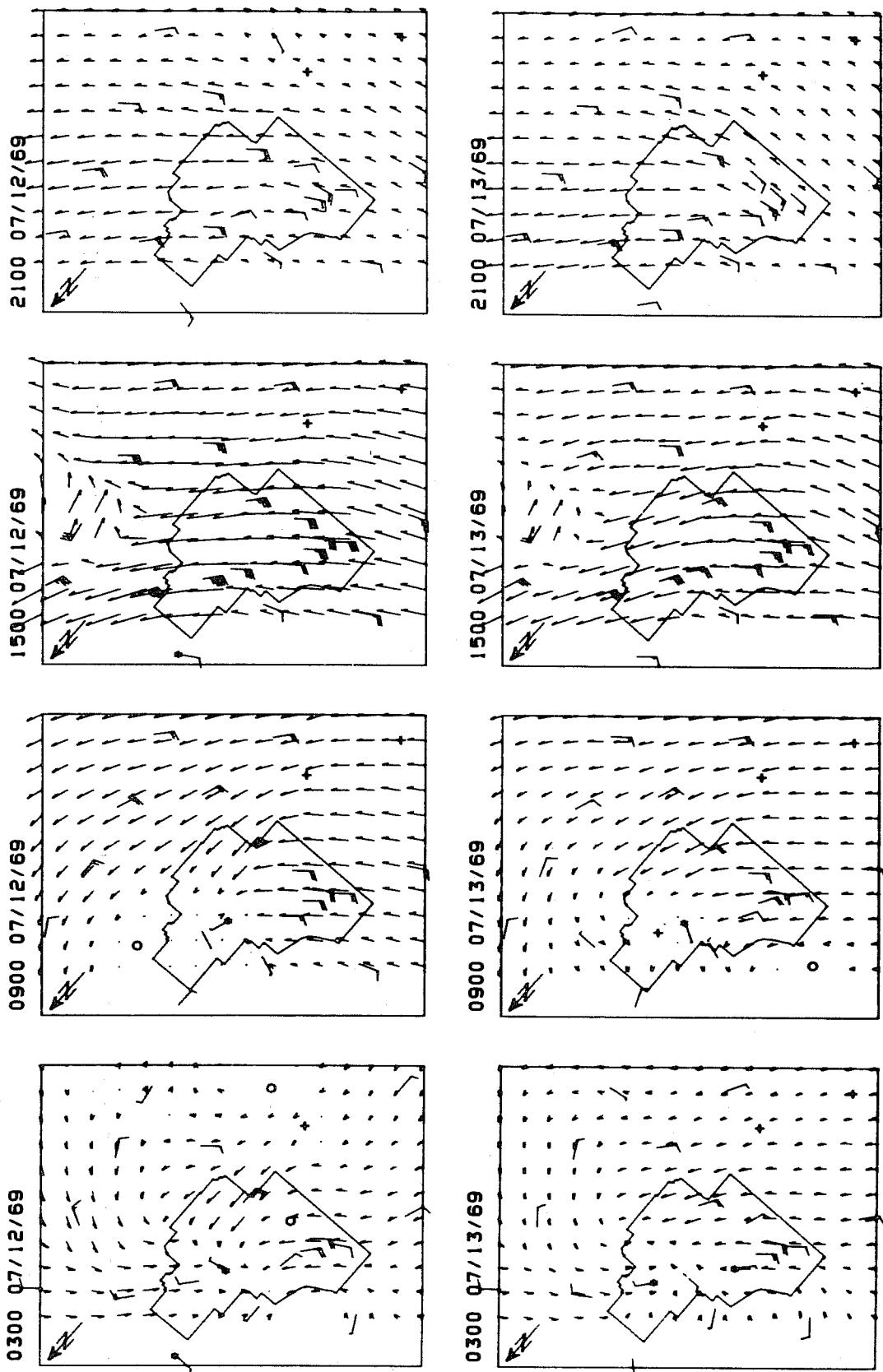


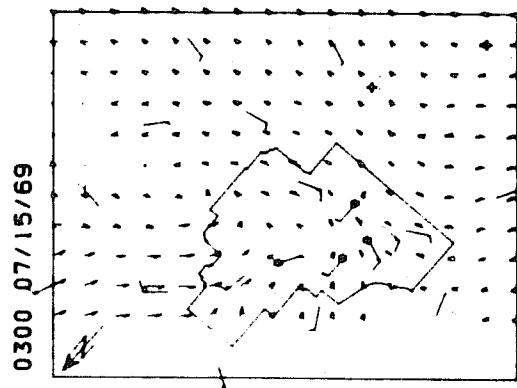
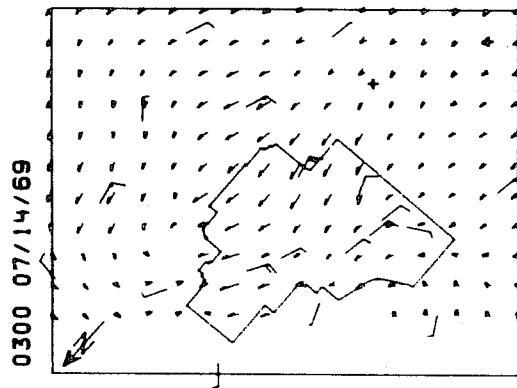
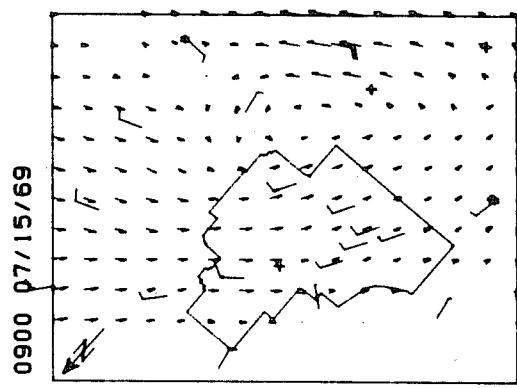
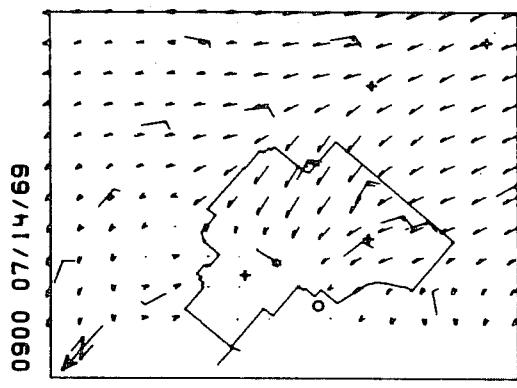
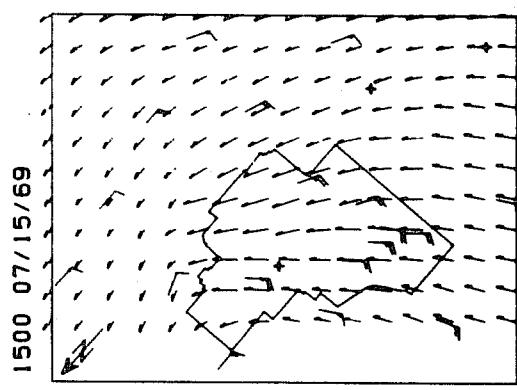
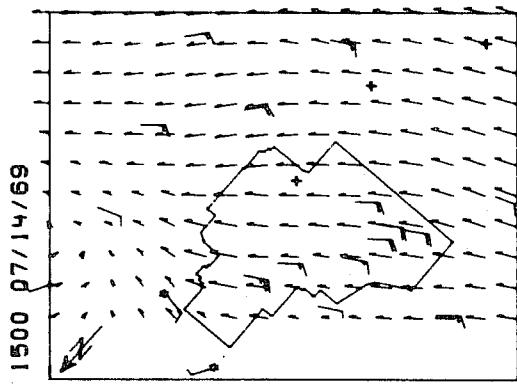
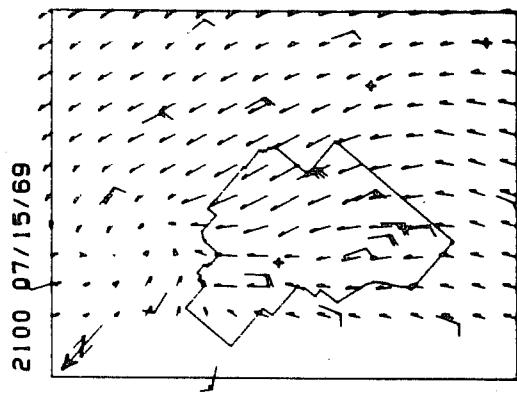
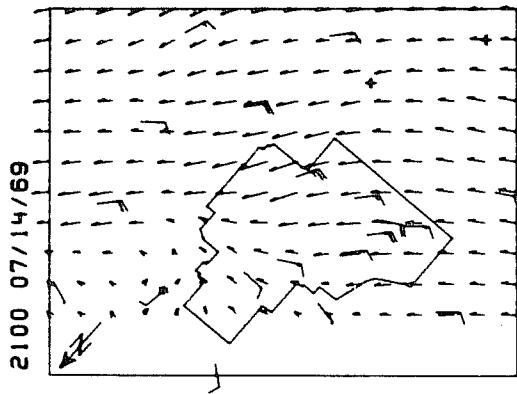


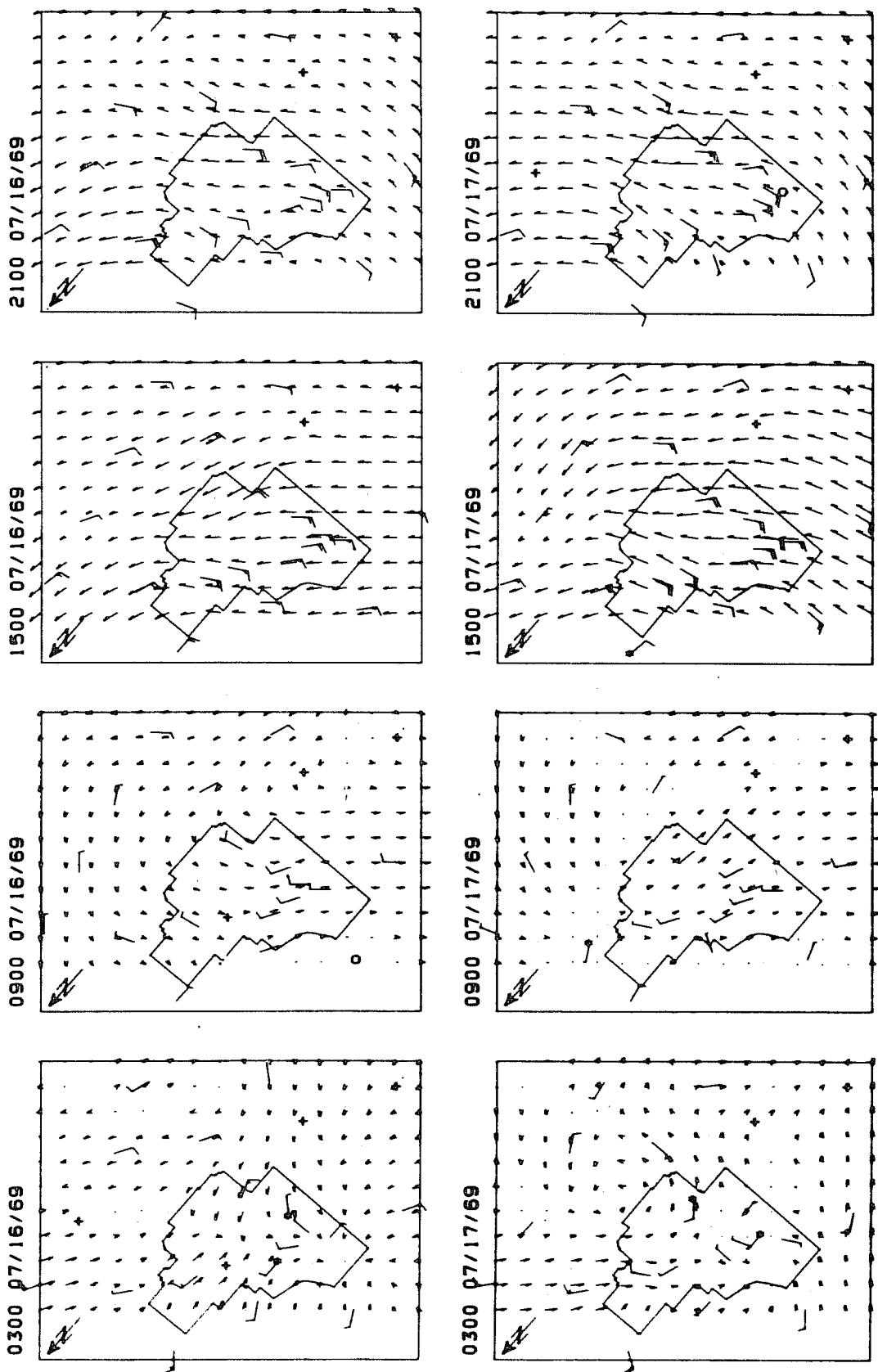


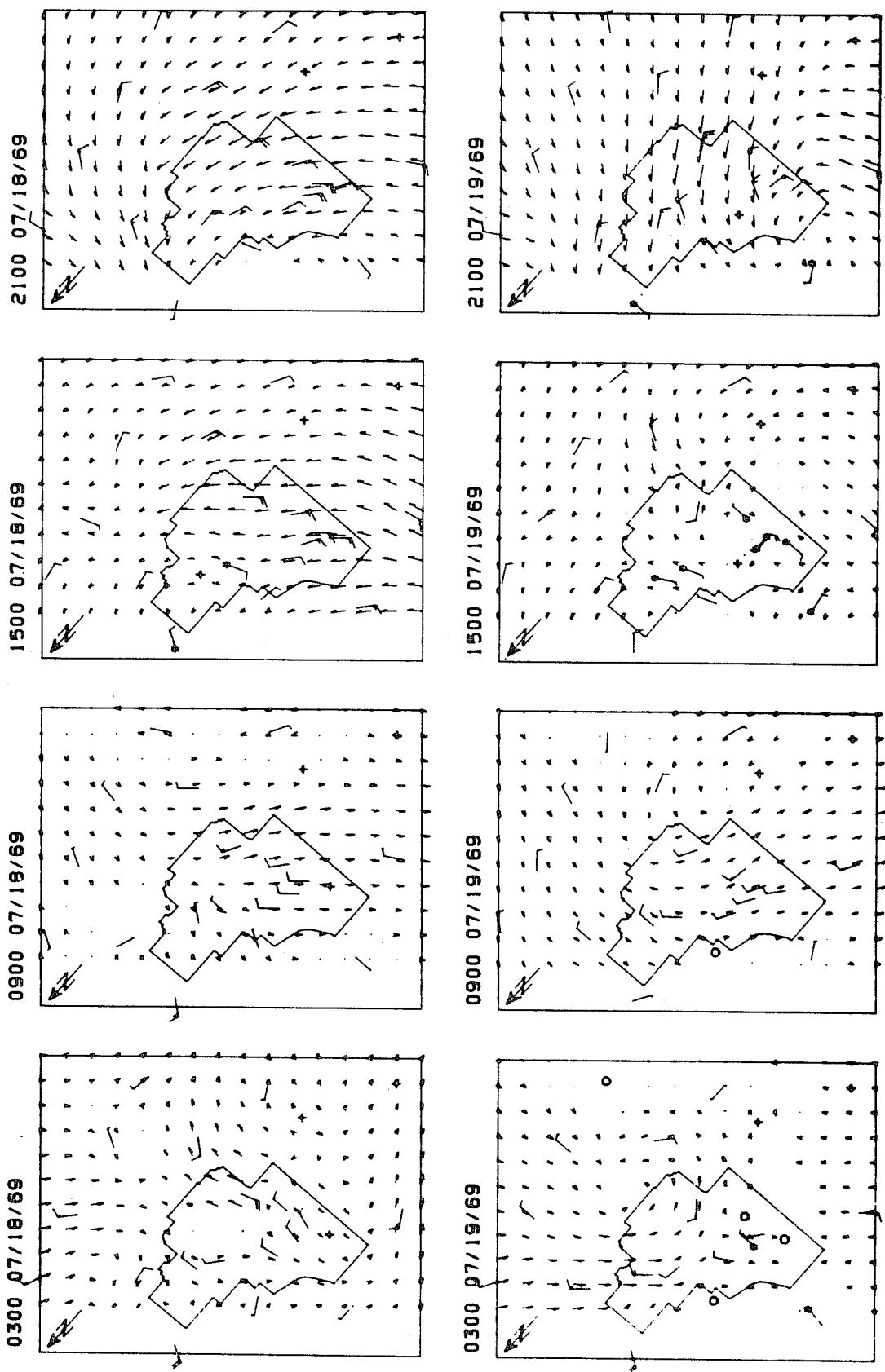




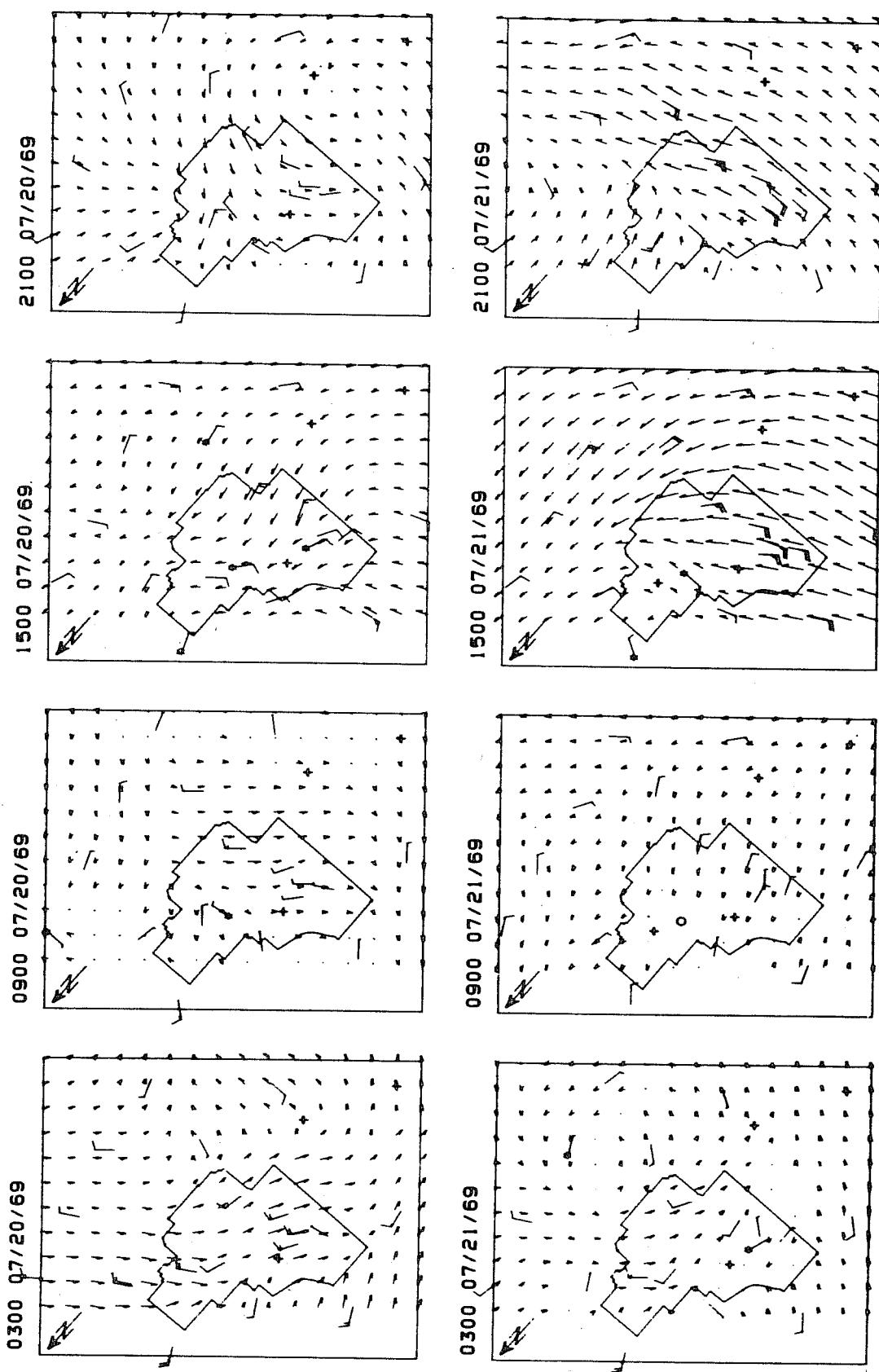


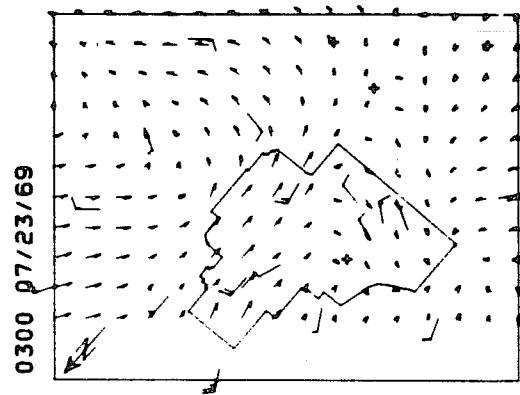
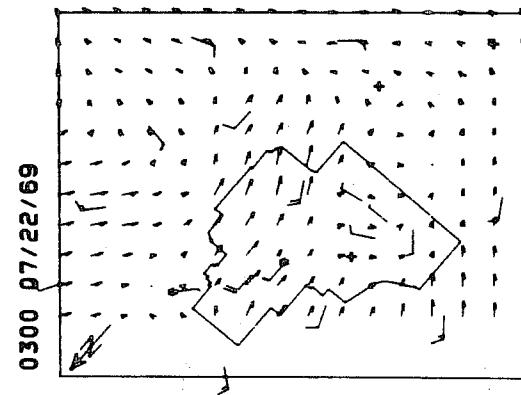
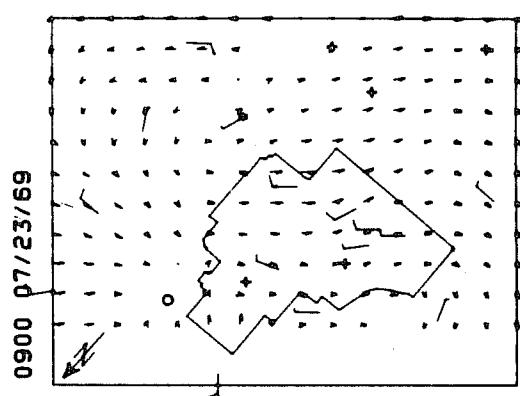
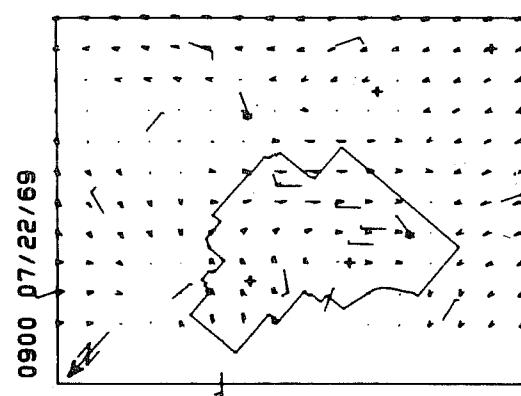
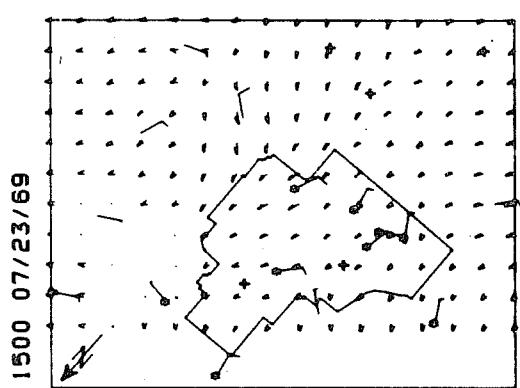
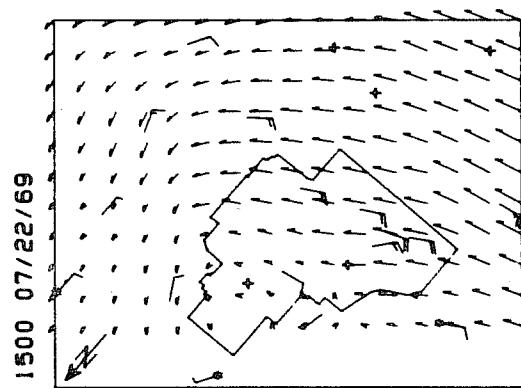
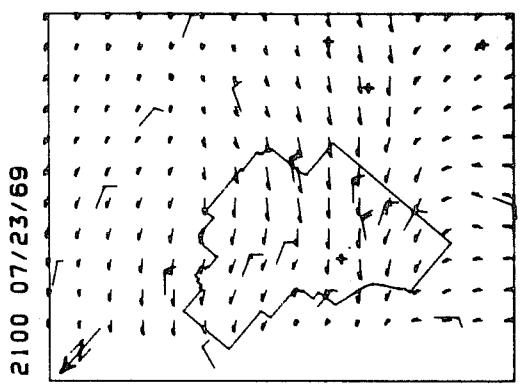
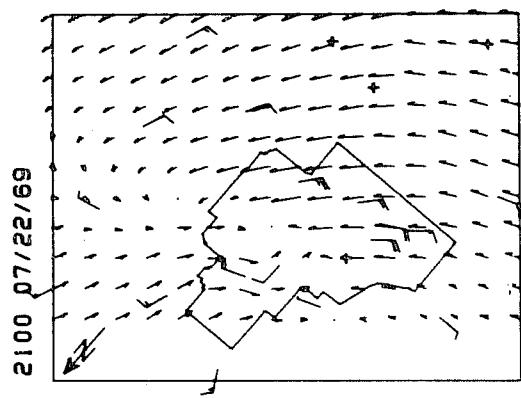


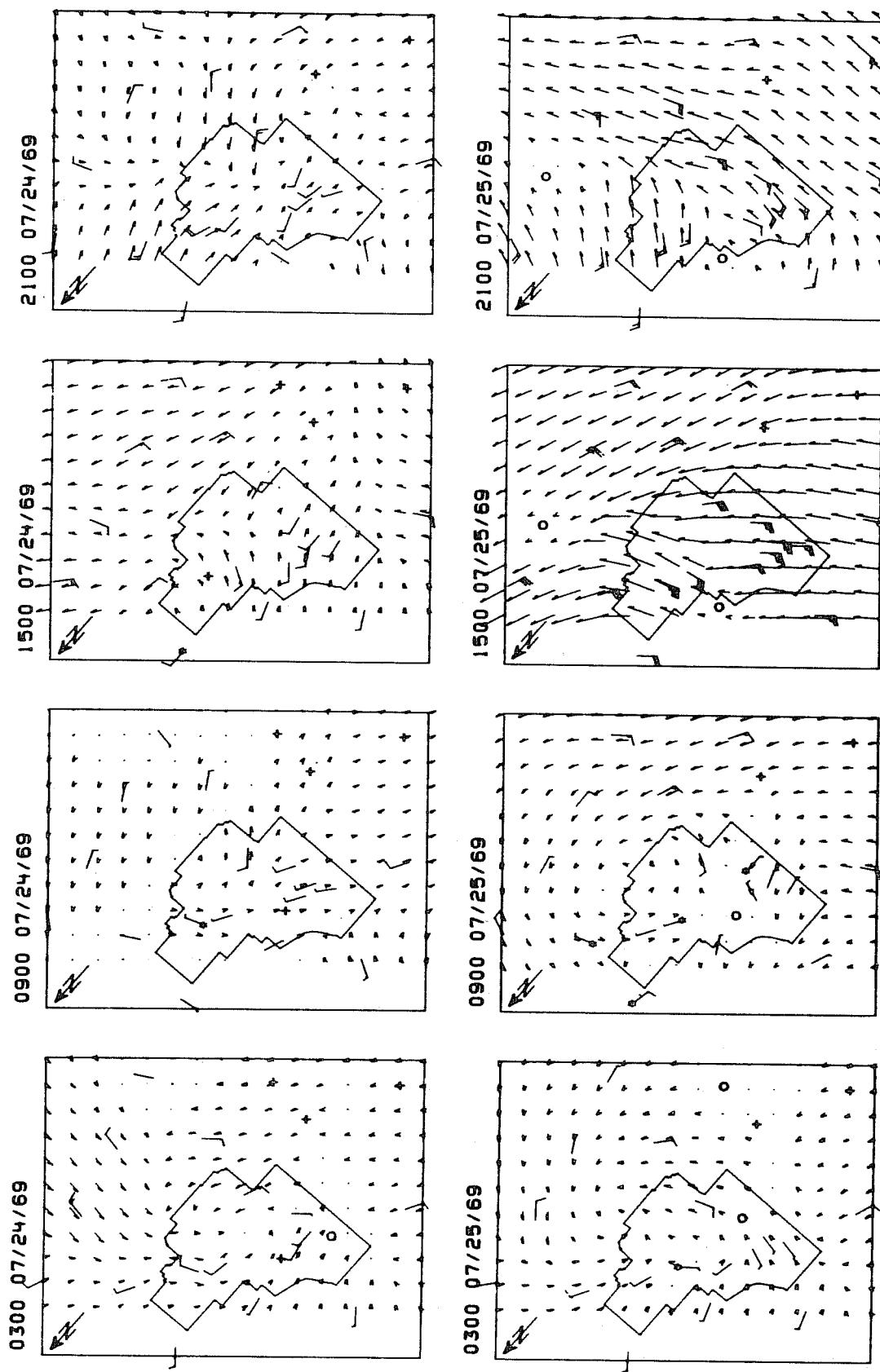


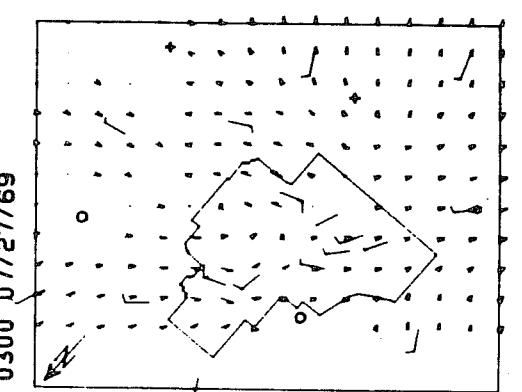
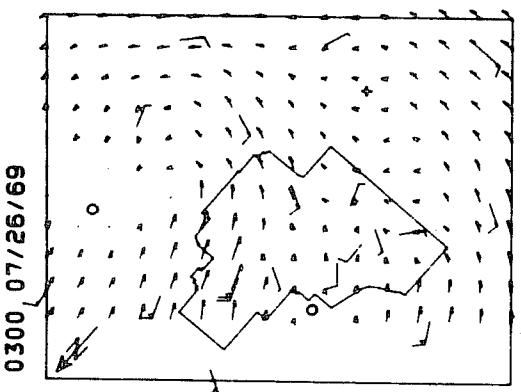
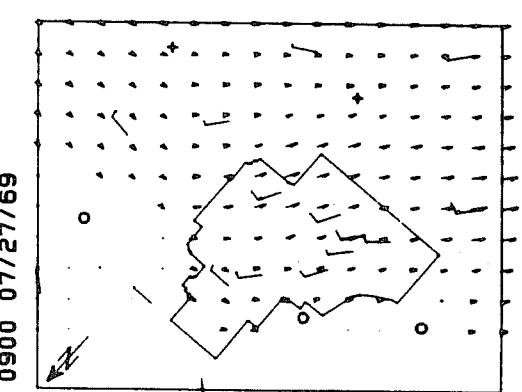
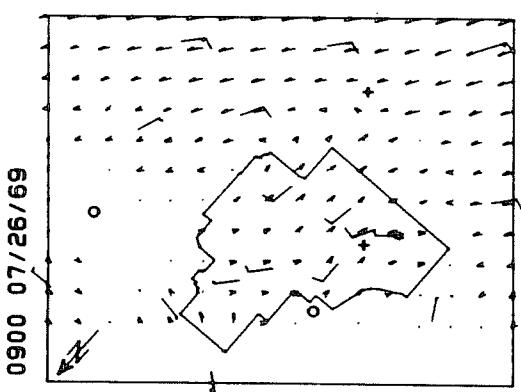
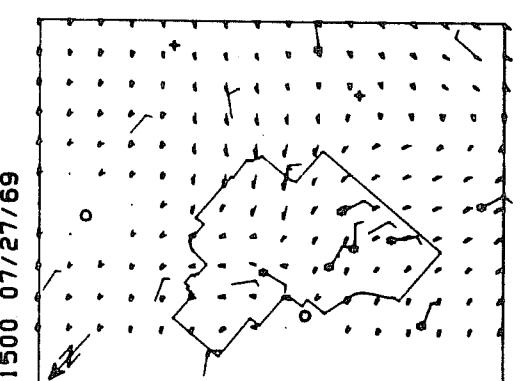
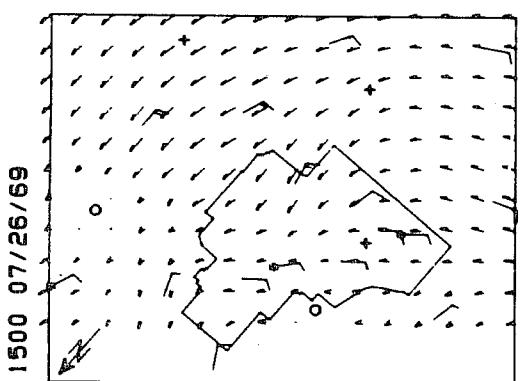
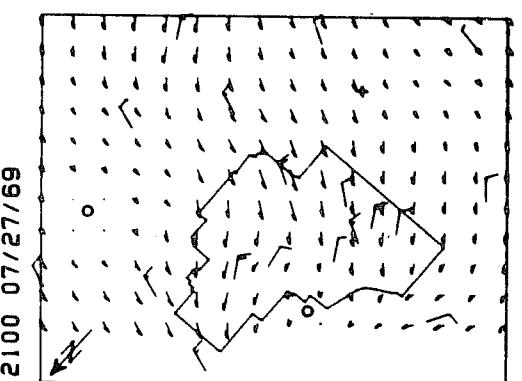
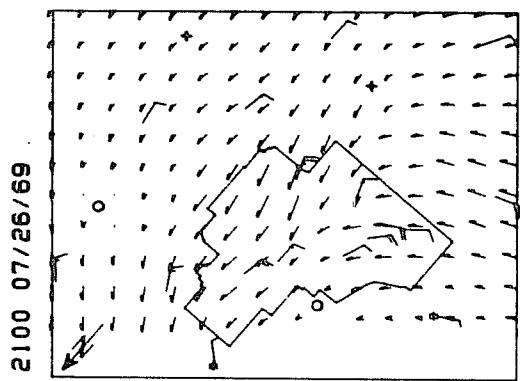


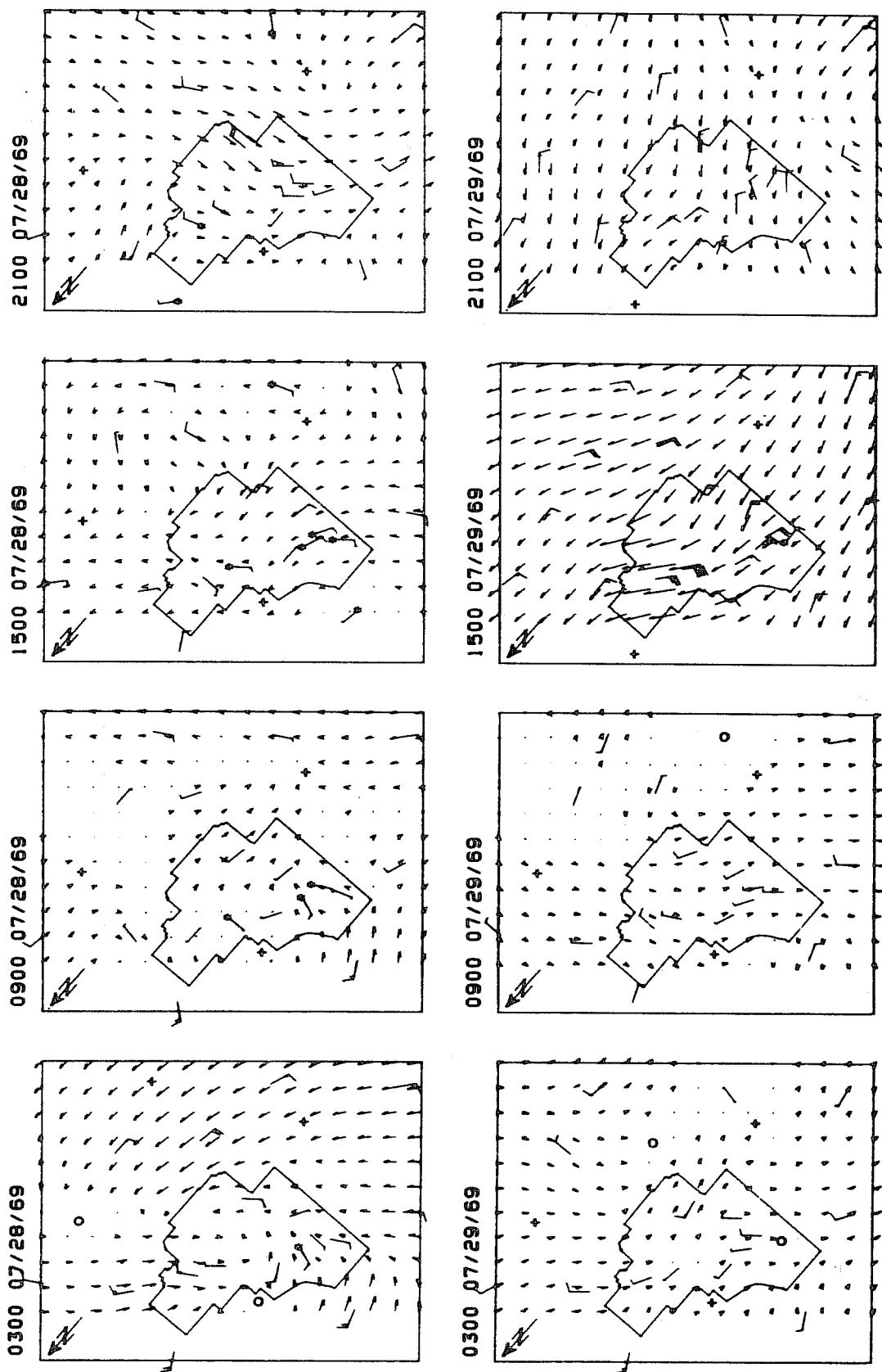
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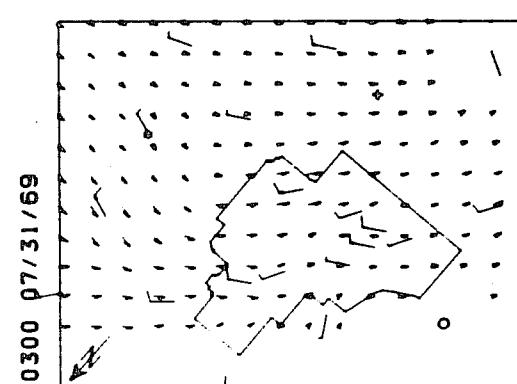
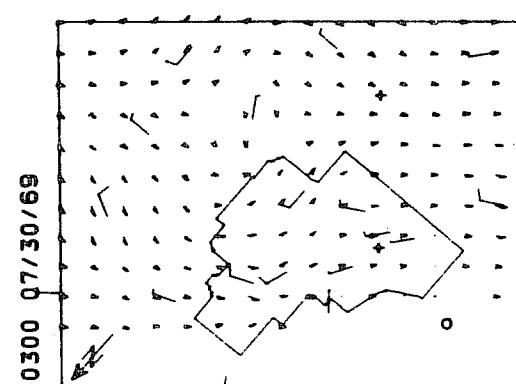
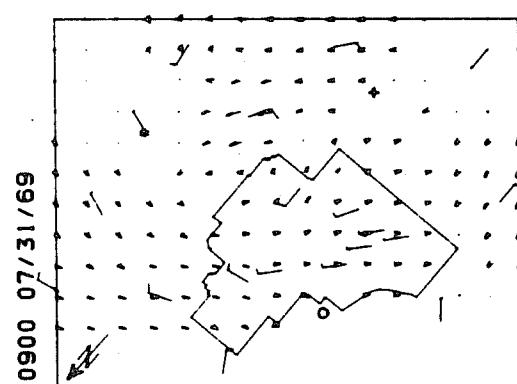
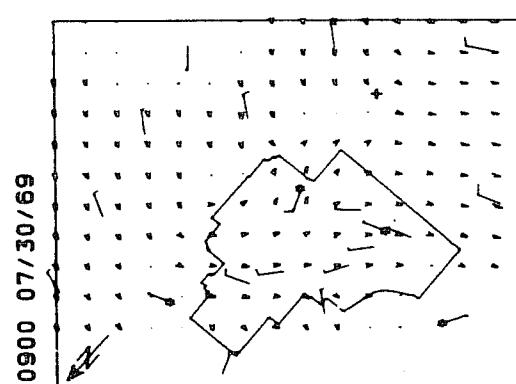
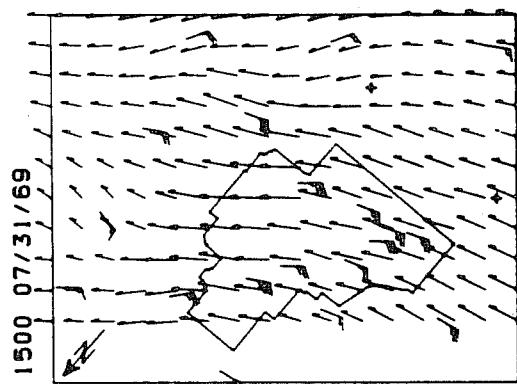
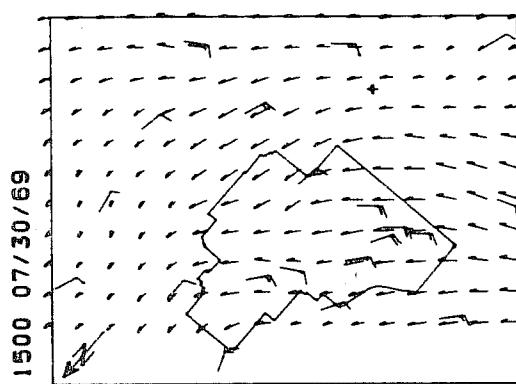
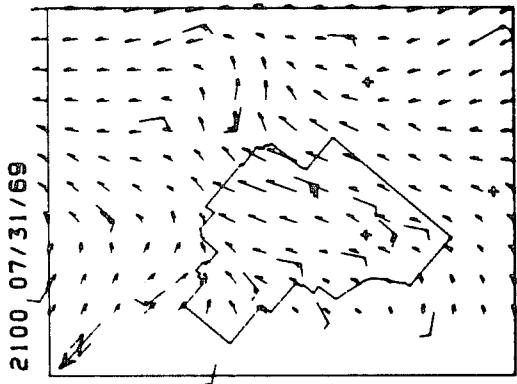
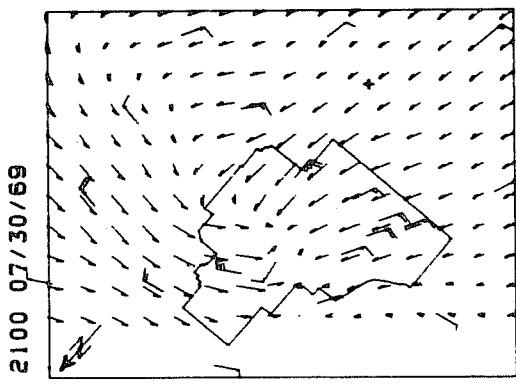


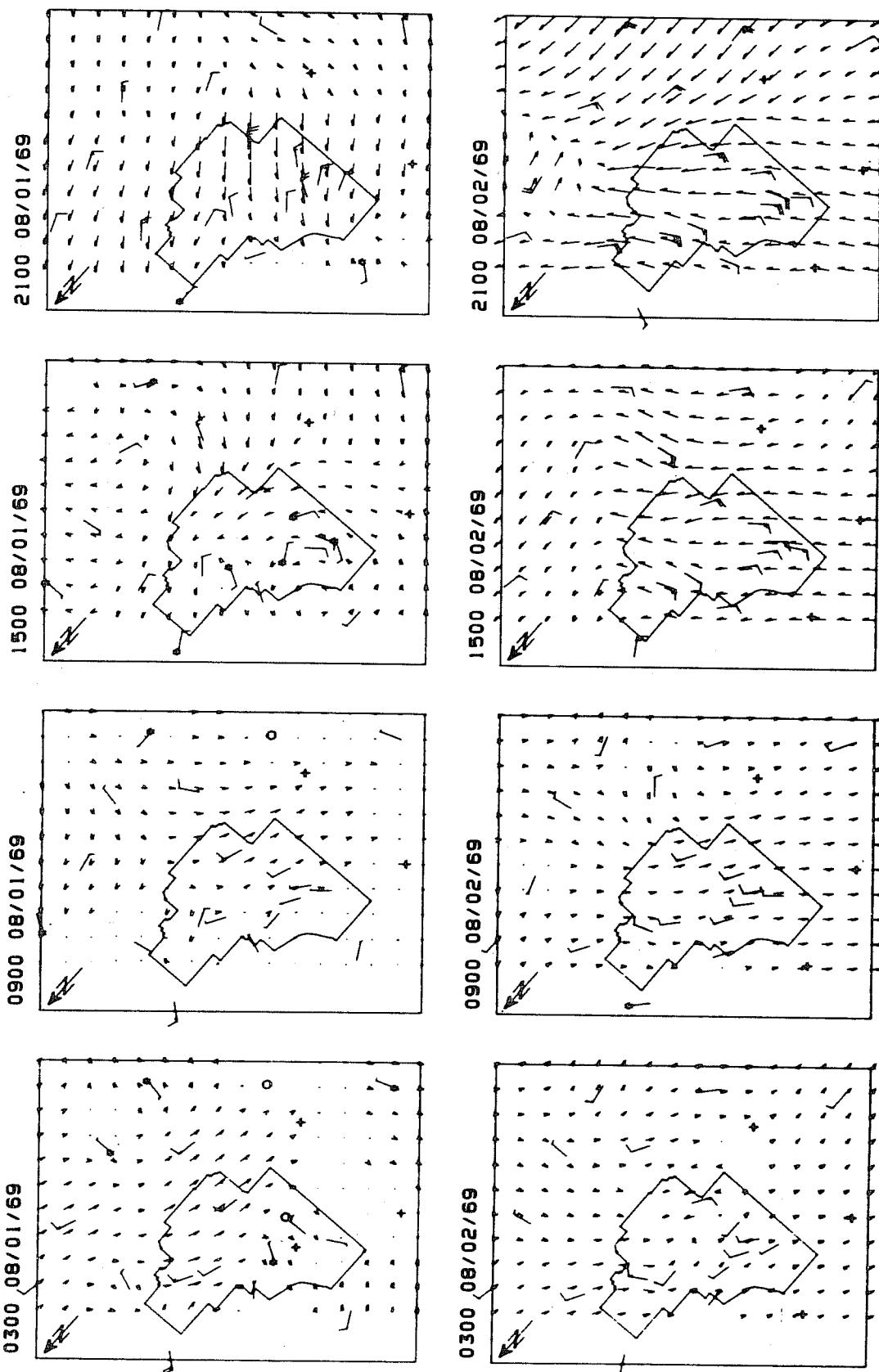


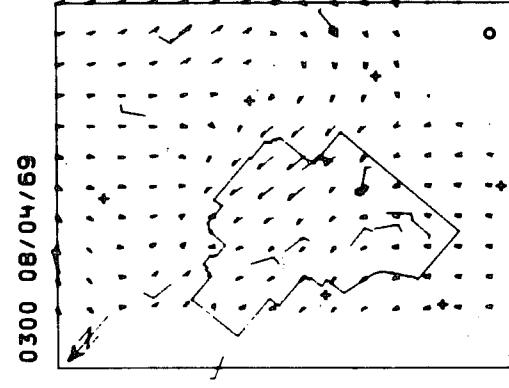
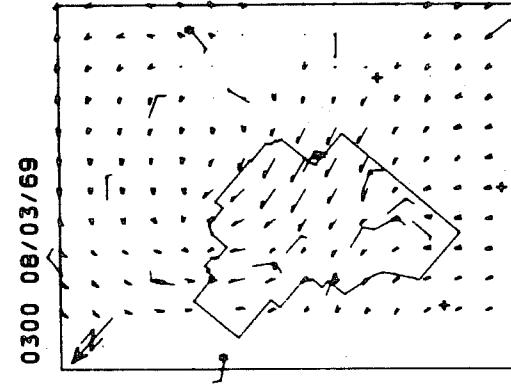
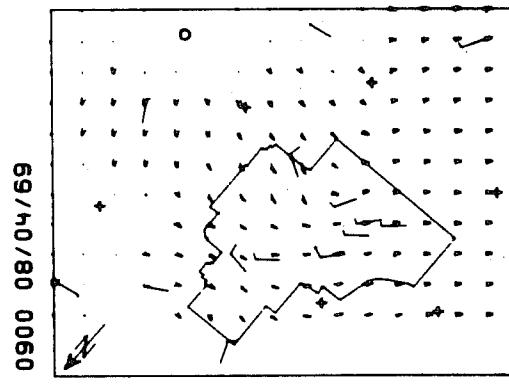
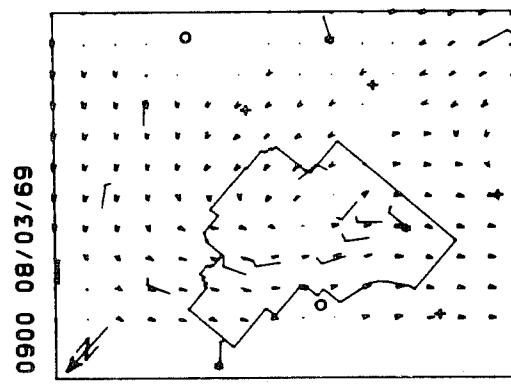
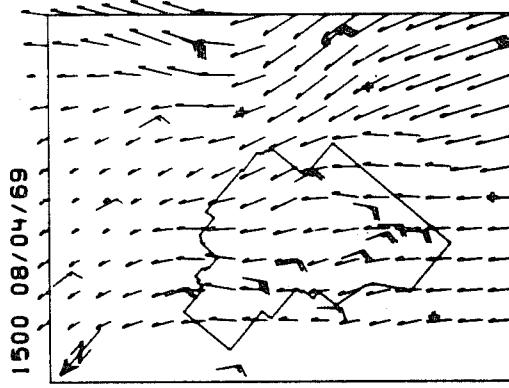
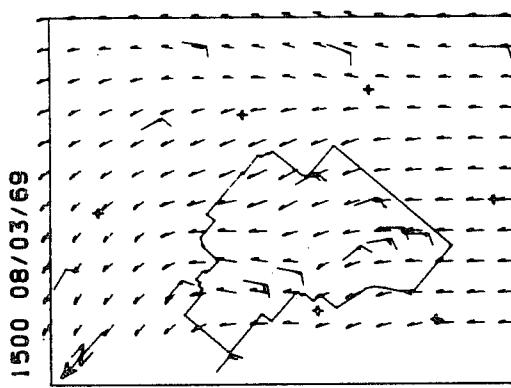
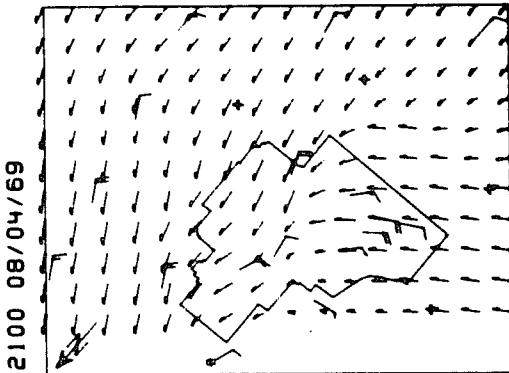
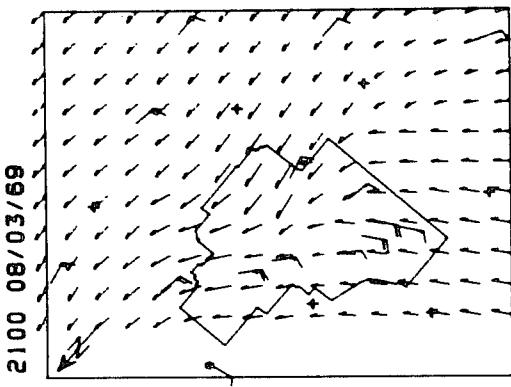


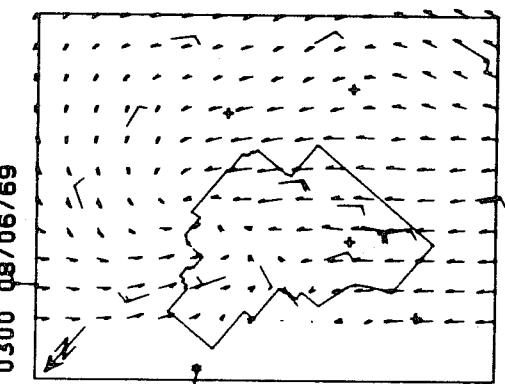
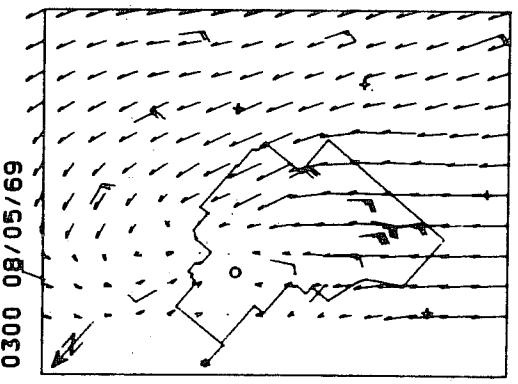
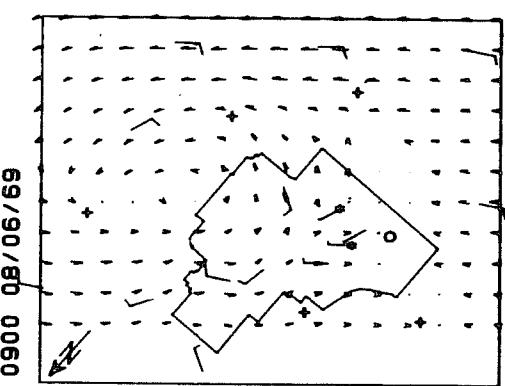
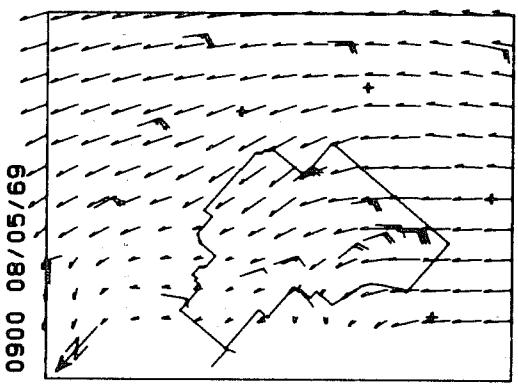
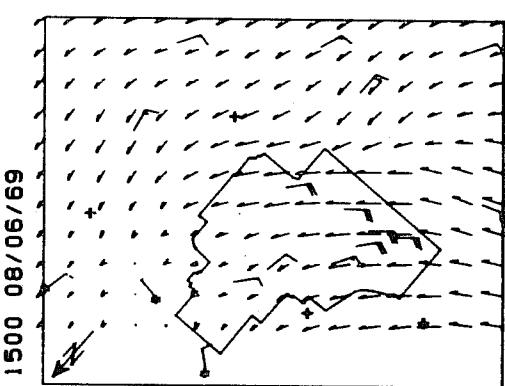
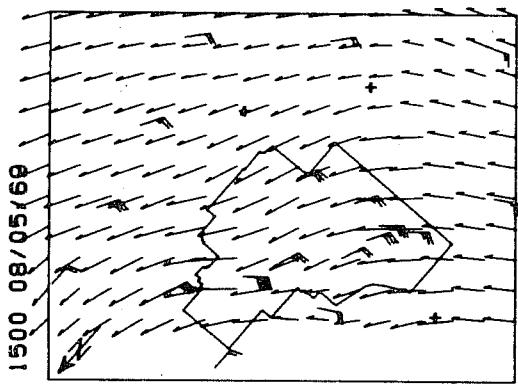
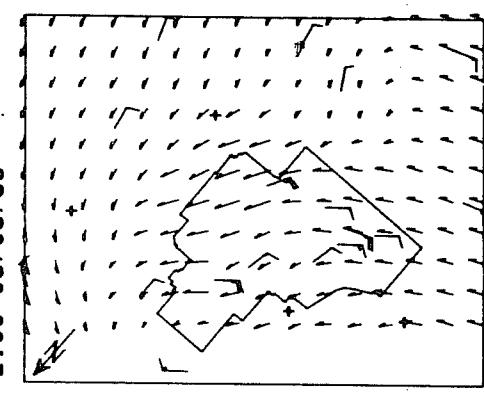
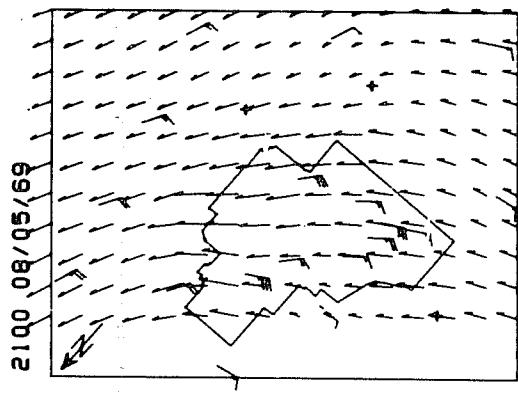


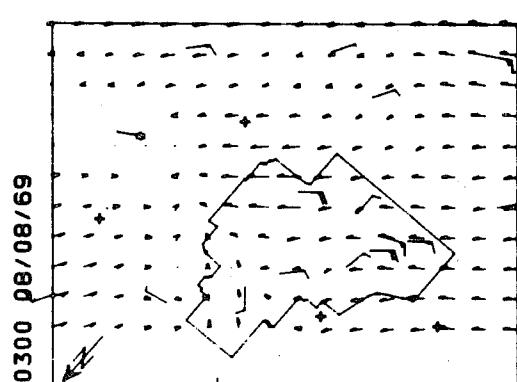
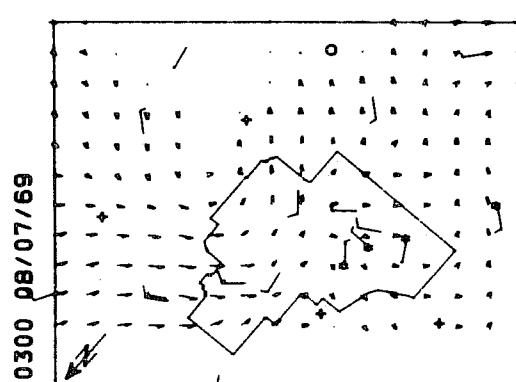
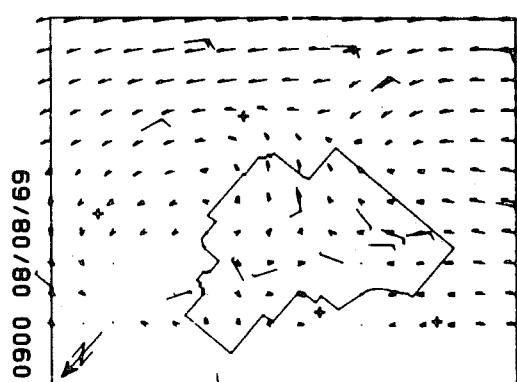
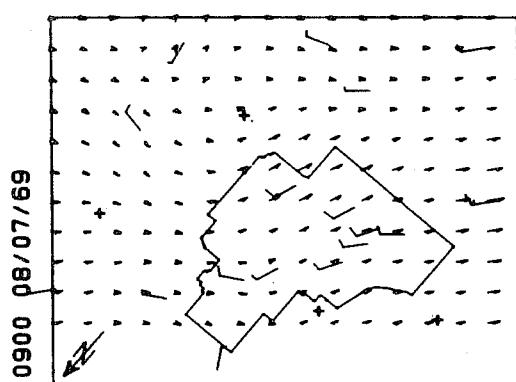
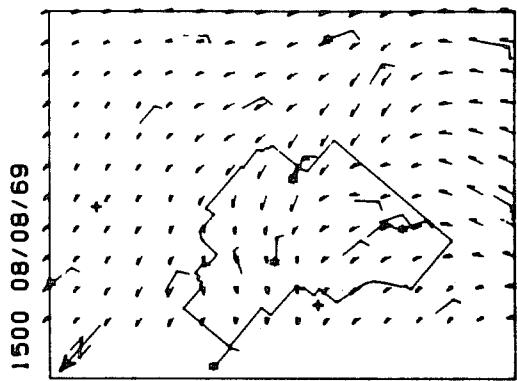
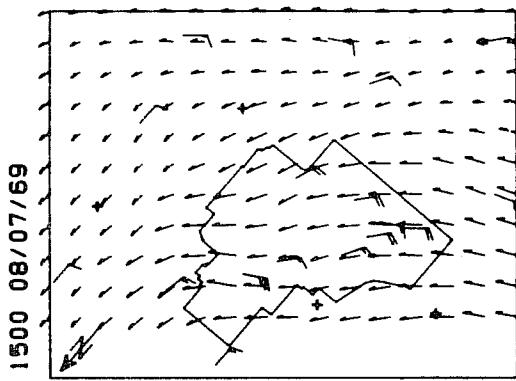
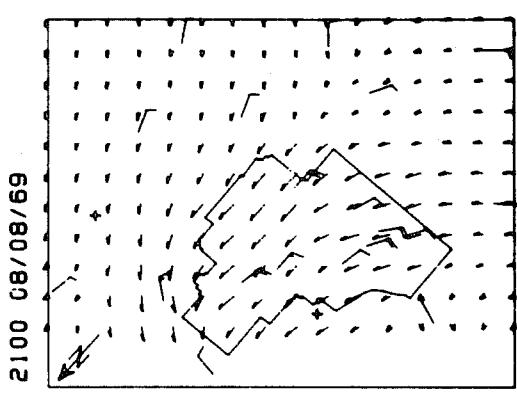
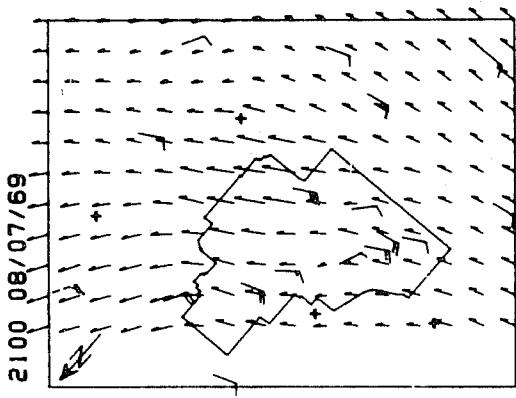




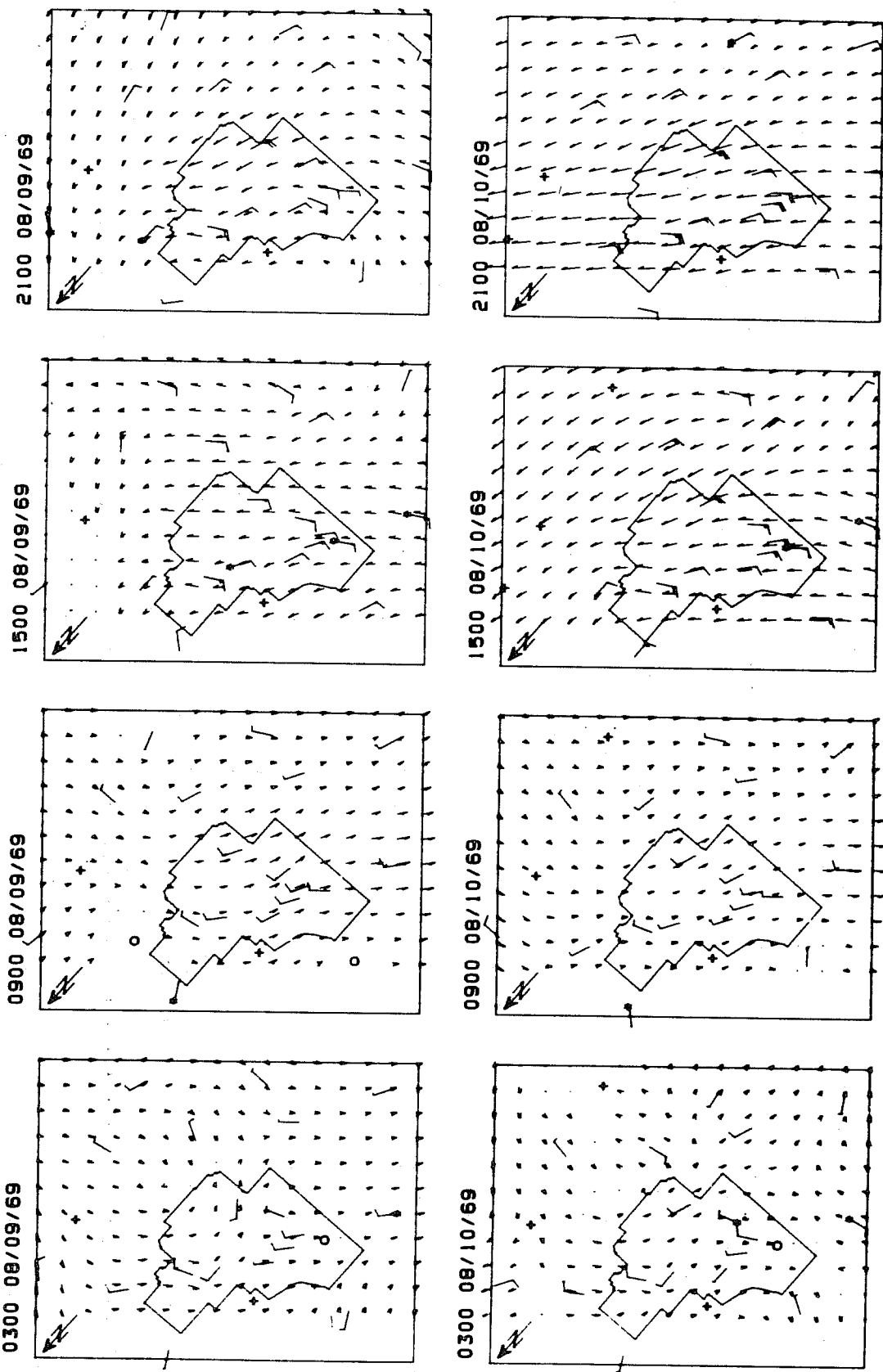


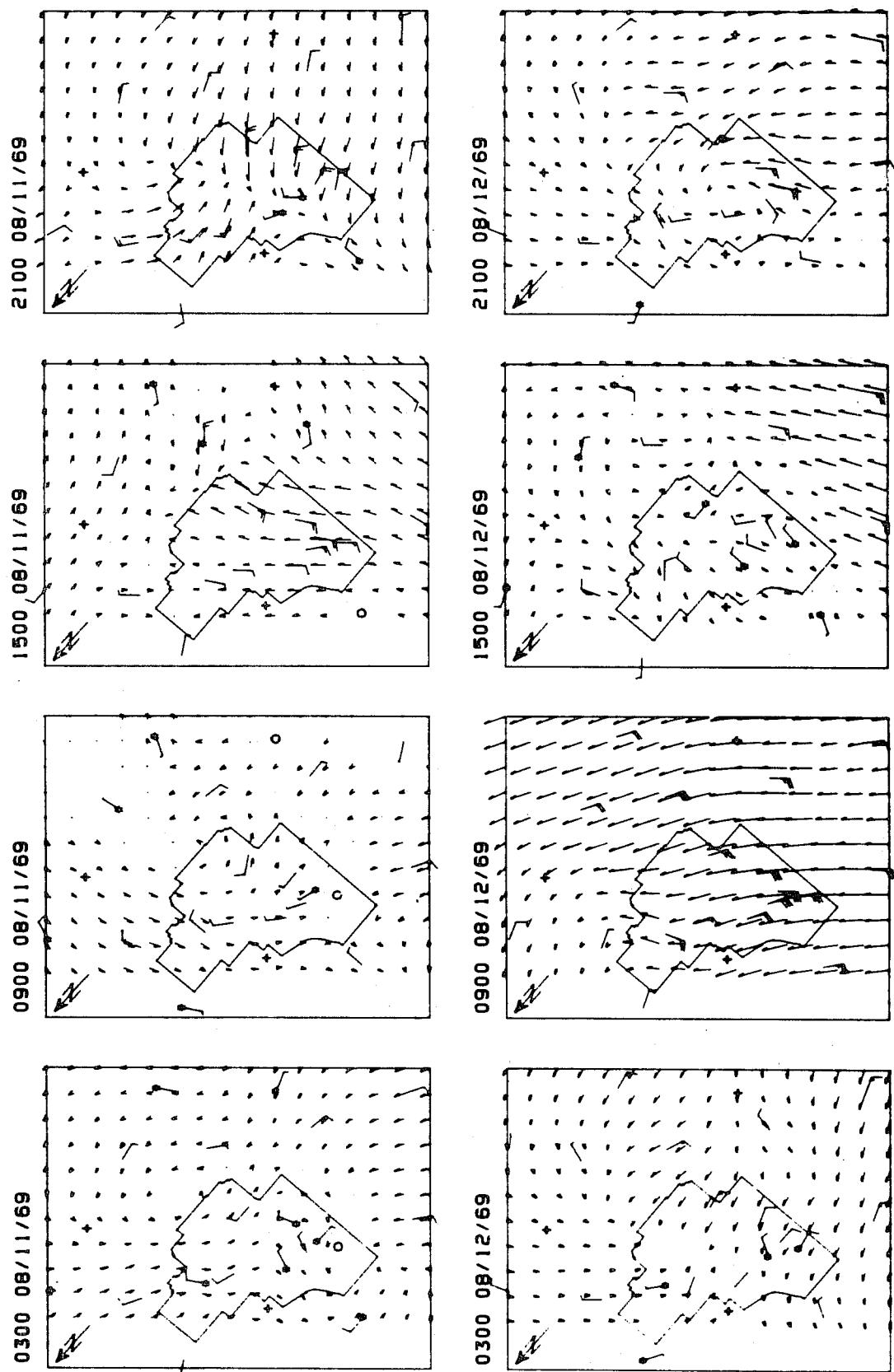




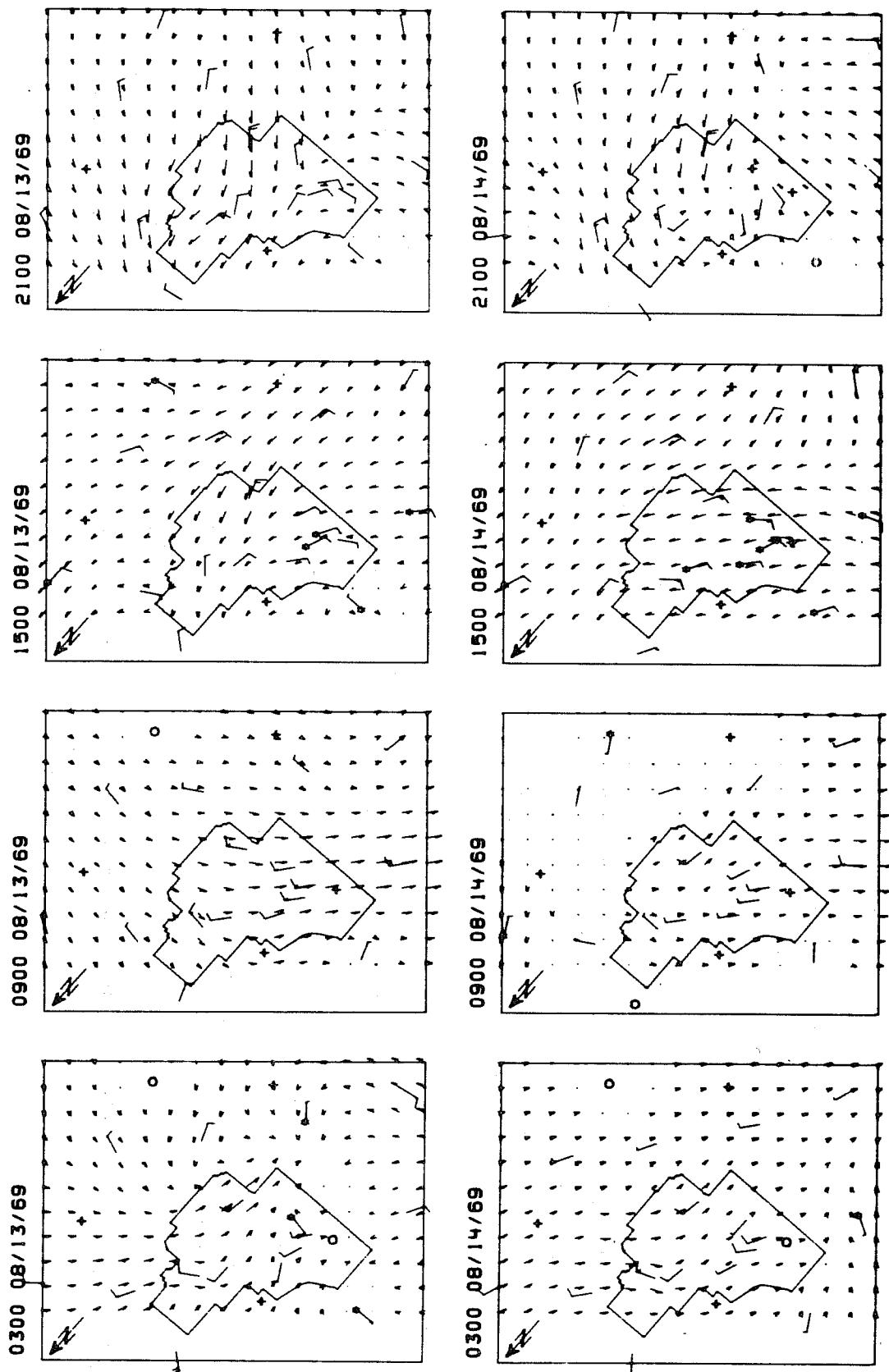


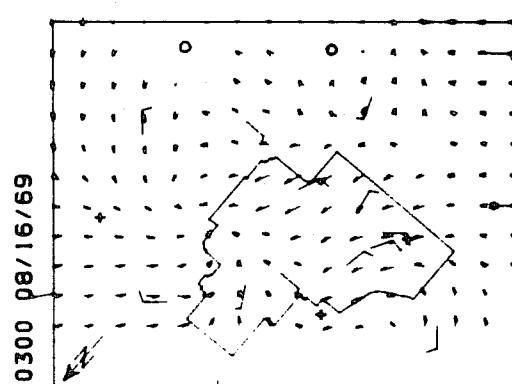
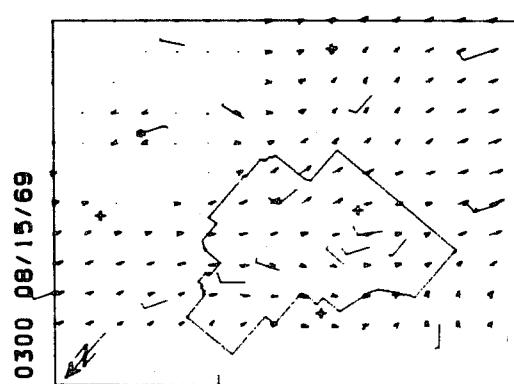
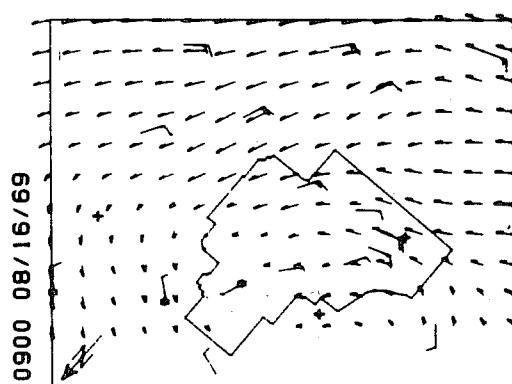
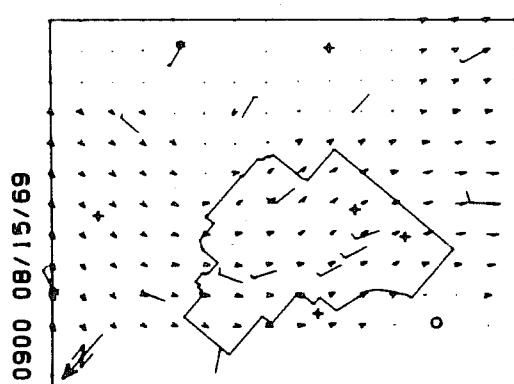
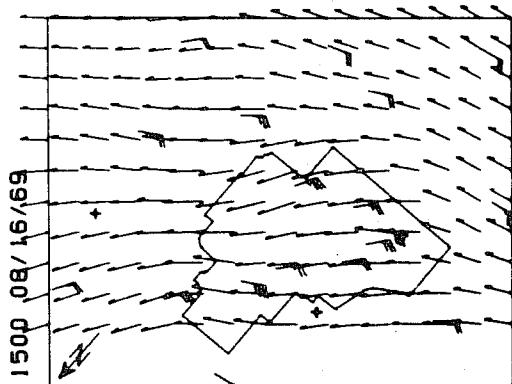
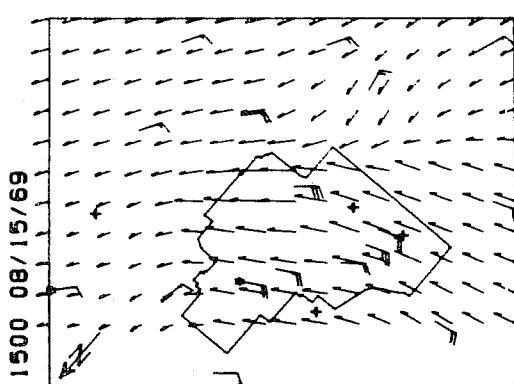
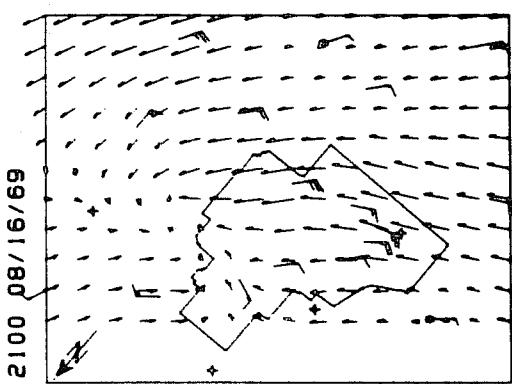
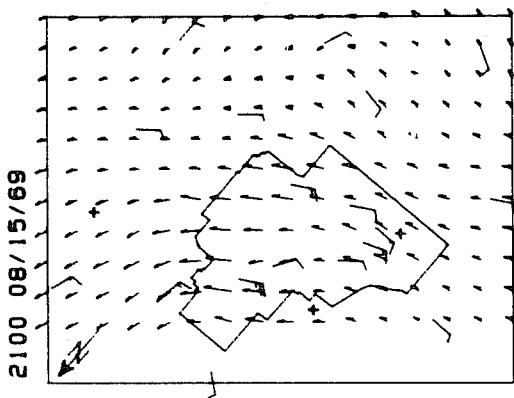
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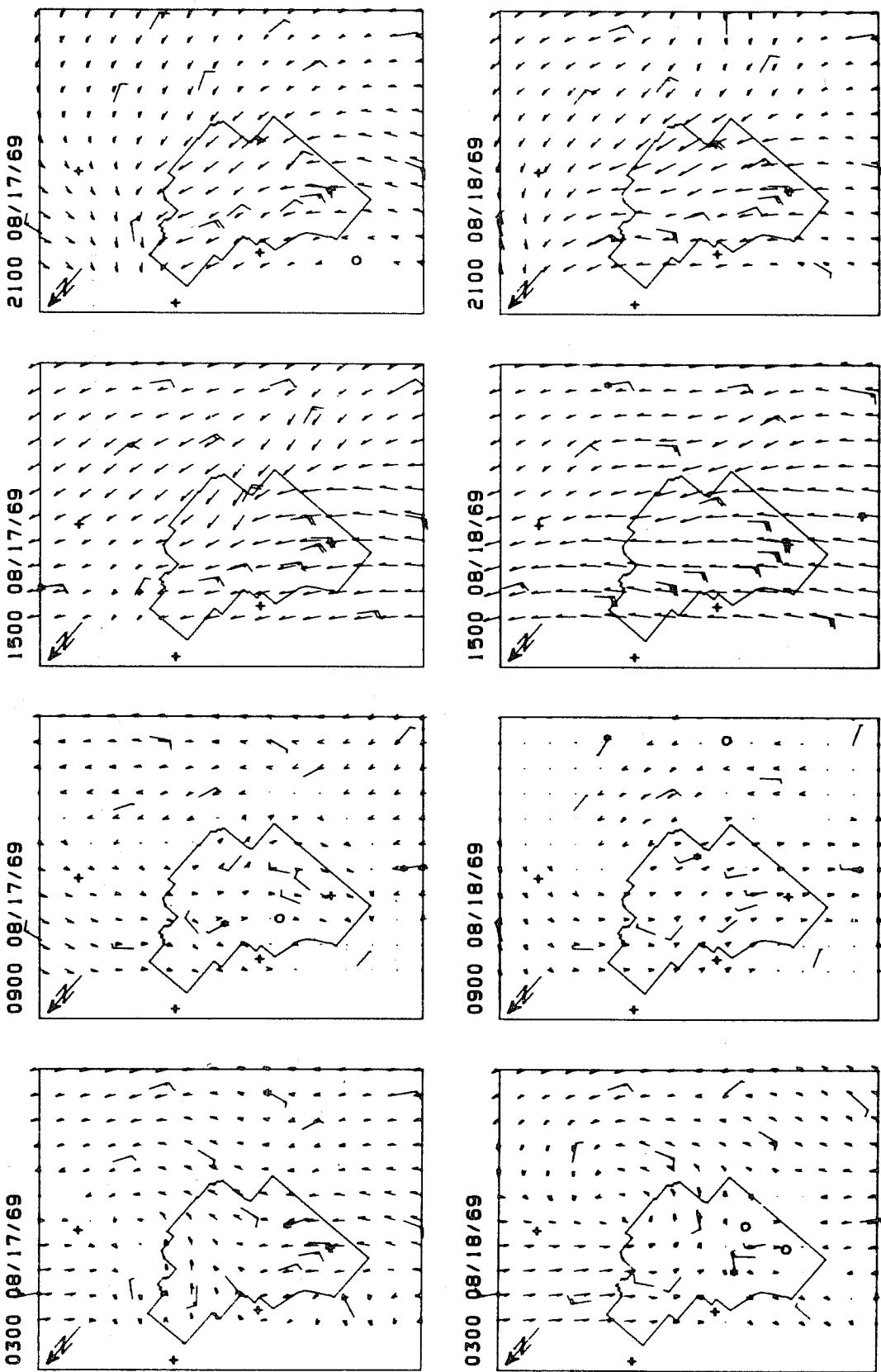


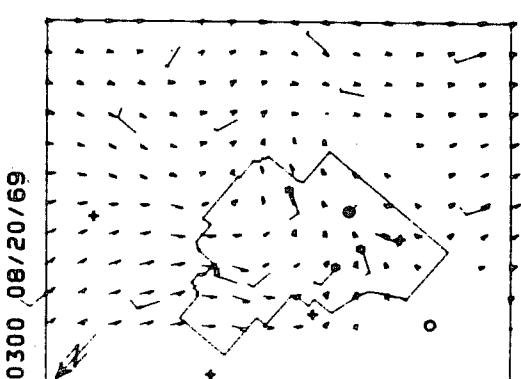
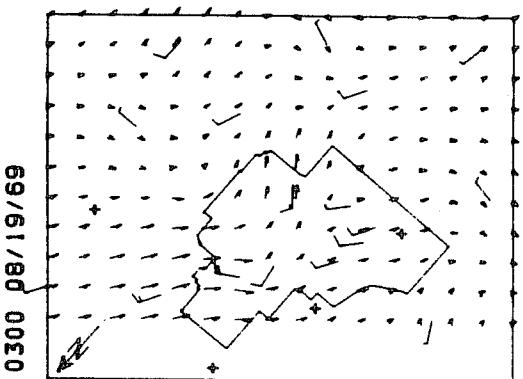
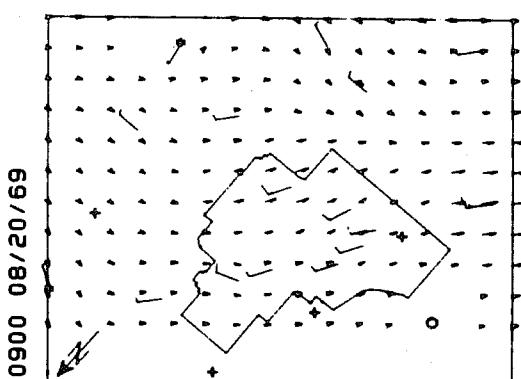
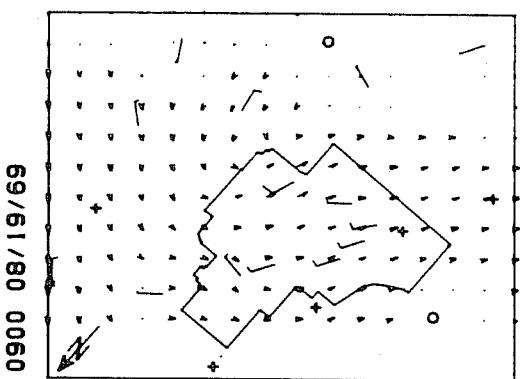
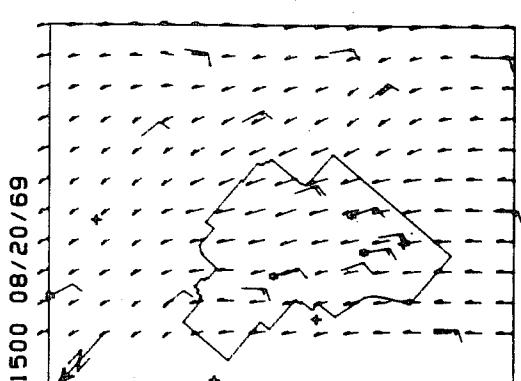
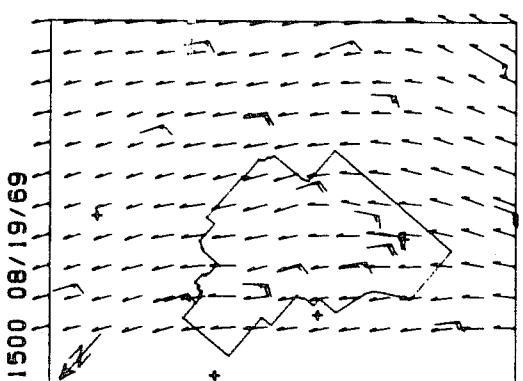
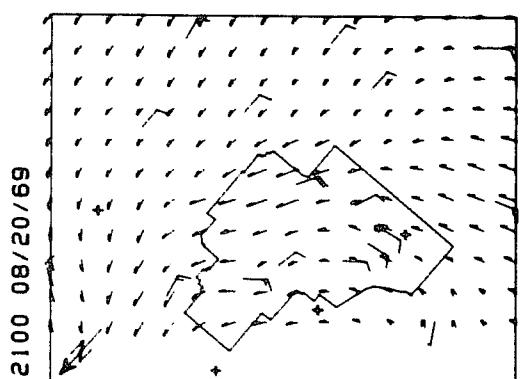
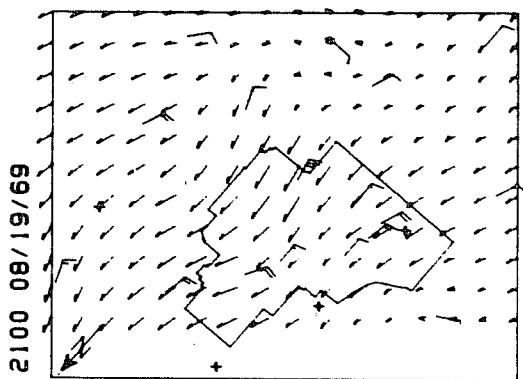


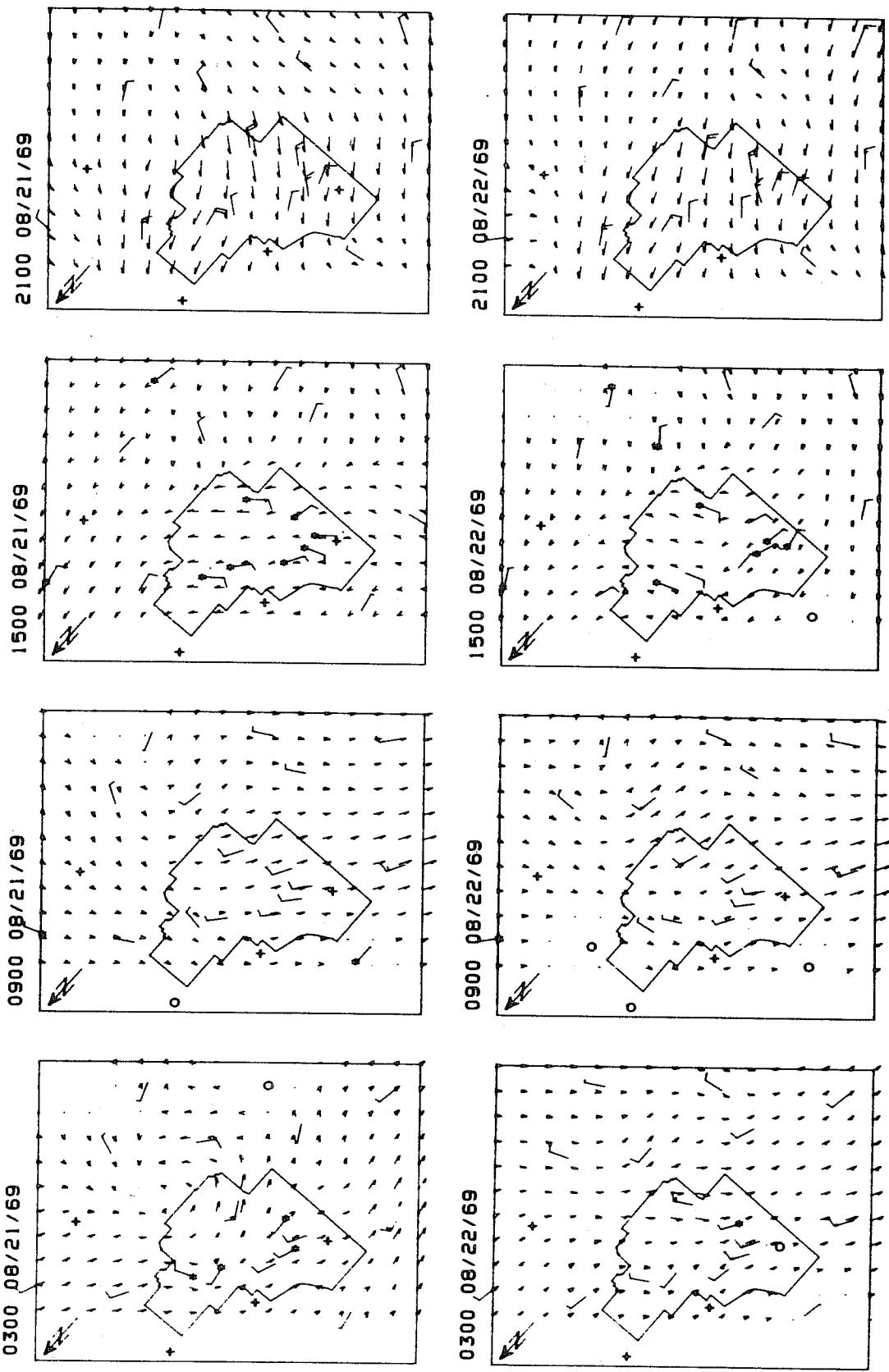
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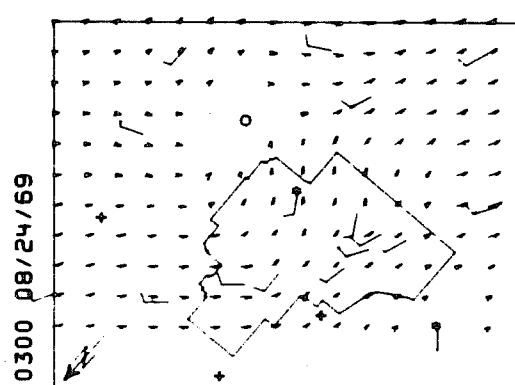
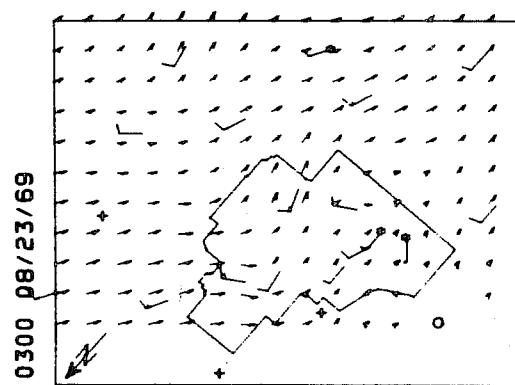
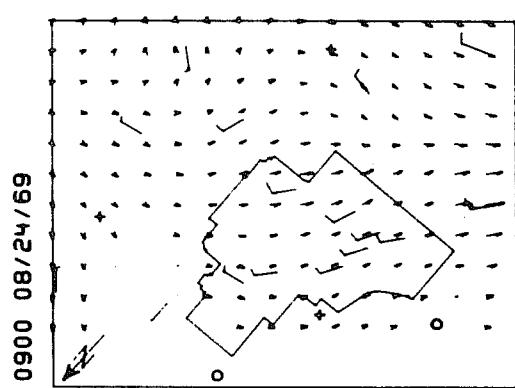
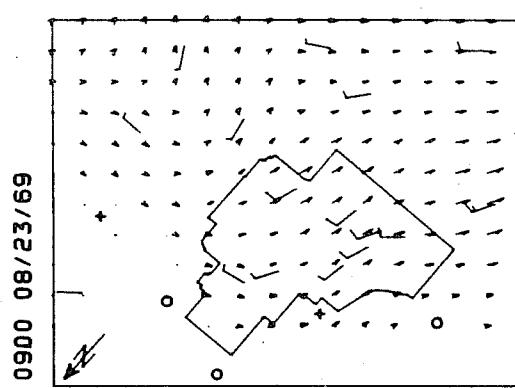
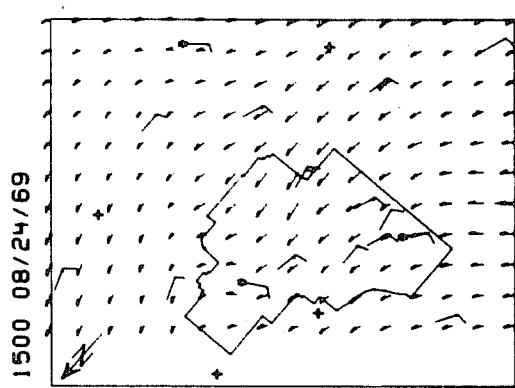
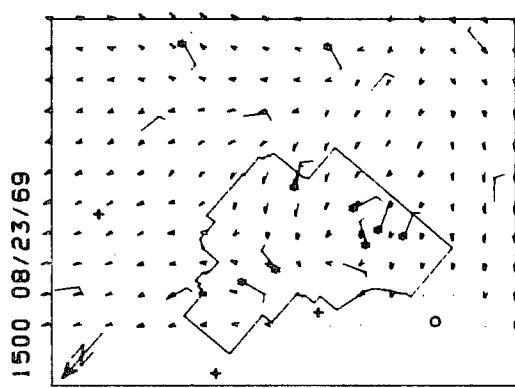
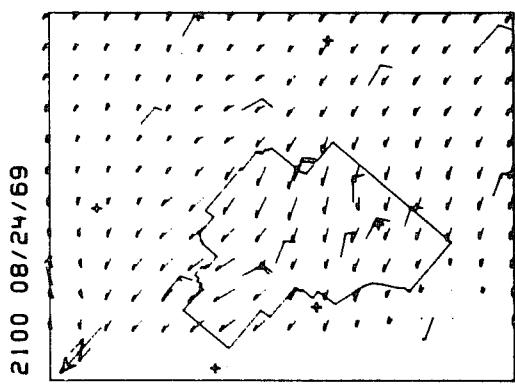
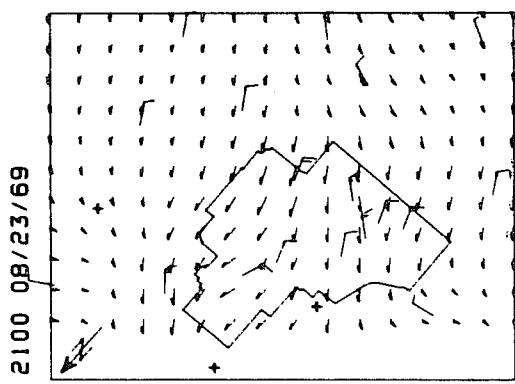


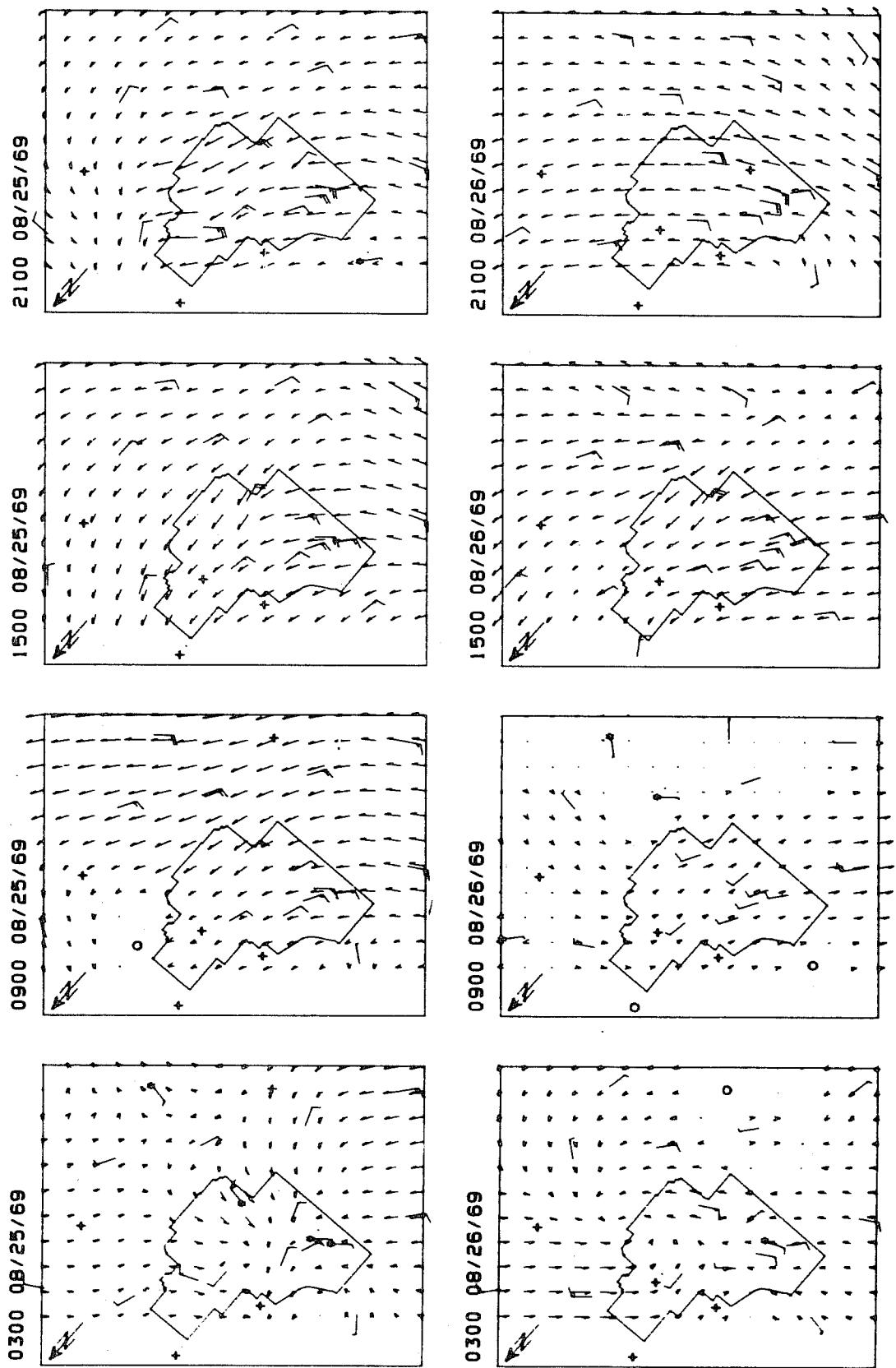


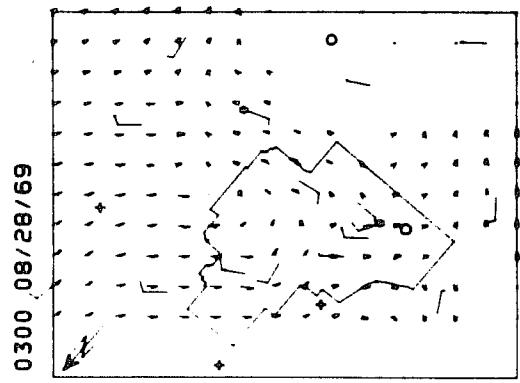
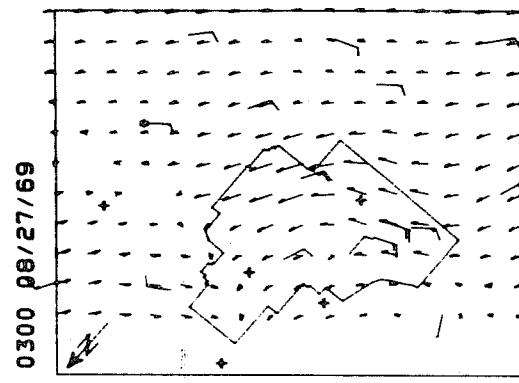
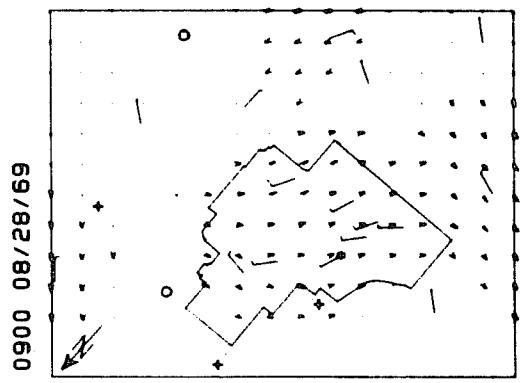
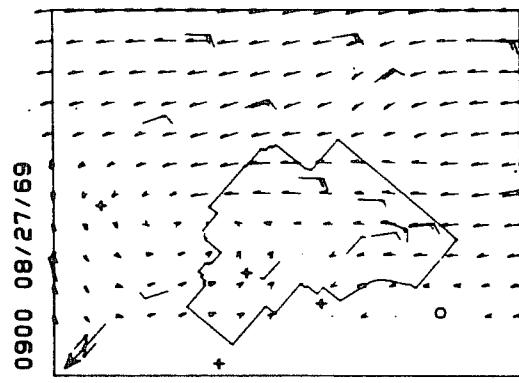
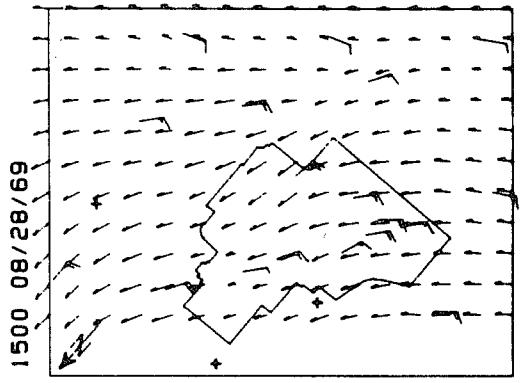
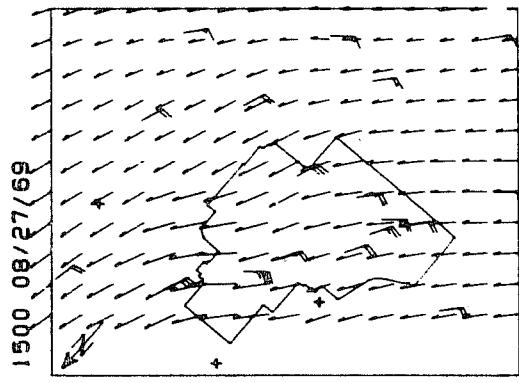
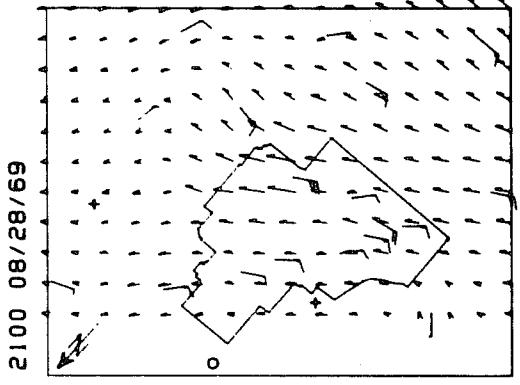
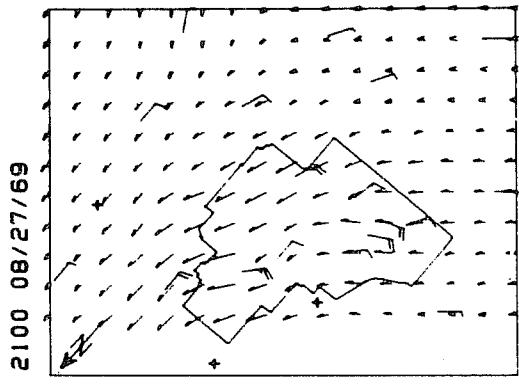


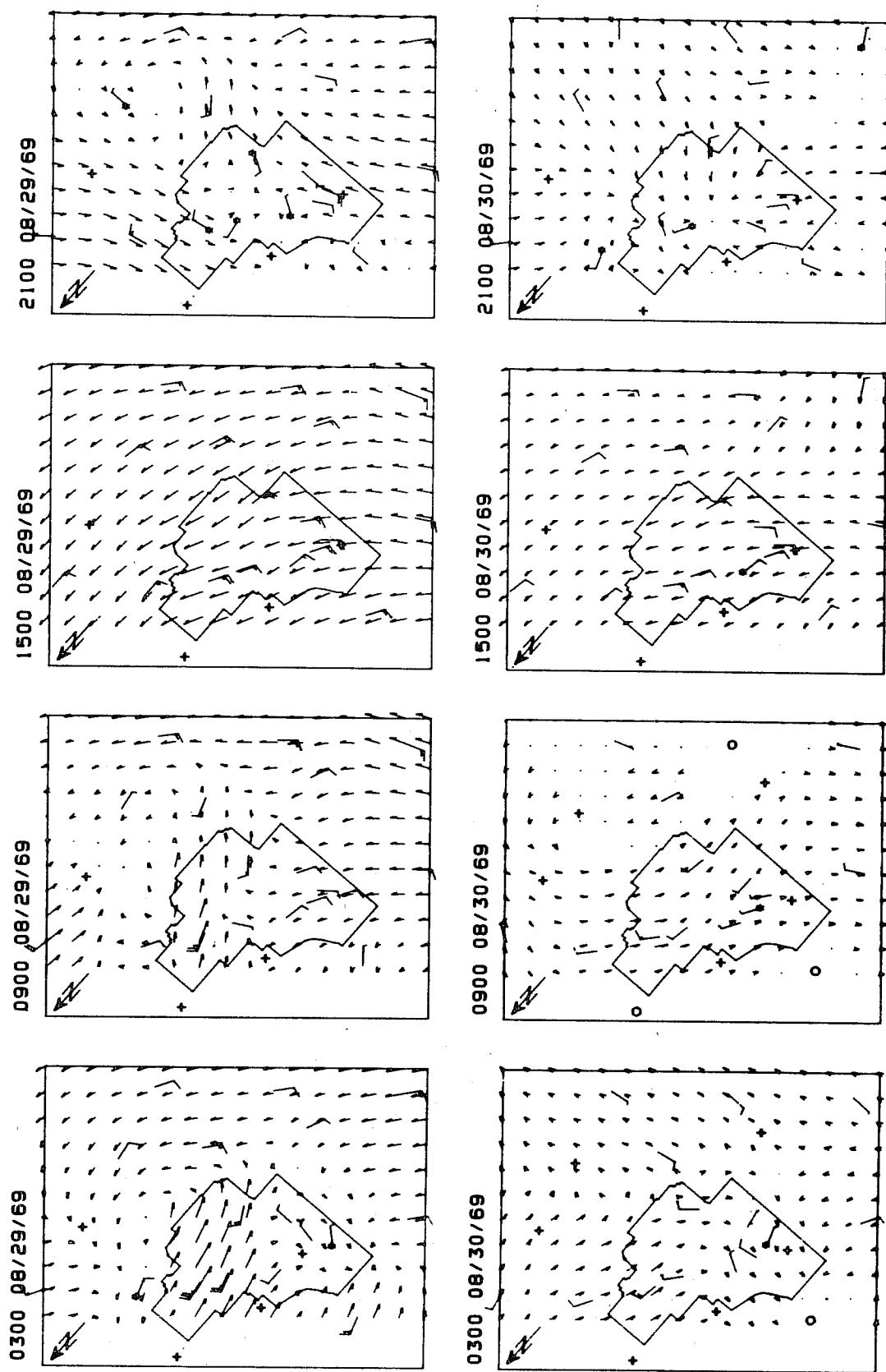


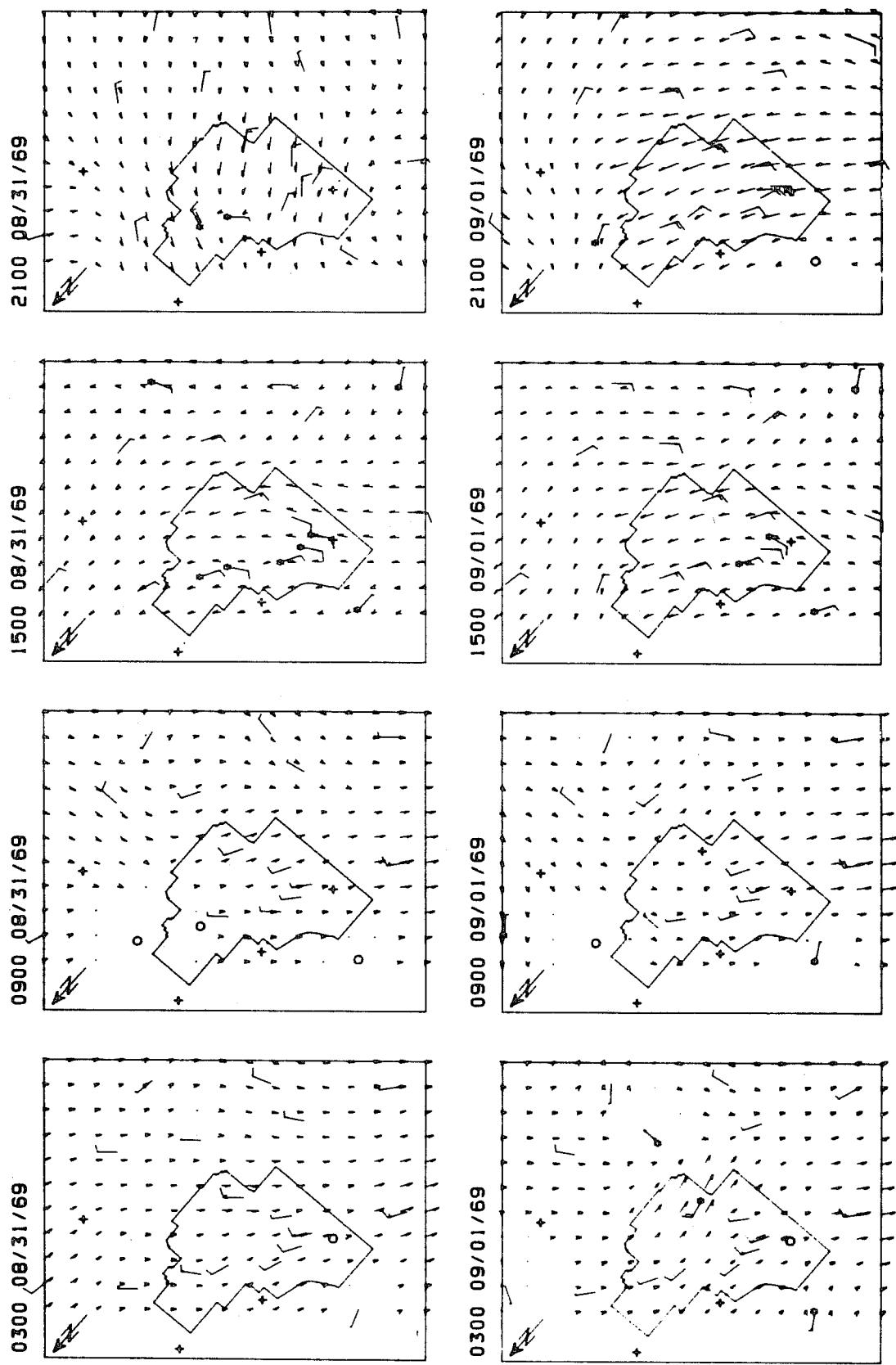


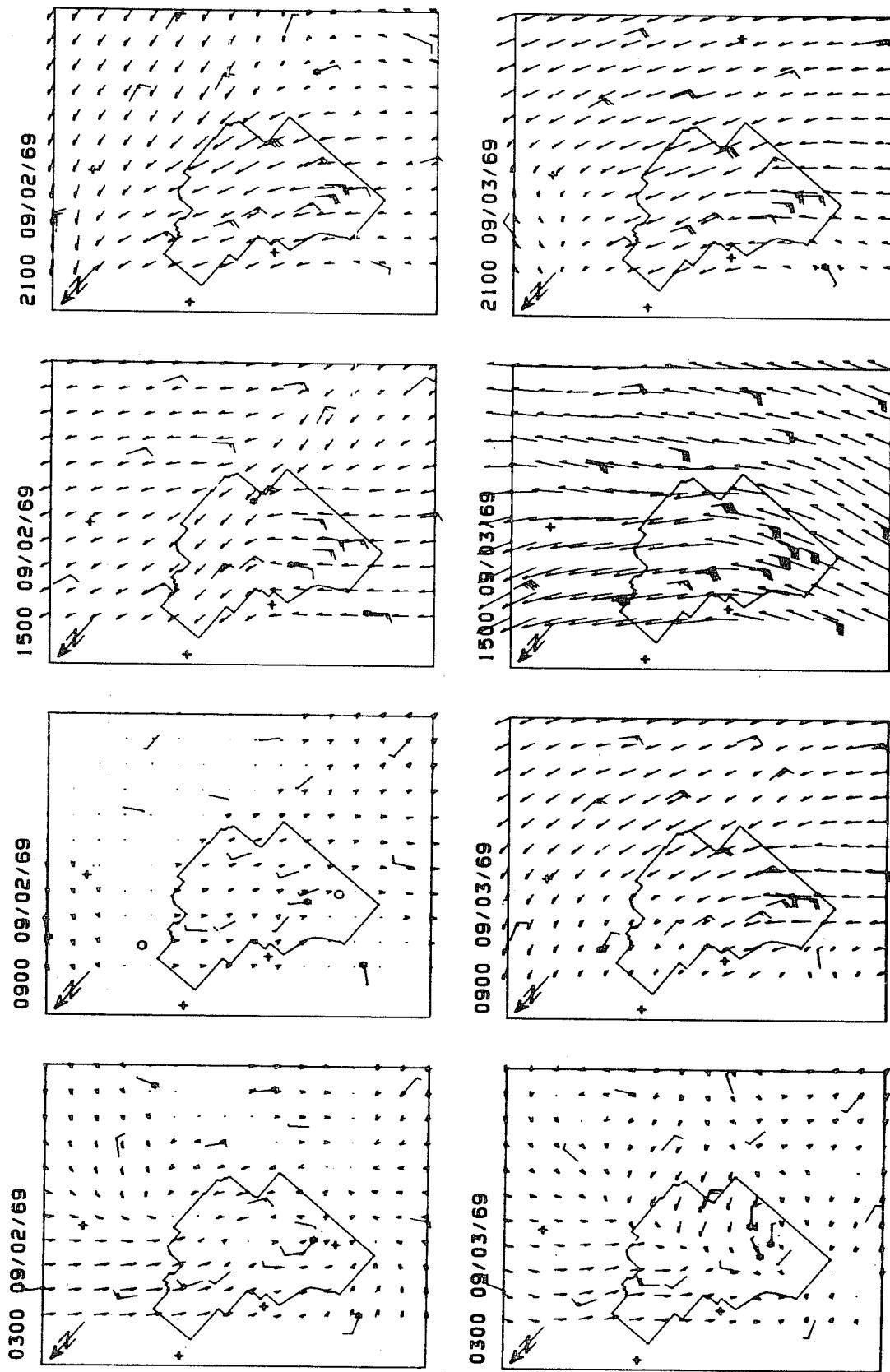


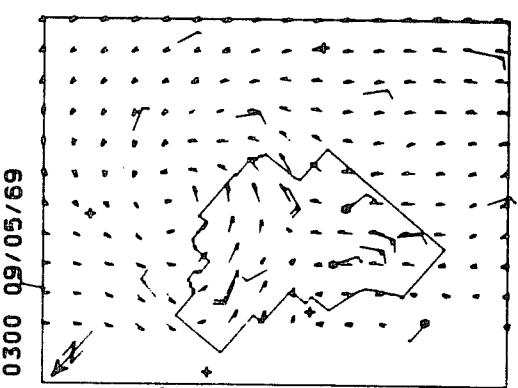
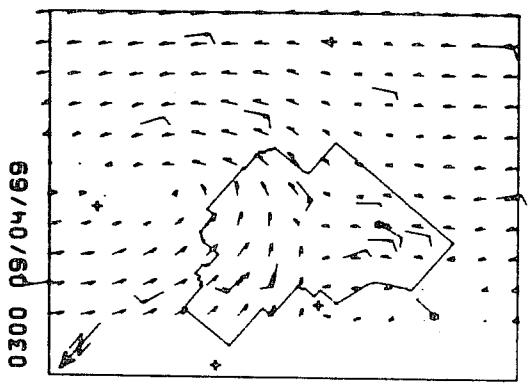
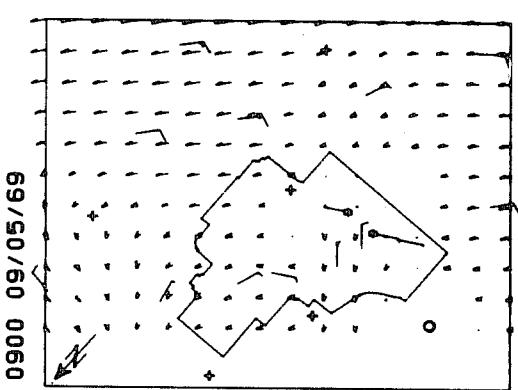
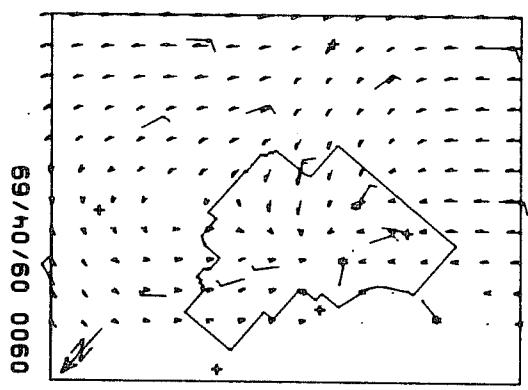
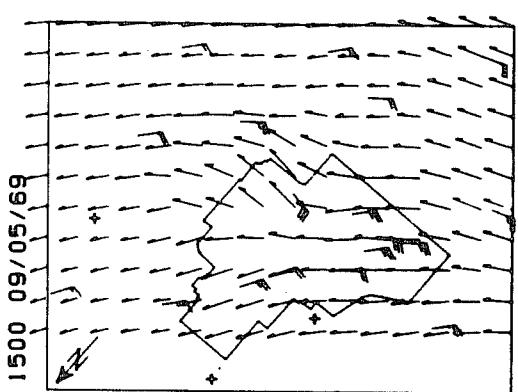
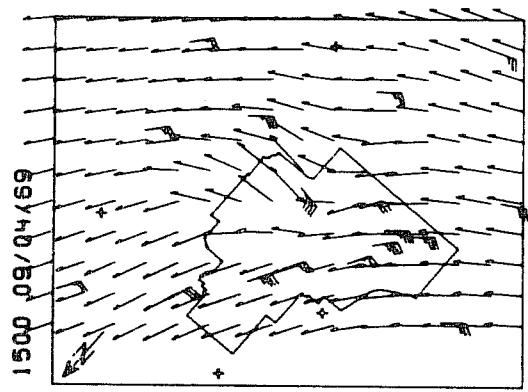
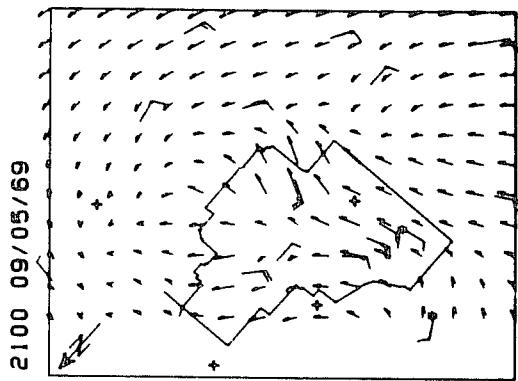
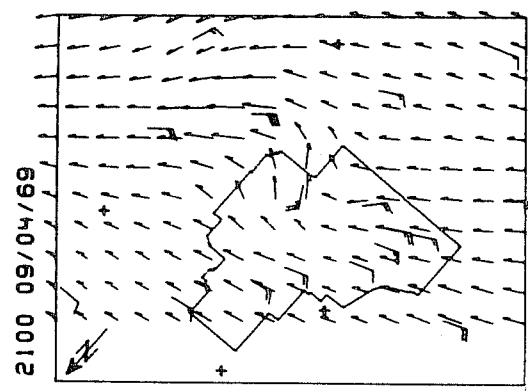


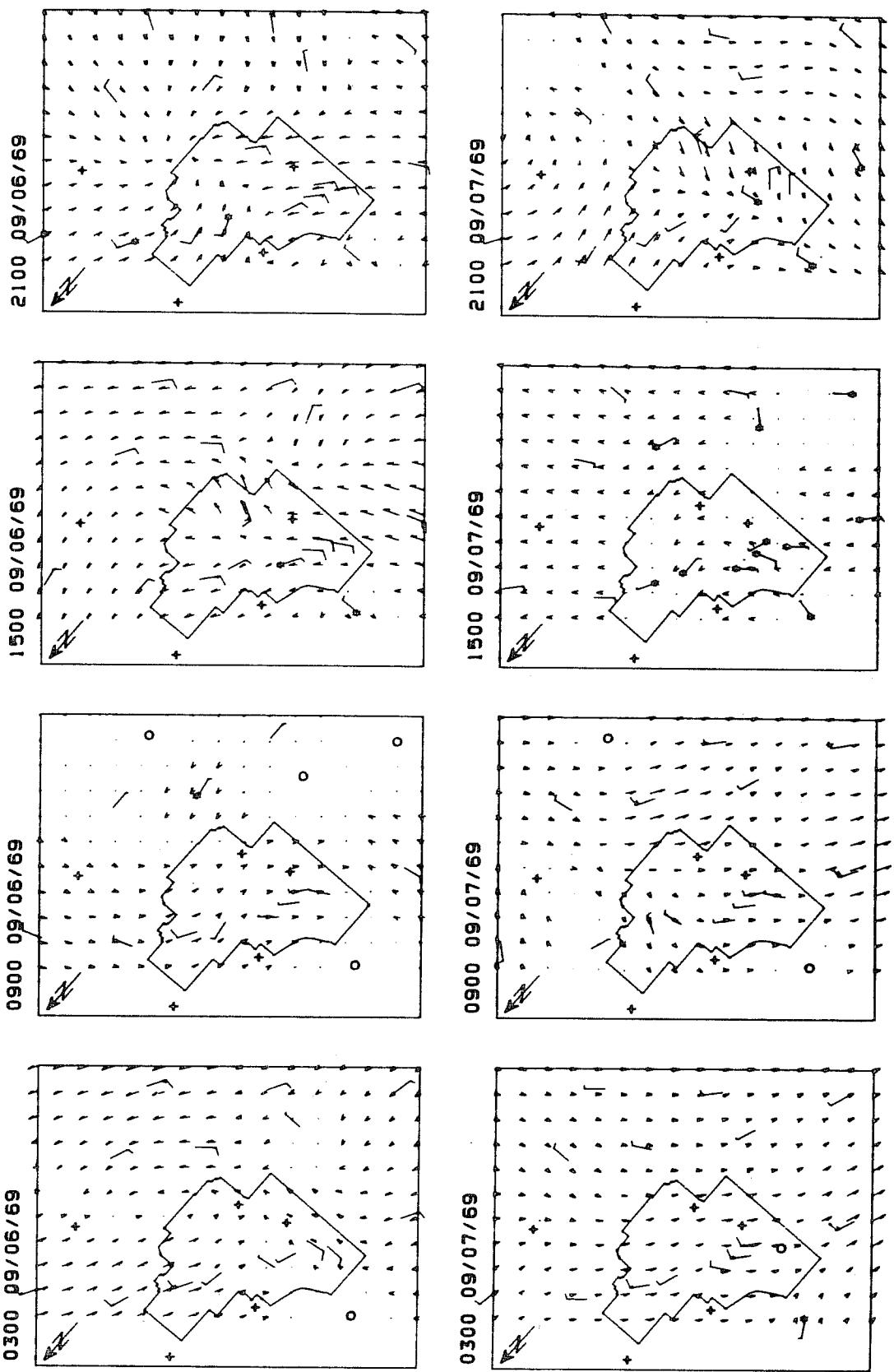


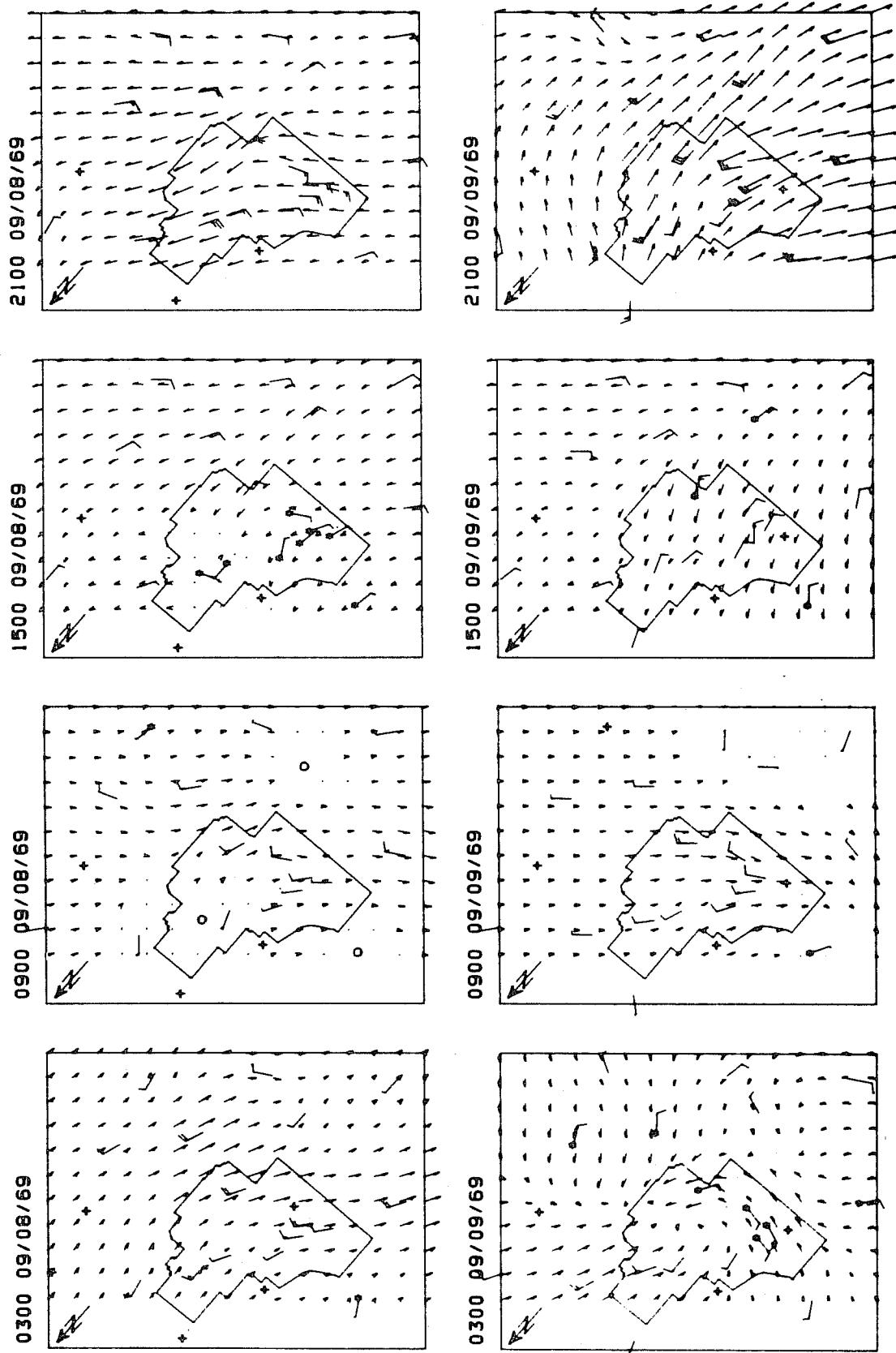


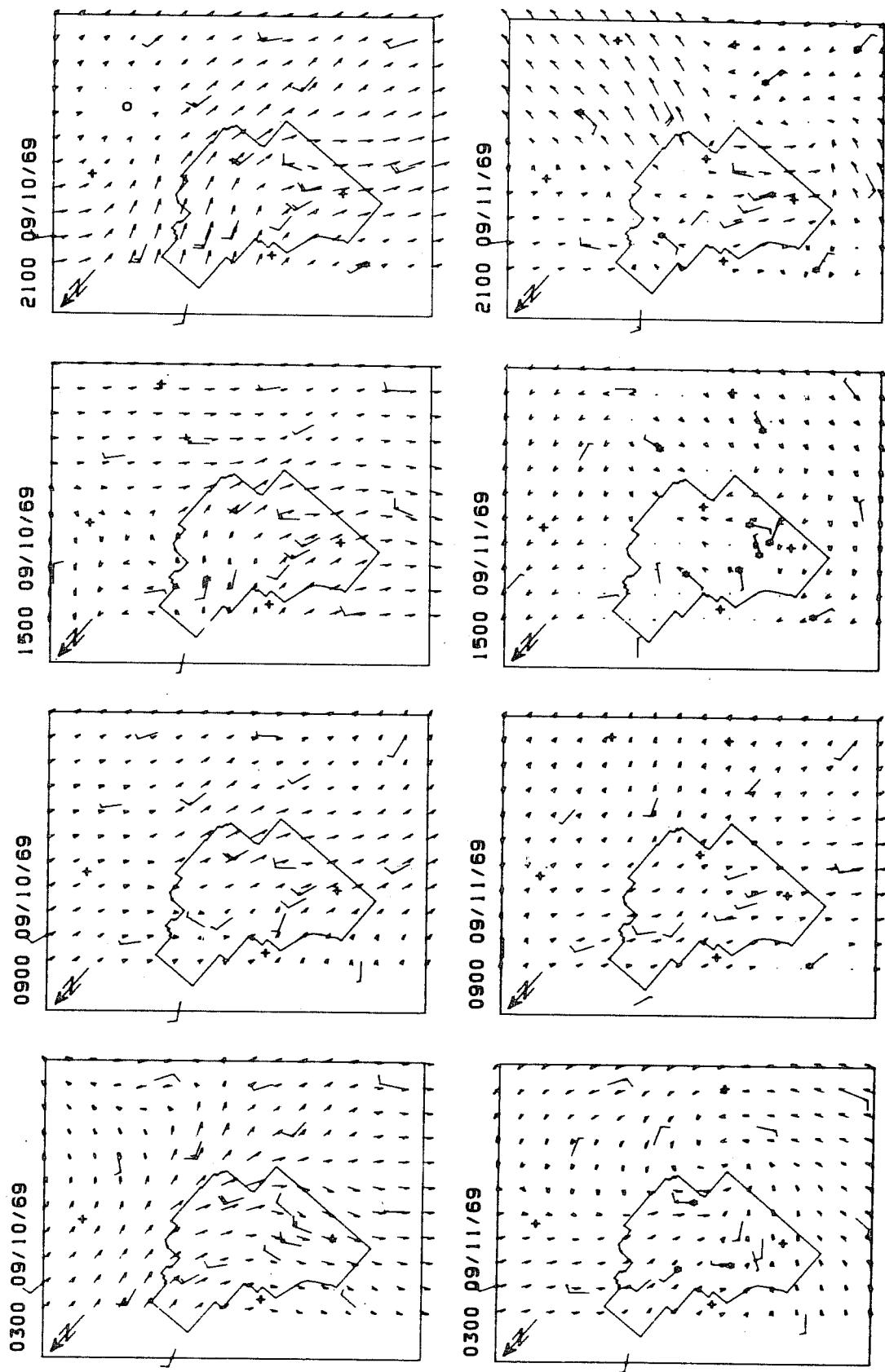


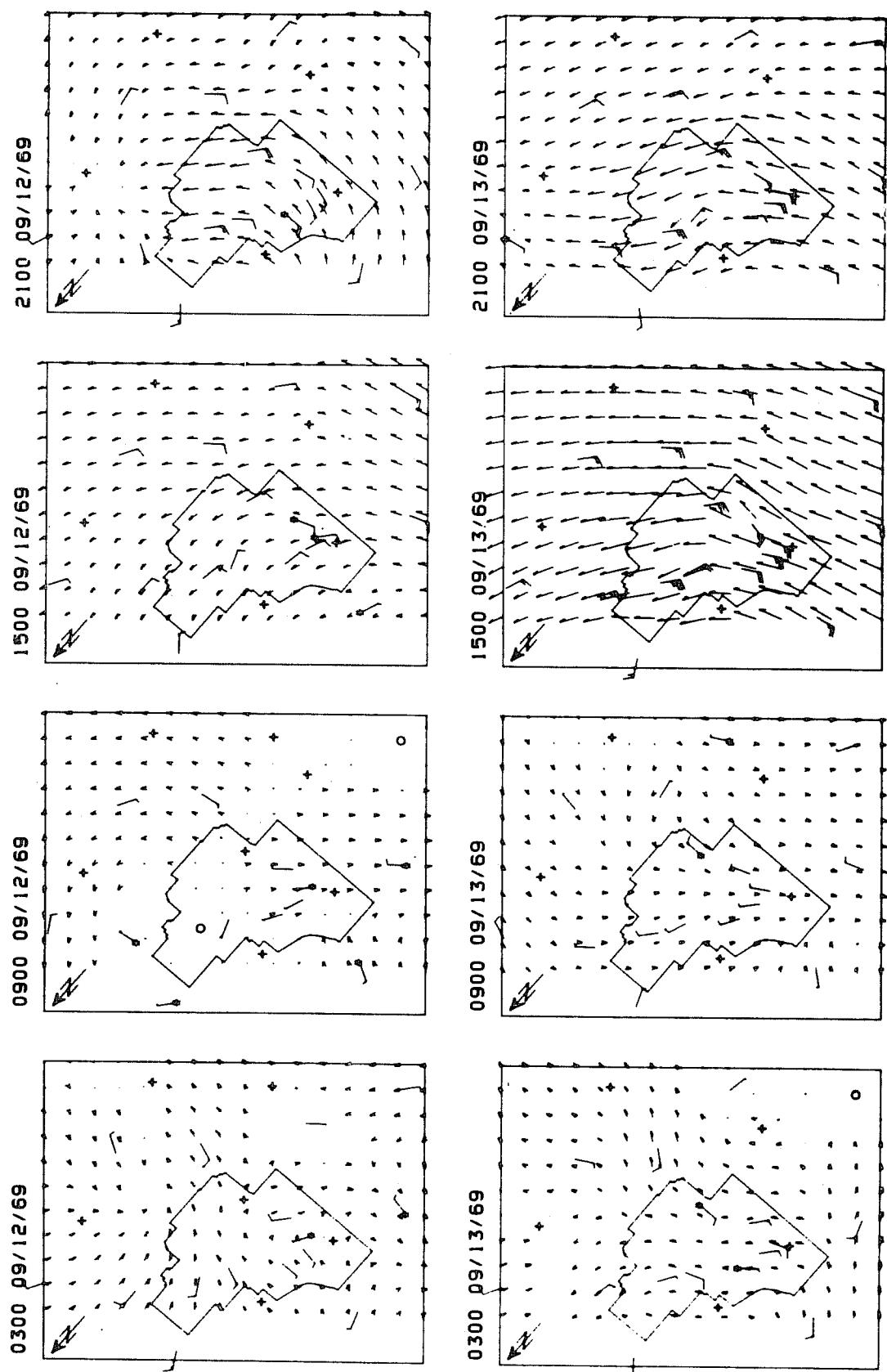


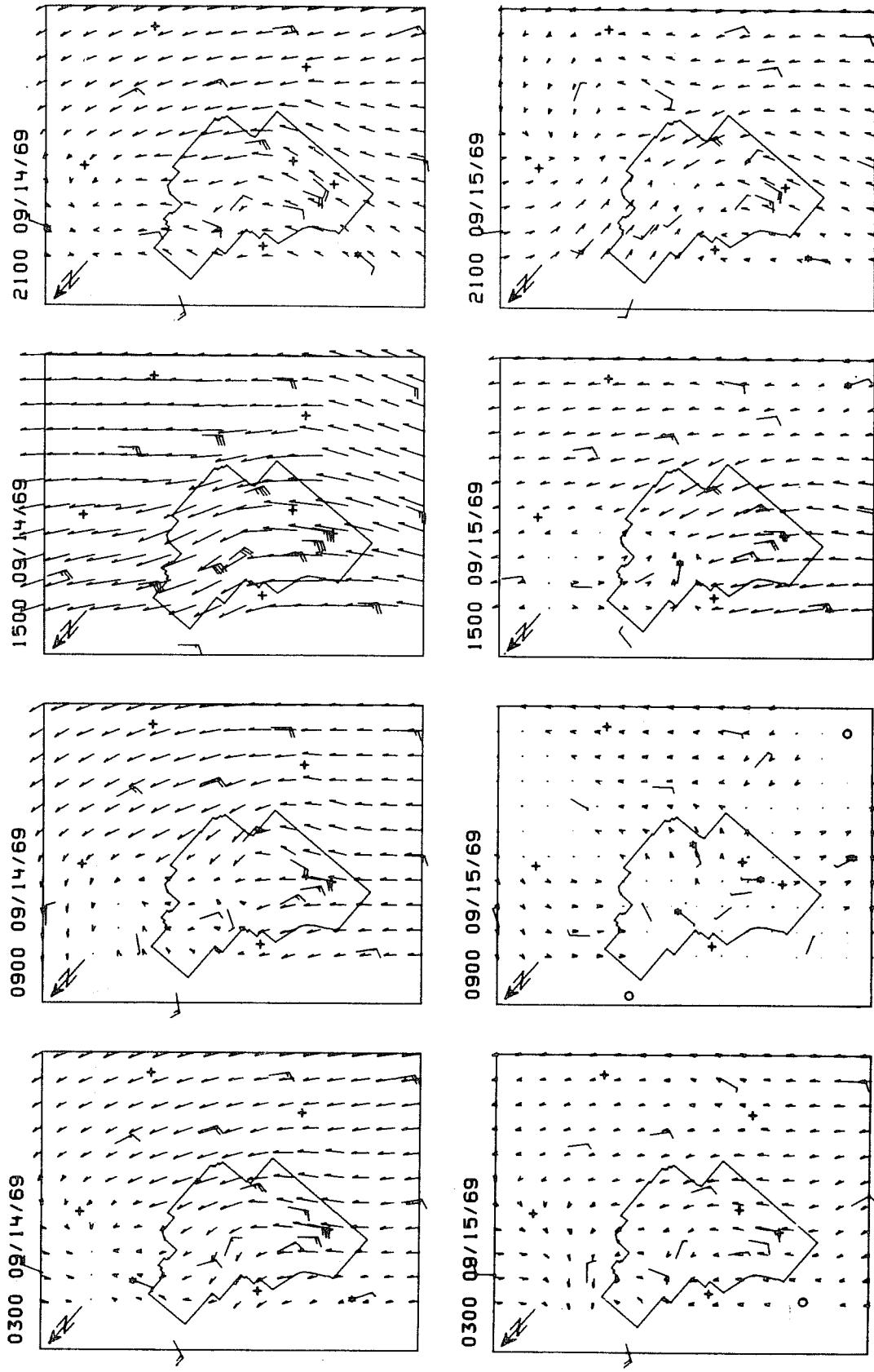


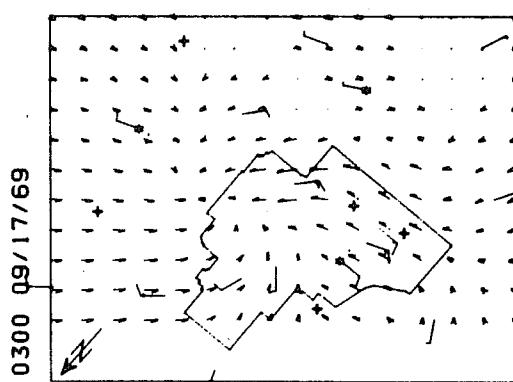
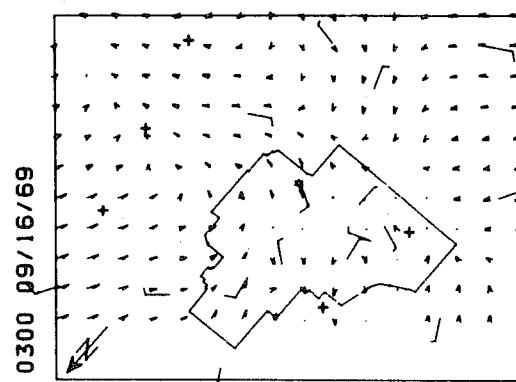
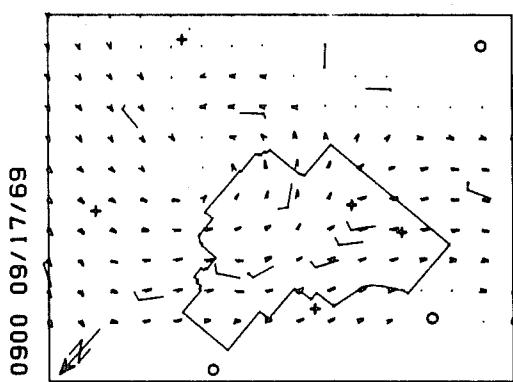
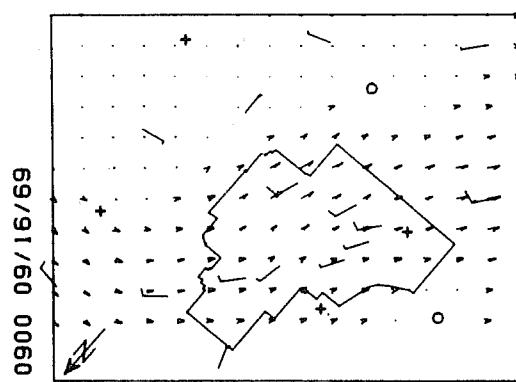
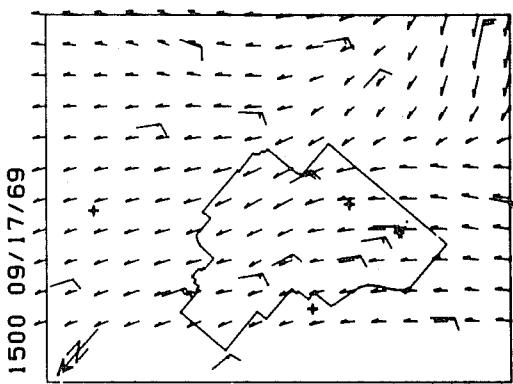
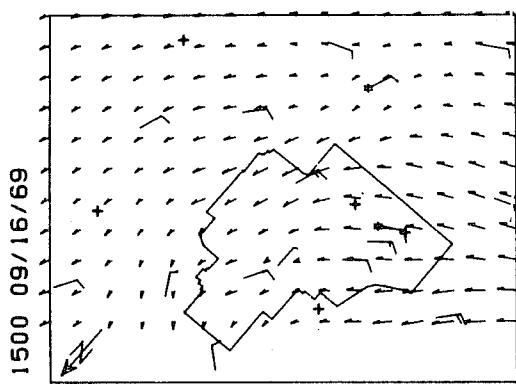
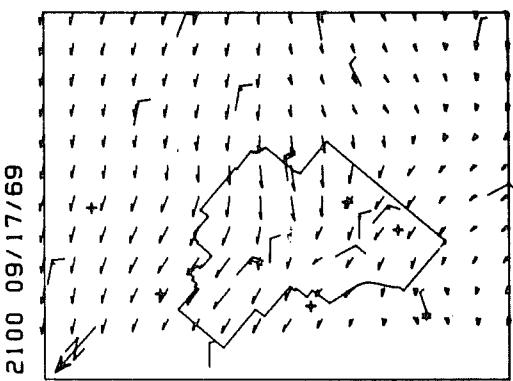
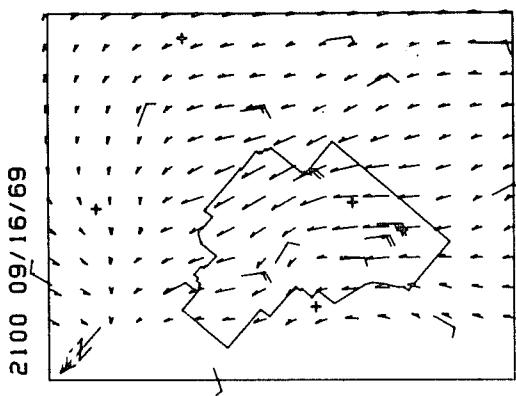


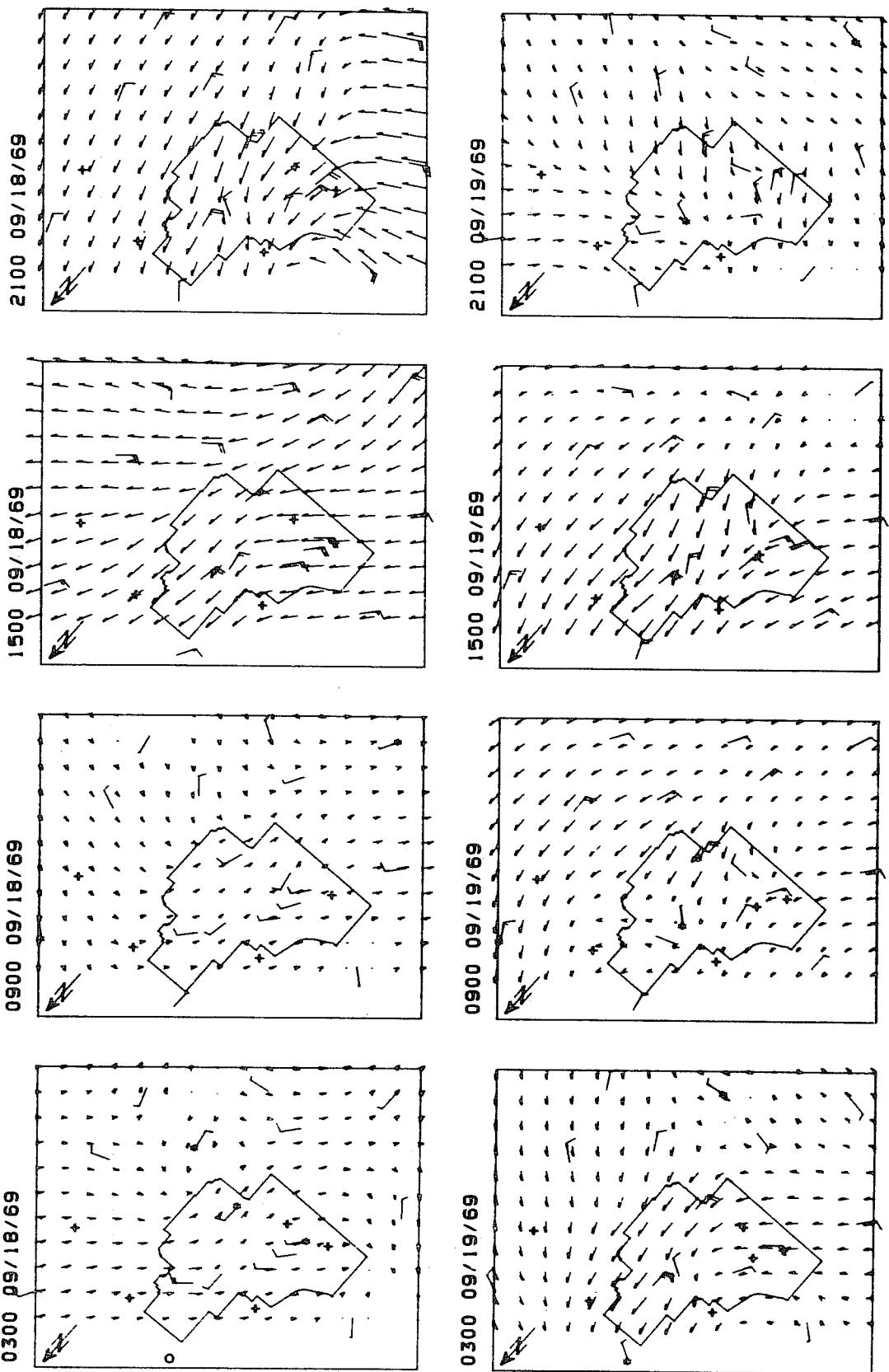


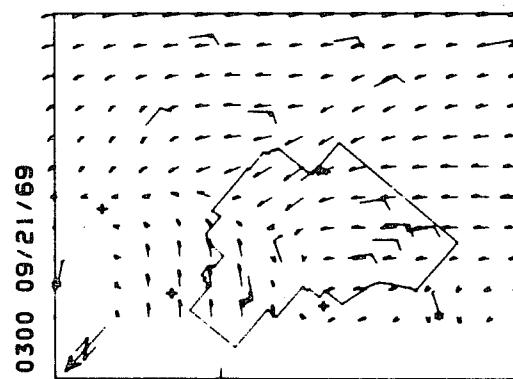
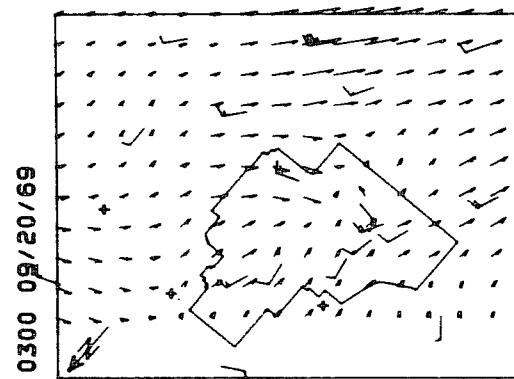
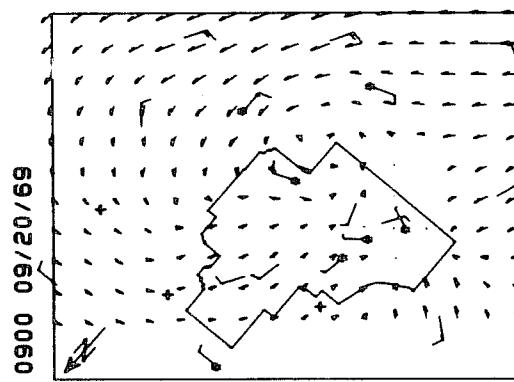
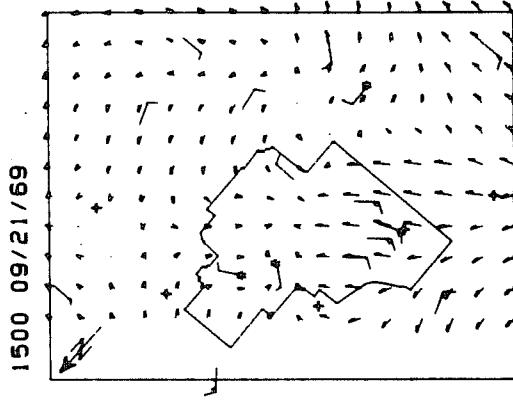
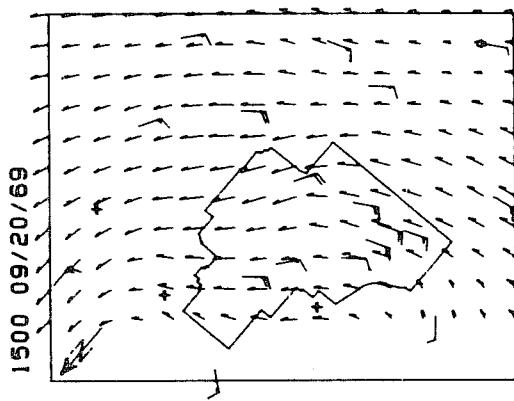
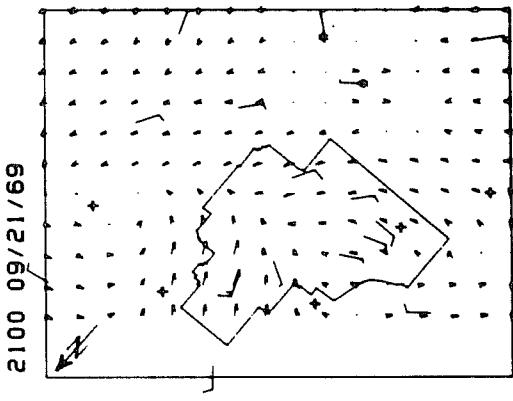
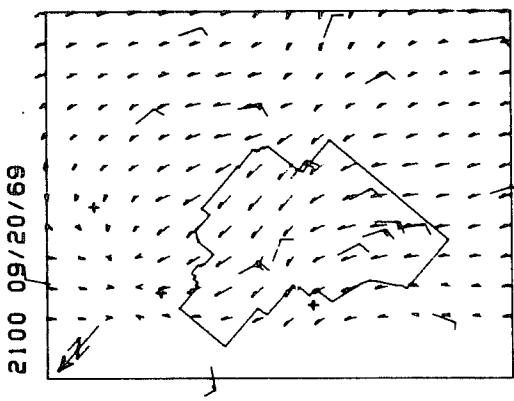




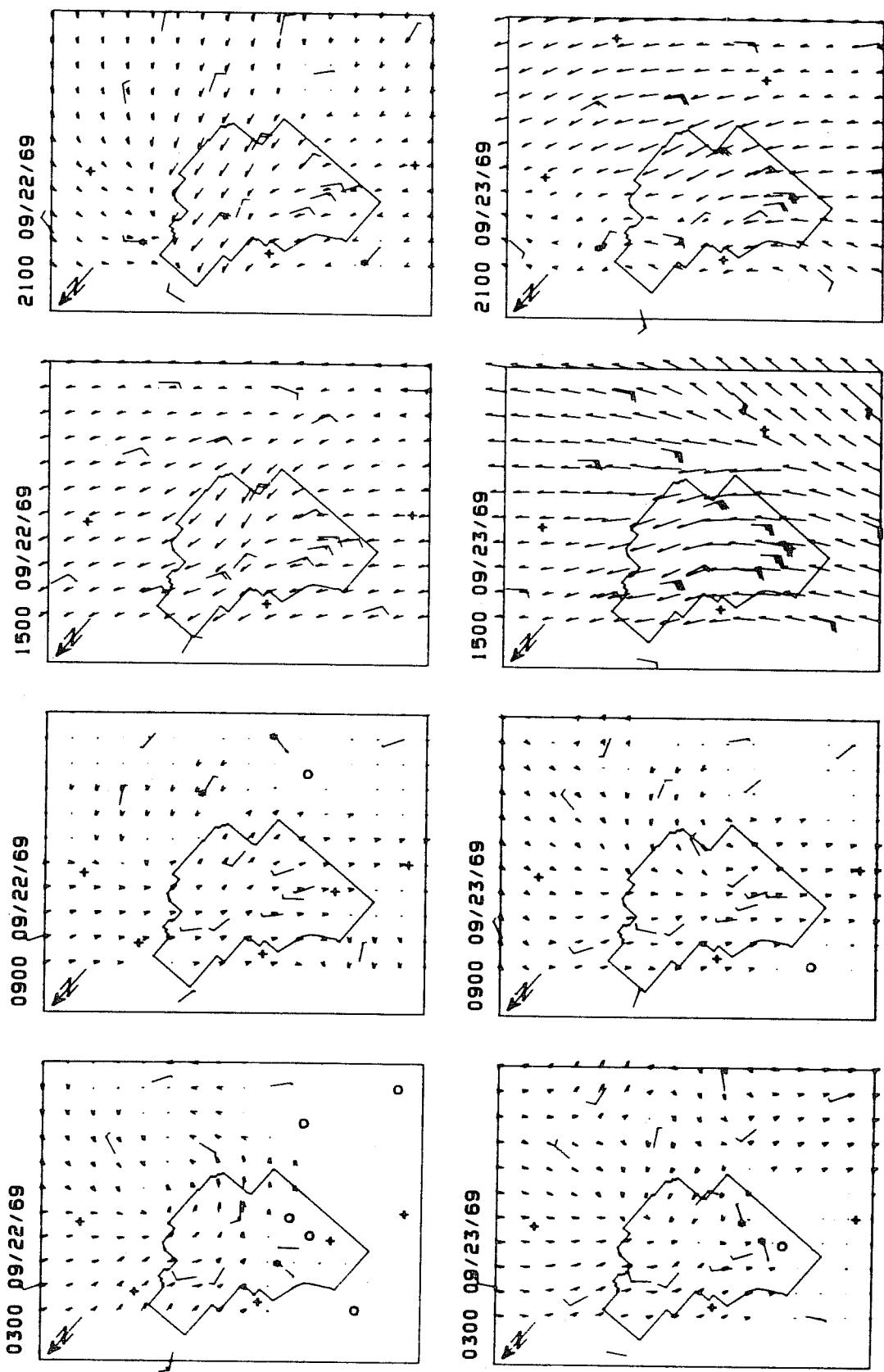


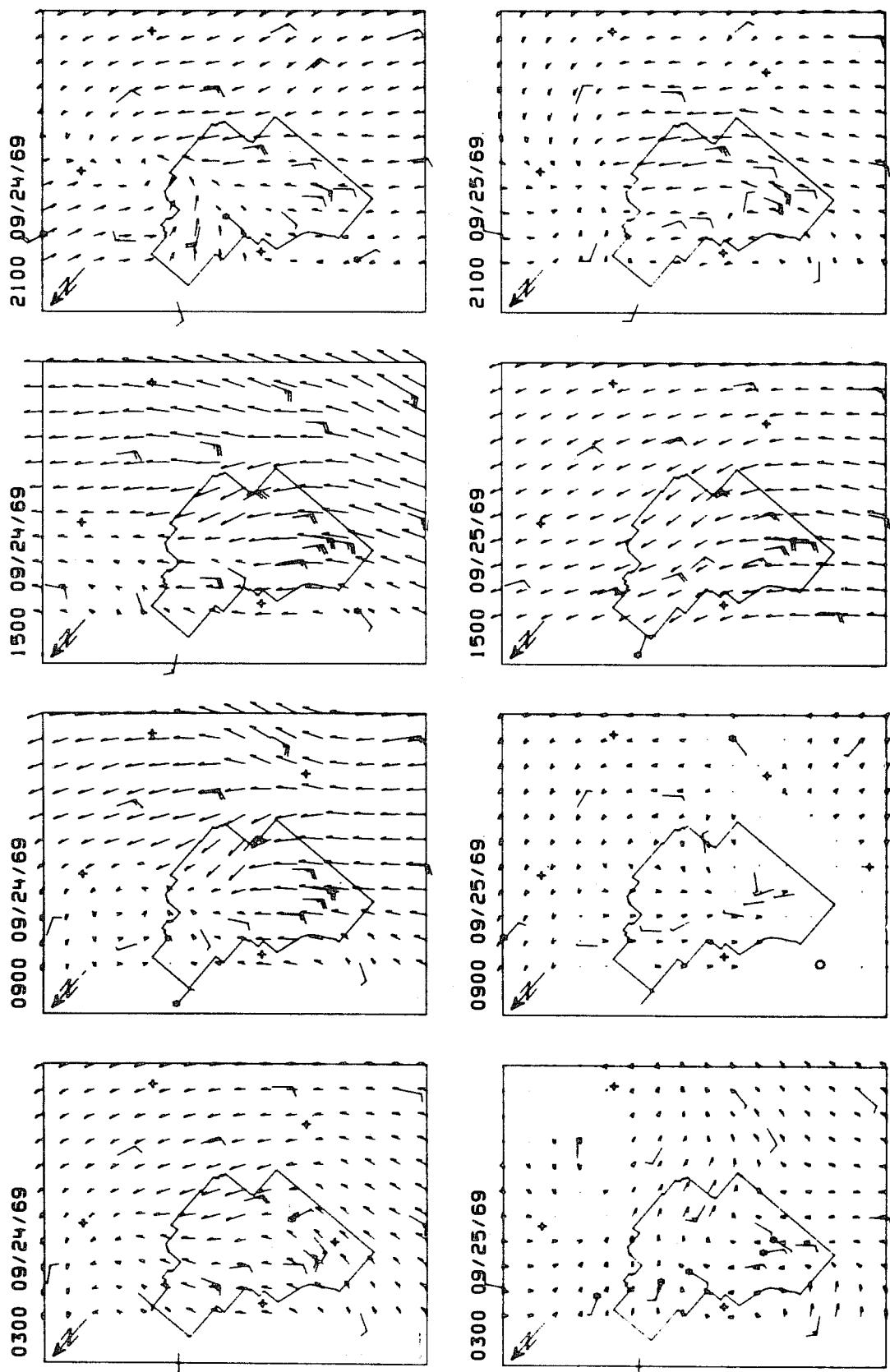




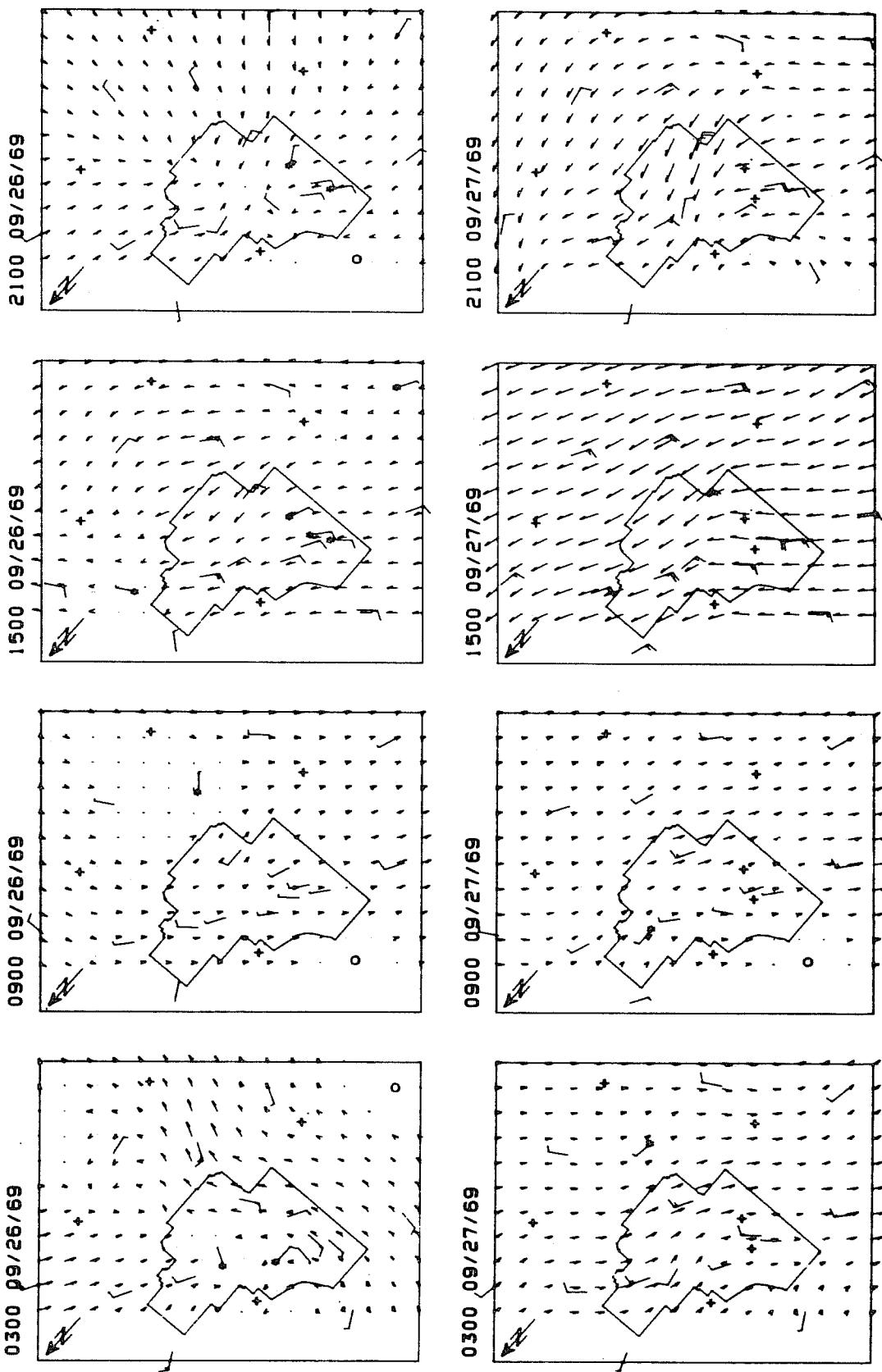


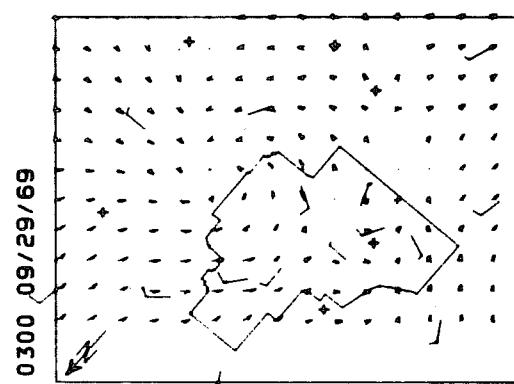
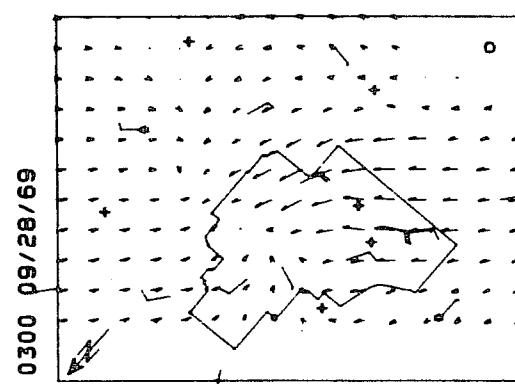
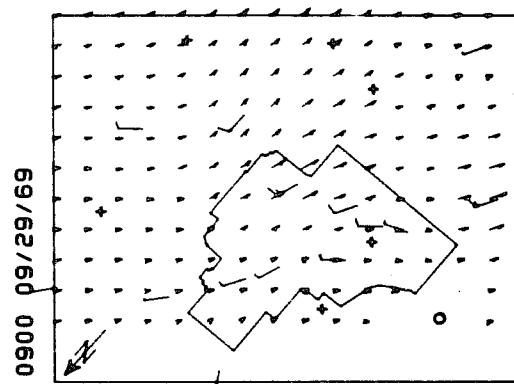
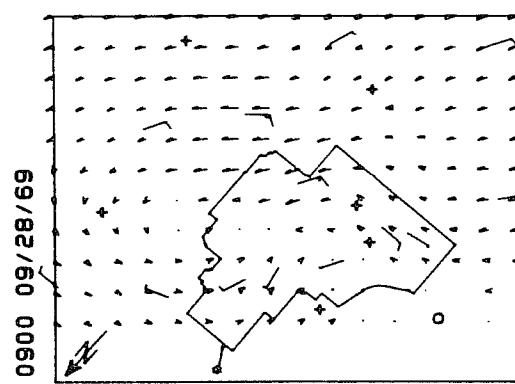
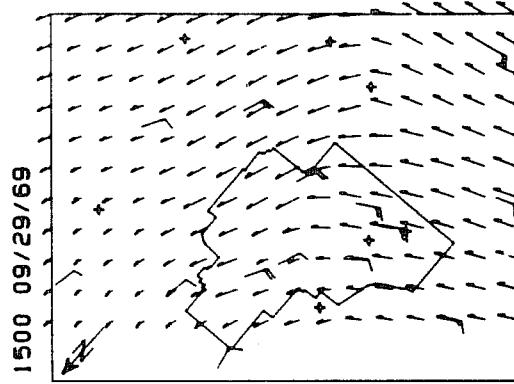
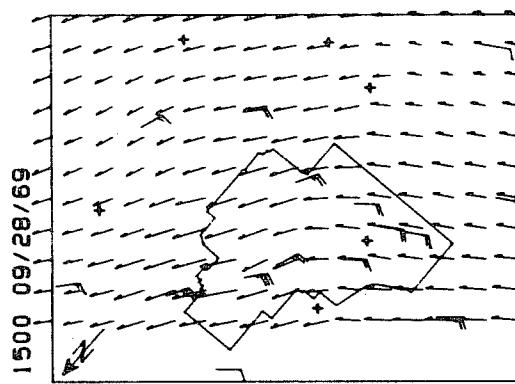
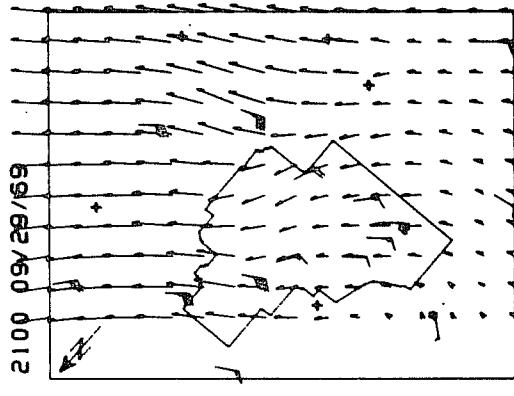
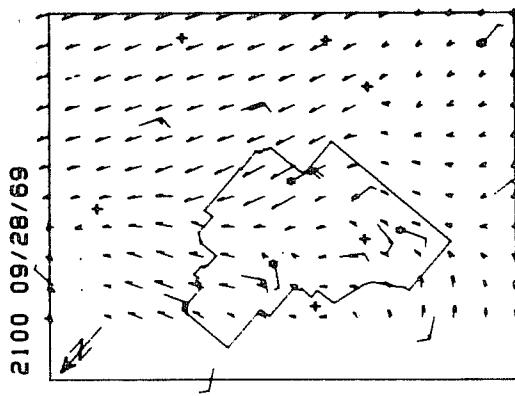
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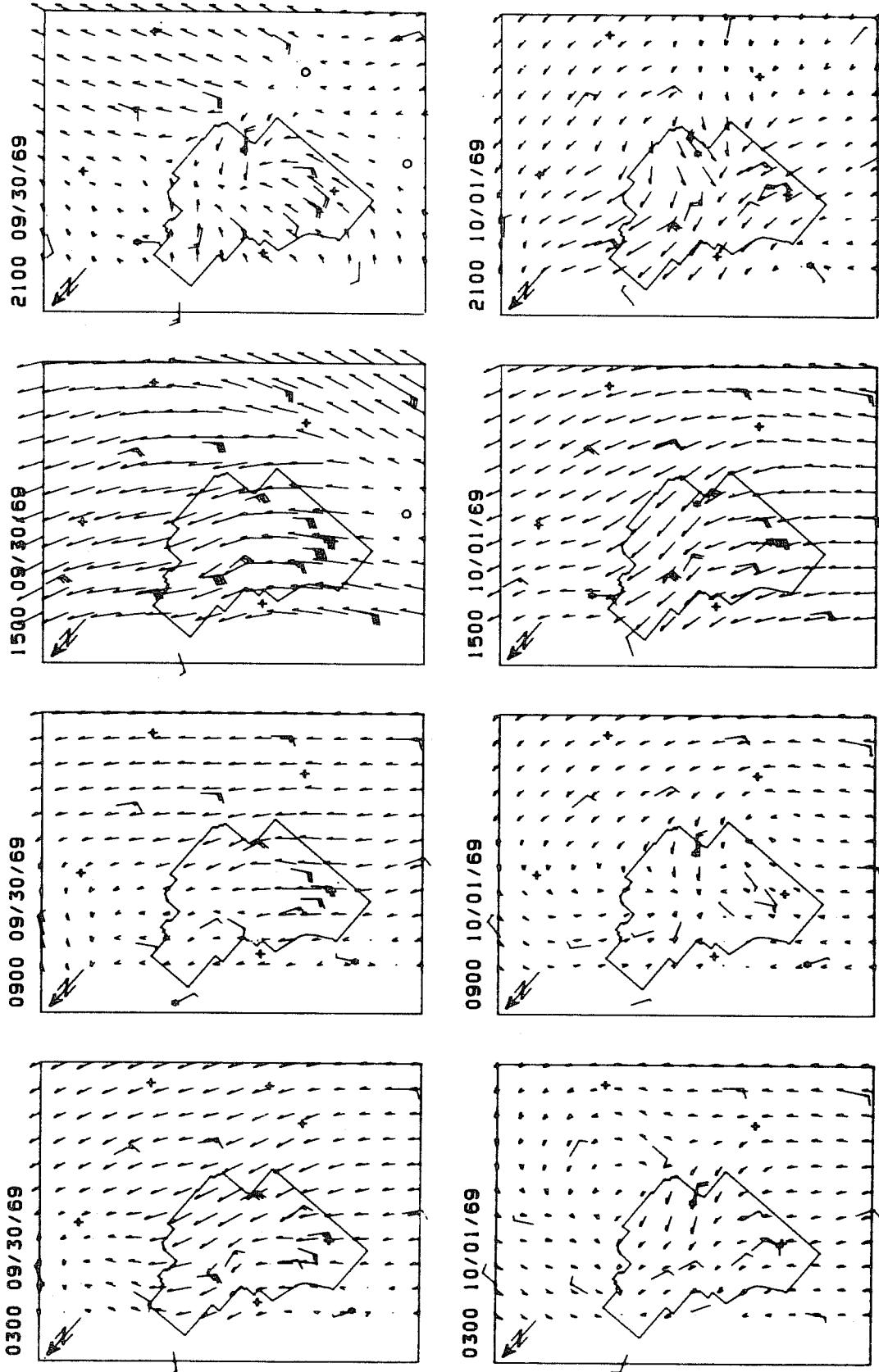


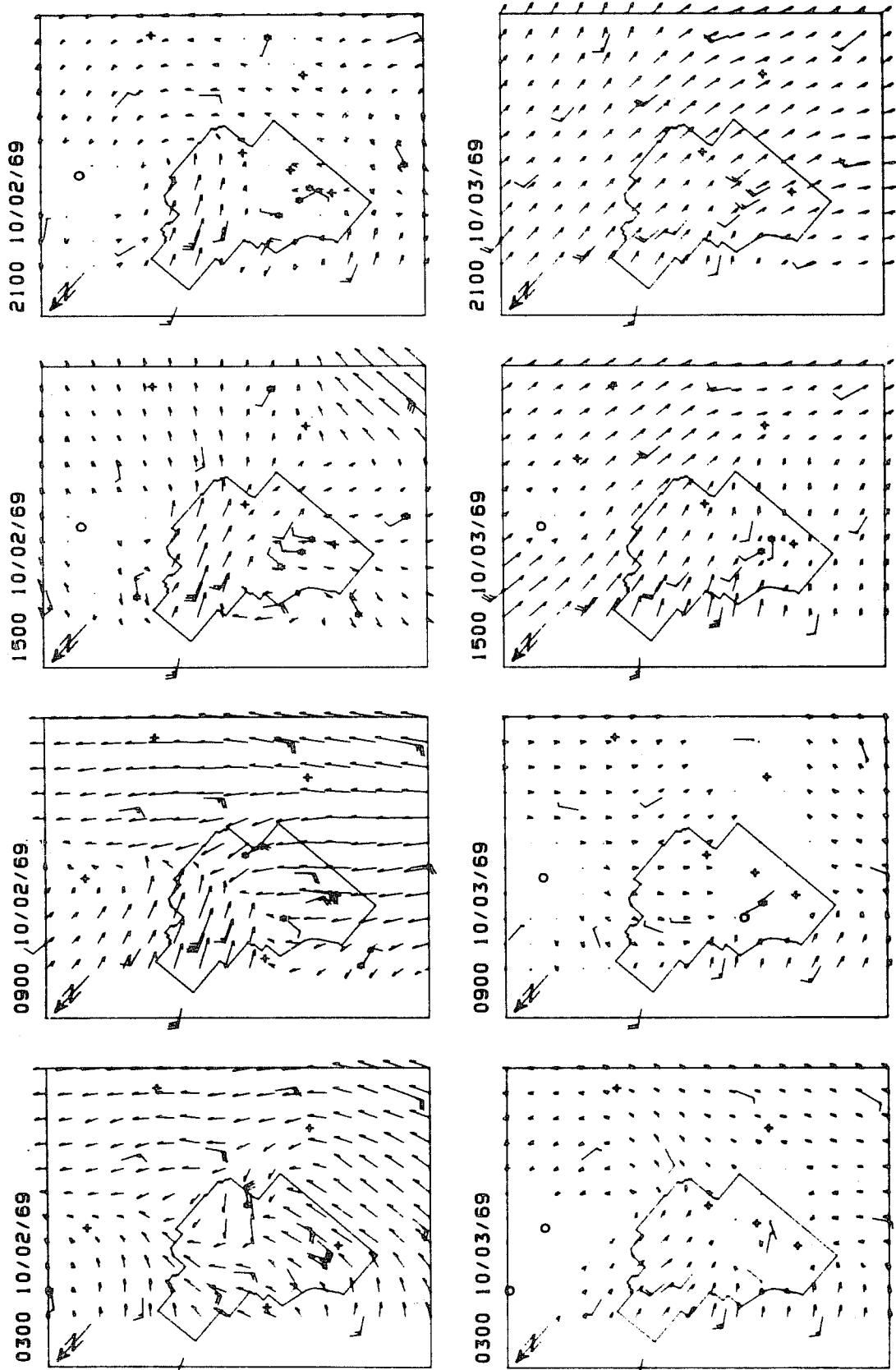


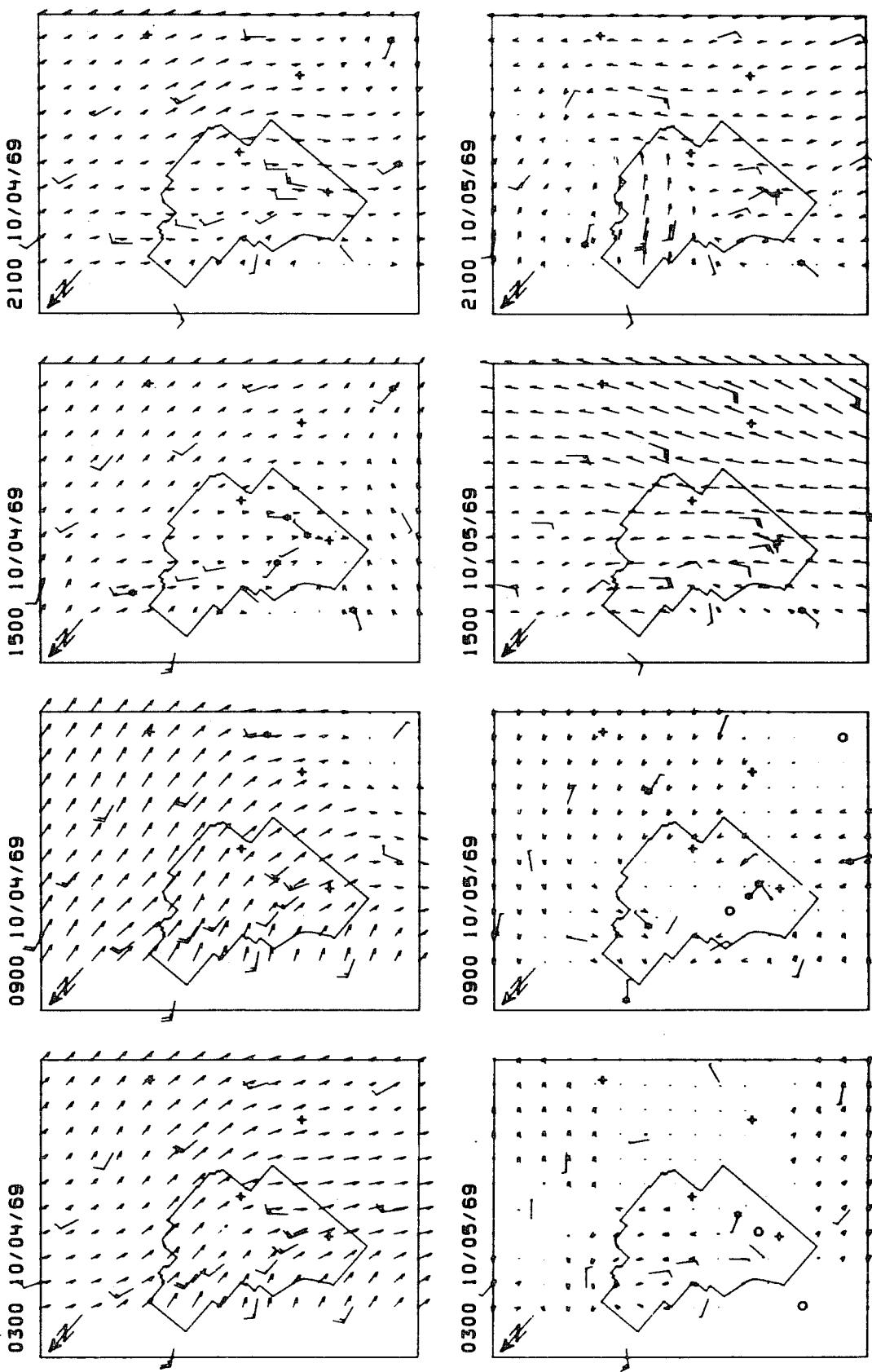
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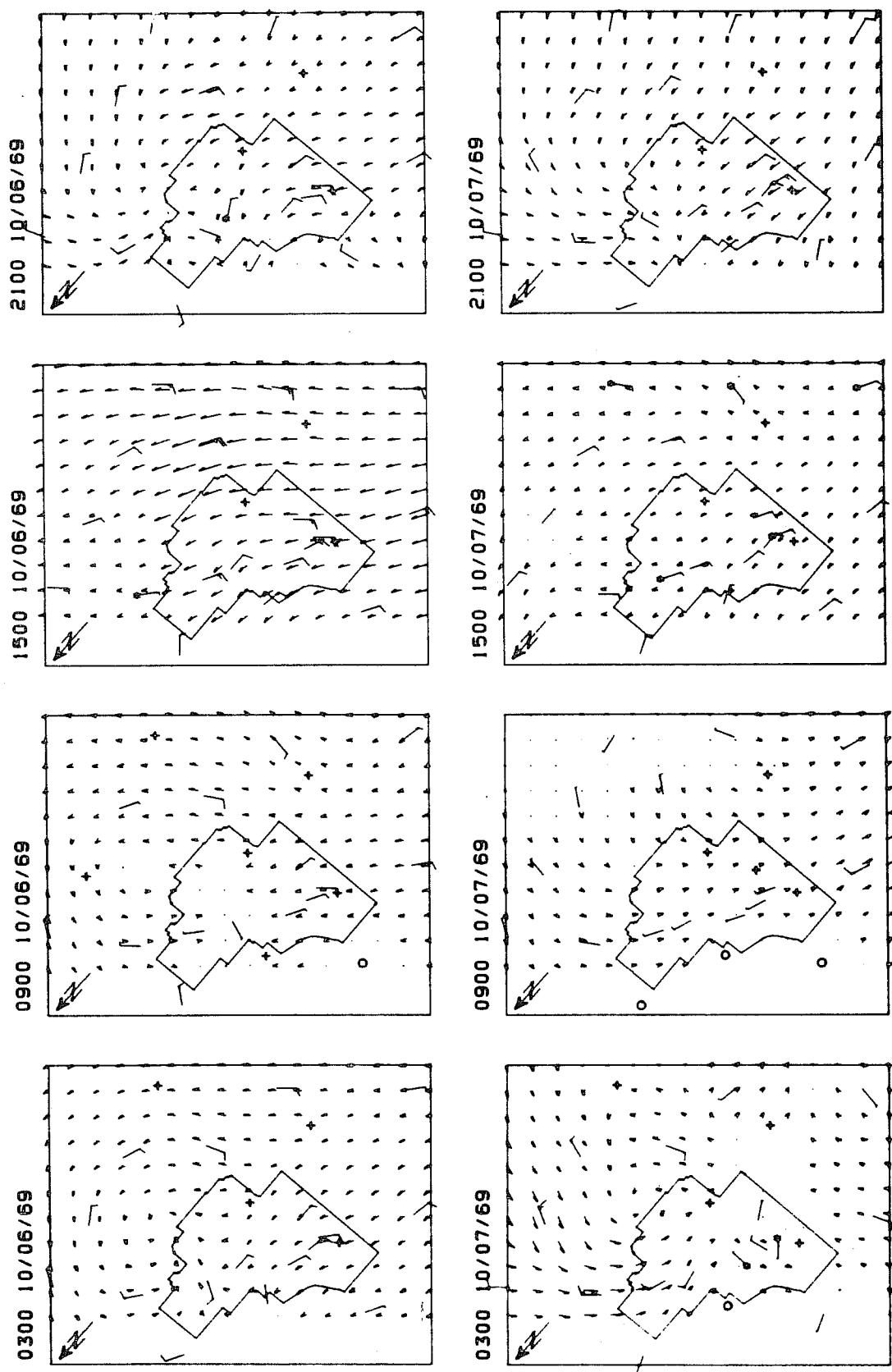




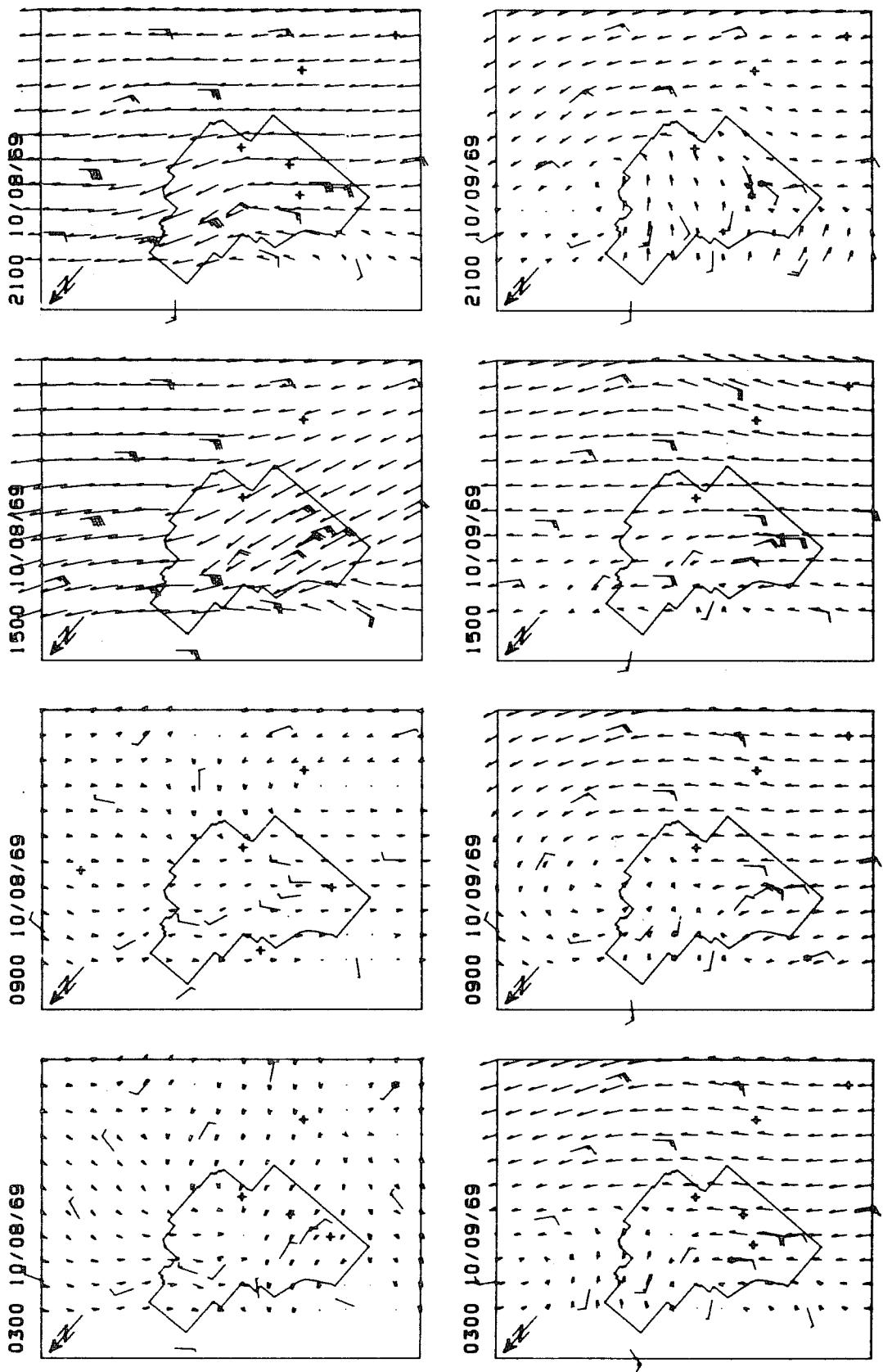


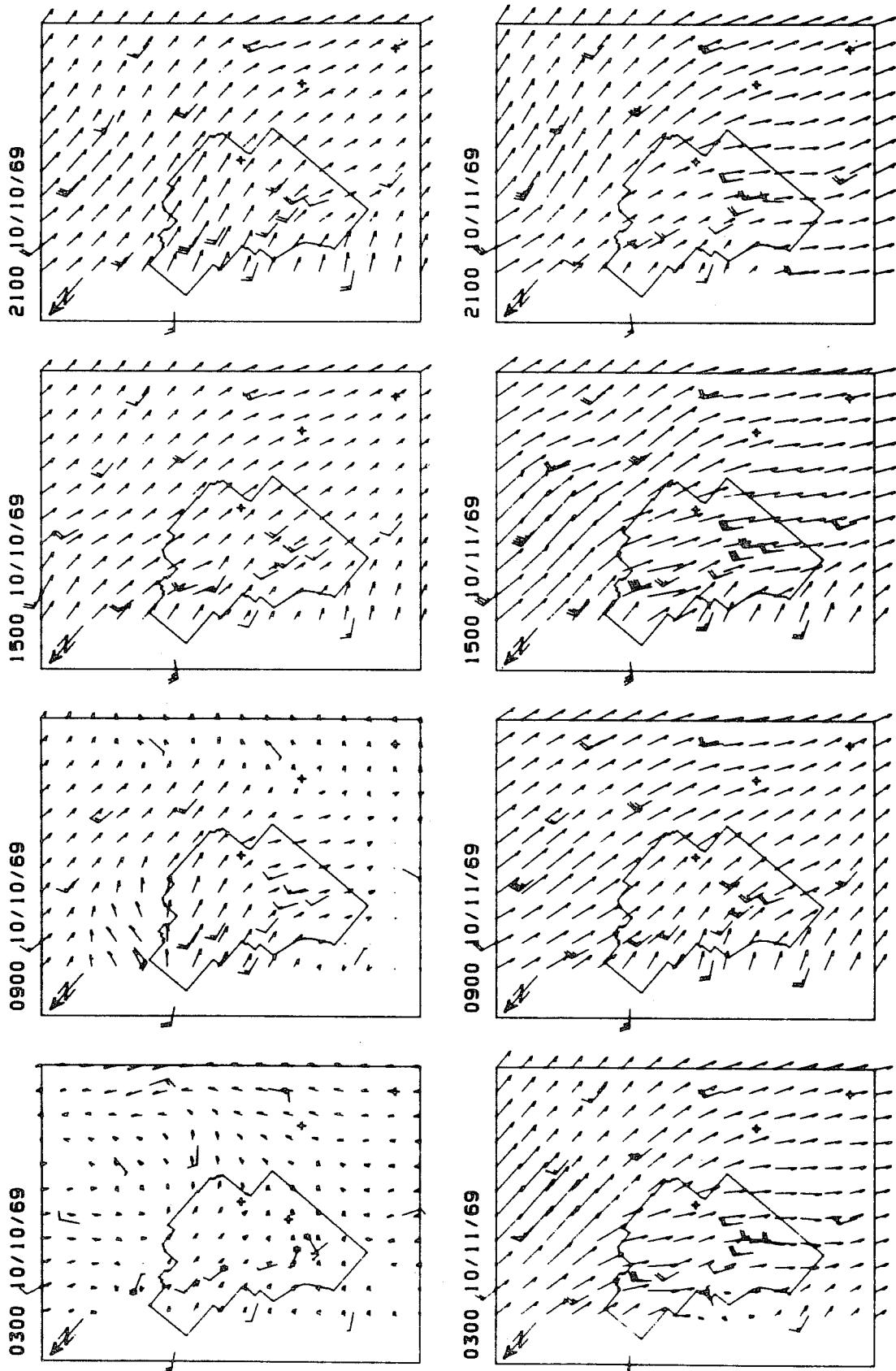




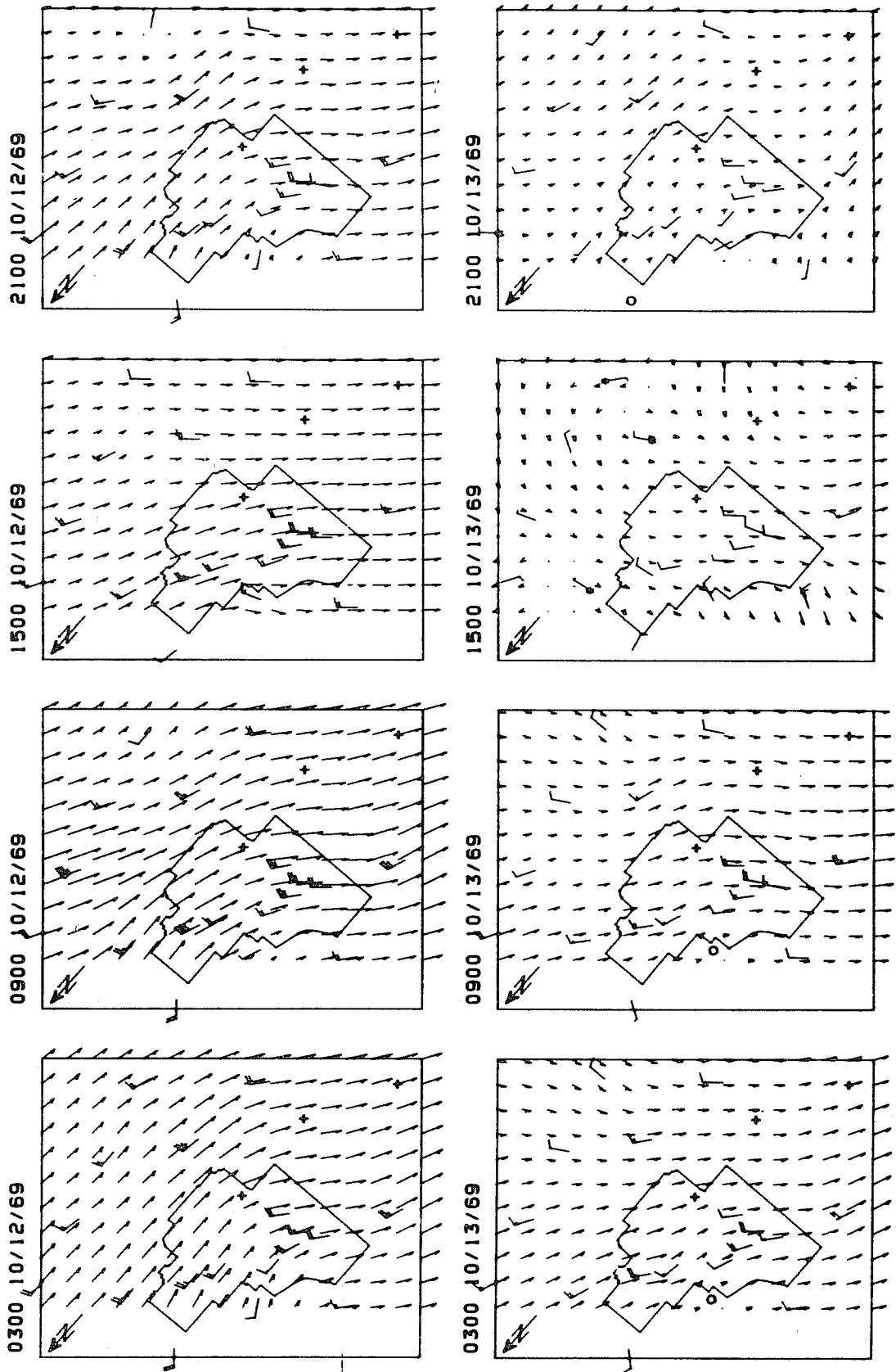


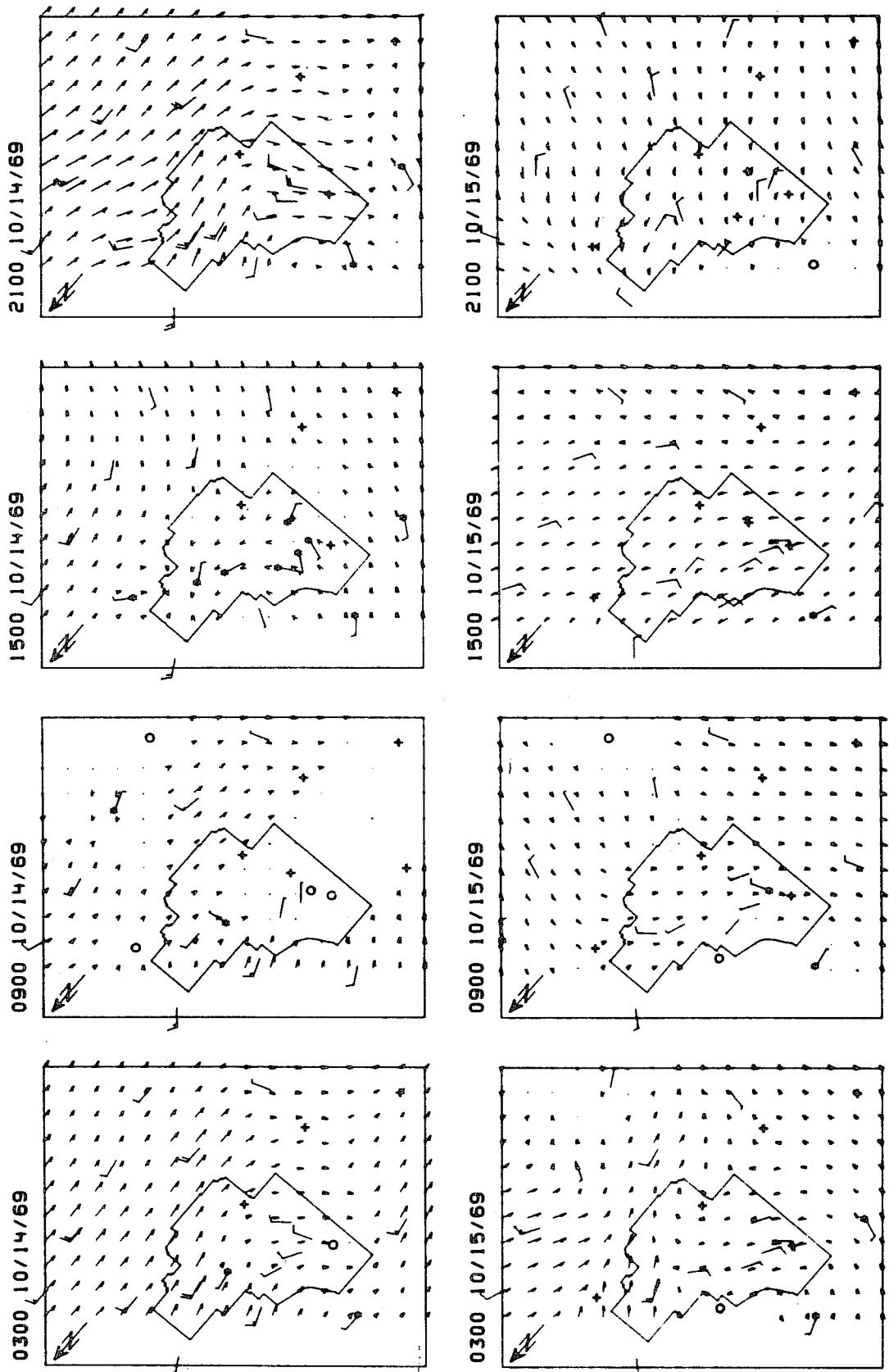
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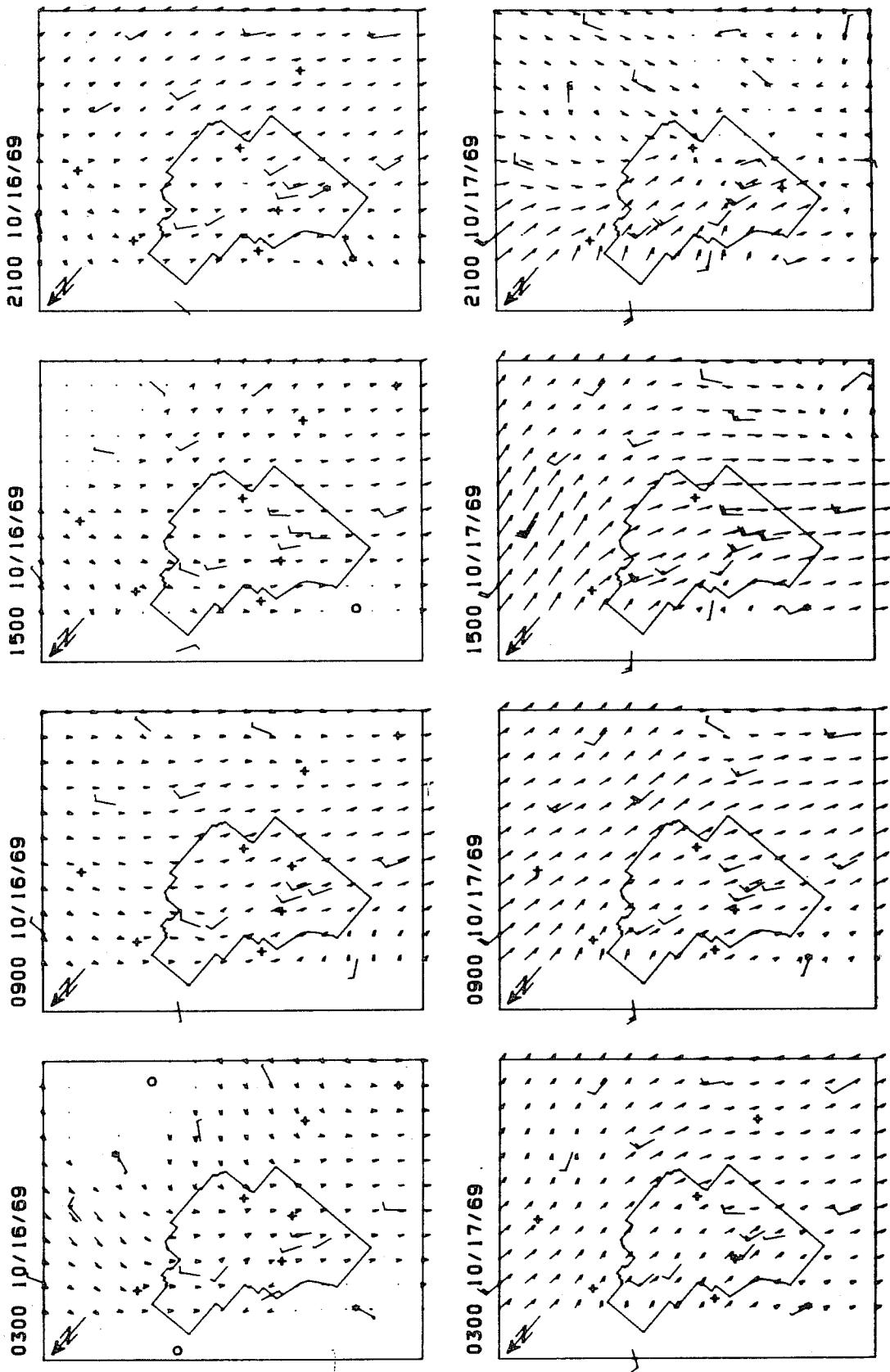


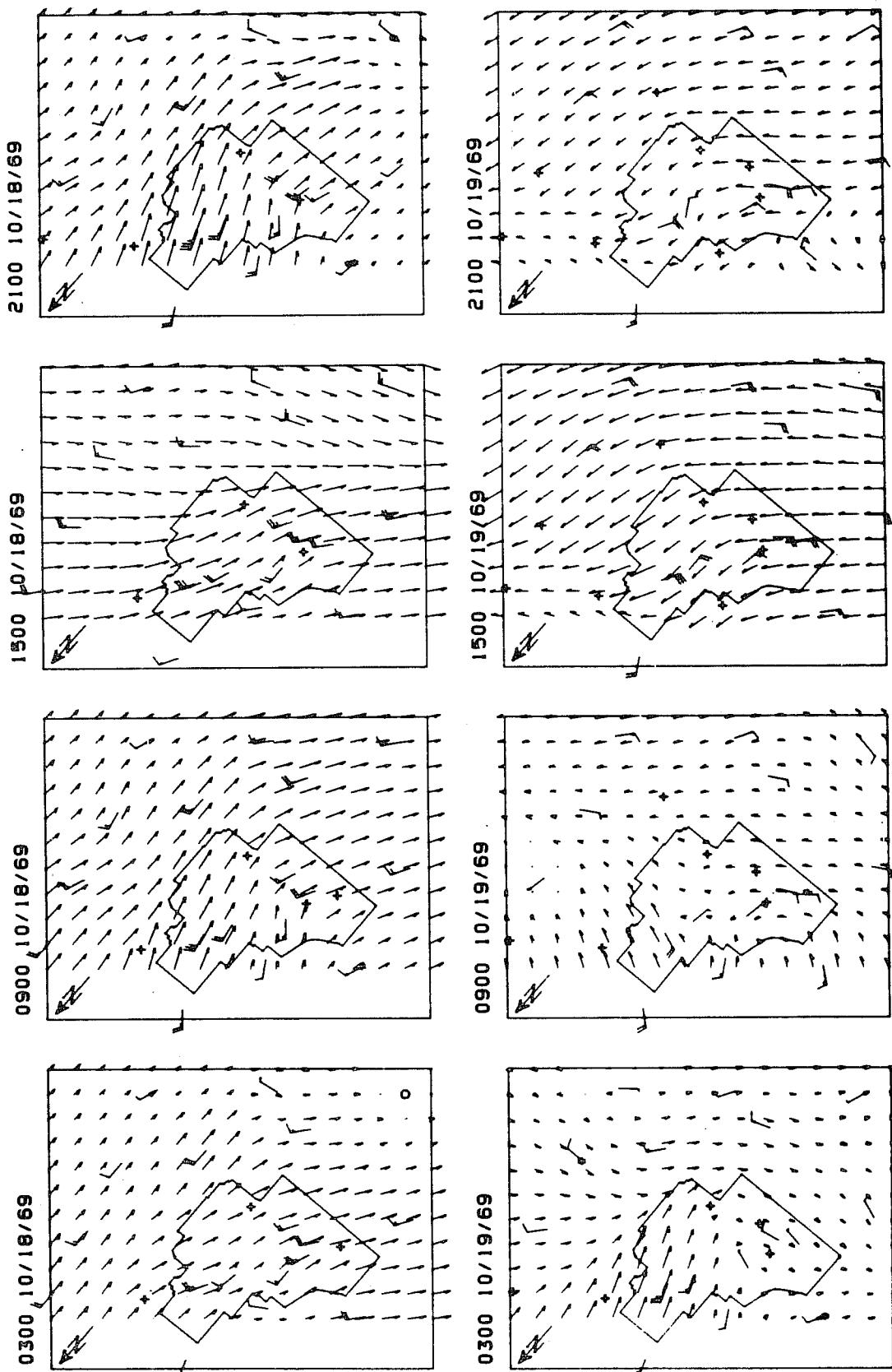
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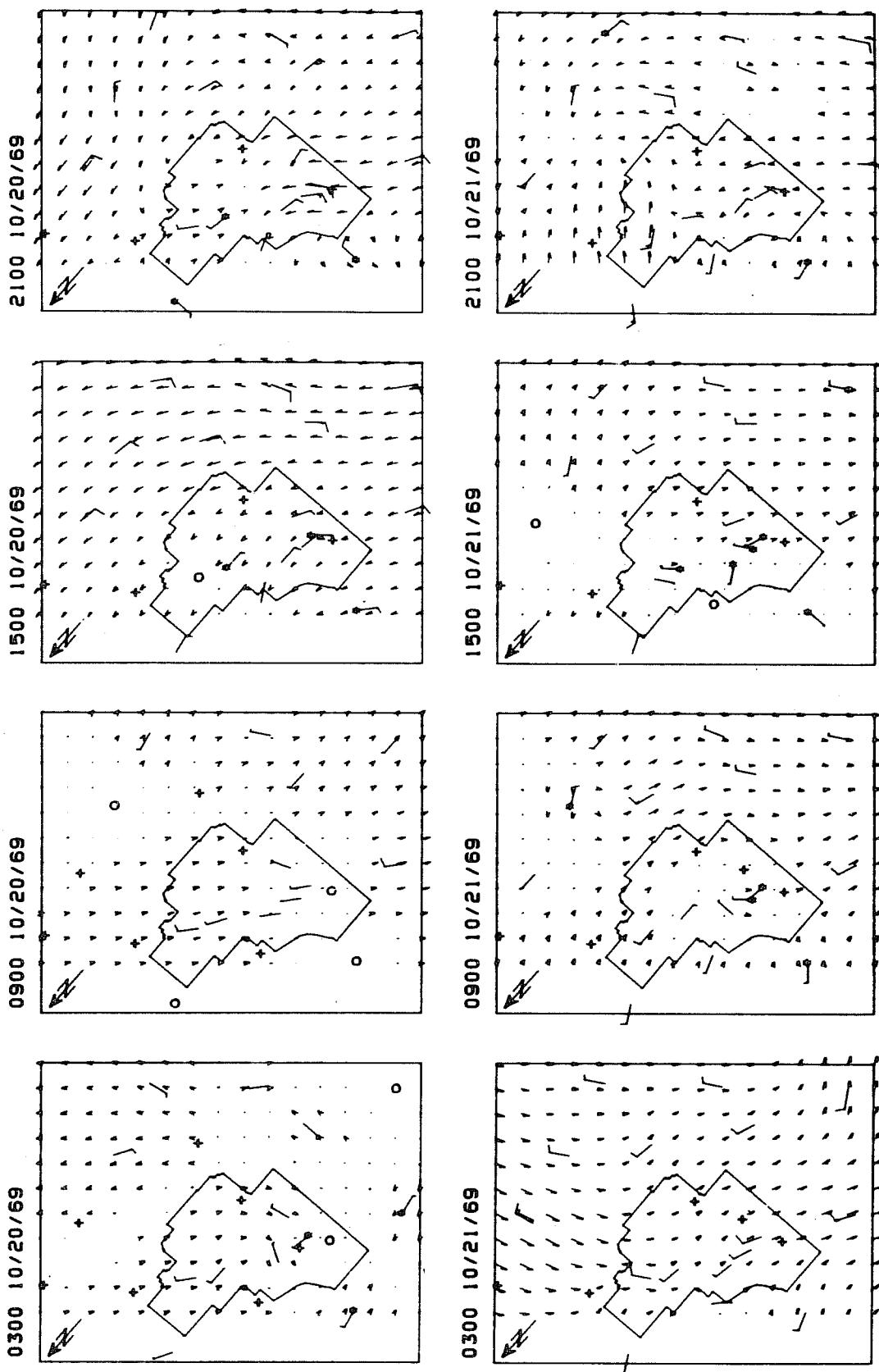


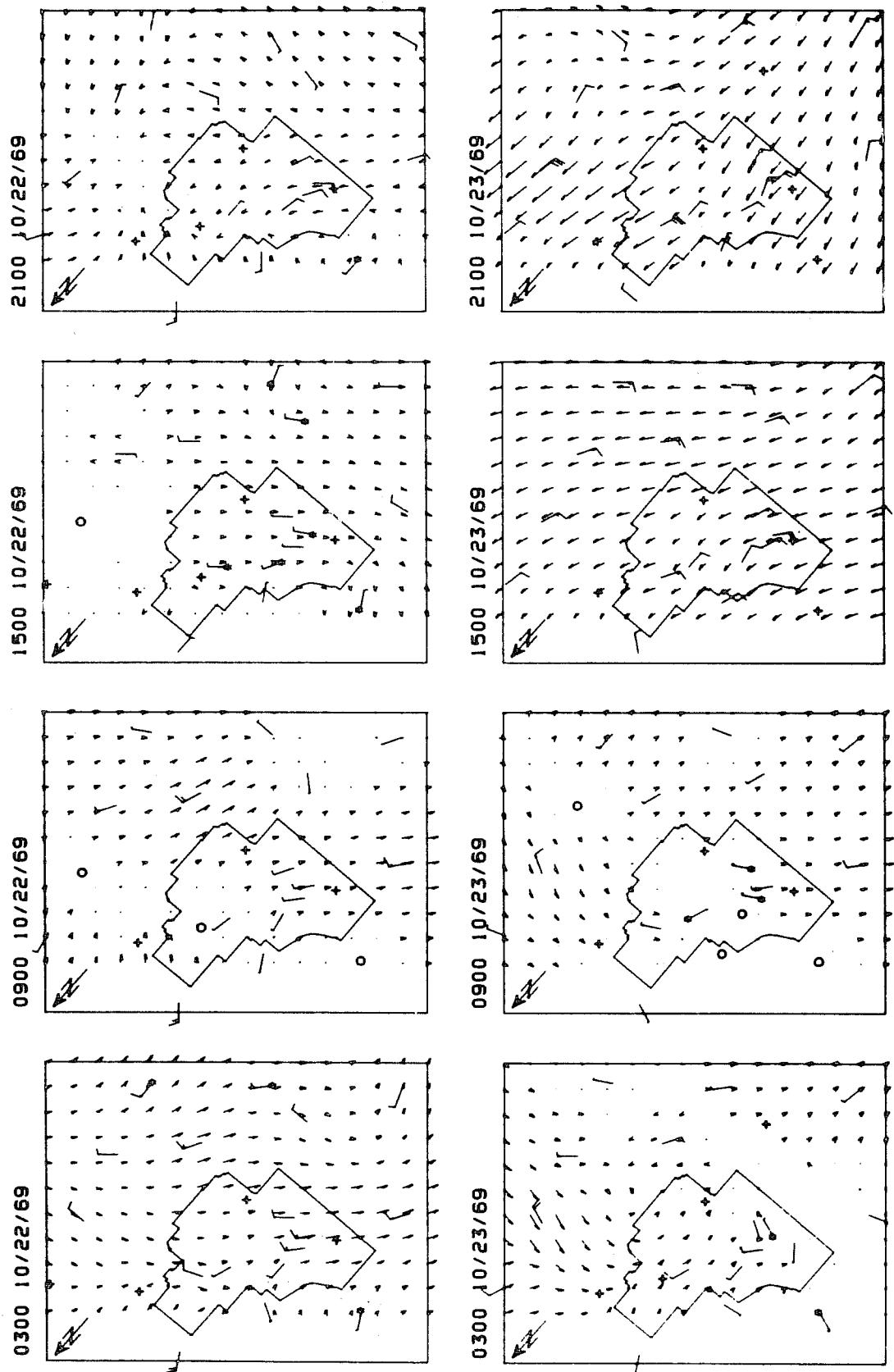


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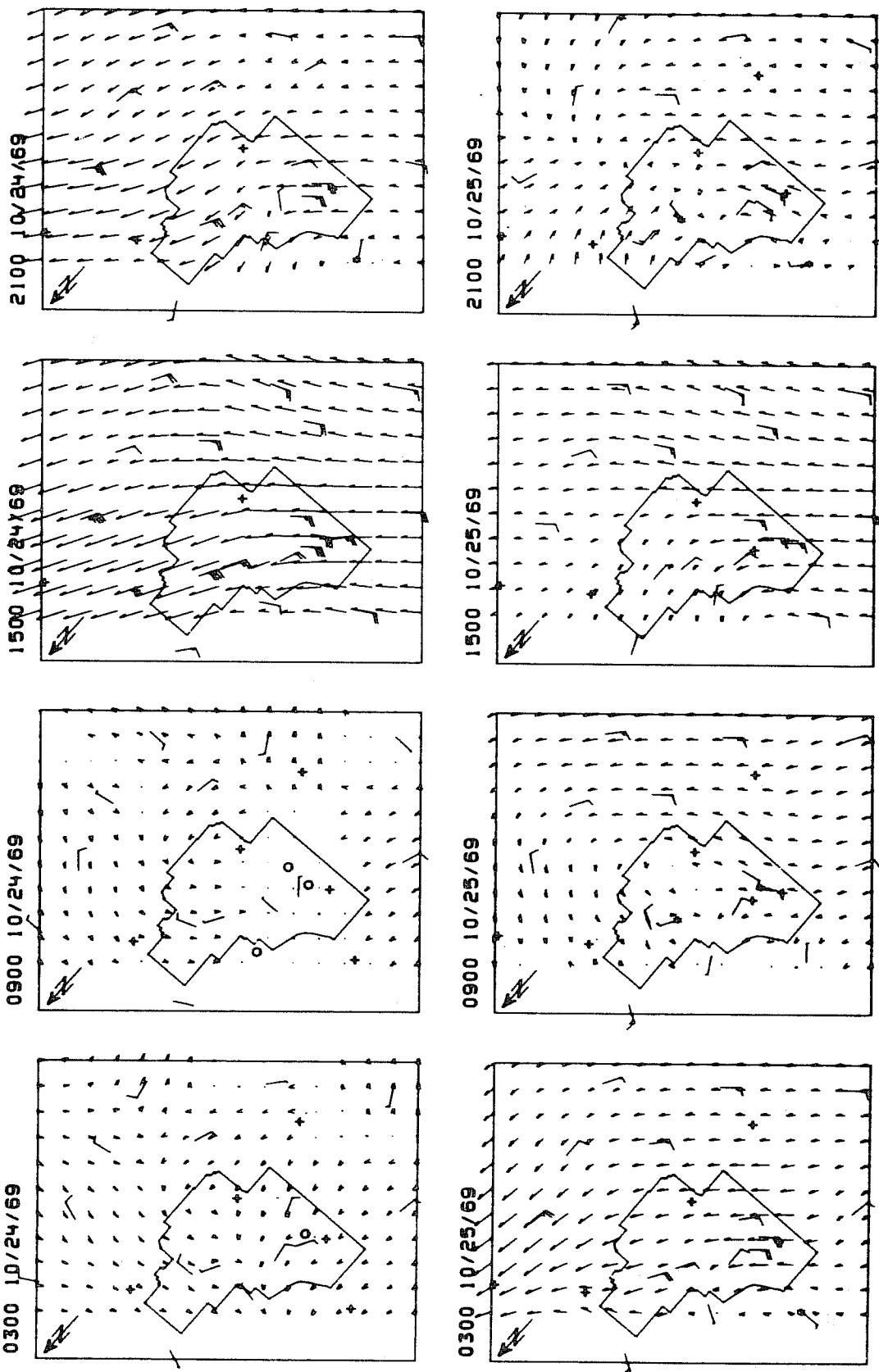




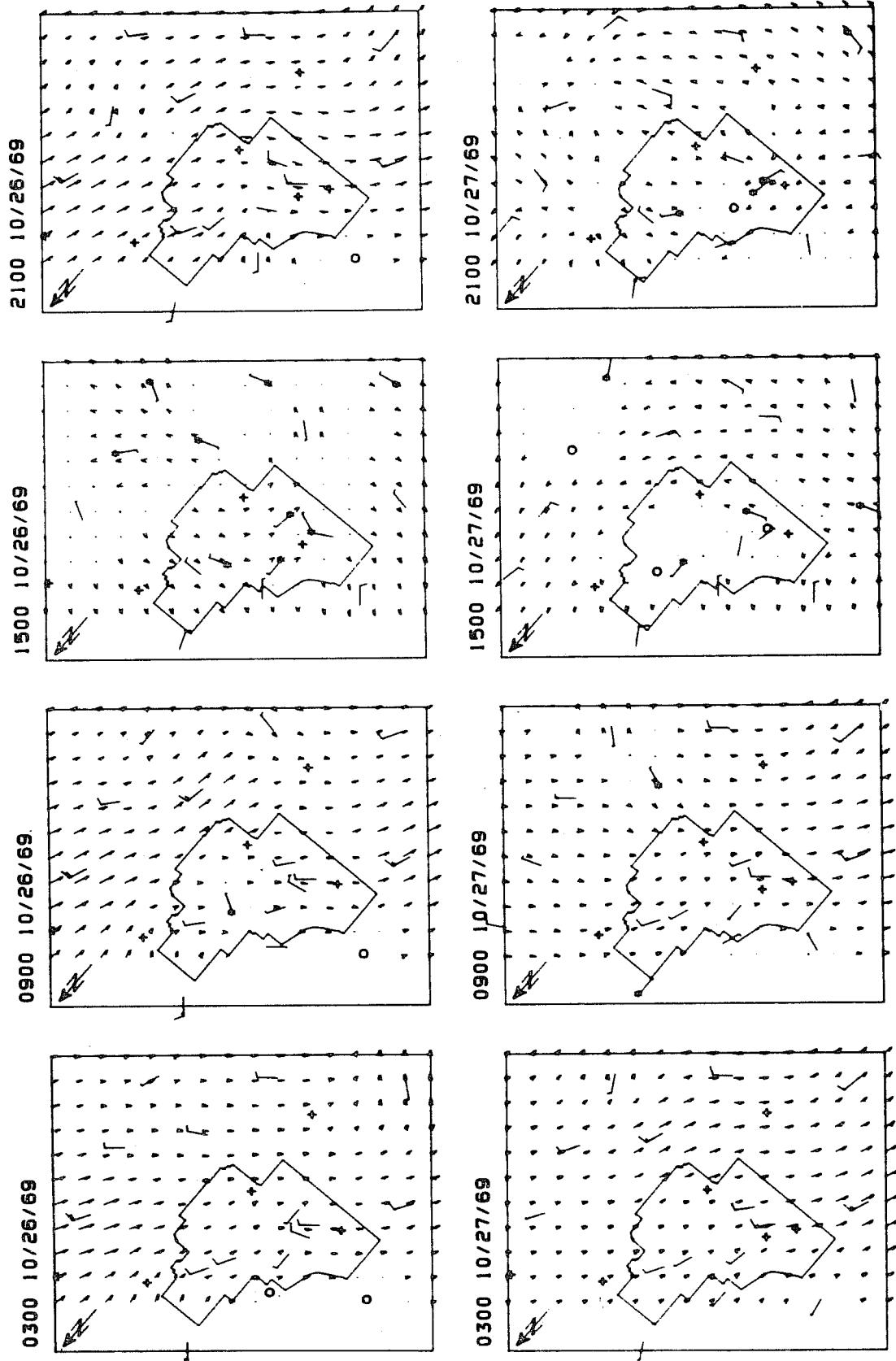




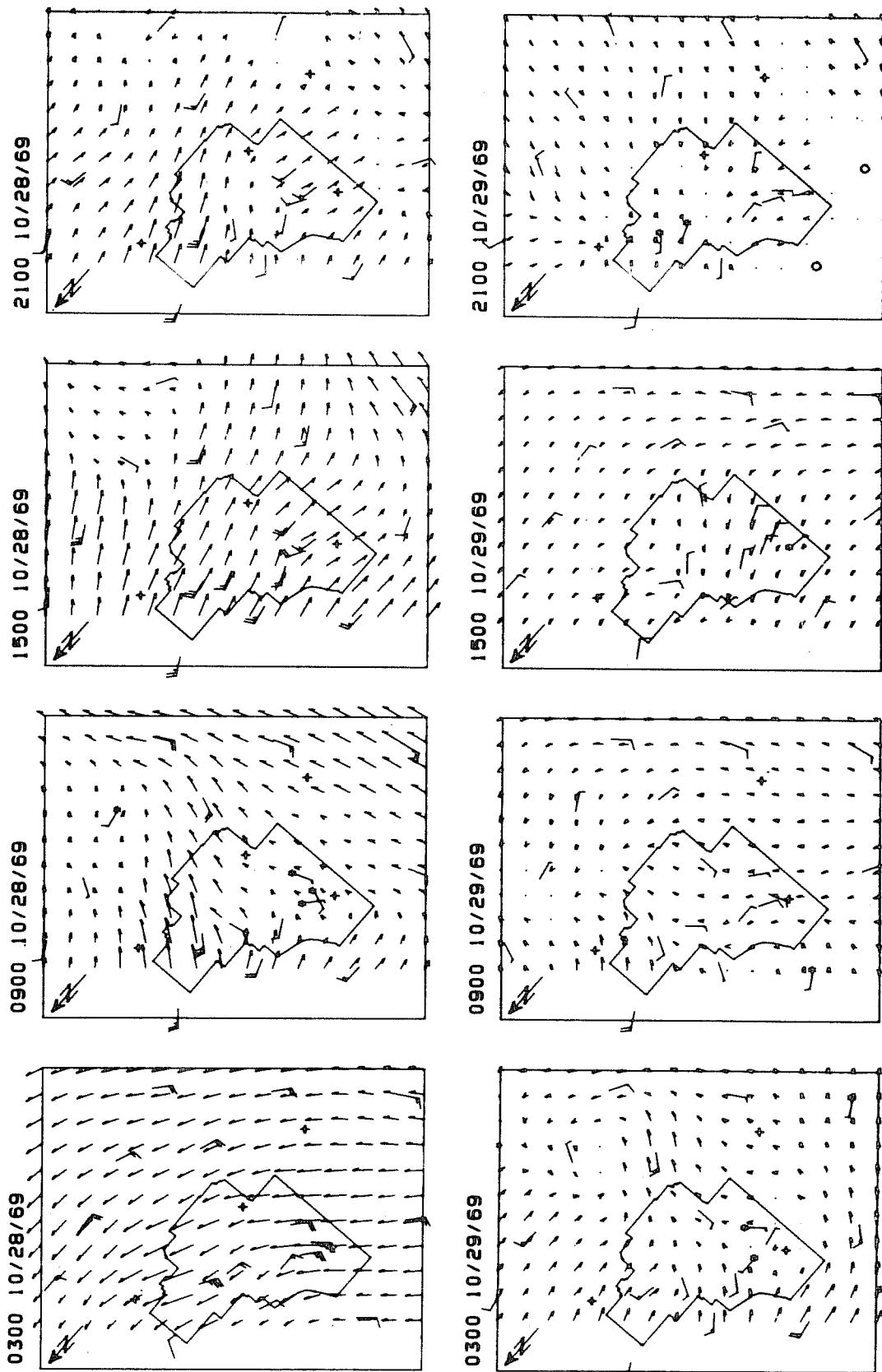
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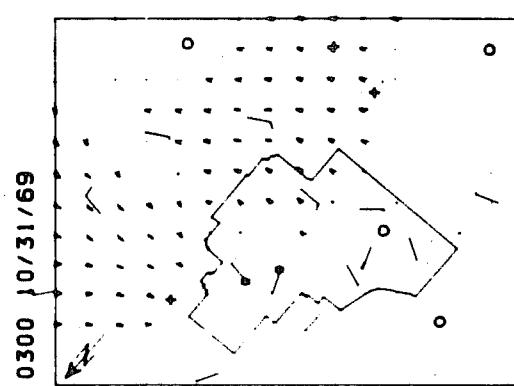
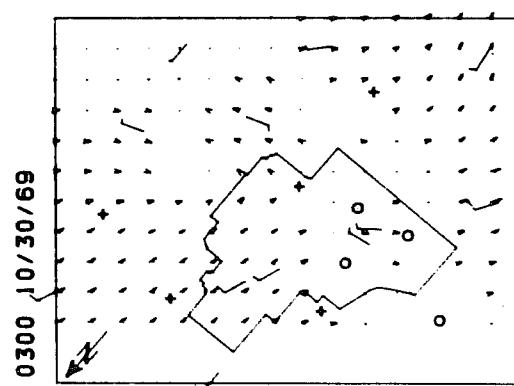
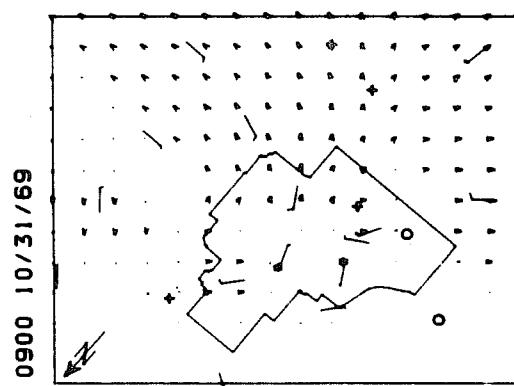
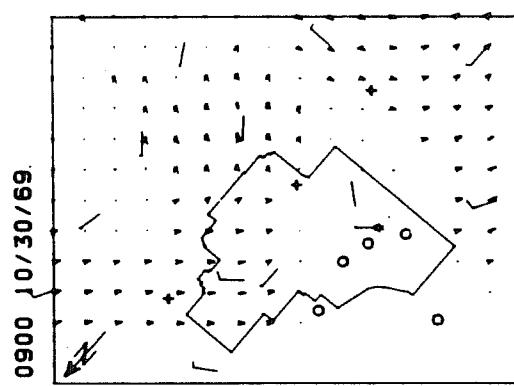
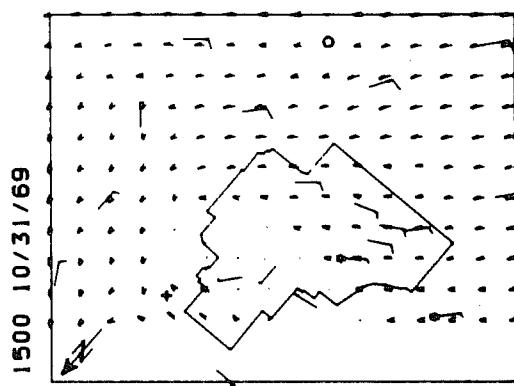
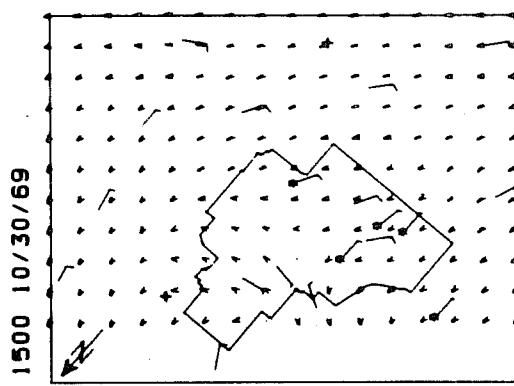
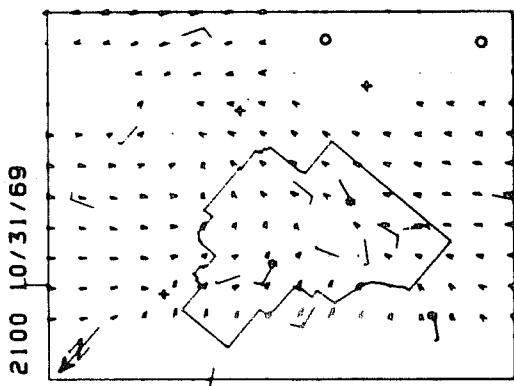
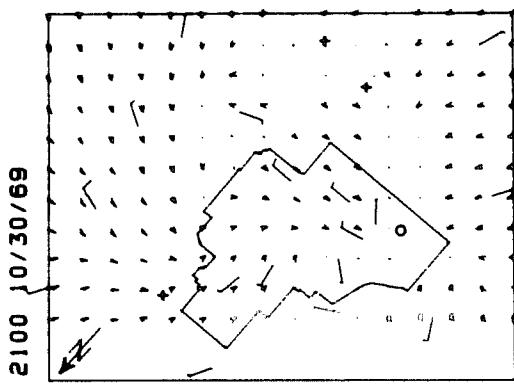


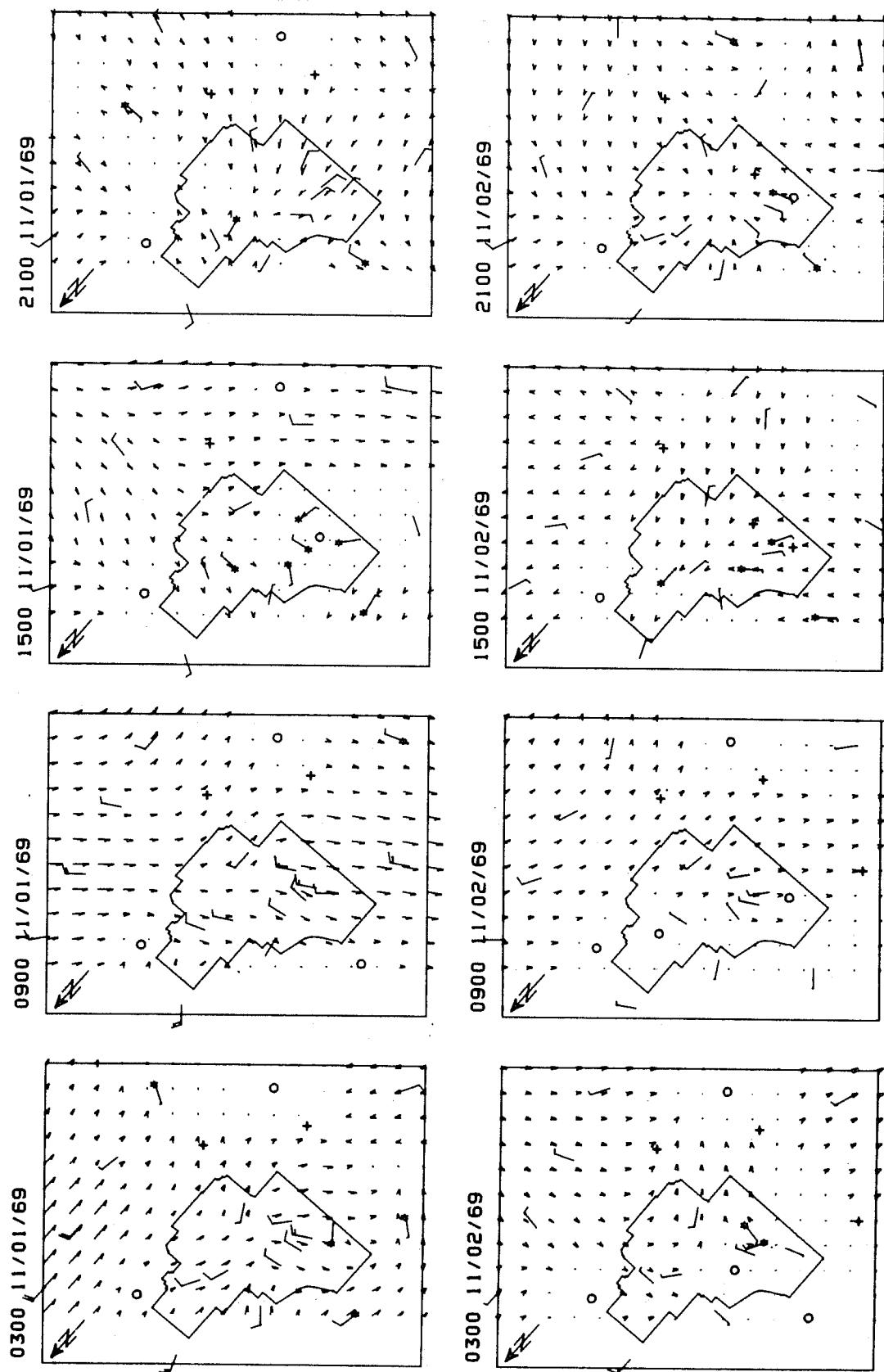
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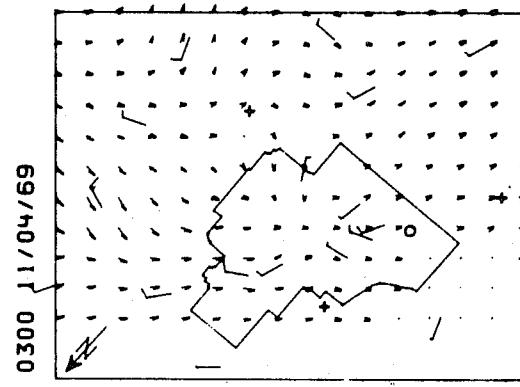
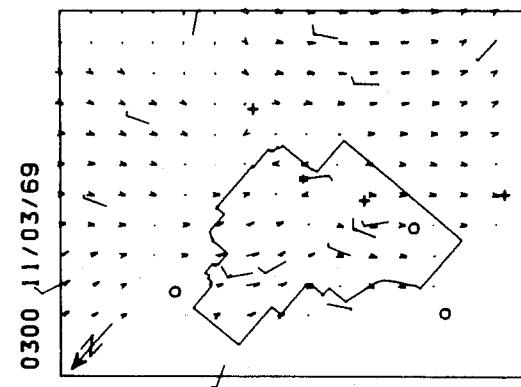
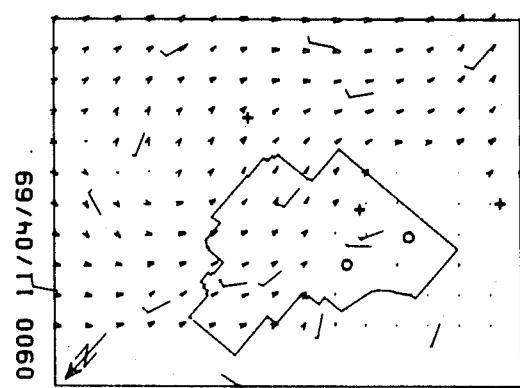
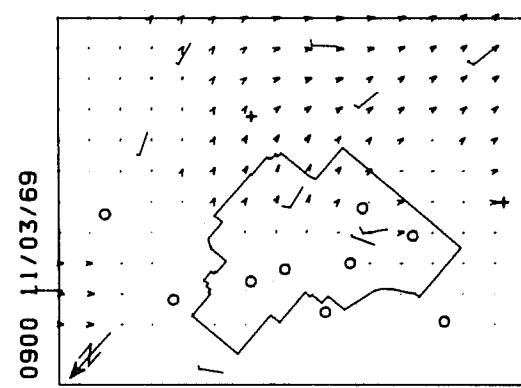
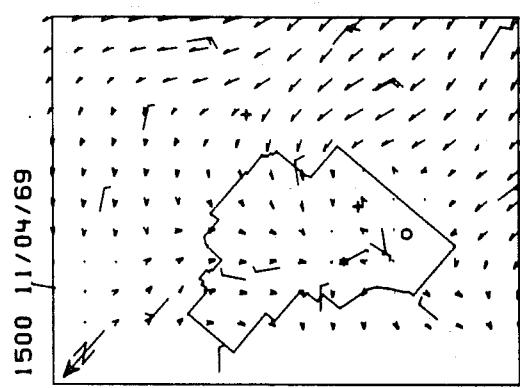
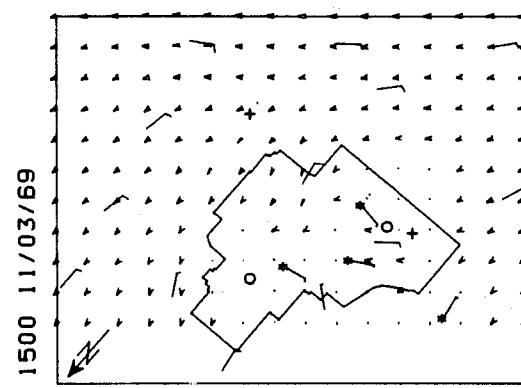
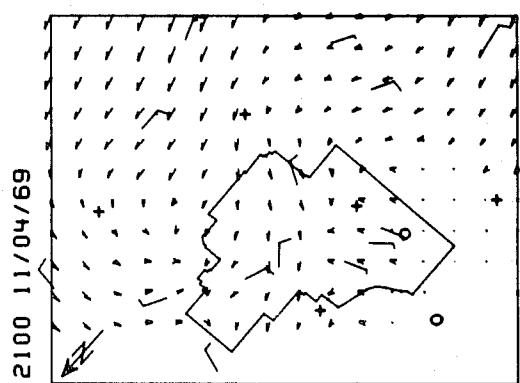
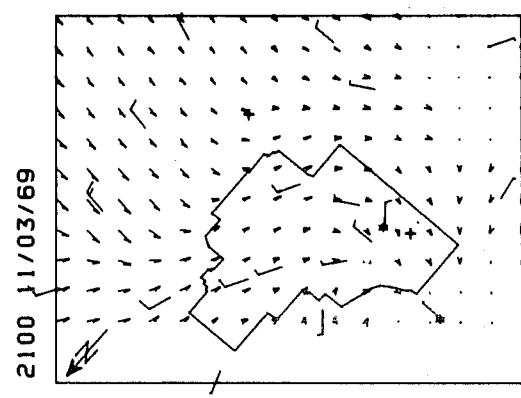


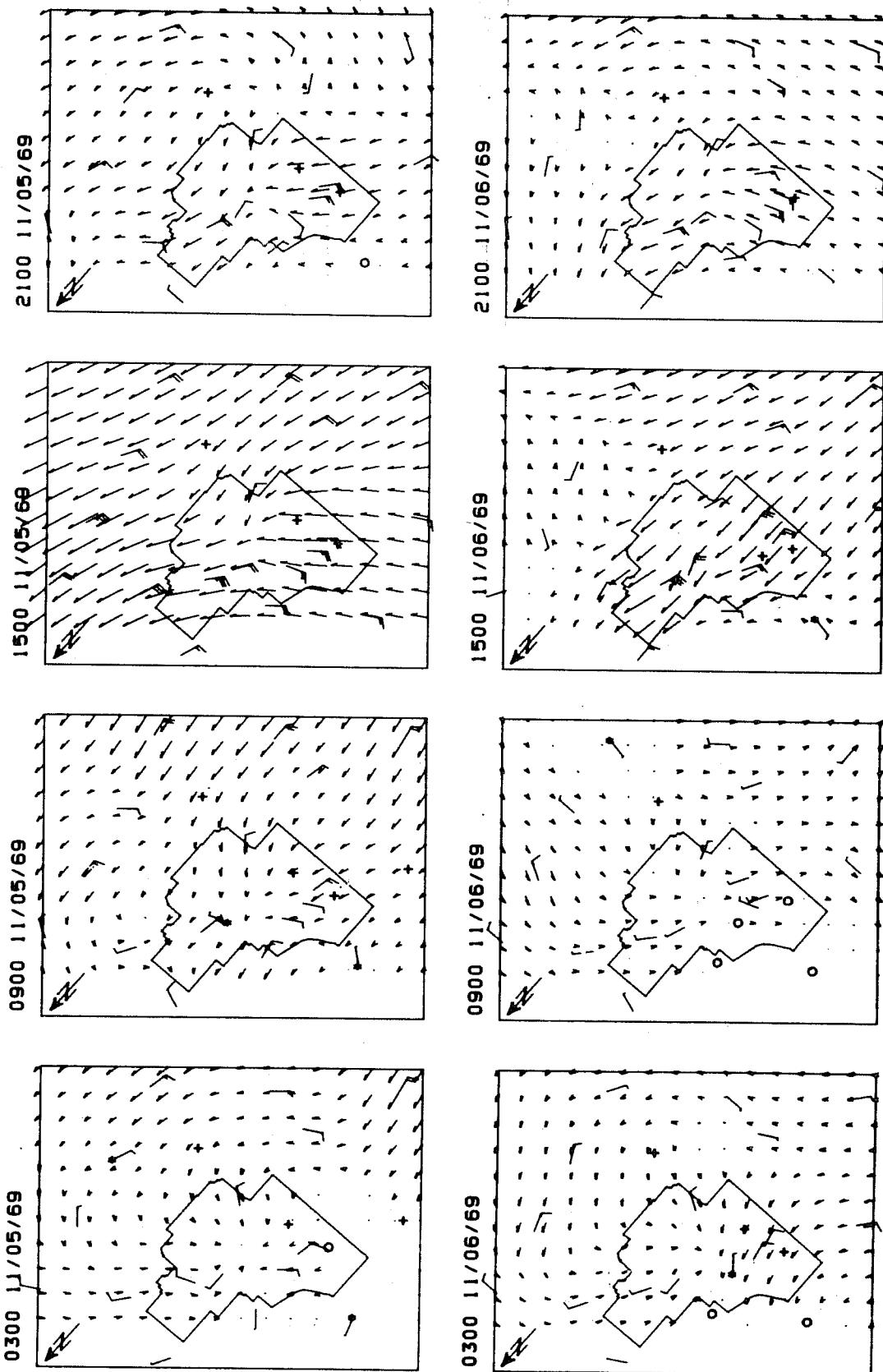
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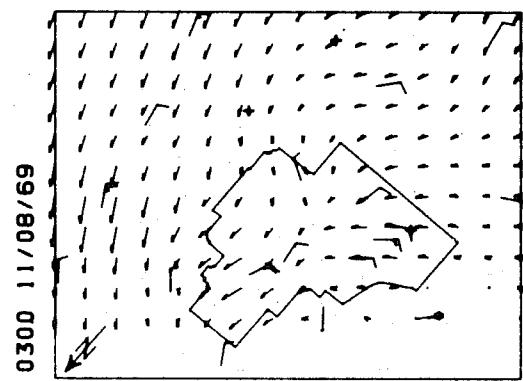
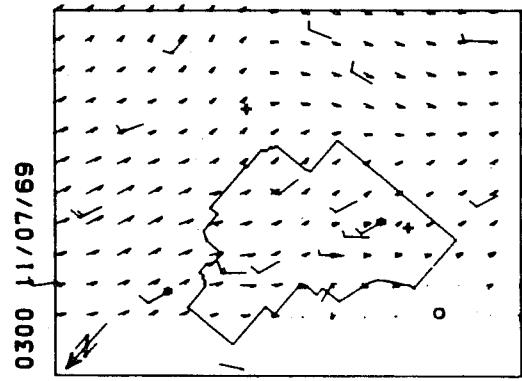
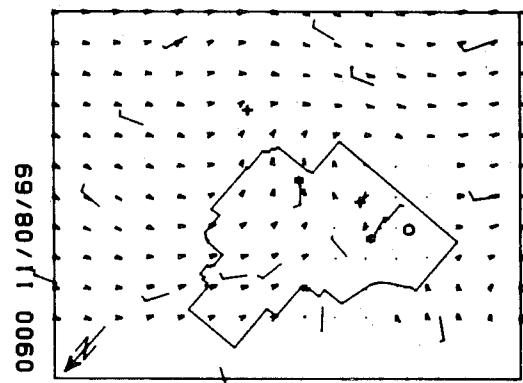
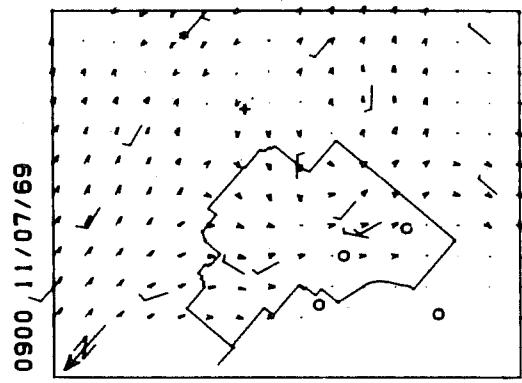
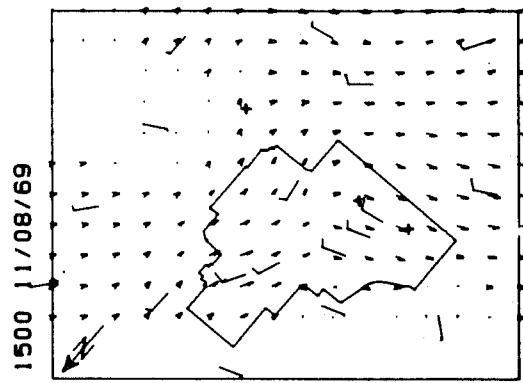
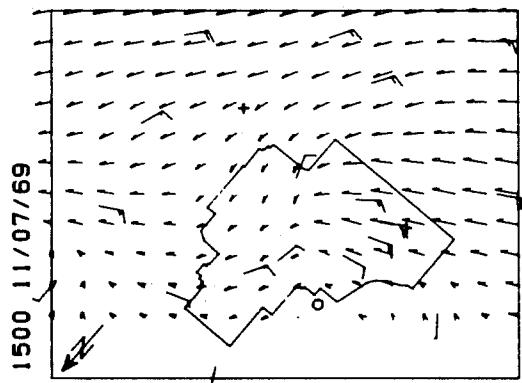
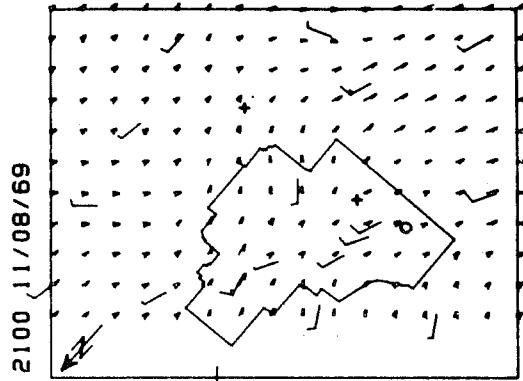
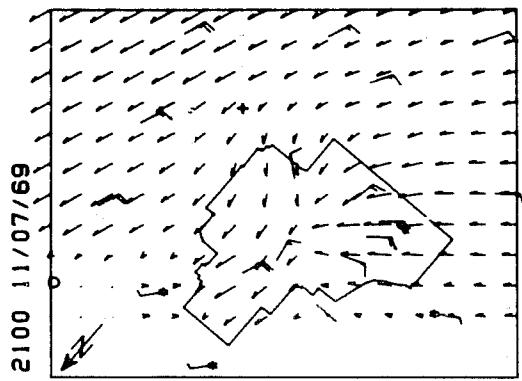


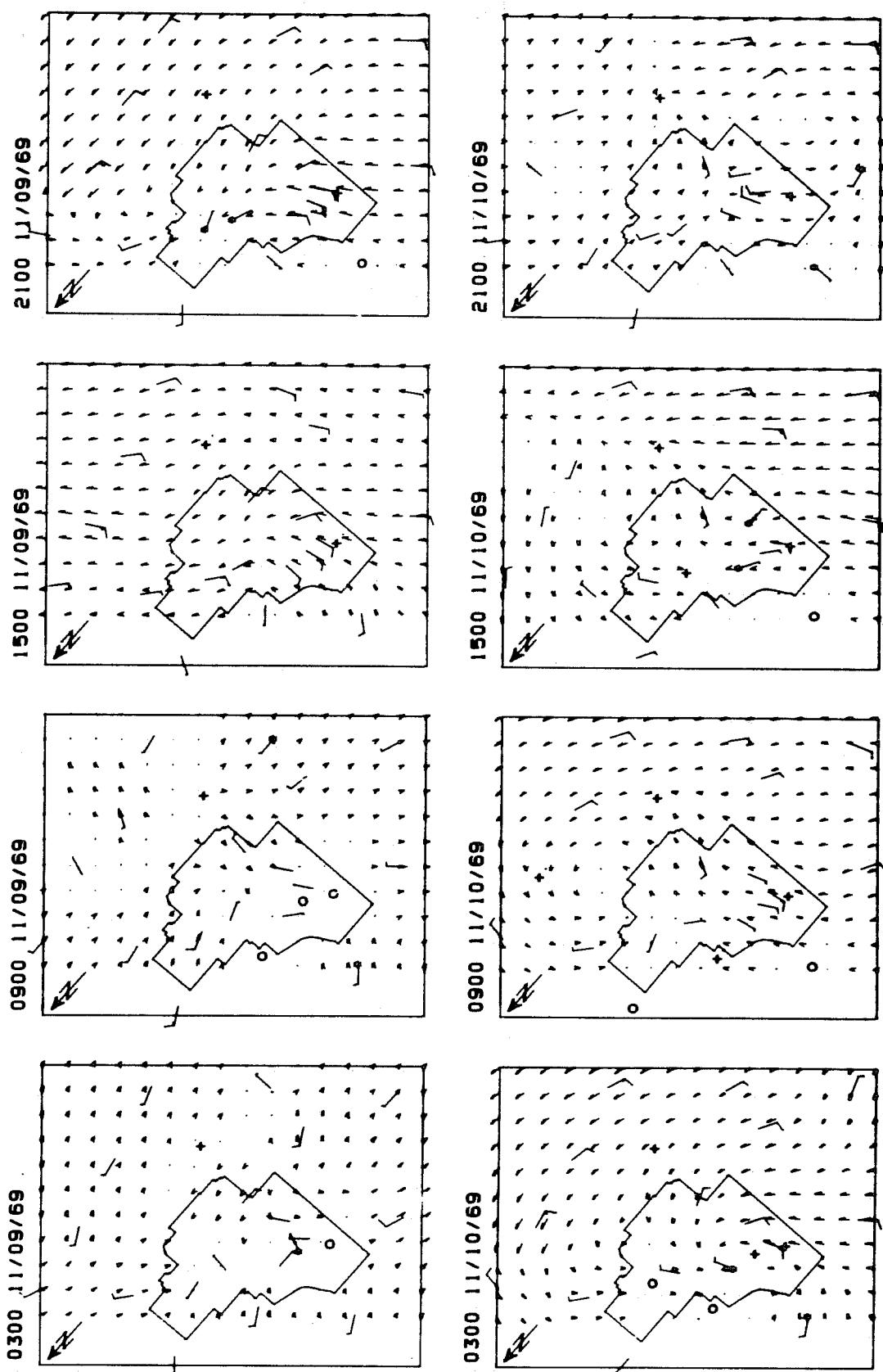


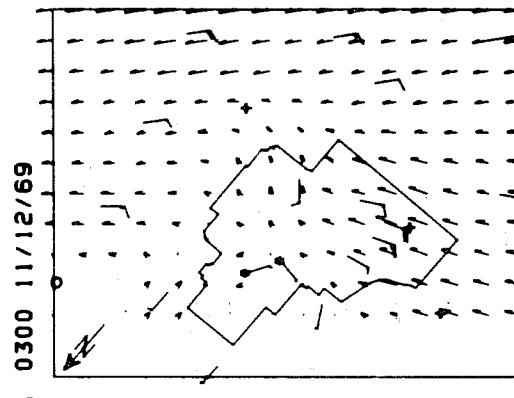
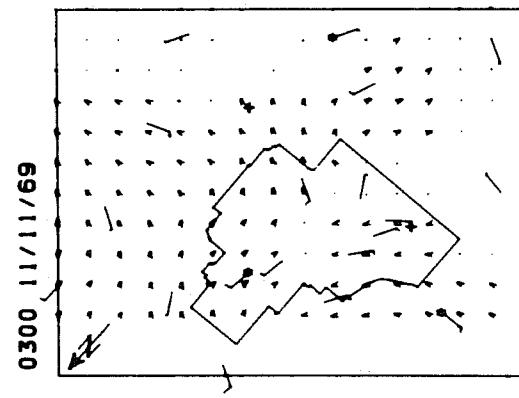
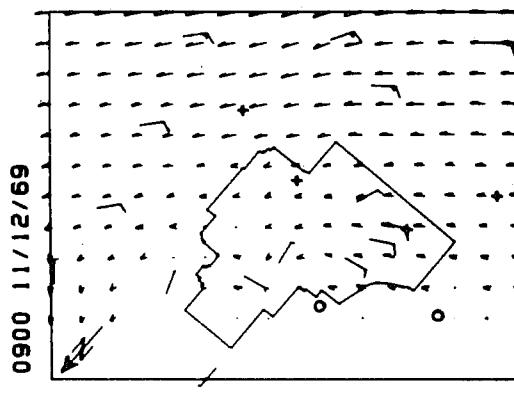
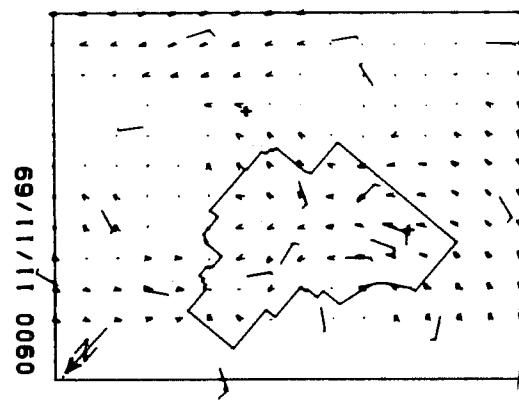
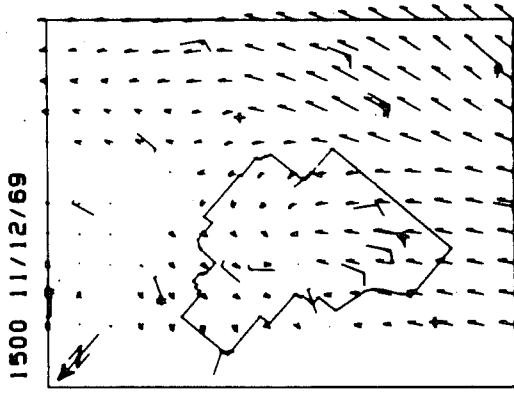
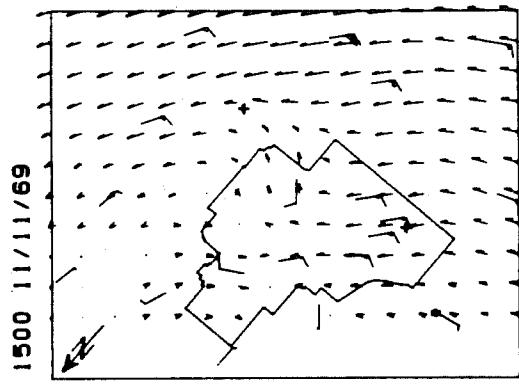
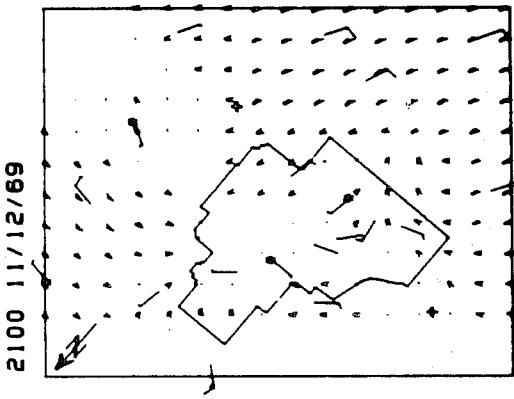
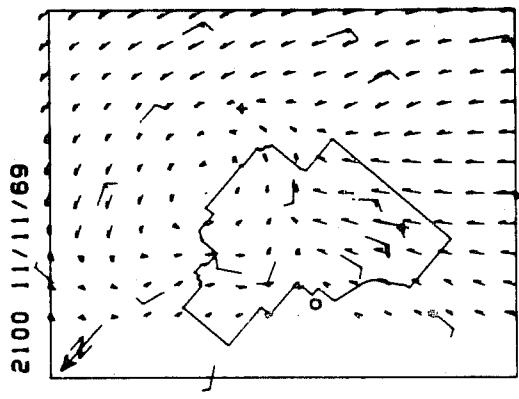


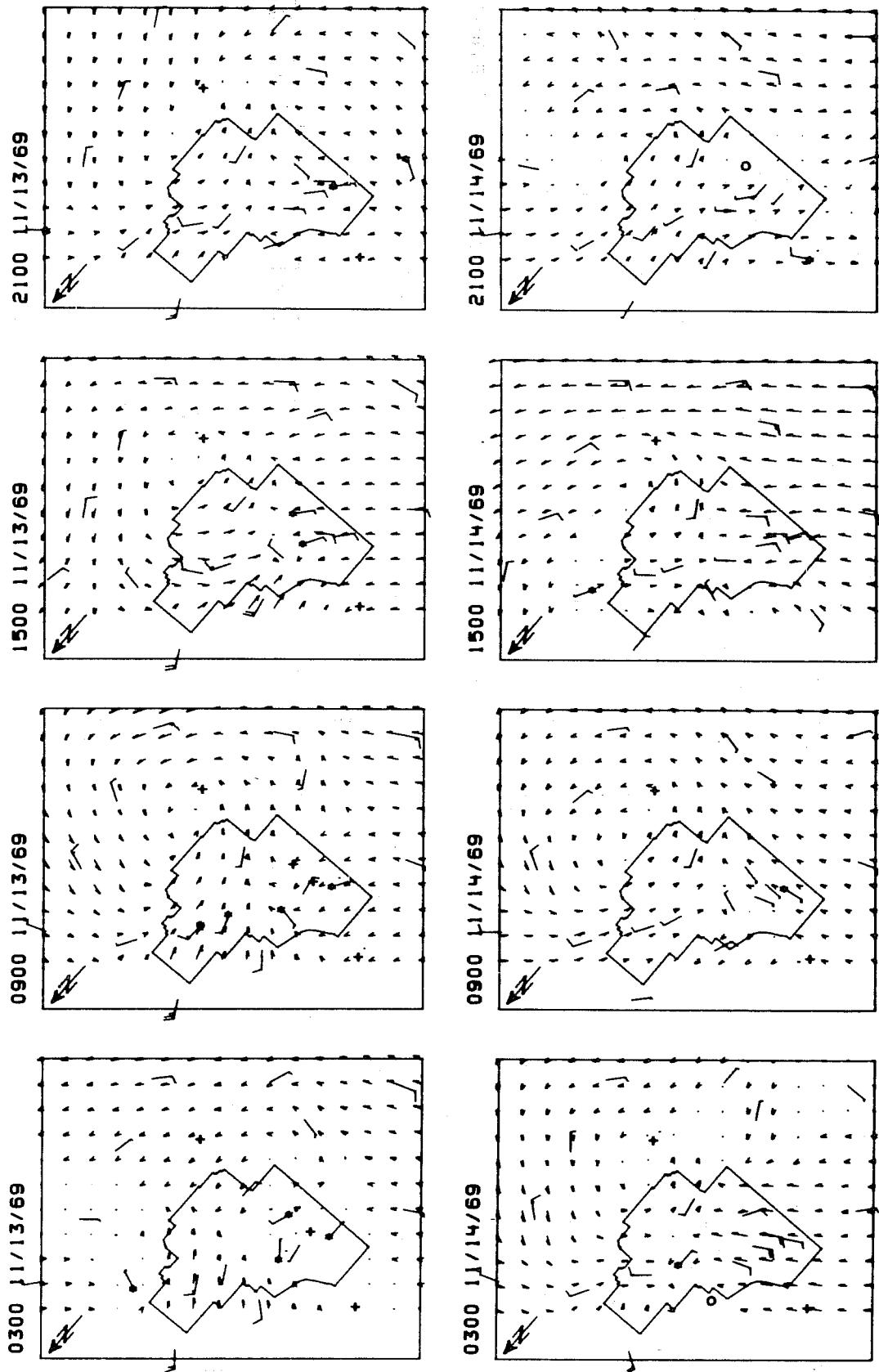


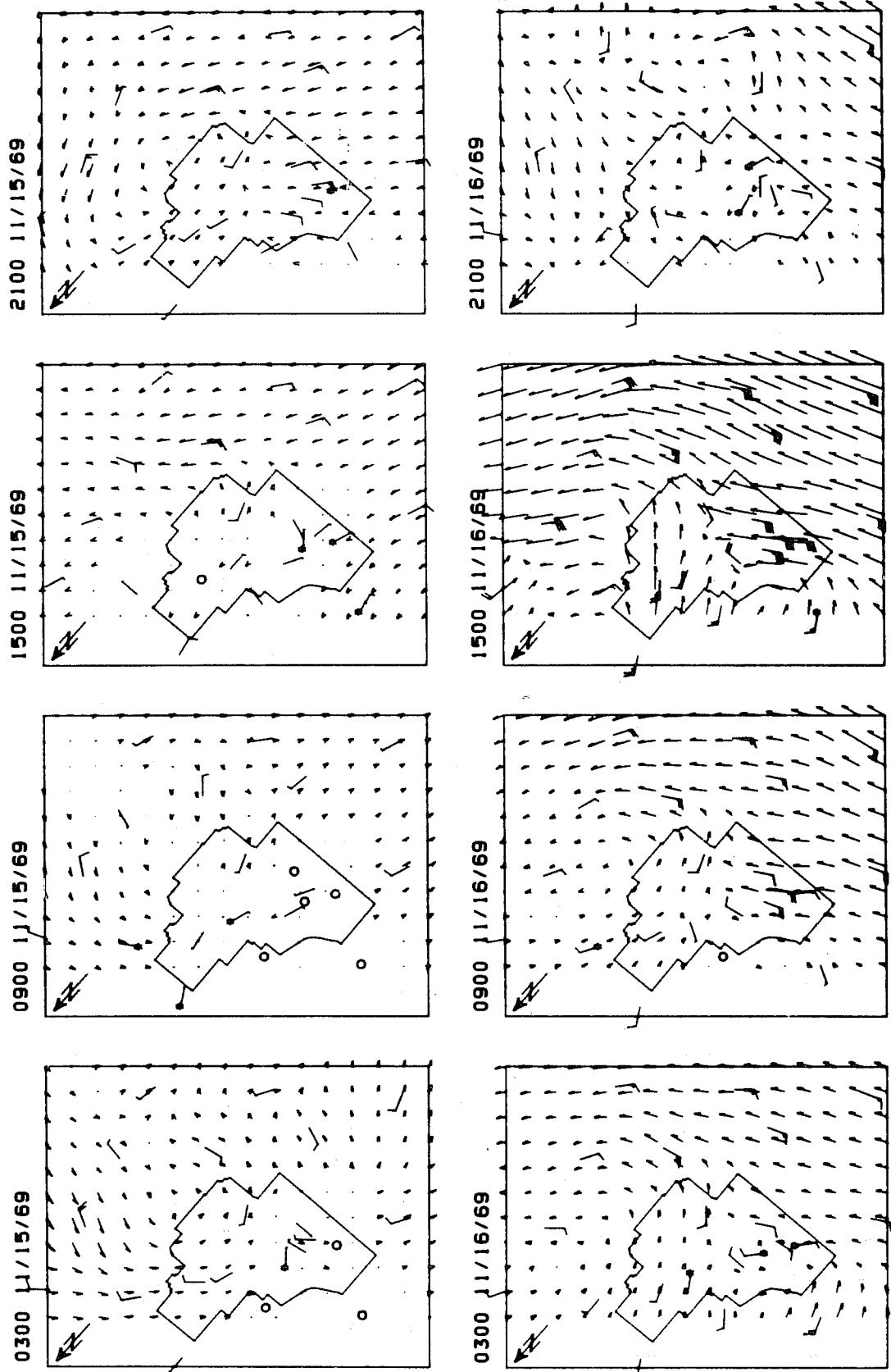


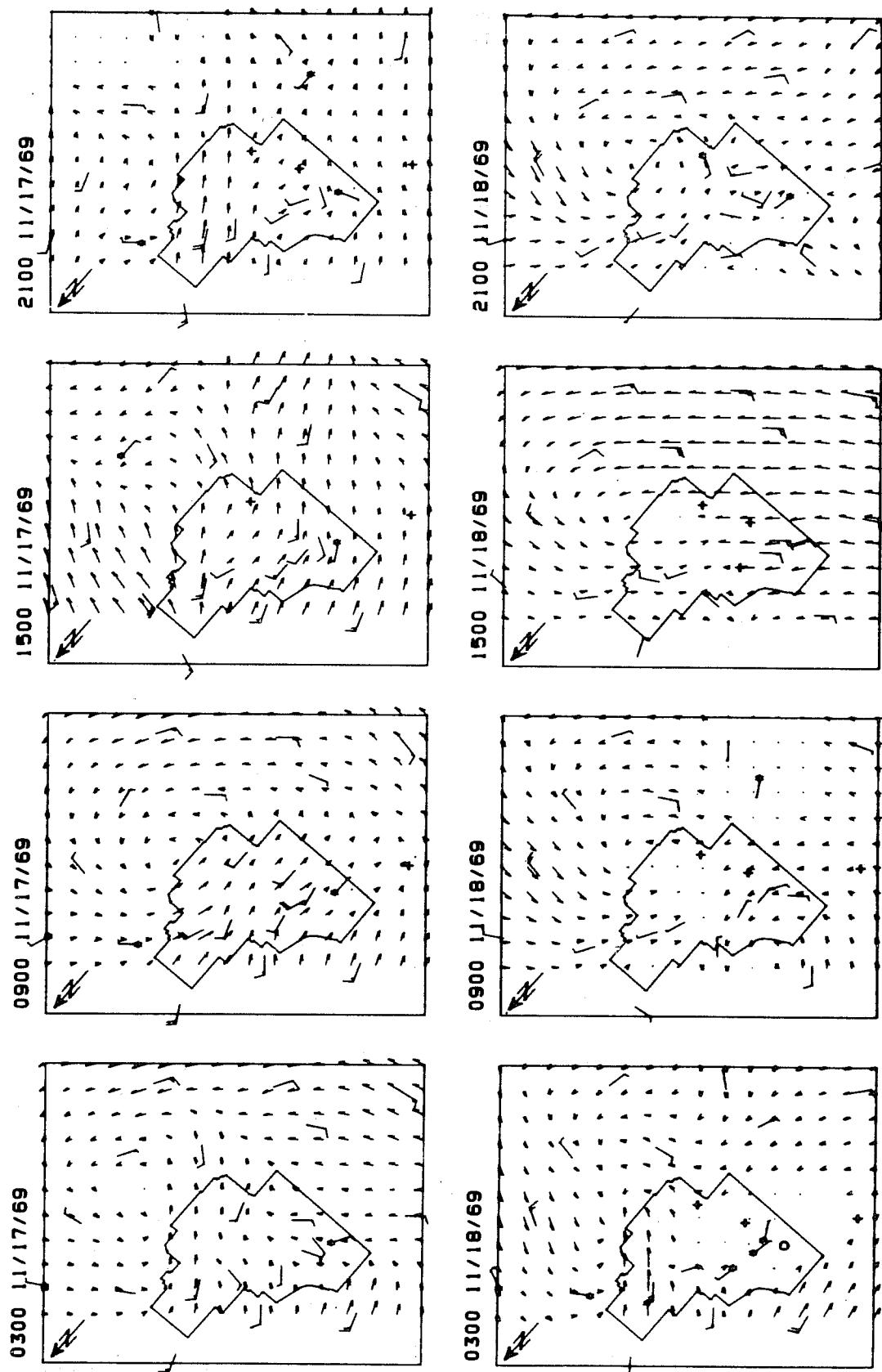


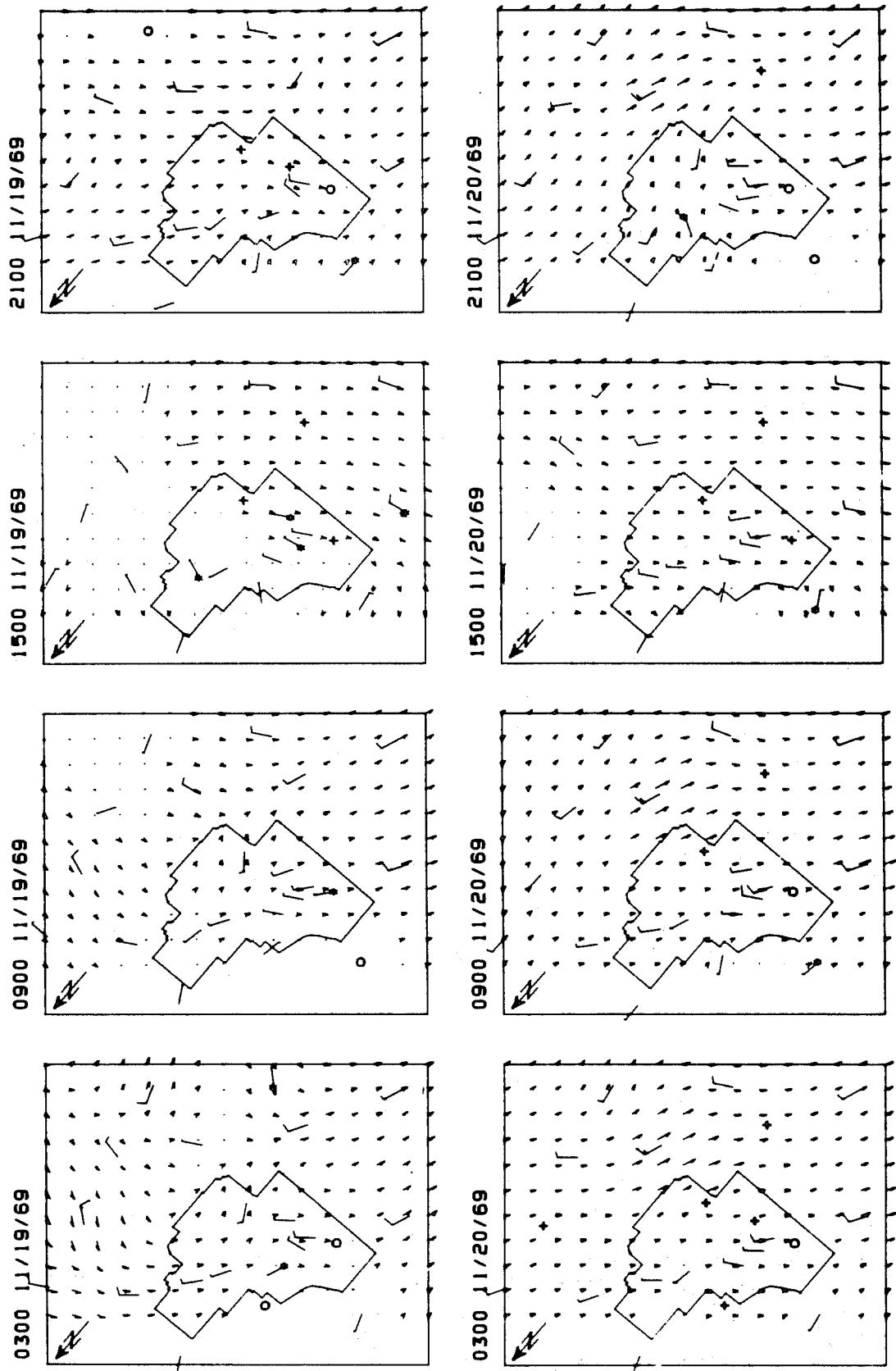


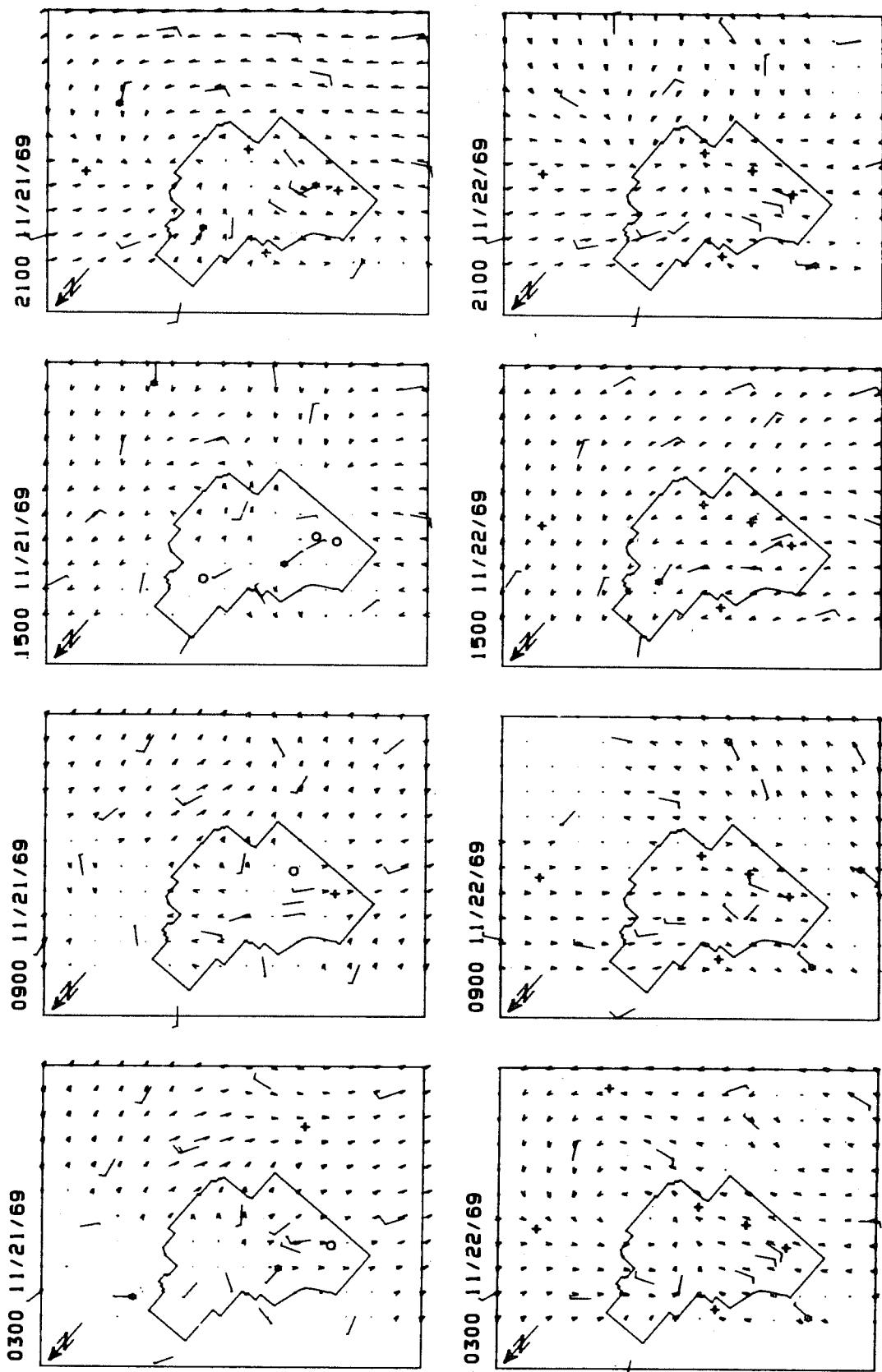


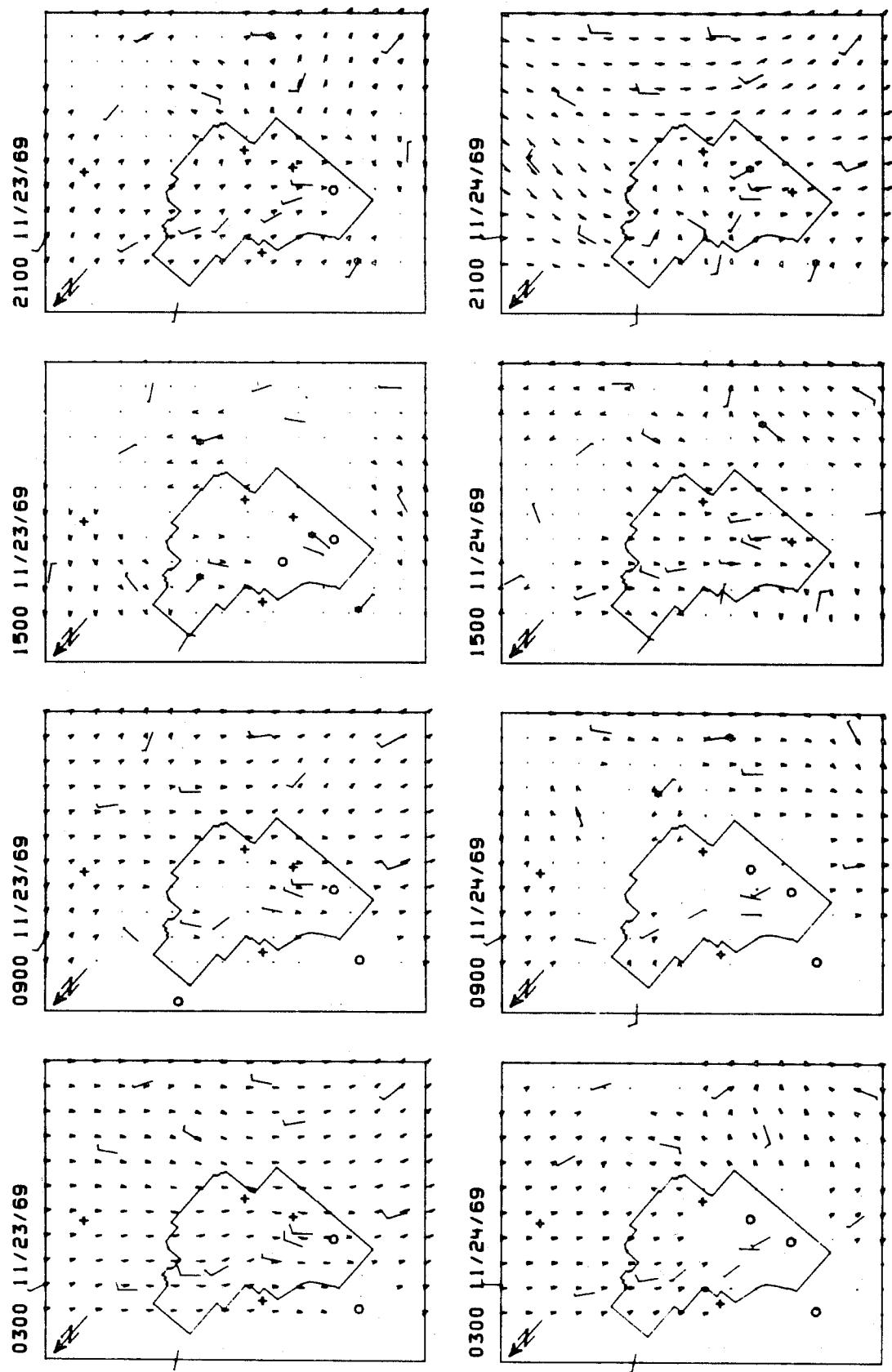


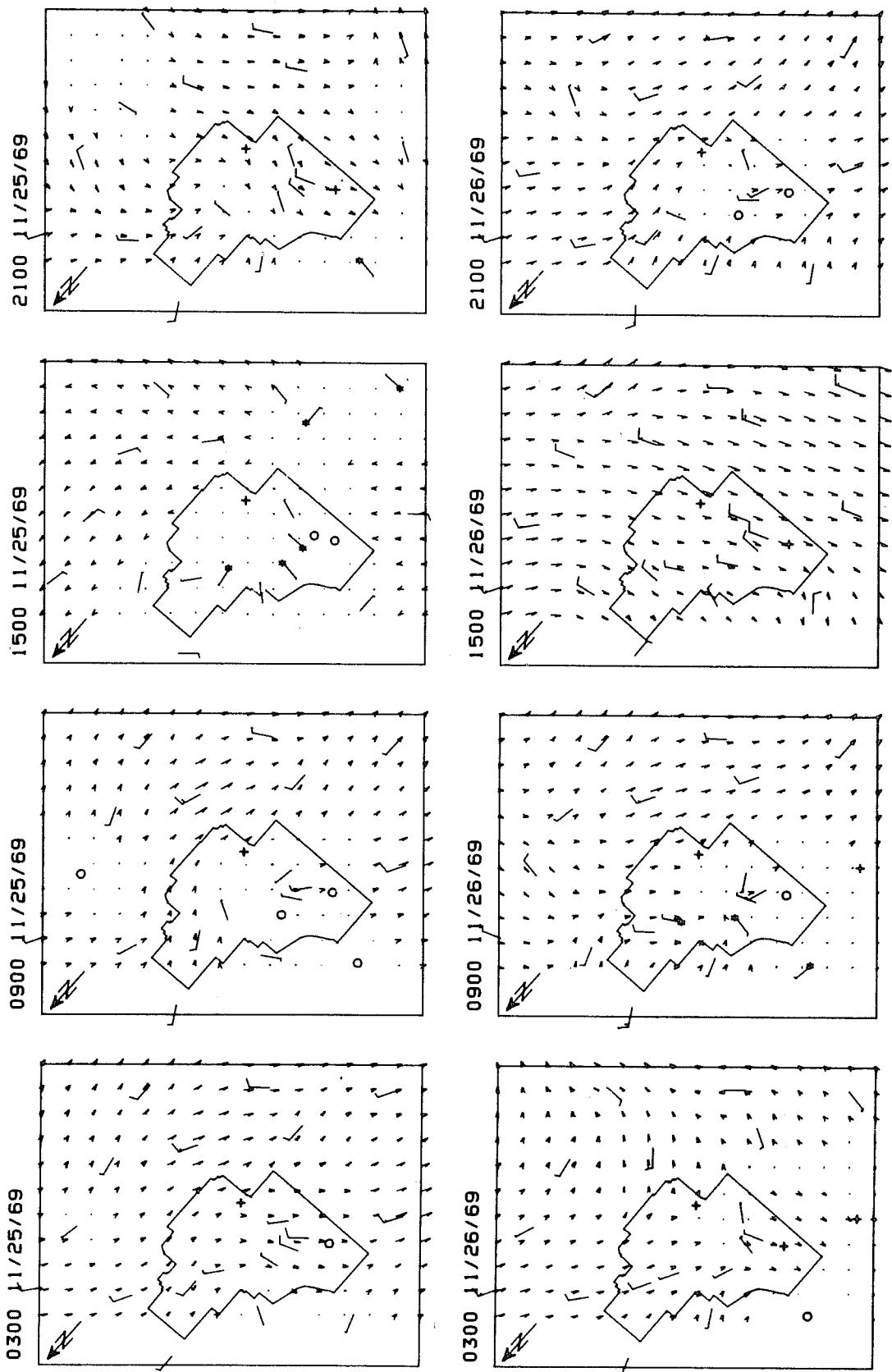


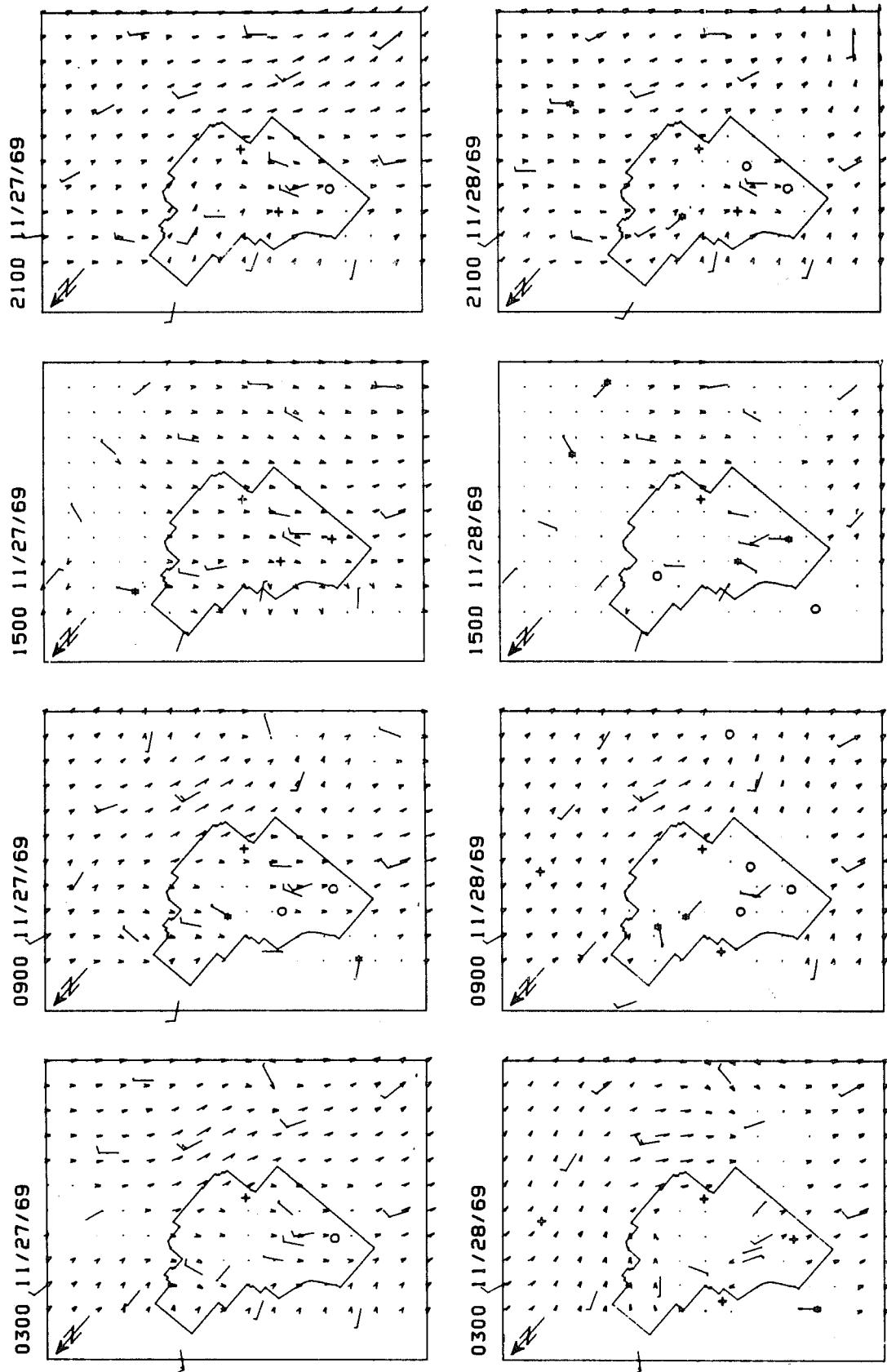




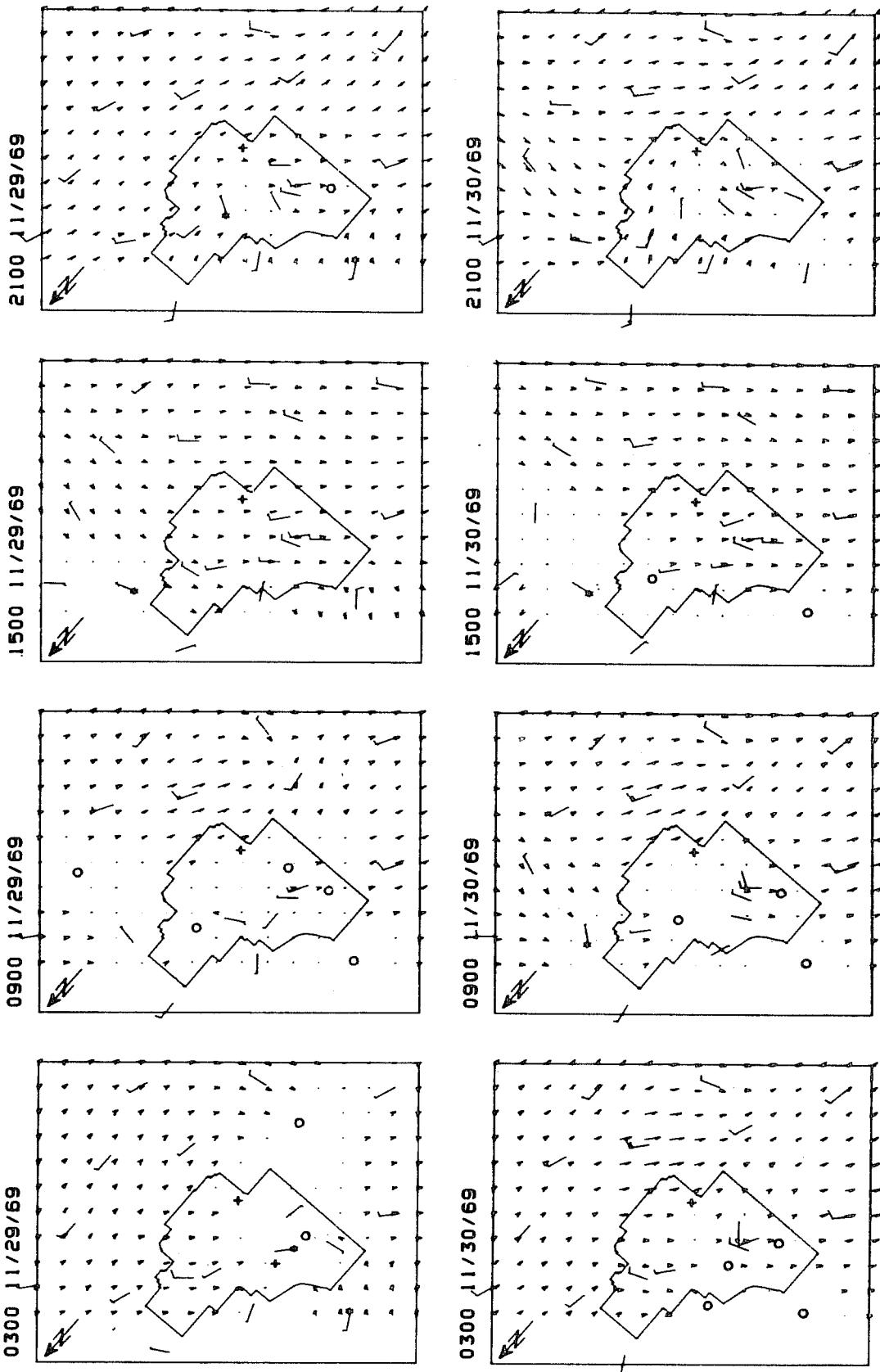


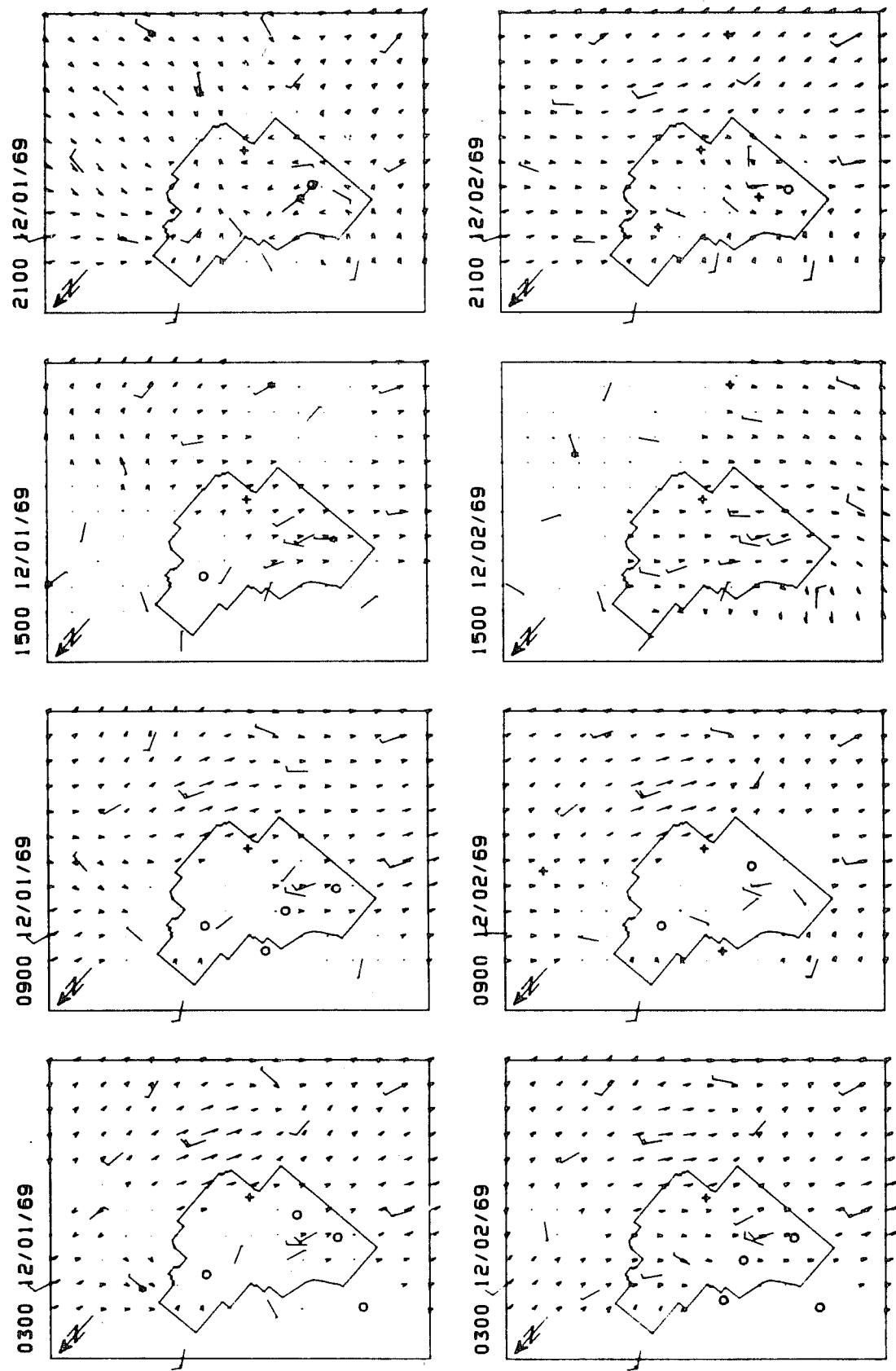


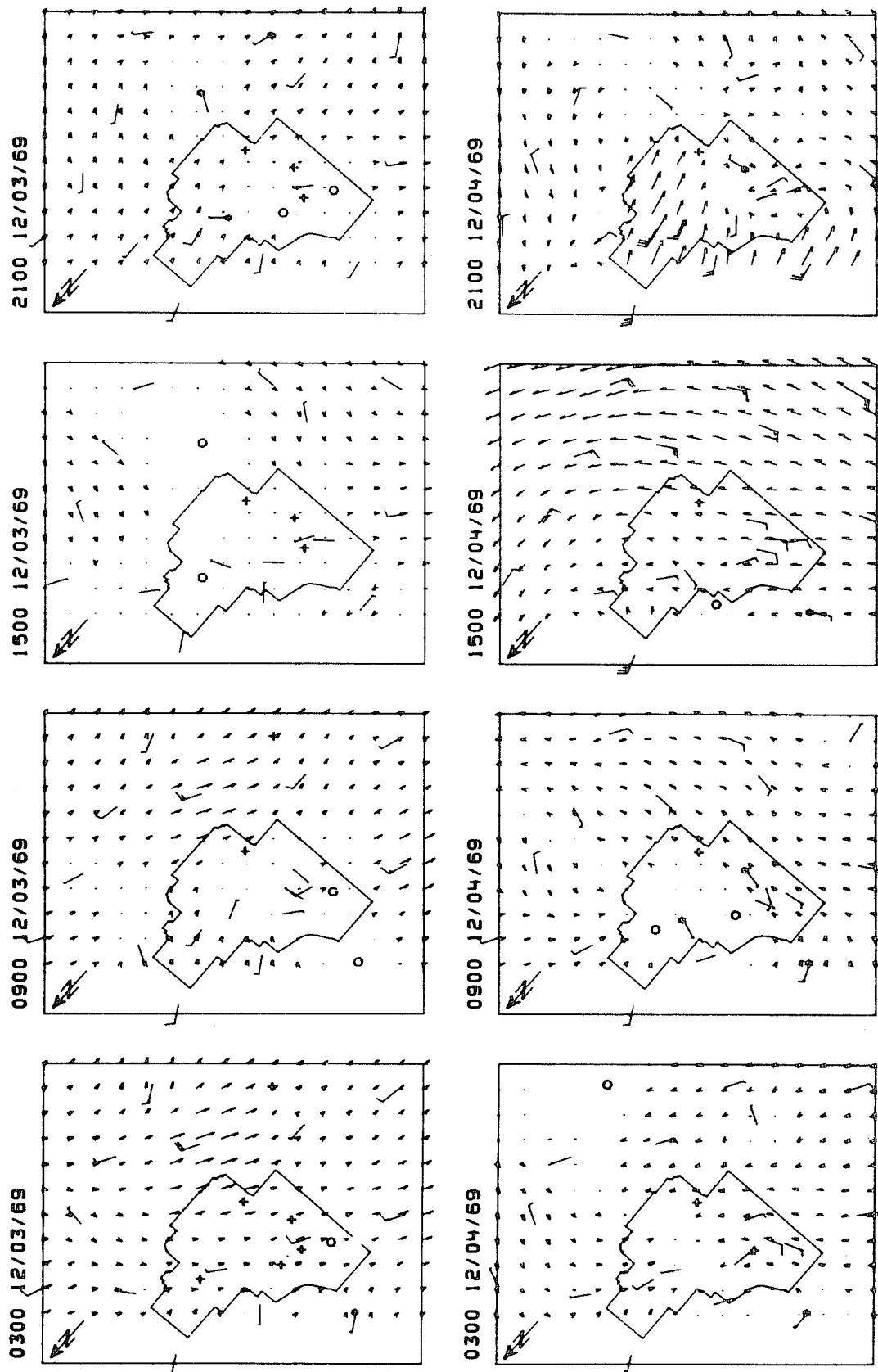


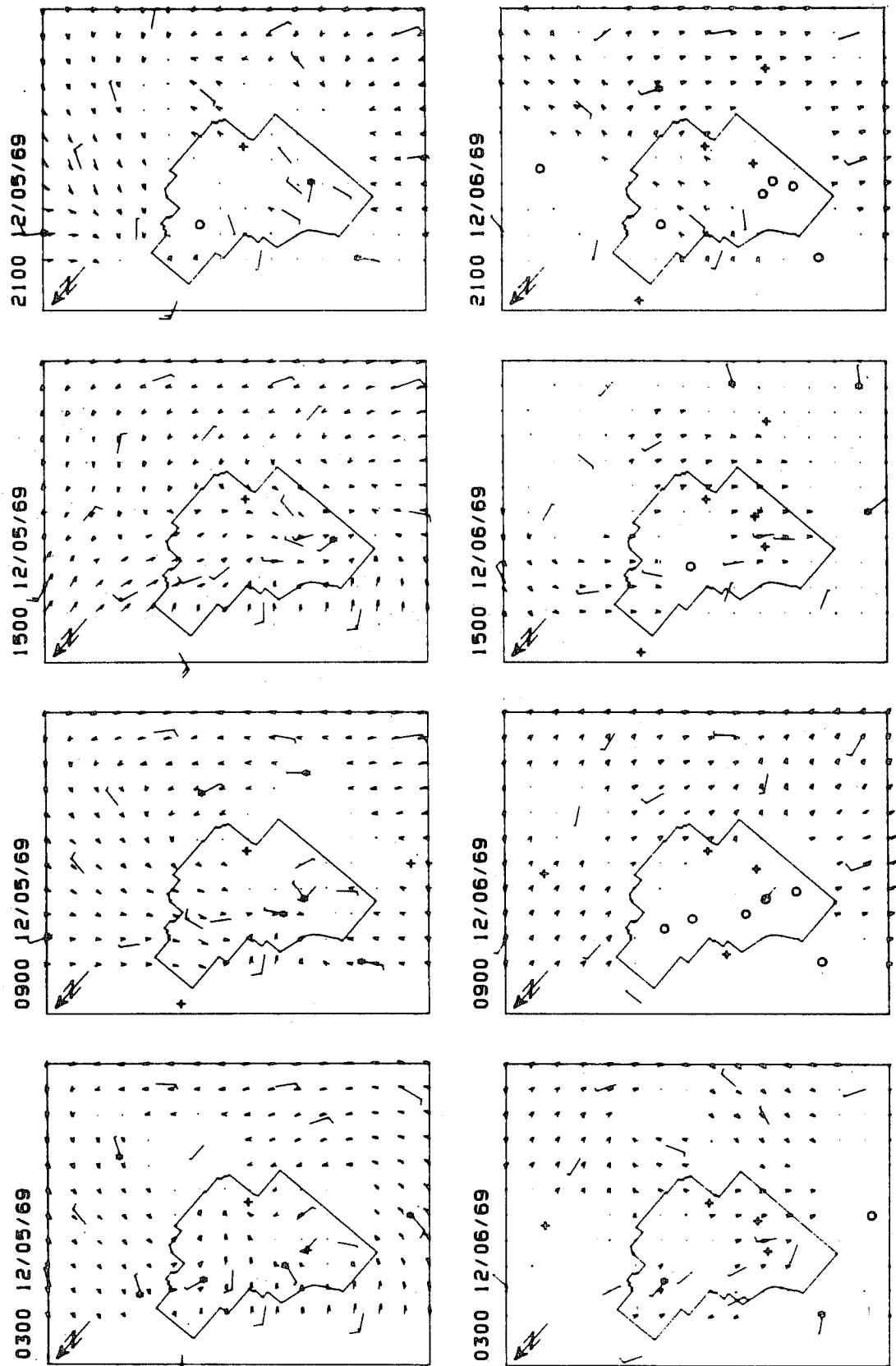


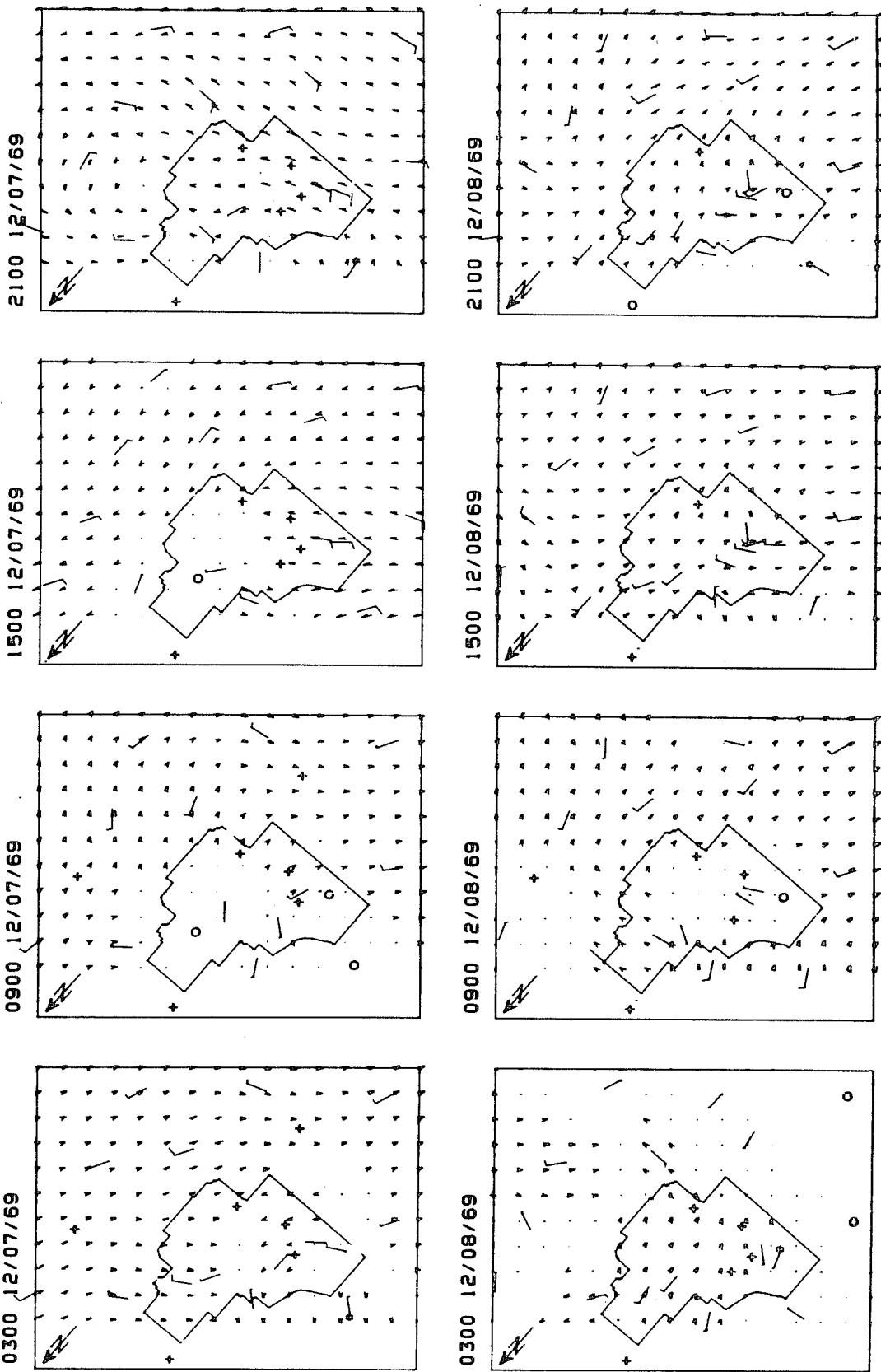
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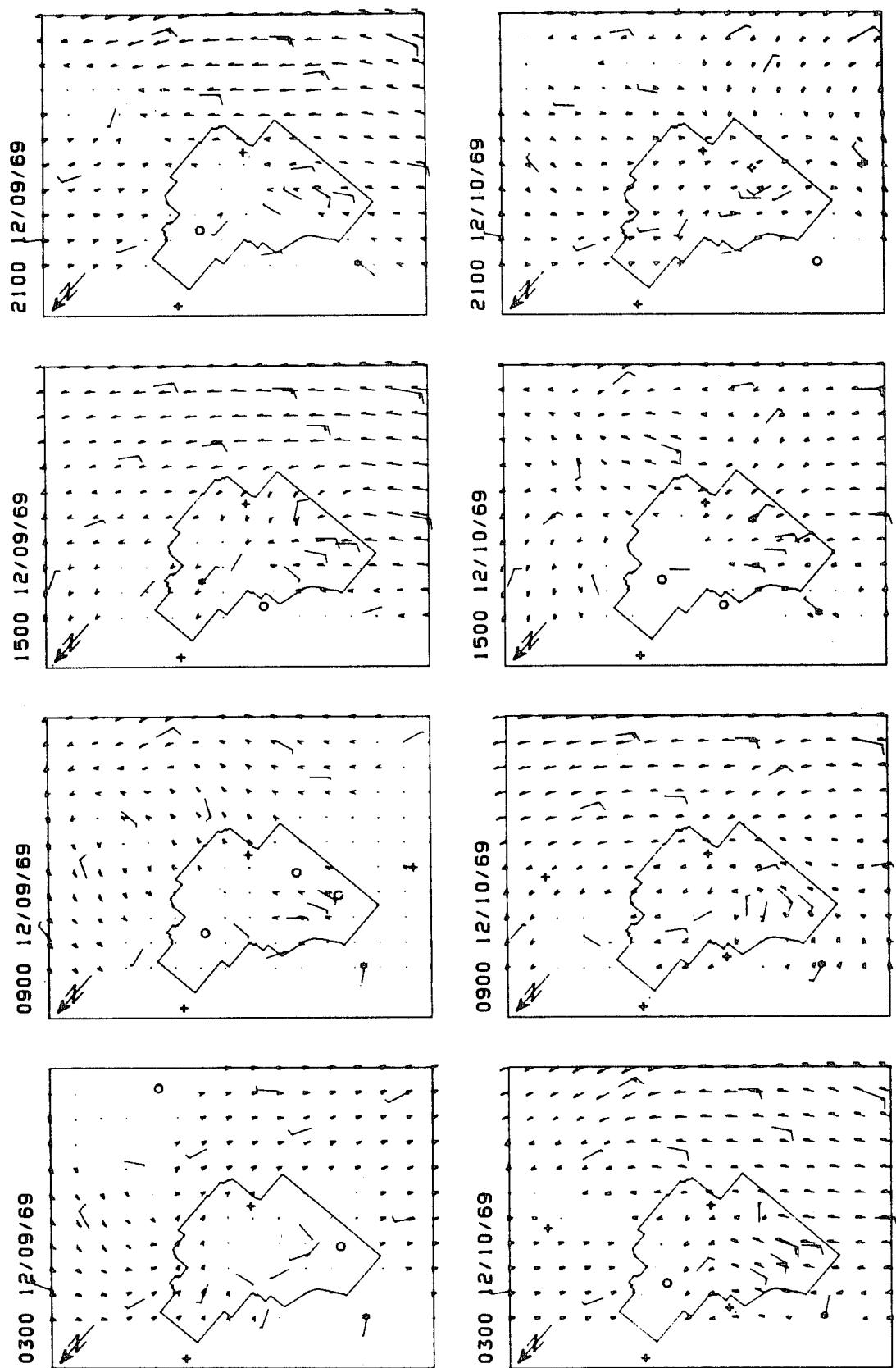




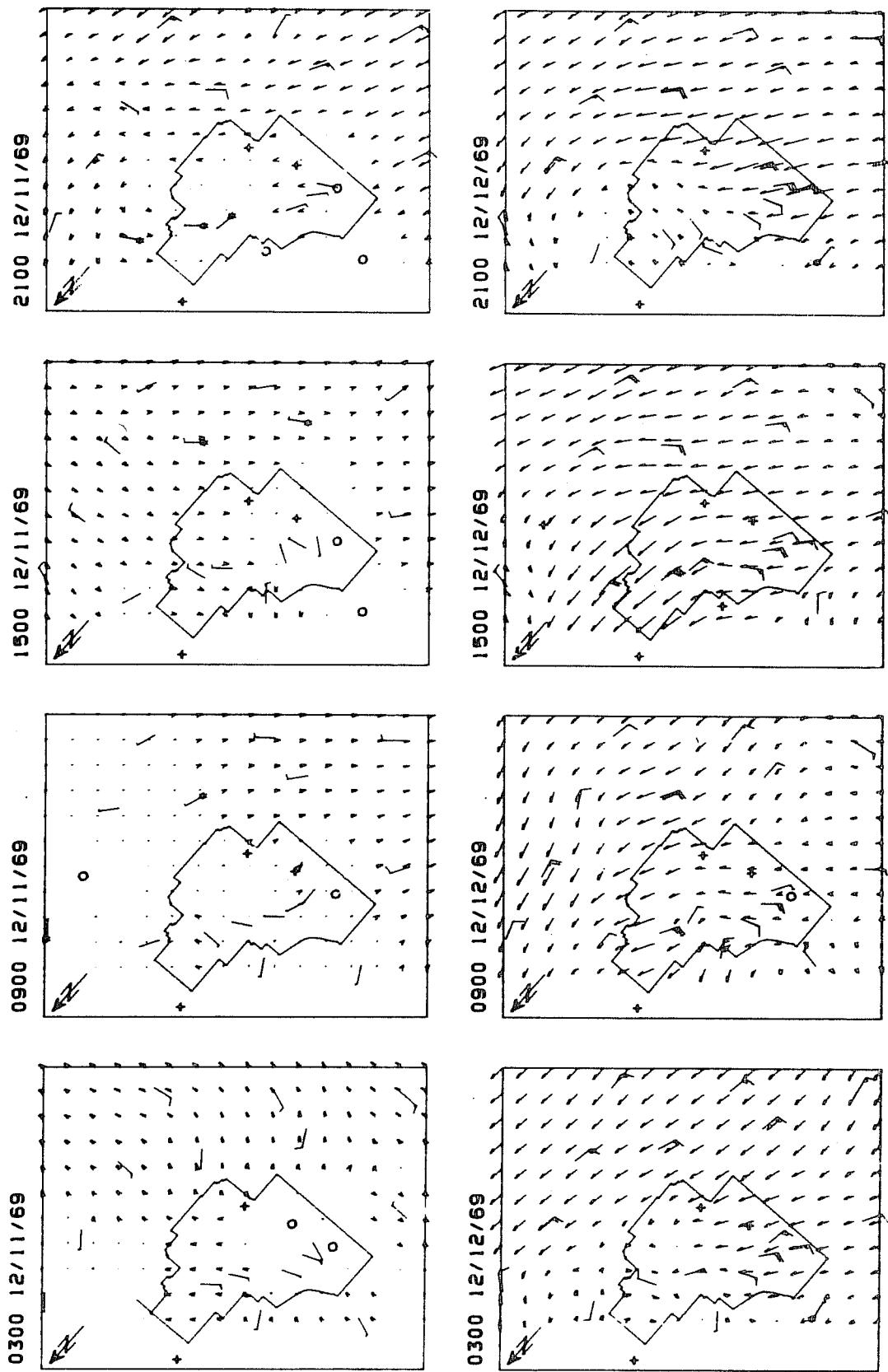


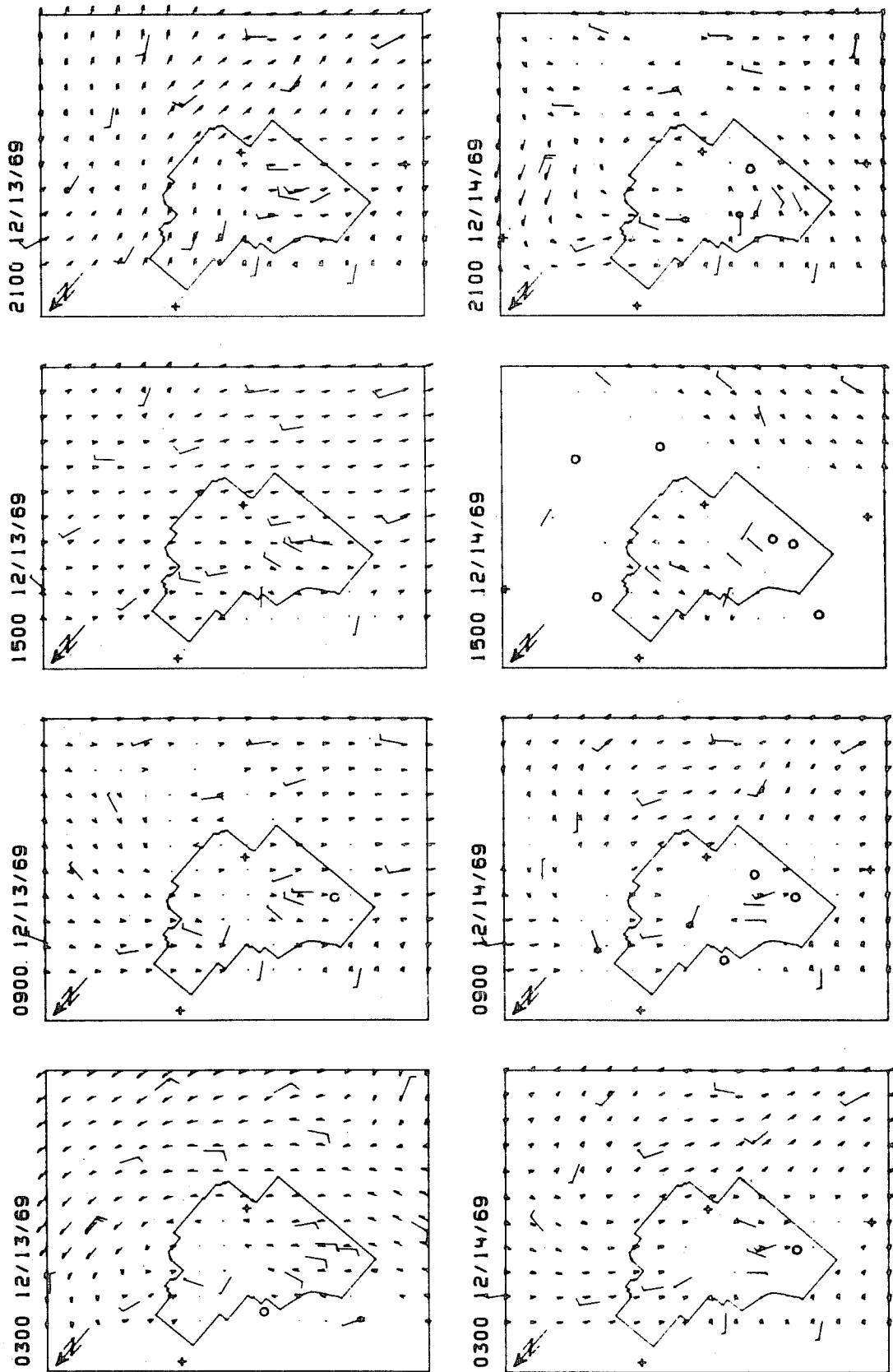


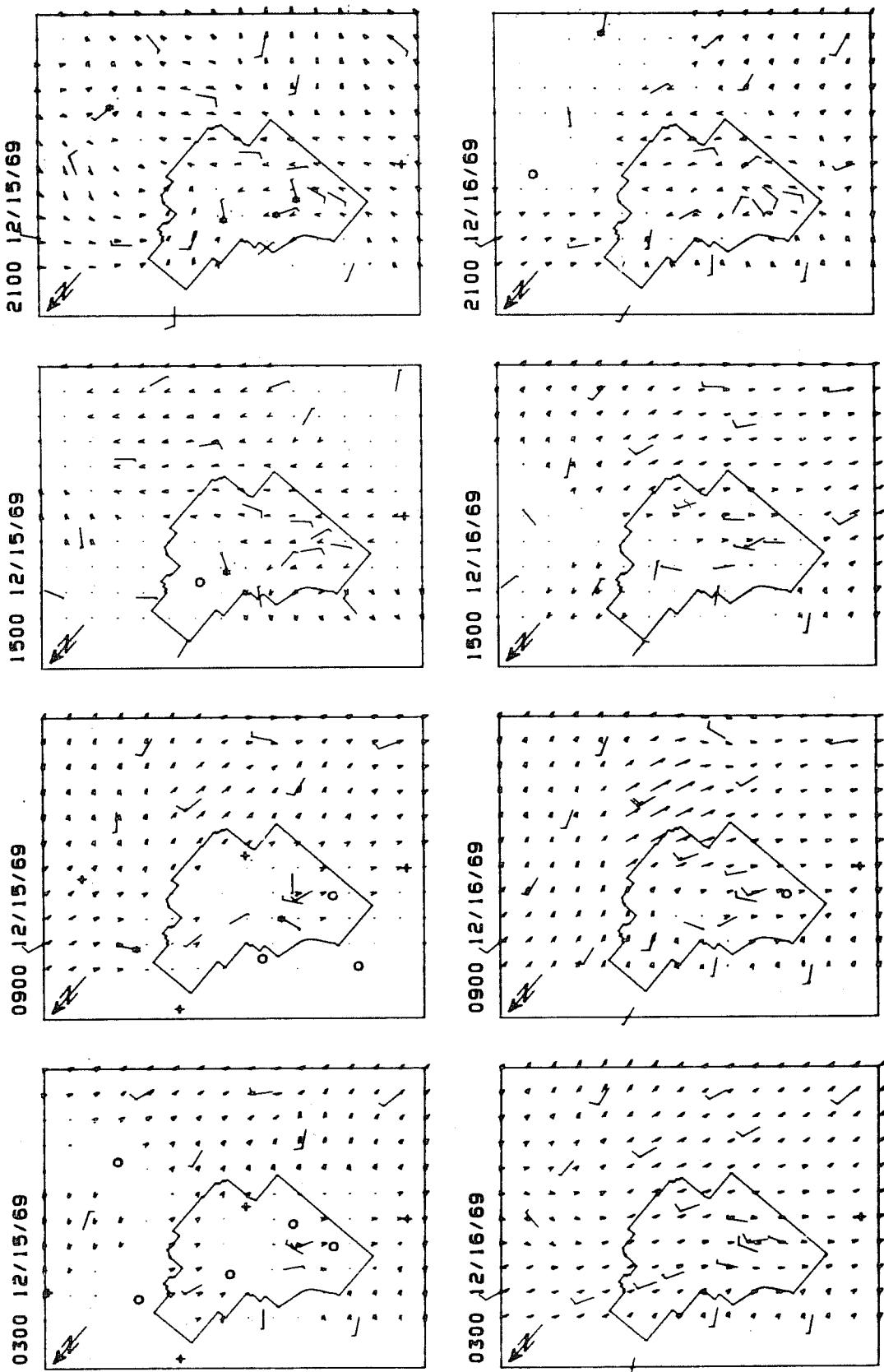




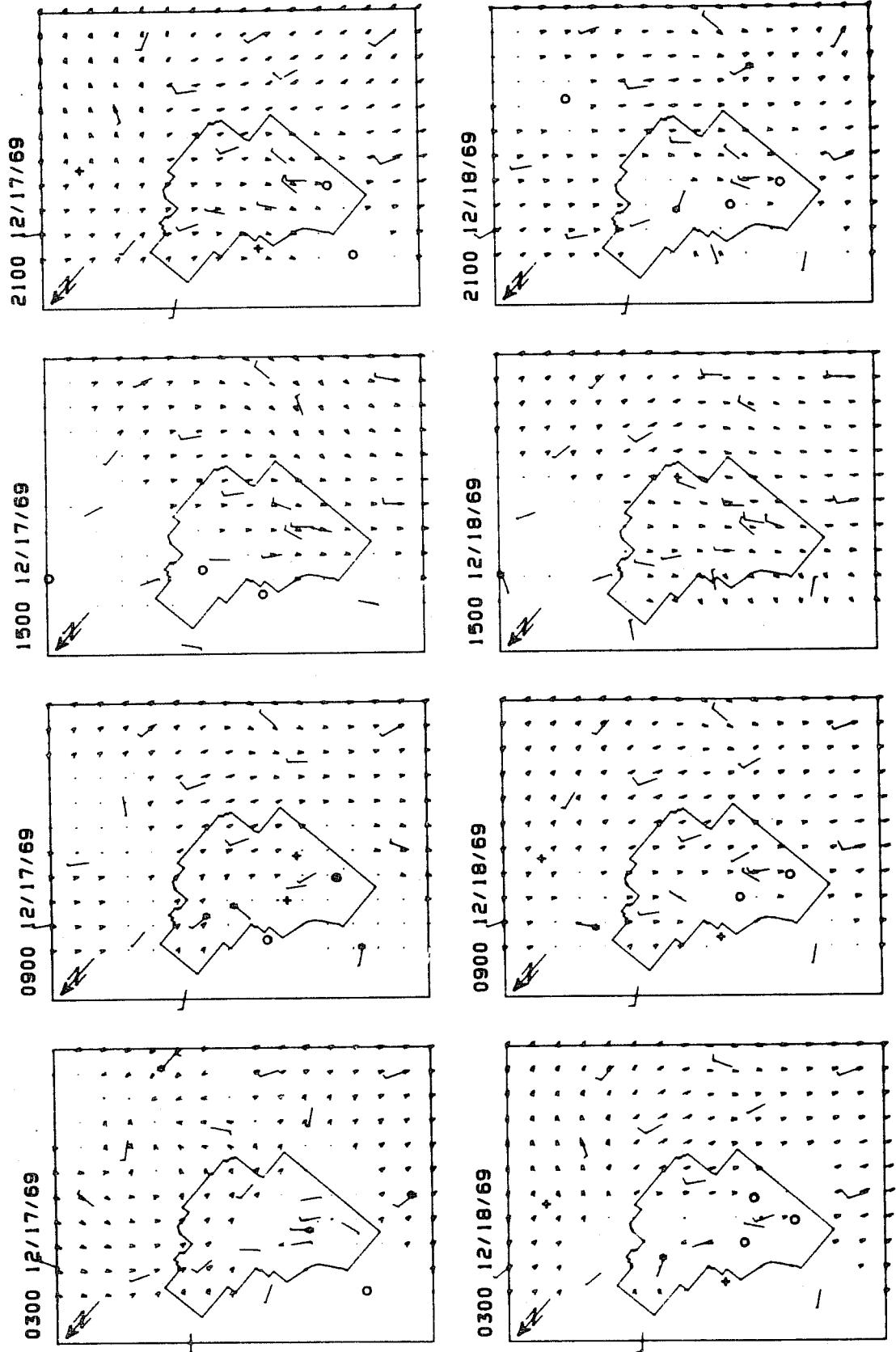
A-172



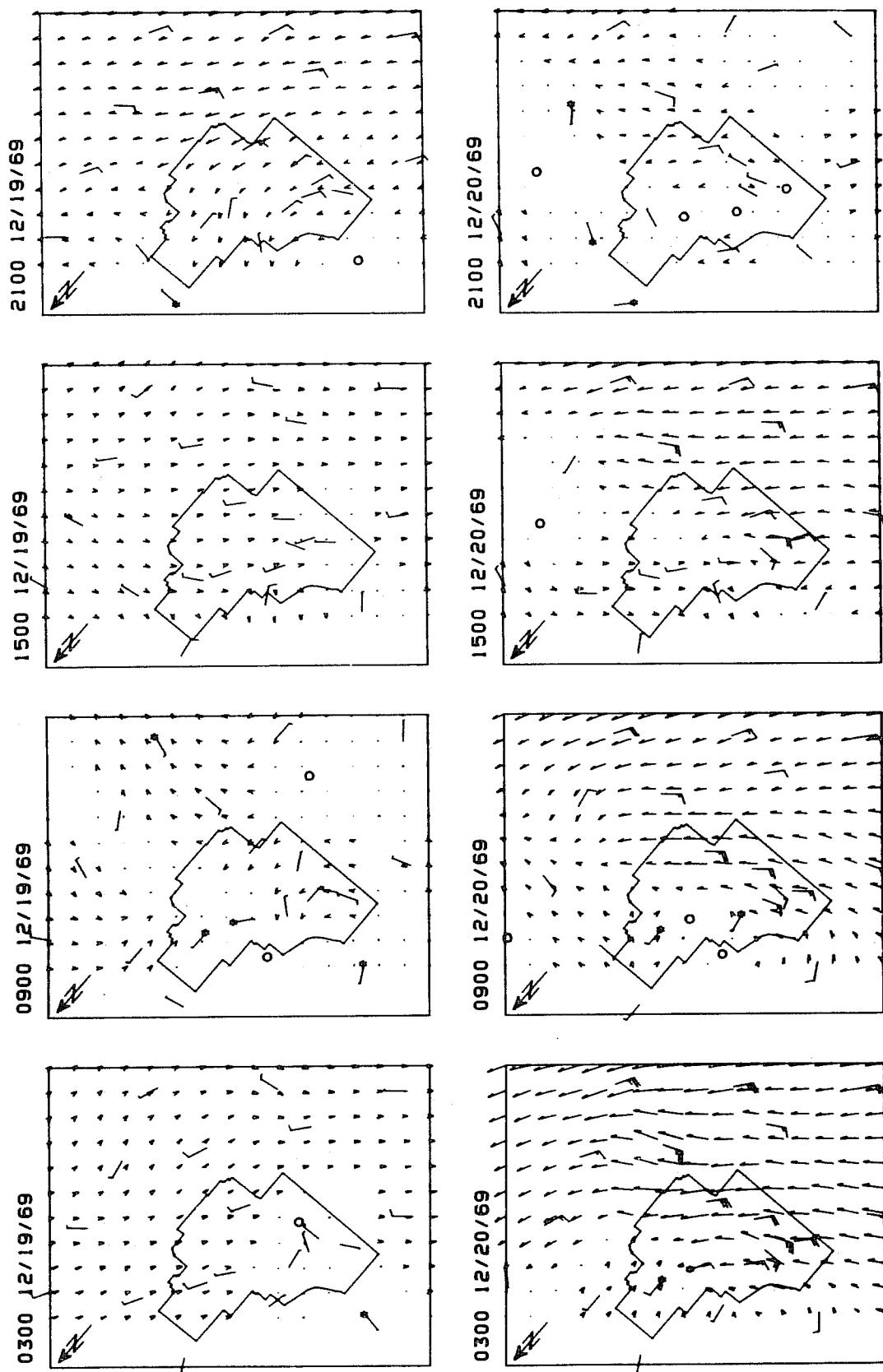




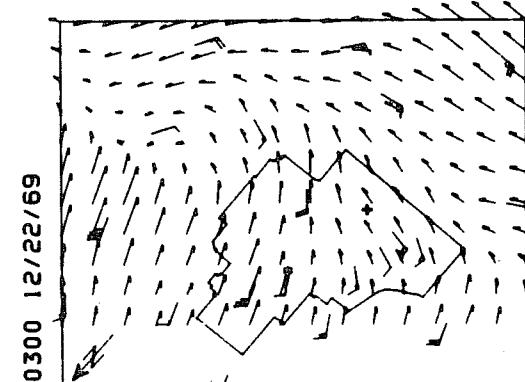
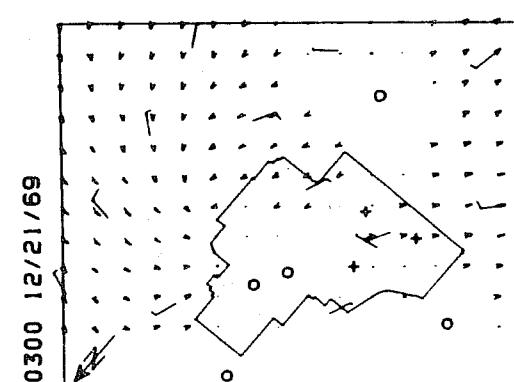
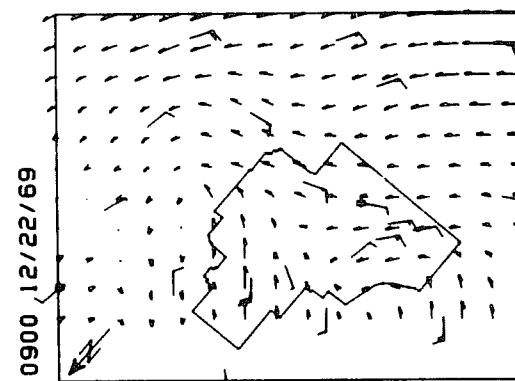
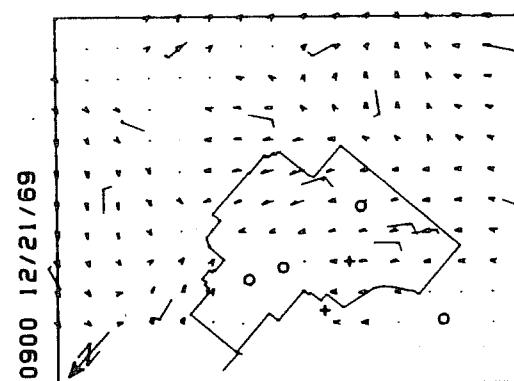
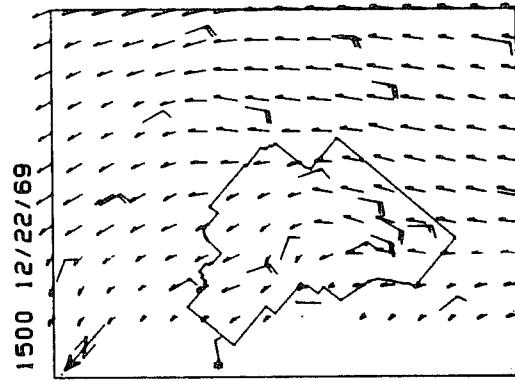
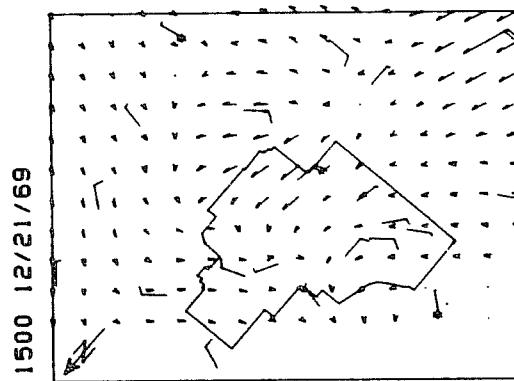
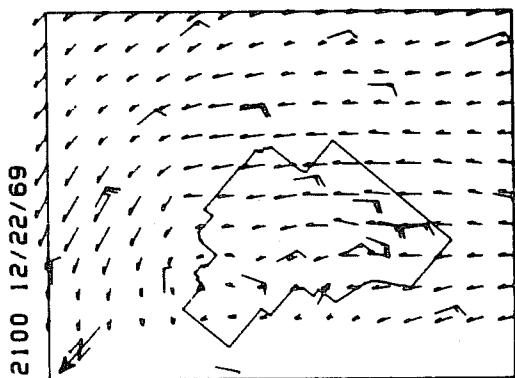
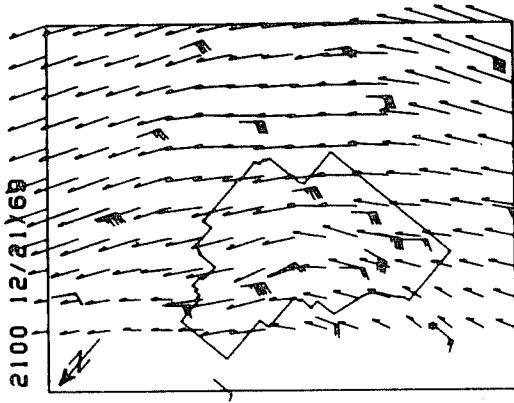
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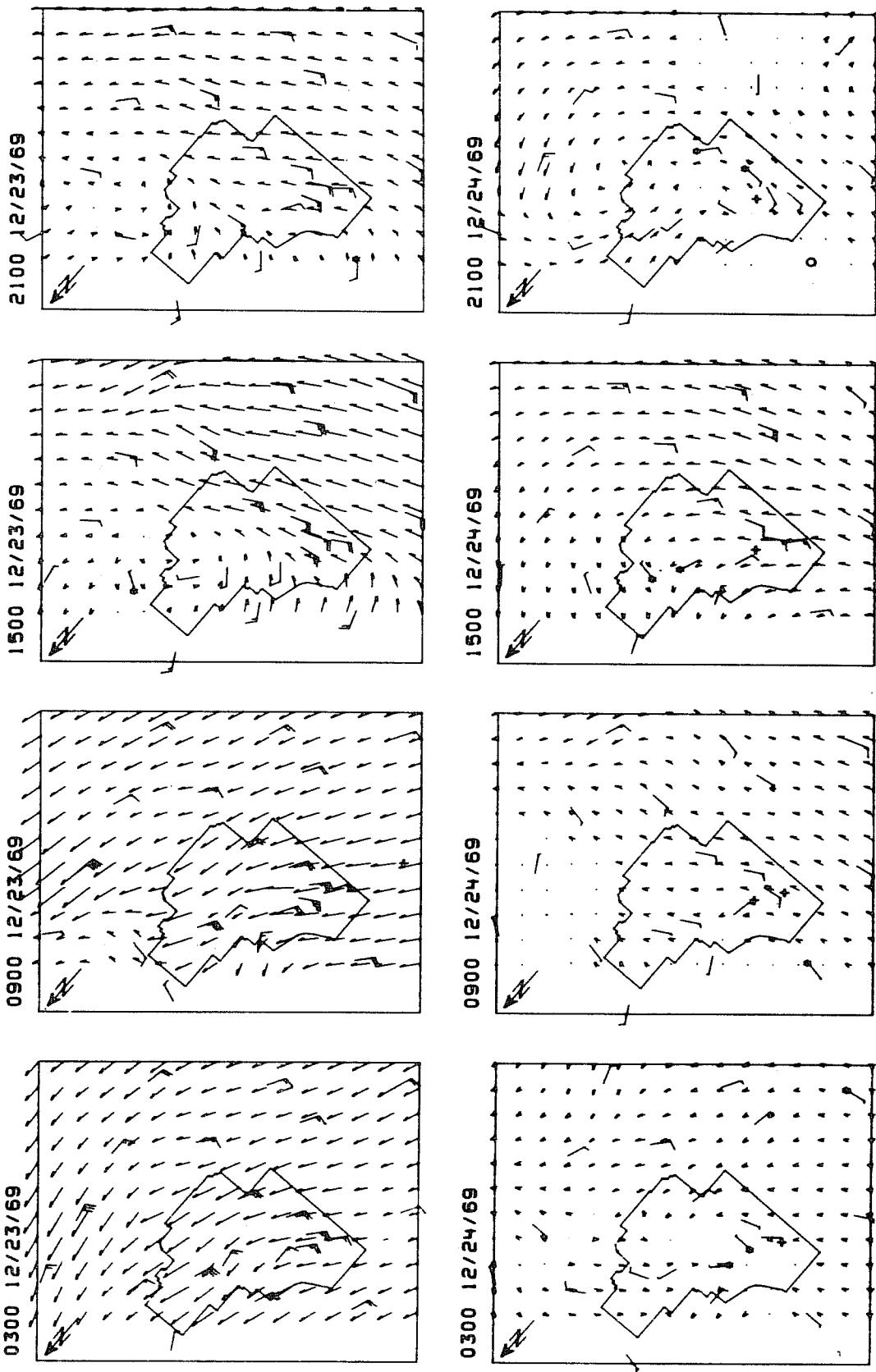


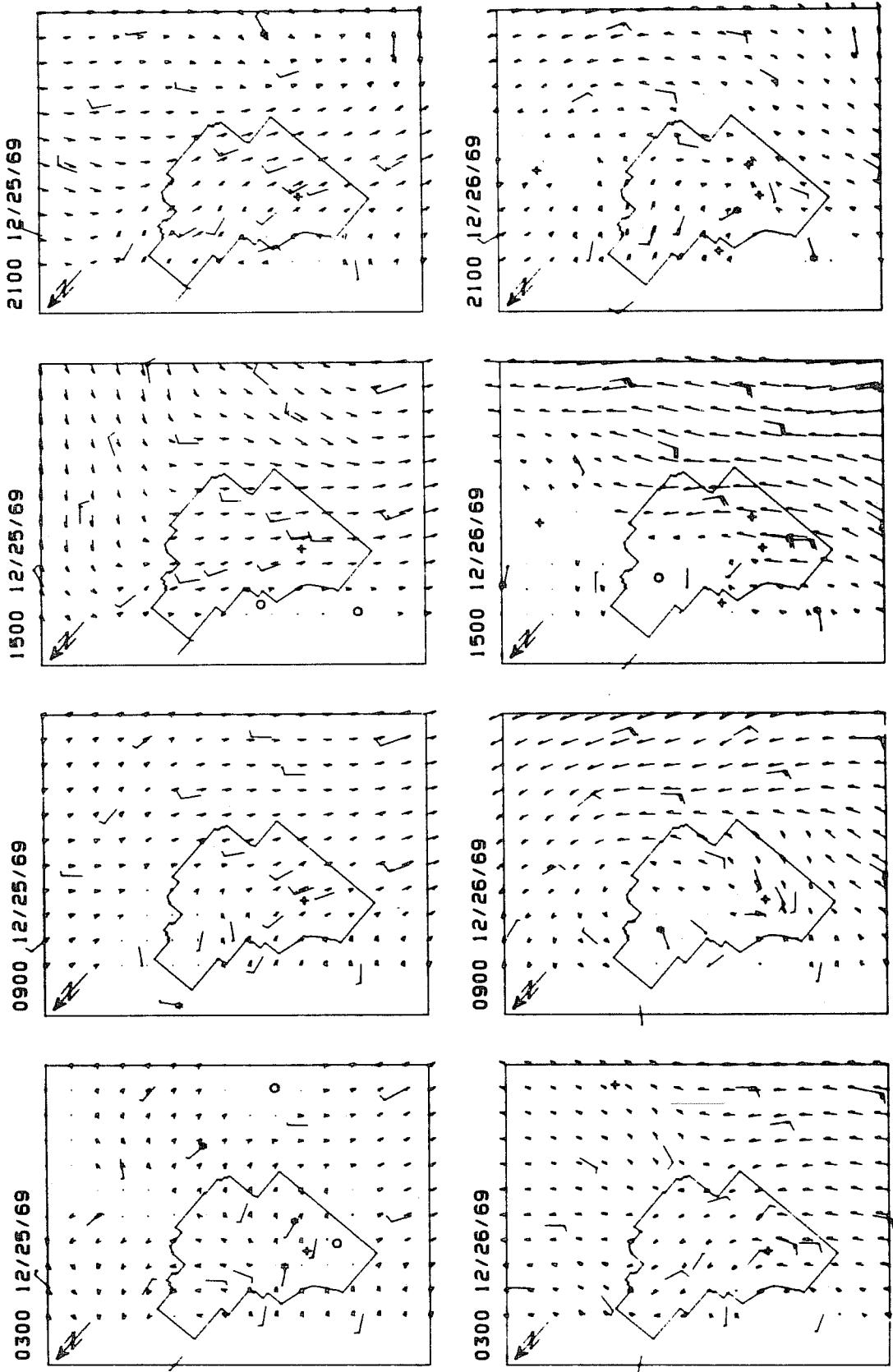
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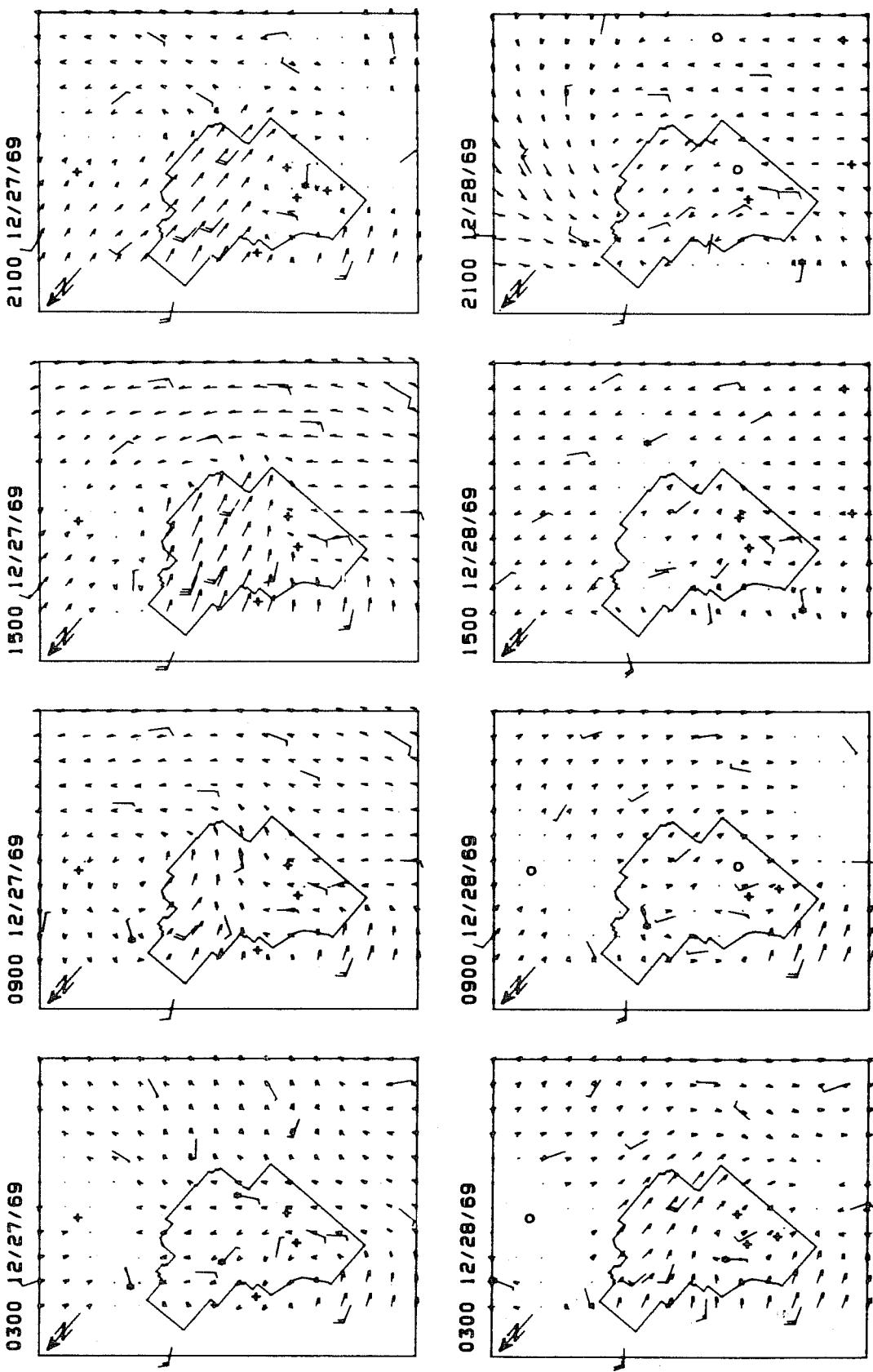
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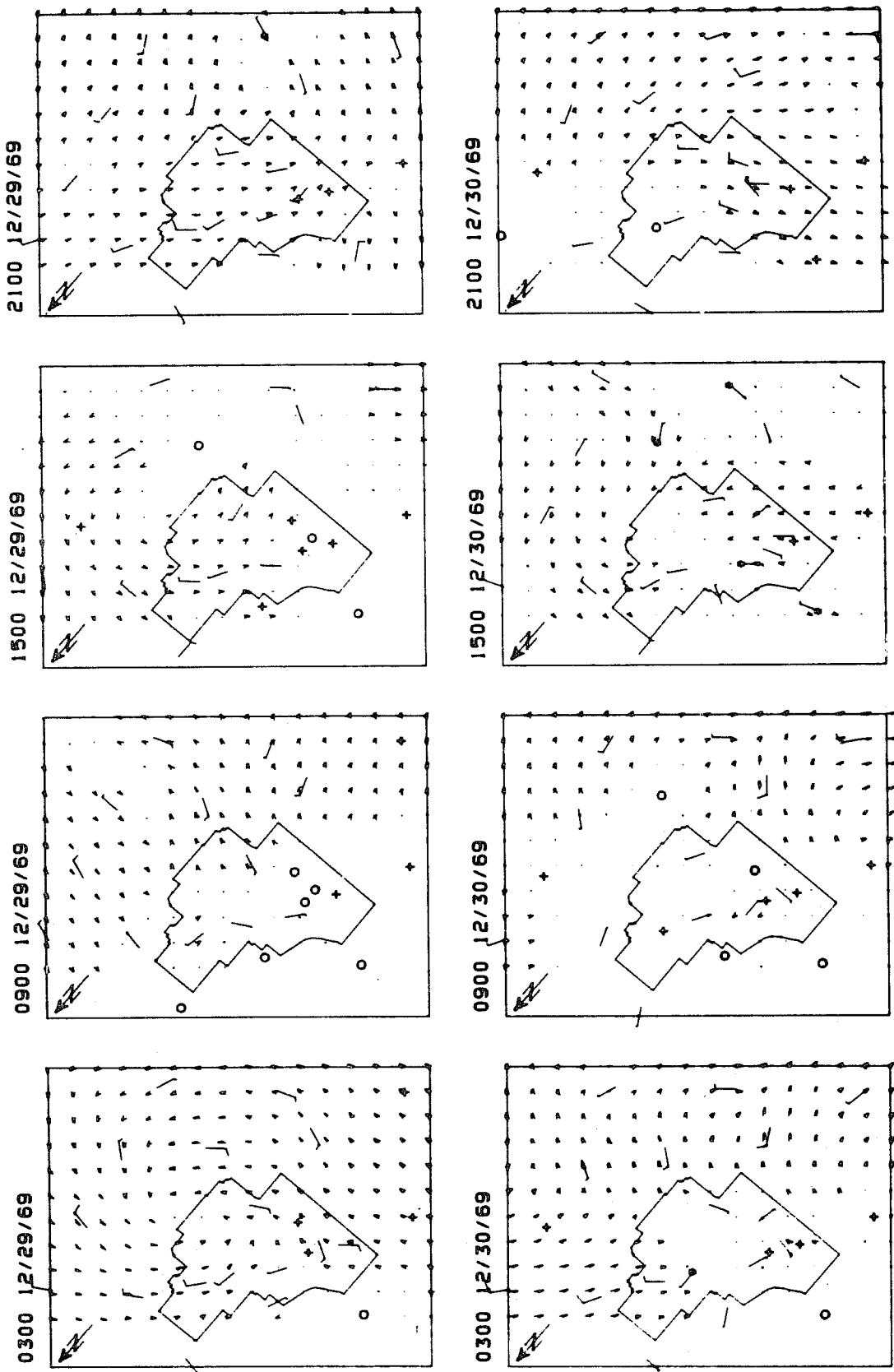






A-180



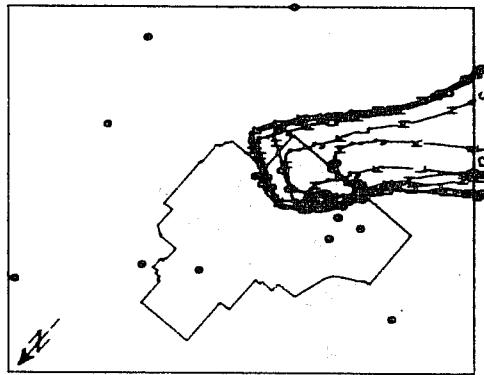


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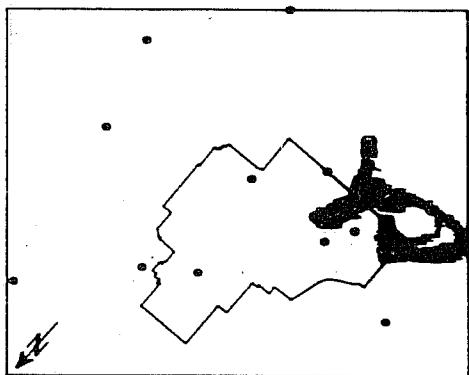
APPENDIX B
Trajectory Plots

Times are Mountain Standard.

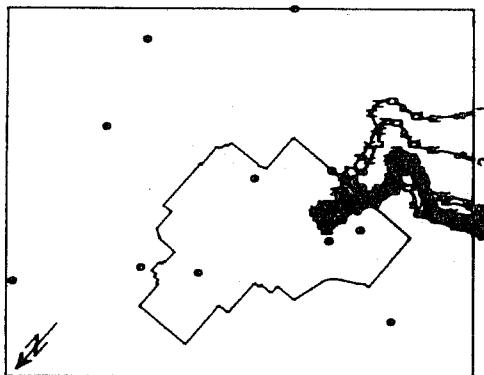
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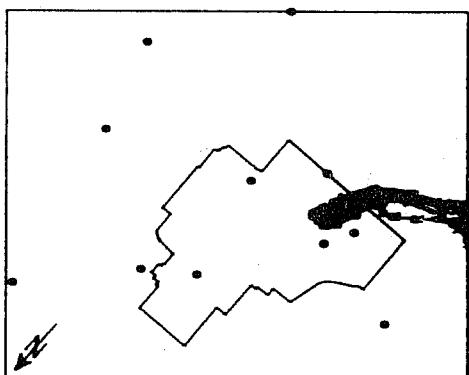
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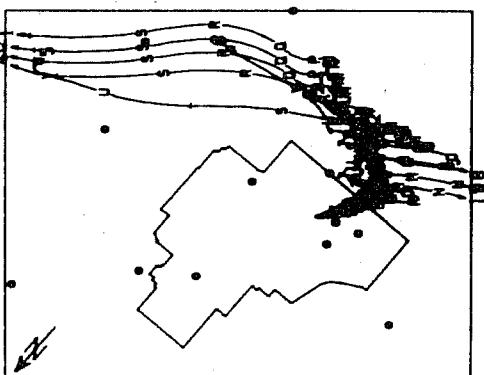
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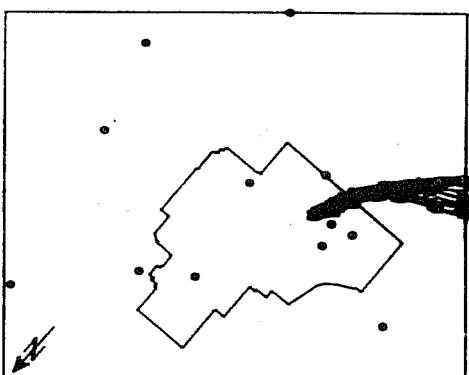
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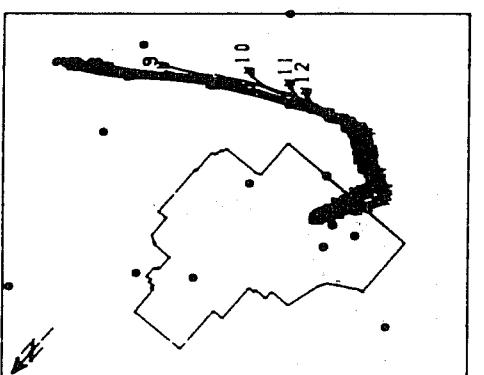
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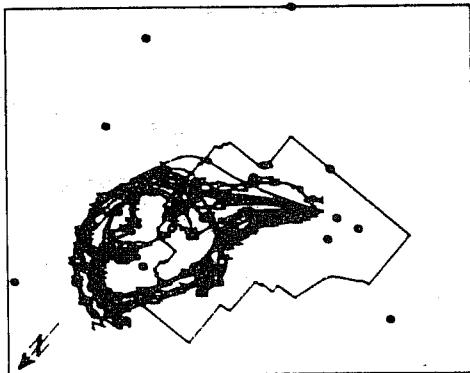
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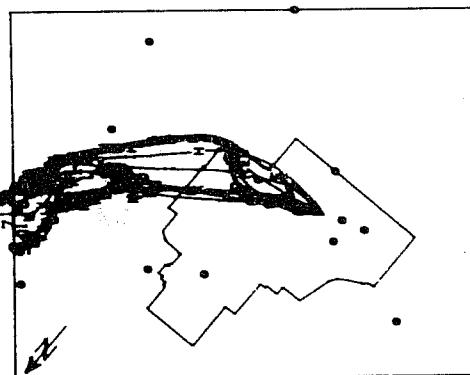
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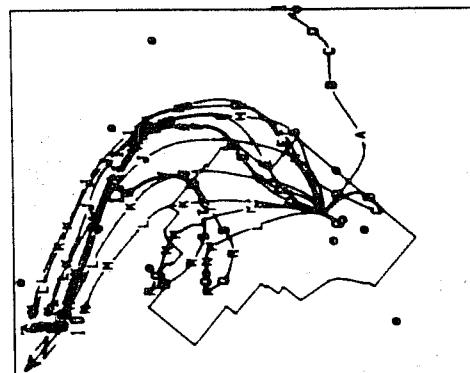
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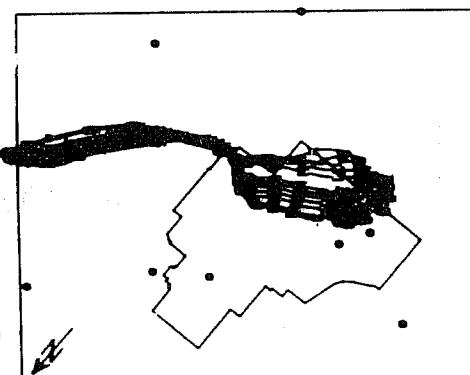
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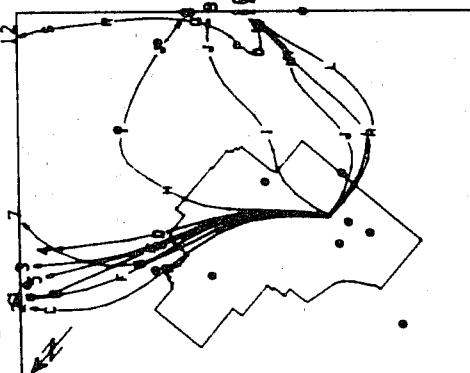
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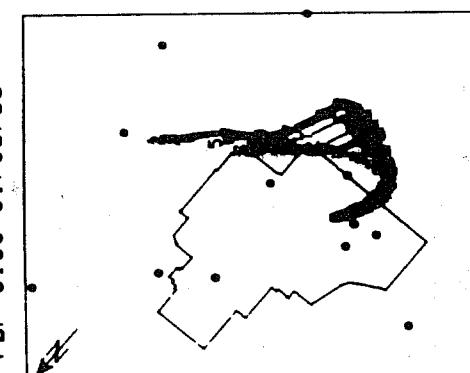
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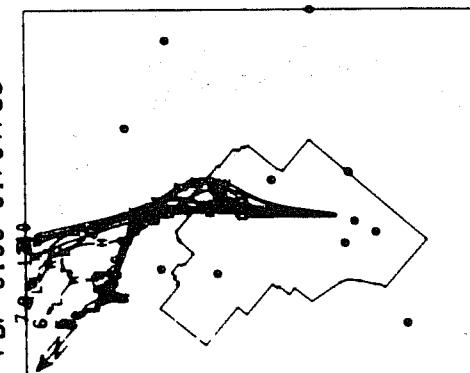
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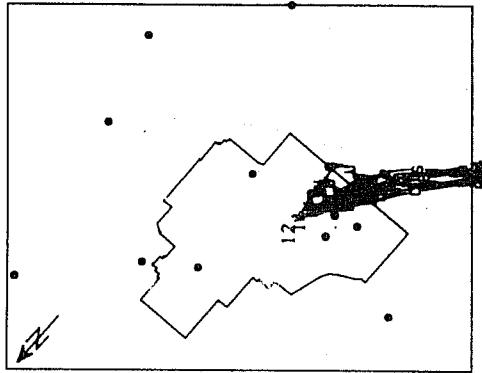
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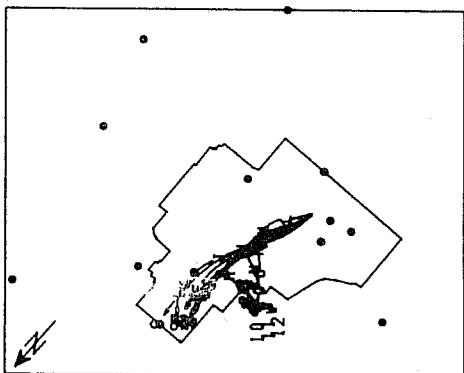
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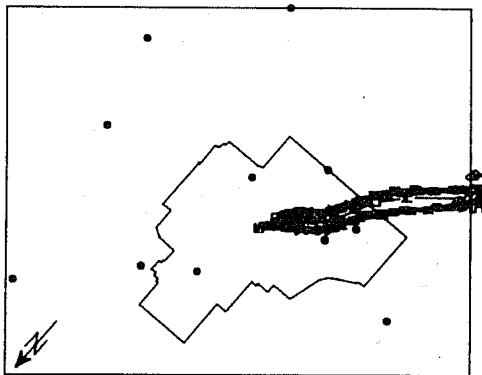
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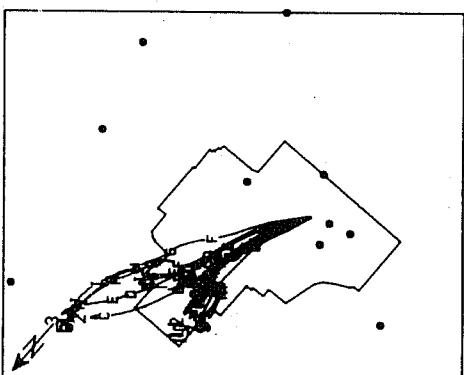
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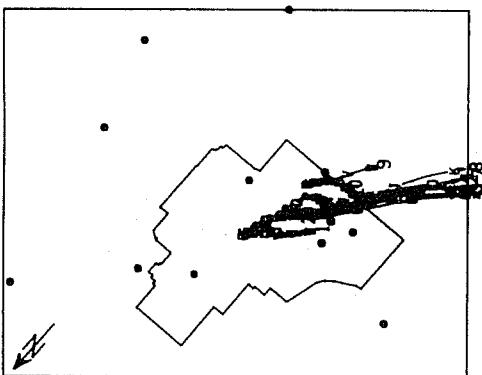
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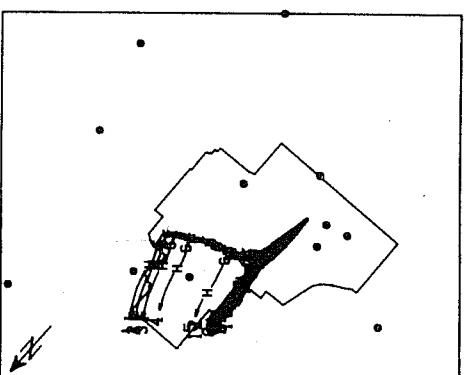
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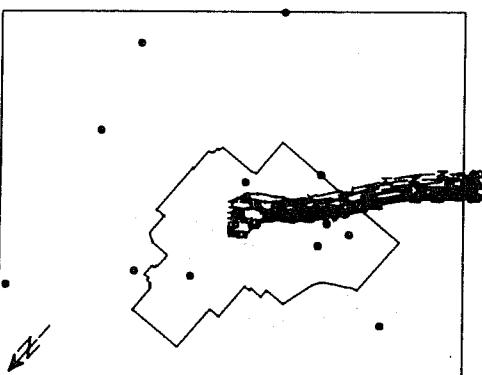
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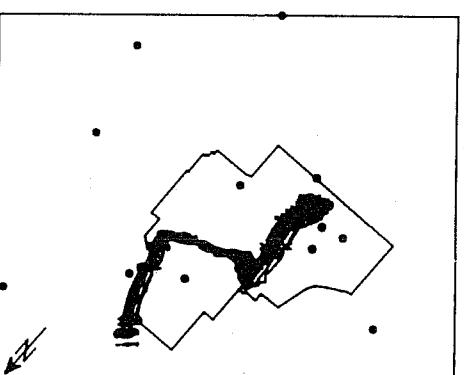
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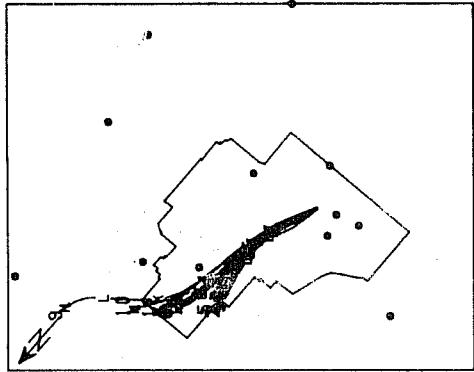
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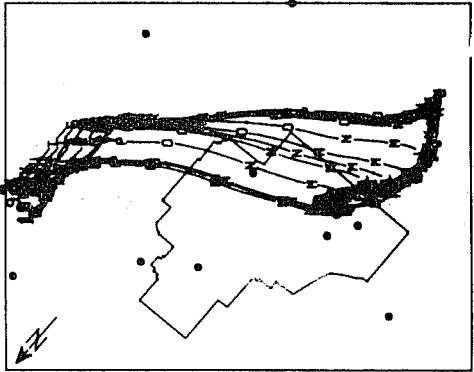
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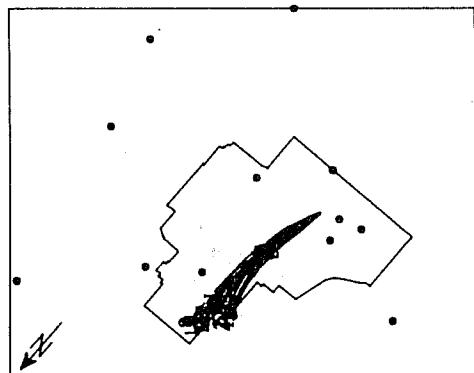
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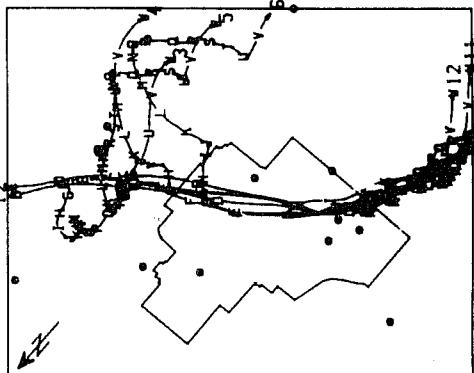
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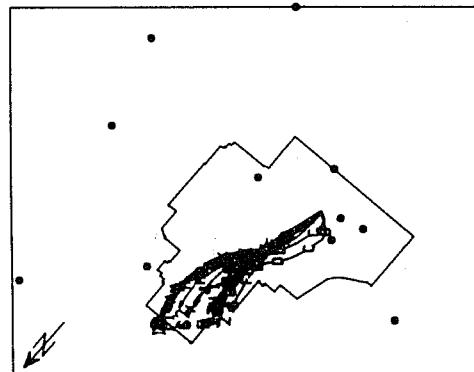
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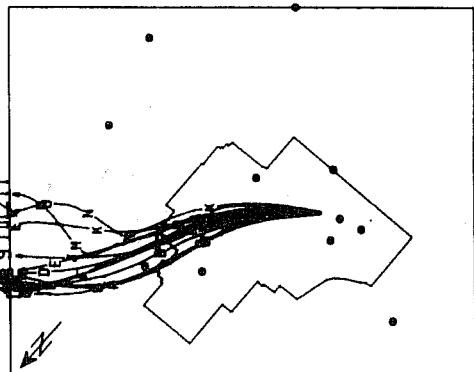
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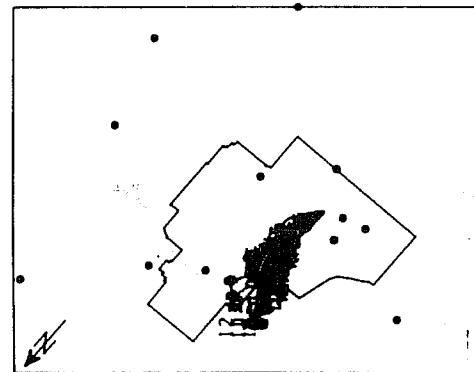
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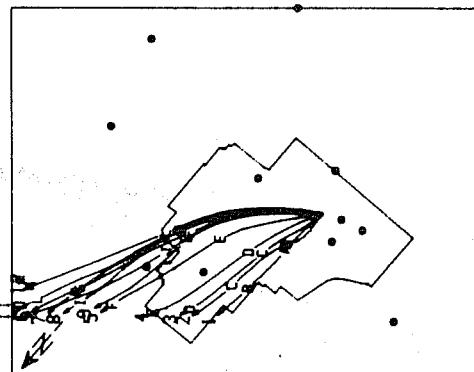
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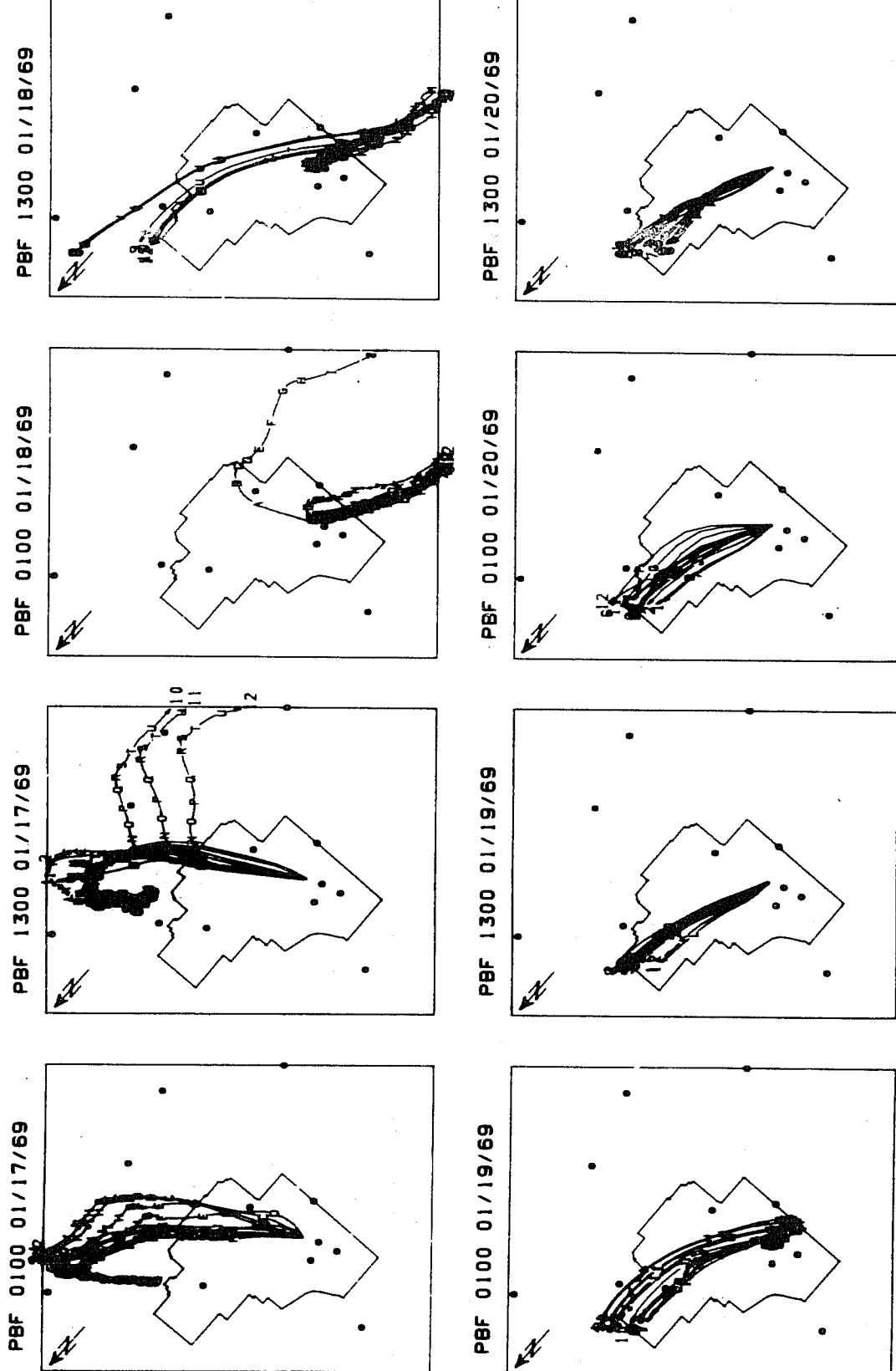


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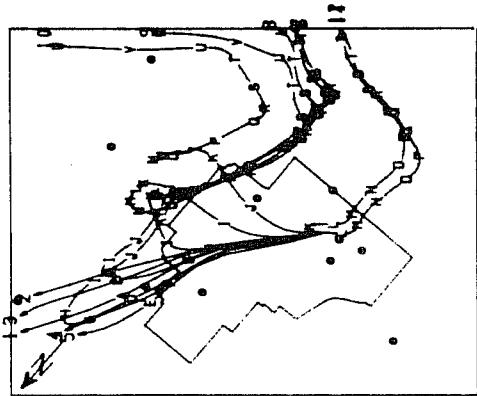


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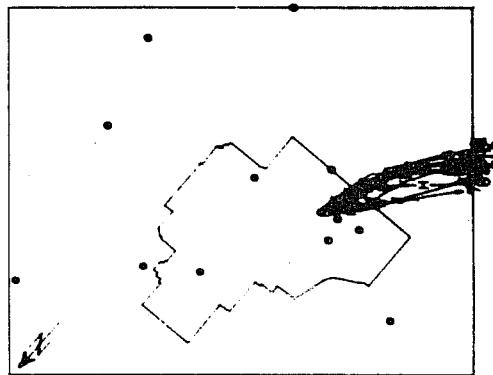




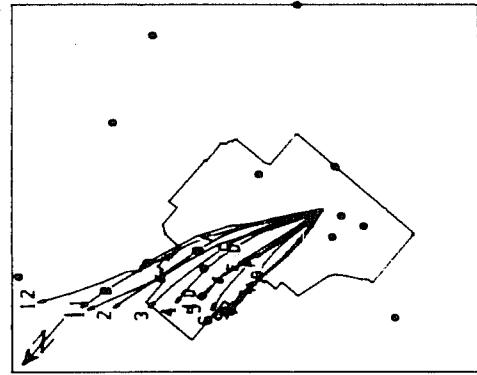
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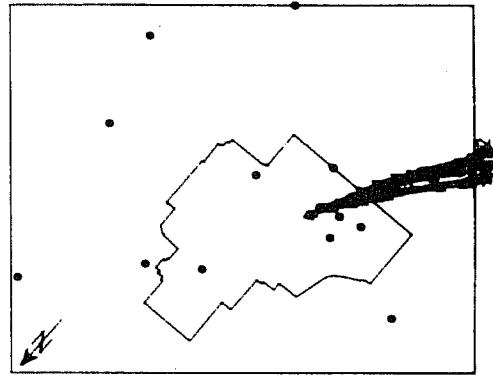
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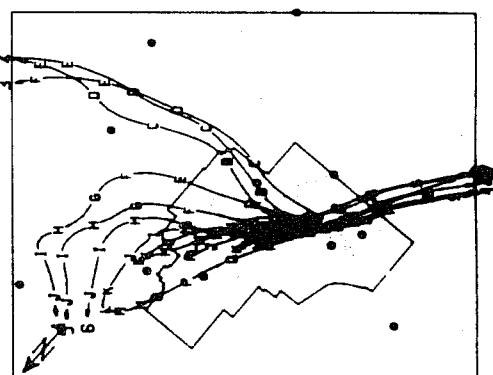
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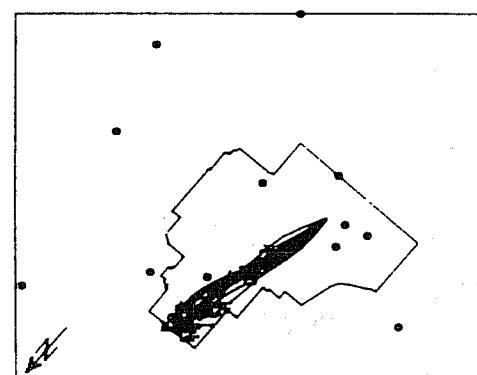
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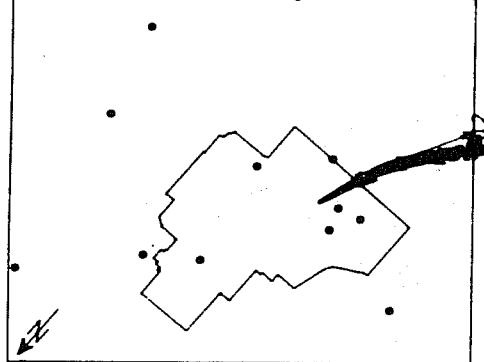
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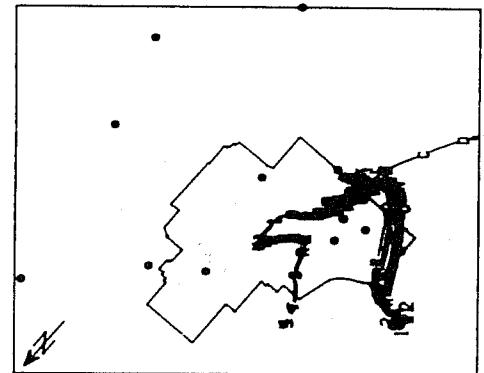
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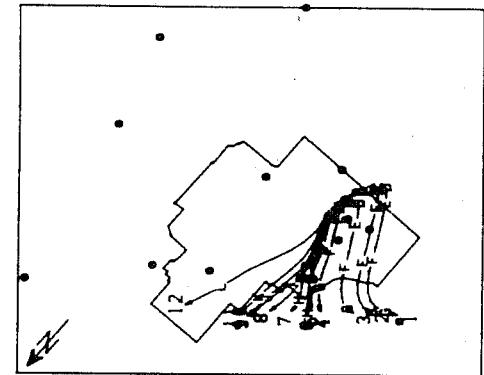
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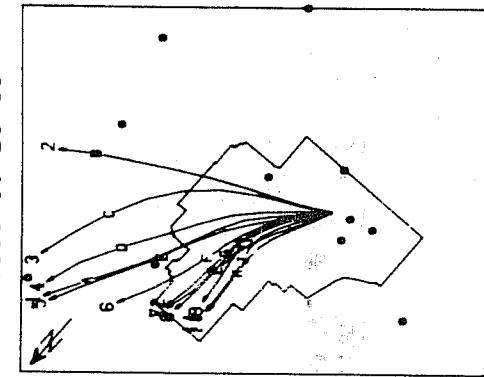
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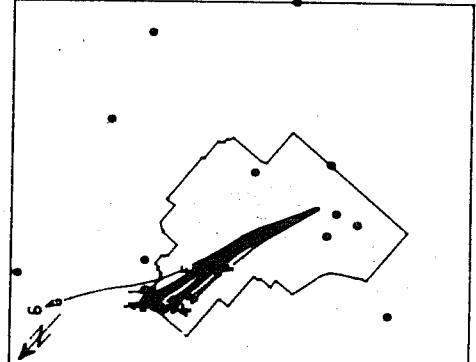
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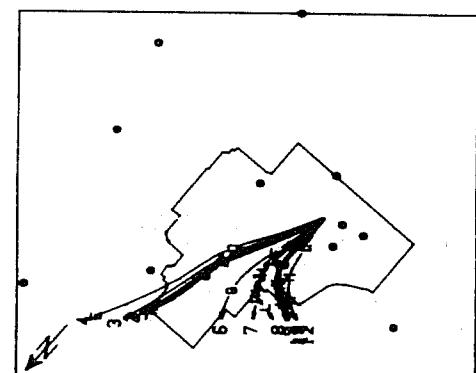
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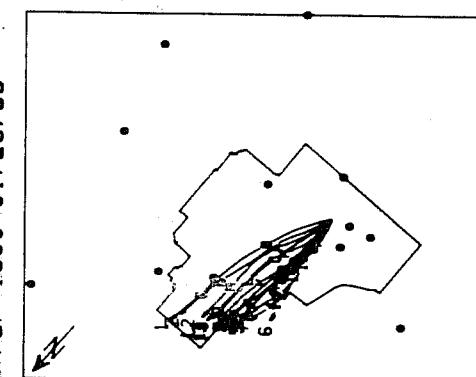
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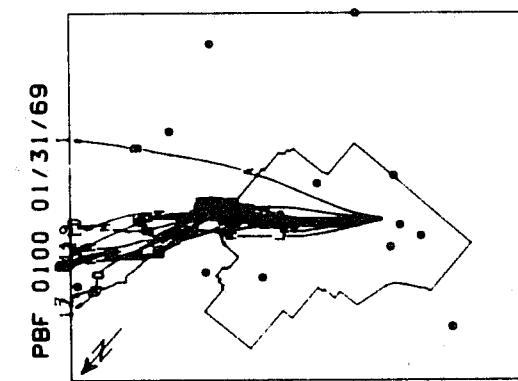
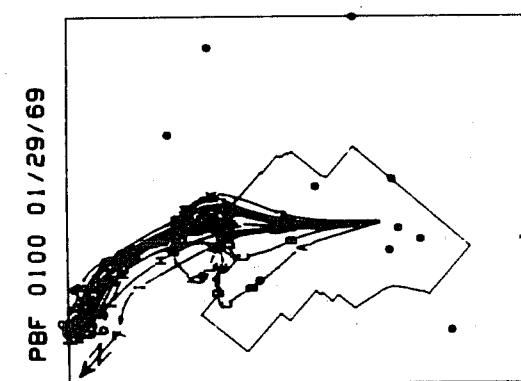
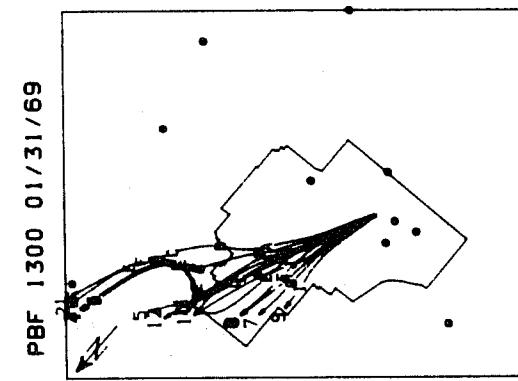
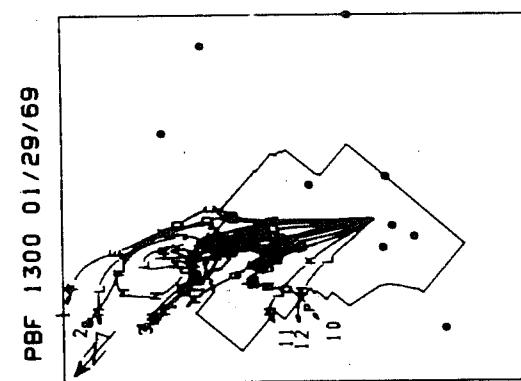
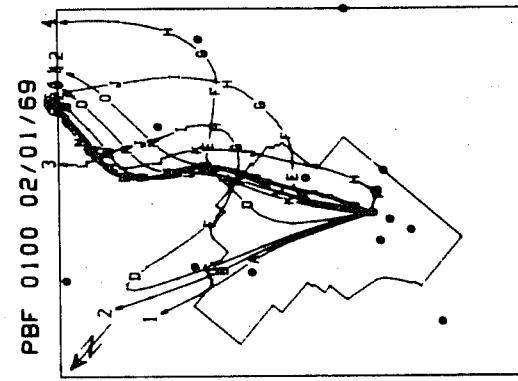
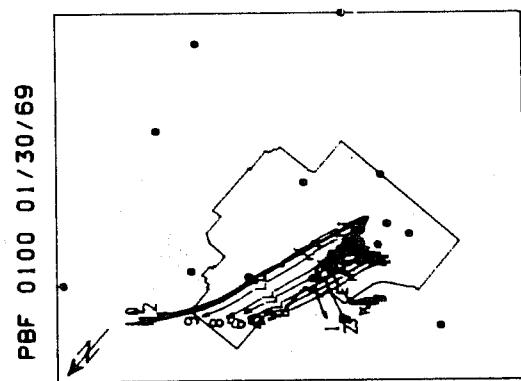
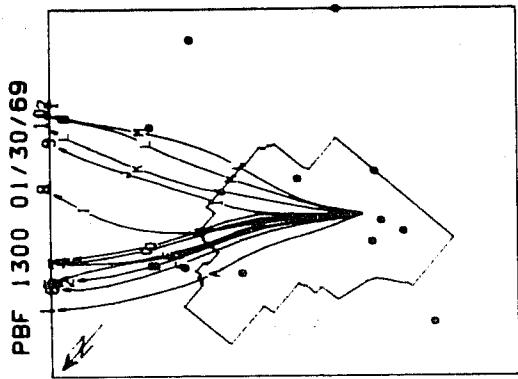


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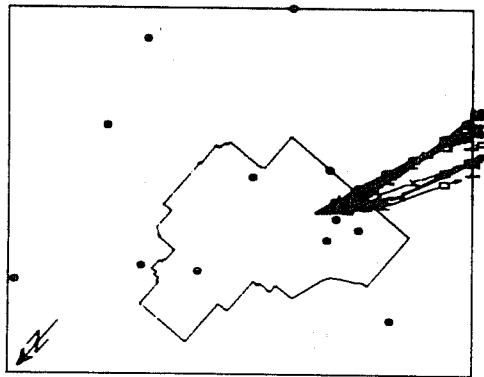


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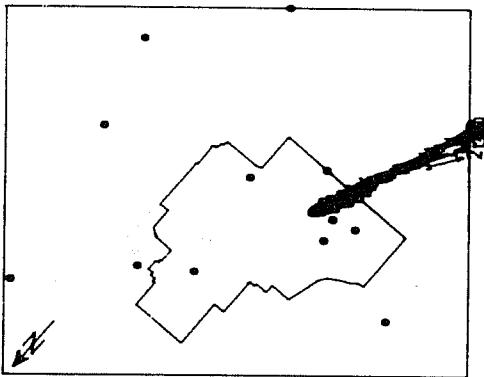
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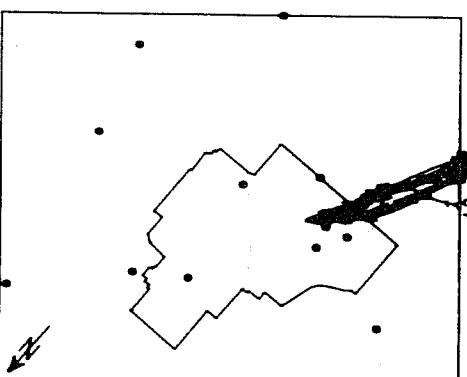
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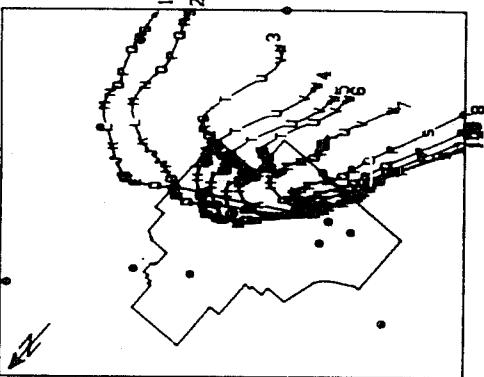
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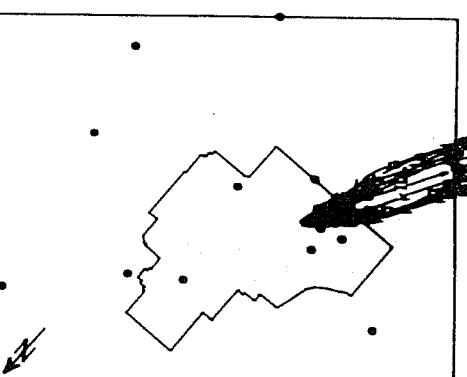
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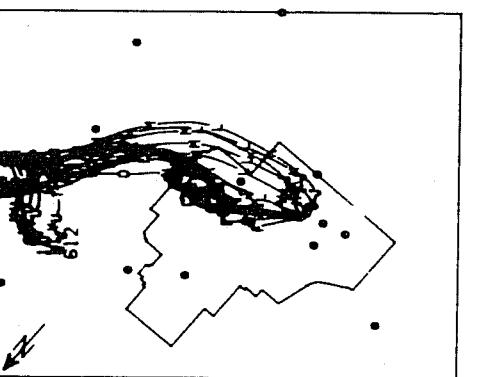
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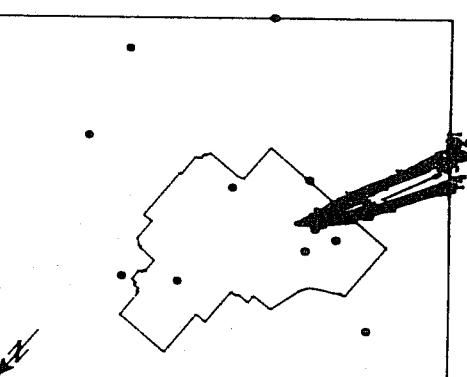
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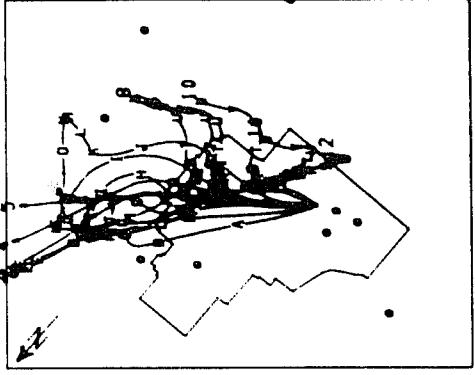
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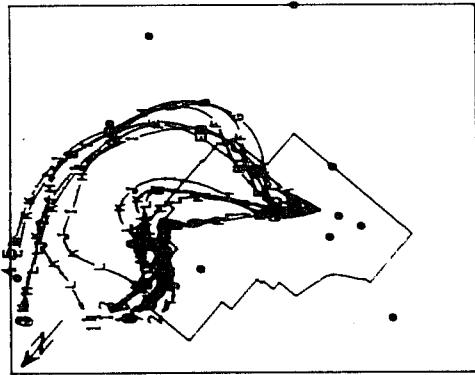
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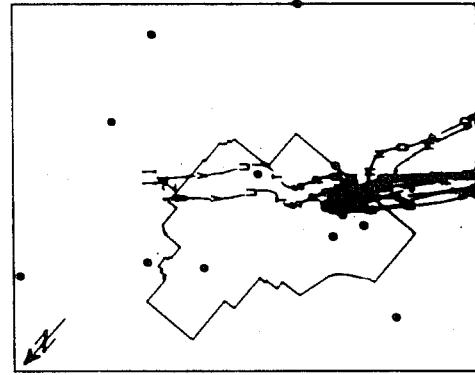
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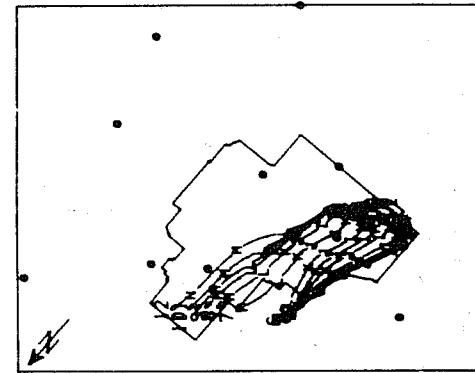
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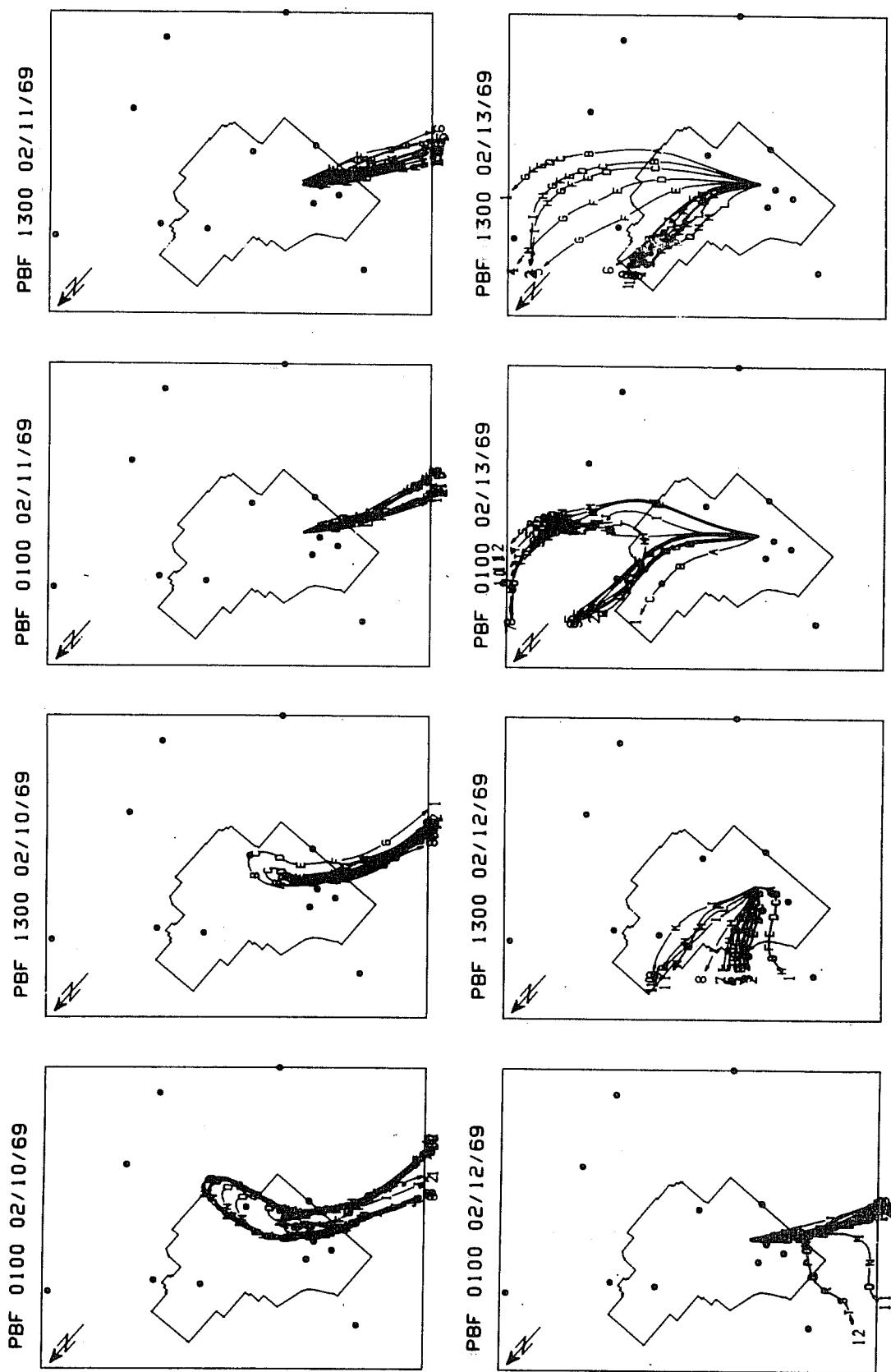


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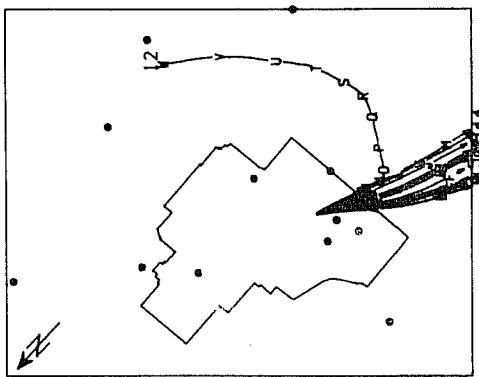


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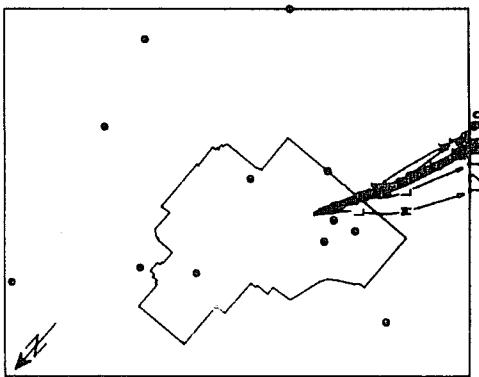




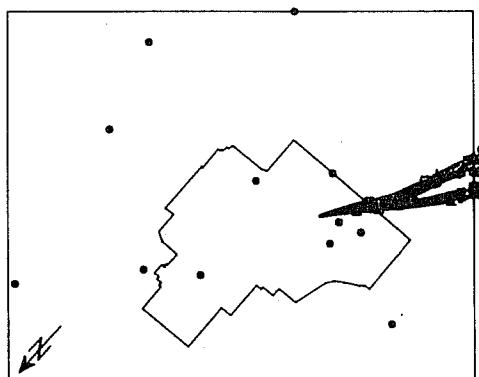
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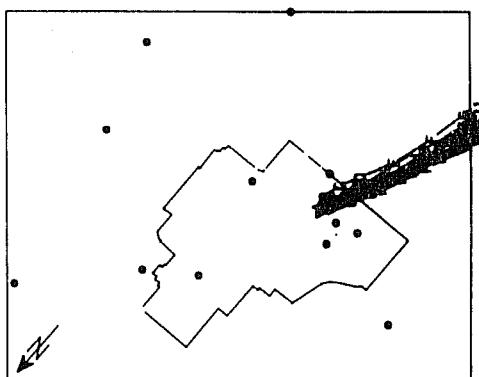
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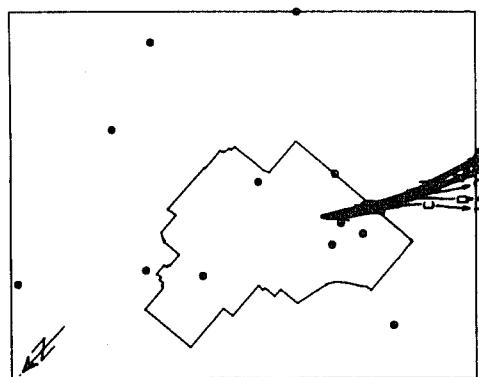
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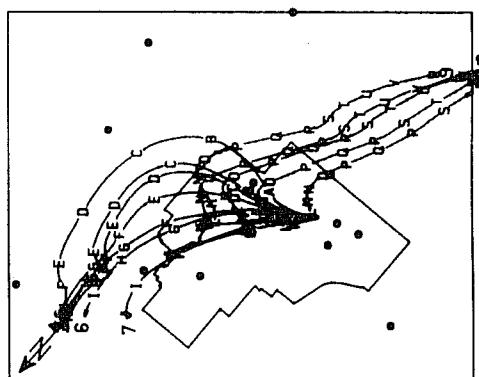
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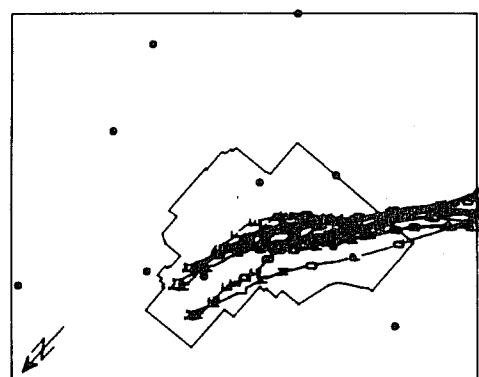
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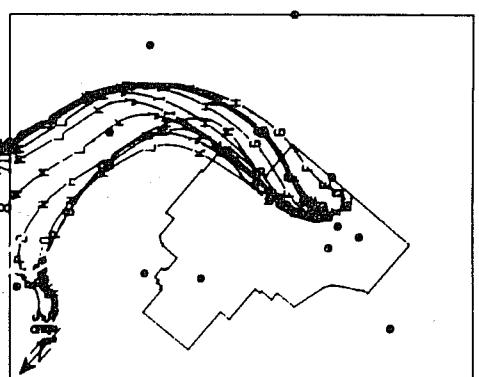
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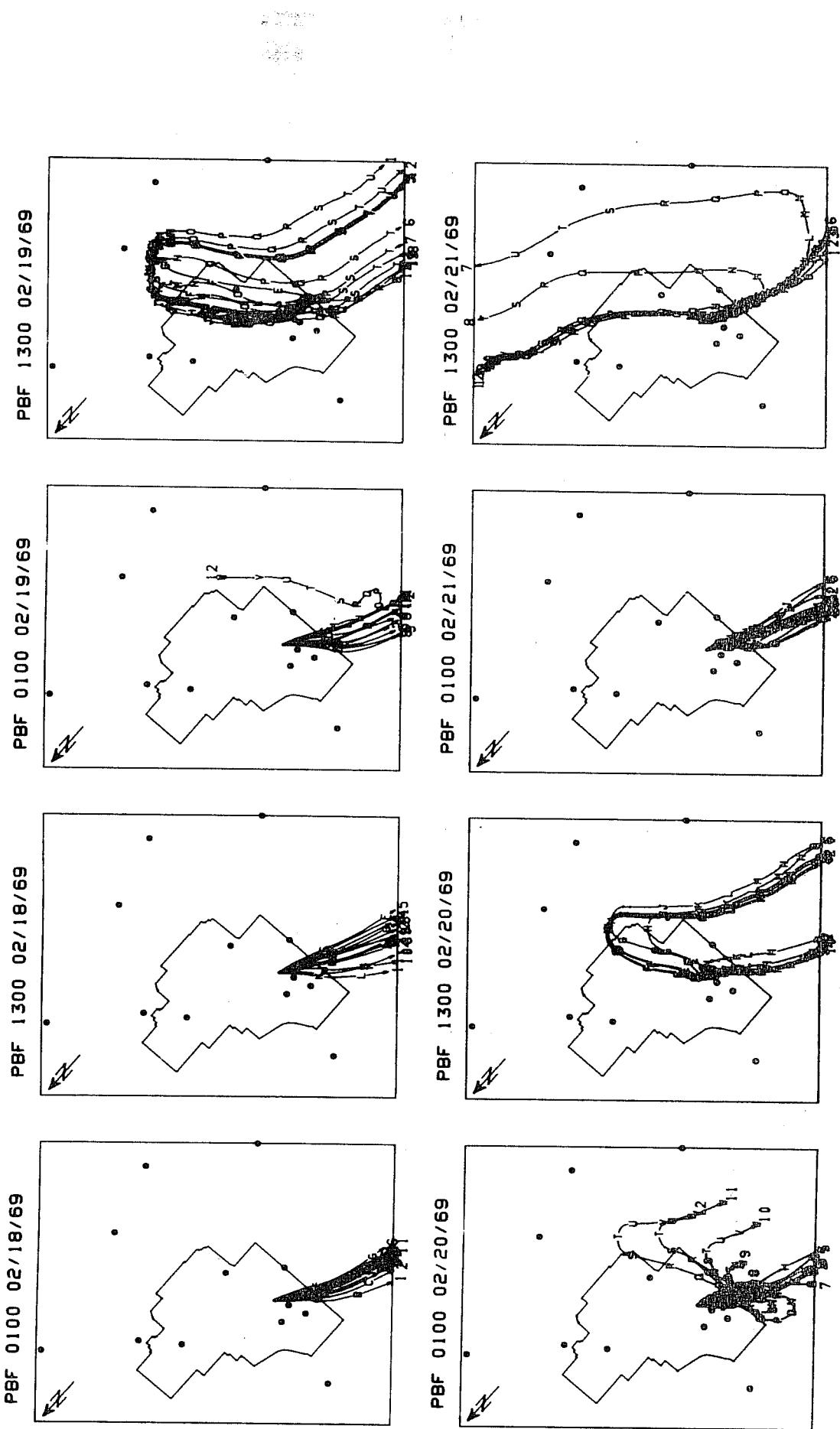


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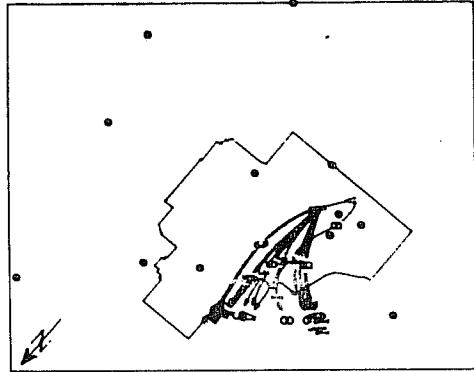


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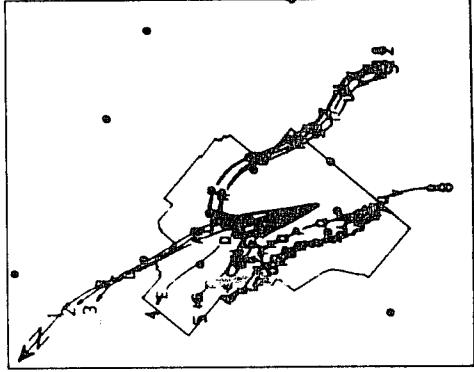




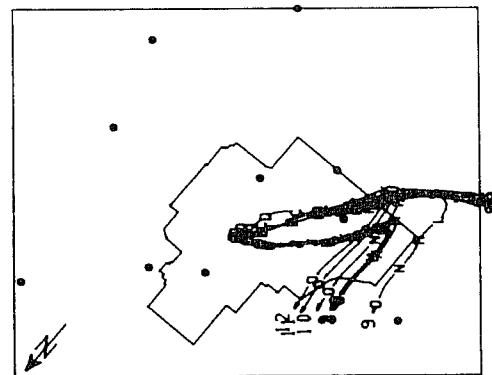
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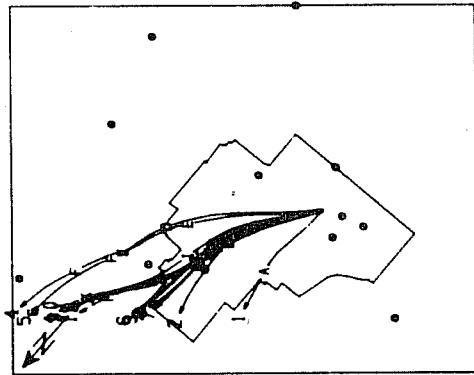
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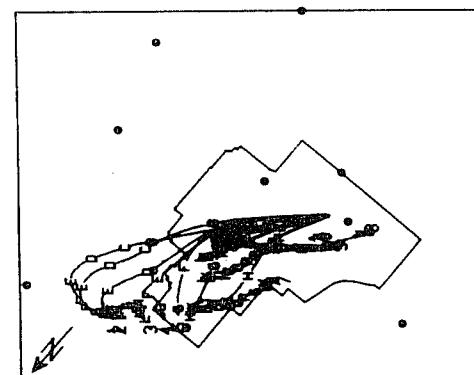
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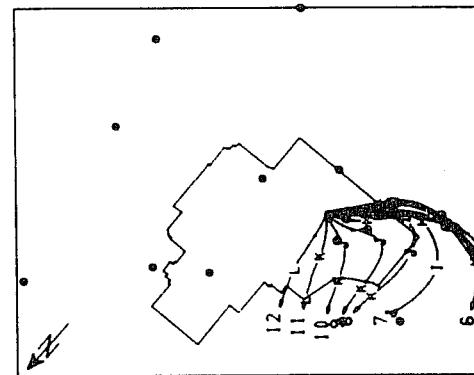
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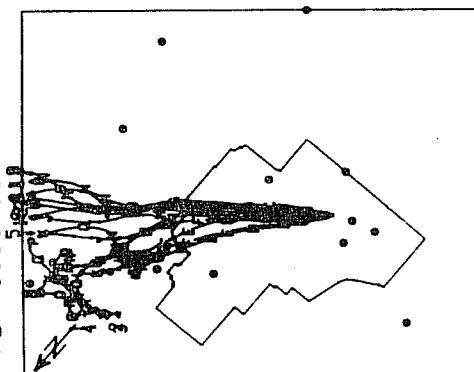
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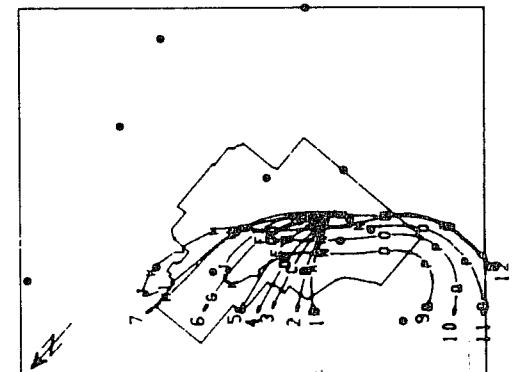
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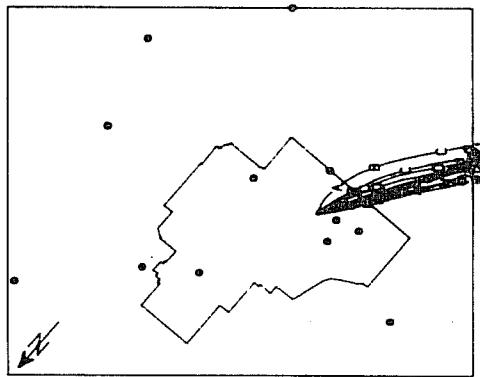
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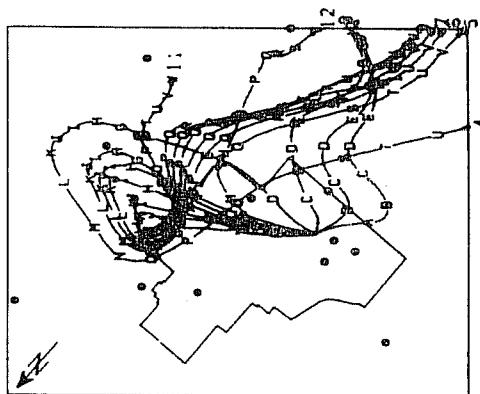
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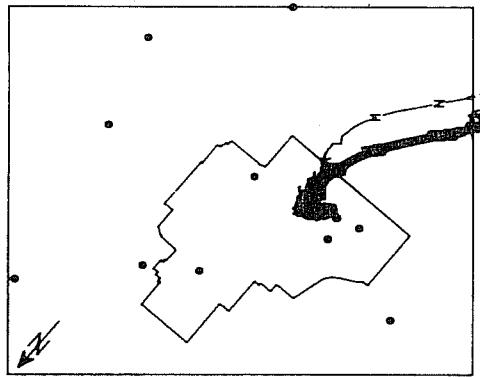
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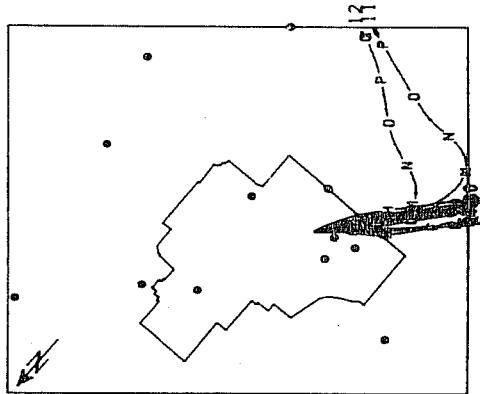
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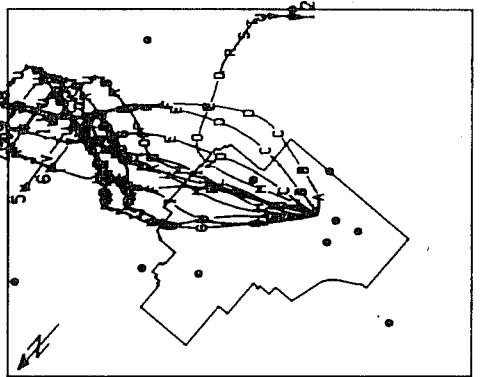
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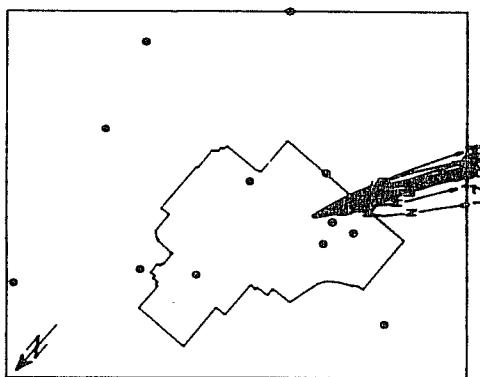
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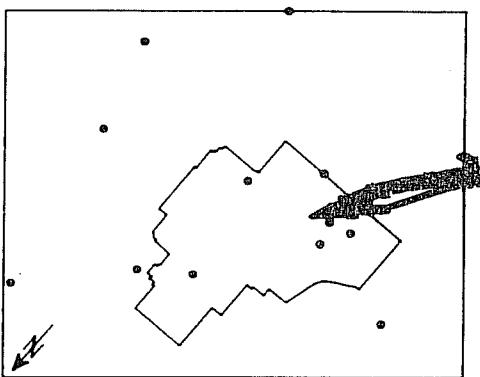
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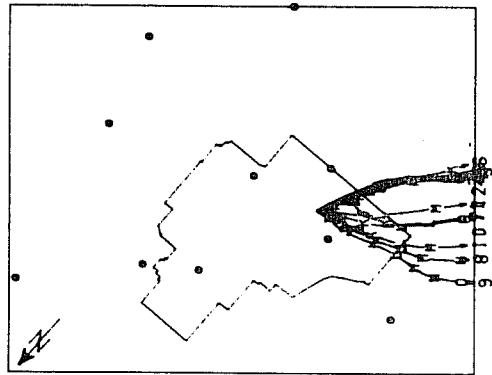
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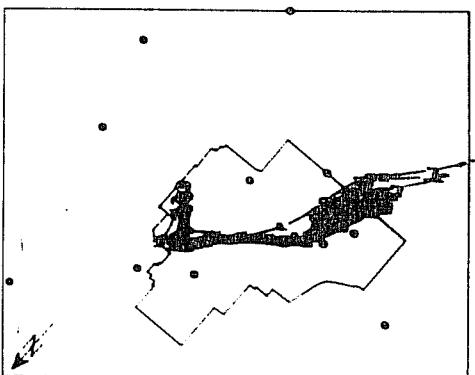
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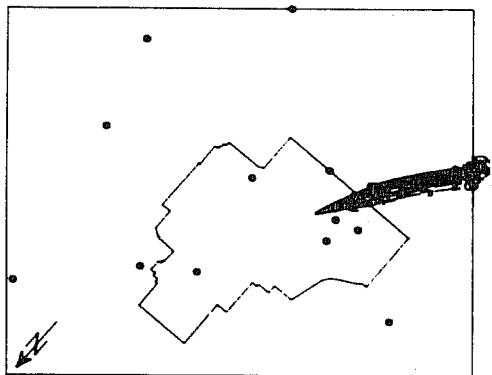
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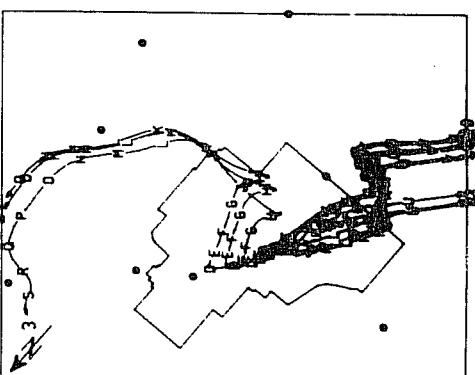
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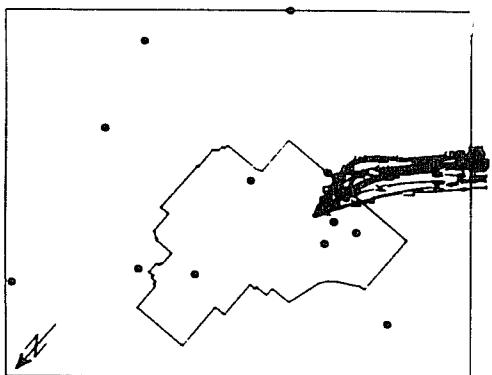
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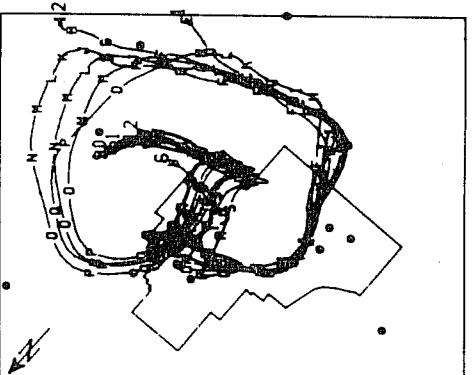
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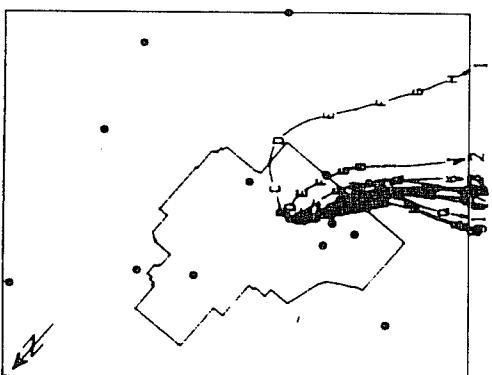
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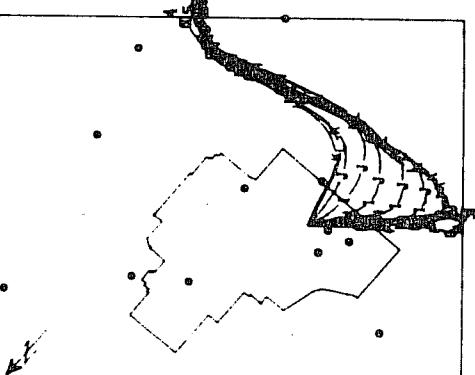
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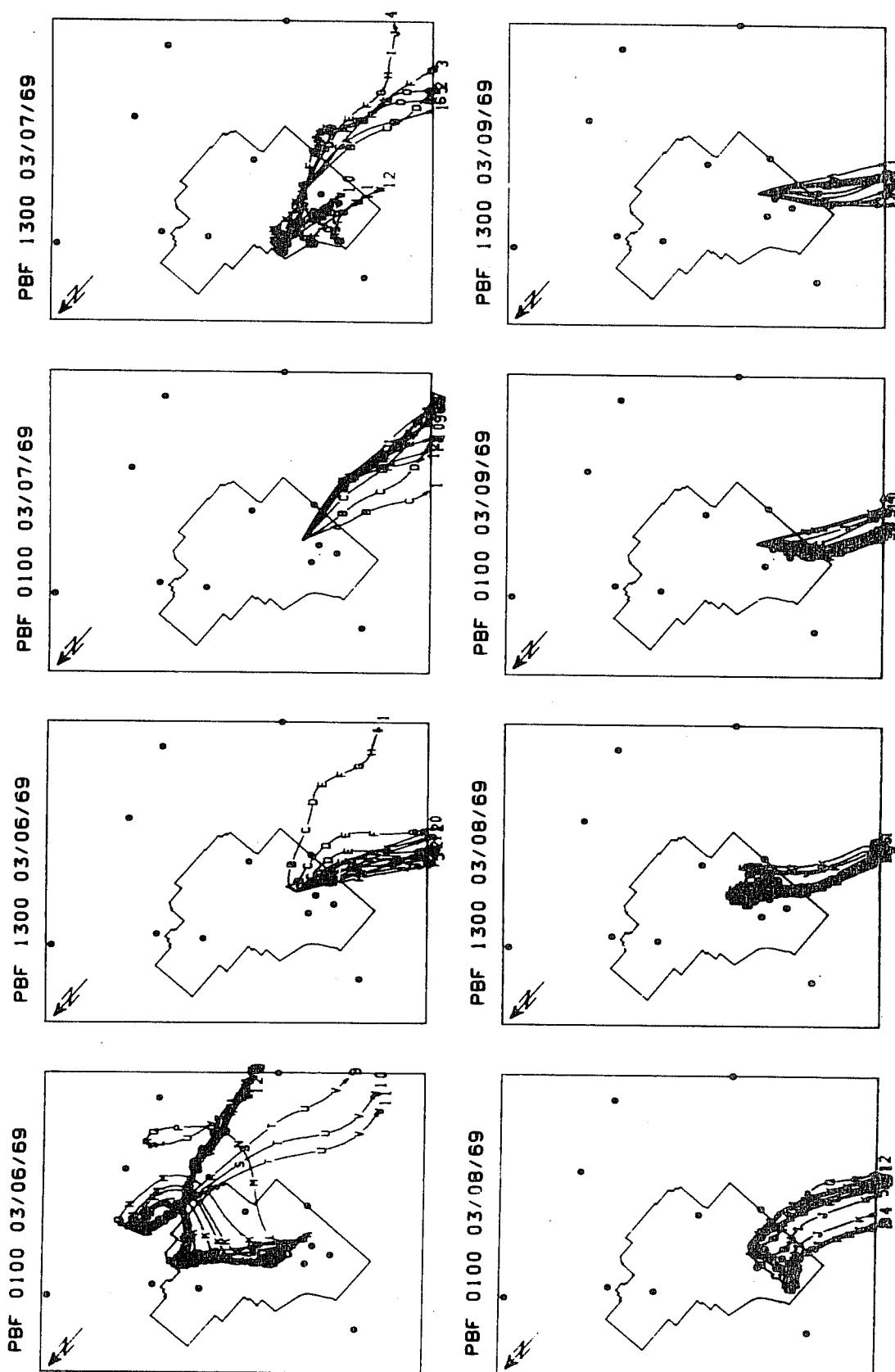


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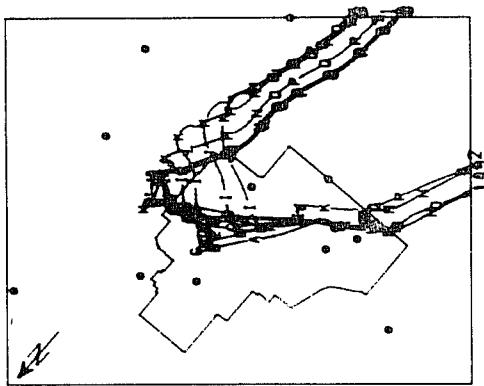


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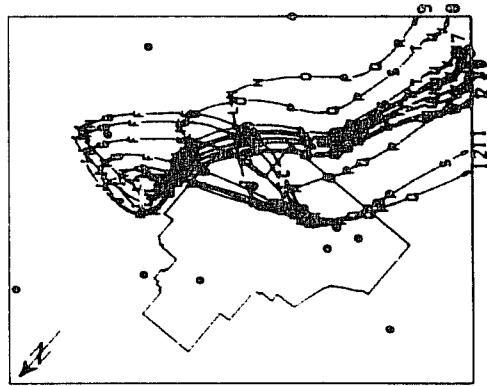




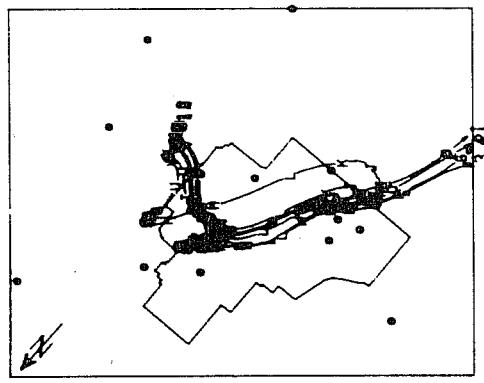
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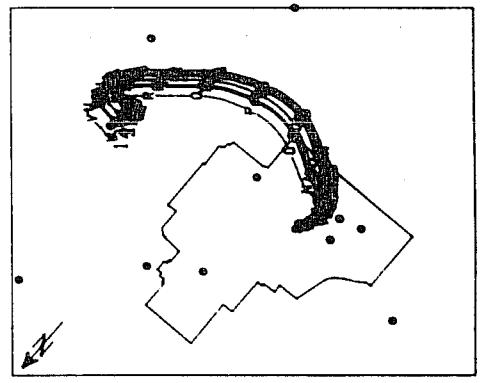
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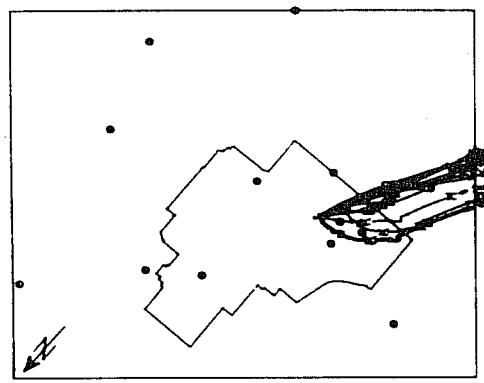
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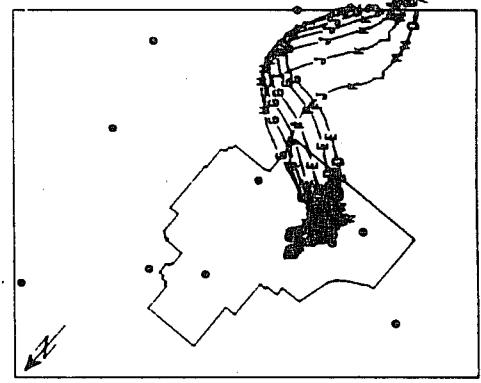
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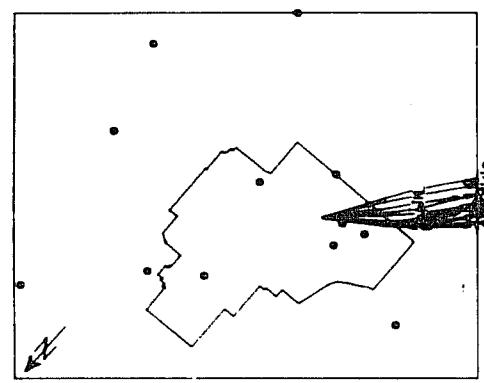
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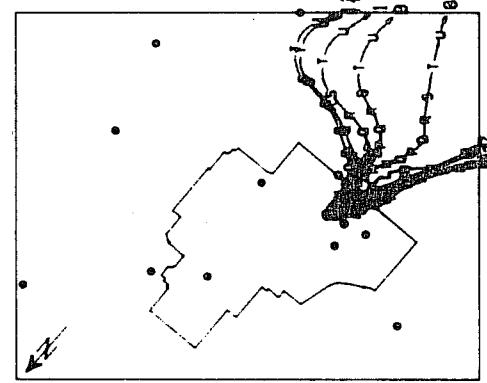
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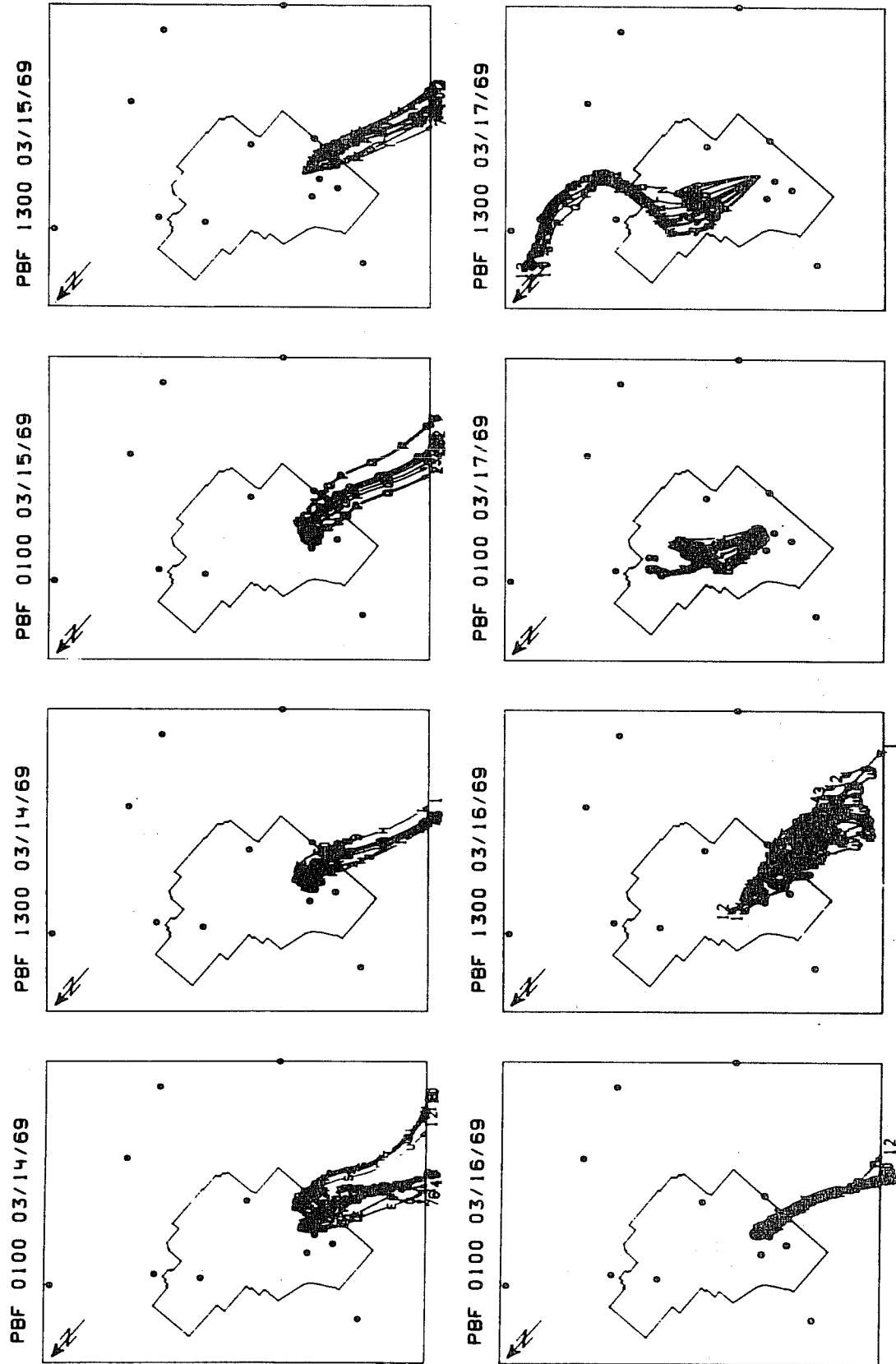


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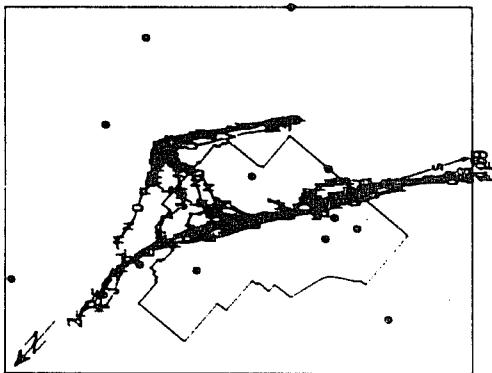


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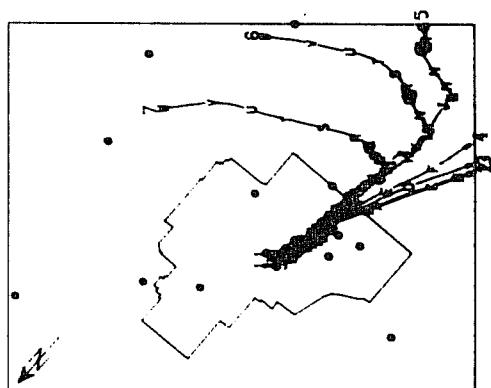




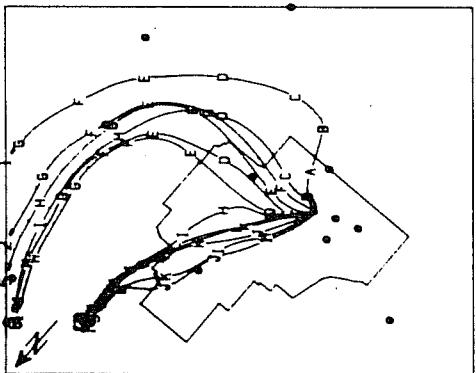
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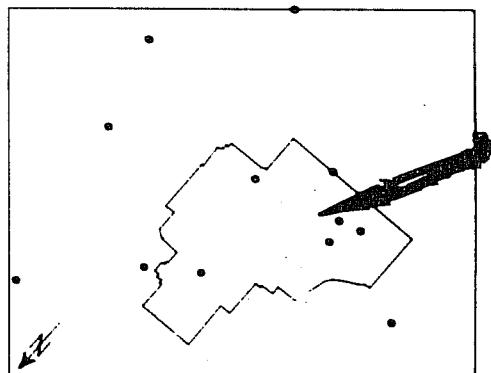
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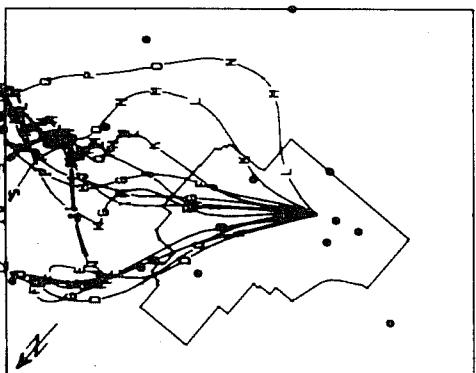
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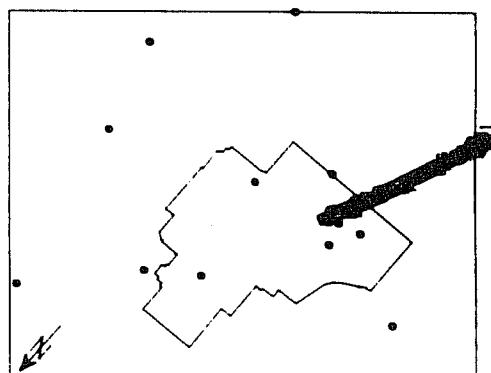
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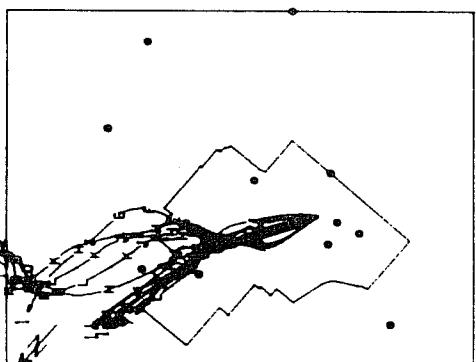
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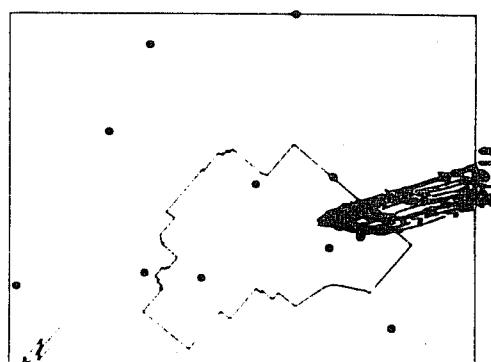
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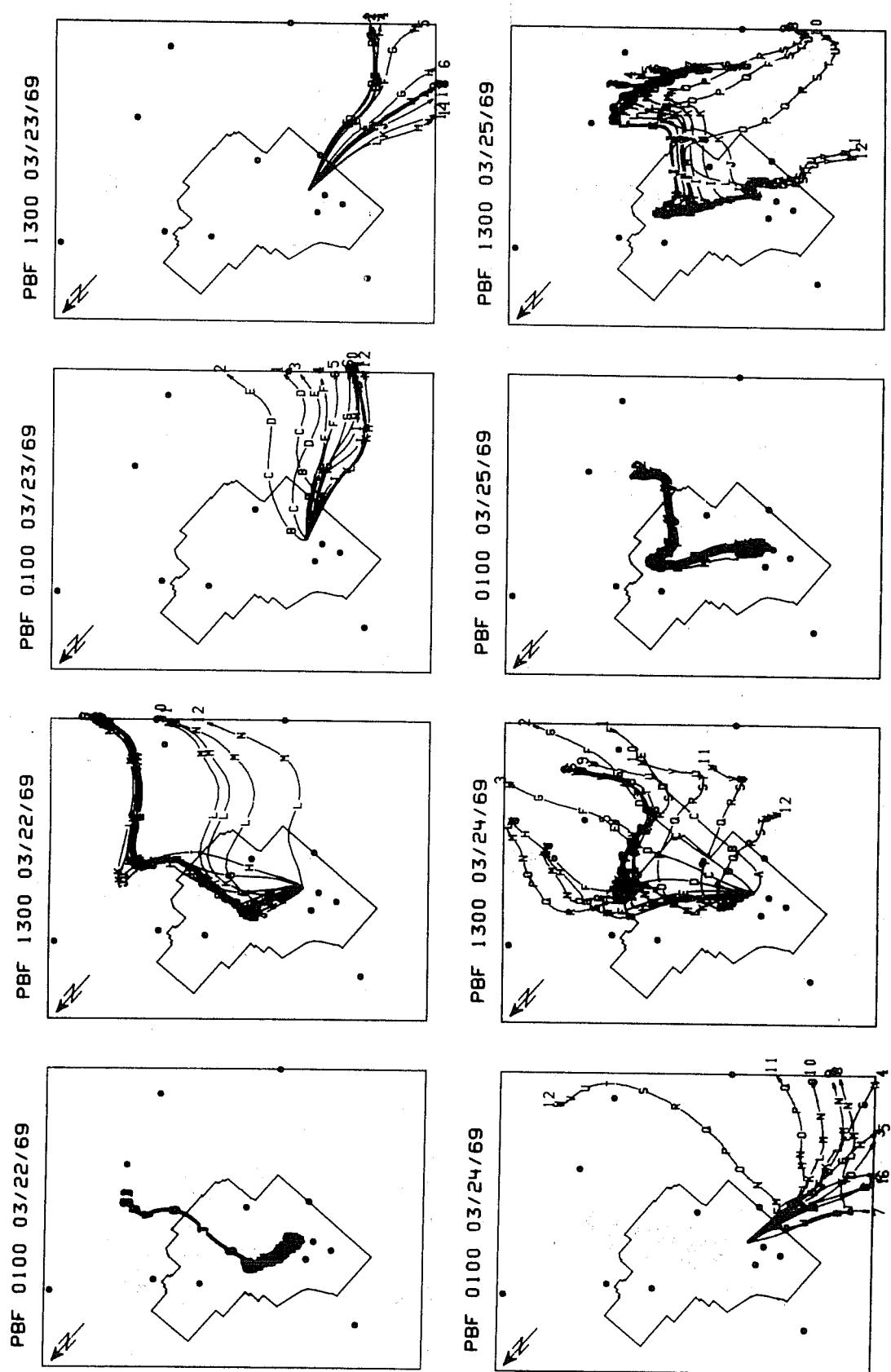


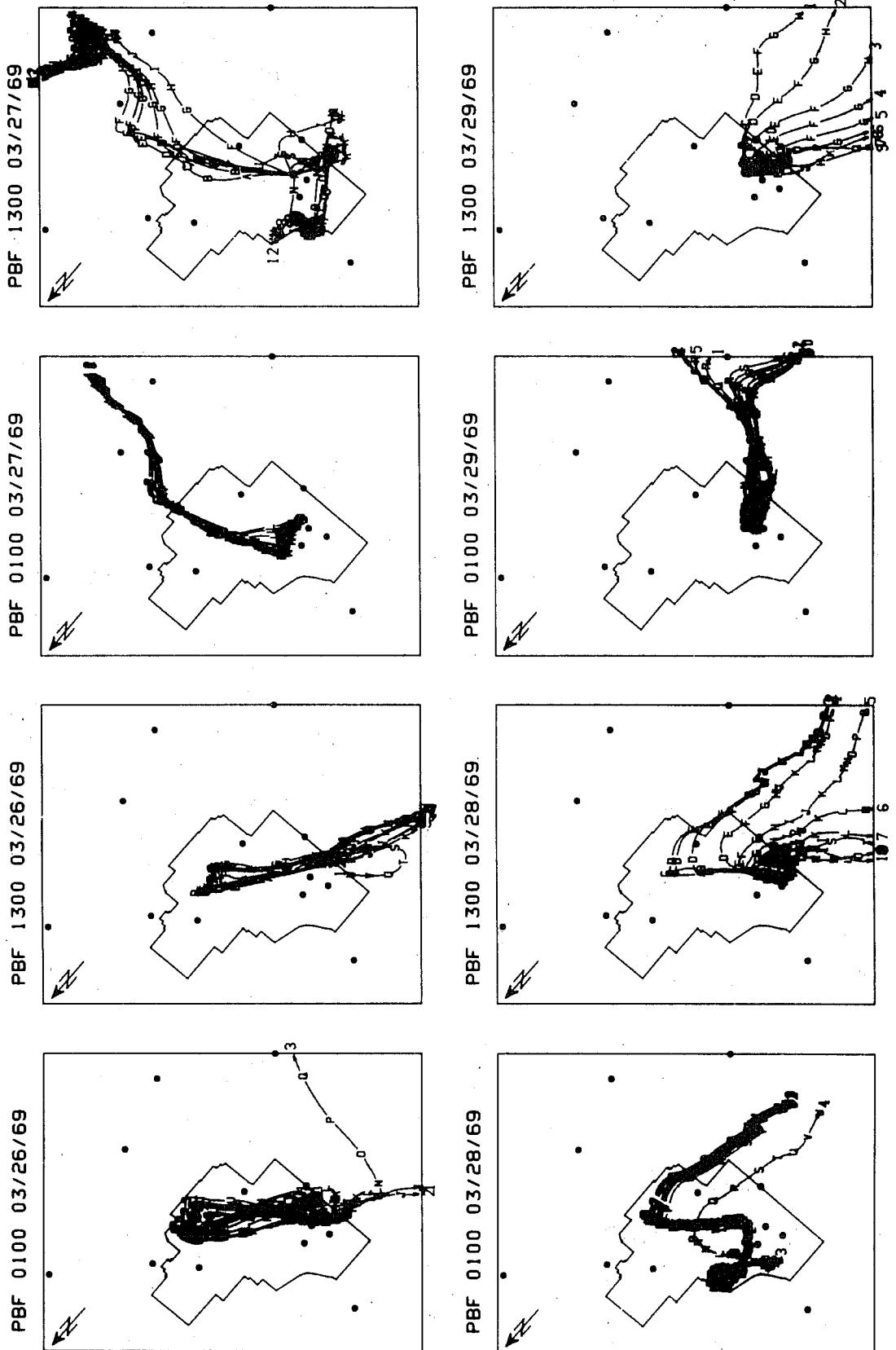
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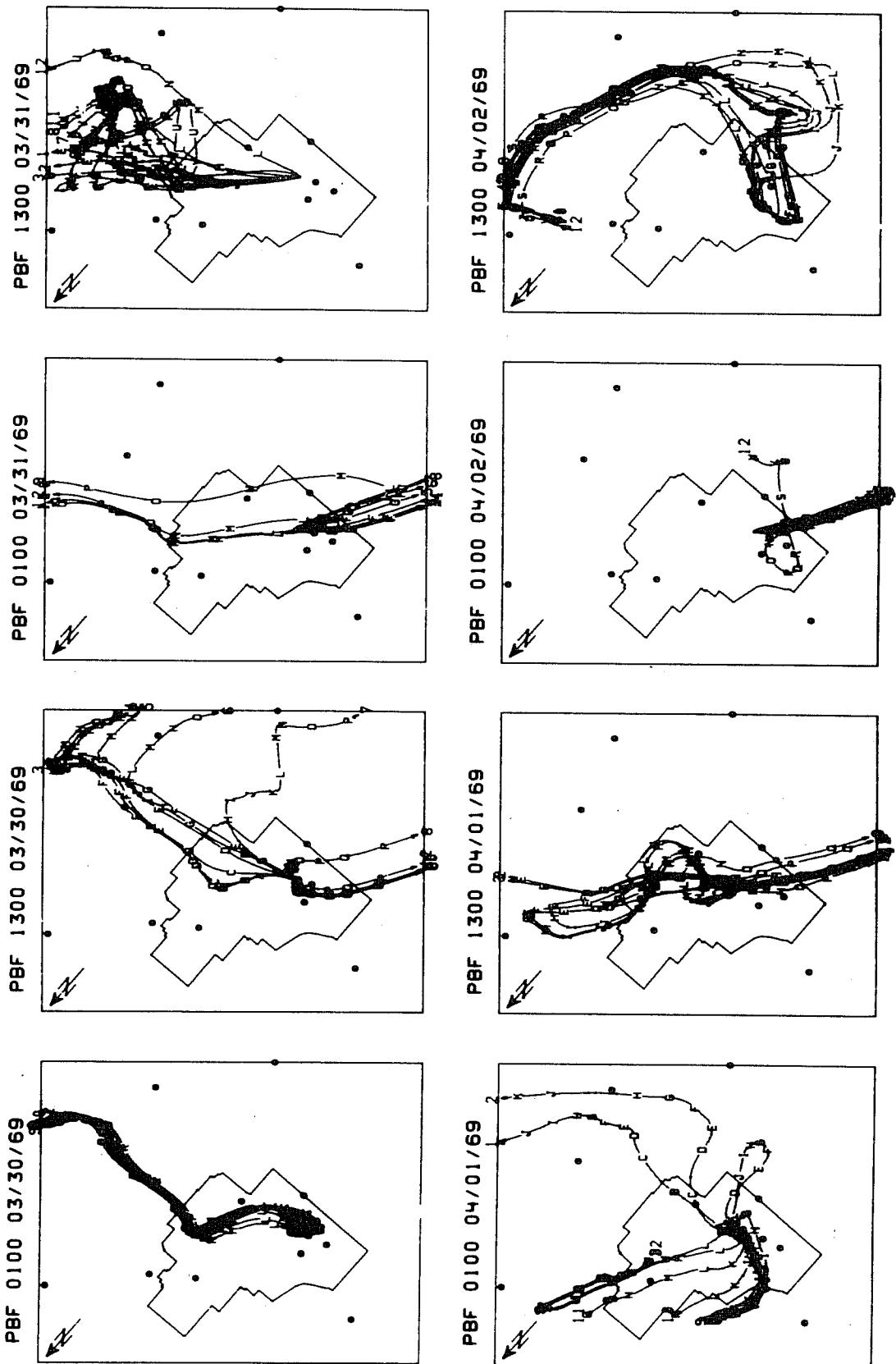


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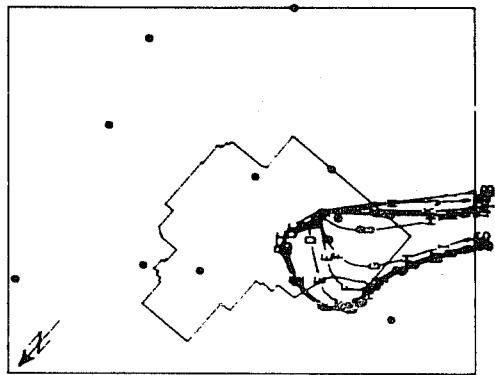




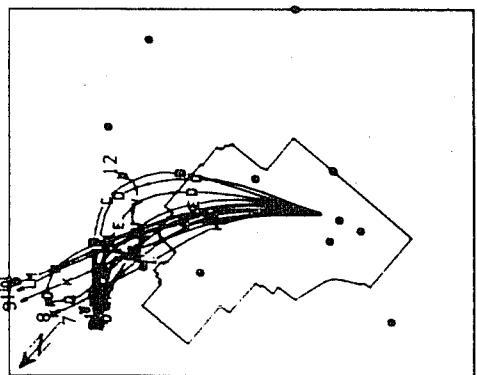




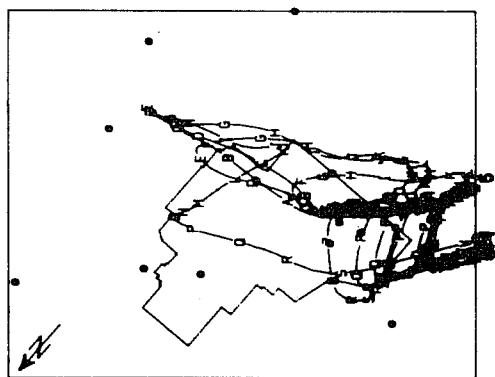
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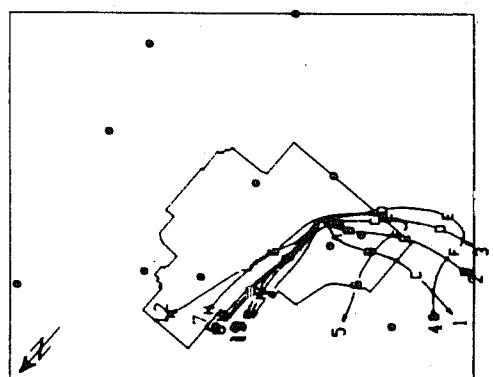
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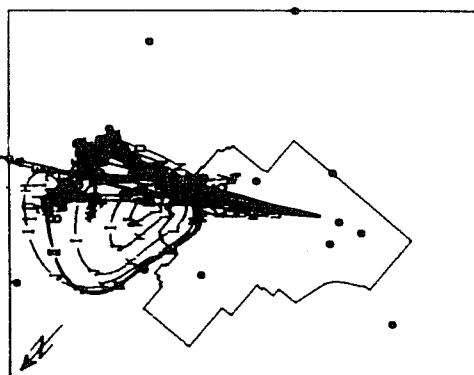
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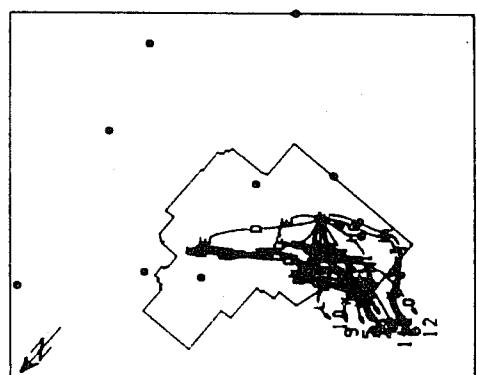
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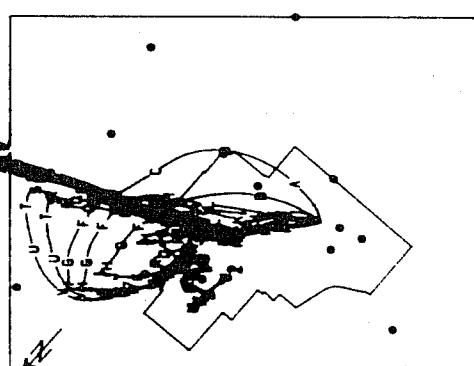
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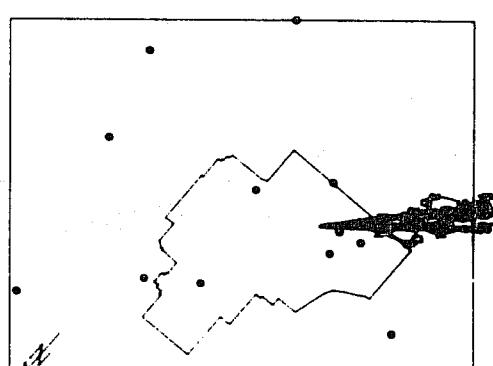
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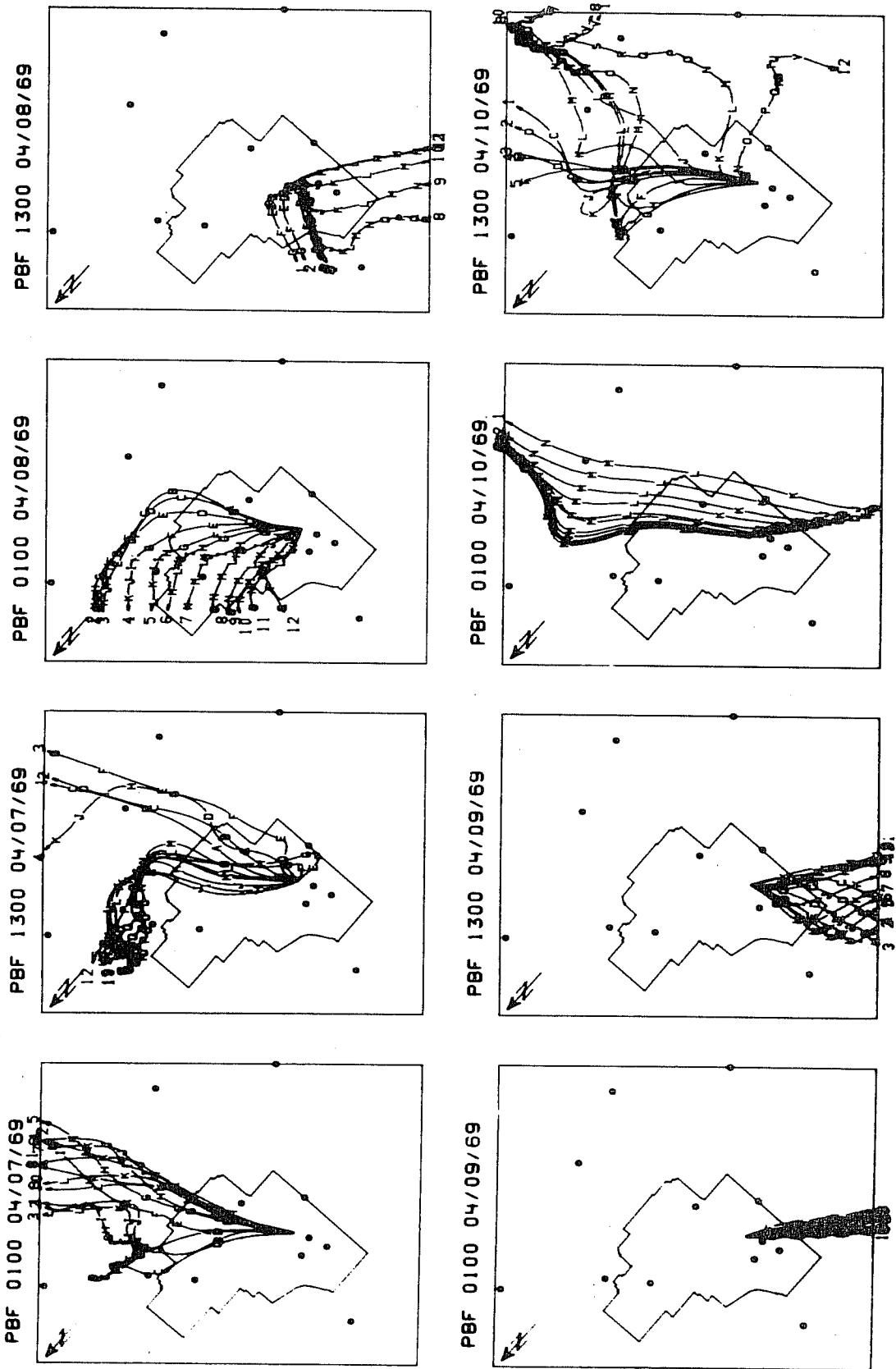


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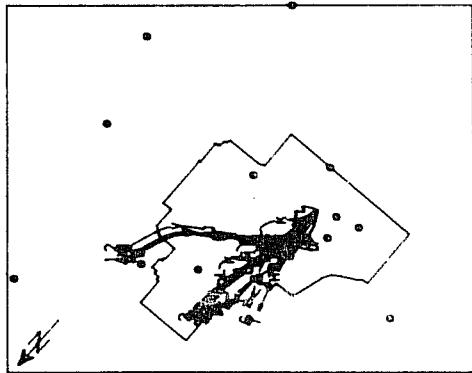


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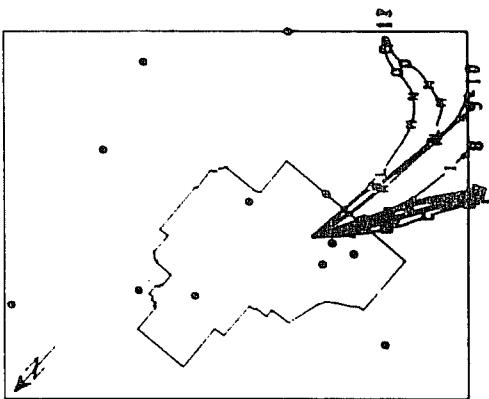




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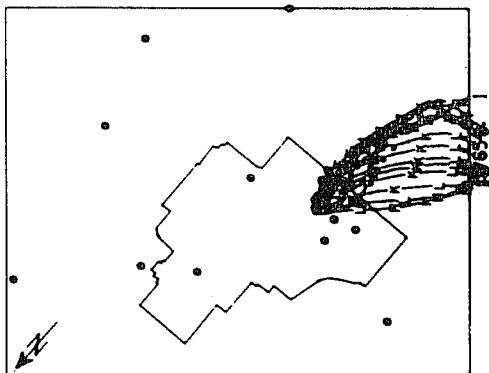
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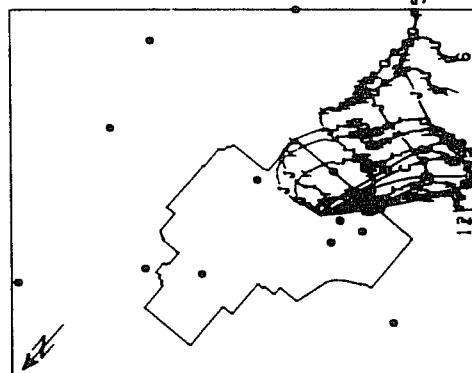
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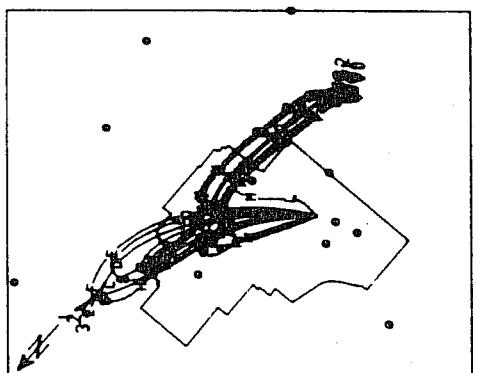
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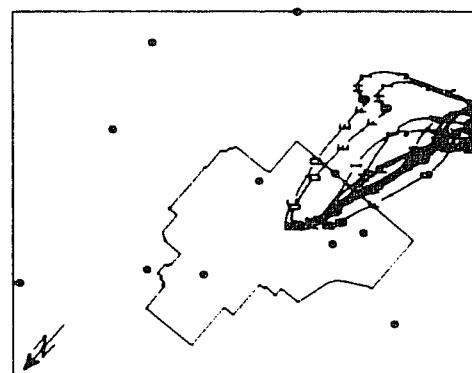
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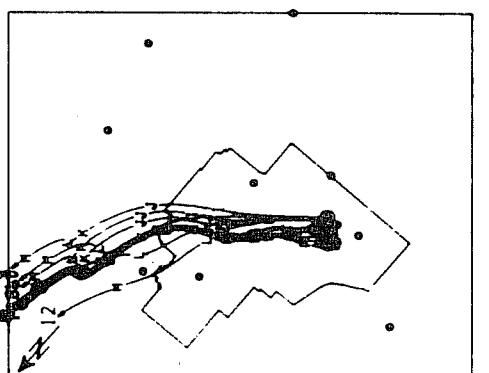
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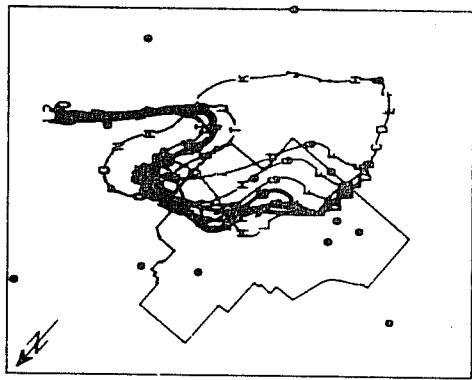
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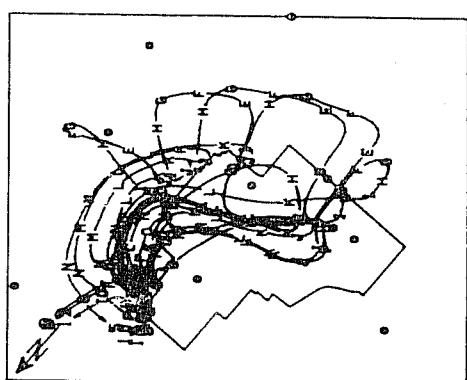
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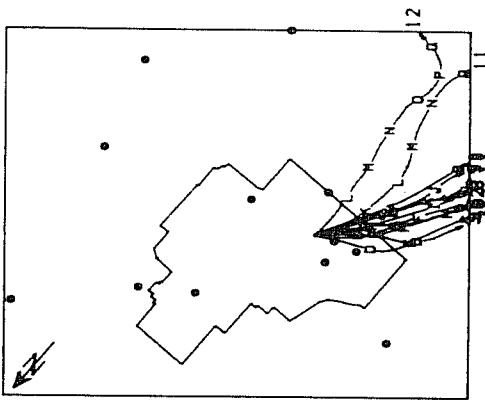
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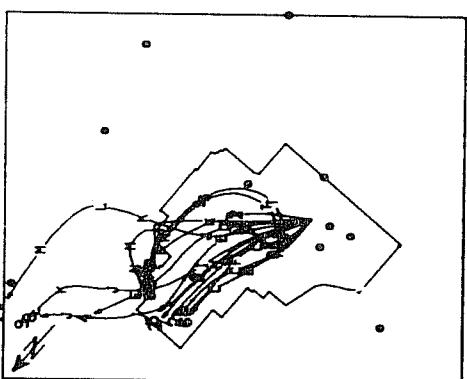
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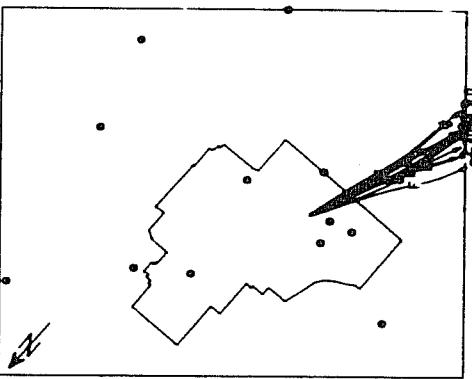
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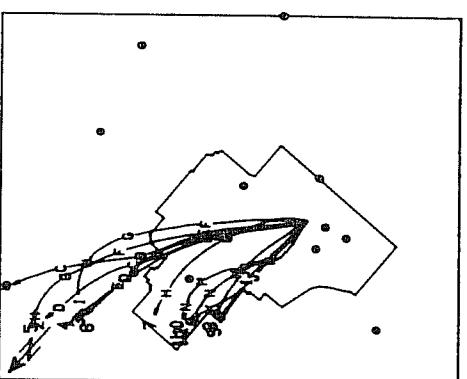
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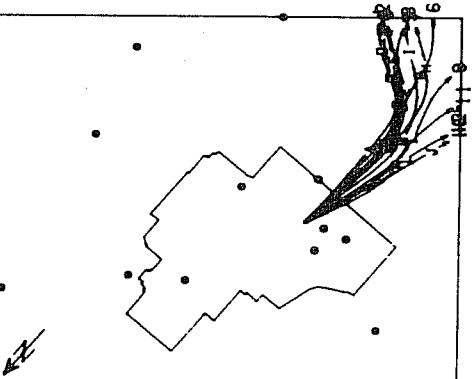
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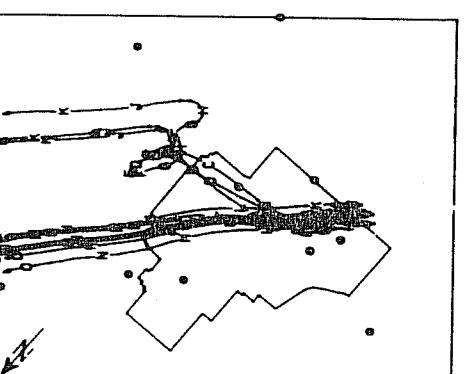
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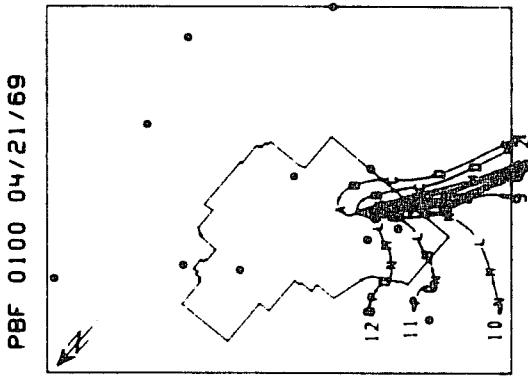
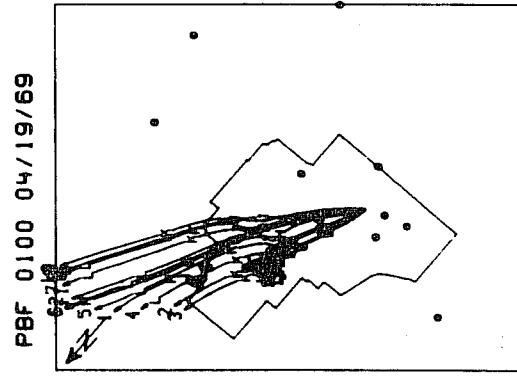
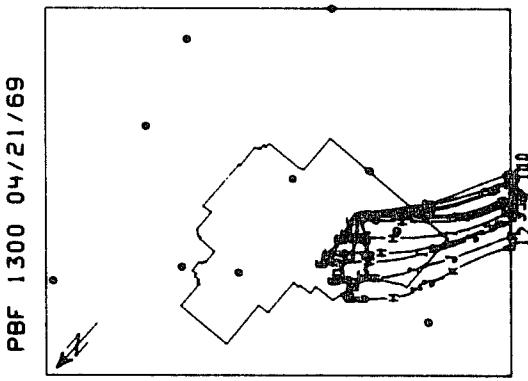
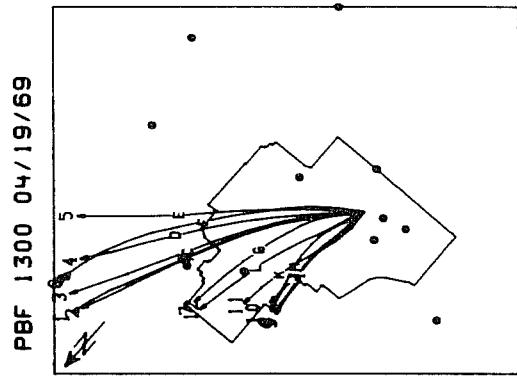
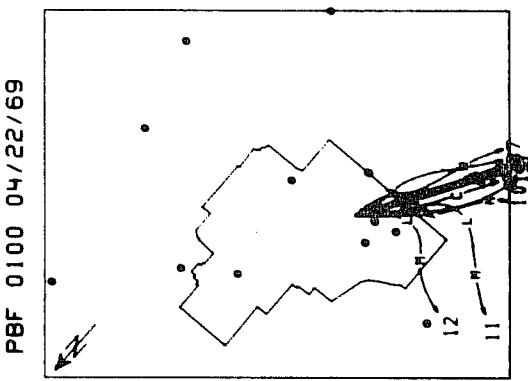
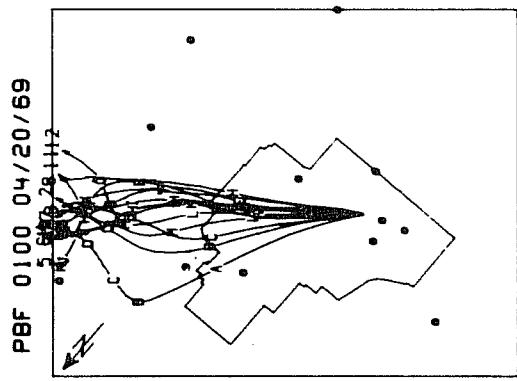
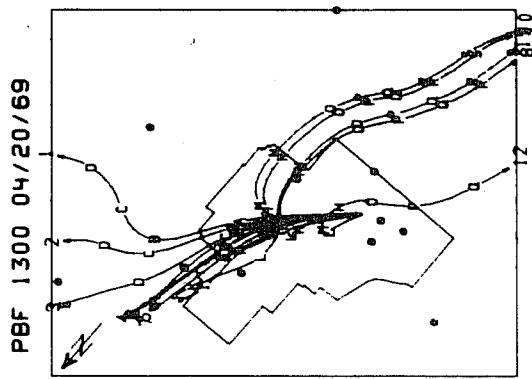


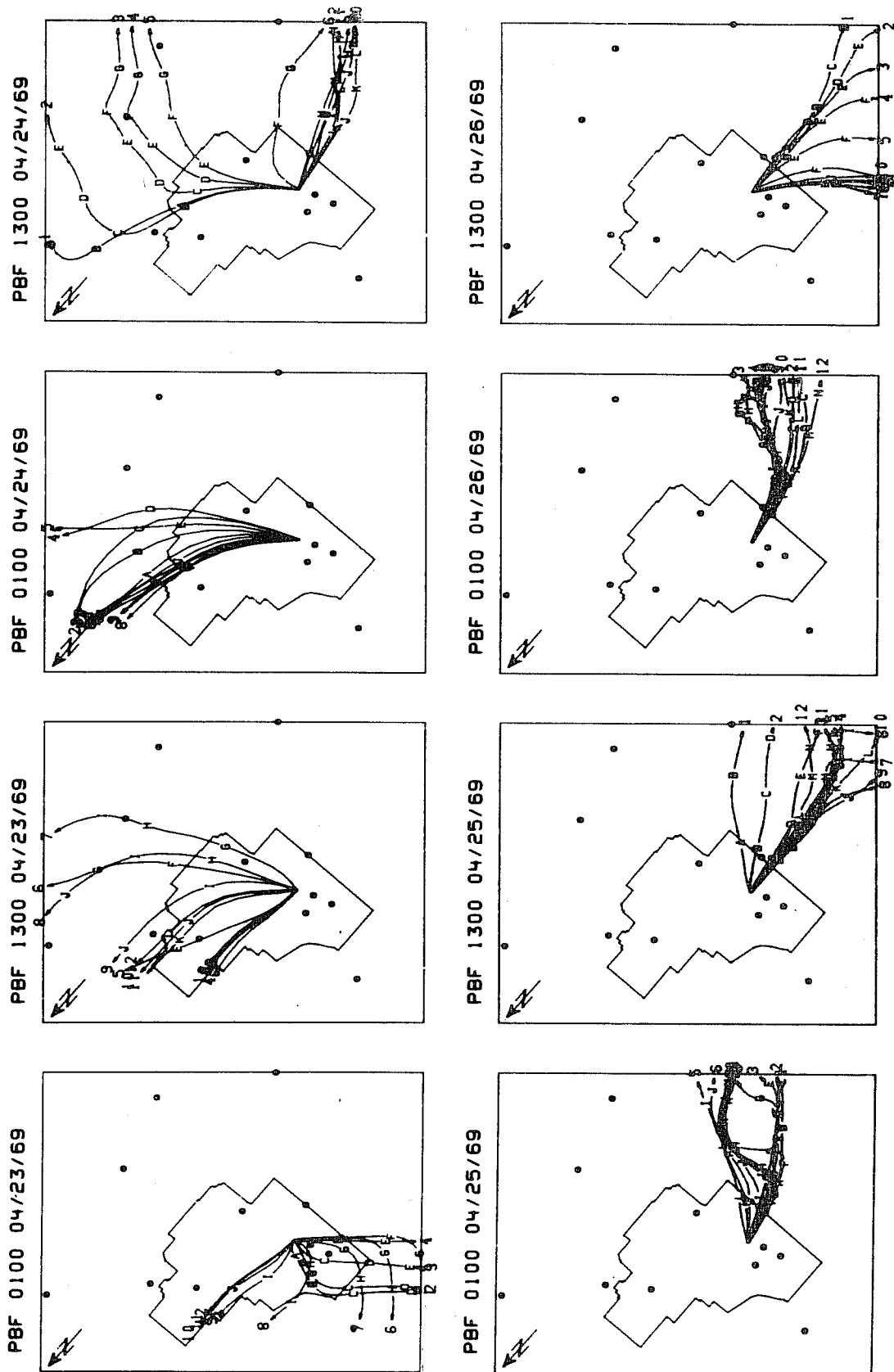
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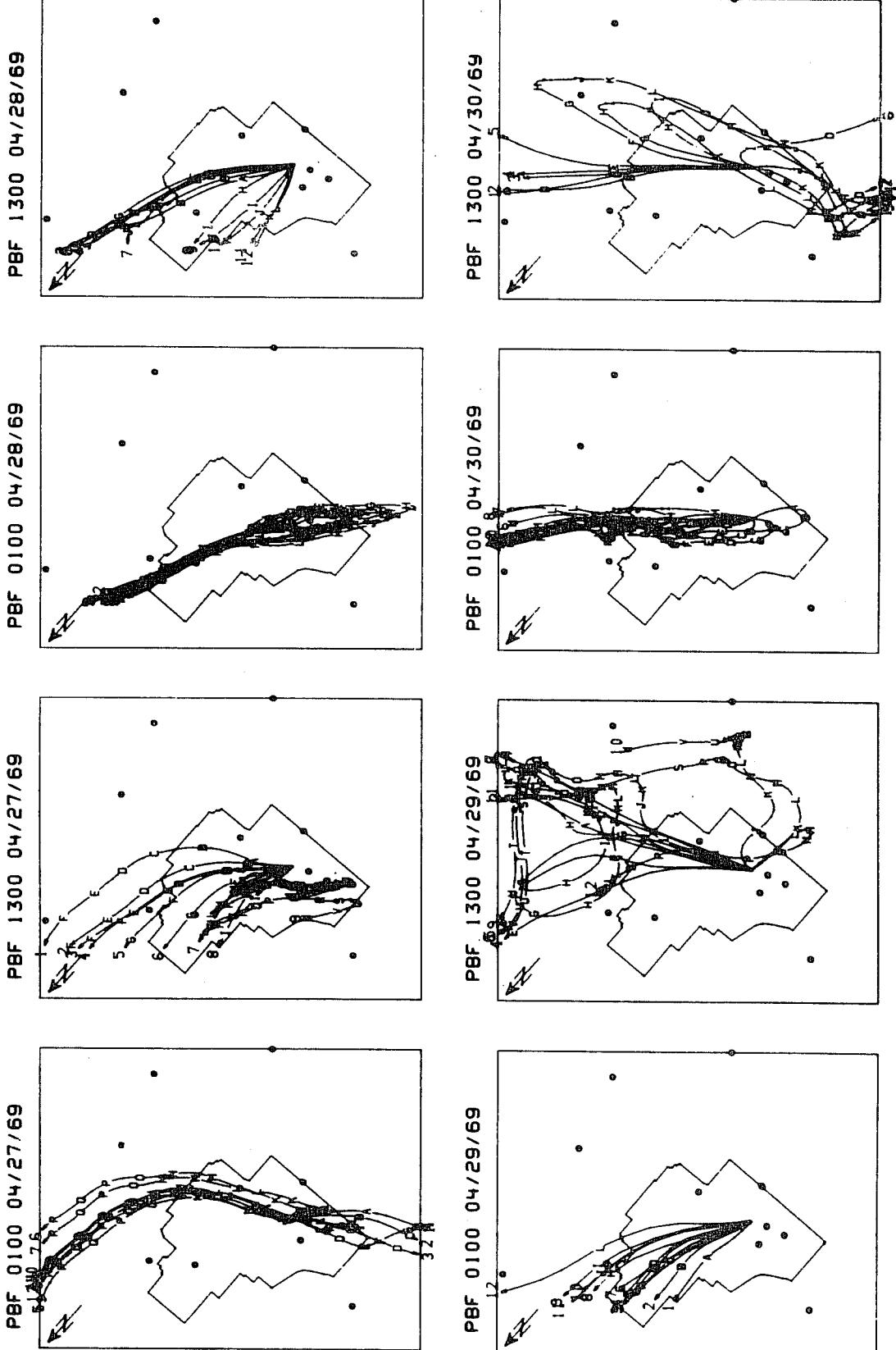


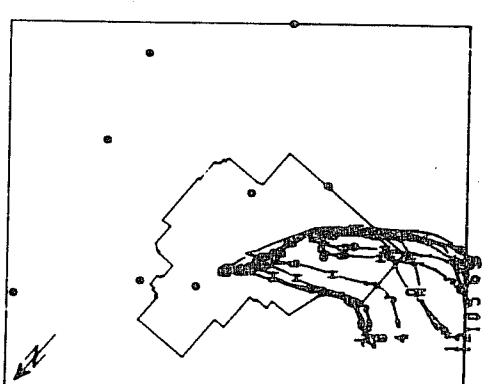
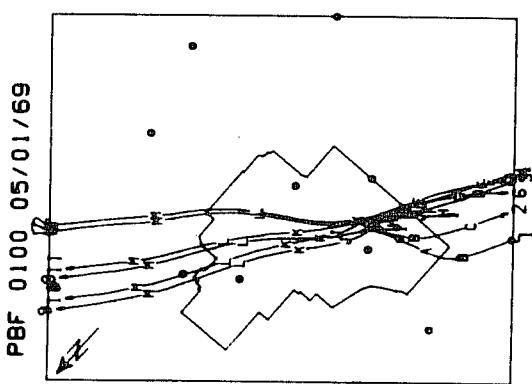
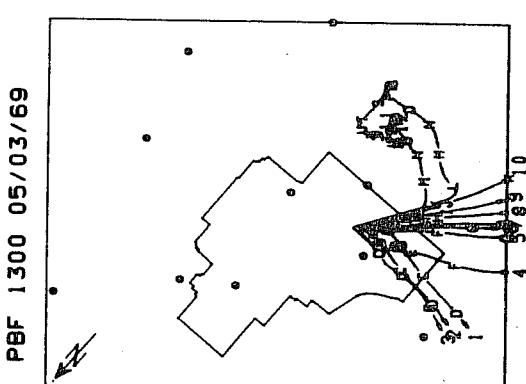
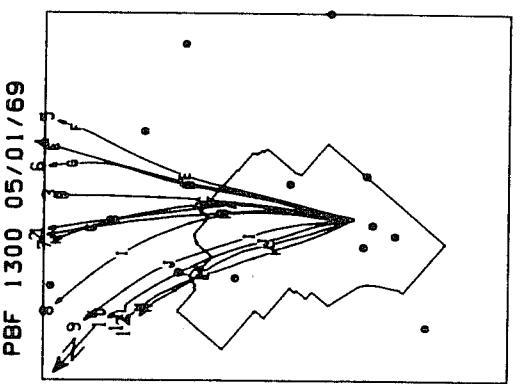
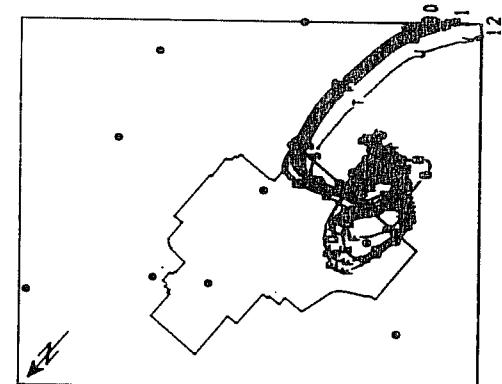
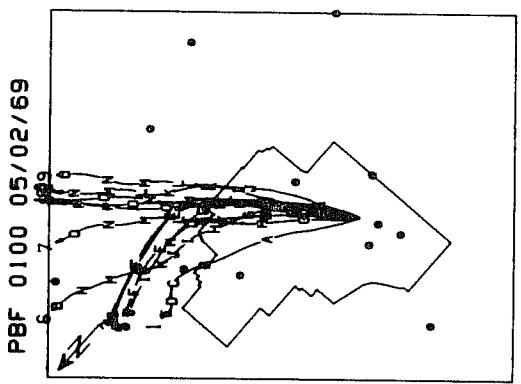
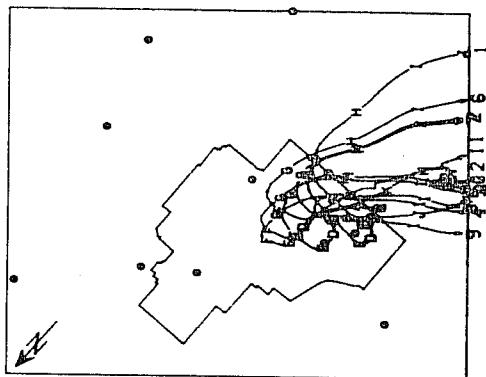
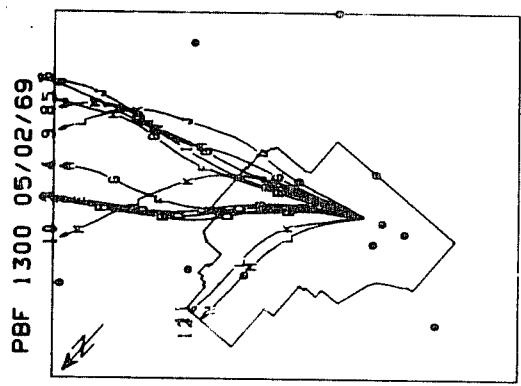
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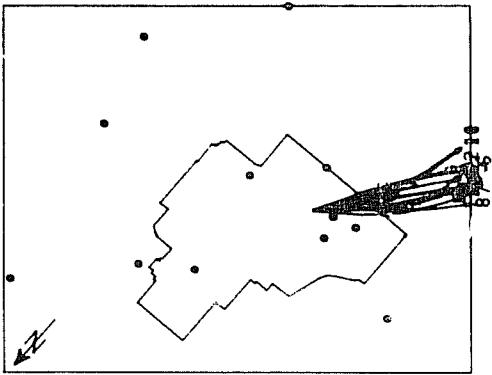


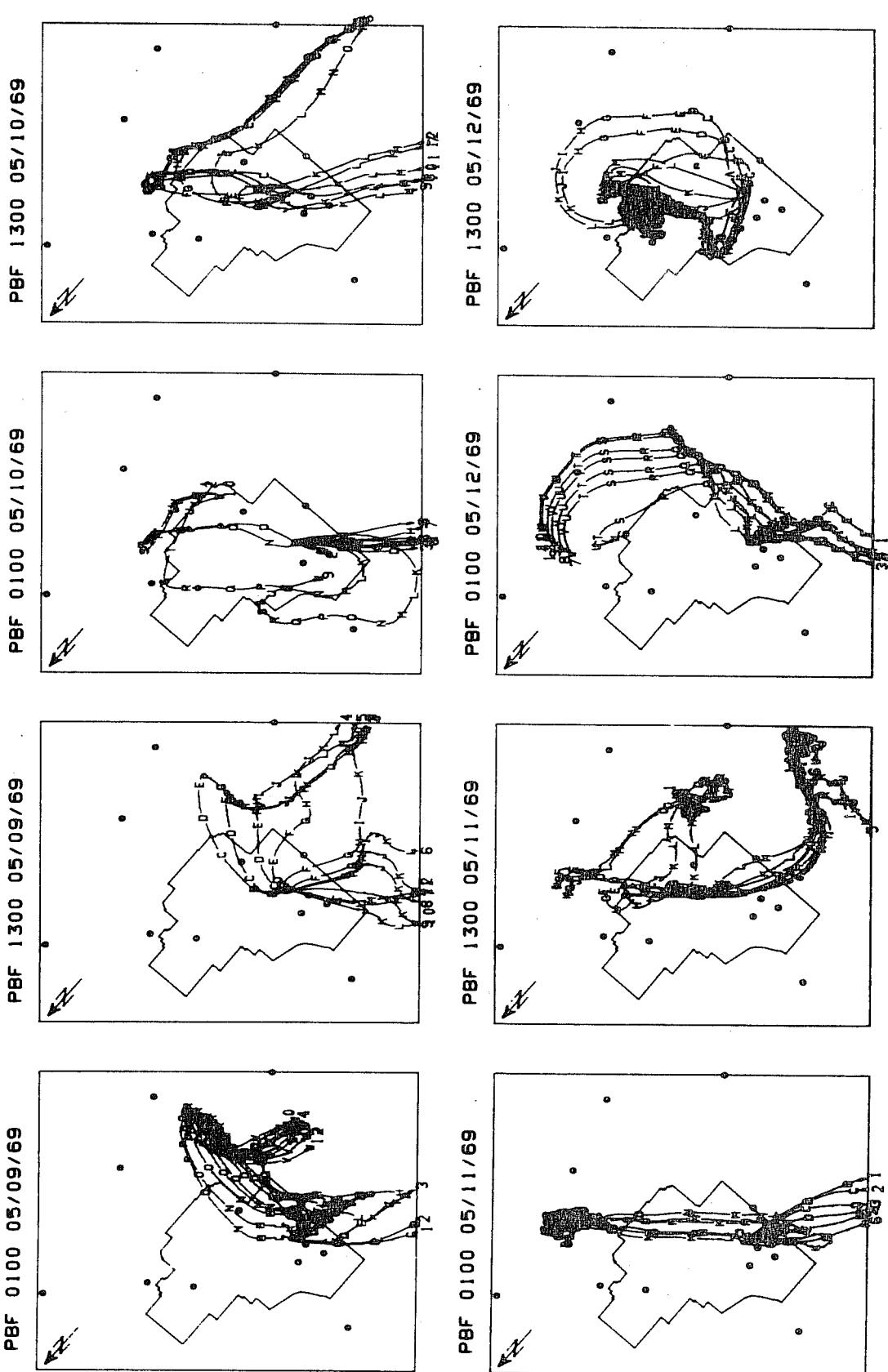




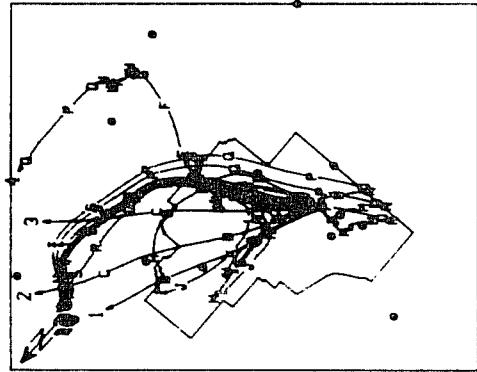


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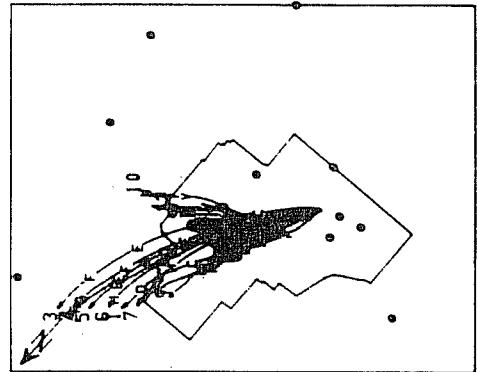




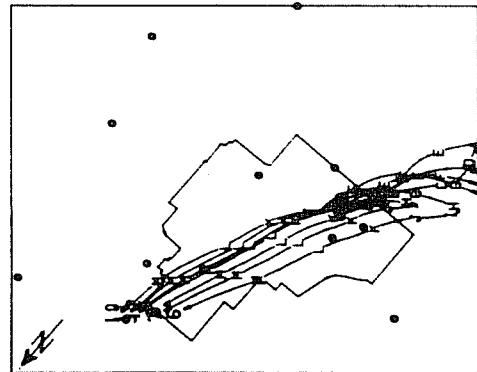
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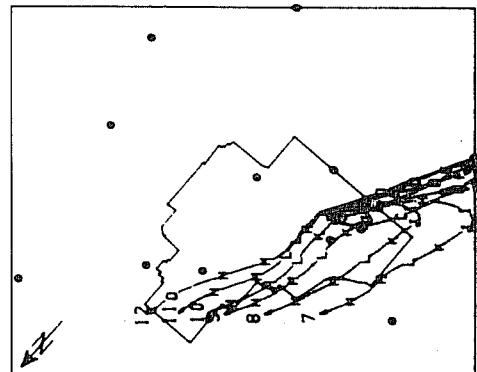
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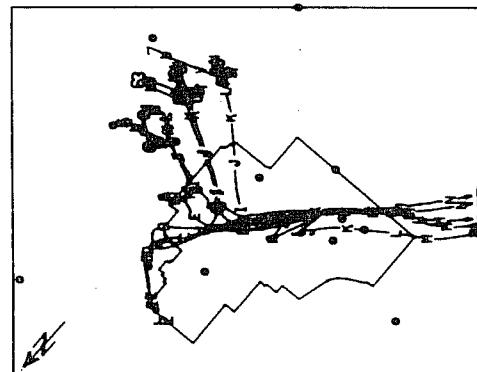
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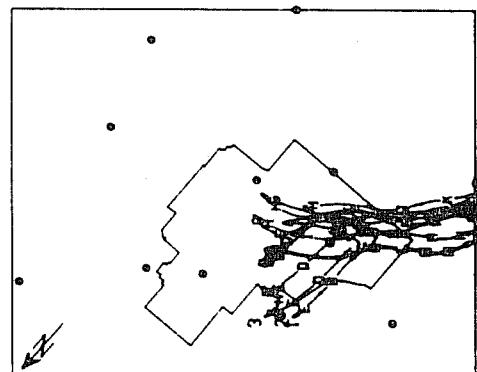
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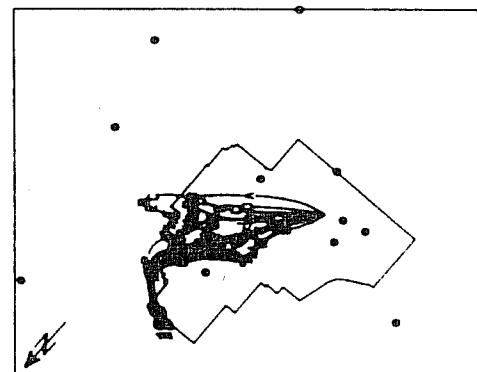
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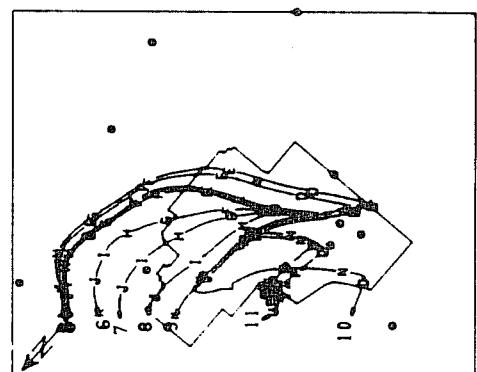
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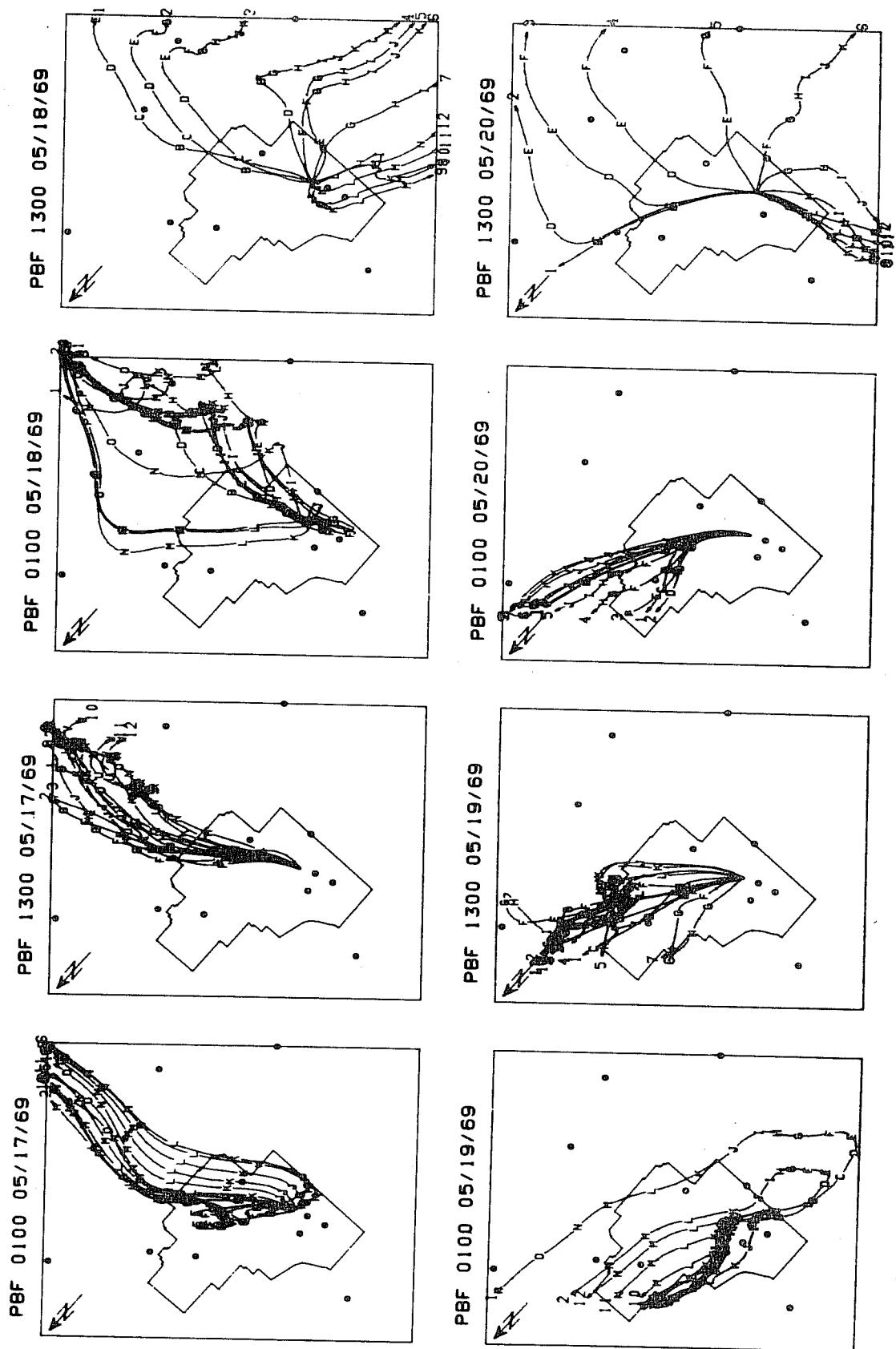


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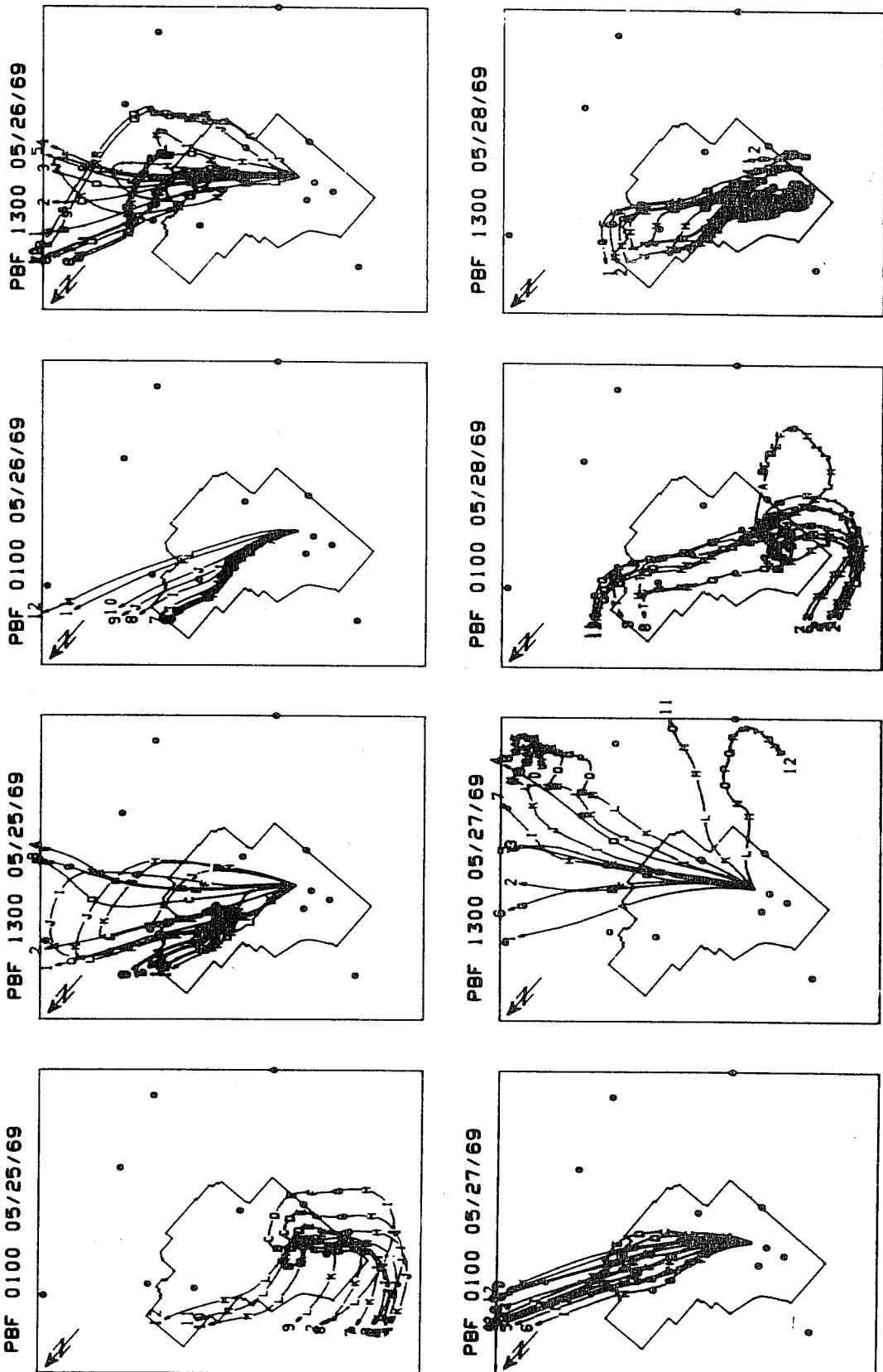
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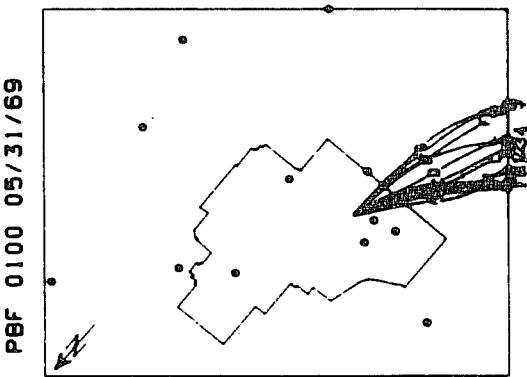
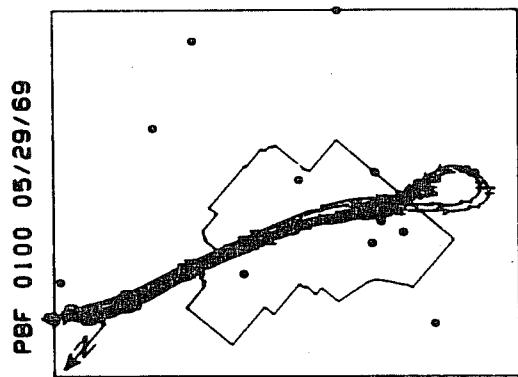
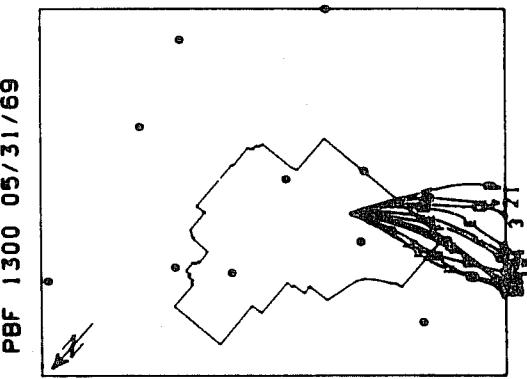
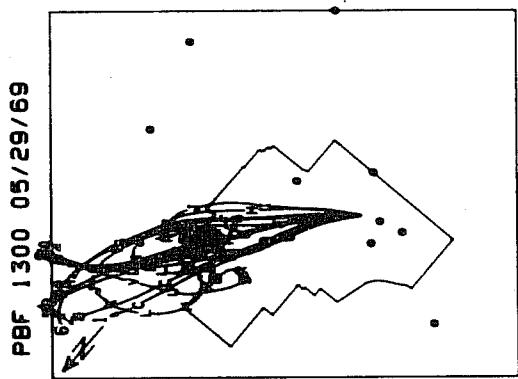
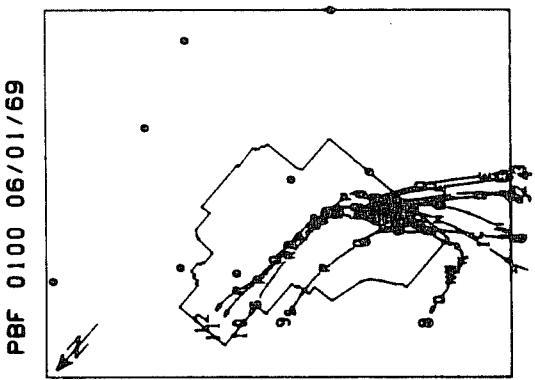
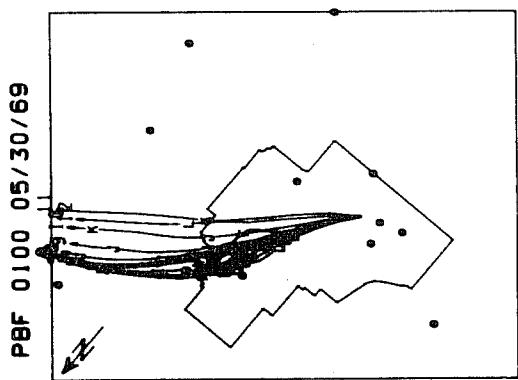
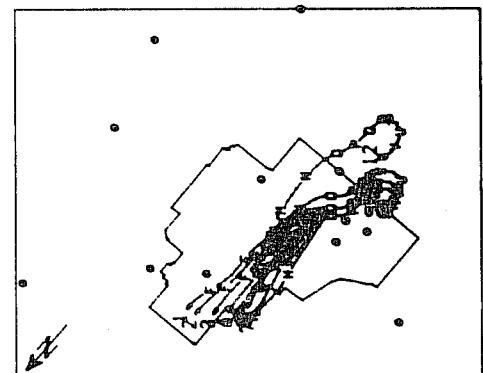
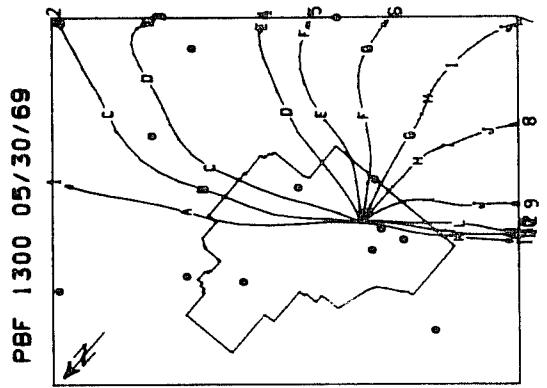
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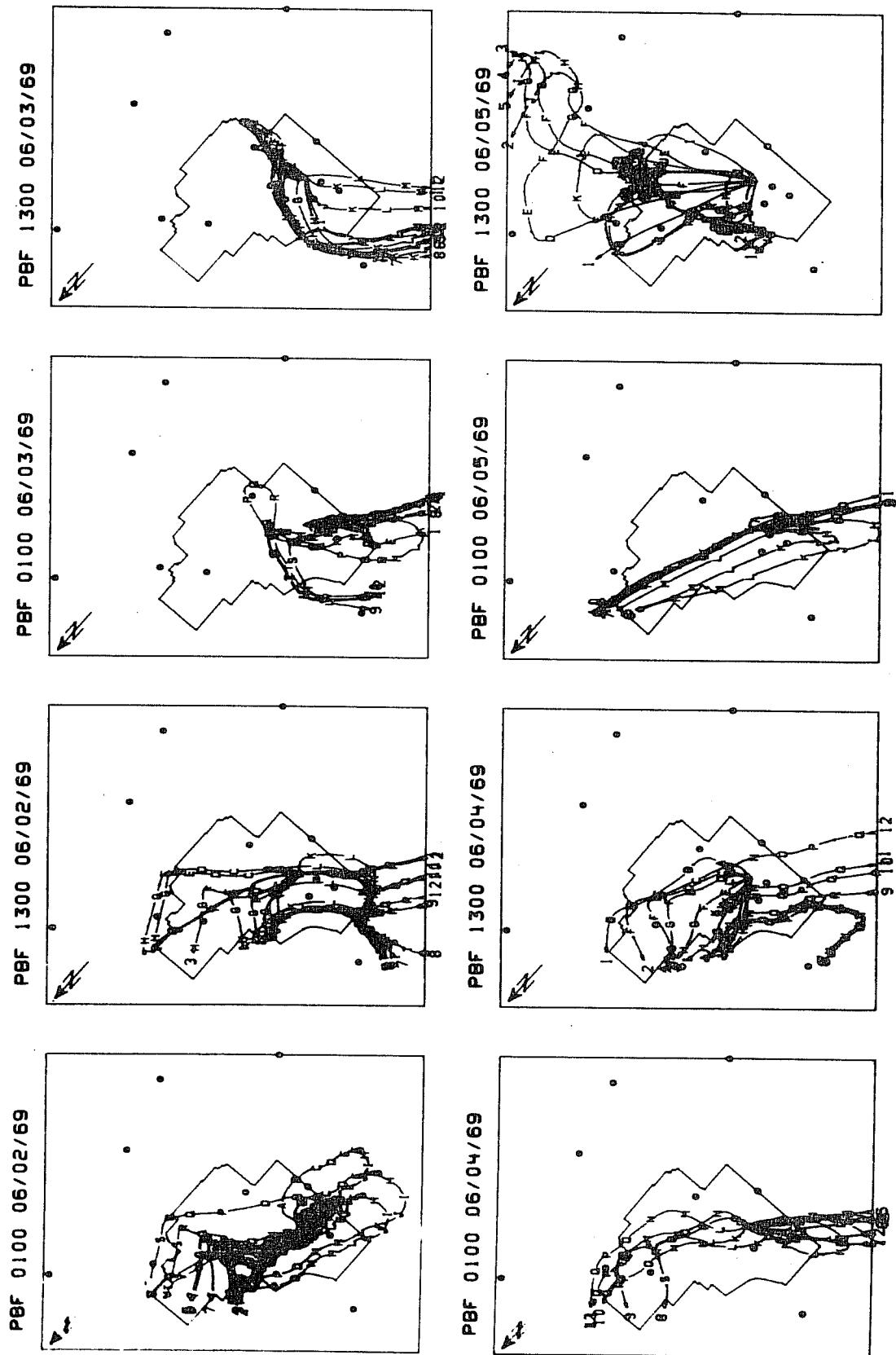
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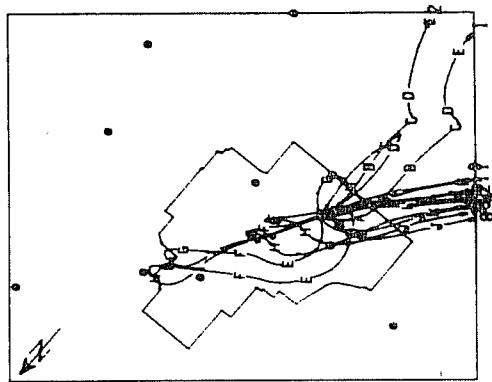
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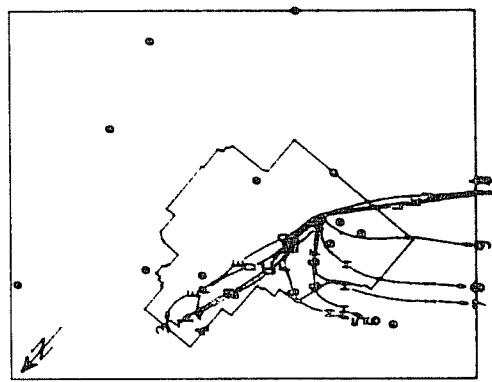




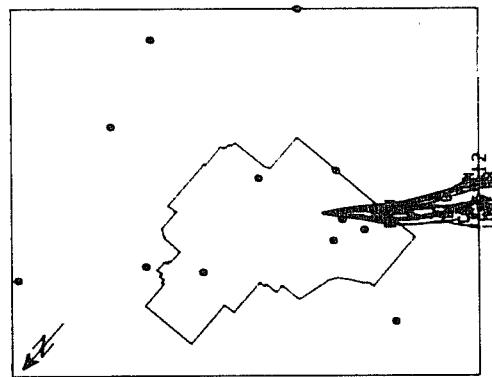
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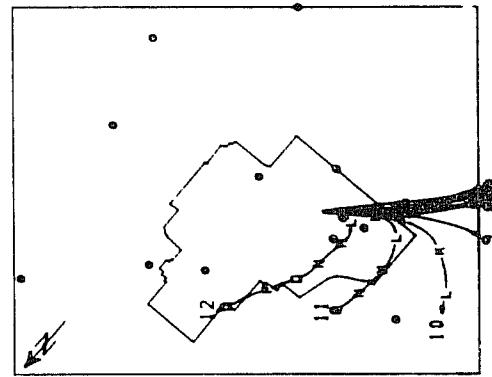
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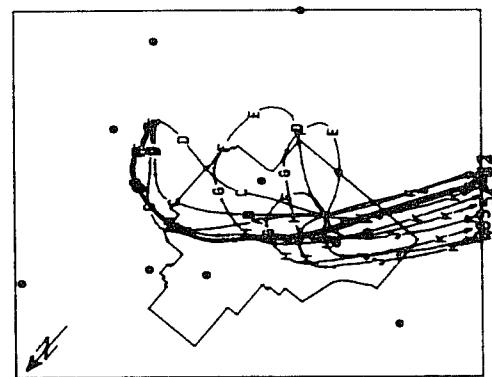
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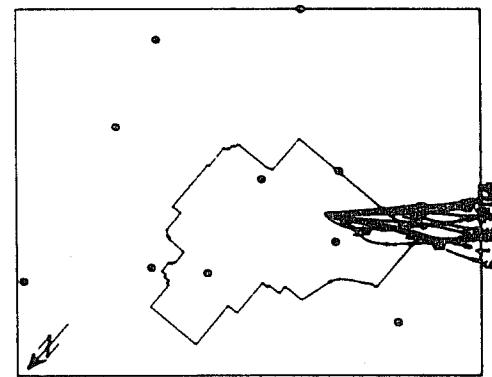
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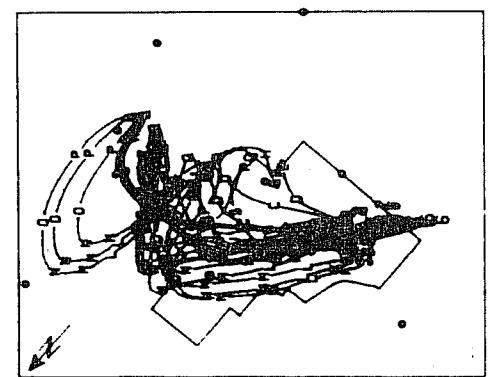
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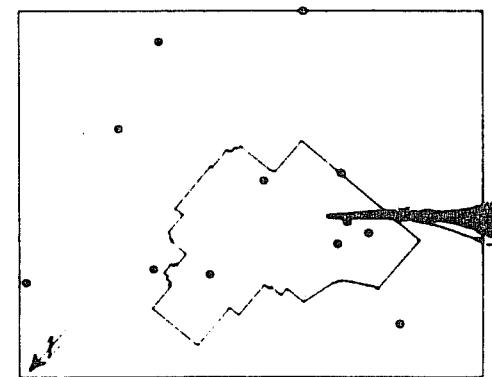
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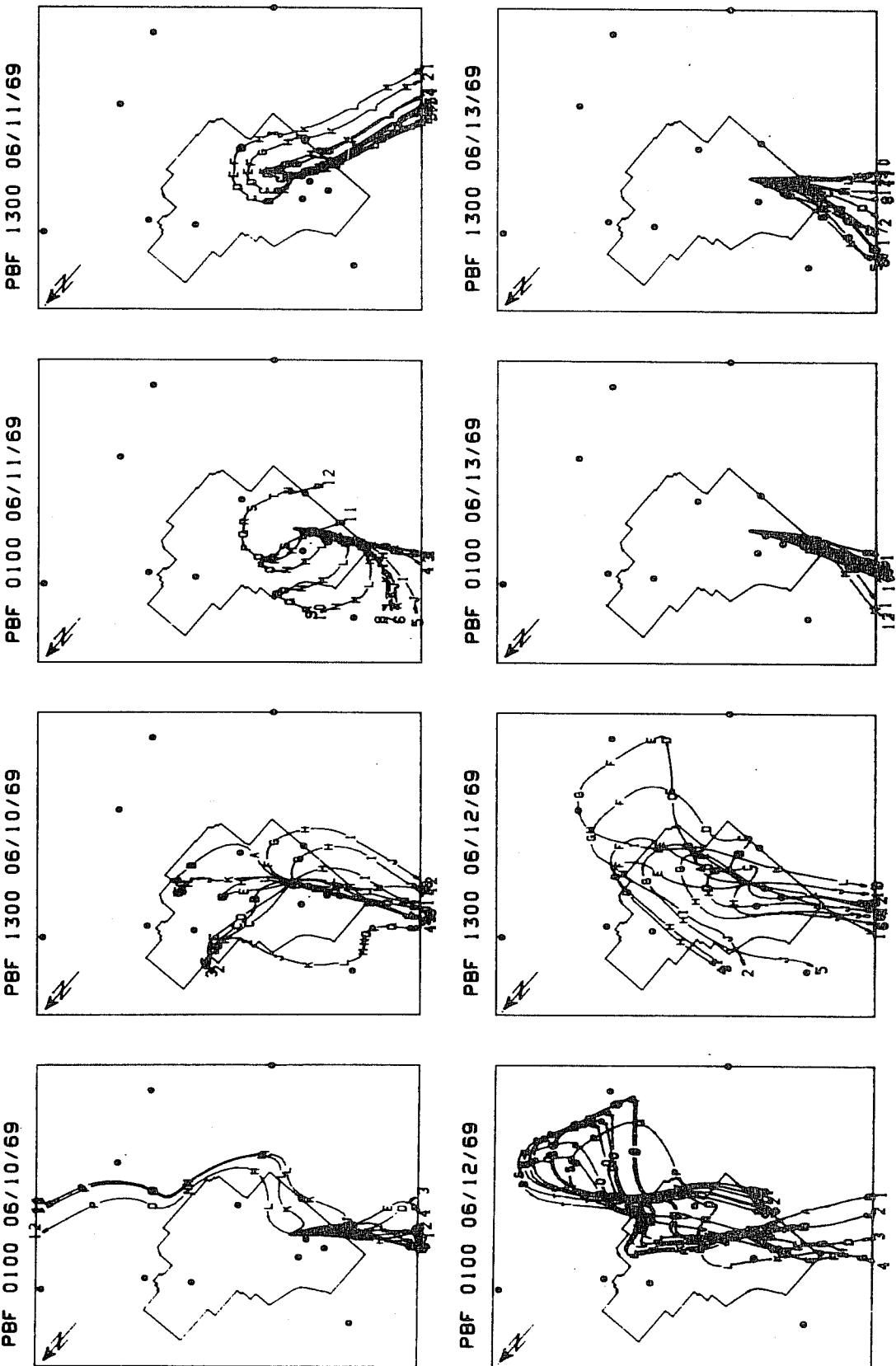


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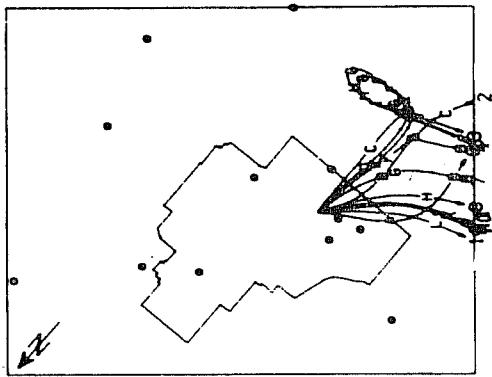


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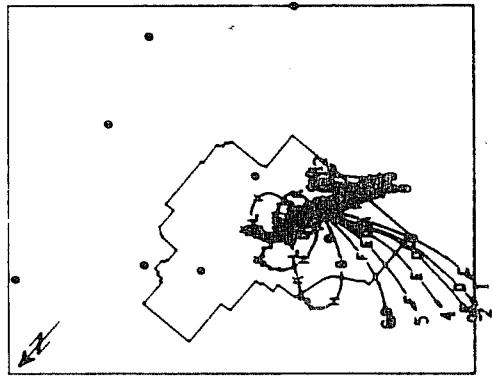




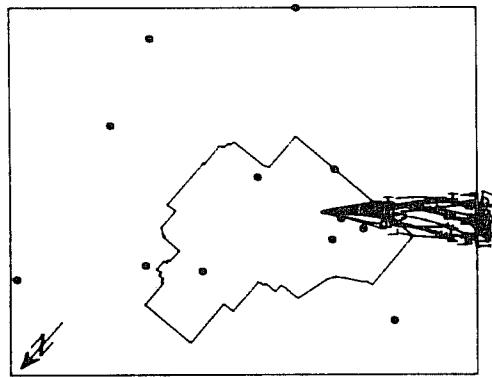
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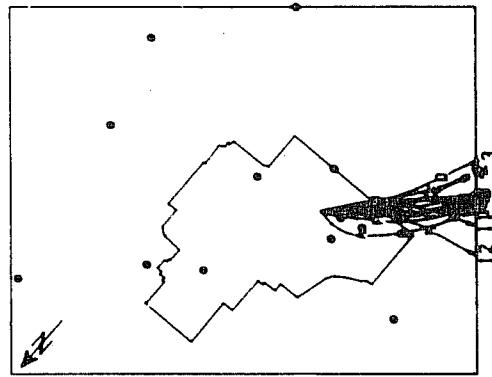
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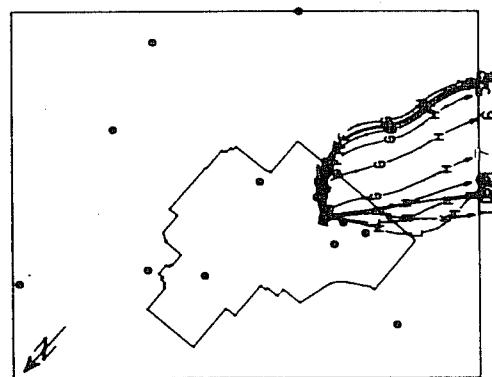
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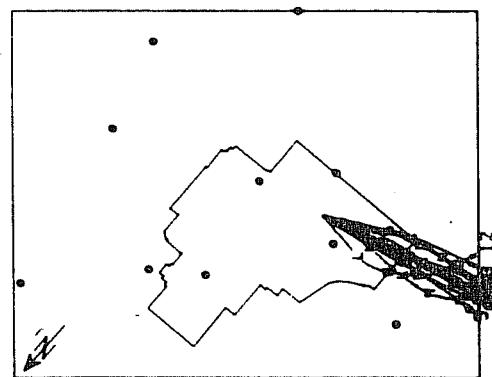
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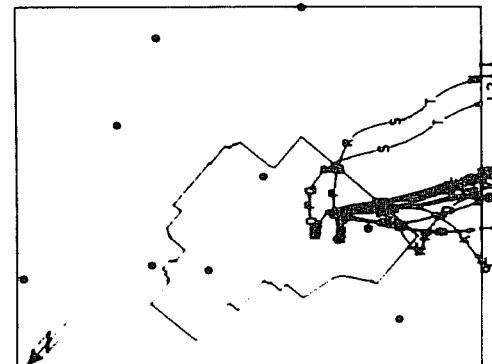
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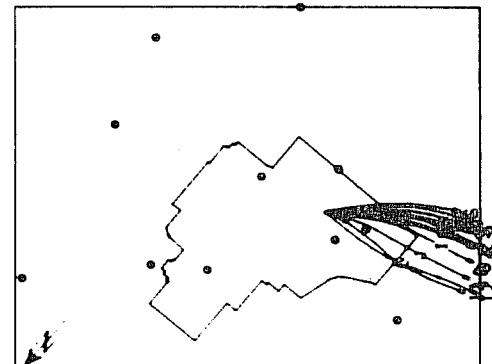
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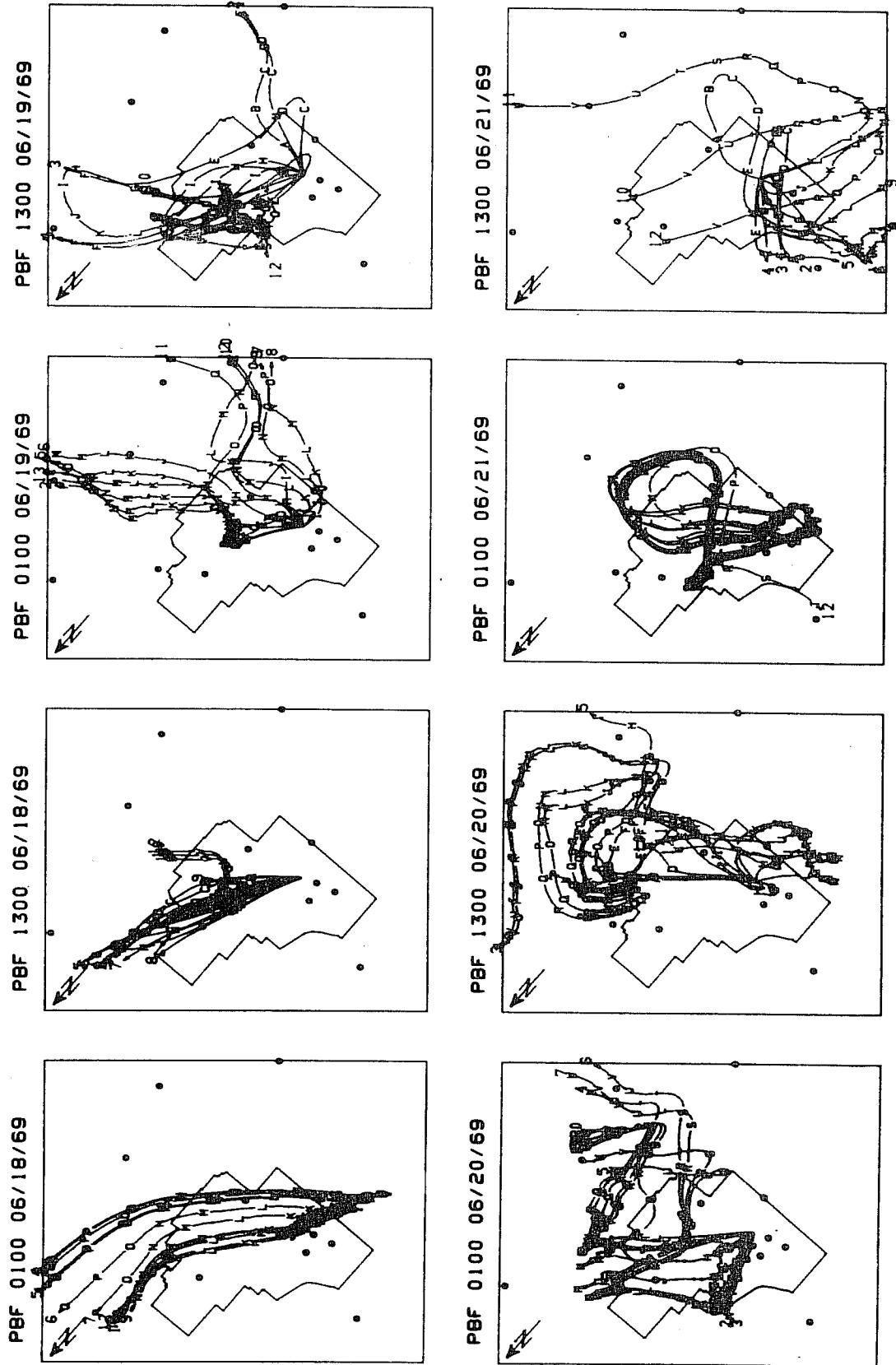


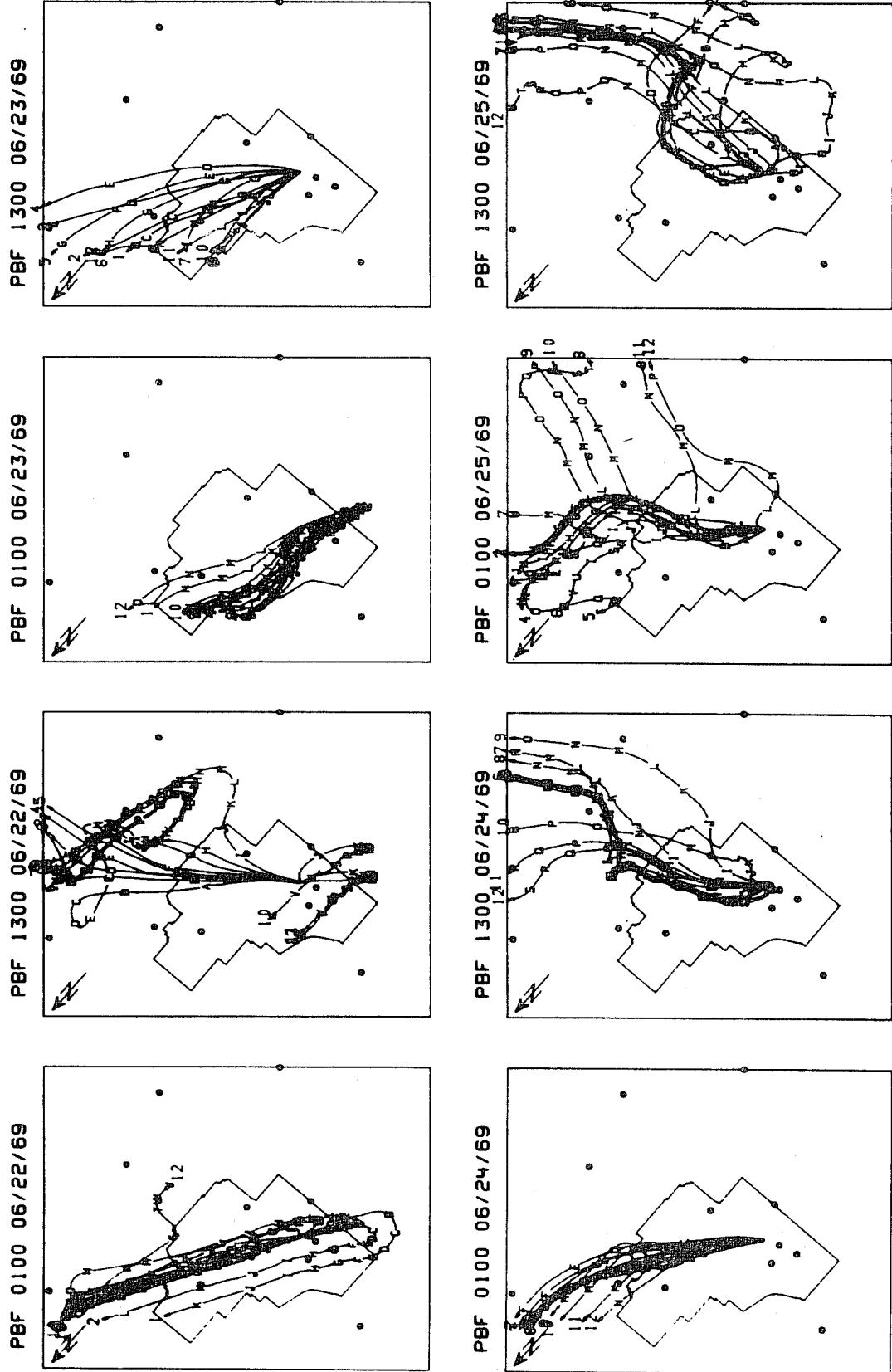
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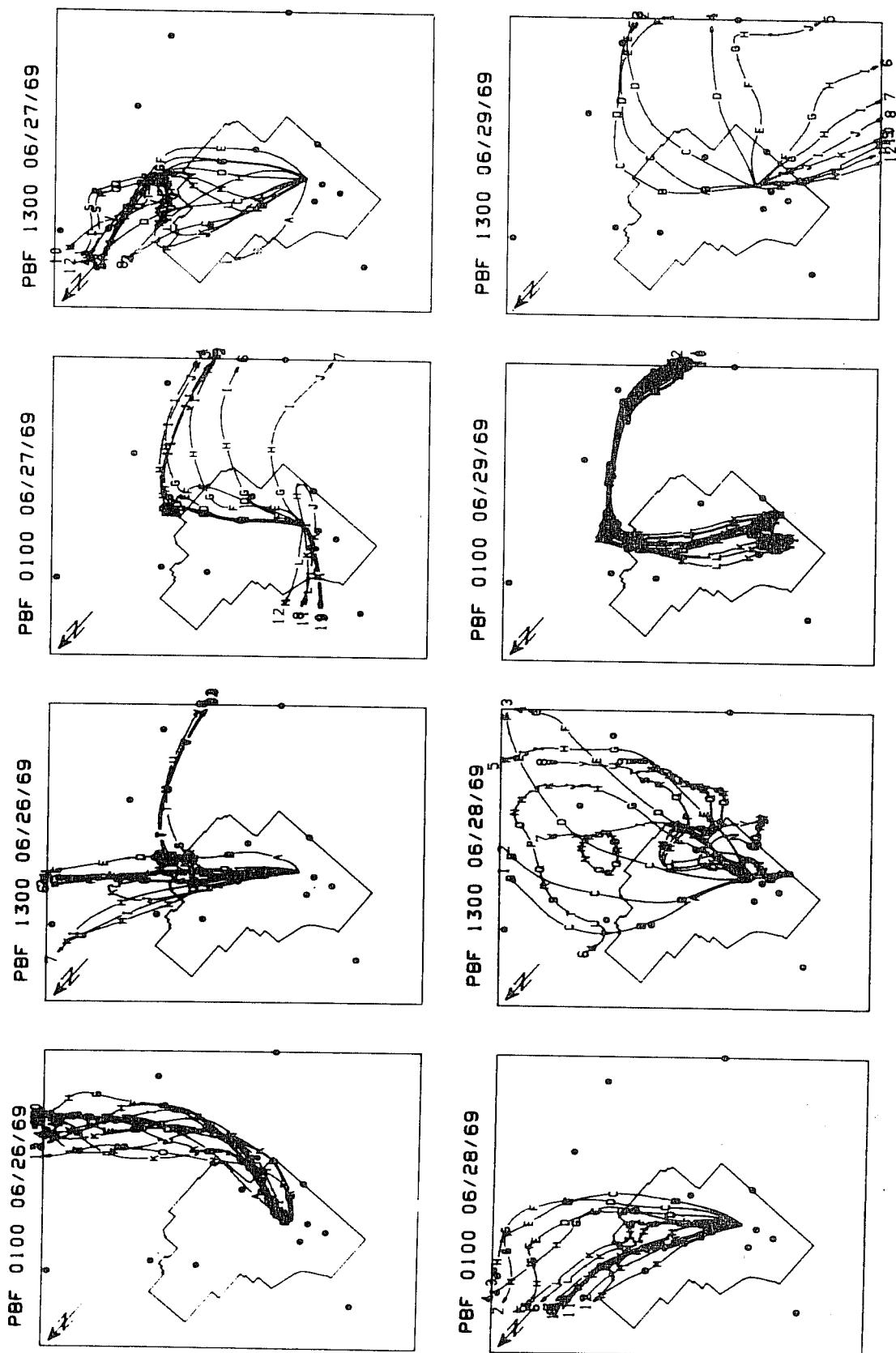


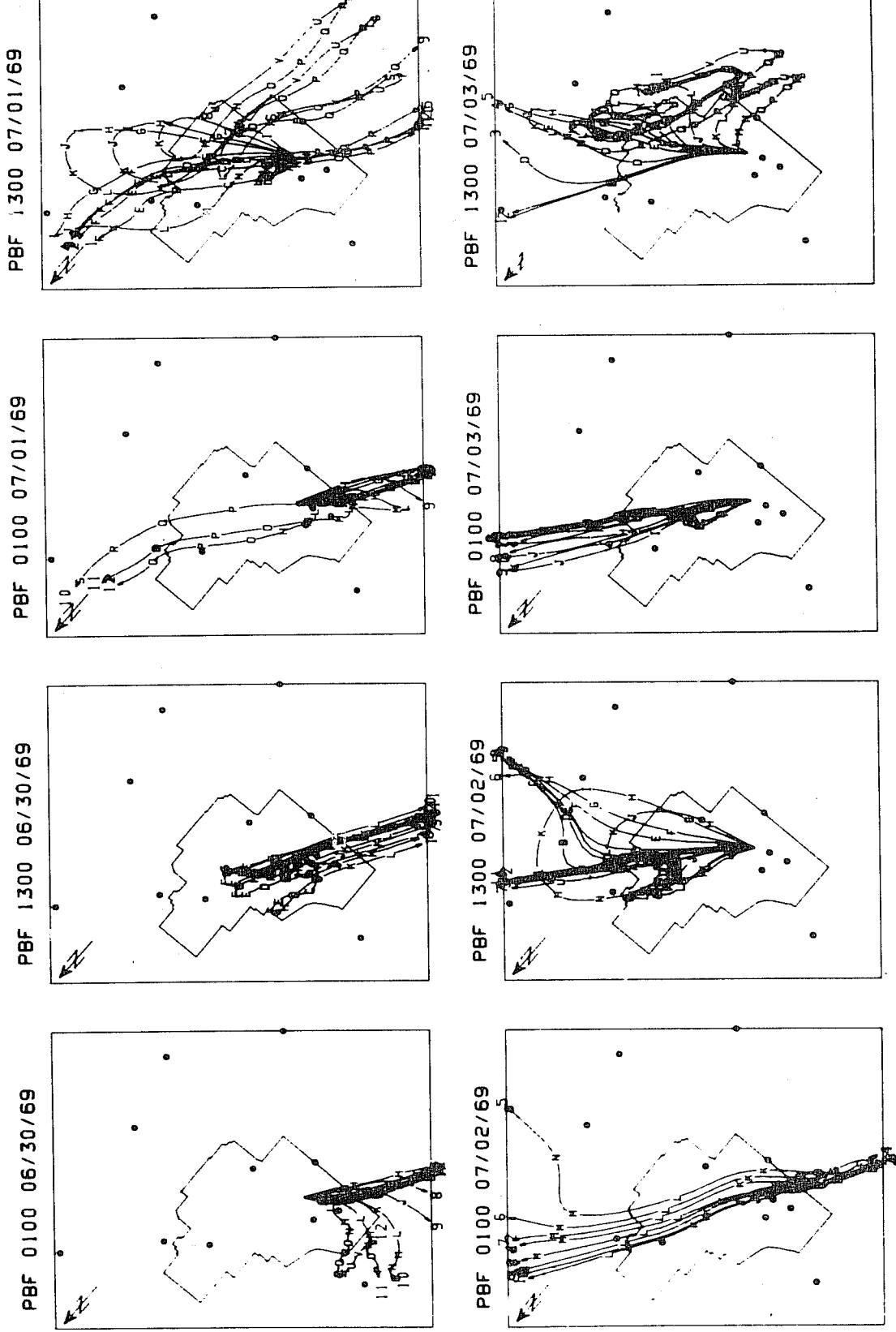
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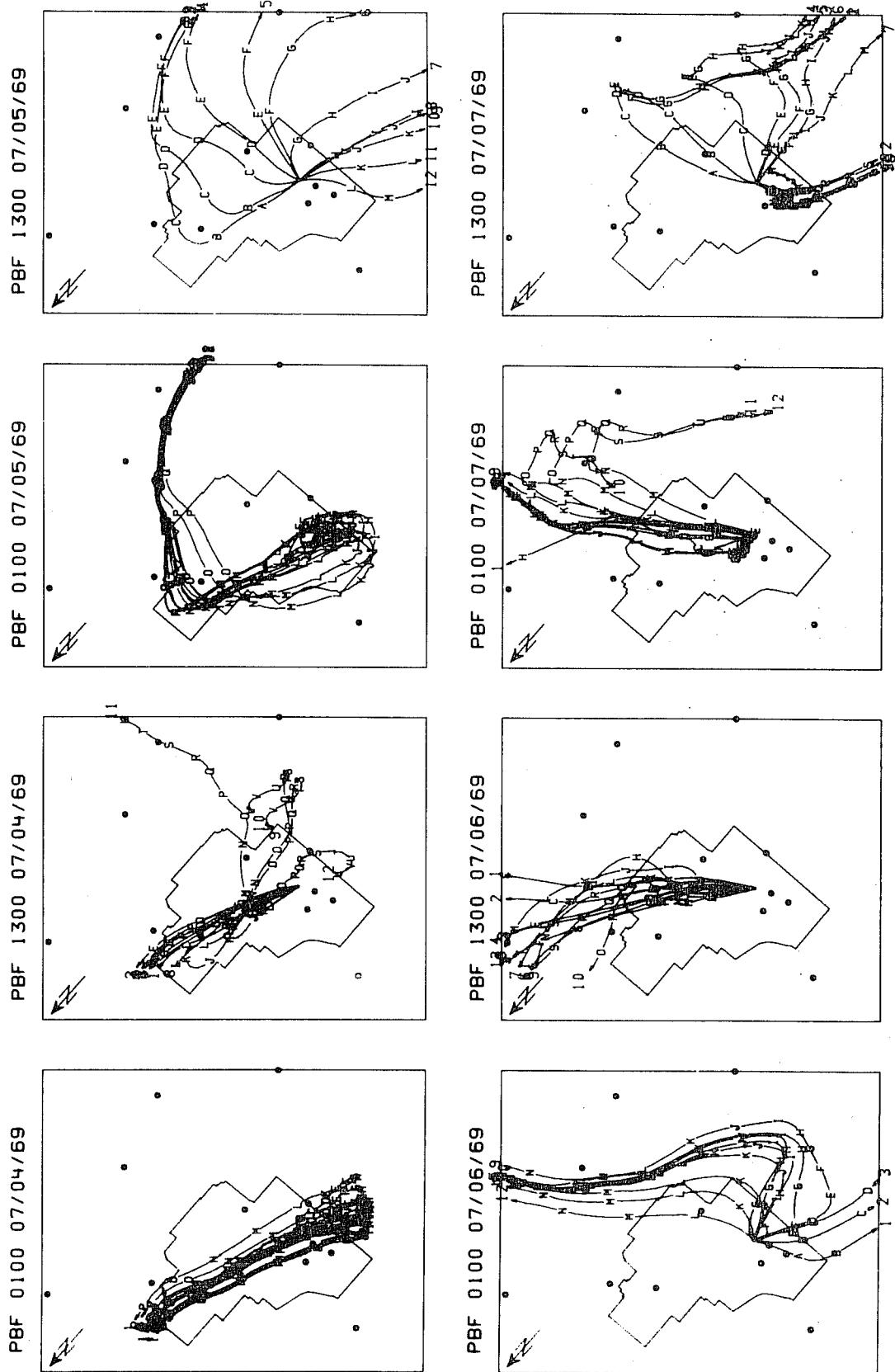




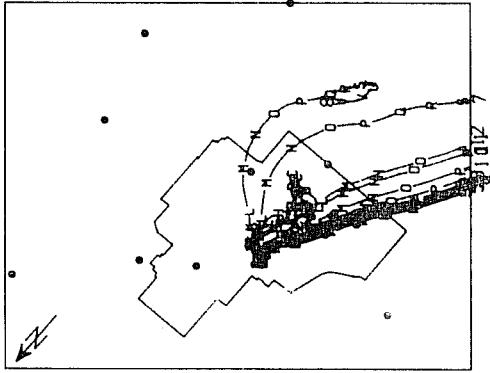




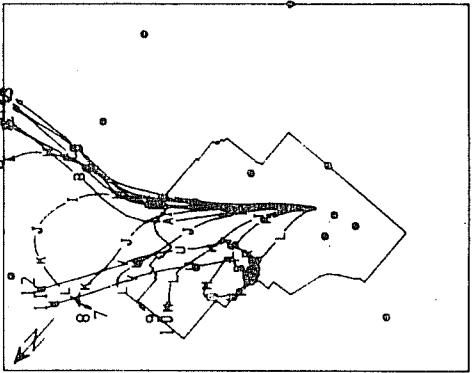




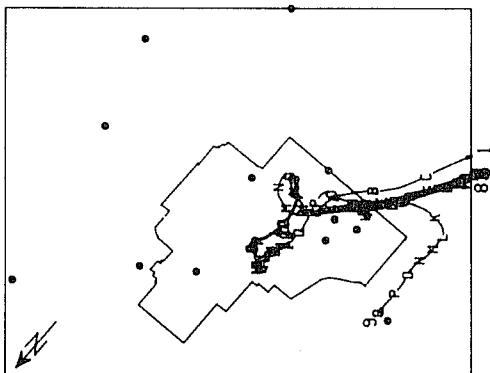
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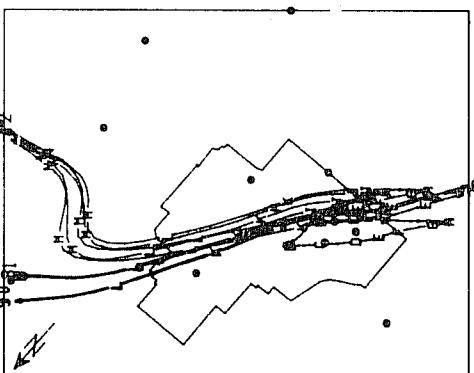
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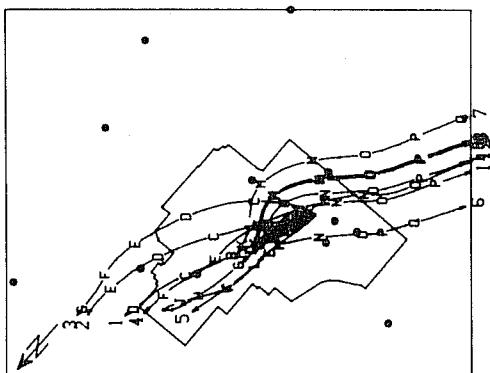
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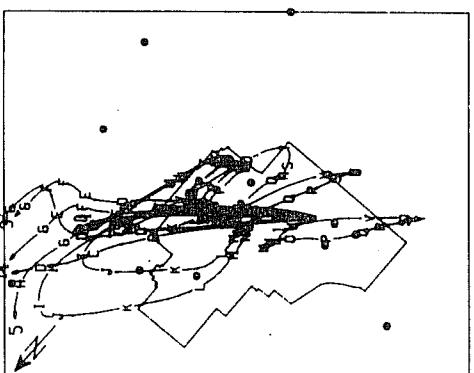
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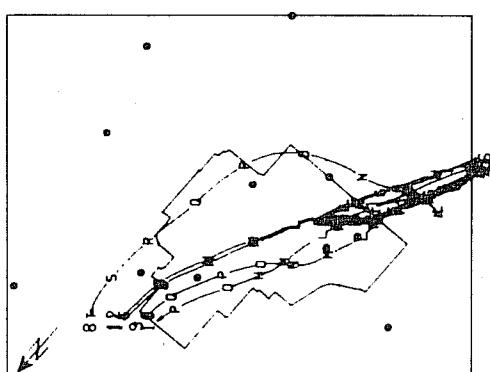
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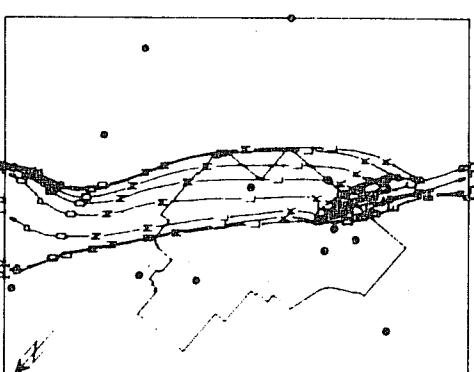
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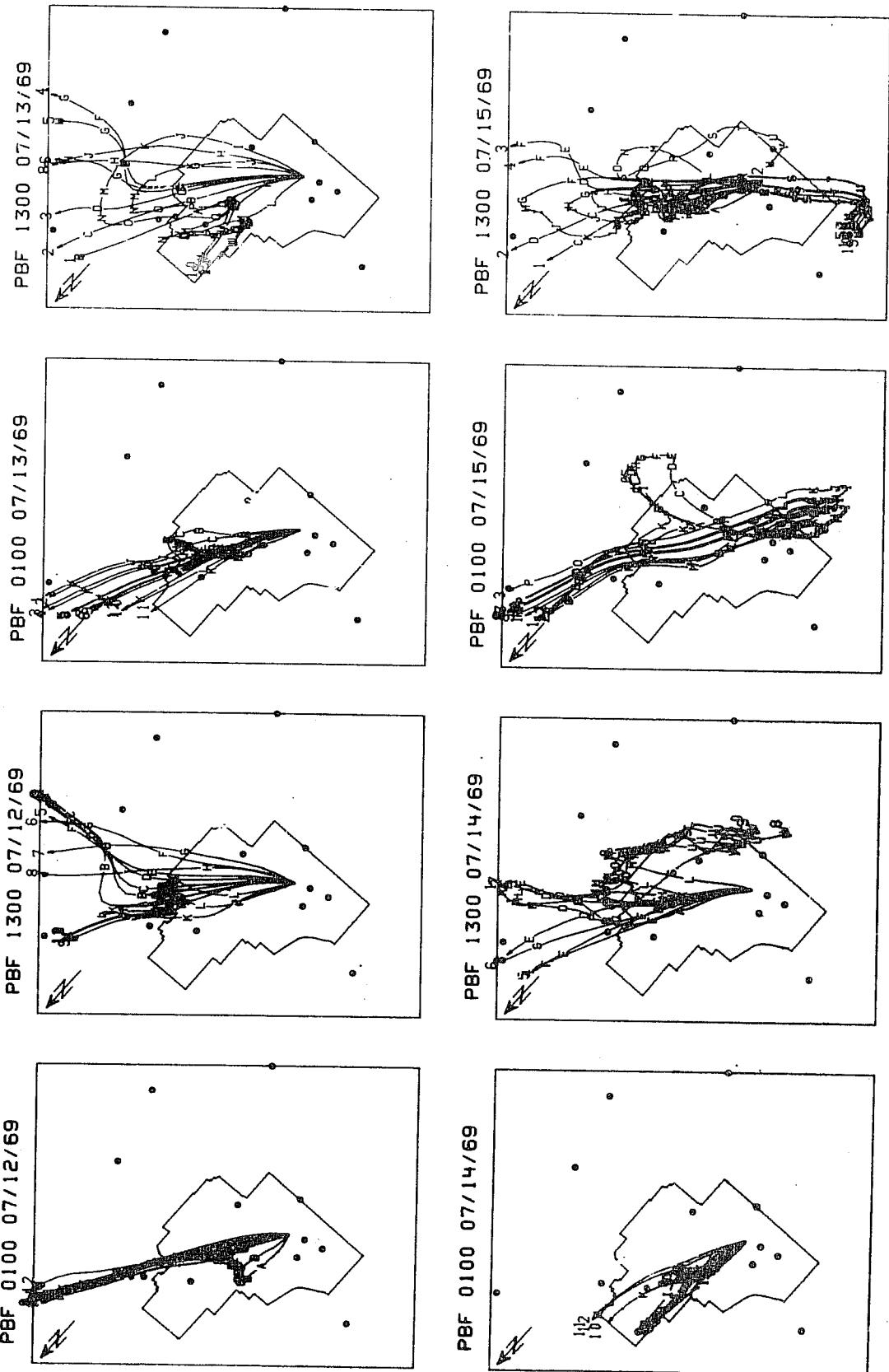


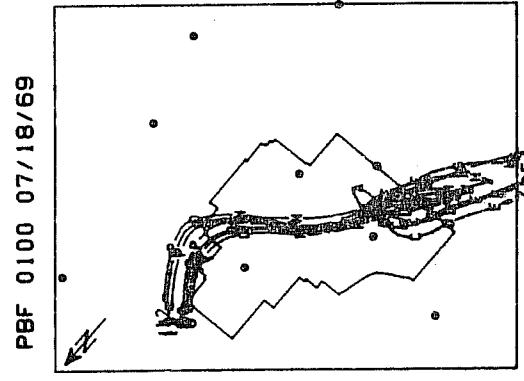
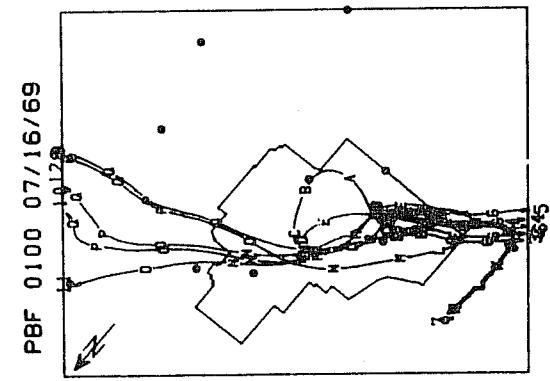
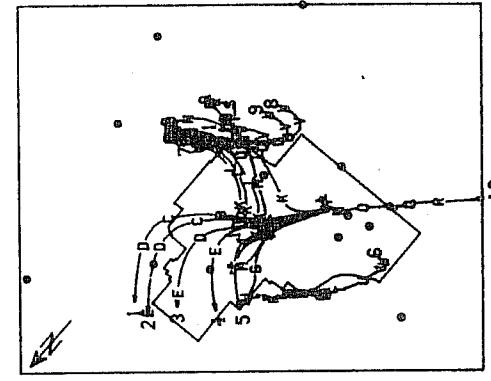
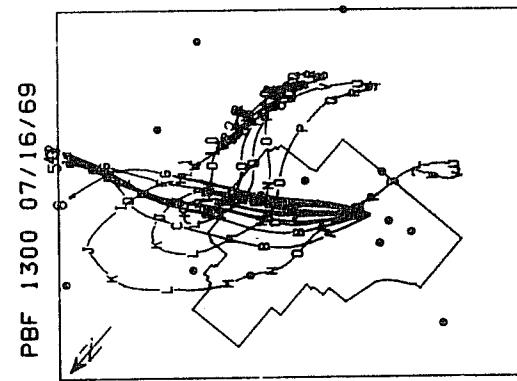
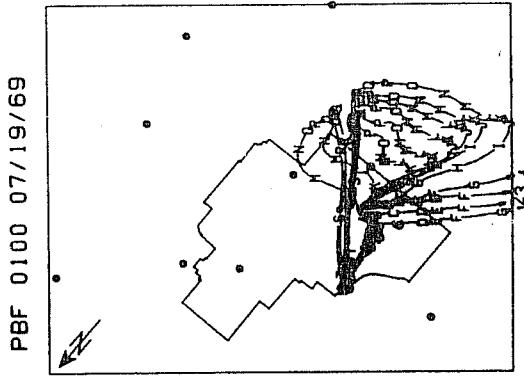
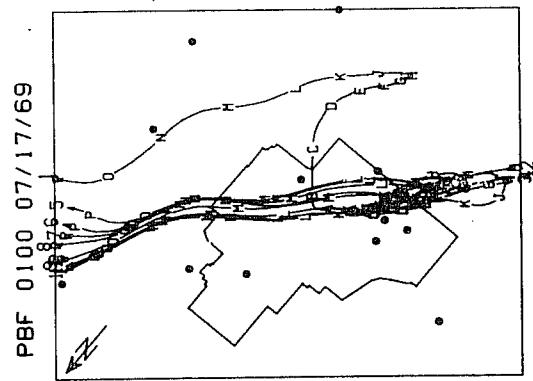
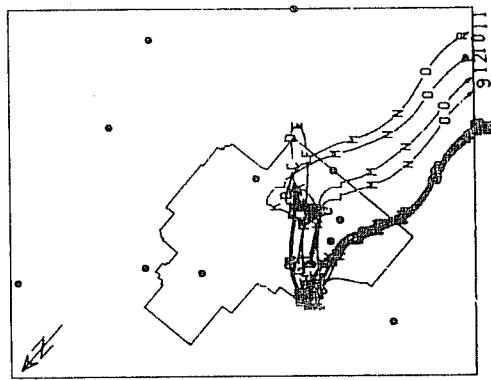
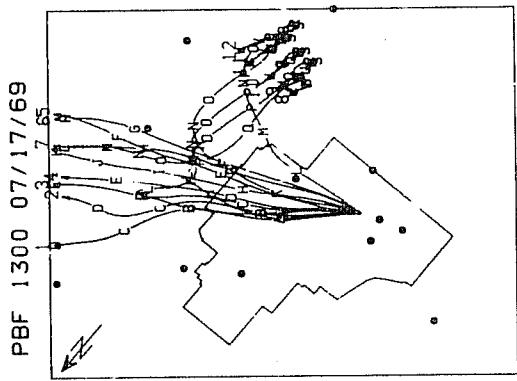
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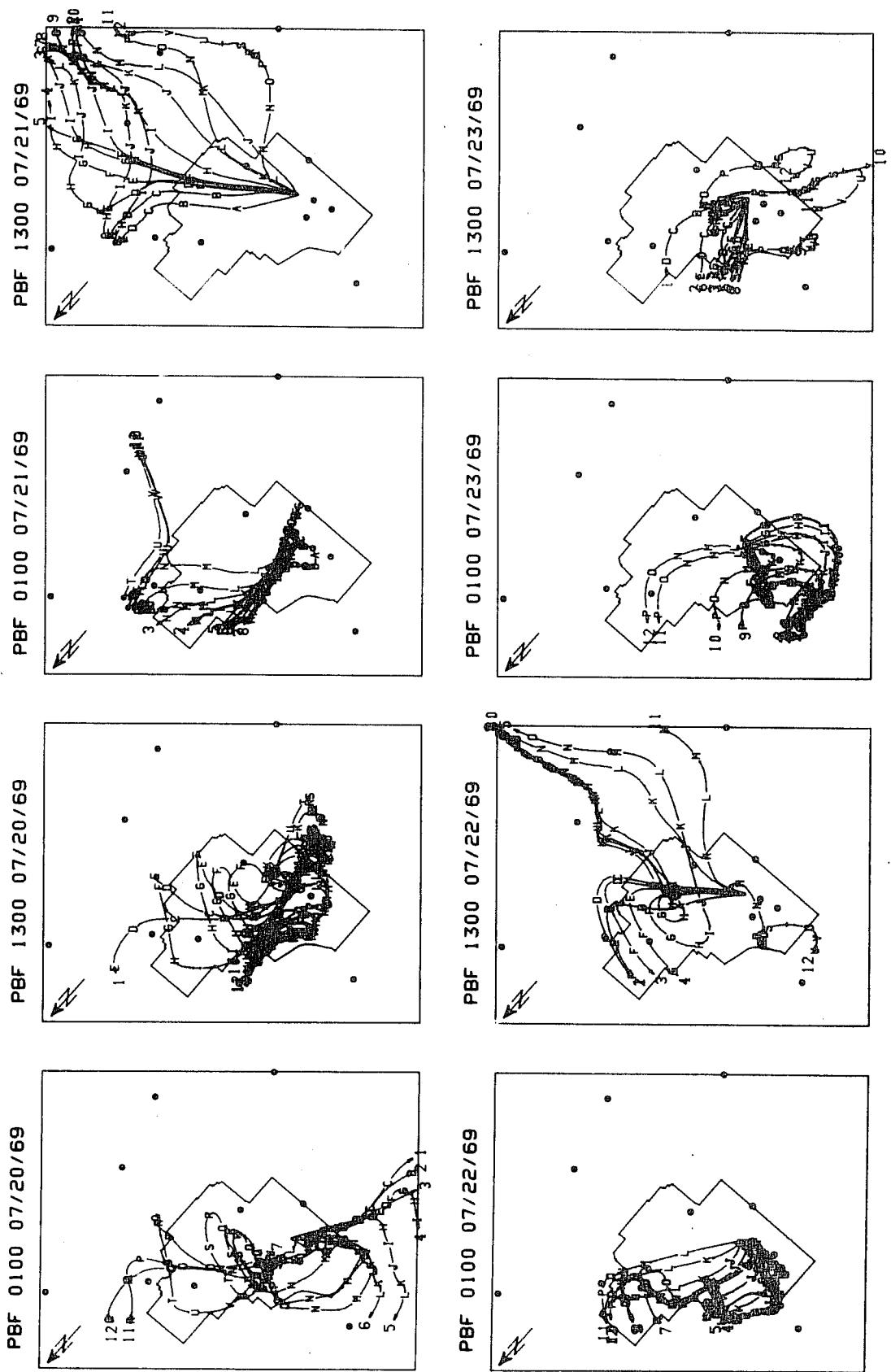


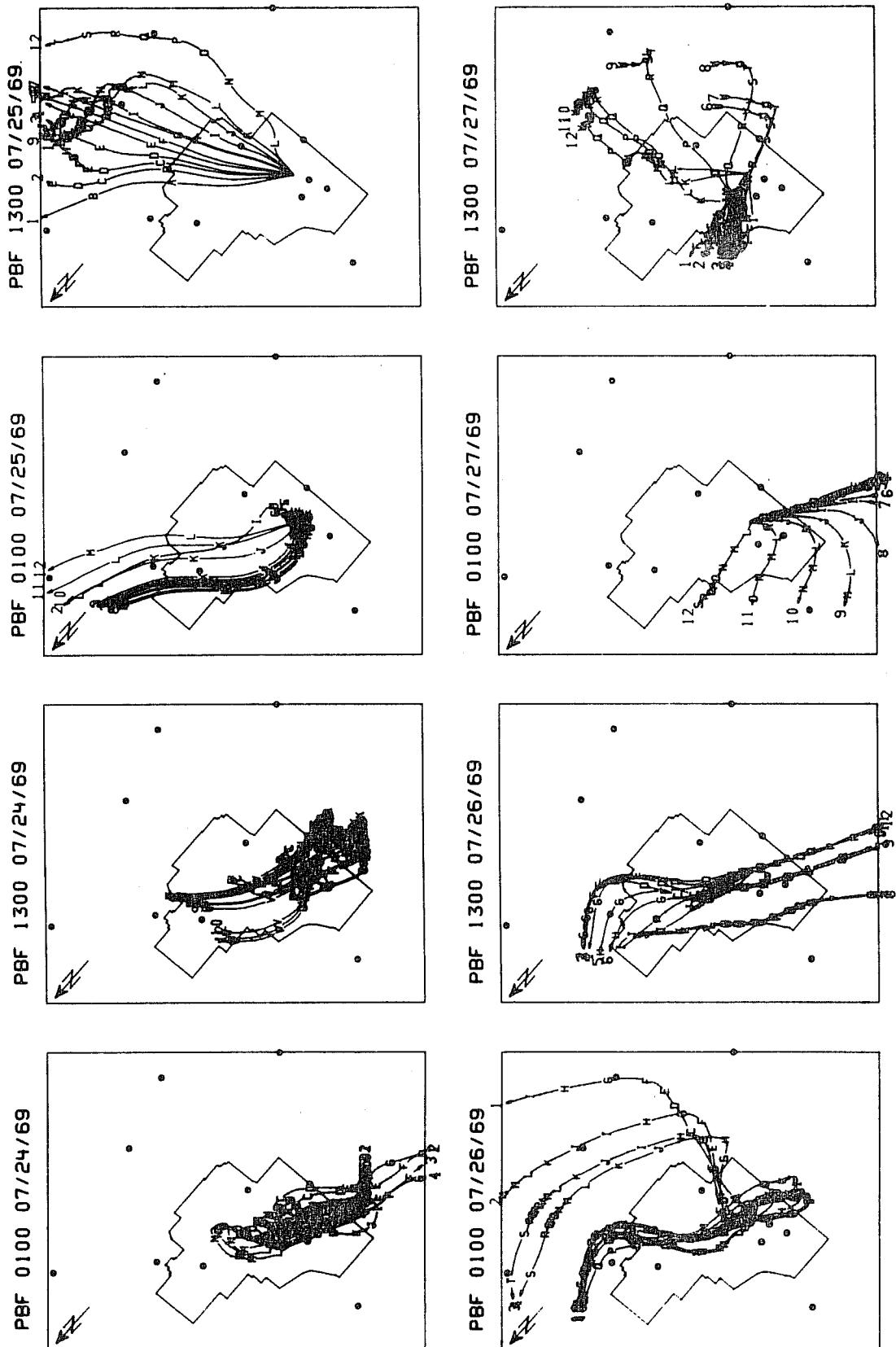
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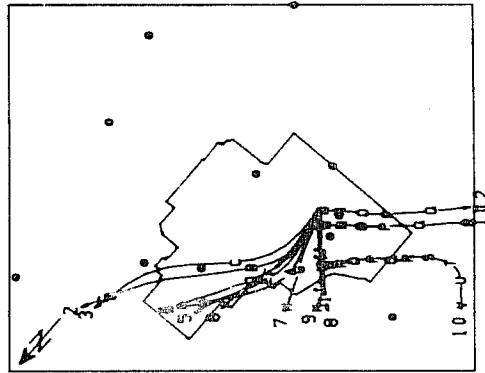




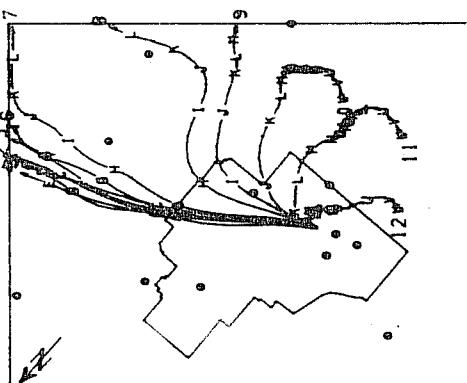




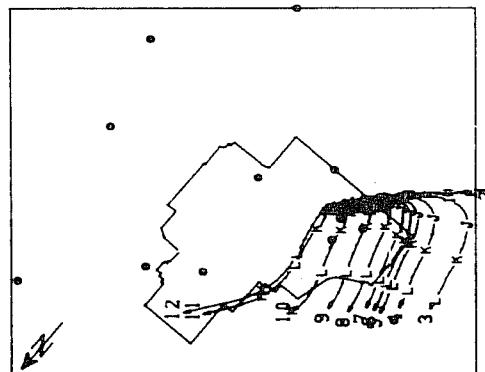
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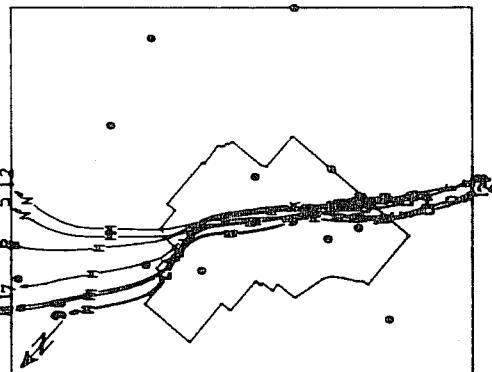
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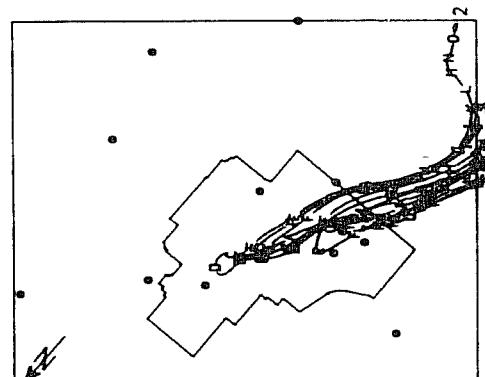
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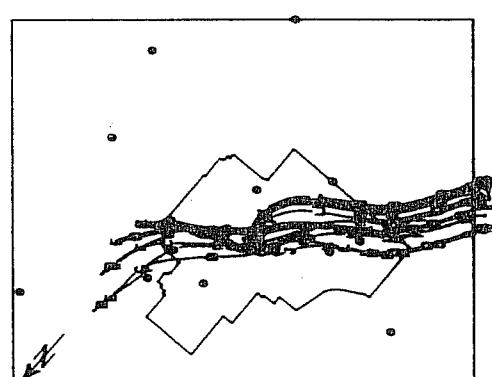
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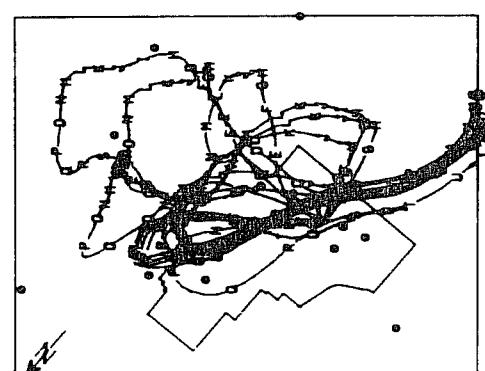
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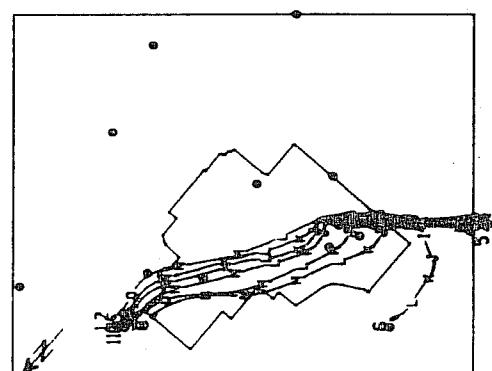
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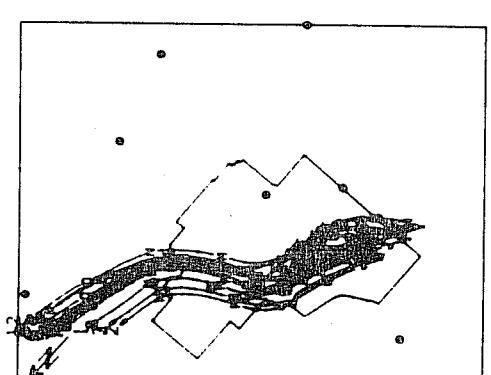
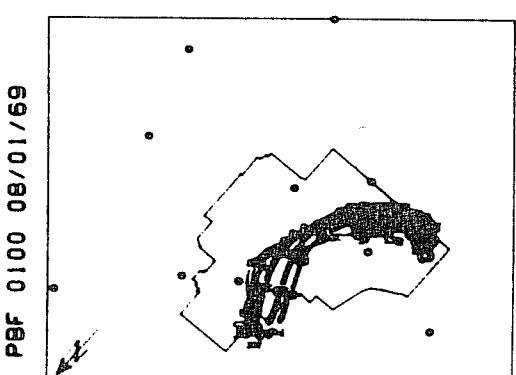
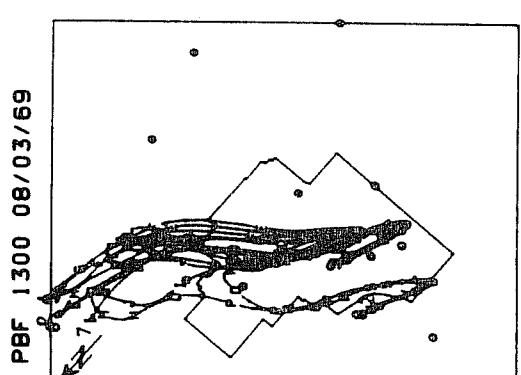
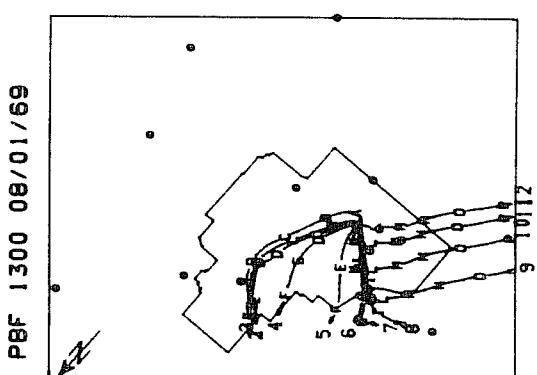
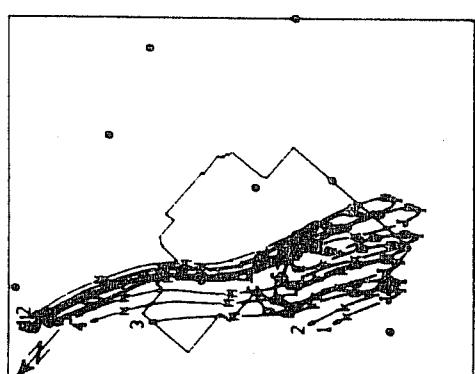
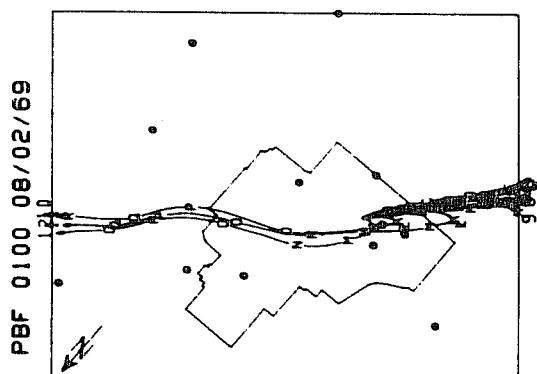
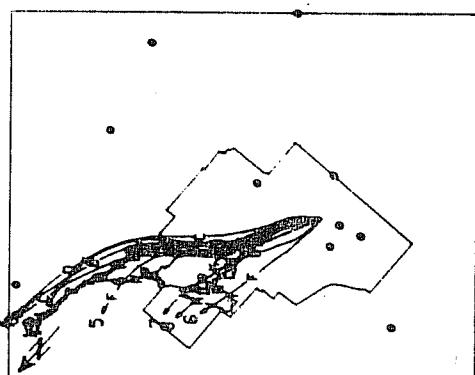
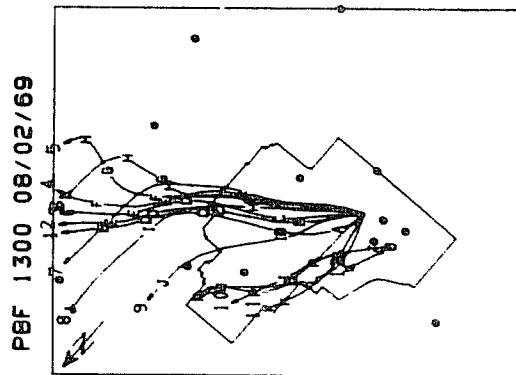


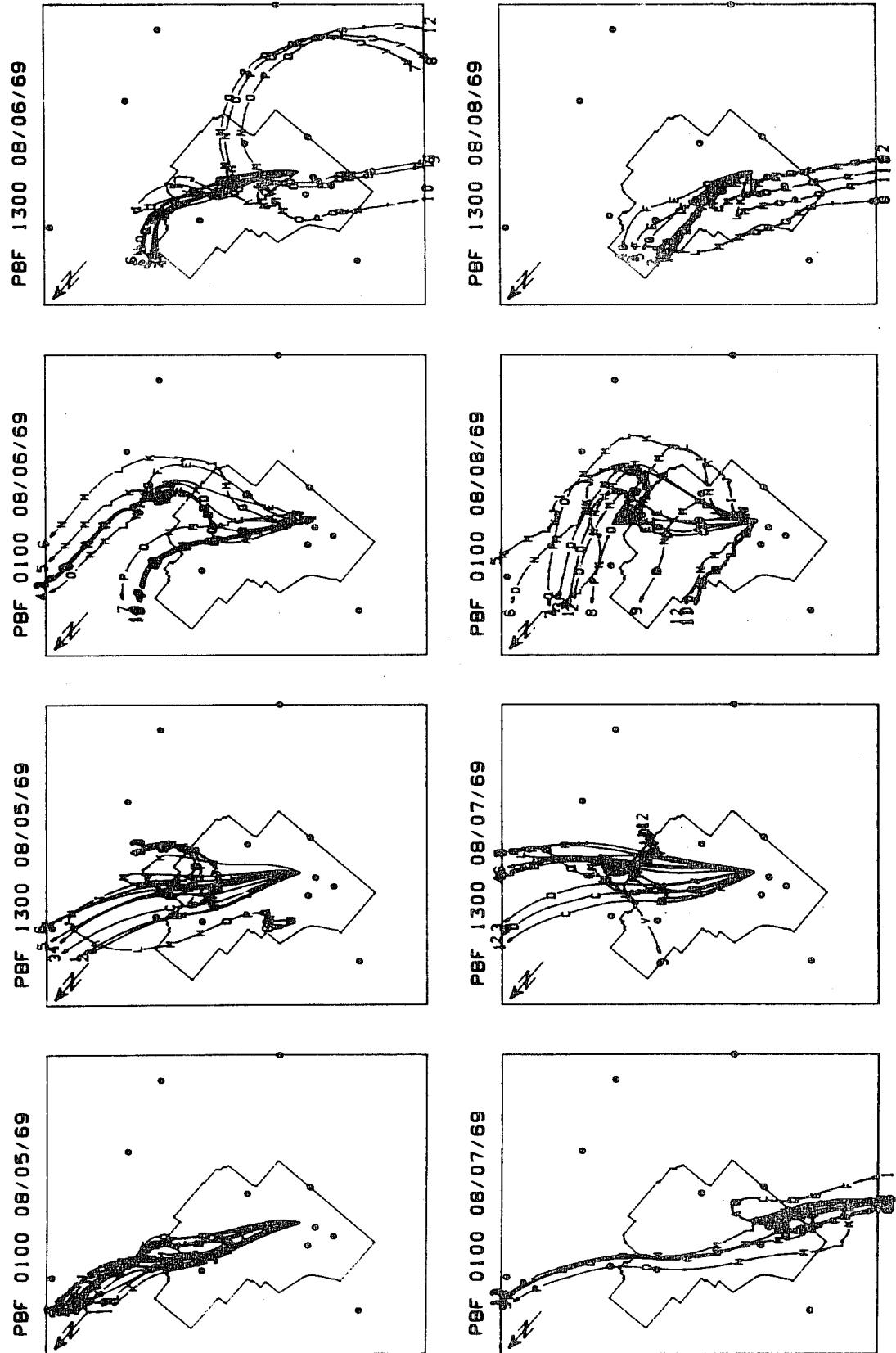
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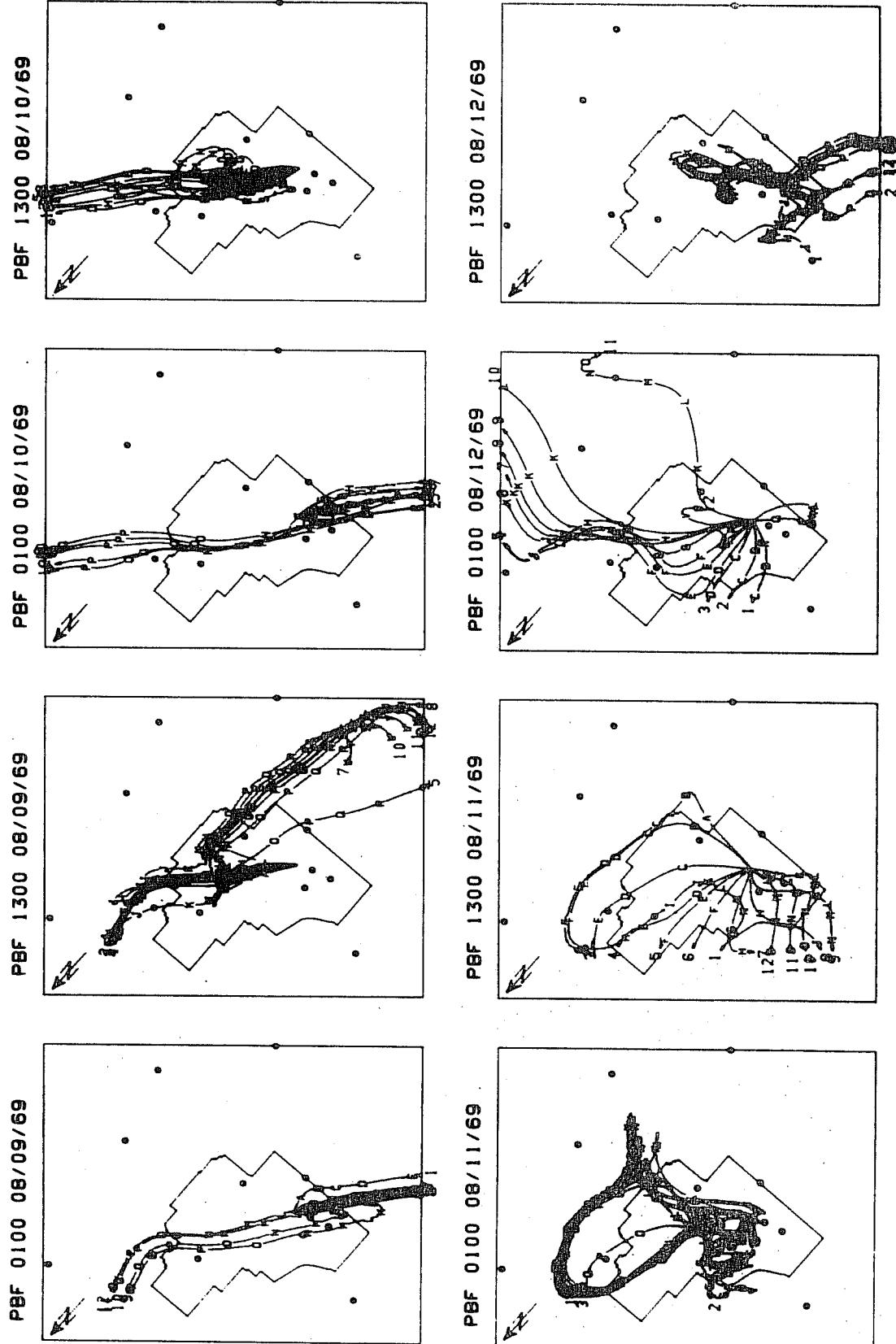


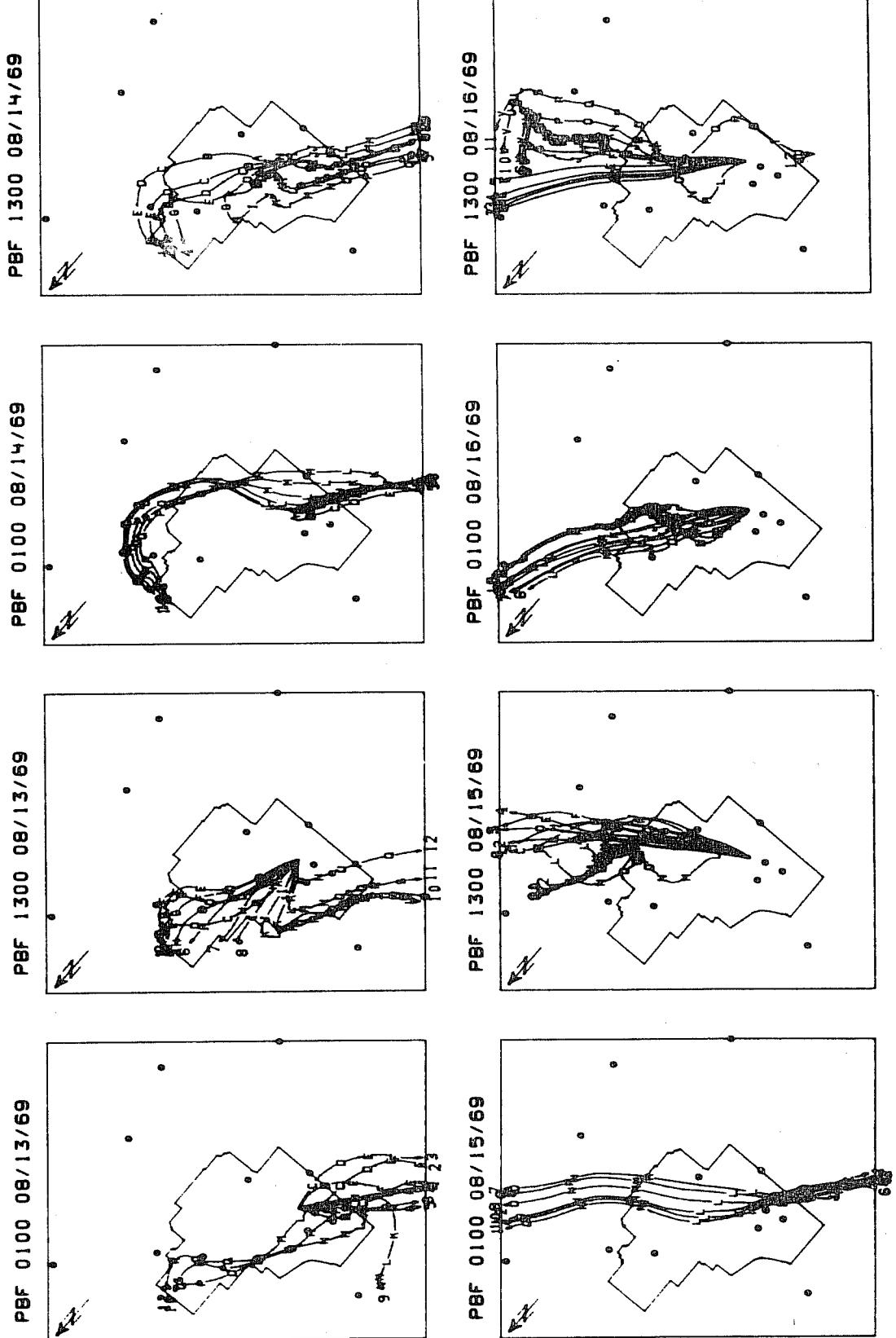
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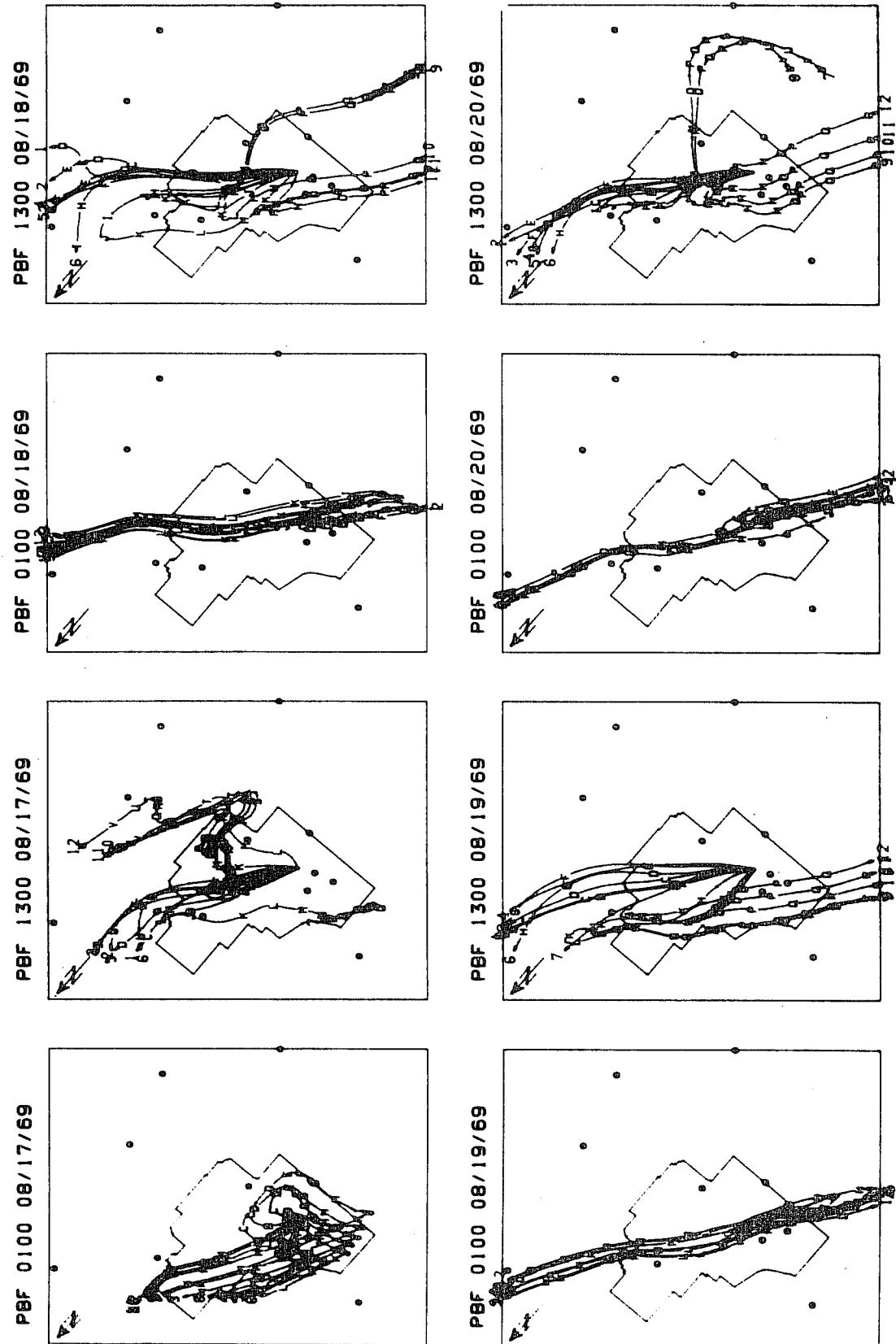


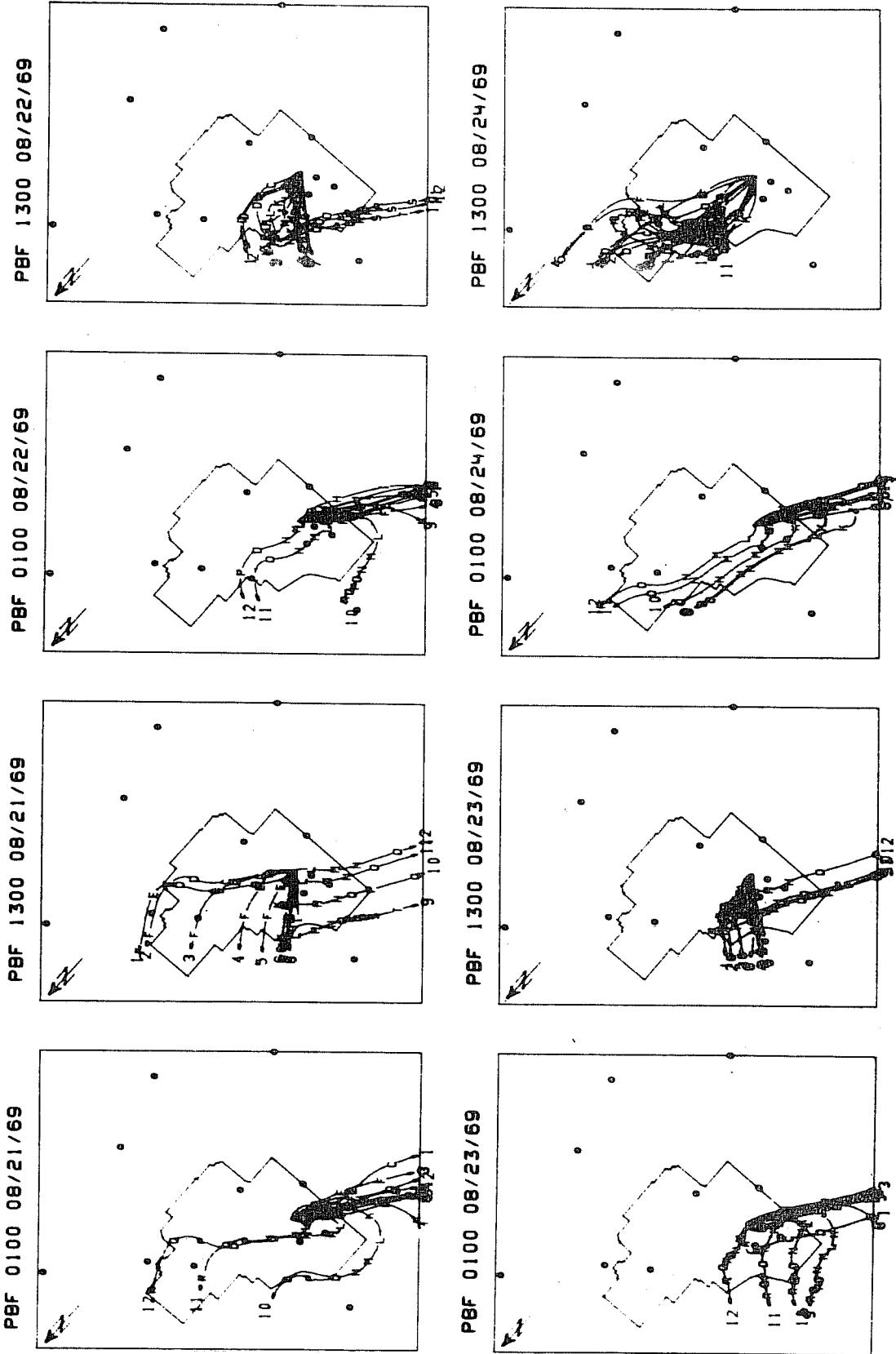


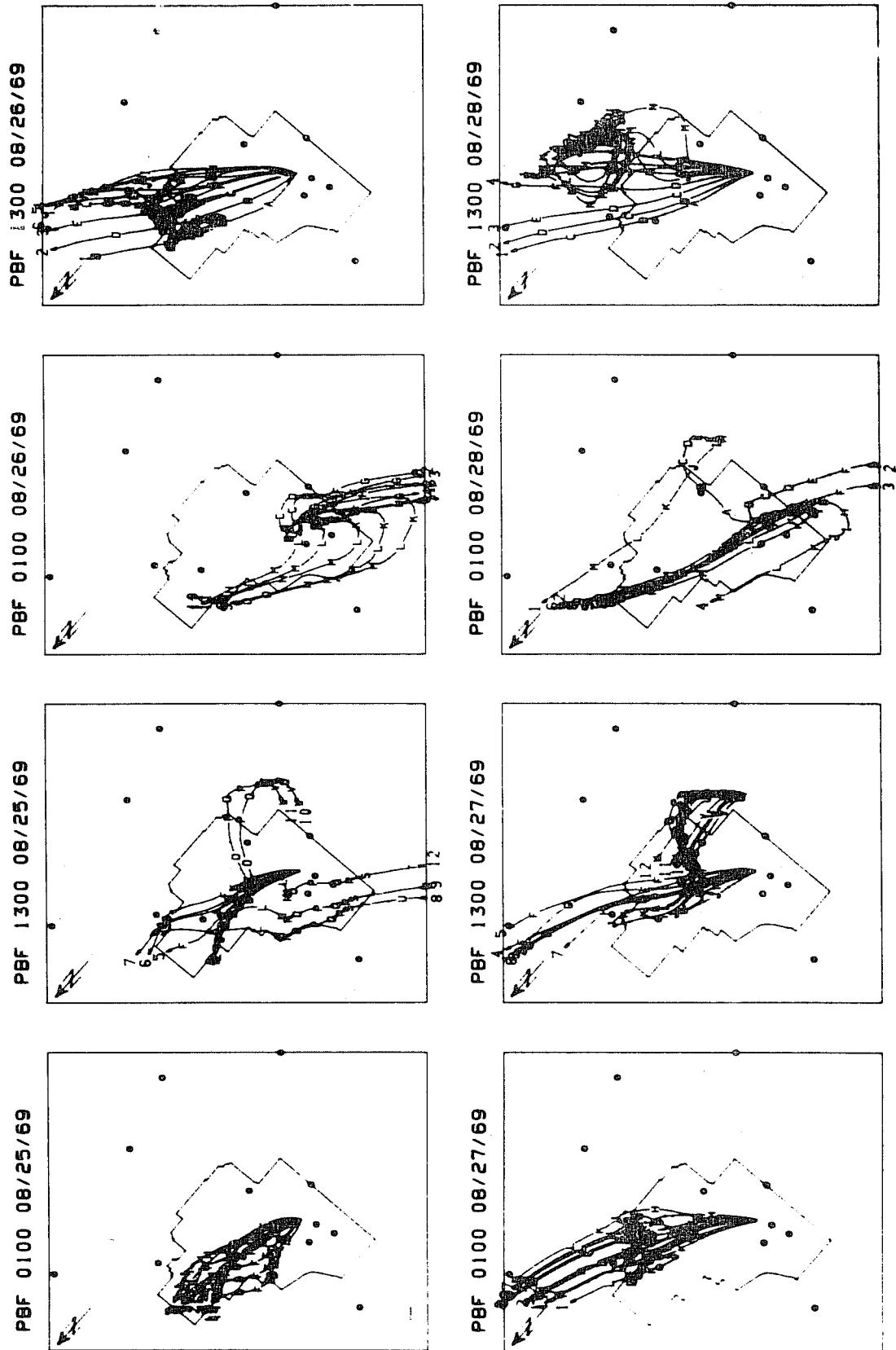




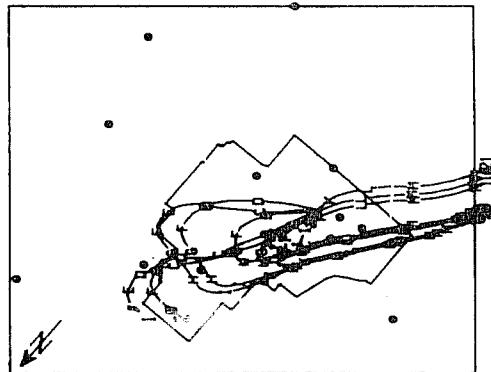




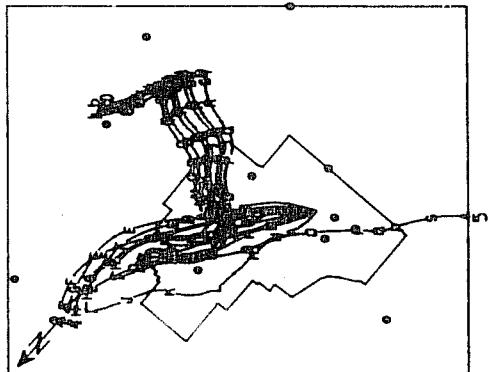




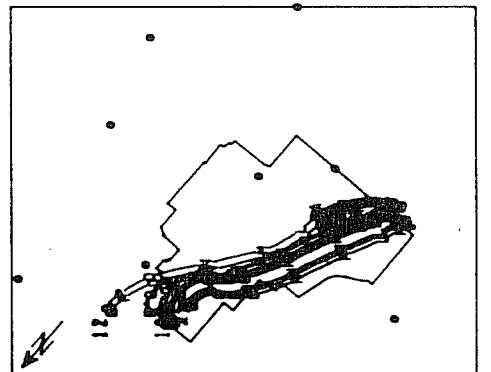
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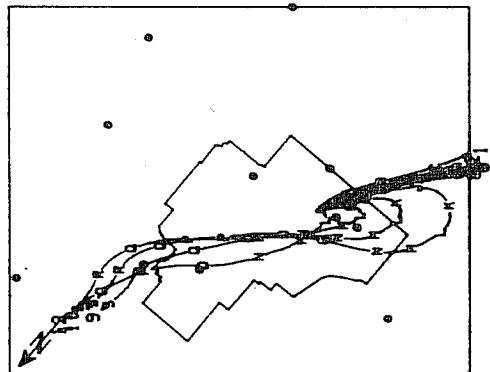
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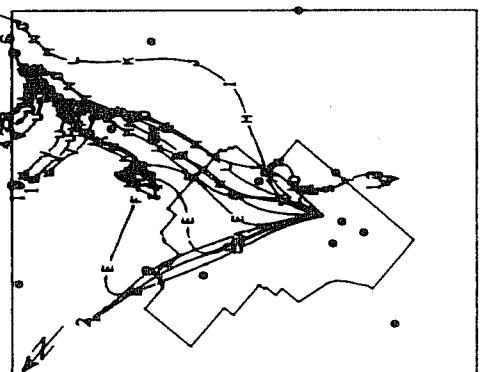
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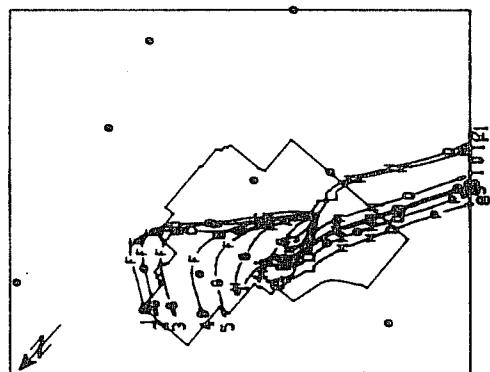
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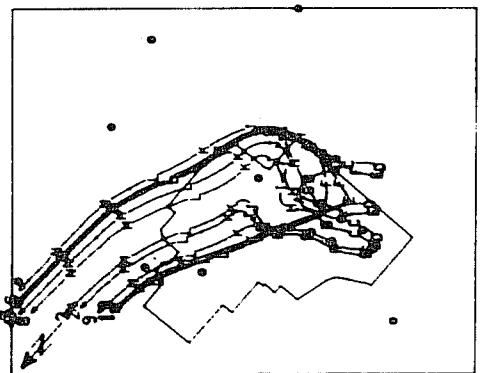
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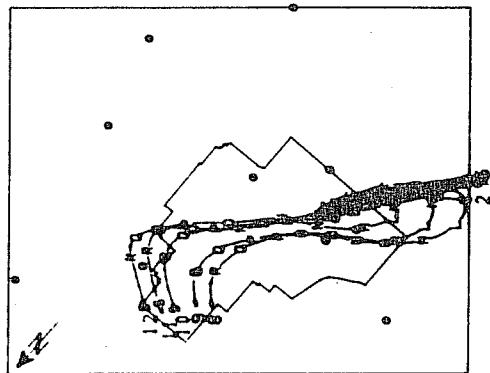
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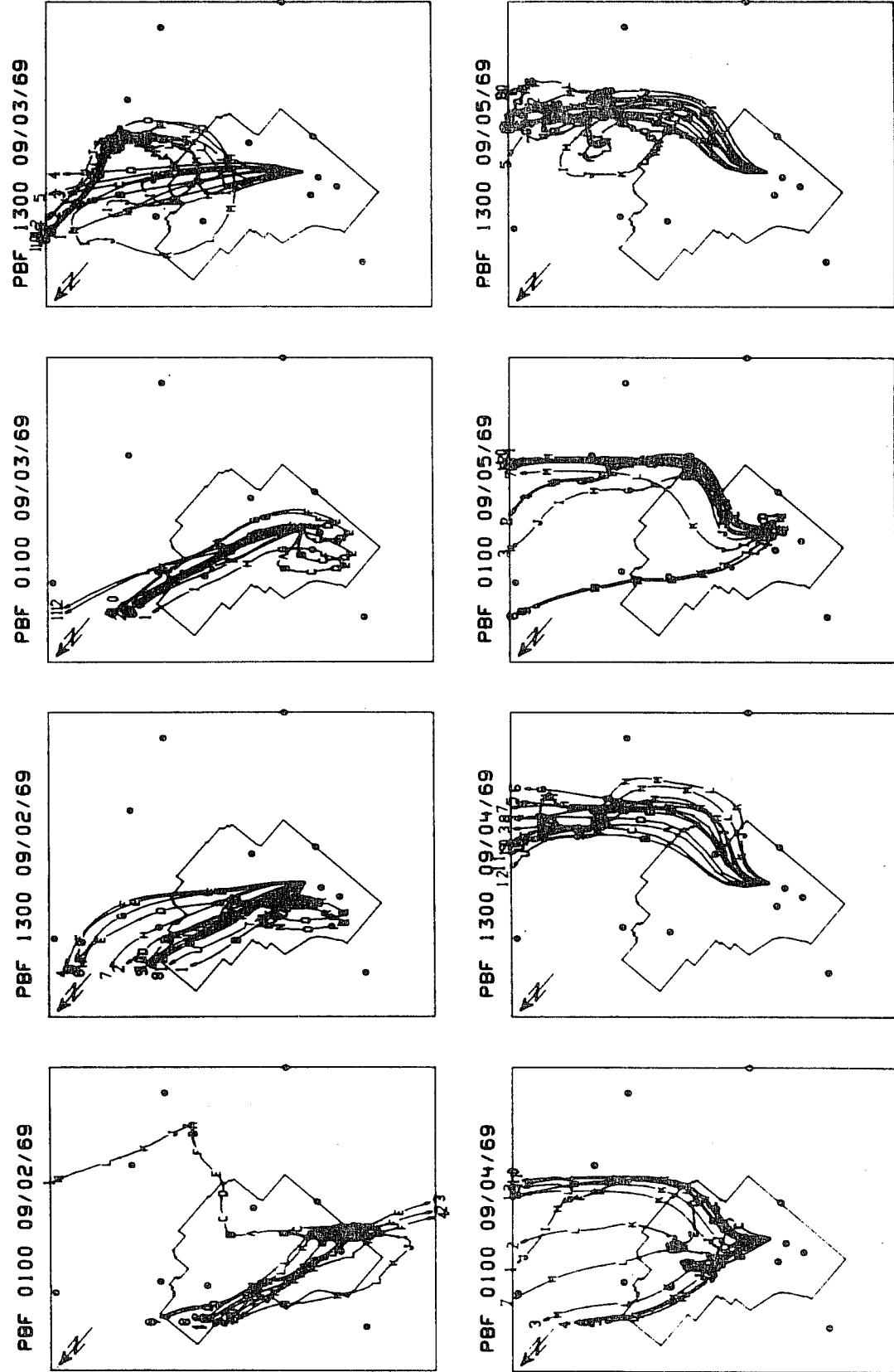


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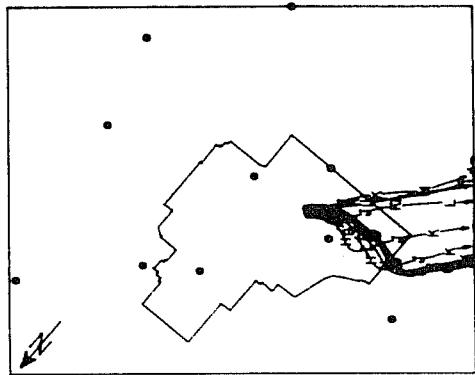


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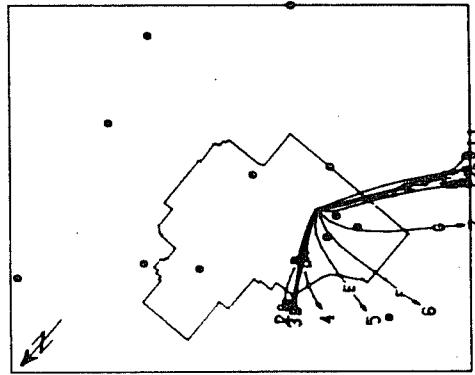




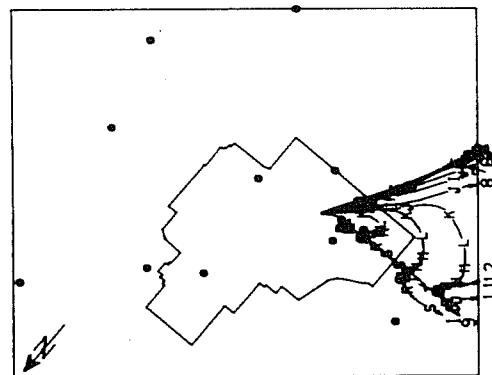
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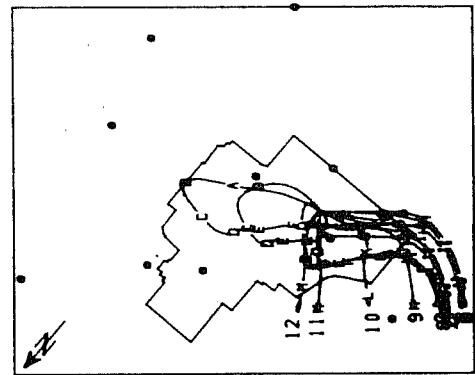
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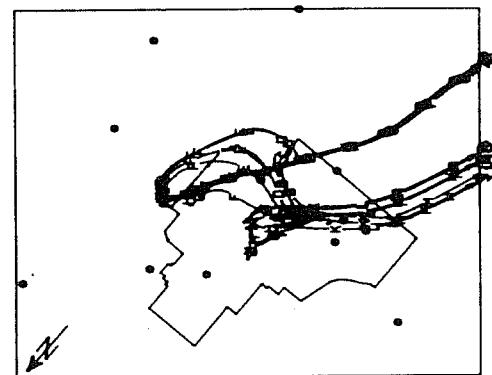
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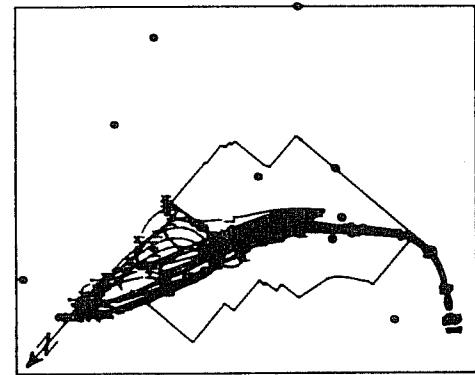
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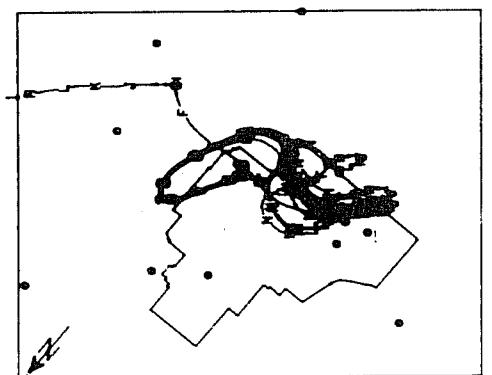
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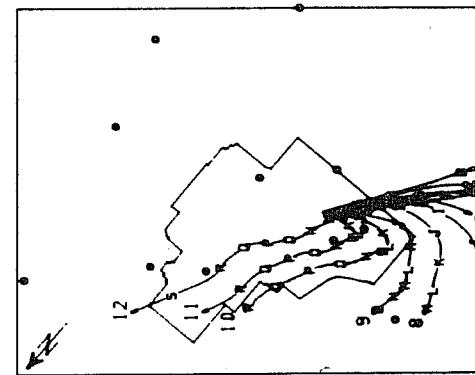
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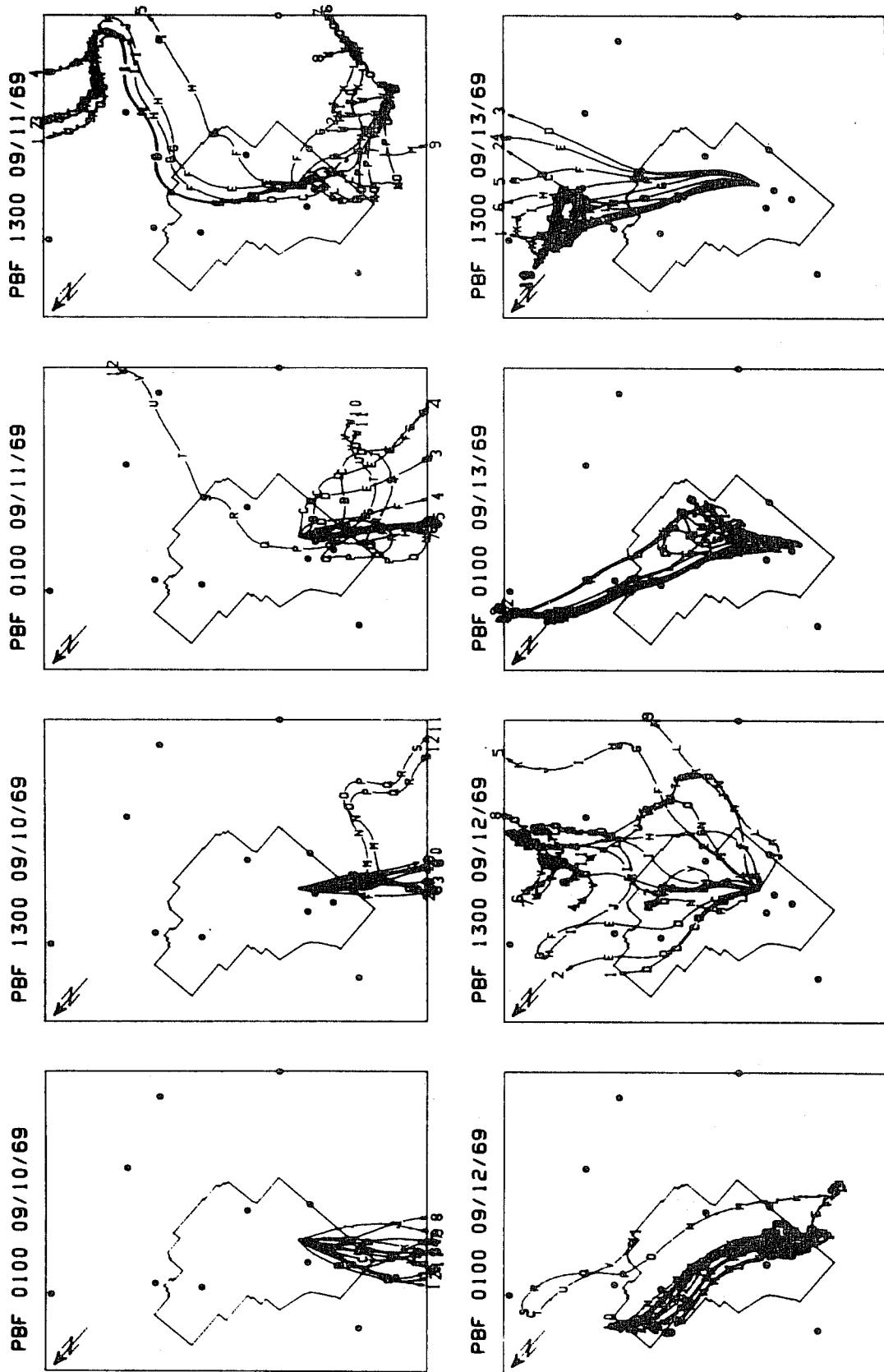


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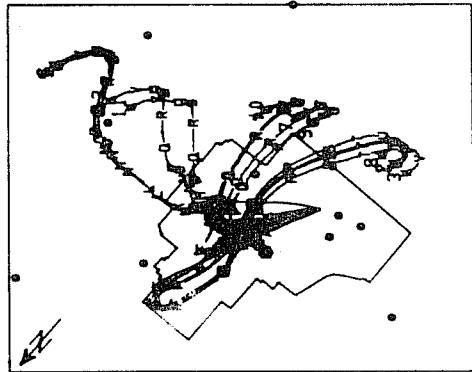


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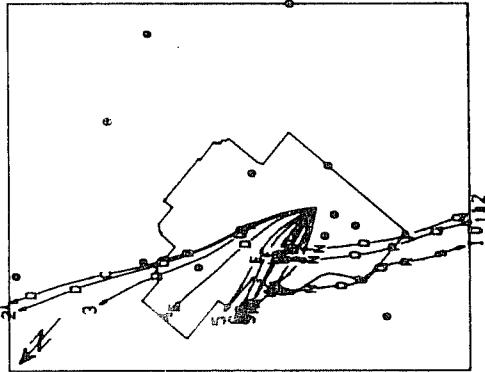




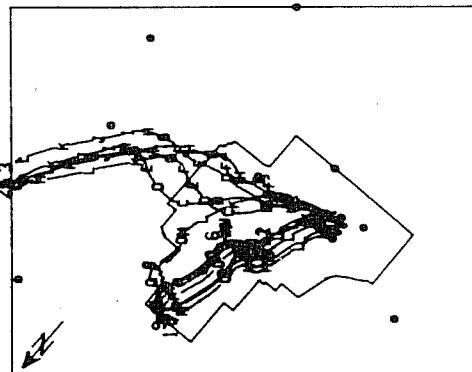
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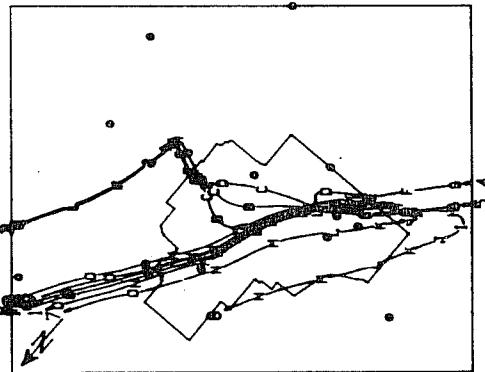
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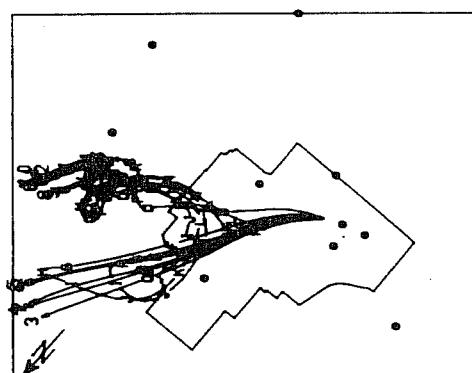
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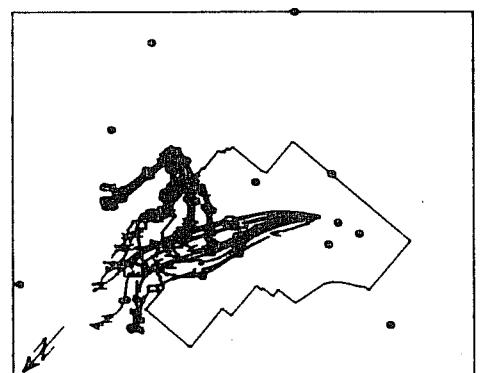
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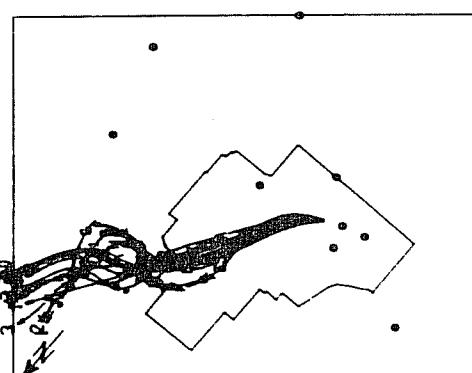
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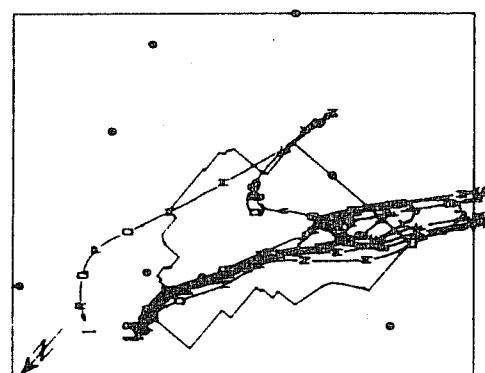
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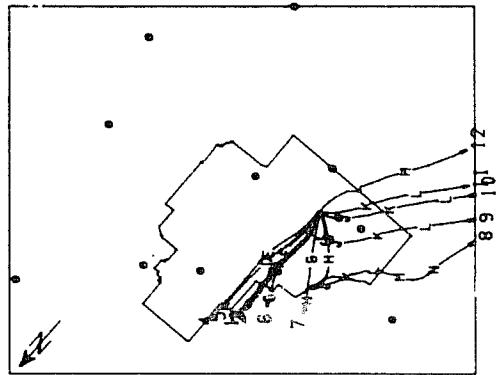
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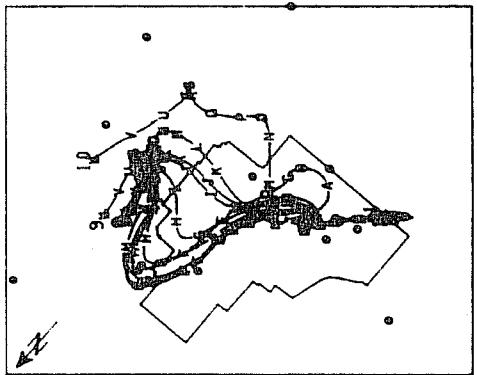
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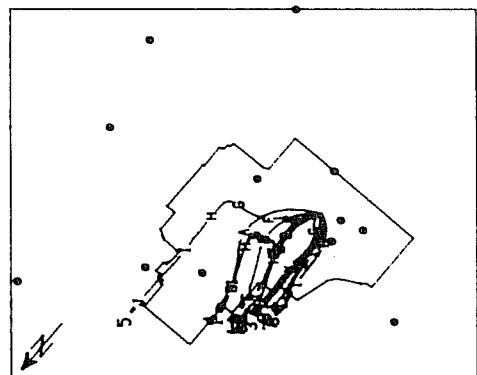
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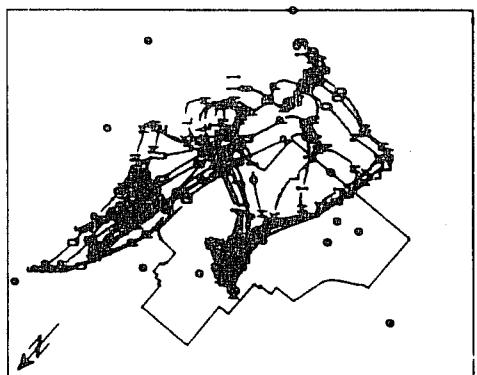
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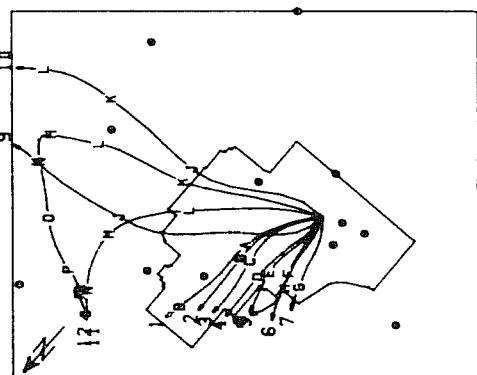
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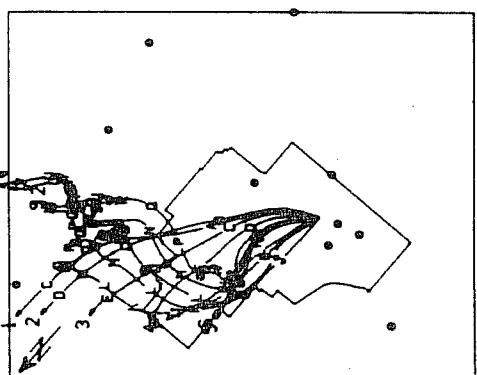
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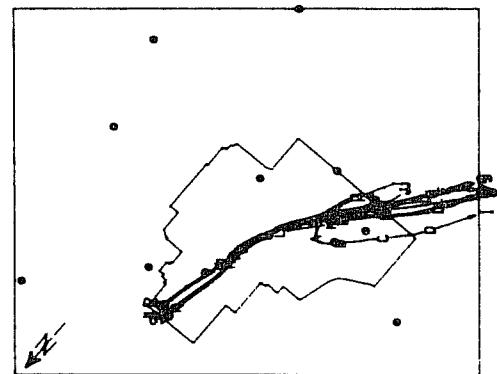
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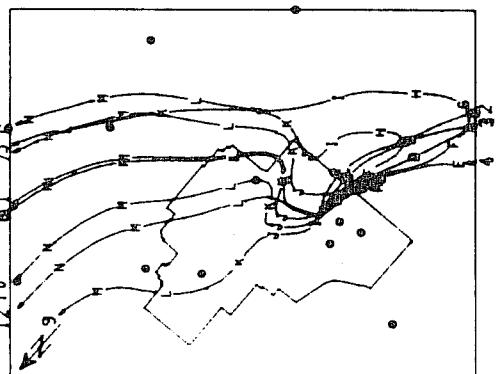
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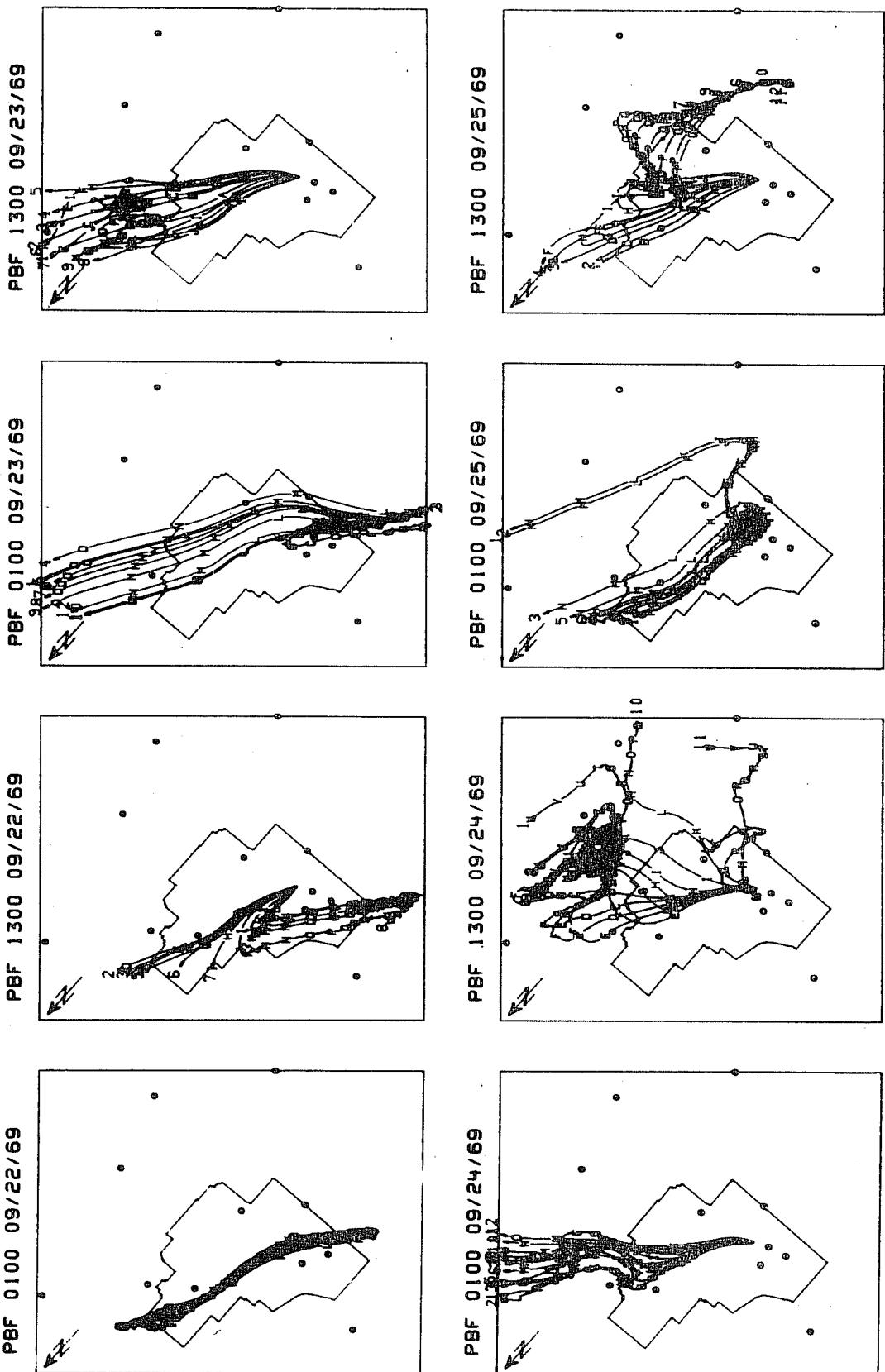


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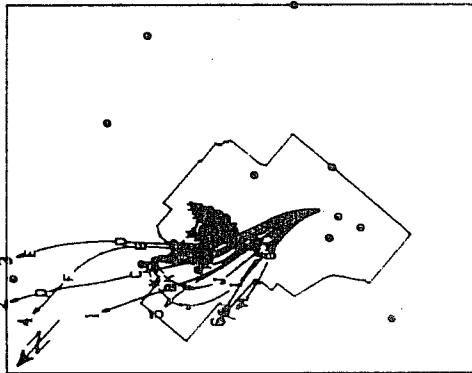


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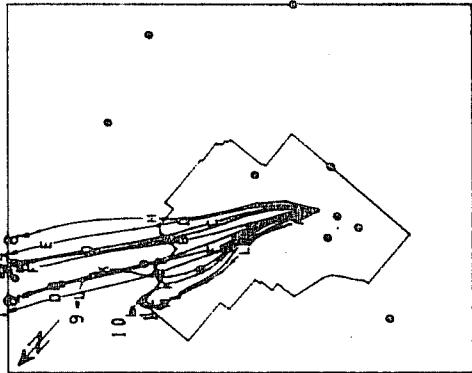




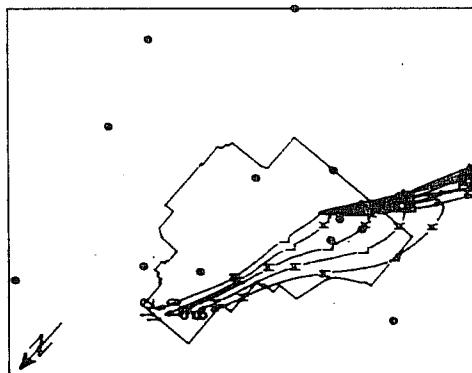
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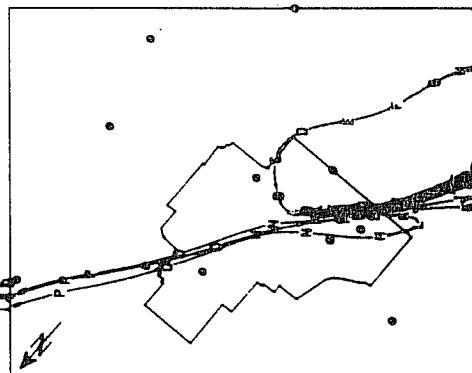
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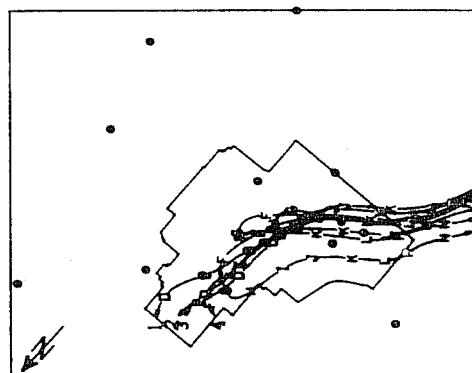
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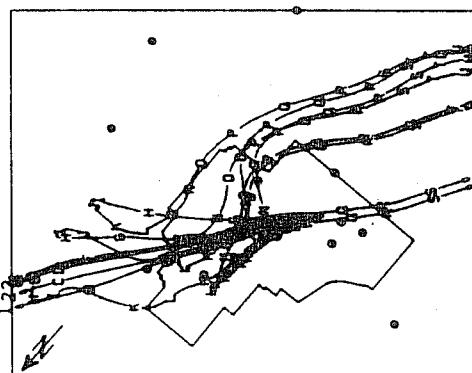
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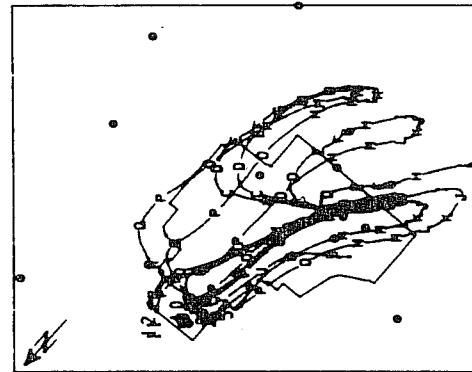
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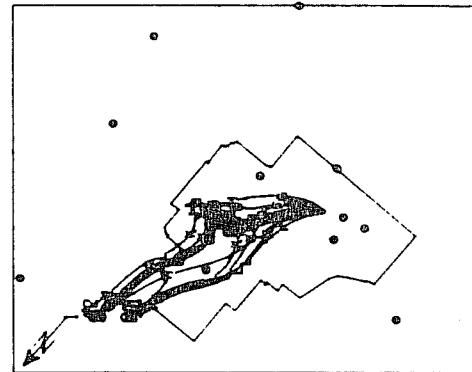
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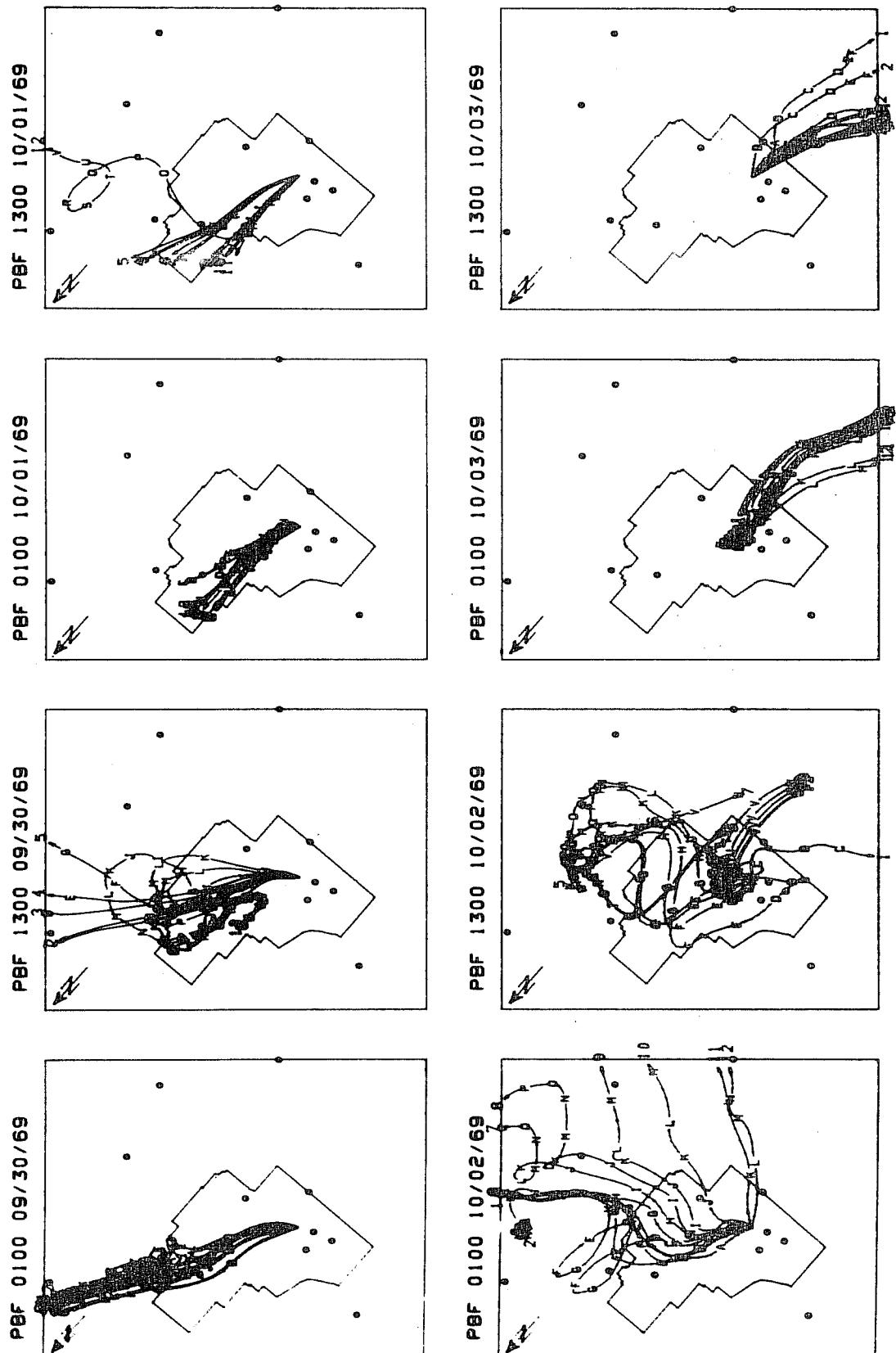


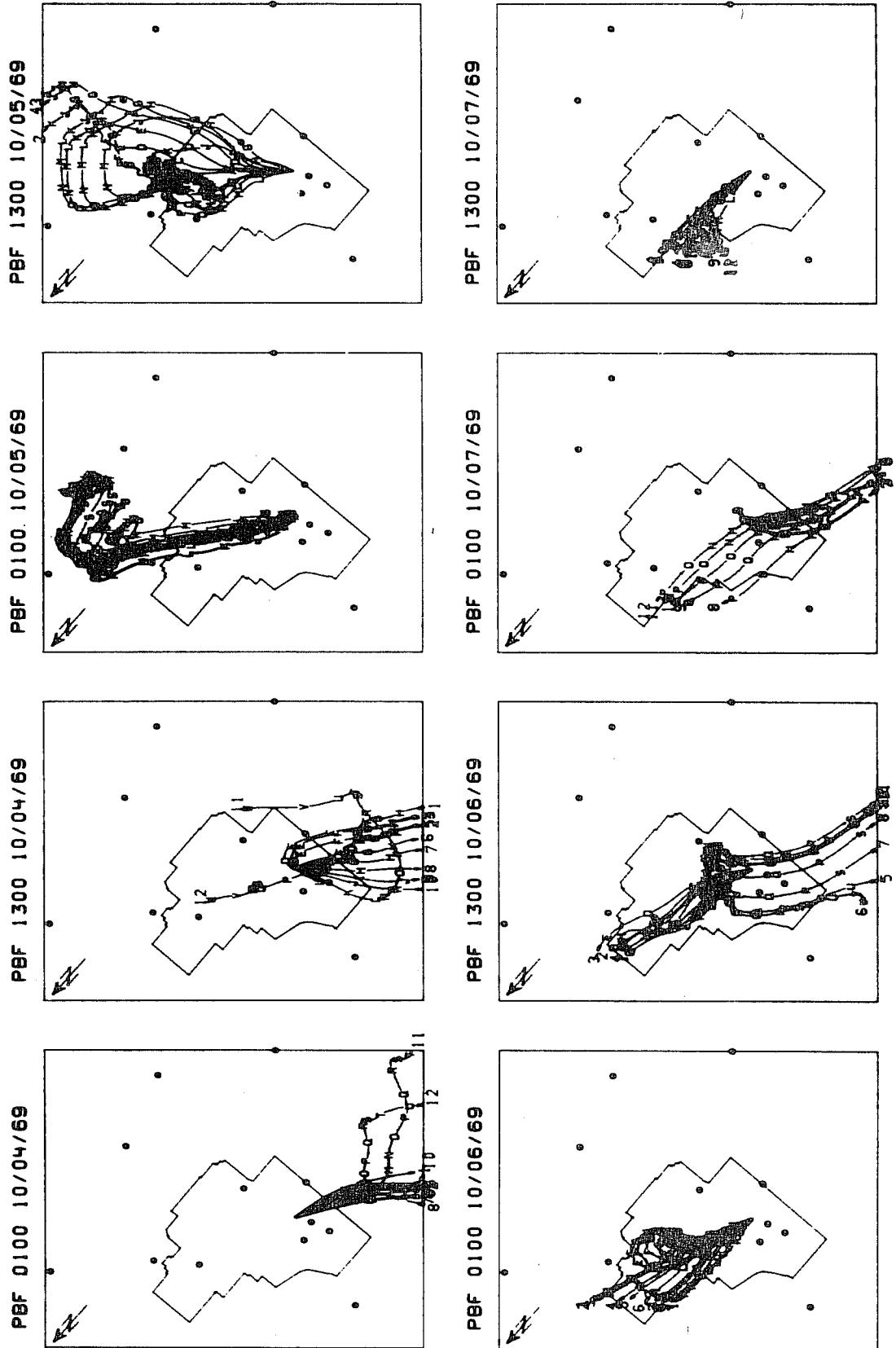
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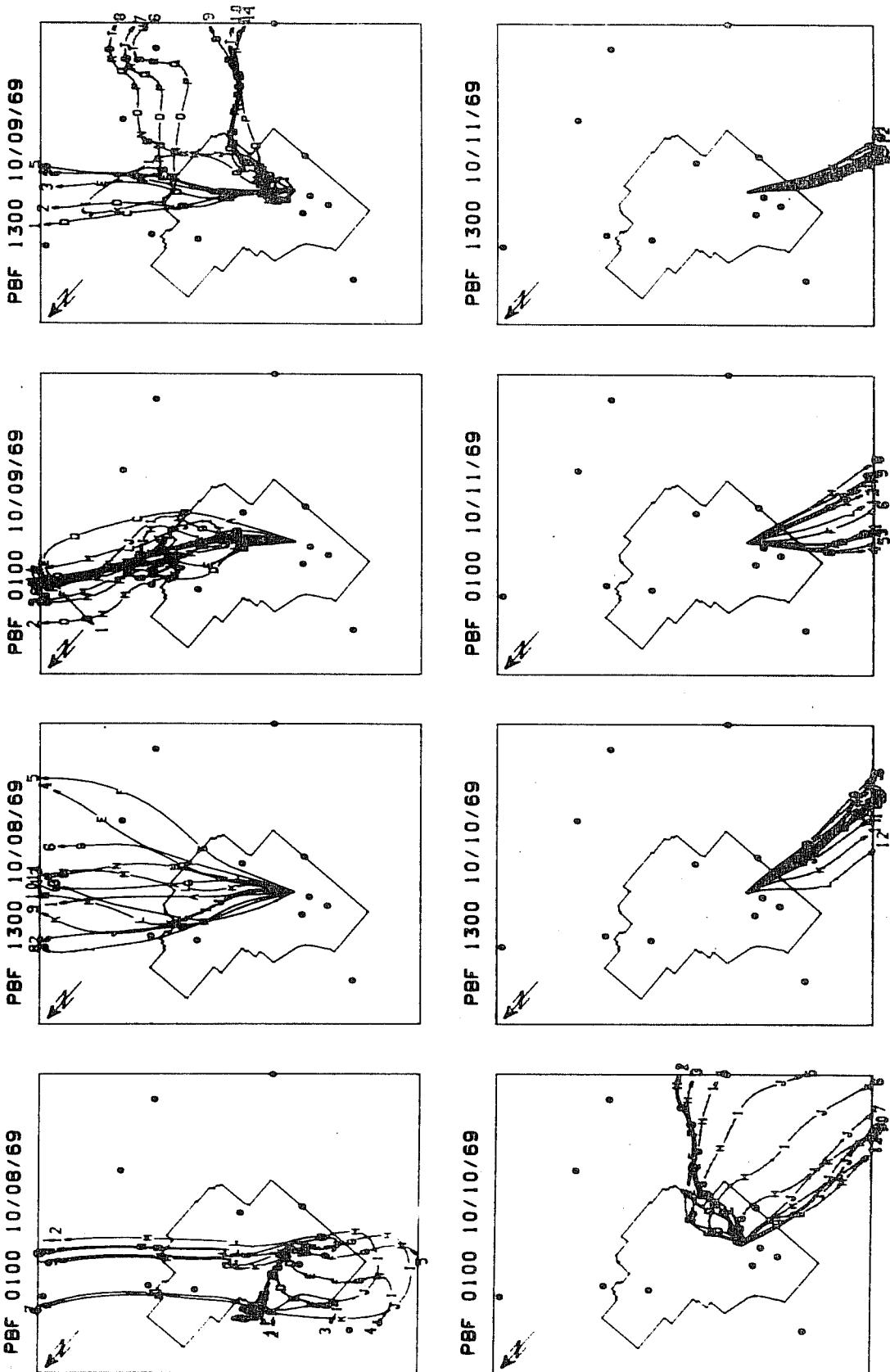


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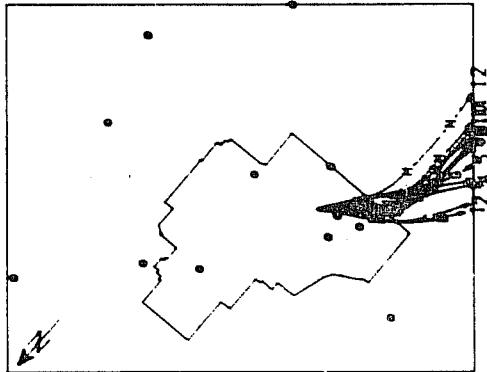




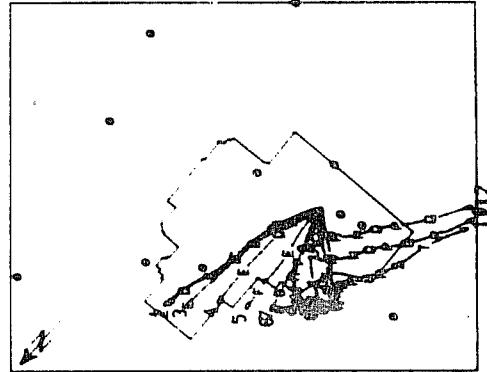




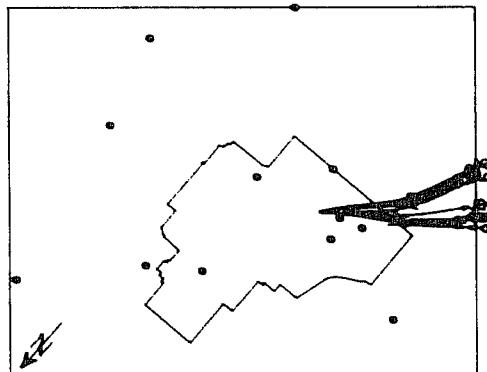
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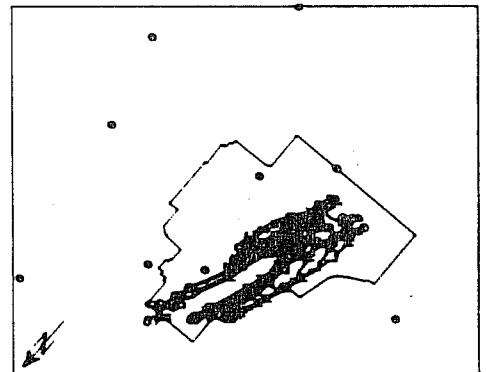
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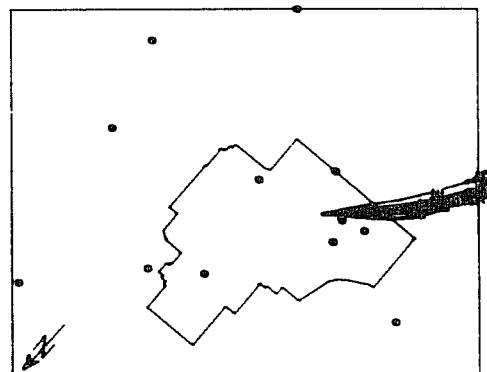
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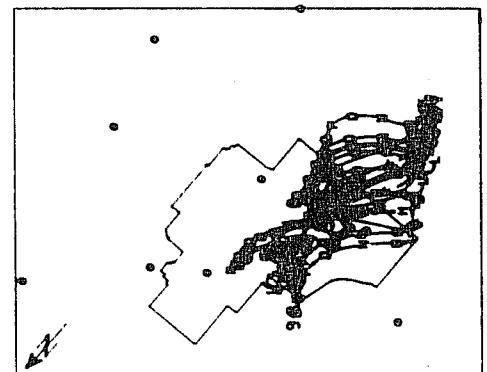
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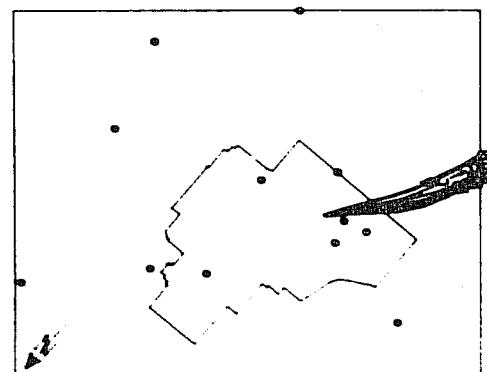
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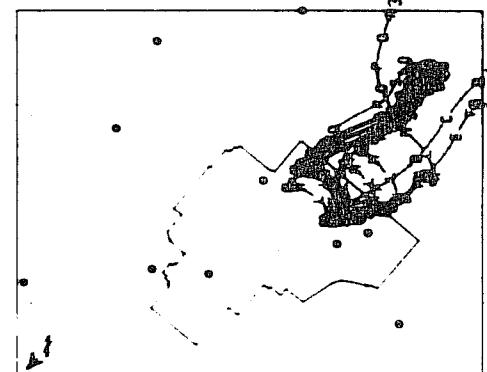
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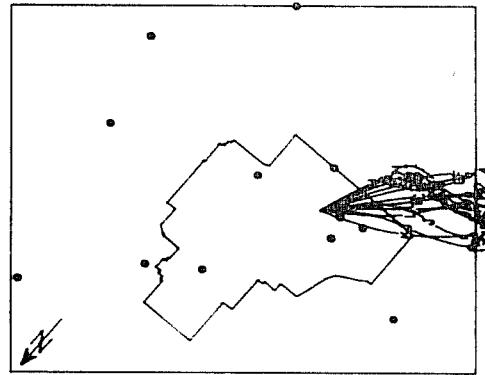
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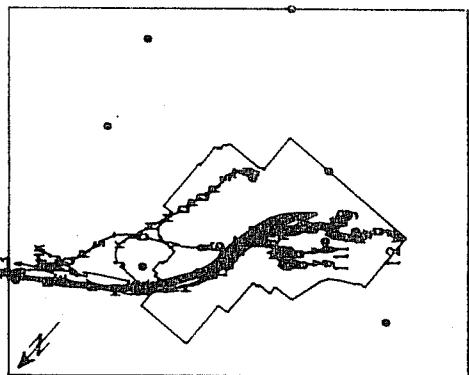
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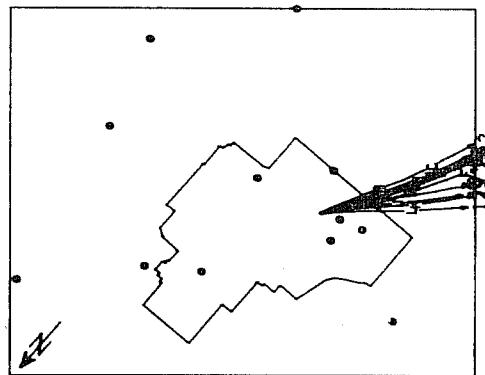
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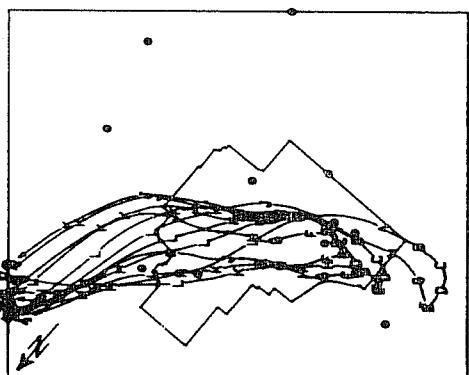
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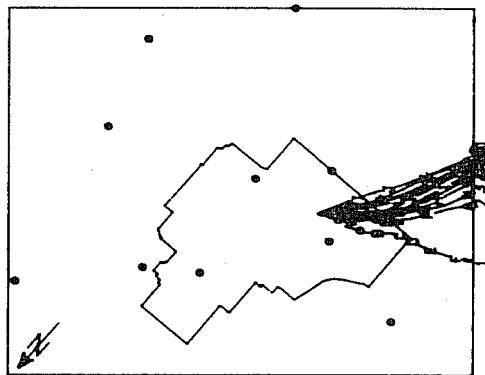
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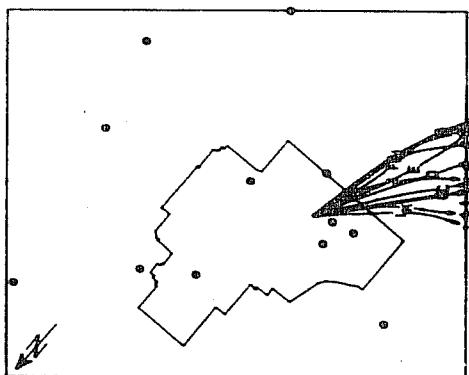
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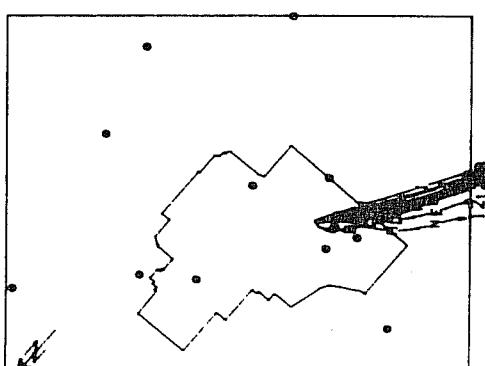
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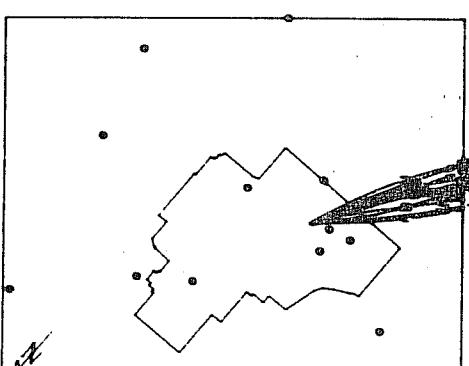
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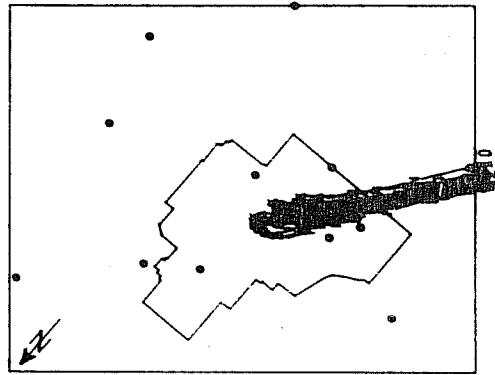
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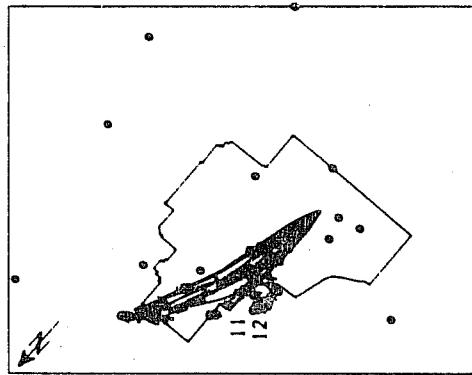
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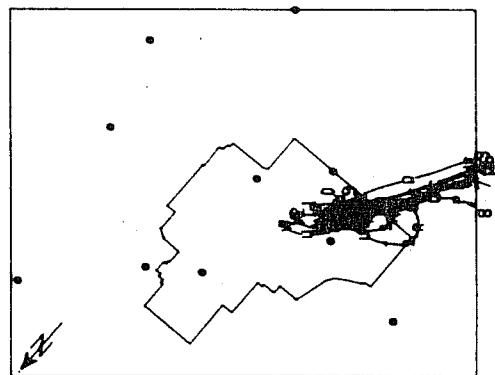
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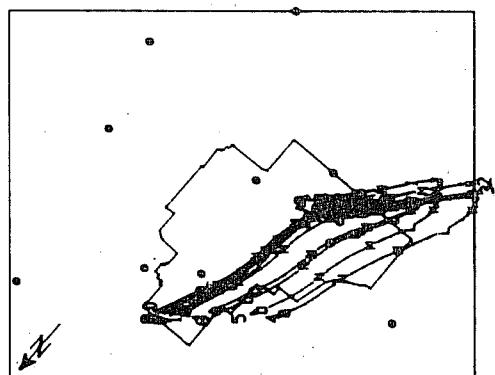
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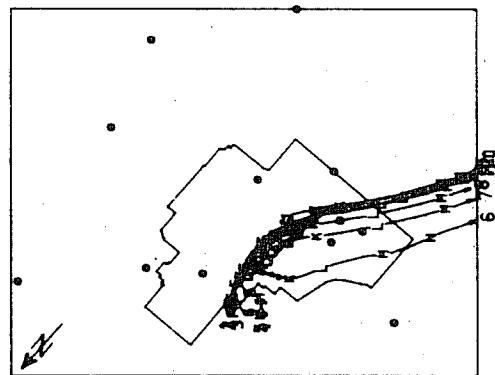
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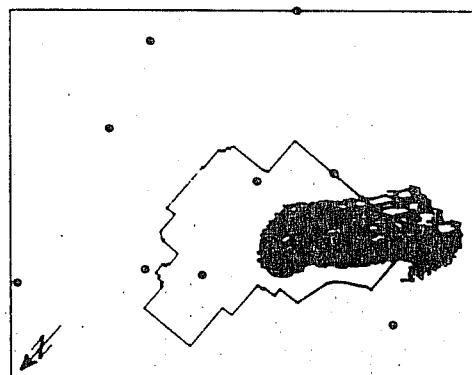
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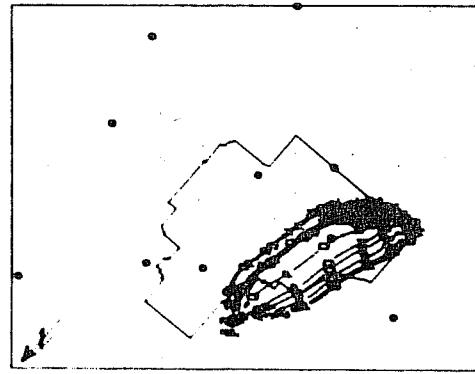
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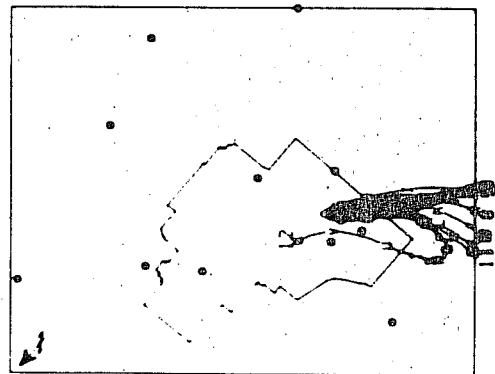
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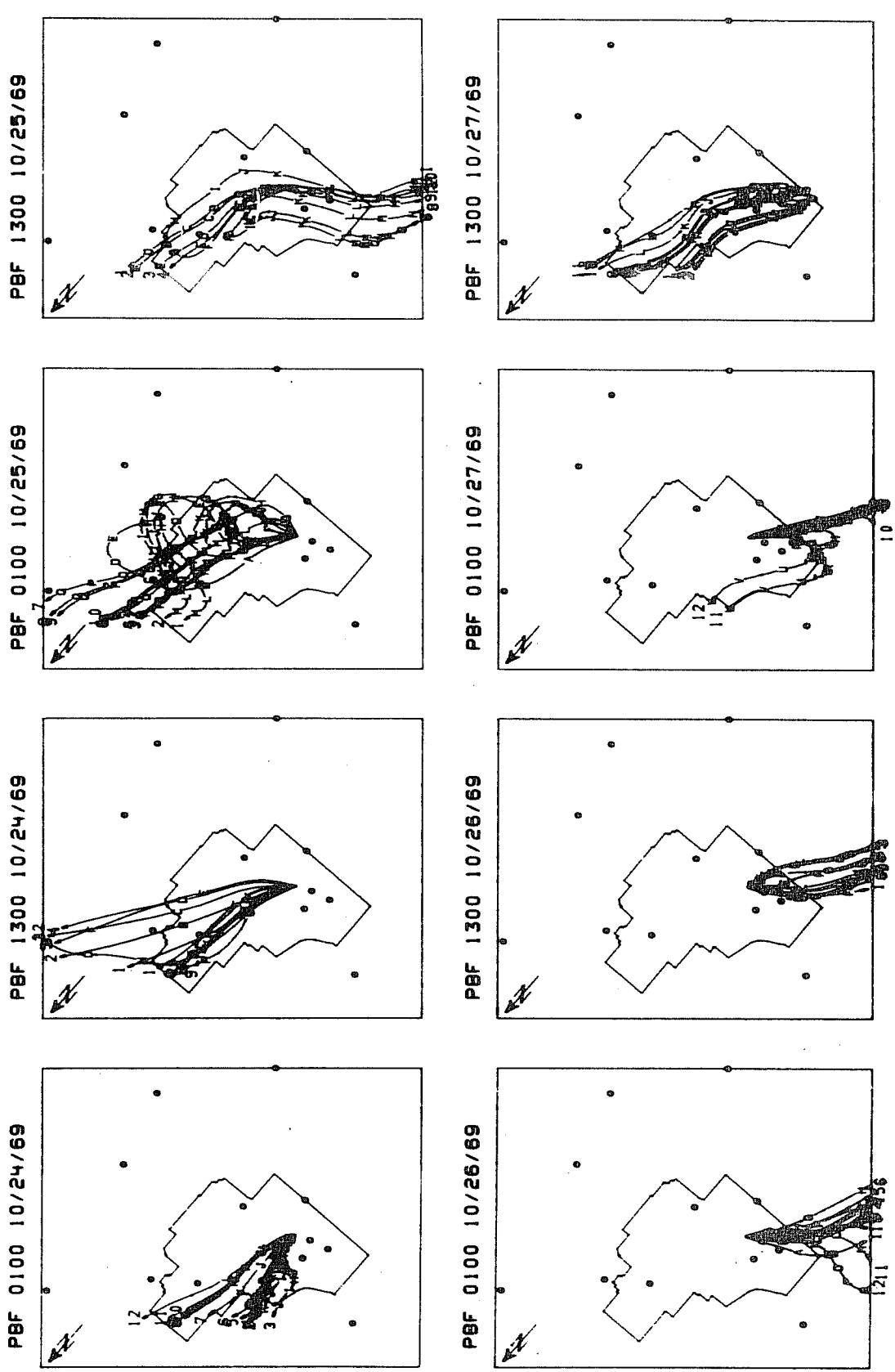


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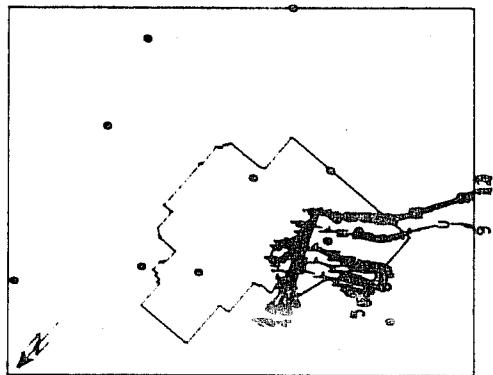


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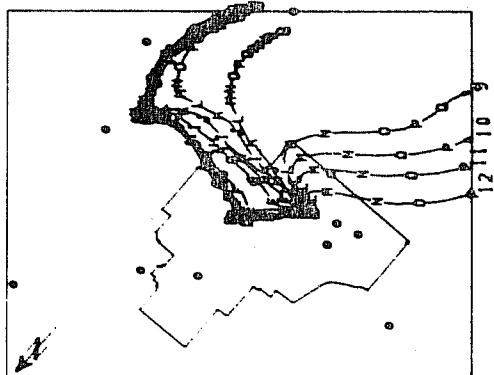




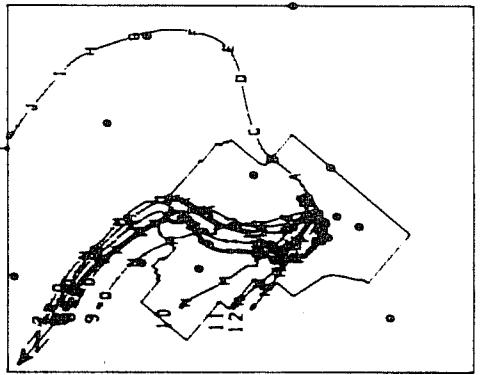
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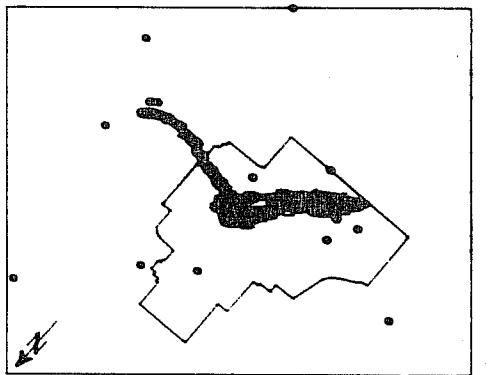
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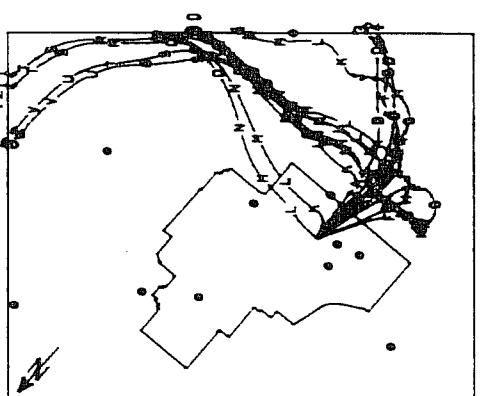
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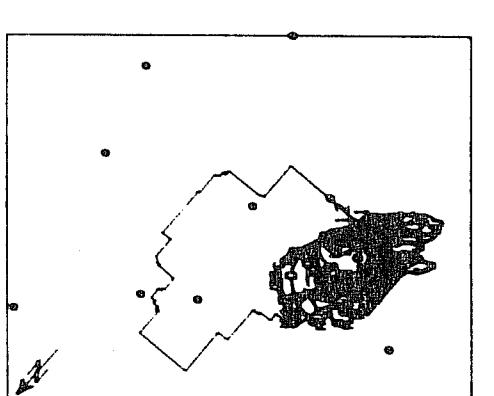
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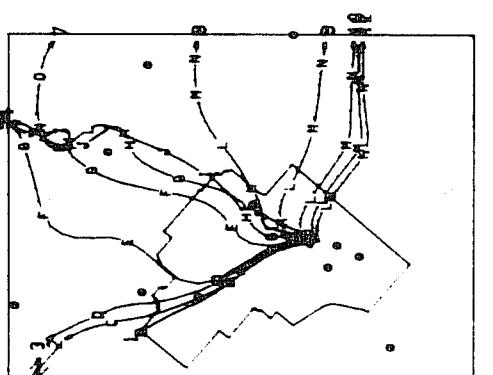
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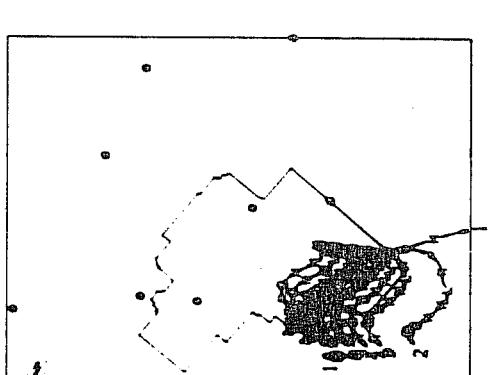
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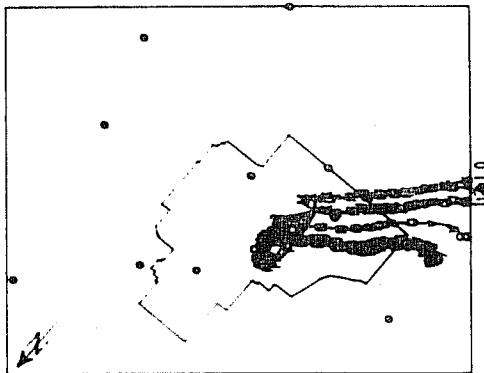
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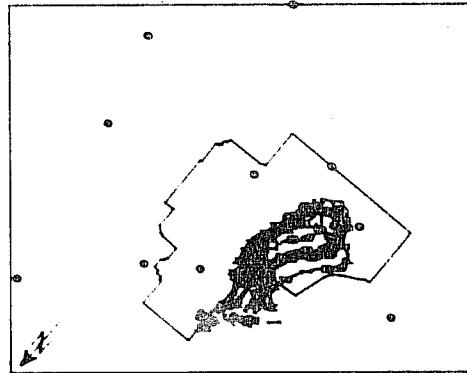
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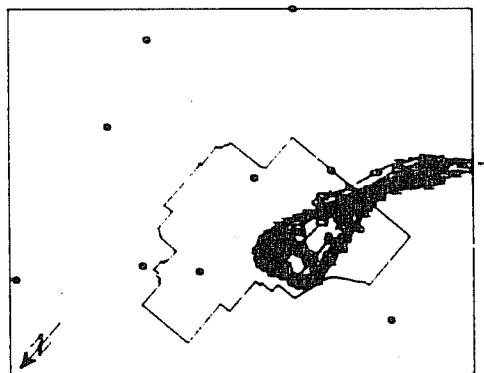
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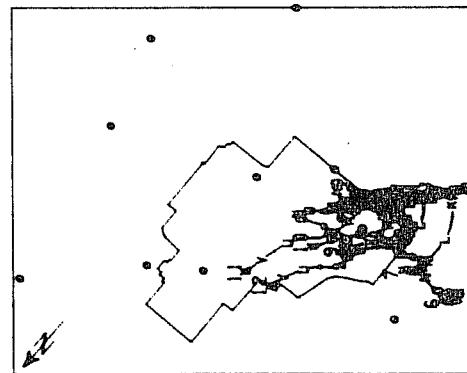
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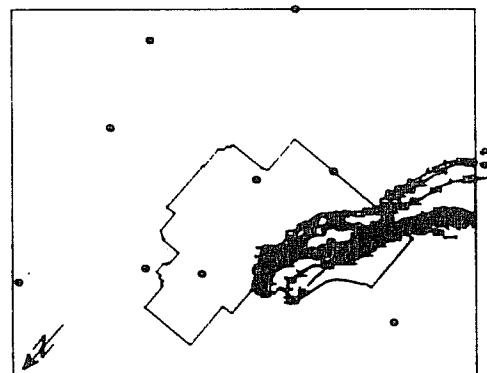
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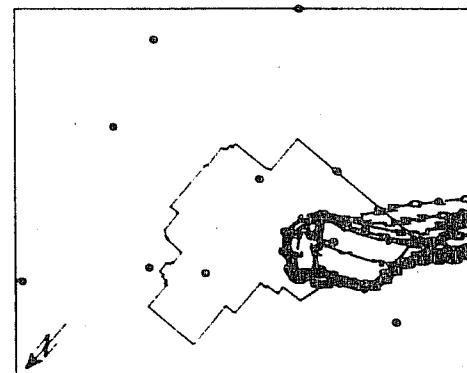
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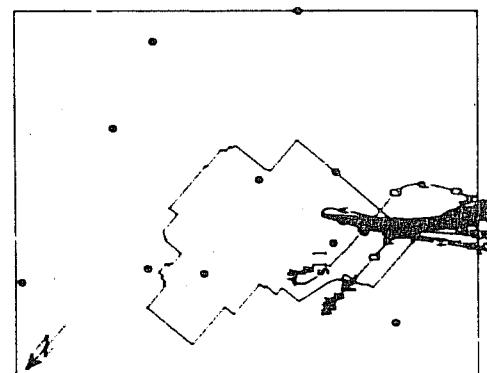
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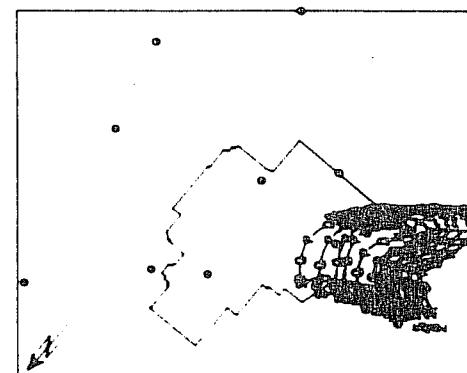
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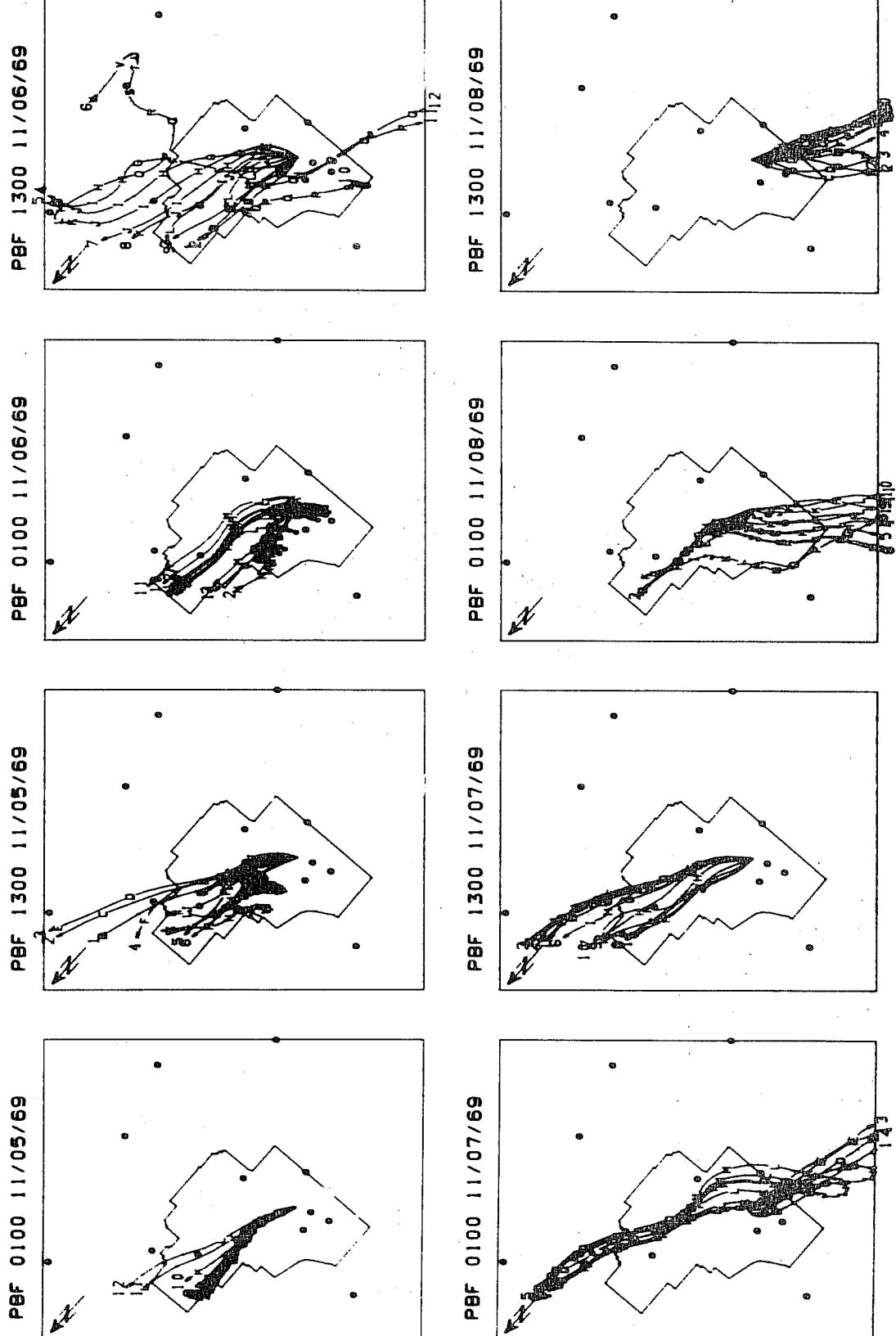


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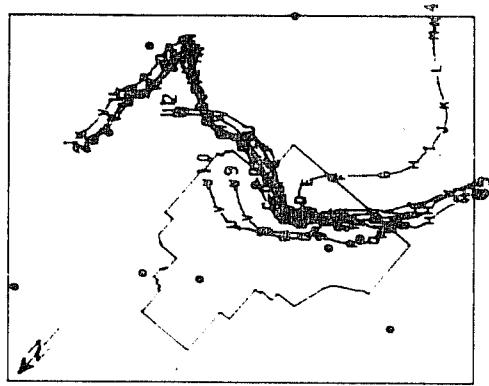


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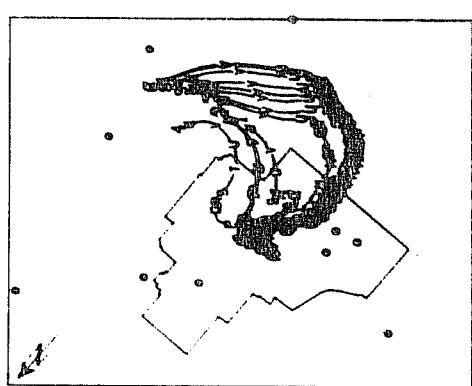




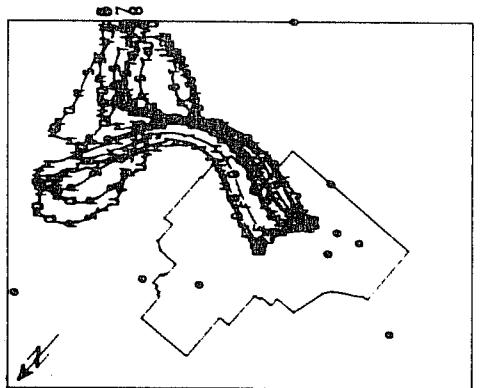
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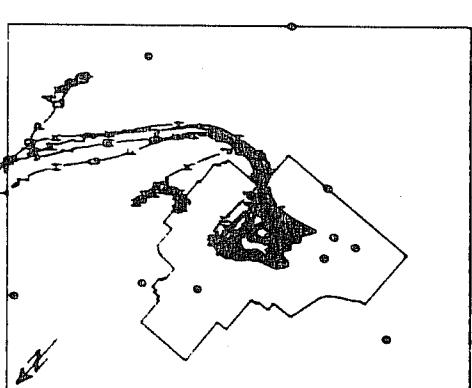
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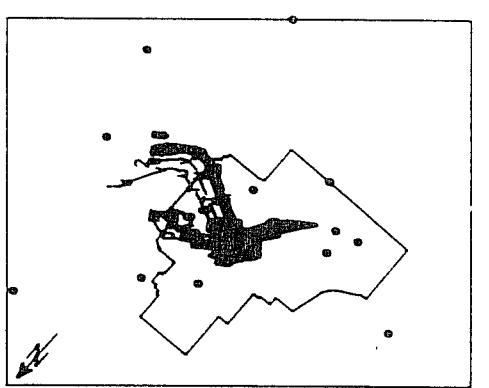
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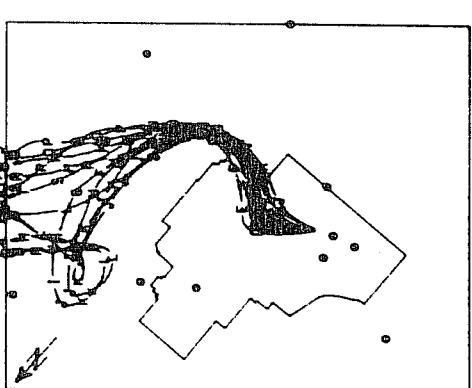
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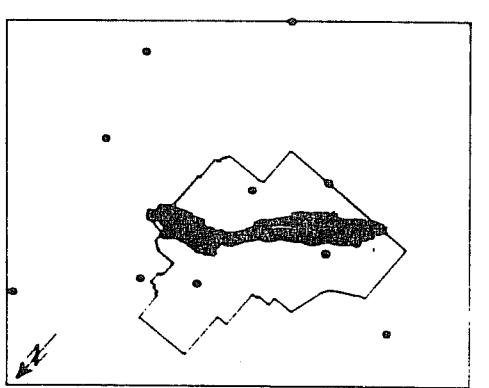
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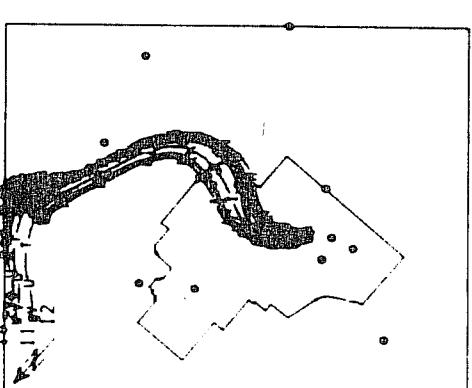
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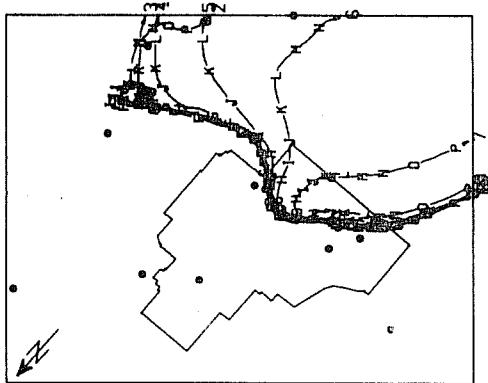
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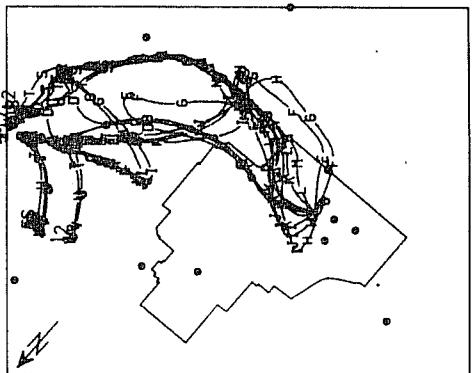
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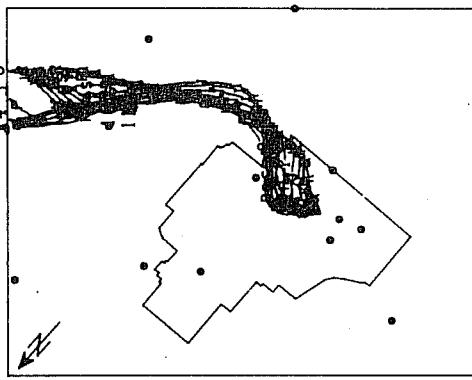
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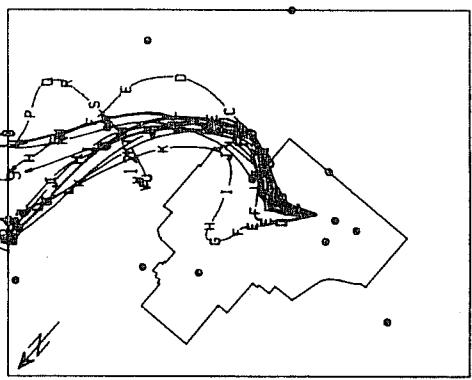
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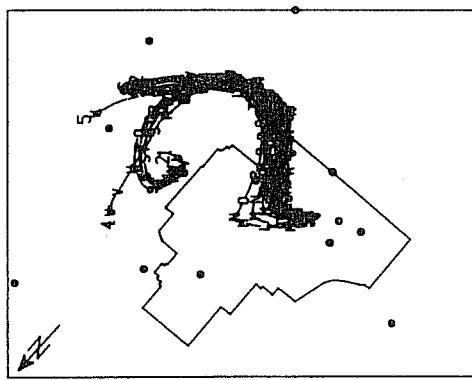
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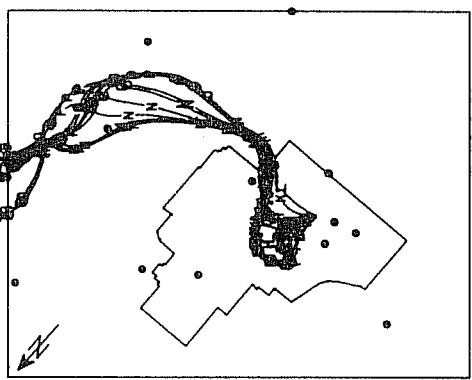
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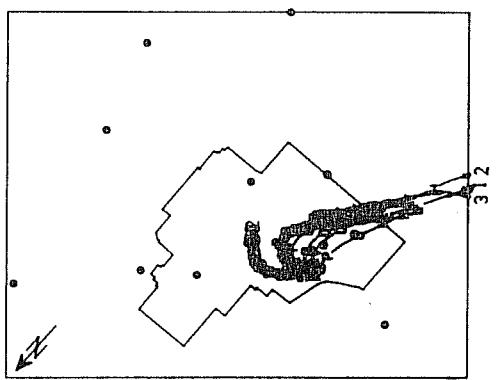
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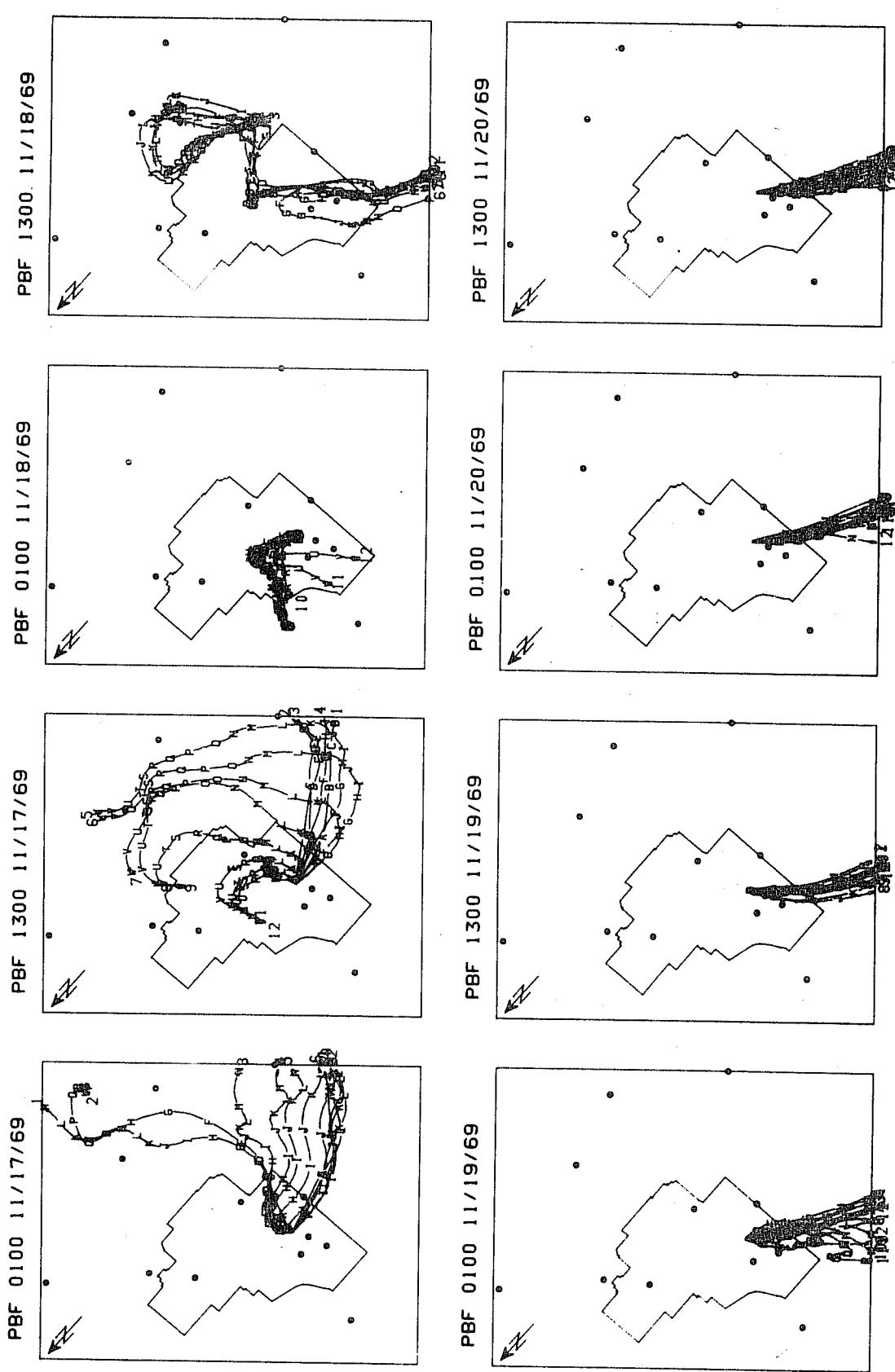


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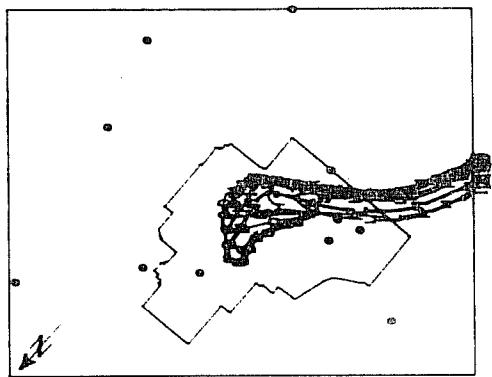


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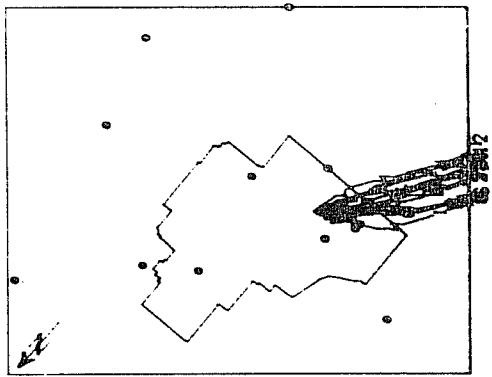




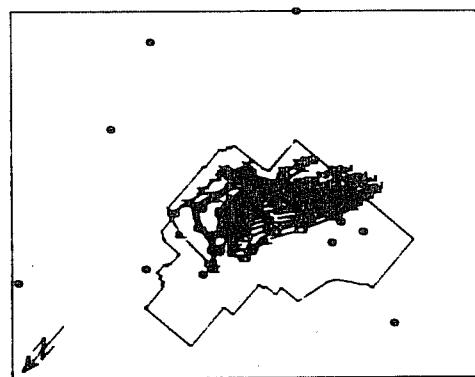
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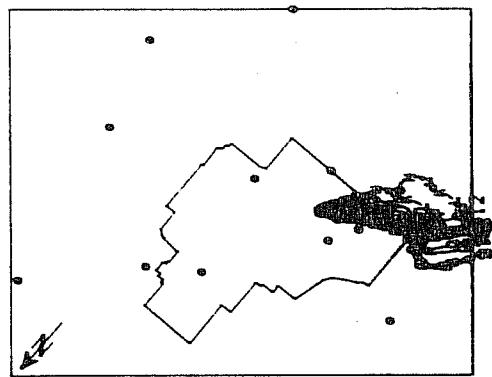
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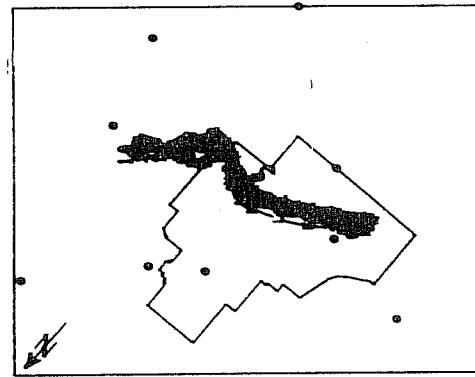
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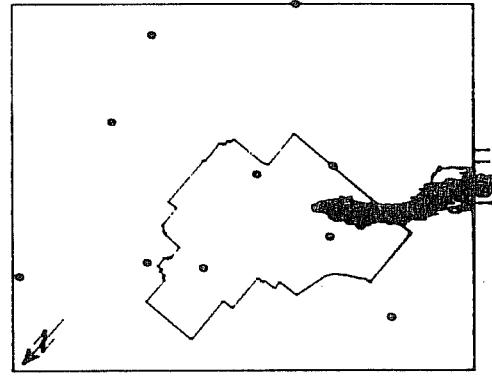
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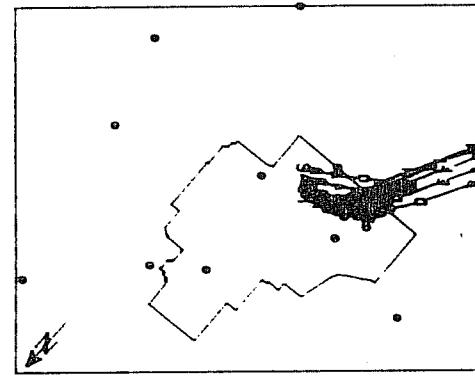
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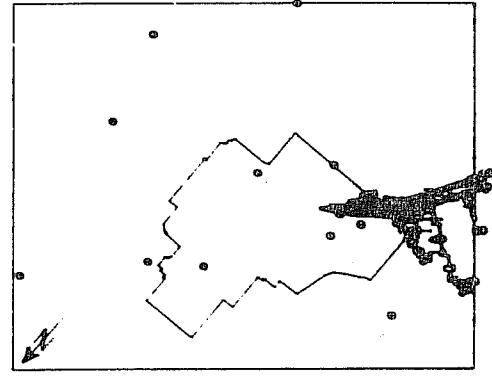
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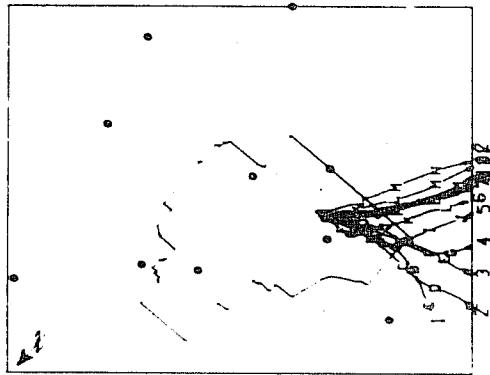
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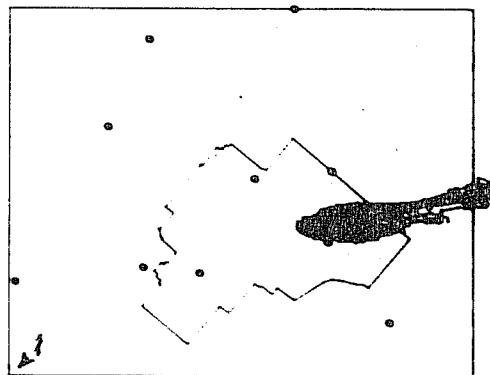
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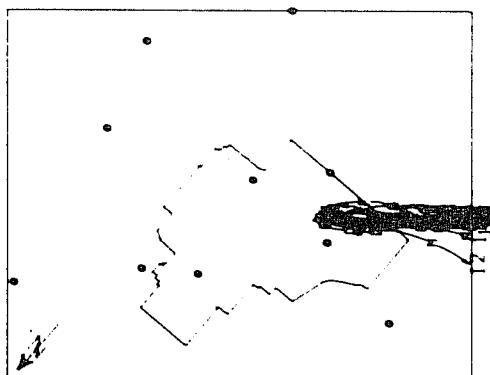
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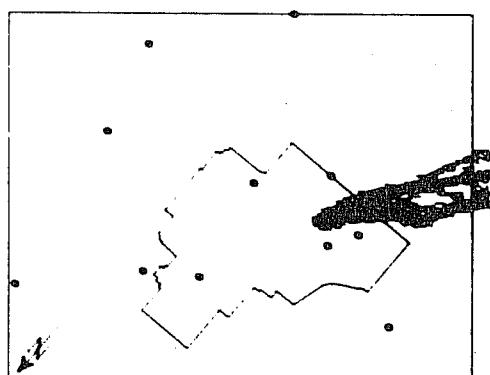
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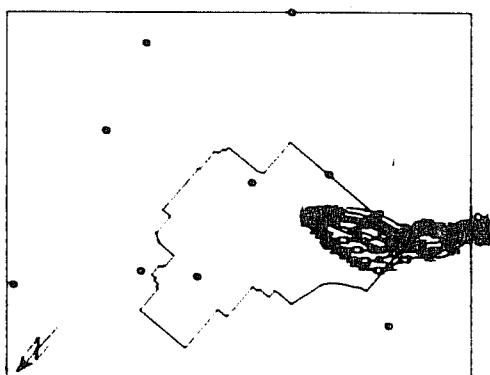
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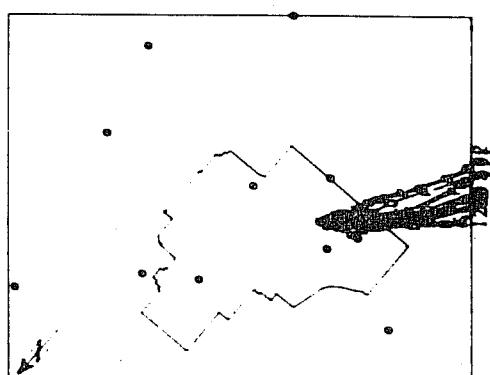
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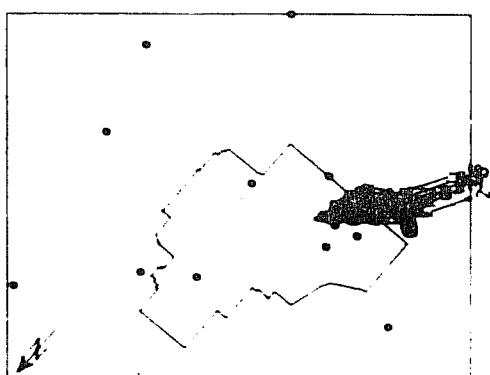
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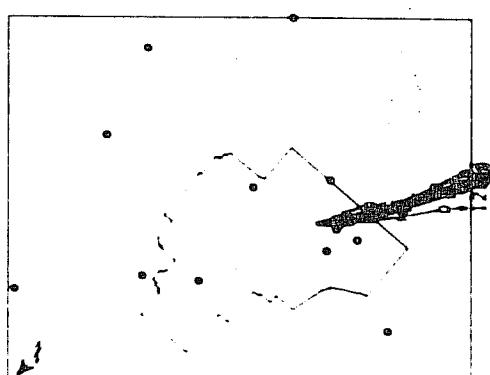
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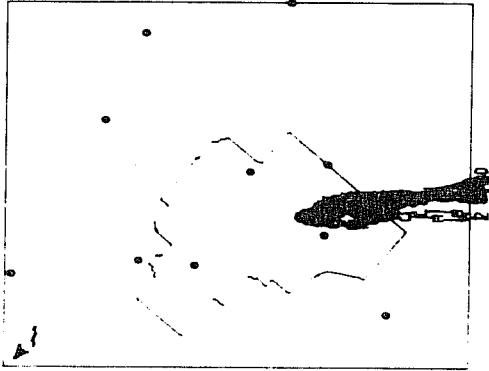
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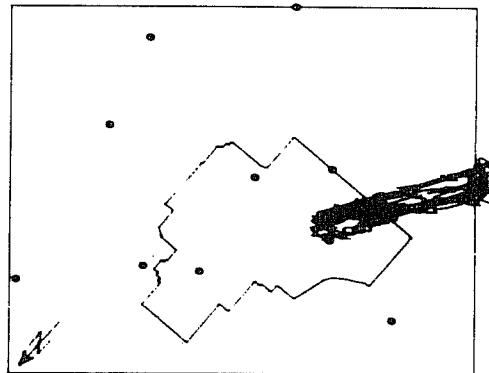
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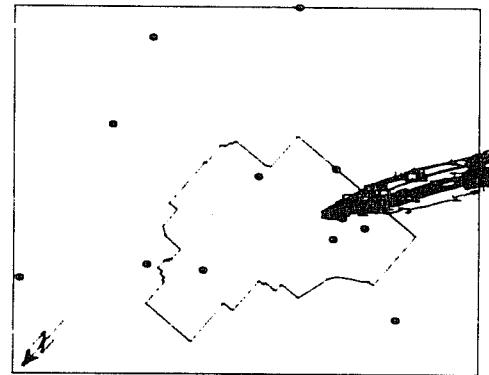
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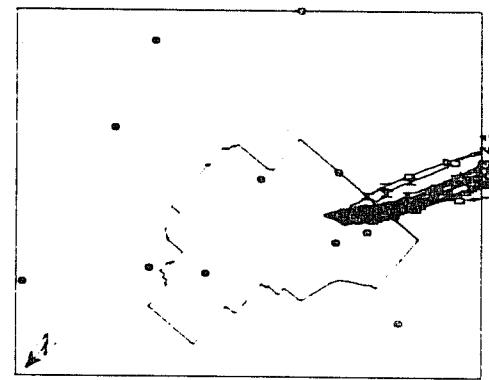
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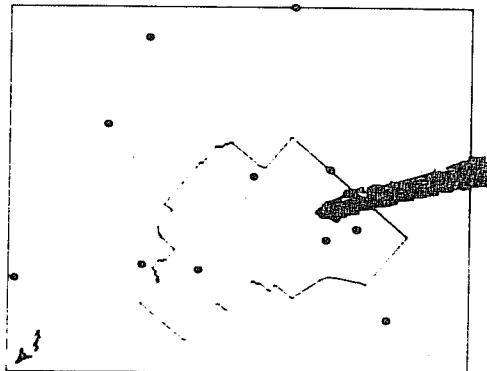
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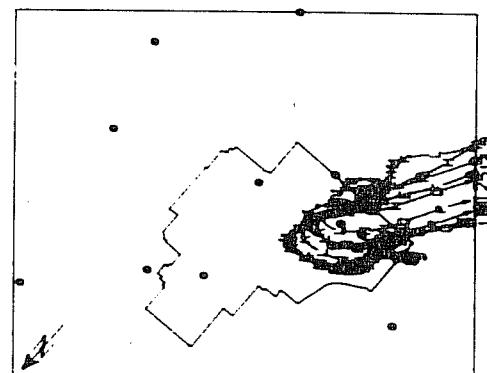
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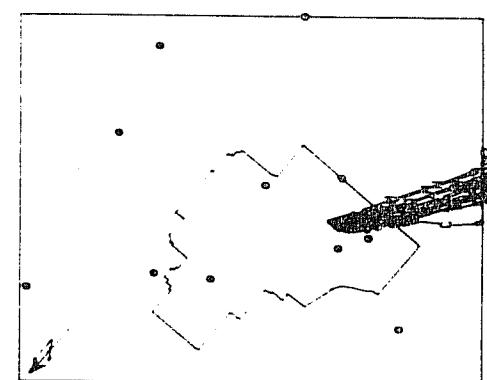
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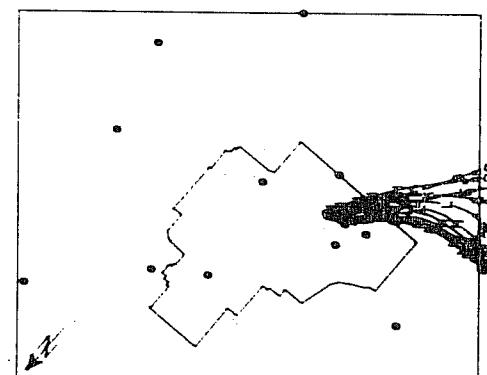
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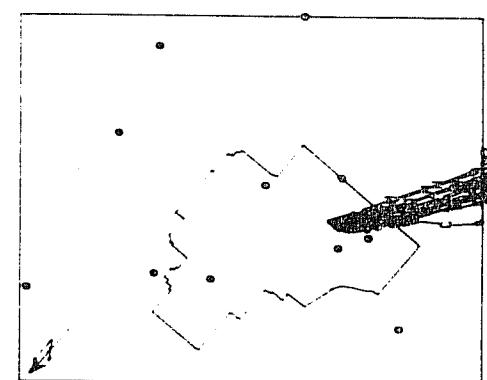
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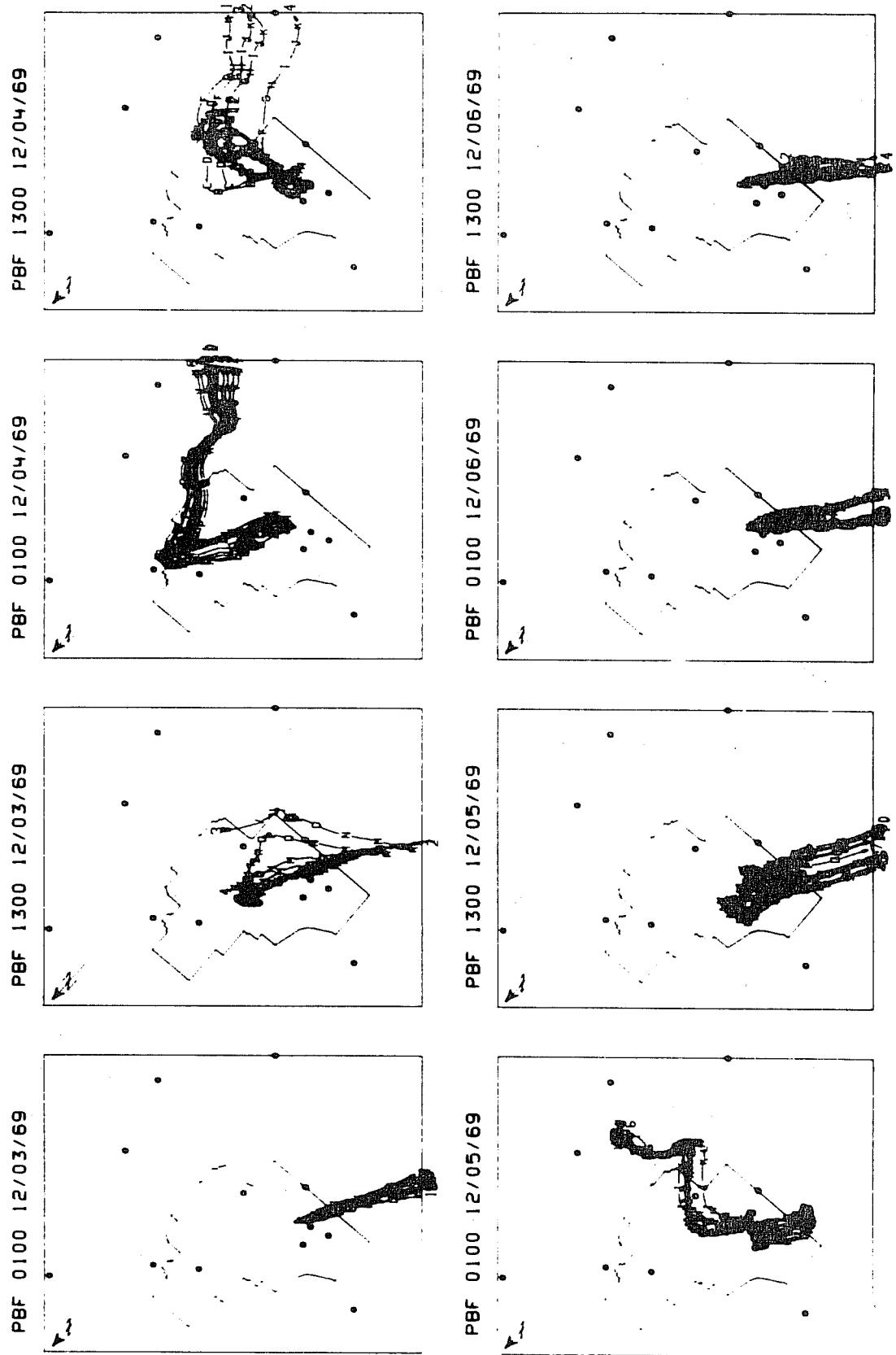


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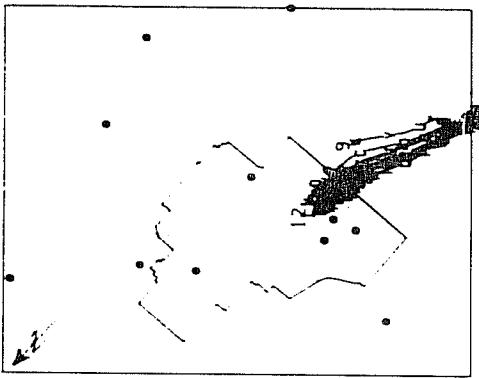


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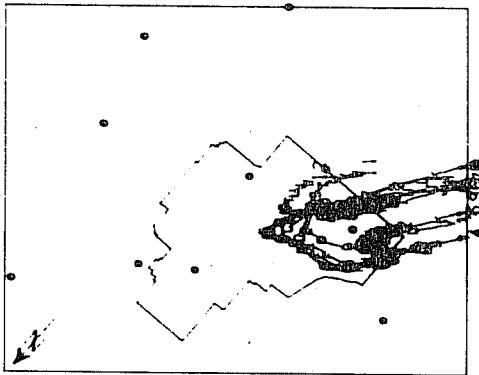




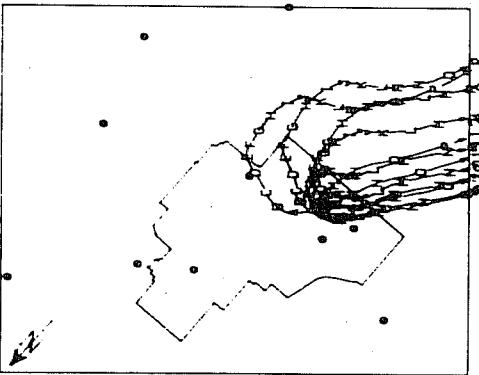
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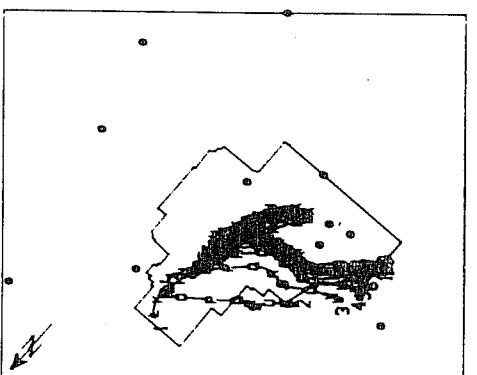
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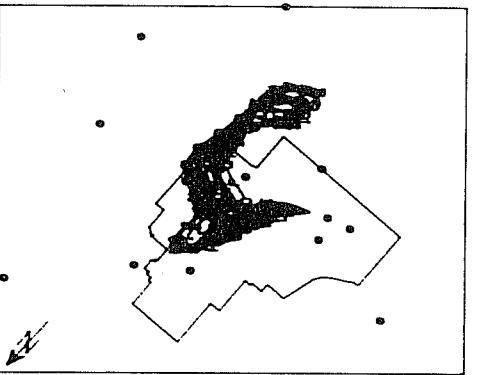
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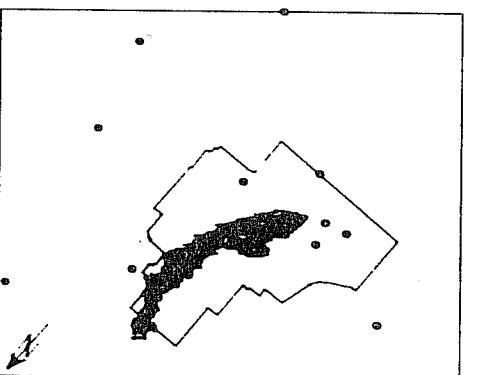
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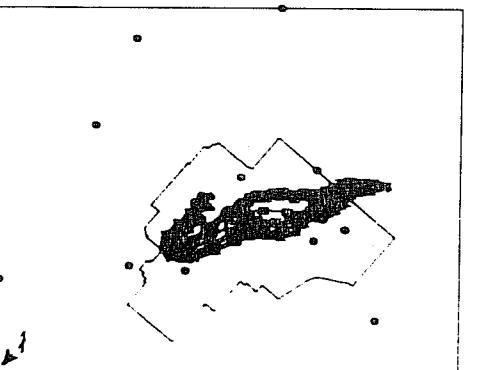
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