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**Gulf Stream Recirculation Experiment (GUSREX)
and
Line Experiment
SOFAR Float Data
1980 - 1982**

by

Maureen A. Kennelly
and
Theresa K. McKee

Woods Hole Oceanographic Institution
Woods Hole, Massachusetts 02543

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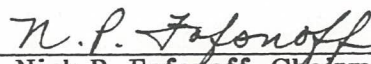
Technical Report

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ABSTRACT

Thirty-nine neutrally buoyant SOFAR floats were tracked in the western North Atlantic at depths of 700 m and 2000 m. These floats were launched in an effort to measure the deep current structure of the Gulf Stream and its recirculation near 55°W. Three separate deployments were made in April and October 1980 and July 1981. The floats were tracked by means of moored autonomous listening stations. The basic data consist of float trajectories, and temperature, pressure, and velocity measurements along the trajectories. This report describes the GUSREX experiment and instrument performance. It presents plots illustrating the horizontal structure and scales of the general circulation in the Gulf Stream and its recirculation for the period October 1980 to May 1982.

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SECTION 1

INTRODUCTION

This report contains SOFAR (Sound Fixing And Ranging) float data obtained from 1980 to 1982 in the North Atlantic for two experiments: GUSREX (Gulf Stream Recirculation Experiment) and the Line Experiment. GUSREX made use of SOFAR floats and ALSs in the highly energetic Gulf Stream and recirculation and was a cooperative experiment with the University of Rhode Island's (URI) "Line Experiment" which used SOFAR floats in studying the interior of the less energetic North Atlantic subtropical gyre. The float data are merged in this report. The main purpose of GUSREX was to categorize the horizontal structure and scales of the general circulation and eddy field in the Gulf Stream and its recirculation.

SOFAR floats, developed in the early 1970's (Rossby and Webb, 1970, 1971), were used successfully in two previous large scale experiments: MODE (Mid Ocean Dynamics Experiment, 1972-1976) and LDE (Local Dynamics Experiment, 1978). Originally, SOFAR floats were tracked by shore based receivers. Beginning in 1980, SOFAR floats were remotely tracked by means of an array of moored autonomous listening stations (ALSs). The development of the ALS extended the range over which SOFAR floats could be tracked, allowing basin-wide experiments such as GUSREX.

Prior to GUSREX, three smaller scale experiments used SOFAR floats in and near the Gulf Stream. Ten SOFAR floats (RI1-RI10), were launched in or near Gulf Stream cold core rings in 1974 (Cheney, et. al., 1976) in order to test the feasibility of tracking Gulf Stream rings. Two long range test floats (LR32 and LR83) were launched in the recirculation region as engineering tests in October, 1977 and July, 1978. Three floats (GS72B, GS73B, GS74B) were deployed to test tracking capability and range in the Gulf Stream in 1979. Plots of trajectories of these floats are presented in Appendix A.

GUSREX

Nineteen SOFAR floats were launched along 55°W in April 1980 on ENDEAVOR cruise 50 (Figure 1 and Table 1). Identifiers for GUSREX floats are in the range GU100 through GU161. All floats were ballasted to equilibrate near 700 m or 2000 m. Data is available for 17 of the 19 floats listed in Table 1. Floats GU111 and GU160 failed soon after launch. Six ALSs (lettered A-F) were moored in the shape of a pentagon centered near 33°N , 55°W (Figure 1 and Table 2). Nominal spacing between moorings was 900 km. ALSs were located in the deep sound channel, near 1300 m in the Sargasso Sea and 700 m in the Slope water region.

XBTs and CTDs were taken along 55°W . Sections of temperature from the XBTs and sections of temperature and salinity anomaly from discrete depths made with the rosette sampler are shown in Figure 2. The CTD data is being analyzed by H. T. Rossby at URI.

A number of papers have been written discussing various aspects of the GUSREX data. A list of these references is provided in Appendix B.

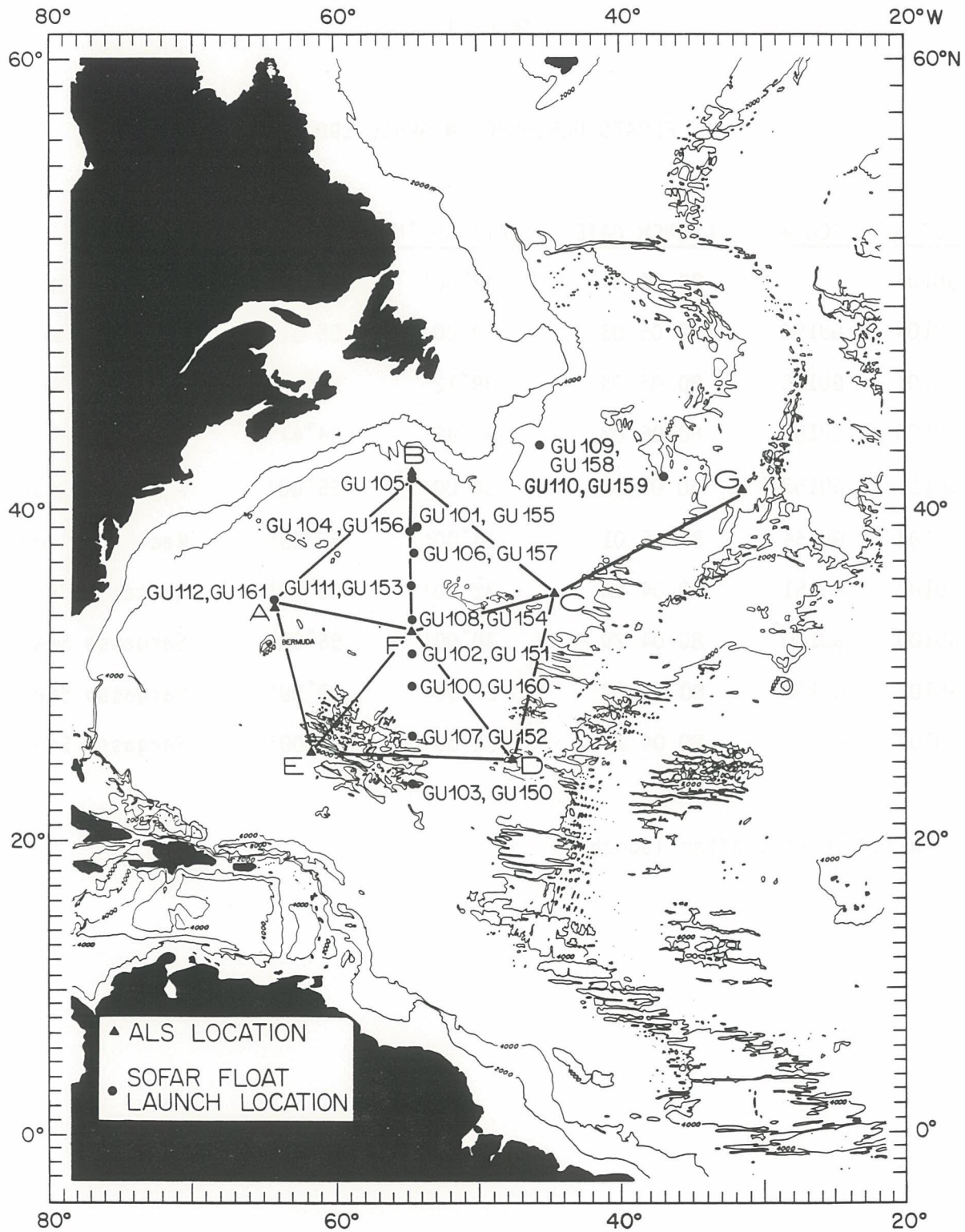


Figure 1. Six ALSs (A-F) were moored in April 1980 and 19 floats were launched at depths of 700 and 2000 meters. ALS G was moored in October 1980, A through F were reset, and 6 more floats were deployed. Floats GU100 through GU112 are 700 m floats; GU150 through GU161 are 2000 m floats.

TABLE 1

FLOATS DEPLOYED IN APRIL 1980

<u>700 m</u>	<u>2000 m</u>	<u>LAUNCH DATE</u>	<u>LATITUDE °N</u>	<u>LONGITUDE °W</u>	<u>REGION</u>
GU105		80 04 04	42°00'	54°59'	Slope water
GU104	GU156	80 05 03	39°00'	55°05'	Gulf Stream
GU101	GU155	80 05 03	39°12'	54°38'	Gulf Stream
GU106	GU157	80 05 02	37°48'	54°47'	Cold Core Ring
GU111*	GU153	80 05 01	36°00'	55°00'	Recirculation
GU108	GU154	80 05 01	34°00'	55°00'	Recirculation
GU102	GU151	80 04 30	32°00'	55°00'	Sargasso Sea
GU100	GU160*	80 04 29	30°00'	55°00'	Sargasso Sea
GU107	GU152	80 04 29	27°00'	54°59'	Sargasso Sea
GU103	GU150	80 04 28	24°00'	55°00'	Sargasso Sea

* Failed shortly after launch

TABLE 2
POSITIONS OF ALSs

<u>ALS</u>	<u>LATITUDE °N</u>	<u>LONGITUDE °W</u>
A	35°03'	64°59'
B ¹	41°58'	55°01'
C	35°29'	45°03'
D ²	25°30'	48°01'
E ³	26°01'	61°59'
F	33°20'	55°01'
G ⁴	41°08'	32°59'

- 1 ALS mooring not found or recovered in September 1980. New ALS set at same site.
- 2 ALS not in place during July 1981 to May 1982. The instrument released prematurely during launch due to a mechanical problem; the mooring was recovered but not reset.
- 3 ALS recorder malfunction.
- 4 ALS in place during period September 1980 to July 1981 to track Newfoundland Basin floats.

During September - October 1980 (OCEANUS cruise 87), six additional SOFAR floats were launched (Table 3). No data were obtained for floats GU112 and GU161. The floats listed in Tables 1 and 3 comprise the first setting of floats. Five of the six ALSs were recovered; Site B was the exception. ALSs were reset at all mooring locations with an additional ALS placed at Site G (Figure 1).

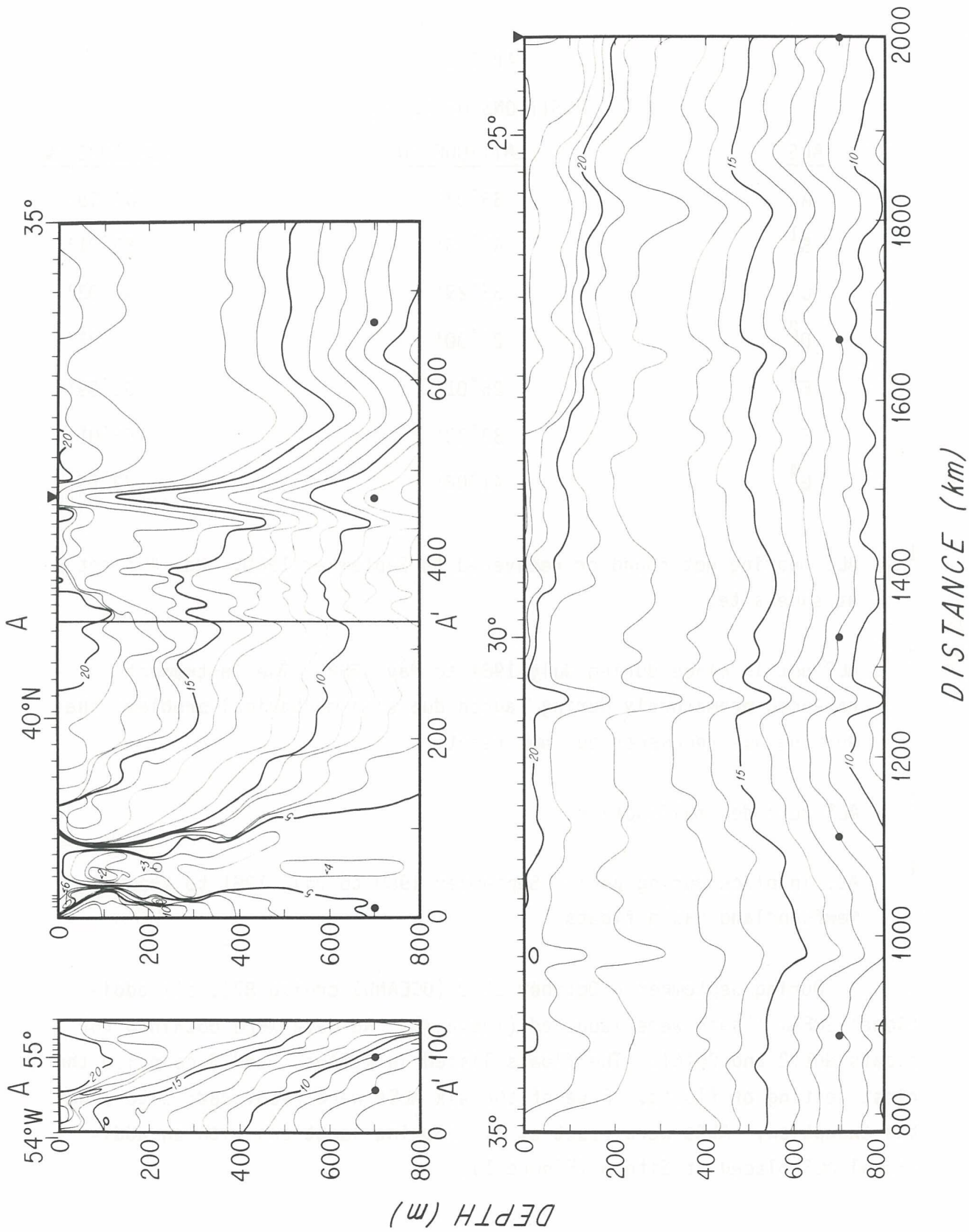
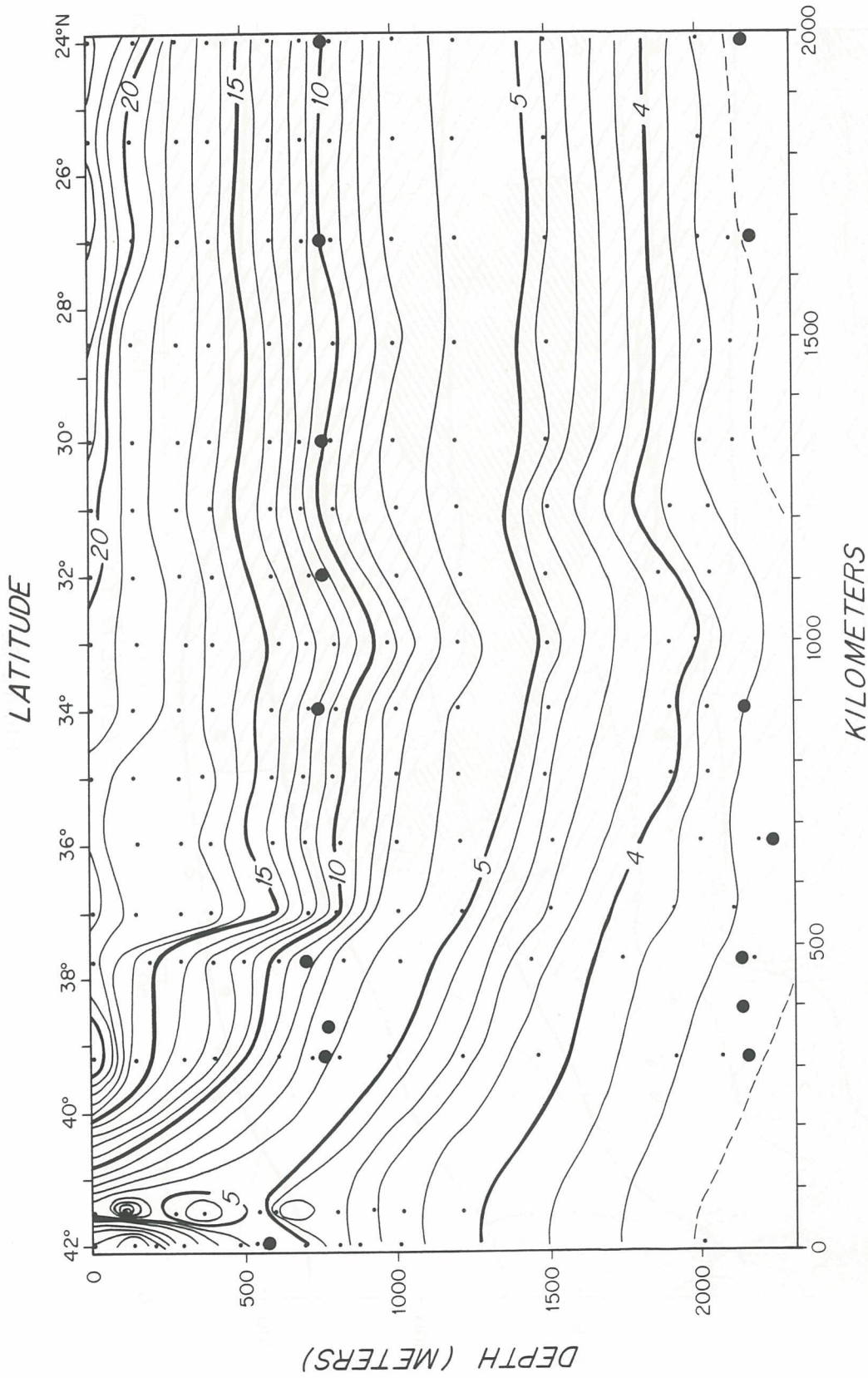


Figure 2a. North-South section of temperature along 55°W from XBTs, 28 April to 4 May 1980. Dots show the location of shallow SOFAR floats at launch. The Gulf Stream was running south parallel to the section from 41°N to 38°N. A short east-west section (A-A') normal to the Stream is shown in upper left. A cold core ring was attached to the southern side of the Stream near 37.5°N, and a warm eddy was located near 33°N.



Figures 2b,c. North-South section of temperature ($^{\circ}\text{C}$) and salinity anomaly ($.01/_{\text{‰}}$) along 55°W from samples taken with a rosette sampler. Large dots show the location of SOFAR floats at the time of their launch; small dots show the location of water samples. Salinity anomaly is the difference in salinity at a given potential temperature between the average observed salinity and the standard potential temperature-salinity relation for the western North Atlantic (Worthington, personal communication).

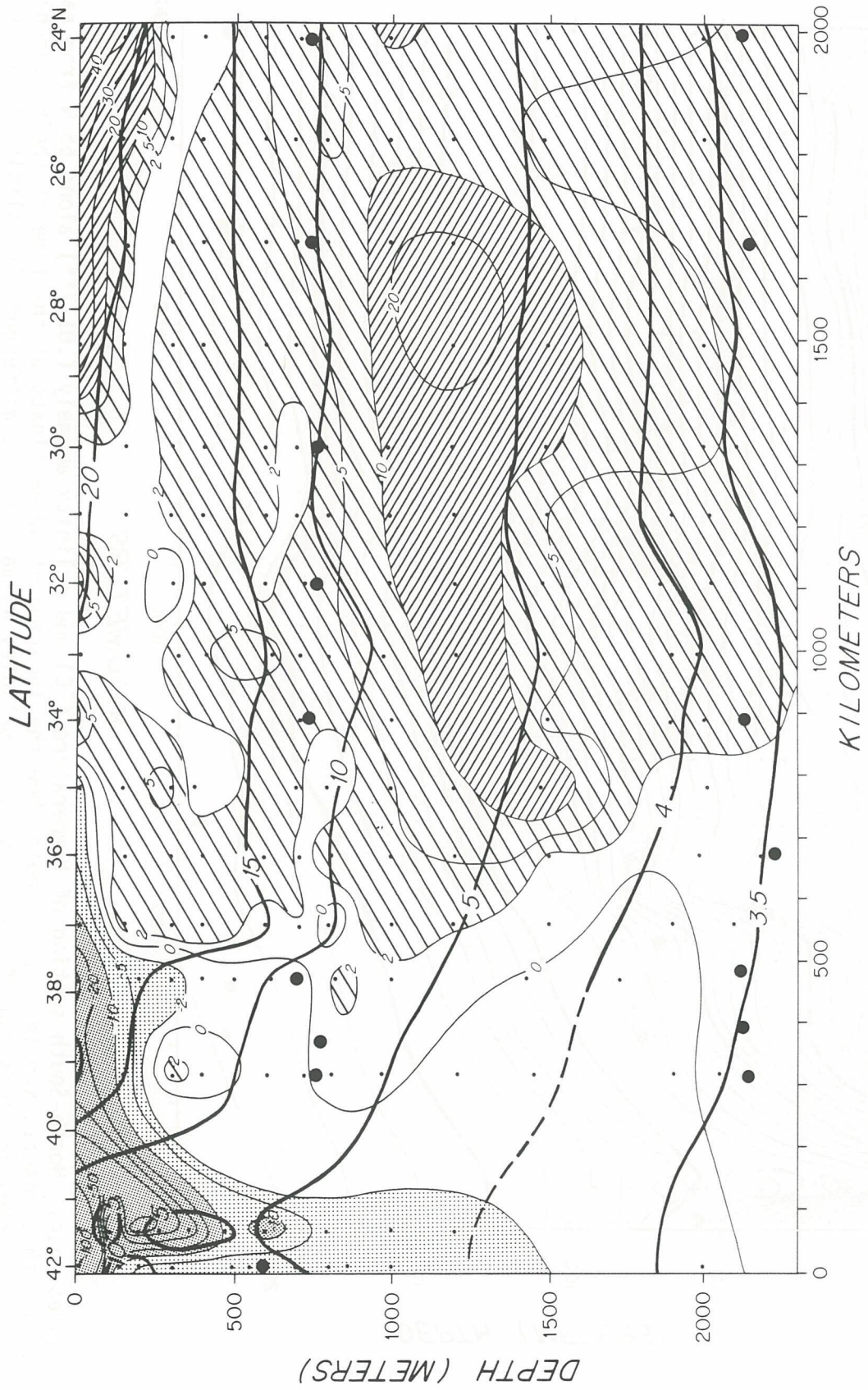


Figure 2c.

TABLE 3

FLOATS DEPLOYED IN SEPTEMBER-OCTOBER 1980

<u>700 m</u>	<u>2000 m</u>	<u>LAUNCH DATE</u>	<u>LATITUDE°N</u>	<u>LONGITUDE°W</u>	<u>REGION</u>
GU109	GU158	80 09 27	43°30'	46°04'	N Atlantic Current
GU110	GU159	80 09 29	41°51'	37°25'	N Atlantic Current
GU112*	GU161*	80 10 12	35°02'	64°54'	Recirculation

* Failed shortly after launch

In July-August 1981 (OCEANUS cruise 101) eighteen SOFAR floats were launched, two at each location (Table 4 and Figure 3). These floats comprise the second setting. An XBT section, made along 55°W during the second setting, is shown in Figure 4. An XBT section across the Gulf Stream and launch location of float GU120 is shown in Figure 5. All seven ALS instruments were recovered and five were reset. There was no replacement at mooring G and there was a premature release at site D during launch and this instrument was not remoored.

TABLE 4

FLOATS DEPLOYED IN JULY-AUGUST 1981

<u>700 m</u>	<u>2000 m</u>	<u>LAUNCH DATE</u>	<u>LATITUDE° N</u>	<u>LONGITUDE° W</u>	<u>REGION</u>
GU113	GU162	81 08 07	41°59'	55°05'	Slope water
GU114	GU163	81 08 06	40°47'	54°55'	Gulf Stream
GU115	GU164	81 08 06	40°30'	55°00'	Gulf Stream
GU116	GU165	81 08 05	37°17'	54°58'	Recirculation
GU117	GU166	81 08 05	36°00'	55°00'	Recirculation
GU118	GU167	81 08 04	32°59'	55°00'	Sargasso Sea
GU119	GU168	81 08 02	27°01'	55°01'	Sargasso Sea
GU121	GU170	81 07 12	35°02'	65°00'	Recirculation
GU120	GU169	81 07 11	37°42'	68°40'	Gulf Stream

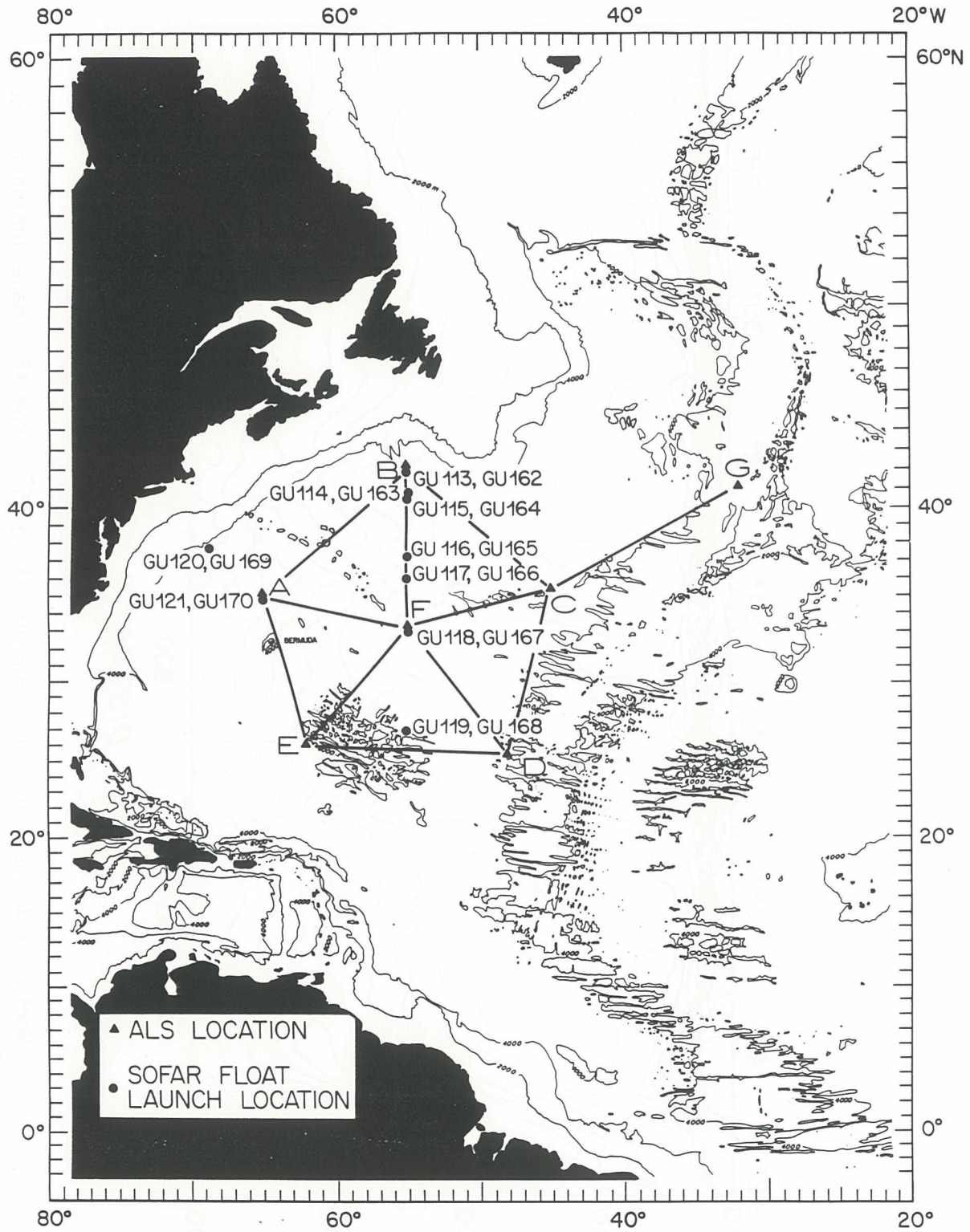


Figure 3. ALSs A, B, C, E, and F were removed in July–August 1981 and eighteen floats were launched. Floats GU113 through GU121 are 700 m floats; GU162 through GU170 are 2000 m floats.

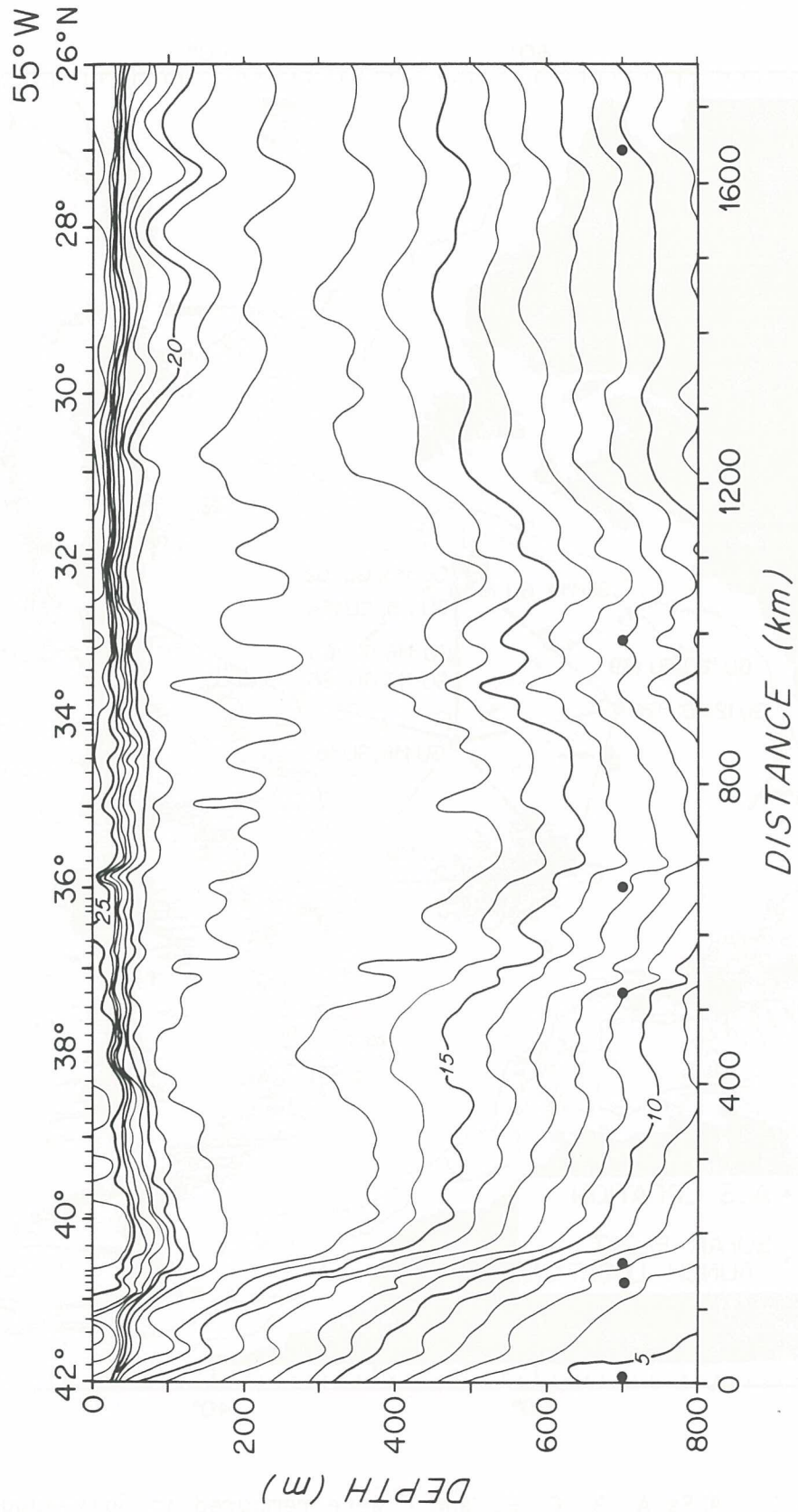


Figure 4. North-South section of temperature along 55°W from XBTs made during the second setting. Dots shown the location of shallow SOFAR floats at launch.

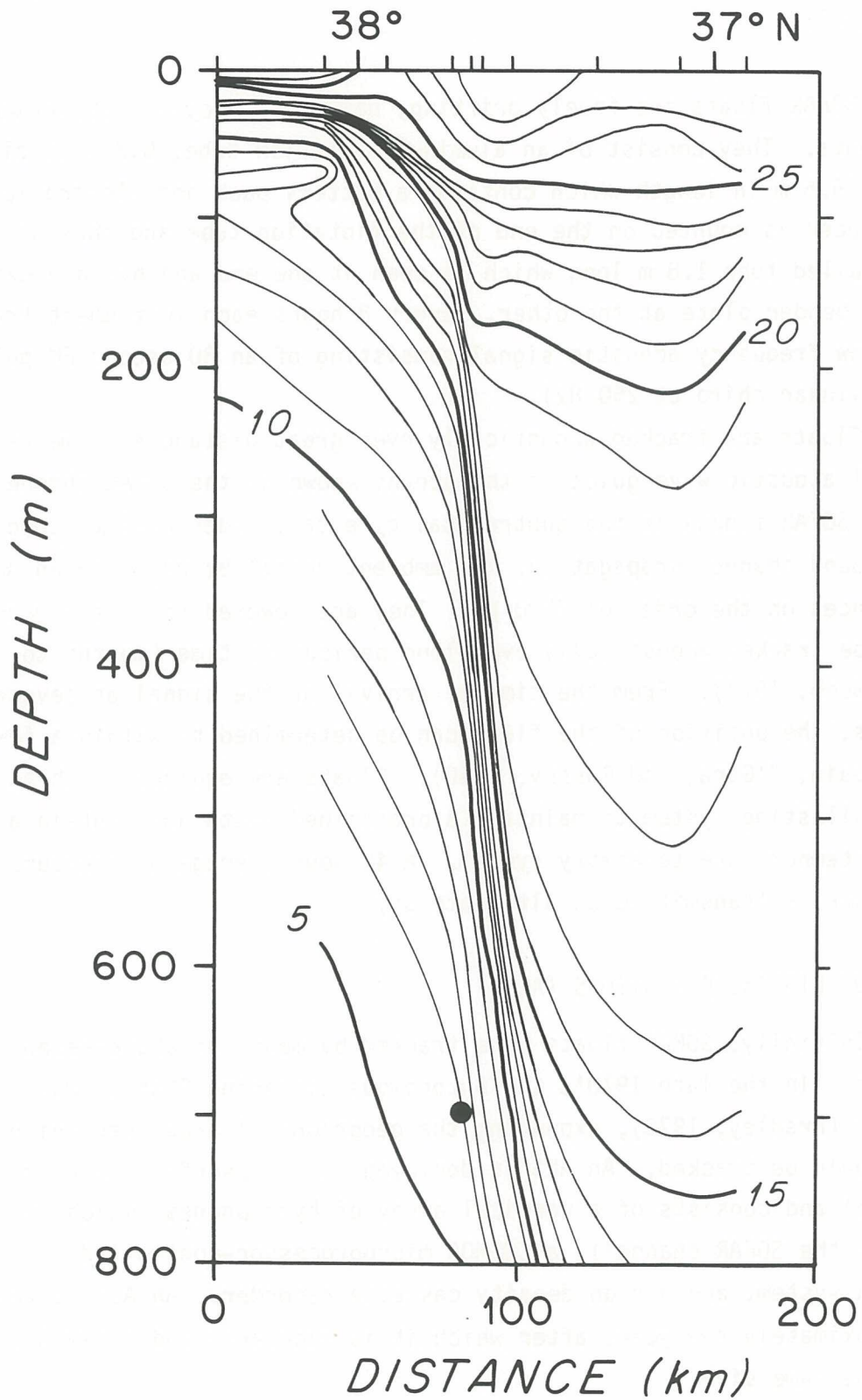


Figure 5. A section of temperature across the Gulf Stream near $37^{\circ}42'N$, $68^{\circ}40'W$, the launch location of SOFAR floats GU120 and GU169.

SOFAR FLOATS

SOFAR floats are freely drifting, neutrally buoyant subsurface instruments. They consist of an aluminum flotation tube, 0.3 m in diameter and 5.5 m in length which contains a battery pack and electronics. A transducer is mounted on the end of the flotation tube and consists of a thin walled tube 1.8 m long which is open at one end and has a piezoelectric bender plate at the other. Every 8 hours each instrument transmits a low frequency acoustic signal consisting of an 80 second FM pulse (1.5 Hz linear chirp at 250 Hz).

Floats are tracked acoustically over great distances by means of a natural acoustic wave guide in the oceans known as the SOFAR channel. Standard SOFAR floats in the subtropical gyre can, under optimal conditions (sound channel propagation, low ambient noise) be heard by an ALS at distances on the order of 2500 km. They are powered to last 2 years and can be tracked acoustically over long periods of time (months to years) (Webb, 1977). From the time of arrival of the signal at several receivers, the position of the float can be determined to within a few miles (Spain, O'Gara, and Rossby, 1980). Floats are equipped with an active ballasting system to maintain a prescribed depth and contain a pressure/temperature telemetry system. A 48 hour average of pressure or temperature is transmitted on alternate days.

AUTONOMOUS LISTENING STATIONS (ALSs)

Initially, SOFAR floats were tracked by means of shore-based receivers. In the late 1970's the Autonomous Listening Station was developed (Bradley, 1978), expanding the geographical area over which floats could be tracked. An ALS is deployed on a subsurface mooring (Figure 6) and consists of a vertical array of hydrophones (which is placed in the SOFAR channel), a COSMOS microprocessor-controlled detection system, and a high density cassette recorder. An ALS is moored for approximately one year, after which it is recovered and a new ALS is set at the same site.

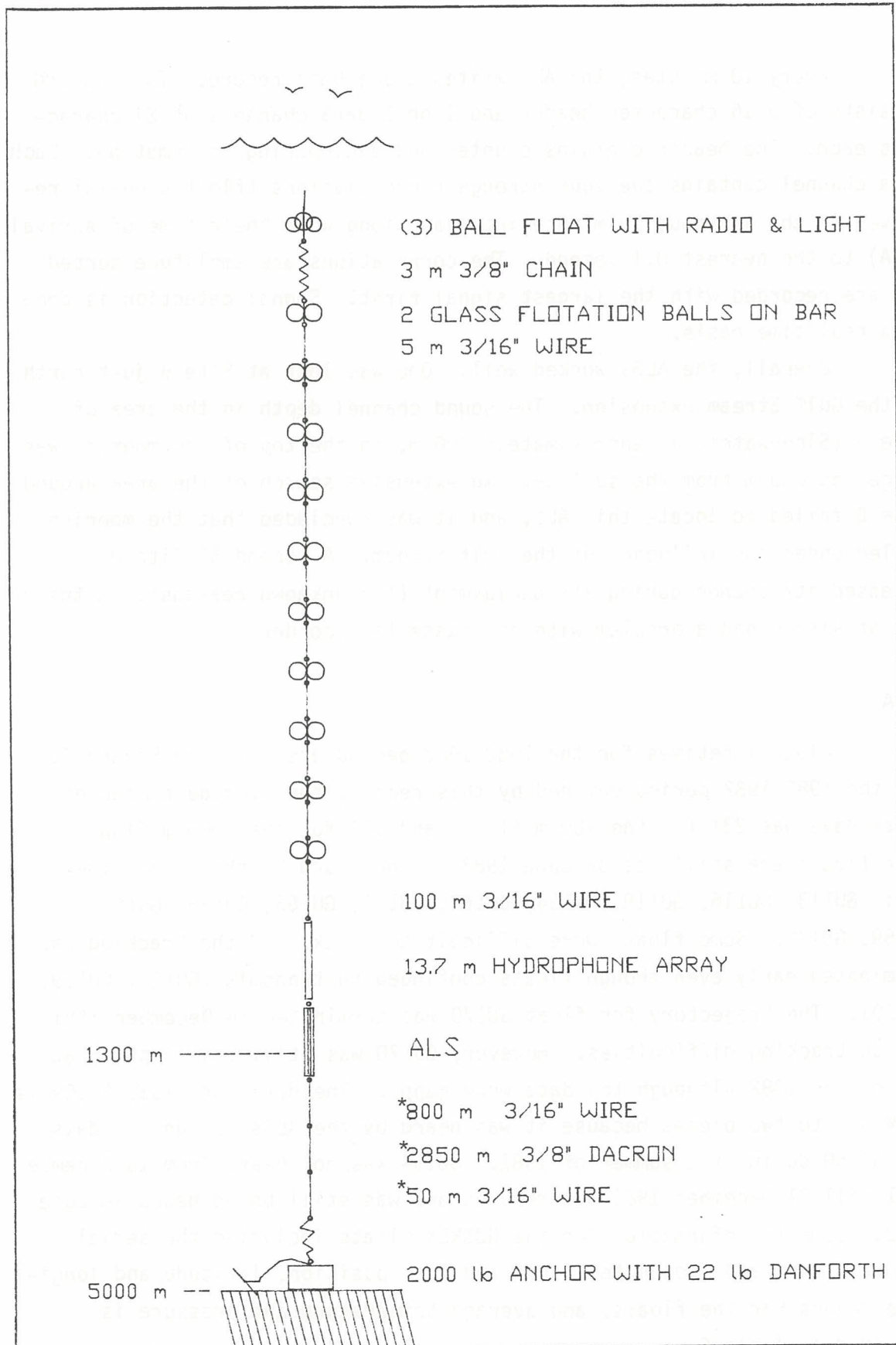


Figure 6. Typical ALS mooring configuration (not to scale) for a water depth of 5000 m and a sound channel depth of 1300 m. *These lengths vary for each ALS location.

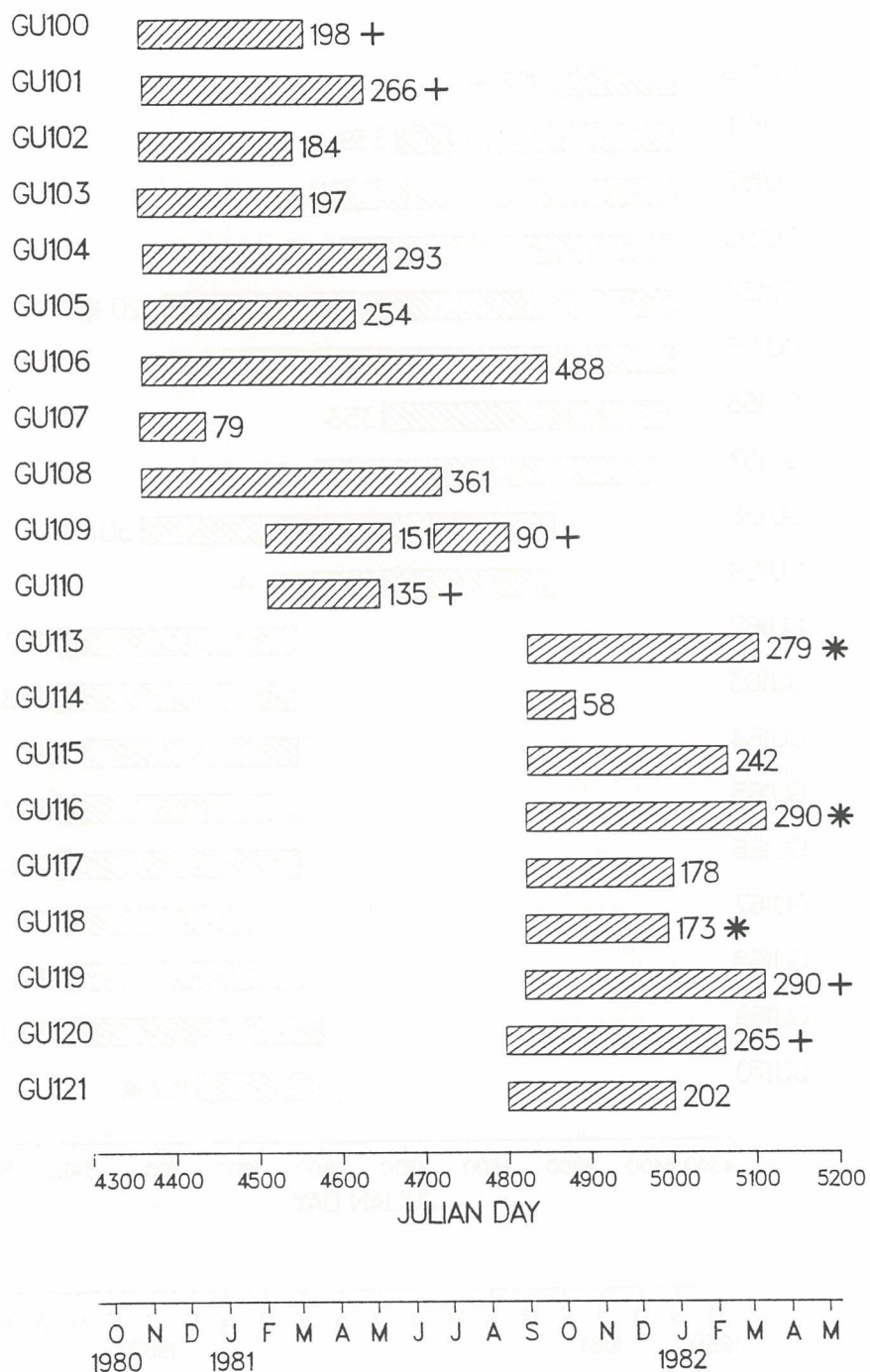
Every 10 minutes, the ALS writes a Sea Data record. This record consists of a 16 character header and 1 or 2 data channels of 24 characters each. The header contains counter and engineering information. Each data channel contains the four strongest correlations (float signals) received in the previous 10 minute interval along with their time of arrival (TOA) to the nearest 0.1 second. The correlations are amplitude sorted and are recorded with the largest signal first. Signal detection is done on a real time basis.

Overall, the ALSs worked well. One was lost at Site B just north of the Gulf Stream extension. The sound channel depth in the area of Site B (Slopewater) is approximately 700 m, so the top of the mooring was placed at 600 m from the surface. An extensive search of the area around Site B failed to locate this ALS, and it was concluded that the mooring failed under the influence of the Gulf Stream. A second at Site D released its anchor during its deployment (for unknown reasons). A third ALS at site E had a problem with its cassette recorder.

DATA

Float lifetimes for the 1980-1982 period are shown in Figure 7. For the 1980-1982 period covered by this report, the average number of float days was 231 for the 700 m floats and 344 for the 2000 m floats. Some floats are still (as of June 1982) being heard by the ALSs. These are: GU113, GU116, GU118, GU154, GU162, GU163, GU165, GU166, GU167, GU169, GU170. Some floats were difficult to track, and the tracking was terminated early even though floats continued to transmit (GU118, GU159, GU170). The trajectory for float GU170 was terminated in December 1981 due to tracking difficulties. However, GU170 was still transmitting at the end of 1982 although the data were gappy. The data for float GU109 is broken into two pieces because it was heard by the ALSs for only 2 days out of 50 during the summer of 1981. GU154 was not heard from 13 December 1981 till 31 December 1981 but resumed and was still being heard in June 1982. Summary information for the GUSREX floats including the serial number, start and stop date, first and last position, latitude and longitude ranges for the floats, and average temperature and pressure is provided in Table 5.

FLOAT LIFETIMES 700 M

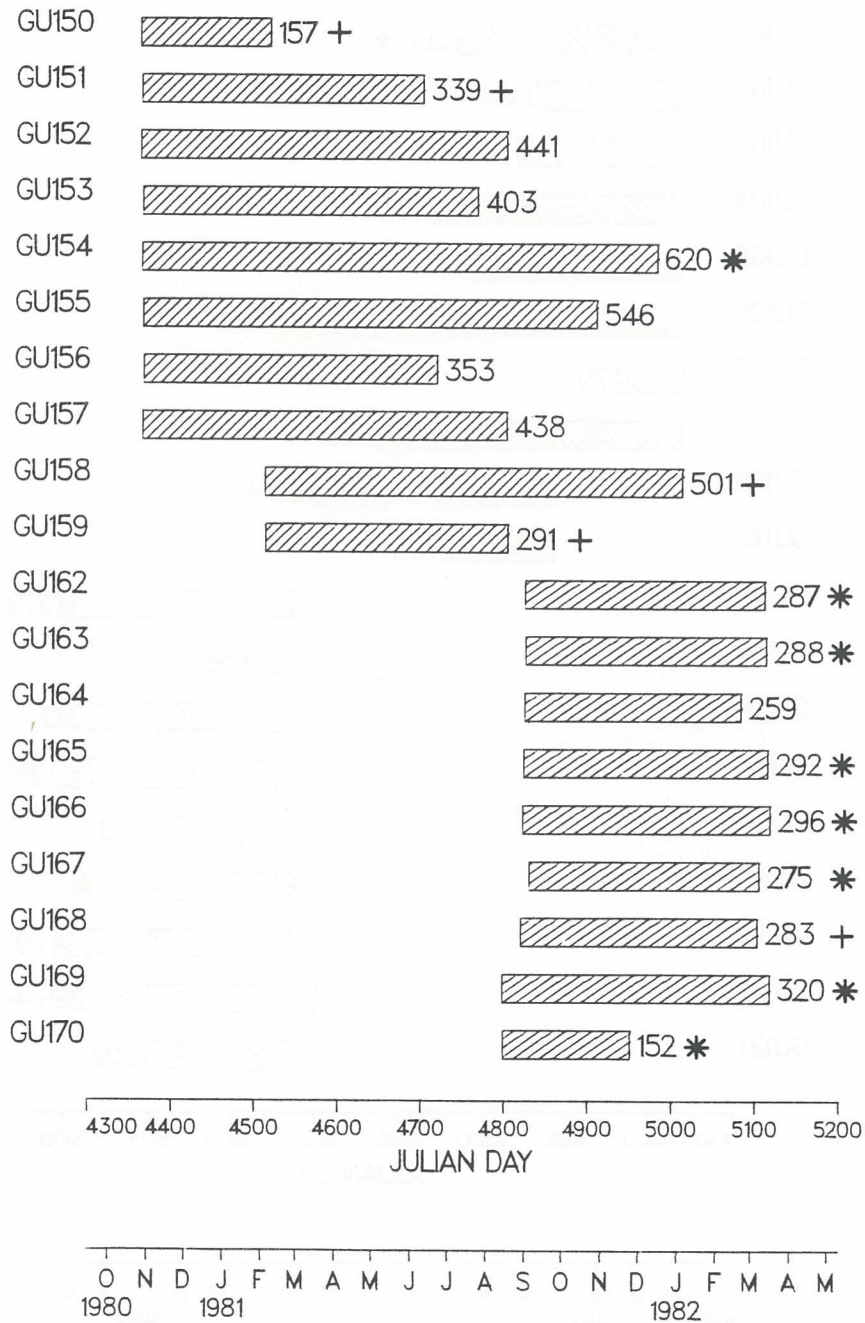


* = Still transmitting as of June, 1982

+ = Reused float

Figure 7a. Histogram of 700 m float lifetimes. First setting floats are GU100 through GU110. Second setting floats are GU113 through GU121. Some of the floats had been used previously (+) and some were still being heard by ALS as of June 1982 (*).

FLOAT LIFETIMES 2000 M



* = Still transmitting as of June, 1982
 + = Reused float

Figure 7b. Histogram of 2000 m float lifetimes. First setting floats are GU150 through GU159. Second setting floats are GU162 through GU170.

Table 5: SUMMARY TABLE OF FLOAT DATA

FLOAT ID	SERIAL NO	START DATE		END DATE		FLOAT LIFETIME DAYS		FIRST POSITION		LAST POSITION		RANGE		AVERAGES	
		CAL	JUL	CAL	JUL	LAT	LOE	LAT	LOE	LAT ^N	LOE ^W	TEMP (°C)	PRES (db)		
GU100	59	800430	4360	801114	4558	198	30.01	55.01	34.15	62.67	30:36	63:52	11.4	707	
GU101	67	800504	4364	810125	4630	266	39.01	54.59	43.77	55.33	38:45	58:52	4.5	815	
GU102	68	800430	4360	801031	4544	184	32.02	55.08	34.19	60.98	31:36	62:54	12.9	736	
GU103	70	800428	4358	801111	4555	197	23.90	55.06	23.95	53.37	22:25	56:51	10.8	707	
GU104	71	800504	4364	810221	4657	293	38.74	55.08	38.91	44.92	35:42	59:44	9.6	792	
GU105	72	800505	4365	810114	4619	254	41.92	55.05	47.09	38.88	38:48	60:38	6.5	655	
GU106	73	800502	4362	810902	4850	488	37.82	54.89	34.99	52.88	33:42	60:48	9.0	713	
GU107	74	800429	4359	800717	4438	79	27.01	55.10	26.16	58.12	26:28	59:55	11.5	719	
GU108	75	800501	4361	810427	4722	361	33.95	55.03	34.94	53.80	31:37	56:47	11.5	700	
GU109A	55	800927	4510	810225	4661	151	43.38	45.96	46.32	37.64	43:50	46:37	10.3	698	
GU109B	55	810418	4713	810717	4803	90	46.79	38.29	45.31	41.55	45:47	42:38	--	--	
GU110	56	800929	4512	810211	4647	135	41.69	37.37	42.06	39.81	40:43	40:37	8.1	675	
GU113*	87	810808	4825	820514	5104	279	42.27	55.21	42.90	59.10	36:43	65:53	--	695	
GU114	91	810807	4824	811004	4882	58	40.84	54.82	42.30	54.59	40:43	56:53	6.7	680	
GU115	89	810807	4824	820406	5066	242	40.63	54.77	43.70	41.40	38:44	55:41	9.2	695	
GU116*	90	810805	4822	820522	5112	290	37.27	54.94	34.61	43.17	33:38	59:43	10.5	692	
GU117	97	810805	4822	820130	5000	178	35.96	54.98	31.34	60.07	30:36	61:54	12.8	700	
GU118*	95	810804	4821	820124	4994	123	33.02	55.06	30.55	57.53	29:34	58:53	11.8	711	
GU119	65	810803	4820	820520	5110	290	27.01	55.06	26.64	49.95	25:29	56:49	11.4	695	
GU120	64	810711	4797	820402	5062	265	37.71	68.40	51.34	36.57	36:52	69:35	9.3	743	
GU121	96	810713	4799	820131	5001	202	34.99	64.81	38.63	71.12	32:39	75:64	11.4	785	

Serial numbers were assigned sequentially to floats as they were constructed.

* Still working as of June 1982

Table 5 (Continued)

FLOAT ID	SERIAL NO	START DATE		END DATE		FLOAT LIFETIME DAYS	FIRST POSITION		LAST POSITION		RANGE		AVERAGES	
		CAL	JUL	CAL	JUL		LAT	LO N	LAT	LO N	LAT°N	LO N°W	TEMP (°C)	PRES (db)
GU150	33	800428	4358	801002	4515	157	23.91	55.09	24.78	55.04	23:25	56:54	3.5	2115
GU151	38	800430	4360	810404	4699	339	31.93	55.09	33.89	55.72	31:35	56:53	3.1	--
GU152	77	800429	4359	810714	4800	441	26.99	55.15	28.69	54.17	26:29	57:53	3.7	2055
GU153	78	800502	4362	810609	4765	403	36.21	54.94	39.02	52.94	33:42	57:52	3.8	2082
GU154*	79	800501	4361	820111	4981	620	33.96	55.05	35.11	63.61	32:39	65:53	--	2042
GU155	80	800503	4363	811031	4909	546	39.24	54.63	35.57	62.08	34:42	64:53	3.8	2024
GU156	81	800504	4364	810422	4717	353	39.03	55.02	40.06	48.48	36:41	56:47	3.7	2176
GU157	82	800503	4363	810715	4801	438	37.78	54.87	41.51	62.31	37:44	63:50	3.5	2044
GU158	42	800928	4511	820211	5012	501	43.53	45.98	41.92	54.24	41:46	55:45	3.5	2047
GU159	43	800929	4512	810717	4803	291	41.76	37.39	42.26	38.83	40:43	40:37	3.6	2112
GU162*	86	810807	4824	820521	5111	287	41.94	55.10	38.60	58.66	34:42	63:55	3.2	2163
GU163*	83	810808	4825	820523	5113	288	40.81	54.76	38.83	48.63	38:43	55:47	3.6	2112
GU164	93	810807	4824	820423	5083	259	40.50	54.92	41.07	52.66	36:42	57:51	--	1807
GU165*	85	810806	4823	820525	5115	292	37.36	55.11	37.03	58.67	35:41	61:54	3.6	--
GU166*	92	810805	4822	820528	5118	296	35.94	55.04	35.16	59.98	35:40	60:51	--	--
GU167*	88	810813	4830	820515	5105	275	32.88	55.03	34.25	52.81	32:36	56:52	--	1994
GU168	45	810803	4820	820513	5103	283	27.02	55.05	26.48	54.41	26:28	56:54	3.7	2028
GU169*	84	810712	4798	820528	5118	320	37.65	68.53	33.30	69.12	32:38	73:68	3.5	2117
GU170*	94	810713	4799	811212	4951	152	34.89	65.09	35.76	65.54	34:36	66:64	3.7	2130

* Still working as of June 1982

The two principal modes of float failure are (1) premature sudden death - the signal stops suddenly, and (2) fading death - the signals gradually become weaker (Table 6). The fading death was traced to a shorter lithium battery life than anticipated. All first setting floats and four second setting floats were powered with lithium batteries. These floats had been recovered during the LDE and were reused in GUSREX (without repowering, in order to reduce costs). The rest (15) of the floats were powered with alkaline batteries, and only one of these faded. The premature sudden death appears to strike preferentially the 700 m floats. The cause of this failure mode is unknown at present, but being investigated.

Of the first setting floats, deployed along 55°W, one float (GU154) did not transmit temperature and one (GU151) remained offscale deep. Float GU109B had spotty temperature and pressure values. Of the floats launched in 1981, one shallow (GU113) and three deep (GU164, GU166, GU167) failed to transmit temperature. Float GU162 was very gappy. GU166 failed to transmit pressure and GU165 was offscale deep.

DATA PROCESSING

Processing at the University of Rhode Island

Initial data processing and float tracking were done at URI under the supervision of H. T. Rossby. This consisted of subdividing the ALS records into individual float files. The signals for an individual float were extracted from the ALS data, and the floats were tracked in two steps. First, the three ALSs which best surrounded a float geographically were used to track it hyperbolically, giving a series of positions and the time that the float emitted the tracking signal. These signaling times were used to obtain an initial offset and drift rate for the float's clock. Then, the best pair of receivers were used to track the float with circular (range-range) navigation using the clock corrections and speed of sound corrections.

The tracking procedure during GUSREX was identical to that used for previous SOFAR float experiments and described by Spain, O'Gara, and Rossby (1980). The three daily times of arrival (TOA) of each SOFAR

TABLE 6
SUMMARY OF FLOAT MORTALITY

Depth	Battery	Number Launched	Number Sudden Deaths	Number Fading Death
700	L	16	9	4
700	A	7	3	0
2000	L	13	3	7
2000	A	8	1	1

L = lithium

A = alkaline

Sudden death occurs when a float stops transmitting suddenly over one day. Fading death occurs when a float's signal decreases in correlation height over many days.

float's acoustic signal were low passed filtered and smoothed using a least squares polynomial fit averaged over 11 observations (3 2/3 days) which corresponds to a half power of 1.5 days. Float positions were obtained from the smoothed TOAs using range-range tracking. The final float trajectories were then smoothed with a filter similar to that used on the TOA's. A "master position" tape containing individual float trajectories smoothed to 3 positions per day was prepared and sent to Woods Hole Oceanographic Institution (WHOI) and this was used for our subsequent processing and data reduction. Table 7 describes the format of one day of float data as it appears on the URI master position tape. For each position, a smoothed velocity and 48 hour average of temperature and pressure are included. Temperature and pressure, telemetered from the float on alternate days (Spain et. al., 1980) appear with the positions for those days. These data have been presented in two informal reports prepared by the URI SOFAR Float Group (Line Experiment FLoats 1980-1981, Line Experiment FLoats 1980-1982, Preliminary Data Report).

Processing at Woods Hole Oceanographic Institution

In order to use the float data to make reasonable calculations of eddy kinetic energy, variances, and vertical velocities, the data were carefully reviewed for correctness. Tests on various methods of smoothing, subsampling, and filtering the data were performed to determine how the data set would be processed. Analysis of the results indicated that the best basic data set would include one position for each day, since the smoothing already done on the tracks had eliminated frequencies higher than a day (inertial and tidal). The velocity components would be derived from the daily fixes using a cubic spline curve fit. This method produced velocities that are different from the URI velocities which are smoothed independently of the positions. The 48 hour average temperature and pressure, transmitted by the float on alternate days were selected rather than the smoothed temperature and pressure provided with the URI format.

Basic processing was accomplished using a series of routines written by Roger Goldsmith and Terry McKee, known as the FLOATER programs. The initial program, REFORM, reads and reformats the data into VAX ASCII

Table 7: Description of URI Master Position Tape Data Format.

TAPE FOR DISTRIBUTION OF FLOAT TRACKS - University of Rhode Island

Tape characteristics:

800 BPI

ASCII

Lateral parity bit ignored (i.e. neither even nor odd parity)

Tape format - 3 records per float per day - tape ordered by float number and within float by day.

Record No. 1 FORMAT(12F10.3)

1. Latitude at 0000Z
2. Longitude at 0000Z
3. Latitude at 0800Z
4. Longitude at 0800Z
5. Latitude at 1600Z
6. Longitude at 1600Z
7. U at 0000Z
8. V at 0000Z
9. U at 0800Z
10. V at 0800Z
11. U at 1600Z
12. V at 1600Z

Latitude and longitude are given in degrees and decimal degrees. North and east are positive, and south and west are negative. Velocity is in centimeters per second. Missing data is assigned 999.0.

Record No. 2 FORMAT(9F10.3)

1. Temperature at 0000Z
2. Pressure at 0000Z
3. Temperature at 0000Z
4. Pressure at 0000Z
5. Temperature at 0000Z
6. Pressure at 0000Z
7. Actual temperature (on temperature days only)
8. Actual pressure (on pressure days only)
9. Telemetry transmission time

Temperature is given in degrees Centigrade. Pressure is given in decibars. Missing data is assigned -1.0. Transmission time is in seconds.

Record No. 3 FORMAT(8I6,6F10.3,2I6)

1. Float number
2. Julian day
3. Security code of operator who prepared the track
4. Julian day float was tracked
5. Record No. of clock correction in TCKTCK file (used only since 4520)
6. Doppler flag (1=Doppler correction used, 0=not used (used only since 4520))
7. Number of points used to smooth for positions (used only since 4520)
8. Number of points used to smooth for telemetry (used only since 4520)
9. Temperature rate of change at 0000Z
10. Pressure rate of change at 0000Z
11. Temperature rate of change at 0800Z
12. Pressure rate of change at 0800Z
13. Temperature rate of change at 1600Z
14. Pressure rate of change at 1600Z
15. Not used
16. Interpolated signal time of arrival flag

Rates of change are per day. Missing data for rates of change is assigned 999.0. If signal time of arrival was interpolated, bit 3=1 for 0000Z, bit 2=1 for 0800Z, and bit 1=1 for 1600Z.

End of file is indicated by a float number of -1 (first variable of record No. 3), followed by an EOF mark.

files, one for each float, in FLOATER format. In this form, the data is easy to access, manipulate, edit and back up. The raw files were then passed through a sub-sampler, SSFDIF, that subsampled the first of the original 3 daily positions and recalculated the east and north components of velocity based on a 24 hour interval. First differences between consecutive temperature and pressure values were calculated. Listings of these derived values were produced along with preliminary trajectory and time series plots. These were reviewed to identify and eliminate erroneous data. Unreasonably high speeds were used to identify bad positions. Radical changes in temperature that were not accompanied by a similar change in pressure (or vice versa) usually indicated a bad value. Temperature and pressure values that drifted outside the range of the sensors were also defined as bad. These points were removed by an editing program, FLEDIT, and flagged as gaps in the data. Gaps of less than ten days duration in position, temperature and pressure were then linearly interpolated. Daily values of temperature and pressure were interpolated from the bi-daily values recorded. Files with gaps of greater than ten days in position information were broken into sub files (GU109, GU154). These series were plotted and reviewed once again for incongruities. Program FFSPLINE then fit a cubic spline to the float positions and recomputed the east and north components of velocity based on the bias and slope of consecutive positions.

CALCULATION OF VERTICAL VELOCITY

Vertical velocity of water was calculated from the float data using the following temperature equation:

$$\frac{\delta T_n}{\delta t} + w \frac{\delta T}{\delta z} = 0$$

or,

$$w = \frac{-\frac{\delta T_n}{\delta t}}{\frac{\delta T}{\delta z}}$$

where

w = vertical velocity of water

$\frac{\delta T}{\delta t}_n$ = time rate of change of temperature at the nominal pressure level (n)

$\overline{\frac{\delta T}{\delta z}}$ = mean temperature gradient

The nominal pressure levels for the floats are: 700 m, 1300 m, 1500 m, and 2000 m. Values for $\overline{\delta T/\delta z}$ were calculated using data from the Climatological Atlas of the World Ocean by Sydney Levitus (NOAA Professional Paper 13) with $\delta z = 200$ m, e.g.

$$\overline{\frac{\delta T}{\delta z}}_{700 \text{ m}} = \frac{T_{600} - T_{800}}{200 \text{ m}}$$

The Levitus Atlas provided $1^\circ \times 1^\circ$ resolution, and $\overline{\delta T/\delta z}$'s for a particular location were interpolated. At locations where there were no values for the mean temperature gradient (i.e., near coasts) the value of the previous (in time) gradient was used in calculations. Actual conditions encountered by a float could produce a $\delta T/\delta z$ that is significantly different from a gradient which is given by the Levitus Atlas data and thus calculated vertical water velocities could be in error.

Temperature was corrected to the nominal pressure level using:

$$T_n = T_o + (P_o - P_n) \frac{\delta T}{\delta z}$$

T_o = observed temperature by a float

P_o = observed pressure by a float

P_n = nominal pressure level

then $\delta T/\delta t$ was calculated as the simple difference

$$\frac{\delta T_n(i)}{\delta t} = \frac{T_n(i+1) - T_n(i-1)}{2\Delta t} \quad i = 2, 3, 4, \dots$$

The float data was smoothed to one measurement per day. Note that if pressure or temperature was missing, then vertical velocities and vertical displacements could not be calculated.

SOFAR floats are nearly isobaric rather than isopycnic, and hence a float track is not an exact water particle path. Variations in measured temperature and pressure suggest that floats in the thermocline move vertically about one third of the deflection of the thermocline. For example, if the thermocline were to descend 300 m a float would descend about 100 m (depending on the actual vertical temperature and density gradients). Relative to the descending water, the float would rise about 200 m. The 2000 m floats remain more nearly isobaric because the vertical temperature and density gradients are much weaker at this depth.

SUMMARY FIGURES

The following figures summarize the SOFAR float data for the periods 1980-1982. Note, arrows are drawn every 30 days for trajectory plots. All plots are mercator projections.

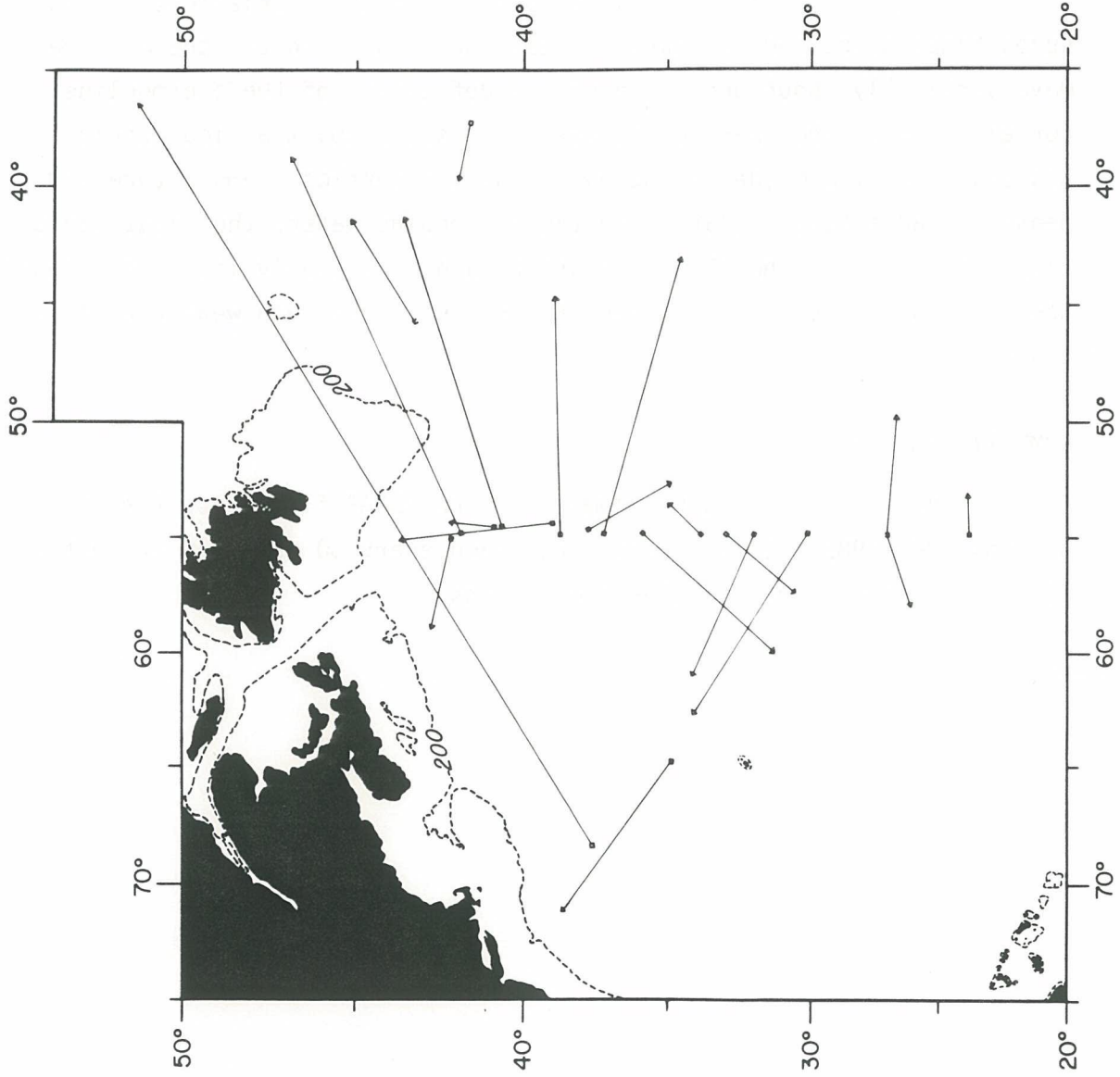


Figure 8. Vector plot of 700 m floats. Small squares (□) denote the launch positions, arrowheads (▶) the last position.

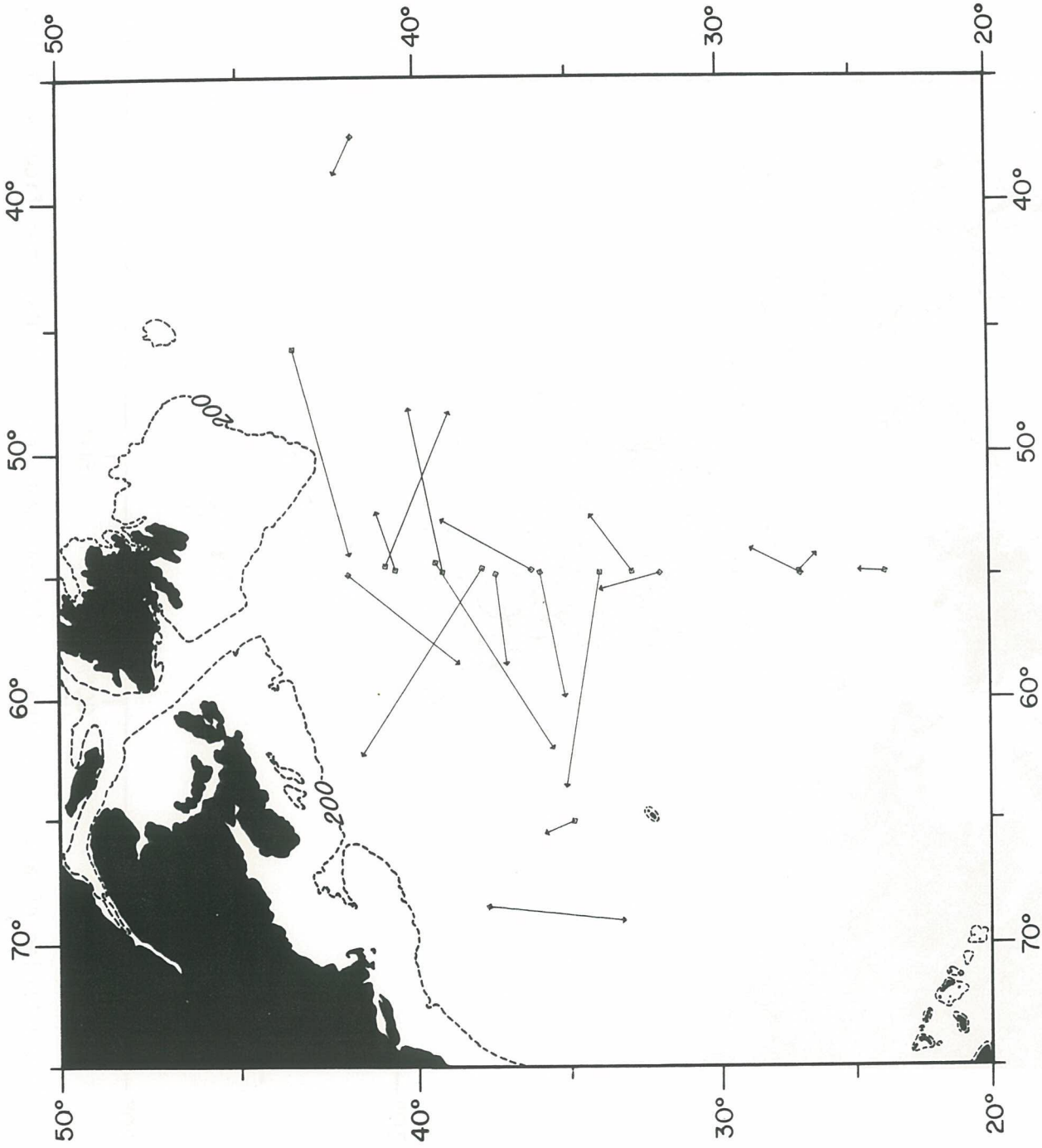


Figure 9. Vector plot of 2000 m floats. Small squares (\square) denote the launch locations, arrowheads (\blacktriangleright) the last position.

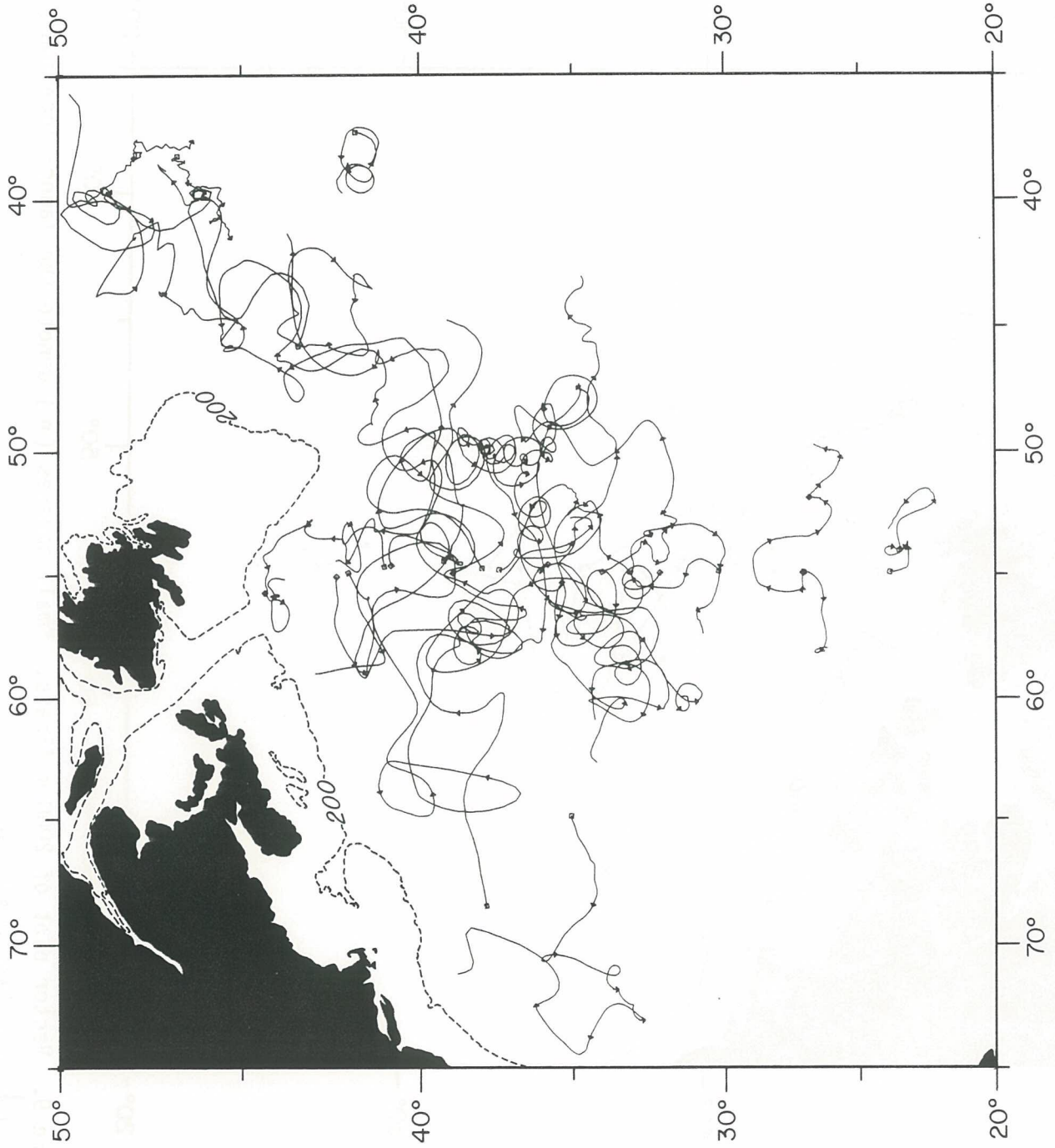


Figure 10. Trajectories of all 700 m floats. (Arrows mark every 30 days for figures 10 through 21.)

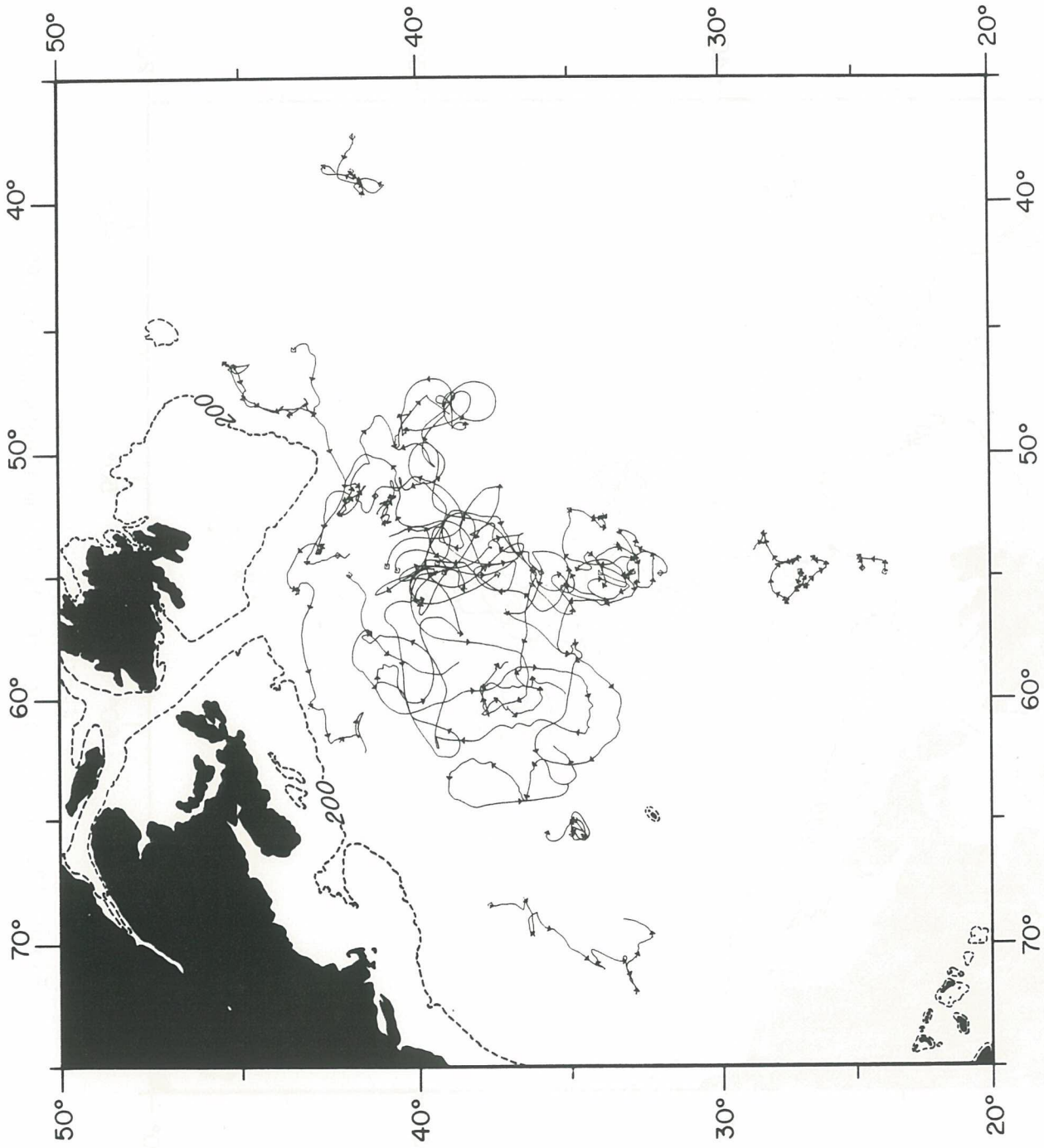


Figure 11. Trajectories of all 2000 m floats.

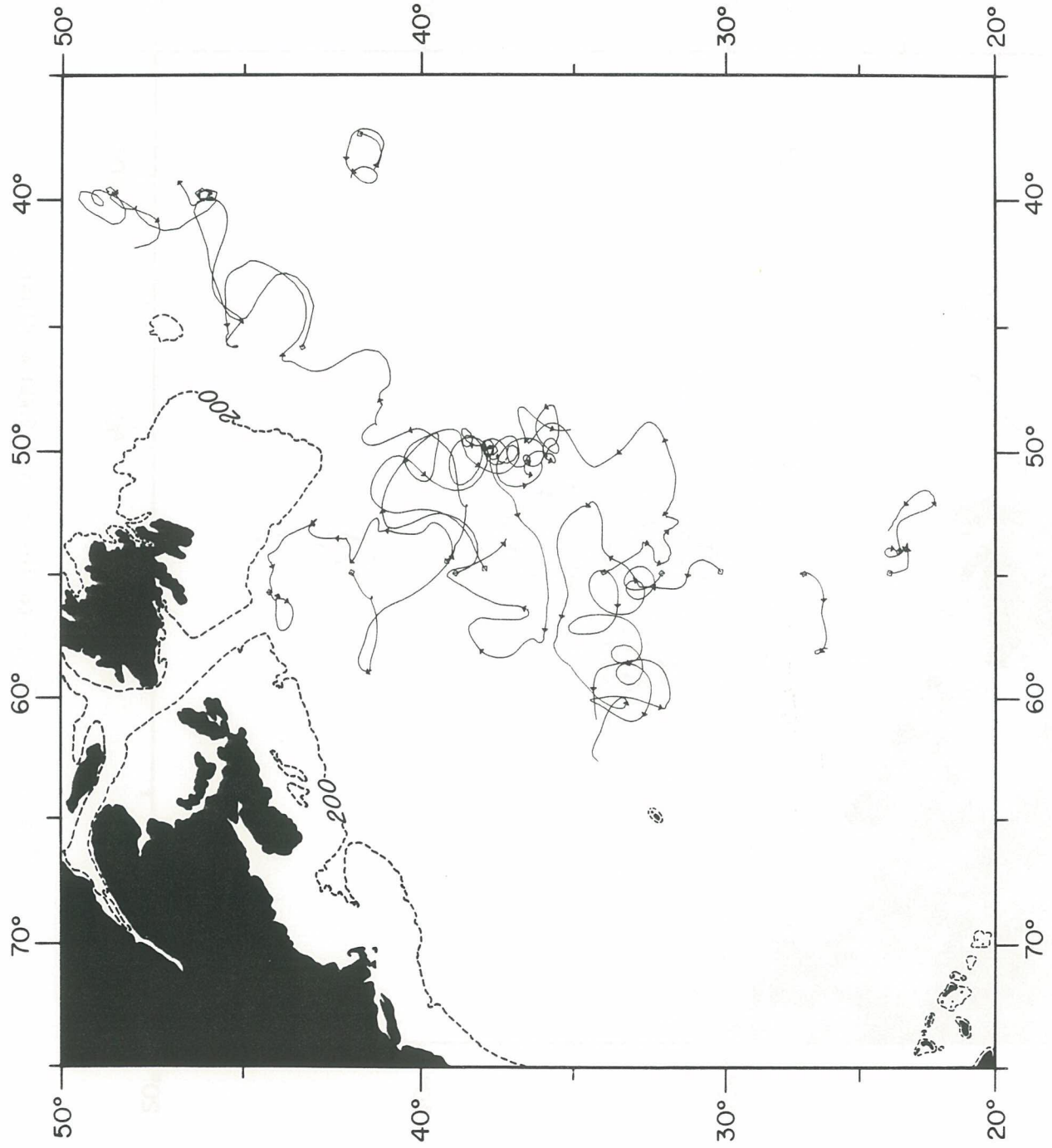


Figure 12. Trajectories of all 700 m floats during 1980.

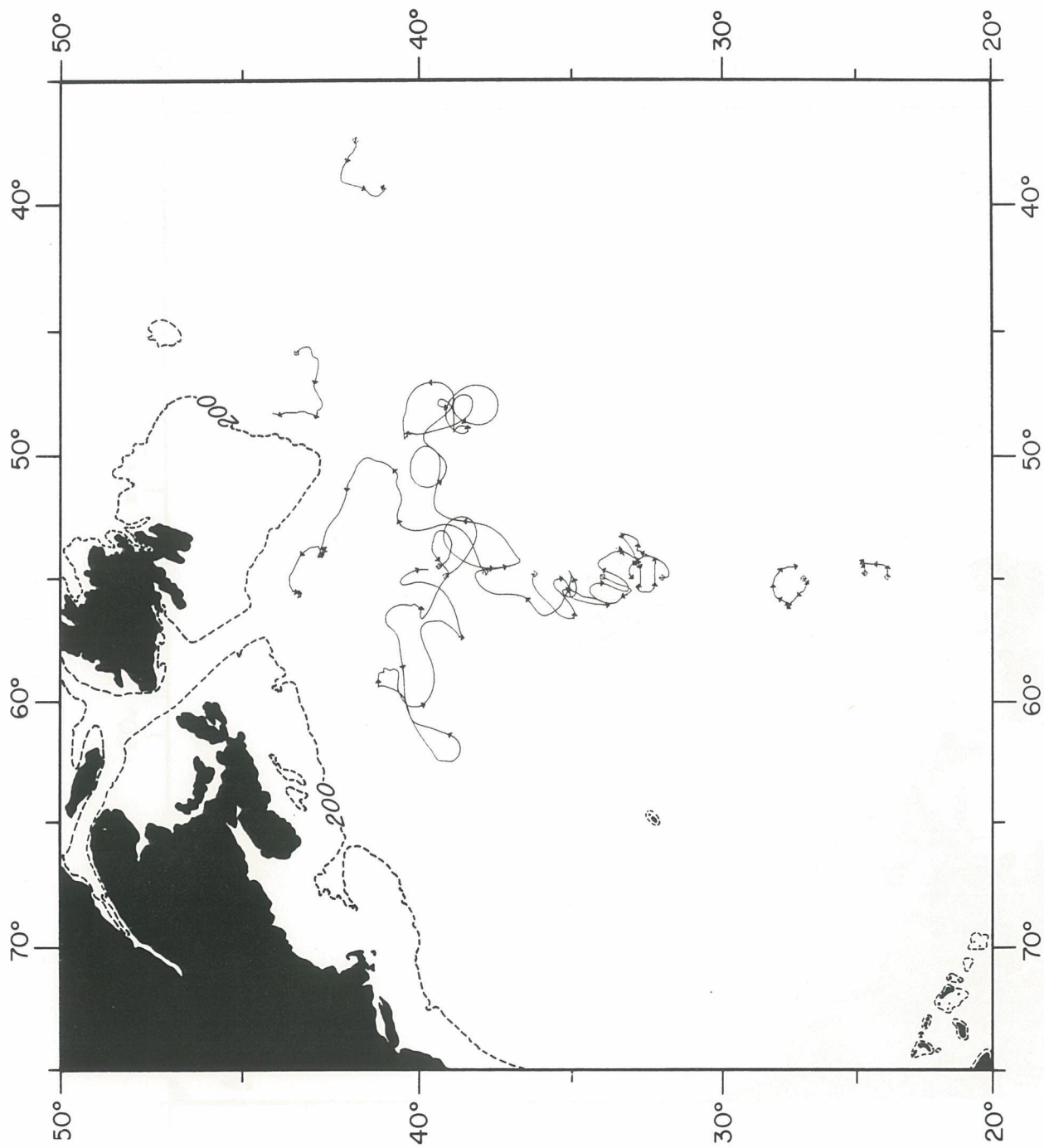


Figure 13. Trajectories of 2000 m floats during 1980.

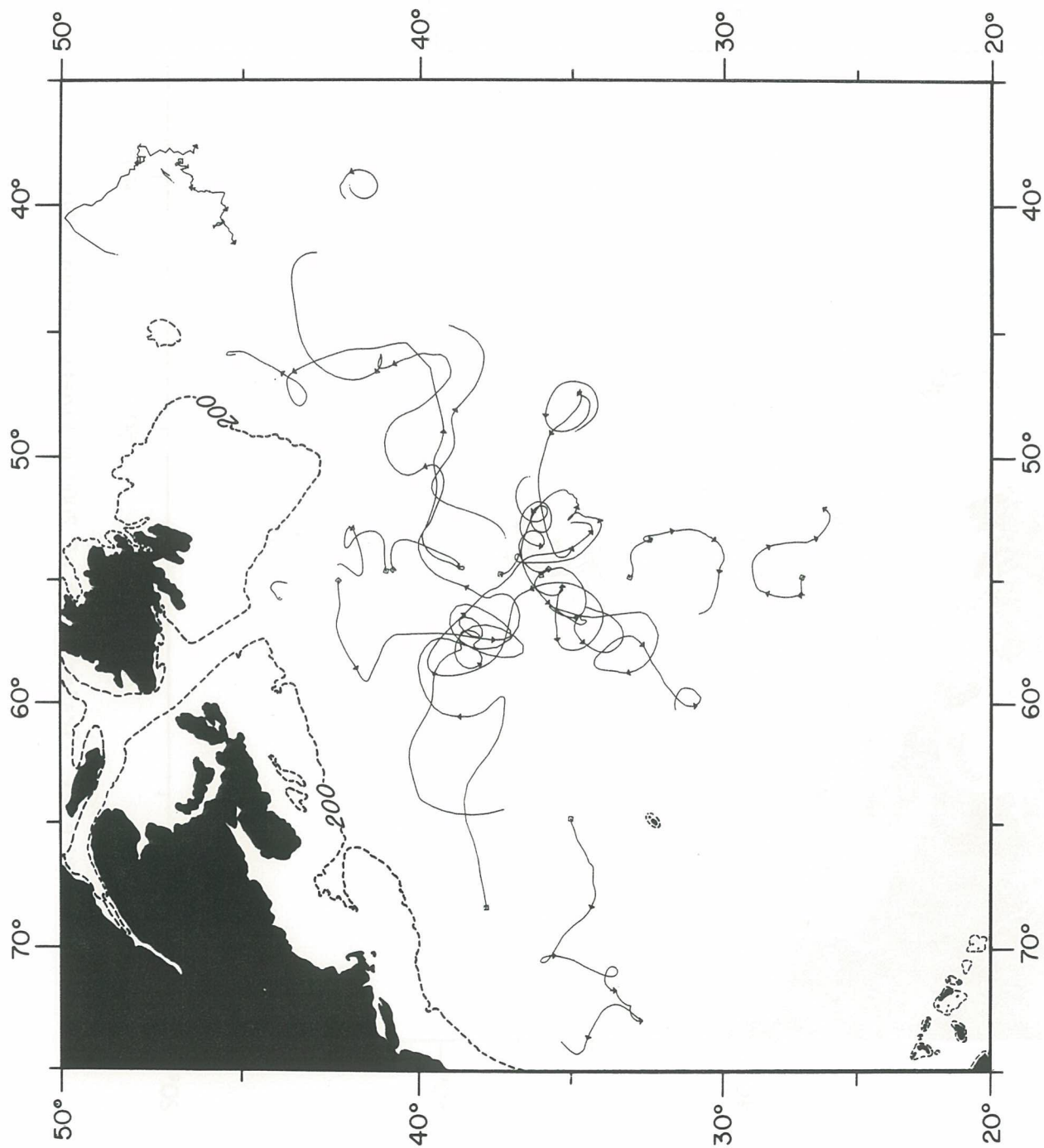


Figure 14. Trajectories of 700 m floats during 1981.

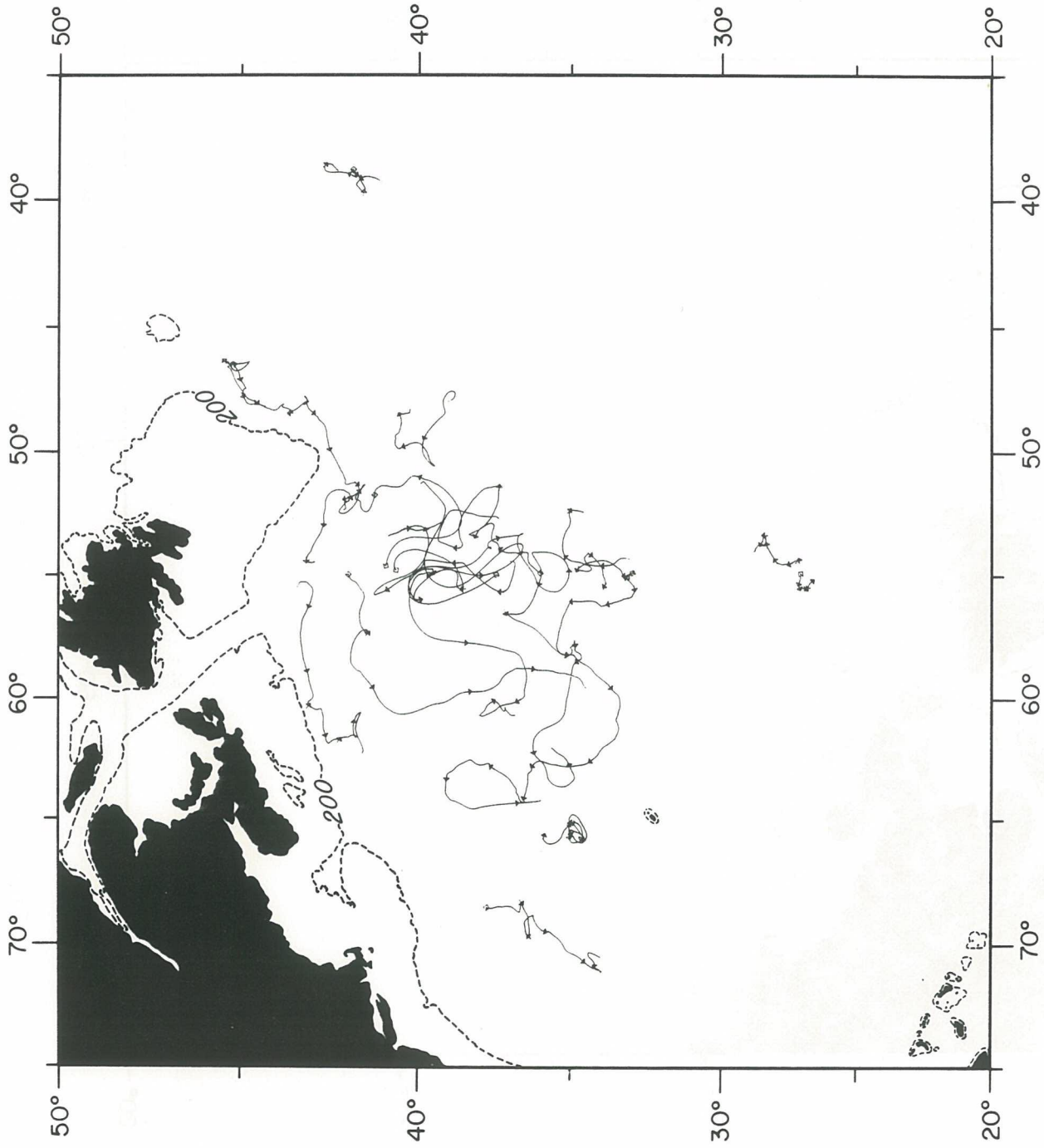


Figure 15. Trajectories of 2000 m floats during 1981.

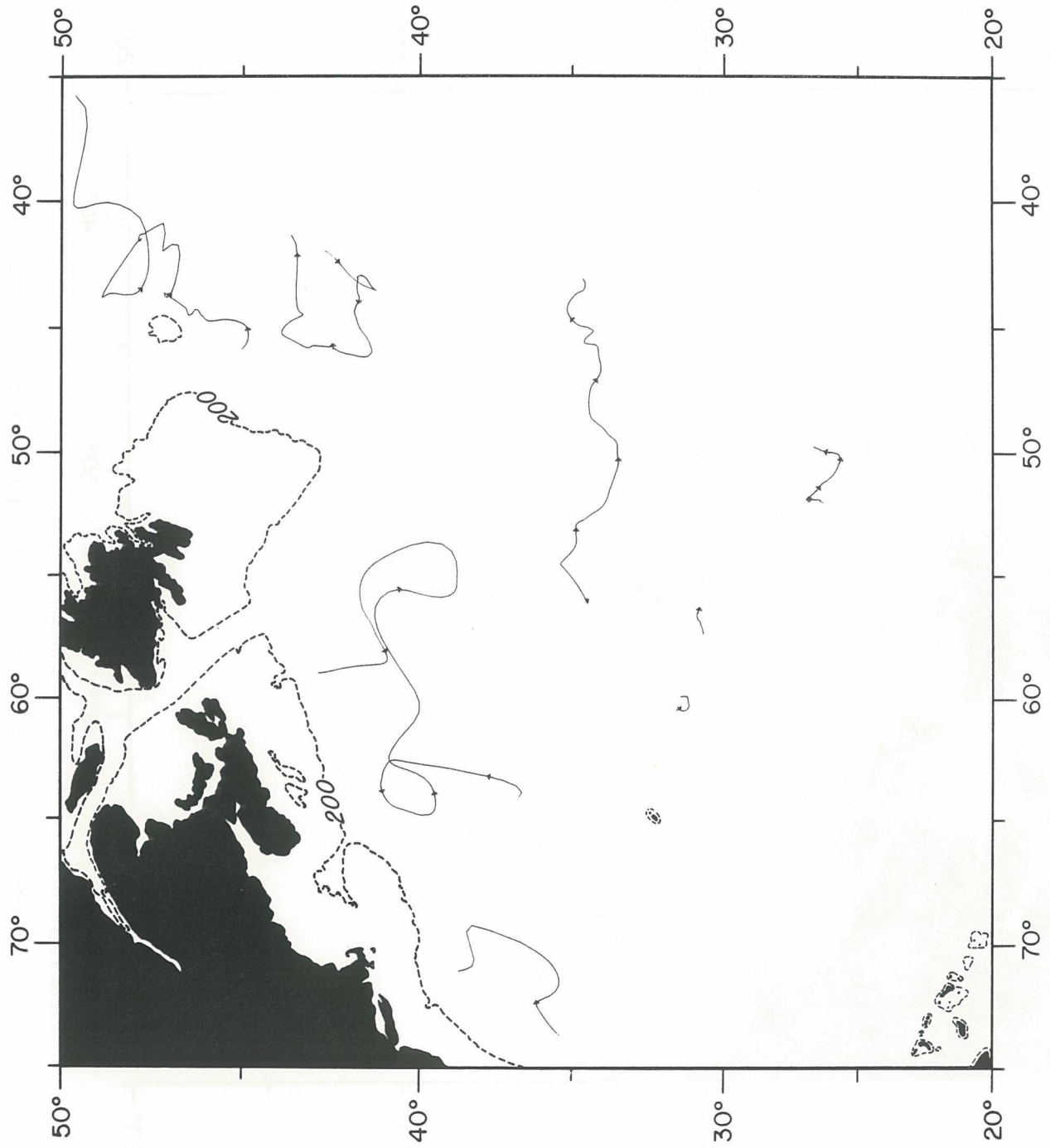


Figure 16. Trajectories of 700 m floats during 1982.

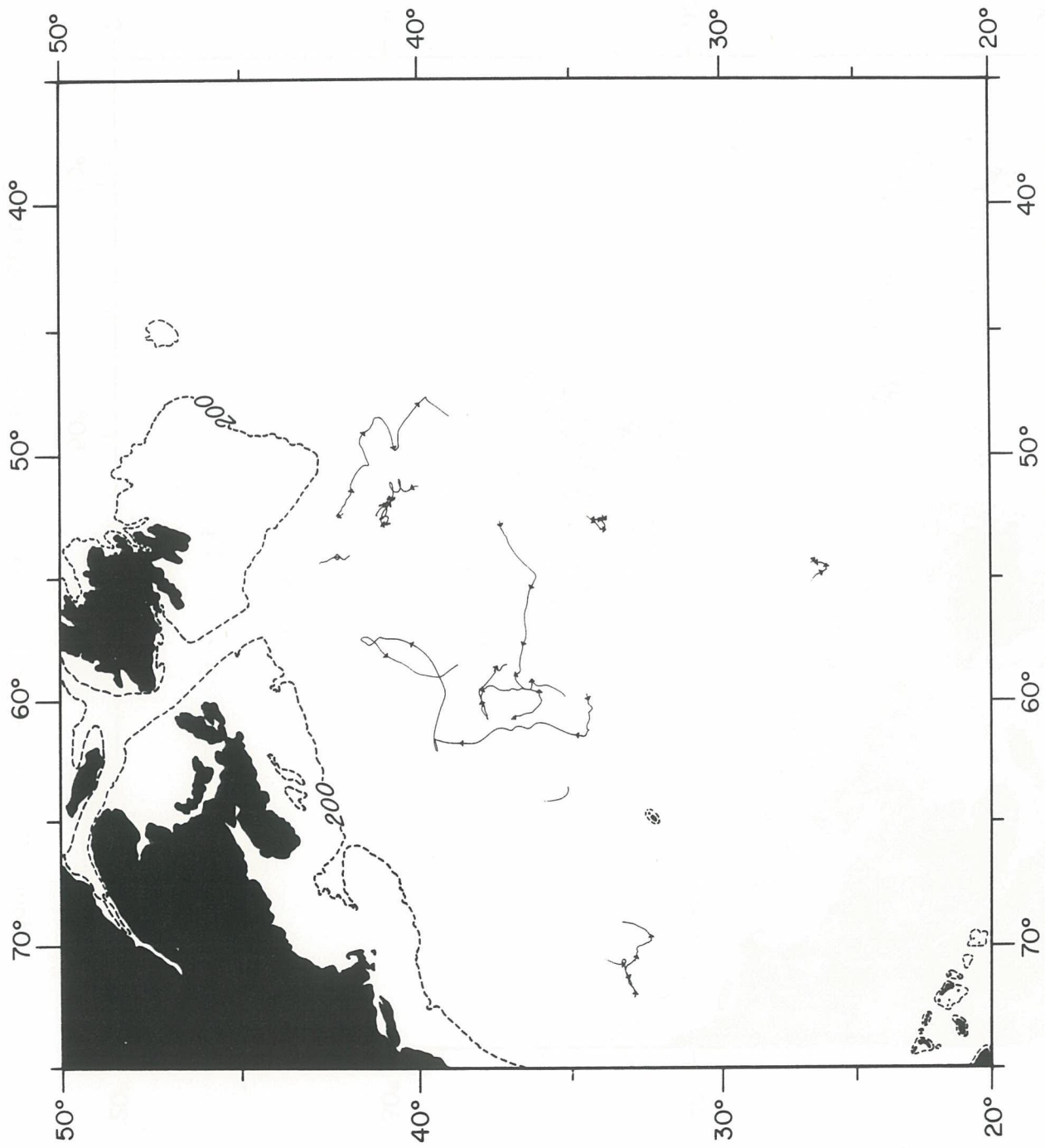


Figure 17. Trajectories of 2000 m floats during 1982.

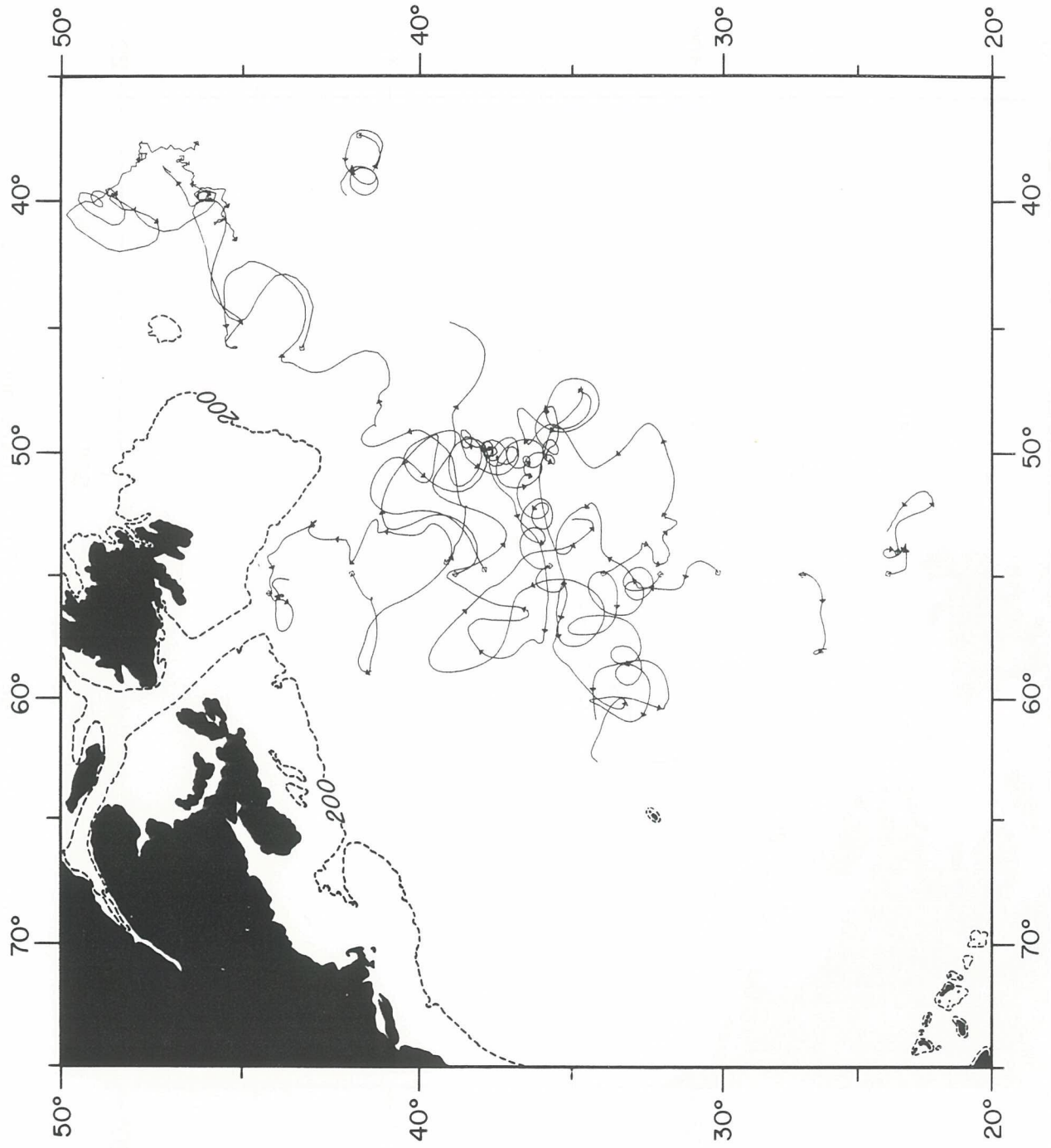


Figure 18. Trajectories from 700 m floats, first setting.

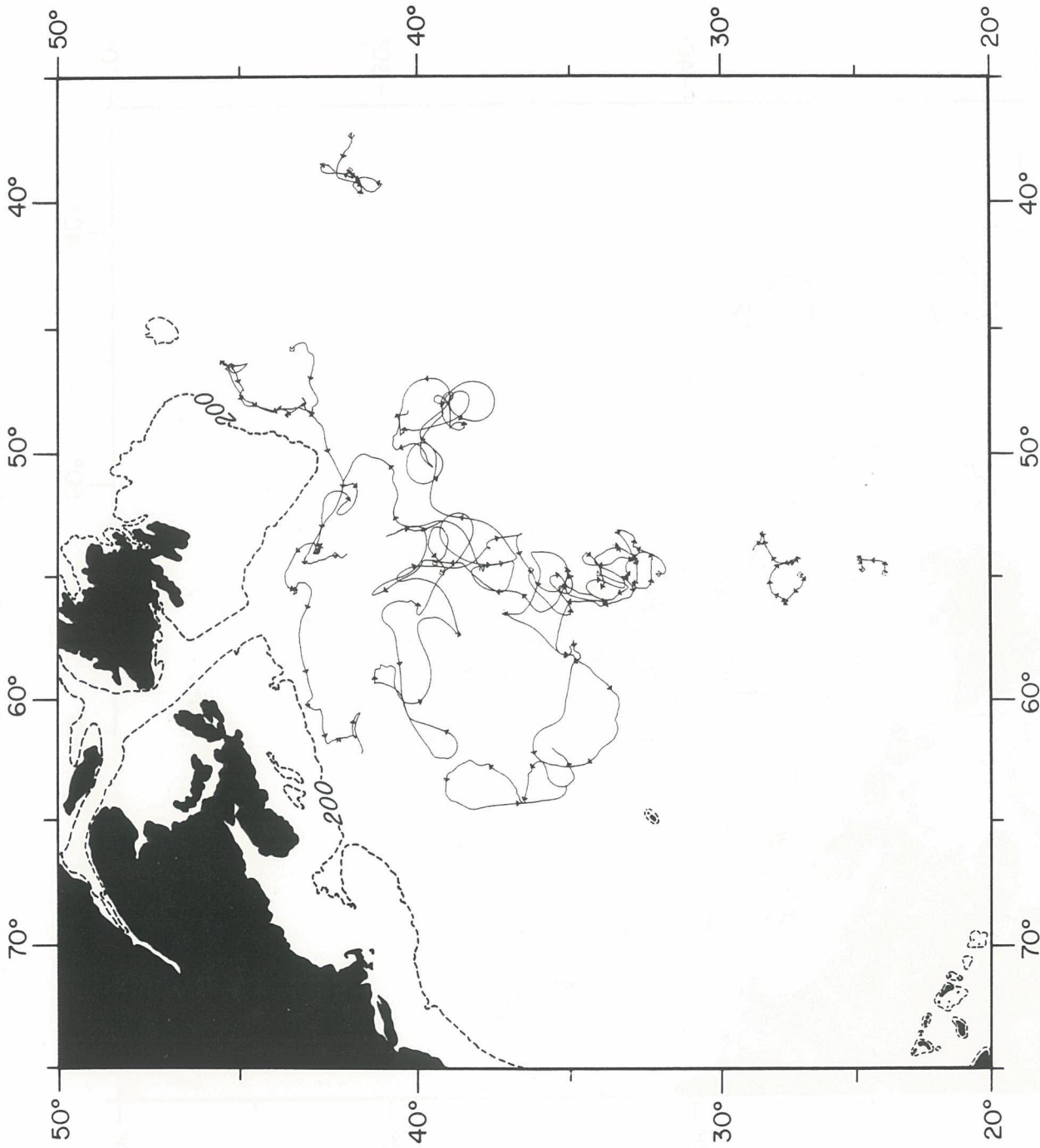


Figure 19. Trajectories from 2000 m floats, first setting.

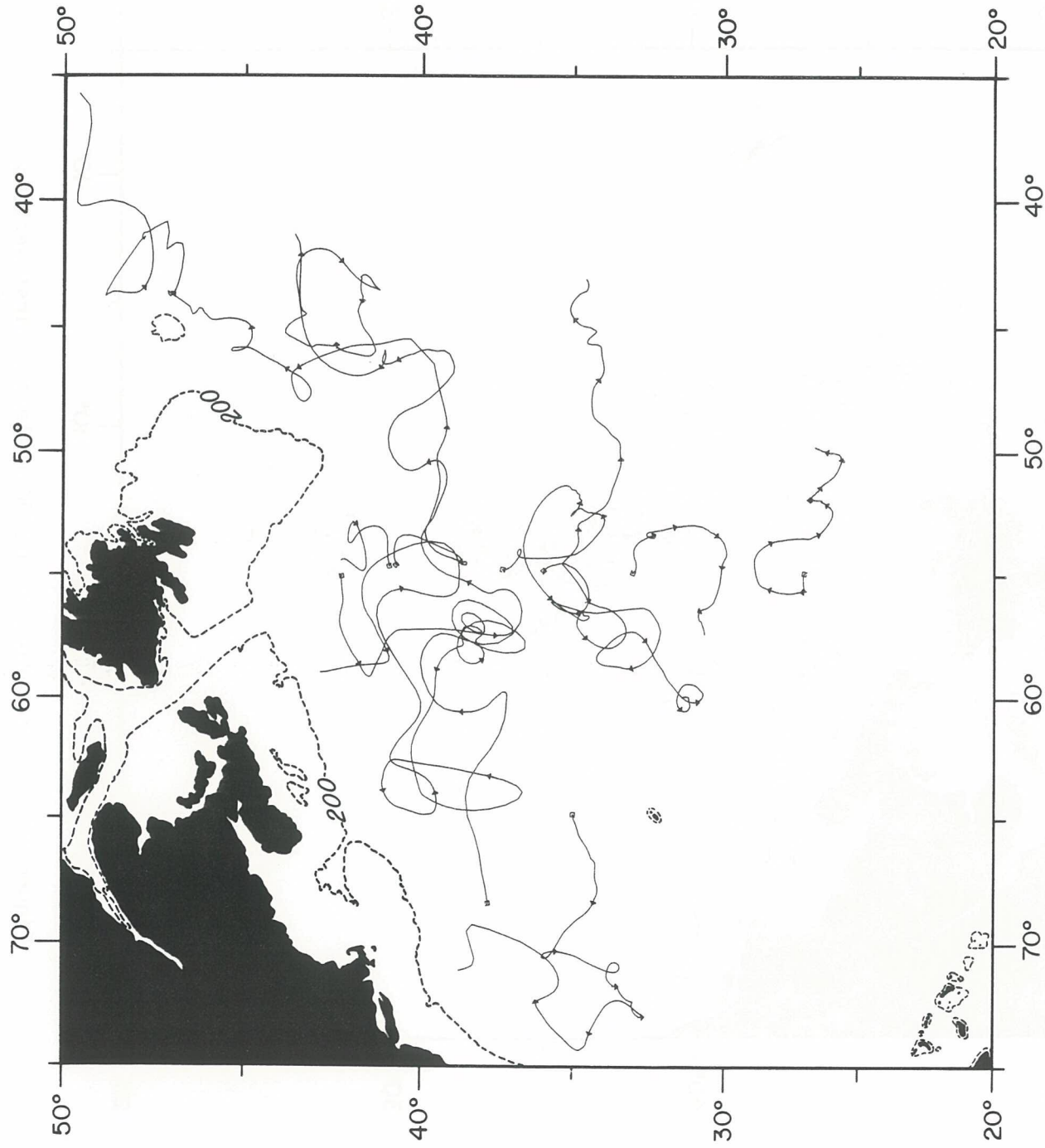


Figure 20. Trajectories from 700 m floats, second setting.

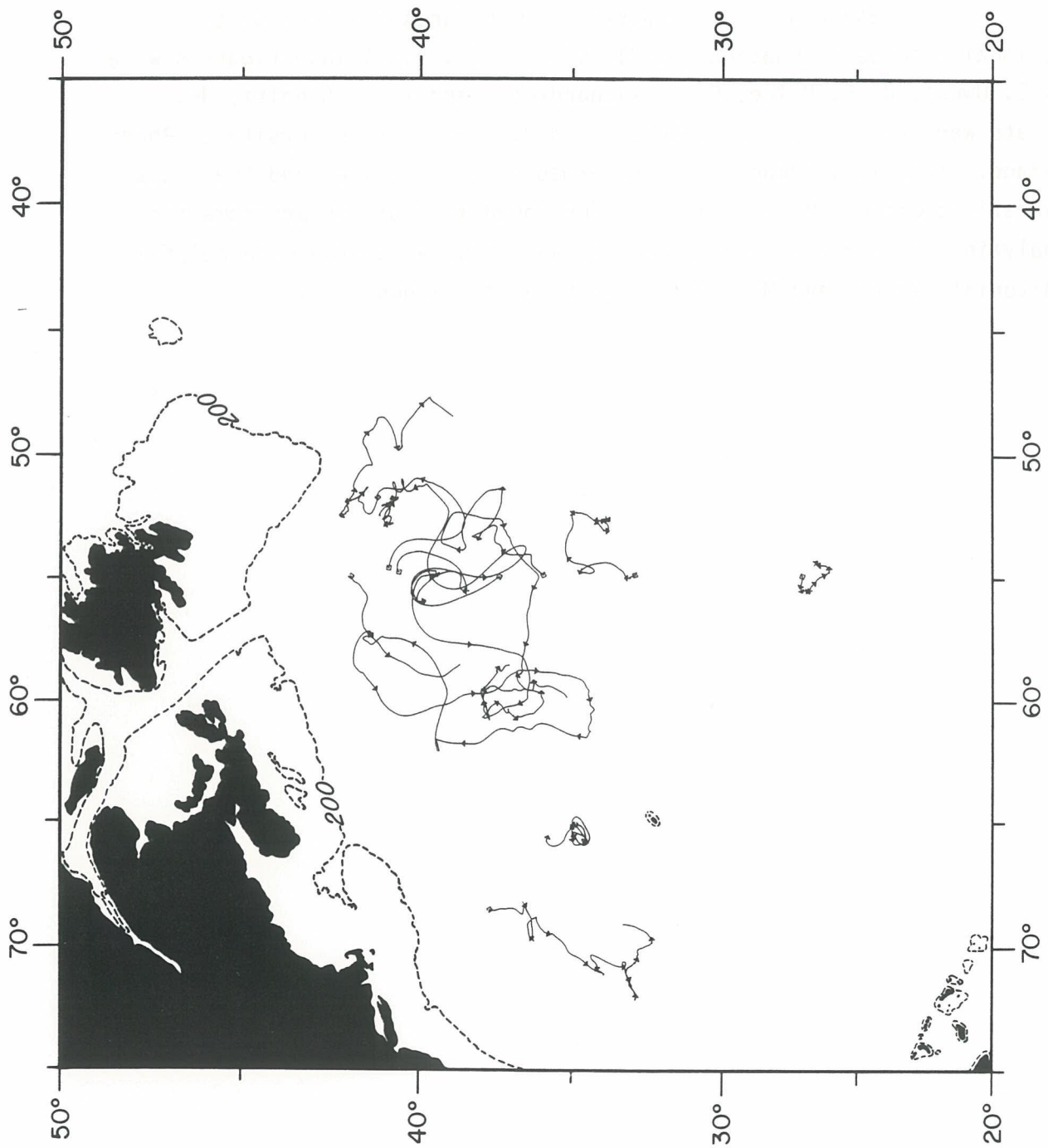


Figure 21. Trajectories from 2000 m floats, second setting.

ACKNOWLEDGEMENTS

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SECTION 2

PLOT DESCRIPTION

All plots in this section were generated using DISSPLA software. A trajectory plot and a group of time series plots are presented for each float. The order of the time series plots is stick diagram, u and v velocity component overplot, vertical velocity and vertical displacement overplot, temperature and pressure overplot (where data are available).

The plots were created for this section with the objective of best presenting the data for a particular float, not for the purpose of inter-comparison. For the time series plots, a standard has been observed in the scale of the time interval on the X axis but the Y axis scale and interval varies for each float according to the minima and maxima of the variable plotted. Two hundred days of data were plotted on each page. Float files of lengths greater than 200 days were continued on subsequent pages. The time axis is annotated with the last 4 digits of the Julian day and with calendar months. Data points are marked daily. Shallow floats (GU100-GU121) are presented first, followed by the deep floats (GU150-GU170).

Individual Float Trajectory Plots

A trajectory for each float is plotted on a linear projection with latitude and longitude scales adjusted to create a page-size plot. Open circles denote the first float position. Small dots mark the daily positions, large dots the 10th day, and every 20th day is annotated with the last four digits of the Julian date. Refer to the conversion chart (Table 8) to convert Julian day to calendar day.

Velocity Stick Plots

One stick is plotted for every day of data. Stick length indicates the speed in cm s^{-1} , and the angle the stick makes with the horizontal axis represents the direction. North is the direction toward the top of the page.

TABLE 8: FLOAT DAY NUMBER TO CALENDAR DATE CONVERSION

1974-1984

Year	Jan. 1	Feb. 1	Mar. 1	Apr. 1	May 1	June 1	July 1	Aug. 1	Sept. 1	Oct. 1	Nov. 1	Dec. 1
1974	2049	2080	2108	2139	2169	2200	2230	2261	2292	2322	2353	2383
1975	2414	2445	2473	2504	2534	2565	2595	2626	2657	2687	2718	2748
1976	2779	2810	2839	2870	2900	2931	2961	2992	3023	3053	3084	3114
1977	3145	3176	3204	3235	3265	3296	3326	3357	3388	3418	3449	3479
1978	3510	3541	3569	3600	3630	3661	3691	3722	3753	3783	3814	3844
1979	3875	3906	3934	3965	3995	4026	4056	4087	4118	4148	4179	4209
1980	4240	4271	4300	4331	4361	4392	4422	4453	4484	4514	4545	4575
1981	4606	4637	4665	4696	4726	4757	4787	4818	4849	4879	4910	4940
1982	4971	5002	5030	5061	5091	5122	5152	5183	5214	5244	5275	5305
1983	5336	5367	5395	5426	5456	5487	5517	5548	5579	5609	5640	5670
1984	5701	5732	5761	5792	5822	5853	5883	5914	5945	5975	6006	6036

Example: Annotation number 4392 is the last 4 digits of Julian day counter 2444392. It refers to June 1, 1980, 0000 GMT.

Velocity Component Overplots

East [●] and North [○] components of velocity are plotted on the same scale as the stick plots.

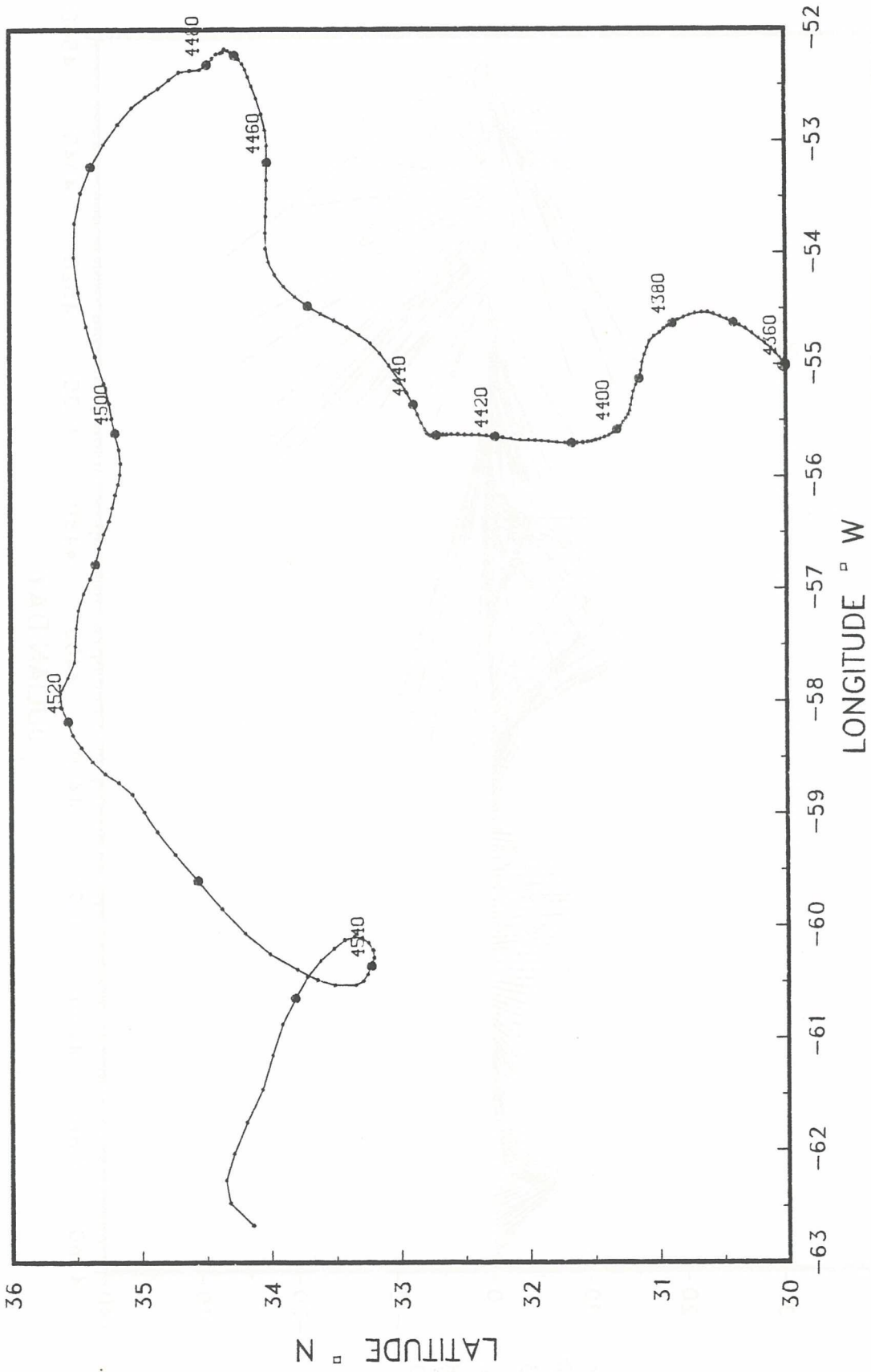
Vertical Velocity and Vertical Displacement Overplots

Vertical velocity [●] is plotted on a scale whose units are meters per day. Refer to Section 1 for the method used to calculate the vertical velocity. Integrated vertical velocity, or vertical displacement [x] is plotted in meters. Floats entering the Gulf Stream exhibit large vertical velocities and subsequently have large vertical displacements.

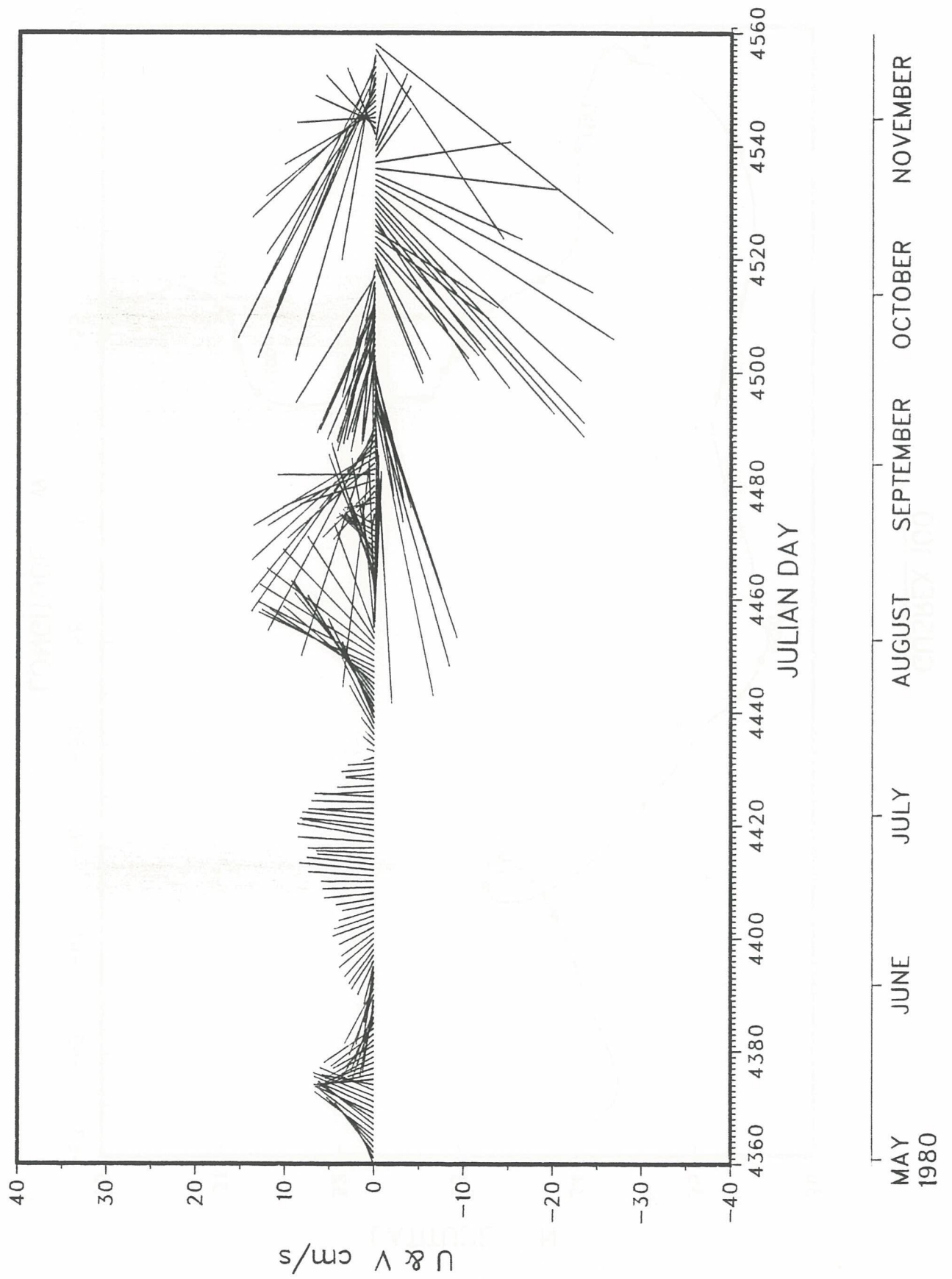
Temperature and Pressure Overplots

Each day's temperature (+) is plotted on a Centigrade scale. The corresponding pressure (▲) is plotted in dbars (right). Pressure is plotted with the deeper values at the bottom of the page.

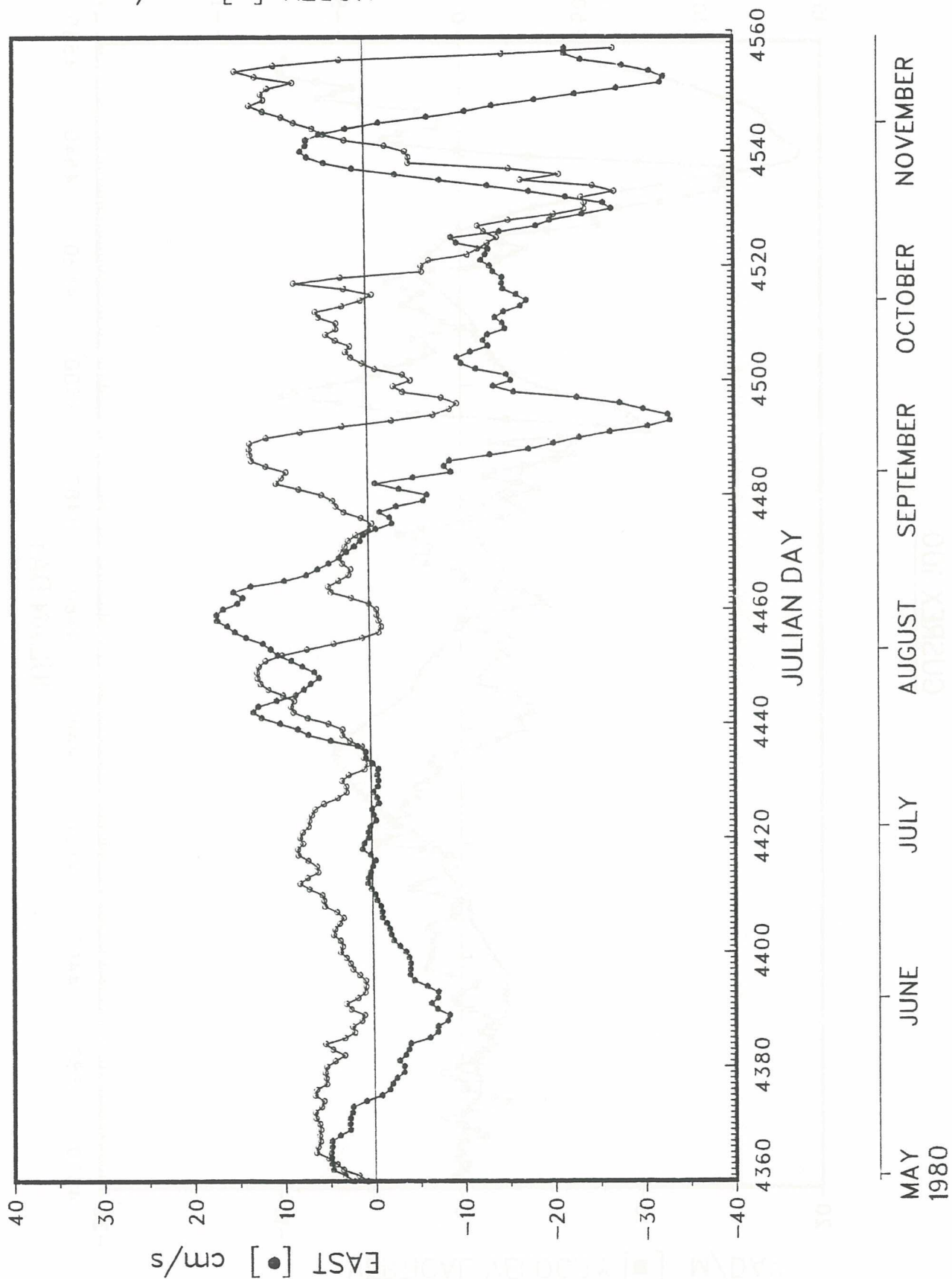
GUSREX 100



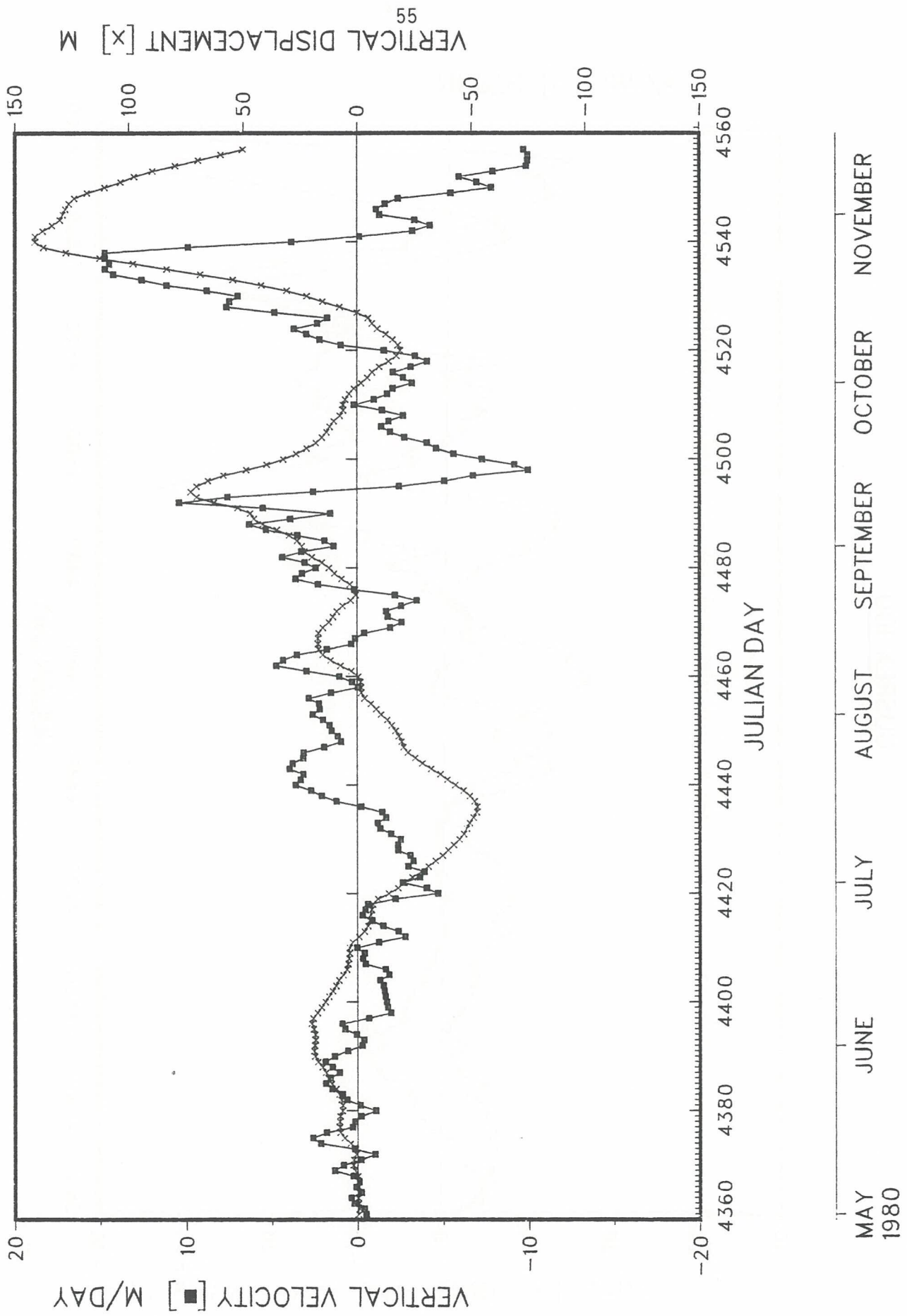
GUSREX 100



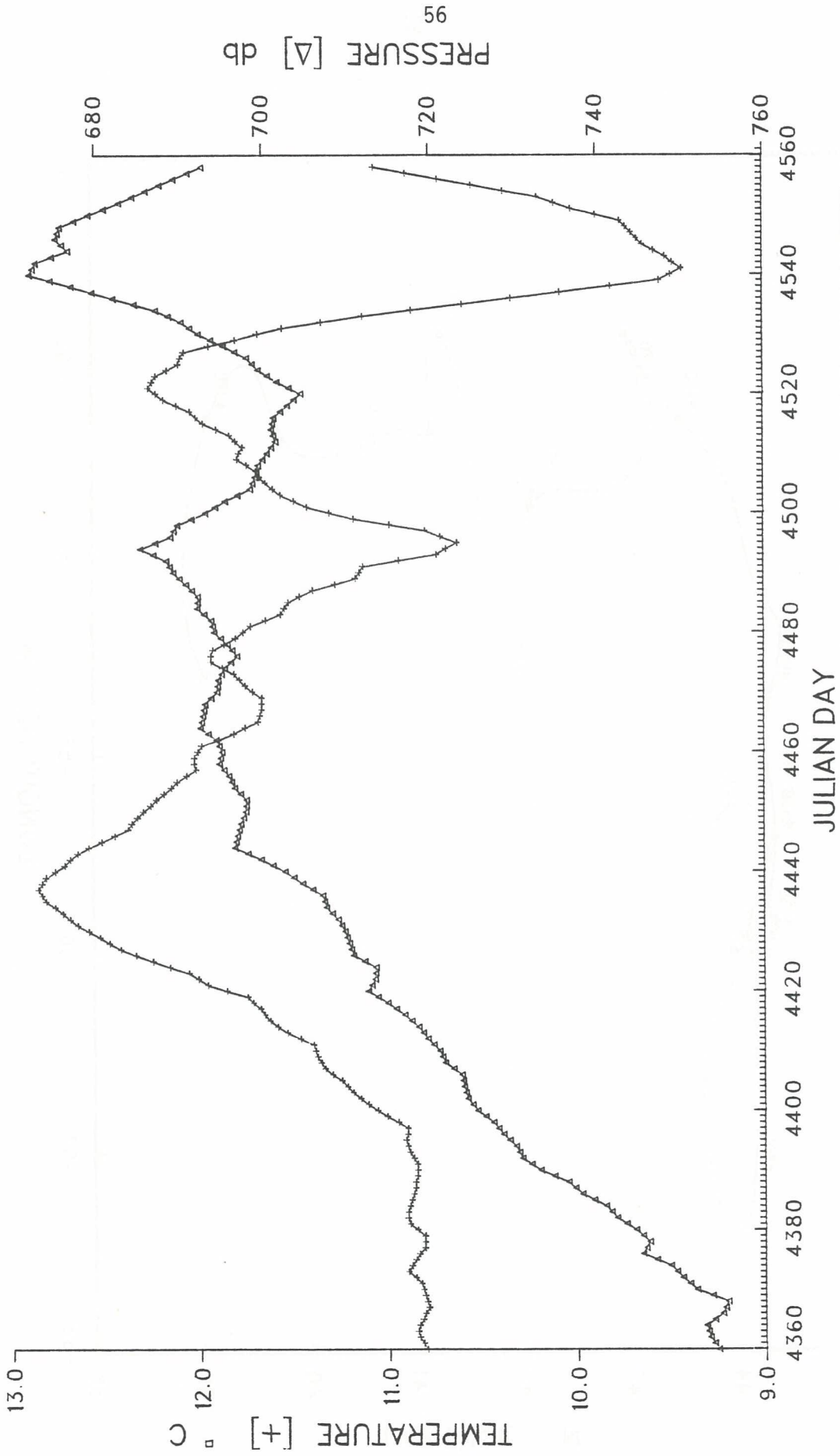
GUSREX 100



GUSREX 100

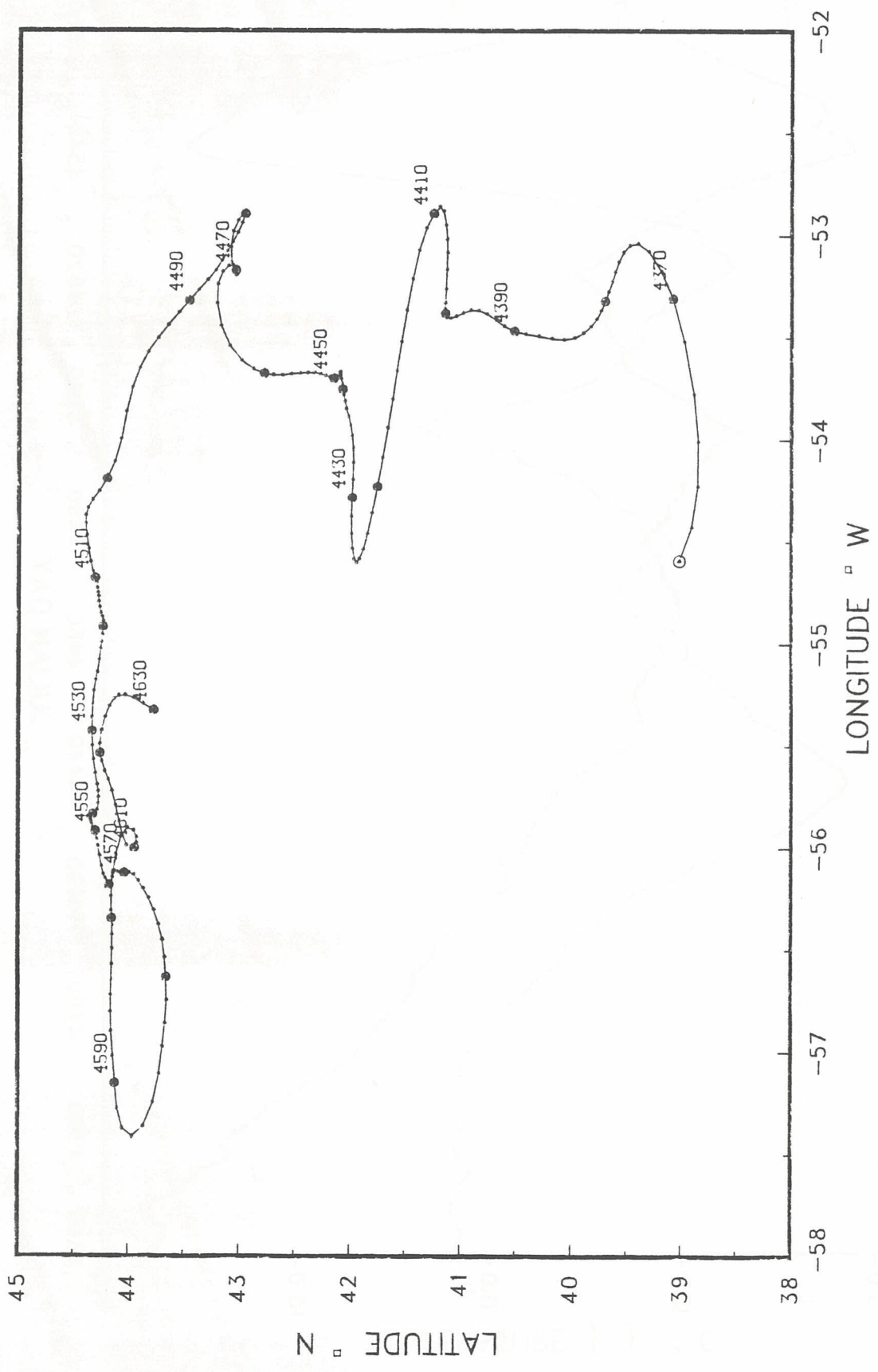


GUSREX 100

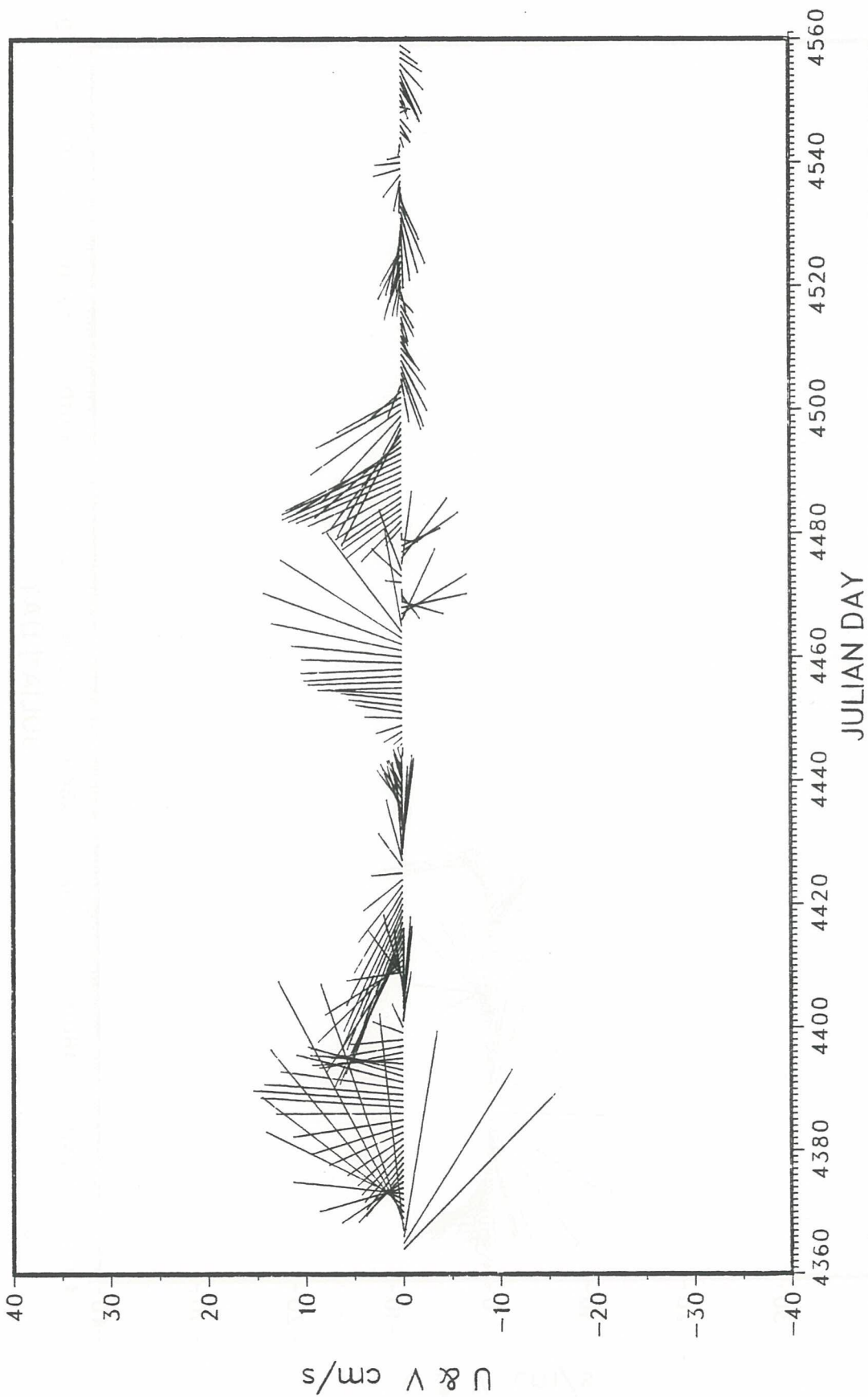


MAY JUNE JULY AUGUST SEPTEMBER OCTOBER NOVEMBER

GUSREX 101

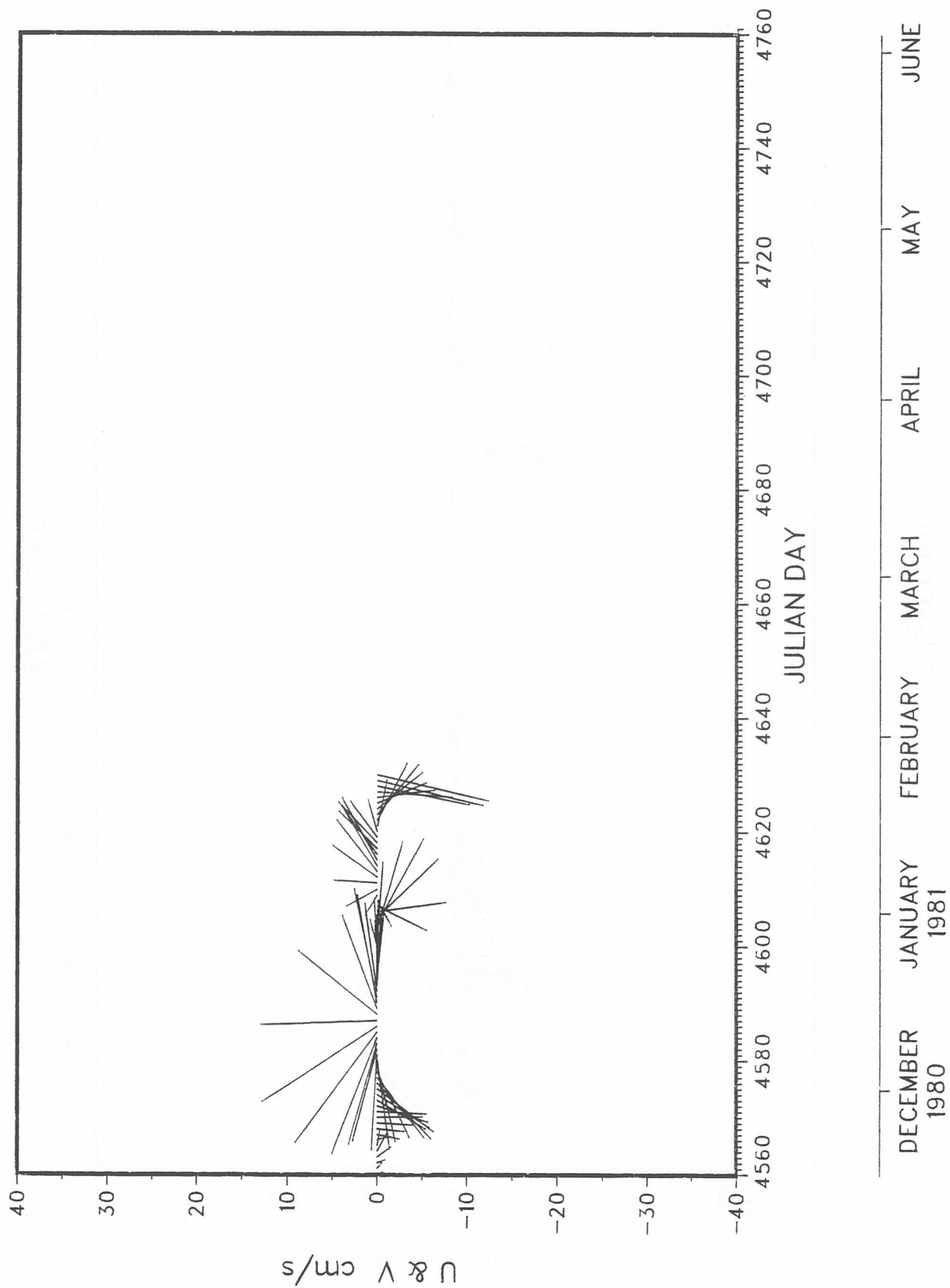


GUSREX 101

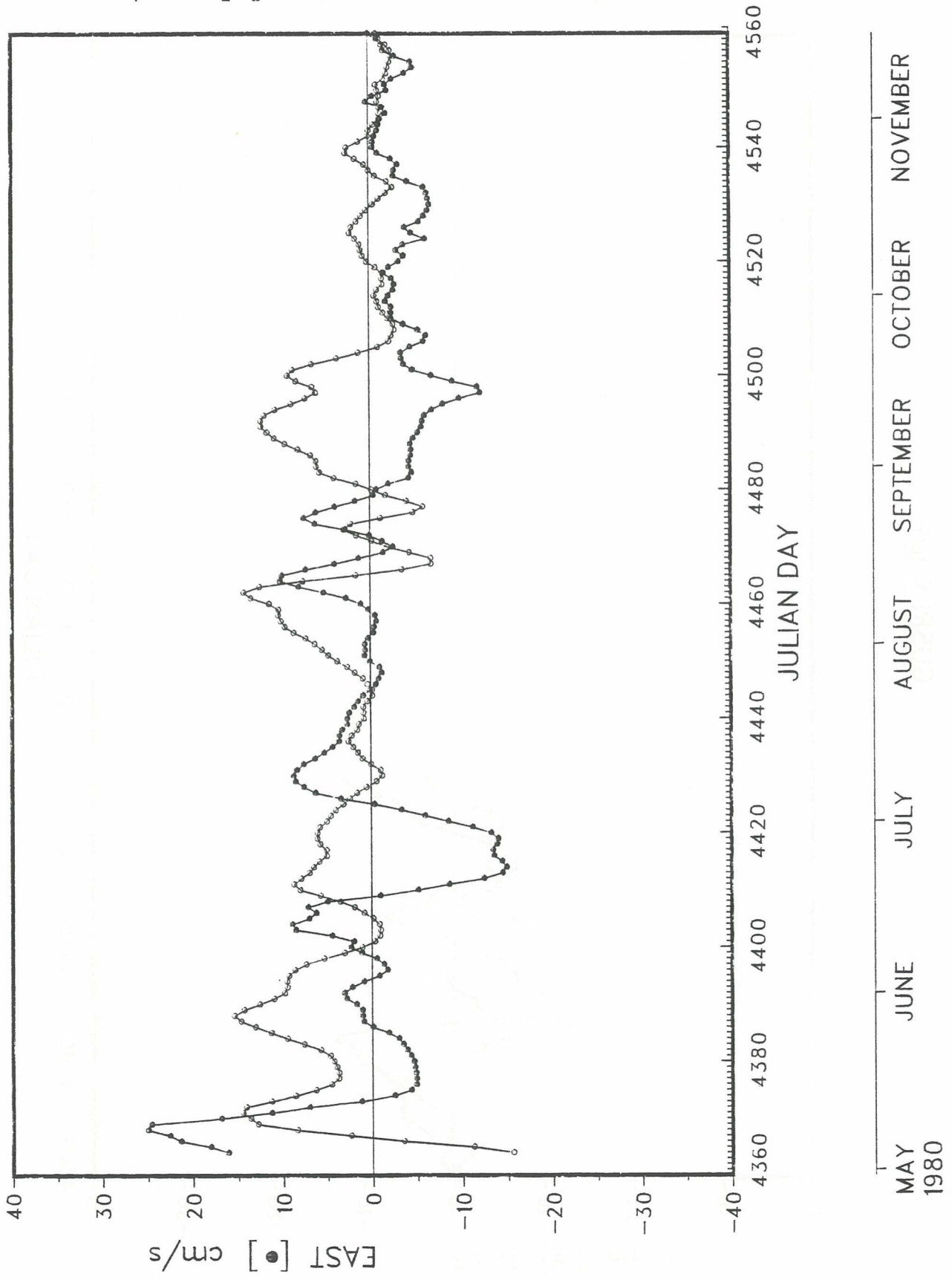


MAY 1980 JUNE JULY AUGUST SEPTEMBER OCTOBER NOVEMBER

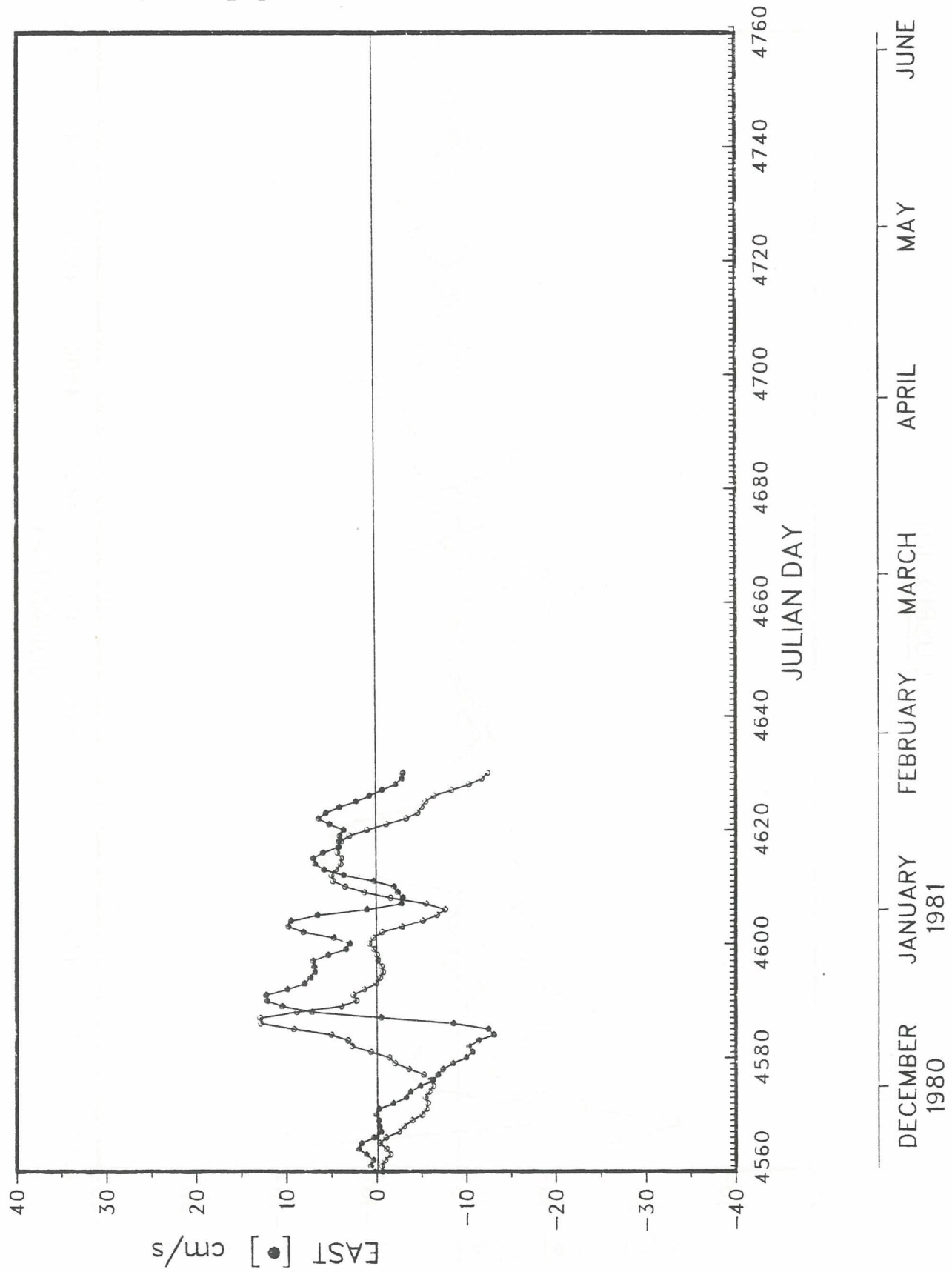
GUSREX 101



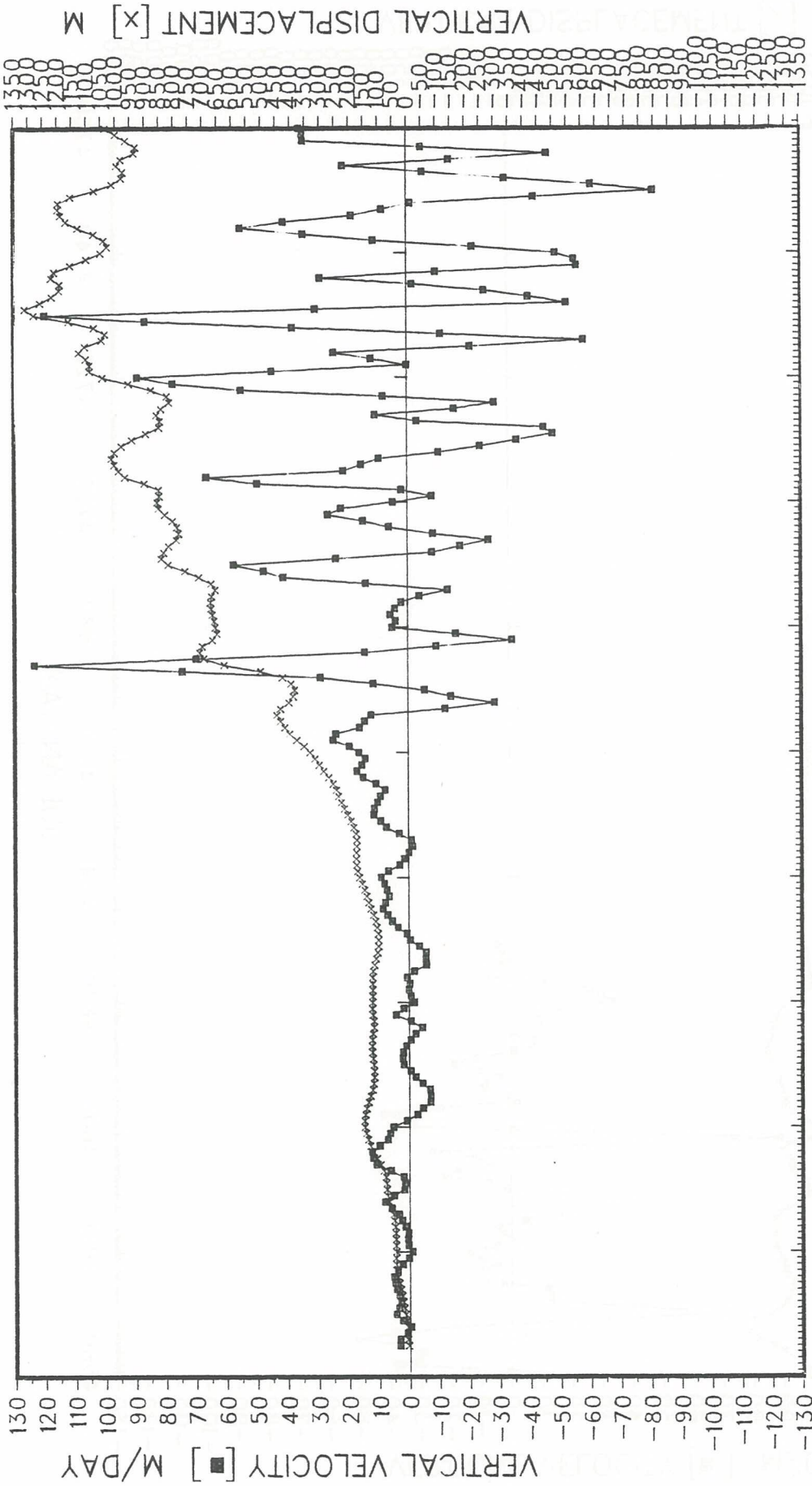
GUSREX 101



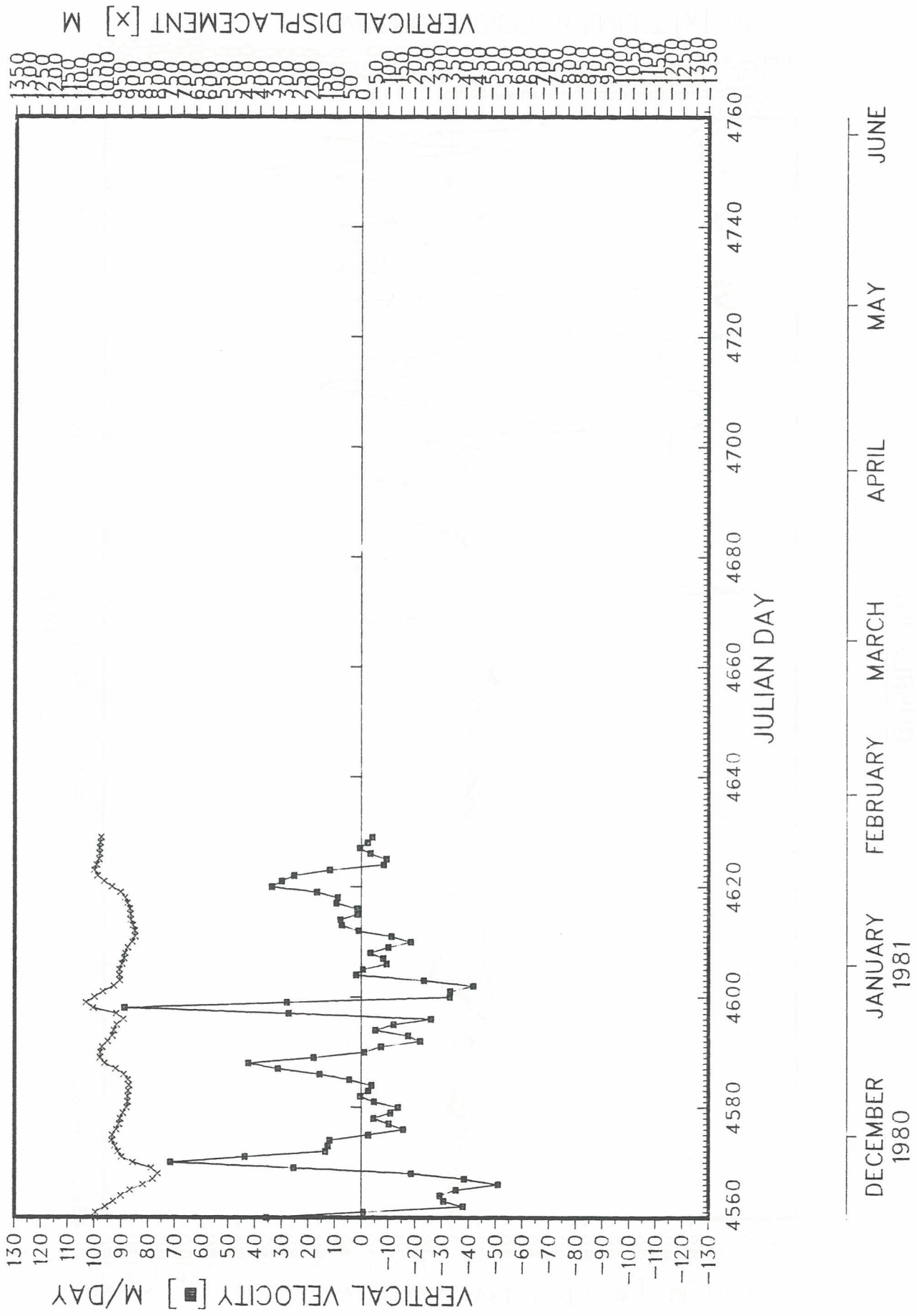
GUSREX 101



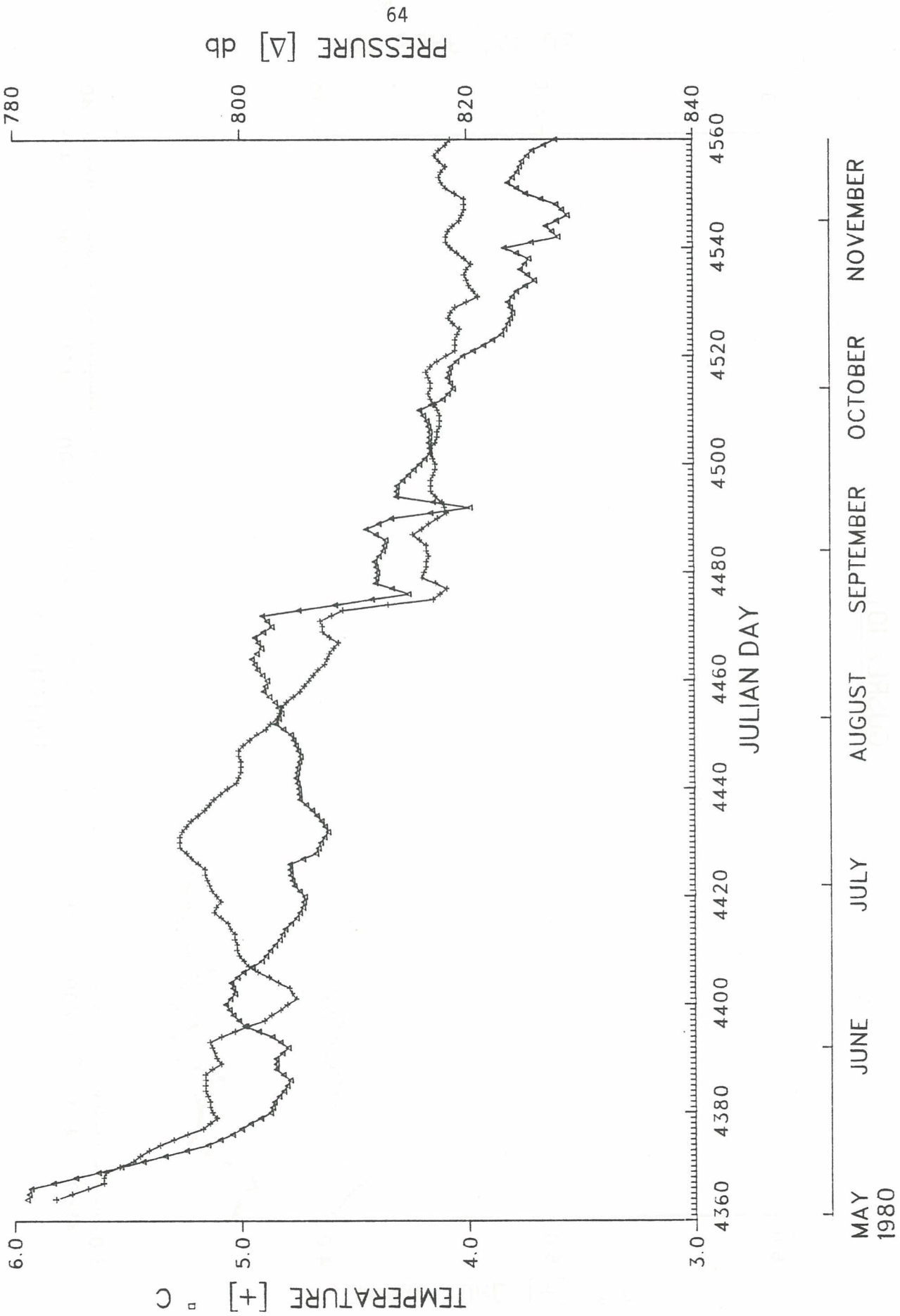
GUSREX 101



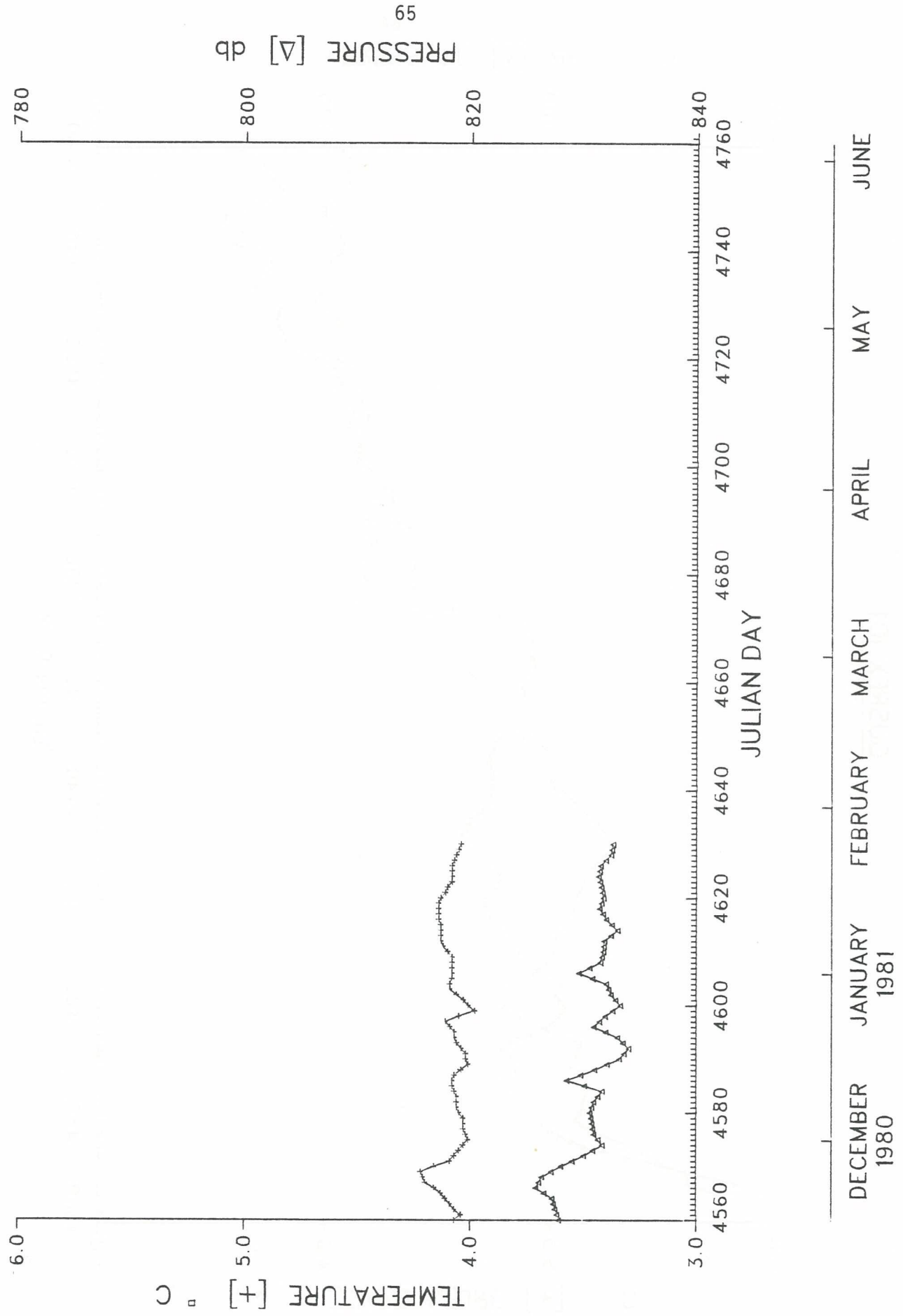
GUSREX 101



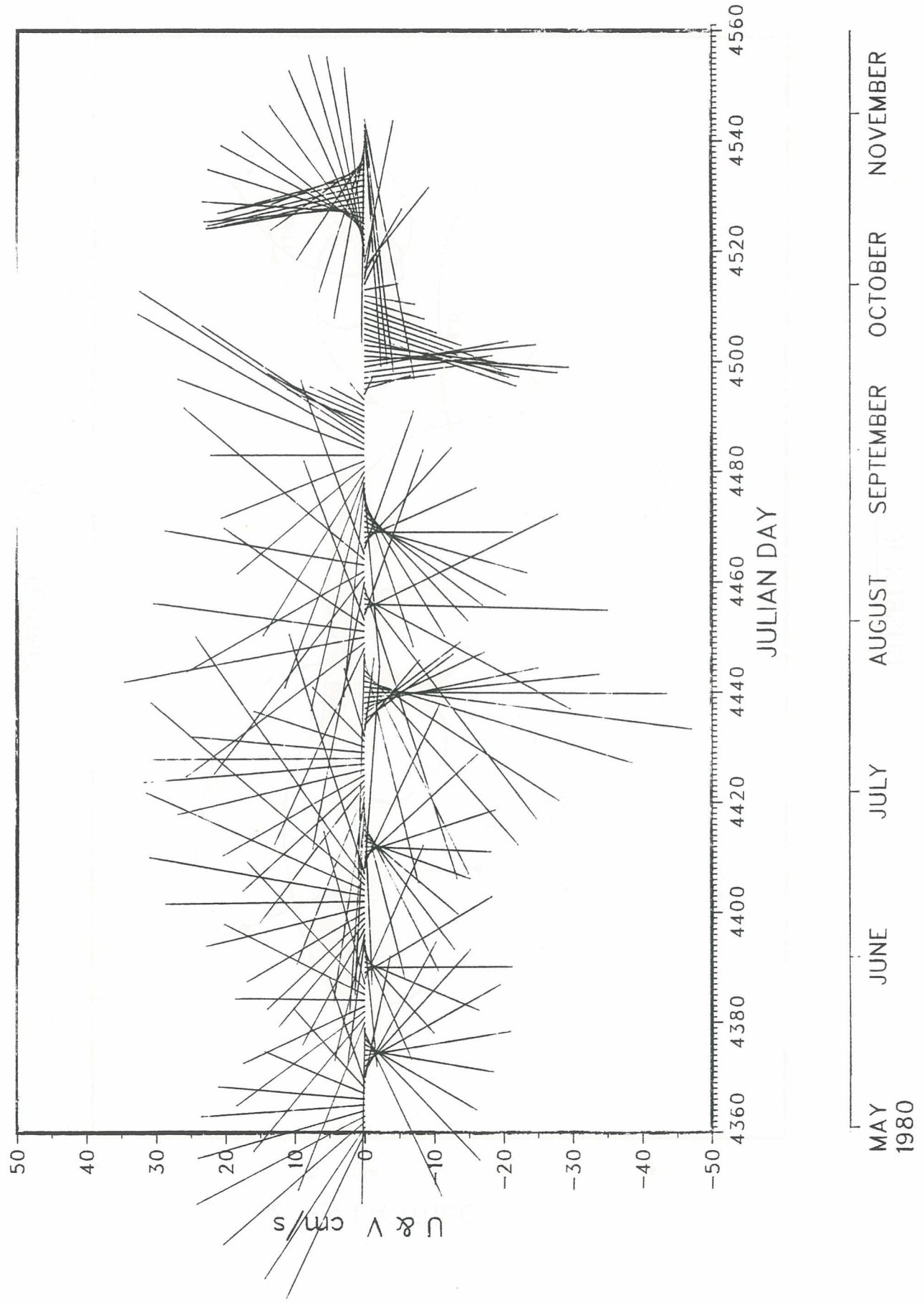
GUSREX 101



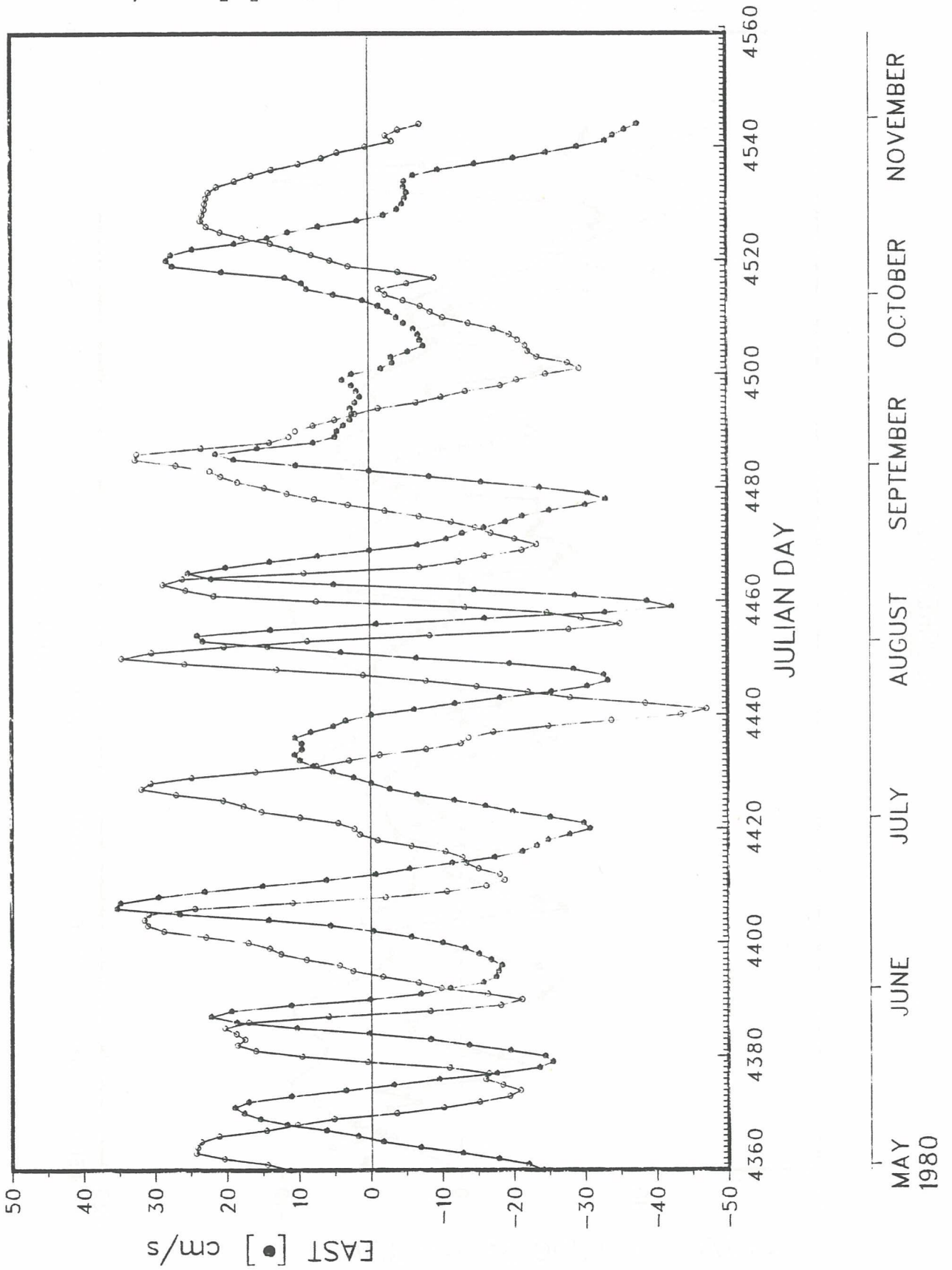
GUSREX 101



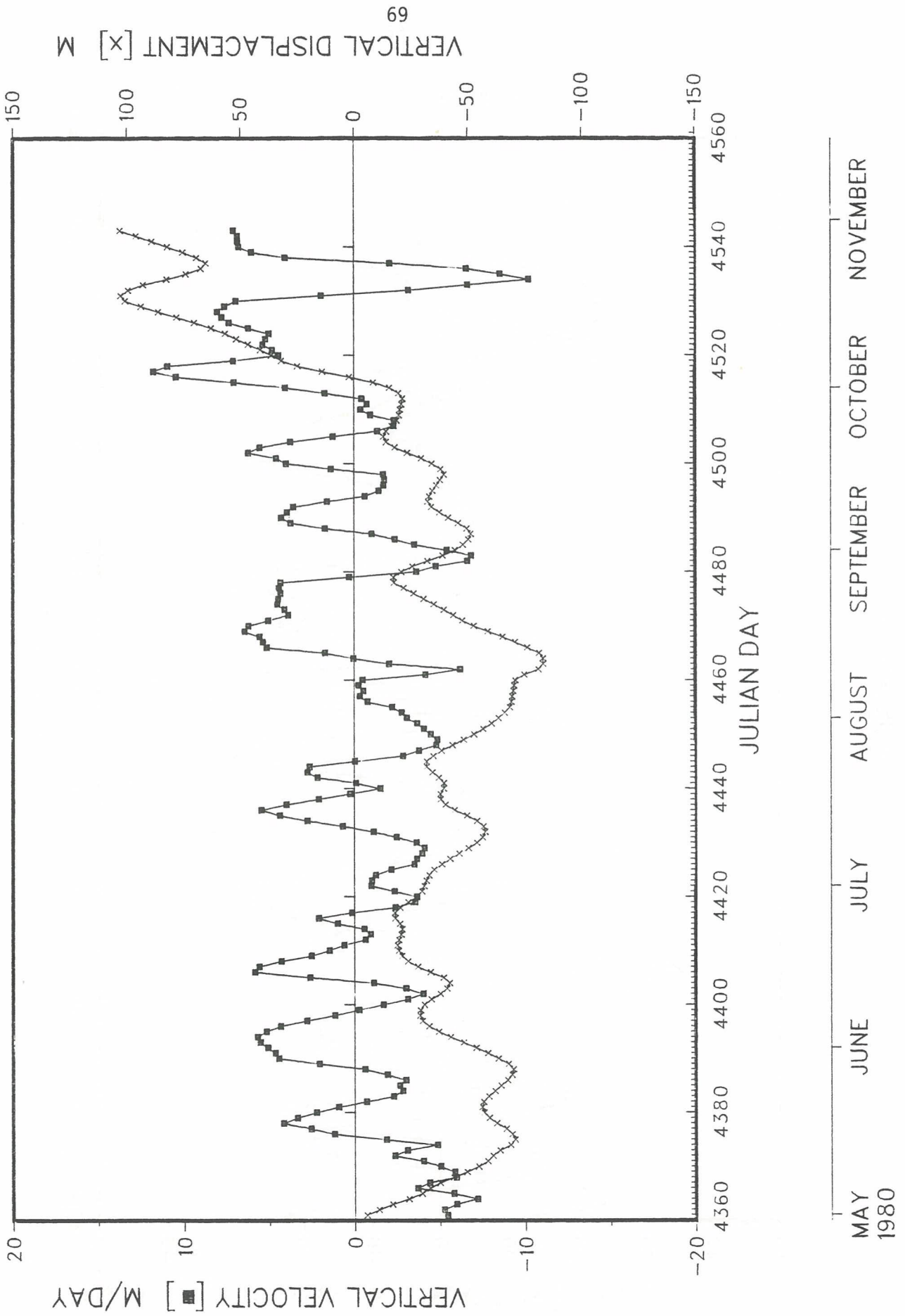
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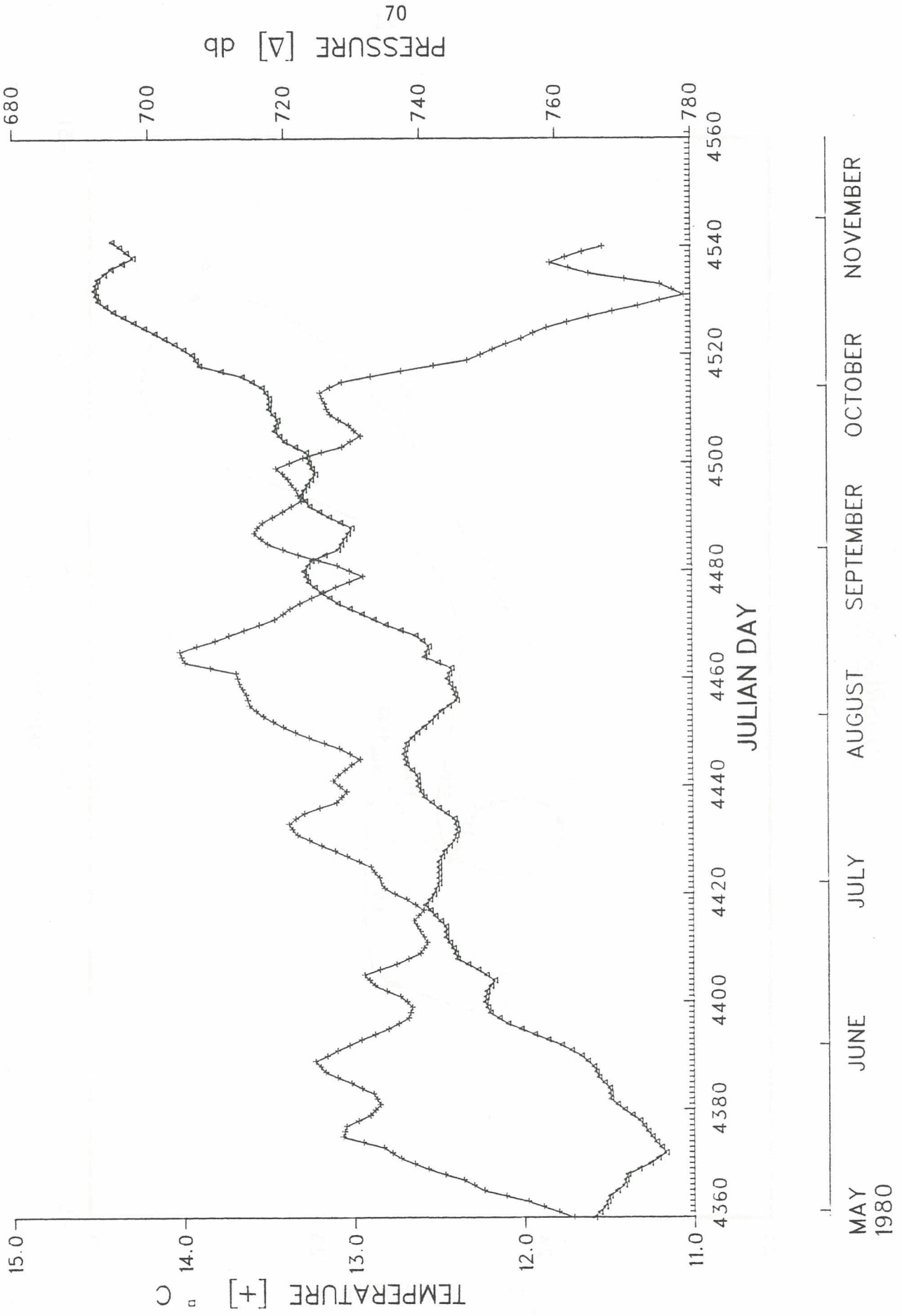
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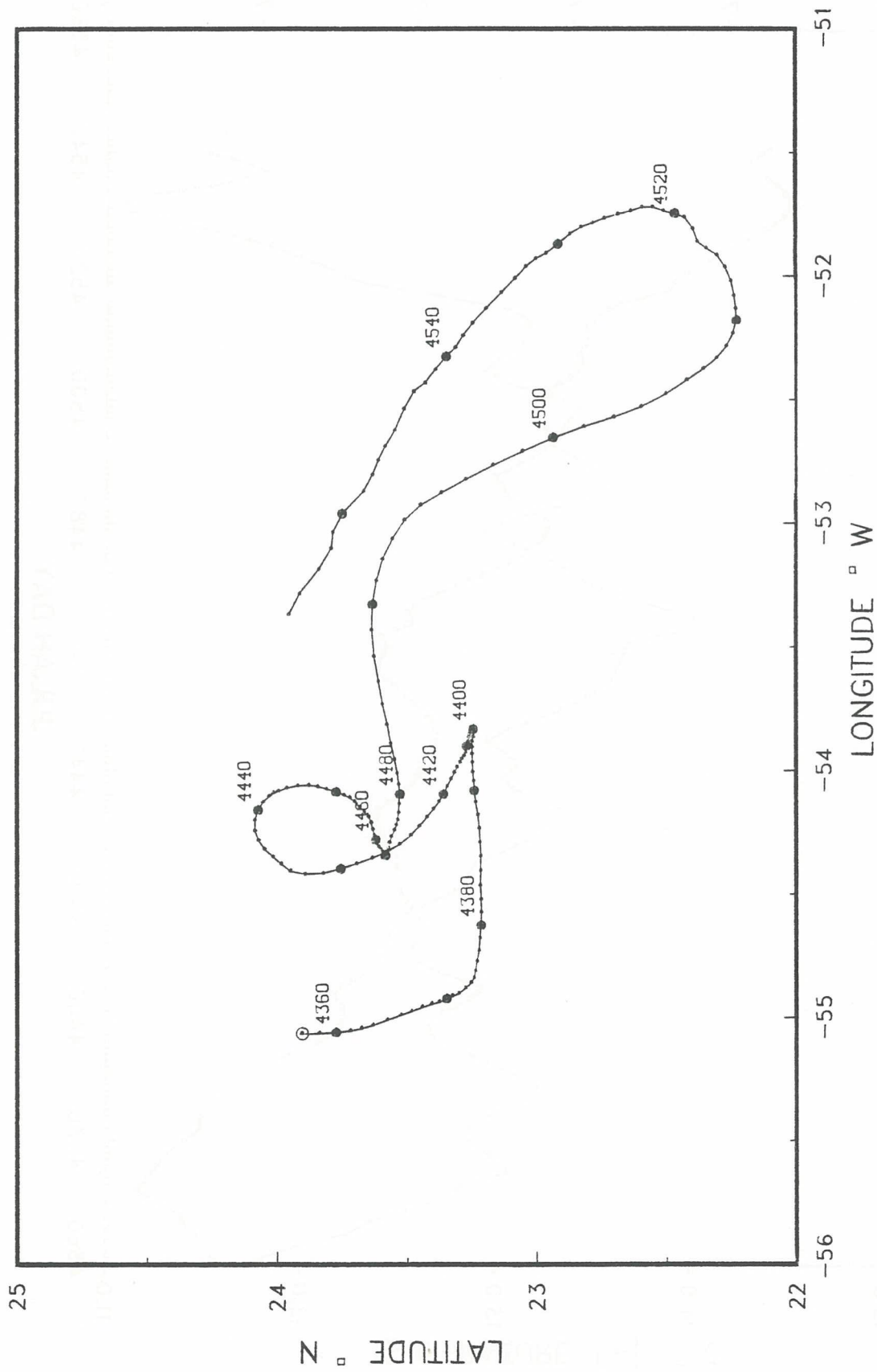
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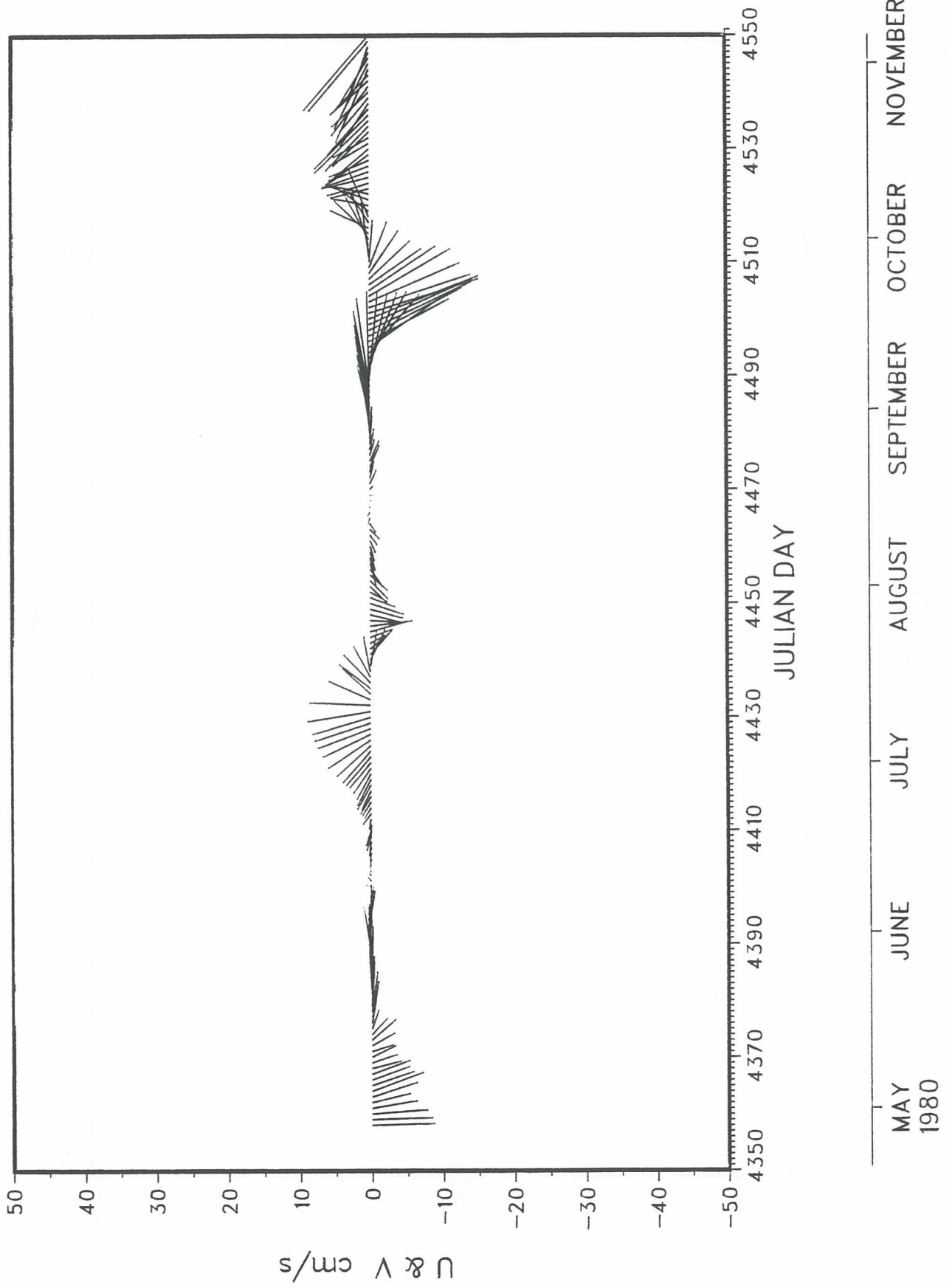
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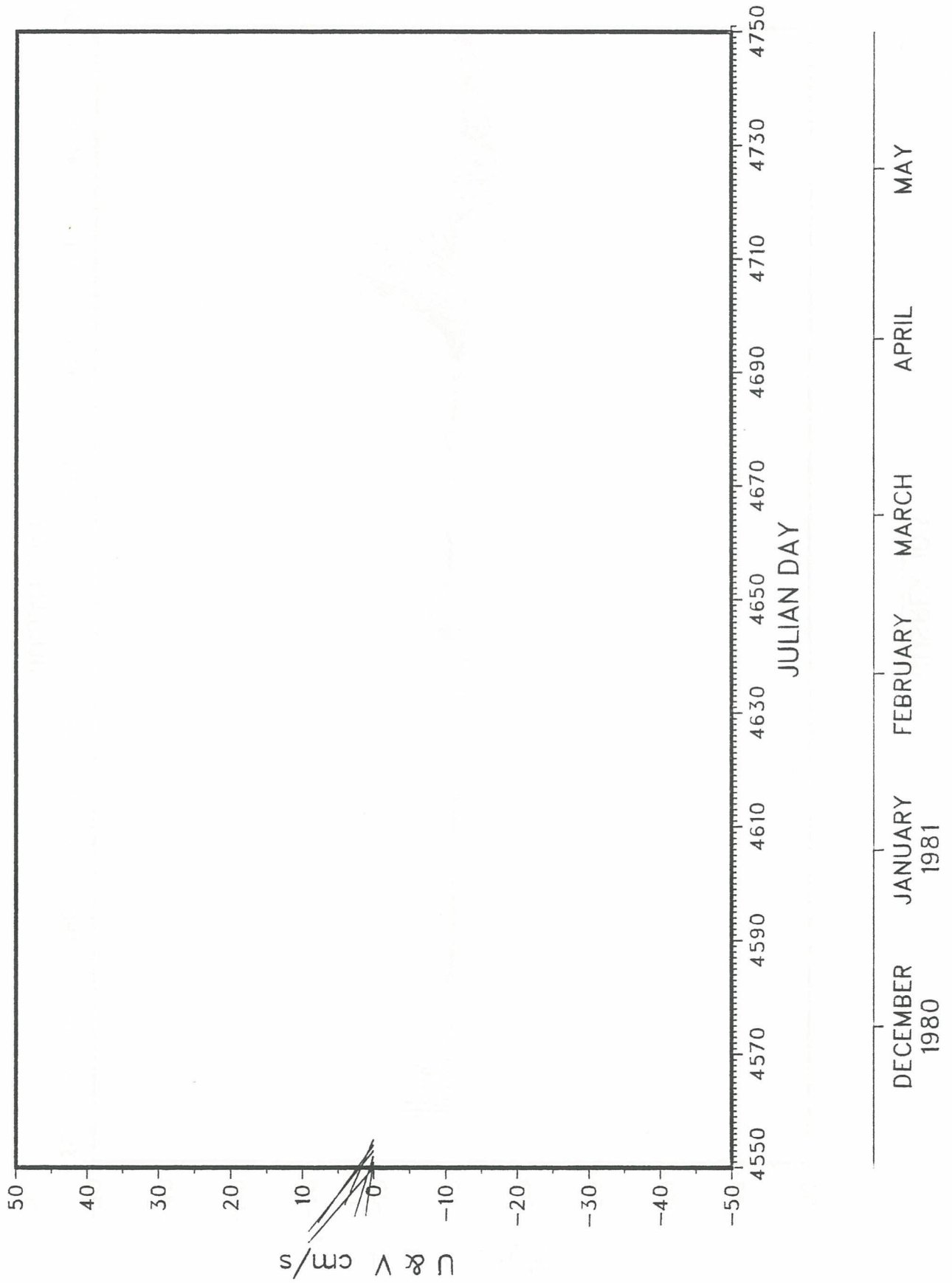
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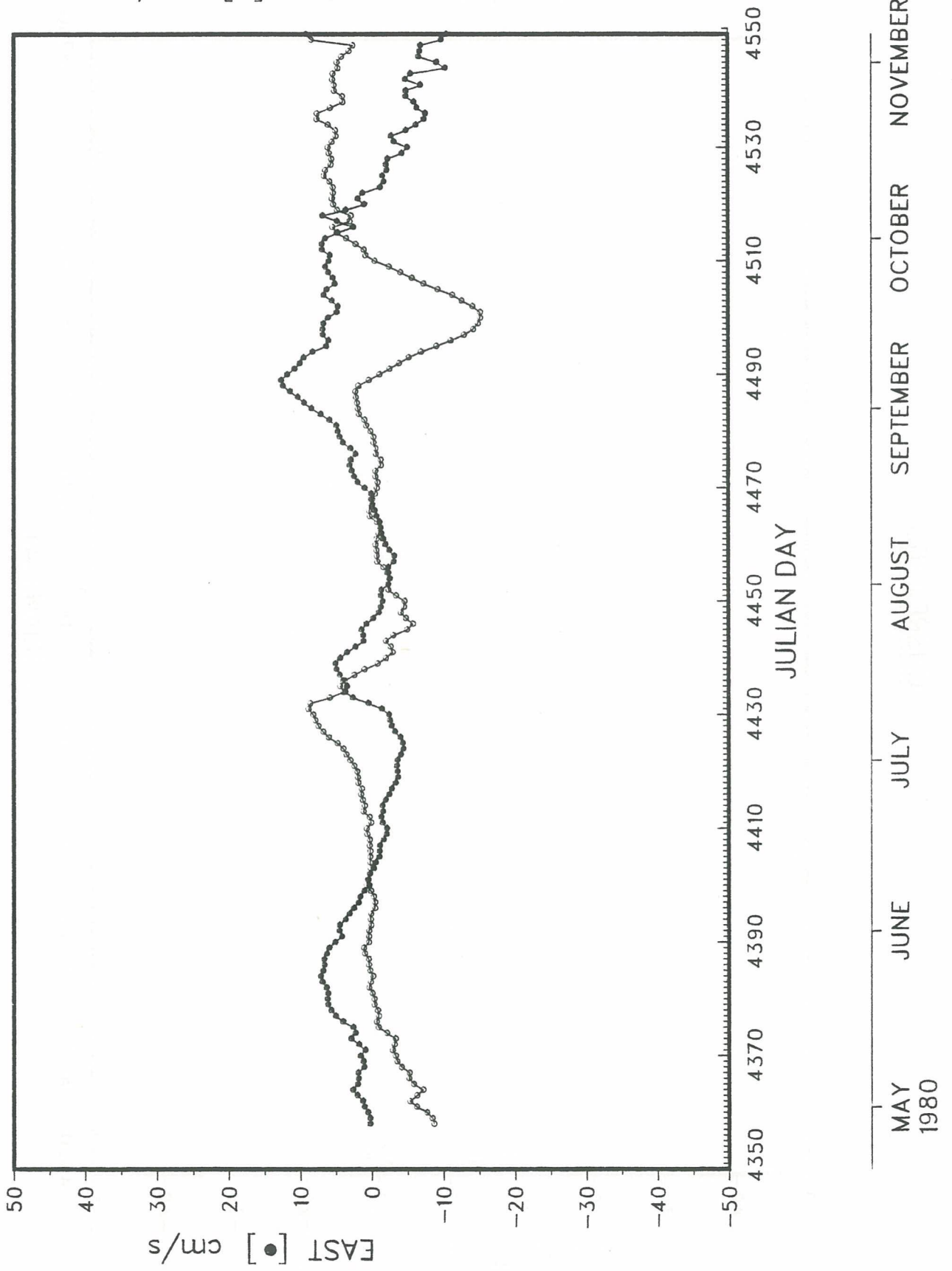
GUSREX 103



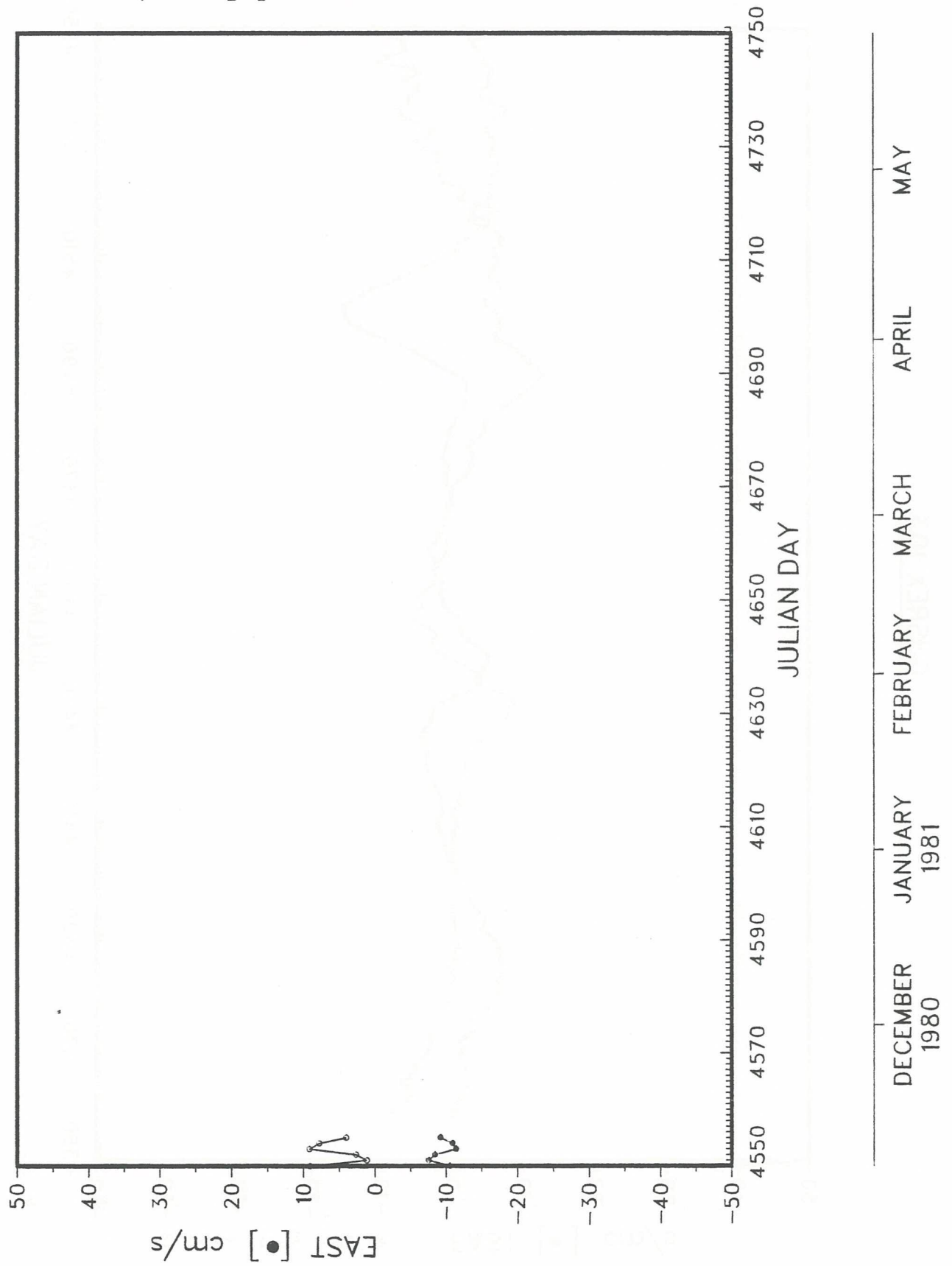
GUSREX 103



GUSREX 103

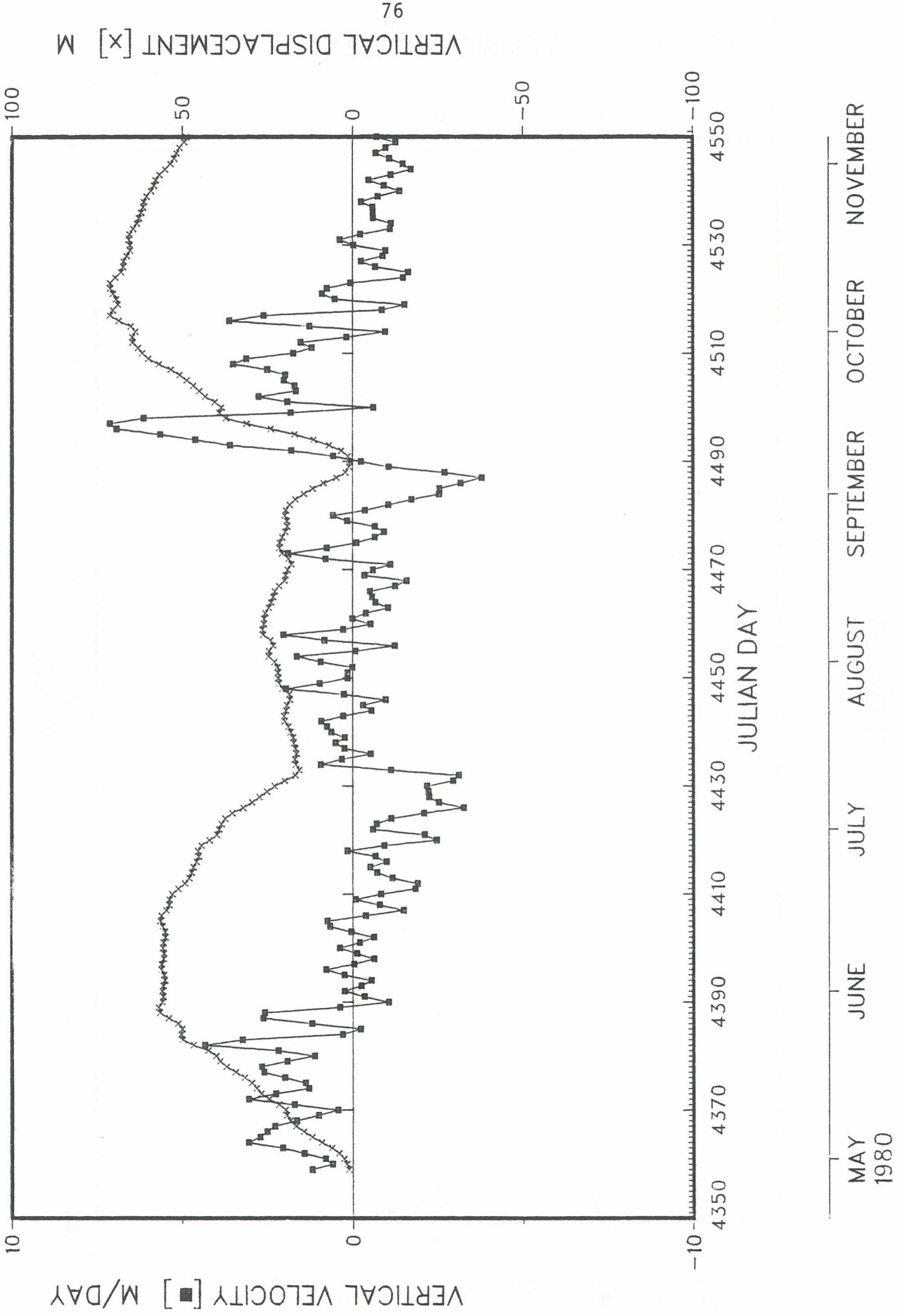


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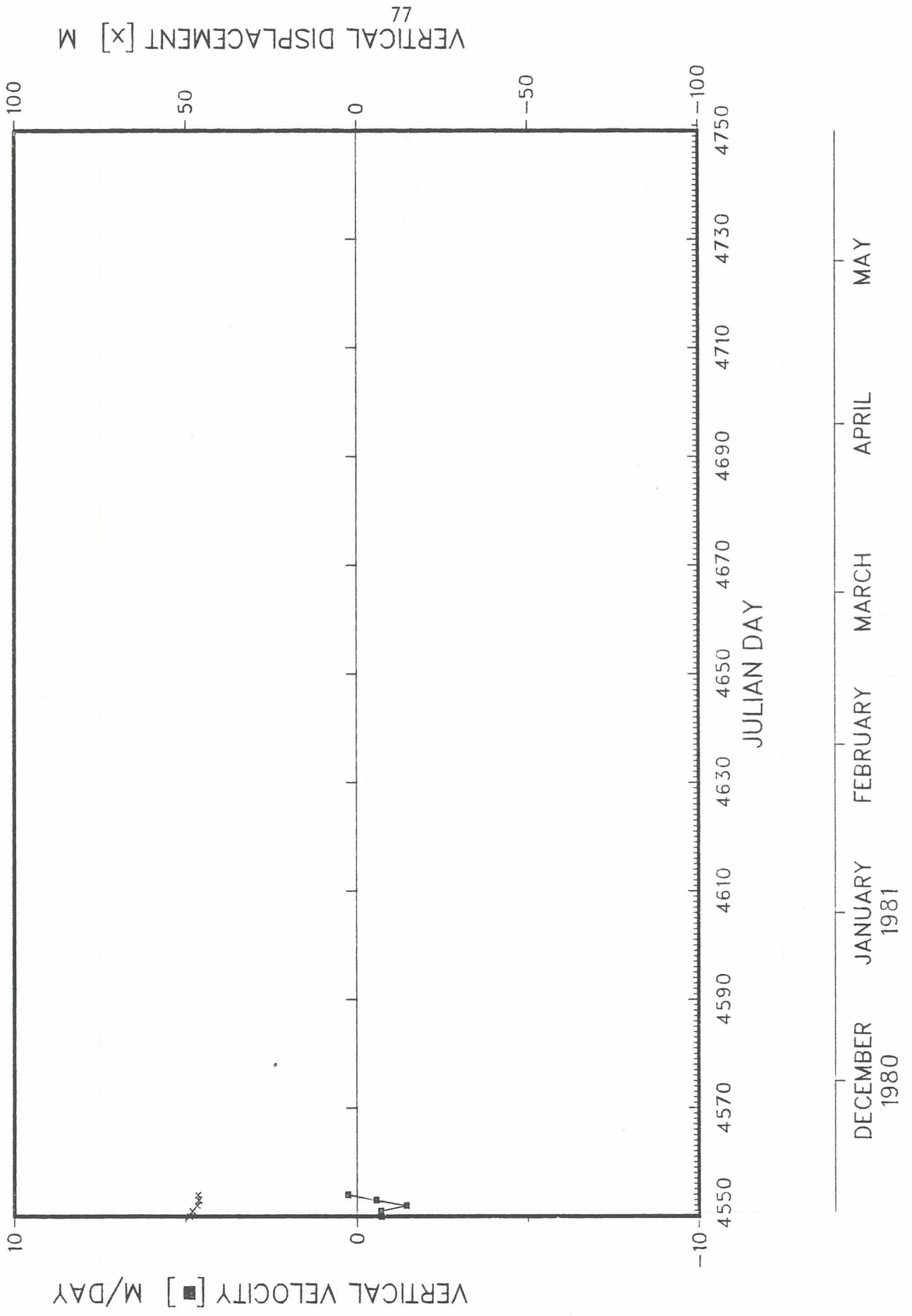


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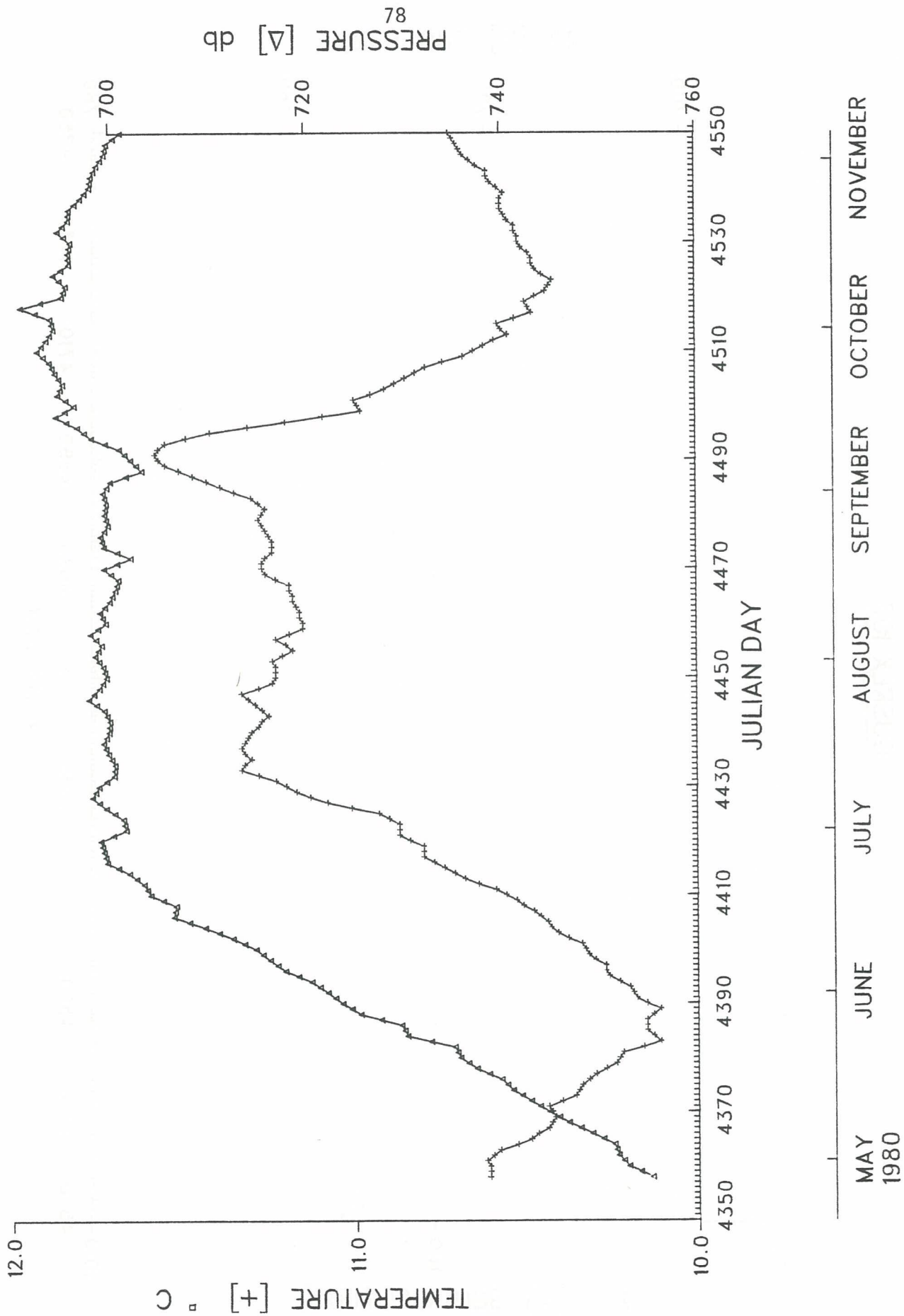
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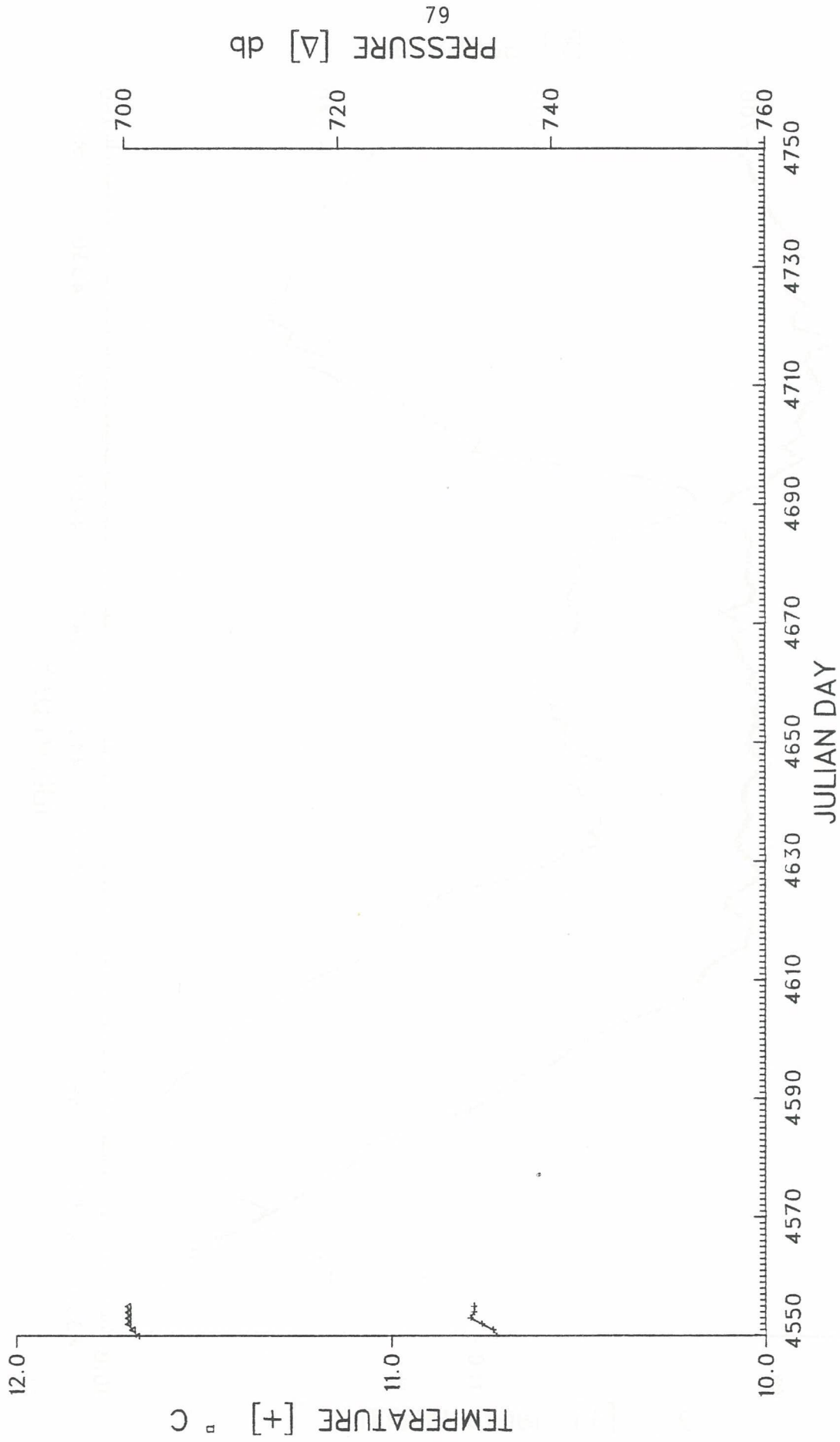
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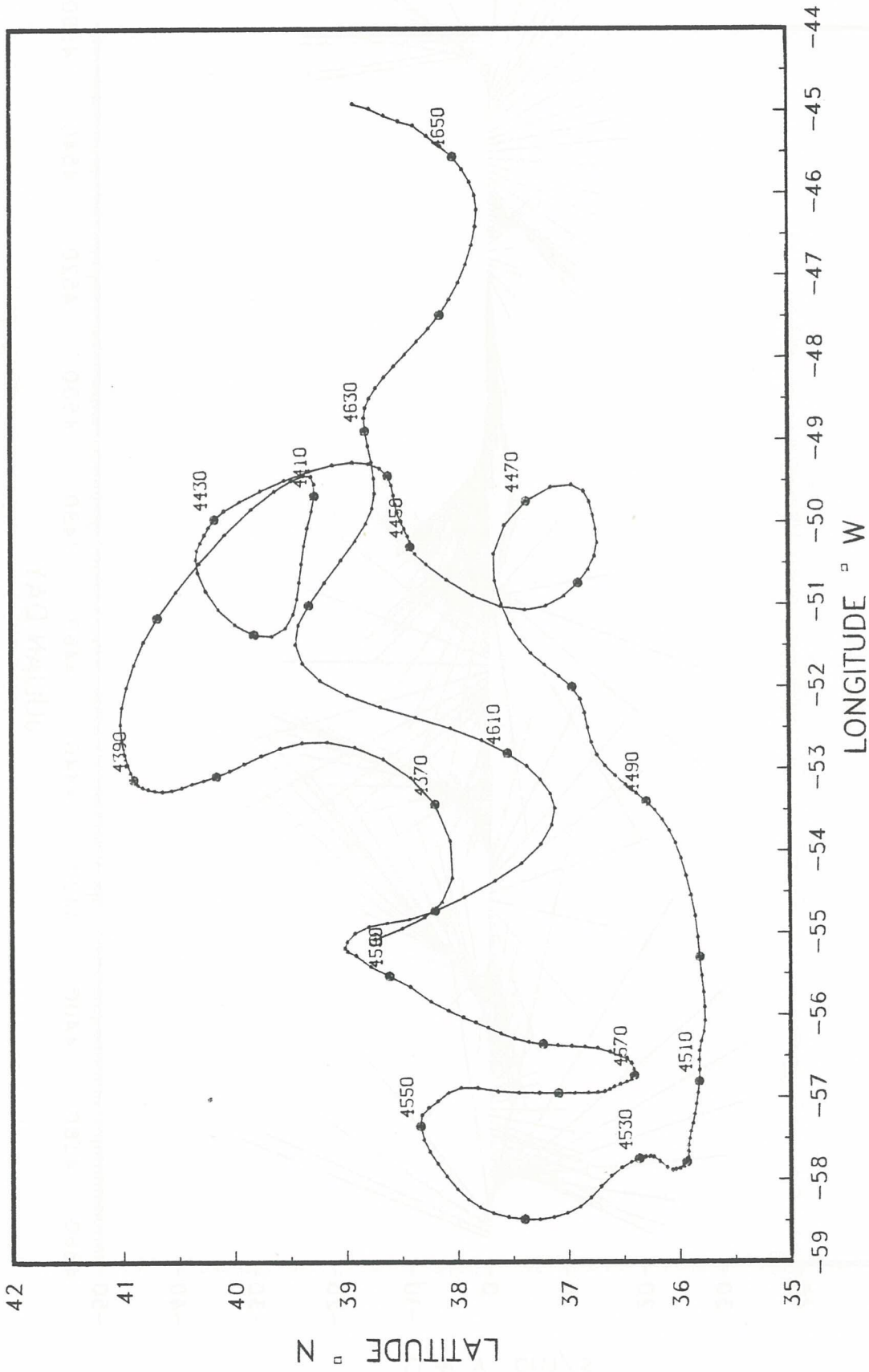
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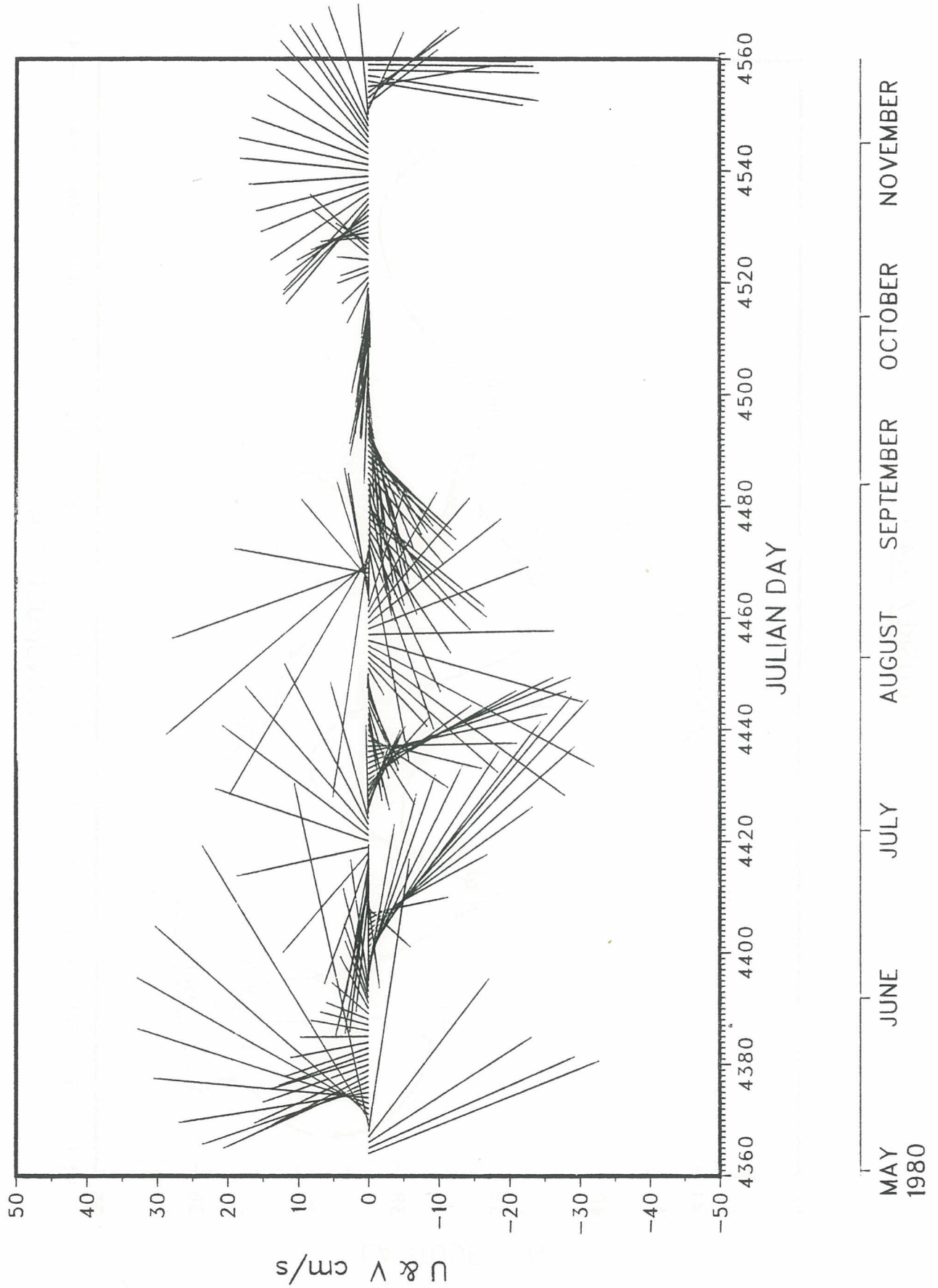
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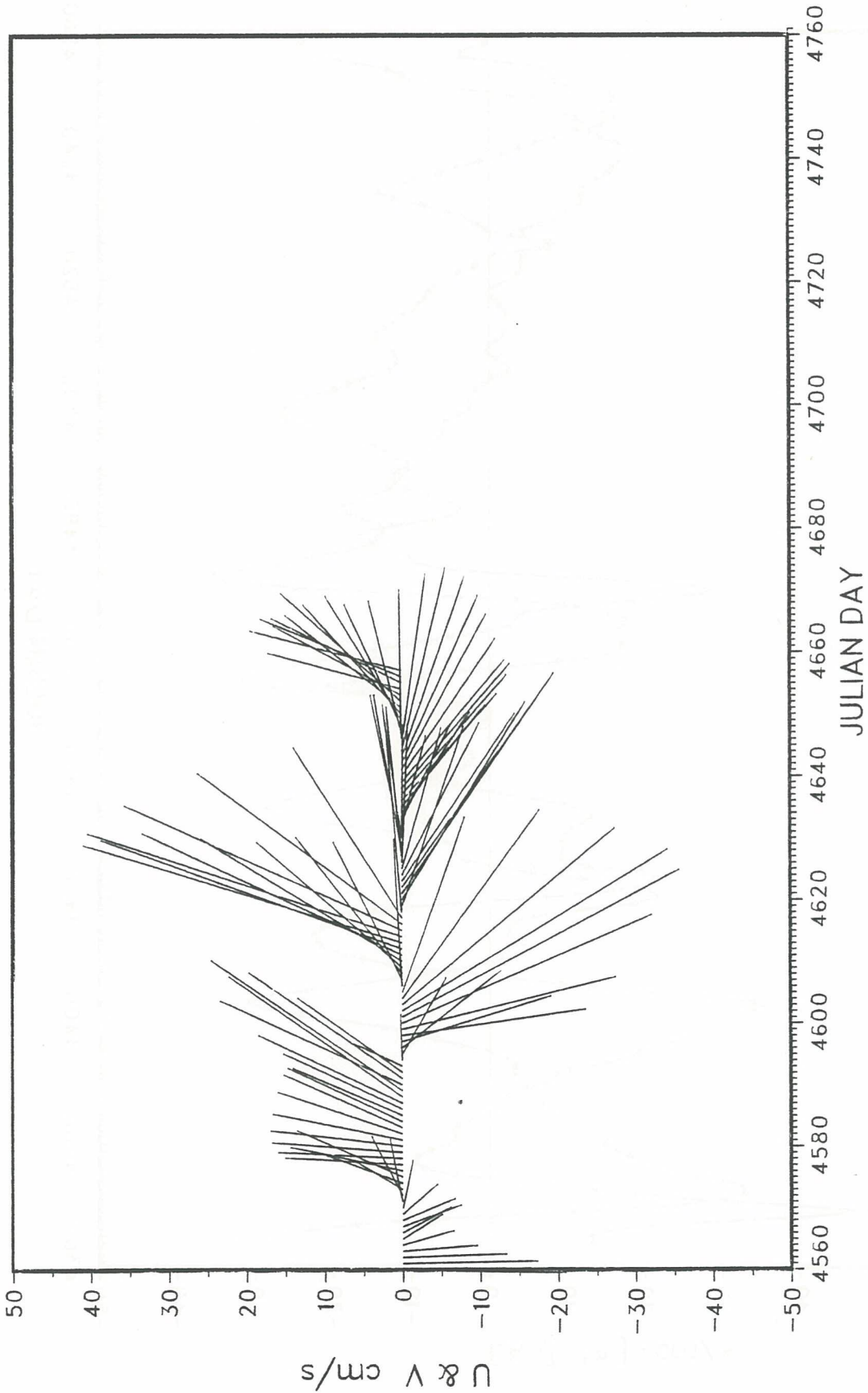
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GUSREX 104

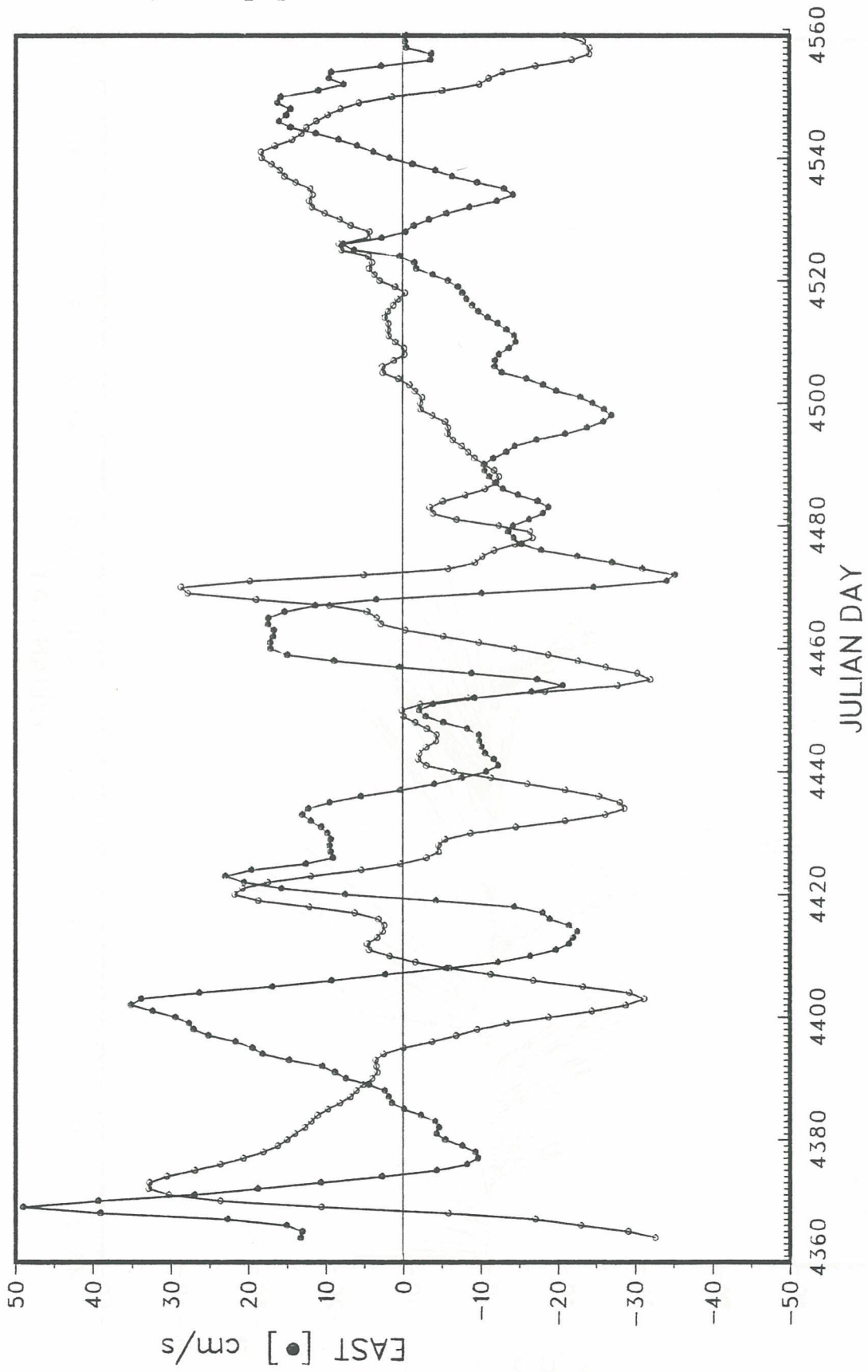


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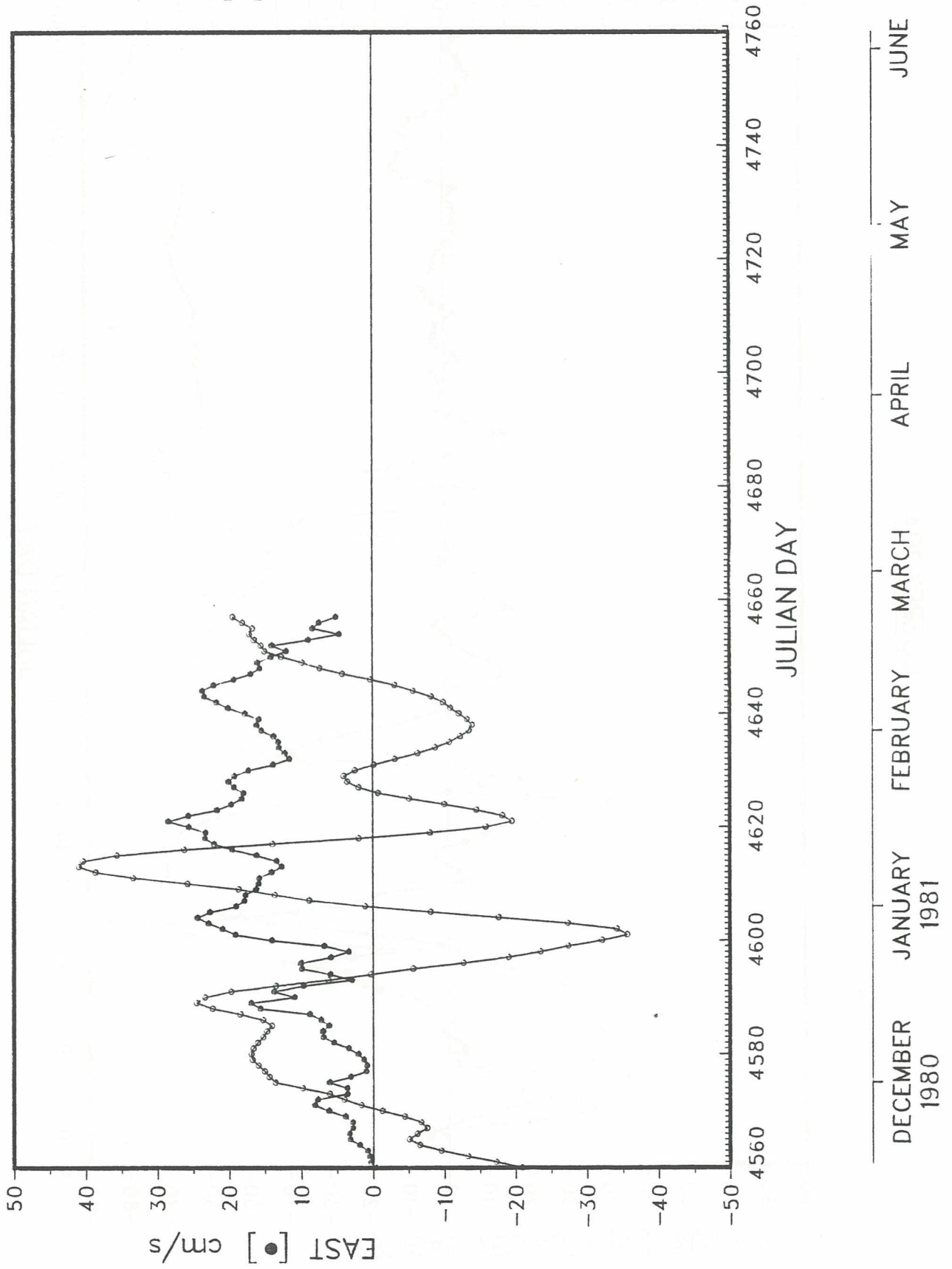
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GUSREX 104

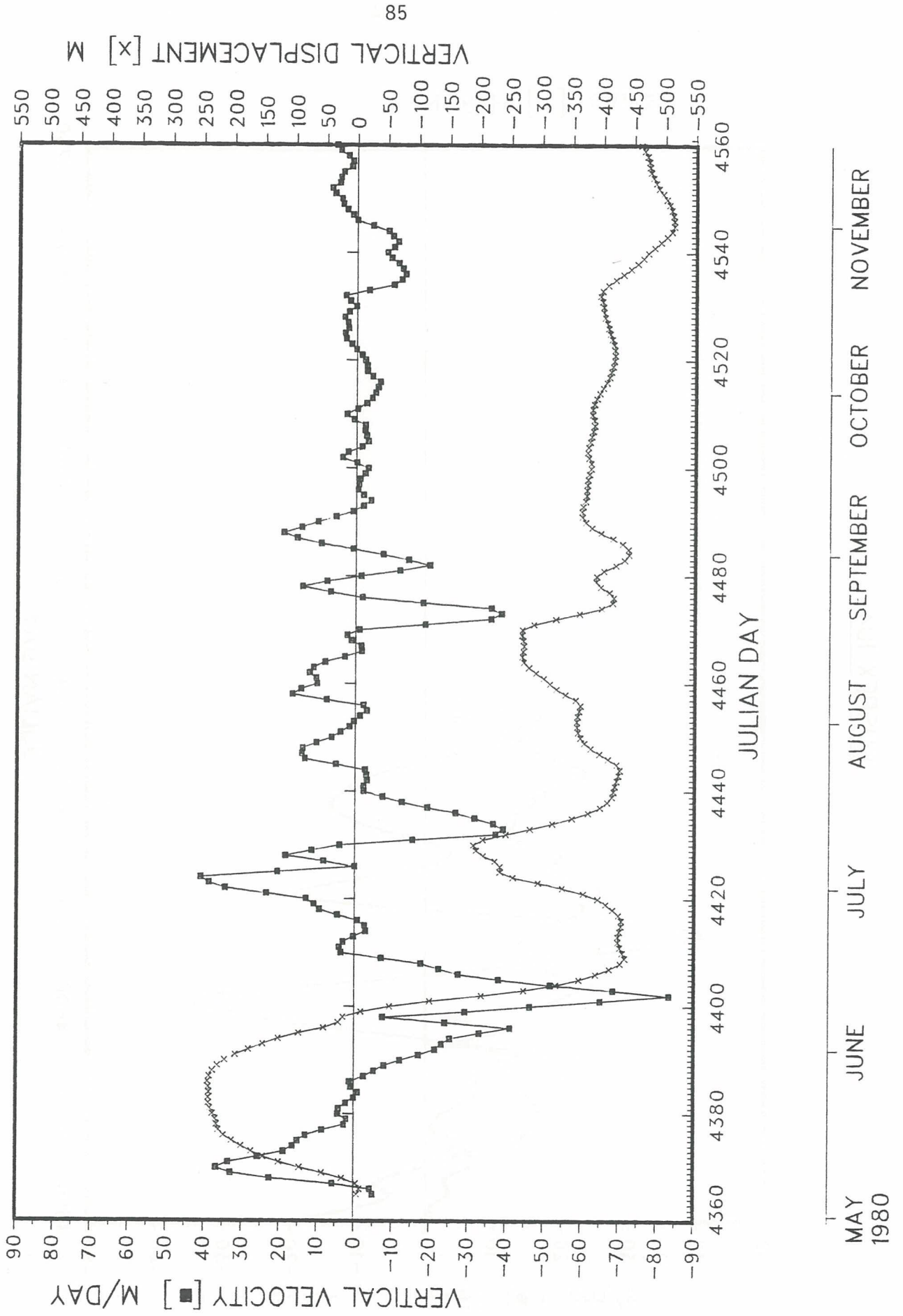


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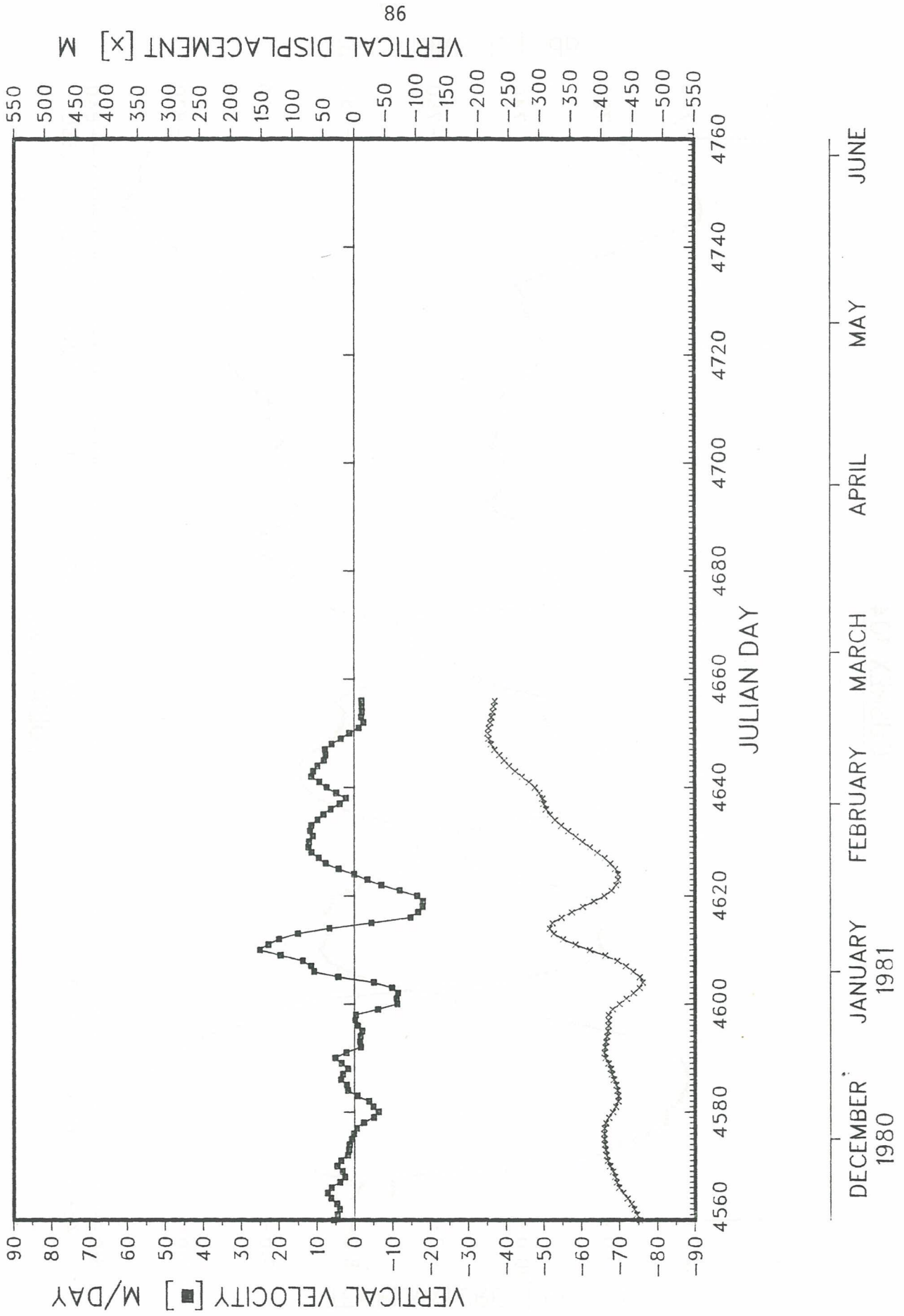
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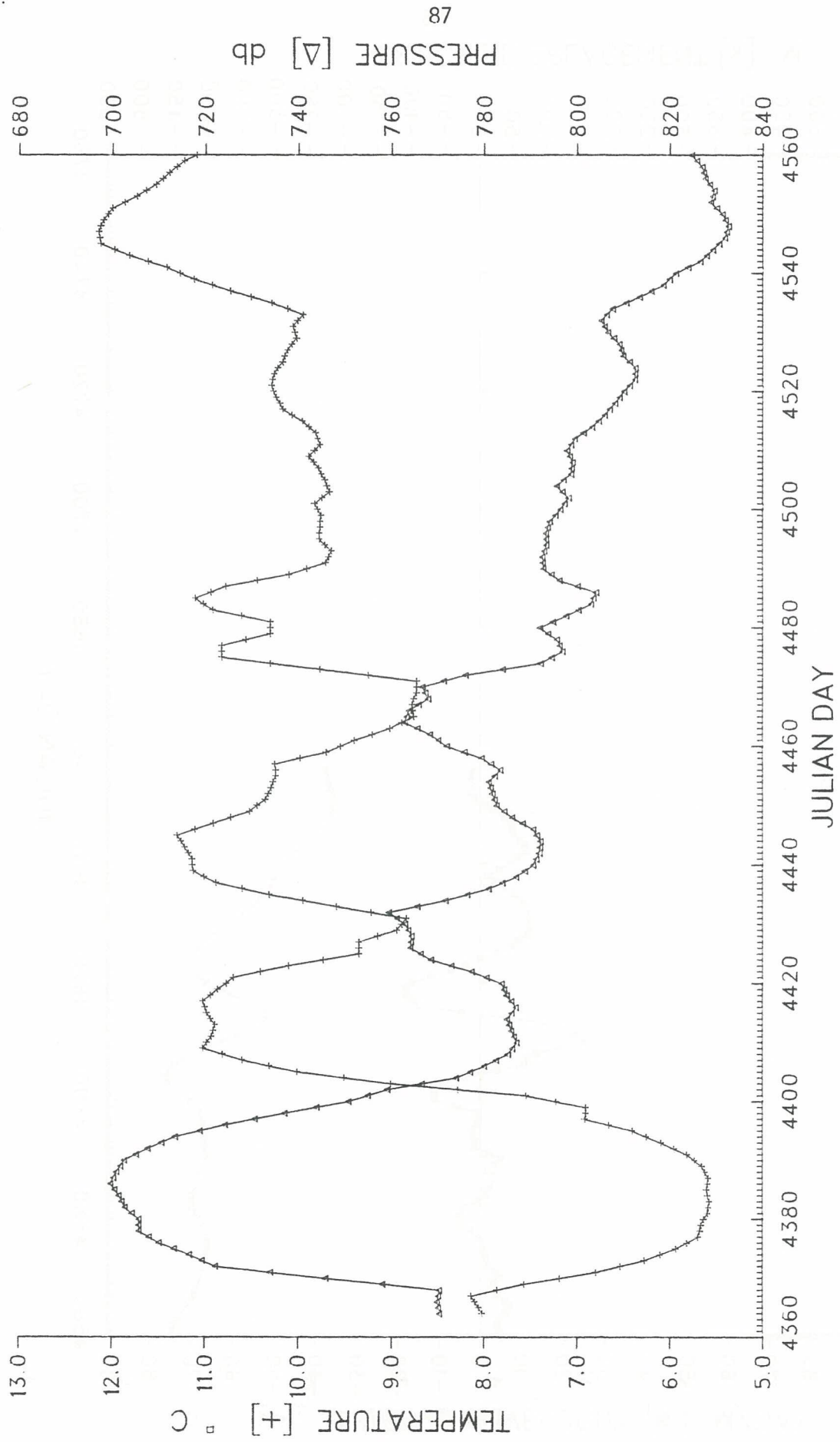
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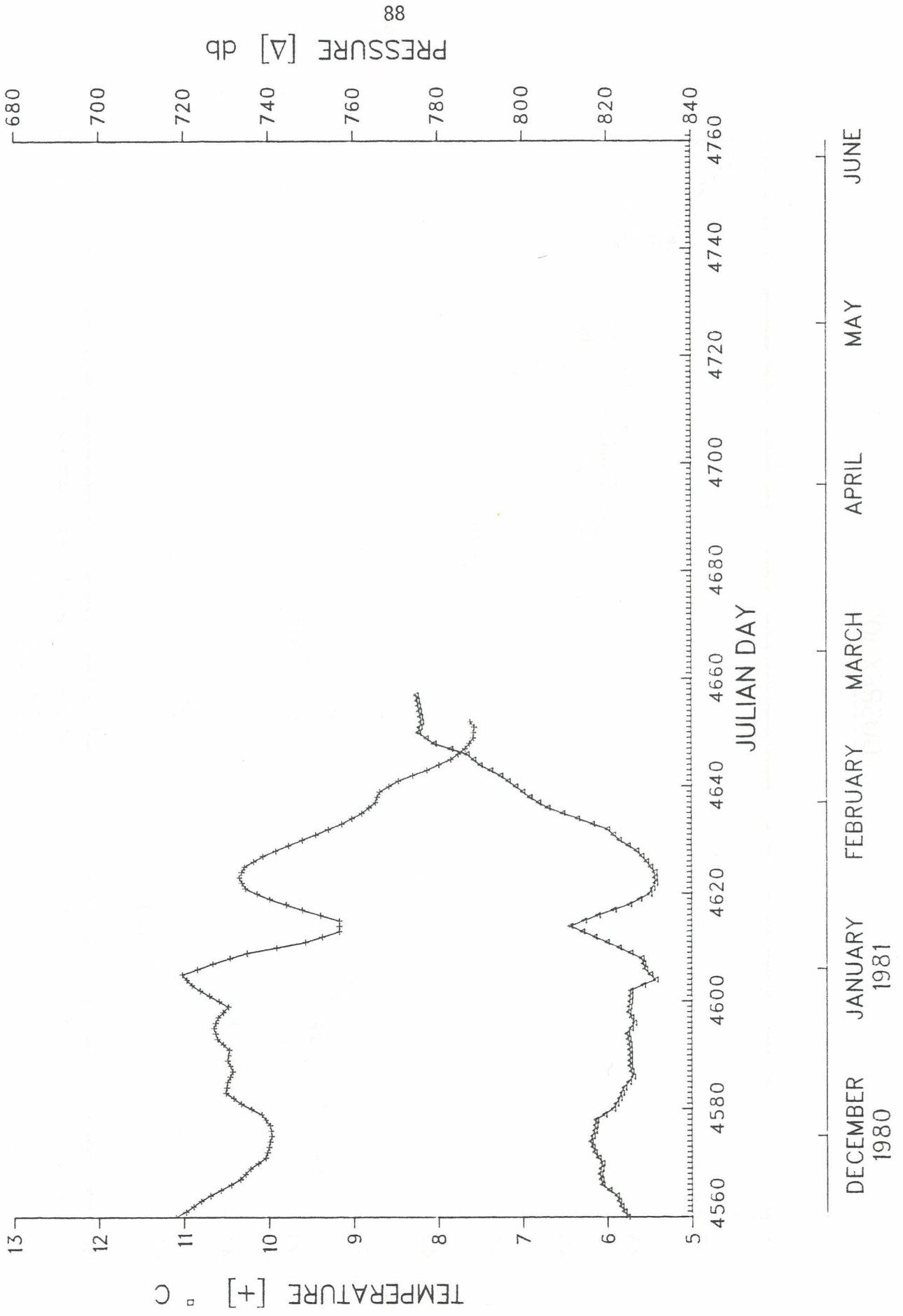
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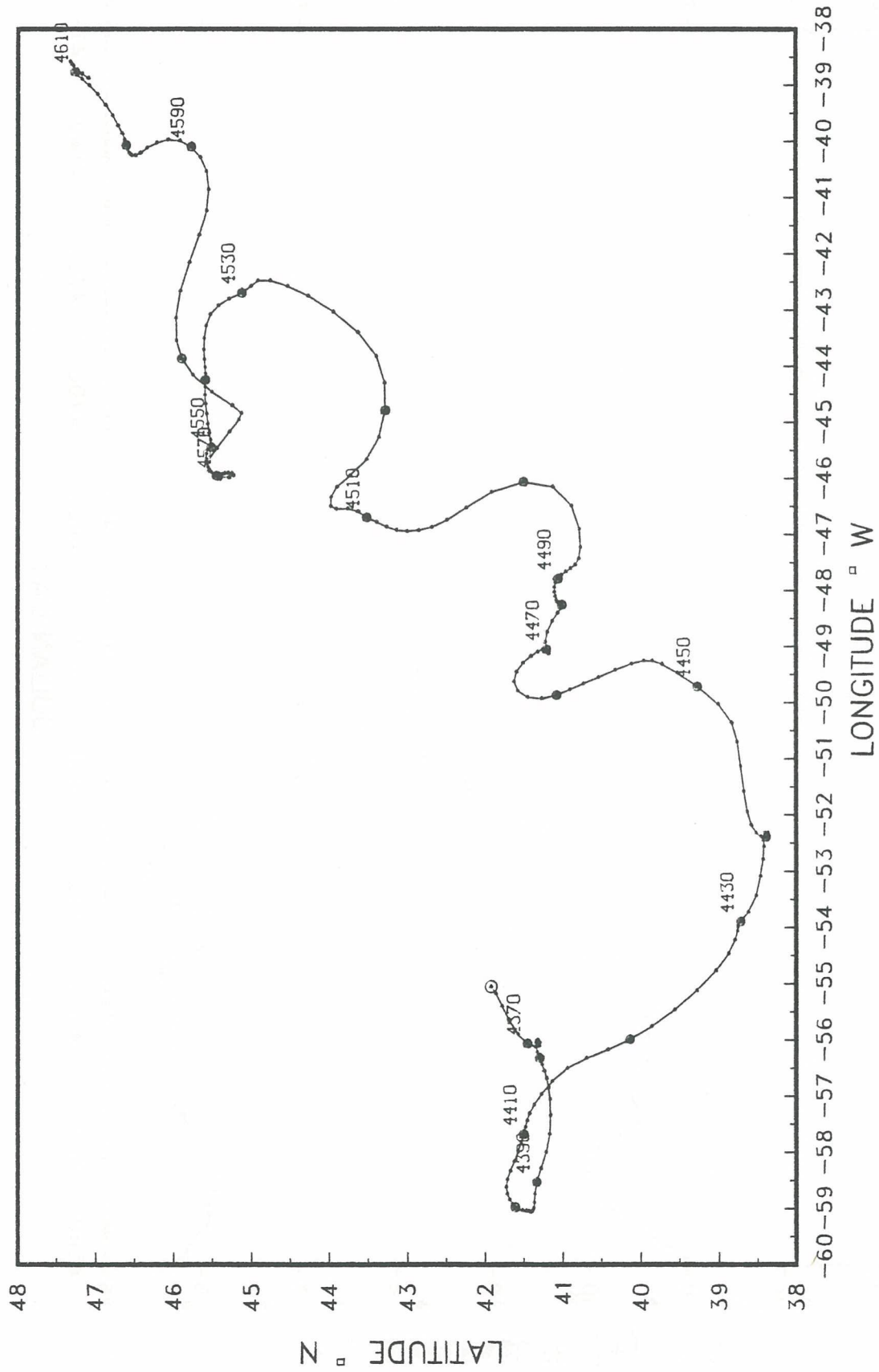
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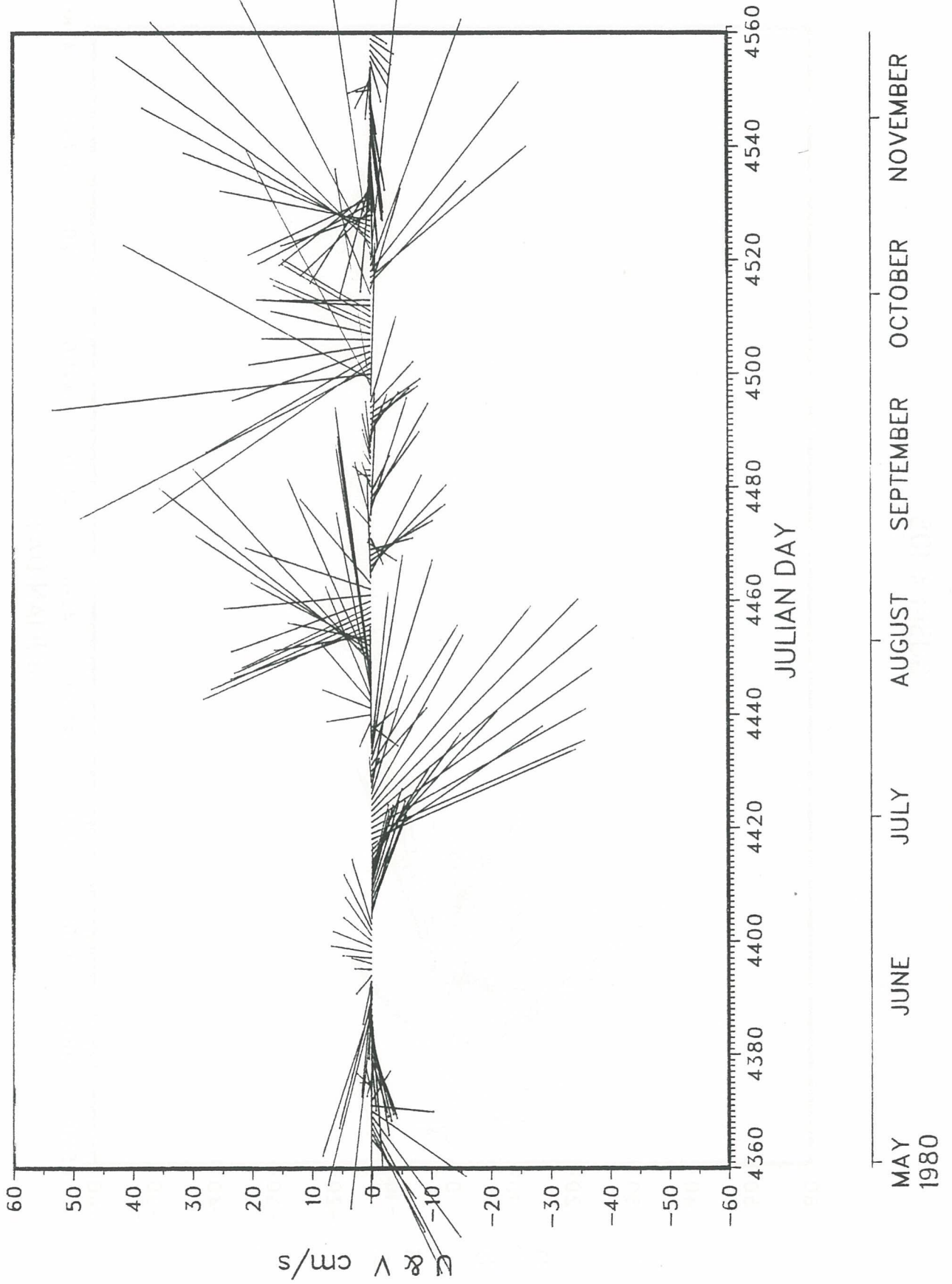
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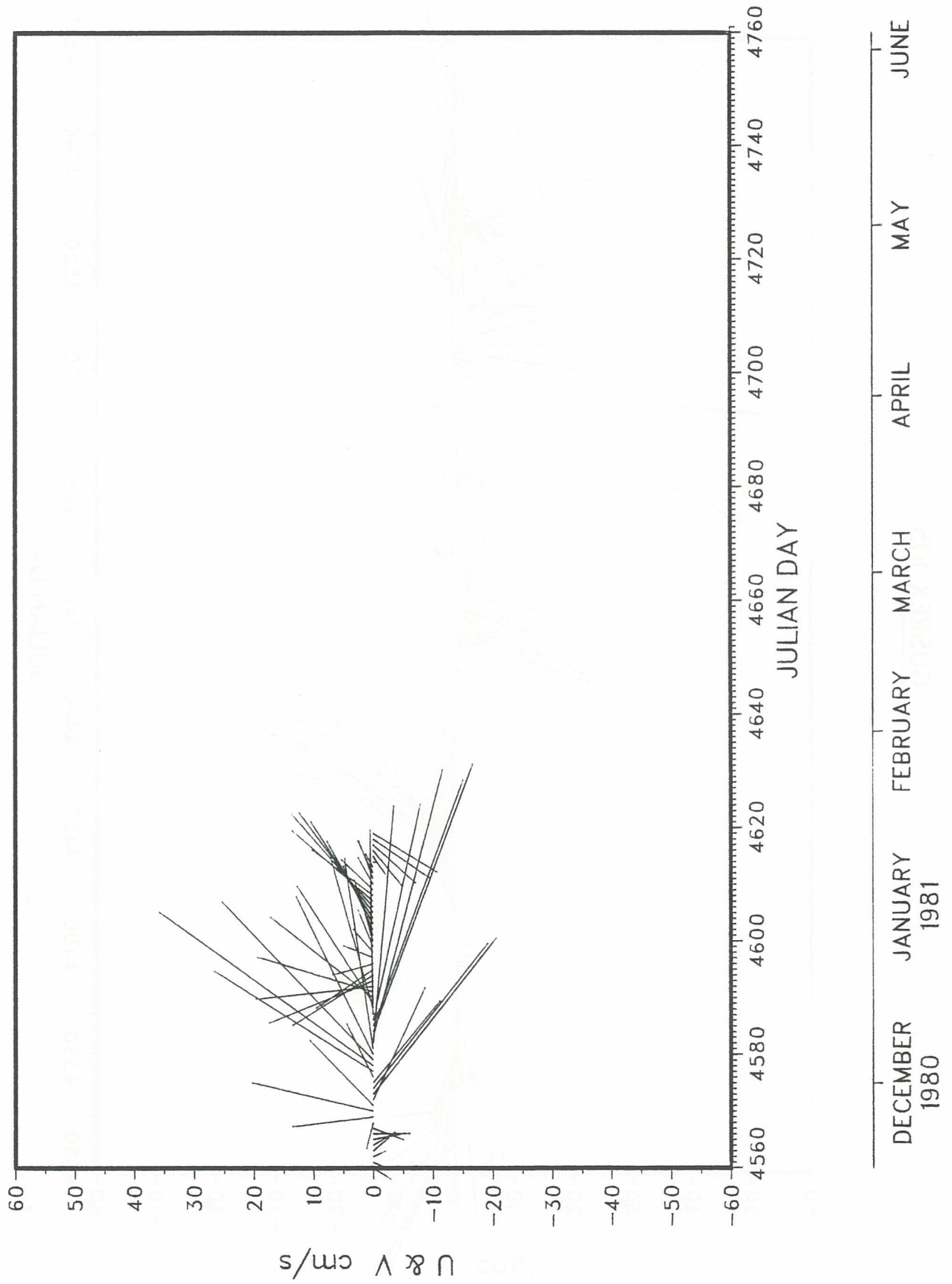
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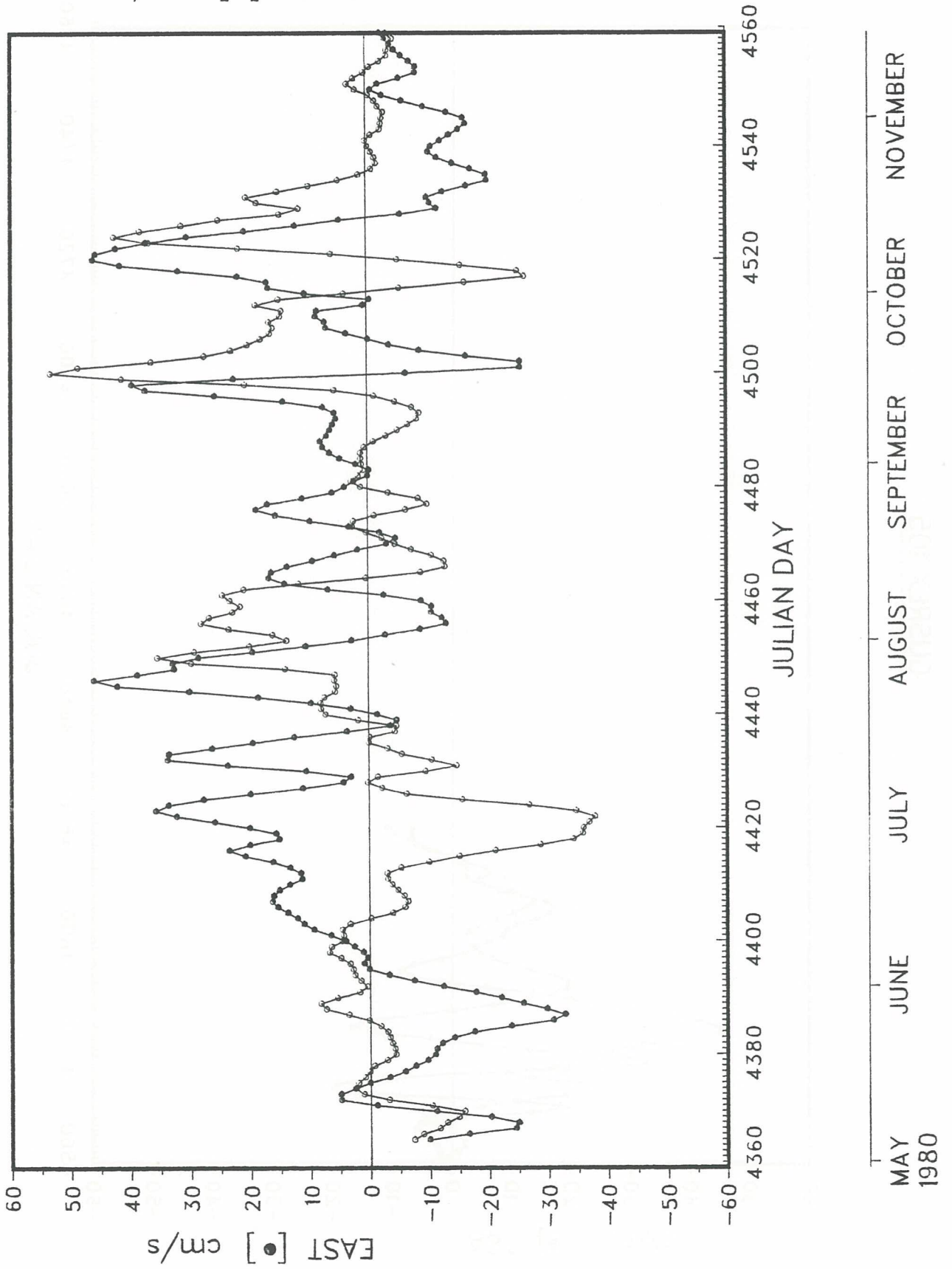
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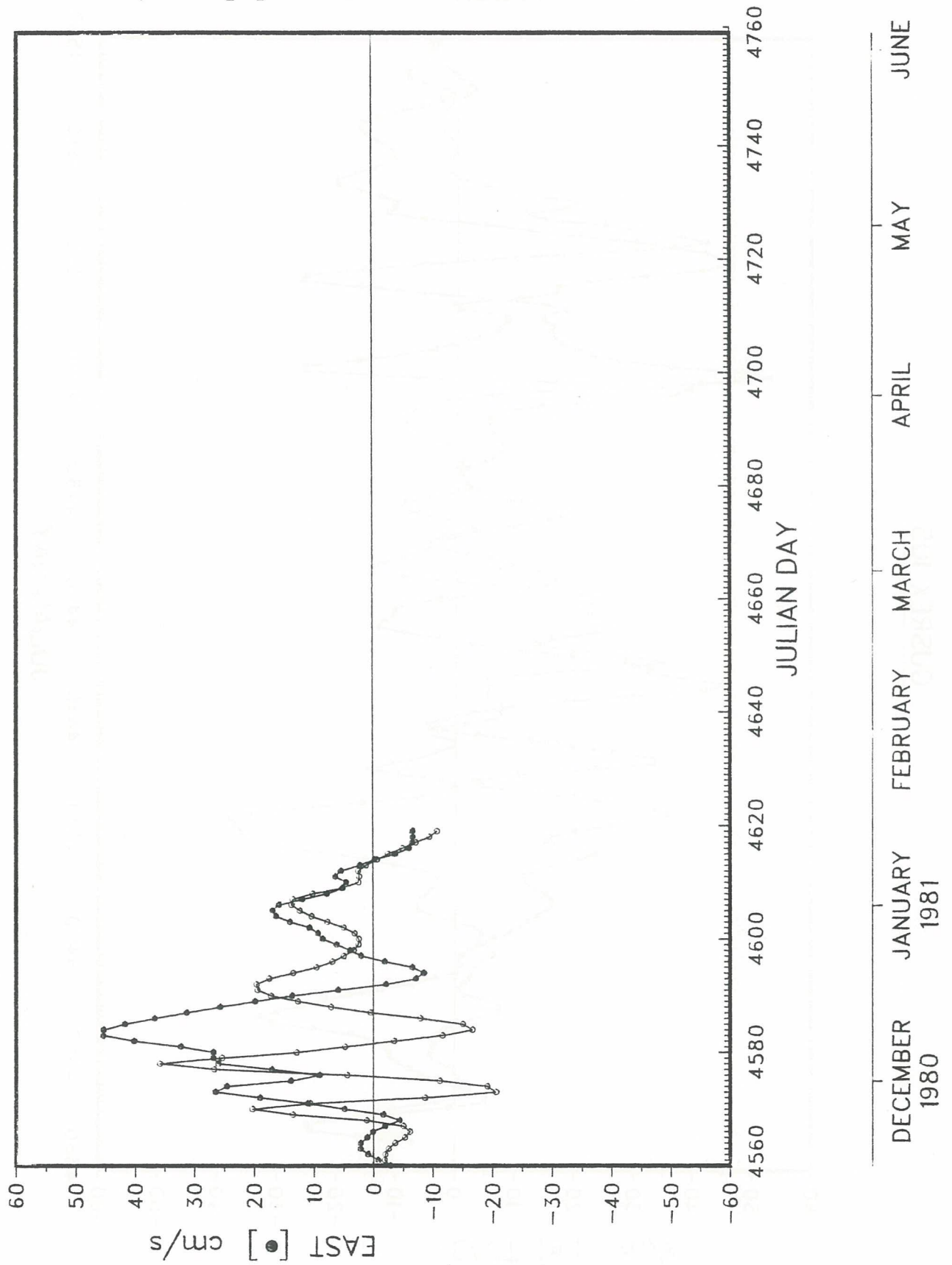
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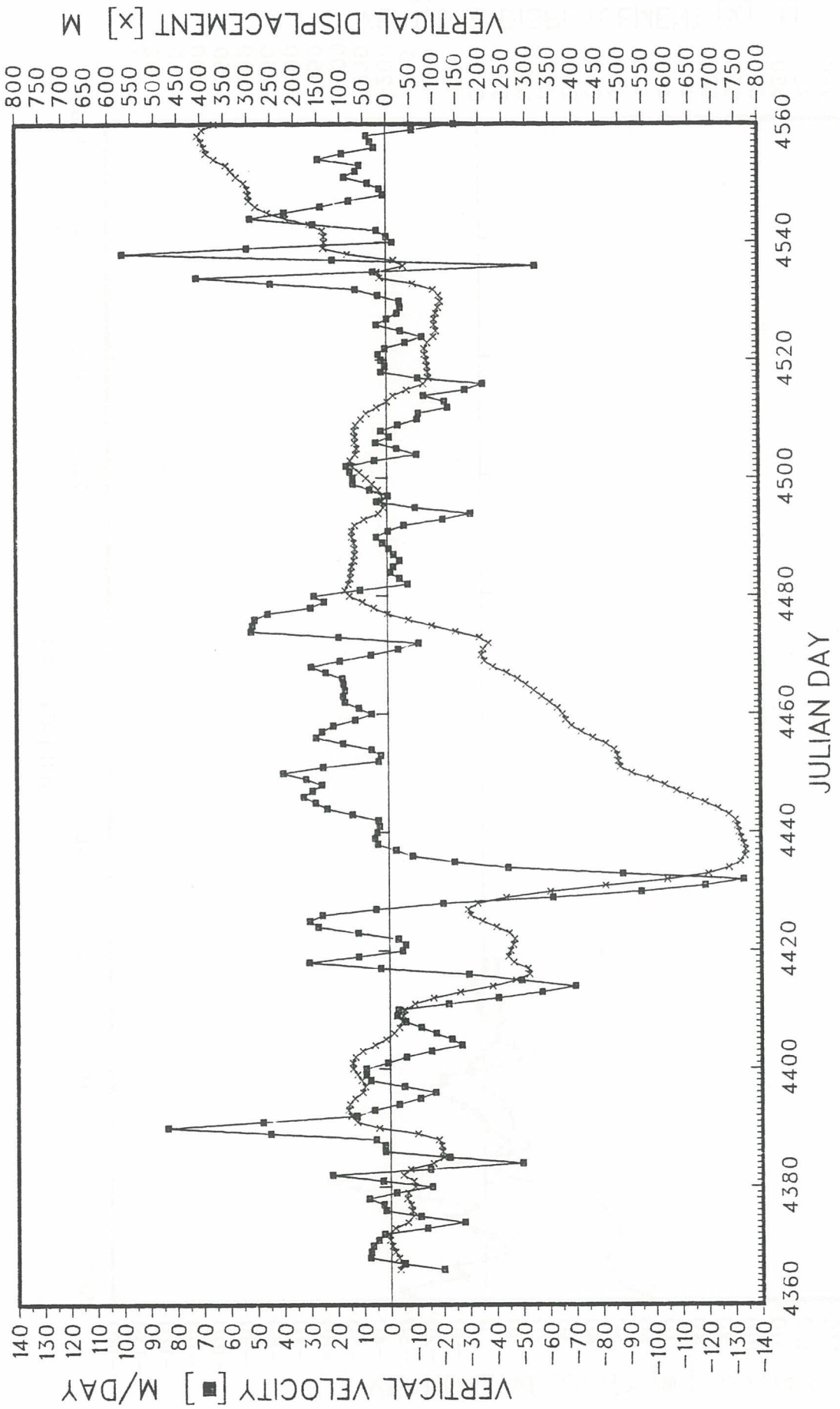
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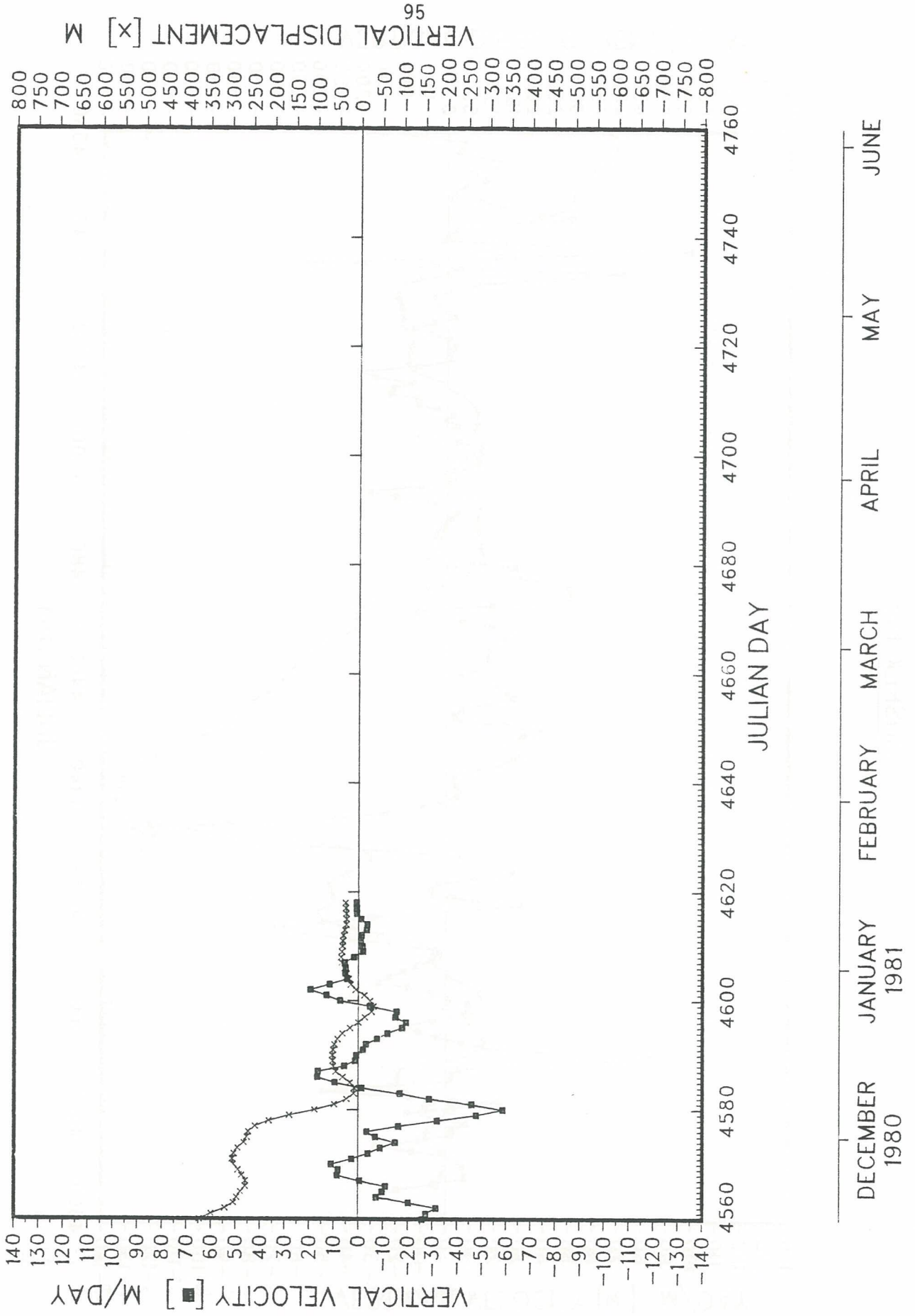
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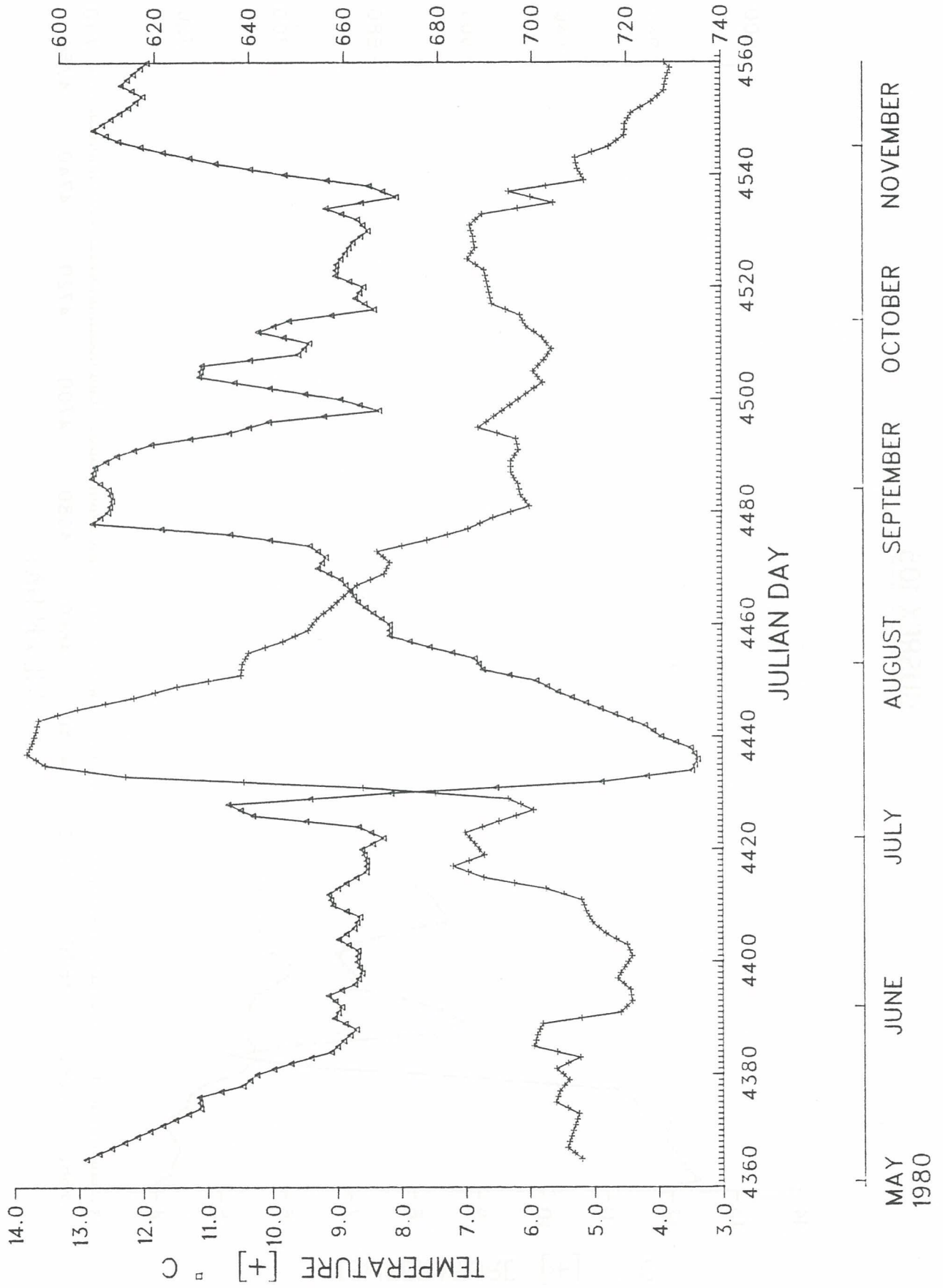
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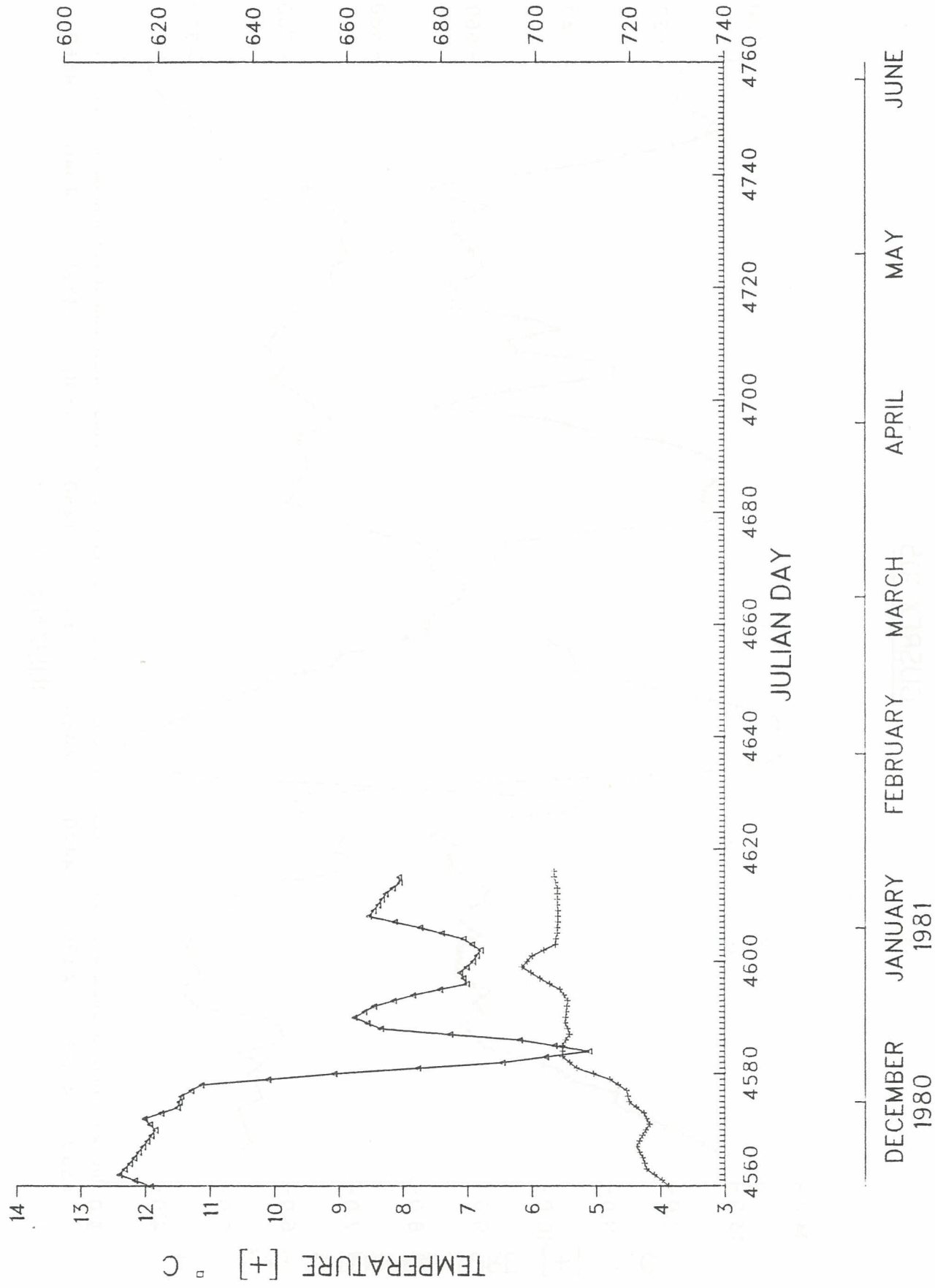
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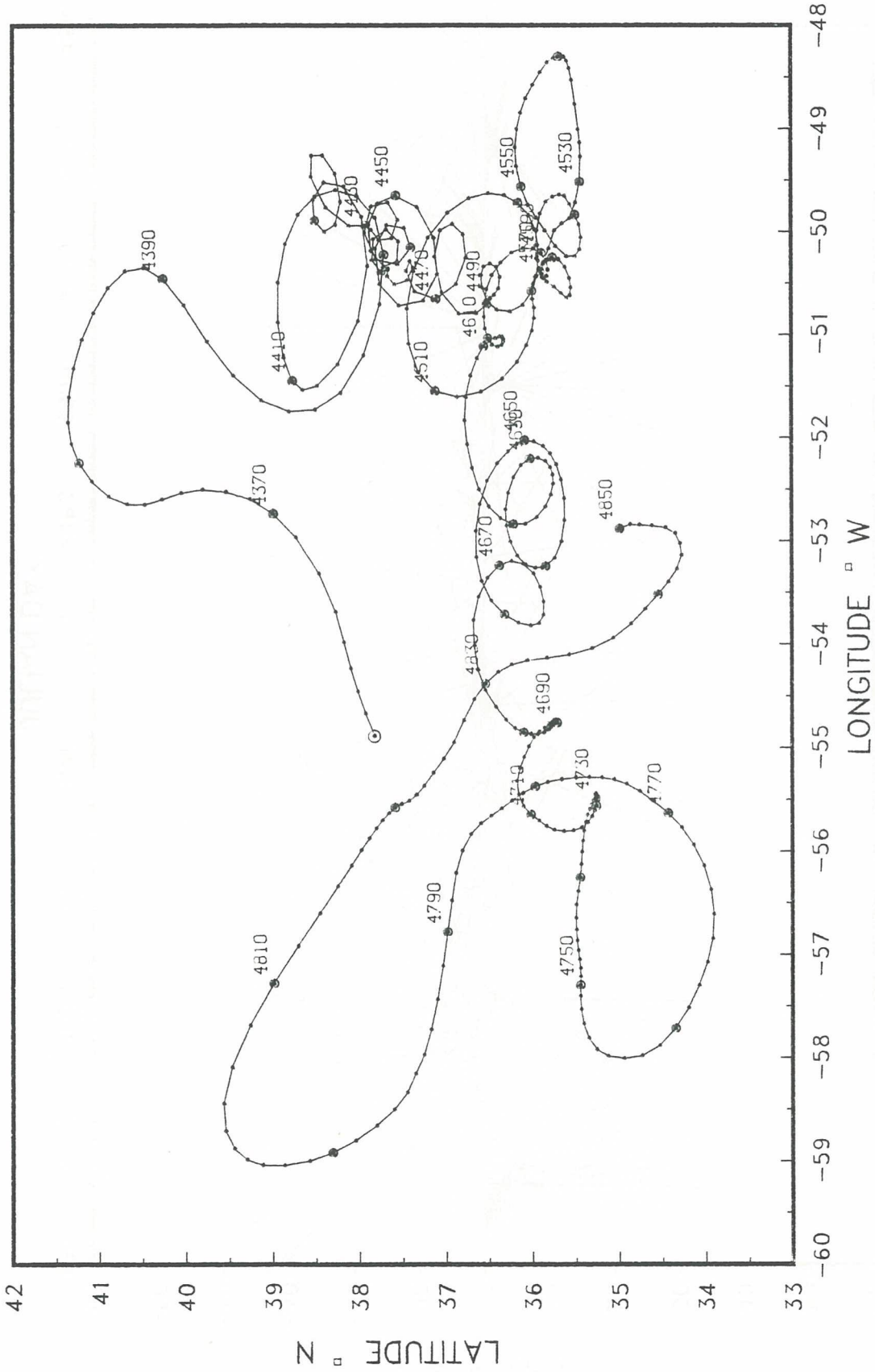
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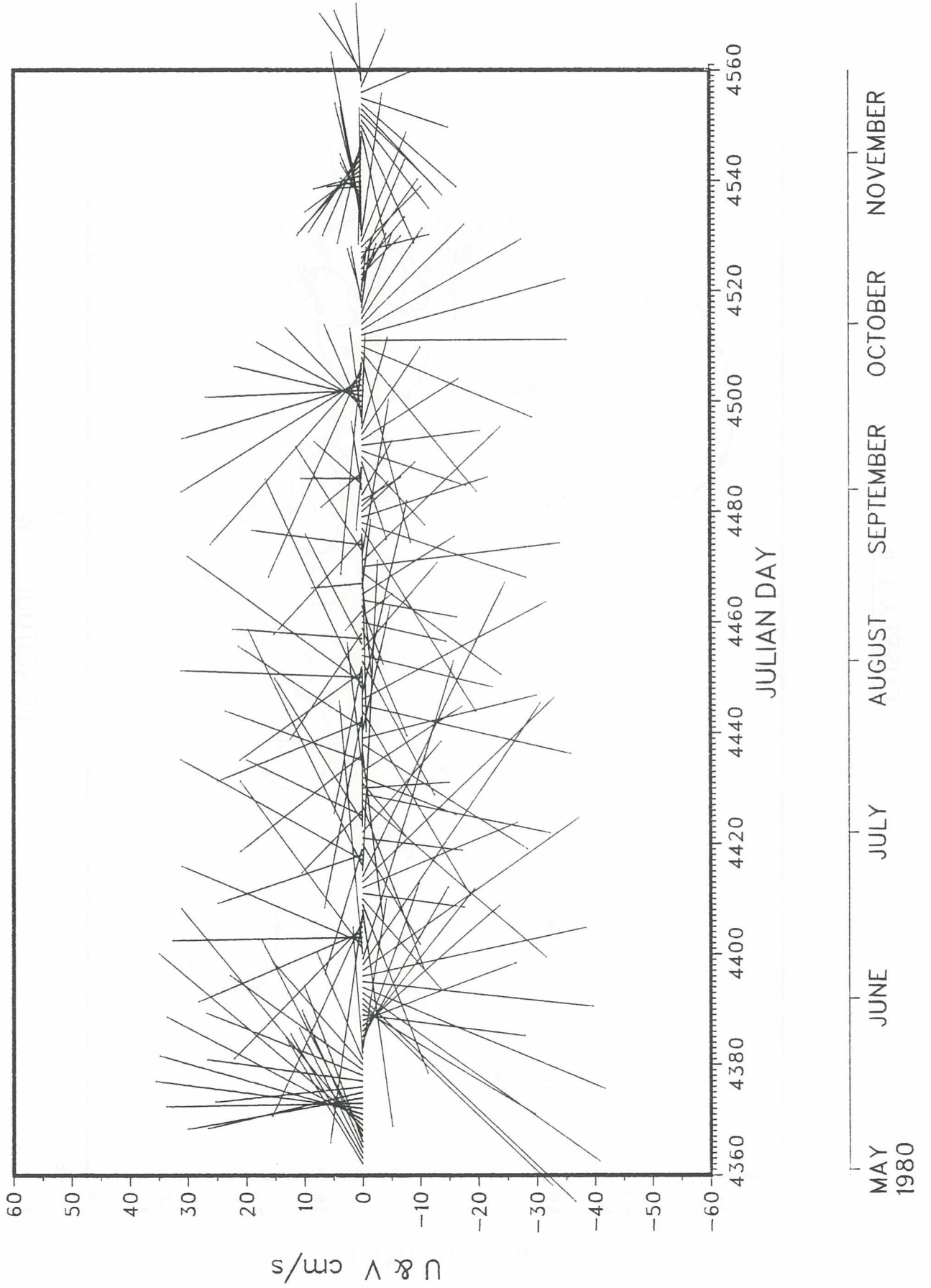
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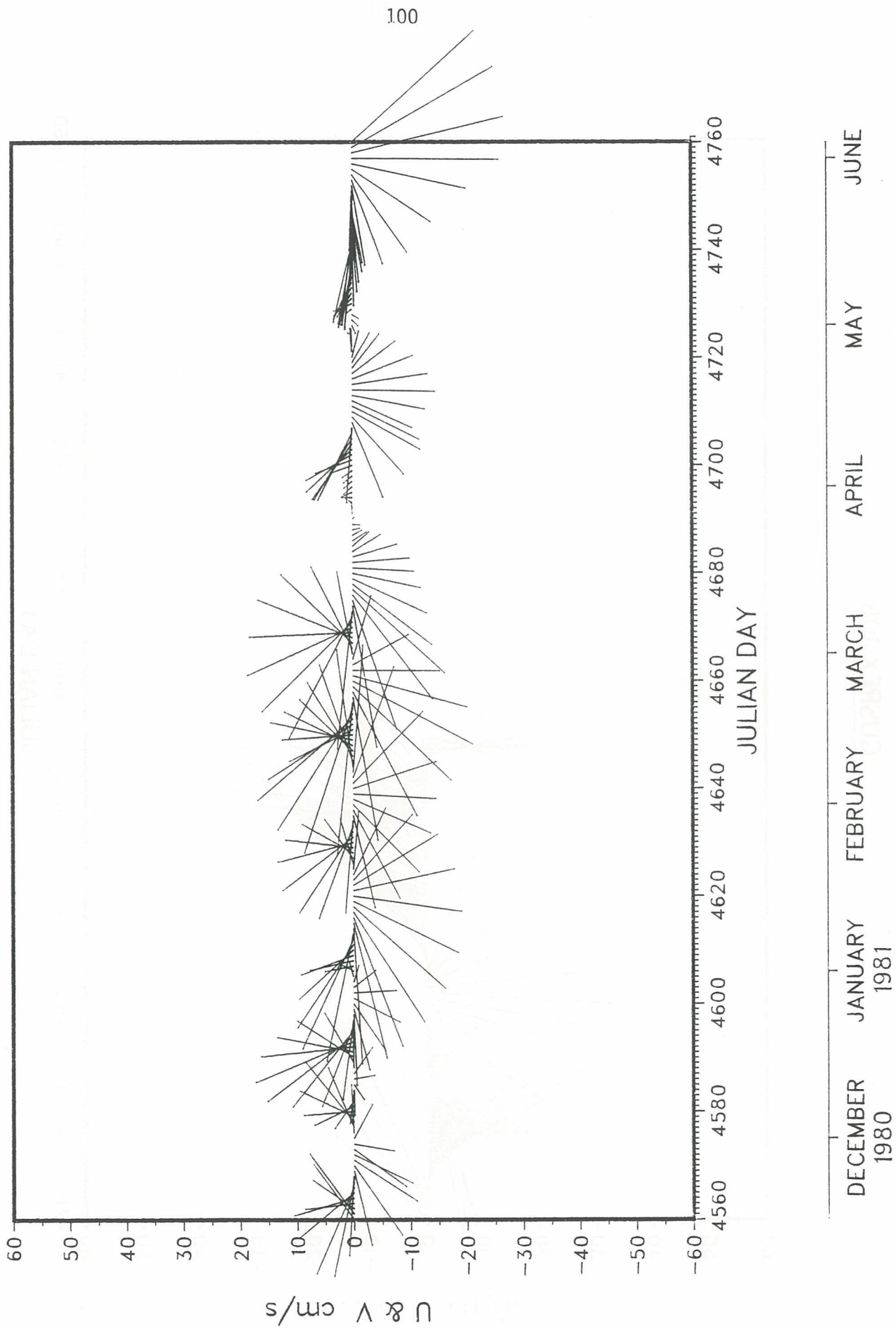
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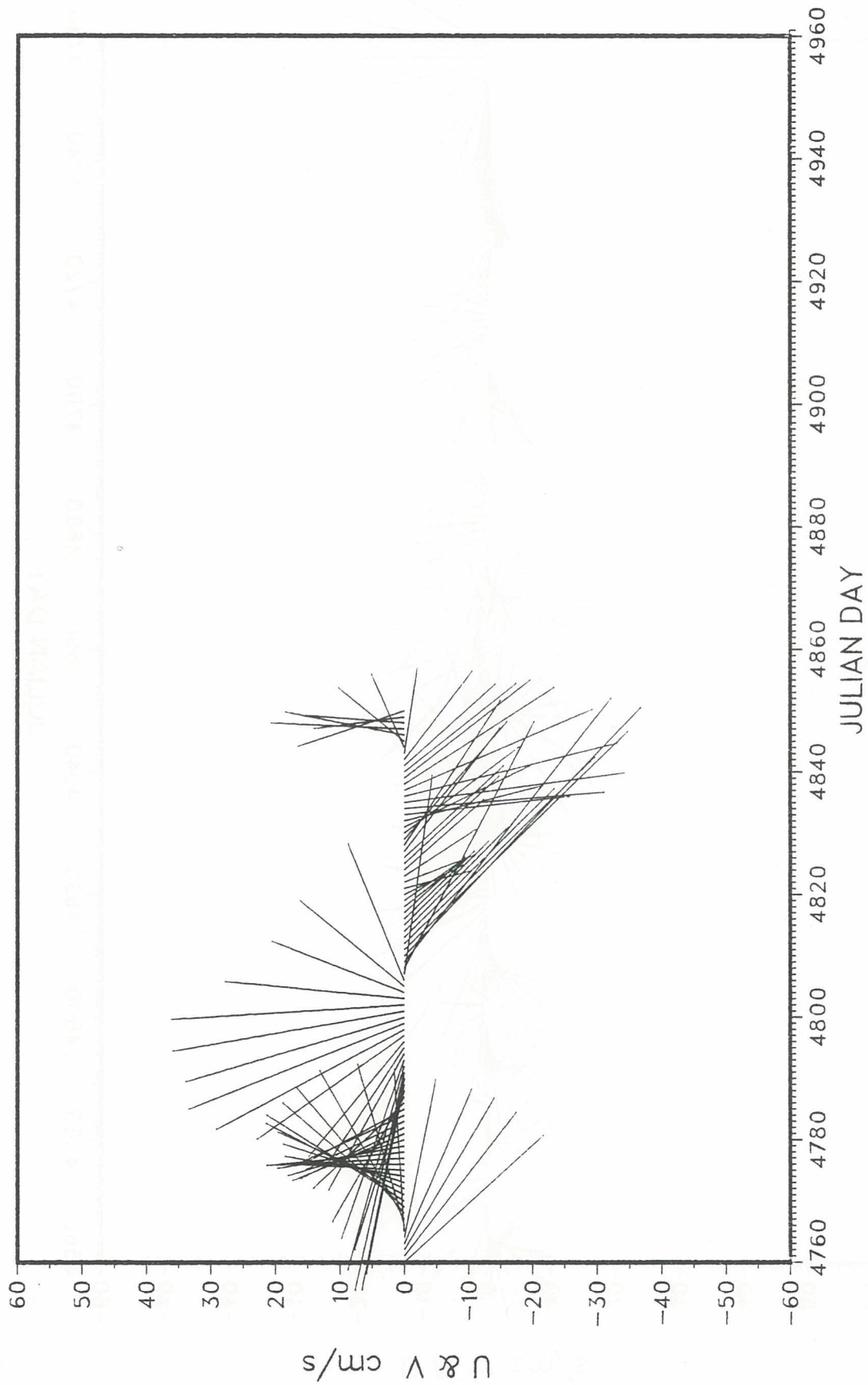
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GUSREX 106

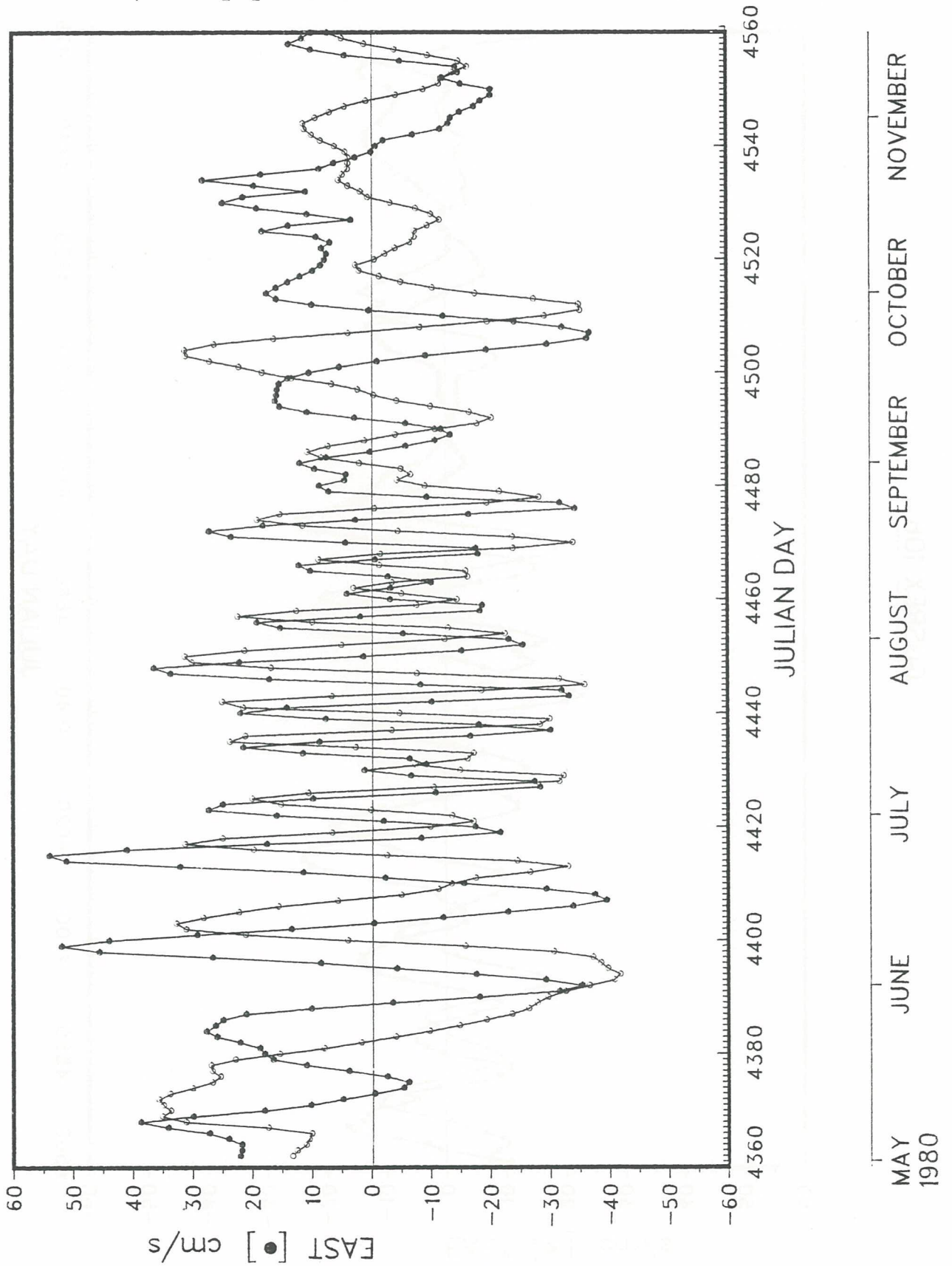


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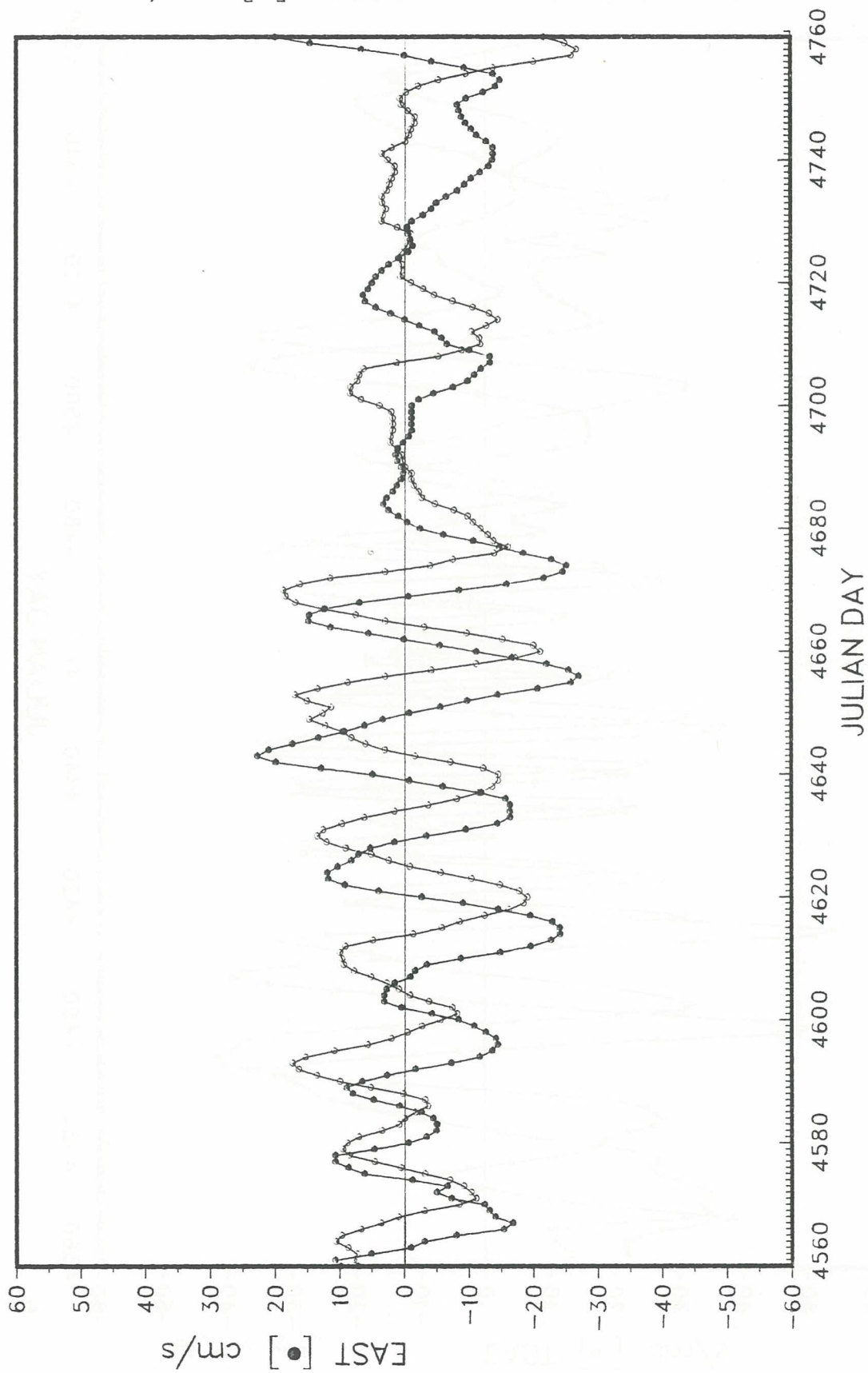


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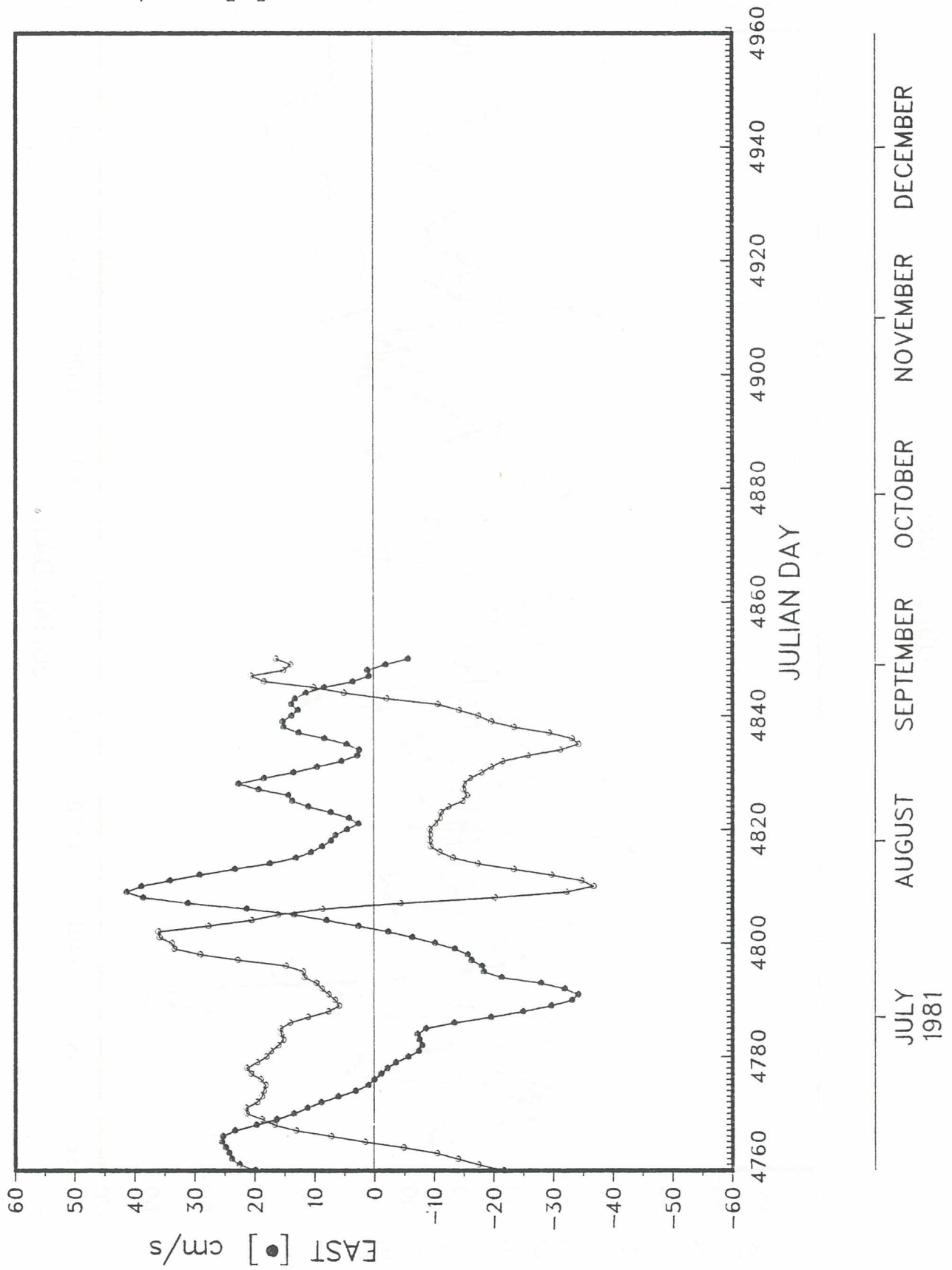
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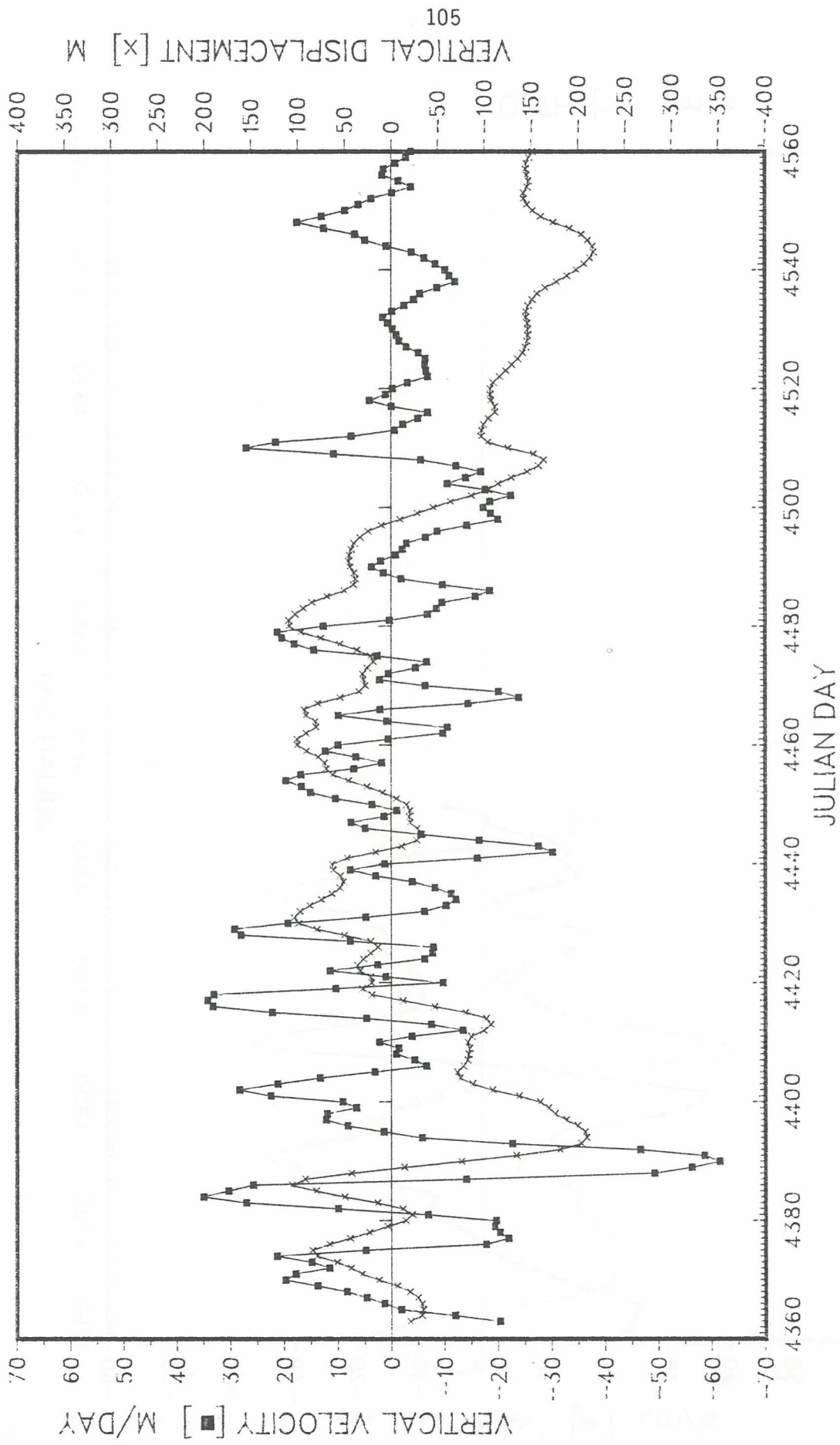
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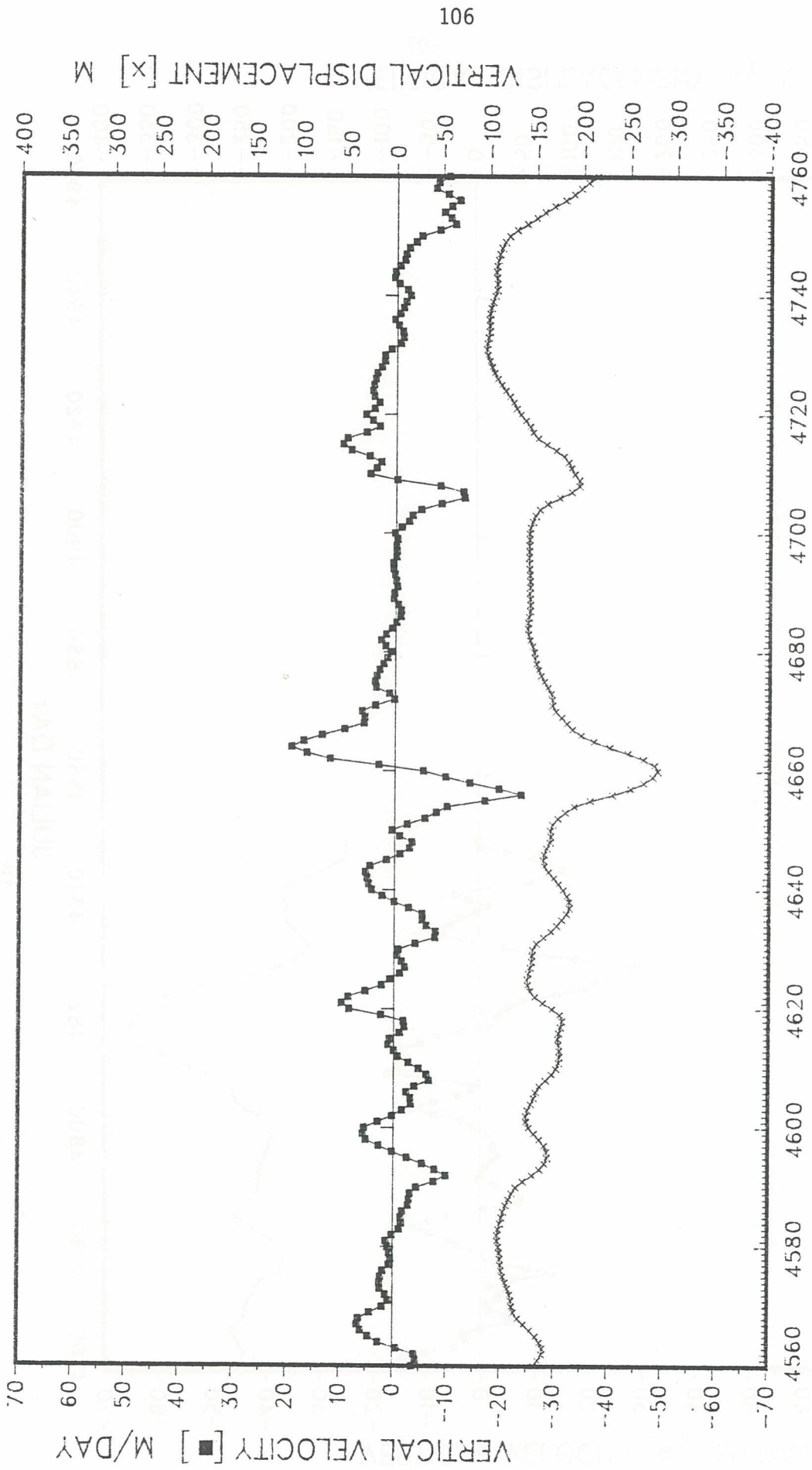
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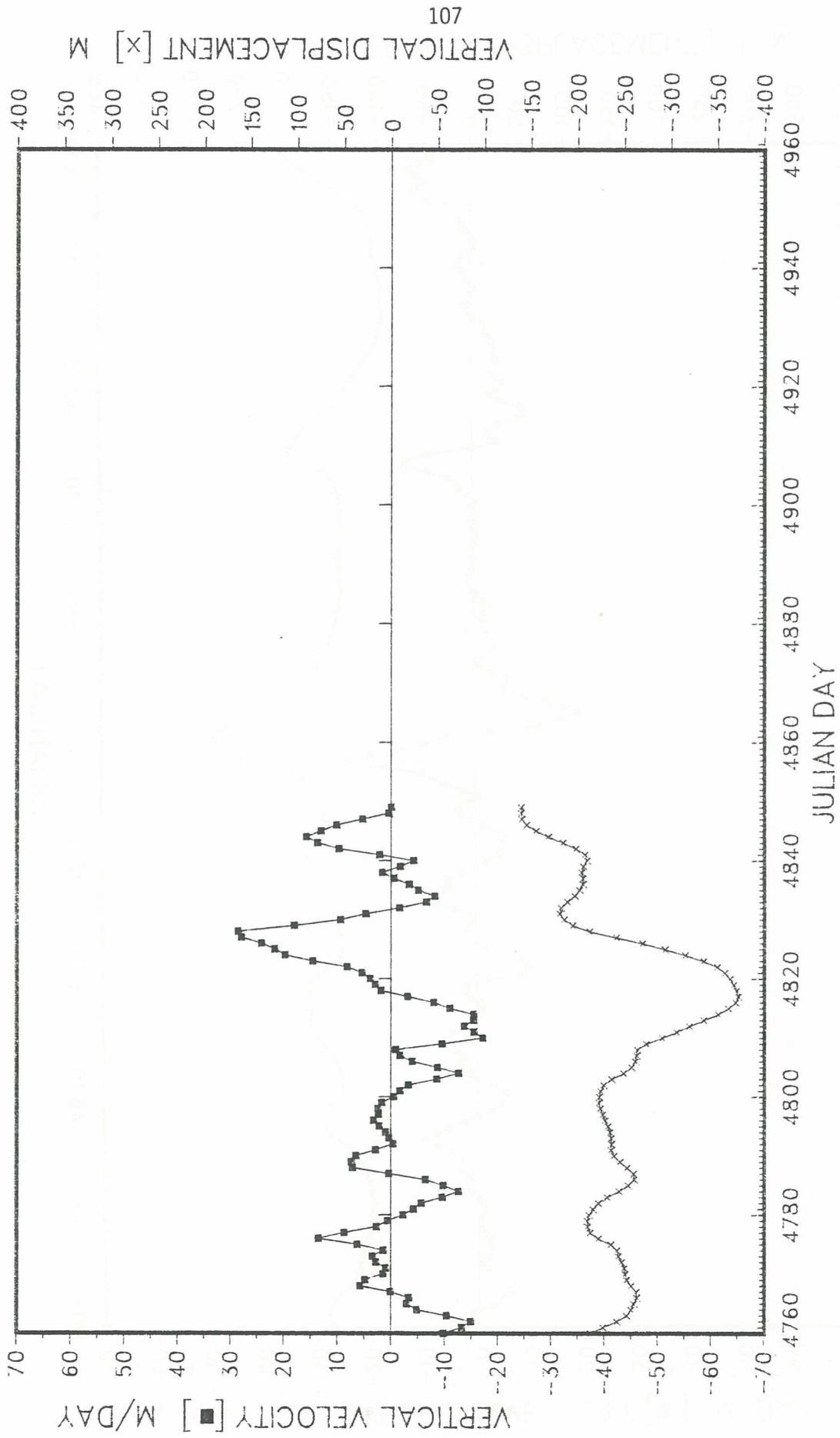
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GUSREX 106

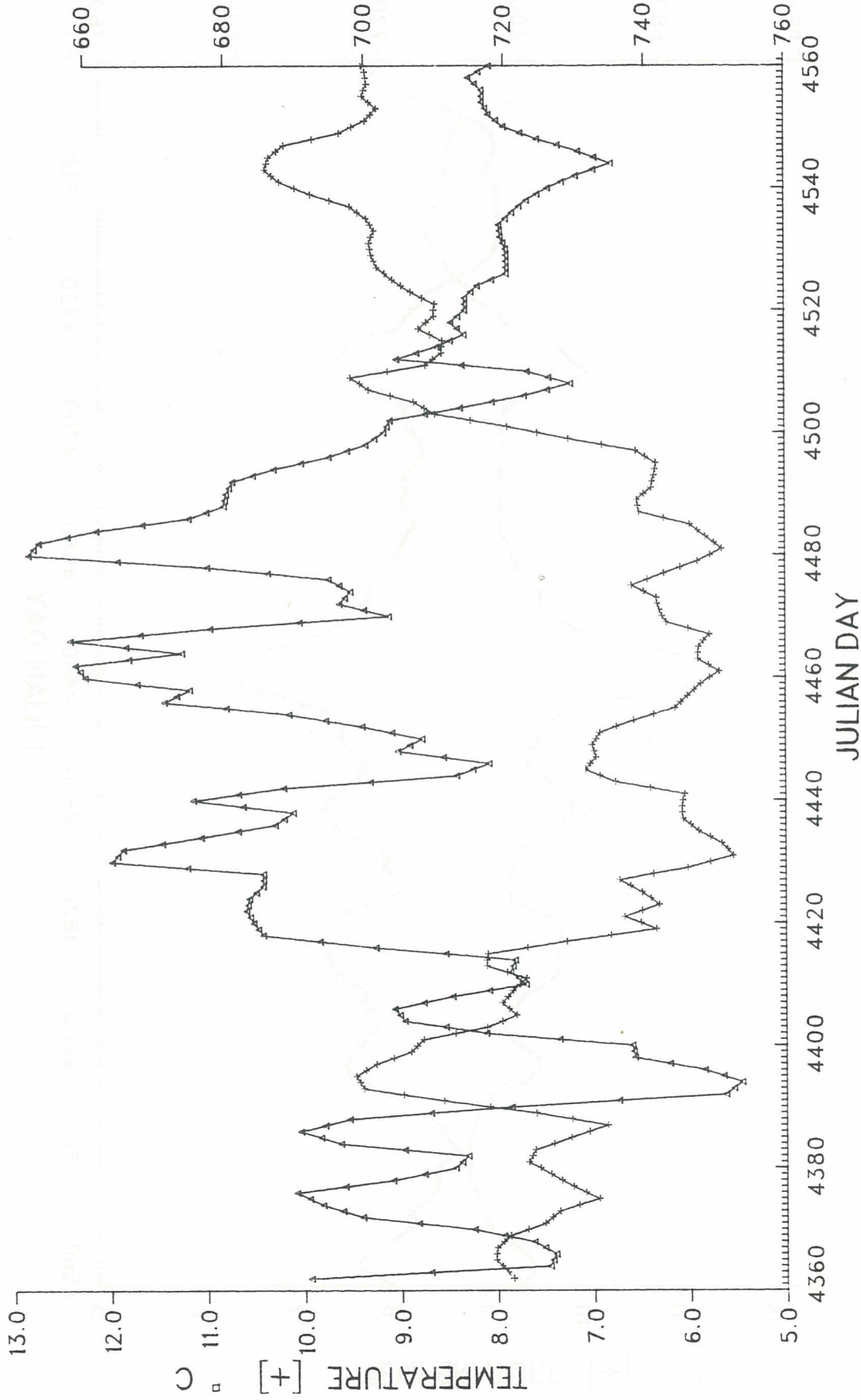


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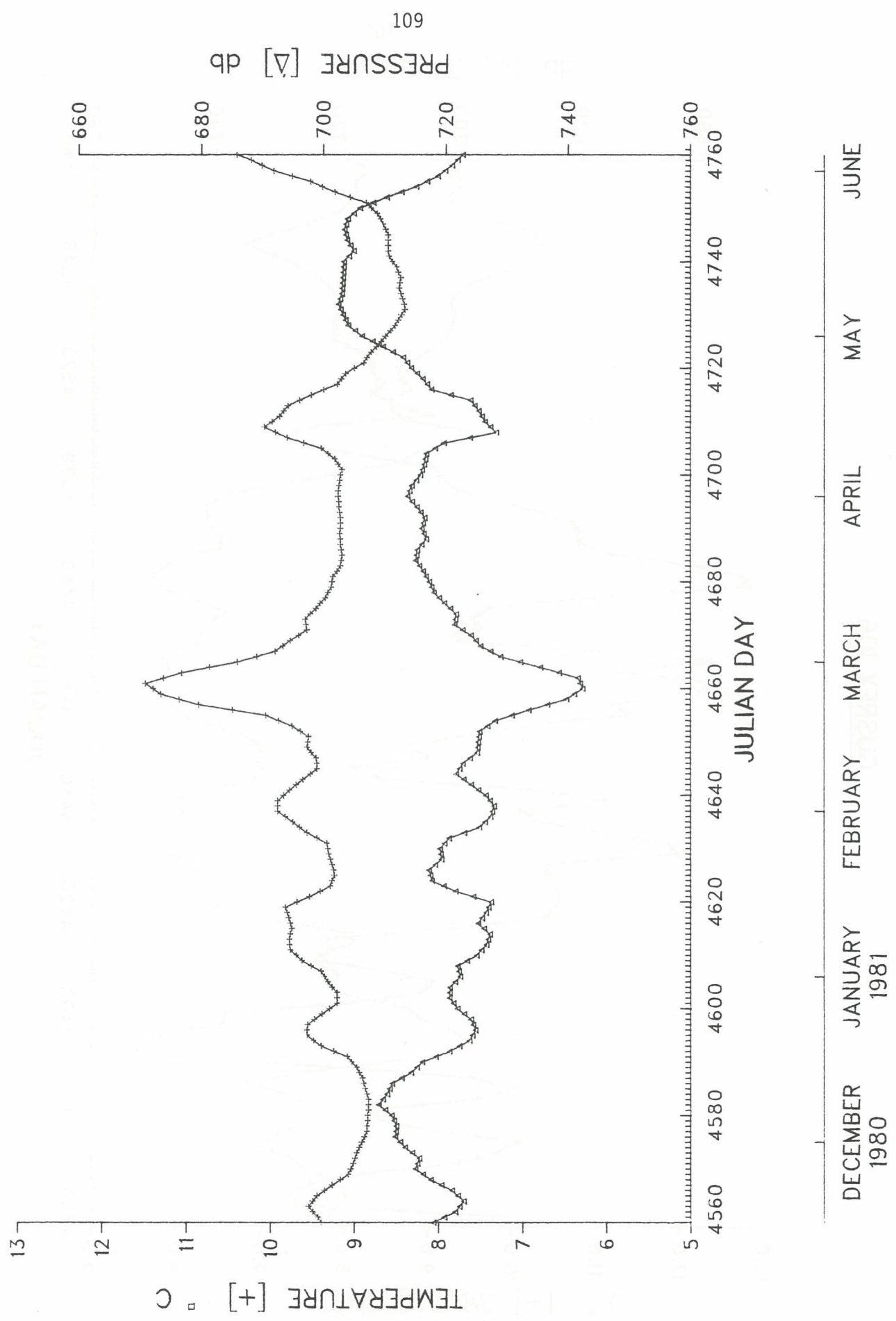
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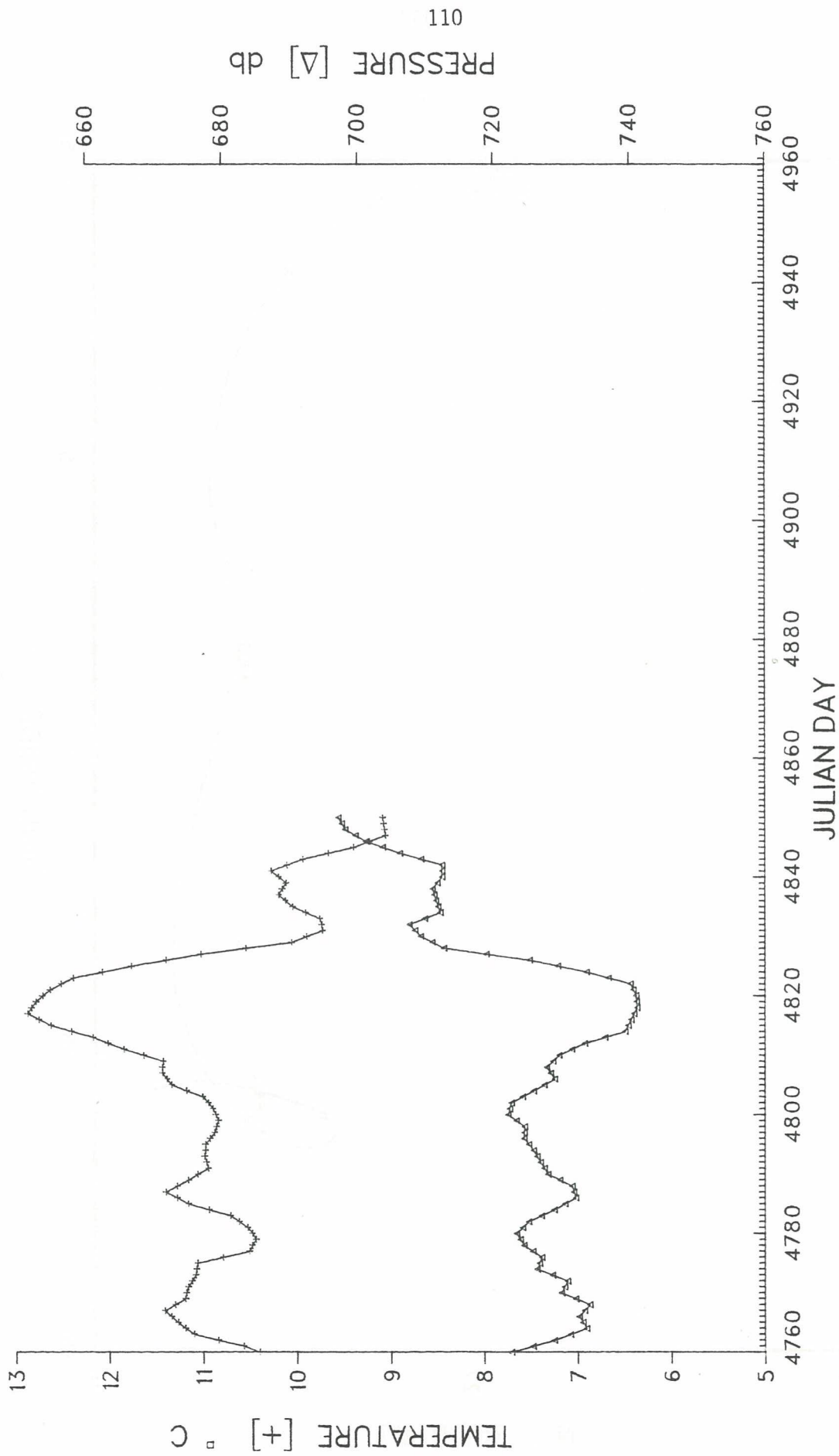
108

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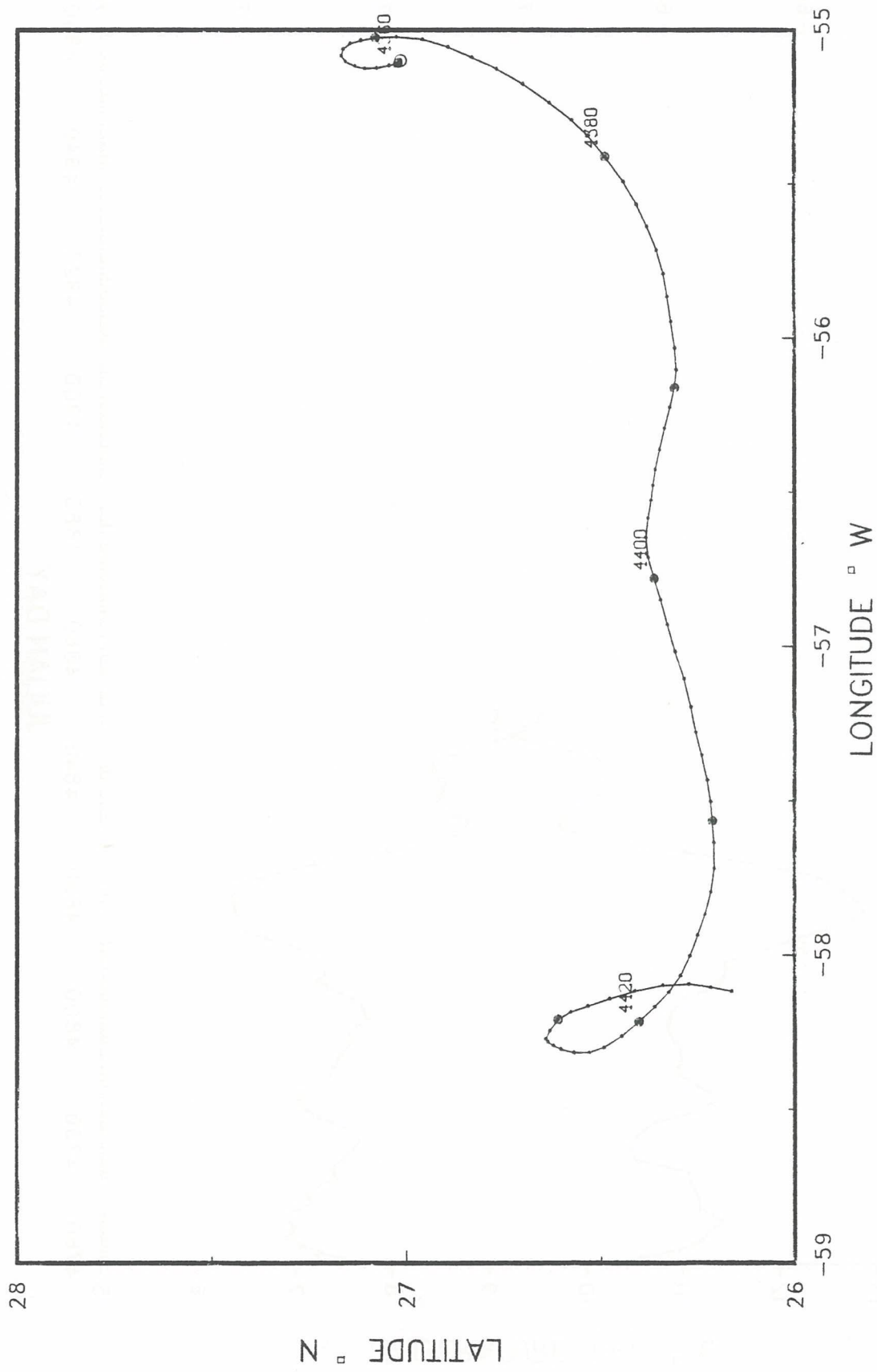
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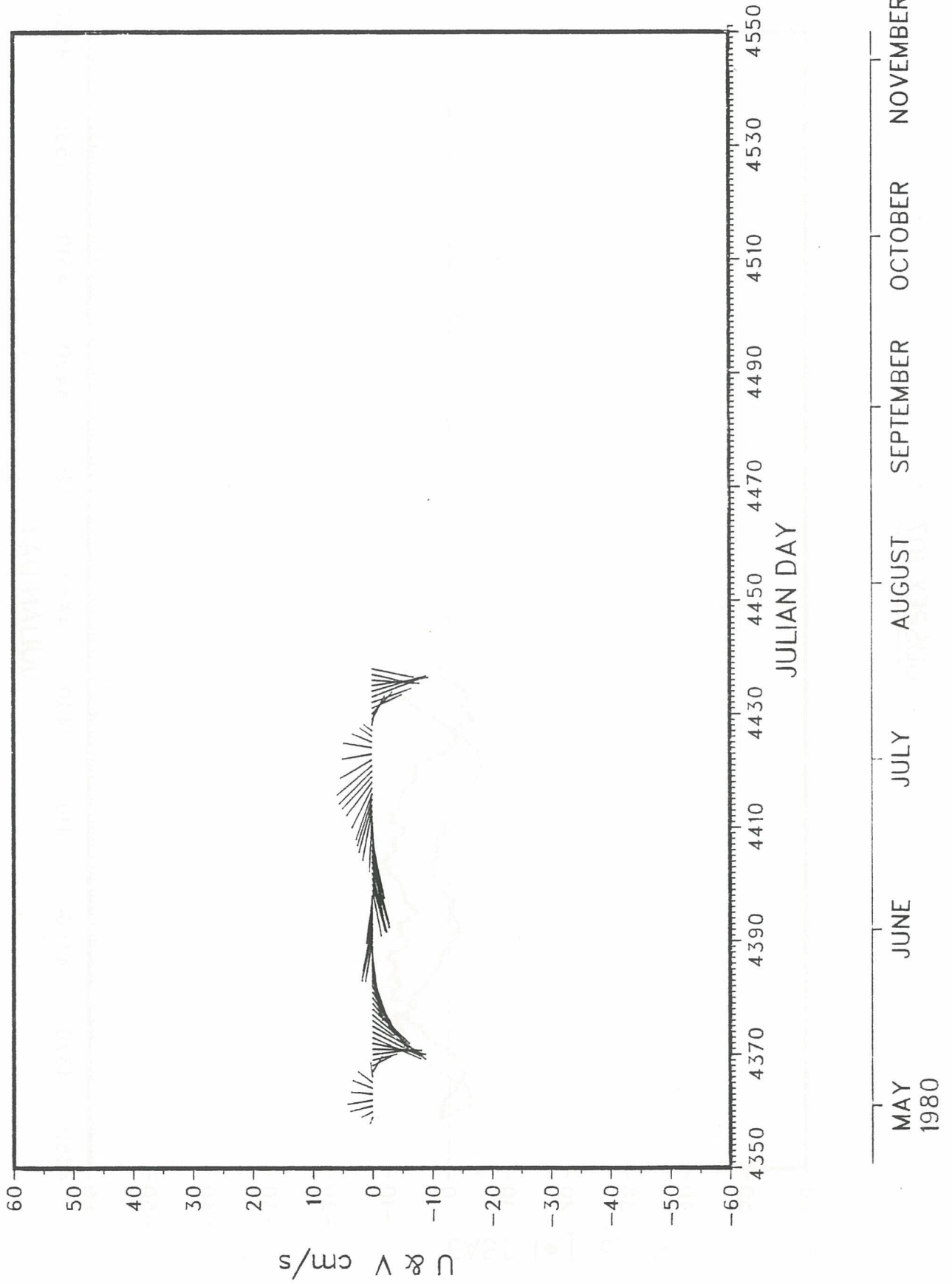
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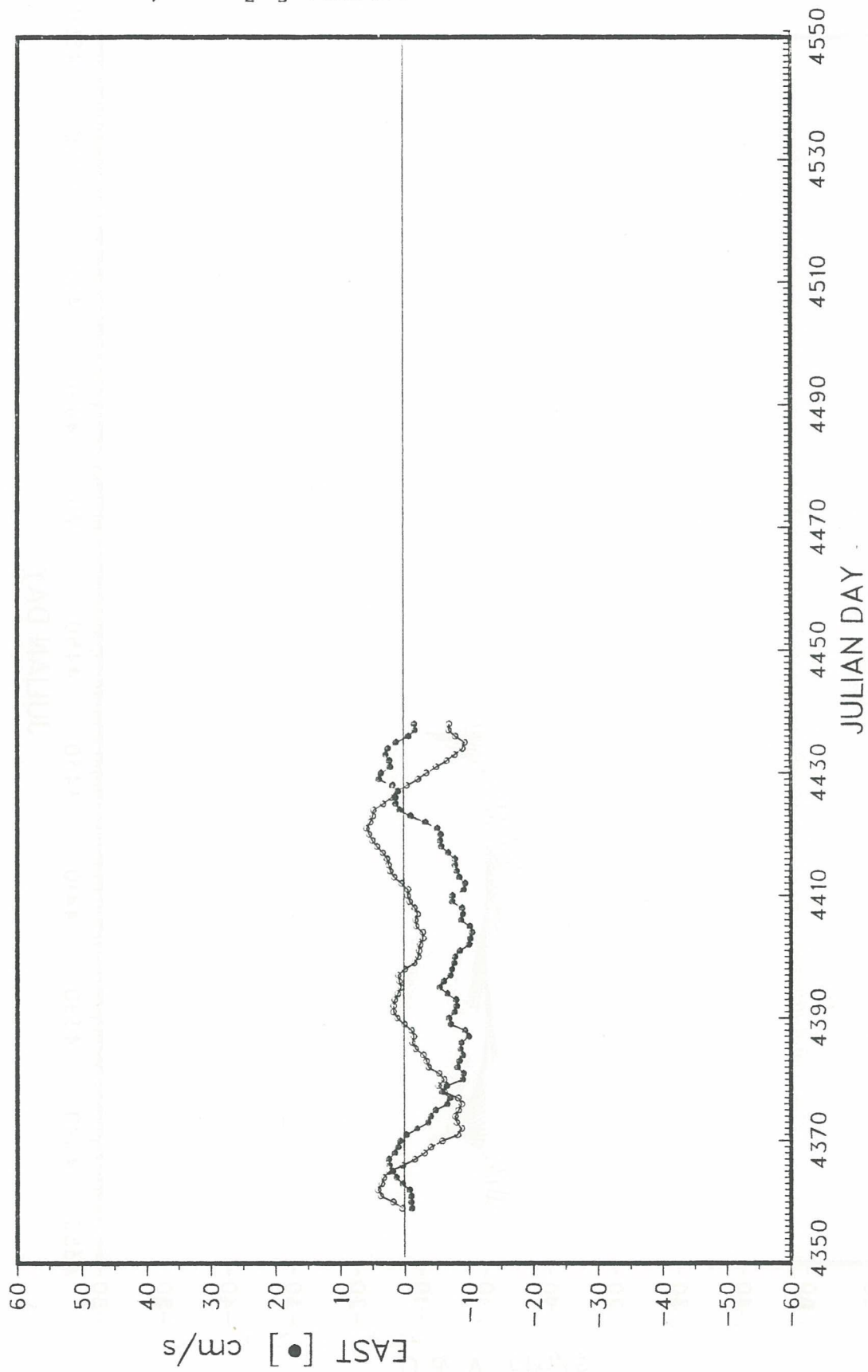
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GUSREX 107

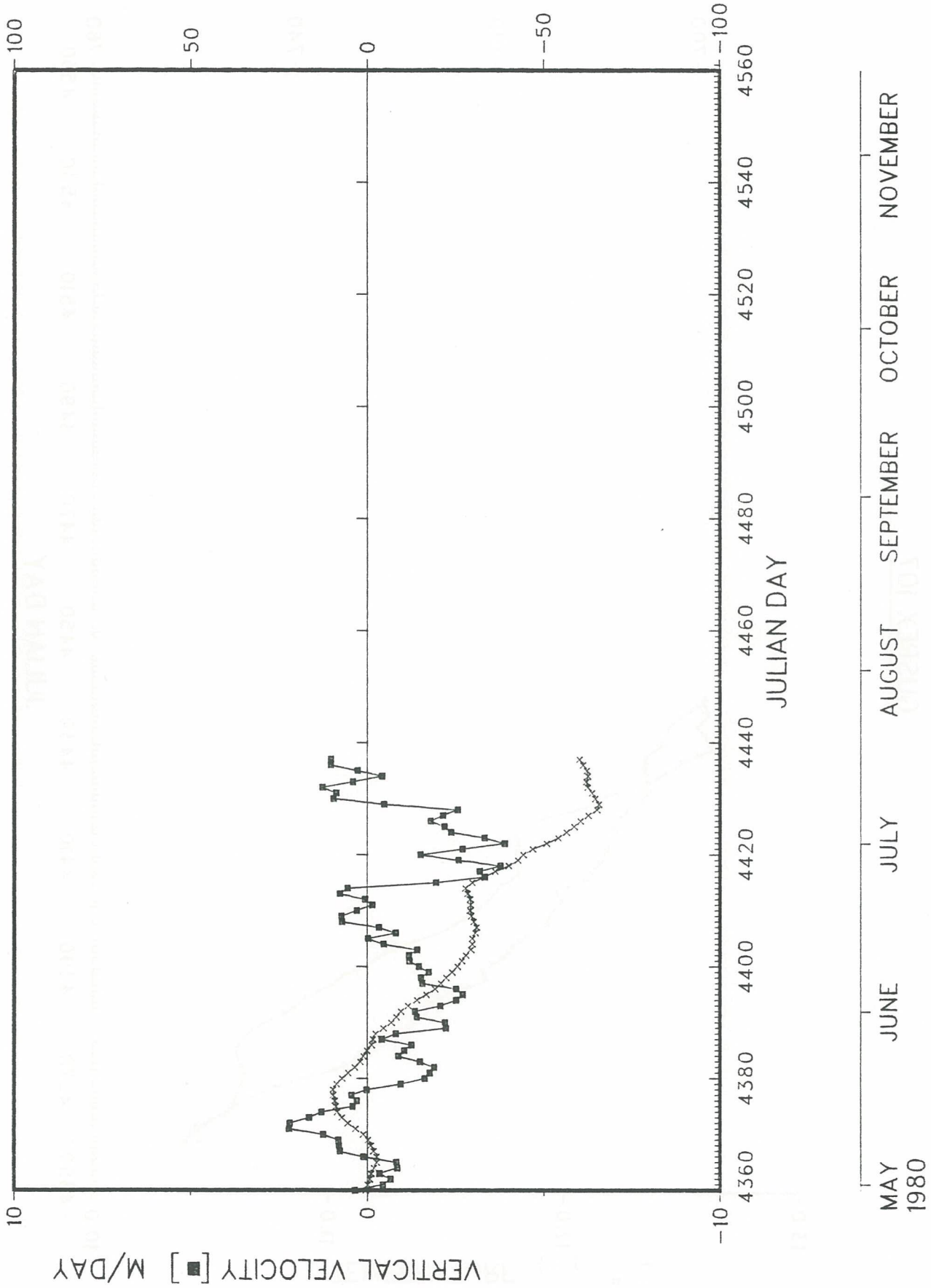


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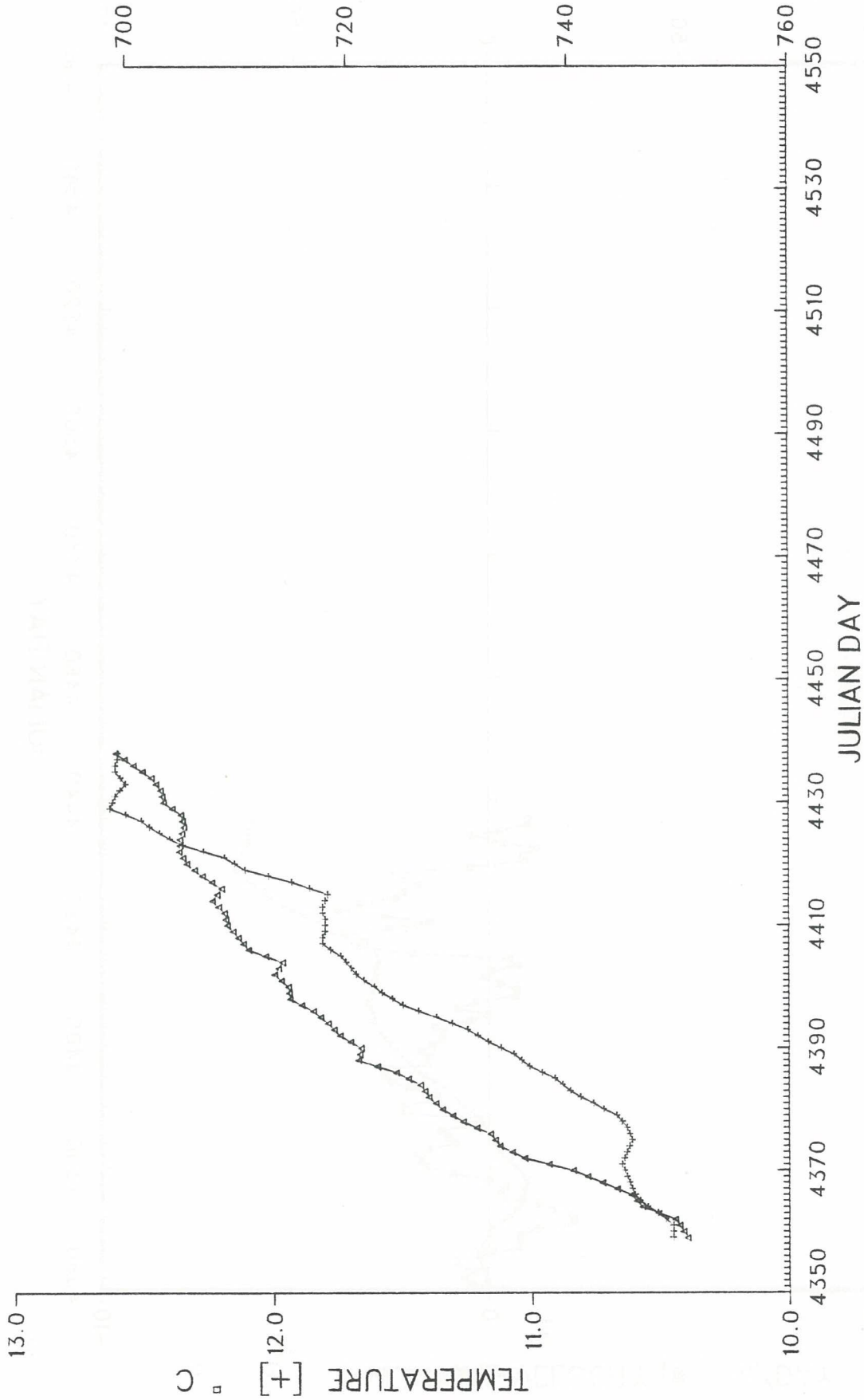


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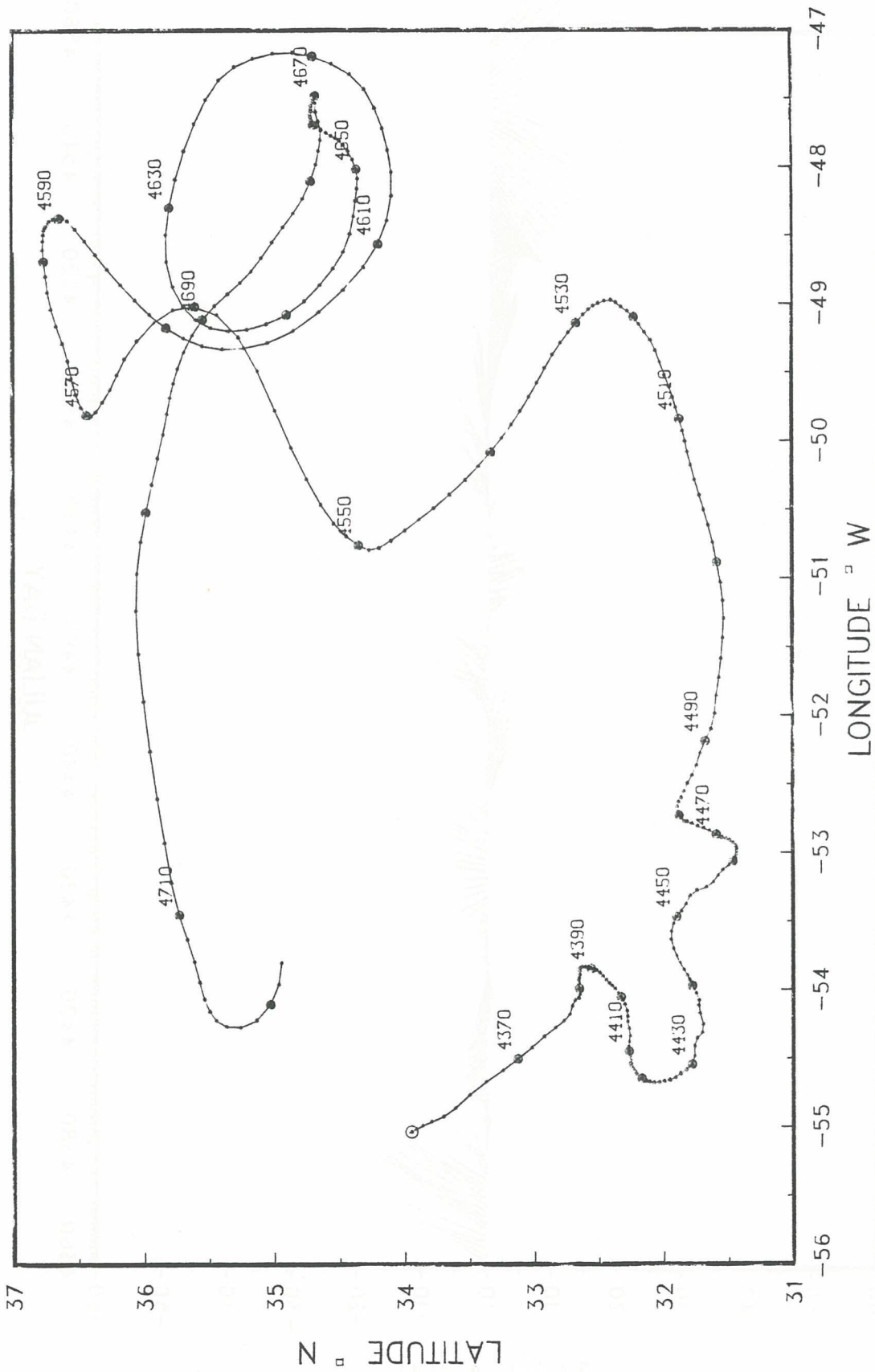


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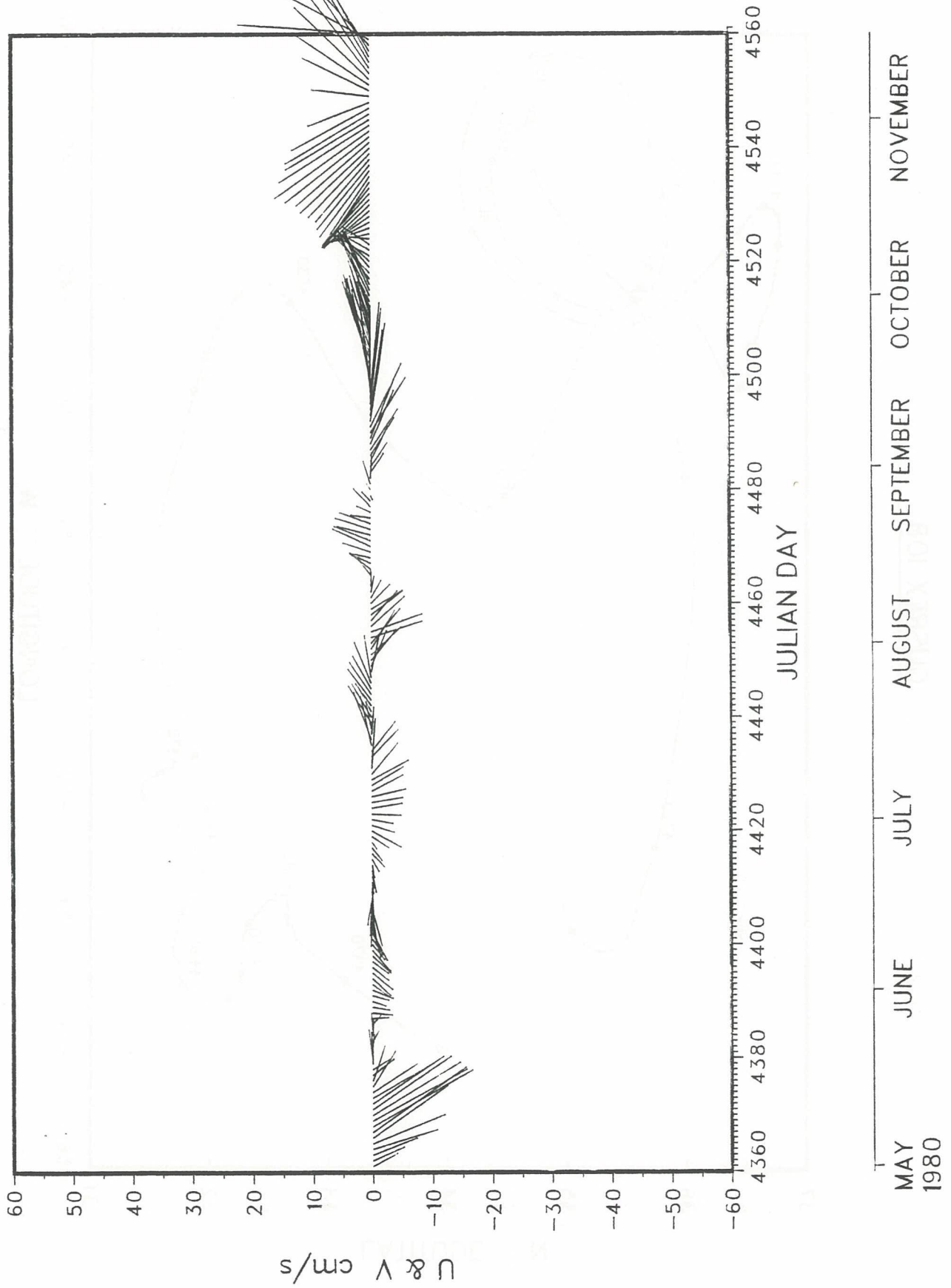


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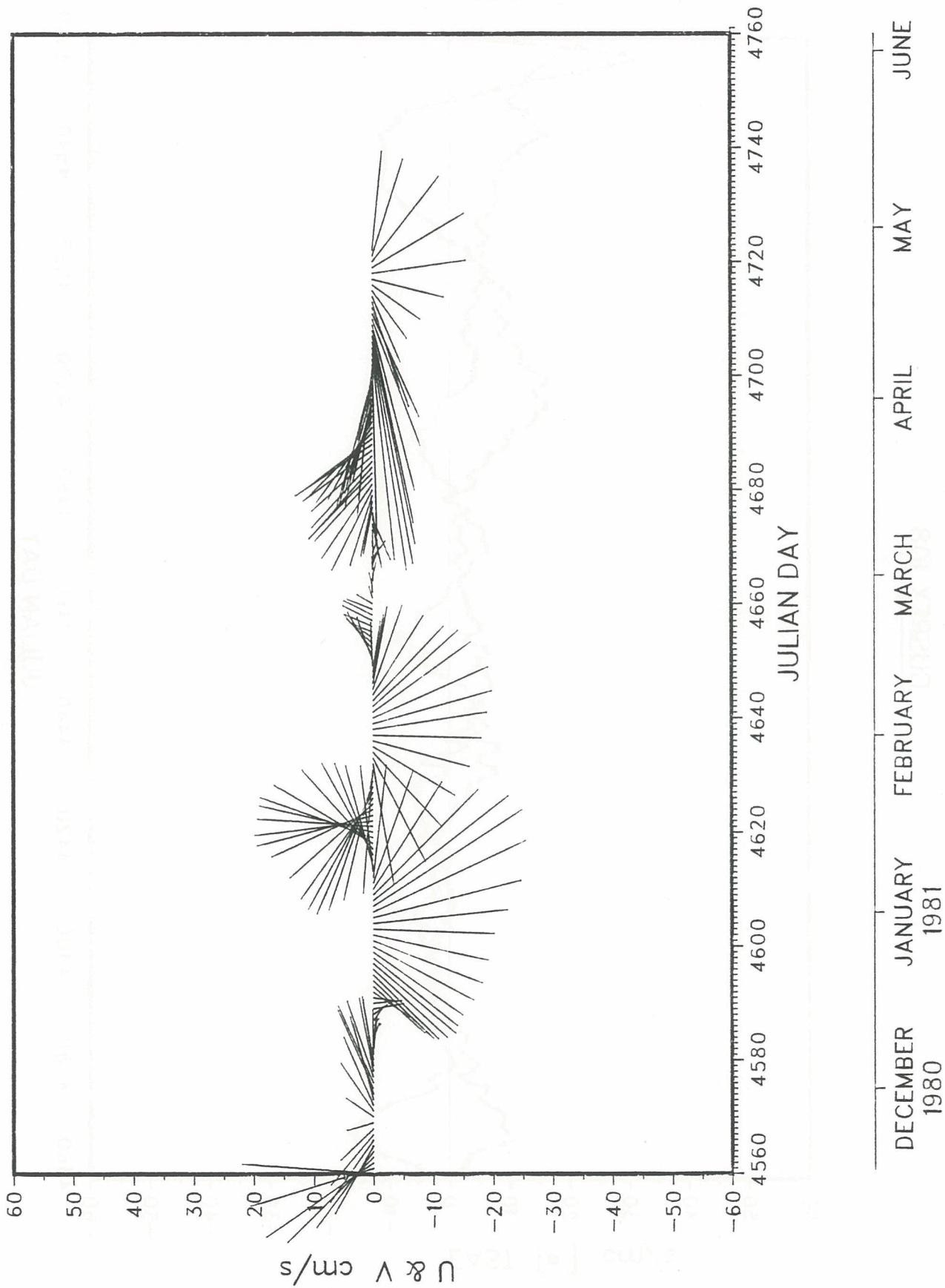
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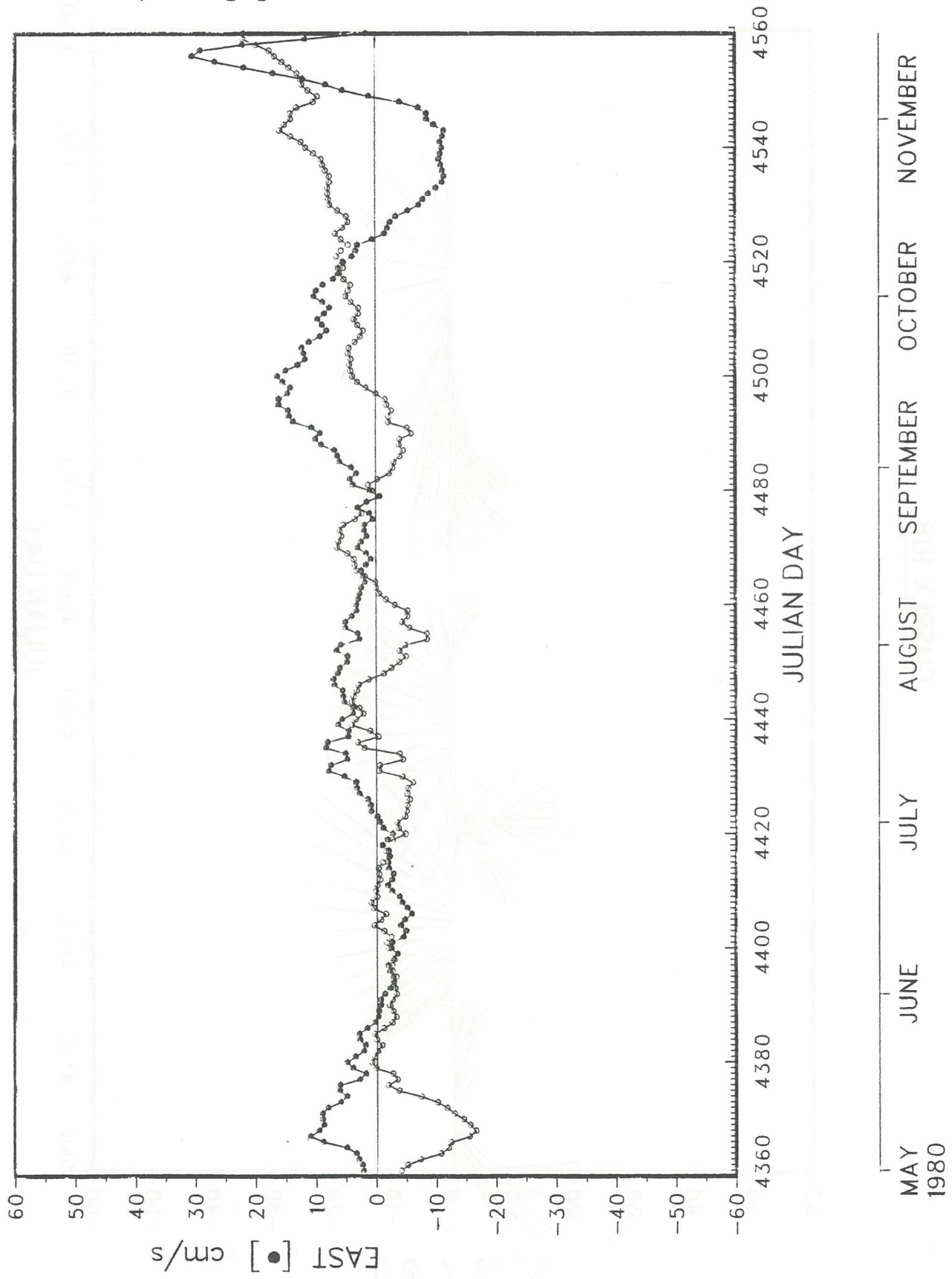
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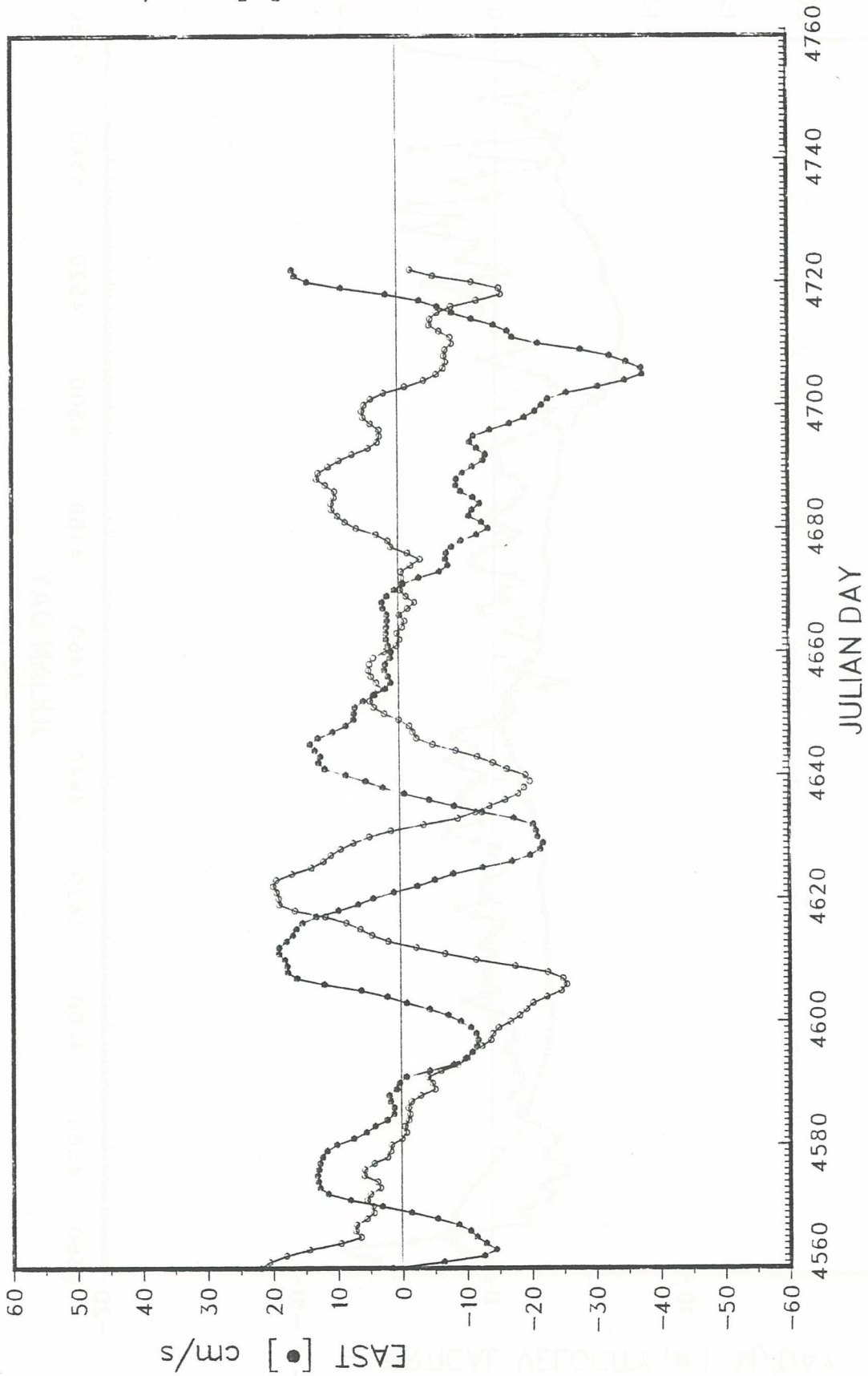
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GUSREX 108

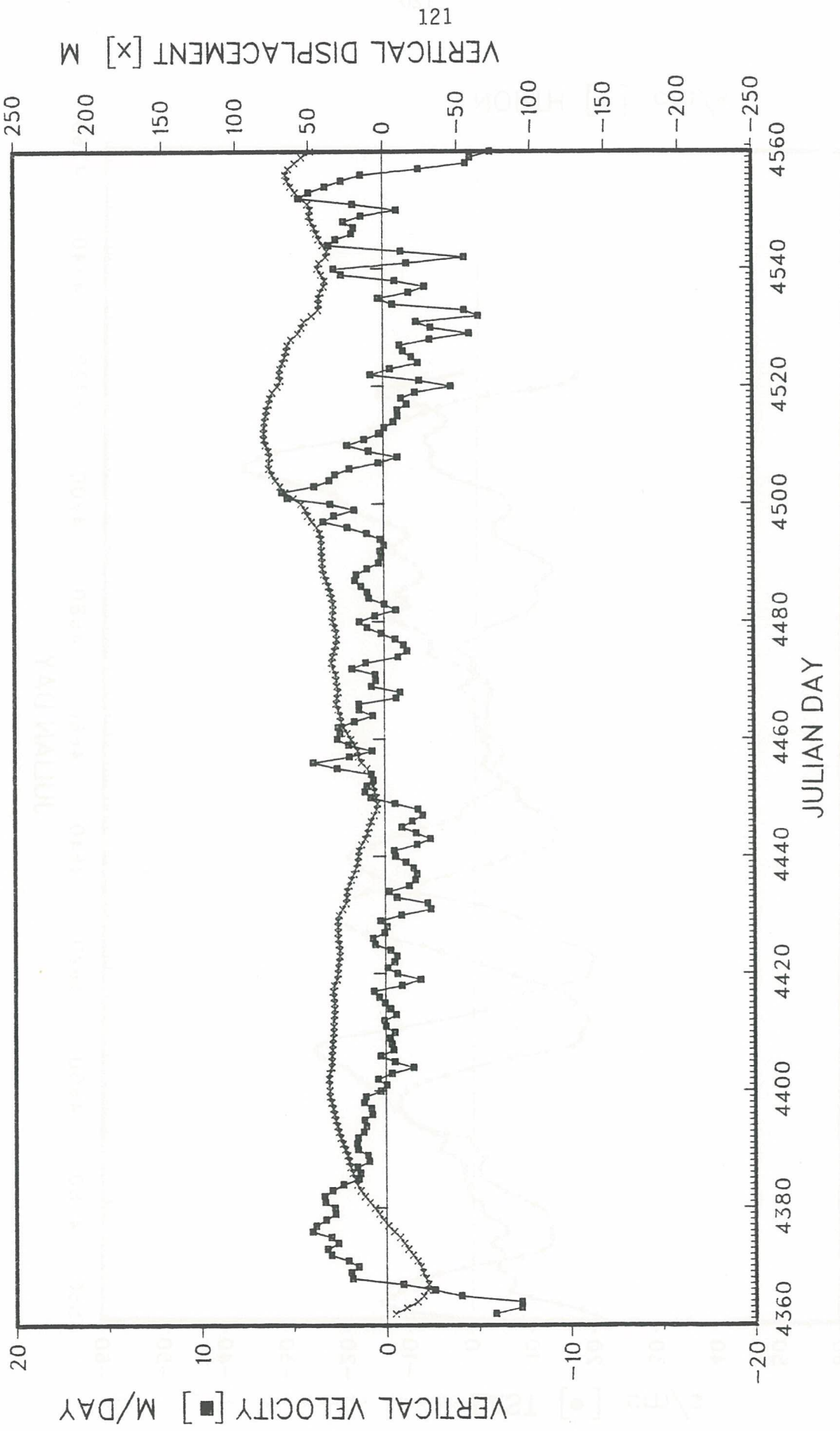


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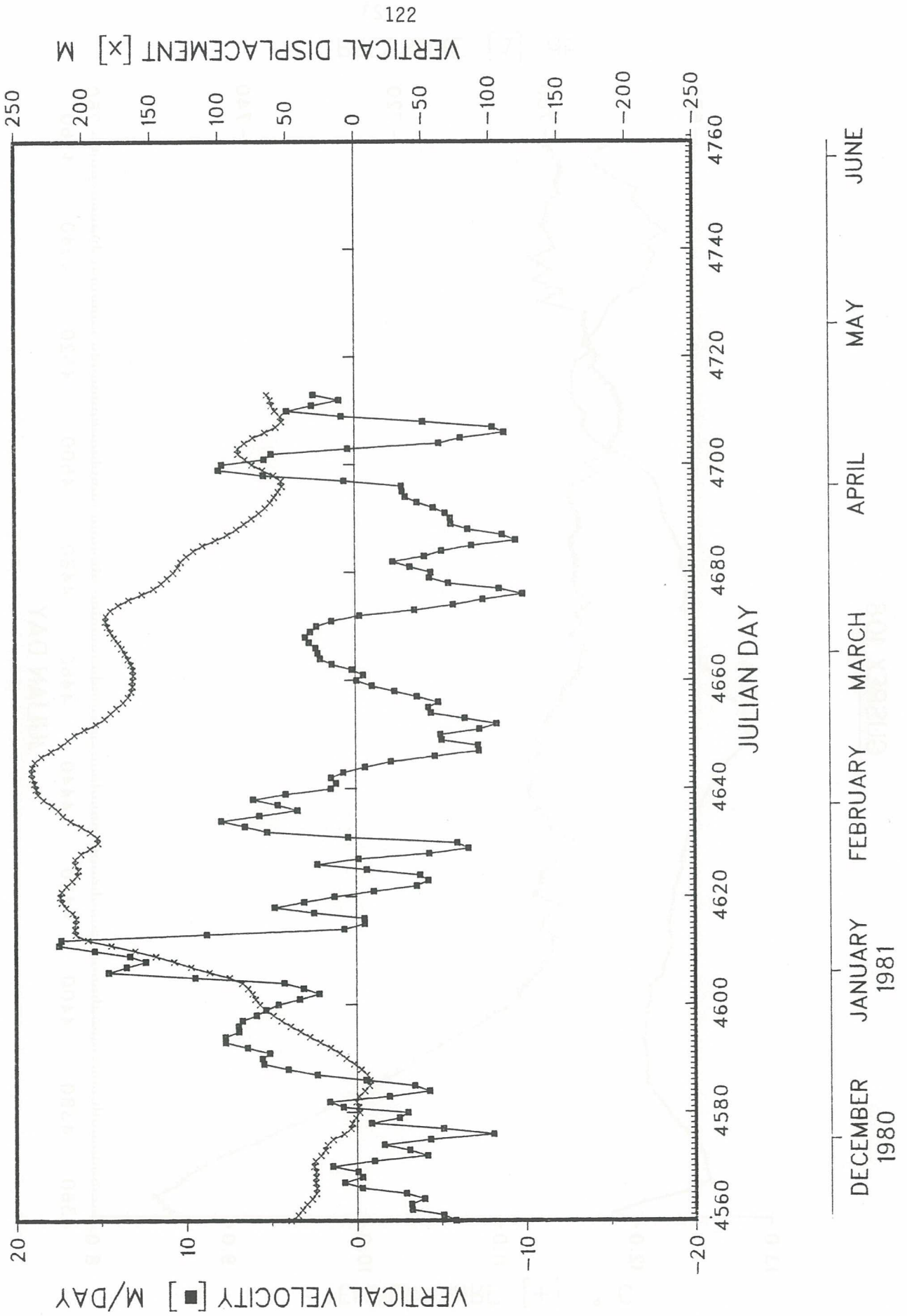


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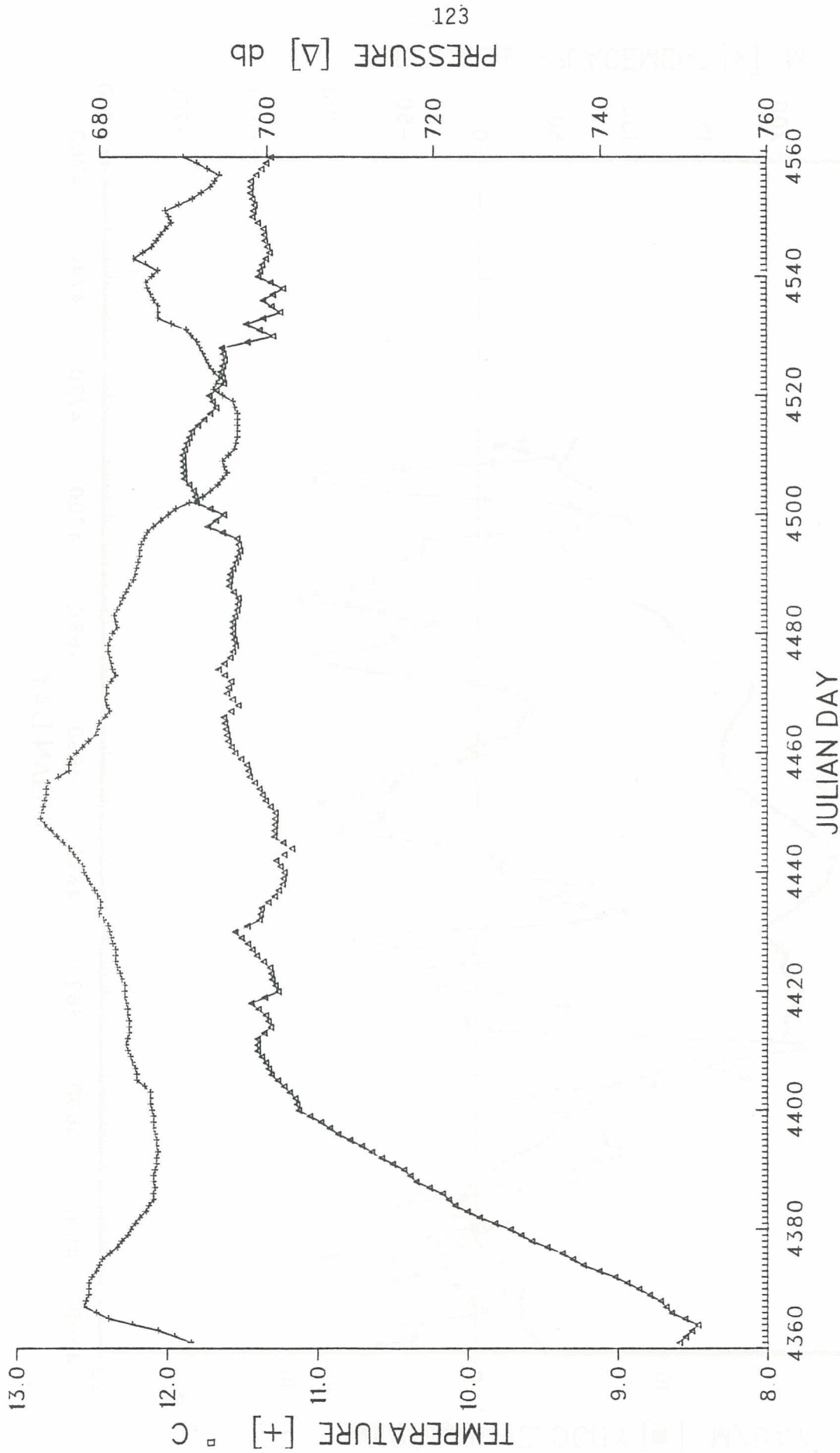
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GUSREX 108



GUSREX 108



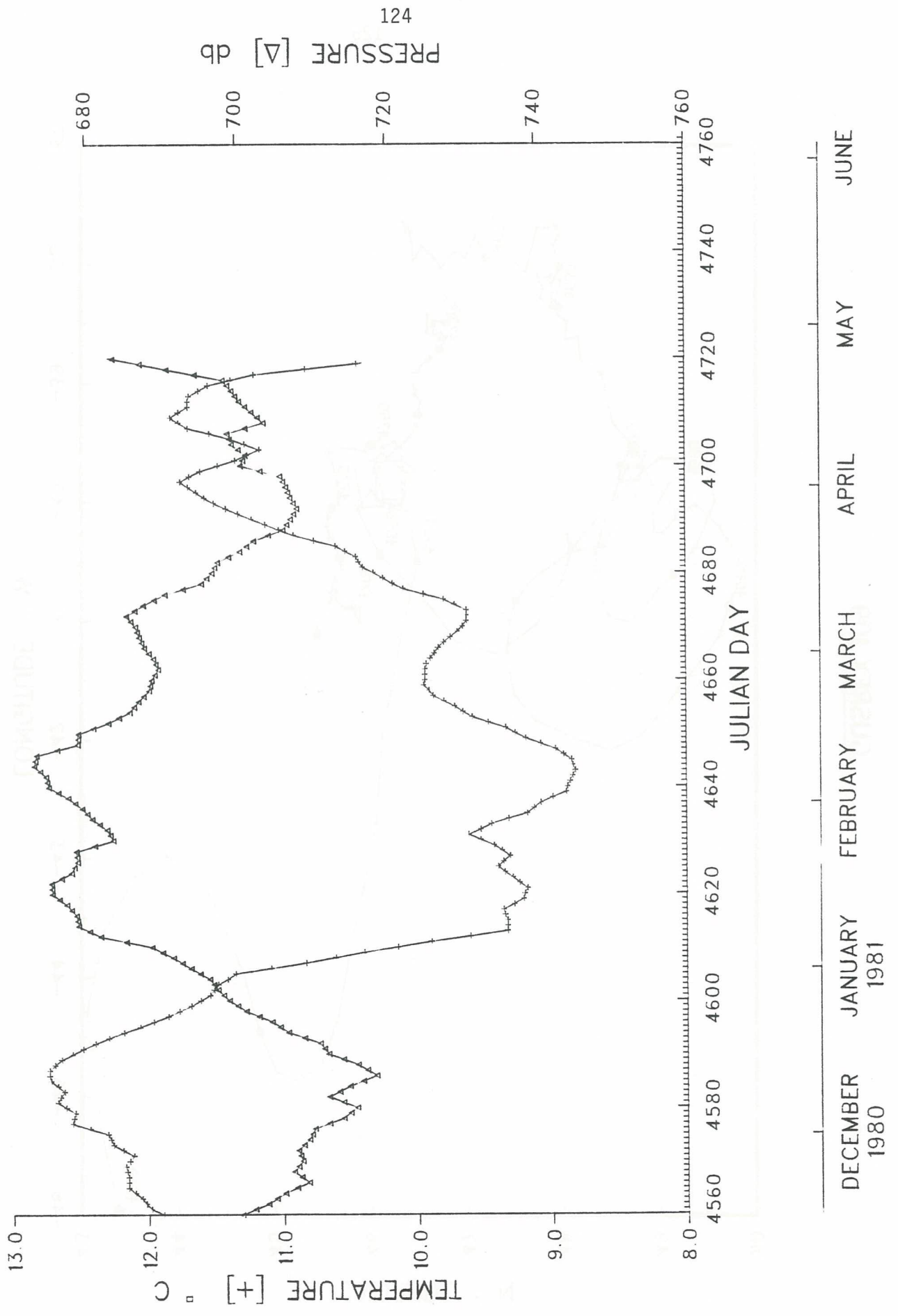
123

TEMPERATURE [°C] (+)
PRESSURE [db] (Δ)

JULIAN DAY

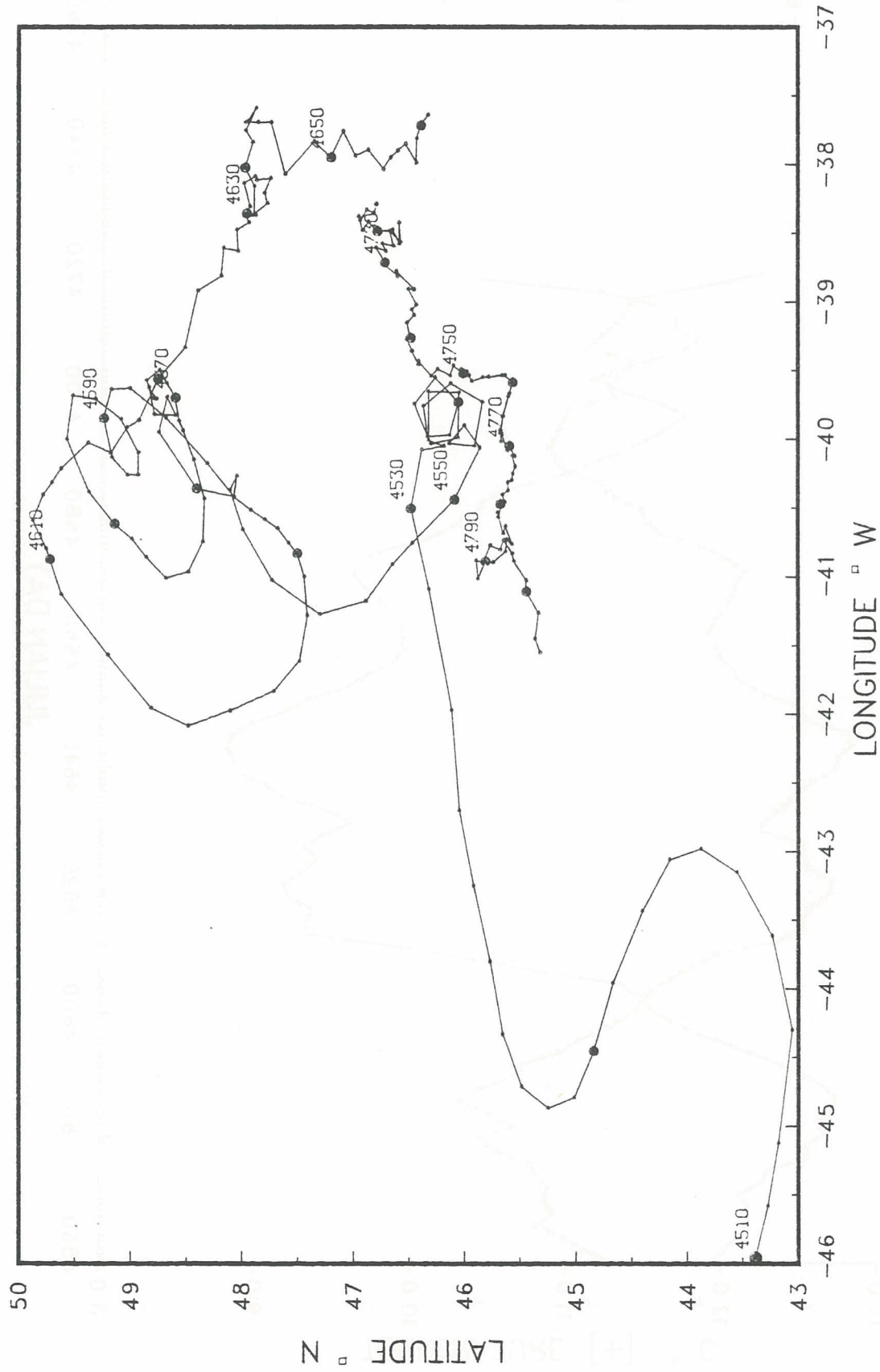
MAY 1980
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AUGUST
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OCTOBER
NOVEMBER

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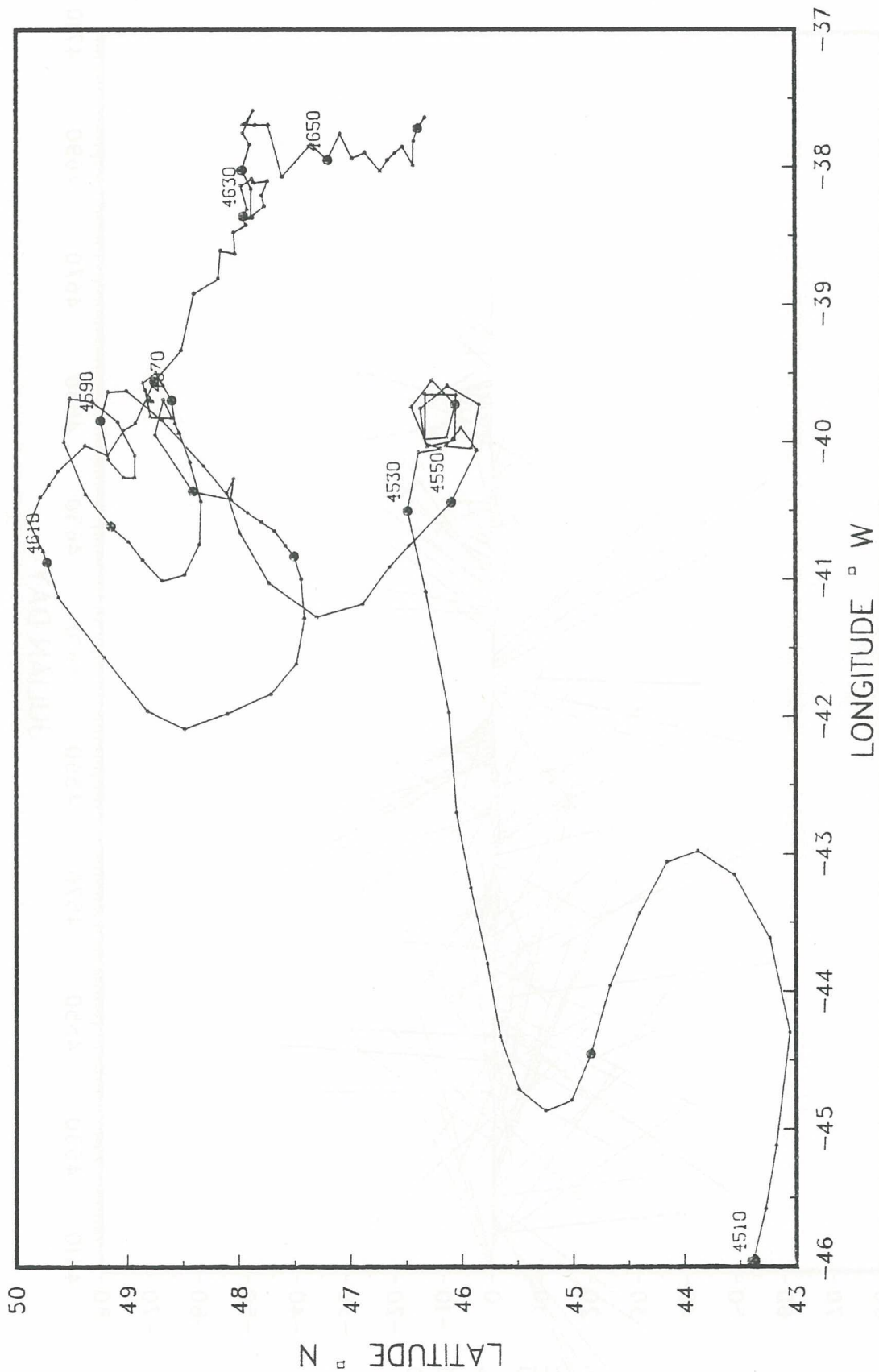


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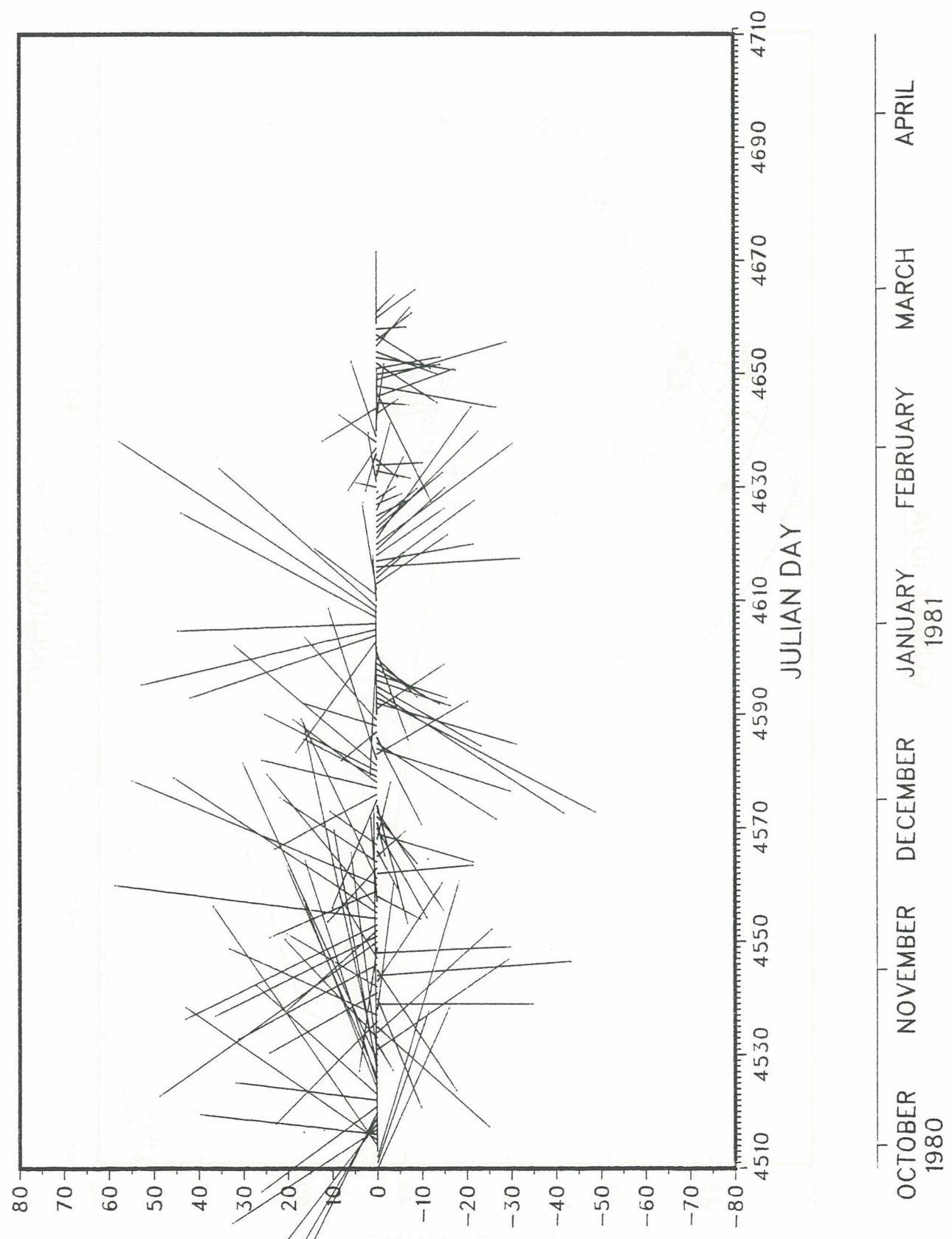


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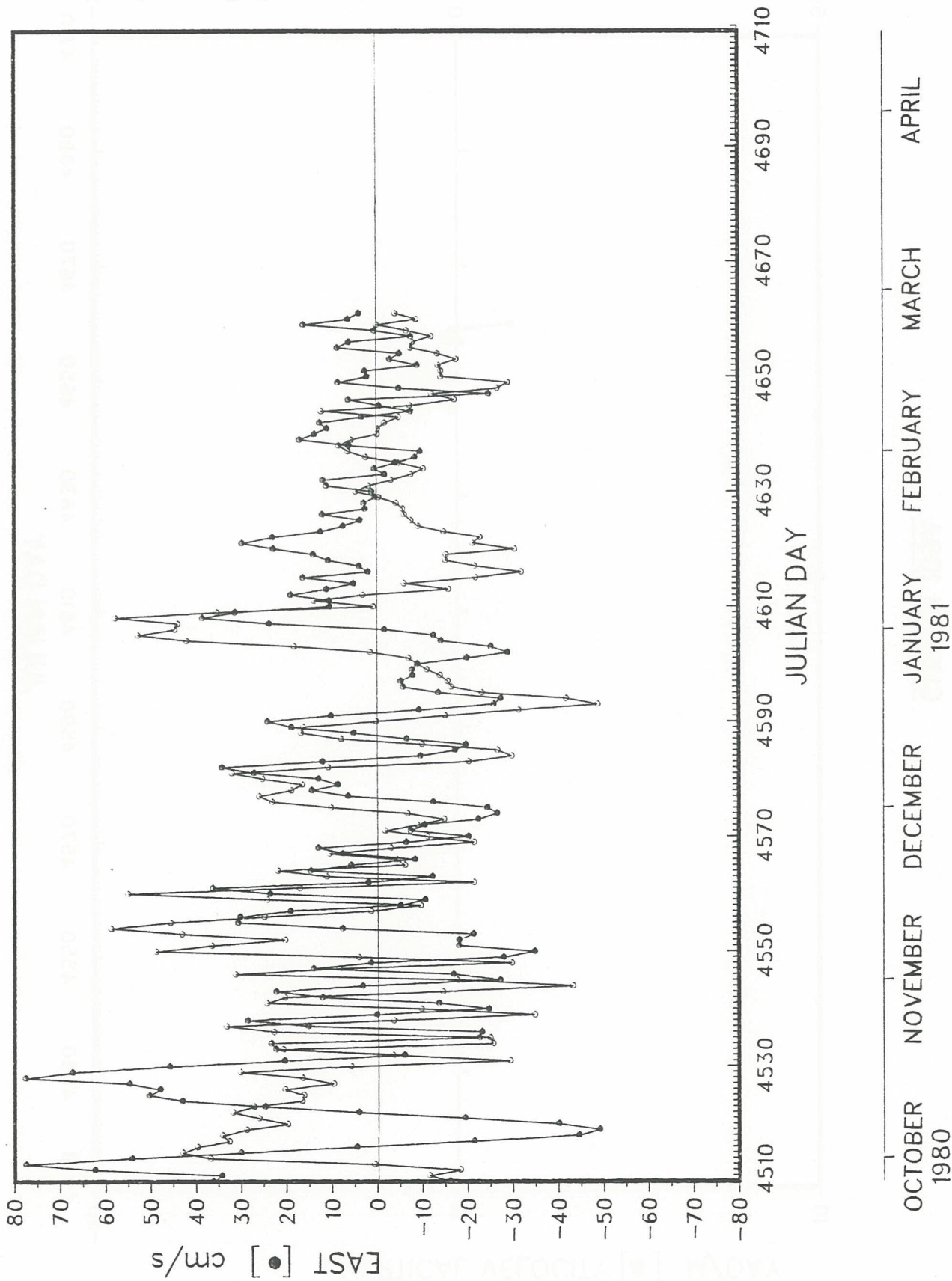


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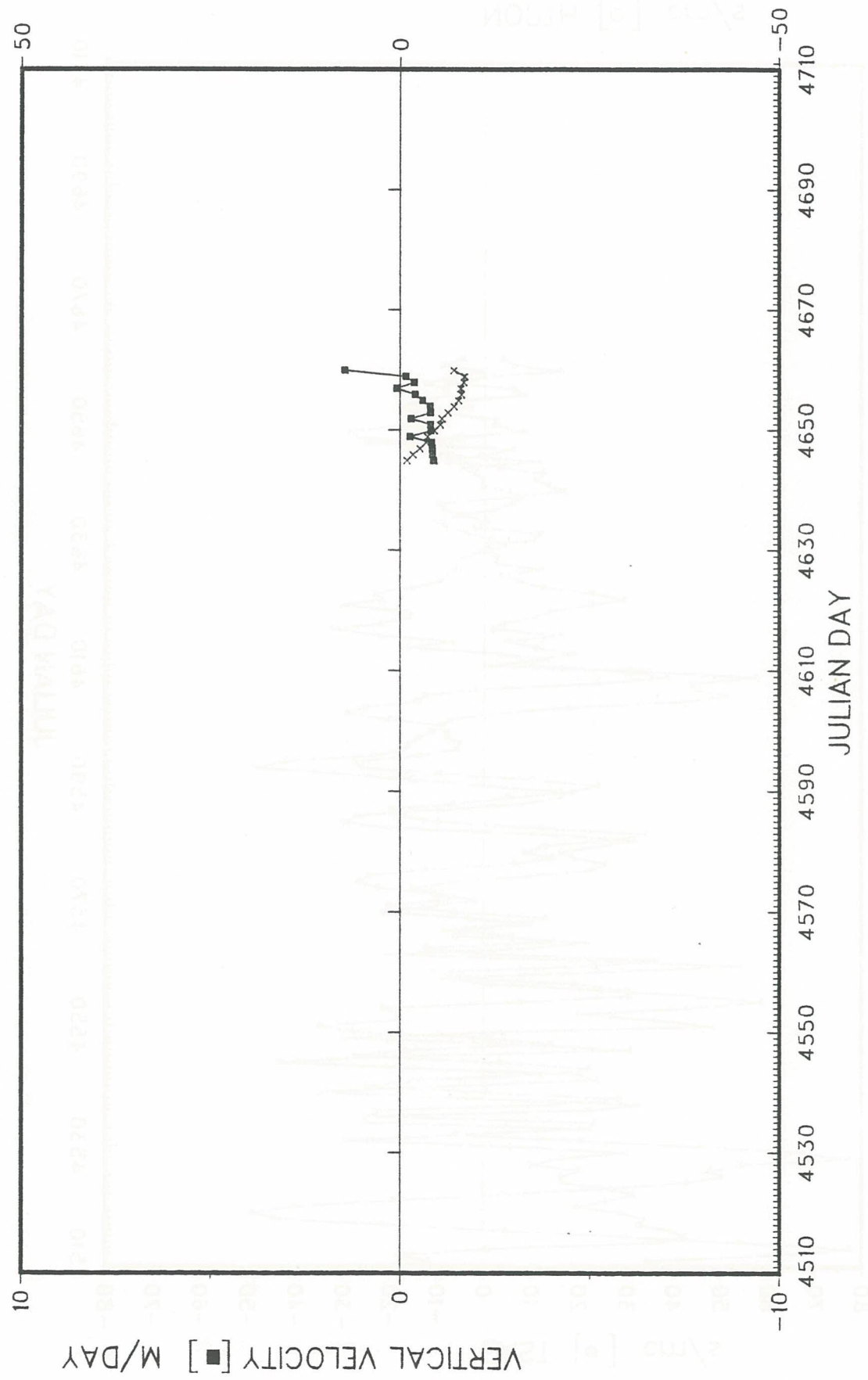
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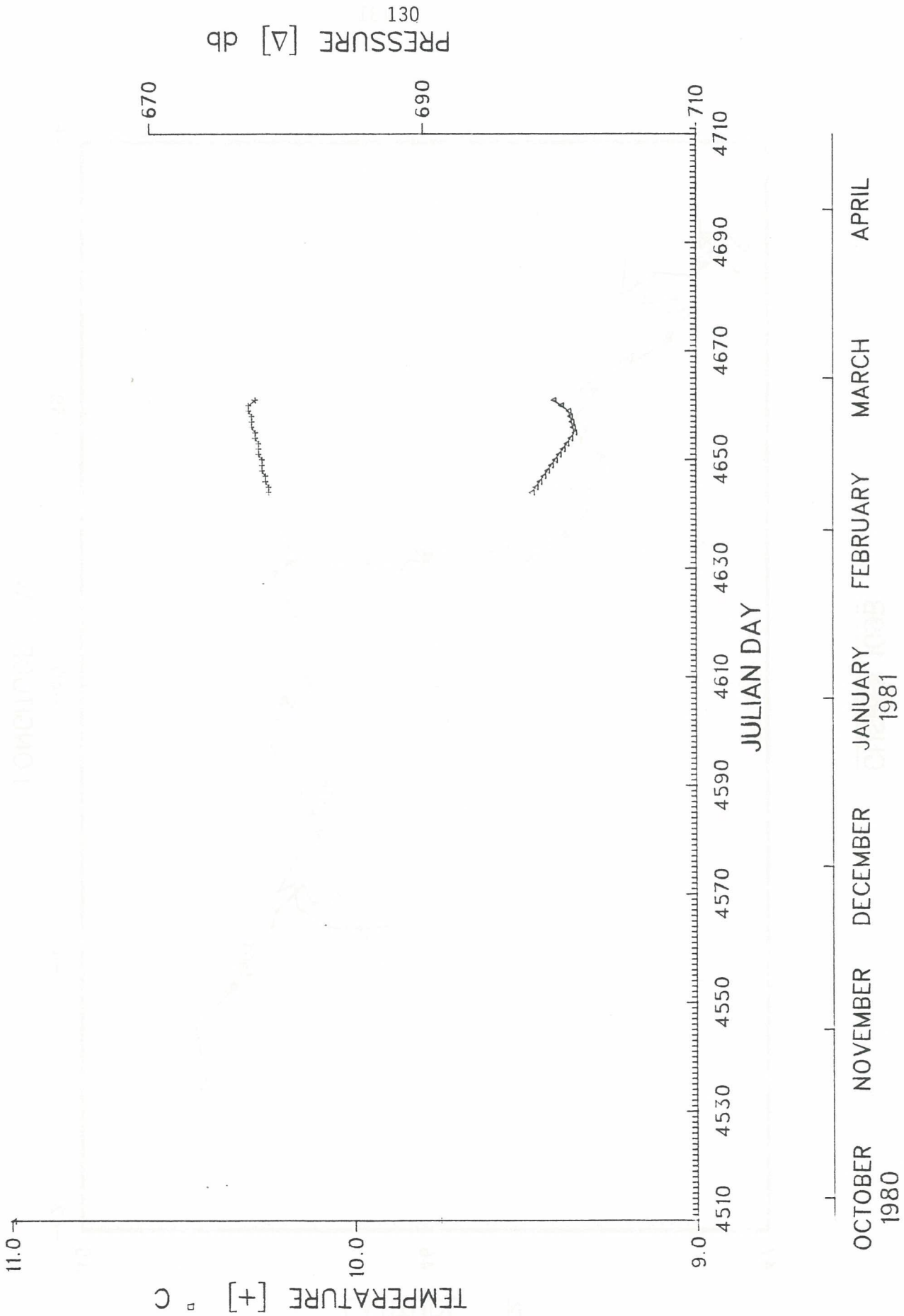
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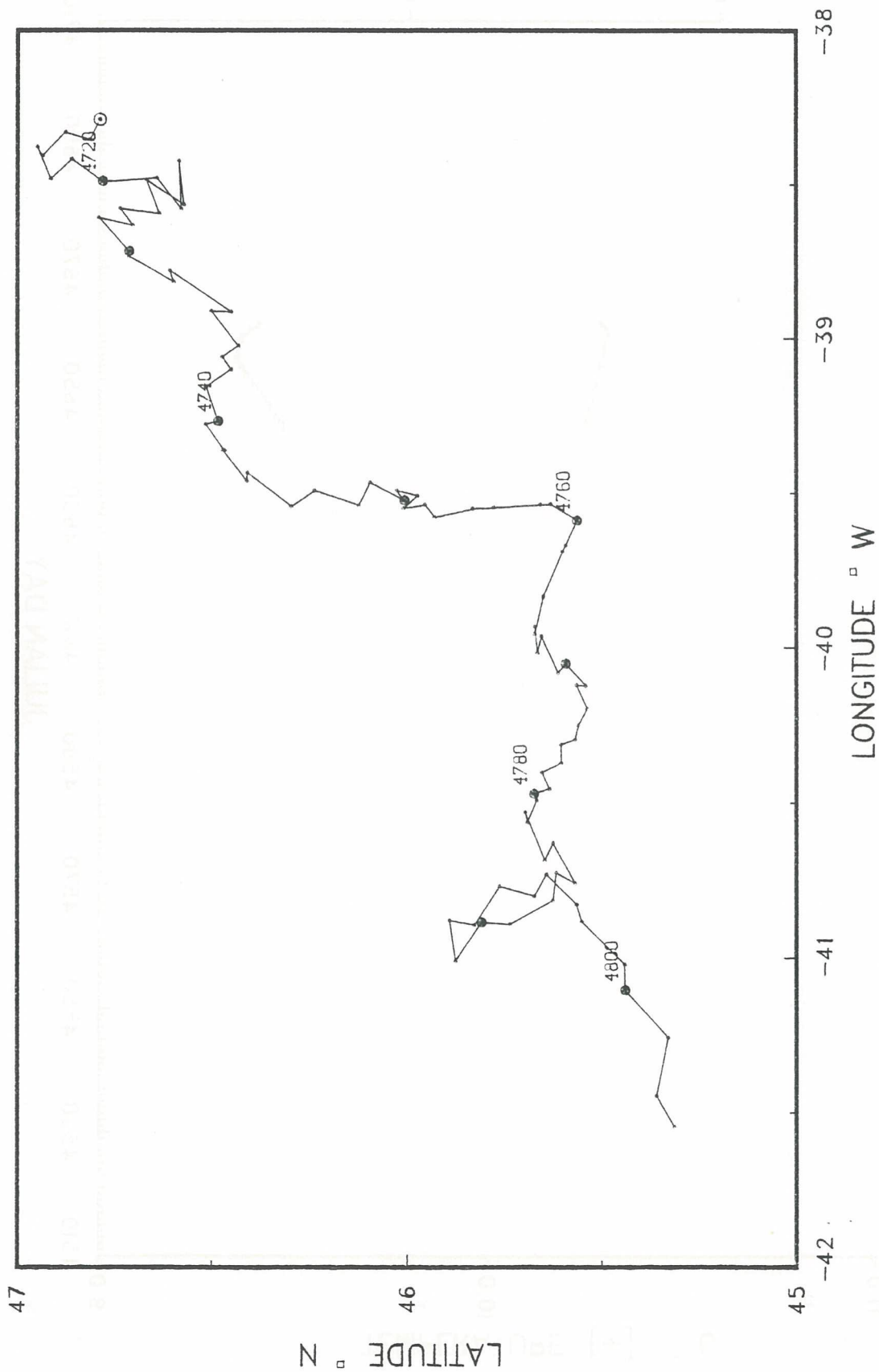
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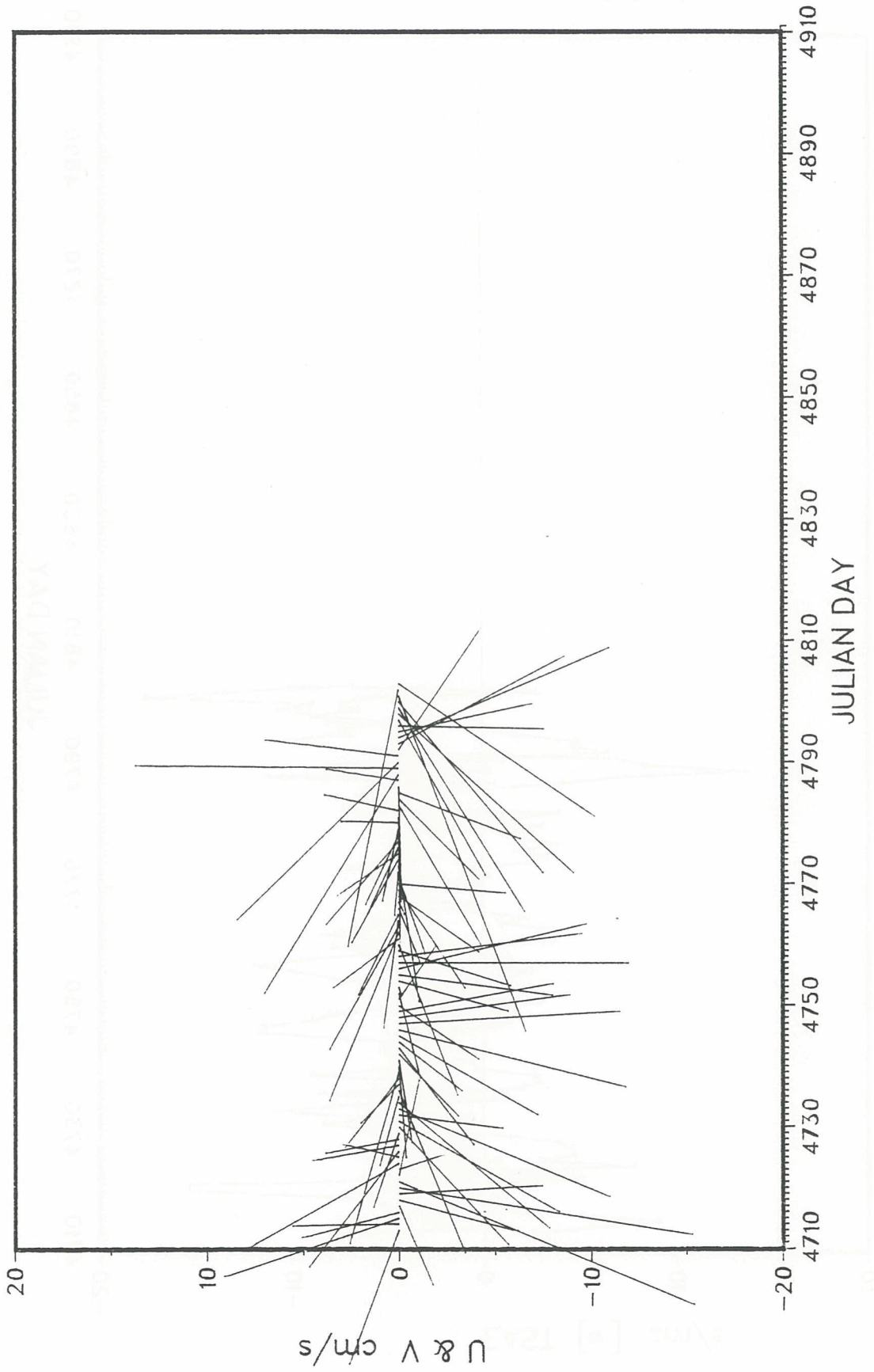
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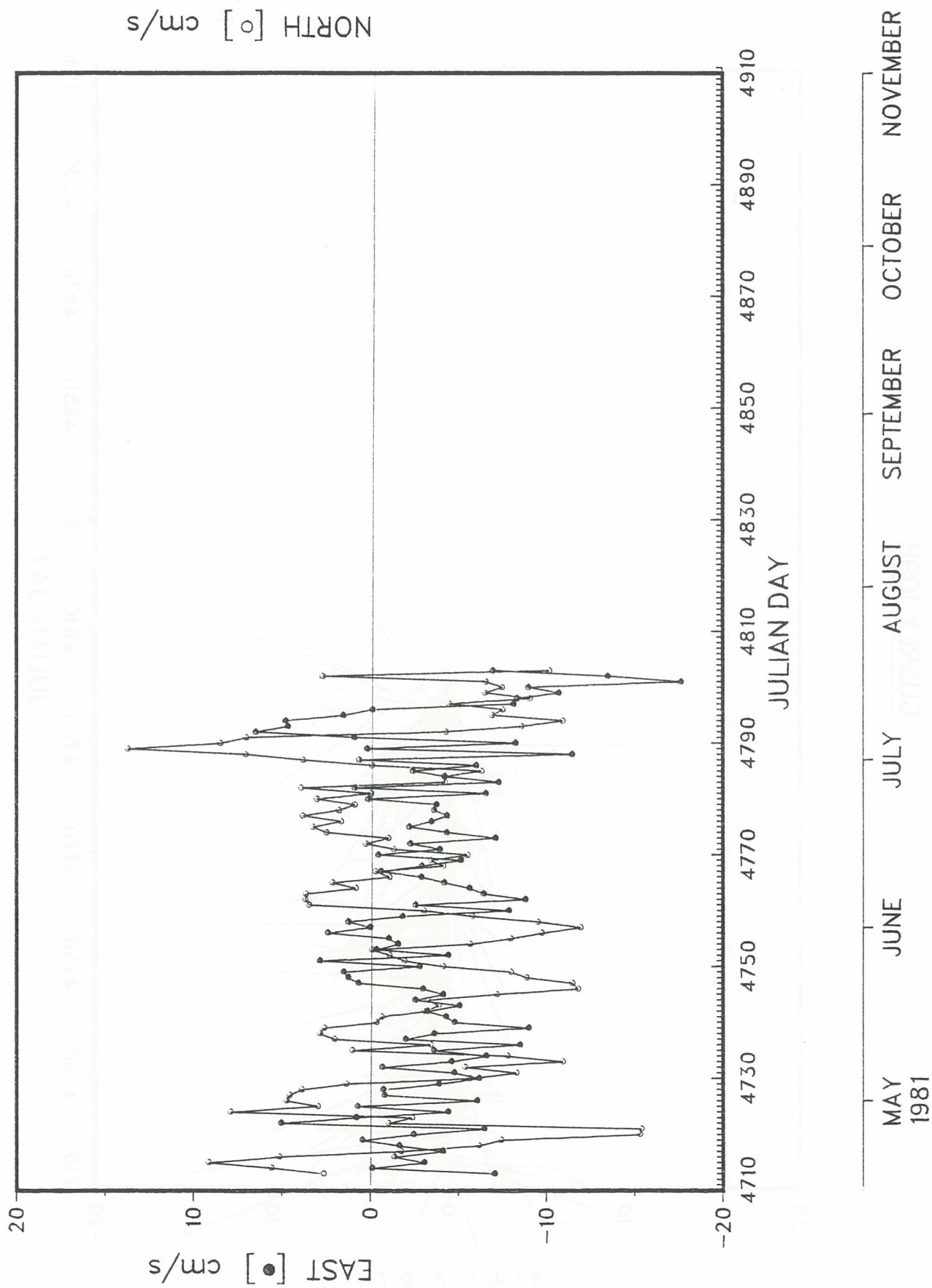


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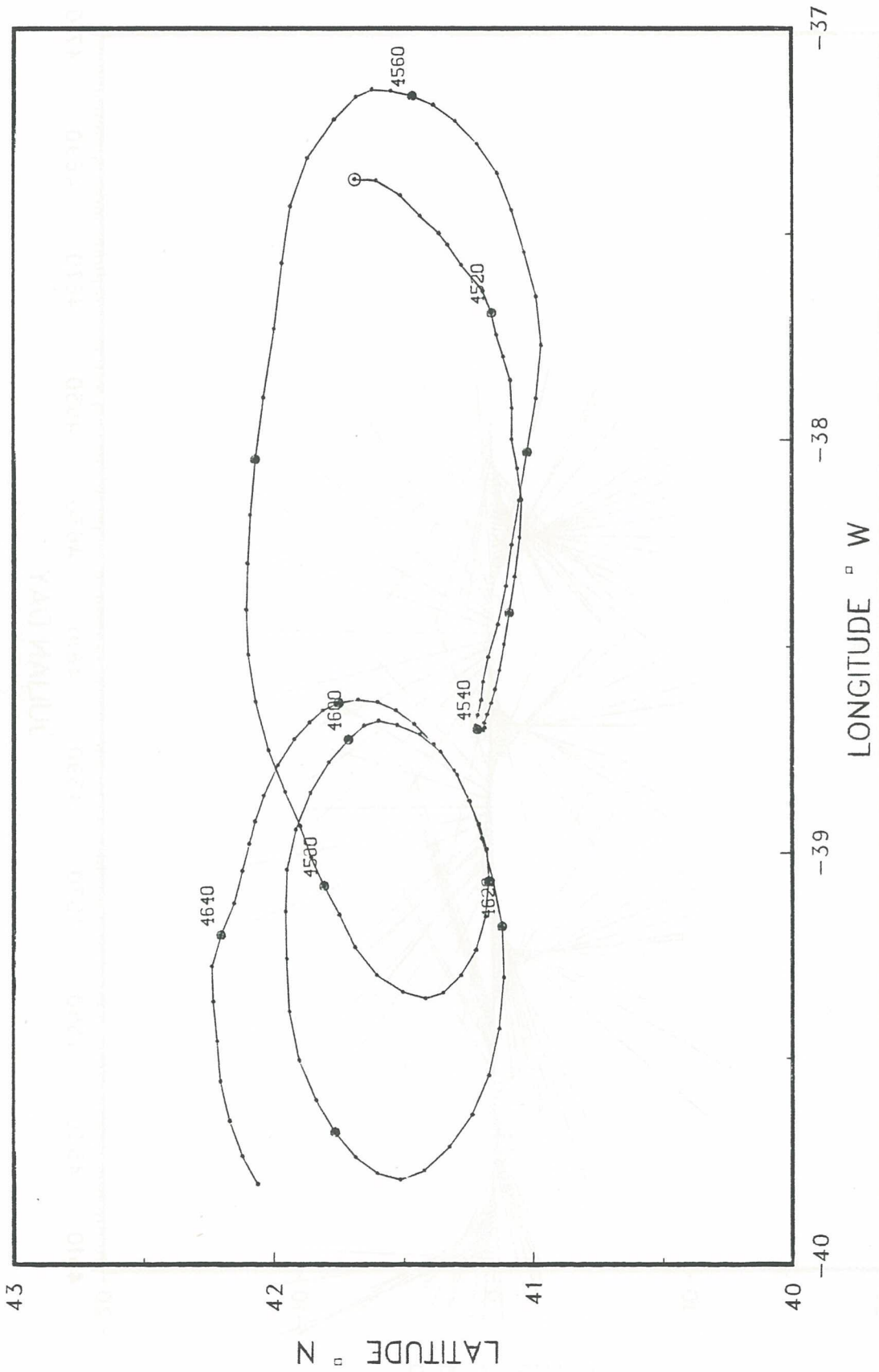


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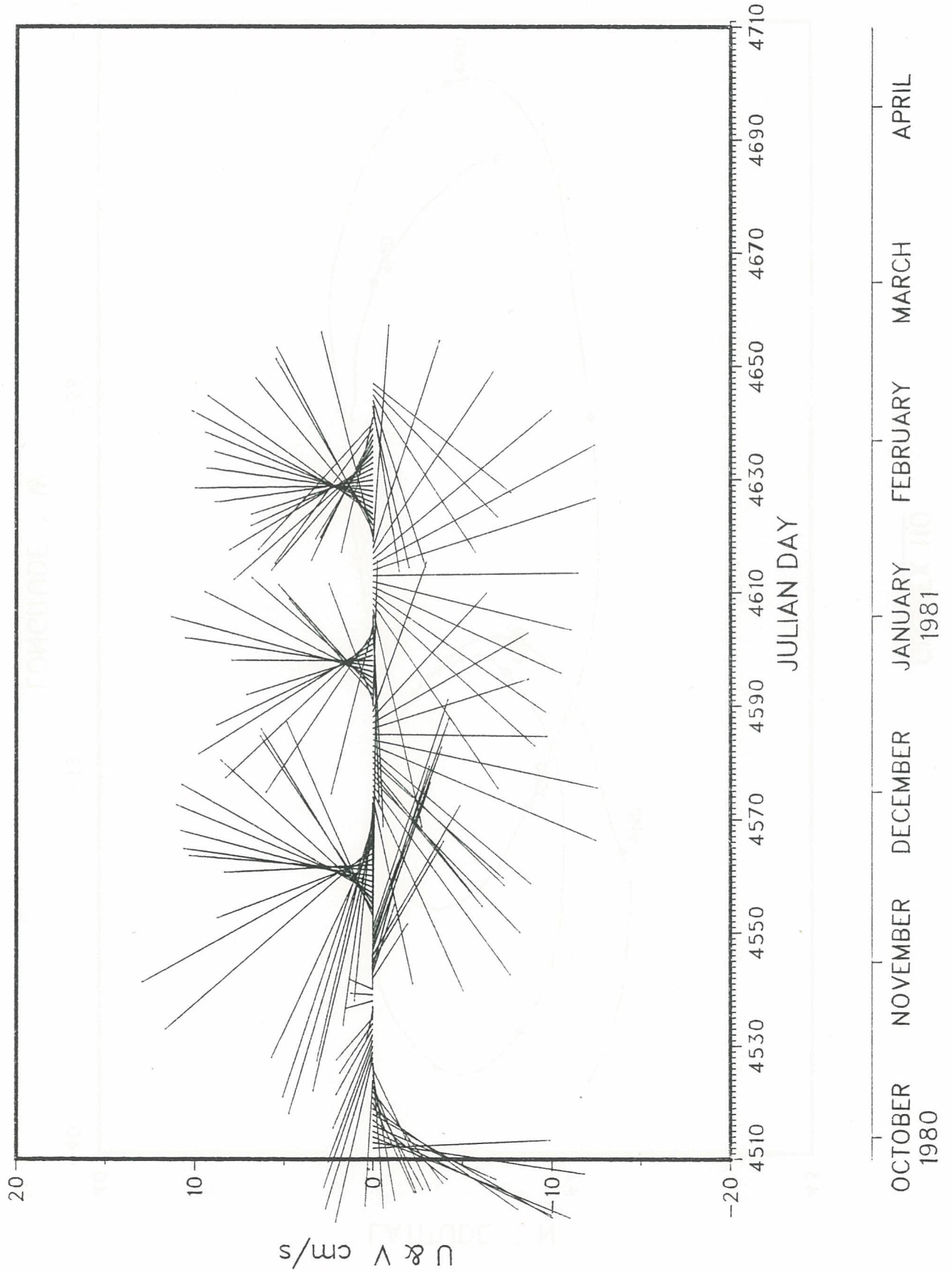
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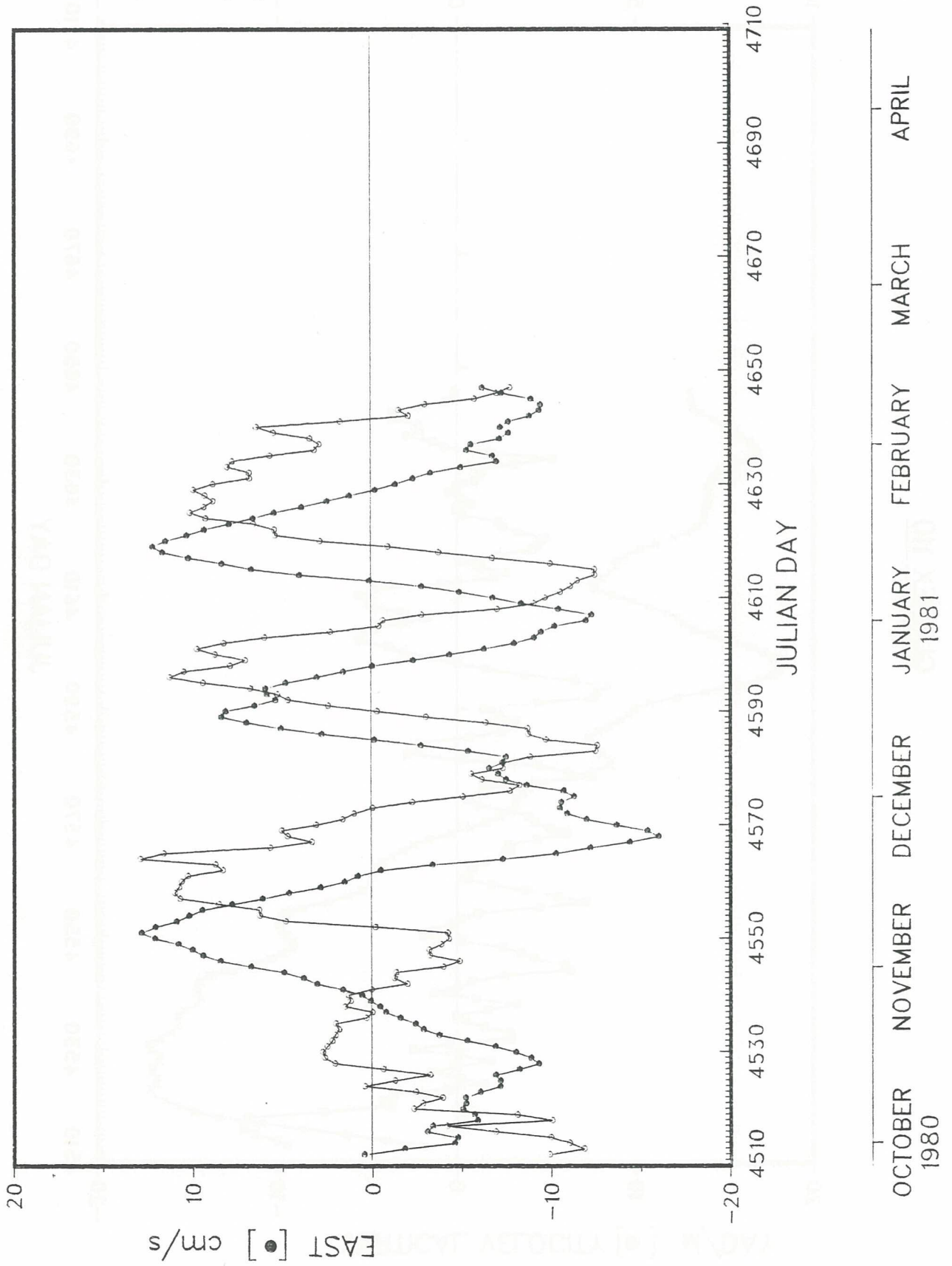
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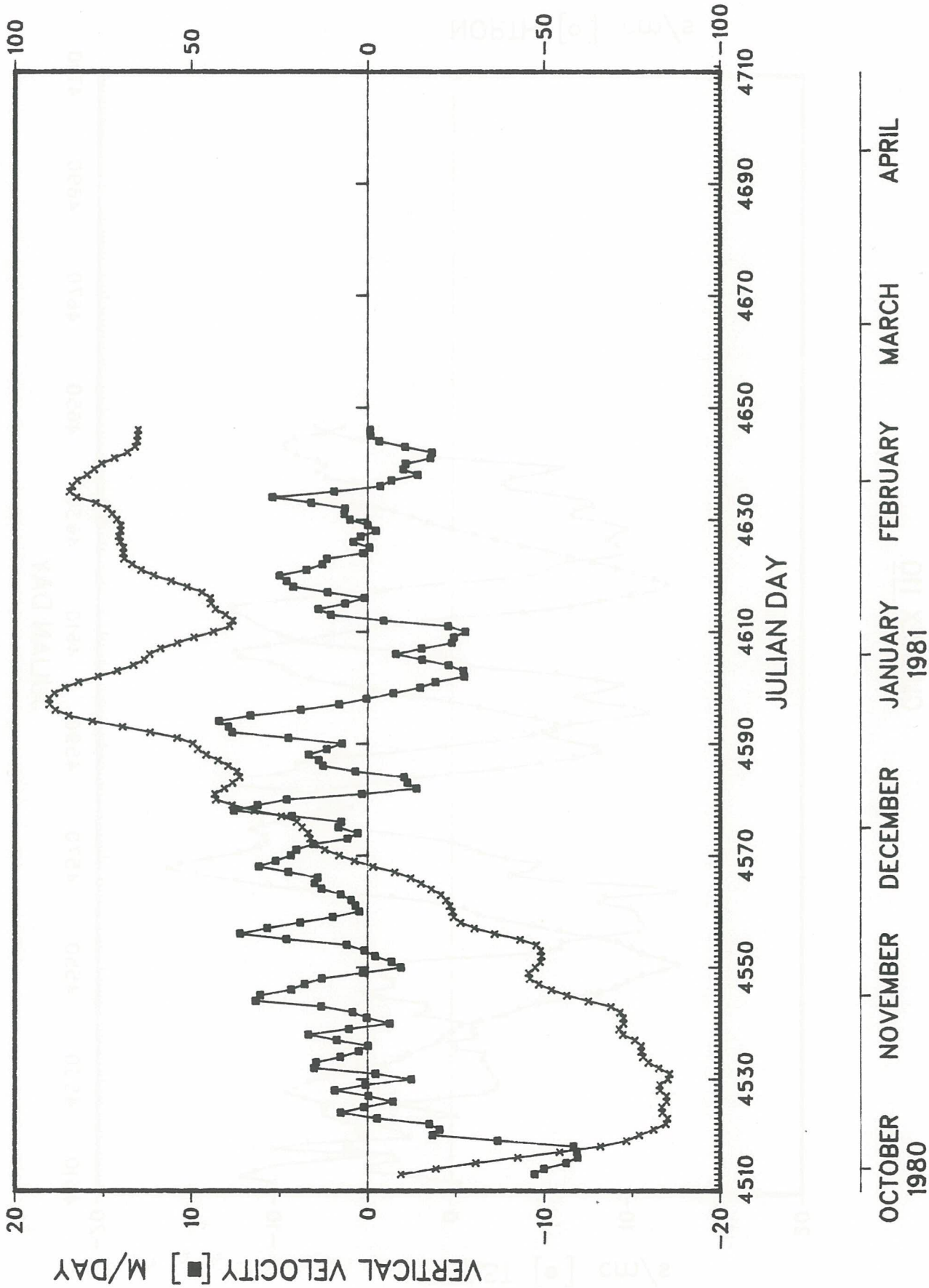
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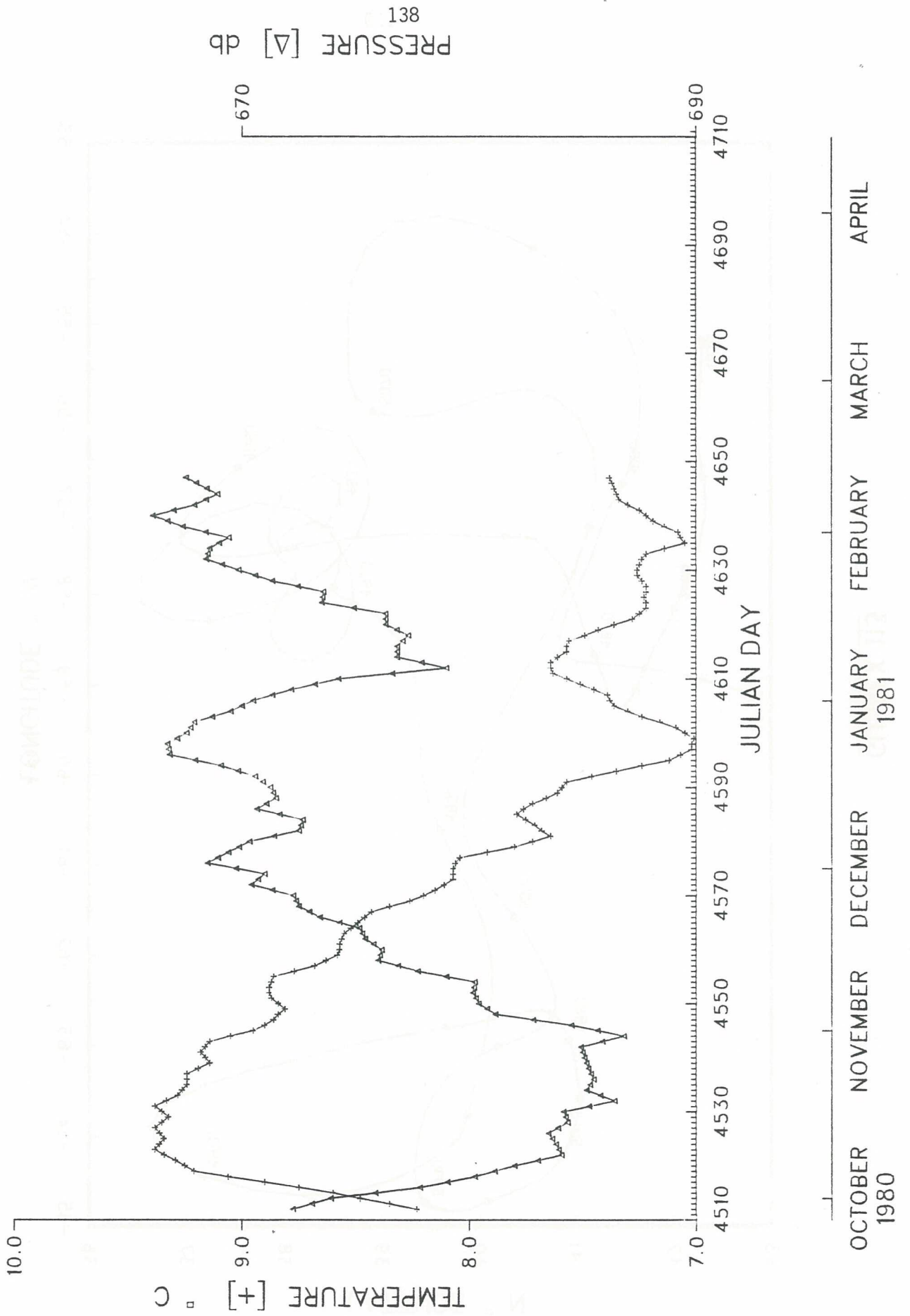
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GUSREX 110

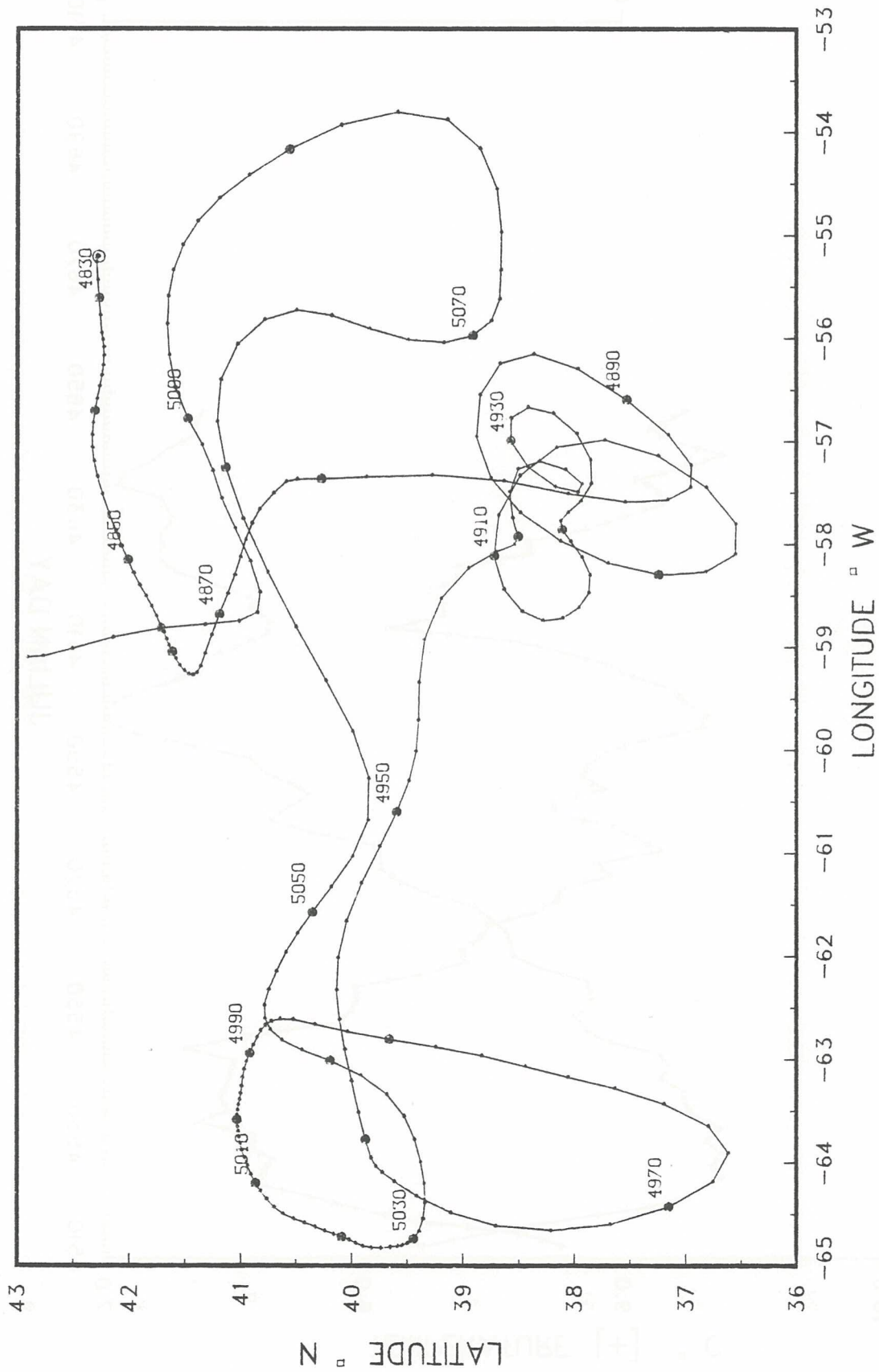


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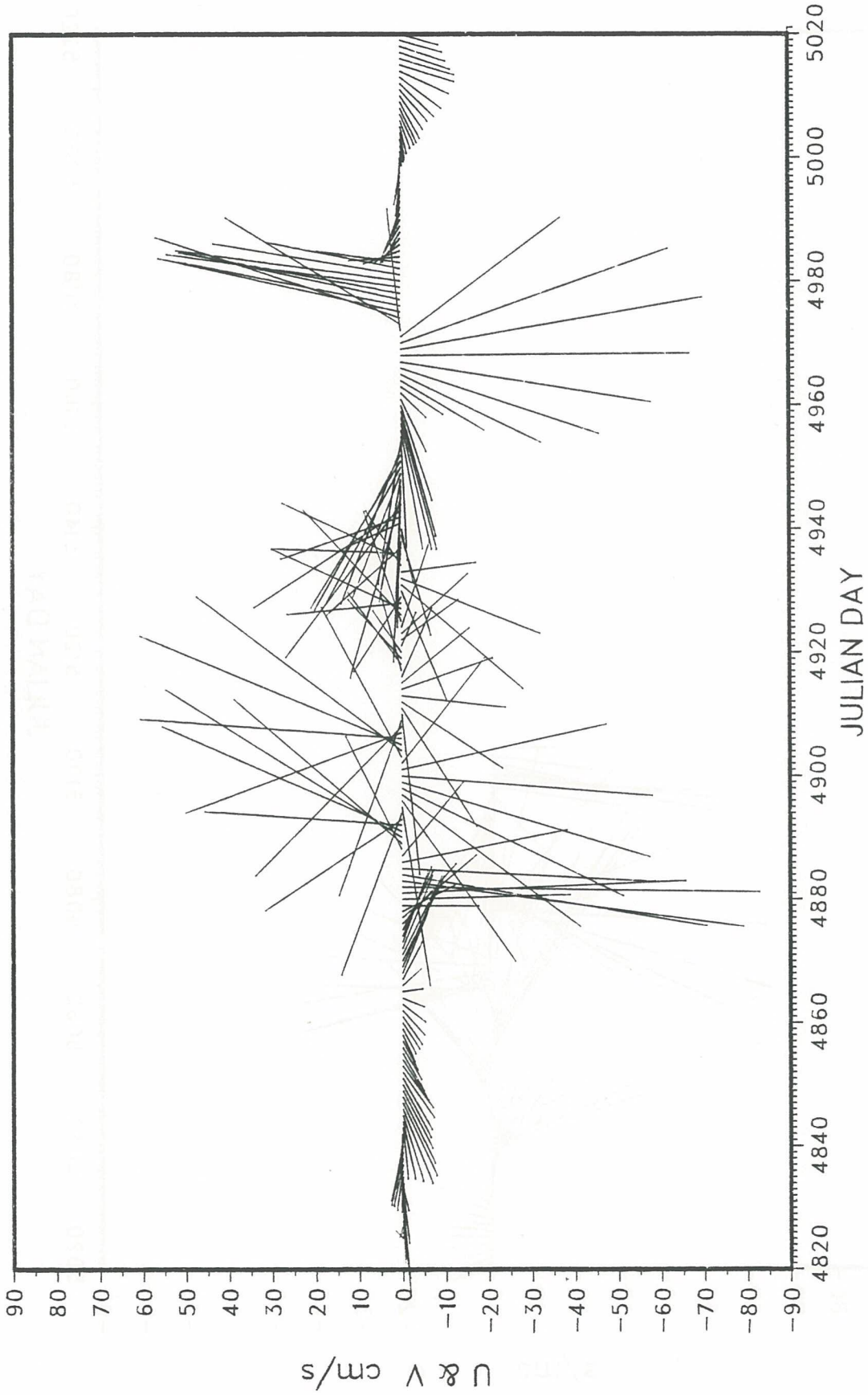


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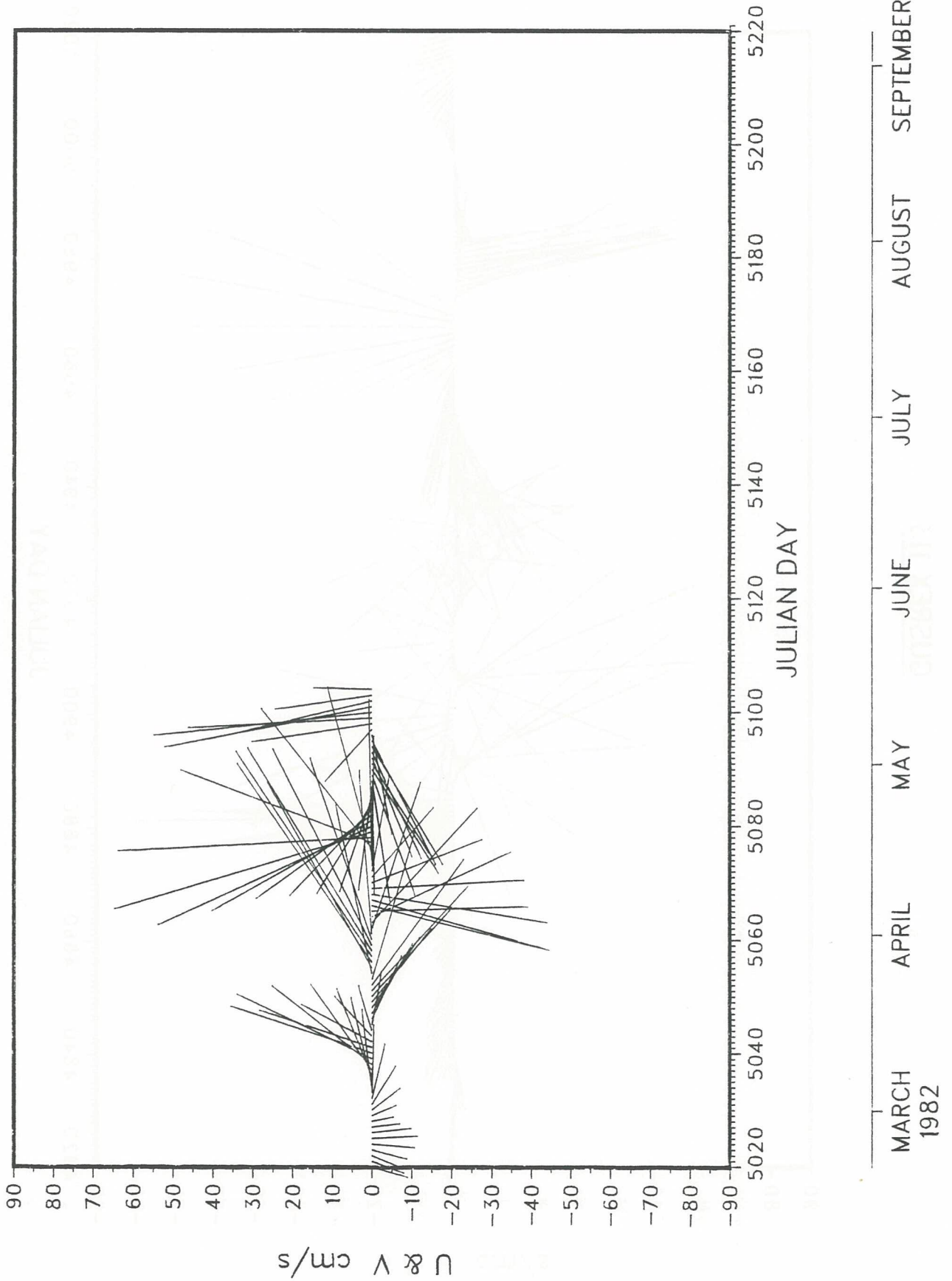


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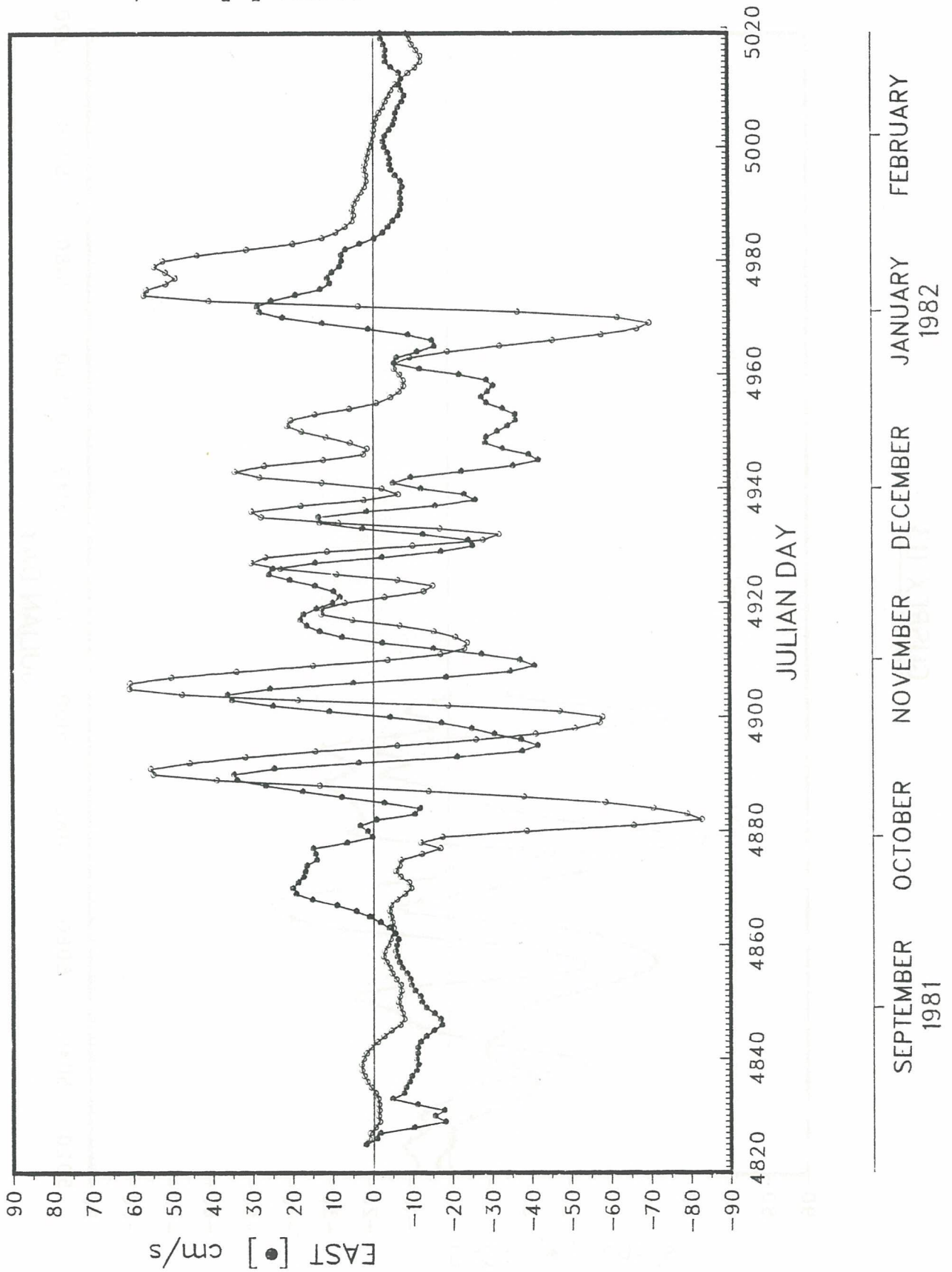


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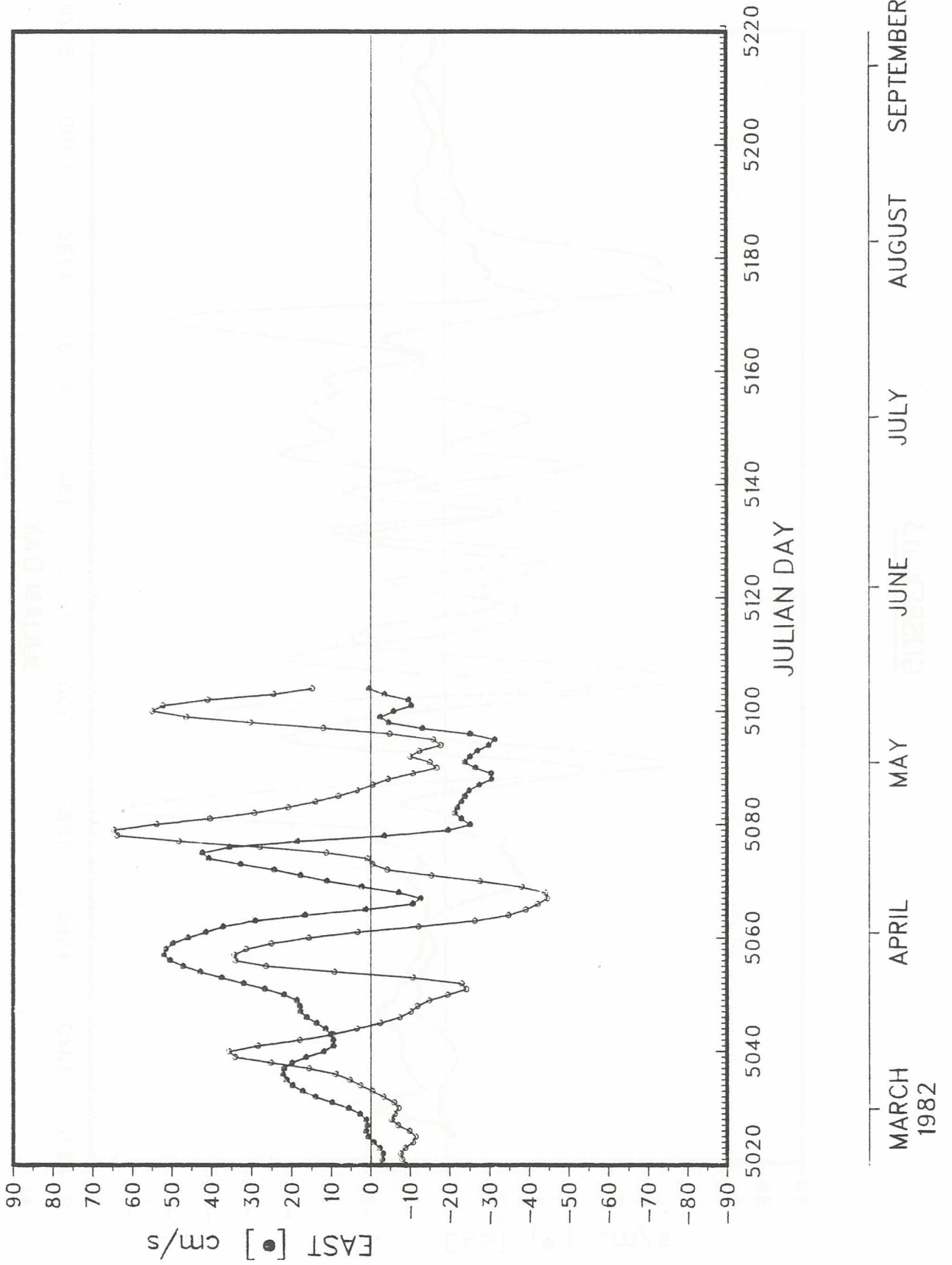
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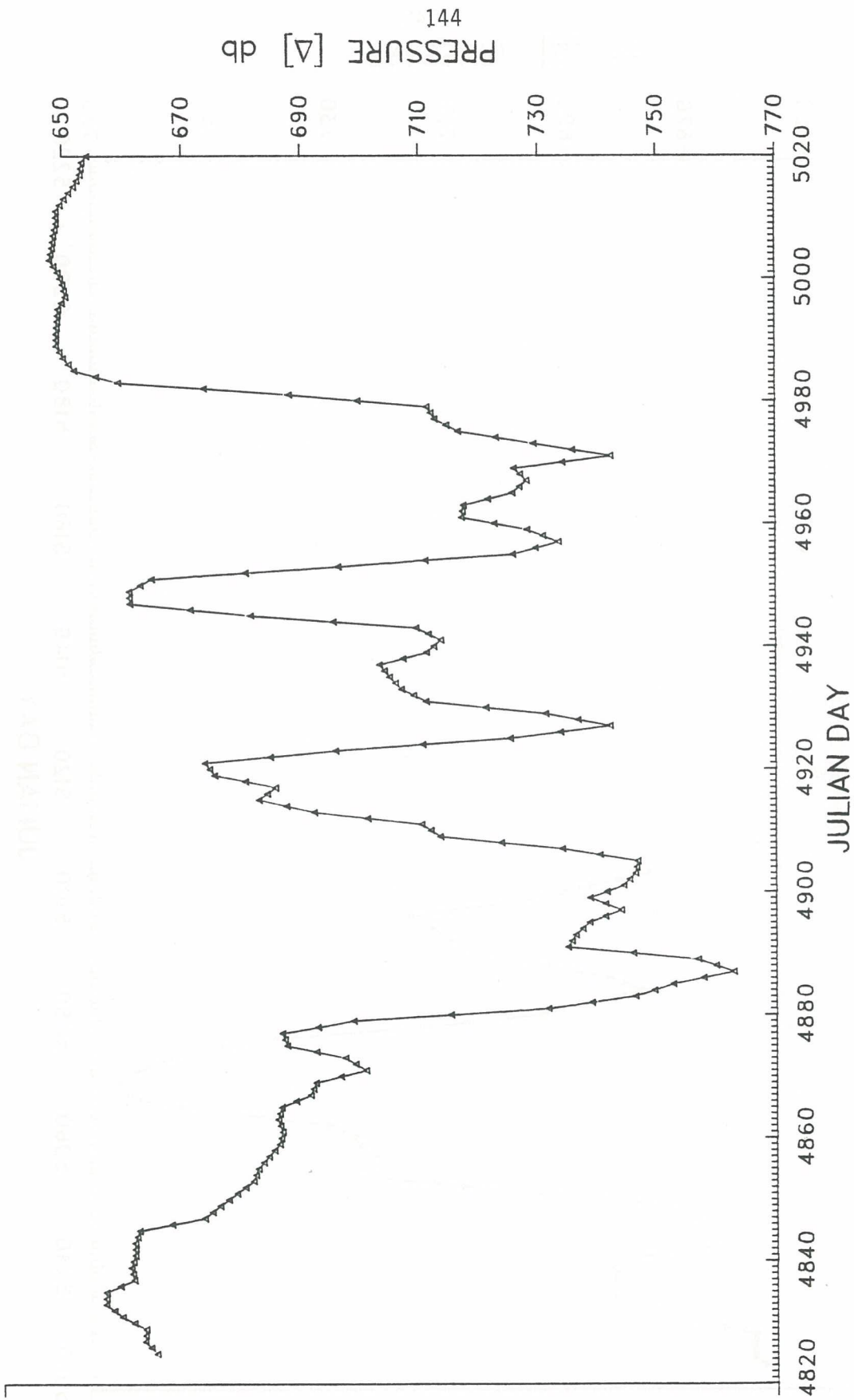
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GUSREX 113

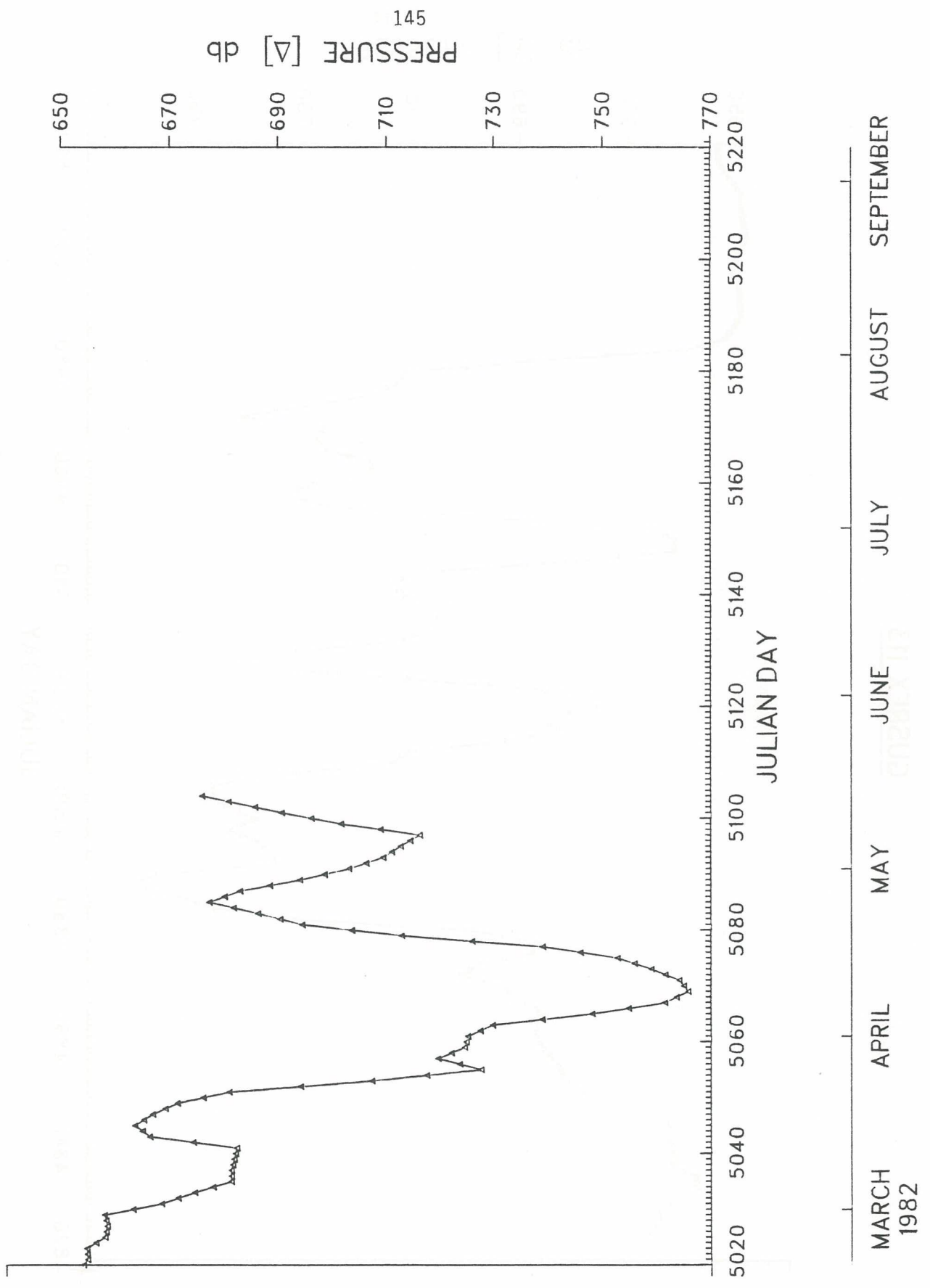


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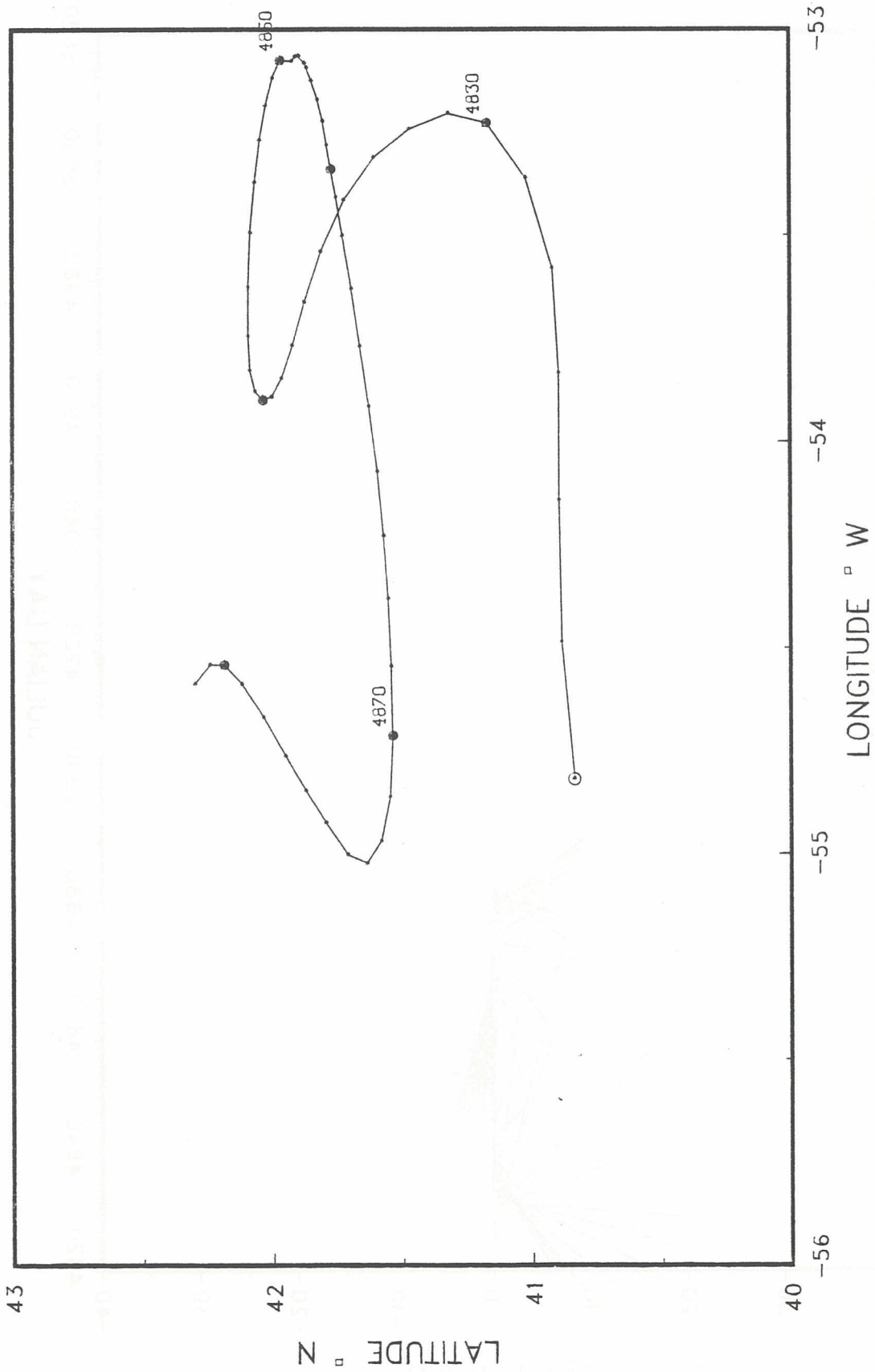


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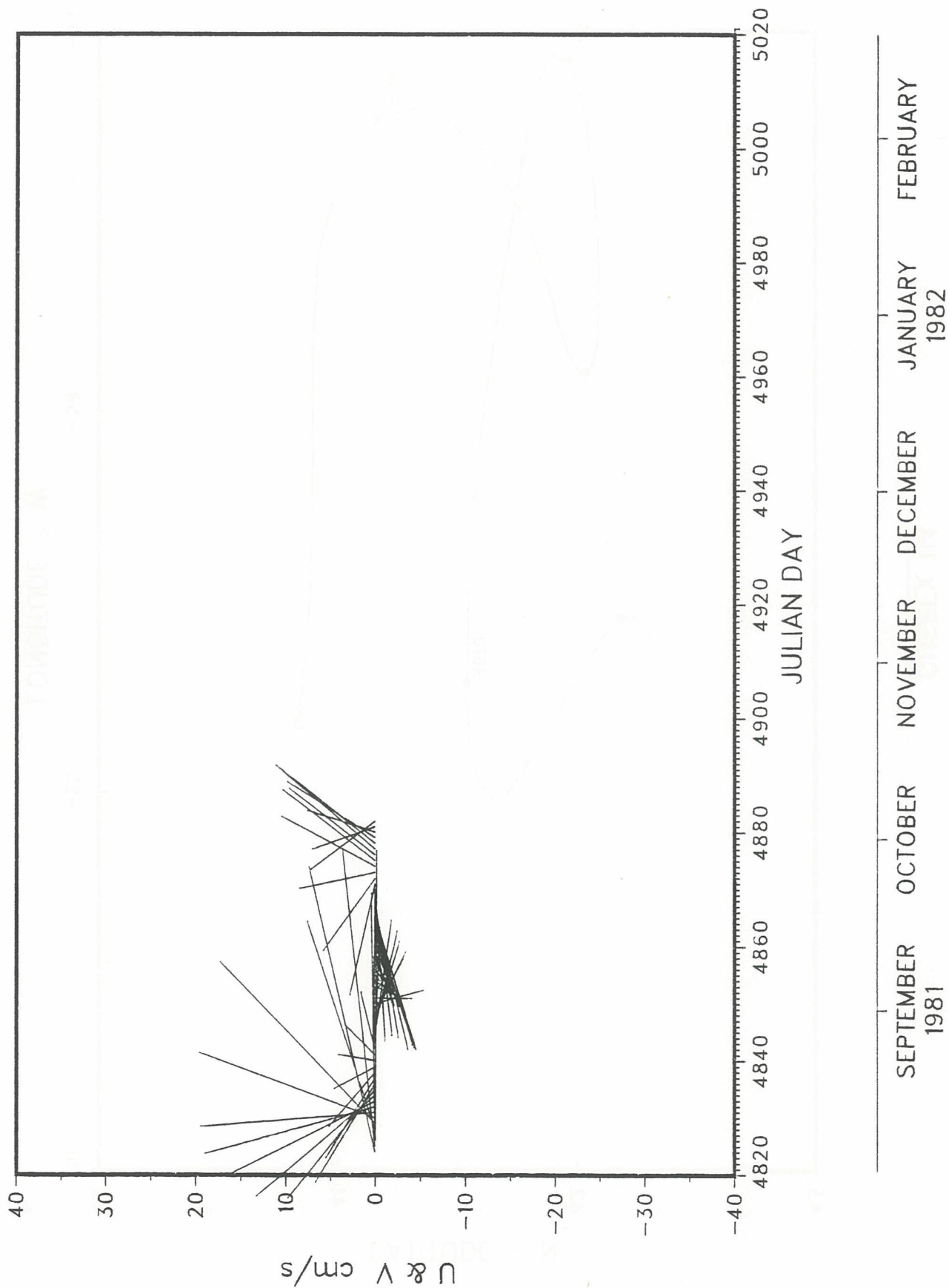


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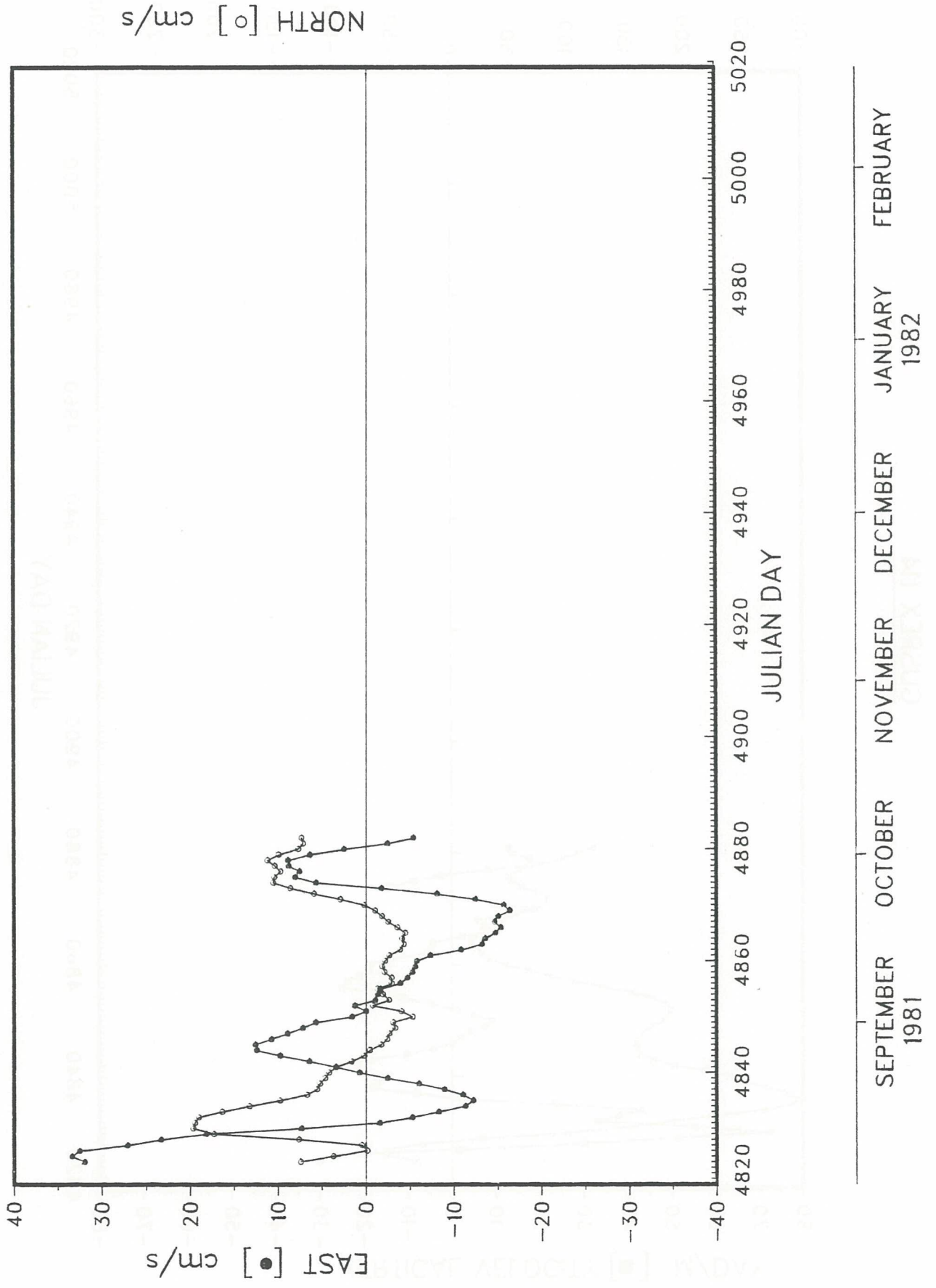


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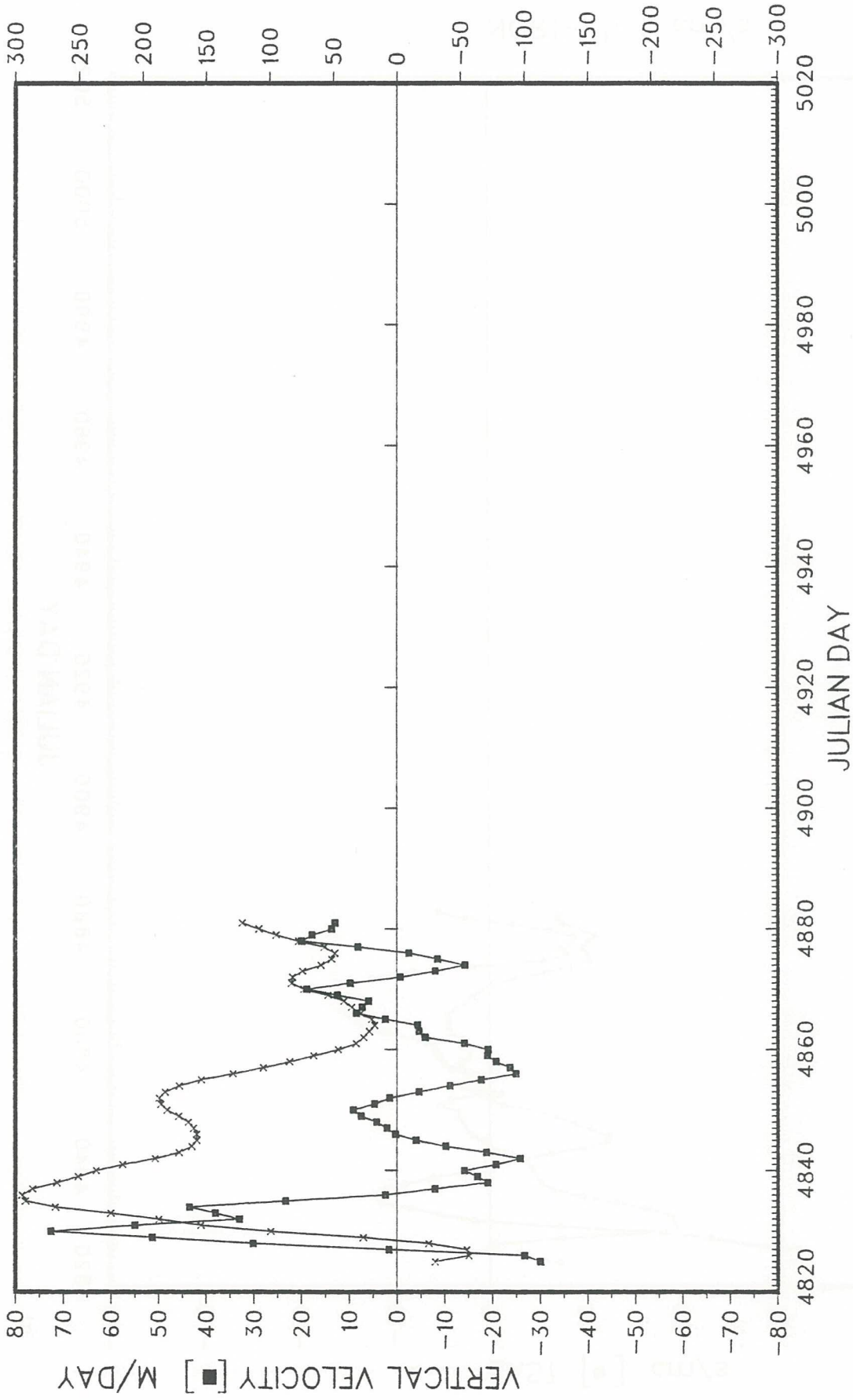
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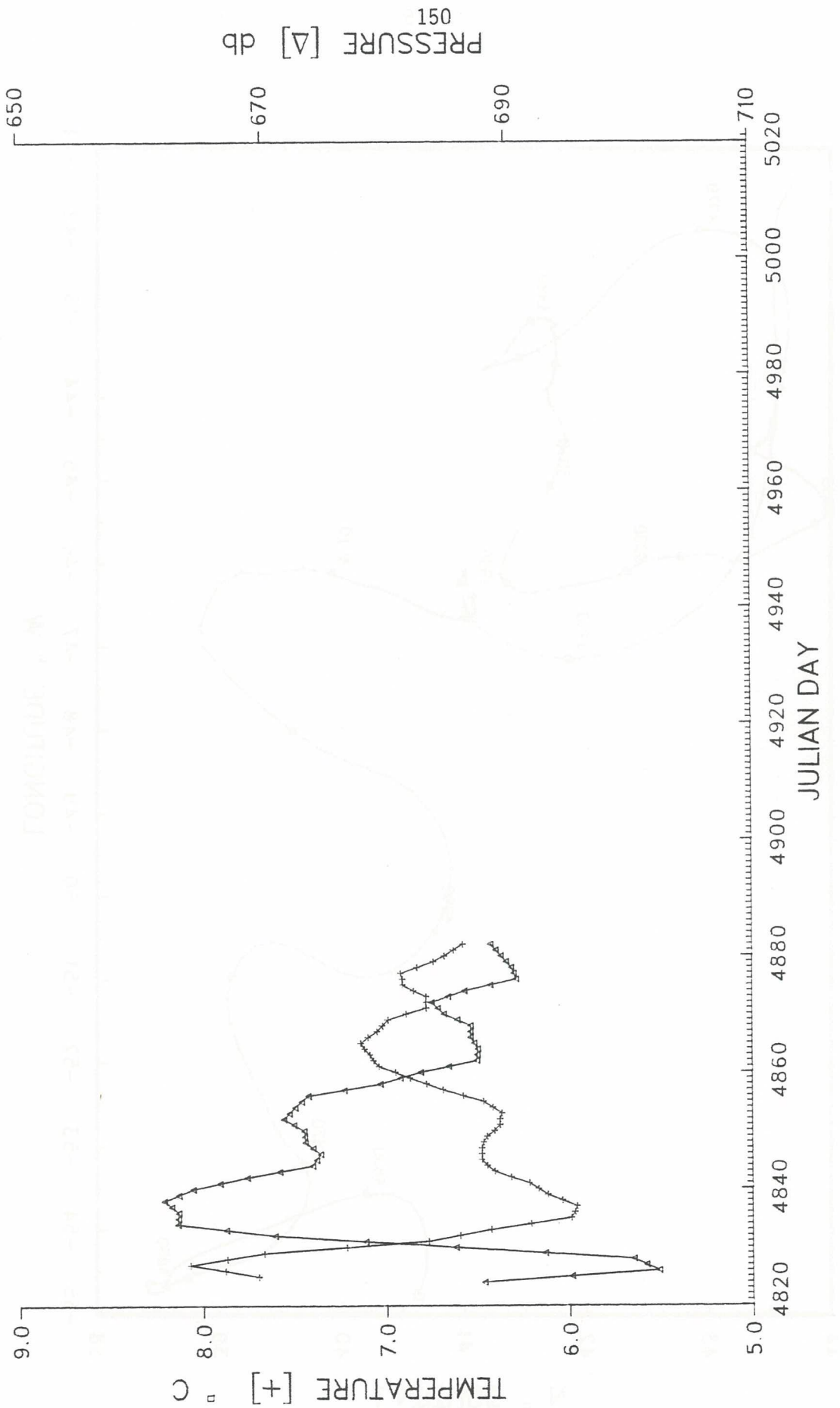
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GUSREX 114

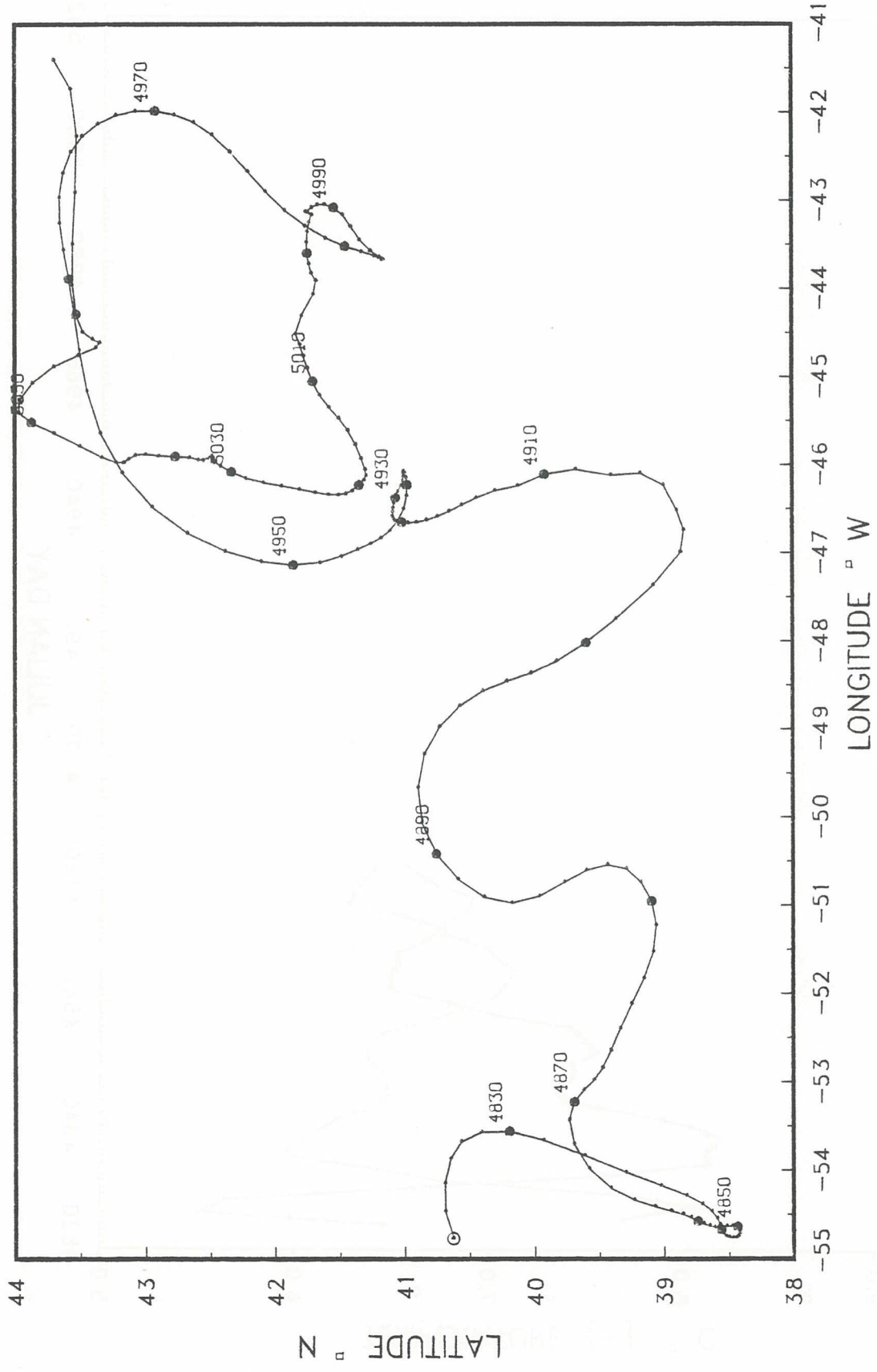


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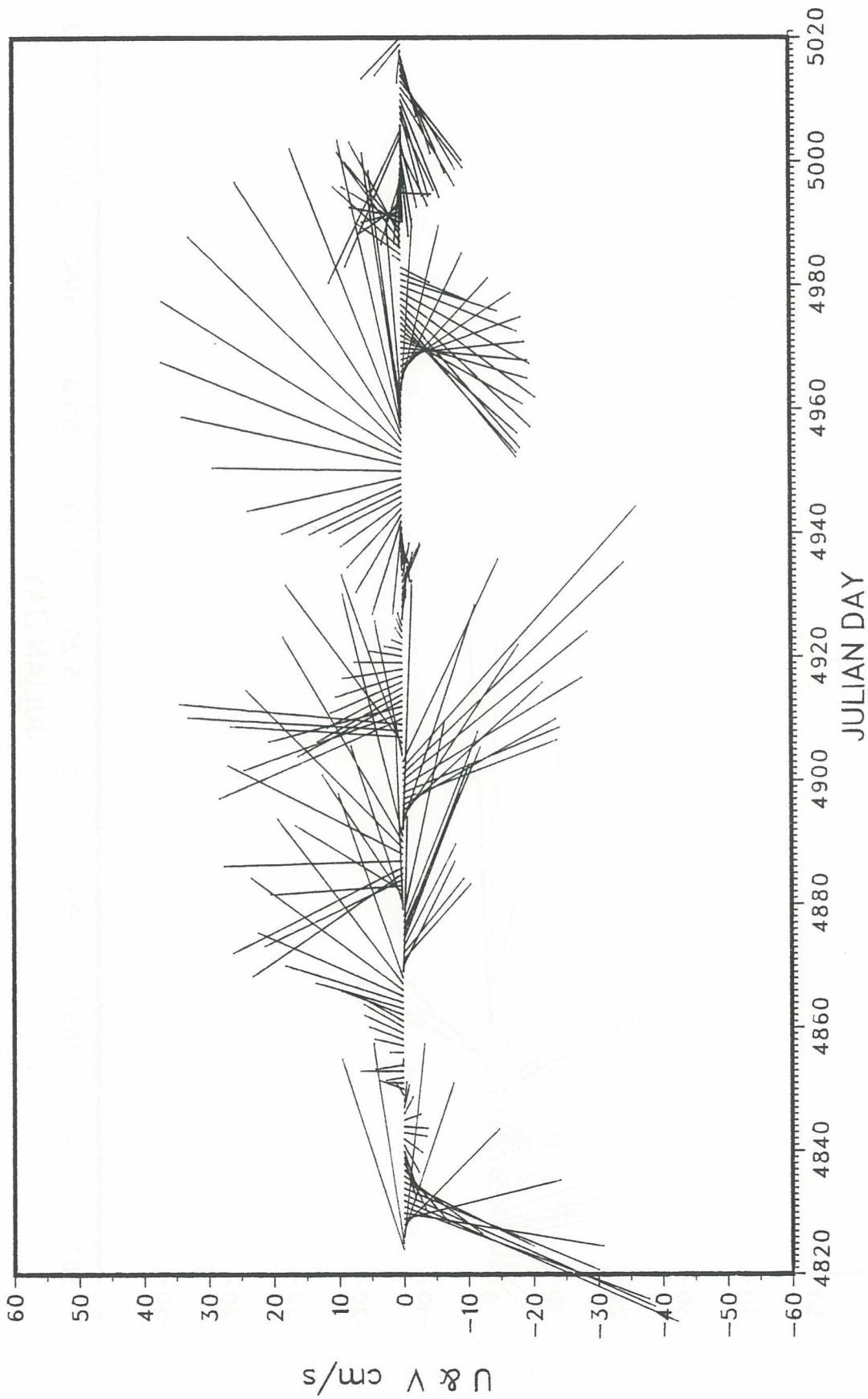


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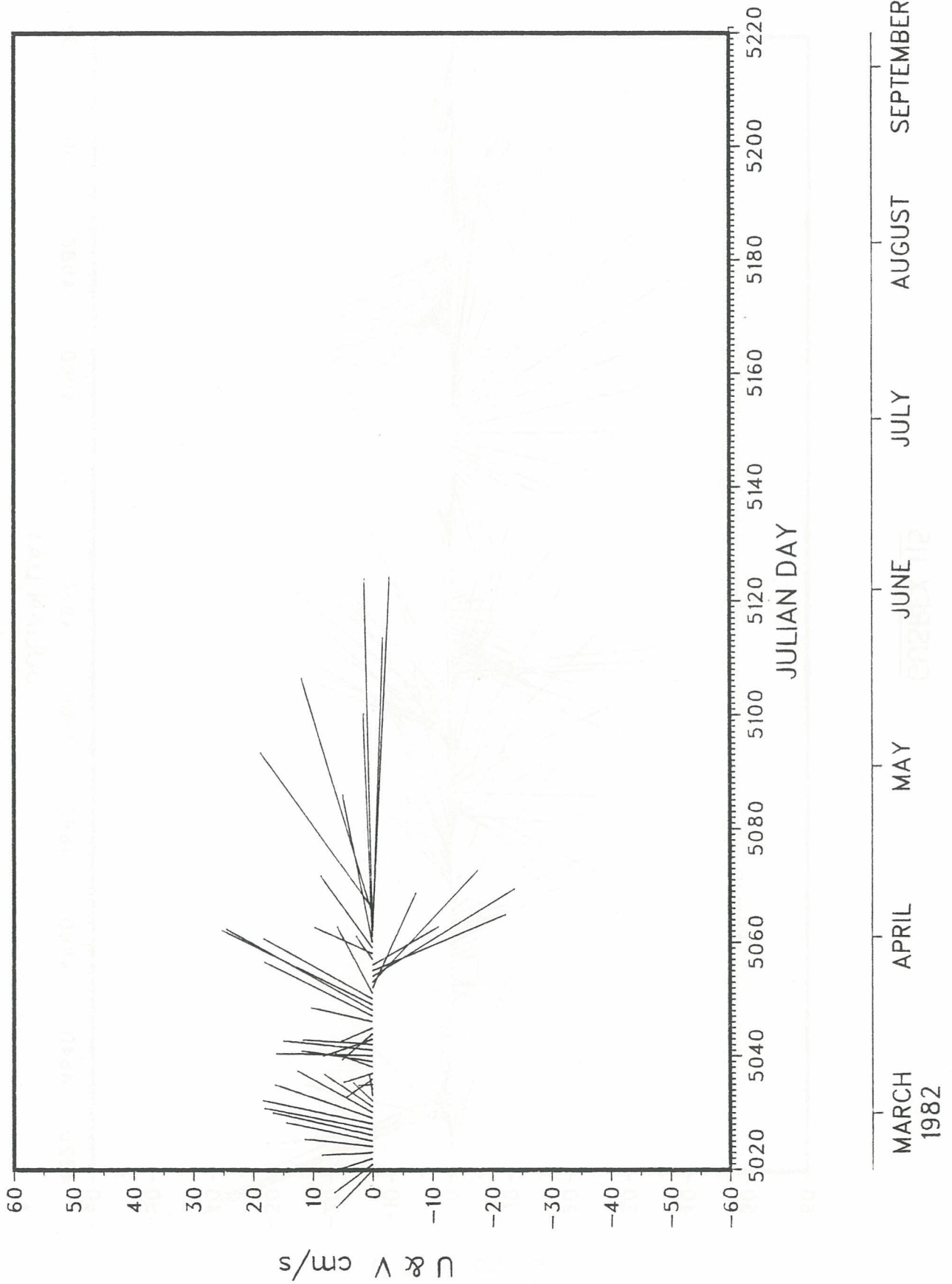


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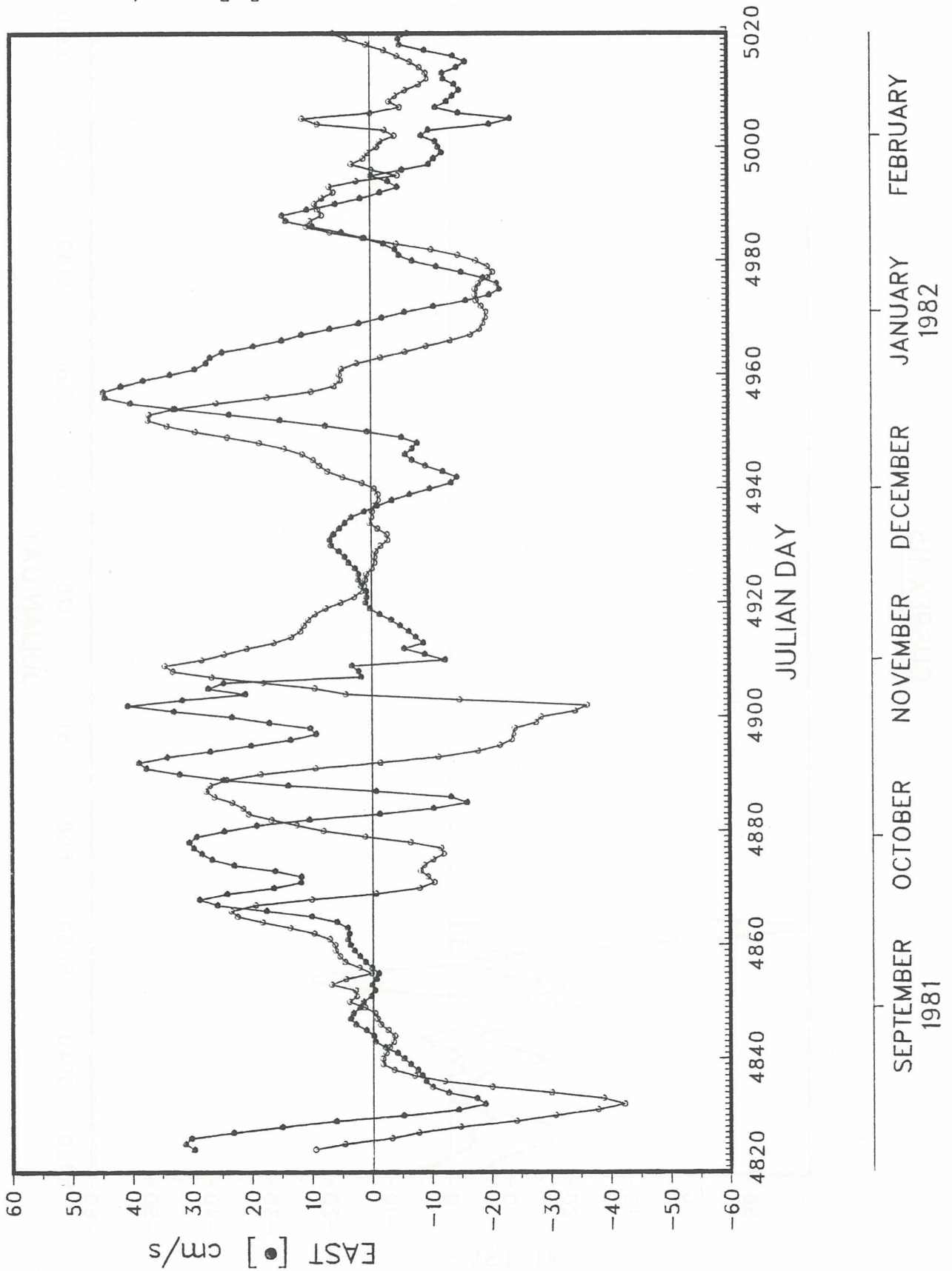


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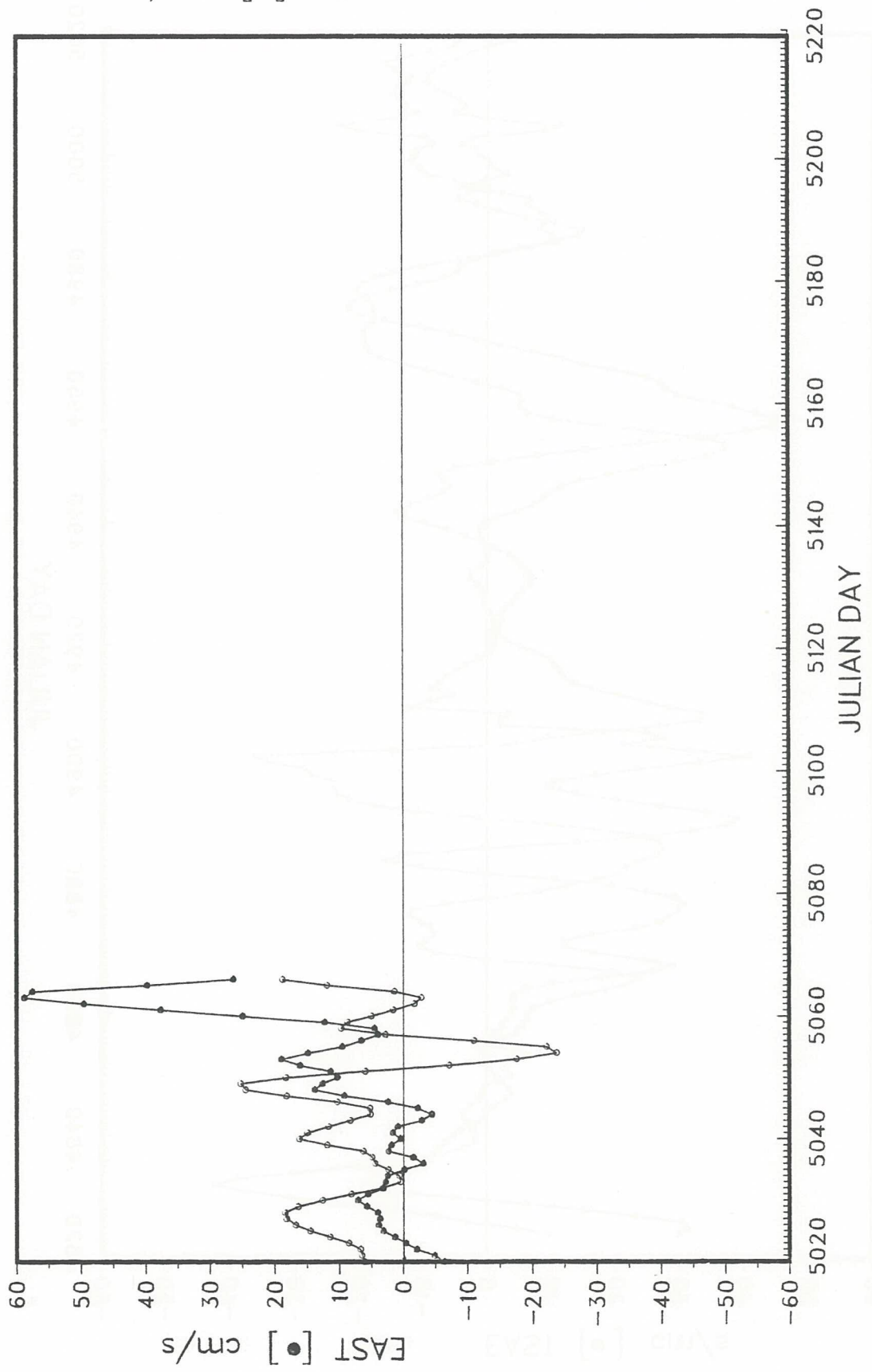
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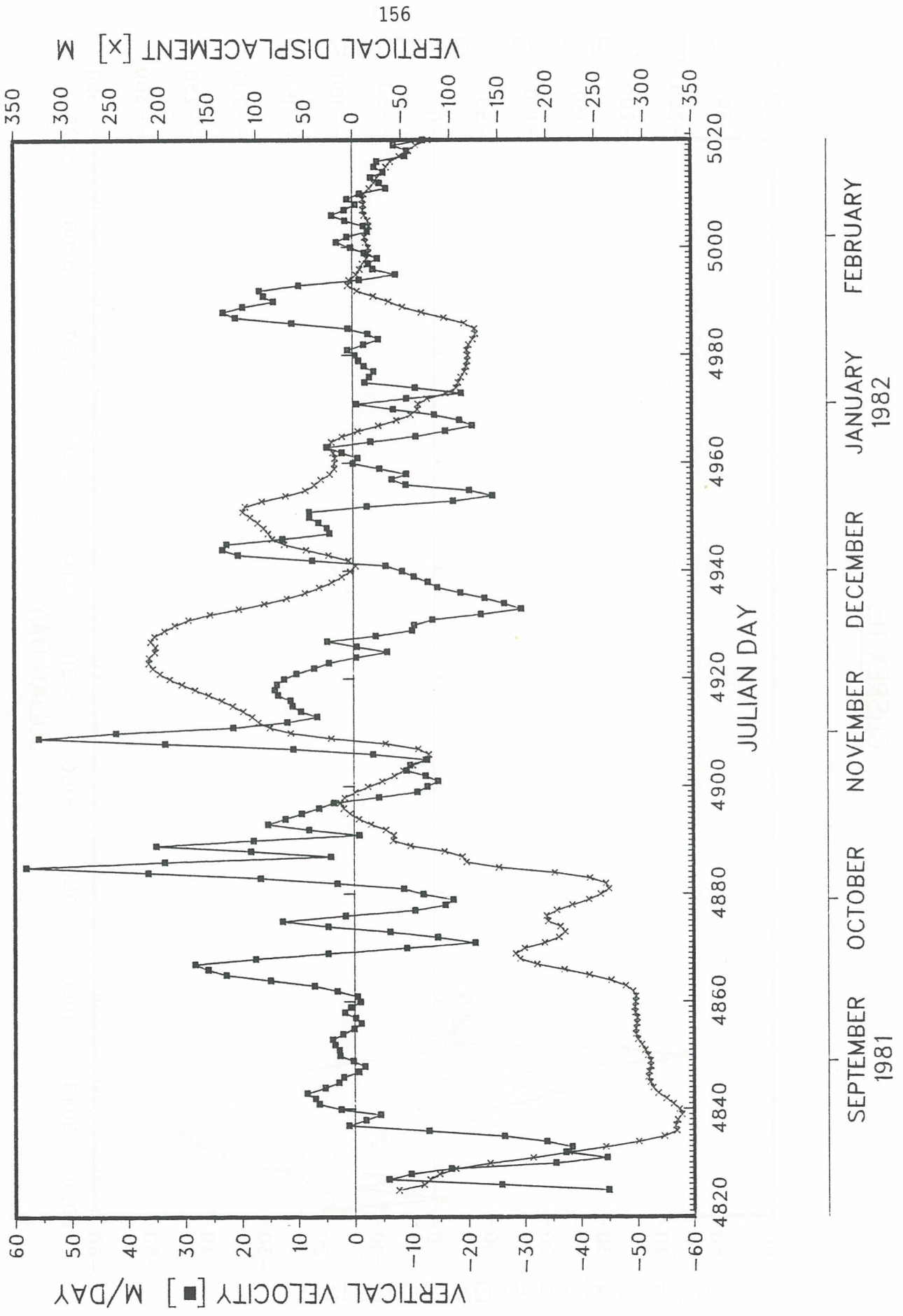


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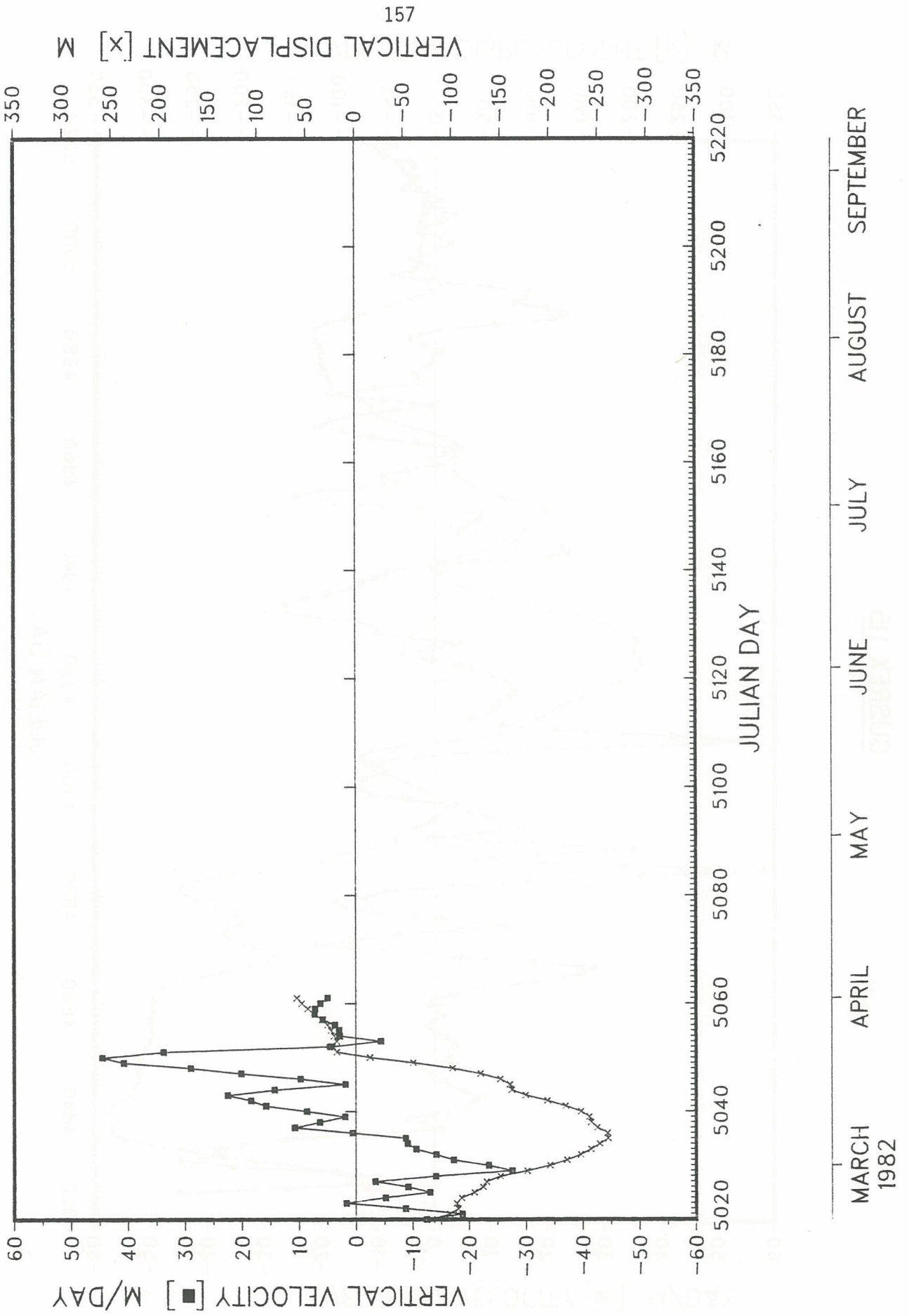


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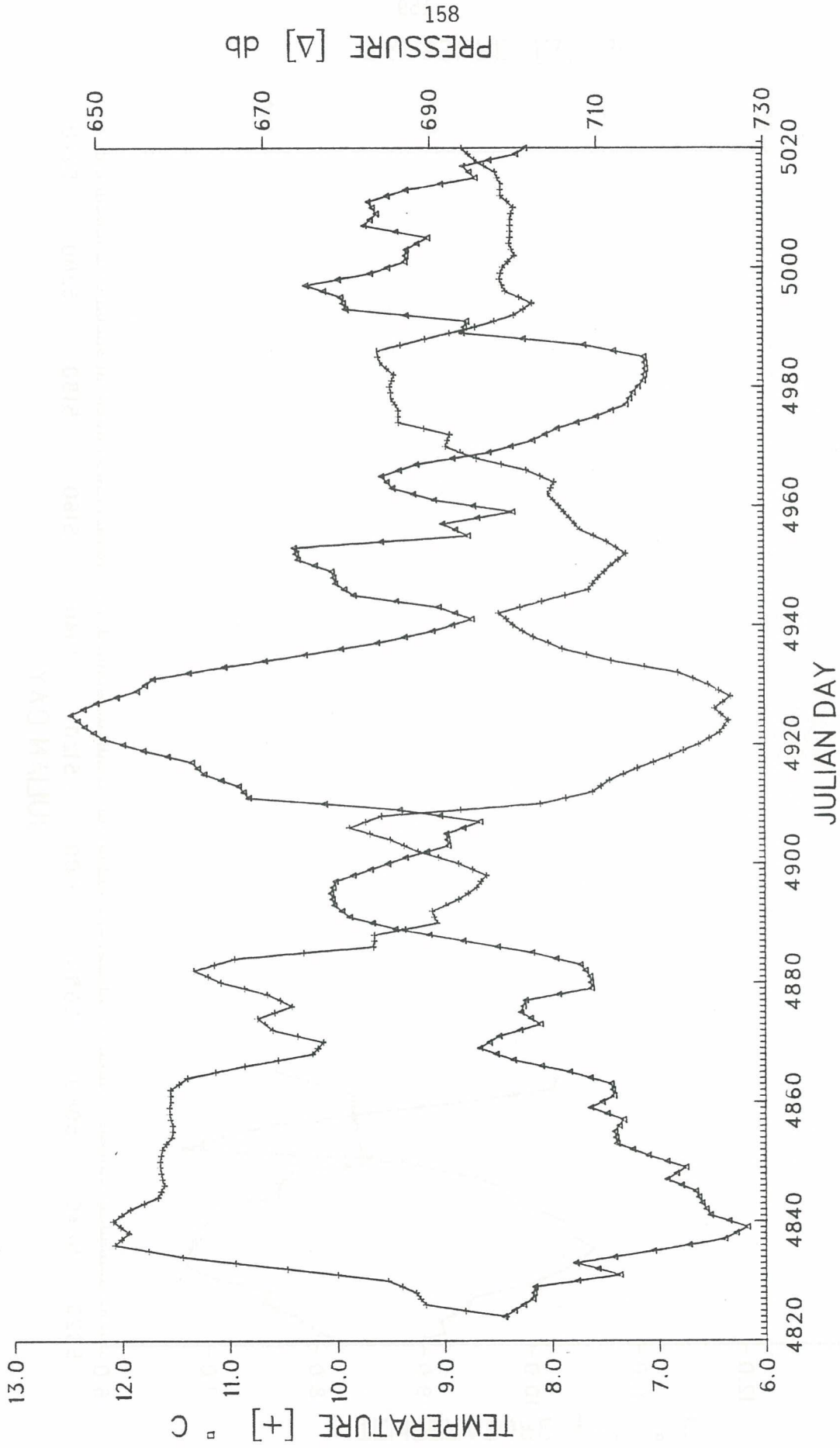
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GUSREX 115

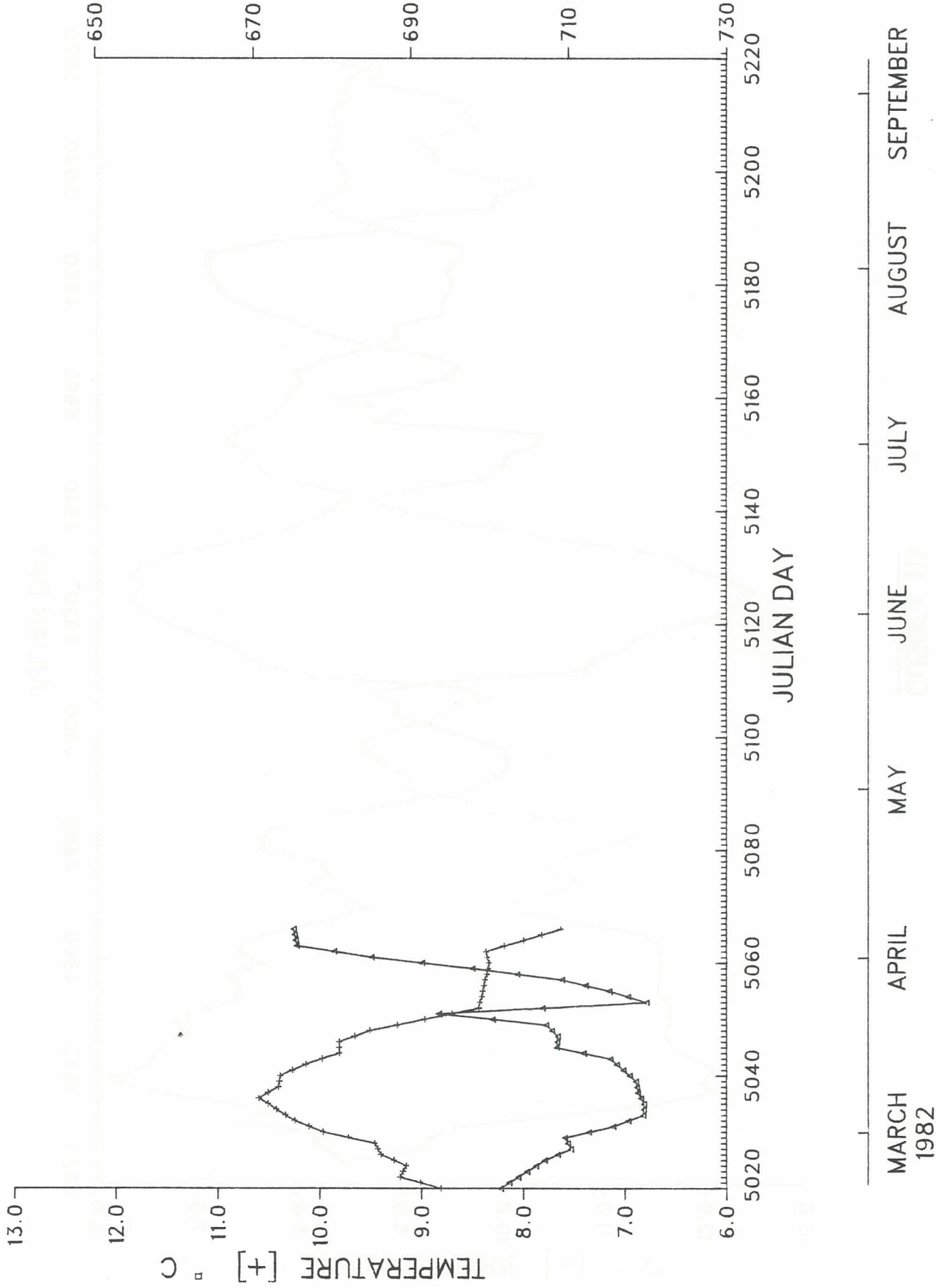


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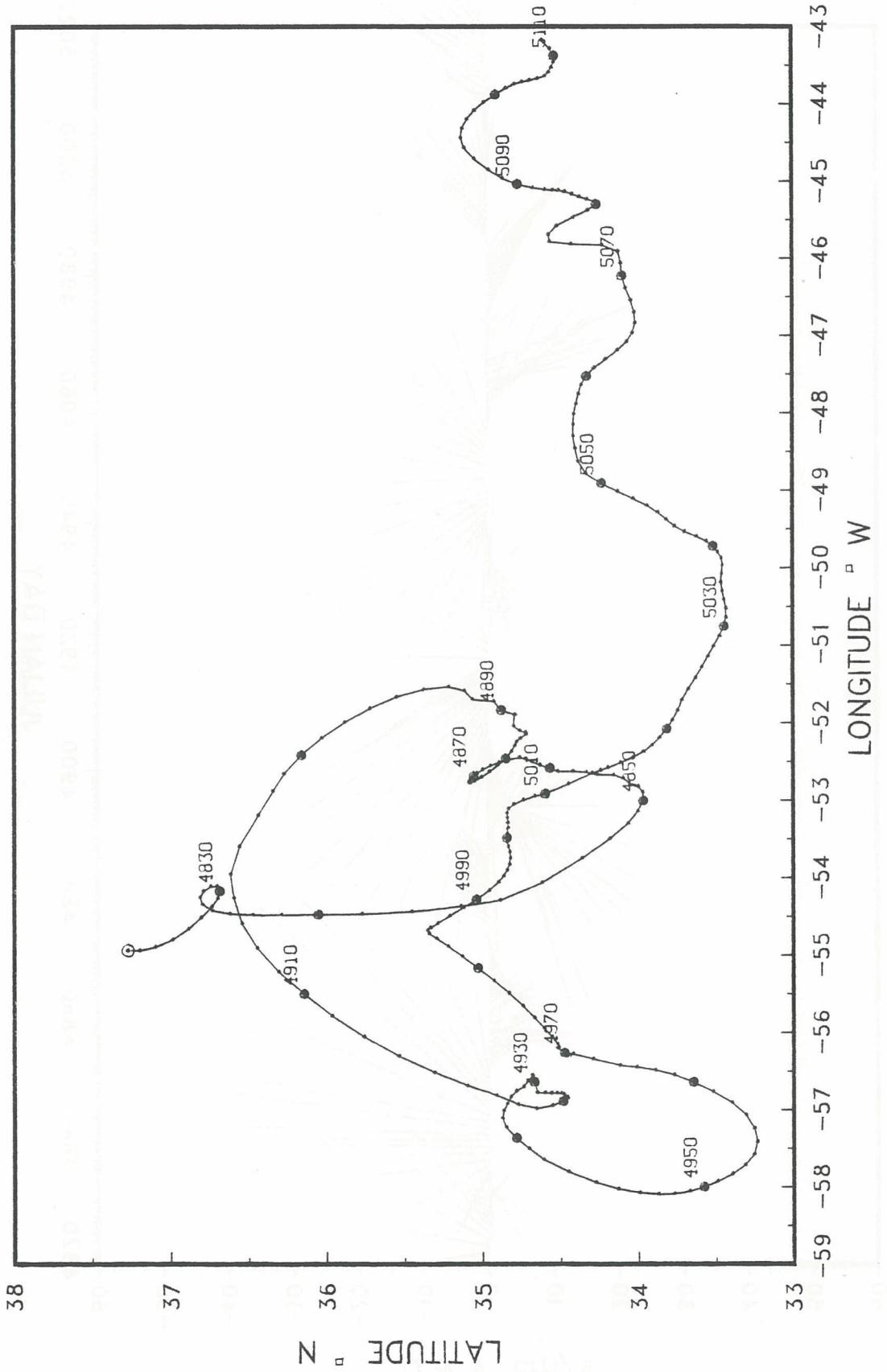


SEPTEMBER 1981 OCTOBER NOVEMBER DECEMBER JANUARY 1982 FEBRUARY

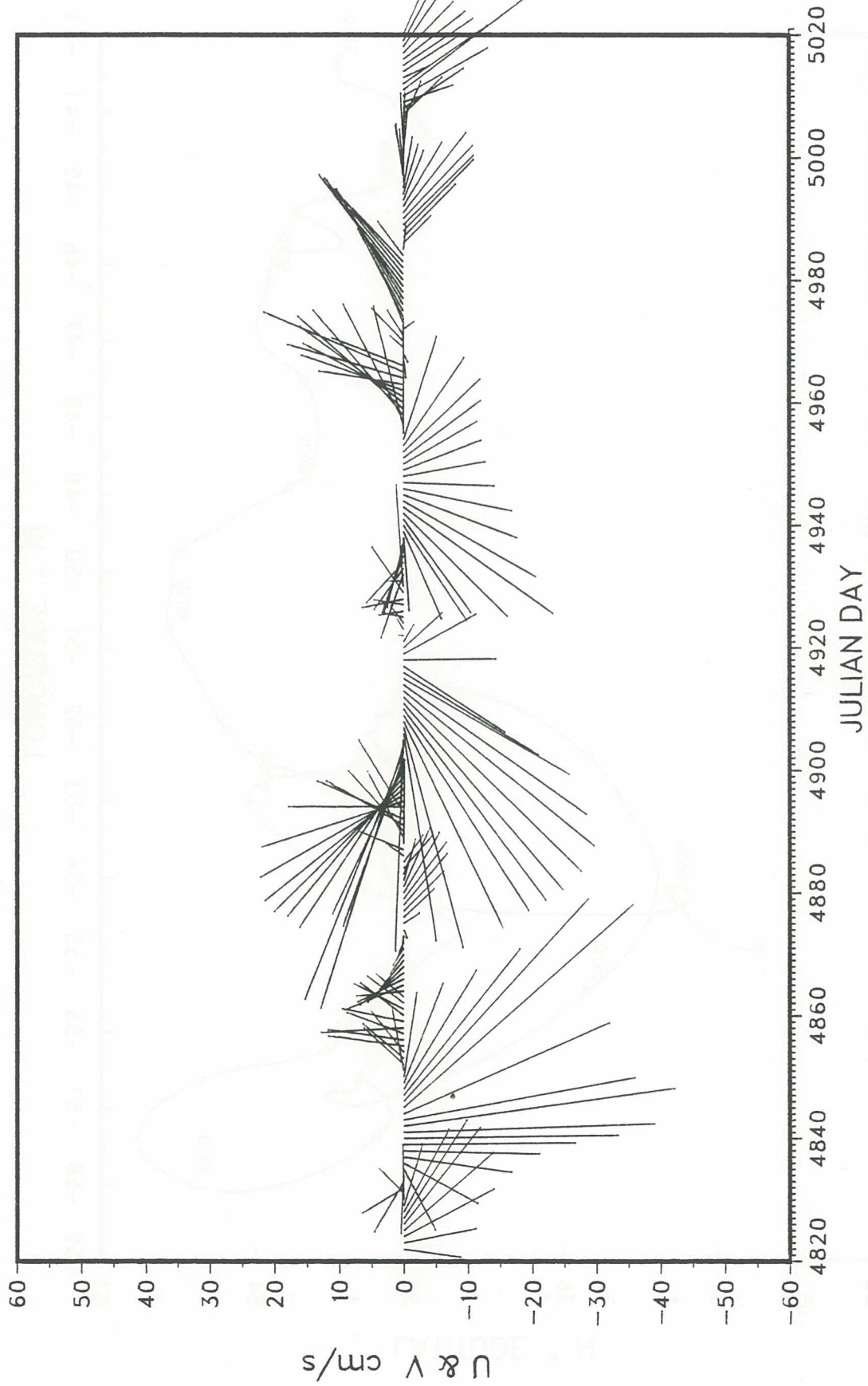
GUSREX 115



GUSREX 116

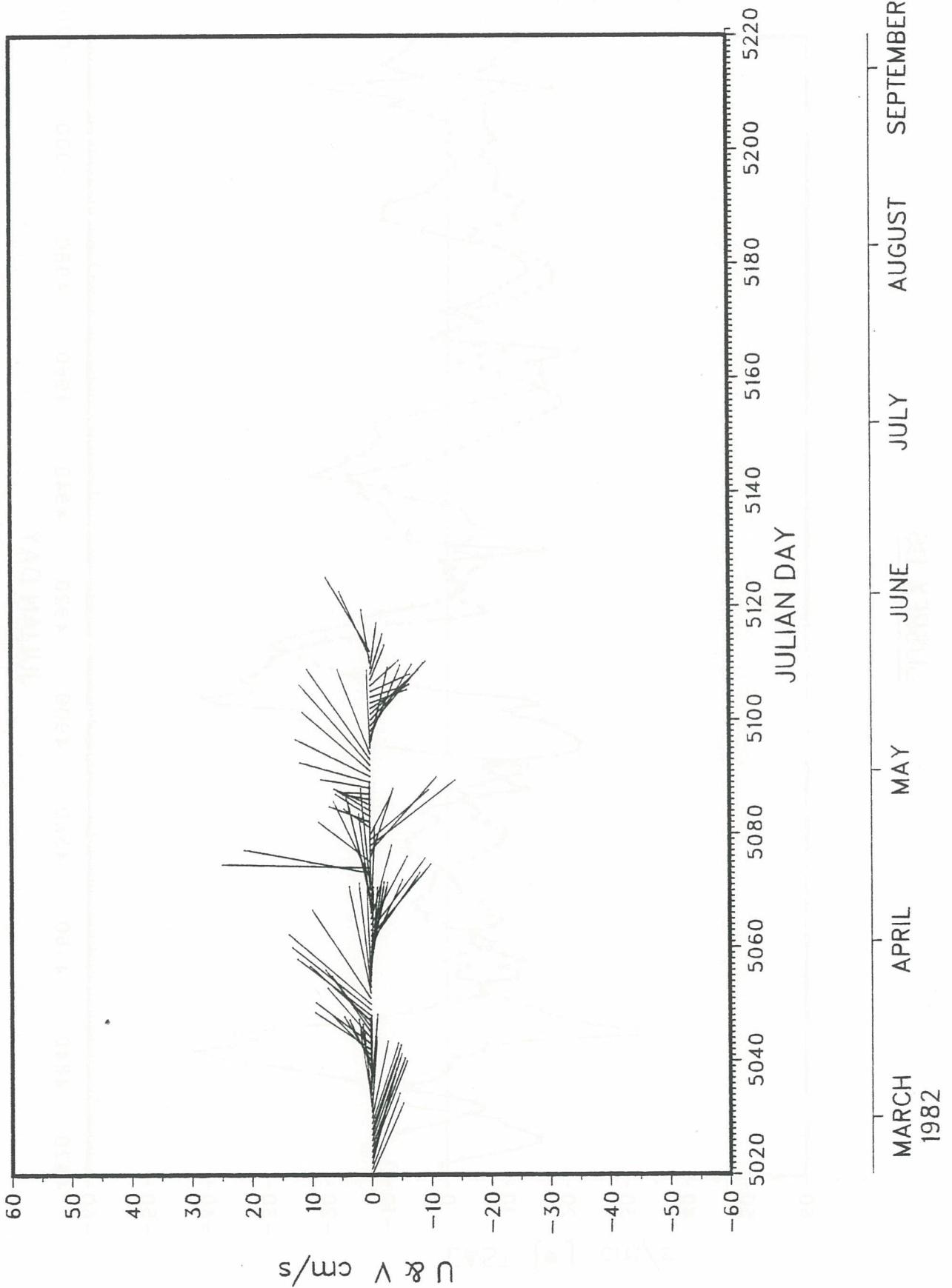


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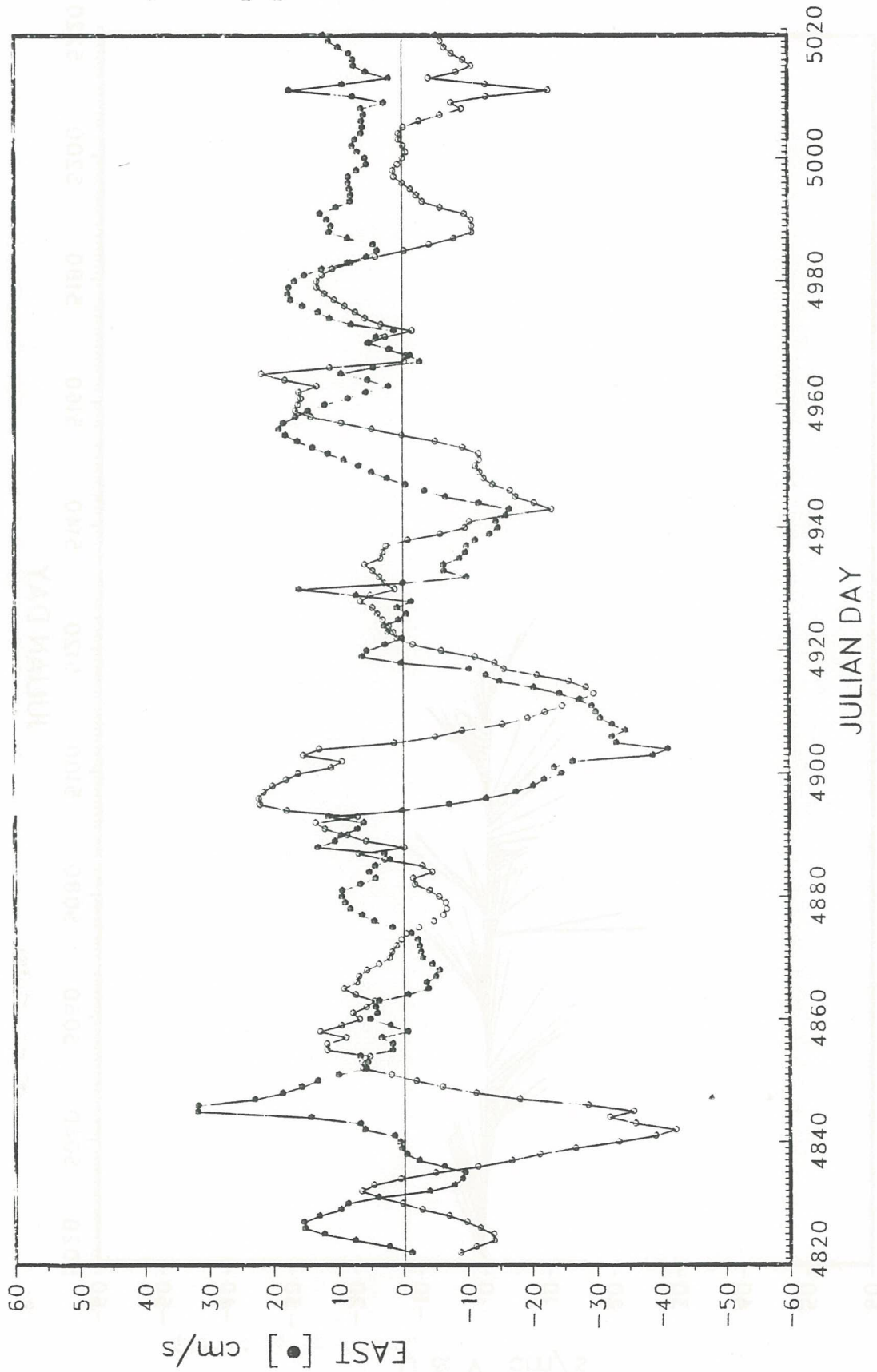


SEPTEMBER 1981 OCTOBER NOVEMBER DECEMBER JANUARY 1982 FEBRUARY

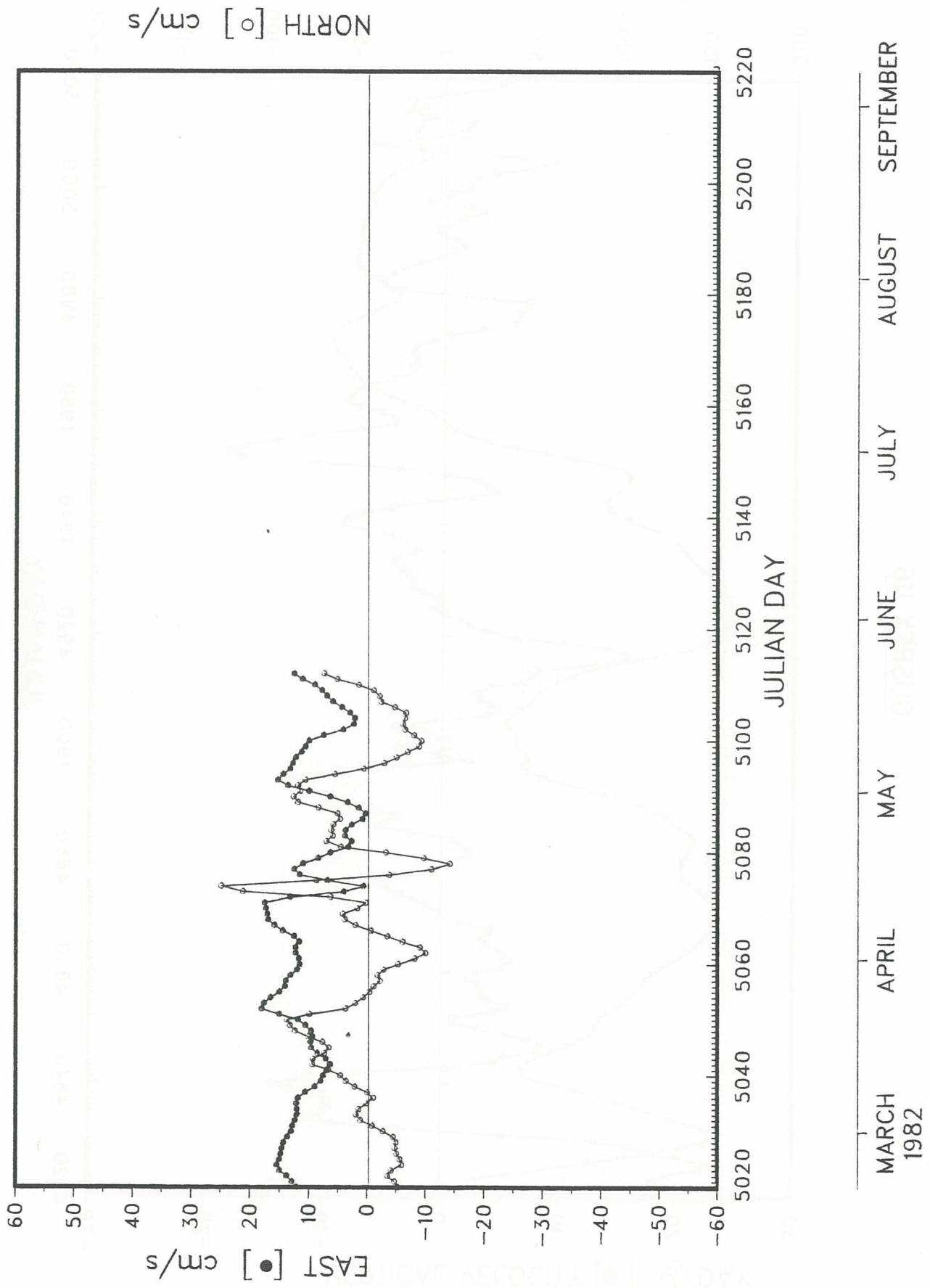
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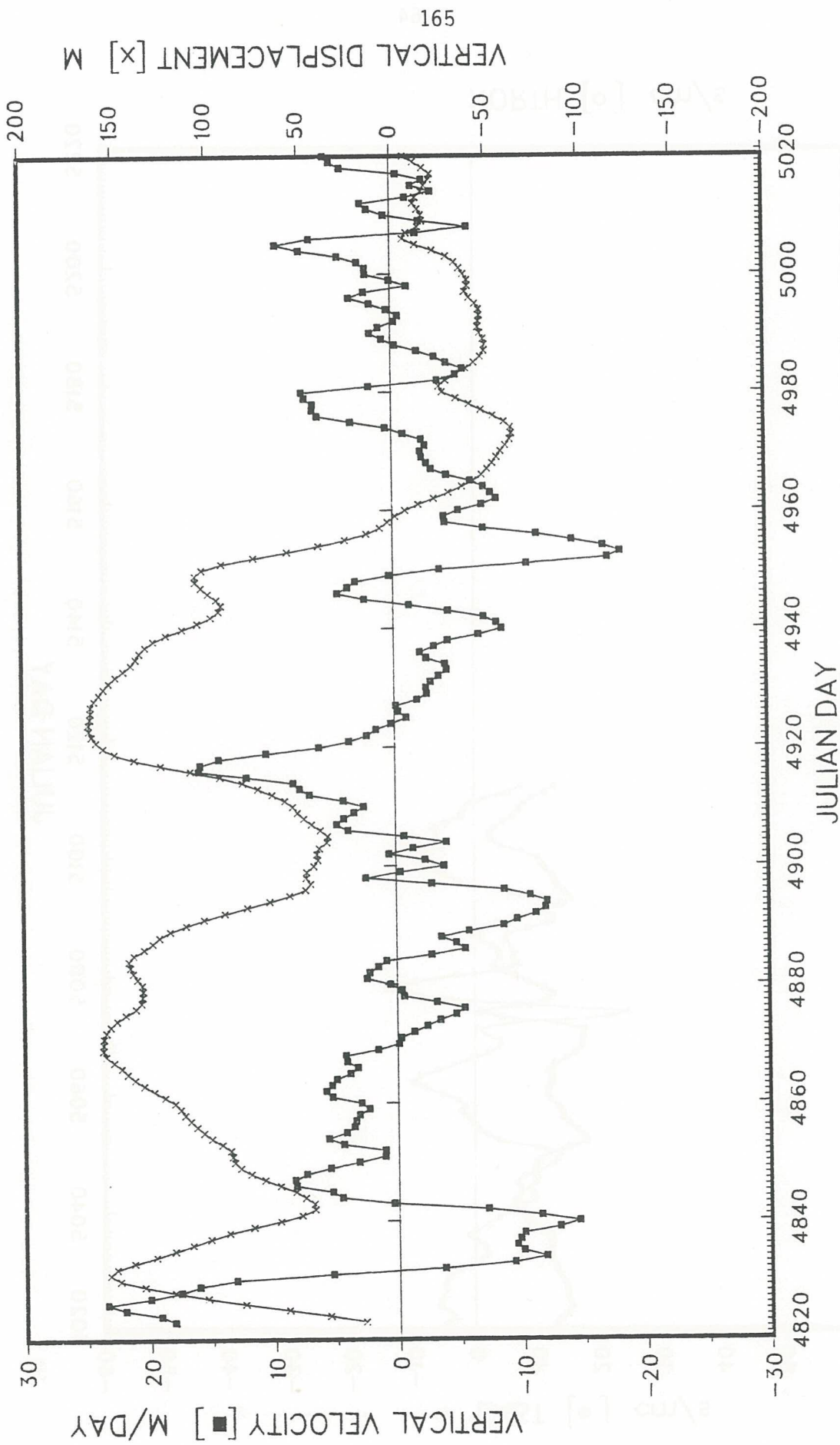
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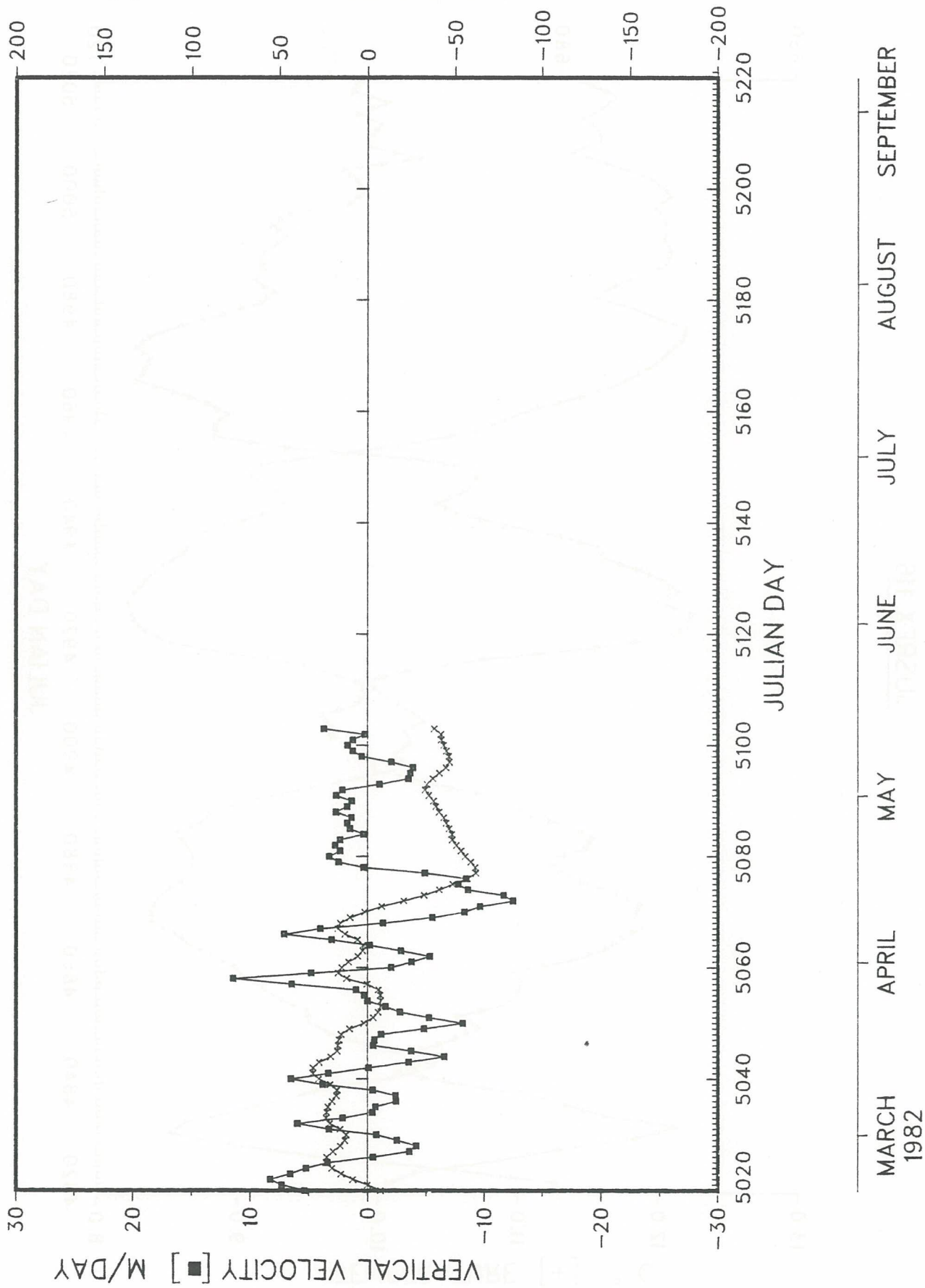
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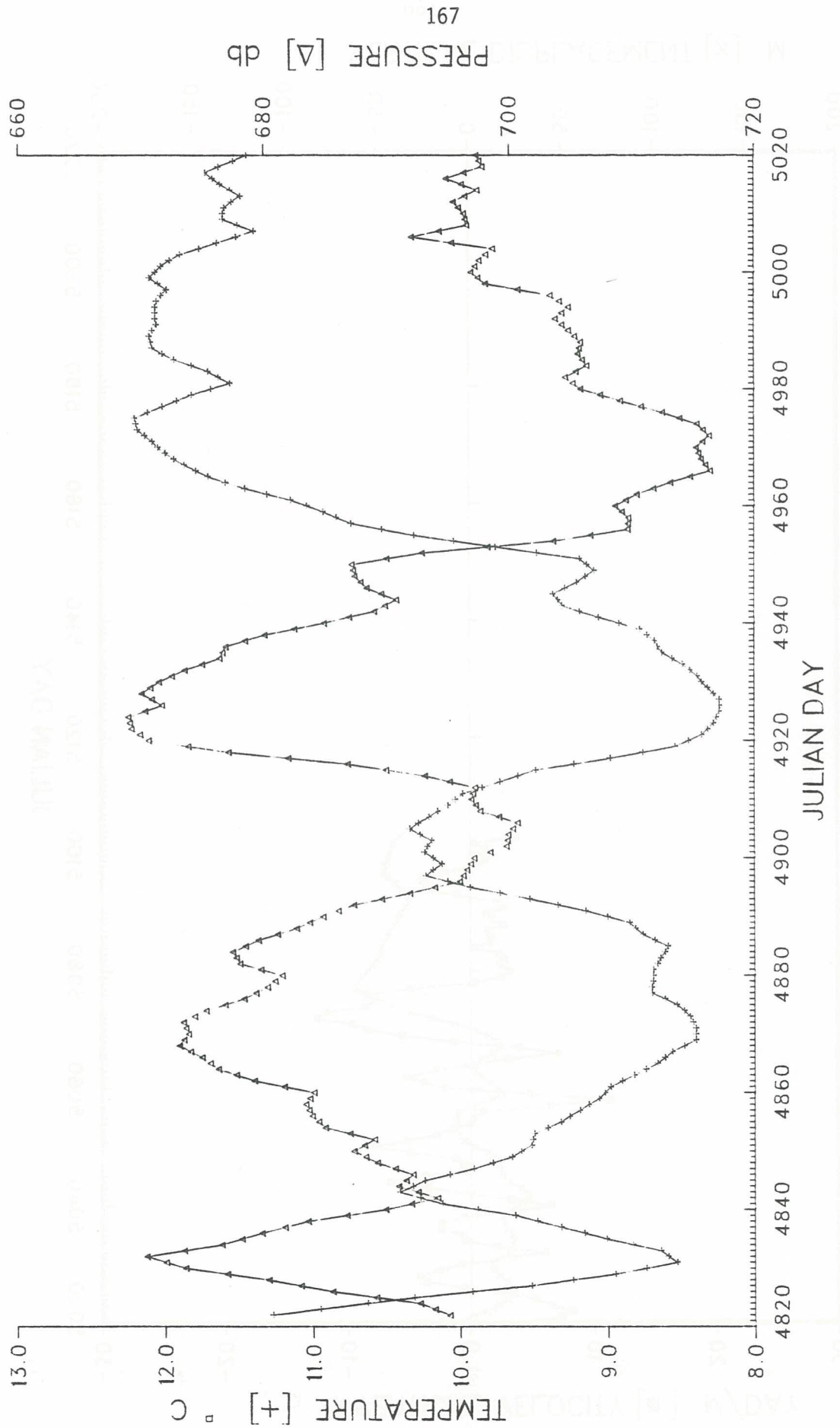
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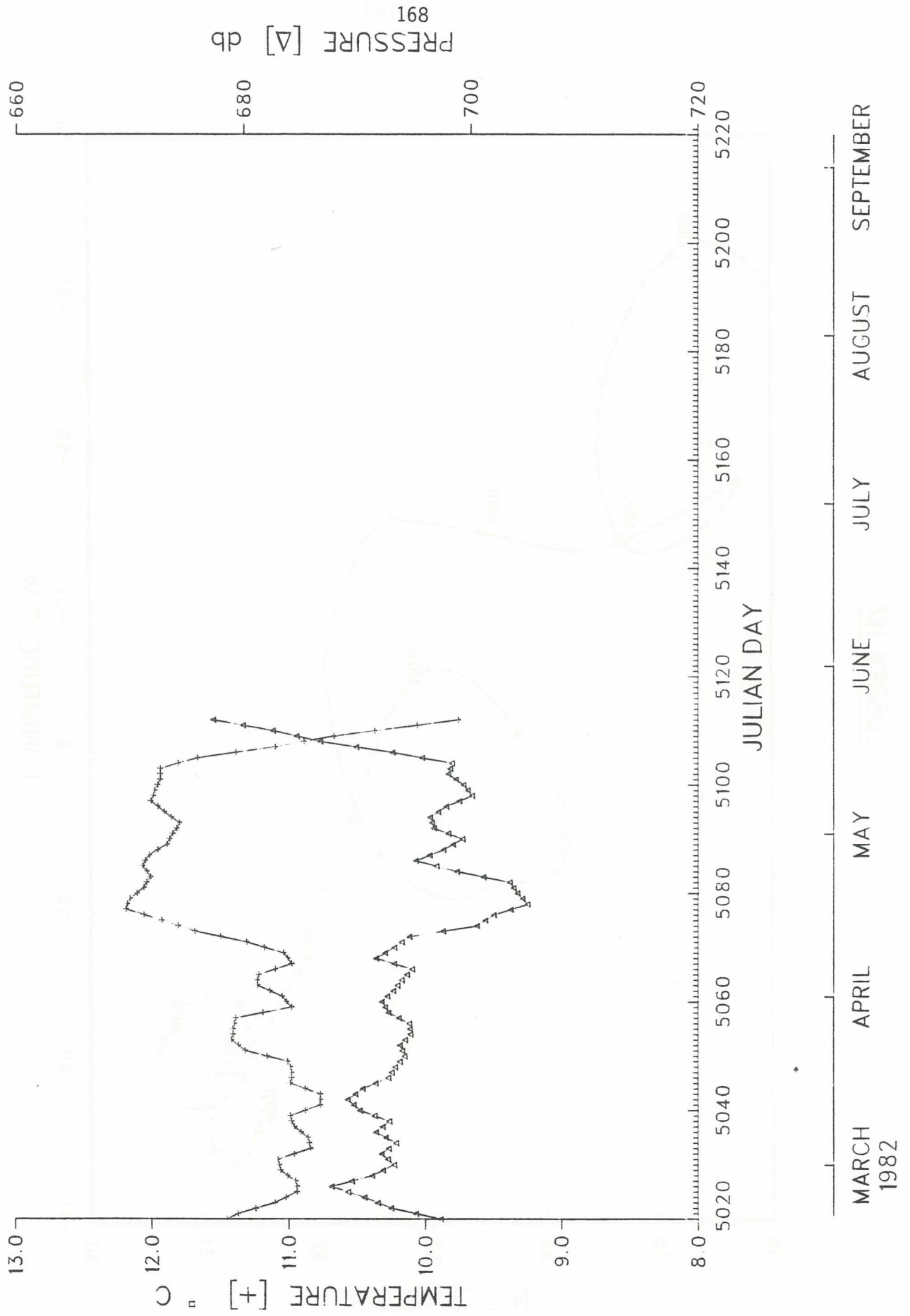
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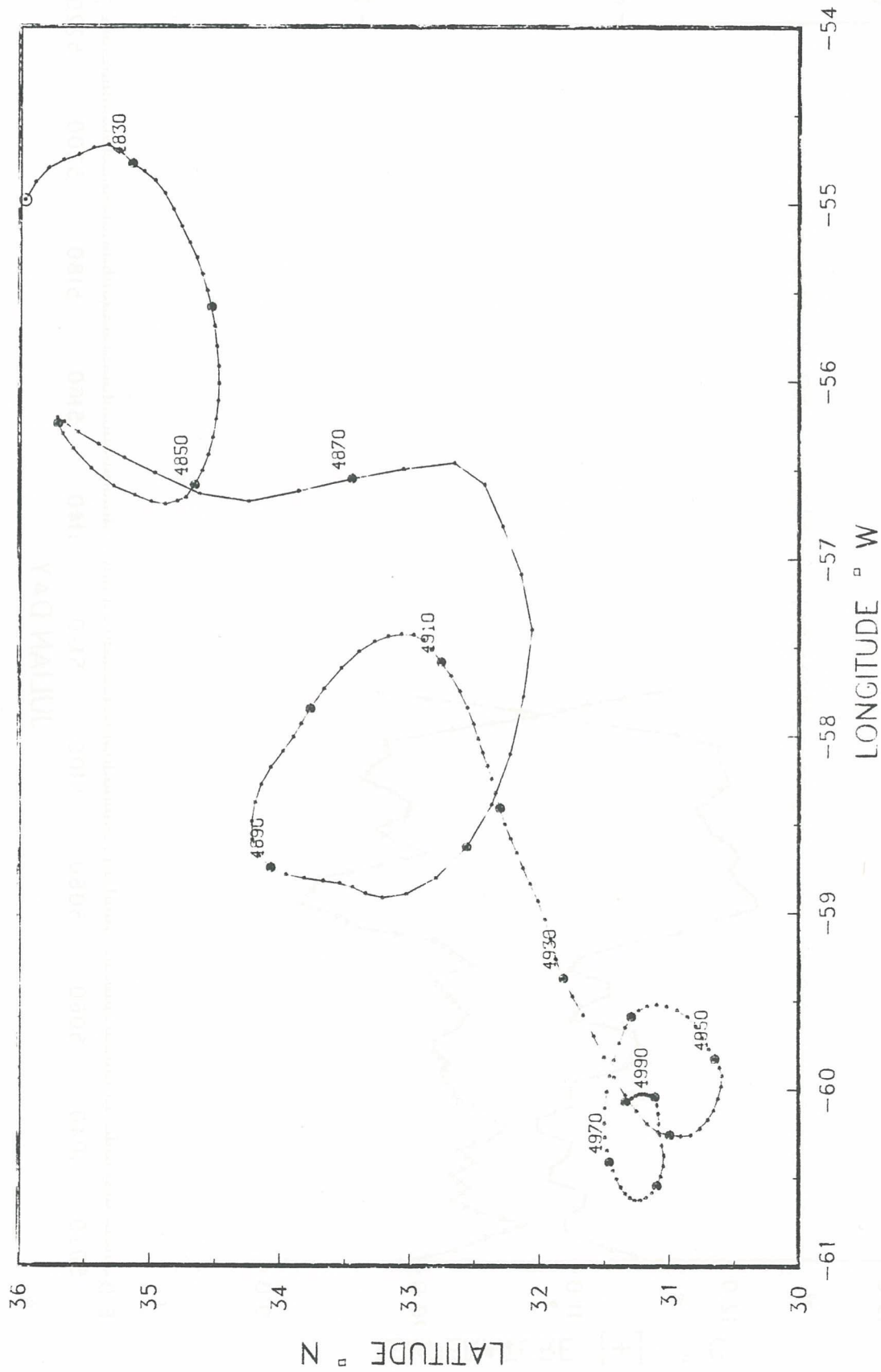
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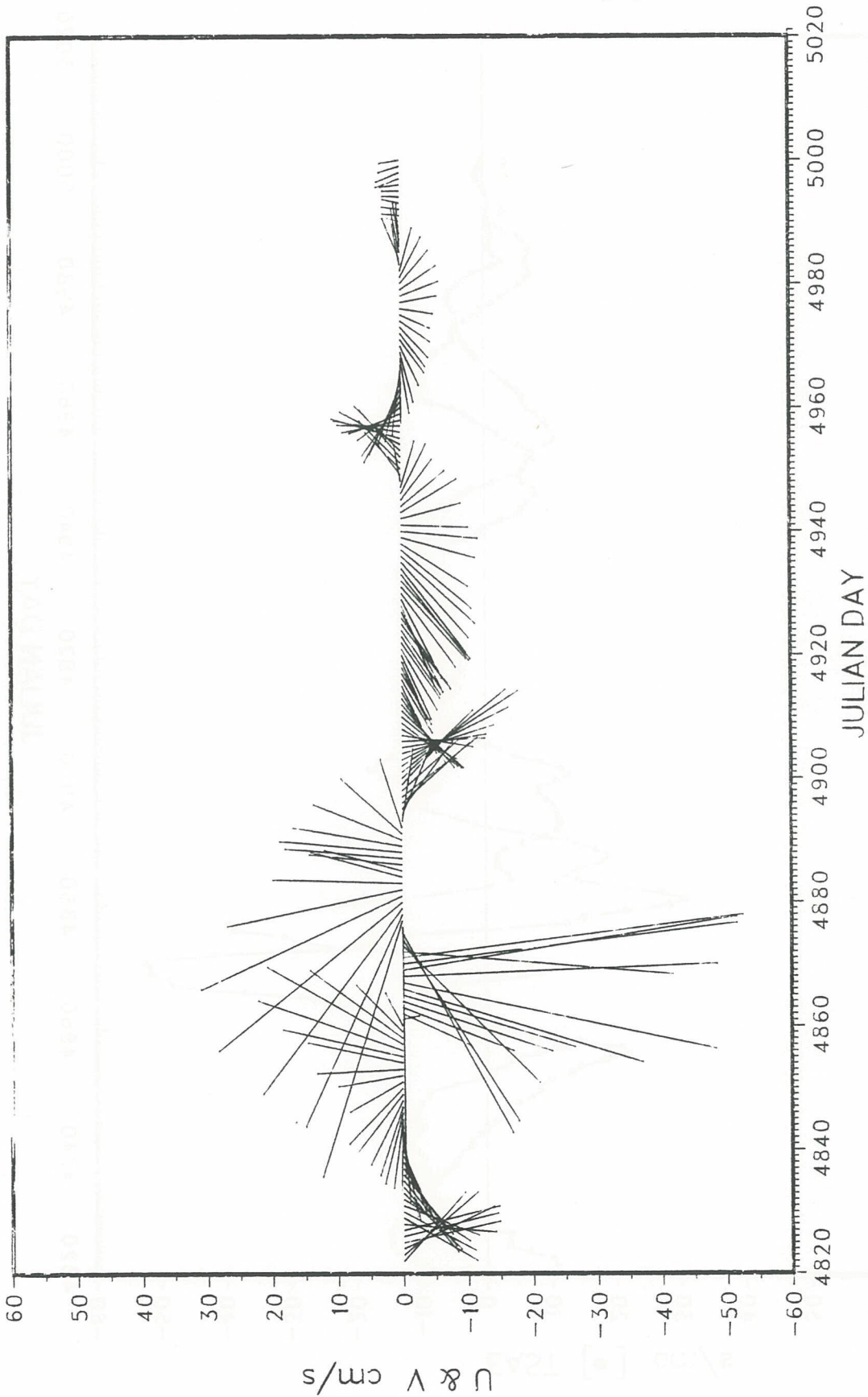
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CUSREX 117

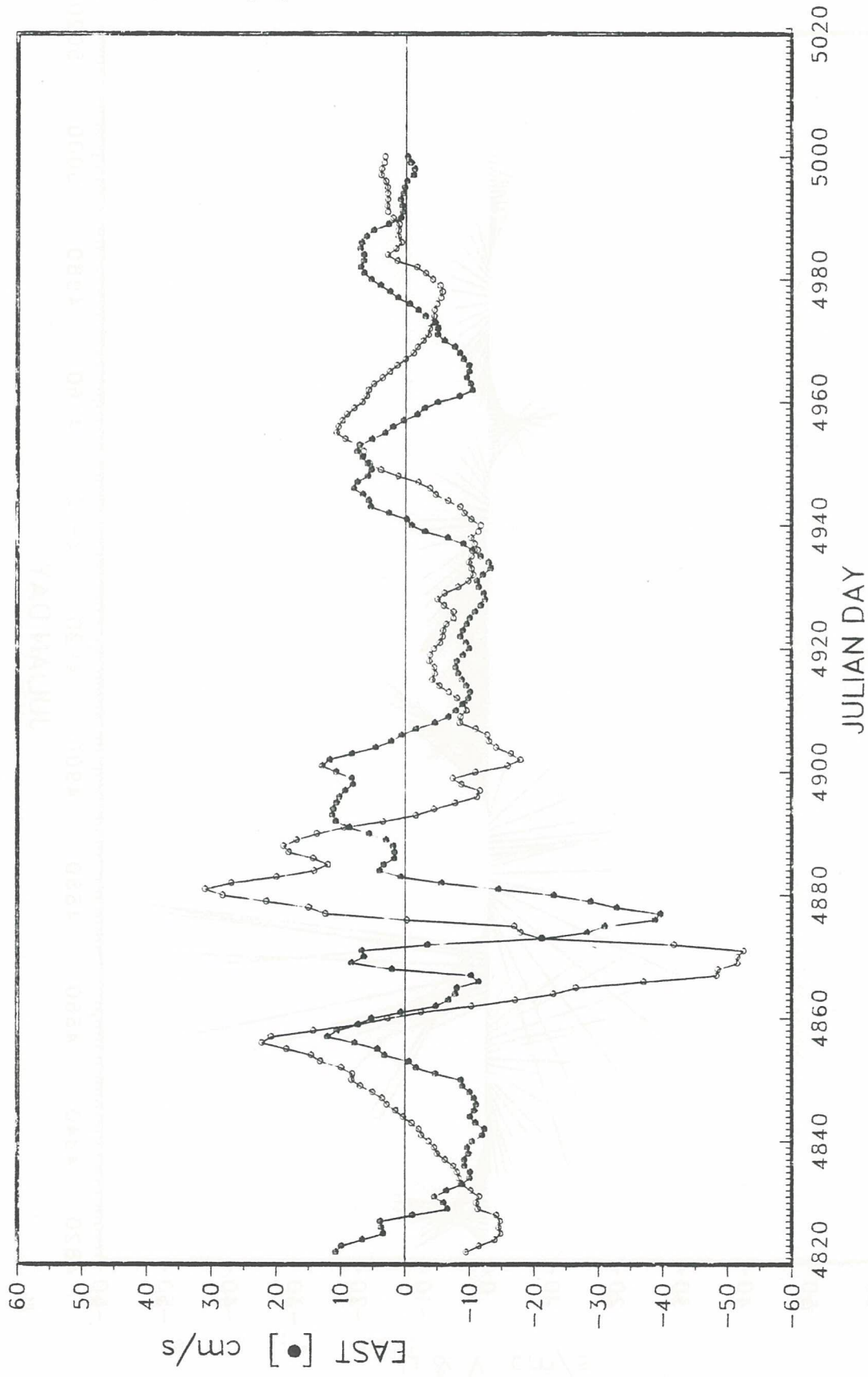


GUSREX 117



SEPTEMBER 1981 OCTOBER NOVEMBER DECEMBER JANUARY 1982 FEBRUARY

GUSREX 117



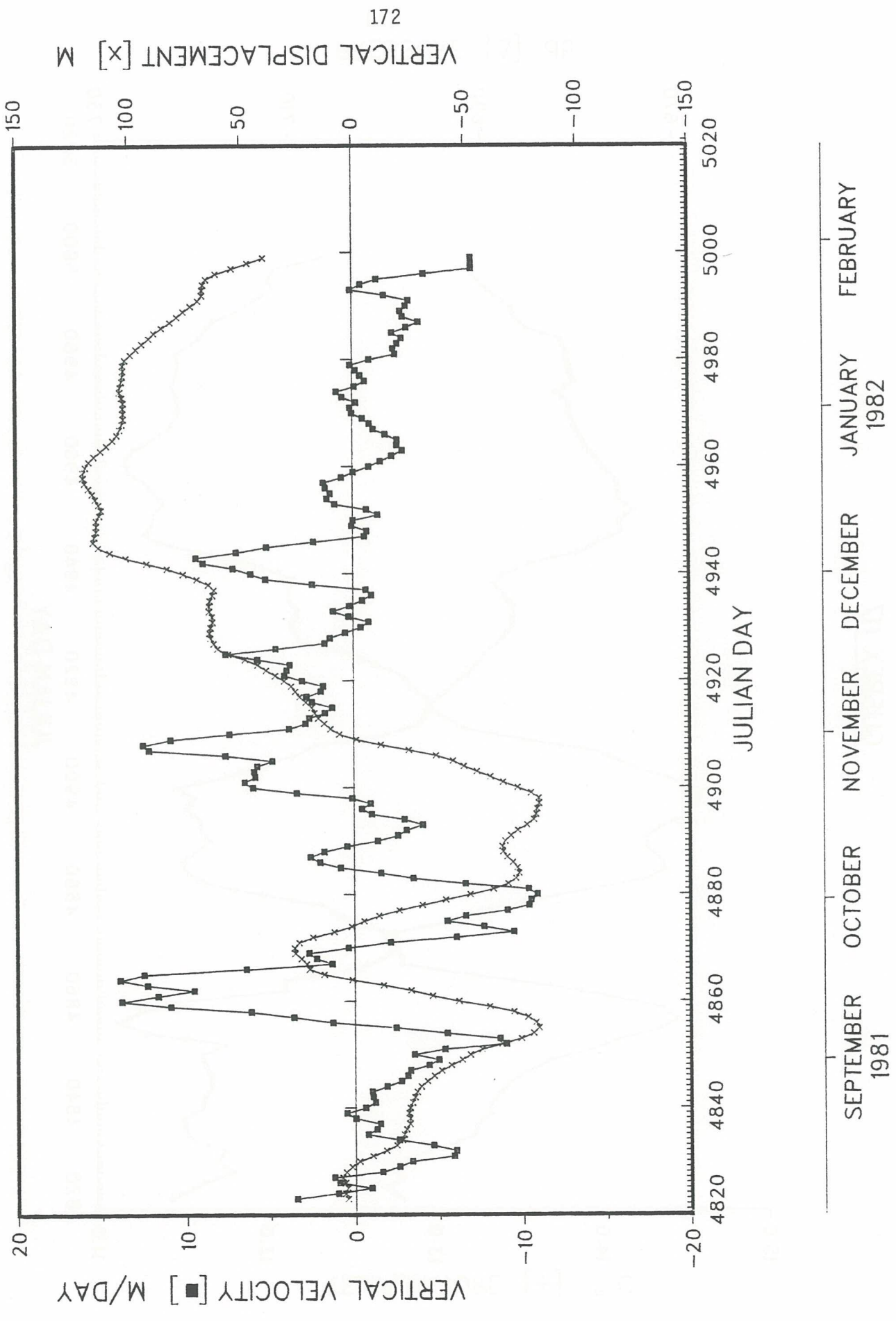
NORTH [○] cm/s

EAST [●] cm/s

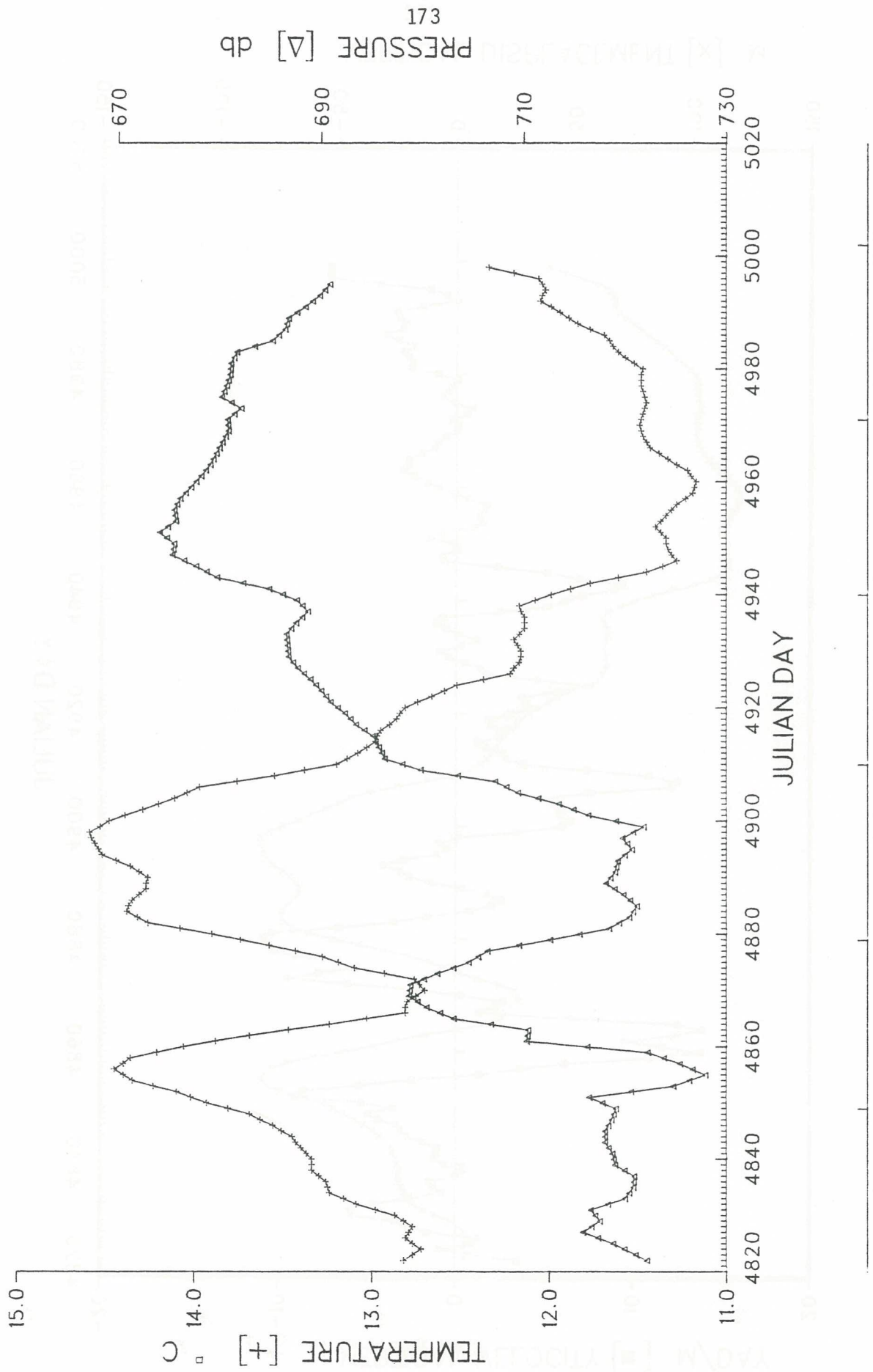
JULIAN DAY

SEPTEMBER 1981 OCTOBER NOVEMBER DECEMBER JANUARY 1982 FEBRUARY

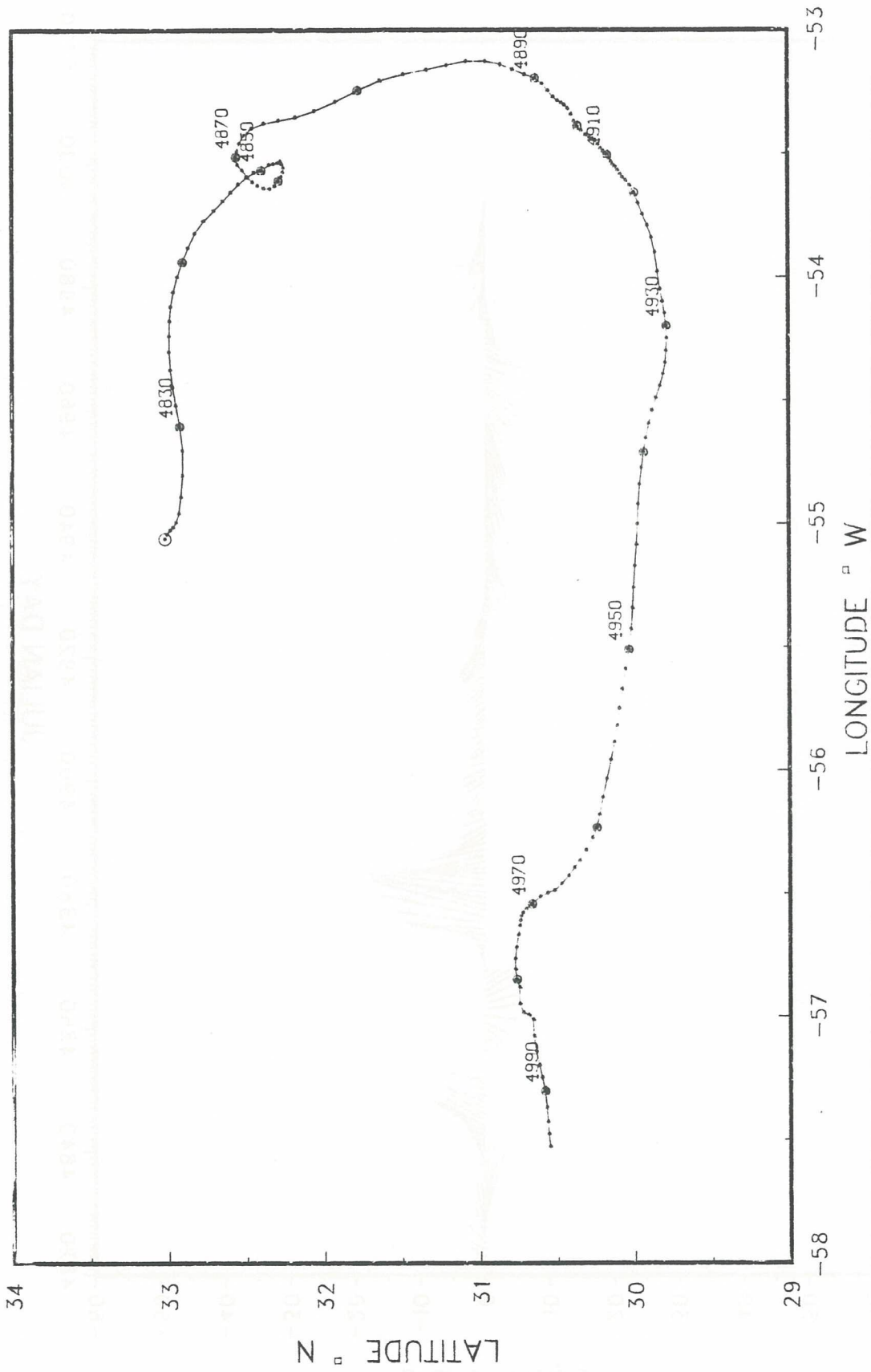
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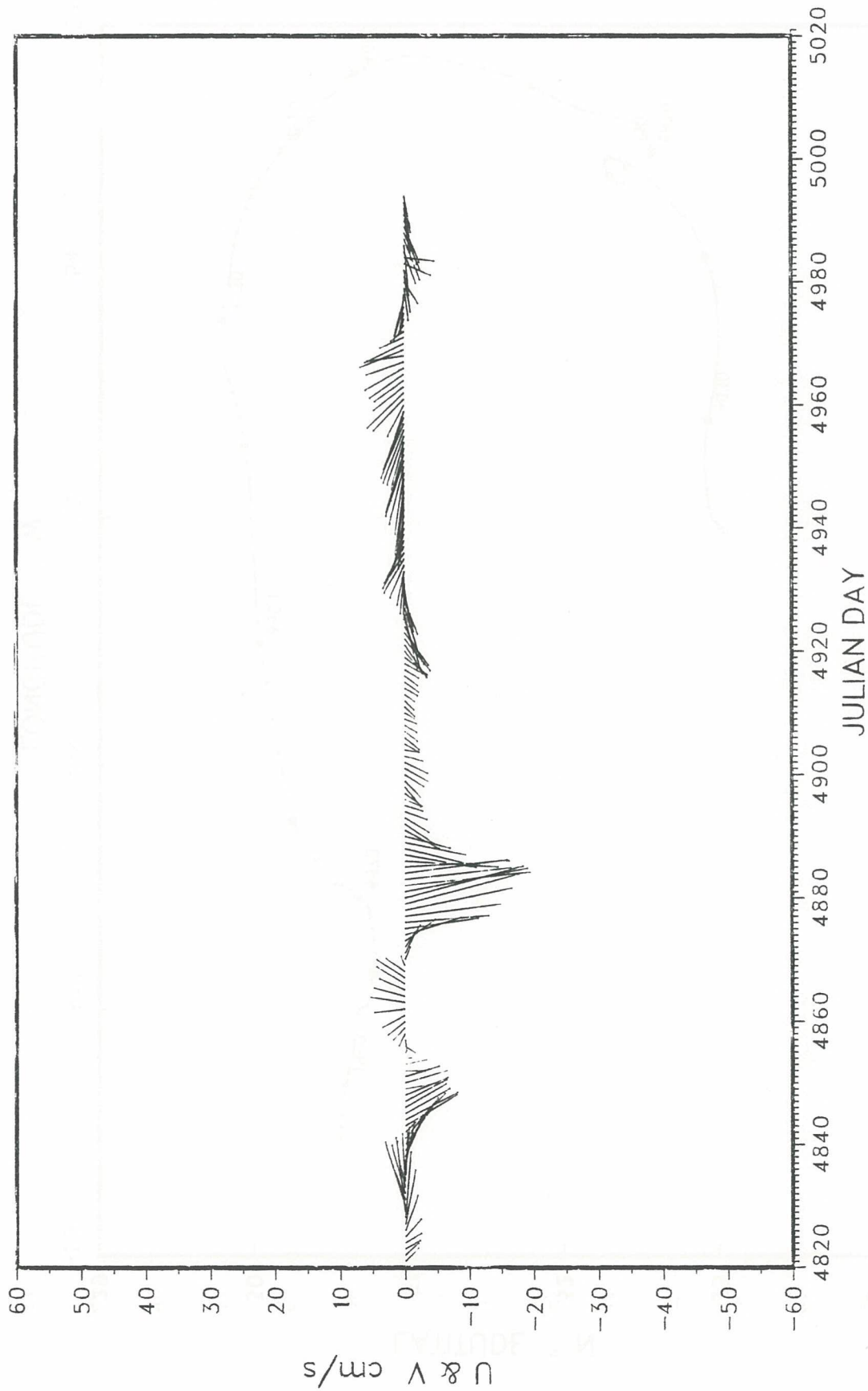
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CUSREX 118

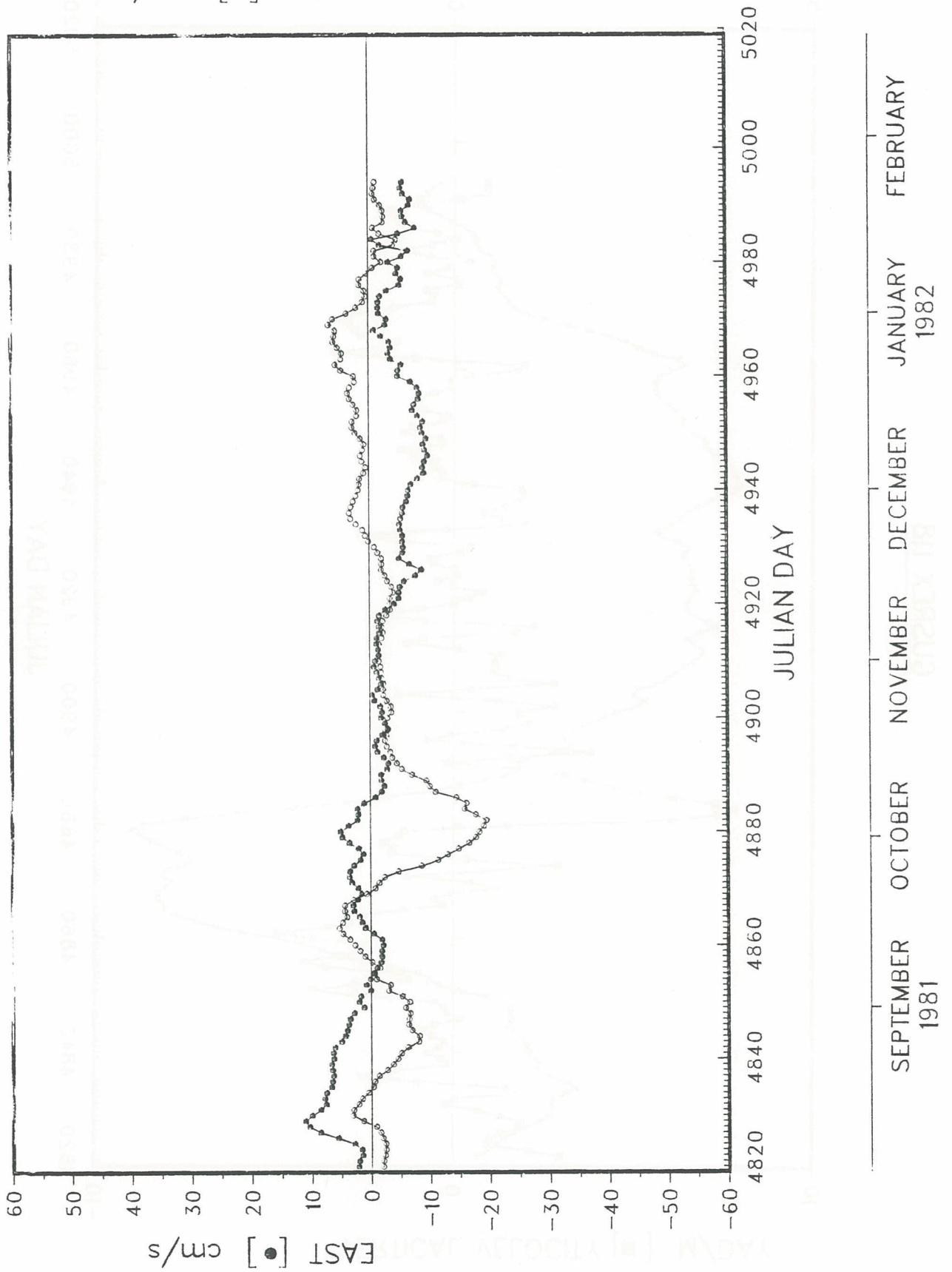


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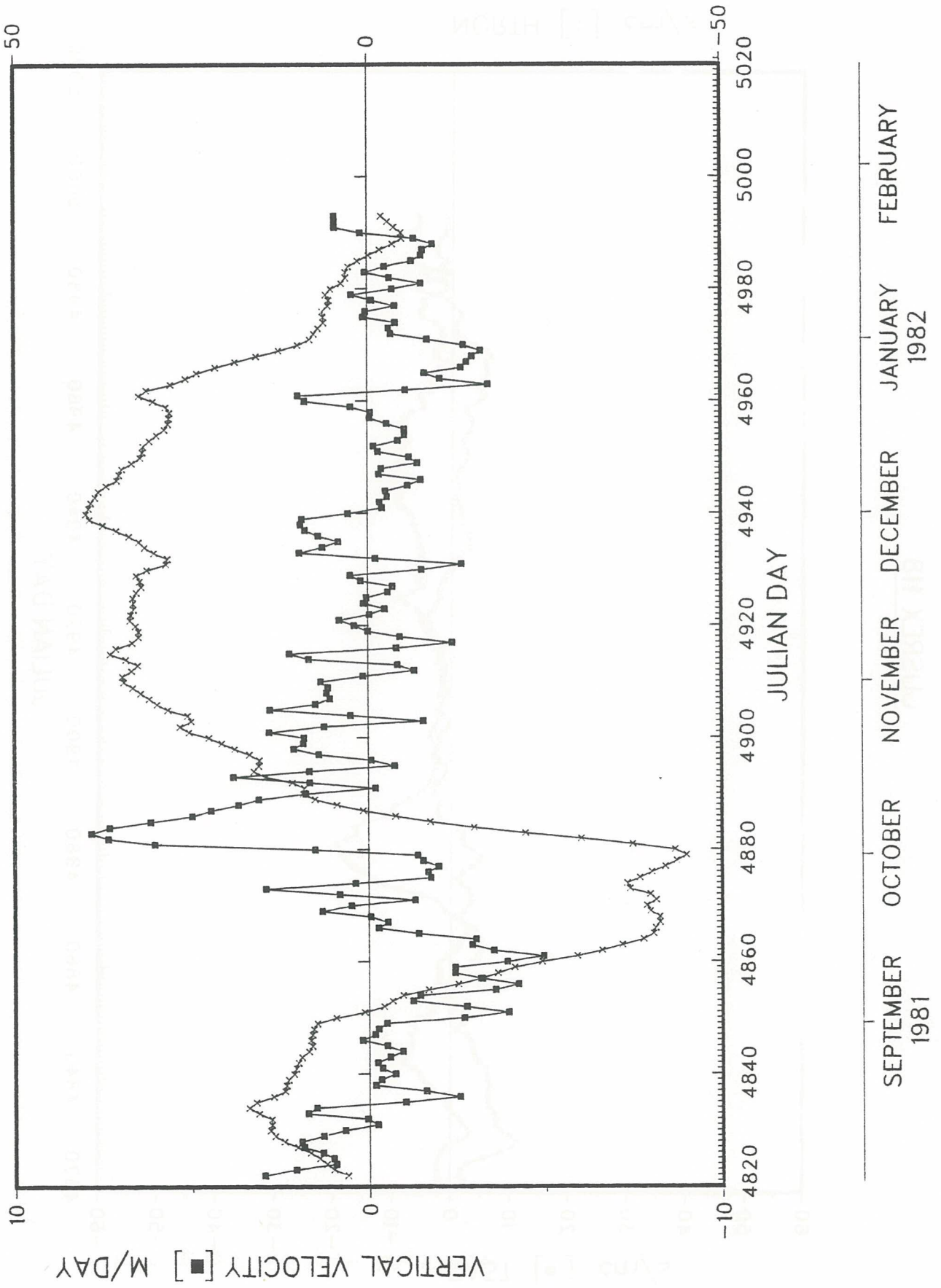


SEPTEMBER 1981 OCTOBER NOVEMBER DECEMBER JANUARY 1982 FEBRUARY

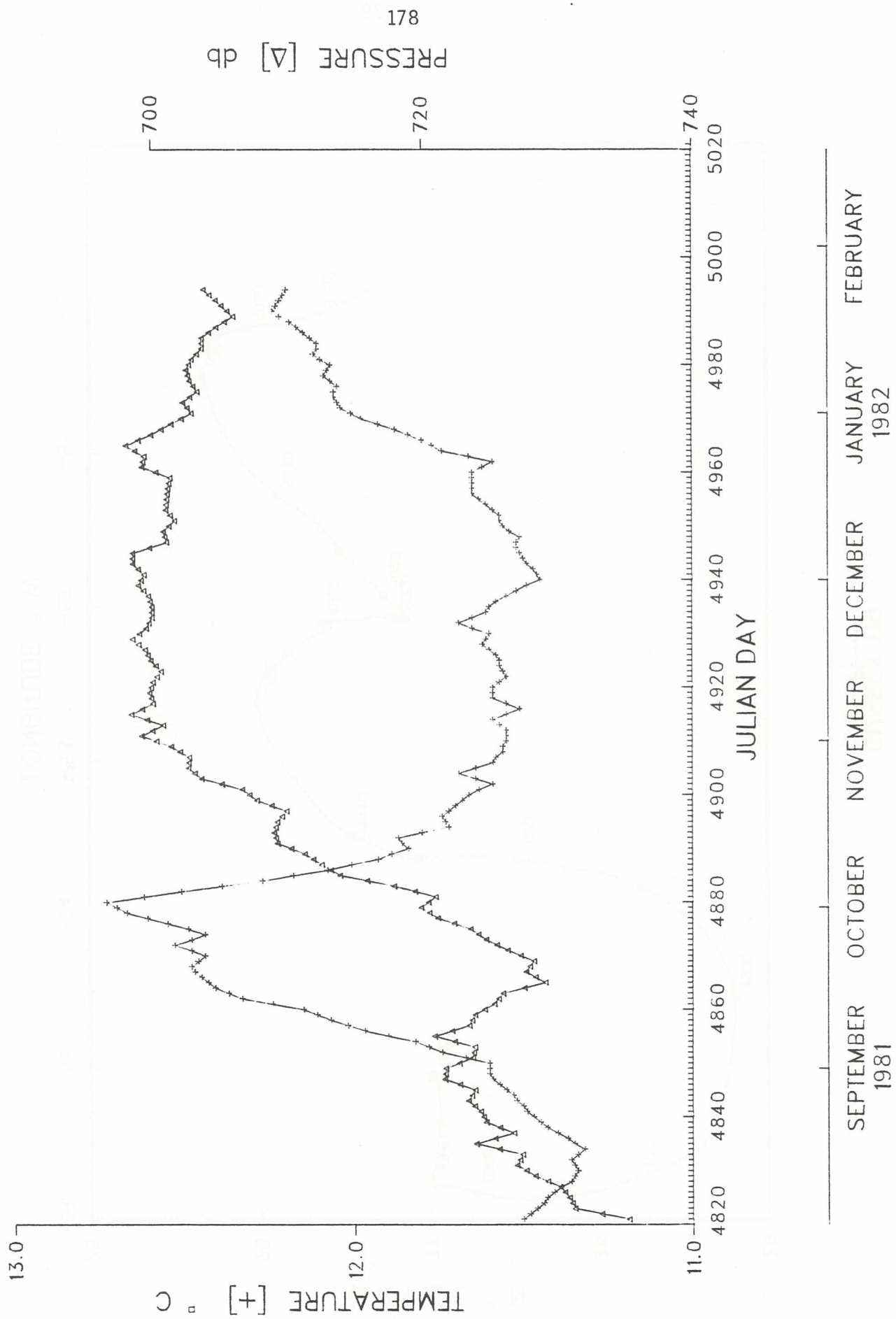
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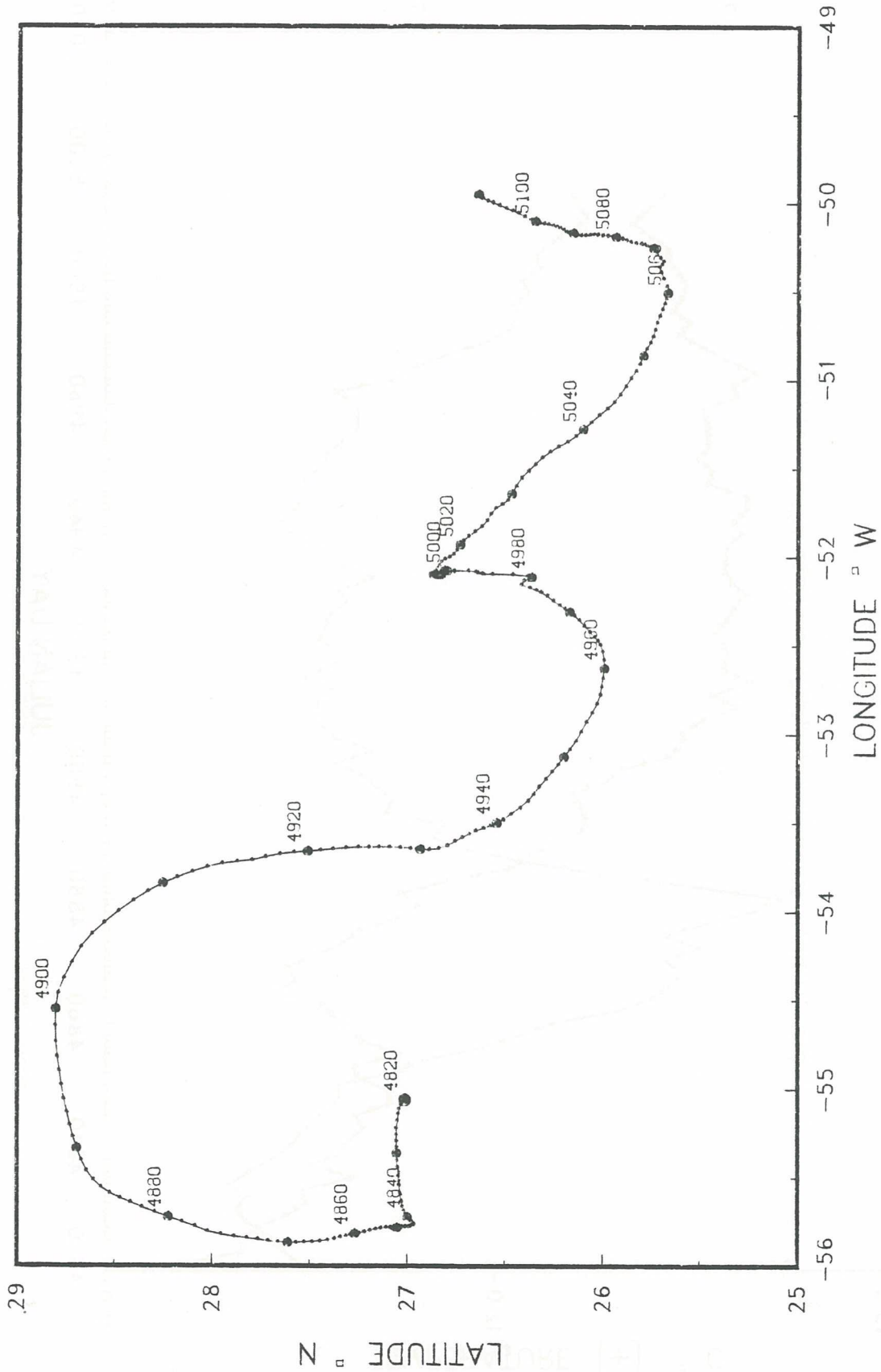
GUSREX 118



GUSREX 118

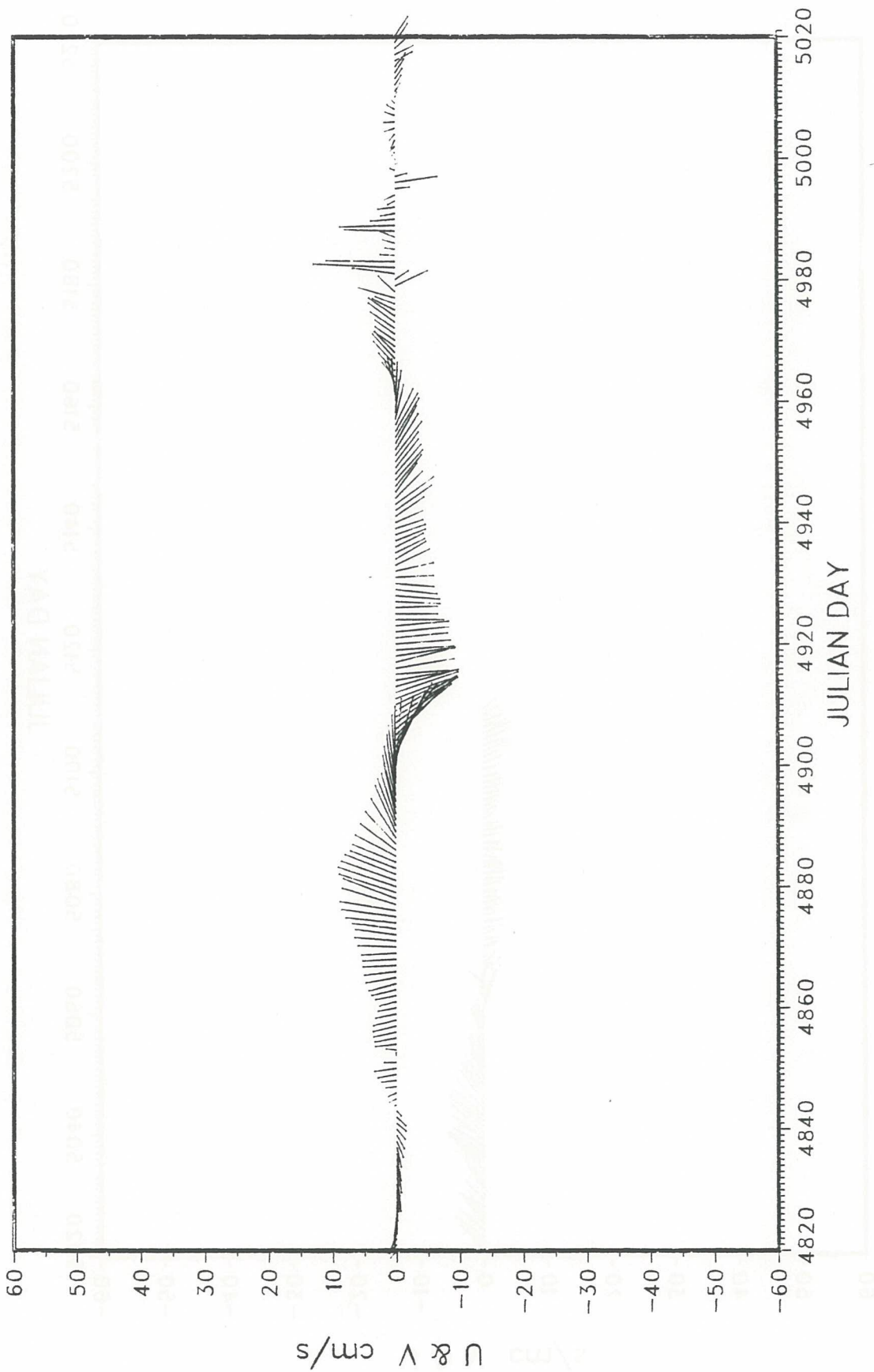


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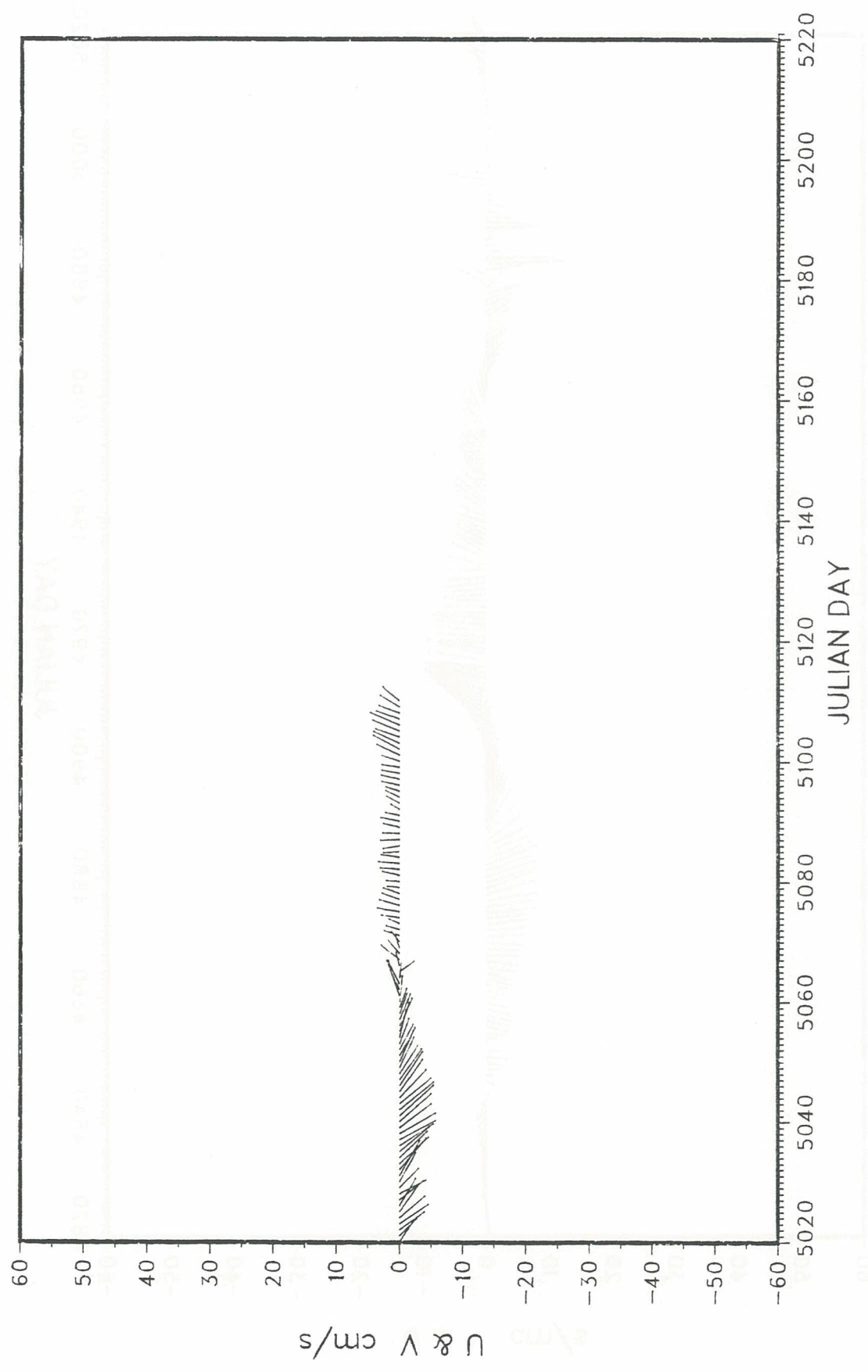
GUSREX 119

GUSREX 119



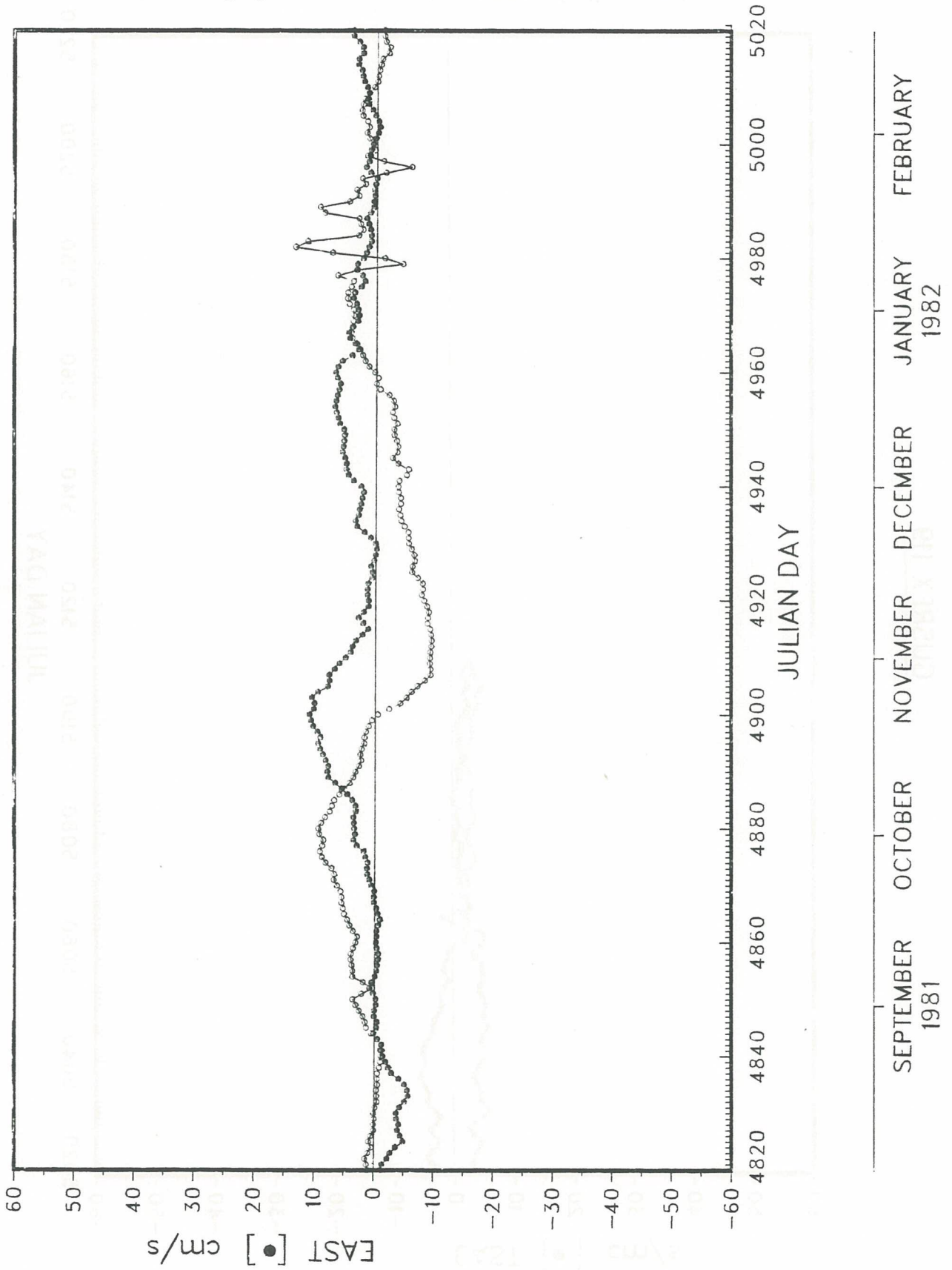
SEPTEMBER 1981 OCTOBER NOVEMBER DECEMBER JANUARY 1982 FEBRUARY

GUSREX 119

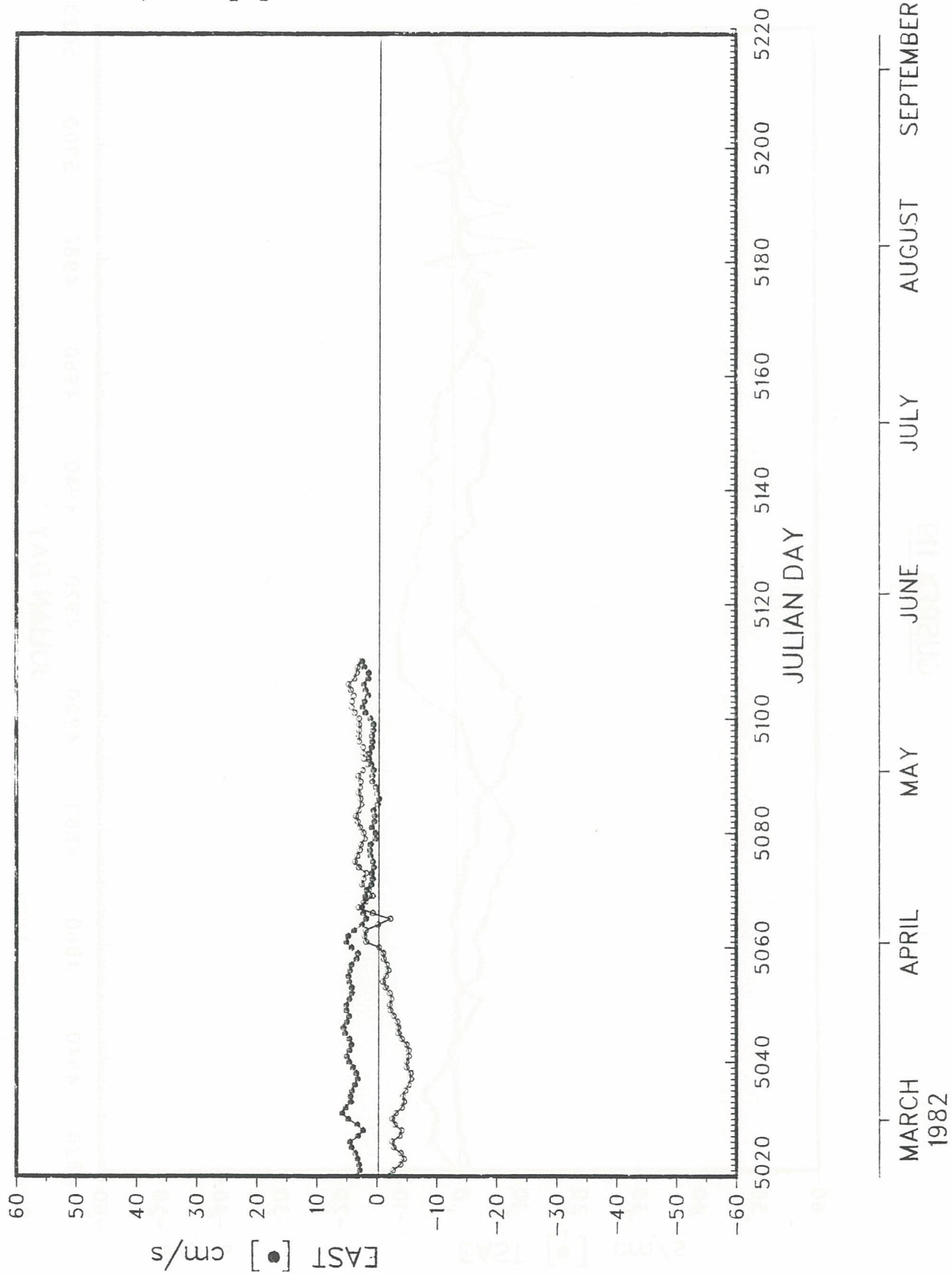


MARCH 1982 APRIL MAY JUNE JULY AUGUST SEPTEMBER

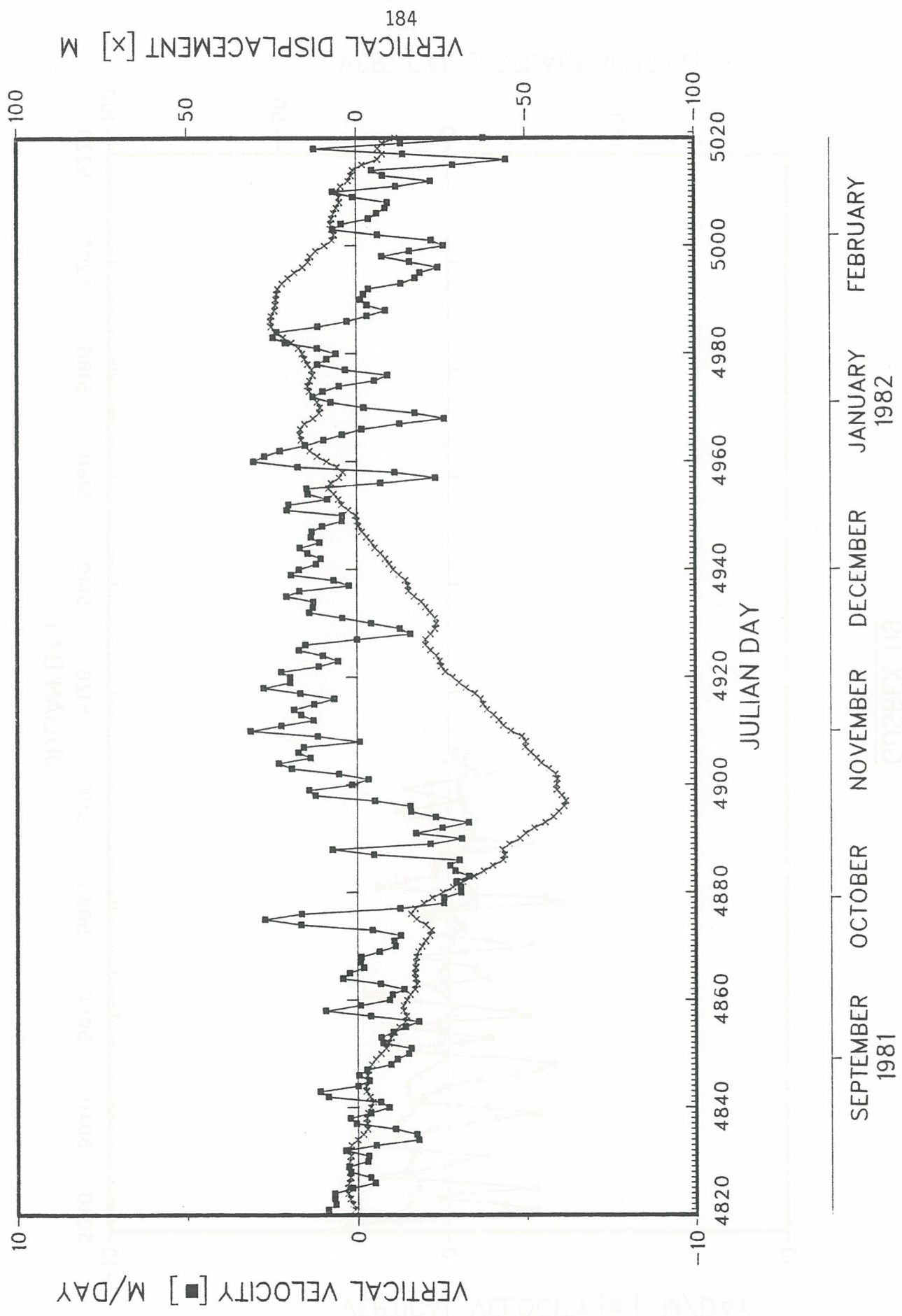
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GUSREX 119

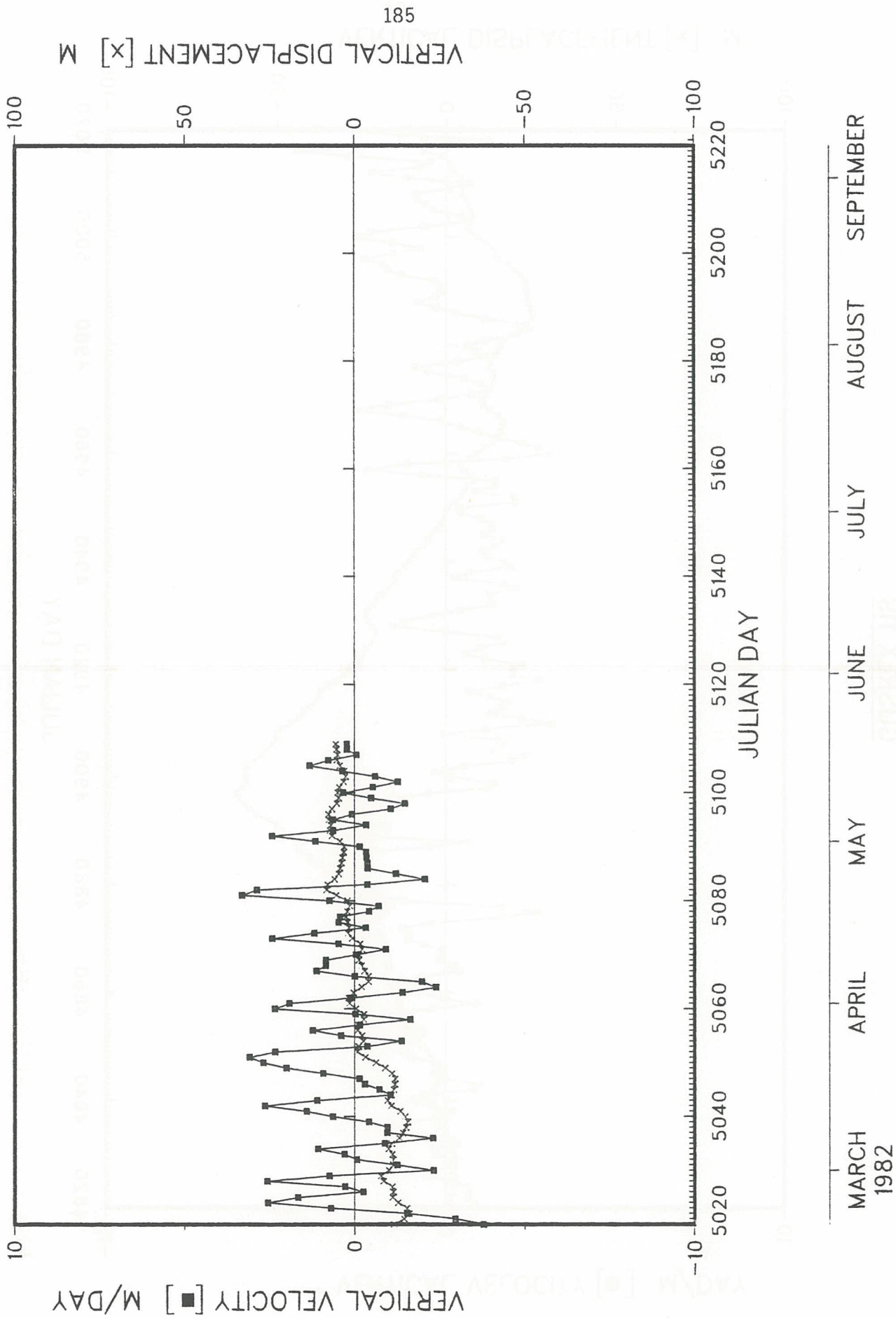


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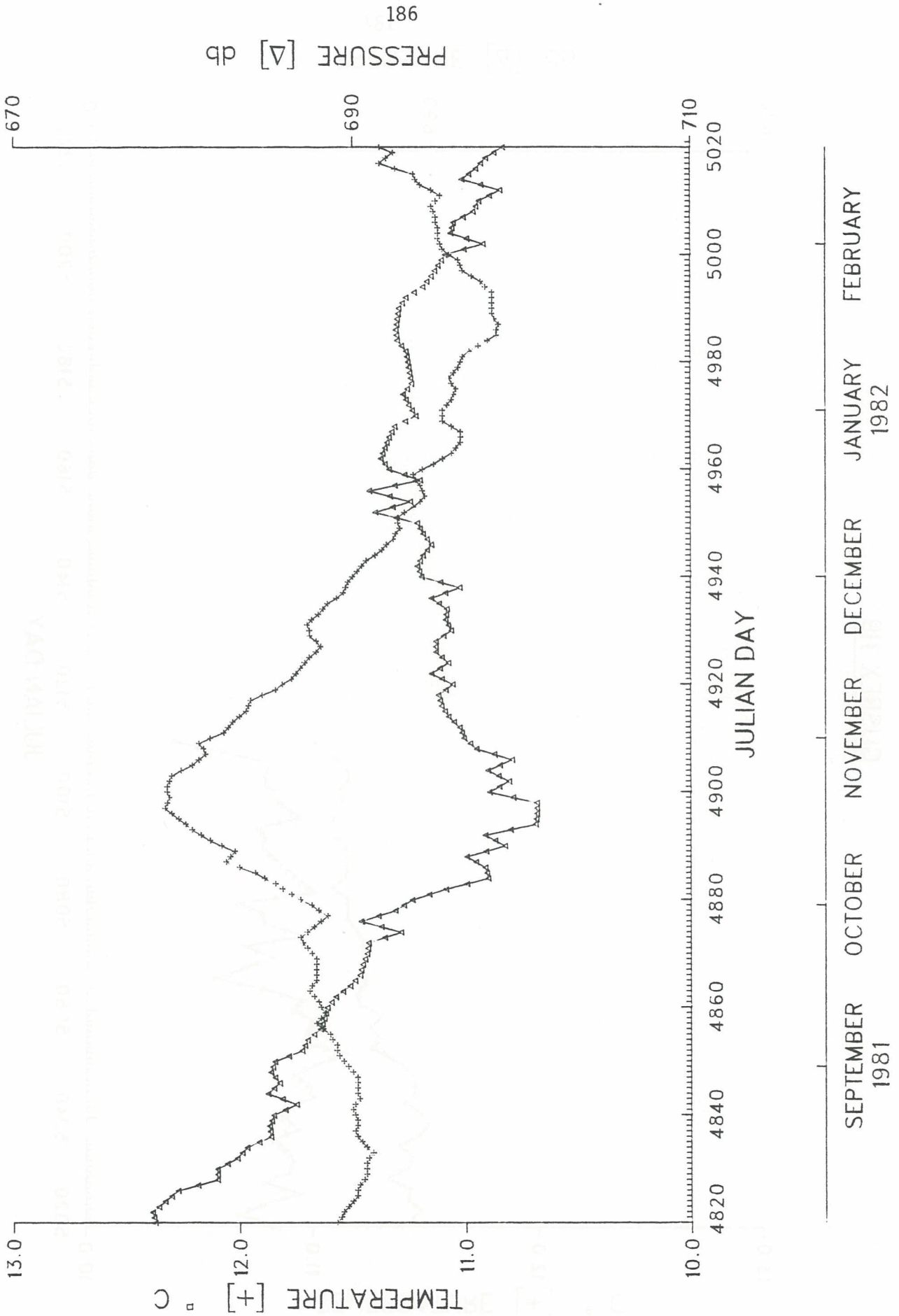


184

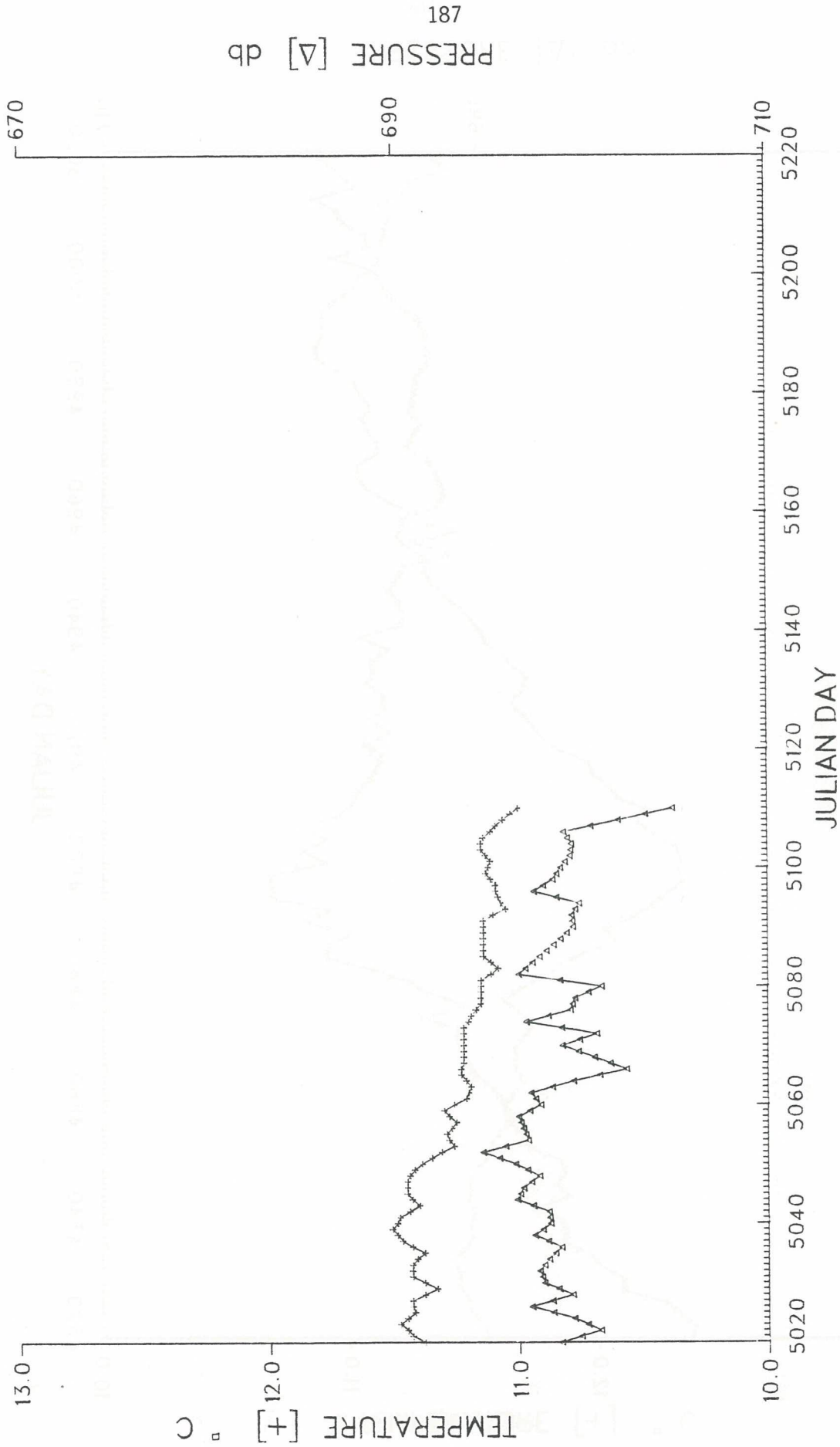
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GUSREX 119



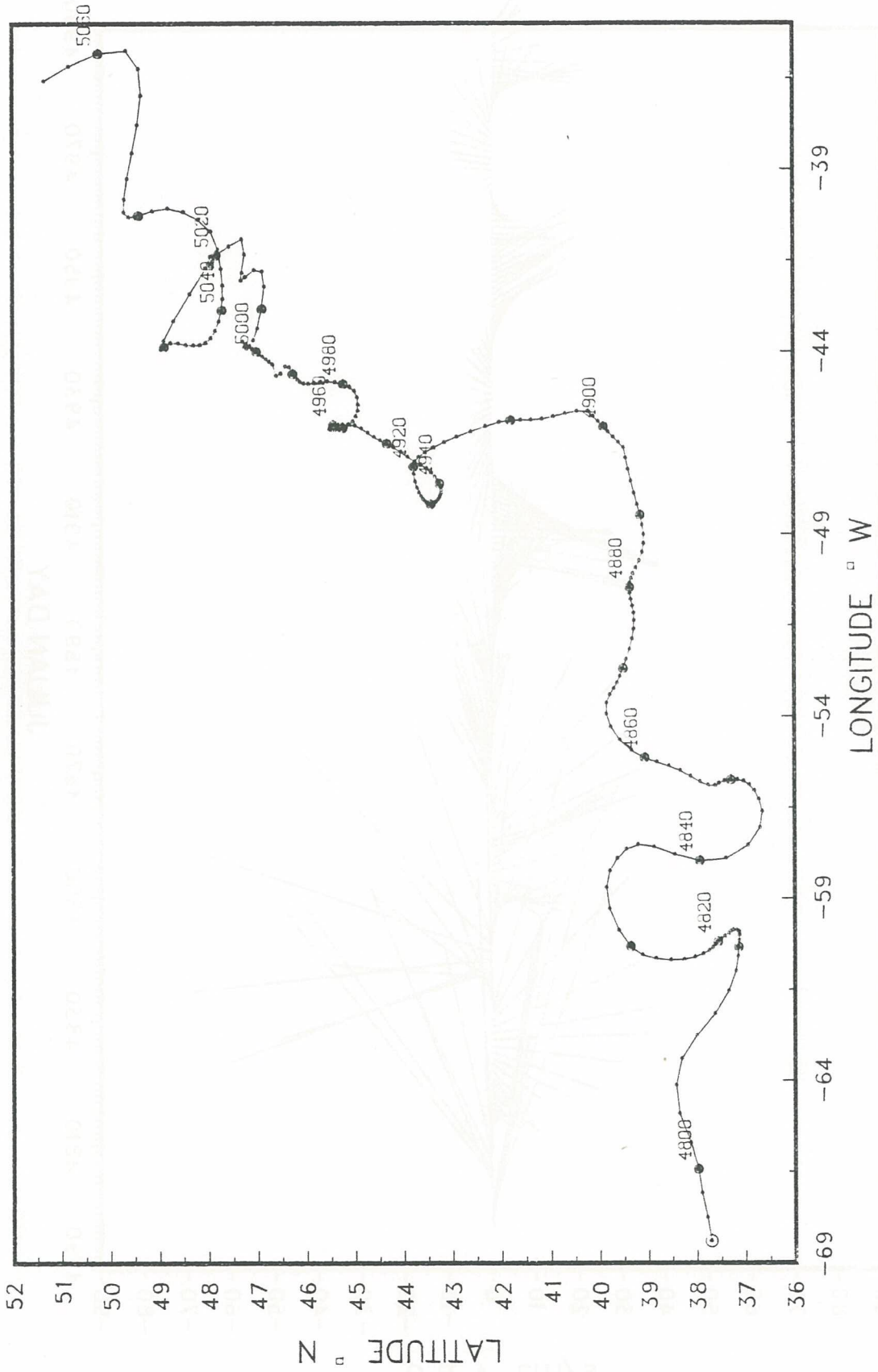
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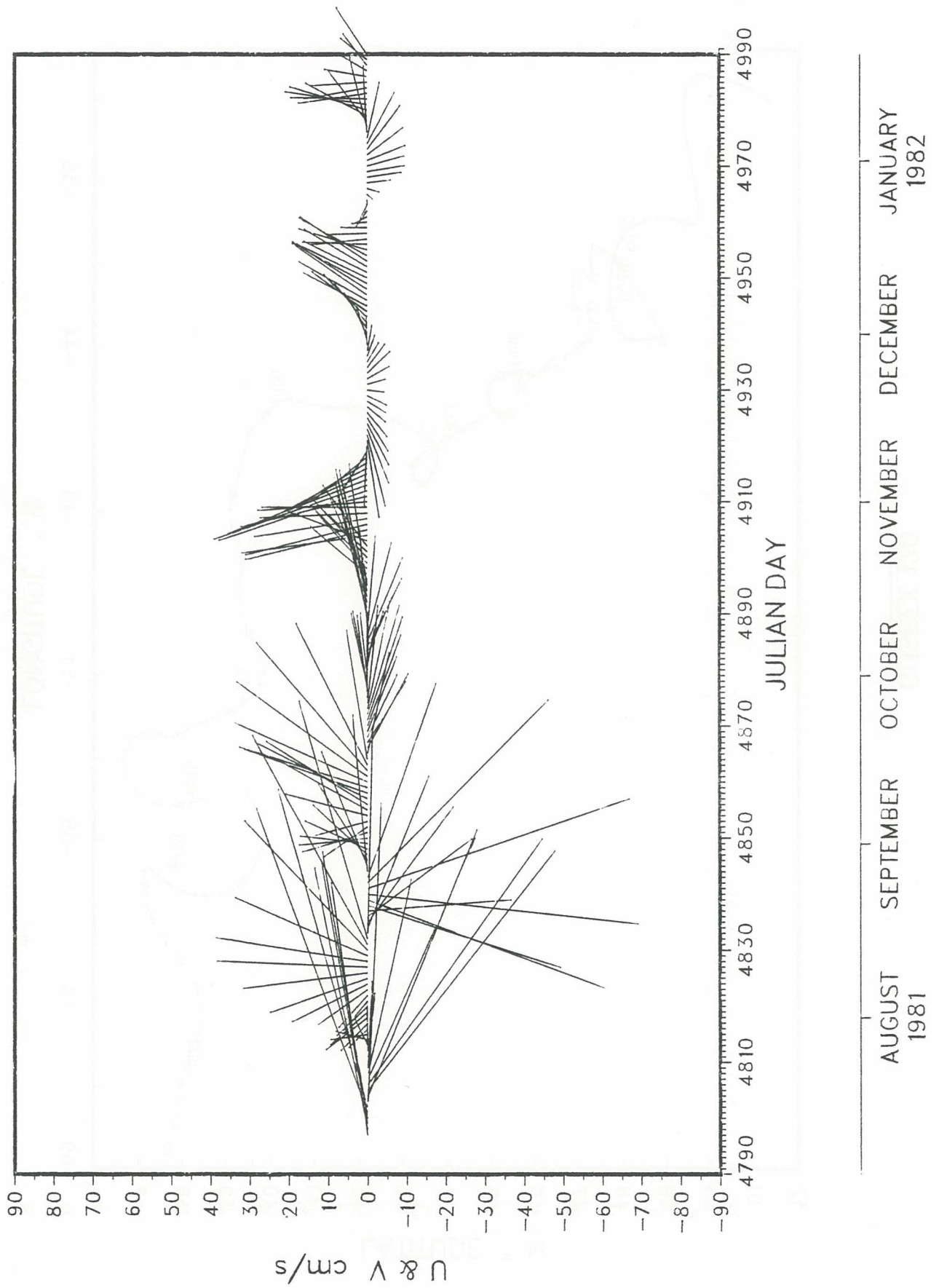
187

MARCH 1982 APRIL MAY JUNE JULY AUGUST SEPTEMBER

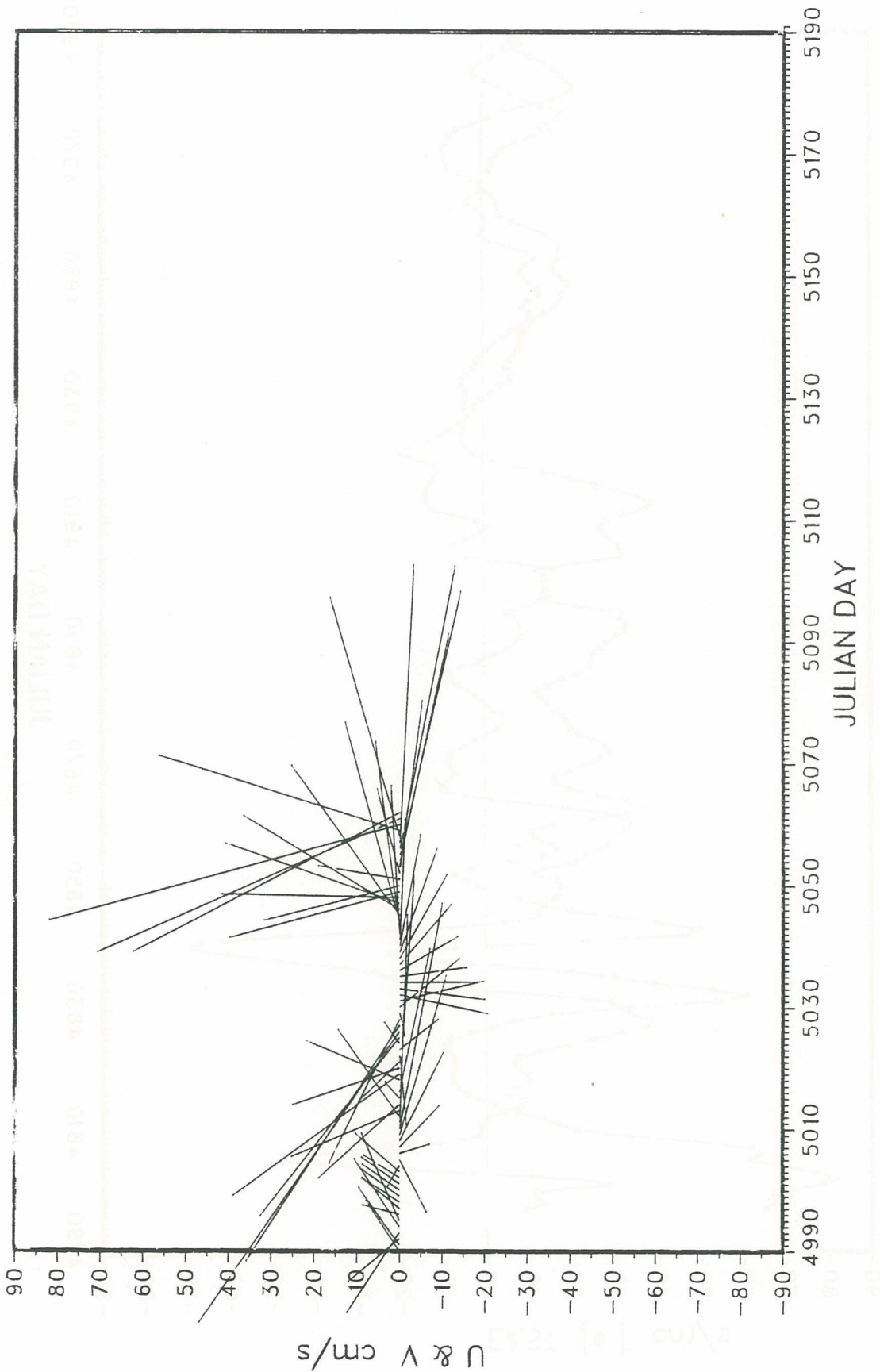
GUSREX 120



GUSREX 120

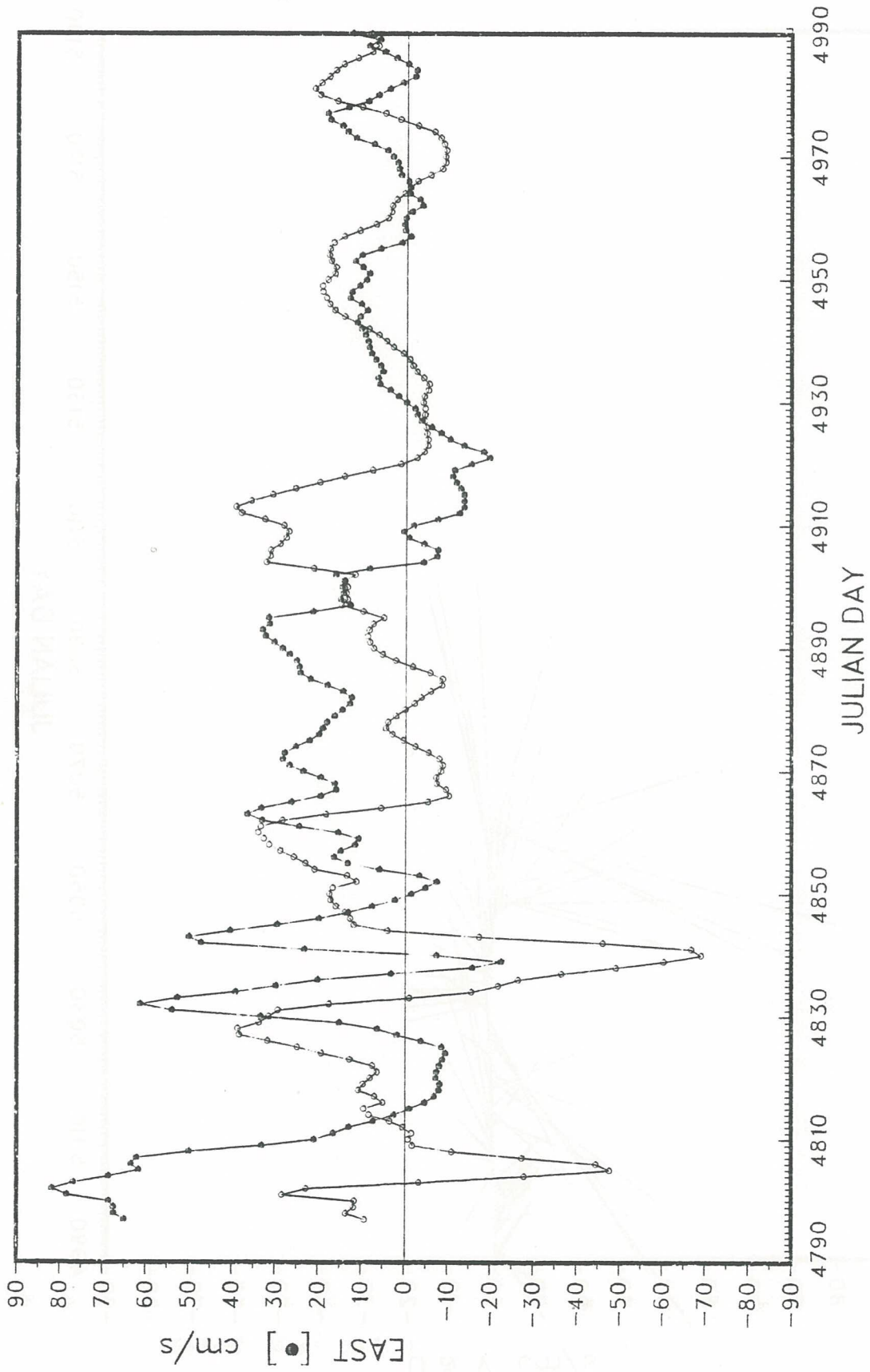


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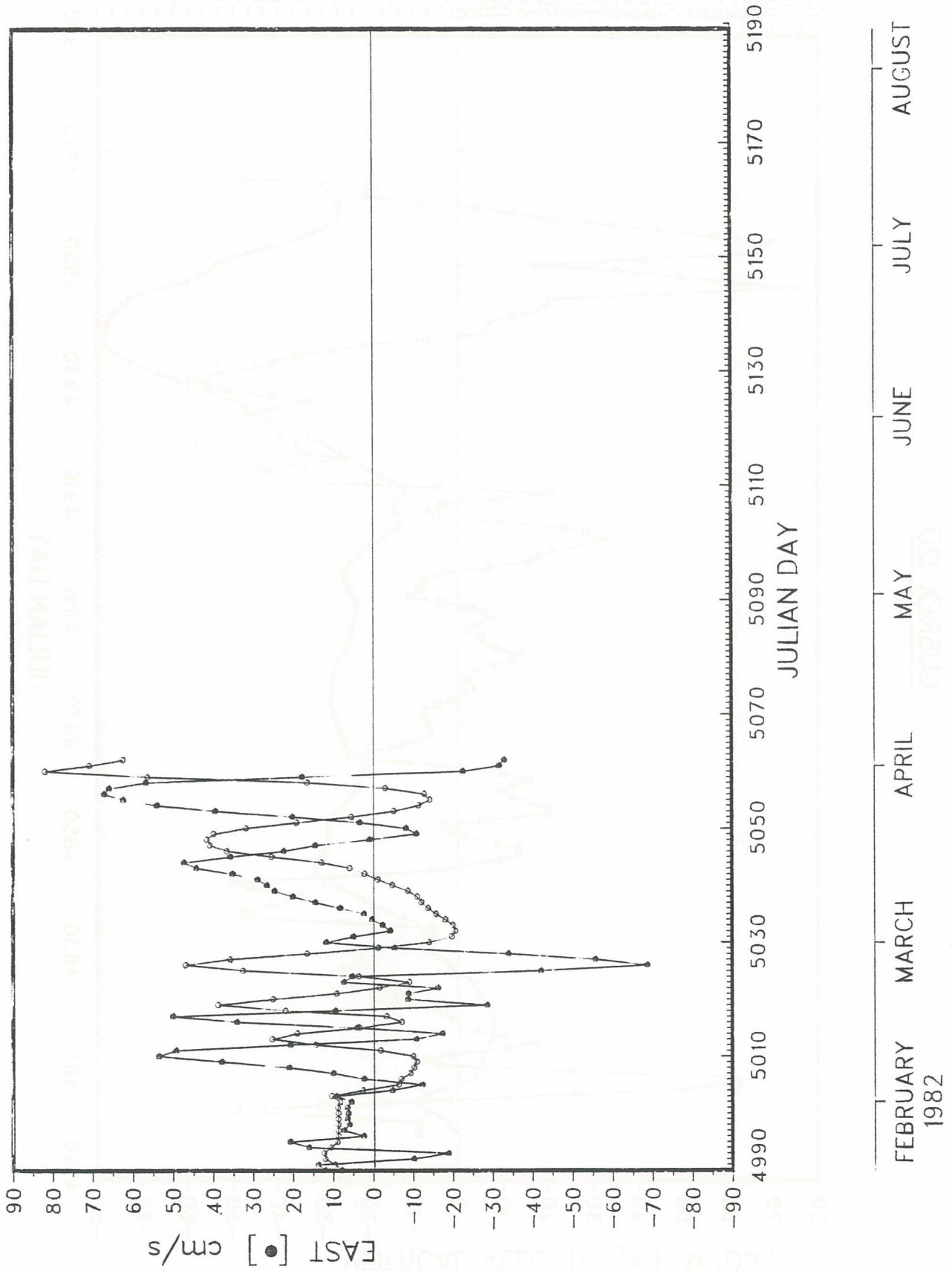
FEBRUARY MARCH APRIL MAY JUNE JULY AUGUST
 1982

GUSREX 120

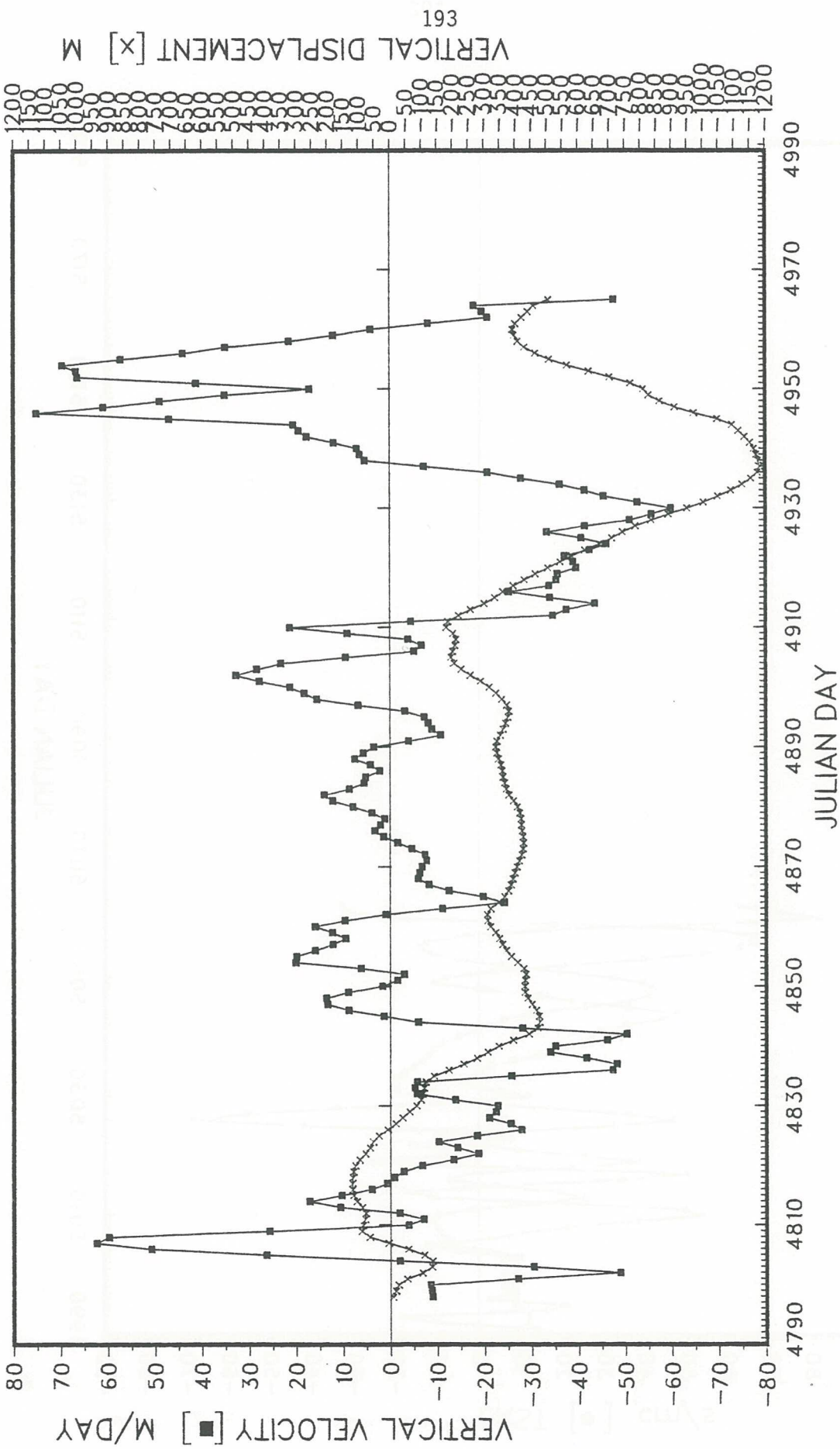


AUGUST 1981 SEPTEMBER OCTOBER NOVEMBER DECEMBER JANUARY 1982

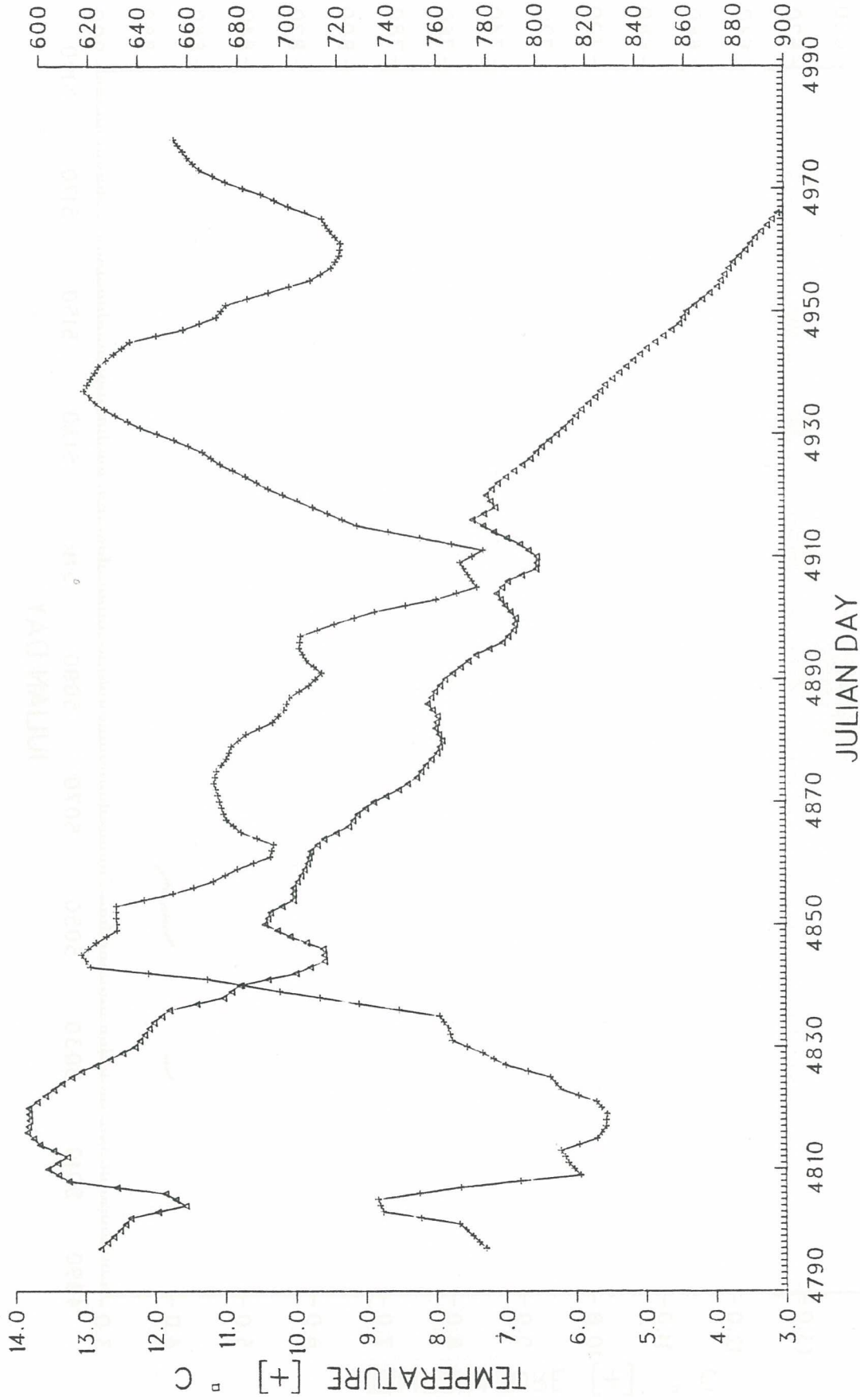
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GUSREX 120

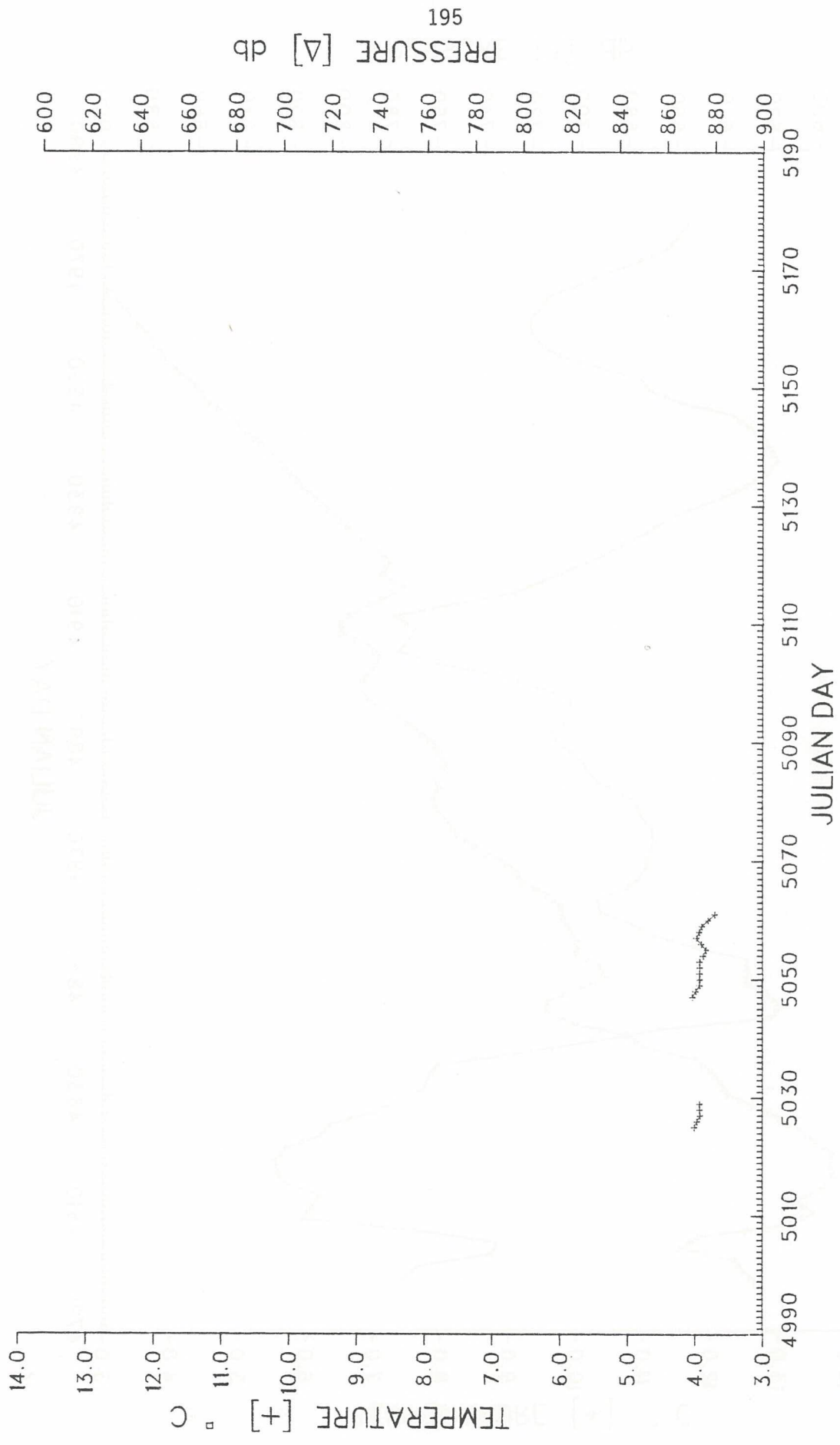


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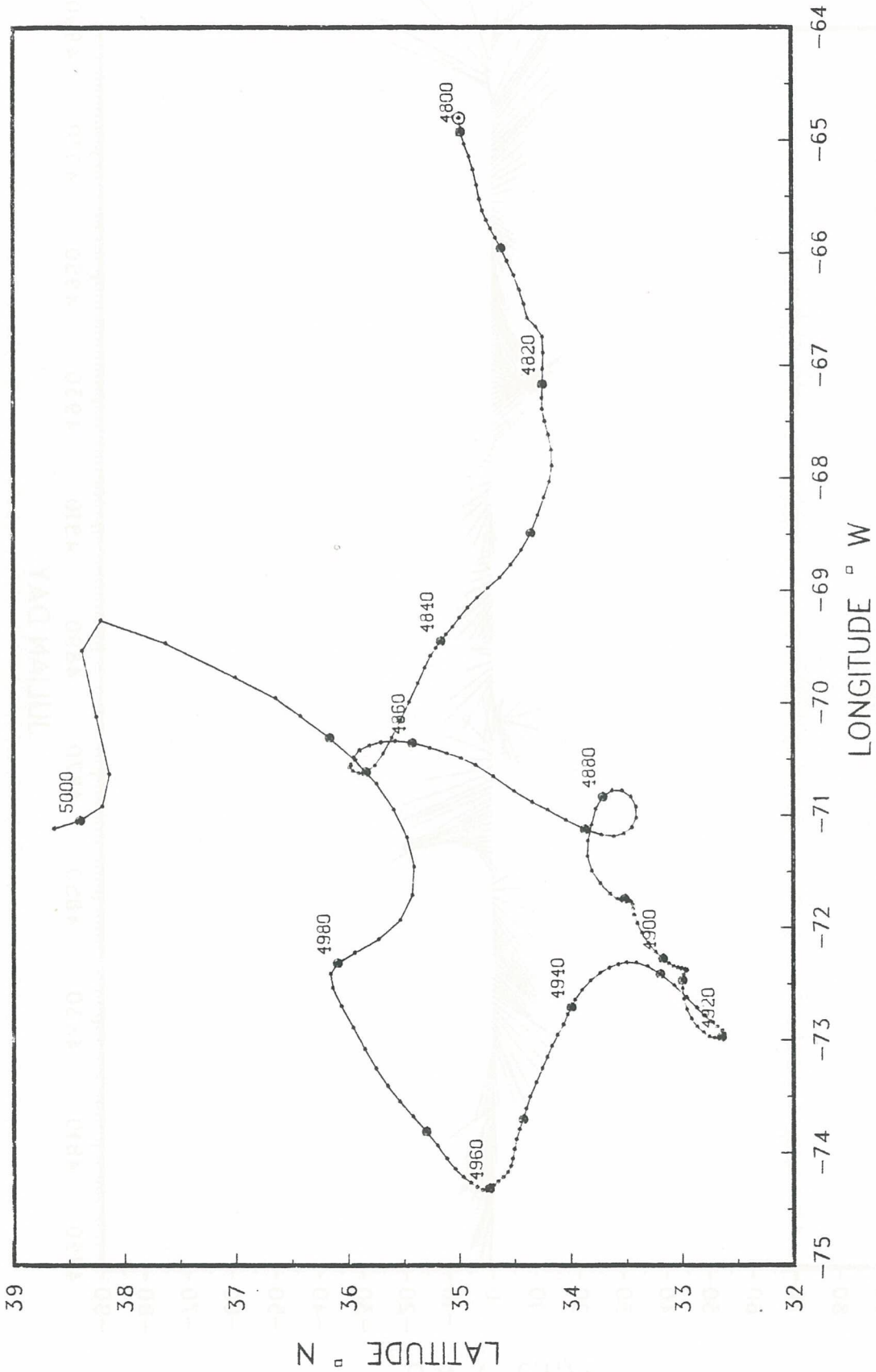
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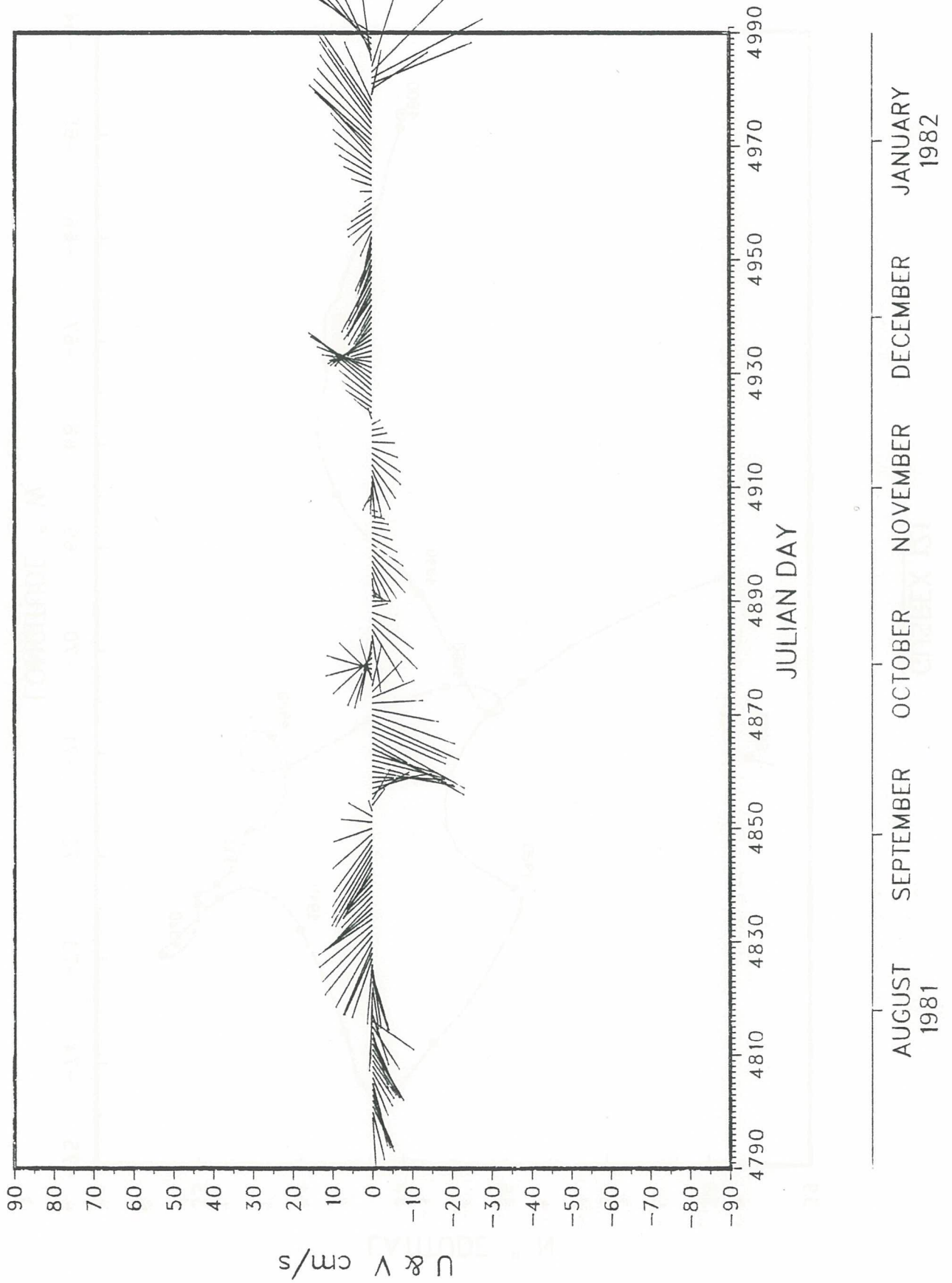


FEBRUARY MARCH APRIL MAY JUNE JULY AUGUST
1982

GUSREX 121

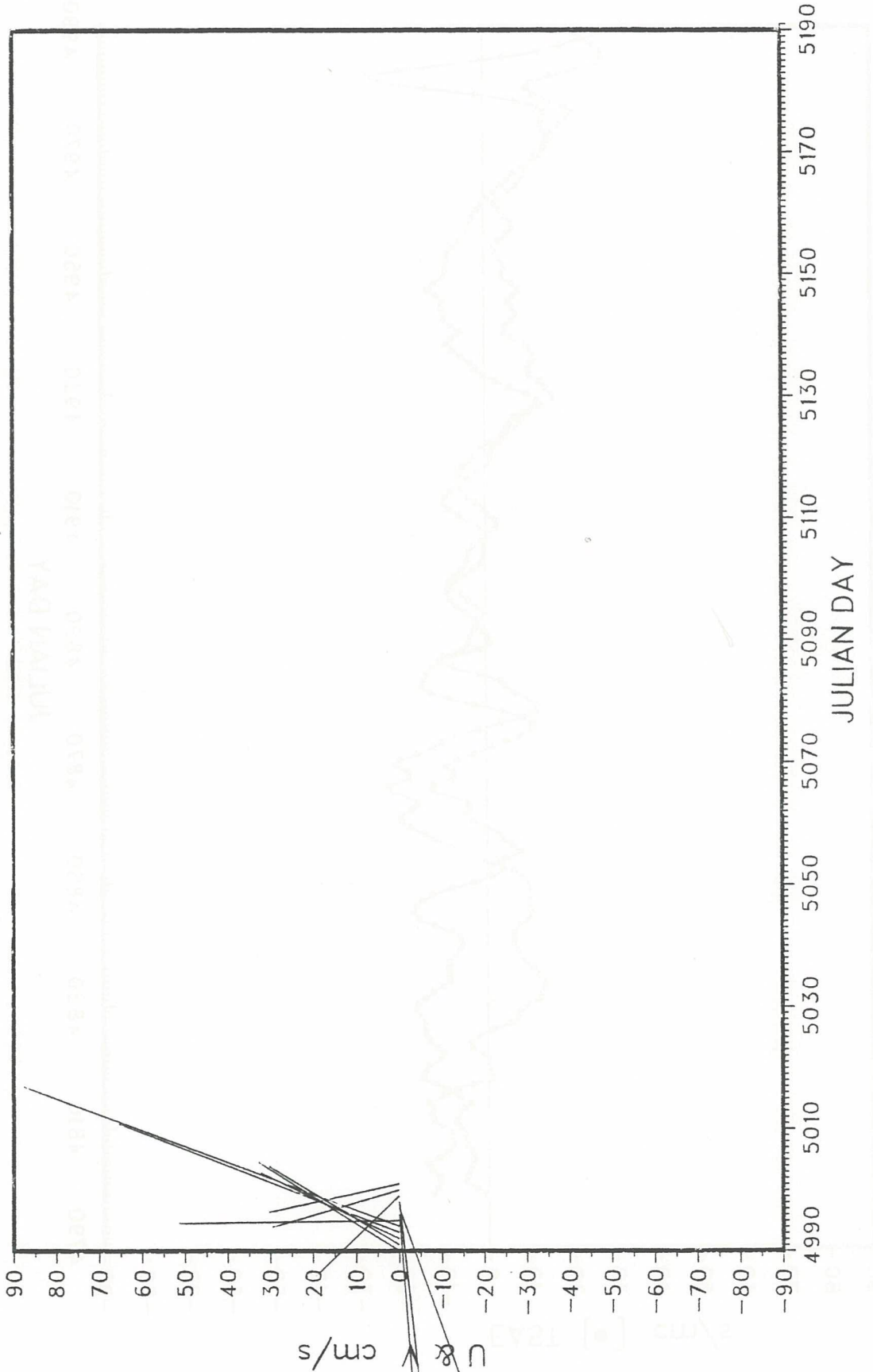


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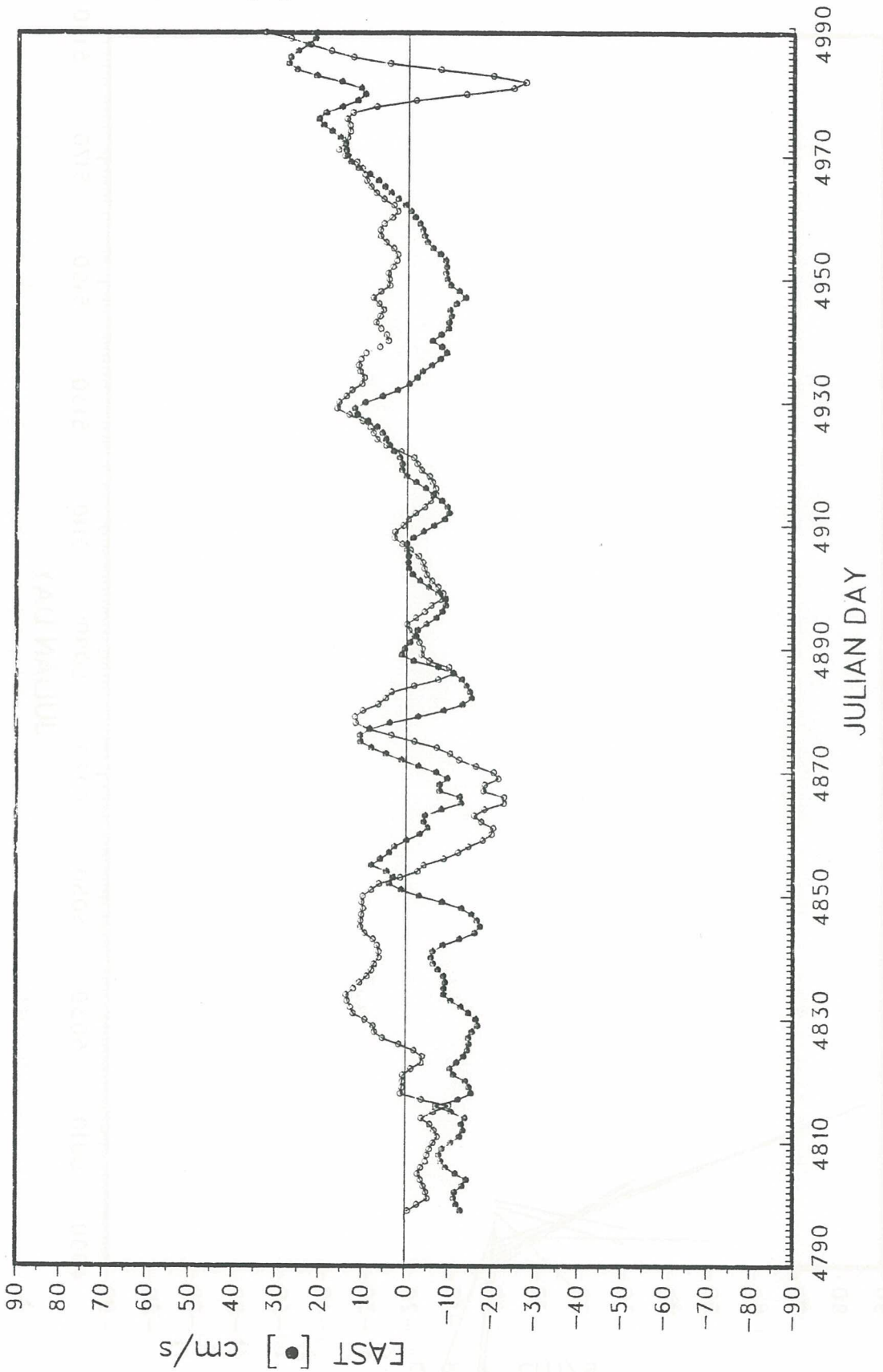
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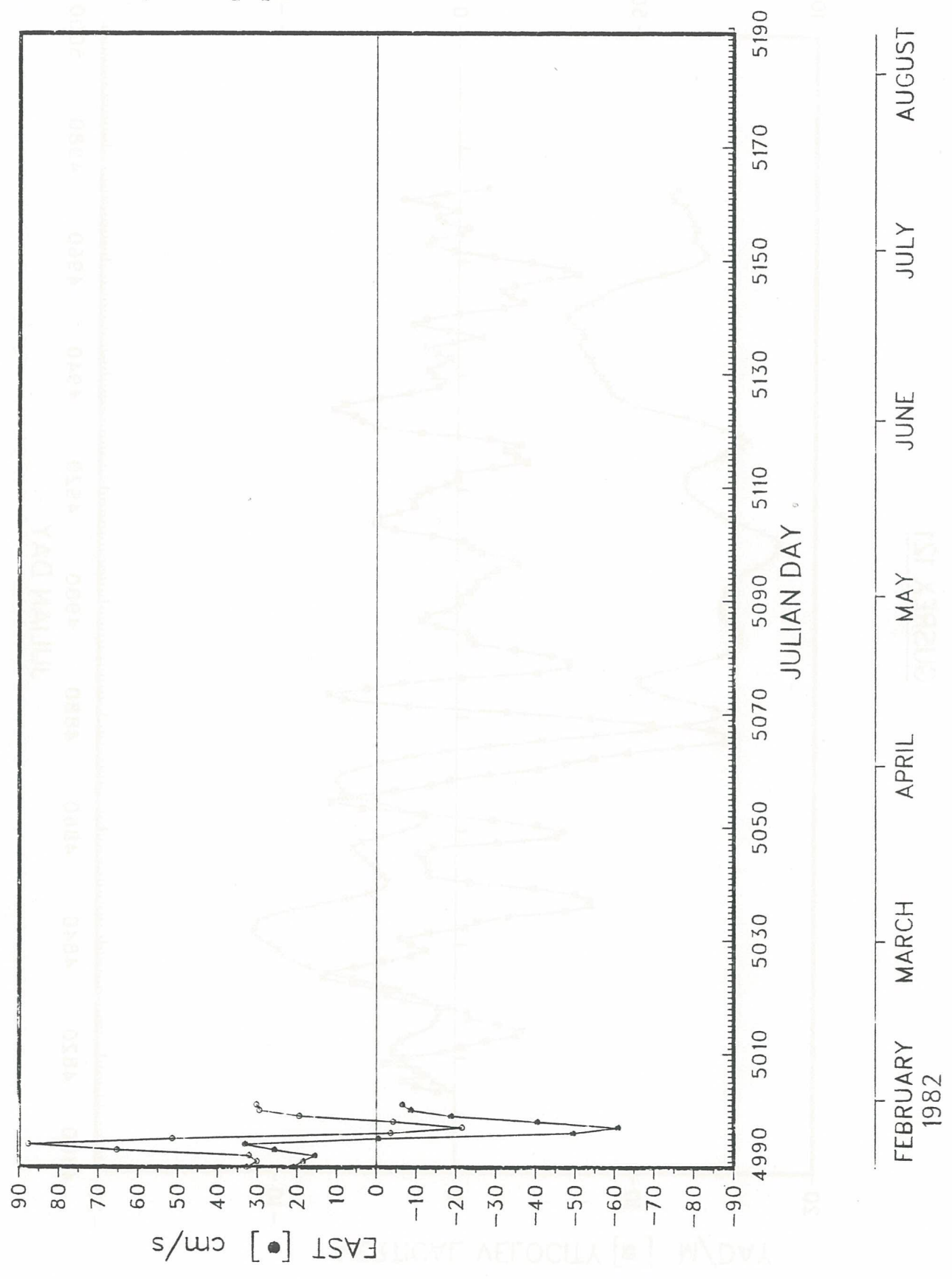
FEBRUARY MARCH APRIL MAY JUNE JULY AUGUST
1982

GUSREX 121

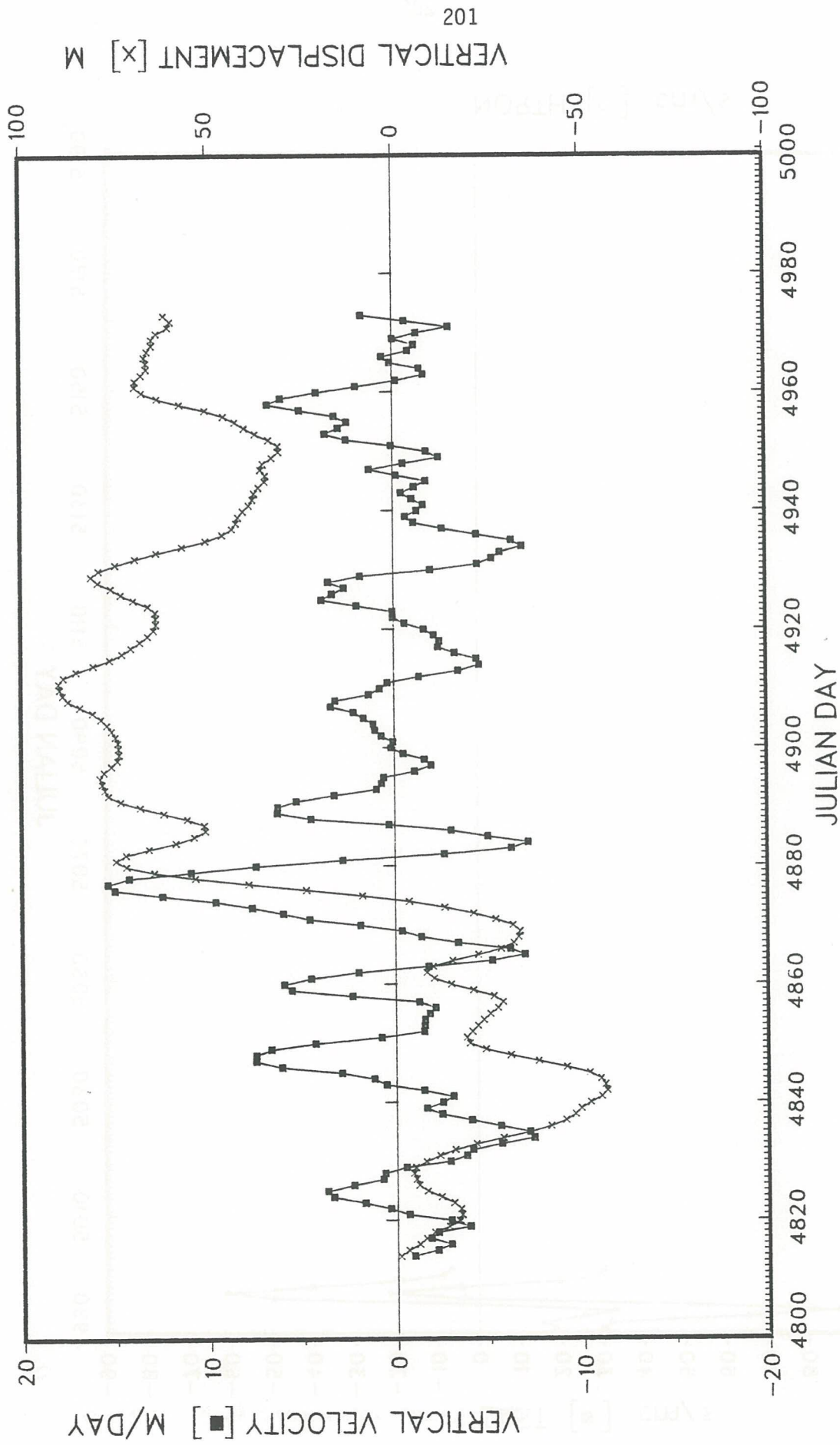


AUGUST 1981 SEPTEMBER 1981 OCTOBER 1981 NOVEMBER 1981 DECEMBER 1981 JANUARY 1982

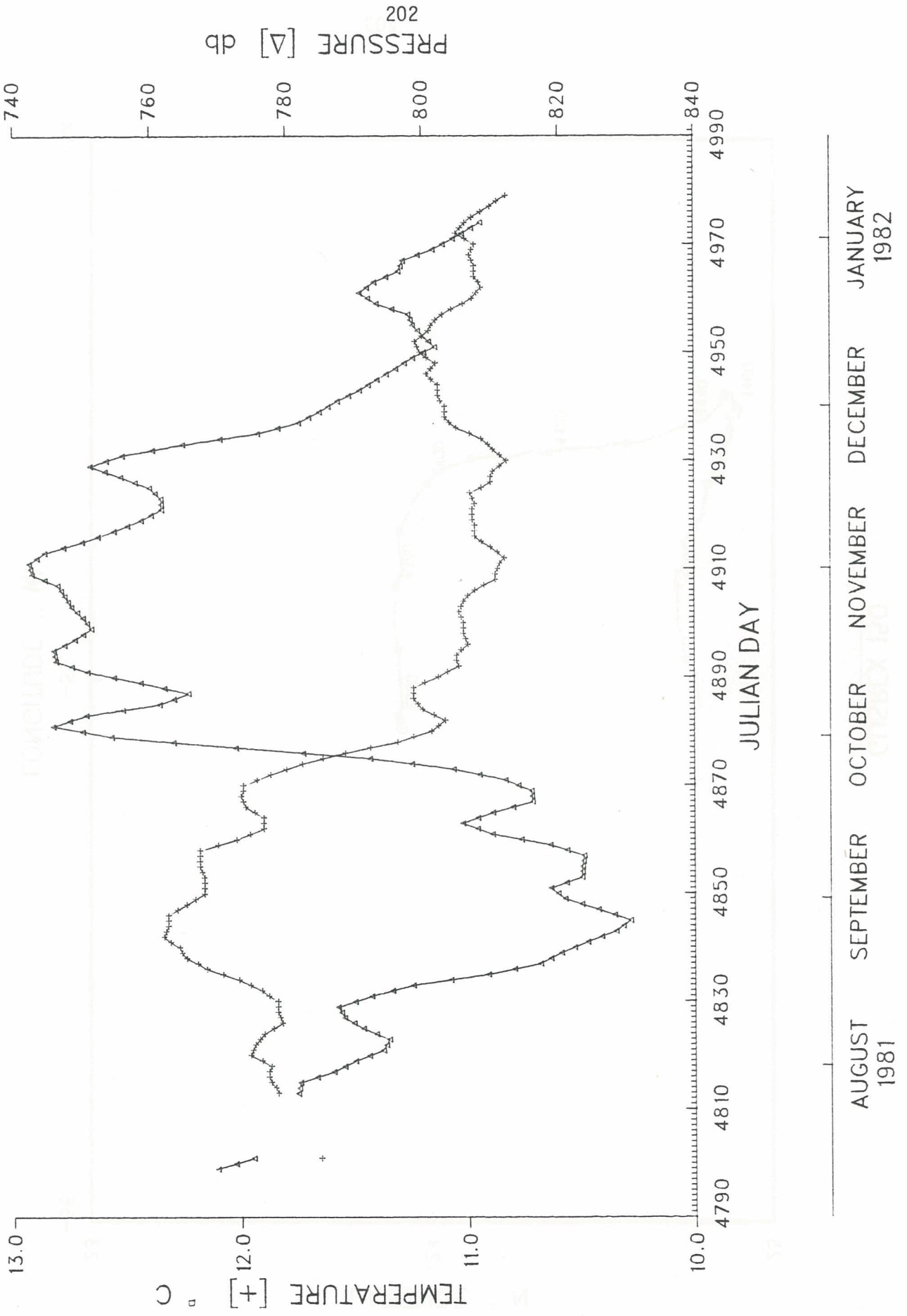
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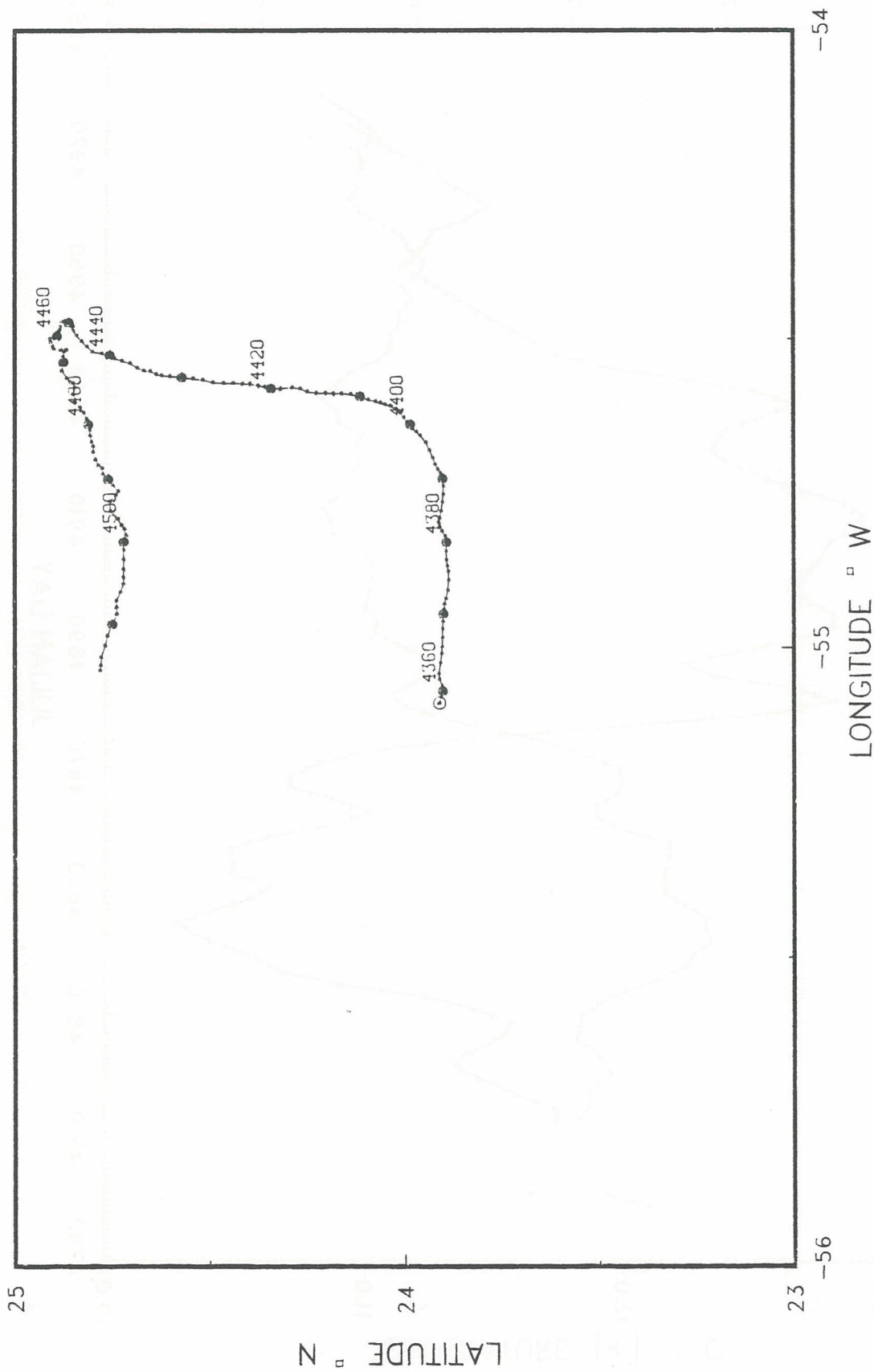
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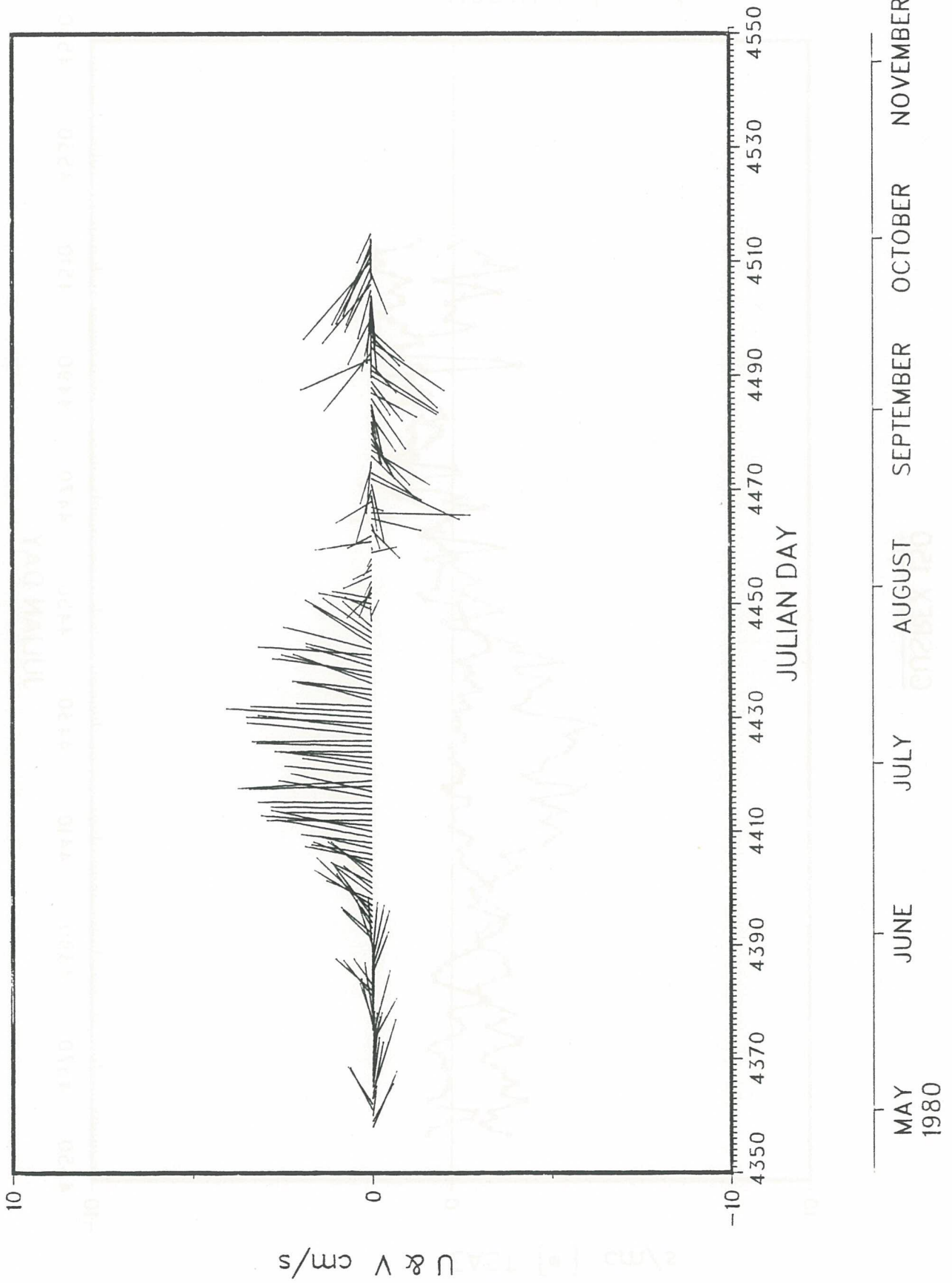
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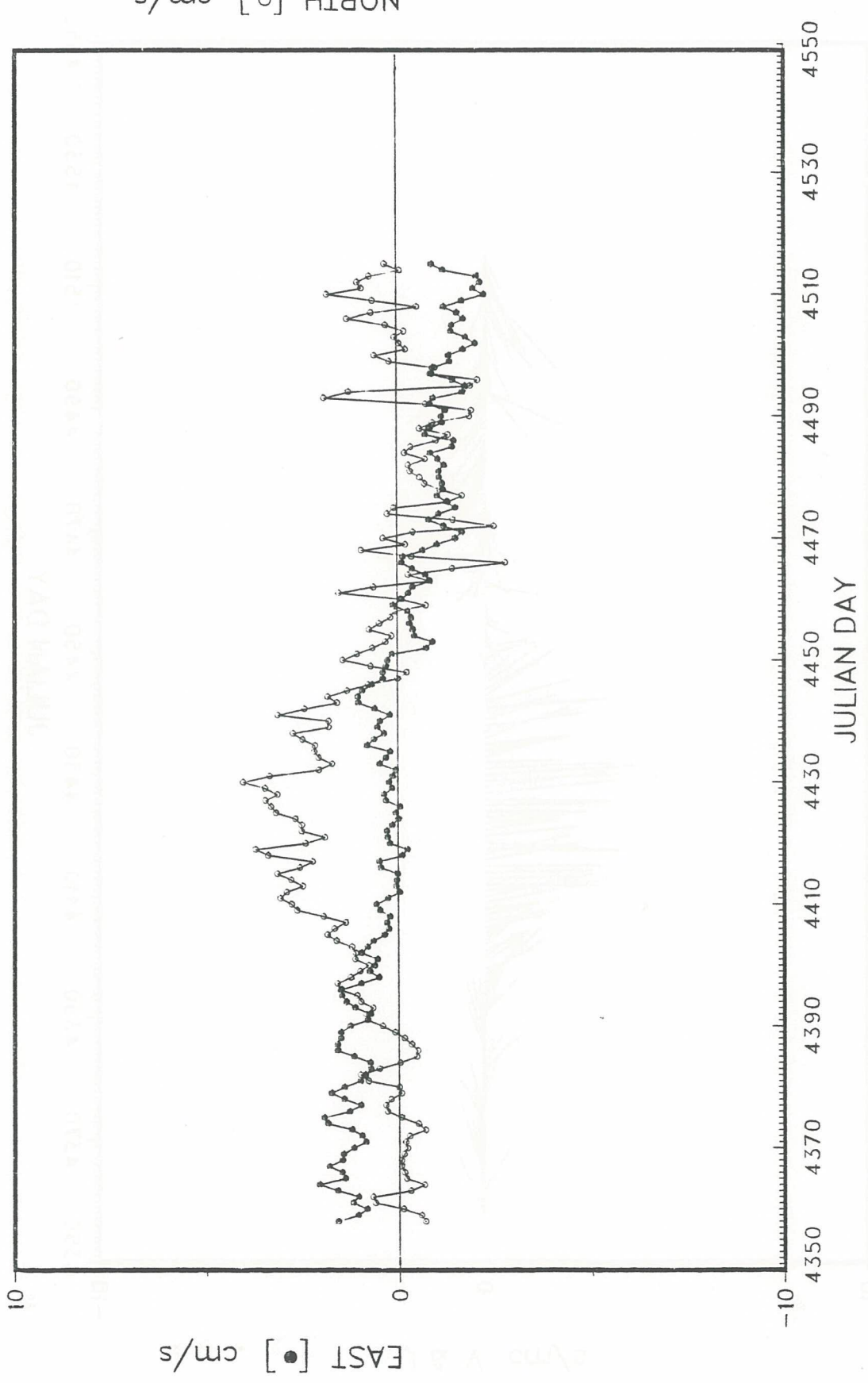
GUSREX 150



GUSREX 150

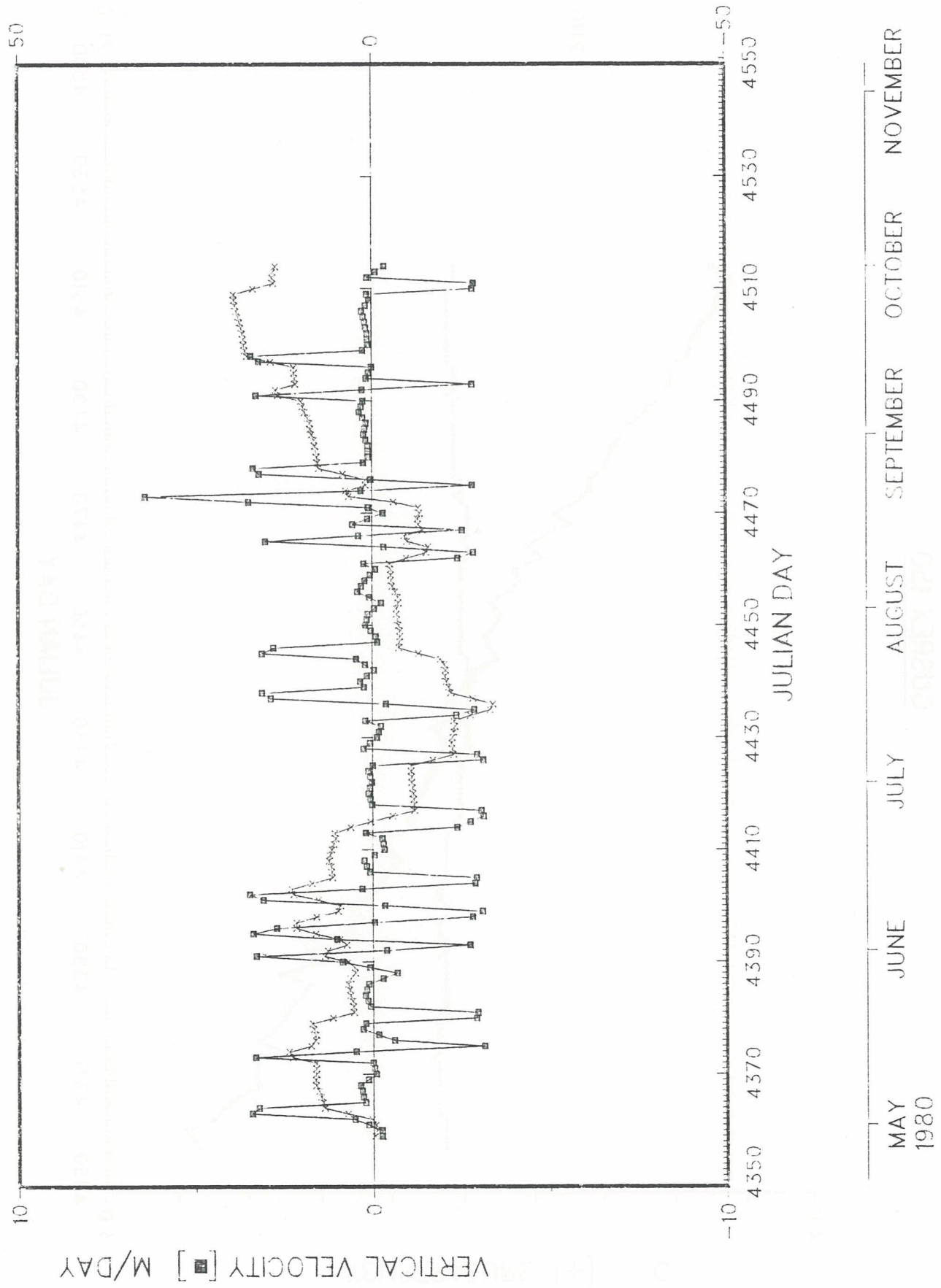


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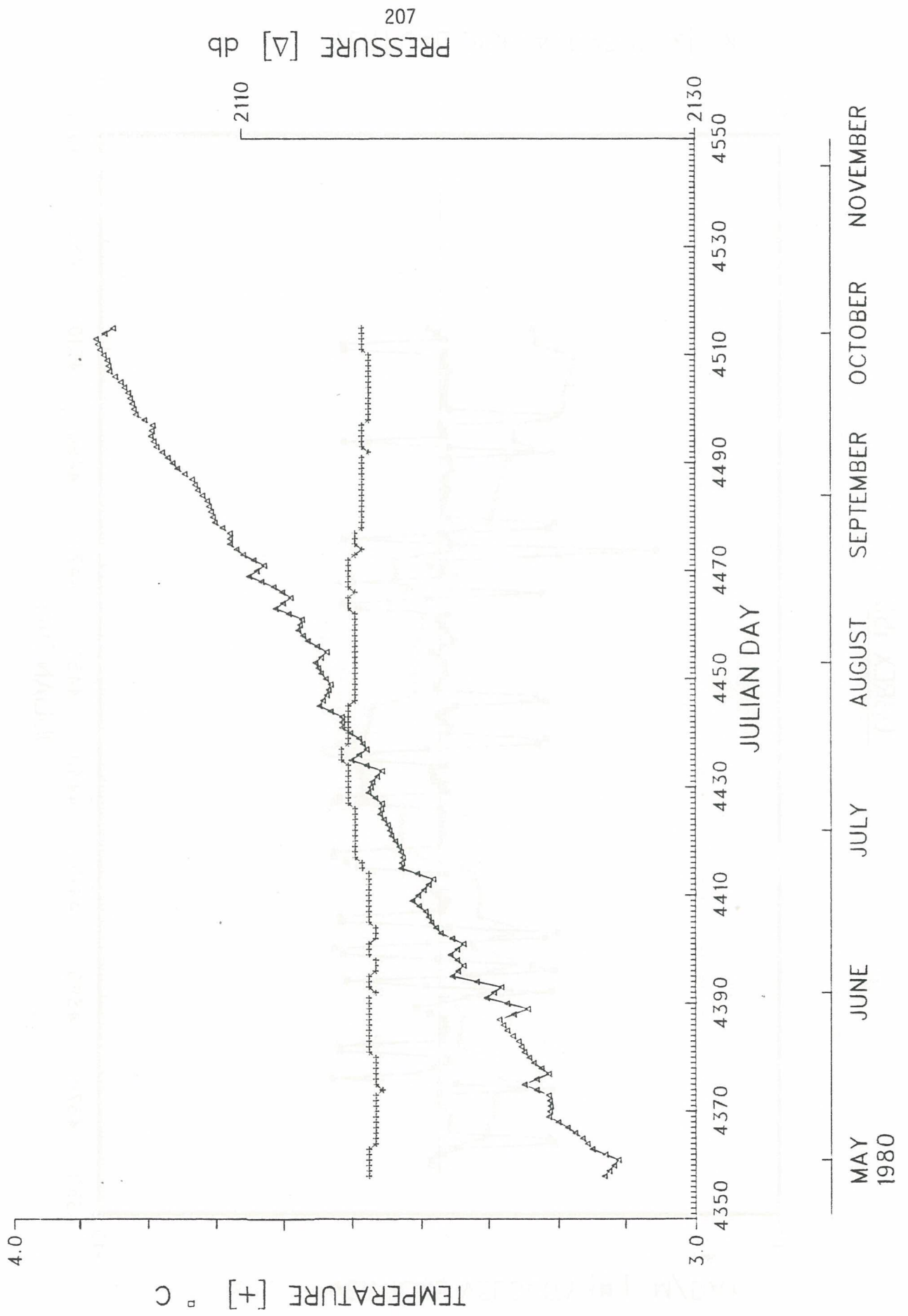


MAY 1980 JUNE JULY AUGUST SEPTEMBER OCTOBER NOVEMBER

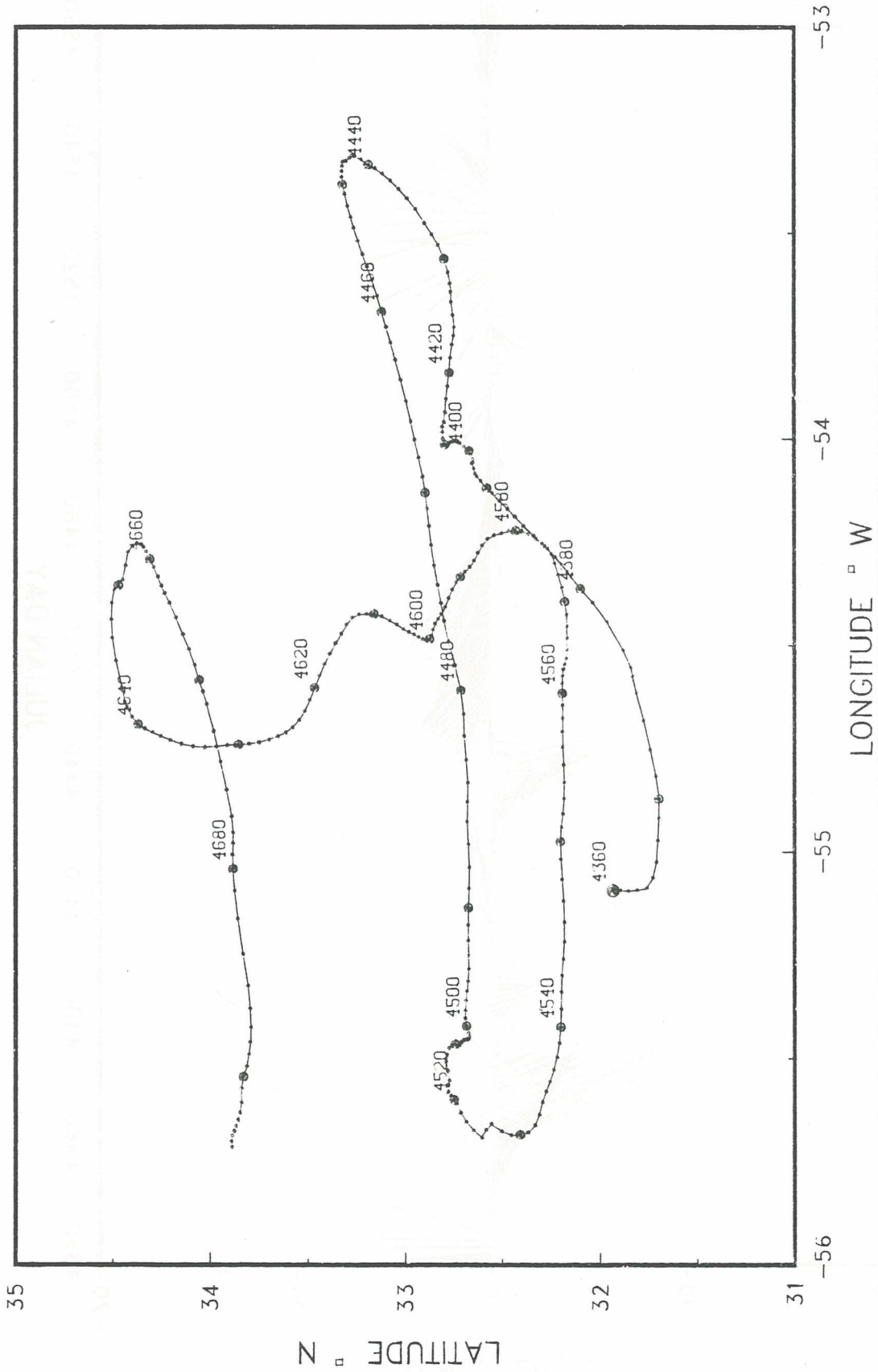
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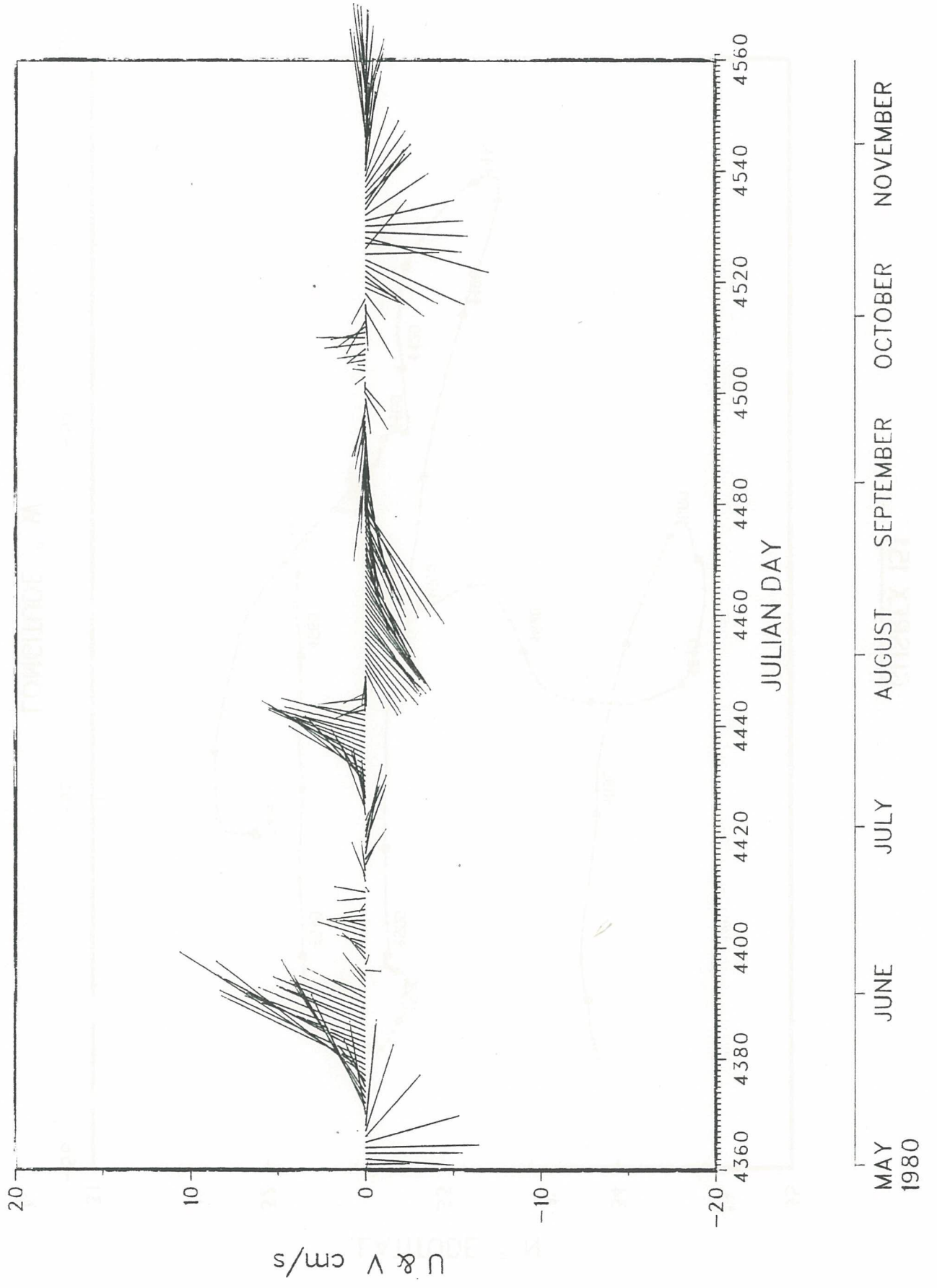
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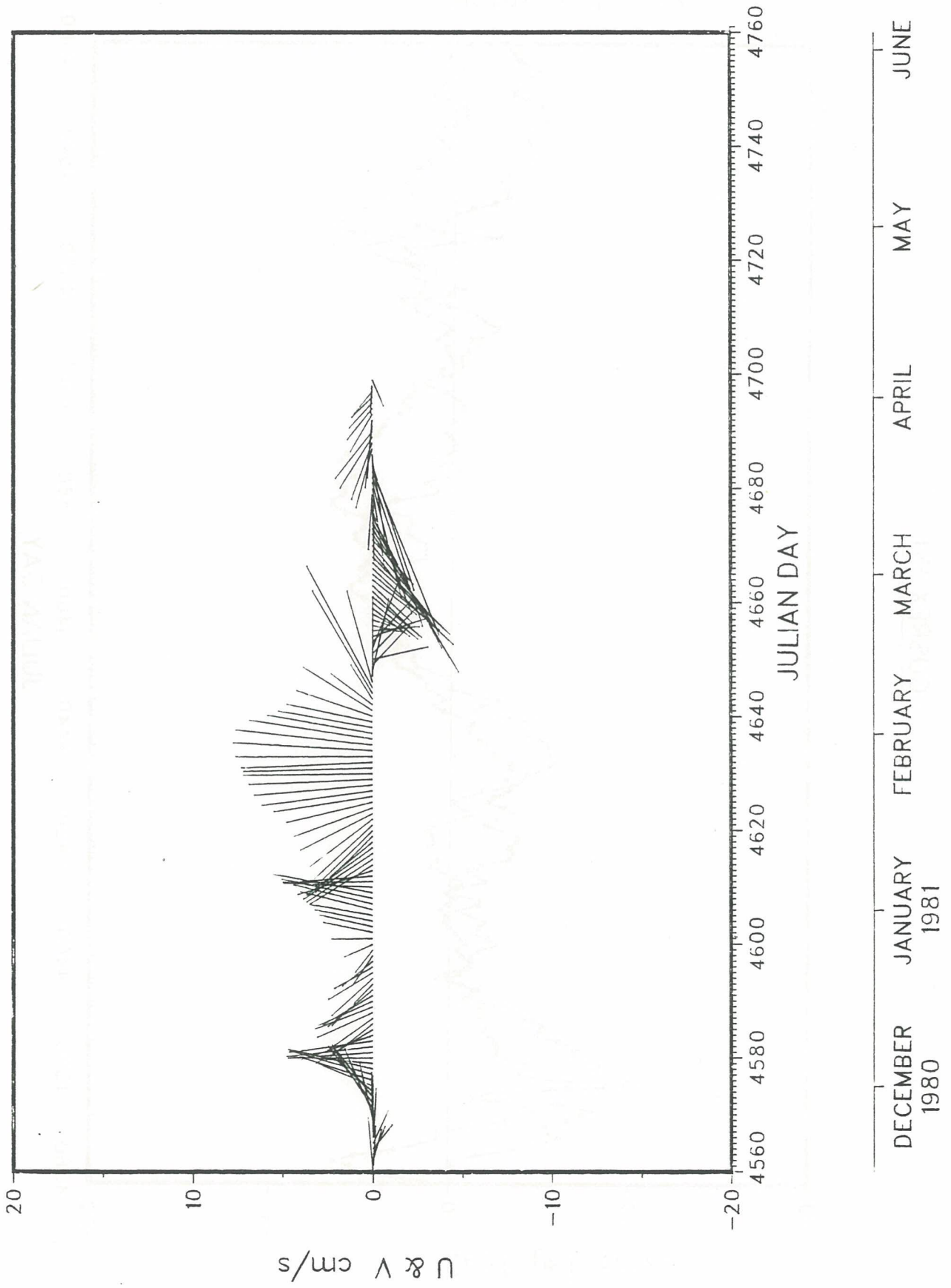
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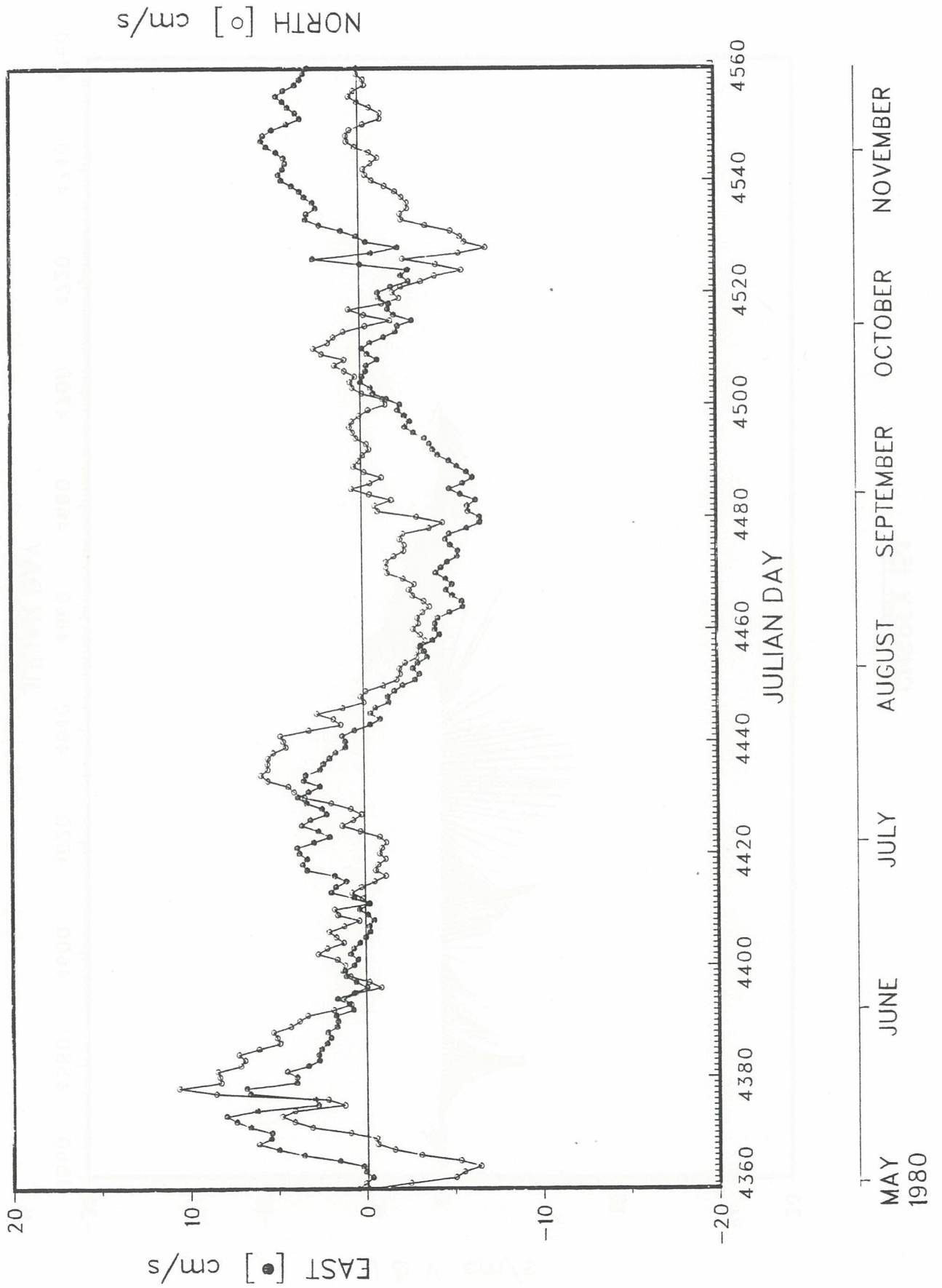
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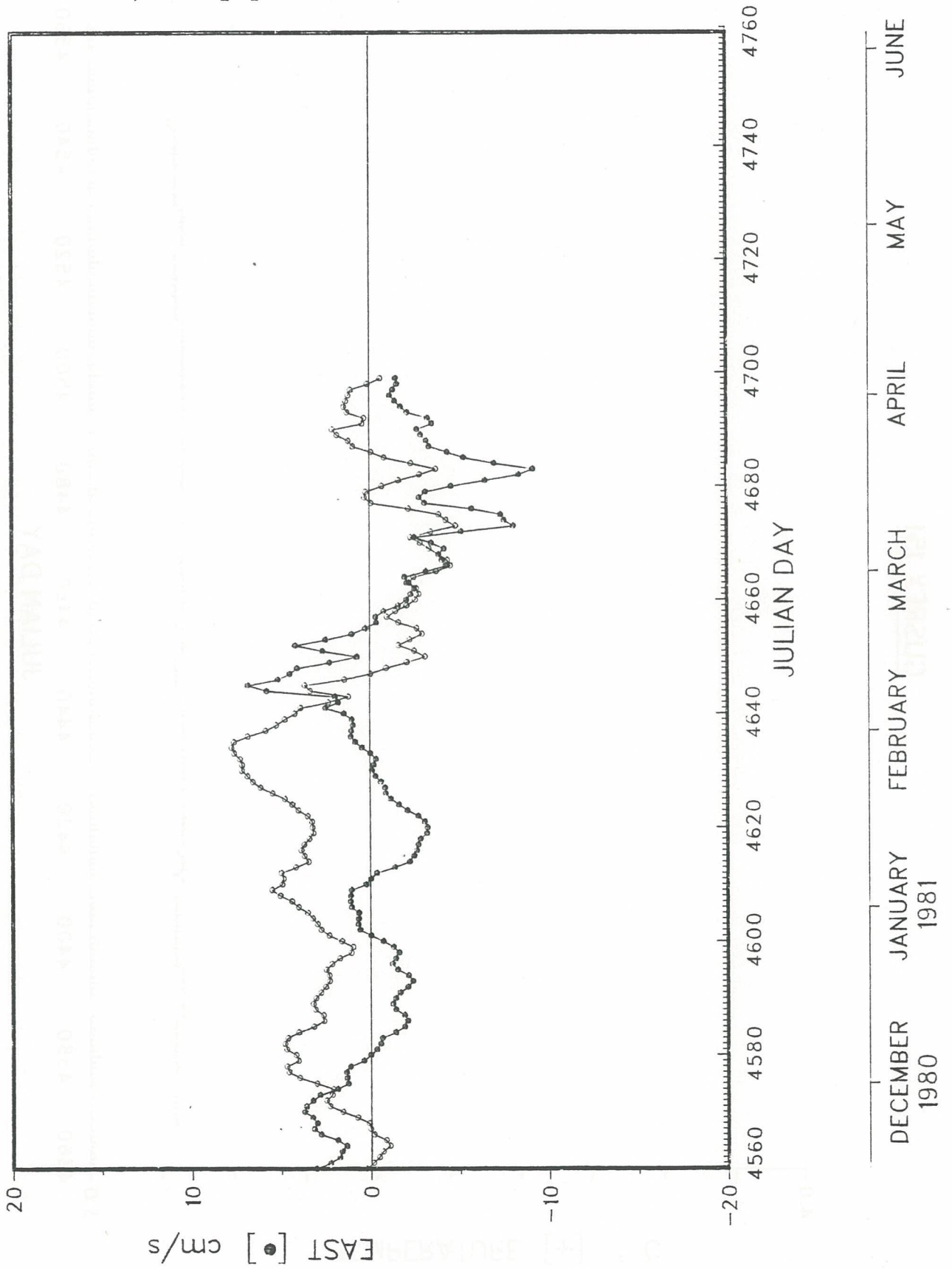
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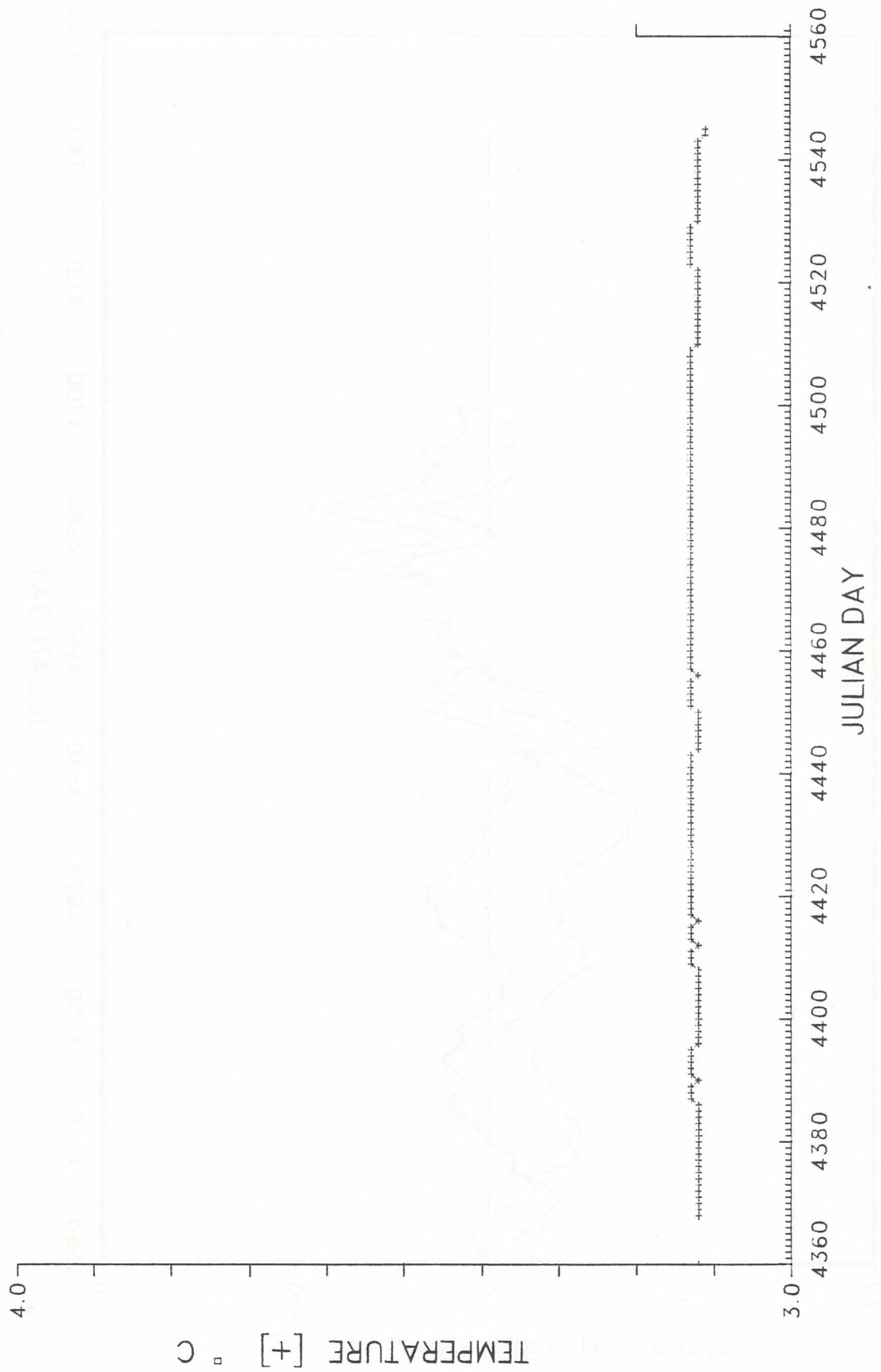
GUSREX 151



CUSREX 151



GUSREX 151



MAY
1980

NOVEMBER

OCTOBER

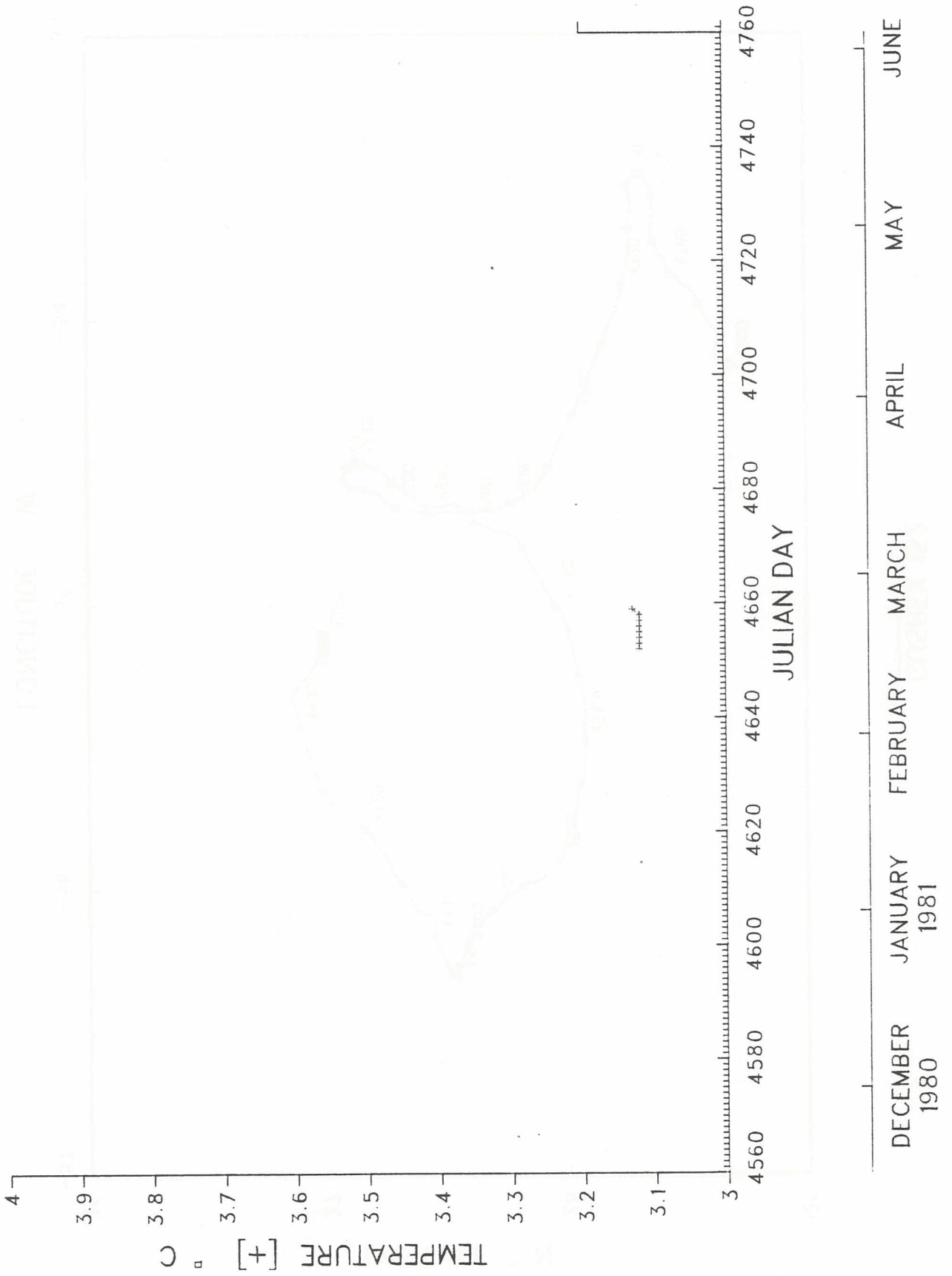
SEPTEMBER

AUGUST

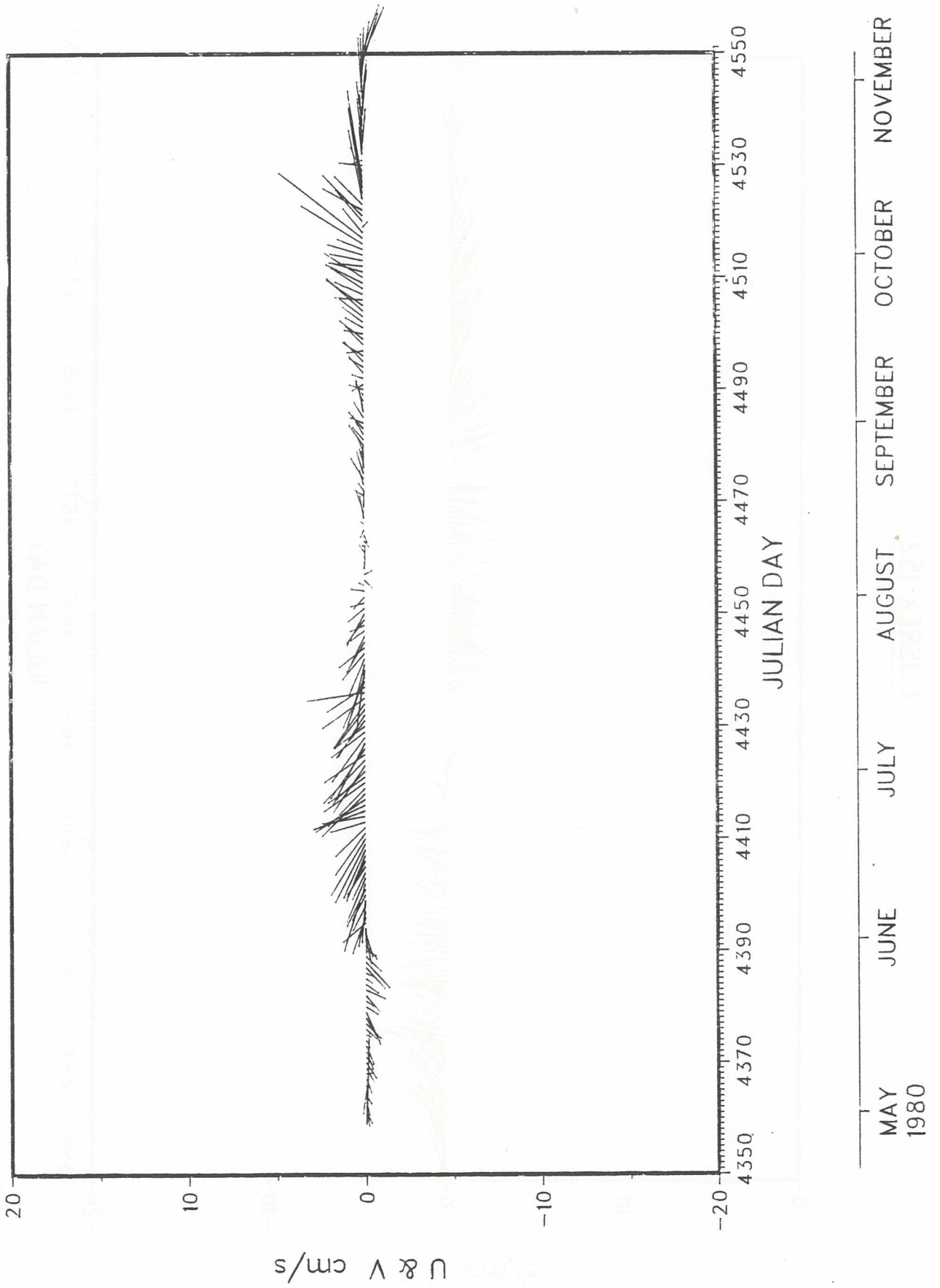
JULY

JUNE

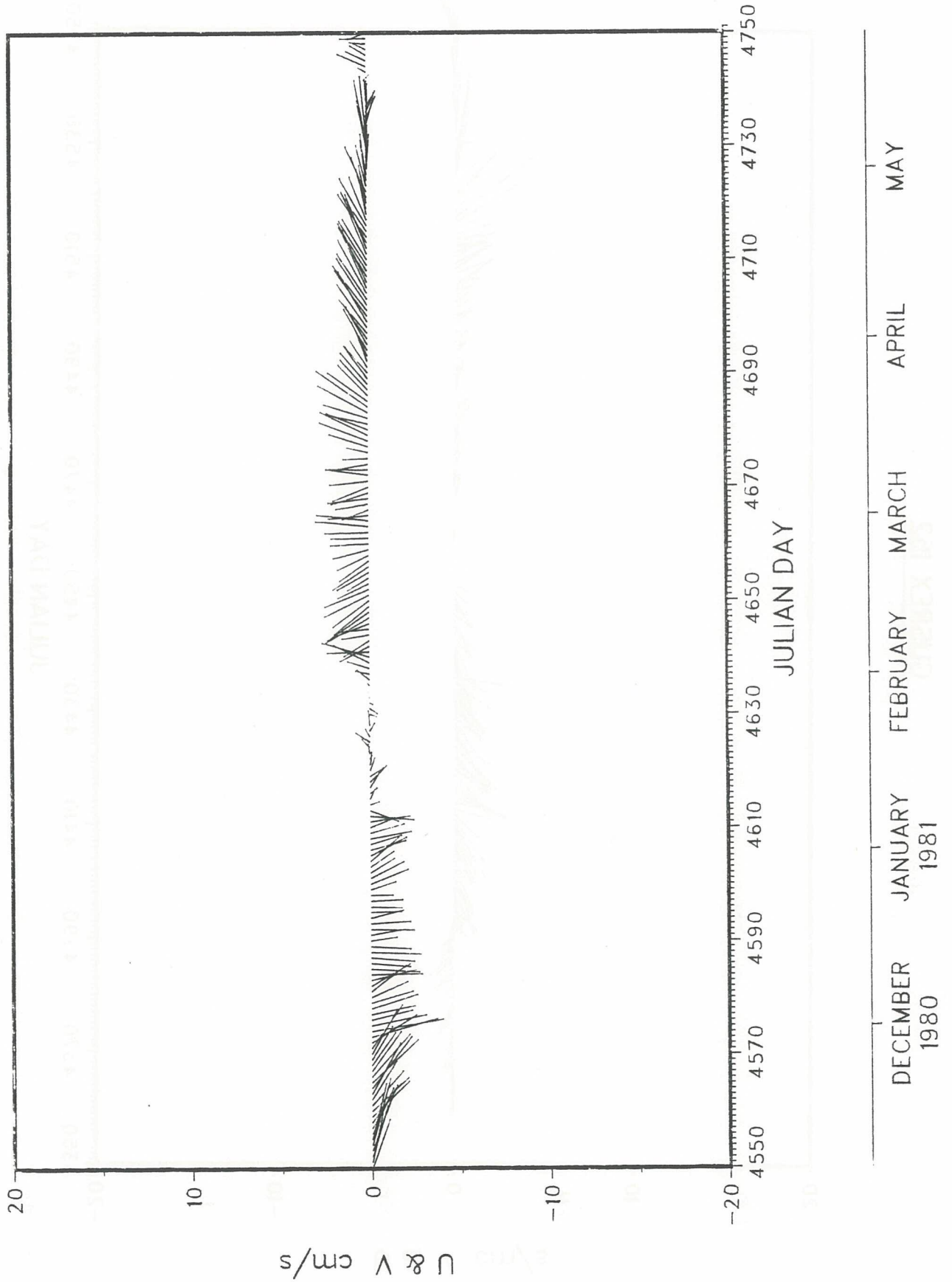
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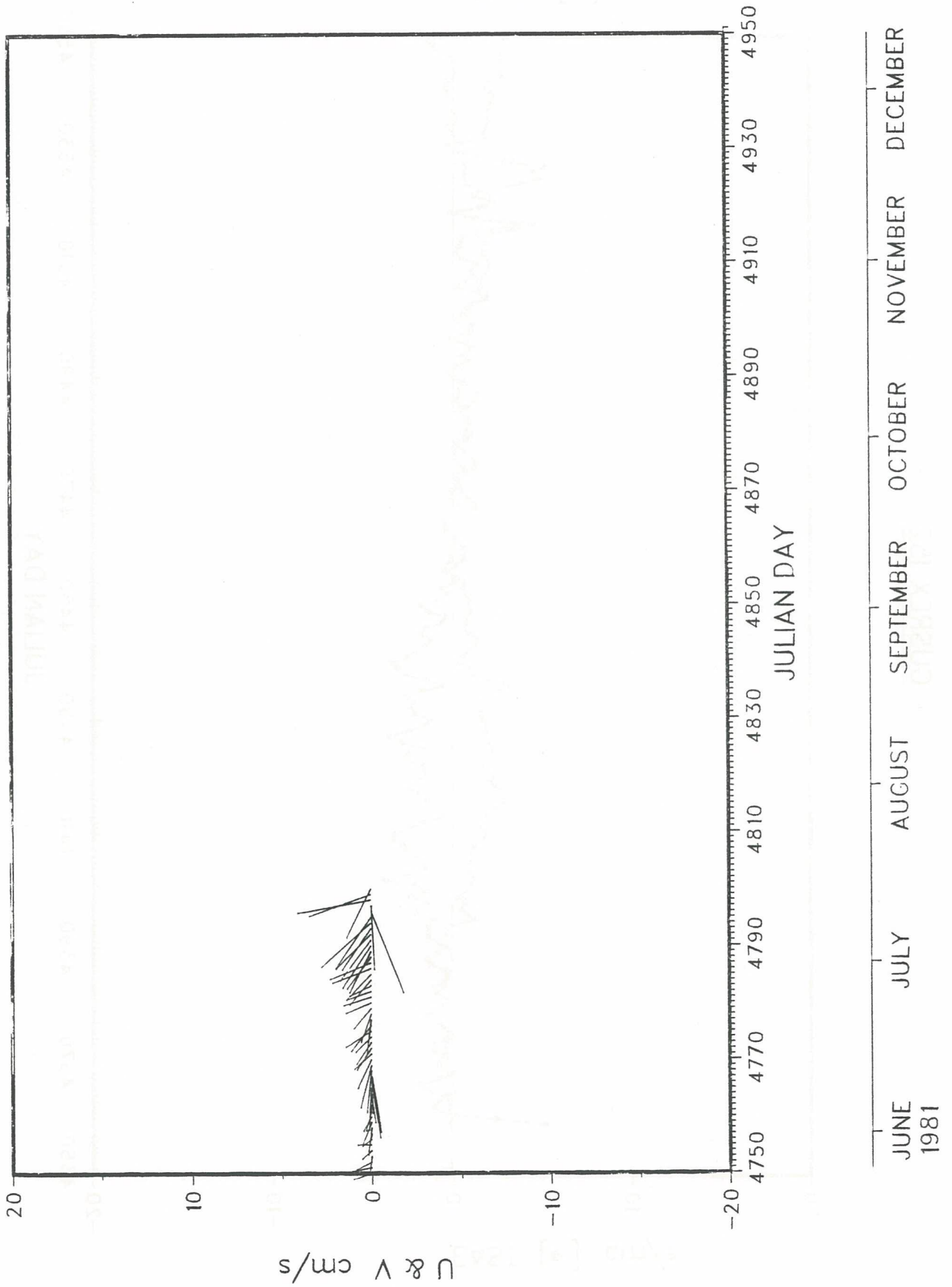
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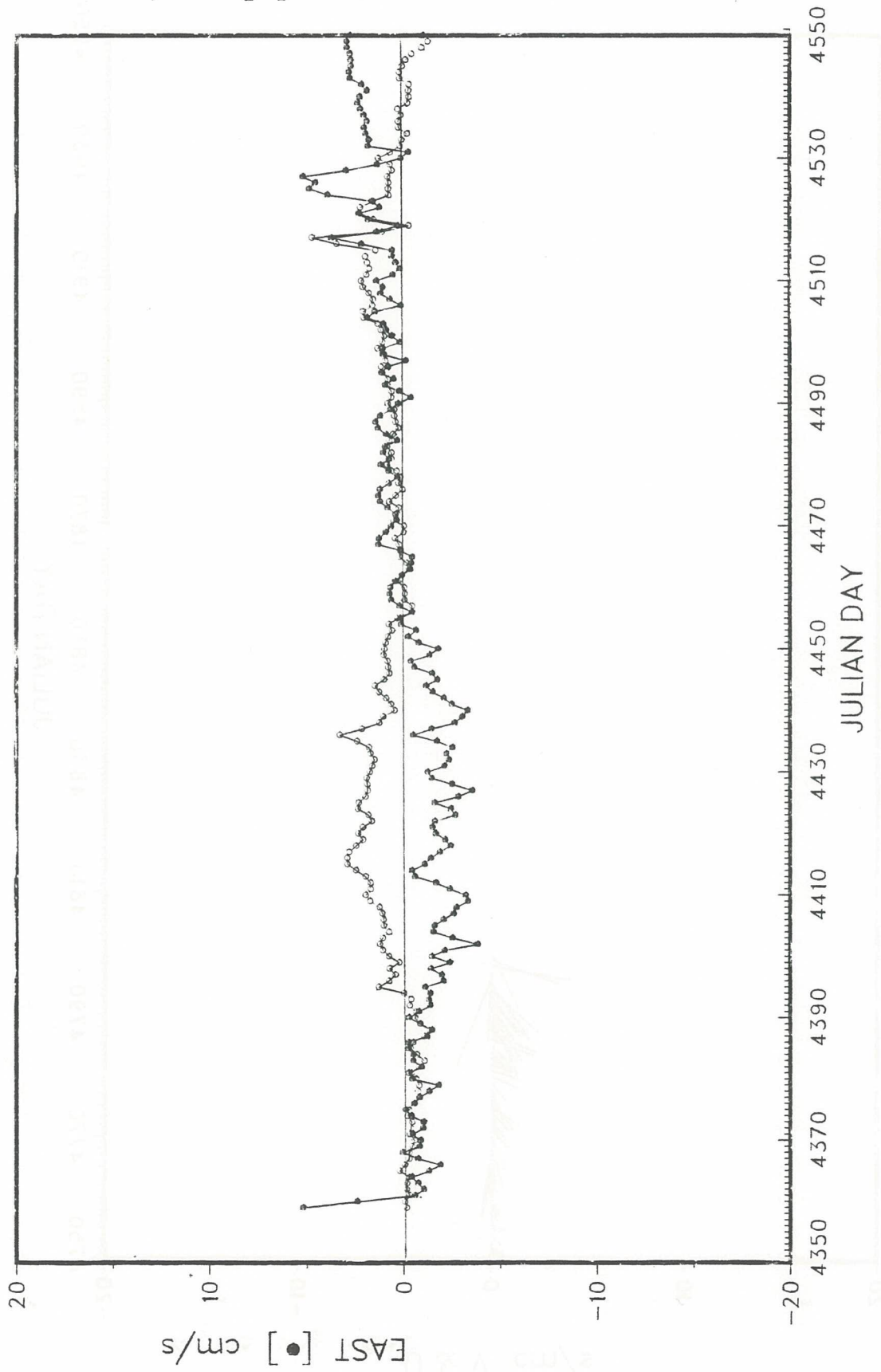
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CUSREX 152

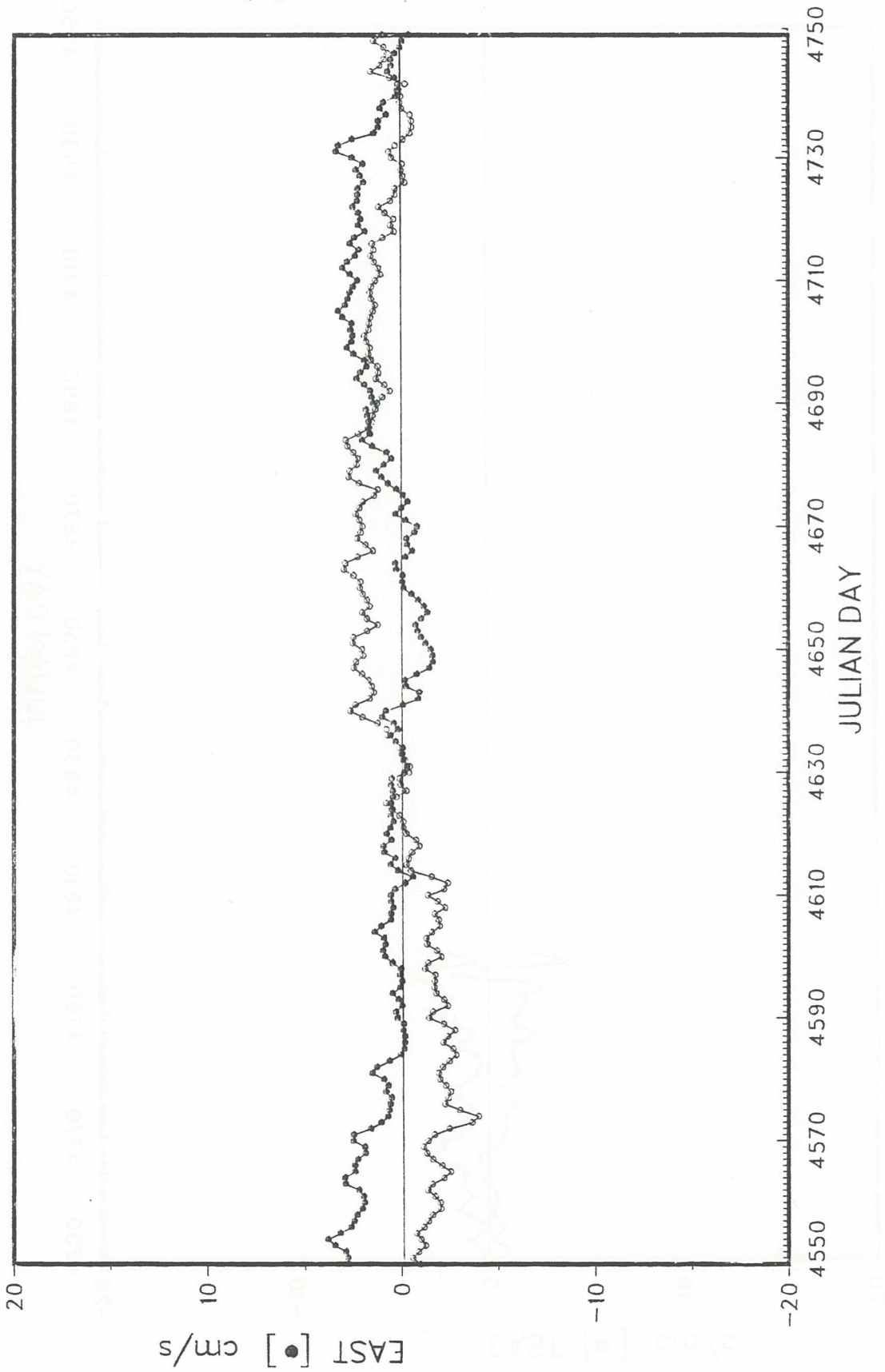


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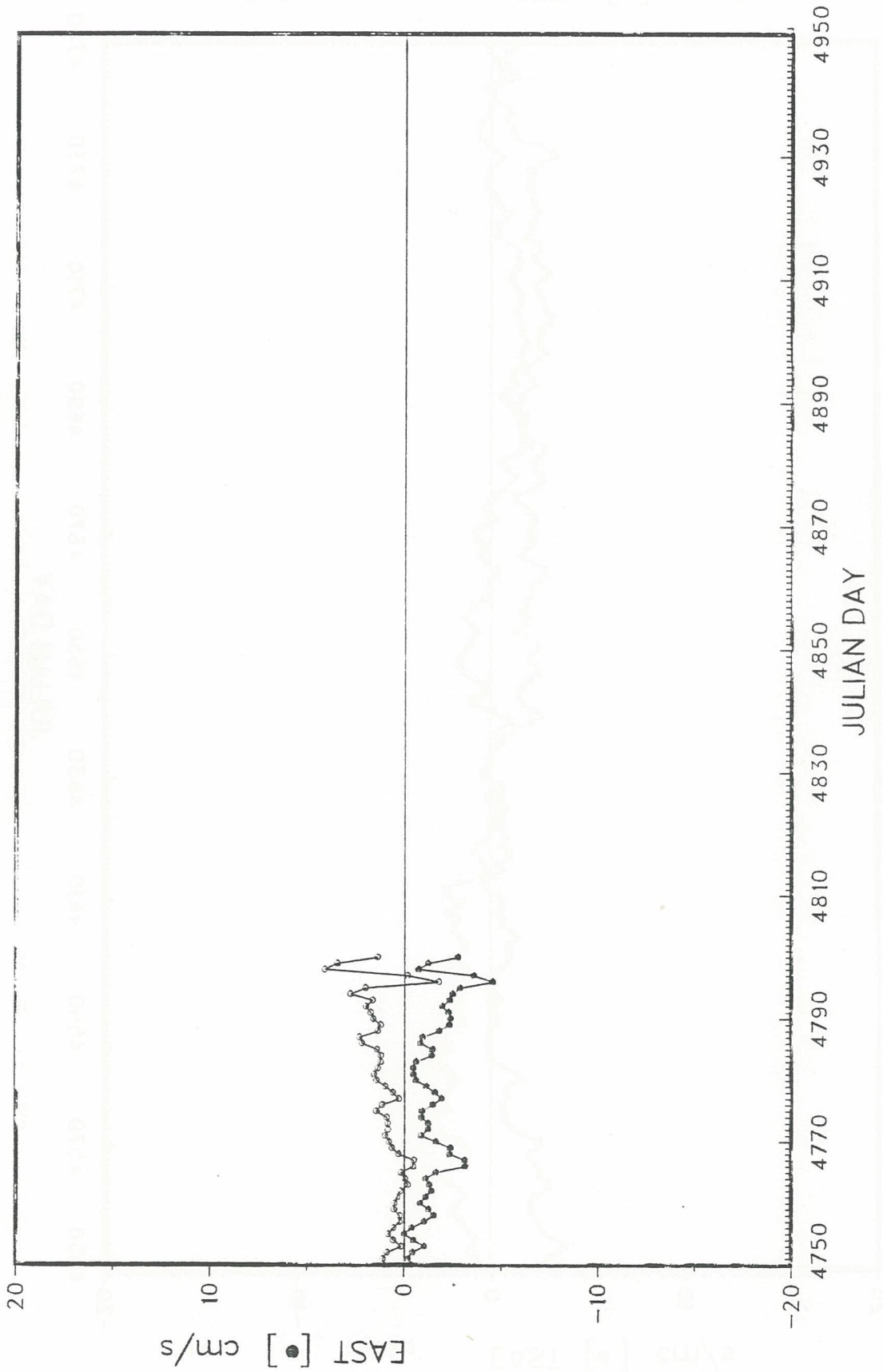
MAY JUNE JULY AUGUST SEPTEMBER OCTOBER NOVEMBER
1980

GUSREX 152



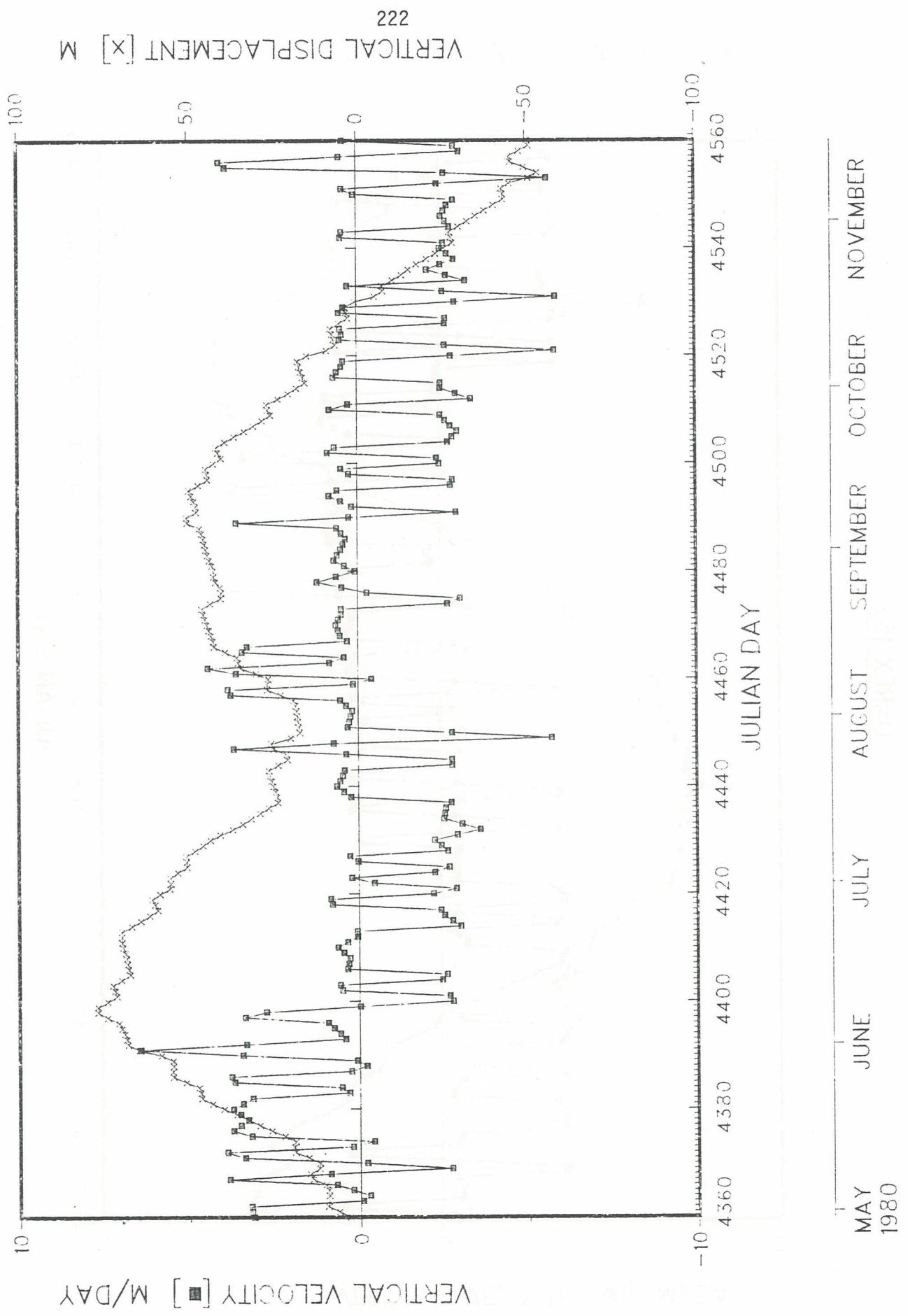
DECEMBER 1980 JANUARY 1981 FEBRUARY MARCH APRIL MAY

GUSREX 152



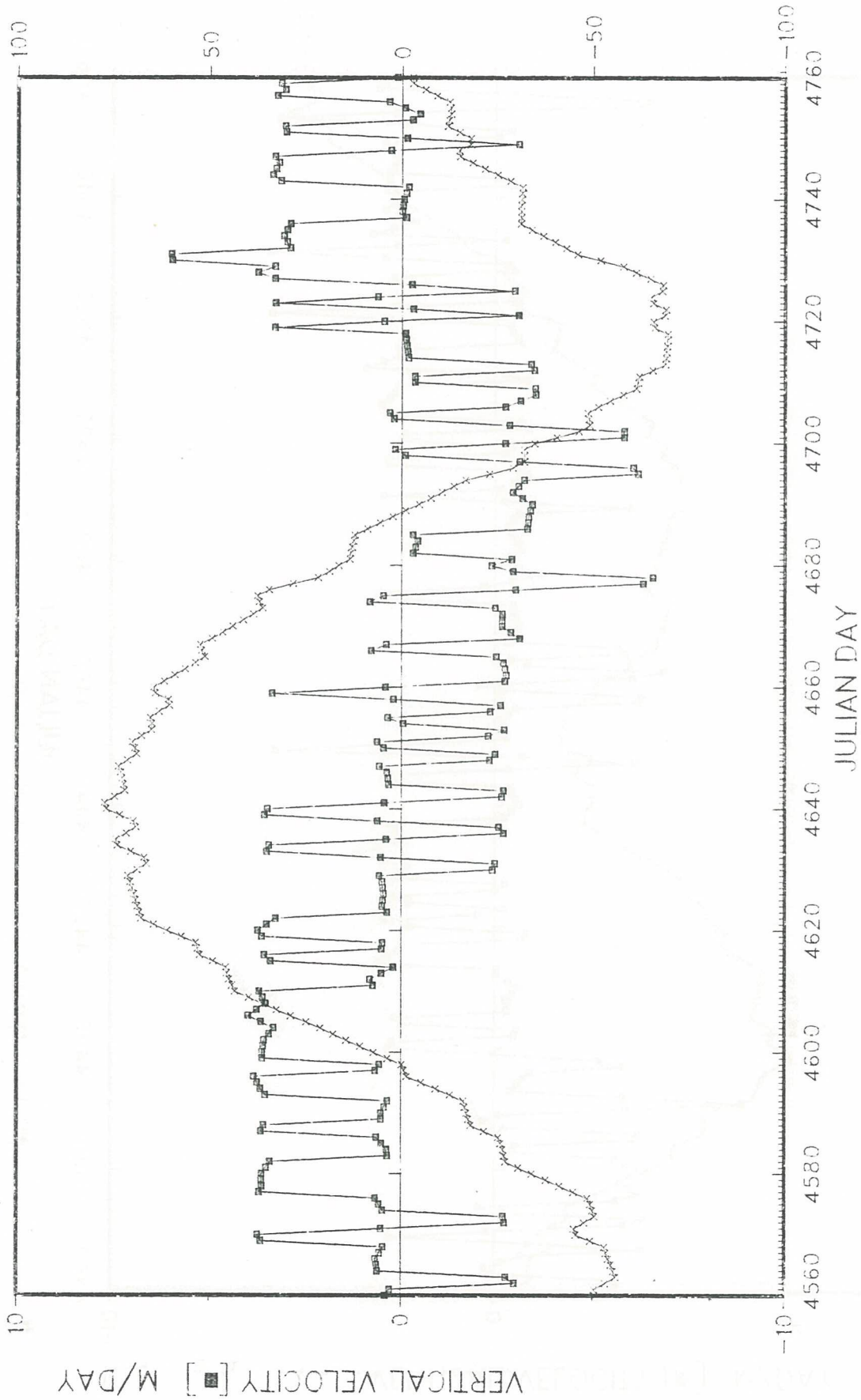
JUNE 1981 JULY AUGUST SEPTEMBER OCTOBER NOVEMBER DECEMBER

GUSREX 152

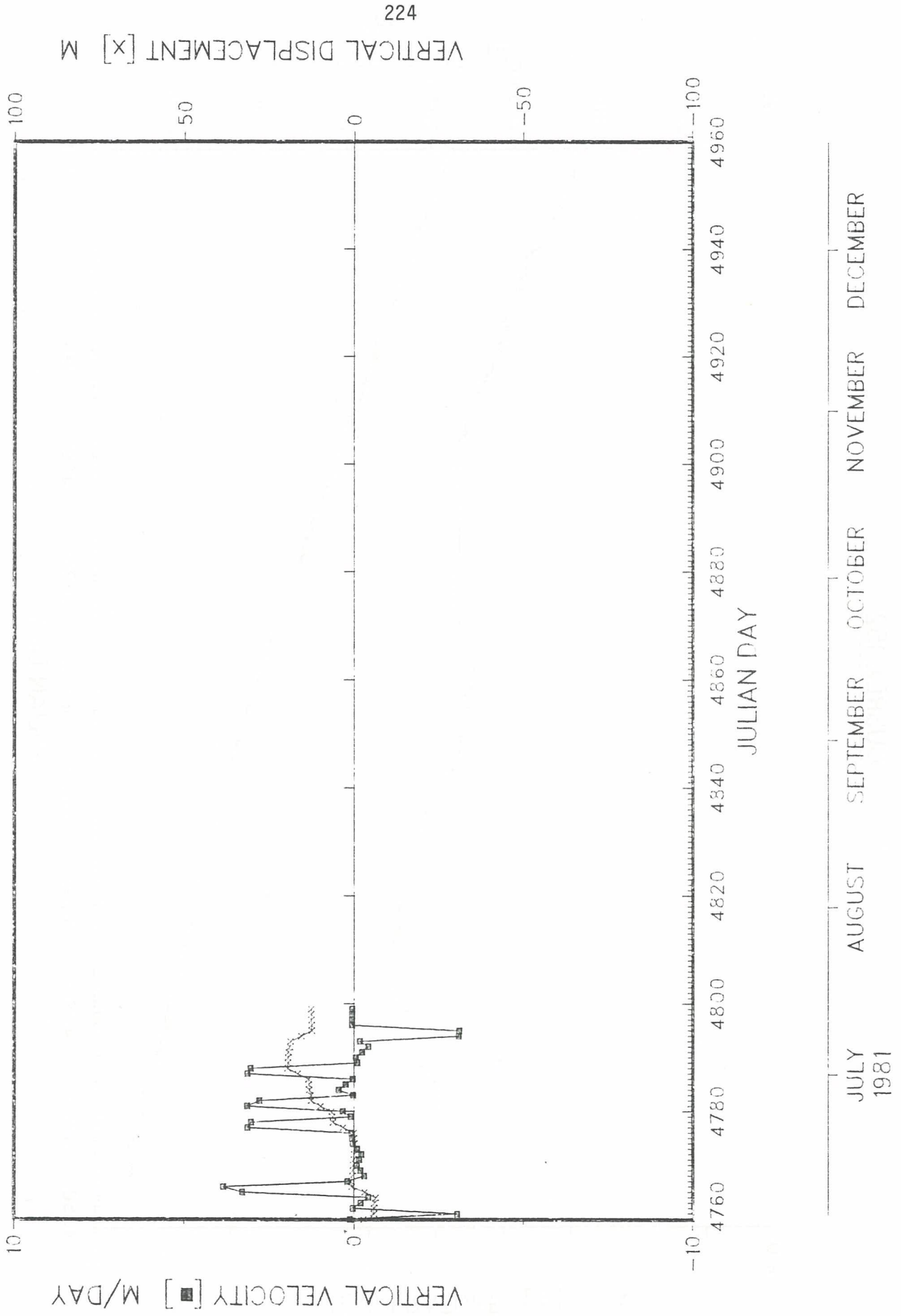


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GUSREX 152

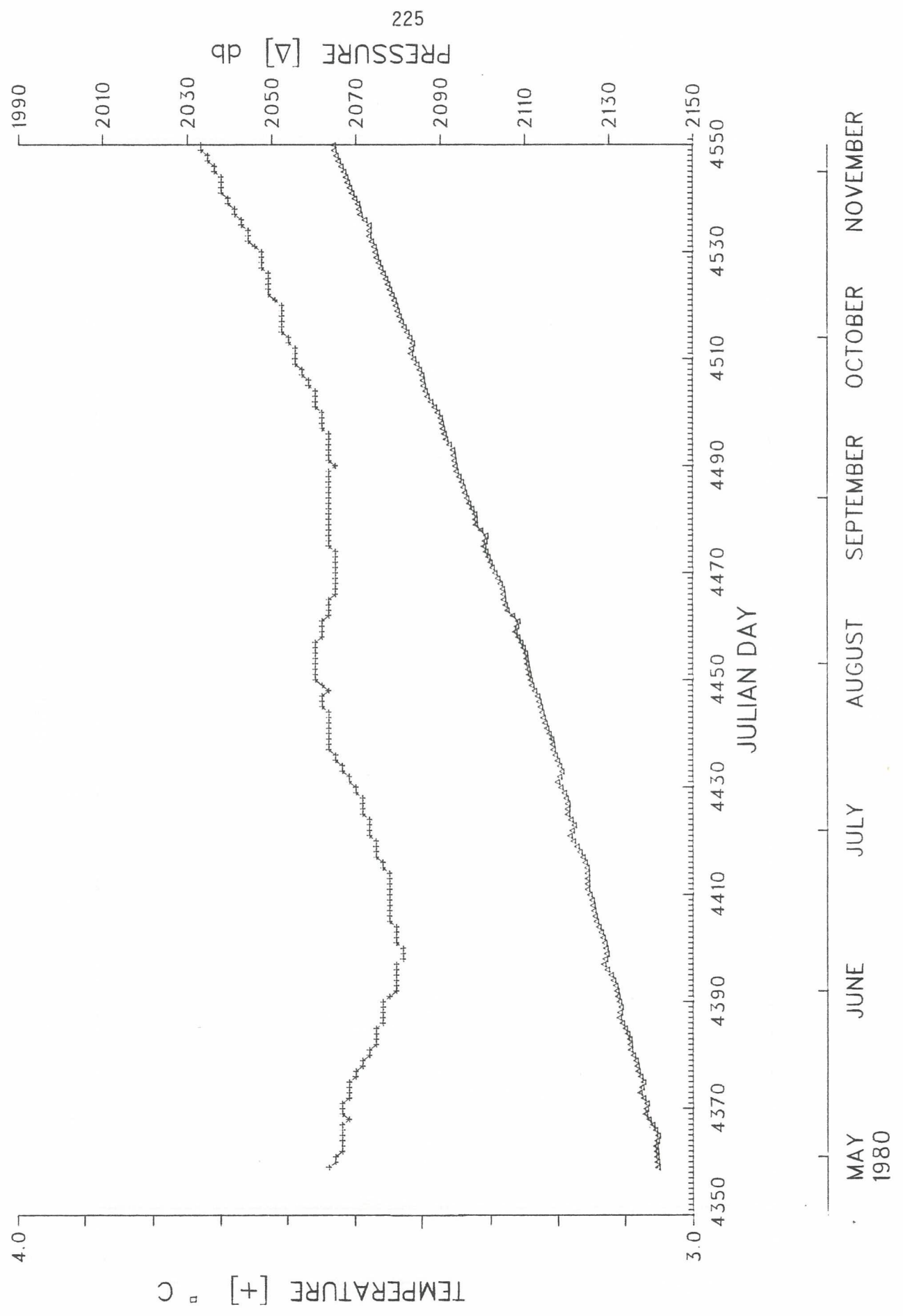


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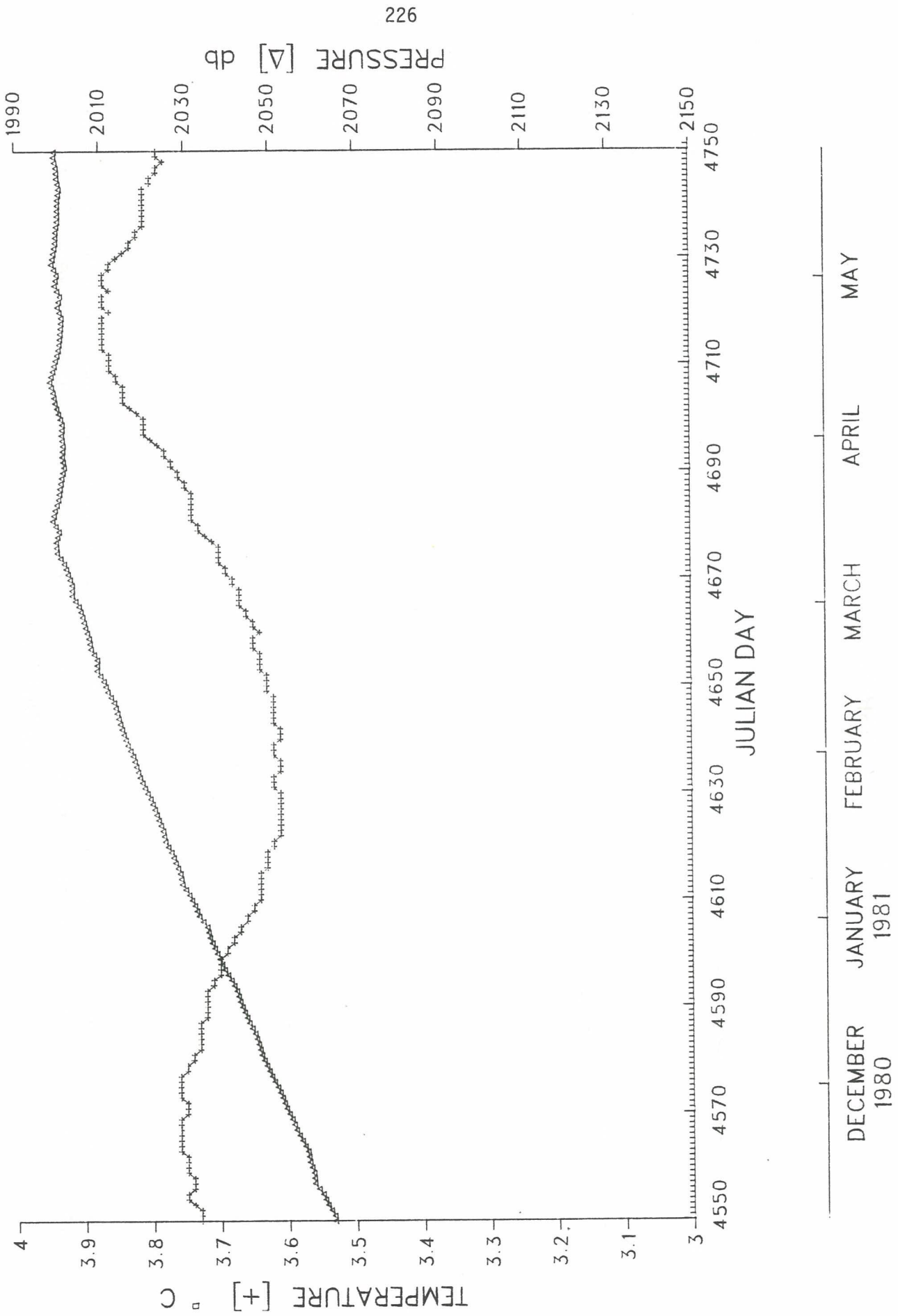


224

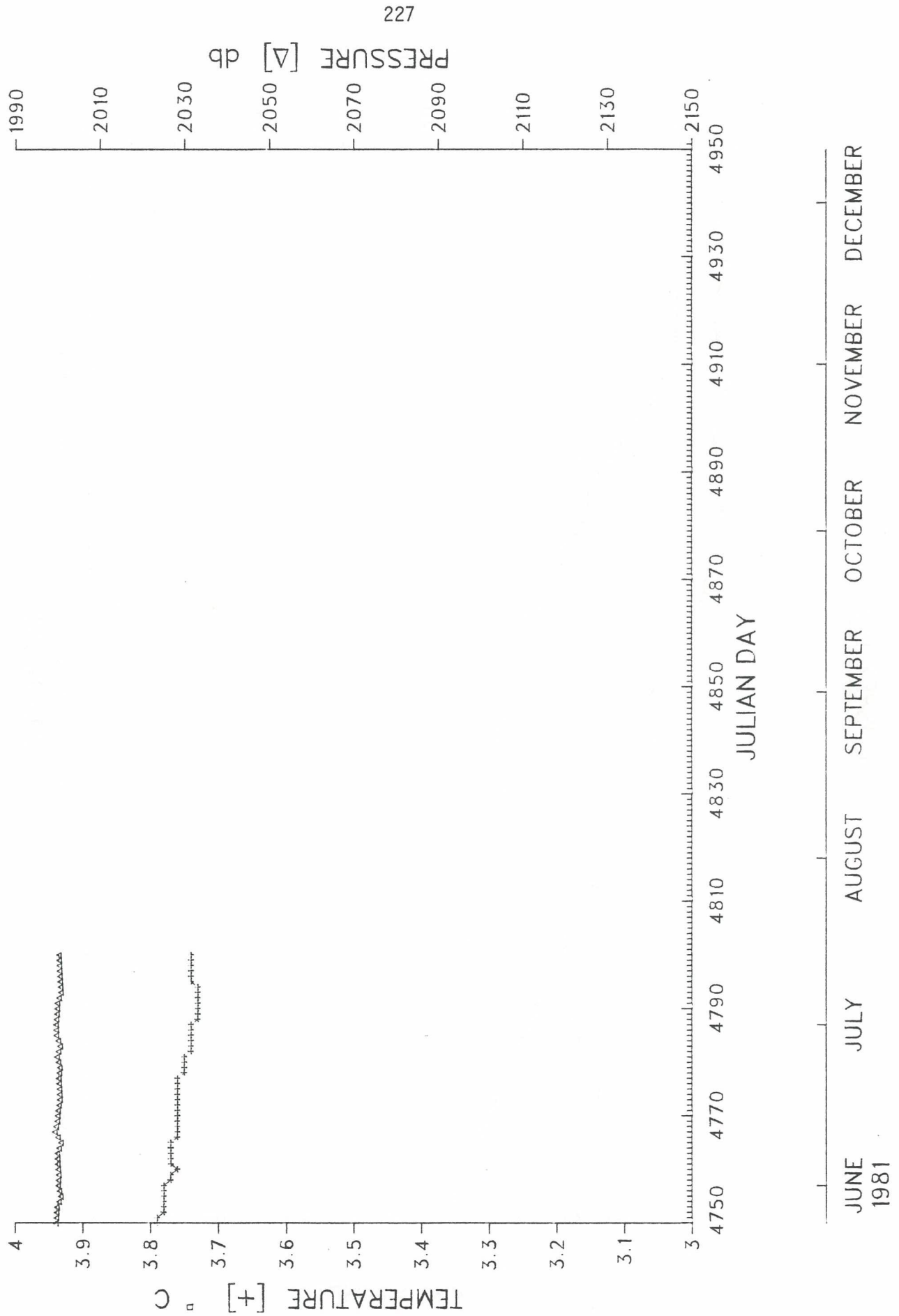
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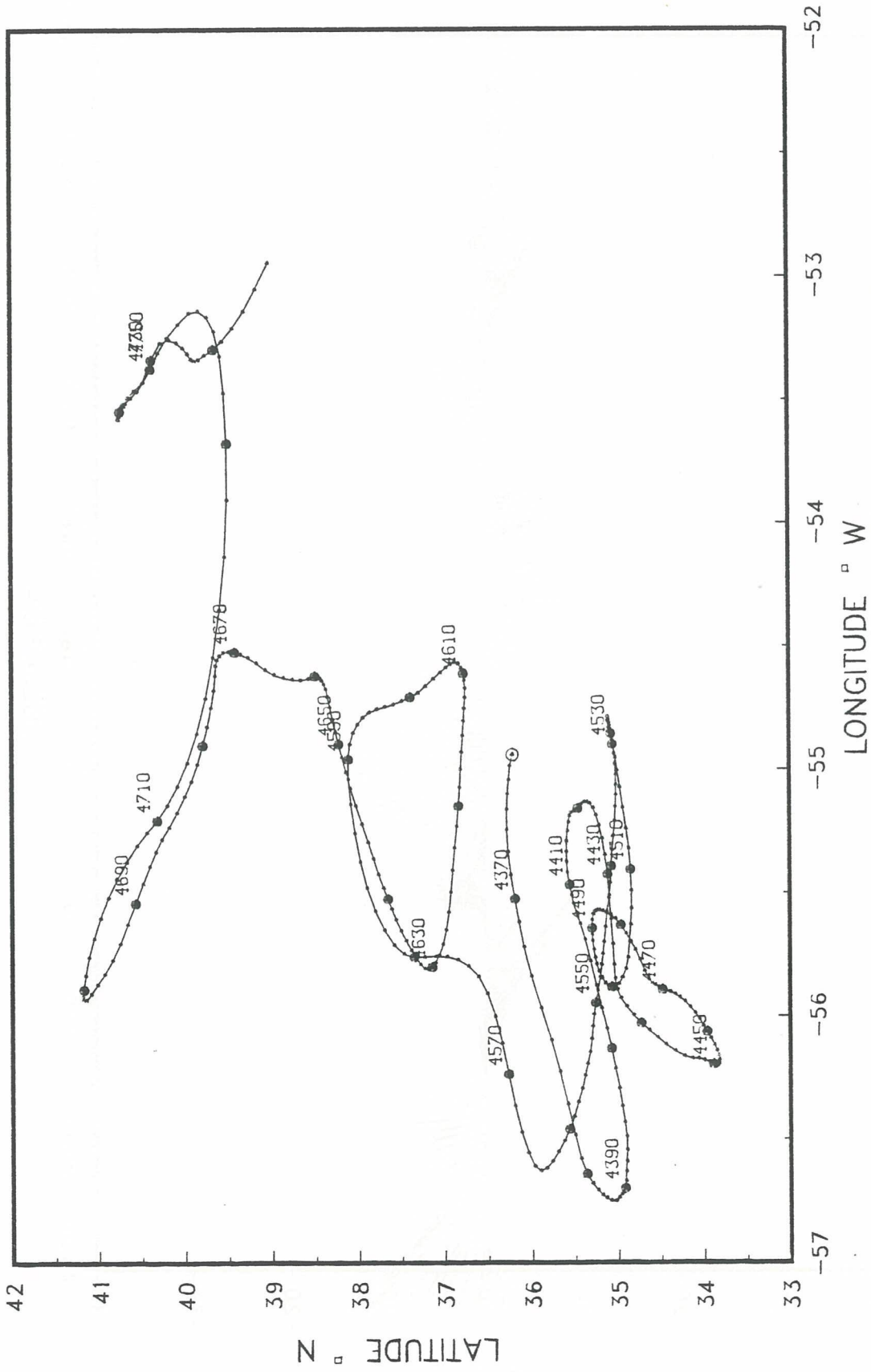
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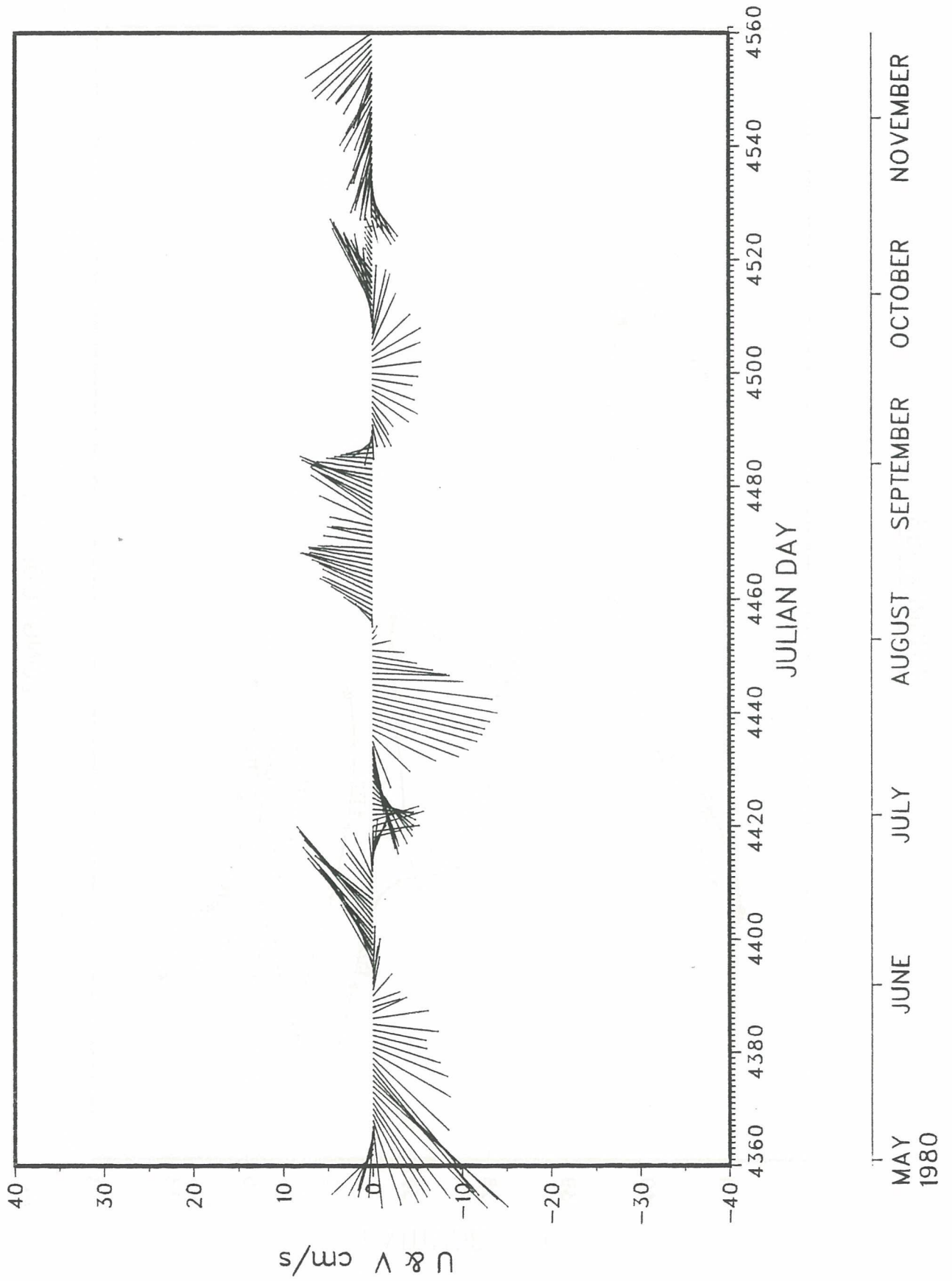
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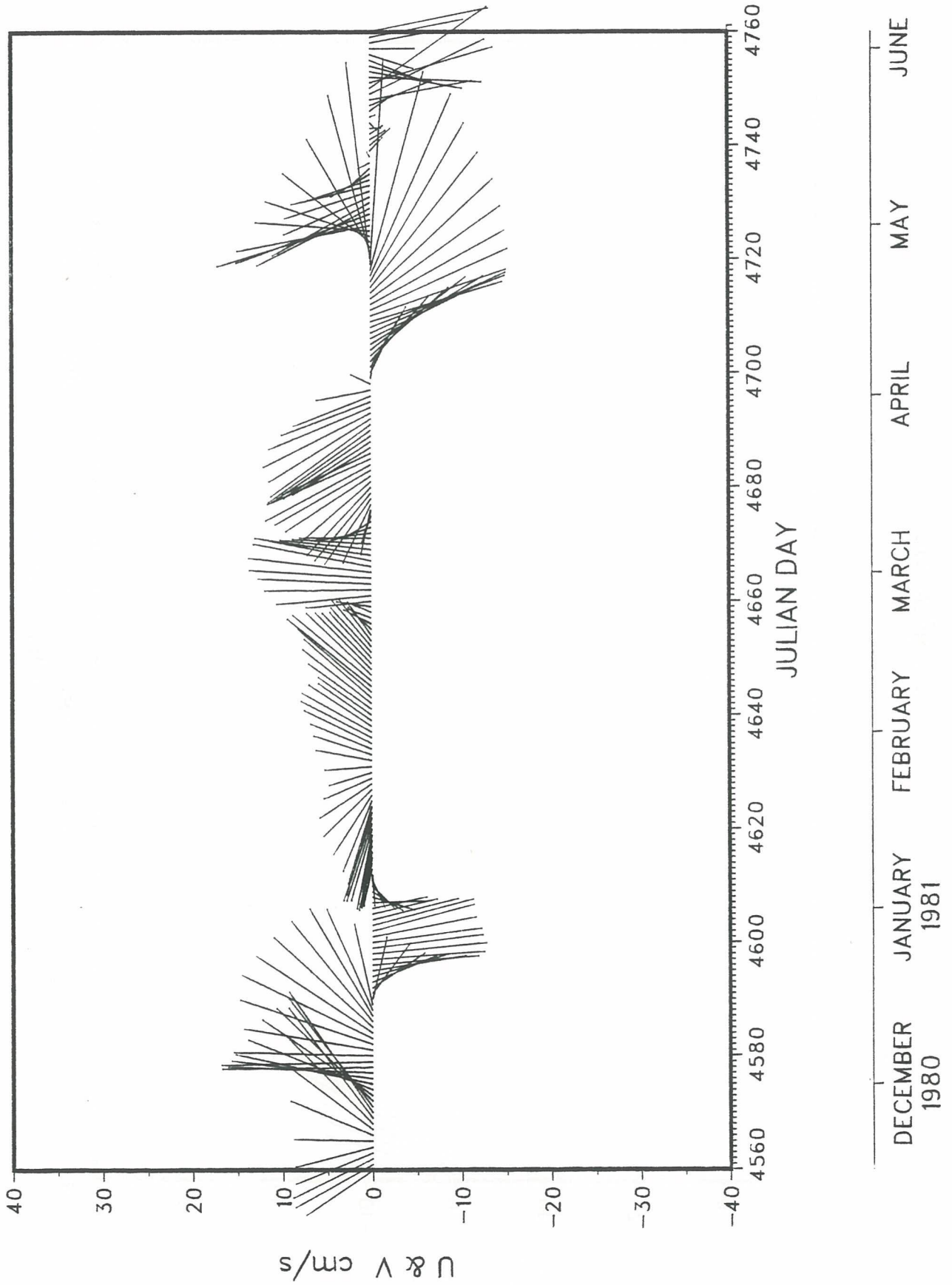
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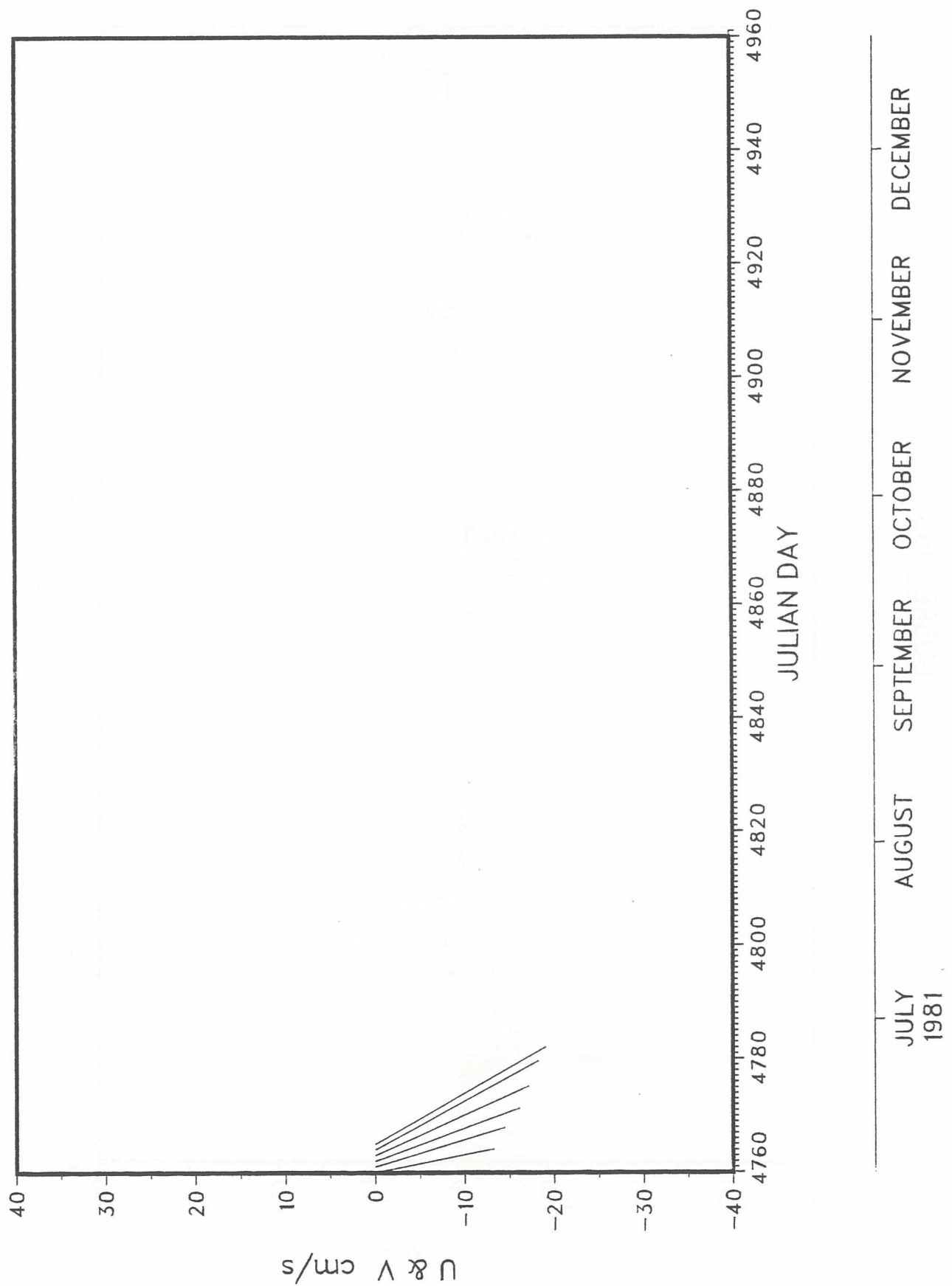
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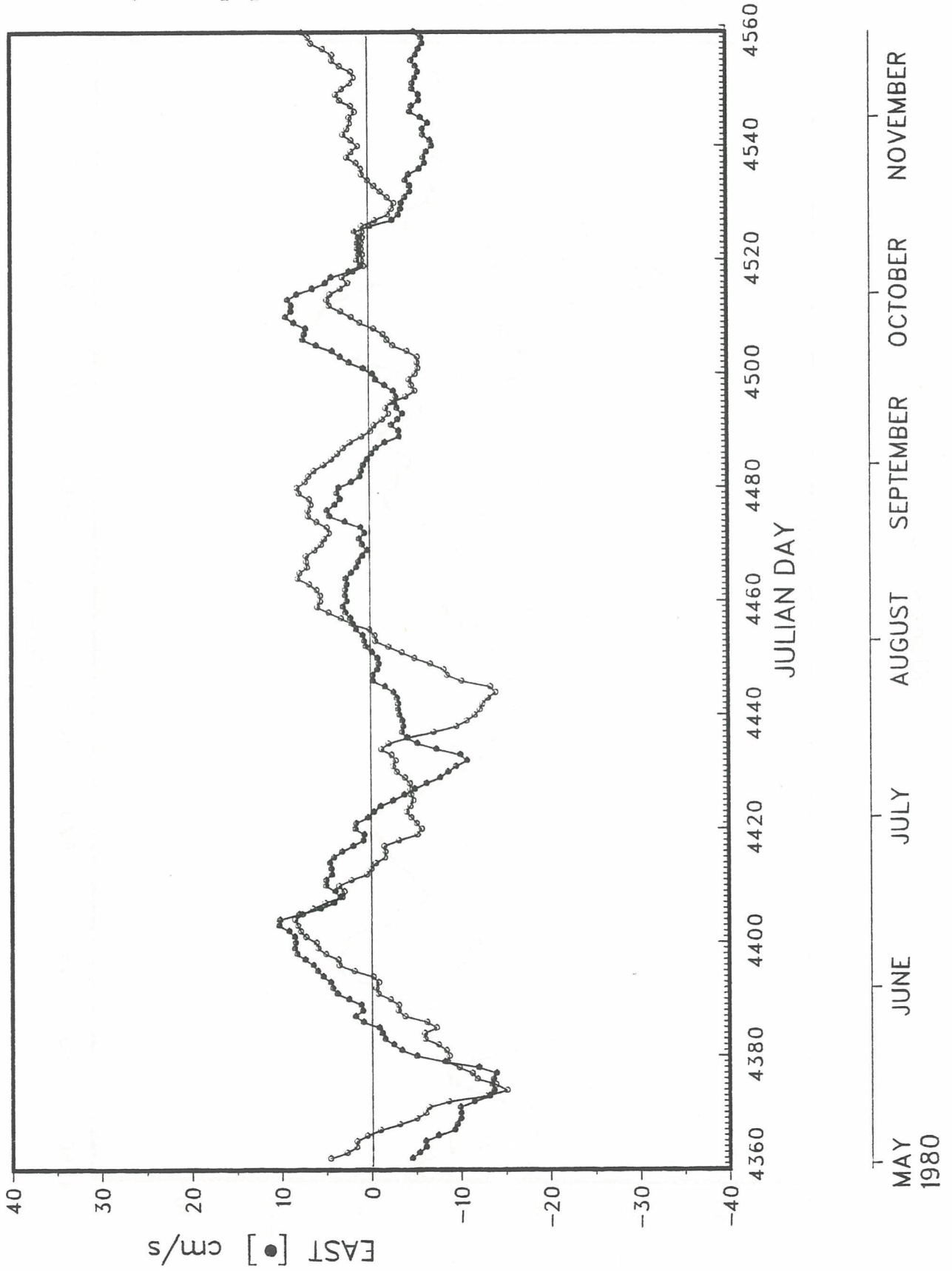
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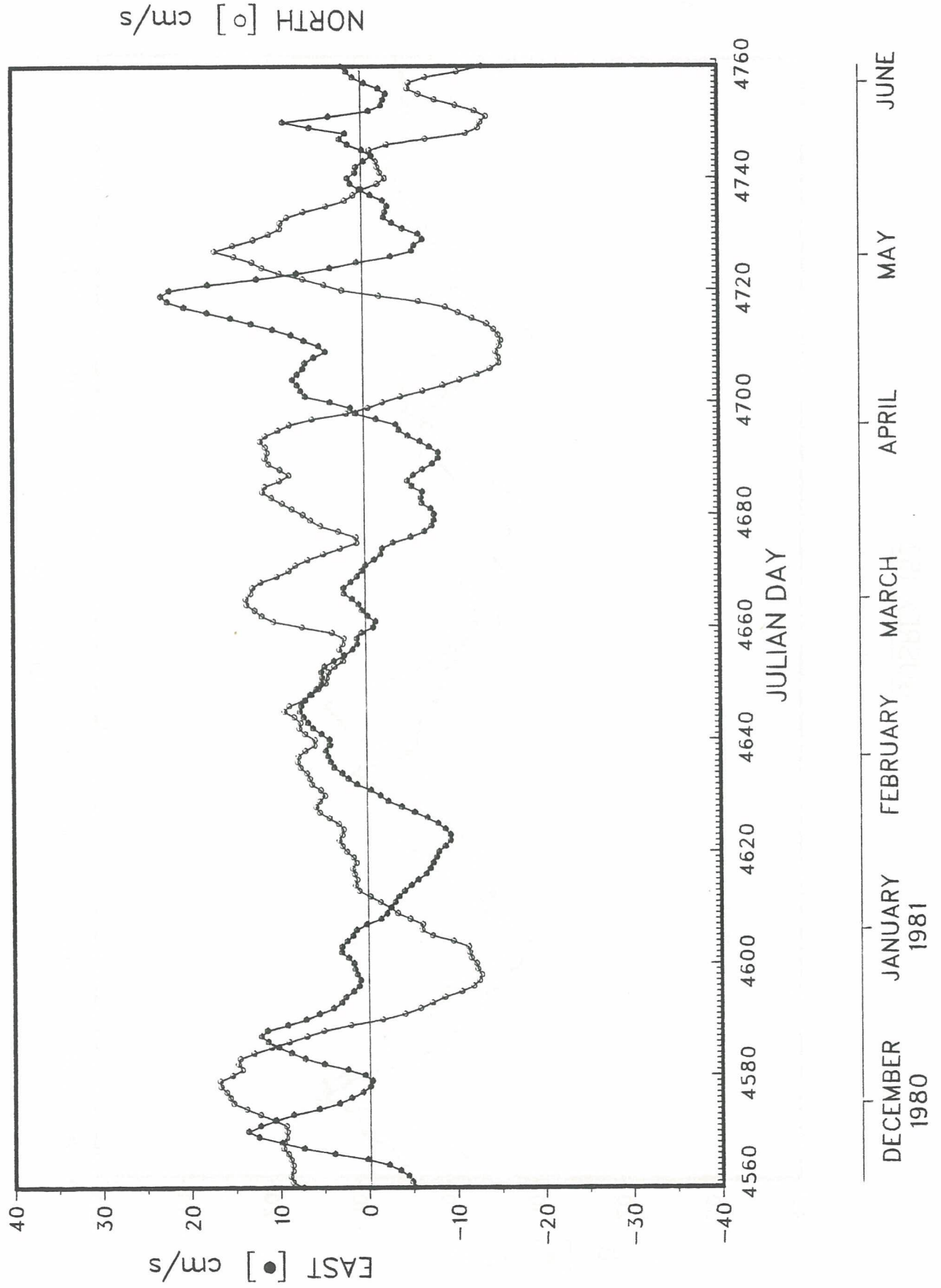
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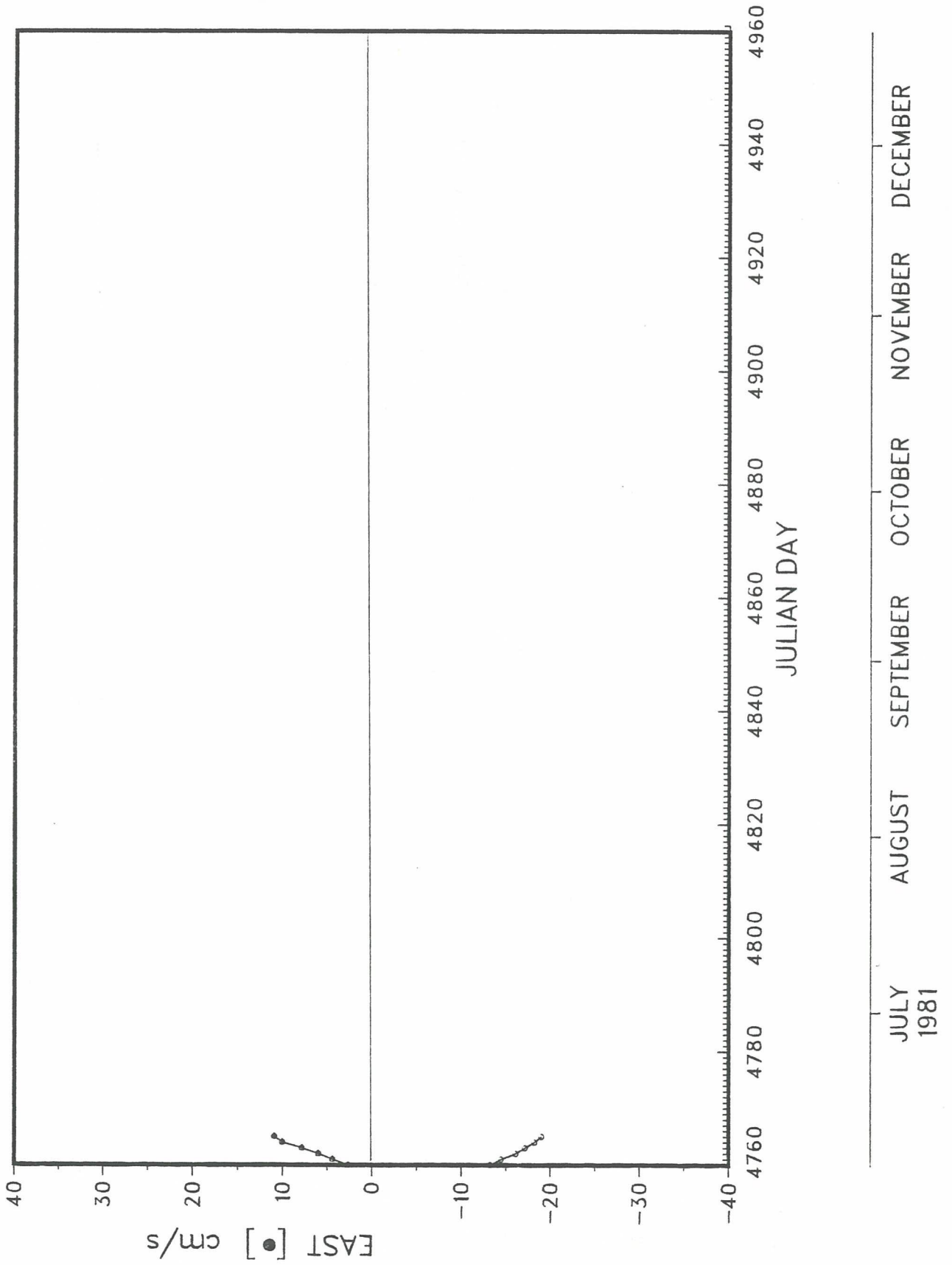
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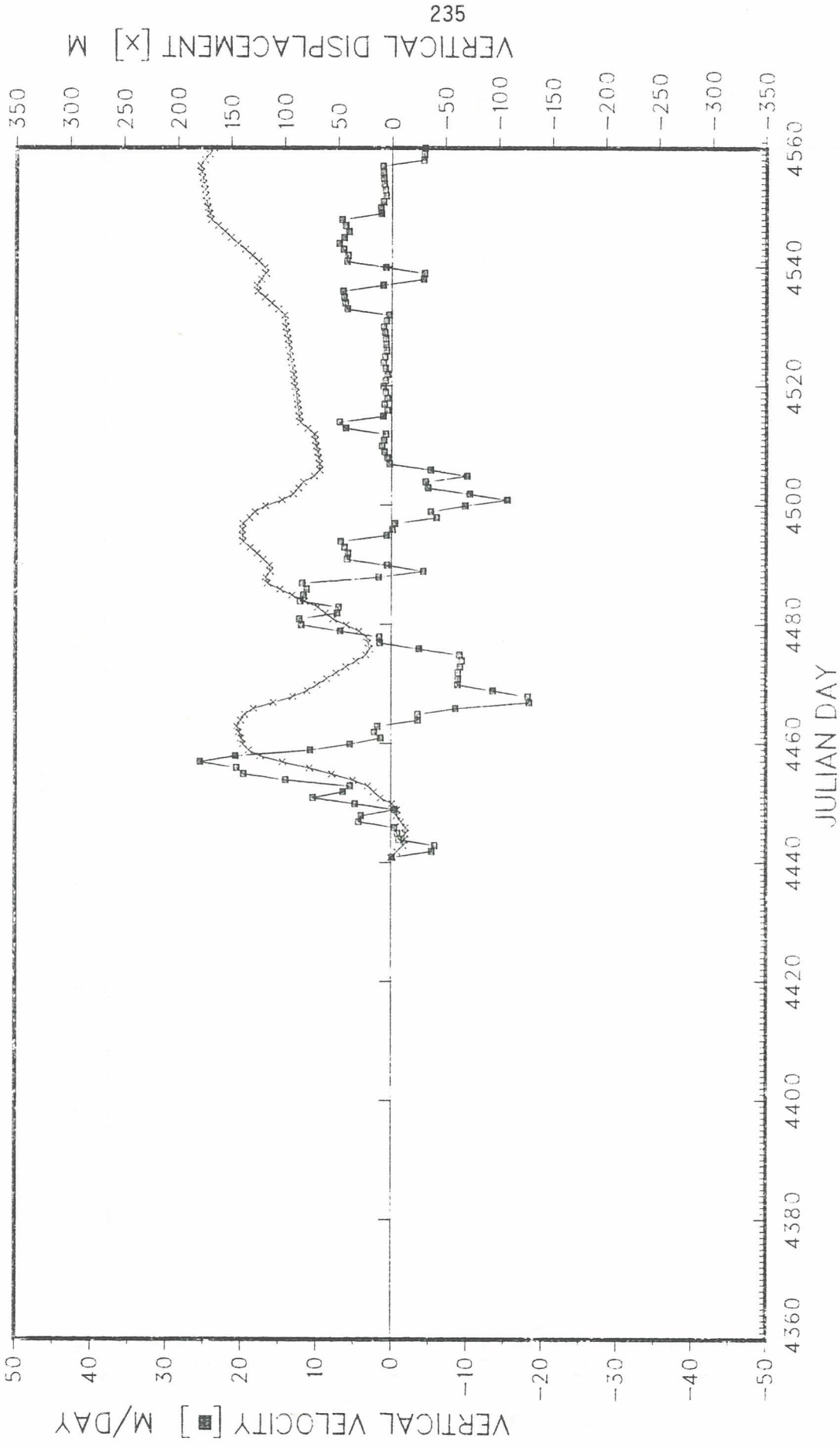
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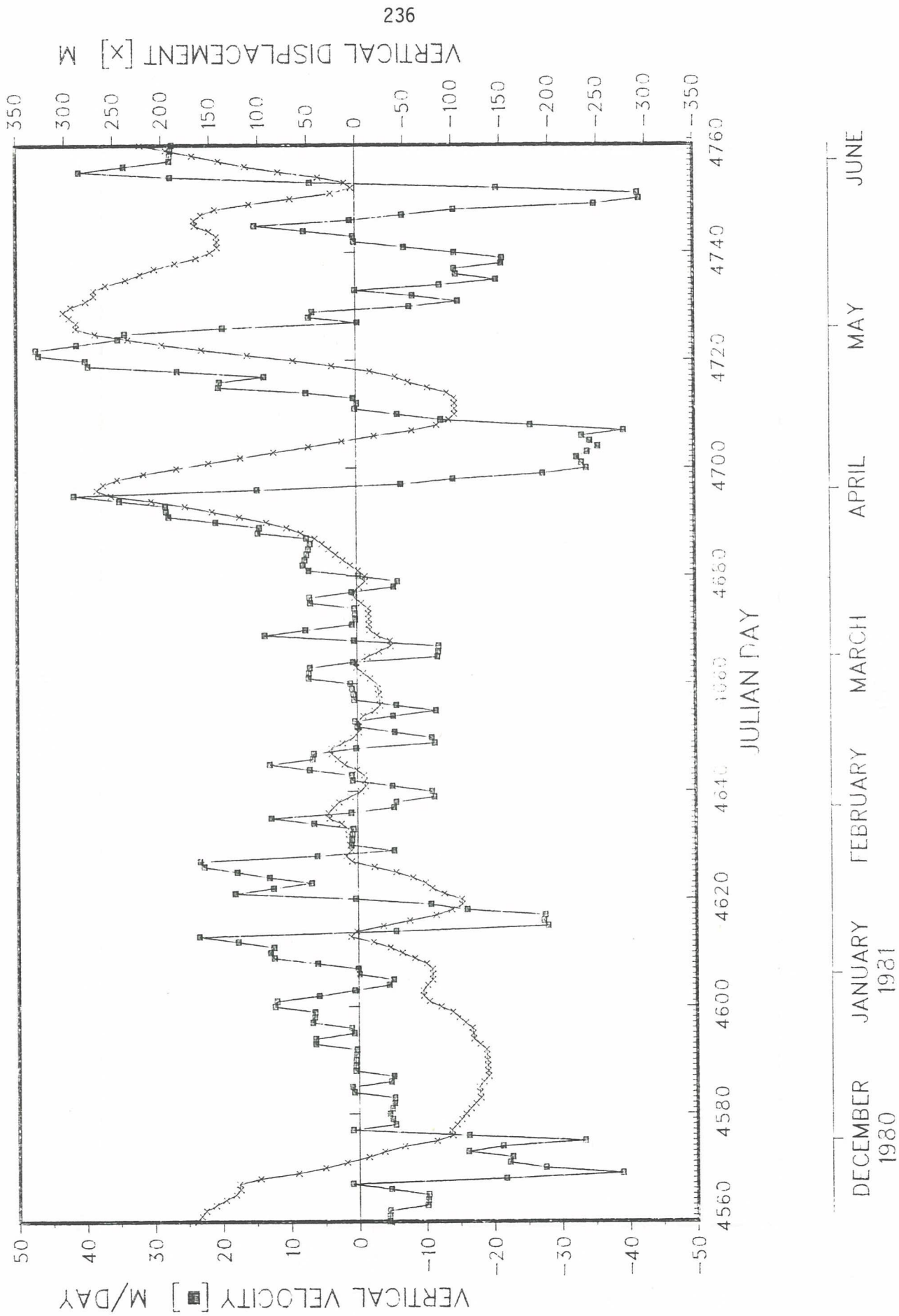
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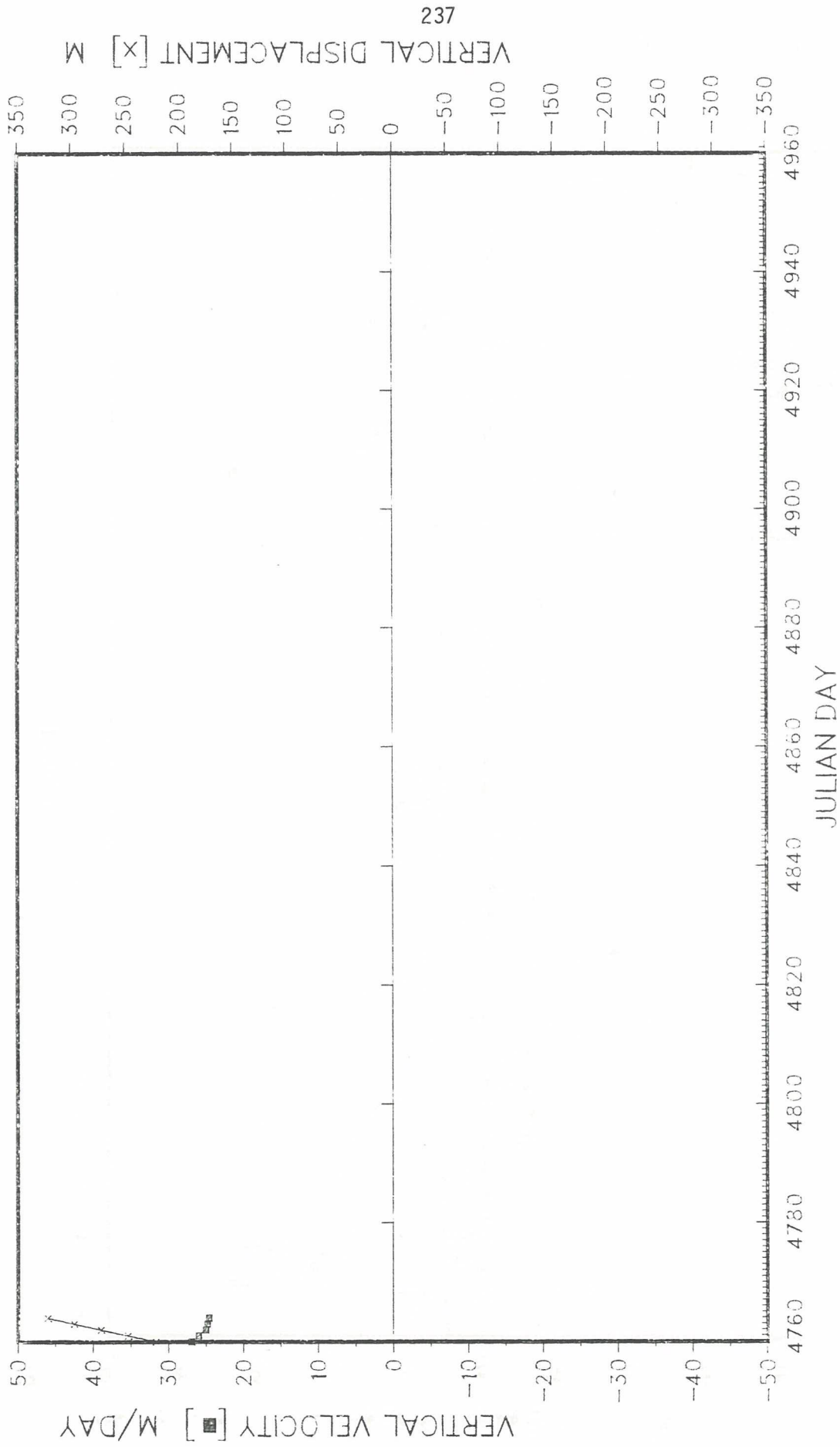
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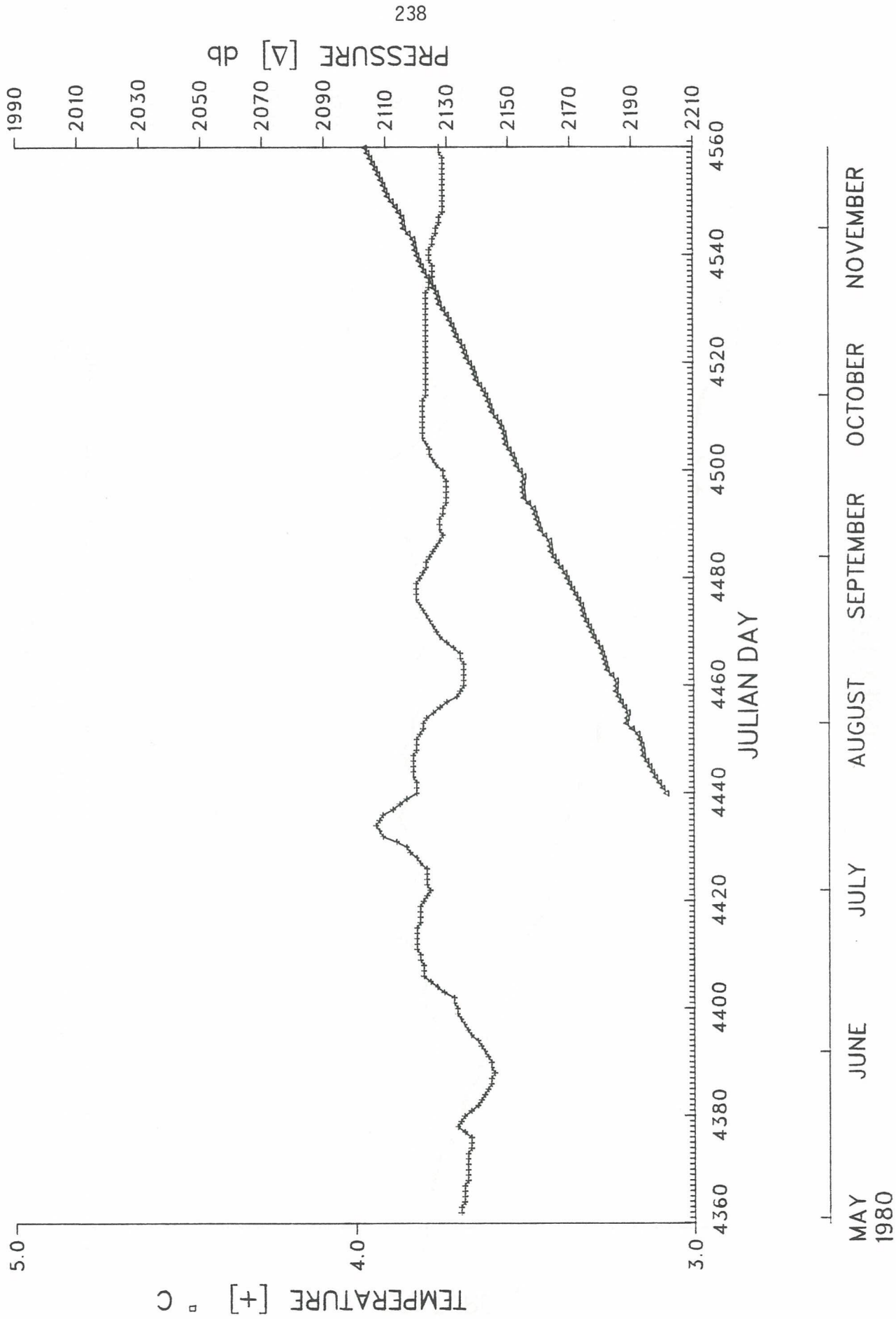
235



CUSREX 153

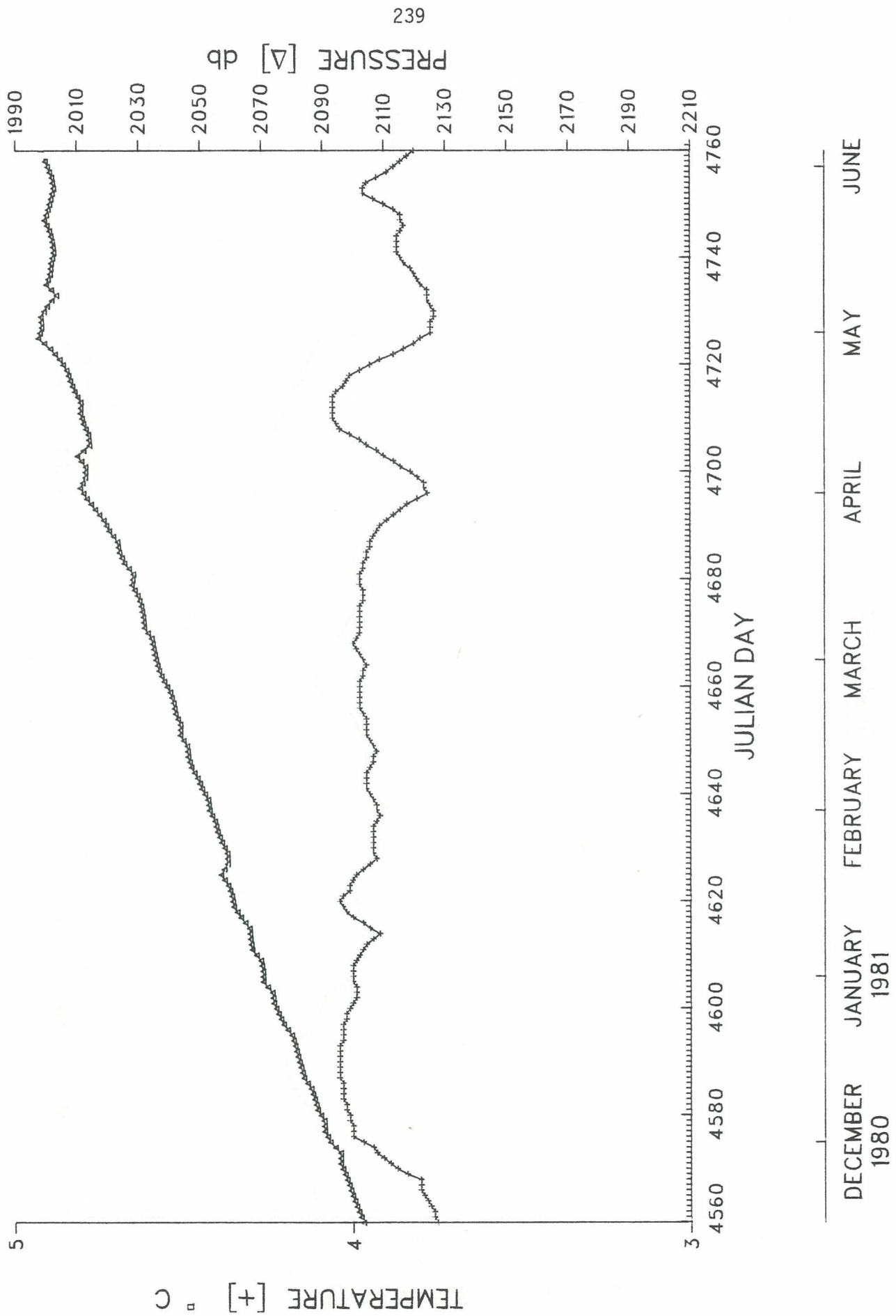


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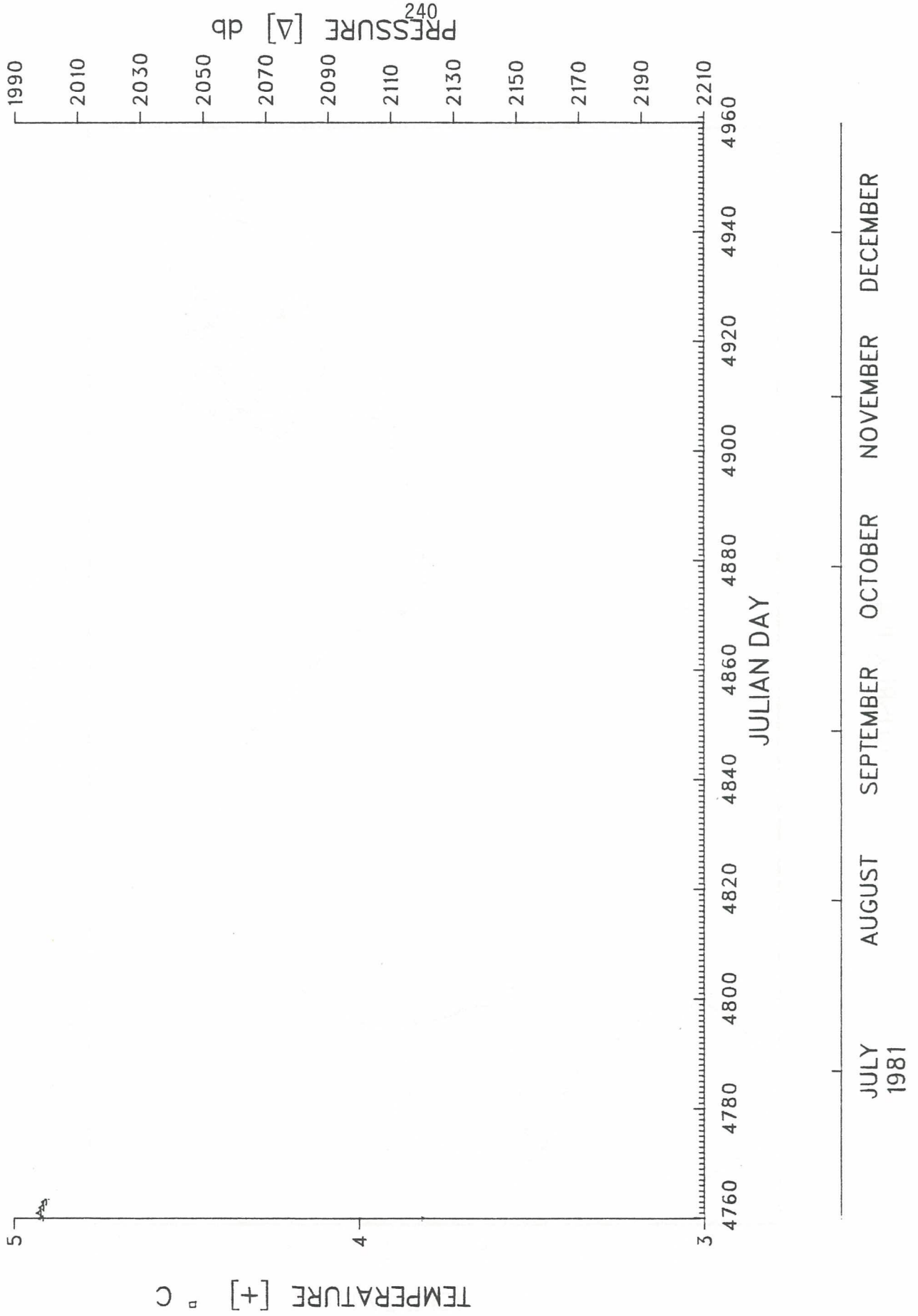


238

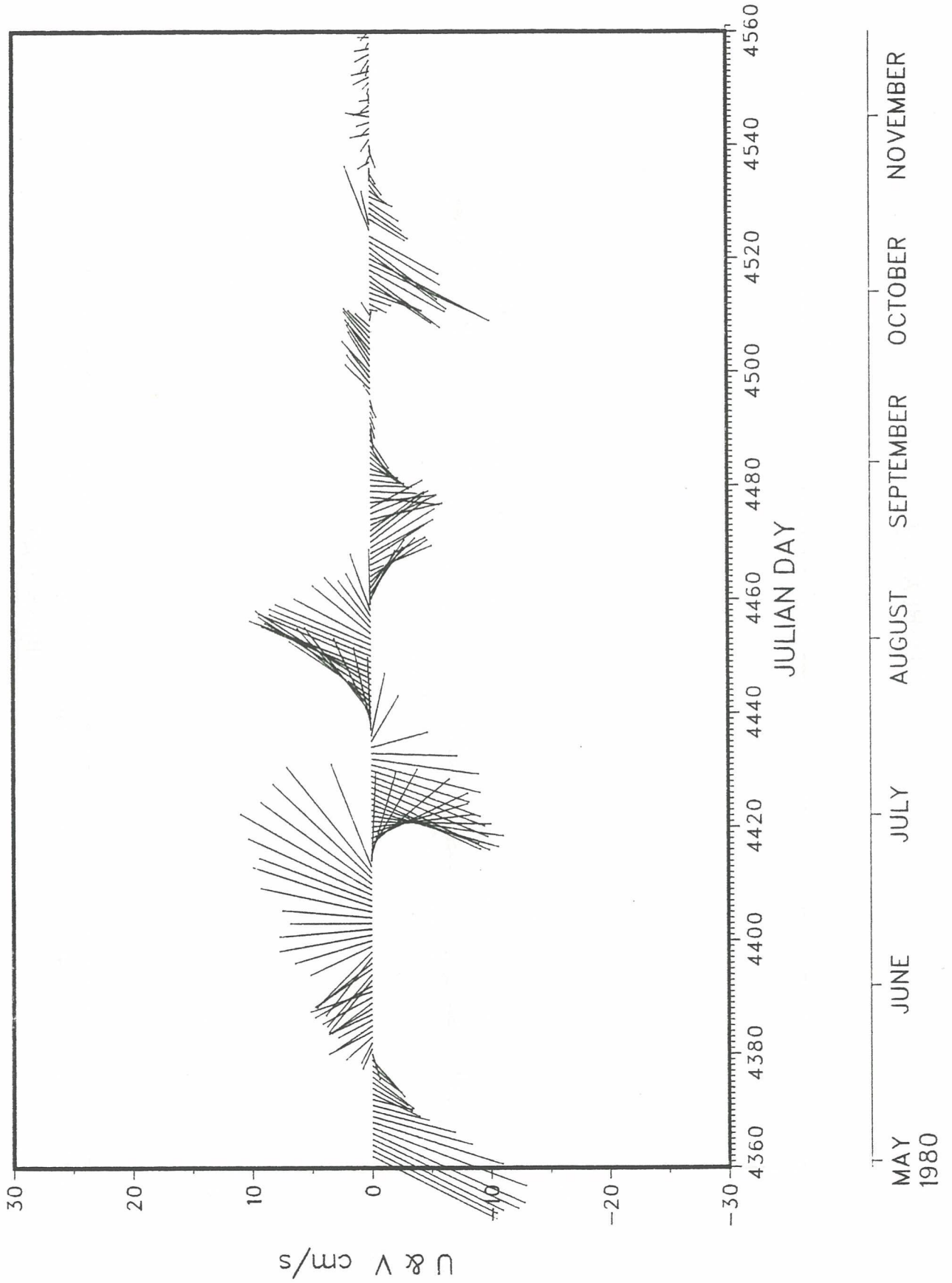
GUSREX 153



GUSREX 153



GUSREX 154



GUSREX 154

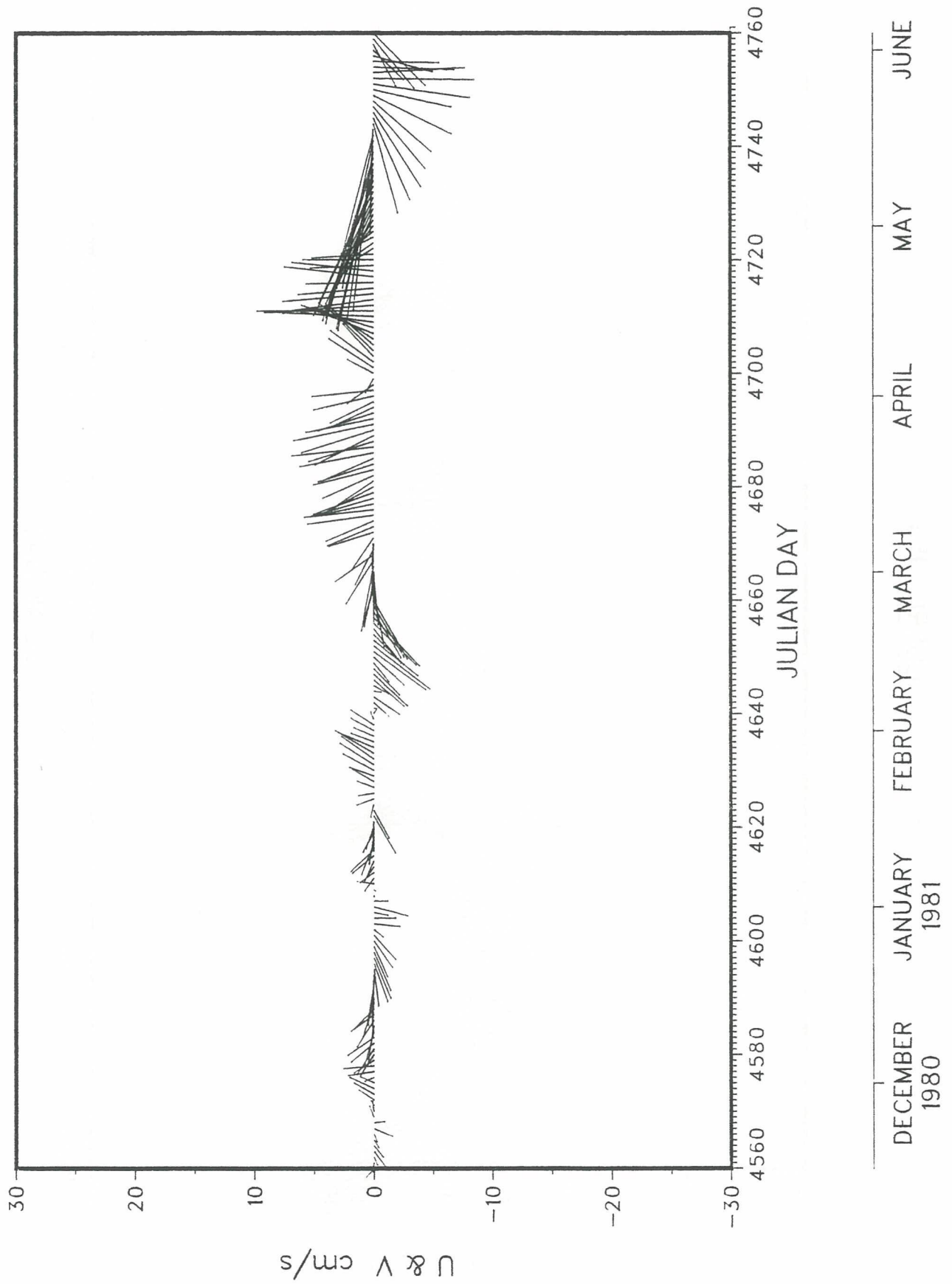
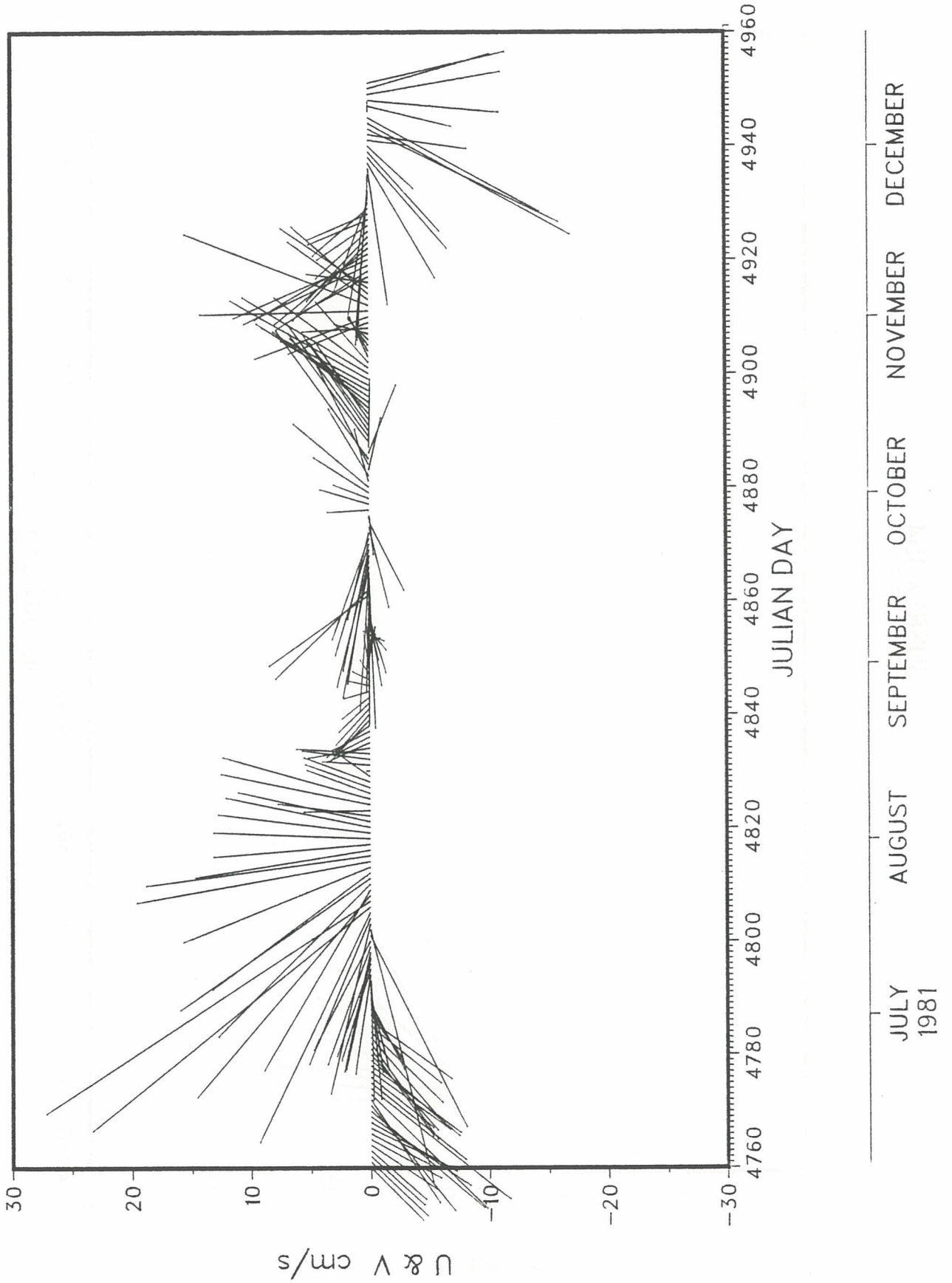
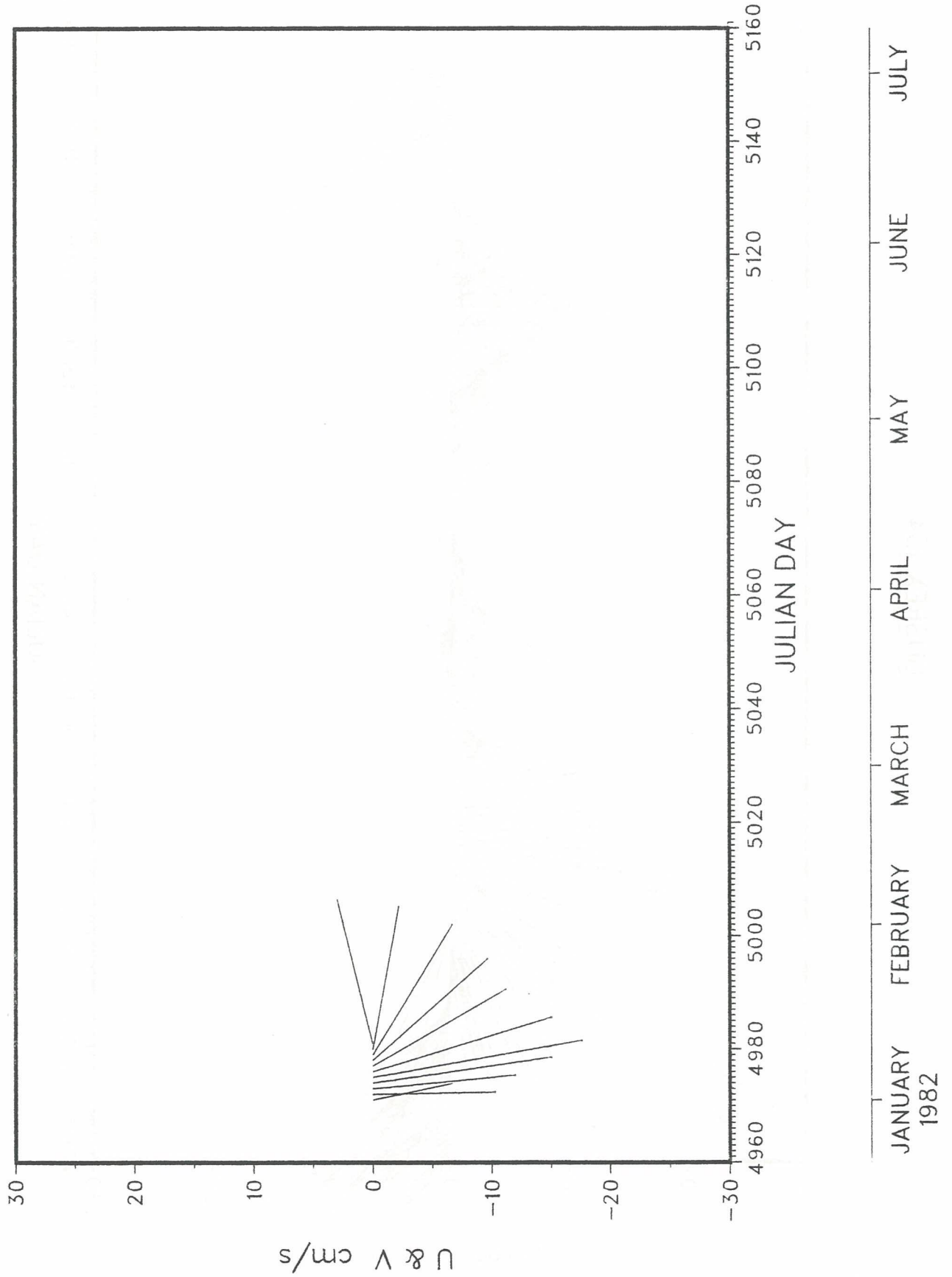


PLATE 100

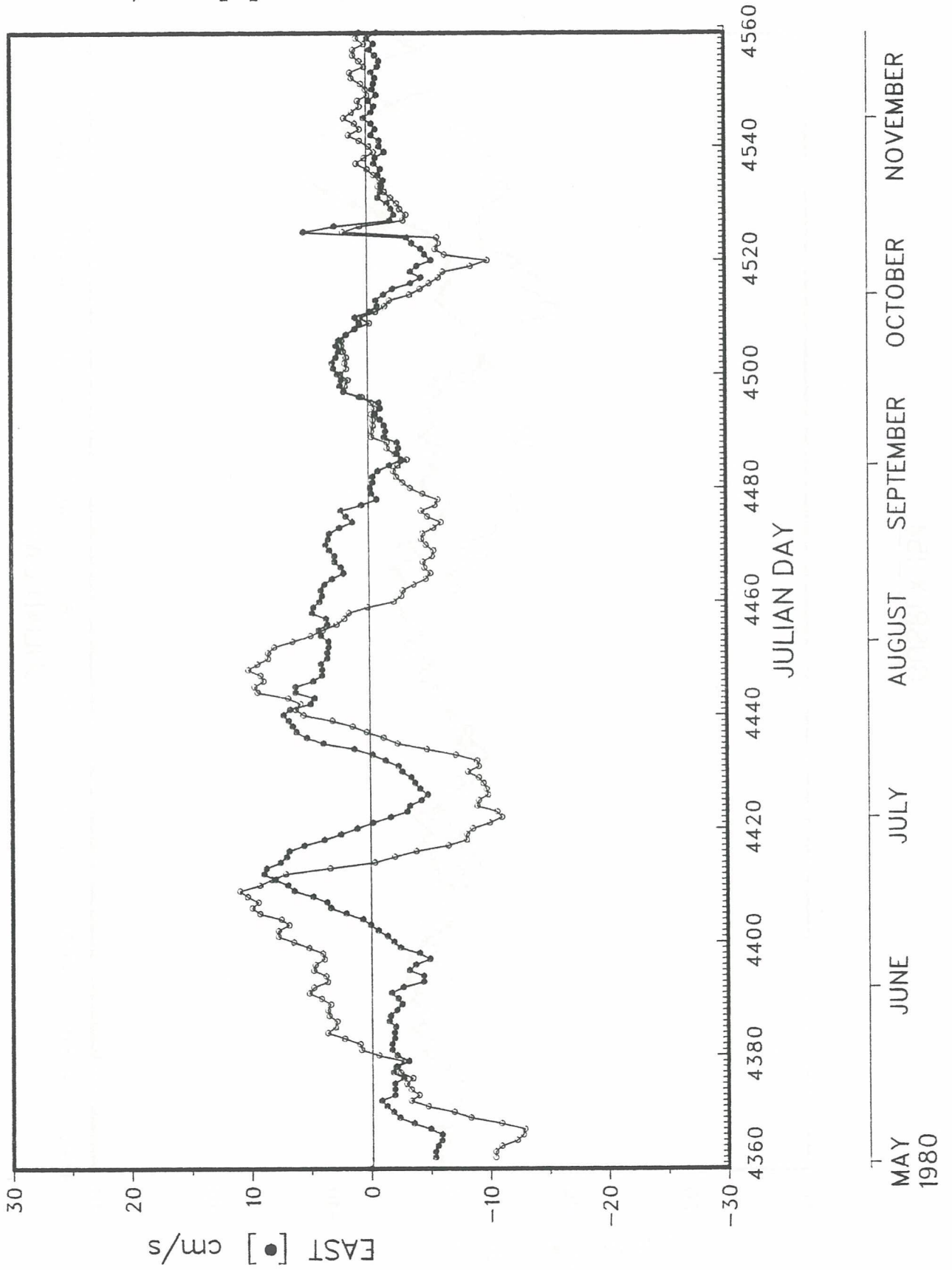
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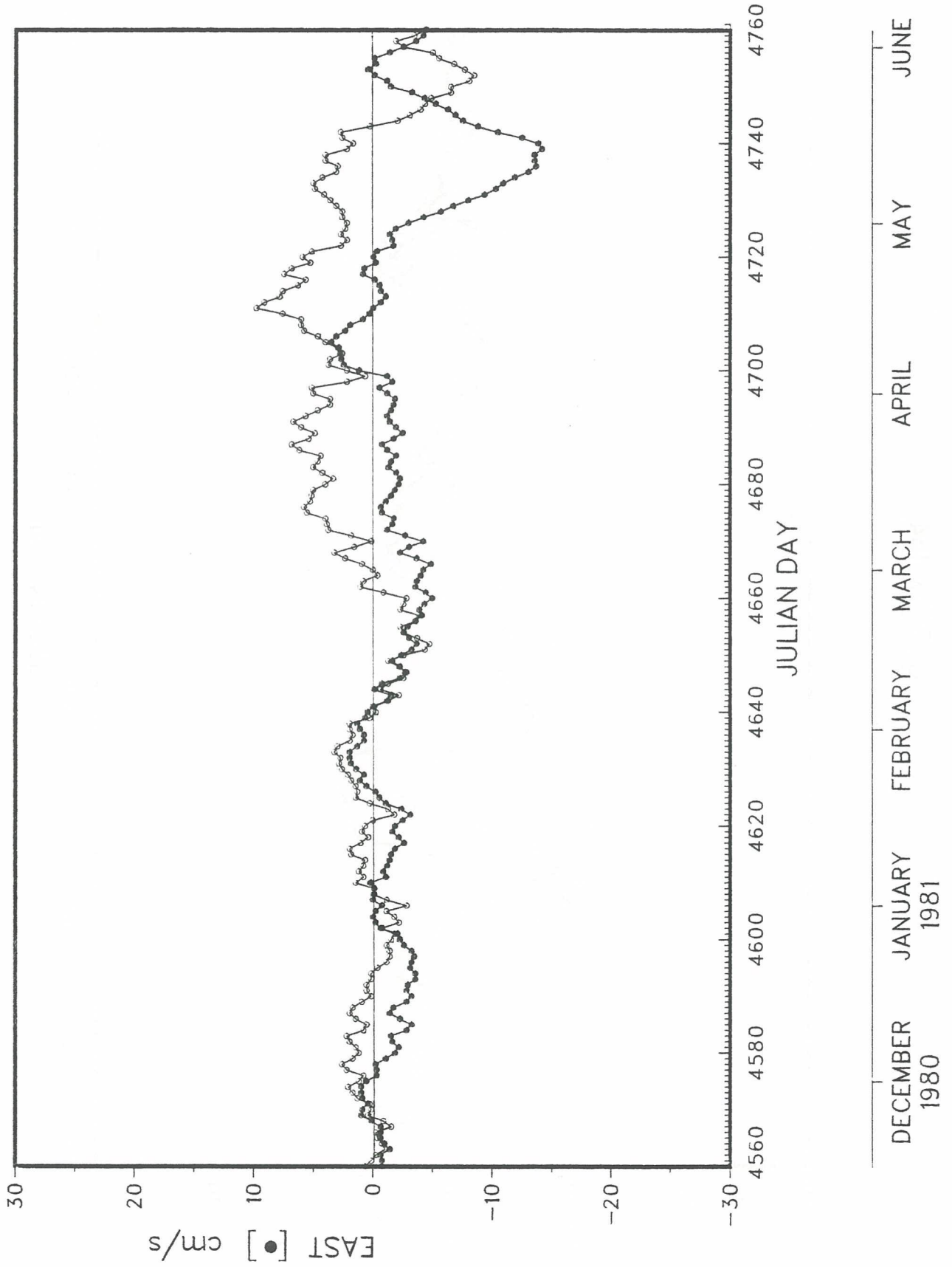
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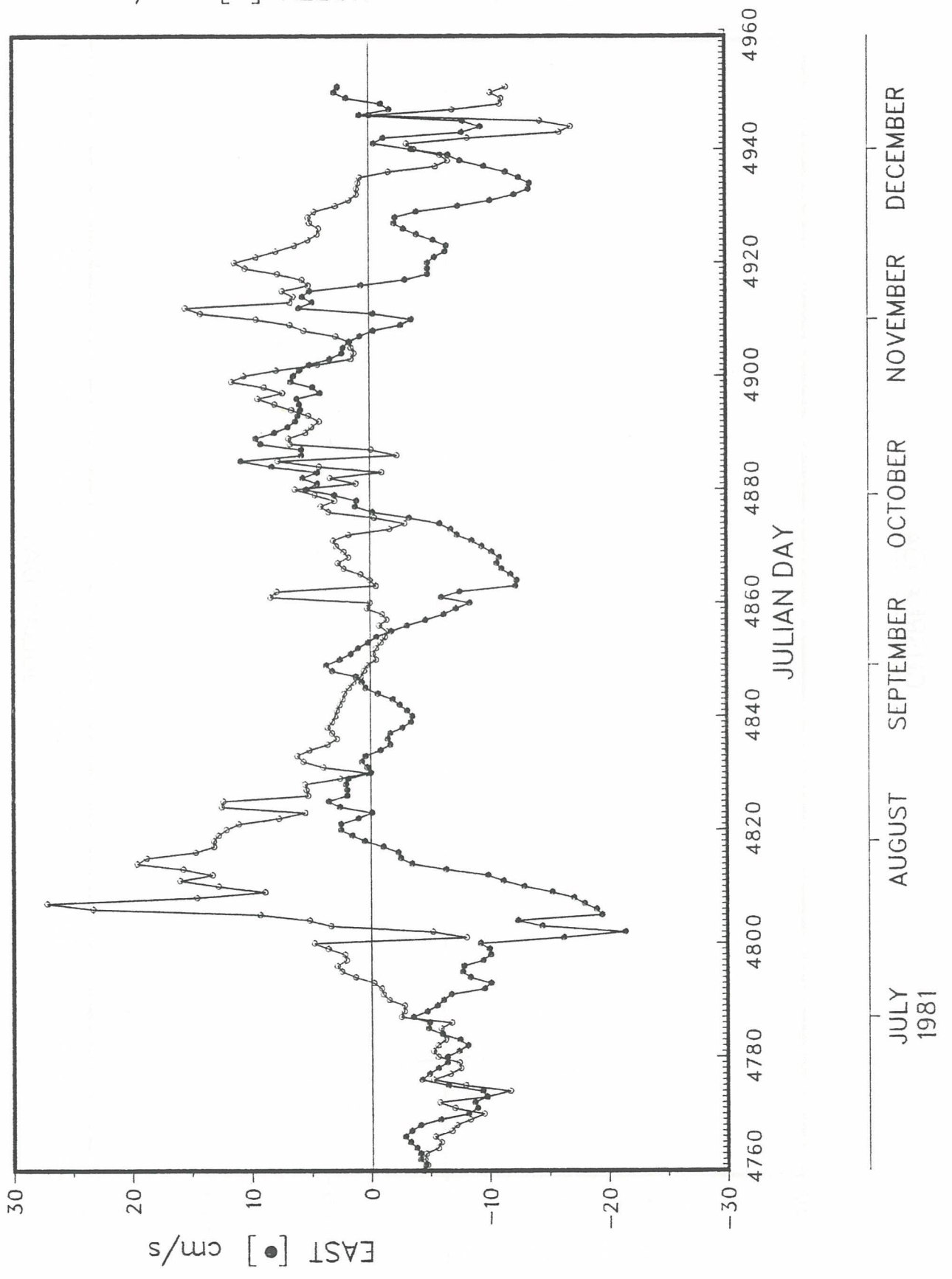
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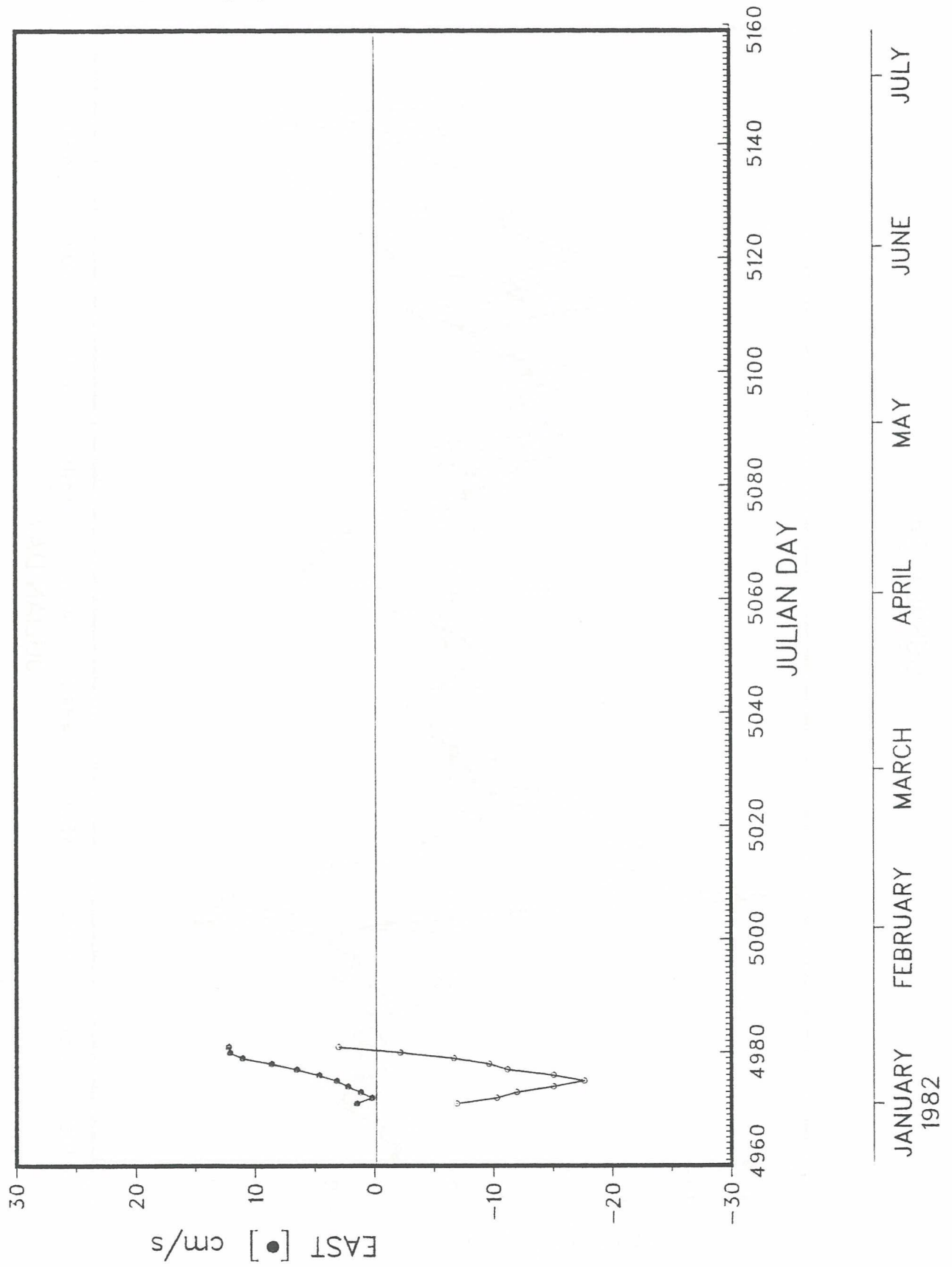
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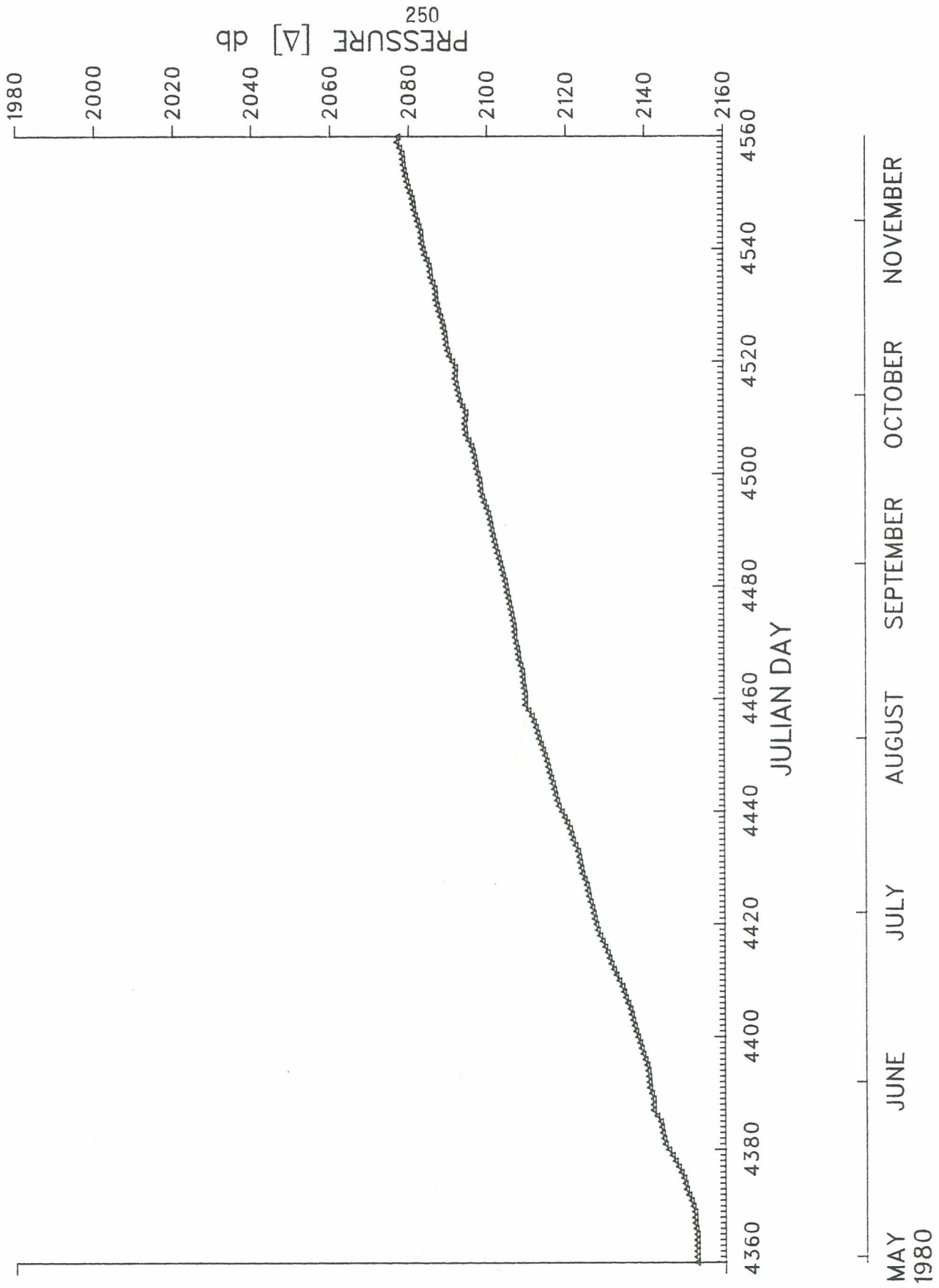
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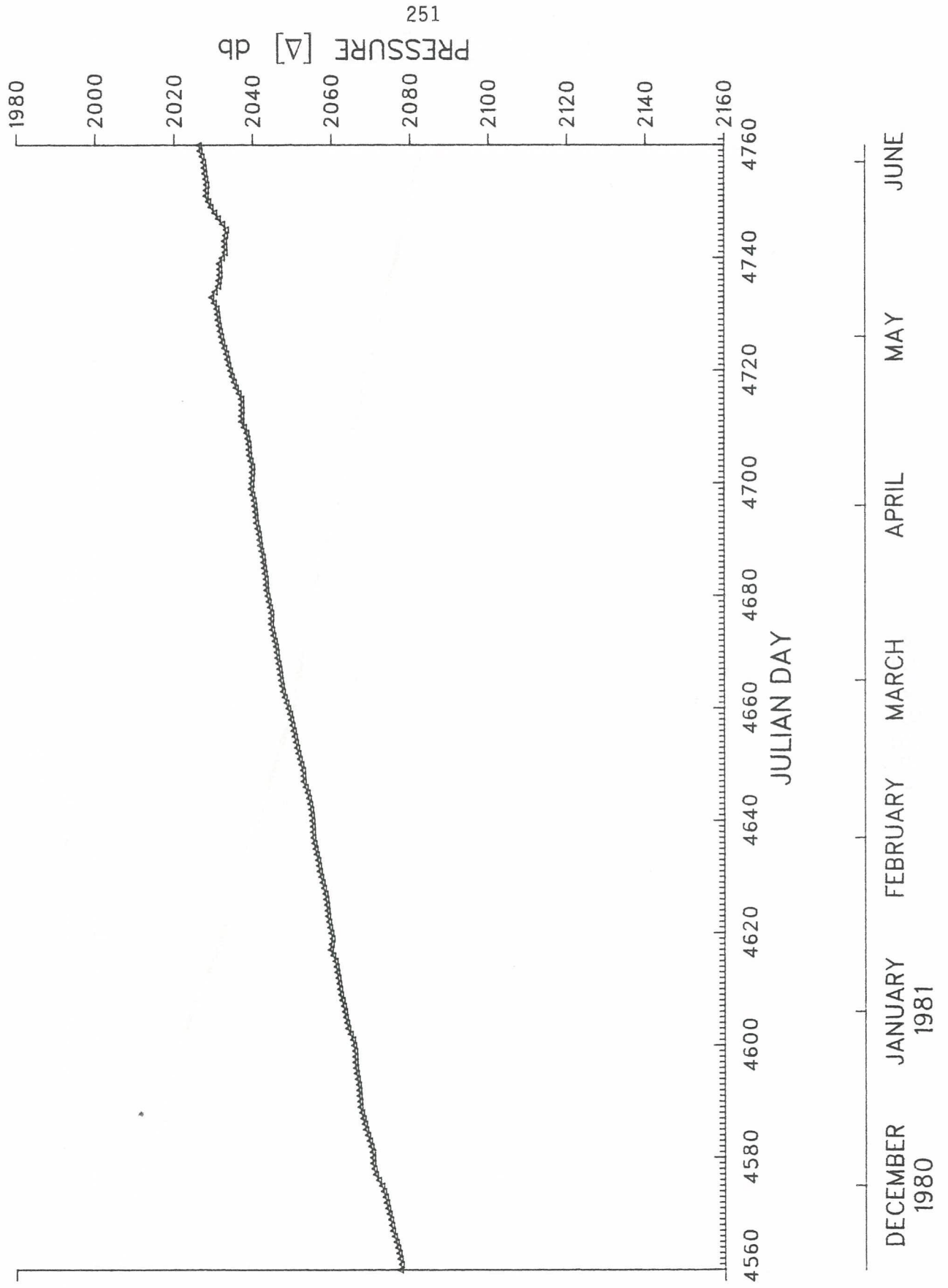
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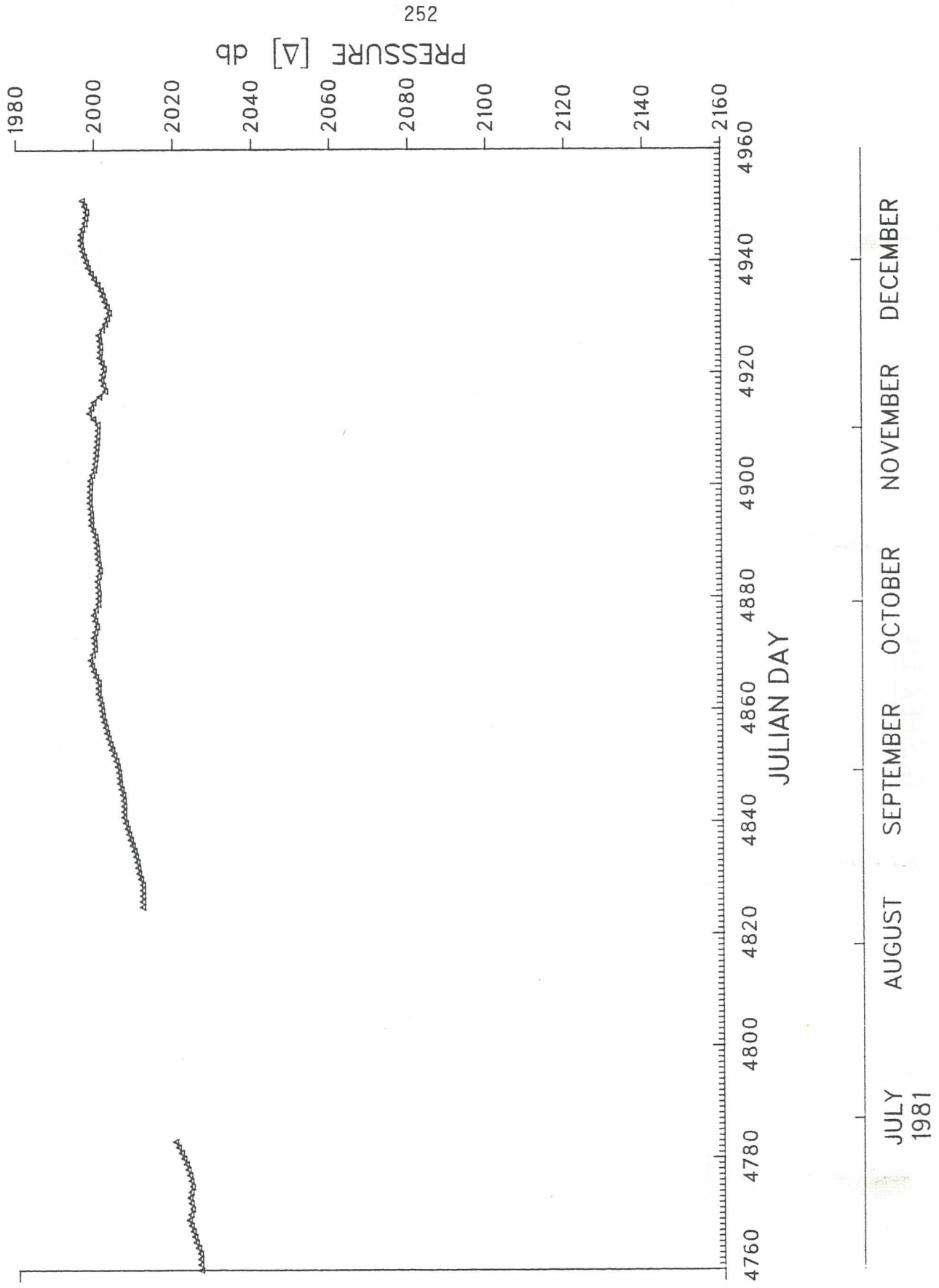
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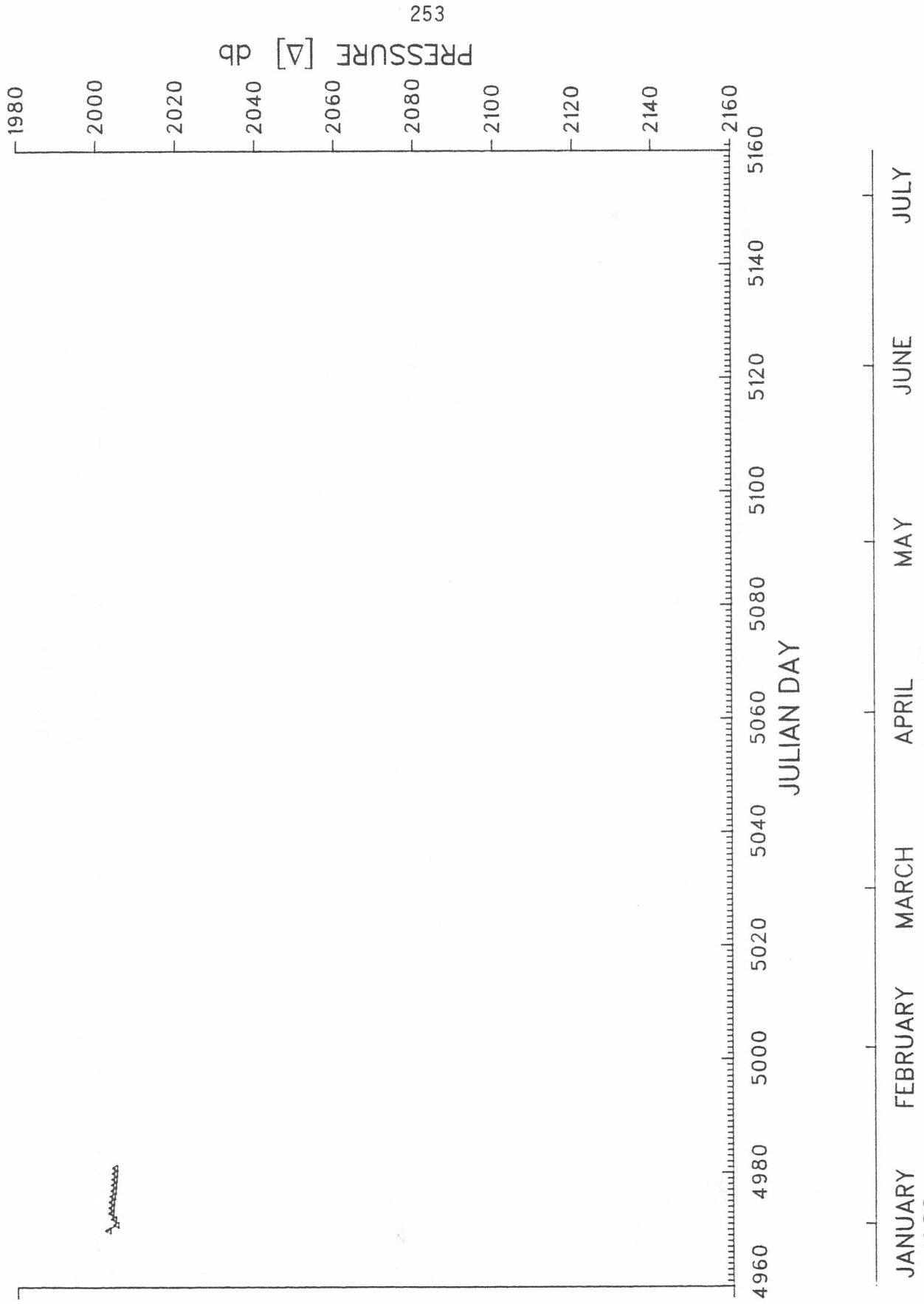
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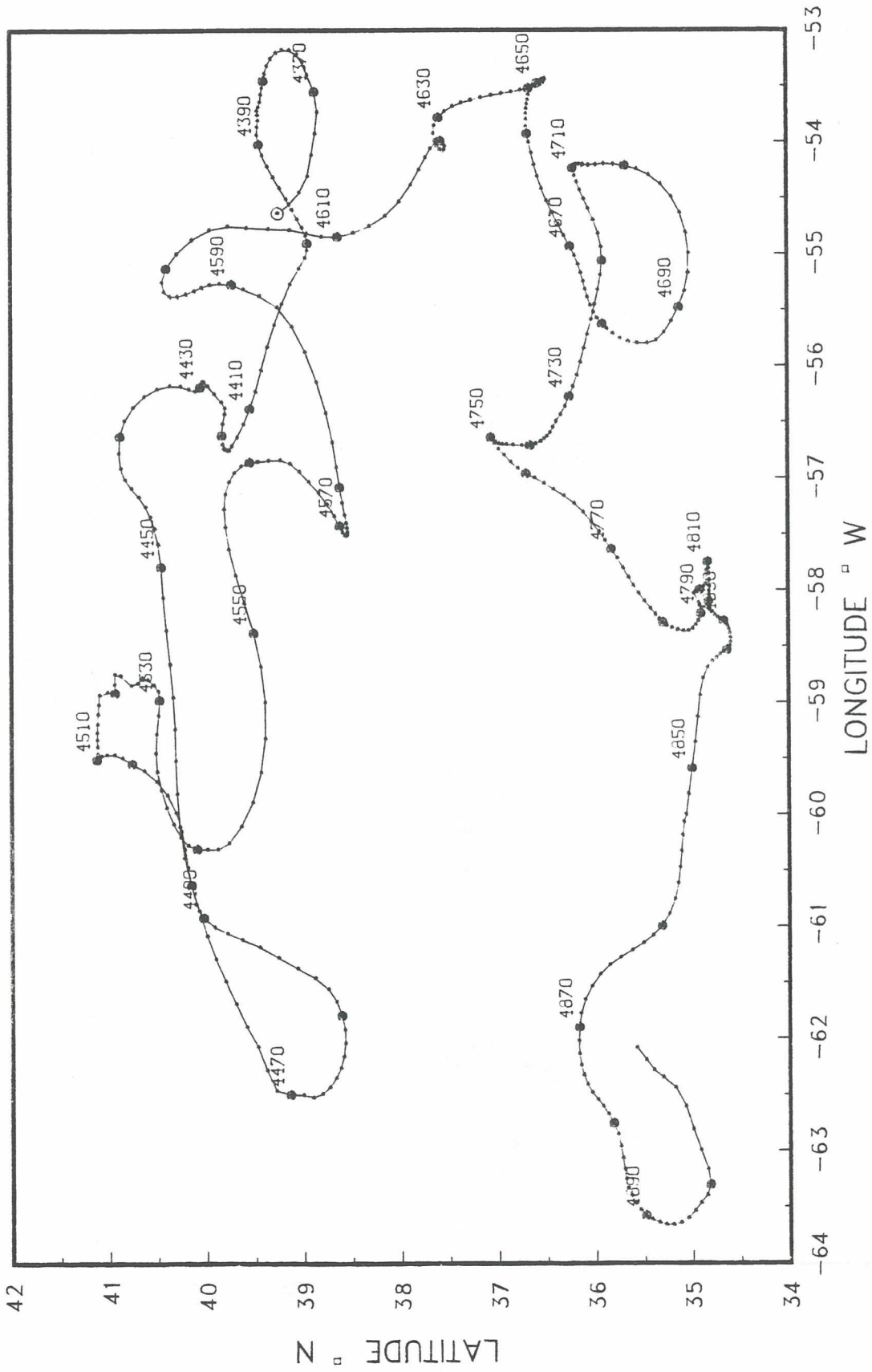
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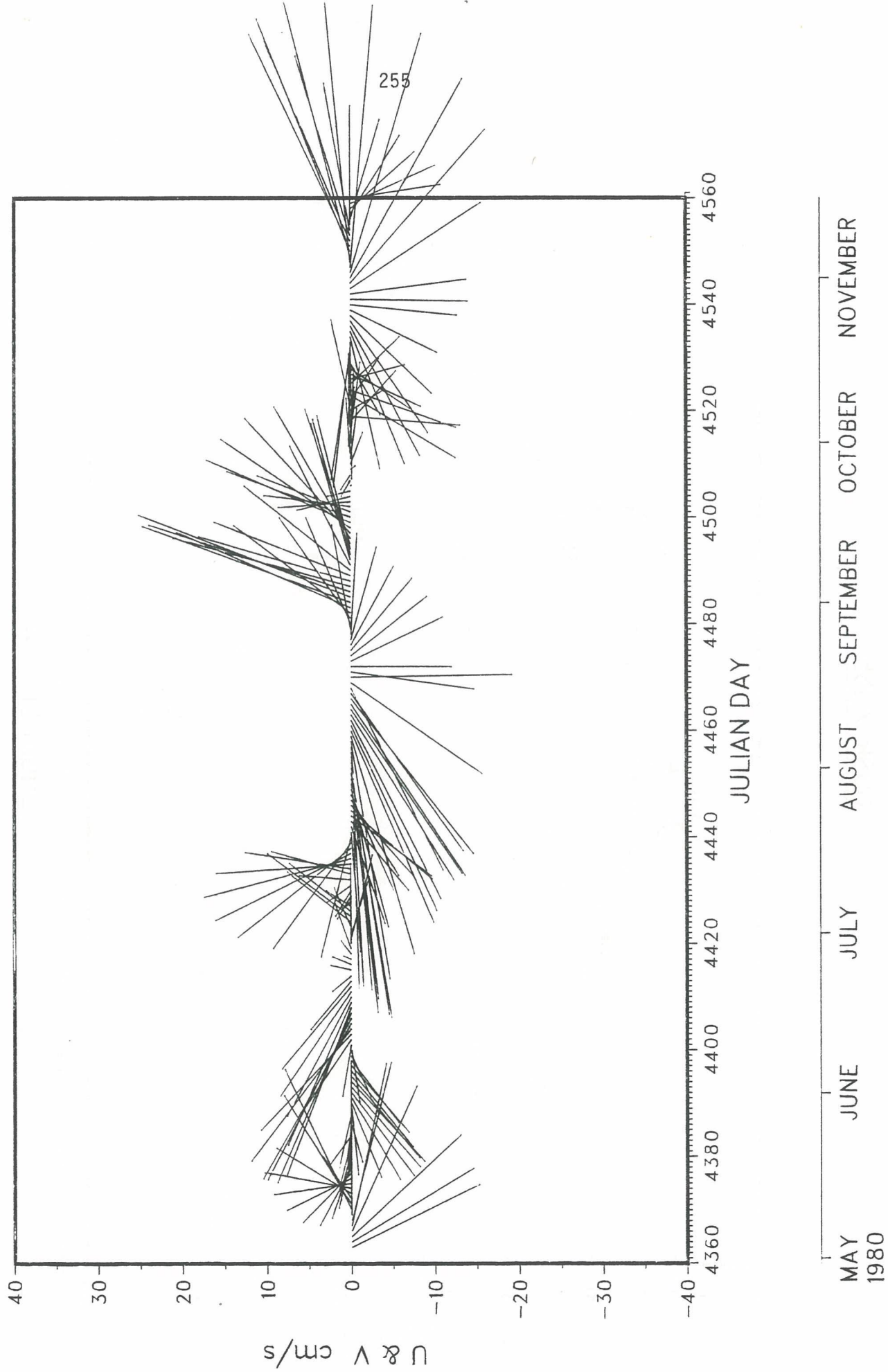
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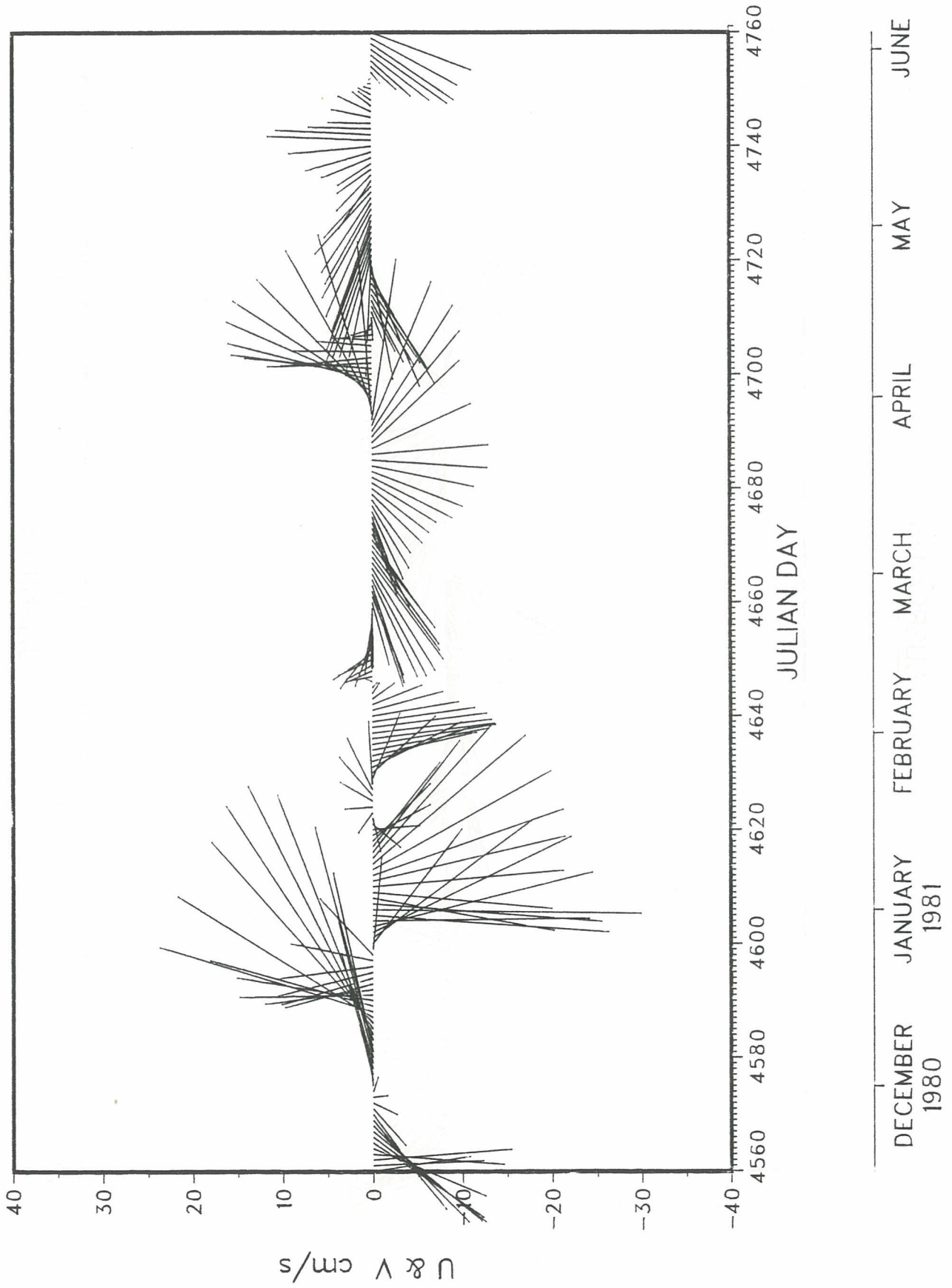
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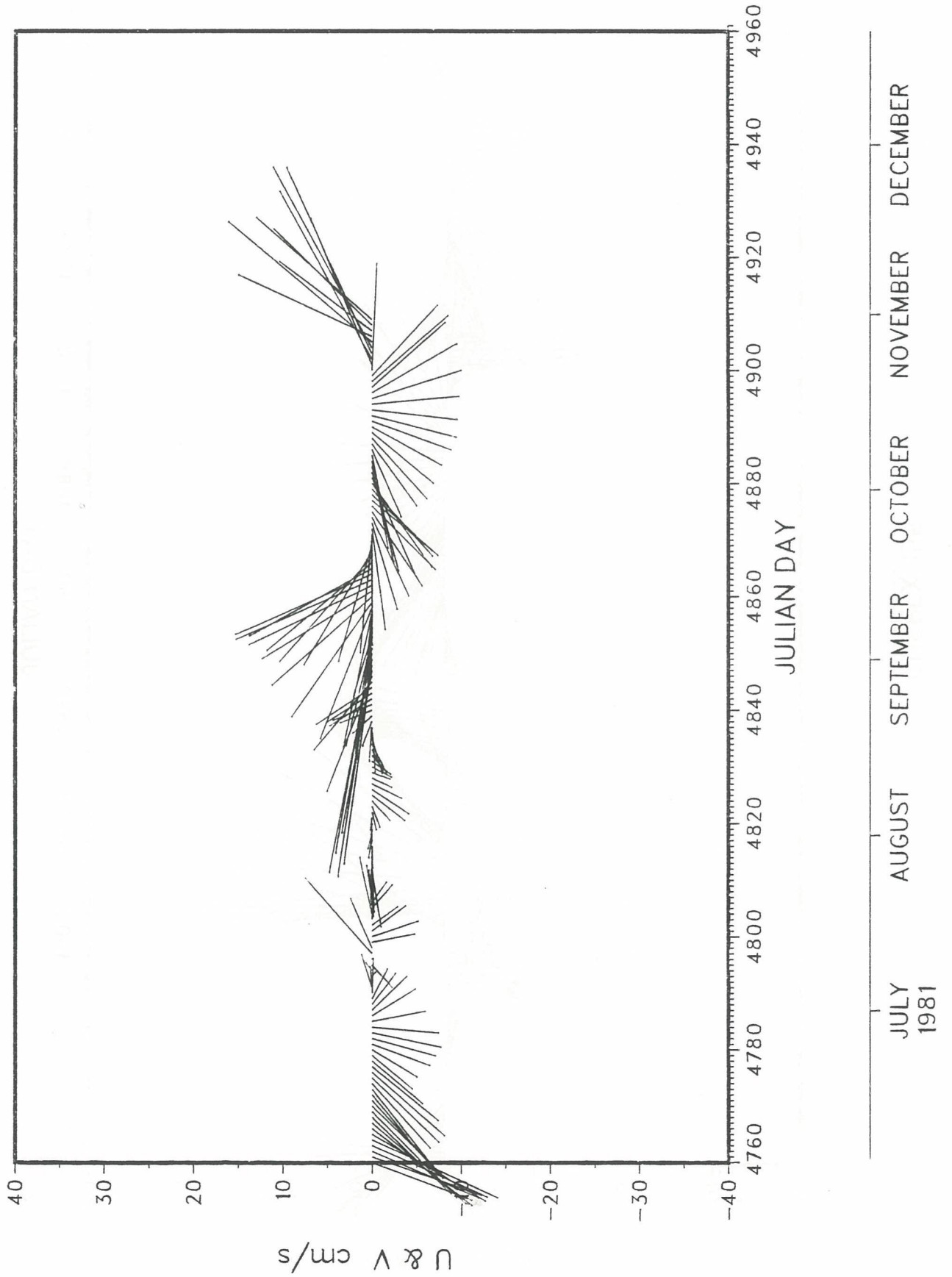
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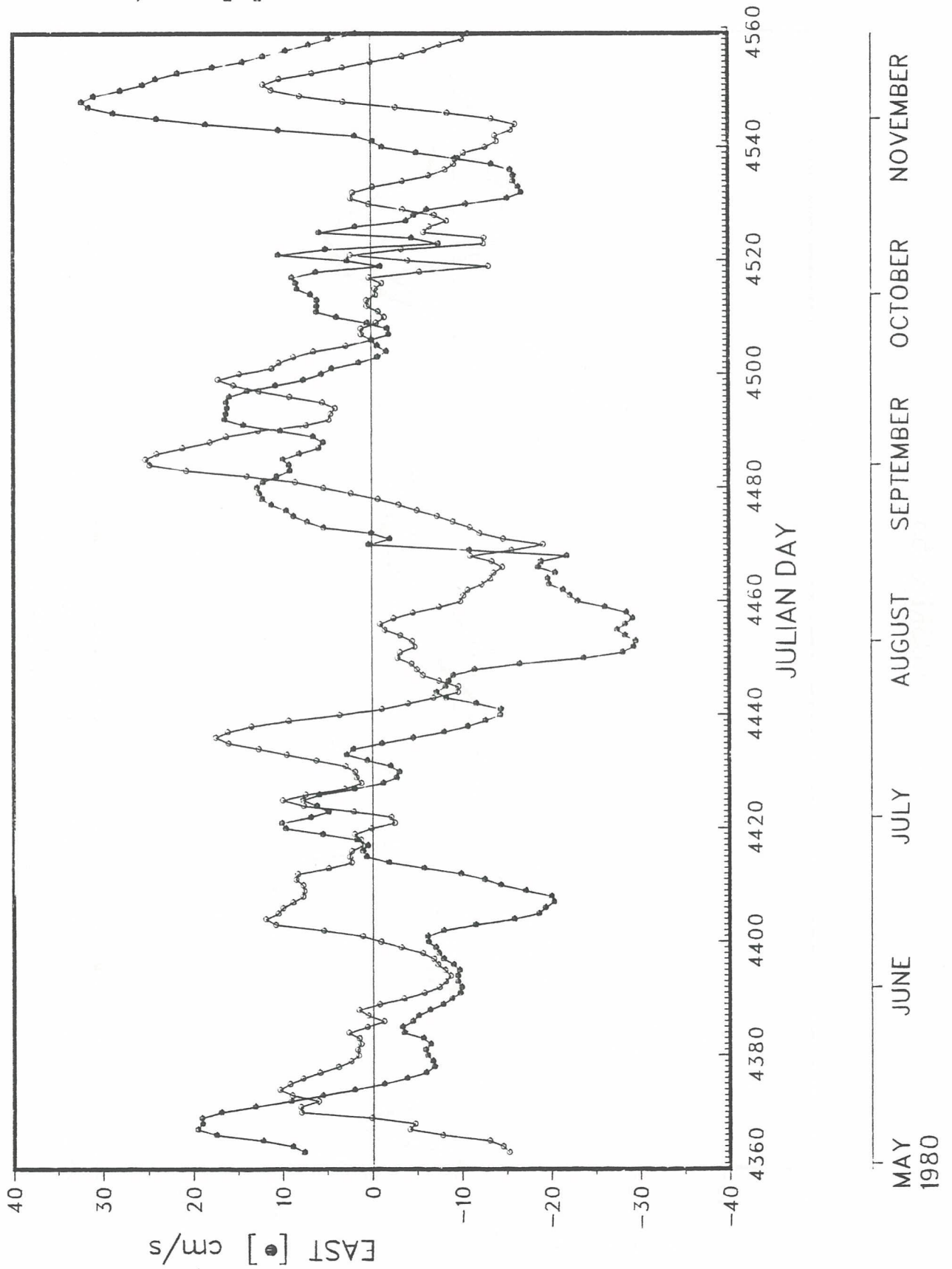
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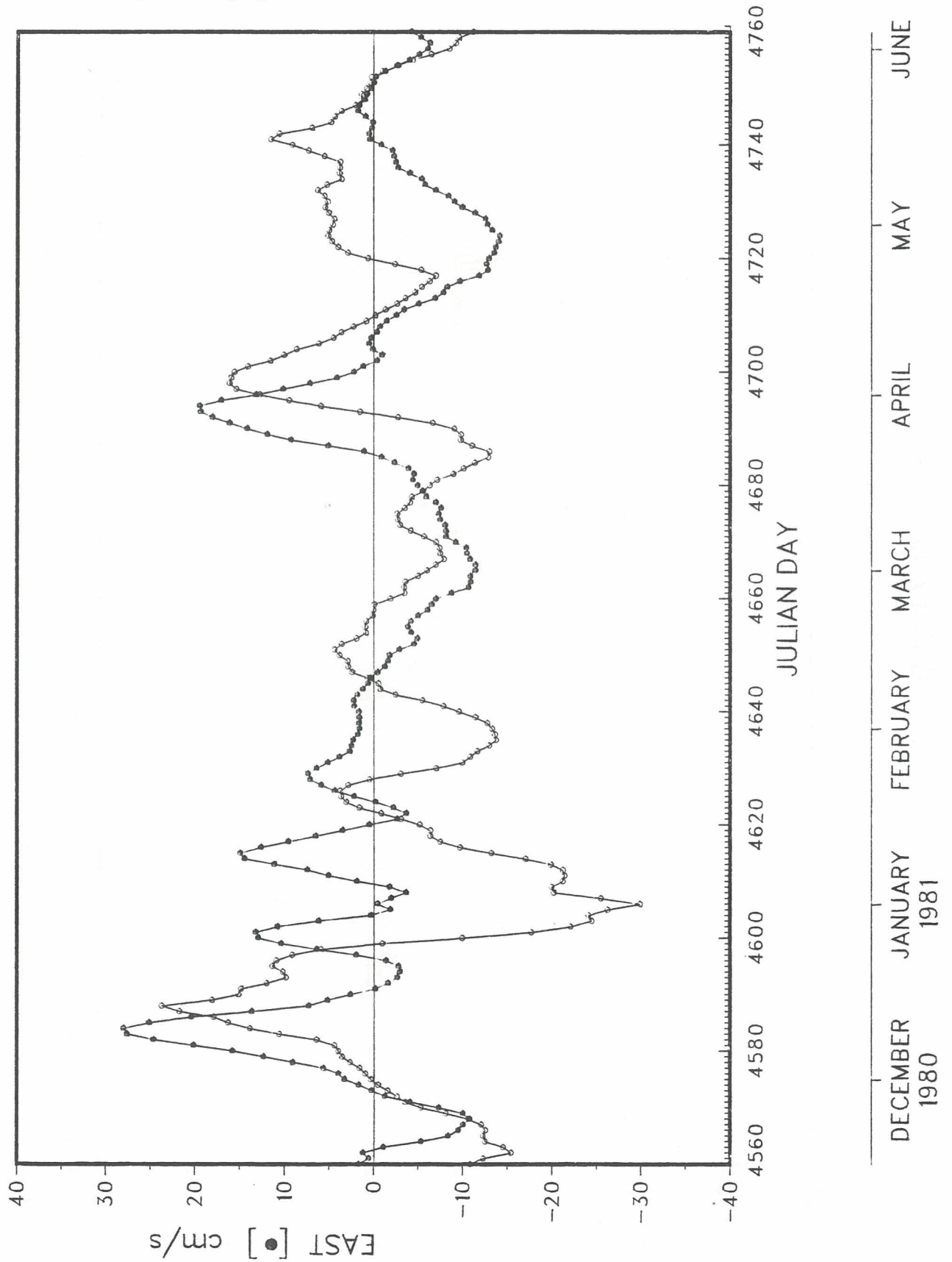
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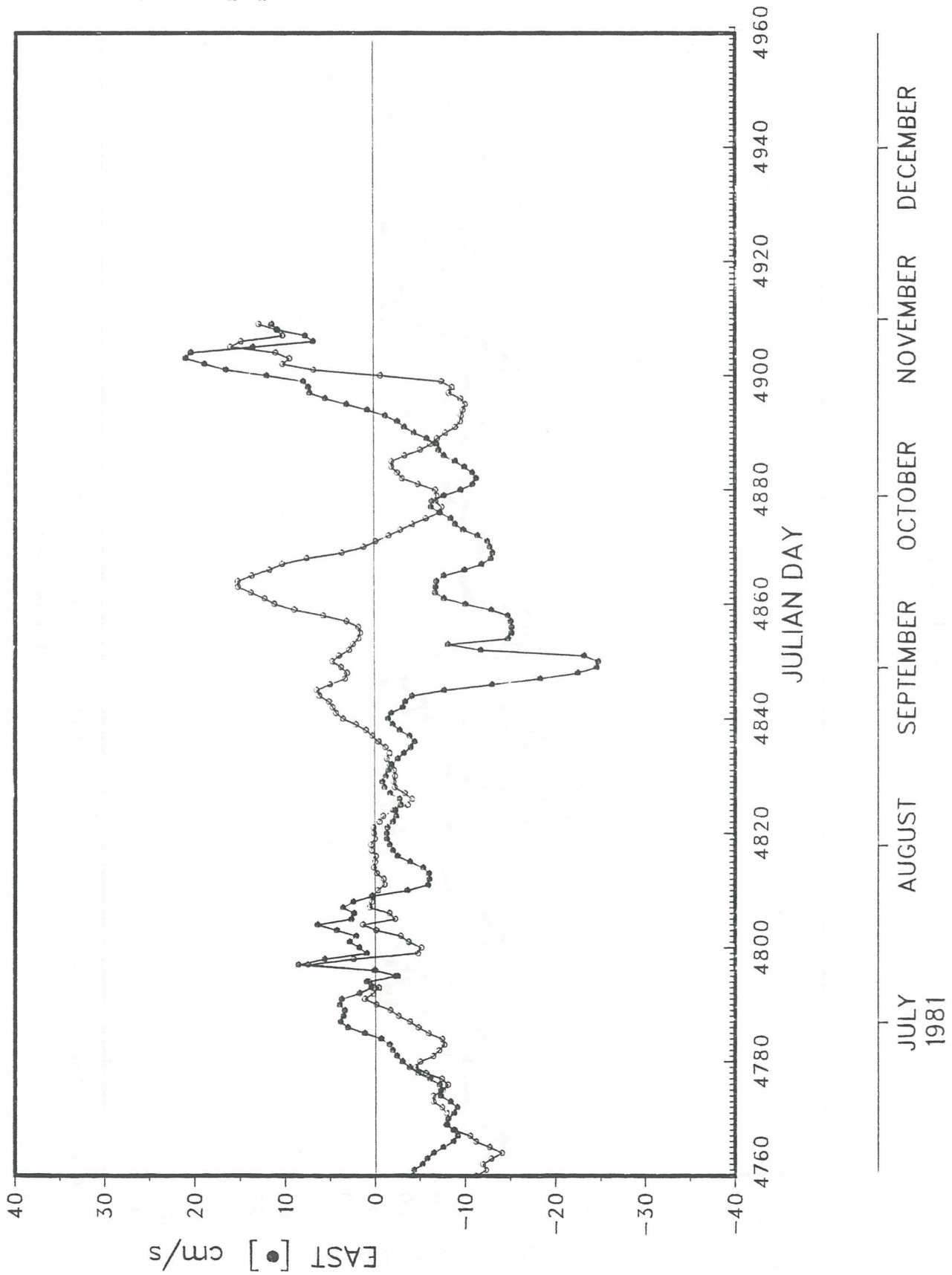
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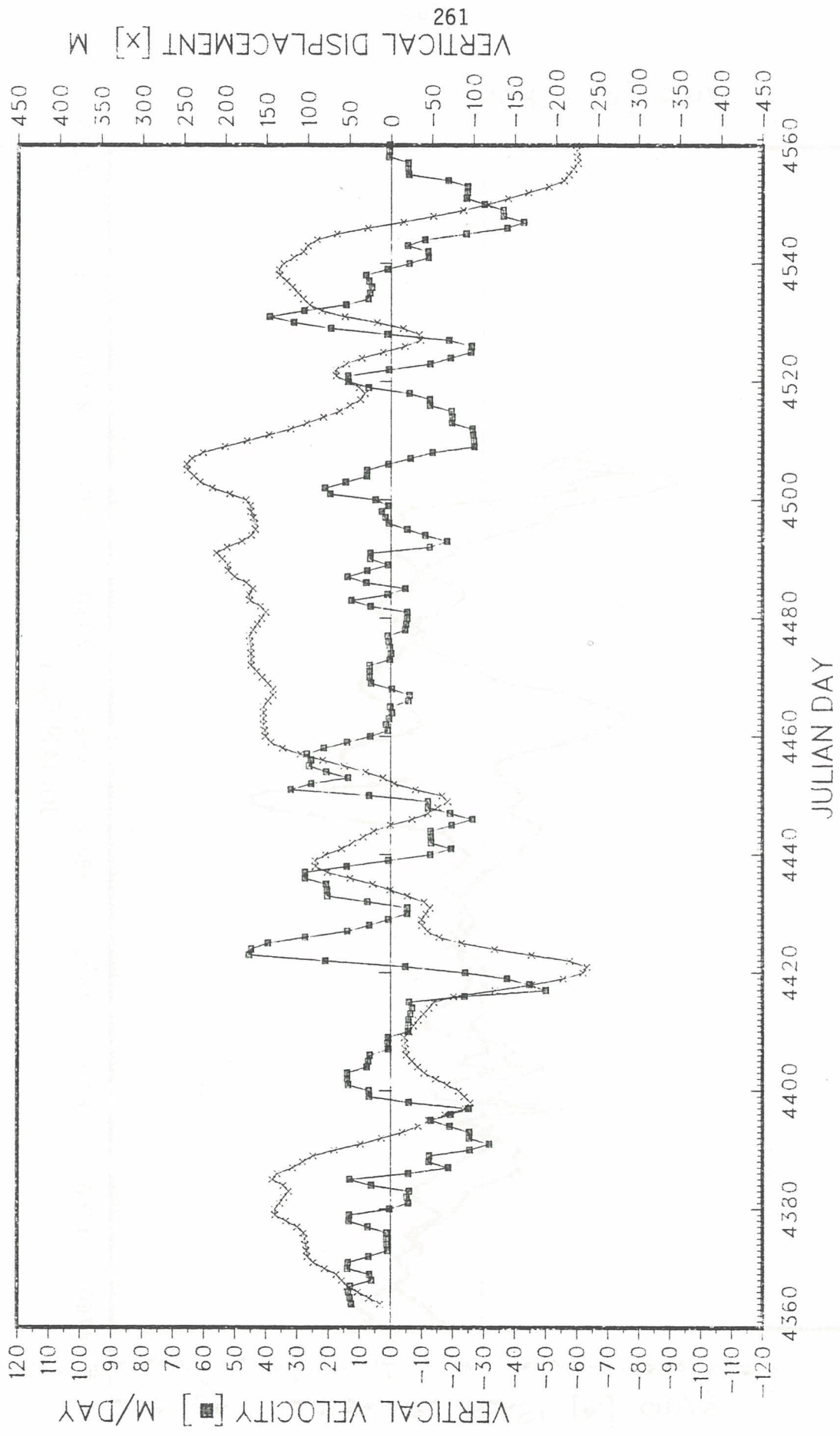
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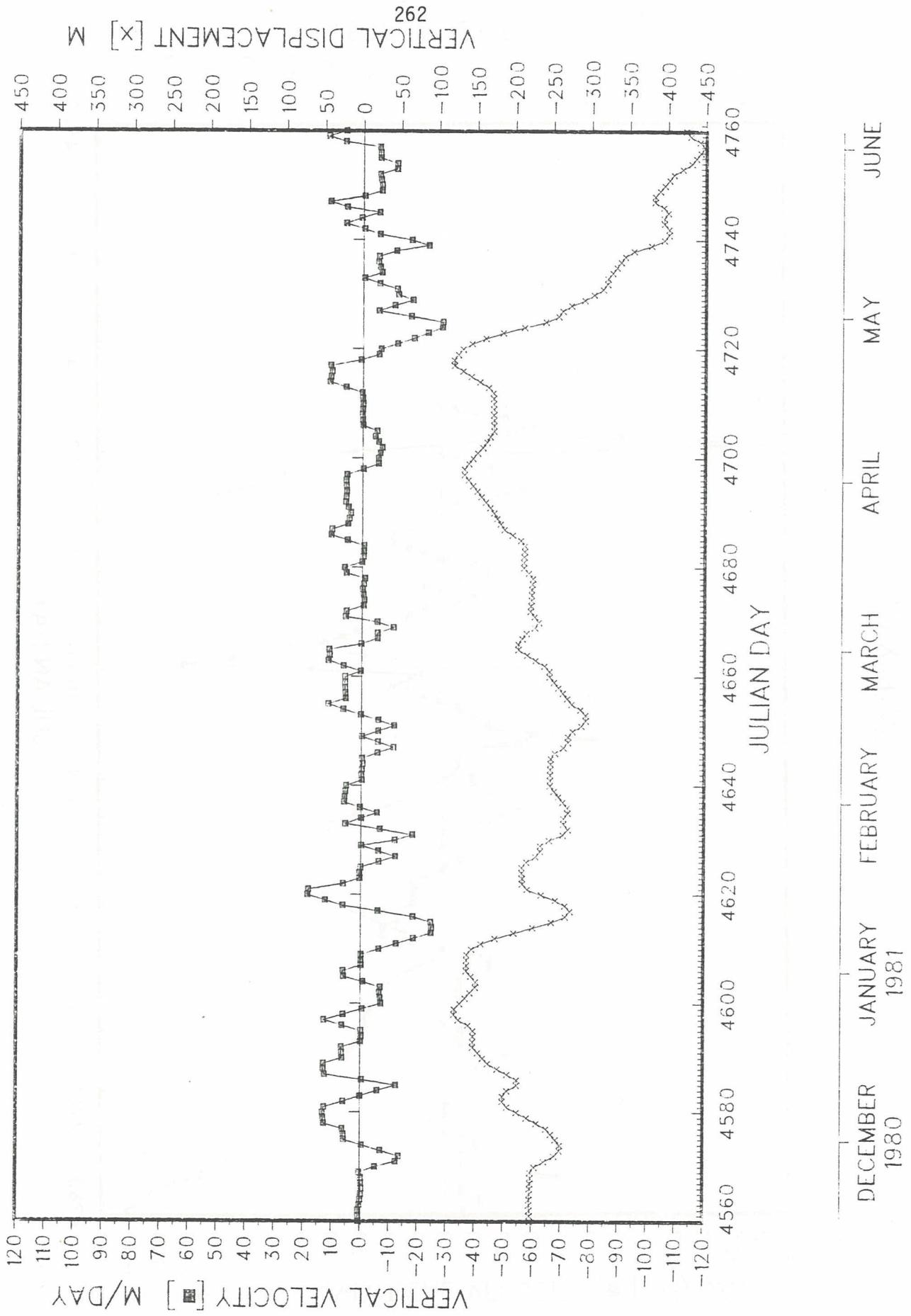
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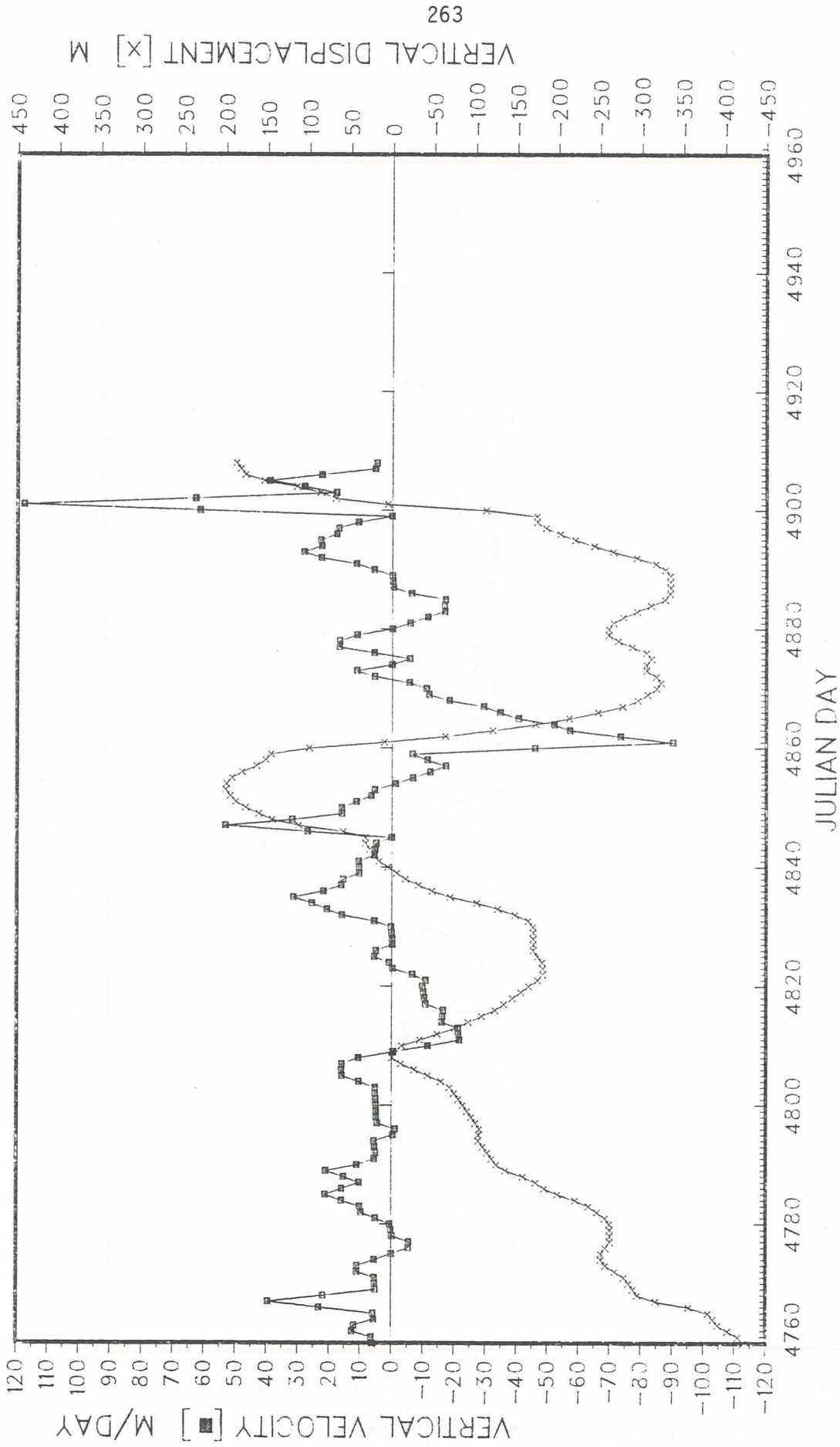
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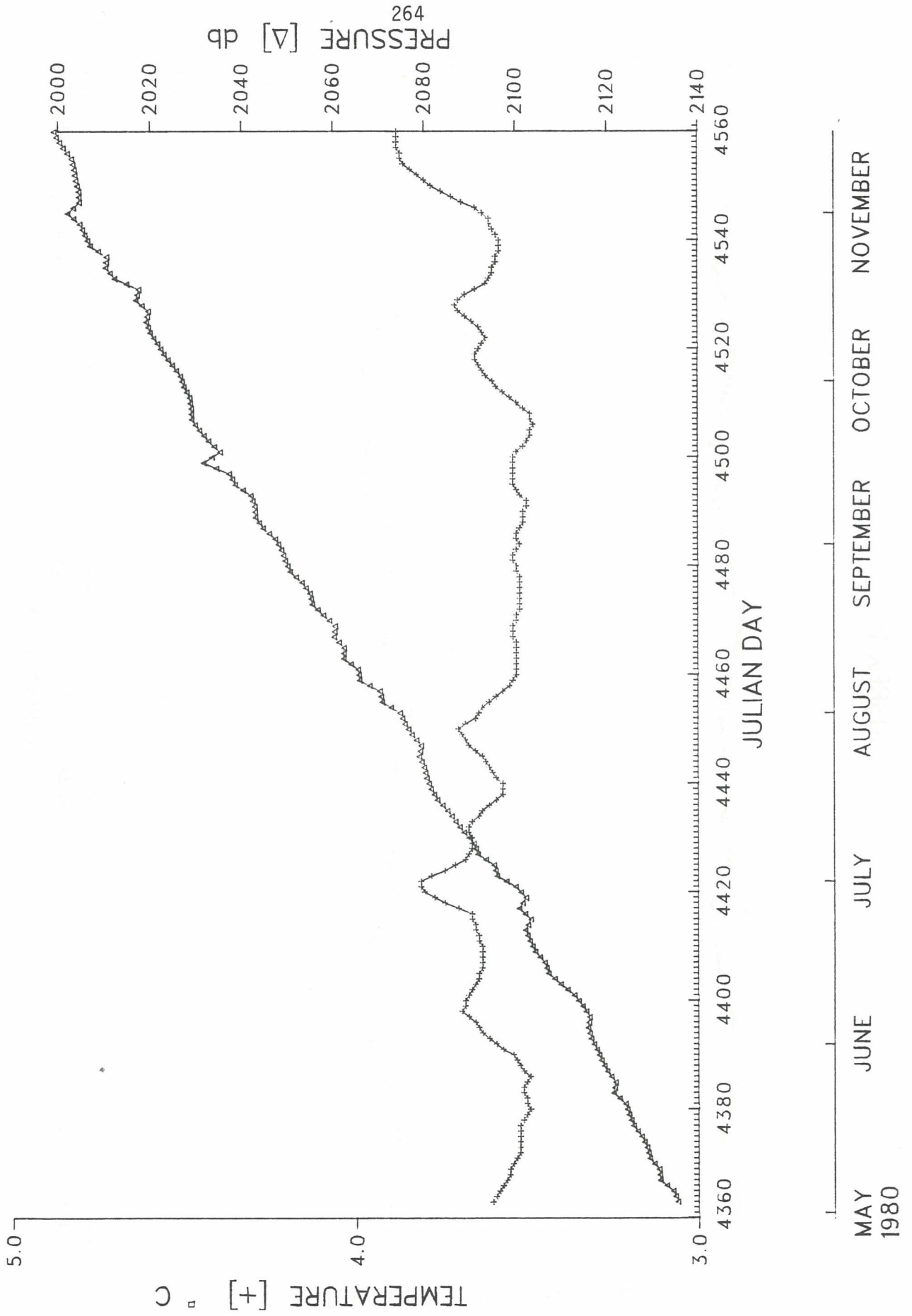
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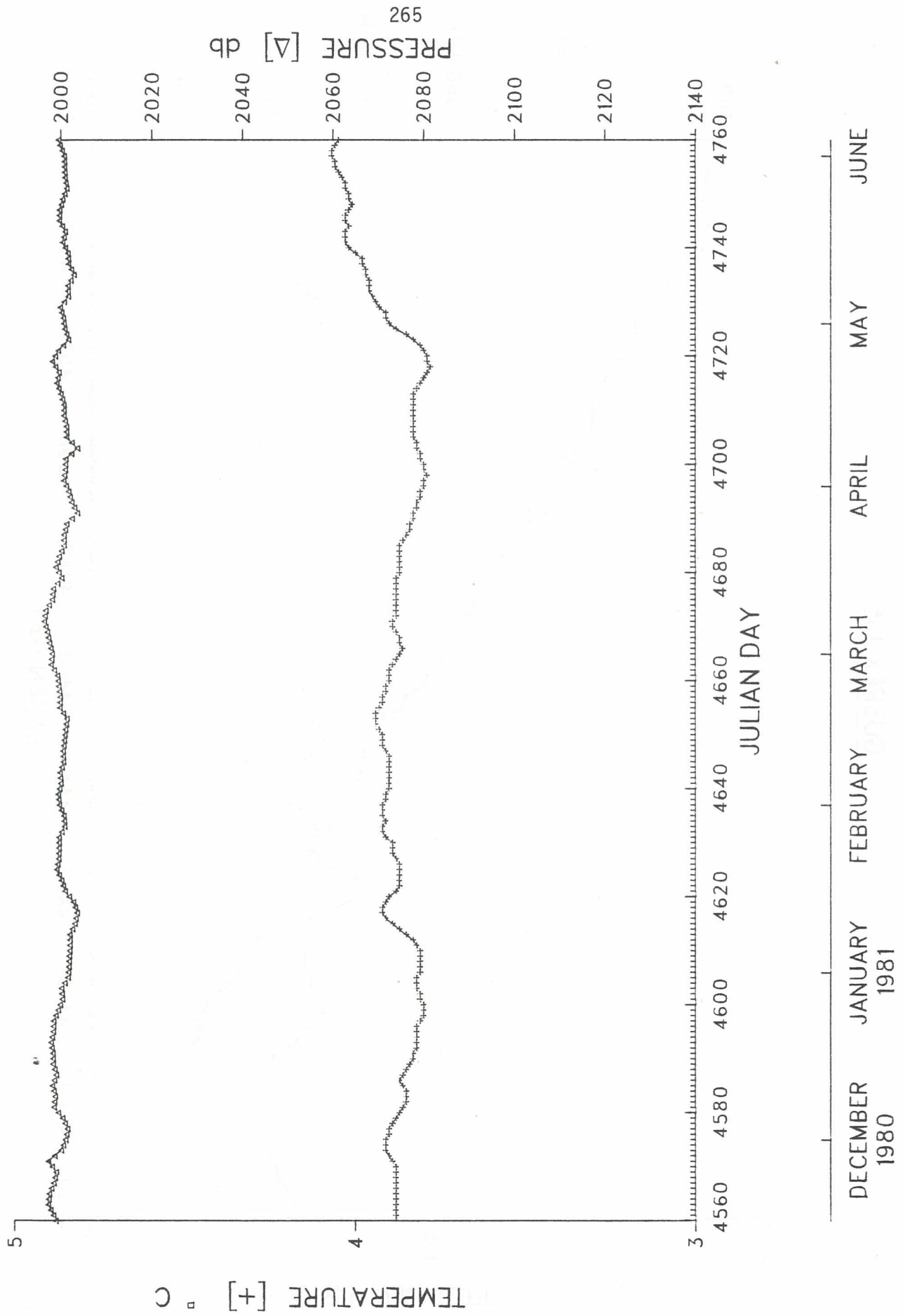
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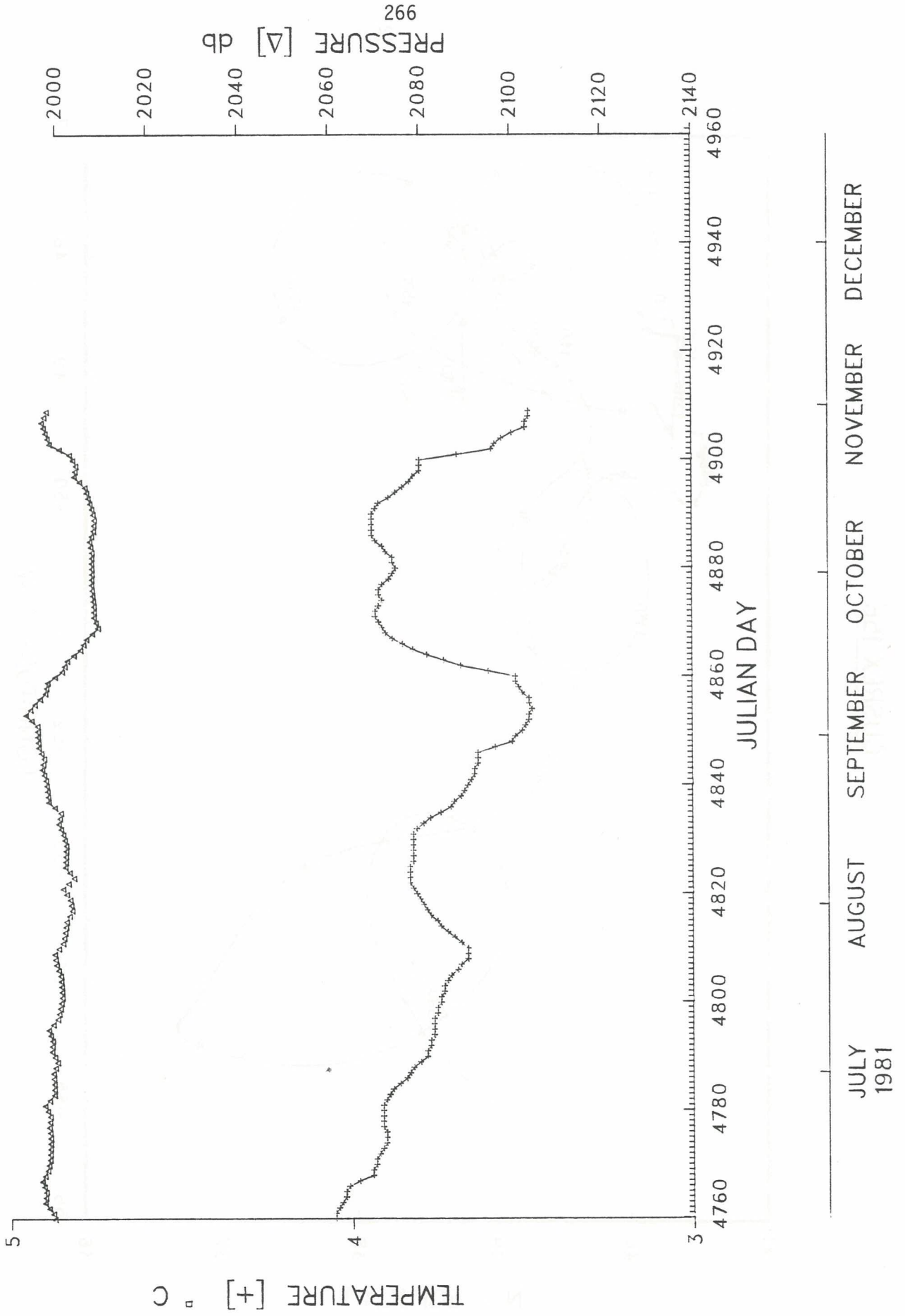
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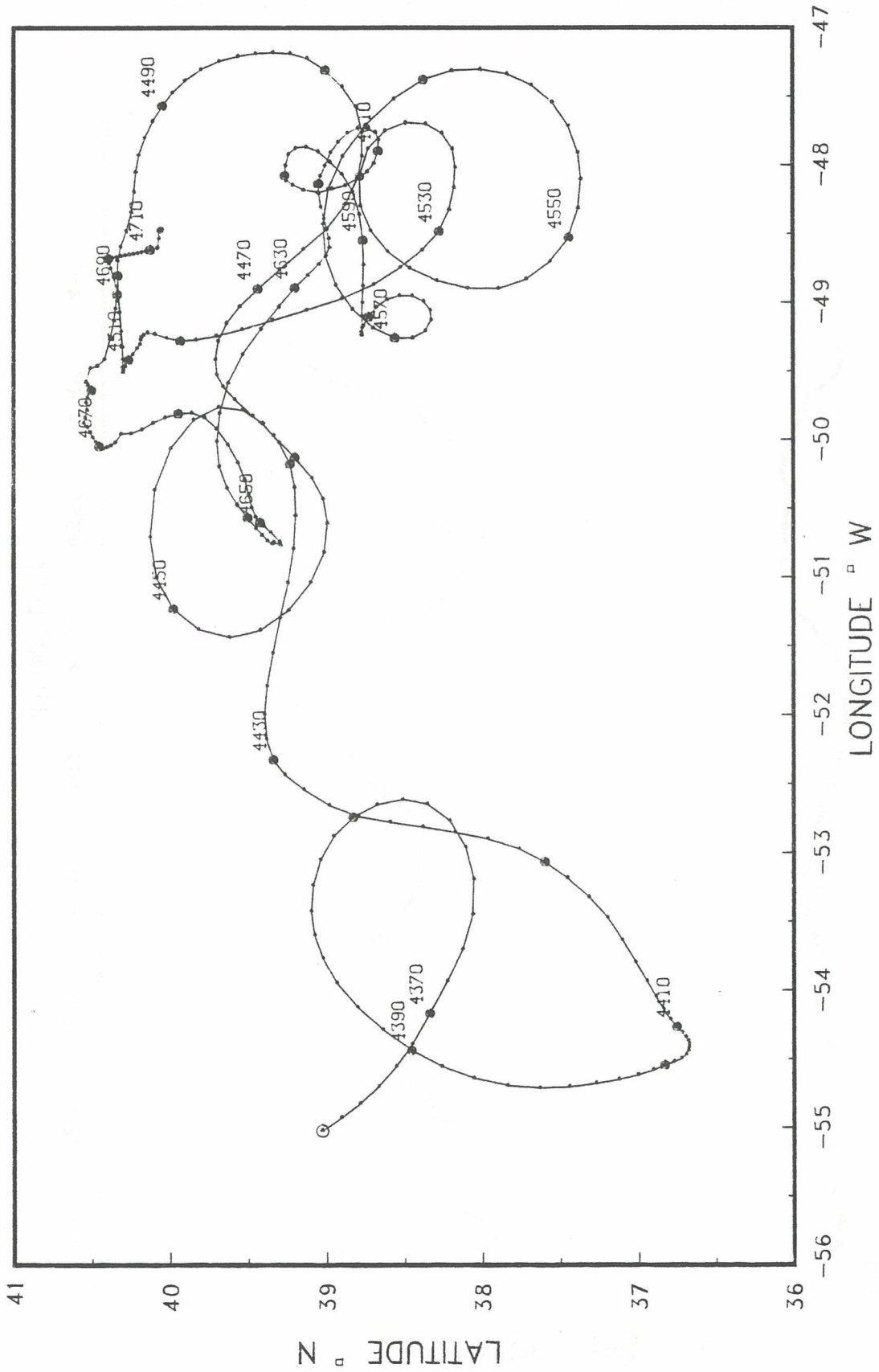
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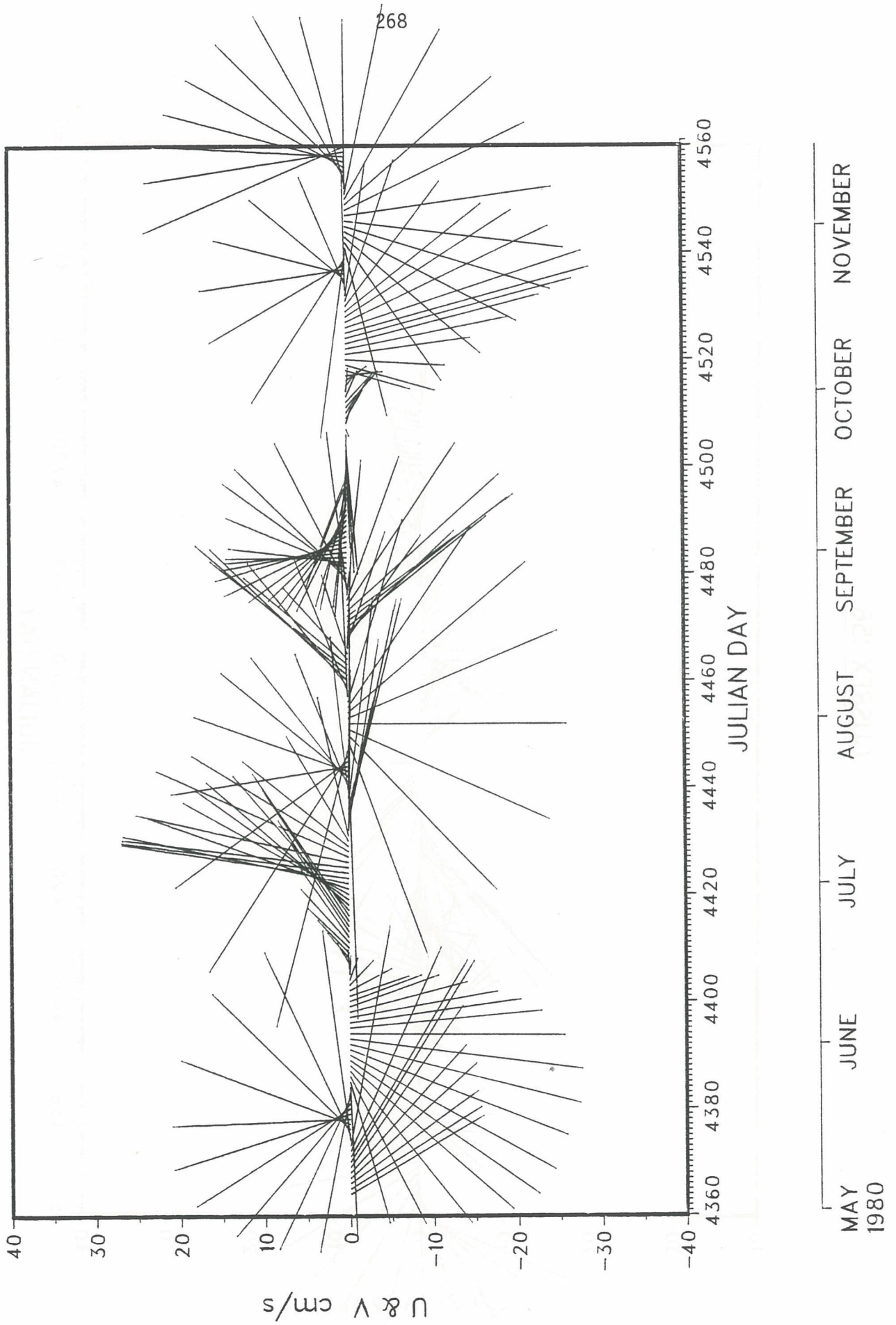
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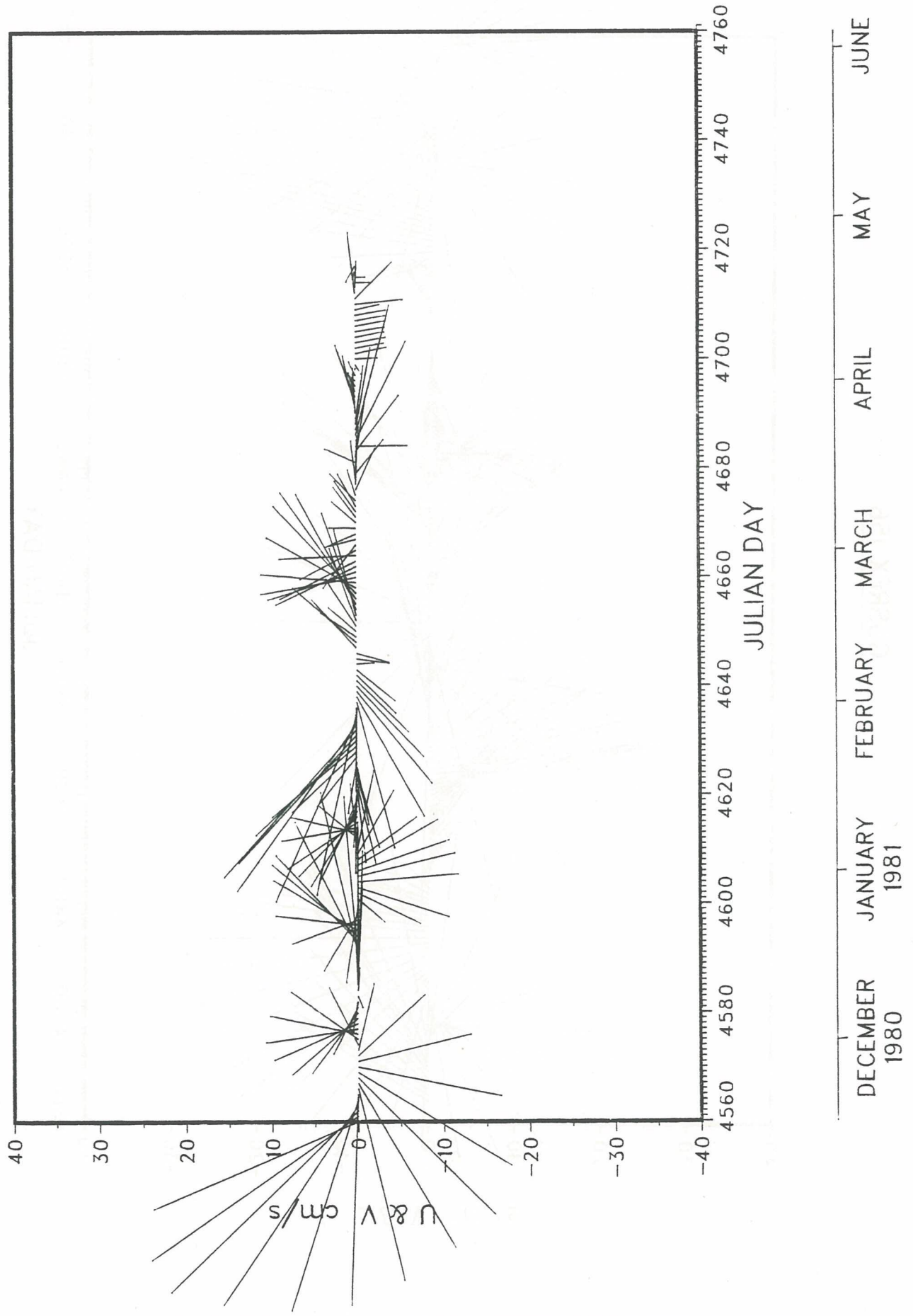
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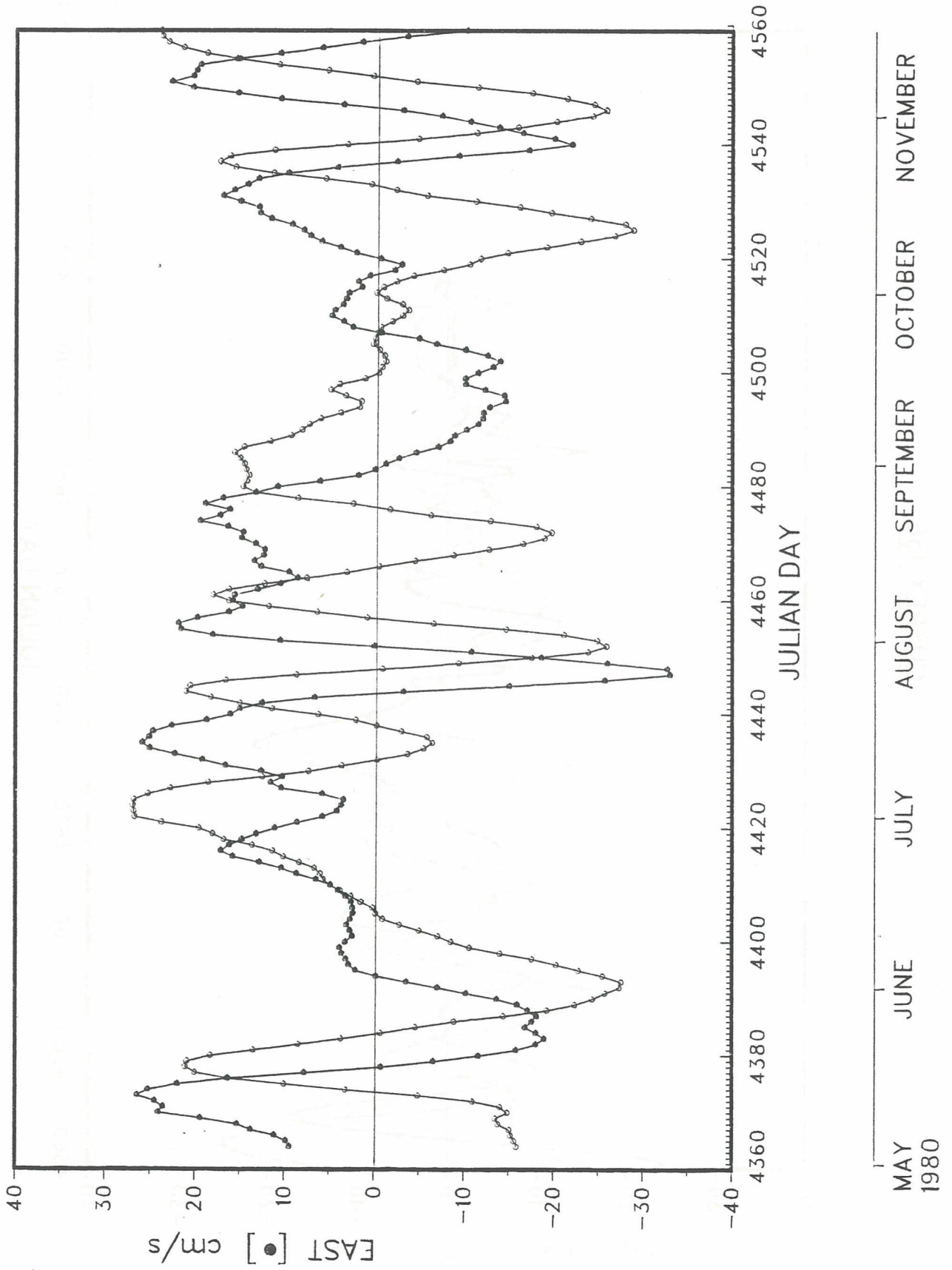
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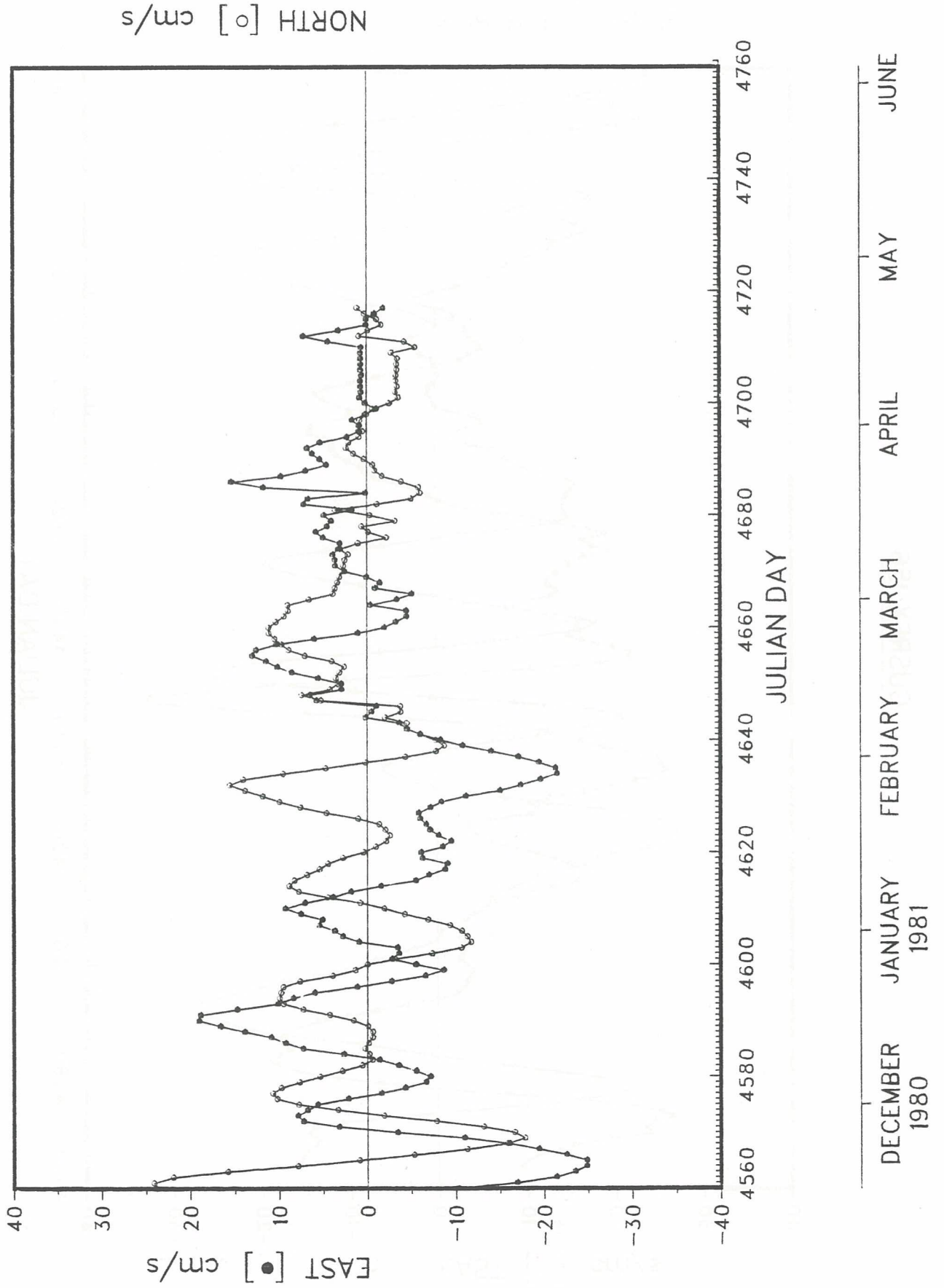
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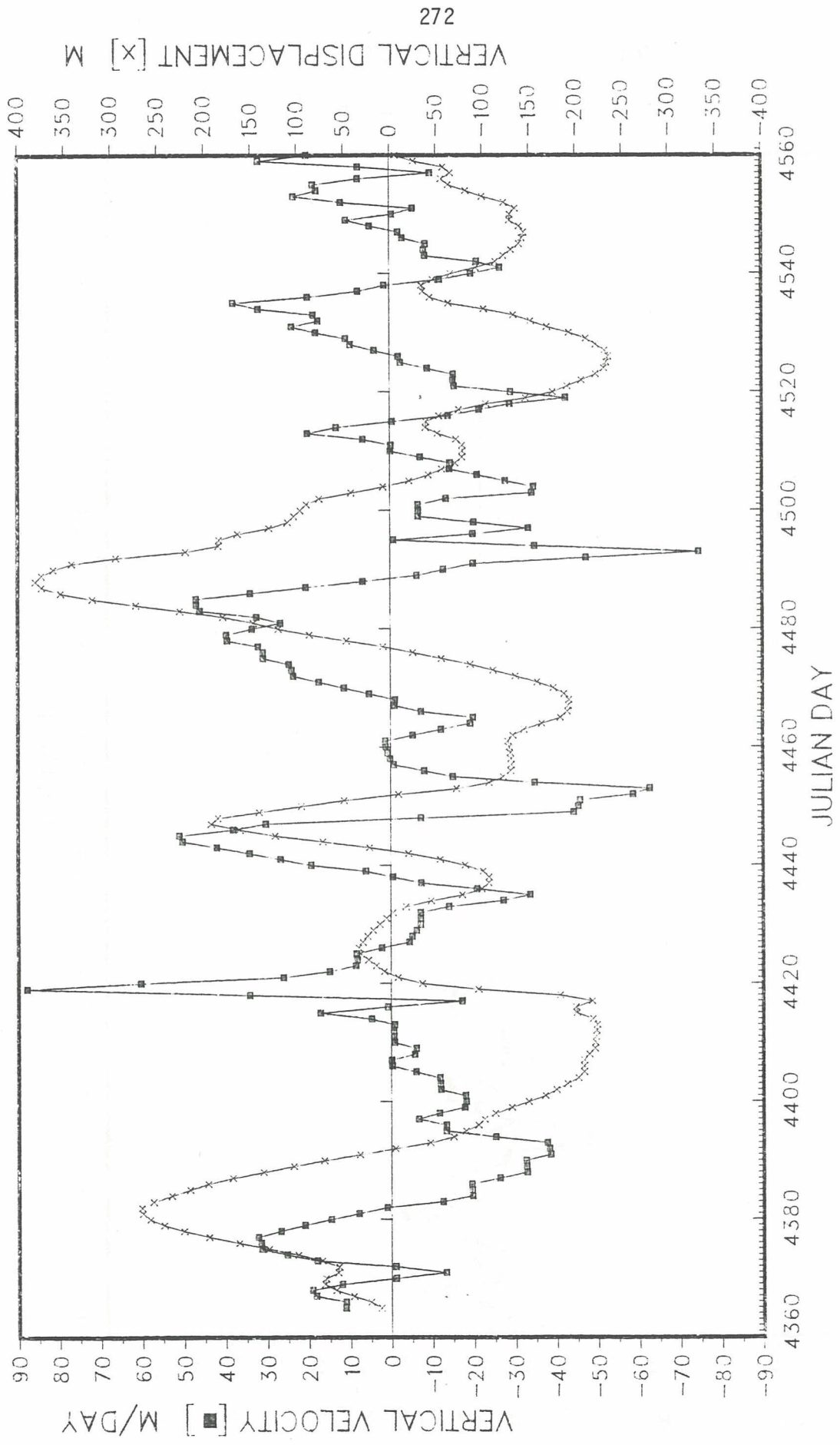
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GUSREX 156



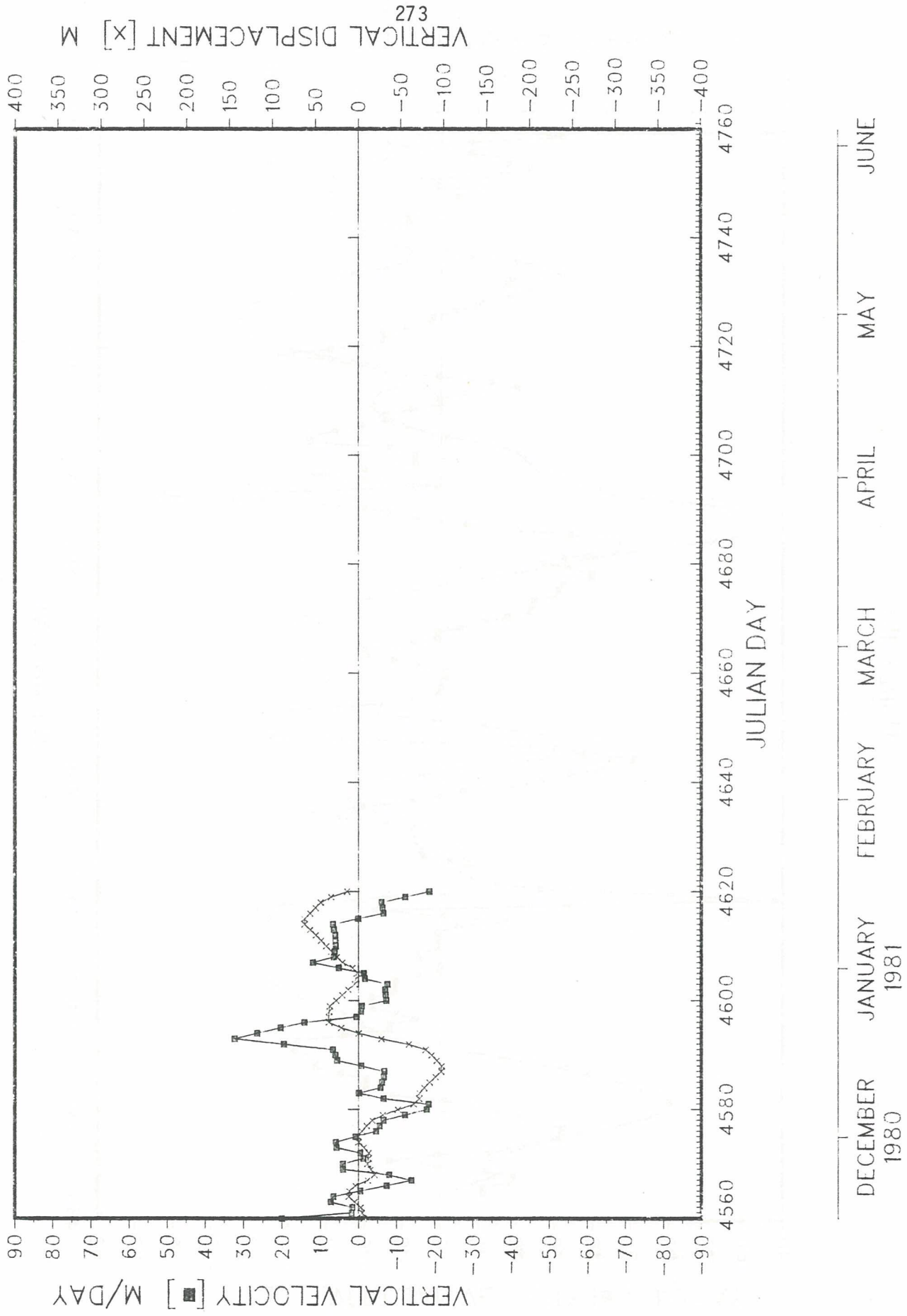
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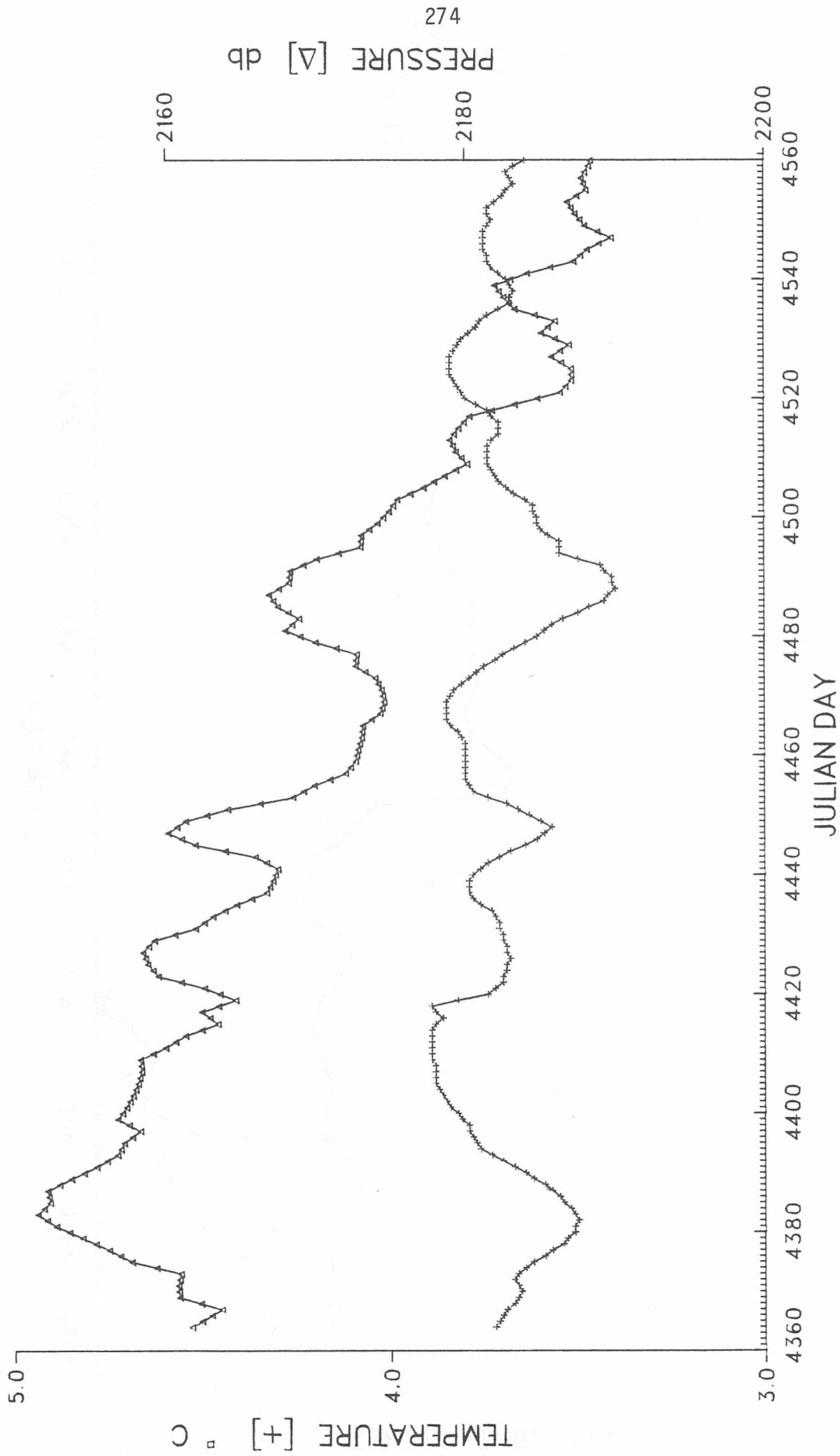
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MAY
1980

JUNE

JULY

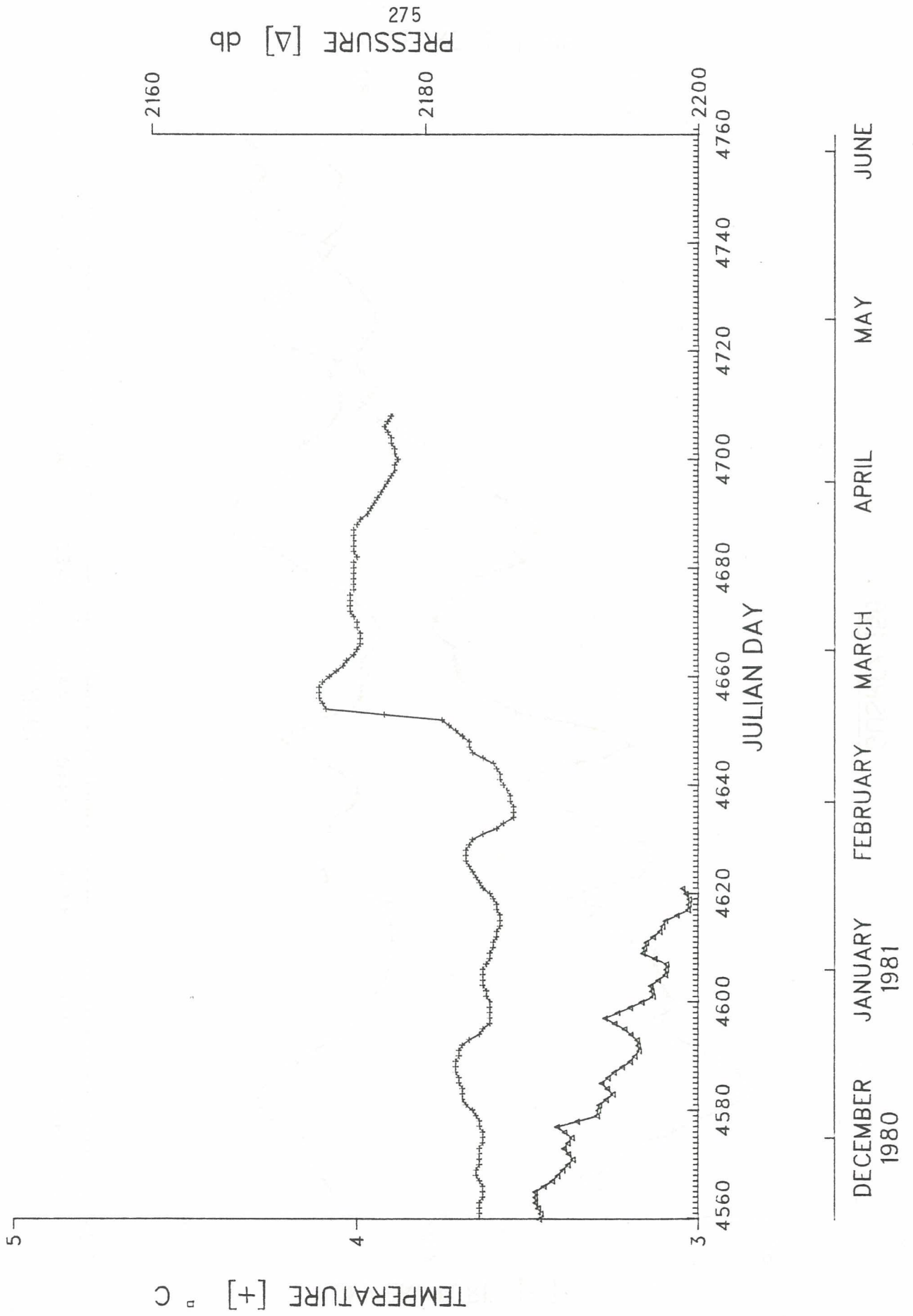
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SEPTEMBER

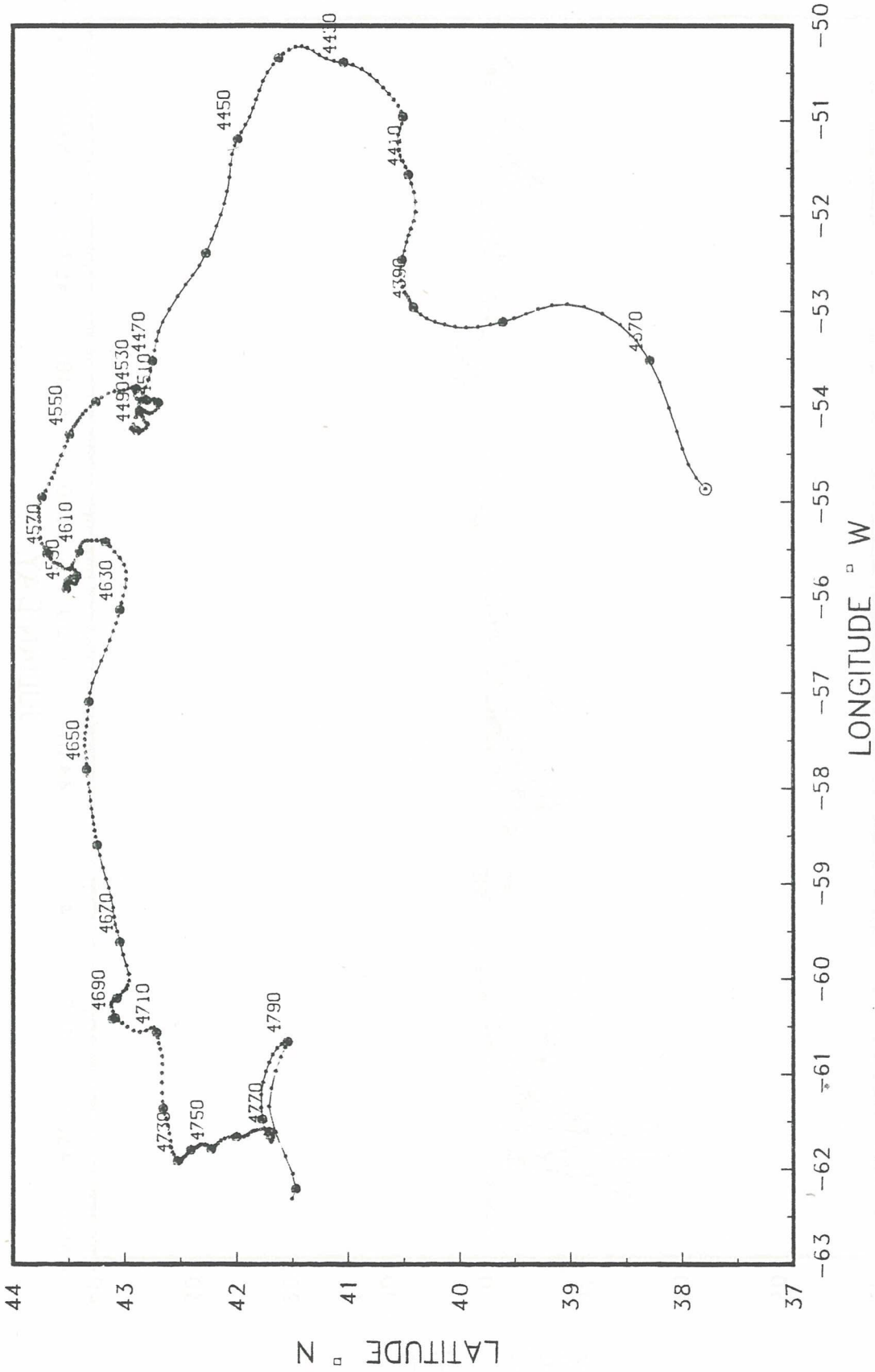
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NOVEMBER

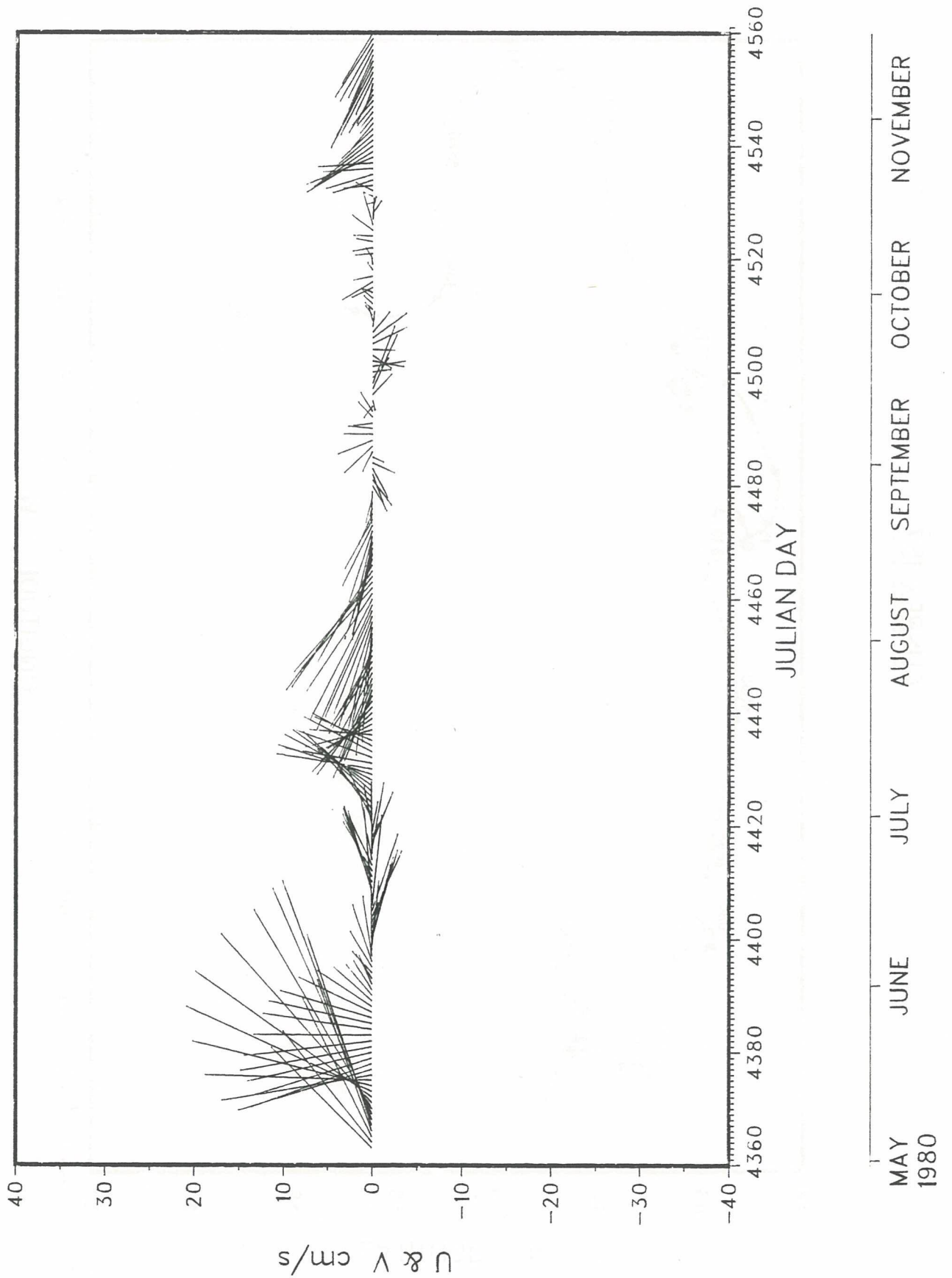
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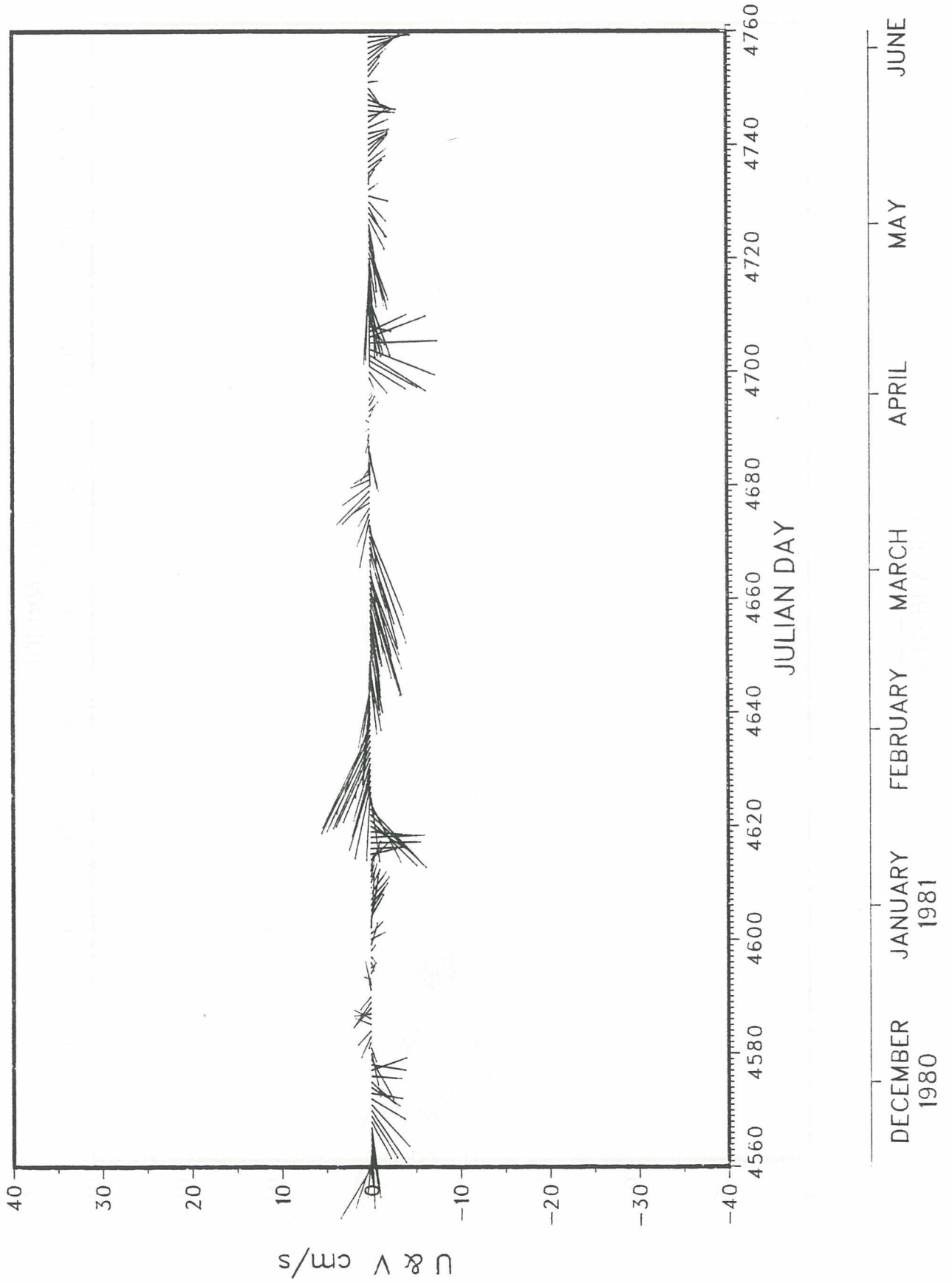
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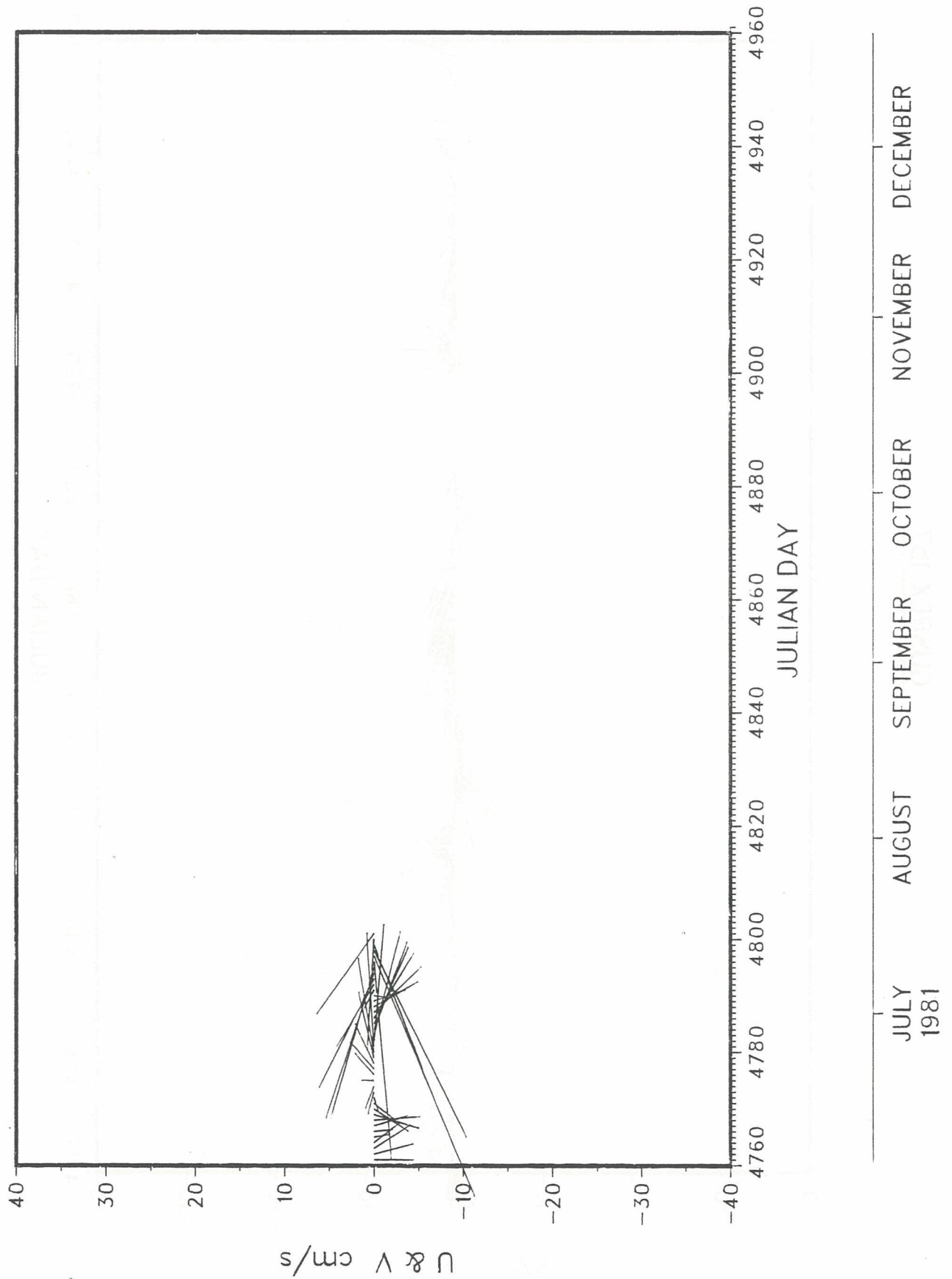
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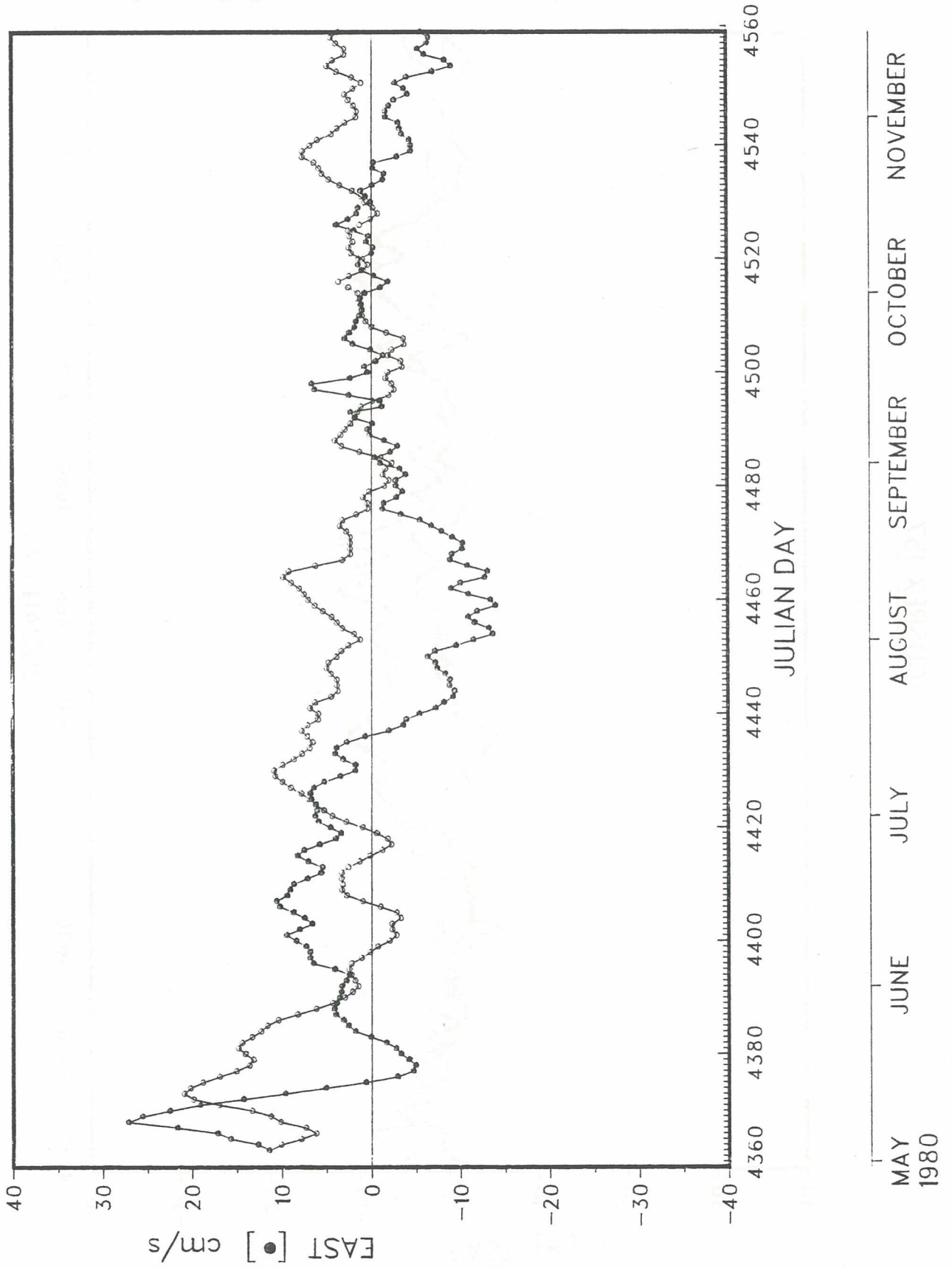
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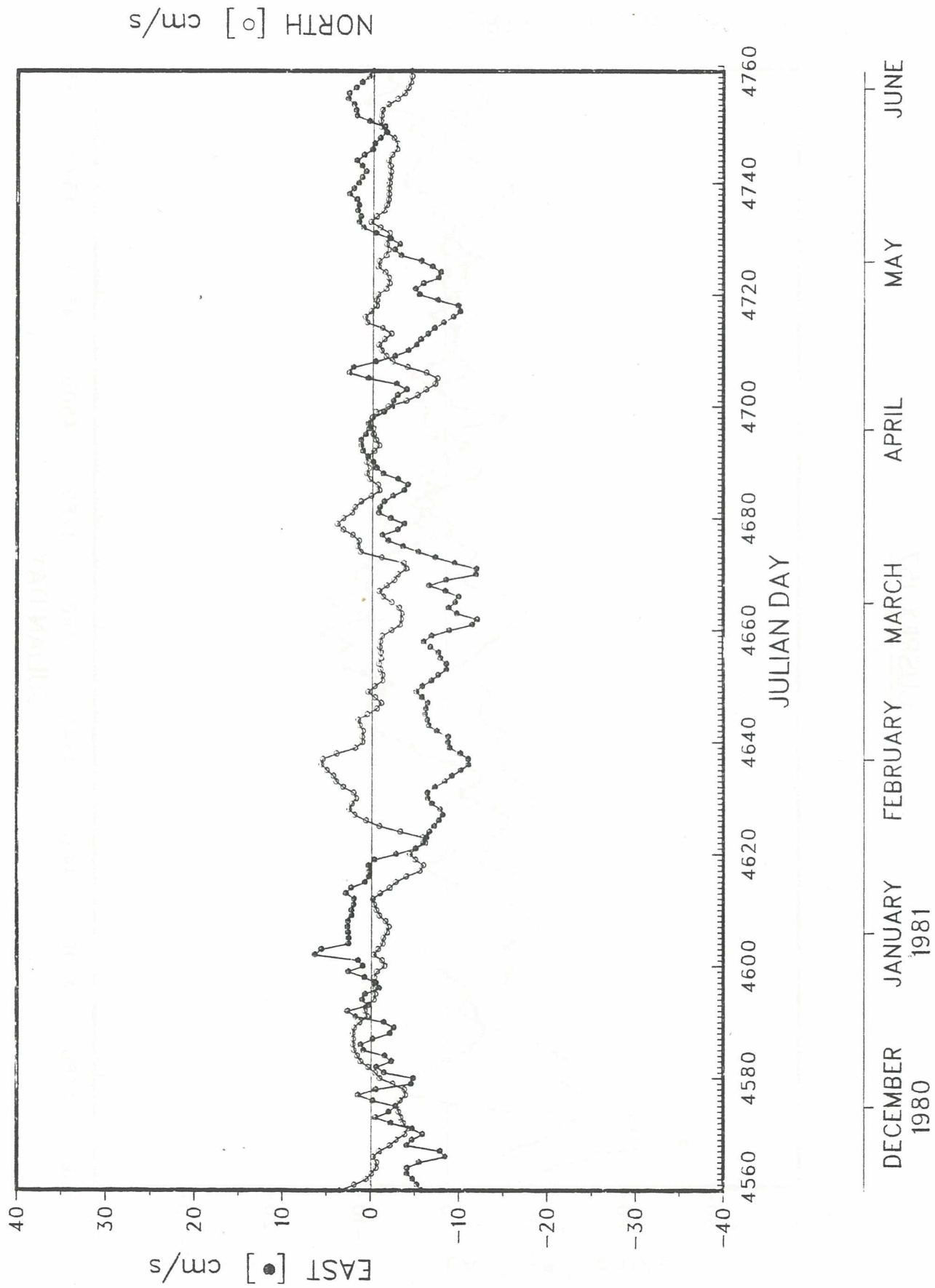
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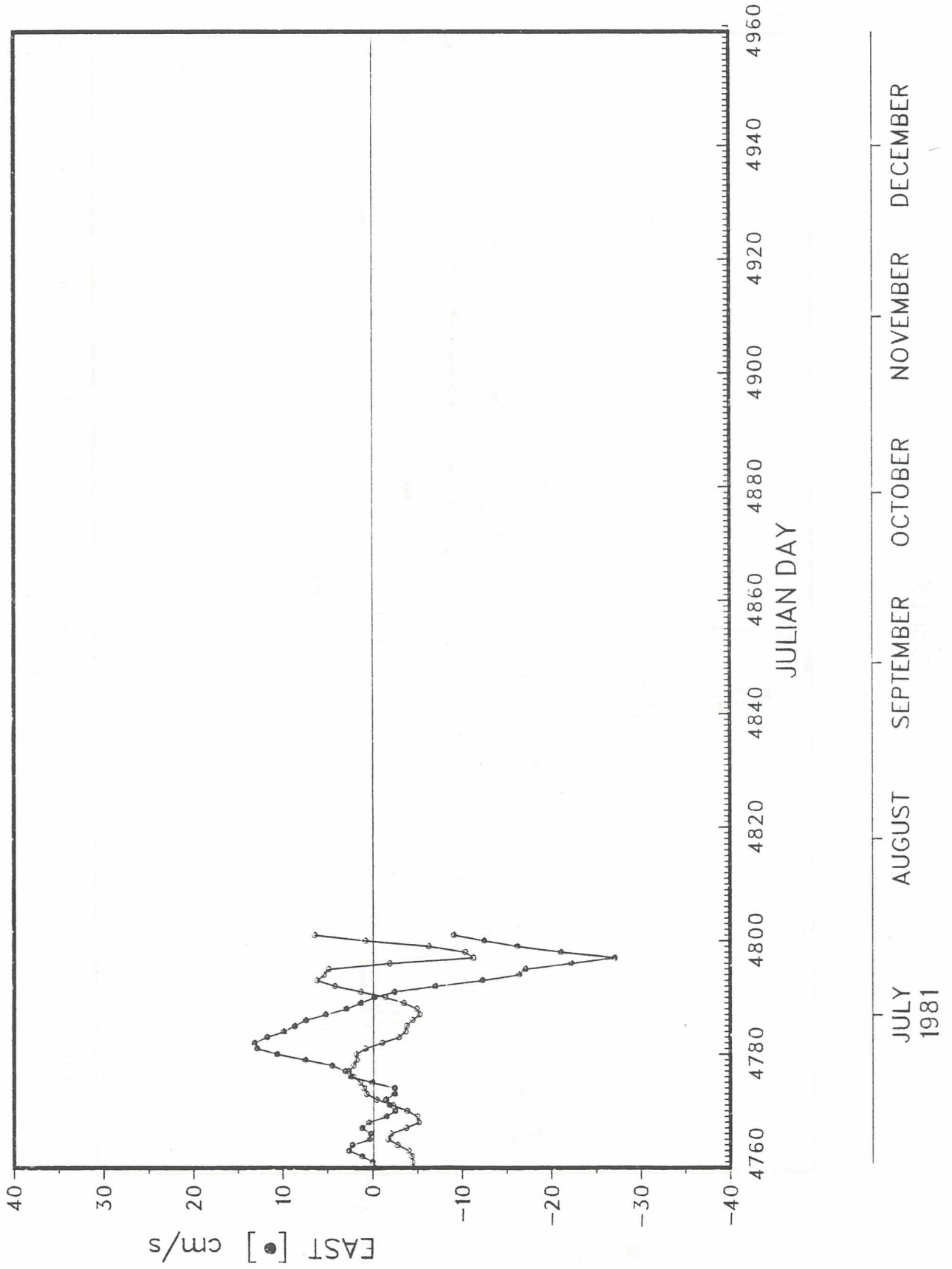
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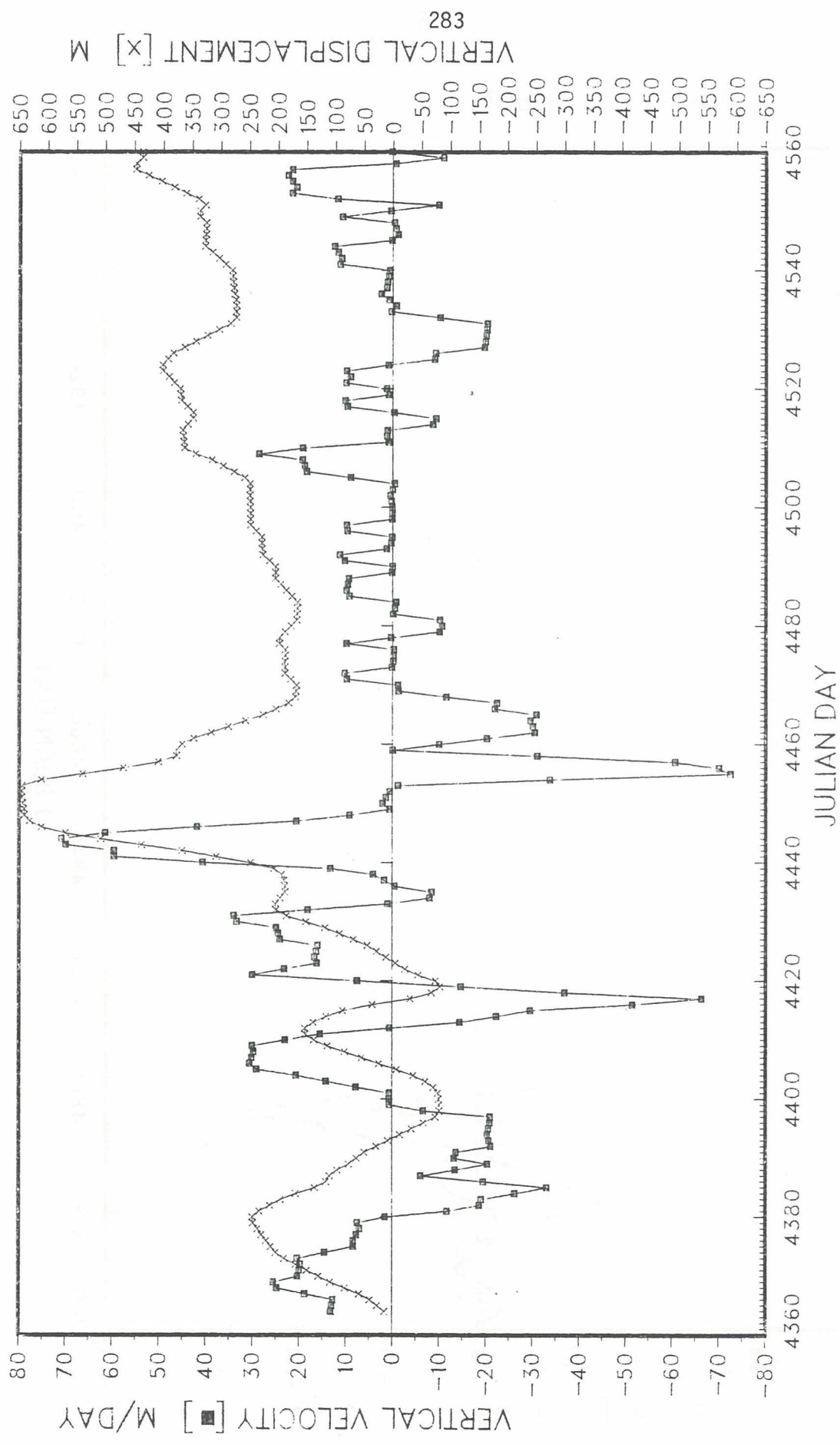
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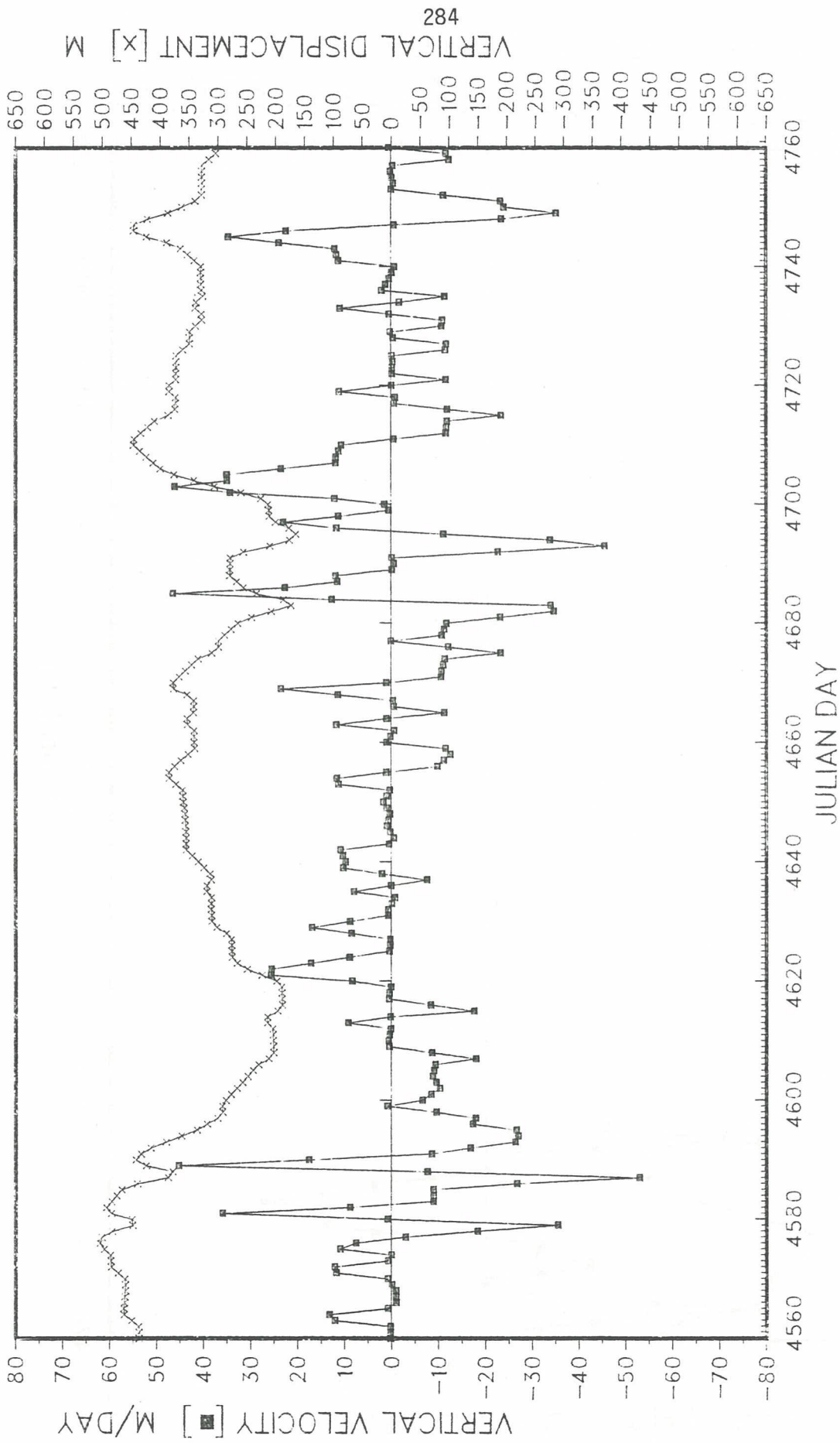
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GUSREX 157

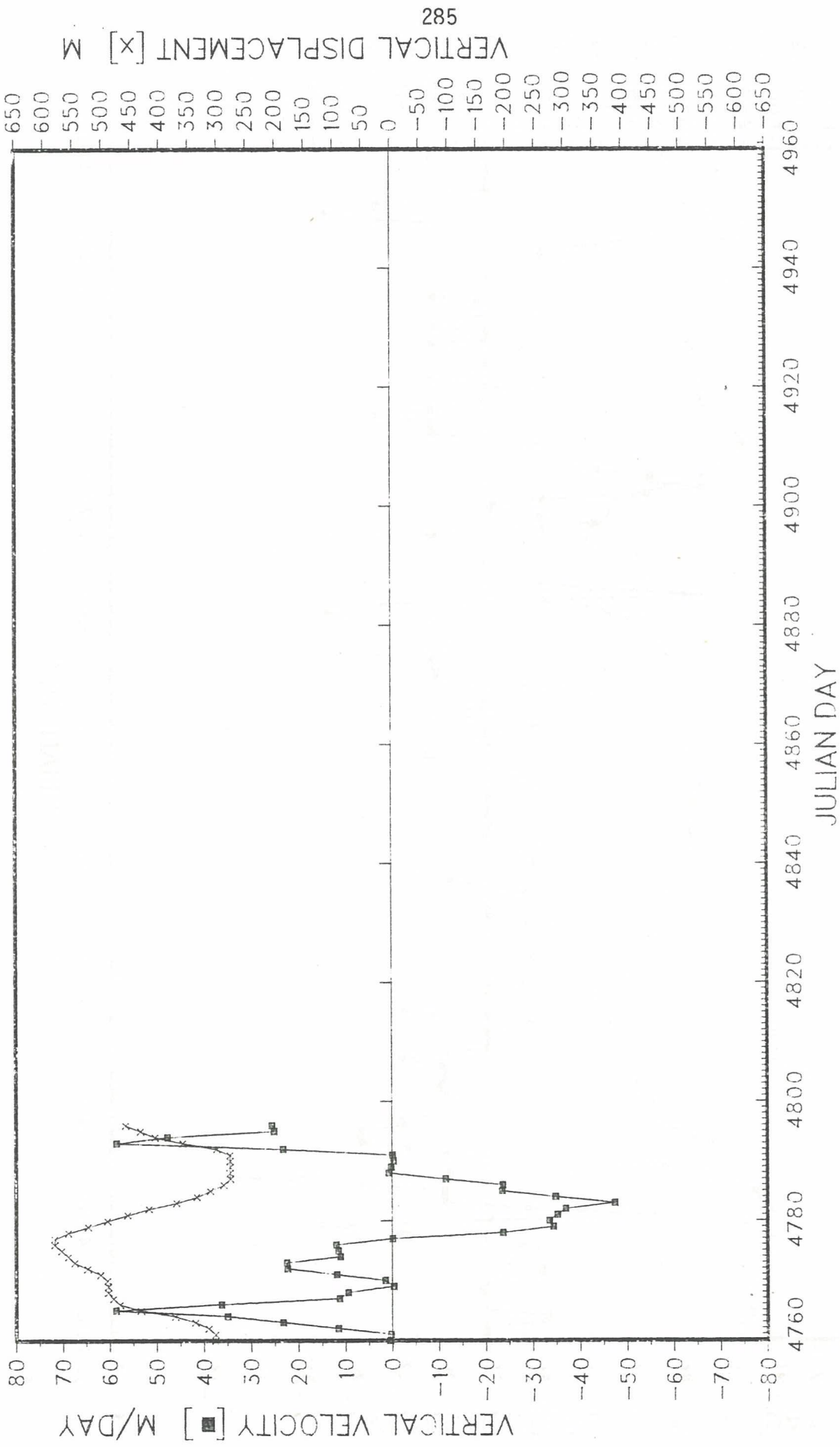


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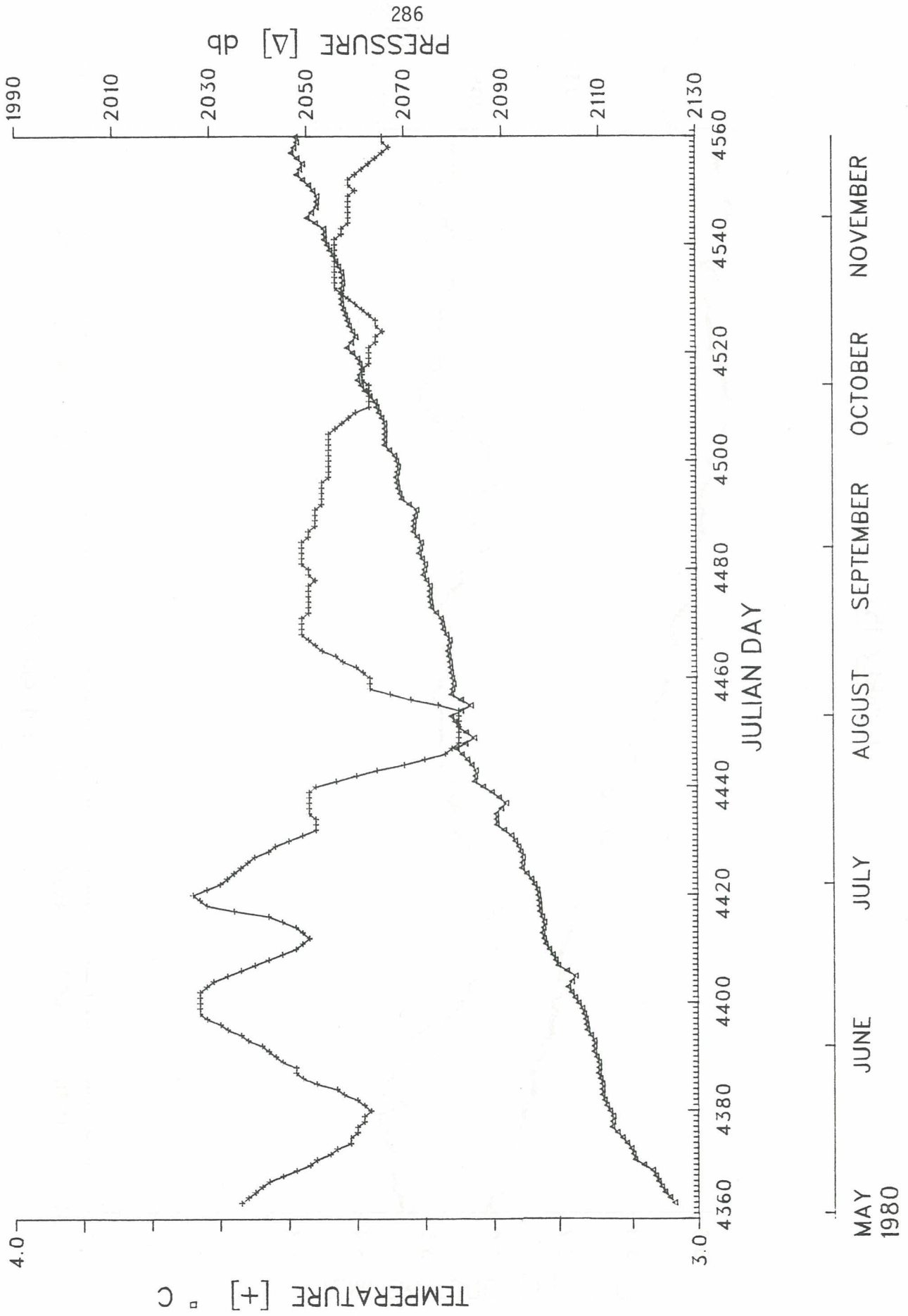


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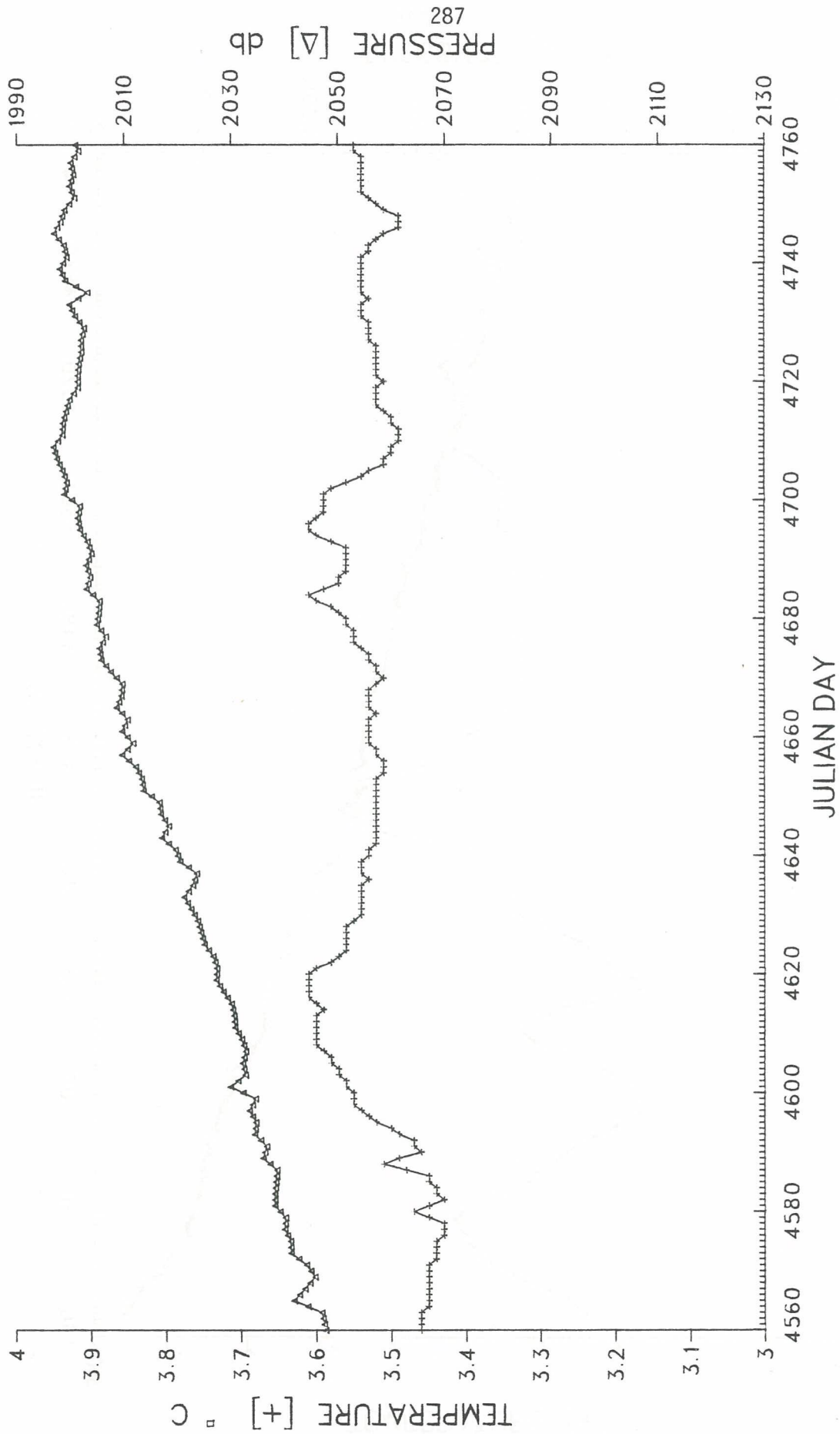
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GUSREX 157

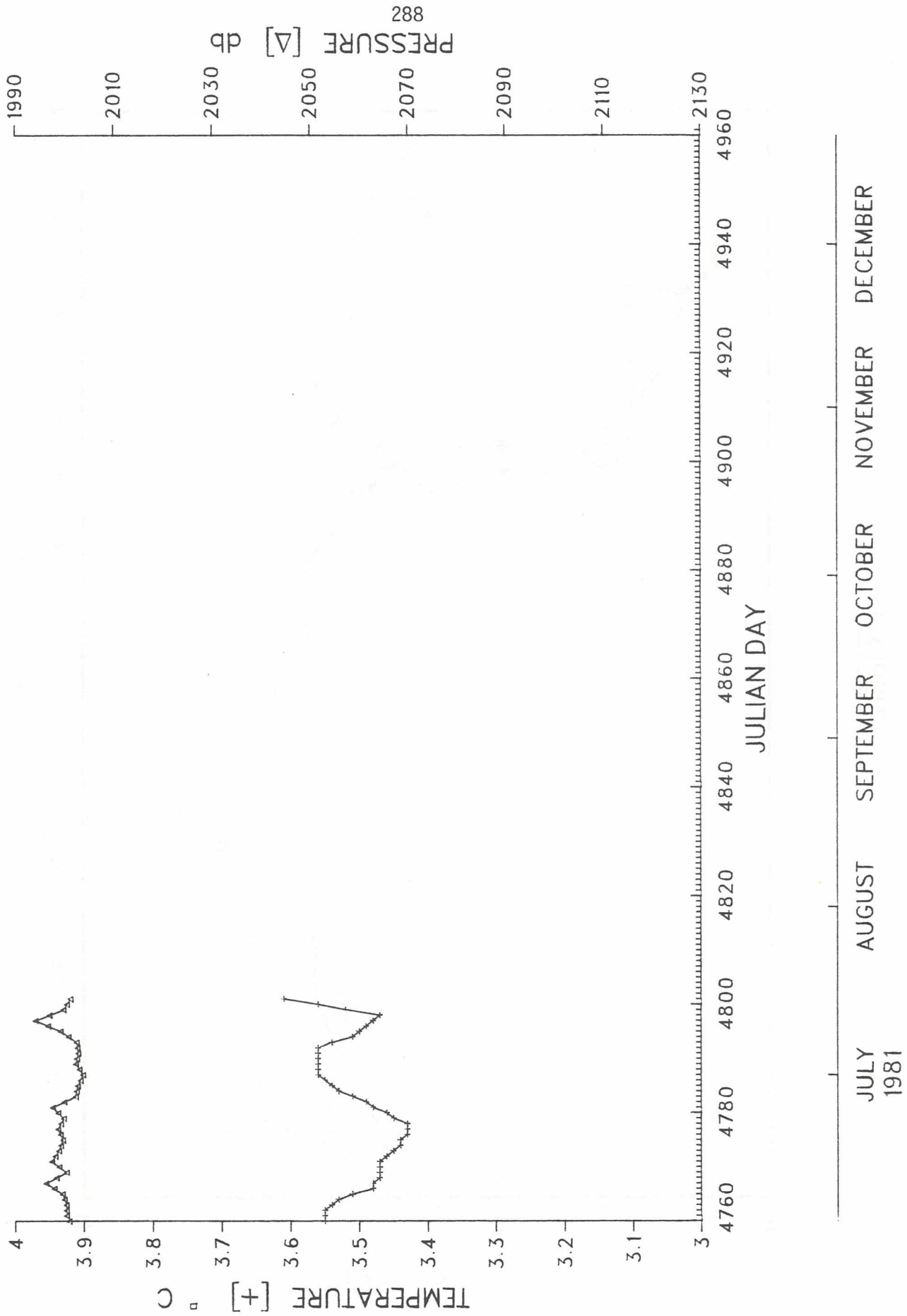


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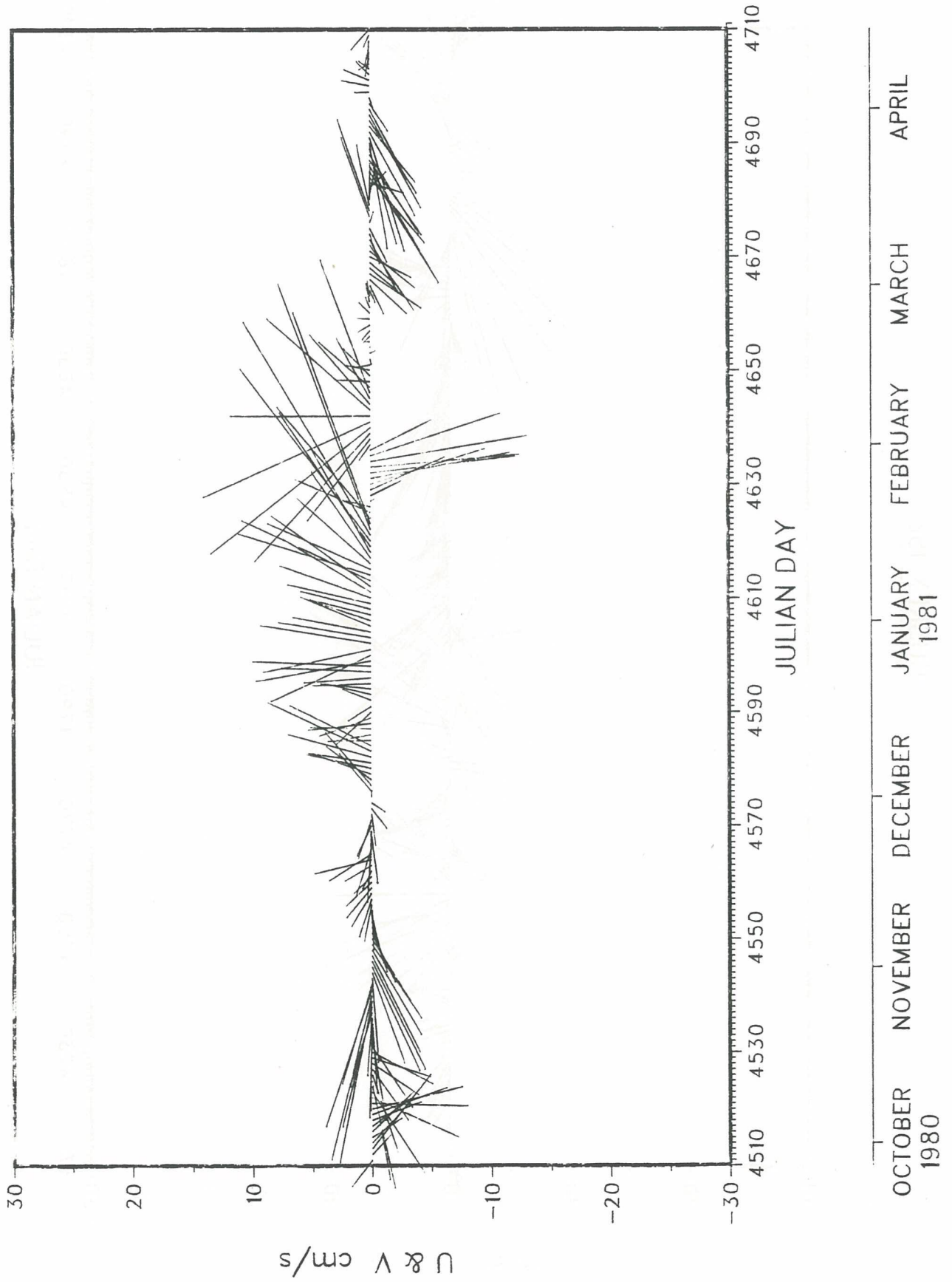


DECEMBER 1980 JANUARY 1981 FEBRUARY MARCH APRIL MAY JUNE

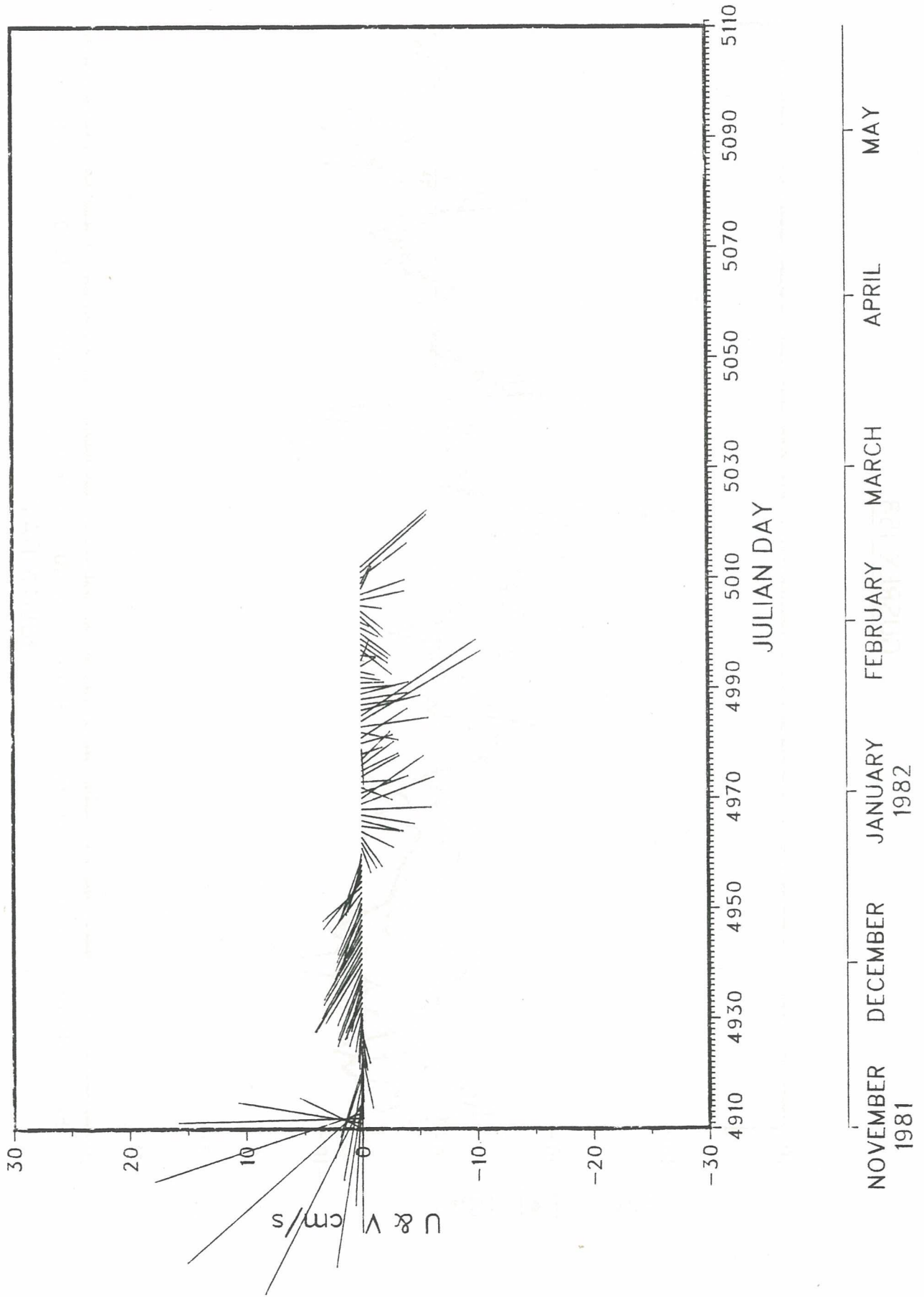
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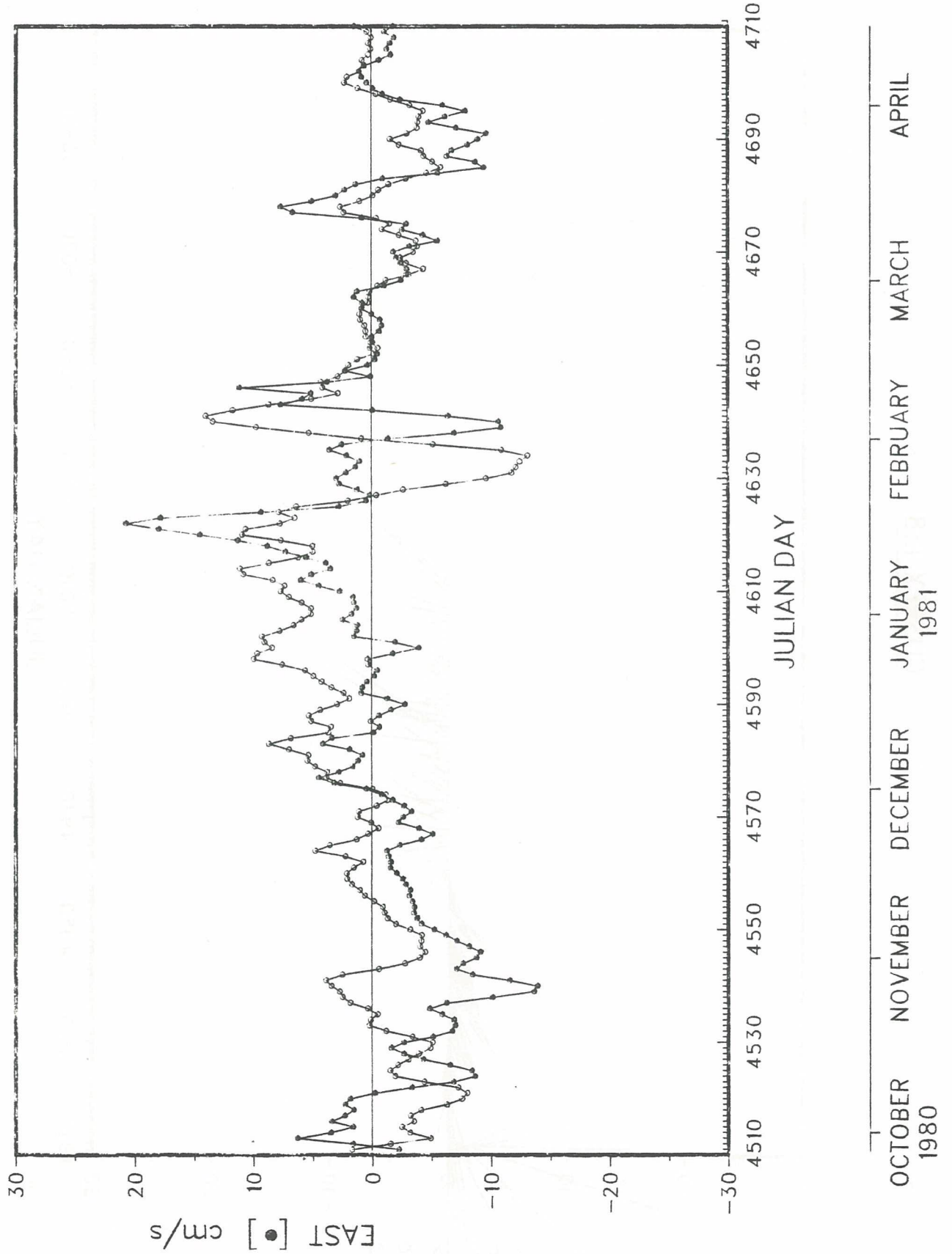
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CUSREX 158

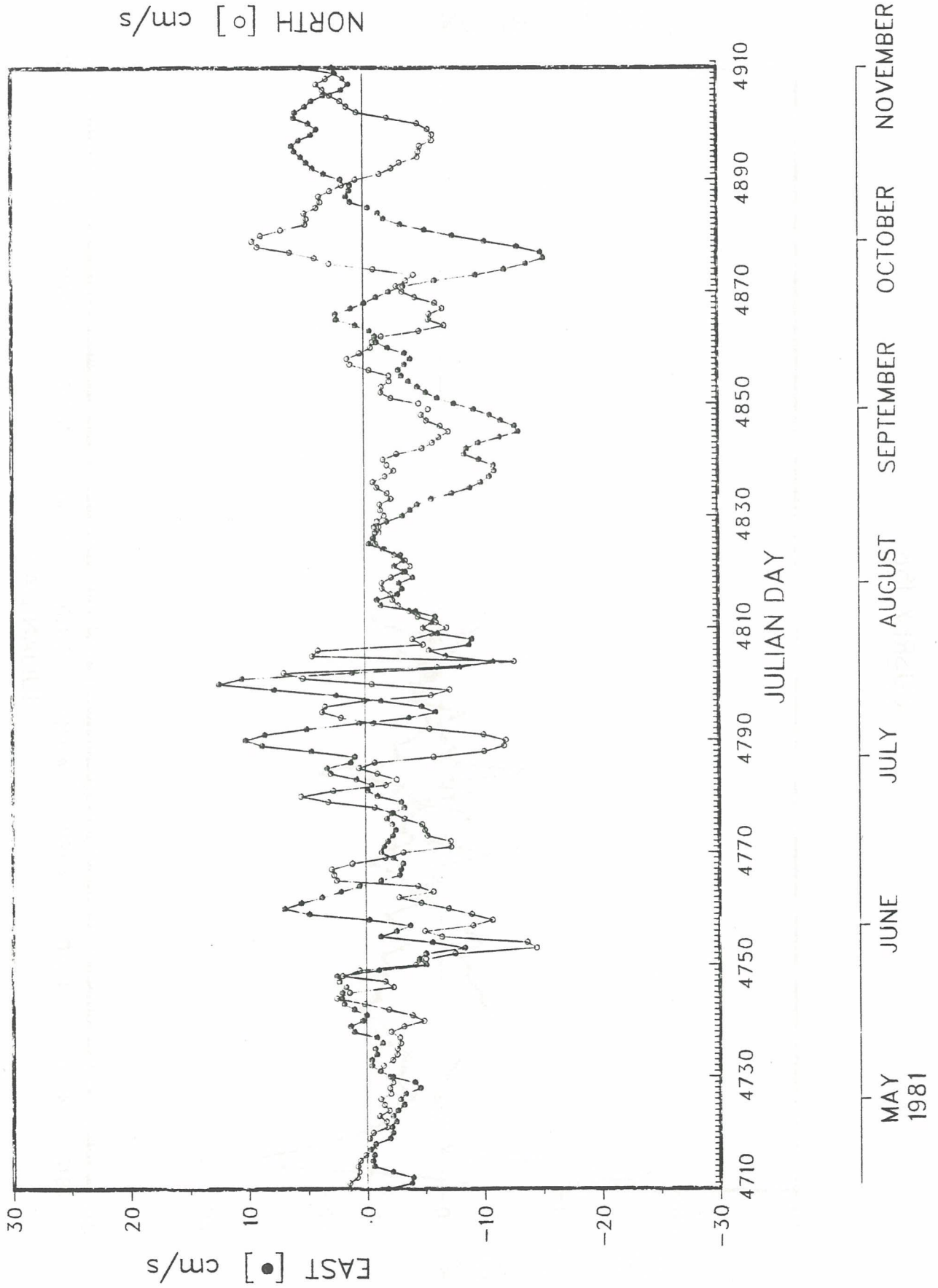


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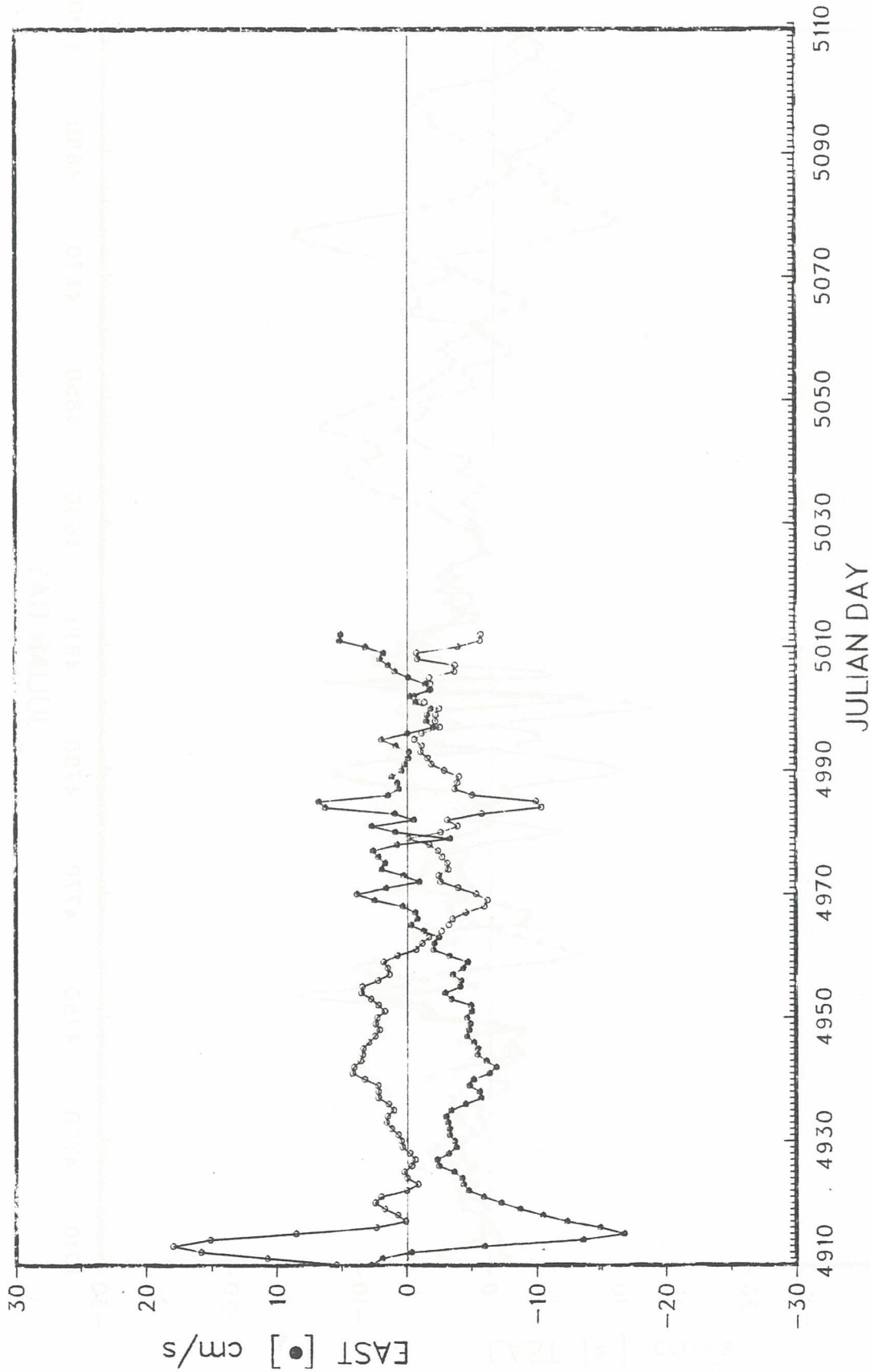


OCTOBER 1980 NOVEMBER 1980 DECEMBER 1980 JANUARY 1981 FEBRUARY 1981 MARCH 1981 APRIL 1981

GUSREX 158

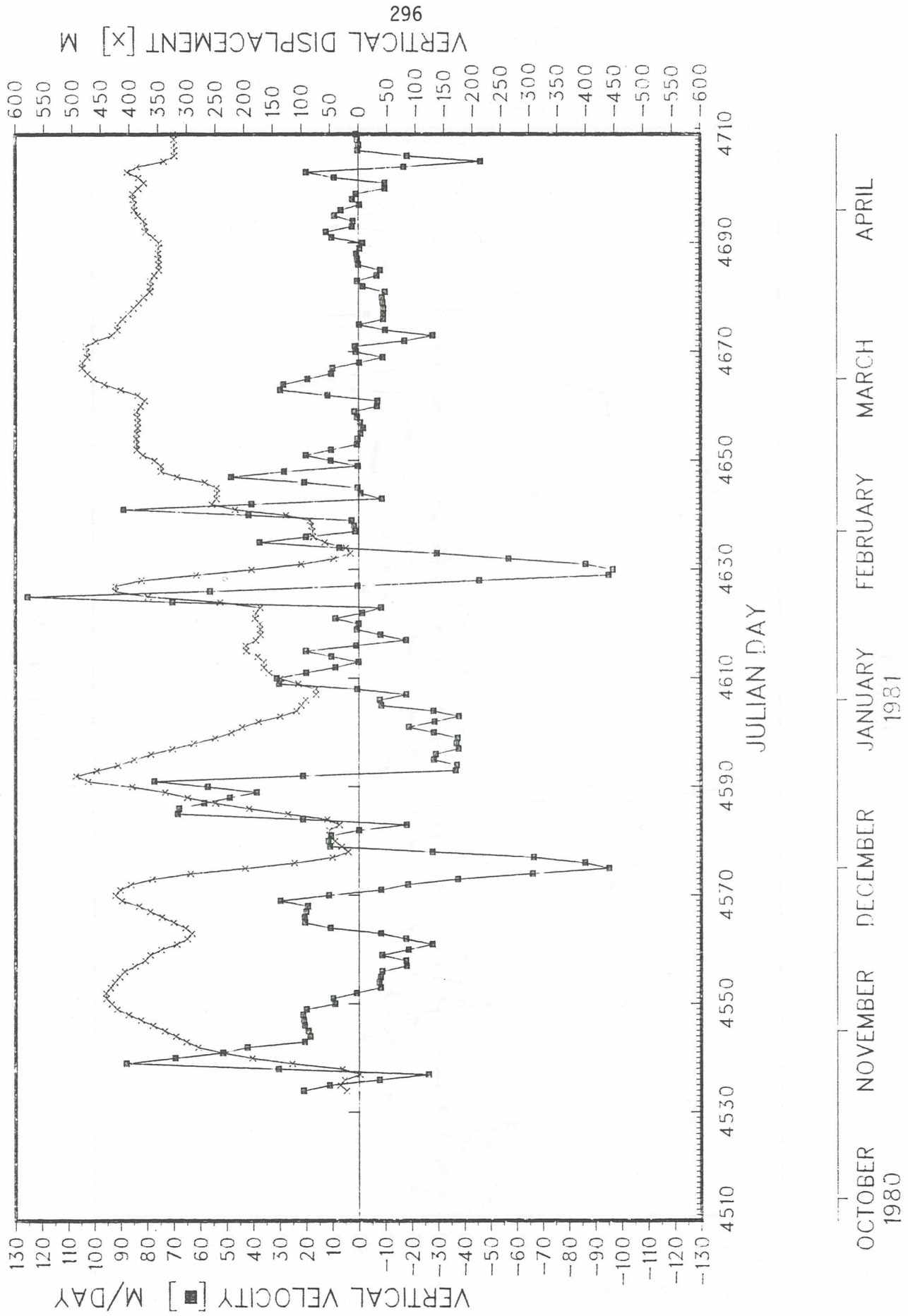


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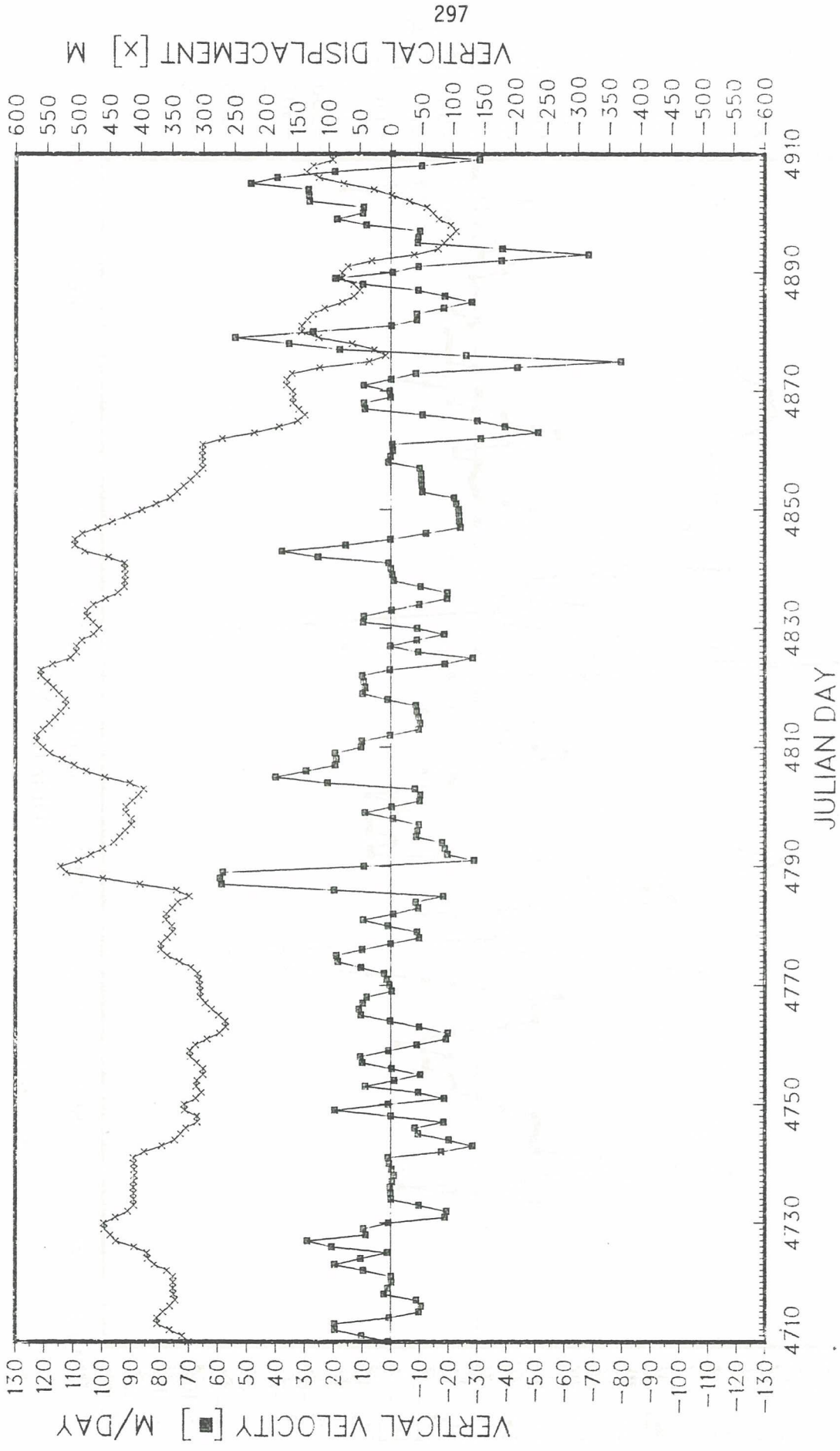
NOVEMBER 1981 DECEMBER 1981 JANUARY 1982 FEBRUARY 1982 MARCH 1982 APRIL 1982 MAY 1982

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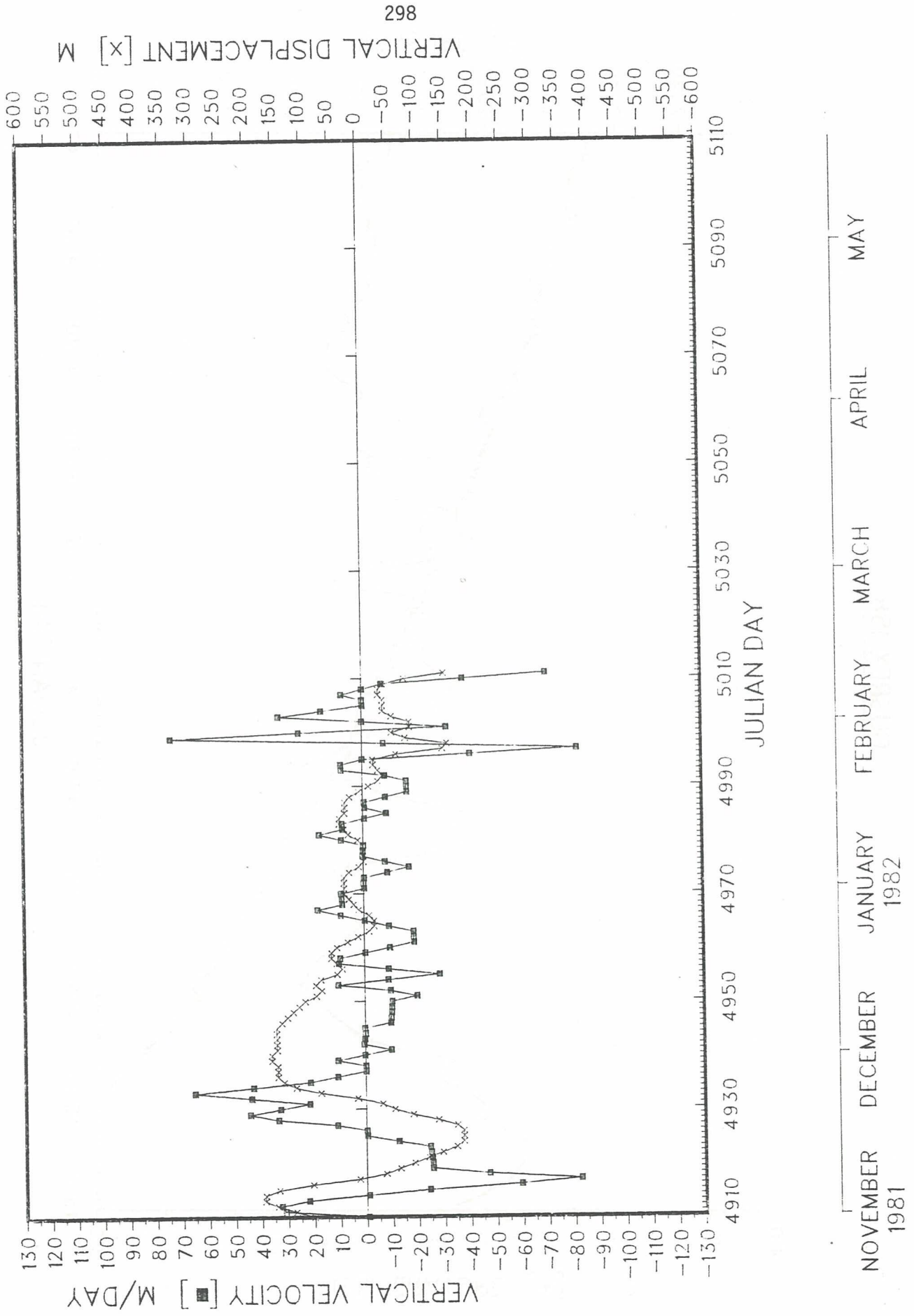
296

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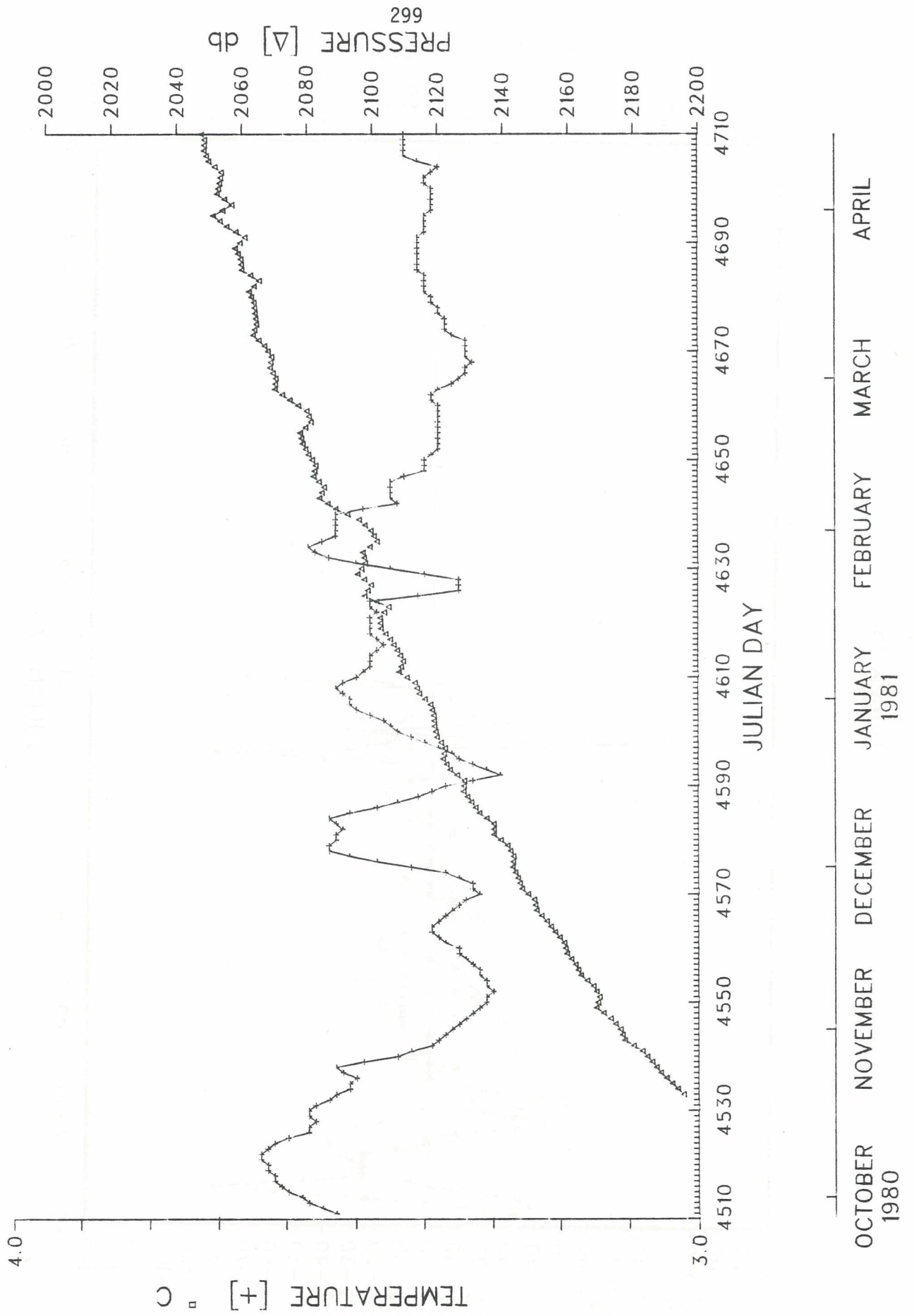


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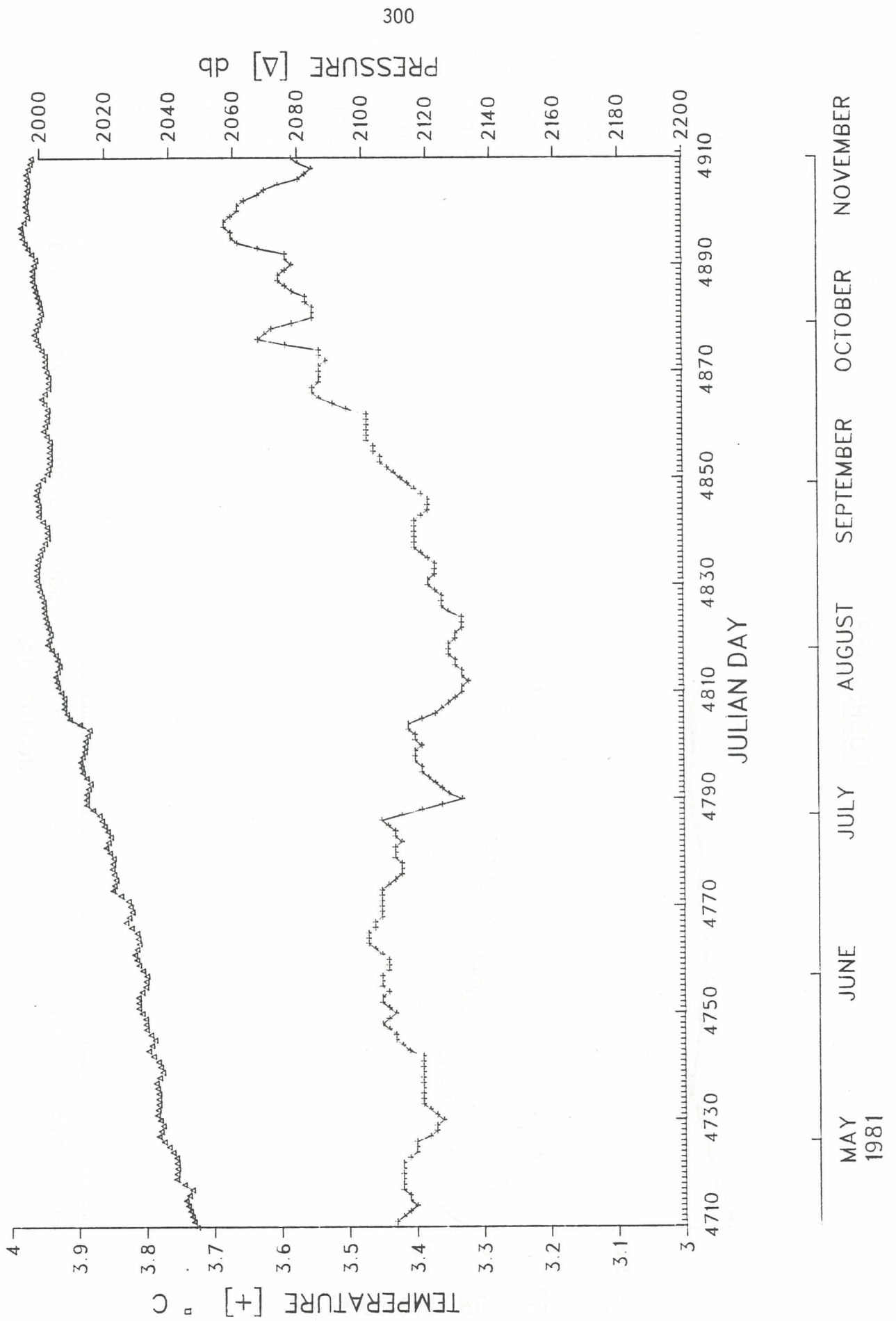
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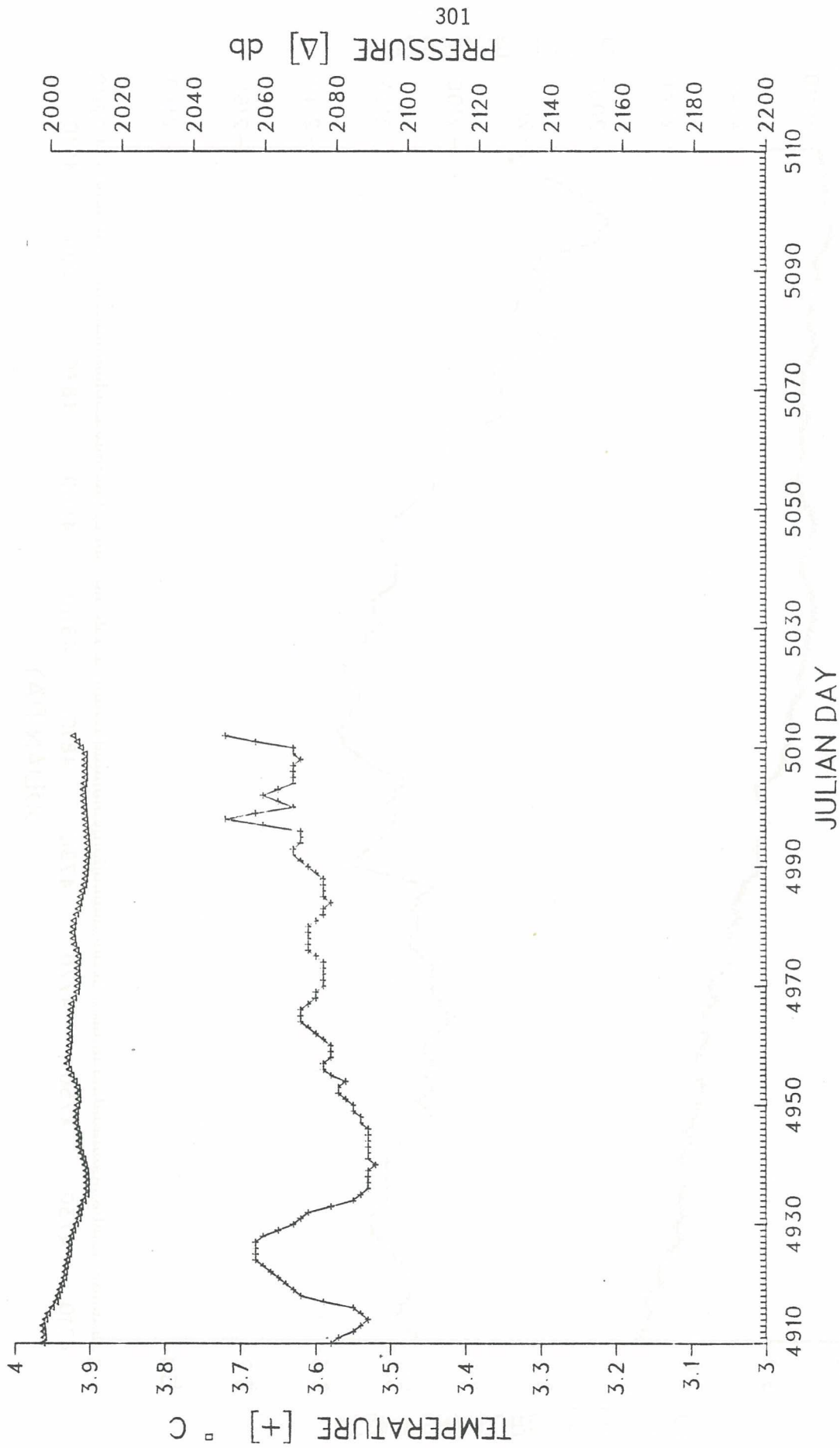
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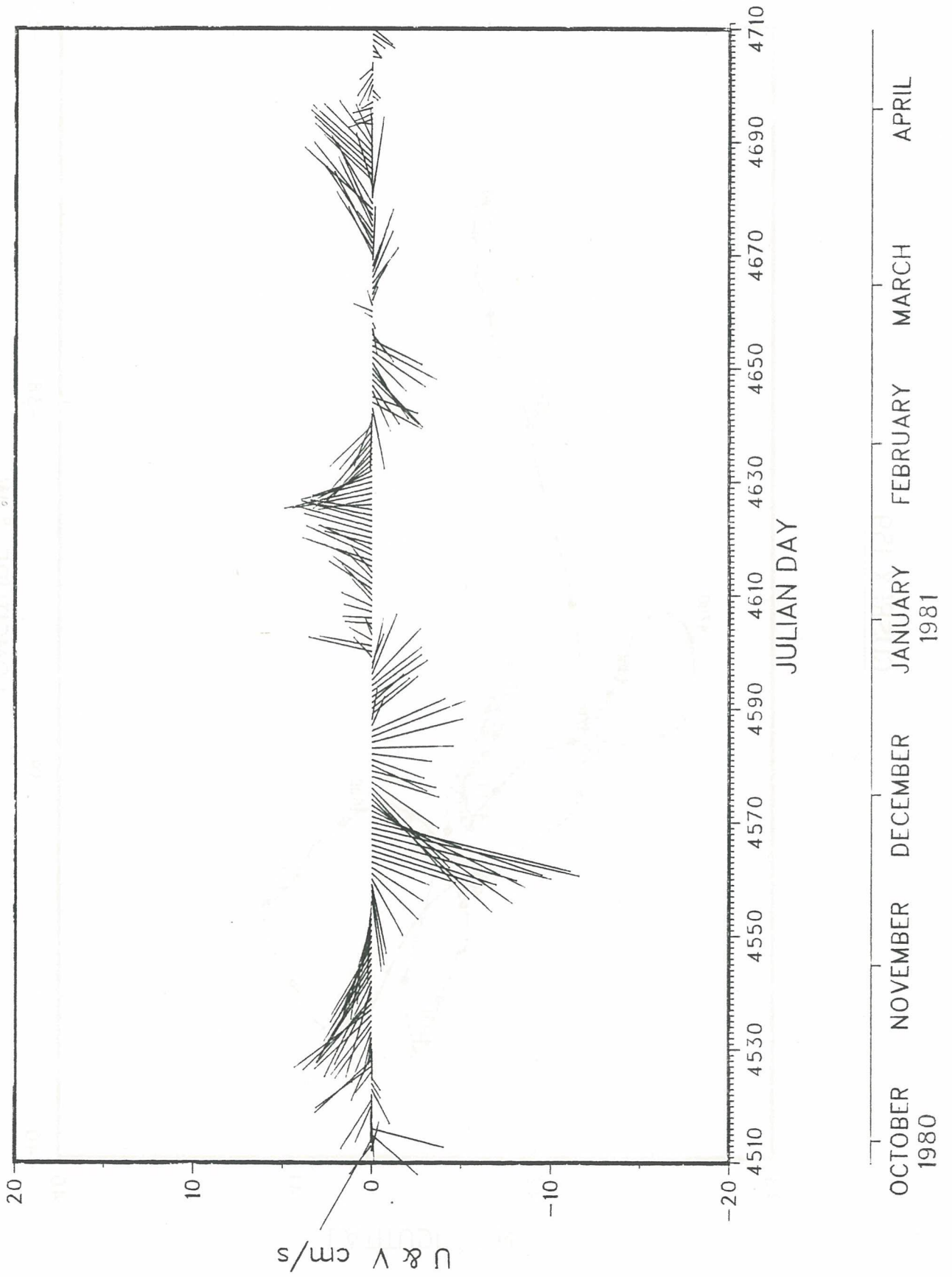
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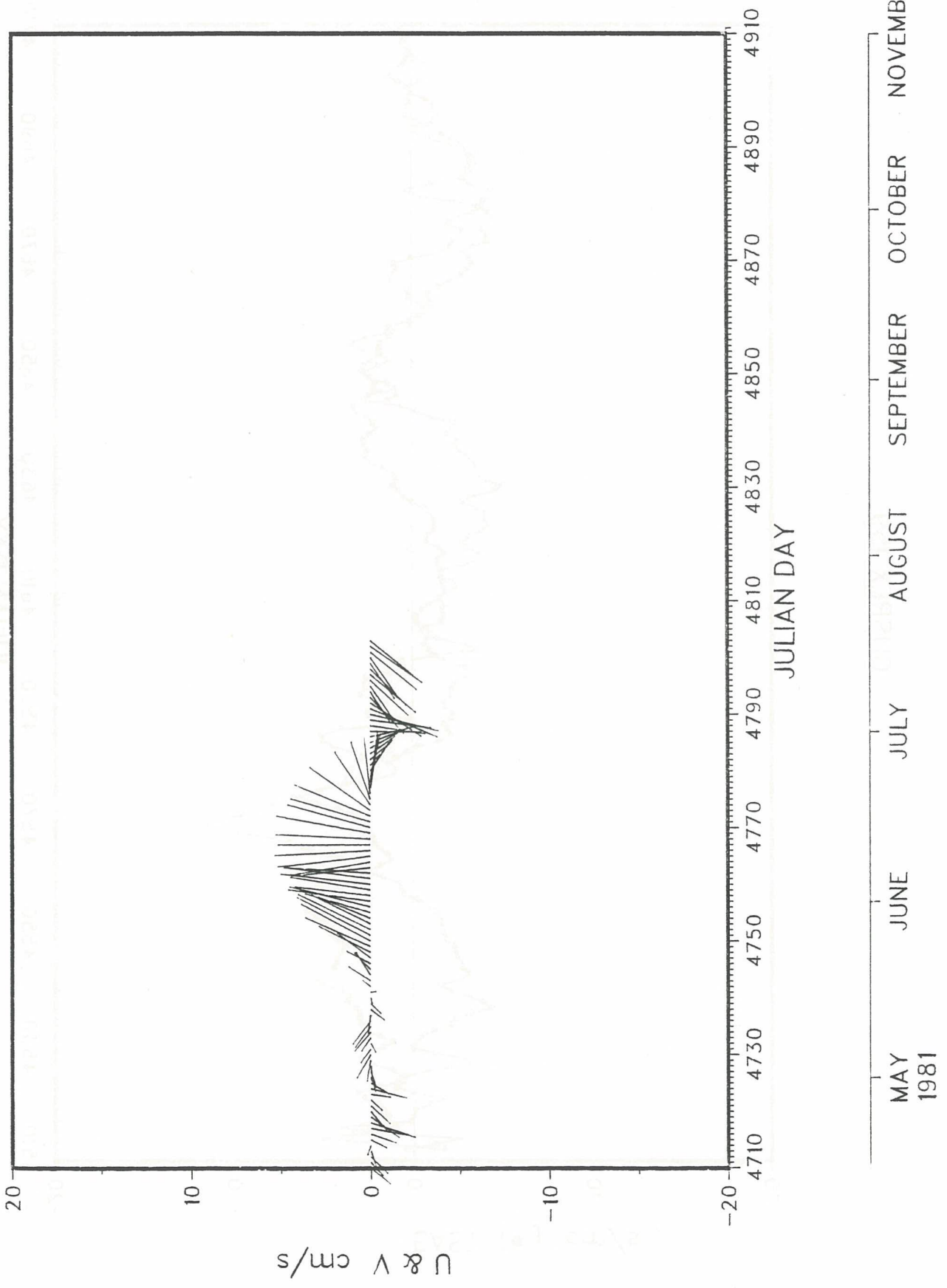
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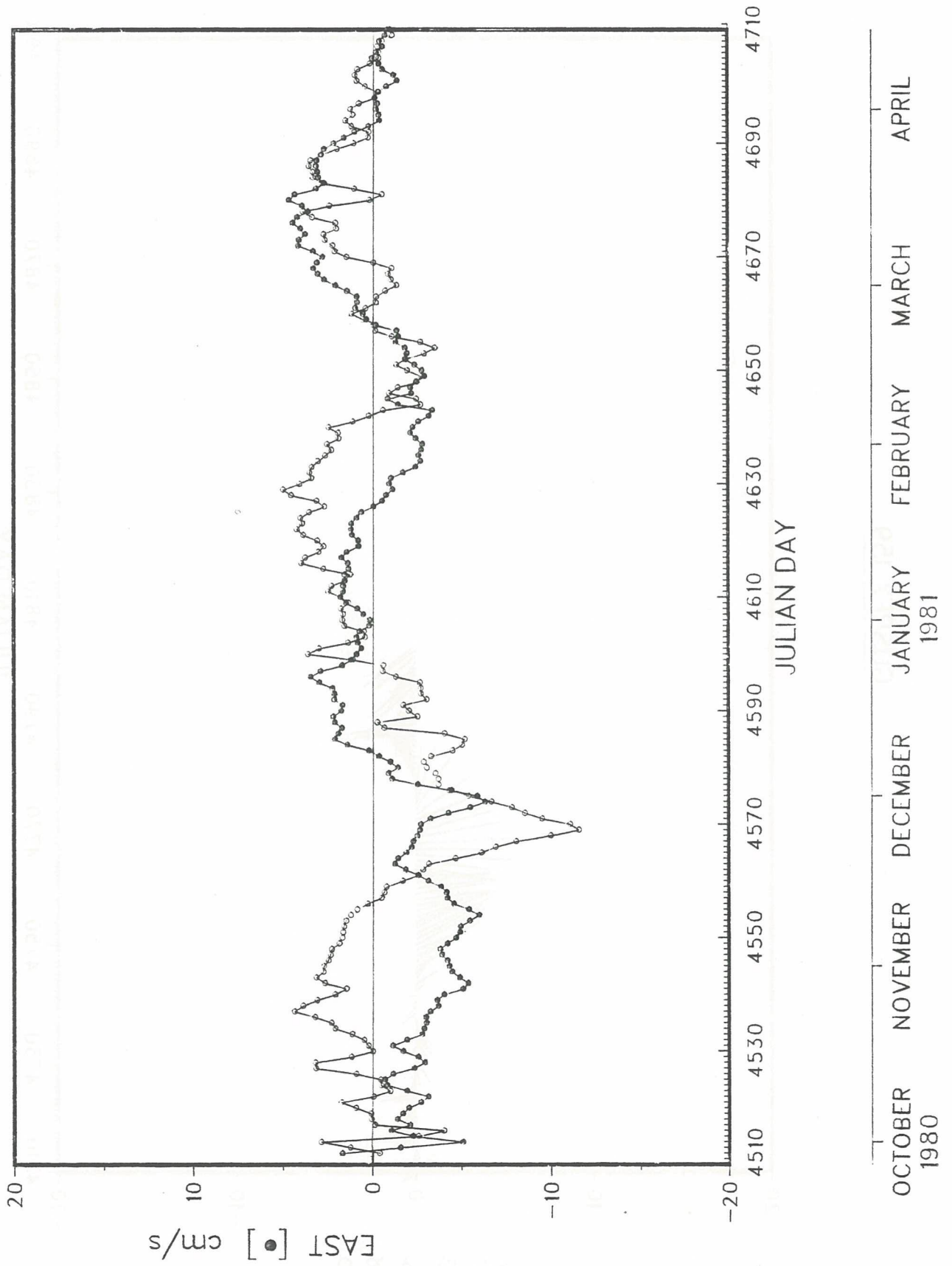
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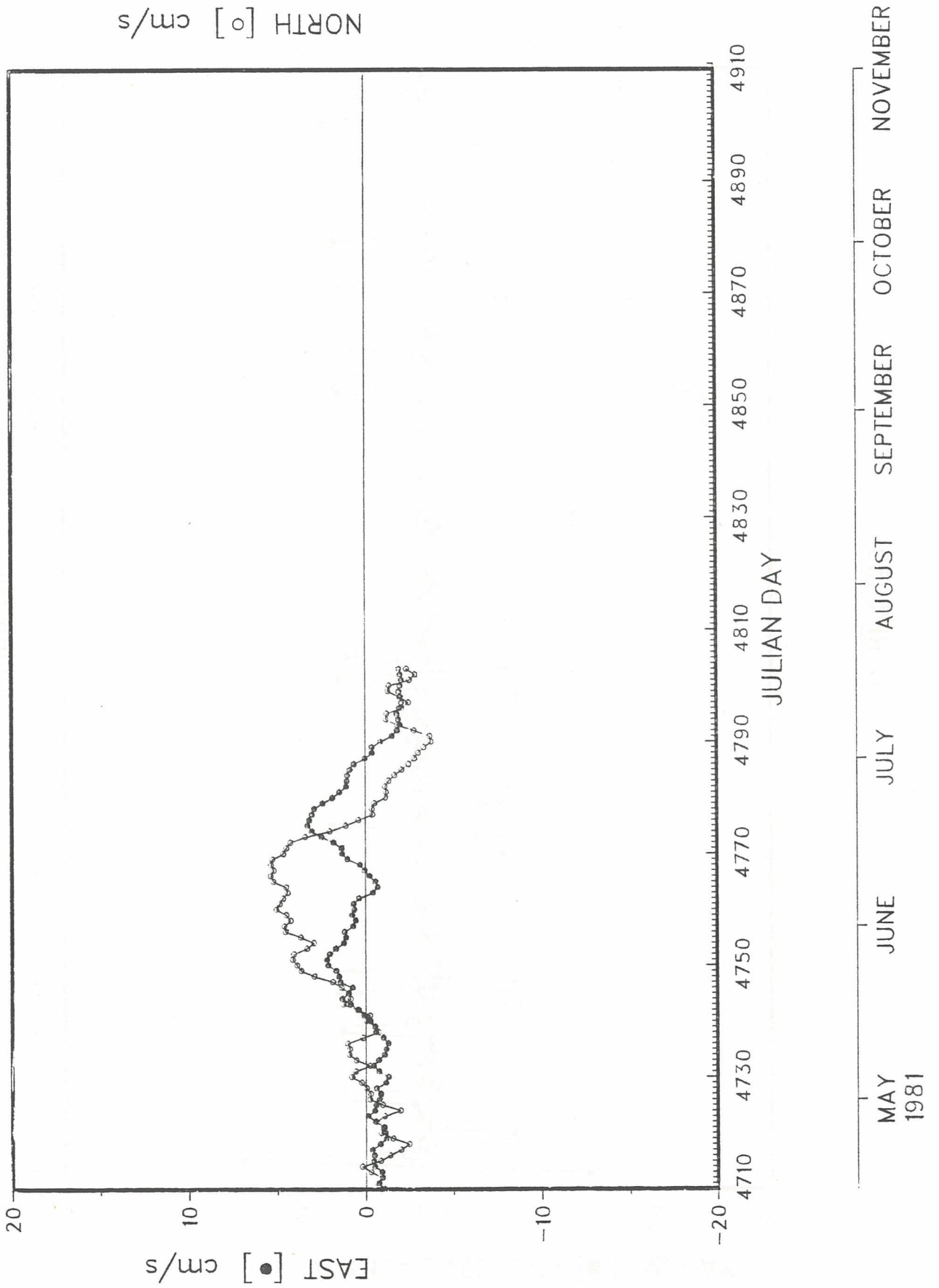
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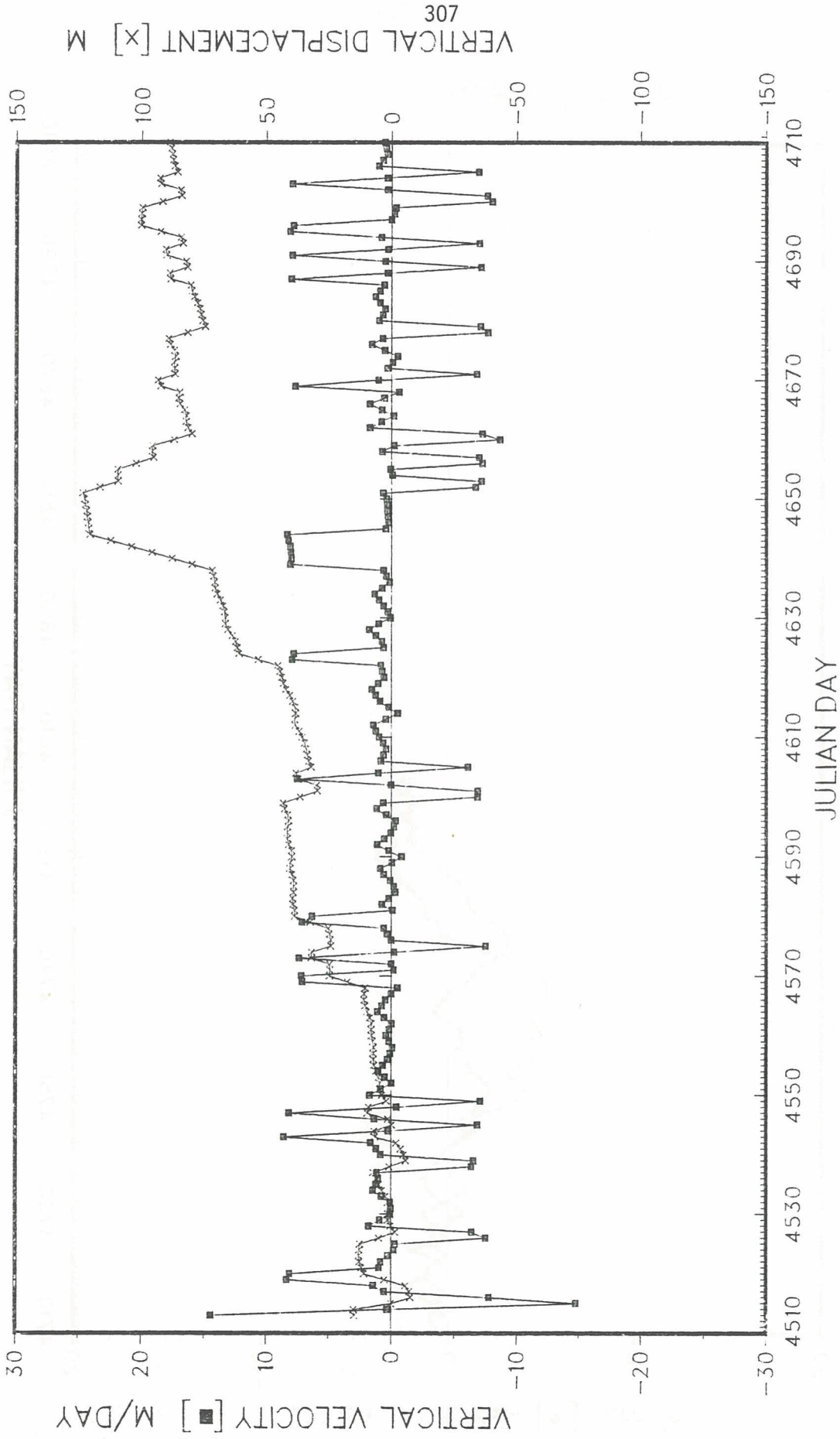
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GUSREX 159

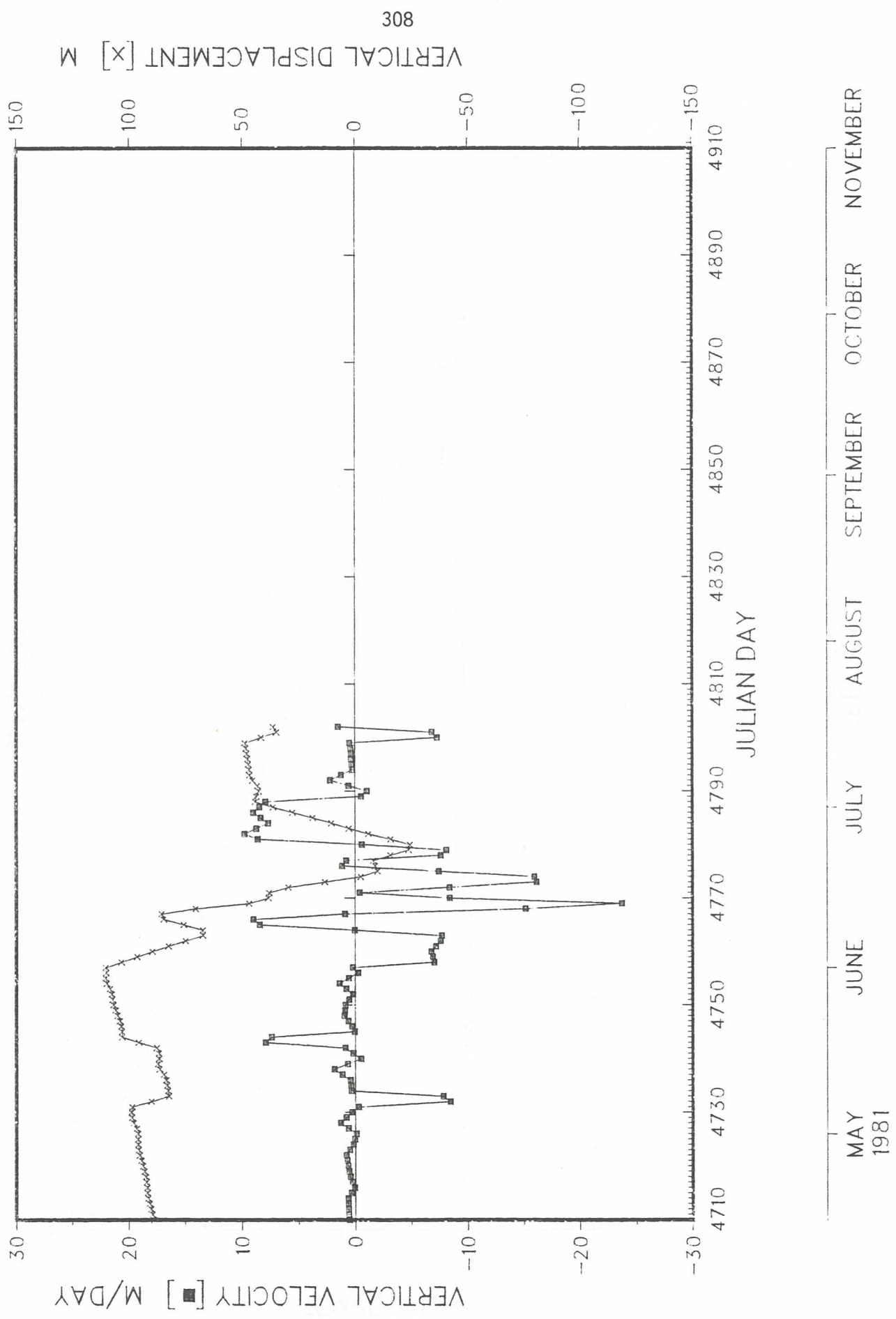


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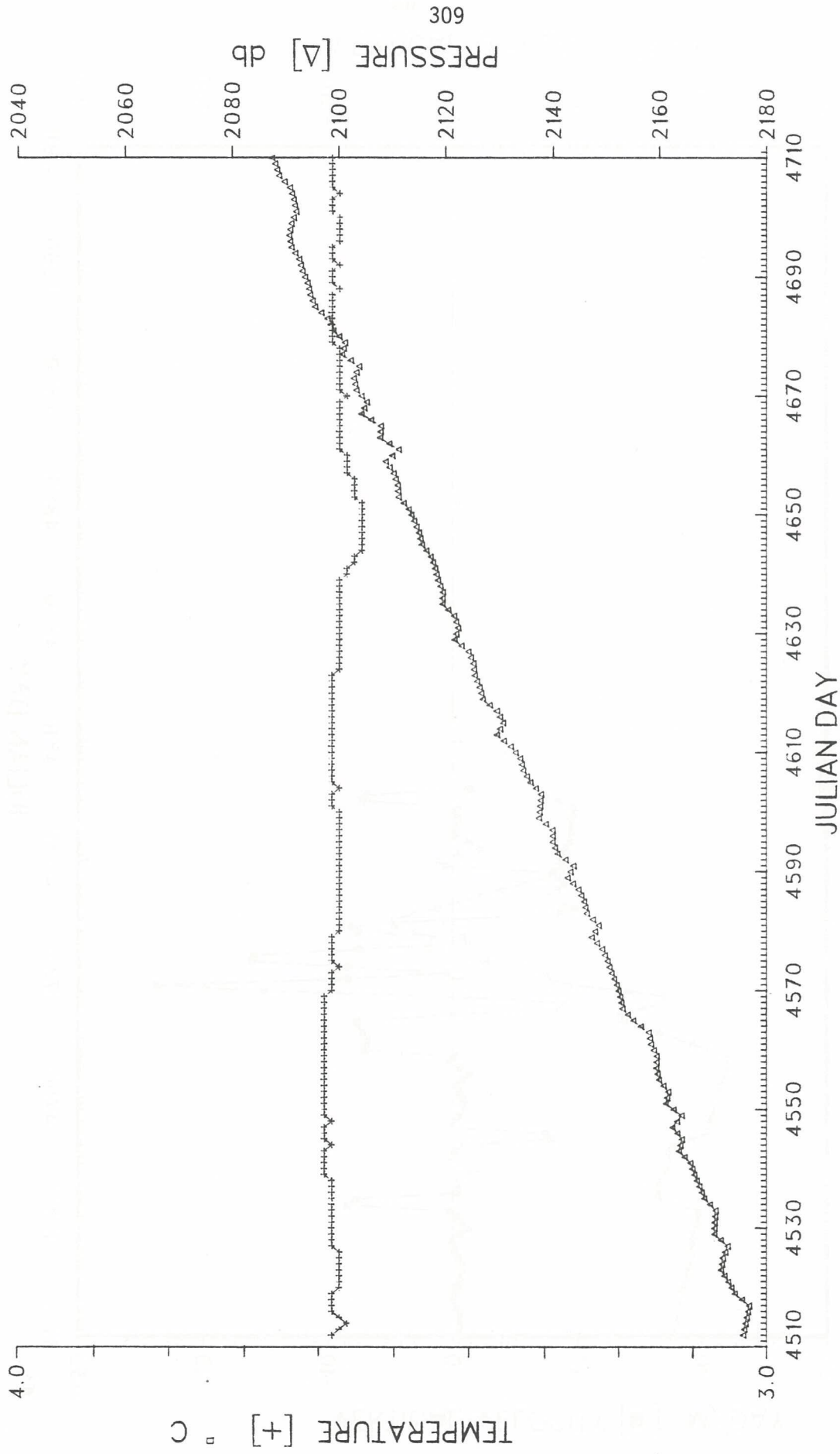
OCTOBER 1980 NOVEMBER DECEMBER JANUARY 1981 FEBRUARY MARCH APRIL

GUSREX 159



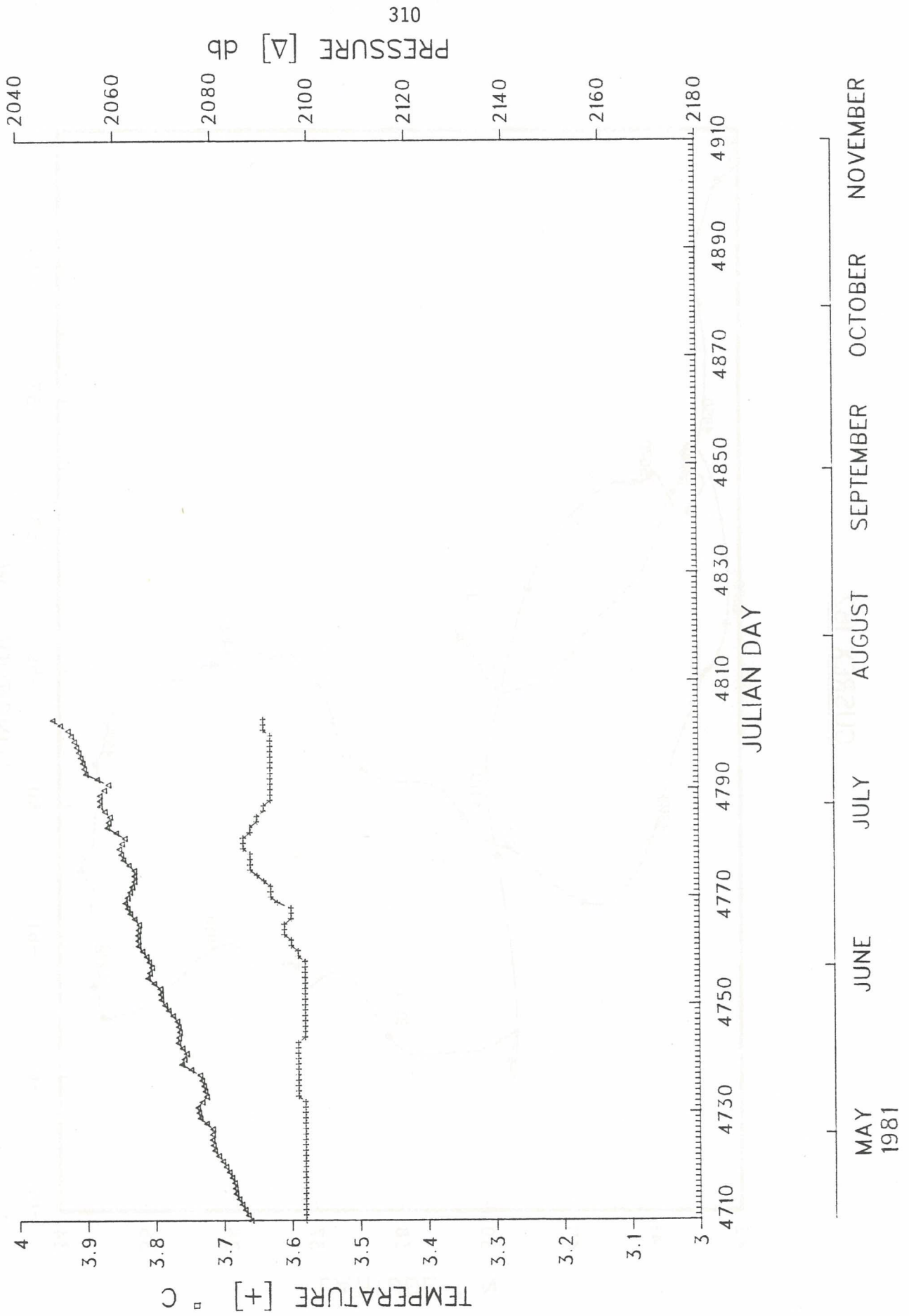
308

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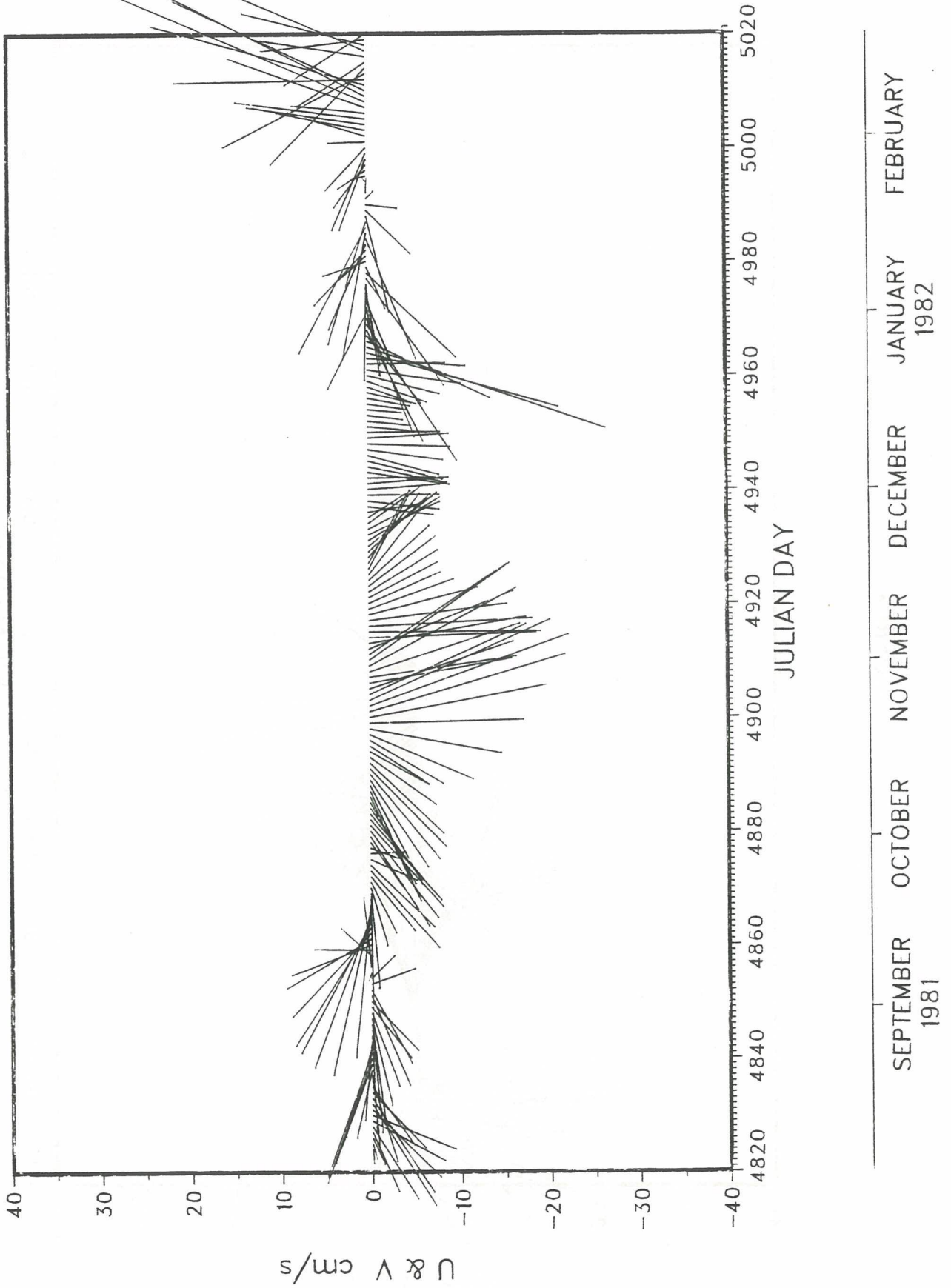


OCTOBER 1980 NOVEMBER DECEMBER JANUARY FEBRUARY MARCH APRIL 1981

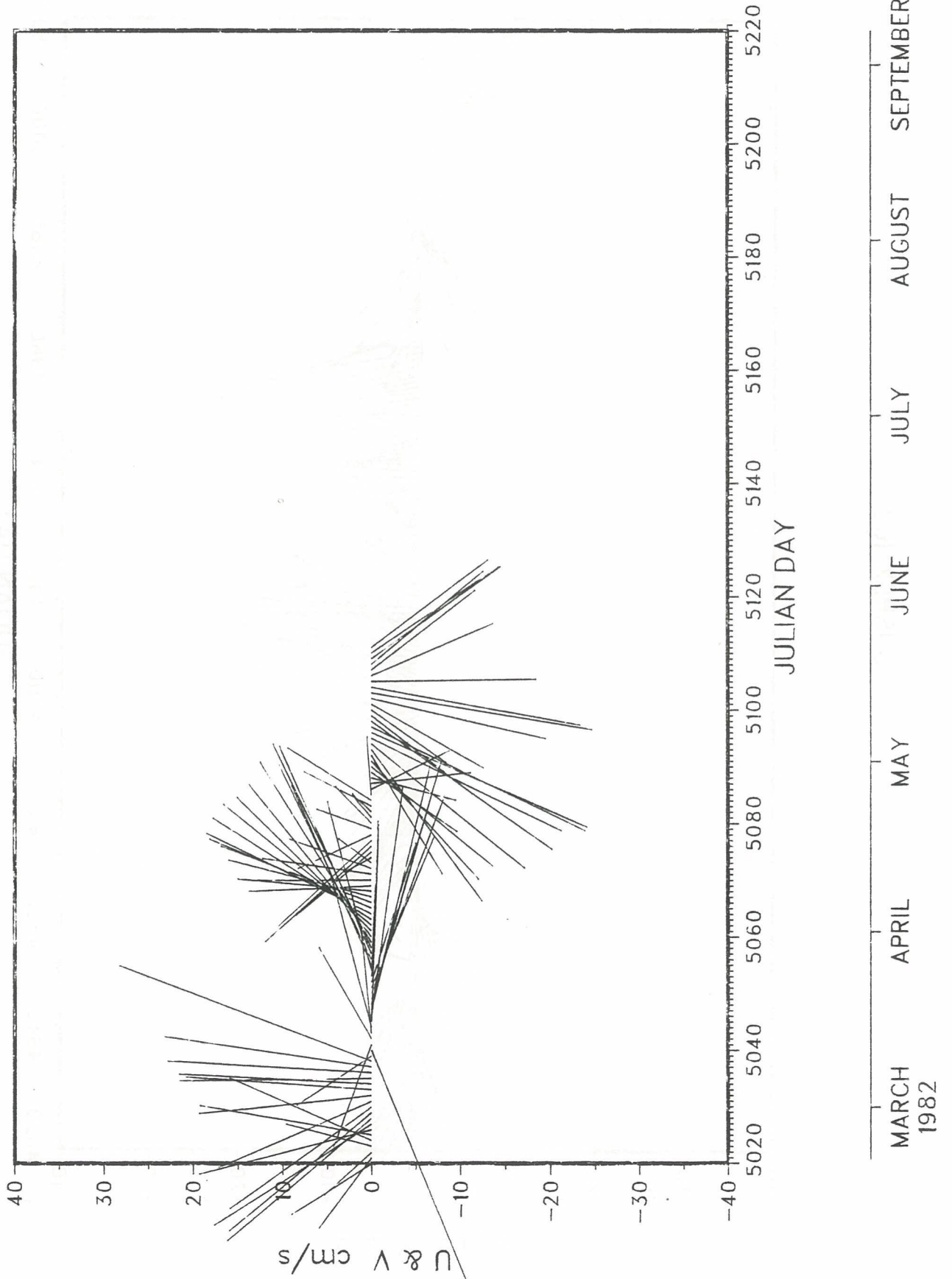
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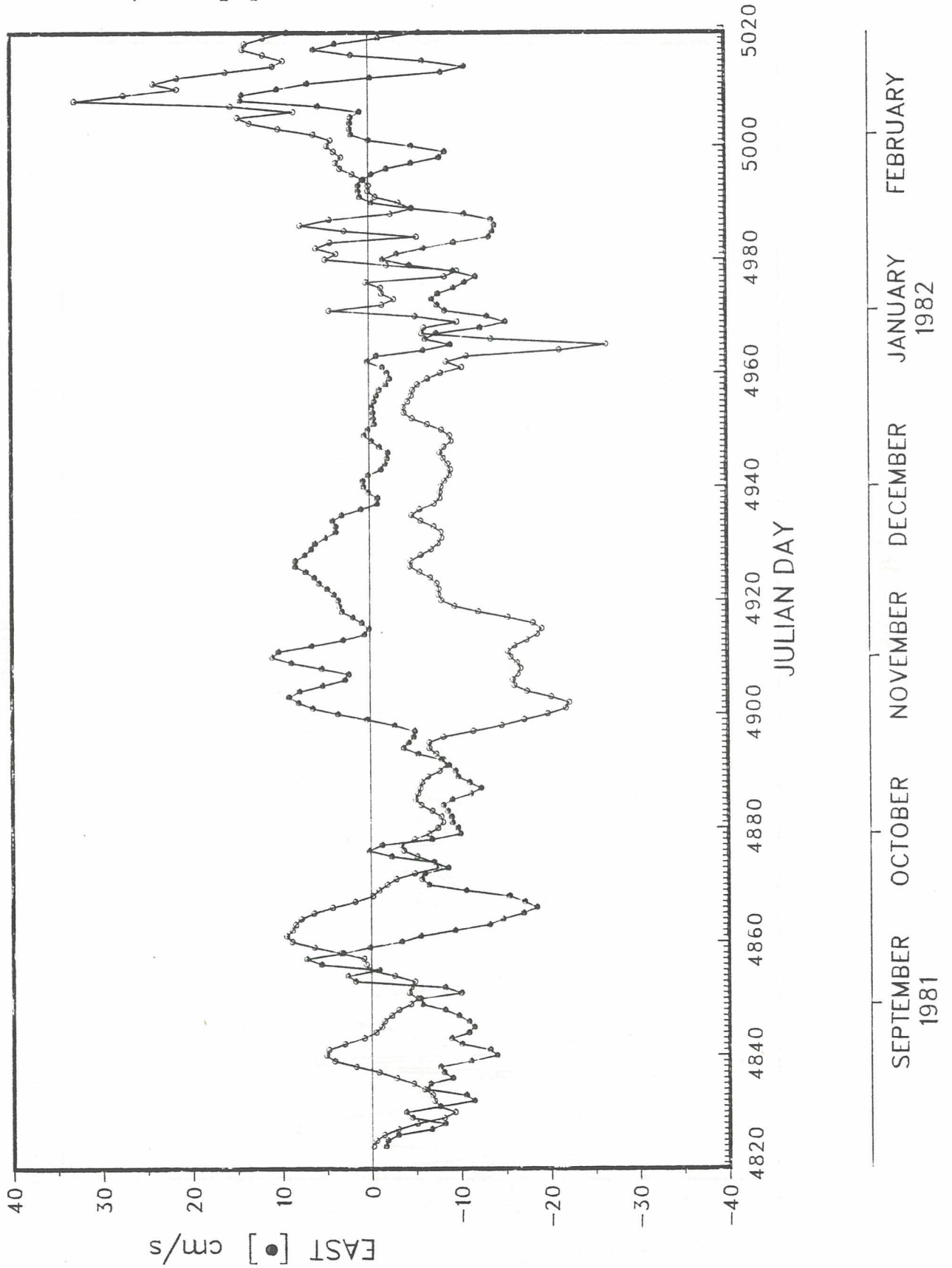
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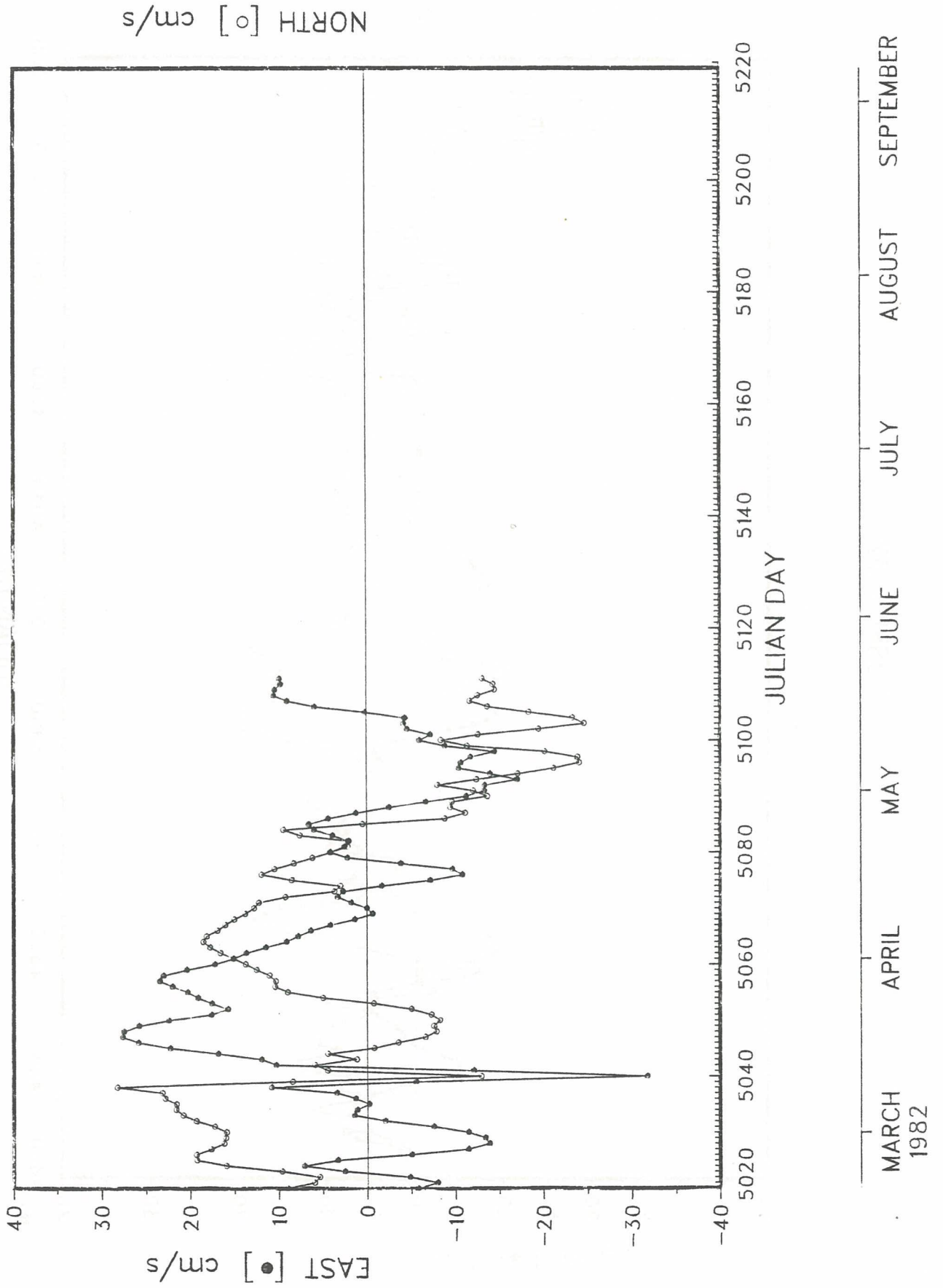
MARCH 1982 APRIL MAY JUNE JULY AUGUST SEPTEMBER

GUSREX 162

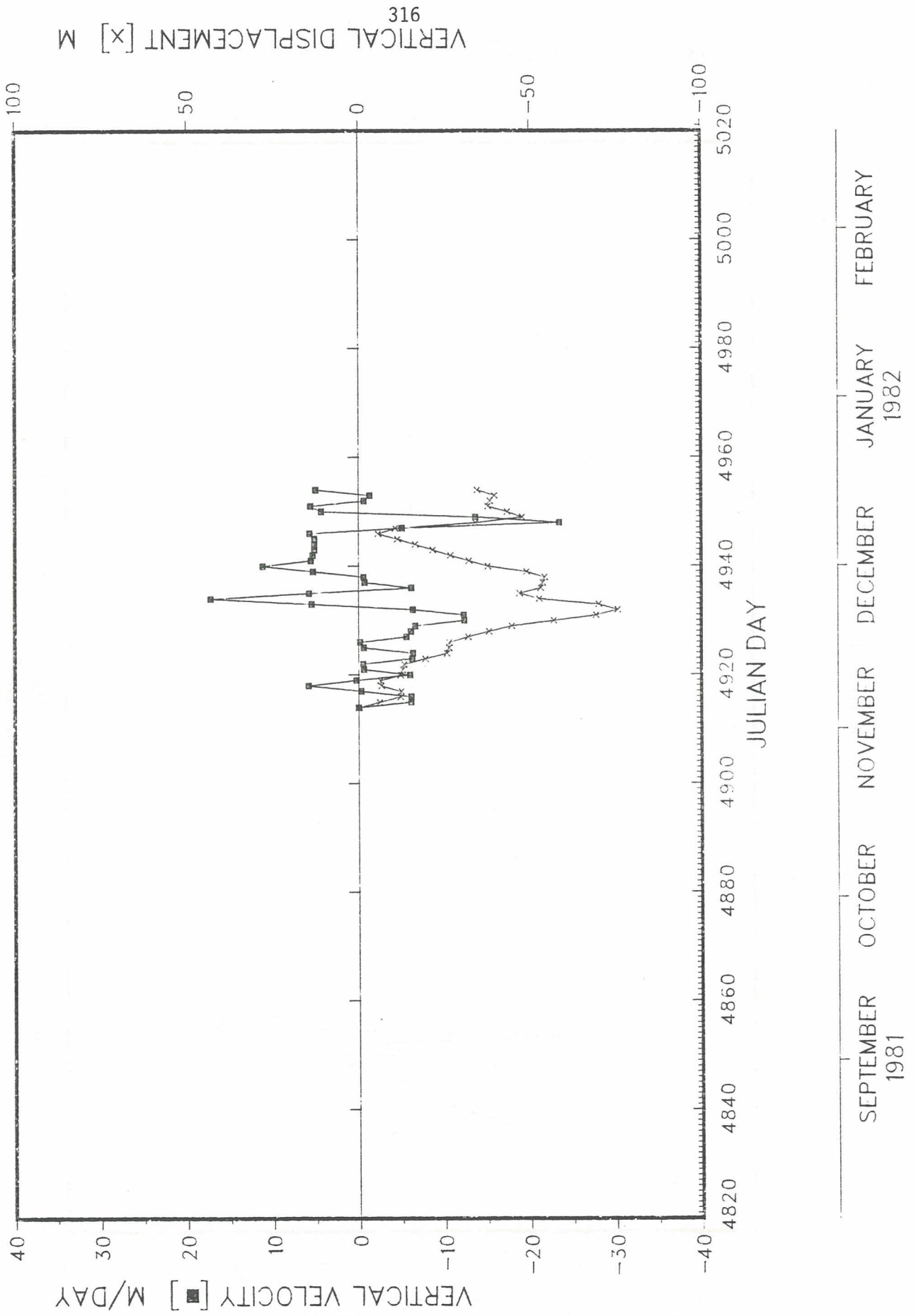
314



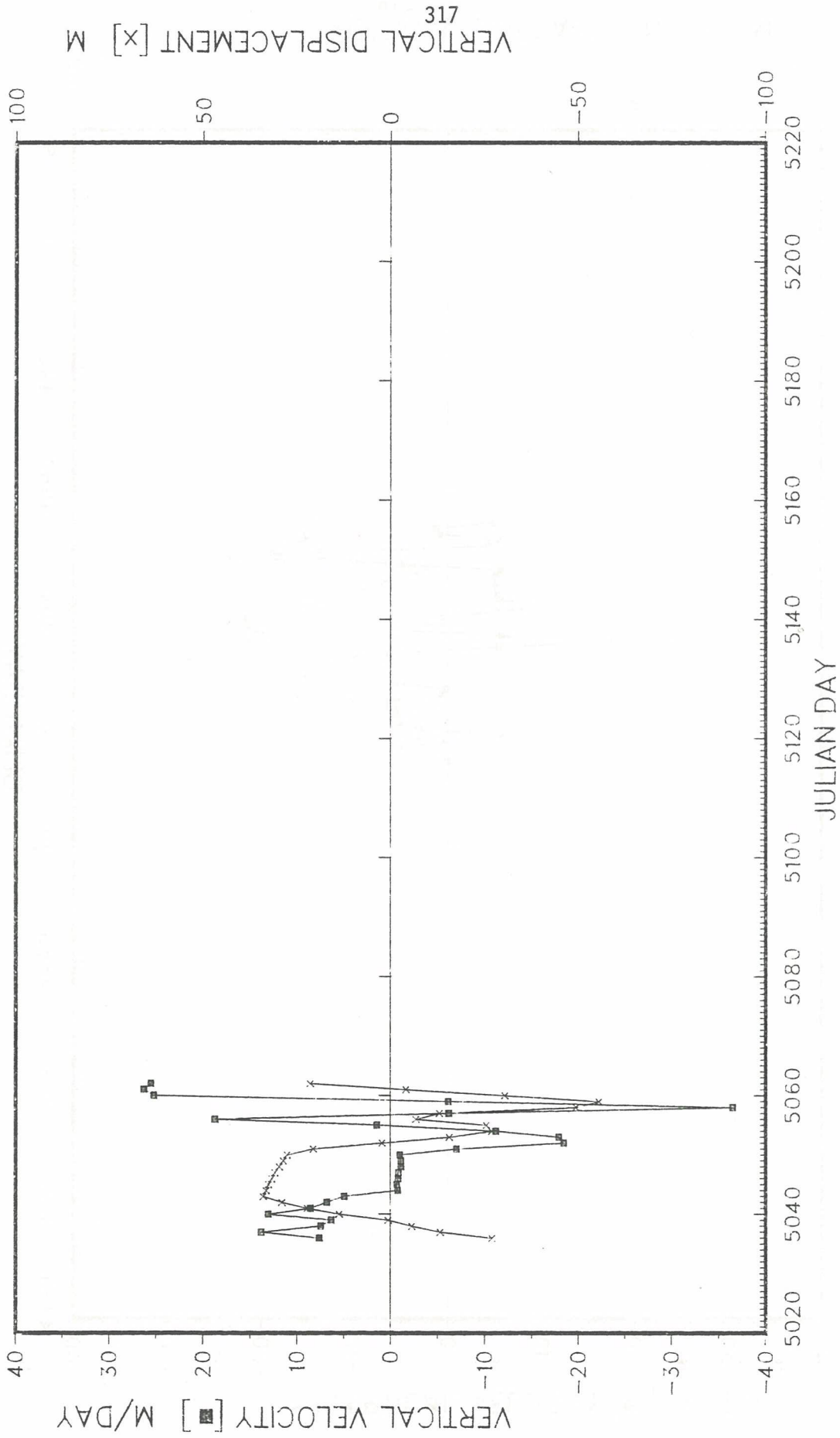
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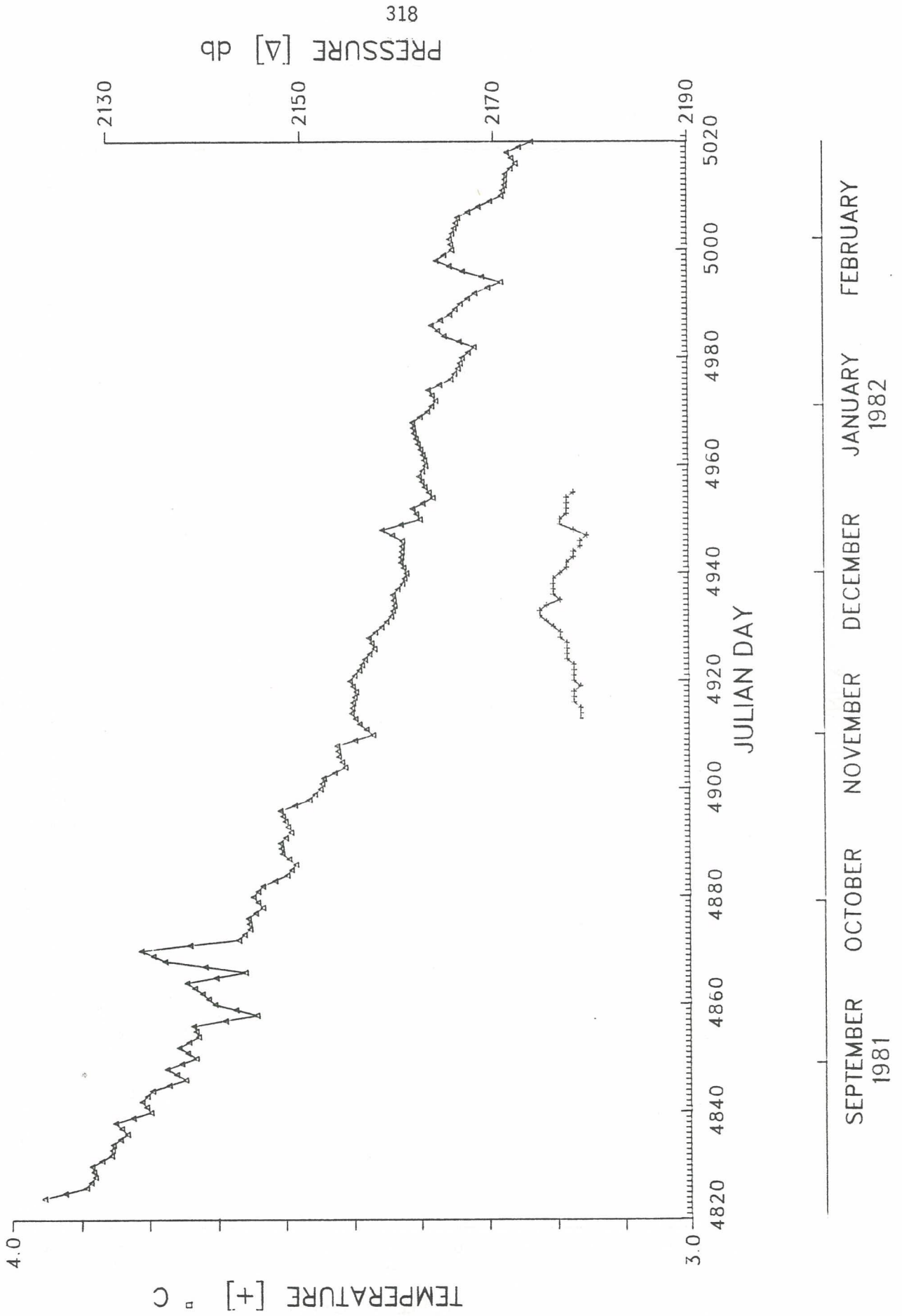
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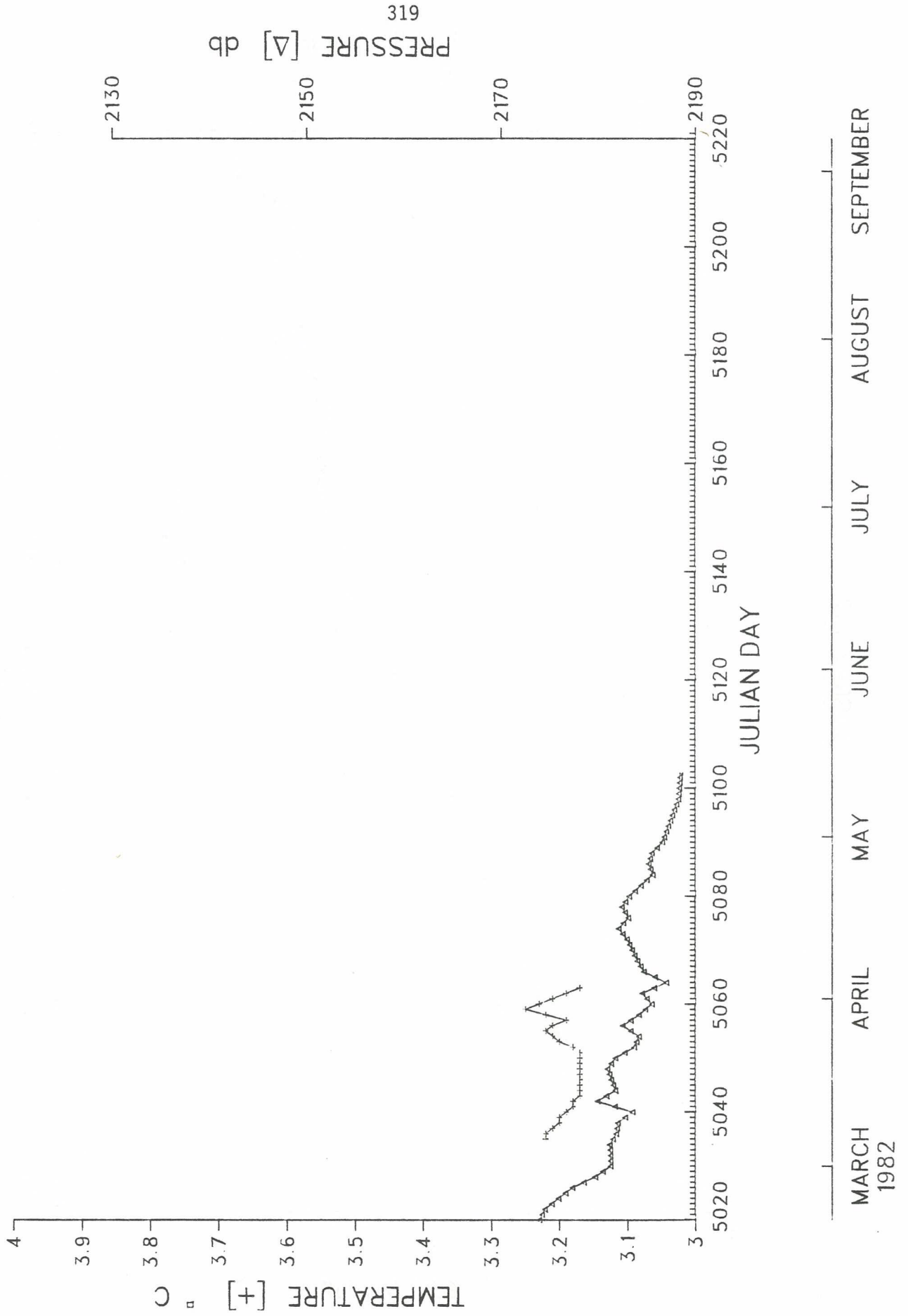
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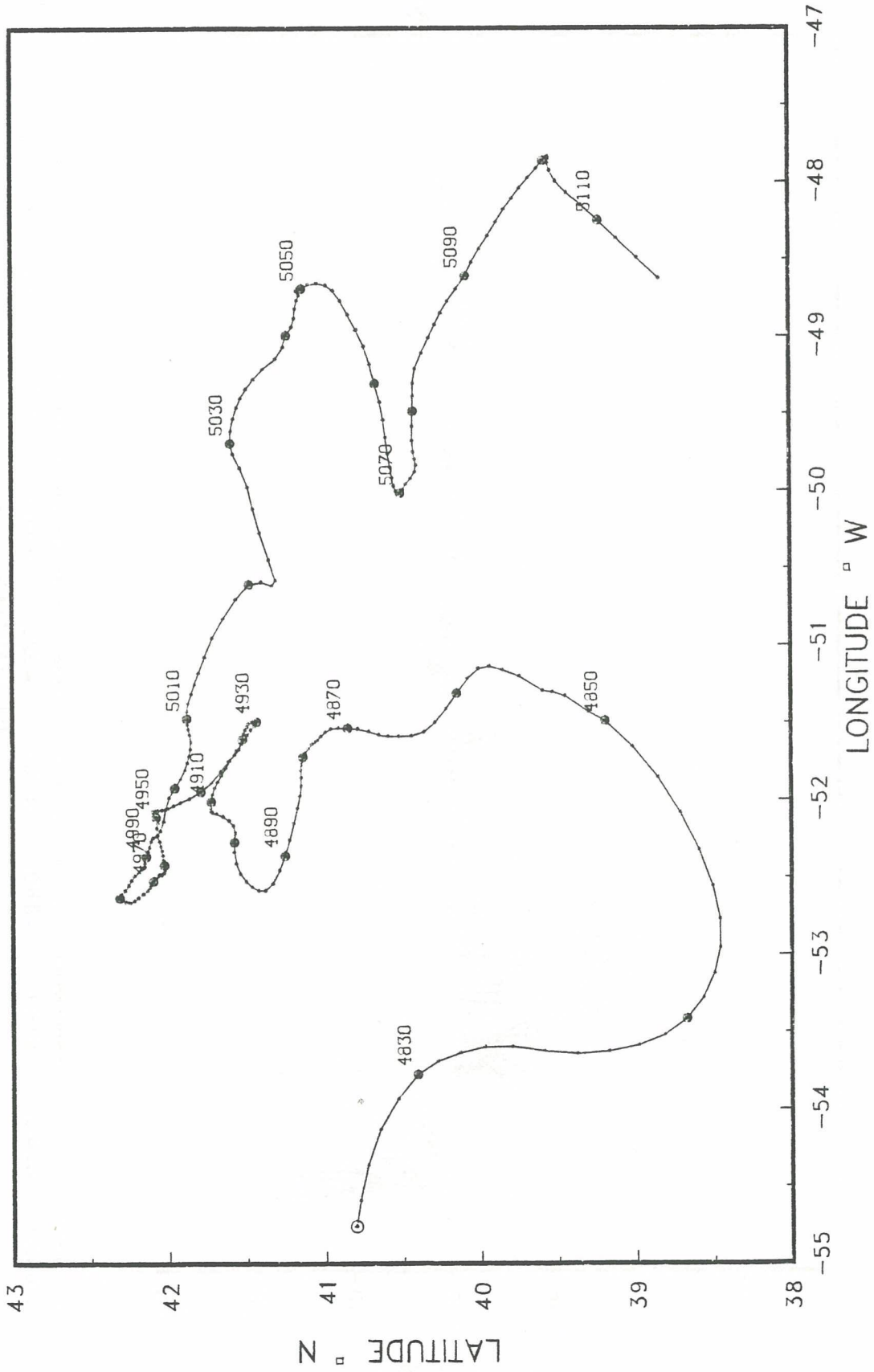
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GUSREX 162

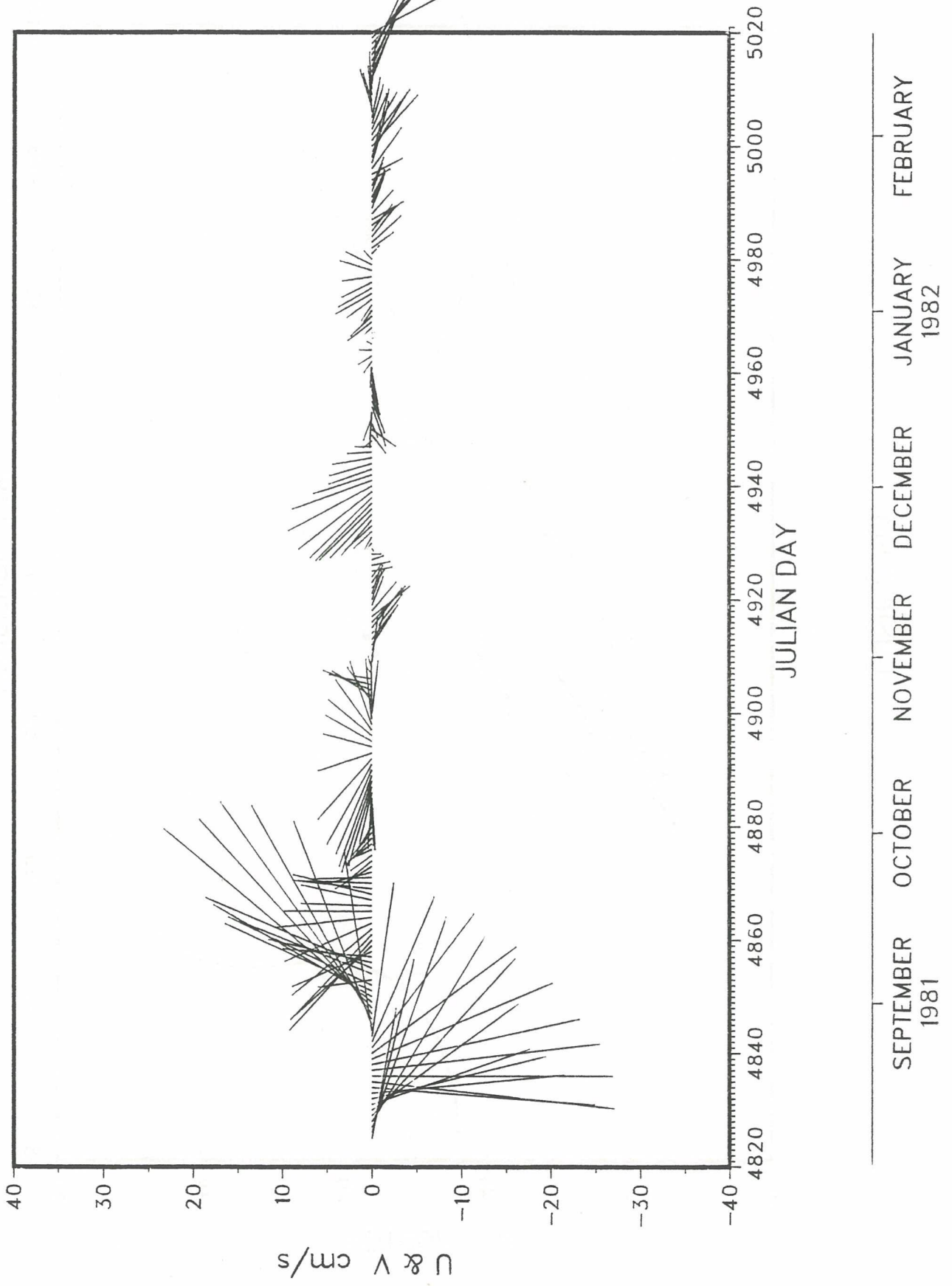


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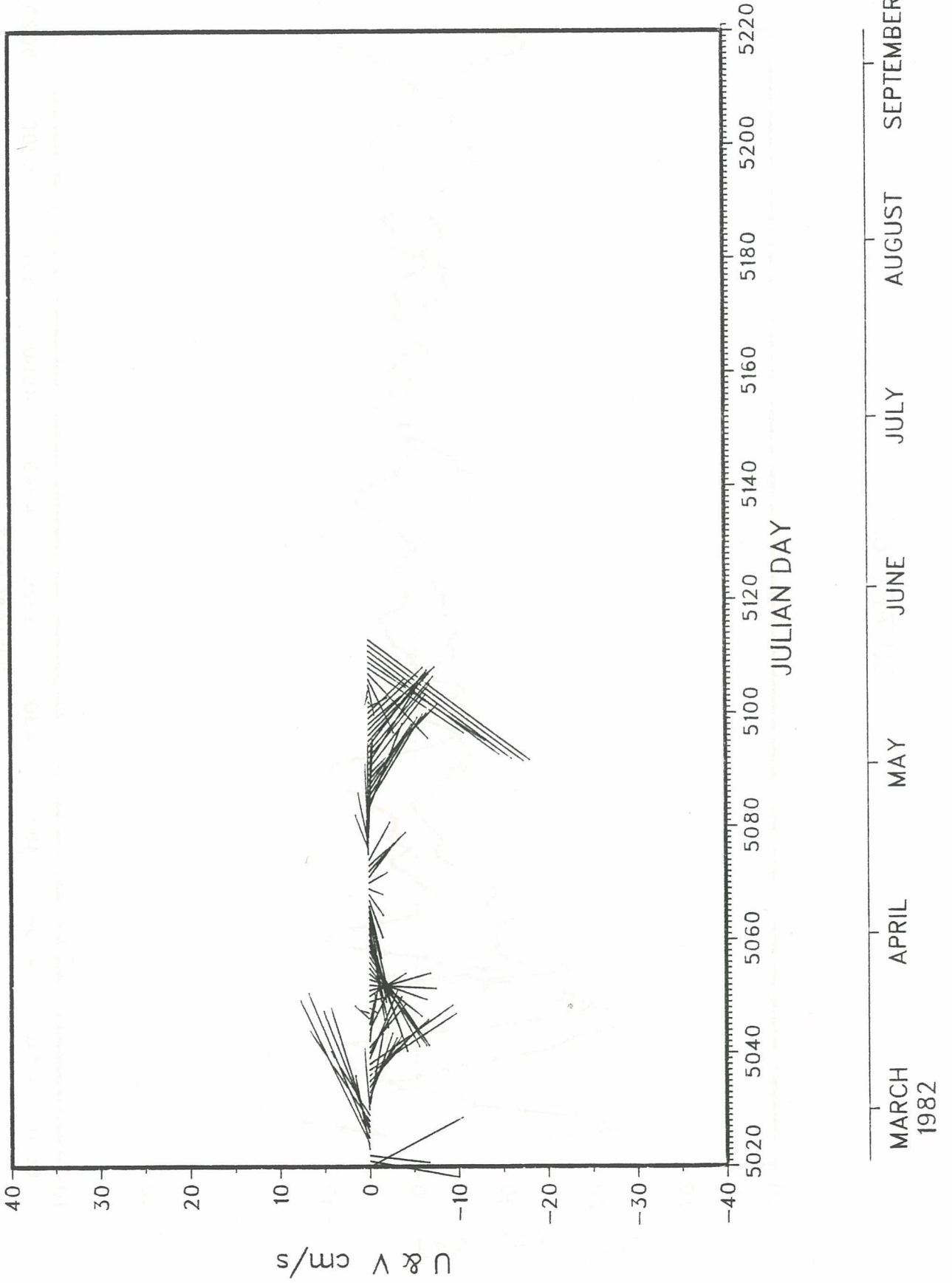


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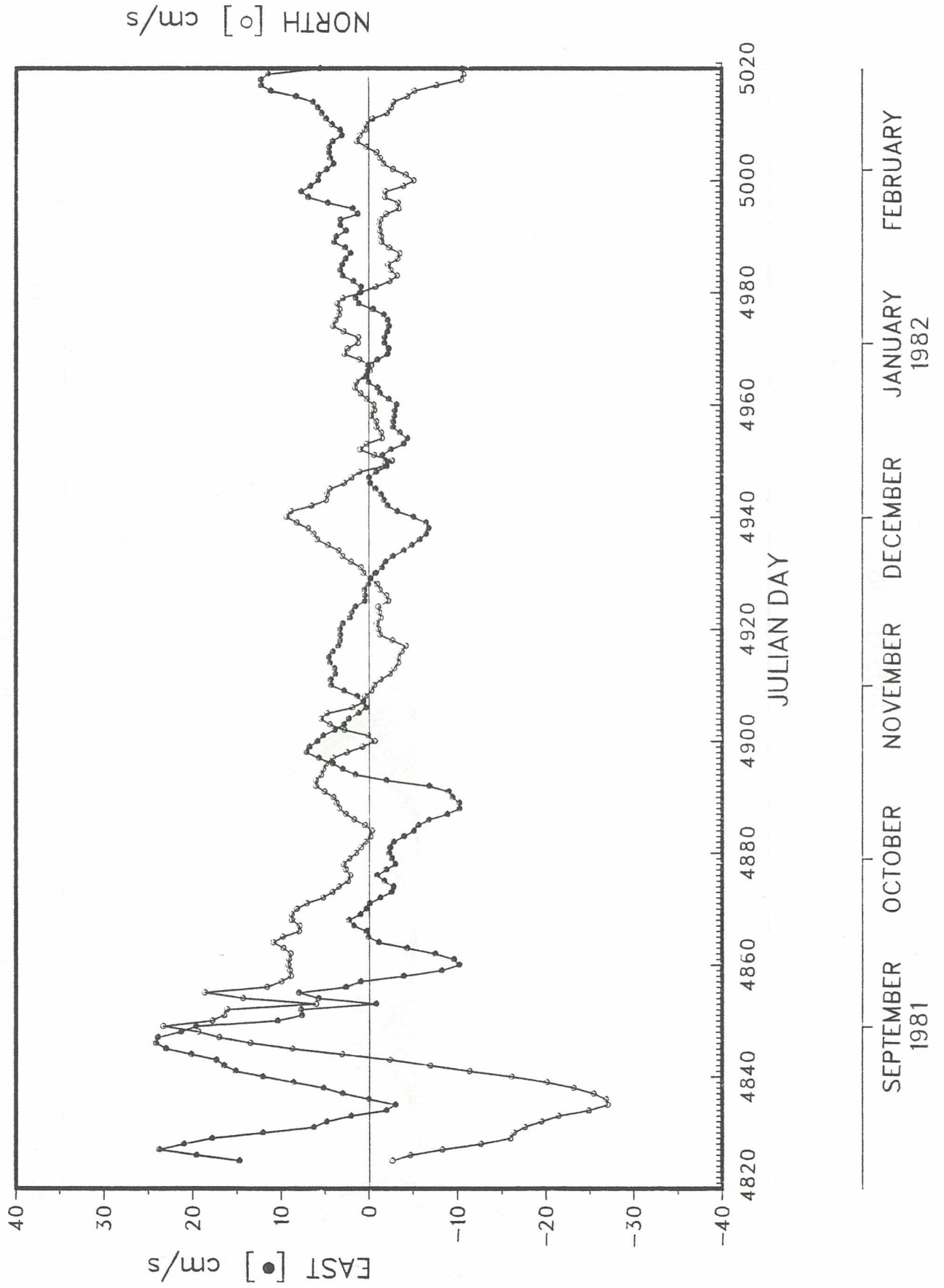
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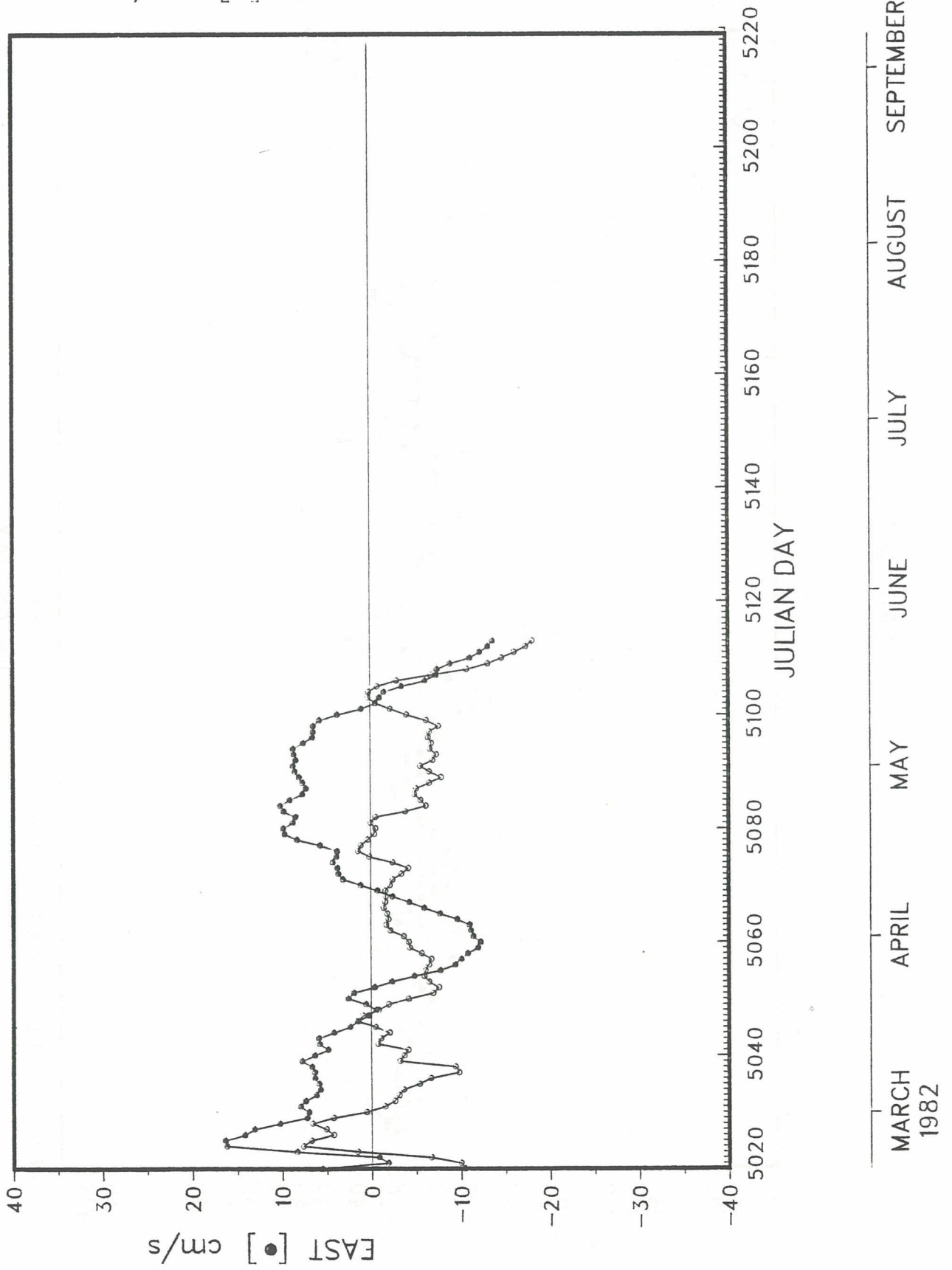
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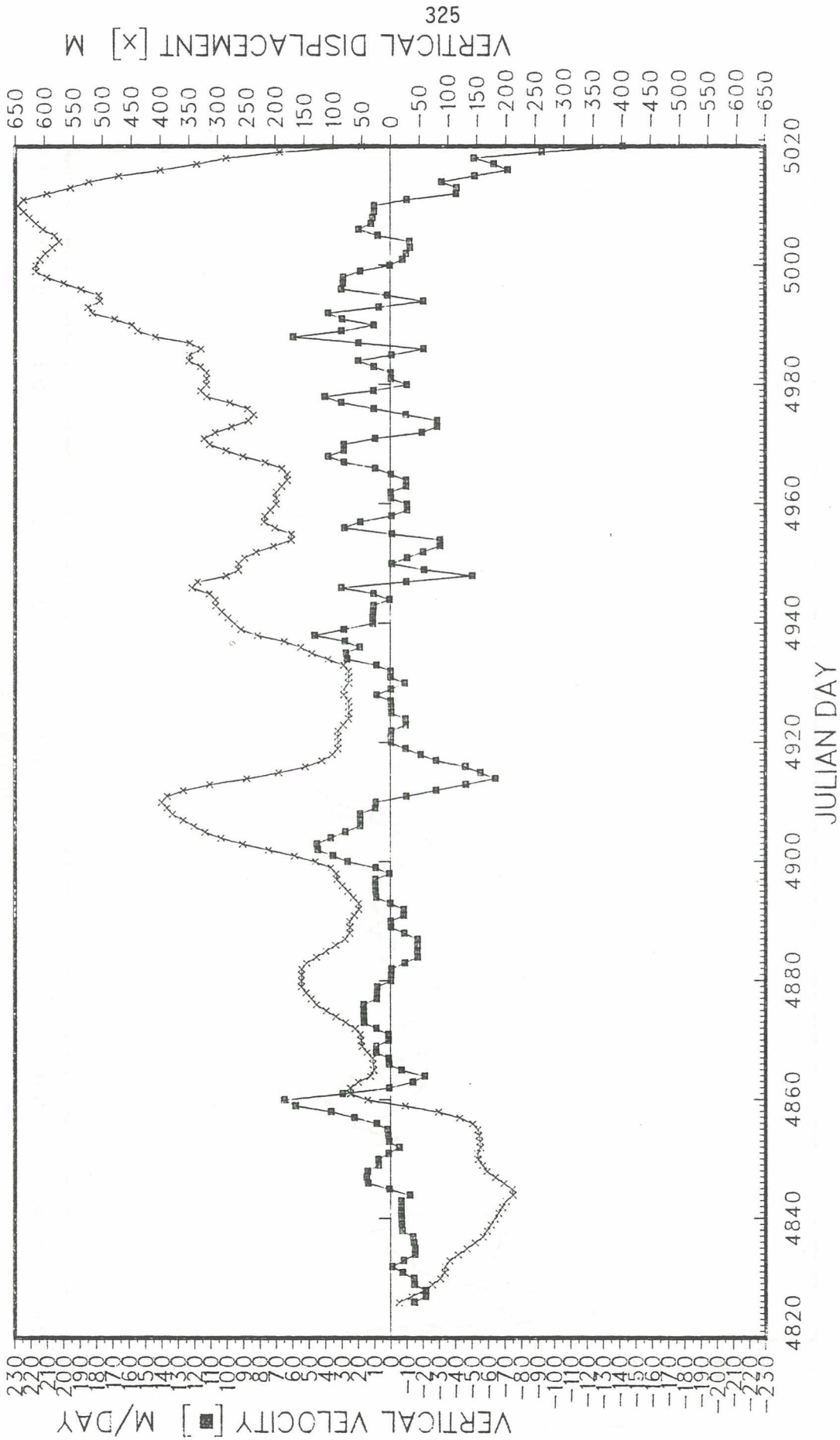
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GUSREX 163

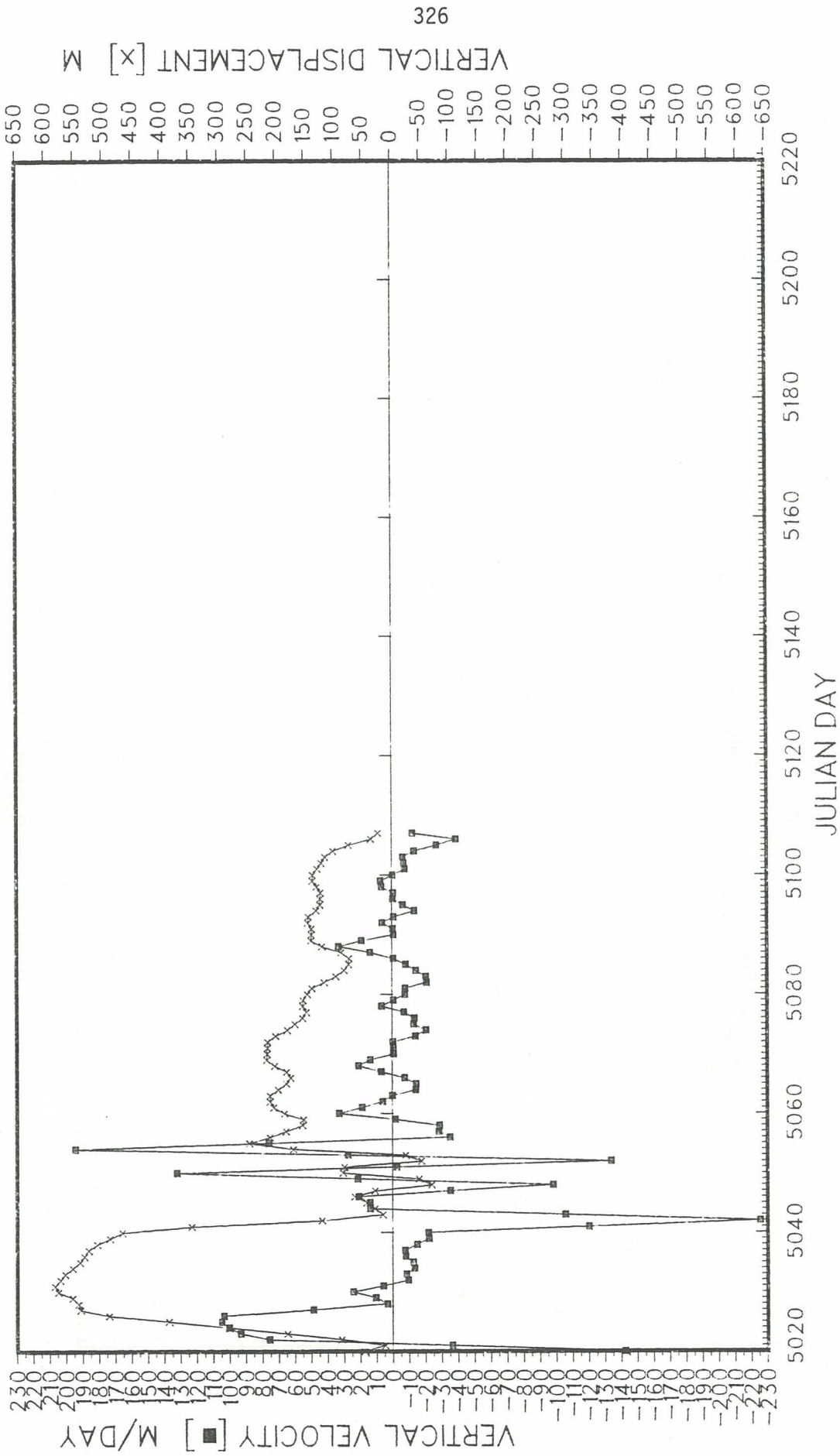


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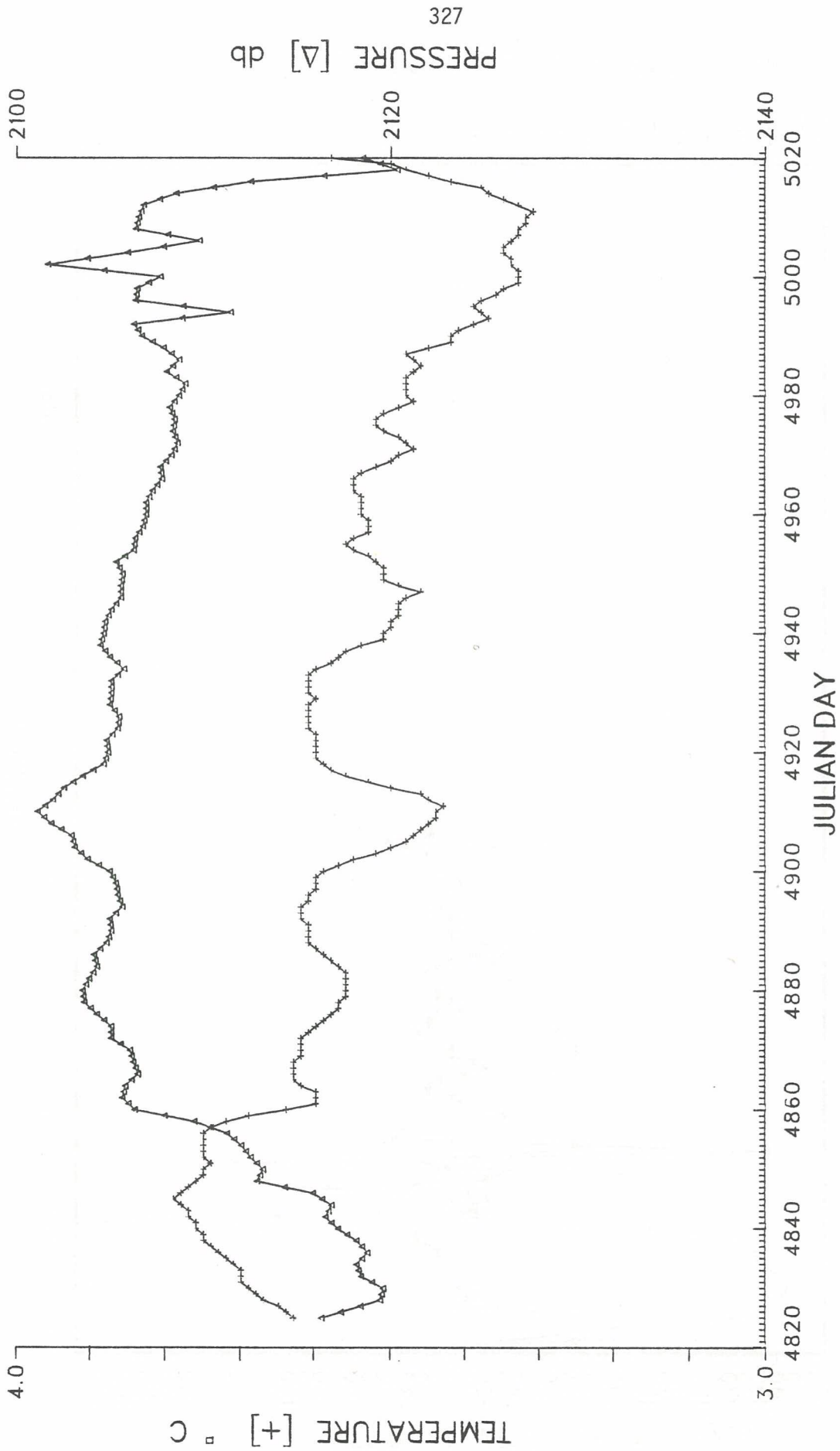


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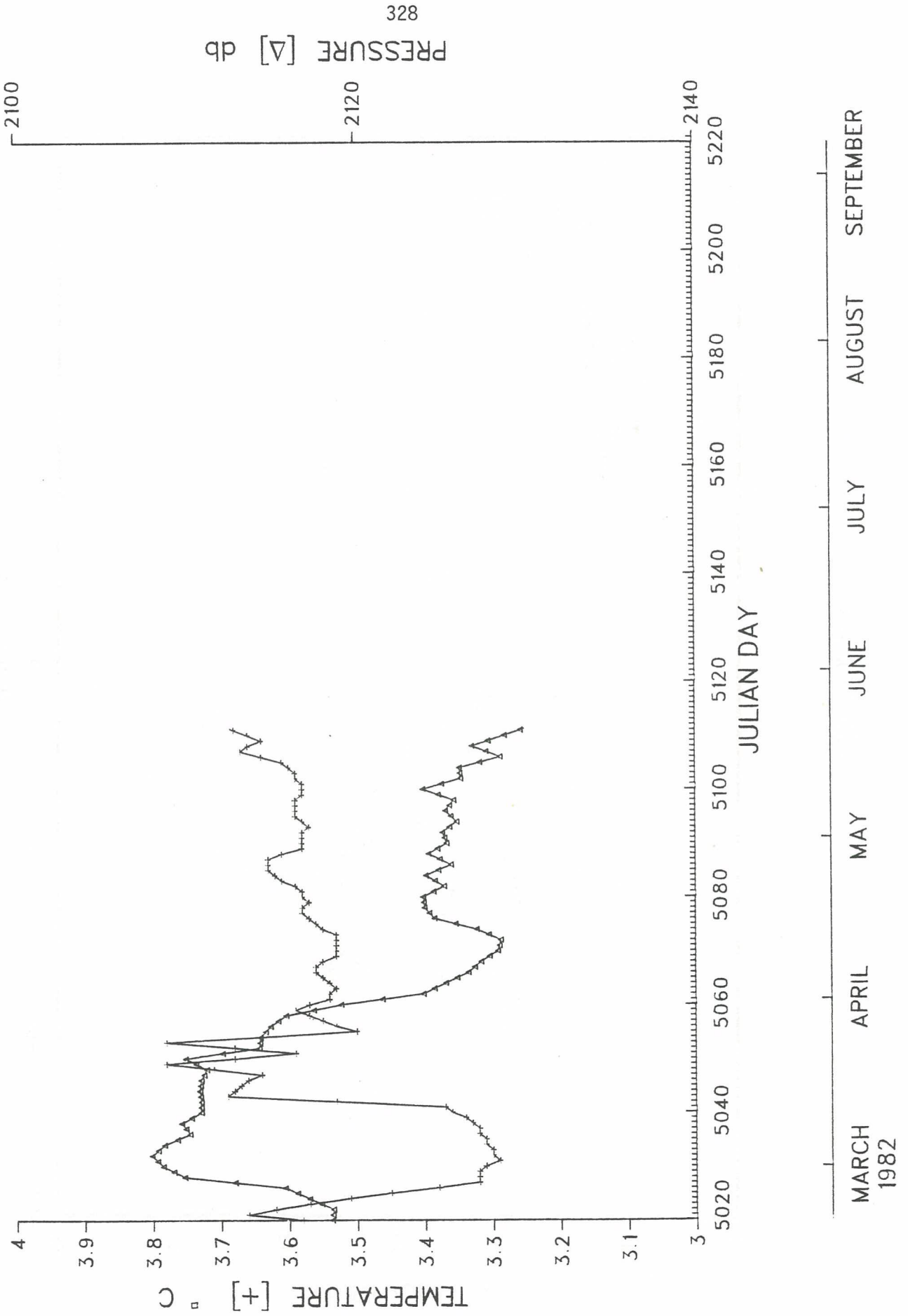


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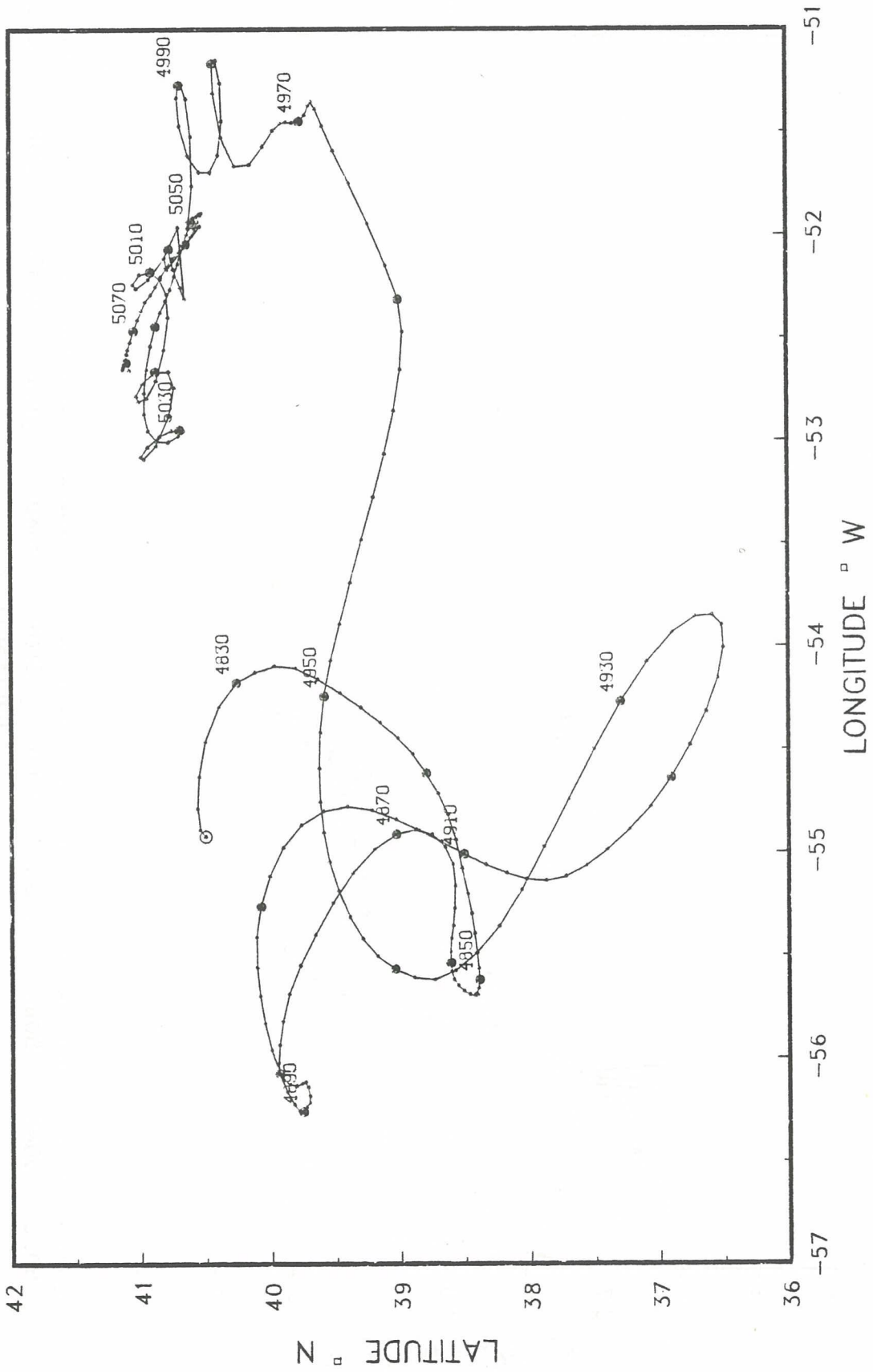


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GUSREX 163

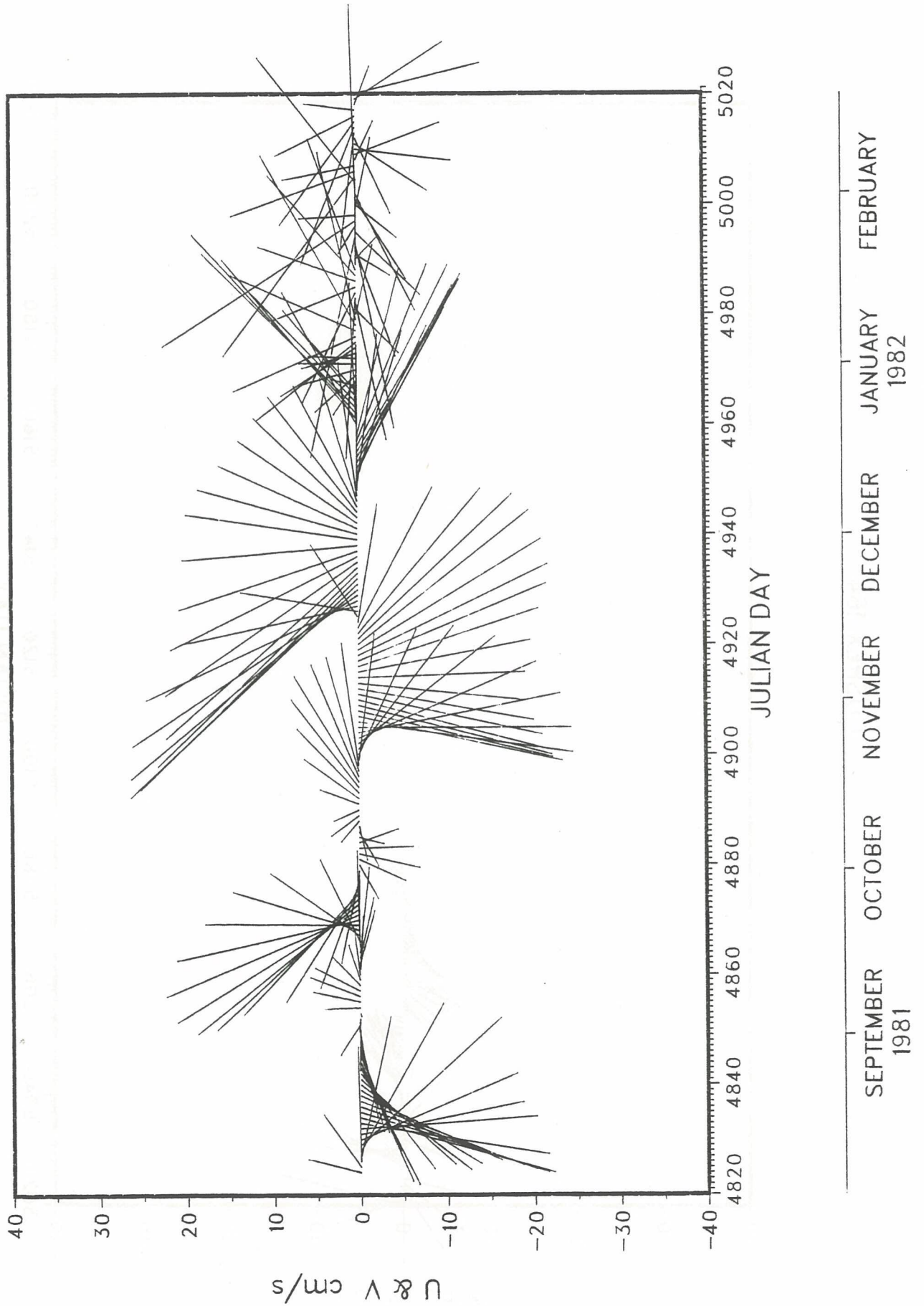


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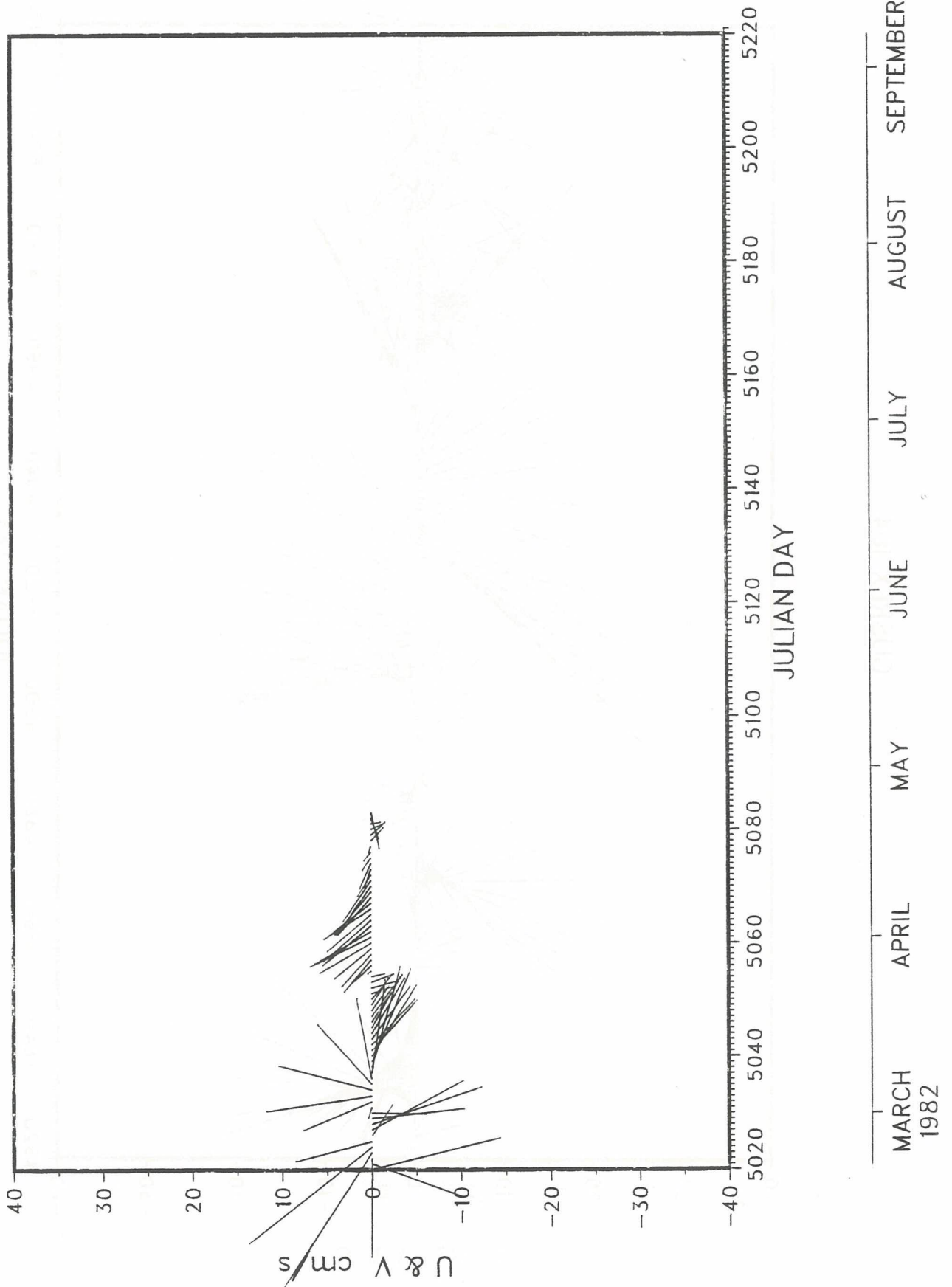


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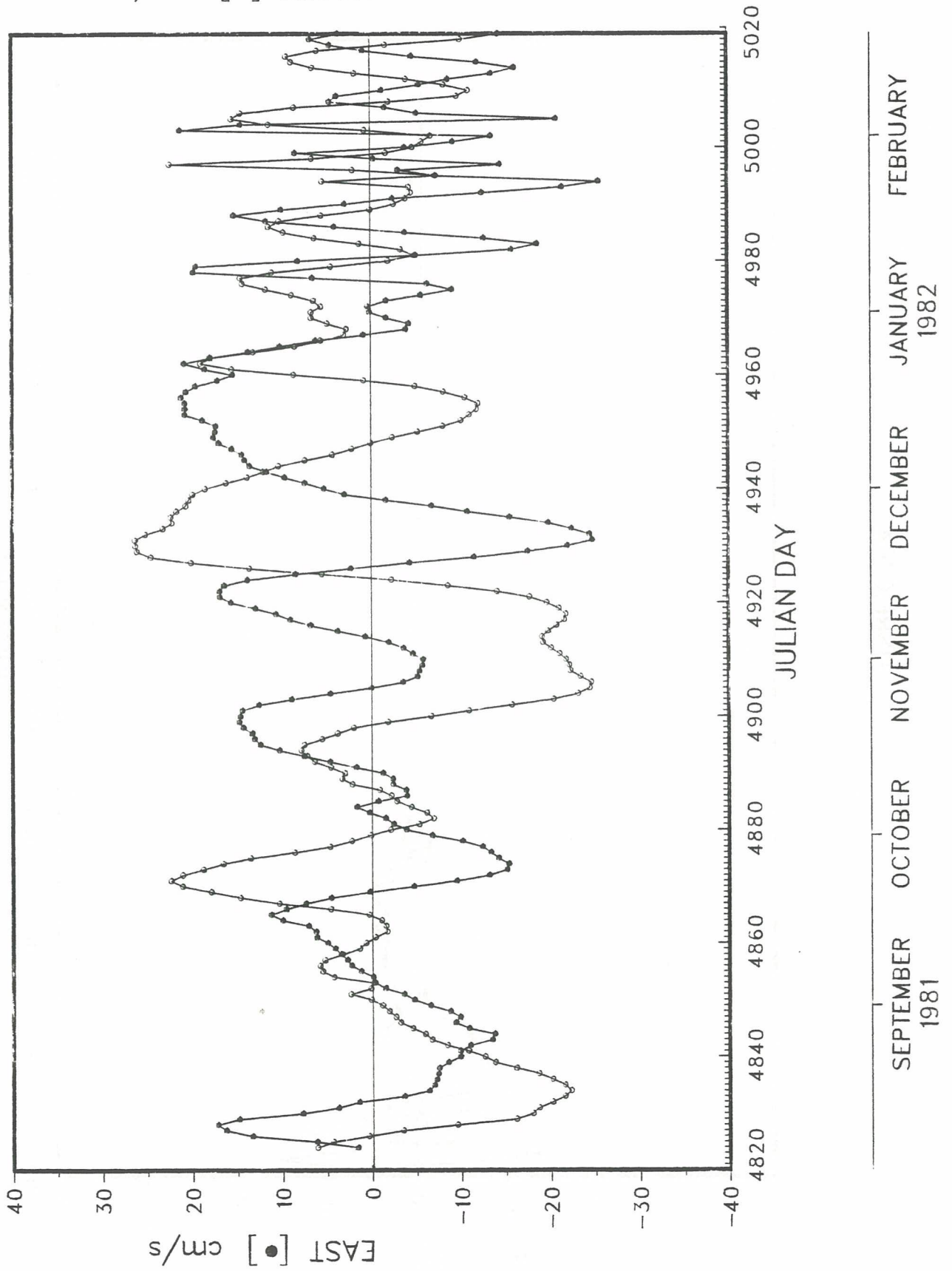
330



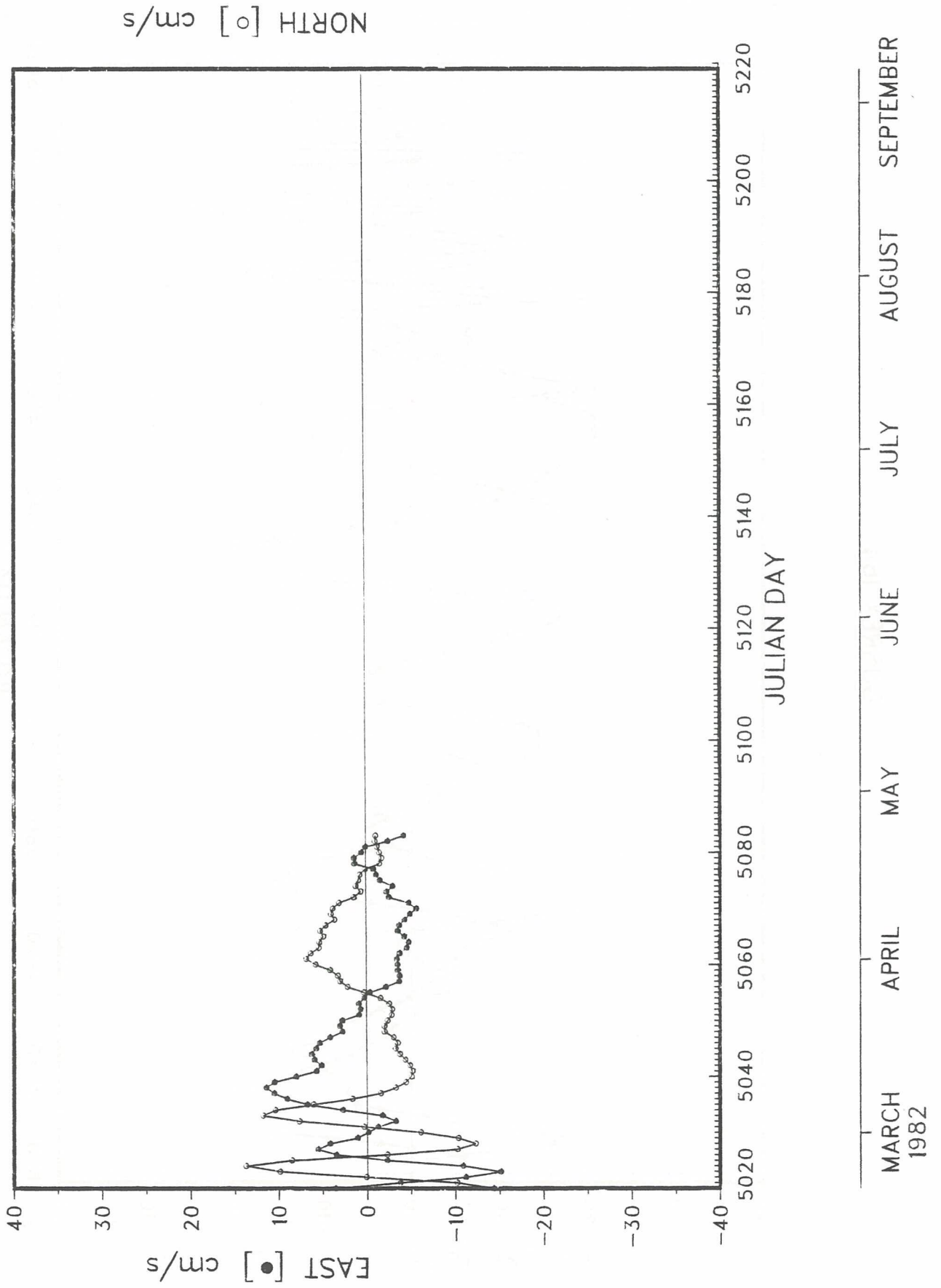
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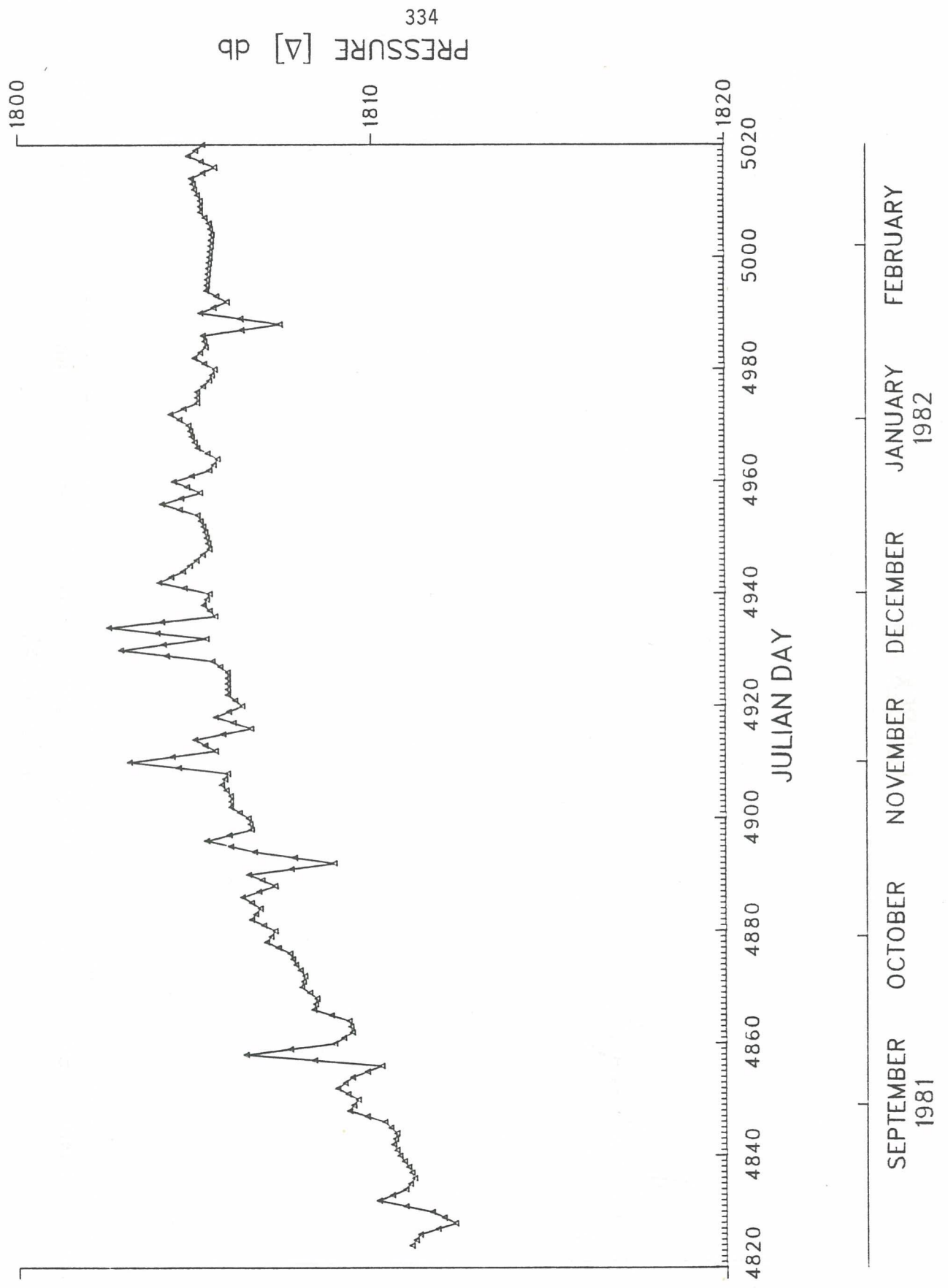
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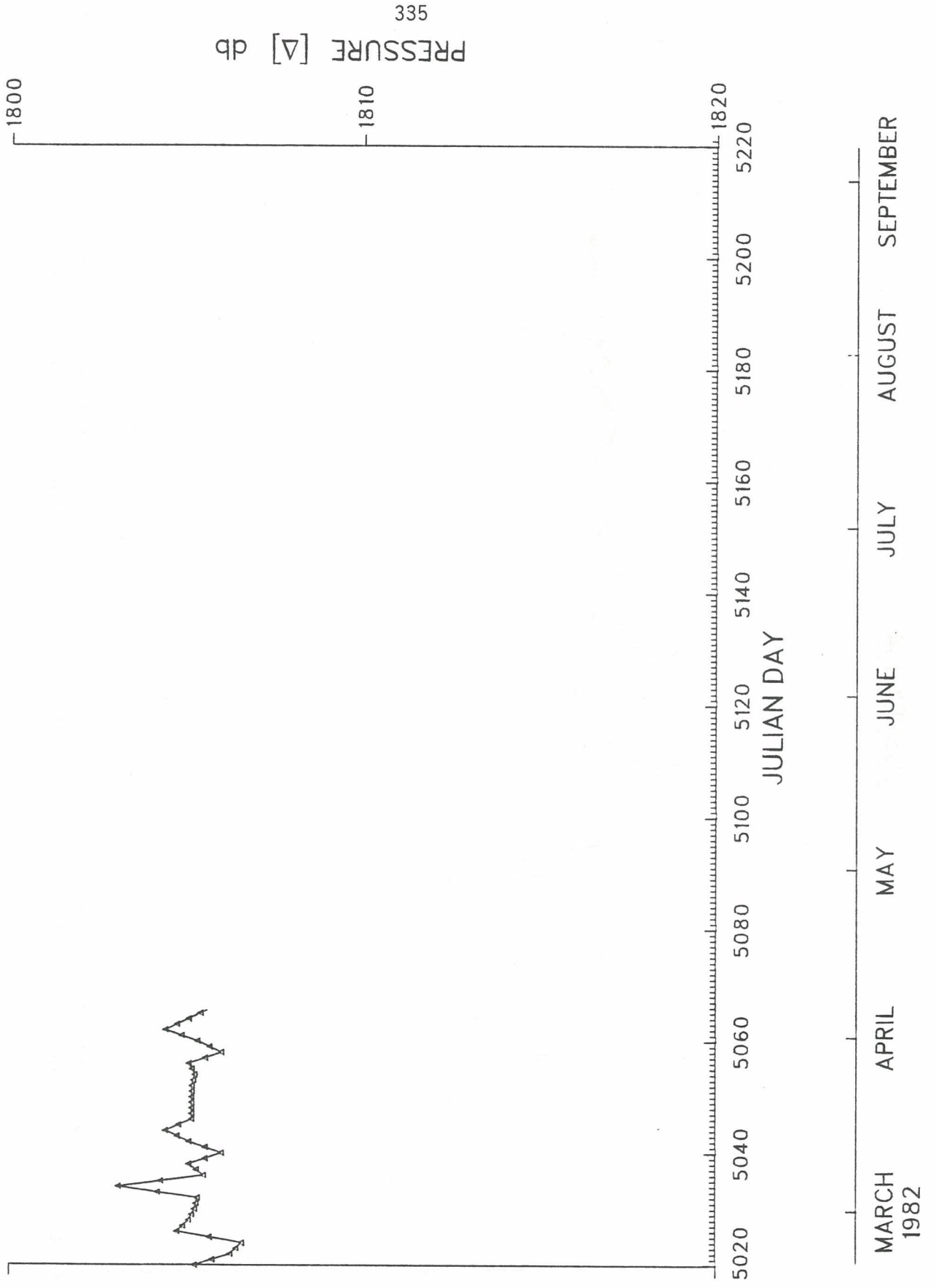
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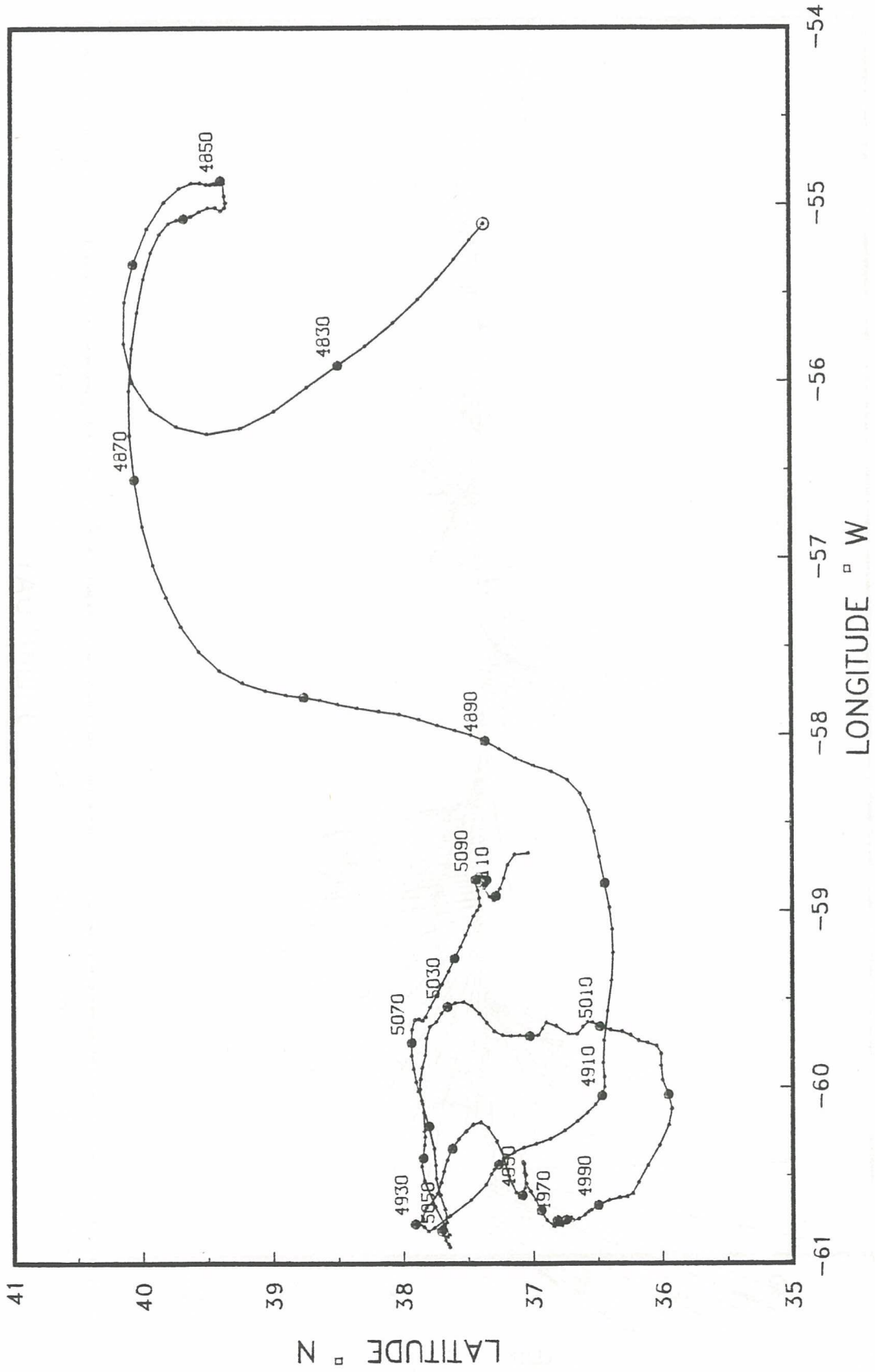
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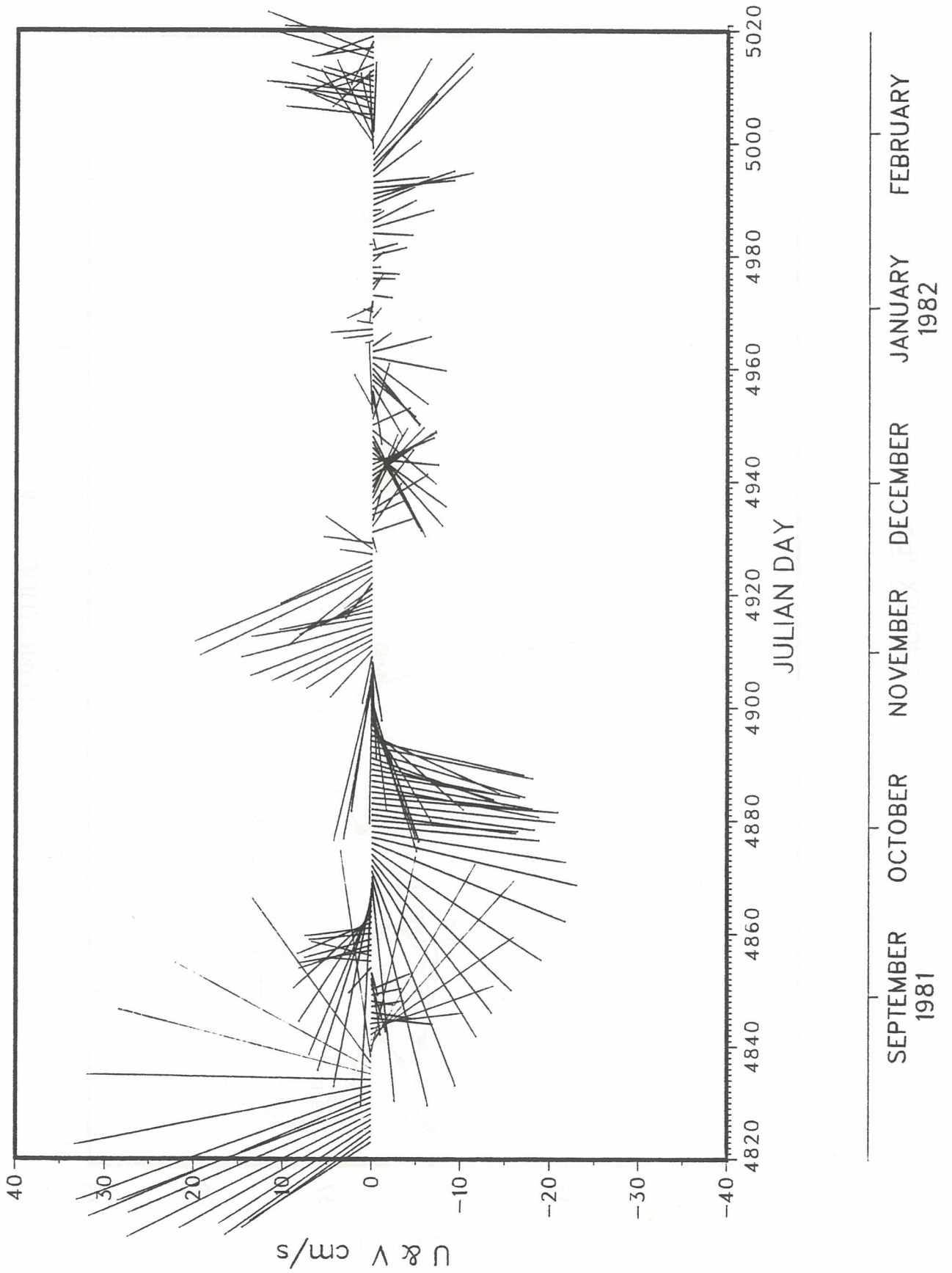
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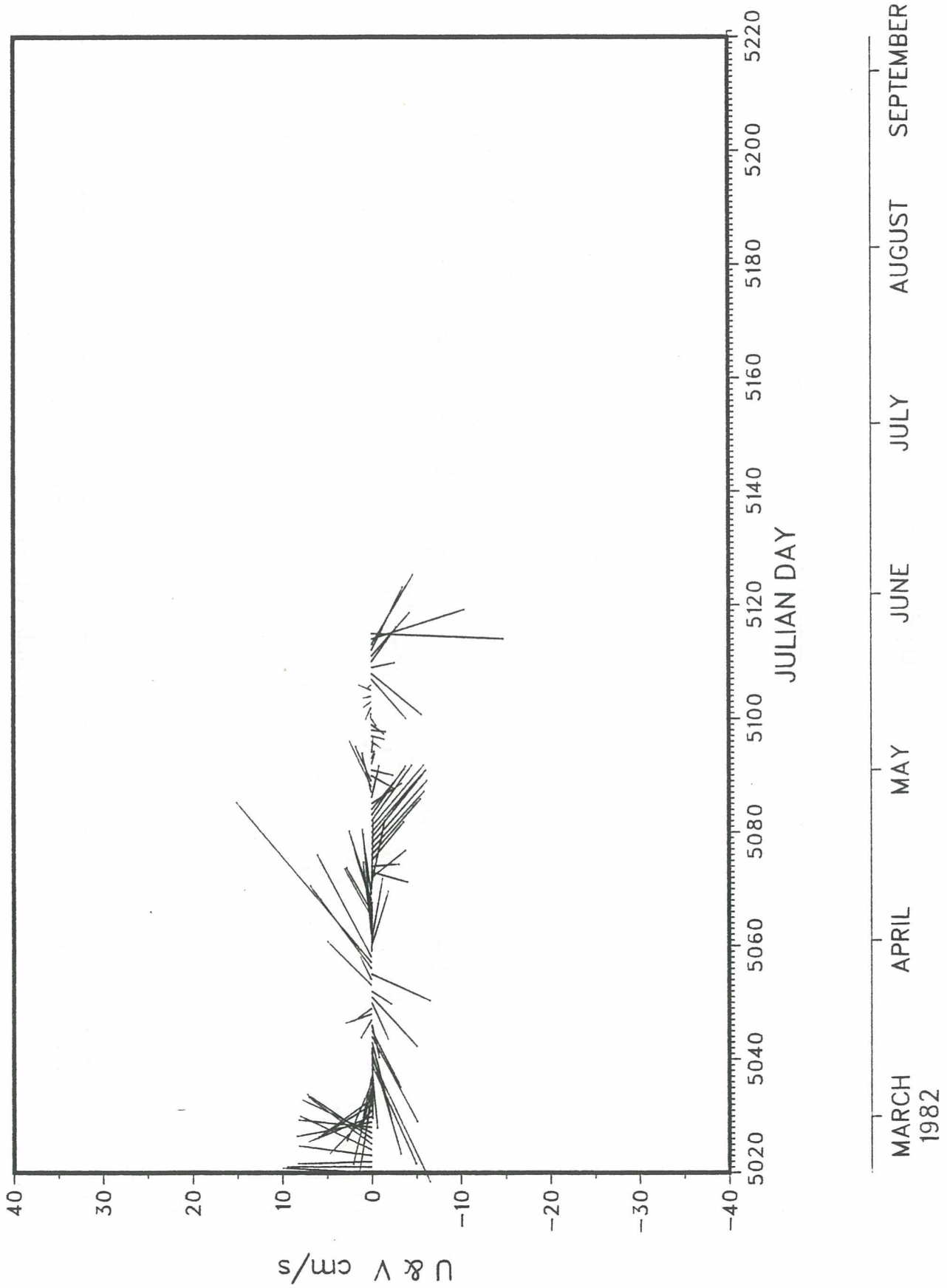
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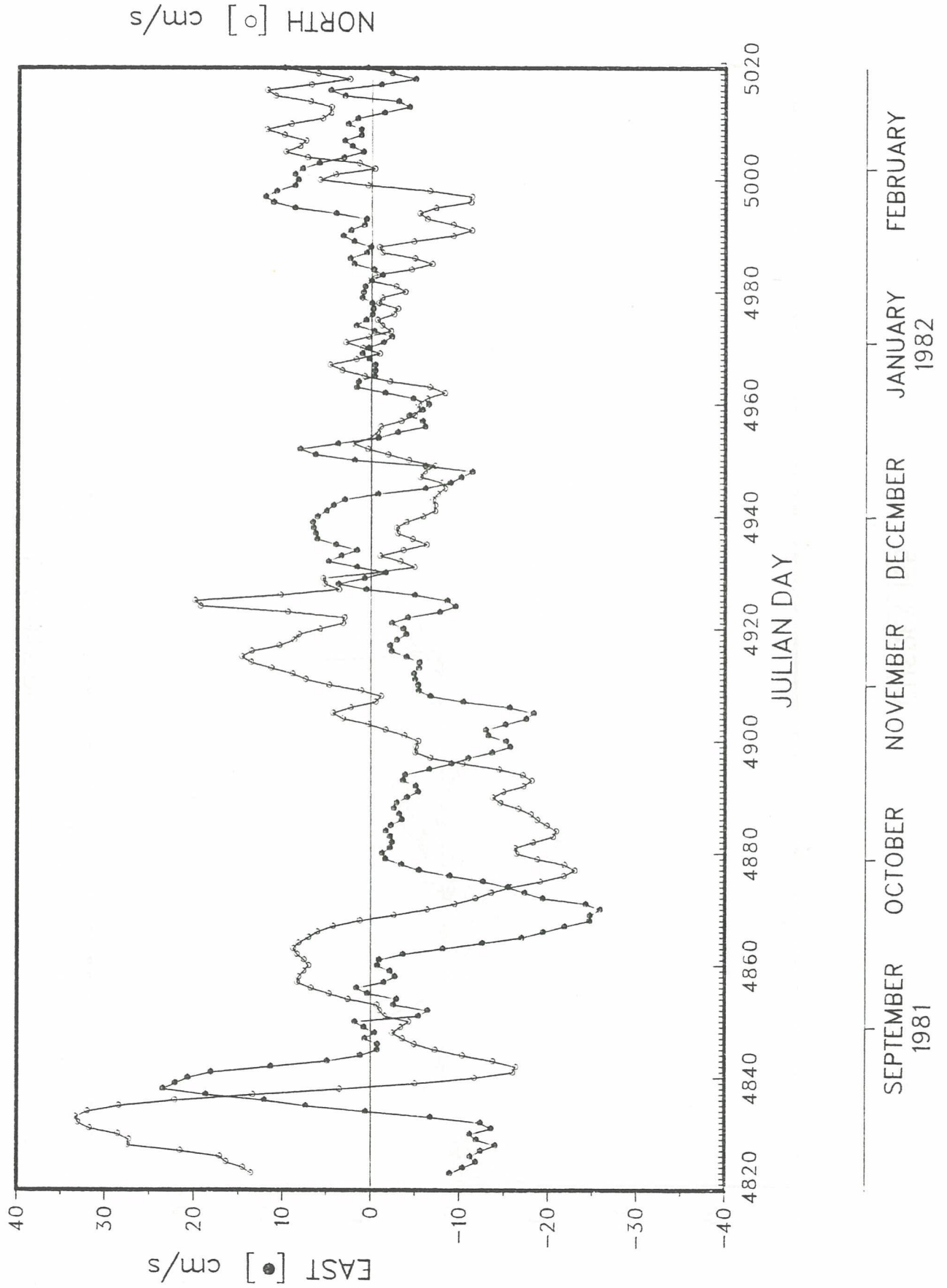
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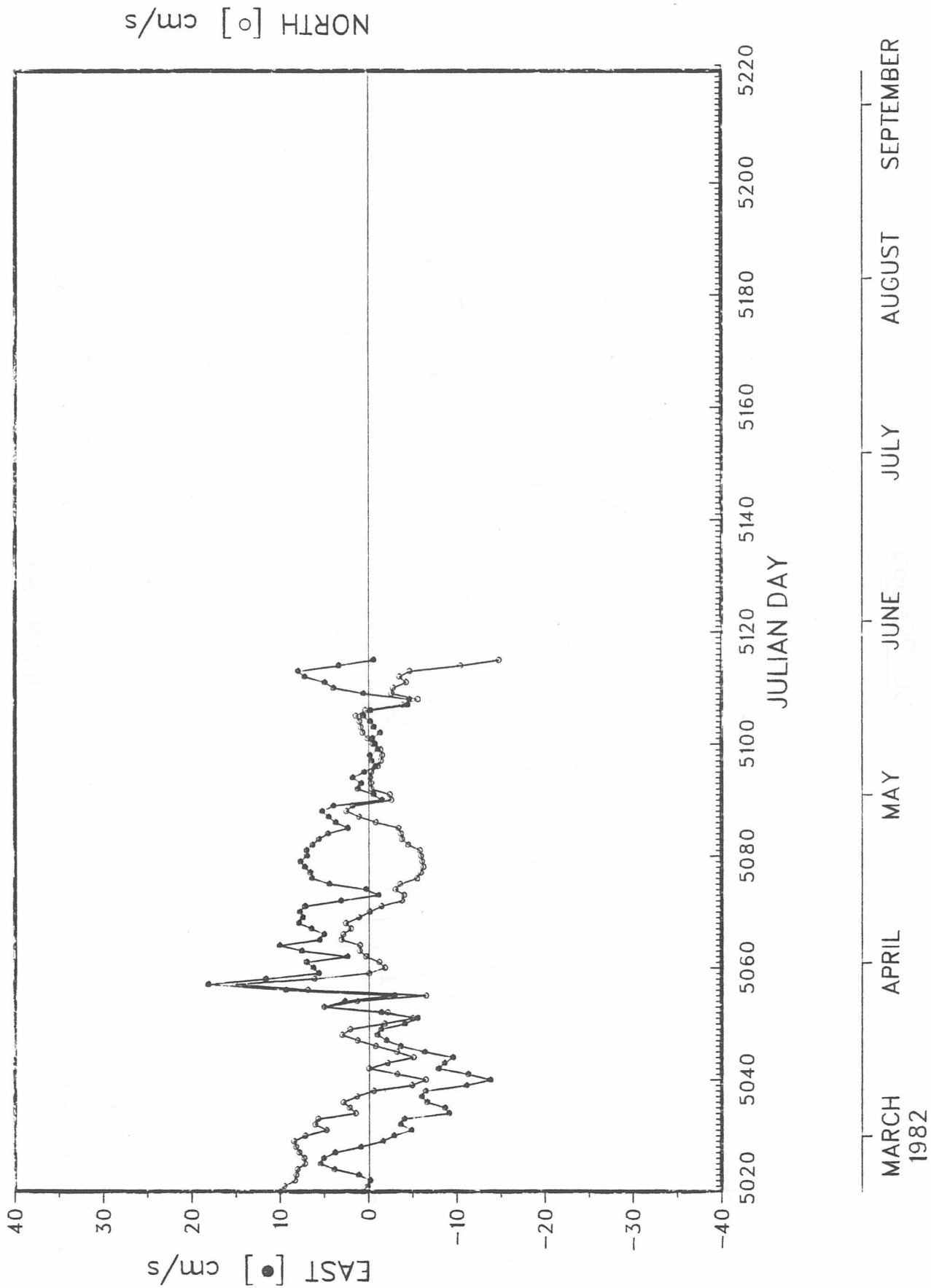
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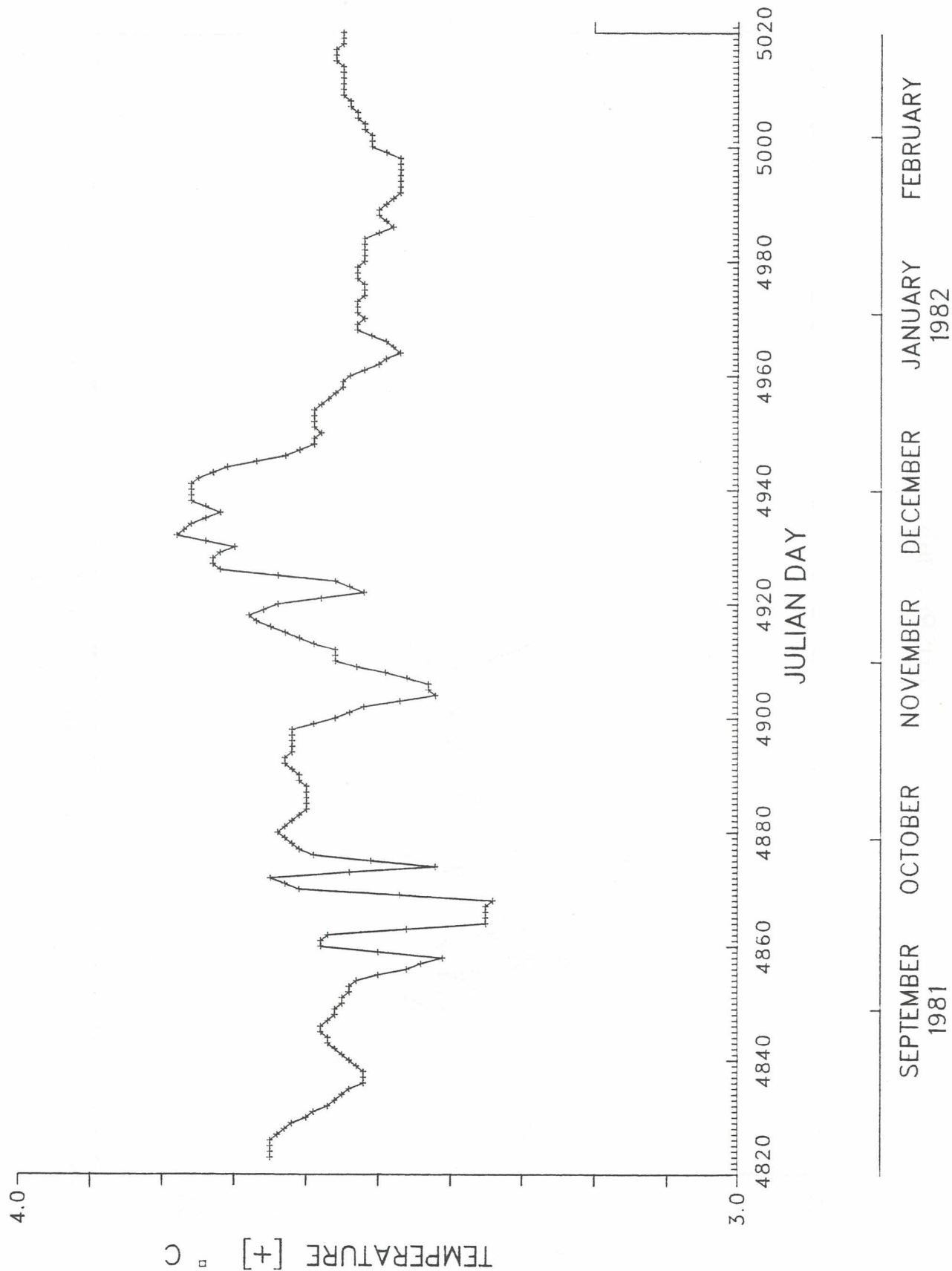
GUSREX 165



GUSREX 165

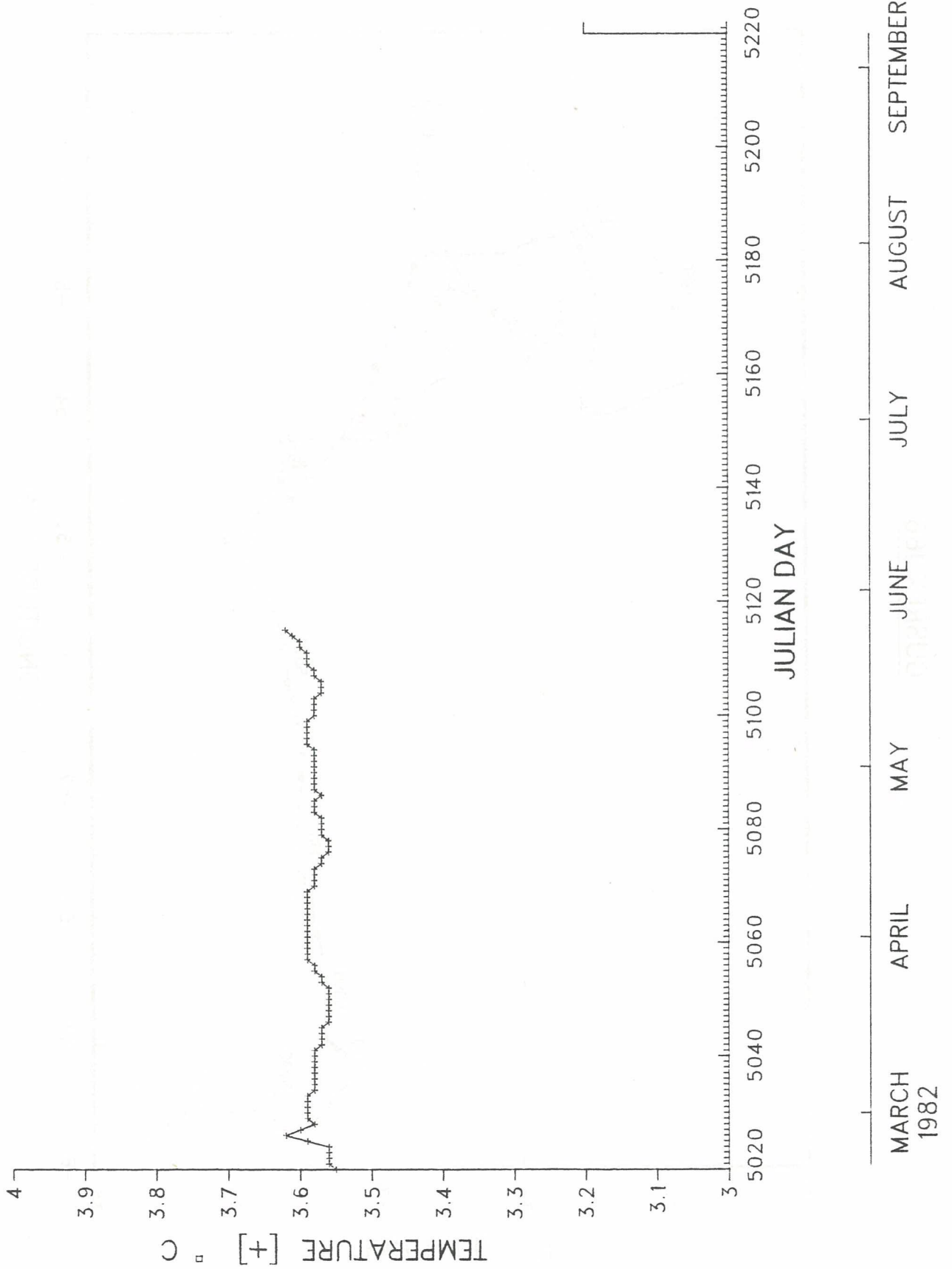


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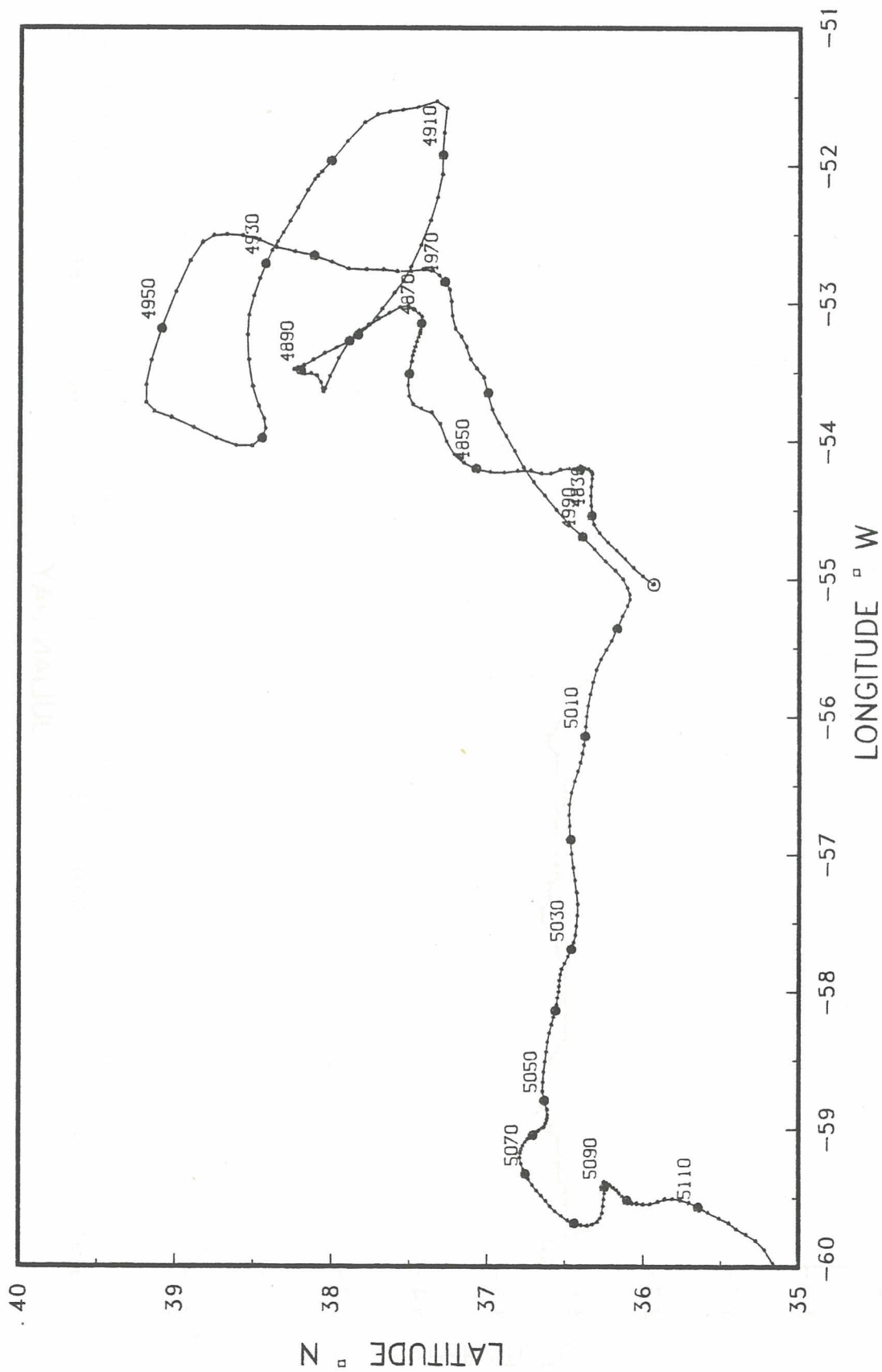


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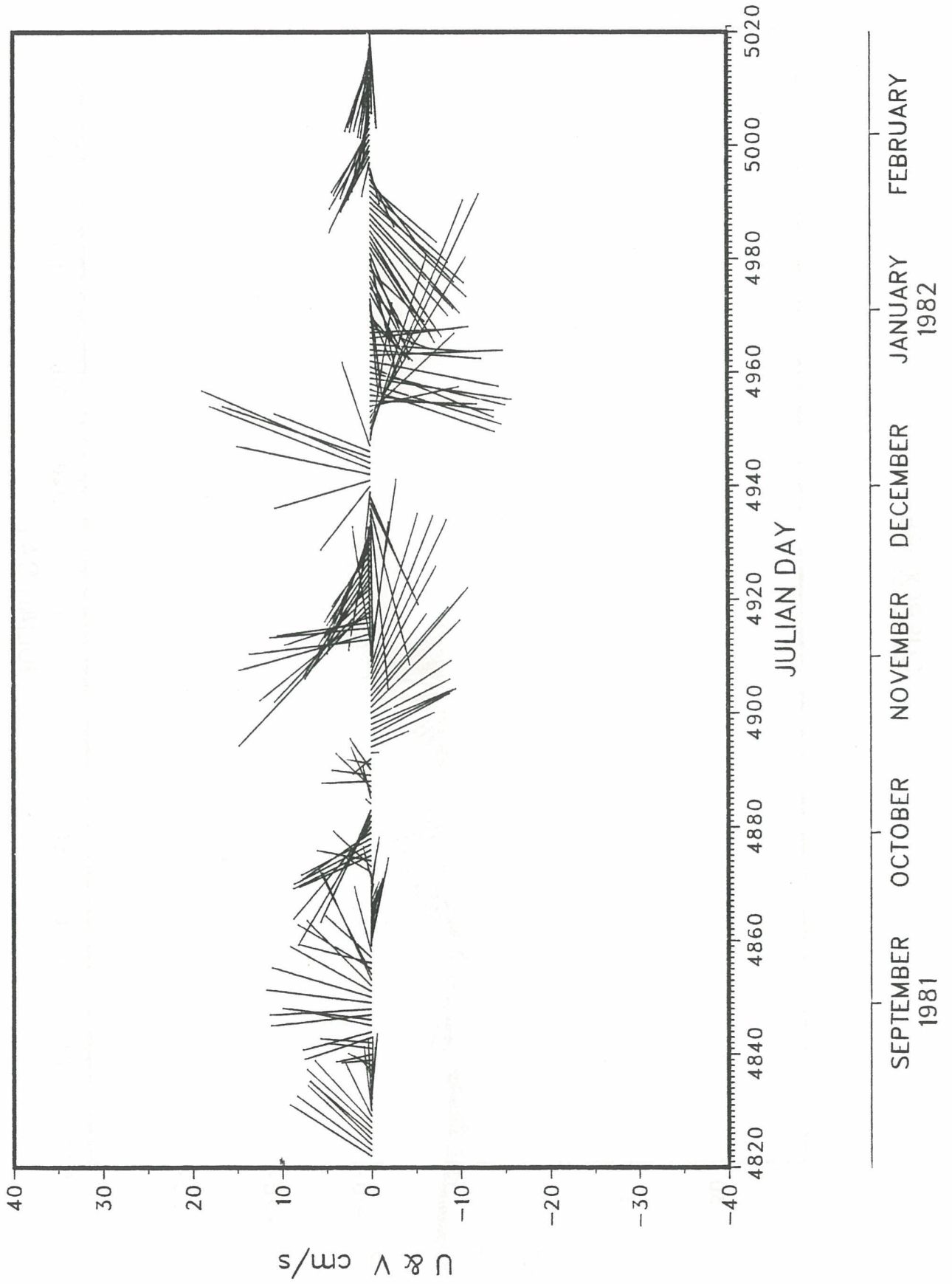
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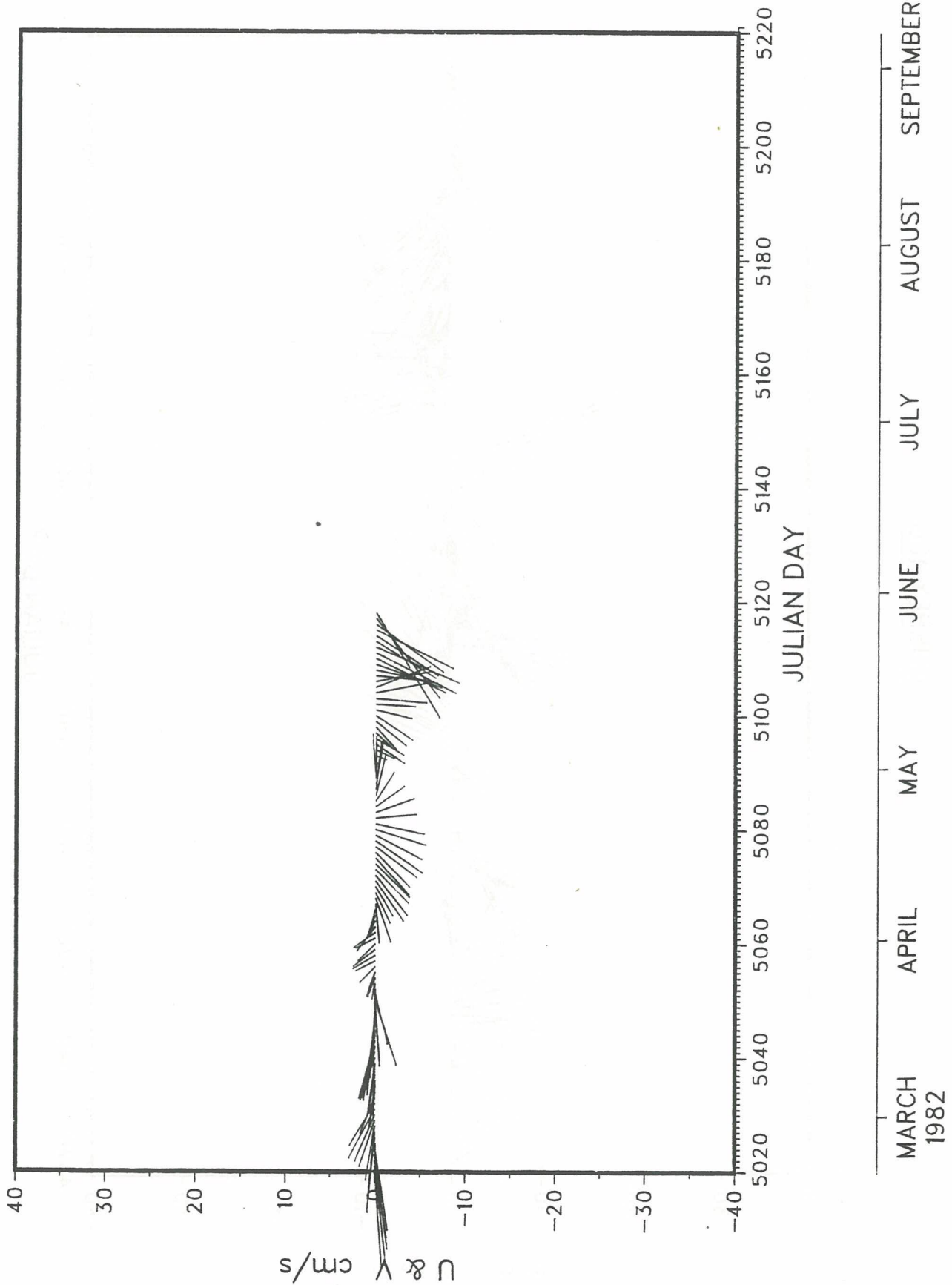
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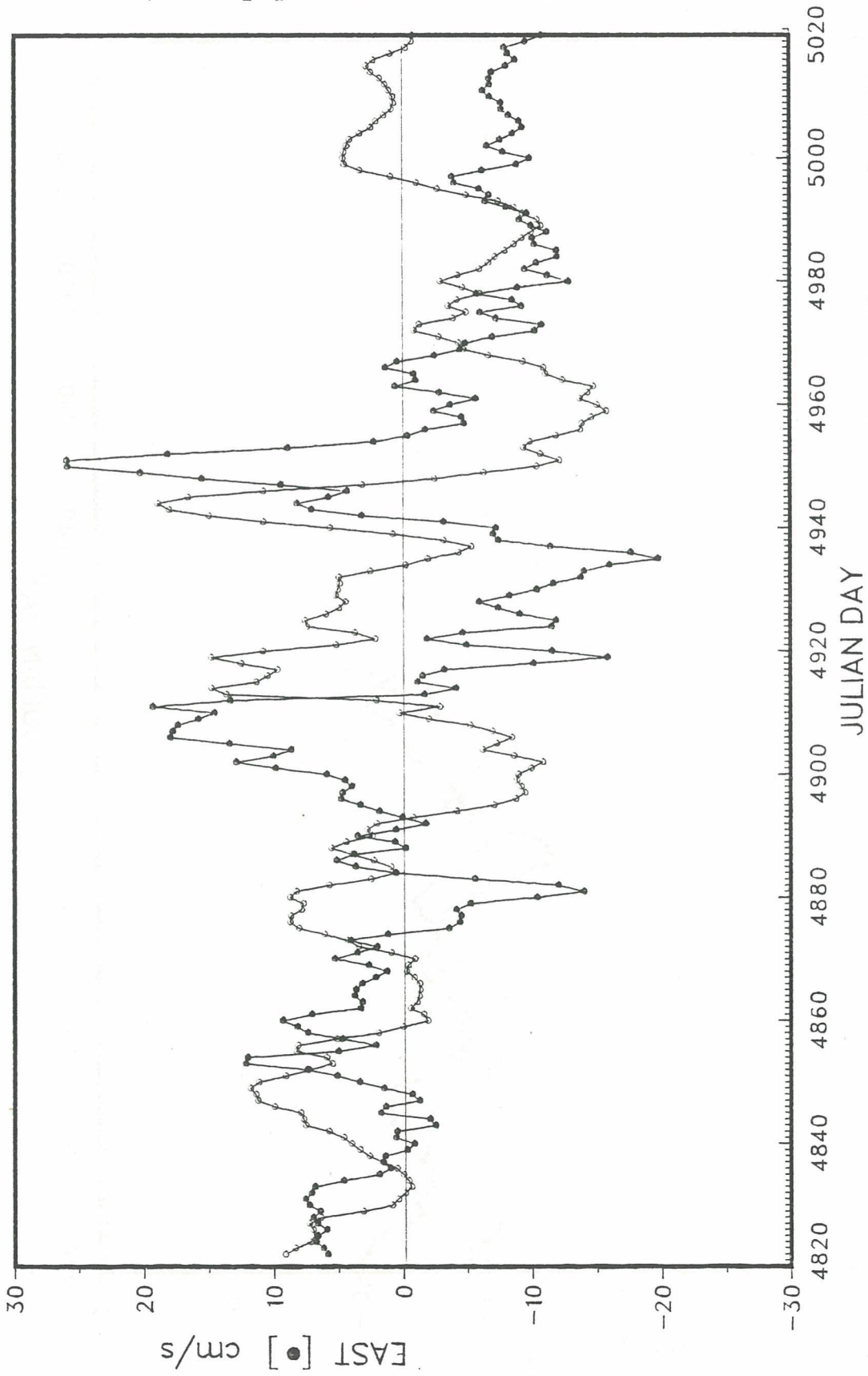
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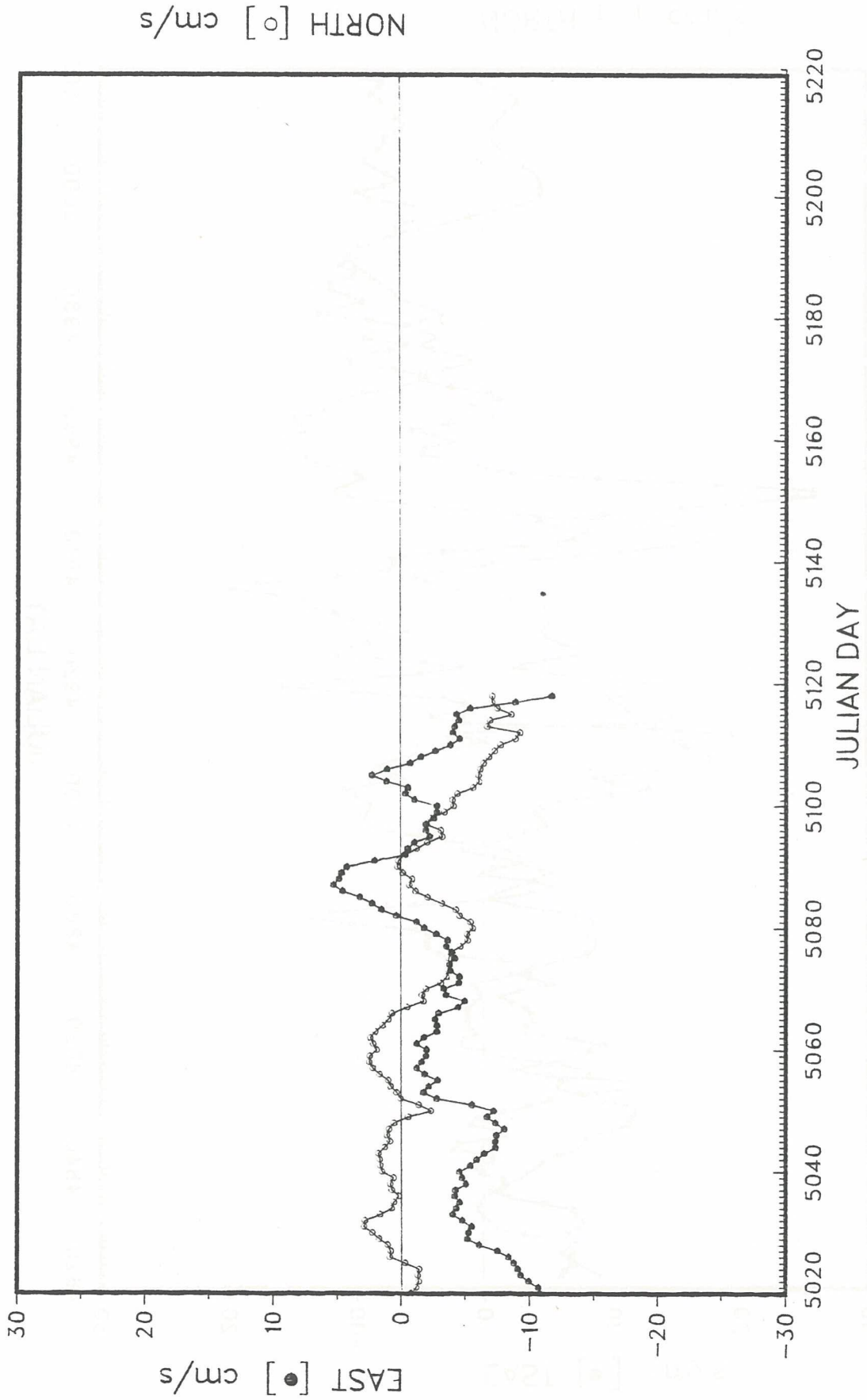
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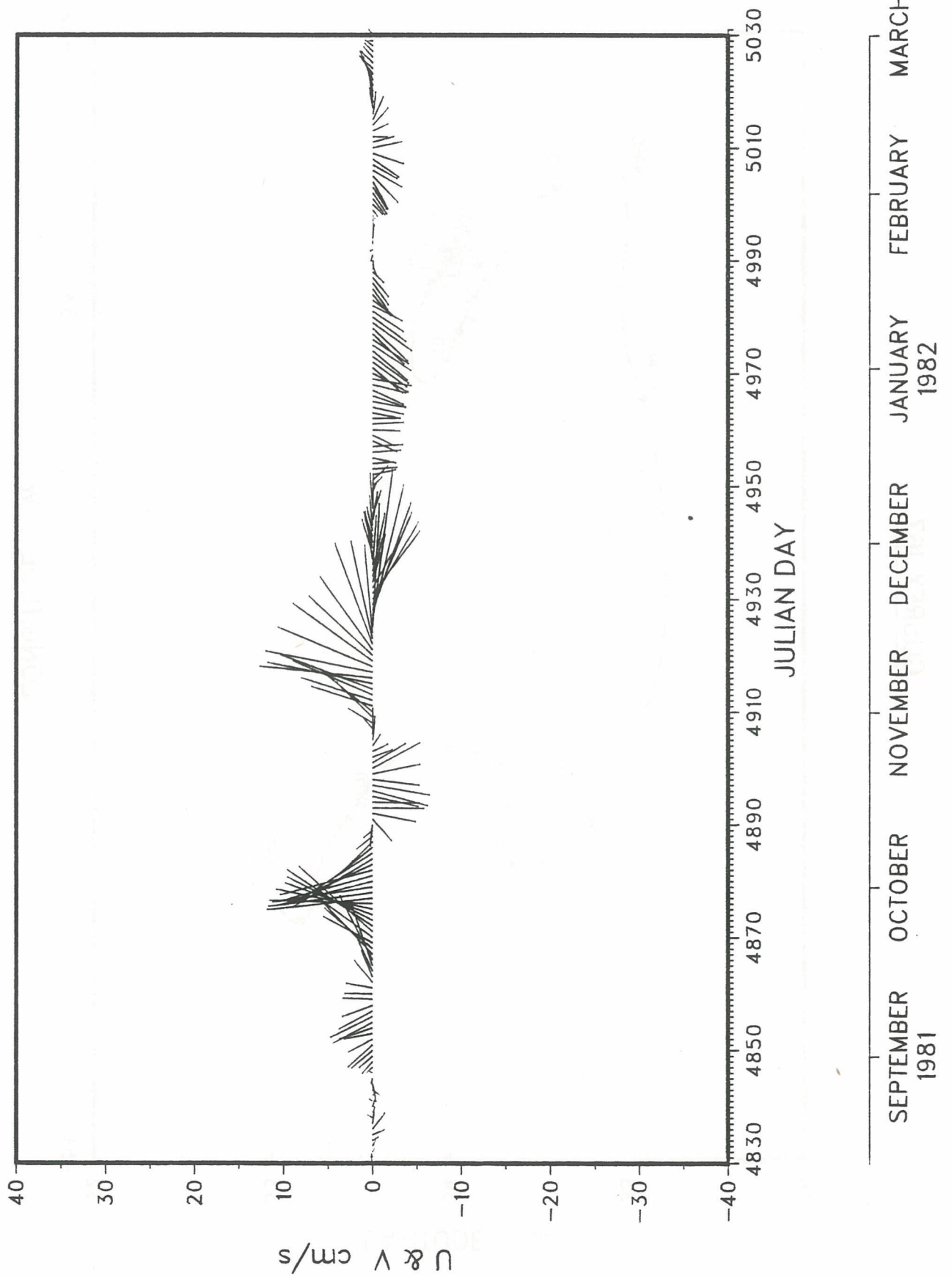
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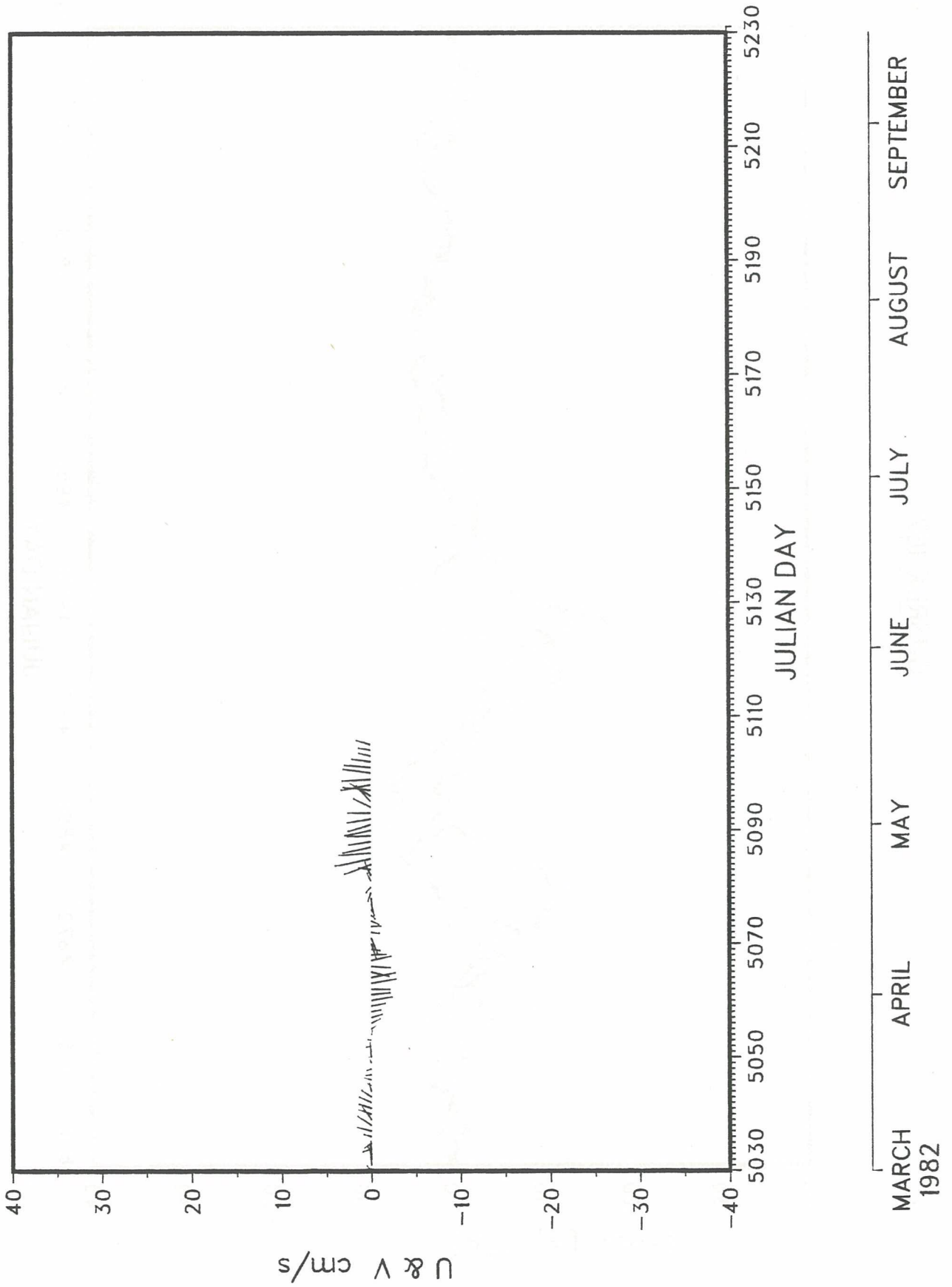
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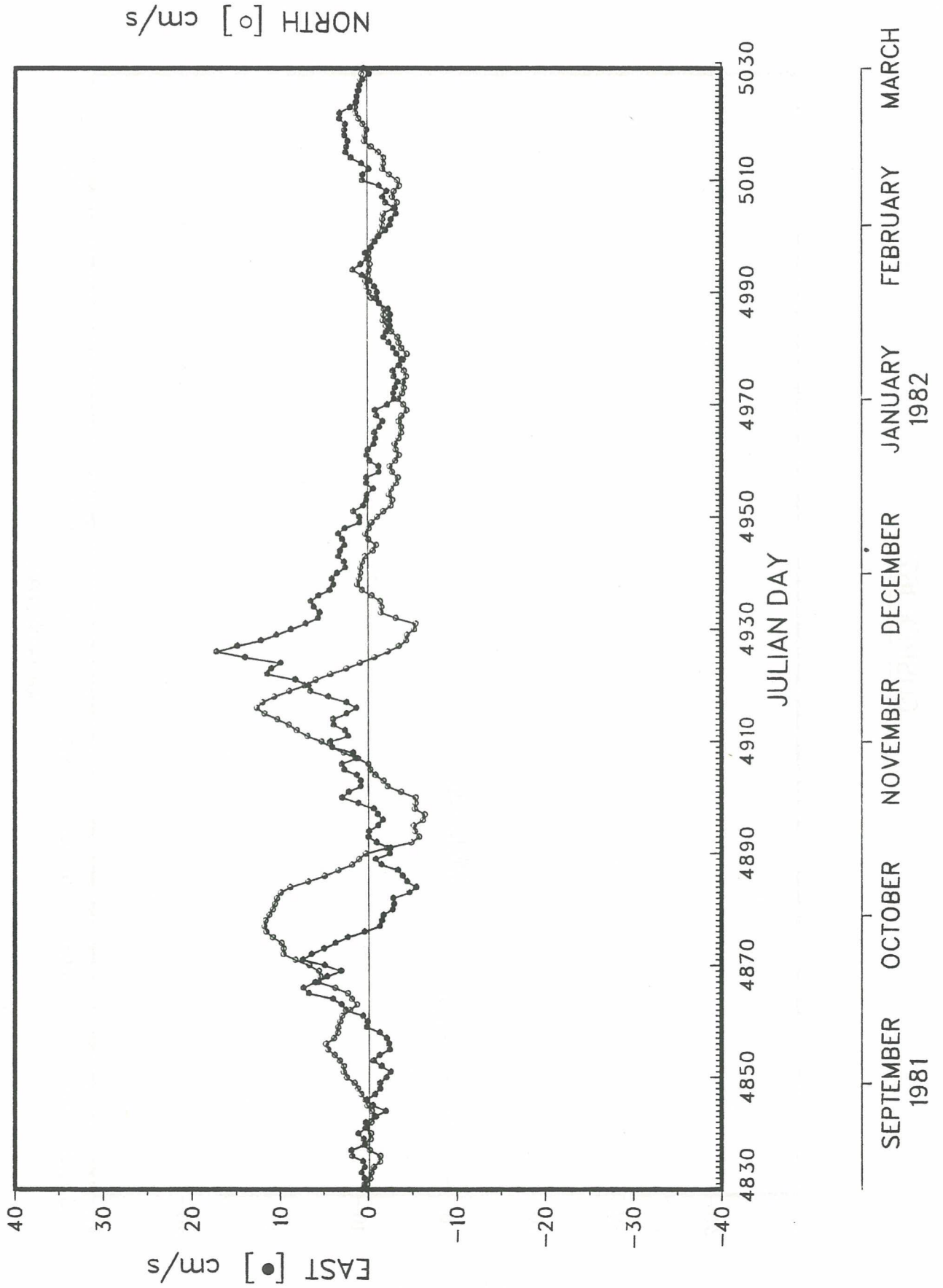
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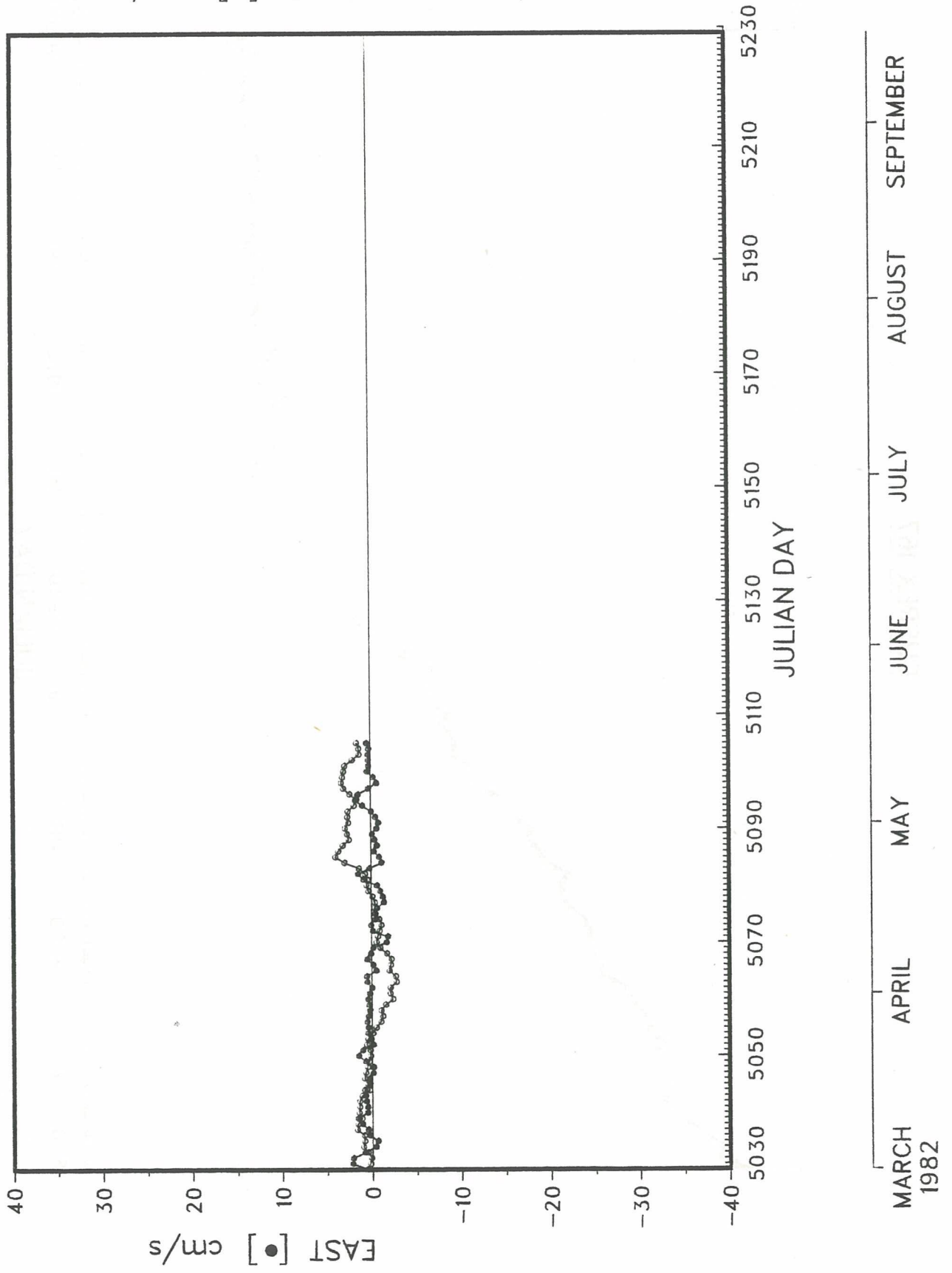
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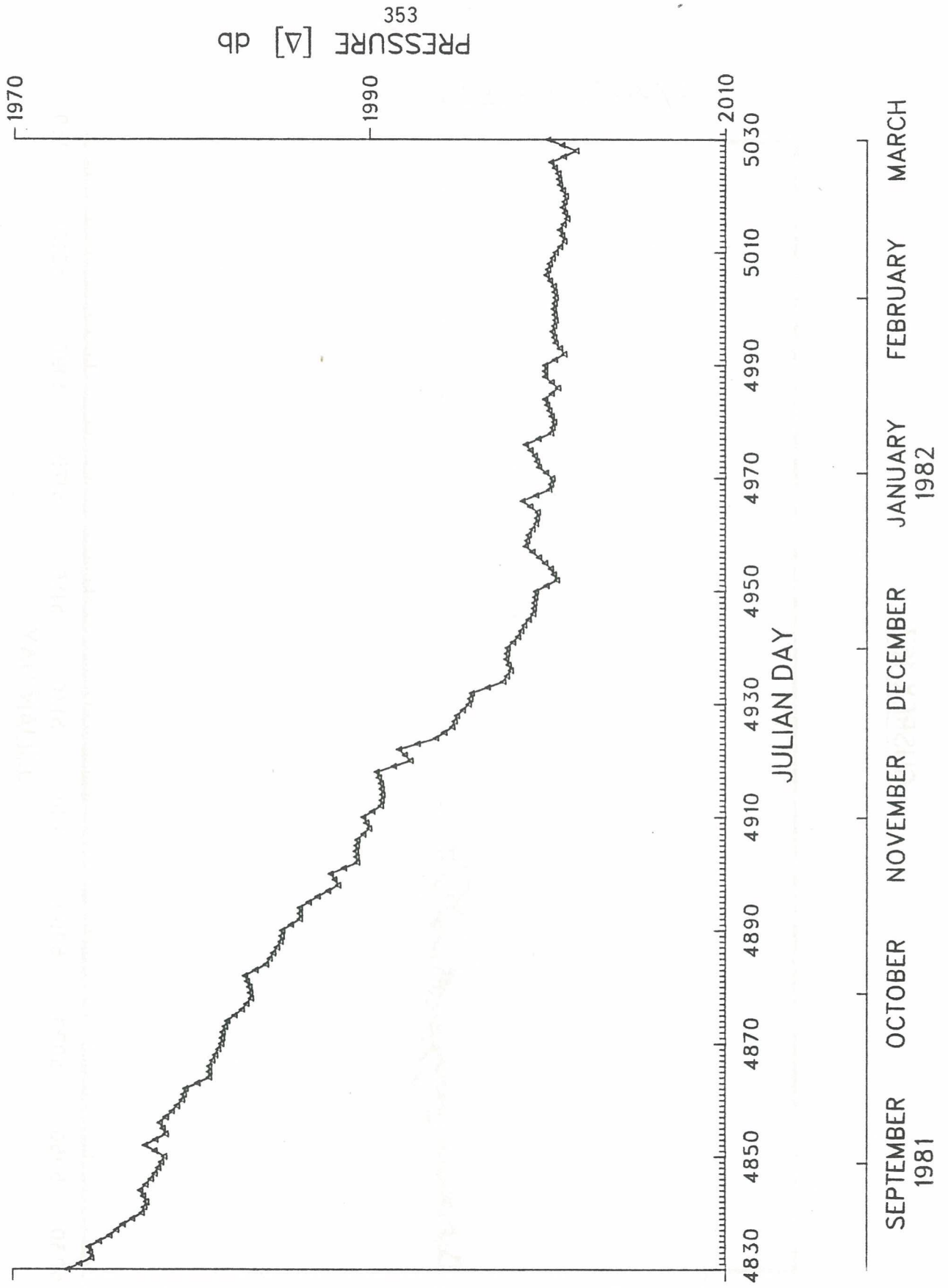
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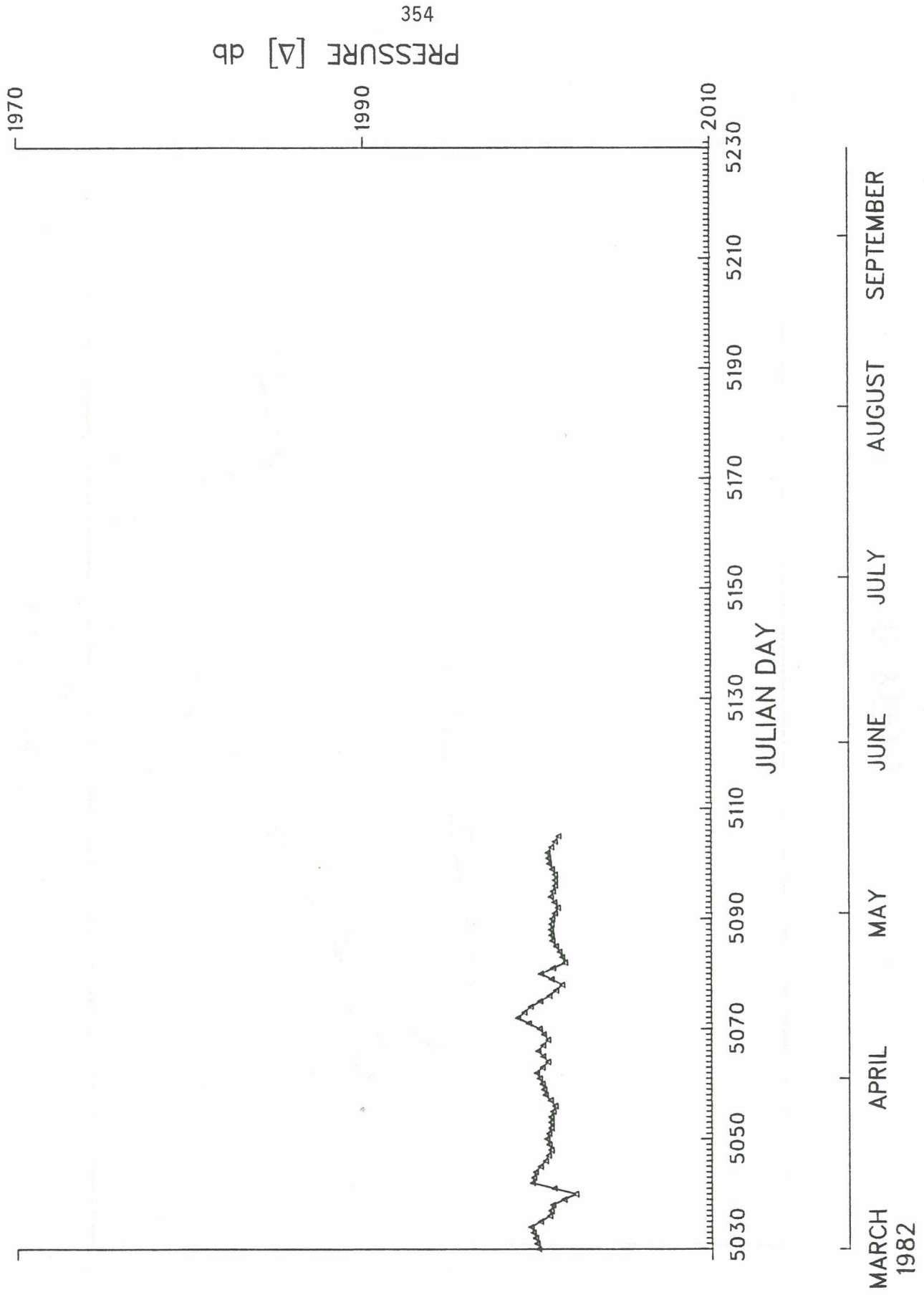
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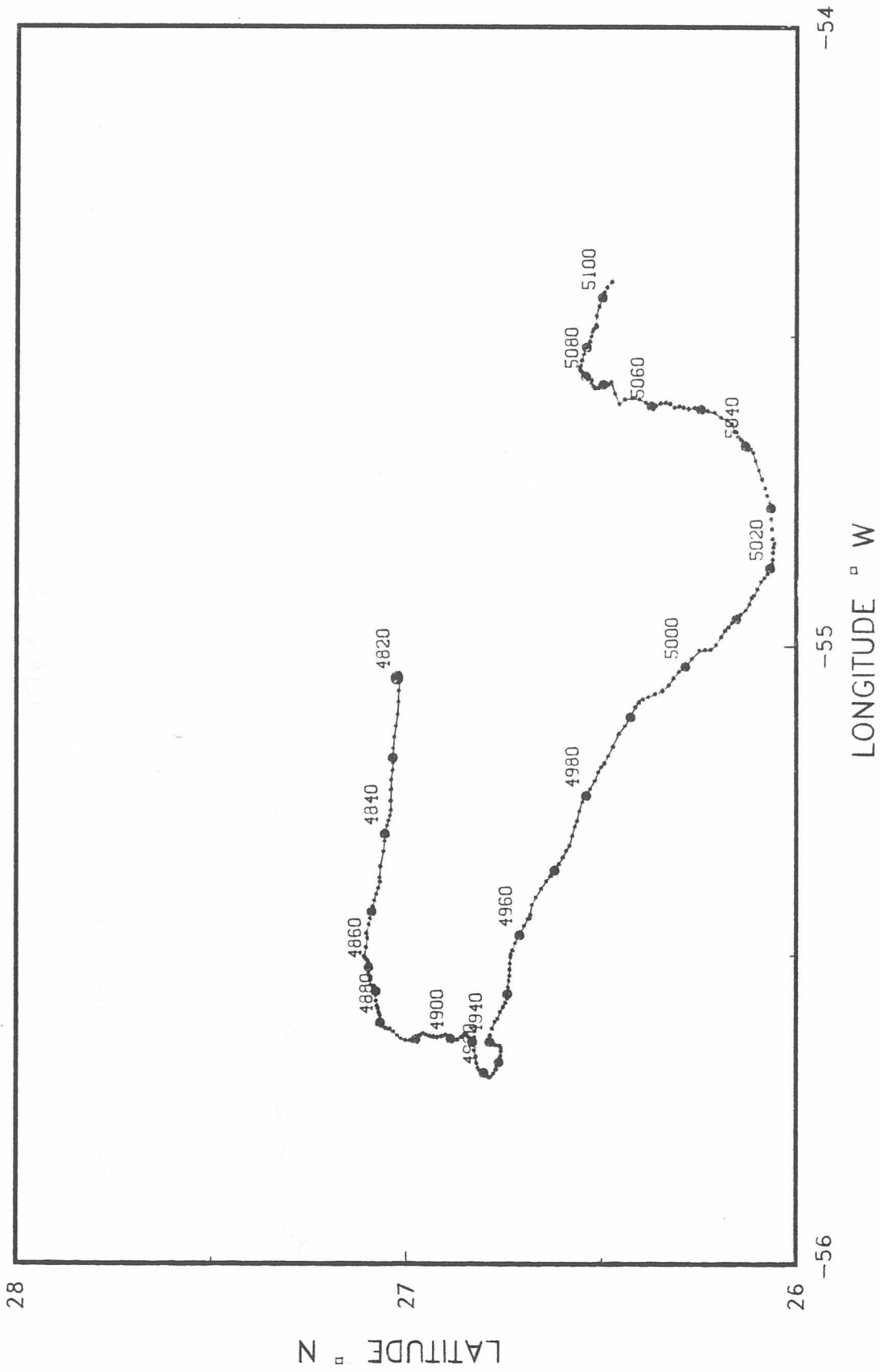
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GUSREX 167

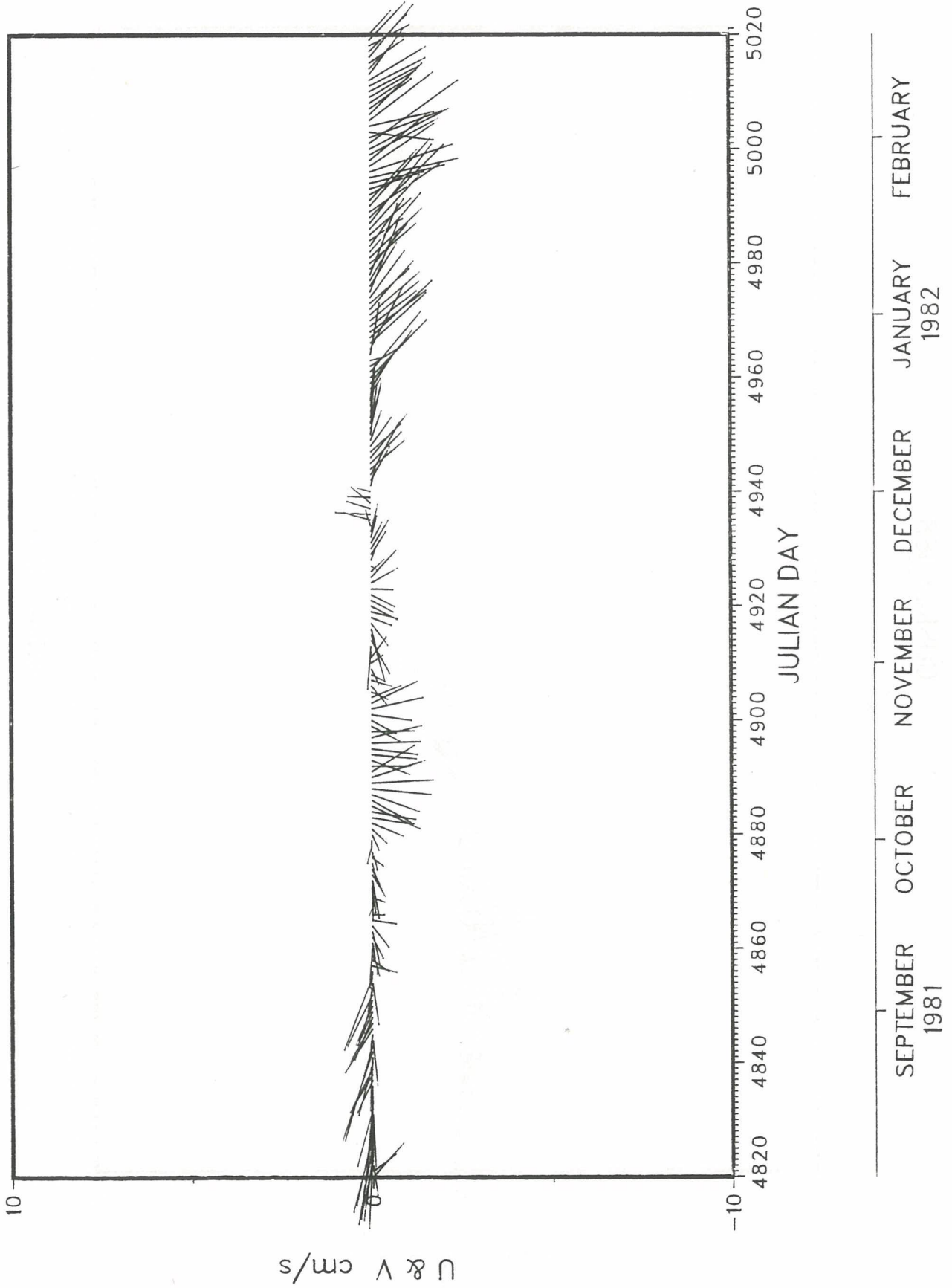


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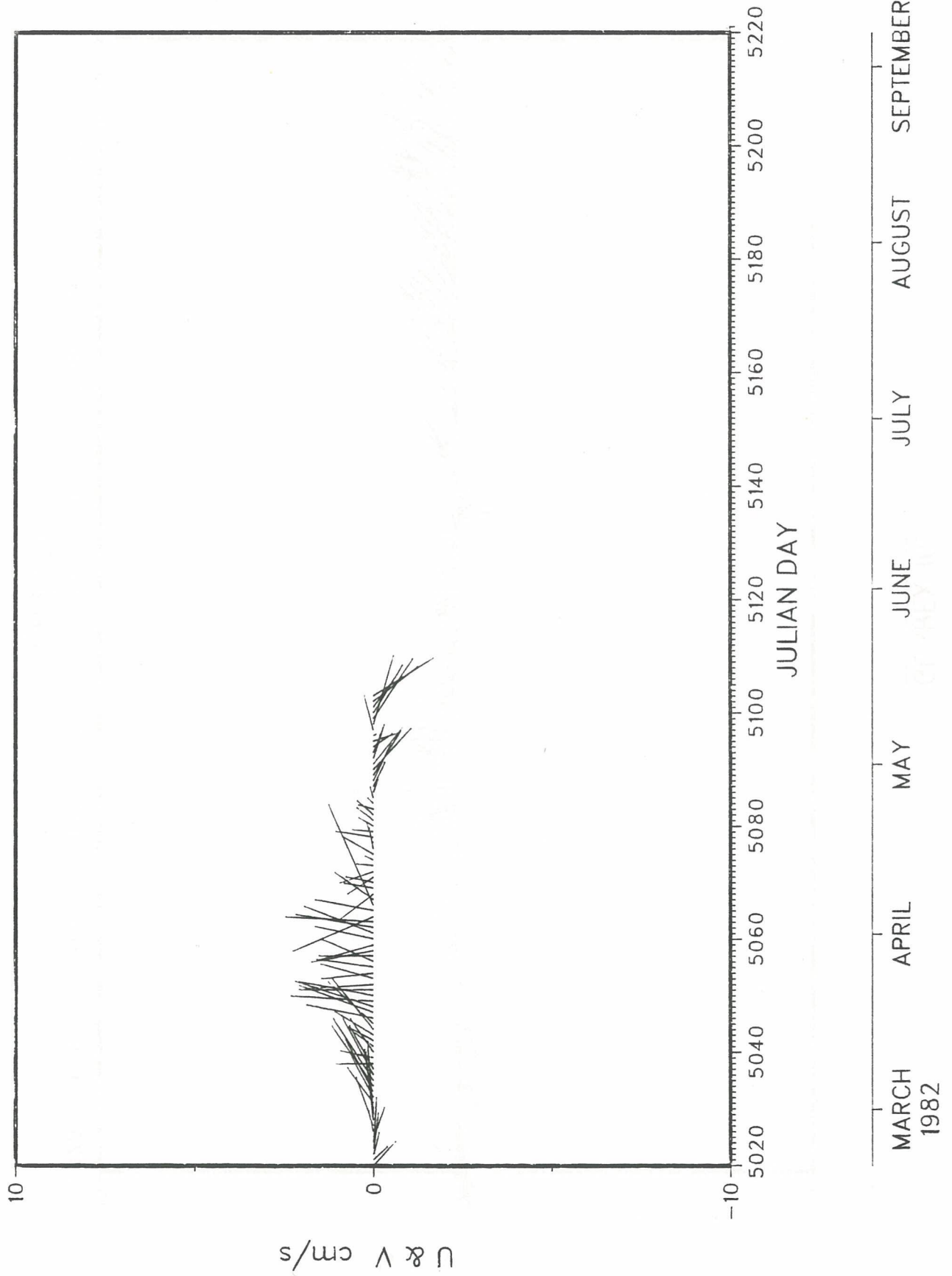


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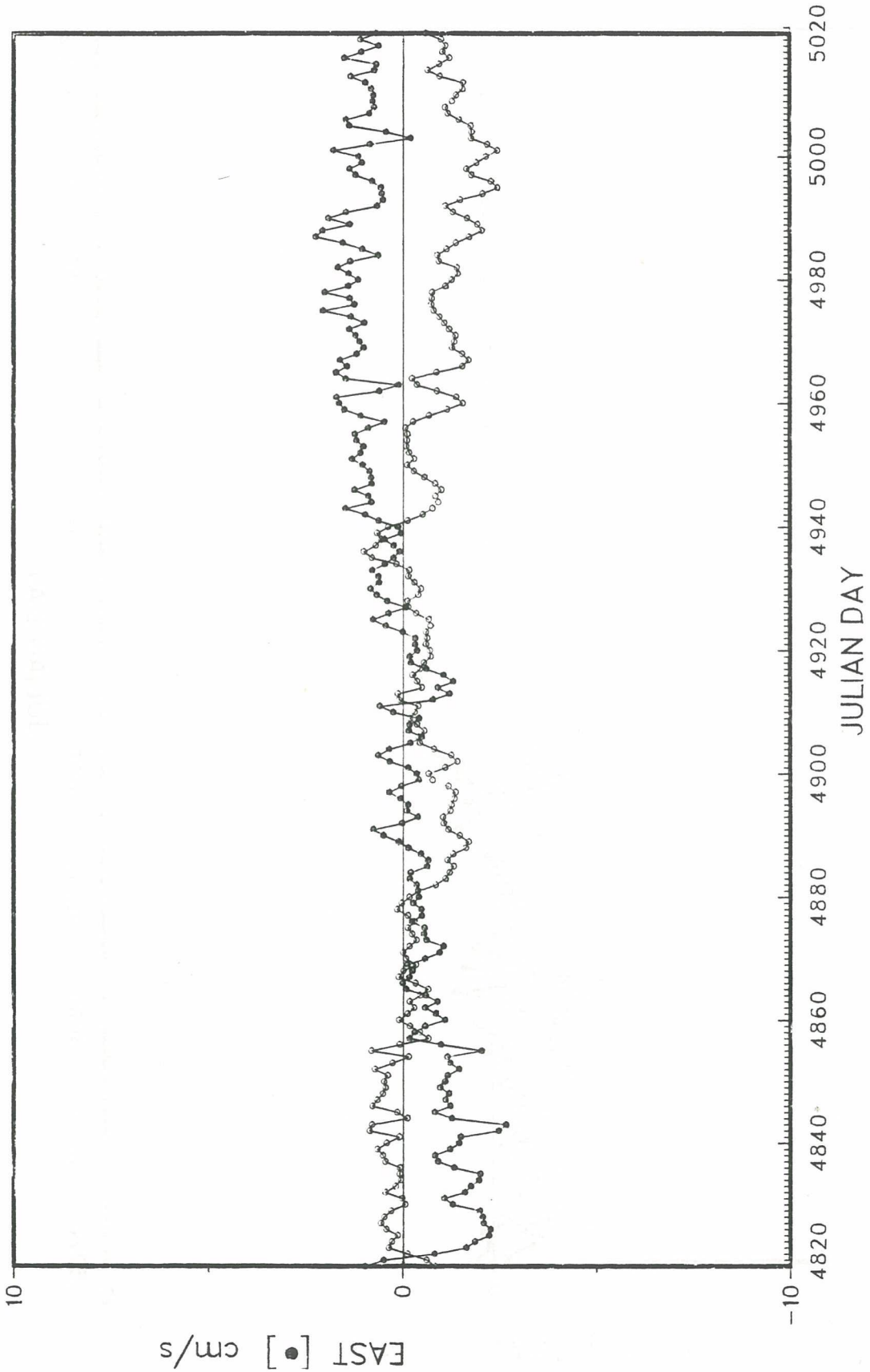
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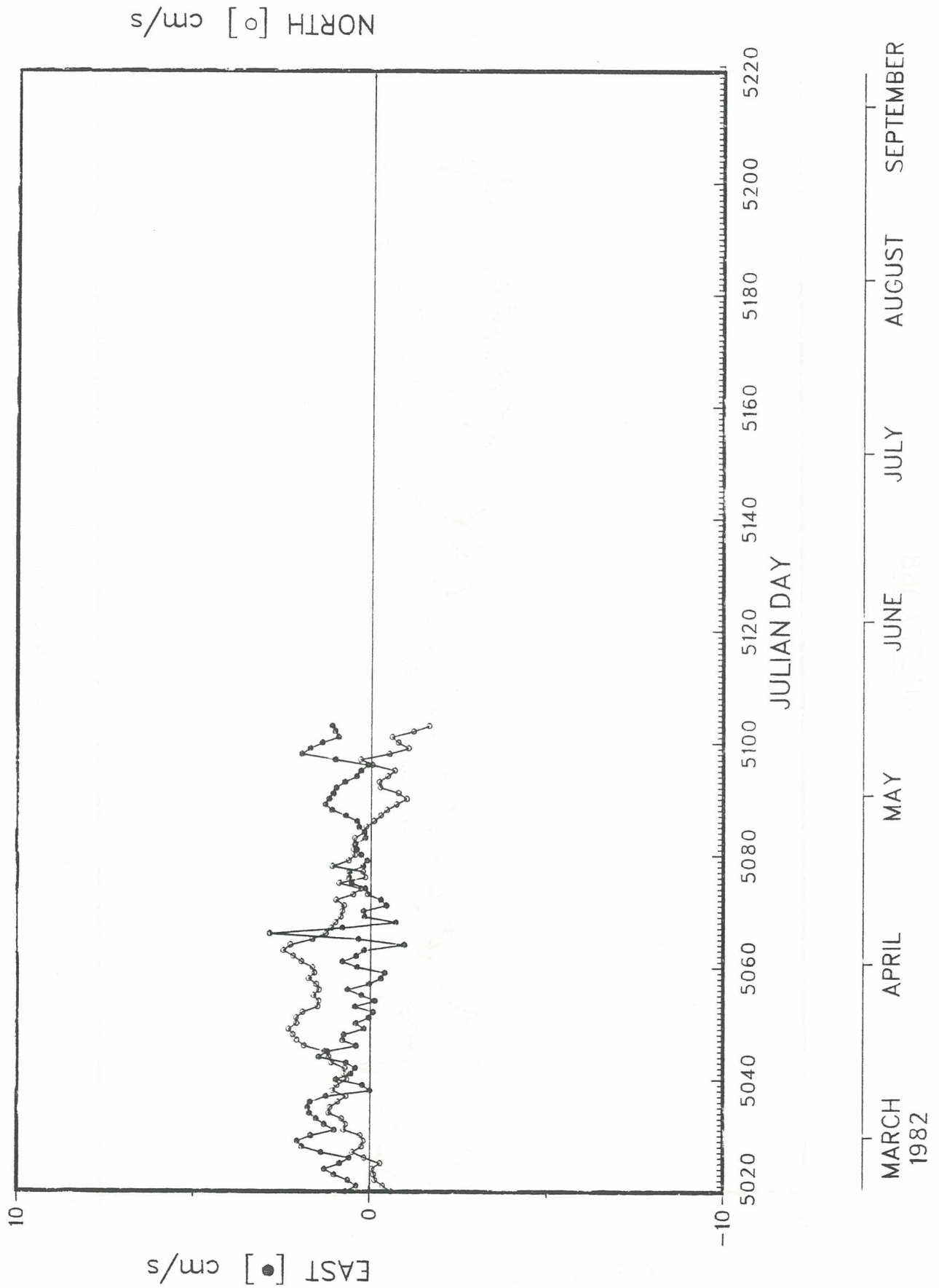


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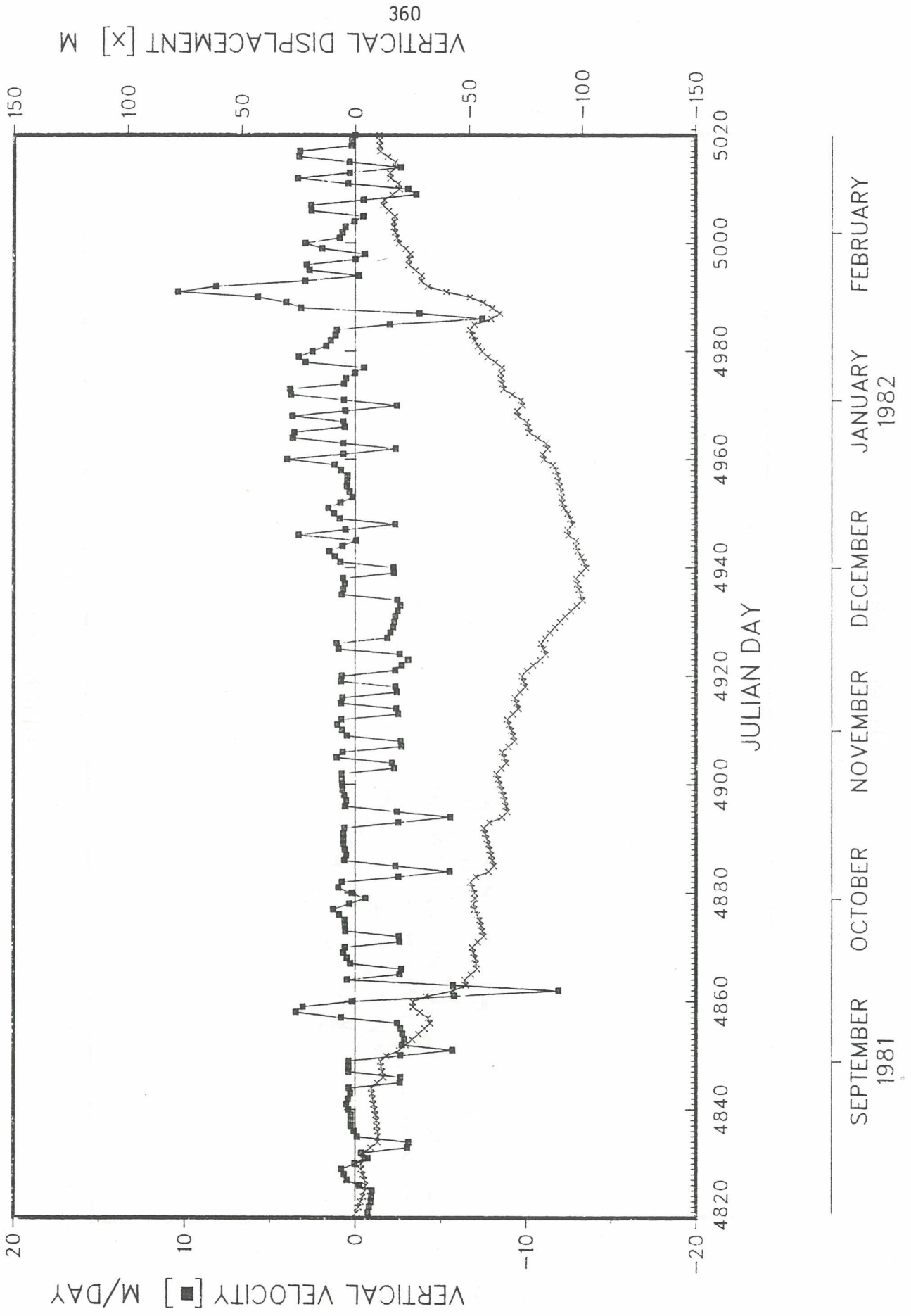


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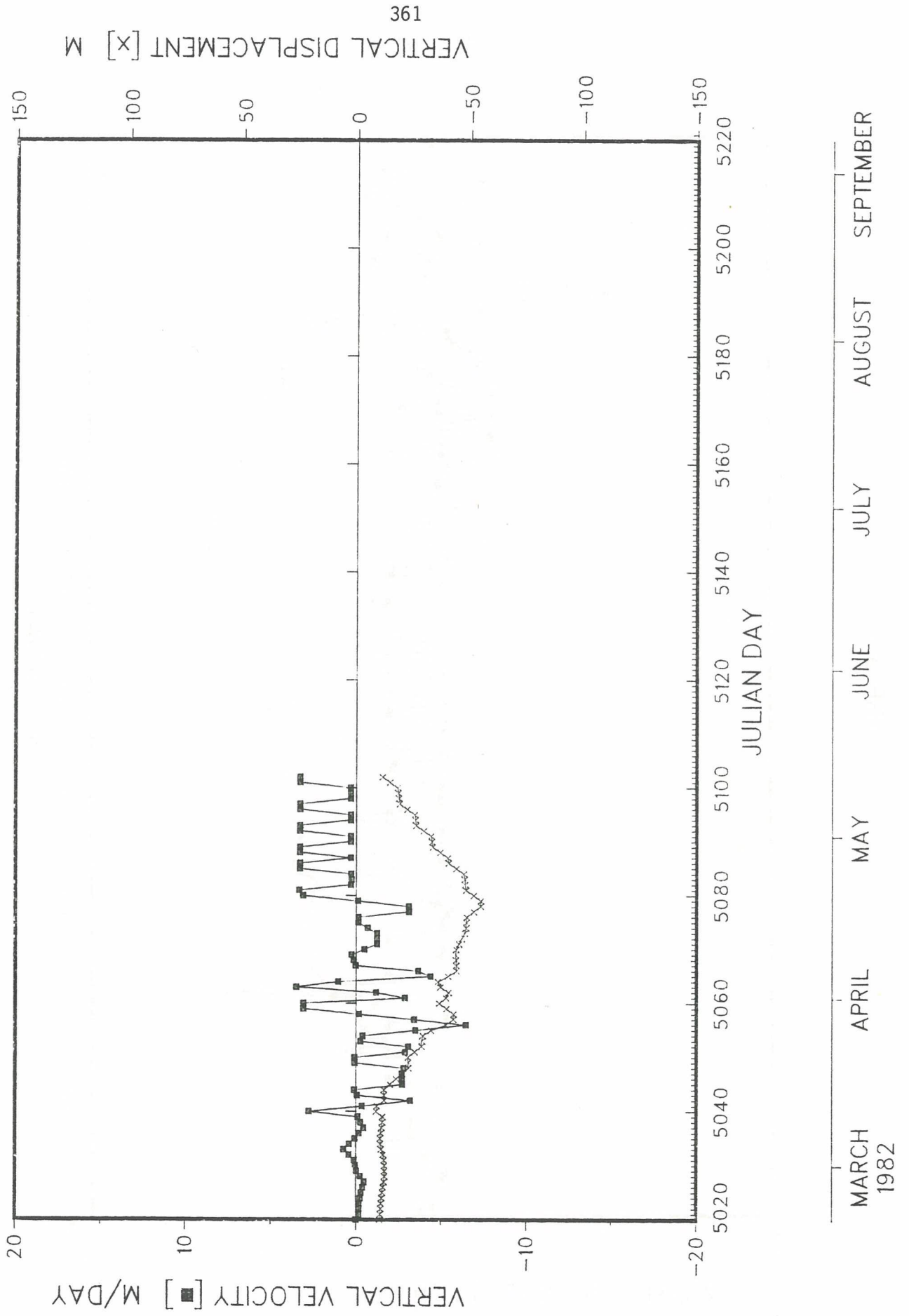


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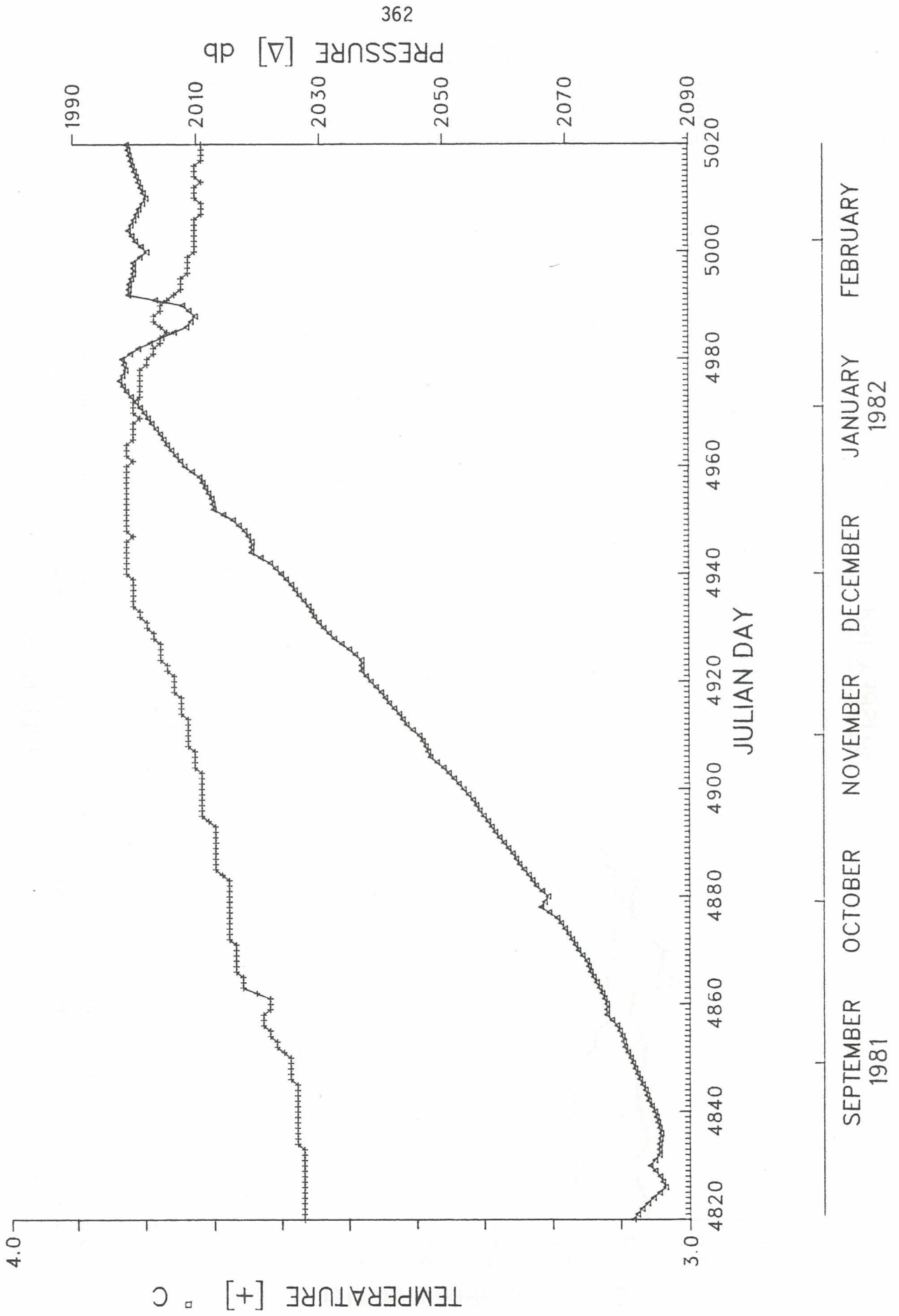


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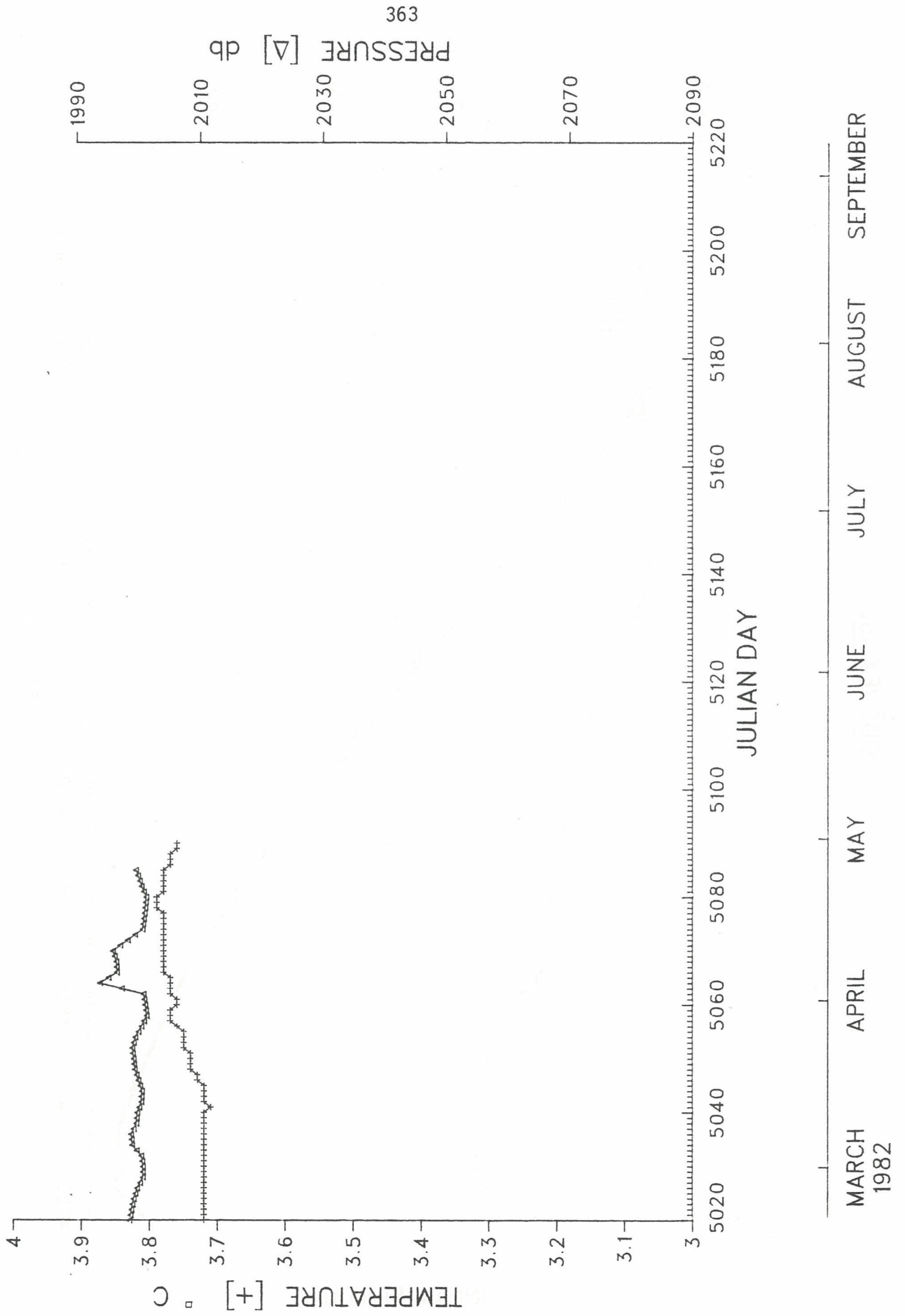
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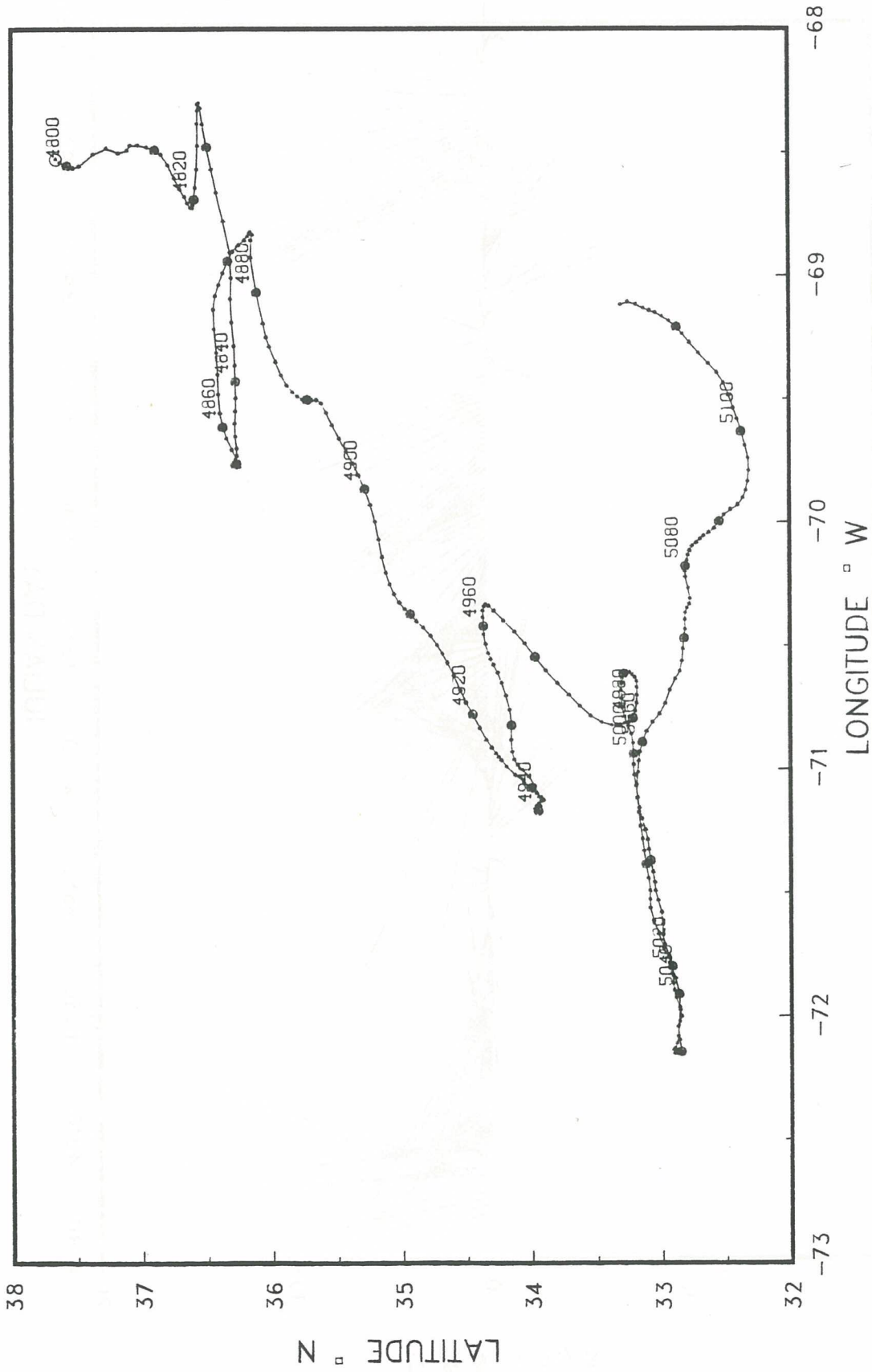
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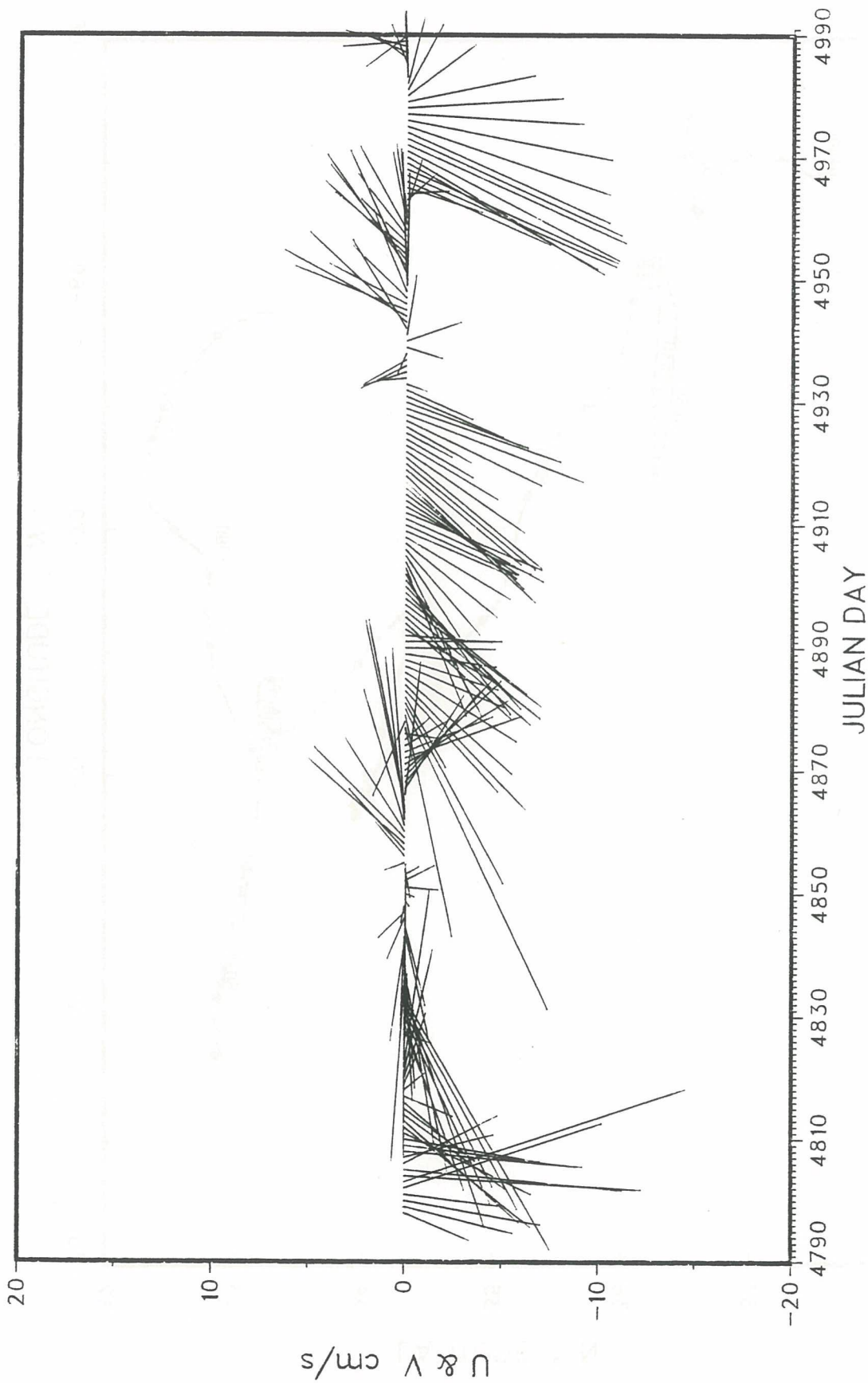
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GUSREX 169

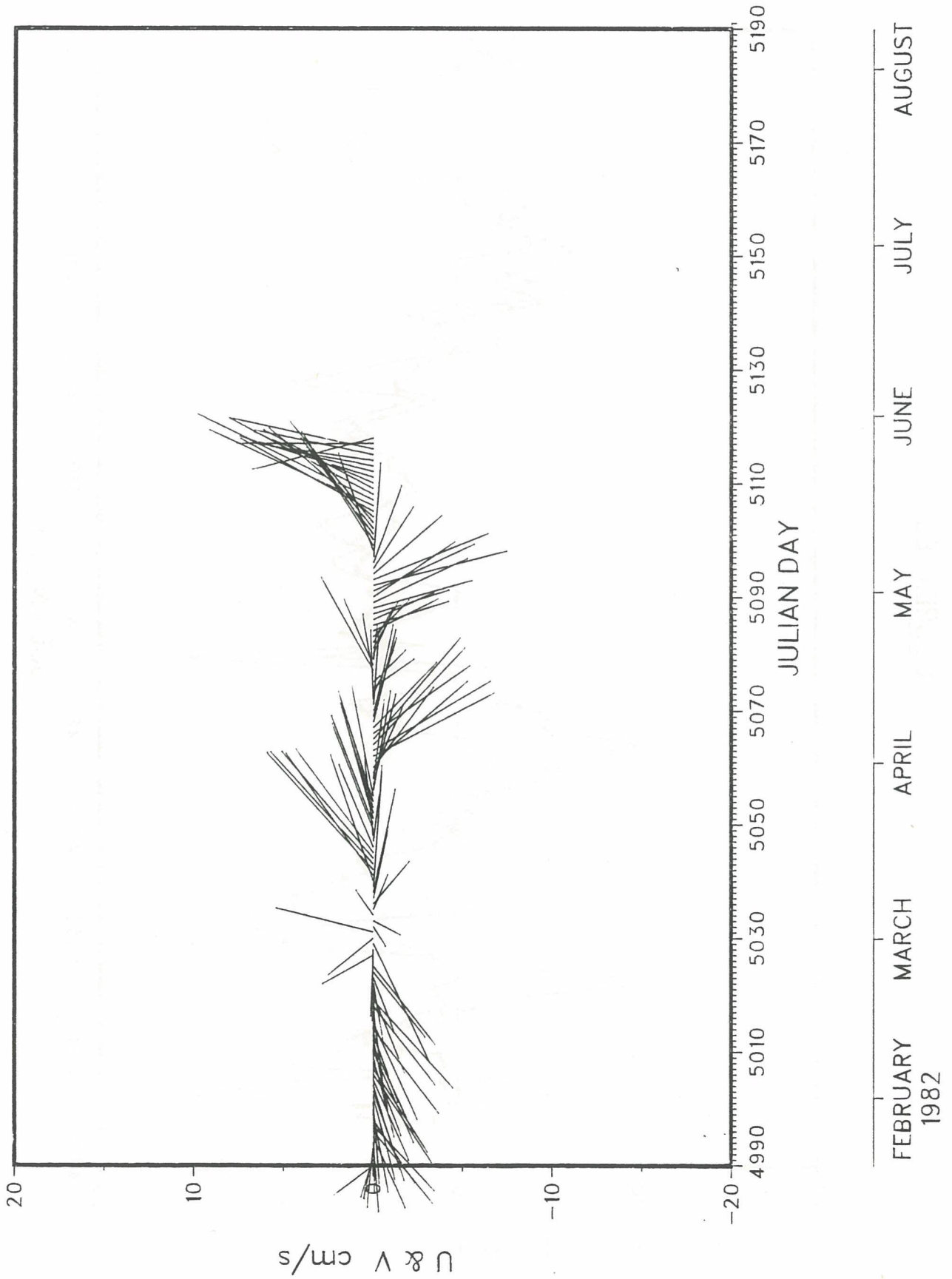


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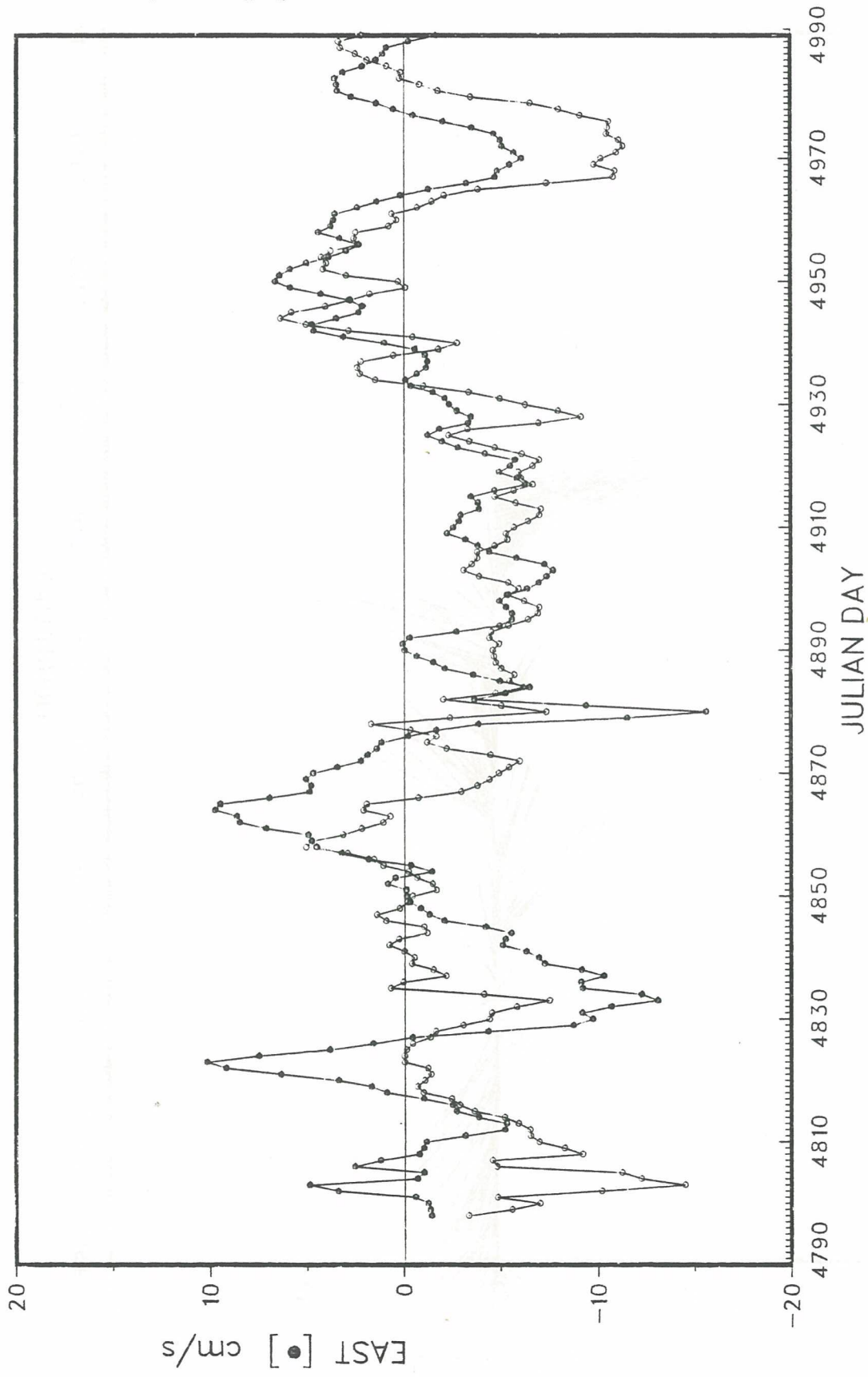


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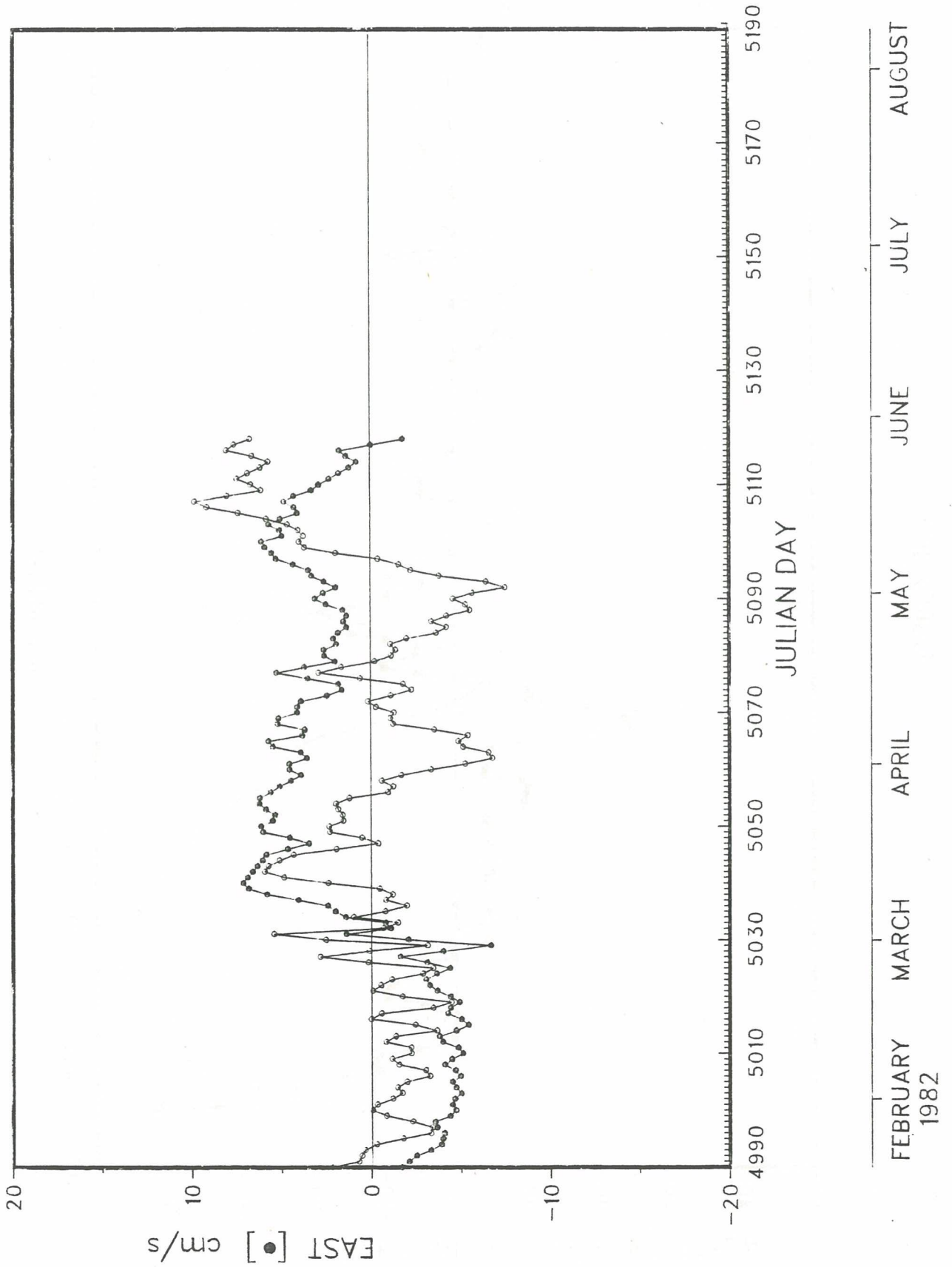


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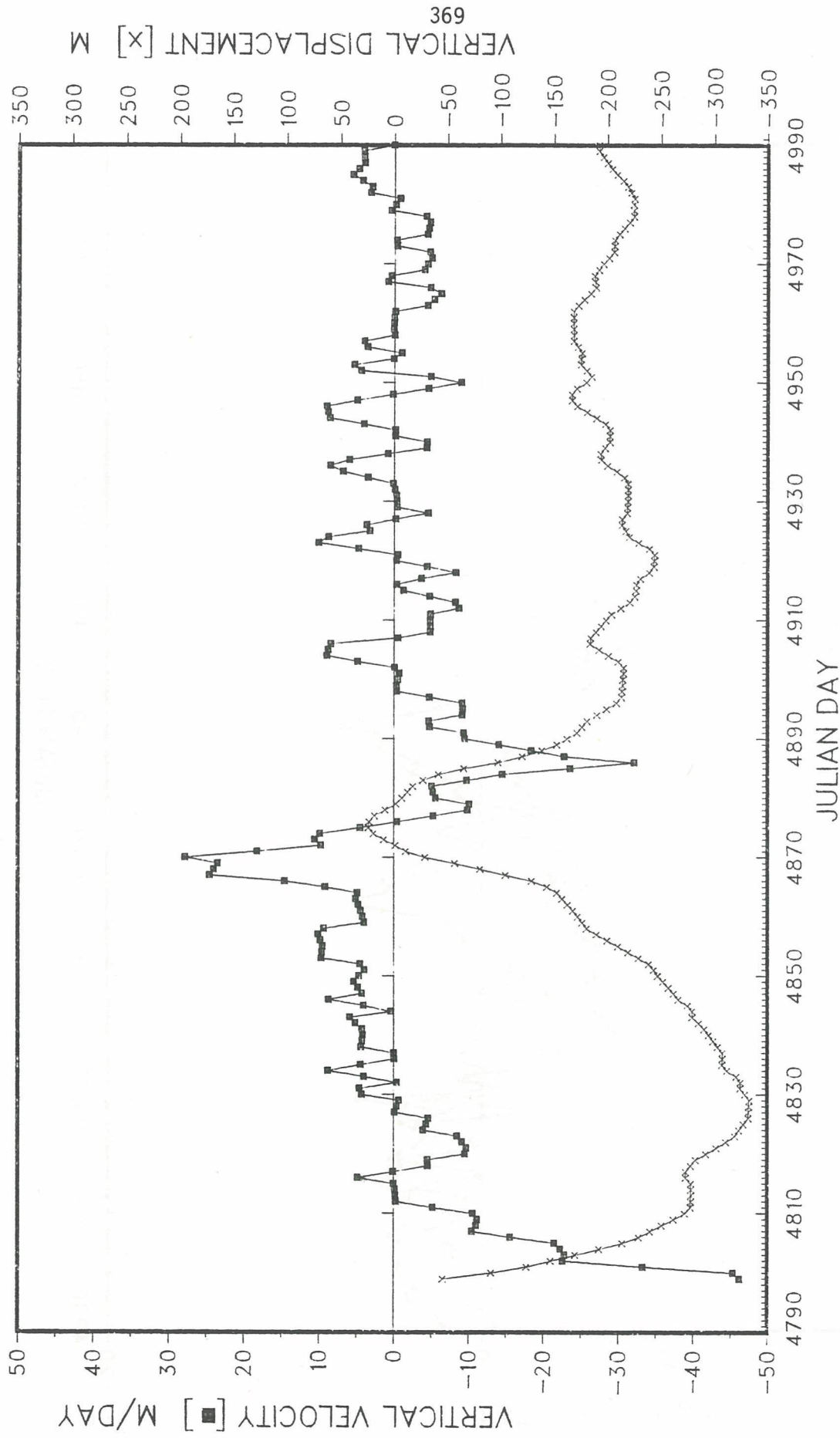


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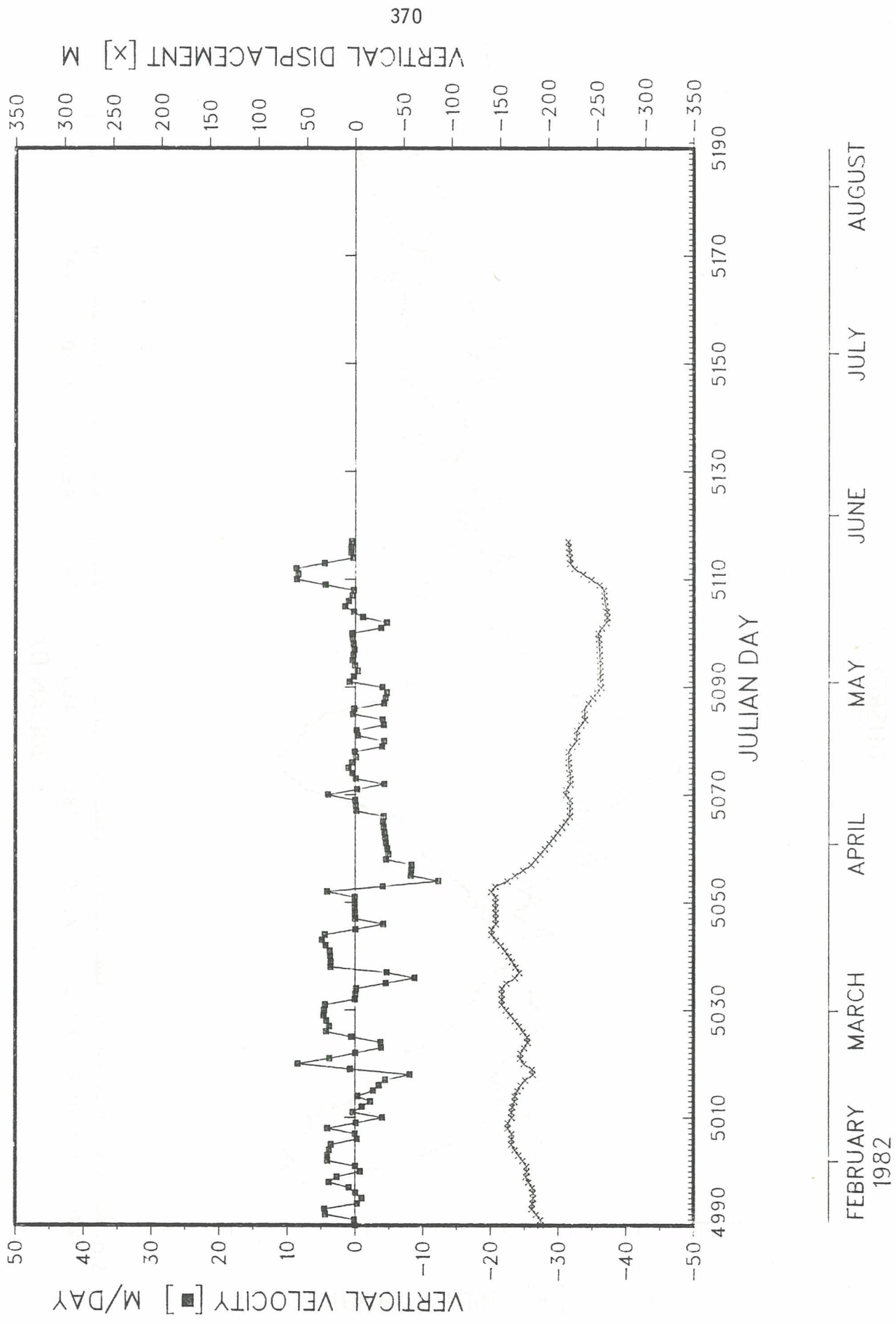


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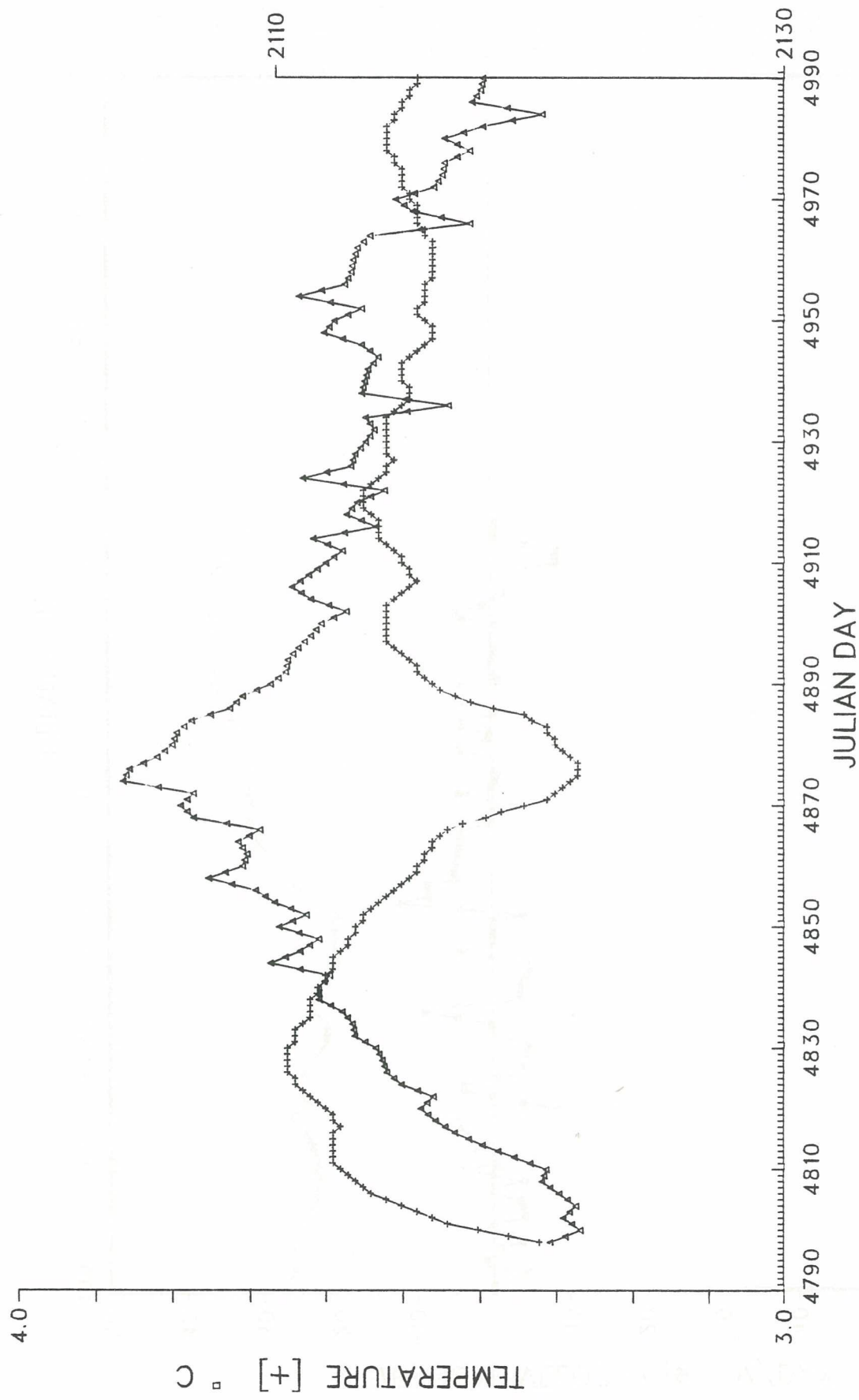


369

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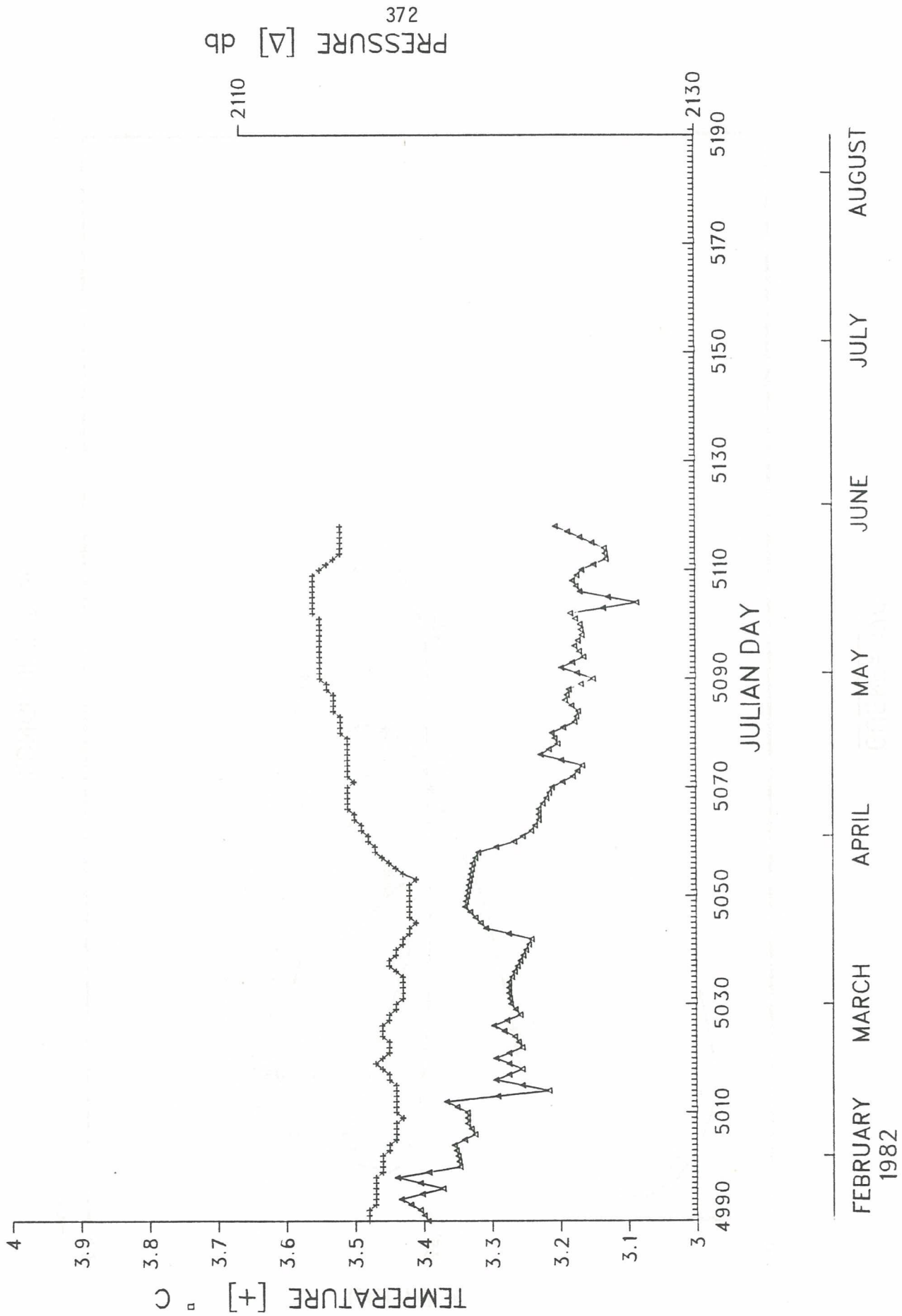
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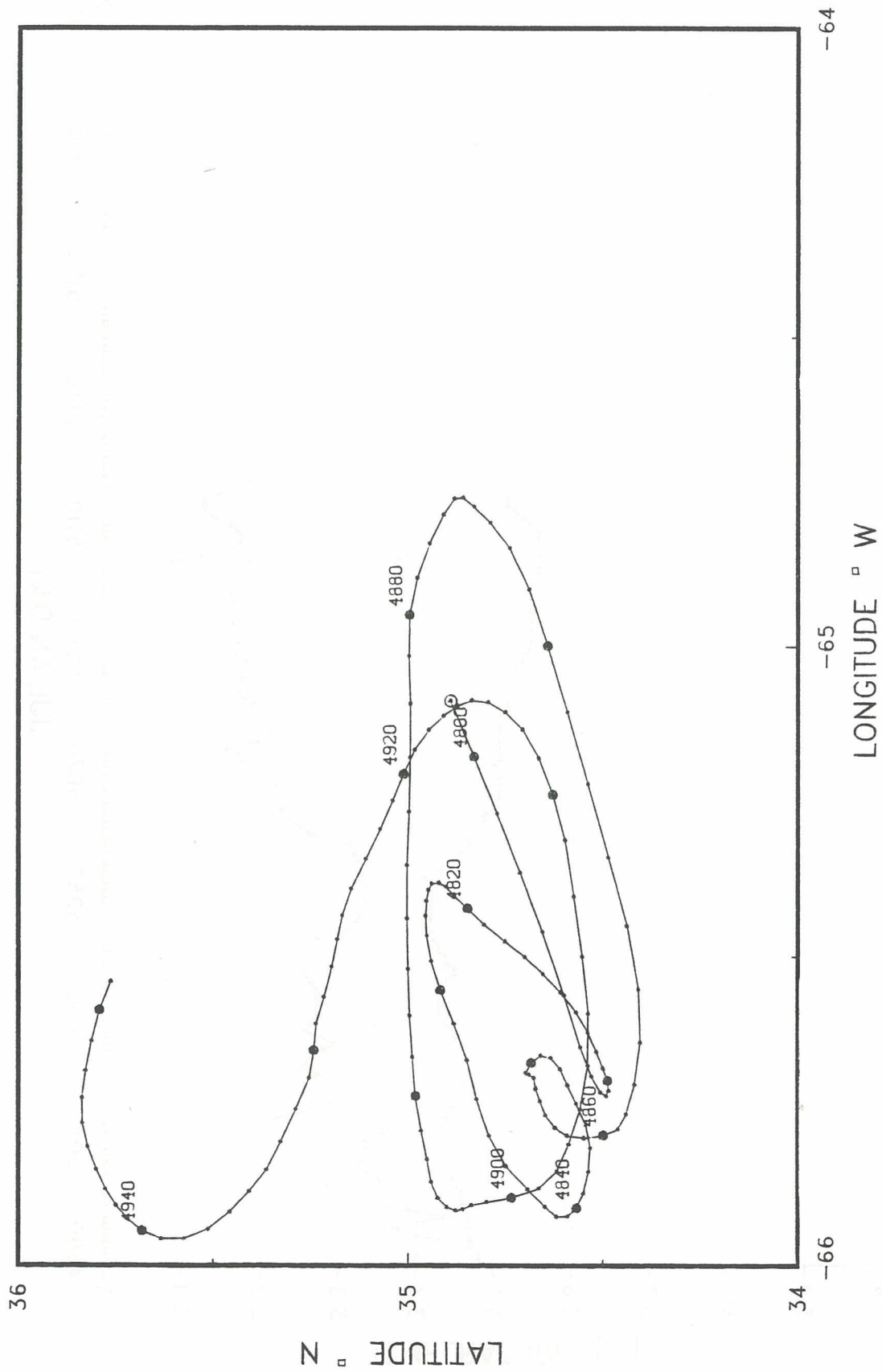
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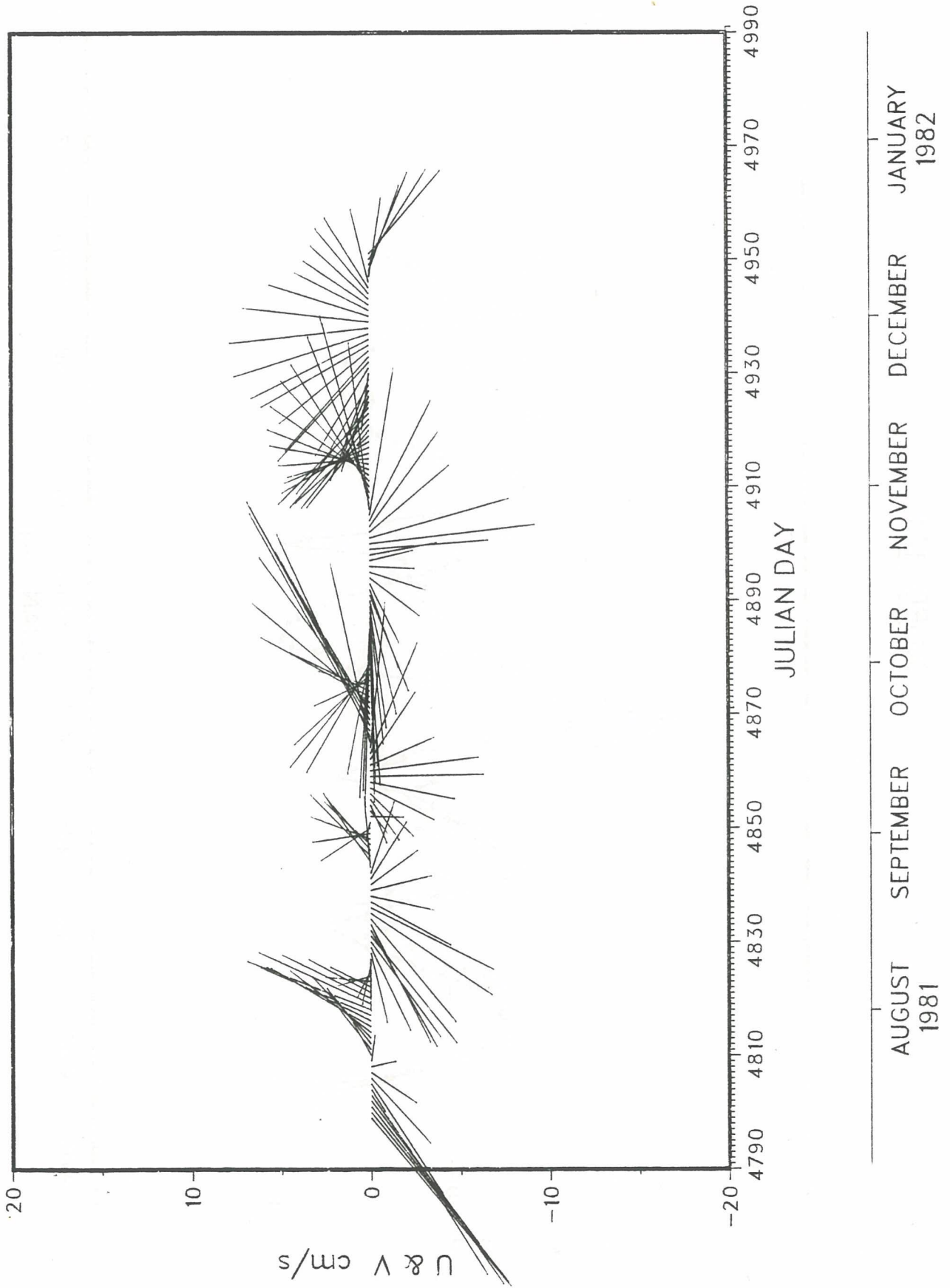


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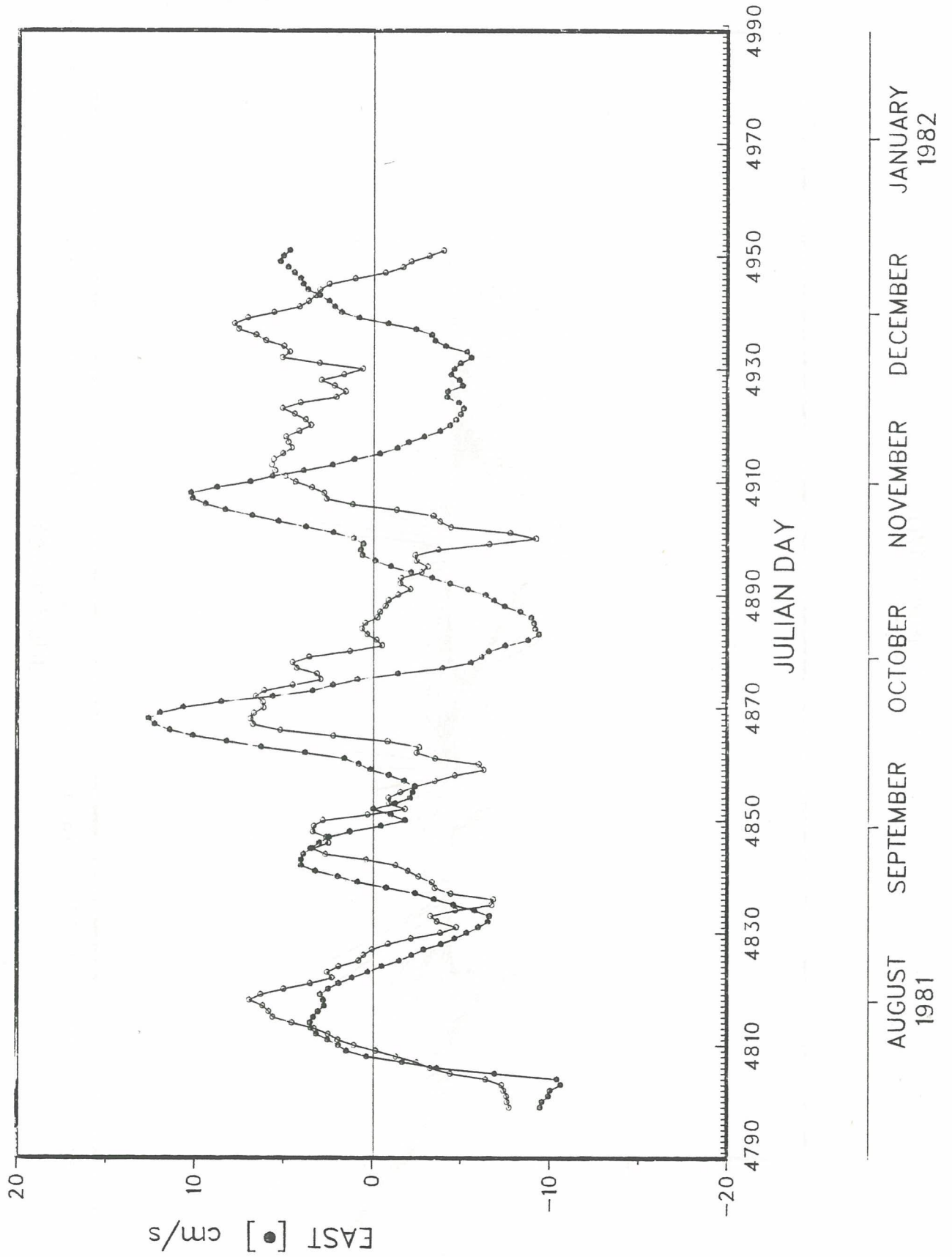


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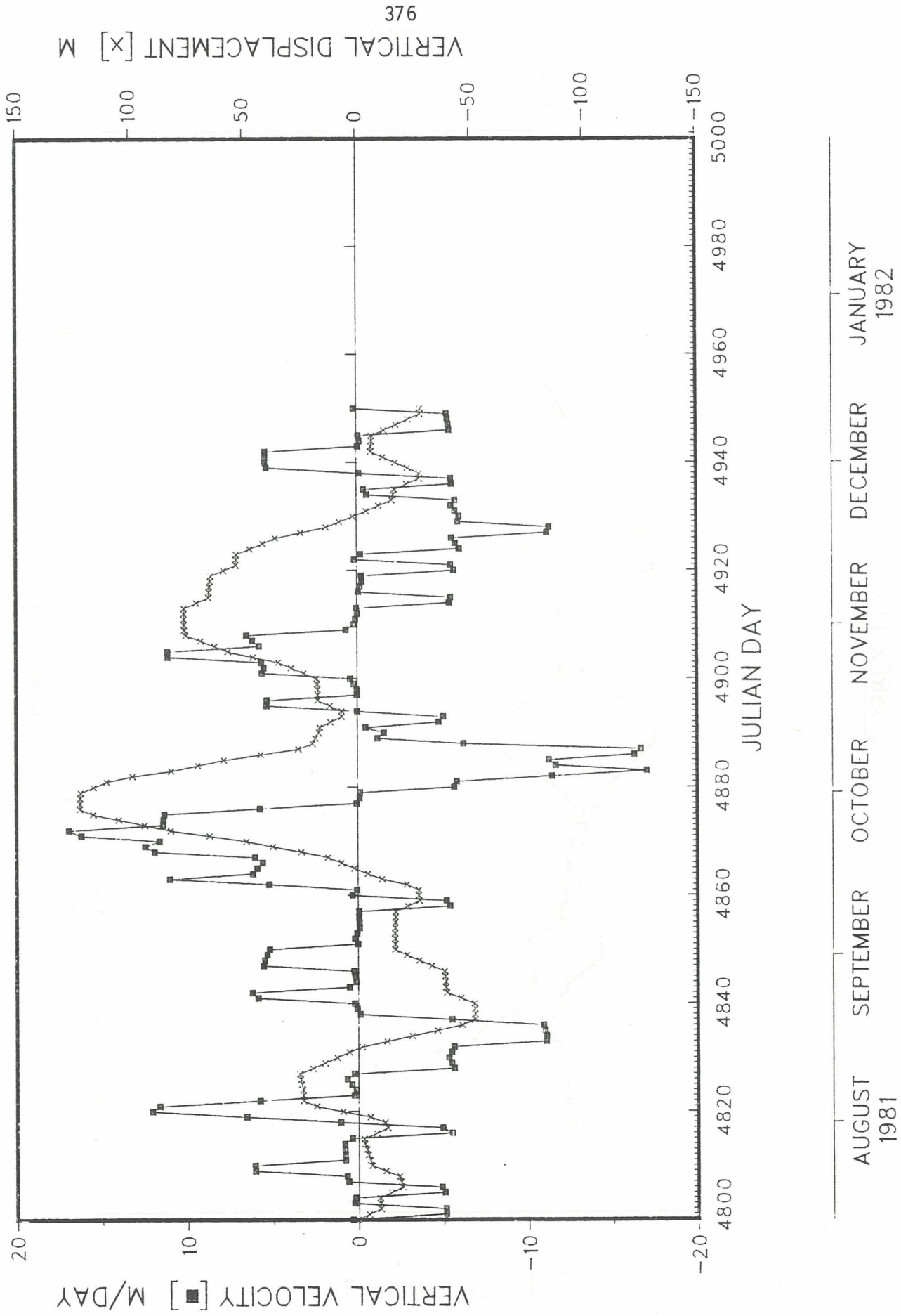
CUSREX 170



GUSREX 170

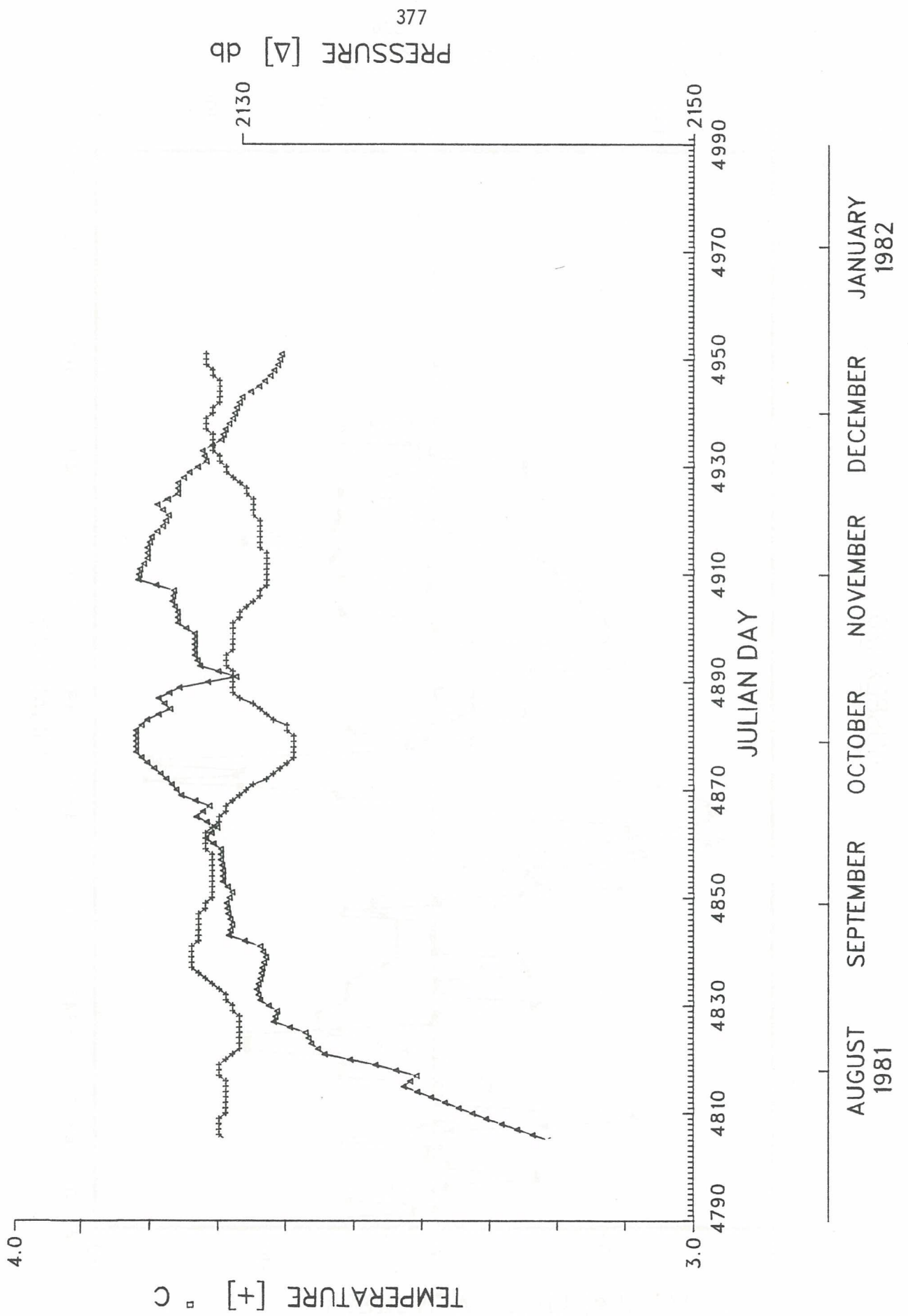


GUSREX 170



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GUSREX 170



APPENDIX A

Prior to GUSREX there were three small experiments which made use of SOFAR floats. The float data from these experiments has not been included in any previous data report; therefore we present it here.

Ring Floats

Floats RI2, RI6, and RI7 were launched in a cyclonic ring centered at $32^{\circ}40' N$, $68^{\circ}55' W$ during late September-early October, 1974. An additional six floats (RI1, RI3, RI4, RI5, RI8, and RI10) were launched in another meander/ring during October 1974. Floats RI5 and RI8 ceased transmitting shortly after launch and were not tracked. A tenth float (RI9) was placed in the Sargasso Sea between the two rings mentioned above. The information for the ring floats is summarized in Table 9. Two of the floats (RI6, RI9) were tracked up until December of 1975 (Cheney, 1977). There is no temperature or pressure information for the Ring floats and therefore no vertical velocities or vertical displacements could be calculated.

TABLE 9

Ring Experiment Floats

<u>FLOAT</u>	<u>DEPTH</u>	<u>LAUNCH DATE</u>	<u>LATITUDE° N</u>	<u>LONGITUDE° W</u>
RI1	230	74 10 07	36° 46'	67° 19'
RI2	750	74 10 02	32° 40'	68° 58'
RI3	770	74 10 08	36° 32'	67° 51'
RI4	990	74 10 08	36° 28'	67° 58'
RI6	1080	74 09 29	32° 40'	68° 58'
RI7	1050	74 09 30	32° 38'	69° 22'
RI9	1290	74 10 05	34° 45'	66° 59'
RI10	530	74 10 07	36° 48'	67° 20'

Long Range Floats

In preparation for GUSREX tests were conducted to determine ALS tracking capability in 1977-1978. The initial engineering test float, LR32, was launched in the recirculation area of the Gulf Stream. Nine months later Float LR83 was deployed. Launch information is summarized in Table 10. There is no temperature or pressure data for the Long Range floats.

TABLE 10

Long Range Experiment Floats

<u>FLOAT</u>	<u>DEPTH</u>	<u>LAUNCH DATE</u>	<u>LATITUDE°N</u>	<u>LONGITUDE°W</u>
LR32	1300	77 10 09	35°00'	61°00'
LR83	1300	78 07 29	35°00'	67°00'

Gulf Stream Floats

An additional test of SOFAR floats and ALS configurations was conducted in 1979. Three floats GS72B, GS73B, and GS74B were launched near but south of the axis of the Gulf Stream (Table 11). The results from the Long Range and Gulf Stream experiments have been discussed by Schmitz et. al., 1981.

TABLE 11

Gulf Stream Experiment Floats

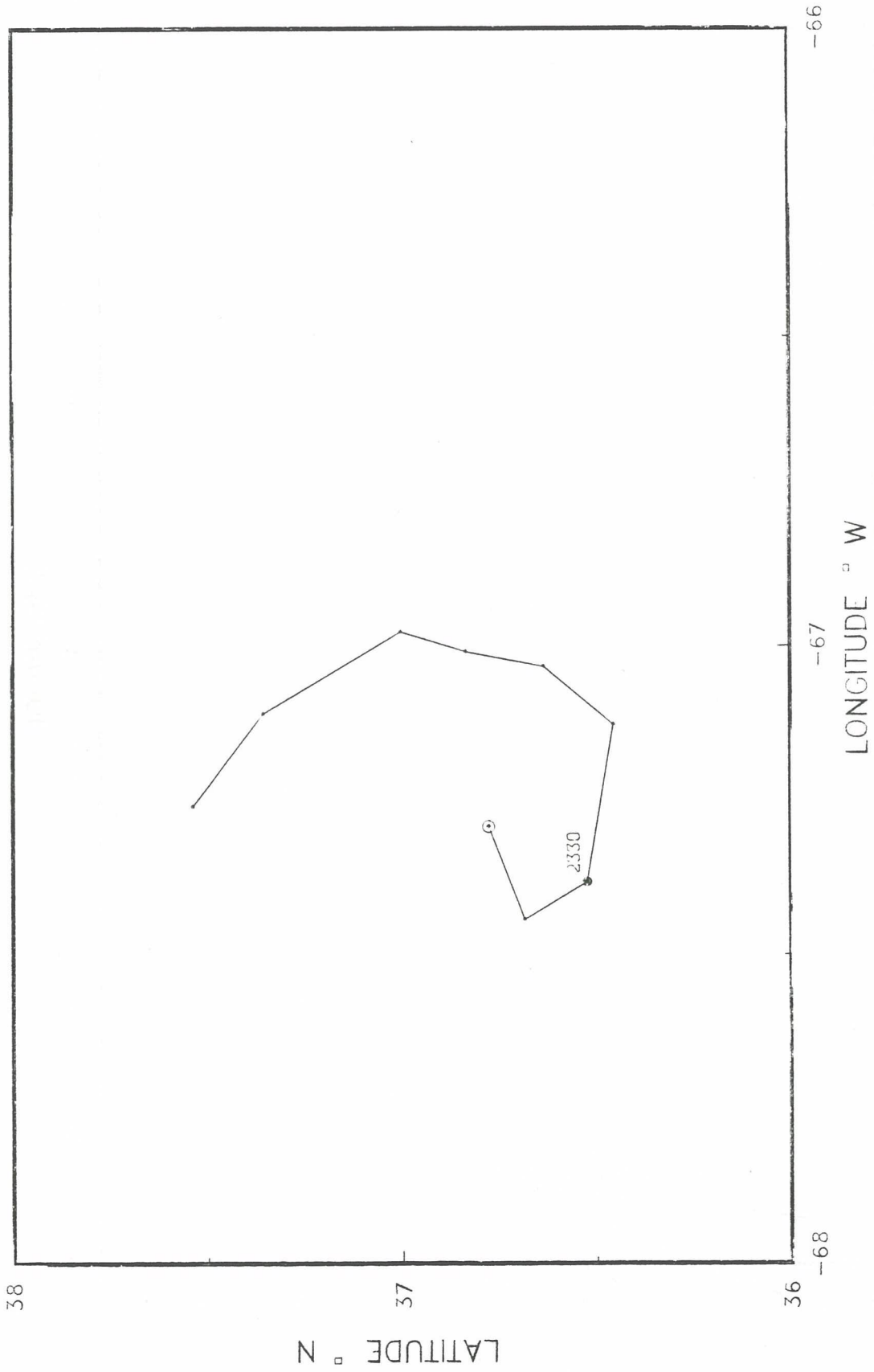
<u>FLOAT</u>	<u>DEPTH (m)</u>	<u>LAUNCH DATE</u>	<u>LATITUDE°N</u>	<u>LONGITUDE°W</u>
GS72B	700	79 06 06	38°24'	67°54'
GS73B	1300	79 06 06	38°24'	67°54'
GS74B	2000	79 06 07	38°24'	67°48'

A-4

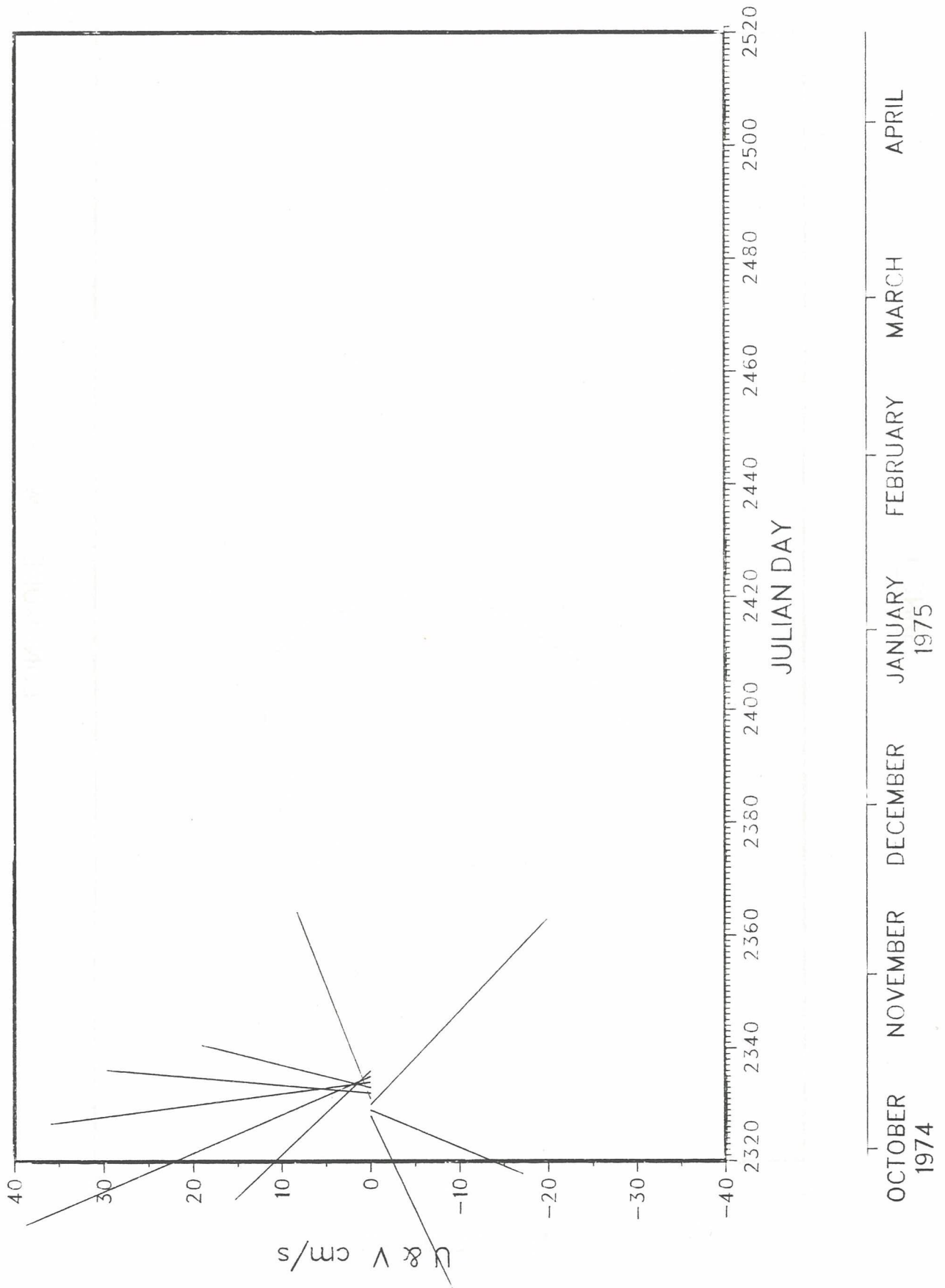
Table 12: Summary of Float Data for Ring, Long Range, and Gulf Stream Experiments.

FLOAT ID	START DATE		END DATE		FIRST POSITION		LAST POSITION		RANGE		AVERAGES	
	CAL	JUL	CAL	JUL	POSITION	POSITION	LAT° N	LONG° W	LAT° N	LONG° W	TEMP	PRES
RI1	741007	2328	741015	2336	36.78	-67.29	37.54	-67.26	36:38	68:66	--	--
RI2	741005	2326	750116	2429	32.70	-69.05	37.96	-66.05	32:39	74:66	--	--
RI3	741008	2329	741021	2342	36.54	-67.83	37.51	-67.19	36:38	68:66	--	--
RI4	741010	2331	741212	2394	36.12	-67.77	34.66	-71.73	34:37	72:67	--	--
RI6C	741006	2327	751229	2776	32.79	-68.92	37.41	-66.59	32:38	-73:65	--	--
RI7	741002	2323	750222	2466	32.55	-69.36	34.41	-74.81	32:35	-75:69	--	--
RI9A	741007	2328	750330	2502	34.82	-66.98	35.15	-68.87	34:36	-70:66	--	--
RI9B	750326	2498	751208	2755	34.66	-69.04	36.26	-66.83	33:37	-71:66	--	--
RI10	741007	2328	741016	2337	36.80	-67.31	37.09	-66.54	36:38	-68:66	--	--
LR31	771012	3429	790121	3895	35.48	-60.76	35.38	-62.95	35:41	-72:59	--	--
LR83	780728	3718	790504	3998	35.71	-66.81	35.26	-73.36	32:36	-76:66	--	--
GS72B	790608	4033	791007	4154	38.51	-67.75	37.90	-57.10	36:42	-68:51	9.6	758
GS73B	790608	4033	791228	4236	38.42	-67.74	34.65	-66.72	32:39	-69:63	4.2	--
GS74B	790608	4033	791122	4200	38.39	-67.71	36.61	-61.61	35:39	-69:59	3.8	2034

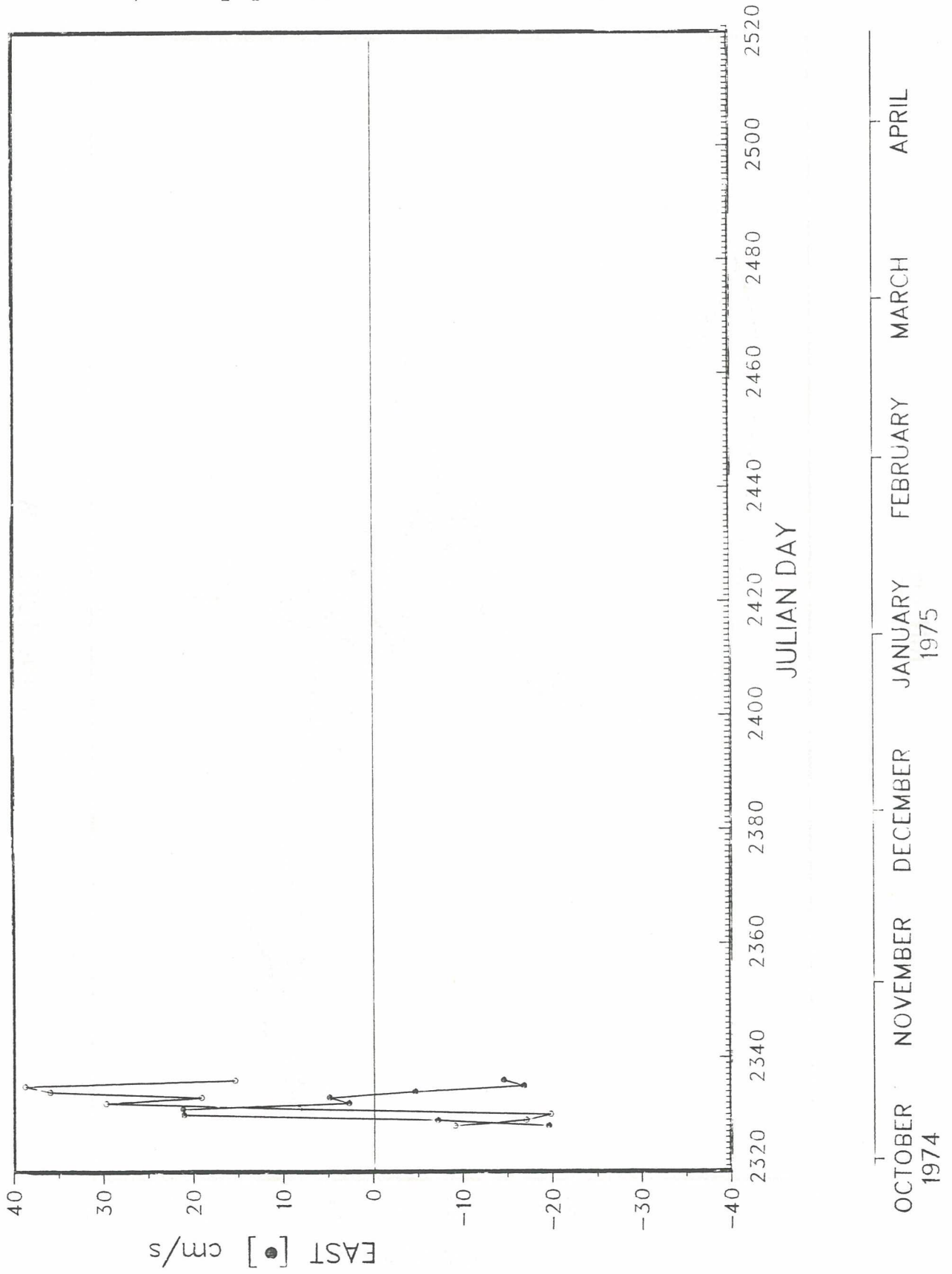
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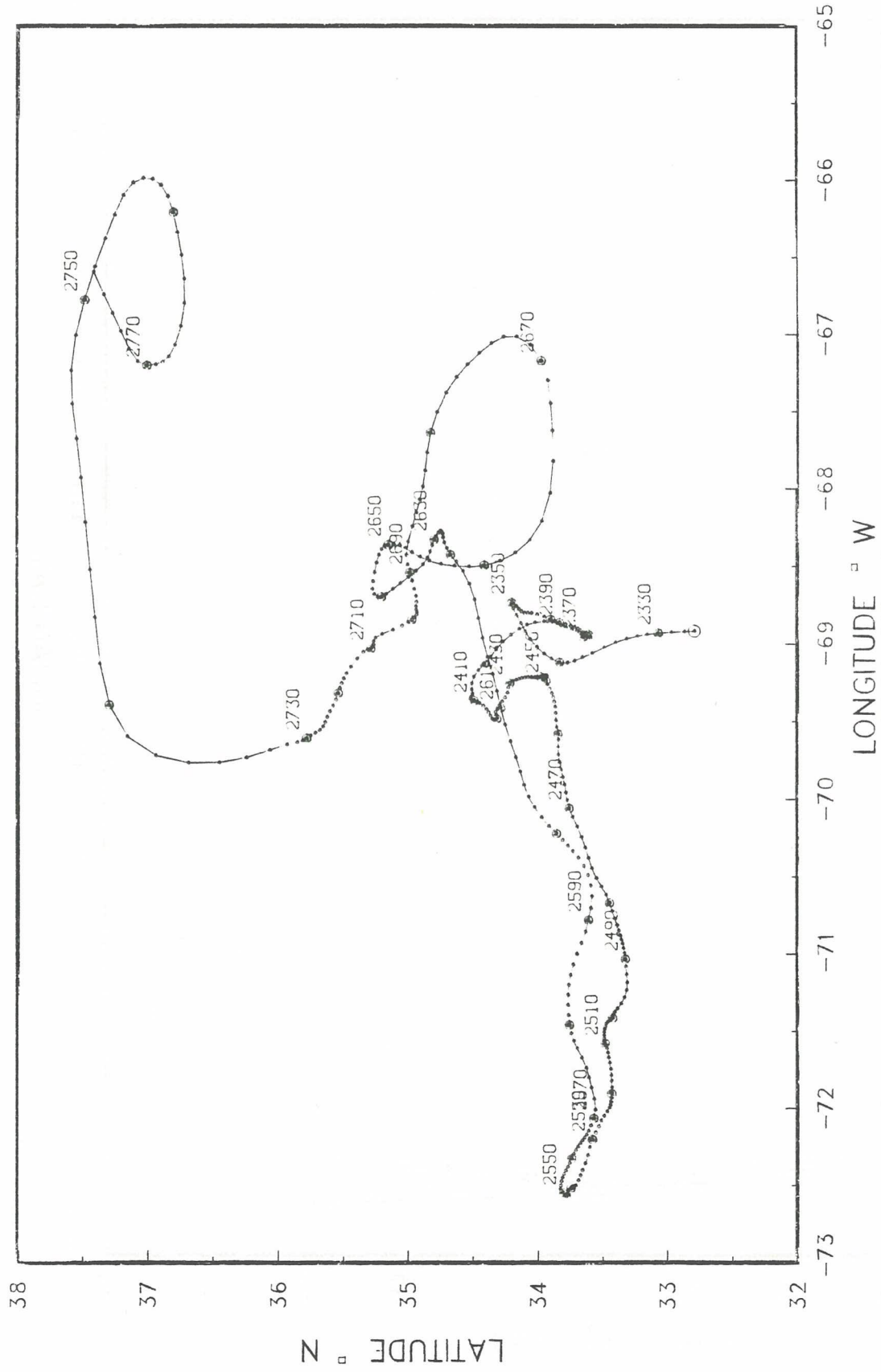
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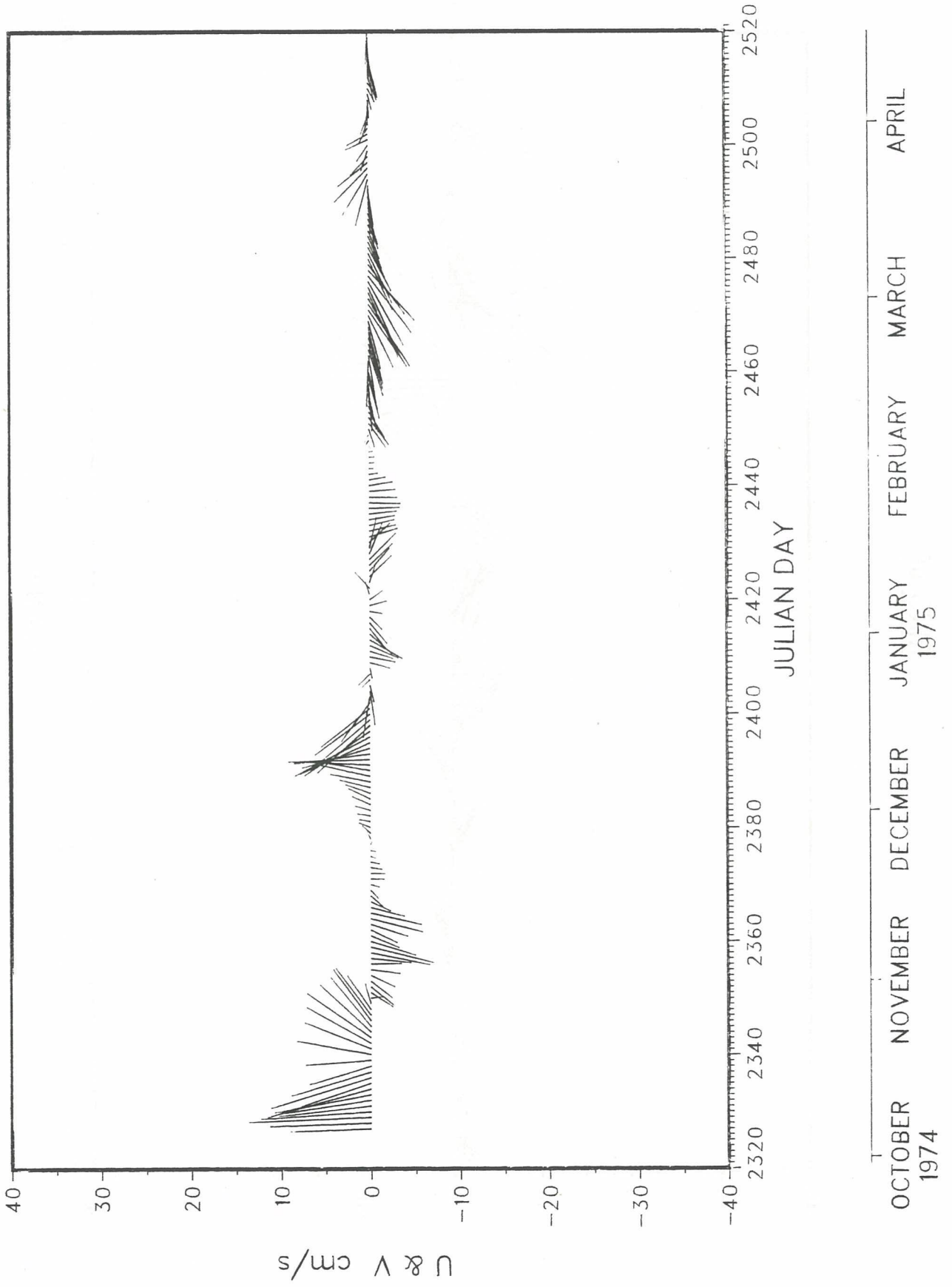
RING 1



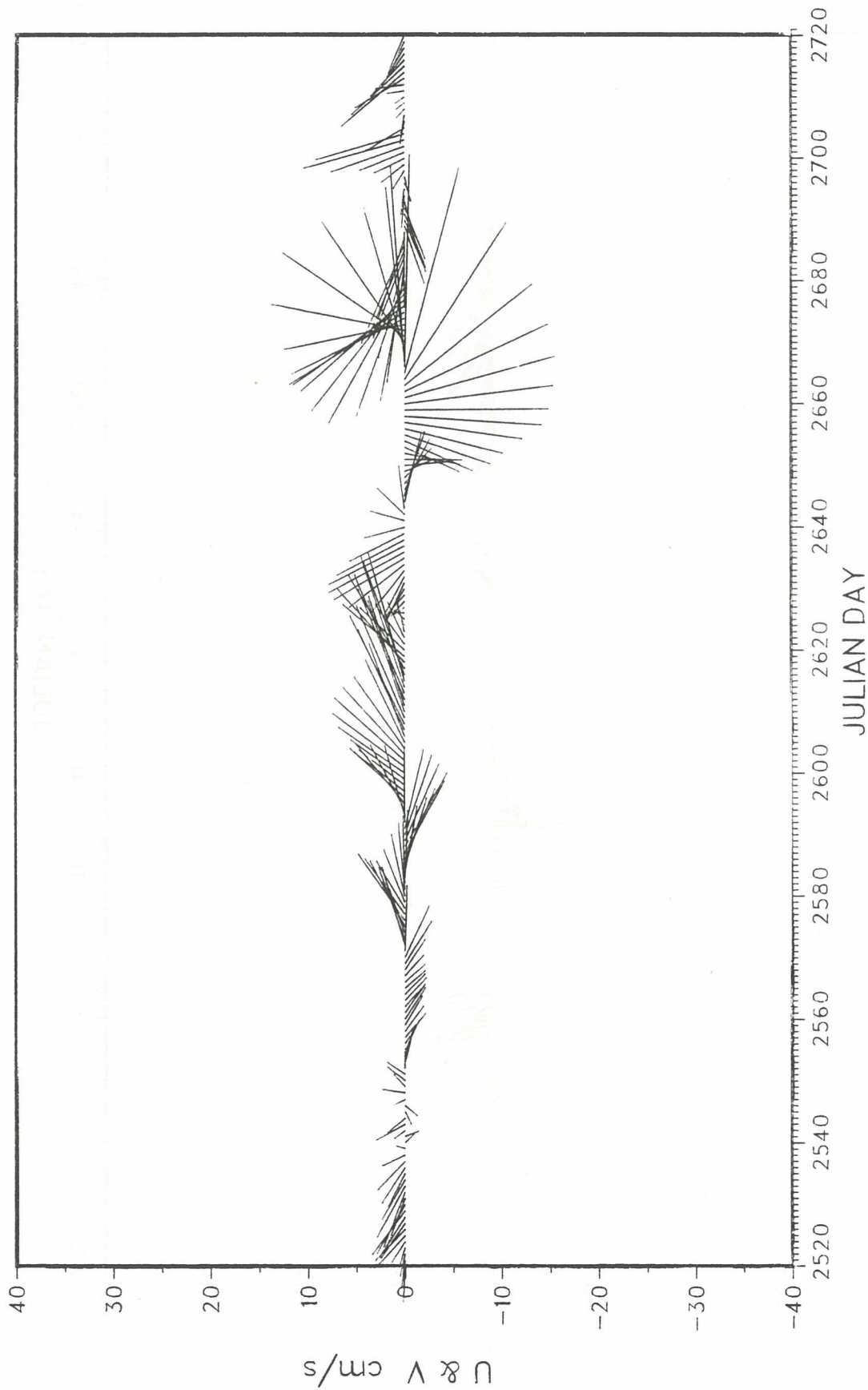
RING 6C



RING 6C

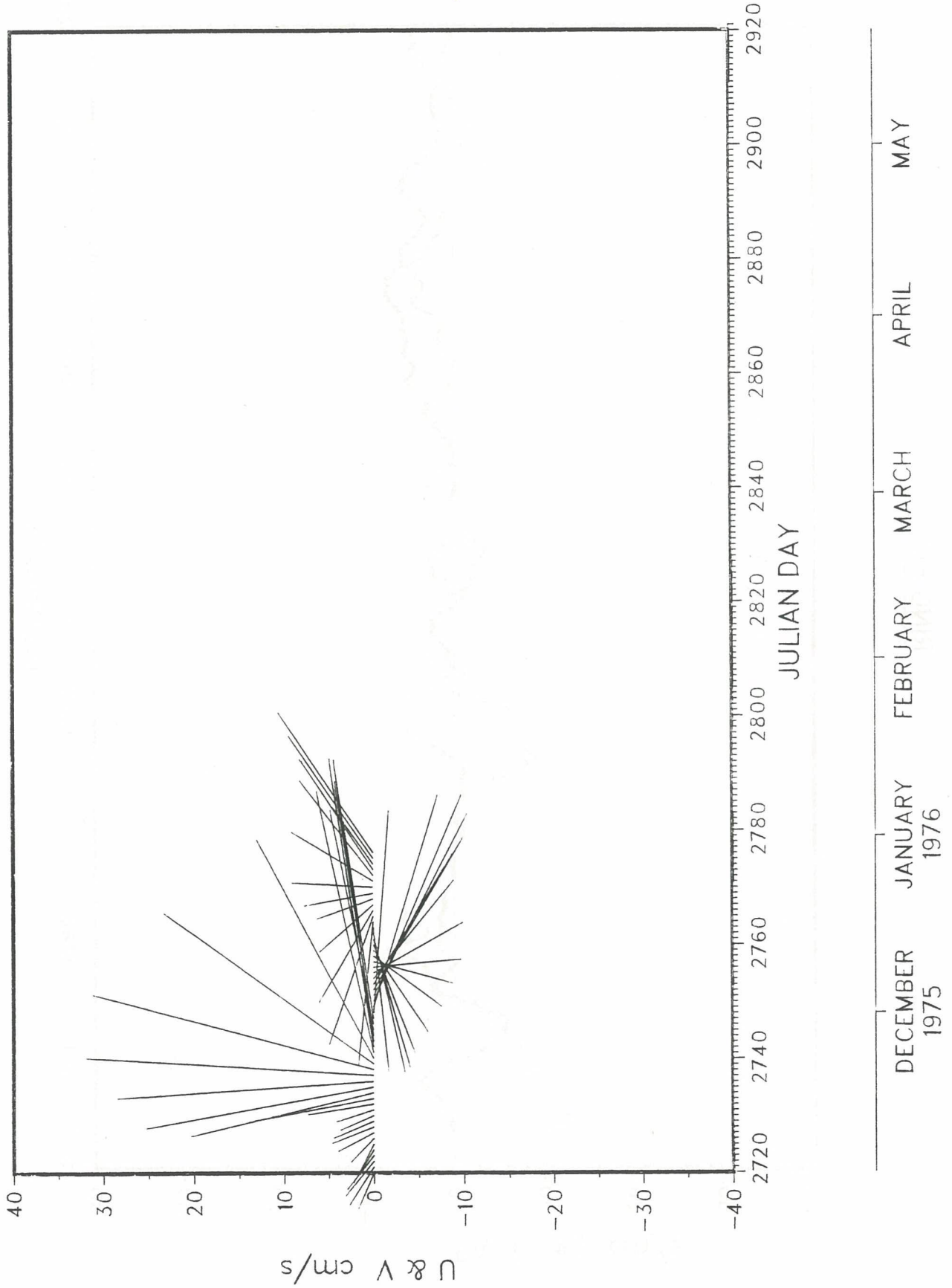


RING 6C

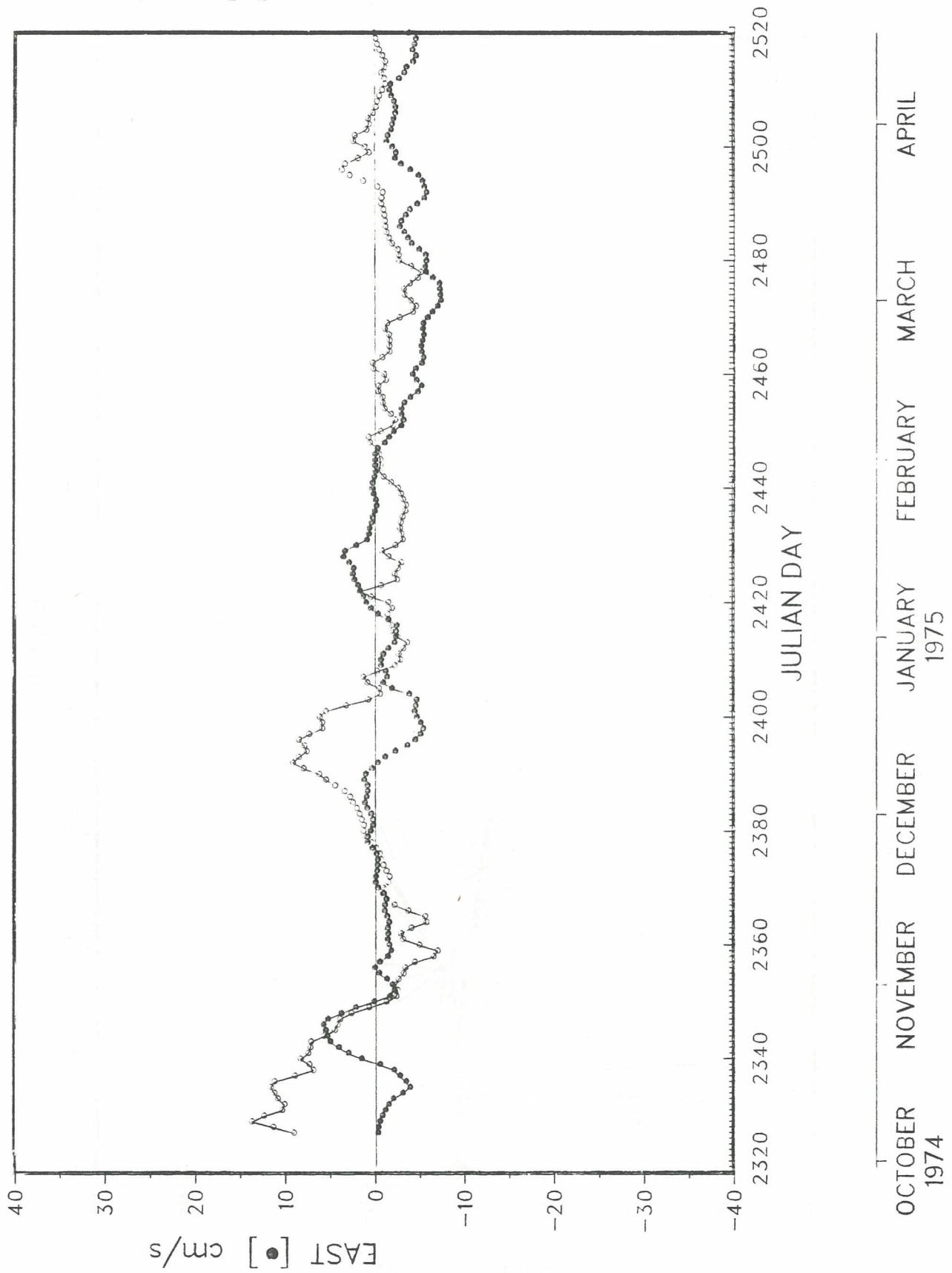


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1975

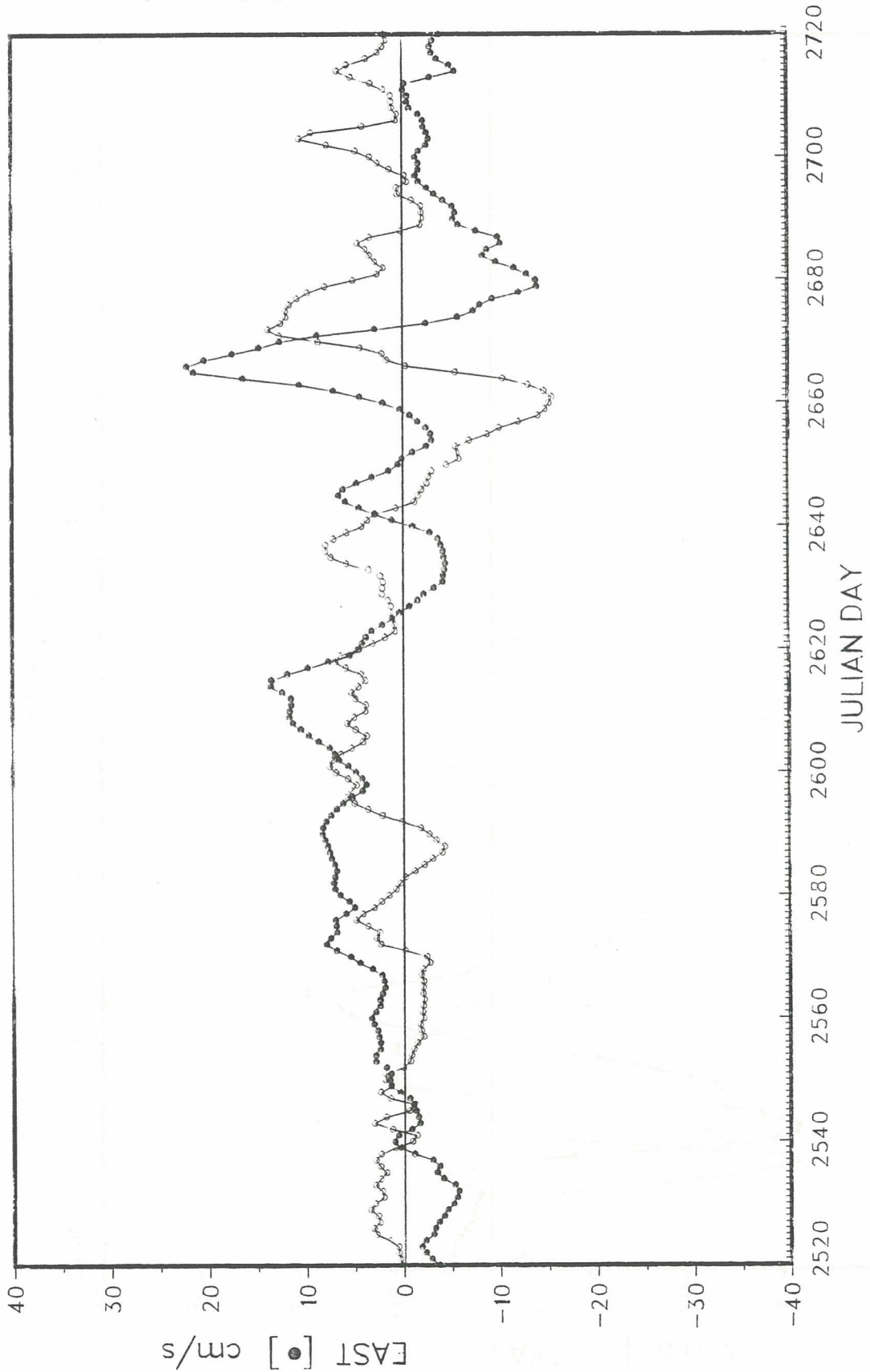
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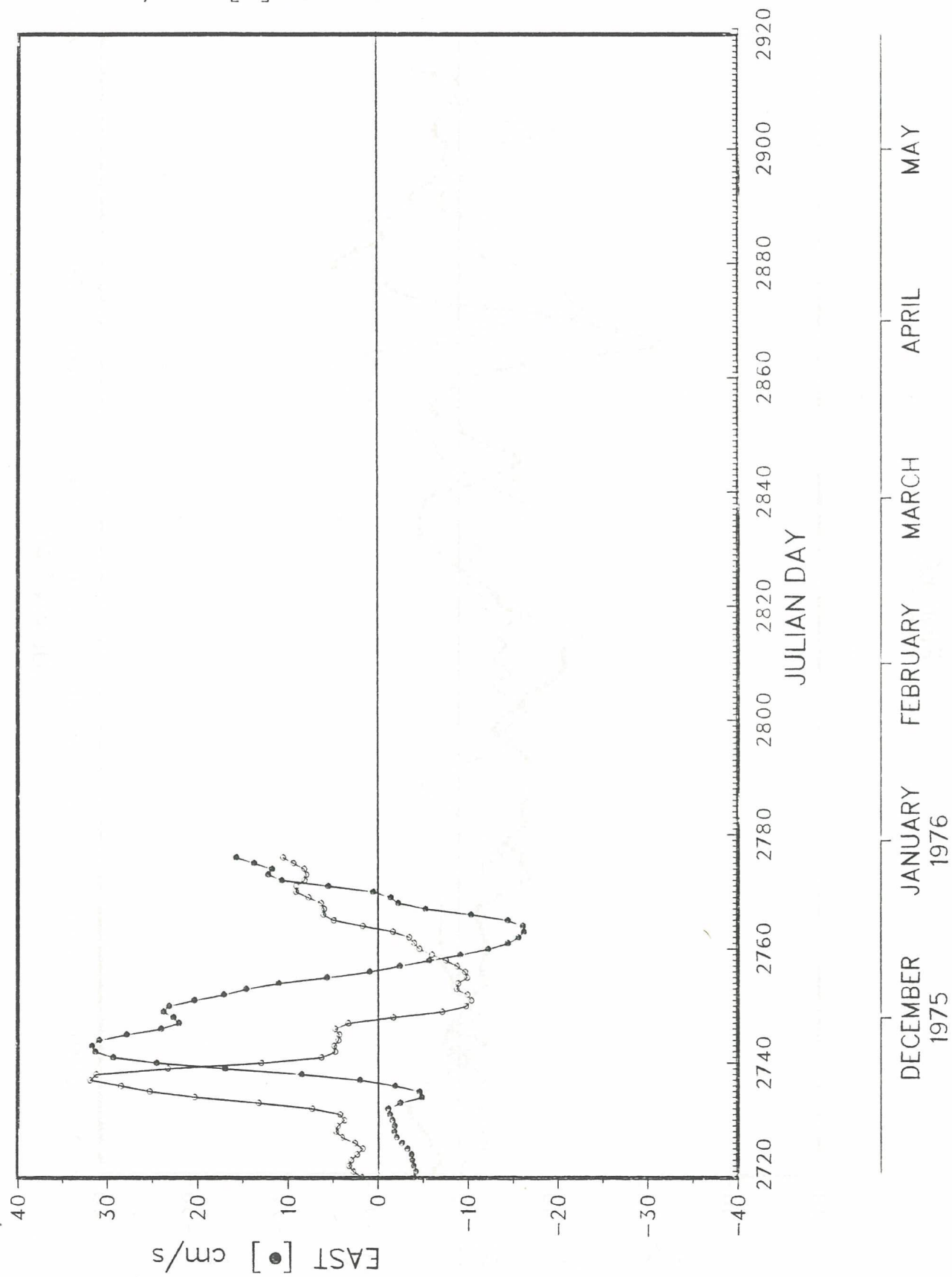
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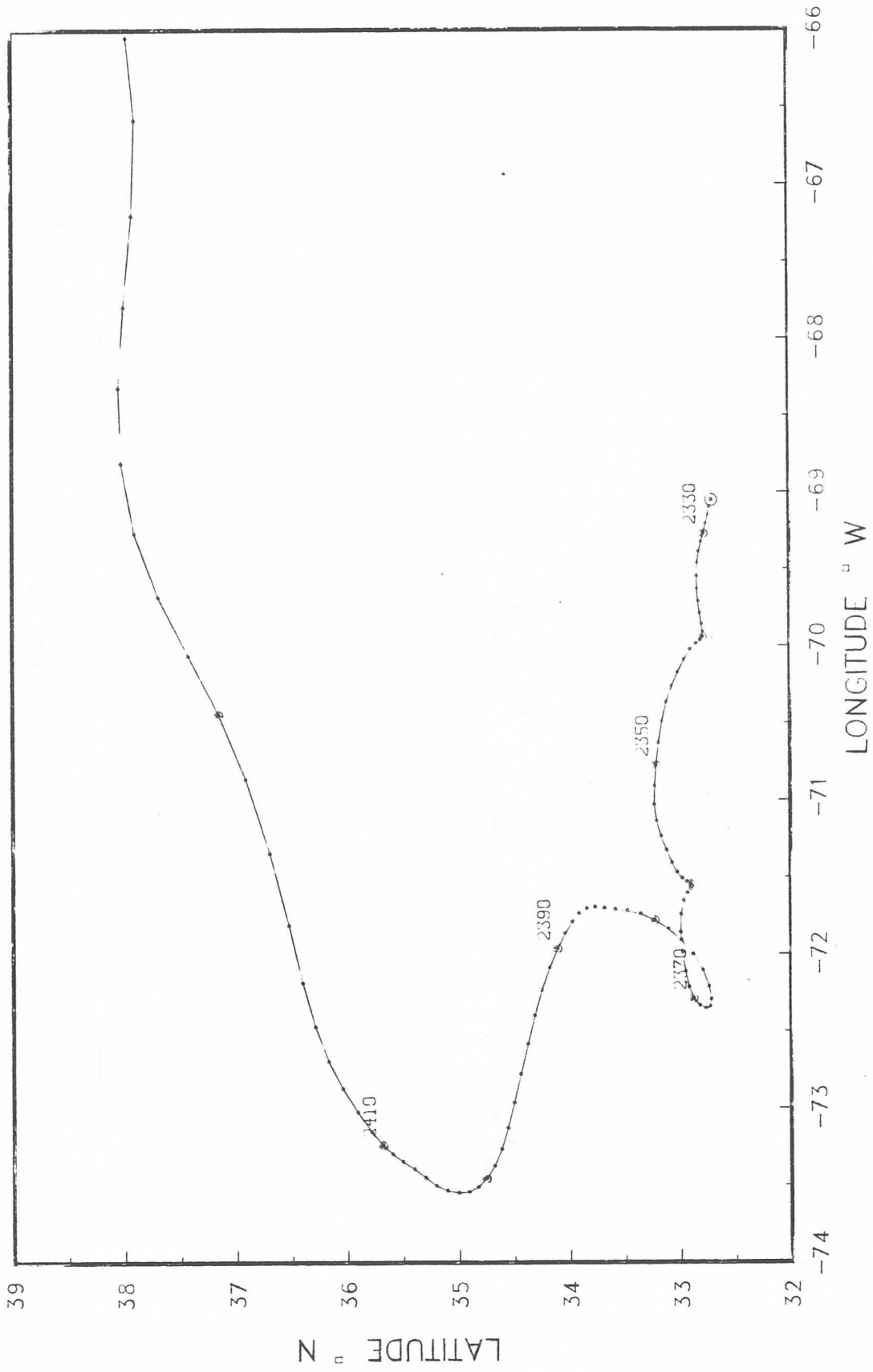
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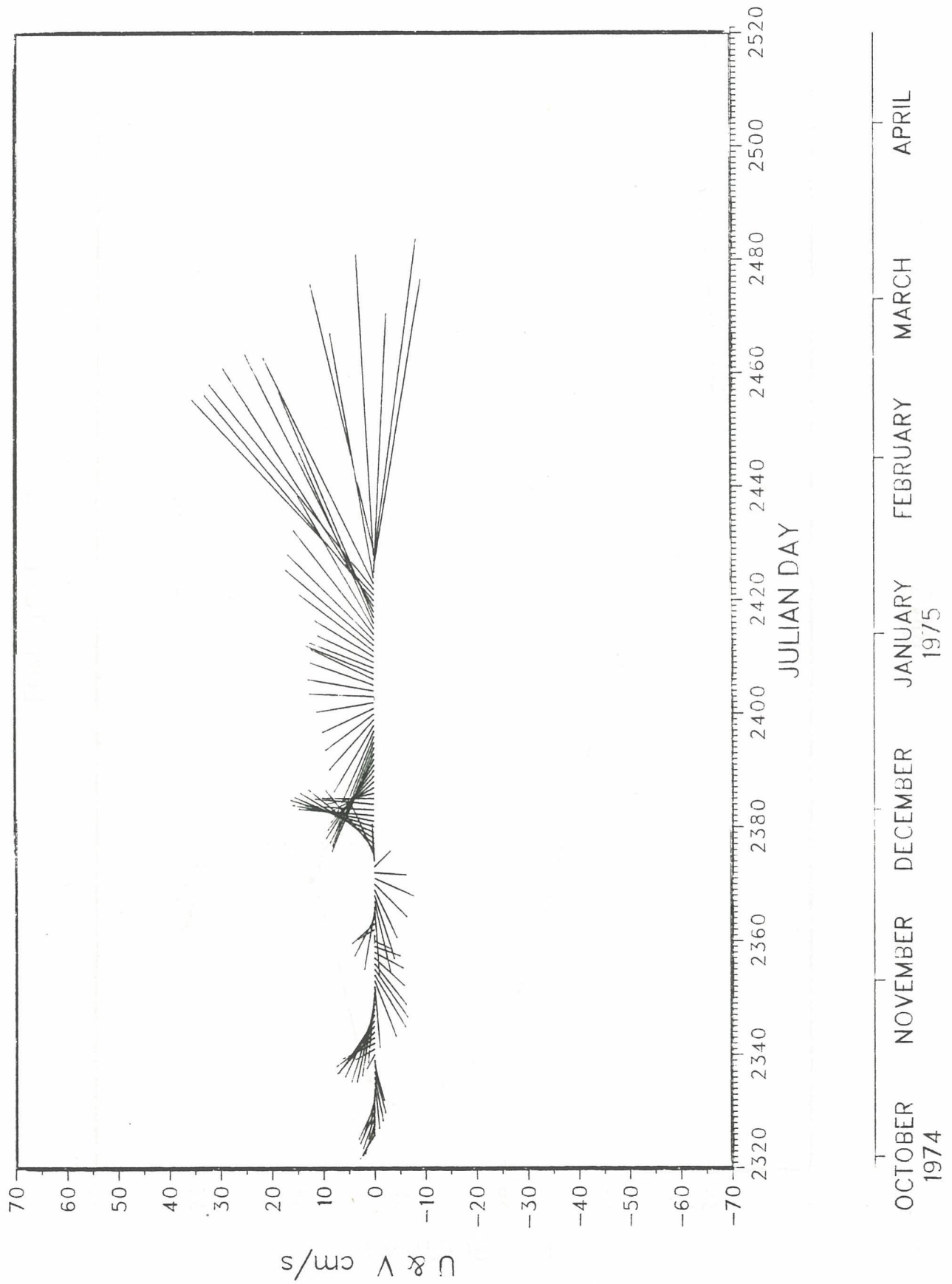
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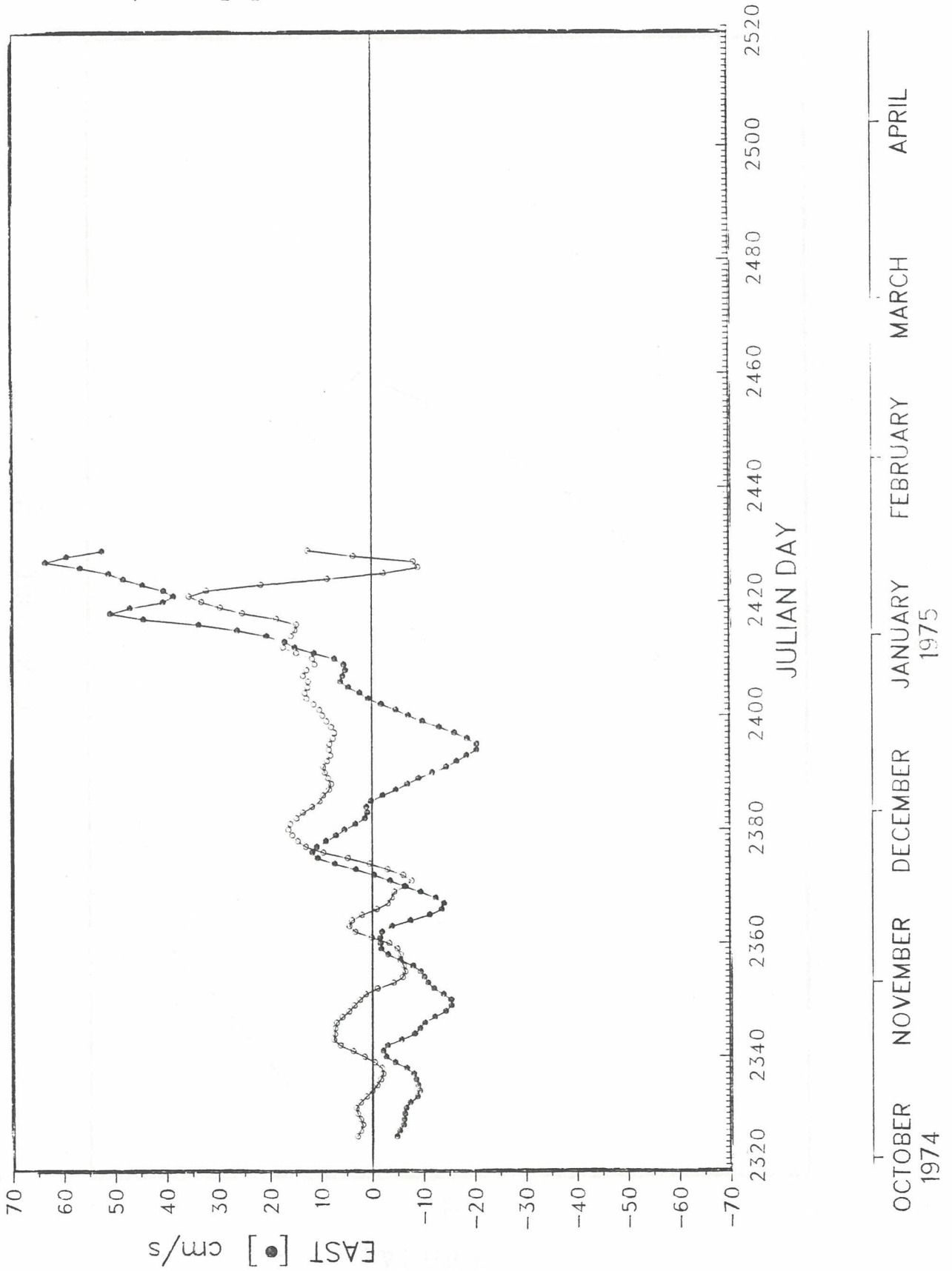
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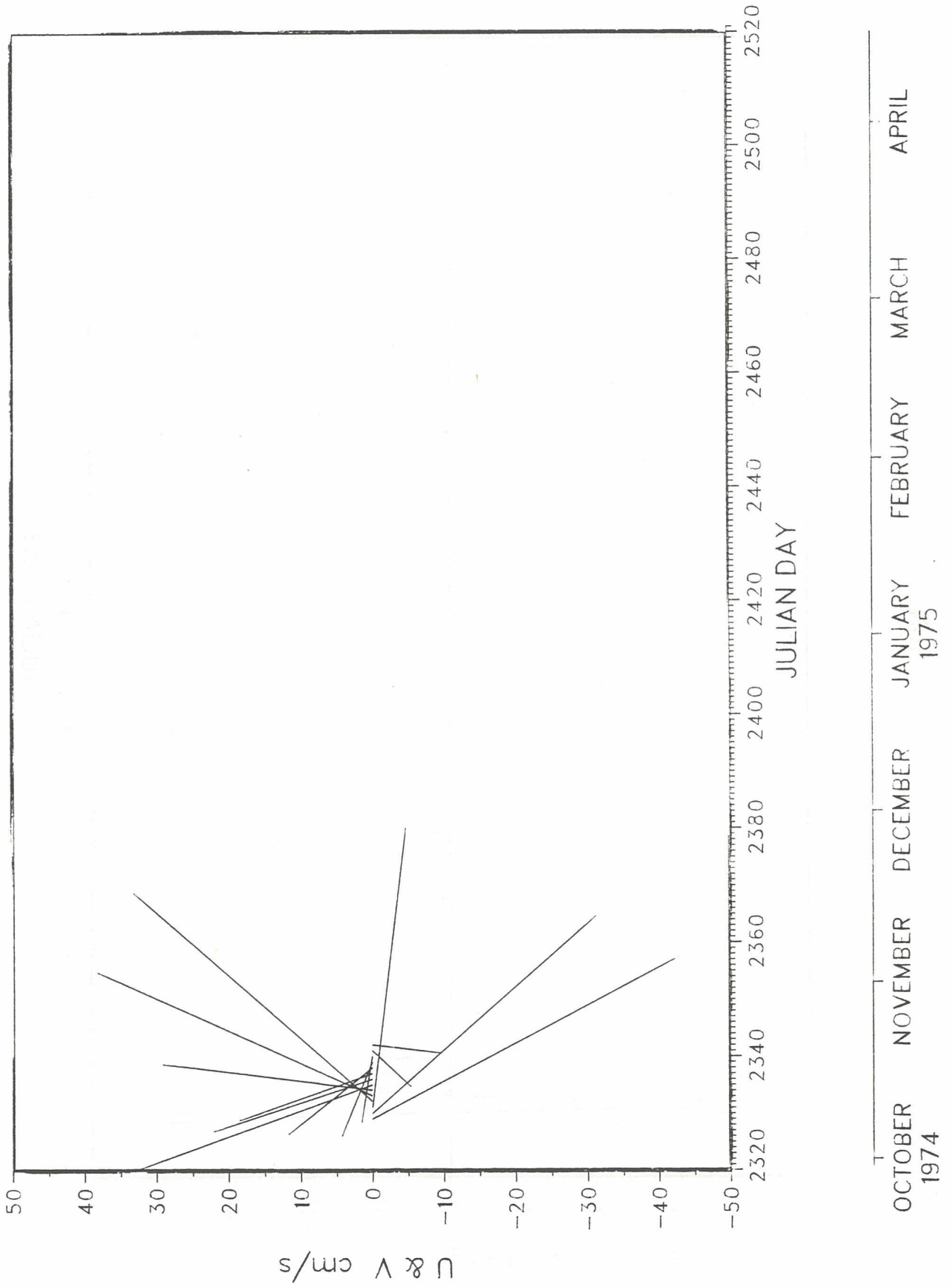
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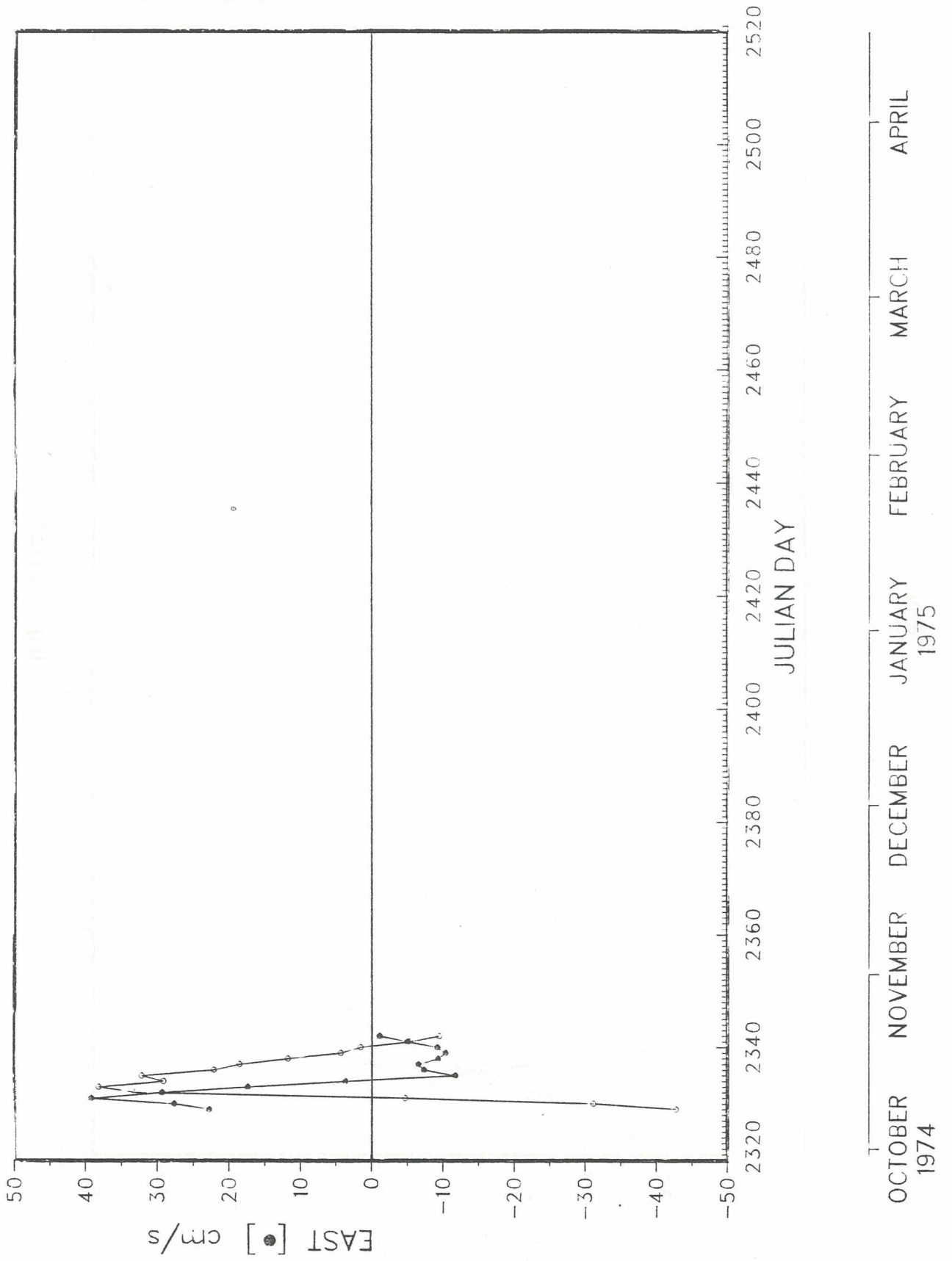
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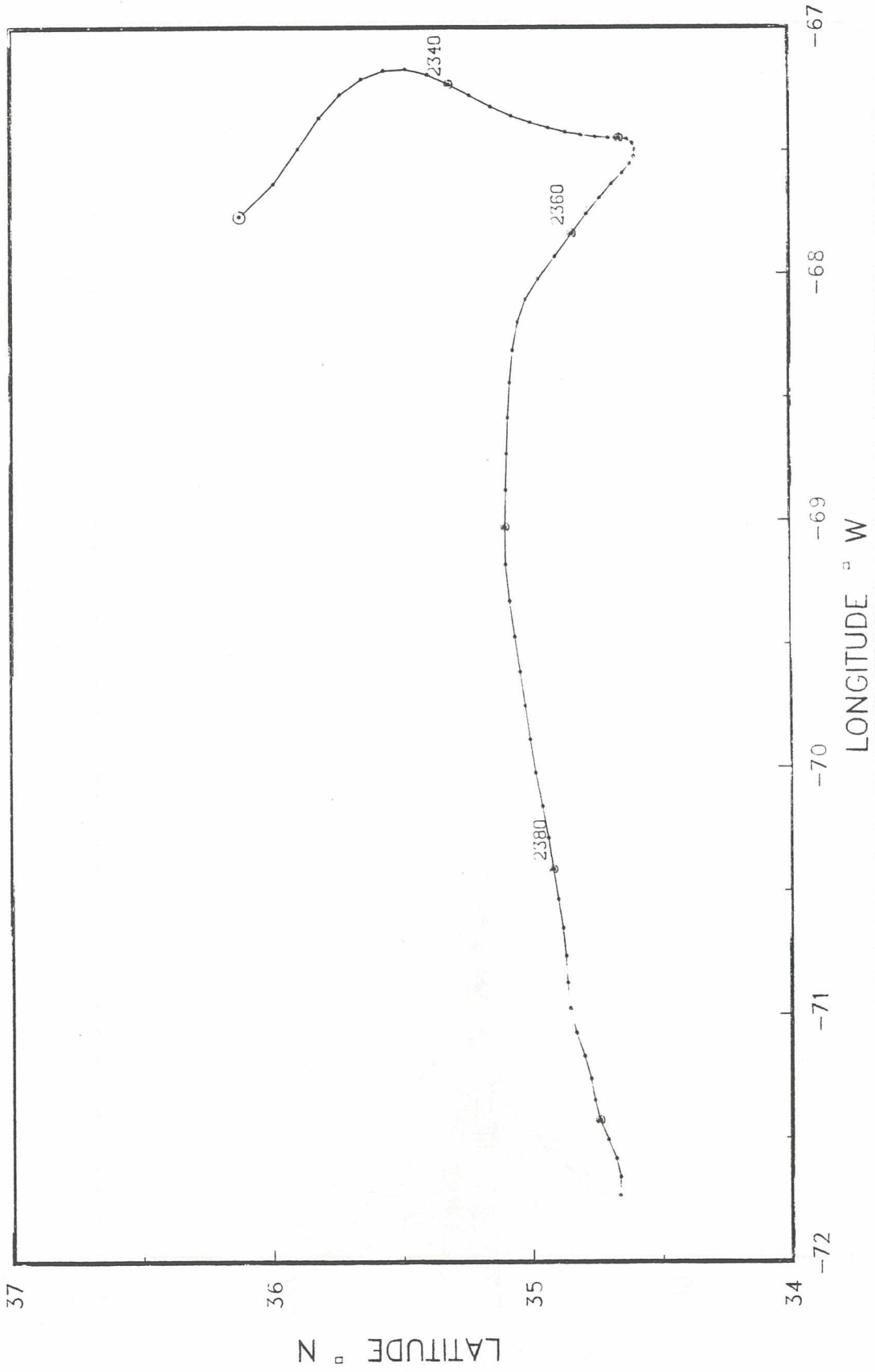
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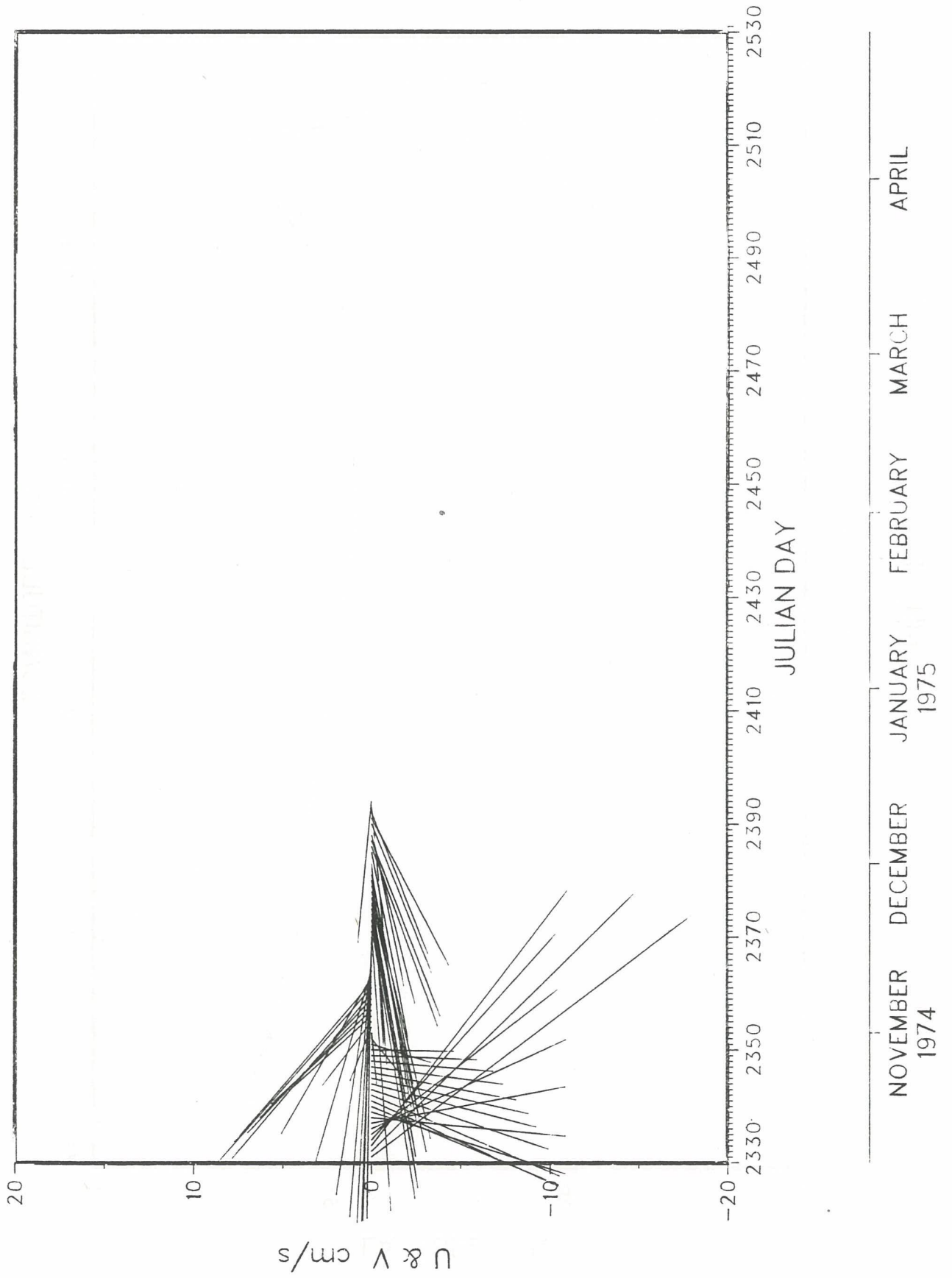
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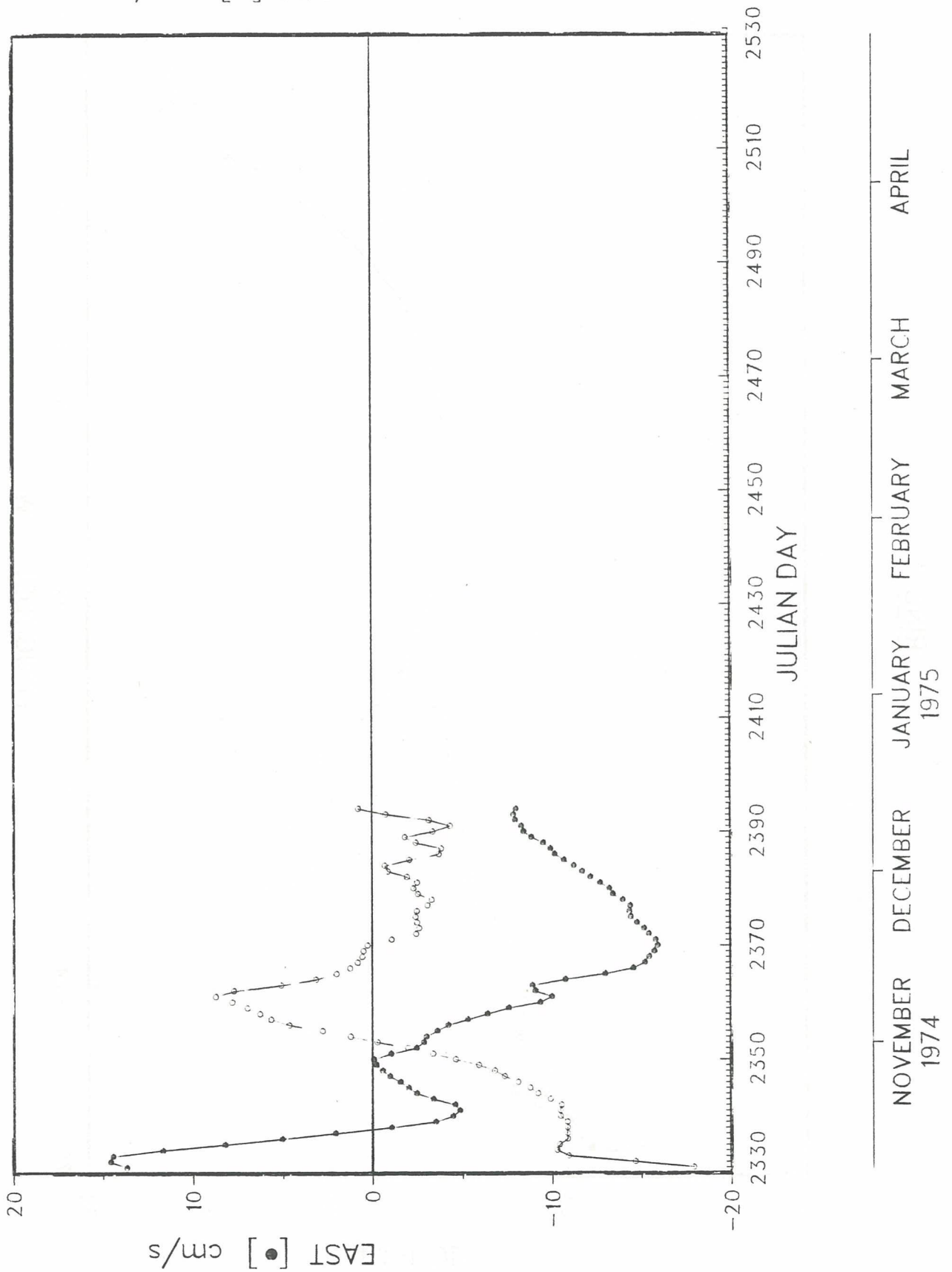
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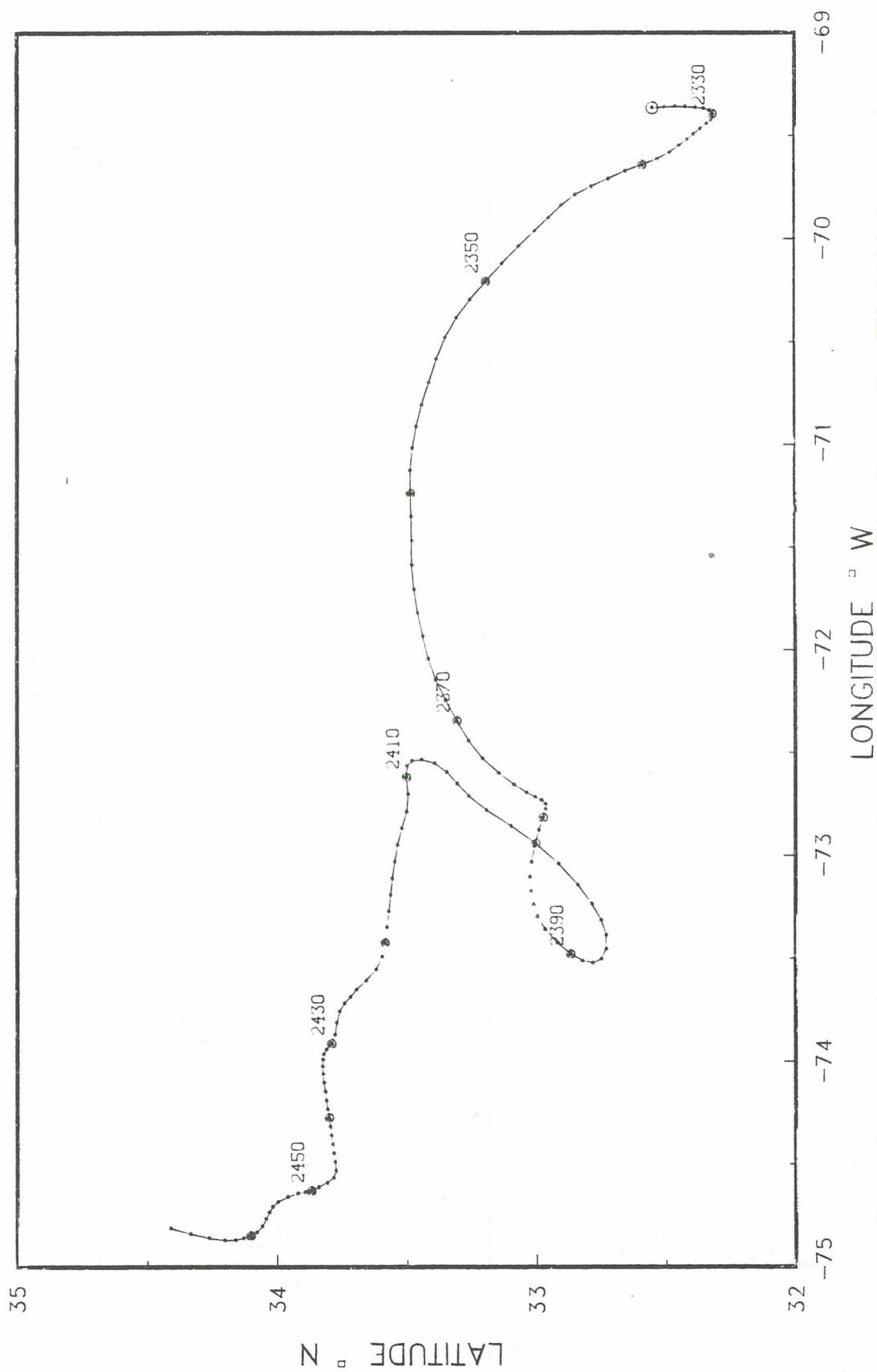
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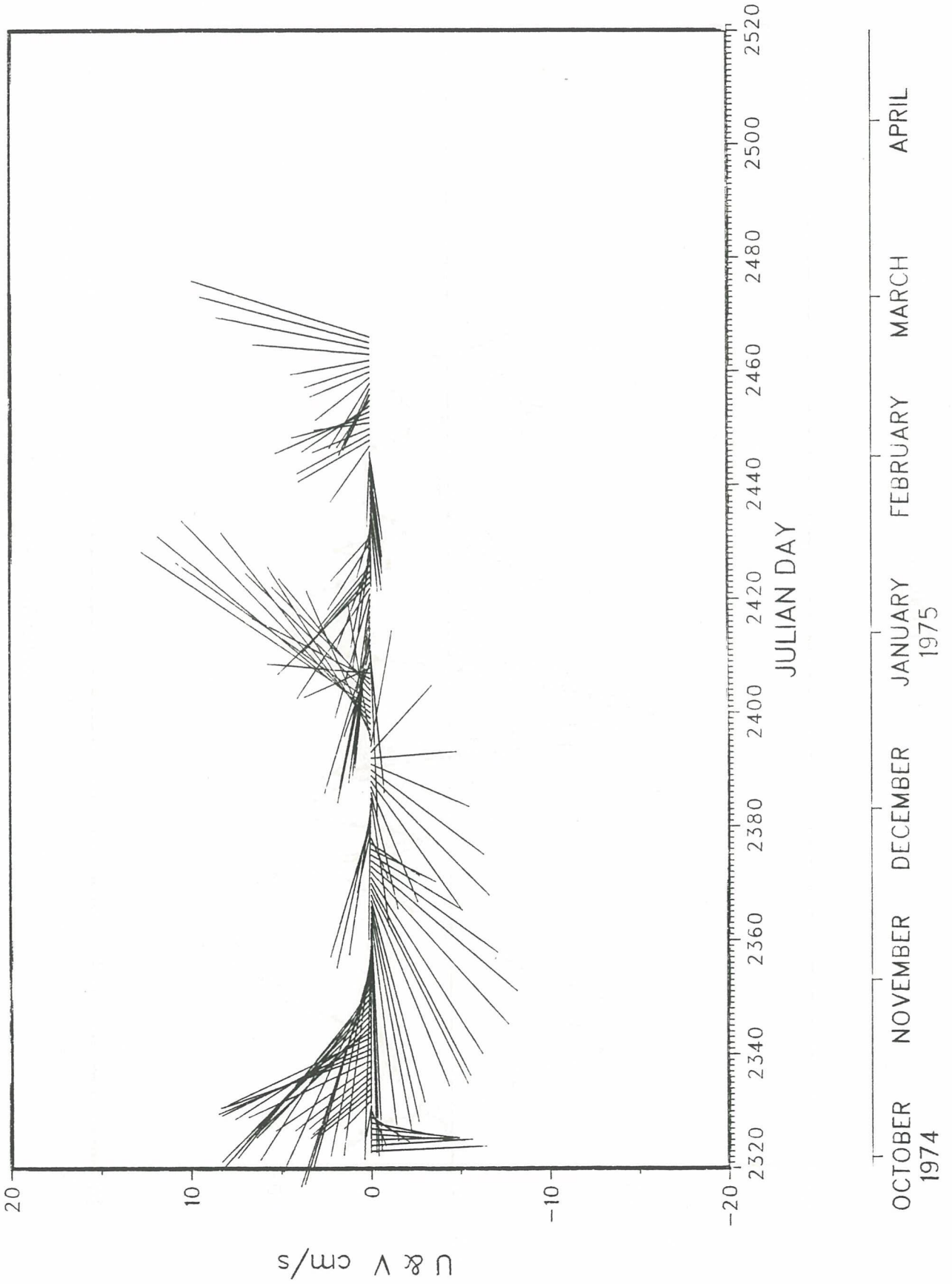
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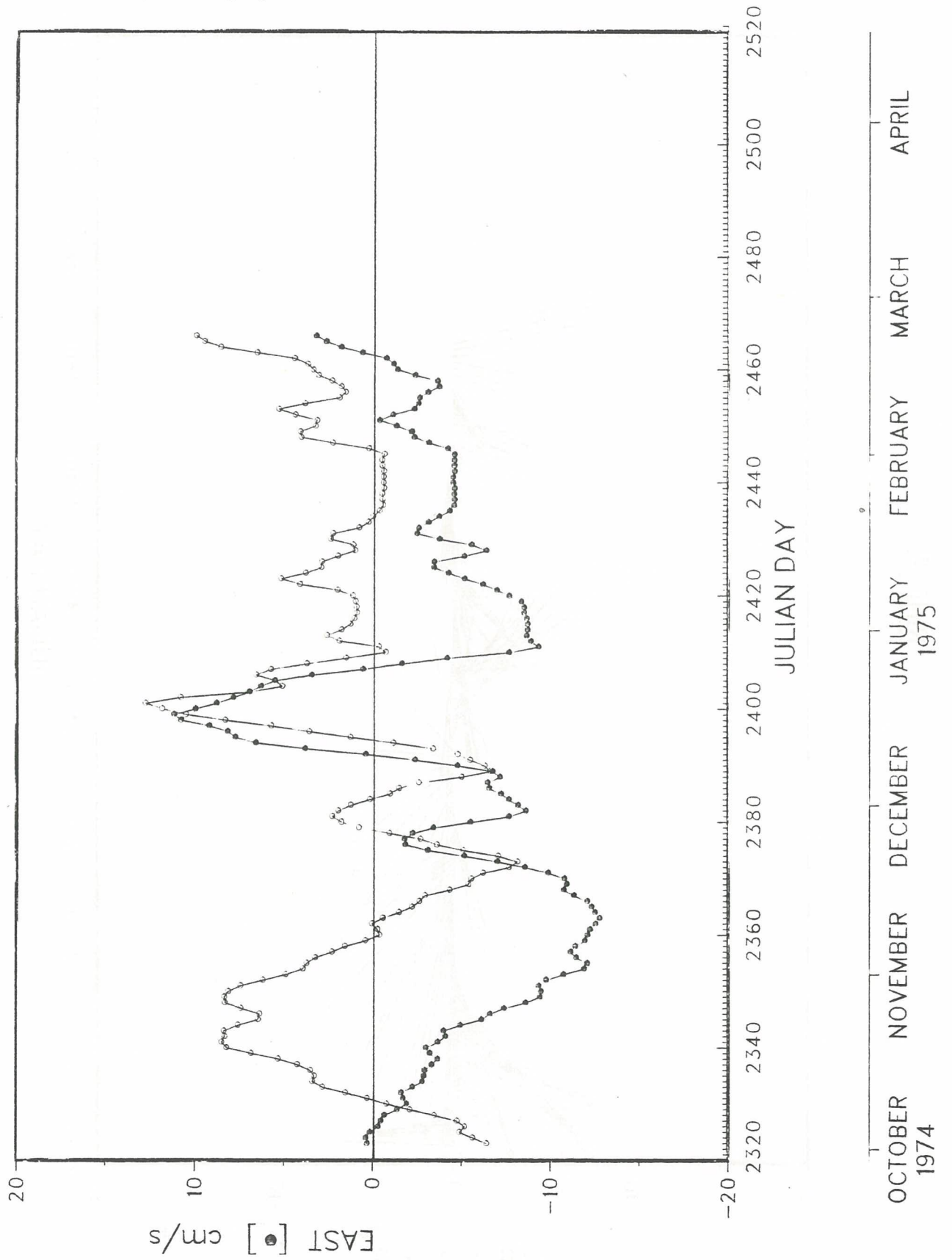
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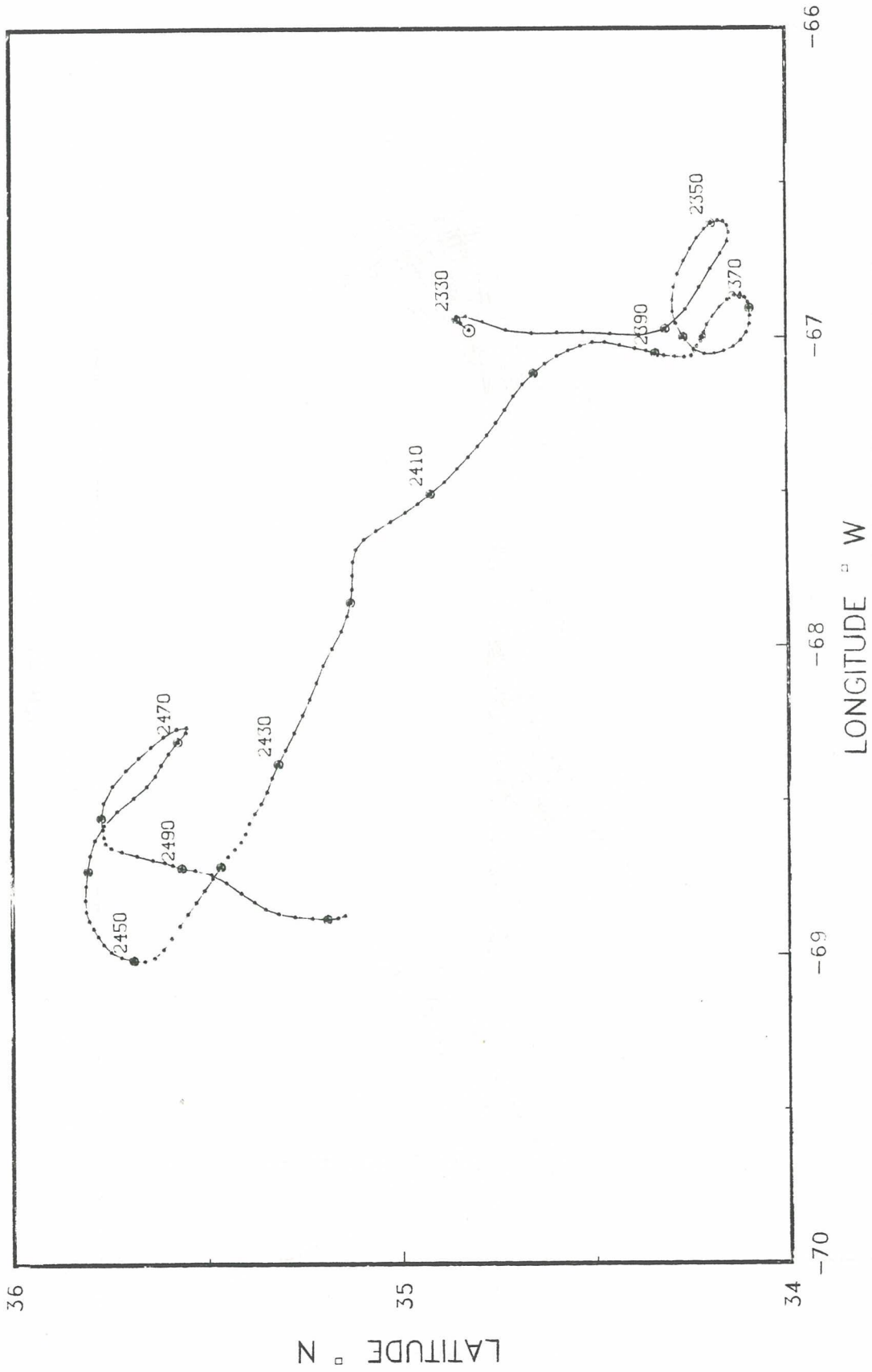
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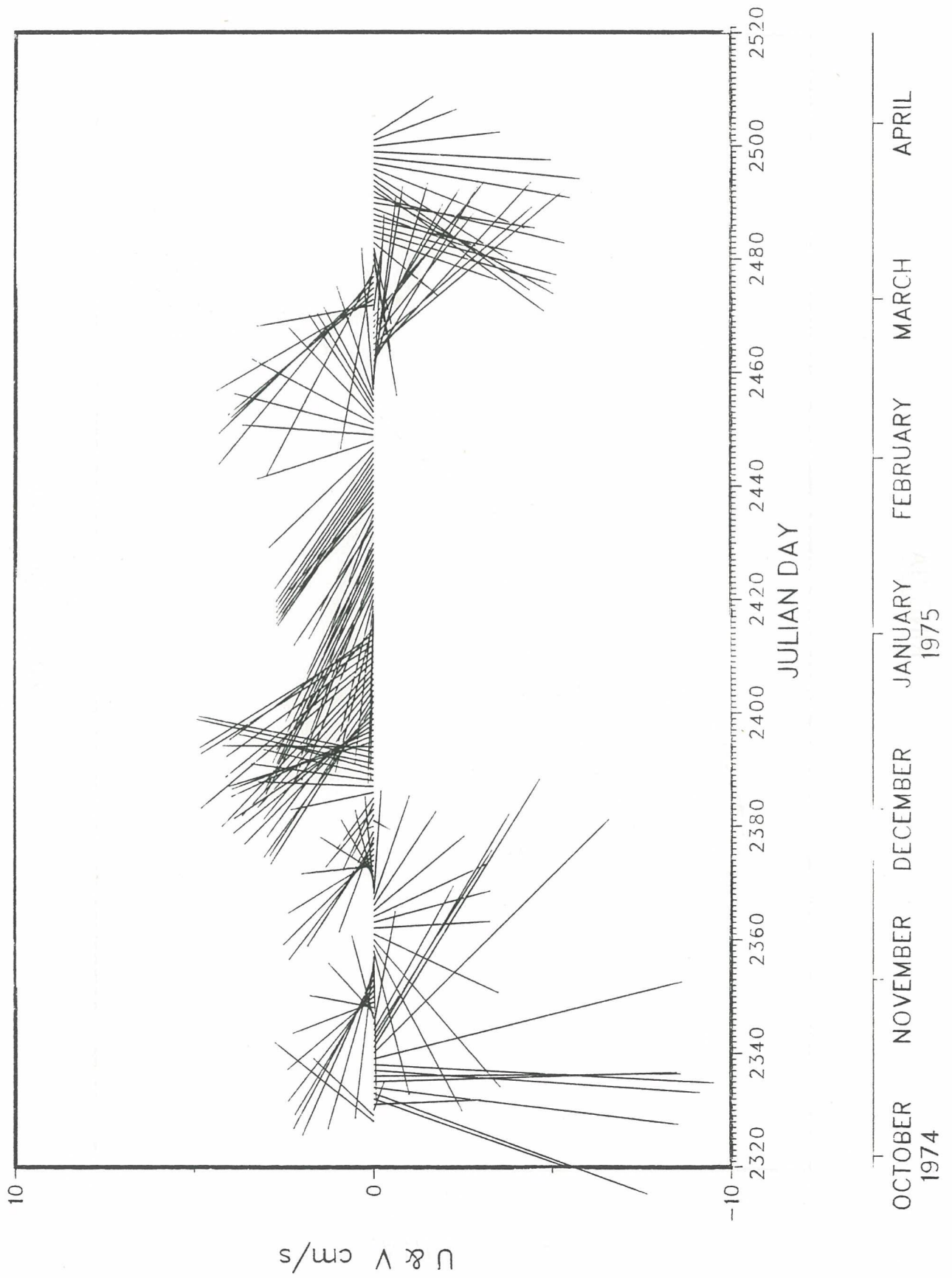
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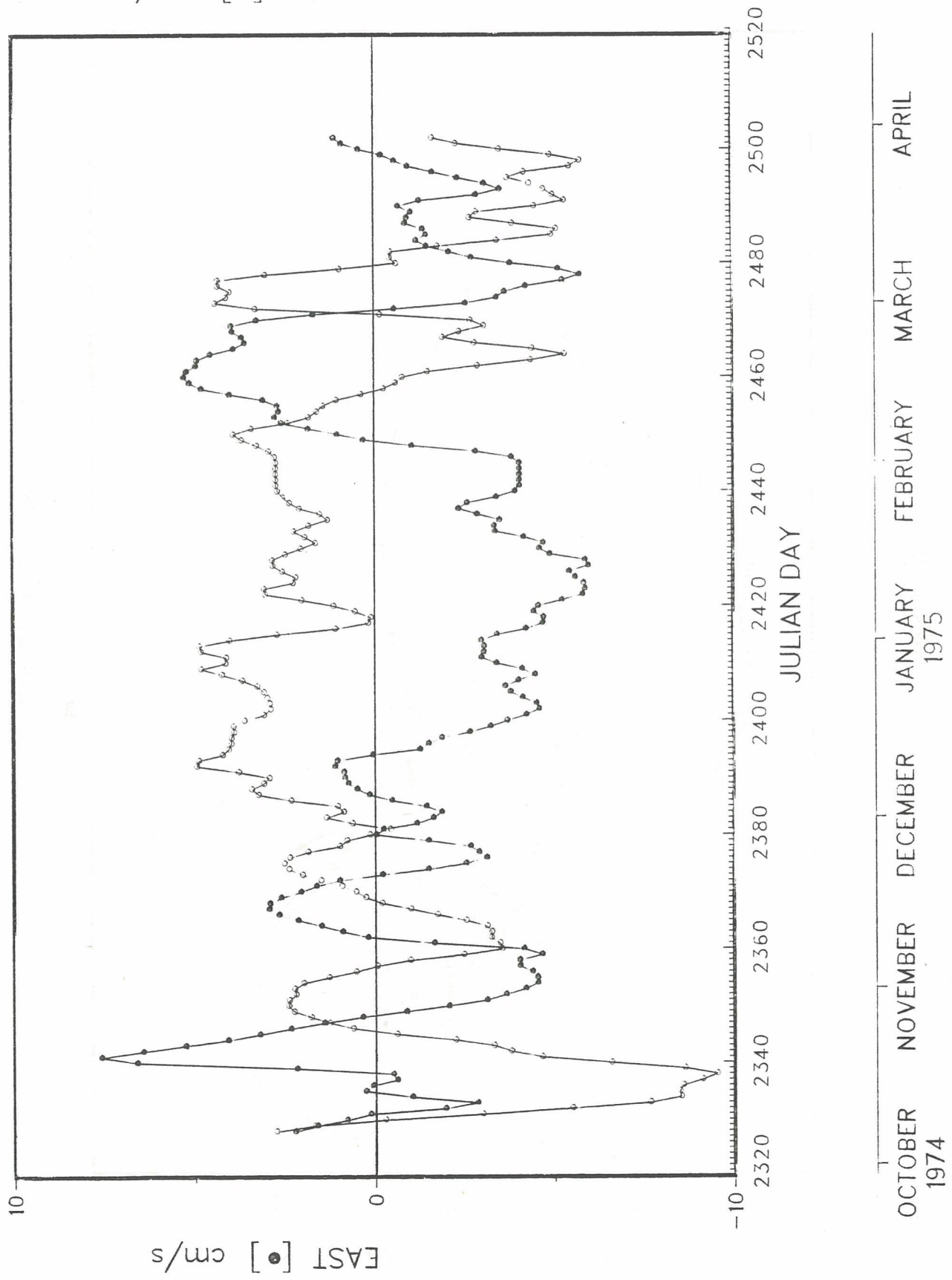
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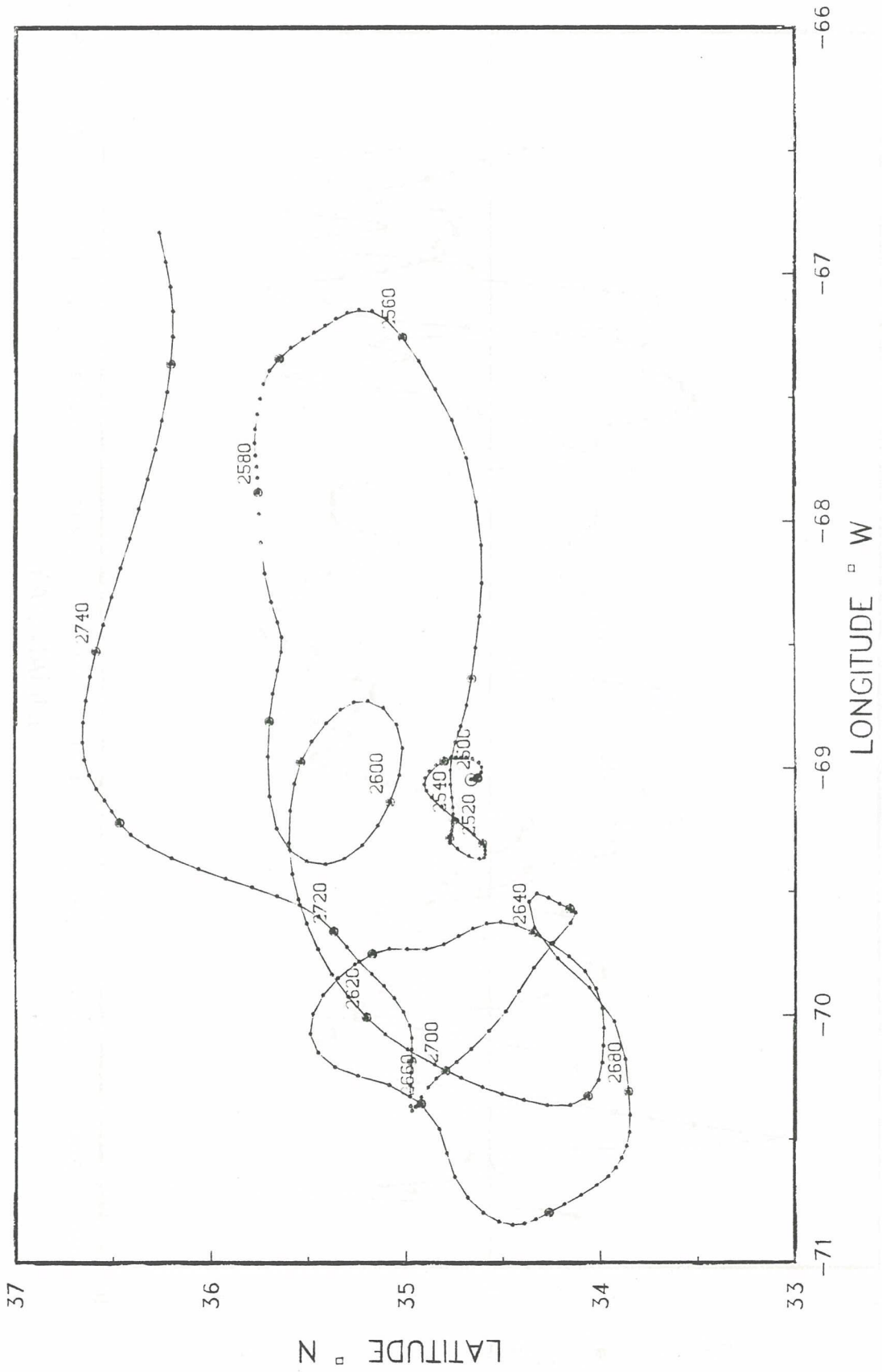
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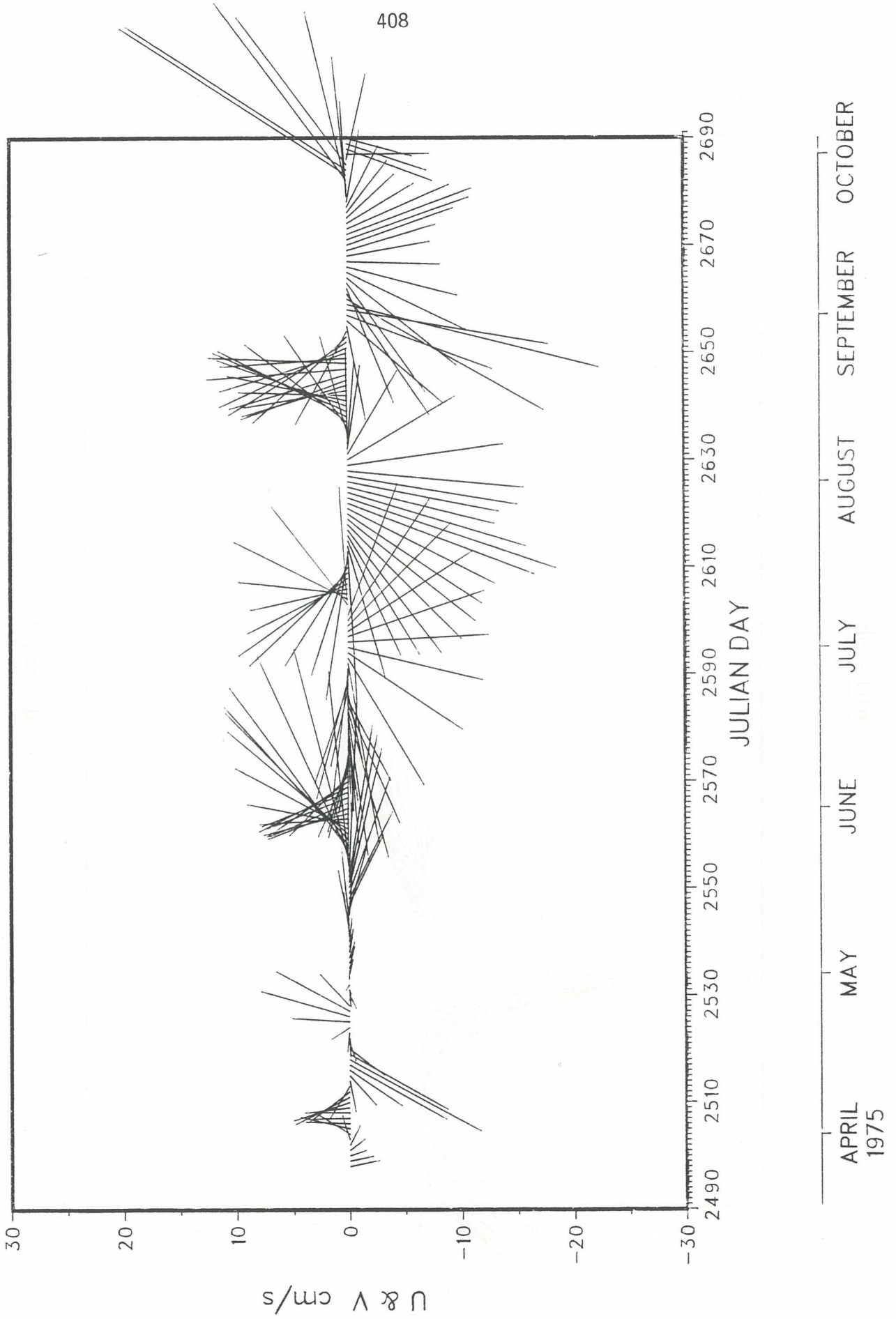
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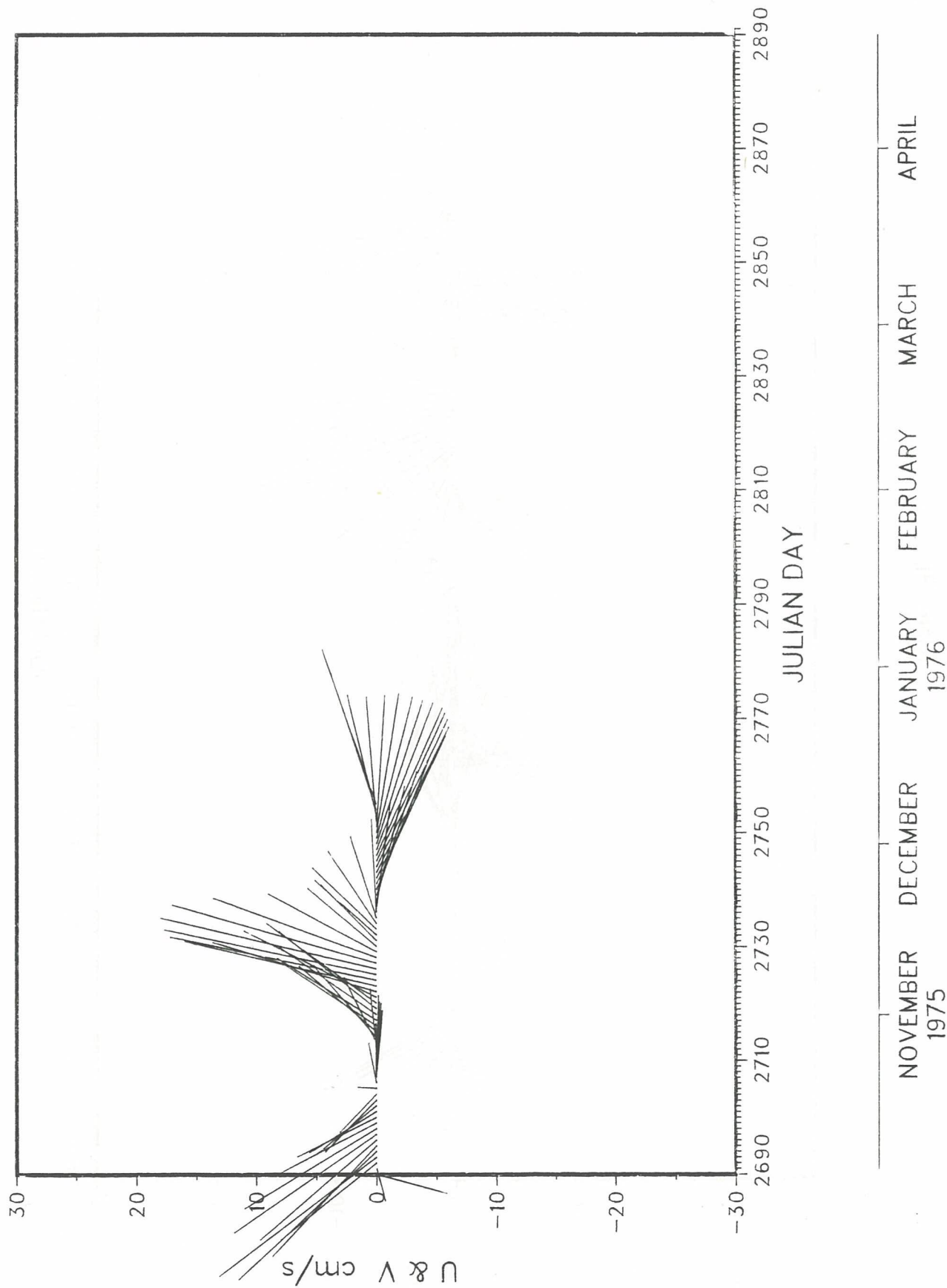
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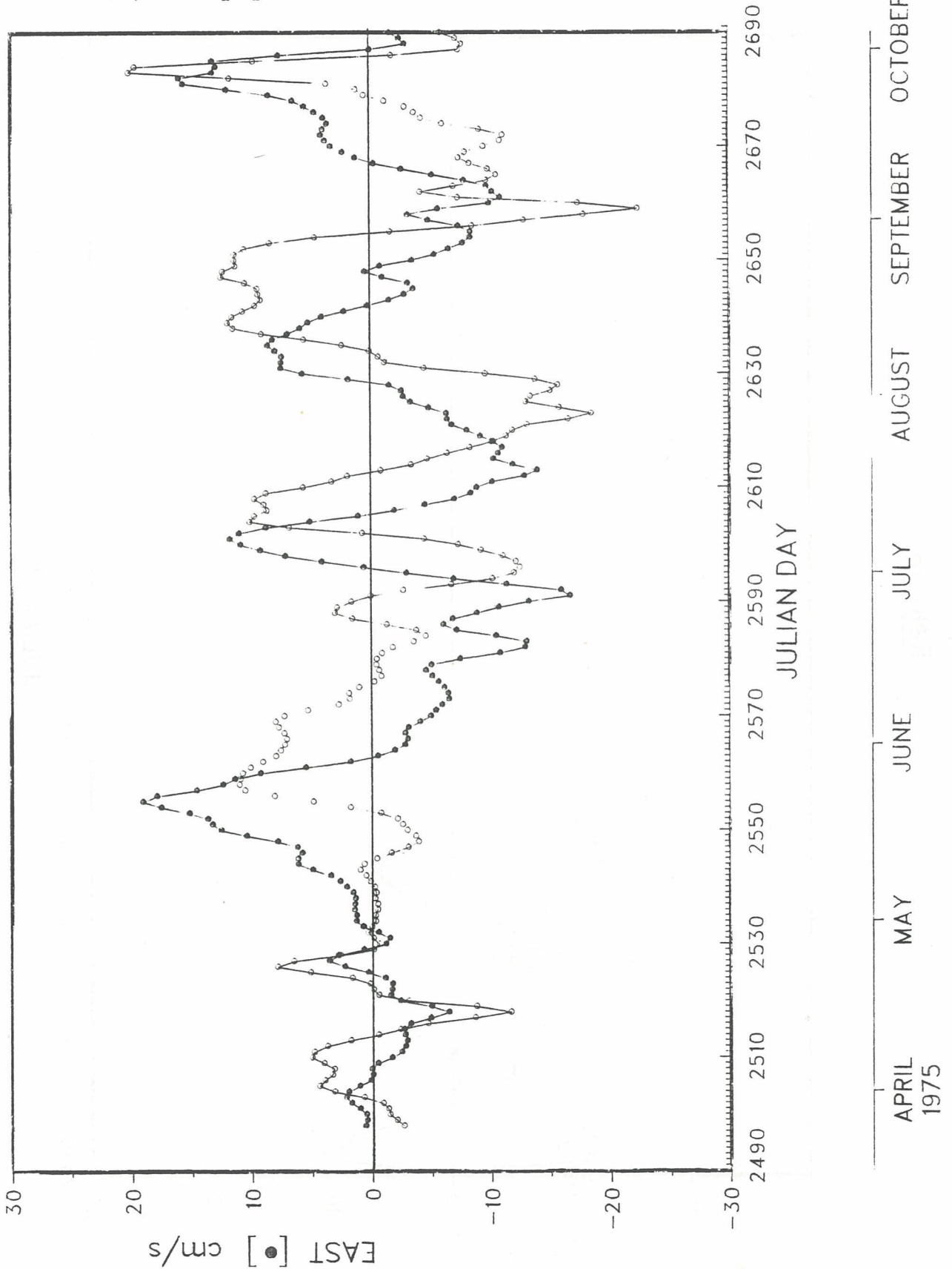
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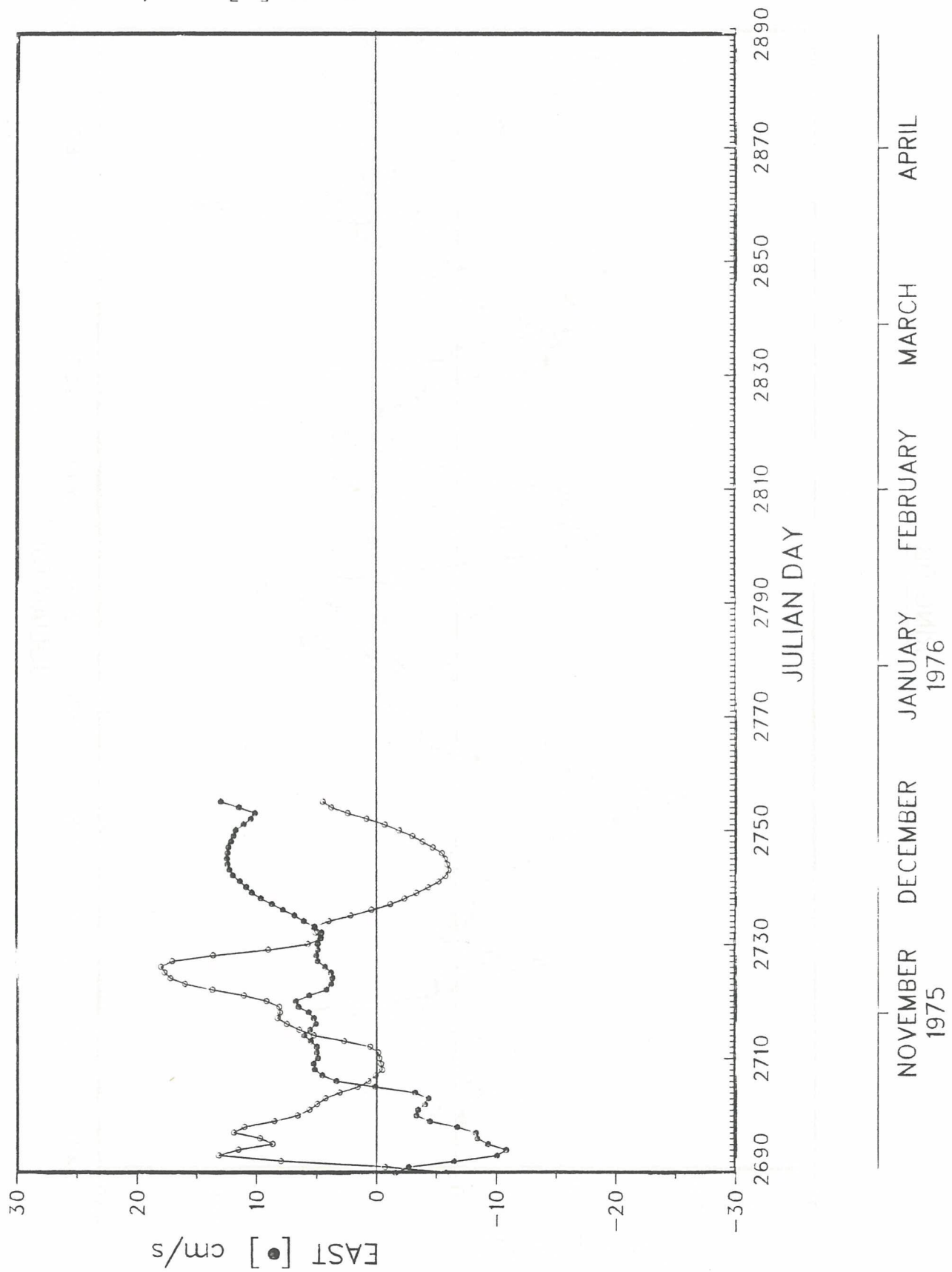
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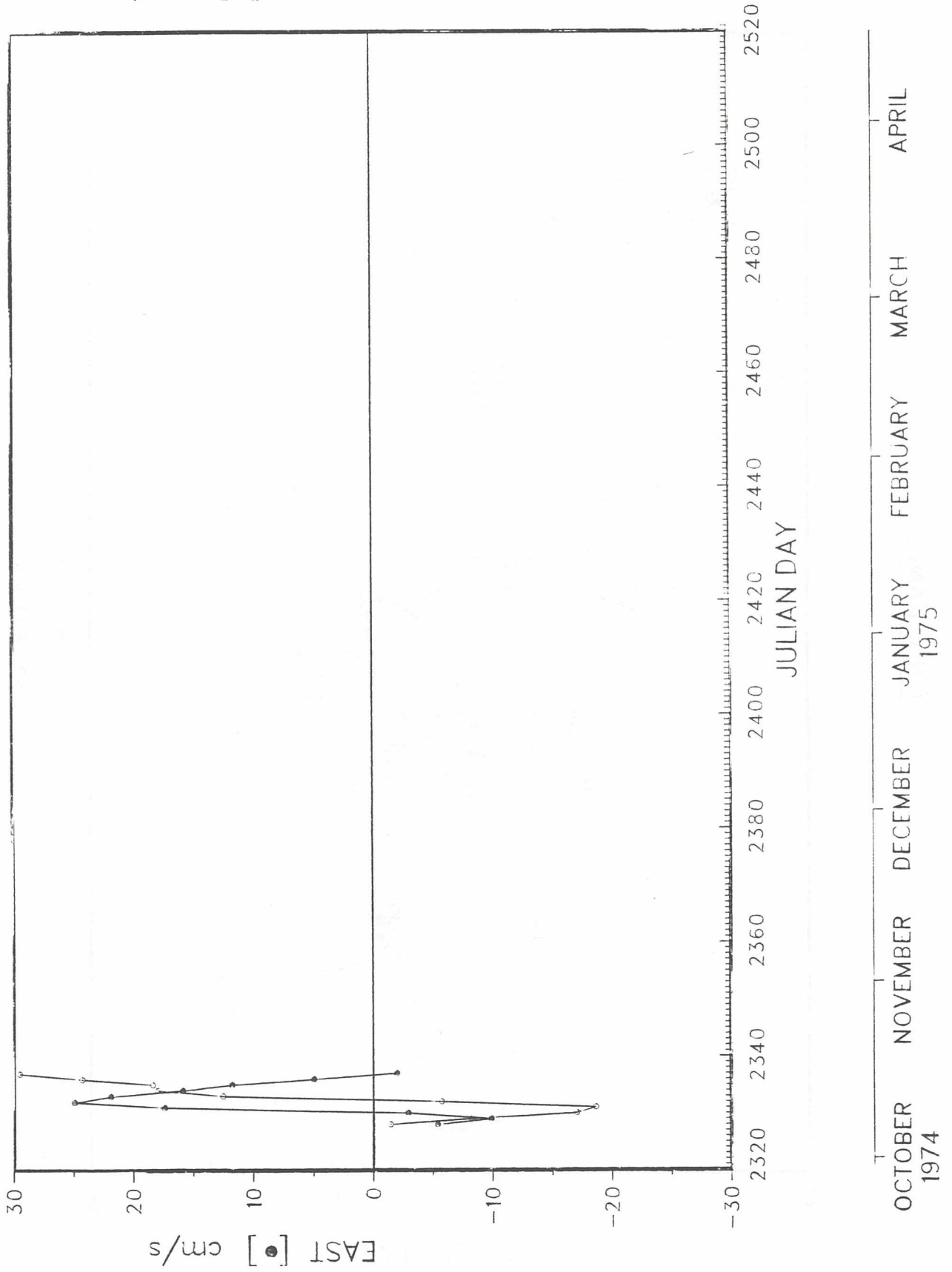
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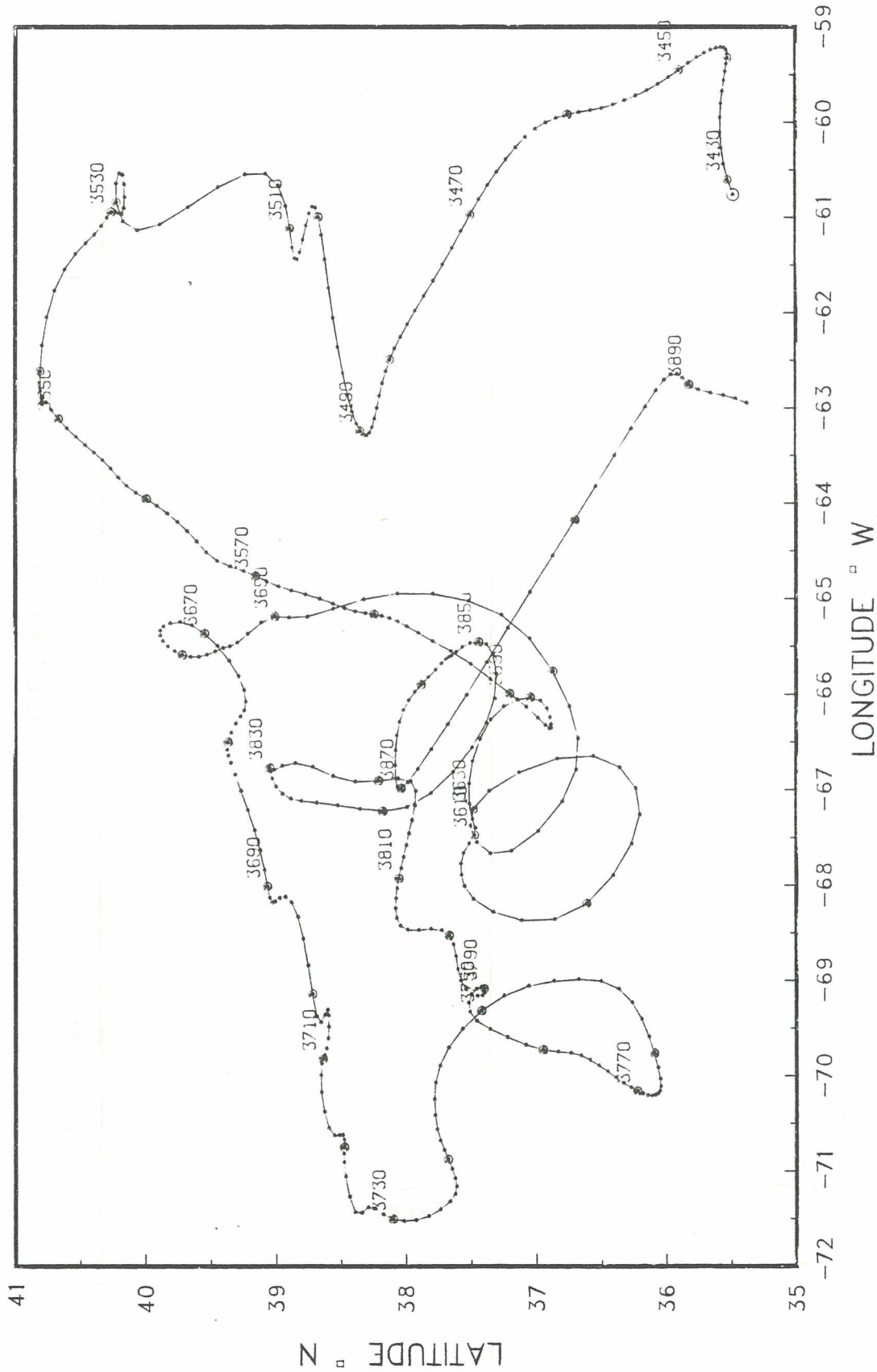
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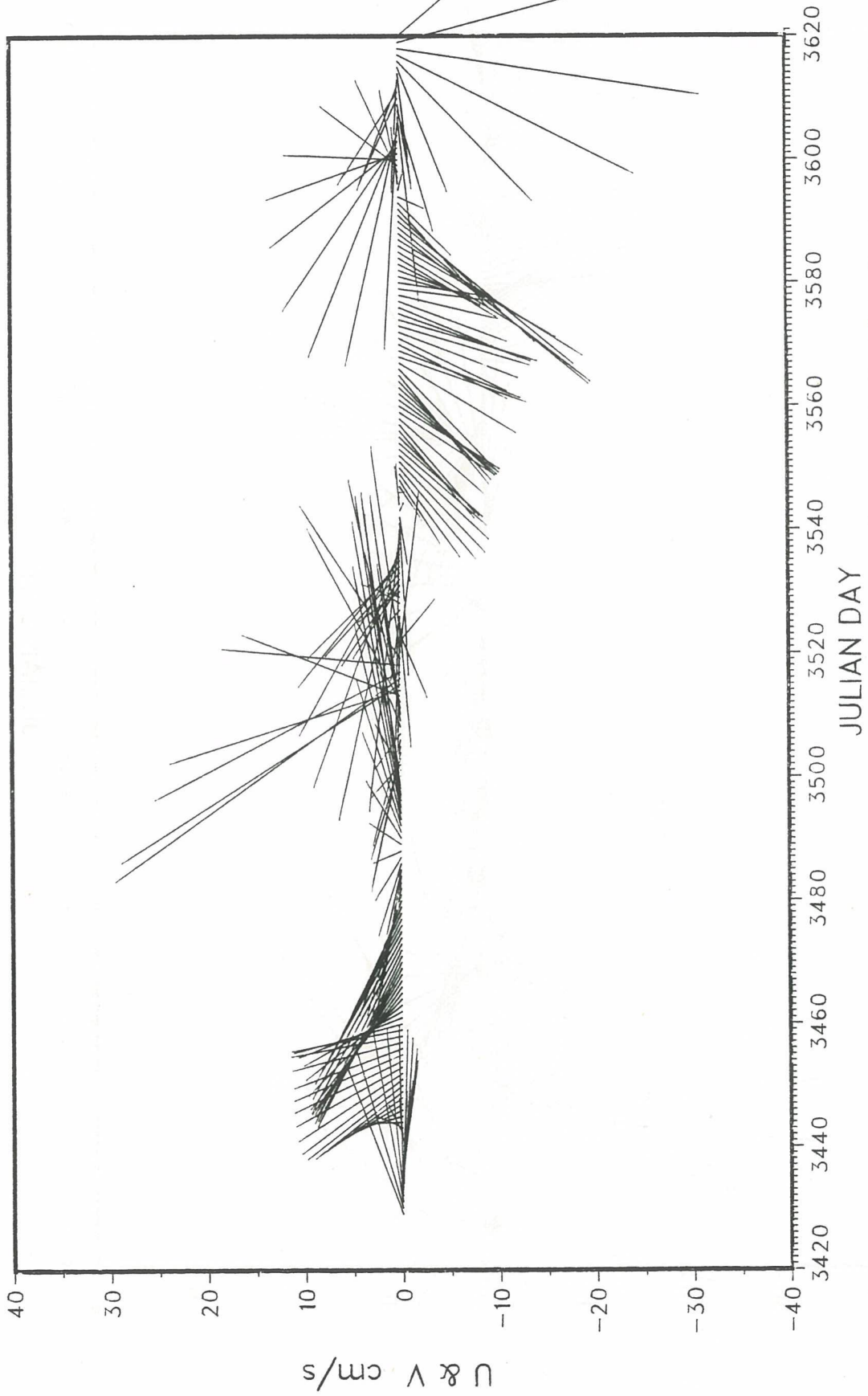


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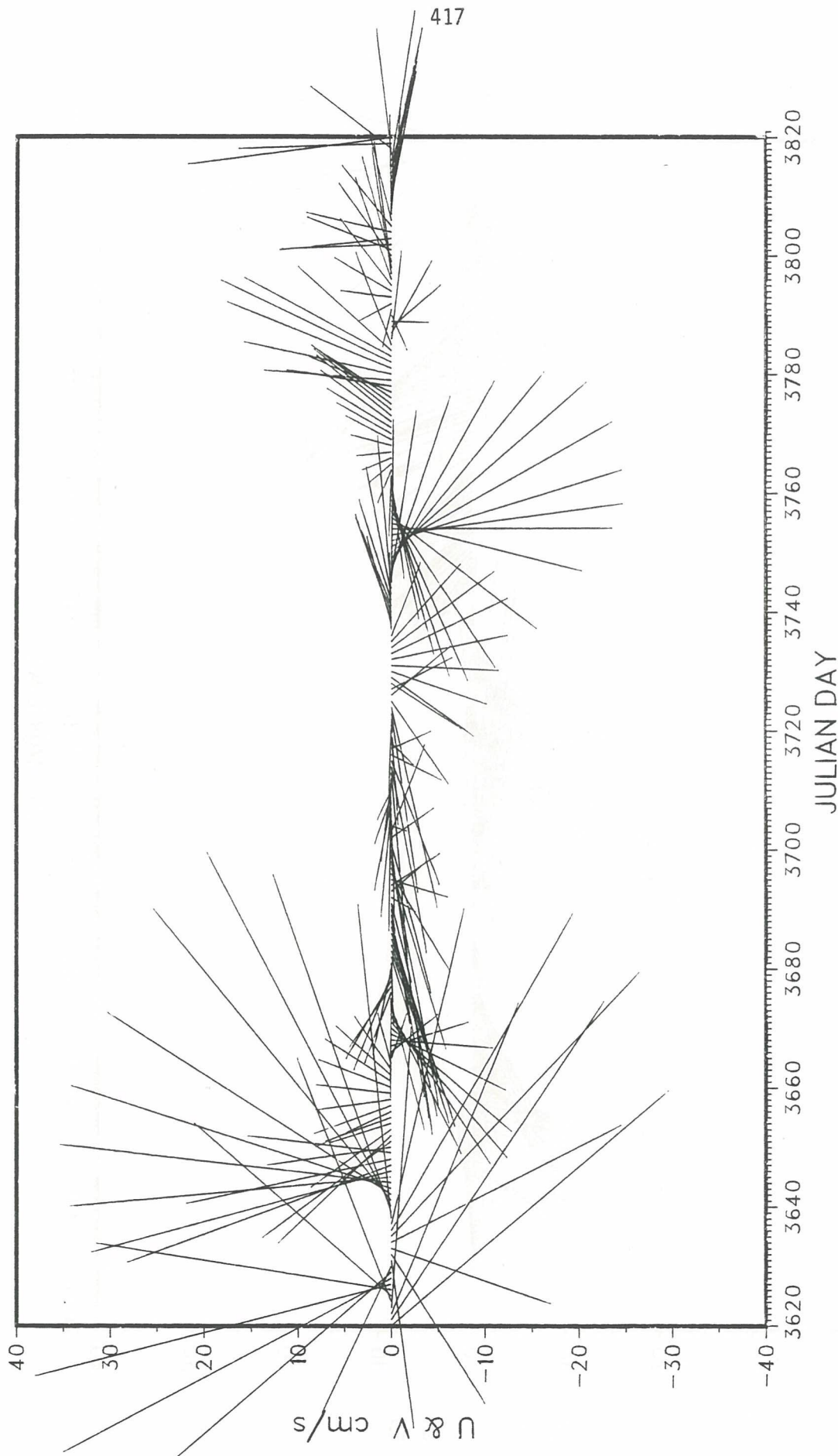
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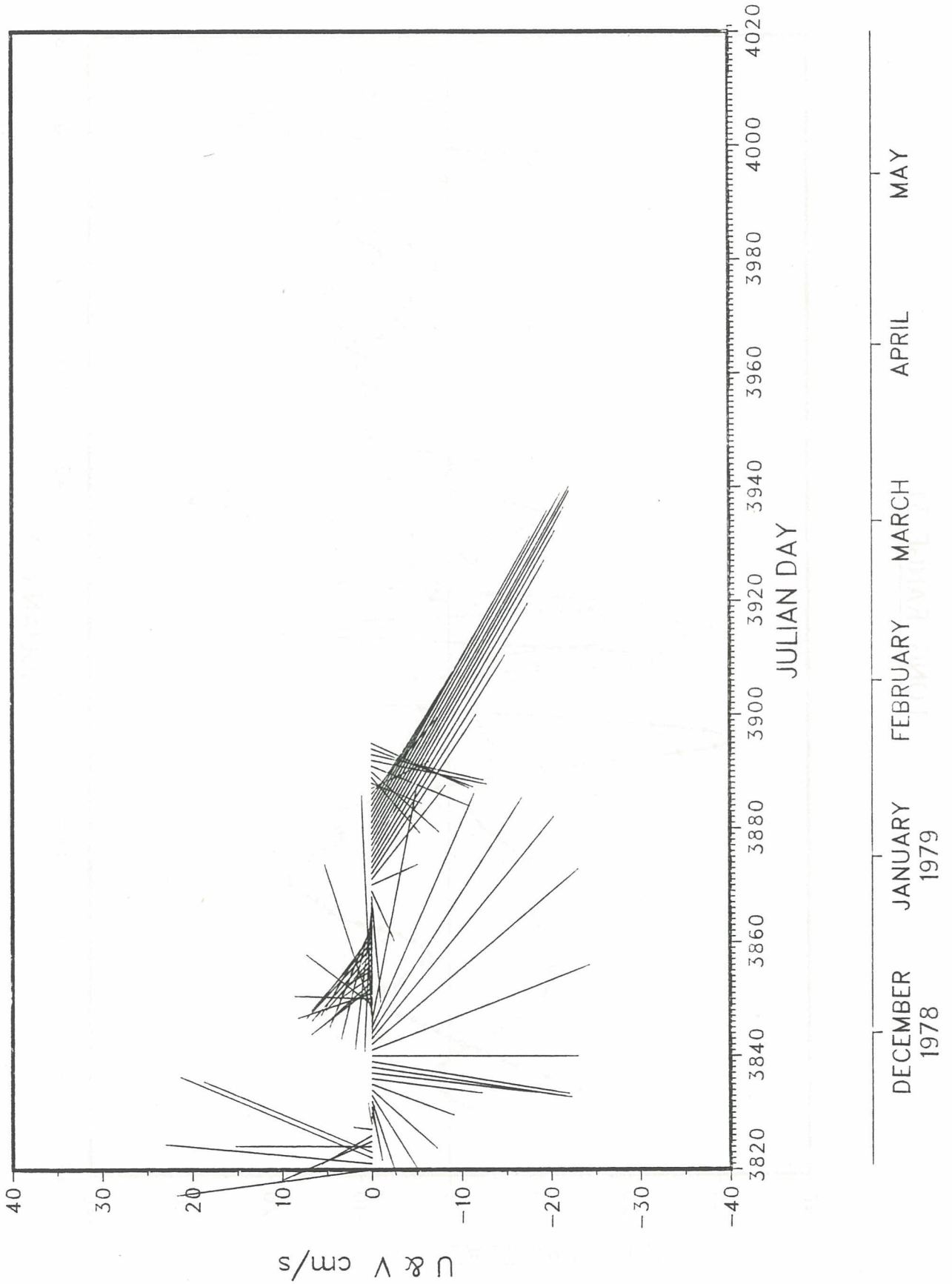
NOVEMBER 1977 DECEMBER JANUARY 1978 FEBRUARY MARCH APRIL

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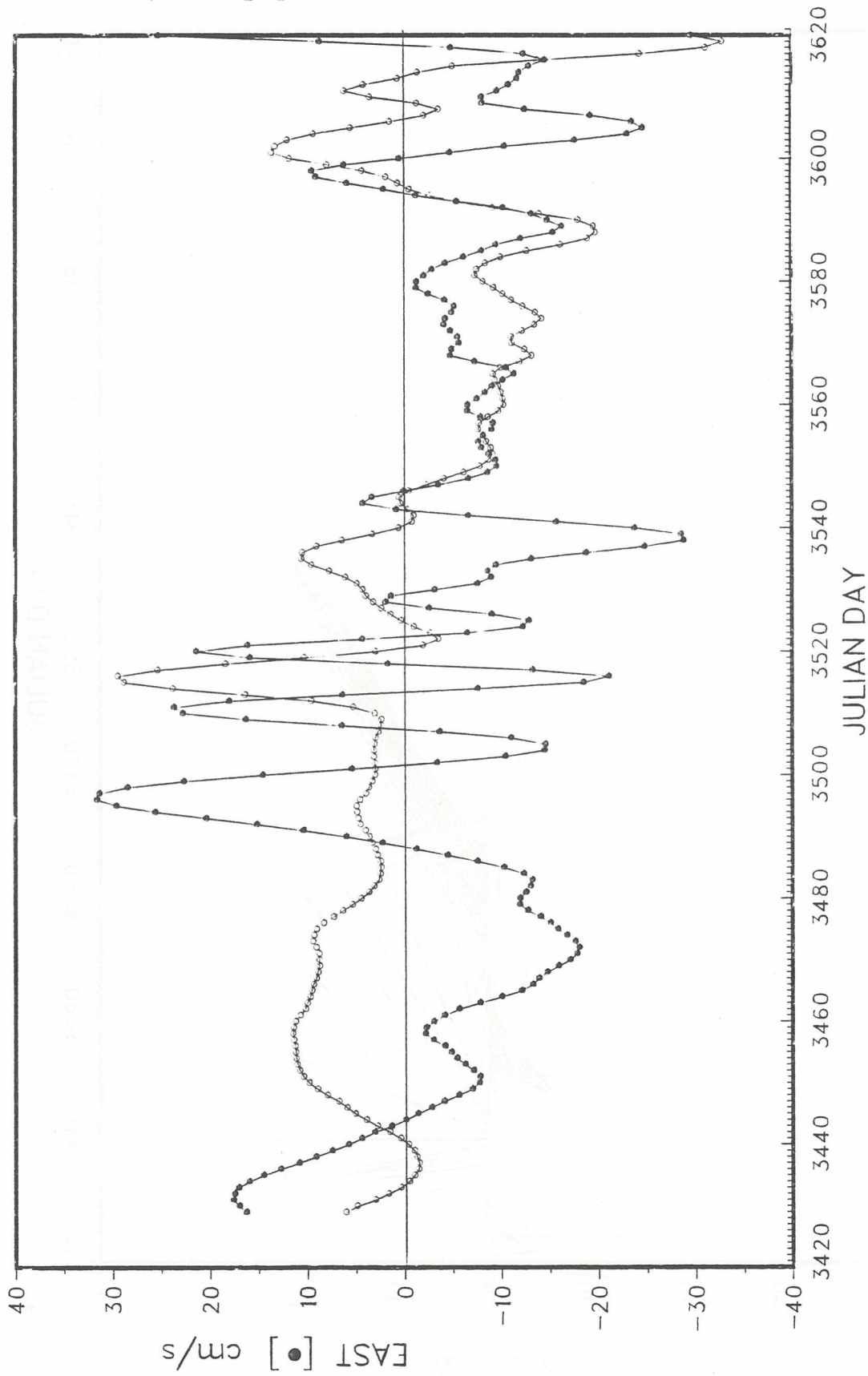


MAY JUNE JULY AUGUST SEPTEMBER OCTOBER NOVEMBER
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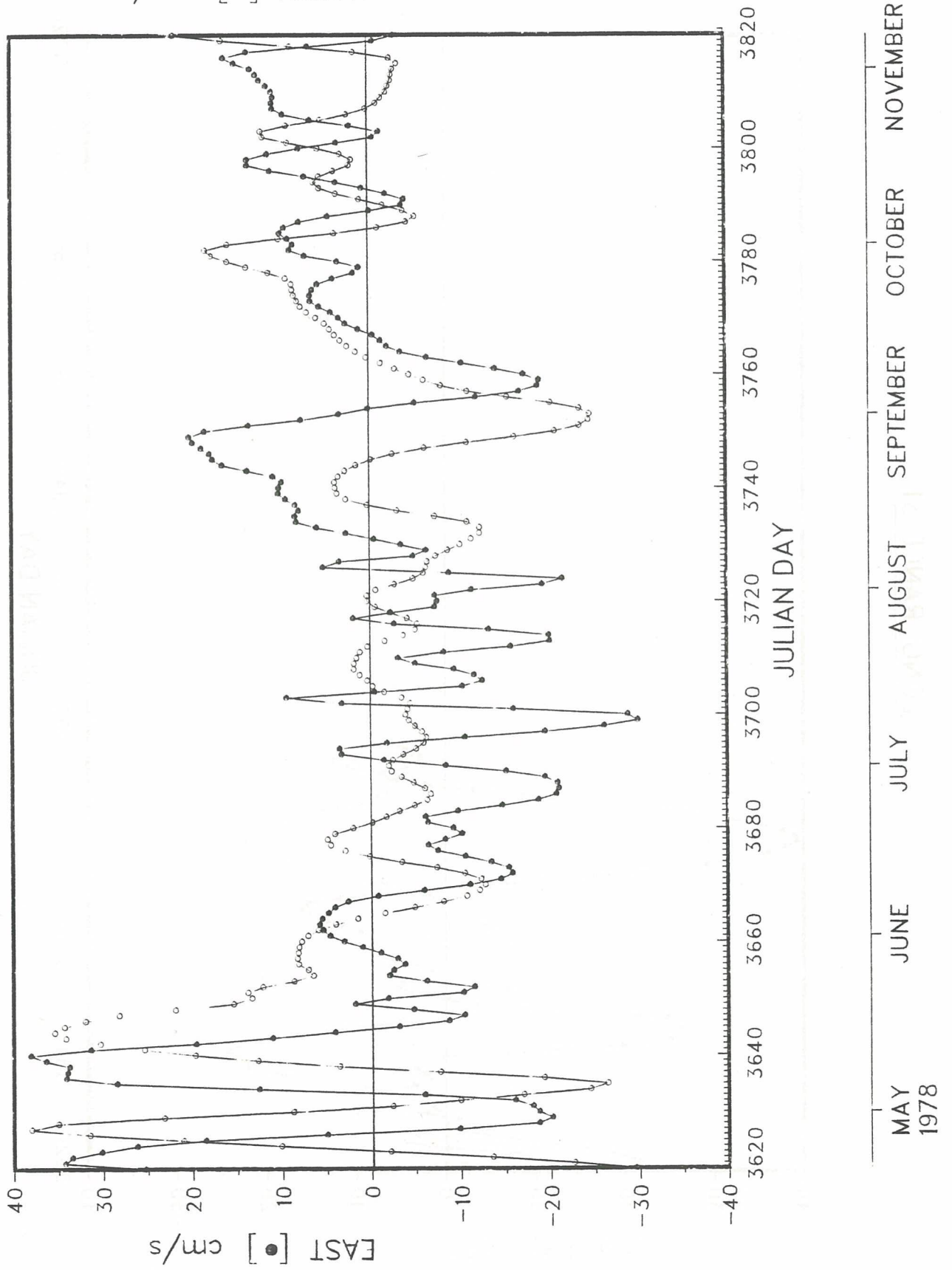


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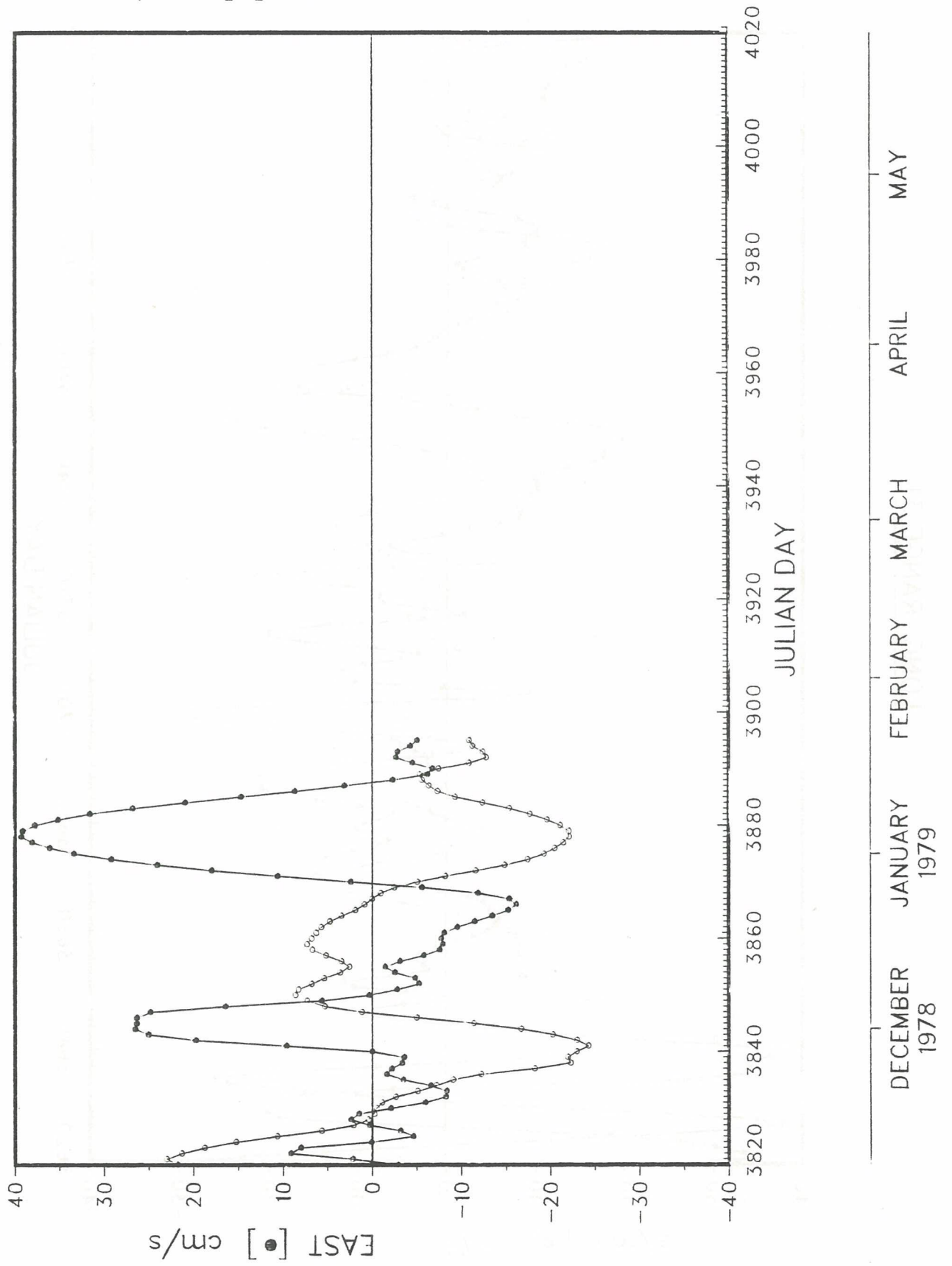


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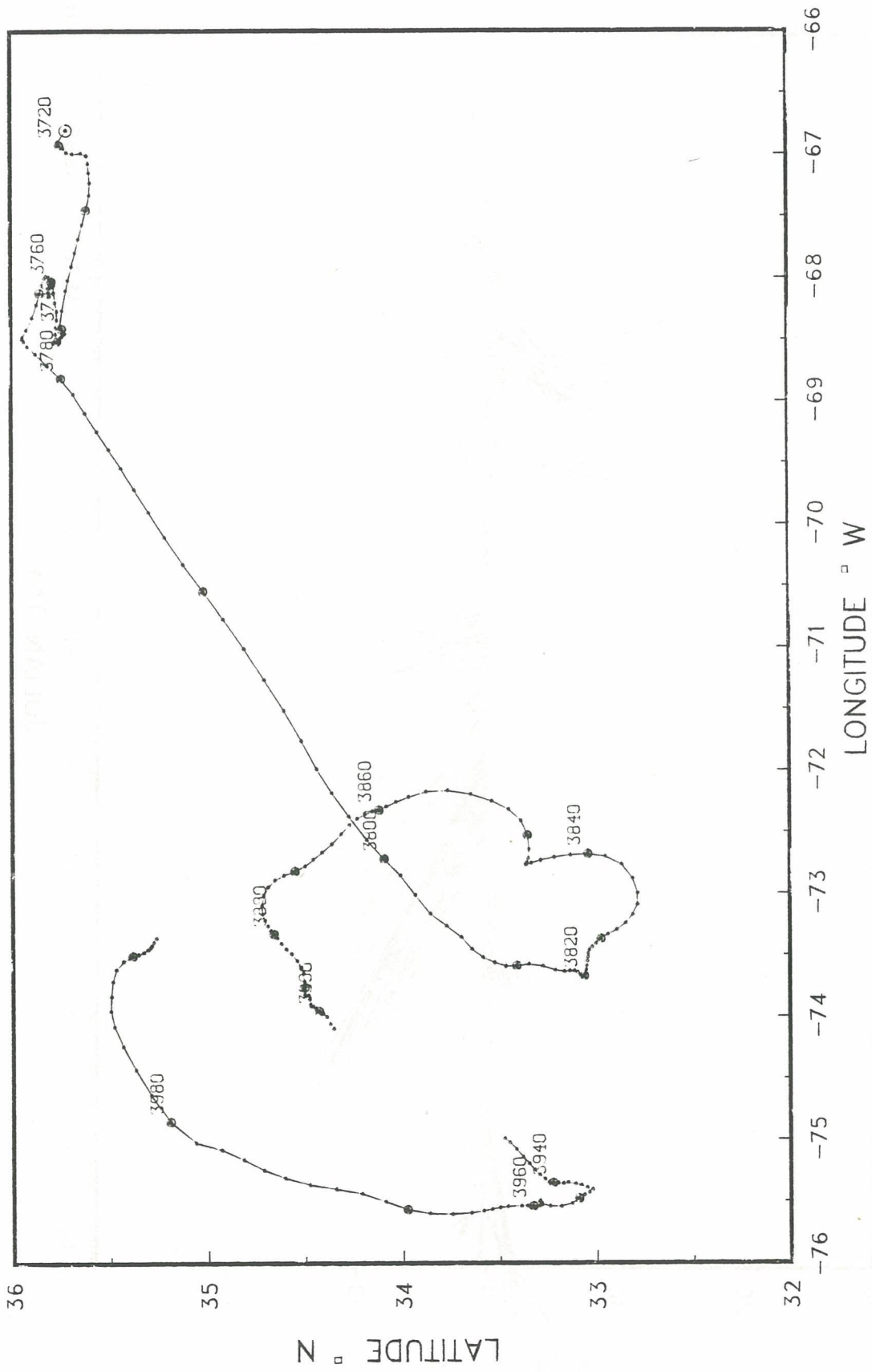
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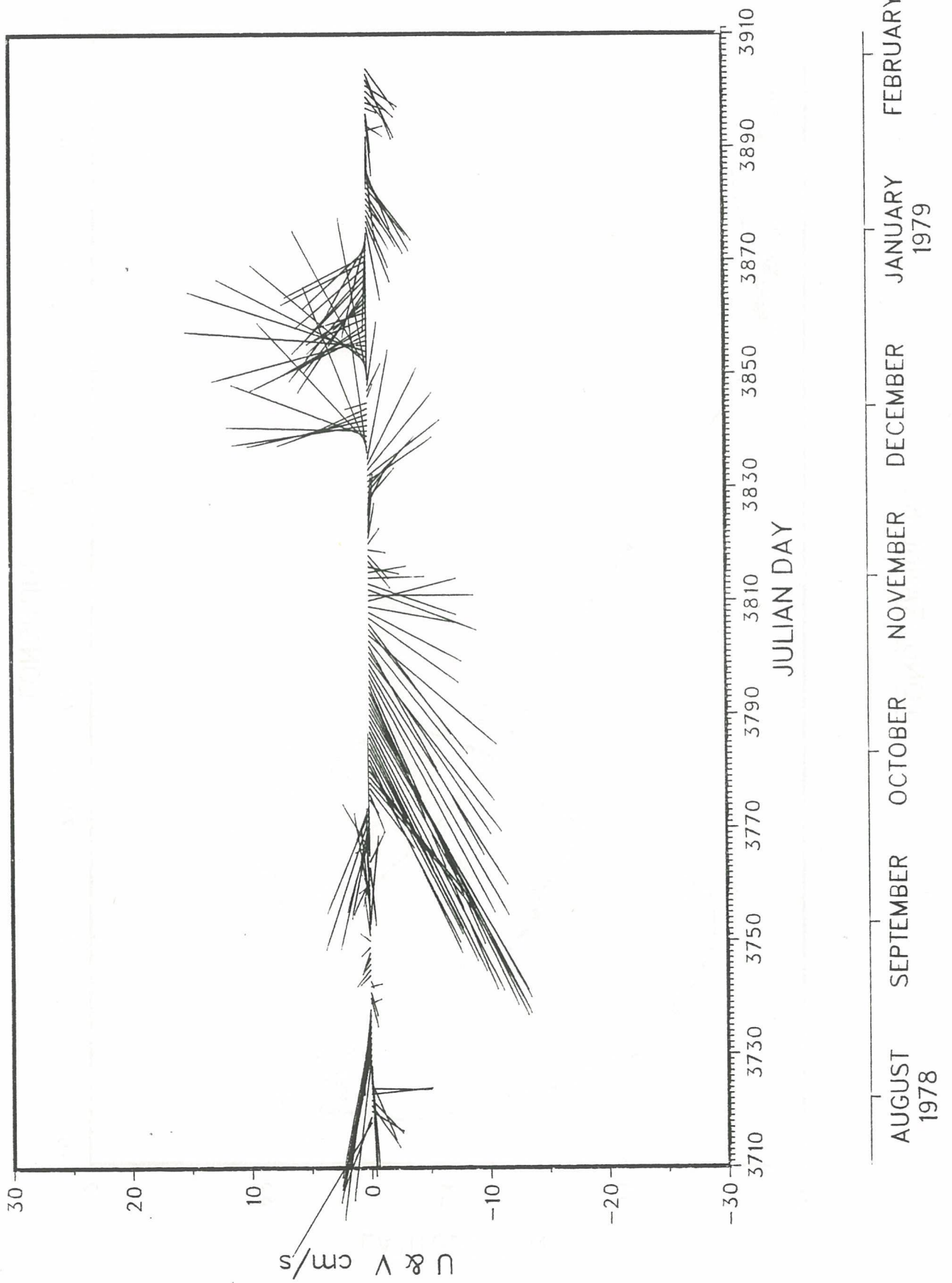
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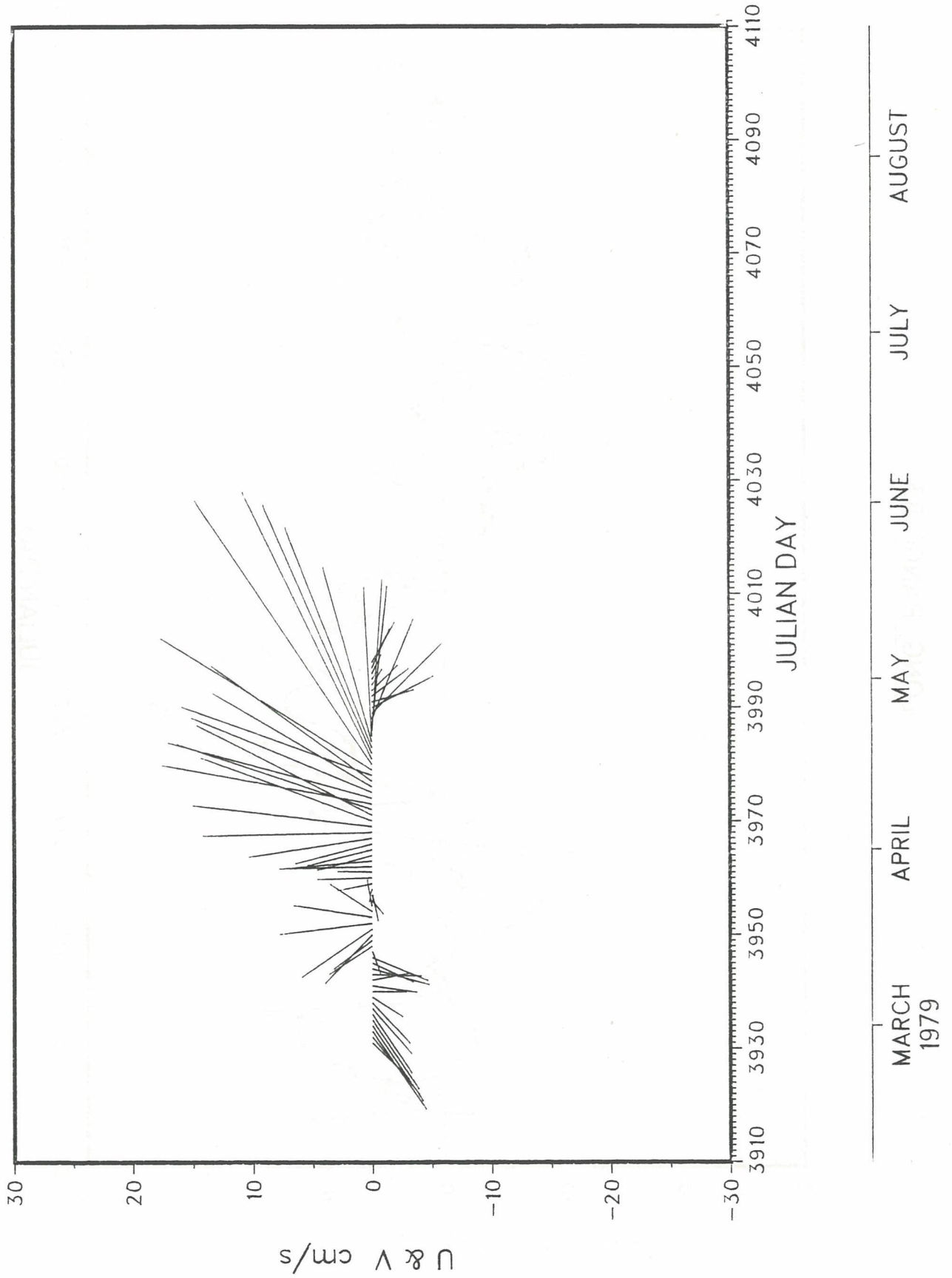
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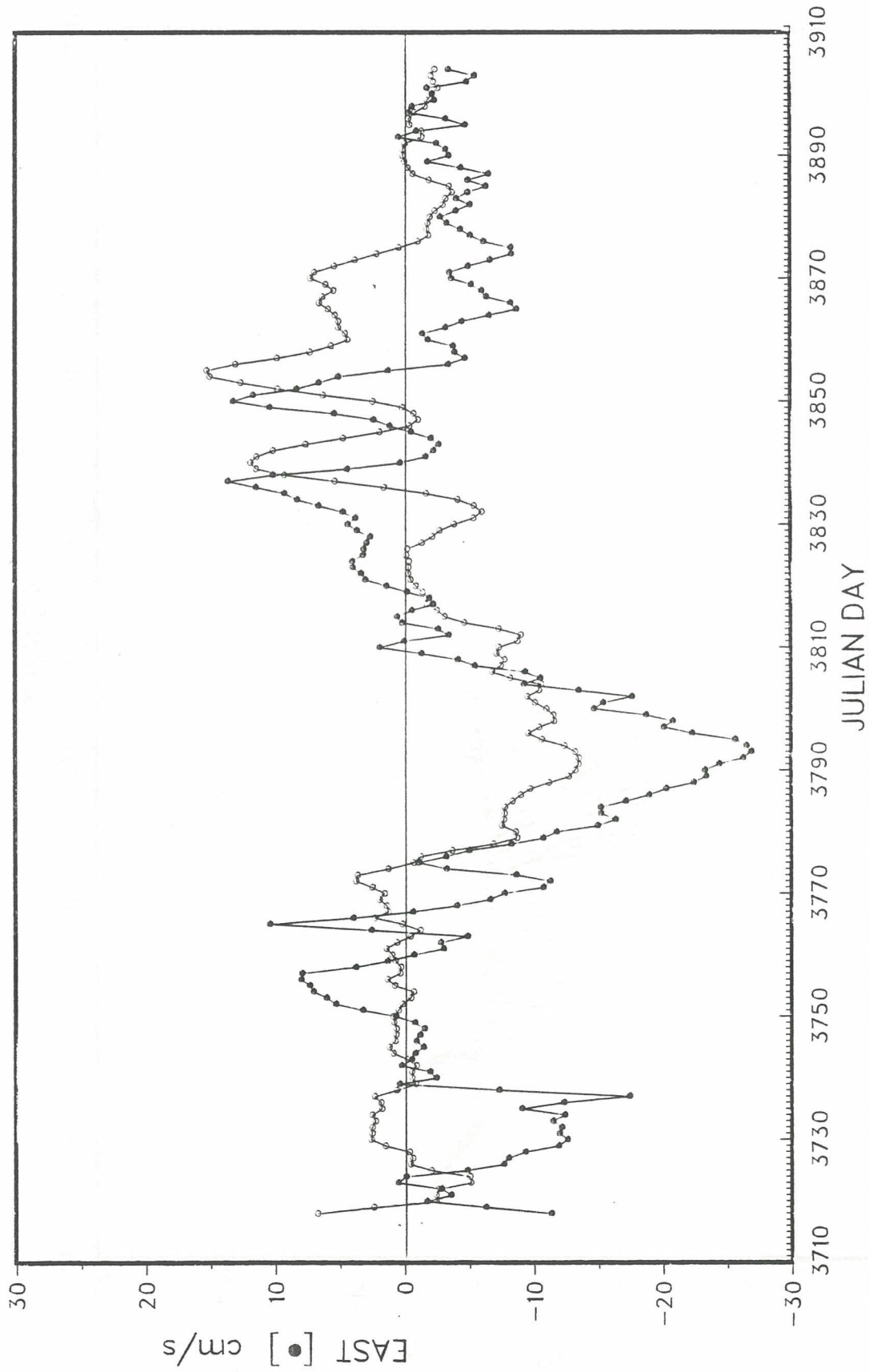
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LONG RANGE 83

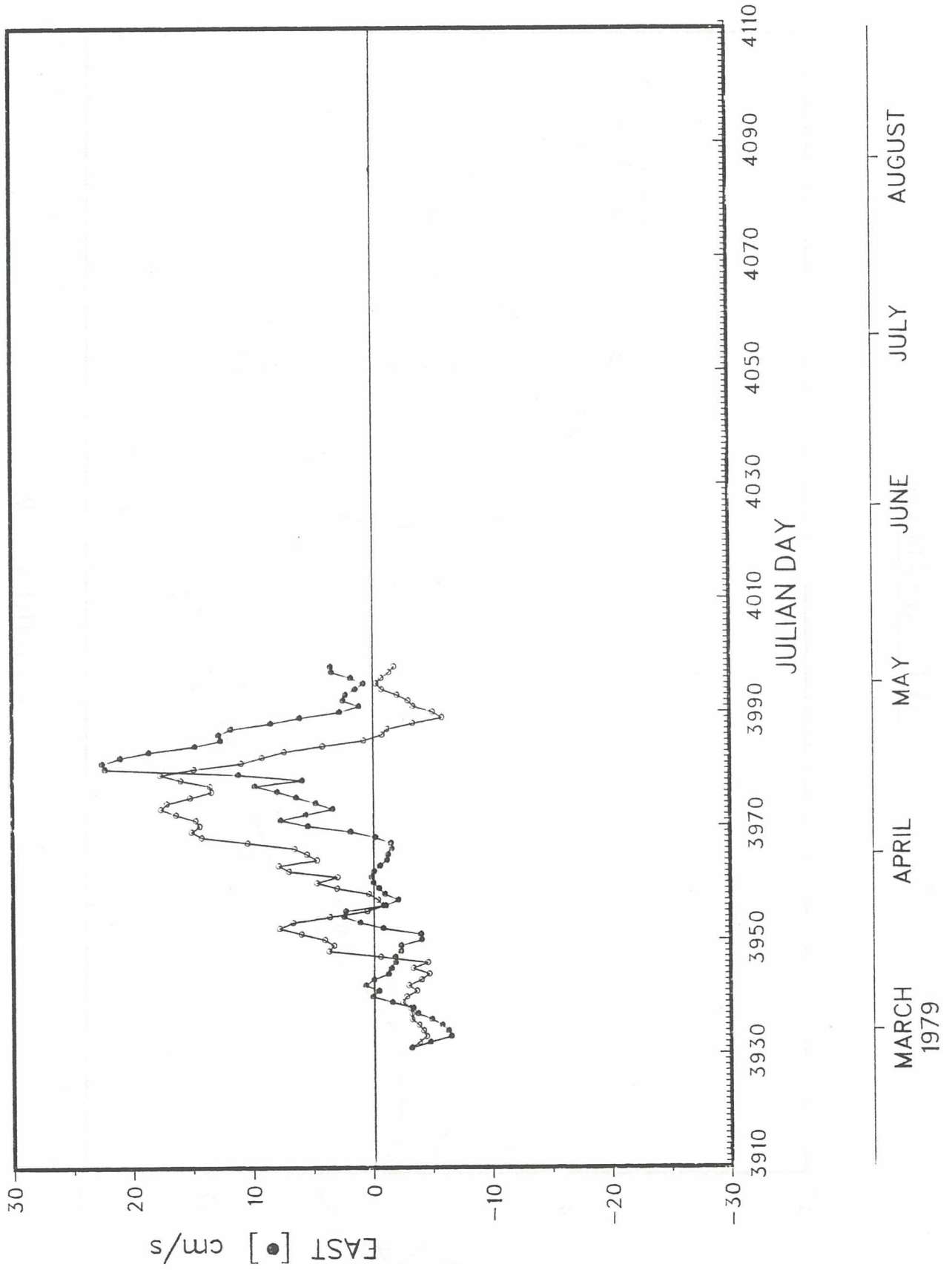


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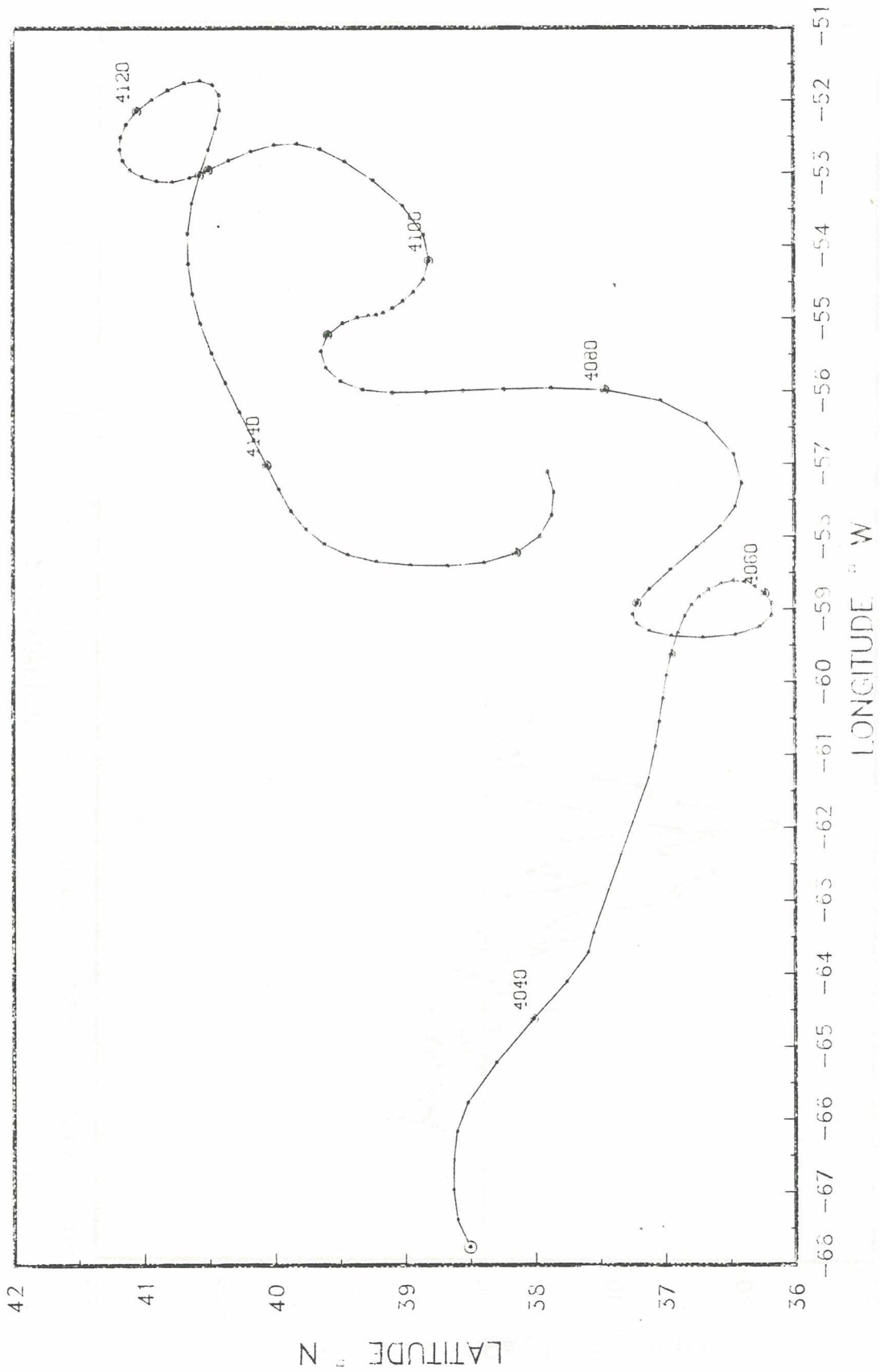


AUGUST 1978 SEPTEMBER OCTOBER NOVEMBER DECEMBER JANUARY 1979 FEBRUARY

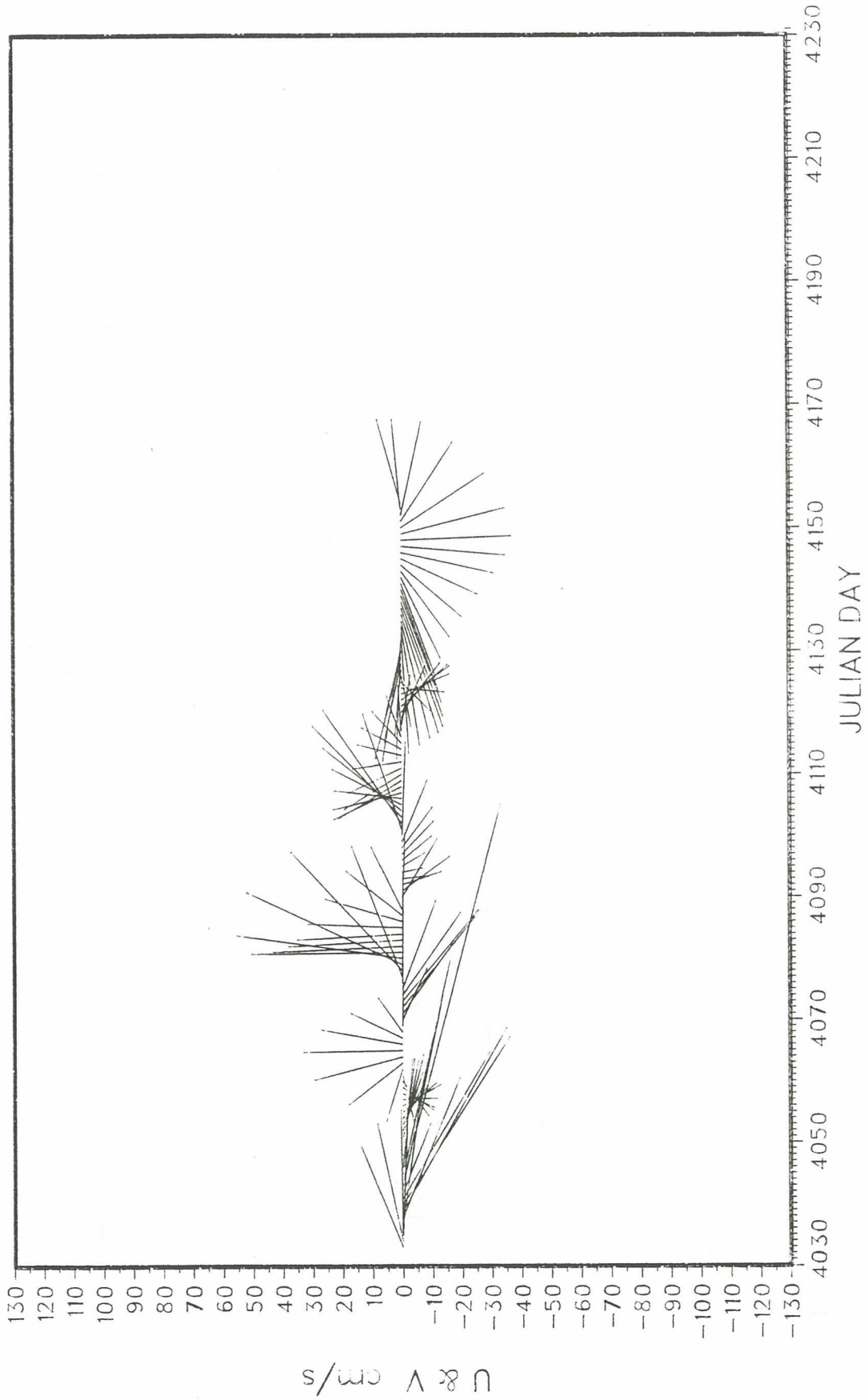
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GULF STREAM 72B

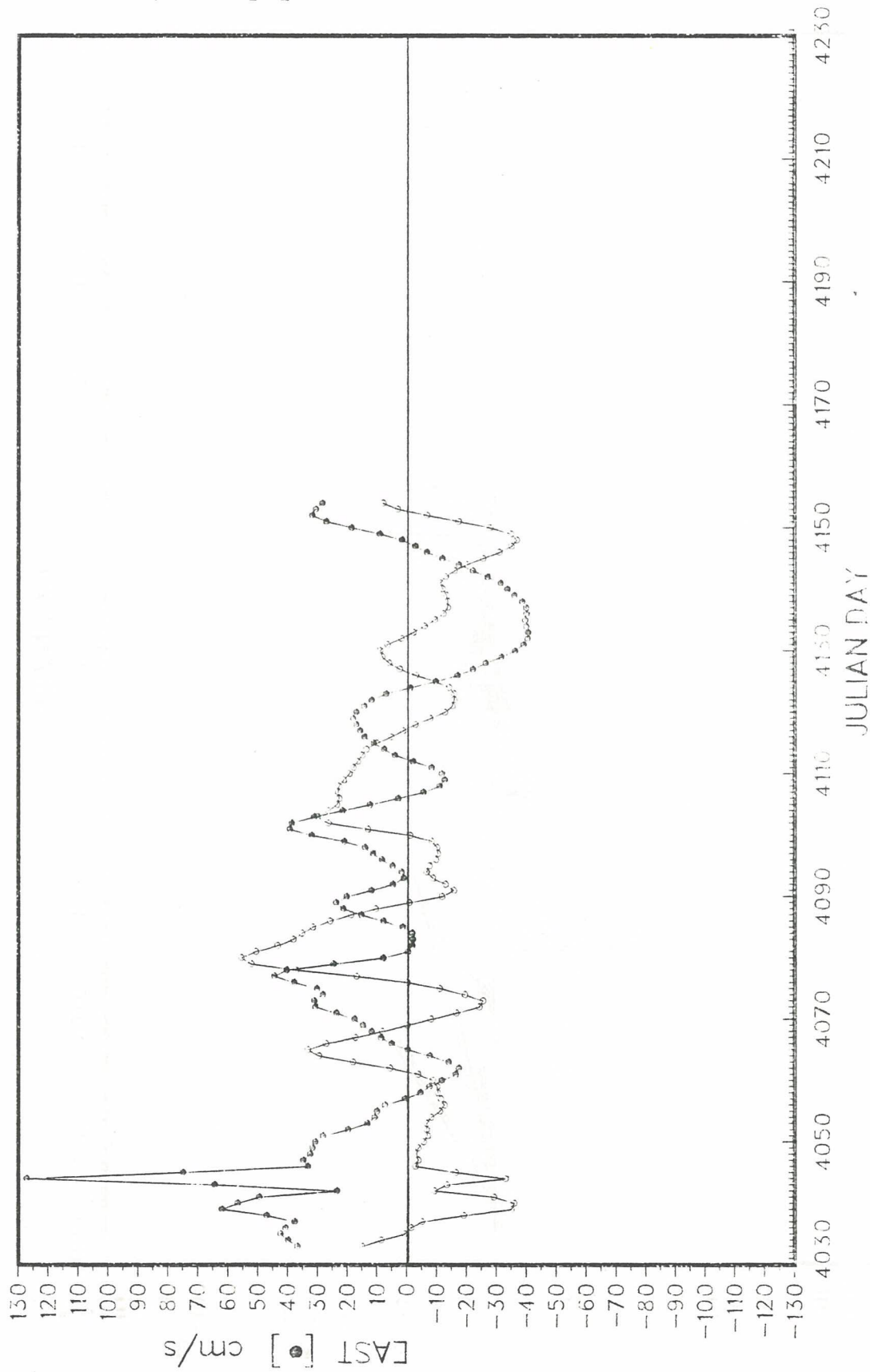


CULF STREAM 72B



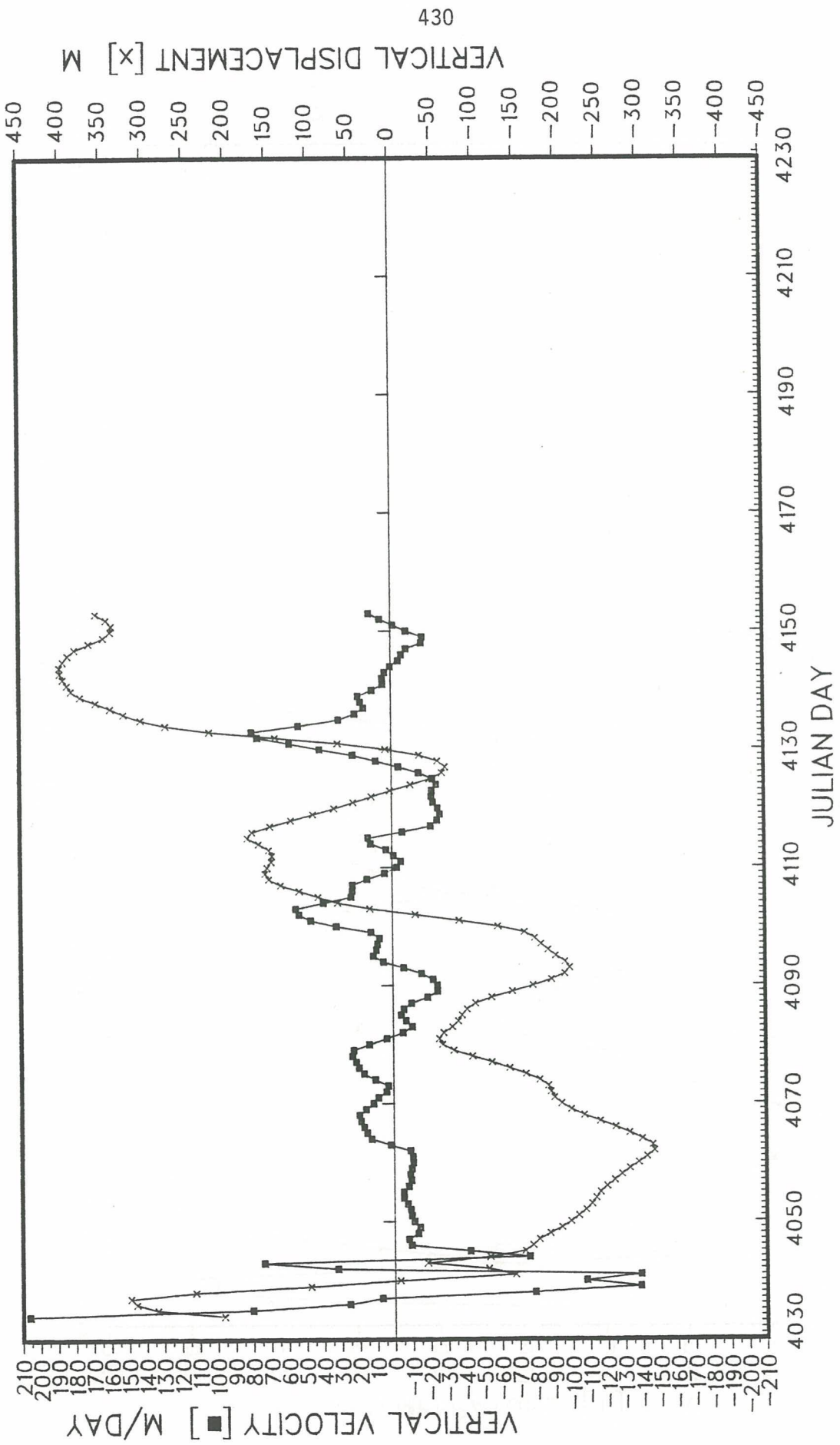
JULY 1979
AUGUST
SEPTEMBER
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NOVEMBER
DECEMBER

CULF STREAM 72B



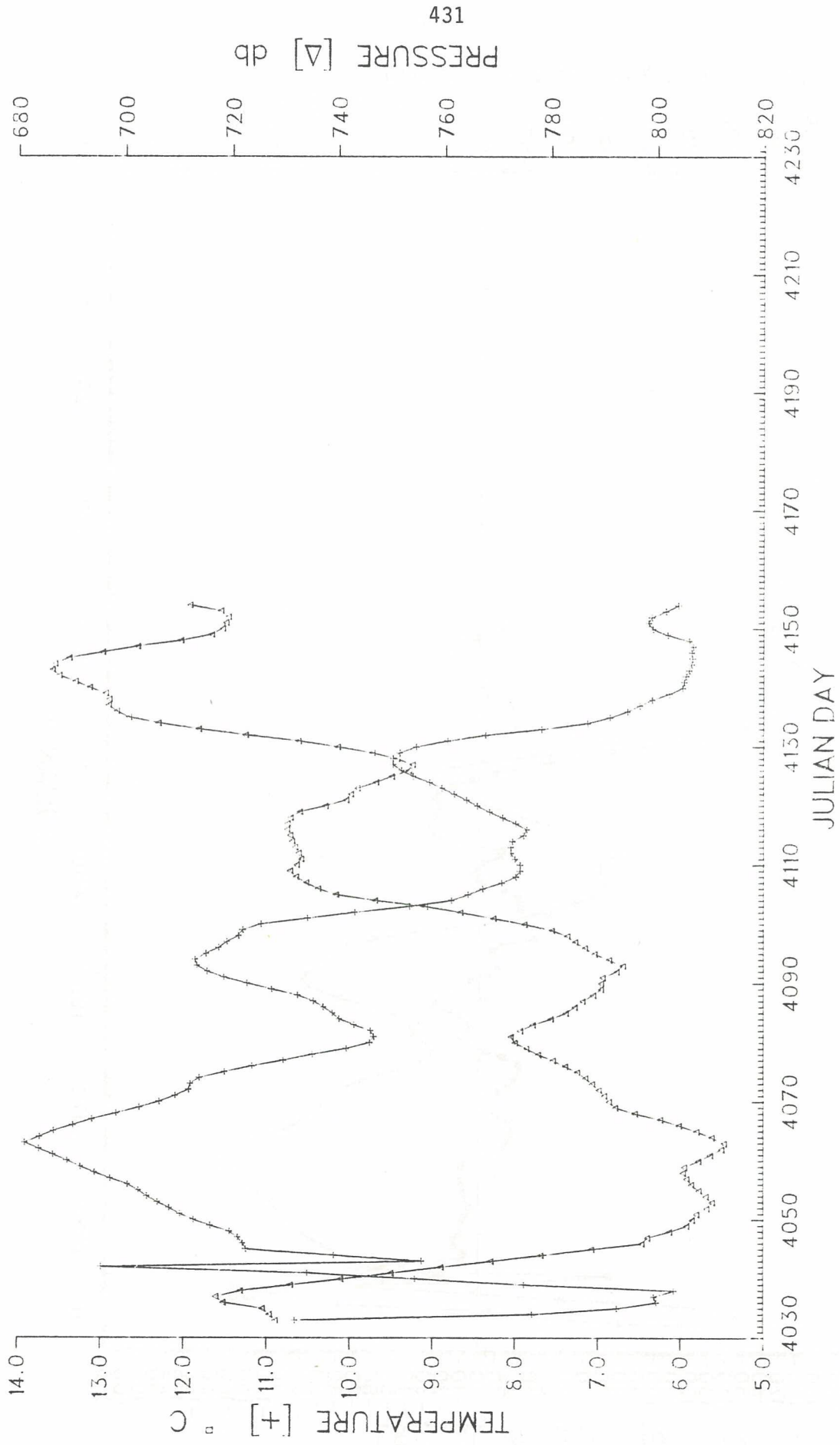
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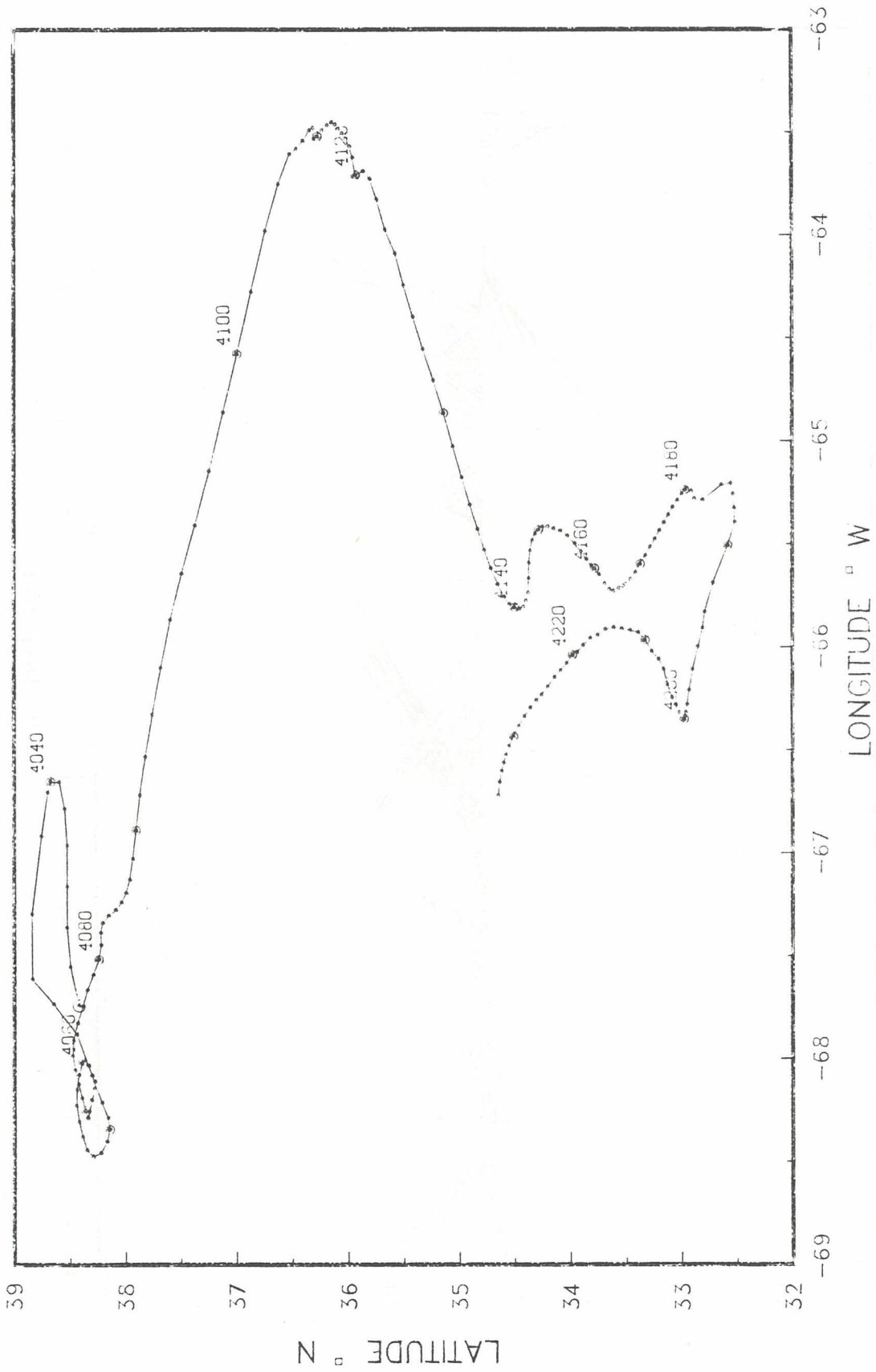
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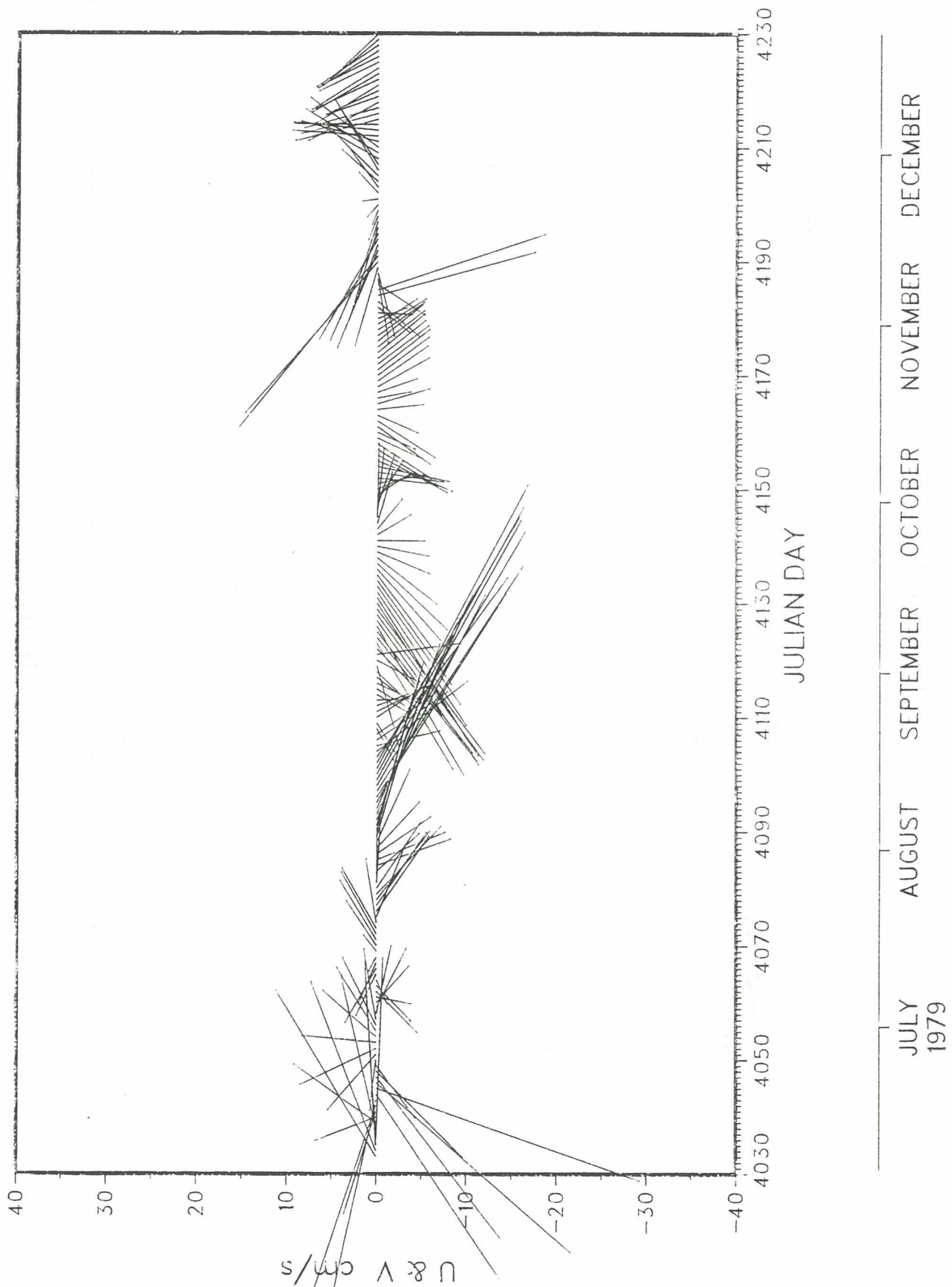


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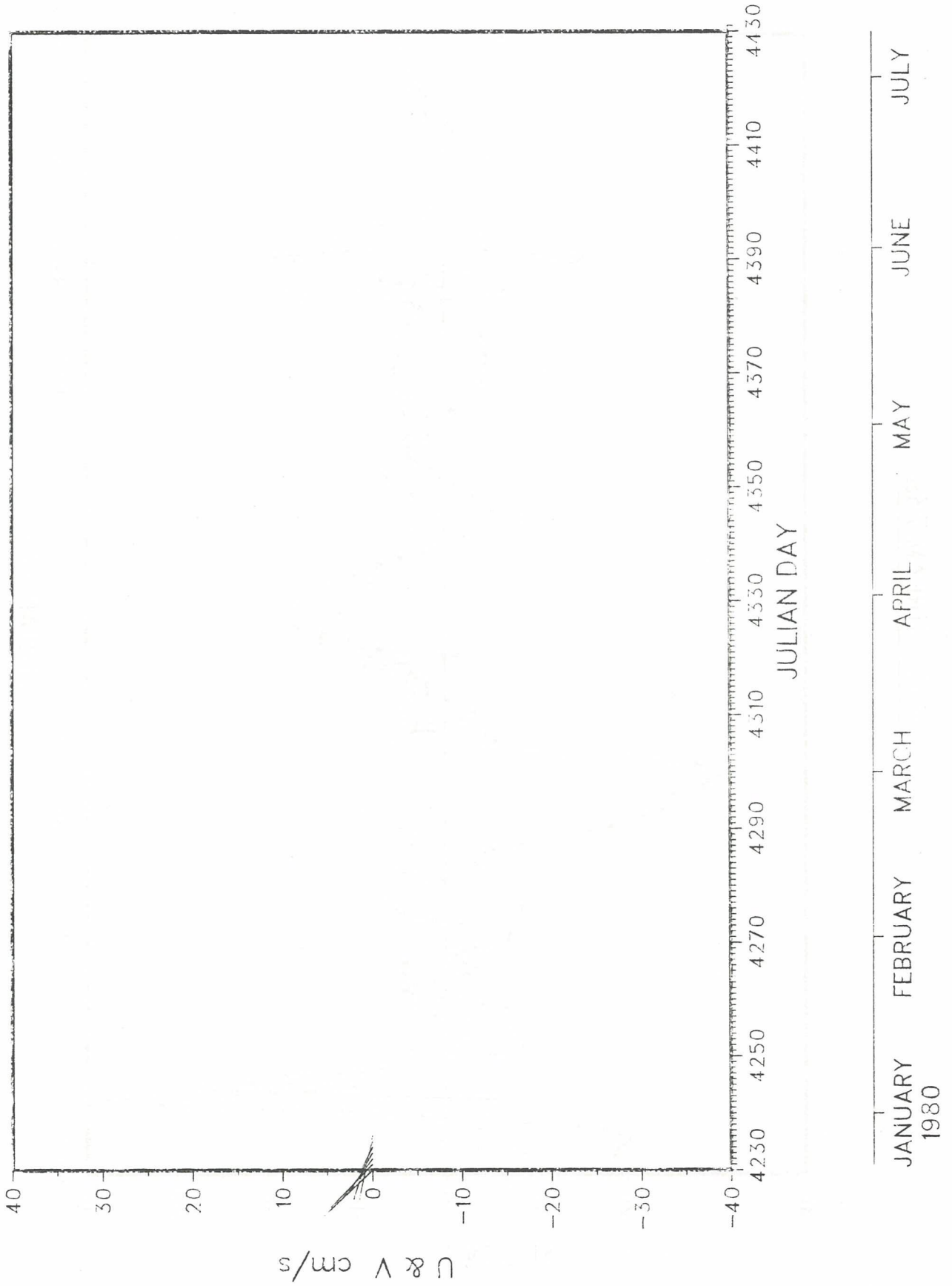
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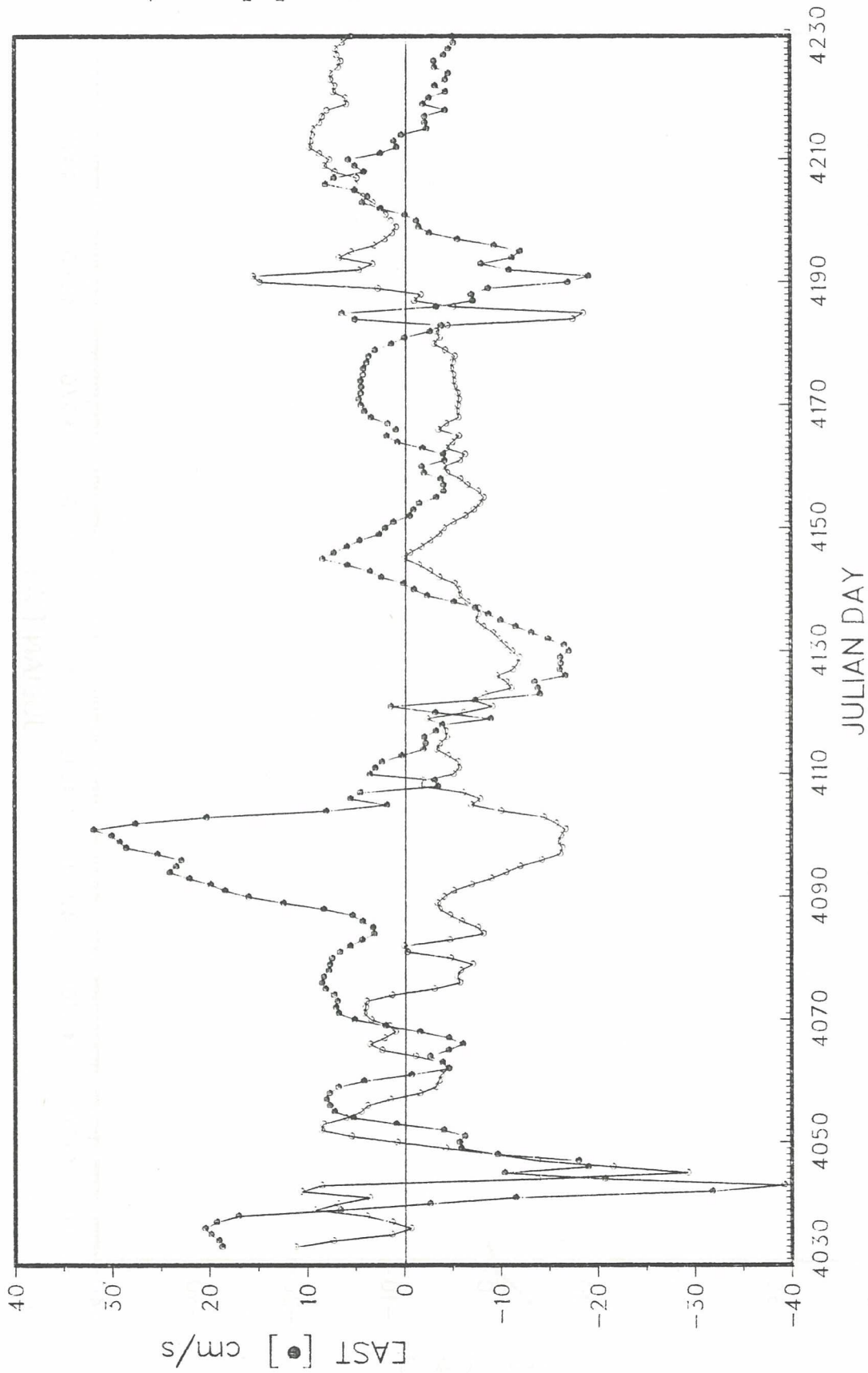
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CULF STREAM 73B



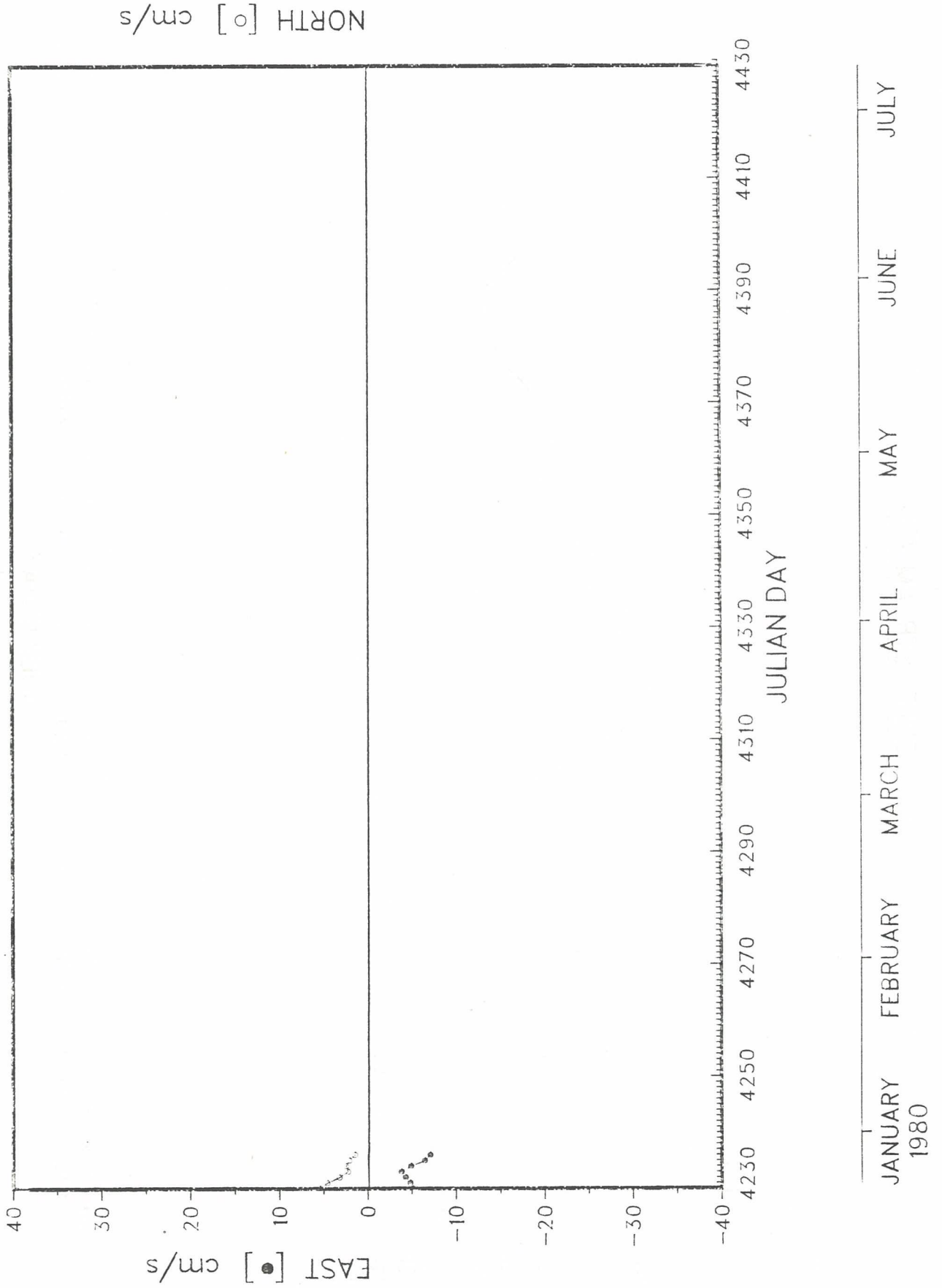
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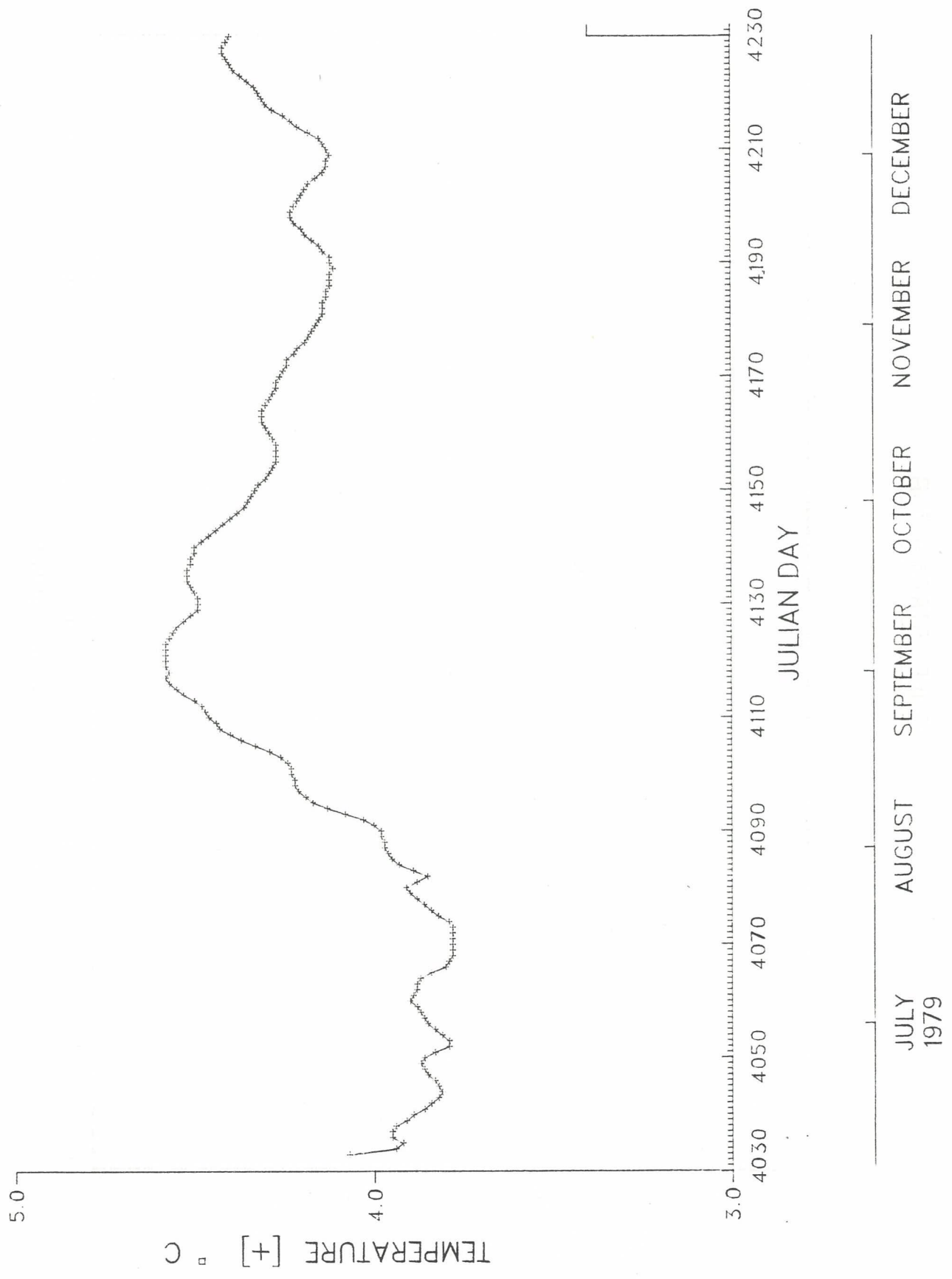
JULY 1979
AUGUST
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NOVEMBER
DECEMBER

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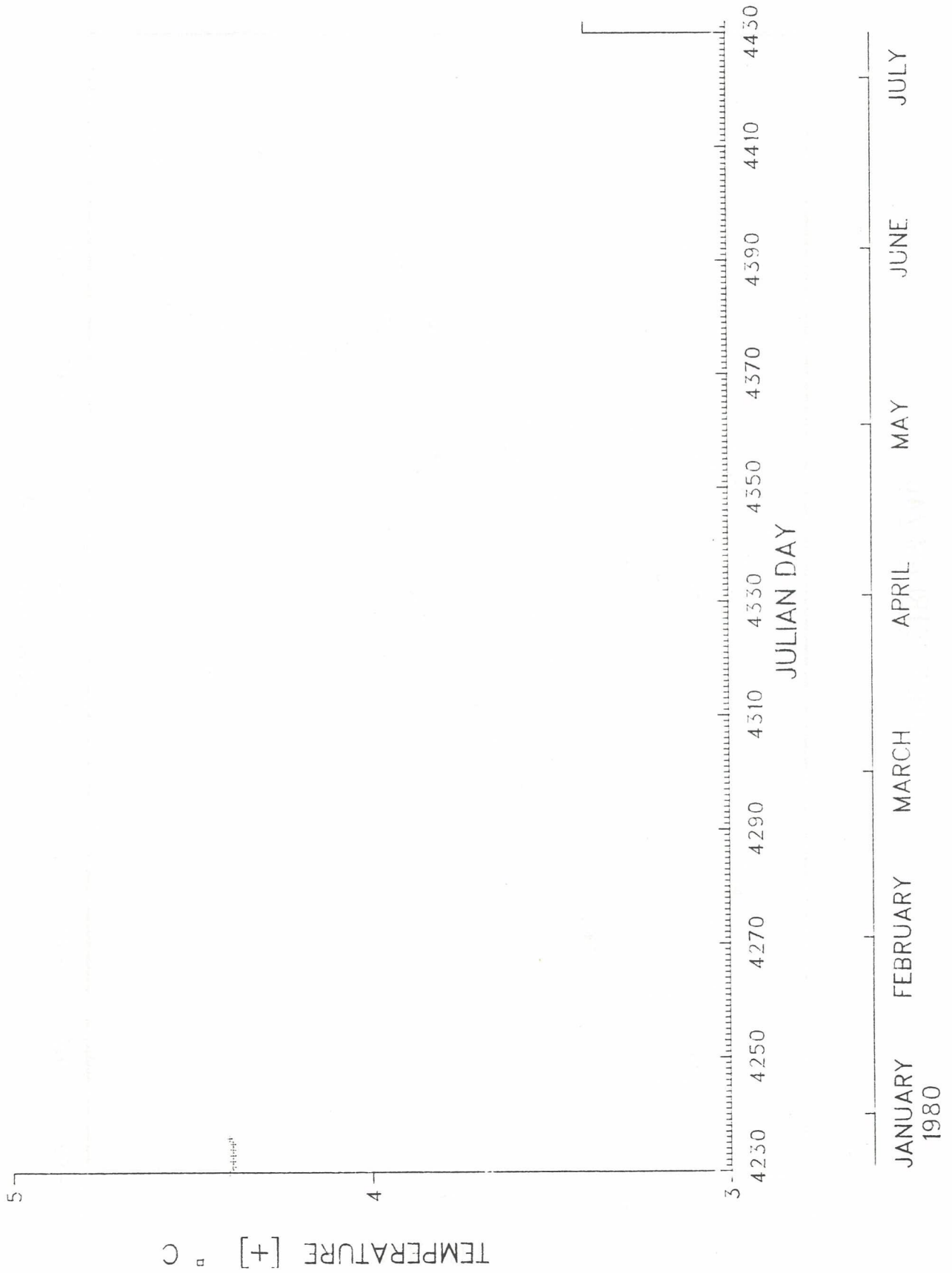
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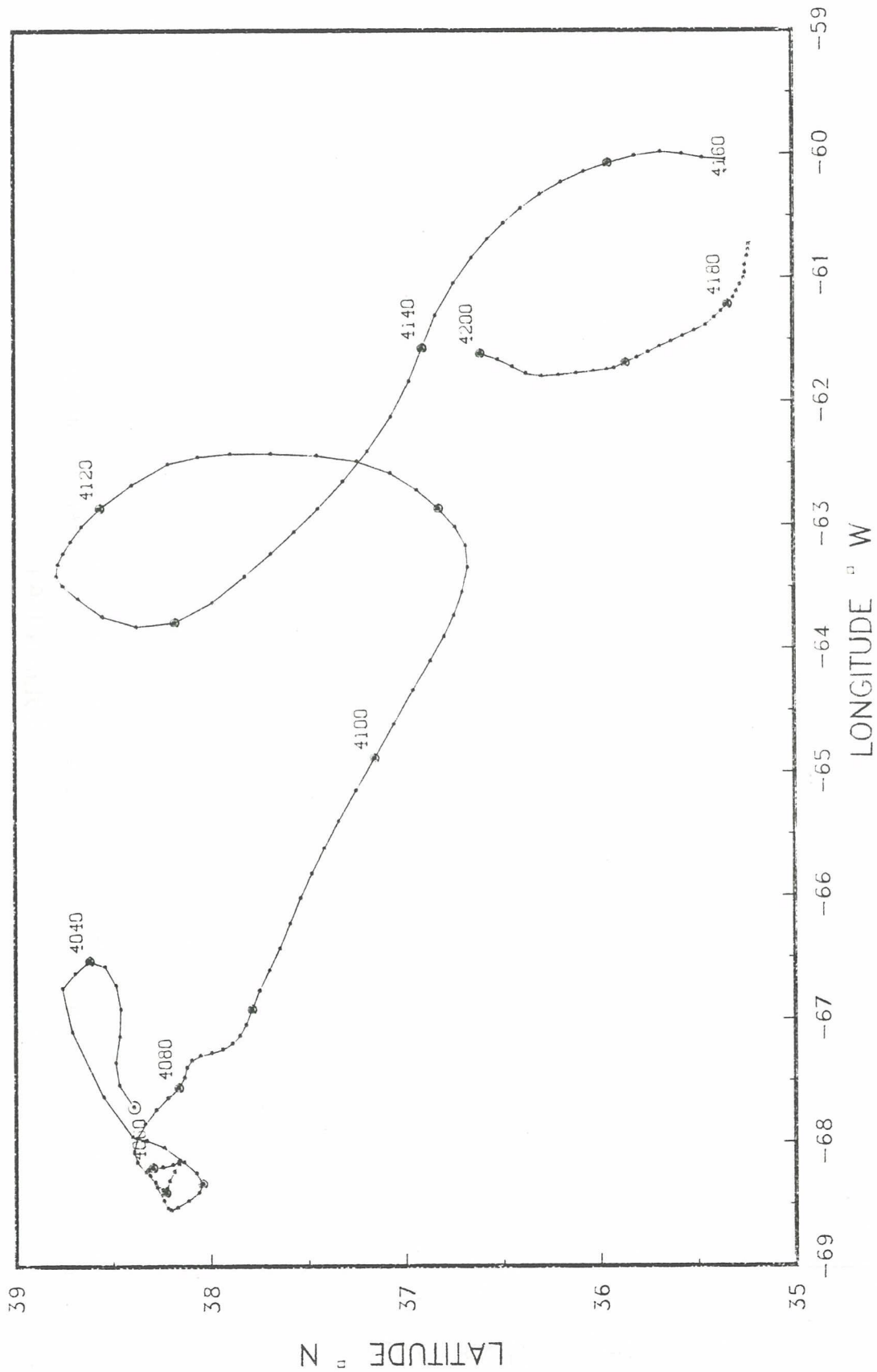
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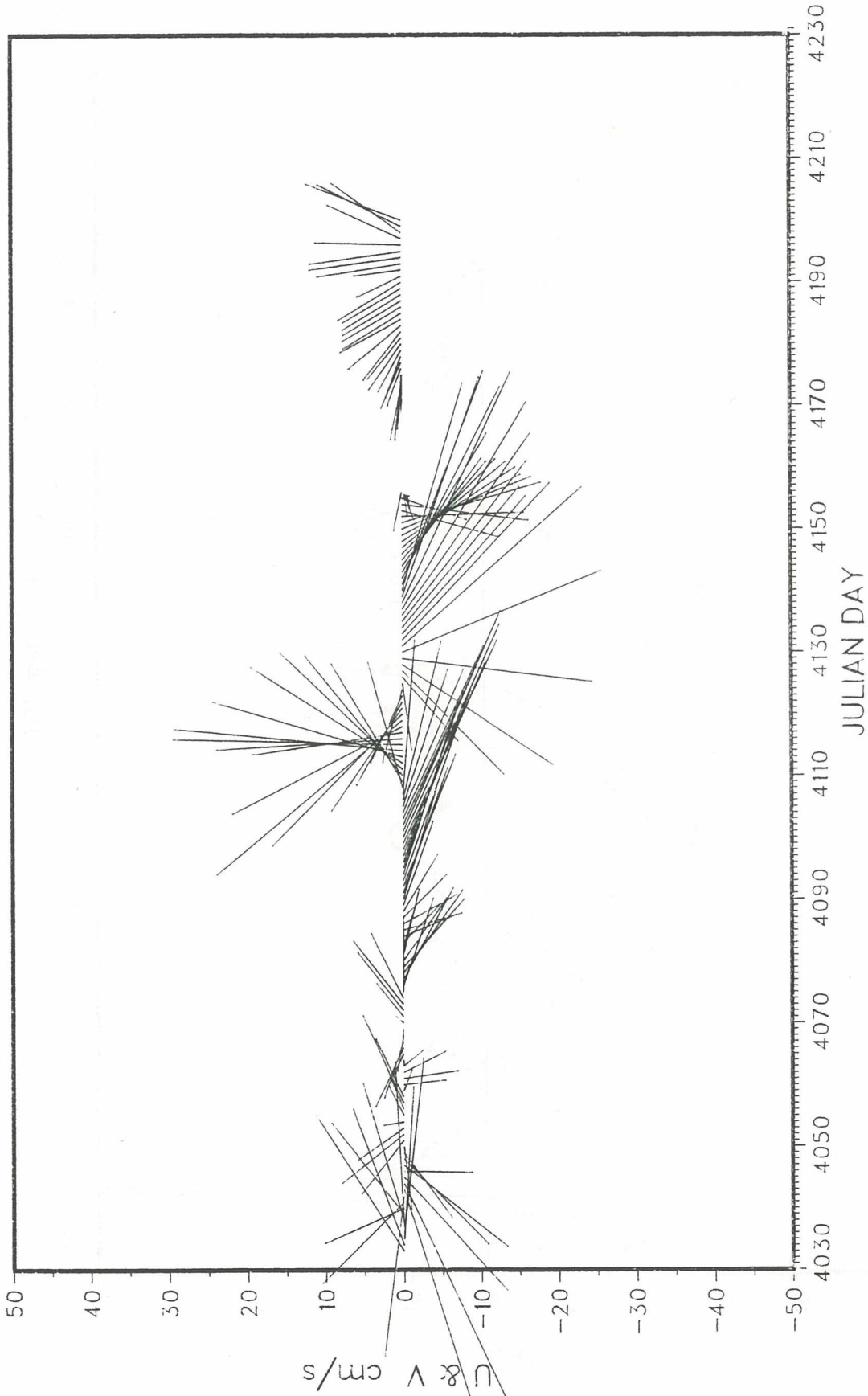
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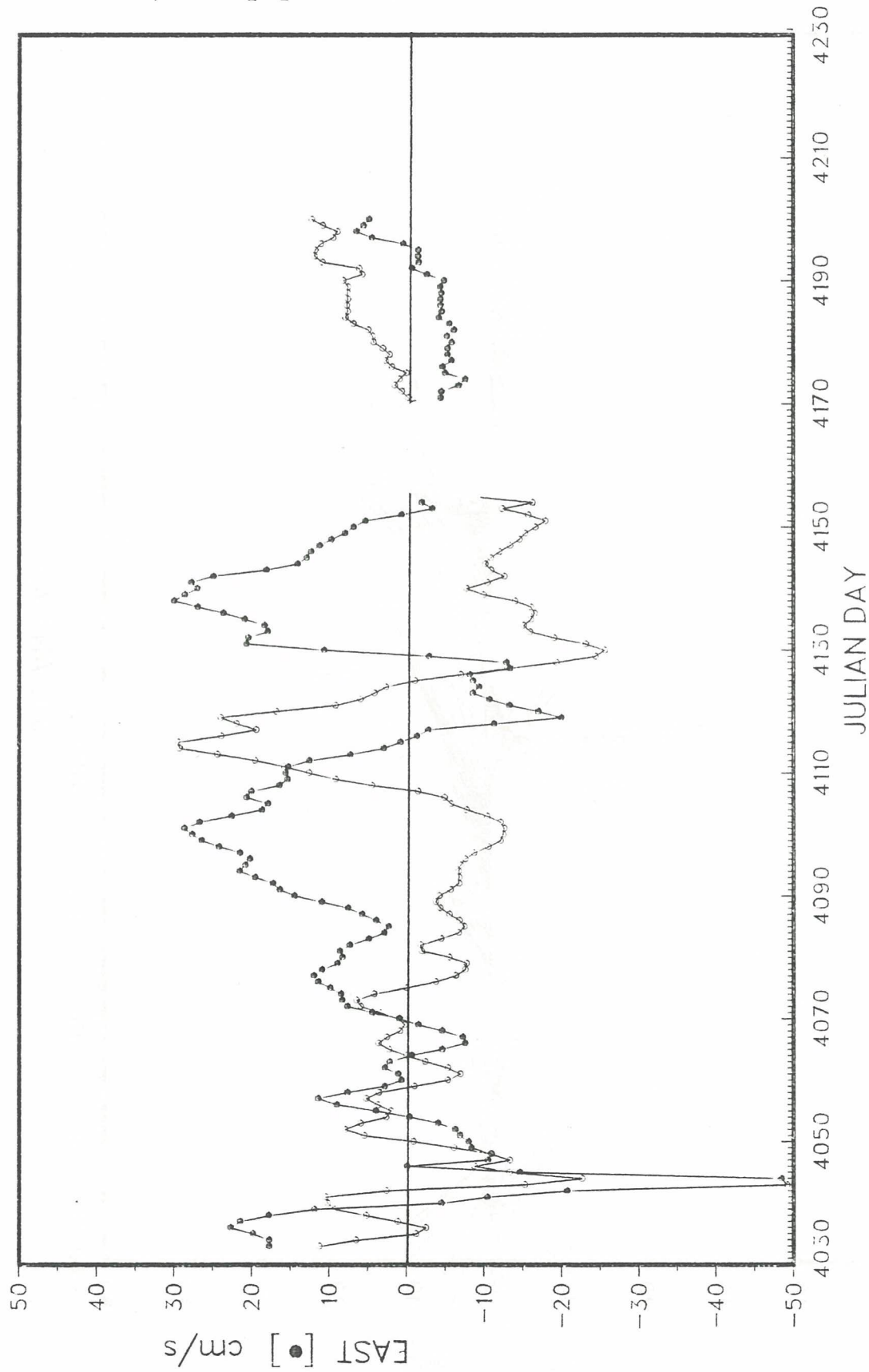


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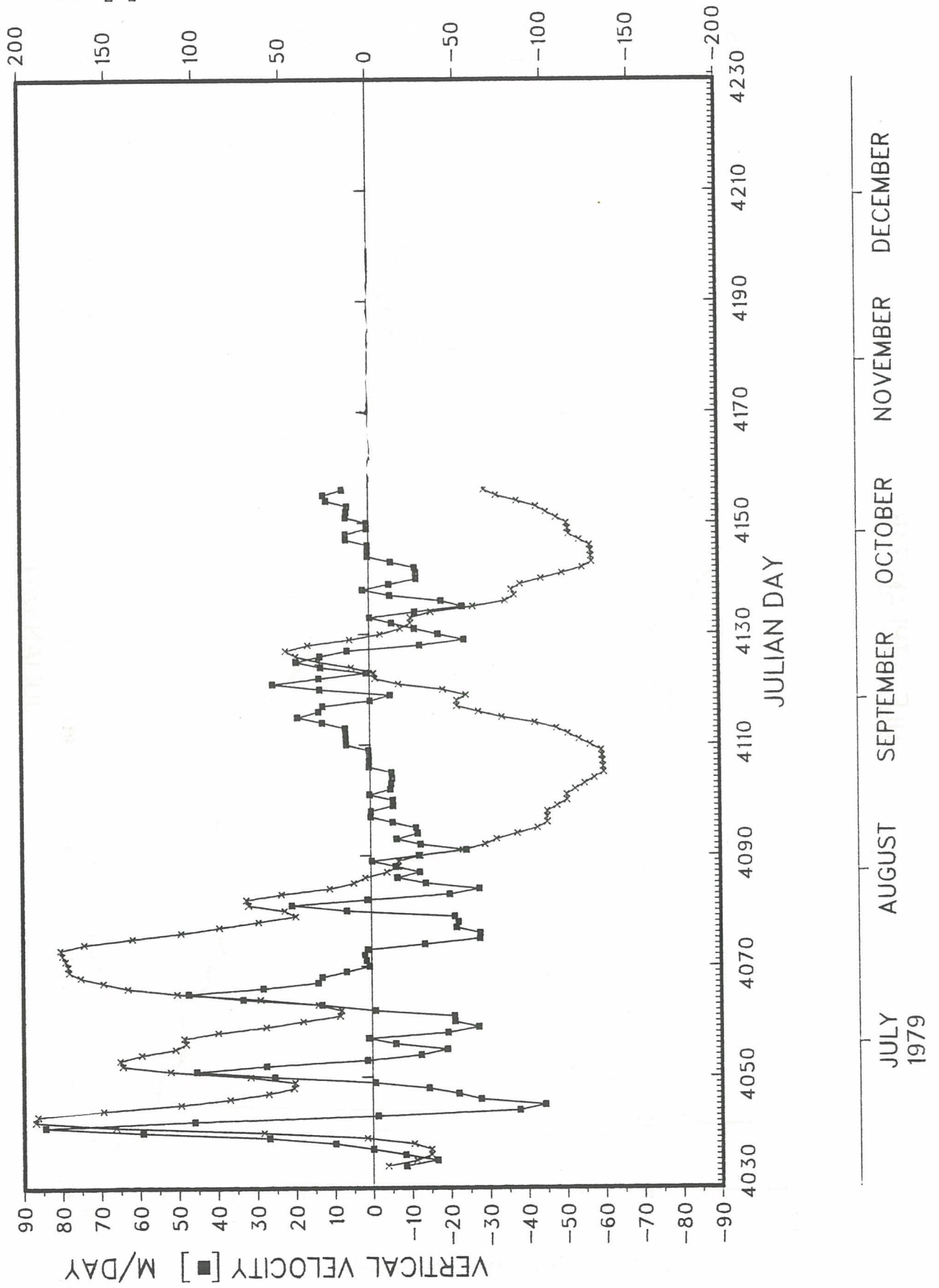


JULY 1979 AUGUST SEPTEMBER OCTOBER NOVEMBER DECEMBER

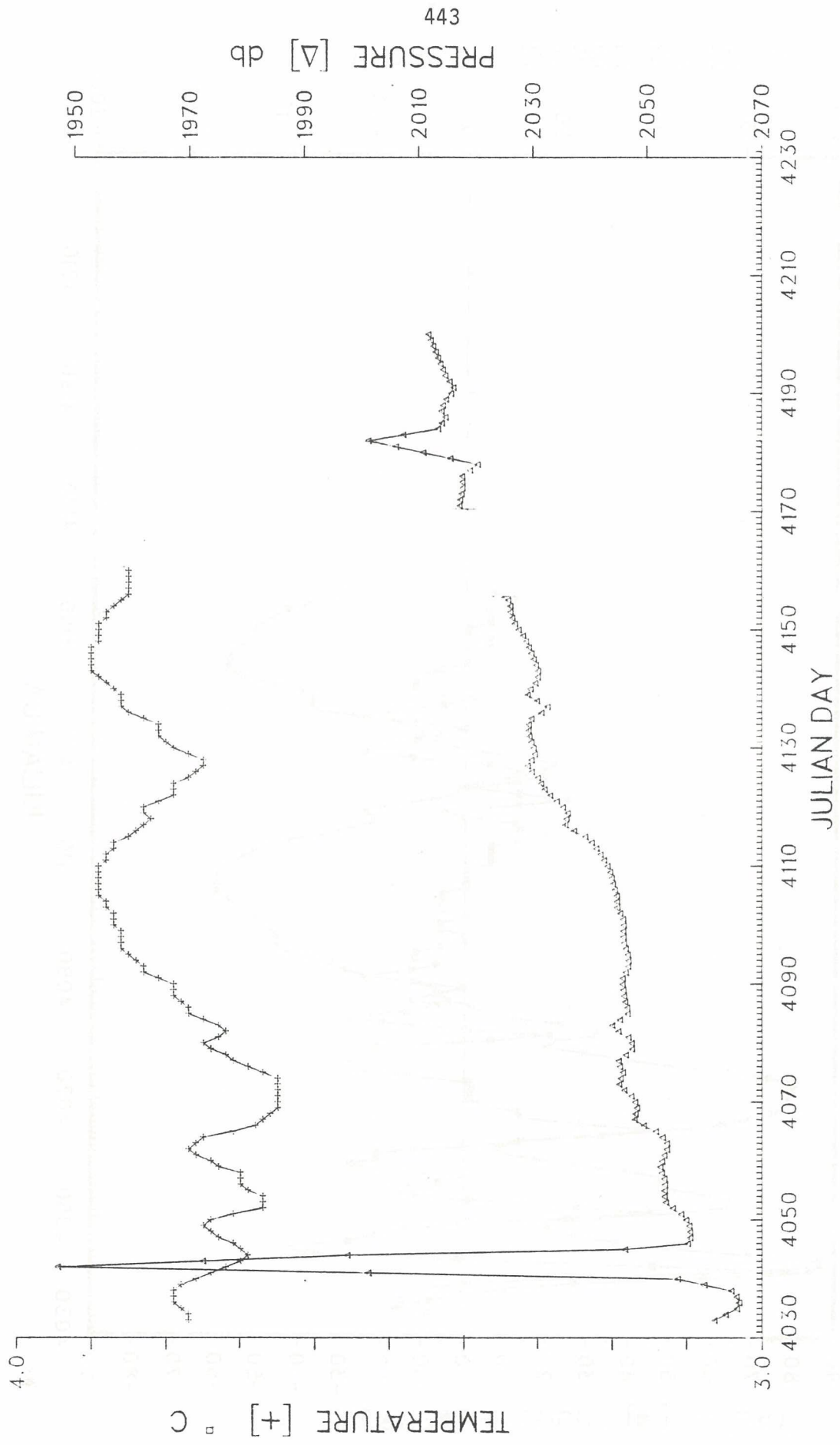
CULF STREAM 74B



GULF STREAM 74B



CULF STREAM 74B



APPENDIX B

Reference List for GUSREX Data

- Owens, W. B. (1984). A synoptic and statistical description of the Gulf Stream and subtropical gyre using SOFAR floats. J. Phys. Oceanogr., 14(6), 104-113.
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