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Gulf Stream Recirculation Experiment – Part II

by

C.M. Wooding, W. B. Owens,
M.E. Zemanovic and J. E. Valdes

September 1989

Technical Report

Funding was provided by the National Science Foundation under
Grant Numbers OCE 81-09145 and OCE 81-17467

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Woods Hole, Massachusetts 02543

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Robert C. Beardsley, Chairman
Department of Physical Oceanography

Gulf Stream Recirculation Experiment — Part II

Christine M. Wooding
W. Brechner Owens
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and
James R. Valdes

June 13, 1989

Abstract

This report presents trajectories and time series of velocity, pressure, and temperature for twelve neutrally-buoyant floats launched during the Gulf Stream Recirculation EXperiment (GUSREX) and two from earlier experiments, that continued to operate after May 1982. These float data were obtained from Autonomous Listening Stations (ALSs) deployed from May 1982 to August 1985.

Table of Contents

Abstract	i
Table of Contents	ii
List of Tables	iii
List of Figures	iii
1 Background	1
2 Instrumentation	10
3 Processing	10
4 General Information for Individual Float Plots	11
Acknowledgements	16
References	17
Appendix A — Individual Float Plots	19
Appendix B — Publications Using GUSREX Float Data	303
Appendix C — Calendar Conversion Tables	304

List of Tables

1	Float information.	7
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List of Figures

1	ALS tracking arrays.	2
2	700-meter float trajectories reported here.	3
3	2000-meter float trajectories reported here.	4
4	All 700-meter GUSREX float trajectories.	5
5	All 2000-meter GUSREX float trajectories.	6
6	Total duration of floats reported here.	9
7	700-meter float duration — all GUSREX floats.	12
8	2000-meter float duration — all GUSREX floats.	13
9	700-meter displacement diagram.	14
10	2000-meter displacement diagram.	15

1 Background

Twelve neutrally-buoyant, SOund Fixing And Ranging (SOFAR) floats launched between April 1980 and August 1981 as part of the Gulf Stream Recirculation EXperiment (GUSREX) continued to work after the first two years of the experiment reported by Kennelly and McKee (1984). In addition, two floats, one launched in October 1976 over the Nares Abyssal Plain as part of POLYMODE and another launched in June 1979 as part of an earlier Gulf Stream experiment also were heard after May 1982. This report presents the trajectories and time series of temperature, pressure, and velocity for these fourteen floats. GUSREX part II coverage of the Northwest Atlantic Ocean lasted for 33 months and then was supplemented by an array of five ALSs deployed to track SOFAR floats launched in the close vicinity of 34°N, 70°W (Site L, Price *et al.*, 1987) (Figure 1).

The GUSREX program, including the Site L coverage, lasted nearly five-and-a-half years. GUSREX was a joint program of Woods Hole Oceanographic Institution and the University of Rhode Island. It focused on the recirculation of the Gulf Stream, addressing such questions as the size and structure of the recirculation south of the Gulf Stream as proposed by Worthington (1976) and the interconnection of the Gulf Stream and the North Atlantic Current at the tail of the Grand Banks (Worthington, 1976; Clarke *et al.*, 1980). As part of GUSREX, a total of forty-three floats was launched along 55°W from 24 to 44°N during two cruises in April–May 1980 and July–August 1981 (Kennelly and McKee, 1984). Except for one case, these floats were launched in pairs with one float ballasted to 700 m and the other to 2000 m (see Figures 2, 3, 4 and 5). Twelve of these floats, five shallow and seven deep, are presented in this report. Table I shows the duration and start and end locations for each float

GUSREX EXPERIMENT AUG 1981 – SEPT 1985

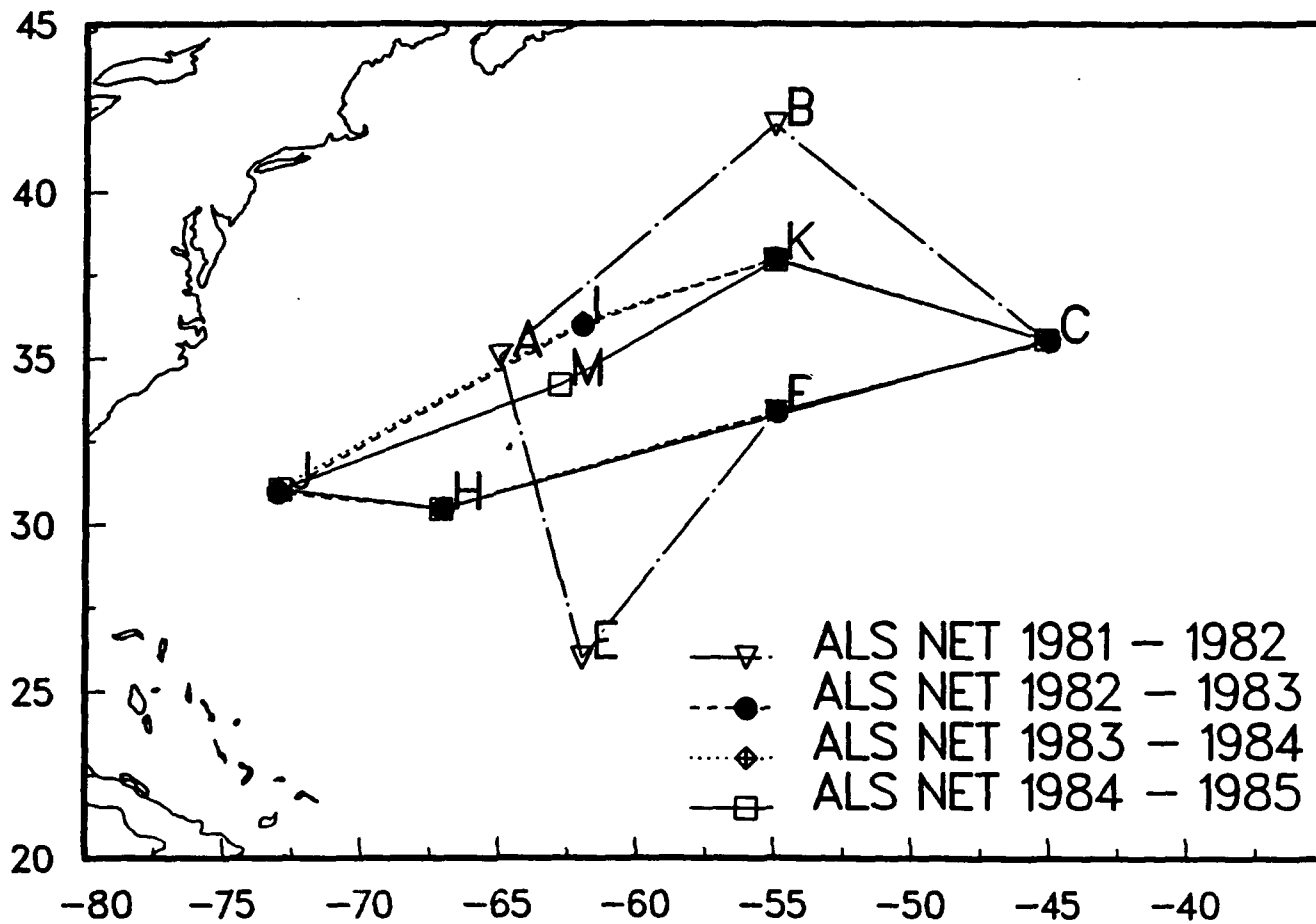


Figure 1: ALS tracking arrays for duration of GUSREX Site L Experiment.

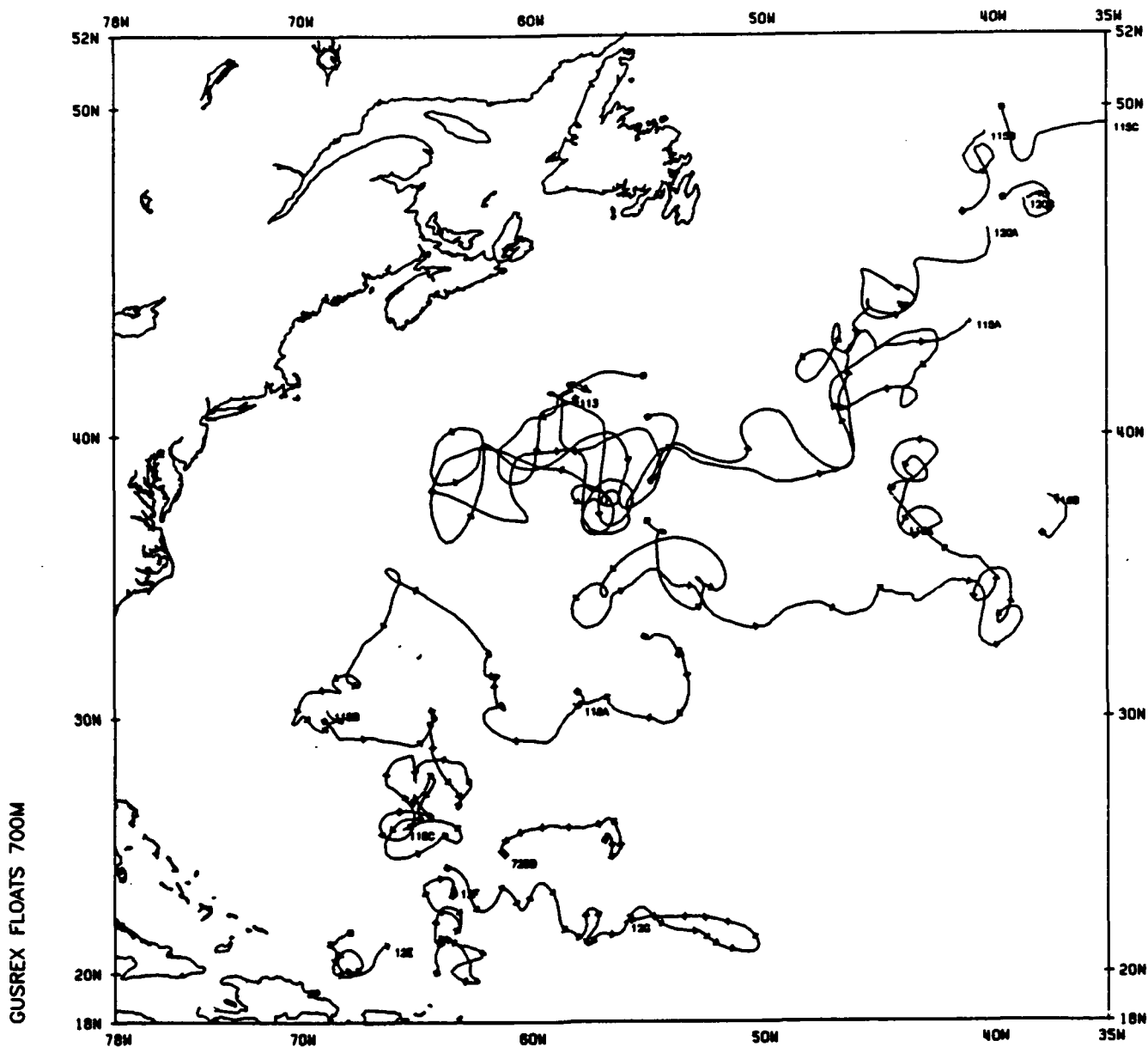


Figure 2: Composite 700-meter trajectories for floats covered in this report. Arrowheads mark every thirtieth day.

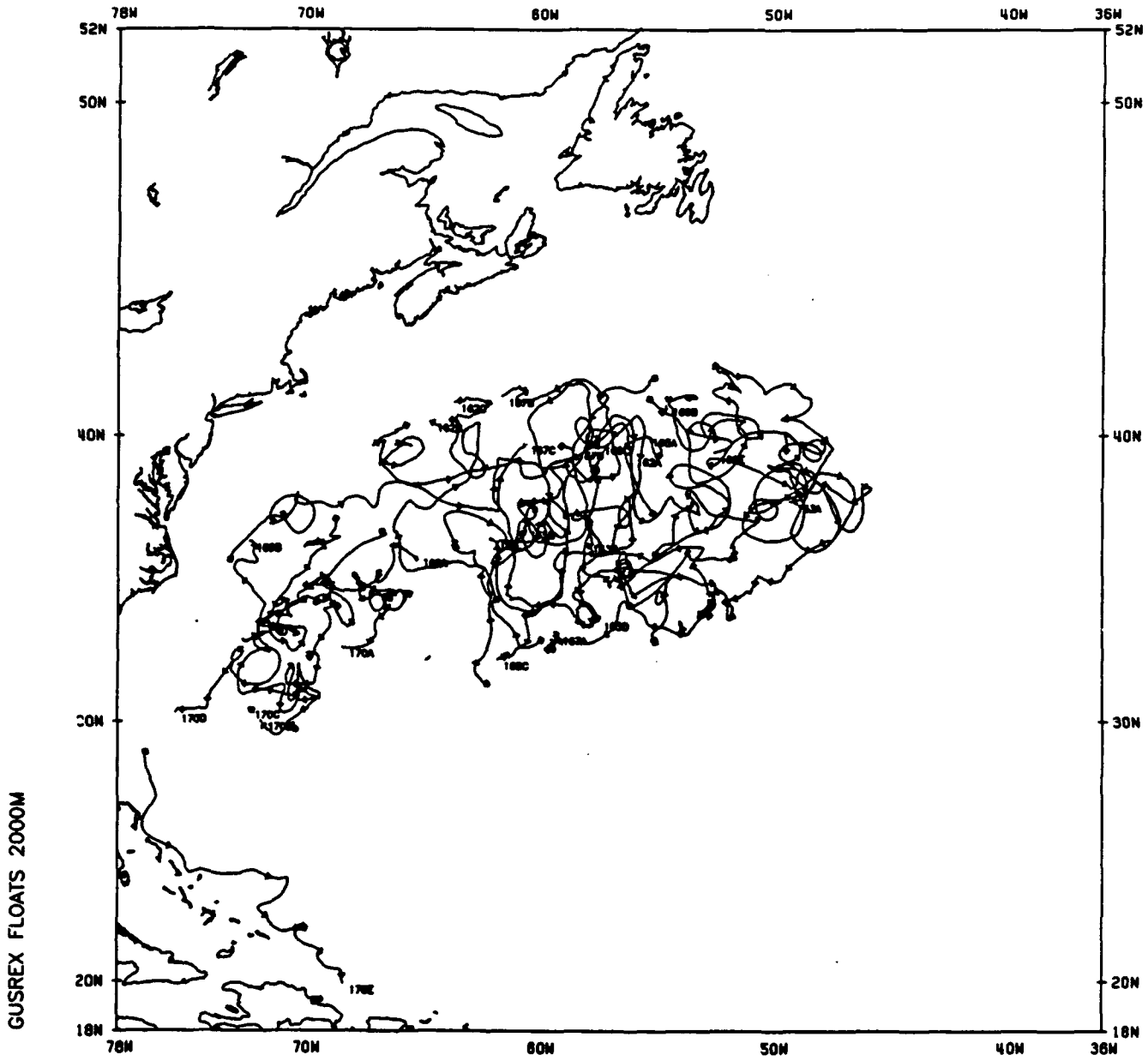


Figure 3: Composite 2000-meter trajectories for floats covered in this report. Arrowheads mark every thirtieth day.

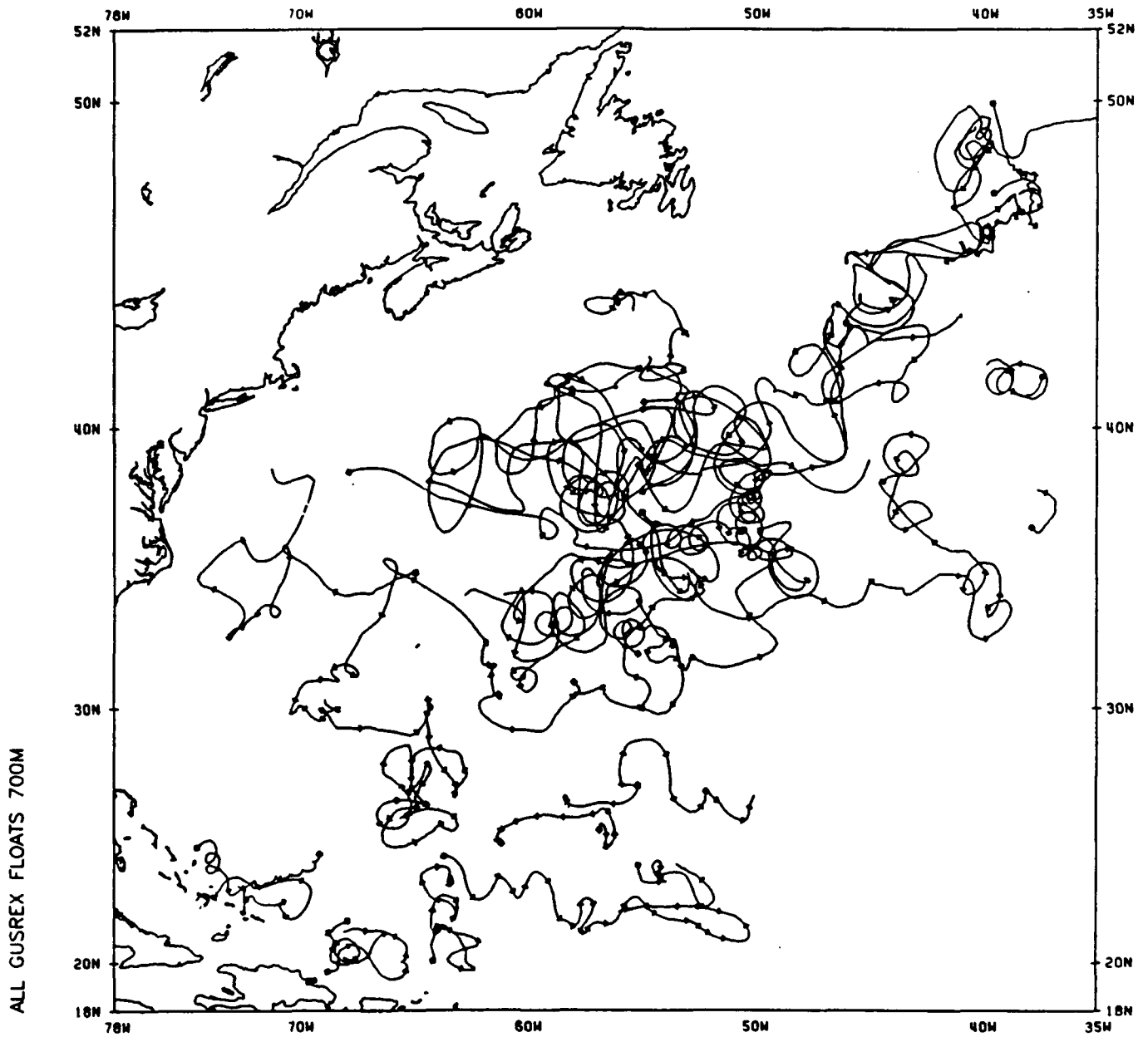


Figure 4: Composite 700-meter trajectories for floats covered in this report and earlier Gulf Stream floats. Arrowheads mark every thirtieth day.

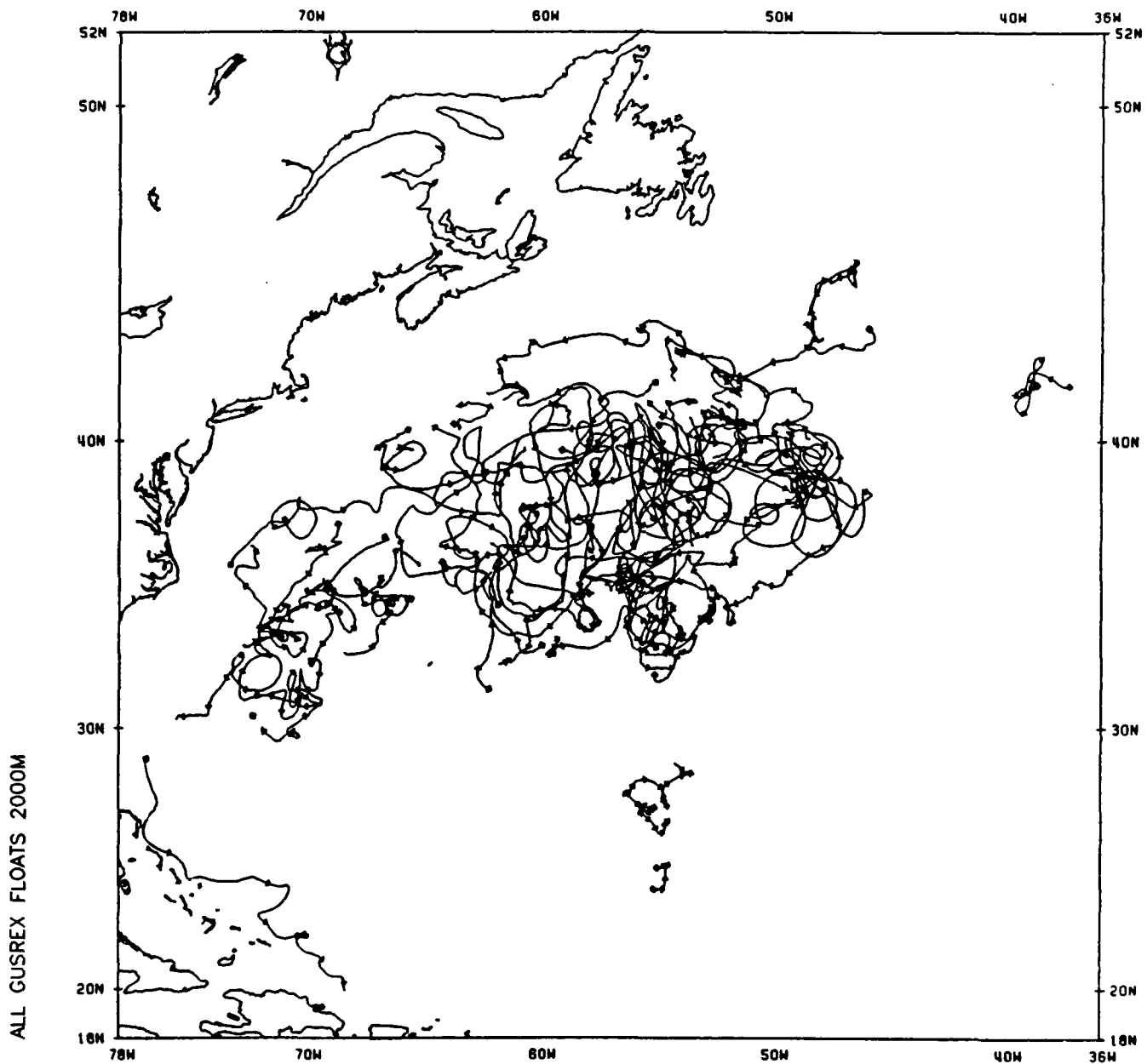


Figure 5: Composite 2000-meter trajectories for floats covered in this report and earlier Gulf Stream floats. Arrowheads mark every thirtieth day.

FLOAT	START	LAT	LONG	STOP	LAT	LONG	NO. DAYS	NOM. DEPTH	INIT. TEMP.	AVE. TEMP.	INIT. PRES.	AVE. PRES.
GS72BB	820530	25.29	-56.76	830504	24.67	-61.10	340	700	14.1	14.5	631.	618.
GU113	810809	41.94	-55.04	821030	41.26	-58.07	448	700	-	-	665.	685.
GU115A	810808	40.60	-54.86	820416	43.67	-40.94	252	700	8.7	9.9	699.	670.
GU115B	820529	46.94	-41.25	820716	49.26	-40.30	49	700	4.8	5.5	640.	684.
GU115C	821007	49.93	-39.54	830110	50.99	-31.99	96	700	4.0	4.8	663.	687.
GU116A	810808	37.10	-54.90	830502	36.89	-43.89	633	700	10.8	10.0	695.	678.
GU116B	830721	36.59	-37.81	830823	37.91	-37.57	34	700	10.0	9.6	690.	684.
GU118A	810806	32.99	-55.02	820202	30.45	-57.93	181	700	11.5	11.8	734.	711.
GU118B	820222	30.96	-57.89	830503	30.32	-68.77	436	700	12.7	12.5	707.	703.
GU118C	830607	29.92	-68.92	850901	25.76	-65.49	818	700	13.2	11.8	705.	698.
GU120A	810719	38.17	-64.21	820402	46.46	-40.15	258	700	11.4	7.8	639.	794.
GU120B	820713	47.34	-39.50	821001	47.30	-38.60	81	700	-	-	-	-
GU162A	810809	41.86	-55.08	820809	39.35	-56.15	366	2000	3.2	3.2	2126.	2163.
GU162B	821123	34.42	-61.83	830425	40.46	-64.66	154	2000	3.2	3.2	-	-
GU162C	830603	40.51	-63.72	830805	41.09	-63.64	64	2000	-	-	-	-
GU163A	810809	40.78	-54.77	830504	37.83	-49.27	634	2000	3.7	3.7	2116.	2115.
GU163B	830605	39.54	-49.46	850829	36.43	-57.99	817	2000	3.7	3.8	2100.	2093.
GU165A	810808	37.42	-55.16	810919	40.01	-55.48	43	2000	3.7	3.5	-	-
GU165B	811005	38.54	-57.51	811223	36.91	-60.69	80	2000	3.6	3.6	-	-
GU165C	820112	36.73	-60.73	830502	32.29	-61.79	476	2000	3.5	3.5	-	-
GU165D	830607	31.40	-62.22	850826	33.73	-57.52	812	2000	3.6	3.6	2199.	2161.
GU166	810807	36.02	-55.02	820717	36.53	-61.98	345	2000	-	-	-	-
GU167A	810809	32.92	-55.02	830505	33.19	-59.26	635	2000	-	-	1972.	1998.
GU167B	830607	32.99	-59.91	840419	41.28	-61.61	318	2000	-	-	1999.	2002.
GU167C	840529	40.34	-65.68	841208	39.75	-60.69	194	2000	-	-	2008.	2011.
GU169A	810721	37.21	-68.66	830505	35.92	-65.23	654	2000	3.5	3.5	2121.	2114.
GU169B	830603	36.78	-66.67	840503	36.44	-72.36	336	2000	3.6	3.6	2079.	2038.
GU169C	840522	35.82	-73.19	850101	39.73	-57.51	225	2000	-	-	-	-
GU169D	850201	41.19	-55.31	850211	41.00	-54.60	11	2000	-	-	-	-
GU169E	850225	41.25	-53.63	850823	39.45	-52.57	180	2000	-	-	-	-
GU170A	810719	34.63	-65.55	820429	32.73	-68.37	285	2000	3.7	3.7	2144.	2136.
GU170B	820604	34.17	-68.59	830503	30.05	-71.86	334	2000	3.6	3.6	2148.	2119.
GU170C	830626	31.17	-72.07	840502	30.33	-75.54	312	2000	3.7	3.7	2065.	2025.
GU170D	840524	28.85	-76.82	841224	19.91	-68.31	215	2000	-	-	-	-
PL12D	810116	19.61	-68.68	810713	21.25	-67.94	179	700	5.4	5.9	-	-
PL12E	810719	21.68	-67.80	820116	21.15	-66.16	182	700	6.2	6.1	-	-
PL12F	820311	20.05	-64.05	830423	23.49	-63.28	409	700	6.2	6.1	-	-
PL12G	830608	24.26	-63.58	850613	22.05	-55.93	737	700	6.2	5.9	-	-

Table 1: Table of float information.

segment. The initial and average values for temperature and pressure are shown (dash indicates absence of data).

Another float still operating in May 1982 was PL12 which was launched on October 4, 1976, at 24.4°N, 69.0°W, as part of a pilot study for POLYMODE called Pre-LDE (Spain *et al.*, 1980; McKee, 1986). This float was launched by Riser and Rossby (1983) in an isolated eddy of warm, saline Mediterranean water in the Nares Abyssal Plain. It was ballasted to approximately 900 m depth in order to track the "meddy". PL12 is the longest operating SOFAR float (Owens *et al.*, 1988). In figures where the floats are divided by depth, PL12 is included with the 700-meter floats.

The other non-GUSREX float covered in this report is GS72B, launched on June 6, 1979, at 38.4°N, 67.9°W, near but south of the axis of the Gulf Stream (Kennelly and McKee, 1984). This float had a nominal depth of 700 m.

Figure 6 is a histogram of total durations. Excluding PL12 because it had such a different history, the average duration for all the Gulf Stream floats is 1.45 years (1.65 if floats with reused batteries aren't included). The average duration of the 13 floats reported here (without PL12) is 2.8 years, which could be lower than the actual value, since five floats (see plus signs on Figure 6) appeared to still be in operation when the last ALS array was retrieved. Of these, four were deep and one shallow, which agrees with earlier observations that the 700-meter floats were more prone to sudden failure (Kennelly and McKee, 1984). In addition, five other floats were fading at the end of their data records. For at least four of these, moving out of range appears to be a sufficient cause of the decreased signal power. GU120, on the other hand, looks like its lithium batteries, reused from an earlier experiment, were giving out. Alkaline-powered floats tend to die abruptly, as GU113 and GU116 did (Kennelly and McKee, 1984).

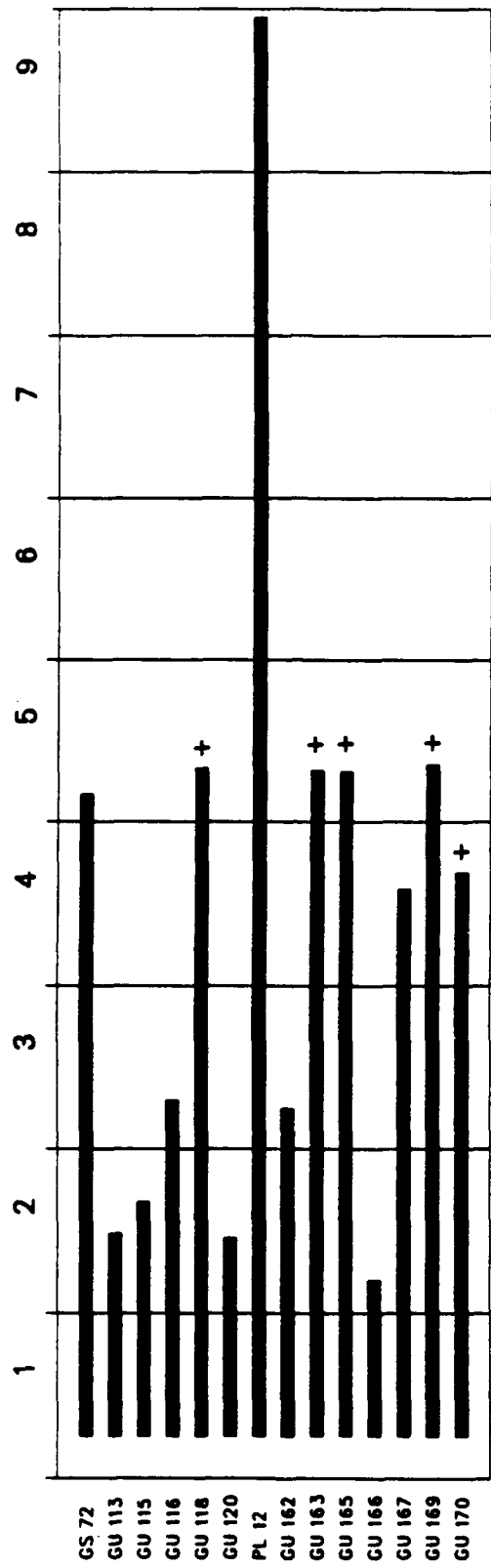


Figure 6: Total duration of floats covered in this report.

2 Instrumentation

SOFAR floats are freely drifting, neutrally-buoyant subsurface instruments. Every eight hours each instrument transmits a low-frequency acoustic signal which, under optimal conditions, can be heard by an ALS at distances on the order of 2500 km. Forty-eight-hour averages of pressure and temperature are transmitted on alternate days. The ALSs are vertical arrays of hydrophones deployed on a subsurface mooring. A microprocessor-controlled detection system records the times of arrival of the four strongest float signals during each ten-minute interval. During the GUSREX experiment, the ALSs were renewed annually.

3 Processing

In general, the floats discussed in this report were tracked using the methods which are standard at W.H.O.I. (Owens and McKee, 1989). Because of the long duration of some of these floats, special care had to be taken in calculating clock drifts. The data after May 1982 were the first floats tracked at W.H.O.I. The earlier data had initially been tracked at the University of Rhode Island (see Spain *et al.*, 1980, for technique), but were later retracked at W.H.O.I. for consistency.

Analysis on Site L floats (Price *et al.*, 1987, p.13) suggests that the precision of float positions is approximately 2 km.

Temperatures or pressures that drifted outside the range of the sensors have been deleted, as have values that were not associated with a position.

Trajectories having gaps greater than ten days were broken into subfiles and labelled A, B, C, etc. This was necessary for all floats being tracked in May 1983, since the first setting ALSs ran out of tape before the next ALSs could be deployed. Gaps of less than ten days in position, temperature, or pressure were

linearly interpolated to the eight-hour interval. See Figures 7 and 8 for times covered by each float. See Figures 9 and 10 for distance traveled by each float, by segment.

These interpolated series were then filtered using a seven point, one-day-half-width Gaussian filter. Finally, a cubic spline was fitted to the filtered positions to produce one location per day, and east and north components of velocity were calculated.

4 General Information for Individual Float Plots

A trajectory plot and a group of time series plots are presented for each float in Appendix A. The order of the time series plots is: "stick diagram" ($u-v$ vectors), u and v velocity component overplot, and temperature and pressure overplot (where data are available). These plots were created with the objective of presenting the data for a particular float; thus the scales vary between floats. The time axis is consistent throughout, with 200 days per page. The time axis is annotated with the last four digits of the Julian day and with the calendar date. Data points are plotted at daily intervals.

The stick plots show a velocity vector for each day, with the stick length proportional to the speed in centimeters per second. North is toward the top of the page. The separate components on the u and v time series are plotted at the same scale.

Temperature and pressure are overplotted, temperature on a centigrade scale marked on the lefthand axis, pressure in decibars on the righthand axis. Pressure is plotted with deeper values at the bottom of the scale.

A trajectory for each float is plotted on a Mercator projection. Open circles denote the first float position, small dots mark the daily positions, large dots every

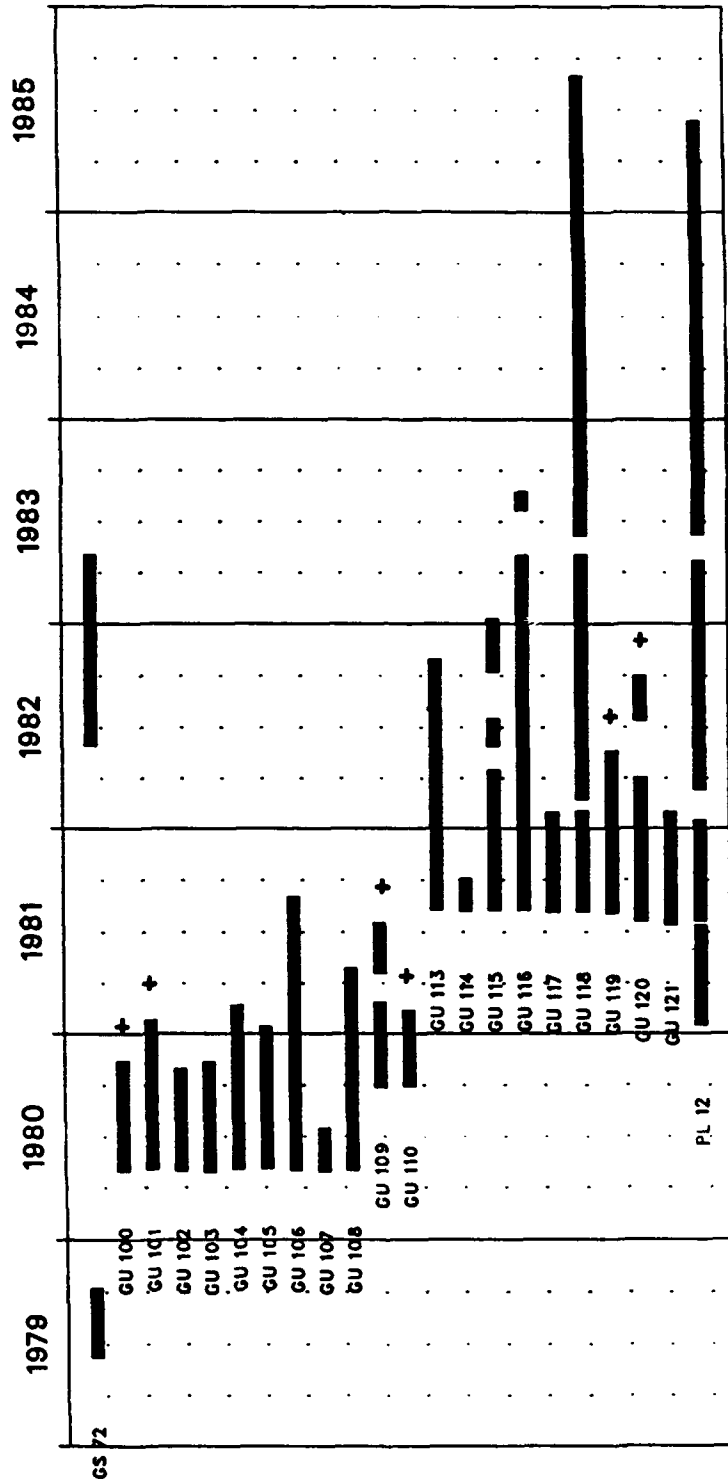


Figure 7: Float duration for all 700-meter GUSREX floats as a time line. + means reused from previous experiment.

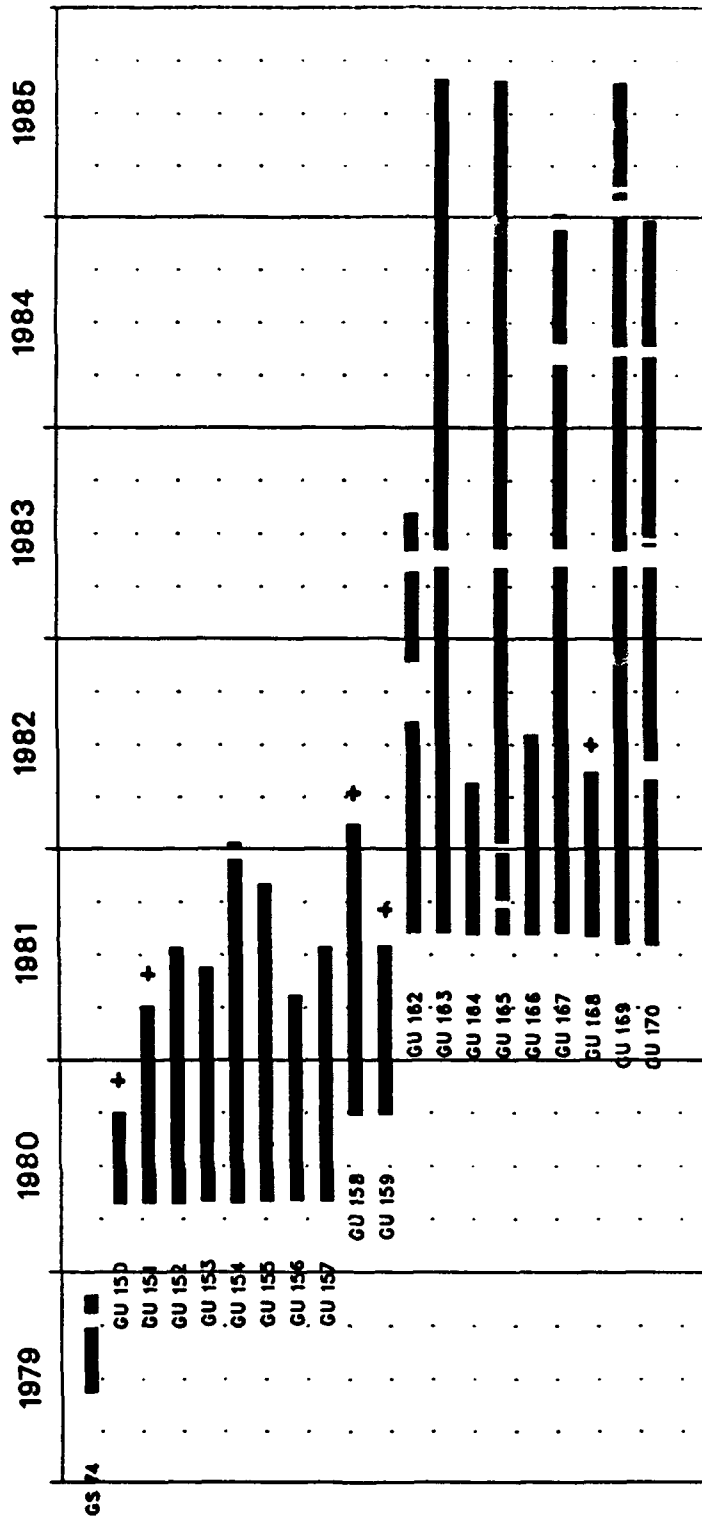


Figure 8: Float duration for all 2000-meter GUSREX floats as a time line. + means reused from previous experiment.

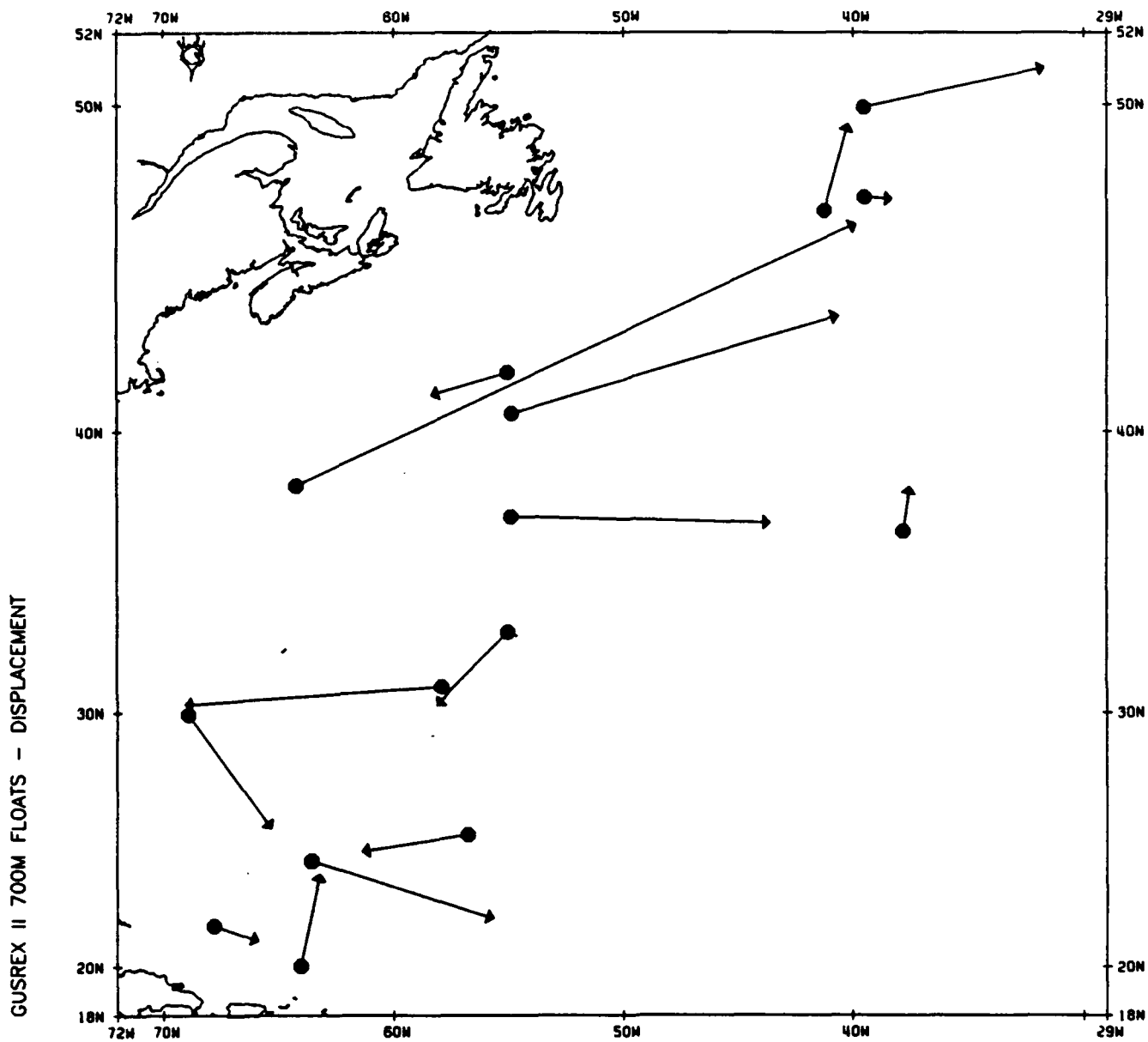
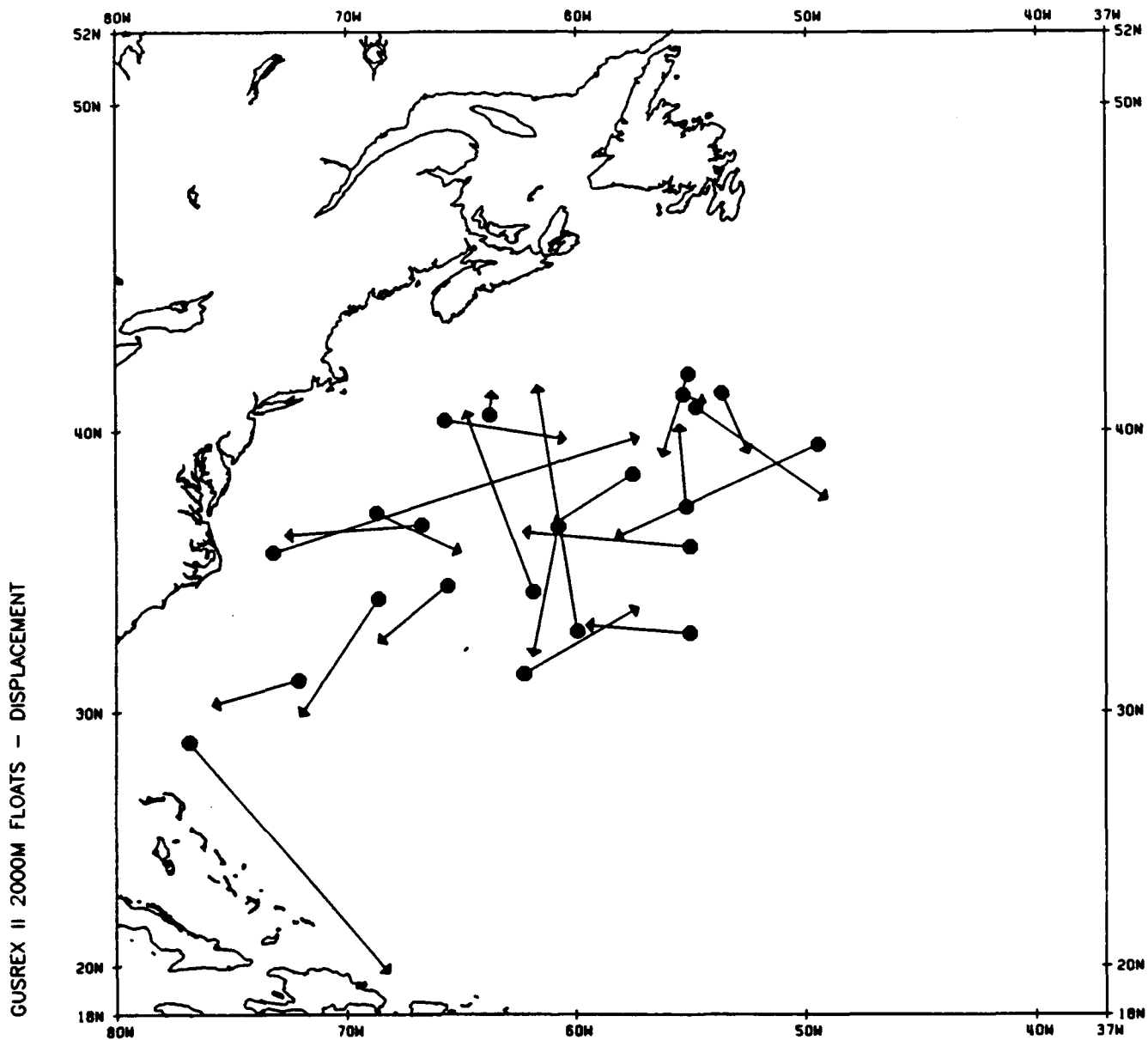


Figure 9: Total displacement of 700-meter floats covered in this report, by segment. Arrows mark final locations.



GUSREX II 2000M FLOATS - DISPLACEMENT

Figure 10: Total displacement of 2000-meter floats covered in this report, by segment. Arrows mark final locations.

tenth day, and every twentieth day is annotated with the last four digits of the Julian day. Refer to Appendix C to convert Julian day to calendar date.

Acknowledgements

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References

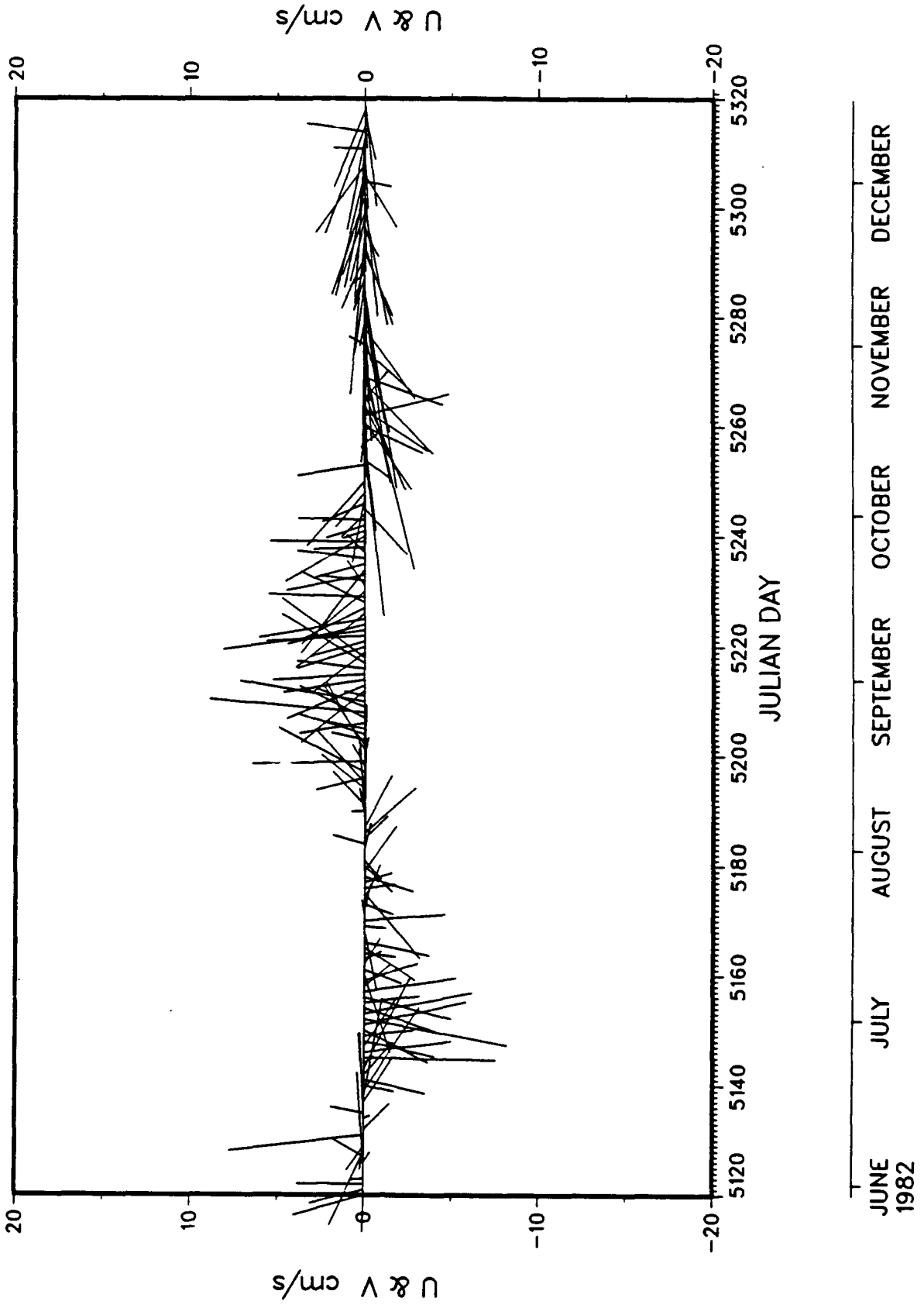
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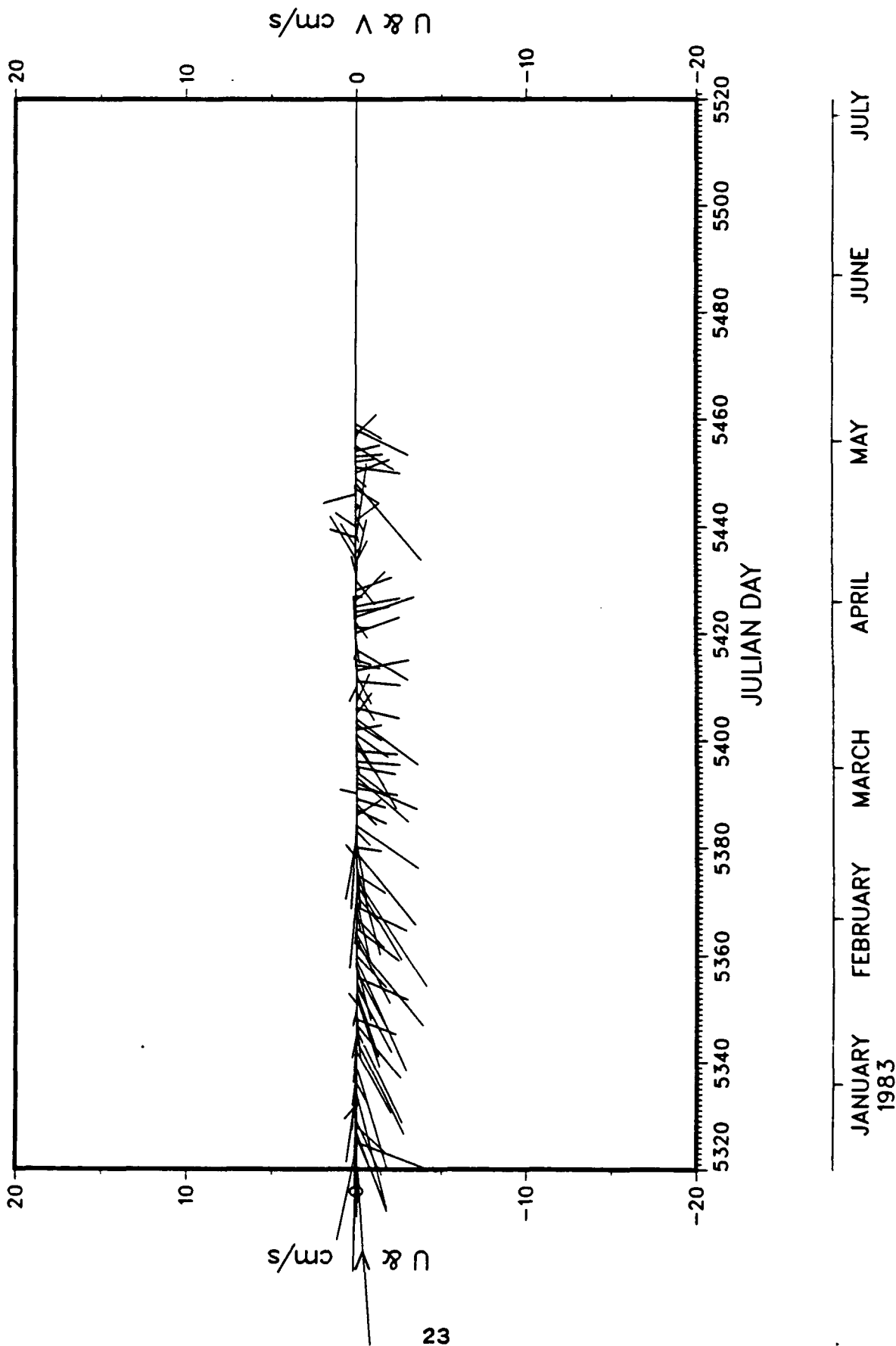
Worthington, L. V., 1976. On the North Atlantic circulation. *The Johns Hopkins Oceanographic Studies*, 6, 110 pp.

APPENDIX A: Individual Float Plots

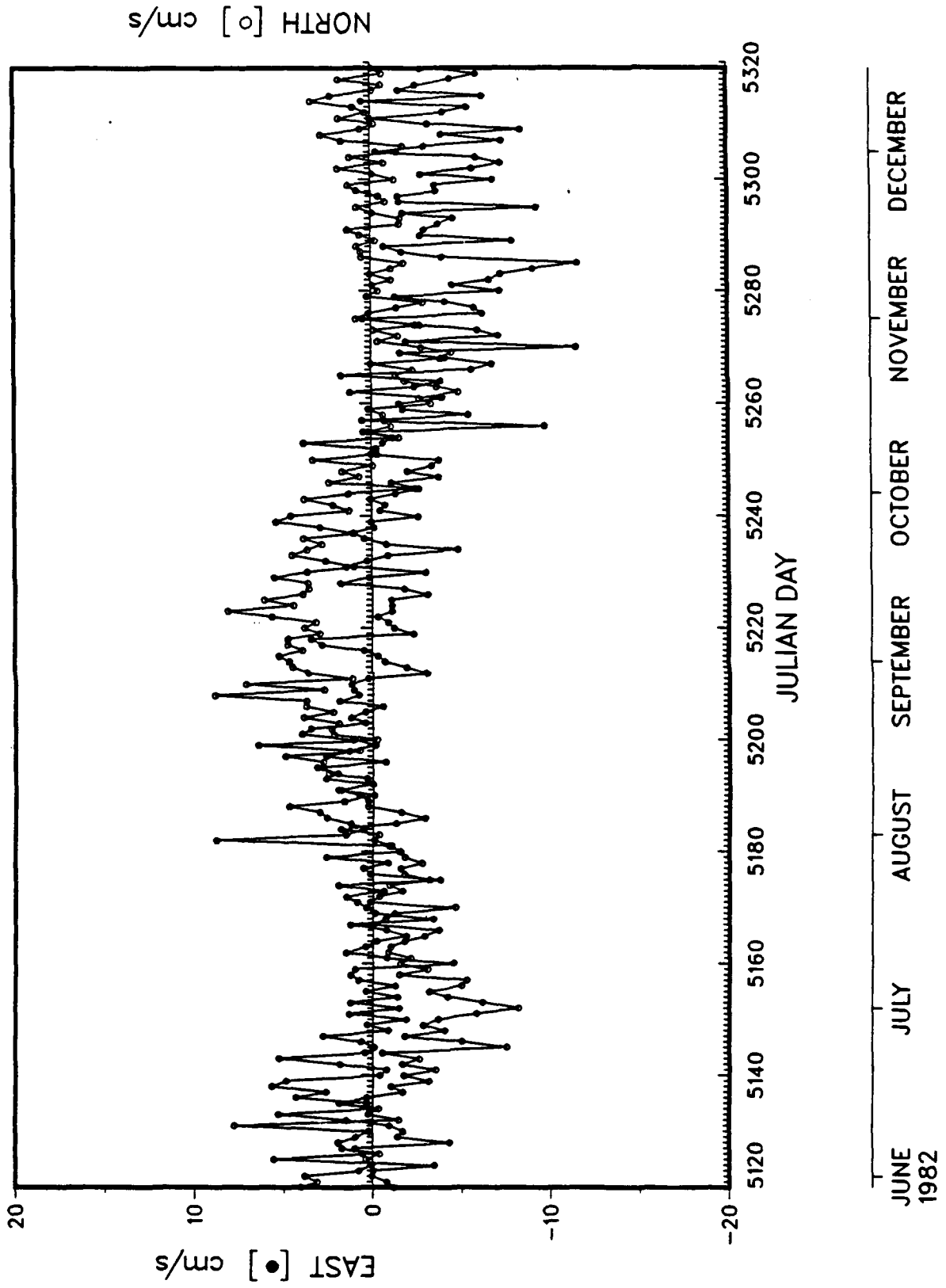
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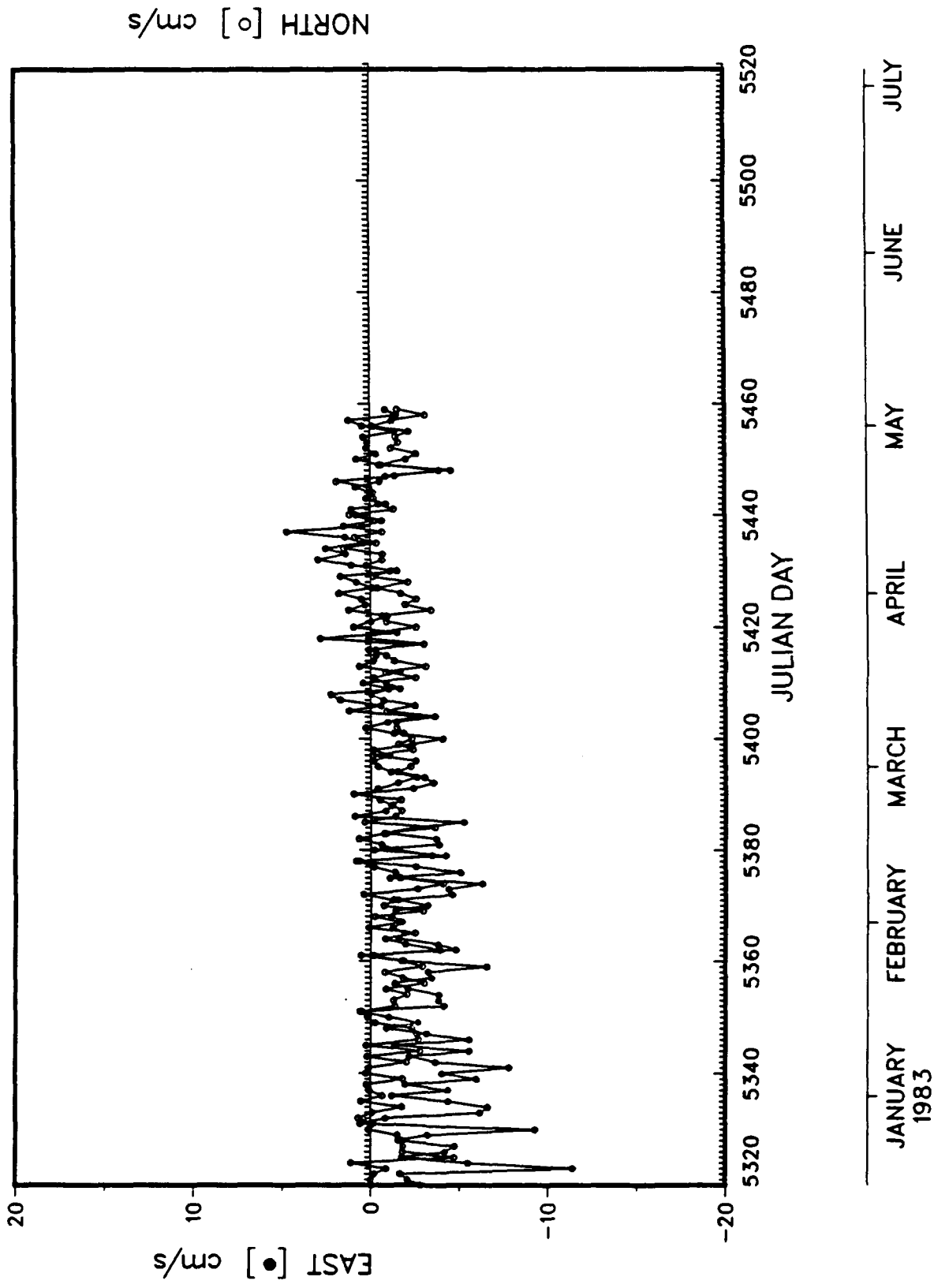
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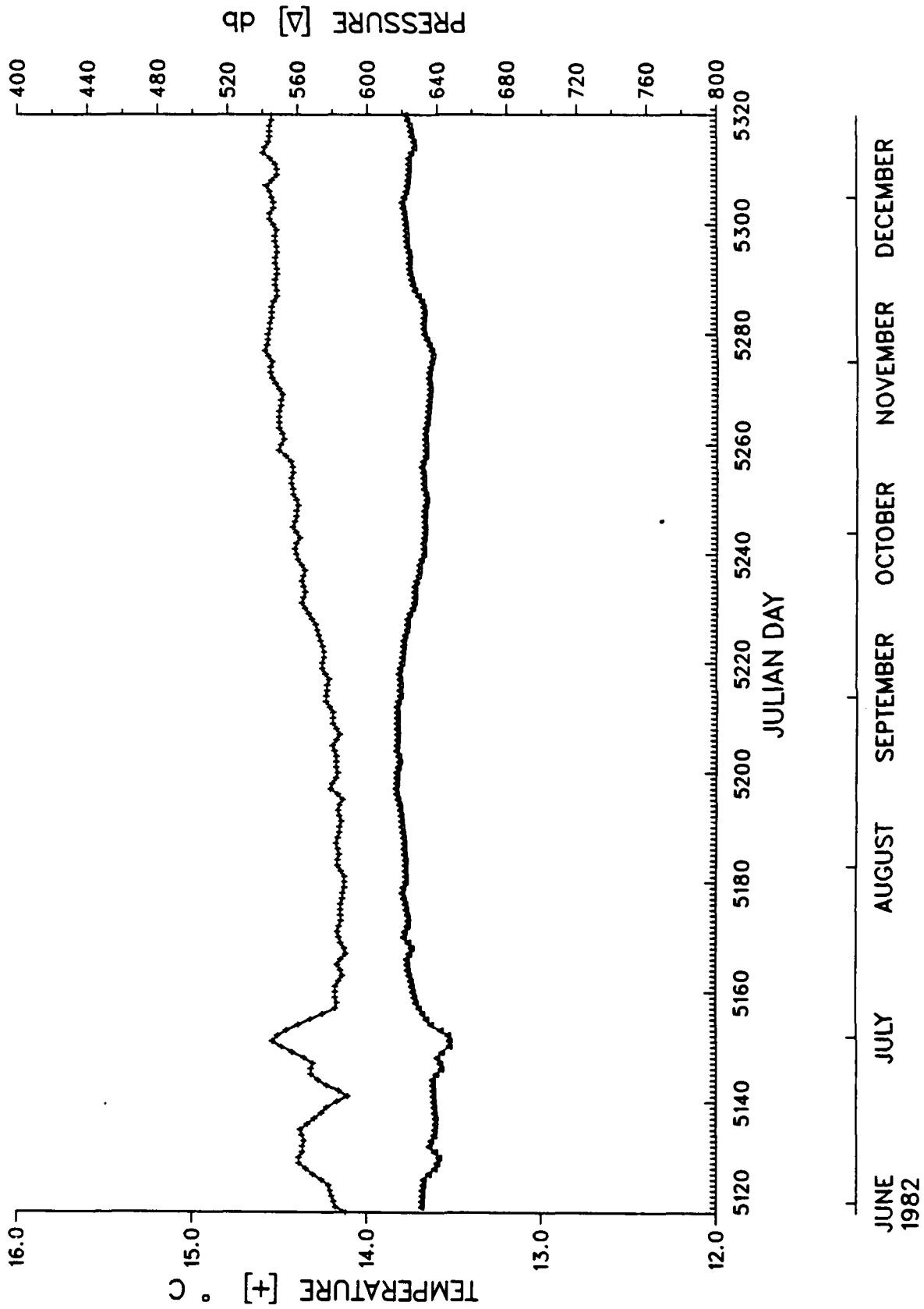
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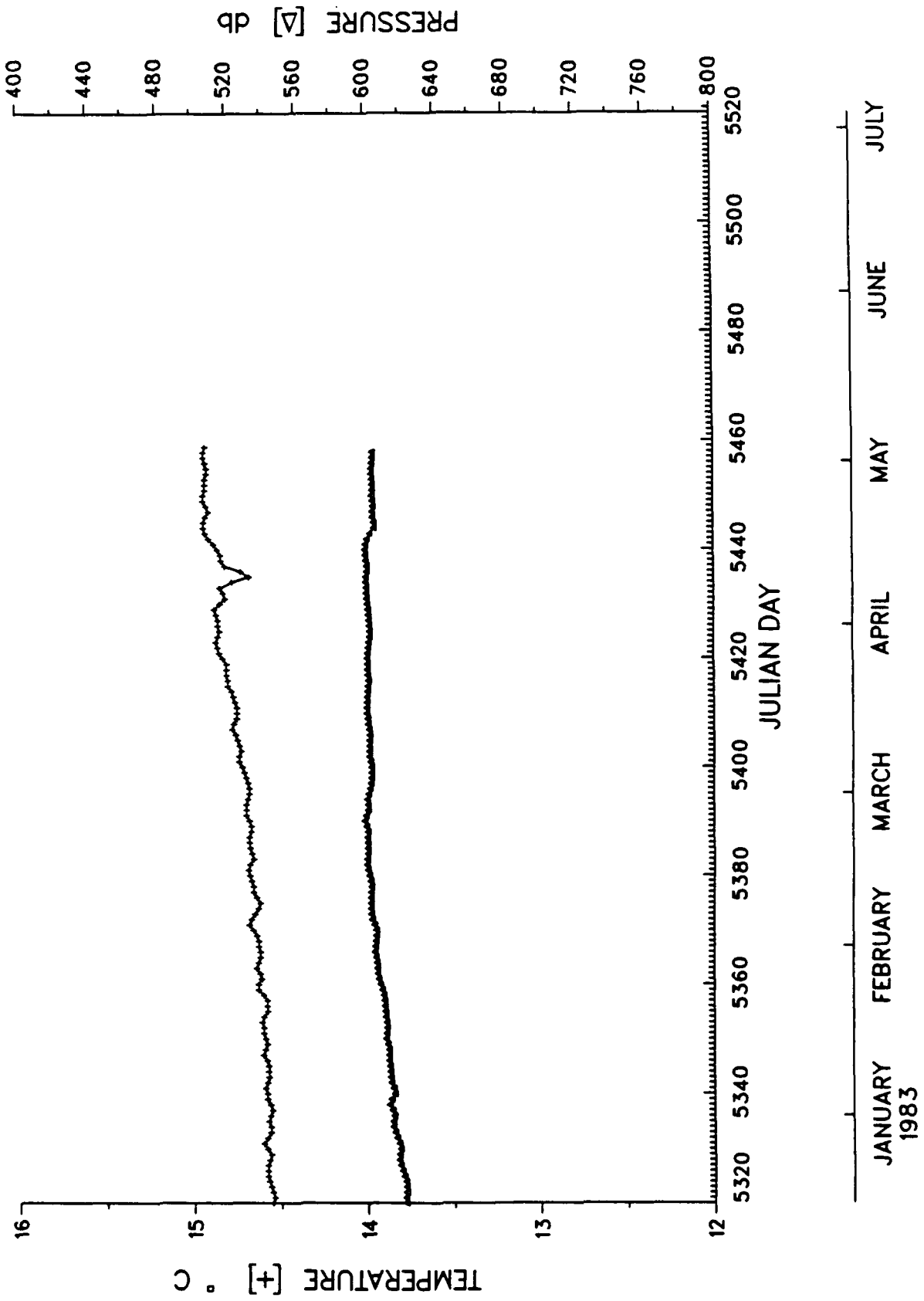
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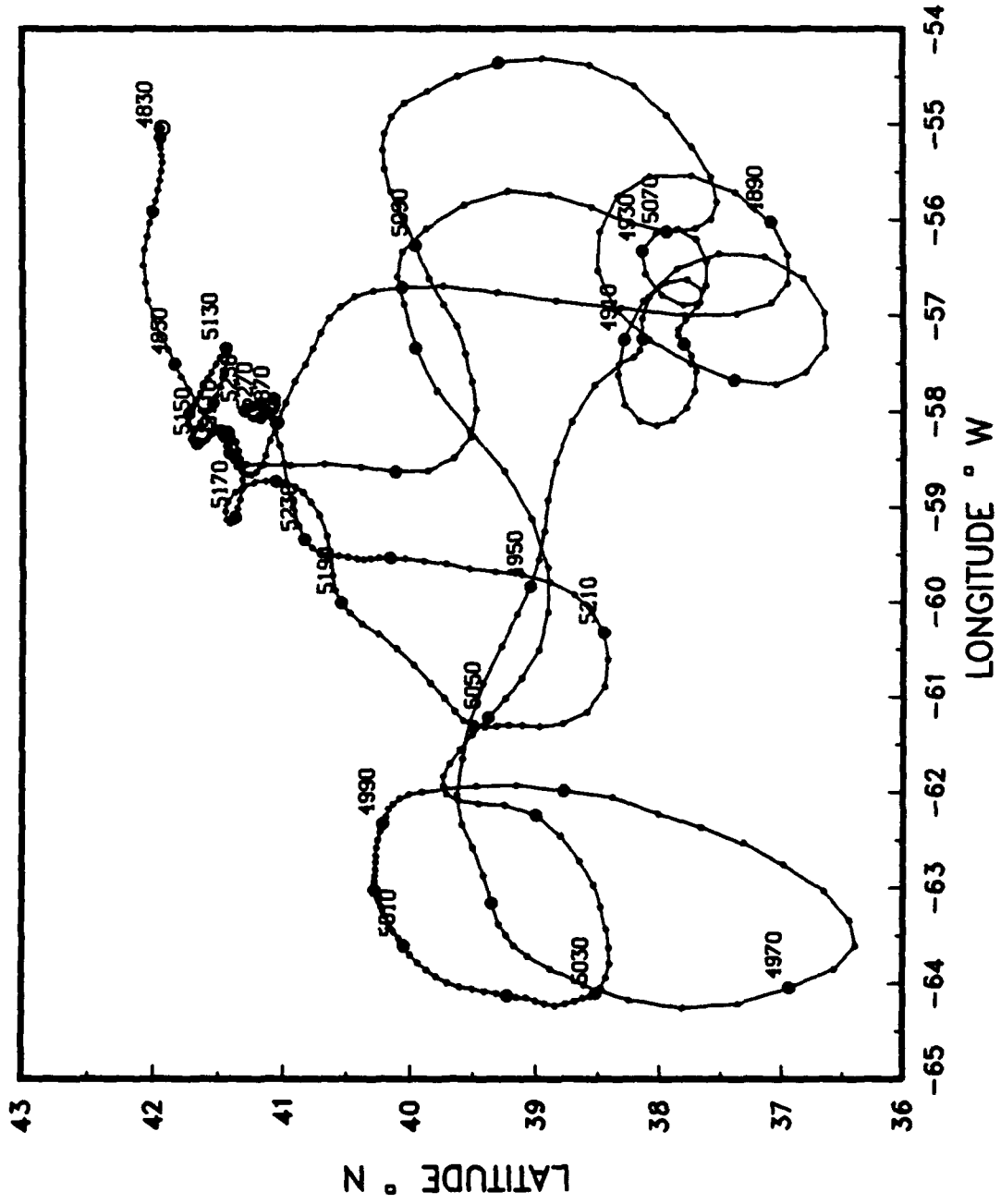


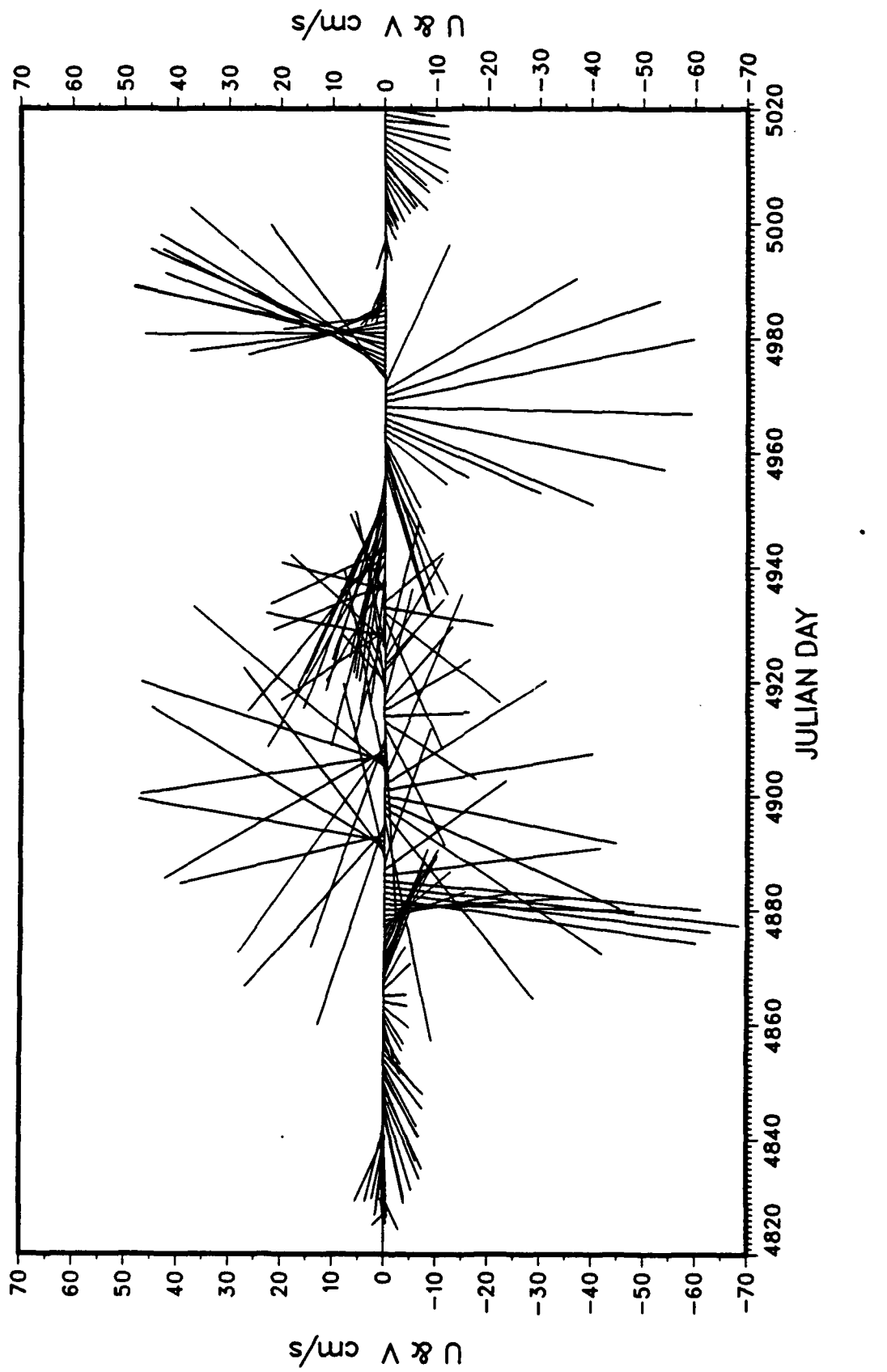
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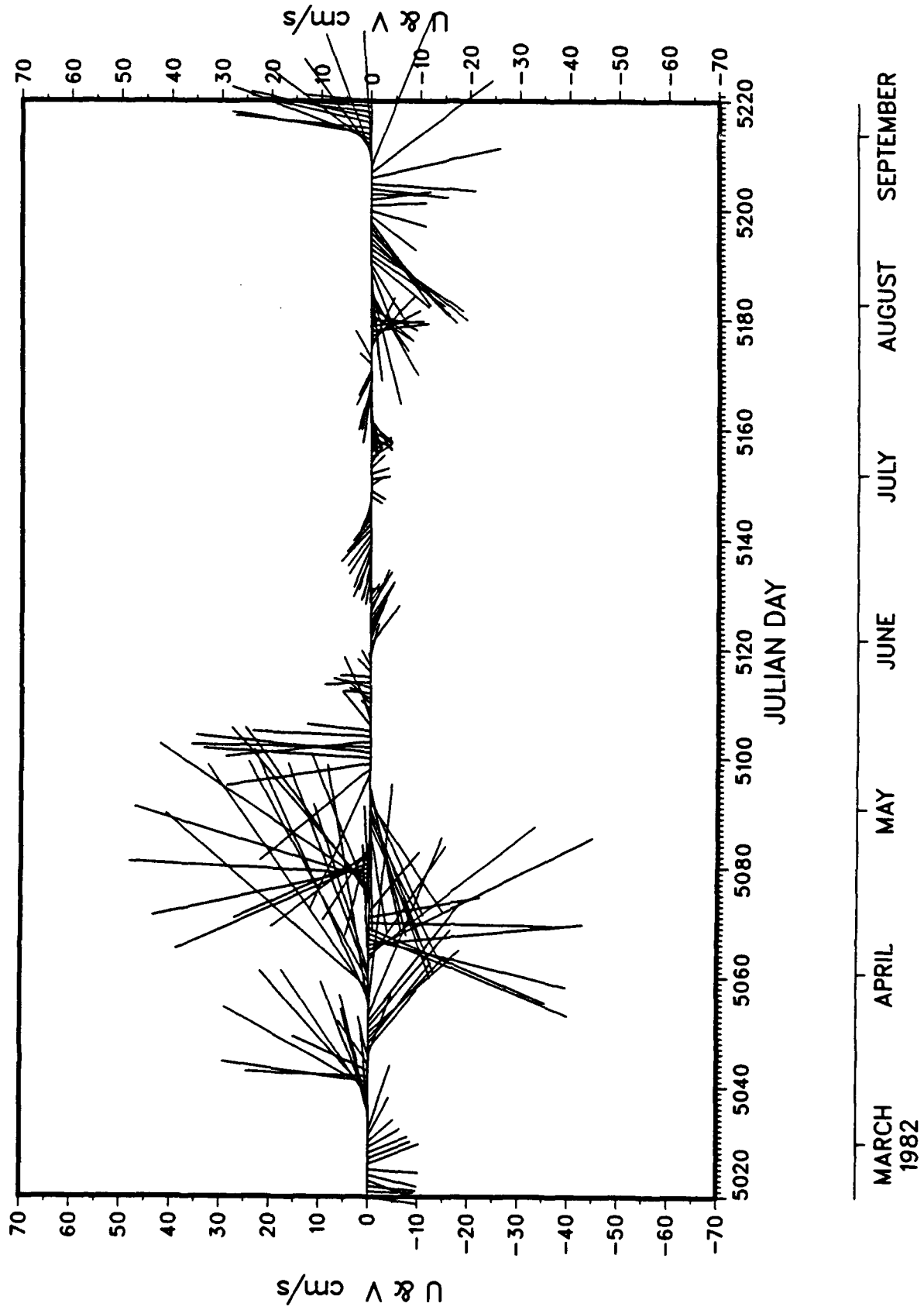
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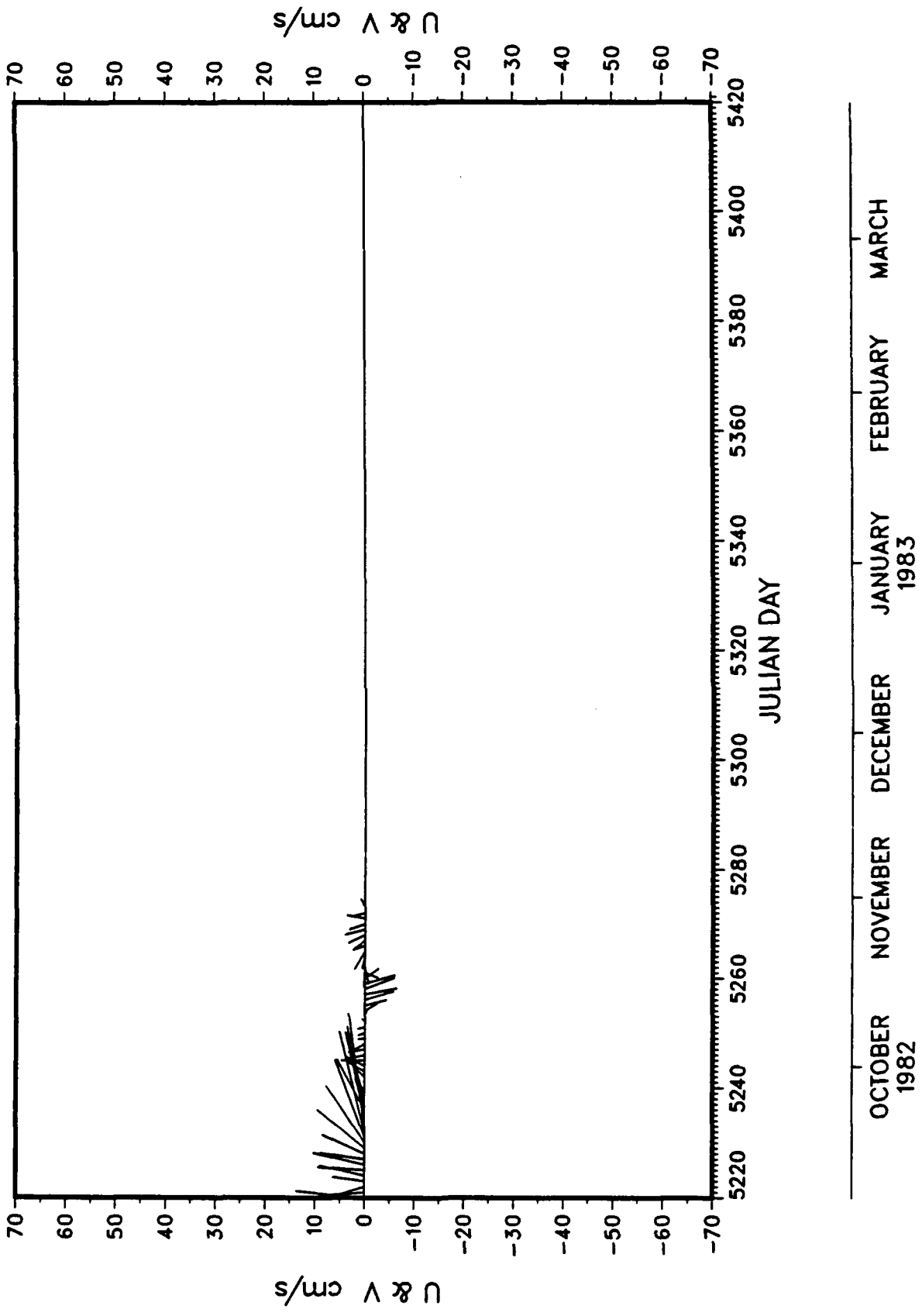


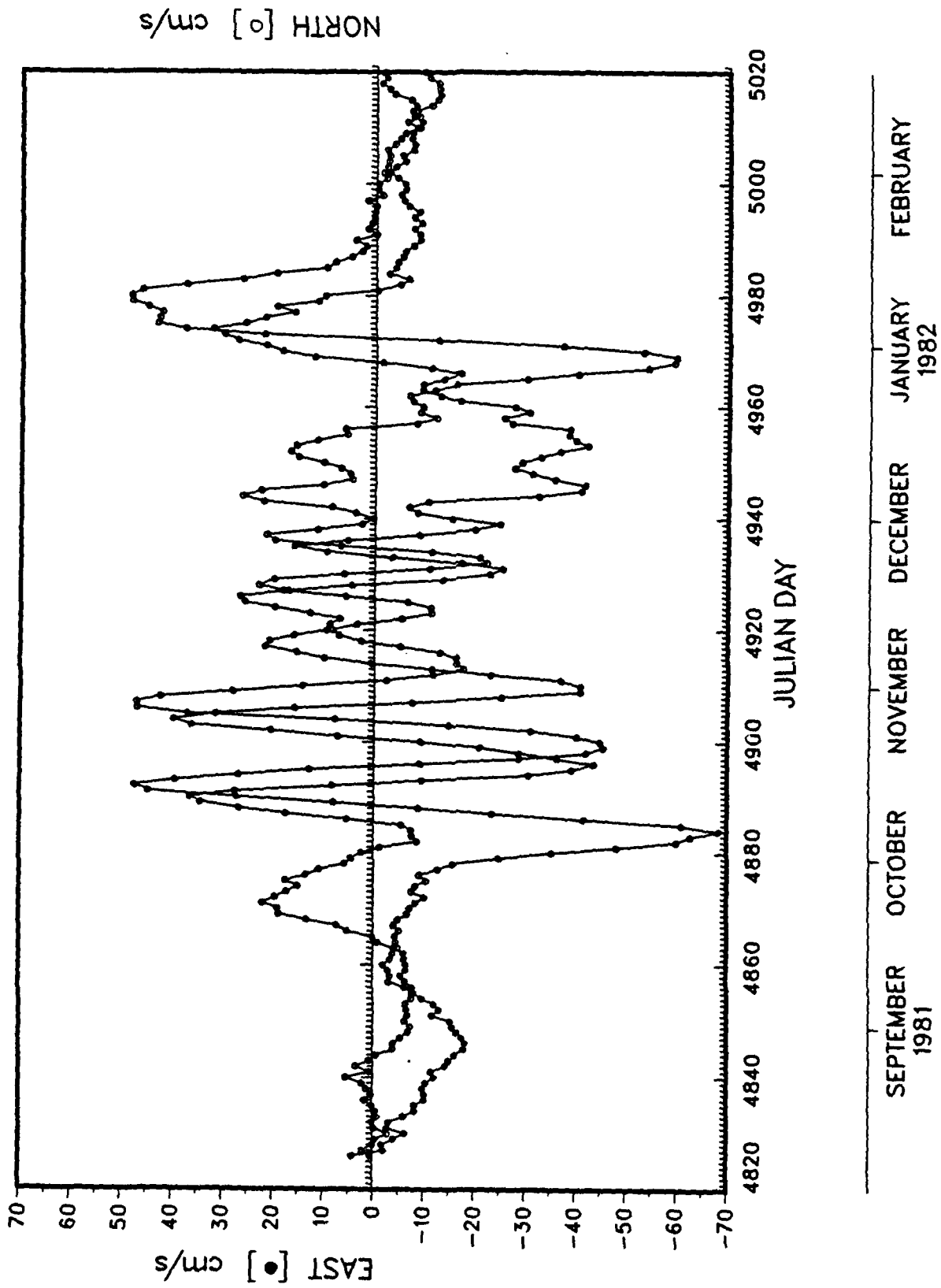


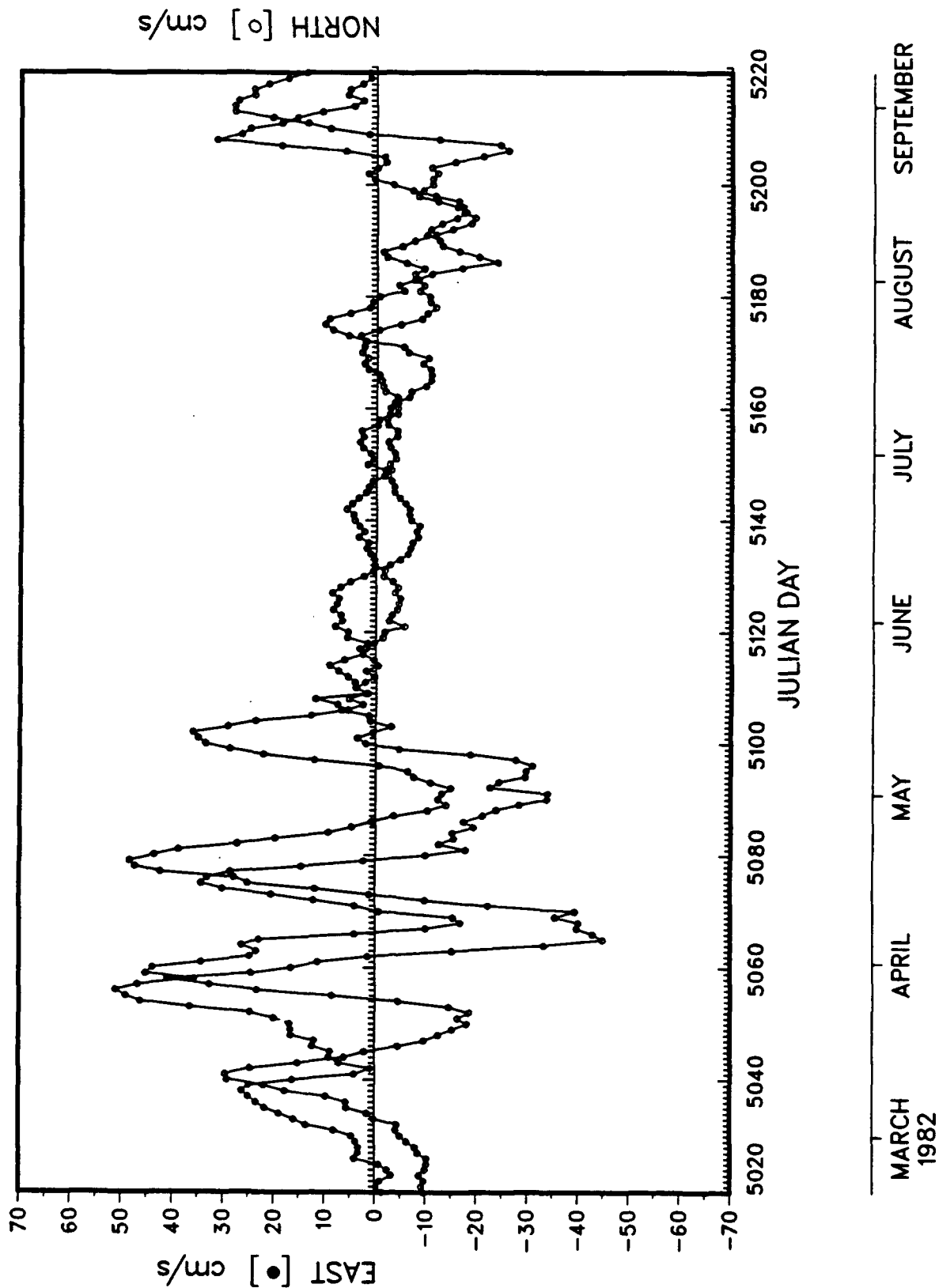


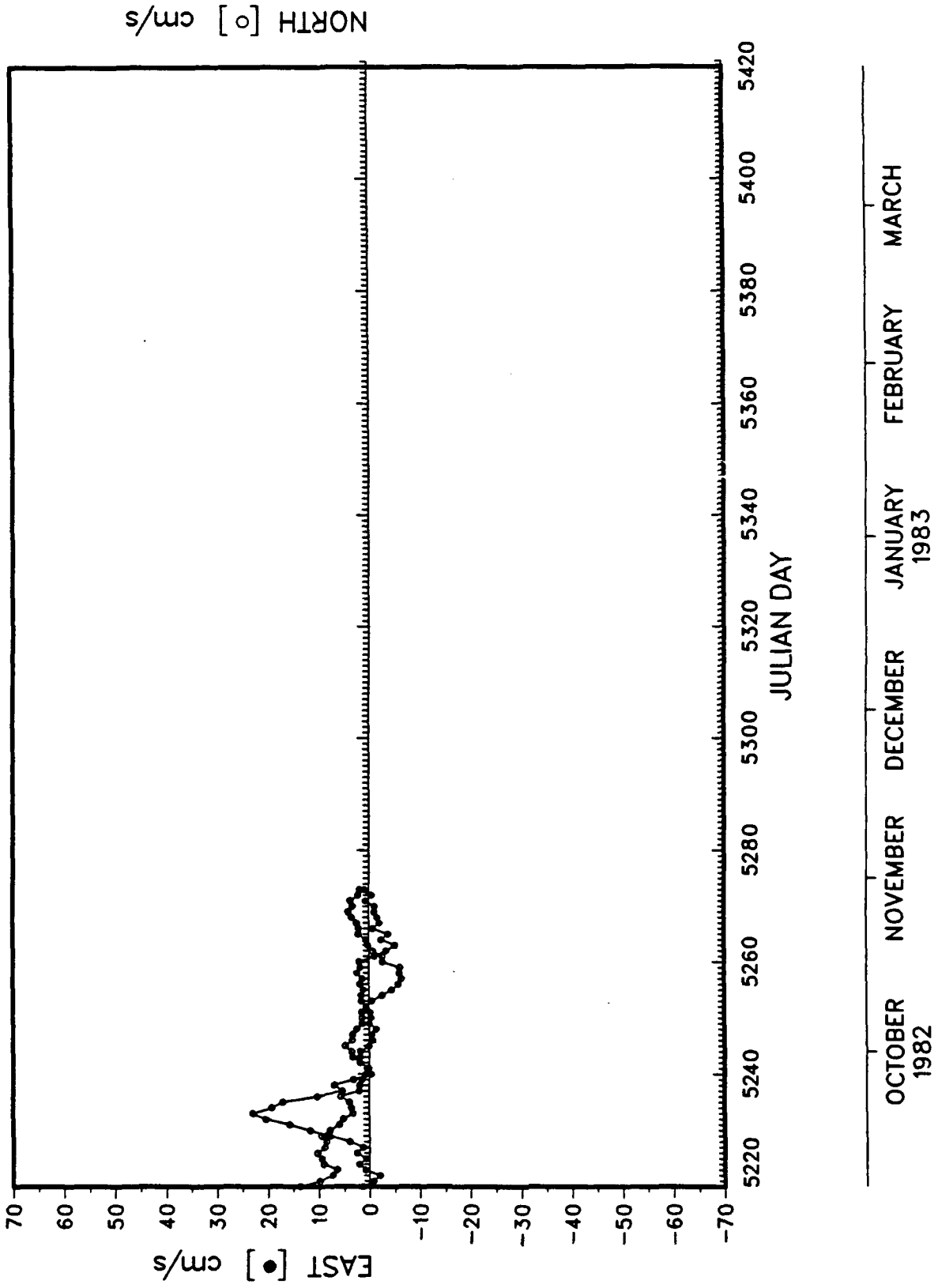
SEPTEMBER 1981 OCTOBER NOVEMBER DECEMBER JANUARY 1982 FEBRUARY



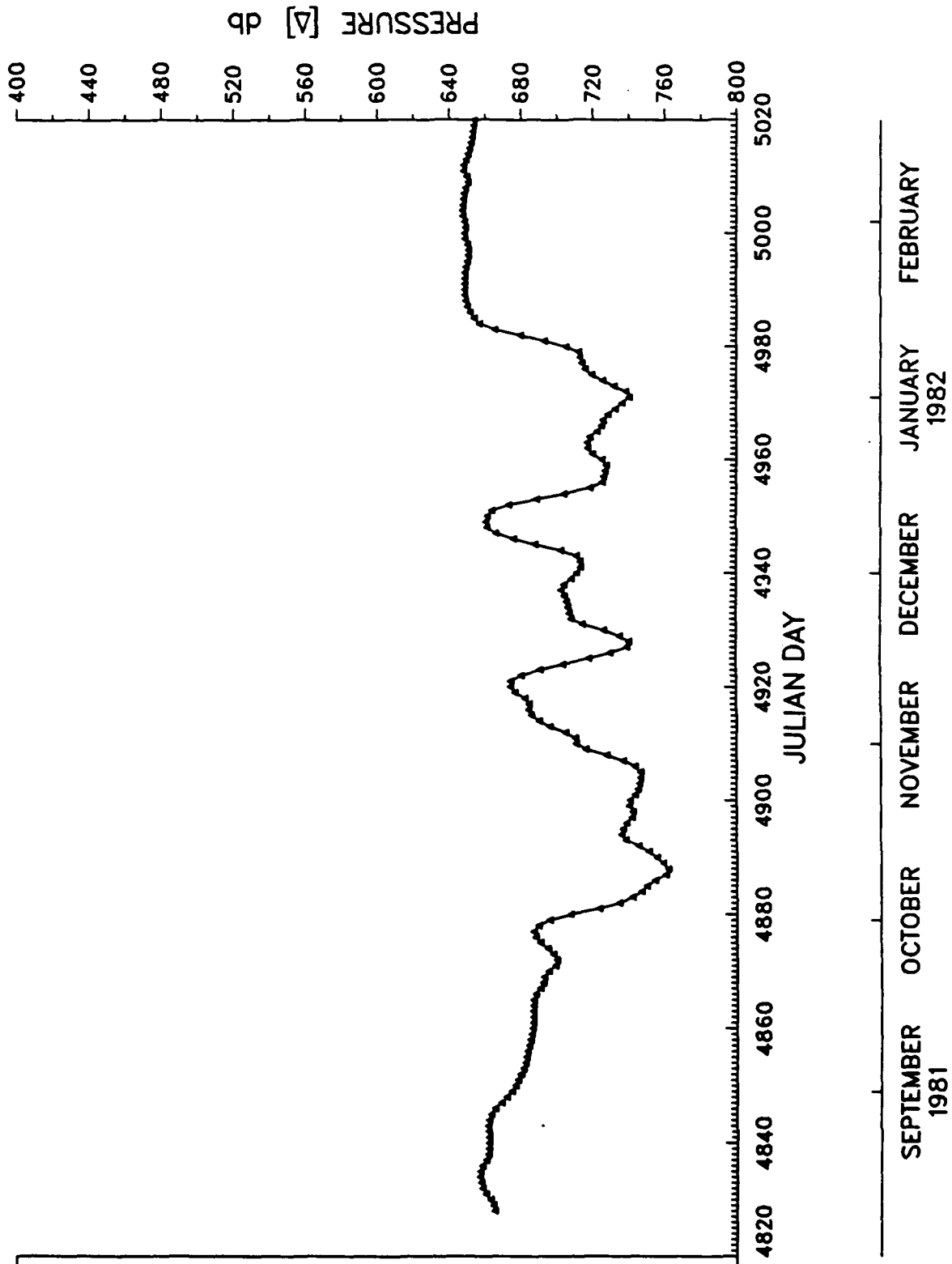


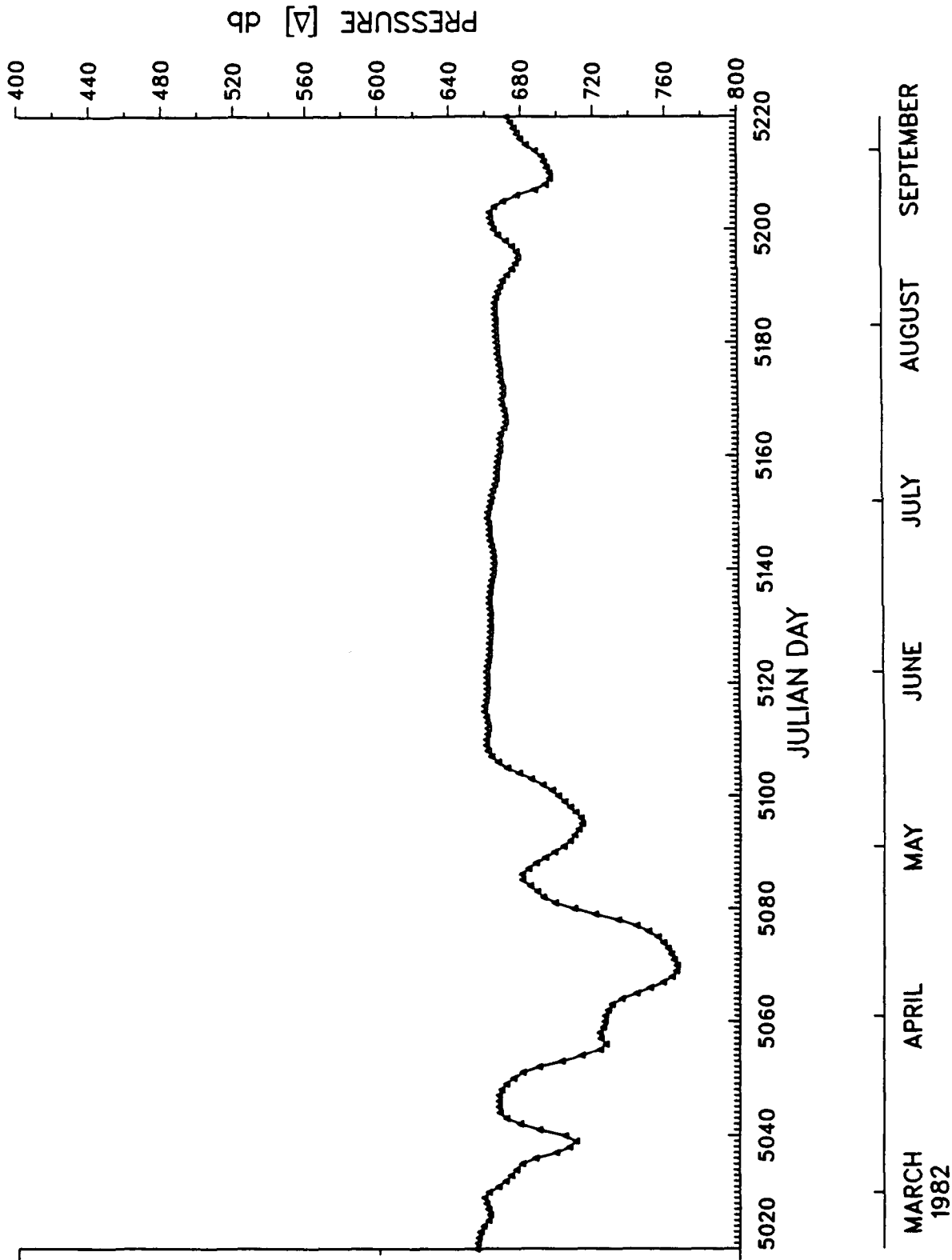




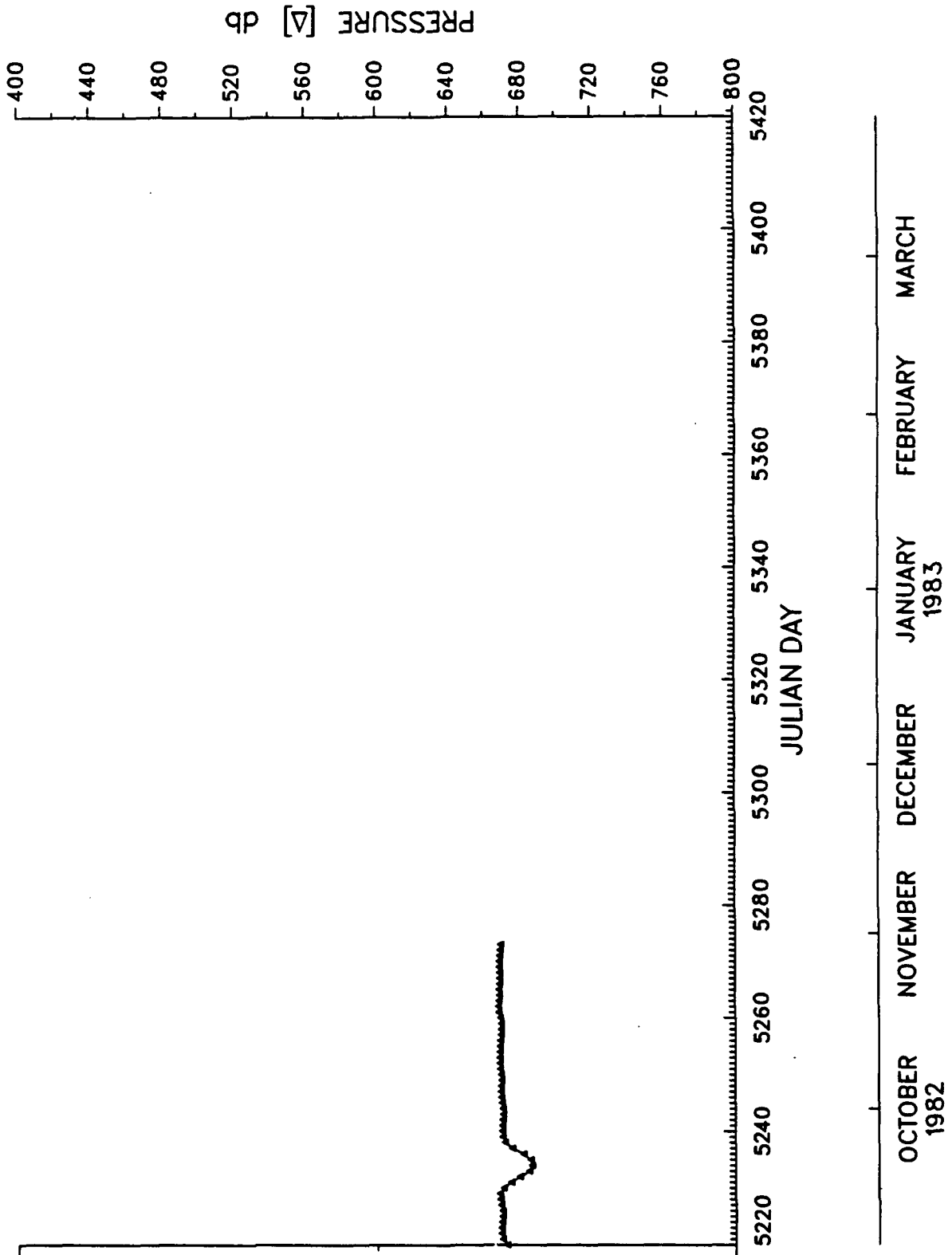


GUSREX 113

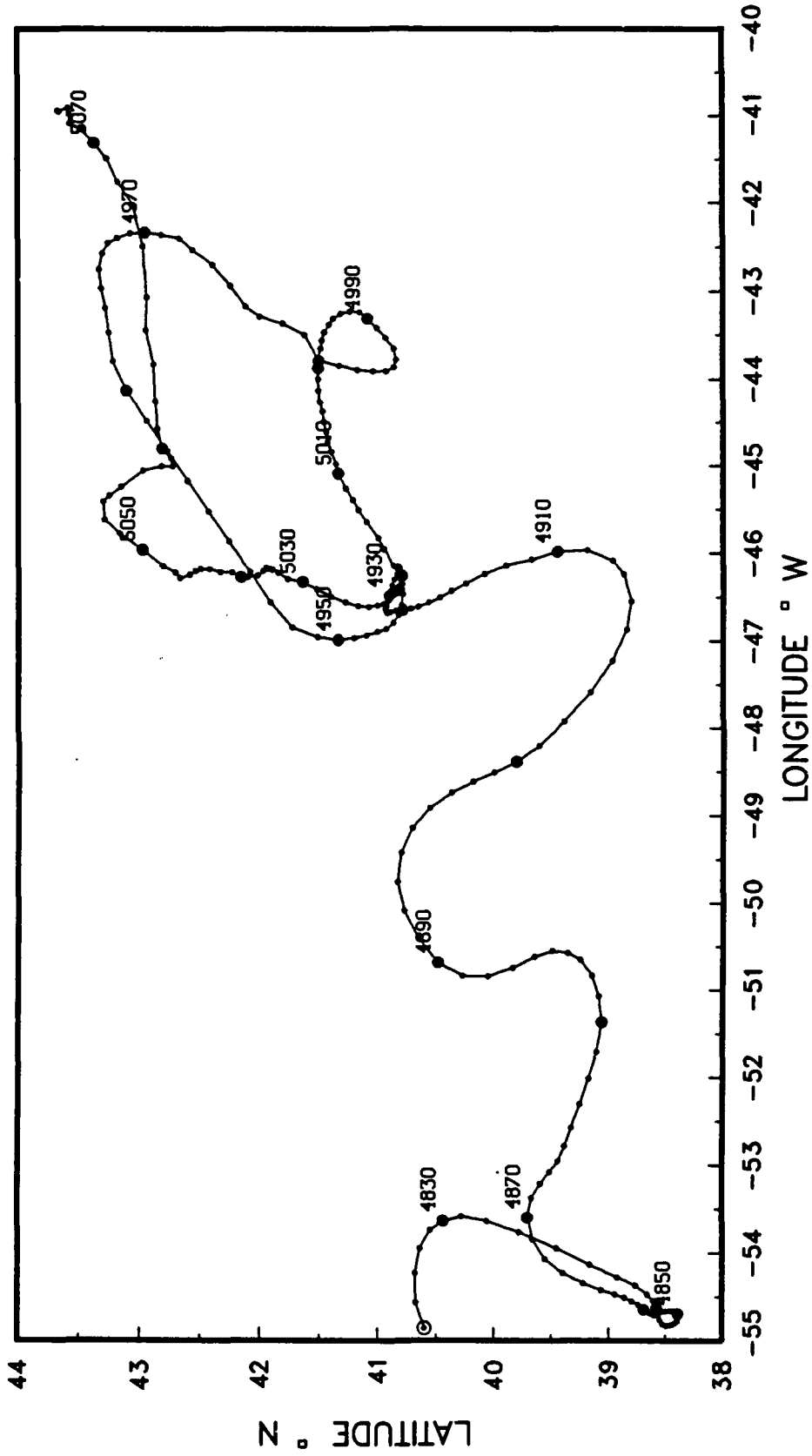




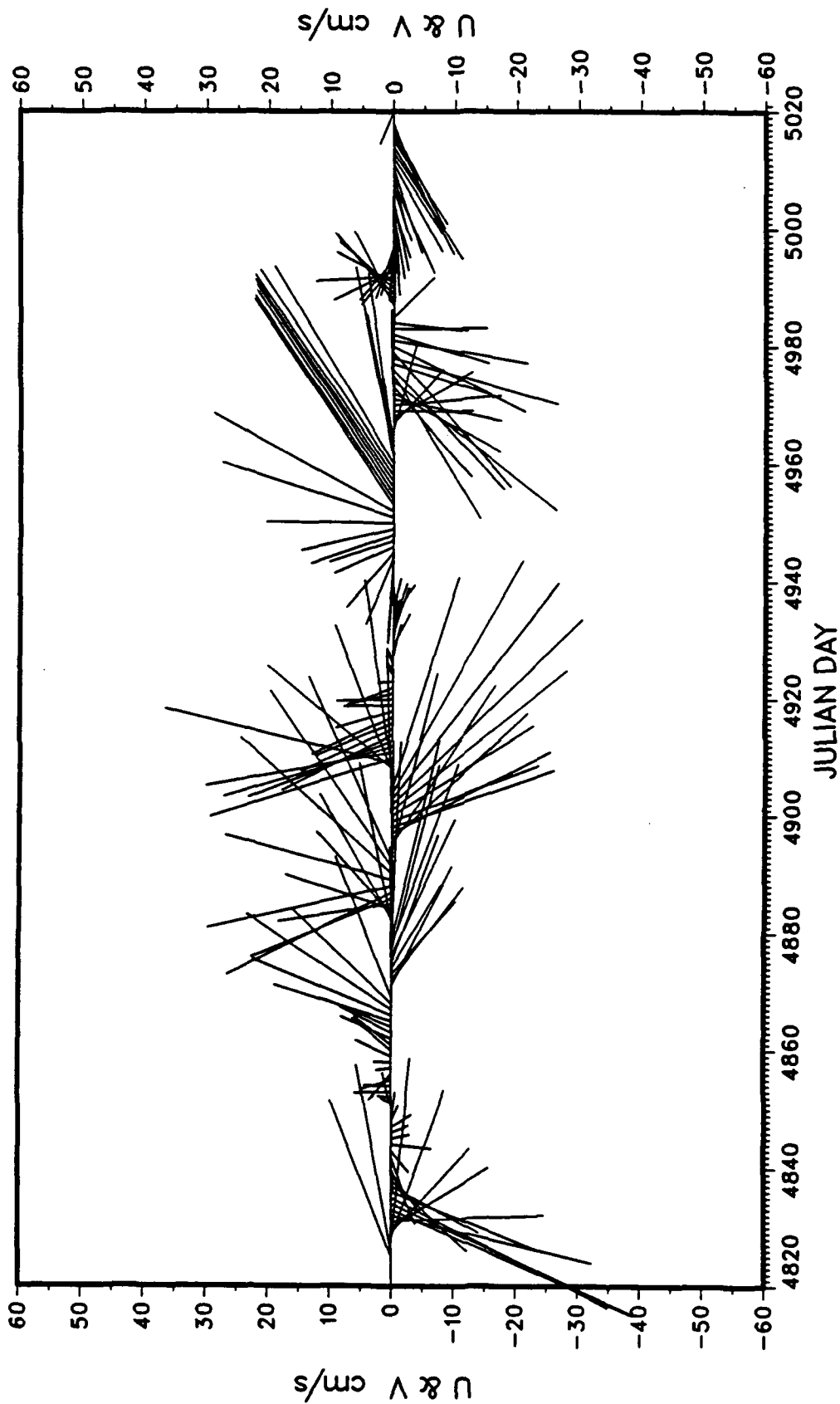
GUSREX 113



GUSREX 115A

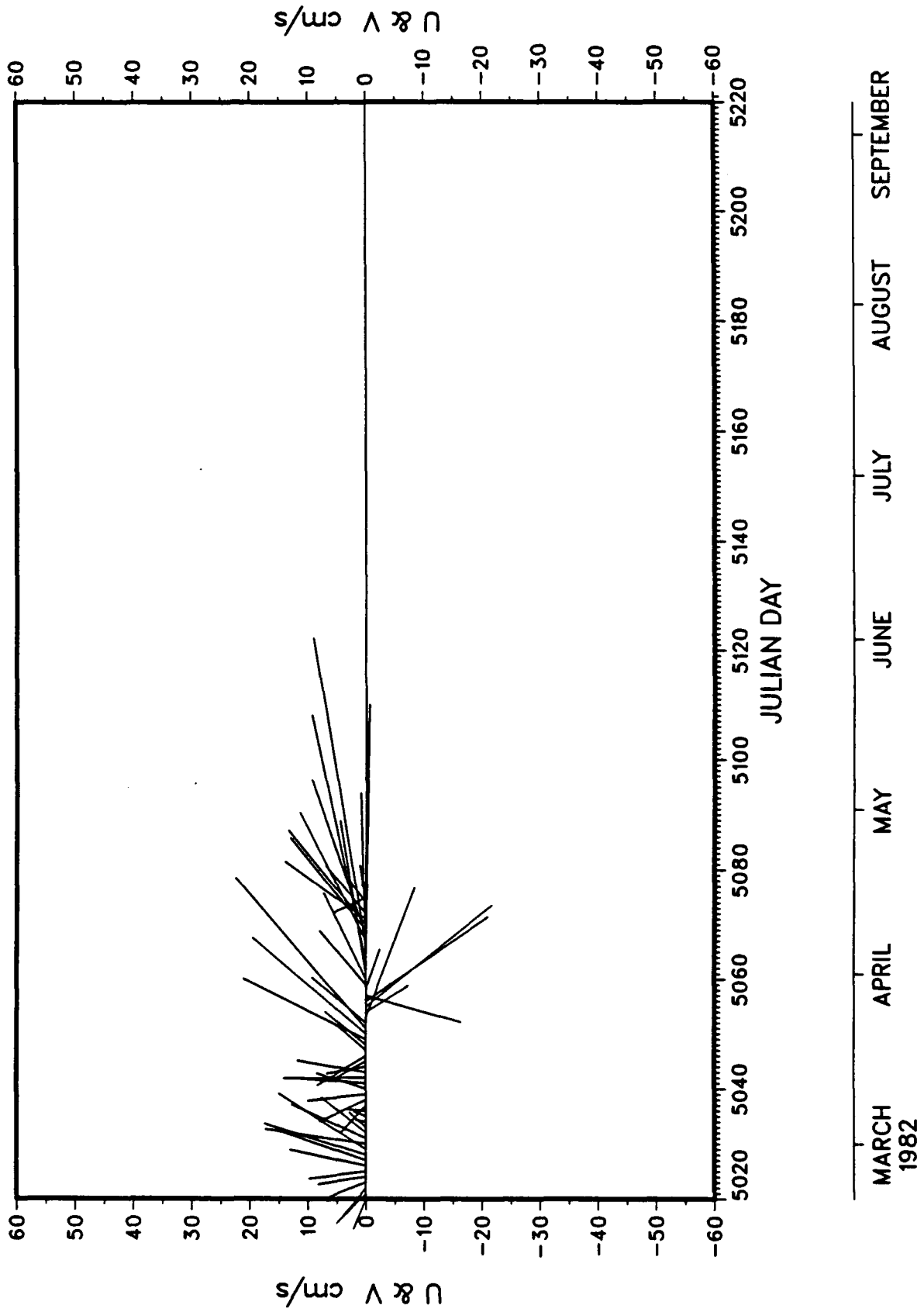


GUSREX 115A

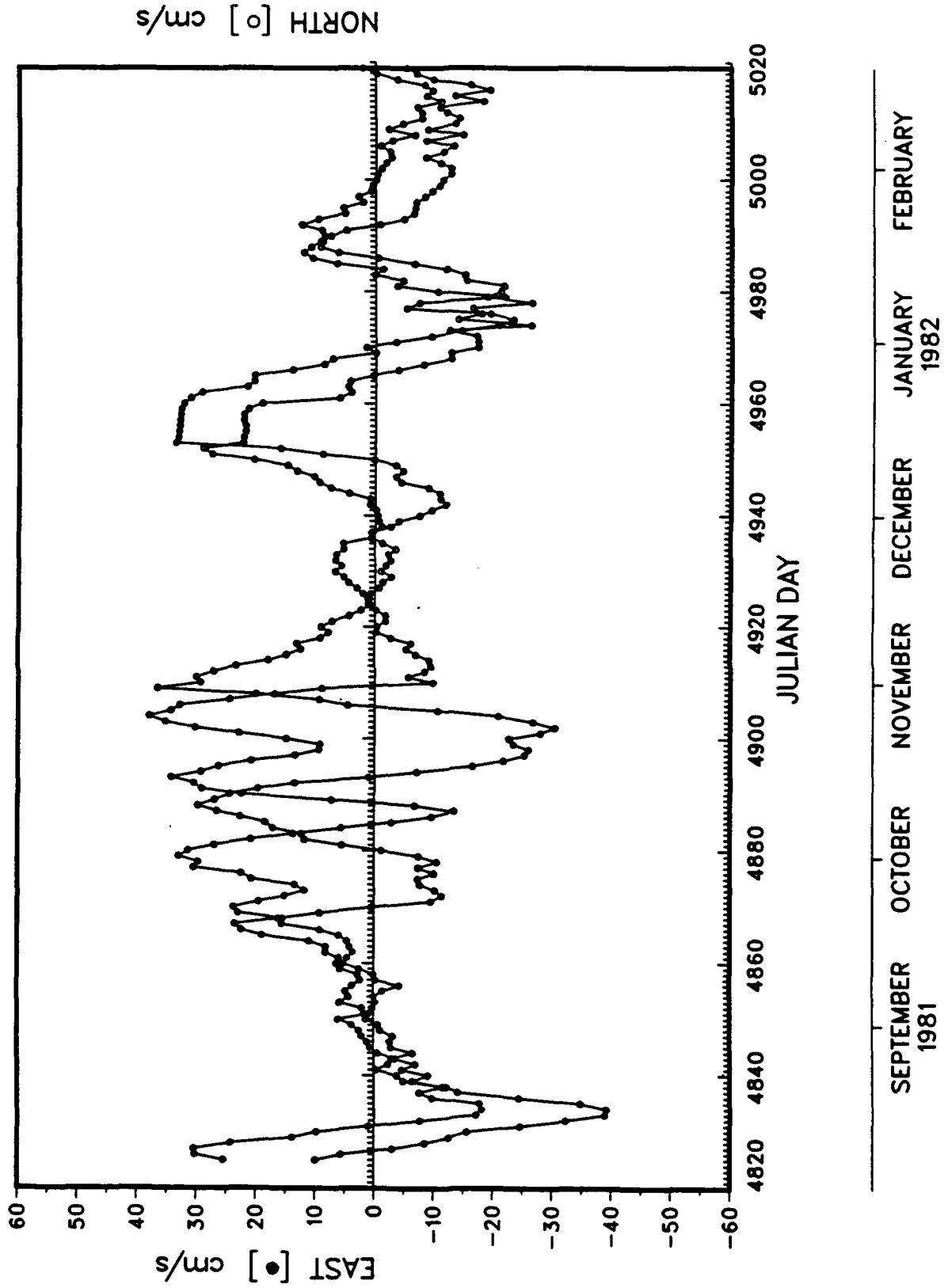


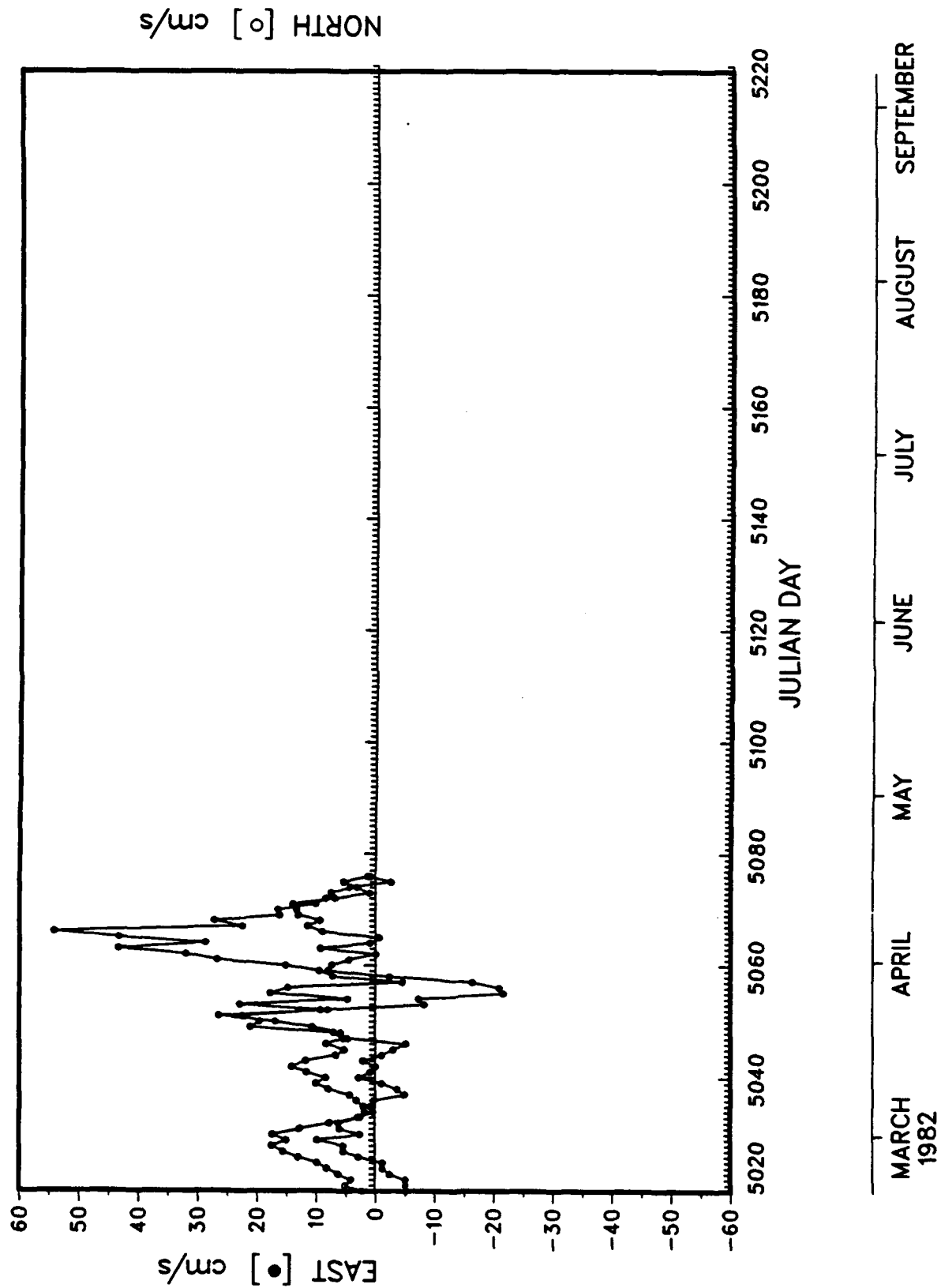
SEPTEMBER 1981 OCTOBER NOVEMBER DECEMBER JANUARY FEBRUARY 1982

GUSREX 115A

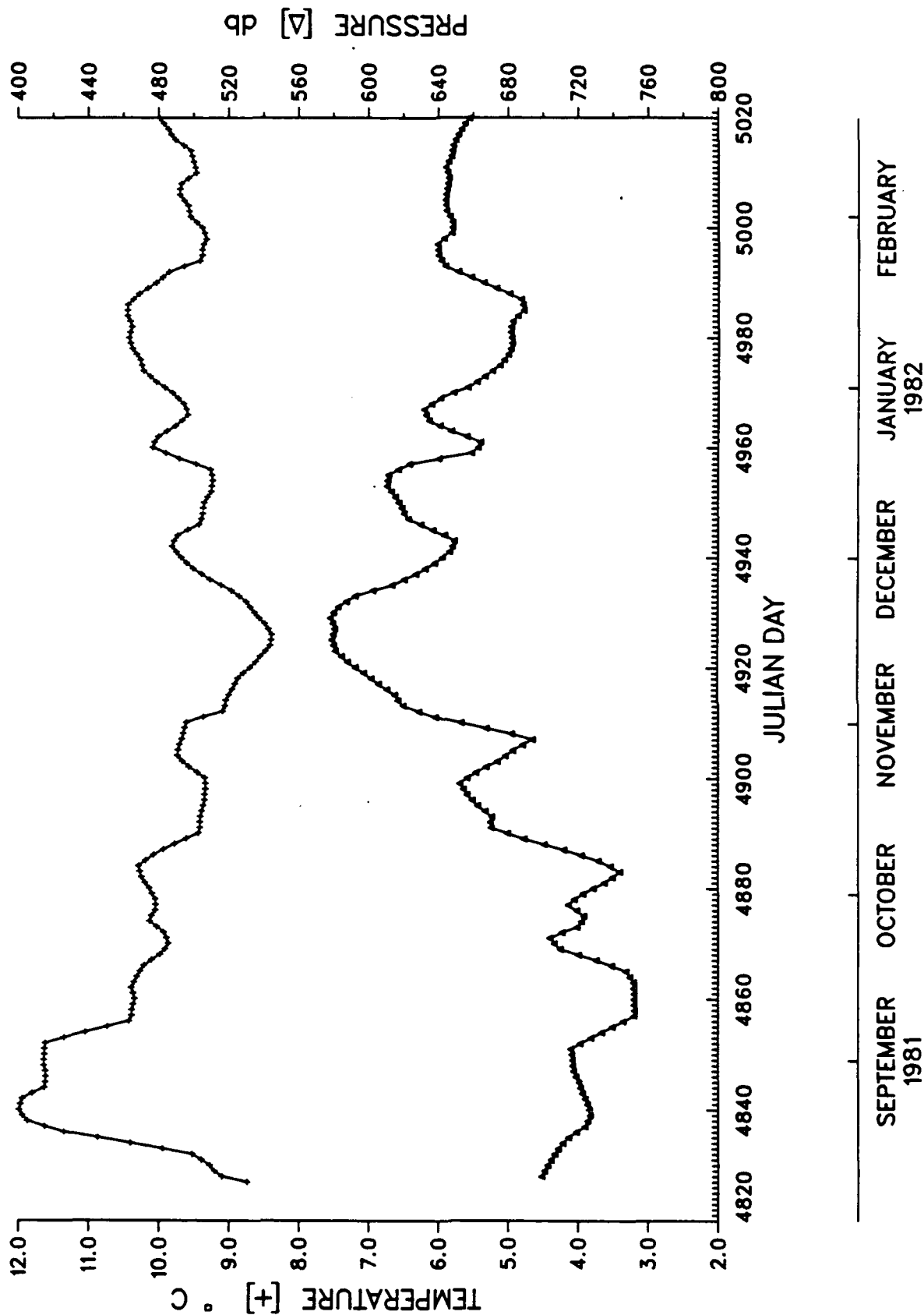


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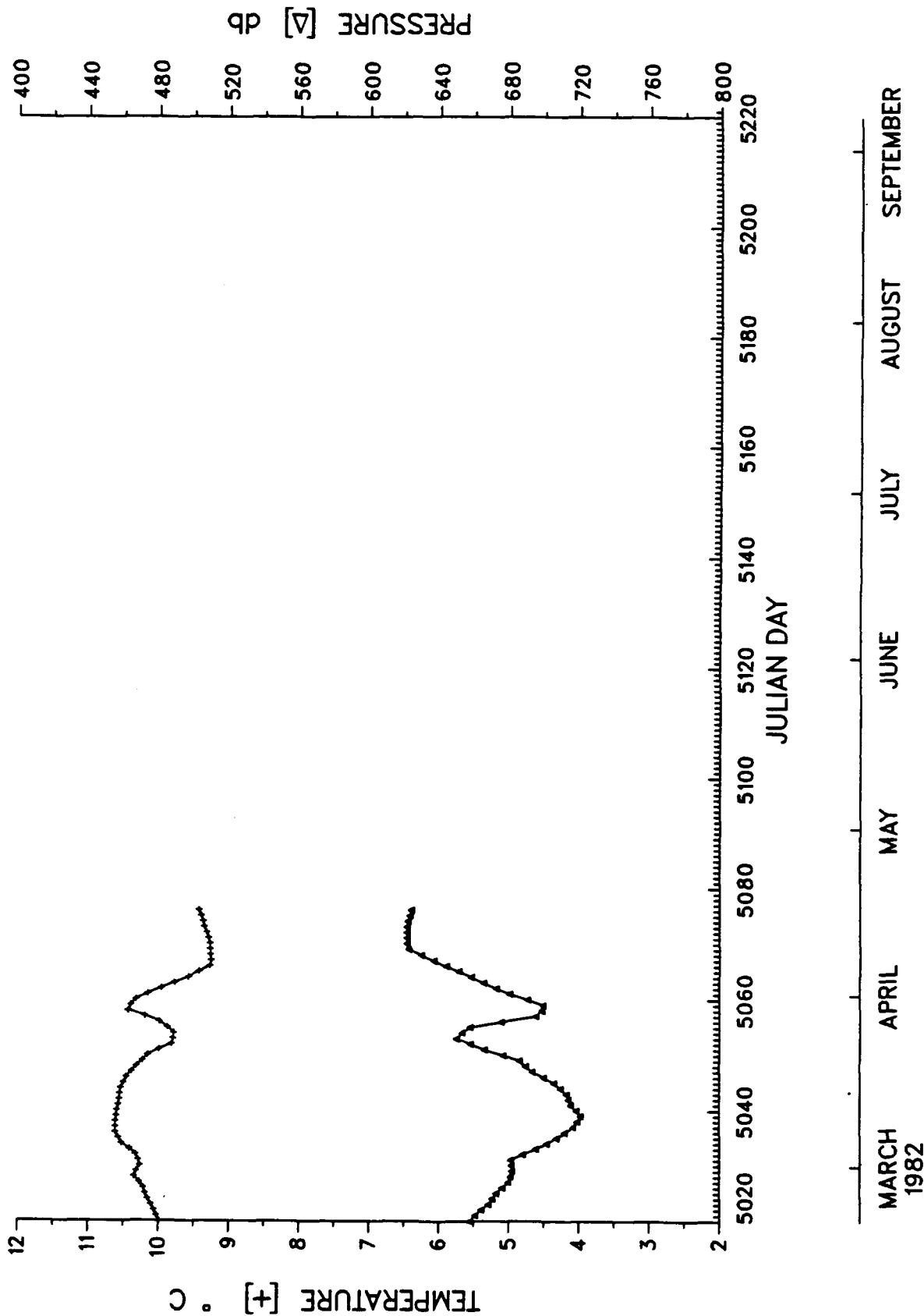




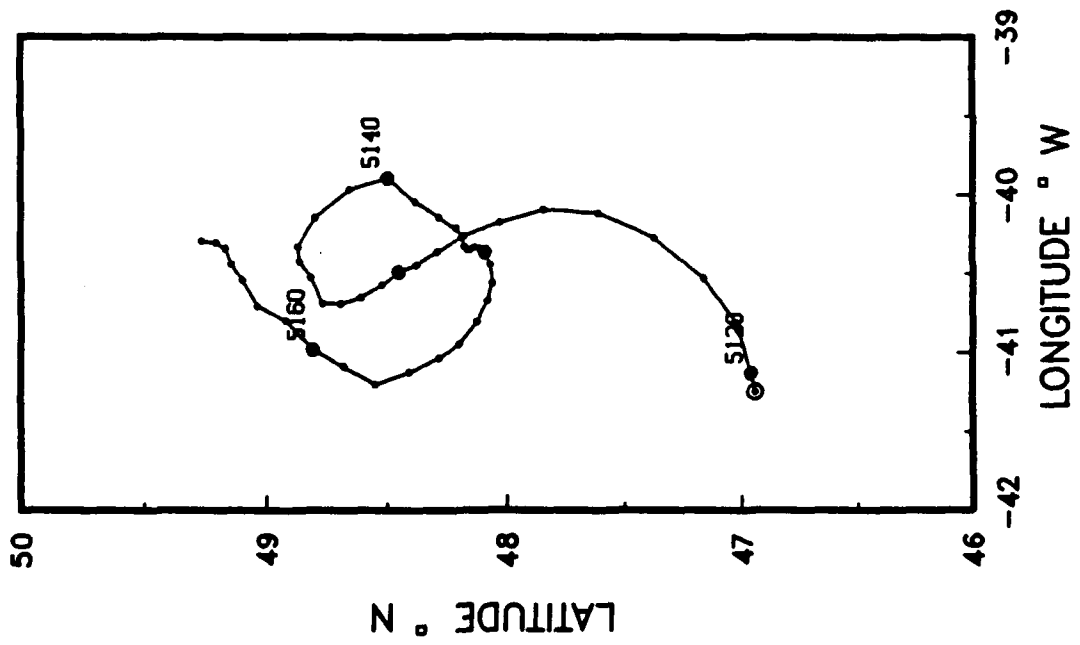
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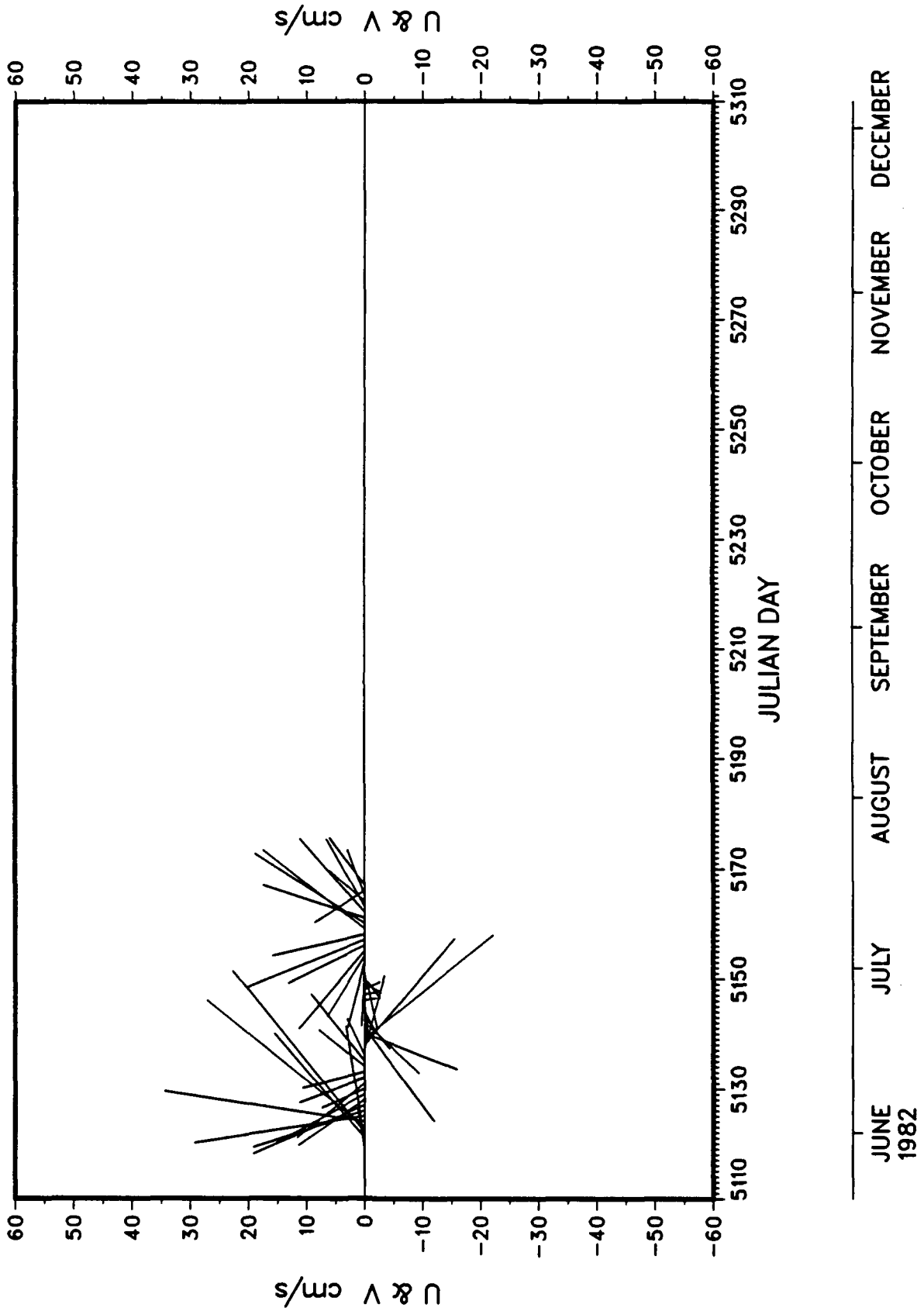


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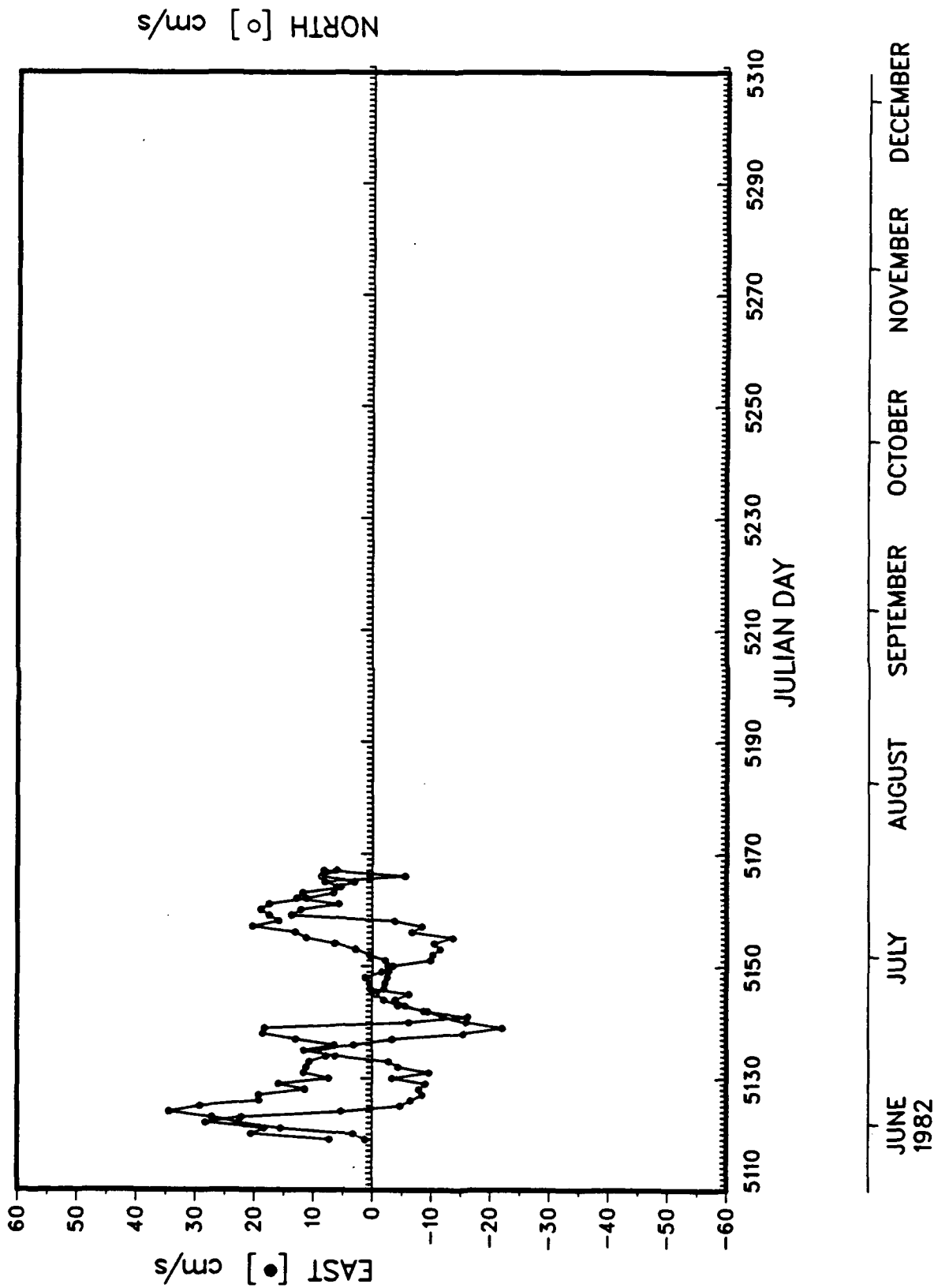


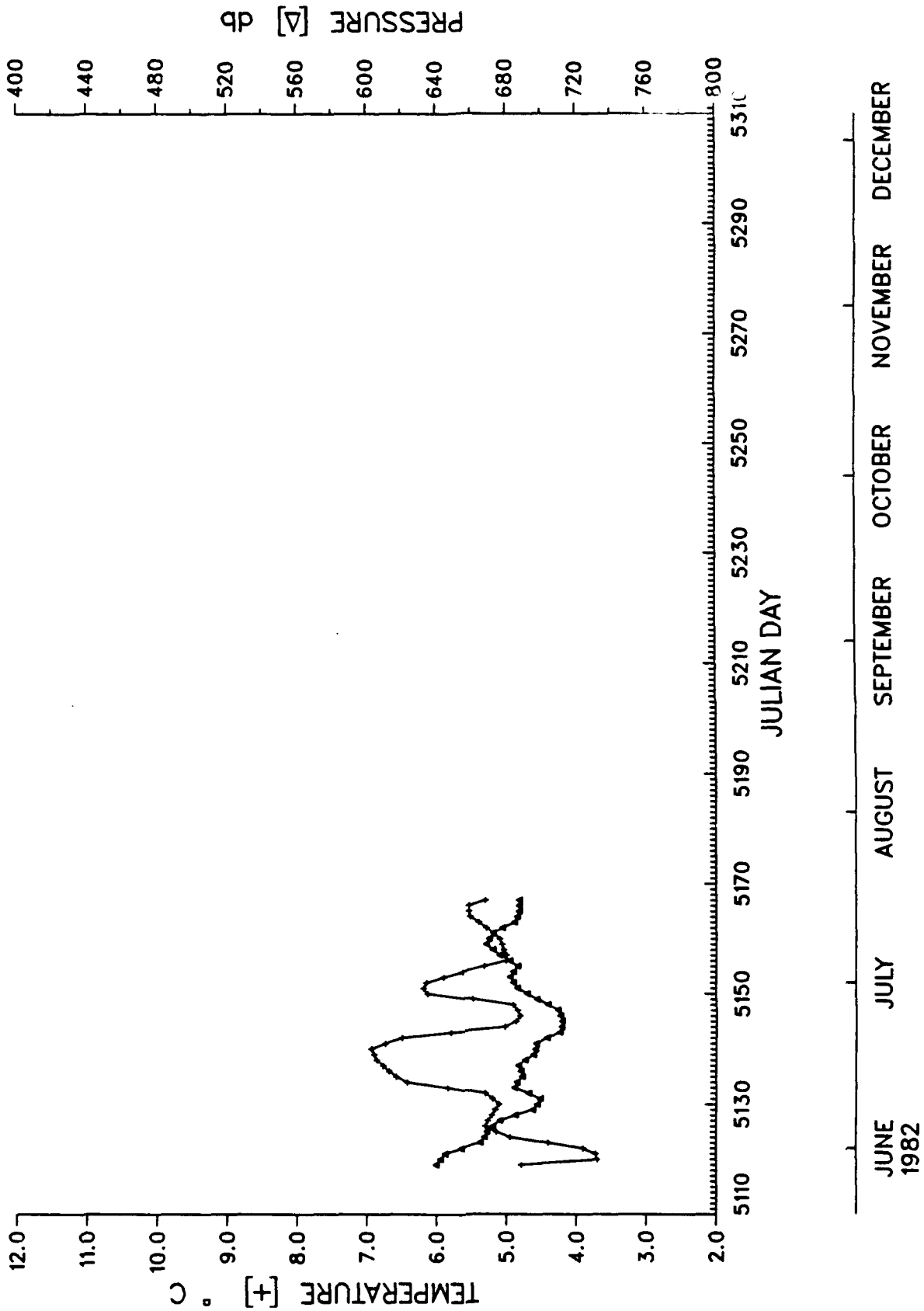
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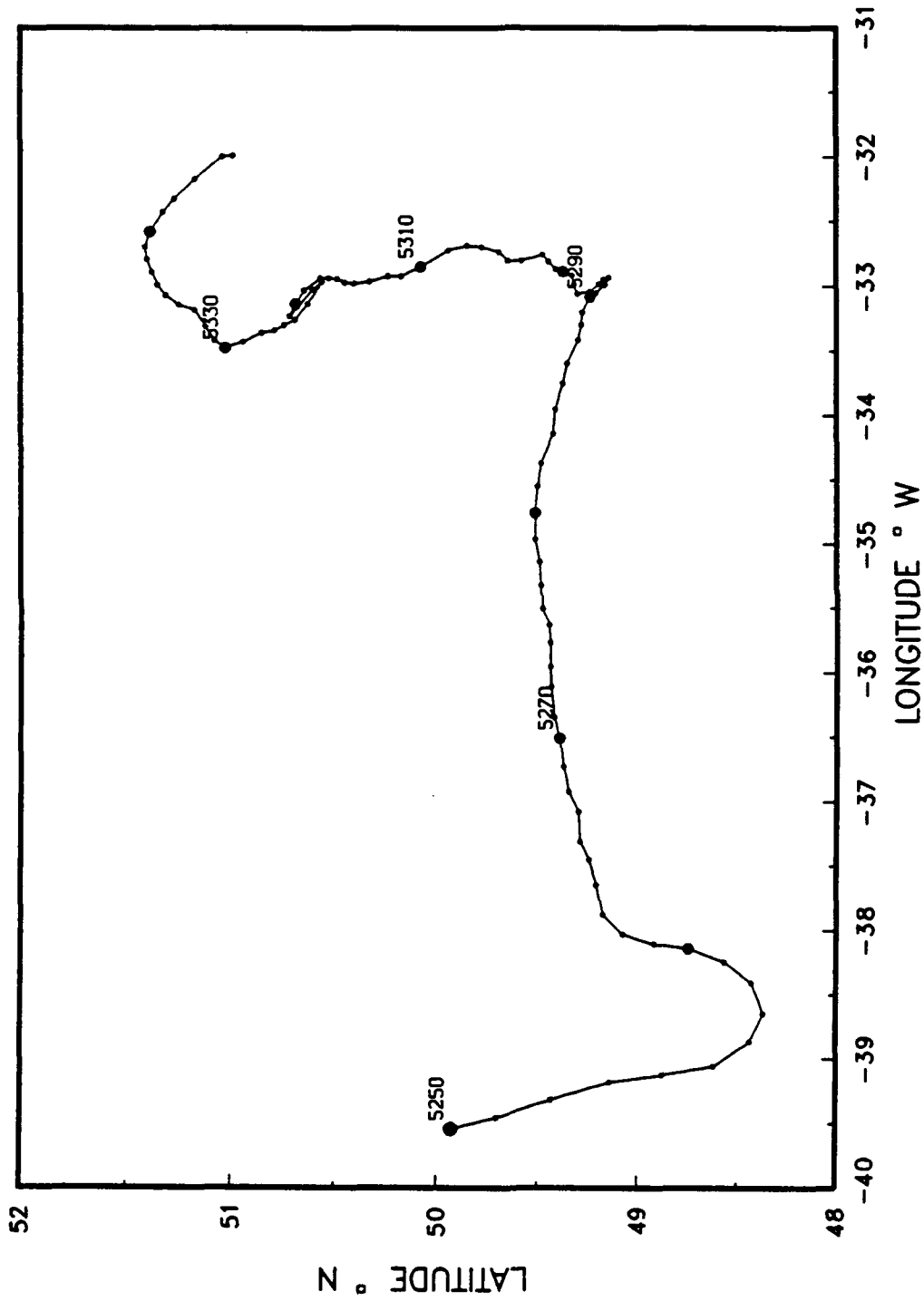


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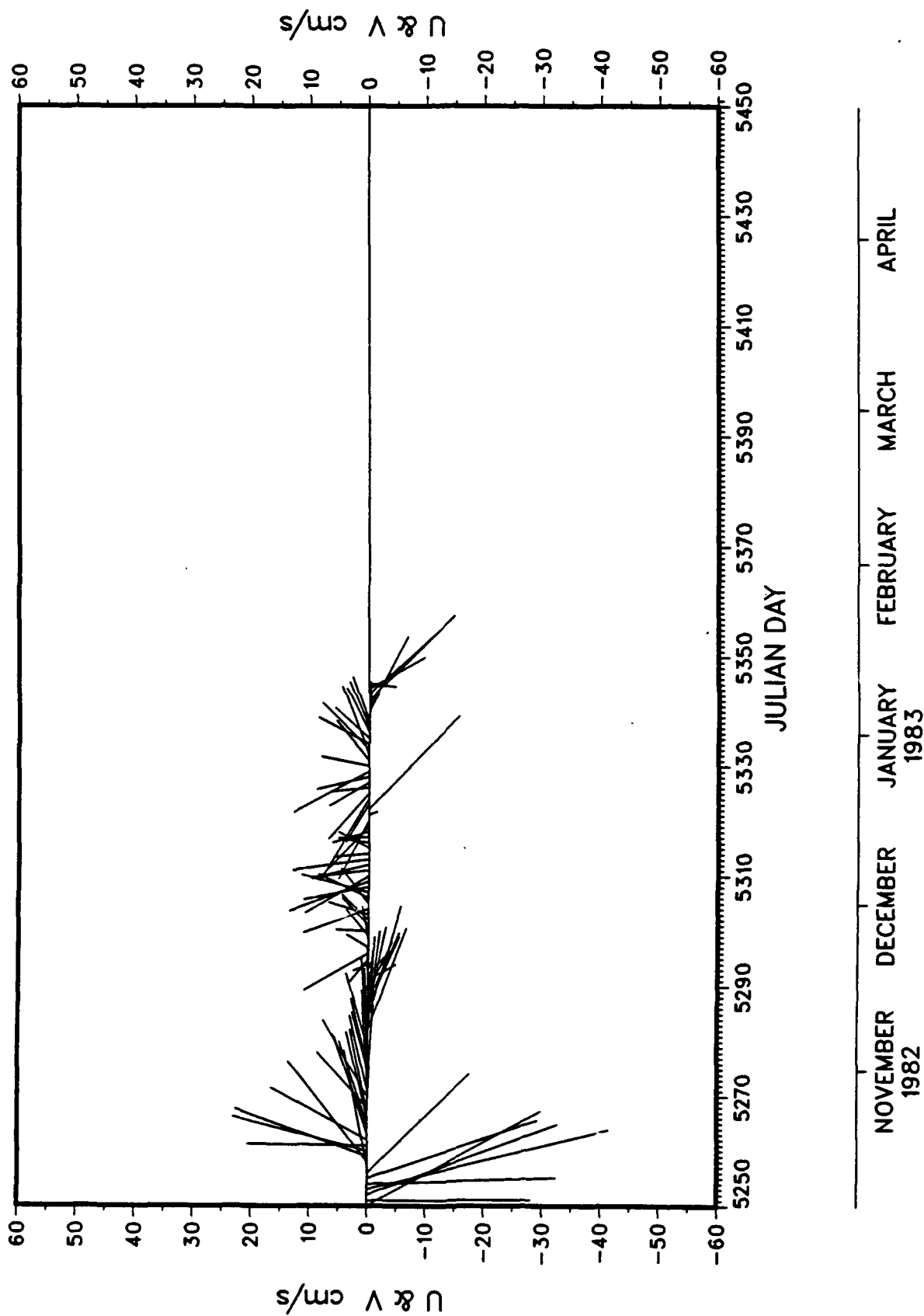




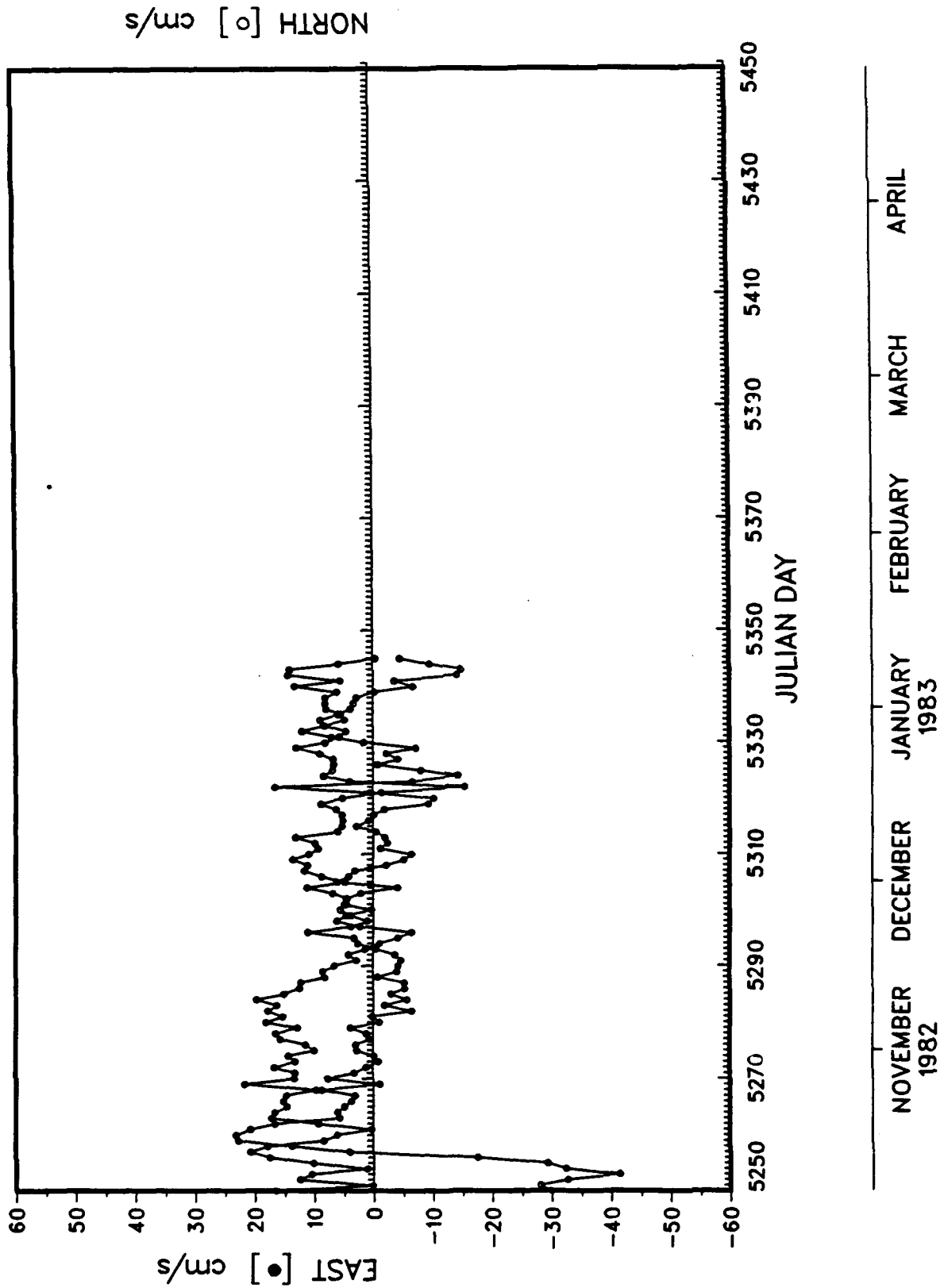
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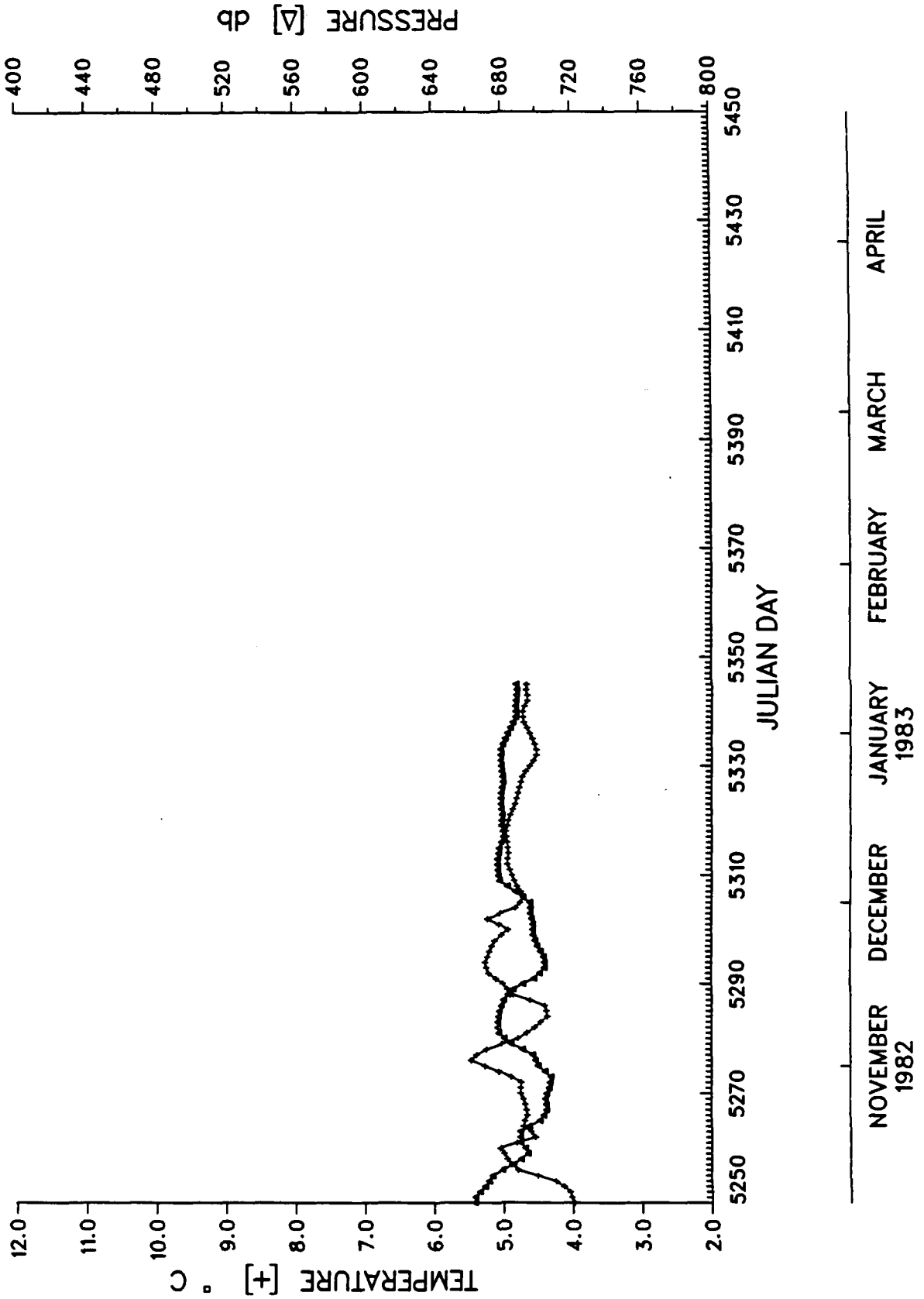
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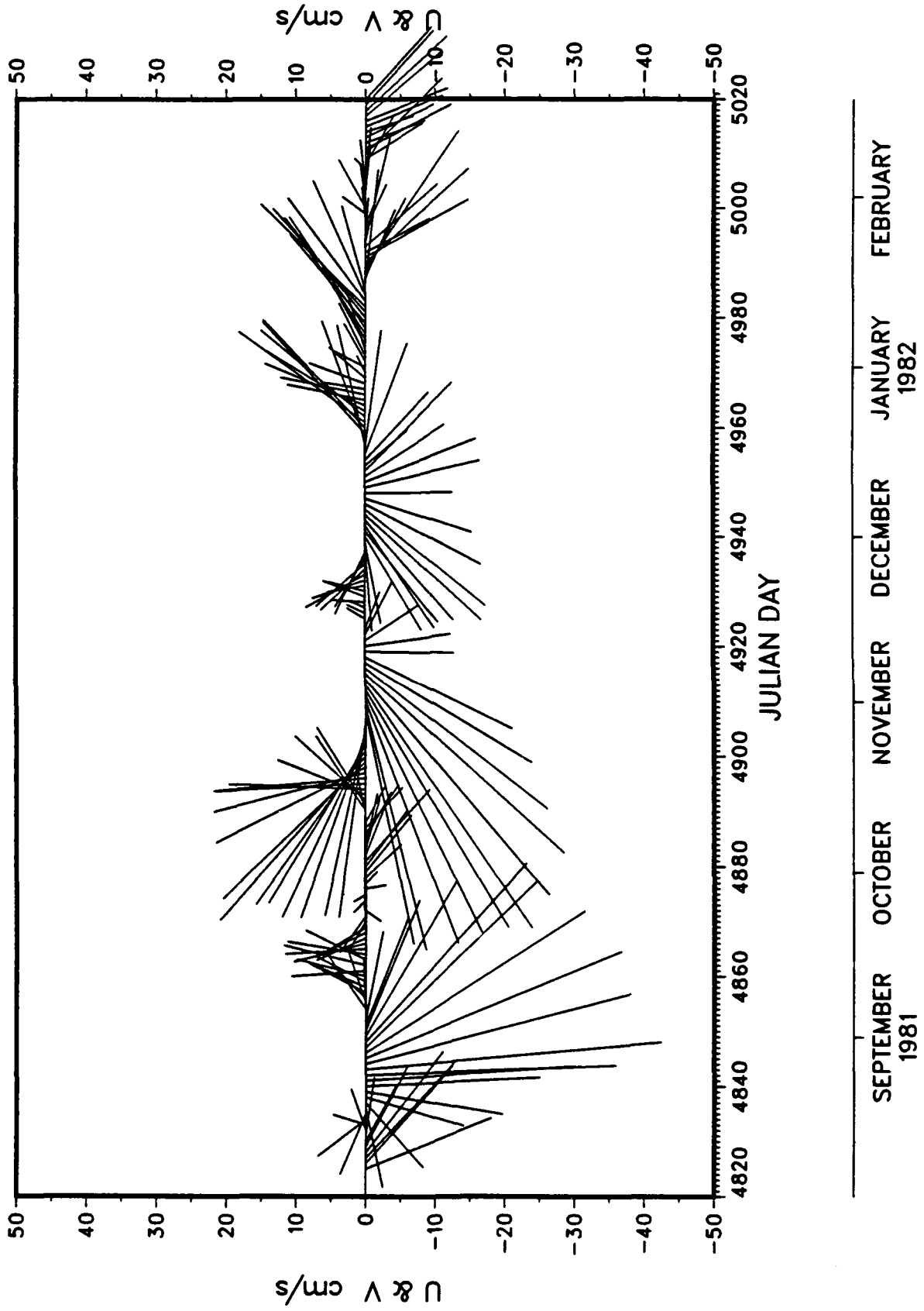
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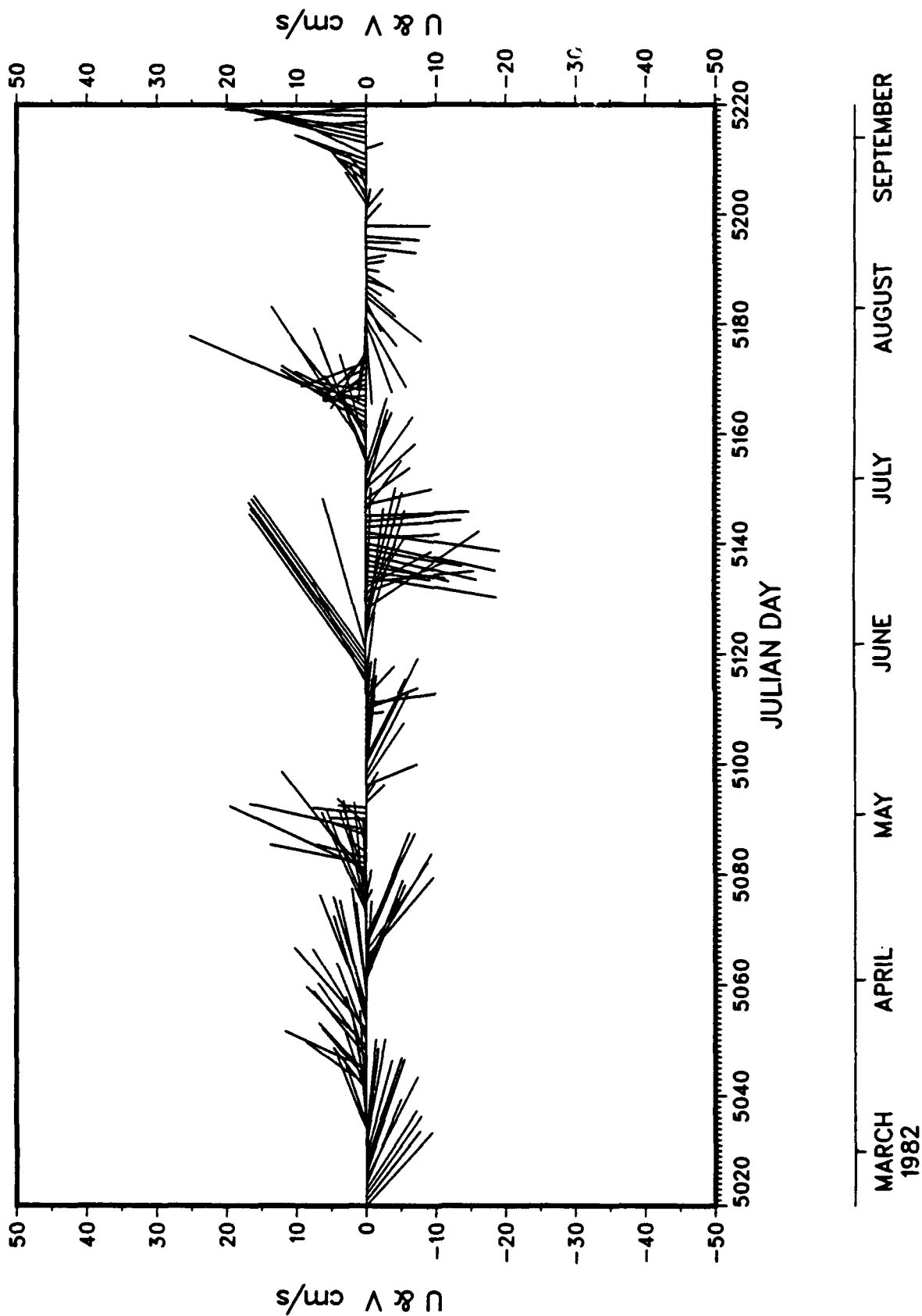
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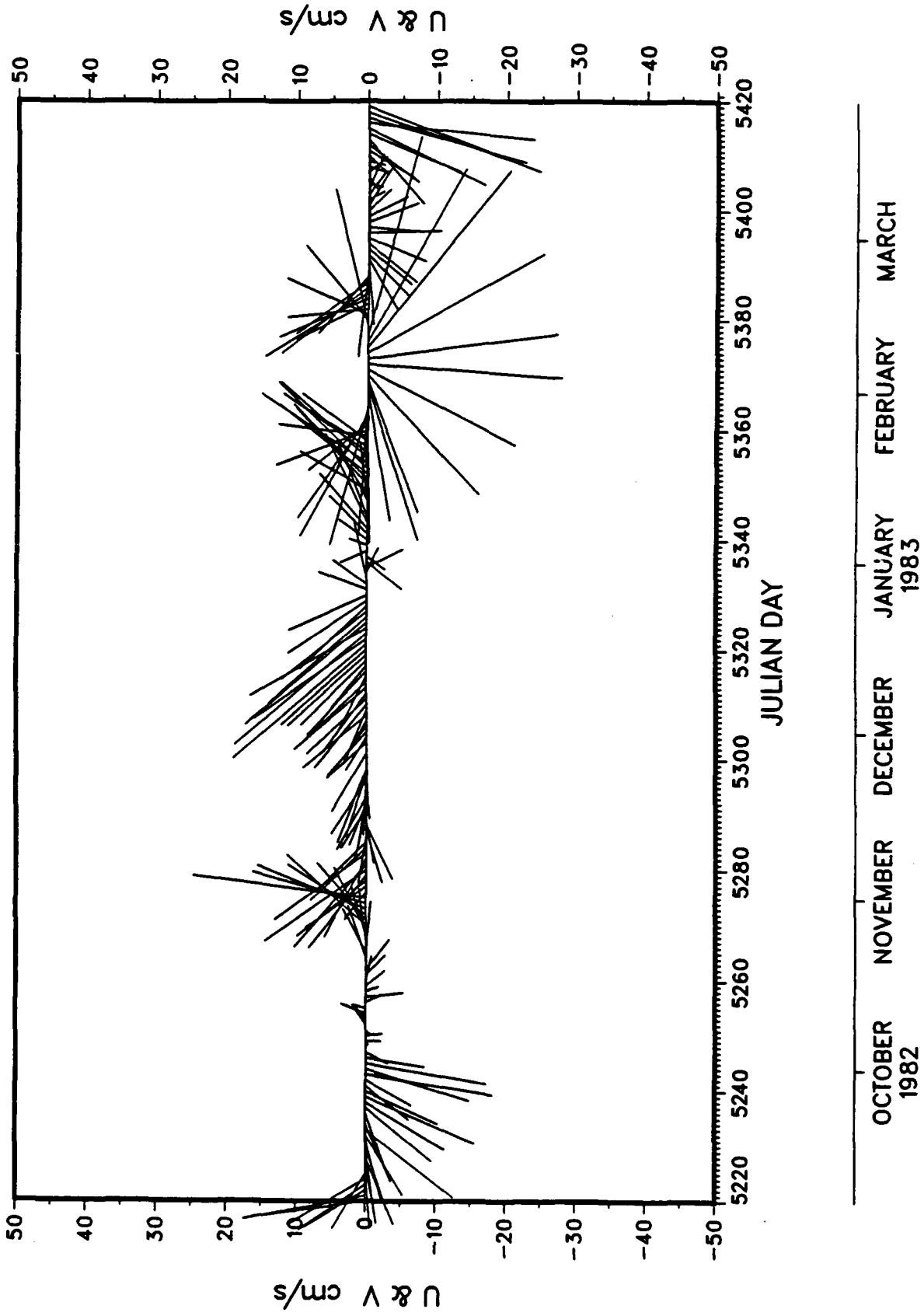


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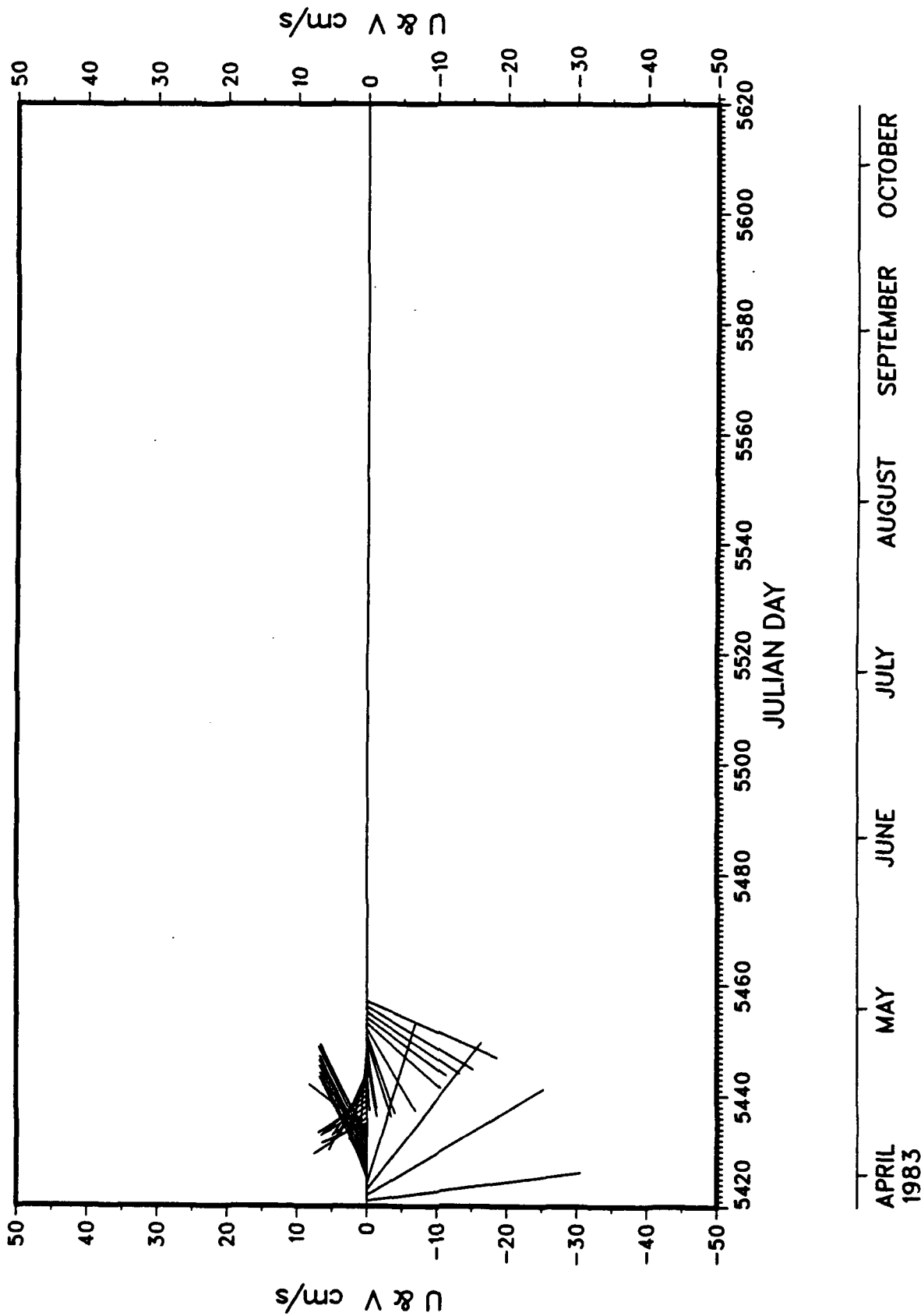


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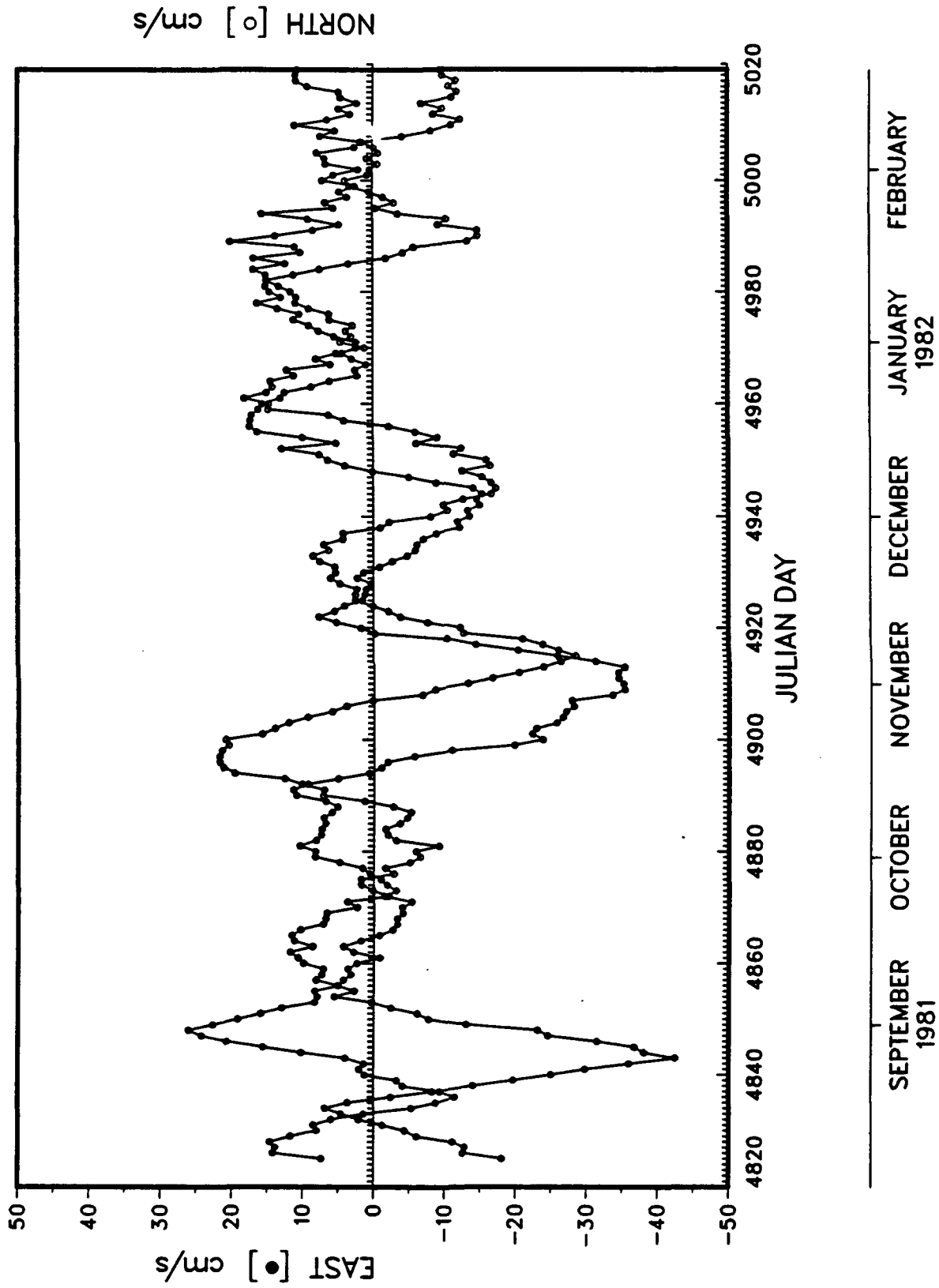




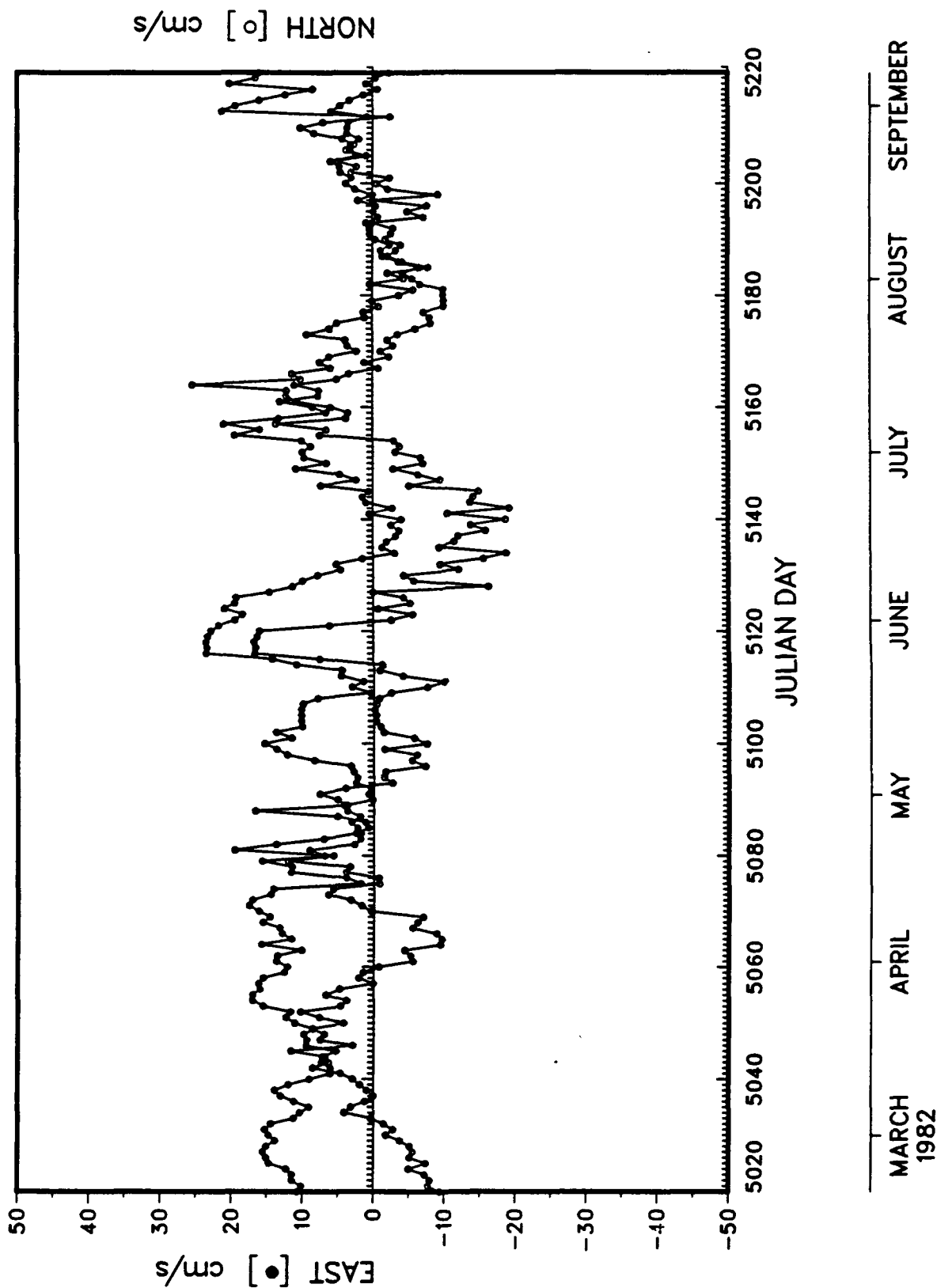
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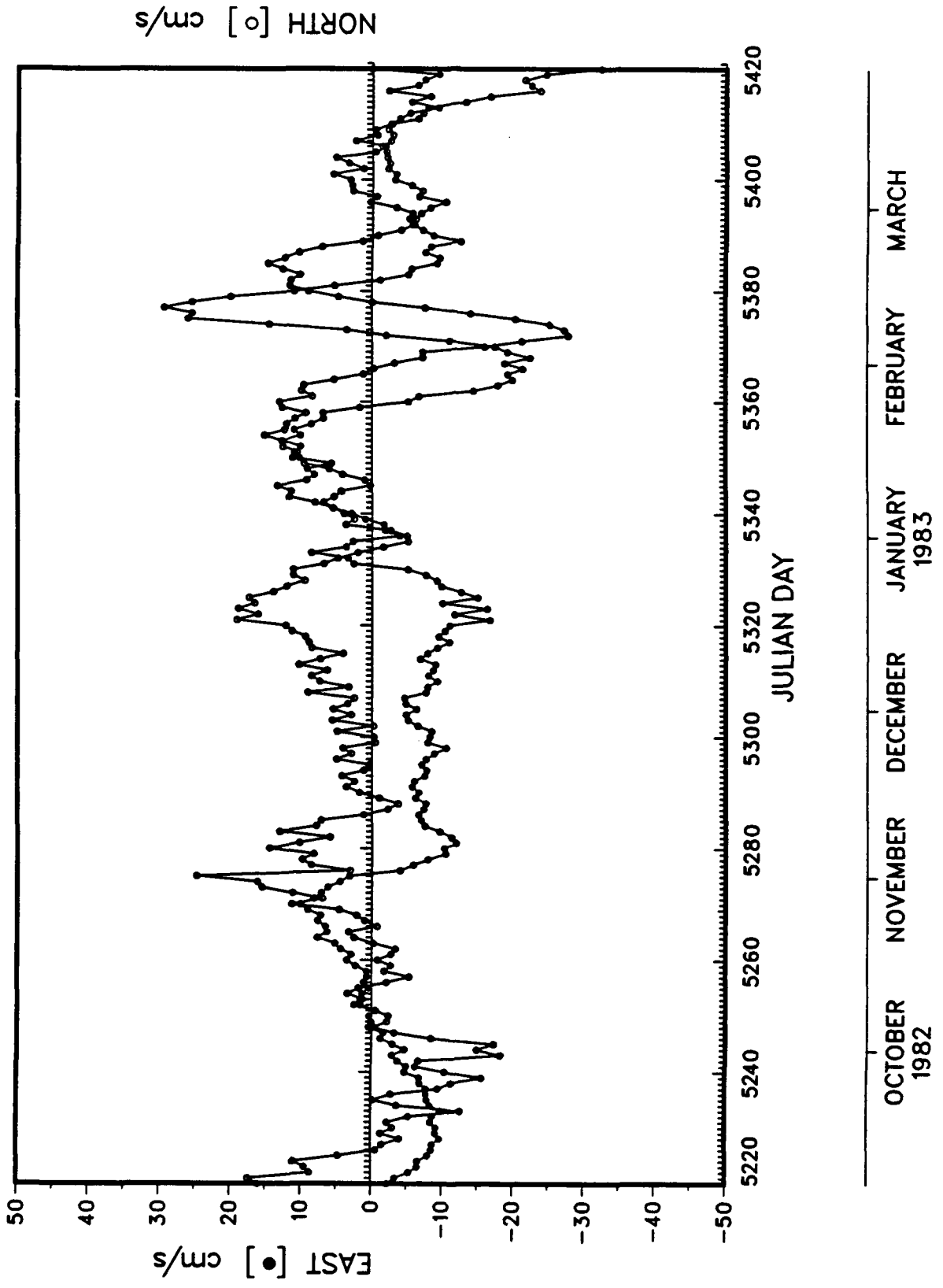


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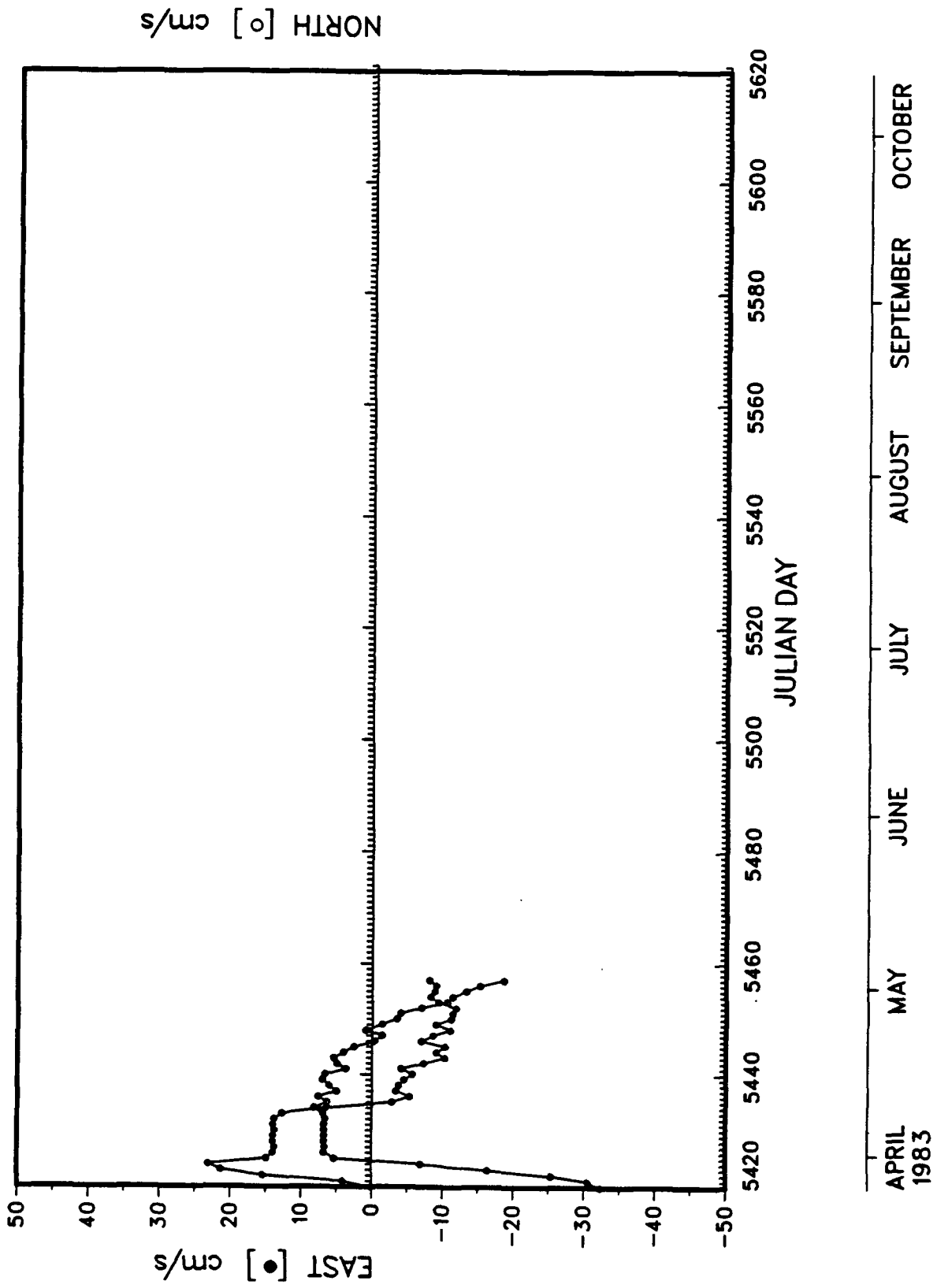


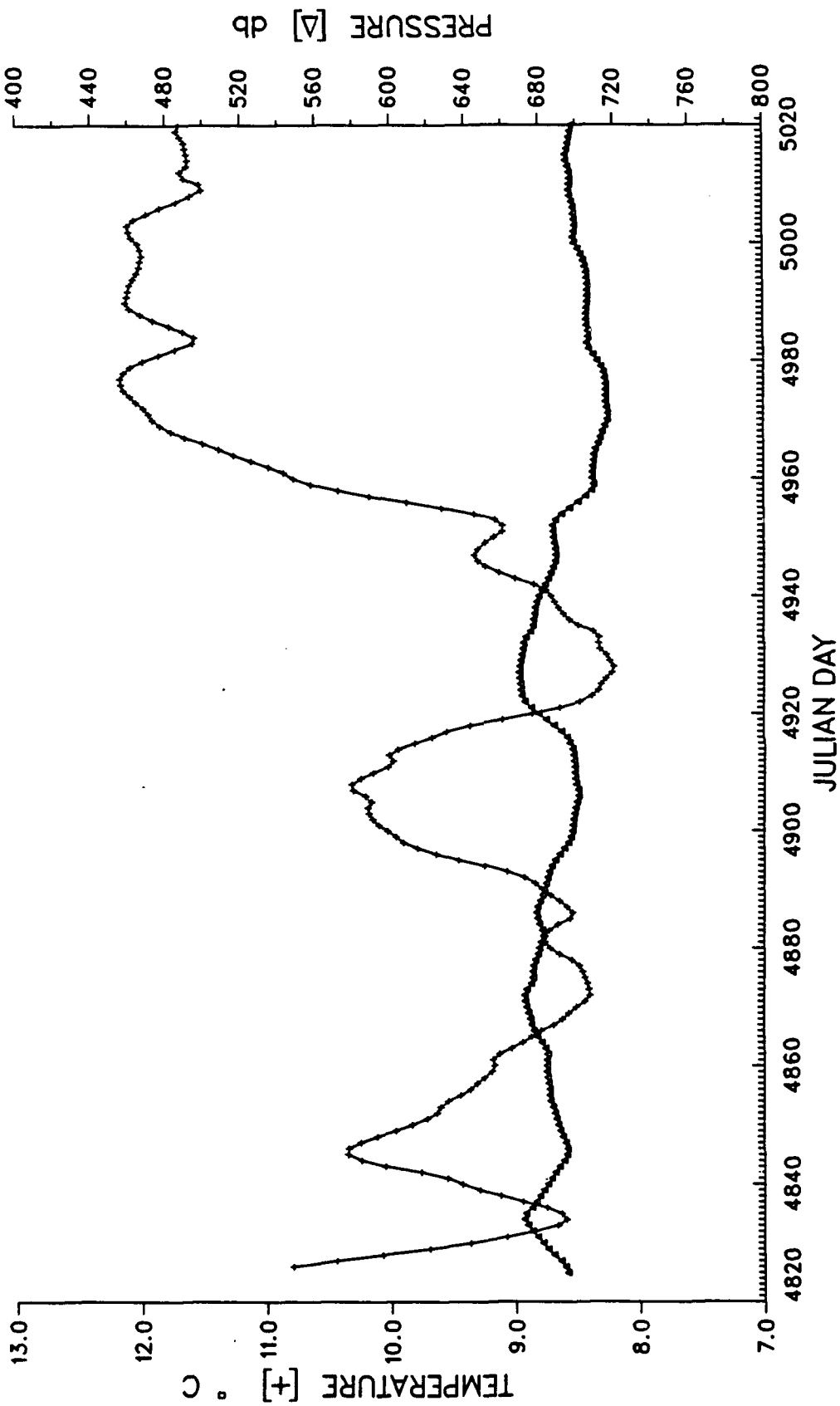
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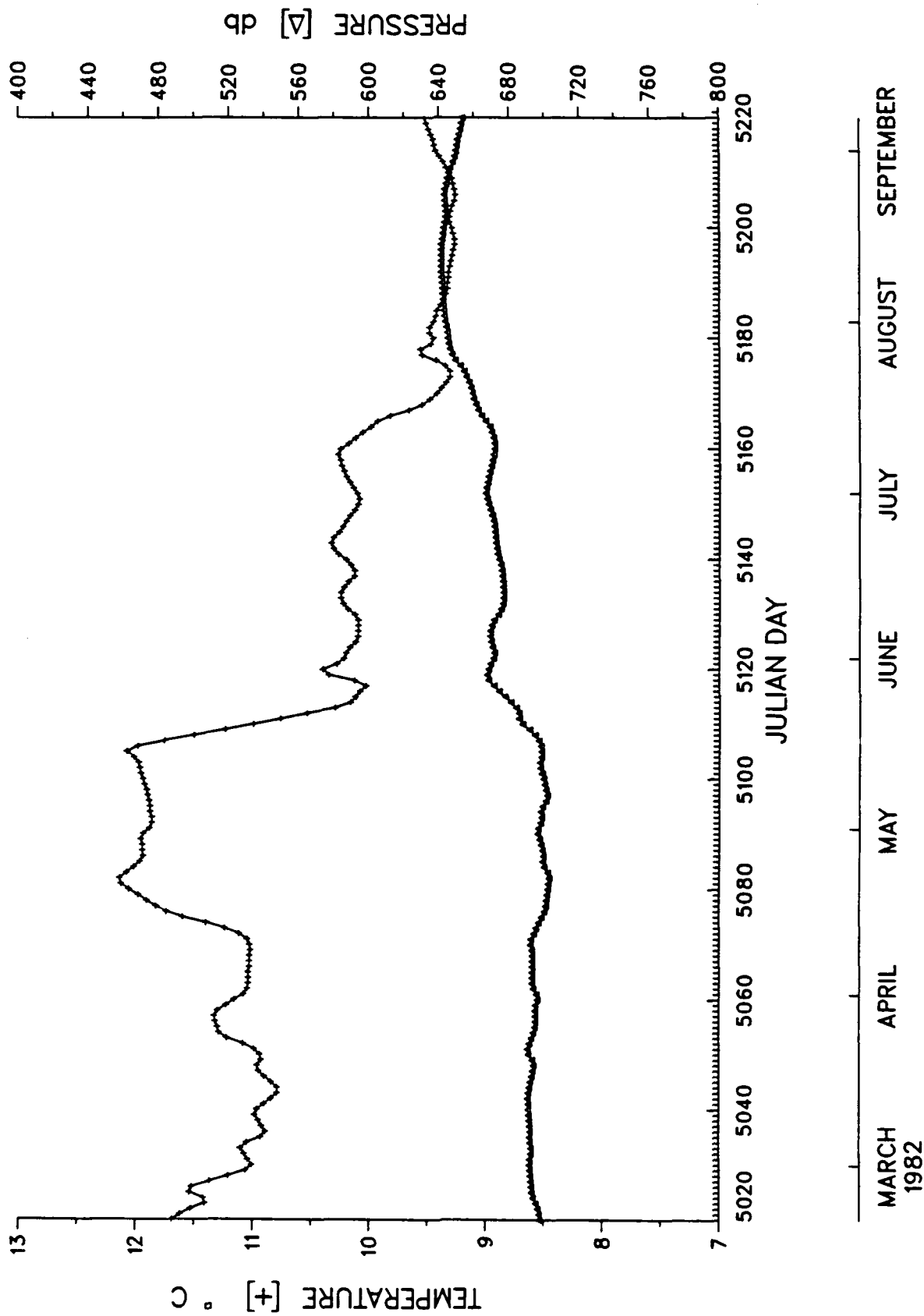
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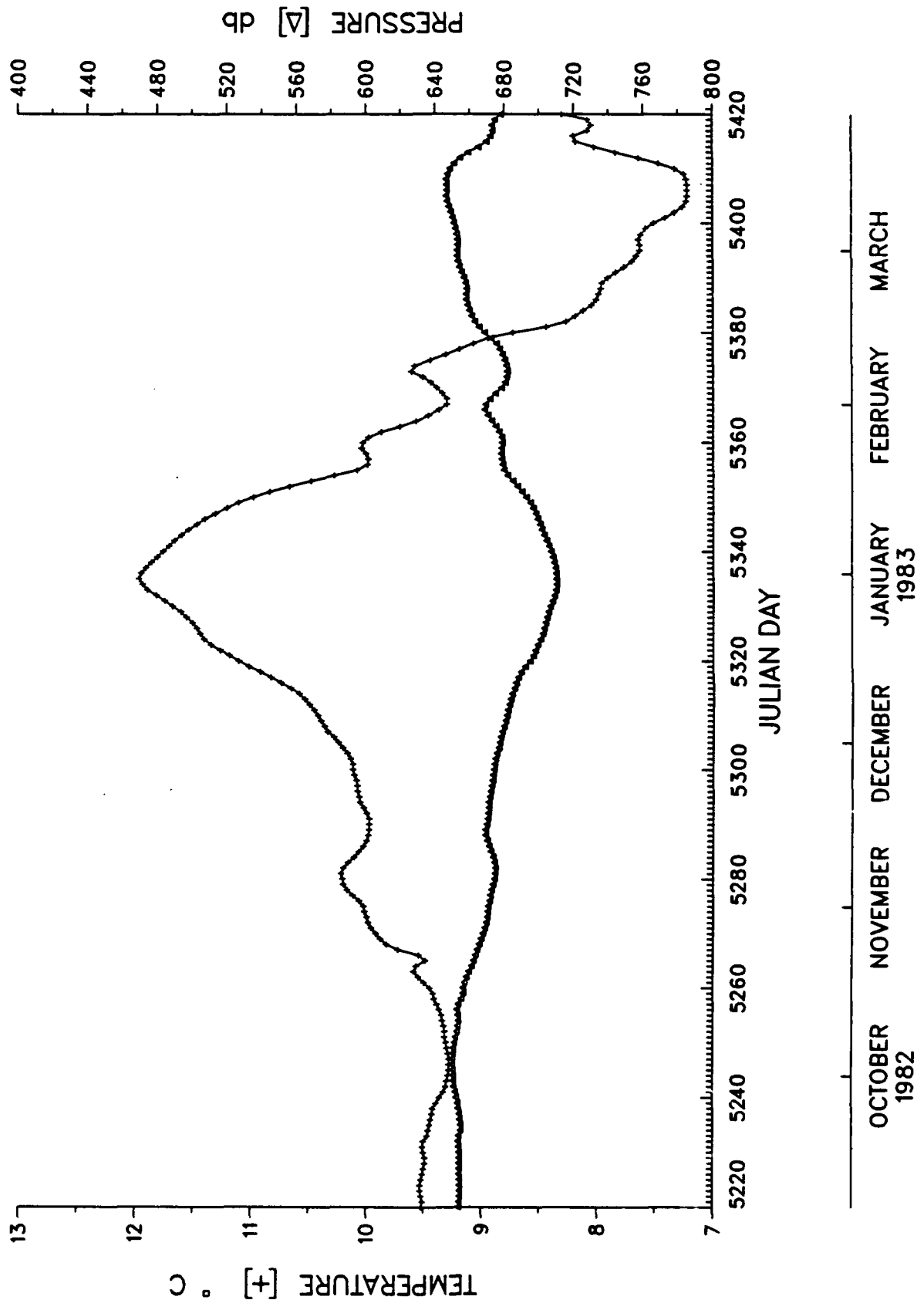


SEPTEMBER 1981 OCTOBER NOVEMBER DECEMBER JANUARY FEBRUARY 1982

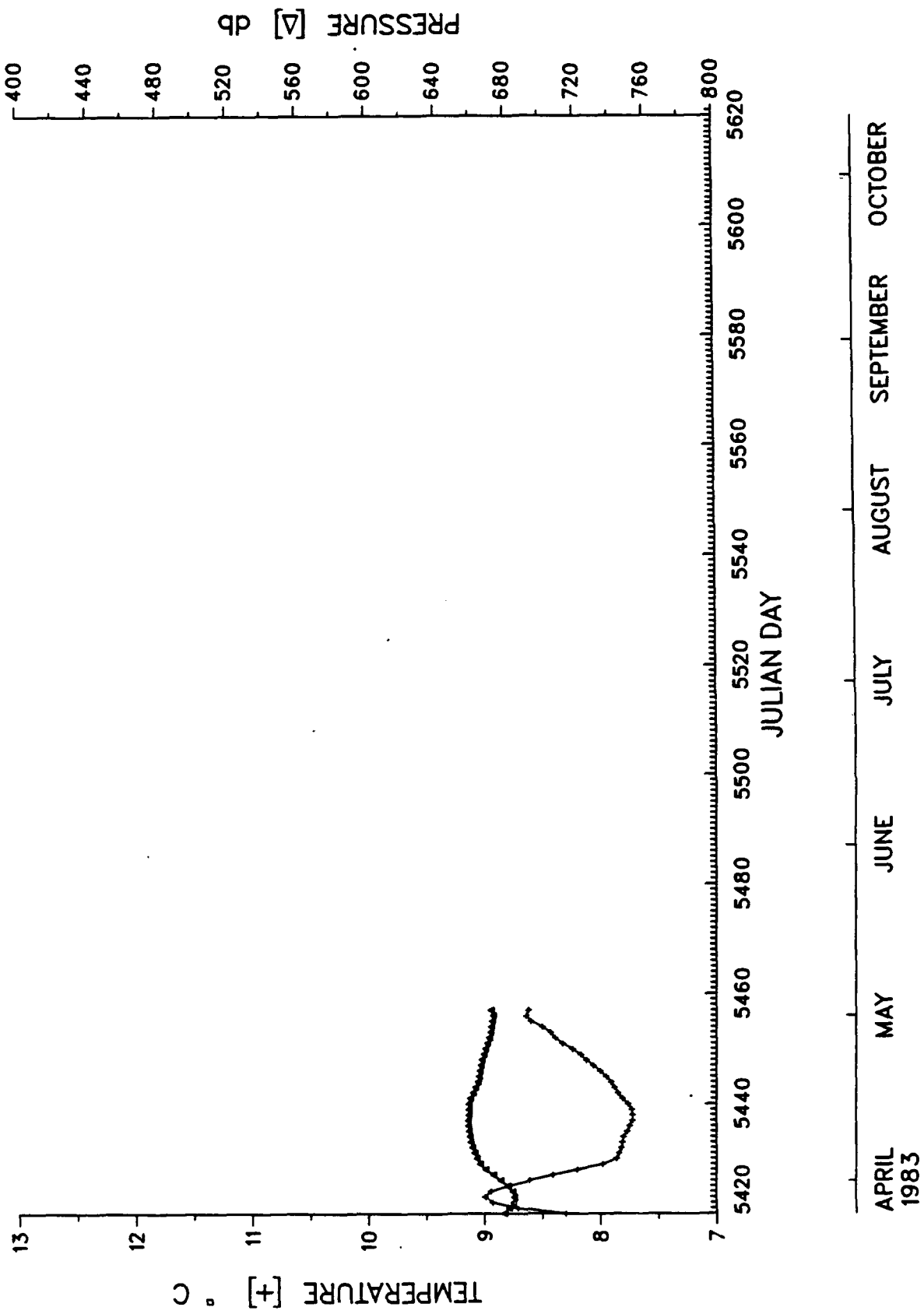
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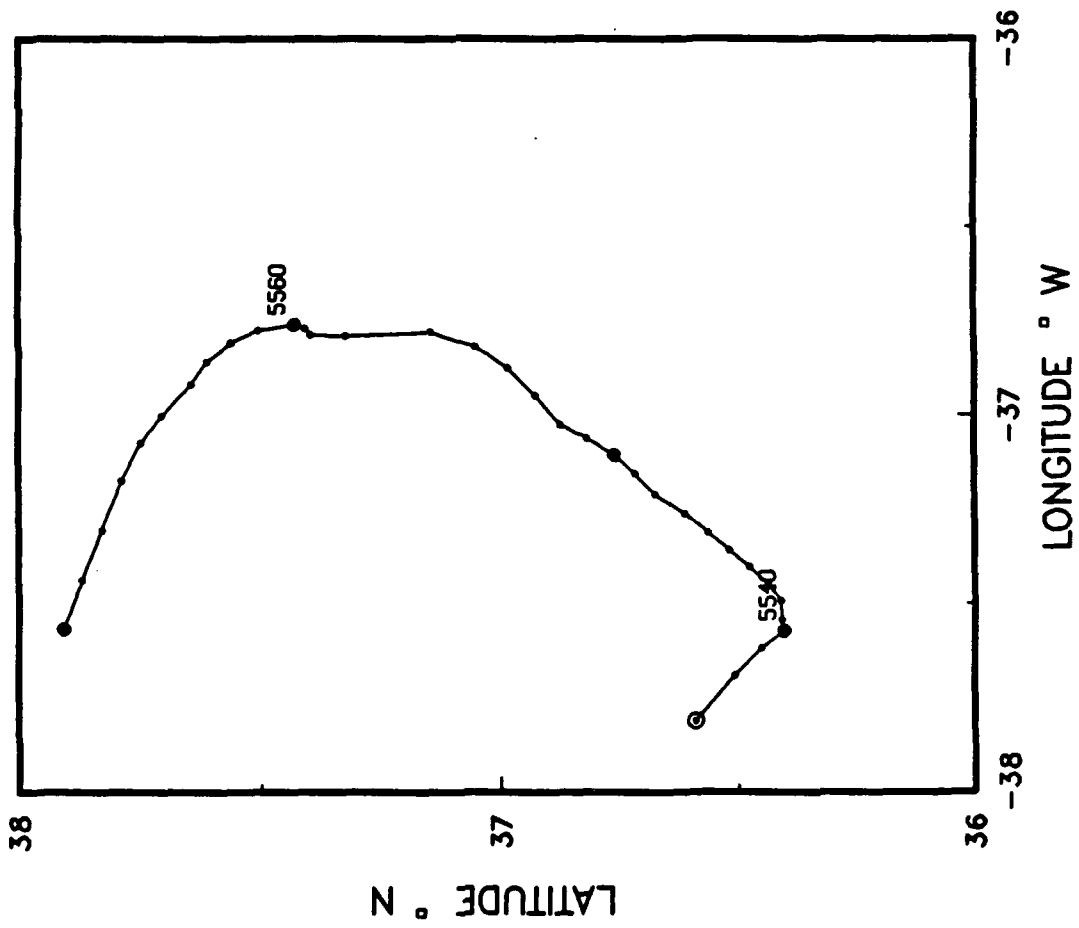
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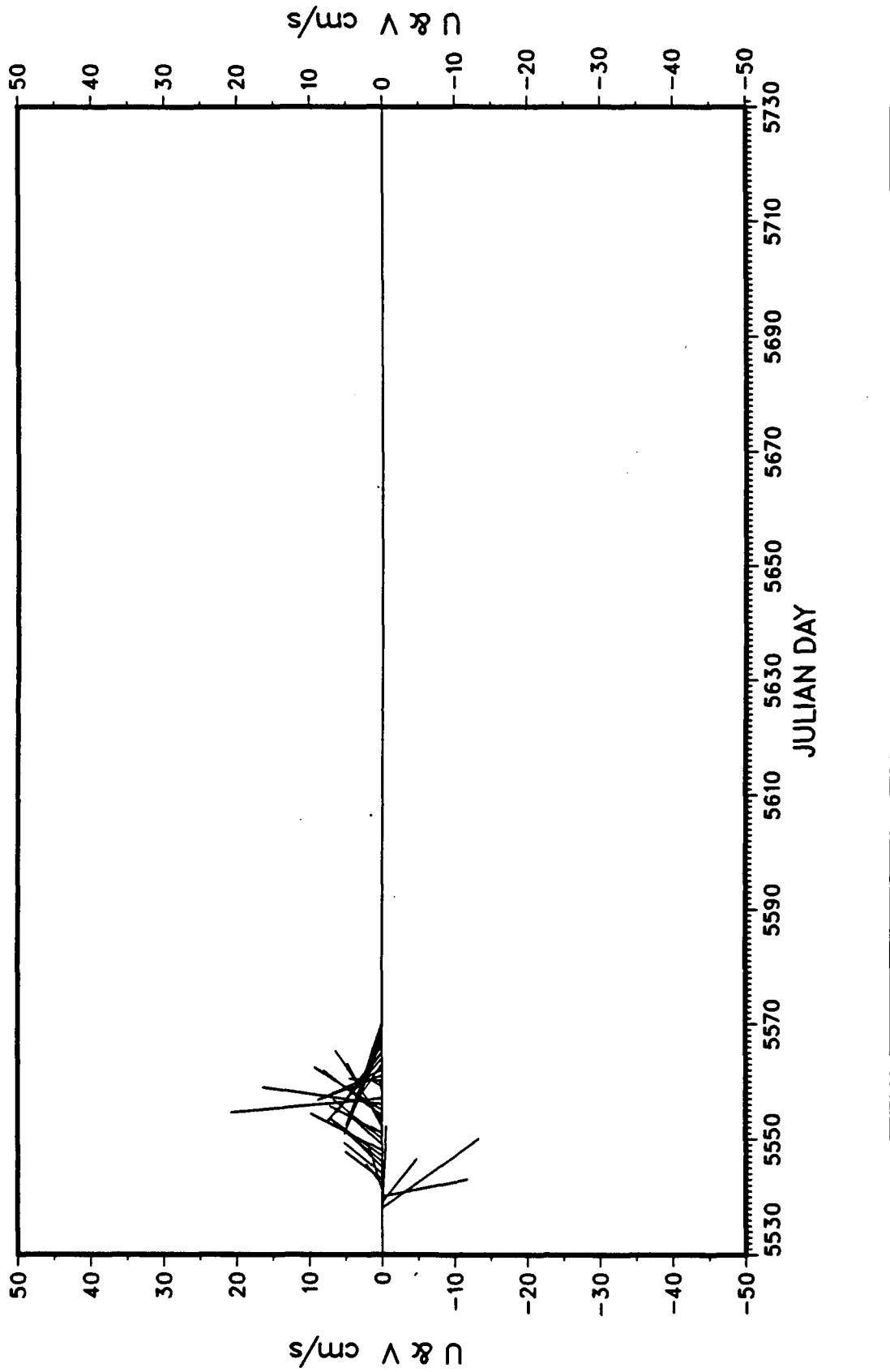
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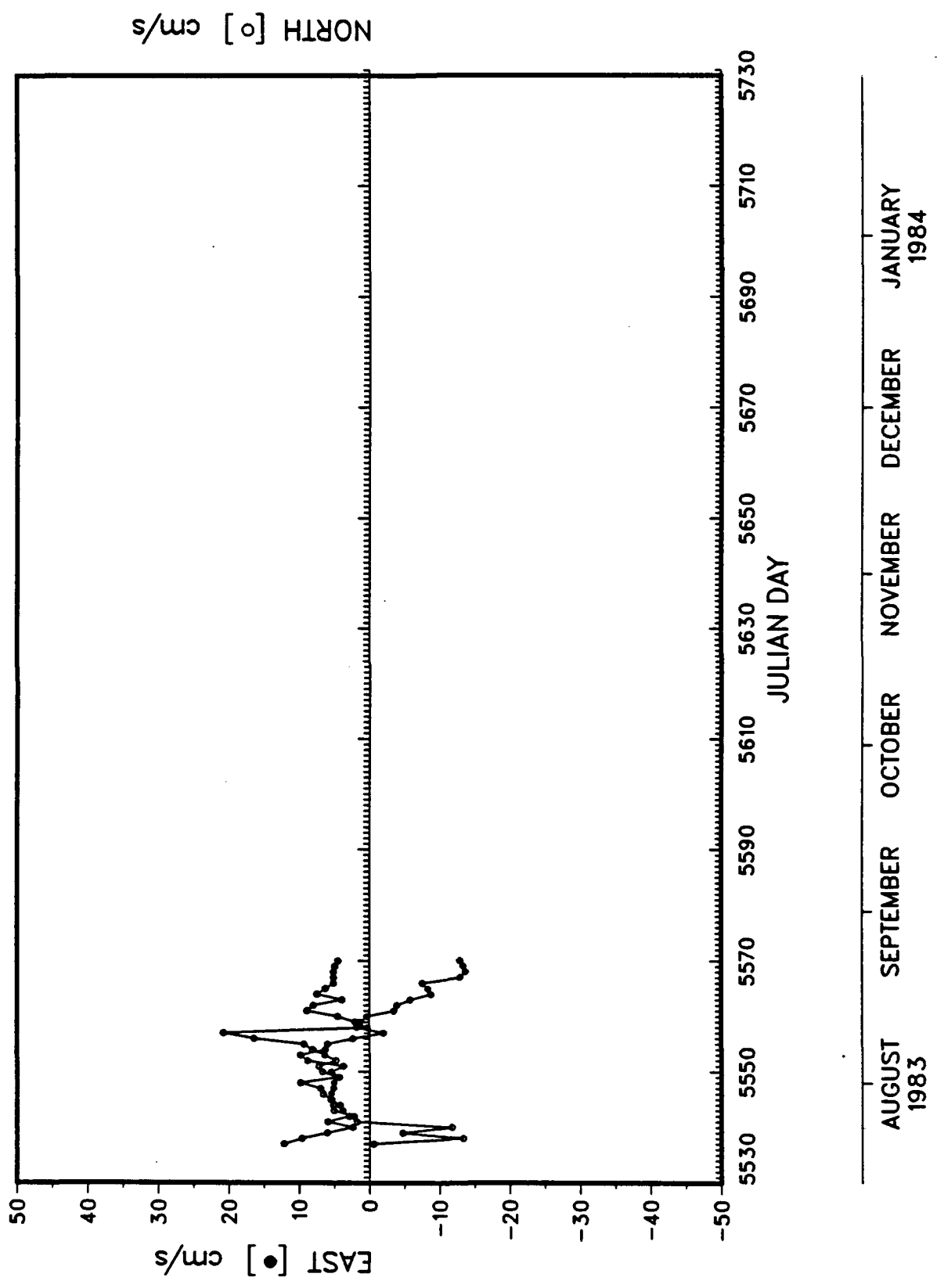


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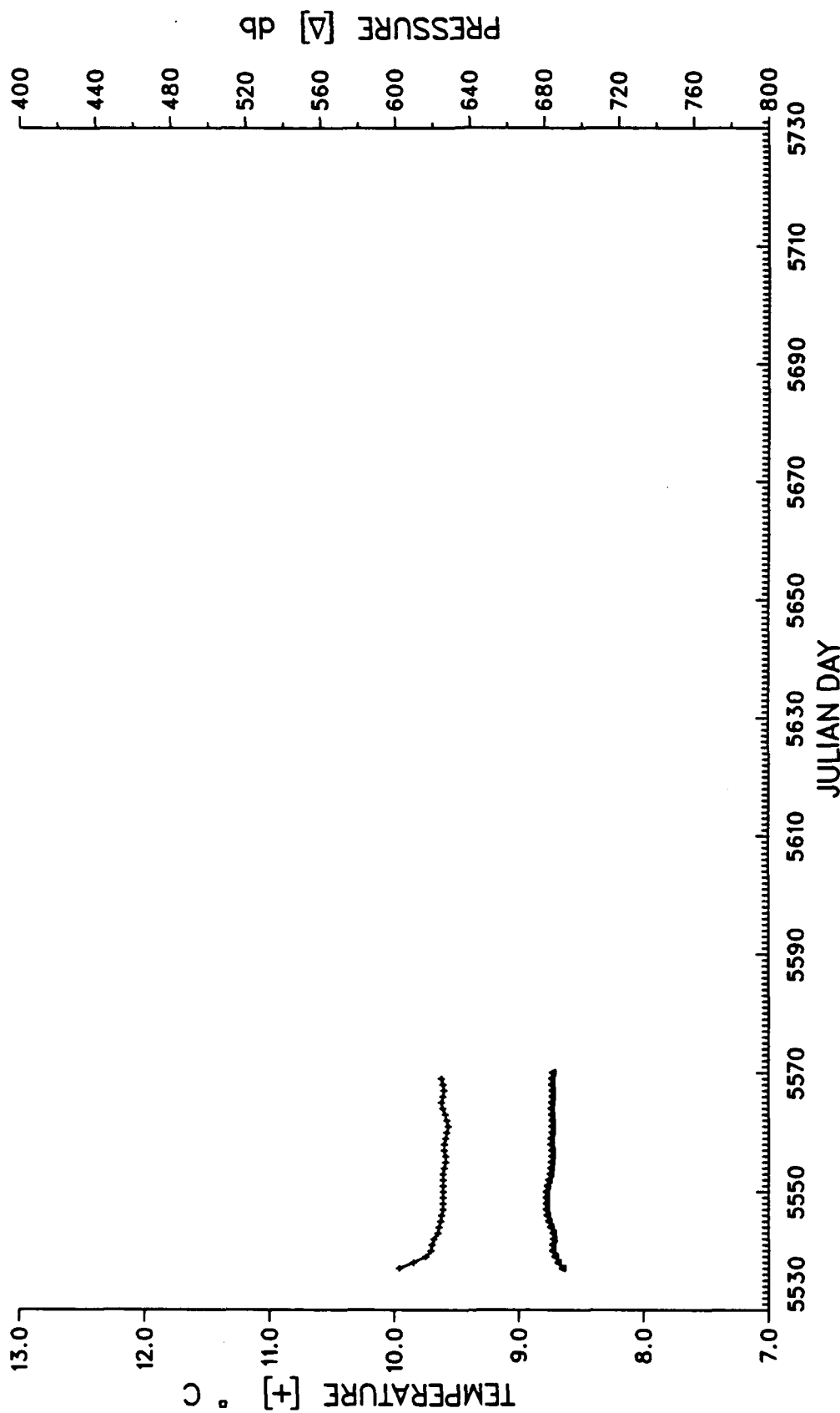


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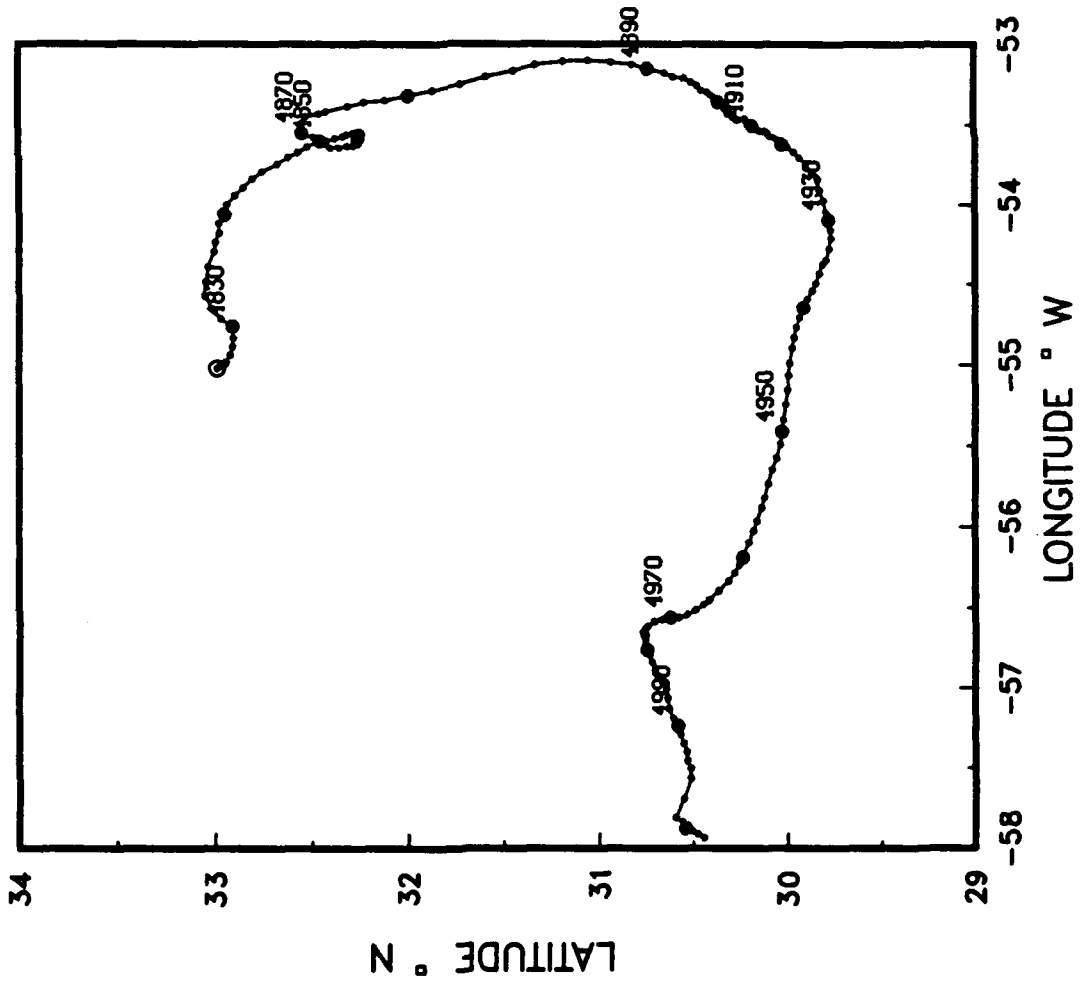




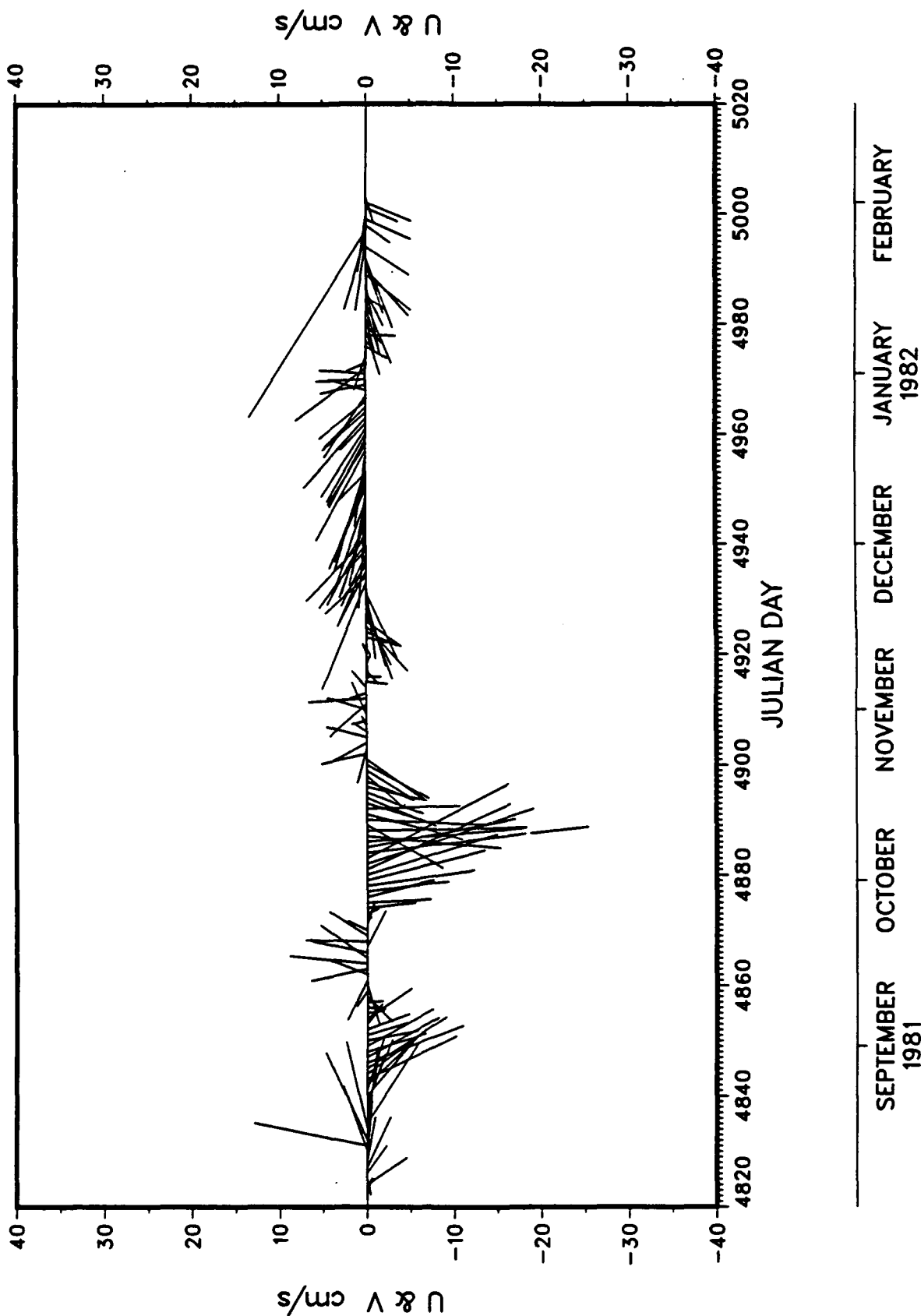
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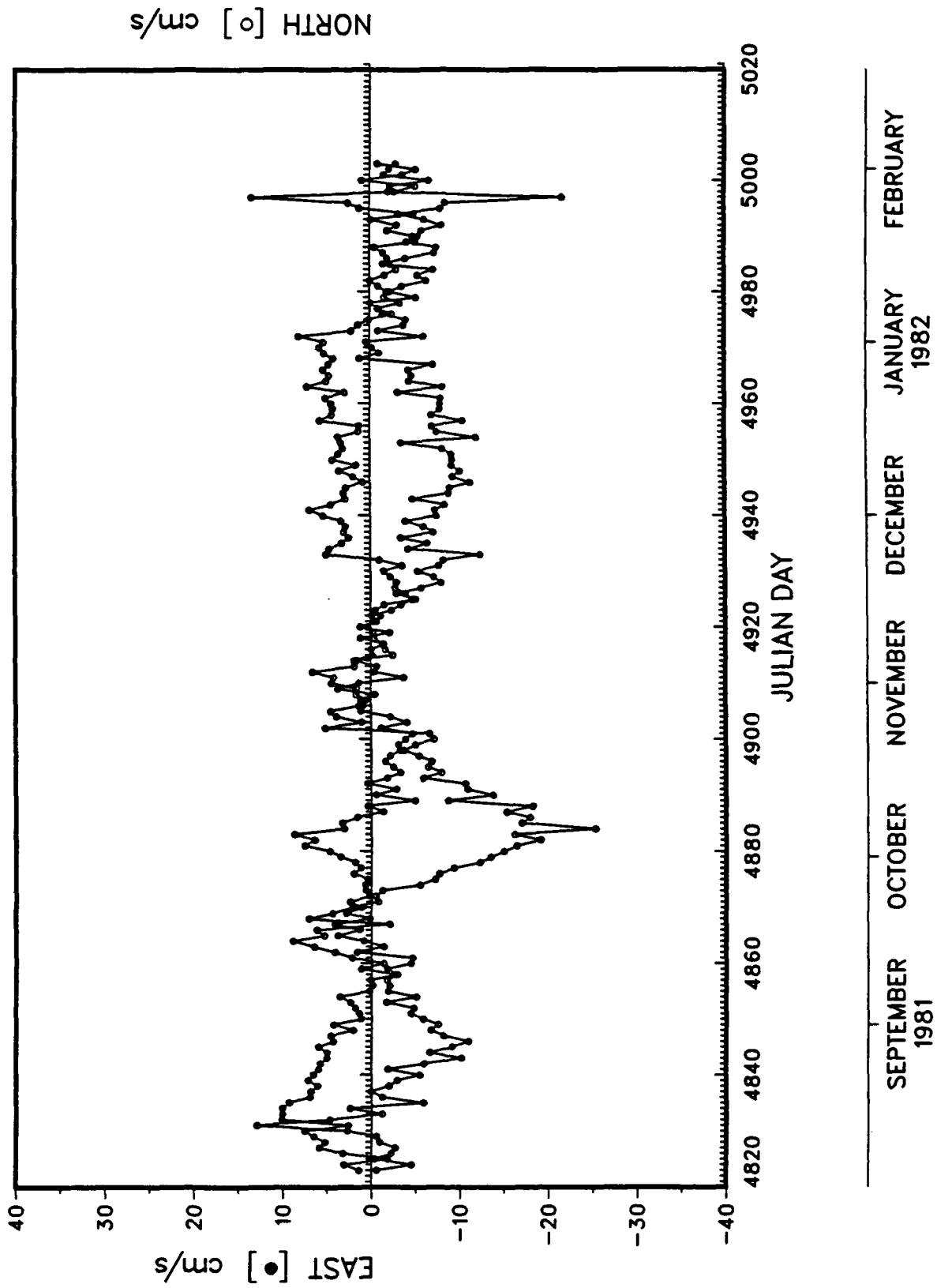
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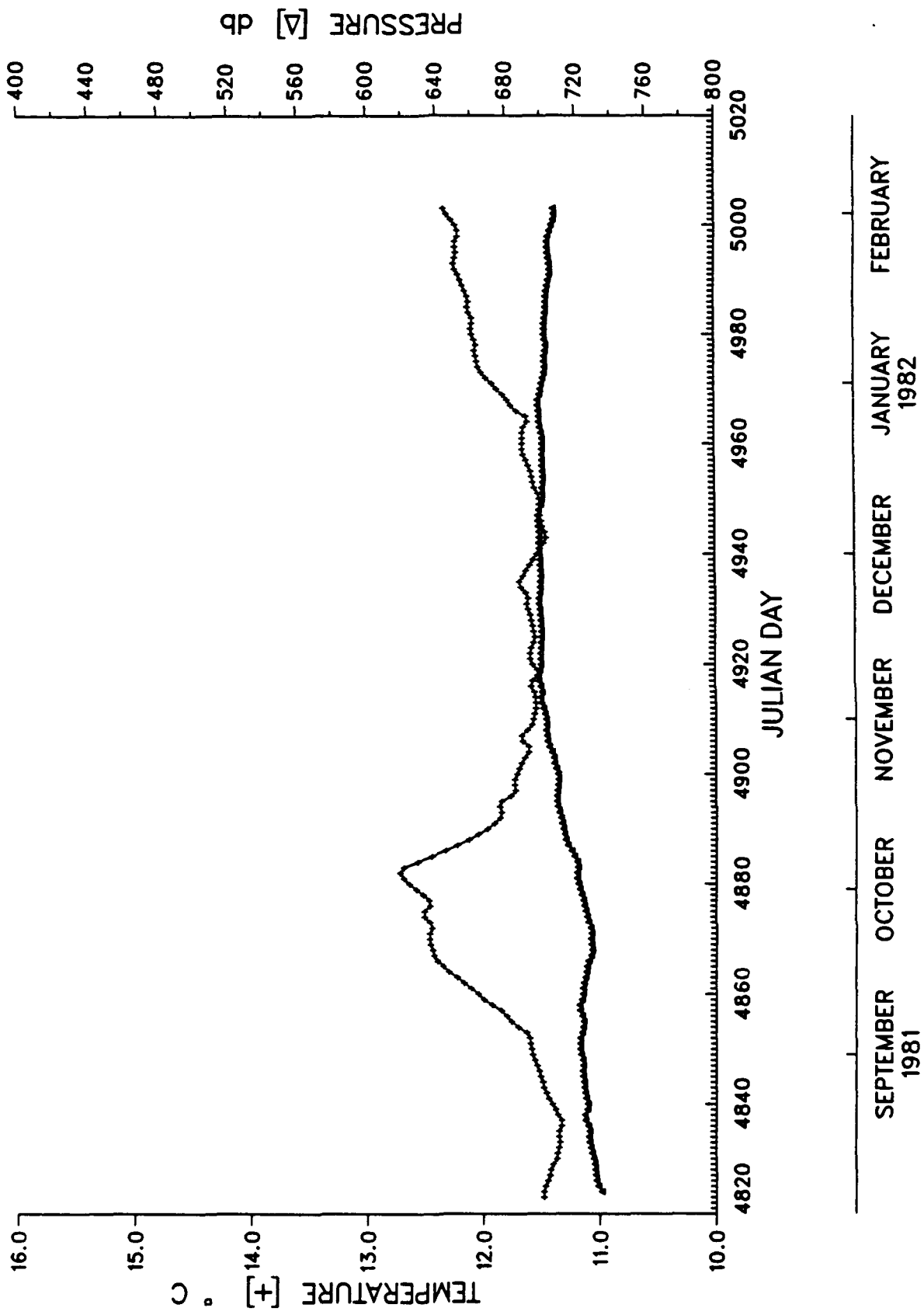
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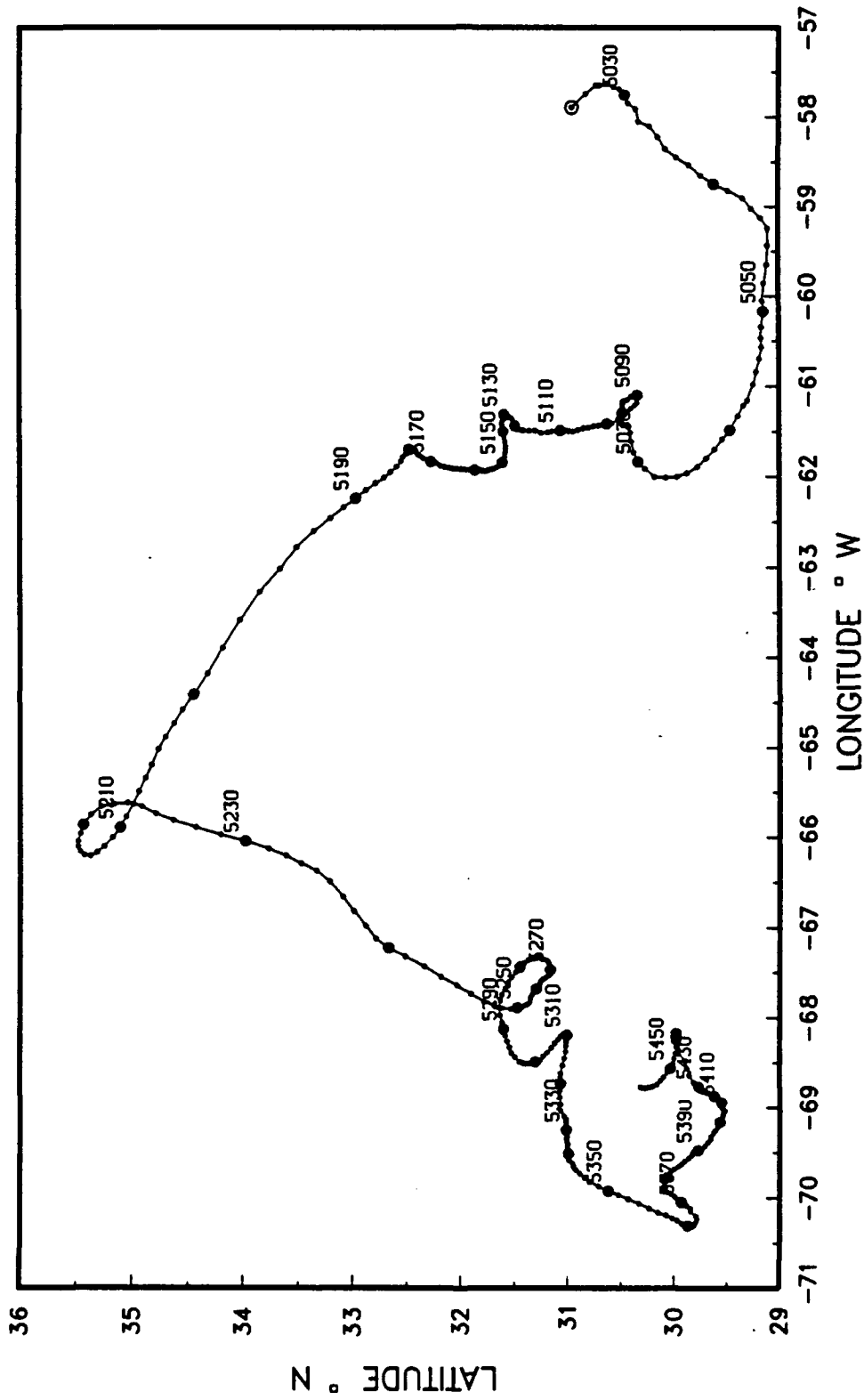


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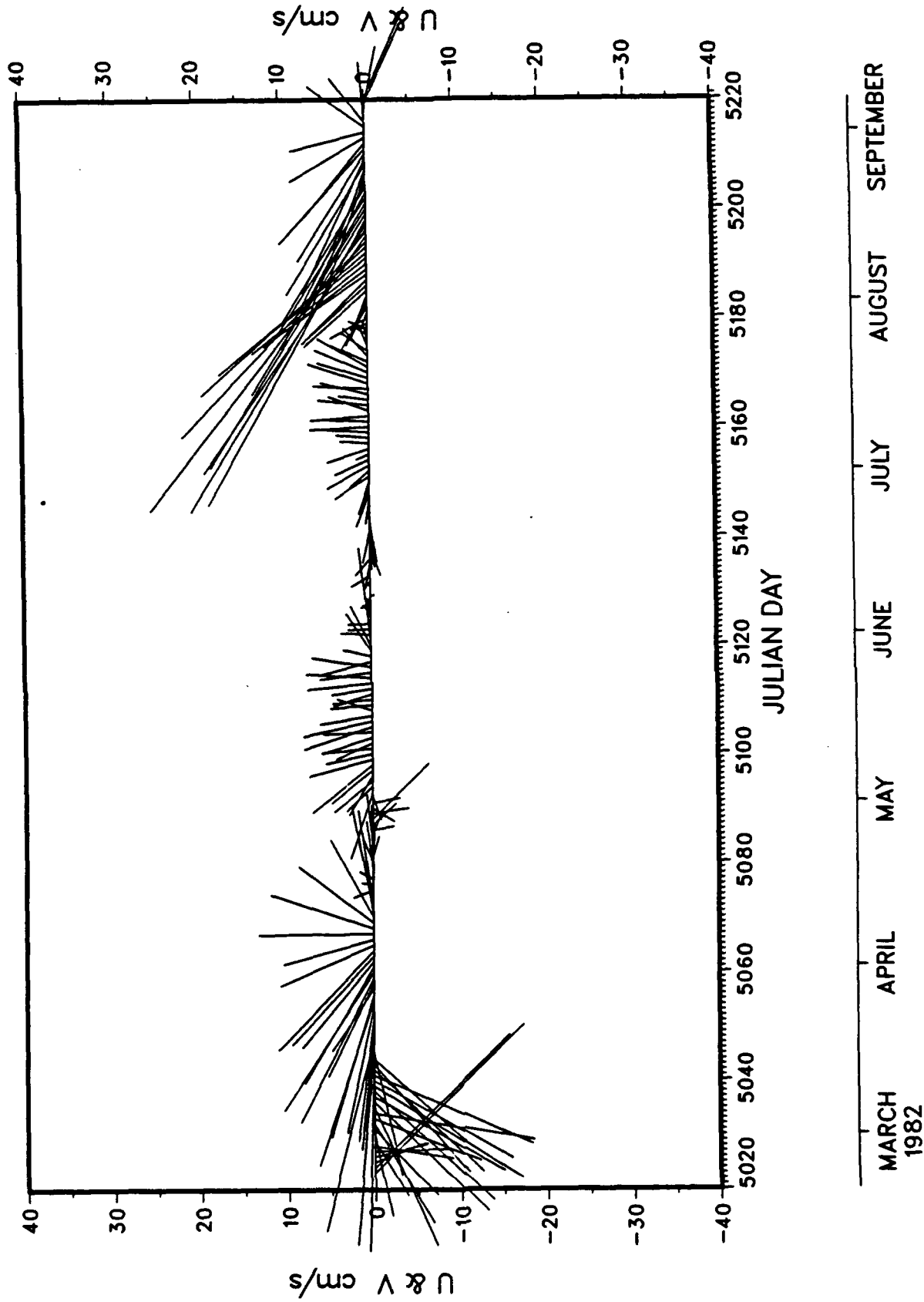


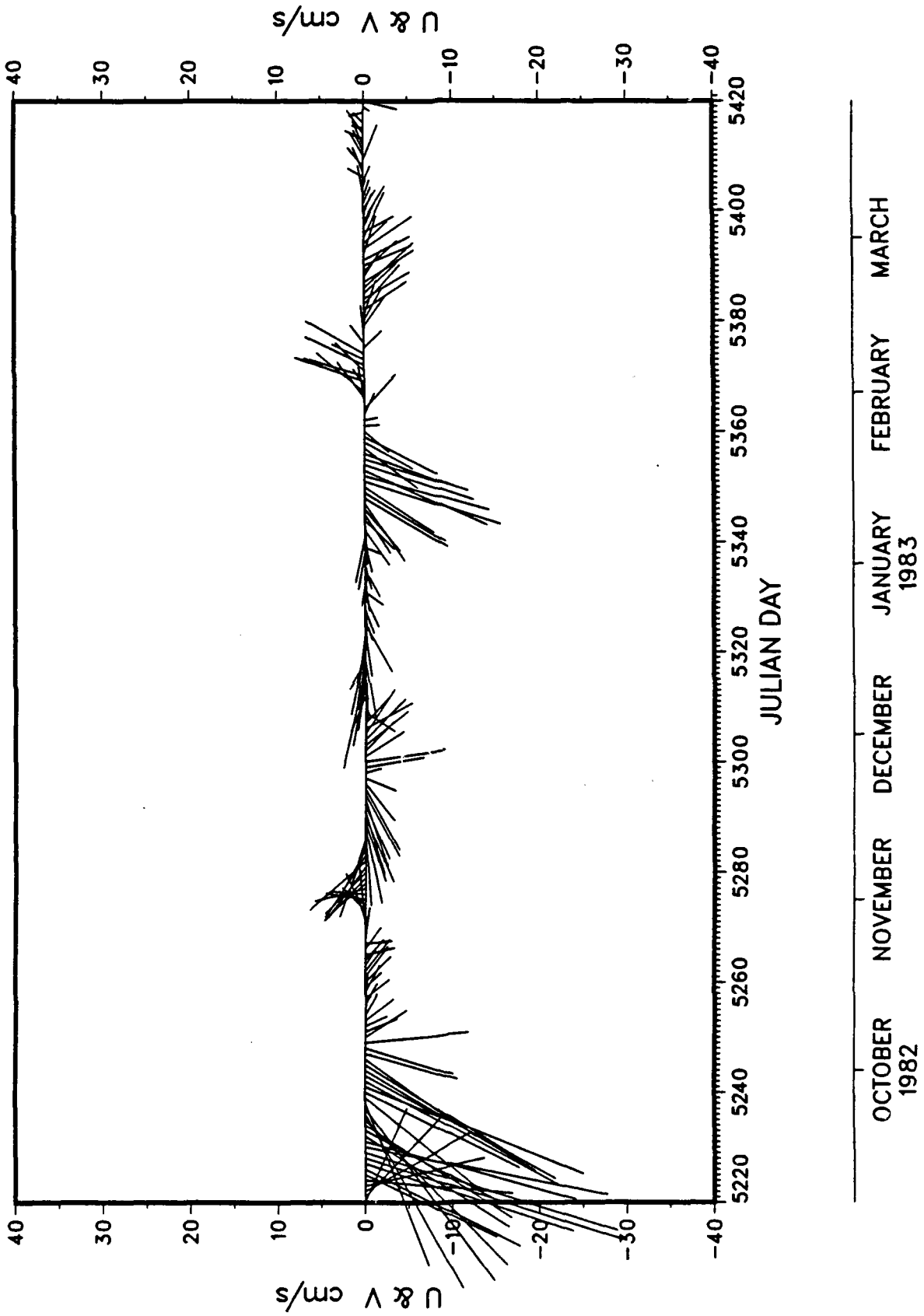
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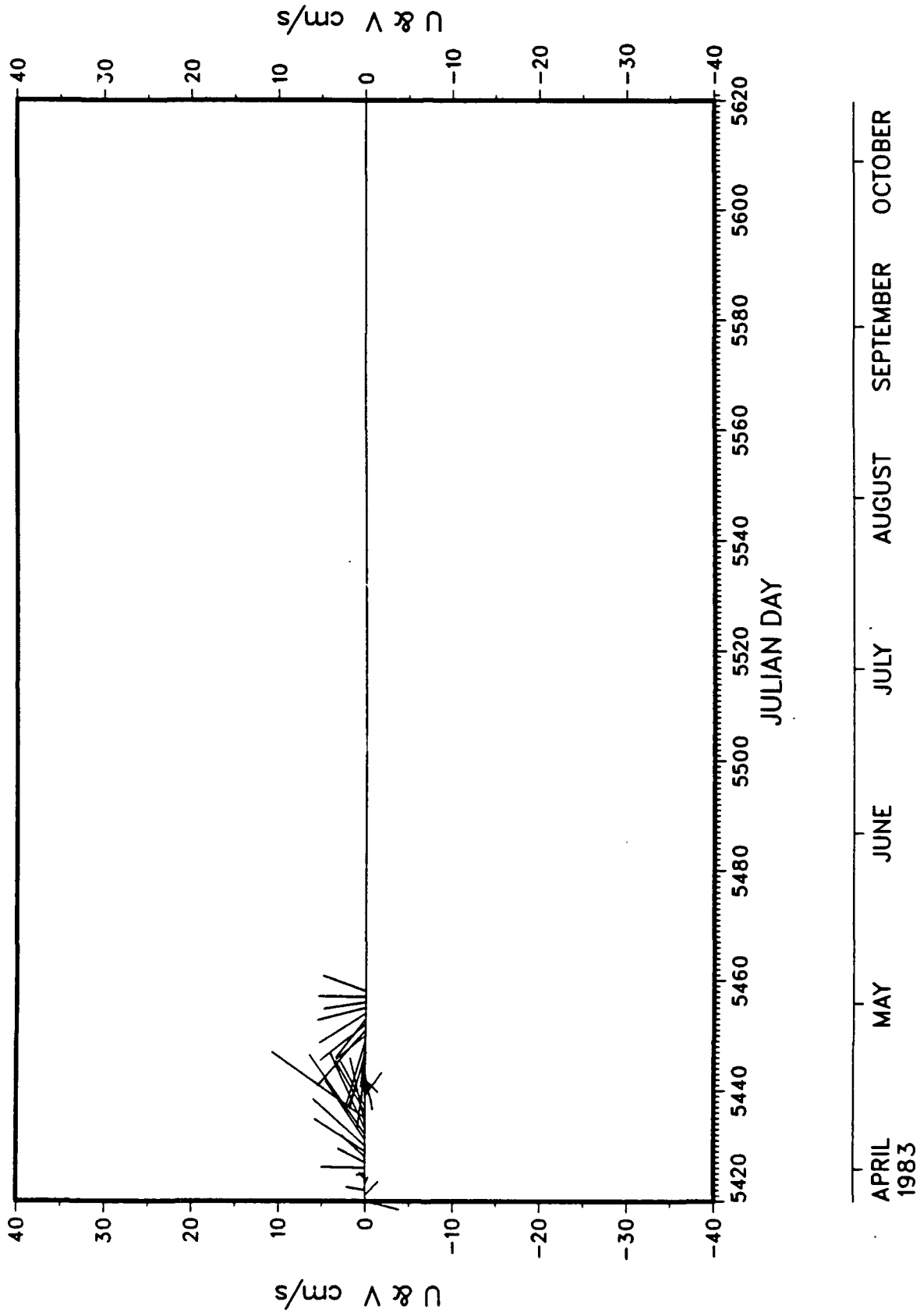
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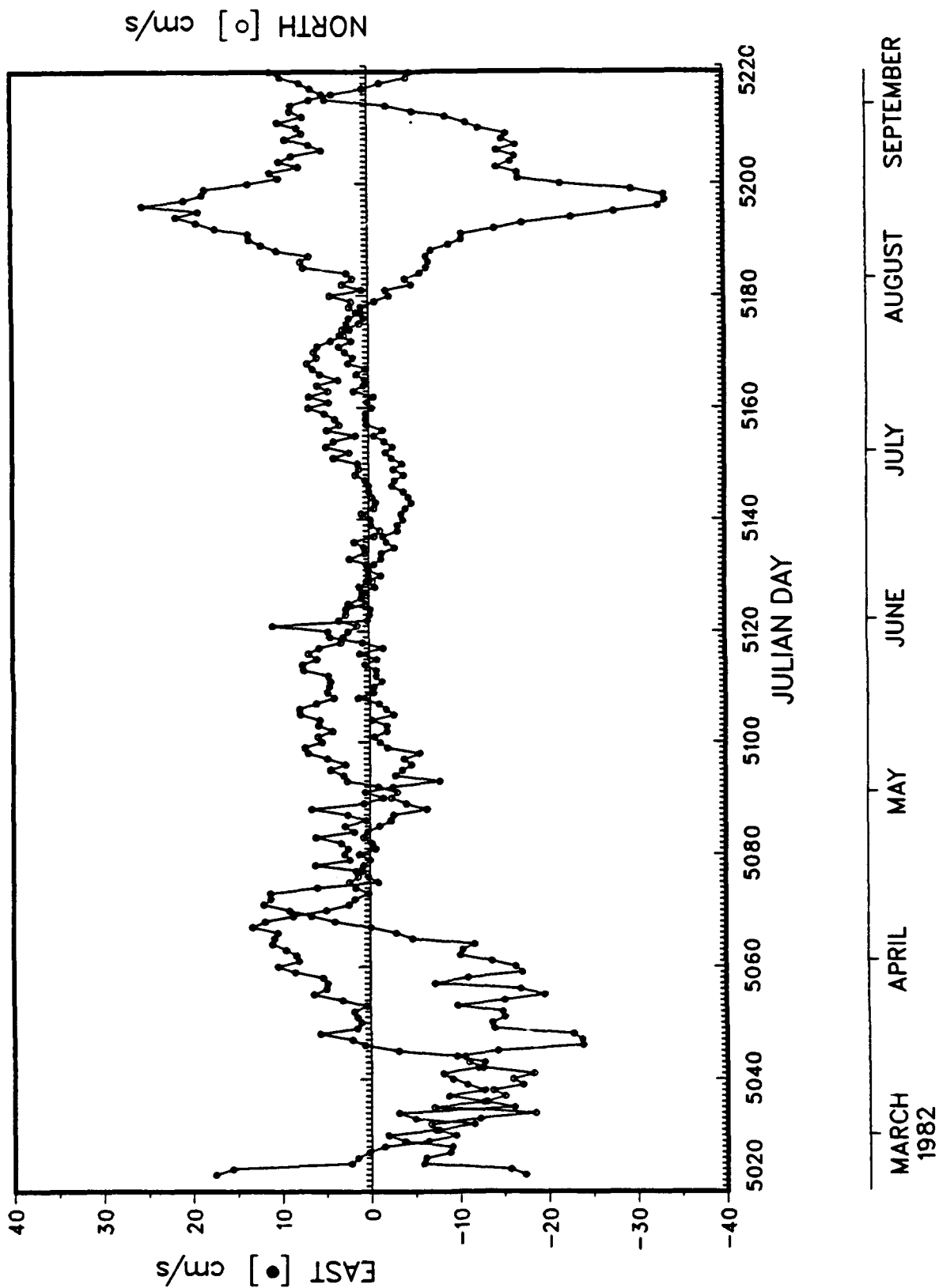




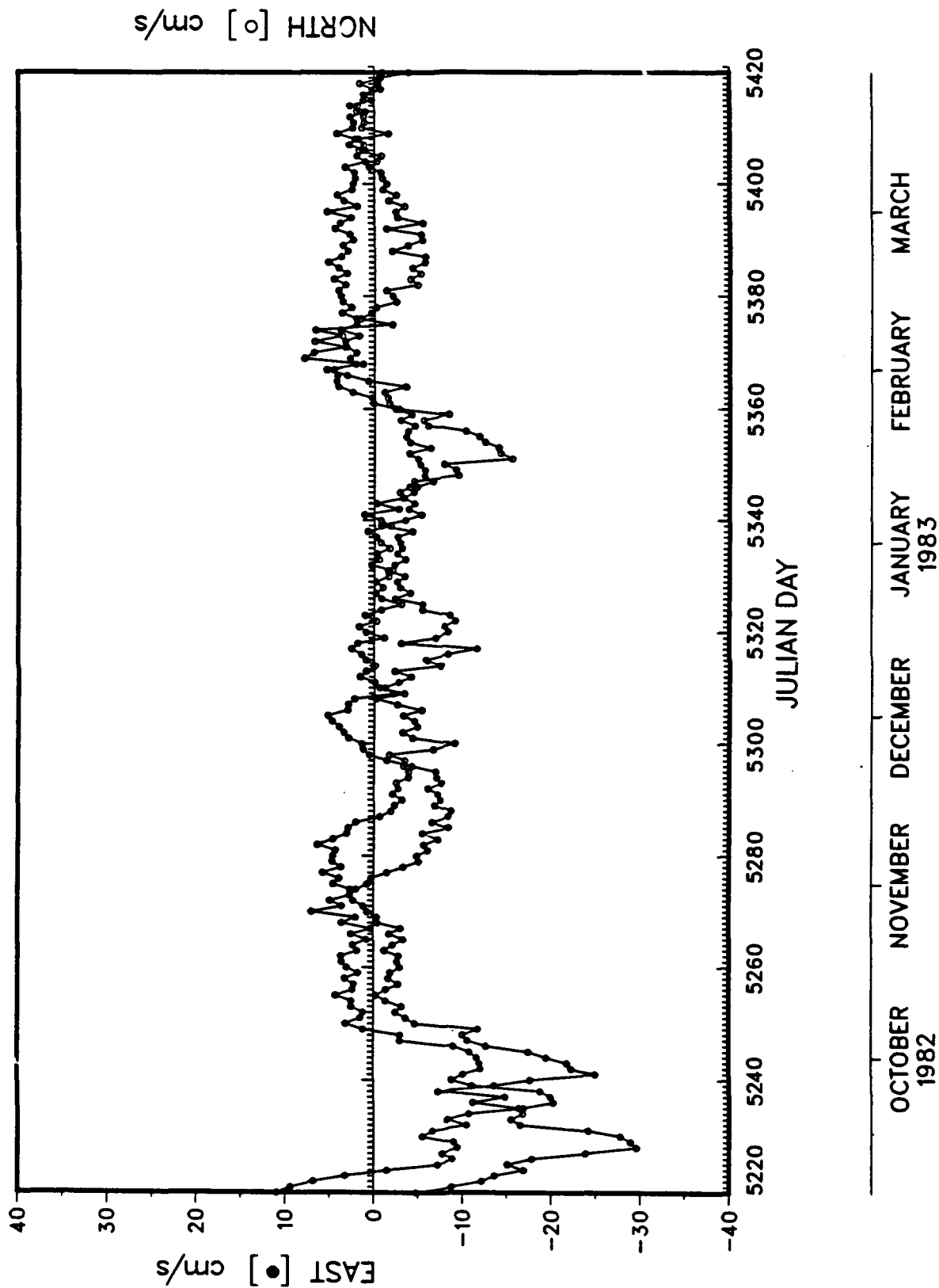
OCTOBER 1982 NOVEMBER DECEMBER JANUARY 1983 FEBRUARY MARCH

GUSREX 118B

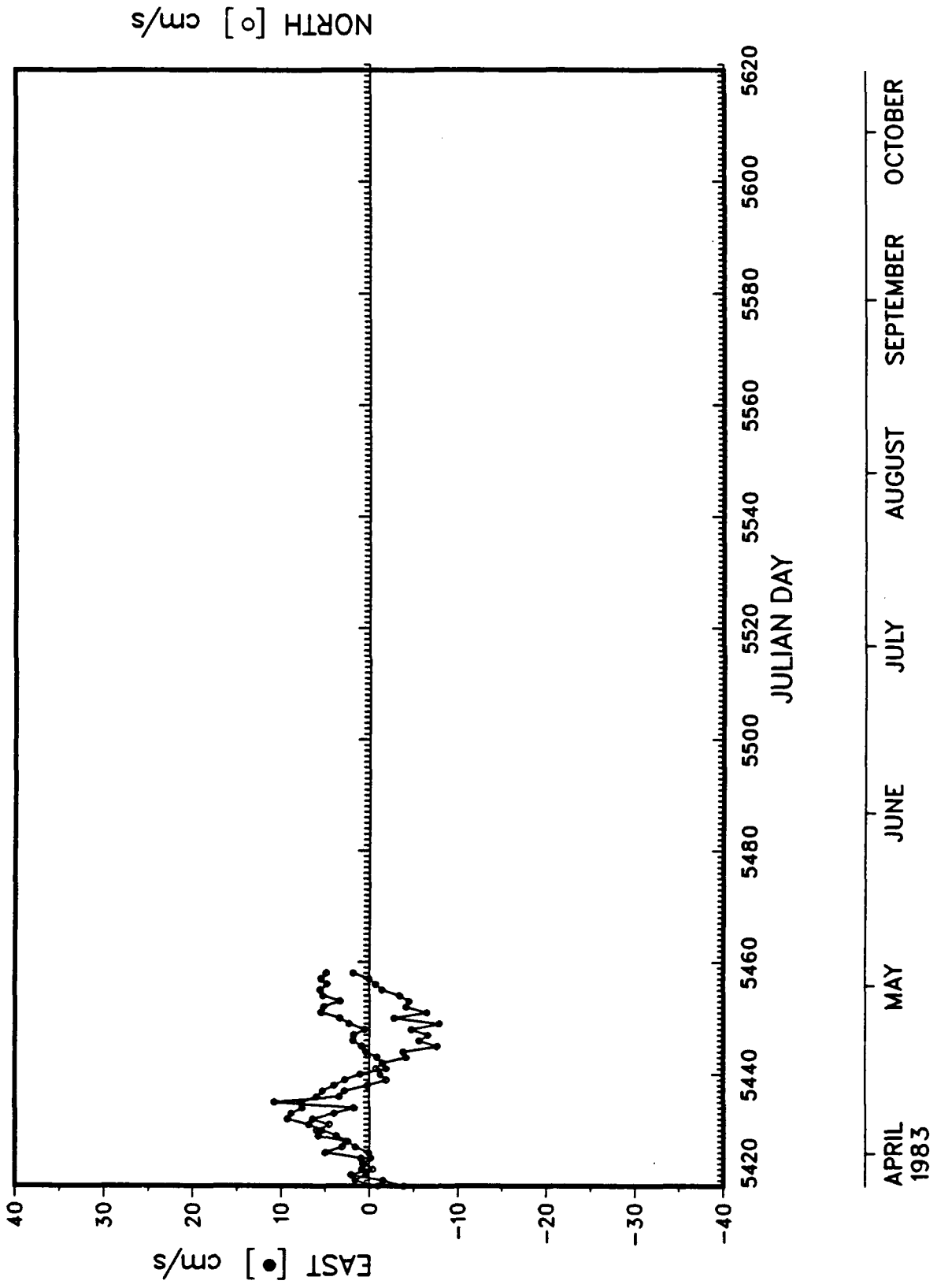




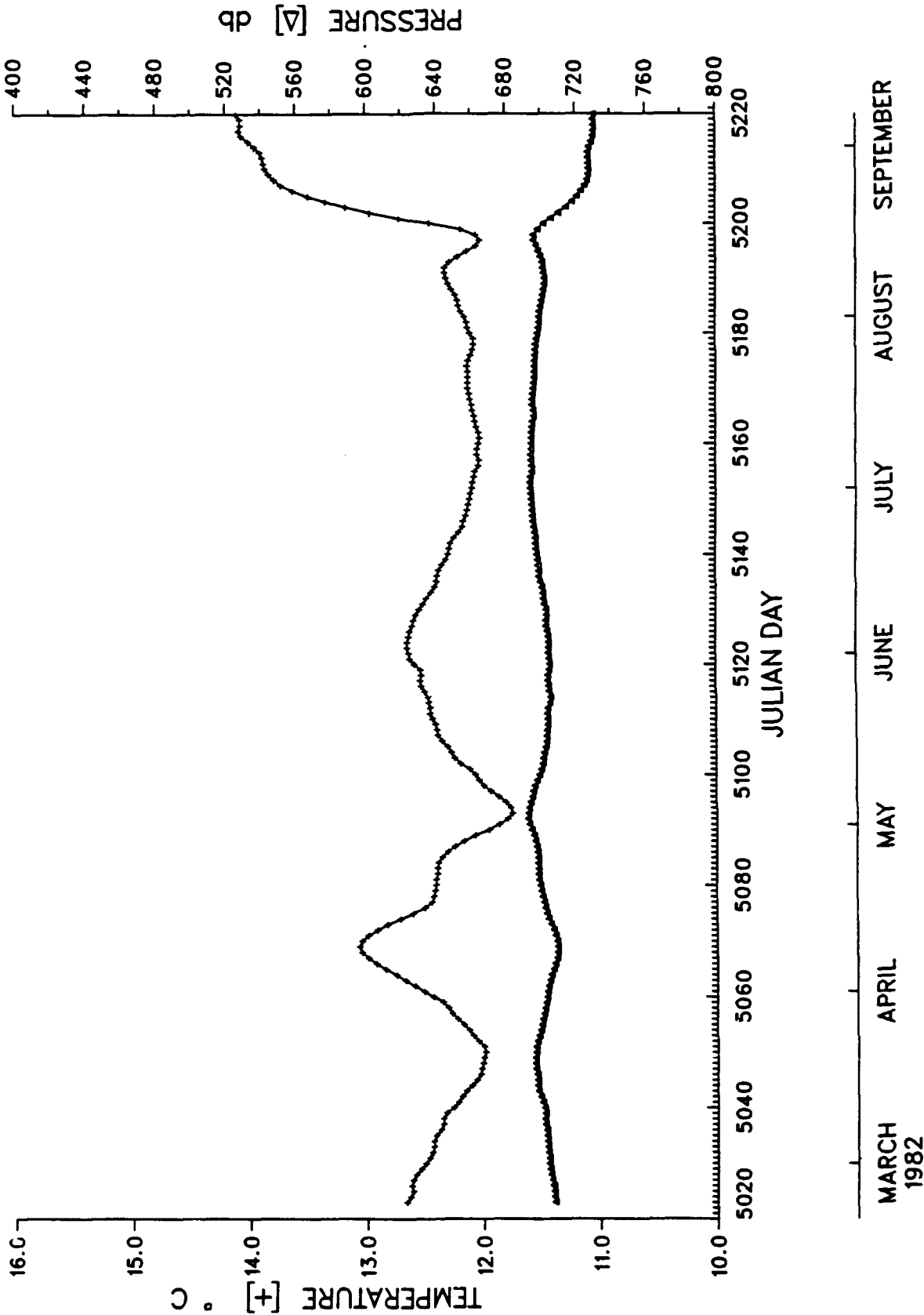
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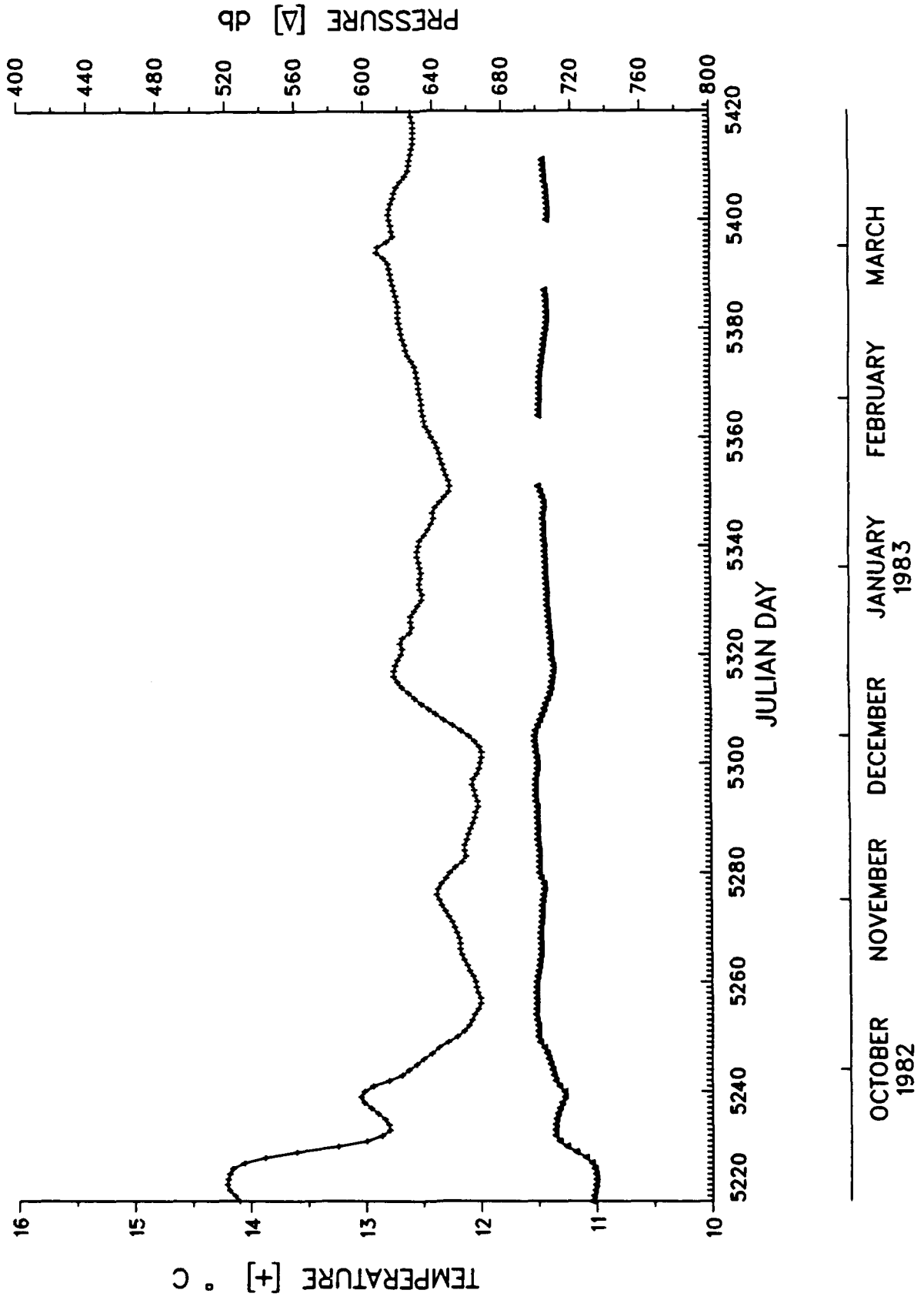
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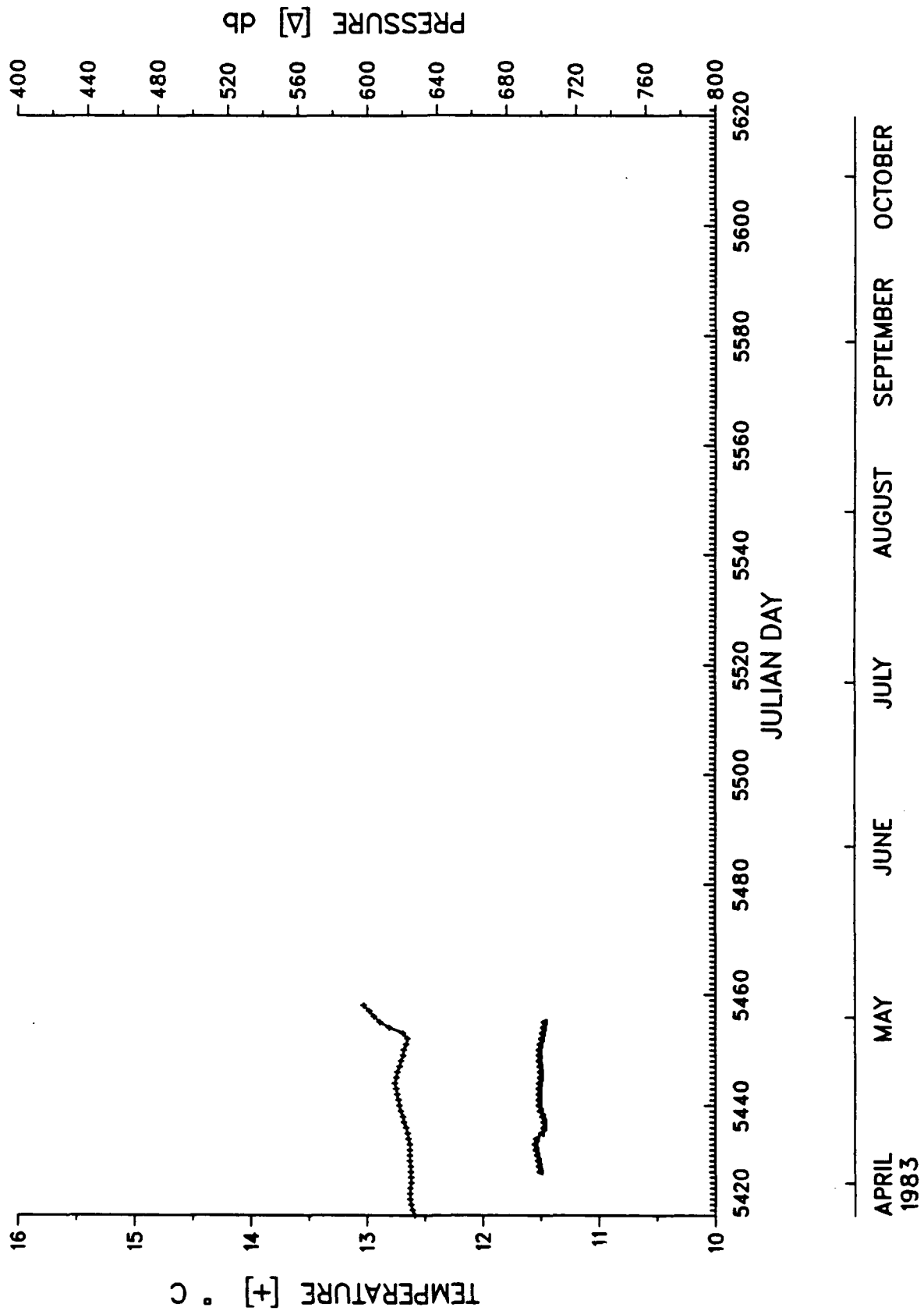
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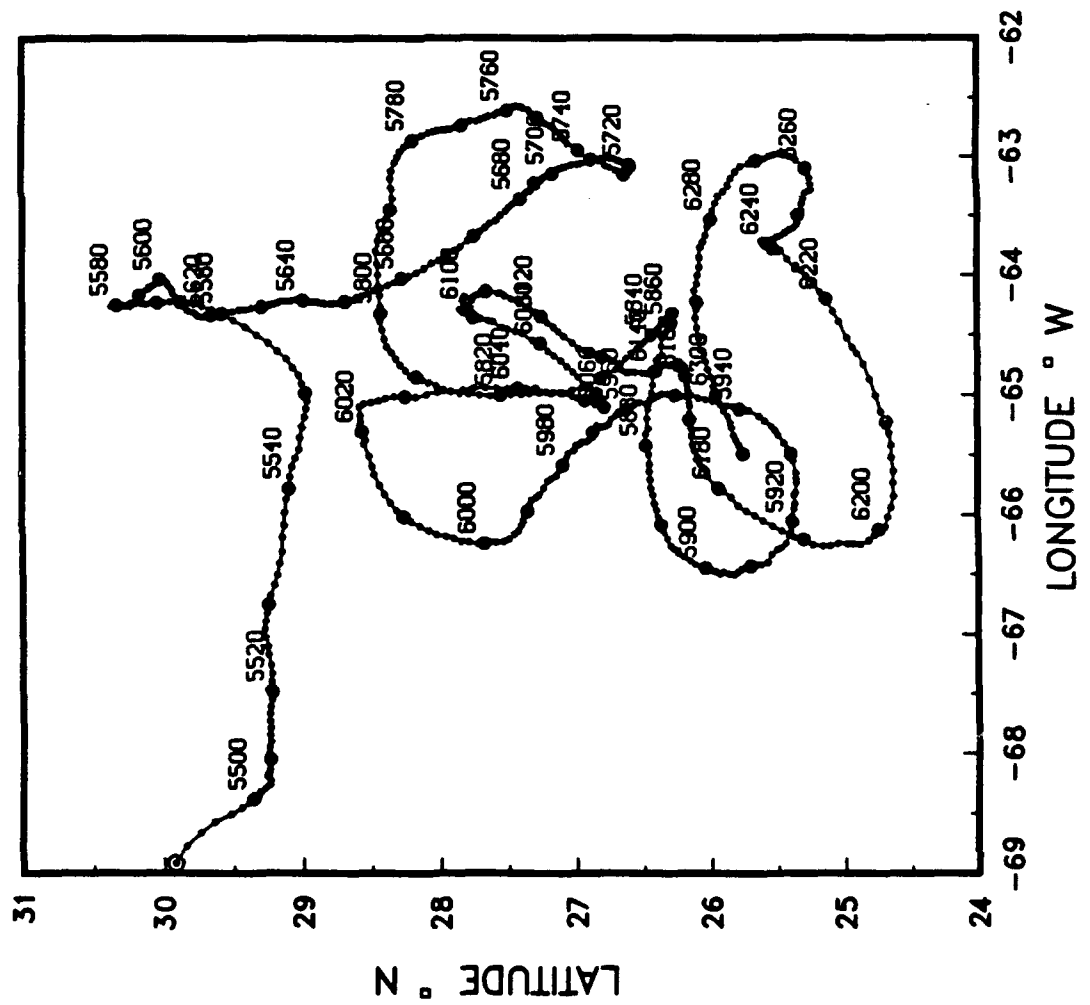
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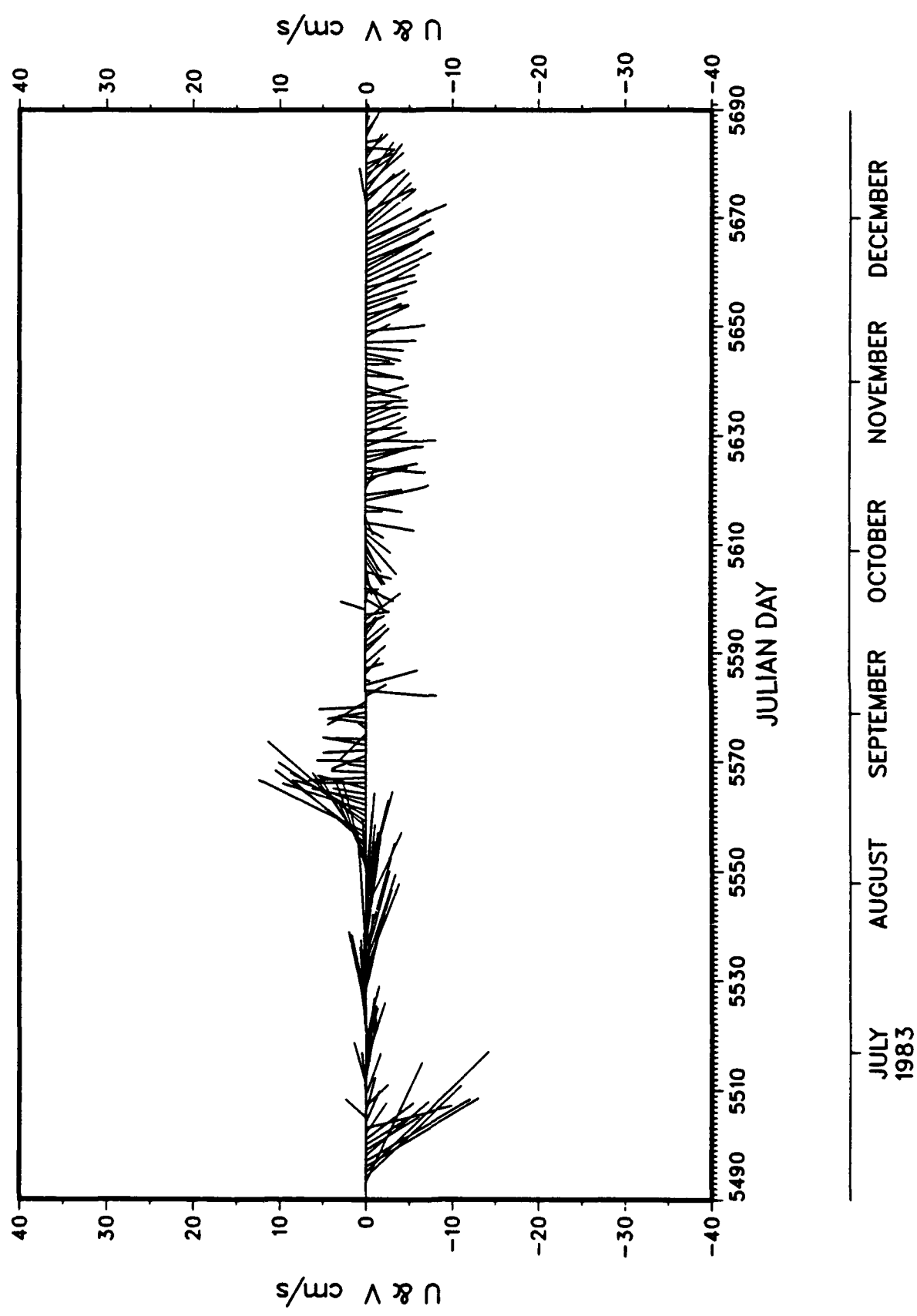
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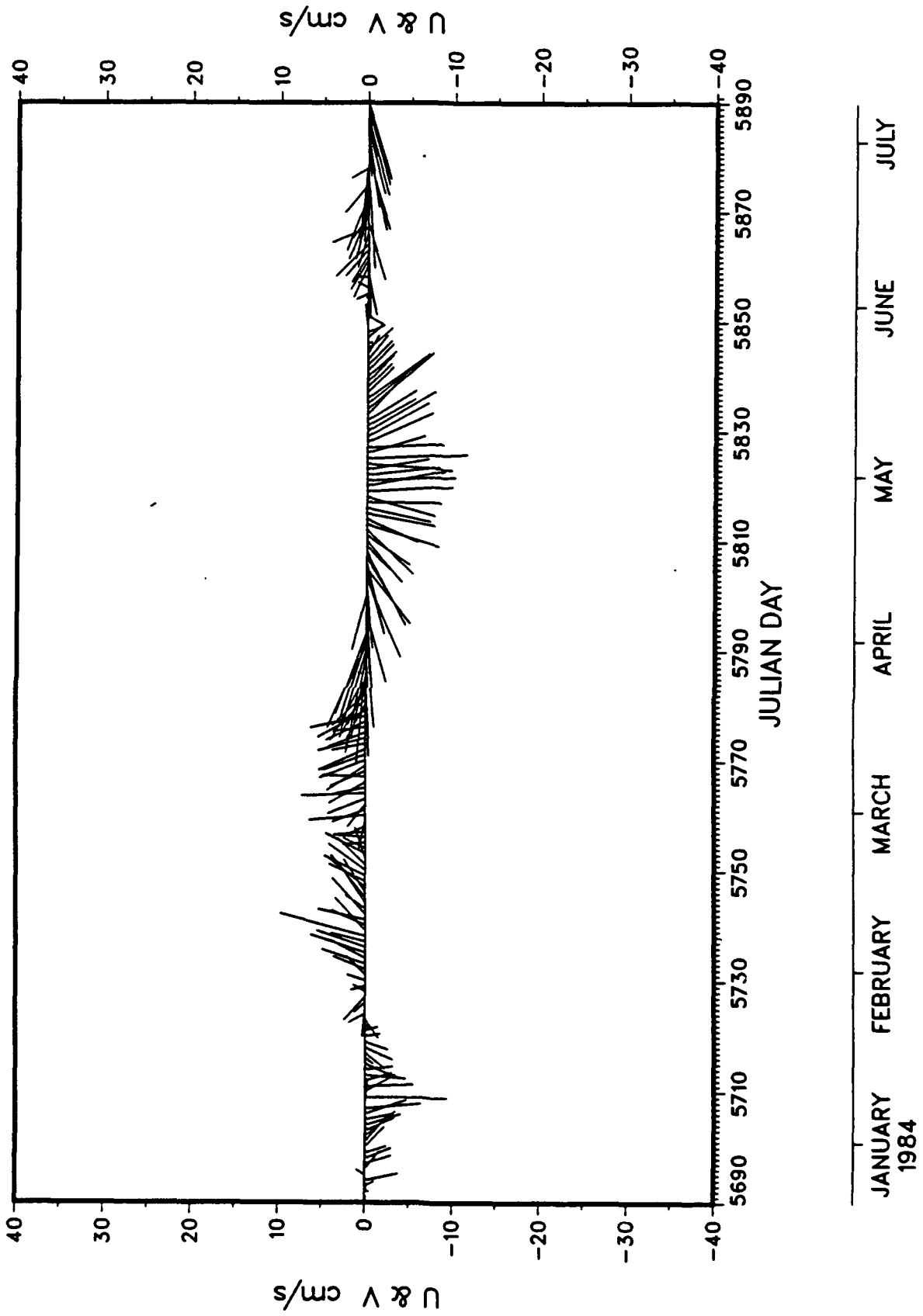


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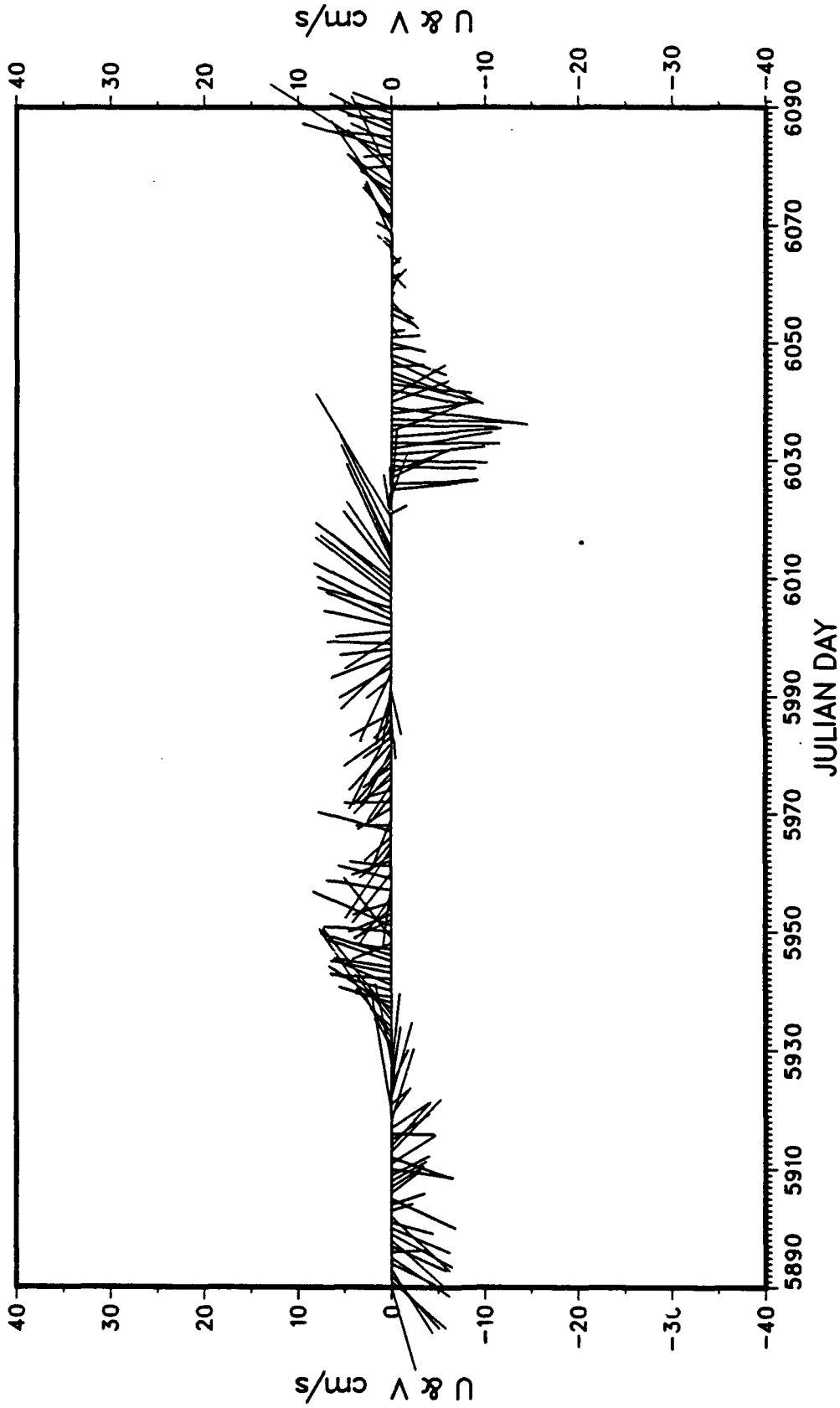


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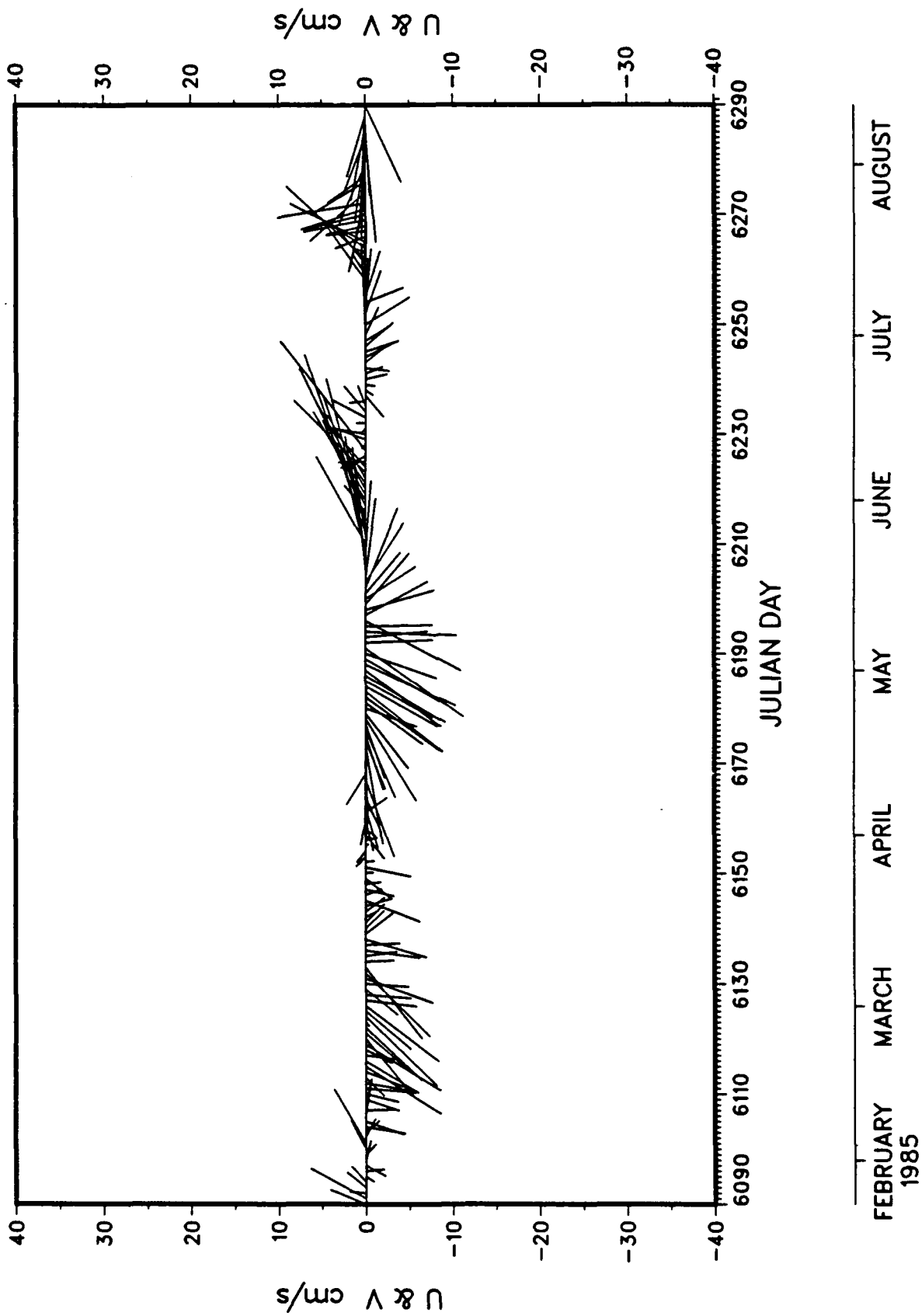


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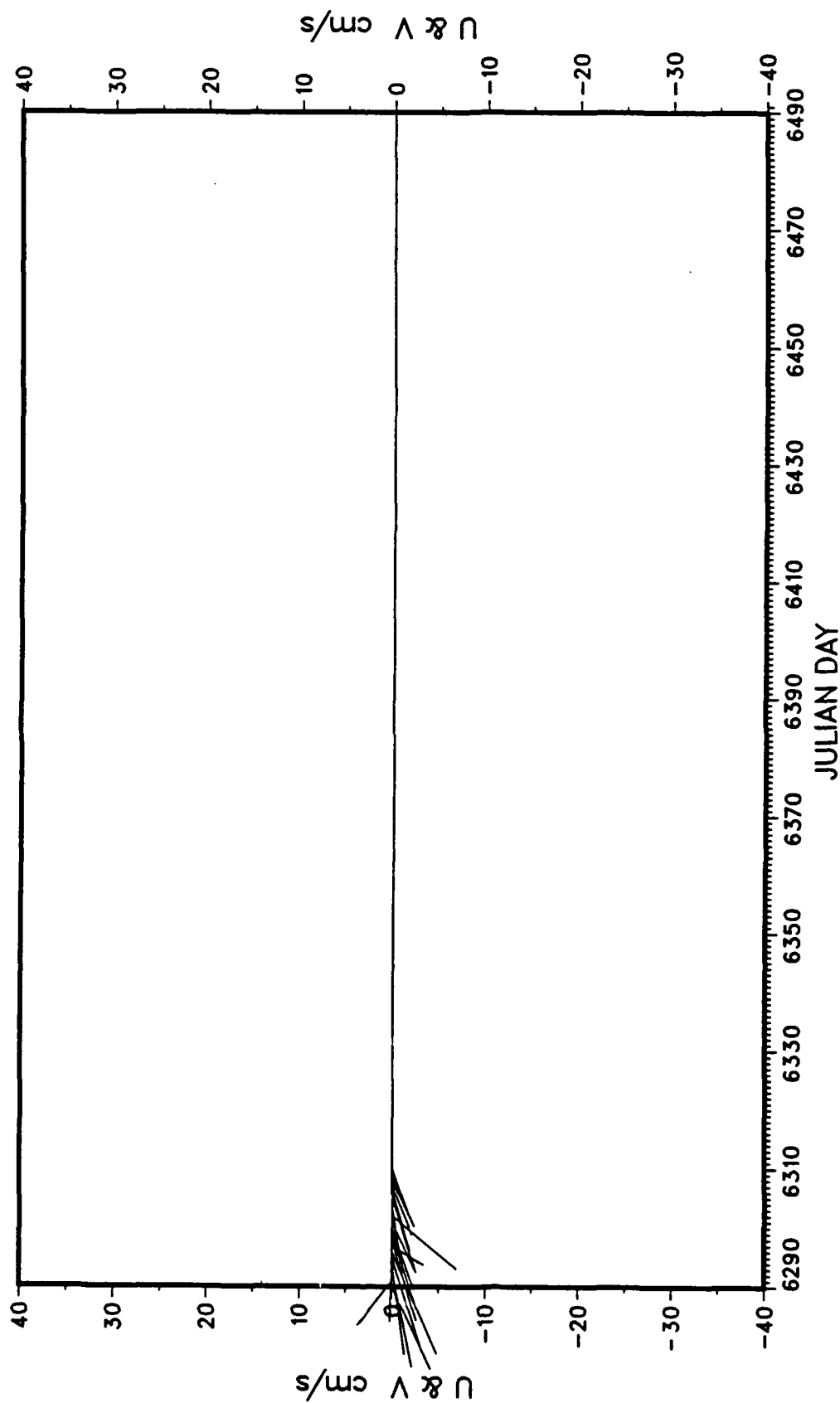


AUGUST 1984
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER
JANUARY 1985

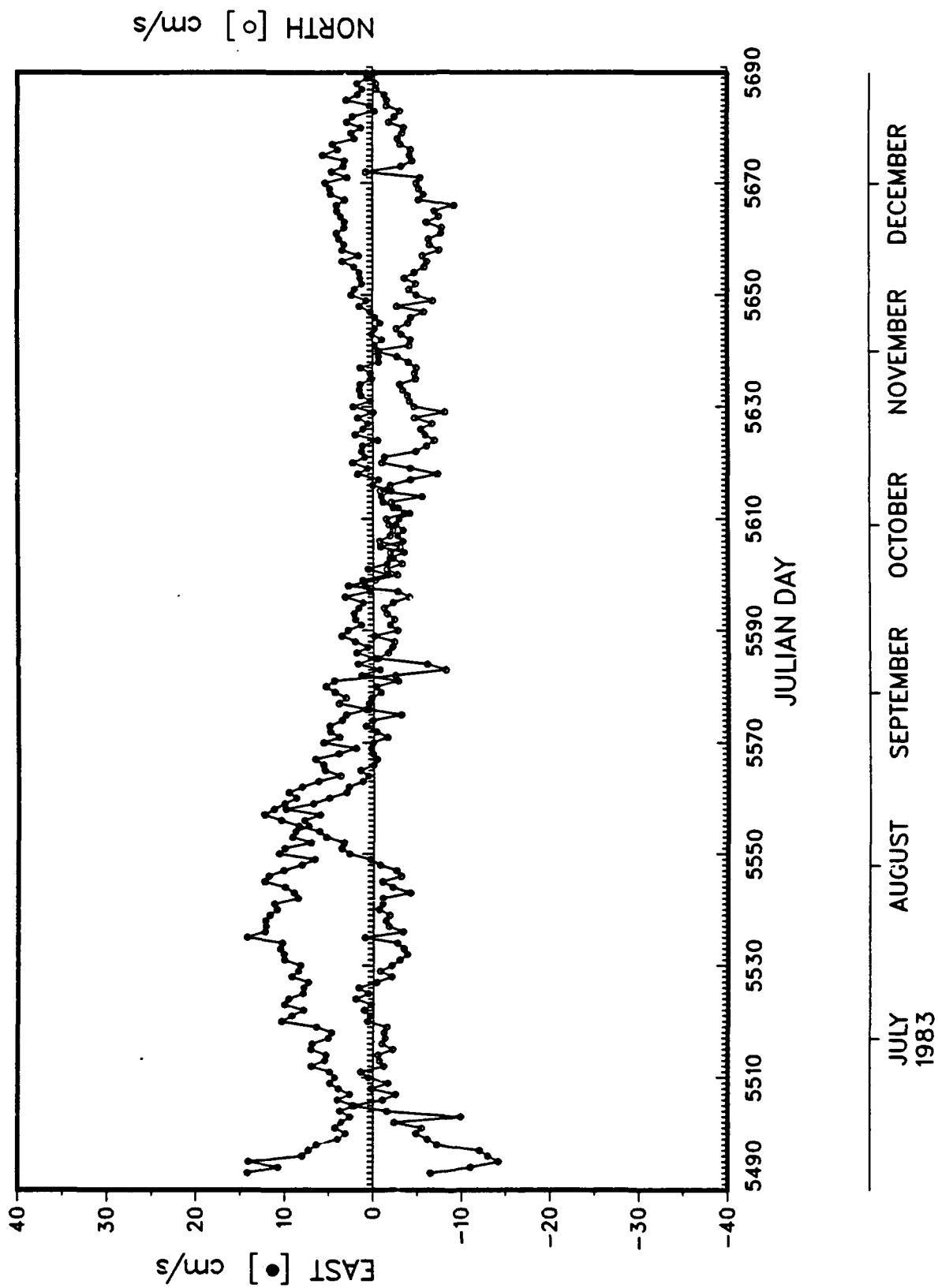
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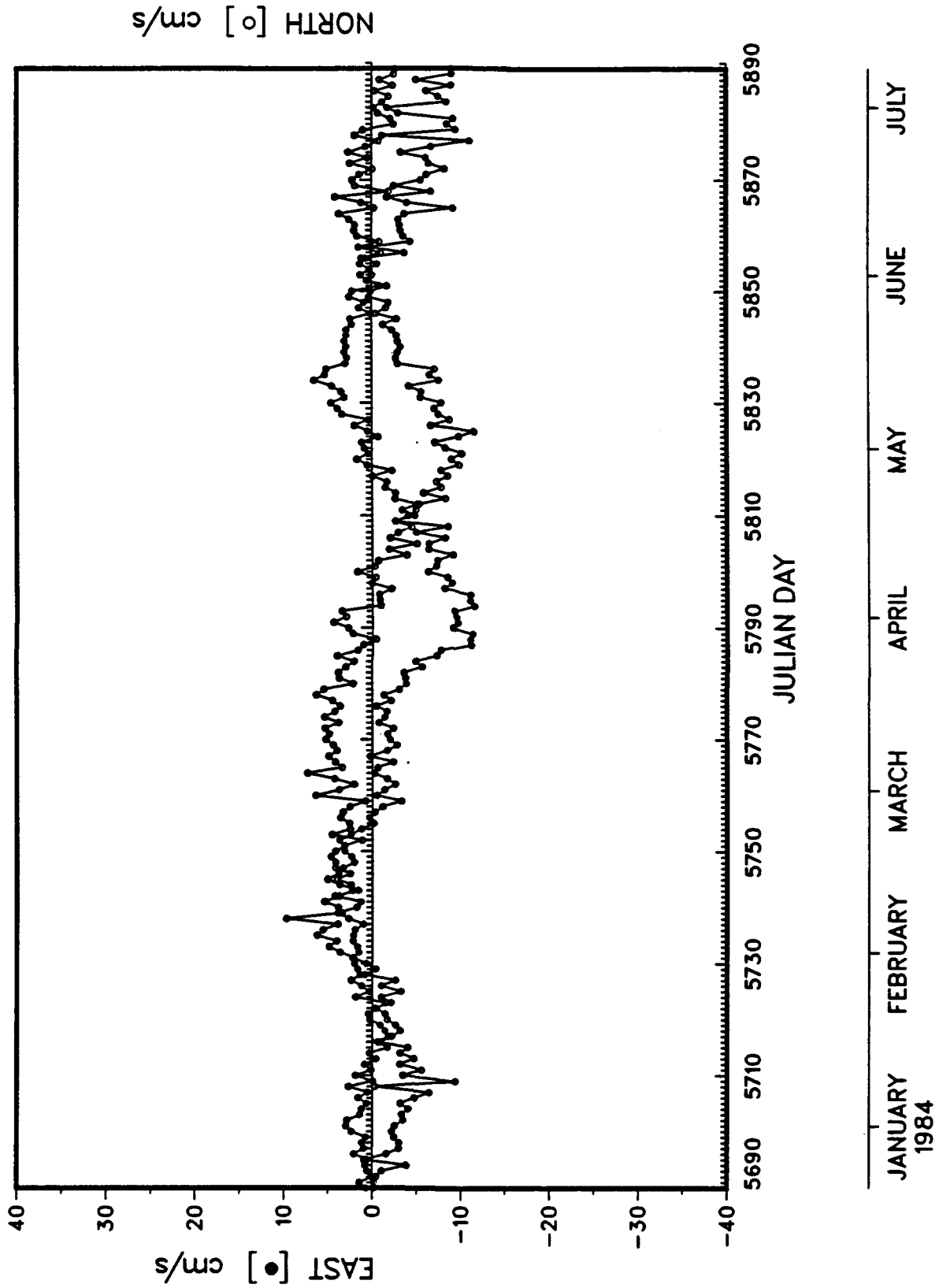
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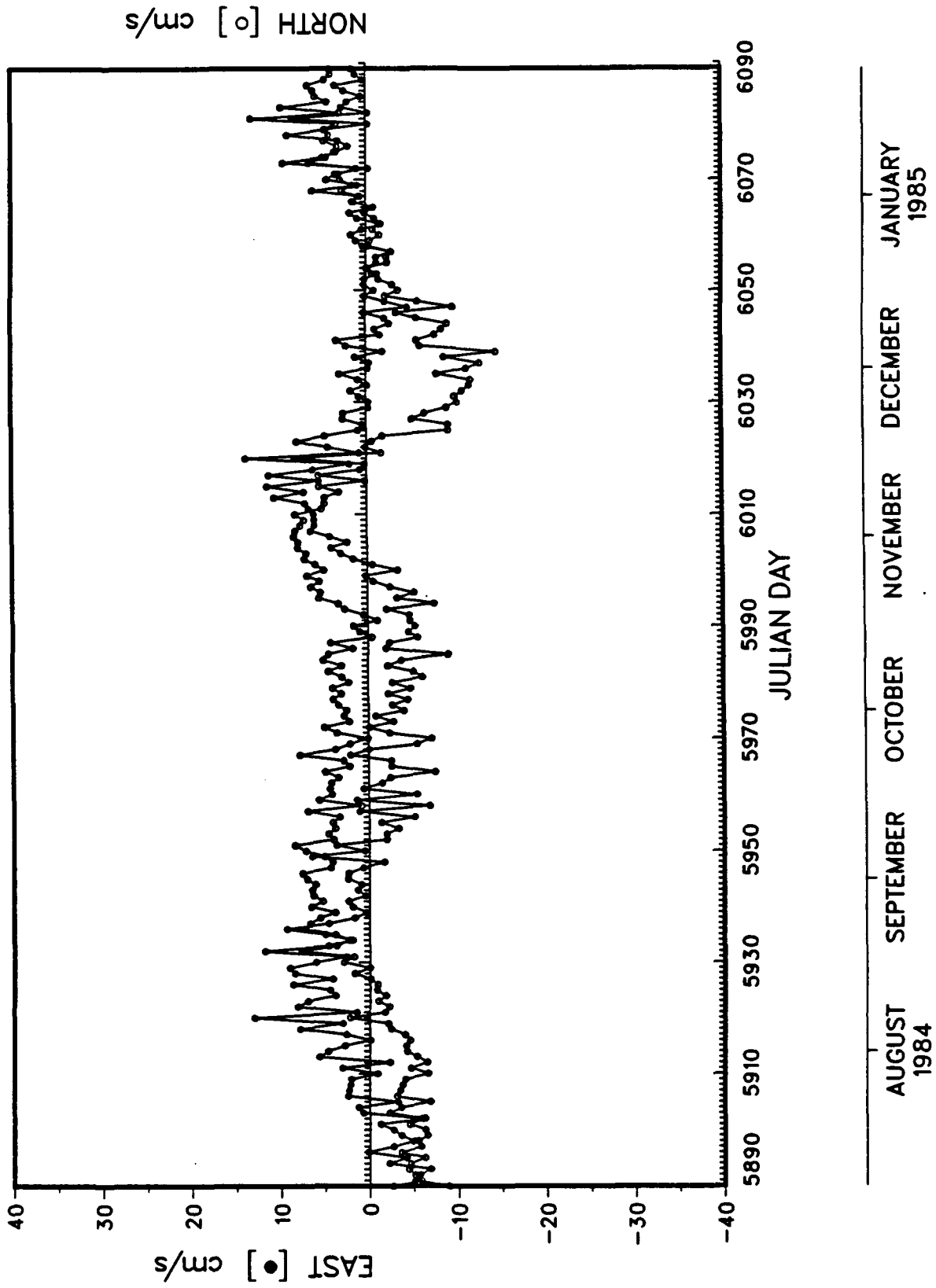


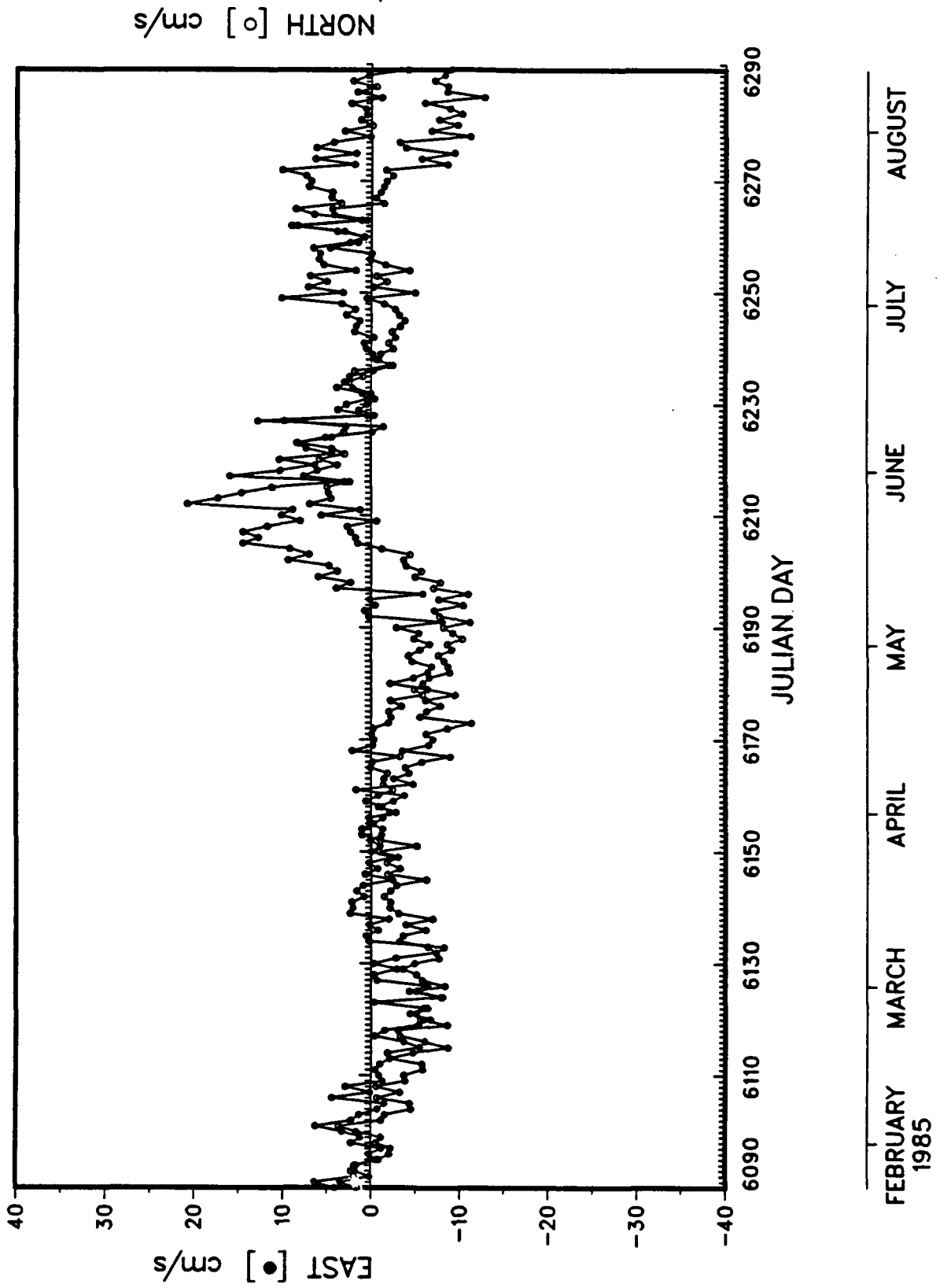
SEPTEMBER 1985 OCTOBER NOVEMBER DECEMBER JANUARY 1986 FEBRUARY

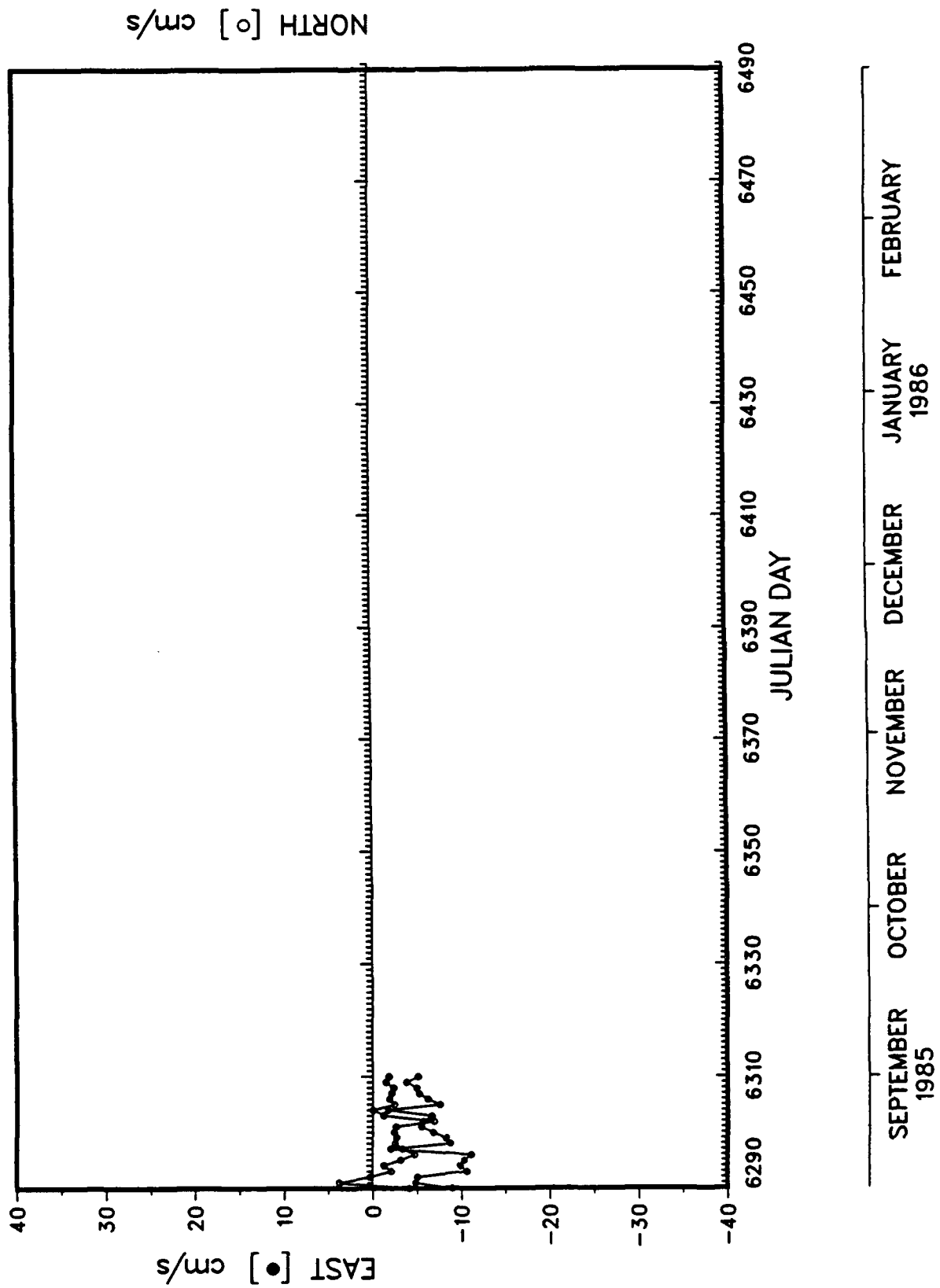


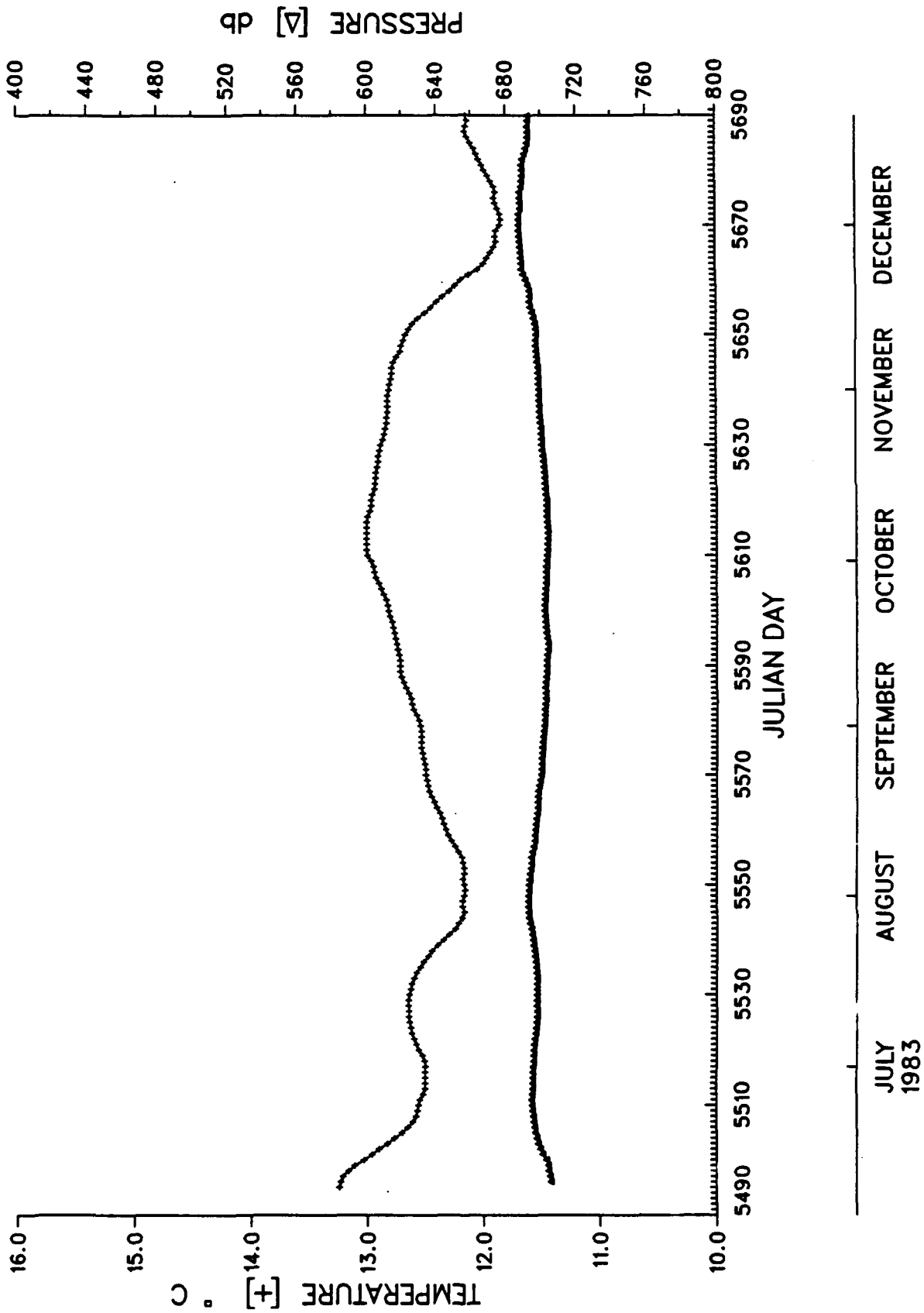
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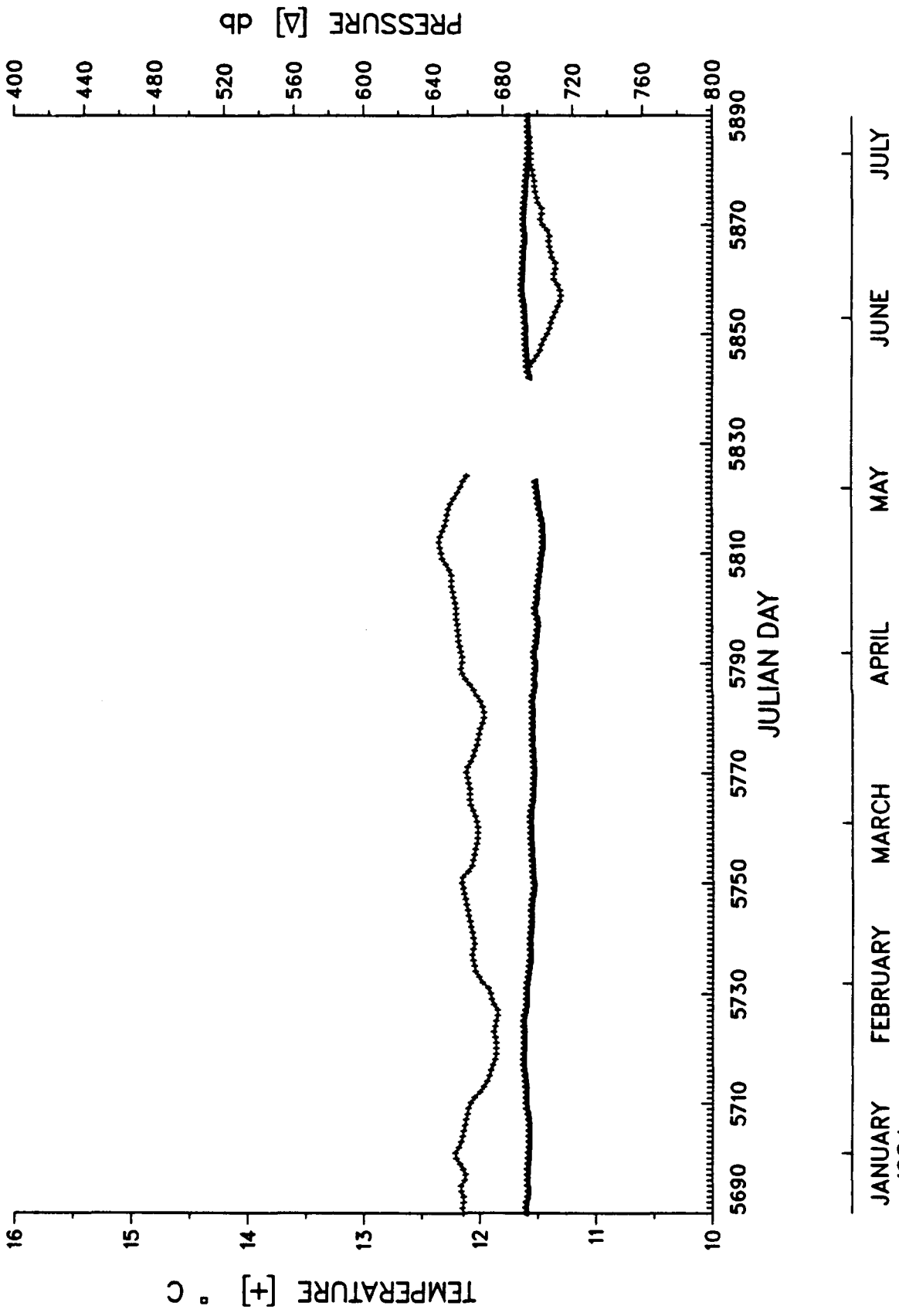


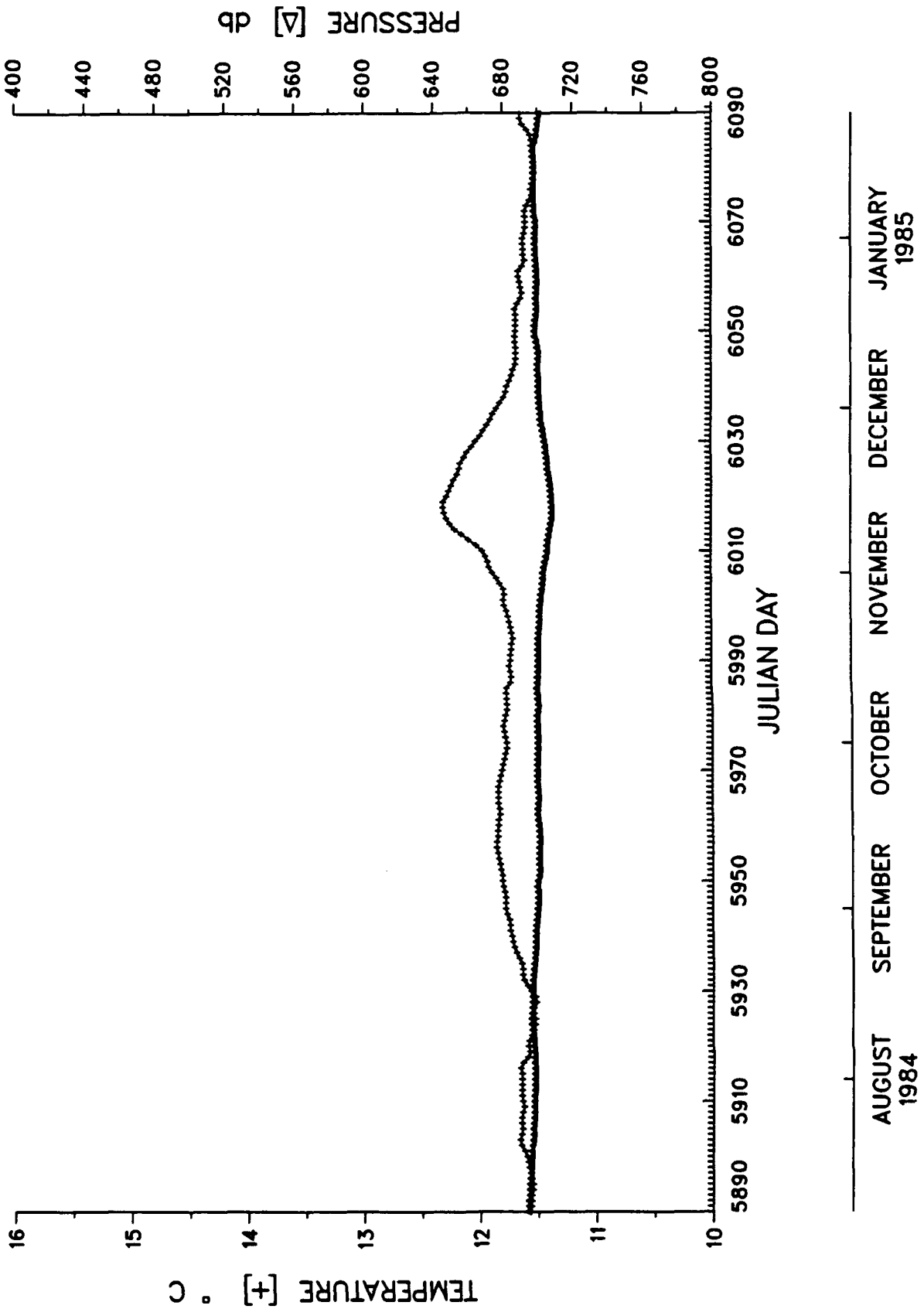


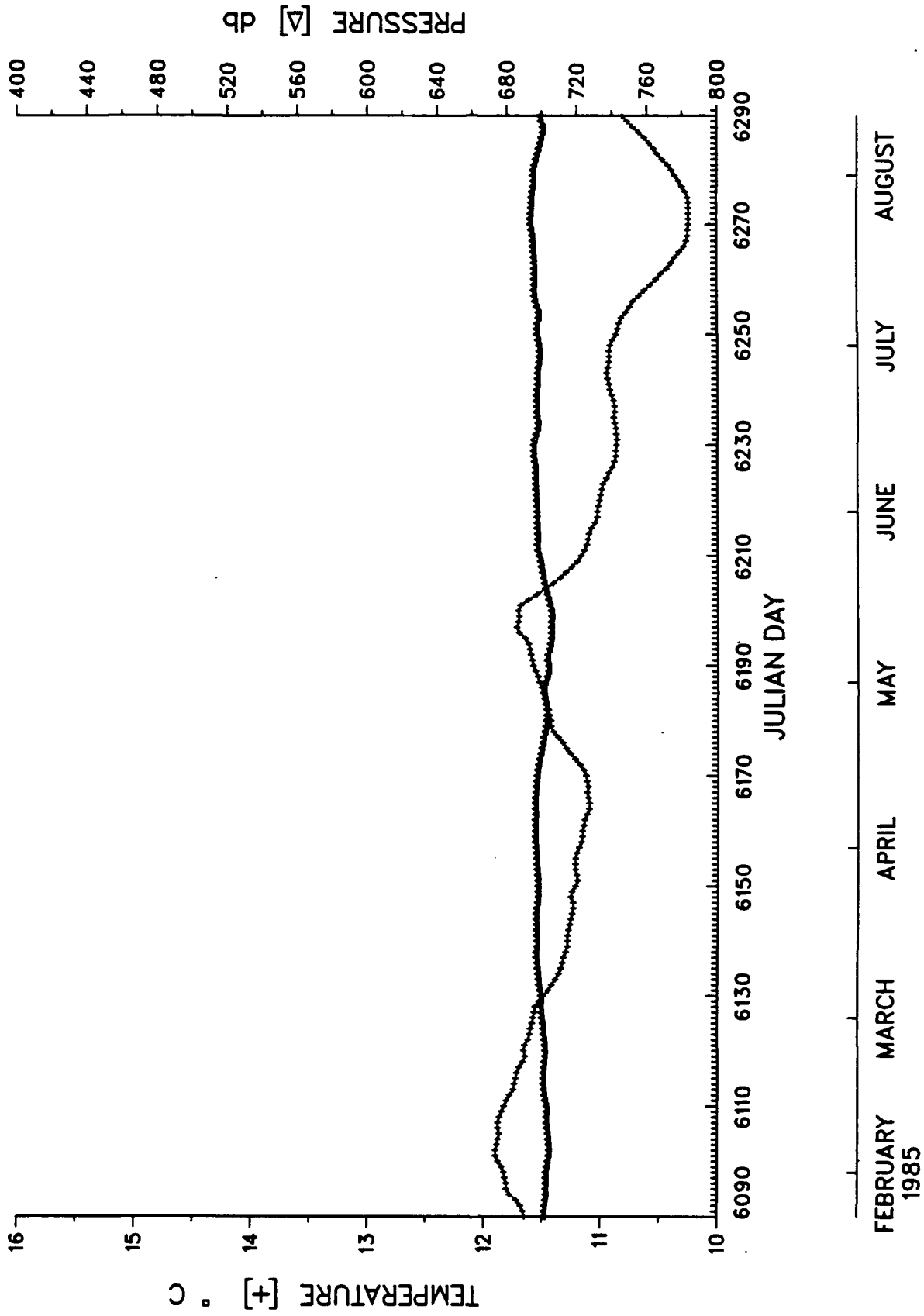


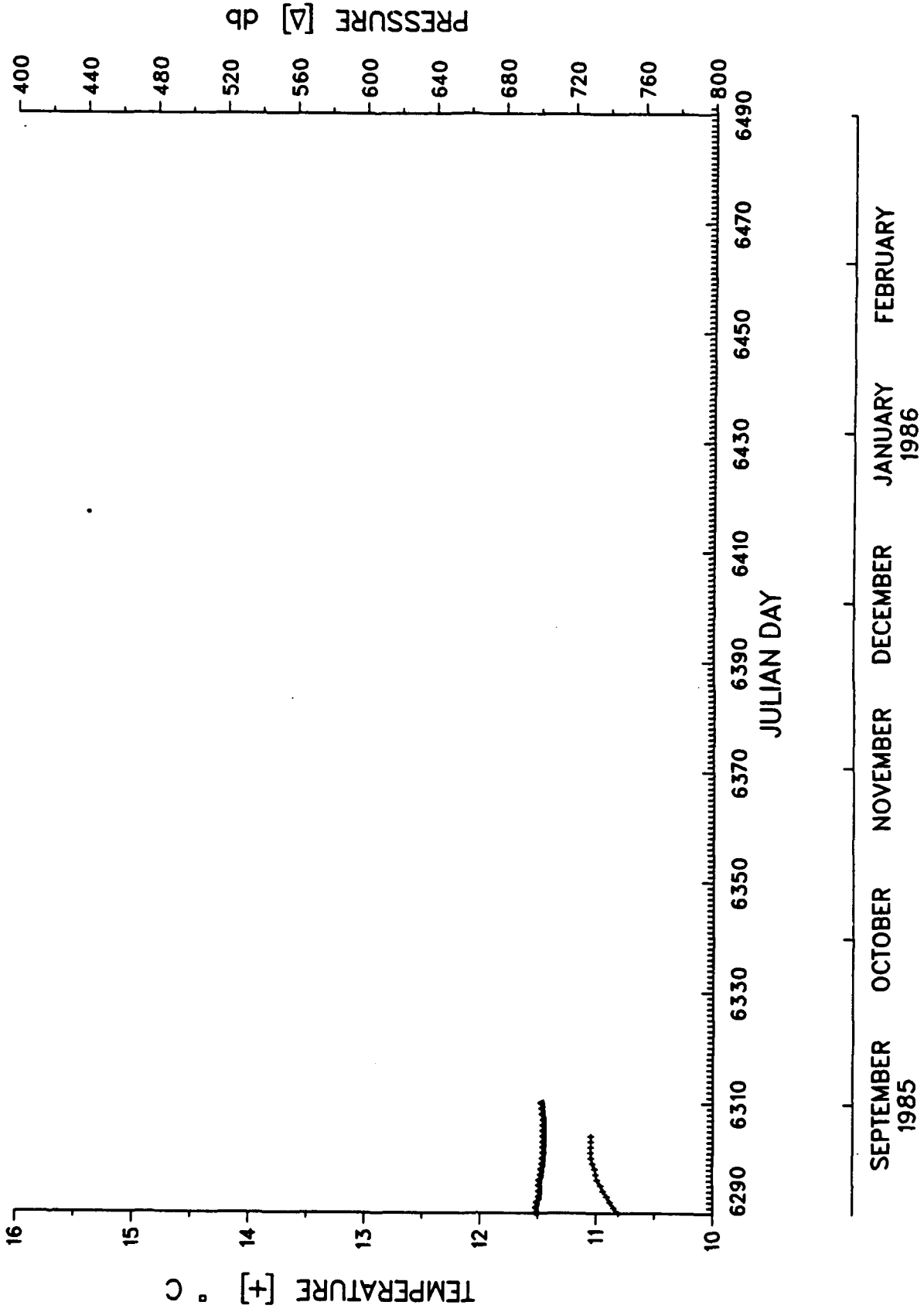




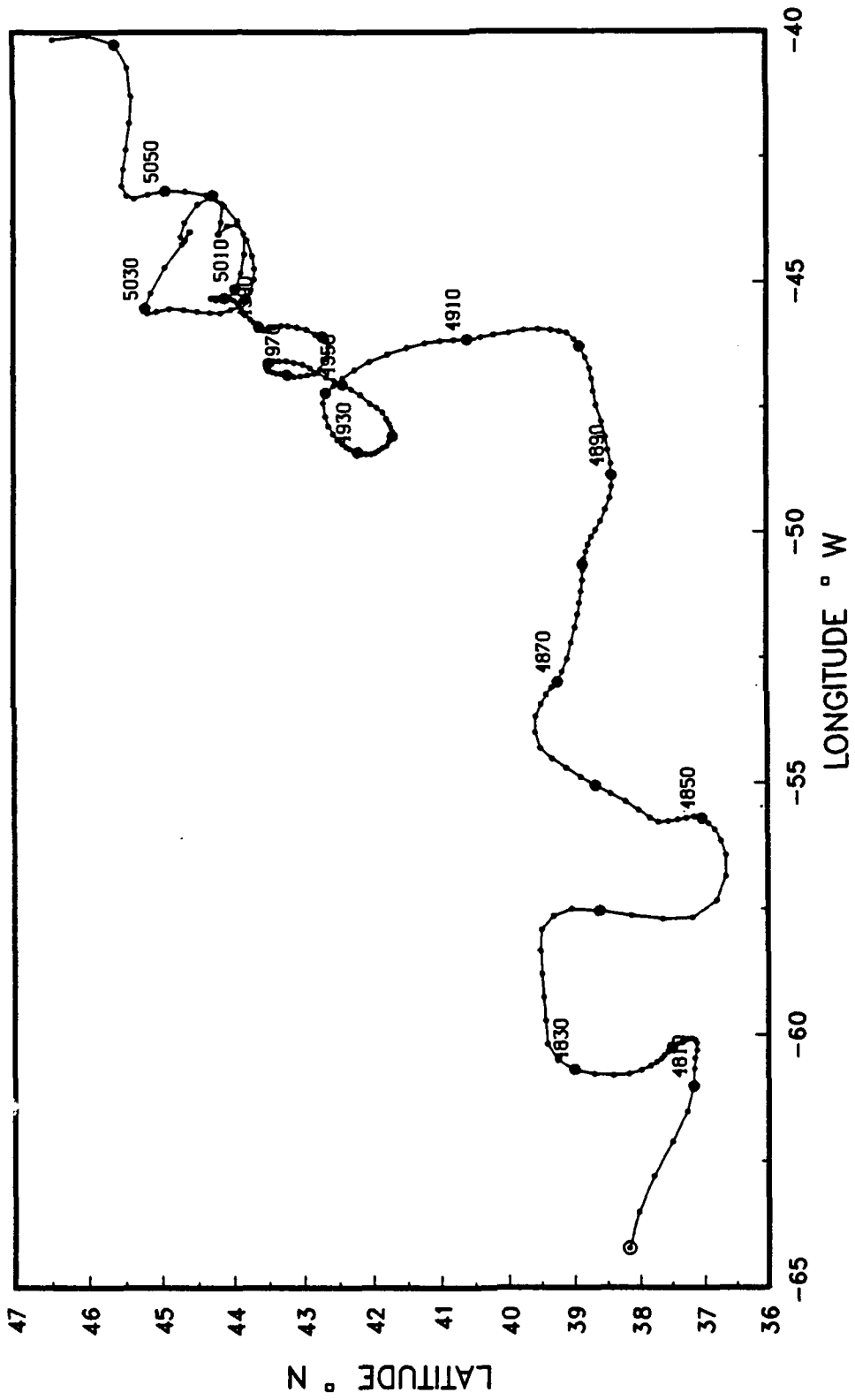


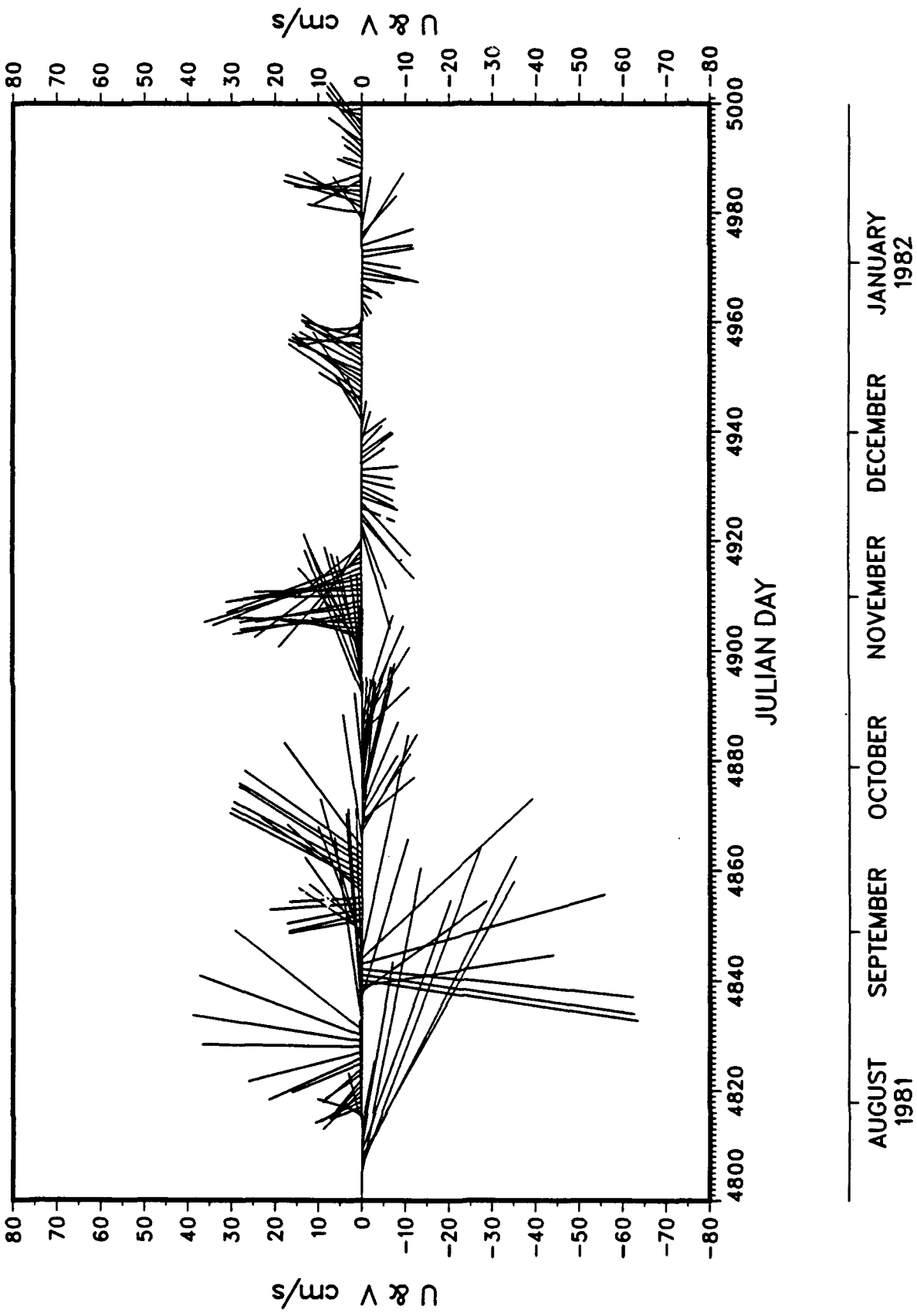


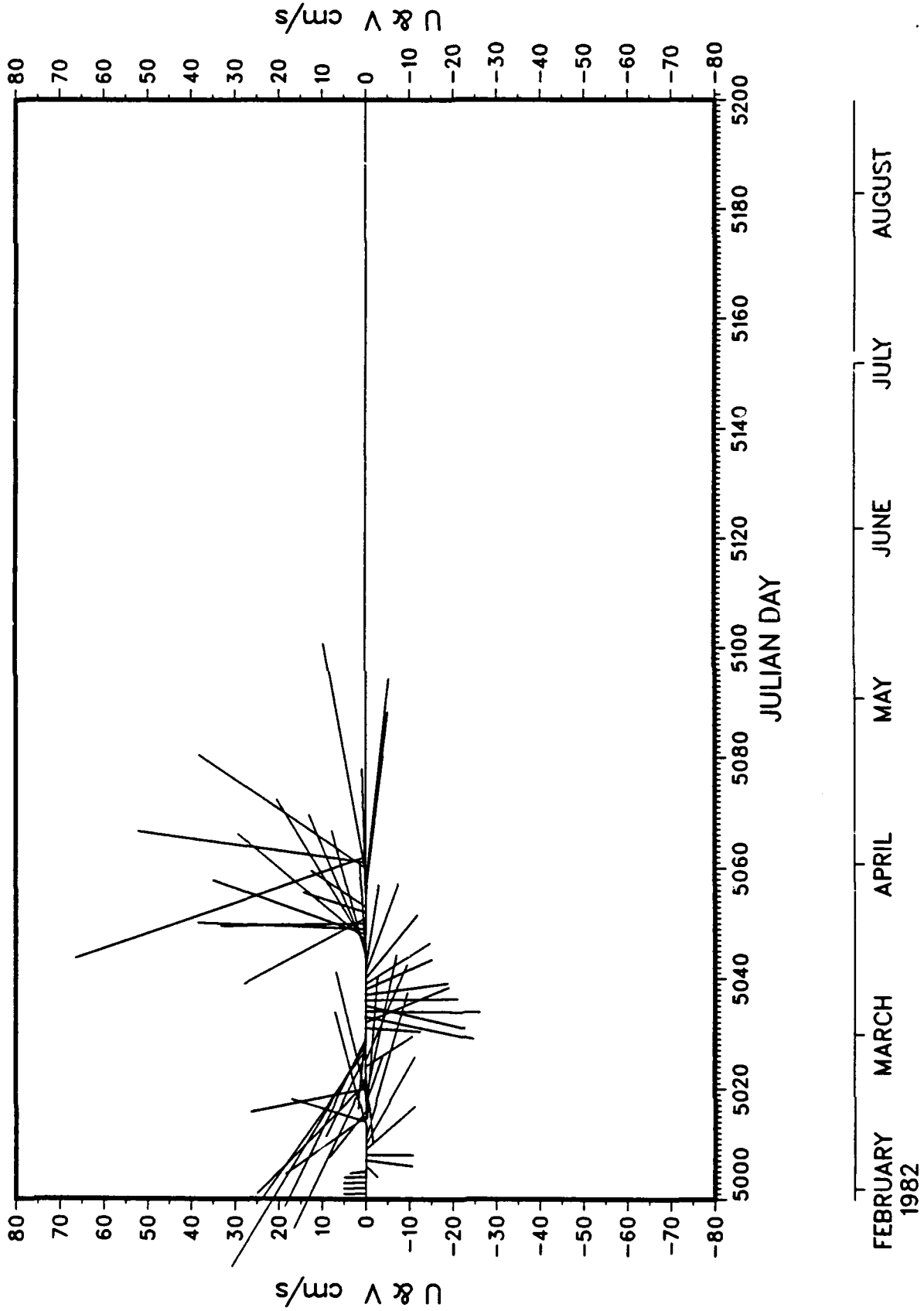




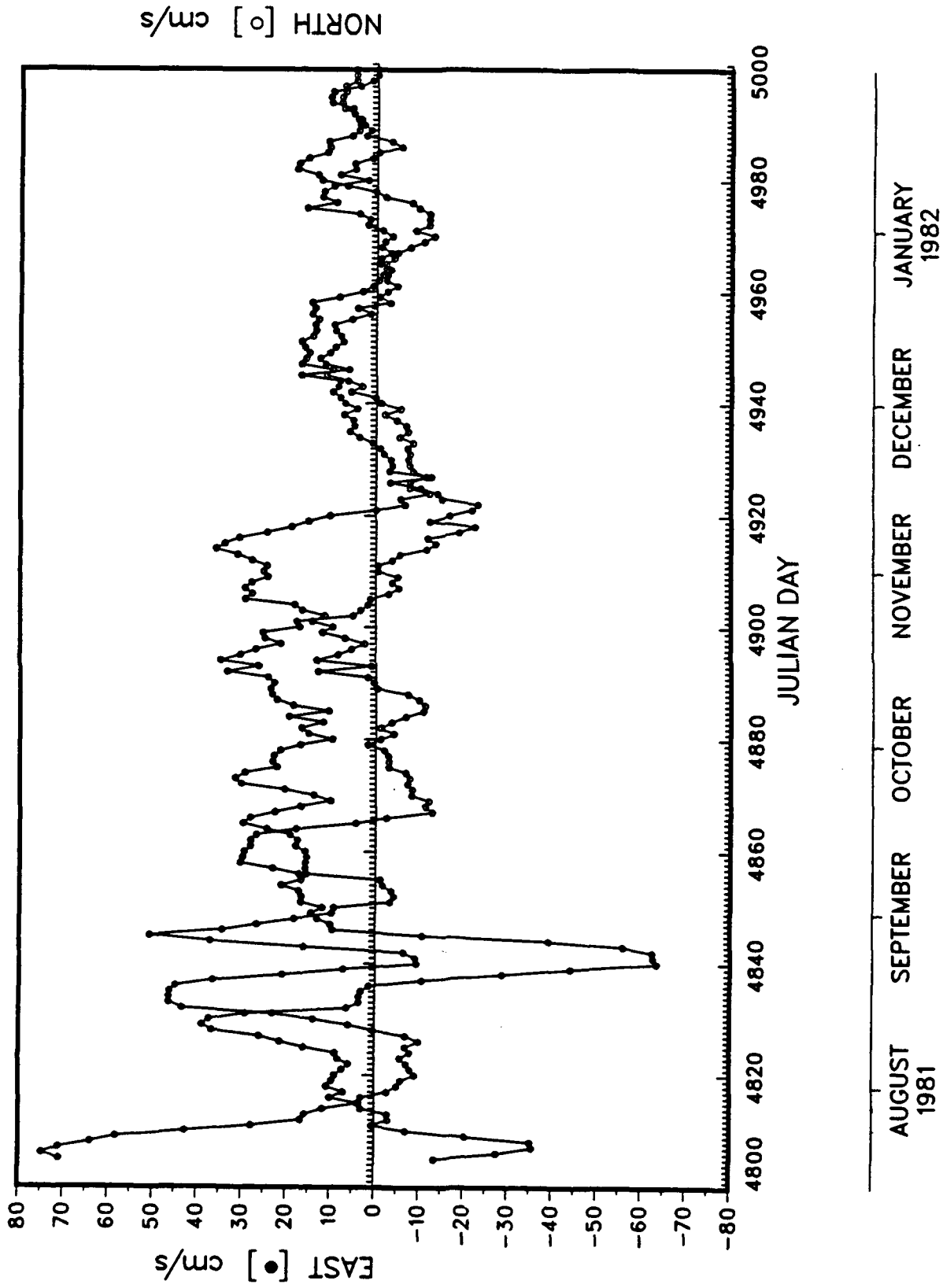
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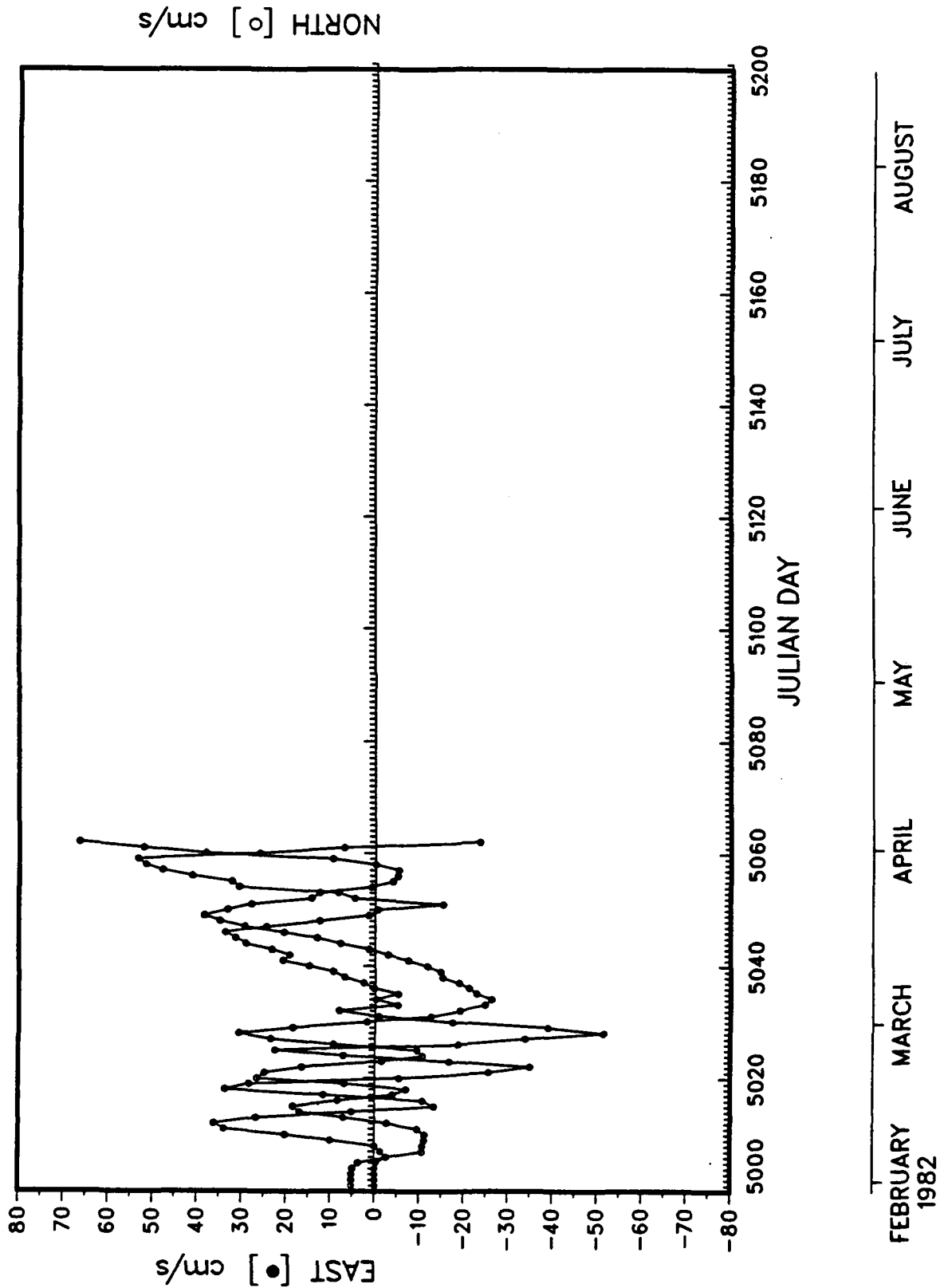




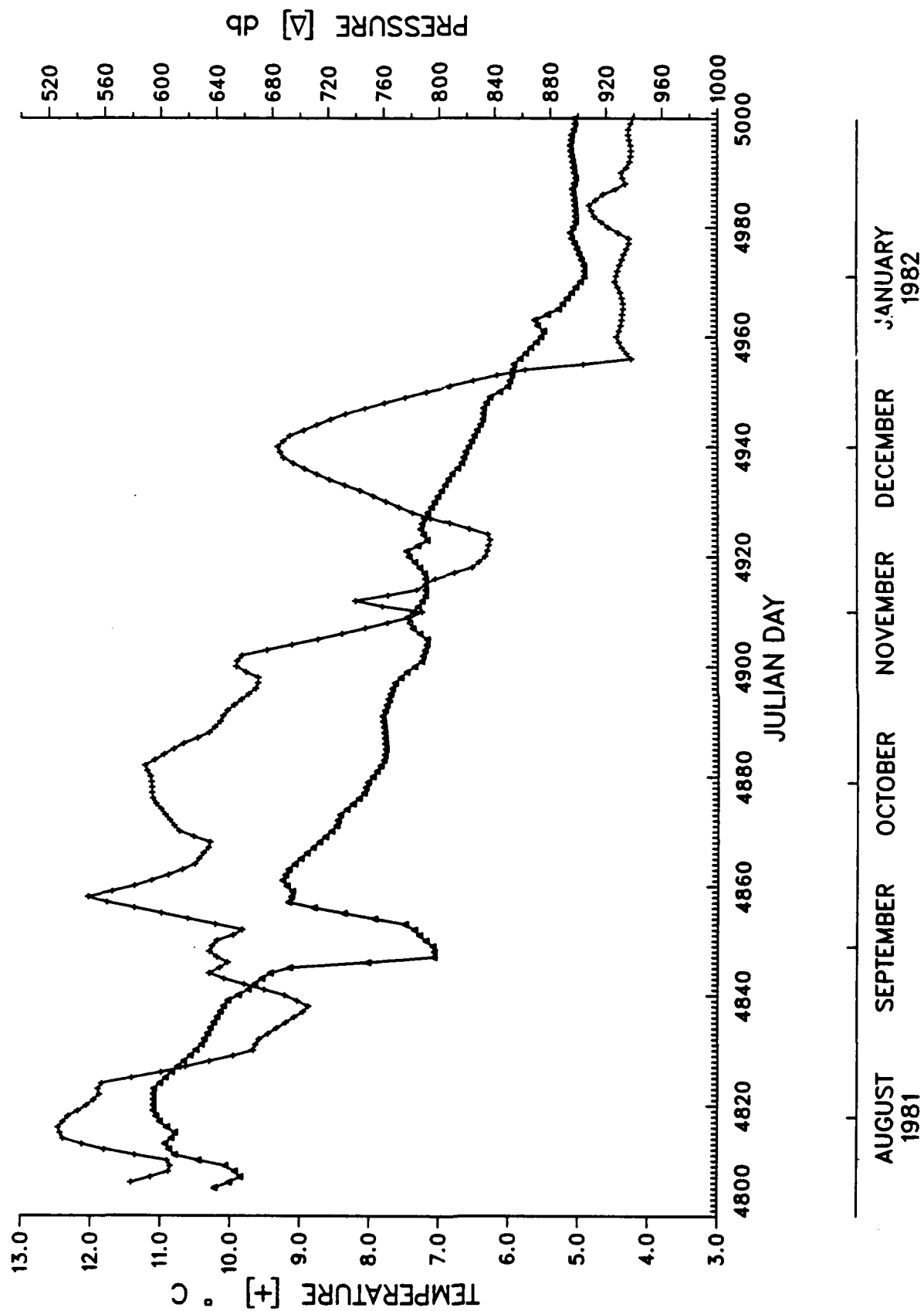
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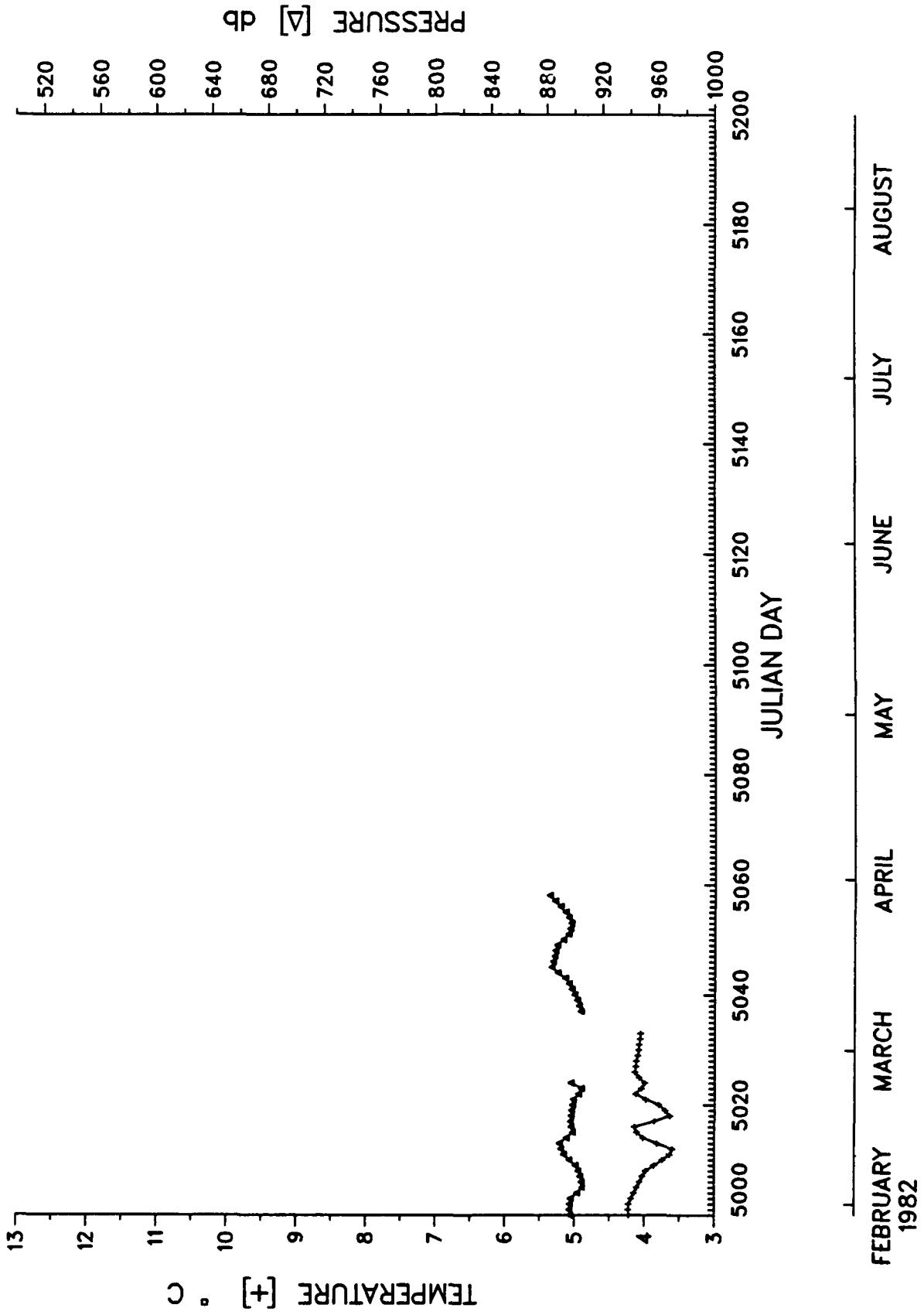


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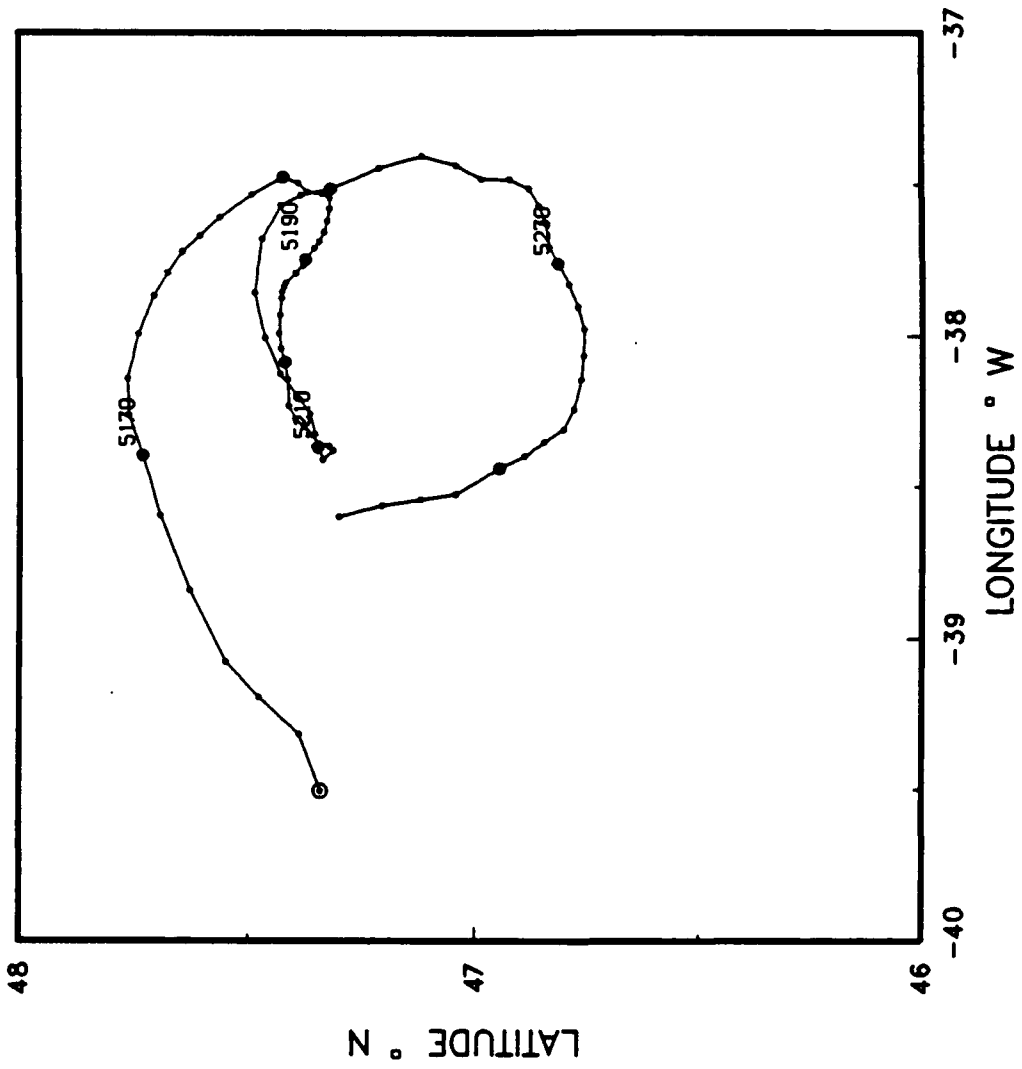


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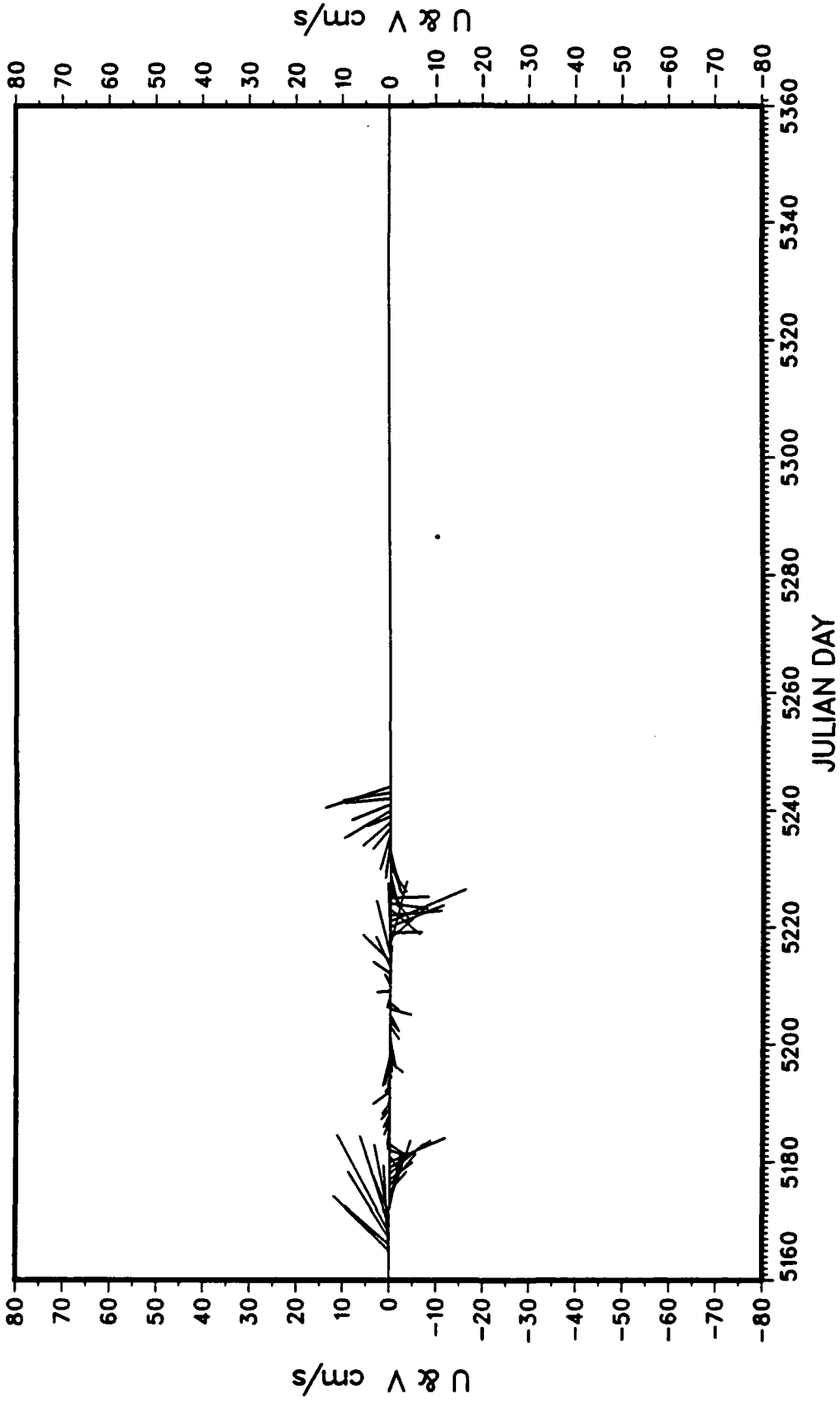




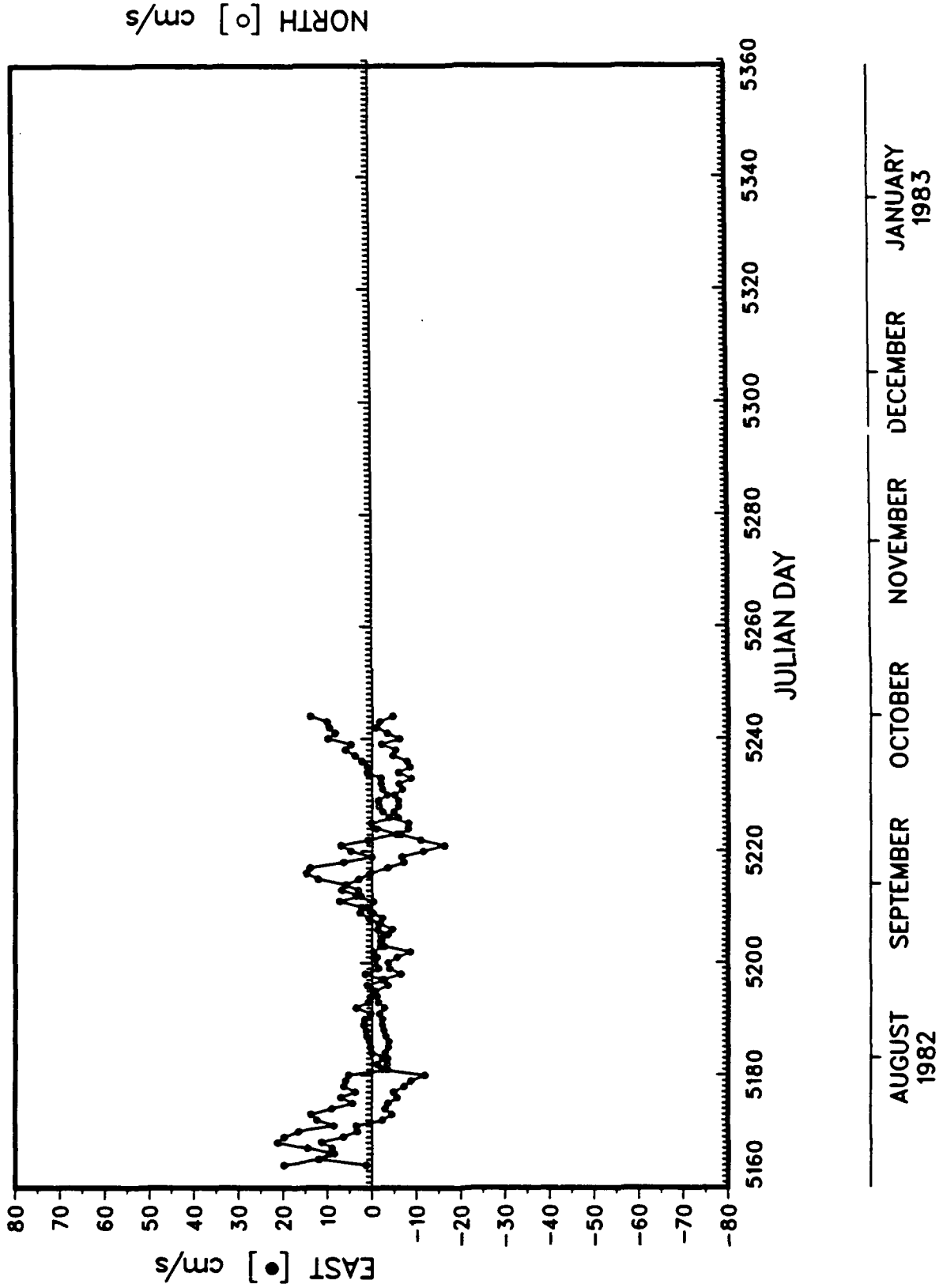
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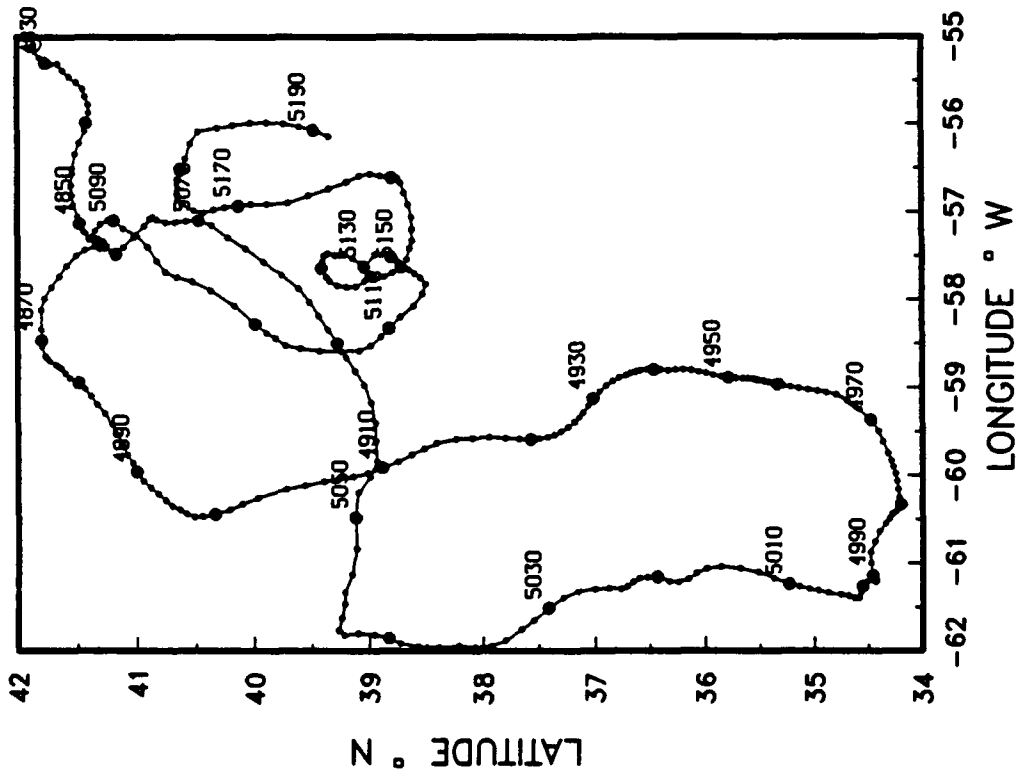
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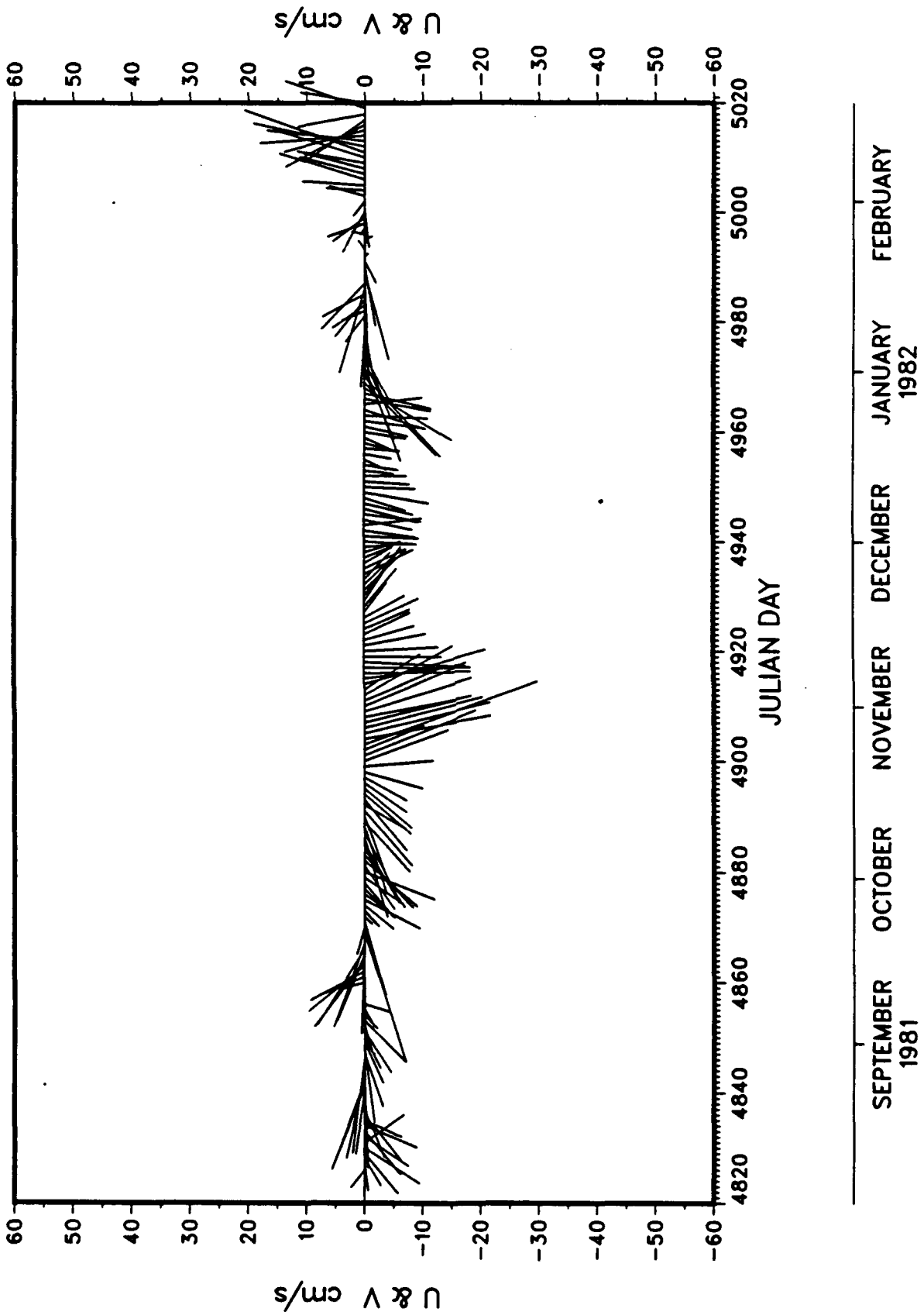
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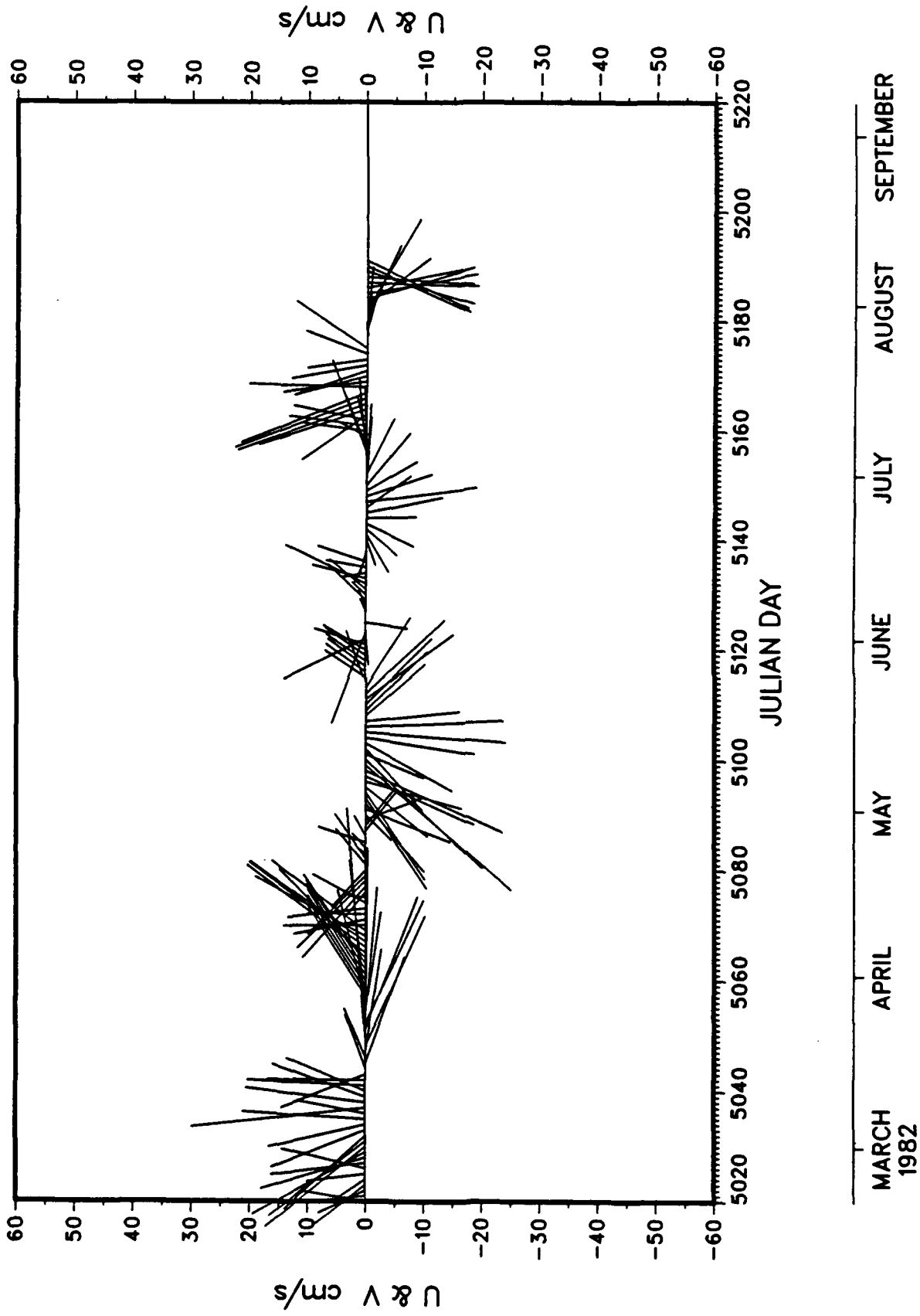


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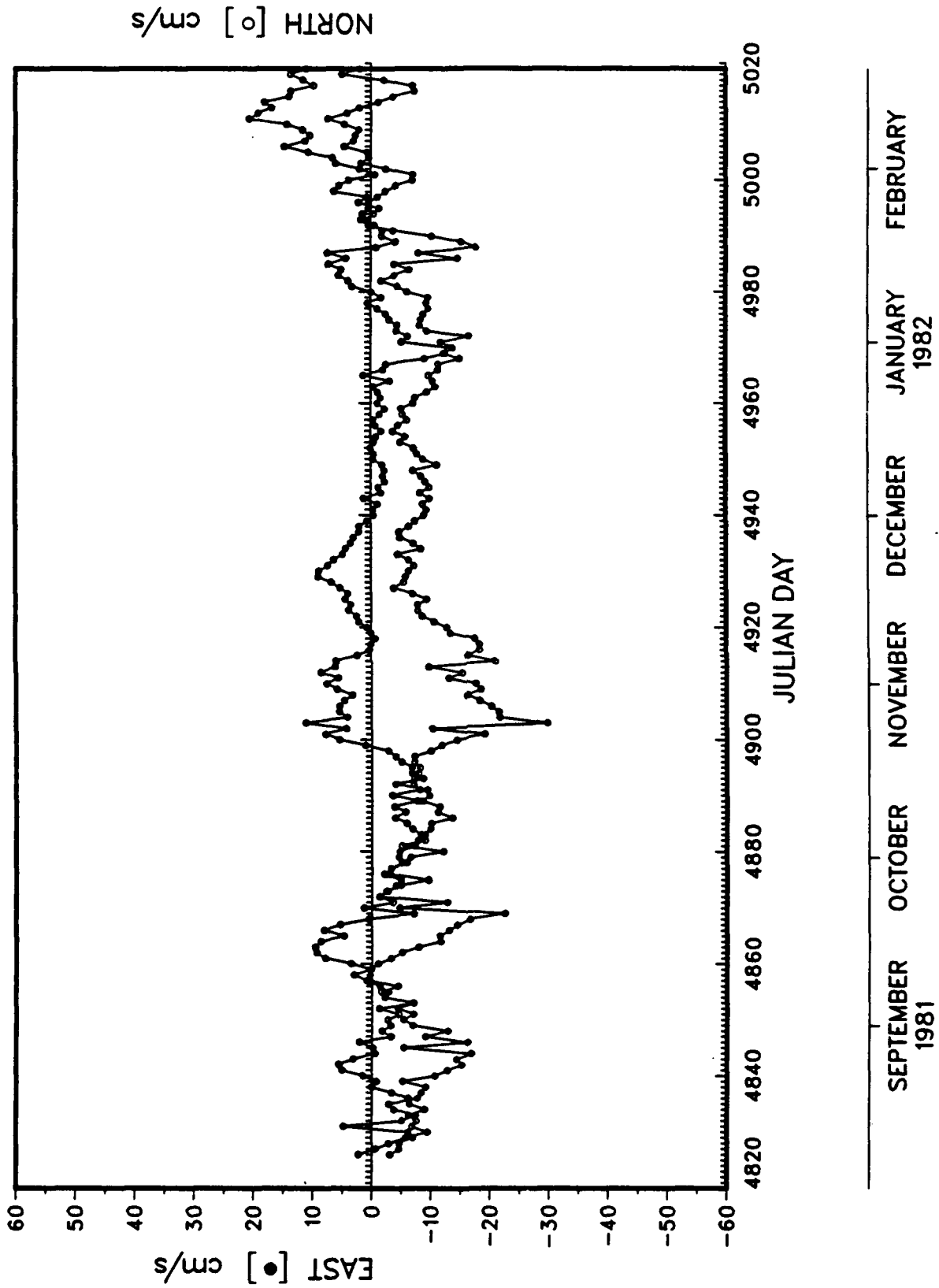


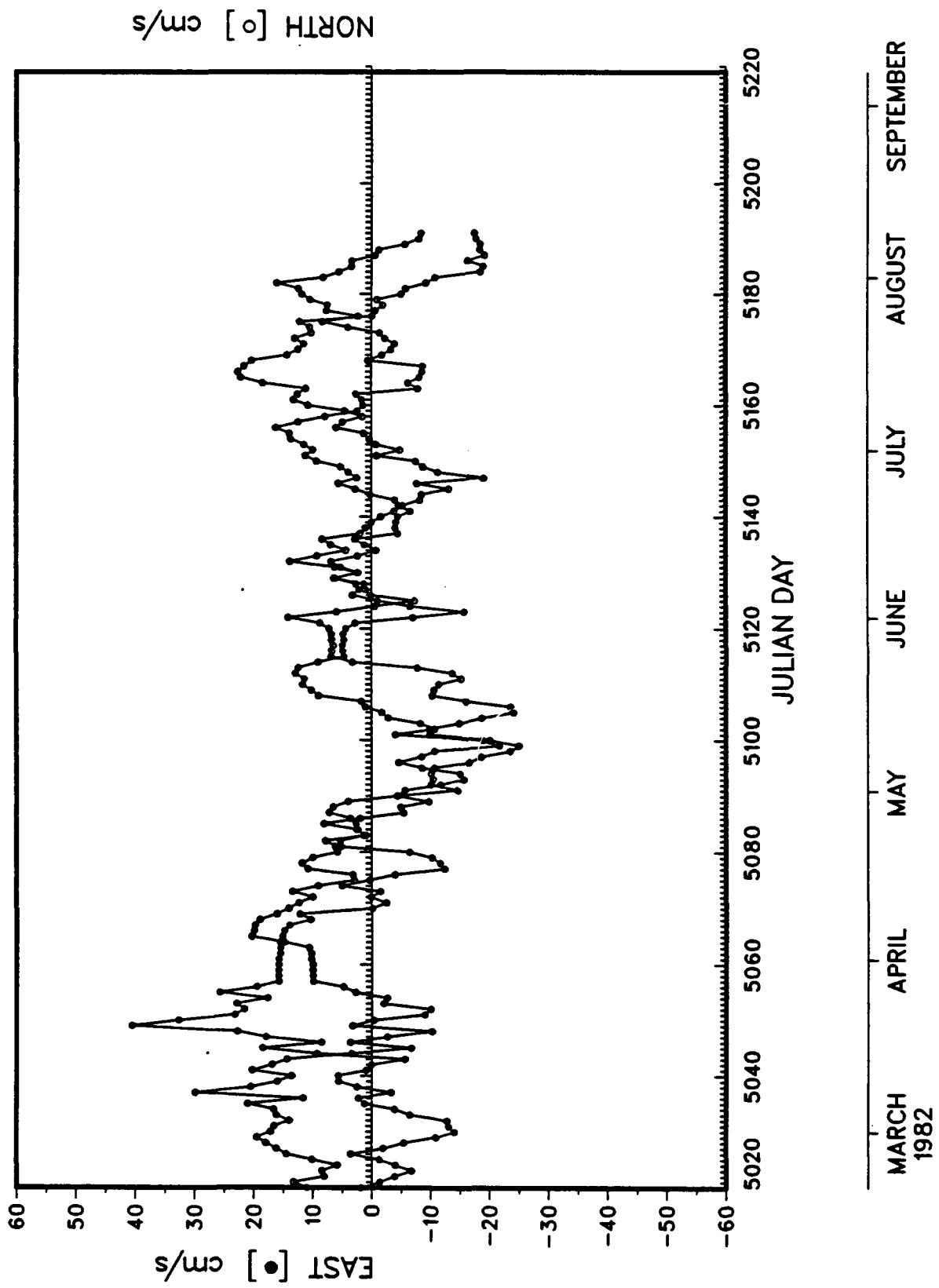
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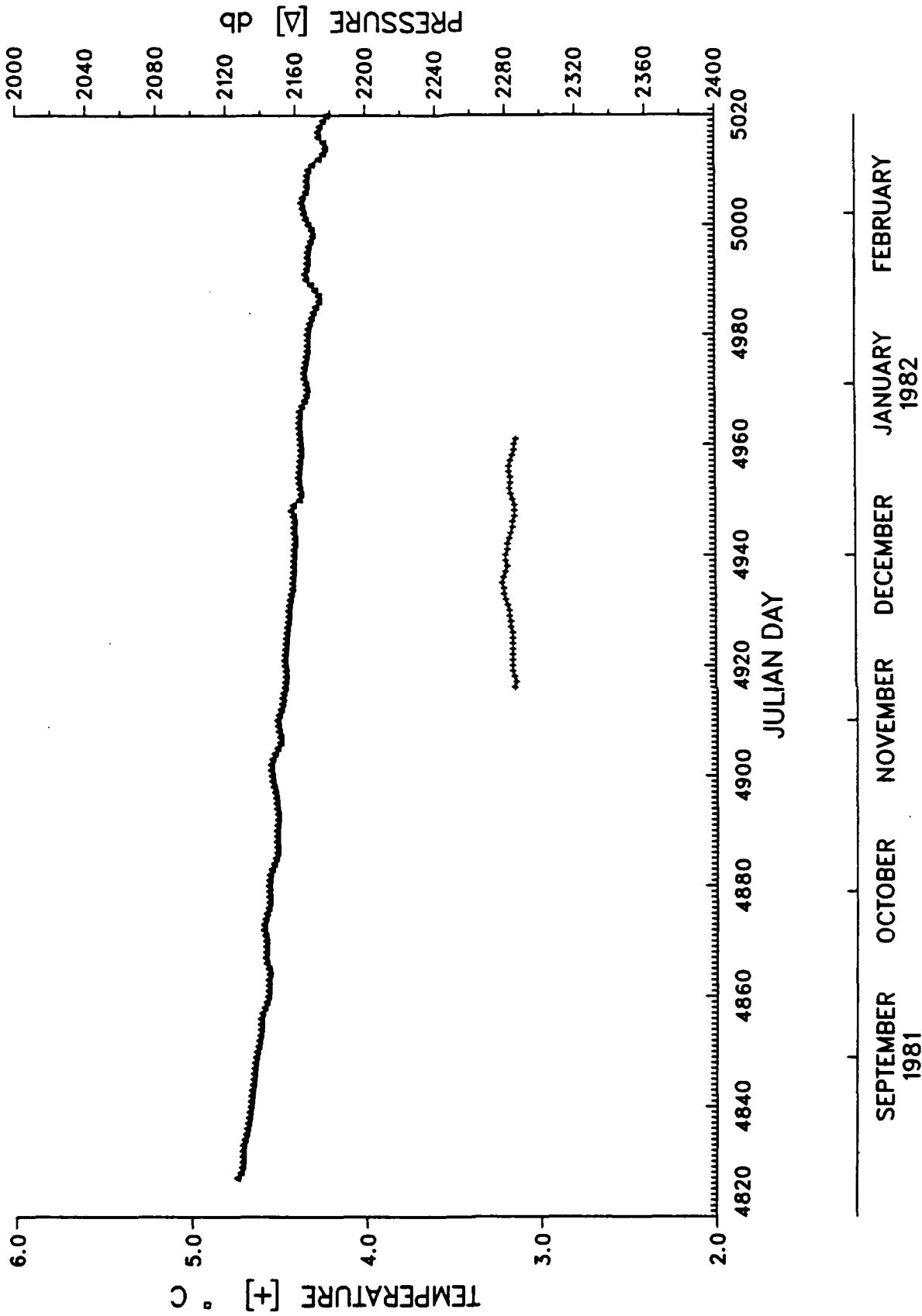


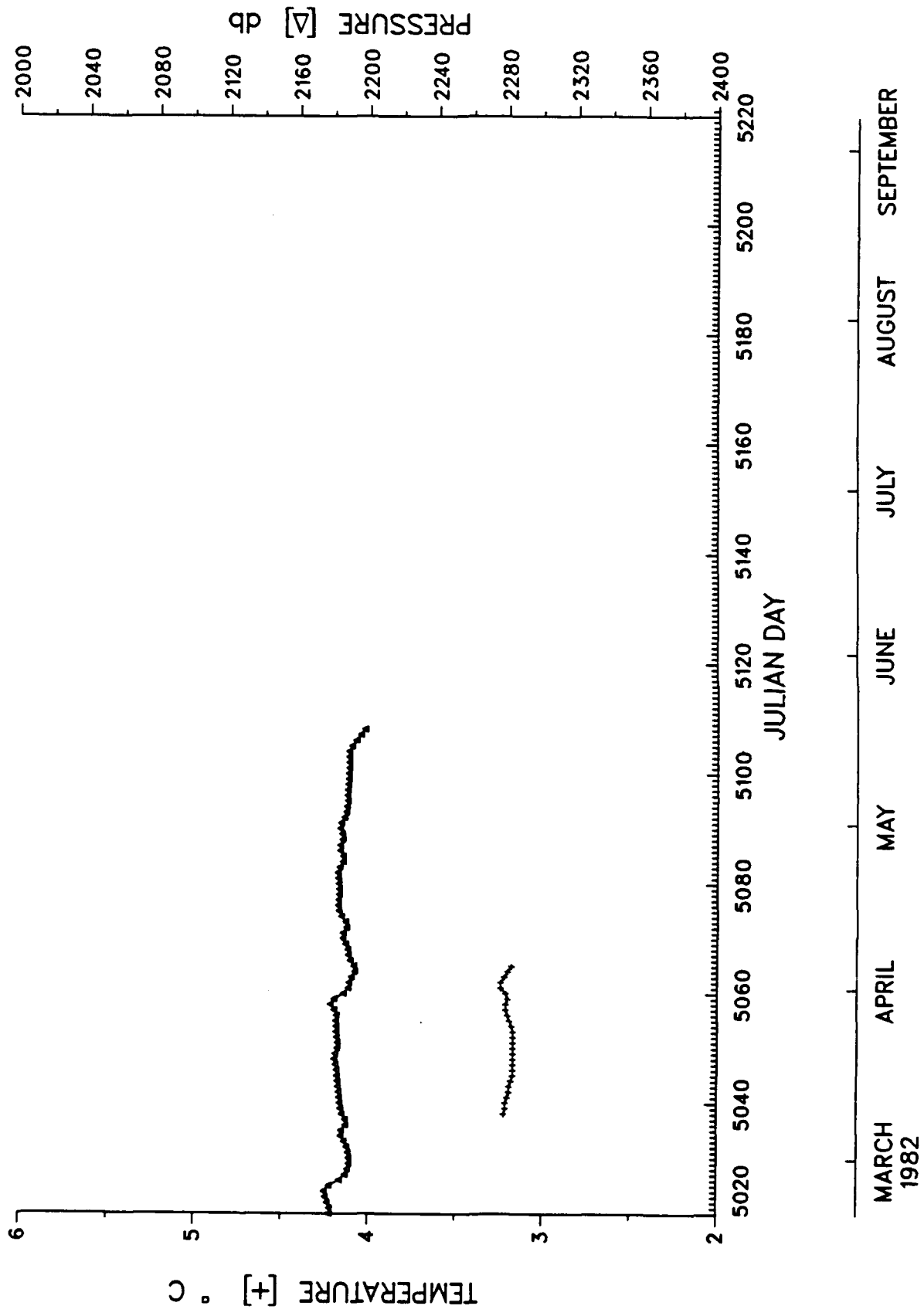
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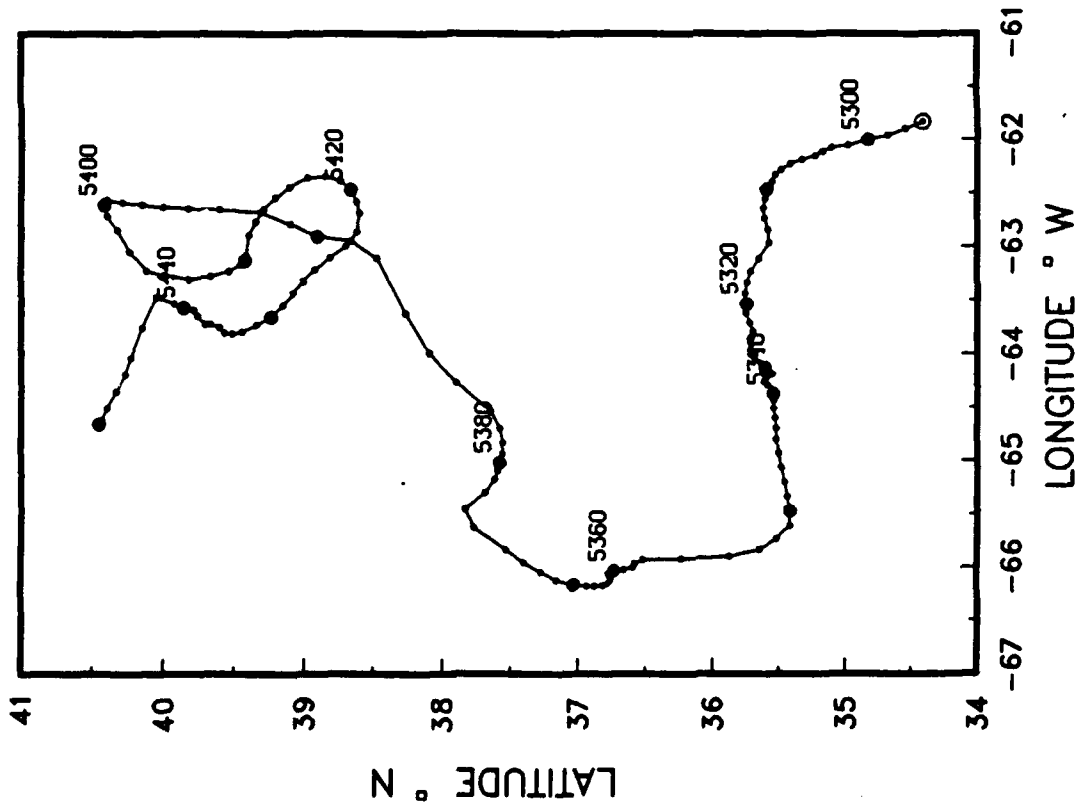


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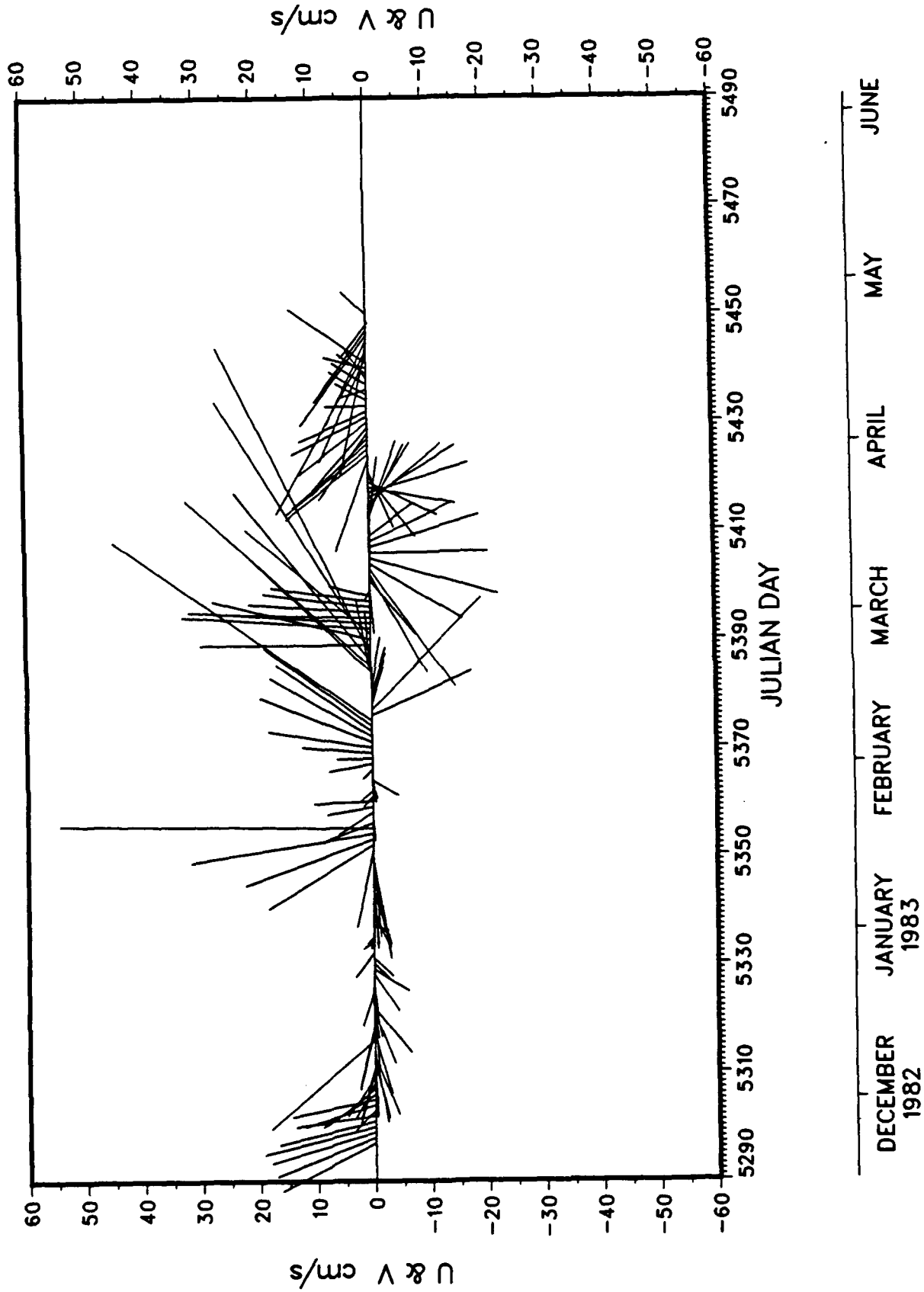




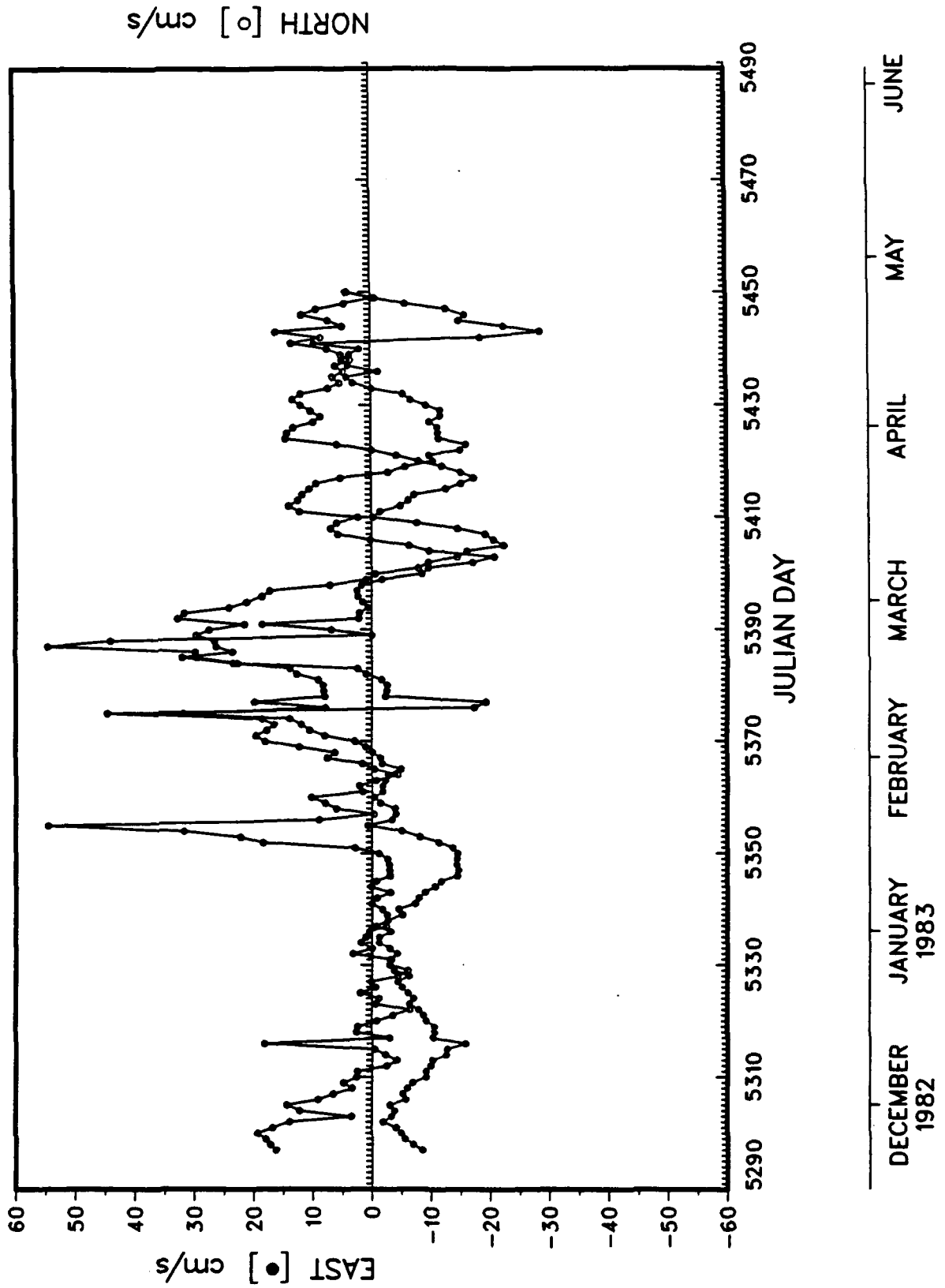
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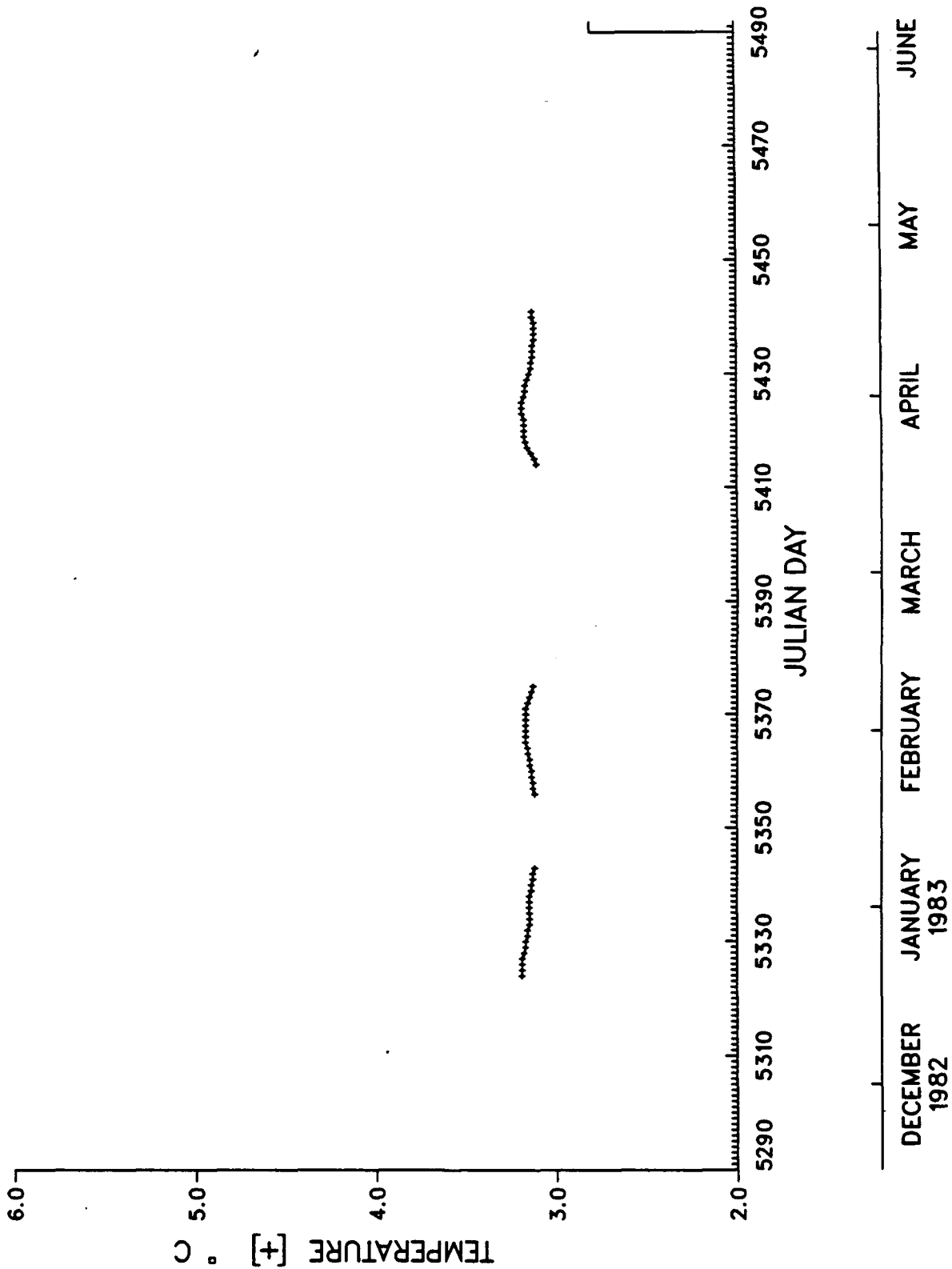


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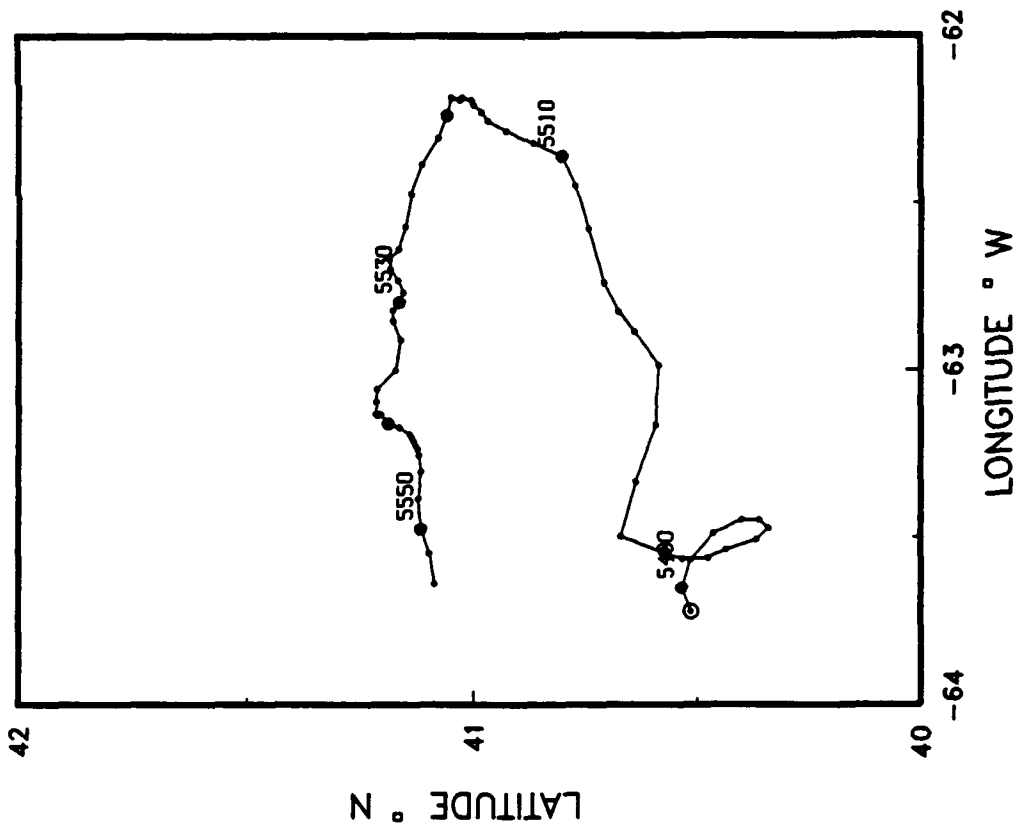


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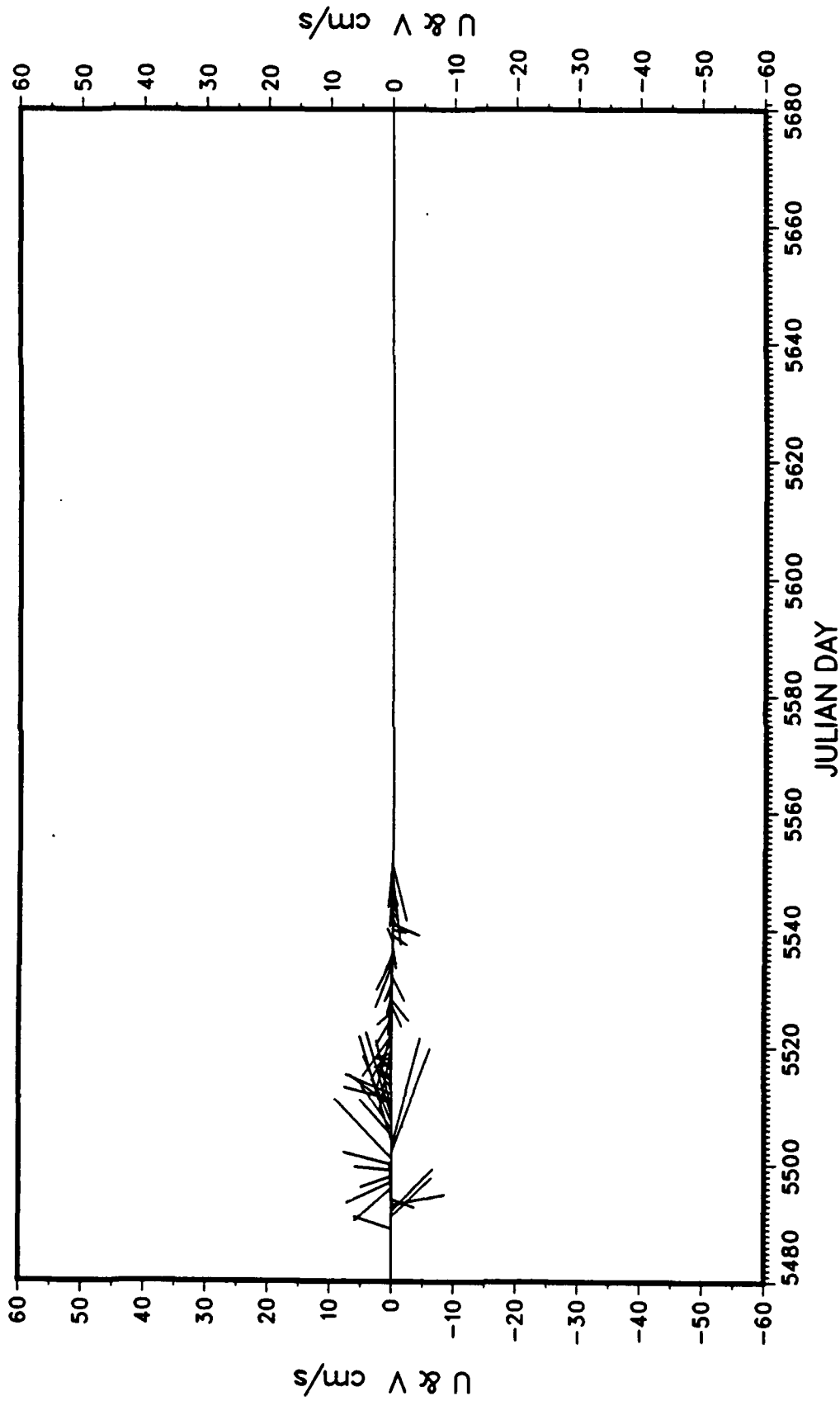




GUSREX 162C

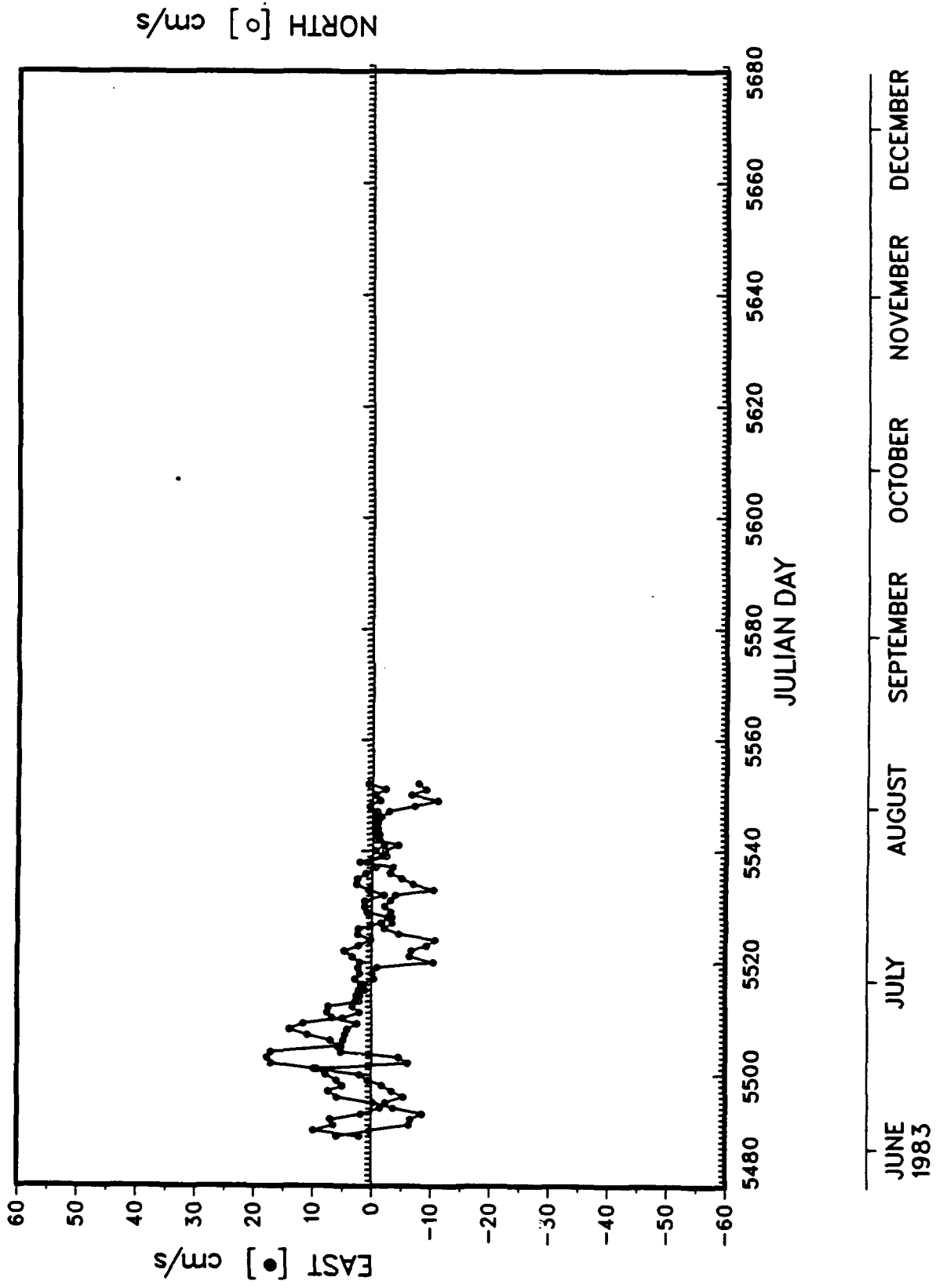


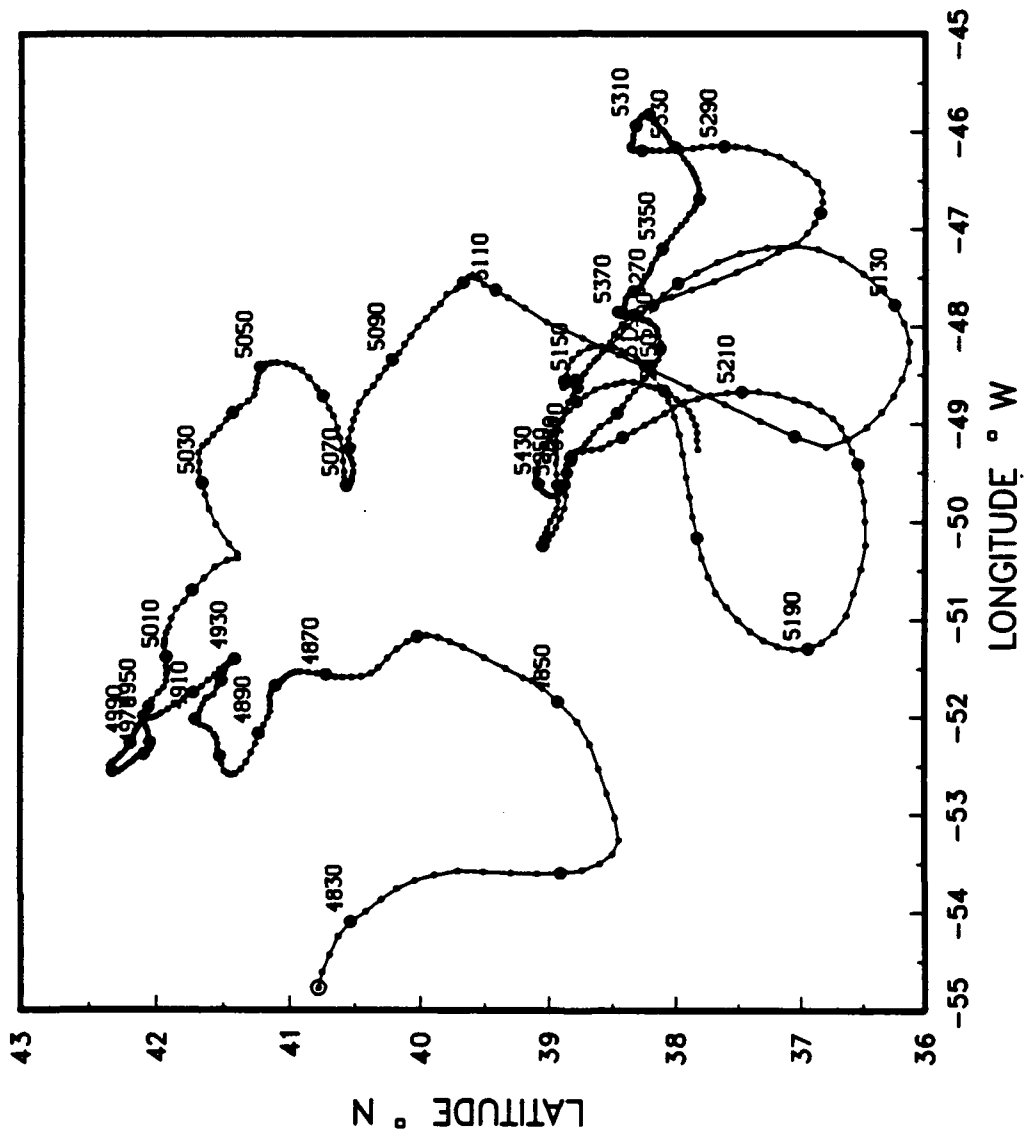
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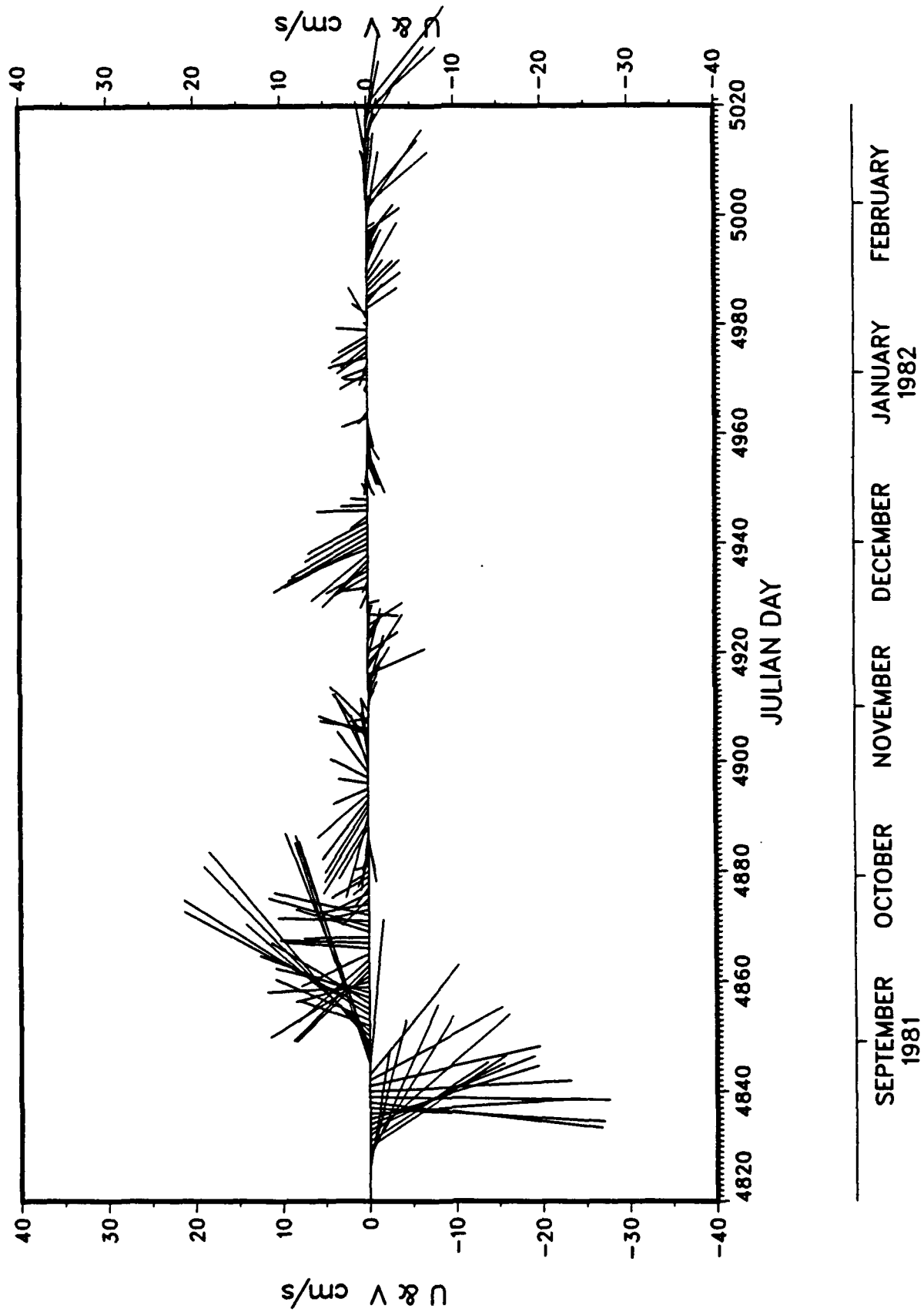
JUNE 1983
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER

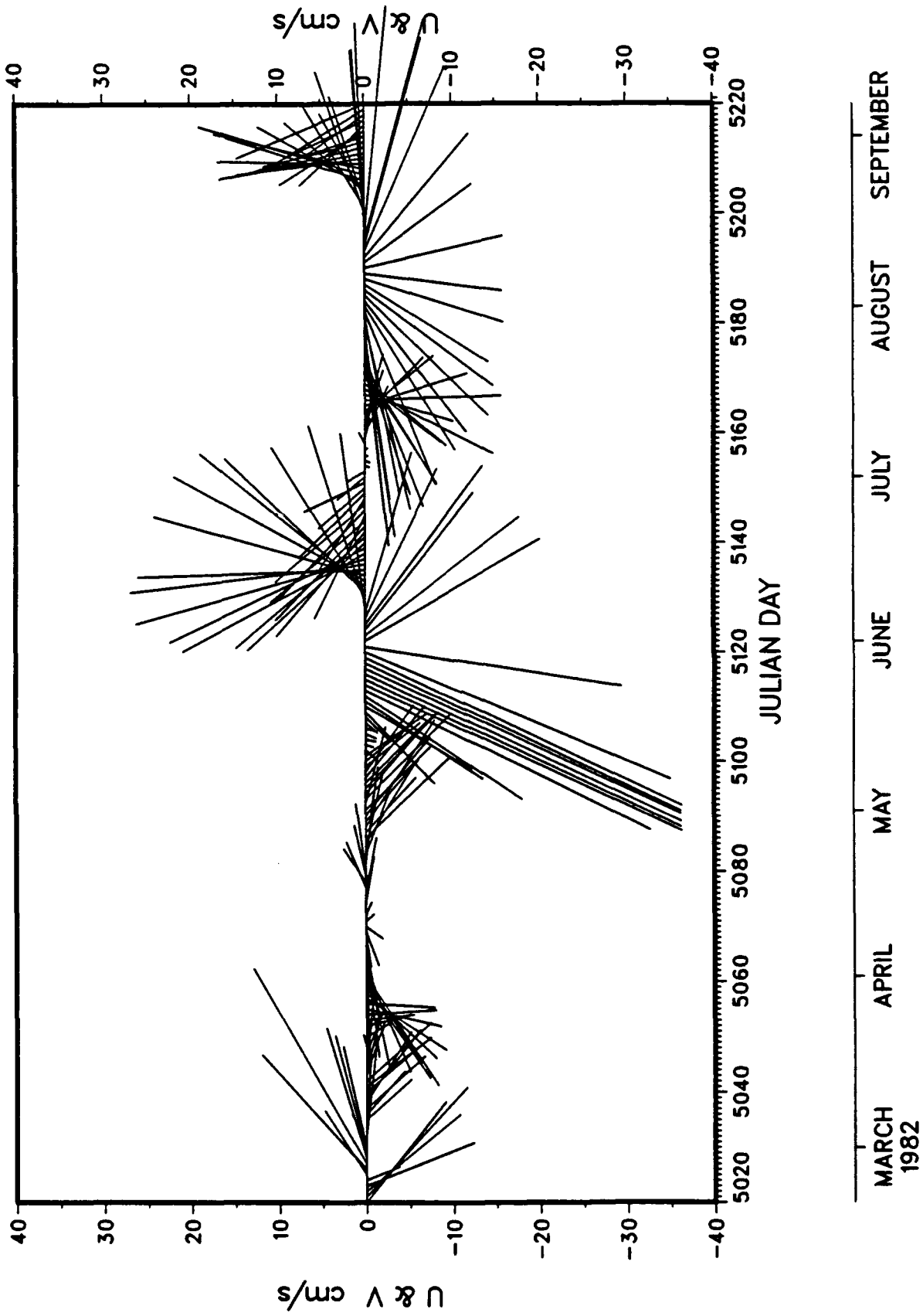
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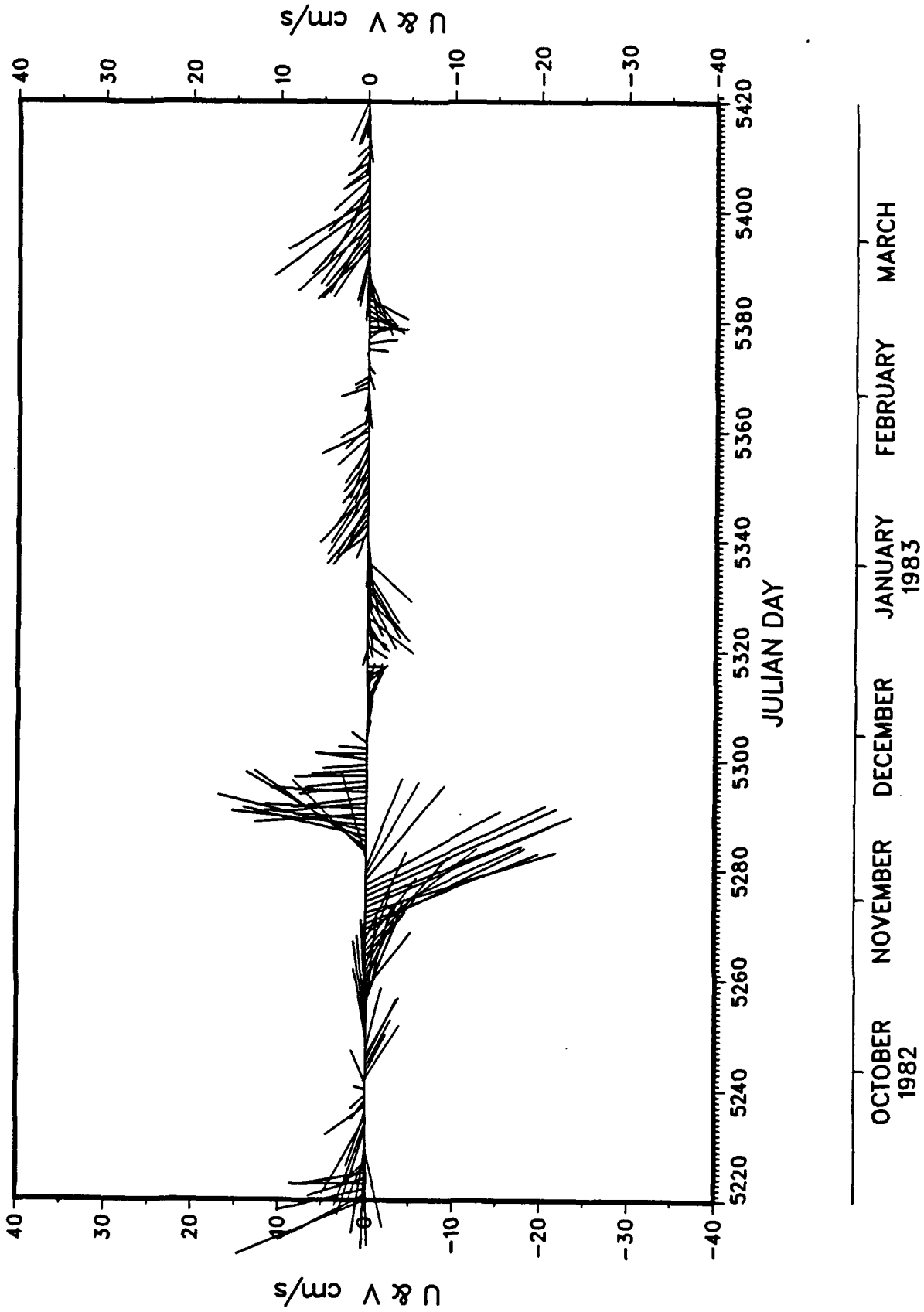


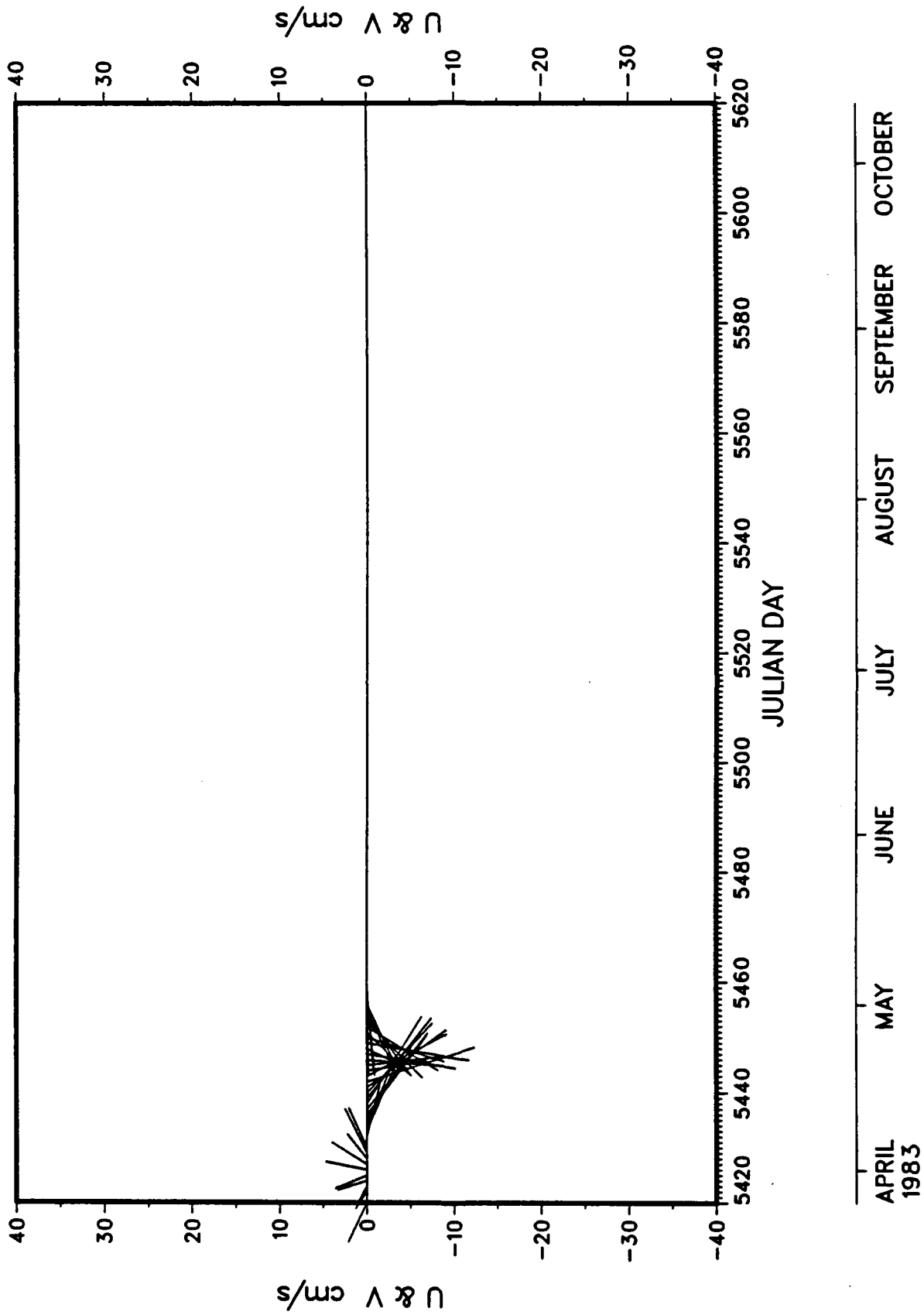
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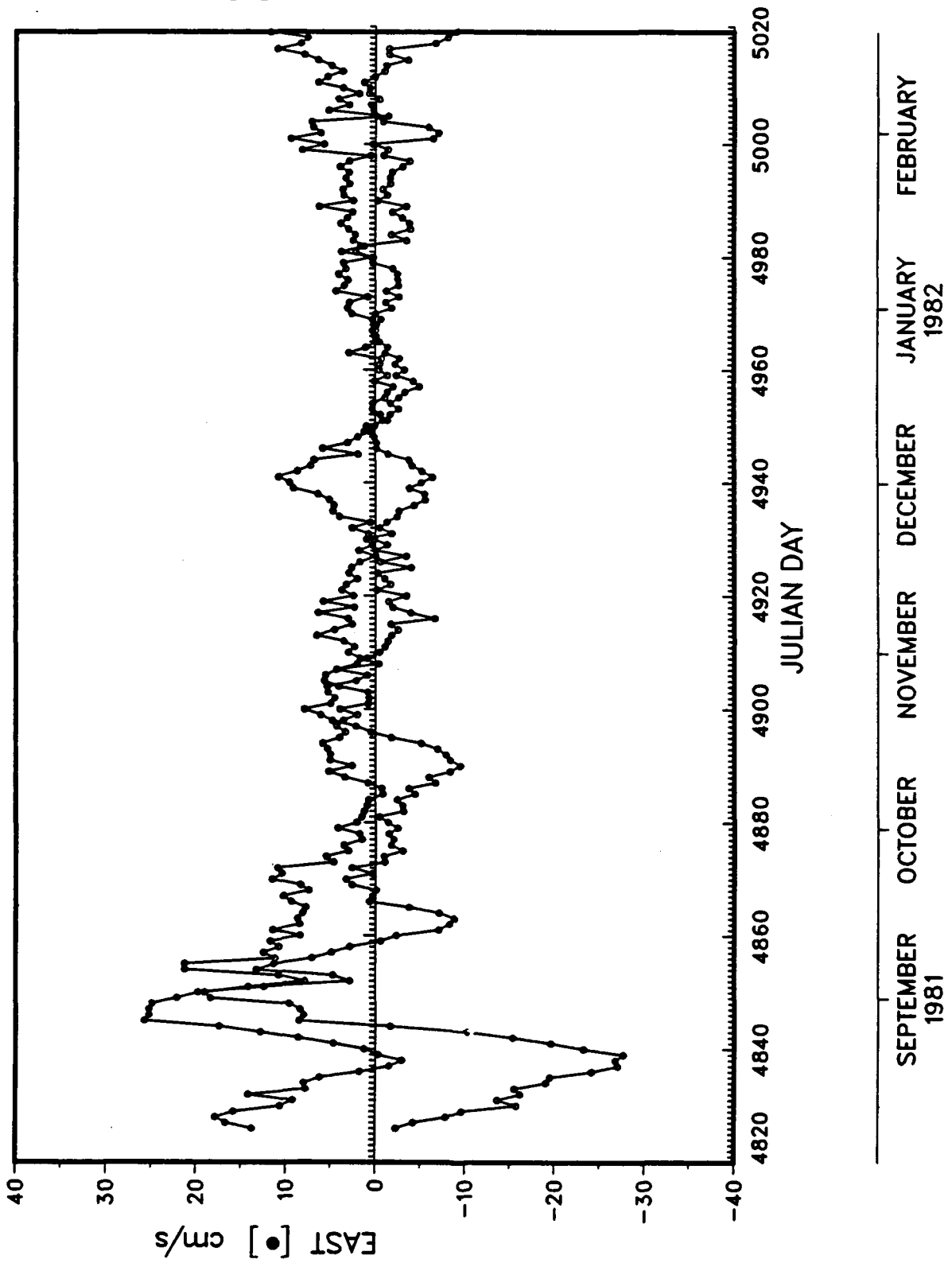


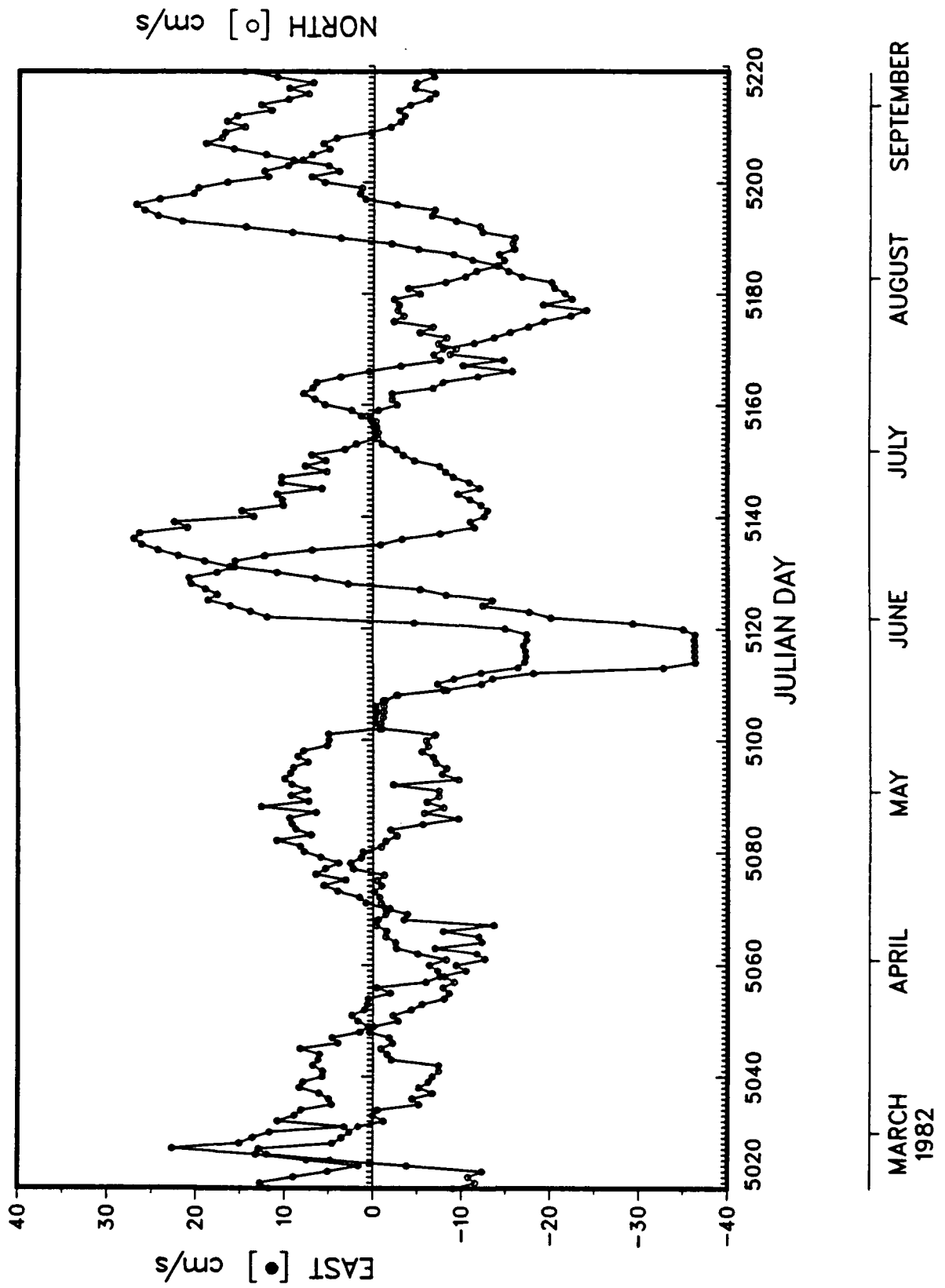
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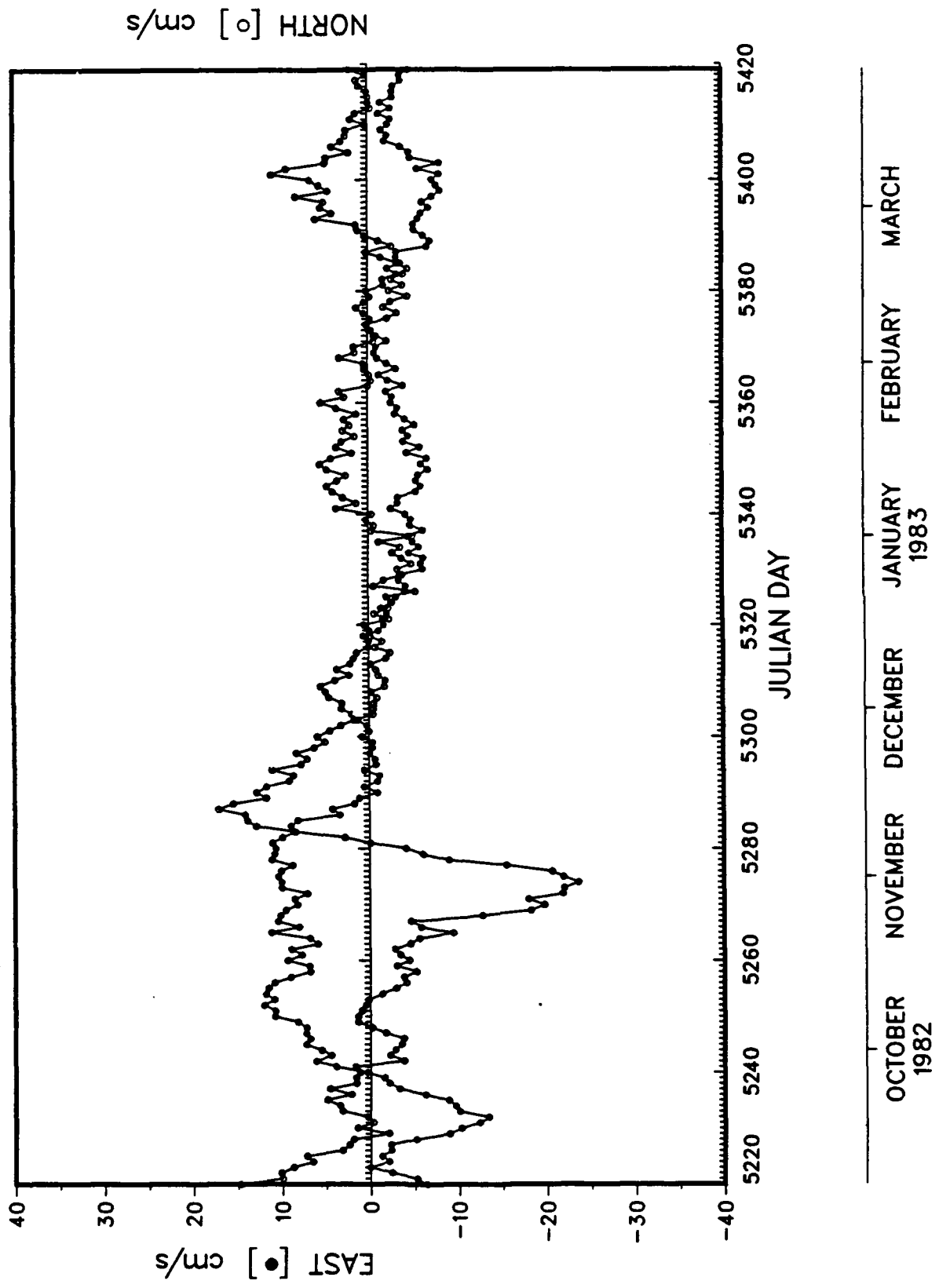


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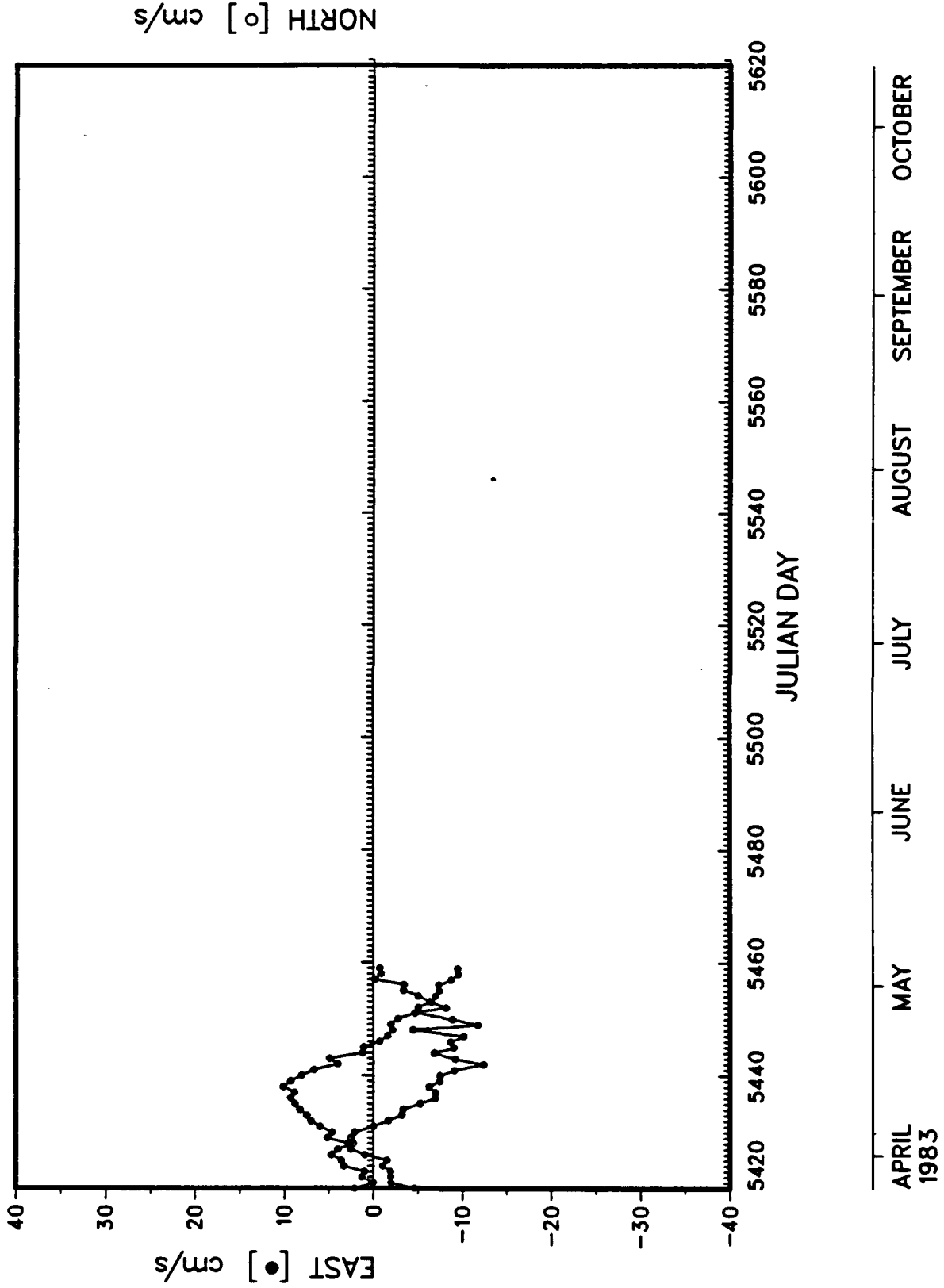




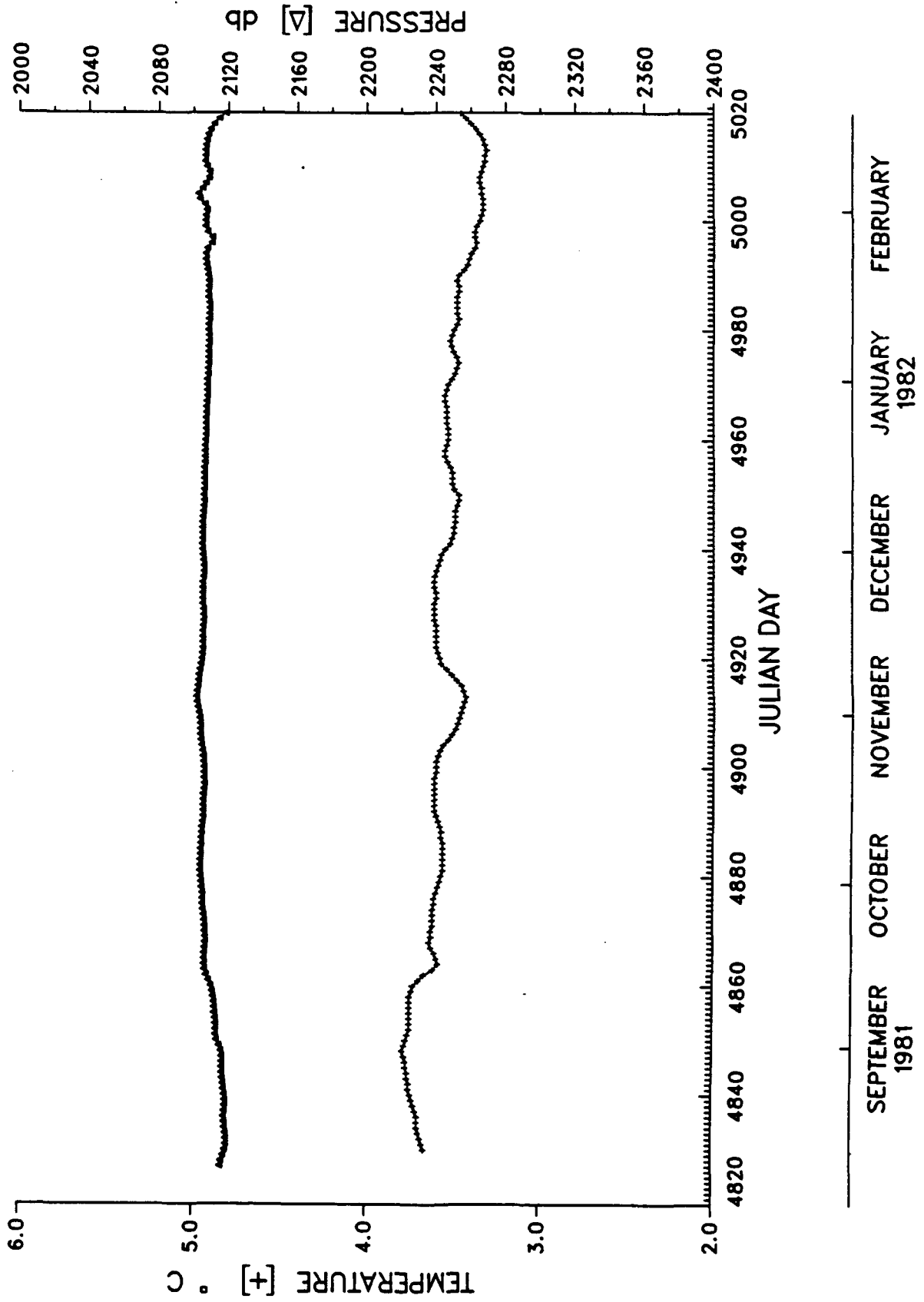
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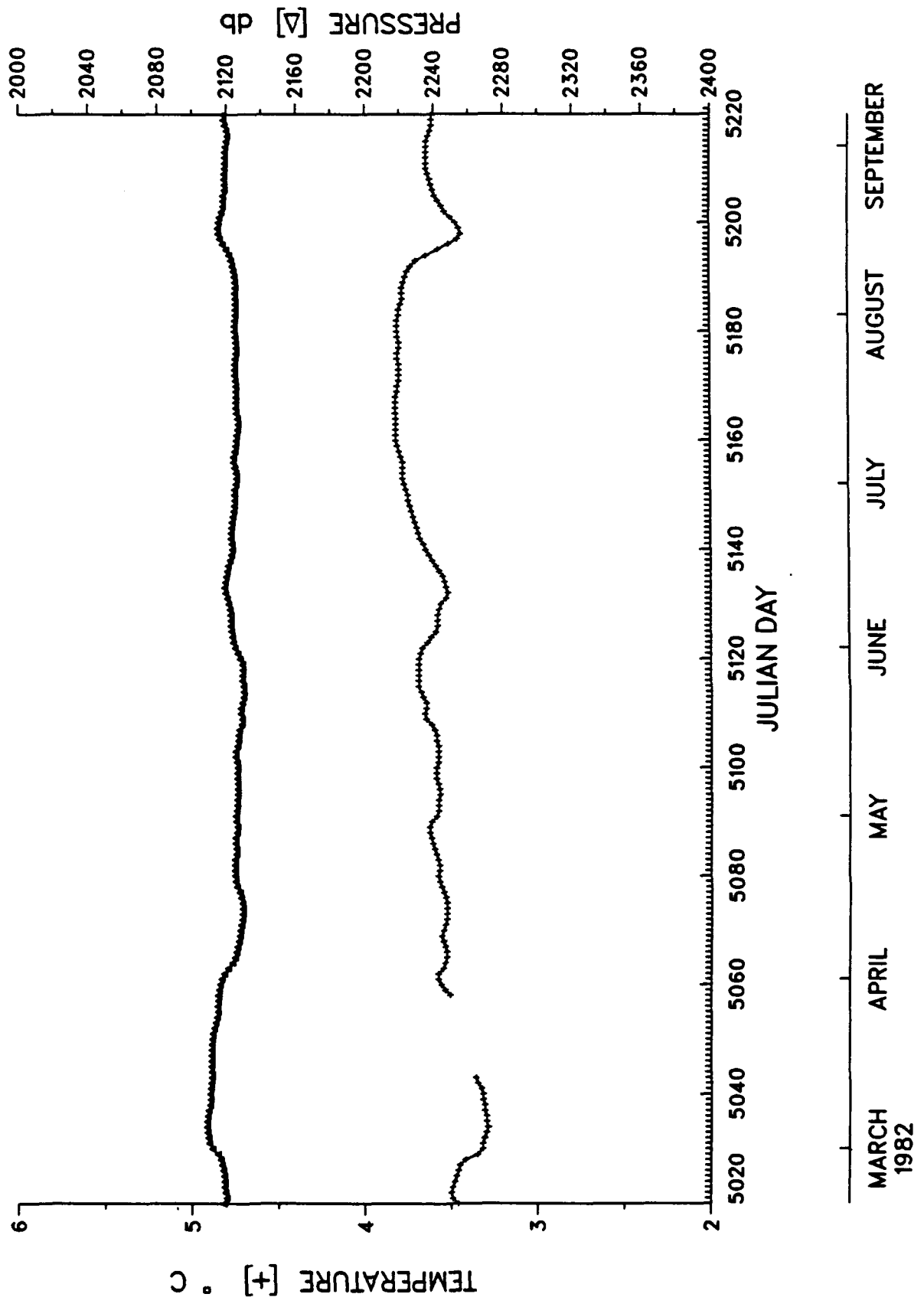


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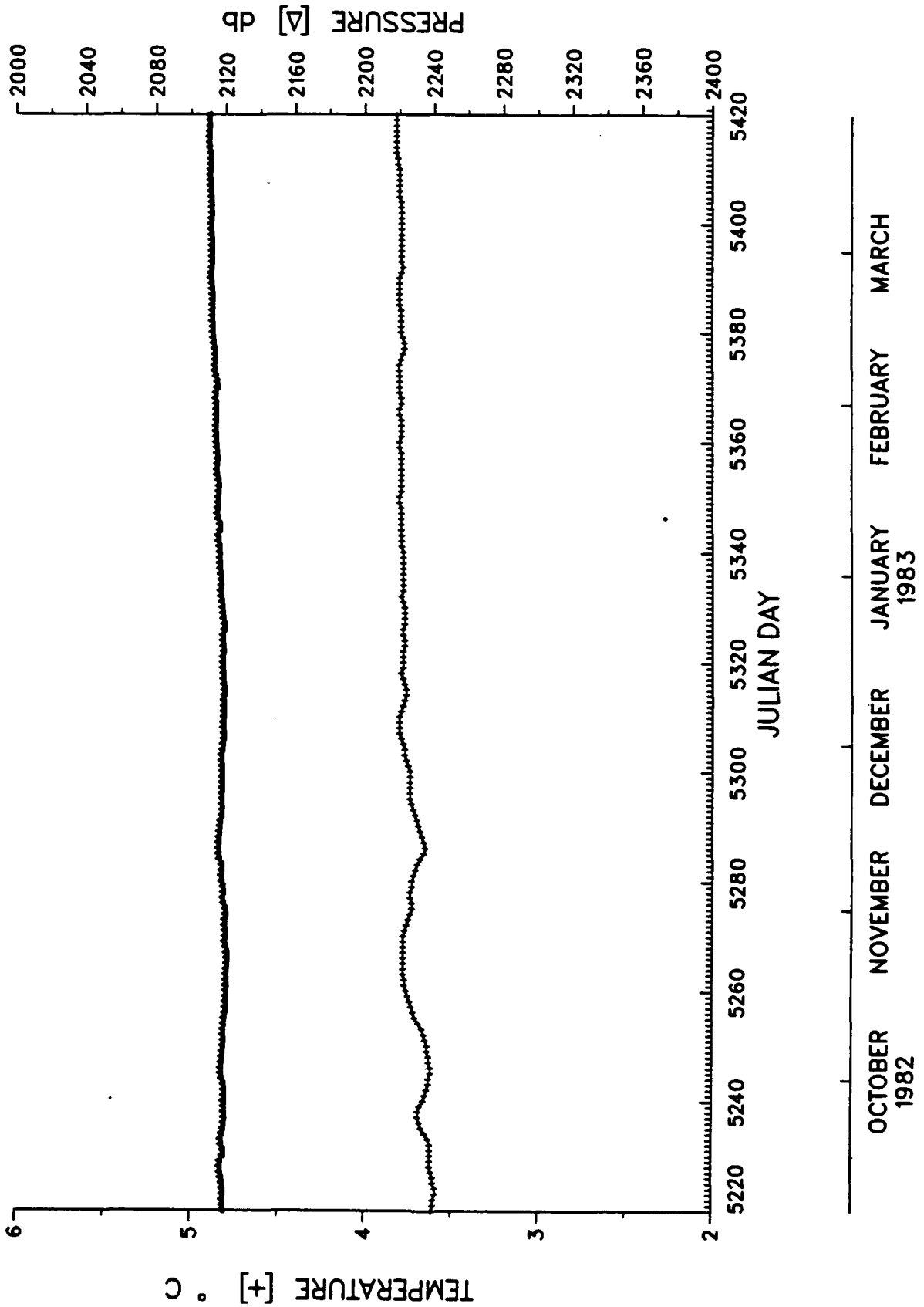


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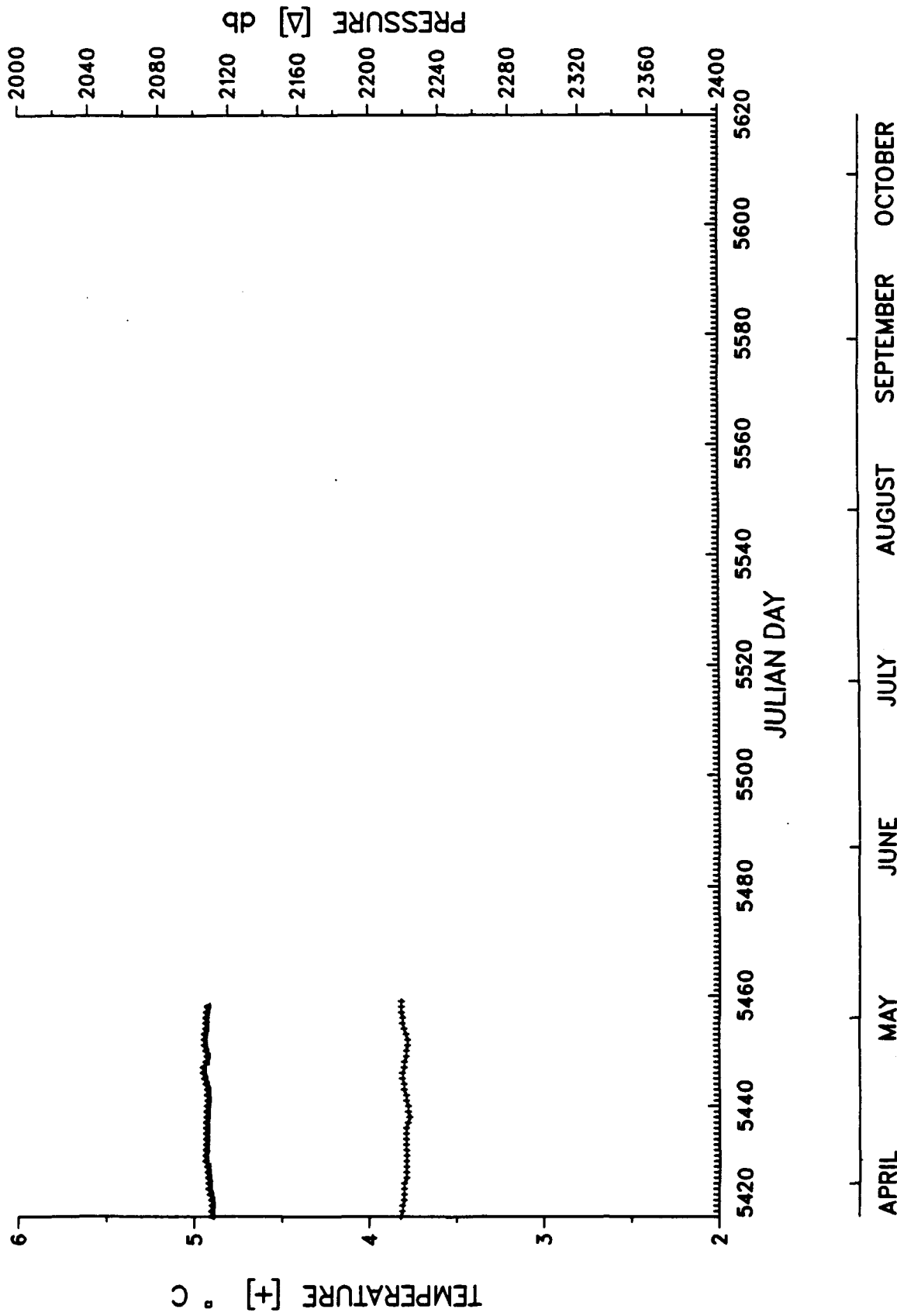




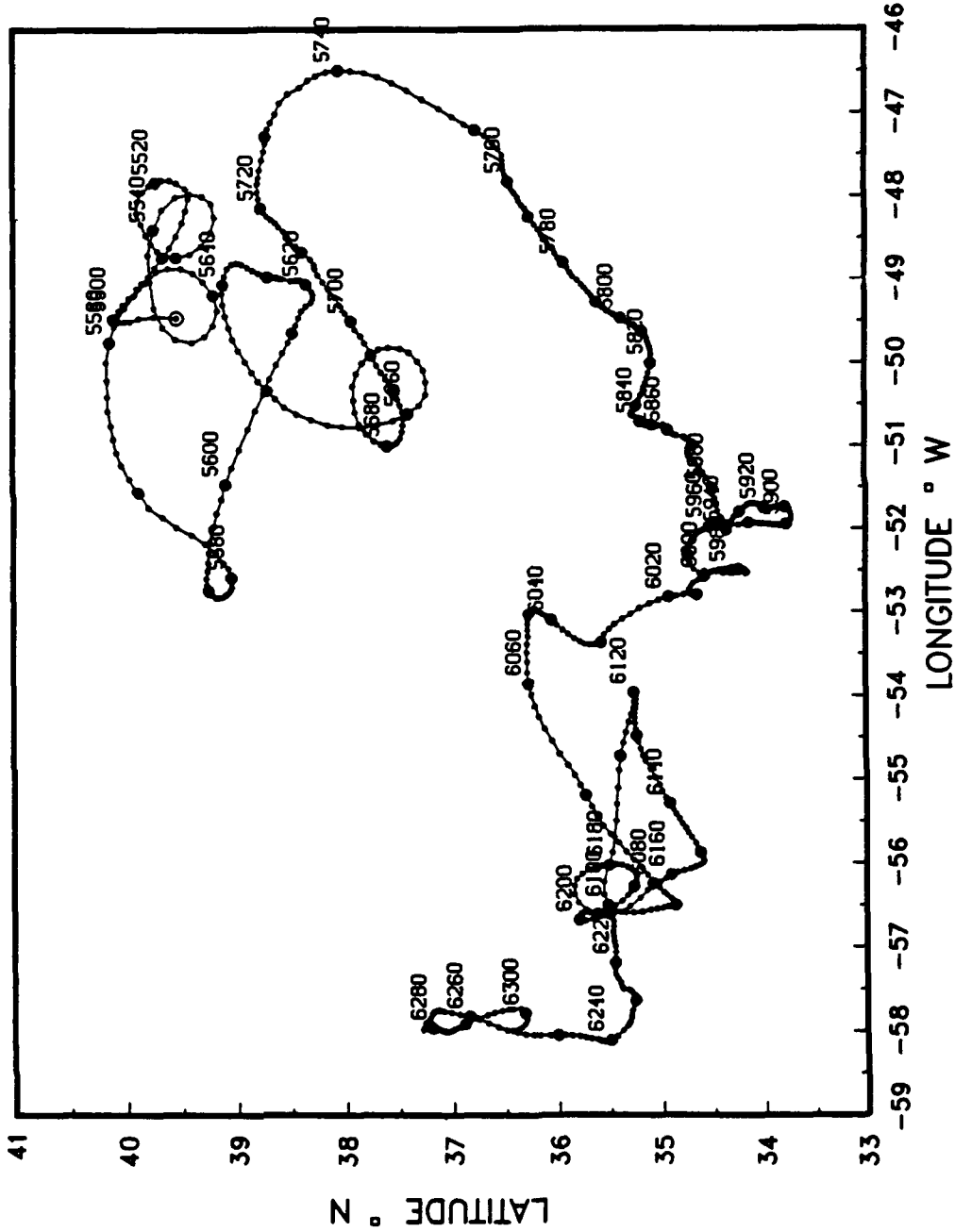
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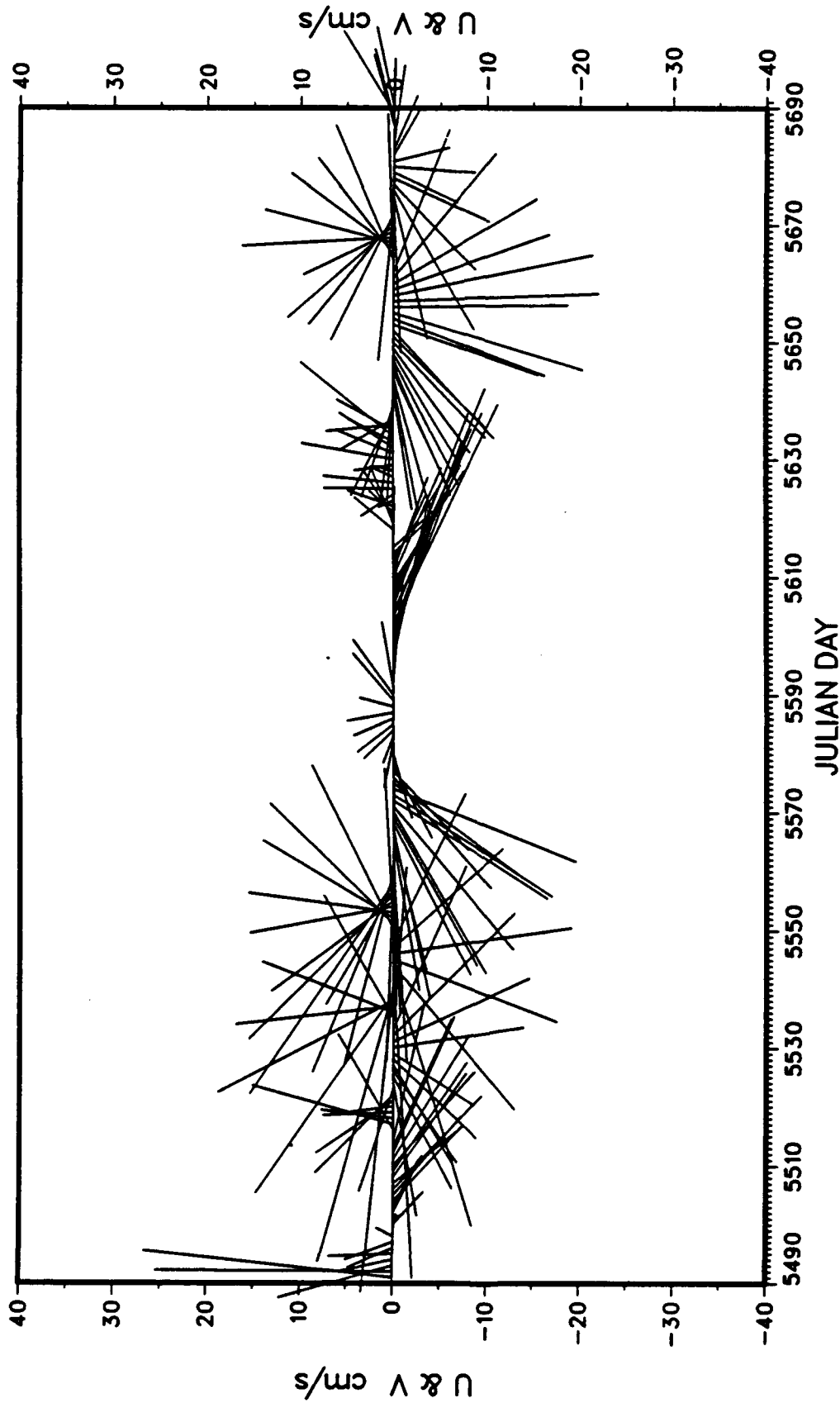
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GUSREX 163B

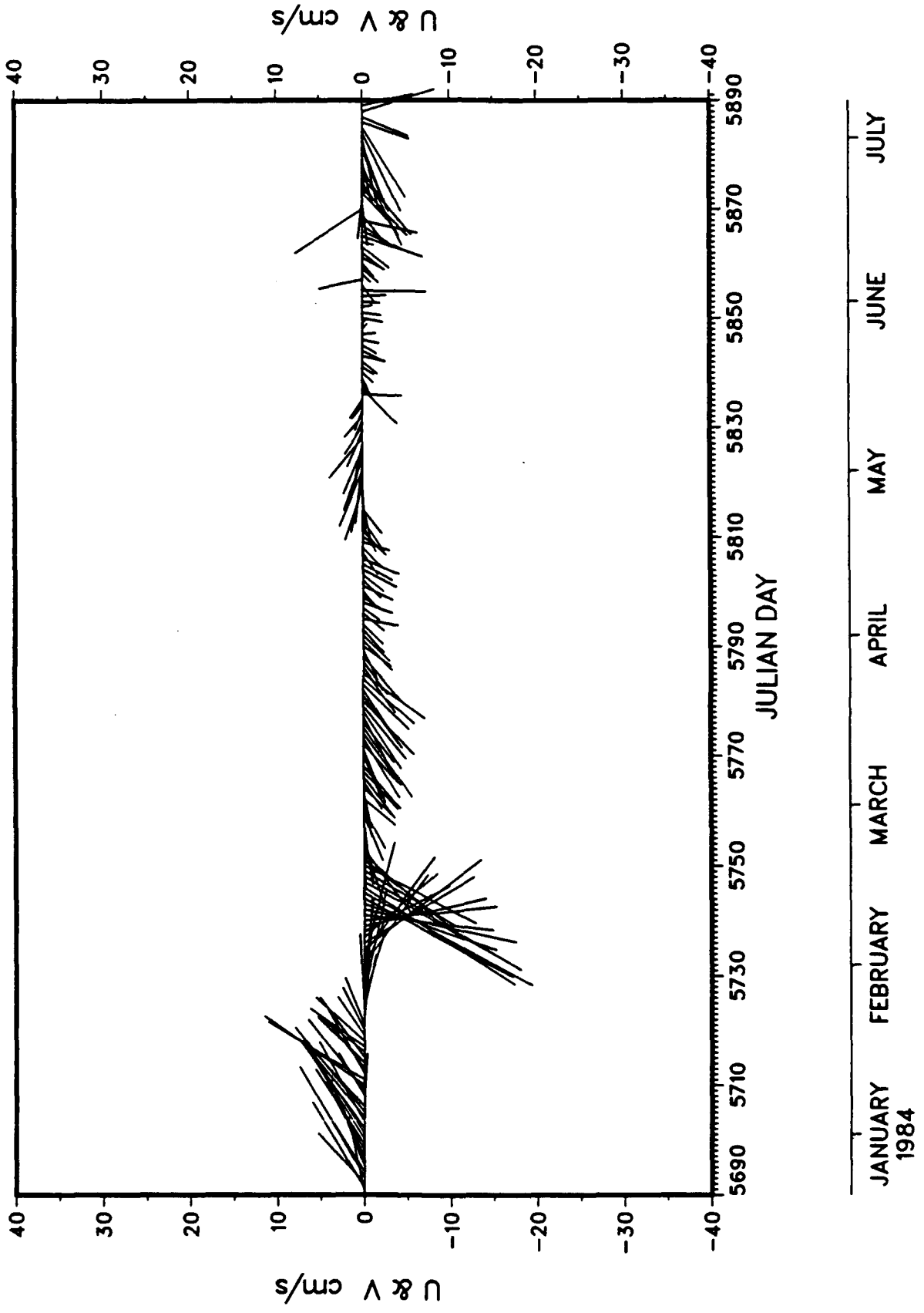


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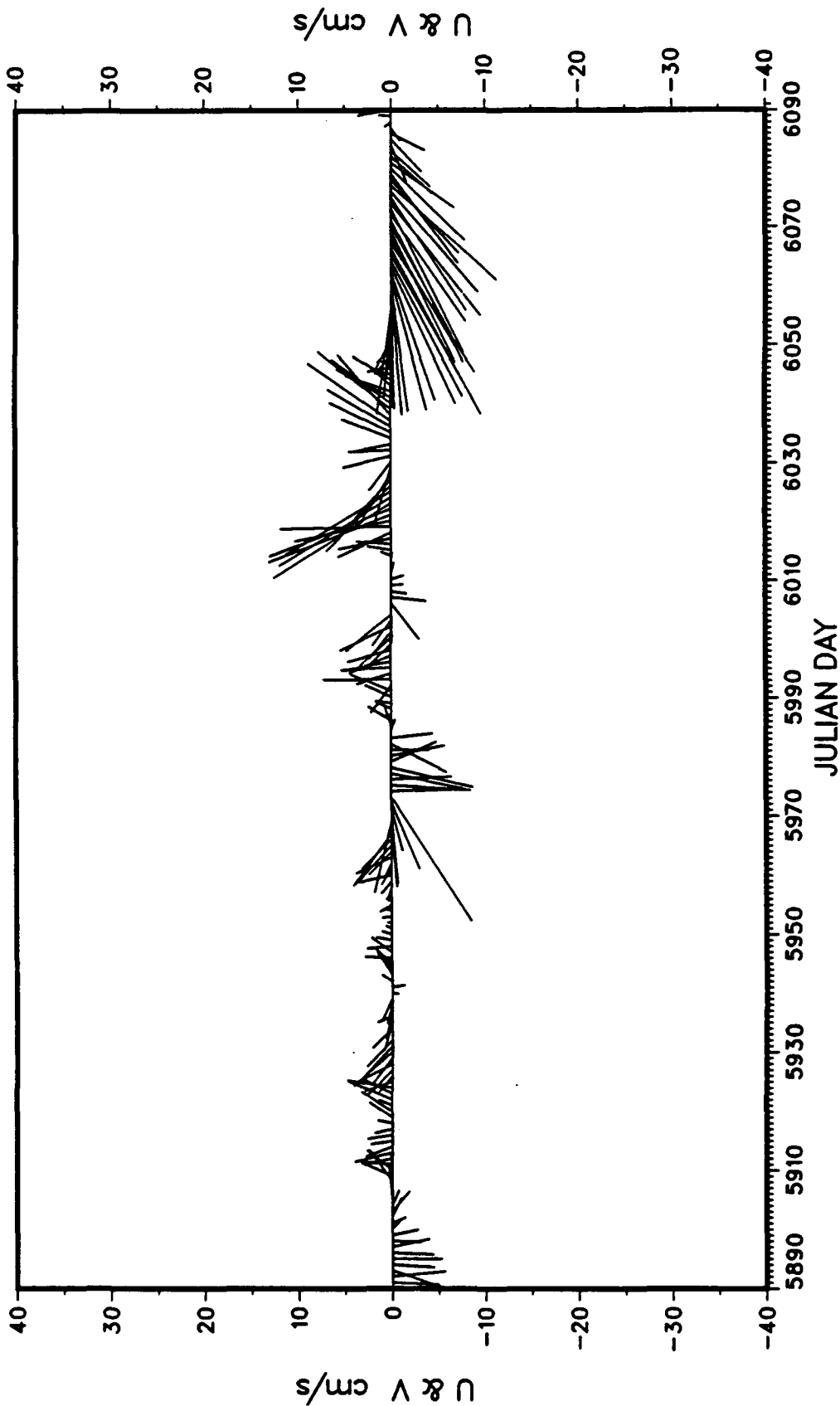


JULY 1983
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER

GUSREX 163B

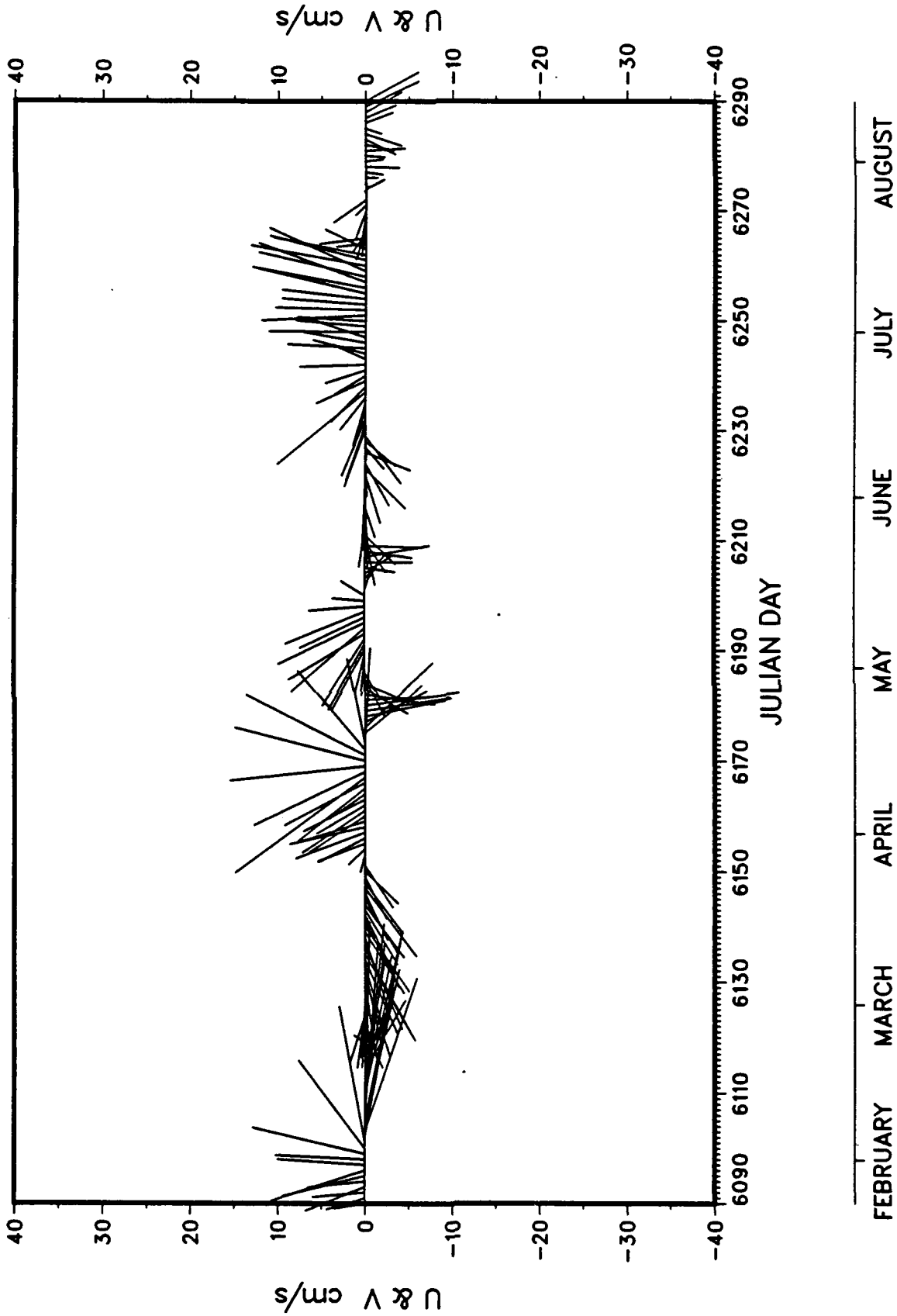


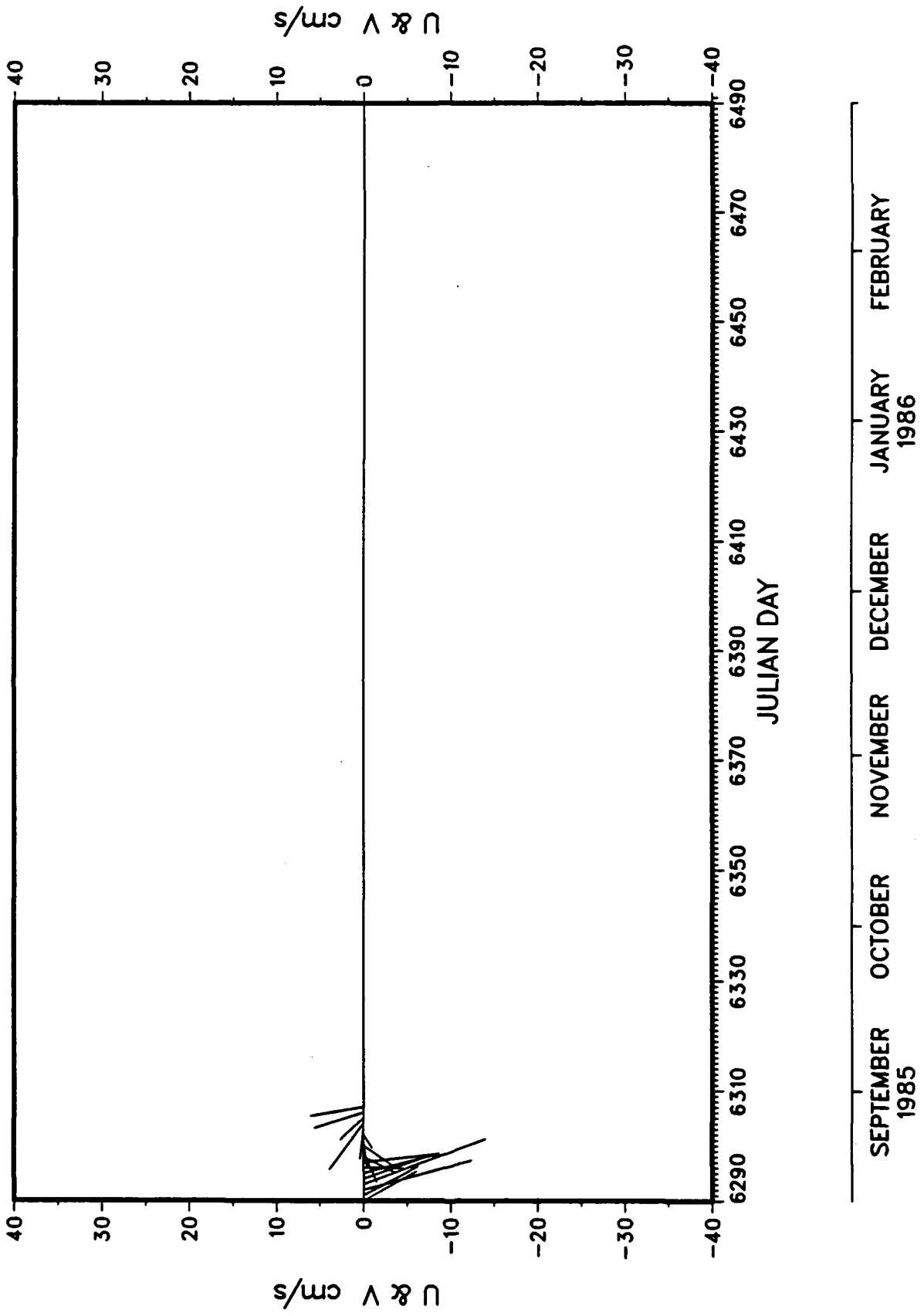
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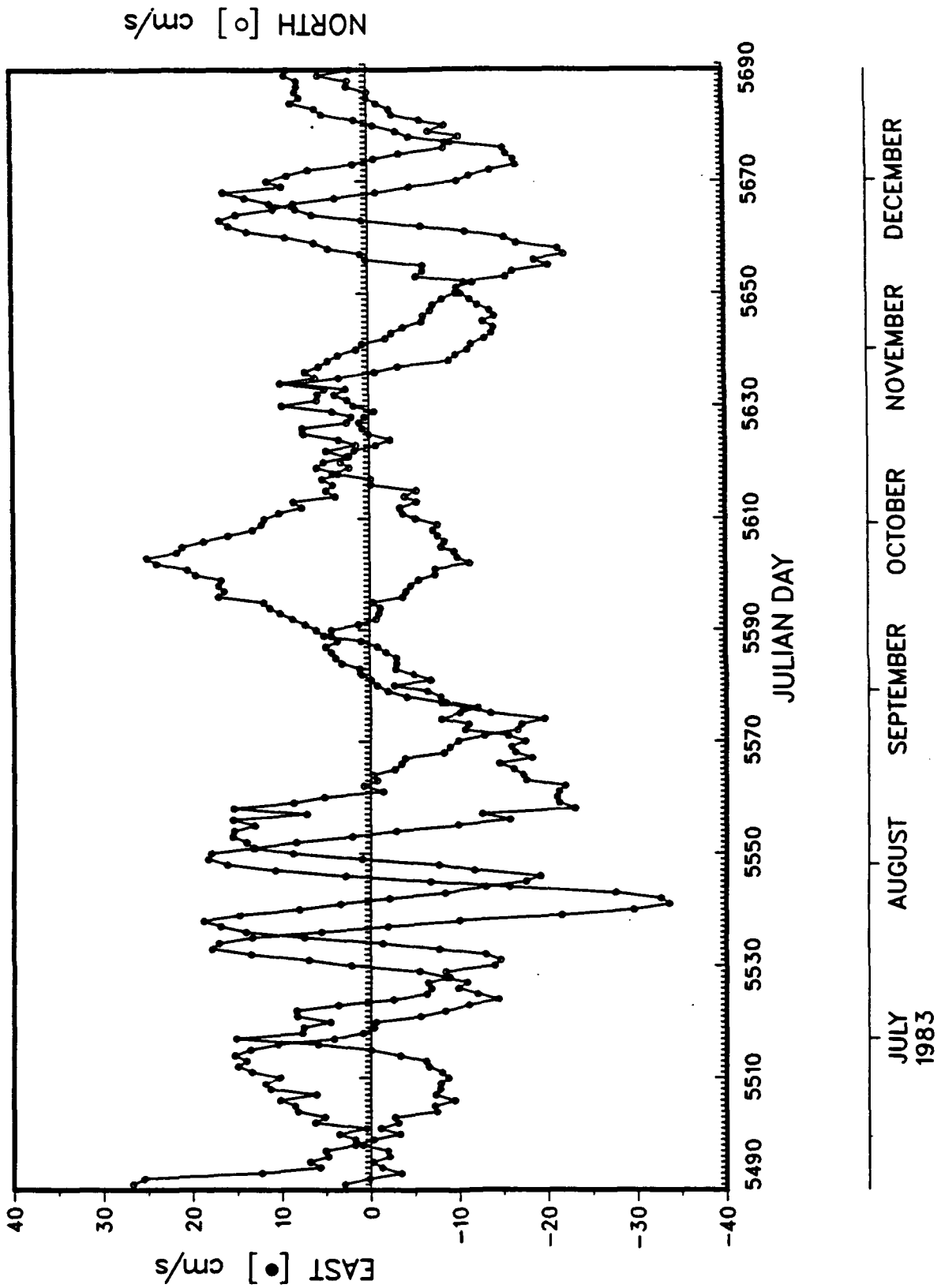
AUGUST 1984
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DECEMBER
JANUARY 1985

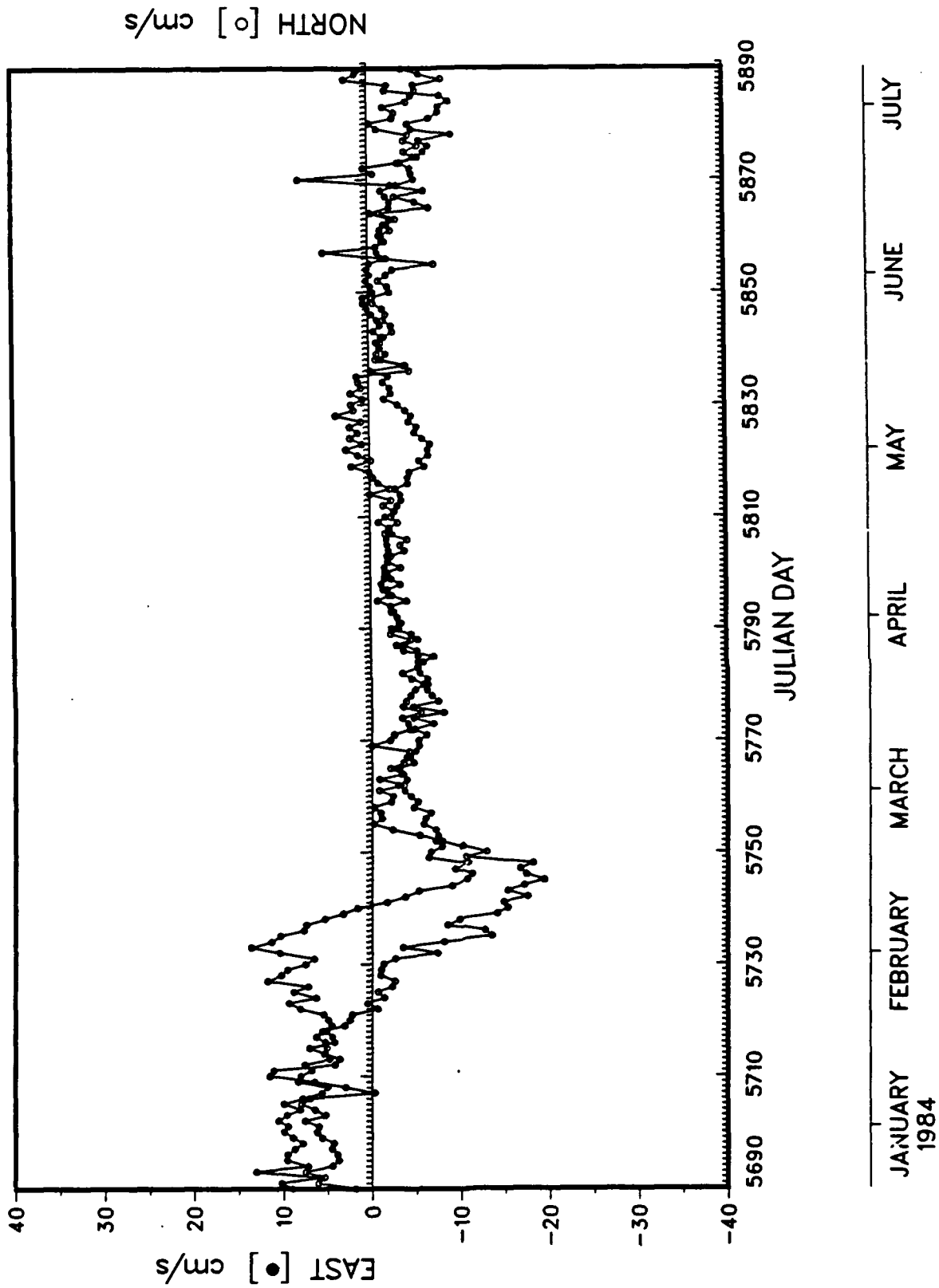
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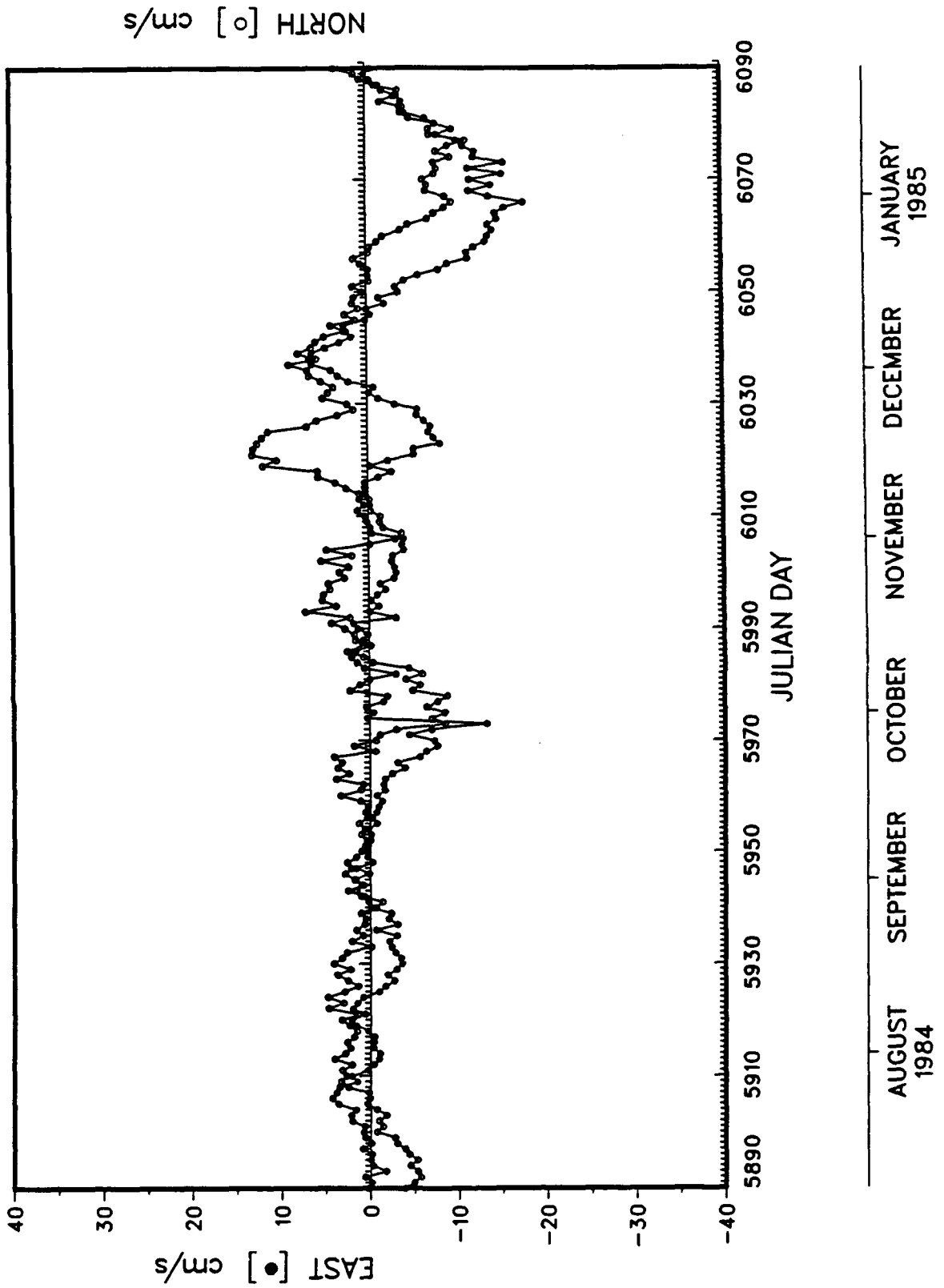


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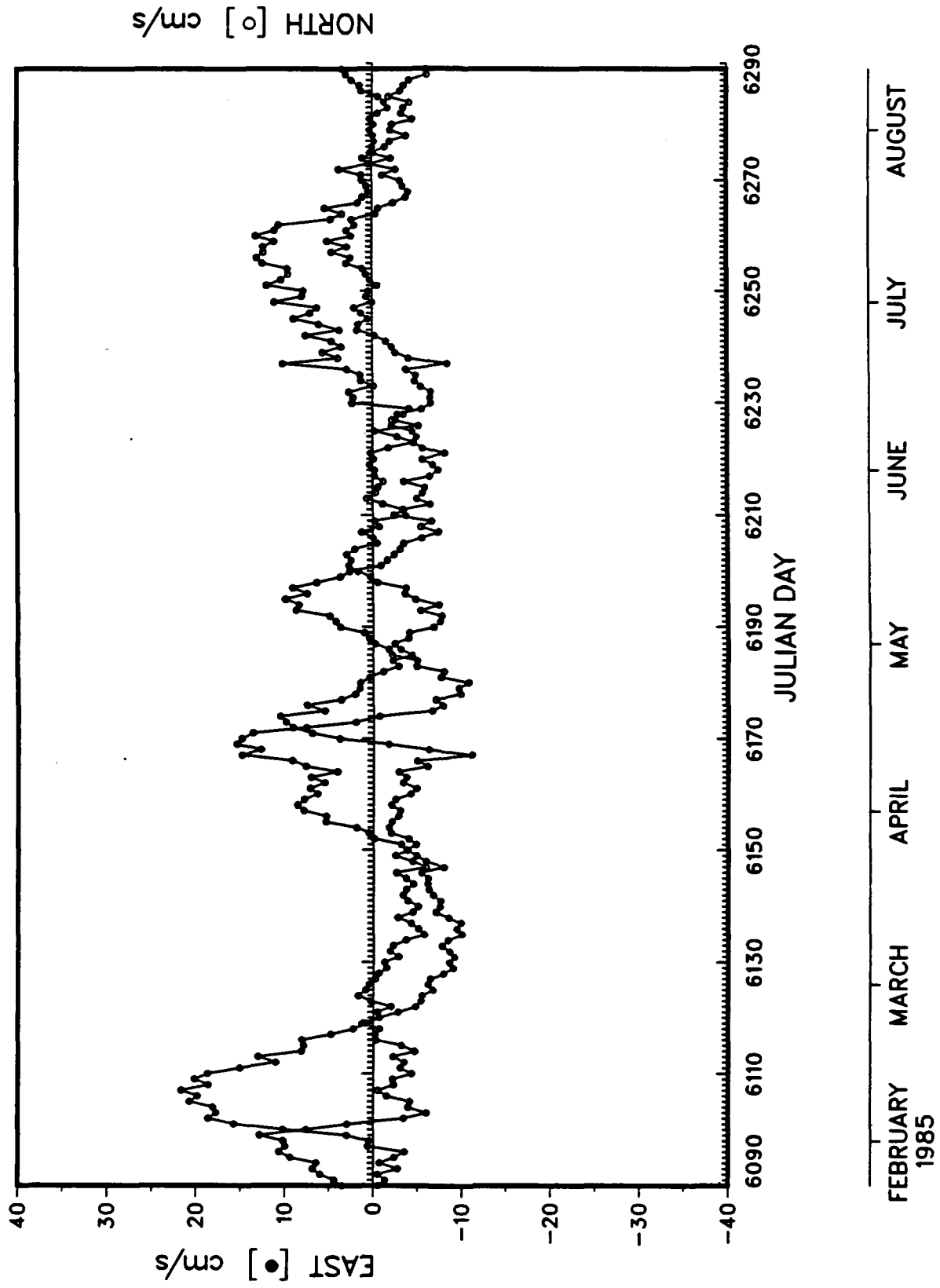




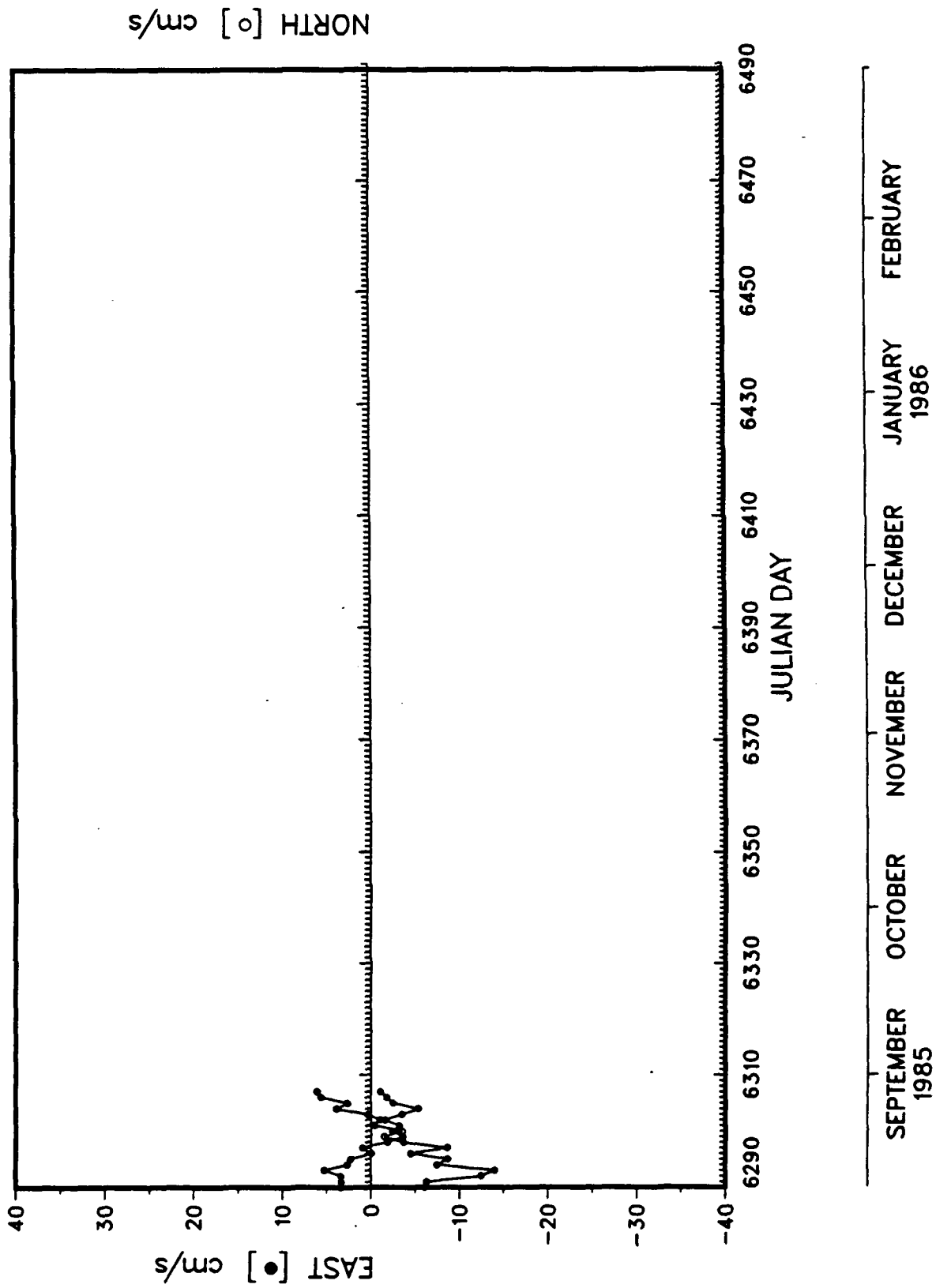
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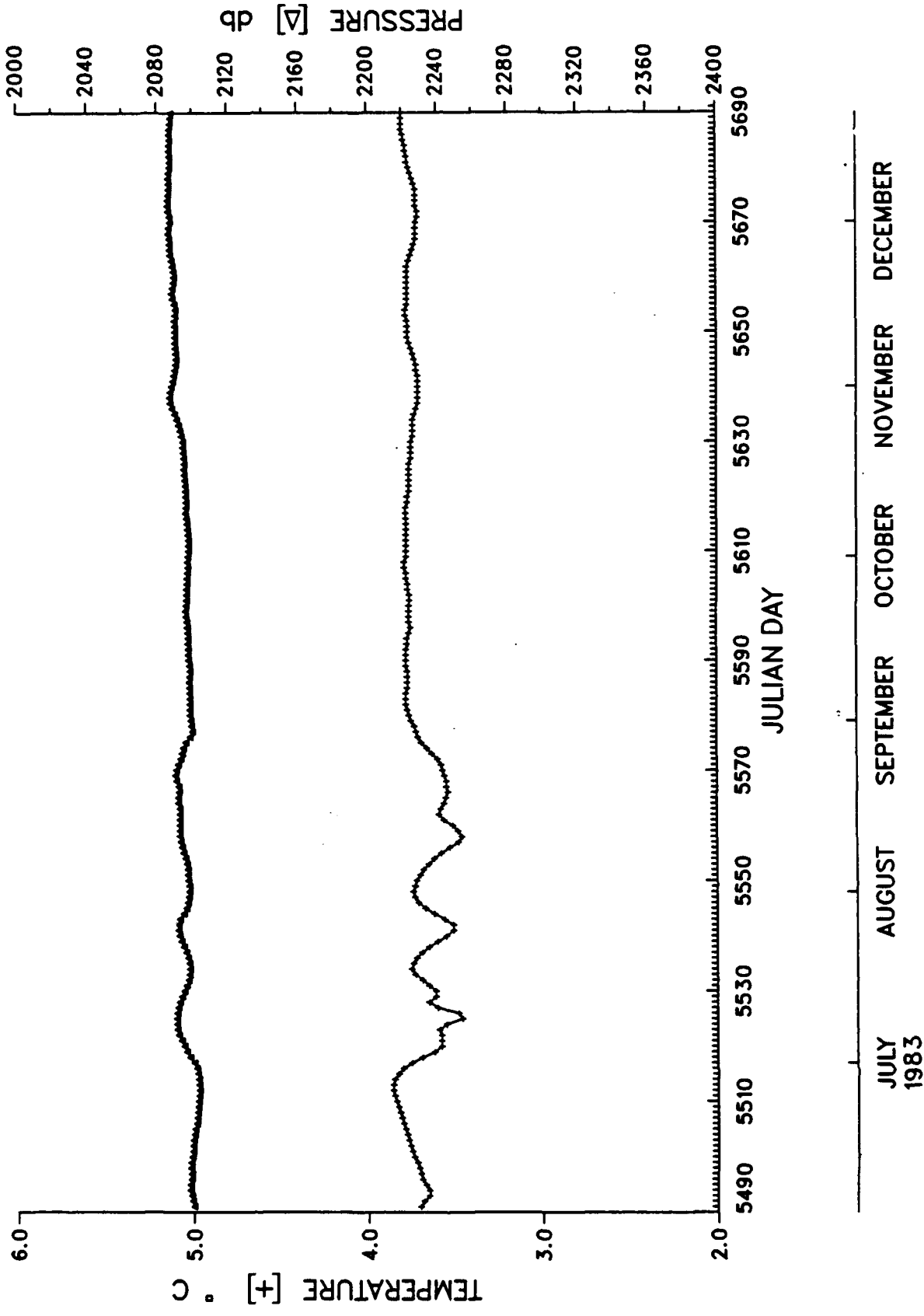
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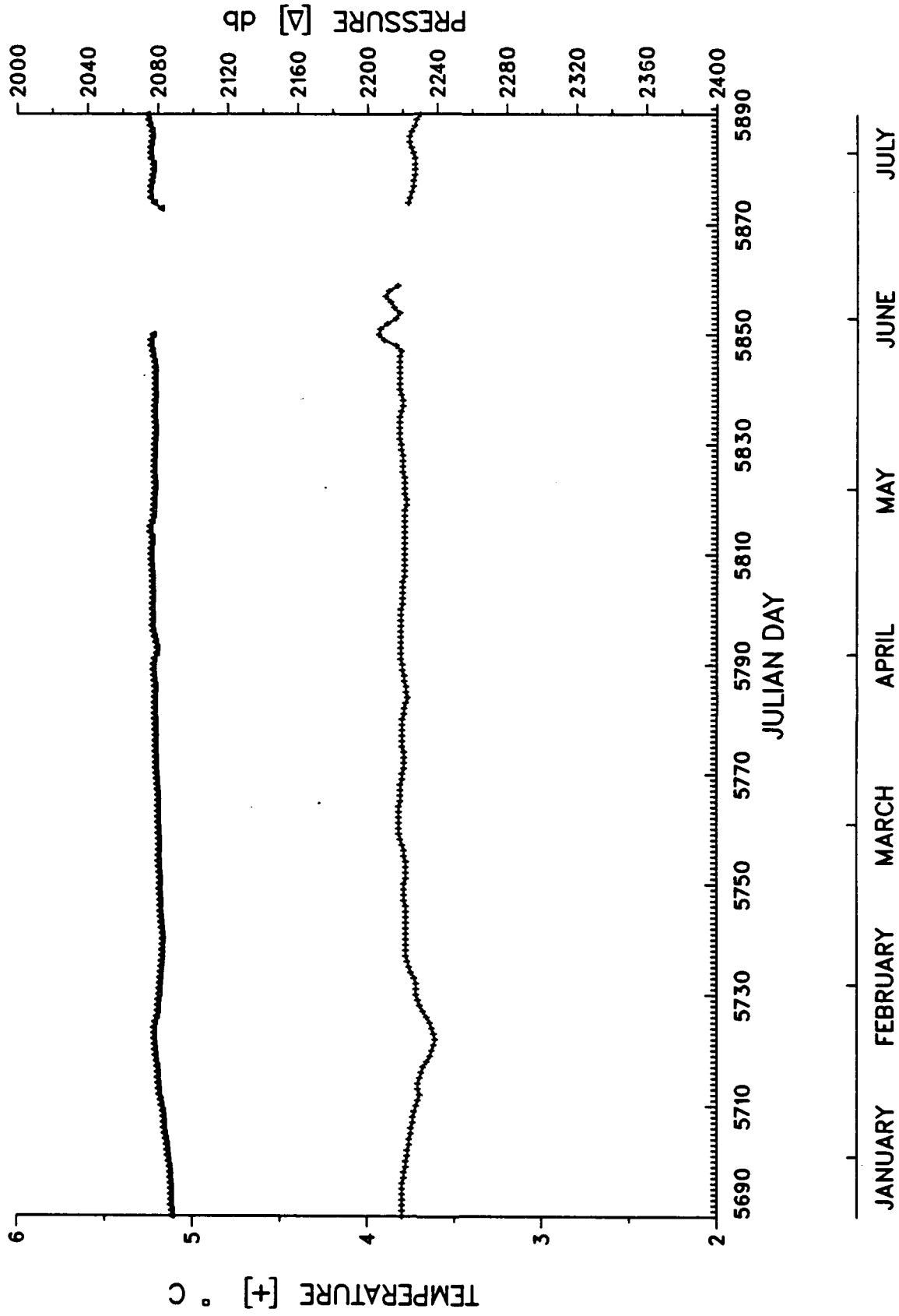
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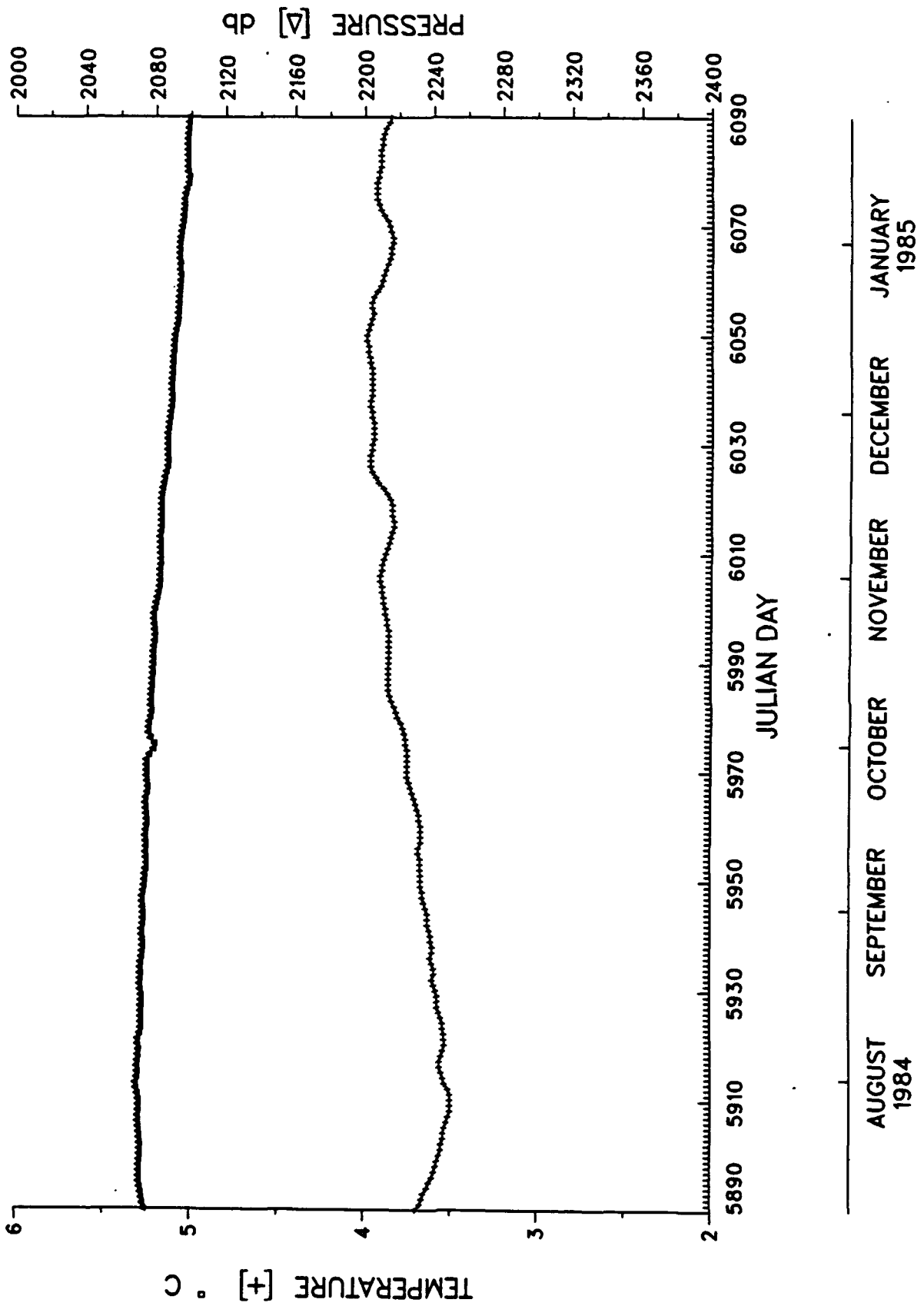
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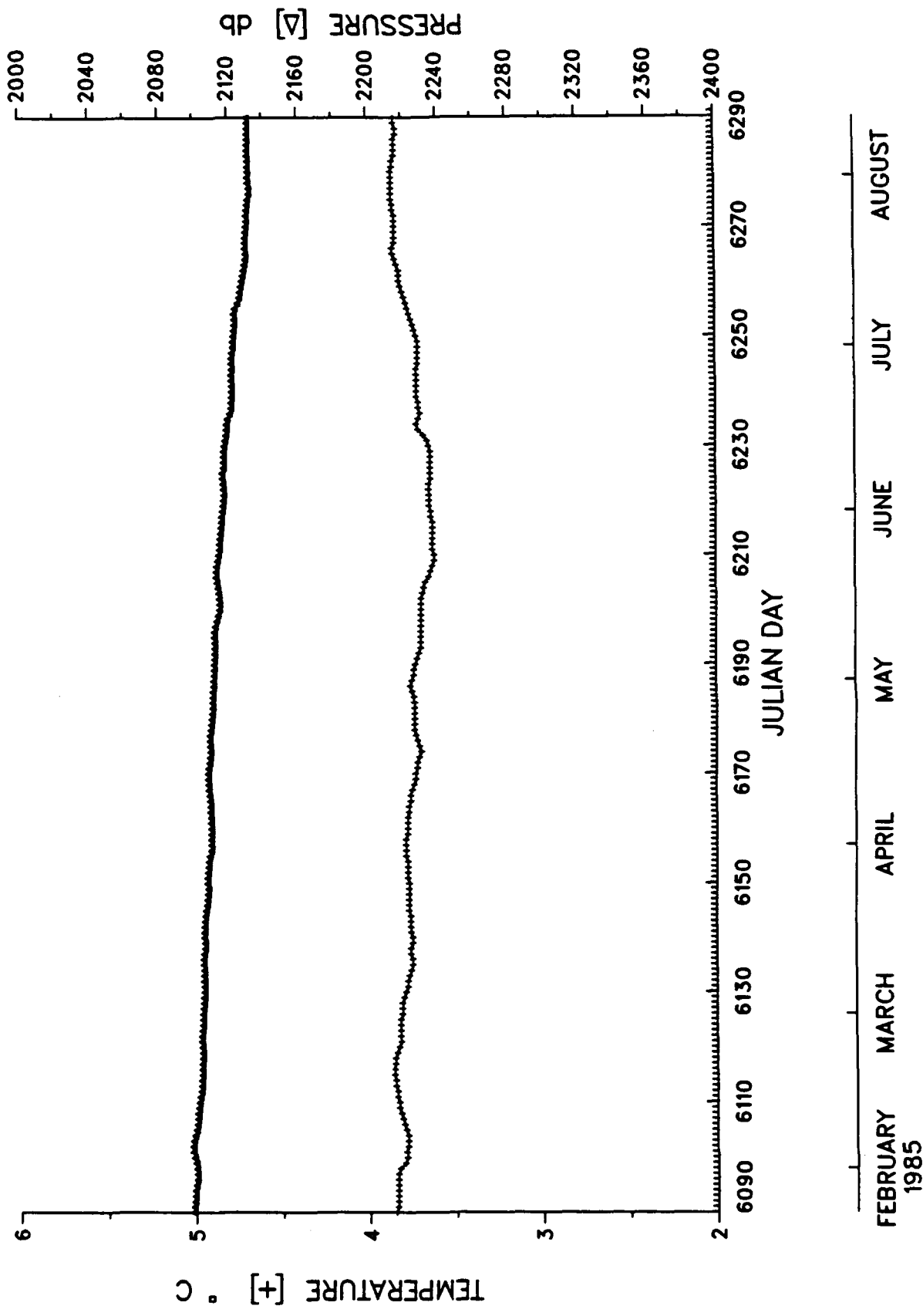
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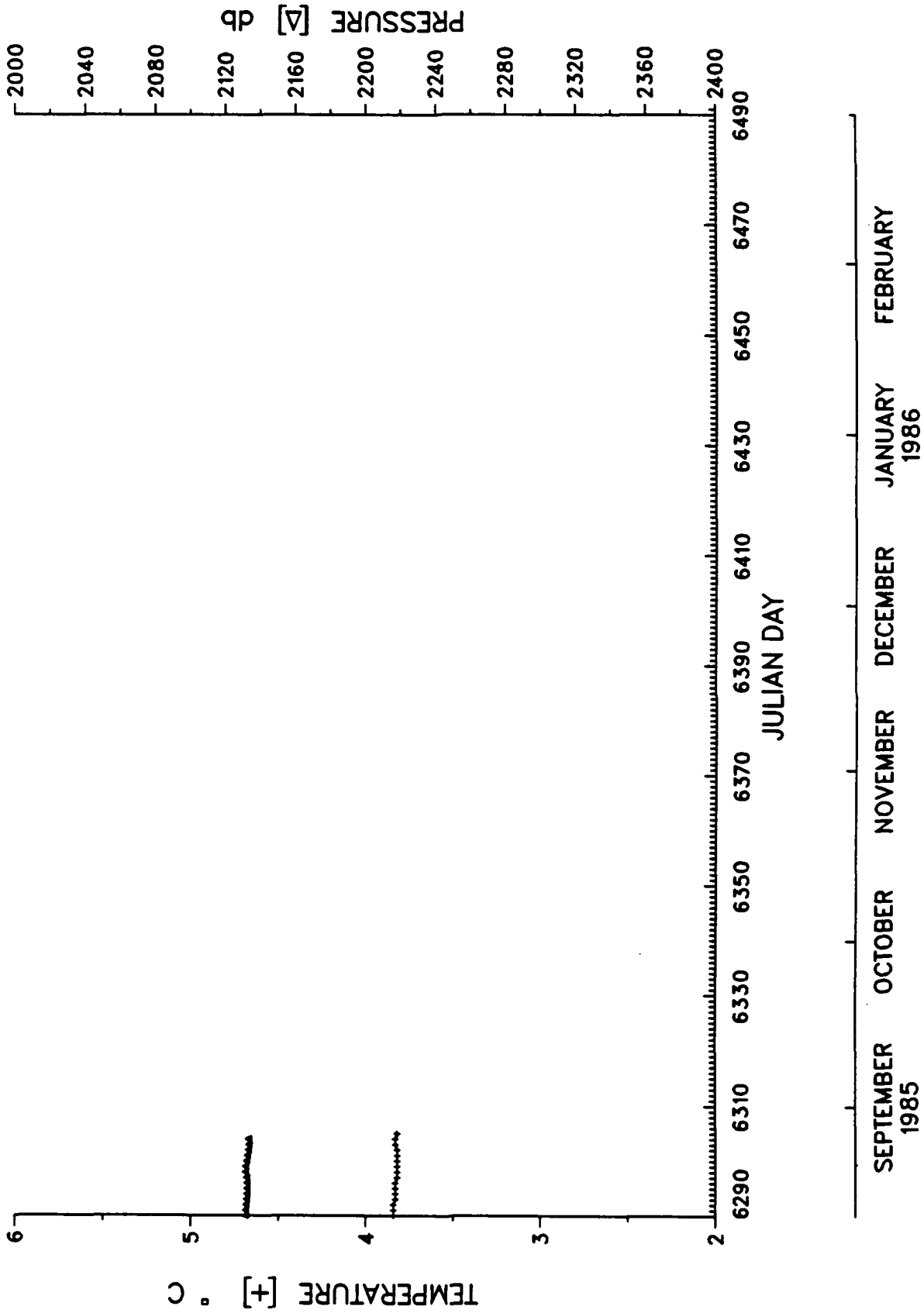


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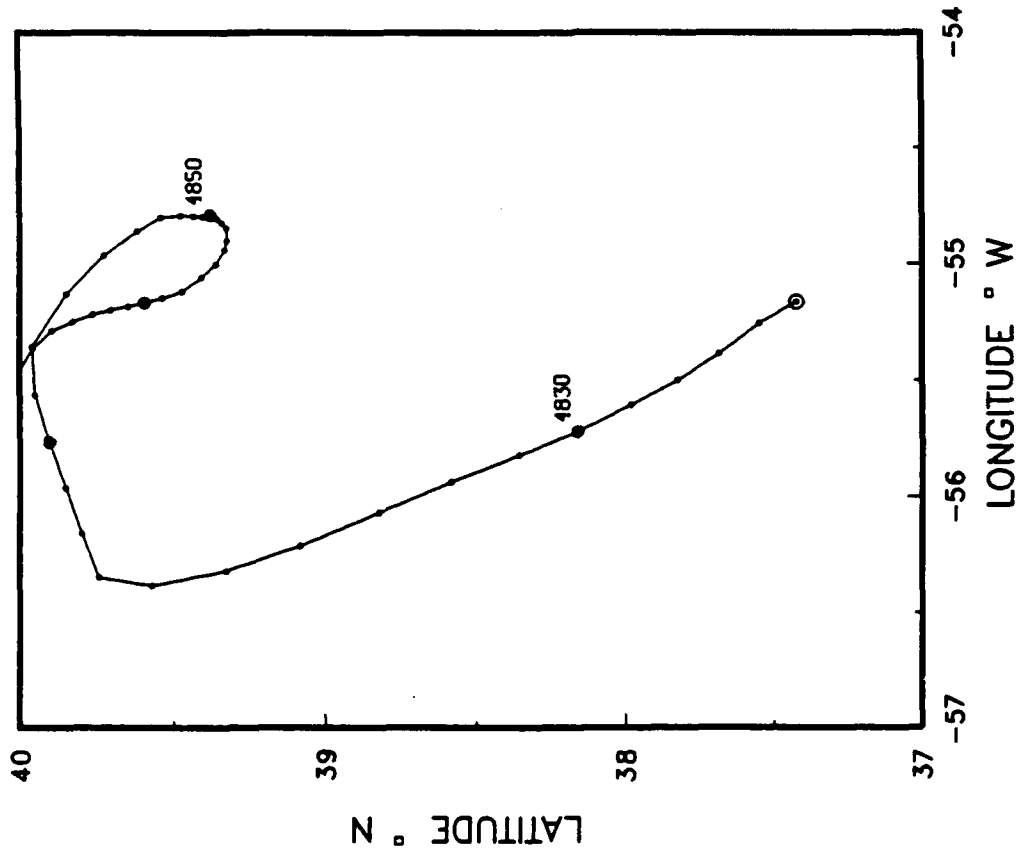


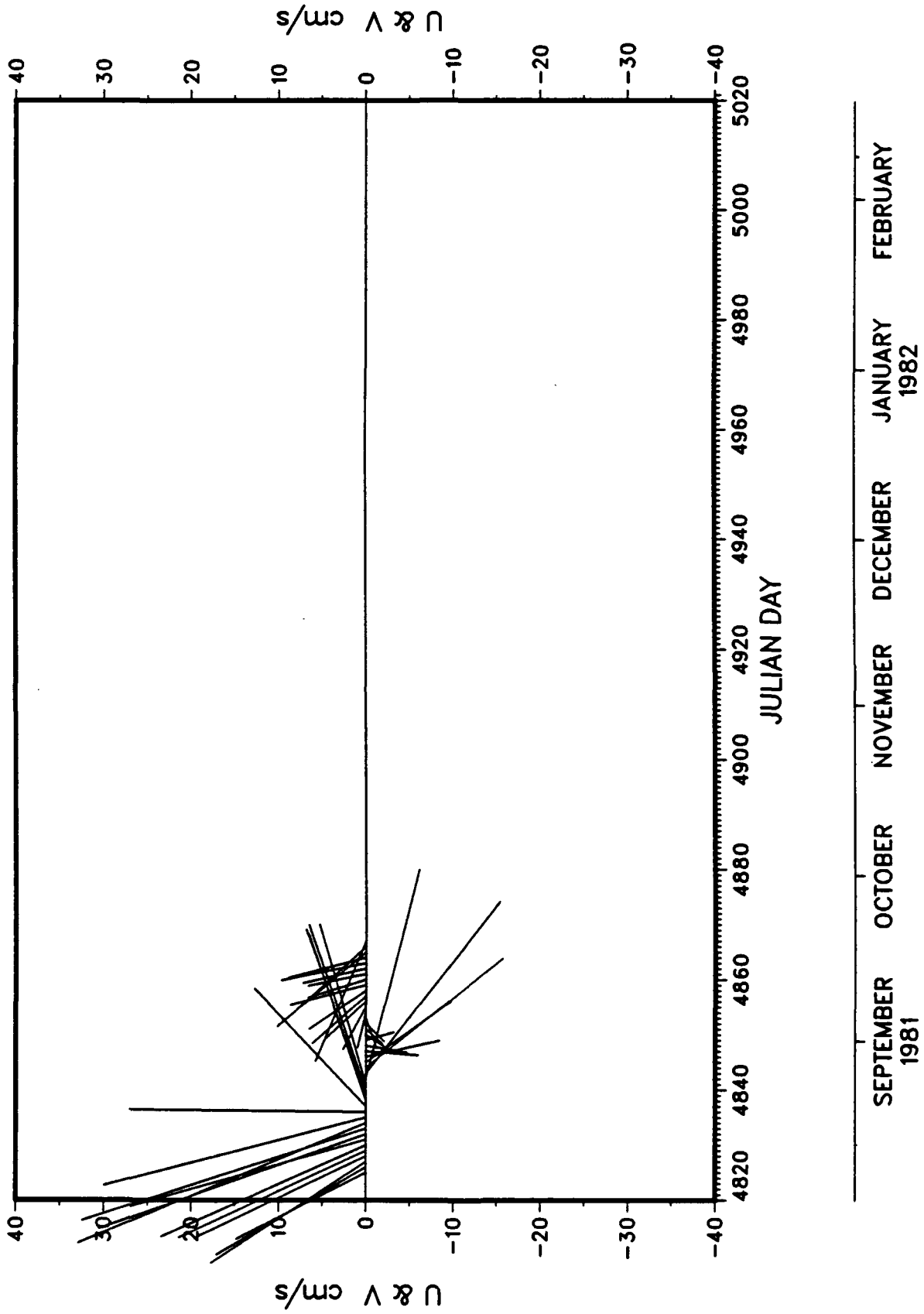
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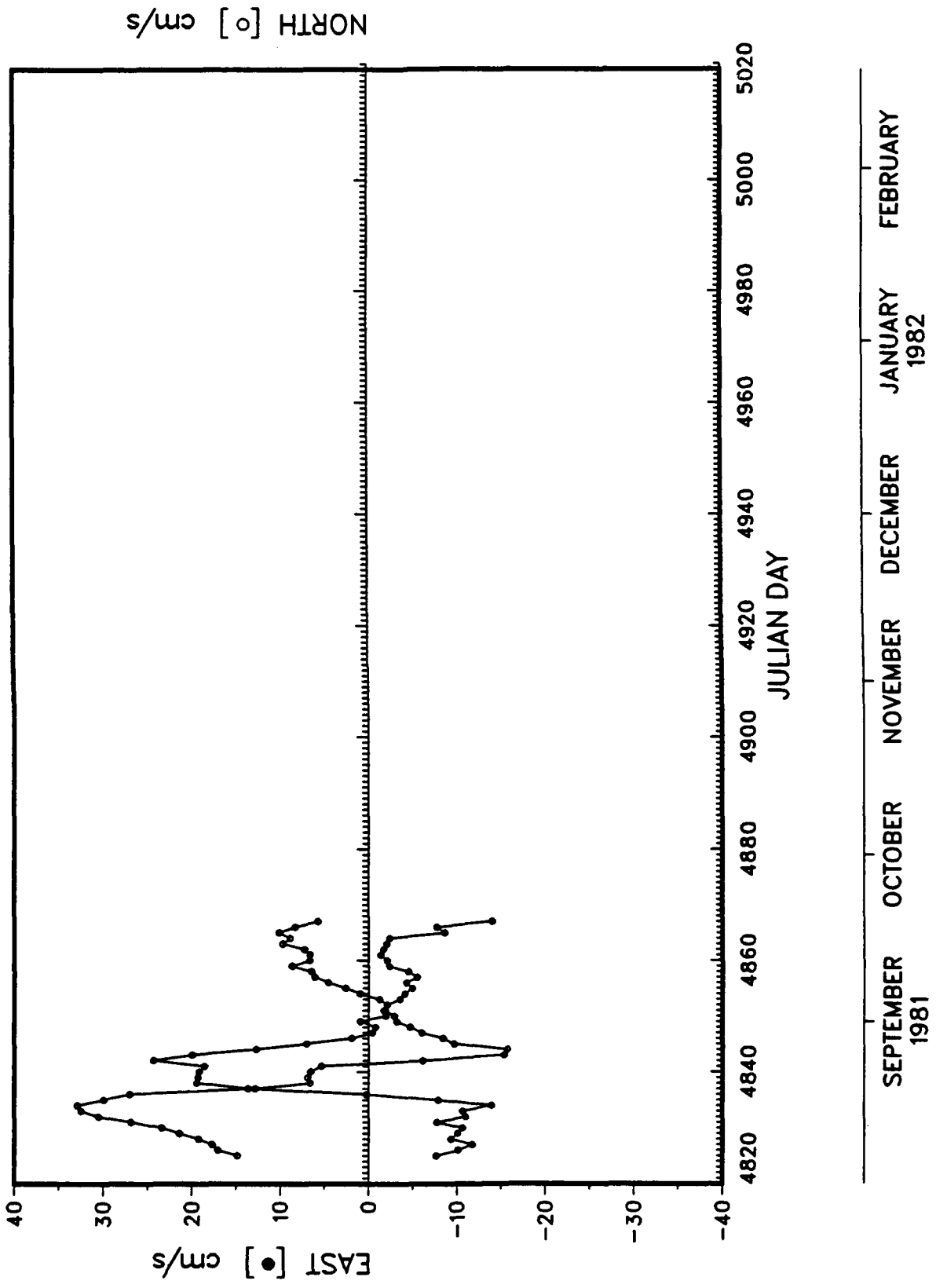


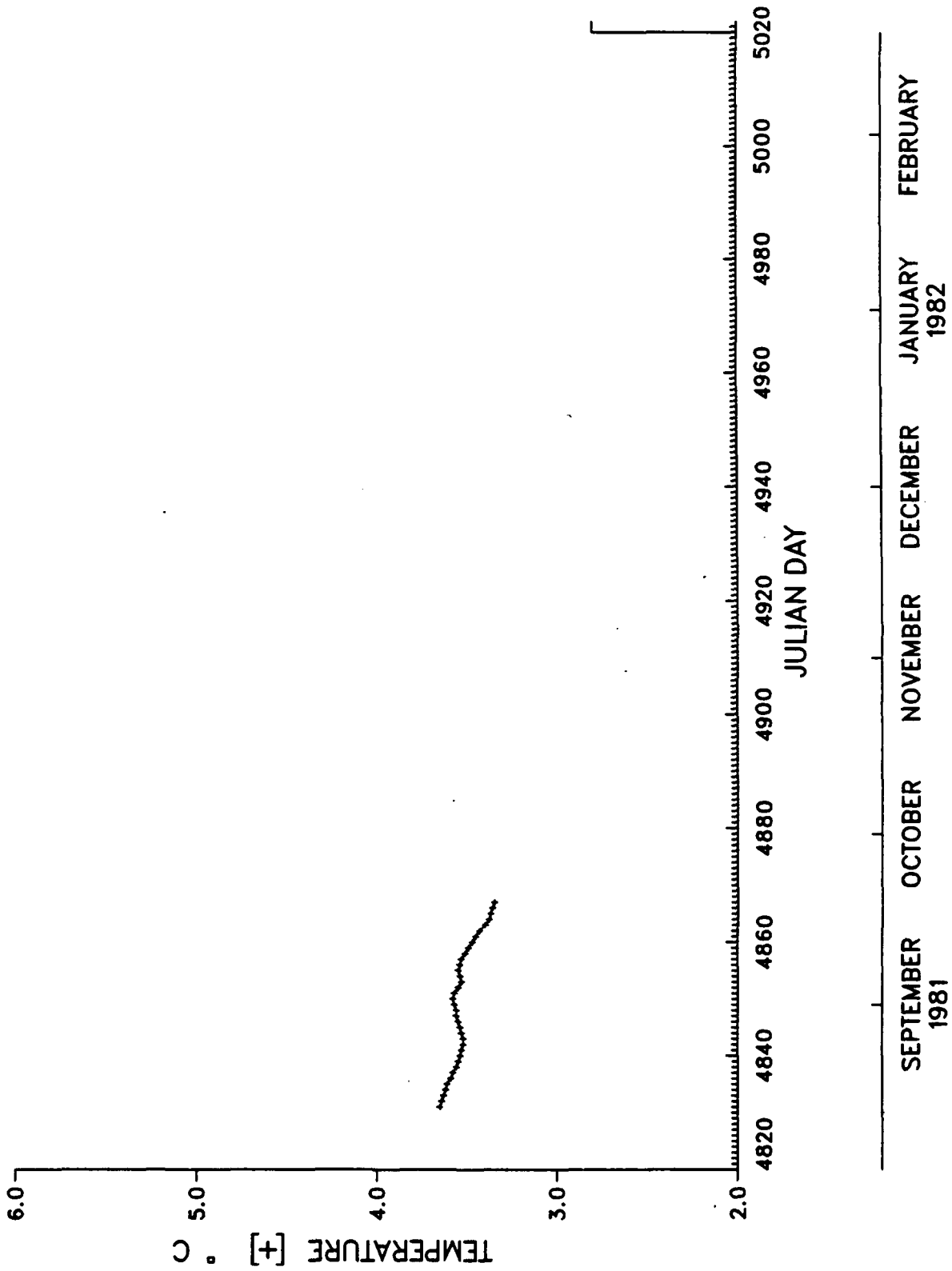
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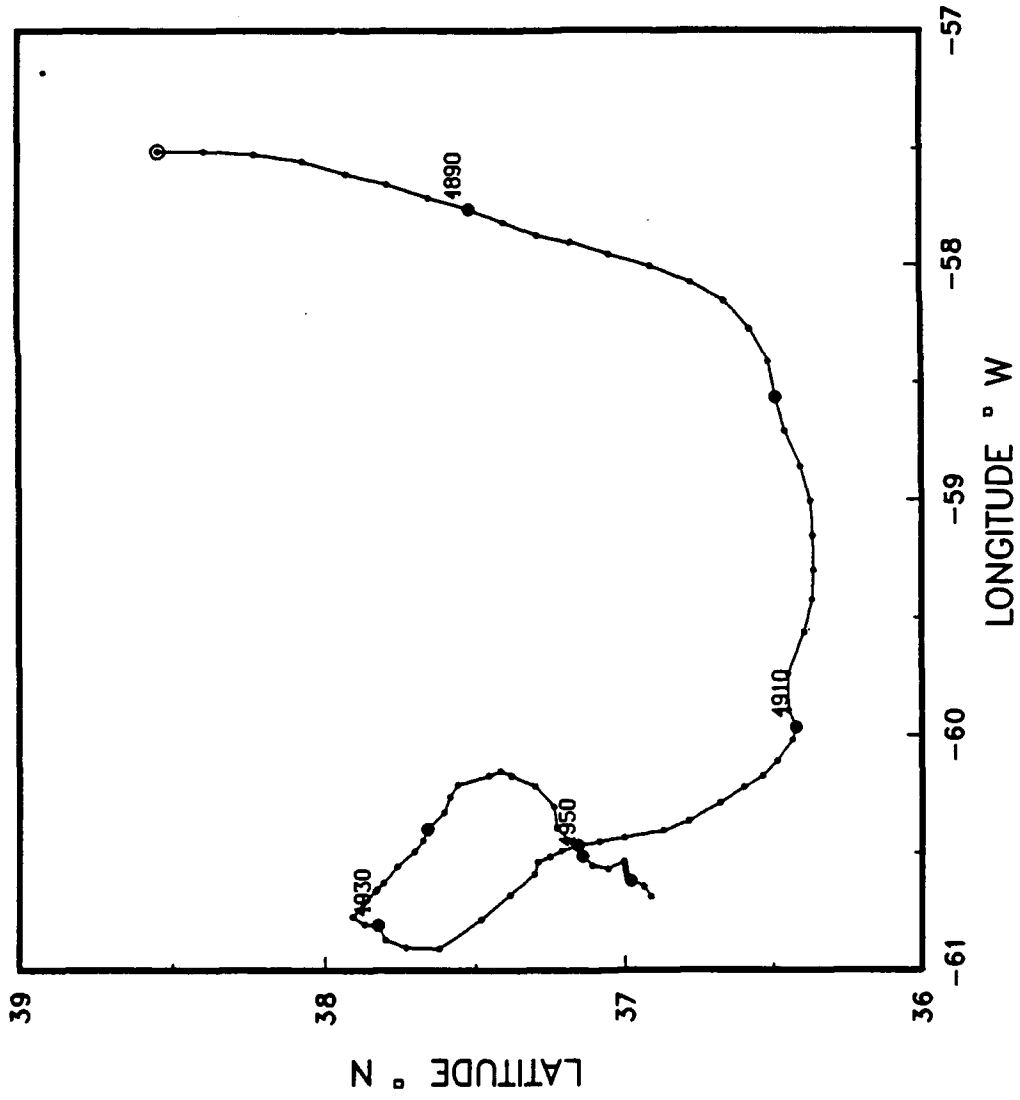




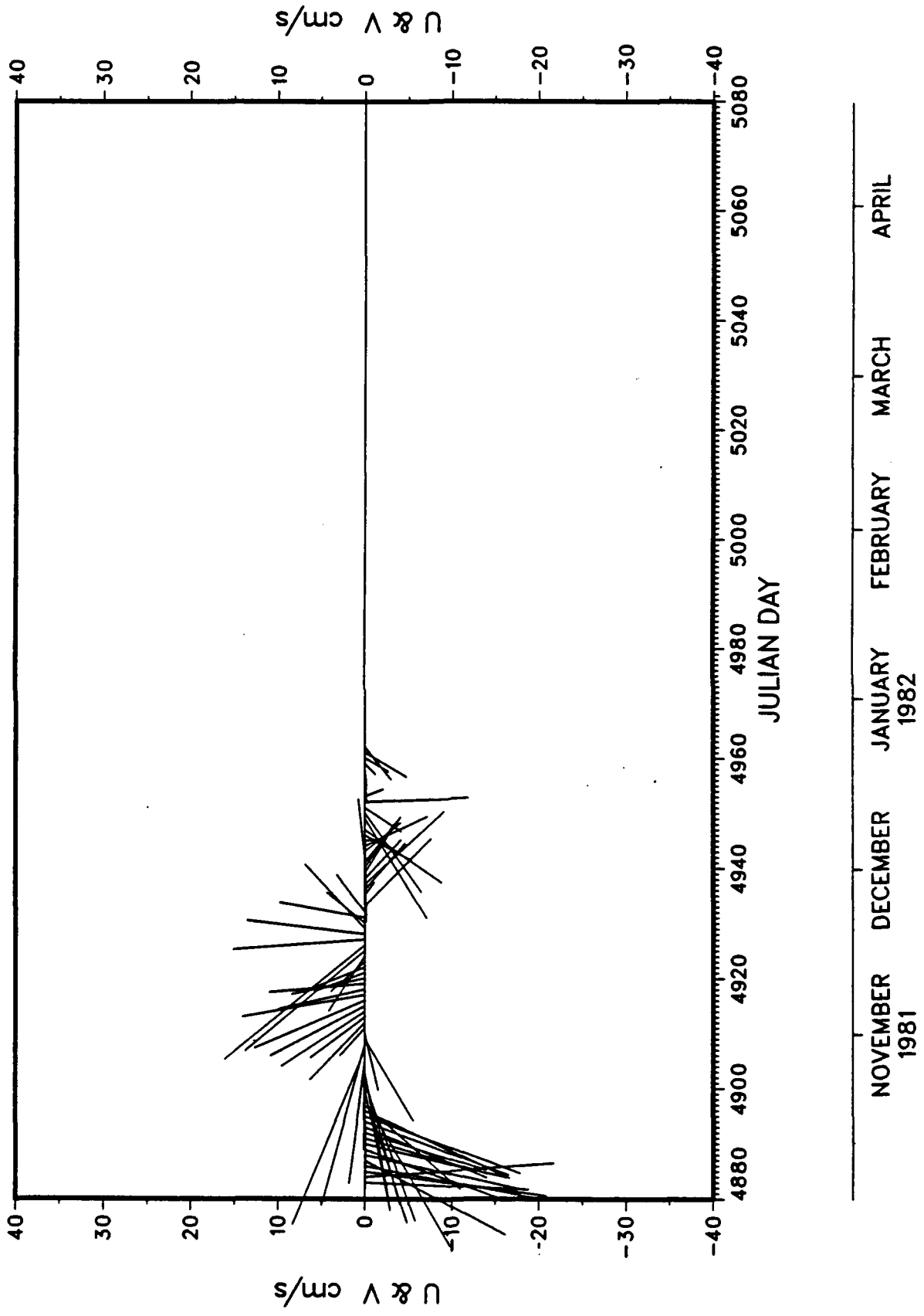
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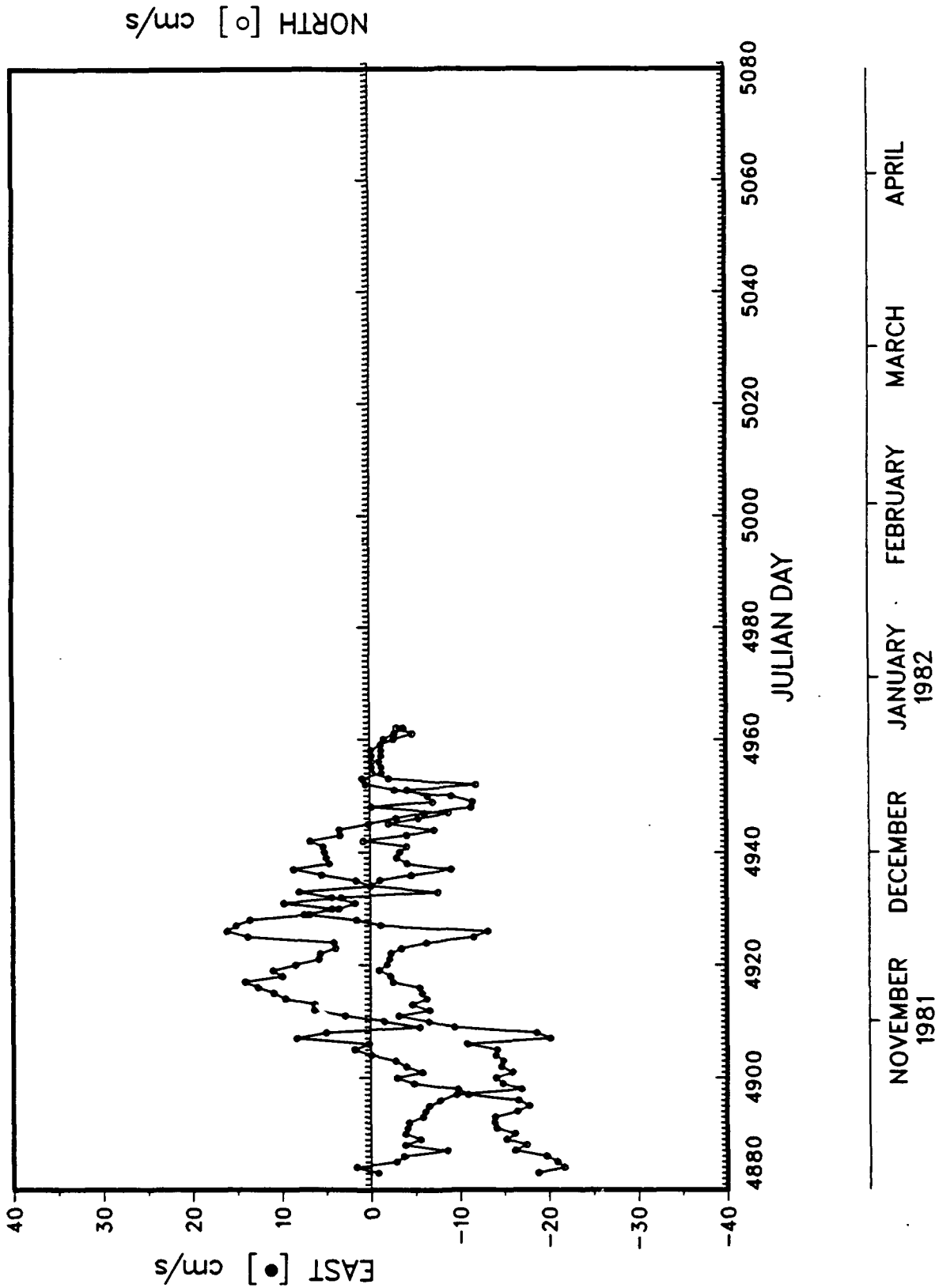




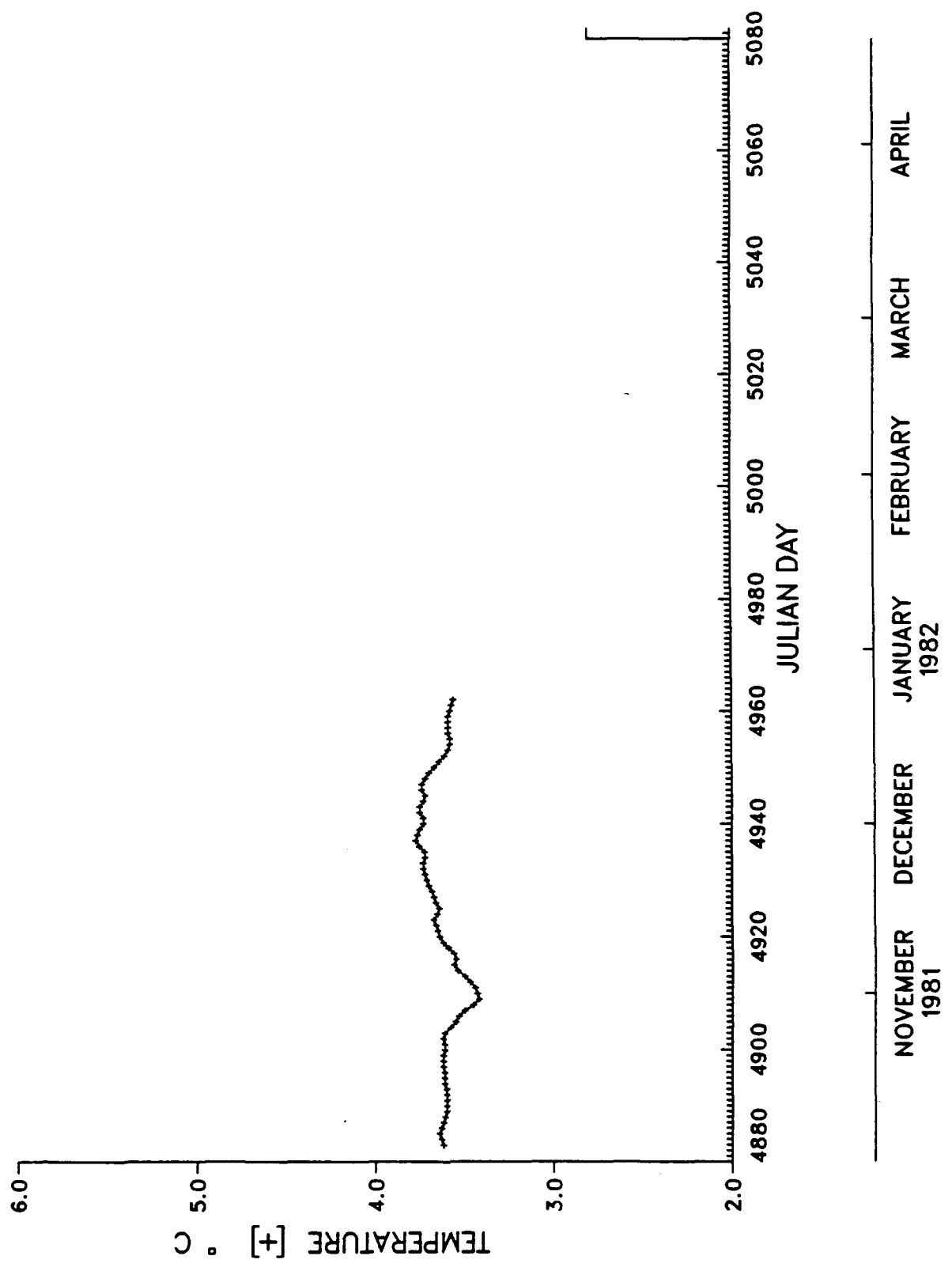
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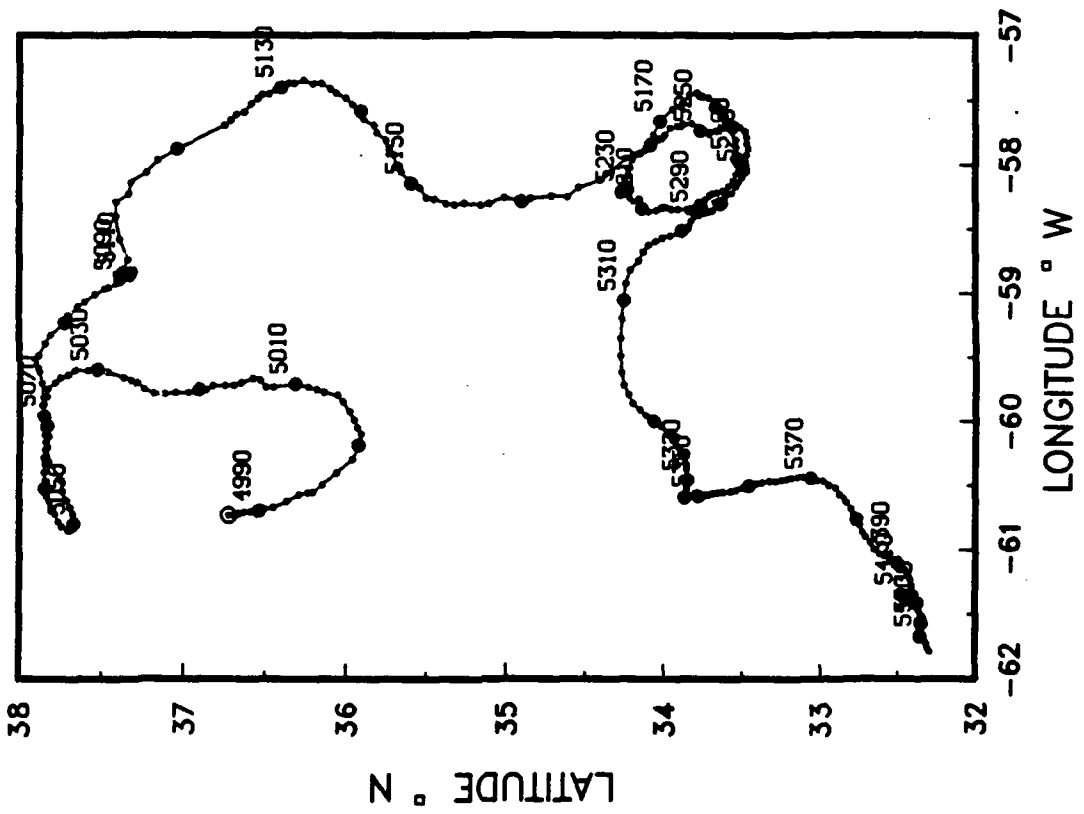
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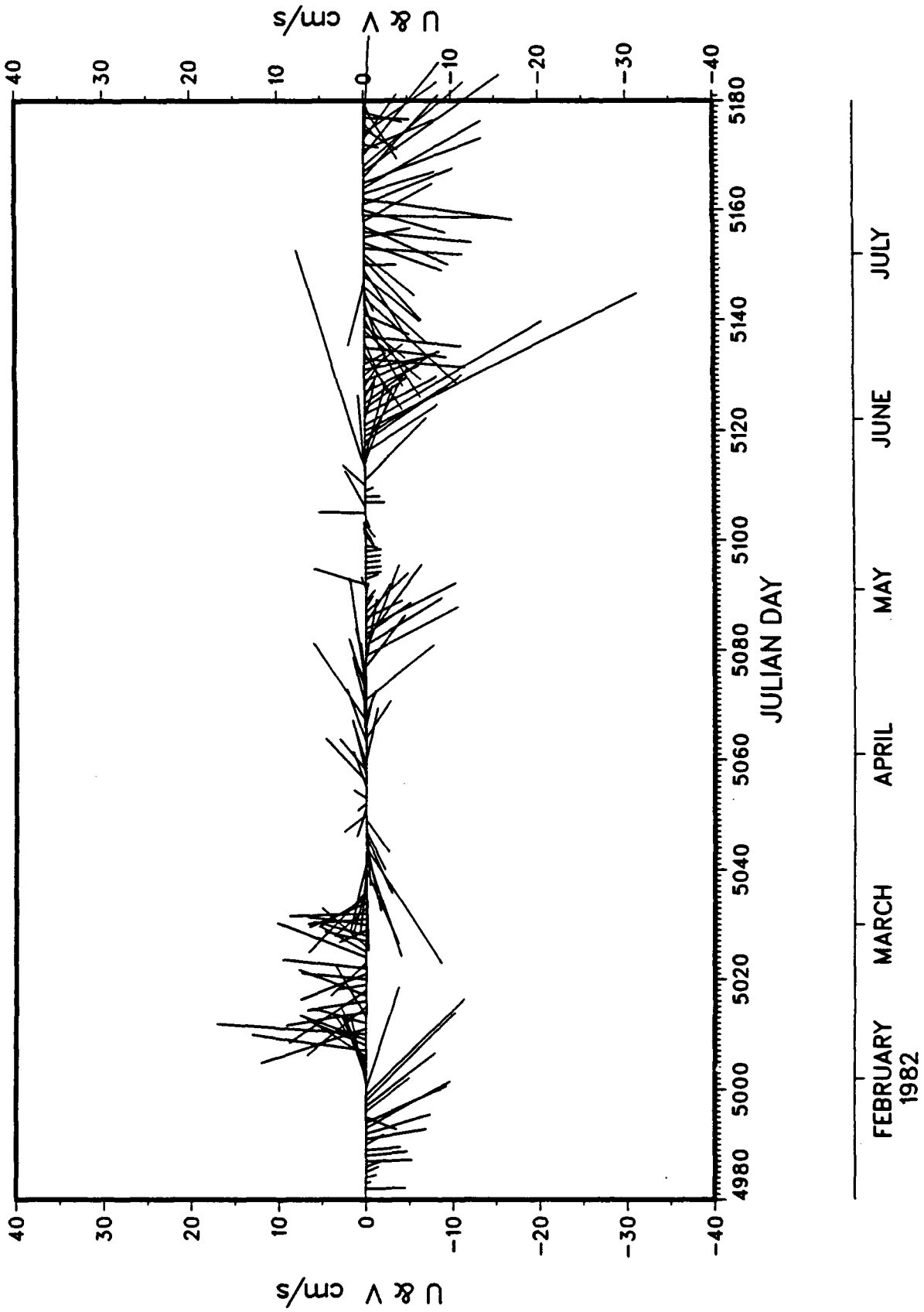
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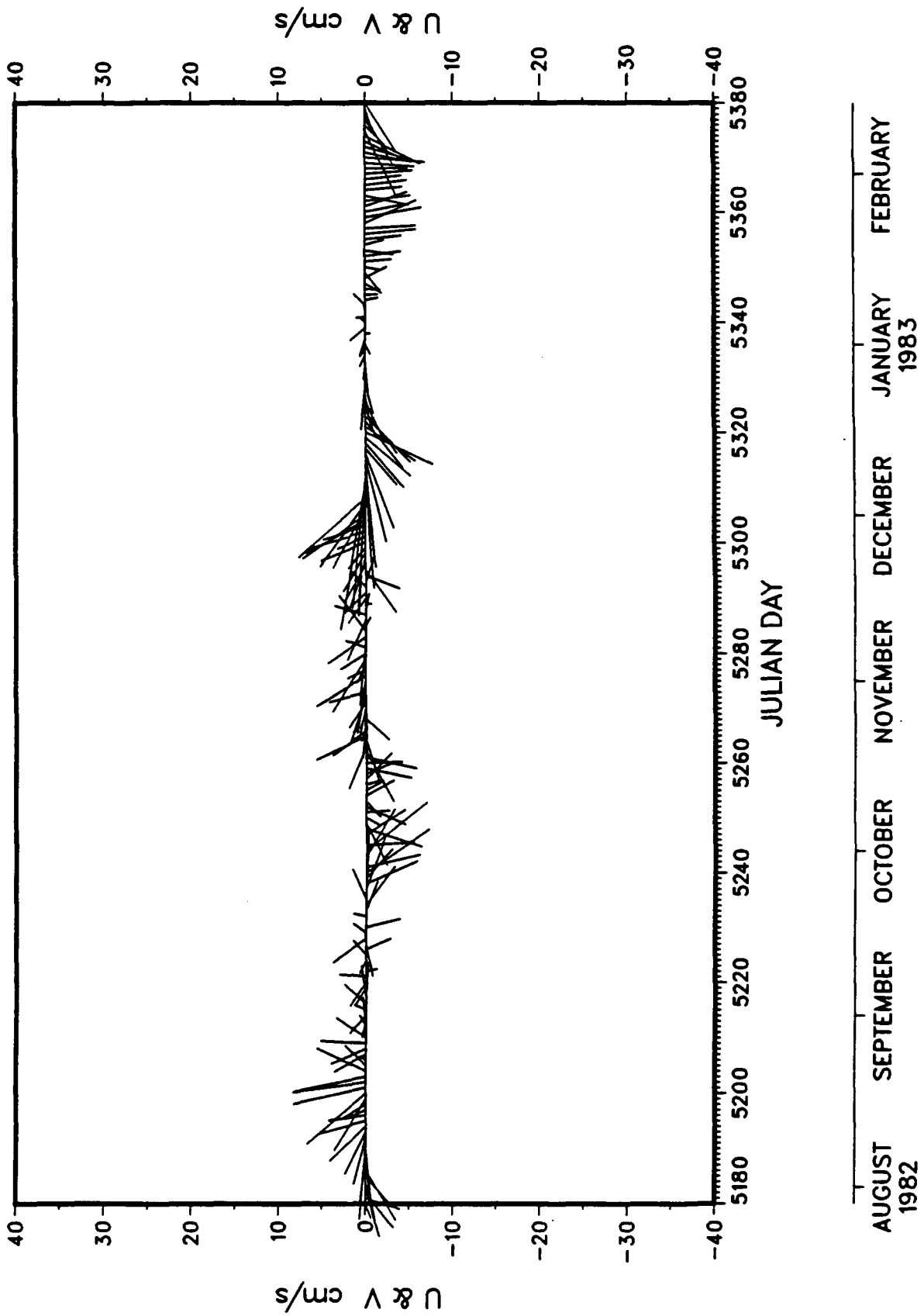
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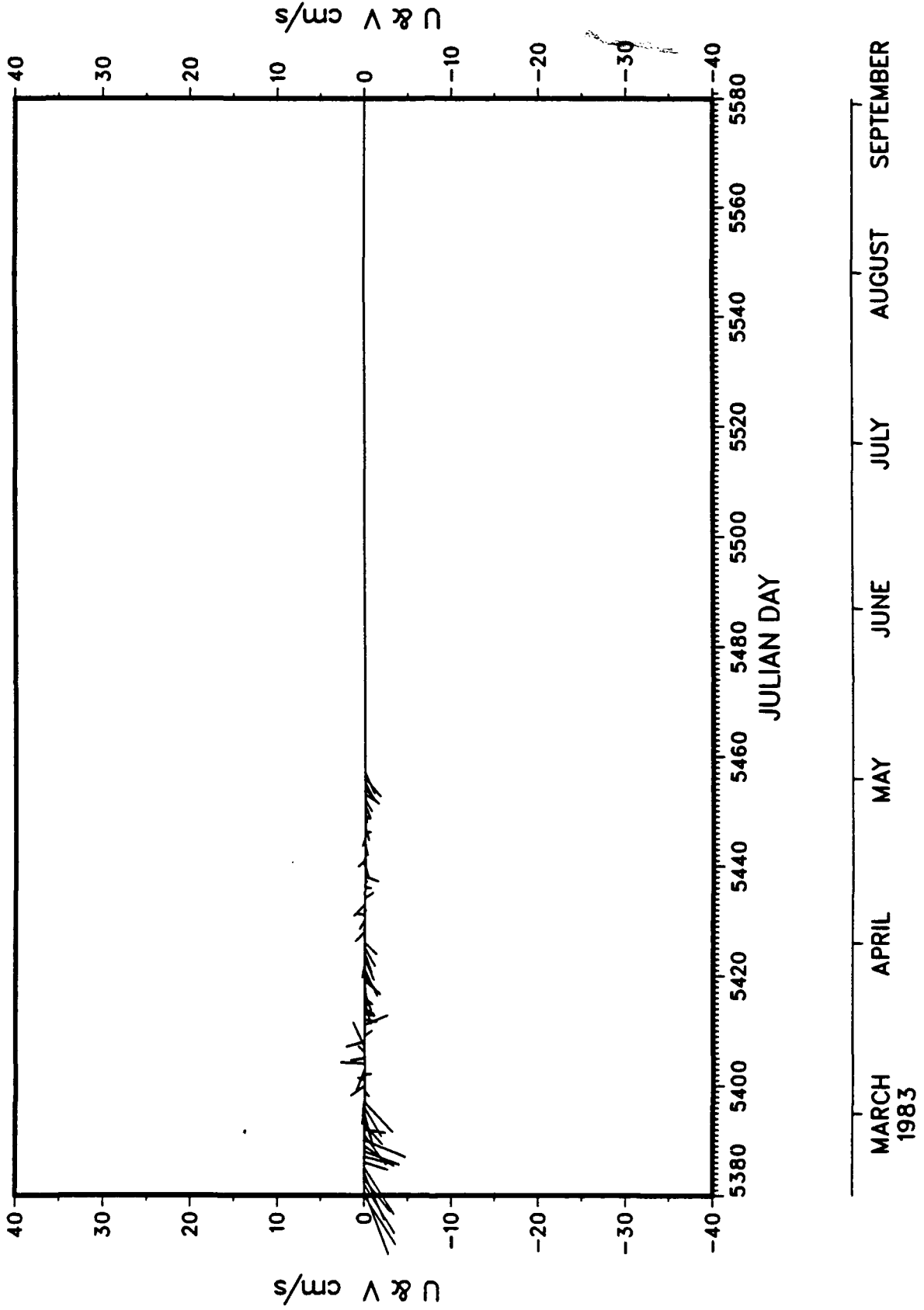
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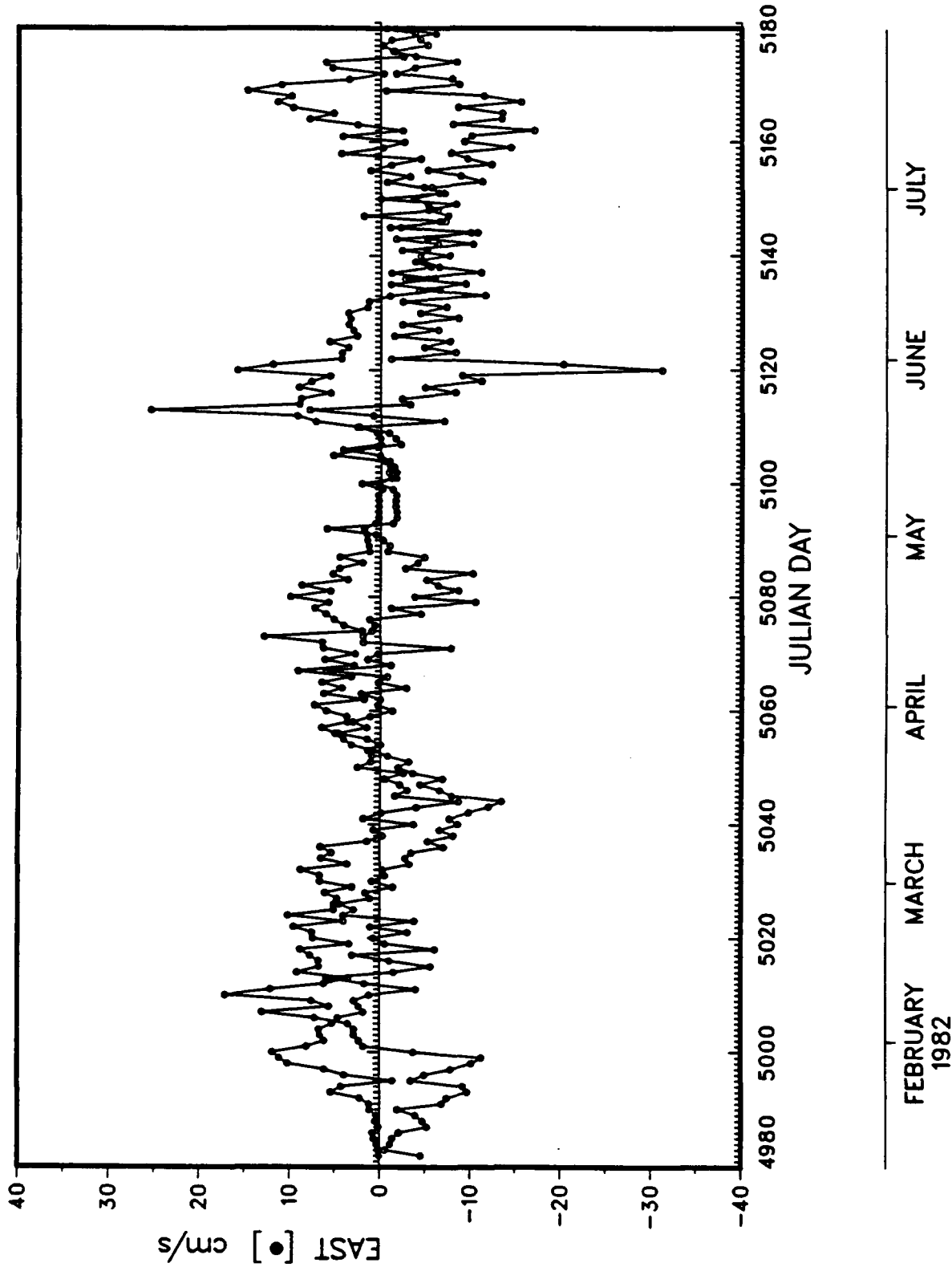
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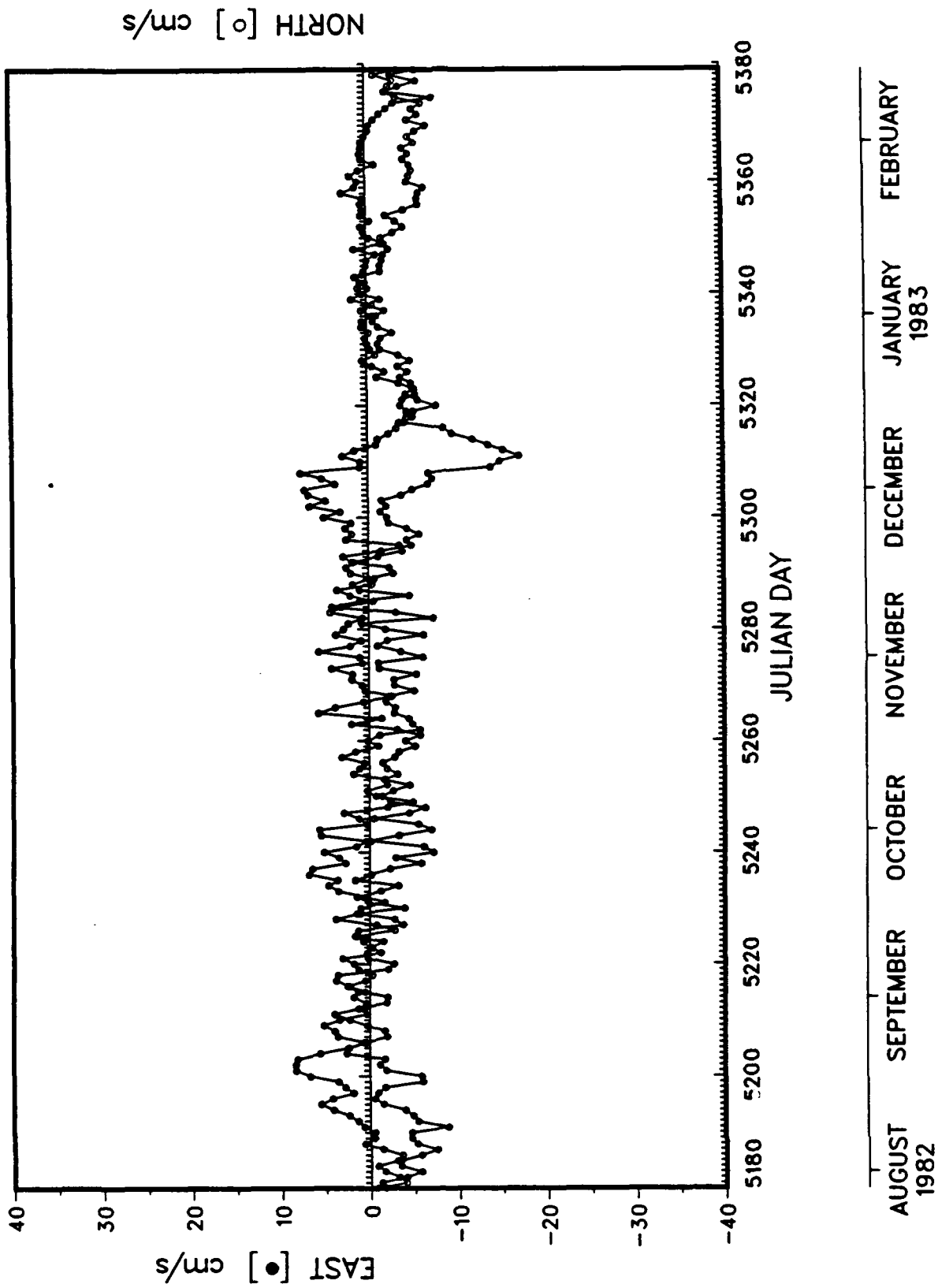


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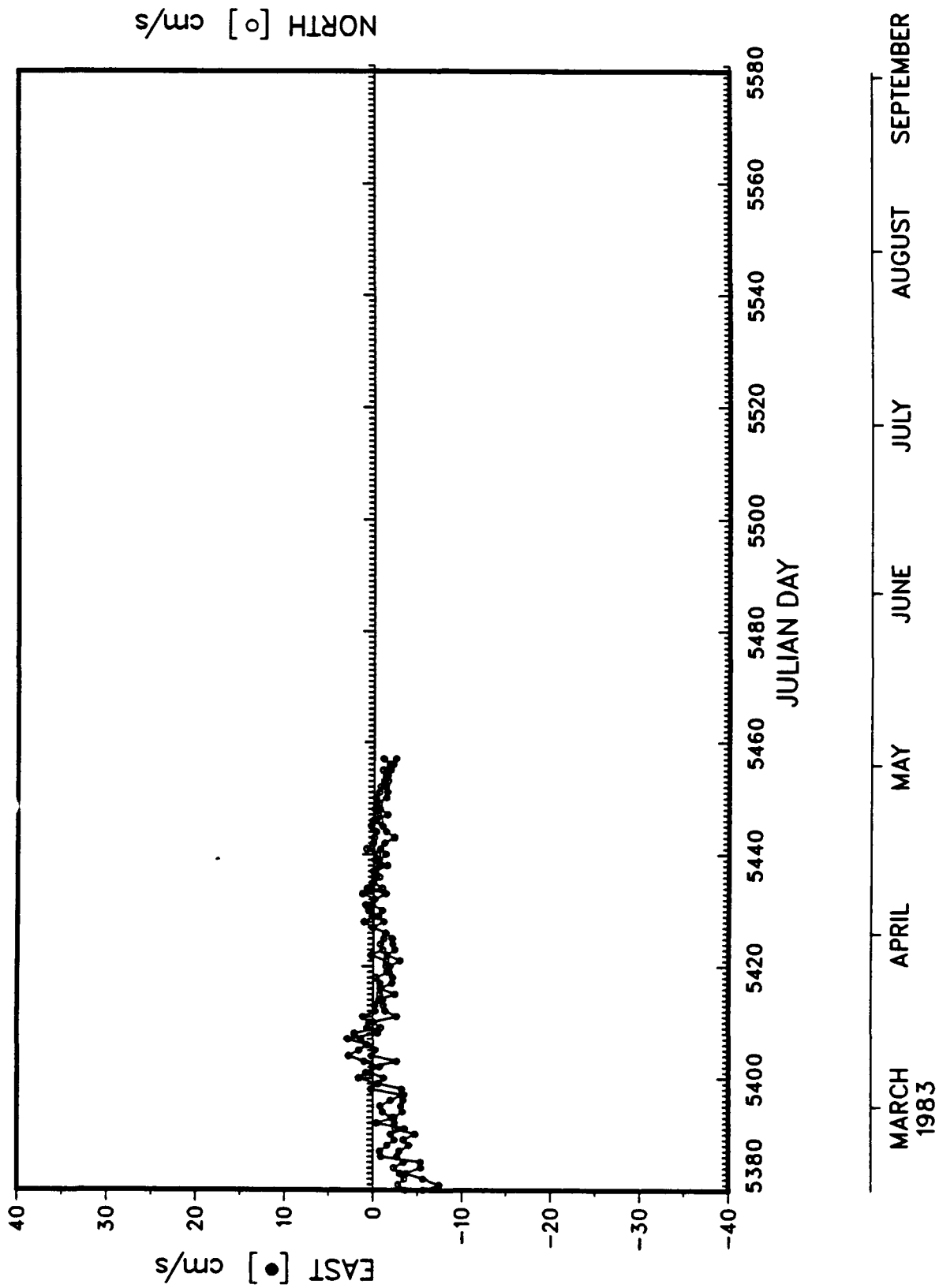


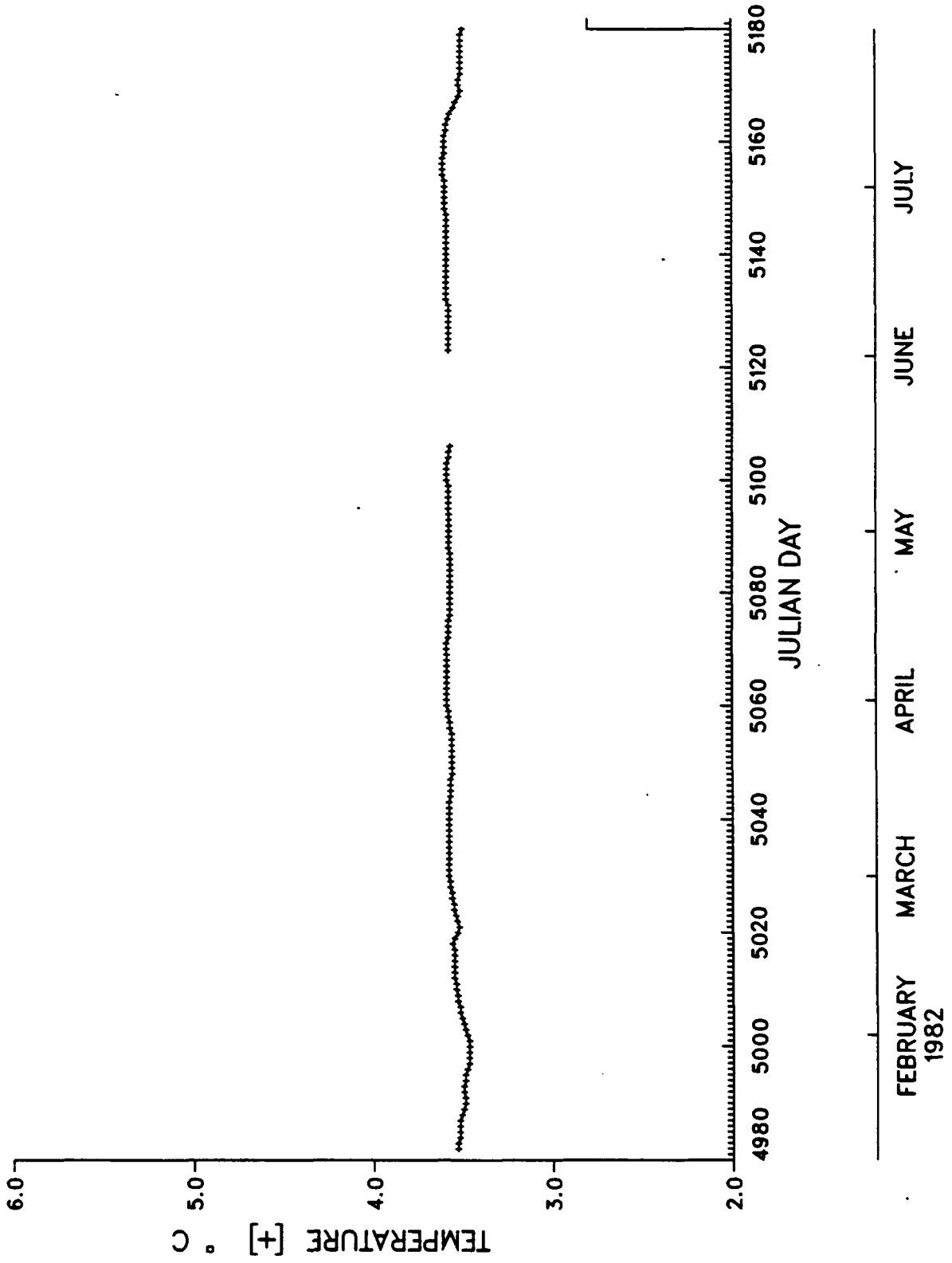
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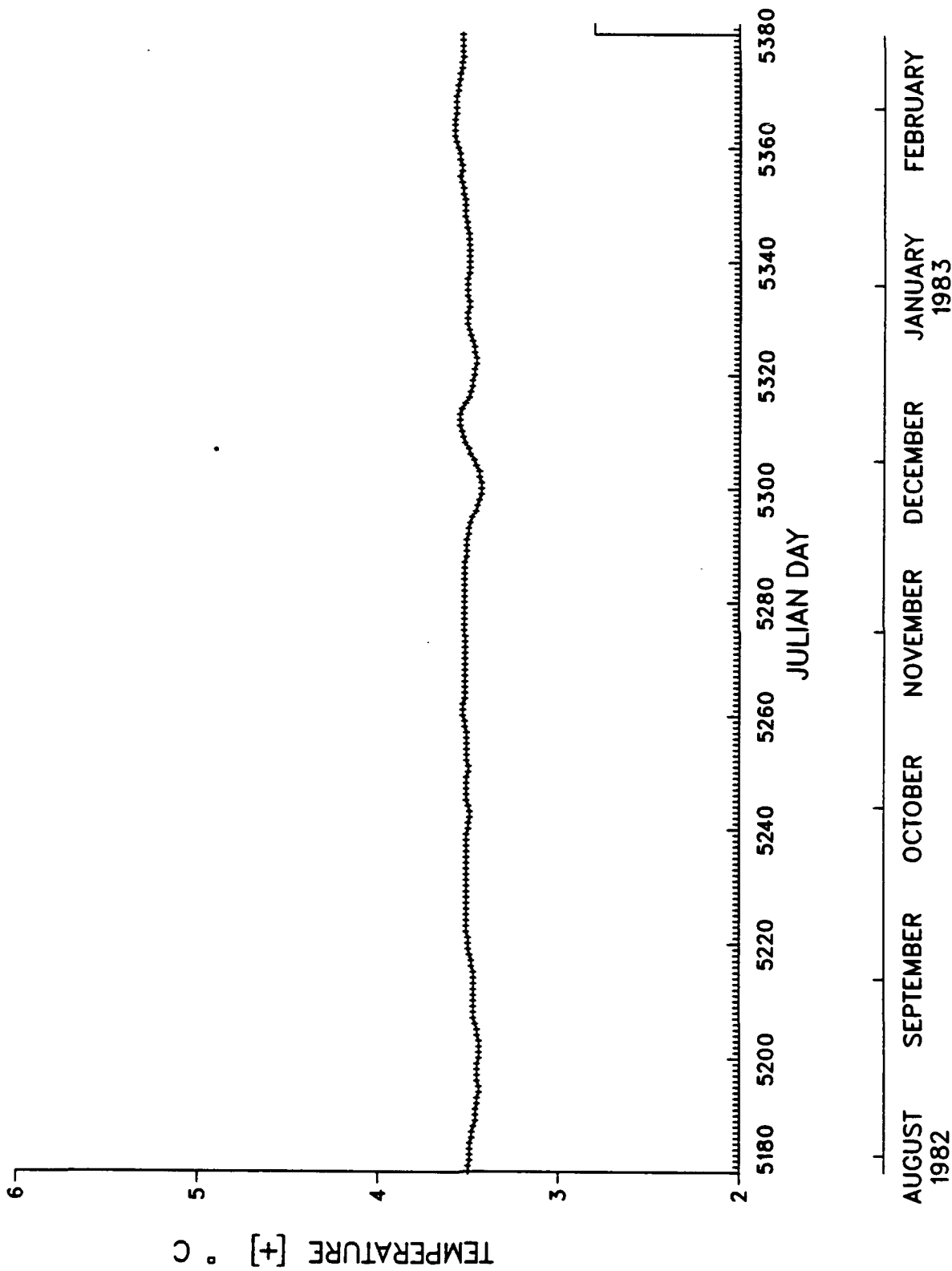


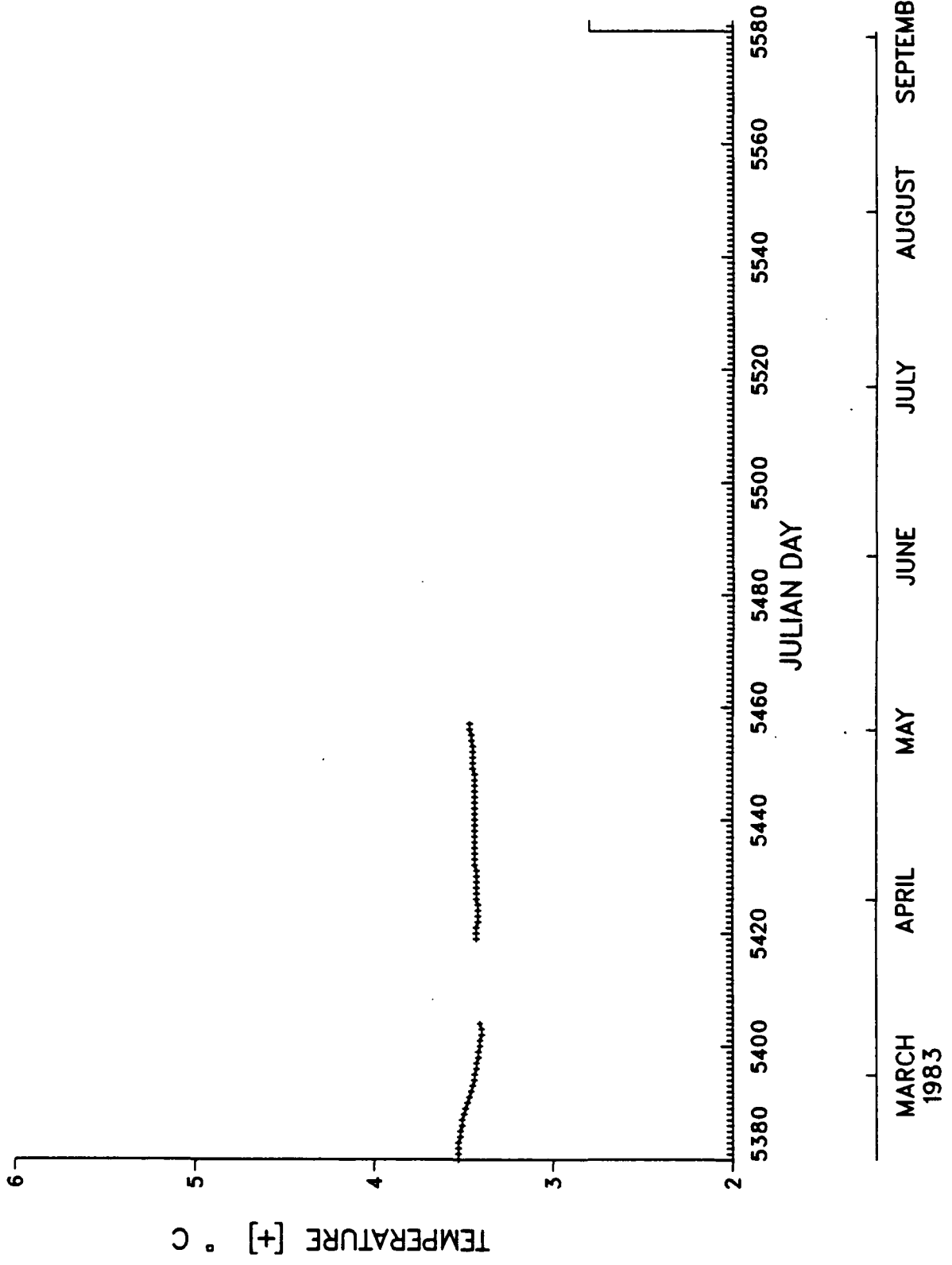
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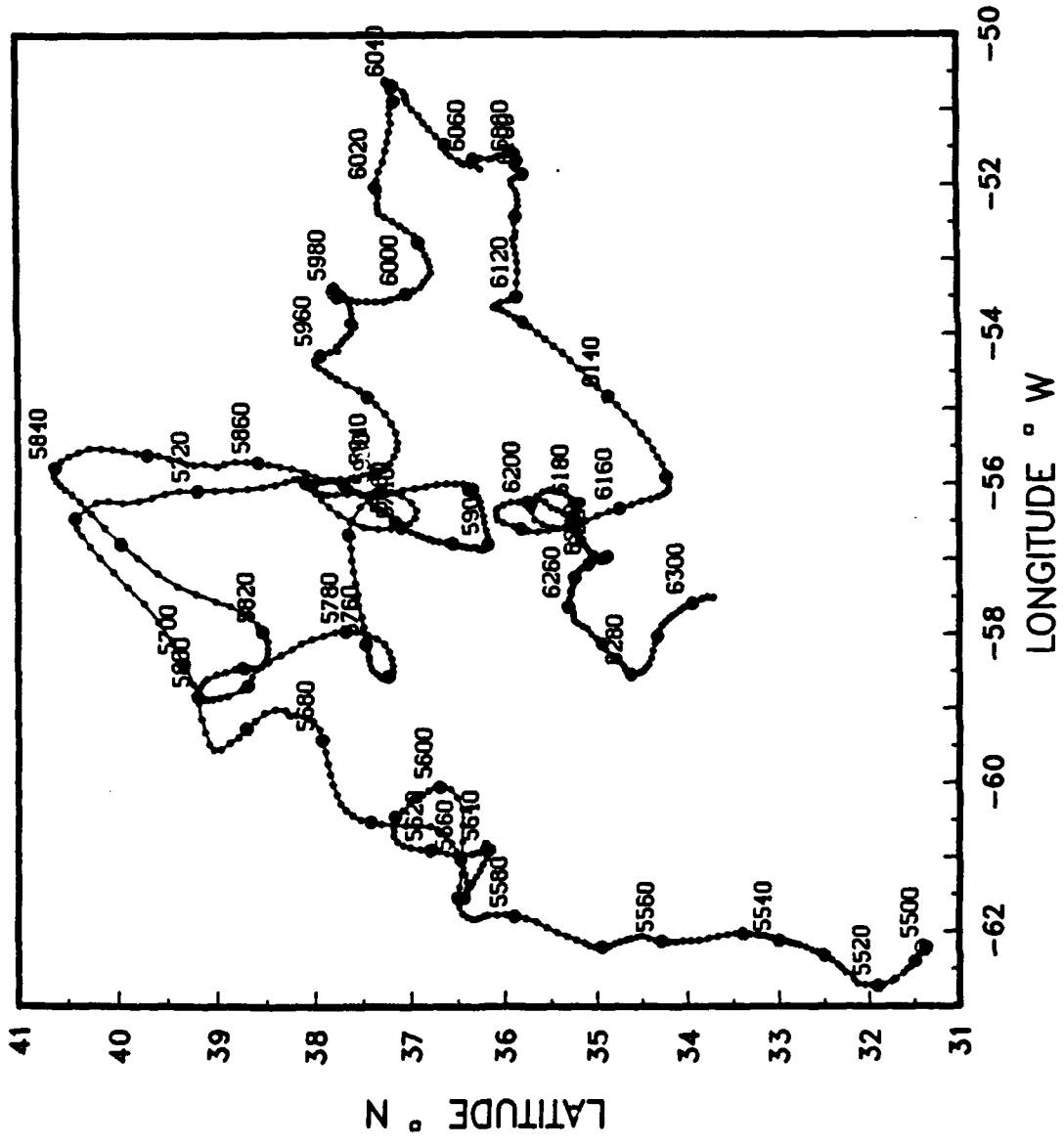


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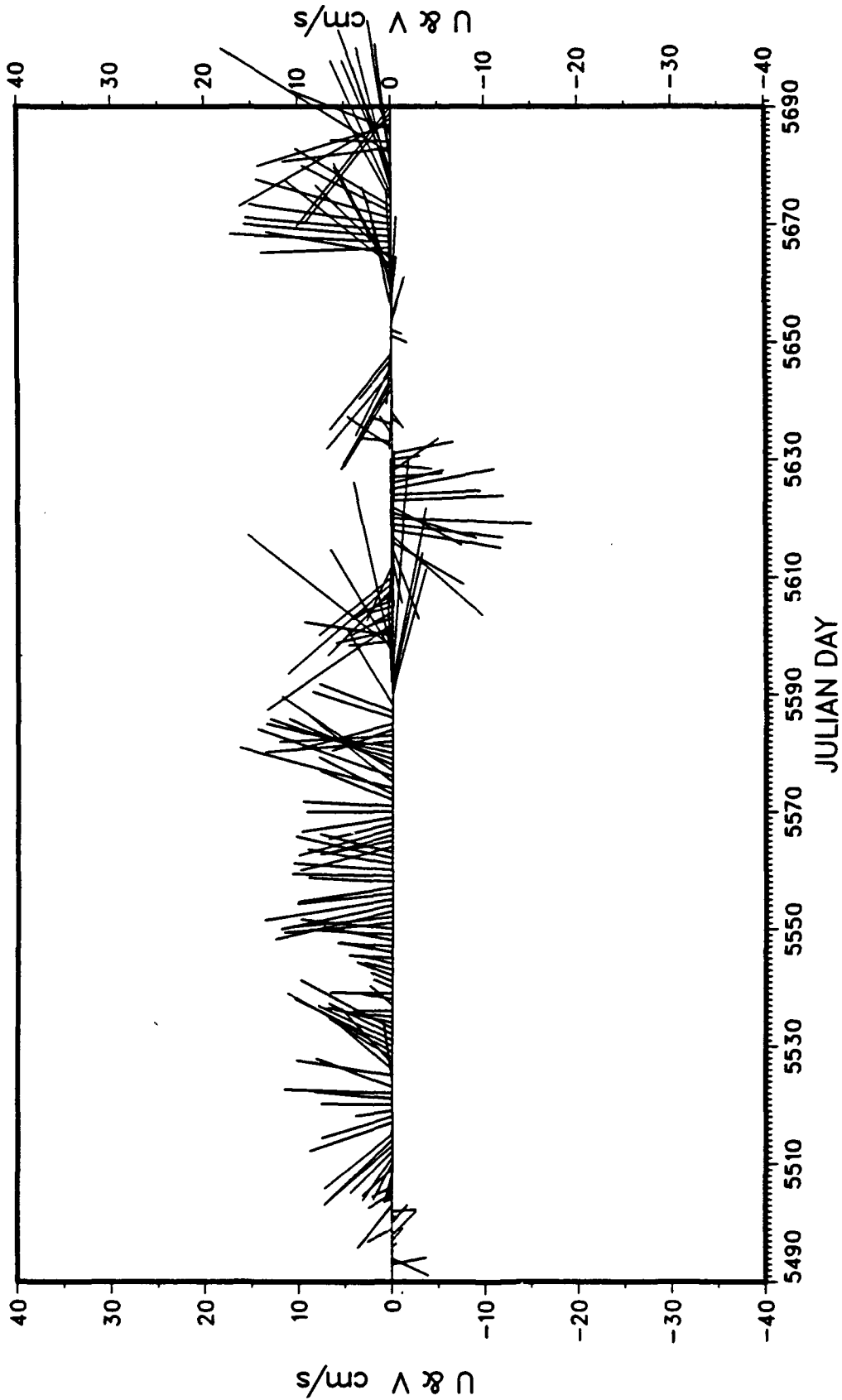




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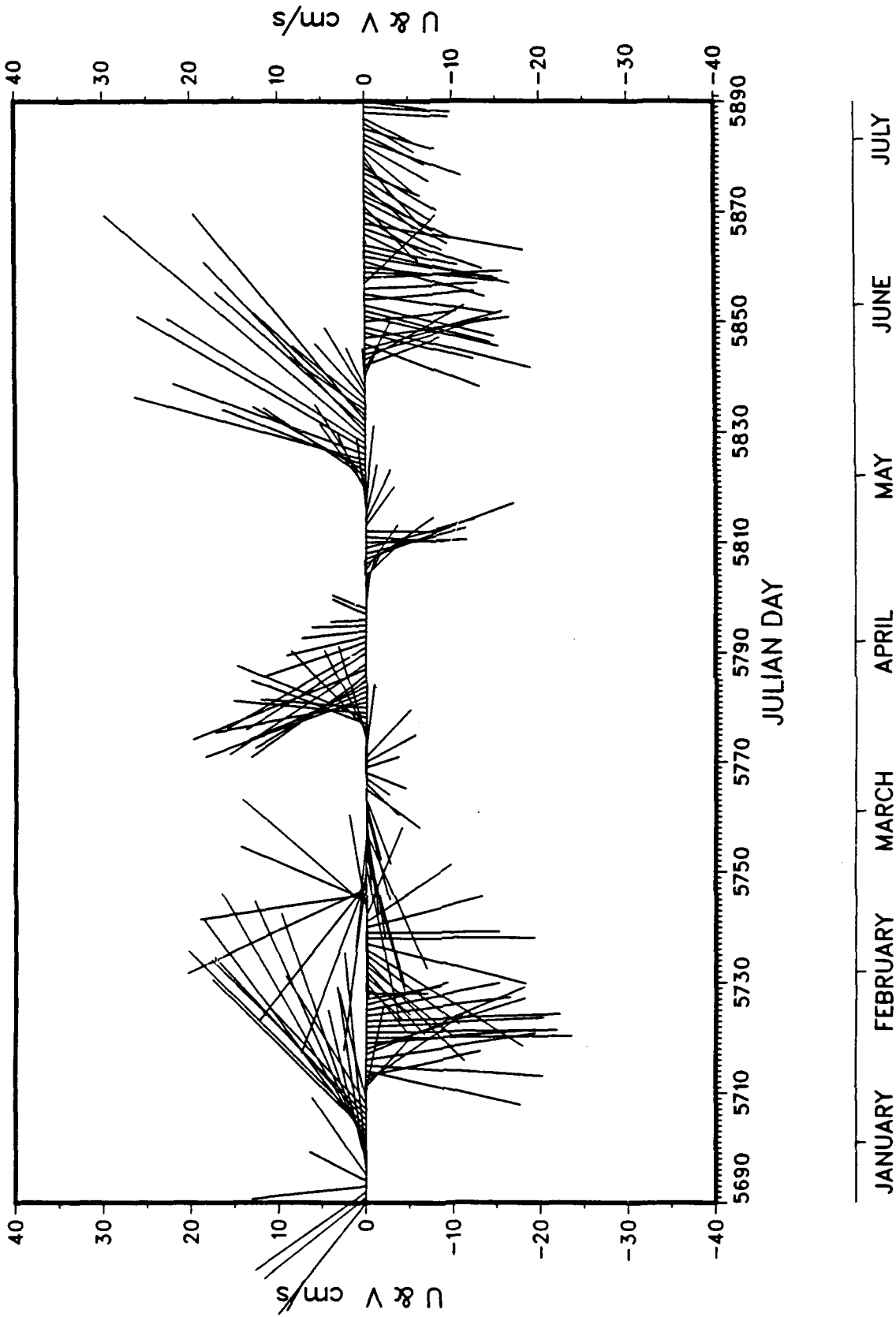


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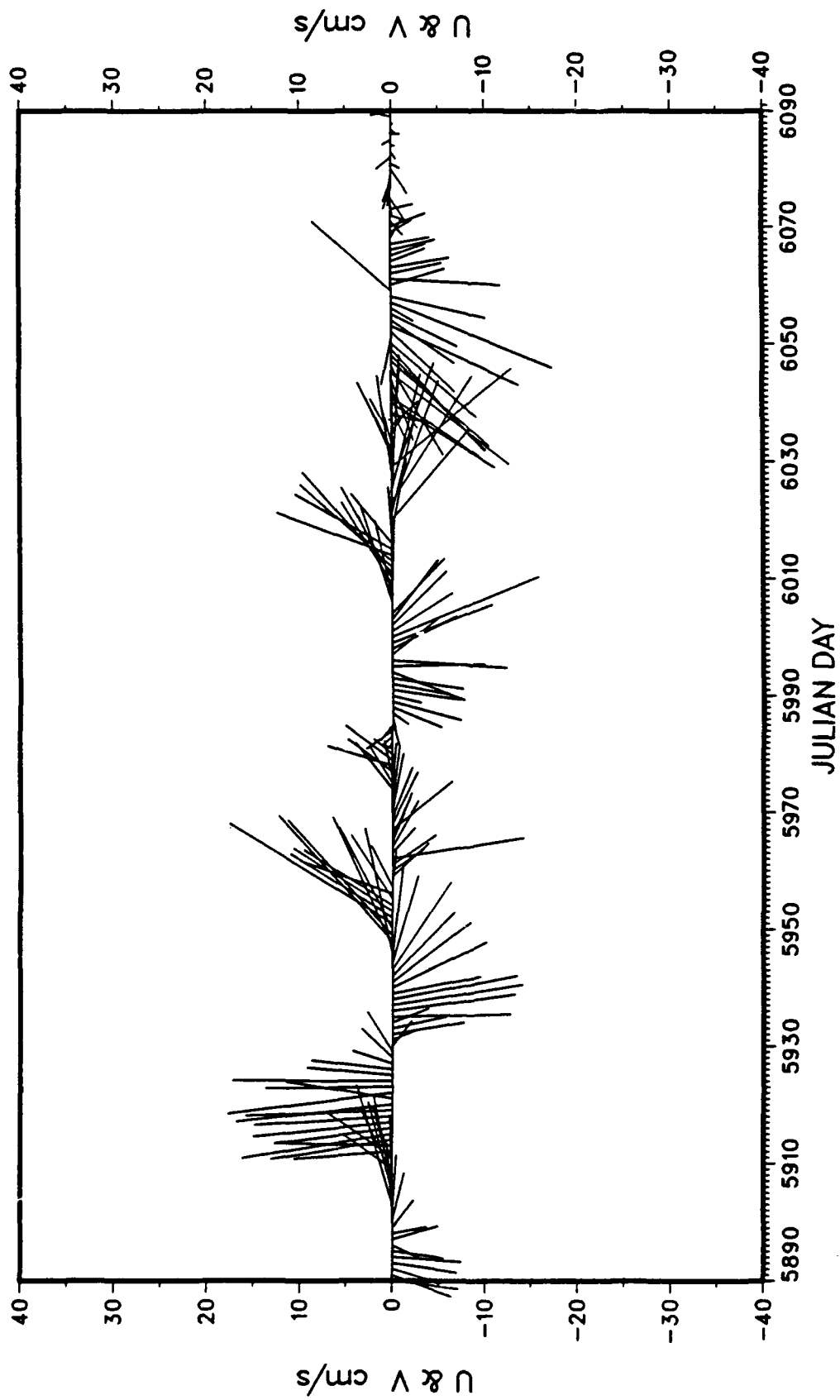


JULY AUGUST SEPTEMBER OCTOBER NOVEMBER DECEMBER
1983

GUSREX 165D

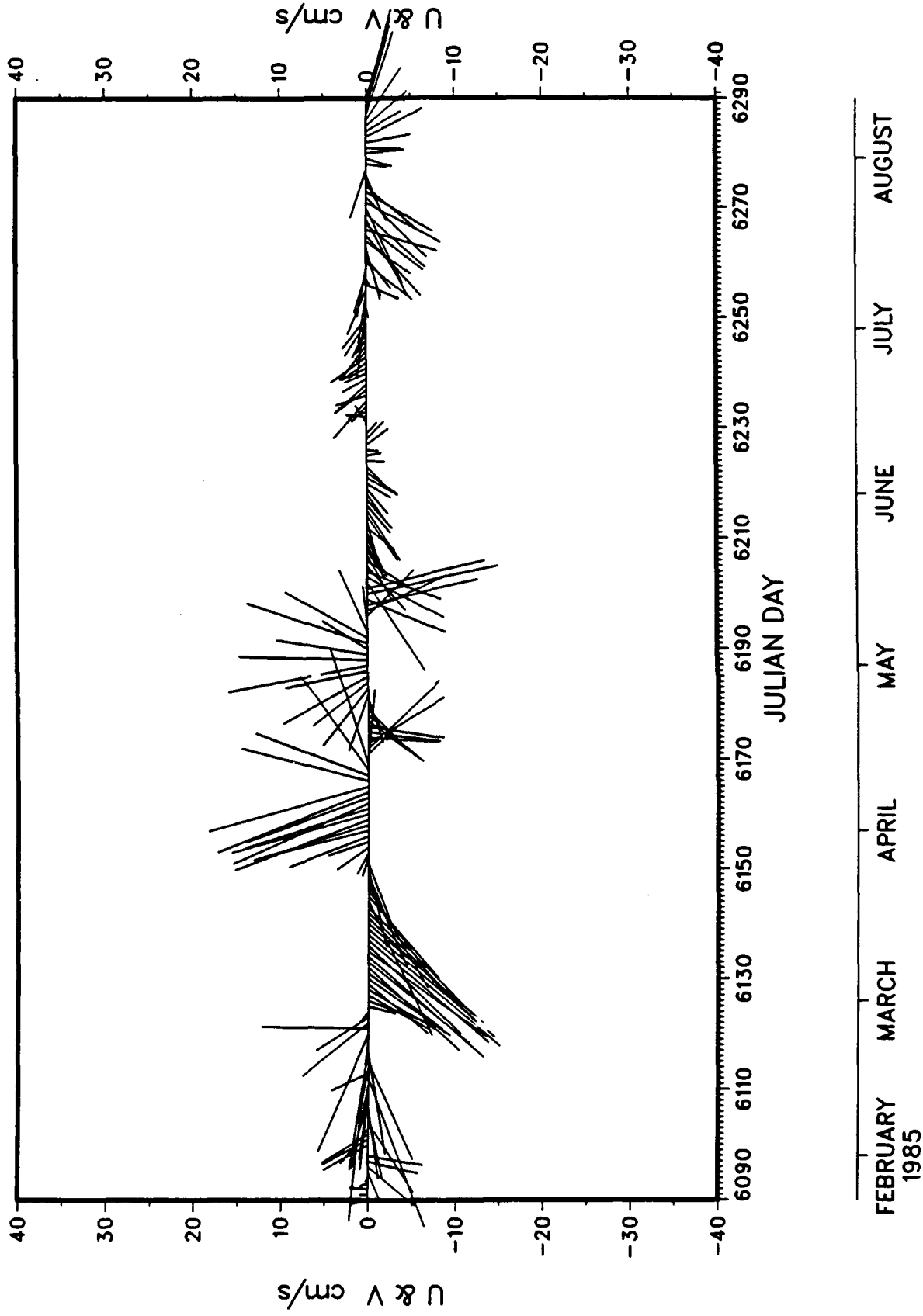


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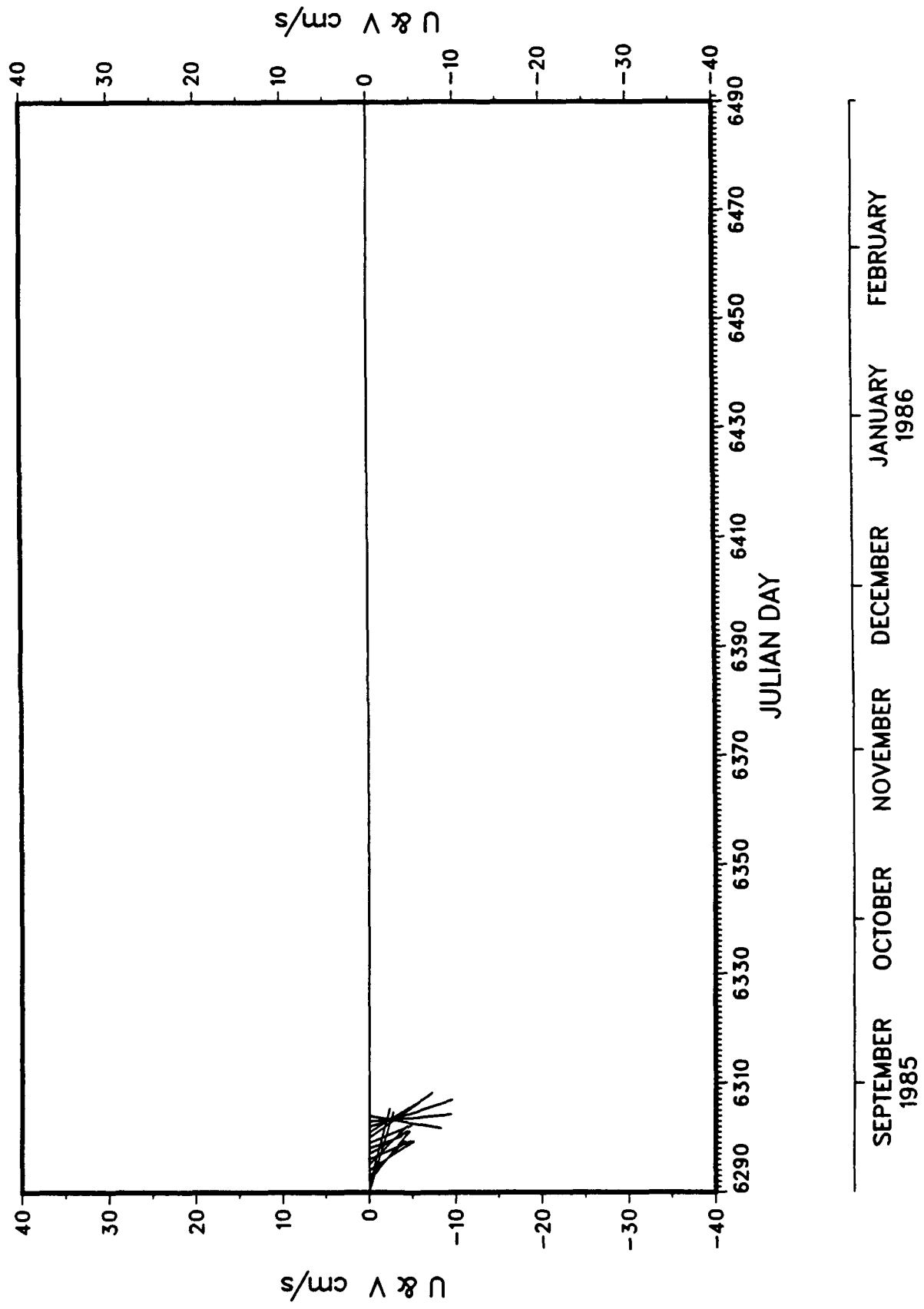


AUGUST 1984 SEPTEMBER OCTOBER NOVEMBER DECEMBER JANUARY 1985

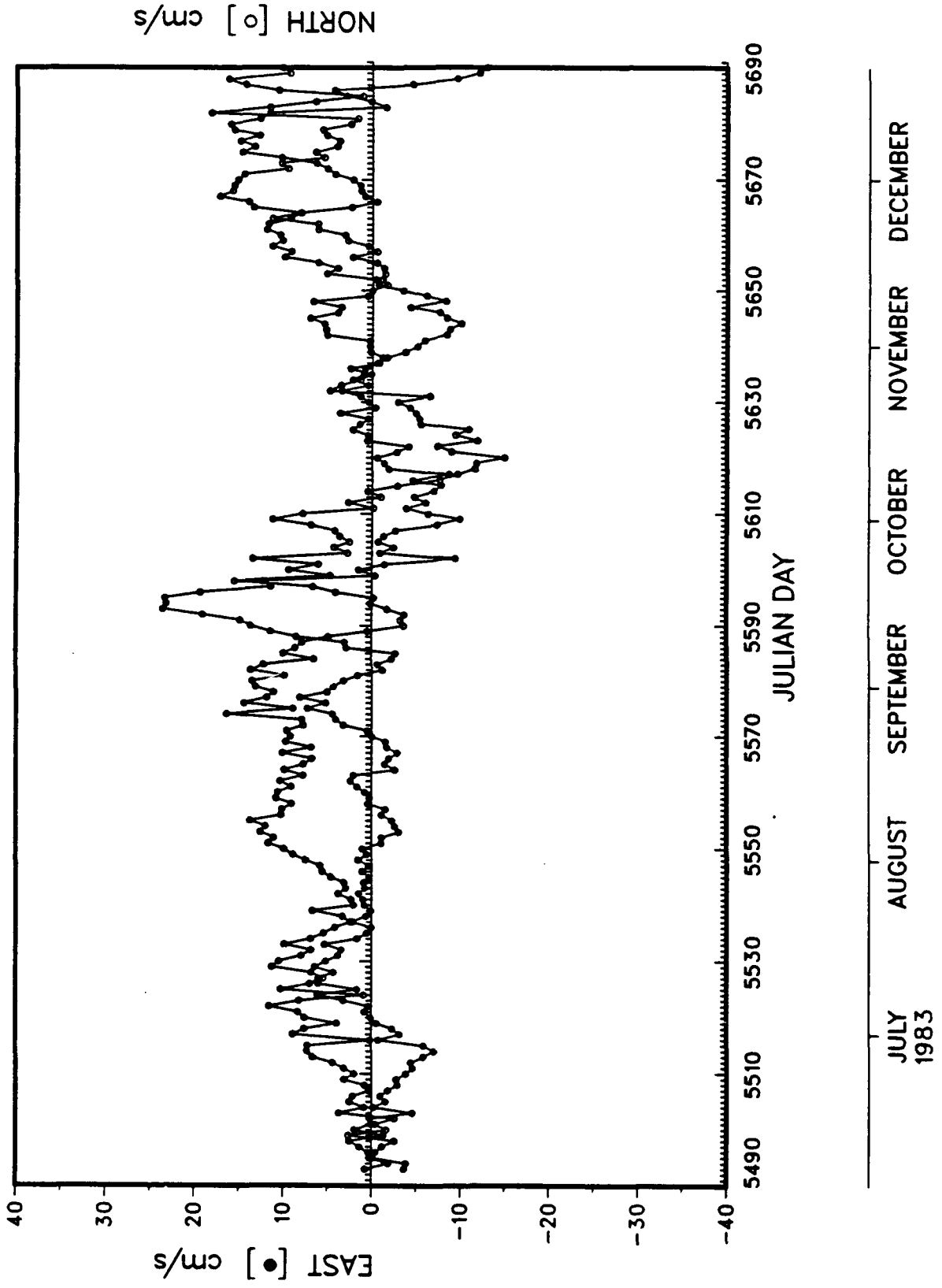
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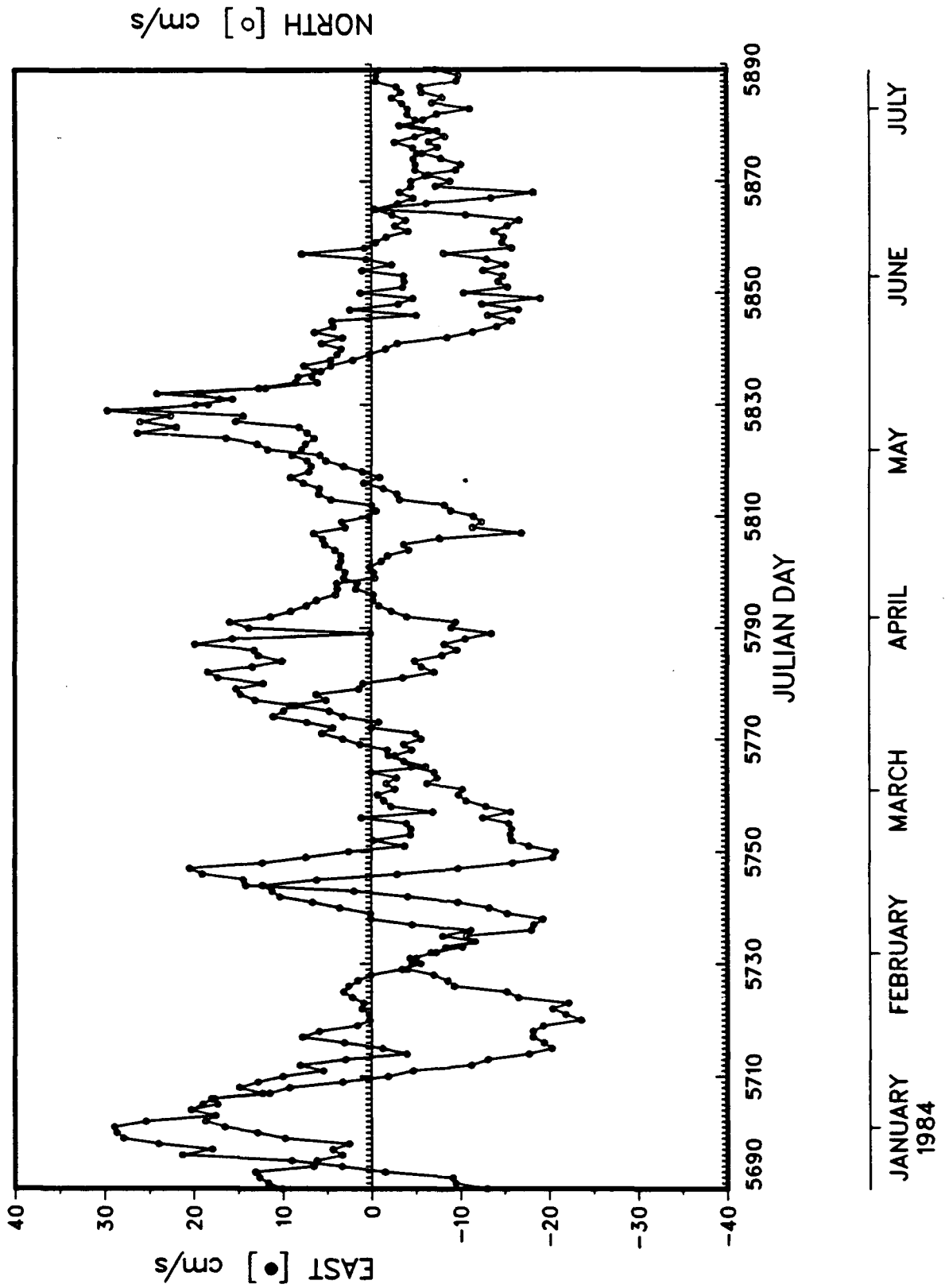


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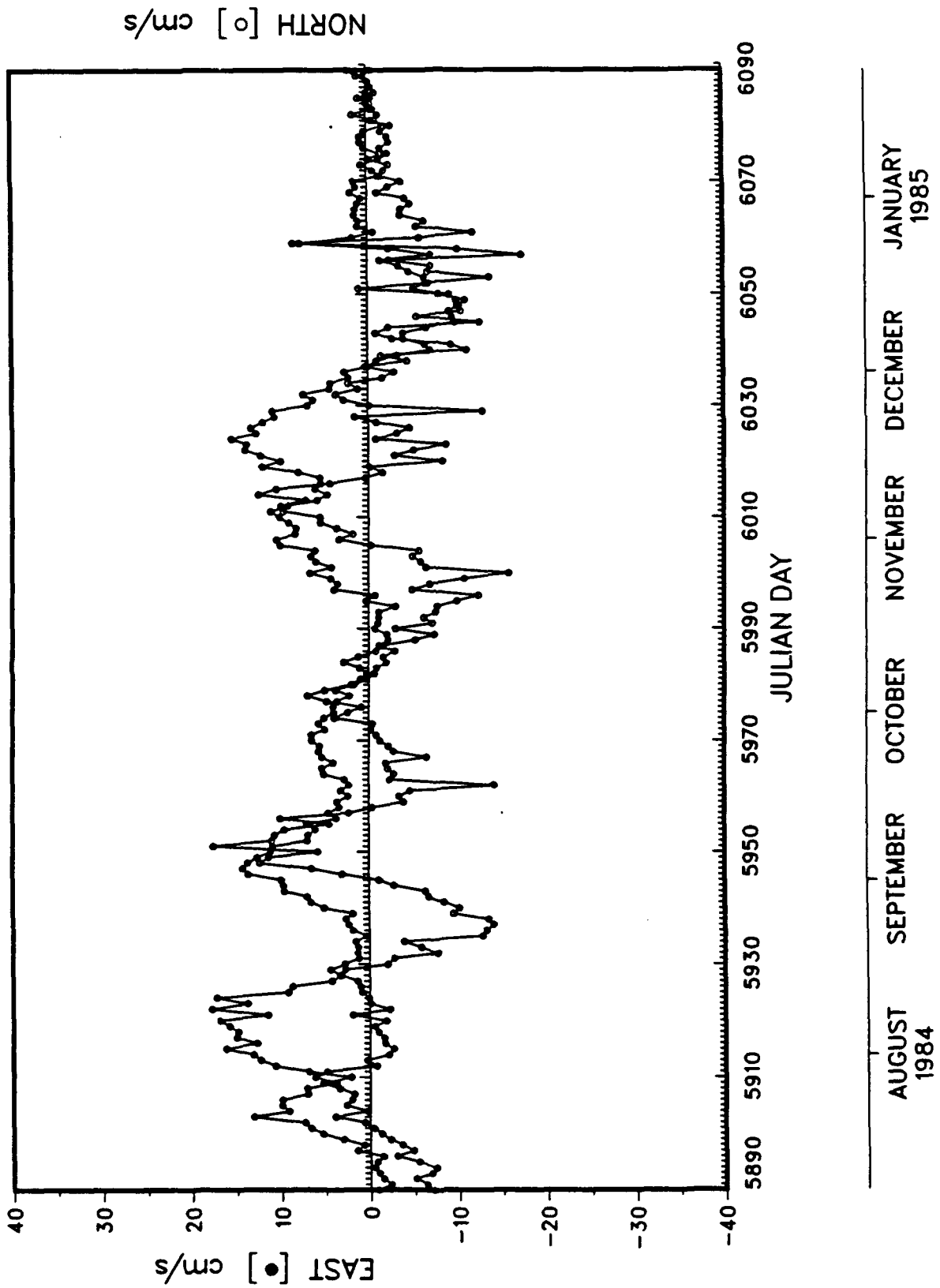


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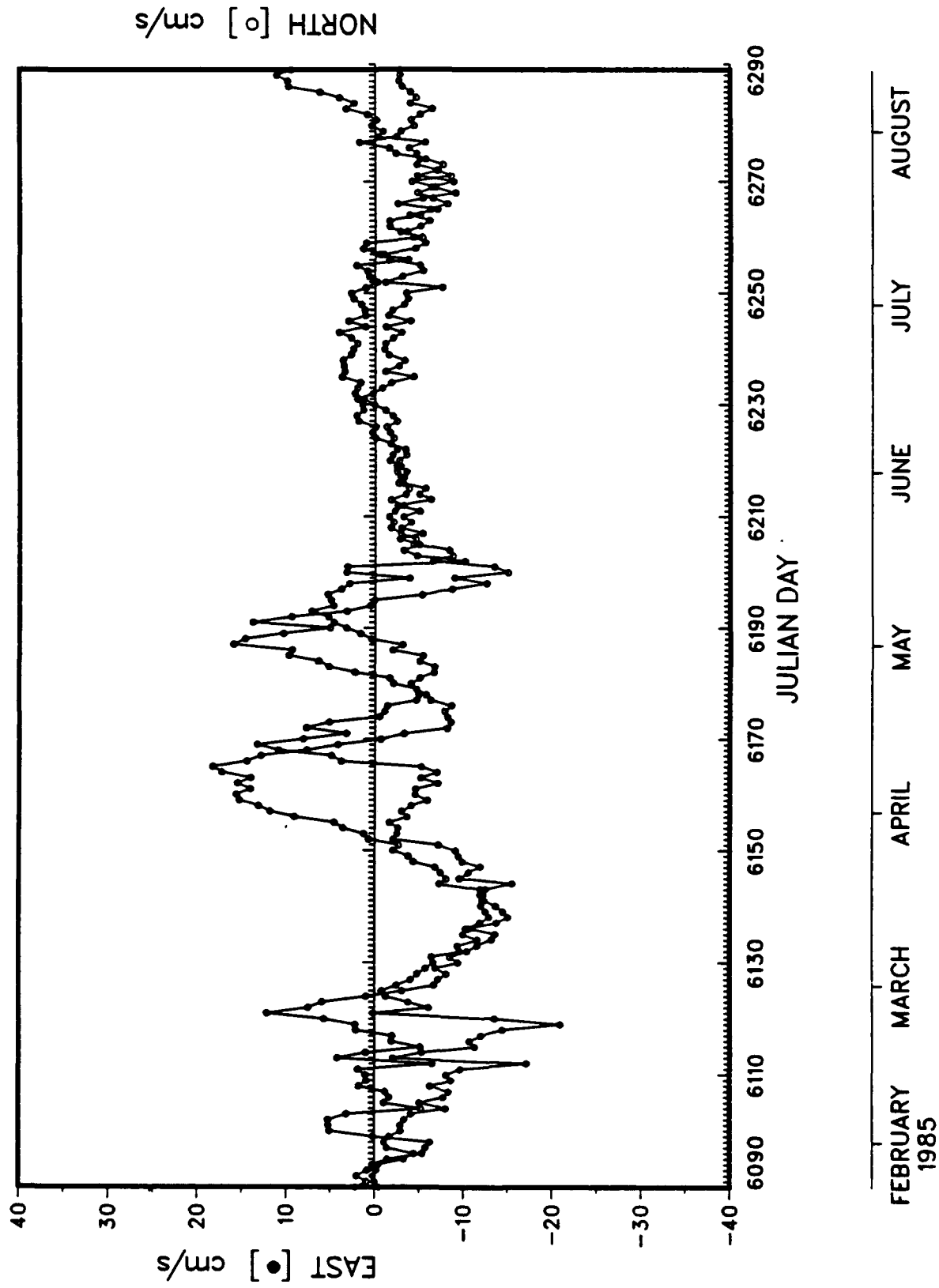




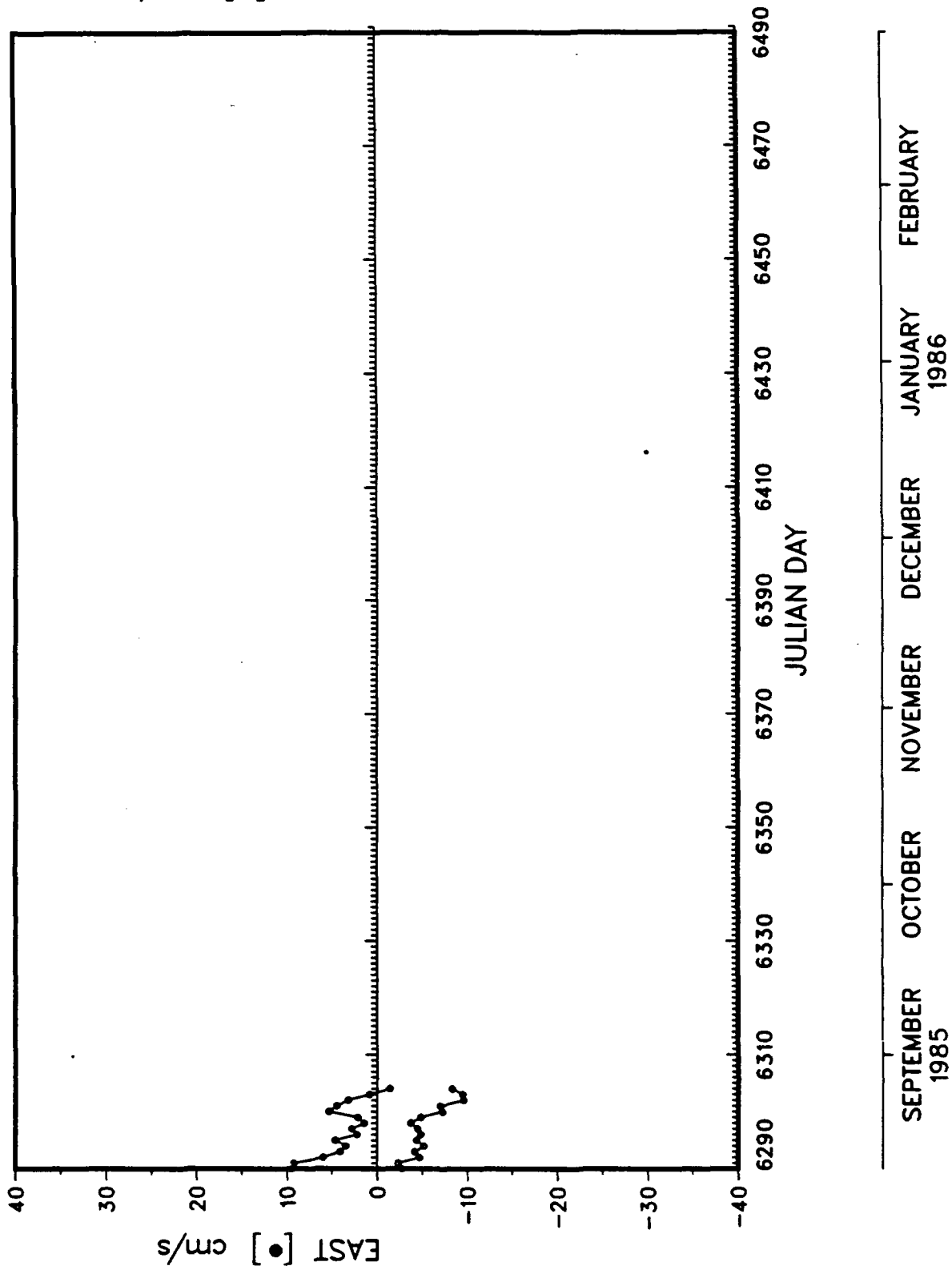
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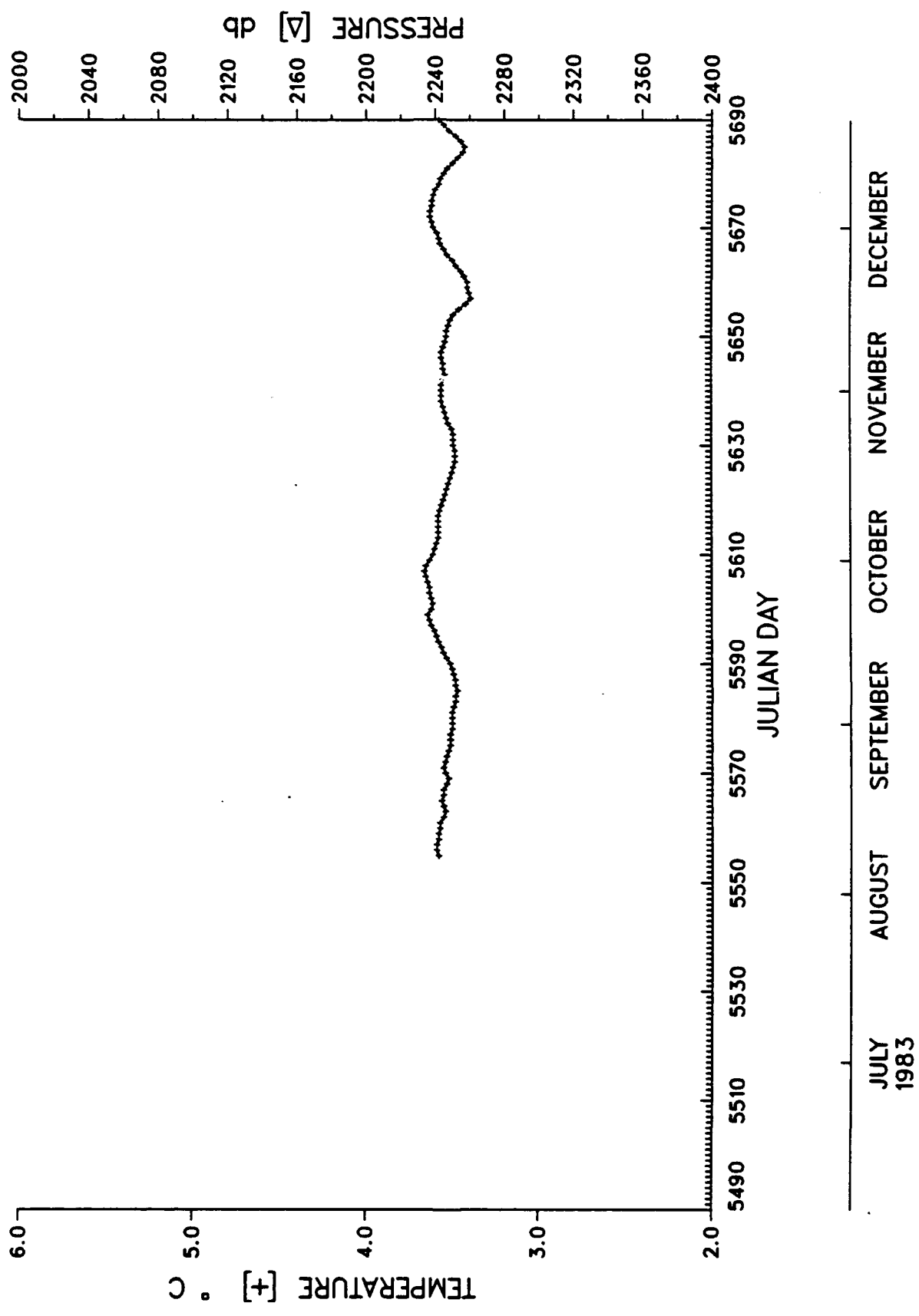


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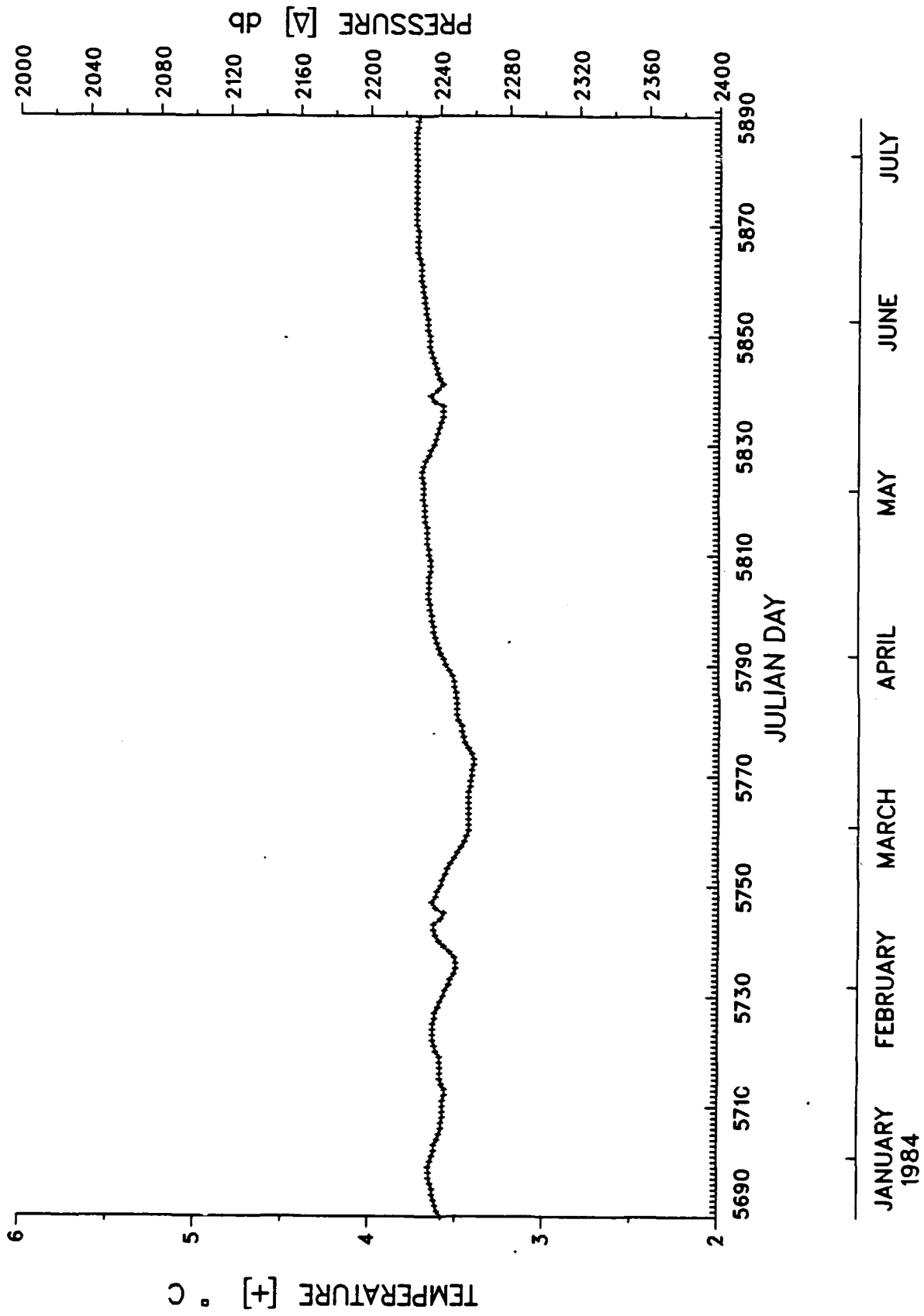


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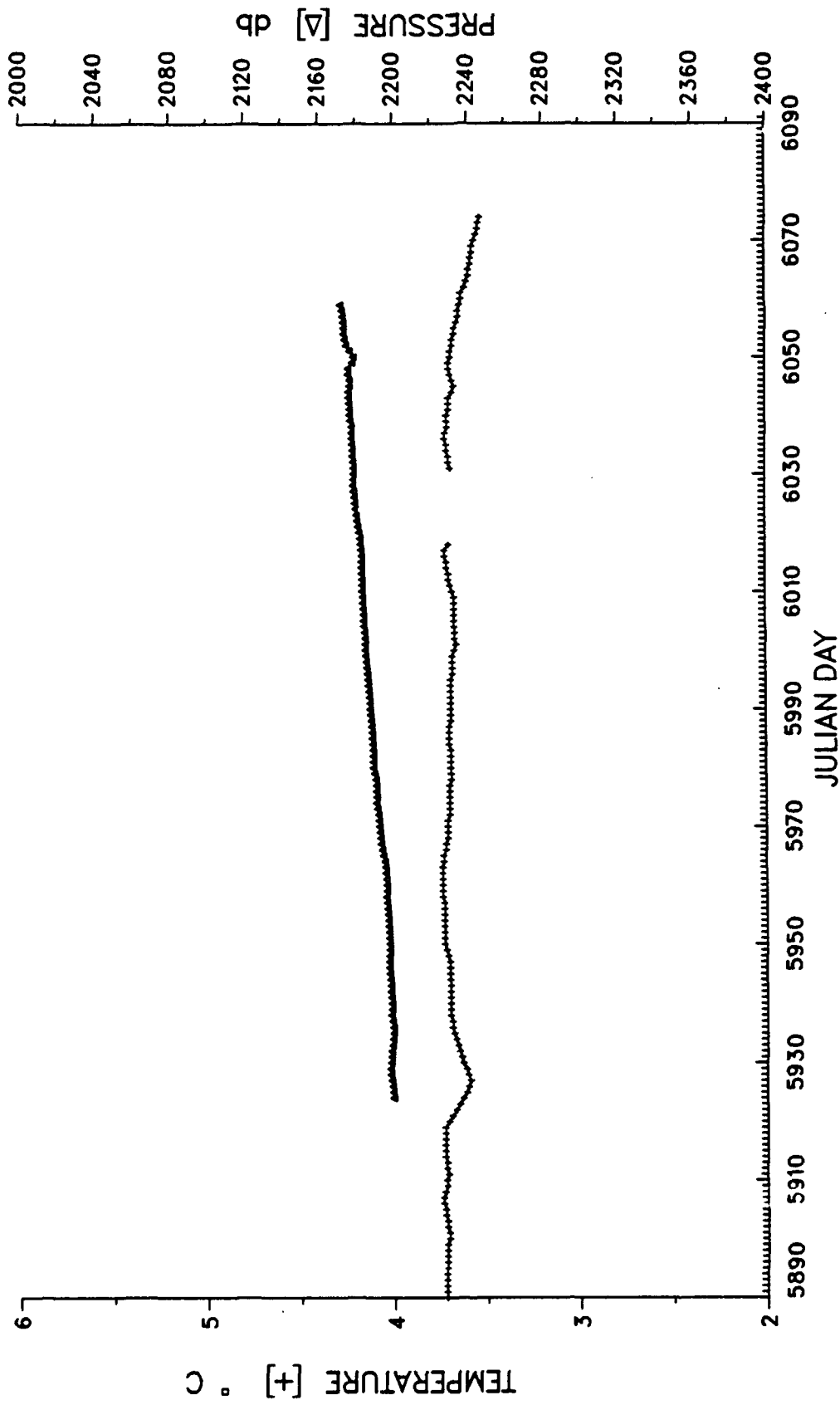




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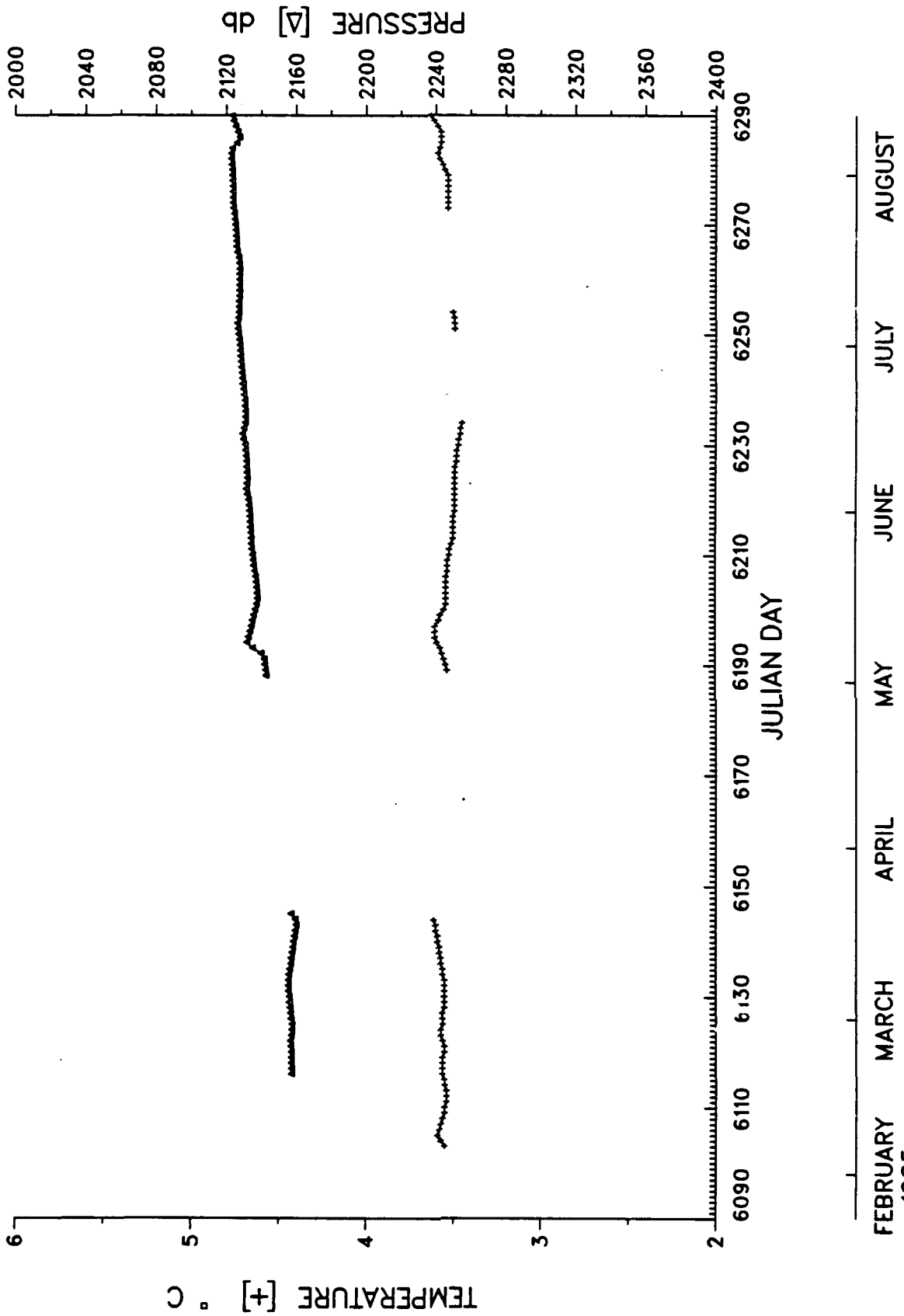


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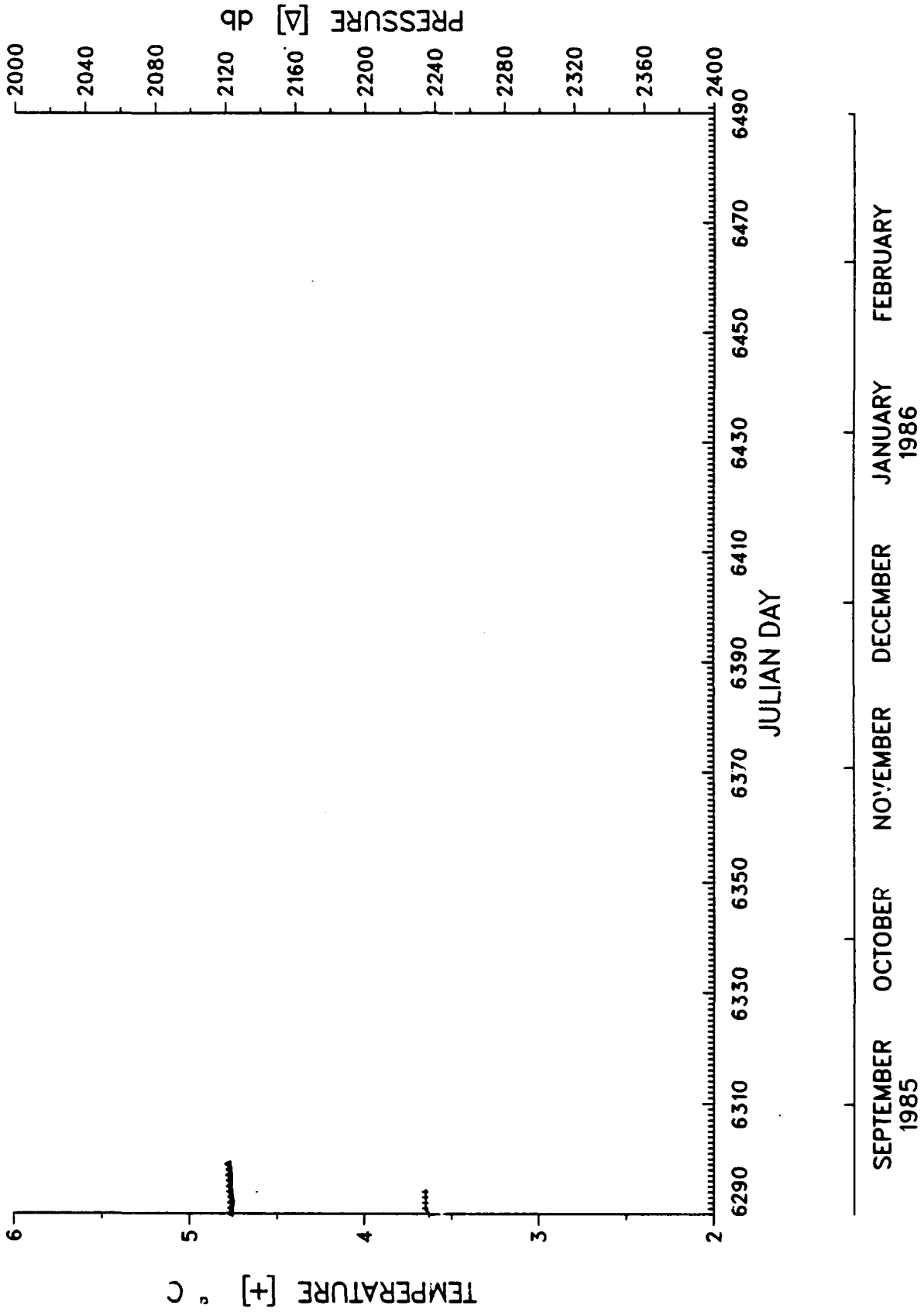


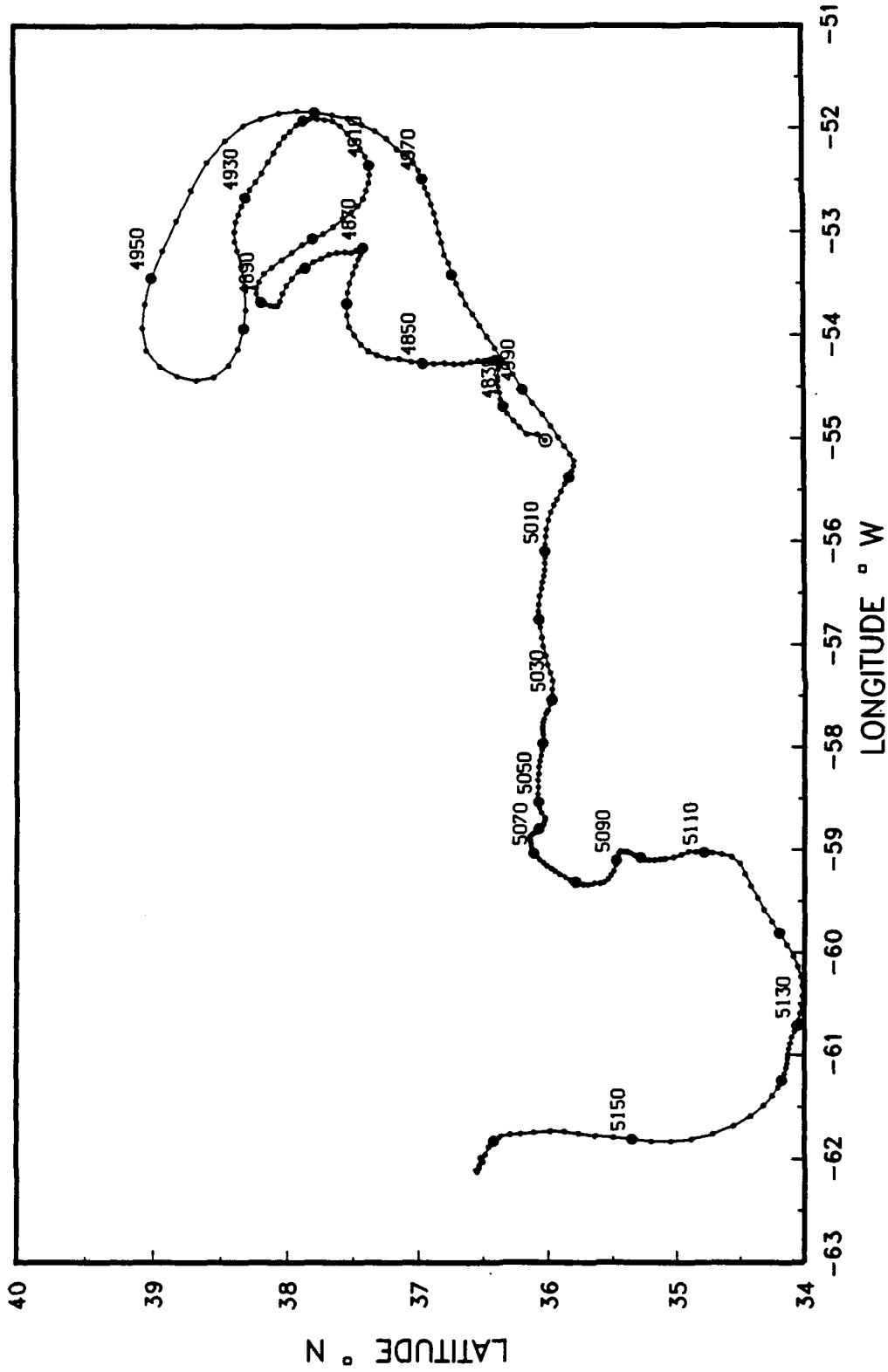
AUGUST 1984 SEPTEMBER OCTOBER NOVEMBER DECEMBER JANUARY 1985

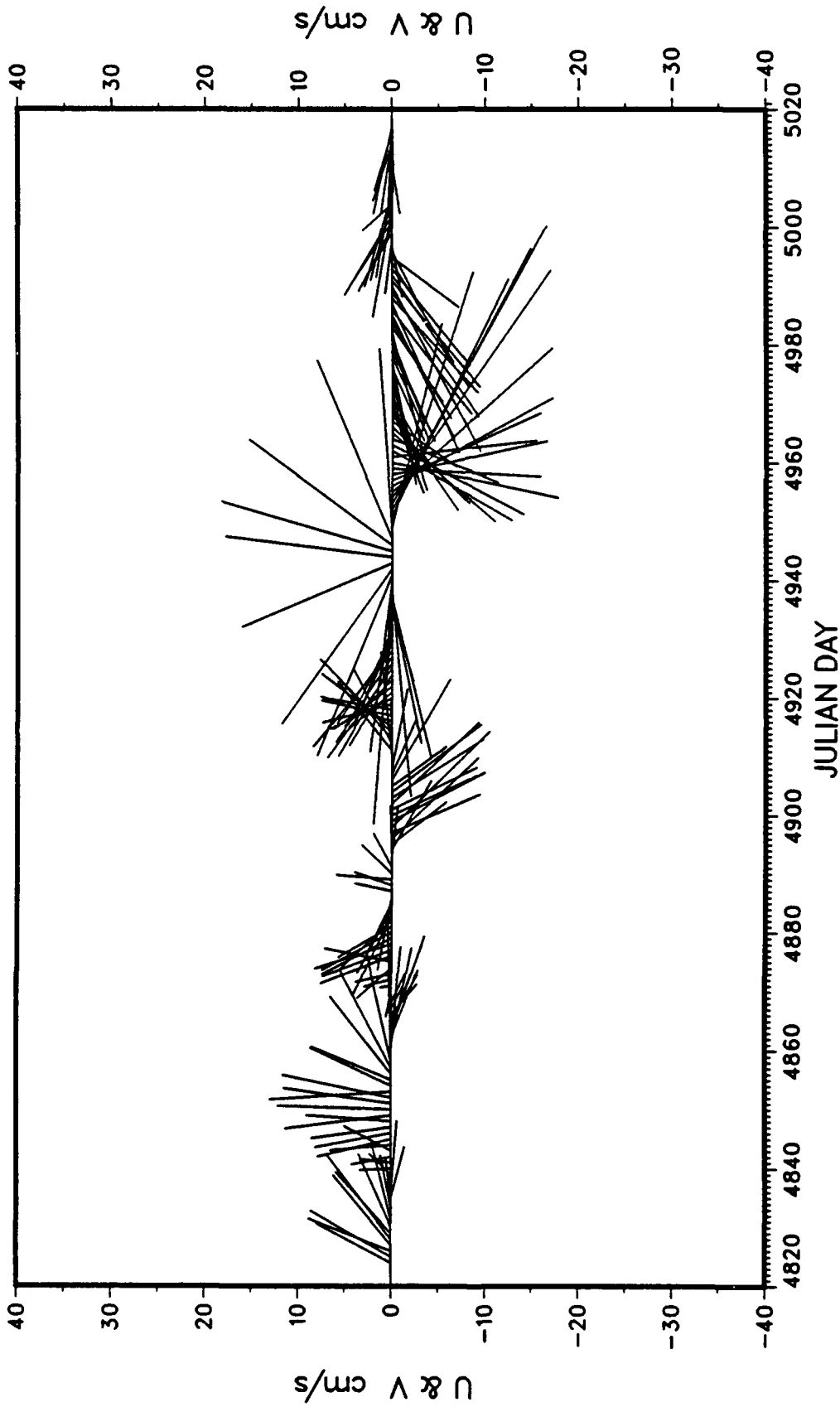
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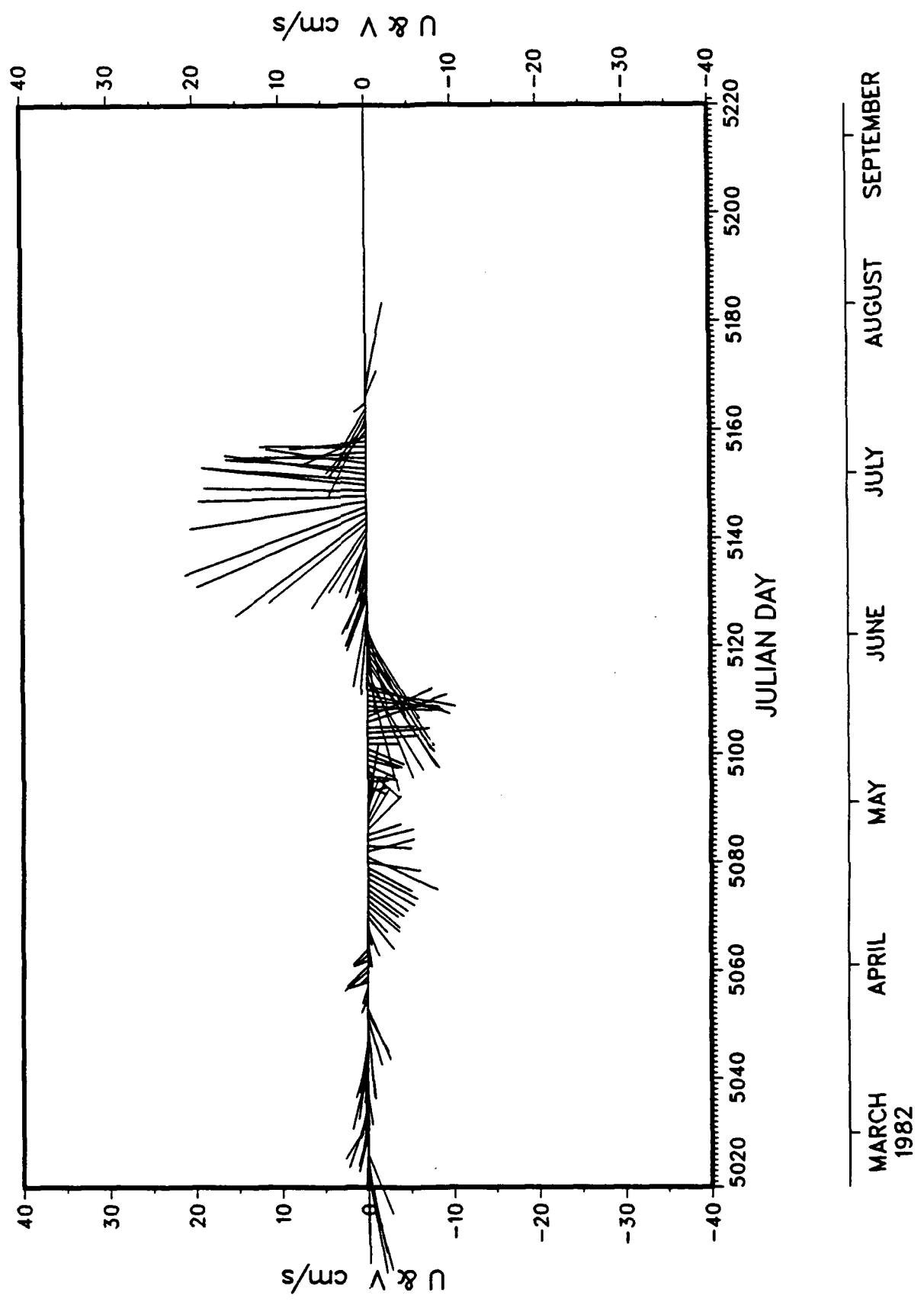
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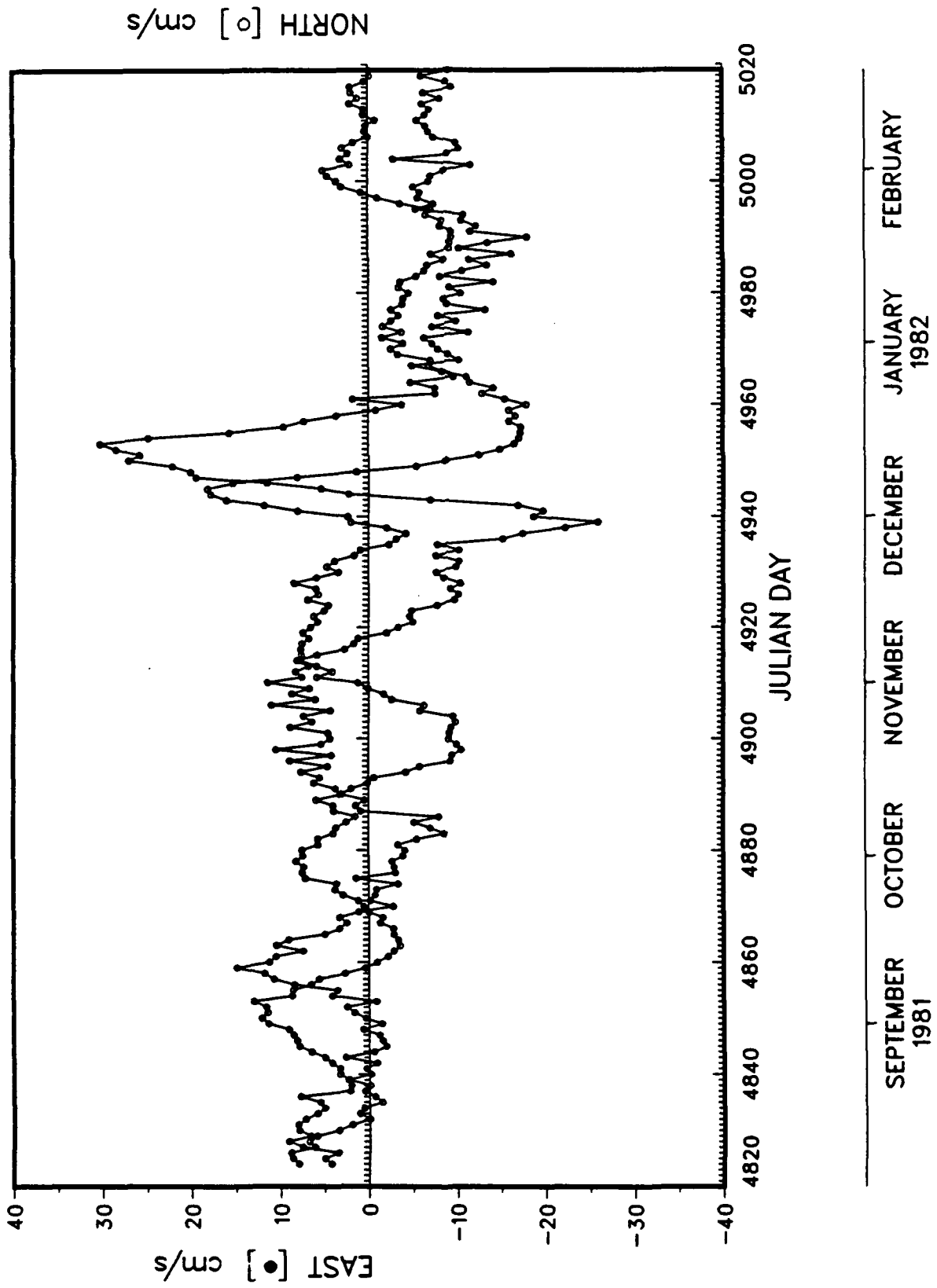


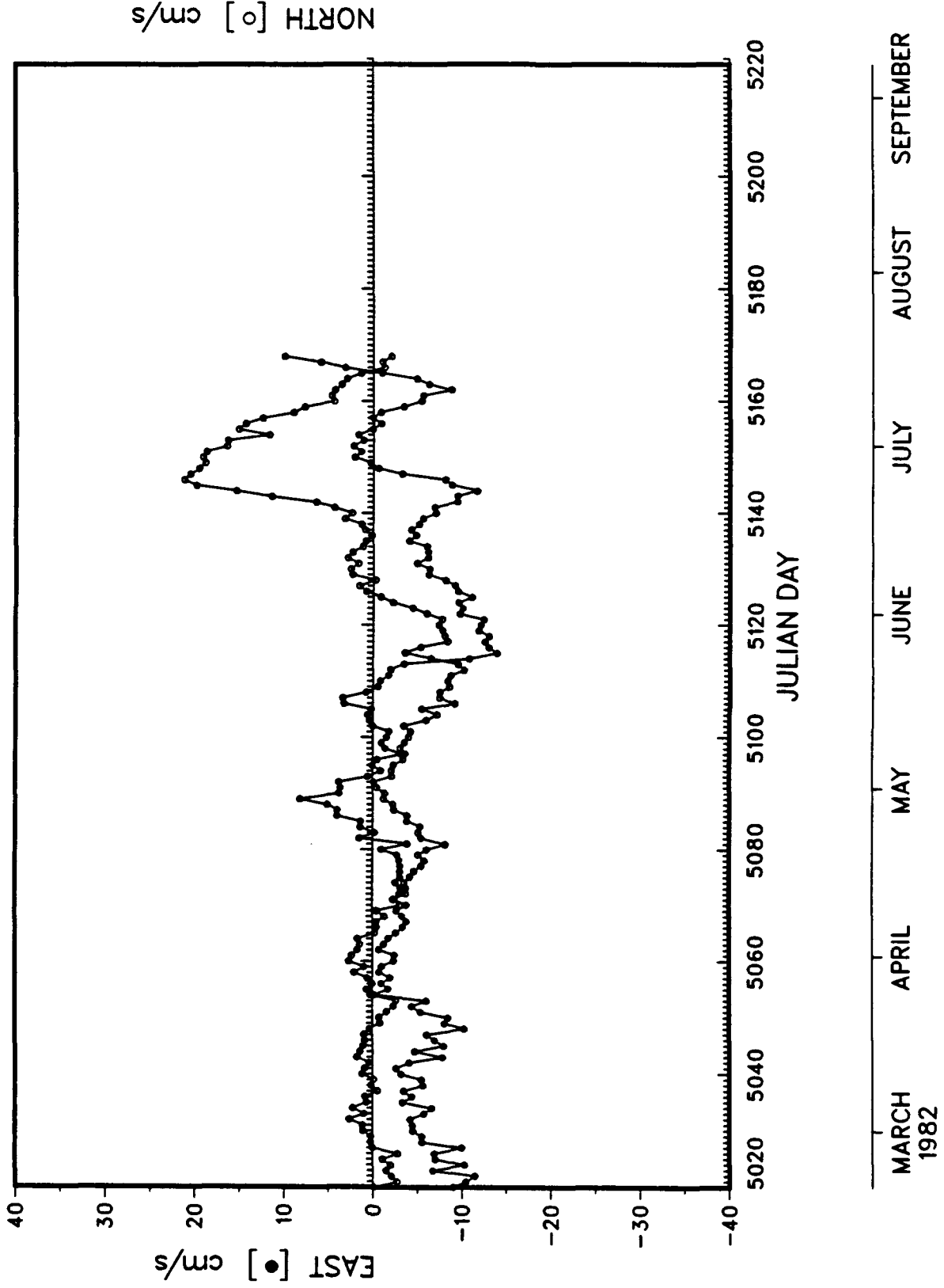


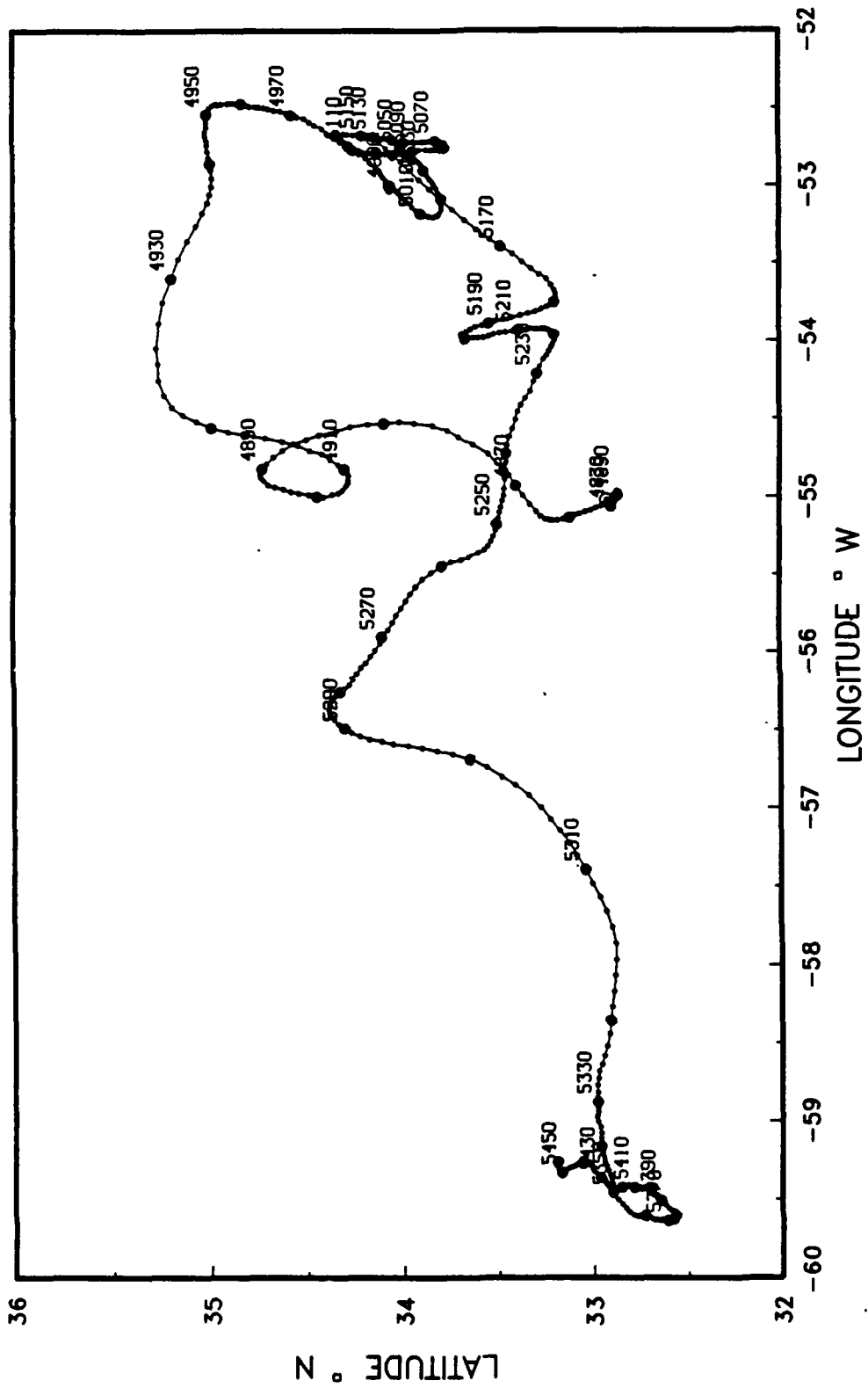


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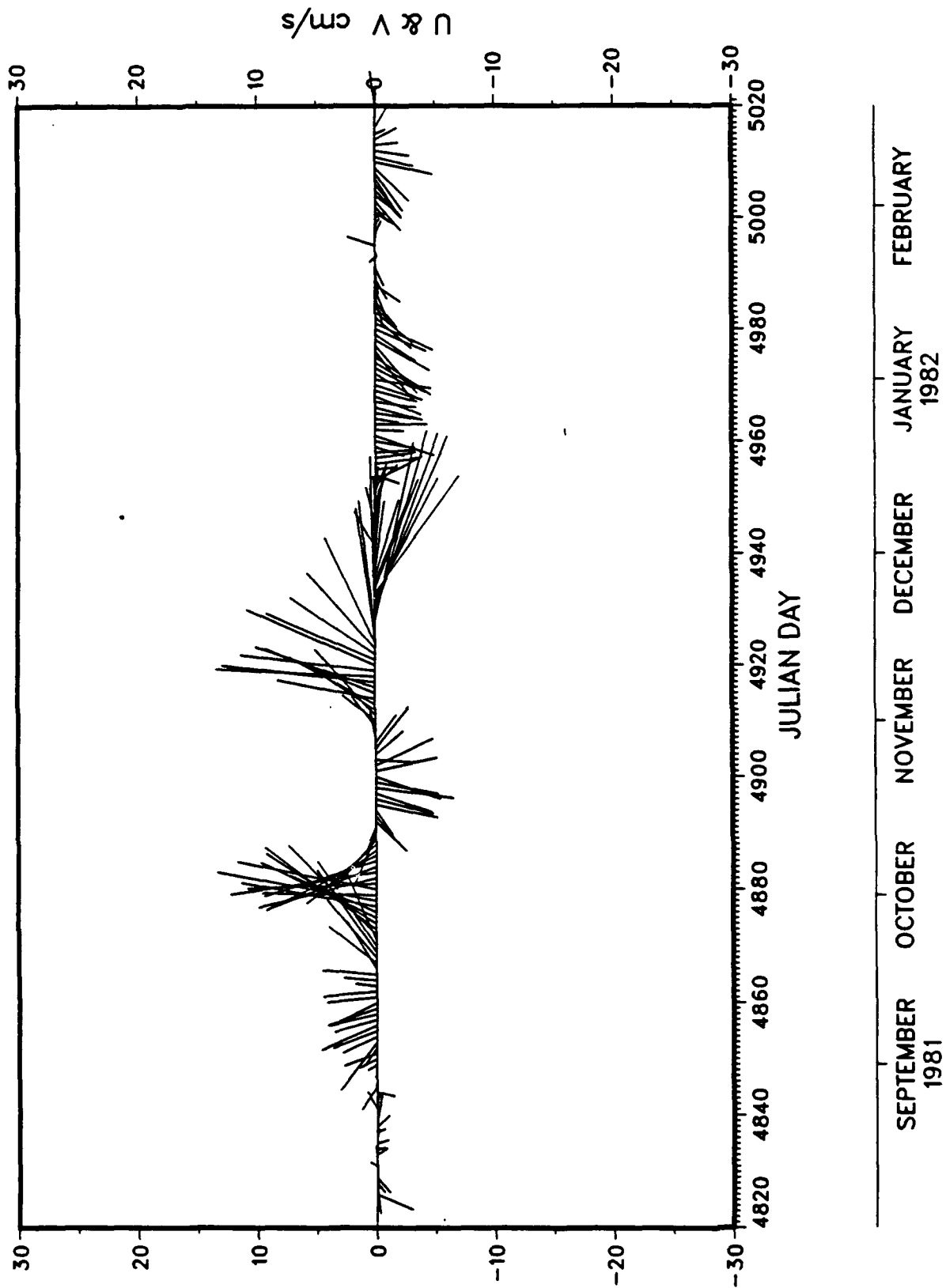


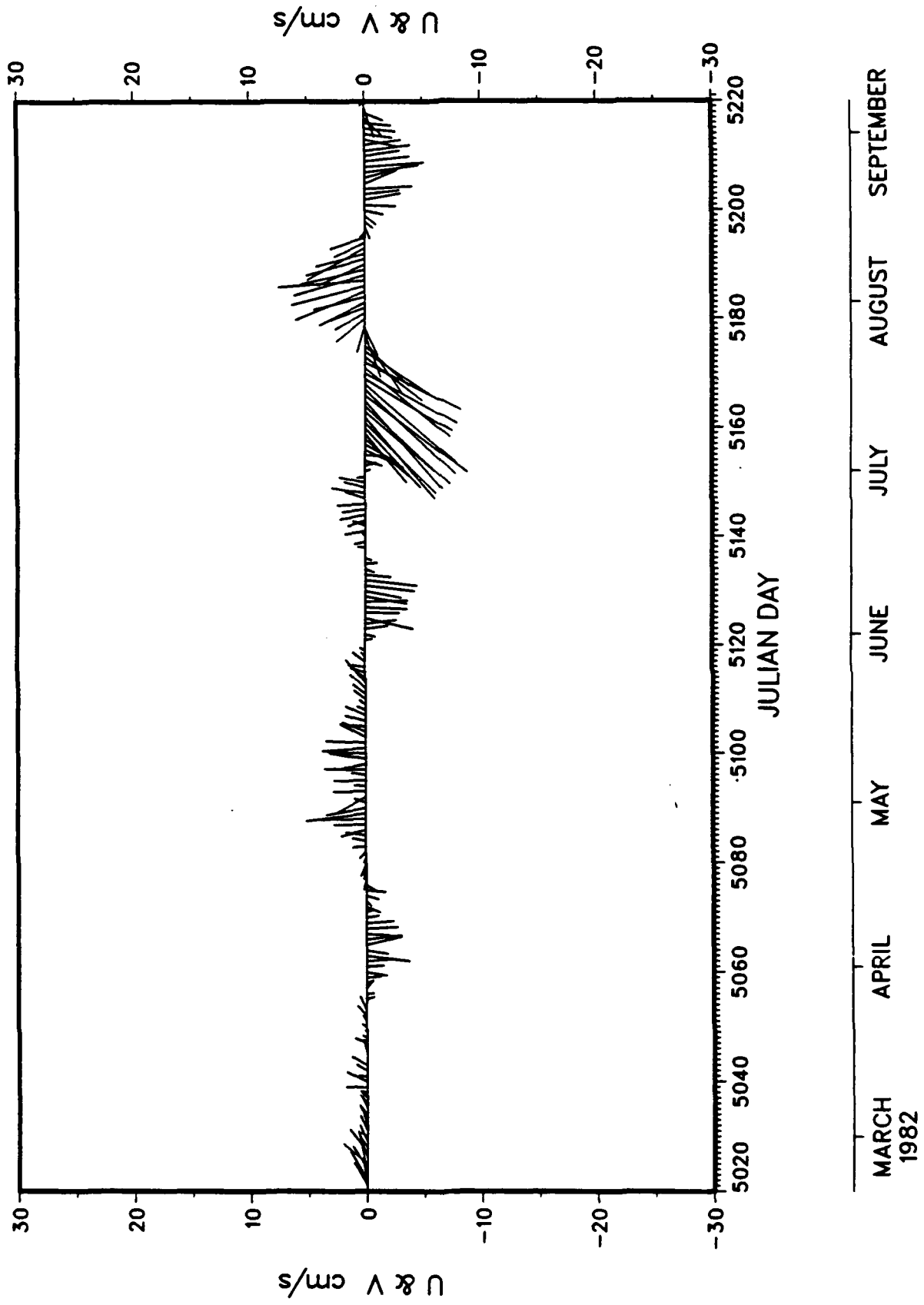




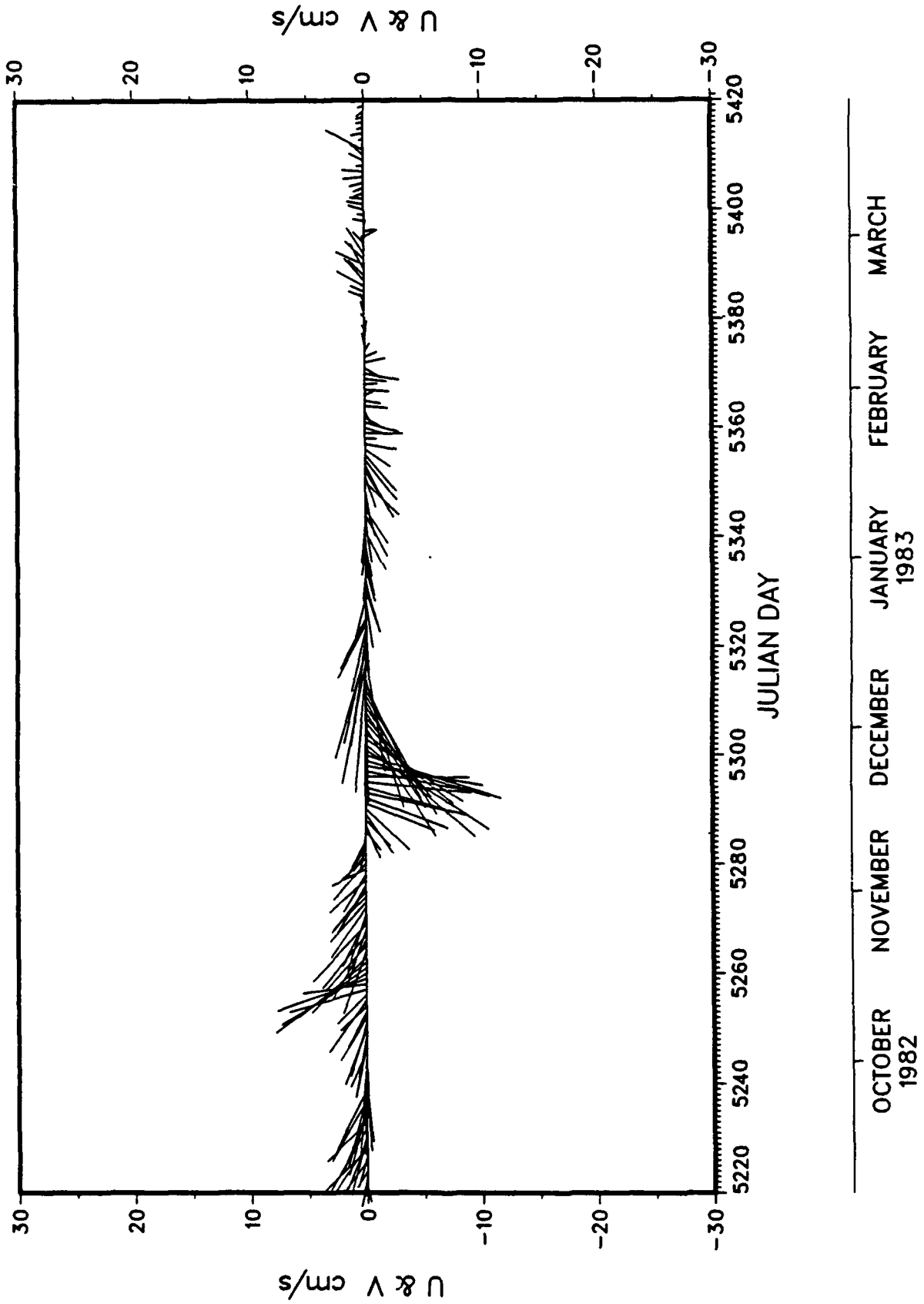


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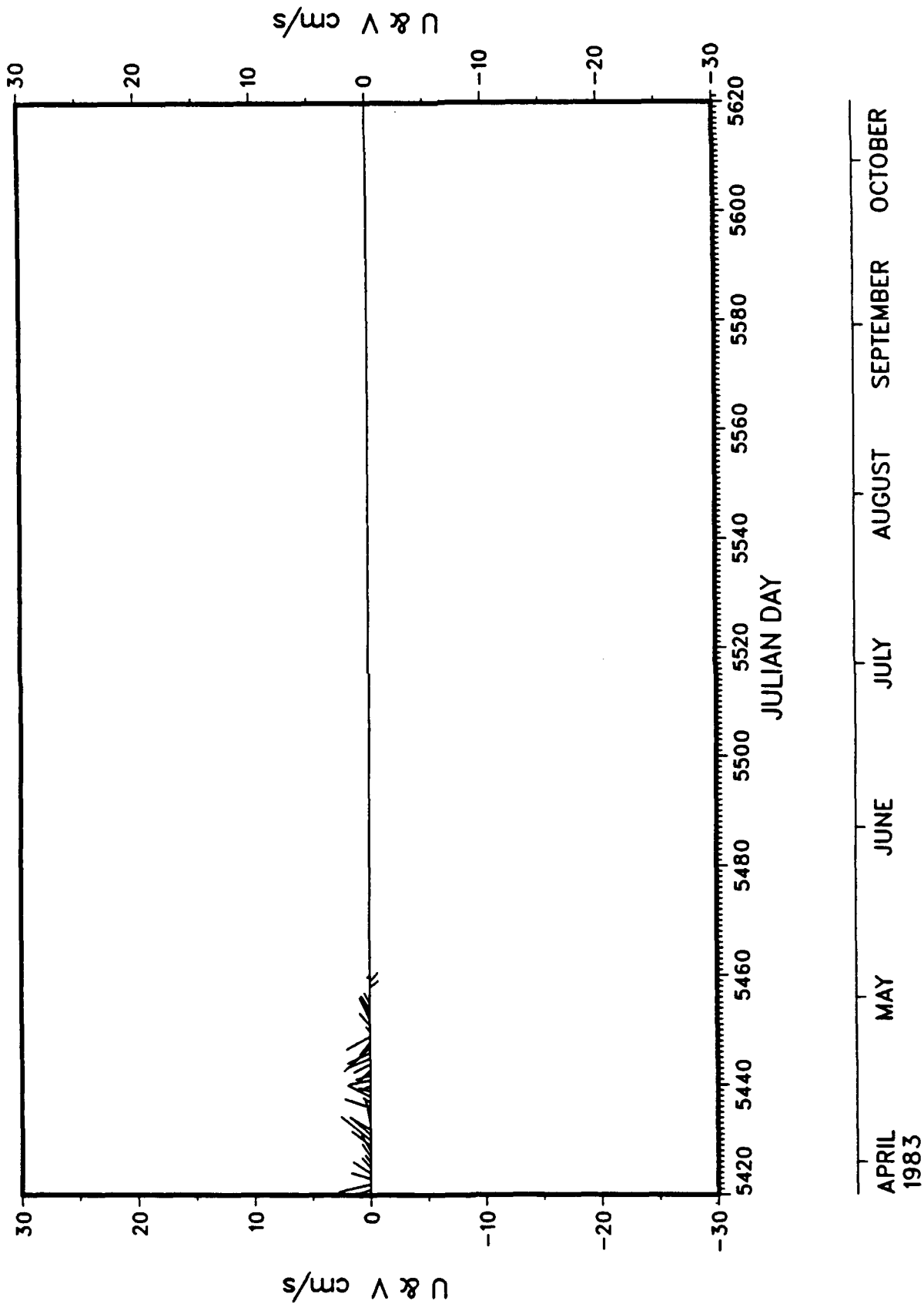




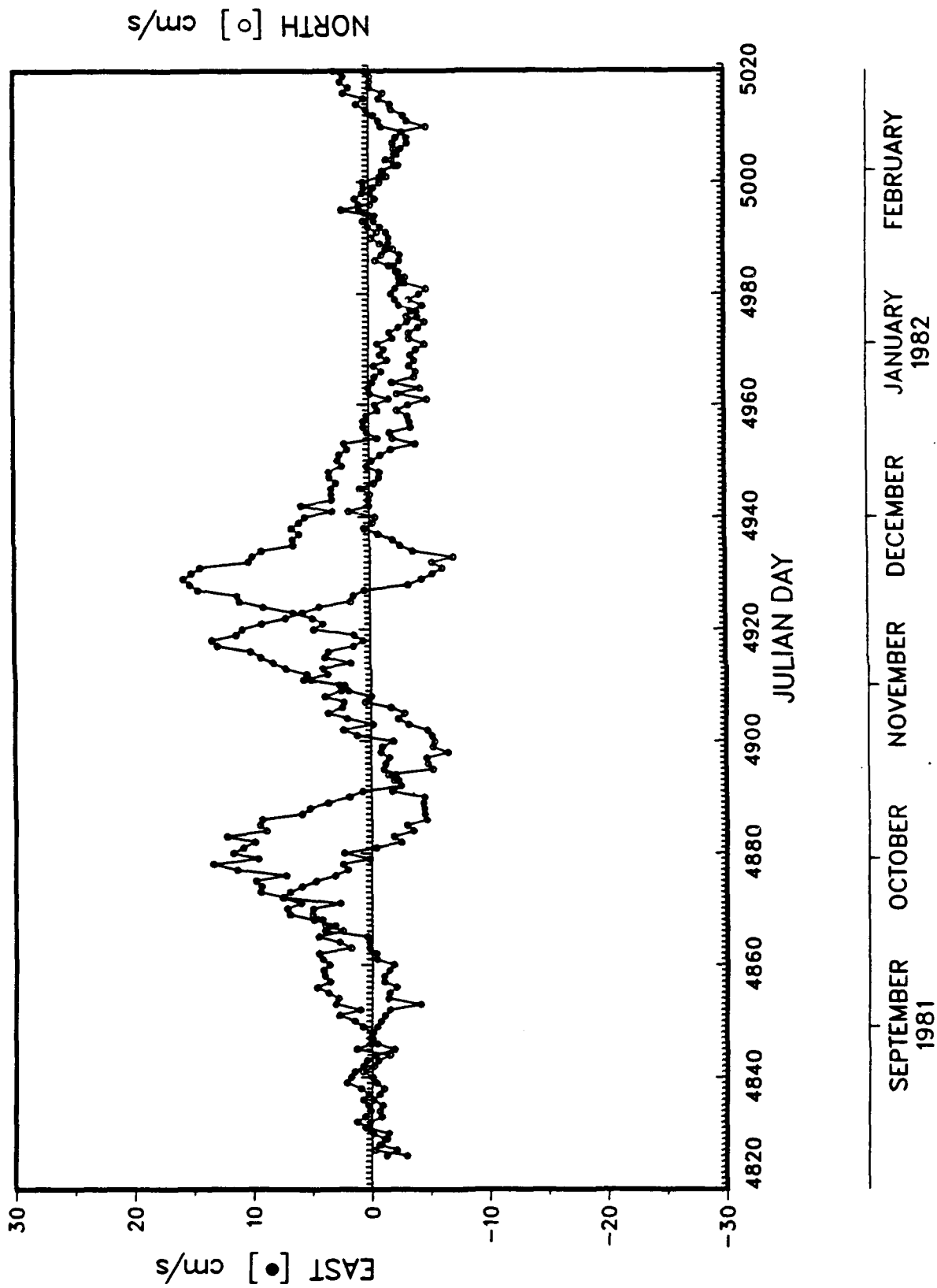
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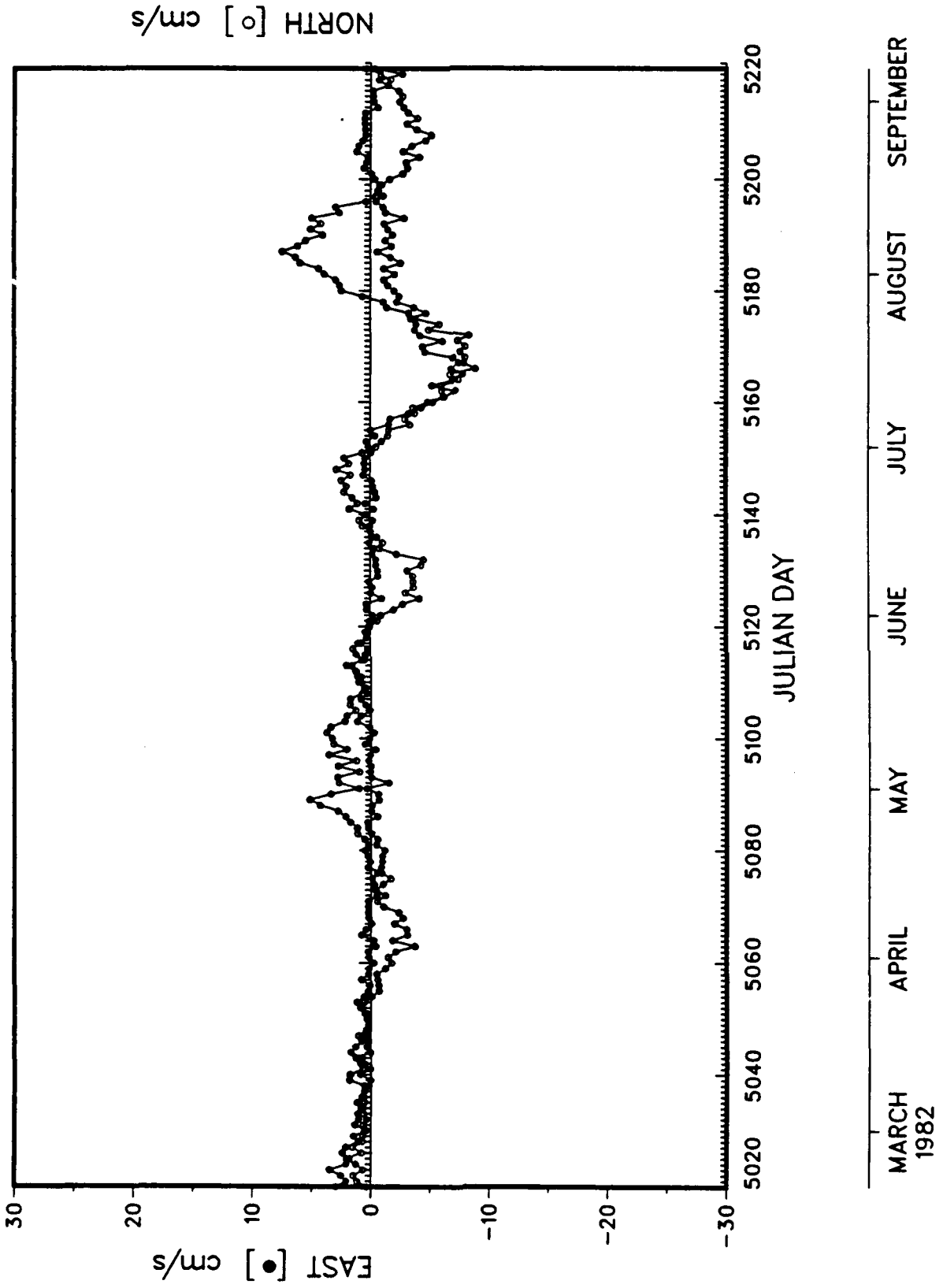


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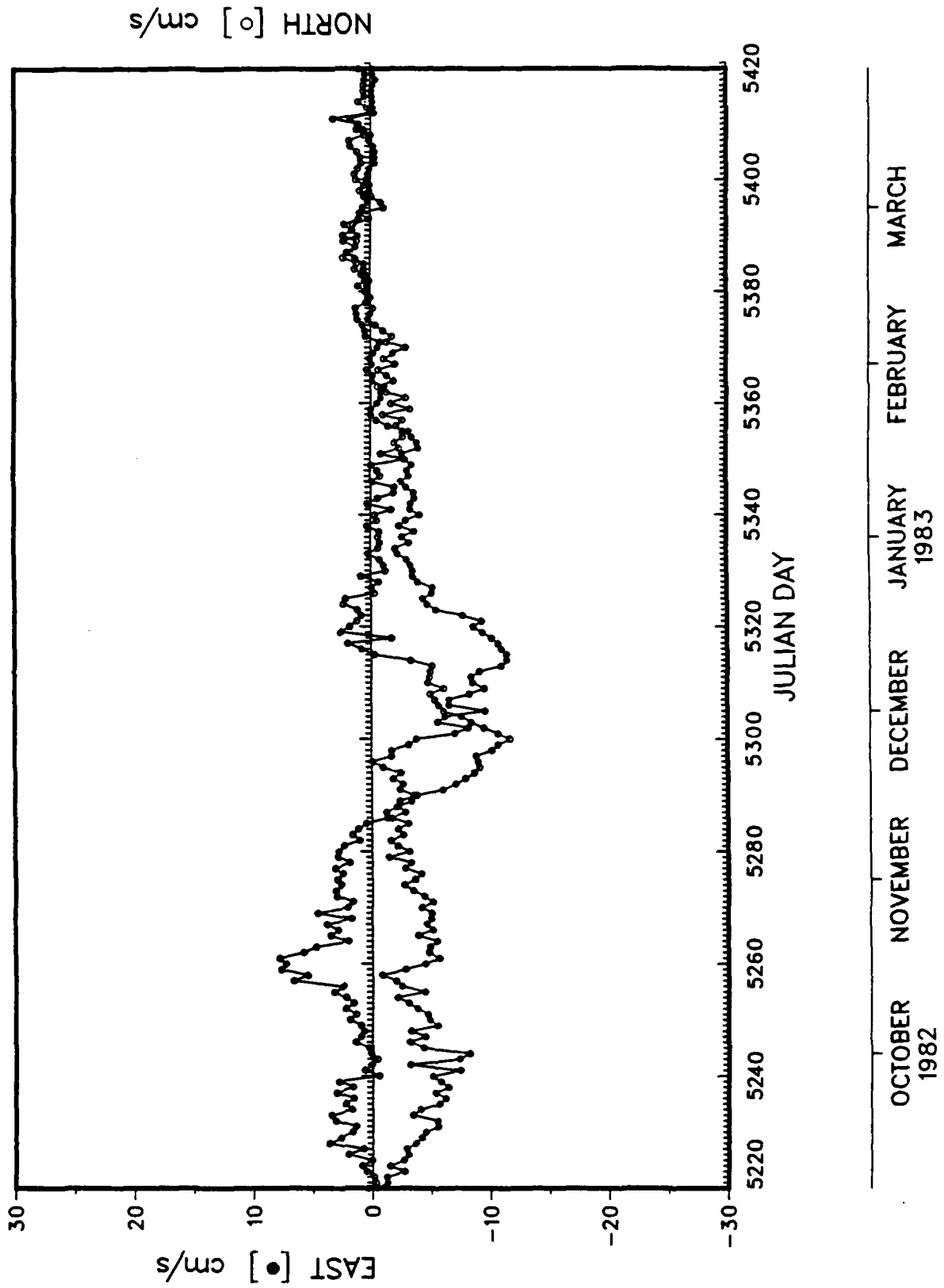


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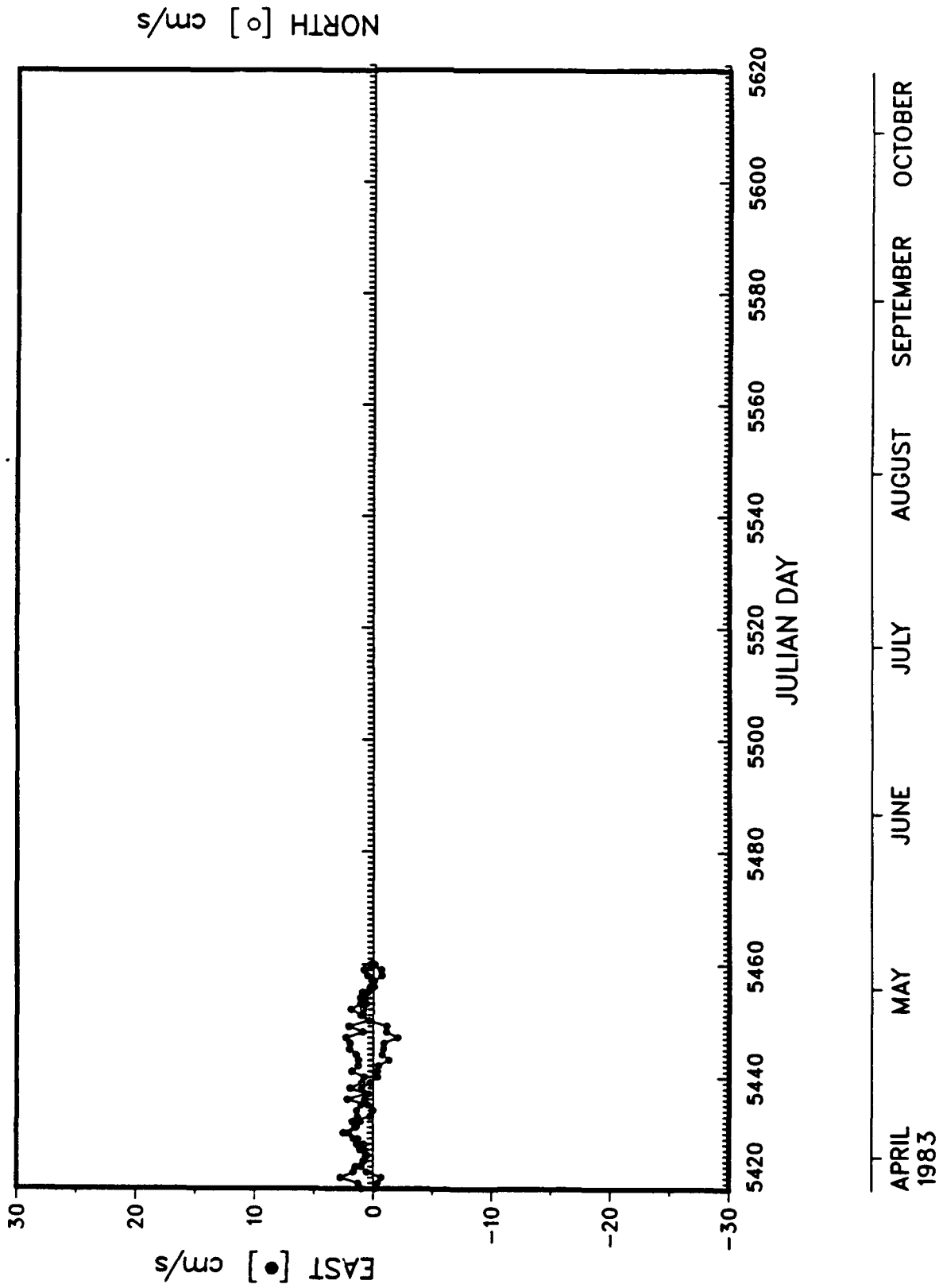




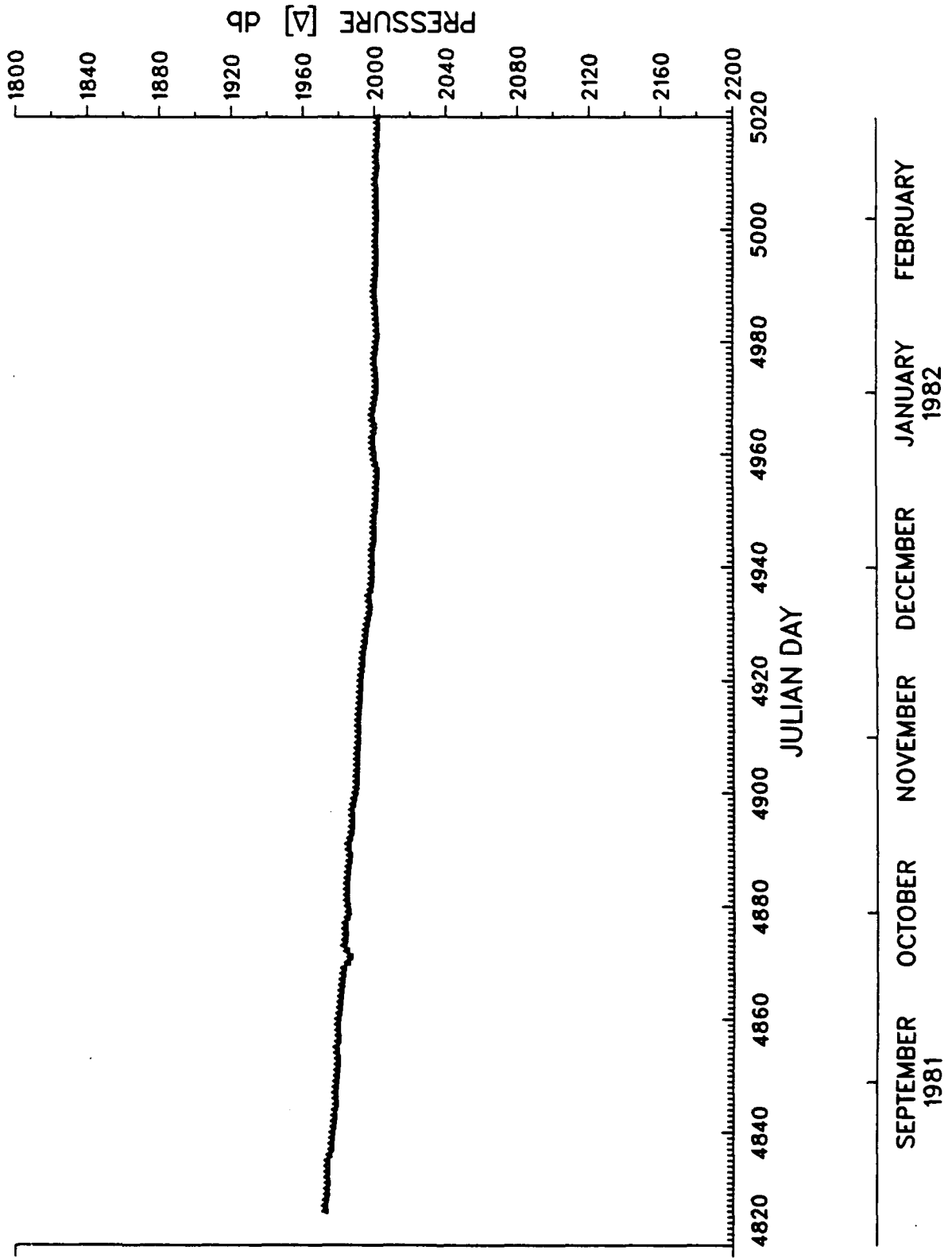
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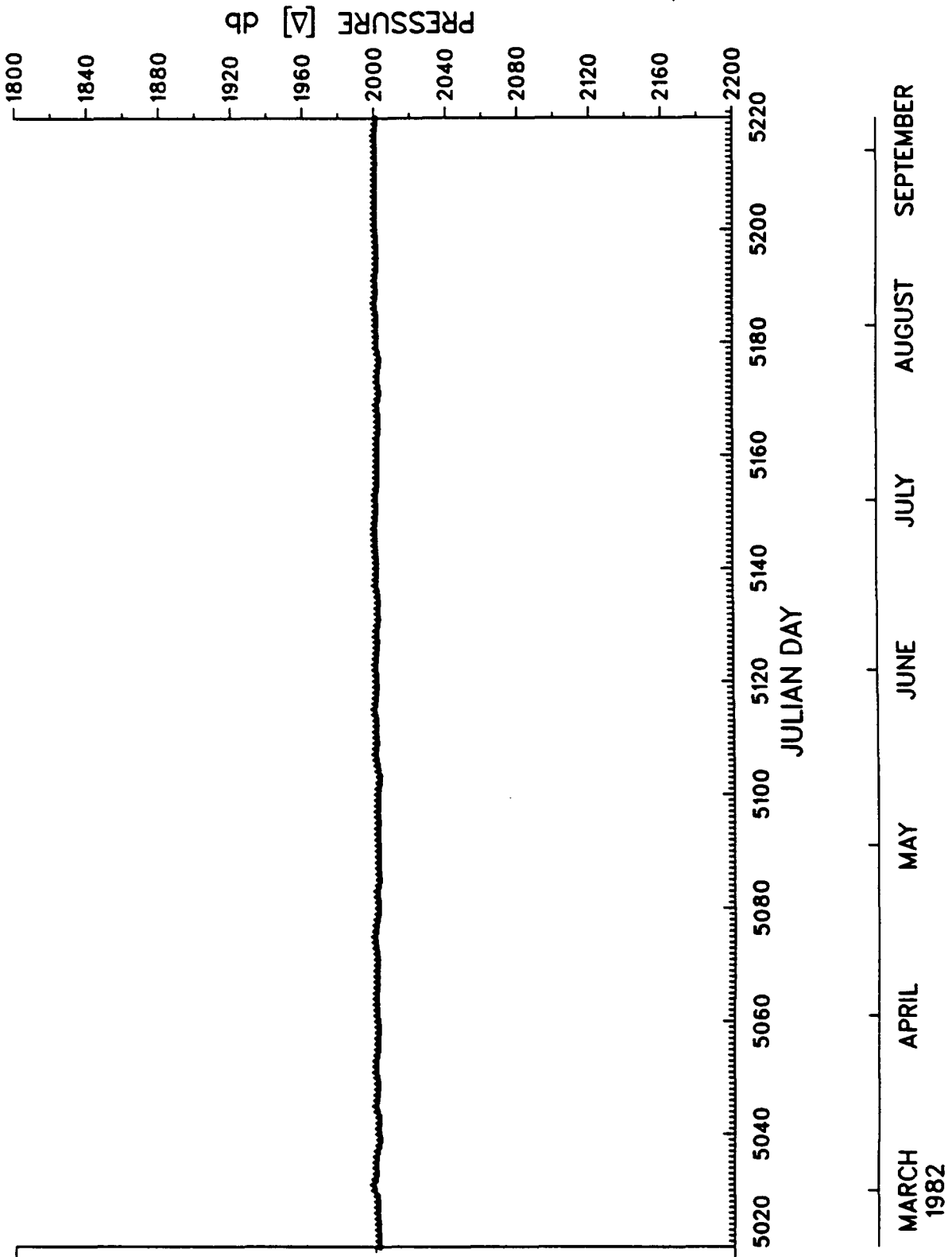


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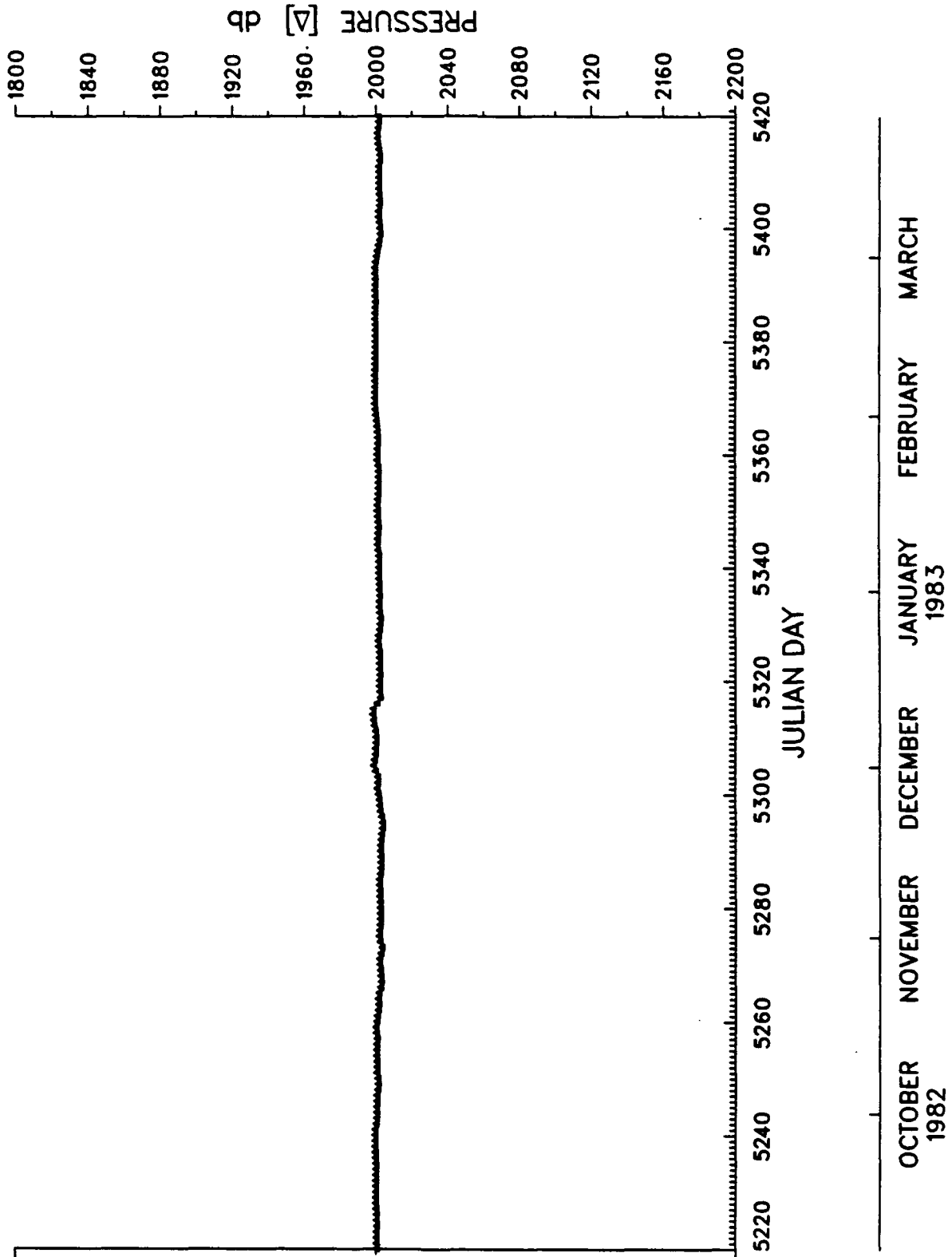


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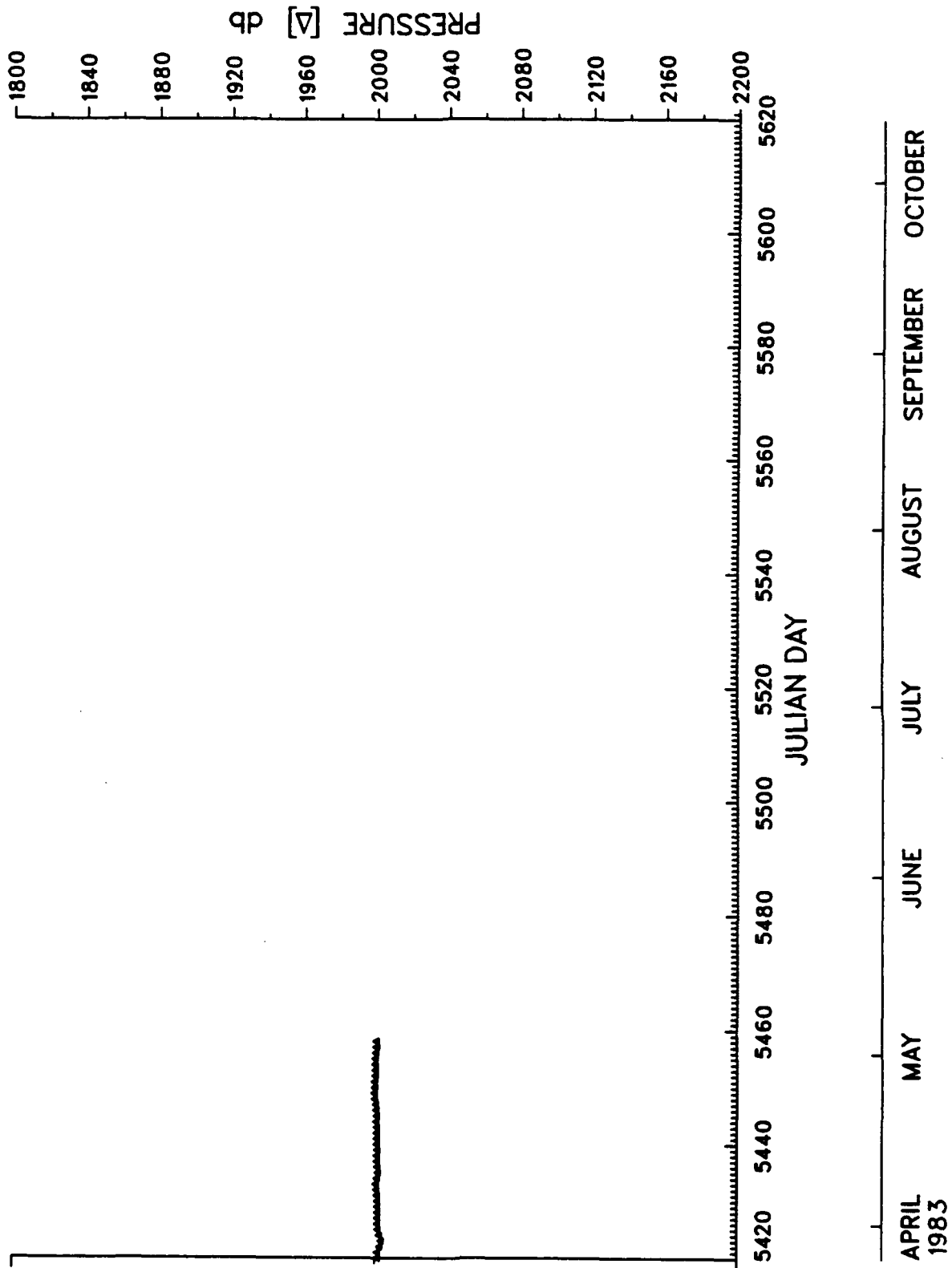




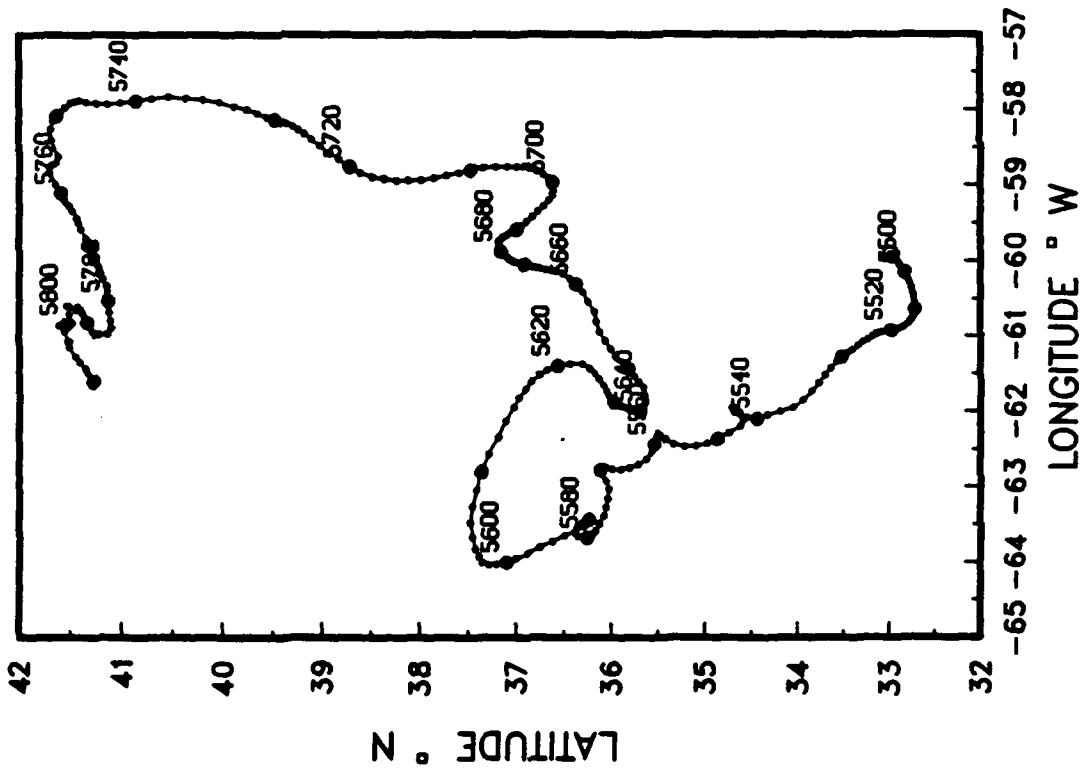
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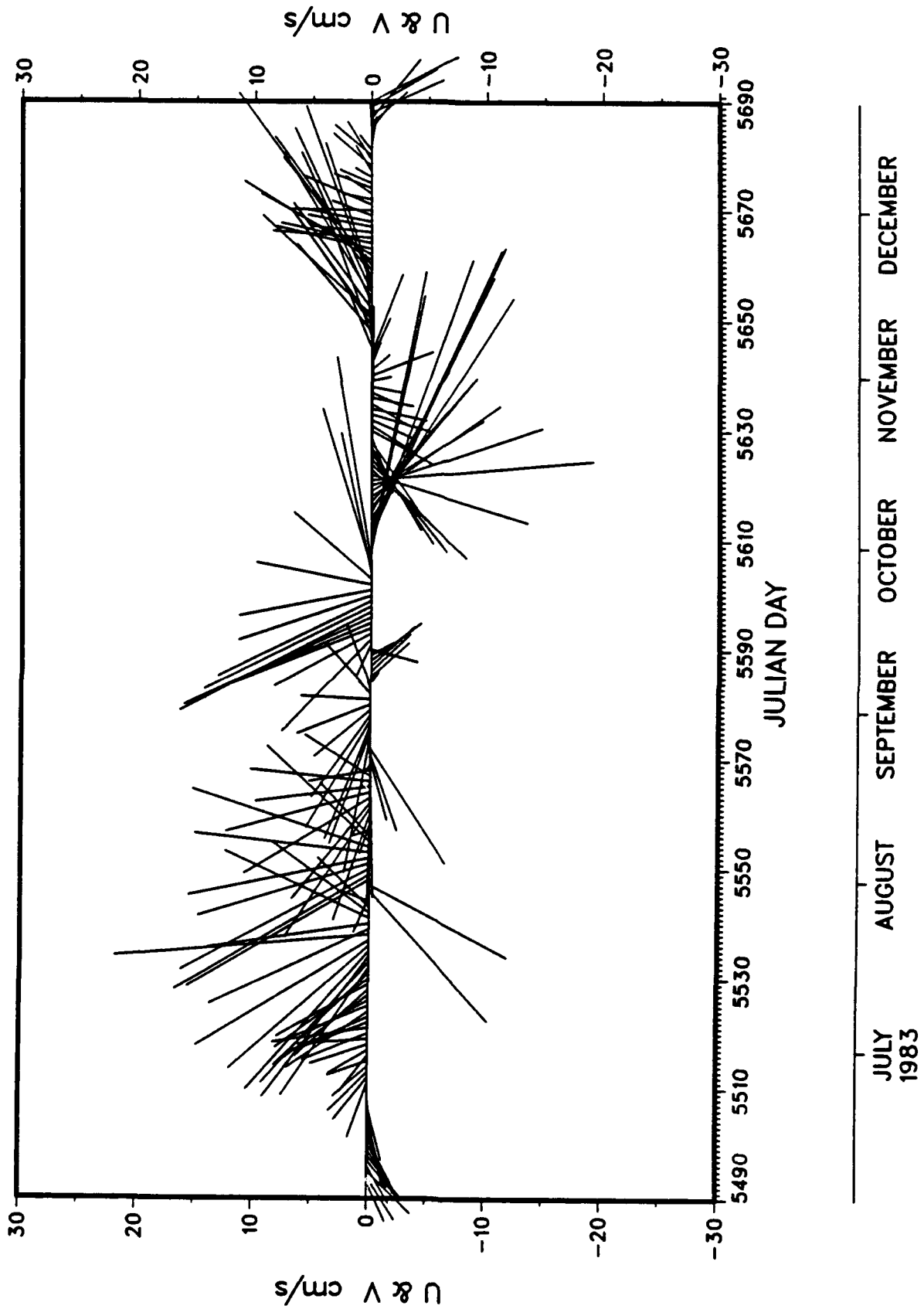


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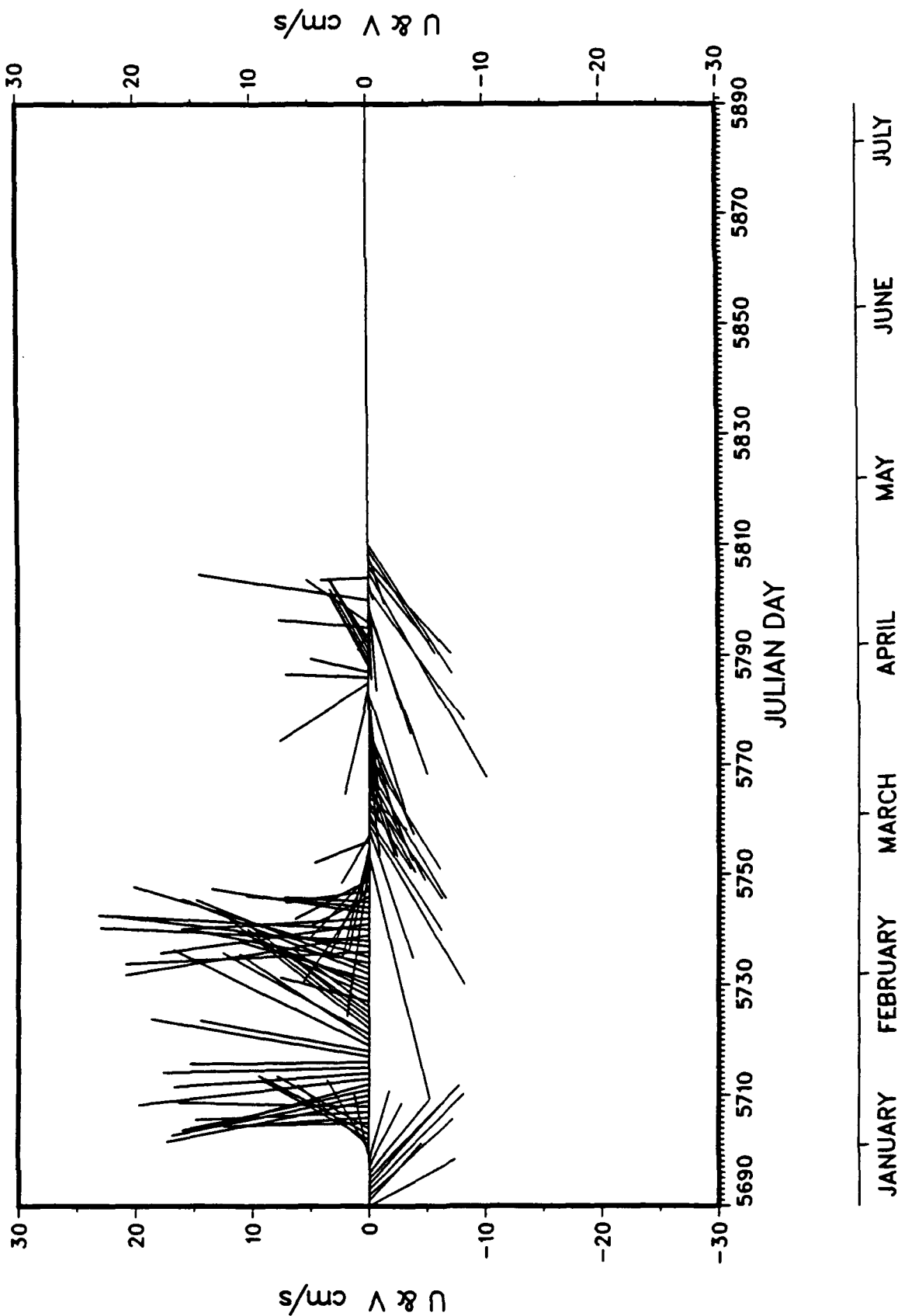


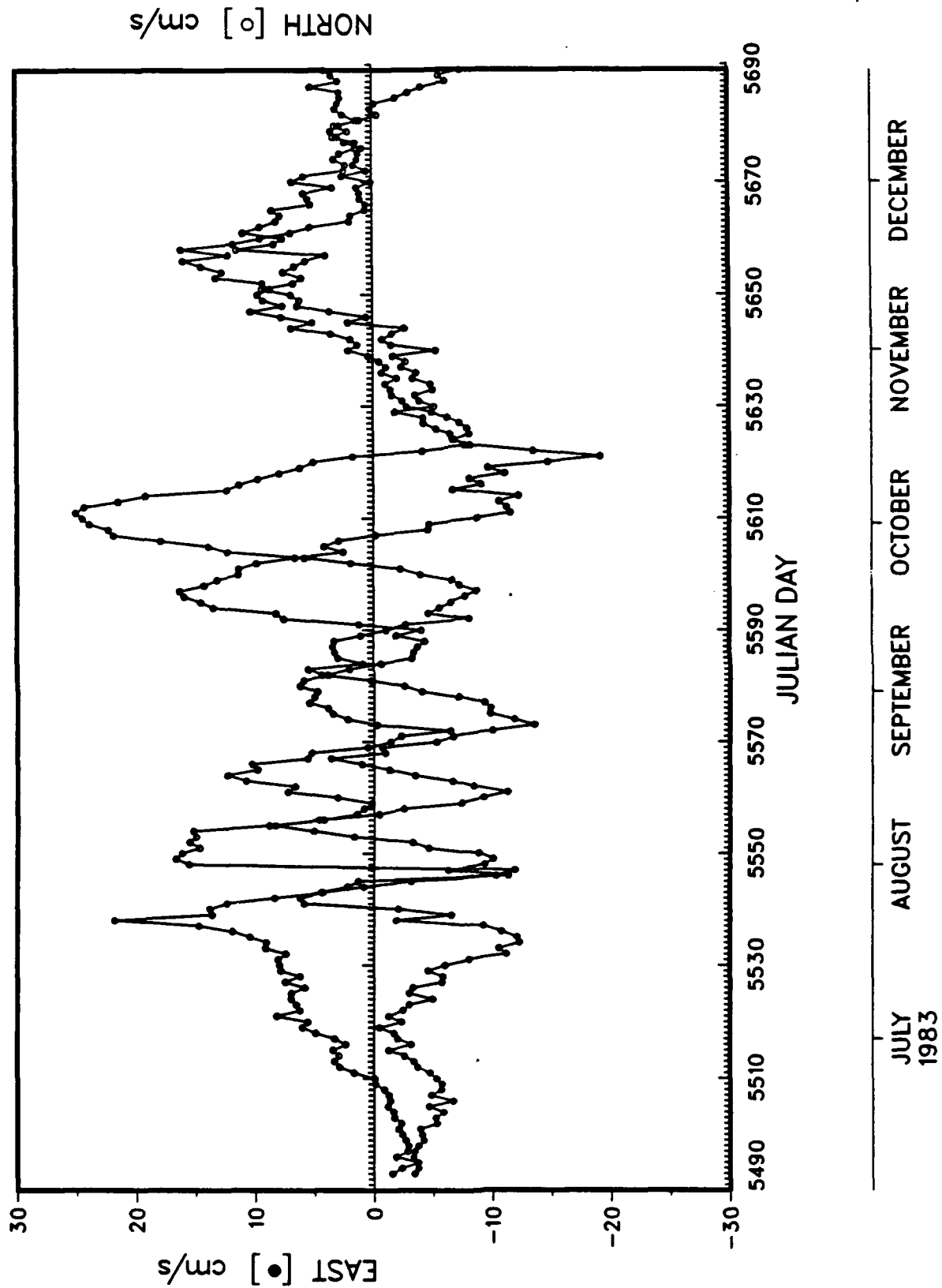
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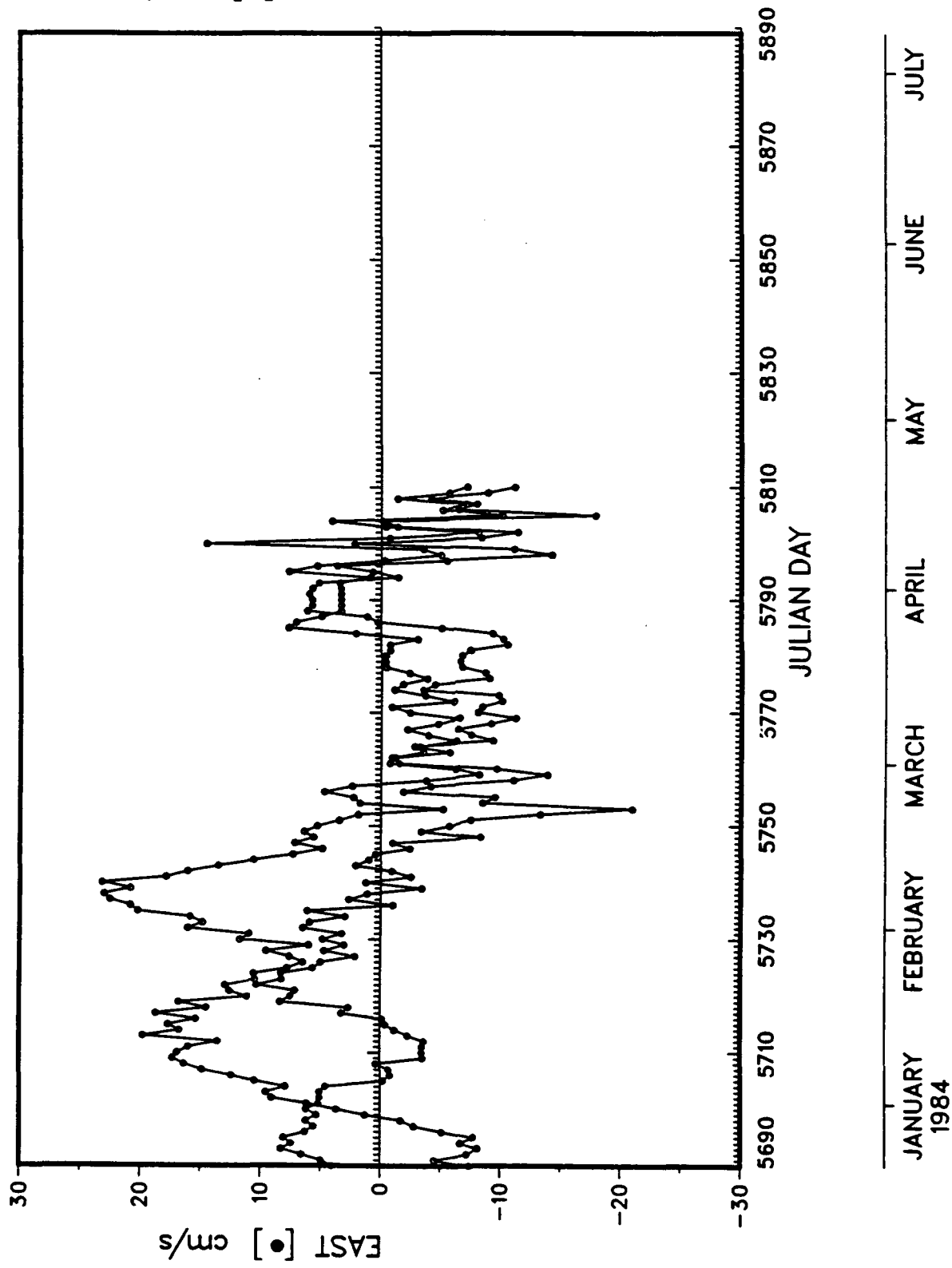




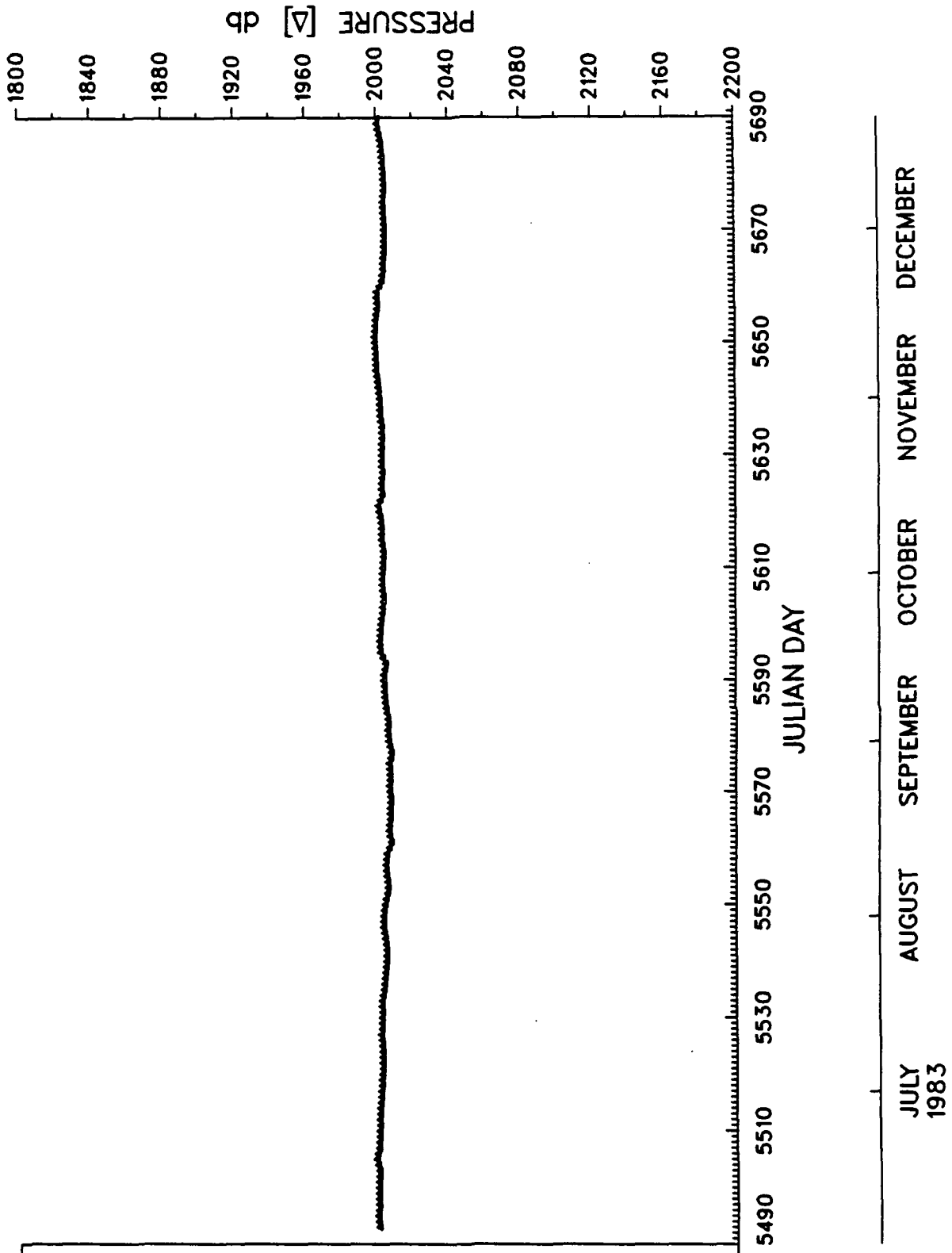
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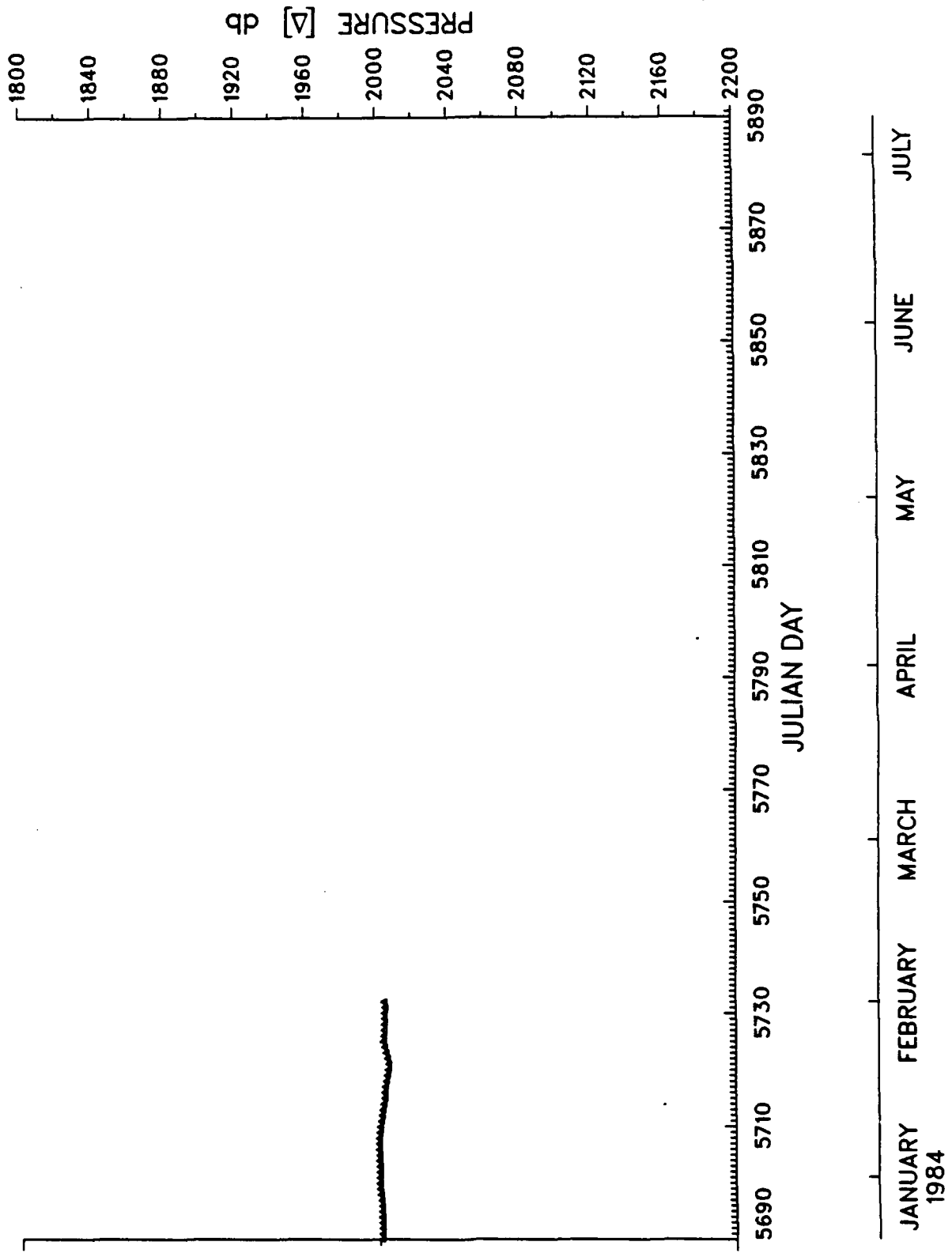


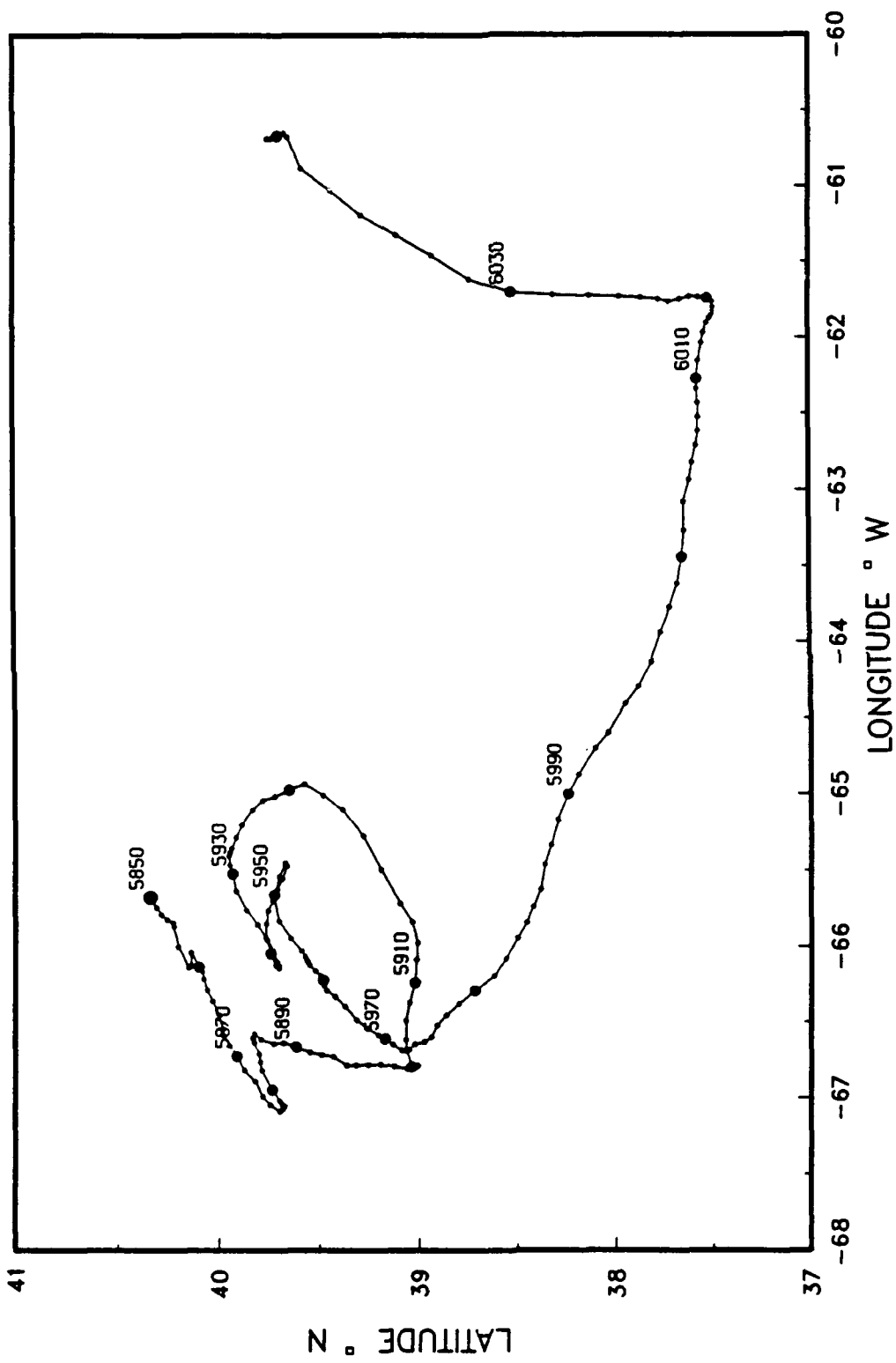


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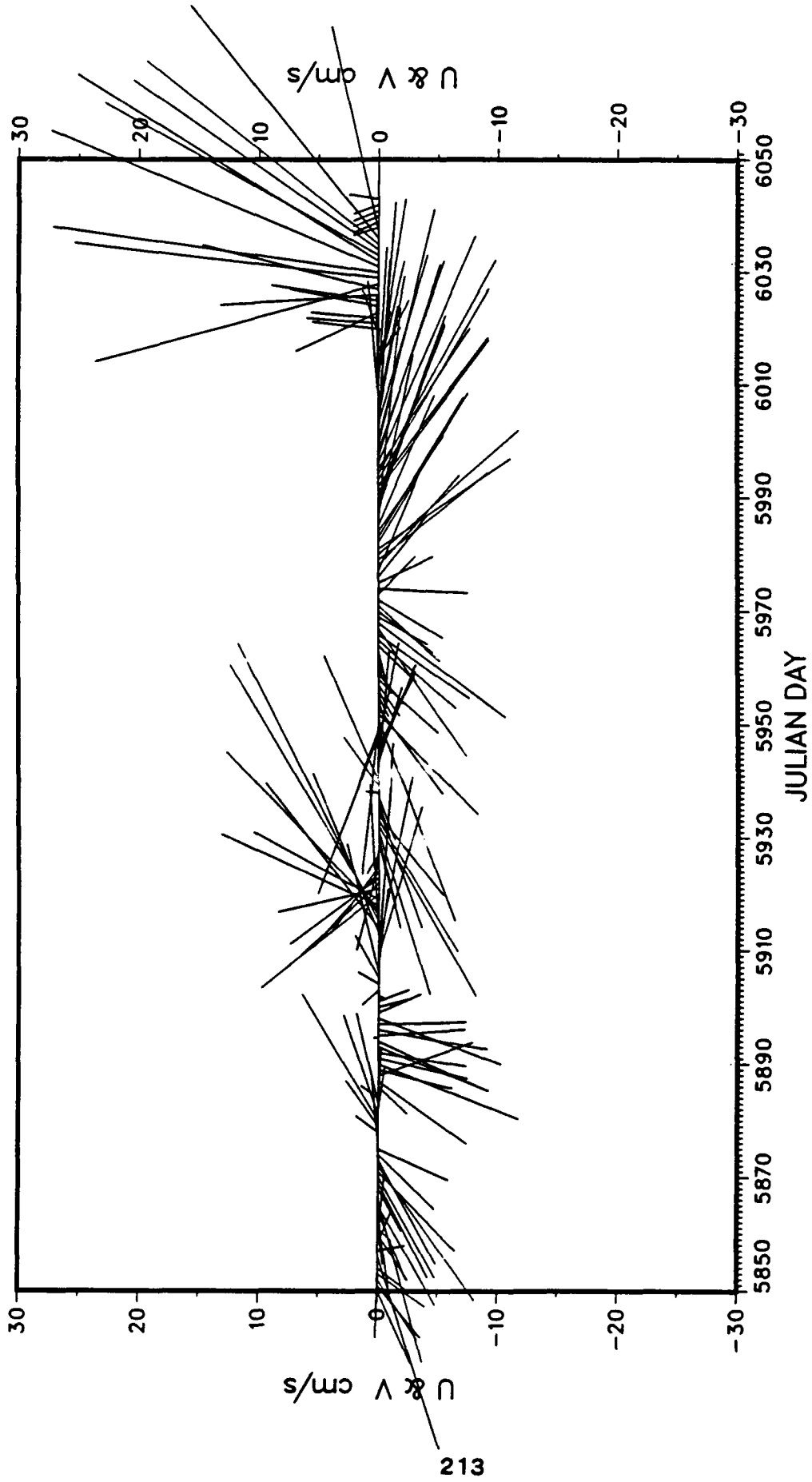


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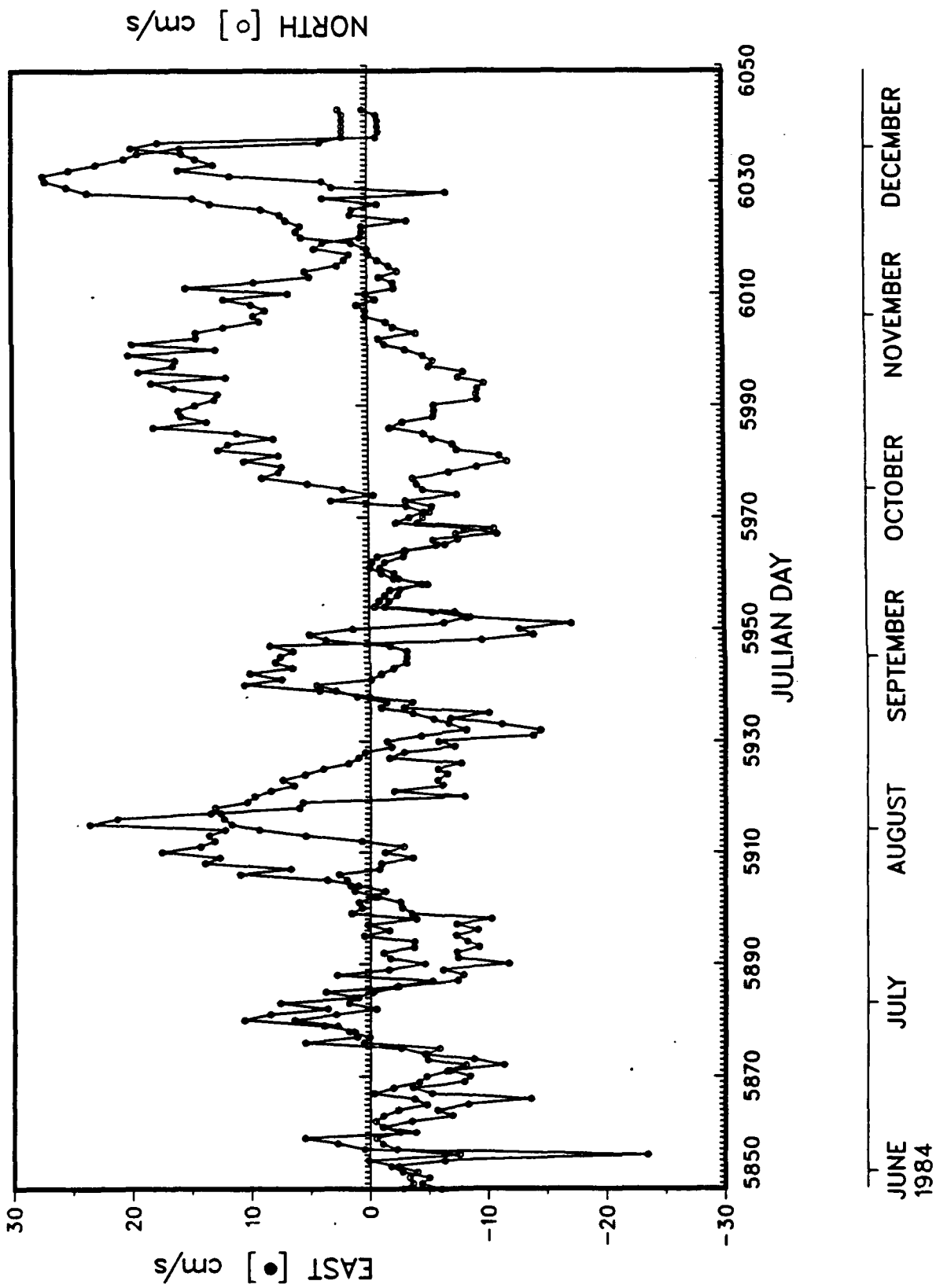


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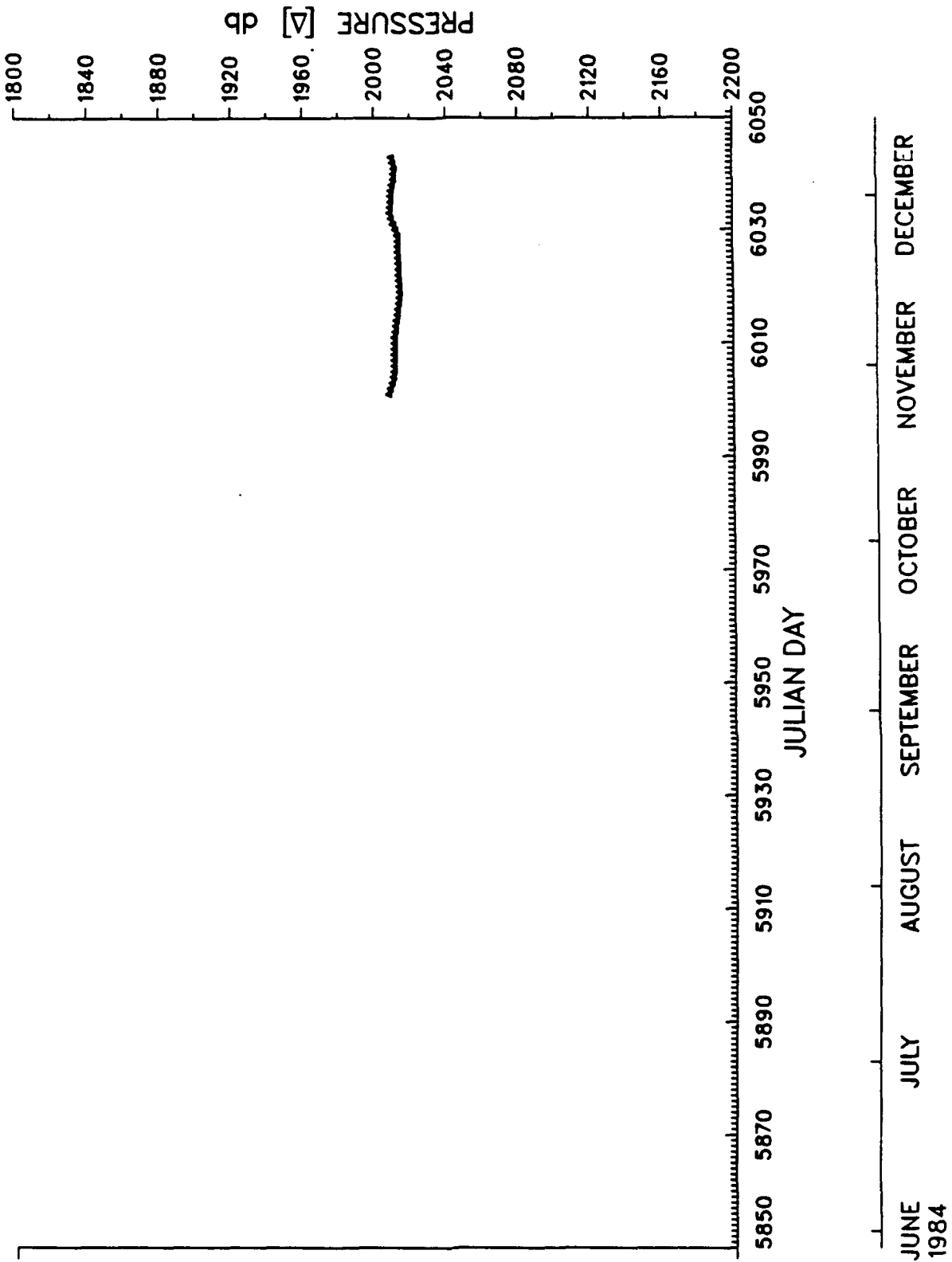


JUNE 1984 JULY AUGUST SEPTEMBER OCTOBER NOVEMBER DECEMBER

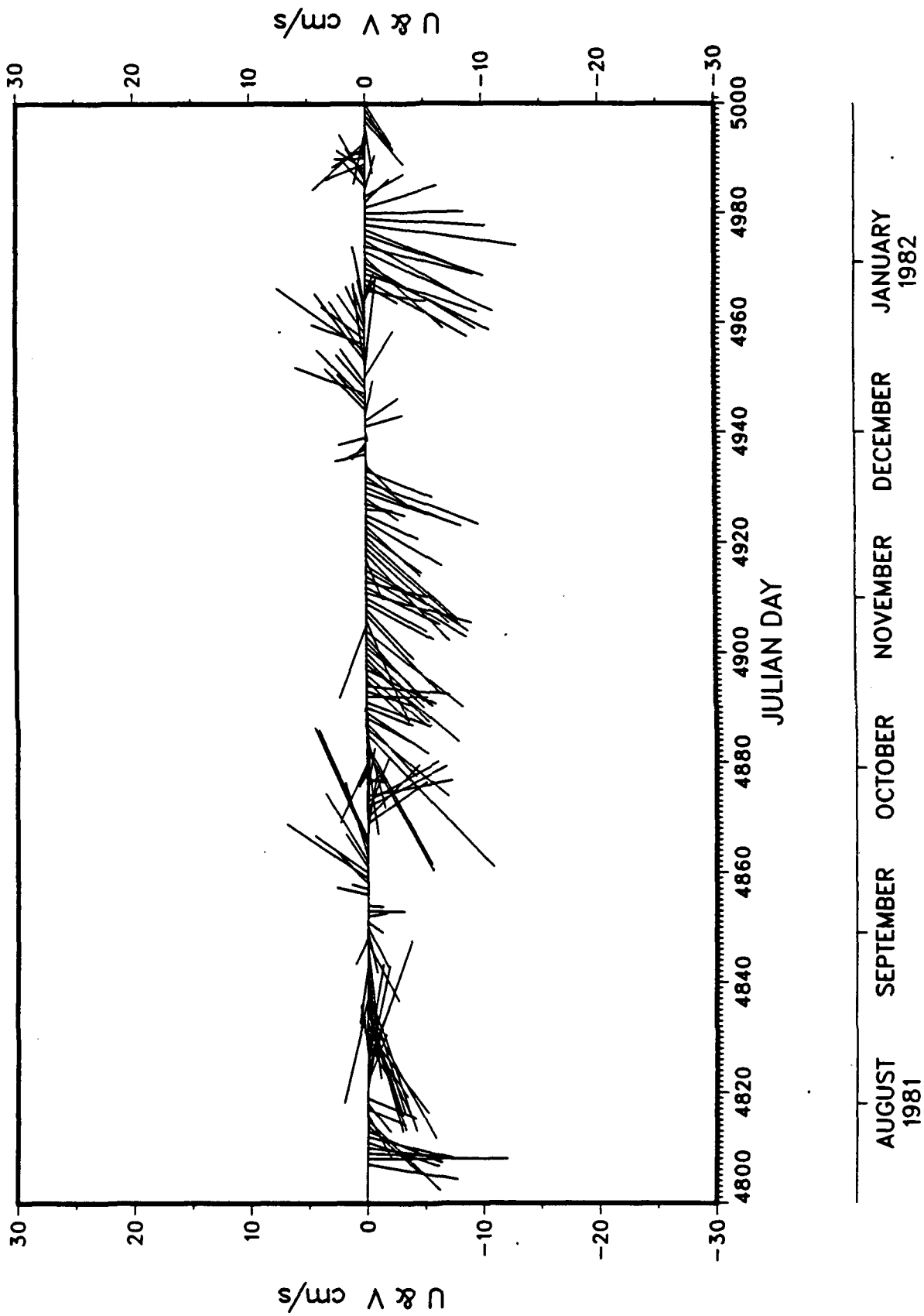
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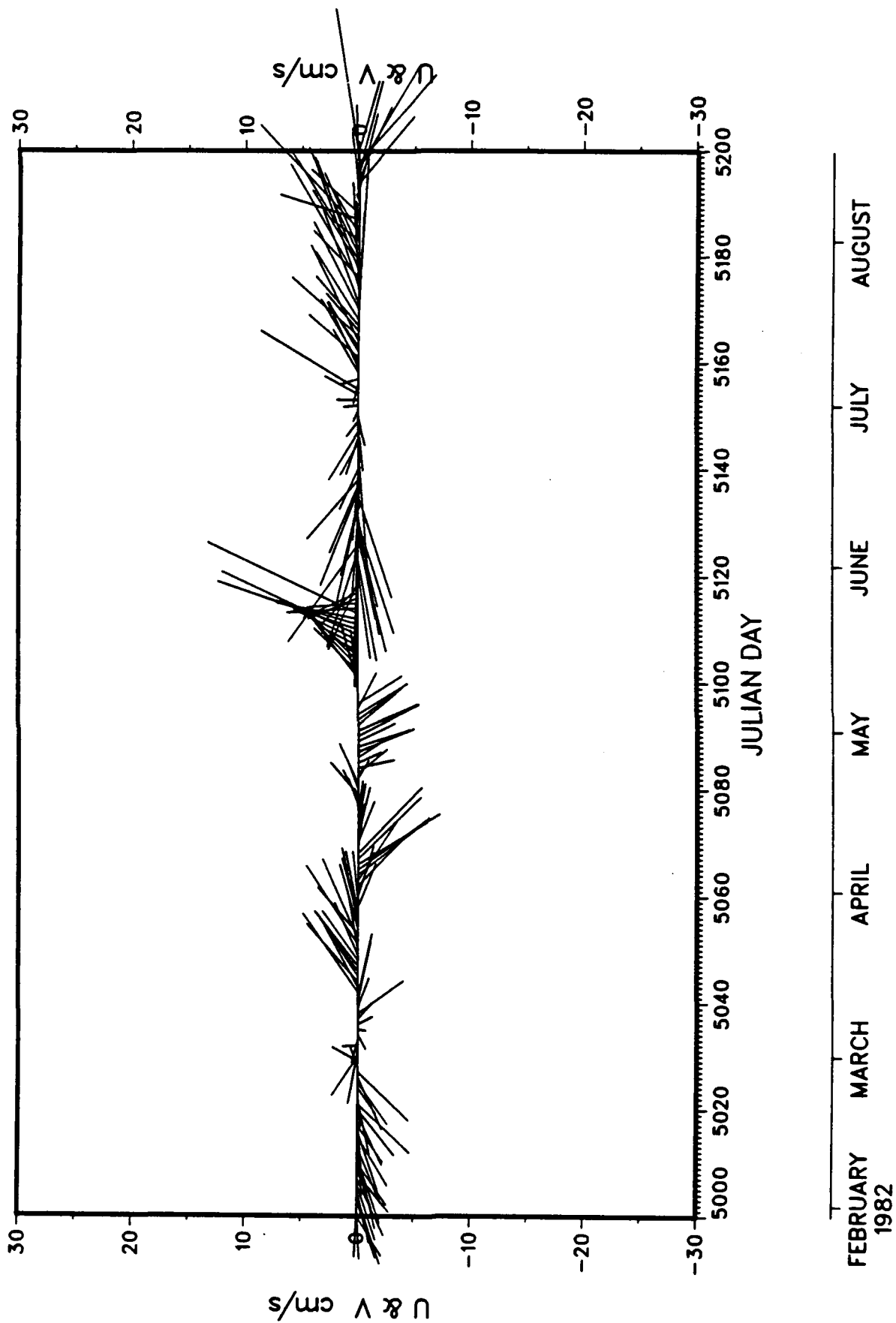
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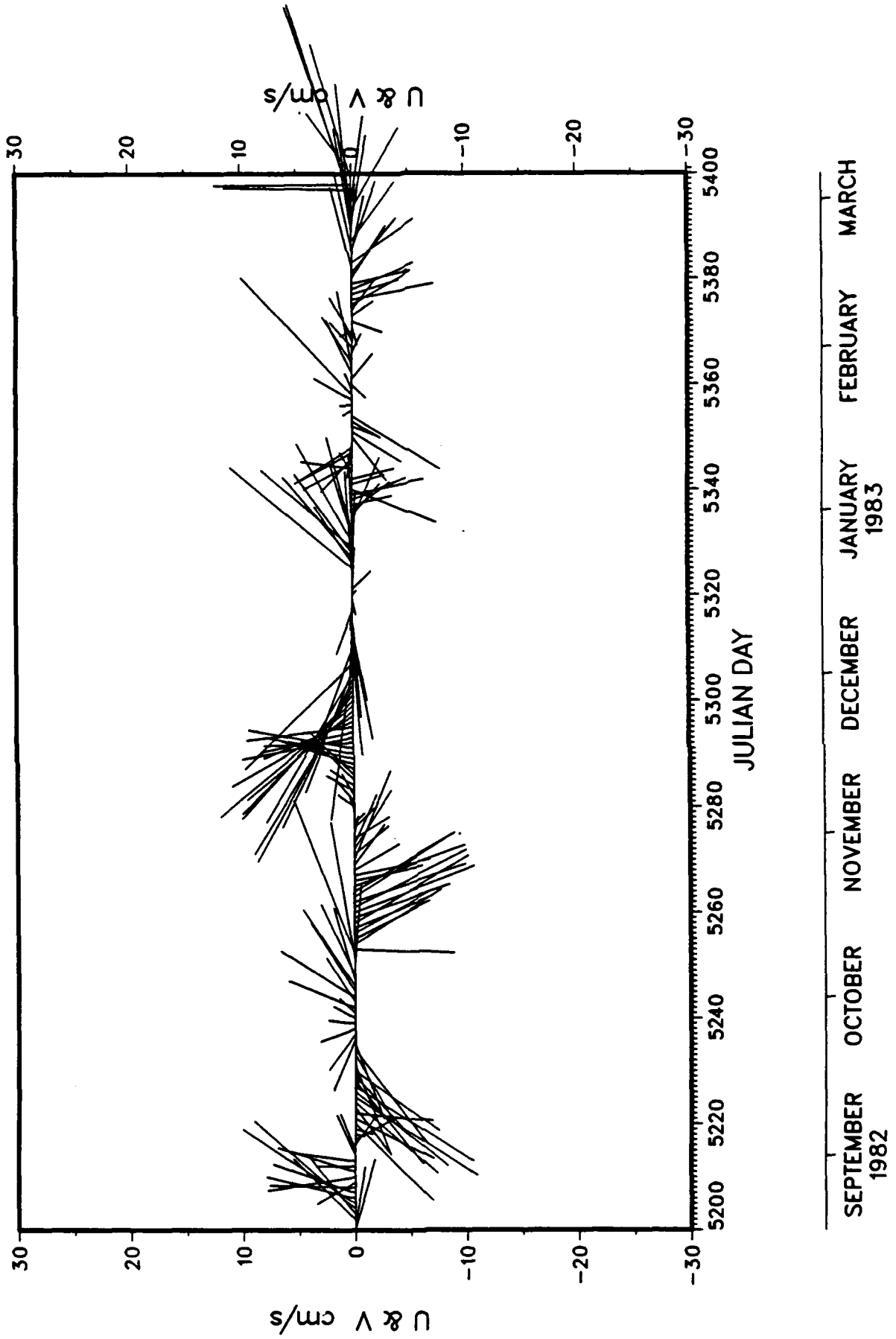
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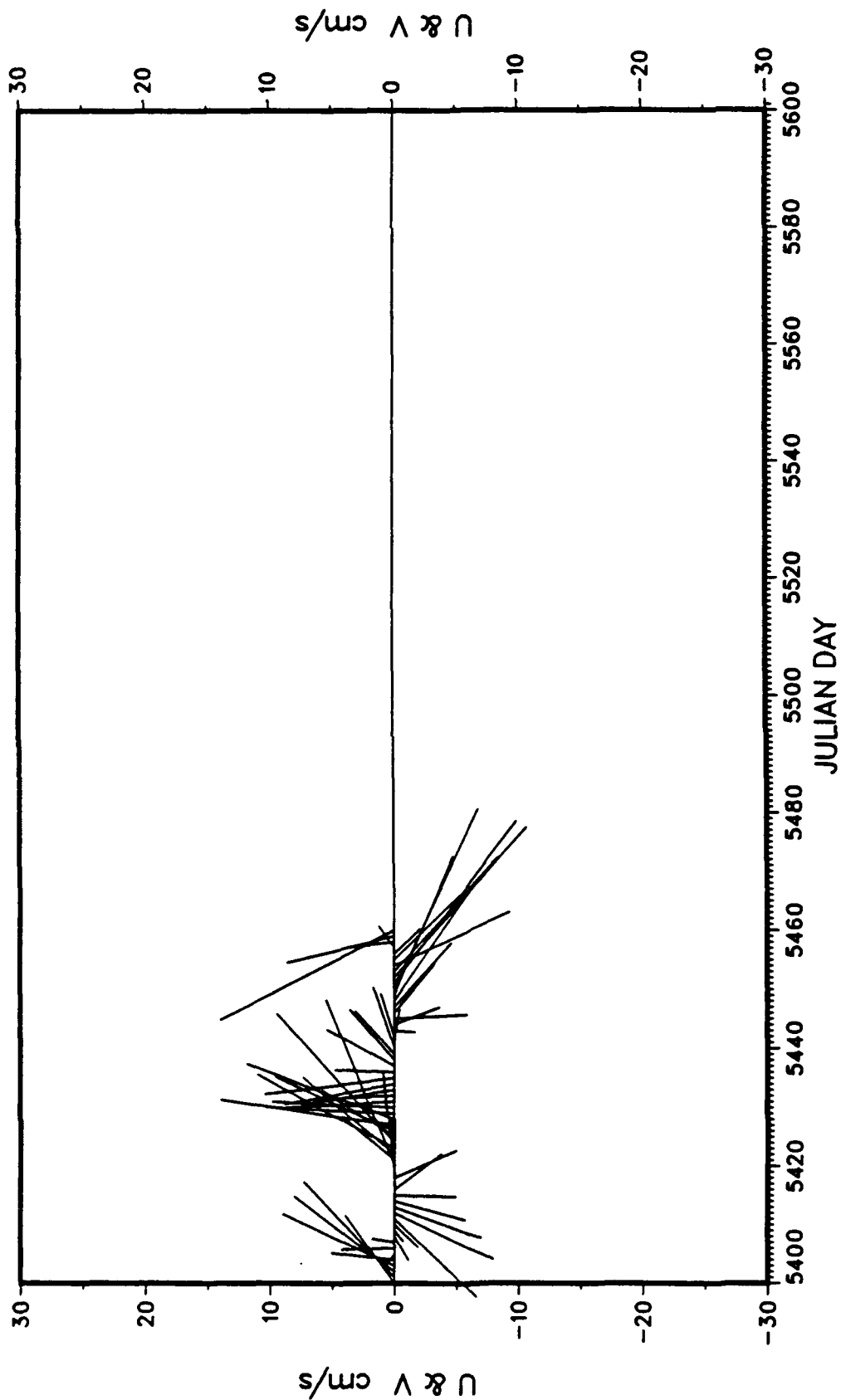
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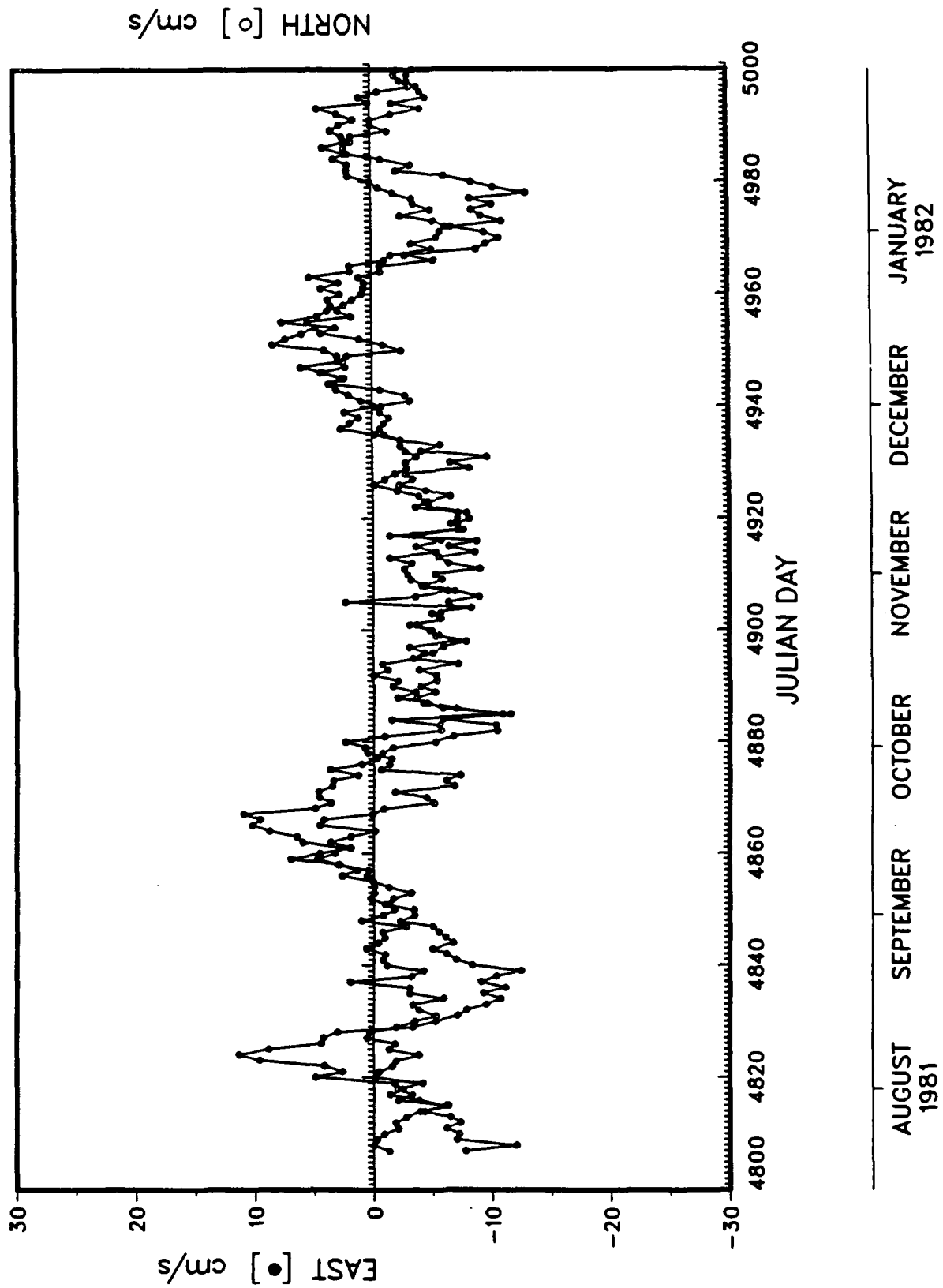


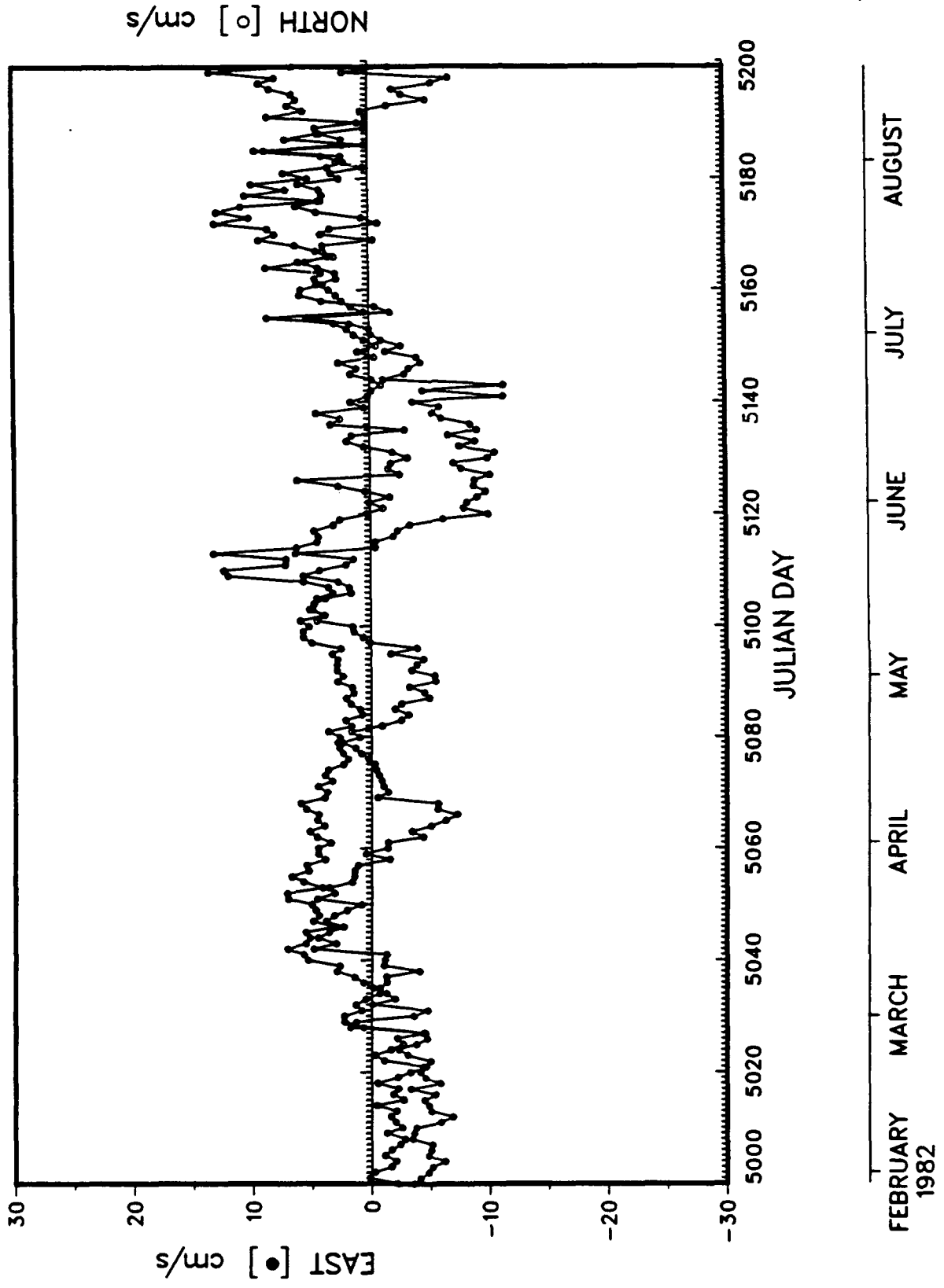
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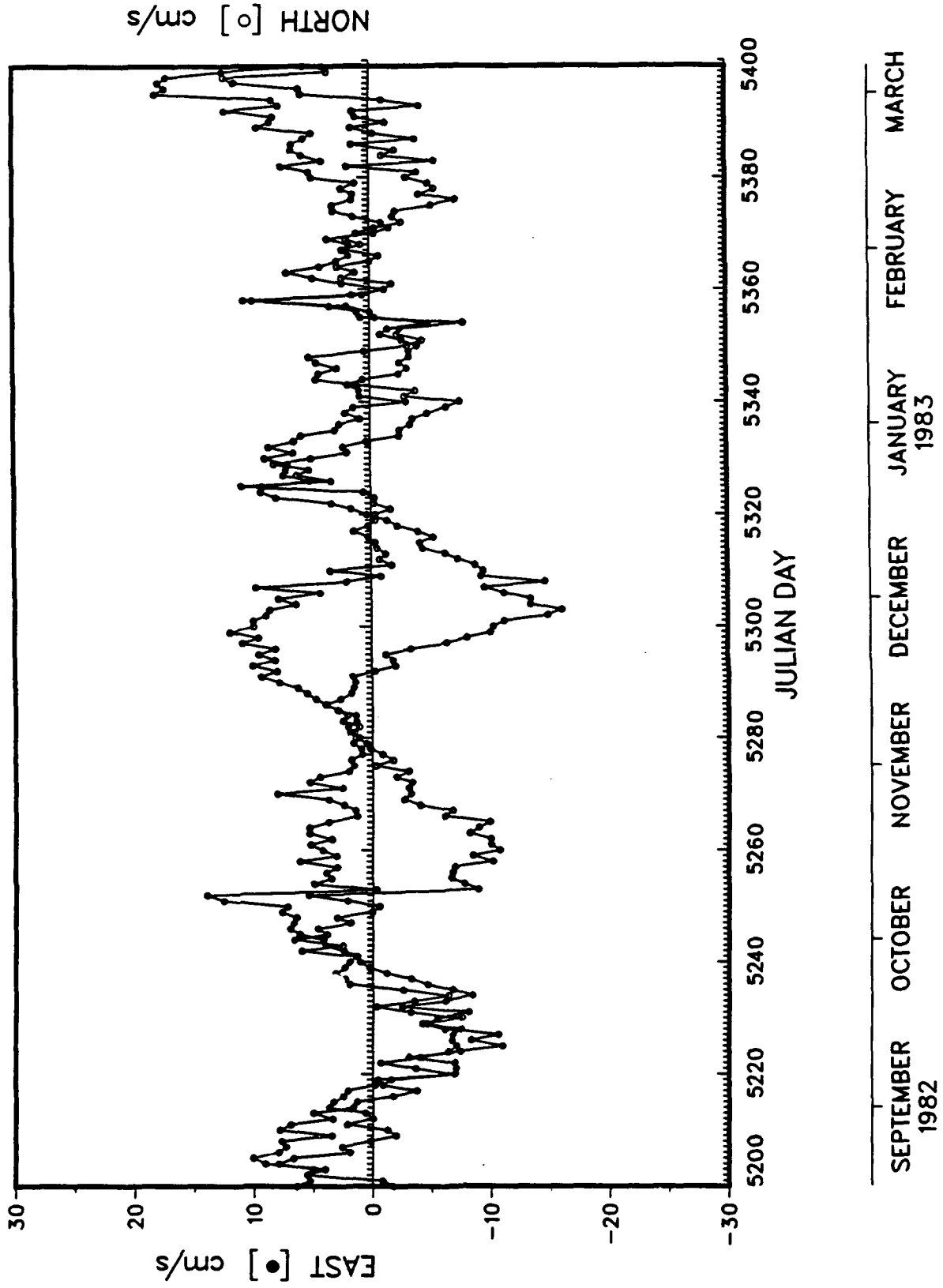
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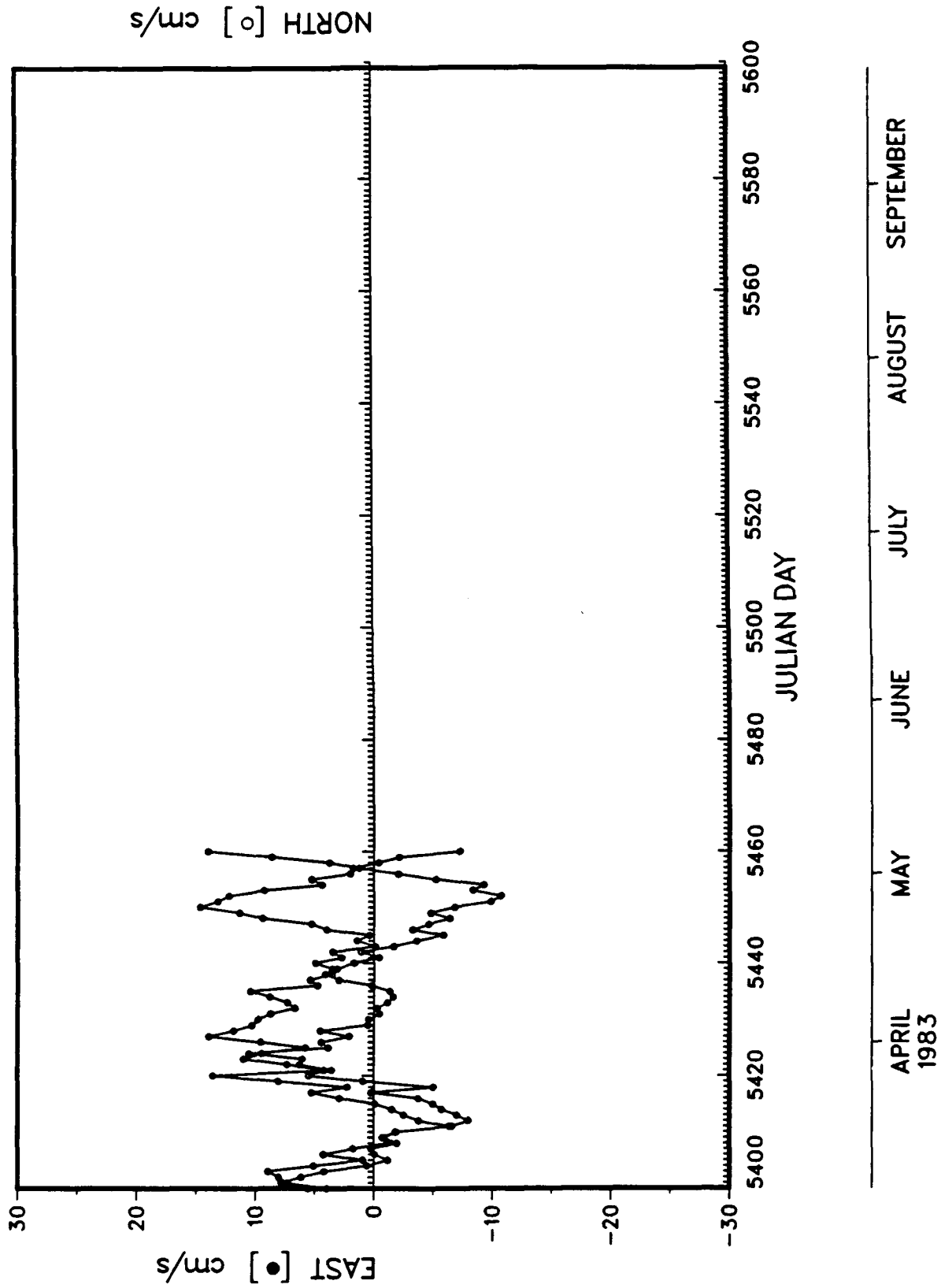




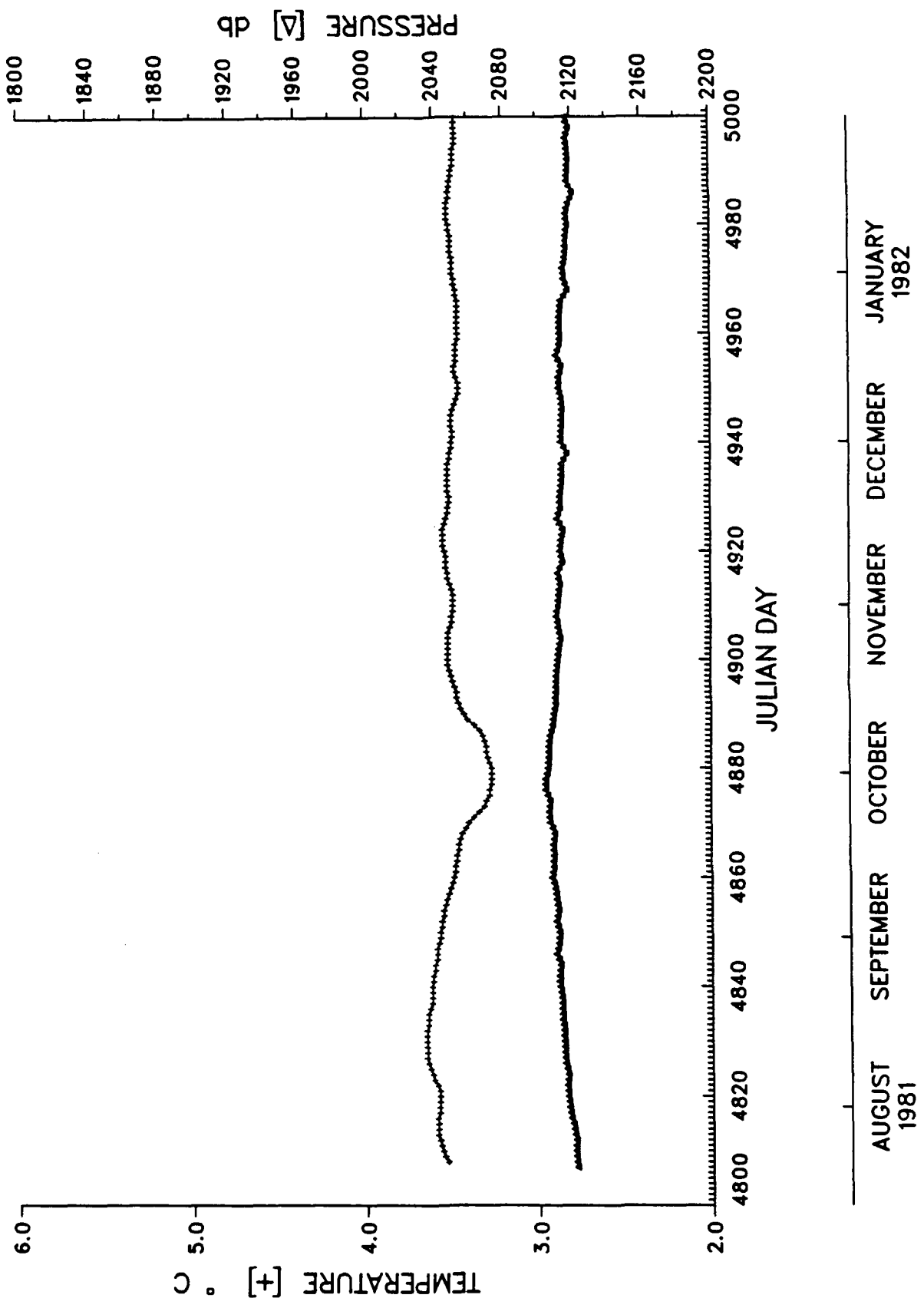
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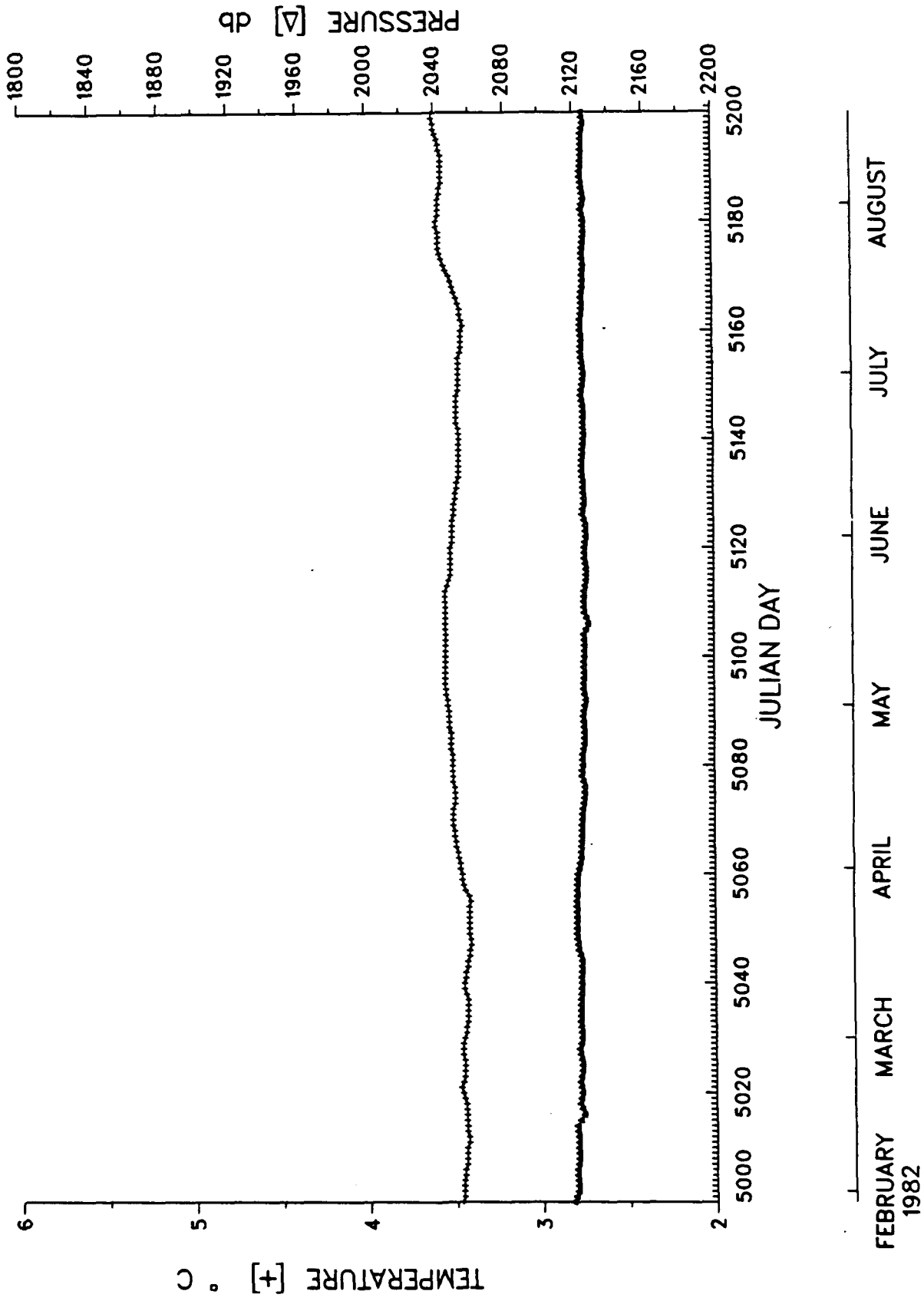
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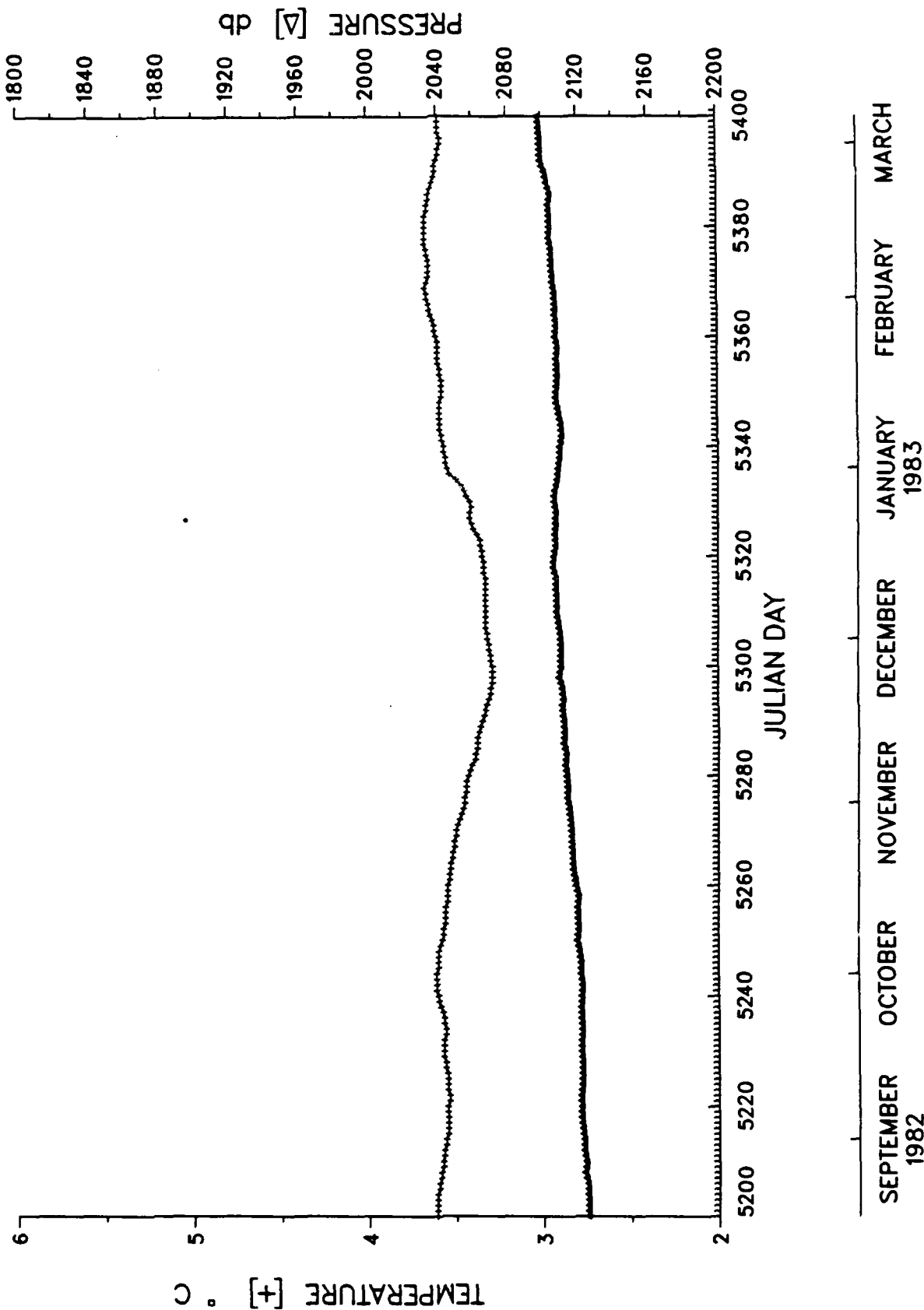
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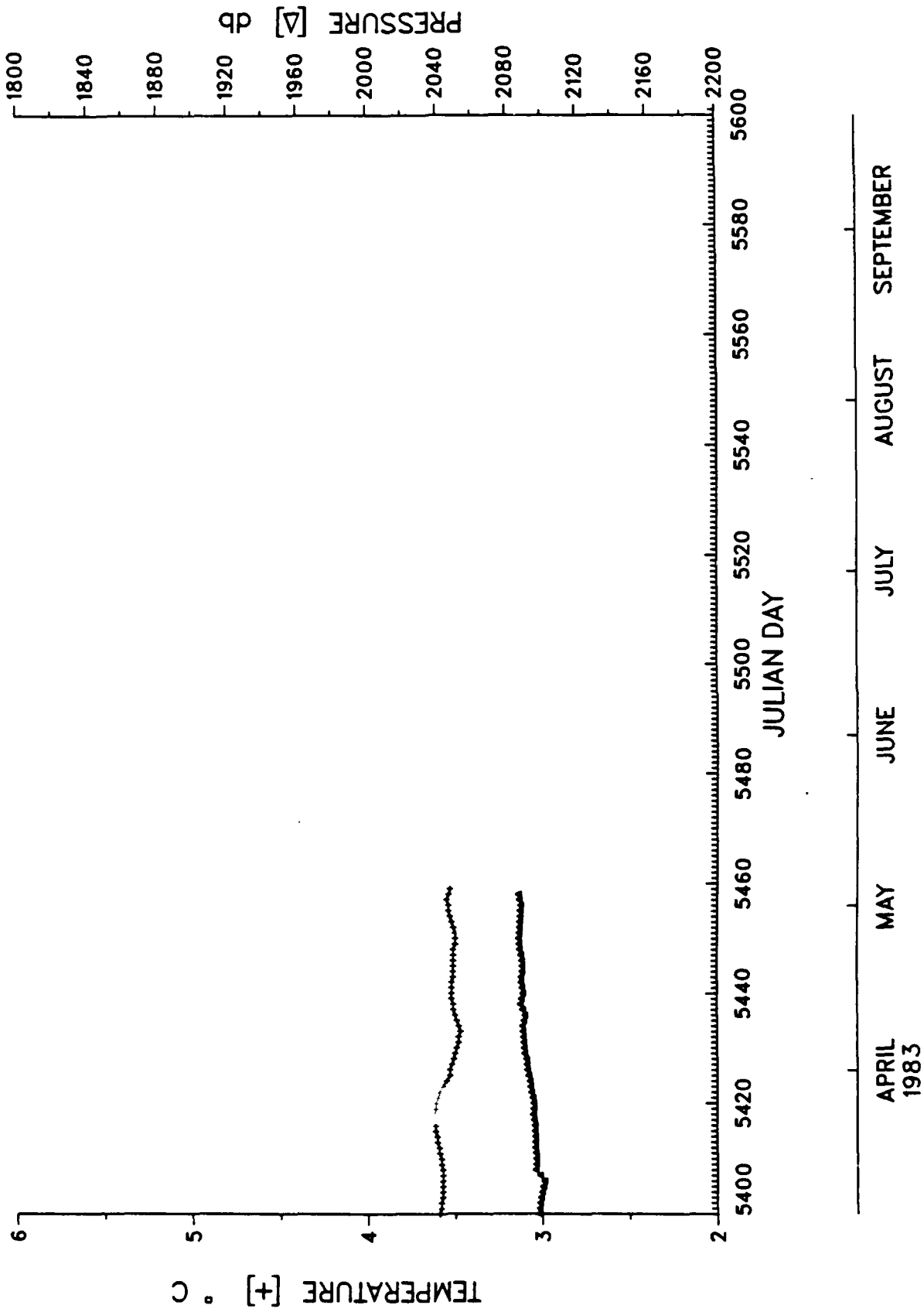
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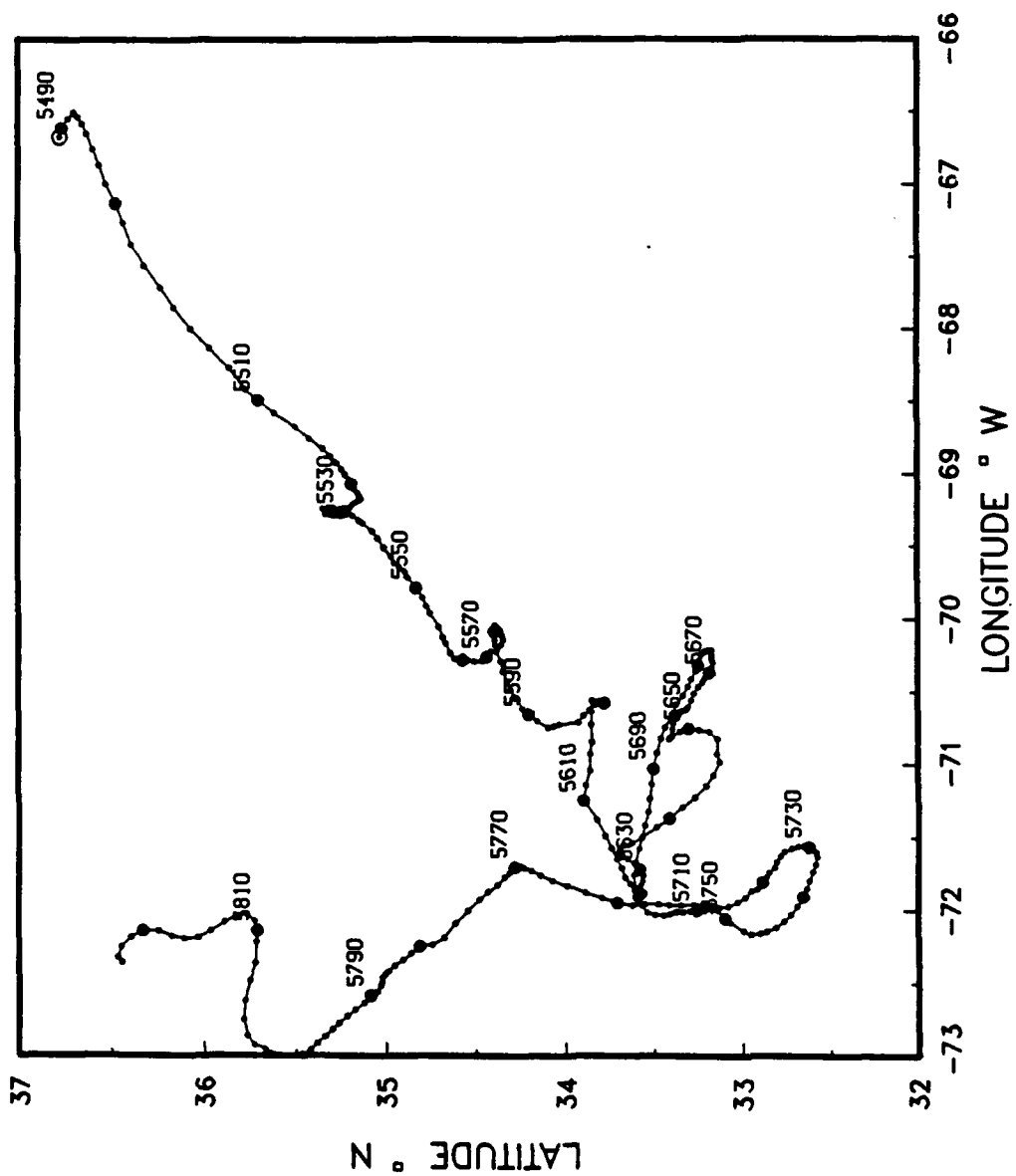
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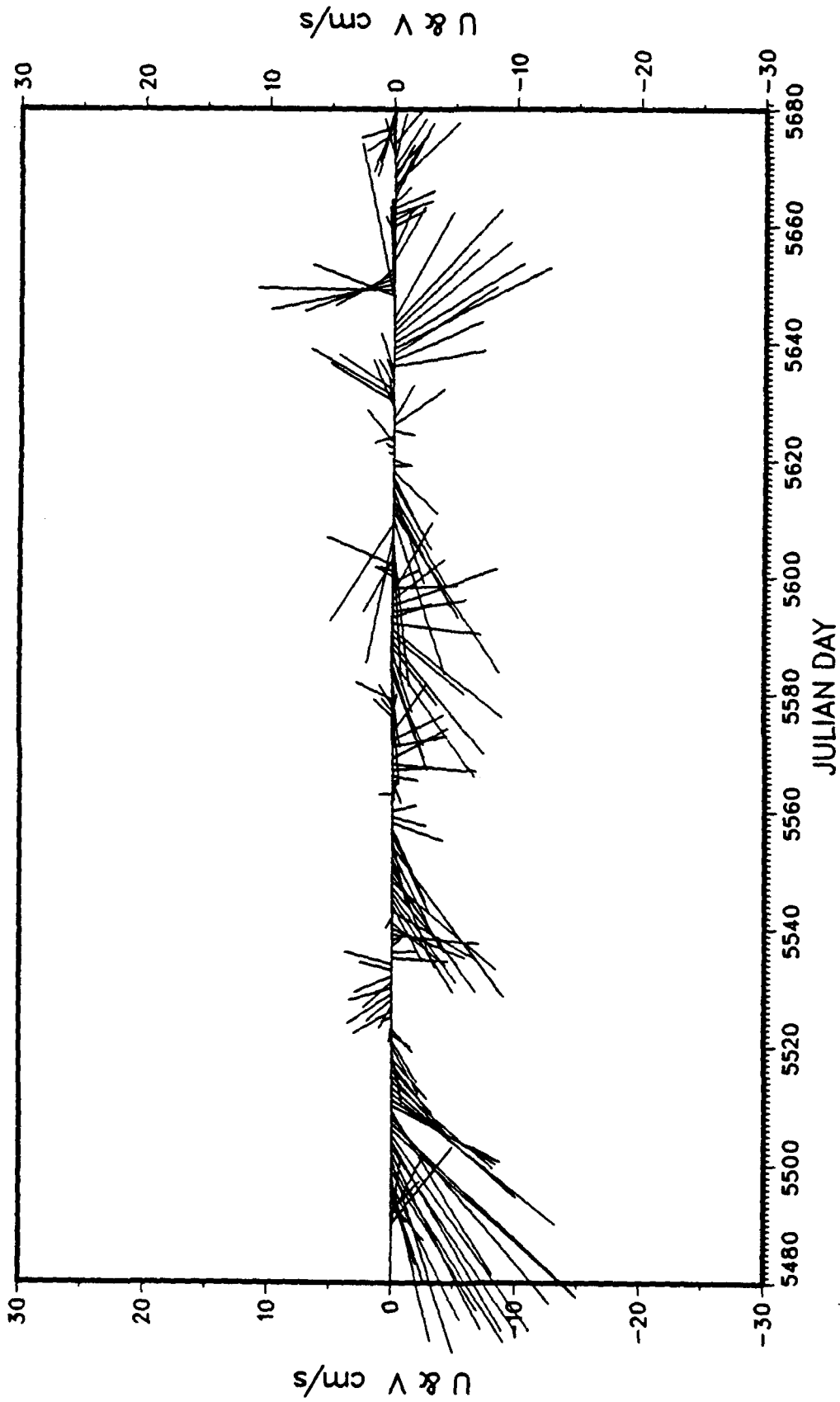
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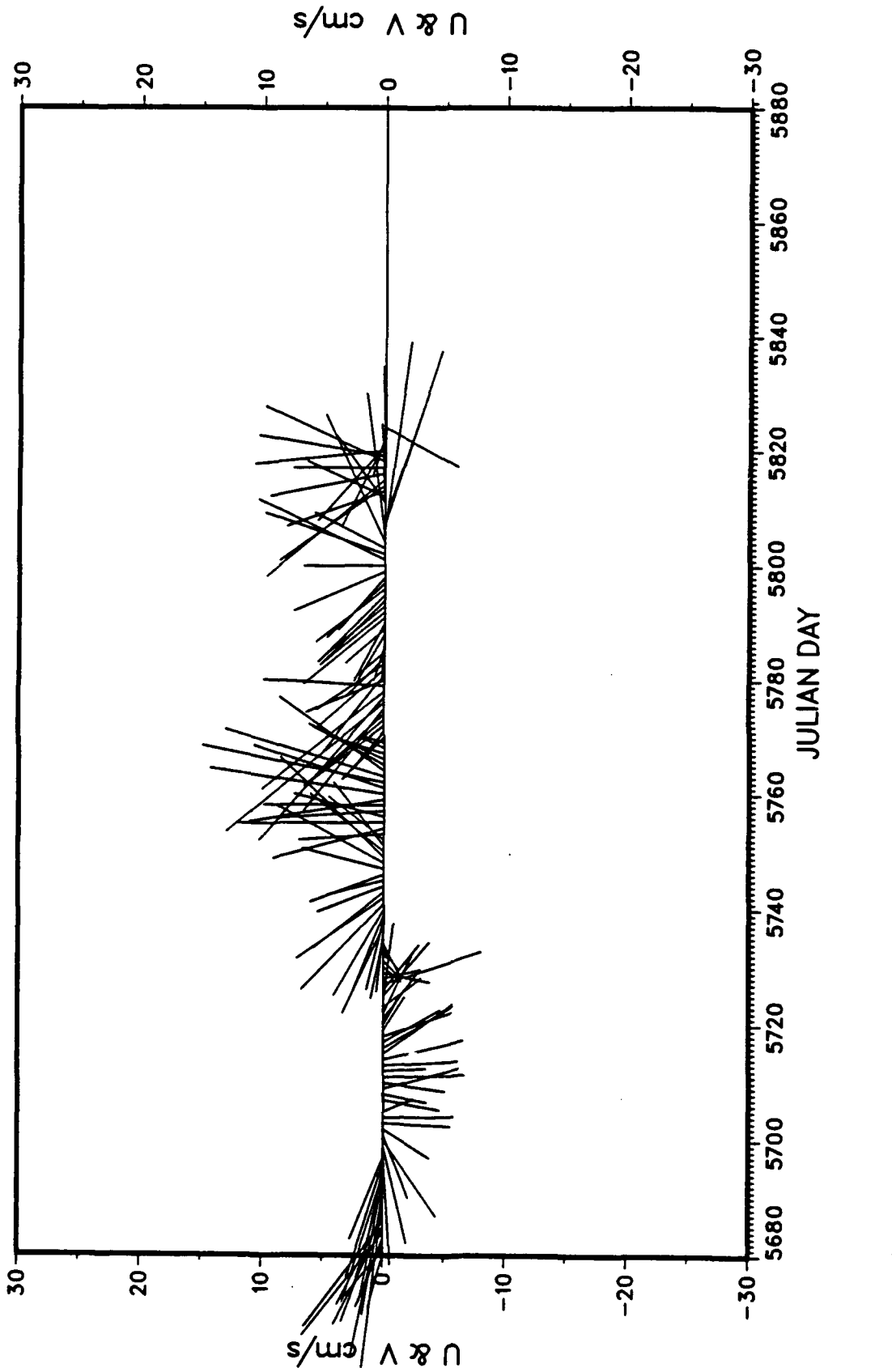
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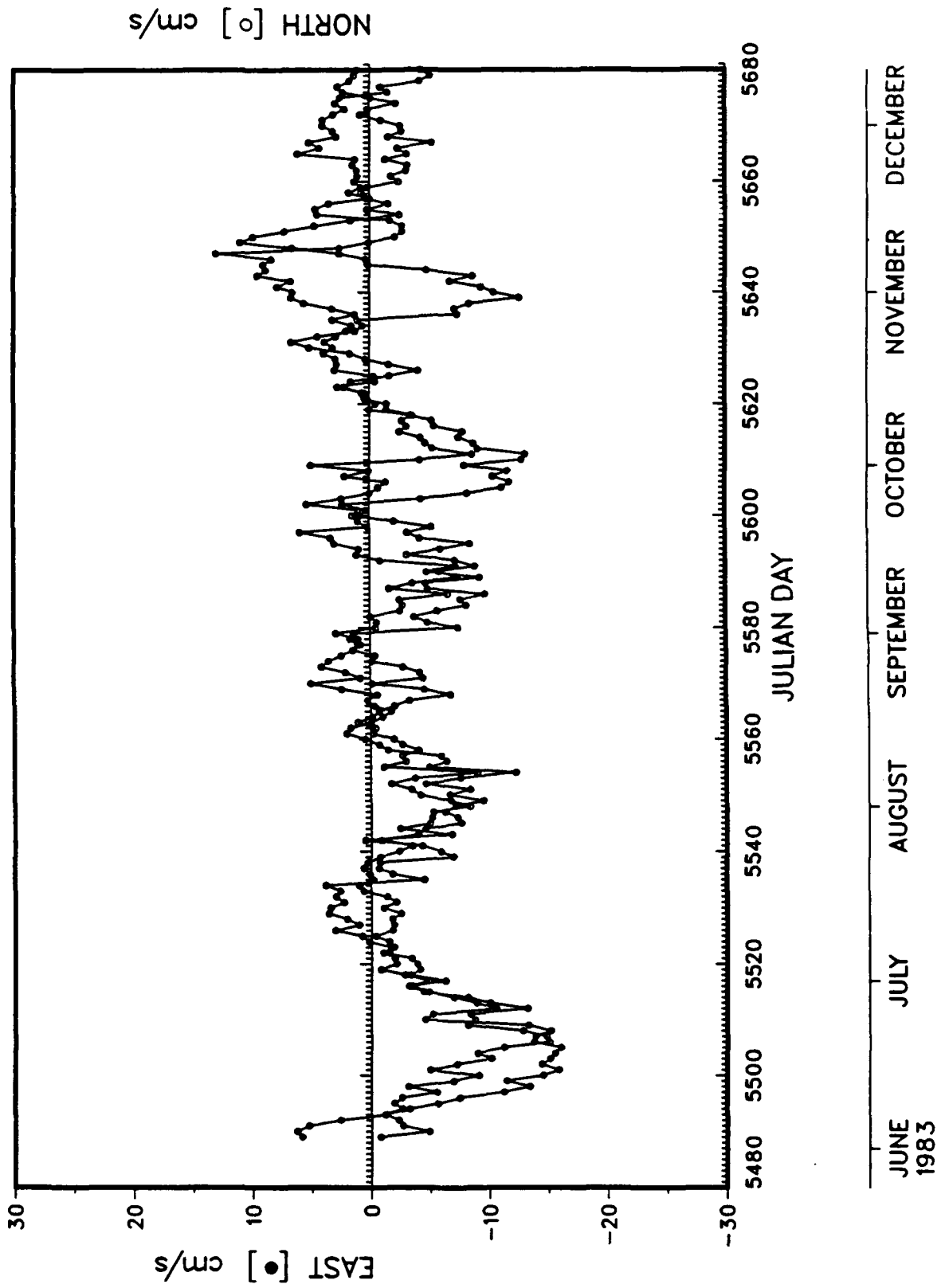
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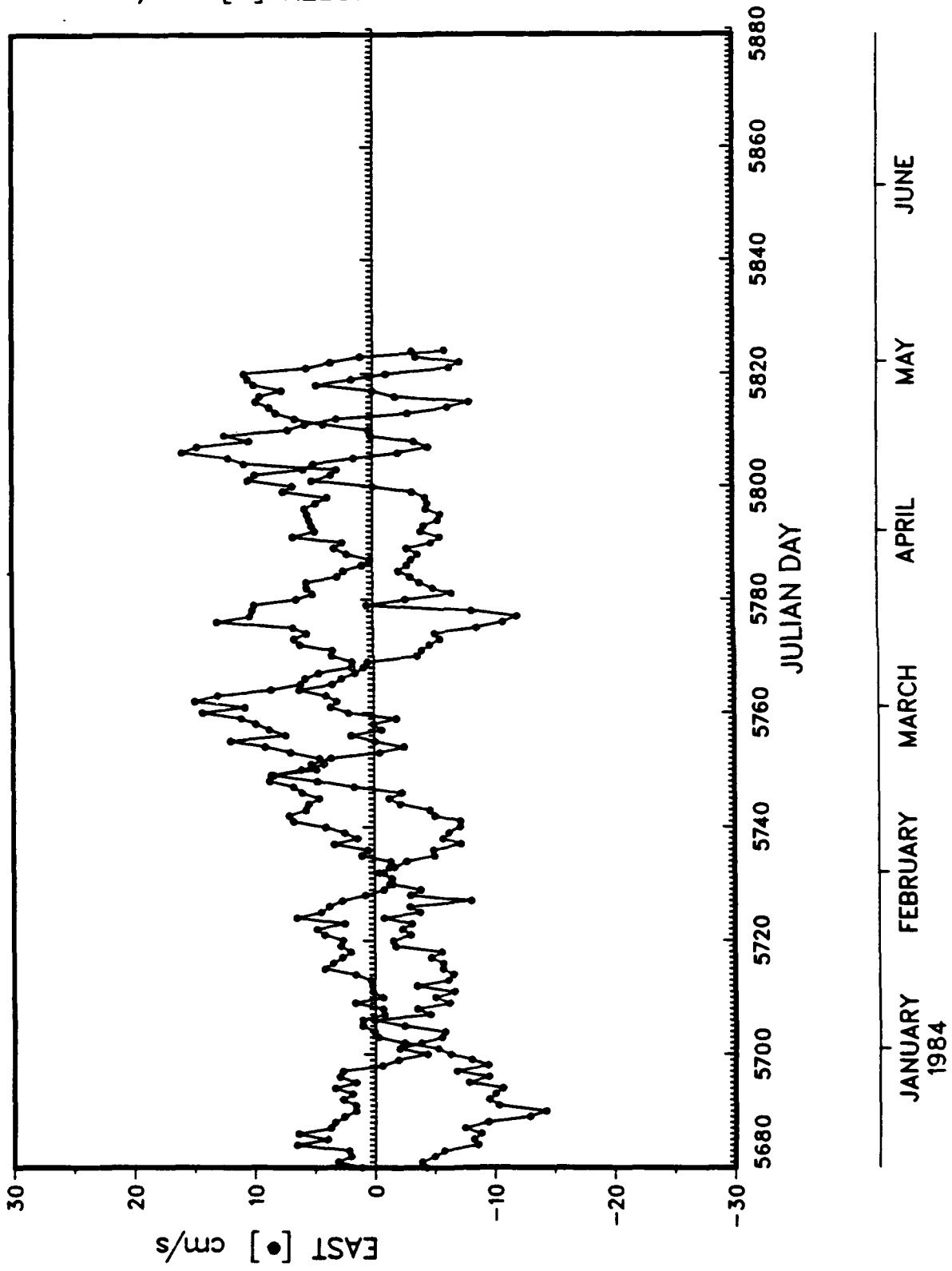
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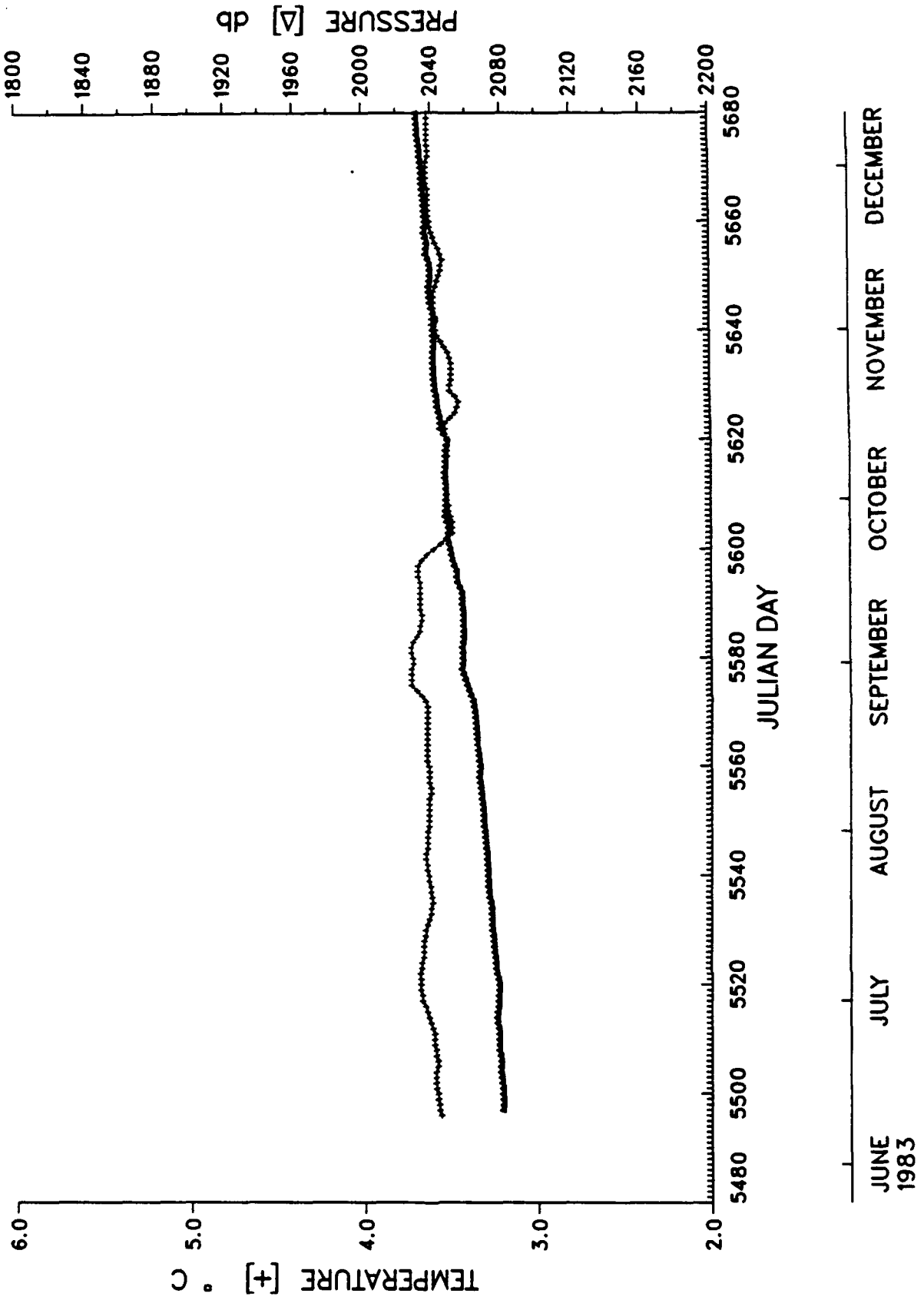
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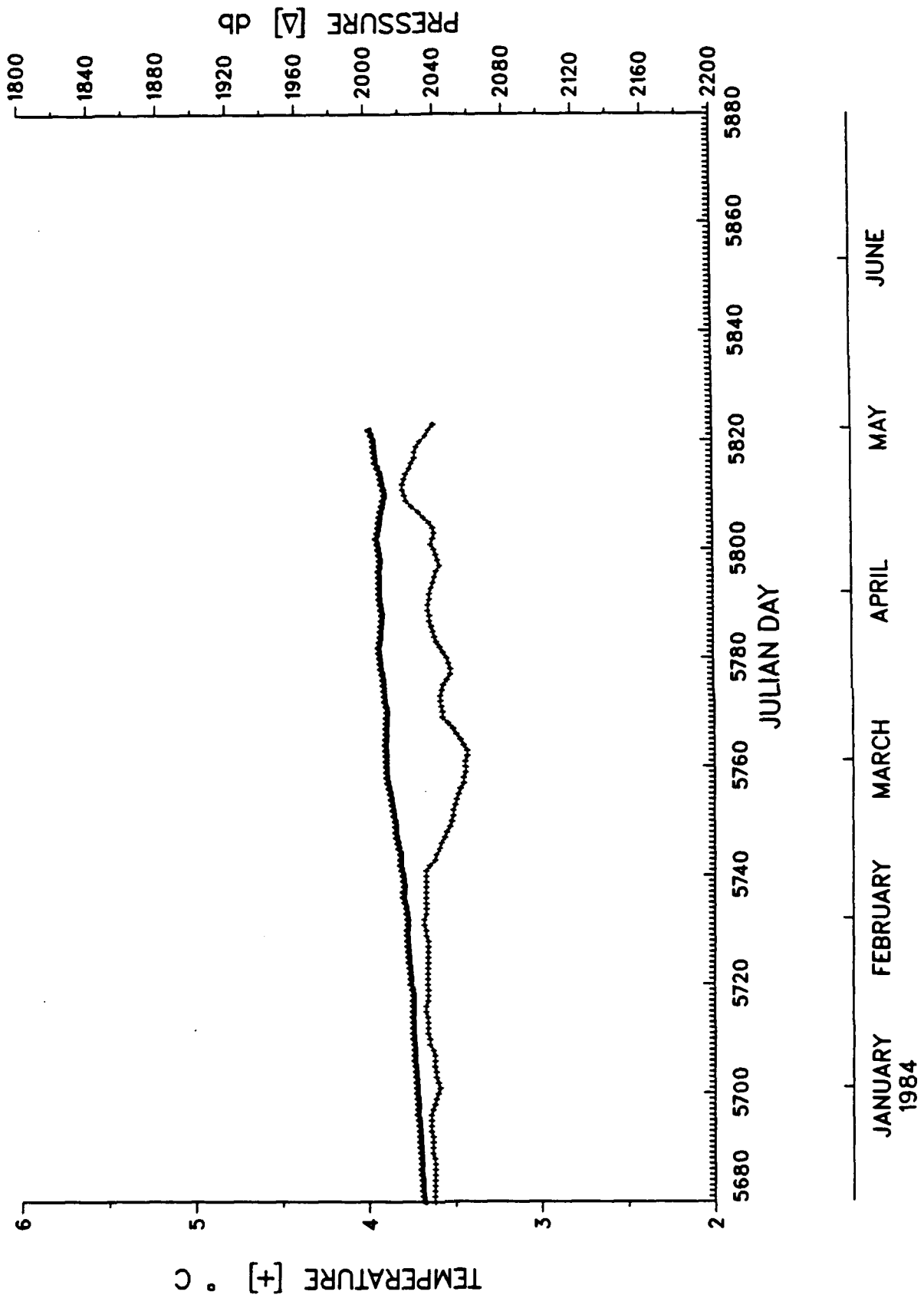
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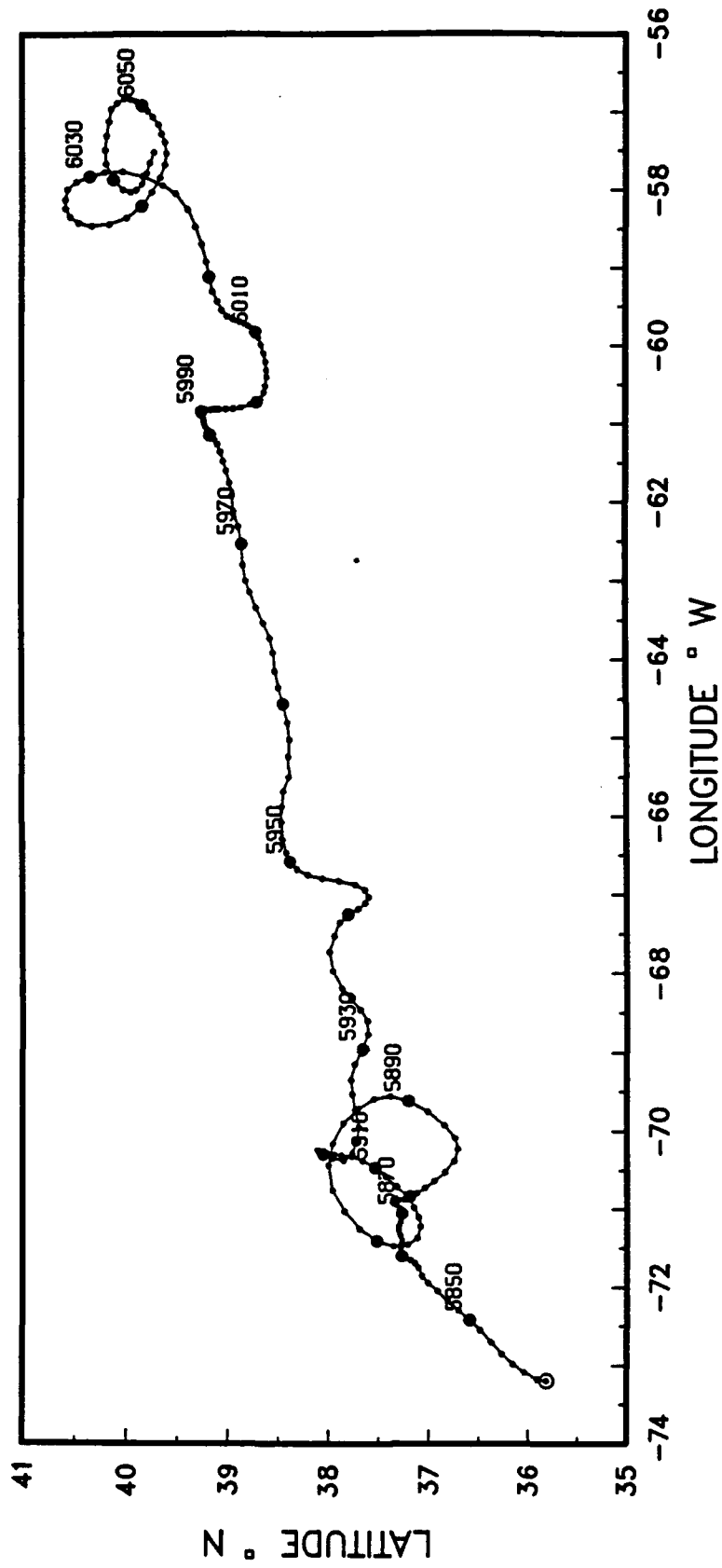
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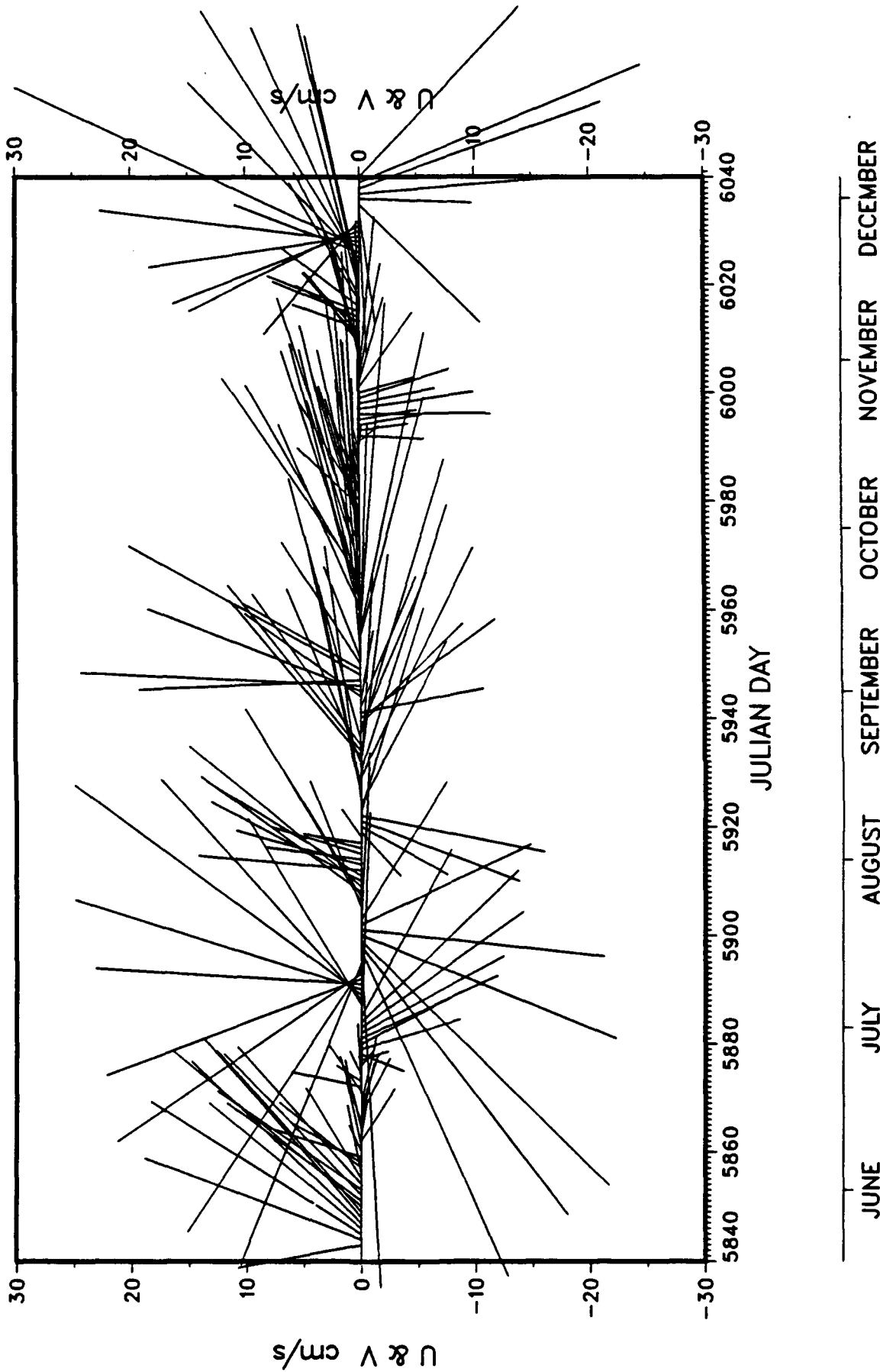
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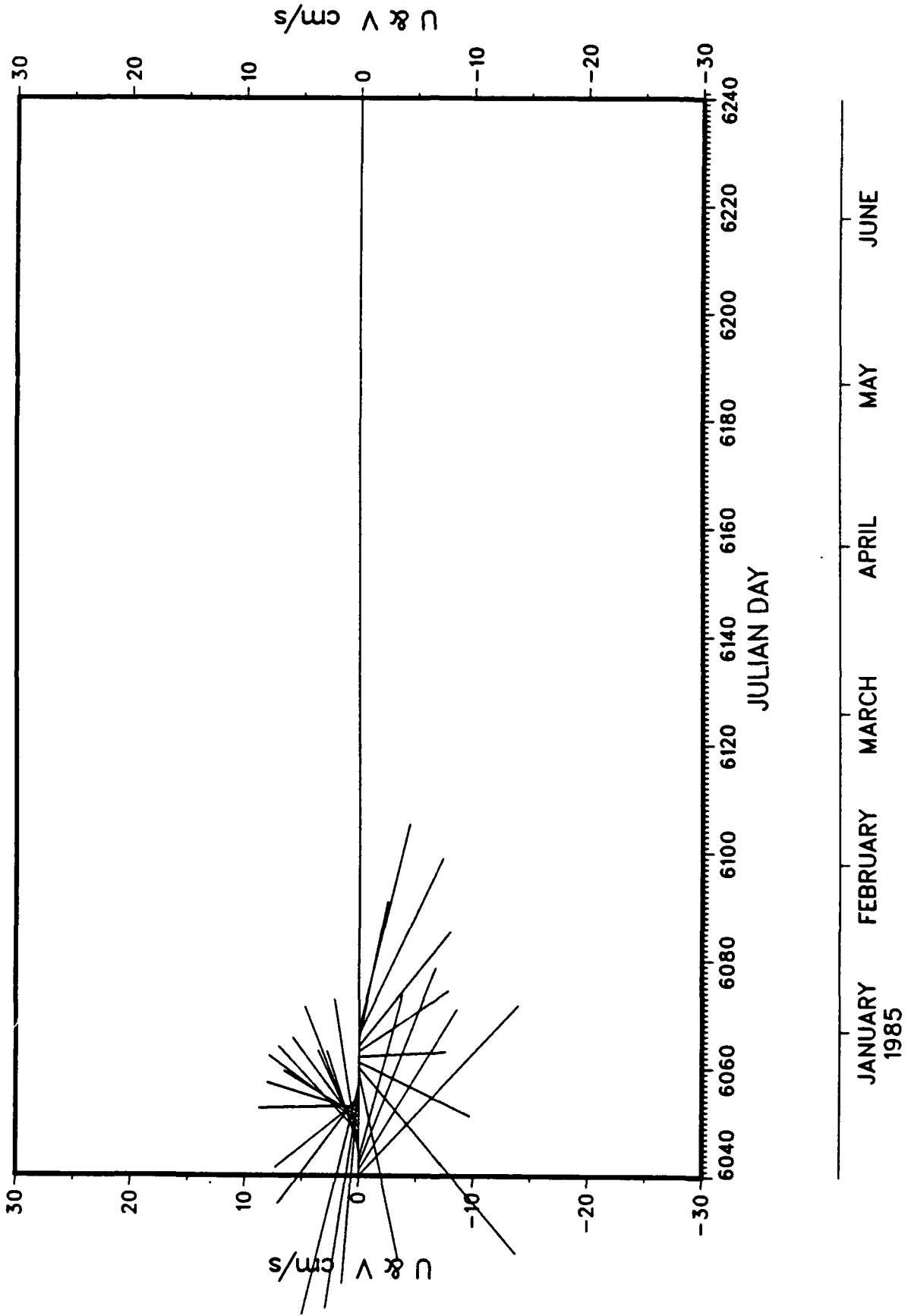
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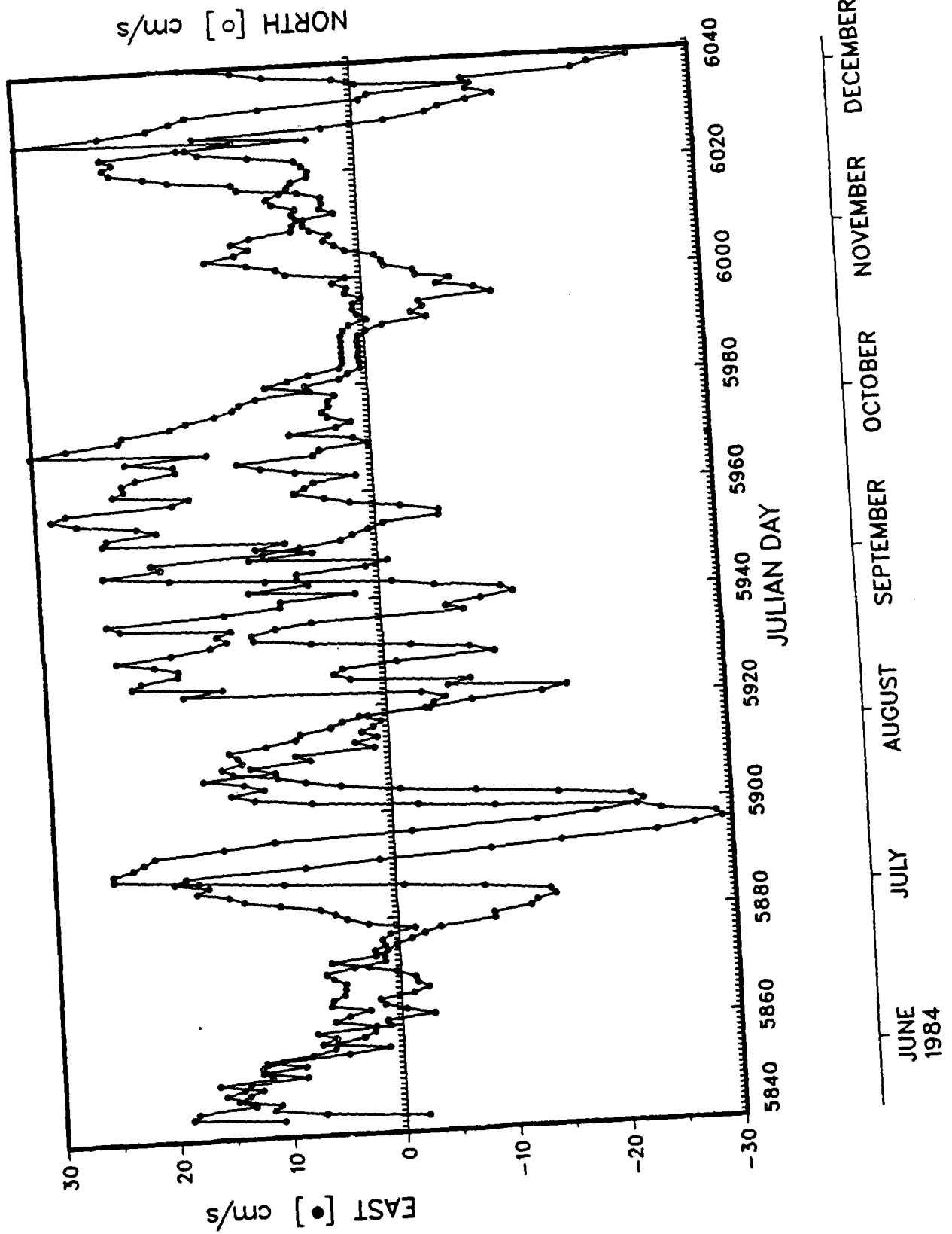
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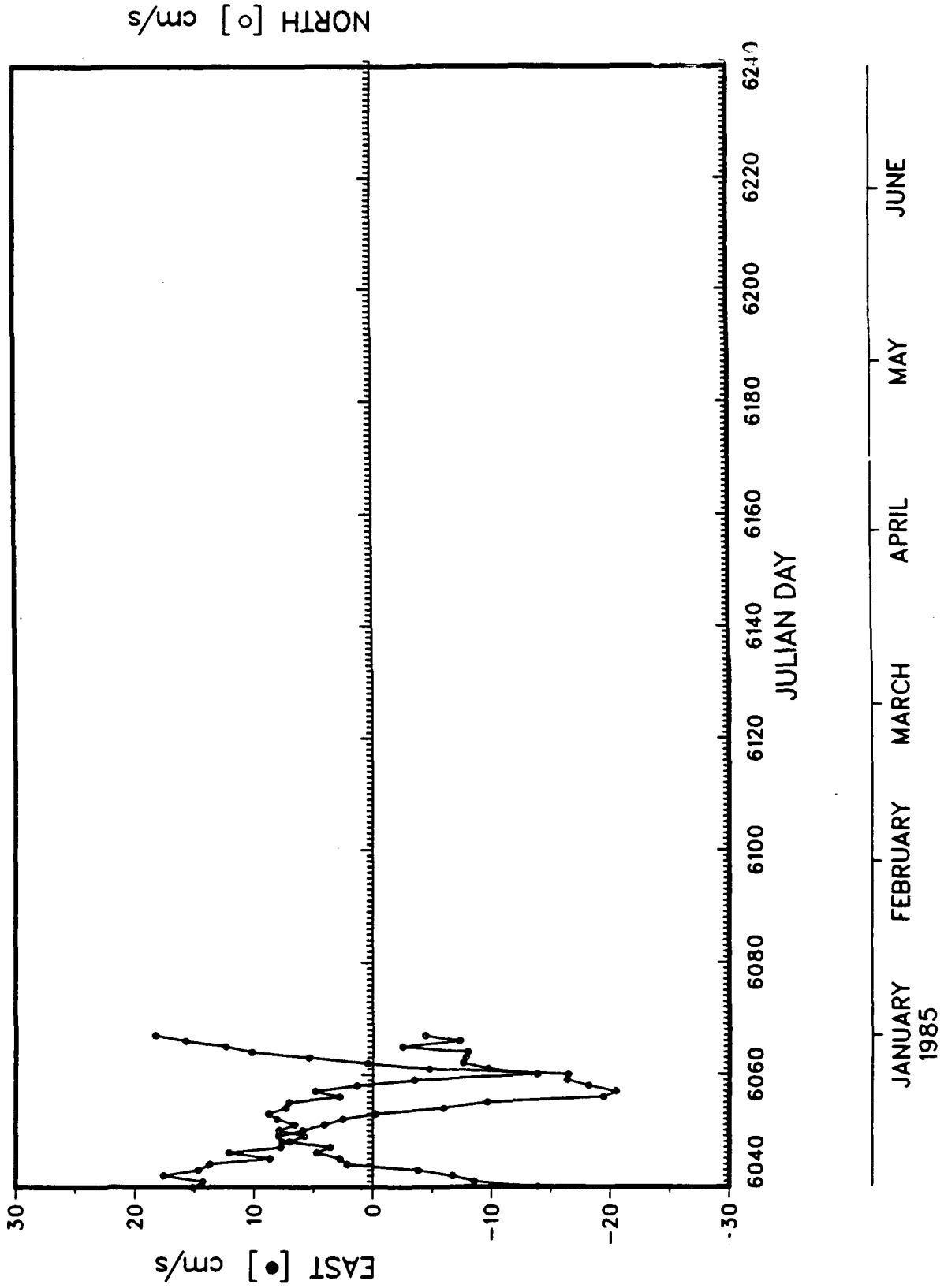
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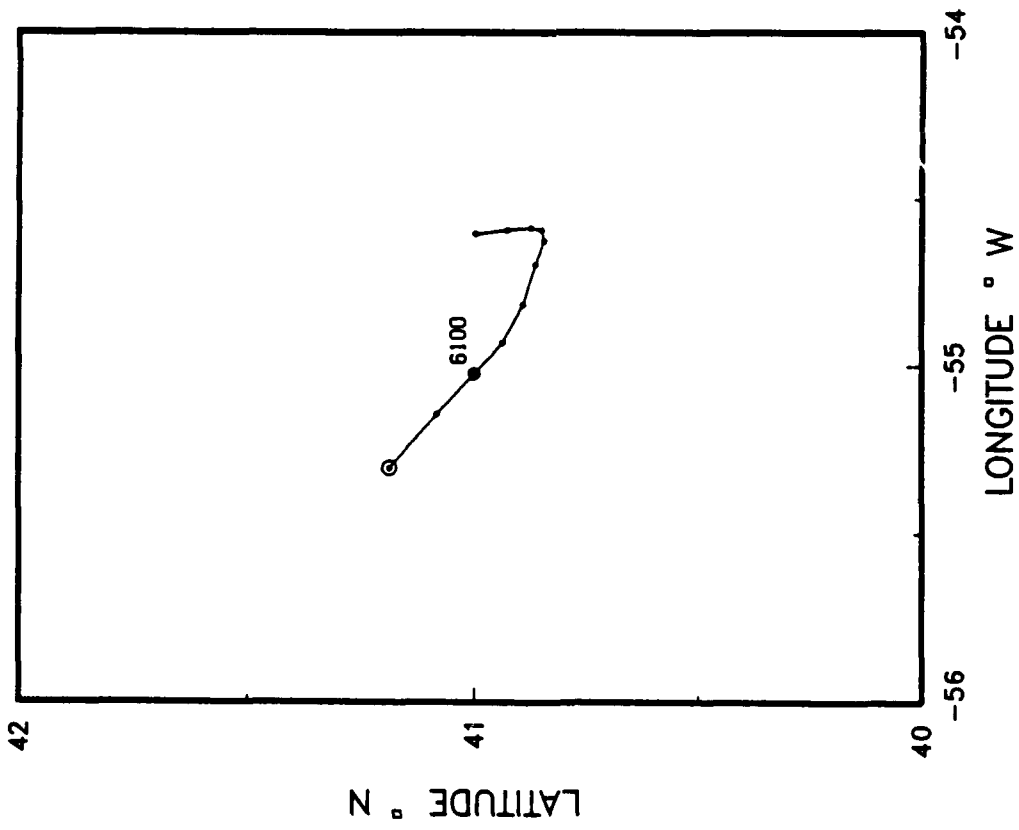
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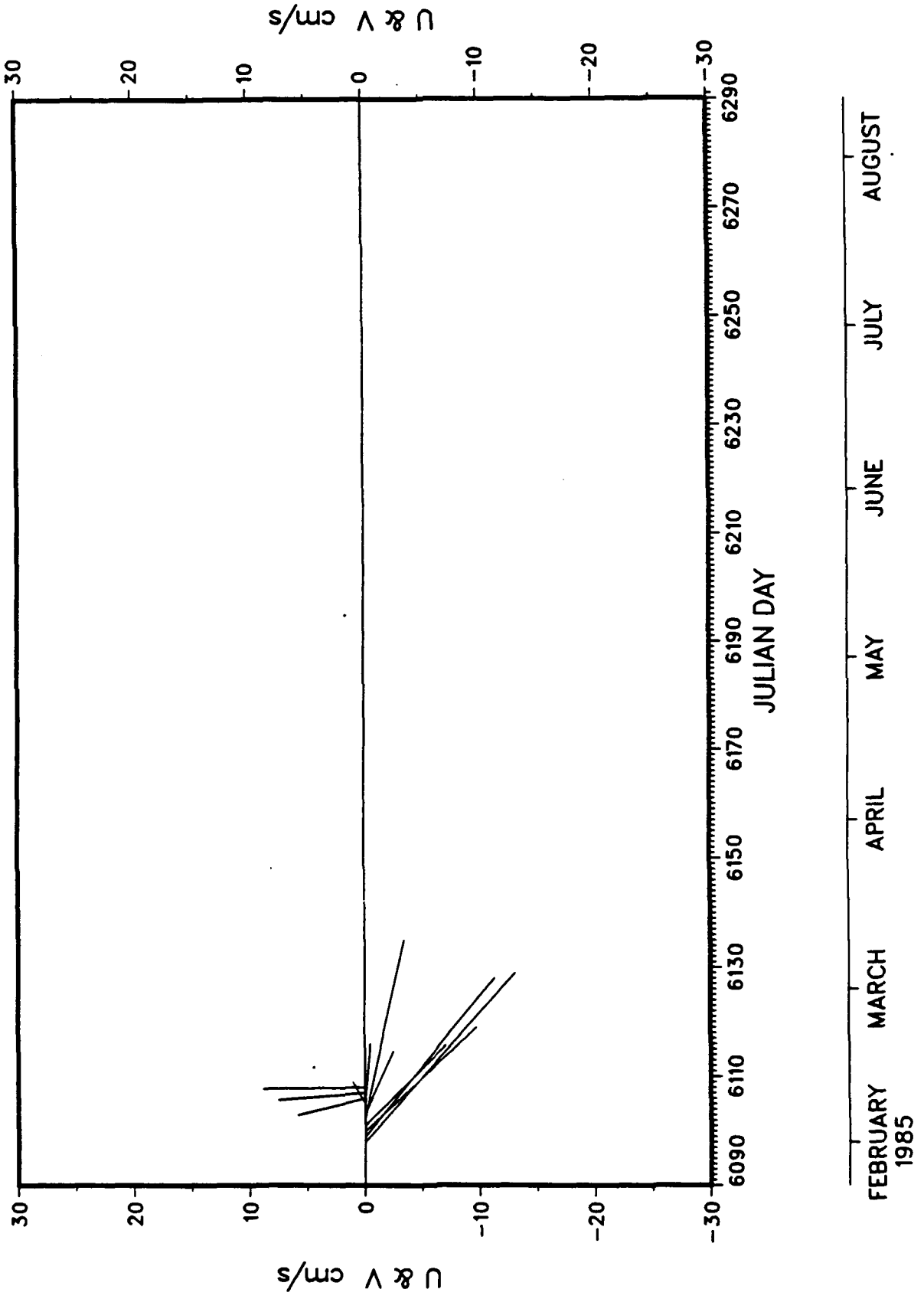
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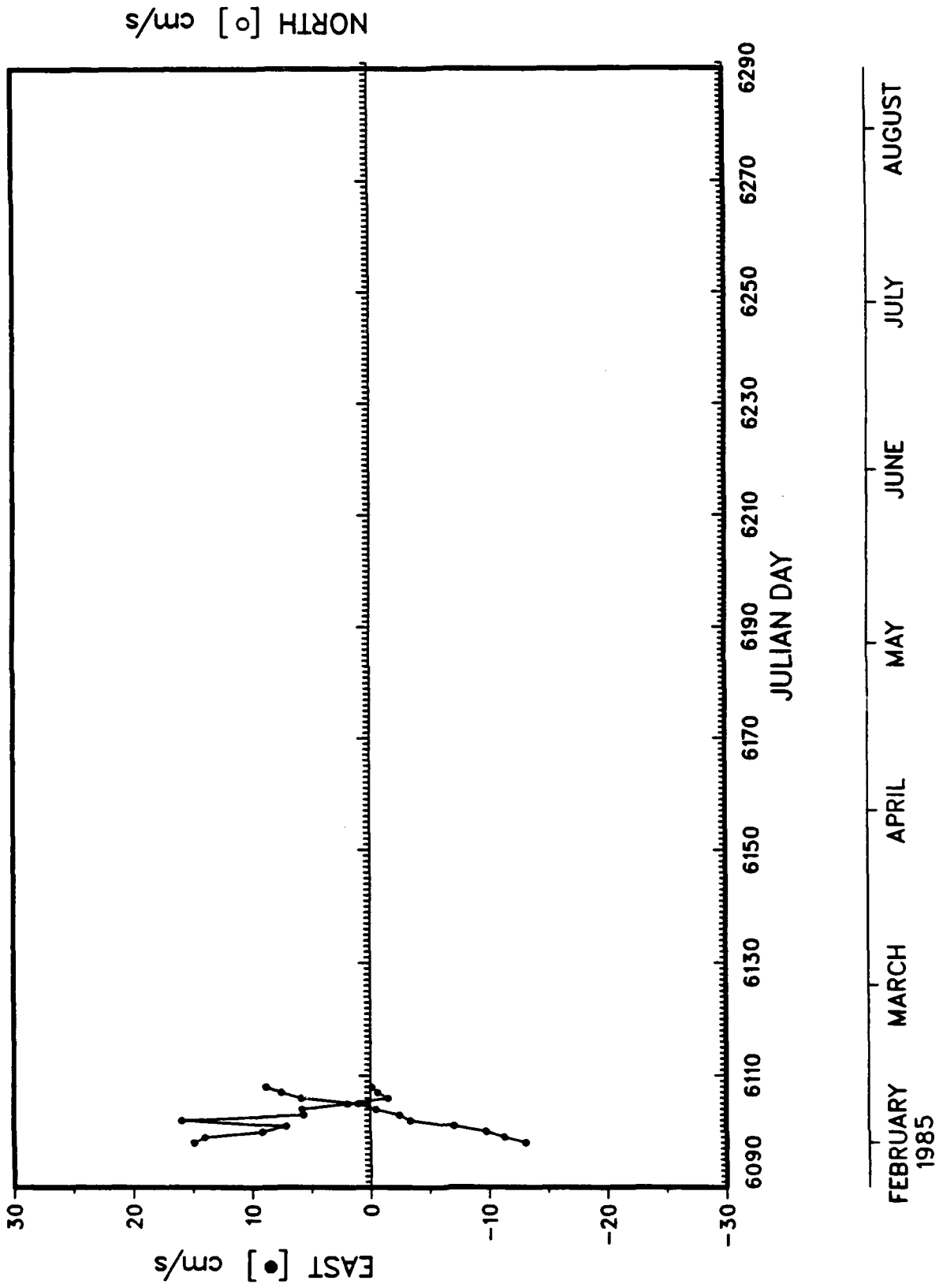
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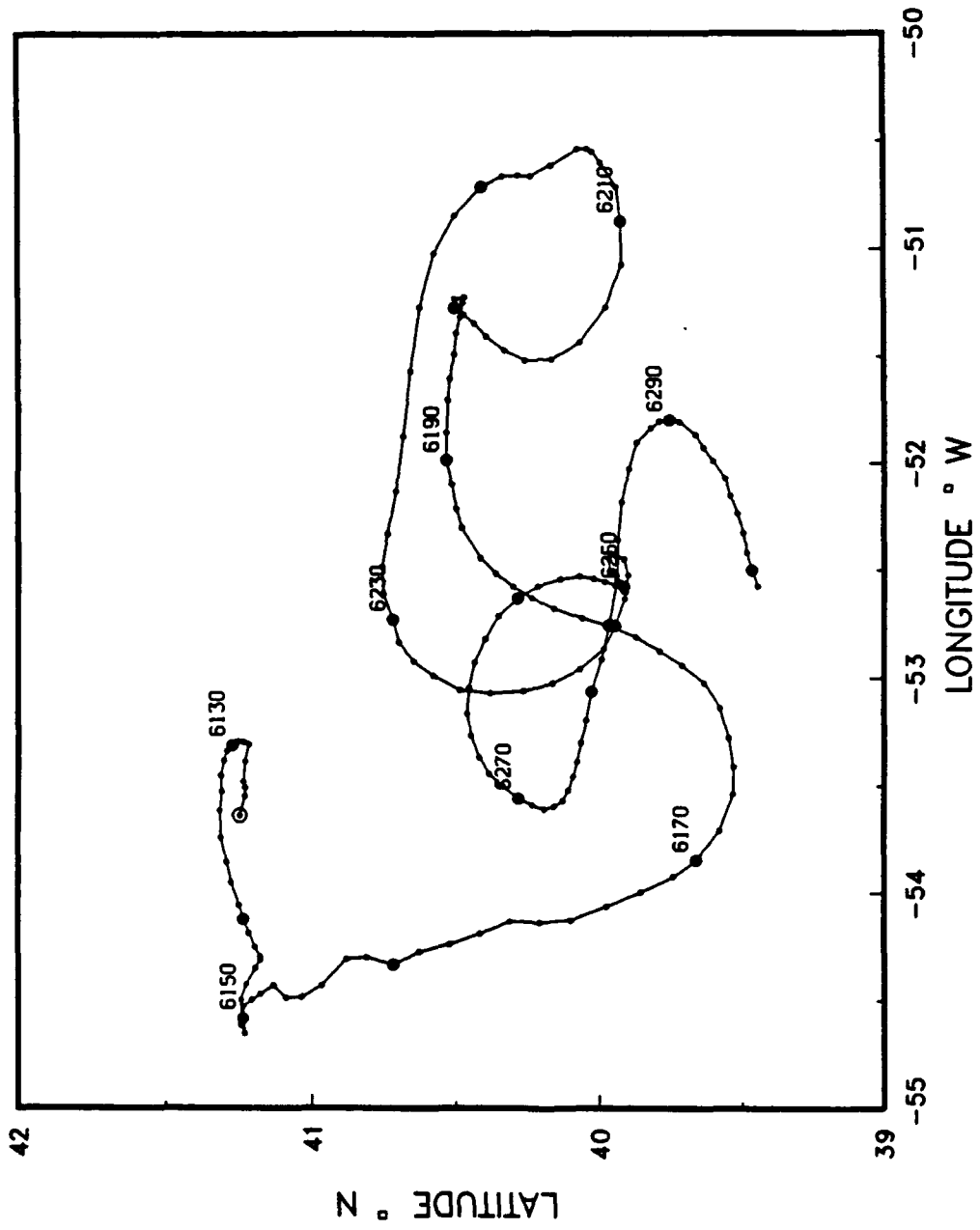
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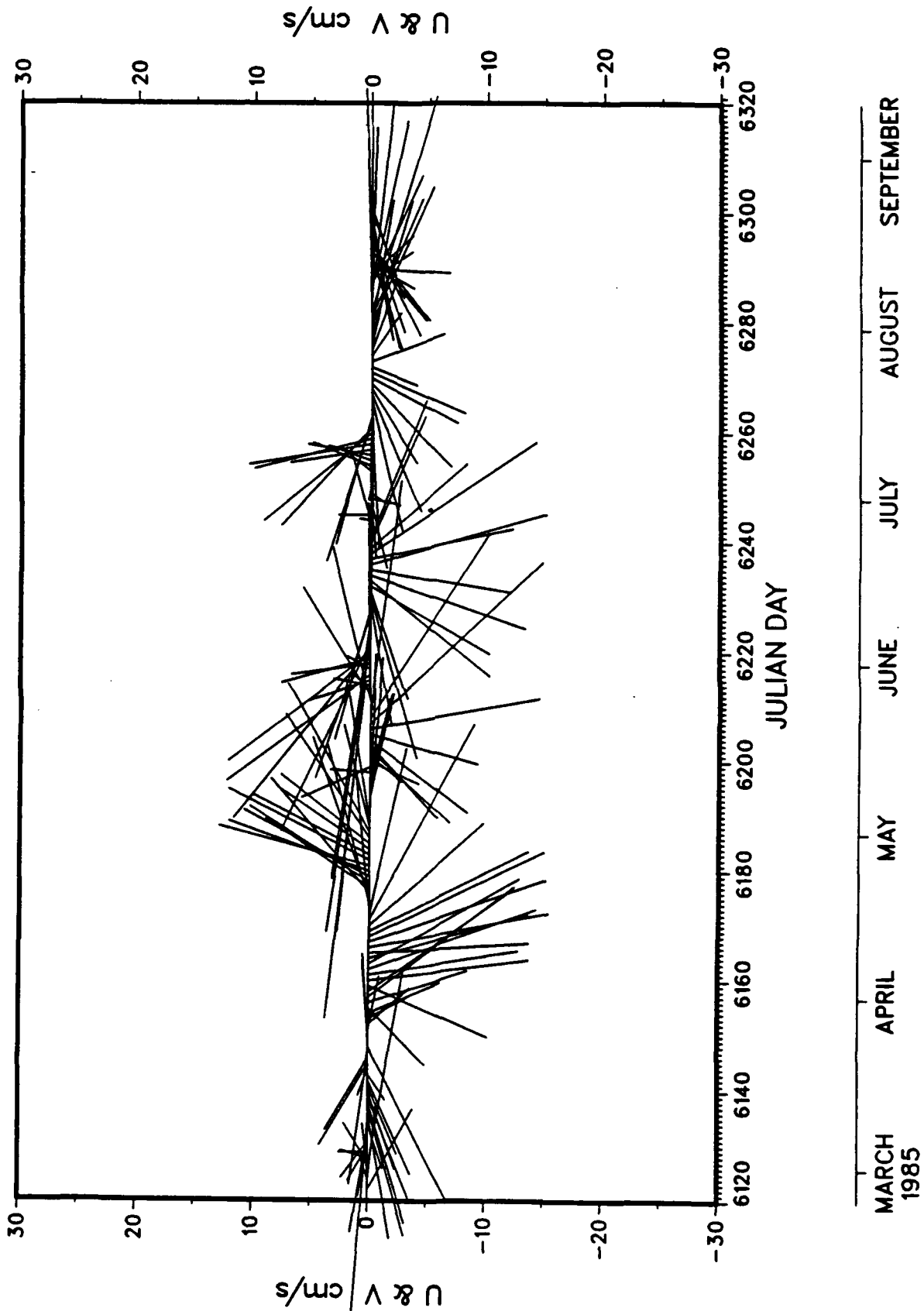
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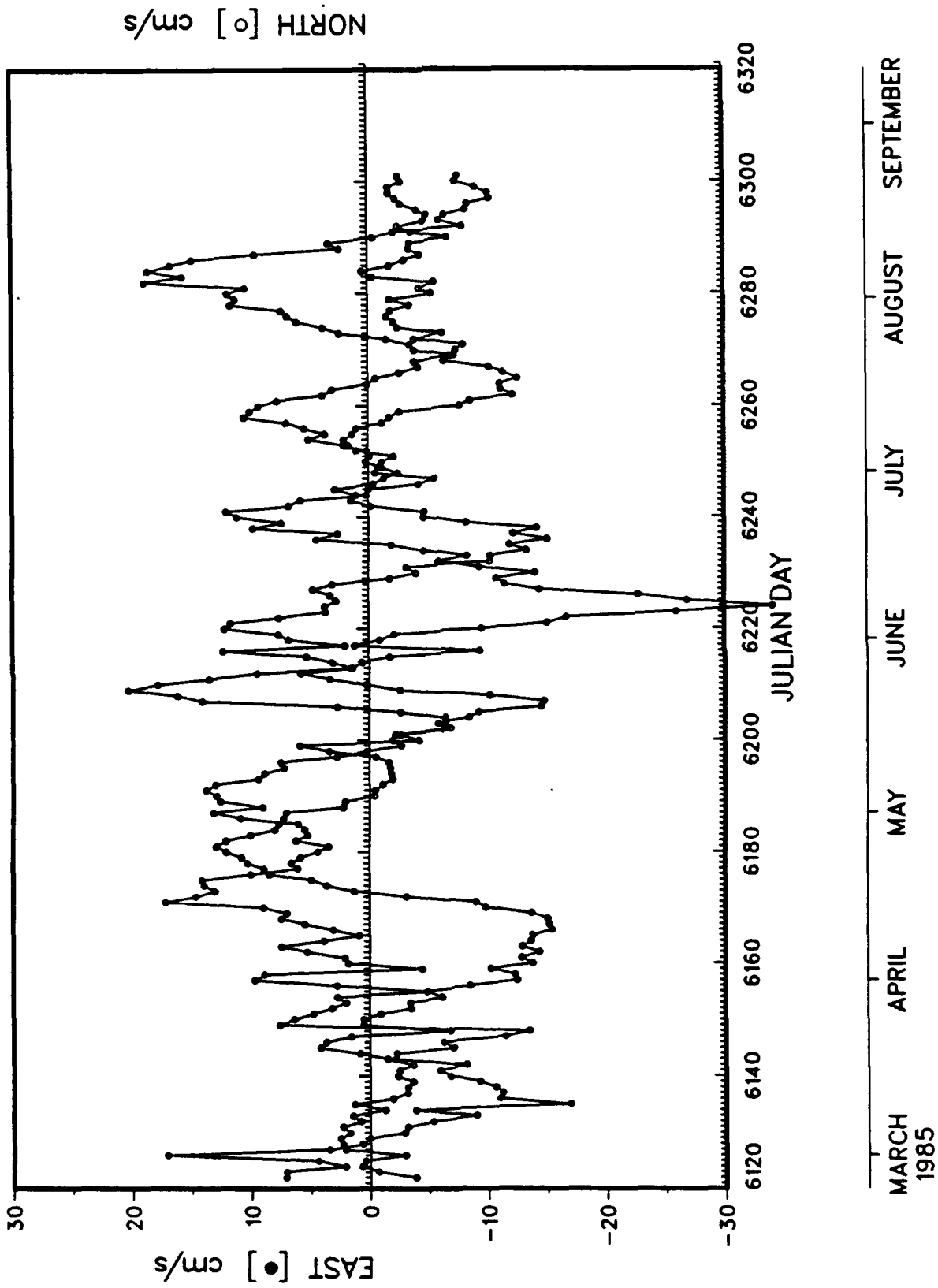
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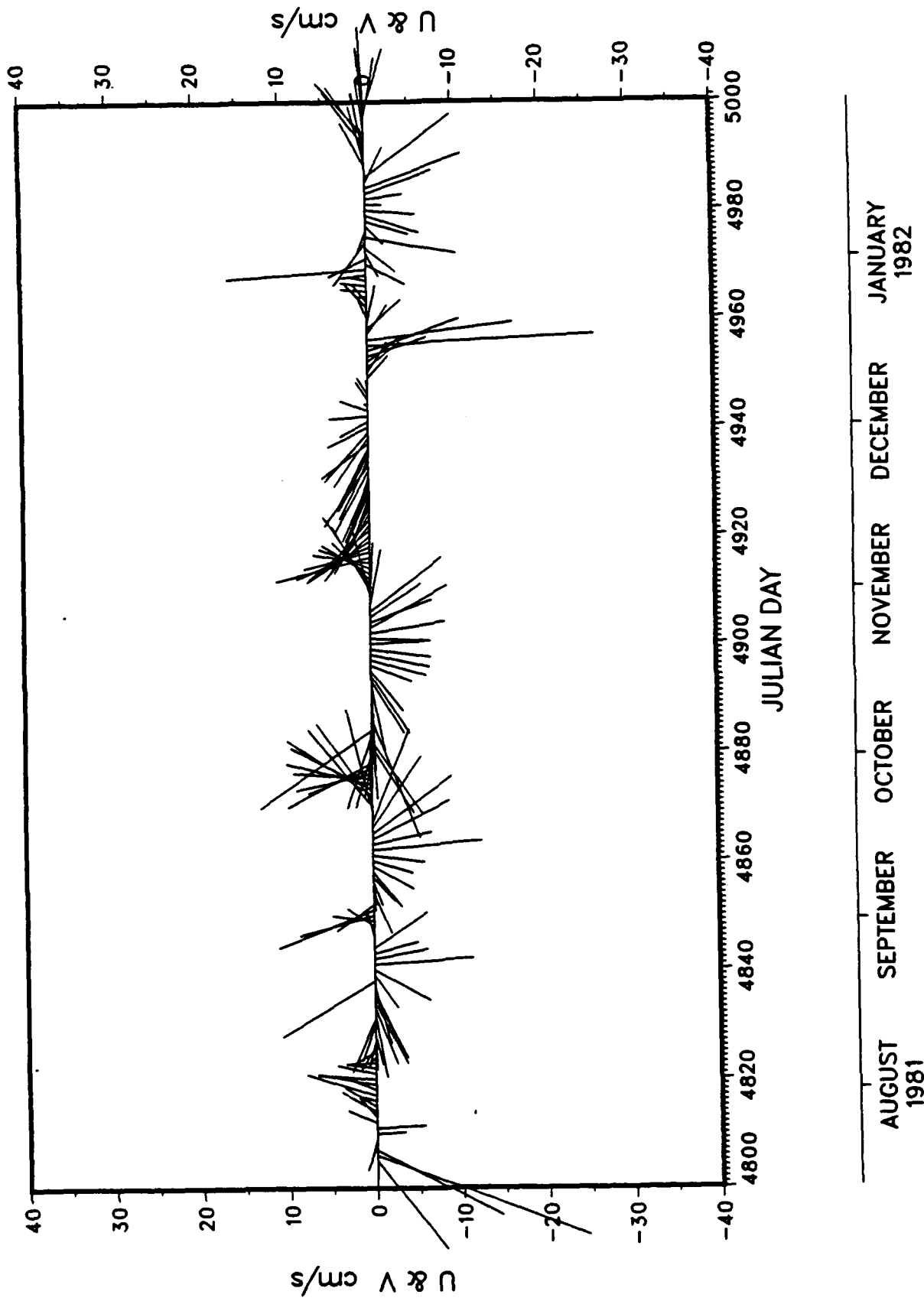
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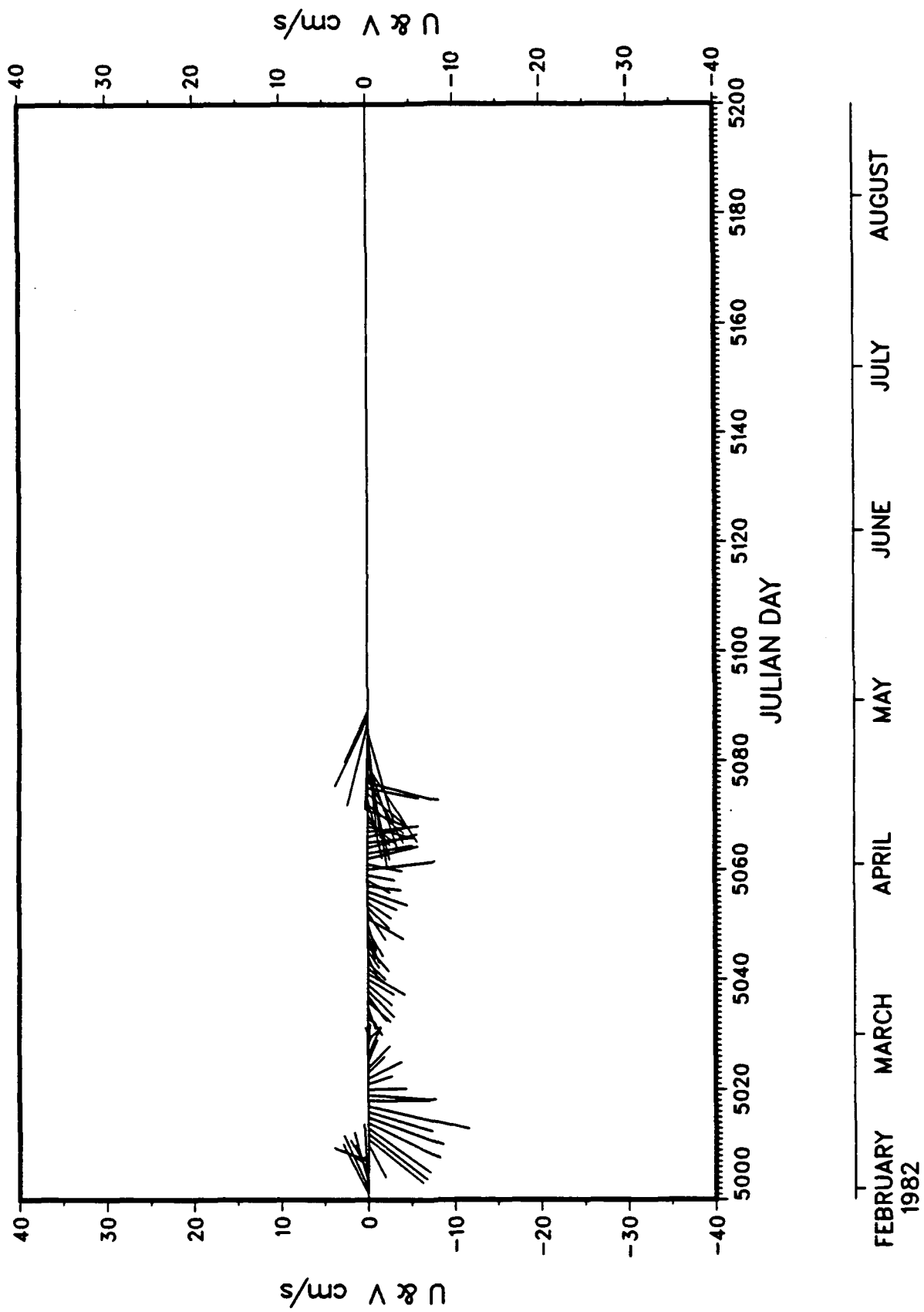
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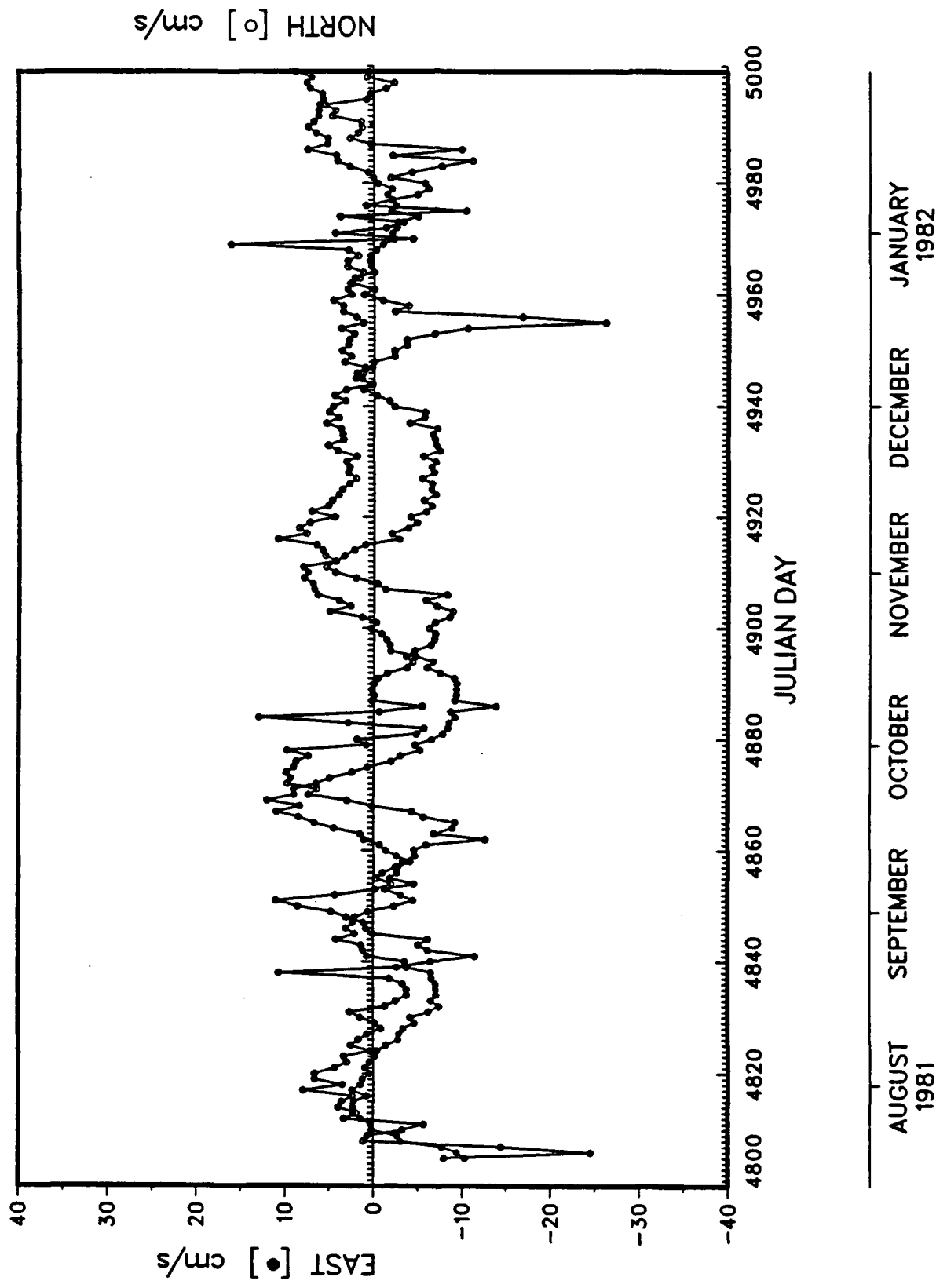
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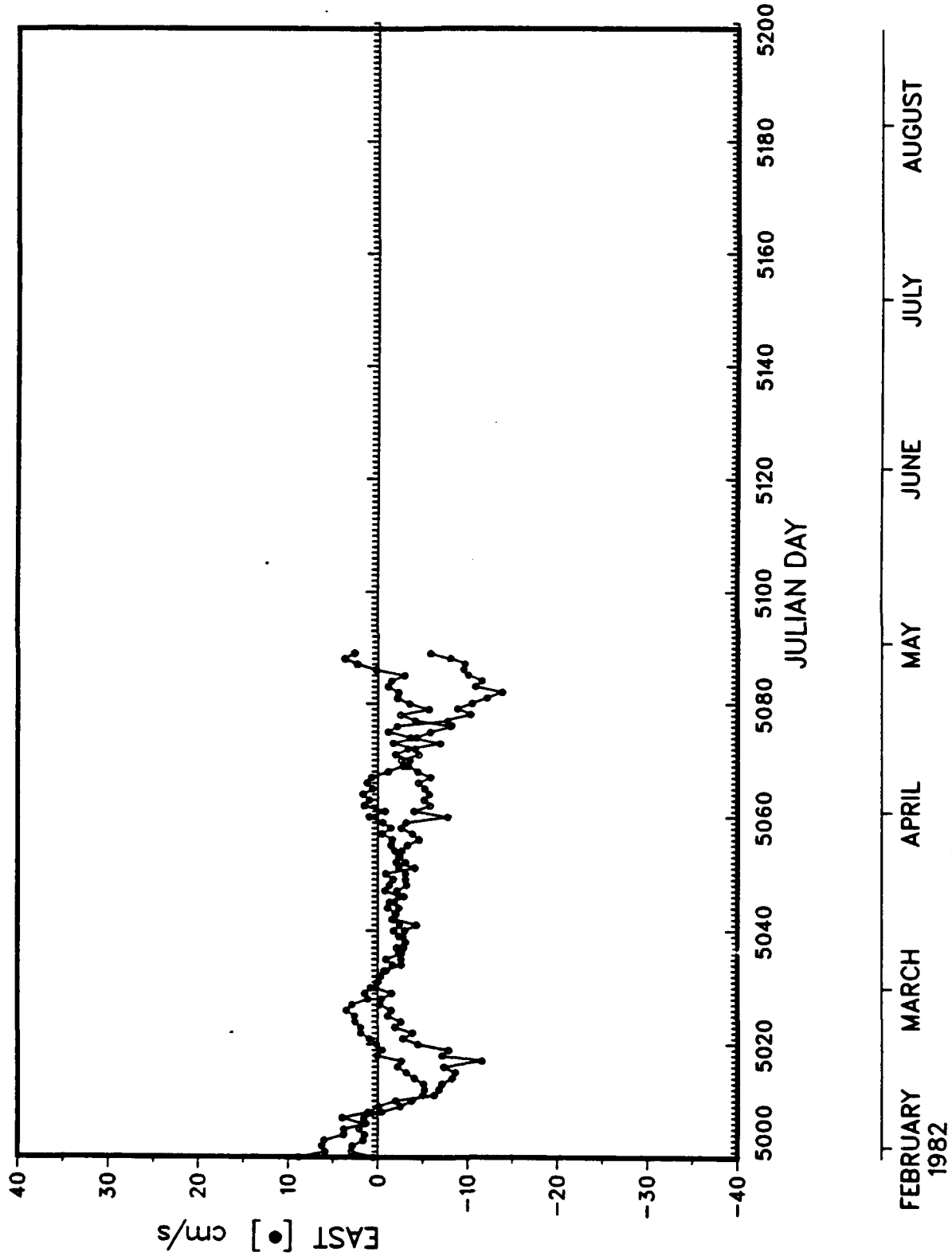
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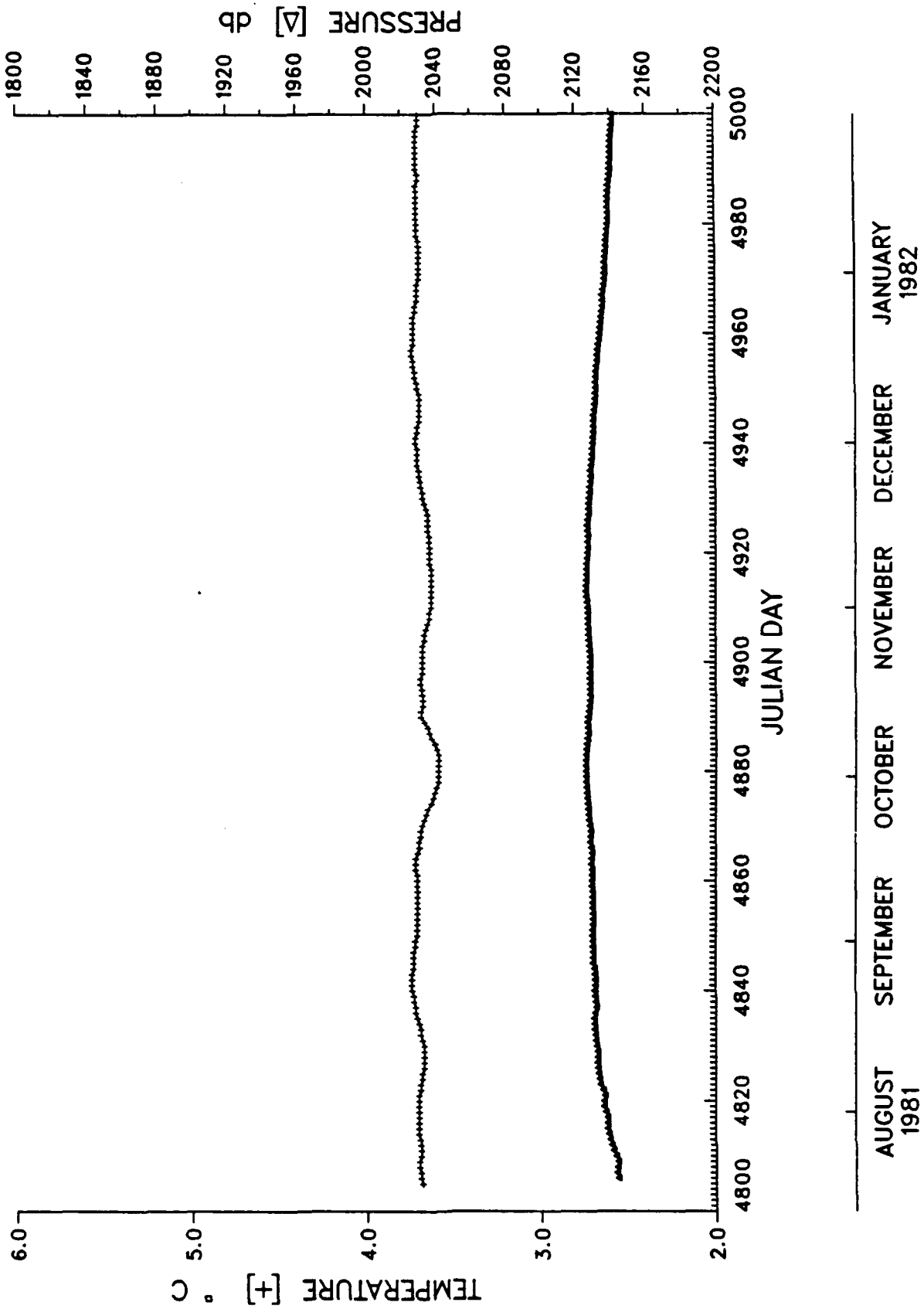


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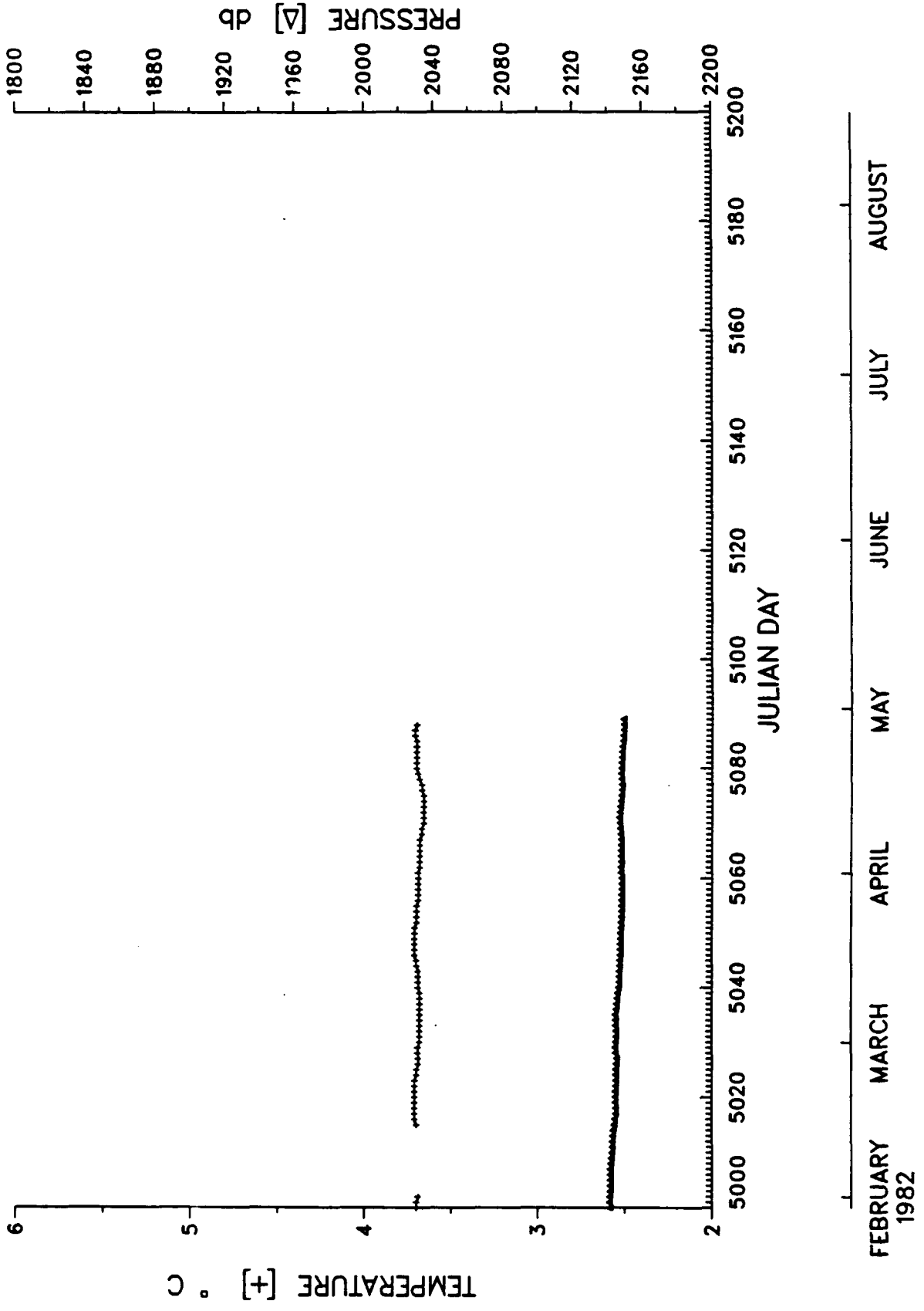


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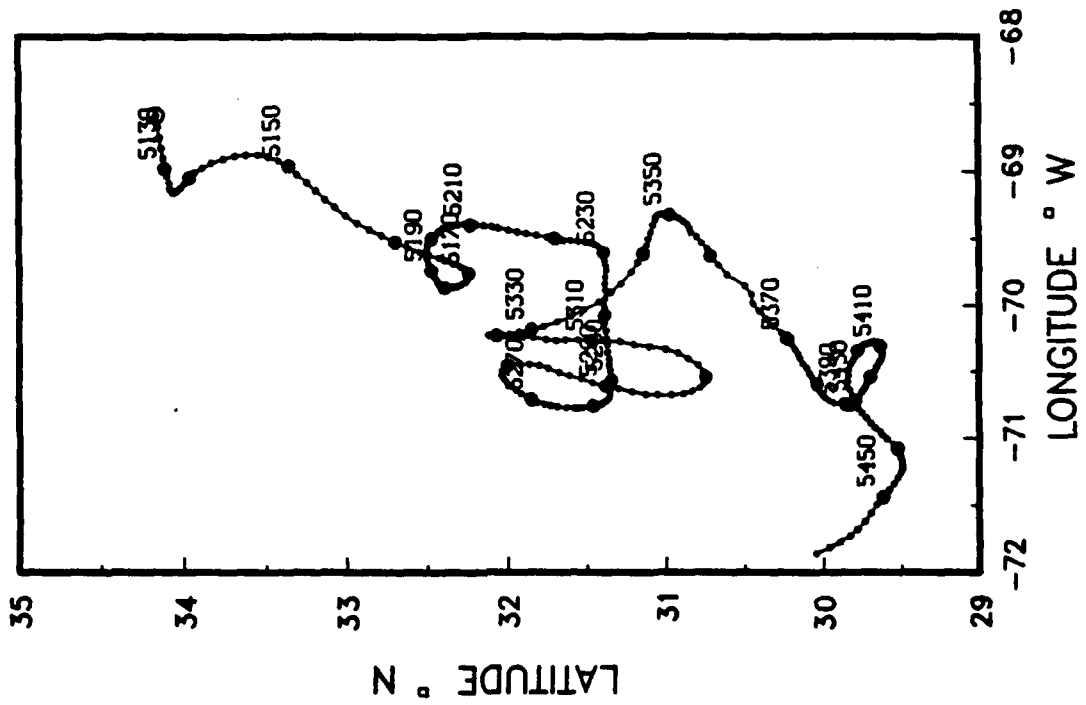




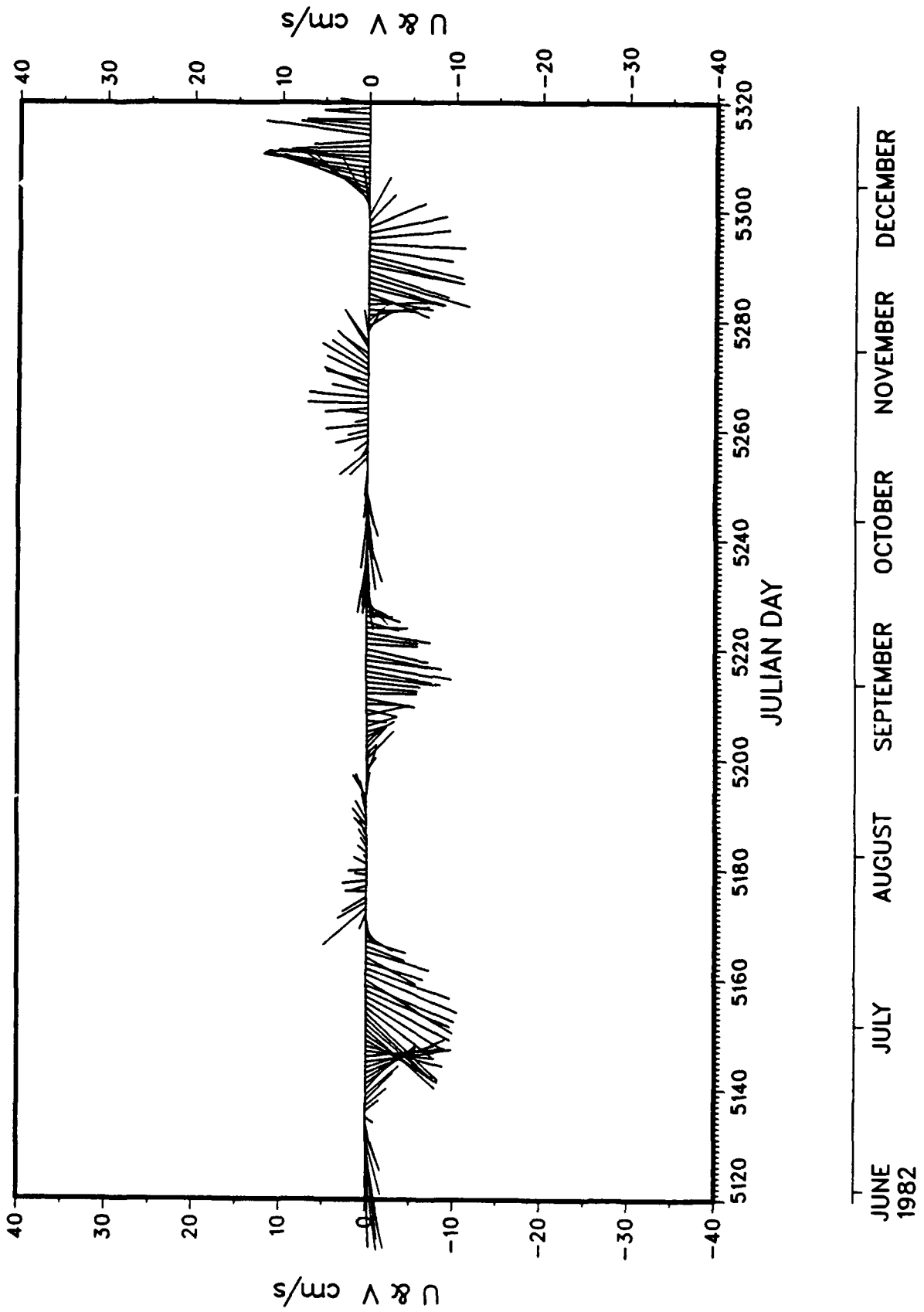
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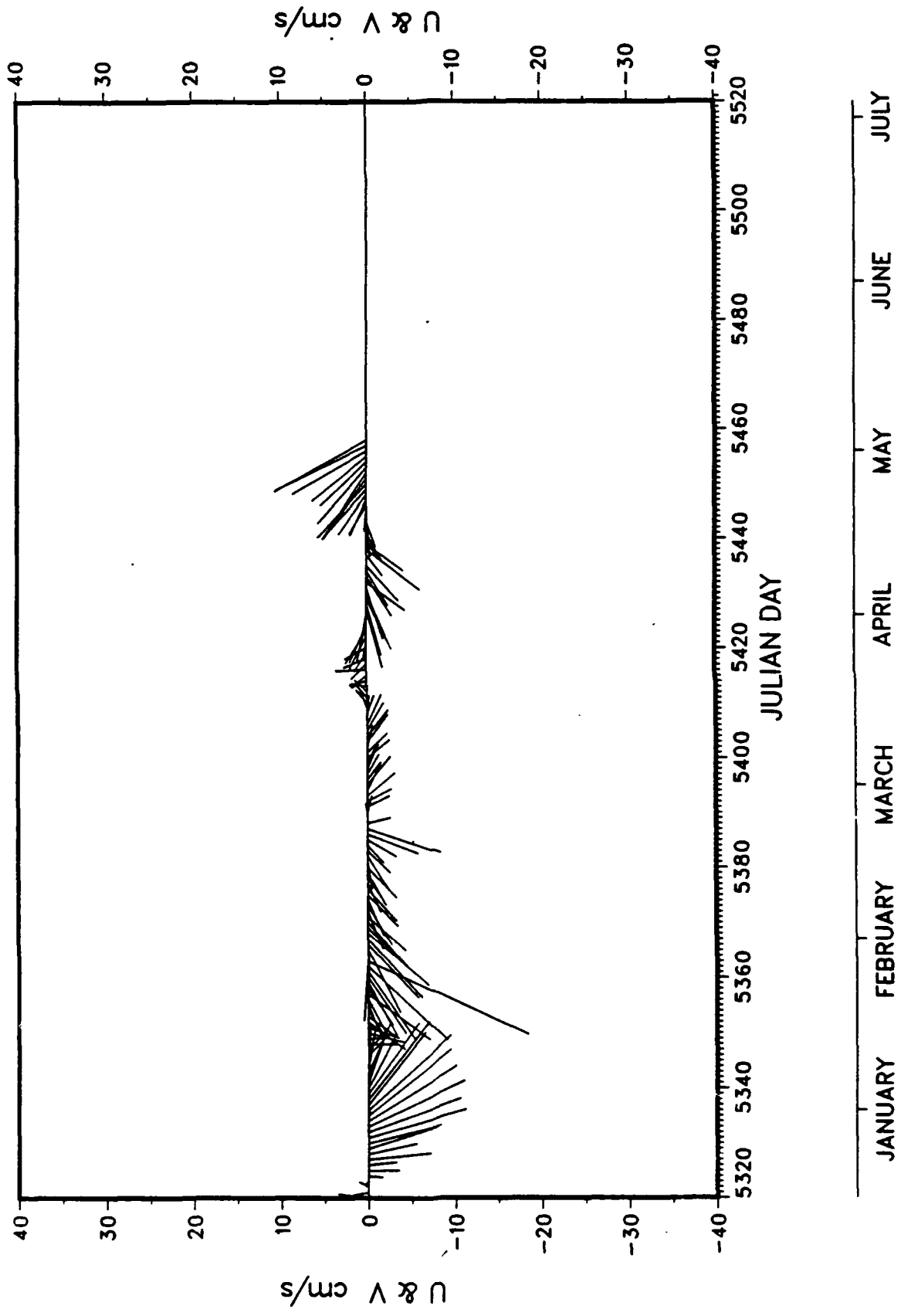
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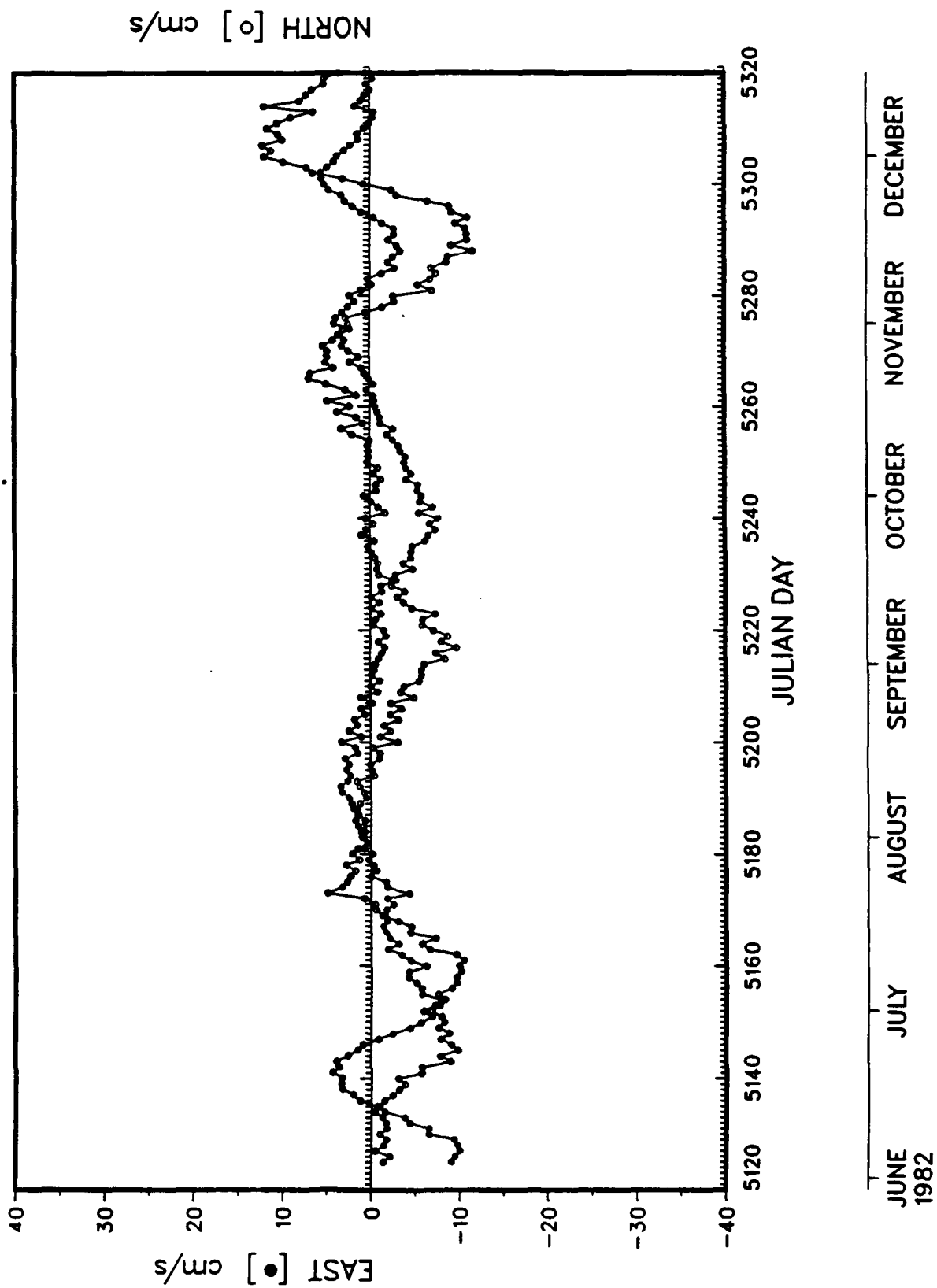
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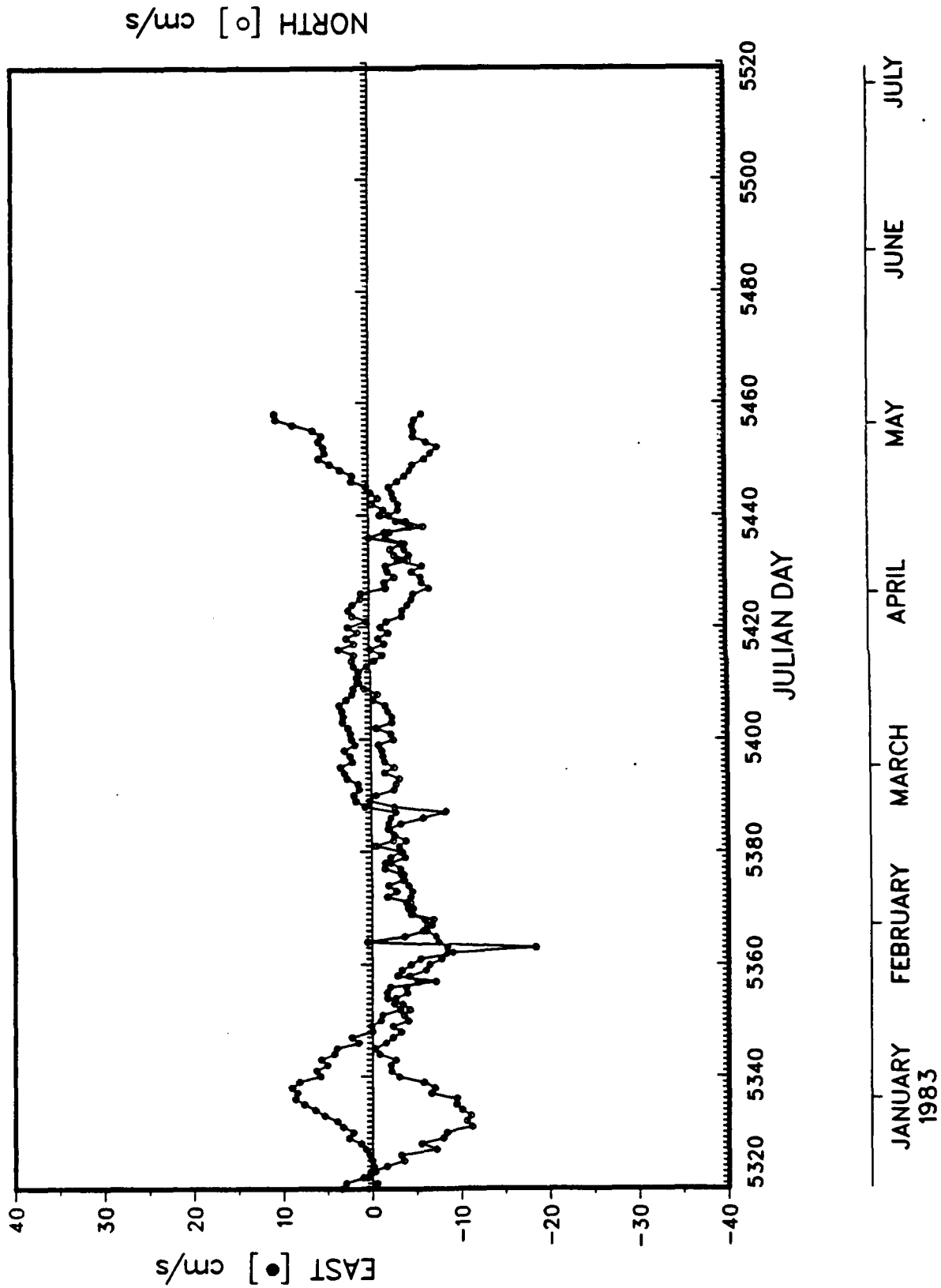
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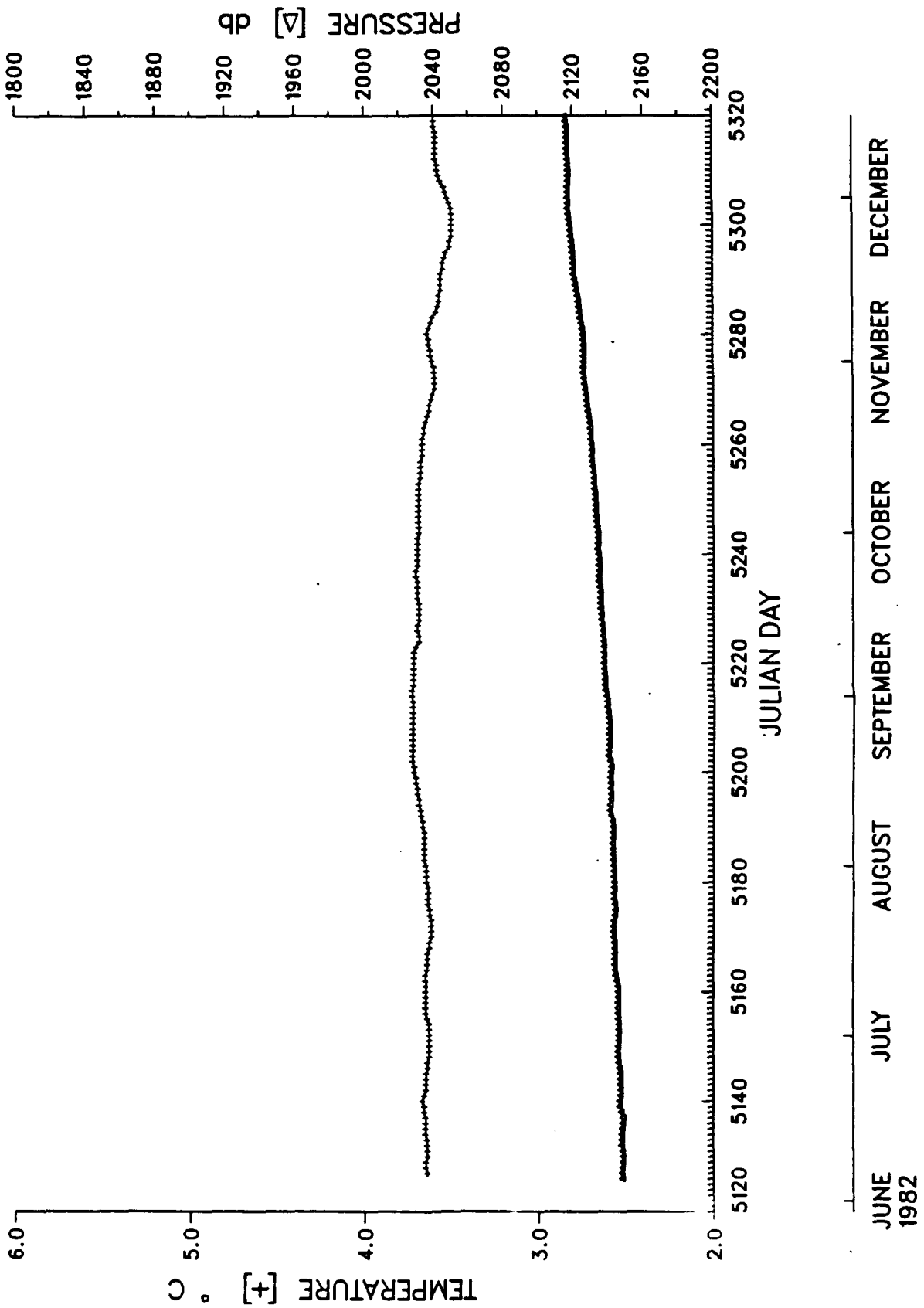
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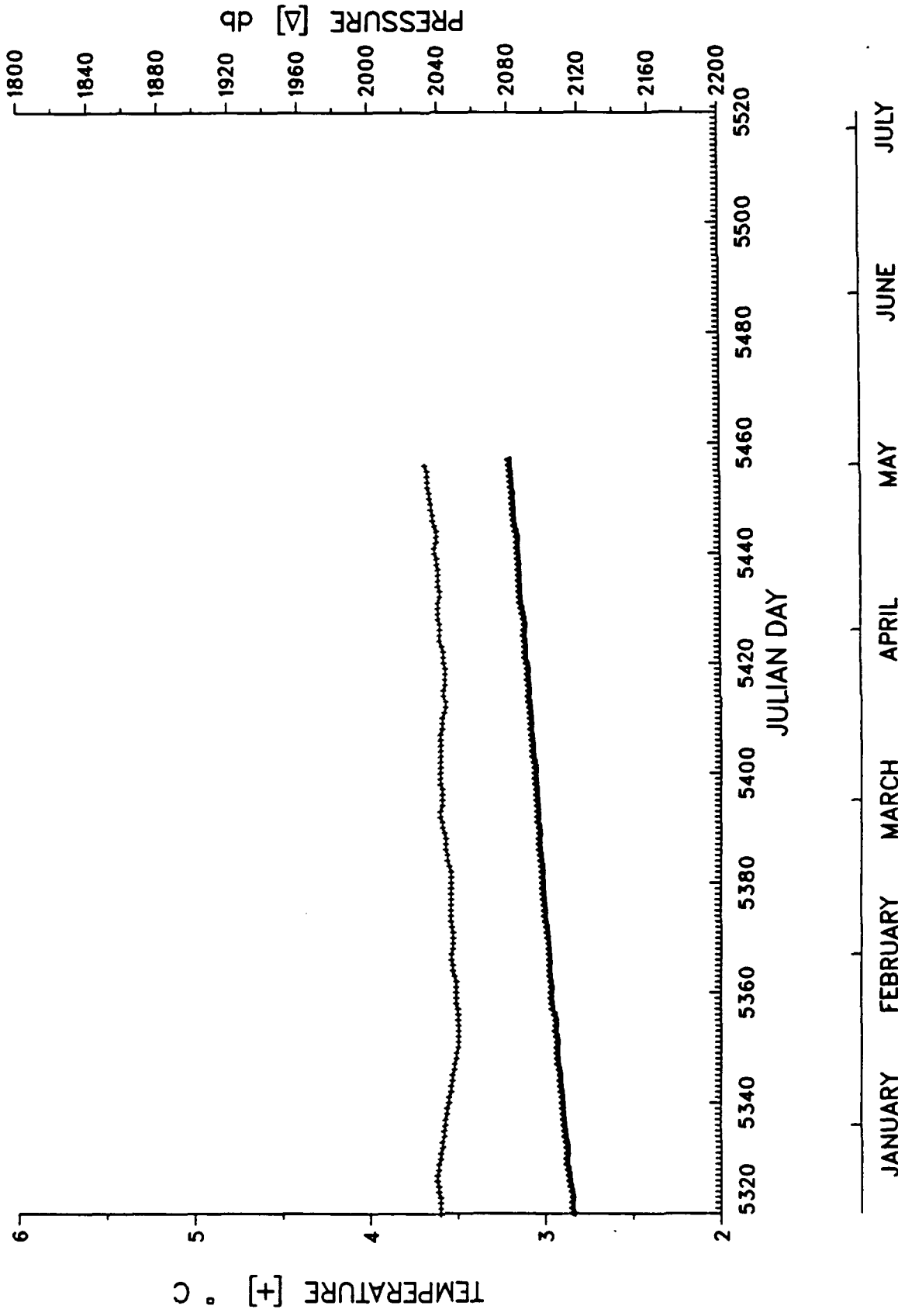
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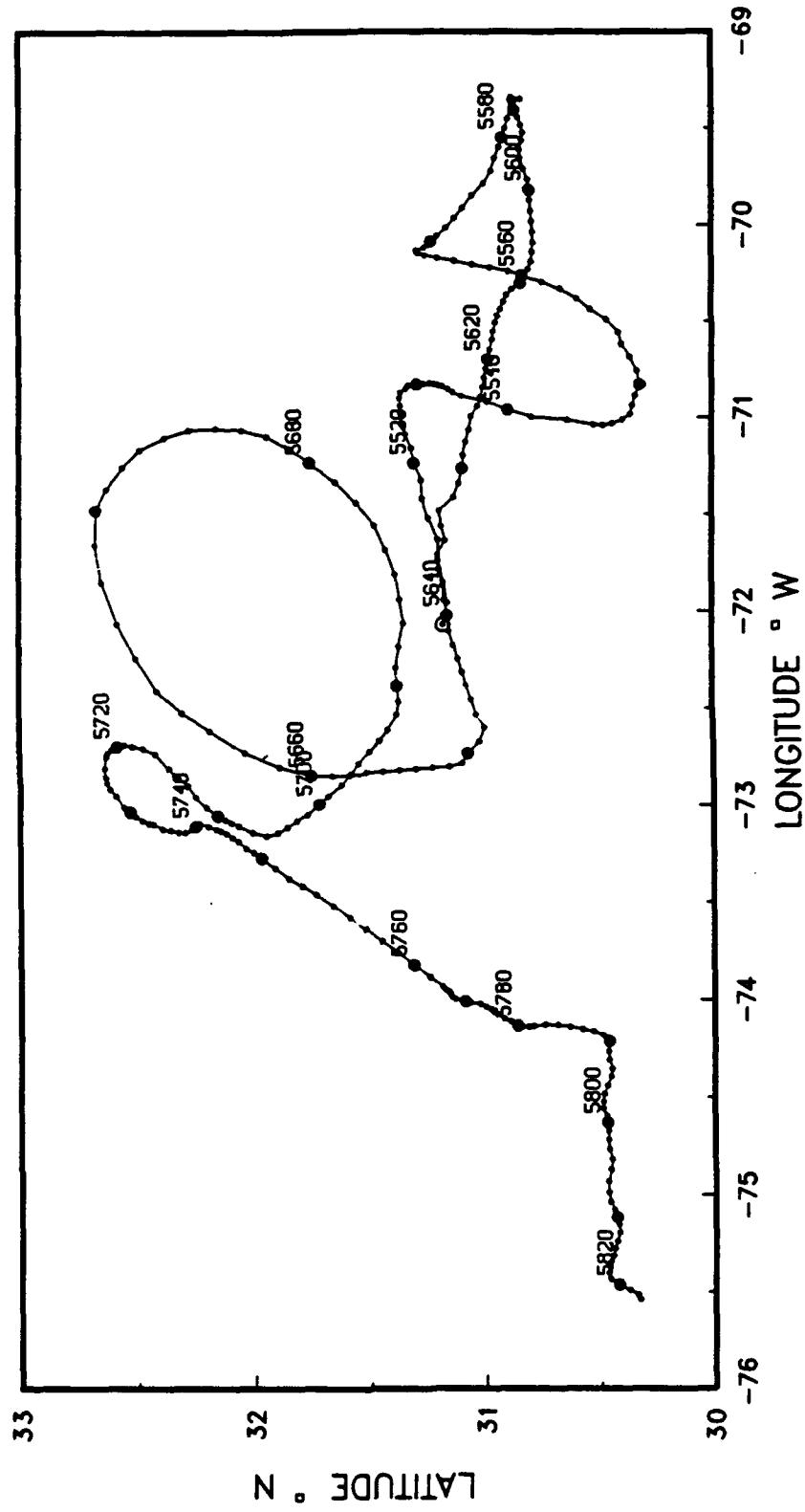
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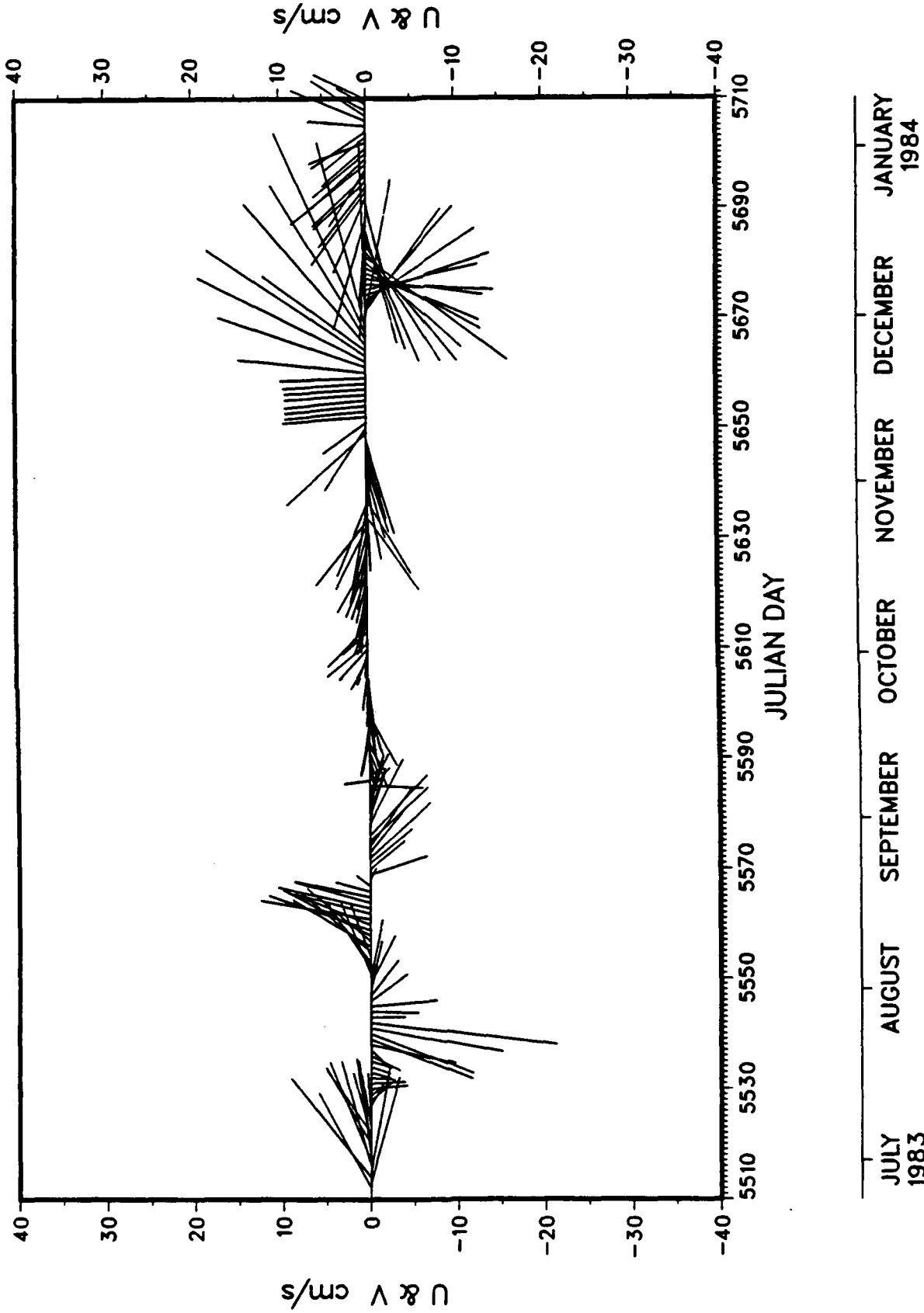
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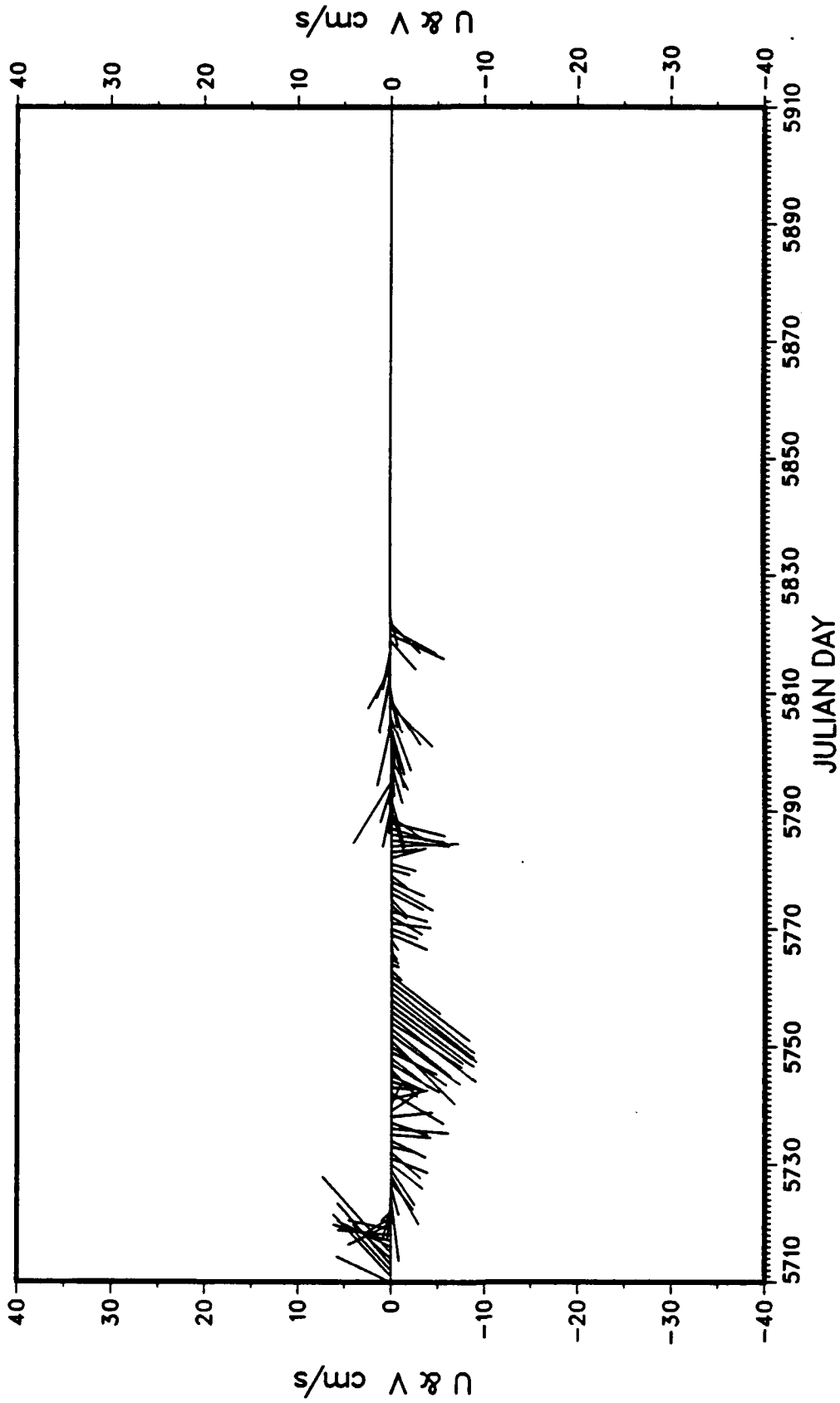
GUSREX 170C



GUSREX 170C

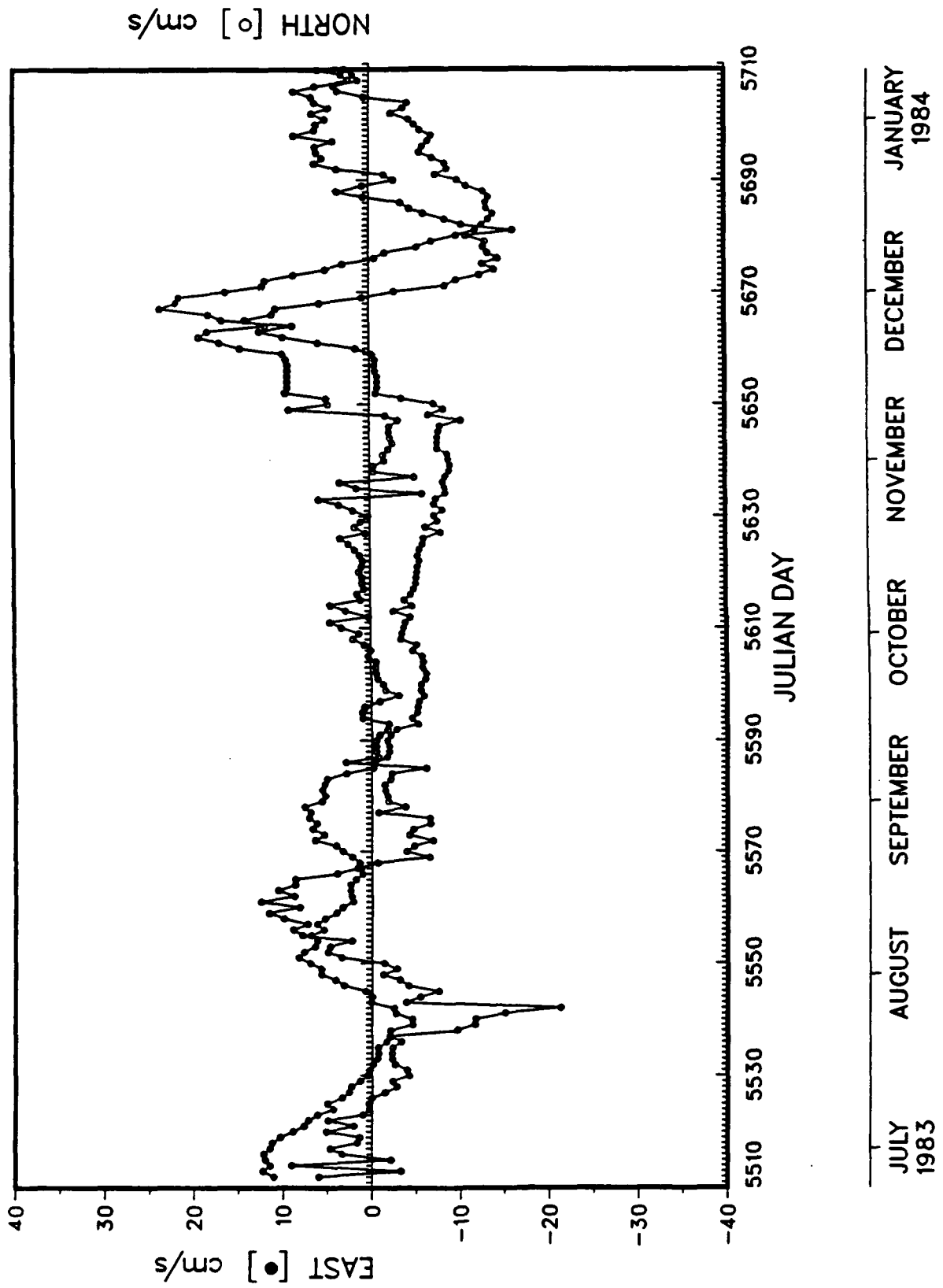


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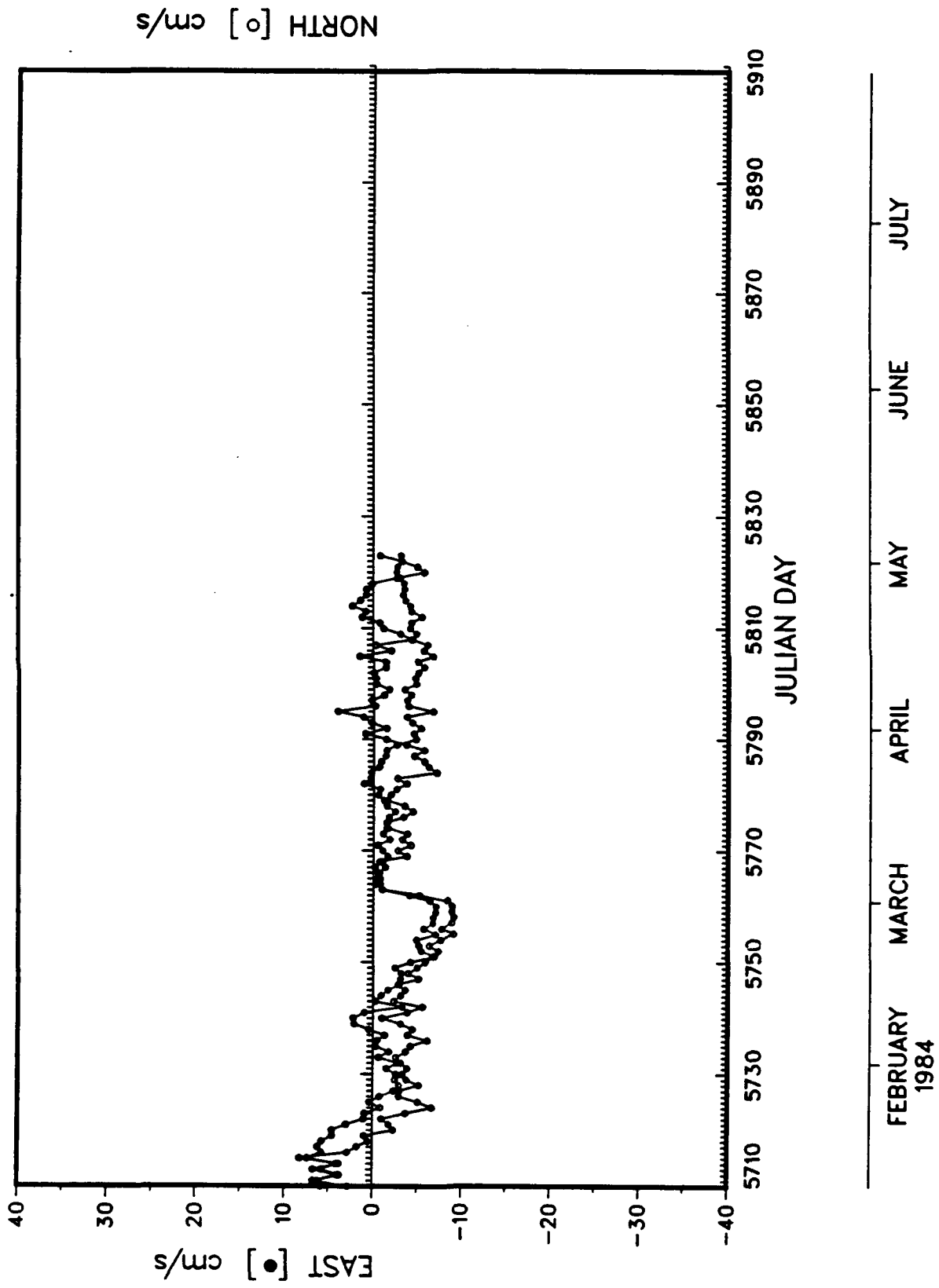


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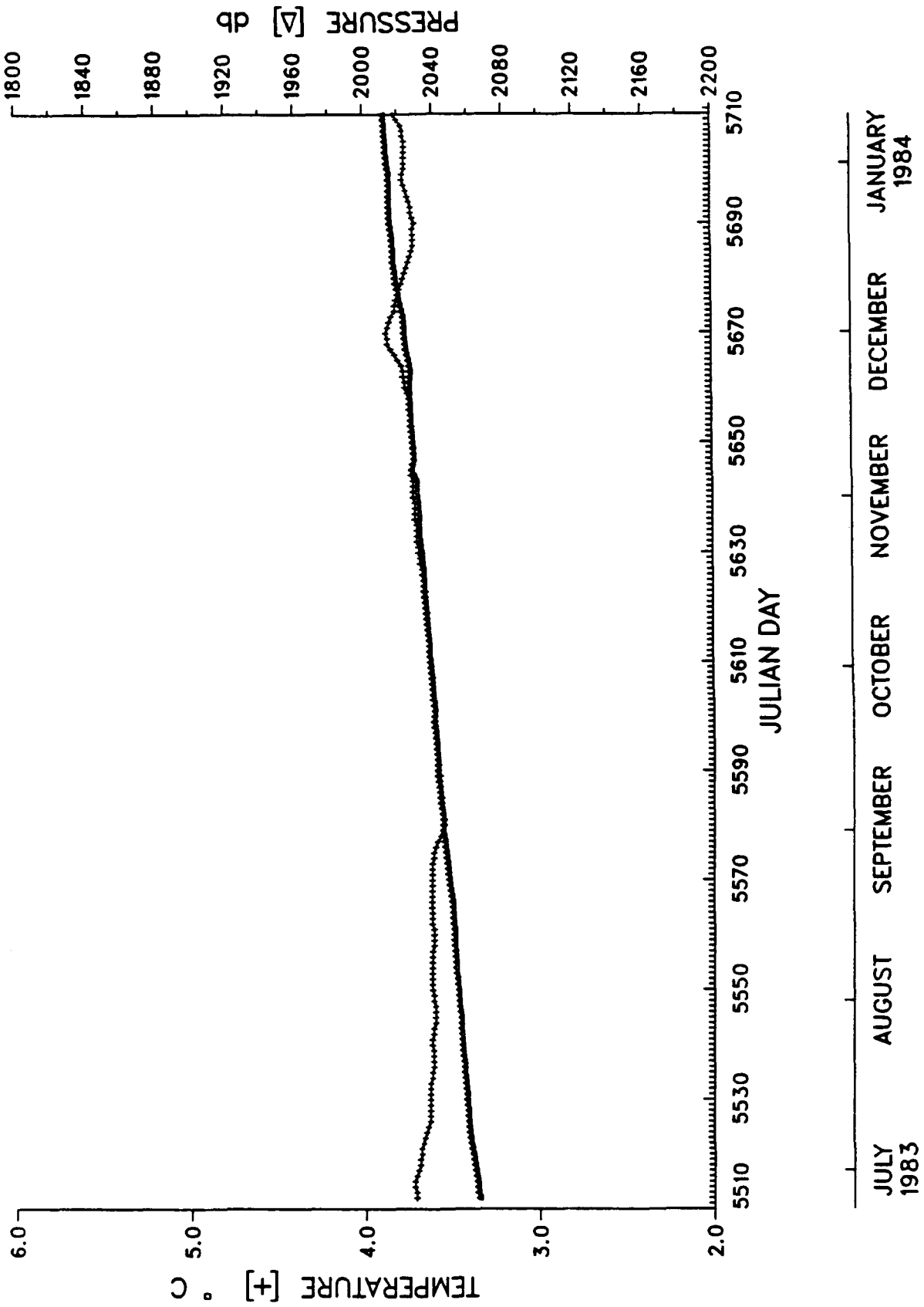
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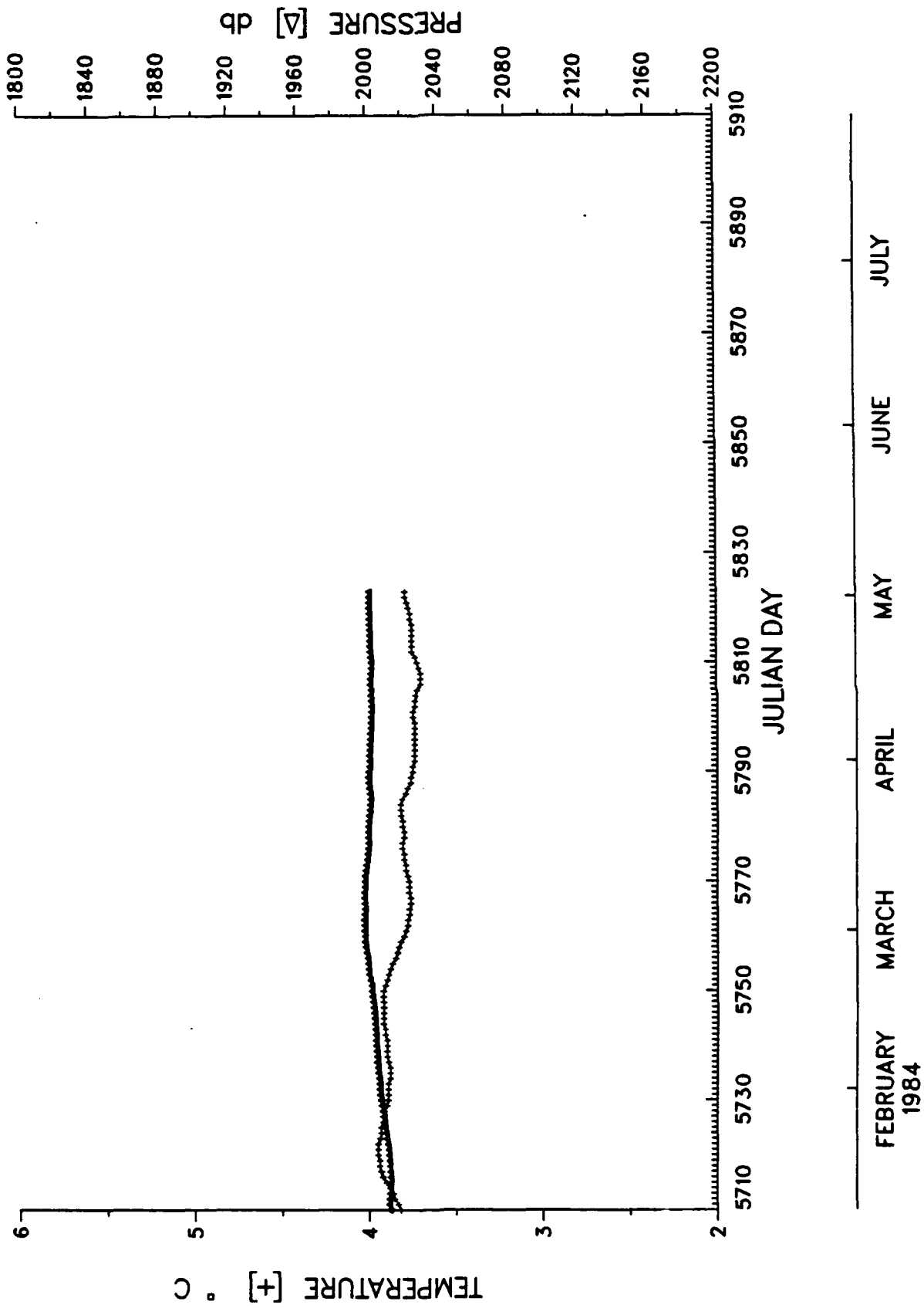
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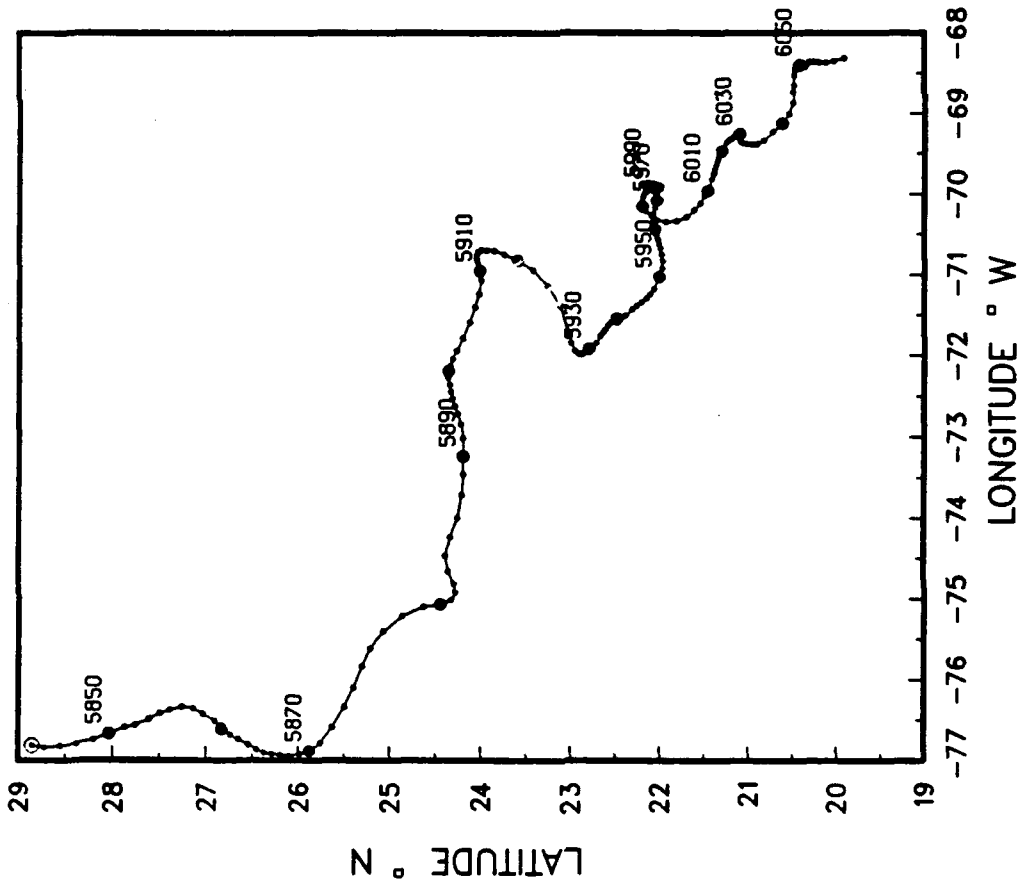
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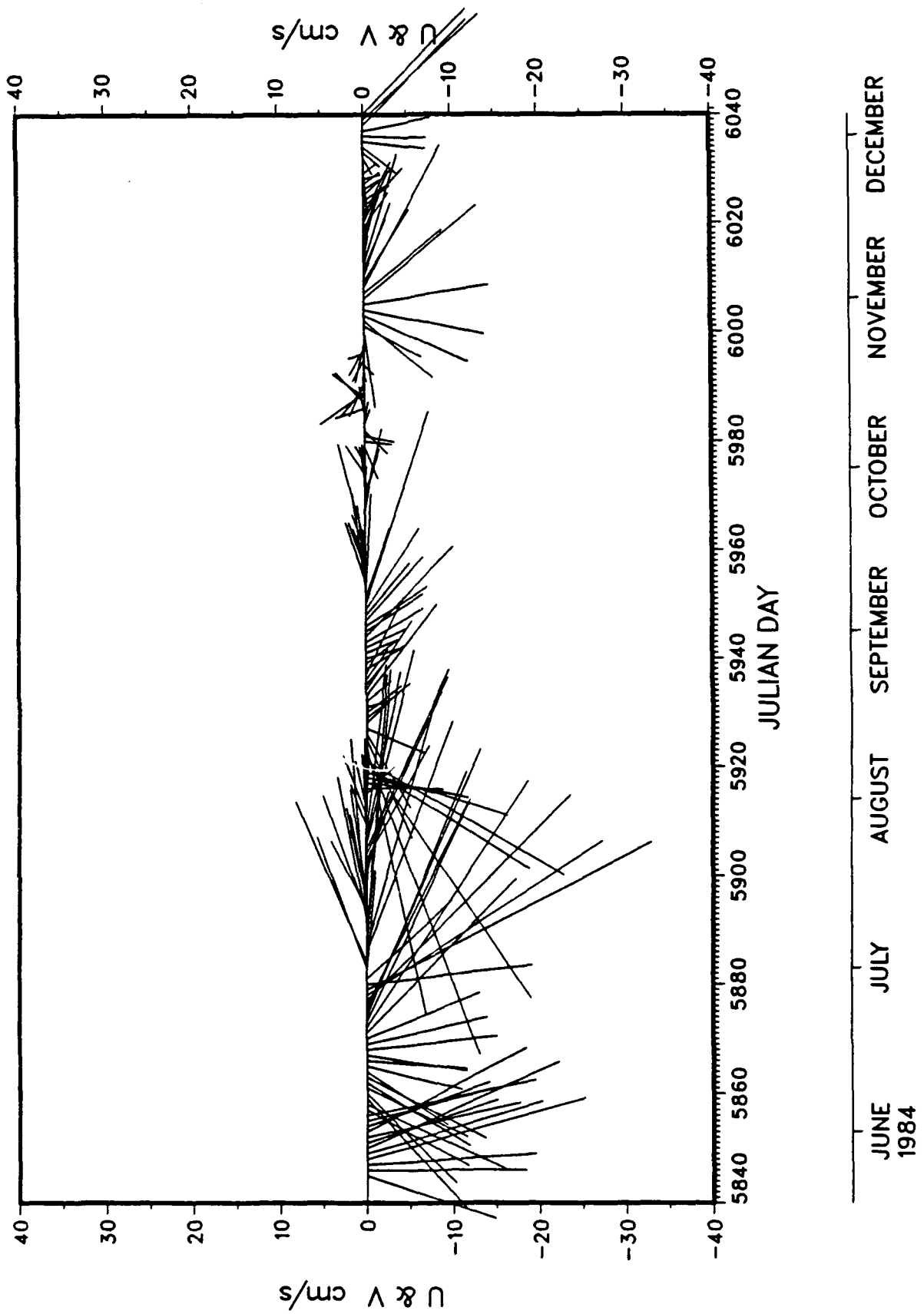
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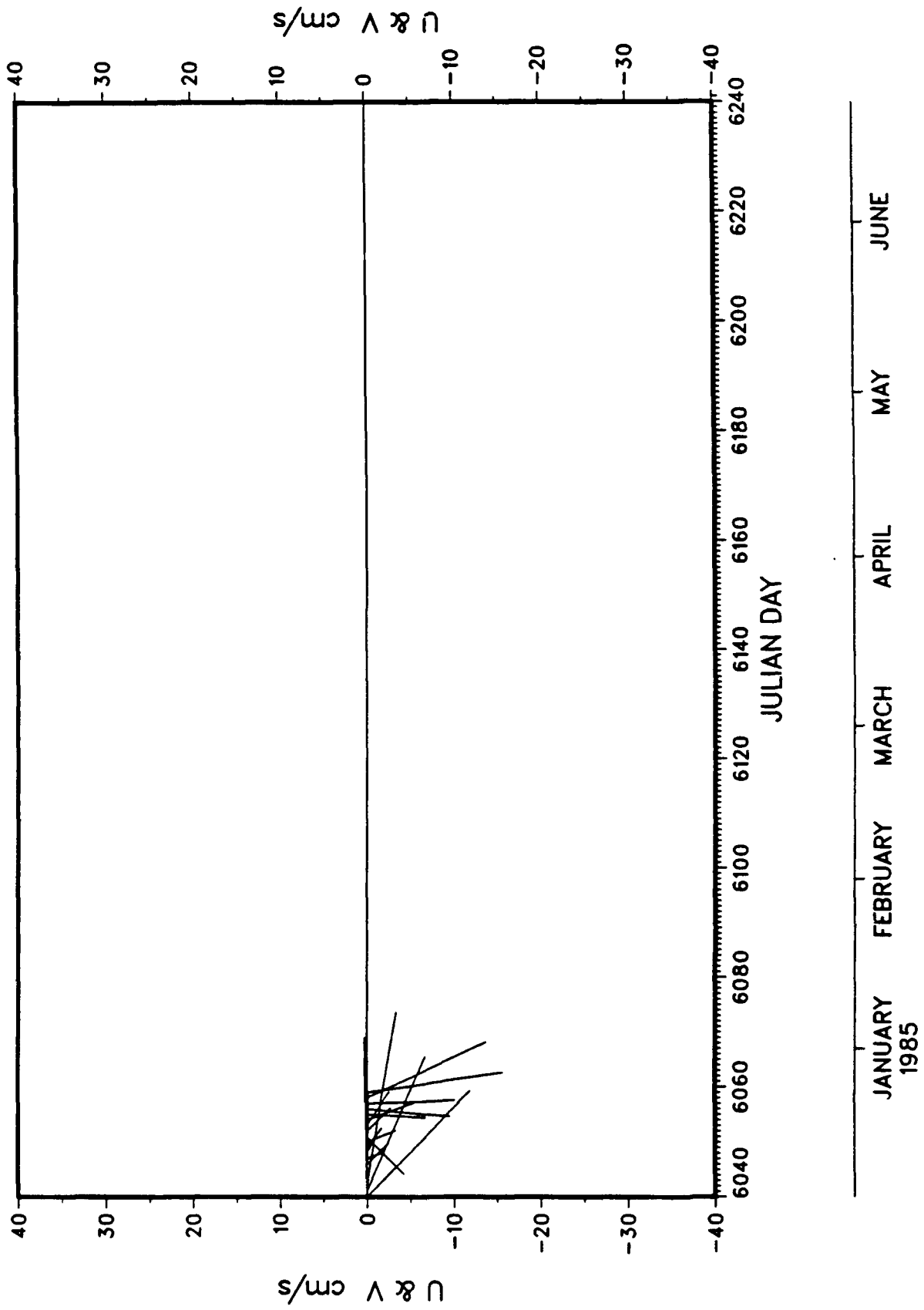
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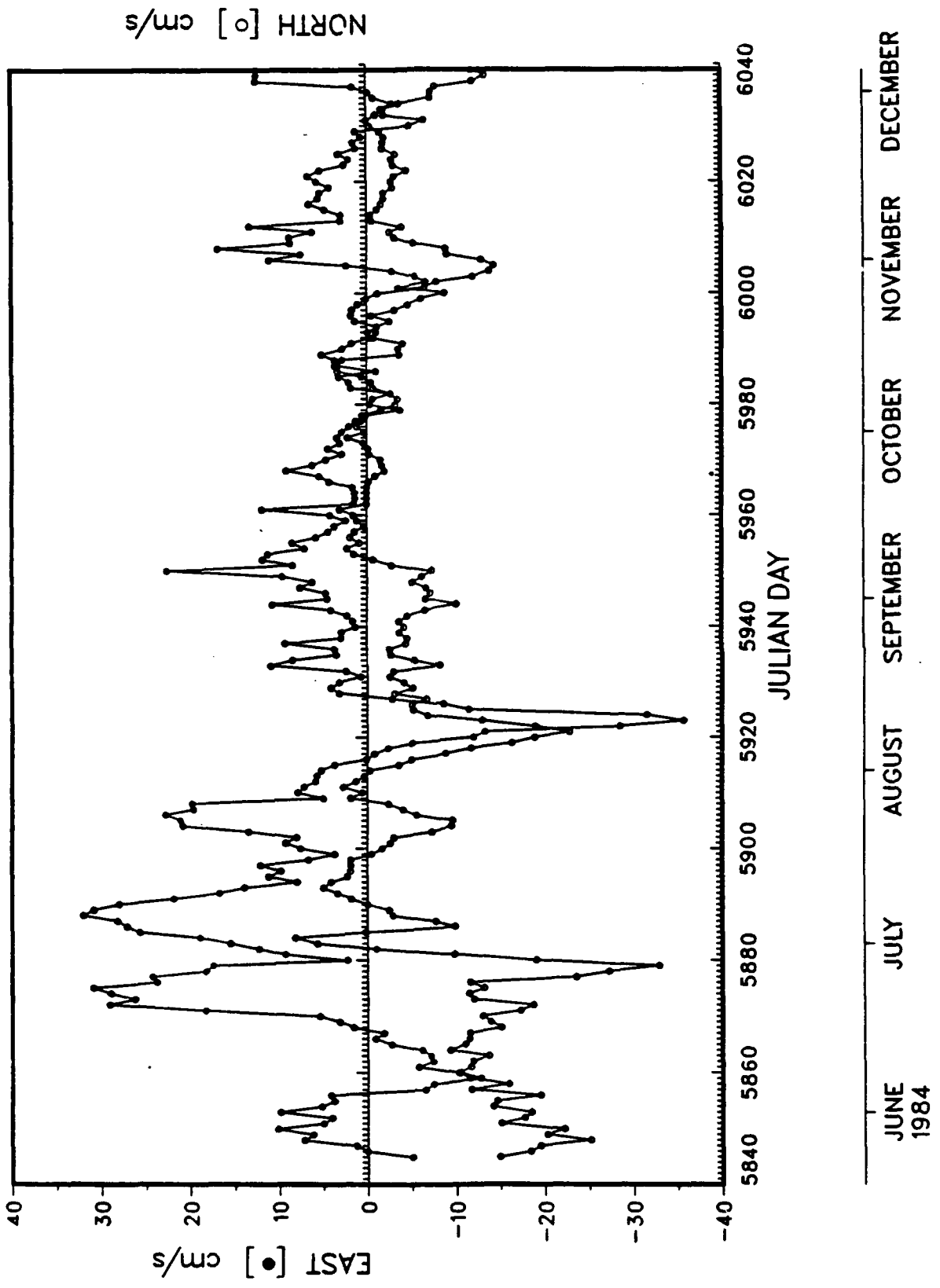
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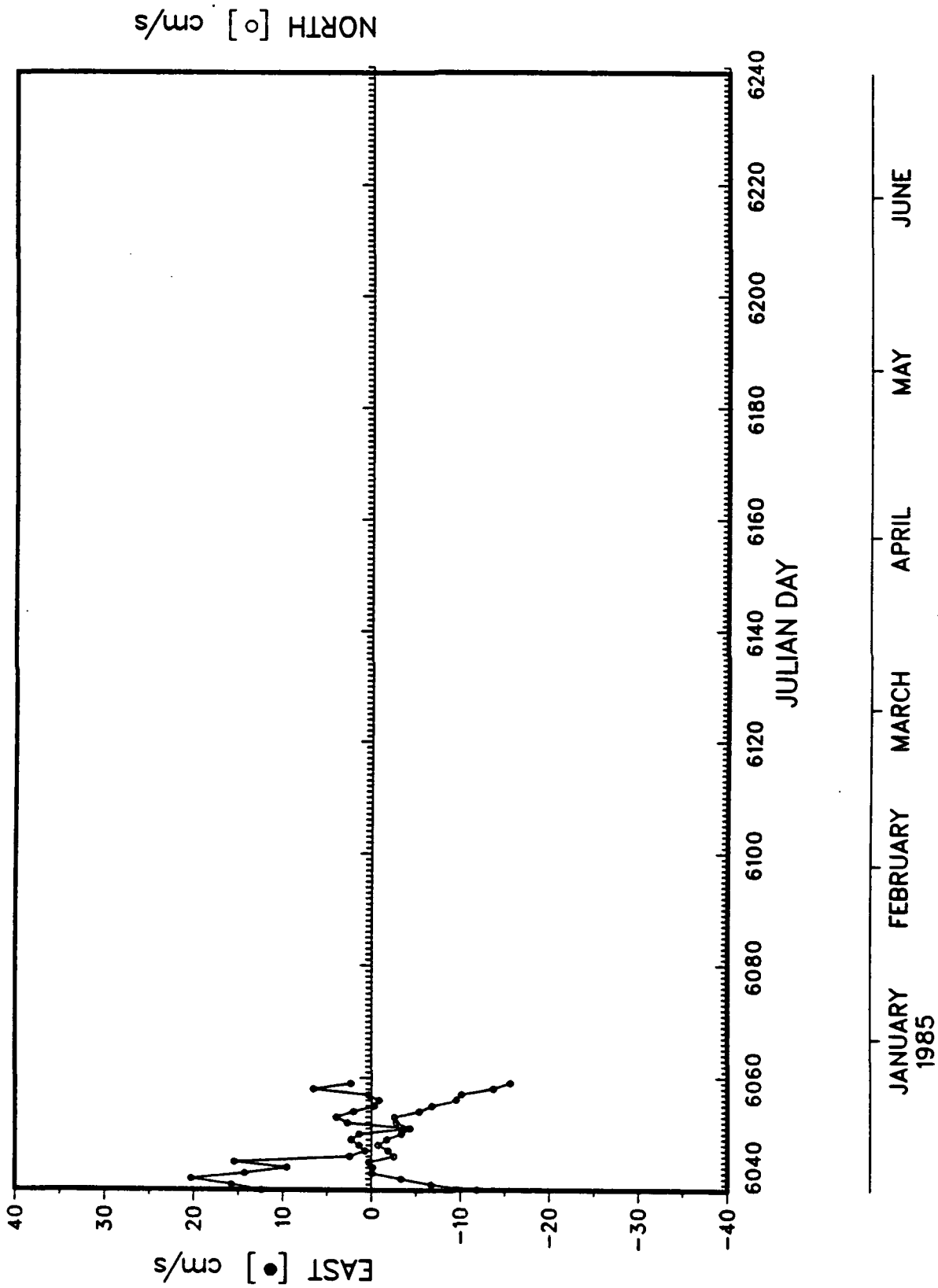
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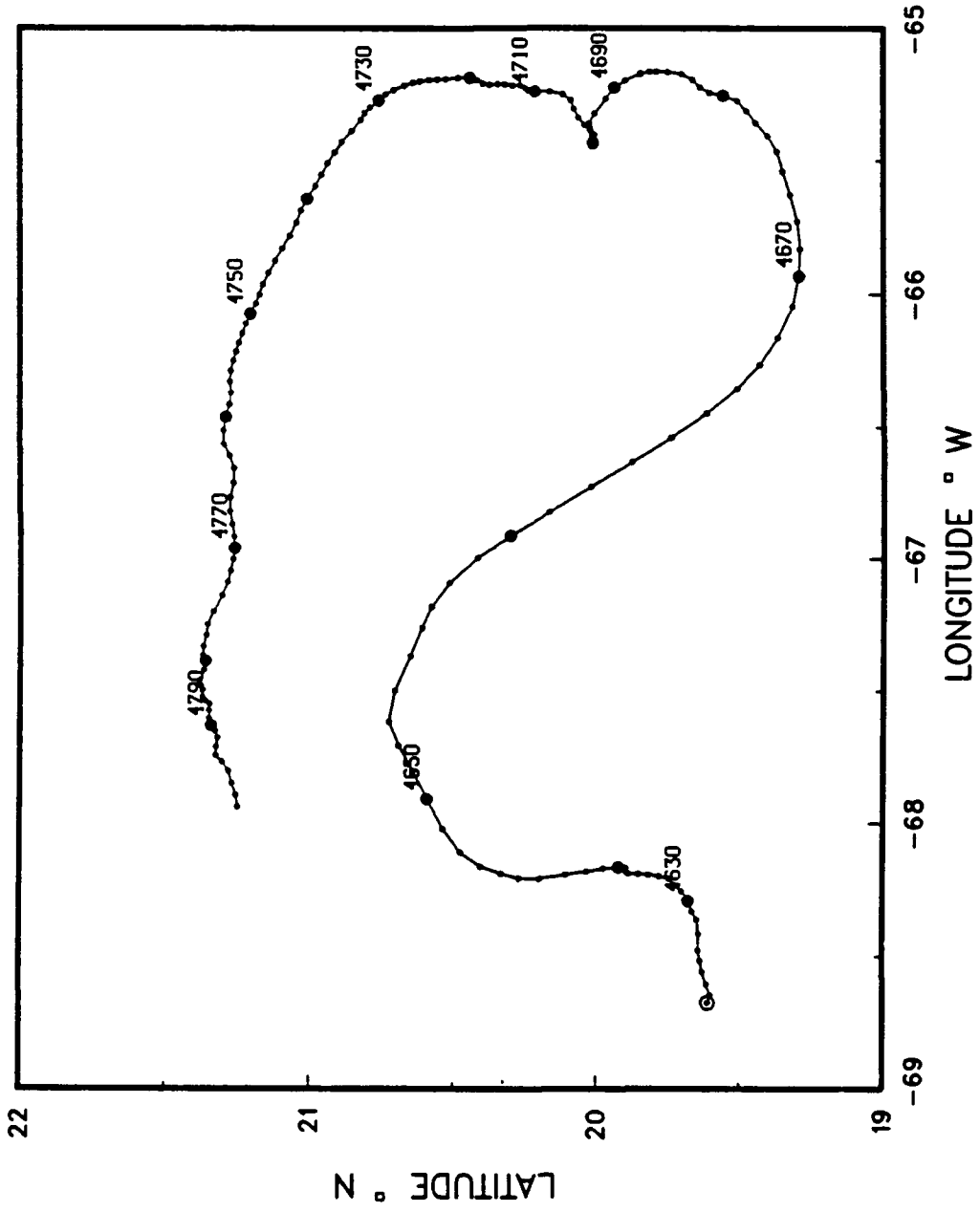
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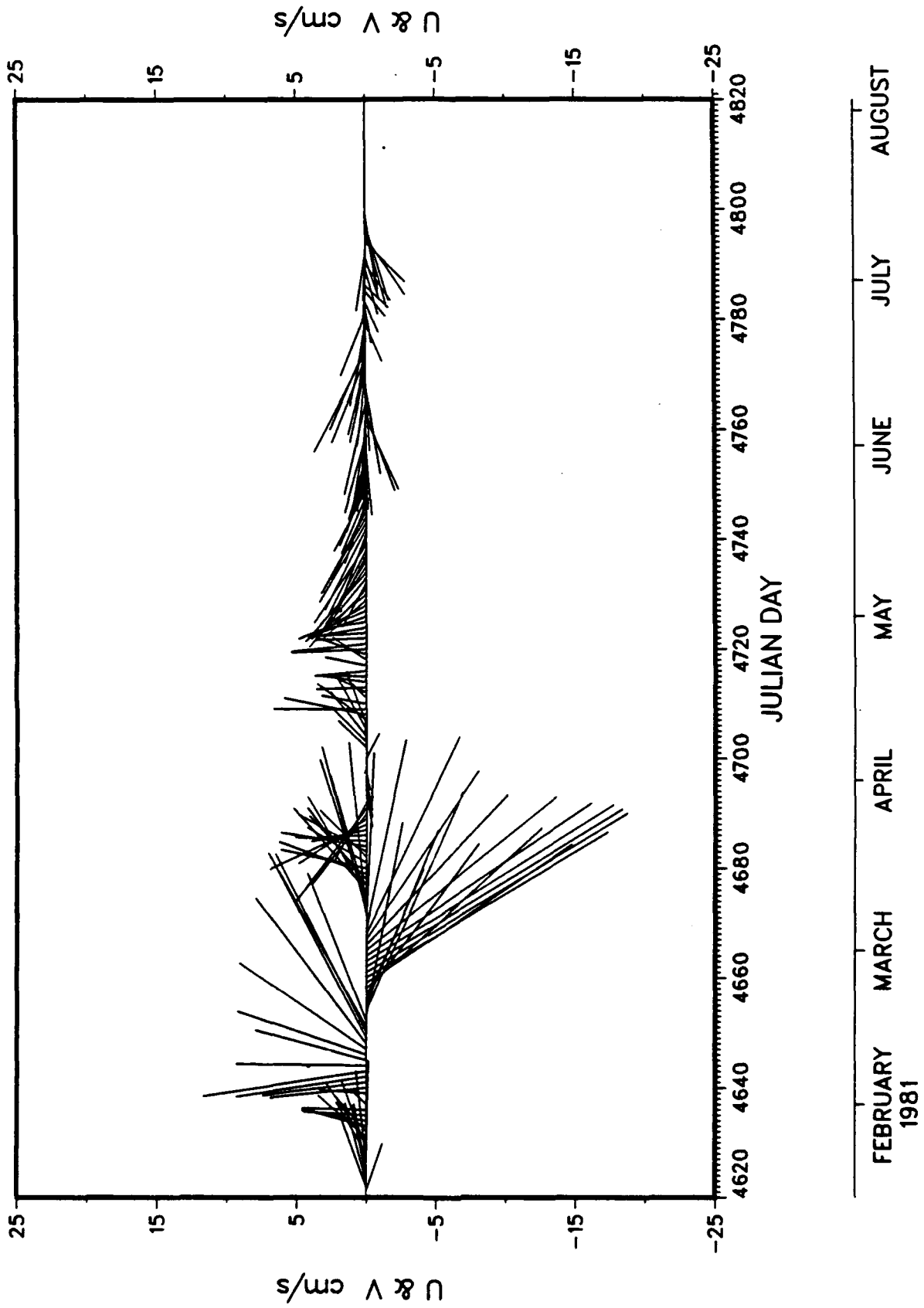
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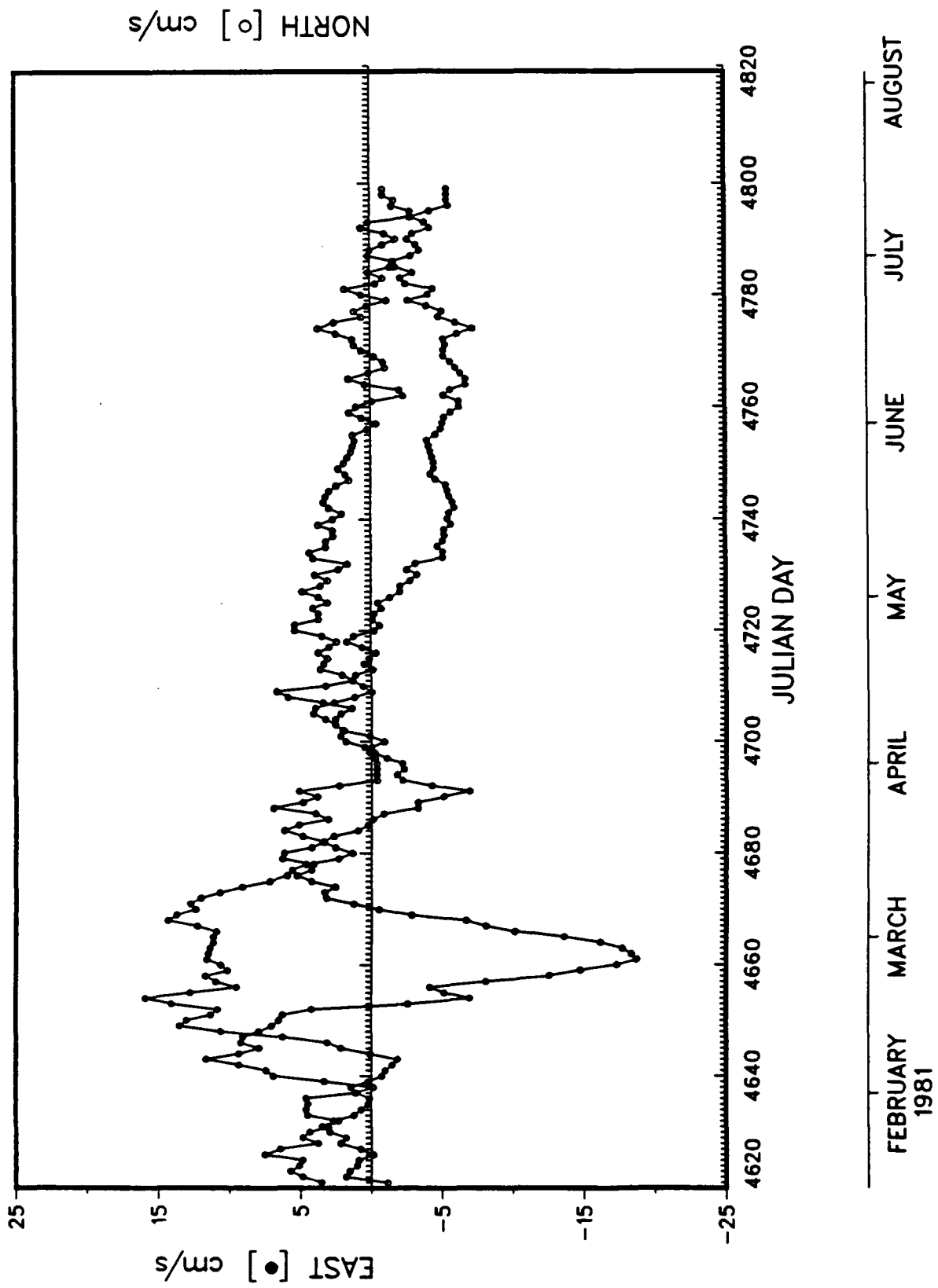
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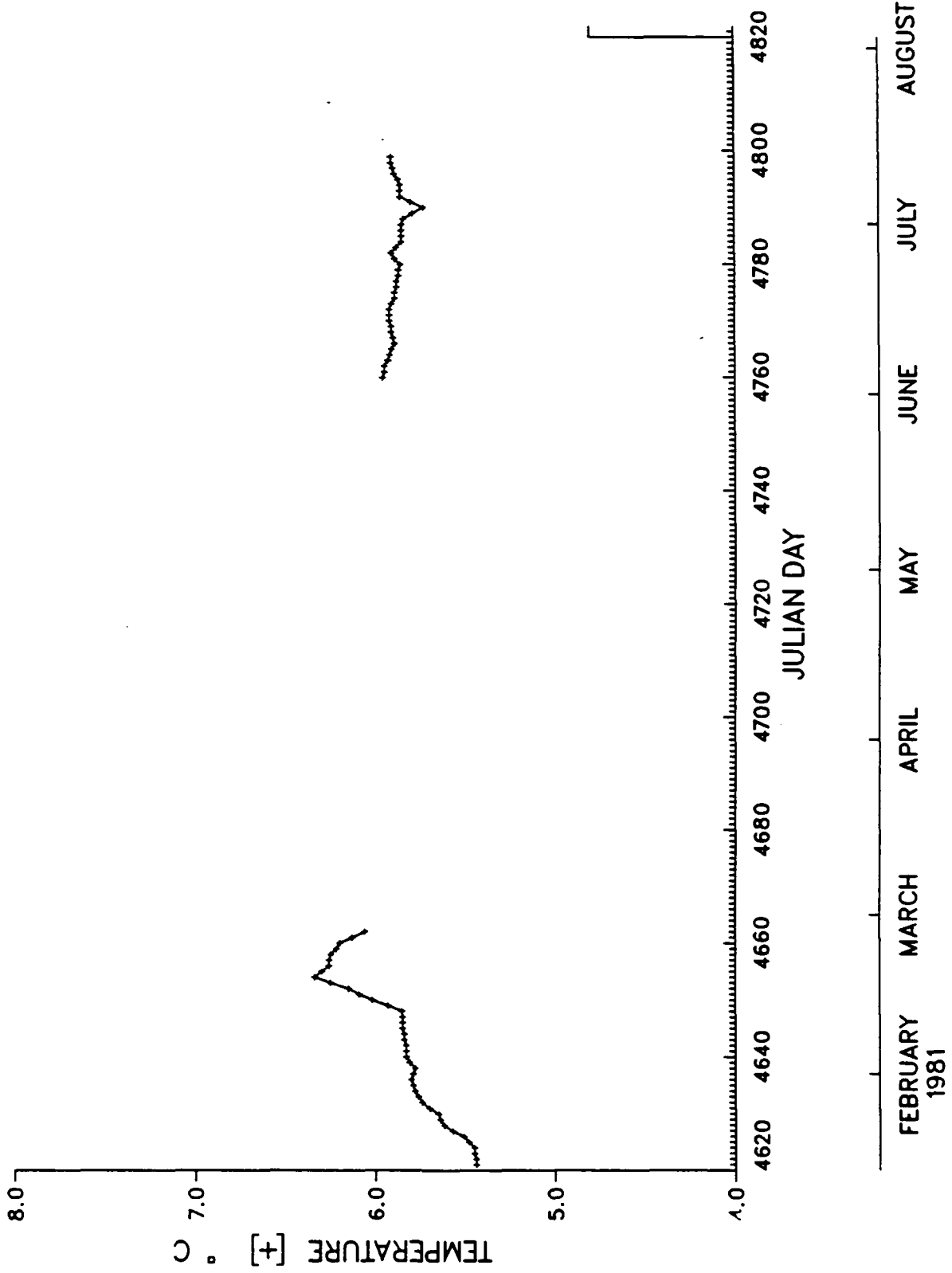


PRE LDE 12D

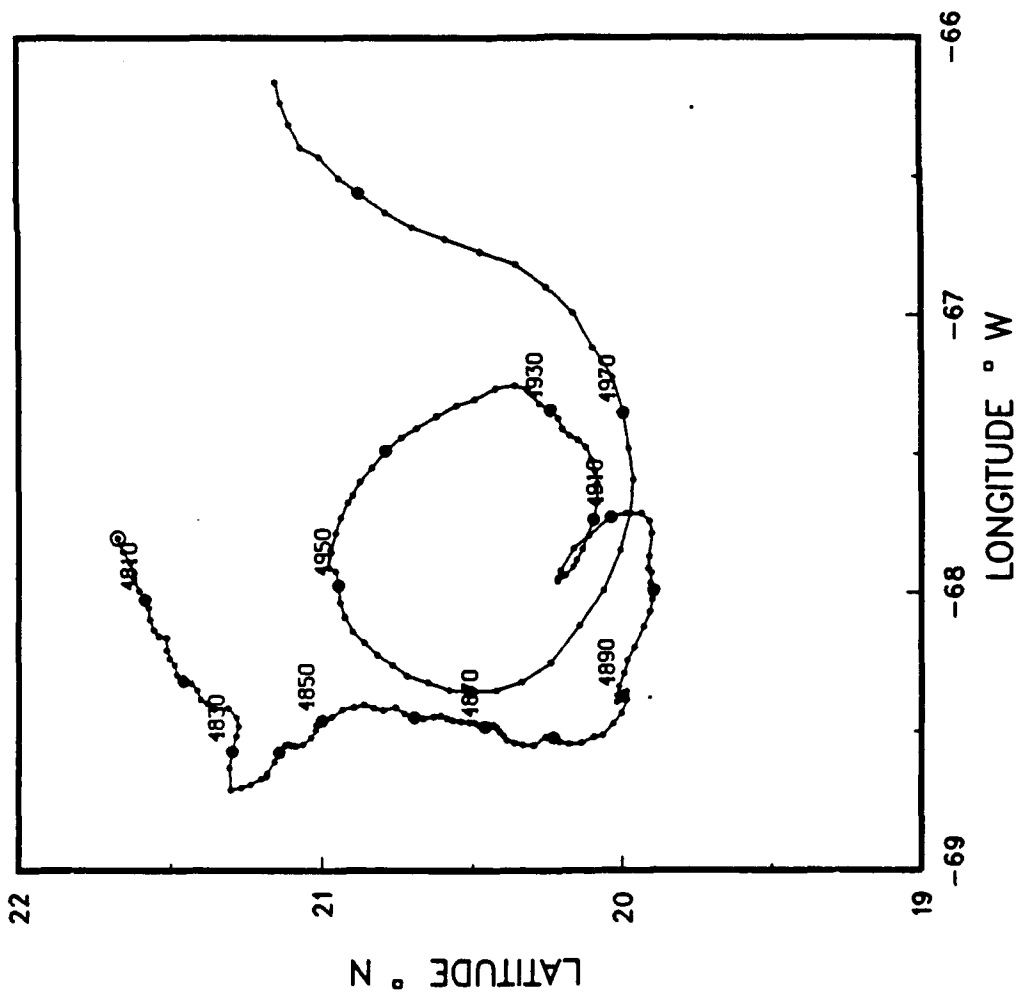


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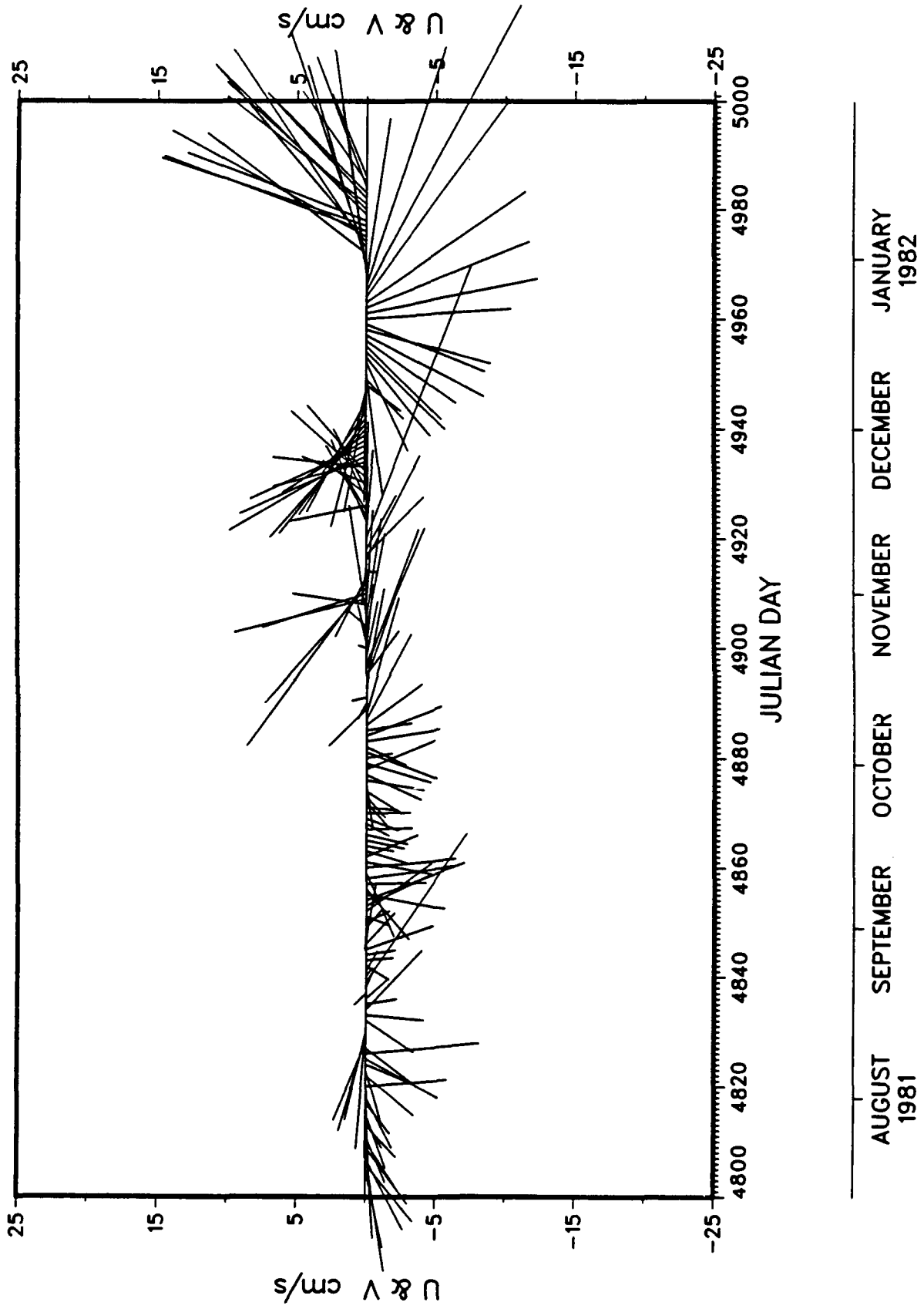




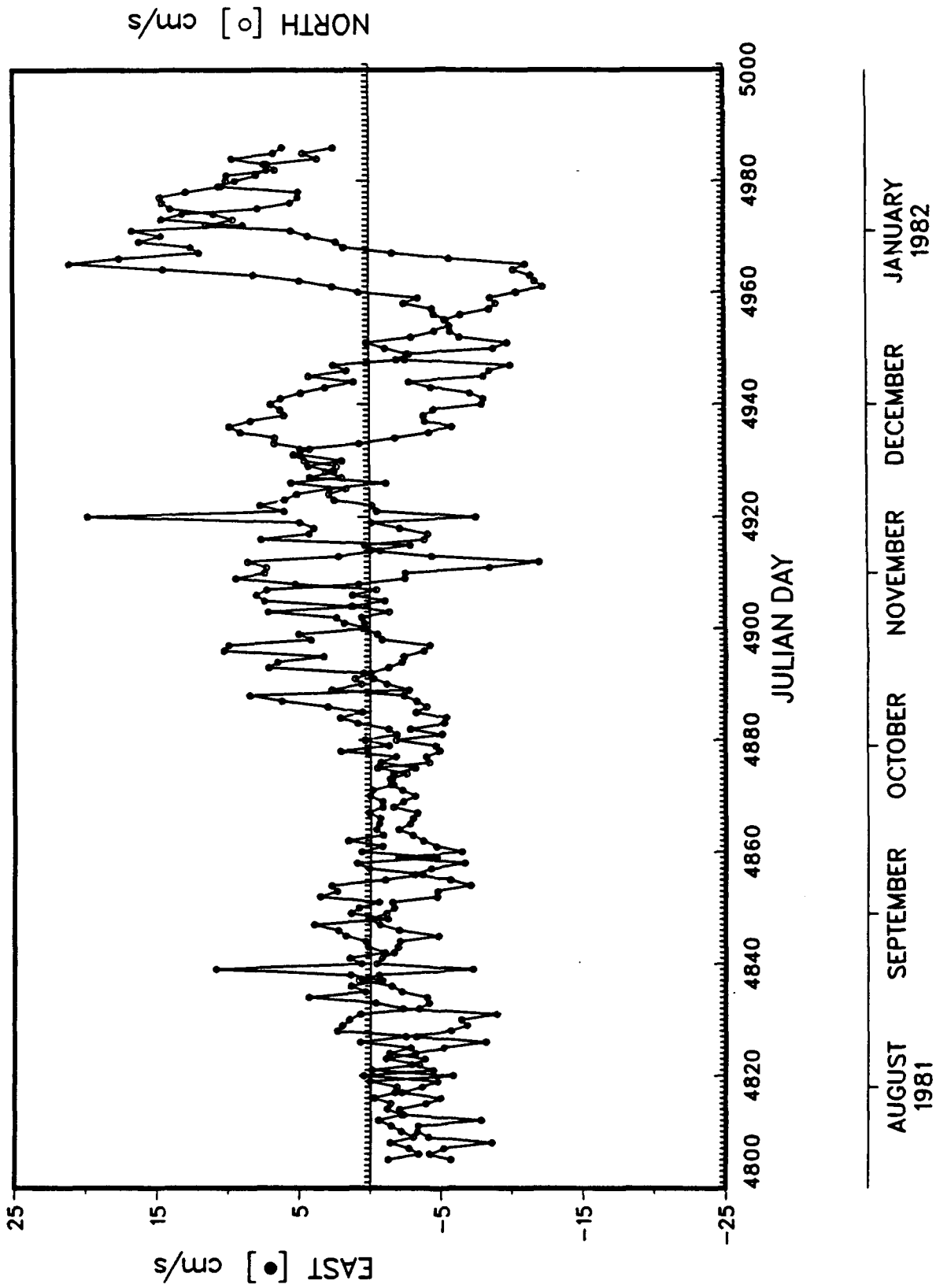
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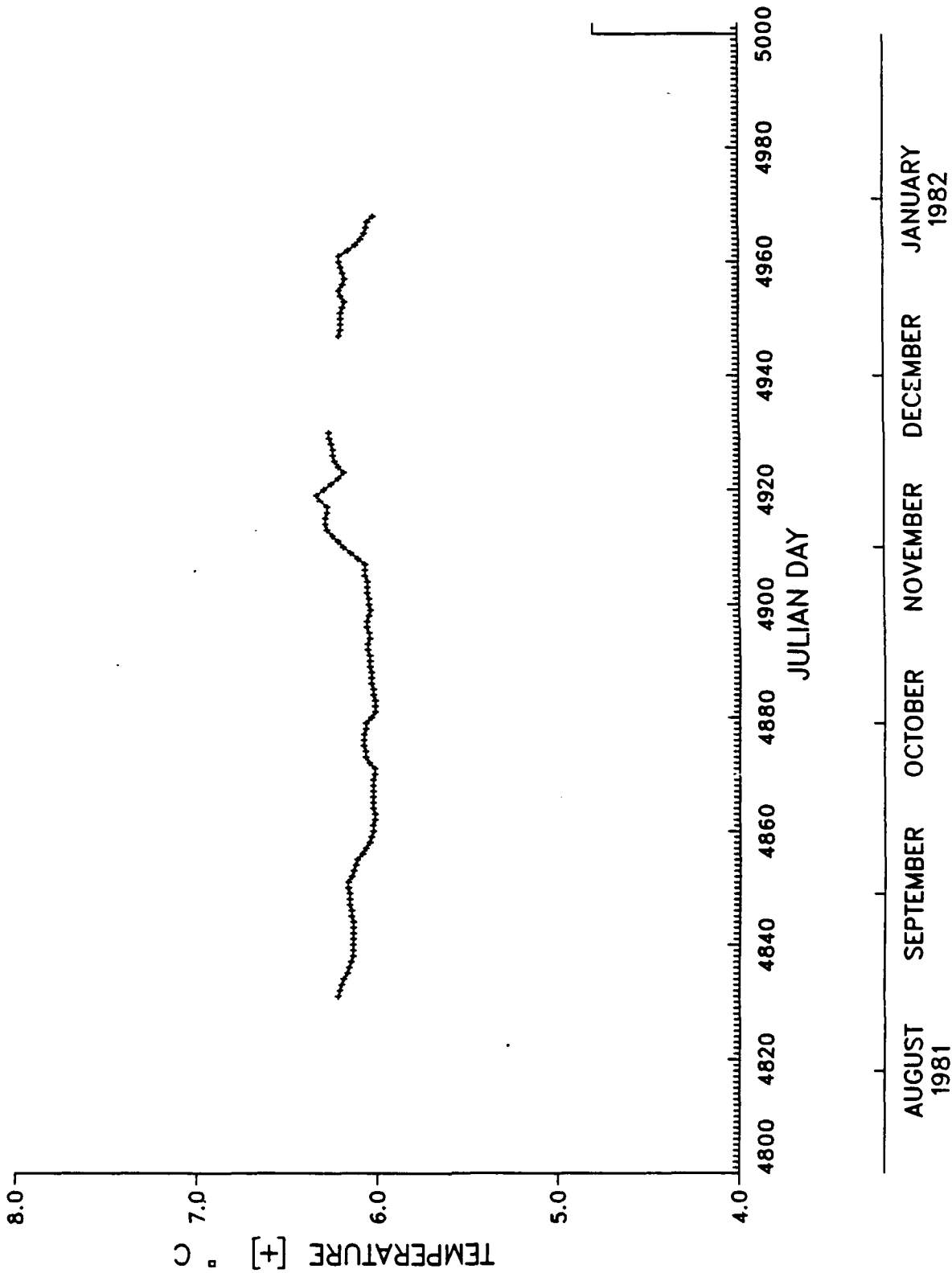
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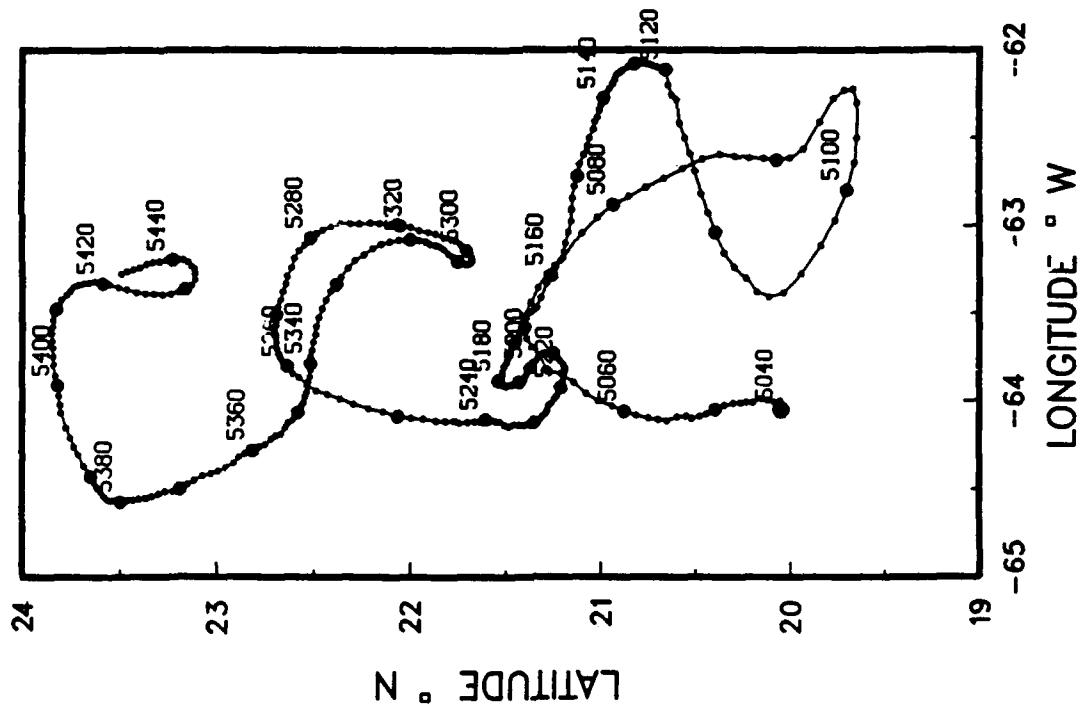
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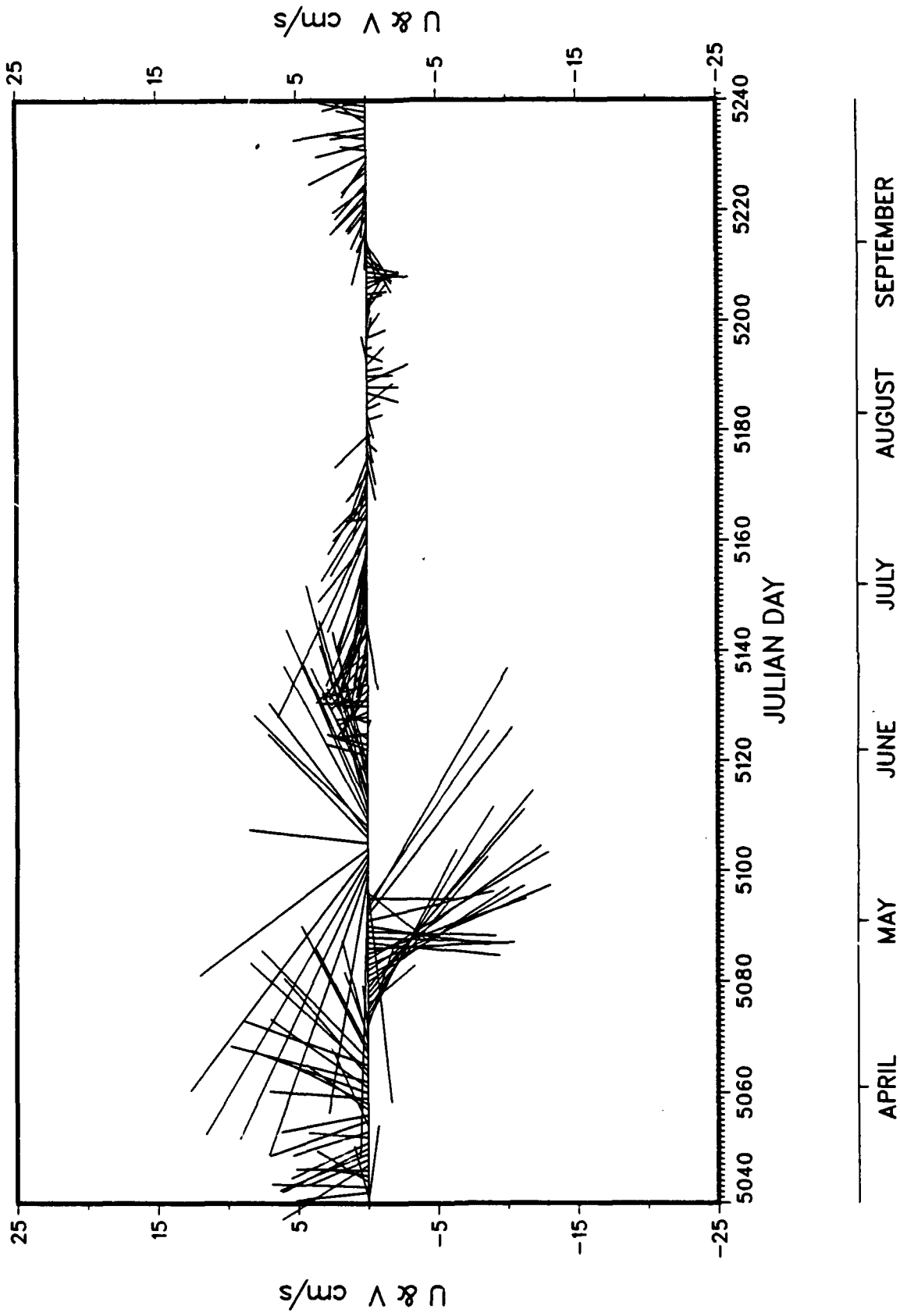
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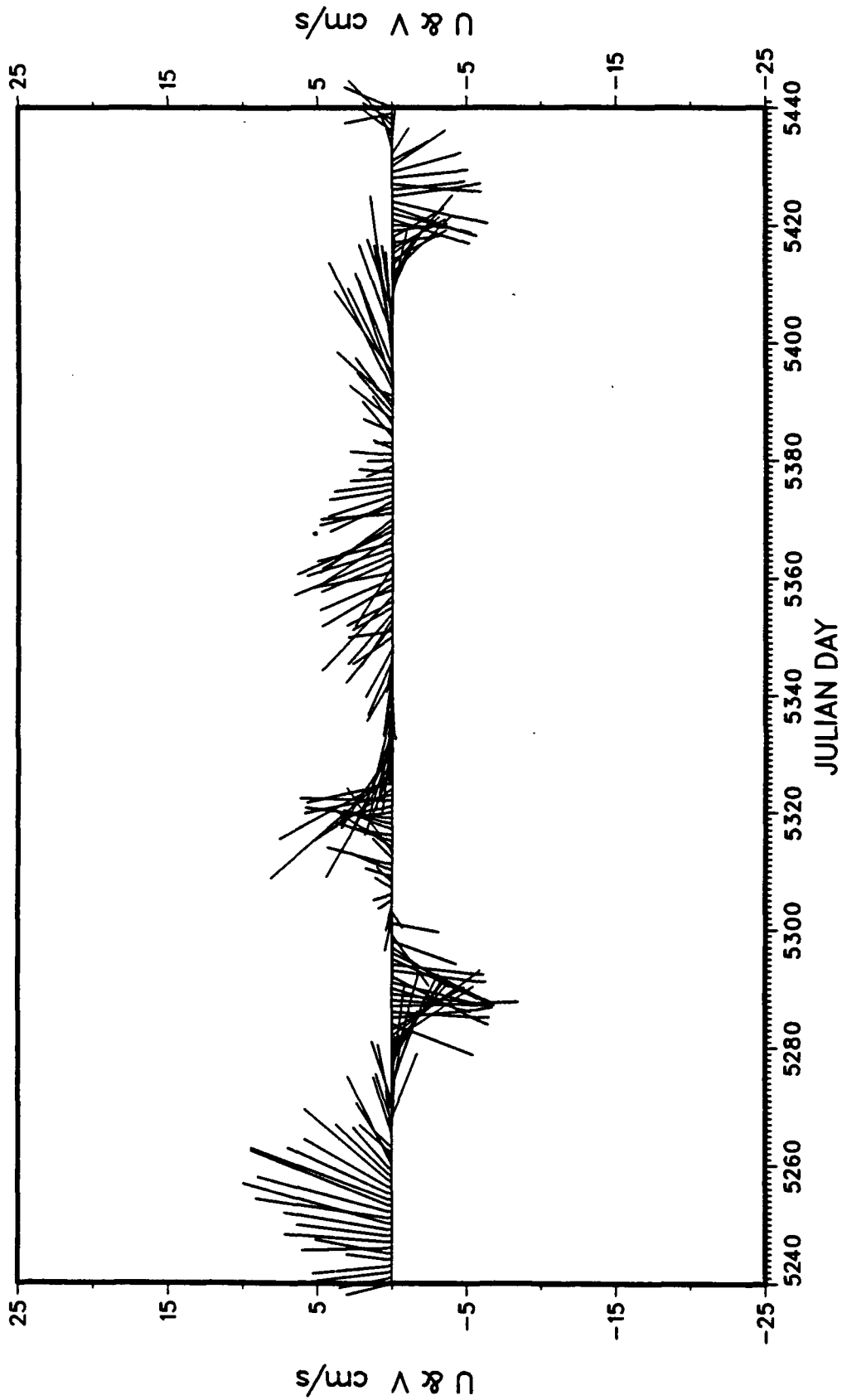
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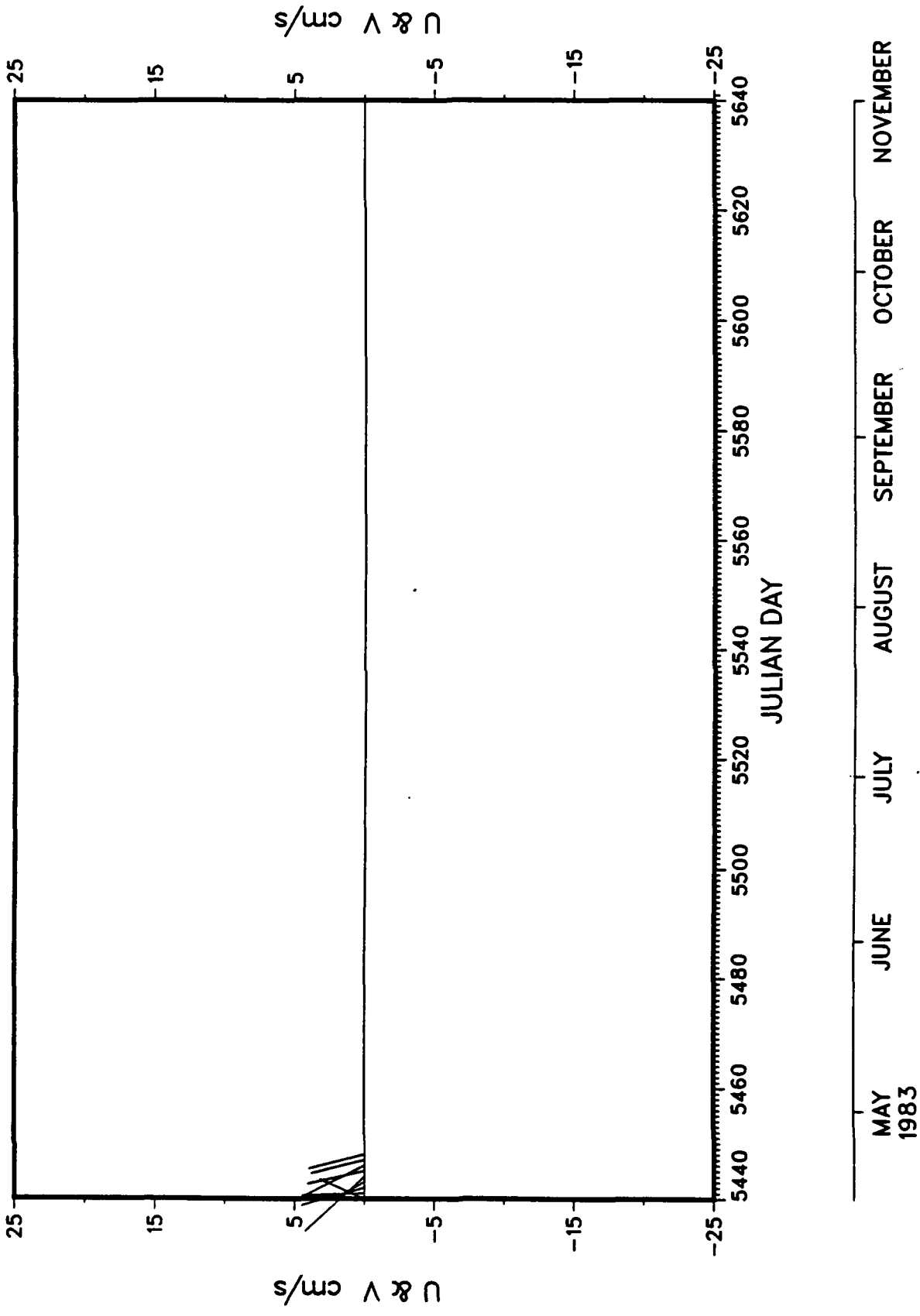
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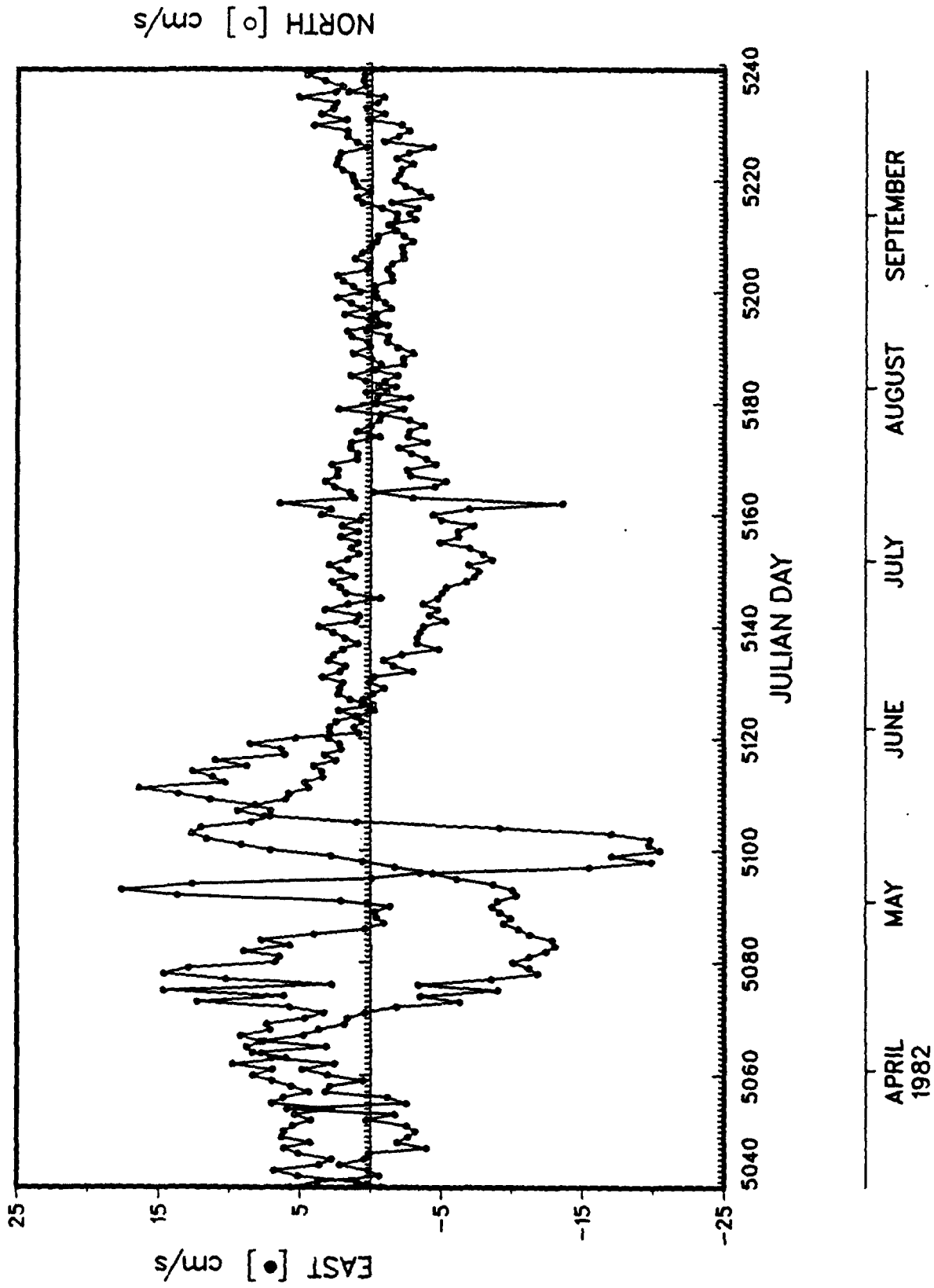
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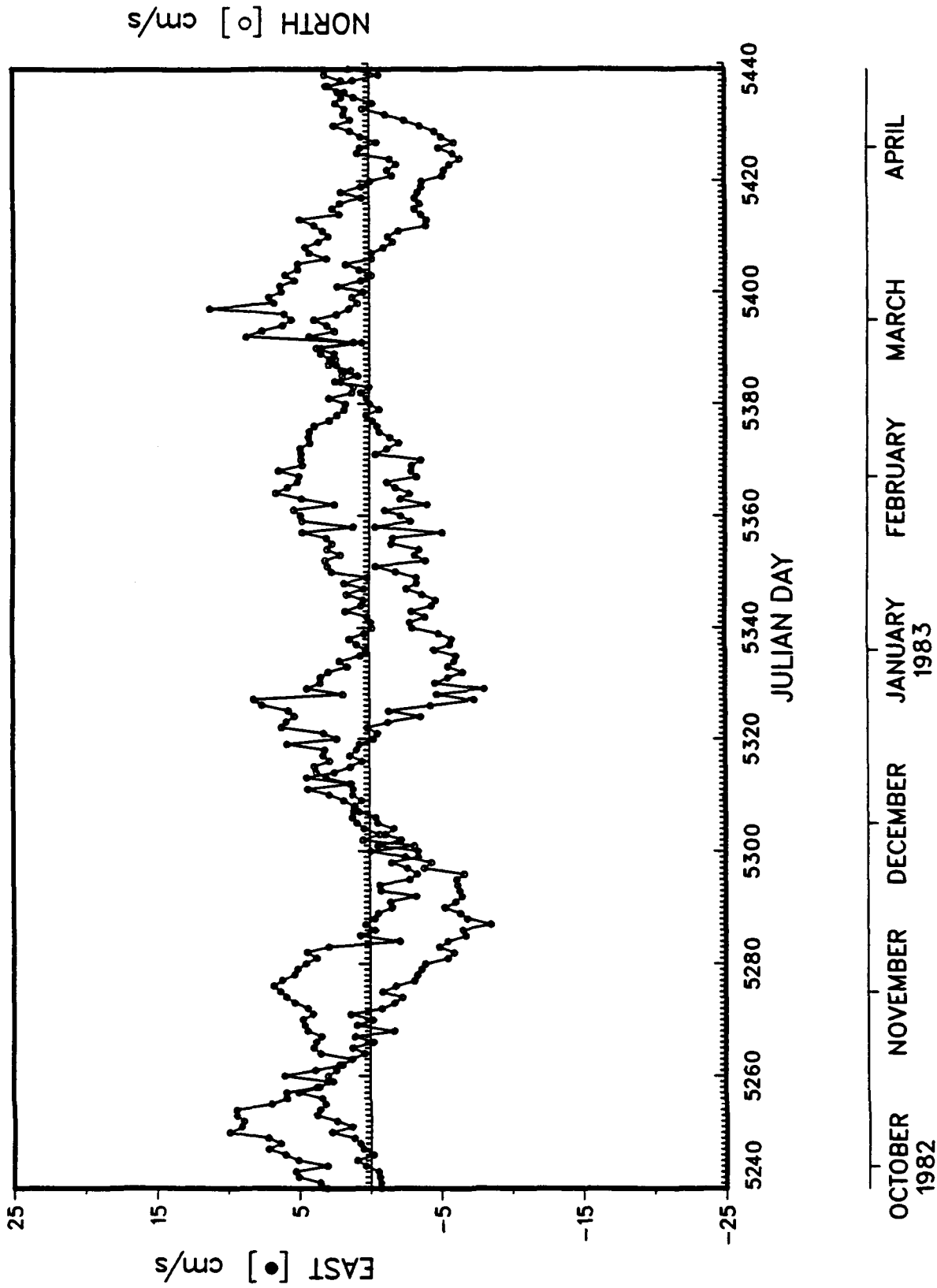


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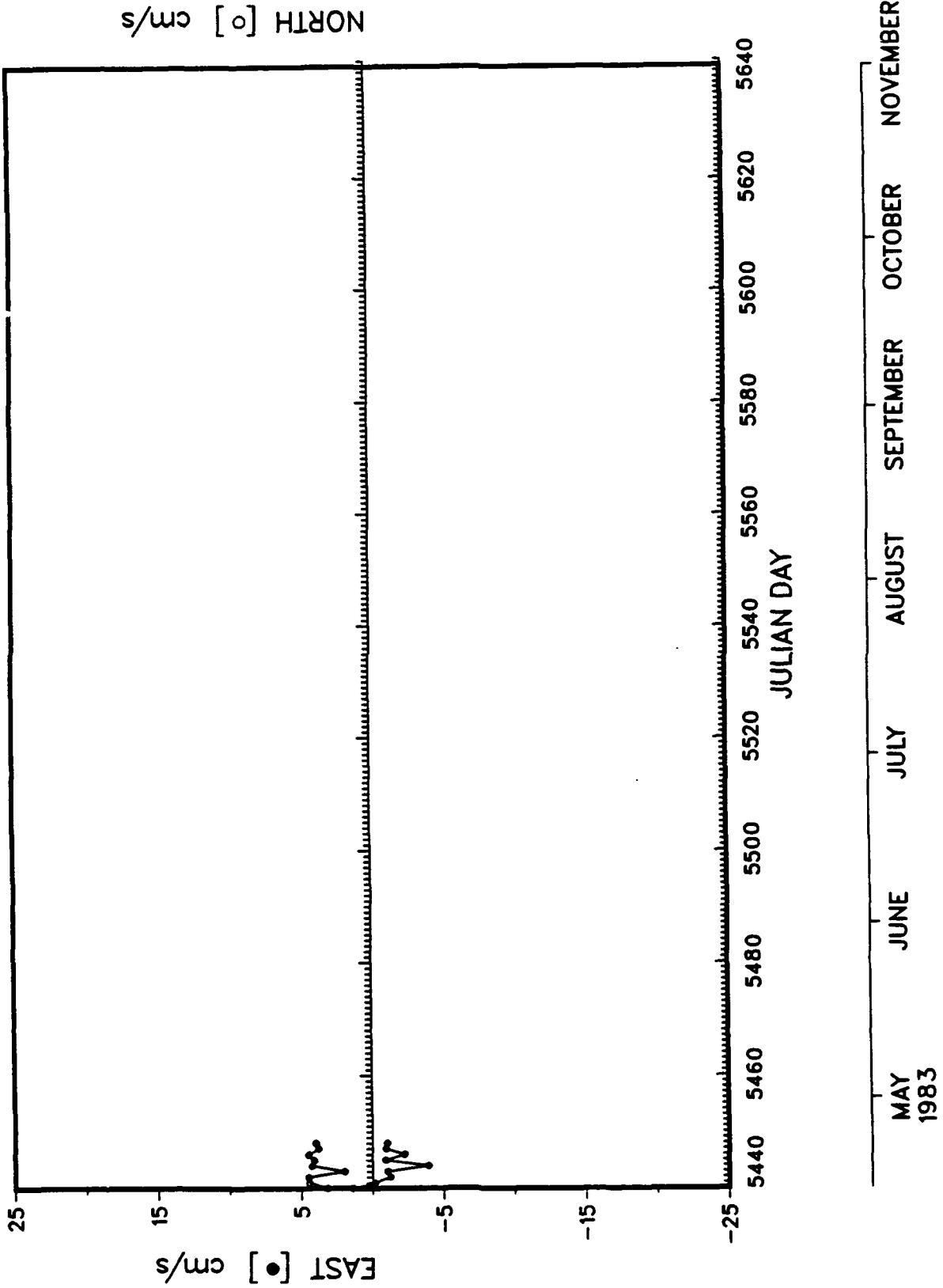


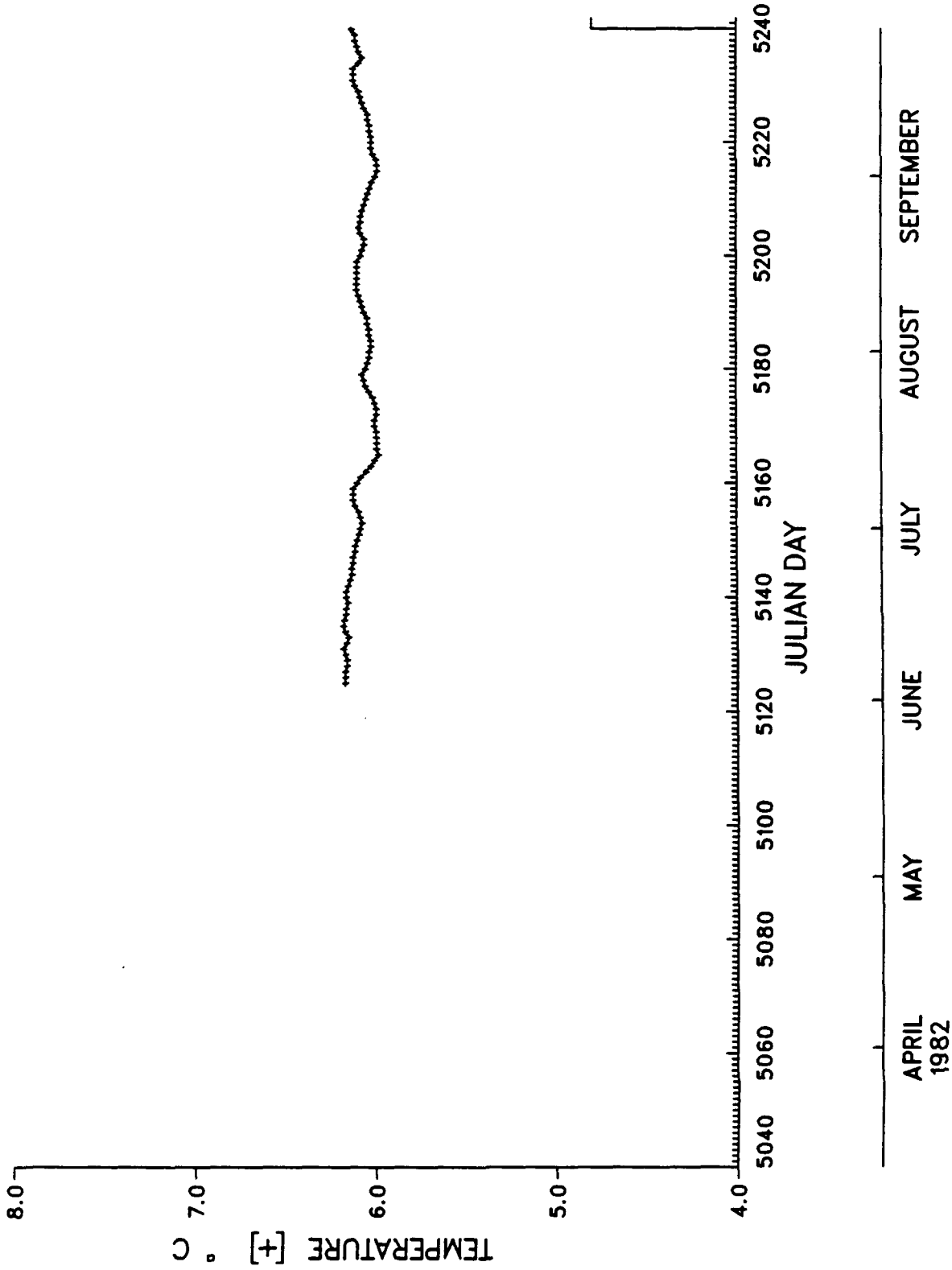
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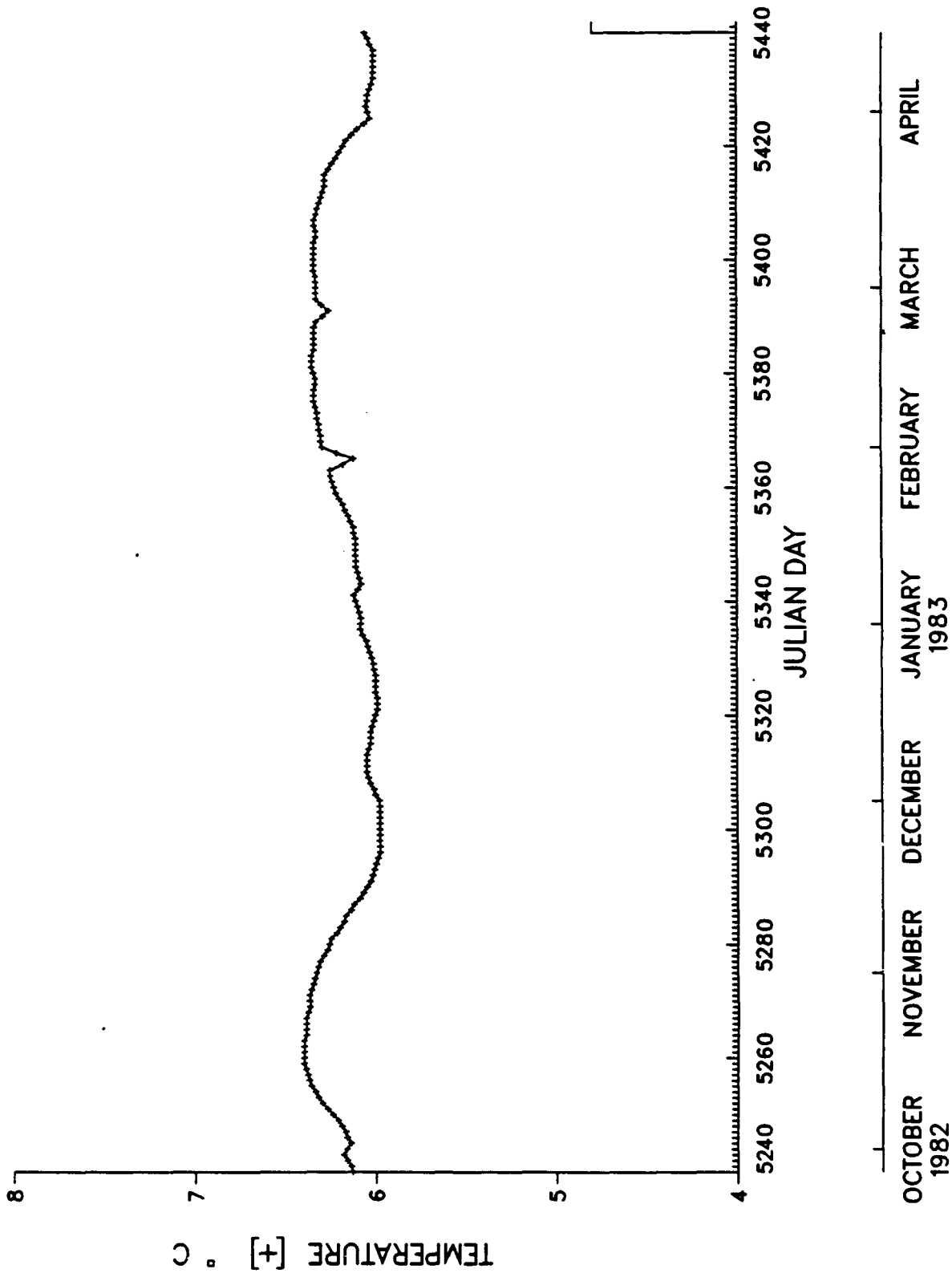


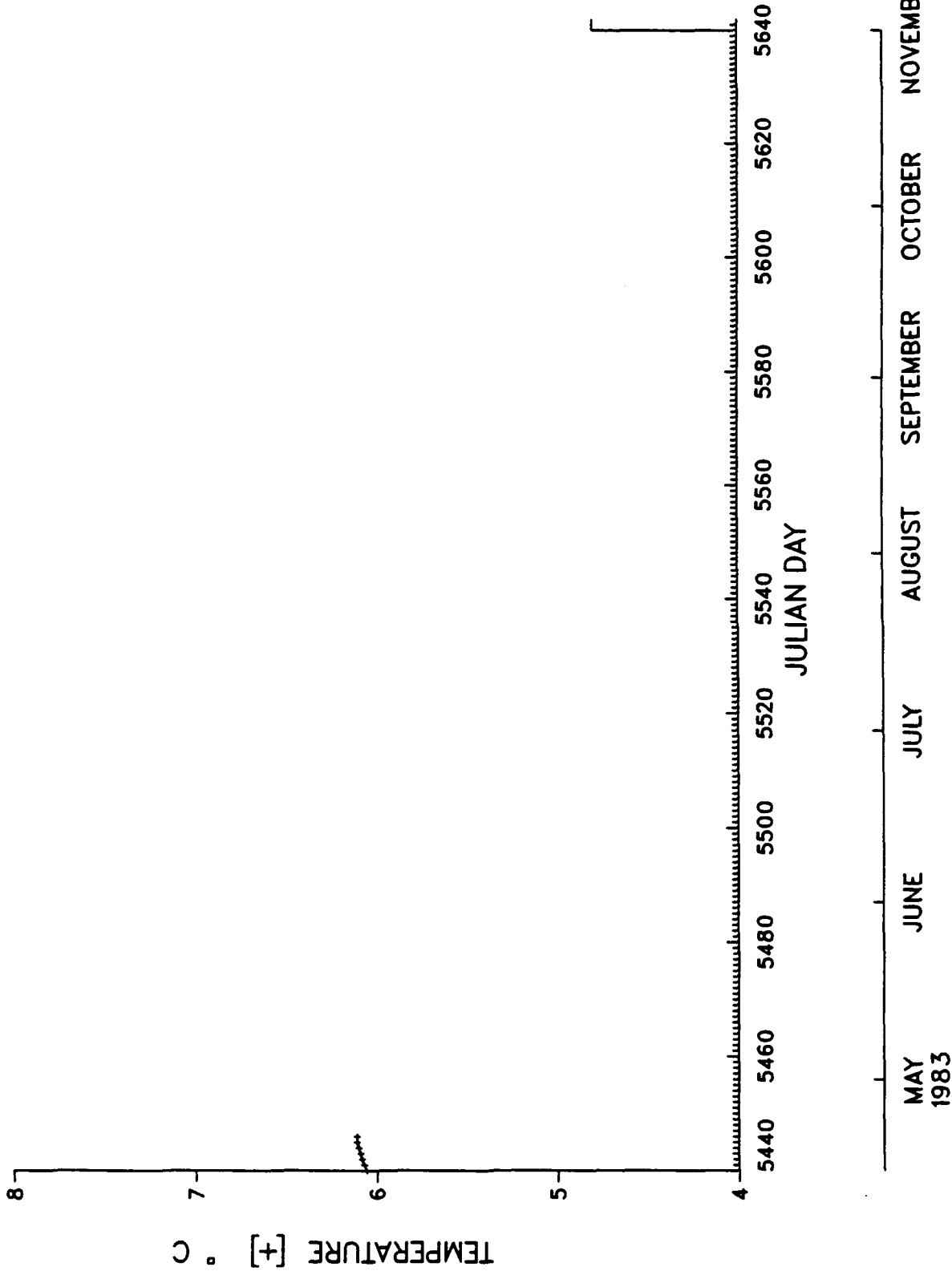
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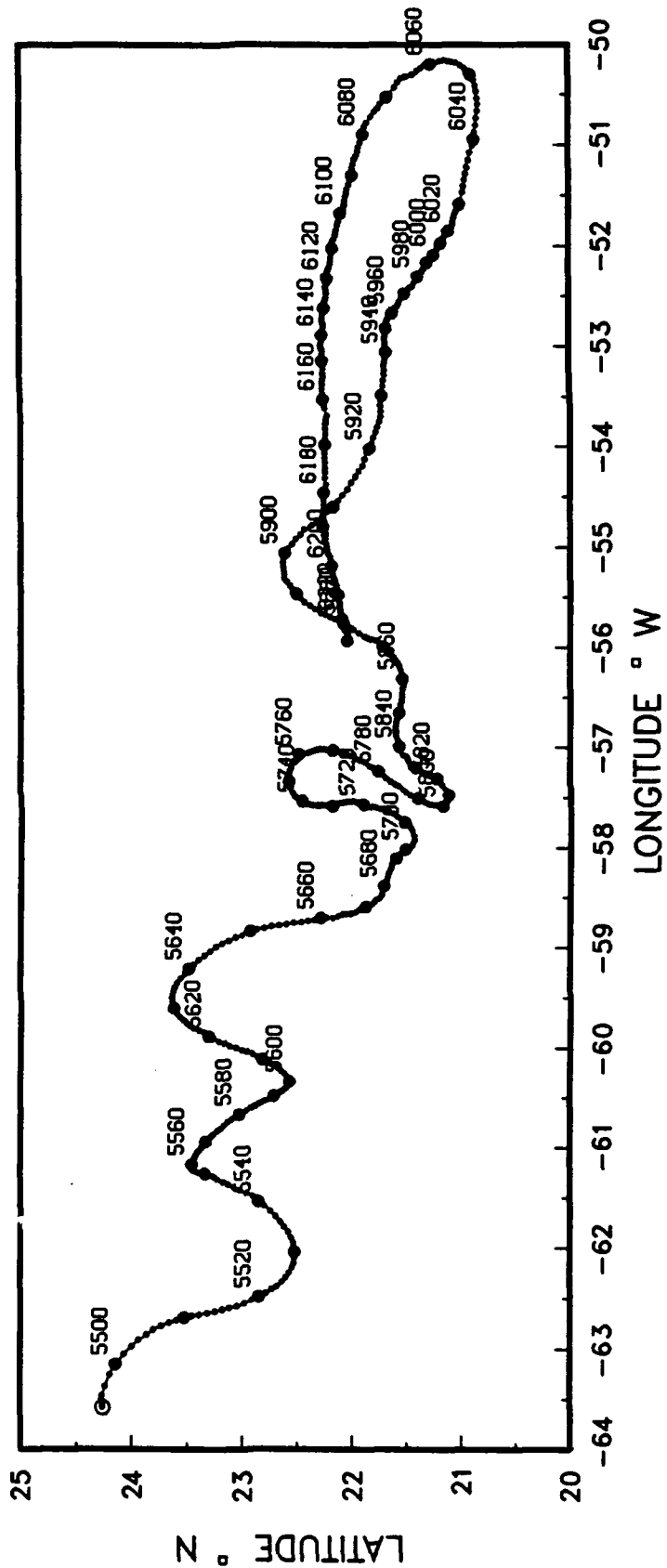


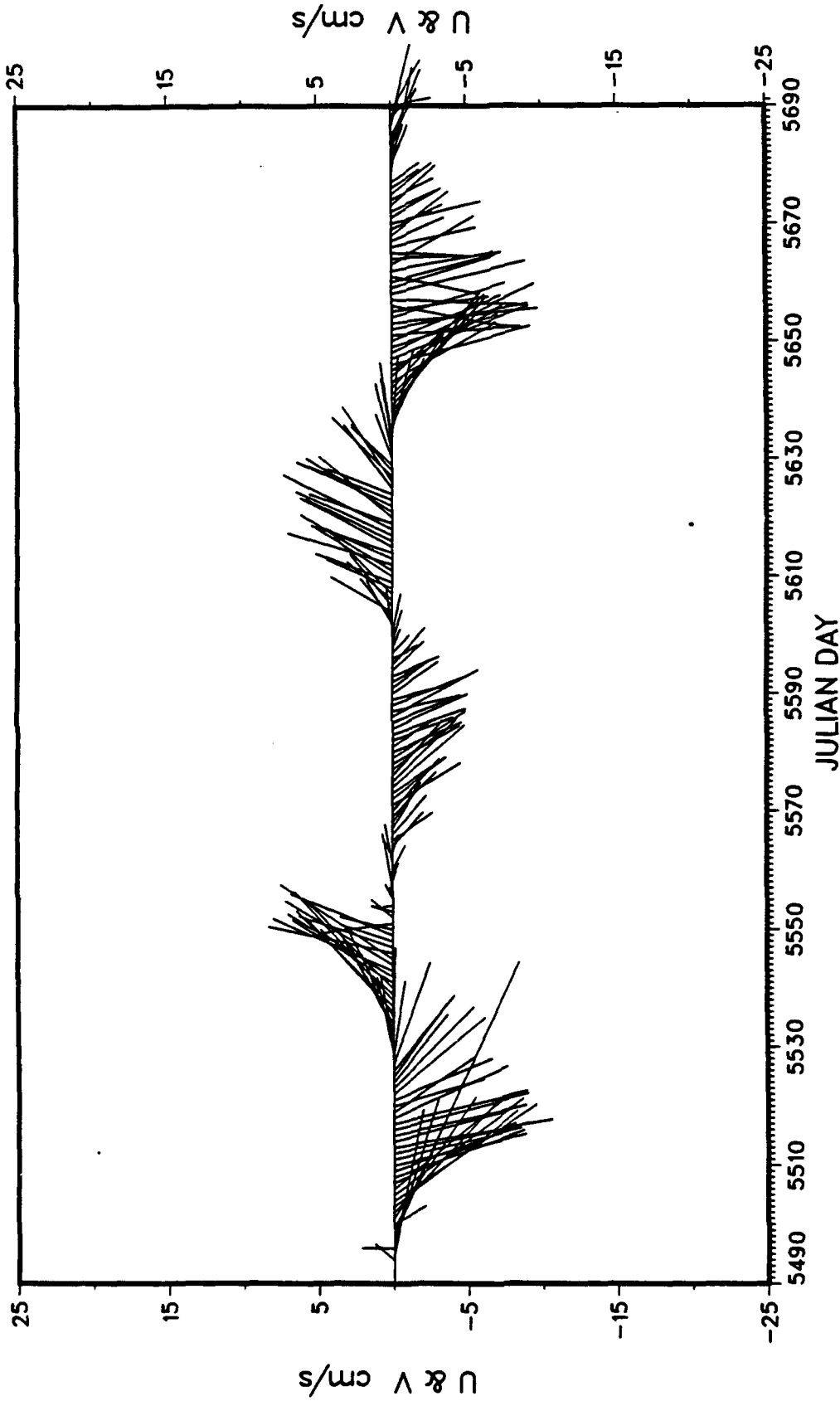
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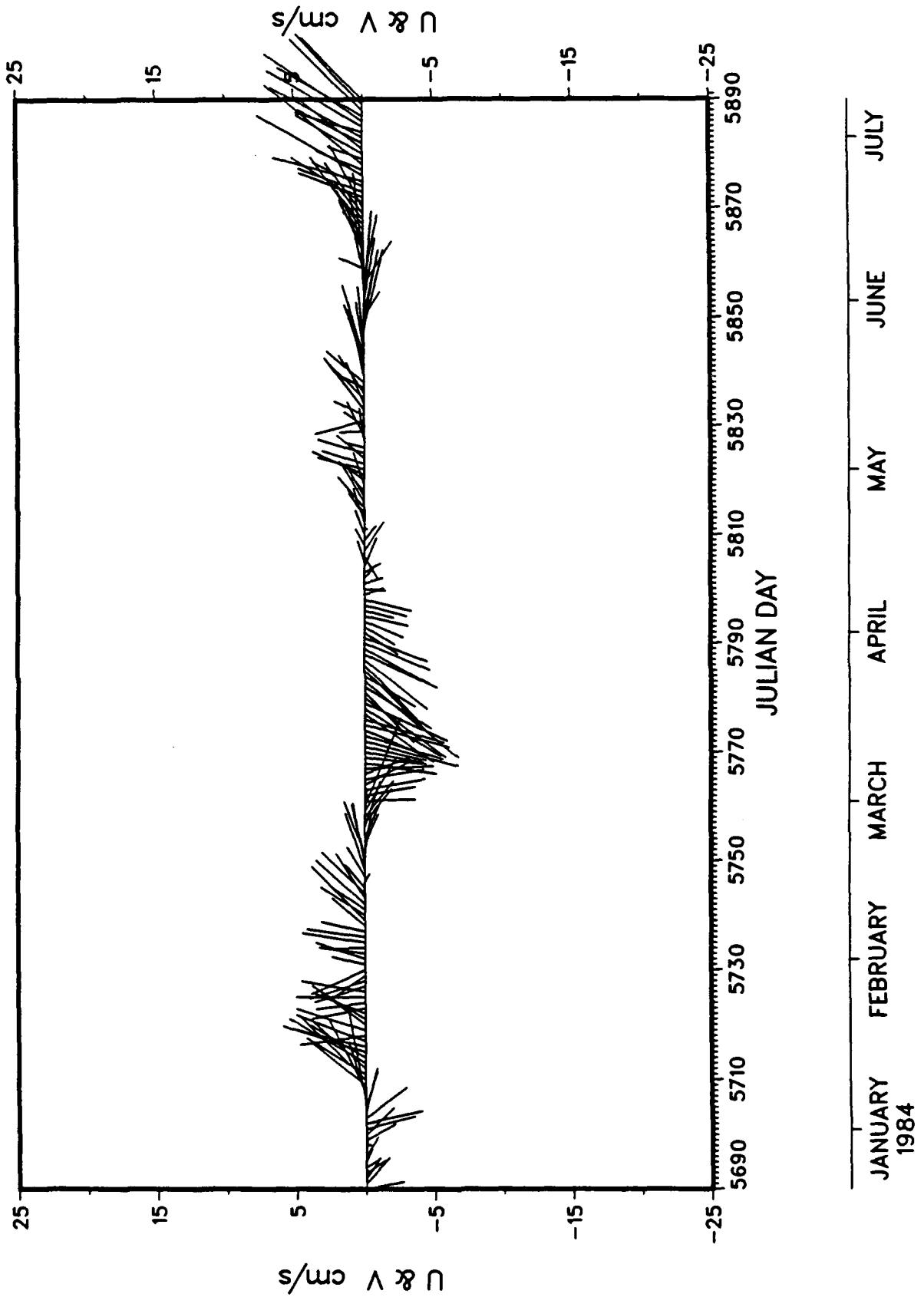


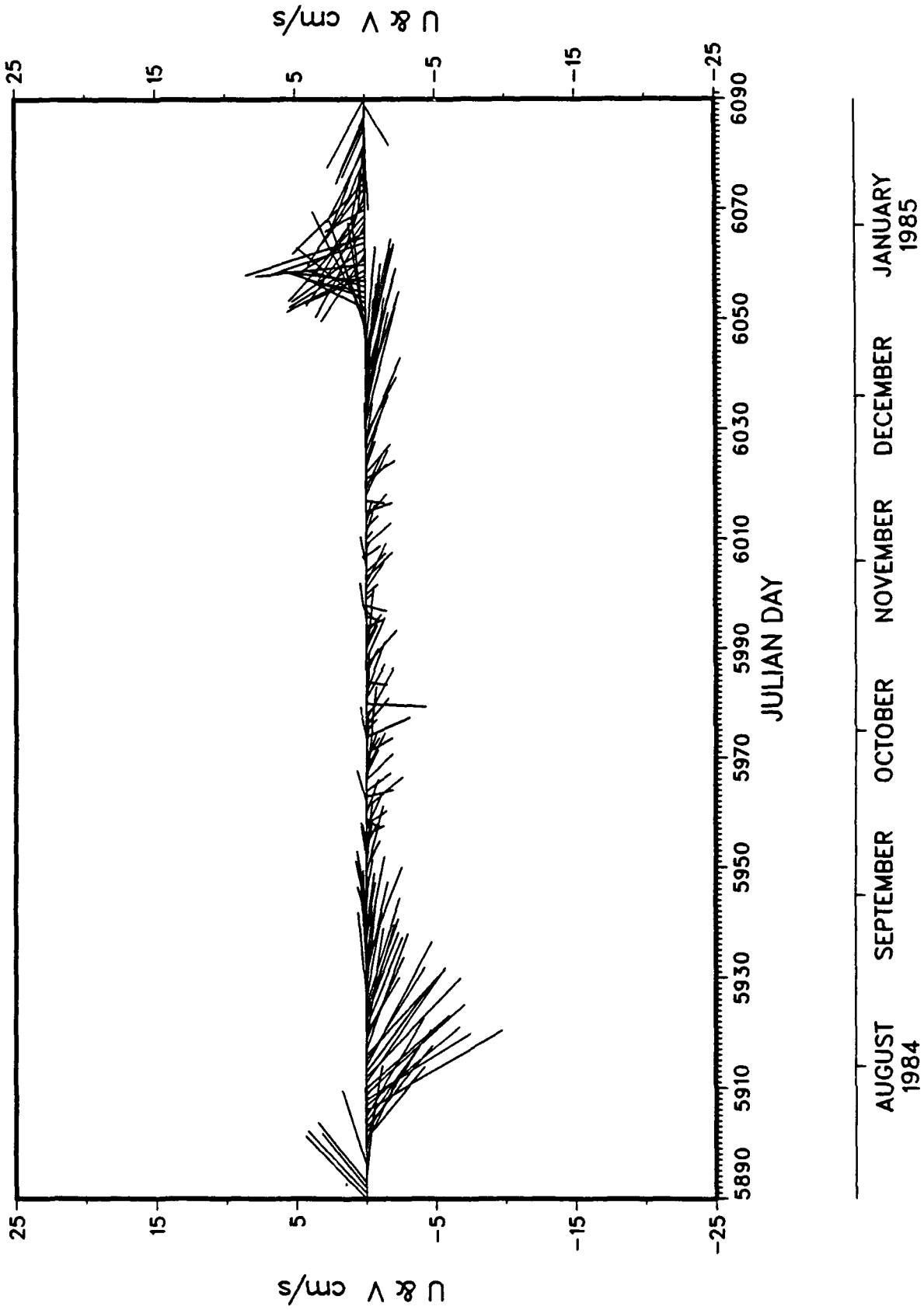
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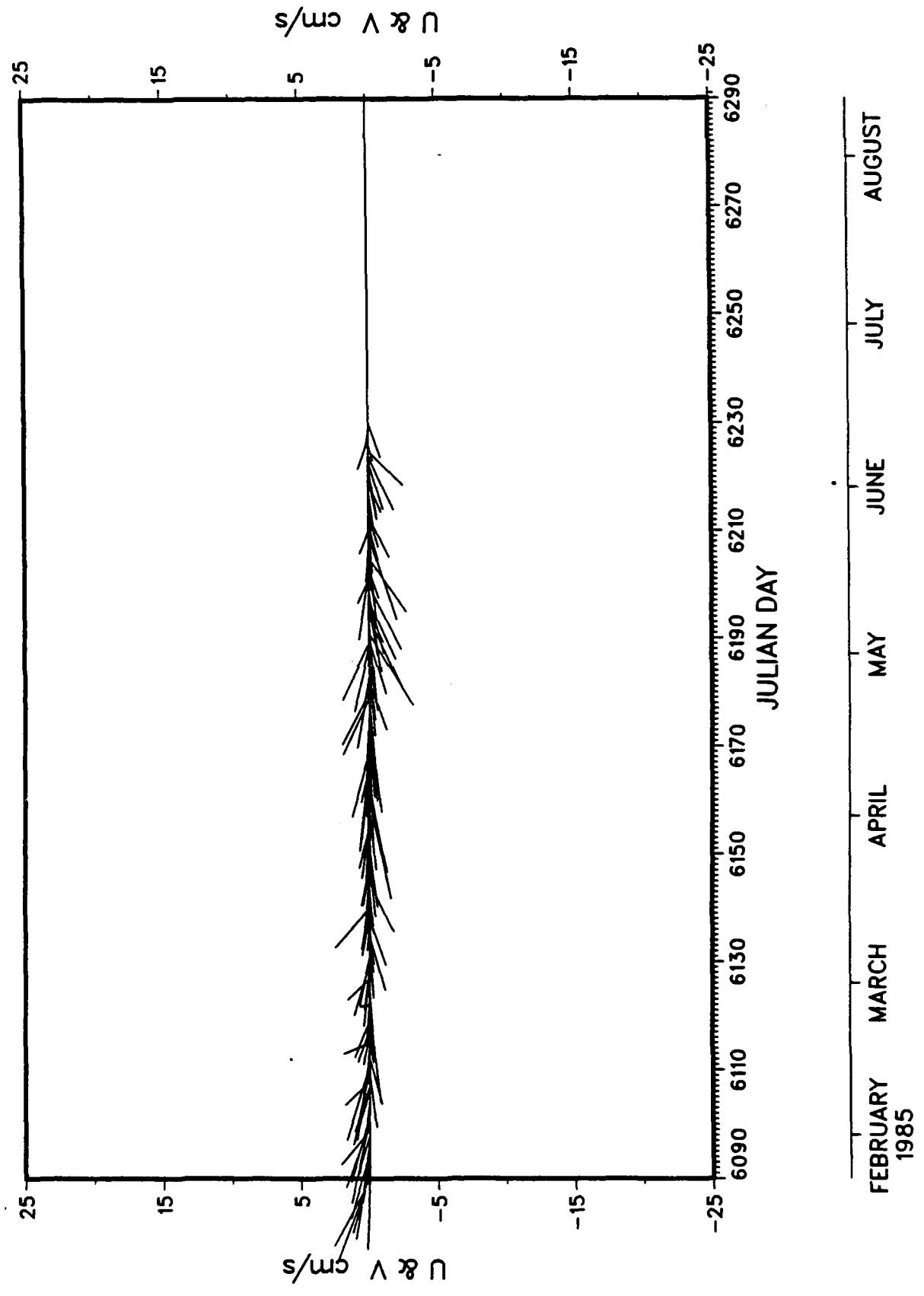


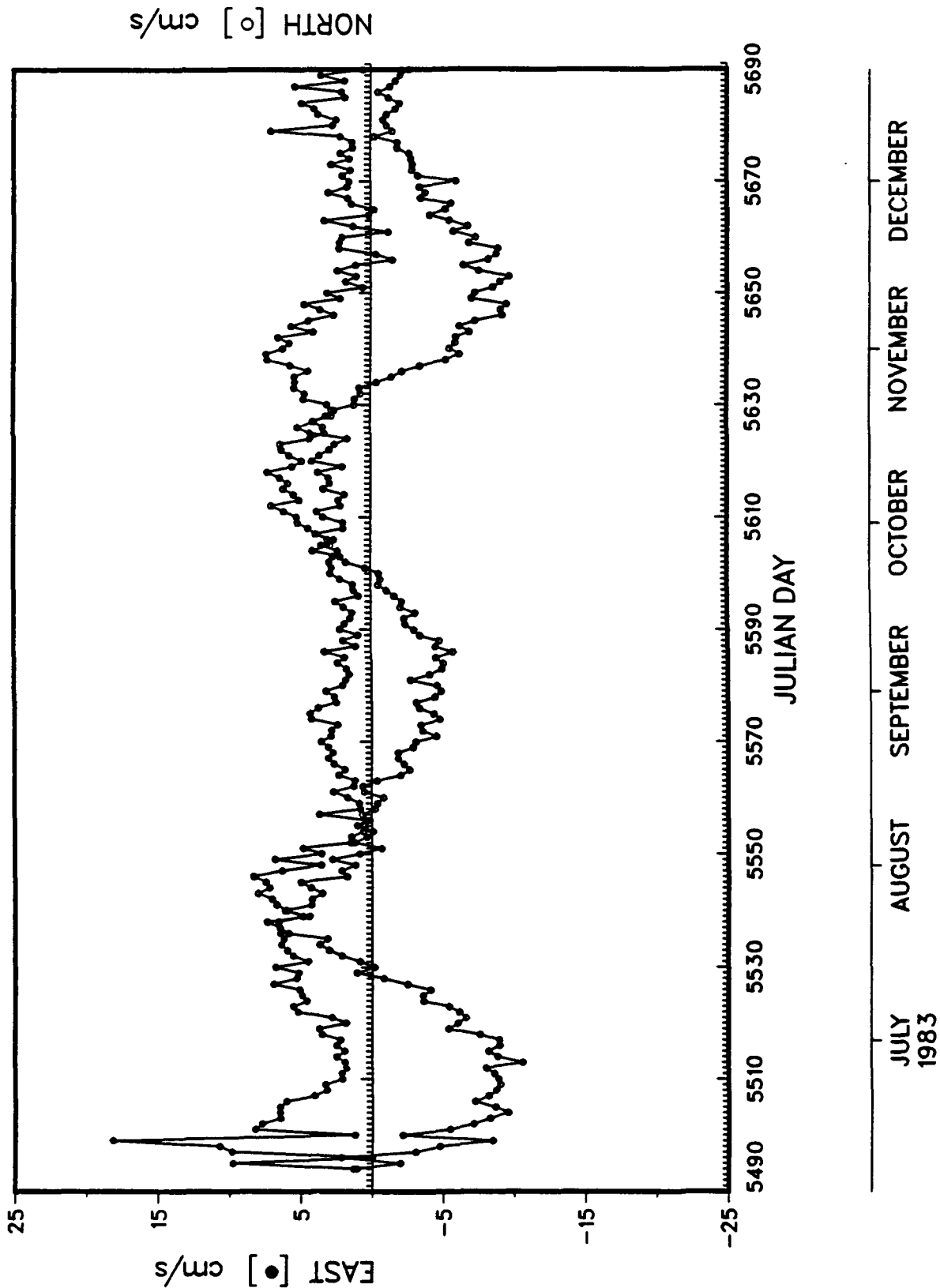
JULY AUGUST SEPTEMBER OCTOBER NOVEMBER DECEMBER
1983



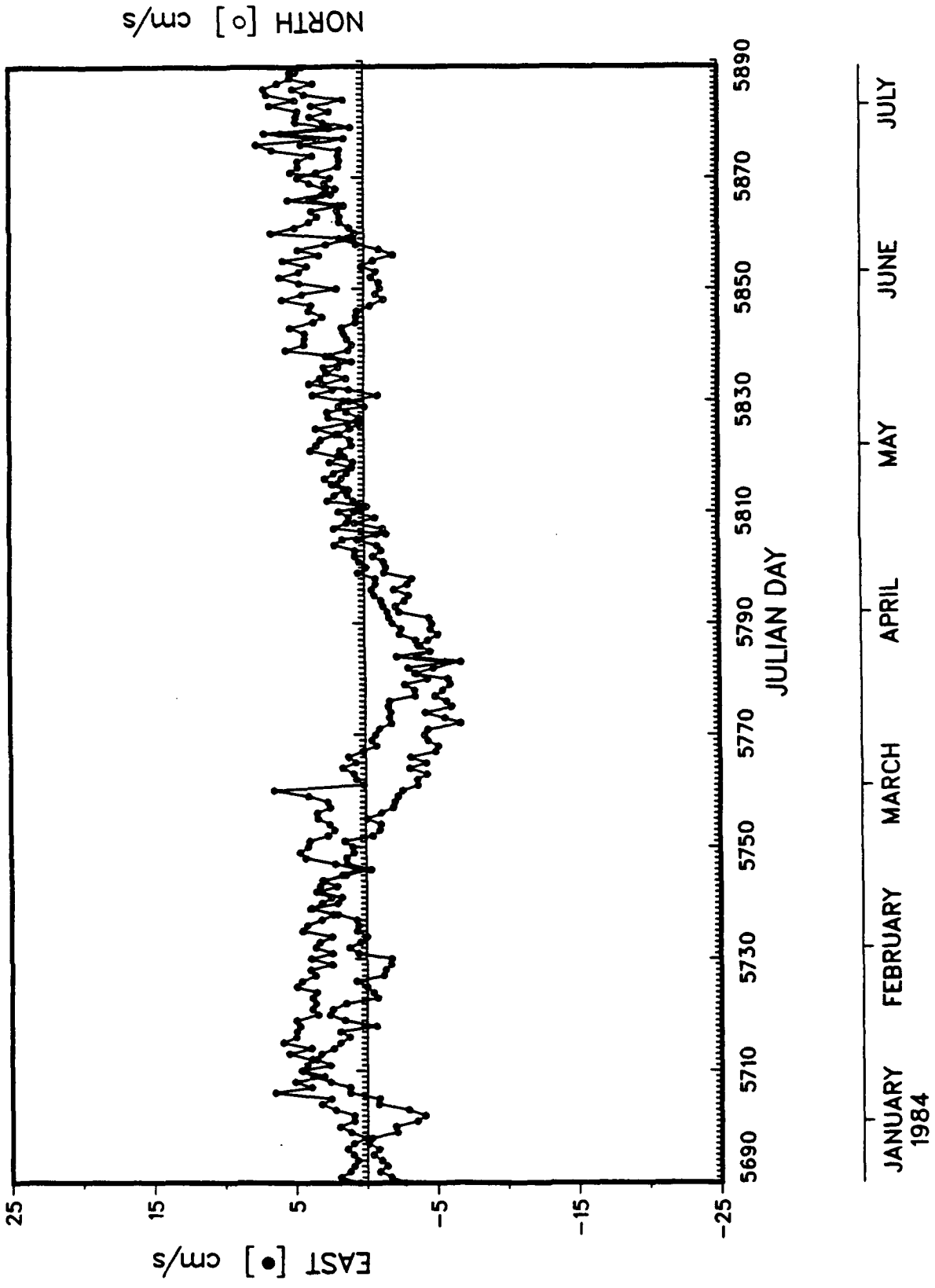


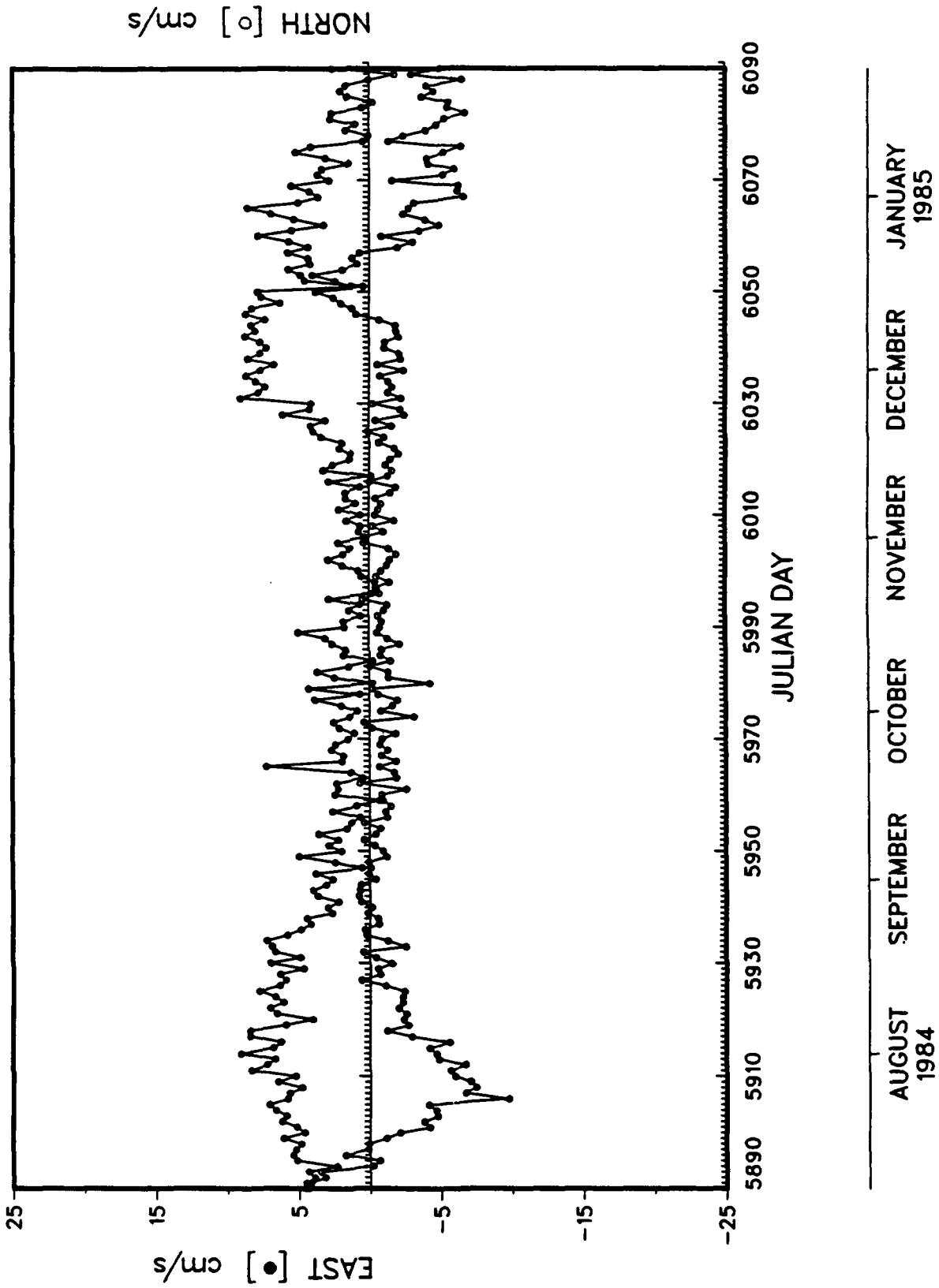
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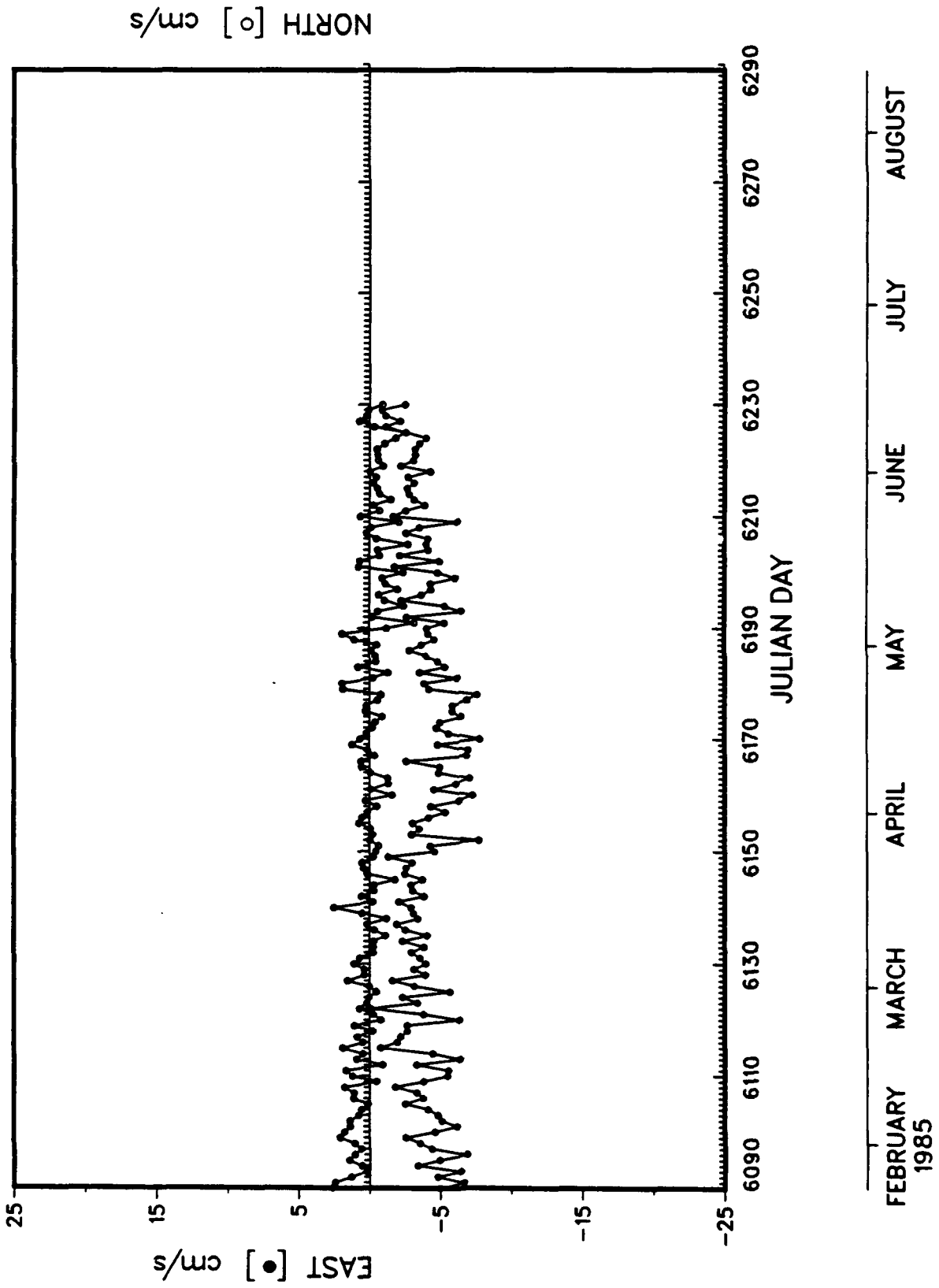


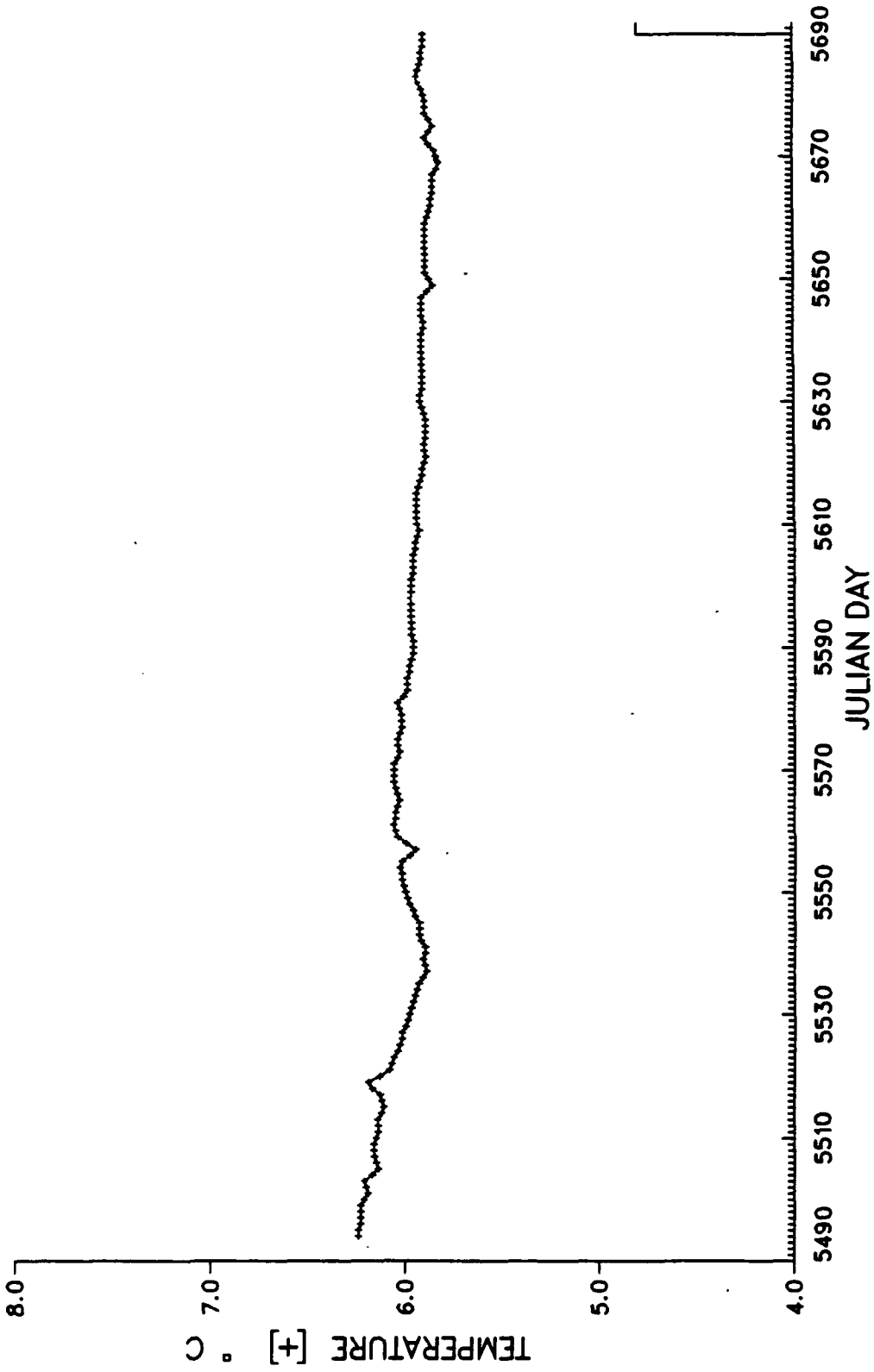
PRE LDE 12G





PRE LDE 12G

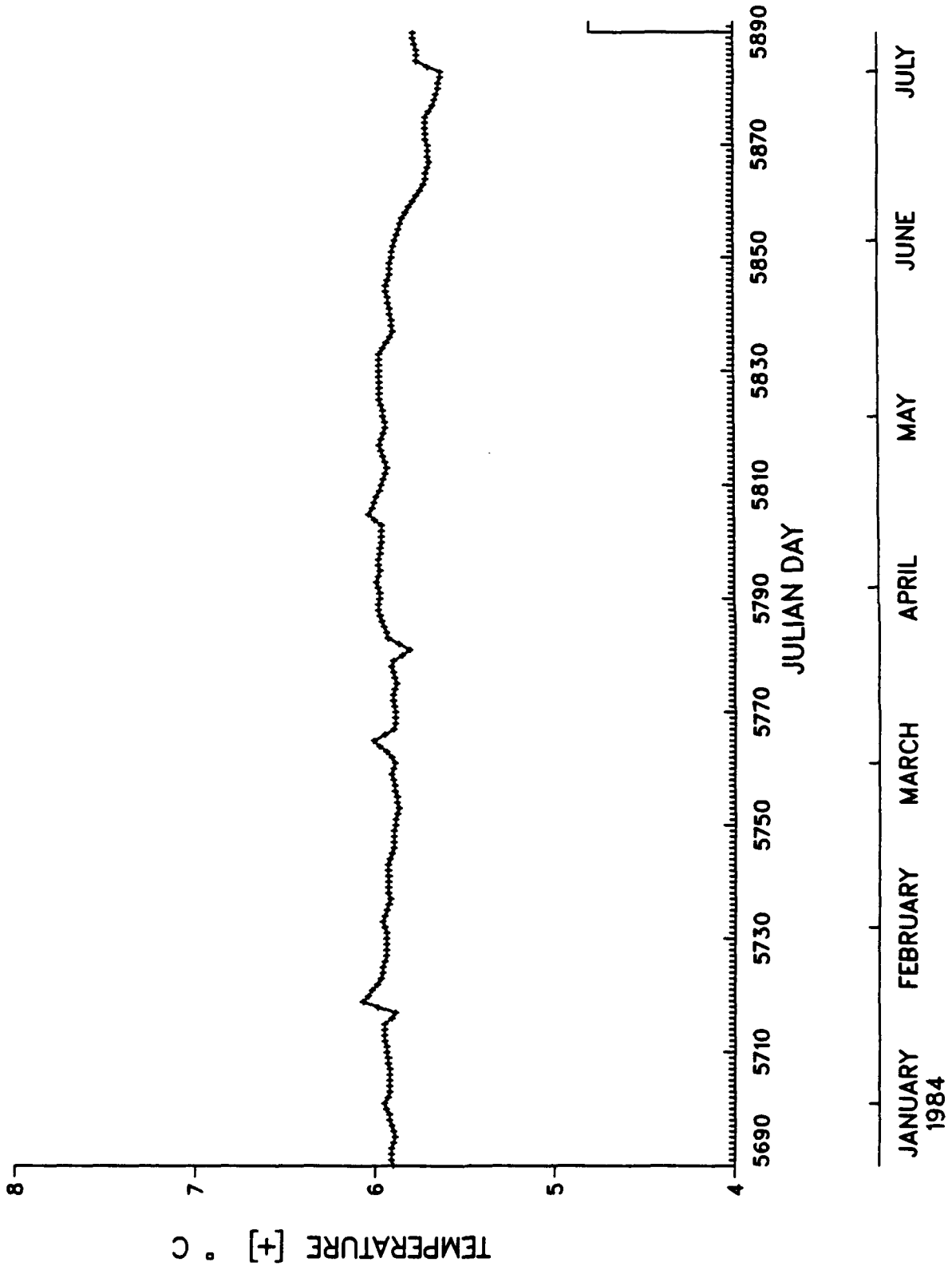


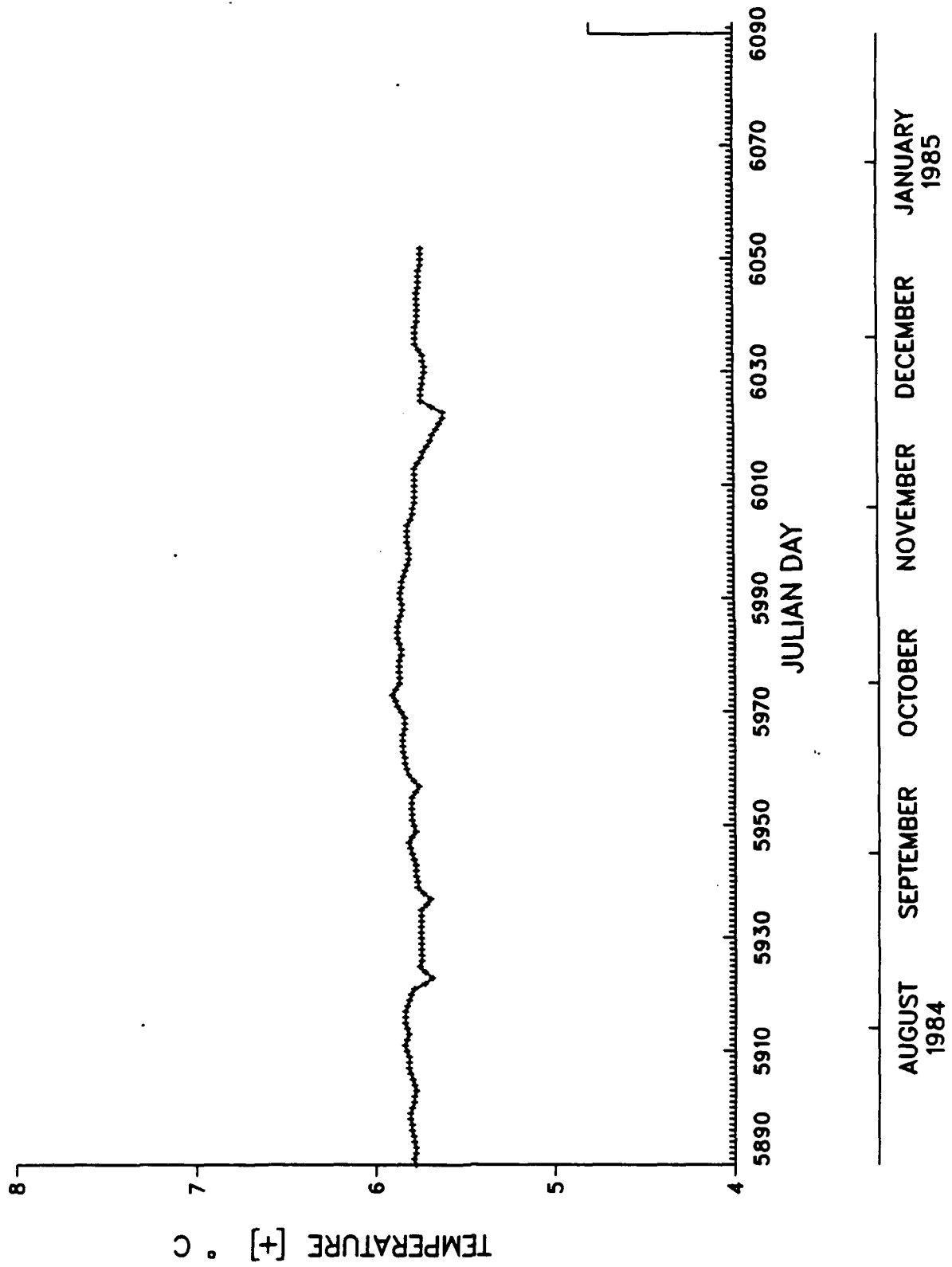


300

JULY AUGUST SEPTEMBER OCTOBER NOVEMBER DECEMBER
1983

PRE LDE 12G





APPENDIX B: Publications Using GUSREX Float Data

- Owens, W. B., 1984. A synoptic and statistical description of the Gulf Stream and subtropical gyre using SOFAR floats. *Journal of Physical Oceanography*, **14**, 104-113.
- Owens, W. B., P. L. Richardson, W. J. Schmitz, Jr., H. T. Rossby, and D. C. Webb, 1988. Nine-year trajectory of a SOFAR float in the southwestern North Atlantic. *Deep-Sea Research*, **35**, 1851-1857.
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**APPENDIX C: Calendar Conversion Tables —
1981 to 1986**

These tables give the year-day and truncated Julian day for each calendar date for the years 1981 through 1986. The truncated Julian days range from 4606 to 6796. To convert to true Julian day, add 2440000.5 to these numbers.

JUL

AUG

SEP

SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT
5	6	7	8	9	10	11	2	3	4	5	6	7	8	6	7	8	9	10	11	12
186	187	188	189	190	191	192	214	215	216	217	218	219	220	249	250	251	252	253	254	255
4791	4792	4793	4794	4795	4796	4797	4819	4820	4821	4822	4823	4824	4825	4854	4855	4856	4857	4858	4859	4860
12	13	14	15	16	17	18	9	10	11	12	13	14	15	13	14	15	16	17	18	19
193	194	195	196	197	198	199	221	222	223	224	225	226	227	256	257	258	259	260	261	262
4798	4799	4800	4801	4802	4803	4804	4826	4827	4828	4829	4830	4831	4832	4861	4862	4863	4864	4865	4866	4867
19	20	21	22	23	24	25	16	17	18	19	20	21	22	20	21	22	23	24	25	26
206	207	208	209	210	211	212	228	229	230	231	232	233	234	263	264	265	266	267	268	269
4805	4806	4807	4808	4809	4810	4811	4833	4834	4835	4836	4837	4838	4839	4868	4869	4870	4871	4872	4873	4874
26	27	28	29	30	31		23	24	25	26	27	28	29	27	28	29	30			
207	208	209	210	211	212		235	236	237	238	239	240	241	270	271	272	273			
4812	4813	4814	4815	4816	4817		4840	4841	4842	4843	4844	4845	4846	4875	4876	4877	4878			
							30	31												
							242	243												
							4847	4848												

OCT

NOV

DEC

SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT
4	5	6	7	8	9	10	1	2	3	4	5	6	7	6	7	8	9	10	11	12
277	278	279	280	281	282	283	305	306	307	308	309	310	311	340	341	342	343	344	345	346
4802	4803	4804	4805	4806	4807	4808	4910	4911	4912	4913	4914	4915	4916	4945	4946	4947	4948	4949	4950	4951
11	12	13	14	15	16	17	15	16	17	18	19	20	21	13	14	15	16	17	18	19
284	285	286	287	288	289	290	319	320	321	322	323	324	325	347	348	349	350	351	352	353
4809	4800	4801	4802	4803	4804	4805	4924	4925	4926	4927	4928	4929	4930	4952	4953	4954	4955	4956	4957	4958
18	19	20	21	22	23	24	22	23	24	25	26	27	28	20	21	22	23	24	25	26
291	292	293	294	295	296	297	326	327	328	329	330	331	332	354	355	356	357	358	359	360
4806	4807	4808	4809	4800	4801	4802	4931	4932	4933	4934	4935	4936	4937	4950	4950	4951	4952	4953	4954	4955
25	26	27	28	29	30	31	29	30						27	28	29	30			
298	299	300	301	302	303	304	333	334						361	362	363	364			
4903	4904	4905	4906	4907	4908	4909	4938	4939						4966	4967	4968	4969			

1982

JAN

SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT
					1	2		1	2	3	4	5	6		1	2	3	4	5	6
					4971	4972		32	33	34	35	36	37		60	61	62	63	64	65
					4977	4978	5008	5002	5003	5004	5005	5006	5007		5030	5031	5032	5033	5034	5035
3	4	5	6	7	8	9	7	8	9	10	11	12	13	7	8	9	10	11	12	13
3	4	5	6	7	8	9	38	39	40	41	42	43	44	66	67	68	69	70	71	72
4973	4974	4975	4976	4977	4978	4979	5008	5009	5010	5011	5012	5013	5014	5036	5037	5038	5039	5040	5041	5042
10	11	12	13	14	15	16	14	15	16	17	18	19	20	14	15	16	17	18	19	20
10	11	12	13	14	15	16	45	46	47	48	49	50	51	73	74	75	76	77	78	79
4980	4981	4982	4983	4984	4985	4986	5015	5016	5017	5018	5019	5020	5021	5043	5044	5045	5046	5047	5048	5049
17	18	19	20	21	22	23	21	22	23	24	25	26	27	21	22	23	24	25	26	27
17	18	19	20	21	22	23	52	53	54	55	56	57	58	80	81	82	83	84	85	86
4987	4988	4989	4990	4991	4992	4993	5022	5023	5024	5025	5026	5027	5028	5050	5051	5052	5053	5054	5055	5056
24	25	26	27	28	29	30	28	29	30					28	29	30	31			
24	25	26	27	28	29	30	59							87	88	89	90			
4994	4995	4996	4997	4998	4999	5000	5029							5057	5058	5059	5060			

FEB

MAR

31
31
5001

APR

SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT
					1	2		1	2	3	4	5	6		1	2	3	4	5	6
					5061	5062		91	92	93					152	153	154	155	156	157
					5068	5069	5092	5061	5062	5063	5064	5065	5066	5091	5122	5123	5124	5125	5126	5127
4	5	6	7	8	9	10	2	3	4	5	6	7	8	6	7	8	9	10	11	12
94	95	96	97	98	99	100	122	123	124	125	126	127	128	157	158	159	160	161	162	163
5064	5065	5066	5067	5068	5069	5070	5092	5093	5094	5095	5096	5097	5098	5127	5128	5129	5130	5131	5132	5133
11	12	13	14	15	16	17	9	10	11	12	13	14	15	13	14	15	16	17	18	19
101	102	103	104	105	106	107	129	130	131	132	133	134	135	164	165	166	167	168	169	170
5071	5072	5073	5074	5075	5076	5077	5099	5100	5101	5102	5103	5104	5105	5134	5135	5136	5137	5138	5139	5140
16	19	20	21	22	23	24	16	17	18	19	20	21	22	20	21	22	23	24	25	26
108	109	110	111	112	113	114	136	137	138	139	140	141	142	171	172	173	174	175	176	177
5078	5079	5080	5081	5082	5083	5084	5106	5107	5108	5109	5110	5111	5112	5141	5142	5143	5144	5145	5146	5147
25	26	27	28	29	30		23	24	25	26	27	28	29	27	28	29	30			
115	116	117	118	119	120		143	144	145	146	147	148	149	178	179	180	181			
5085	5086	5087	5088	5089	5090		5113	5114	5115	5116	5117	5118	5119	5148	5149	5150	5151			
							30	31												
							150	151												
							5120	5121												

JUN

MAY

SEP

AUG

JUL

SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT
4	5	6	7	8	9	10	8	9	10	11	12	13	14	5	6	7	8	9	10	11
185	186	187	188	189	190	191	220	221	222	223	224	225	226	248	249	250	251	252	253	254
5155	5156	5157	5158	5159	5160	5161	5190	5191	5192	5193	5194	5195	5196	5218	5219	5220	5221	5222	5223	5224
11	12	13	14	15	16	17	15	16	17	18	19	20	21	12	13	14	15	16	17	18
192	193	194	195	196	197	198	227	228	229	230	231	232	233	255	256	257	258	259	260	261
5162	5163	5164	5165	5166	5167	5168	5197	5198	5199	5200	5201	5202	5203	5225	5226	5227	5228	5229	5230	5231
18	19	20	21	22	23	24	22	23	24	25	26	27	28	19	20	21	22	23	24	25
199	200	201	202	203	204	205	234	235	236	237	238	239	240	262	263	264	265	266	267	268
5169	5170	5171	5172	5173	5174	5175	5204	5205	5206	5207	5208	5209	5210	5232	5233	5234	5235	5236	5237	5238
25	26	27	28	29	30	31	29	30	31					26	27	28	29	30		
206	207	208	209	210	211	212	241	242	243					269	270	271	272	273		
5176	5177	5178	5179	5180	5181	5182	5211	5212	5213					5239	5240	5241	5242	5243		

DEC

NOV

OCT

SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT
3	4	5	6	7	8	9	7	8	9	10	11	12	13	5	6	7	8	9	10	11
276	277	278	279	280	281	282	311	312	313	314	315	316	317	339	340	341	342	343	344	345
5246	5247	5248	5249	5250	5251	5252	5281	5282	5283	5284	5285	5286	5287	5309	5310	5311	5312	5313	5314	5315
10	11	12	13	14	15	16	14	15	16	17	18	19	20	12	13	14	15	16	17	18
283	284	285	286	287	288	289	318	319	320	321	322	323	324	346	347	348	349	350	351	352
5253	5254	5255	5256	5257	5258	5259	5288	5289	5290	5291	5292	5293	5294	5316	5317	5318	5319	5320	5321	5322
17	18	19	20	21	22	23	21	22	23	24	25	26	27	19	20	21	22	23	24	25
290	291	292	293	294	295	296	325	326	327	328	329	330	331	353	354	355	356	357	358	359
5260	5261	5262	5263	5264	5265	5266	5295	5296	5297	5298	5299	5300	5301	5323	5324	5325	5326	5327	5328	5329
24	25	26	27	28	29	30	28	29	30					26	27	28	29	30	31	
297	298	299	300	301	302	303	332	333	334					360	361	362	363	364	365	
5267	5268	5269	5270	5271	5272	5273	5302	5303	5304					5330	5331	5332	5333	5334	5335	

SEP

AUG

JUL

SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT
3	4	5	6	7	8	9	7	8	9	10	11	12	13	4	5	6	7	8	9	10
184	185	186	187	188	189	190	219	220	221	222	223	224	225	247	248	249	250	251	252	253
5519	5520	5521	5522	5523	5524	5525	5554	5555	5556	5557	5558	5559	5560	5582	5583	5584	5585	5586	5587	5588
10	11	12	13	14	15	16	14	15	16	17	18	19	20	11	12	13	14	15	16	17
191	192	193	194	195	196	197	226	227	228	229	230	231	232	254	255	256	257	258	259	260
5526	5527	5528	5529	5530	5531	5532	5561	5562	5563	5564	5565	5566	5567	5589	5590	5591	5592	5593	5594	5595
17	18	19	20	21	22	23	21	22	23	24	25	26	27	18	19	20	21	22	23	24
198	199	200	201	202	203	204	233	234	235	236	237	238	239	261	262	263	264	265	266	267
5533	5534	5535	5536	5537	5538	5539	5568	5569	5570	5571	5572	5573	5574	5596	5597	5598	5599	5600	5601	5602
24	25	26	27	28	29	30	28	29	30	31				25	26	27	28	29	30	
205	206	207	208	209	210	211	240	241	242	243				268	269	270	271	272	273	
5540	5541	5542	5543	5544	5545	5546	5575	5576	5577	5578				5603	5604	5605	5606	5607	5608	

31
212
5547

DEC

NOV

OCT

SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT
2	3	4	5	6	7	8	6	7	8	9	10	11	12	4	5	6	7	8	9	10
275	276	277	278	279	280	281	310	311	312	313	314	315	316	338	339	340	341	342	343	344
5610	5611	5612	5613	5614	5615	5616	5645	5646	5647	5648	5649	5650	5651	5673	5674	5675	5676	5677	5678	5679
9	10	11	12	13	14	15	13	14	15	16	17	18	19	11	12	13	14	15	16	17
282	283	284	285	286	287	288	317	318	319	320	321	322	323	345	346	347	348	349	350	351
5617	5618	5619	5620	5621	5622	5623	5652	5653	5654	5655	5656	5657	5658	5680	5681	5682	5683	5684	5685	5686
16	17	18	19	20	21	22	20	21	22	23	24	25	26	18	19	20	21	22	23	24
289	290	291	292	293	294	295	324	325	326	327	328	329	330	352	353	354	355	356	357	358
5624	5625	5626	5627	5628	5629	5630	5659	5660	5661	5662	5663	5664	5665	5687	5688	5689	5690	5691	5692	5693
23	24	25	26	27	28	29	27	28	29	30				25	26	27	28	29	30	31
296	297	298	299	300	301	302	331	332	333	334				359	360	361	362	363	364	365
5631	5632	5633	5634	5635	5636	5637	5666	5667	5668	5669				5694	5695	5696	5697	5698	5699	5700

30
303
5630

1984

JAN

SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT
1	2	3	4	5	6	7	5	6	7	8	9	10	11	4	5	6	7	8	9	10
5701	5702	5703	5704	5705	5706	5707	5736	5737	5738	5739	5740	5741	5742	5764	5765	5766	5767	5768	5769	5770
8	9	10	11	12	13	14	12	13	14	15	16	17	18	11	12	13	14	15	16	17
5708	5709	5710	5711	5712	5713	5714	5743	5744	5745	5746	5747	5748	5749	5771	5772	5773	5774	5775	5776	5777
15	16	17	18	19	20	21	19	20	21	22	23	24	25	18	19	20	21	22	23	24
5715	5716	5717	5718	5719	5720	5721	5750	5751	5752	5753	5754	5755	5756	5778	5779	5780	5781	5782	5783	5784
22	23	24	25	26	27	28	26	27	28	29	30	31	25	26	27	28	29	30	31	
5722	5723	5724	5725	5726	5727	5728	5757	5758	5759	5760				85	86	87	88	89	90	91
29	30	31												5785	5786	5787	5788	5789	5790	5791
5729	5730	5731																		

FEB

MAR

APR

MAY

JUN

SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT
1	2	3	4	5	6	7	6	7	8	9	10	11	12	3	4	5	6	7	8	9
5792	5793	5794	5795	5796	5797	5798	5827	5828	5829	5830	5831	5832	5833	5855	5856	5857	5858	5859	5860	5861
8	9	10	11	12	13	14	13	14	15	16	17	18	19	10	11	12	13	14	15	16
5799	5800	5801	5802	5803	5804	5805	5834	5835	5836	5837	5838	5839	5840	5862	5863	5864	5865	5866	5867	5868
15	16	17	18	19	20	21	20	21	22	23	24	25	26	17	18	19	20	21	22	23
5806	5807	5808	5809	5810	5811	5812	5841	5842	5843	5844	5845	5846	5847	5869	5870	5871	5872	5873	5874	5875
22	23	24	25	26	27	28	27	28	29	30	31			24	25	26	27	28	29	30
5813	5814	5815	5816	5817	5818	5819	5848	5849	5850	5851	5852			176	177	178	179	180	181	182
29	30													5876	5877	5878	5879	5880	5881	5882
5820	5821																			

JUL							AUG							SEP														
SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT								
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210	211
5883	5884	5885	5886	5887	5888	5889	5890	5891	5892	5893	5894	5895	5896	5897	5898	5899	5900	5901	5902	5903	5904	5905	5906	5907	5908	5909	5910	5911

1986

JAN							FEB							MAR							
SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	
			1	2	3	4							1								1
			1	2	3	4							32								60
			6432	6433	6434	6435							6463								6491
5	6	7	8	9	10	11	2	3	4	5	6	7	8	2	3	4	5	6	7	8	
5	6	7	8	9	10	11	33	34	35	36	37	38	39	61	62	63	64	65	66	67	
6436	6437	6438	6439	6440	6441	6442	6464	6465	6466	6467	6468	6469	6470	6492	6493	6494	6495	6496	6497	6498	
12	13	14	15	16	17	18	9	10	11	12	13	14	15	9	10	11	12	13	14	15	
12	13	14	15	16	17	18	40	41	42	43	44	45	46	68	69	70	71	72	73	74	
6443	6444	6445	6446	6447	6448	6449	6471	6472	6473	6474	6475	6476	6477	6499	6500	6501	6502	6503	6504	6505	
19	20	21	22	23	24	25	16	17	18	19	20	21	22	16	17	18	19	20	21	22	
19	20	21	22	23	24	25	47	48	49	50	51	52	53	75	76	77	78	79	80	81	
6450	6451	6452	6453	6454	6455	6456	6478	6479	6480	6481	6482	6483	6484	6506	6507	6508	6509	6510	6511	6512	
26	27	28	29	30	31		23	24	25	26	27	28	29	23	24	25	26	27	28	29	
26	27	28	29	30	31		54	55	56	57	58	59	60	82	83	84	85	86	87	88	
6457	6458	6459	6460	6461	6462		6485	6486	6487	6488	6489	6490	6491	6513	6514	6515	6516	6517	6518	6519	

APR							MAY							JUN							
SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	
			1	2	3	4							1								1
			91	92	93	94							2								2
			6522	6523	6524	6525							6554								6584
6	7	8	9	10	11	12	4	5	6	7	8	9	10	8	9	10	11	12	13	14	
96	97	98	99	100	101	102	124	125	126	127	128	129	130	159	160	161	162	163	164	165	
6527	6528	6529	6530	6531	6532	6533	6555	6556	6557	6558	6559	6560	6561	6590	6591	6592	6593	6594	6595	6596	
13	14	15	16	17	18	19	11	12	13	14	15	16	17	15	16	17	18	19	20	21	
103	104	105	106	107	108	109	131	132	133	134	135	136	137	166	167	168	169	170	171	172	
6534	6535	6536	6537	6538	6539	6540	6562	6563	6564	6565	6566	6567	6568	6597	6598	6599	6600	6601	6602	6603	
20	21	22	23	24	25	26	18	19	20	21	22	23	24	22	23	24	25	26	27	28	
110	111	112	113	114	115	116	138	139	140	141	142	143	144	173	174	175	176	177	178	179	
6541	6542	6543	6544	6545	6546	6547	6569	6570	6571	6572	6573	6574	6575	6604	6605	6606	6607	6608	6609	6610	
27	28	29	30				25	26	27	28	29	30	31	29	30						
117	118	119	120				145	146	147	148	149	150	151	180	181						
6546	6549	6550	6551				6576	6577	6578	6579	6580	6581	6582	6611	6612						

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