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REPORT 169

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1985

COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANIZATION
MARINE LABORATORIES
G.P.O. BOX 1538, HOBART, TAS. 7001, AUSTRALIA

National Library of Australia Cataloguing-in-Publication Entry

Current meter data from the Australian Coastal Experiment.

Bibliography.

ISBN 0 643 03653 9.

1. Ocean currents—Australia—Observations. 2. Ocean temperature—Australia—Observations. I. Freeland, Howard J. II. Commonwealth Scientific and Industrial Research Organization, Australia. Marine Laboratories. (Series: Report (Commonwealth Scientific and Industrial Research Organization, Australia. Marine Laboratories); no. 169).

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CURRENT METER DATA FROM THE AUSTRALIAN COASTAL EXPERIMENT; A DATA REPORT

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CSIRO Marine Laboratories Report No. 169 (1985)

Abstract

This report presents current meter data acquired by three groups during an international experiment known as the Australian Coastal Experiment (ACE). Data presented are plots for each instrument recovered of current velocity (vectors and components) and in situ temperature, all low-passed to eliminate tidal and other high-frequency signals.

Introduction

During 1983/84, 50 current meters were deployed on 17 moorings off the coasts of New South Wales and Tasmania as part of a large international experiment called the Australian Coastal Experiment (ACE). The purpose of the experiment was to prove the dynamics of coastal trapped waves (Clarke and Thompson, 1984), and to this end most of the moorings were deployed along three lines at right angles to the coastline and extending across the continental shelf and slope. Each of the three main lines comprised 5 moorings, with 15 current meters along each line. Two additional moorings were deployed: one near Maria Island, on the east coast of Tasmania; one near Coffs Harbour, northern New South Wales. The former is to the south and the latter to the north of the main experiment. Figure 1, a map of southeastern Australia with major land marks included for reference, shows the approximate positions of the current meter mooring sites.

Other data also gathered as part of ACE are salinity, temperature, pressure profiles (White and Church, 1985), meteorological and sea level data (Forbes, 1985 a and b), satellite-tracked buoy data (Cresswell et al., 1985), infrared satellite photographs and expendable bathythermograph (from ship and airplane) data. This report will present the current meter data only.

Instrument deployment

All current meters were Aanderaa instruments (mostly RCM4s, but several were RCM5s) deployed on moorings with subsurface buoyancy. Table 1 lists the deployment location of each mooring together with the depths of the current meters on each mooring. In Table 1, and in subsequent notes, the three principal lines are labelled 1, 2 and 3 from south to north. The two other moorings are designated lines 0 and 4 to fit this convention. Each of the lines of moorings had identical nominal configuration, so the moorings are numbered 1 through 5 along each line from inshore to offshore. Thus mooring 24 uniquely designates line 2, 4th mooring from the coast.

Individual current meters are mnemonically coded in the computer files; the same convention is adopted in this report. A file labelled fNMsDEPTH indicates: f - for filtered file; line # N; mooring # M; s (for "slash") to separate different fields of information ; and DEPTH is the actual instrument depth in metres. For lines 0 and 4 the lone mooring was equivalent to moorings #2 on the 3 main lines and so is also designated #2. Table 2 illustrates, with the aid of bar diagrams, the periods of time for which current meter data exist at each site.

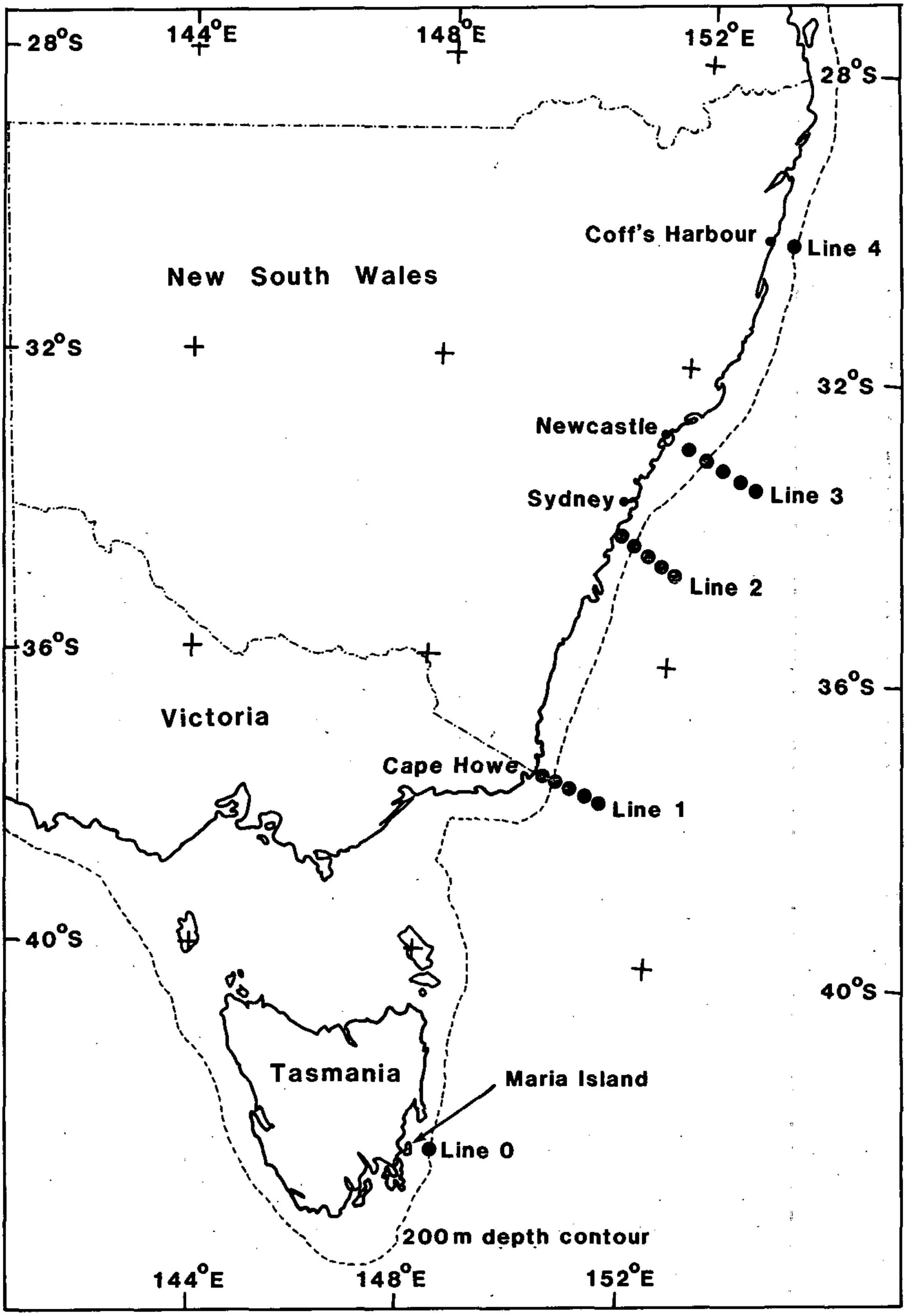


Figure 1 Approximate locations of mooring sites along the east coast of Australia

Table 1 Mooring statistics

Line #	Mooring #	Latitude	Longitude	Distance offshore **	Water depth	Instruments (depth in m)
0	2	42°40.1'S	148°27.1'E		200	125, 190
1	1	37°32.4'S	150°11.0'E	18.3	140	75, 125
1	2	37°32.4'S	150°14.4'E	22.9	201	75, (125), 190
1	3	37°32.5'S	150°17.8'E	27.5	500	125, 190, 450
1	4*					(190), (450), (650), (1000)
1	5	37°35.1'S	150°24.9°E	38.9	2270	720, 1270, 2170
2	1	34°19.7'S	151°11.5'E	20.7	142	82, 132
2	2	34°23.0'S	151°17.9'E	32.6	212	87, 137, 202
2	3	34°25.2'S	151°20.2'E	36.6	500	125, 190, 450
2	4	34°27.3'S	151°28.8'E	50.9	1290	280, 540, 740, 1090
2	5	34°28.5'S	151°33.8'E	58.8	1910	360, 910, 1810
3	1	33°07.0'S	152°09.0'E	39.3	134	75, 125
3	2	33°11.1'S	152°17.9'E	54.9	200	75, 125, 190
3	3	33°12.8'S	152°19.7'E	59.1	500	125, 190, 450
3	4	33°15.0'S	152°24.5'E	67.5	1193	190, 450, 650, 1000
3	5	33°17.5'S	152°26.8'E	73.1	1990	450, 1000, 1900
4	2	29°00.4'S	153°50.3'E		202	(75), 125, 190

* mooring not recovered
( ) indicates zero data returned
** in km from 20 m isobath

Data recovery and commentary

Mooring 02: This mooring was deployed later and recovered later than the other ACE moorings. The raw, pre-filtered data from 190 m appeared to have a character rather different from that at 125 m; however, we could find no fault with either instrument and no reason for discarding data from one site or the other. Data return was 100% on both instruments deployed.

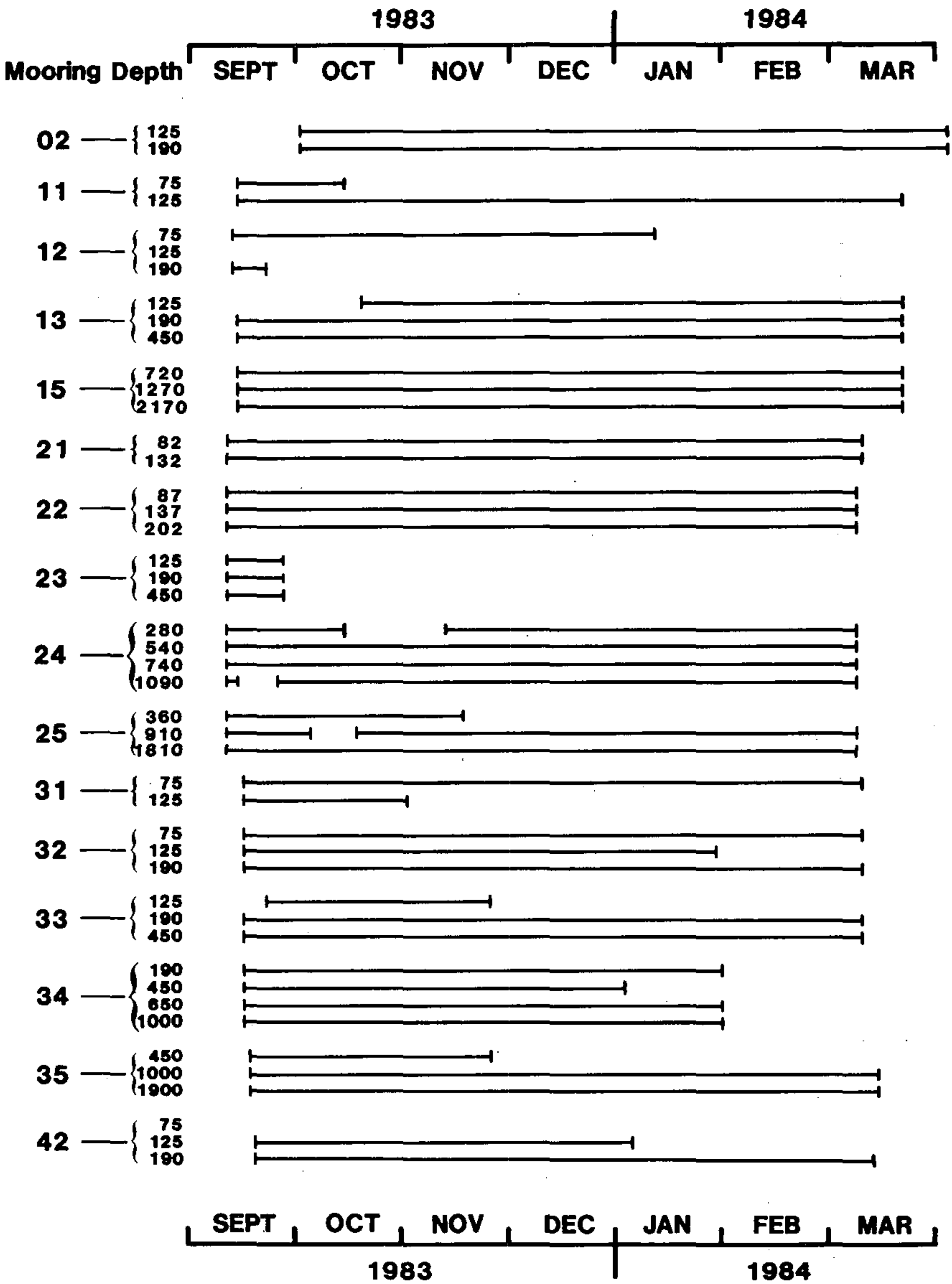
Mooring 11: This mooring, along with all other line 1 moorings, was initially deployed with an incorrect rotor counter setting. The moorings were recovered in October 1983, the instruments reset and the moorings redeployed. The data gaps that resulted were all small and easily filled, by linear interpolation, prior to filtering. The shallow instrument on mooring 11 returned data on the first deployment only.

Mooring 12: This mooring was set adrift, probably by a fishing vessel, in early January of 1984. The top current meter was recovered at sea and produced good data. However, no data was returned from the 125 m instrument on the first deployment and neither the 125 m nor the 190 m instruments from the second deployment was ever found.

Mooring 13: The shallow meter did not produce data on the first deployment; however, all other data are good.

Mooring 14: This mooring has never been recovered. The reason is not known.

Table 2 Periods for which data exist at individual current meter sites



Mooring 15: This site had no instrument problems and scored a perfect data return. However, the instruments were nearly 300 m deeper than intended during the second deployment period. The assigned depths are based on the pressure records of the upper two instruments after the October 1983 redeployment.

Mooring 21: This mooring was moved by a fishing vessel to water 7 m deeper than intended. However, the data return is almost perfect. The Savonius rotor on the shallow meter appears to have been too tight and the rotor stalled during periods of weak flow. At other times, speeds corresponded well with those at neighbouring sites and the rotor appeared to be performing well. The resulting data gaps were short and filled before filtering. There are no gaps in the filtered records.

Mooring 22: This mooring was deployed in water 12 m too deep; hence an instrument aimed to be at 75 m depth is listed as f22s87 etc. Data return was 100%.

Mooring 23: Near the beginning of October 1983 this mooring was set adrift, probably by a fishing vessel. The mooring was replaced with equipment that was never recovered.

Mooring 24: This mooring was launched in water 90 m too deep. The instruments at 280 m and 1090 m depth showed periods of time when, for whatever reason, the Savonius rotor stalled. For the shallow instrument this occurred during a period of weak flow, but for the deep one high speeds caused excessive instrument tilt and rotor stalling. The resulting gaps are too large to fill in any reasonable way. Excessive tilt of the 1090 m mooring during days 150 to 180 make this period of the record questionable.

Mooring 25: This mooring was launched in water too shallow by 90 m. The shallow instrument lost its rotor in mid-November 1983 and the one at 910 m suffered from a fouled or seized rotor for a lengthy period near the beginning of October 1983.

Mooring 31: This mooring was launched and recovered in good order. However, the mooring was apparently hit by a fishing vessel early in November 1983. The shallow instrument was undamaged, but the gimbal on the deep instrument was bent and it began reporting suspicious directions. It then developed an electrical fault. No data were retained for the period following the "hit" at the deep current meter.

Mooring 32: This mooring was launched and recovered in good order. The centre instrument, however, lost its rotor during an intense burst of speed at the end of January 1984.

Mooring 33: This mooring was launched and recovered in good order. The shallow instrument, at 125 m, lost its rotor during an intense burst of speed in November 1983.

Mooring 34: This mooring was subjected to particularly intense currents. These caused large vertical excursions of the top end of the mooring that resulted in the top two (ORE steel sphere) buoys imploding near the end of January 1984. Prior to that event, the instrument at 450 m lost its rotor near the beginning of December 1983. After the buoys imploded, the top of the mooring was too heavy and most of the mooring lay on the bottom. The instrument launched at 650 m was not on the bottom but was hung upside down. Backup buoyancy near the bottom of the mooring was sufficient to keep the deepest meter in a proper attitude, and indeed the data from that site suggest no abnormality. However, the buoyancy was insufficient to raise the mooring to the surface after the release had been fired, so the mooring remained upside down, anchored to the bottom by the imploded buoys. The mooring was subsequently recovered by a chartered fishing vessel.

Mooring 35: As for mooring 34, large, vertical excursions resulted in buoy implosion. However, in this case, the violence of the implosion severed the mooring line, so the mooring did not have to support the dead weight of the imploded buoys. As a result, the shallowest meter, at 450 m, was useless after 25 November (it was hanging loosely upside down), but the reserve buoyancy kept the remaining instruments standing upright and in good order. The mooring was recovered without event, although it rose to the surface very slowly.

Mooring 42: This mooring was deployed and recovered without incident. However, the instrument at 75 m failed immediately on deployment, and that at 125 m slowly developed a major electrical problem that made the quality of data very uncertain beyond early January. The deep instrument behaved well.

Data handling and presentation

The raw current meter data were processed in the usual way, editing out spikes and performing minimal filtering designed primarily to eliminate the phase discrepancy of half a sampling interval between speed and direction. The time series was subsampled to 1-hourly intervals, separated into orthogonal components (u-component positive to the east and v positive to north), filtered by a Lanczos-cosine filter and subsampled at 12-hourly intervals. The Lanczos-cosine filter used is a popular one, called "Lancz7" by Thompson (1983), and is effective at supressing tidal and other high-frequency signals. If a time series $T_i = T(i\Delta t)$ is filtered to produce a new time series $\hat{T}_i$ then we define the symmetric filter weights as

$$\hat{T}_i = \sum_{k=-n}^{n} W_k T_{i+k}.$$

Symmetry is required to conserve phase, so $W_k = W_{-k}$. For this particular filter the weights are prescribed by:-

$$W_k = \frac{1}{2}\left[1 + \cos\left(\frac{k\pi}{60}\right)\right] \sin\left(\frac{pk\pi}{12}\right)/\left(\frac{pk\pi}{12}\right)$$

and (1)

$$W_o = 1$$

where $p = 0.7$ and $n = 60$, and the W_k are normalised so that

$$\sum_{k=-n}^{n} W_k = W_o + 2\sum_{k=1}^{n} W_k = 1.$$

This filter has a half-power point at a period of about 40 hours and effectively passes all energy at periods greater than 48 hours, i.e. it has a very steep slope to the frequency response function. This filter has the defect of passing about 1% of the signal at K_1 tidal frequency. For current meter data this is of no consequence, but it makes the filter quite inappropriate for tide gauge data. Modifying the value p from 0.7 to 0.6 produces the Lancz6 filter (Thompson, 1983), which efficiently suppresses the K_1 tide (and all other tides) at the slight cost of having a shallower frequency response function that reduces energy levels noticeably for periods as long as 70 hours. The Lanczos-cosine filter is quite short and so relatively little data is lost at the beginning and end of the time series.

For the purposes of display, the orthogonal (u and v) components were rotated into alongshore and cross-shore components. The single rotation angle used for each line of current meters was determined by measuring the bearing of the 200 m isobath (which roughly defines the edge of the continental shelf). The angles used fitted quite well with the directions of the major axes of the covariance matrix of u and v. On each of the plots a vector time series is presented and alongshore is "up" the figure. For reference the actual rotation angle used is entered on each plot and the direction of true north is indicated by a compass rose.

Each plot includes data at 12-hourly intervals and shows velocity vectors, velocity components, and temperature all plotted against time. Some of the instruments measured pressure and some measured conductivity. Salinity was calculated when appropriate, but the time series are mostly of rather doubtful accuracy and are not presented here. Note that the typical speeds encountered vary enormously from one site to another and so the scale of speed varies from one plot to another. Each diagram is labelled by the mnemonic code discussed earlier, which should enable the reader to determine specifically which instrument corresponds to the plot.

Acknowledgements

The authors wish to express their appreciation to George Cavill, Master, and the crew of R.V. Sprightly. We owe thanks also to the scientific support personnel of the three institutions (CSIRO, IOS, OSU) who worked hard ashore and at sea preparing, deploying and recovering the instruments. David Crooks, Peter Richards and Deidre Waddington assisted in processing the data. The participation of Oregon State University was supported by the U.S. Office of Naval Research.

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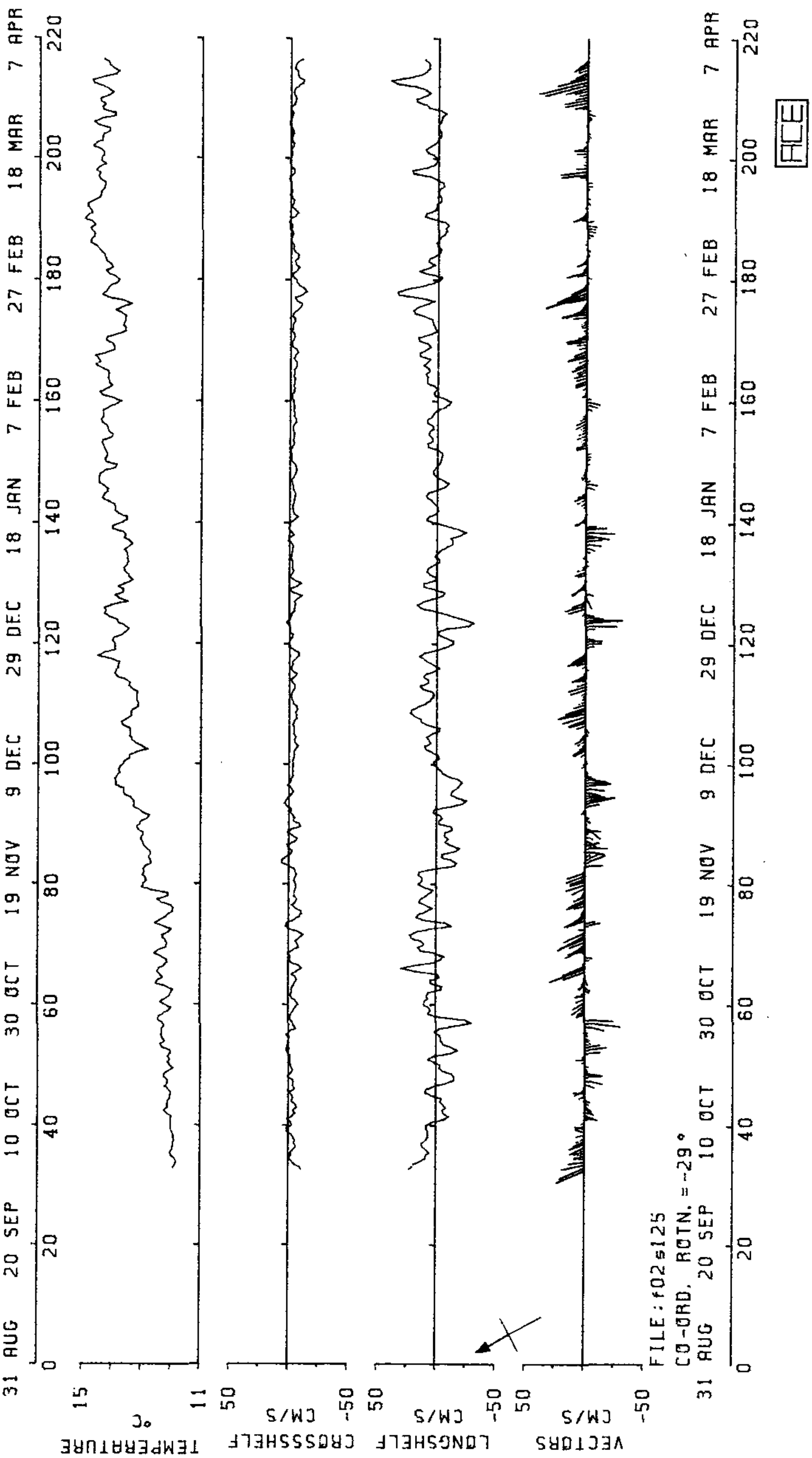
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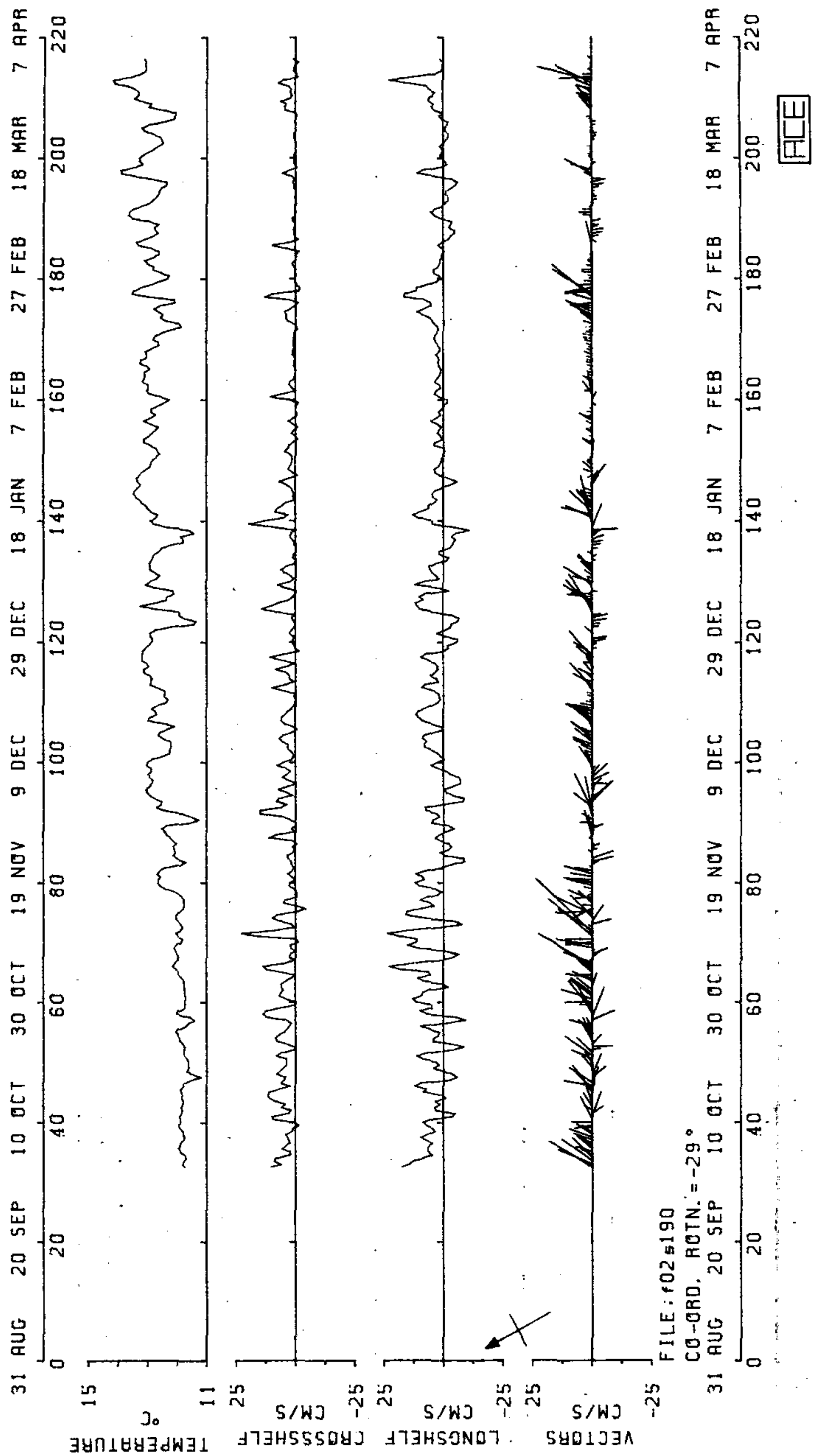
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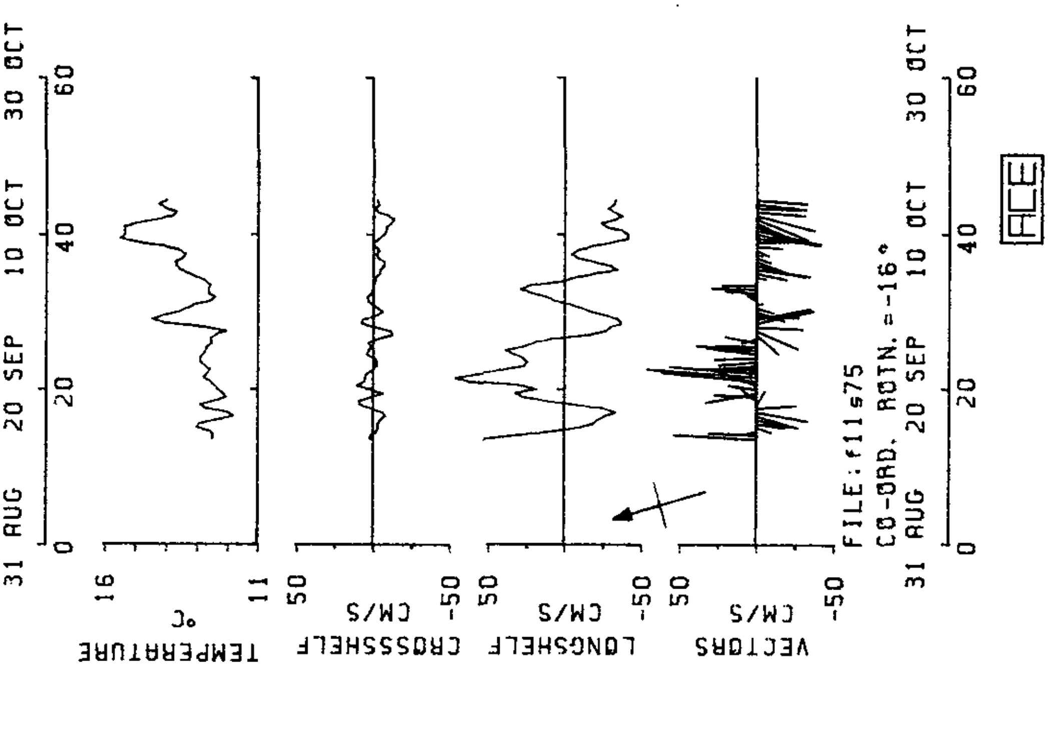
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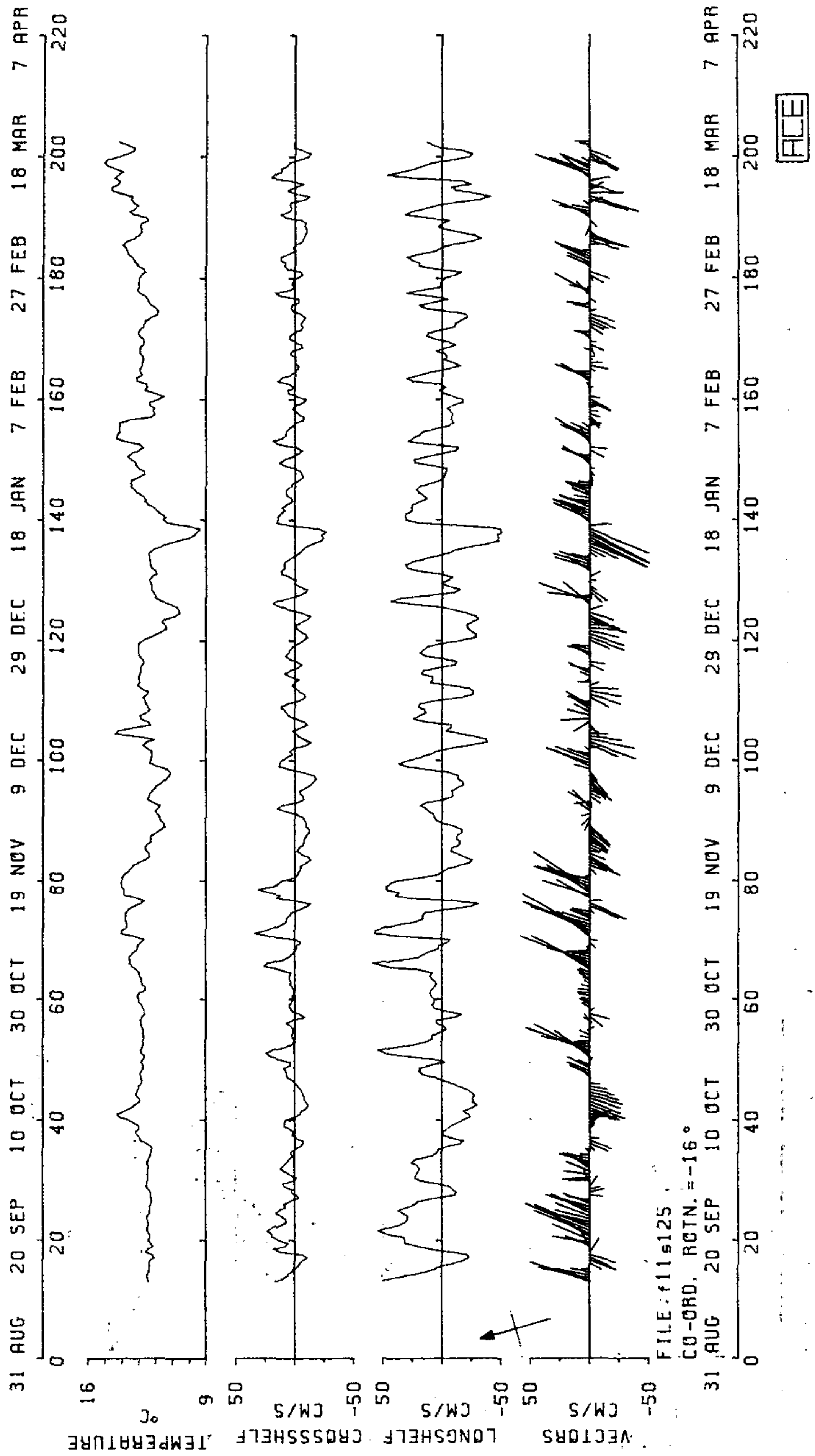
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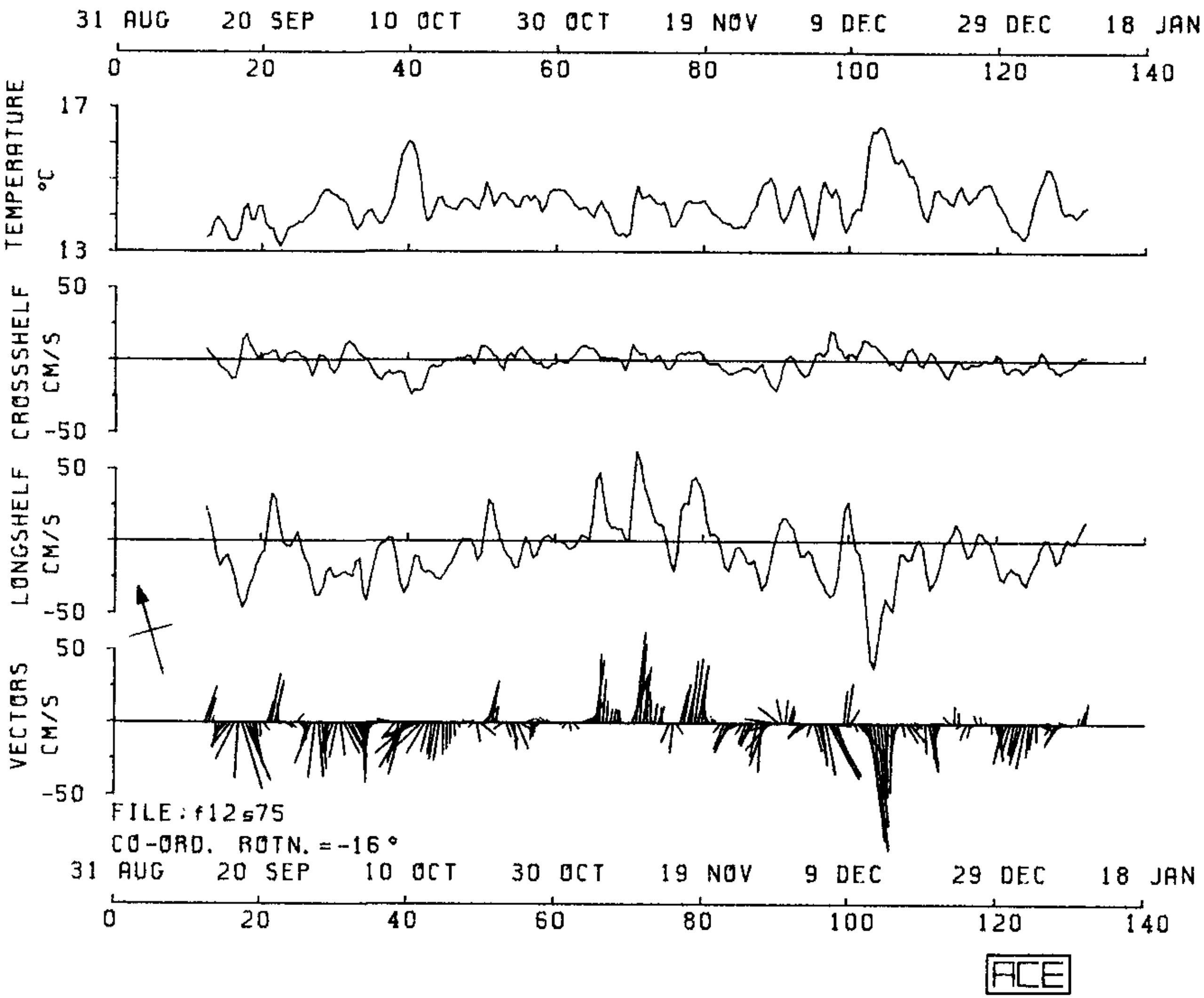
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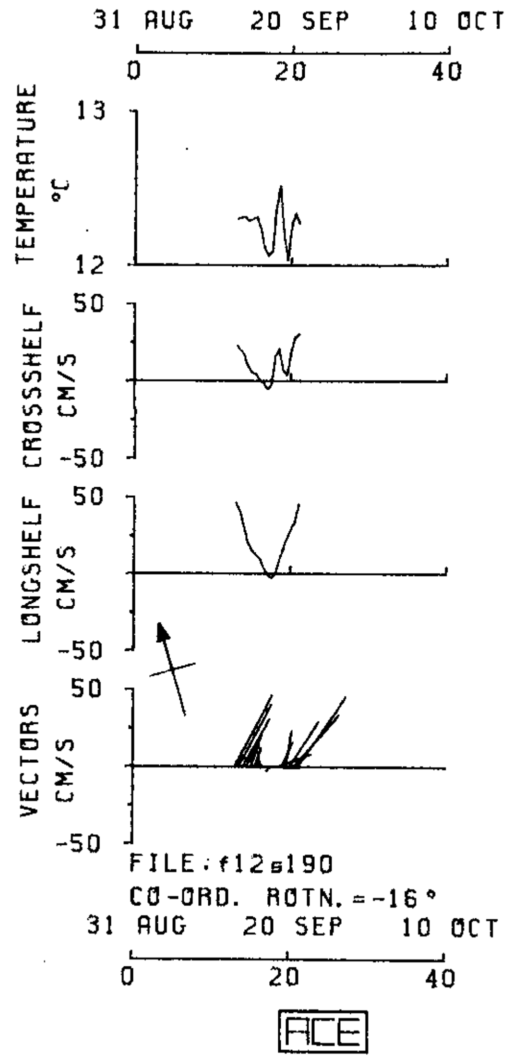
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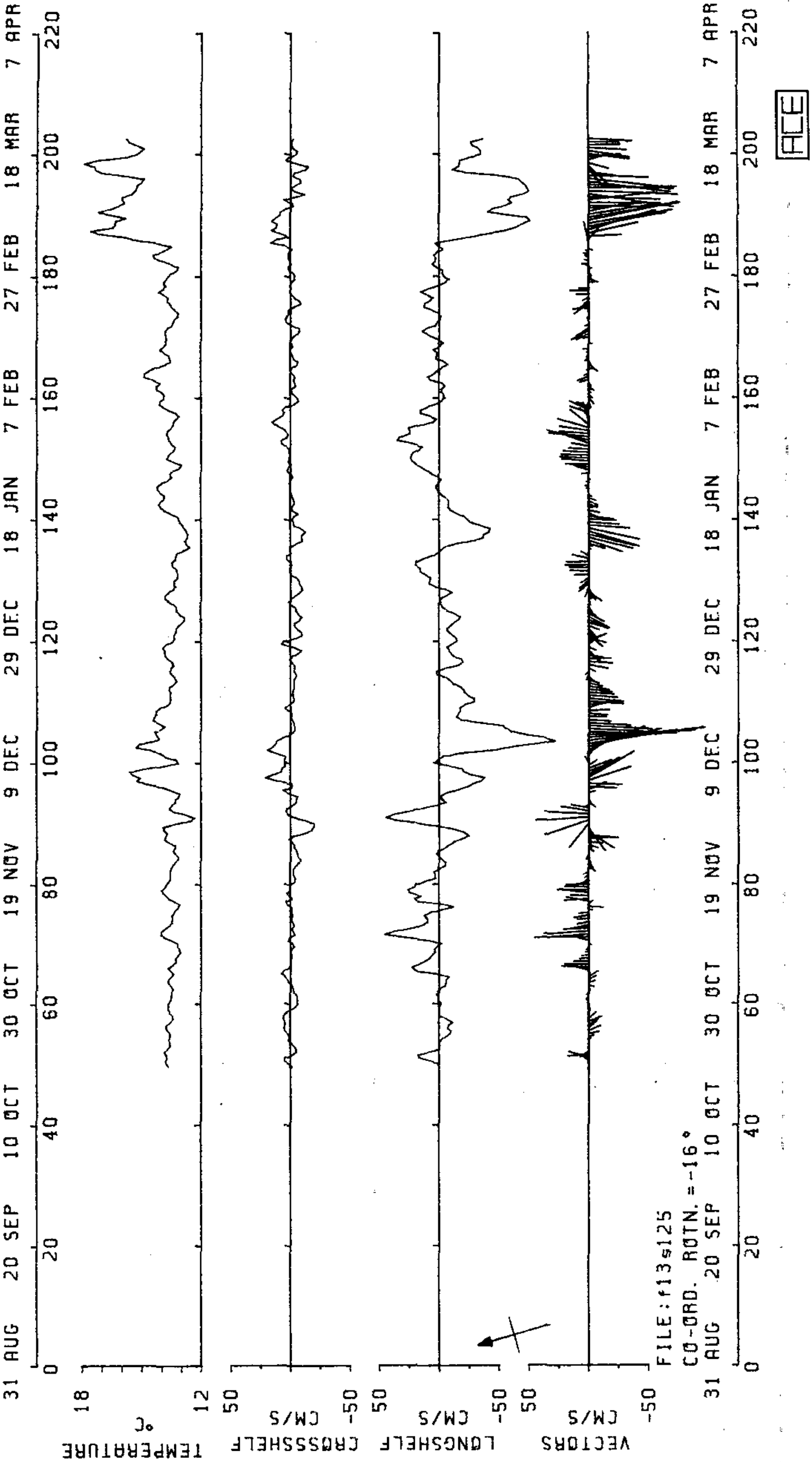

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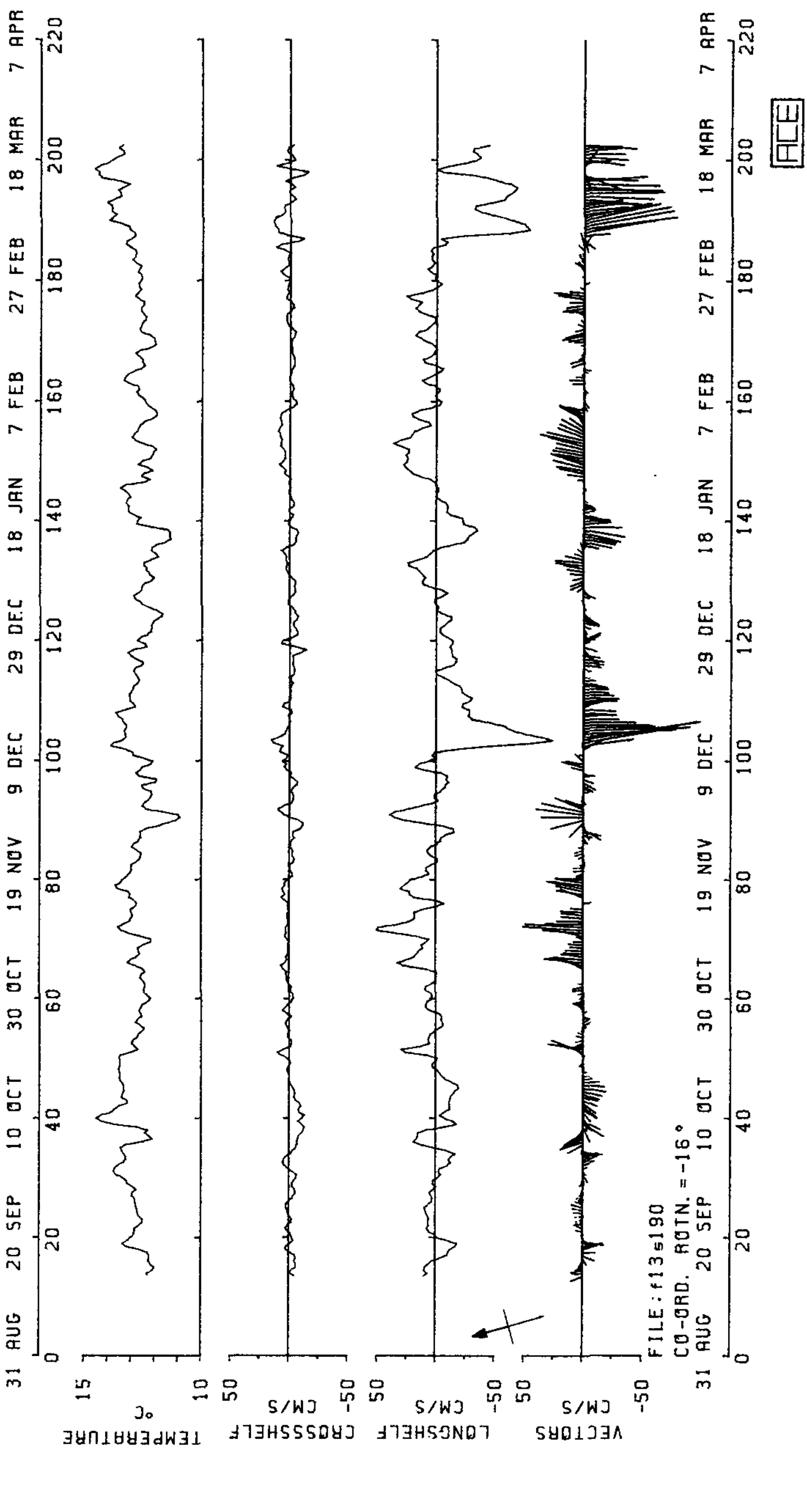
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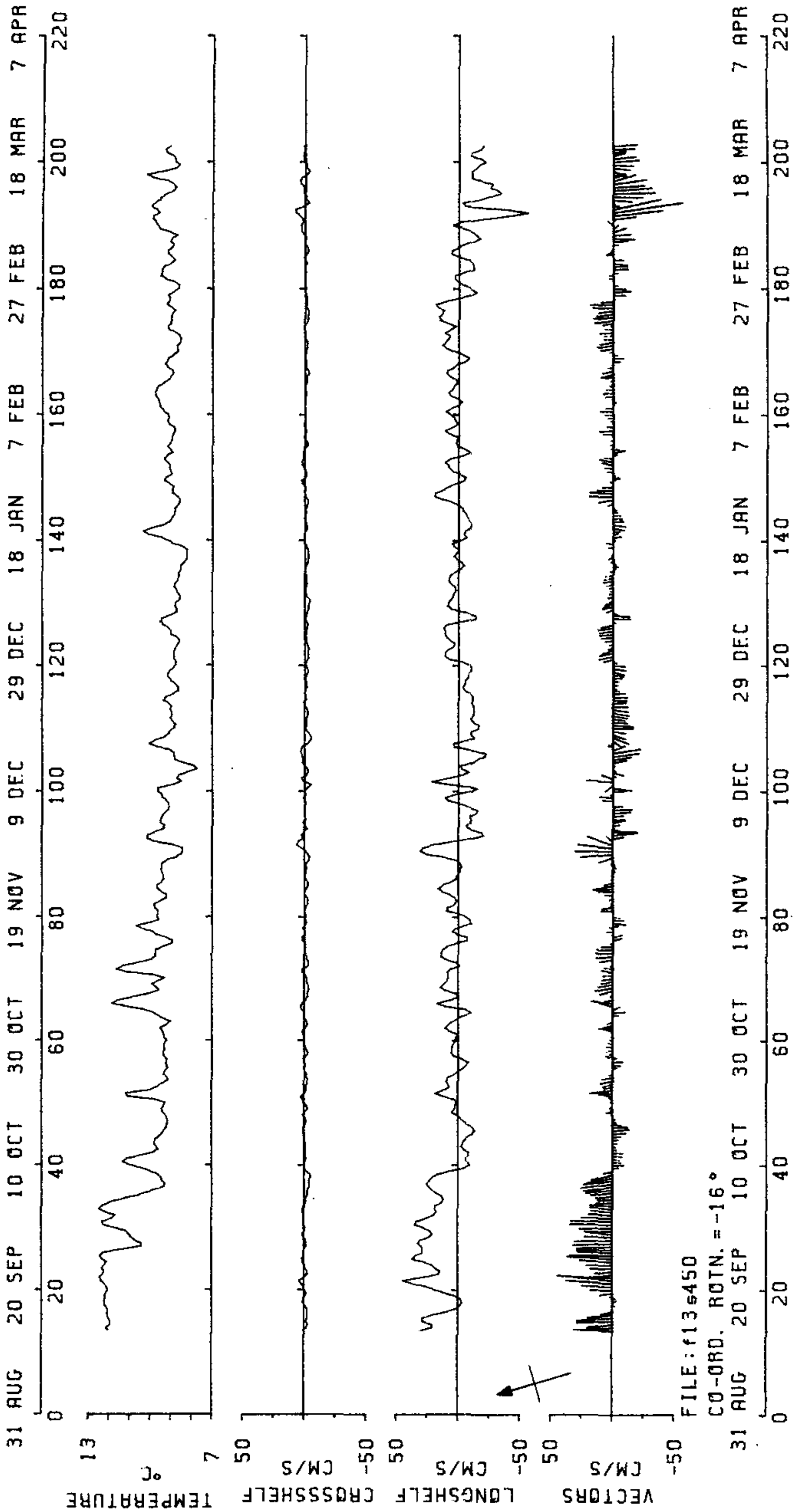
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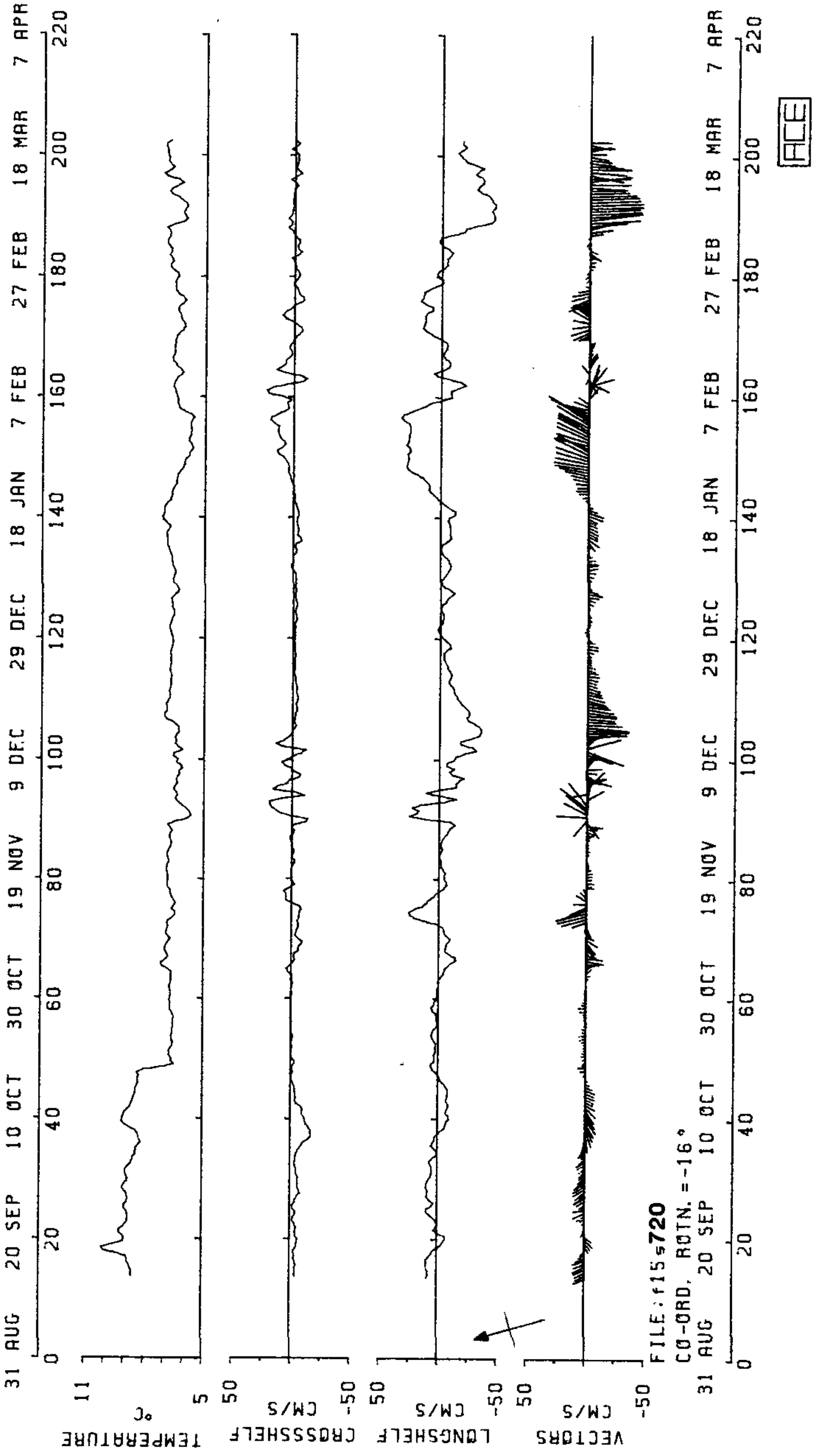
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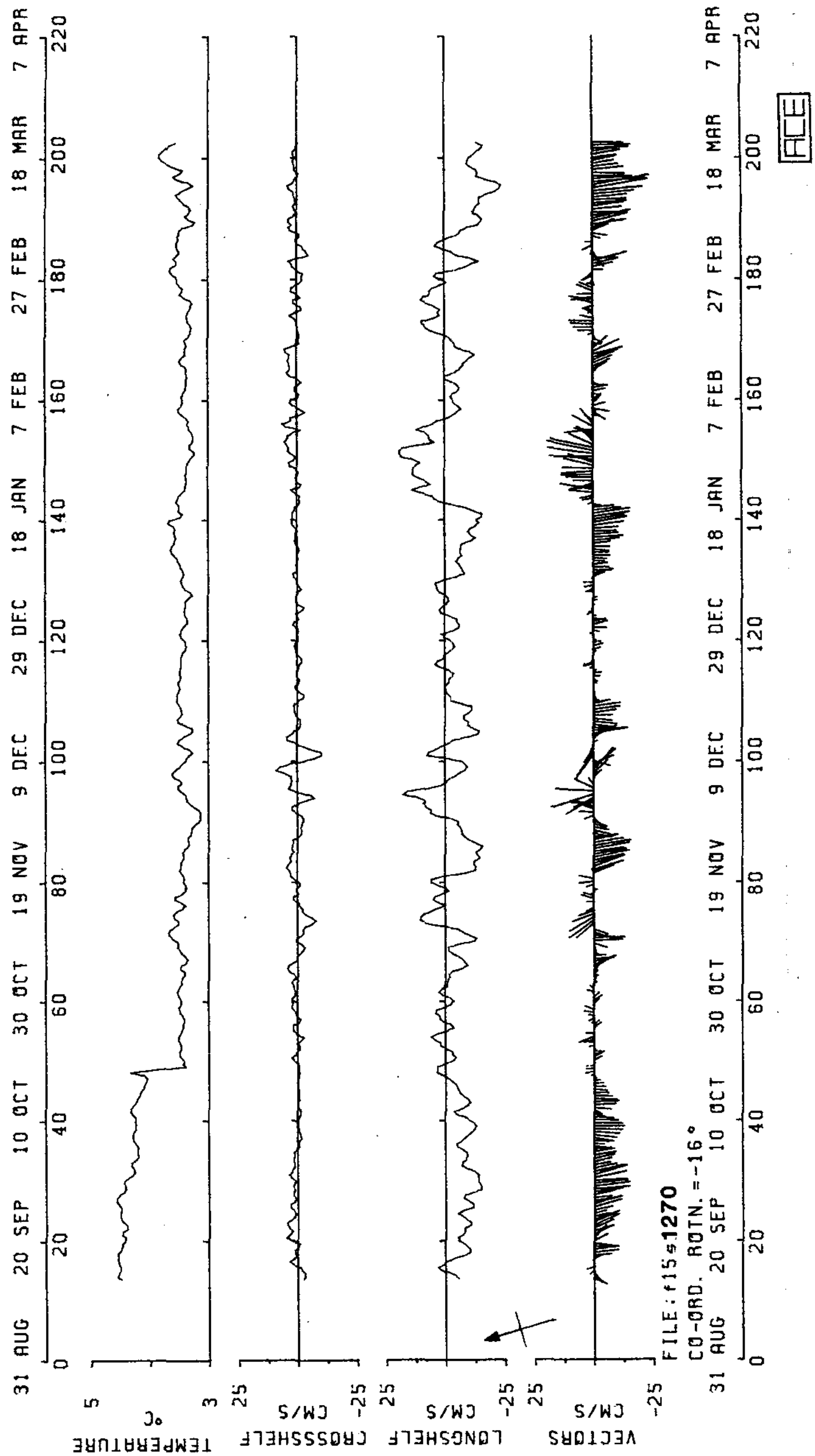
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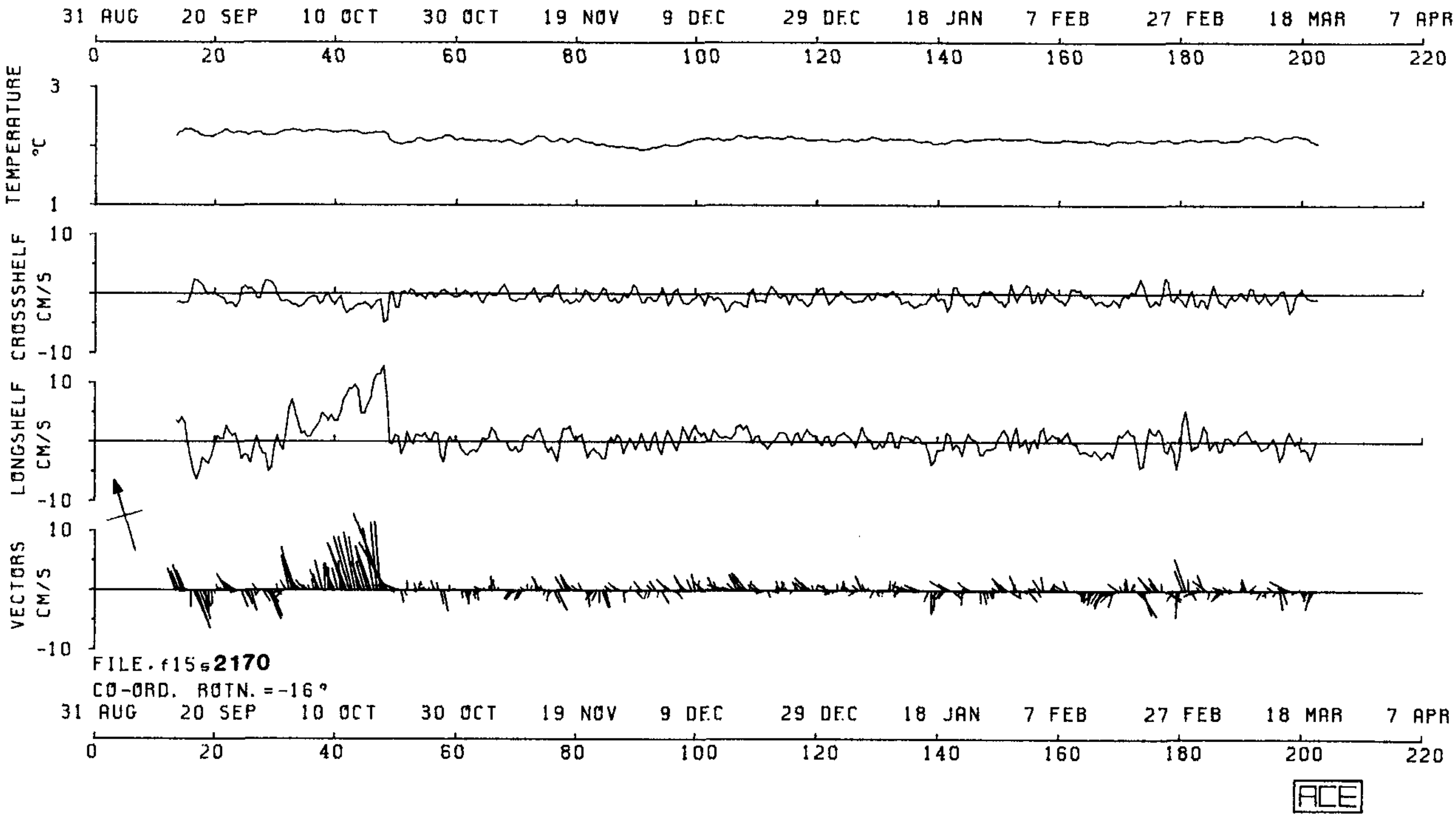
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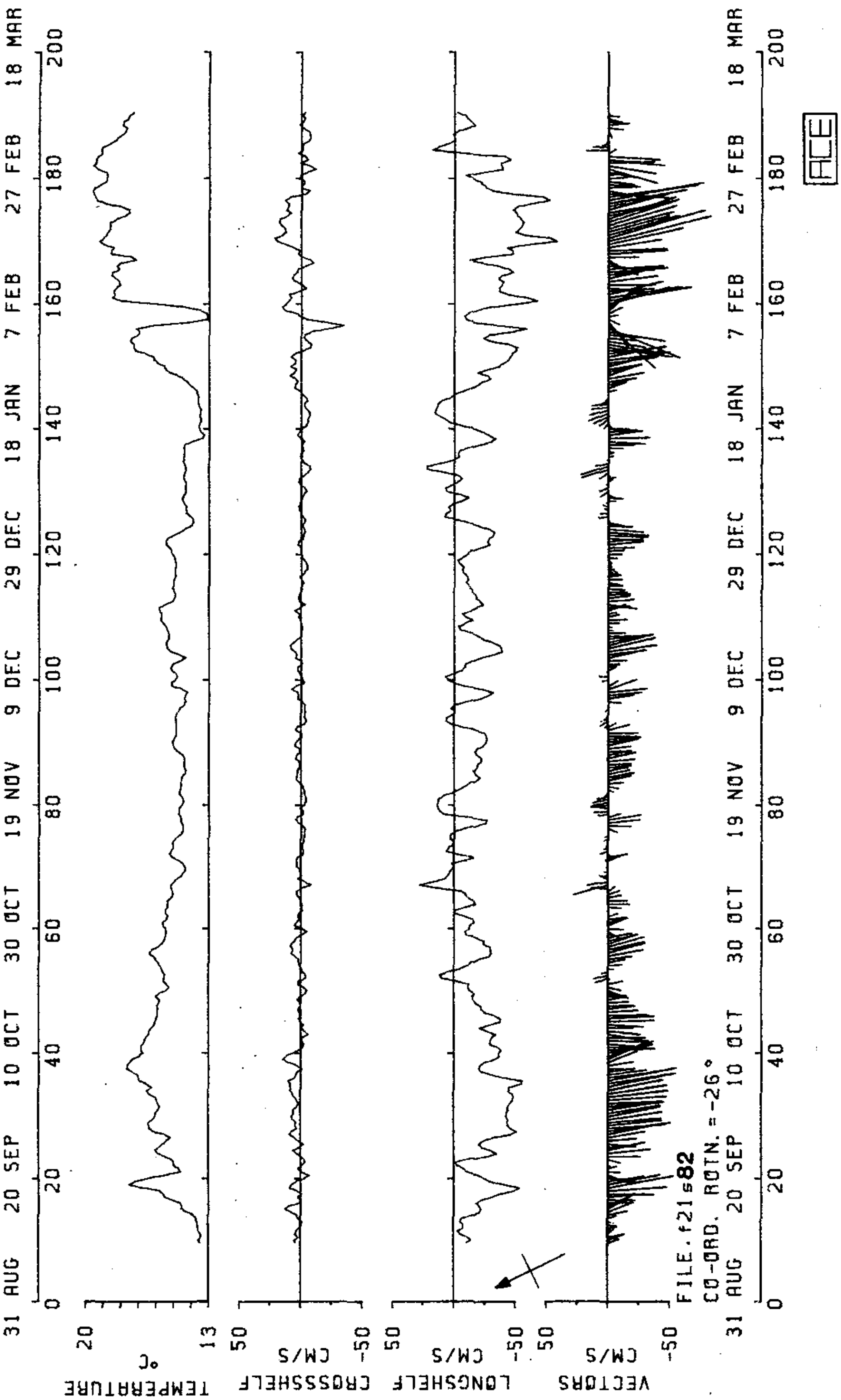
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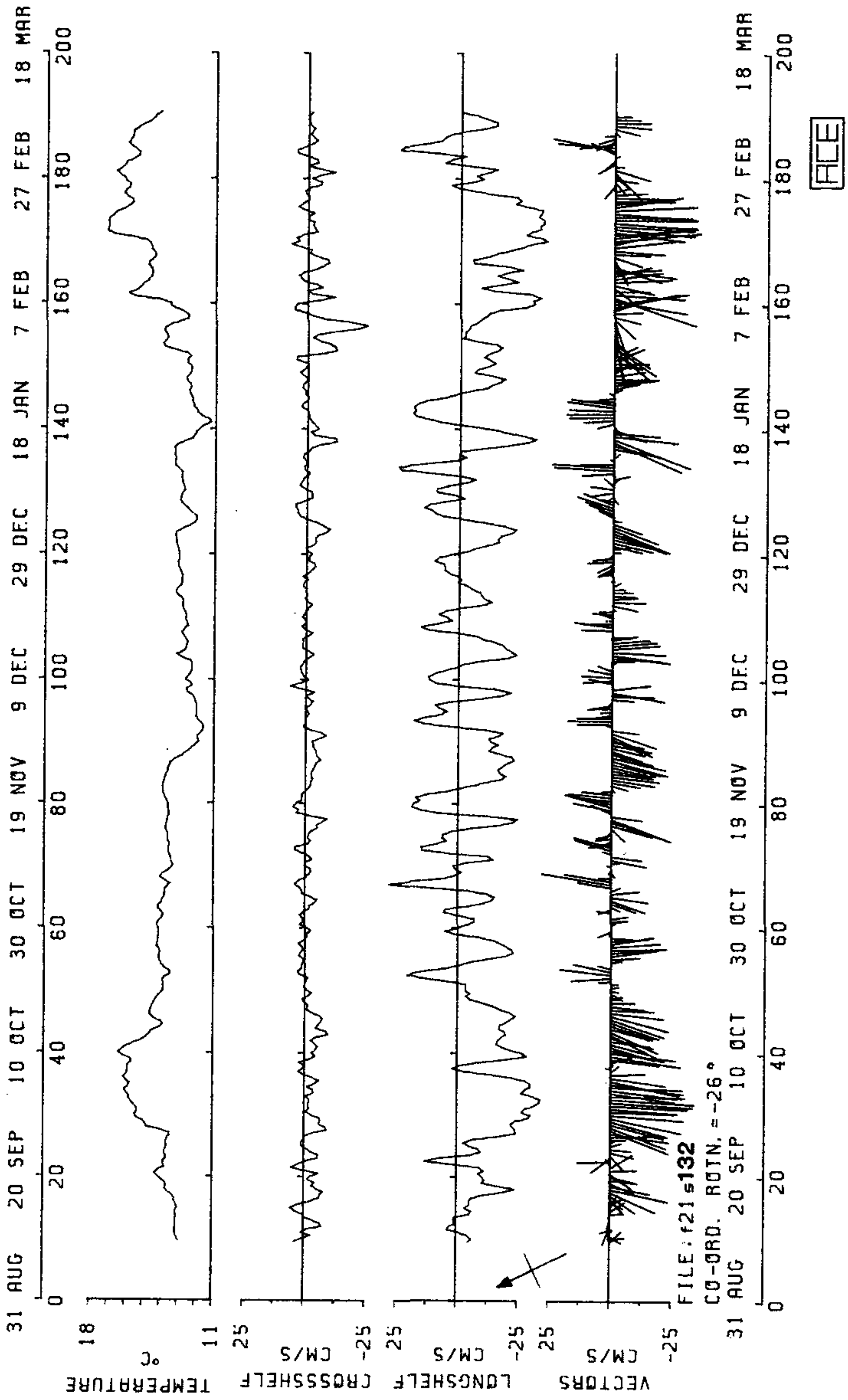
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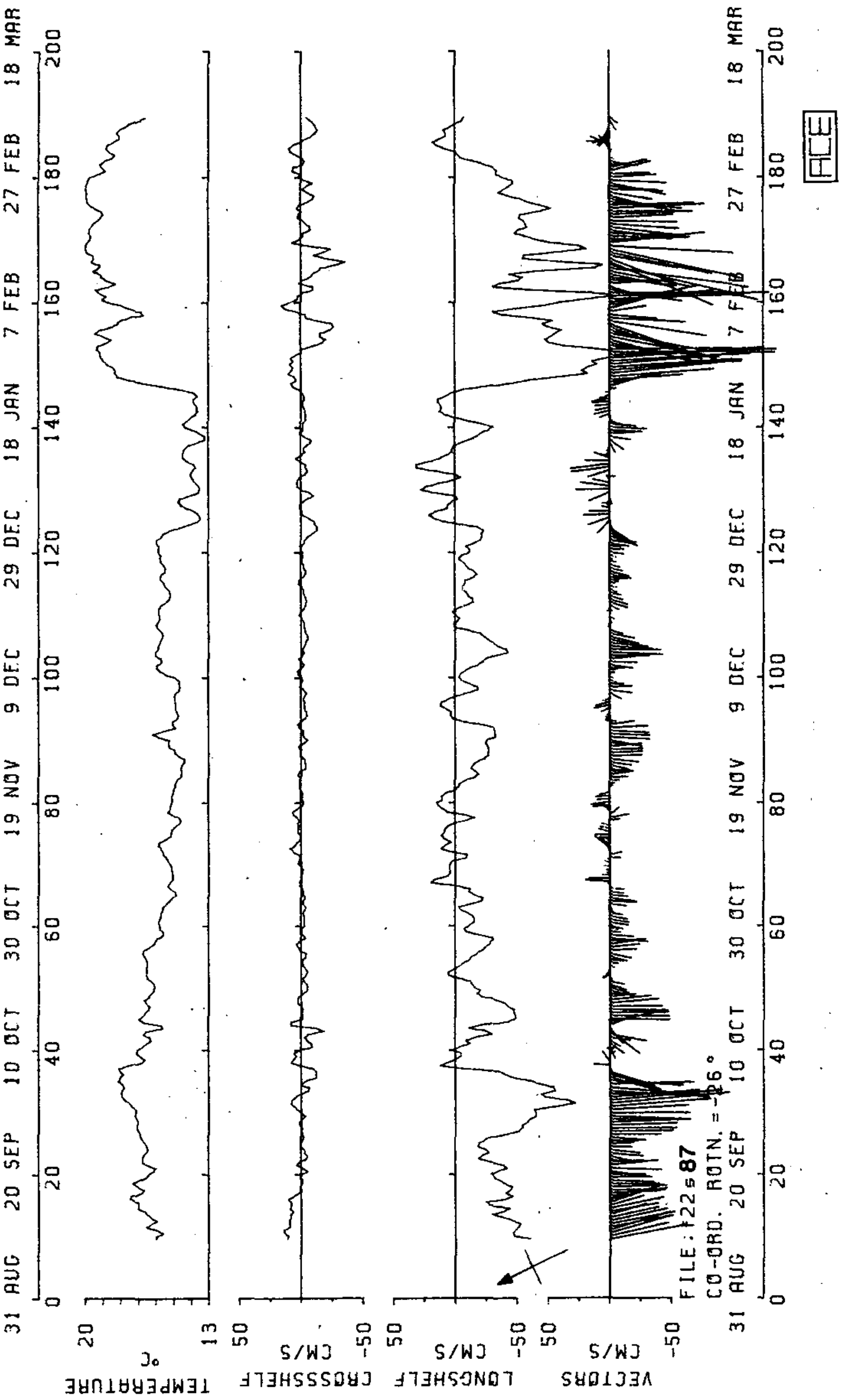
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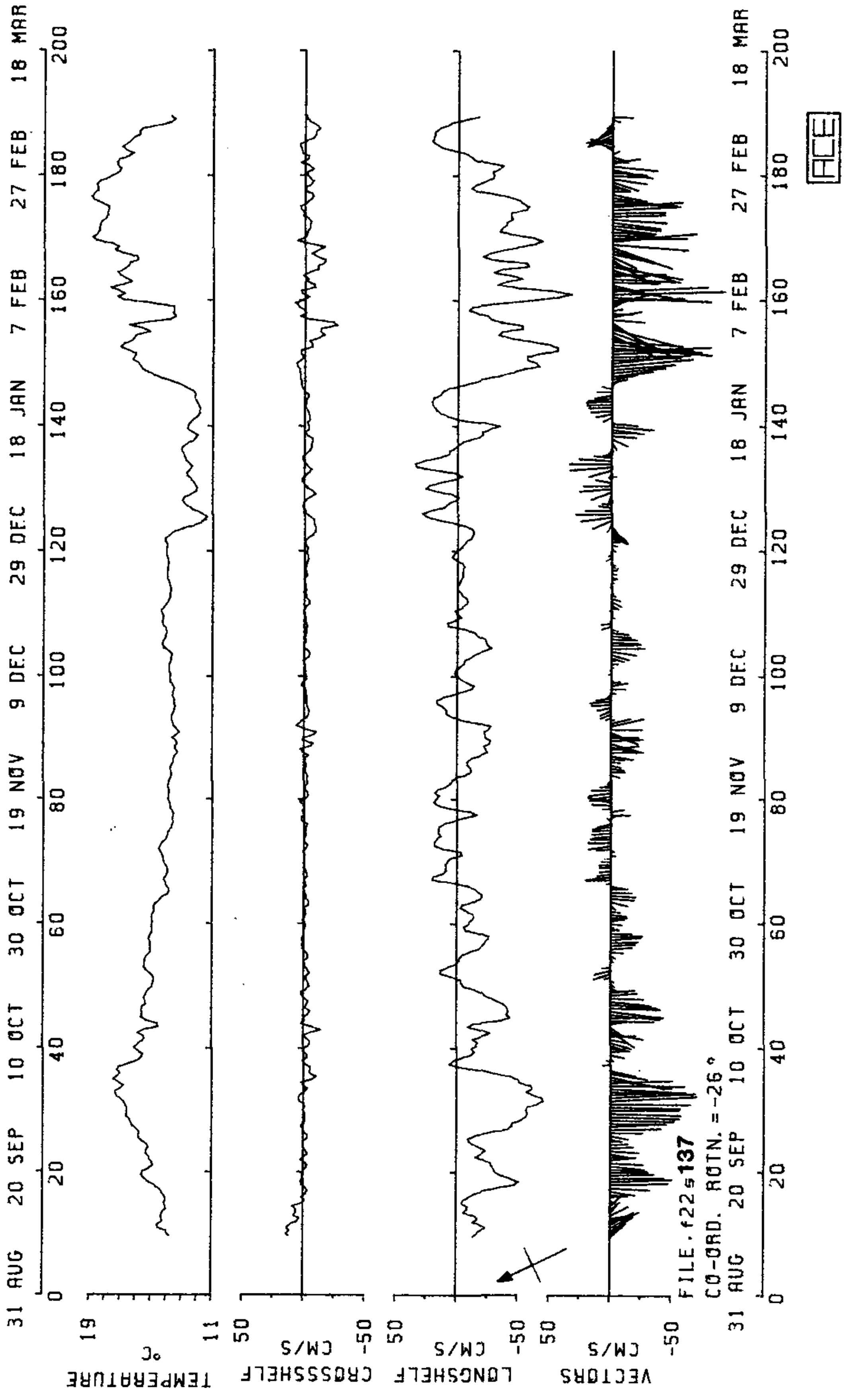
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TEMPERATURE
°C
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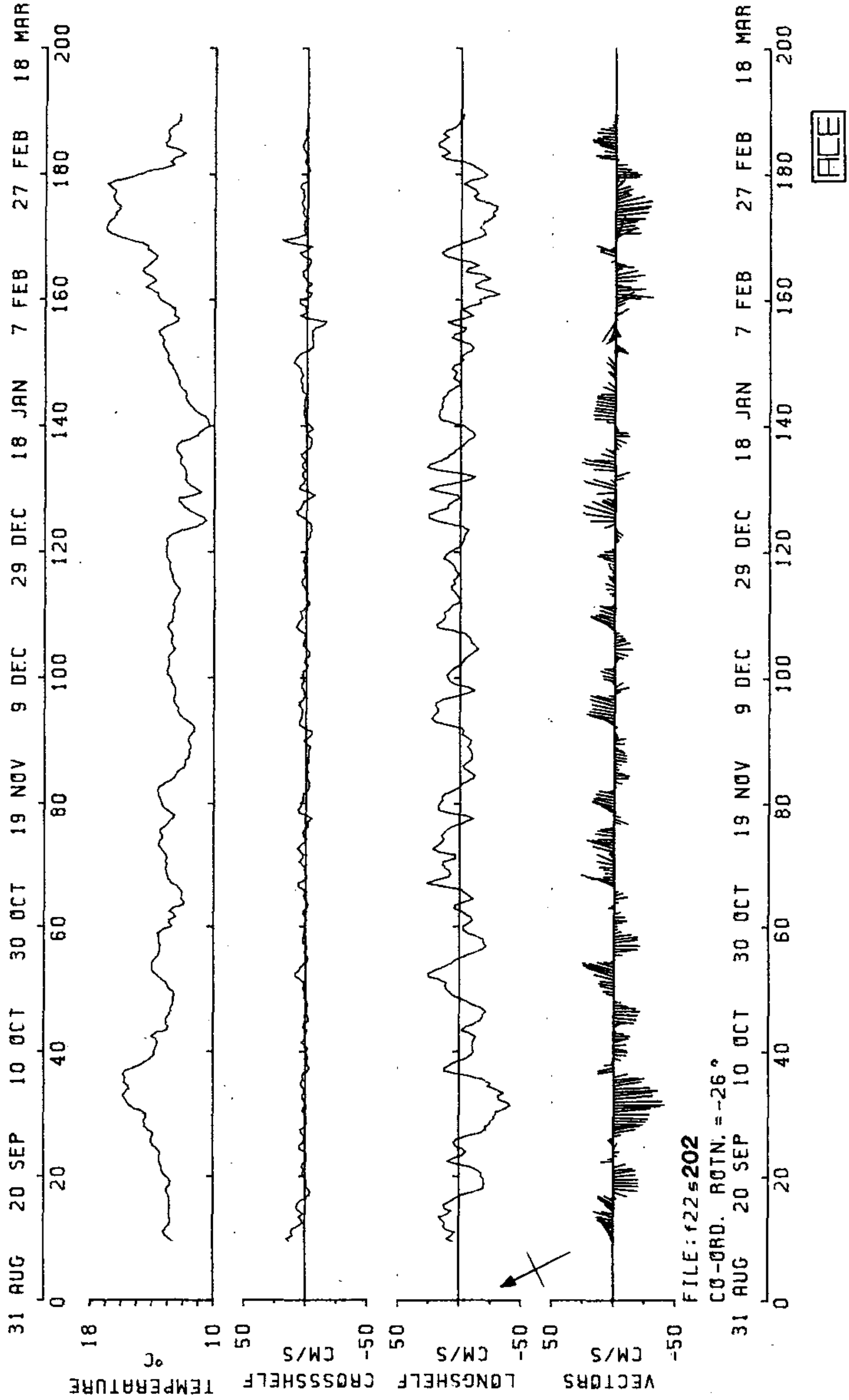
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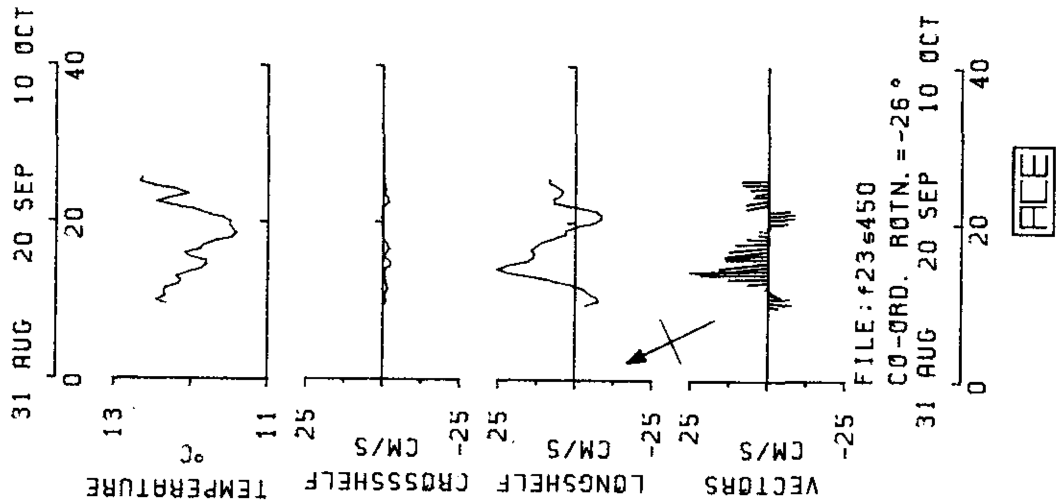
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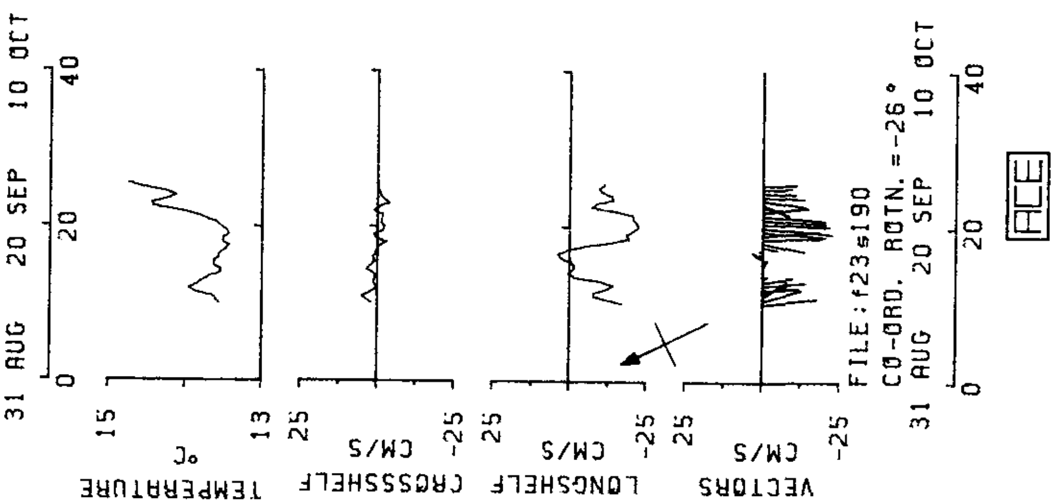
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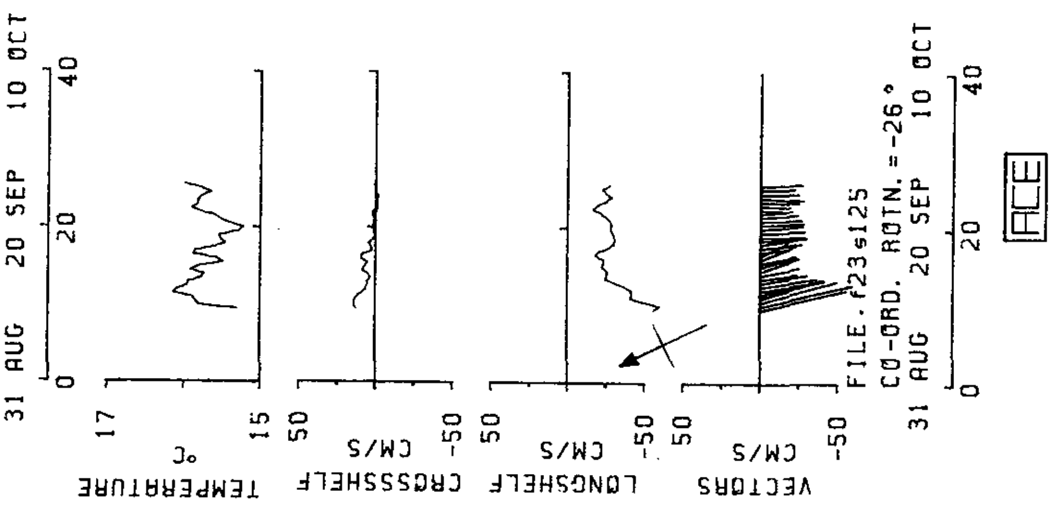
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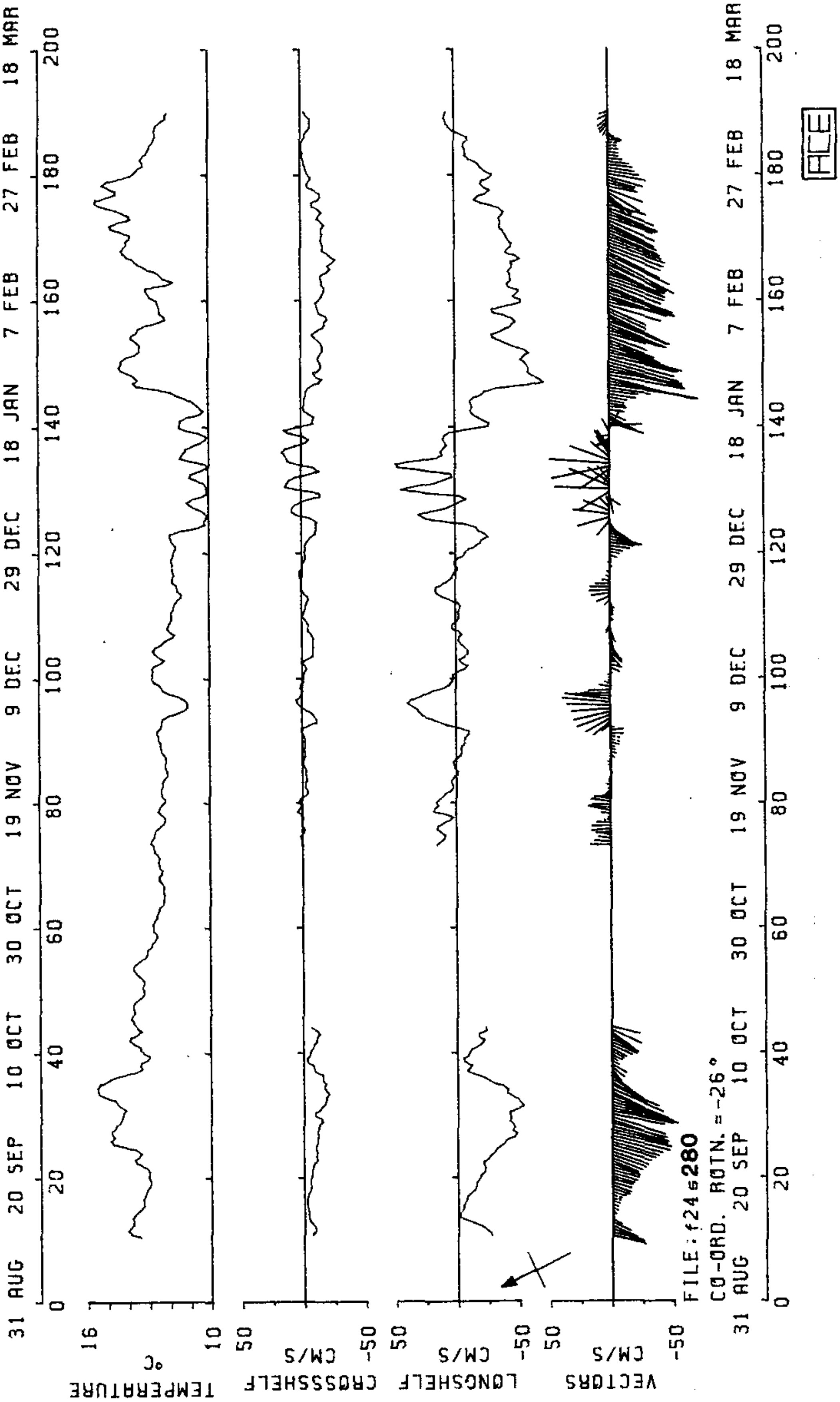
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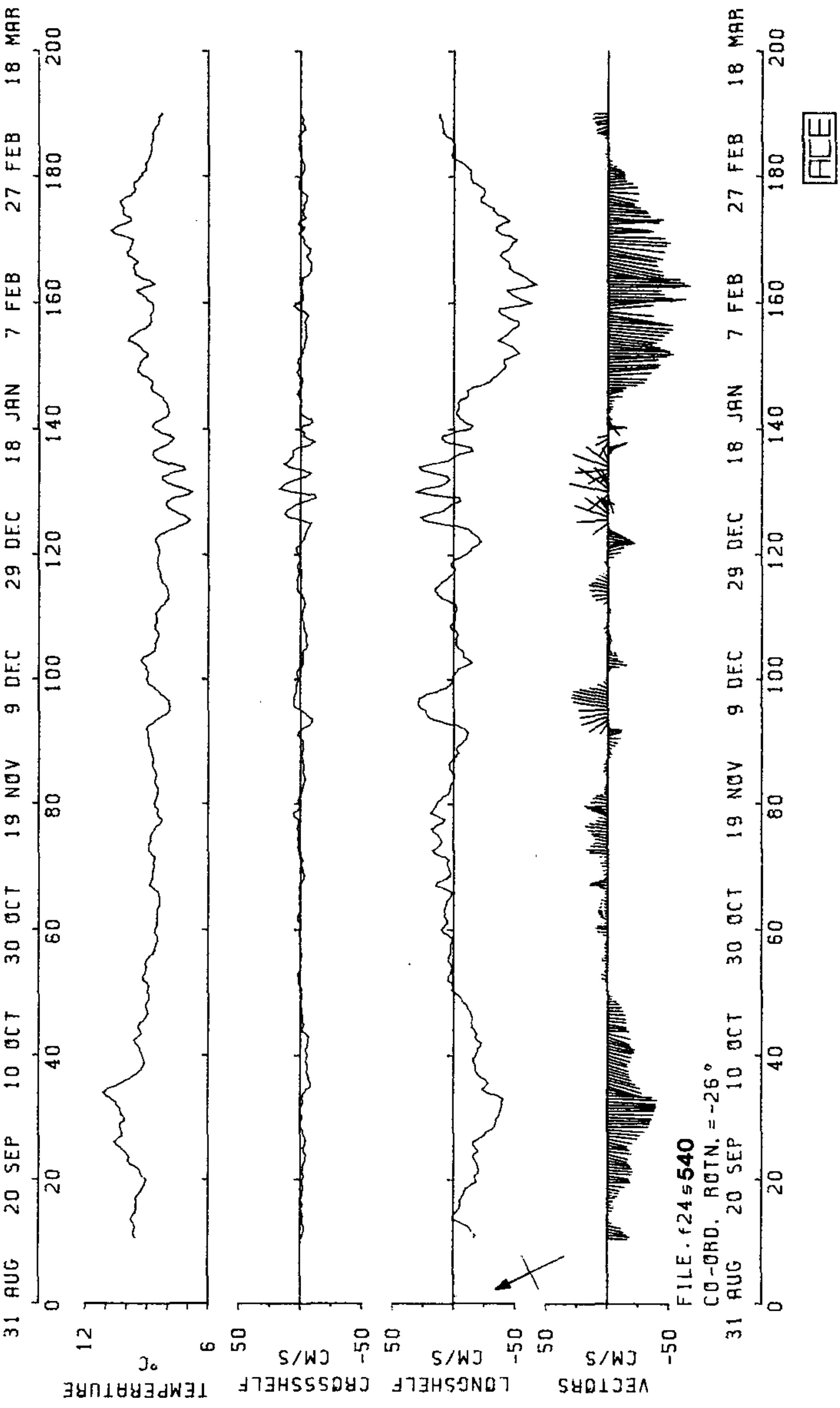
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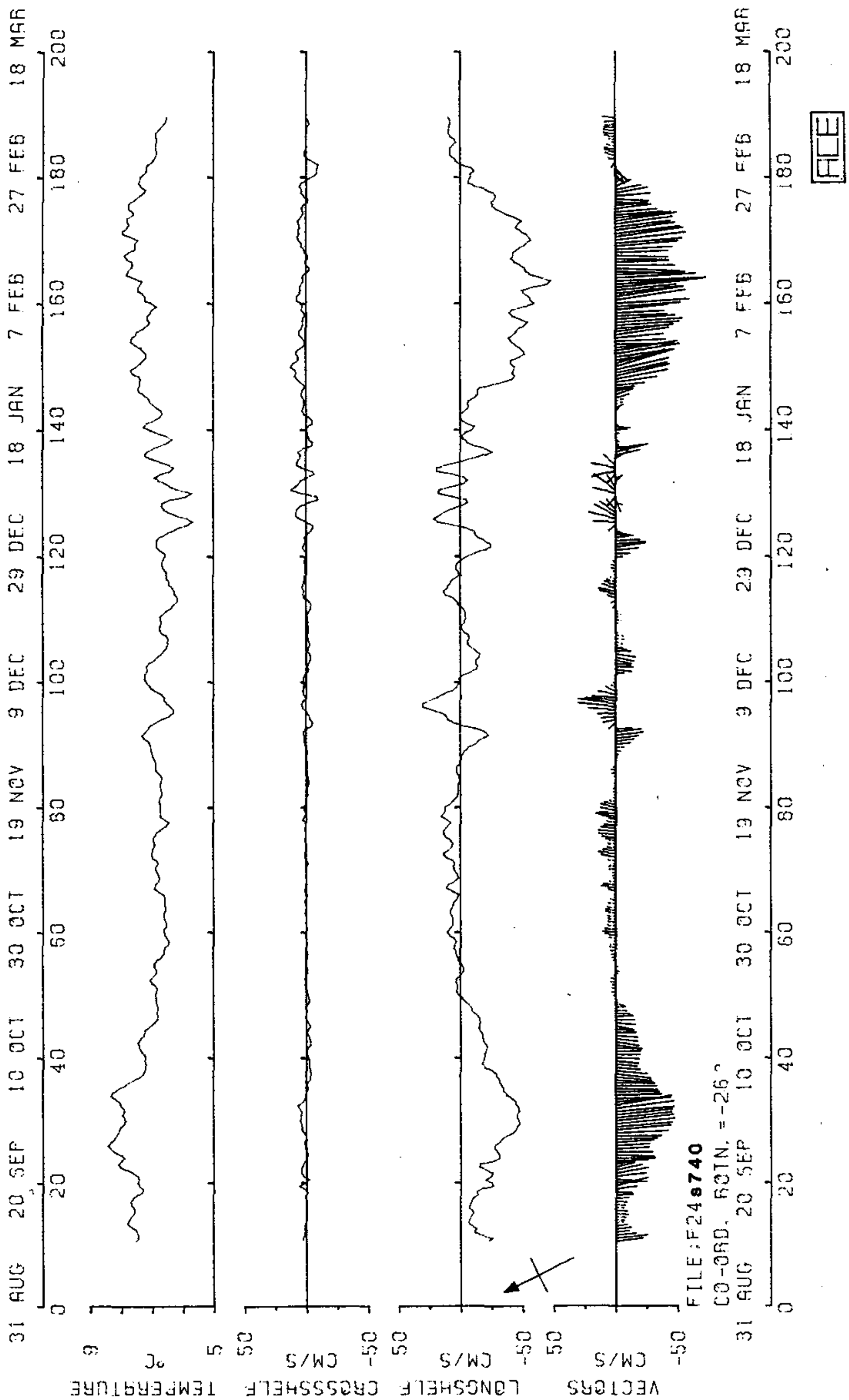
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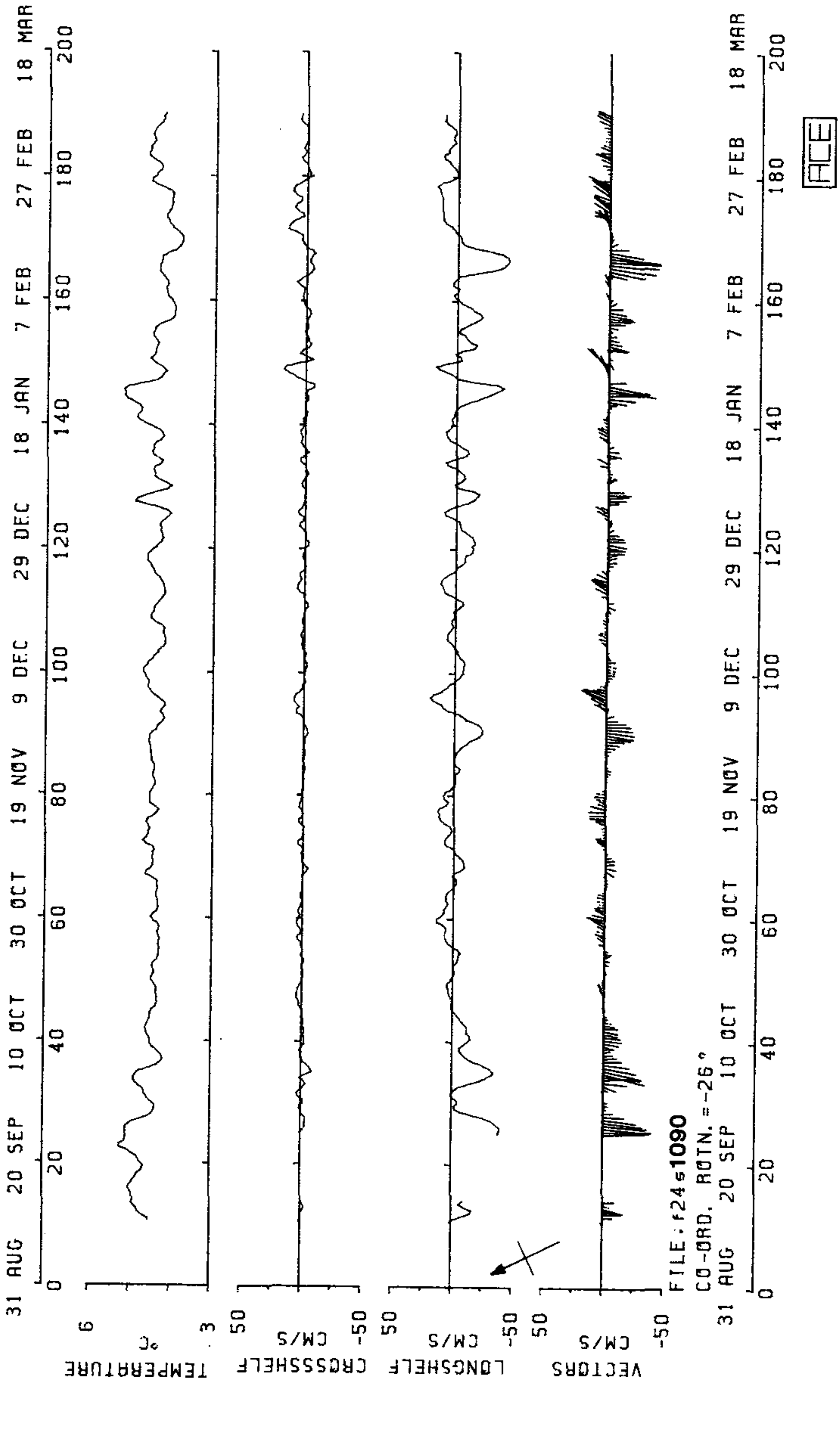

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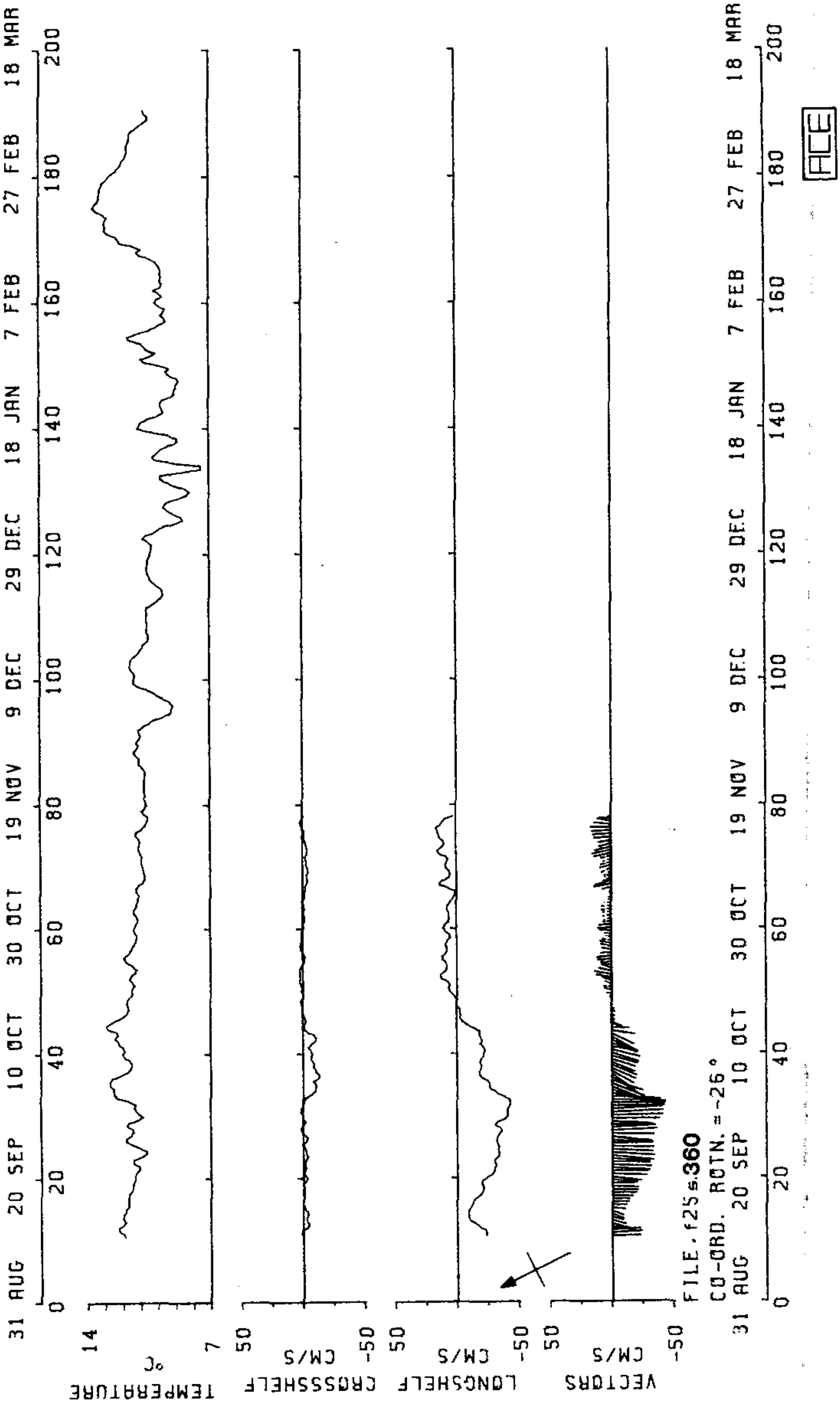
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200
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°C
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CM/S
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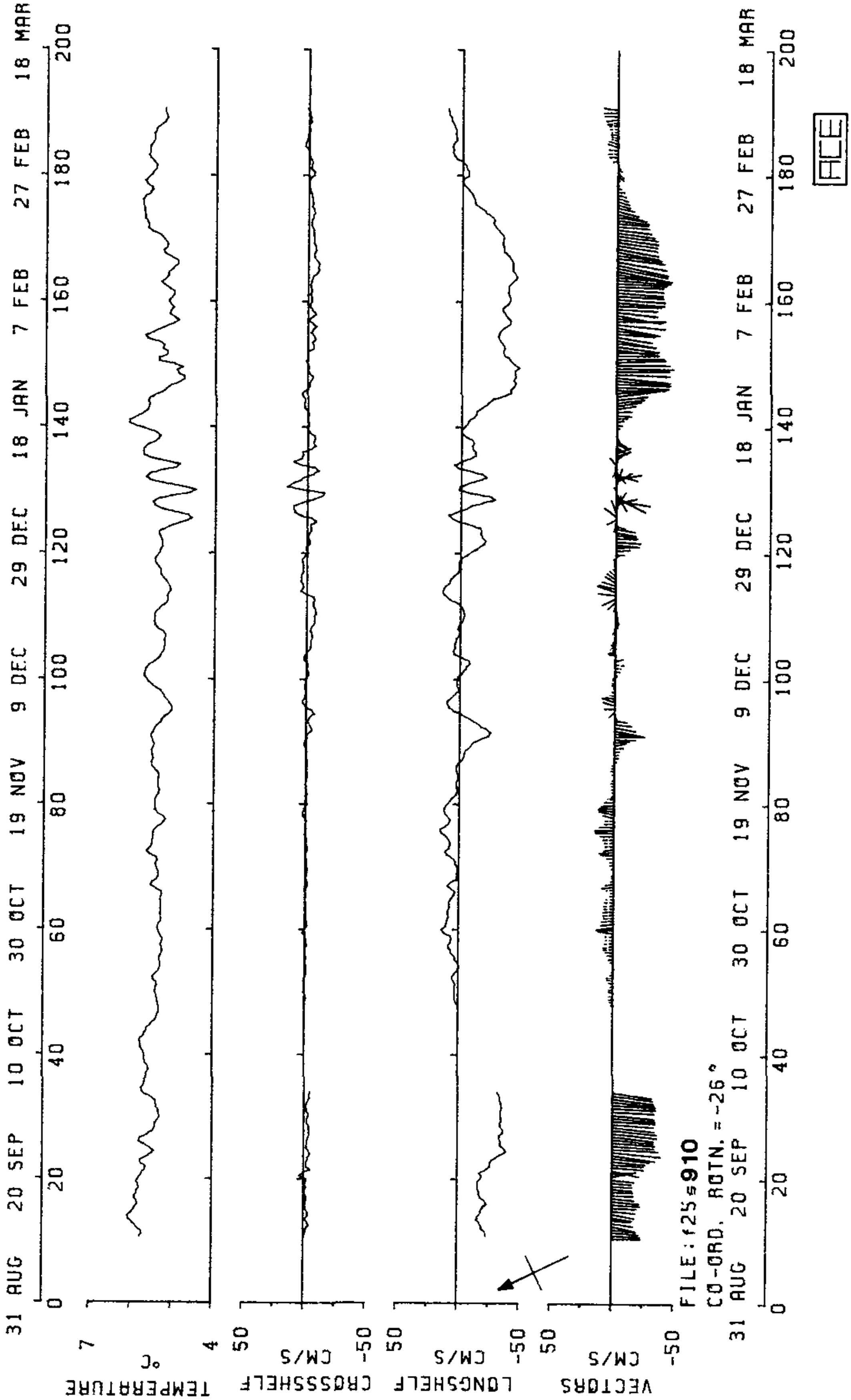
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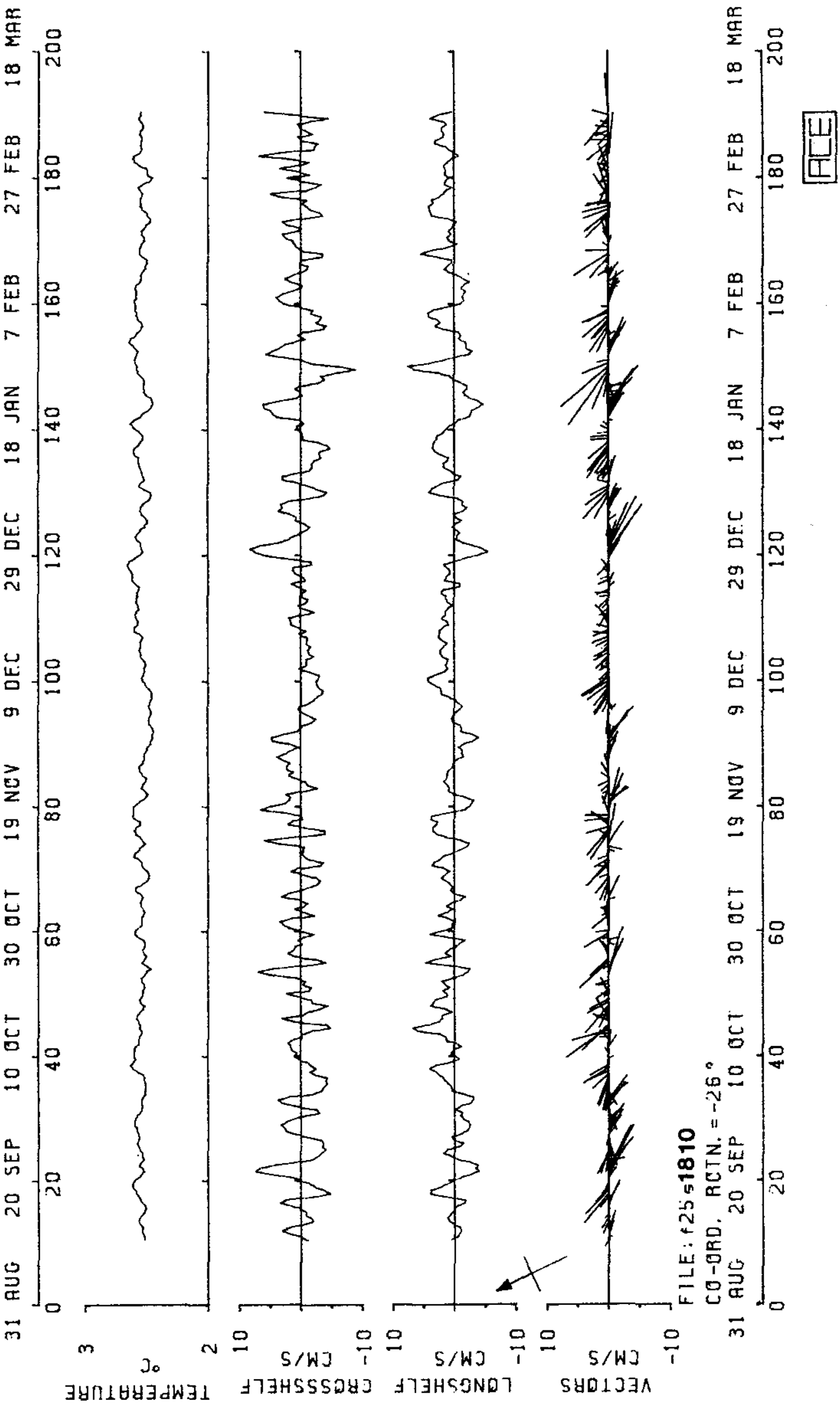

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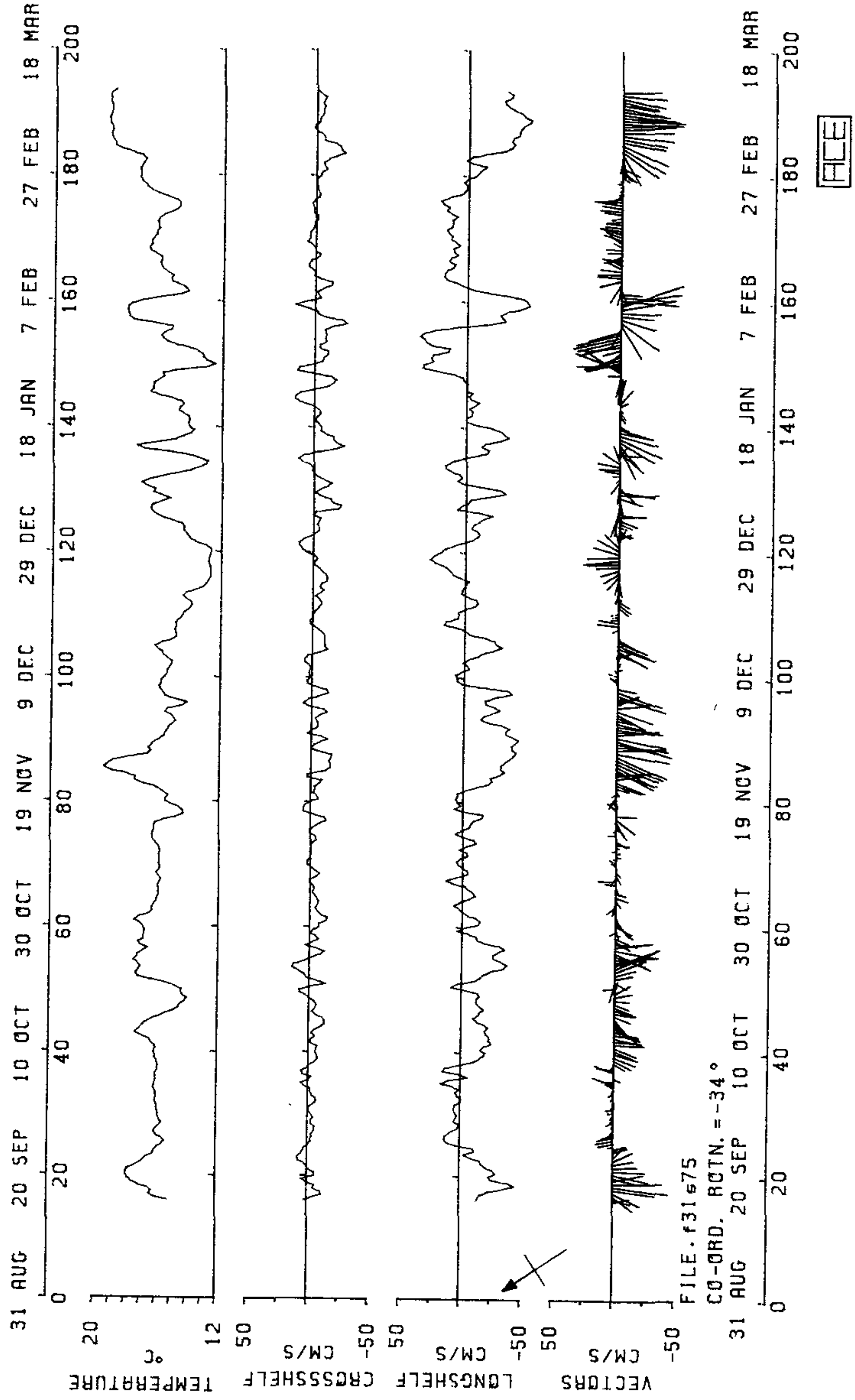
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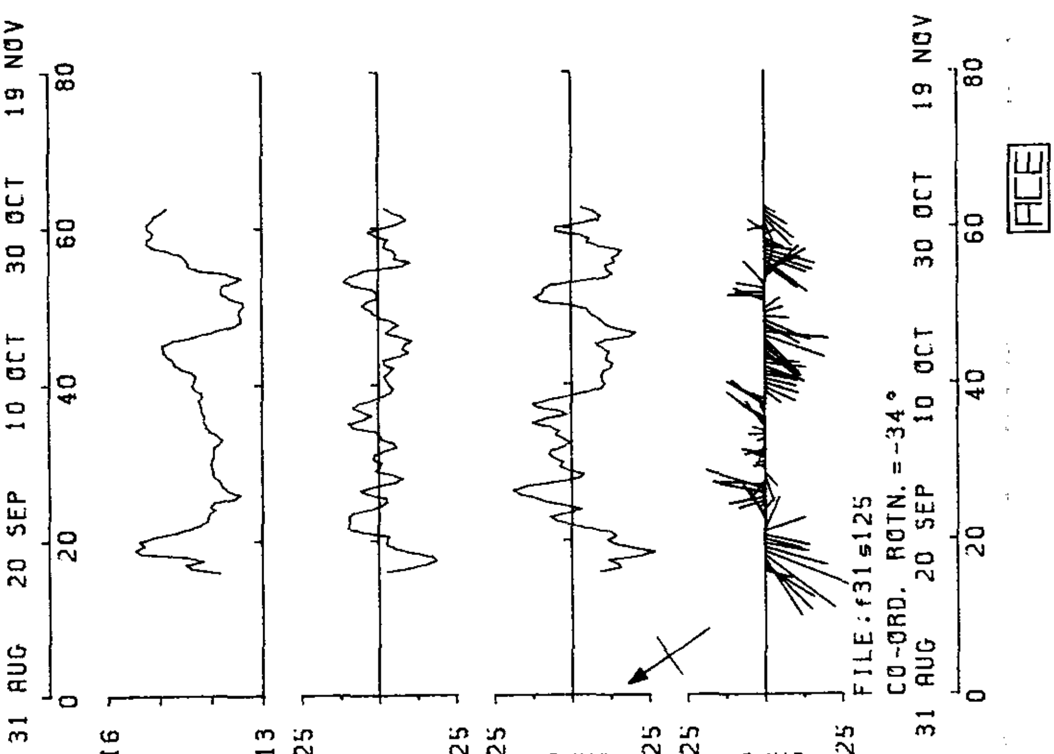
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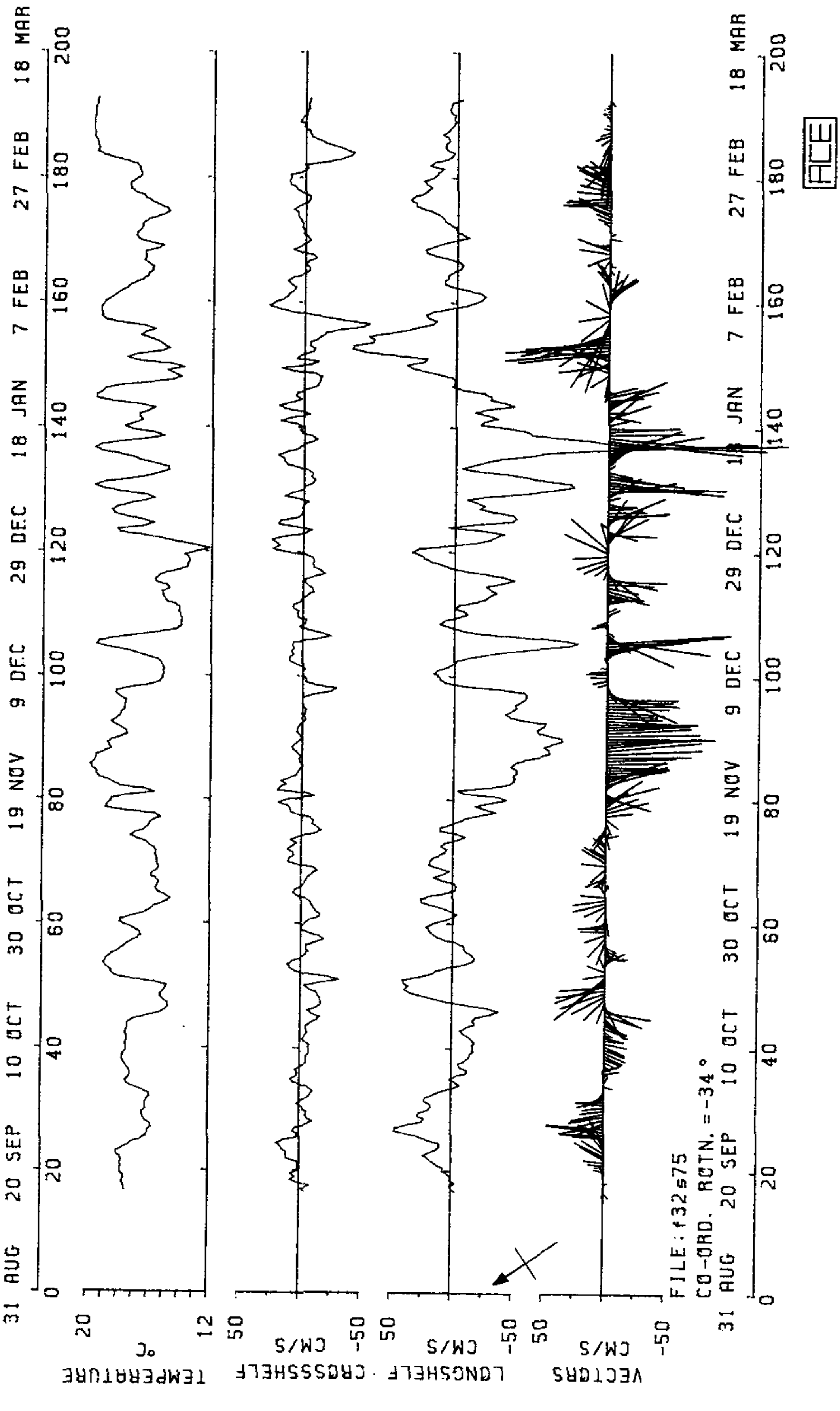
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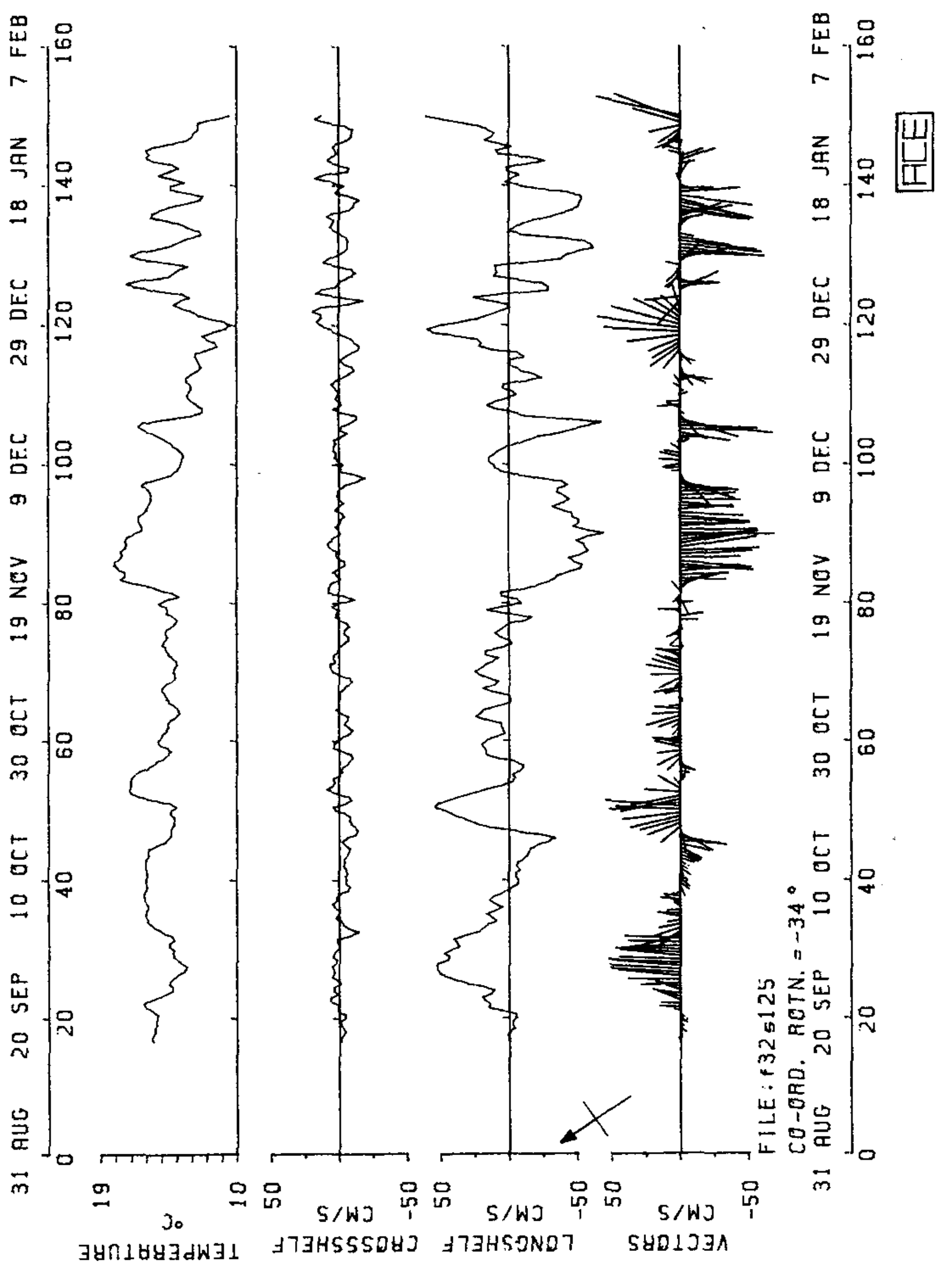

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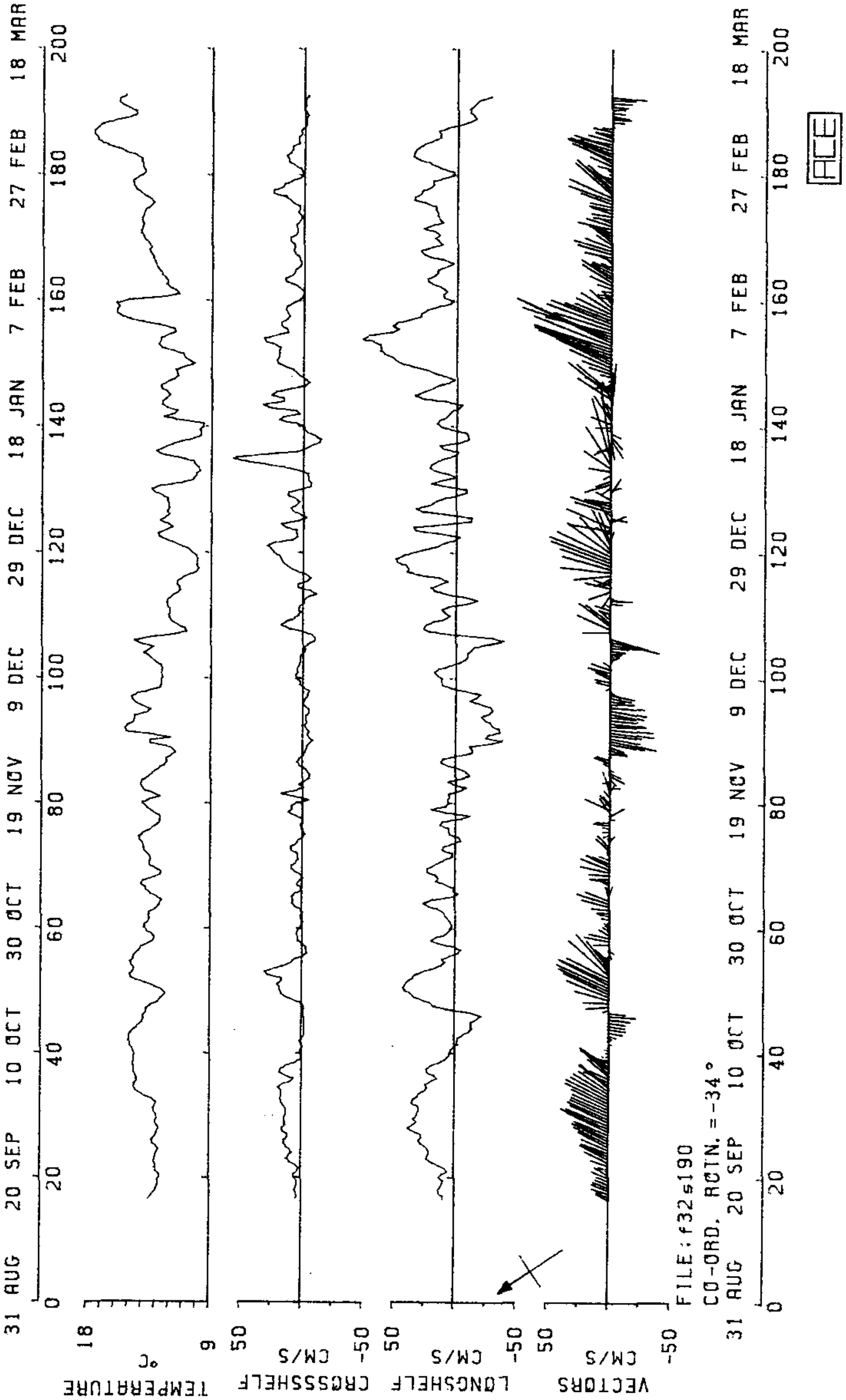
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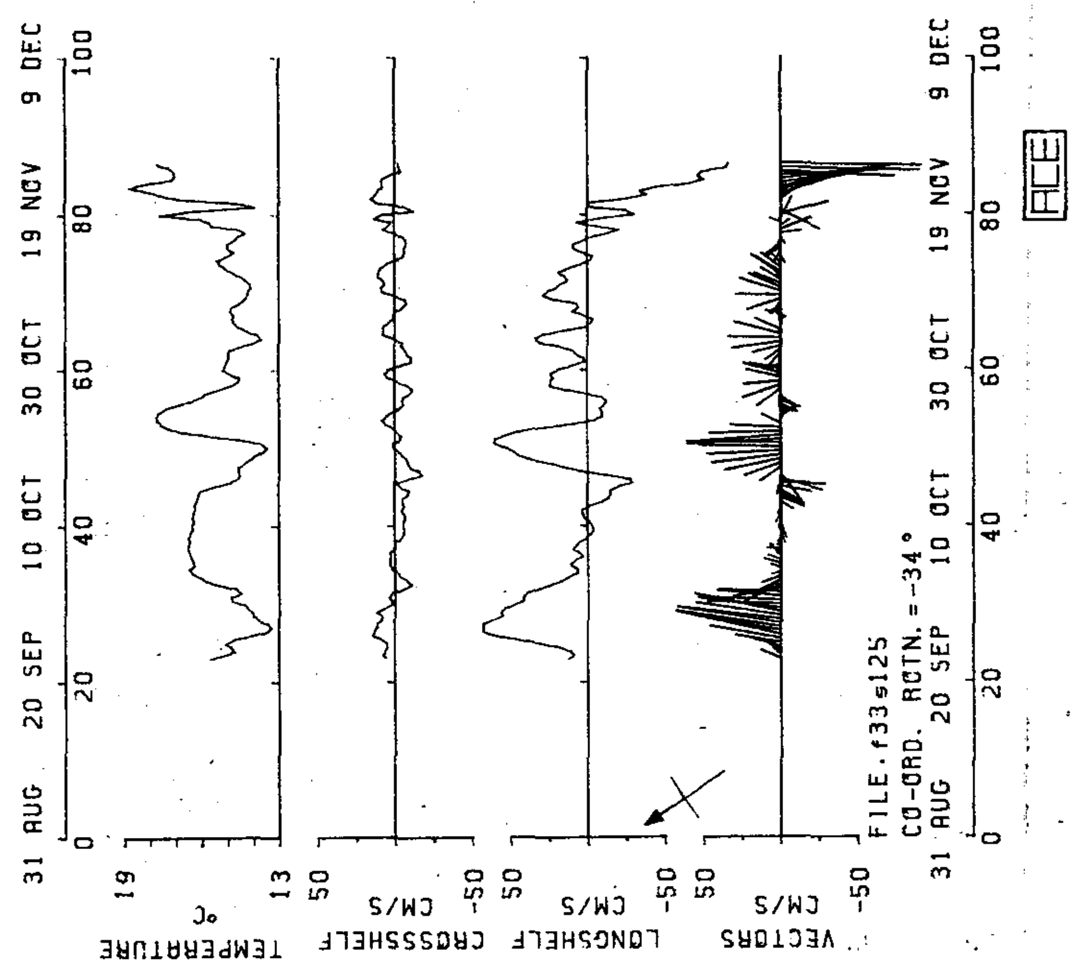

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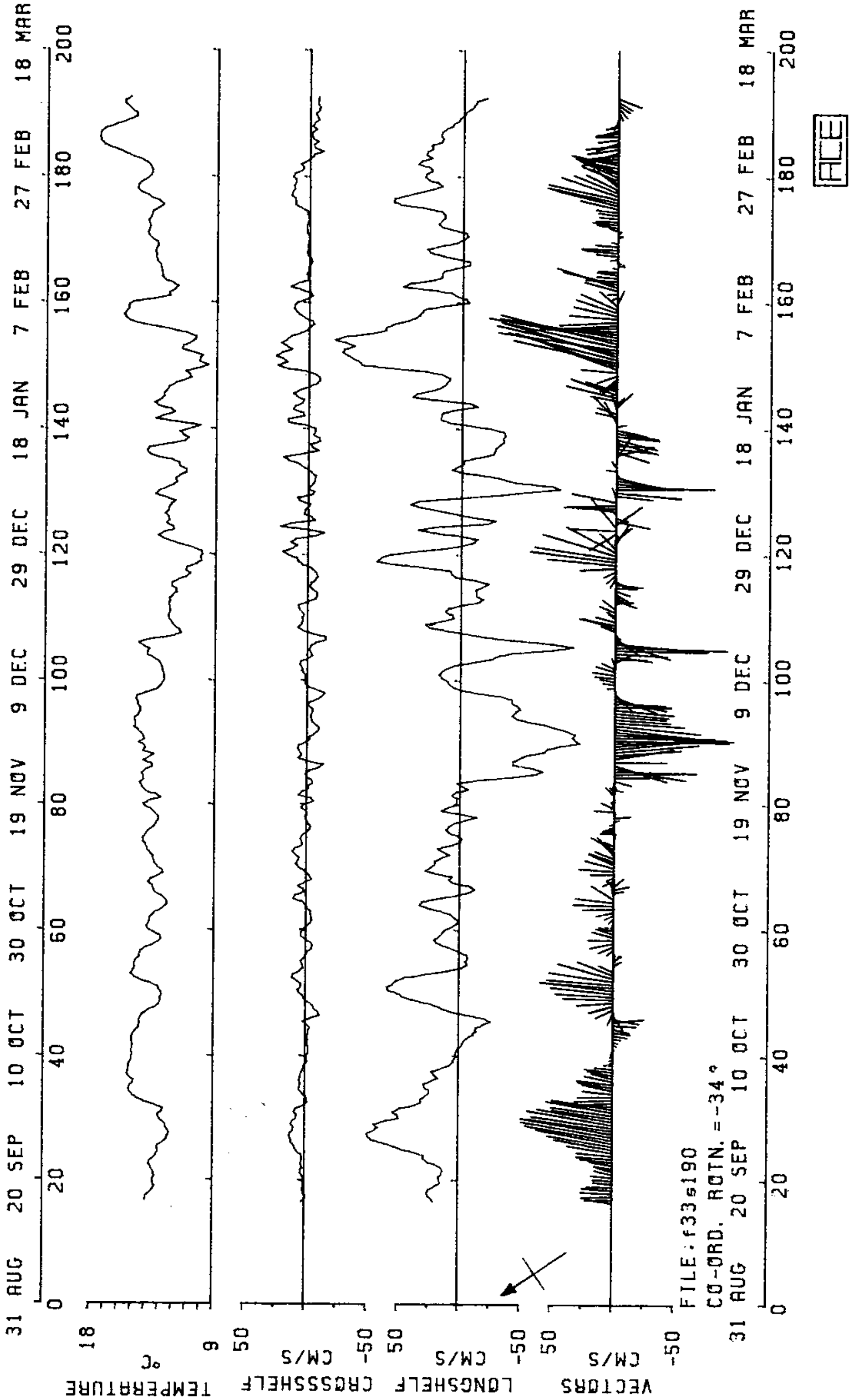
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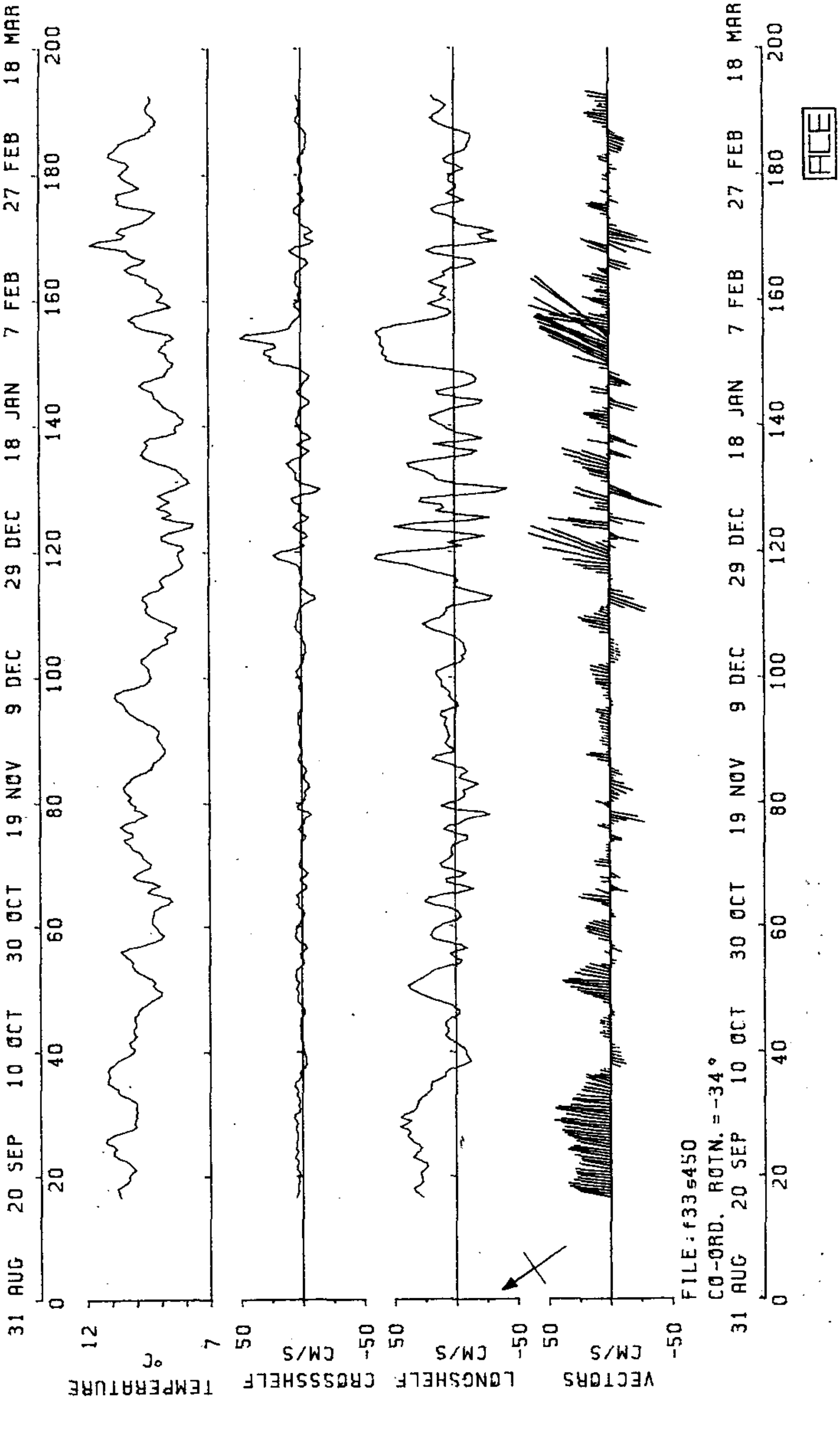
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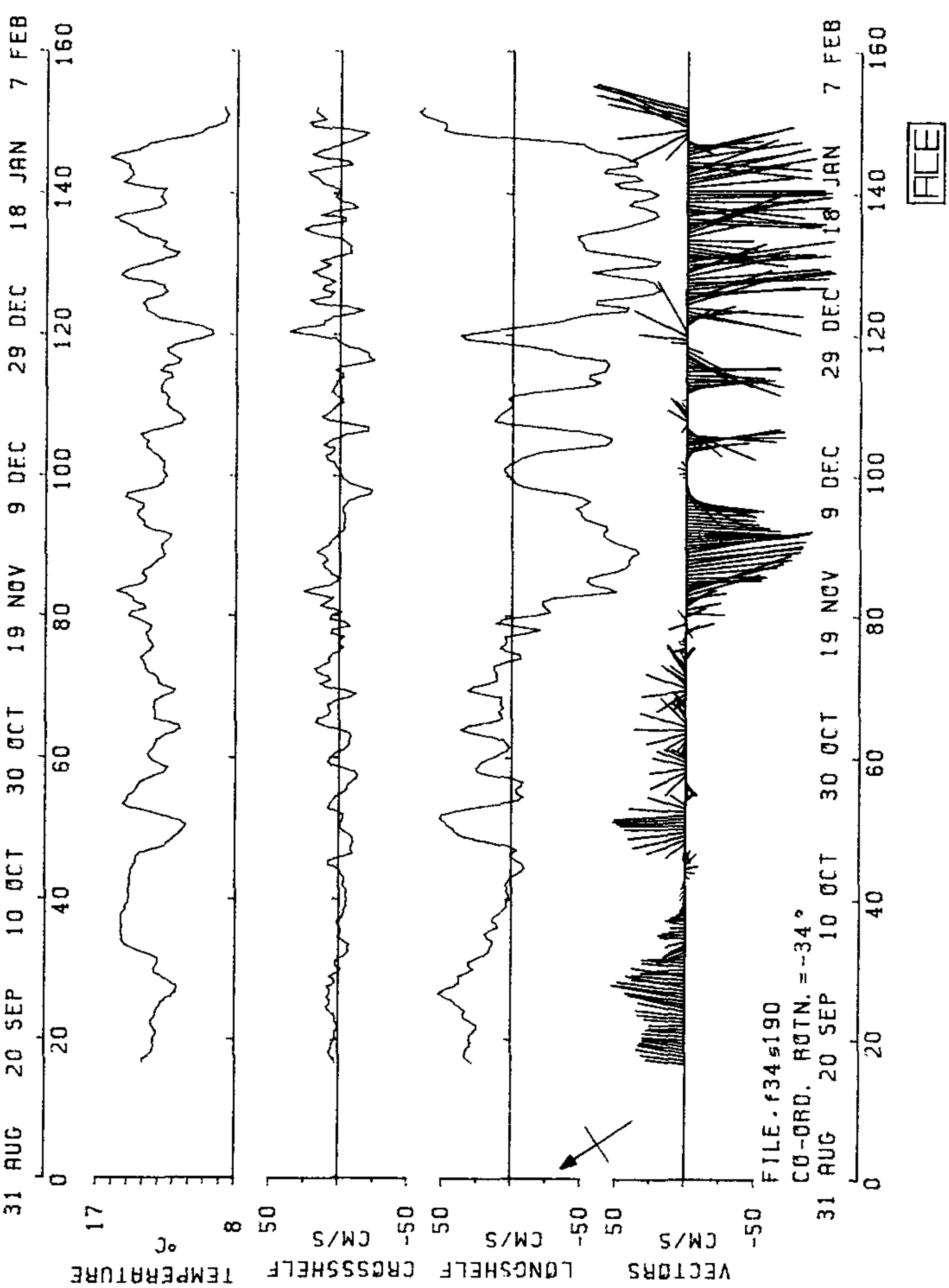
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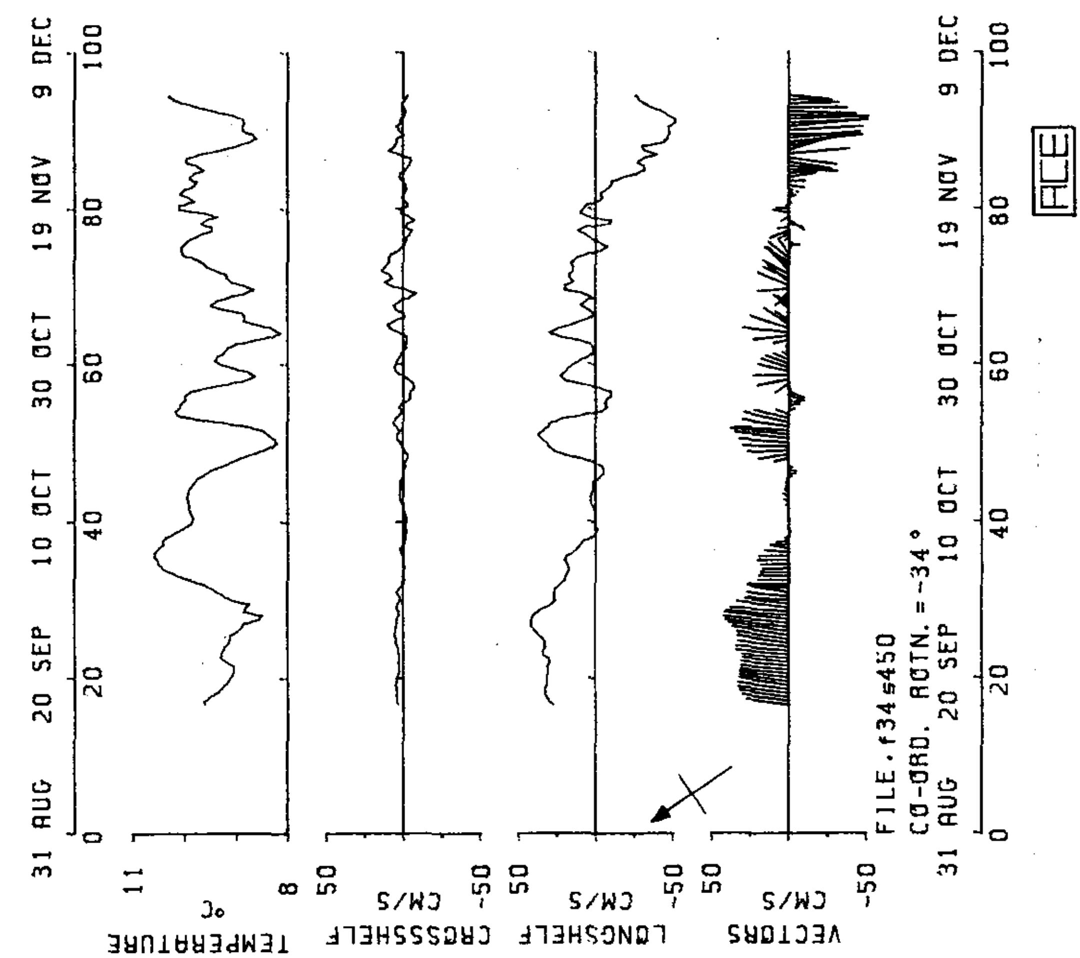
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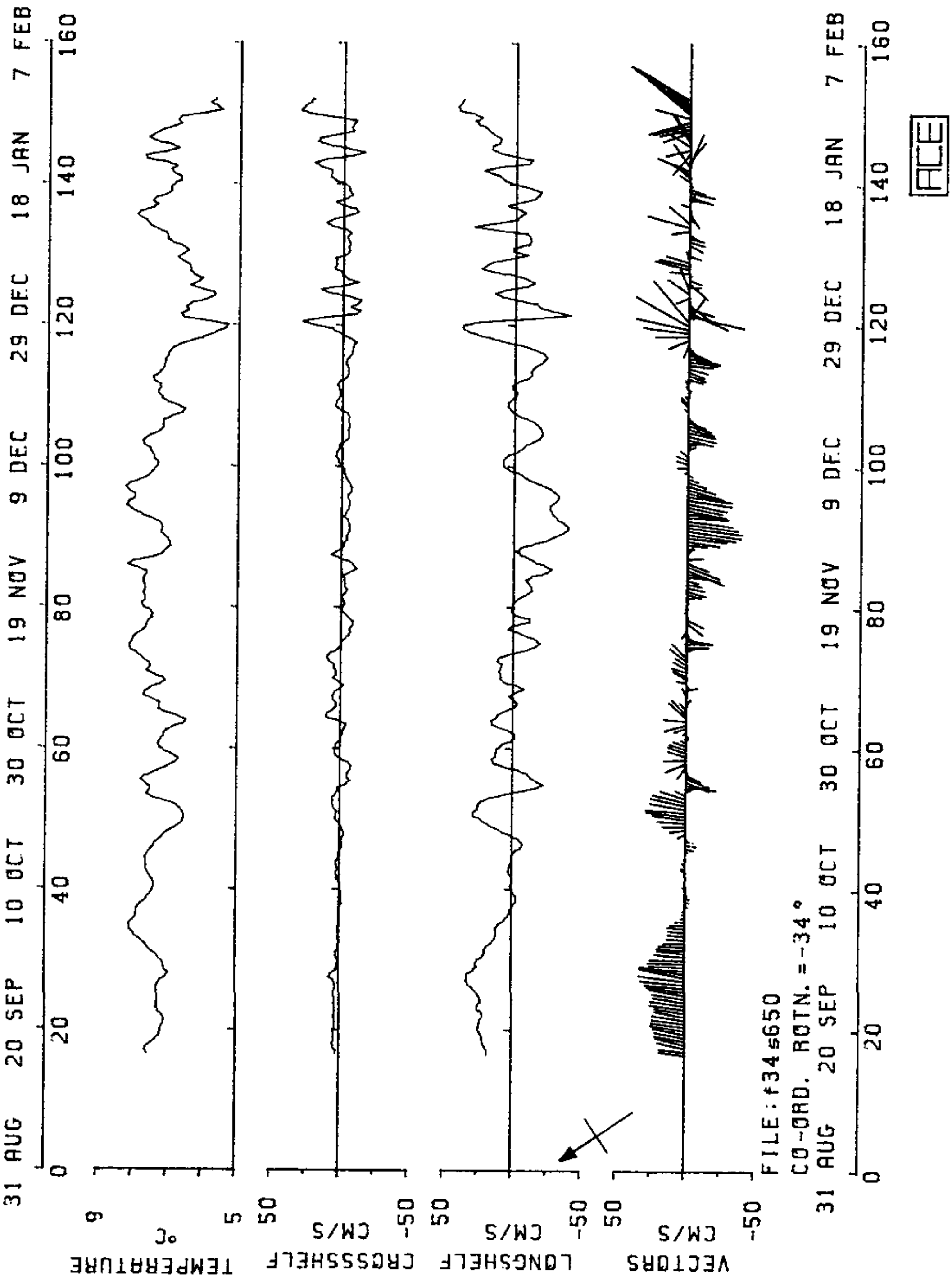
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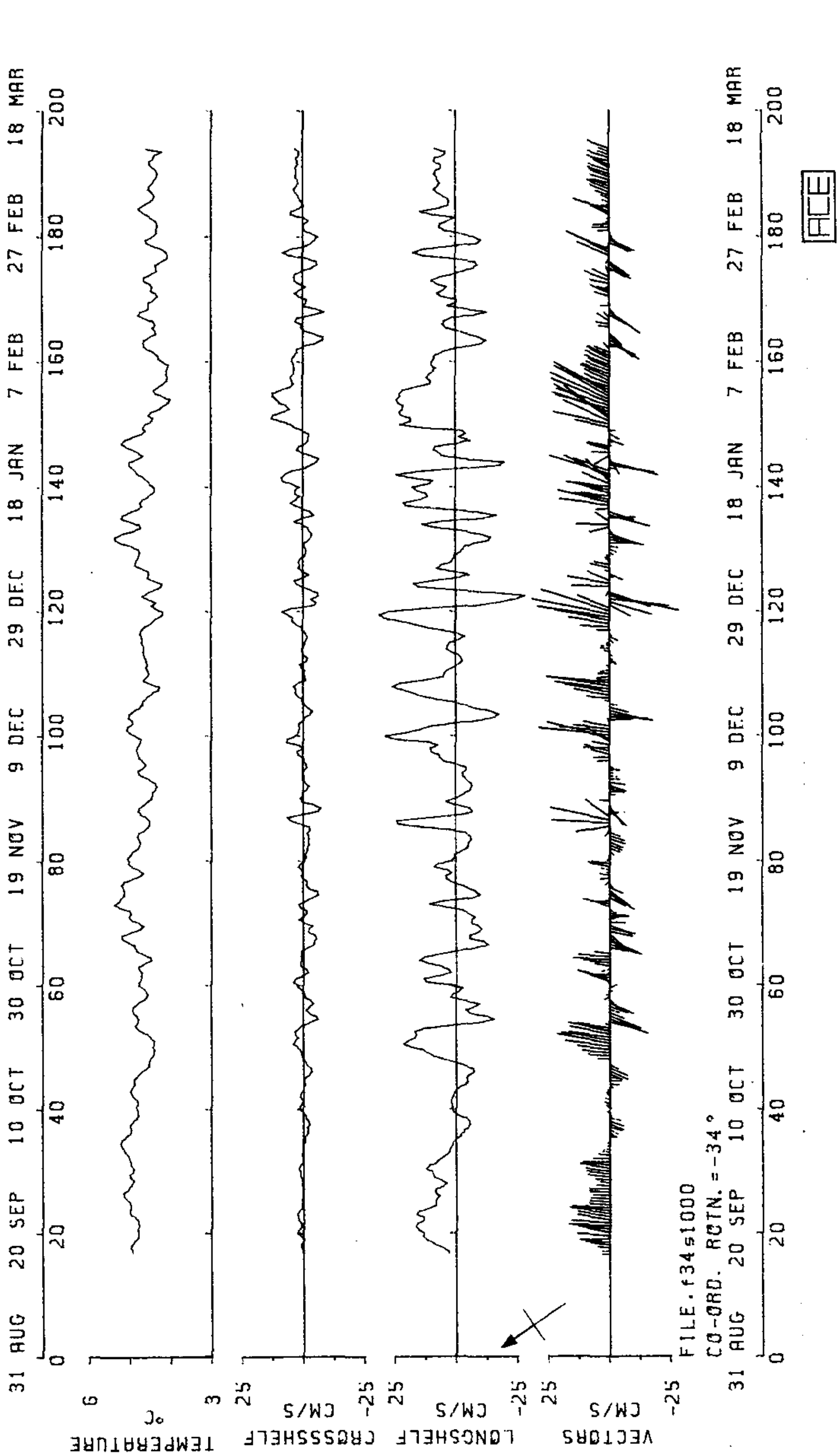
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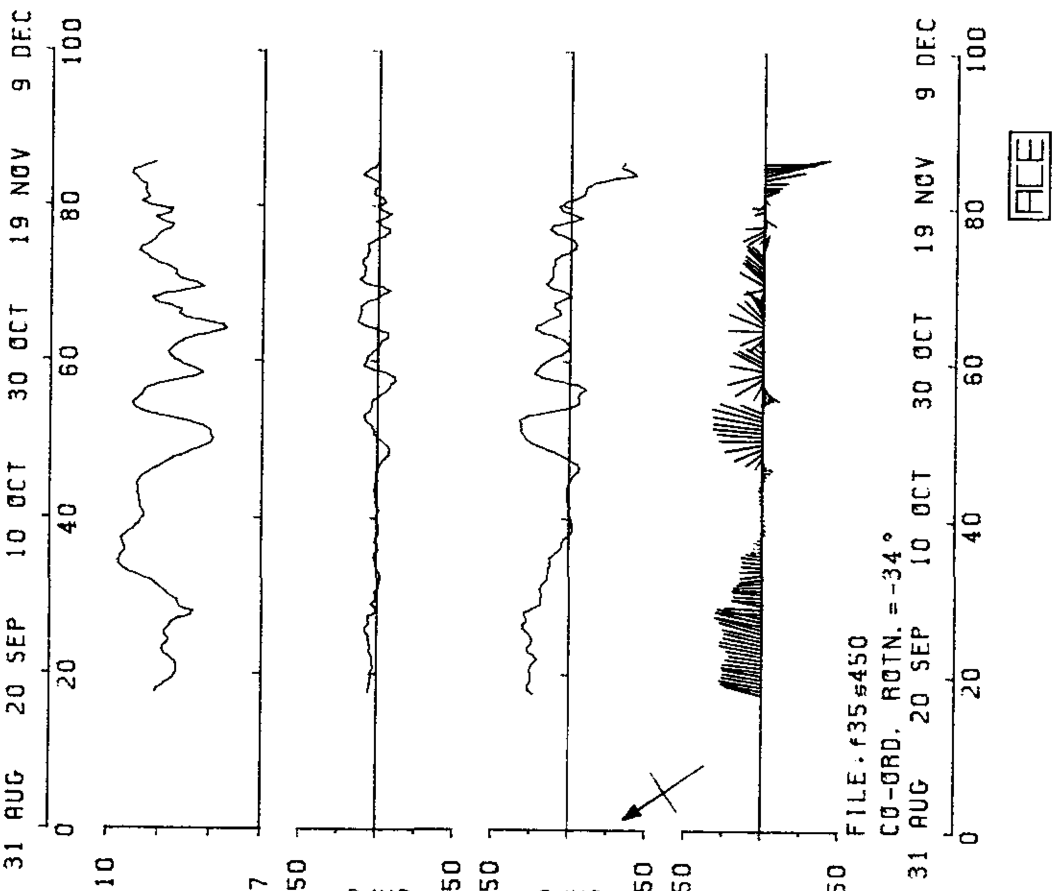
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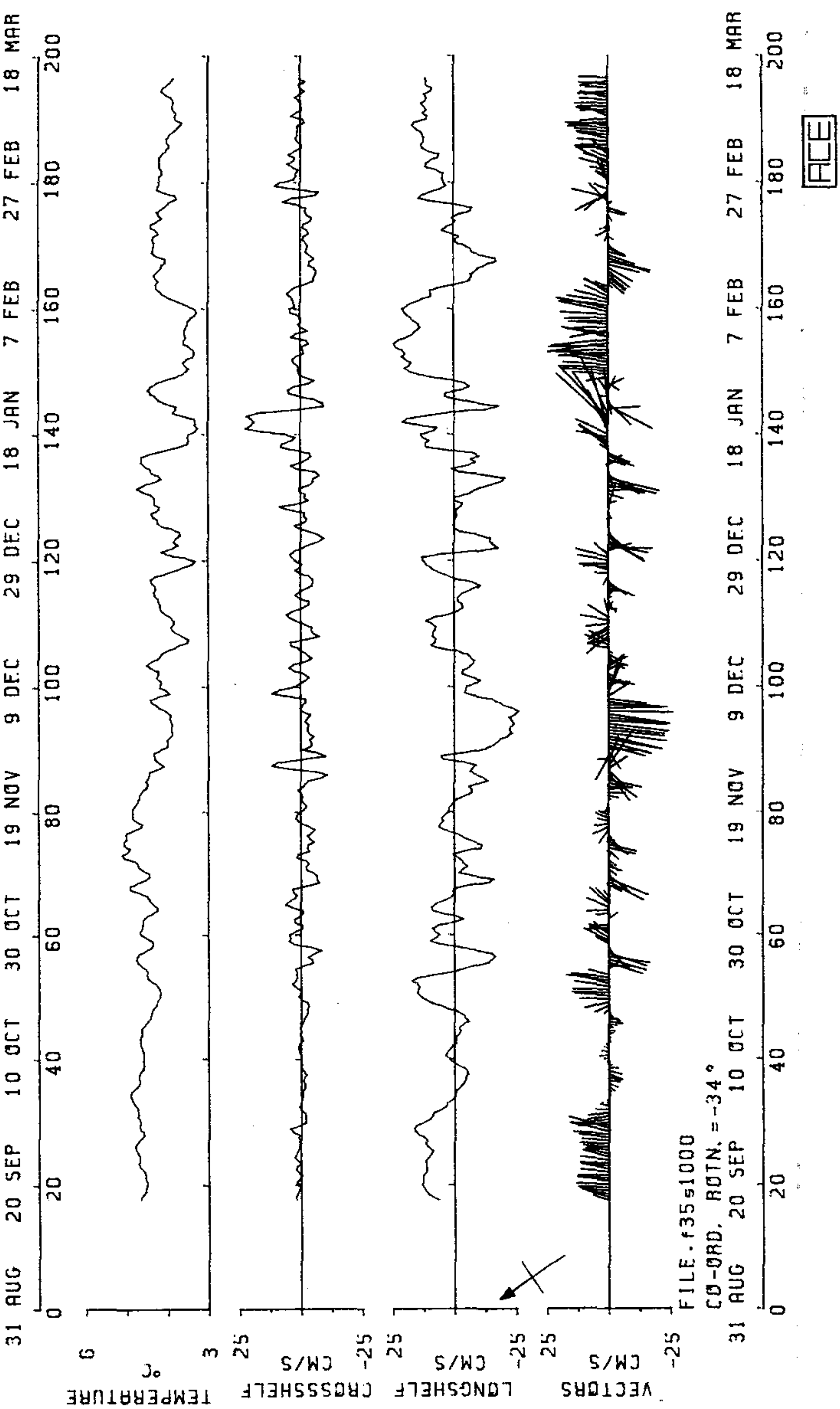
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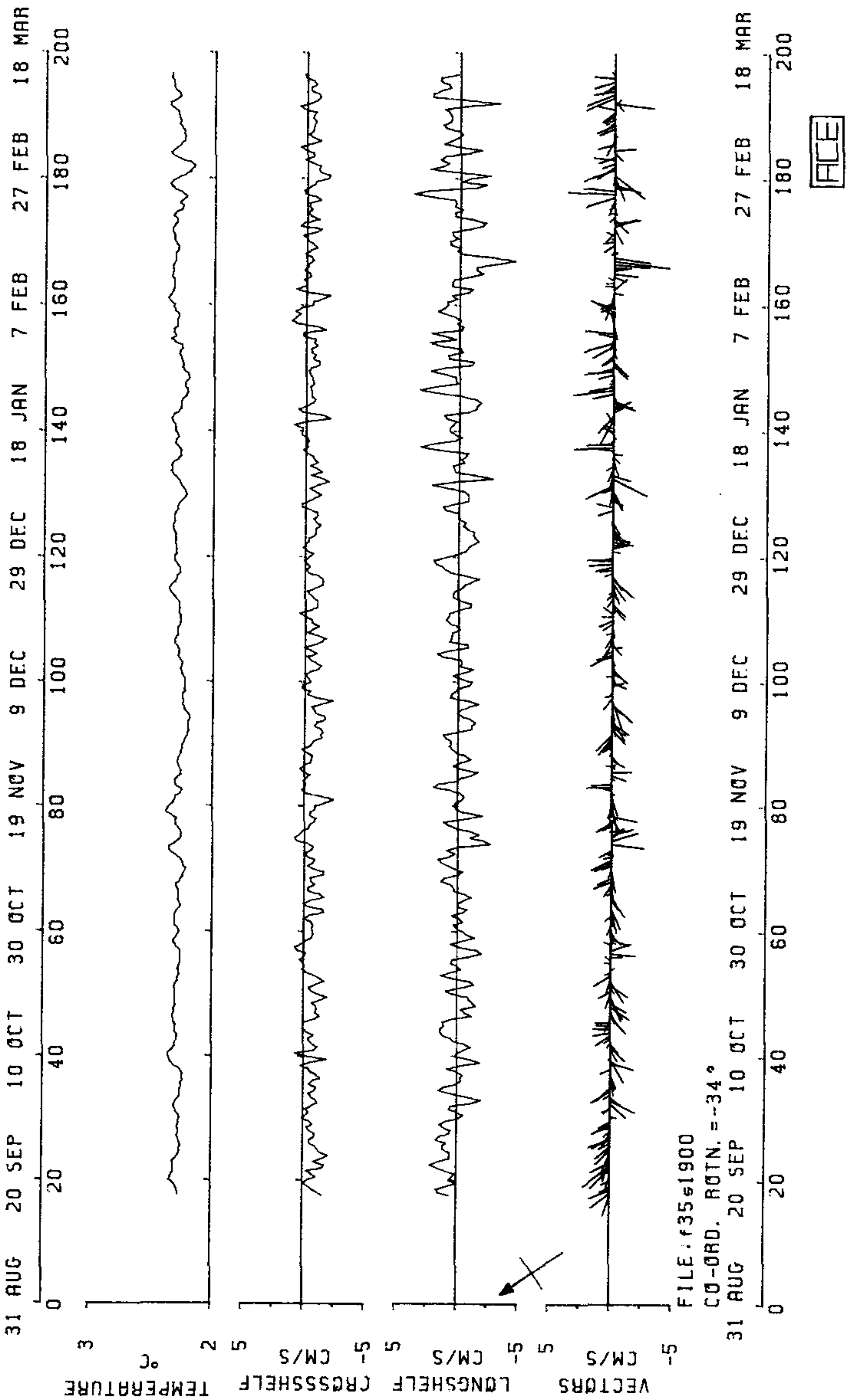

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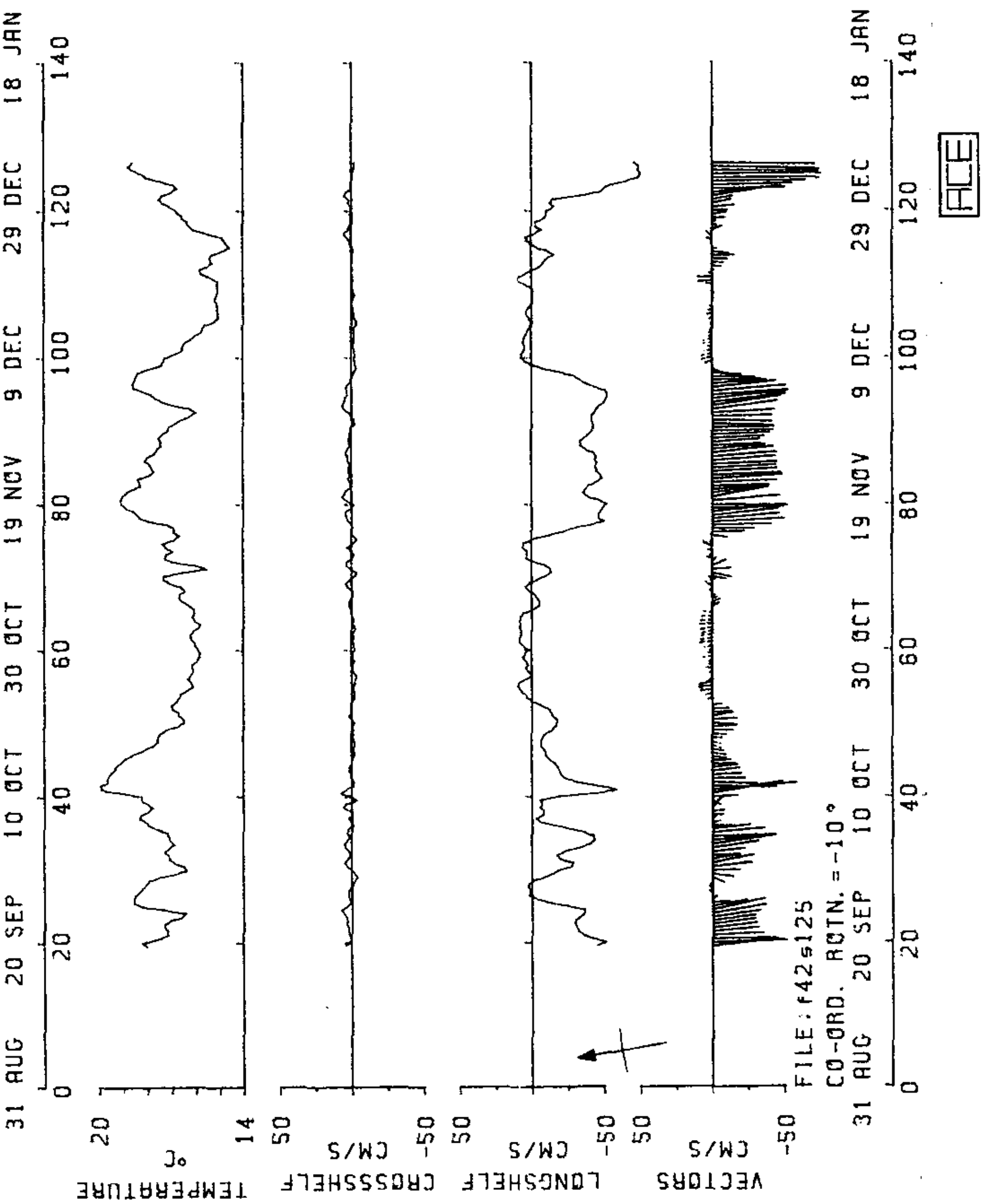
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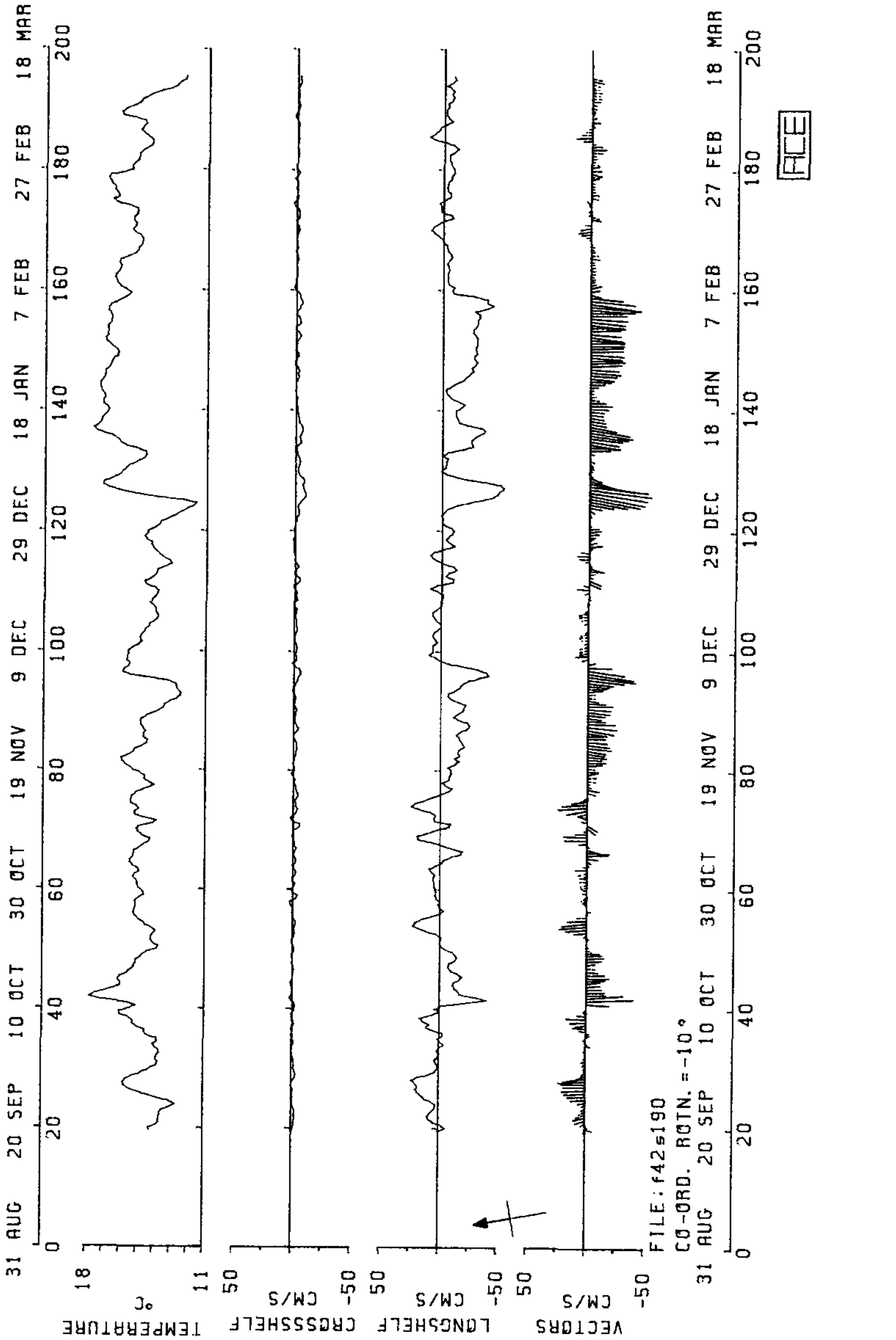
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CO-ORD. ROTN. = -10°
ACE

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Division of Oceanography
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ISSN 0725-4598