Long Time-Series of Filtered Current Records for the B.C. Coast, 1979-1982

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1987

Canadian Data Report of Hydrography and Ocean Sciences No. 52

Fisheries and Oceans Pêches et Océans

Canada

Canadian Data Report Of Hydrography and Ocean Sciences

These reports provide a medium for the documentation and dissemination of data in a form directly useable by the scientific and engineering communities.

Generally, the reports will contain raw and/or analyzed data but will not contain interpretations of the data. Such compilations will commonly have been prepared in support of work related to the programs and interests of the Ocean Science and Surveys (OSS) sector of the Department of Fisheries and Oceans.

Data Reports are produced regionally but are numbered and indexed nationally. Requests for individual reports will be fulfilled by the issuing establishment listed on the front cover and title page. Out of stock reports will be supplied for a fee by commercial agents.

Regional and headquarters establishments of Ocean Science and Surveys ceased publication of their various report series as of December 1981. A complete listing of these publications and the last number issued under each title are published in the *Canadian Journal of Fisheries and Aquatic Sciences*, Volume 38: Index to Publications 1981. The current series began with Report Number 1 in January 1982.

Rapport statistique canadien sur l'hydrographie et les sciences océaniques

Ces rapports servent de véhicule pour la compilation et la diffusion des données sous une forme directement utilisable par les scientifiques et les techniciens.

En général, les rapports contiennent des données brutes ou analysées mais ne fournissent pas d'interprétations des données. Ces compilations sont préparées le plus souvent à l'appui de travaux reliés aux programmes et intérêts du service des Sciences et Levés océaniques (SLO) du ministère des Pêches et des Océans.

Les rapports statistiques sont produits à l'échelon régional mais sont numérotés et placés dans l'index à l'échelon national. Les demandes de rapports seront satisfaites par l'établissement auteur dont le nom figure sur la couverture et la page de titre. Les rapports épuisés seront fournis contre rétribution par des agents commerciaux.

Les établissements des Sciences et Levés océaniques dans les régions et à l'administration centrale ont cessé de publier leurs diverses séries de rapports depuis décembre 1981. Vous trouverez dans l'index des publications du volume 38 du *Journal canadien des sciences halieutiques et aquatiques*, la liste de ces publications ainsi que le dernier numéro paru dans chaque catégorie. La nouvelle série a commencé avec la publication du Rapport n° 1 en janvier 1982.

Canadian Data Report of Hydrography and Ocean Sciences No. 52

1987

LONG TIME-SERIES OF FILTERED CURRENT RECORDS FOR THE B.C. COAST, 1979-1982

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ABSTRACT

Freeland, H.J. 1987. Long time-series of filtered current records for the B.C. coast, 1979-1982. Can. Data Rep. Hydrogr. Ocean Sci. 52:80p.

This report presents plots of low-pass filtered current and temperature records from a variety of sites distributed along the coast of British Columbia. The time series consist of individual deployments of, typically, 6 months duration that have been merged to form long time-series. Some of the data were collected as part of the Coastal Ocean Dynamics Experiment other in association with a U.S. project known as SuperCODE. The longest time-series resulting extends over more than 3 years from May 1979 to July 1982 at a site off southern Vancouver Island.

Data have been filtered using a Lanczos-Cosine filter with a half-power point near 40 hours. This filter effectively suppresses tidal and higher frequency oscillations but leaves unchanged oscillations with periods longer than about 2 days.

key words: SuperCODE, Currents, Vancouver Island.

RÉSUMÉ

Freeland, H.J. 1987. Long time-series of filtered current records for the B.C. coast, 1979-1982. Can. Data Rep. Hydrogr. Ocean Sci. 52:80p.

Ce rapport présente des diagrammes de données de courant et de température filtrées pour les basses fréquences provenant de divers emplacements répartis le long de la côte de la Colombie-Britannique. La série chronologique est constituée de déploiements individuels d'une durée typique de 6 mois qui ont été fusionnés pour former de longues séries chronologiques. Certaines des données ont été recueillies dans le cadre de l'Experiénce sur la dynamique des eaux côtières, d'autres en association avec le projet américain connu sous le nom de SuperCODE. La plus longue série chronologique qui en découle s'étend sur une période de plus de trois ans de mai 1979 à juillet 1982 à un emplacement situé au large de la partie sud de l'île Vancouver.

Les données ont été filtrées à l'aide d'un filtre Lanczos Cosine ayant un point à demi-puissance près de 40 heures. Ce filtre supprime efficacement les oscillations des marées et de fréquences plus élevées mais ne modifie pas les oscillations ayant des périodes plus longues que 2 jours environ.

Mots-clés: SuperCODE, courants, île Vancouver.

ACKNOWLEDGMENTS

Several individuals contributed to the collection and processing of these data. I thank Reg Bigham, Al Stickland, Les Spearing and Andrew Lee. I gratefully acknowledge the assistance of the officers and crew of the C.S.S. PARIZEAU for their contribution to the success of this project.

INTRODUCTION

The CODE (Coastal Ocean Dynamics Experiment) program was an interdisciplinary investigation of the circulation, water properties and biology of the west coast of Vancouver Island. As an important part of CODE moorings were deployed along the coast and the data from these moorings reported on in various technical and scientific reports. (See, for examples, Freeland (1983), Thomson et al. (1985), Freeland and Denman (1982).) Subsequent to this experiment 5 moorings were deployed on the 210m isobath (the shelf break) to look at the propagation of low frequency signals along the continental margin. The timing of these deployments was chosen to fit the timing of an experiment taking place off the west coast of the U.S.A. called SuperCODE. The primary SuperCODE array consisted of moorings extending from southern California to the Oregon/Washington border. Besides the primary array, a group of Mexican scientists from Centro de Investigacion Cientifica y de Educacion Superior de Ensenada (Baja California) maintained a shelf break mooring off Baja California, and the Ocean Physics Division of the Institute of Ocean Sciences maintained the series of 5 moorings along the B.C. coast. One of these moorings, L.P.B., for La Perouse Bank, occupied the same site as a mooring known as CZ3 in CODE. Thus at that single site a very long time series results.

Figure 1 shows a map of the B.C. coastline with the mooring locations identified. In all of the following notes mnemonic labels are used to represent the mooring sites, these labels refer to local landmarks and are as follows:

L.P.B.	La Perouse Bank
E.P.	Estevan Point
W.H.	Winter Harbour
Q.C.S.S.	Queen Charlotte Sound, South
C.S.J.	Cape St. James

Individual current meters will be identified by appending a slash and the instrument depth to the mnemonic code. For example, E.P./100 is a current meter at 100 metres depth off Estevan Point. Table 1 summarizes the deployment statistics for each mooring including the latitude and longitude of each site and the date of first deployment and final recovery.

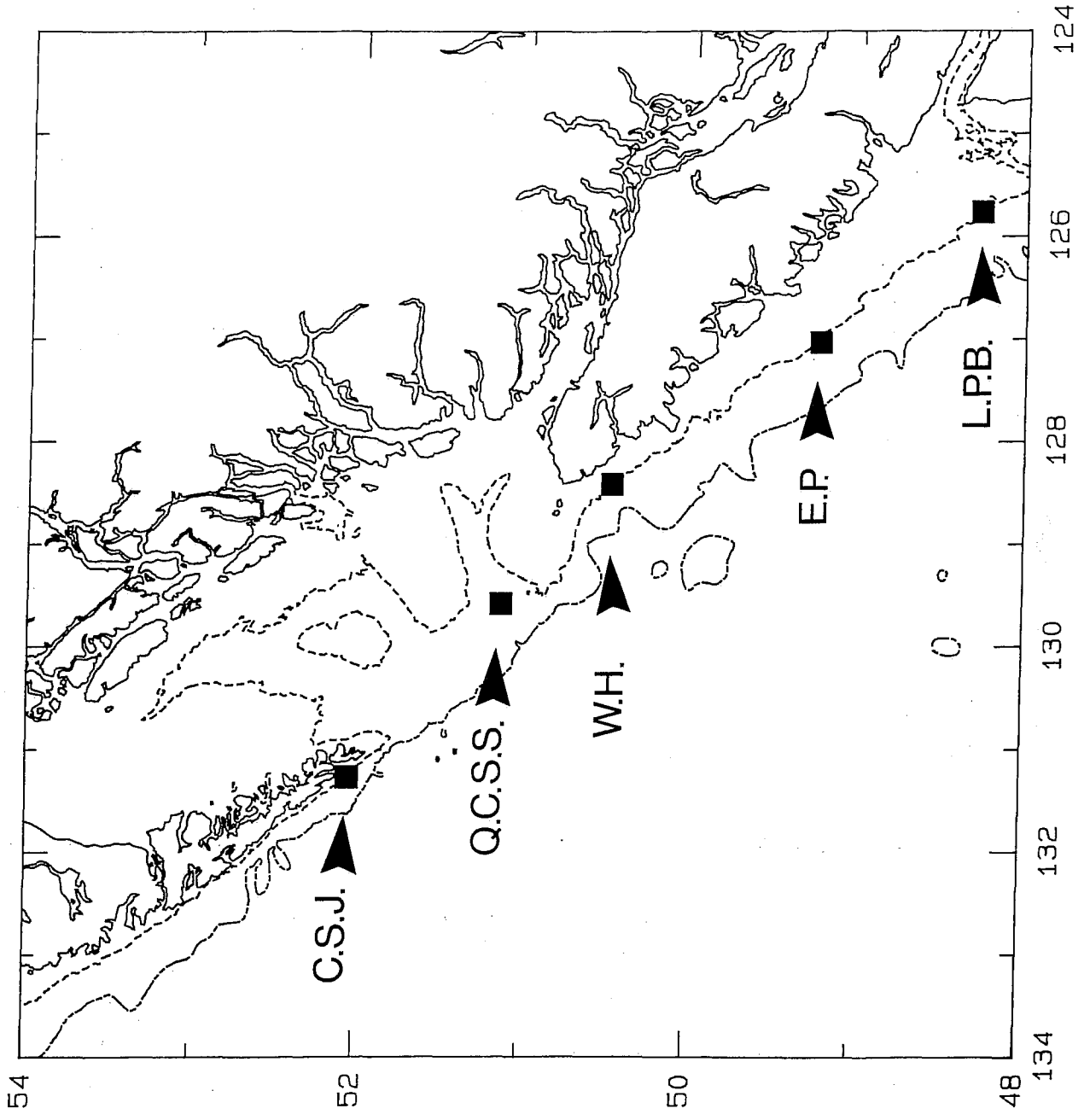
C.S.J.
Q.C.S.S.
W.H.
E.P.
L.P.B.
54
52
50
48
124
126
128
130
132
134

Table 1. Mooring statistics

Site	Latitude	Longitude	Deployed	Recovered
L.P.B.	48°16'N	125°46'W	22/5/79	17/7/82
E.P.	49°14'N	127°02'W	05/9/81	23/8/82
W.H.	50°29'N	128°25'W	09/6/81	23/8/82
Q.C.S.S.	51°08'N	129°35'W	06/9/81	17/9/82
C.S.J.	52°03'N	131°16'W	06/9/81	25/8/82

All current meters deployed were Aanderaa RCM-4 instruments sampling at 30 minute or 60 minute intervals. Buoyancy was supplied by spherical buoys at a depth of 45 metres and at an intermediate depth part way down each mooring. All moorings were subsurface and used 1 or 2 Interocean acoustic releases near the anchor.

PROCESSING

The raw data tapes were processed using the methods described by Yee and Stucchi (1979). This produced calibrated files, one for each current meter deployment, containing data measured at 30 minute or 60 minute intervals. Tides dominate these time-series and it is necessary to remove the tides before the low-frequency currents can be displayed. This was done as follows:-

1. The individual high frequency calibrated data files were subsampled to 1 hour intervals if the original sampling interval was other than 1 hour.

2. Files corresponding to sequential deployments at a single depth at a particular location were concatenated to produce a single file. Data gaps were filled at this stage by dummy records.

3. Data gaps shorter than 40 hours were filled by linear interpolation.

4. The time-series were then filtered using a Lanczos-Cosine filter, and subsampled at 12 hour intervals. The resulting series were then written to magnetic tape and used as the master source of low-frequency data displayed in this report.

The Lanczos-Cosine filter employed is defined as follows:-

C_i is a series of filter coefficients which when convolved with a time series D_i produces a filtered version $\hat{D}_i$, thus

$$\hat{D}_i = C_o D_i + \sum_{j=1}^{N} C_j \, (D_{i+j} + D_{i-j}).$$

The filter coefficients are defined by

$$C_o = 1/Q,$$

$$C_i = (0.5/Q)\left[1 + \cos\left(\frac{\pi i}{60}\right)\right] \sin\left(\frac{0.7\pi i}{12}\right) \Big/ \left(\frac{0.7\pi i}{12}\right)$$

where $Q = 17.132$ and $1 \leq i \leq N = 60$.

STATISTICS

Table 2 shows a list of basic current meter statistics derived from the data presented in this report. The means of u, v and T (east and north components of velocity and temperature respectively) are denoted by $\bar{u}$, $\bar{v}$ and $\bar{T}$. The respective variances are denoted by $\overline{u'^2}$, $\overline{v'^2}$ and $\overline{T'^2}$. Also listed are the cross-covariances $\overline{u'v'}$, $\overline{u'T'}$ and $\overline{v'T'}$, the latter two representing eddy heat fluxes. The columns λ_1 and λ_2 contain the major and minor axes of the velocity covariance matrices, and is the direction of the major axes. These are computed as follows:

1. The covariance matrix C is computed

$$\mathbf{C} = \begin{pmatrix} \overline{u'^2} & \overline{u'v'} \\ \overline{v'u'} & \overline{v'^2} \end{pmatrix}$$

Table 2. Statistics of each current meter site

Site/Depth	$\bar{u}$	$\bar{v}$	$\overline{u'^2}$	$\overline{v'^2}$	$\overline{u'v'}$	λ_1	λ_2	θ	$\bar{T}$	$\overline{T'^2}$	$\overline{u'T'}$	$\overline{v'T'}$
LPB/50	3.43	-0.77	112.2	109.8	-84.6	195.7	26.4	135.4	9.10	82.8	-4.85	4.39
LPB/100	1.29	0.53	71.3	79.6	-59.4	135.0	15.9	133.0	8.18	67.7	-0.70	0.88
LPB/150	-3.91	0.68	60.1	12.0	-16.4	65.2	6.9	162.8	7.14	51.2	-0.57	0.55
EP/50	-2.11	2.70	178.8	317.5	-172.7	434.2	62.1	124.1	8.71	76.6	-6.00	9.20
EP/100	-2.61	4.29	184.1	245.4	-158.9	376.5	53.0	129.6	7.88	62.6	-2.67	5.00
EP/150	-4.59	7.38	73.9	85.2	-71.4	151.2	7.9	132.7	7.38	54.7	0.09	0.21
WH/50	-0.92	4.50	286.9	451.9	-265.1	647.0	91.8	126.4	8.85	79.6	-7.84	8.50
WH/100	-1.20	2.06	115.5	183.7	-116.4	270.9	28.4	126.8	7.70	60.4	-4.93	5.69
WH/150	-0.35	1.58	42.0	71.3	-44.3	103.4	10.0	125.9	7.03	49.8	-0.54	1.23
QCSS/50	1.08	3.95	79.3	186.9	-22.4	191.4	74.8	101.3	8.75	77.6	-3.51	8.14
QCSS/100	1.56	1.72	64.4	129.2	-19.7	134.7	58.9	105.6	7.68	59.7	-1.72	1.89
QCSS/150	1.69	-1.24	40.5	50.1	-6.3	53.2	37.4	116.4	7.06	50.3	-1.08	-0.19
CSJ/50	9.23	-9.21	208.2	309.0	-188.7	453.9	63.0	127.5	8.72	77.4	4.02	-5.54
CSJ/100	6.30	-5.22	117.9	198.8	-124.1	288.9	27.8	126.0	7.85	61.9	1.51	2.91
CSJ/150	1.90	0.81	48.3	81.3	-54.5	121.7	7.8	126.6	6.93	48.3	1.24	2.04

2. The eigenvalues of $\mathbf{C}$ are found by solving $\det(\mathbf{C} - \lambda\mathbf{I}) = 0$ which yields the quadratic equation $\lambda^2 - (\overline{u'^2} + \overline{v'^2})\lambda + \overline{u'^2}\,\overline{v'^2} - \overline{u'v'}^2 = 0$. This has two solutions λ_1 and λ_2, both are positive and real and we are at liberty to set $\lambda_1 > \lambda_2$.

3. The eigenvector $\underline{e}_1$ corresponding to the eigenvalue λ_1 yields the direction of the major axis and is determined by solving $(\mathbf{C} - \lambda_1\mathbf{I})\underline{e}_1 = 0$. Thus if $\underline{e}_1 = (e_{11}, e_{12})$ then the angle θ is given by $\theta = \arctan(e_{12}/e_{11})$.

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Freeland, H.J. and K.L. Denman, 1982. A topographically controlled upwelling centre off southern Vancouver Island. J. Mar. Res. 40(4), 1069-93.

Freeland H.J. 1983. Low frequency currents observed off southern Vancouver Island, 1979-1981. Can. Data Rep. Hydrogr. Ocean Sci. 7:80p.

Thomson, R.E., W.R. Crawford, H.J. Freeland and W.S. Huggett. 1985. Low-pass filtered current meter records for the west coast of Vancouver Island: Coastal Oceanic Dynamics Experiment, 1979-81. Can. Data Rep. Hydrogr. Ocean Sci. 40:102p.

THE DIAGRAMS

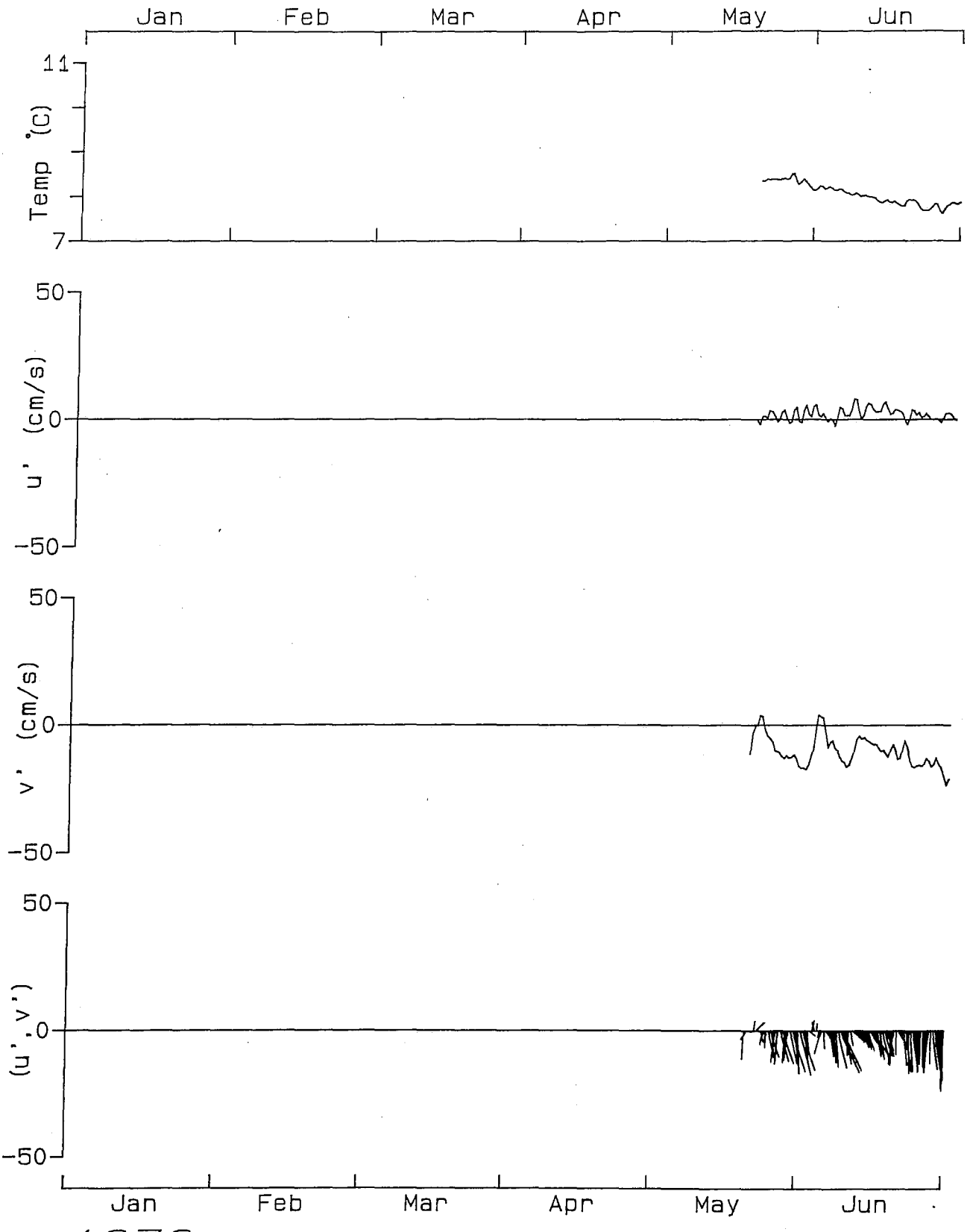
On each of the following we plot data corresponding to 6 months at a time. Data corresponding to January through June is plotted on left hand pages and July through December on right hand pages. For display purposes axes were rotated so that the principal axis of variance is in the y-direction. The true direction of the y-axis can be determined from the column θ in Table 2, which gives the direction of the major axis in degrees measured counter clock-wise from east. The angle of rotation is $\phi = \theta - 90^{o}$. If we write the unrotated and rotated velocities as (u,v) and (u',v') respectively, i.e. u is E/W component and v is N/S component, then:

$$u' = u \cos(\phi) + v \sin(\phi)$$

and

$$v' = v \cos(\phi) - u \sin(\phi).$$

From the bottom of each page the velocity vectors (u',v') are entered, followed by plots of v' and u' separately and finally the temperature time series. Throughout the diagrams the same scale is used for velocities, the velocity components and time. The temperature time scale changes from one instrument to another.


Jan
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Temp °(C)
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u' (cm/s)
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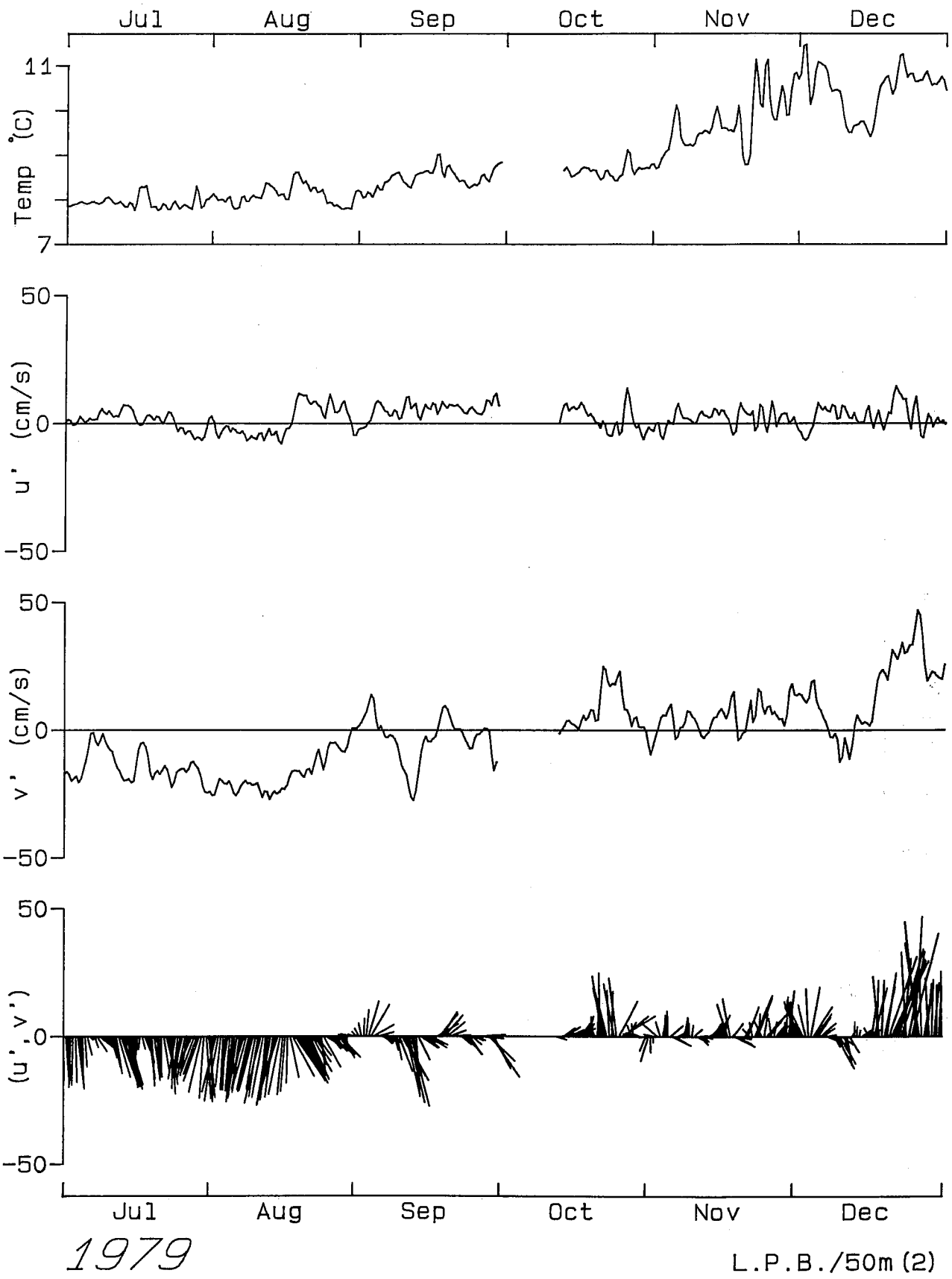
1979
L.P.B./50m (1)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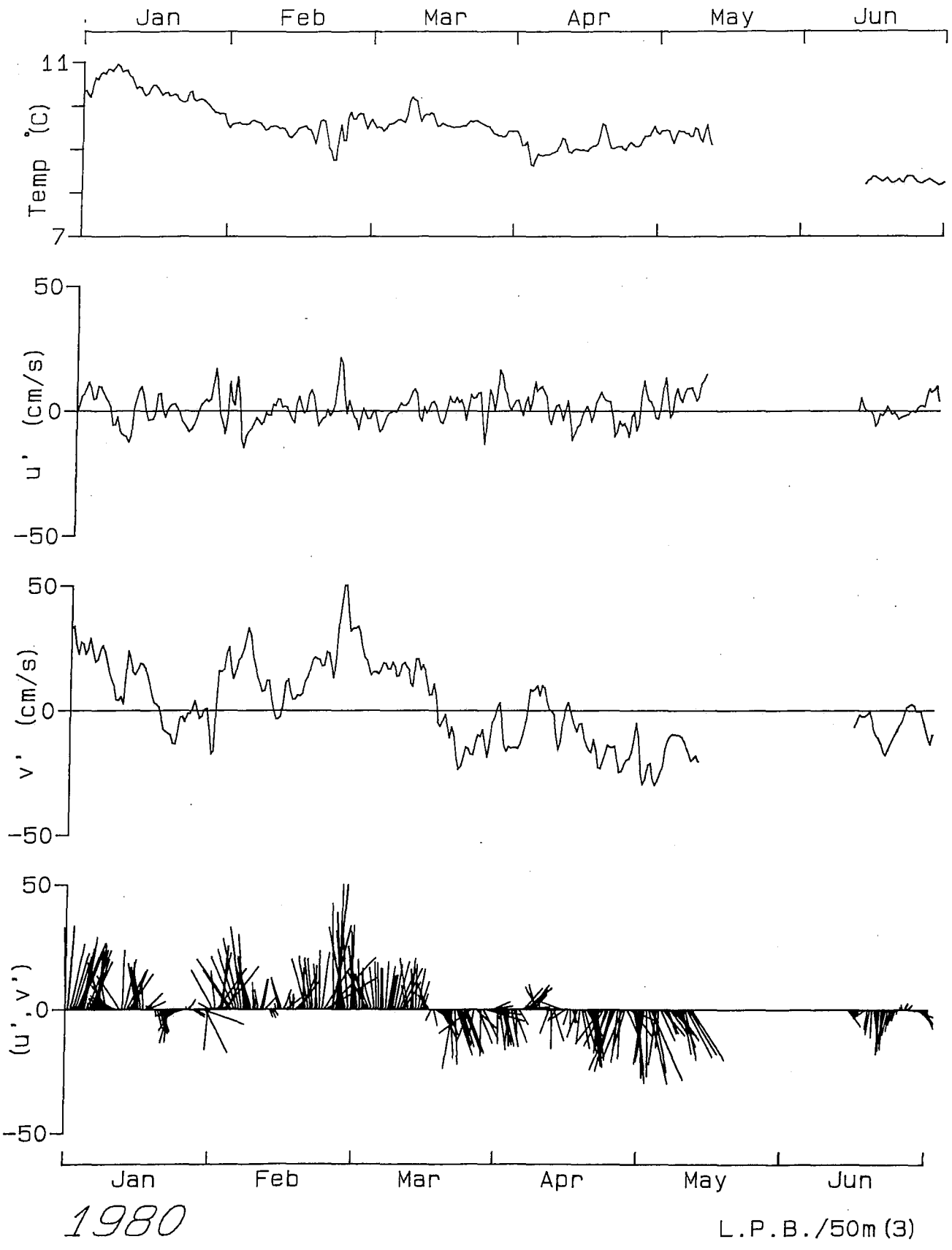
1979
L.P.B./50m (2)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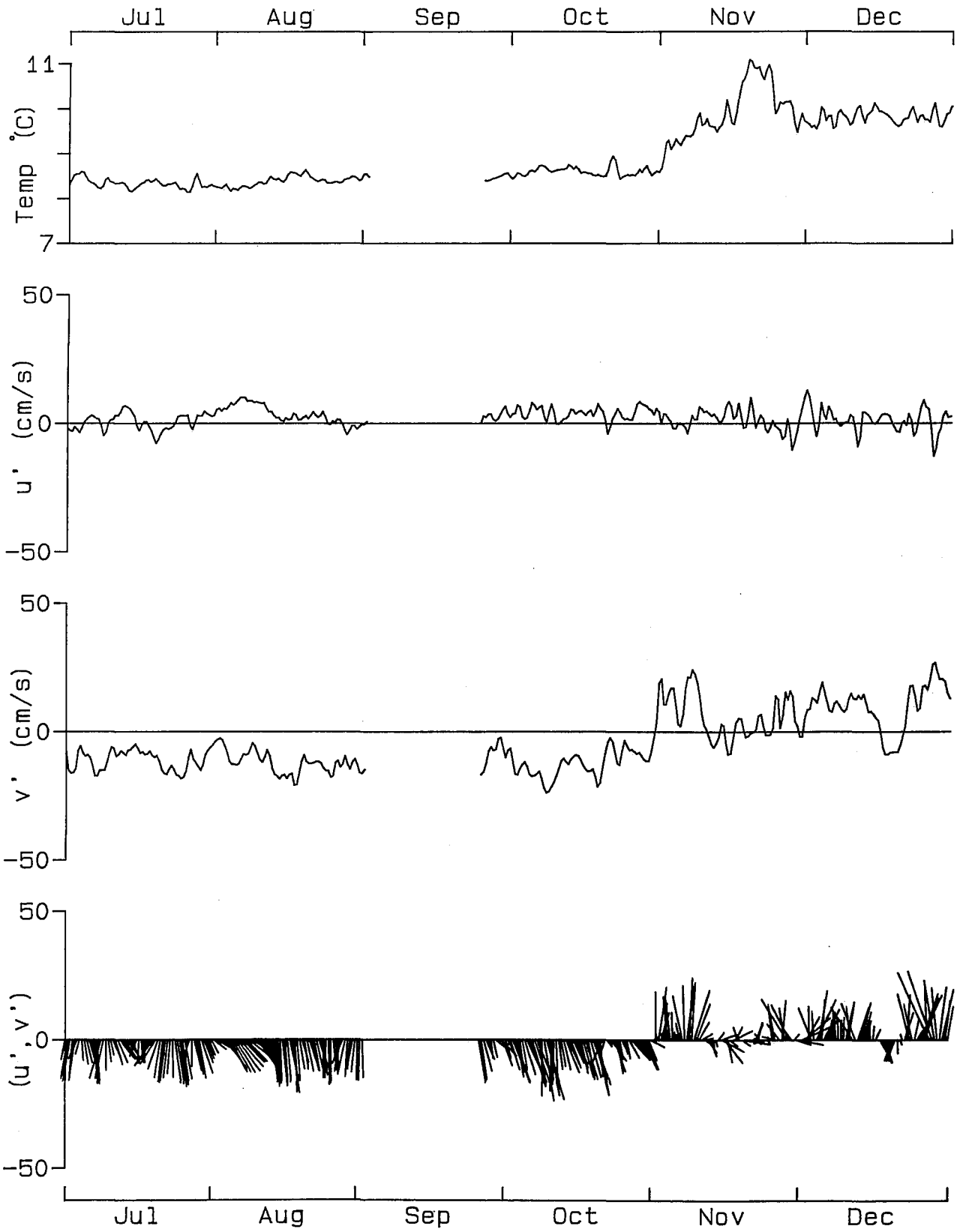
1980
L.P.B./50m (3)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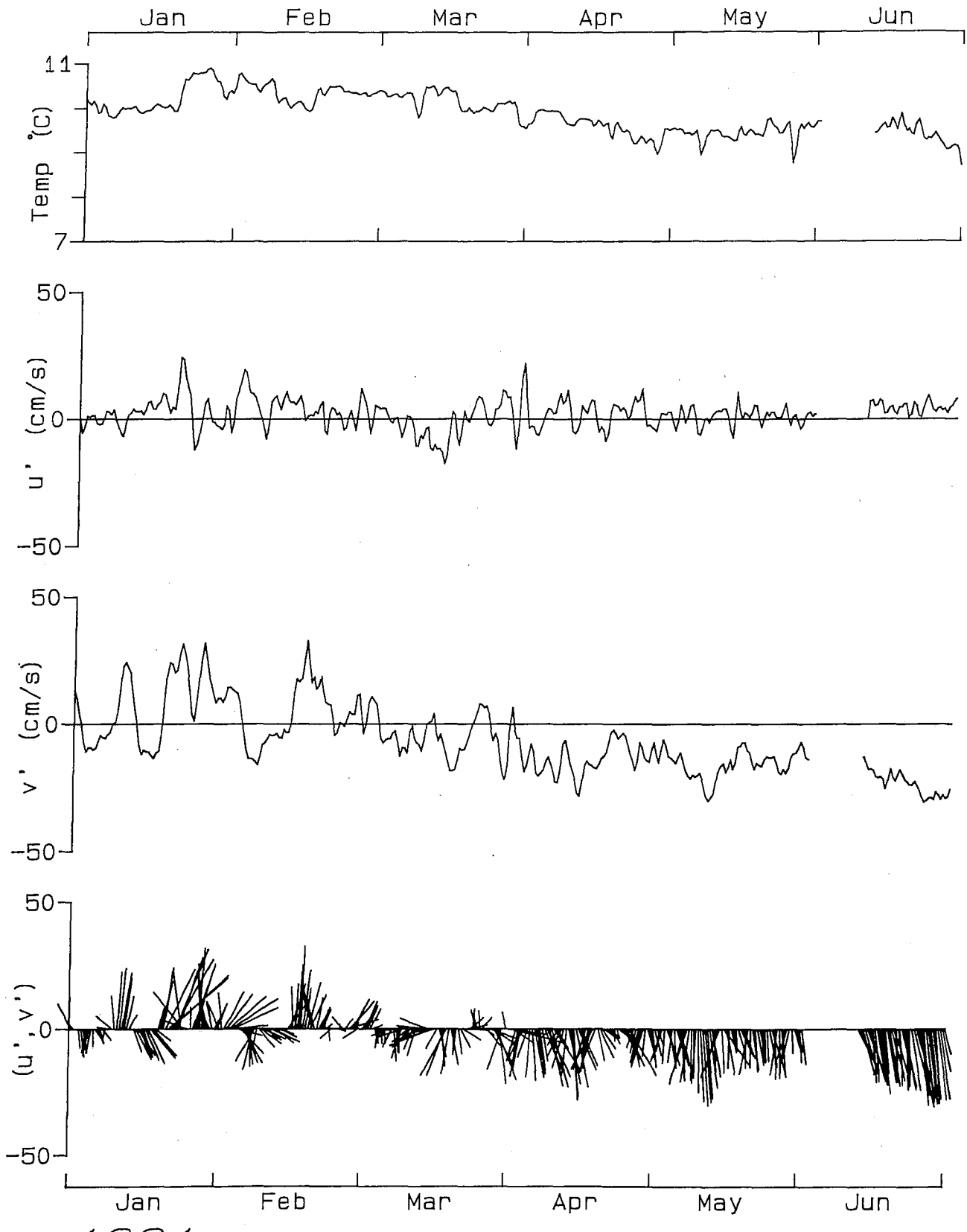
1980
L.P.B./50m (4)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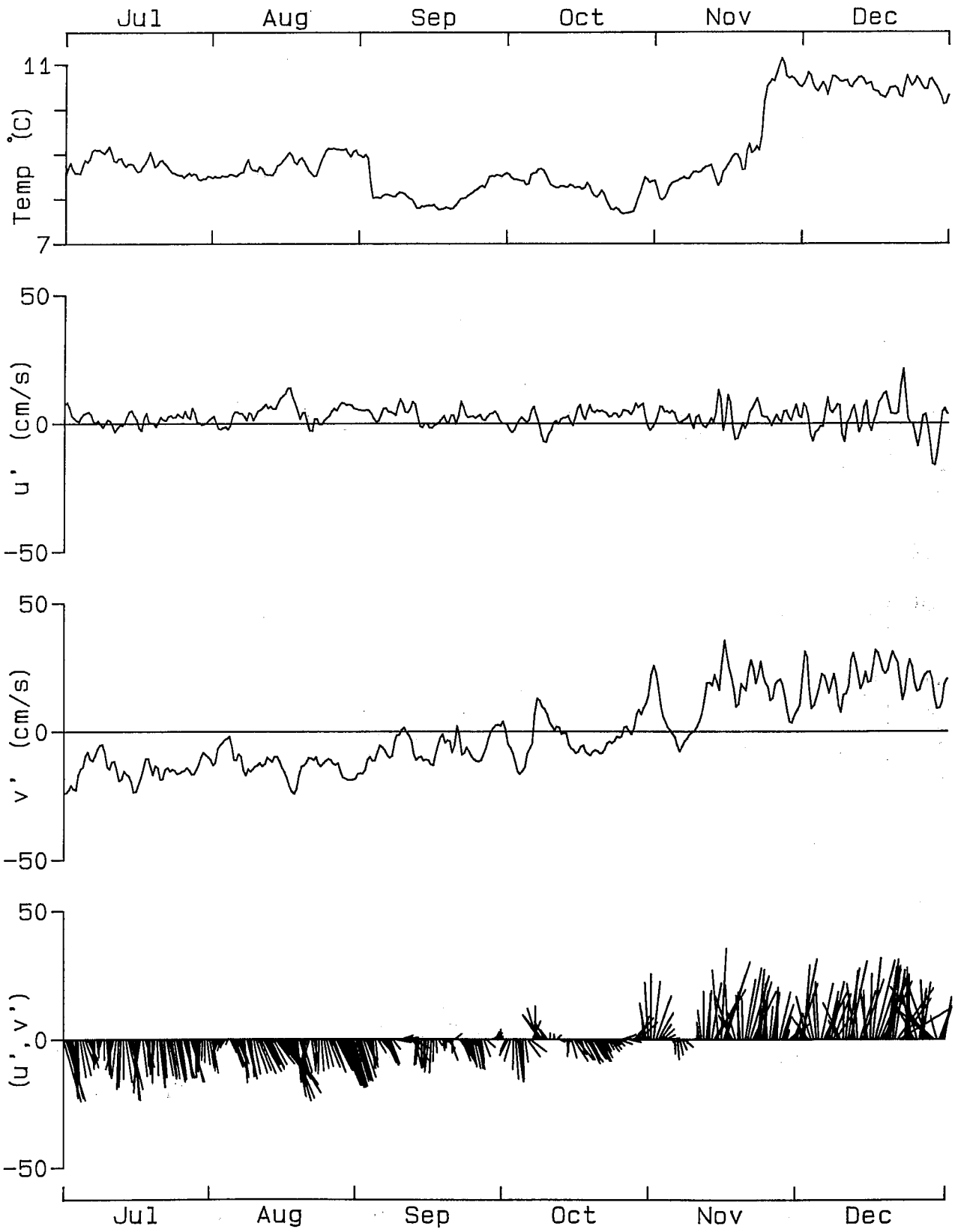
1981
L.P.B./50m (5)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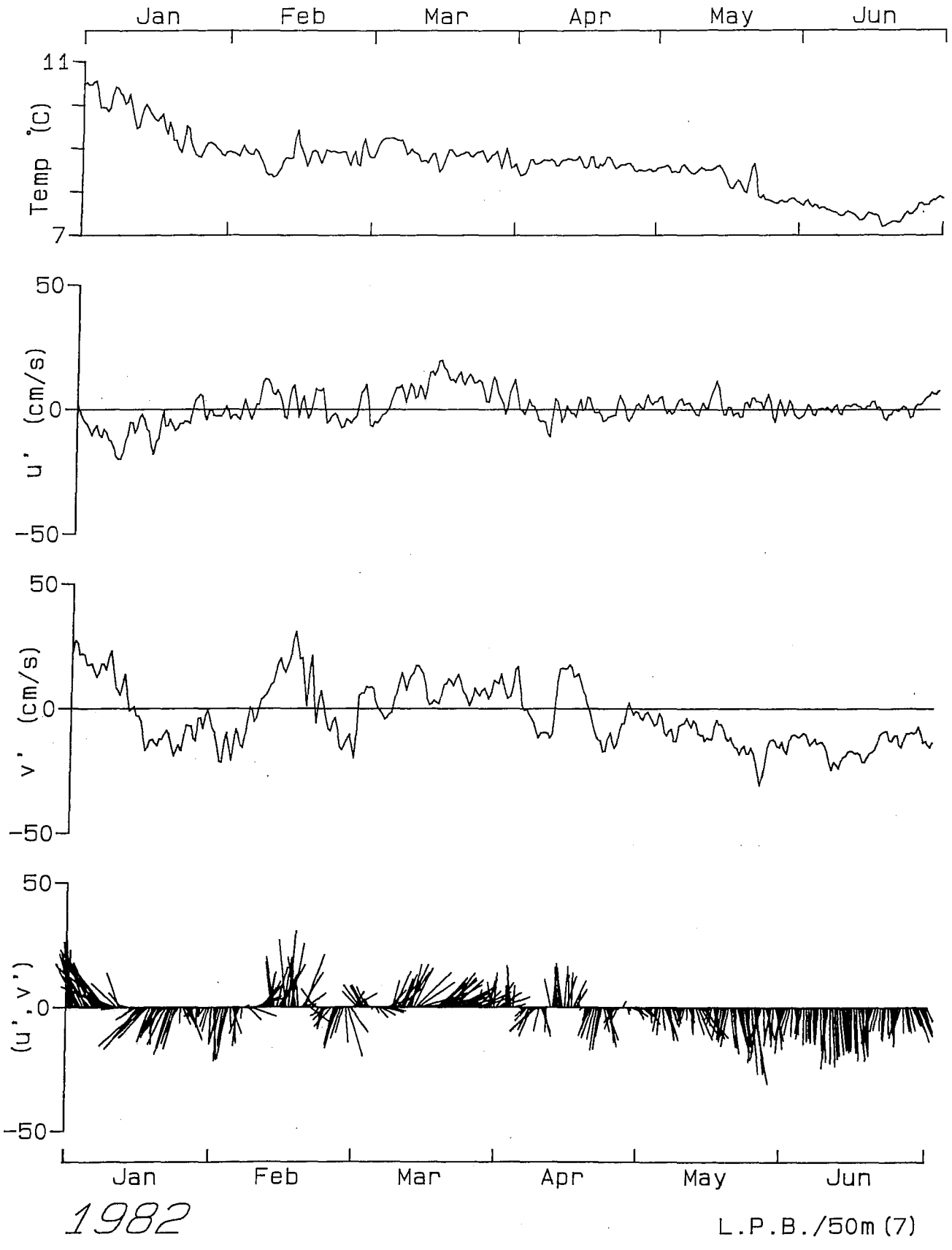
1981
L.P.B./50m (6)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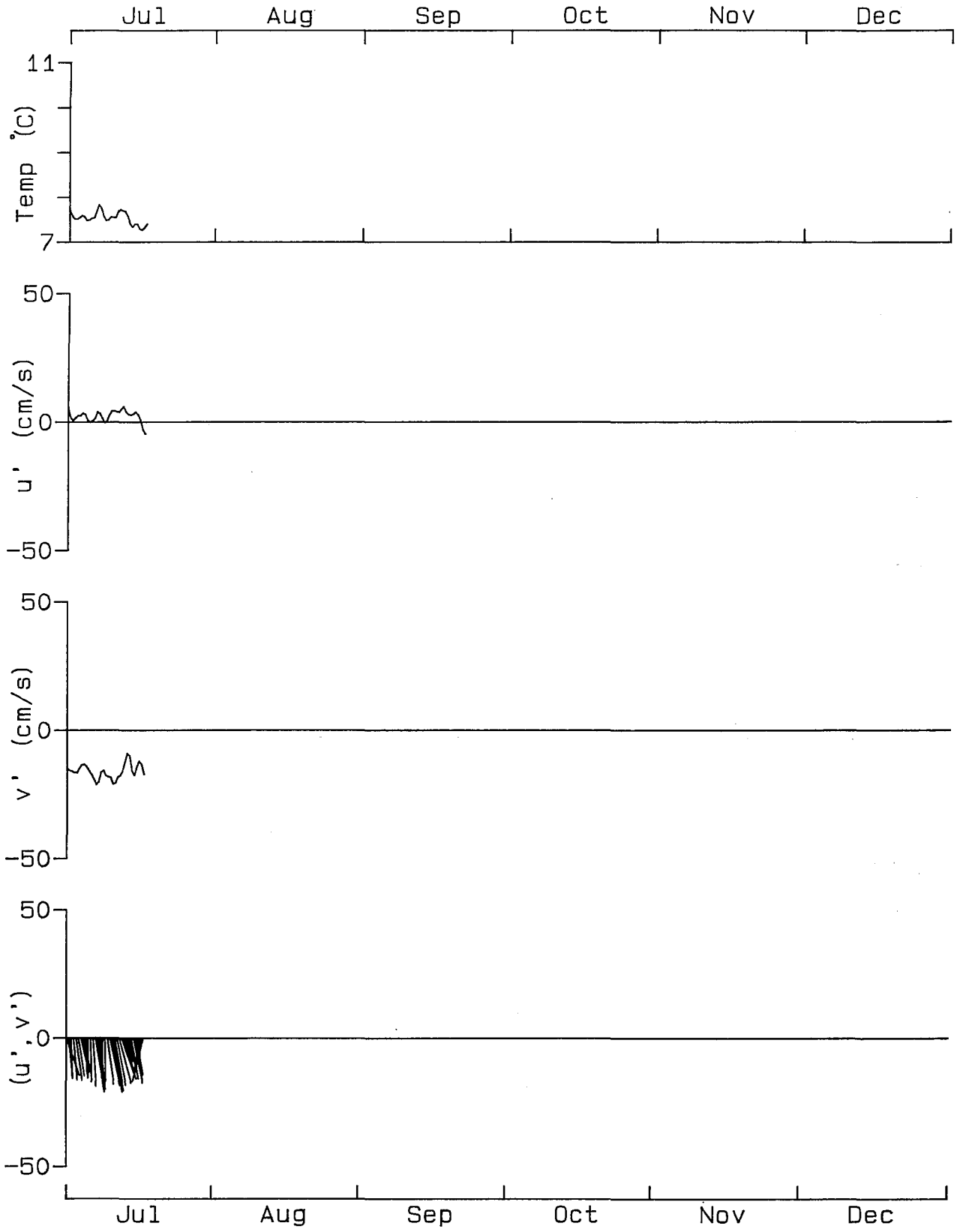
1982
L.P.B./50m (7)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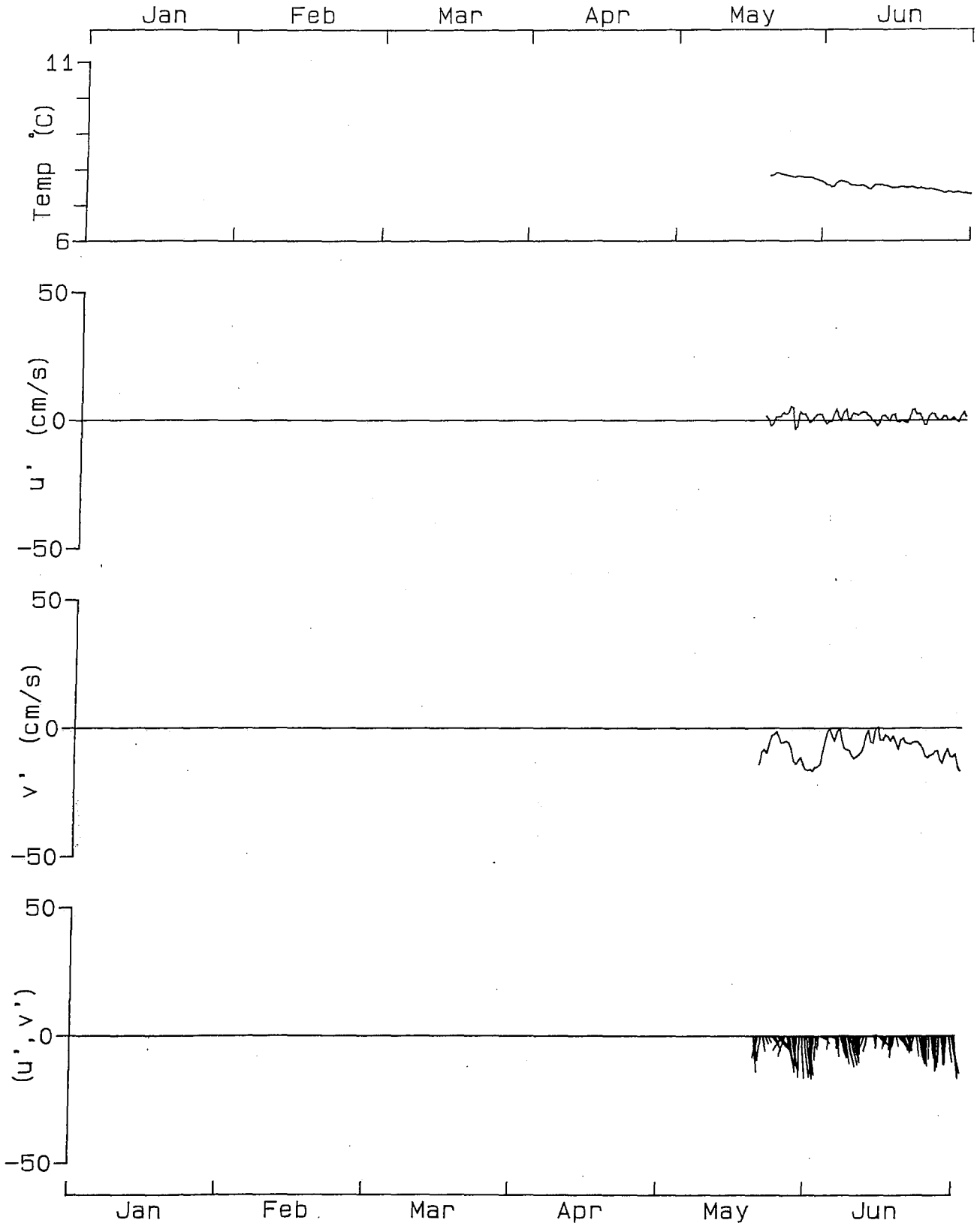
1982
L.P.B./50m (8)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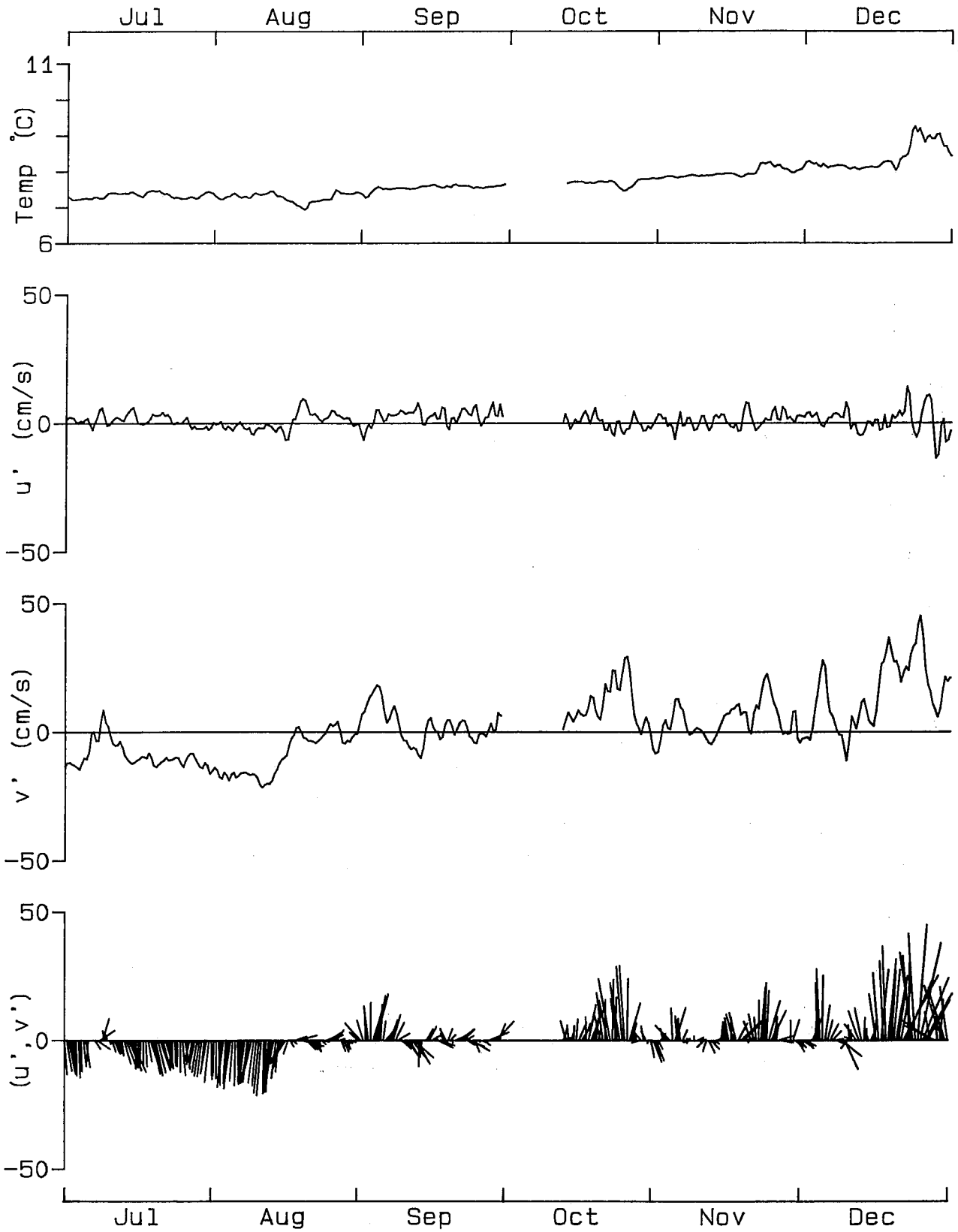
1979
L.P.B./100m(1)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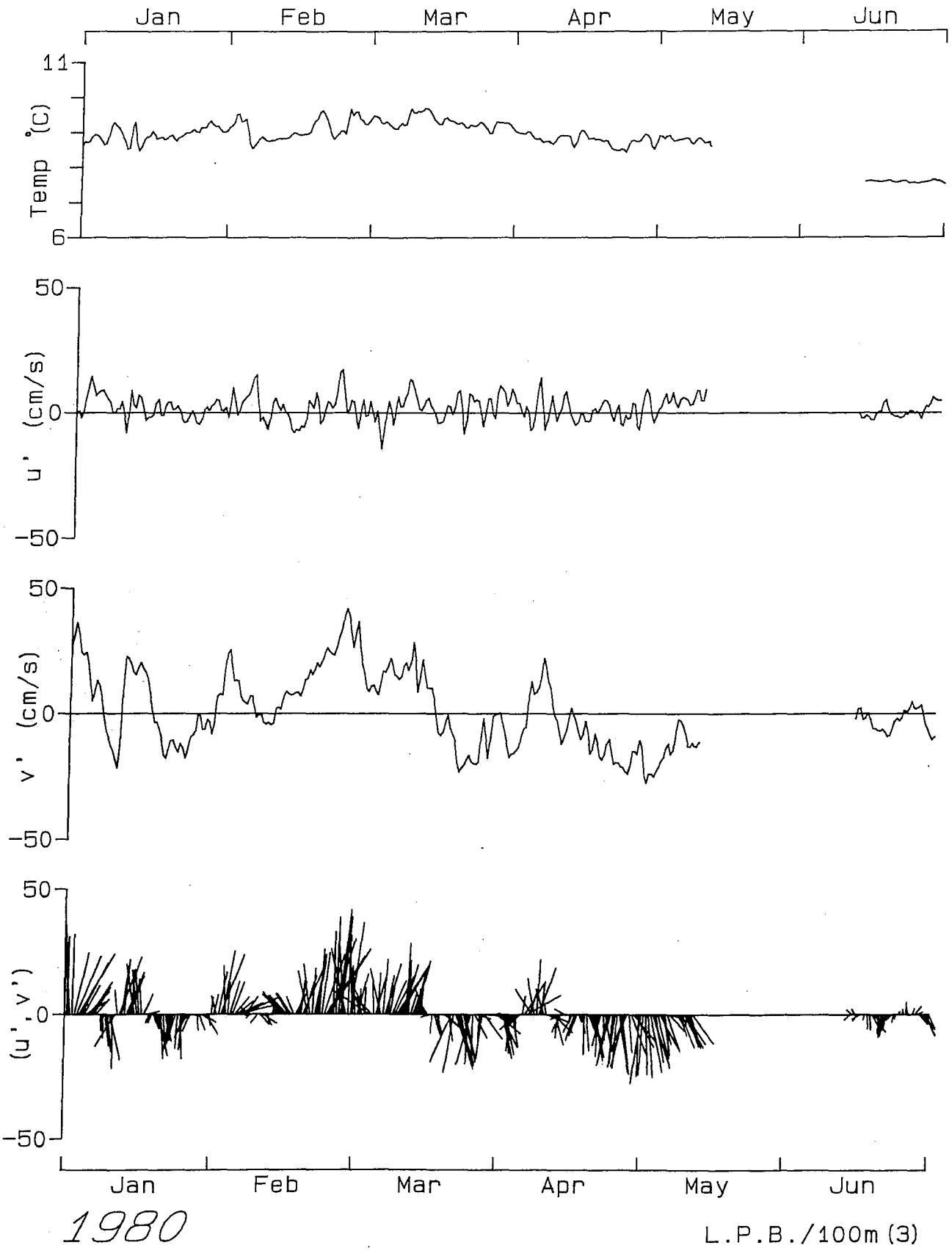
1979
L.P.B./100m (2)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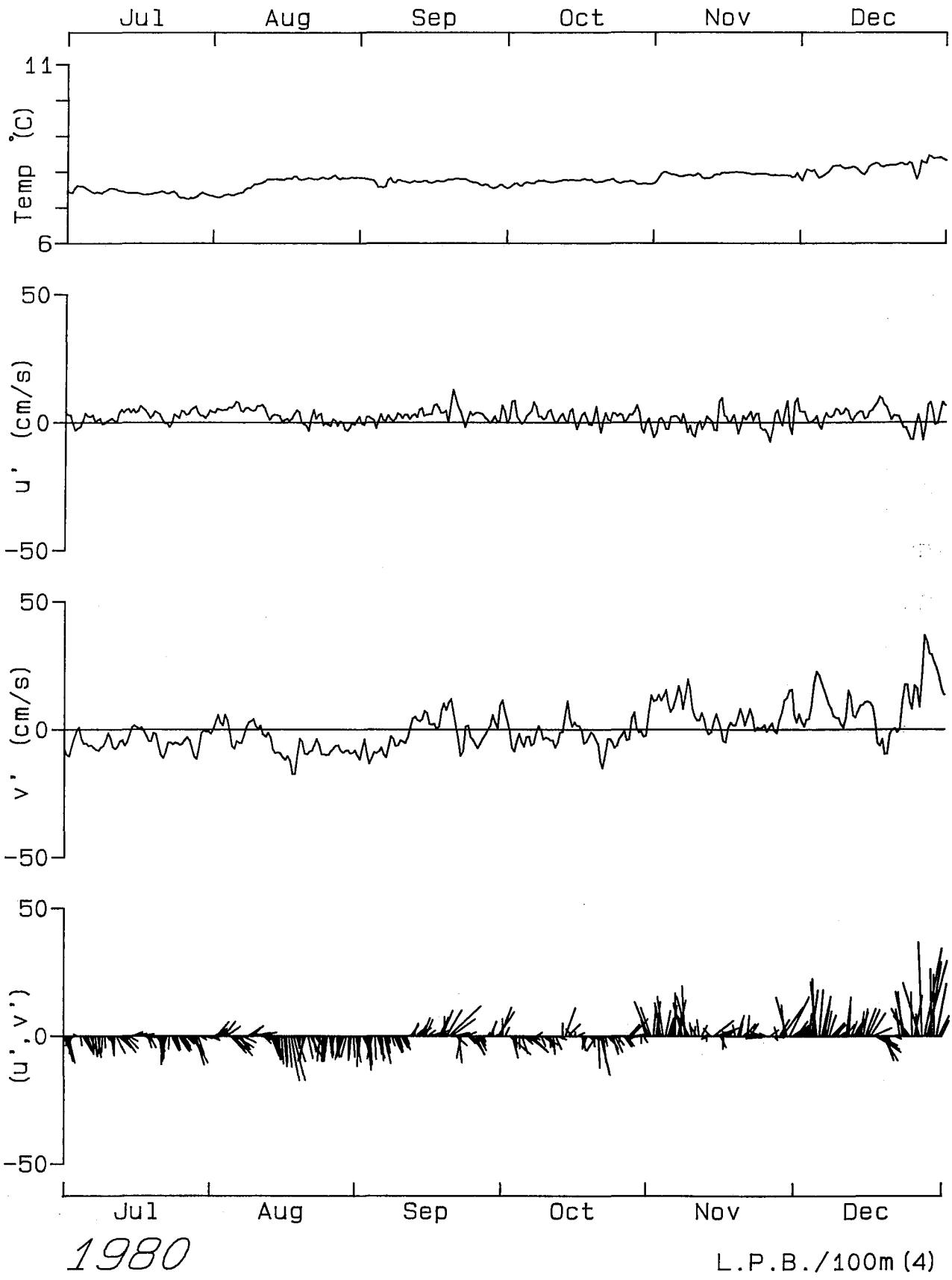
1980
L.P.B./100m (3)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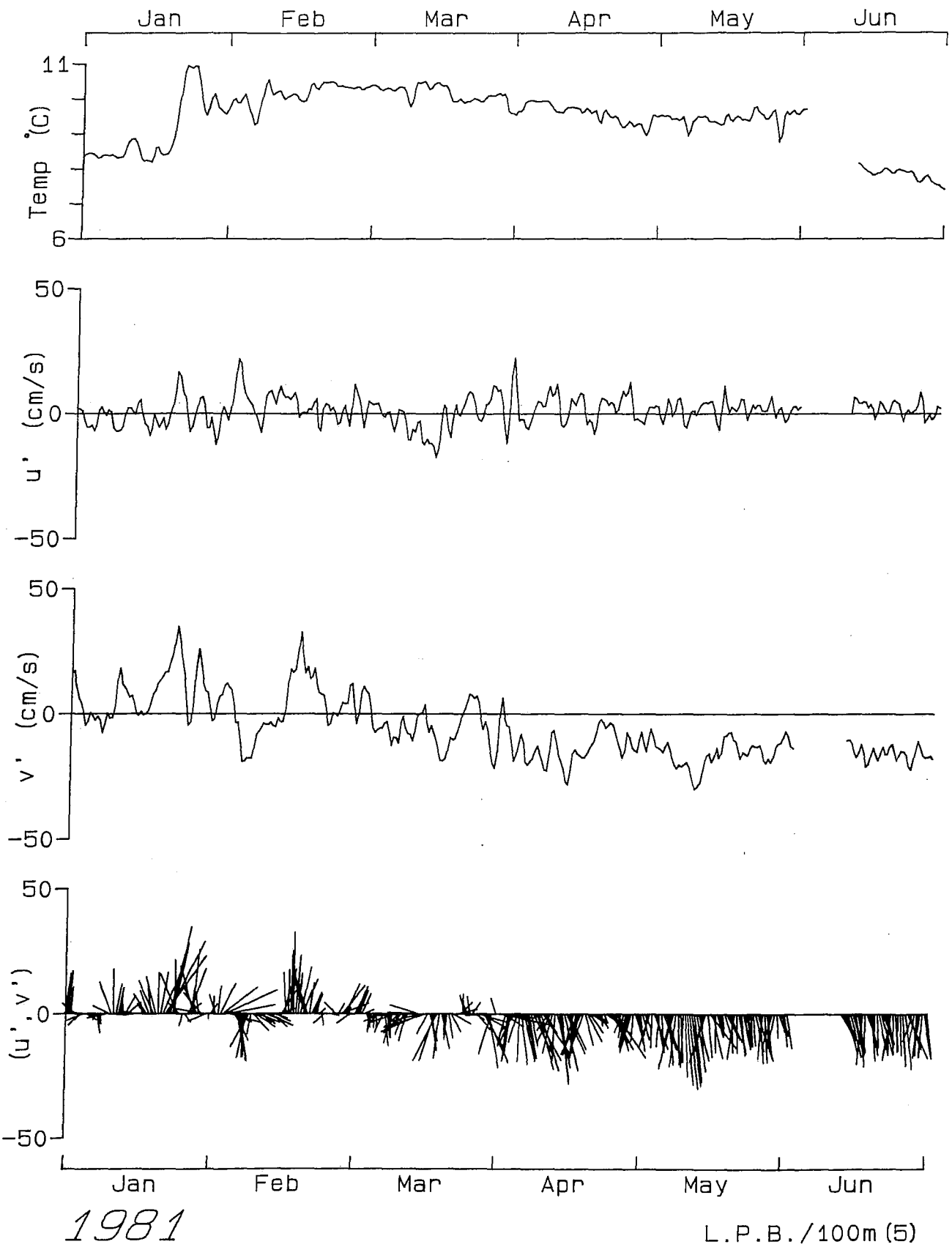
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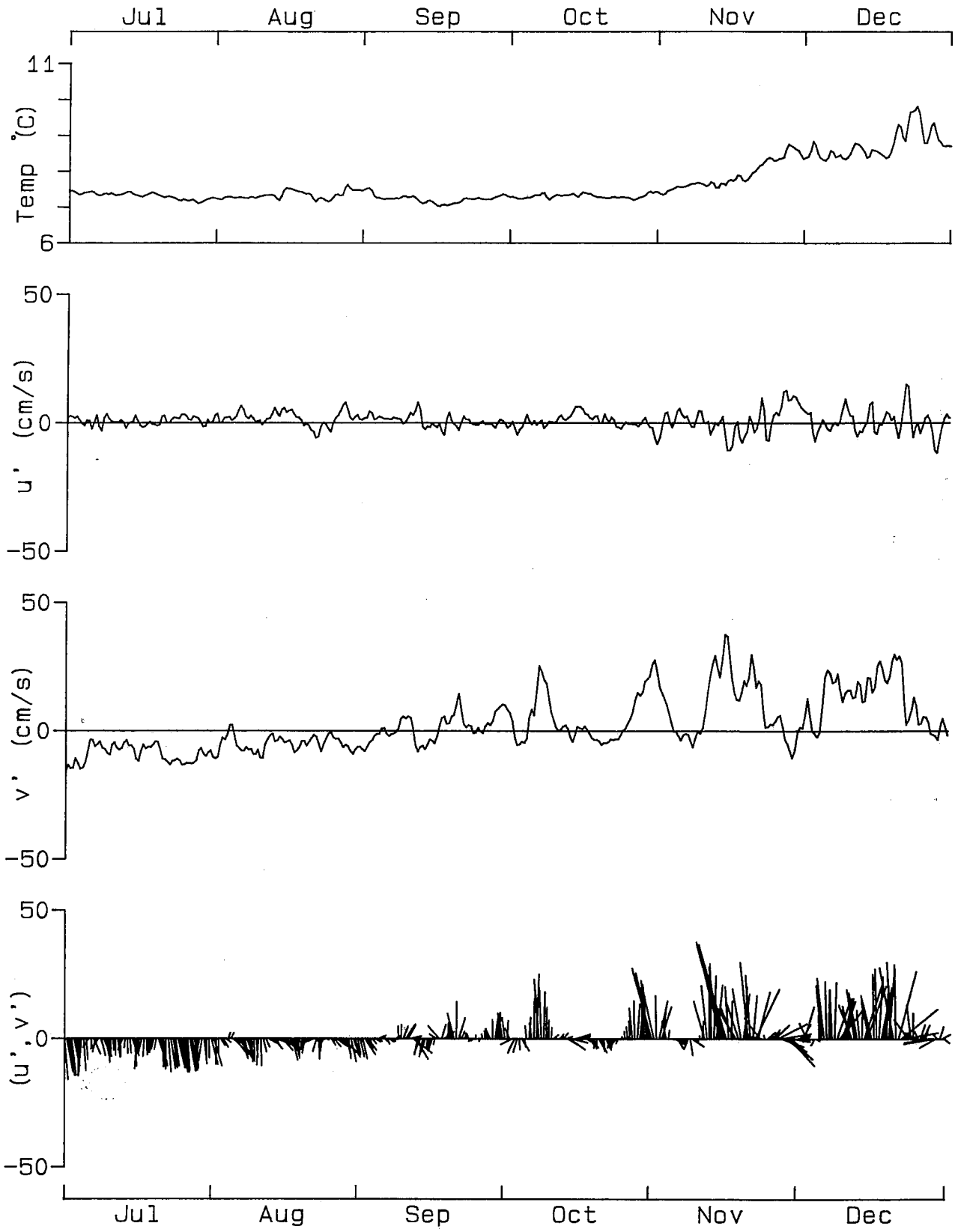
1981
L.P.B./100m (5)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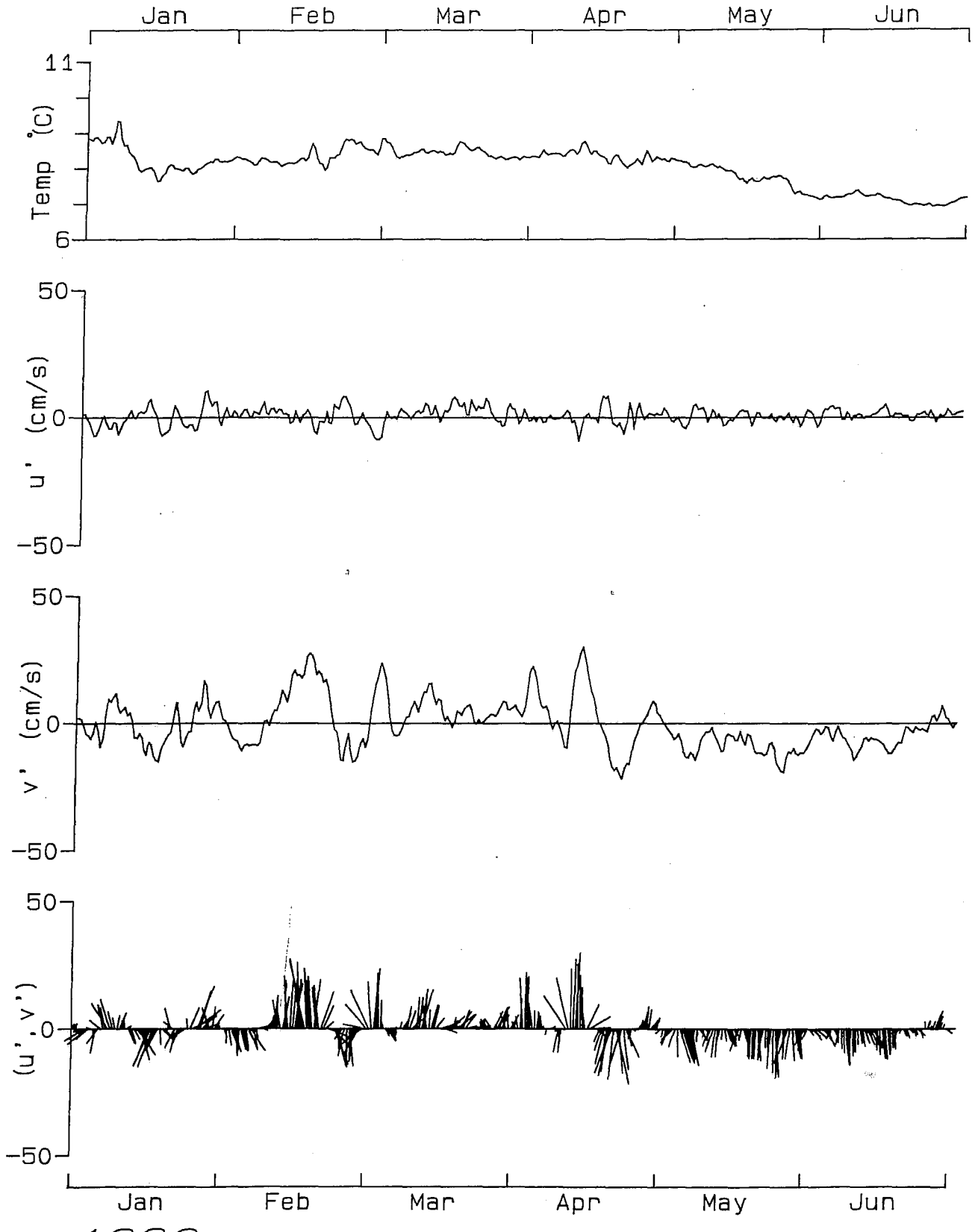
1981
L.P.B./100m (6)


Jan
Feb
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11
Temp °(C)
6
50
u' (cm/s)
0
-50
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v' (cm/s)
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(u',v')
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-50
Jan
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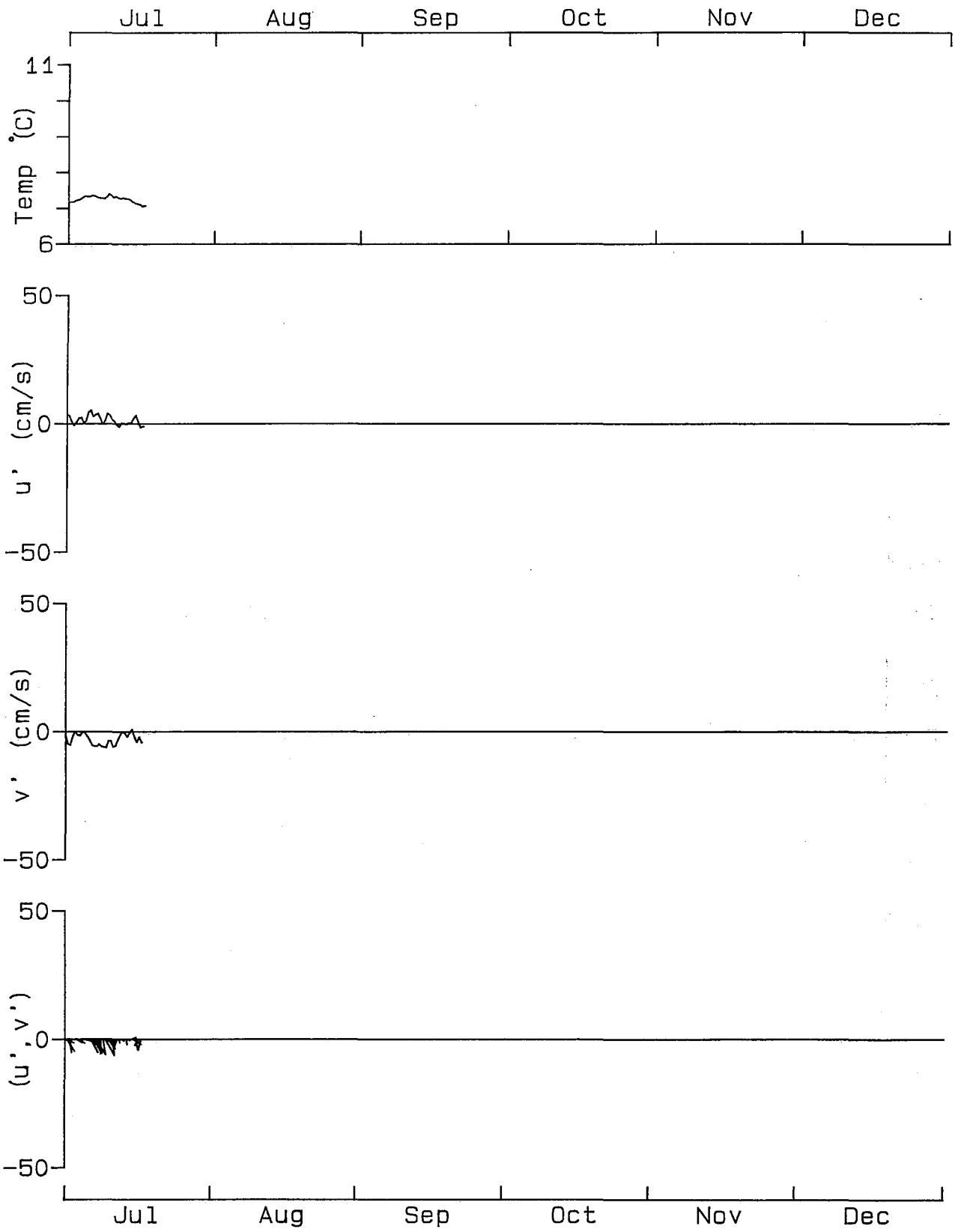
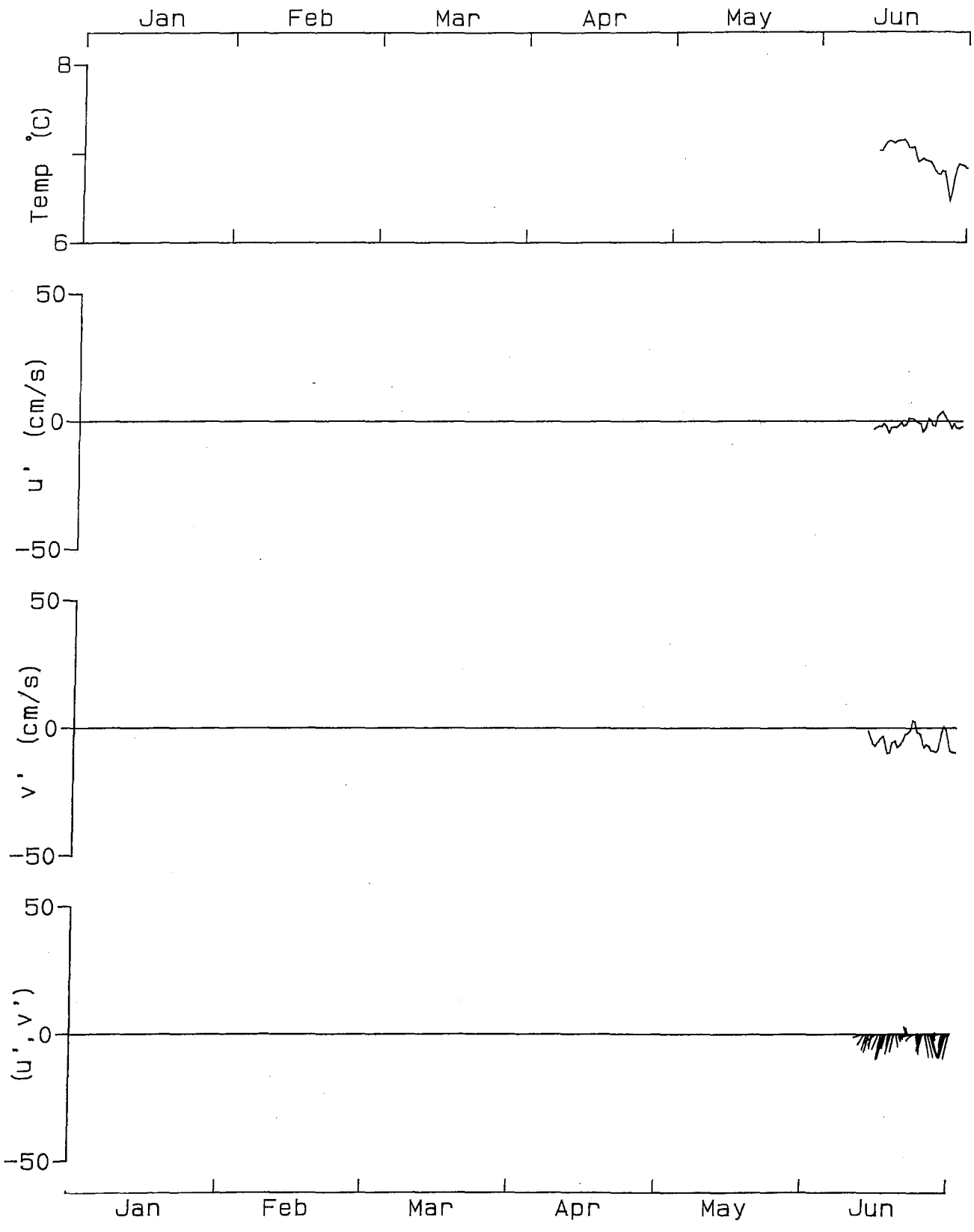
May
Jun
1982
L.P.B./100m (7)



1982

L.P.B./100m (8)


Jan
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Jun
8
6
Temp °(C)
50
0
-50
u' (cm/s)
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v' (cm/s)
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-50
(u', v')
Jan
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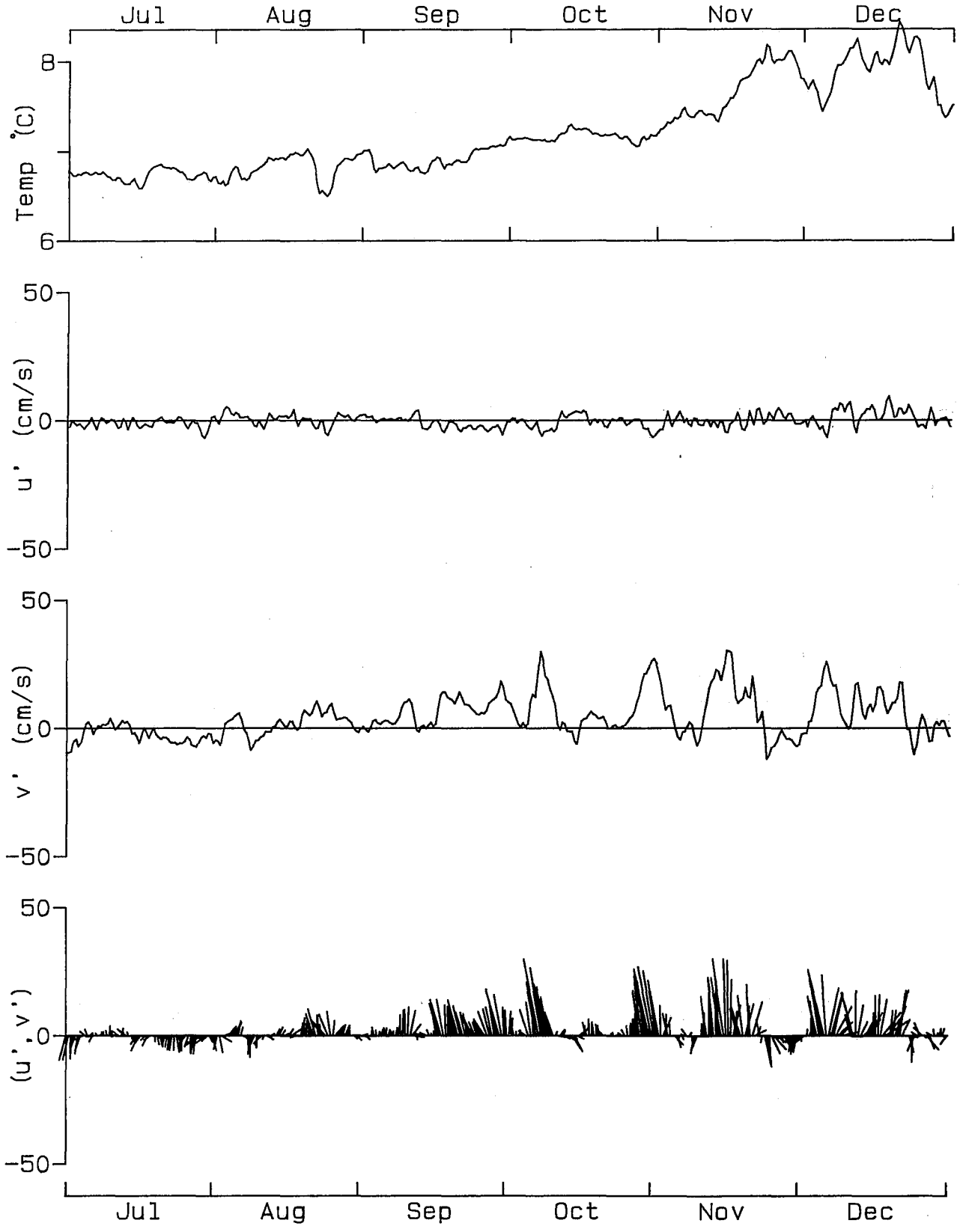
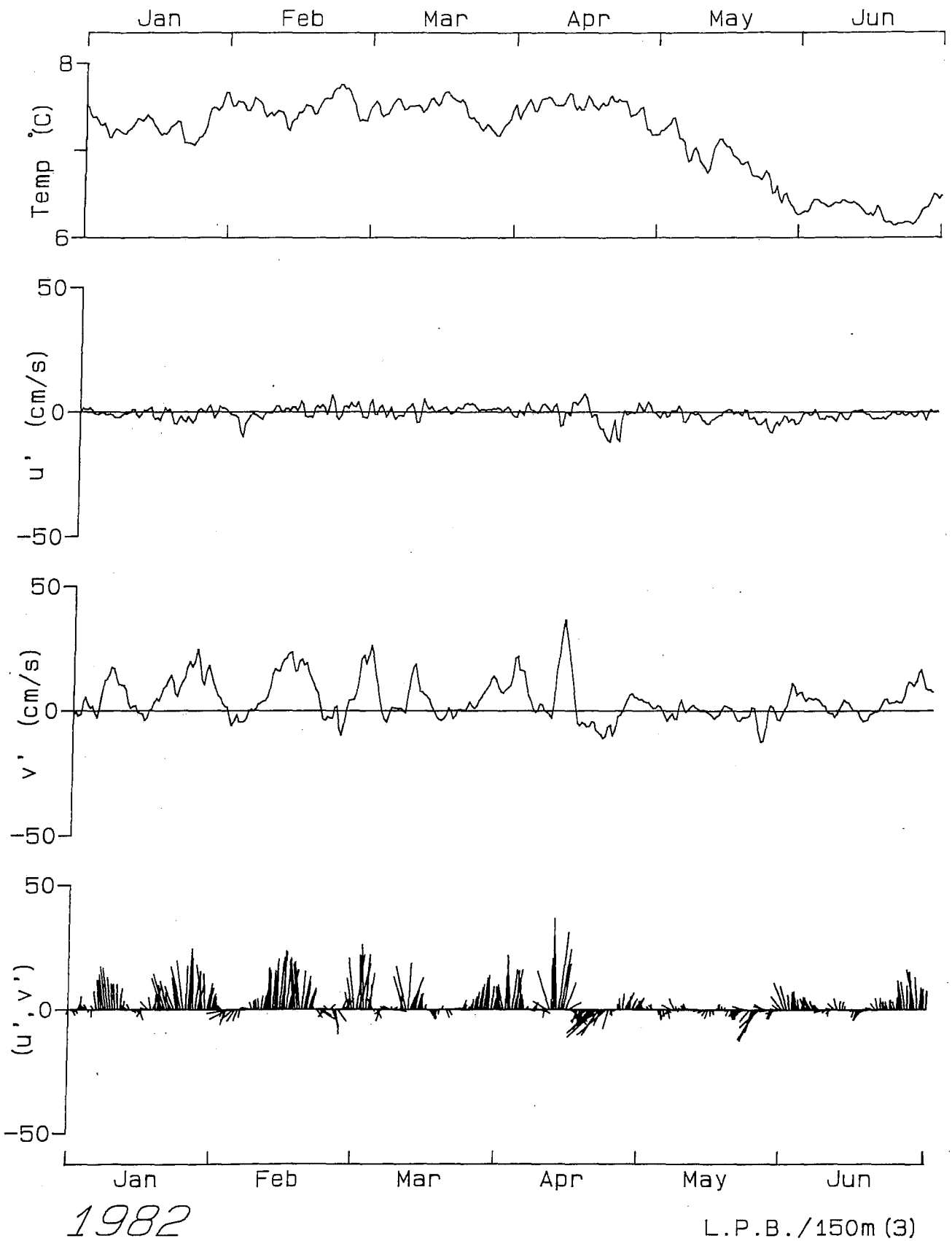
1981
L.P.B./150m (1)



1981

L.P.B./150m (2)


Jan
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Temp °(C)
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u' (cm/s)
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v' (cm/s)
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(u',v')
Jan
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May
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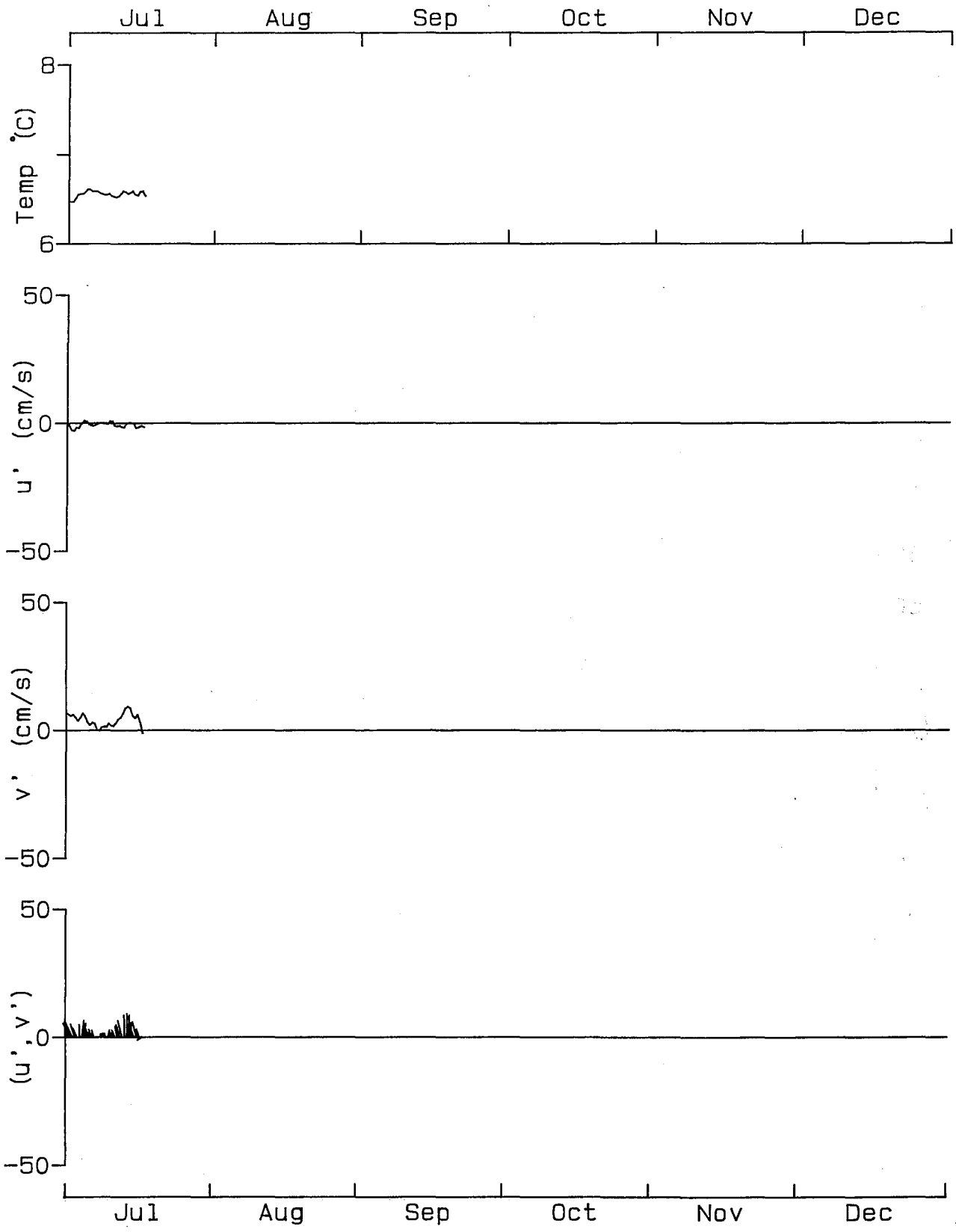
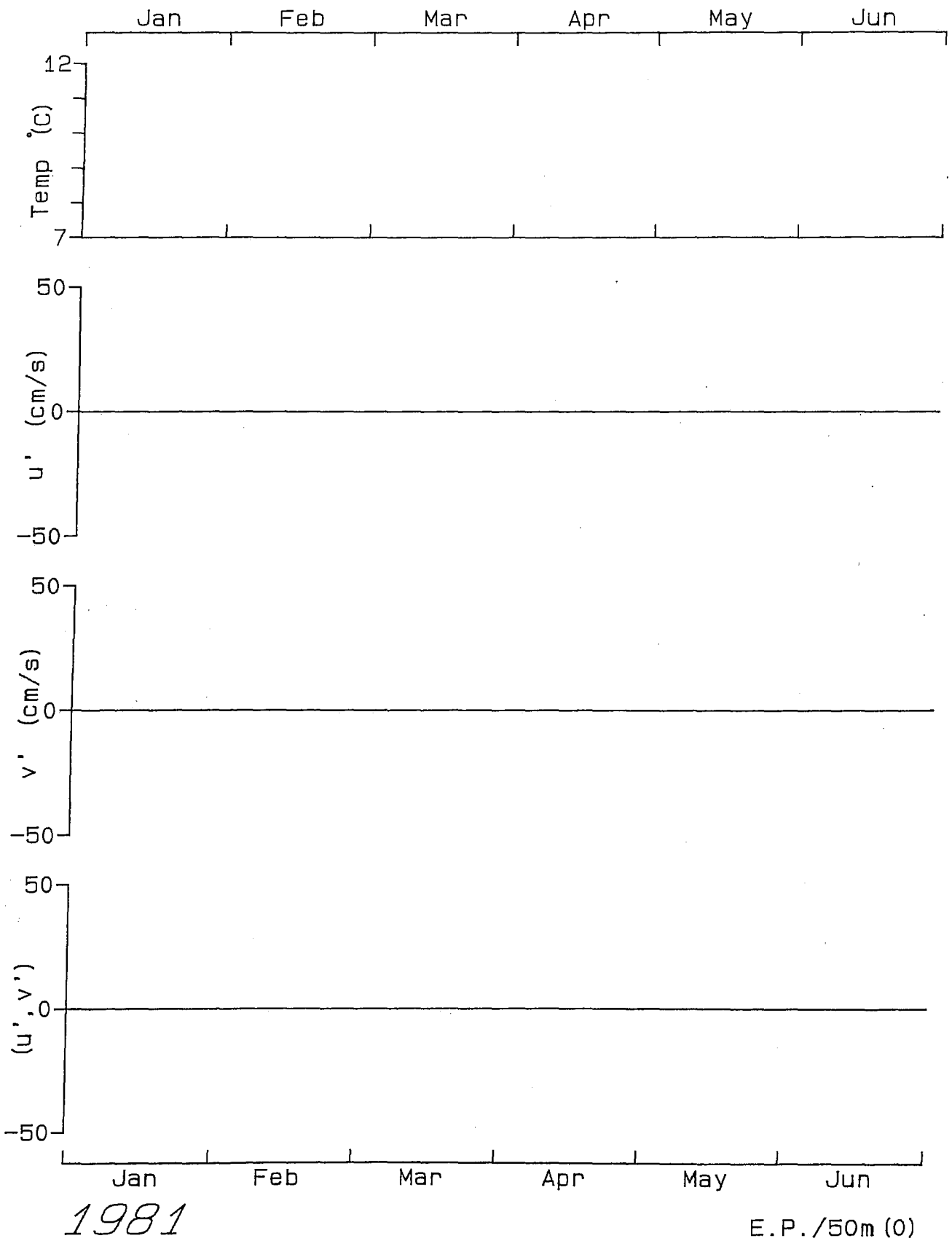
1982
L.P.B./150m (3)



1982

L.P.B./150m (4)


Jan
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Temp °(C)
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u' (cm/s)
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v' (cm/s)
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(u',v')
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Jan
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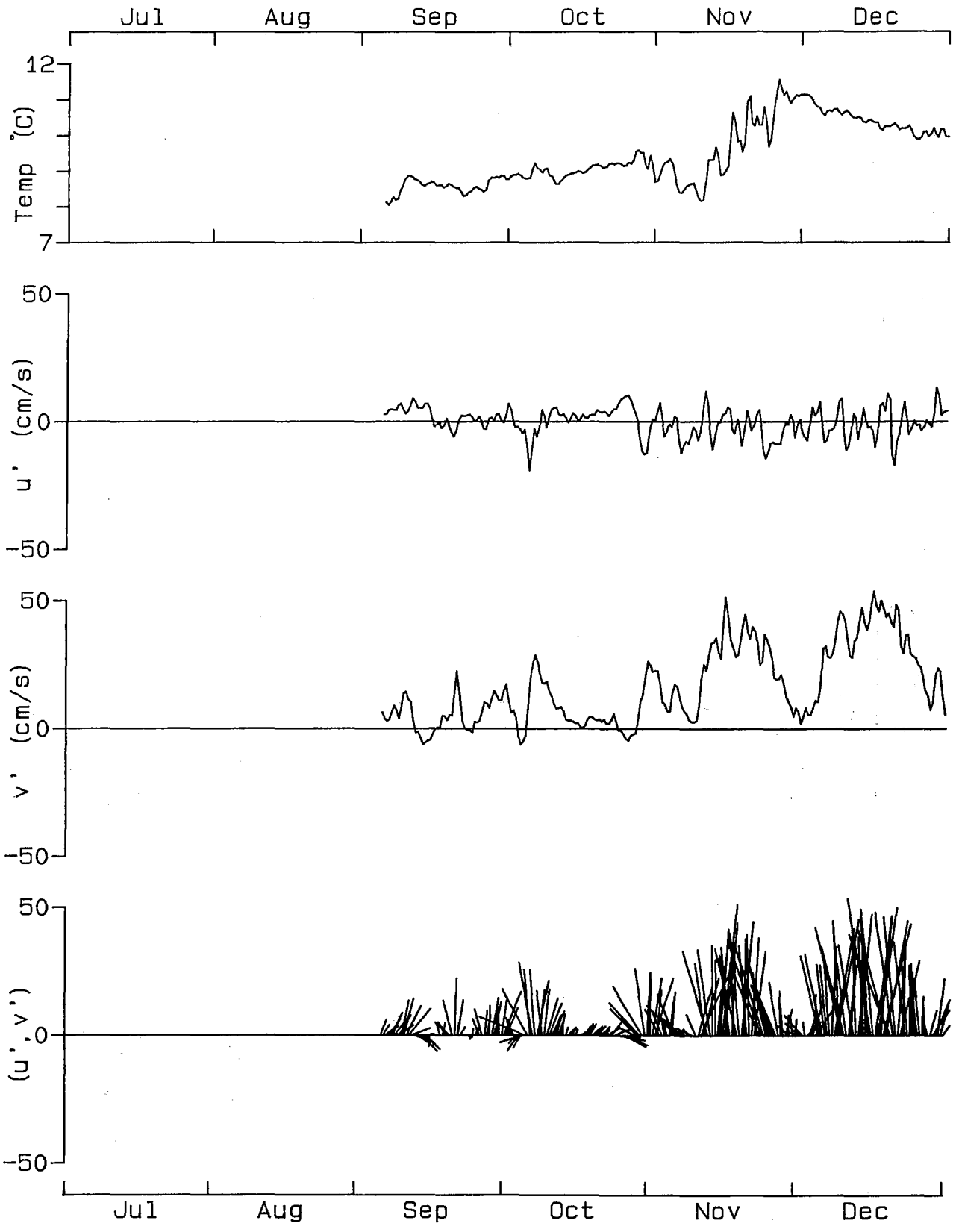
1981
E.P./50m (0)


Jul
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Temp °(C)
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u' (cm/s)
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v' (cm/s)
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(u',v')
Jul
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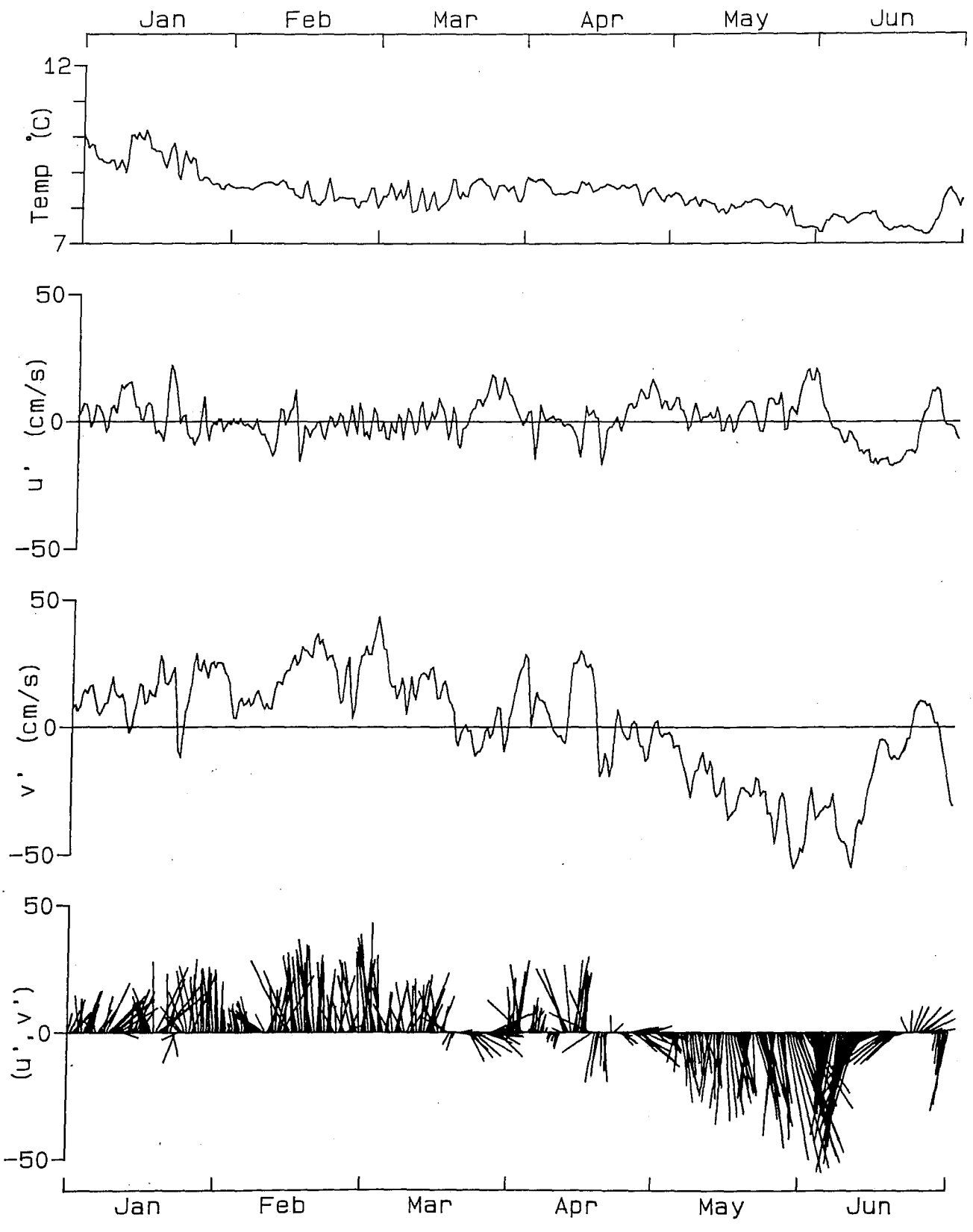
1981
E.P./50m (1)


Jan
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Temp °(C)
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u' (cm/s)
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v' (cm/s)
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(u',v')
Jan
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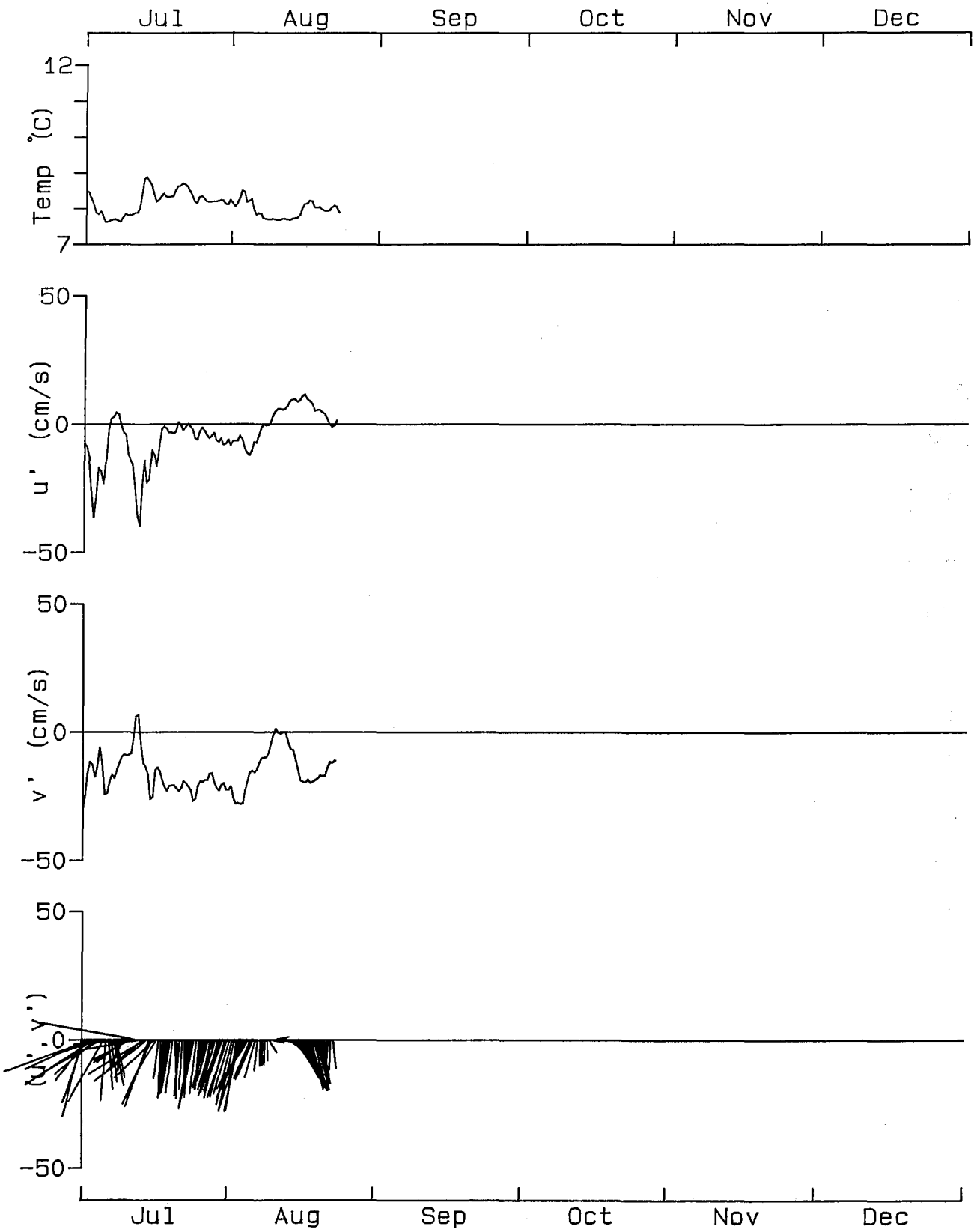
1982
E.P./50m (2)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Temp °(C)
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u' (cm/s)
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u'v')
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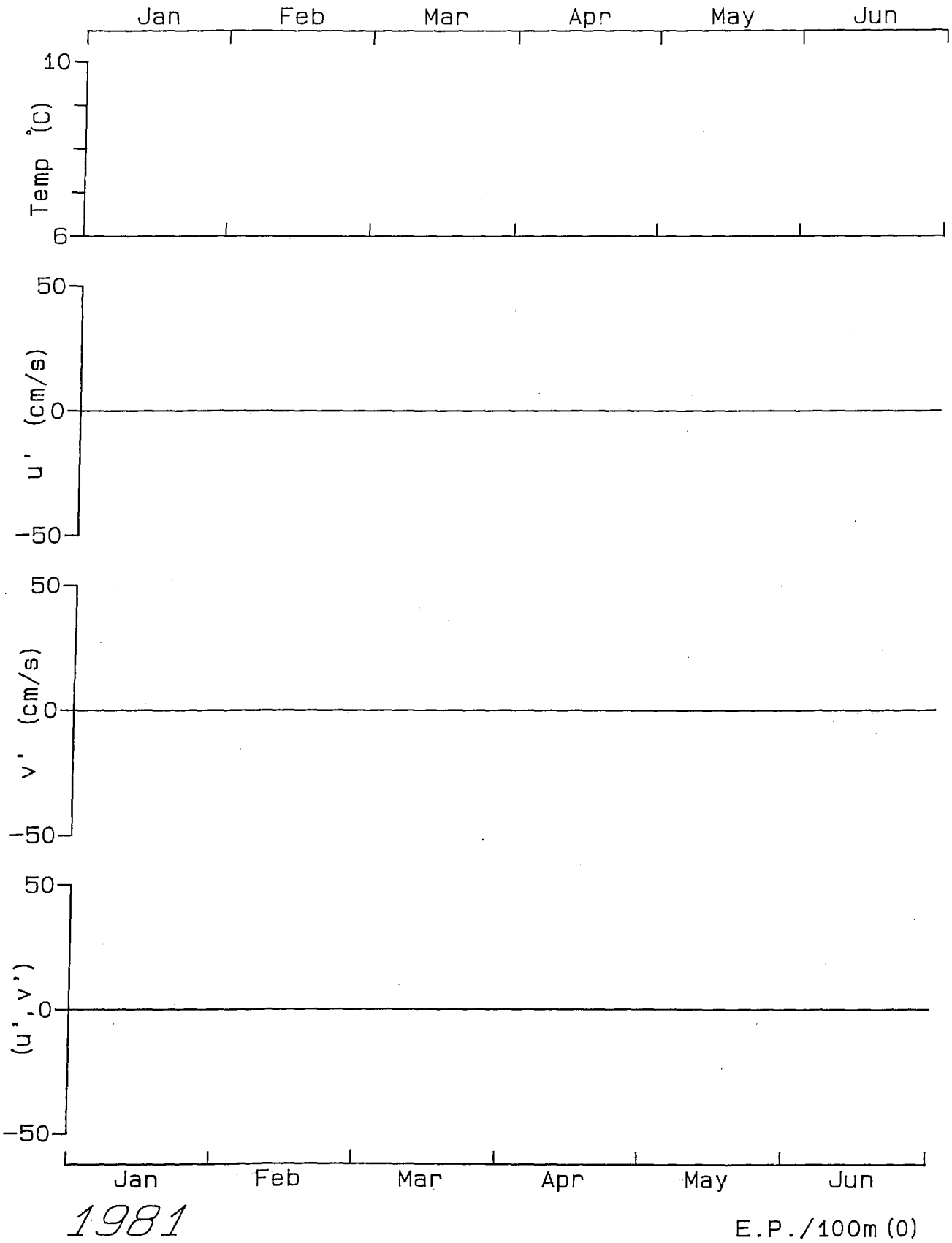
1982
E.P./50m (3)


Jan
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Temp °(C)
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u' (cm/s)
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v' (cm/s)
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Jan
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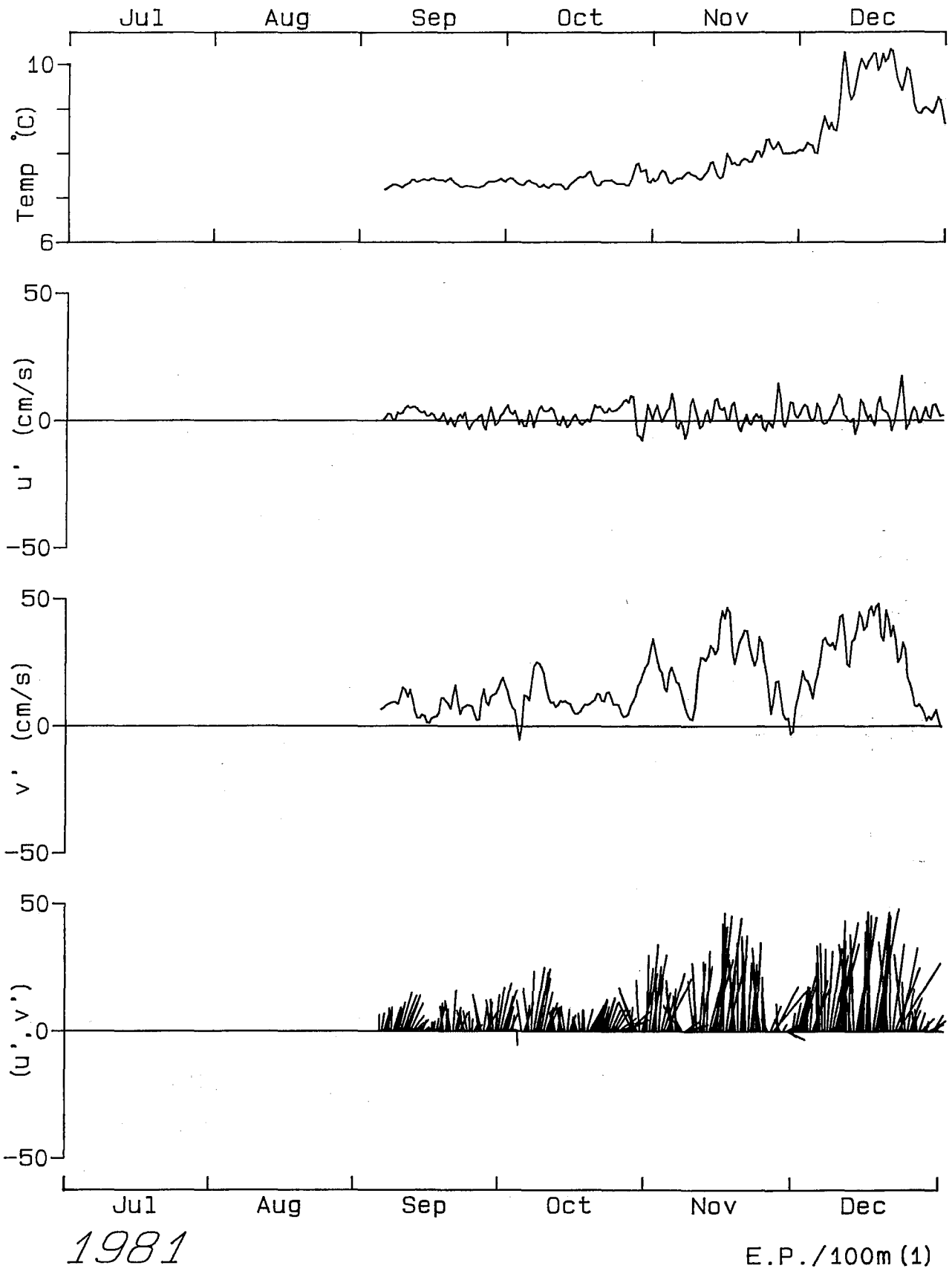
1981
E.P./100m (0)


Jul
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Temp °(C)
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u' (cm/s)
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v' (cm/s)
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(u'.v')
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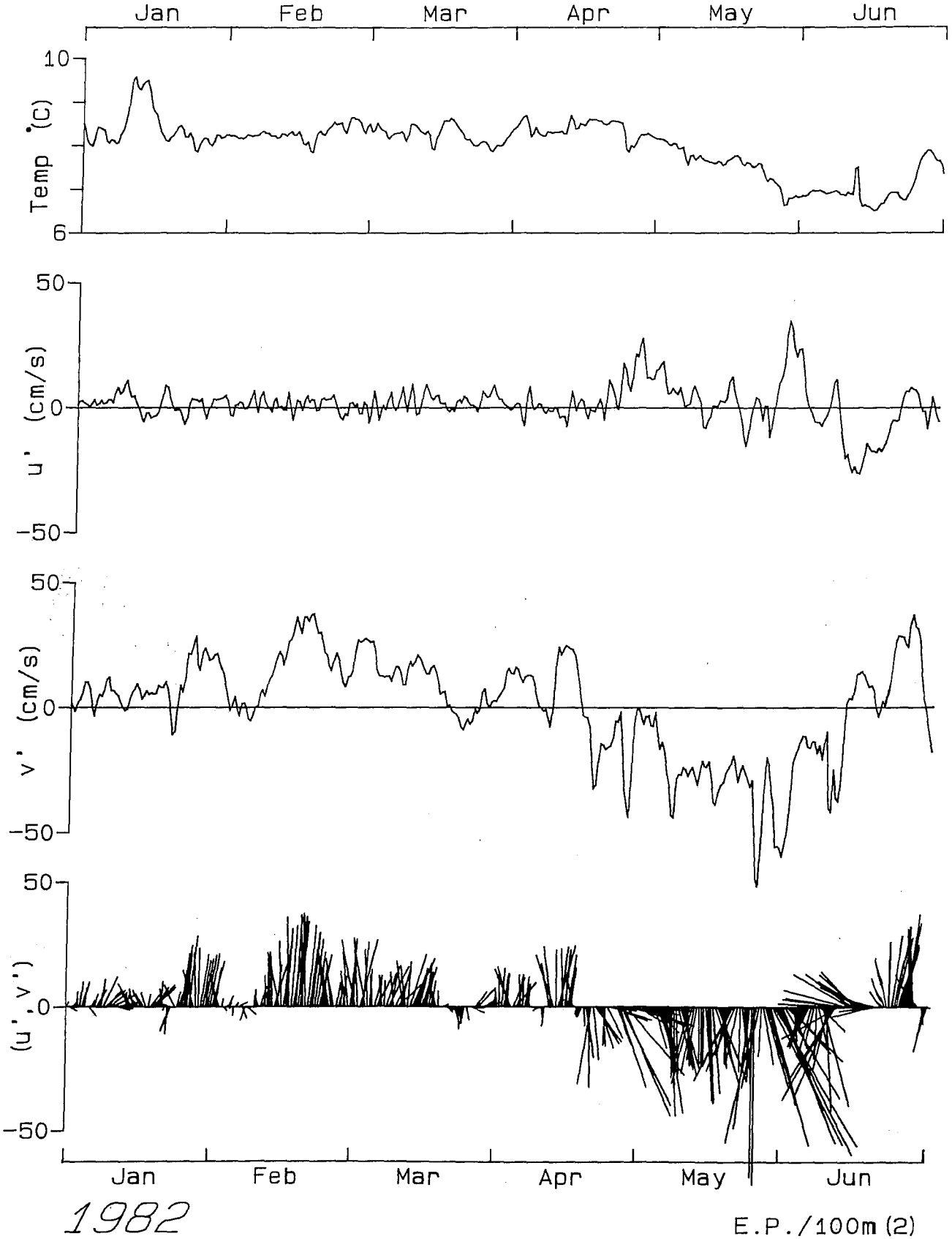
1981
E.P./100m (1)


Jan
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Temp °(C)
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u' (cm/s)
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v' (cm/s)
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-50
(u', v')
Jan
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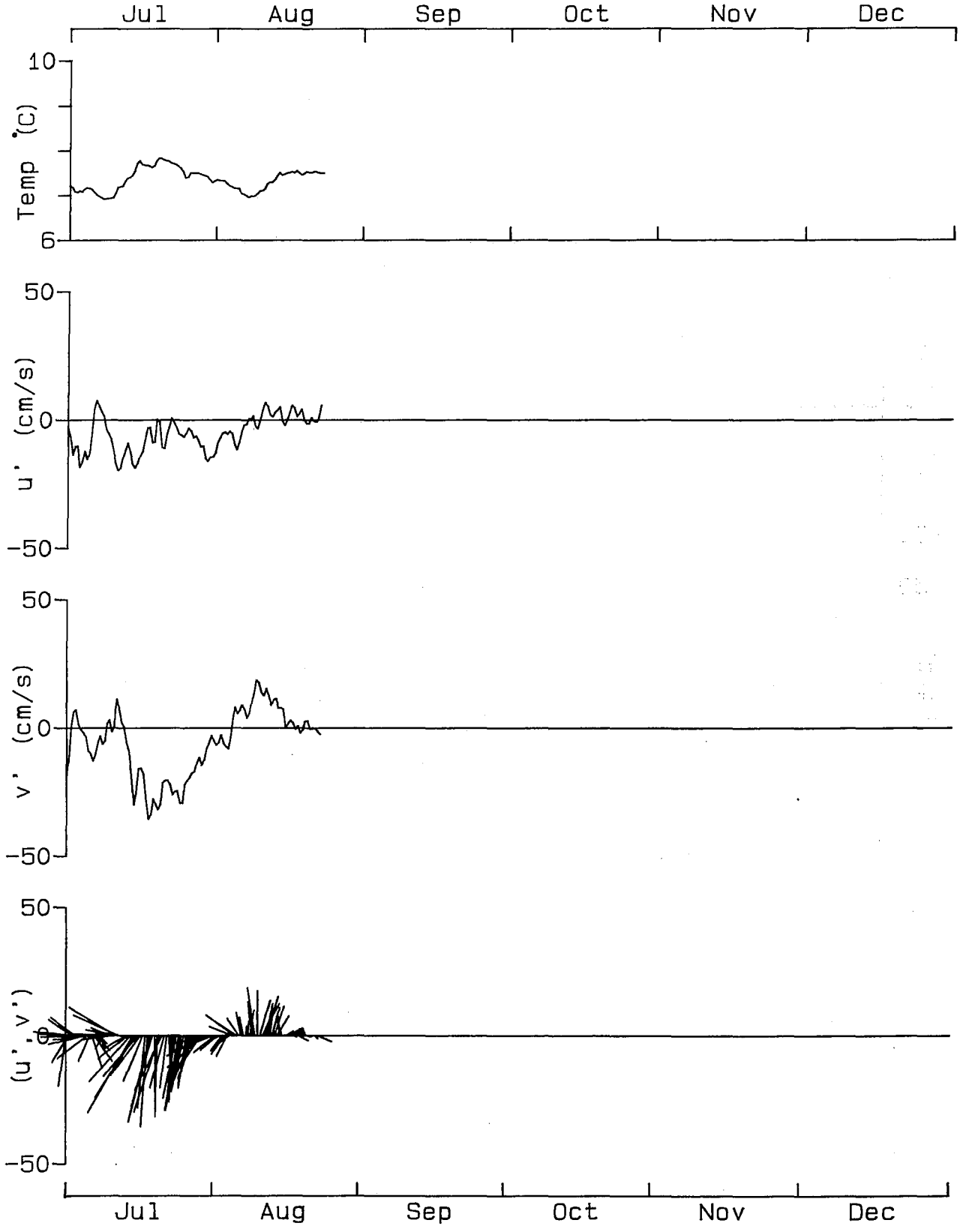
1982
E.P./100m (2)


Jul
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Dec
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Temp °(C)
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u' (cm/s)
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-50
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v' (cm/s)
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-50
50
(u', v')
0
-50
Jul
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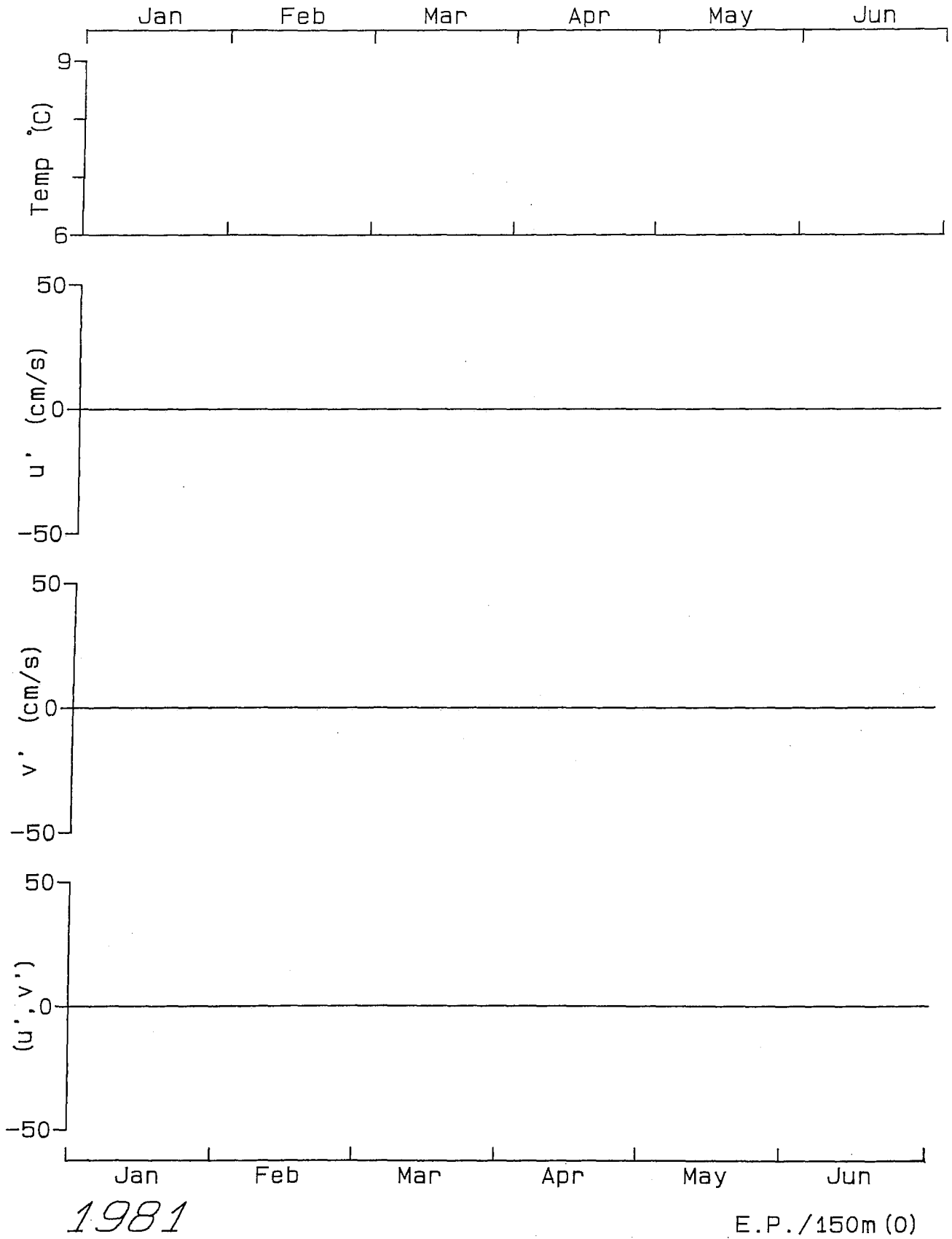
1982
E.P./100m (3)


Jan
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Temp °(C)
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−50
u' (cm/s)
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−50
v' (cm/s)
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−50
(u',v')
Jan
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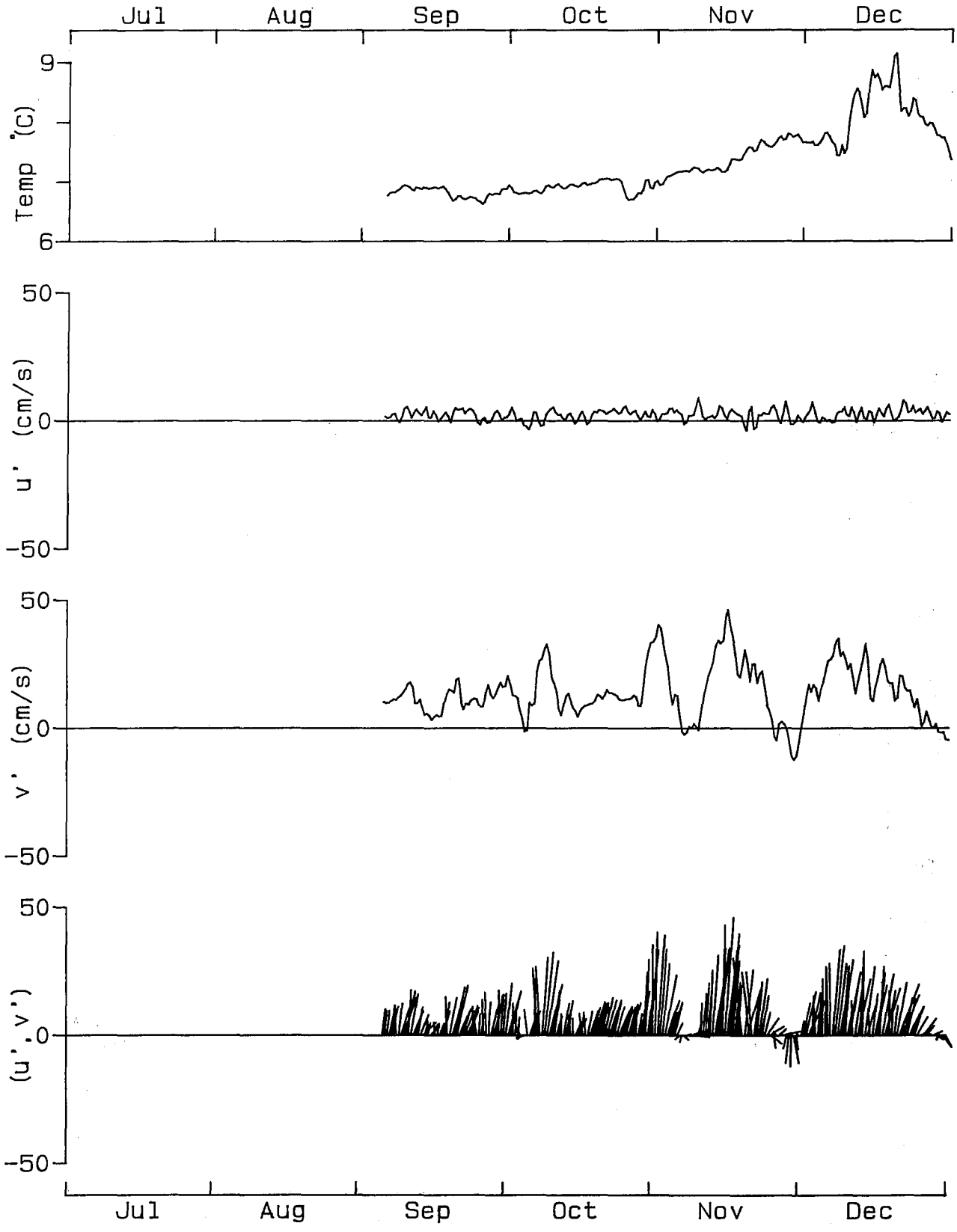
1981
E.P./150m (0)


Jul
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Temp °(C)
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u' (cm/s)
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v' (cm/s)
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(u'.v')
Jul
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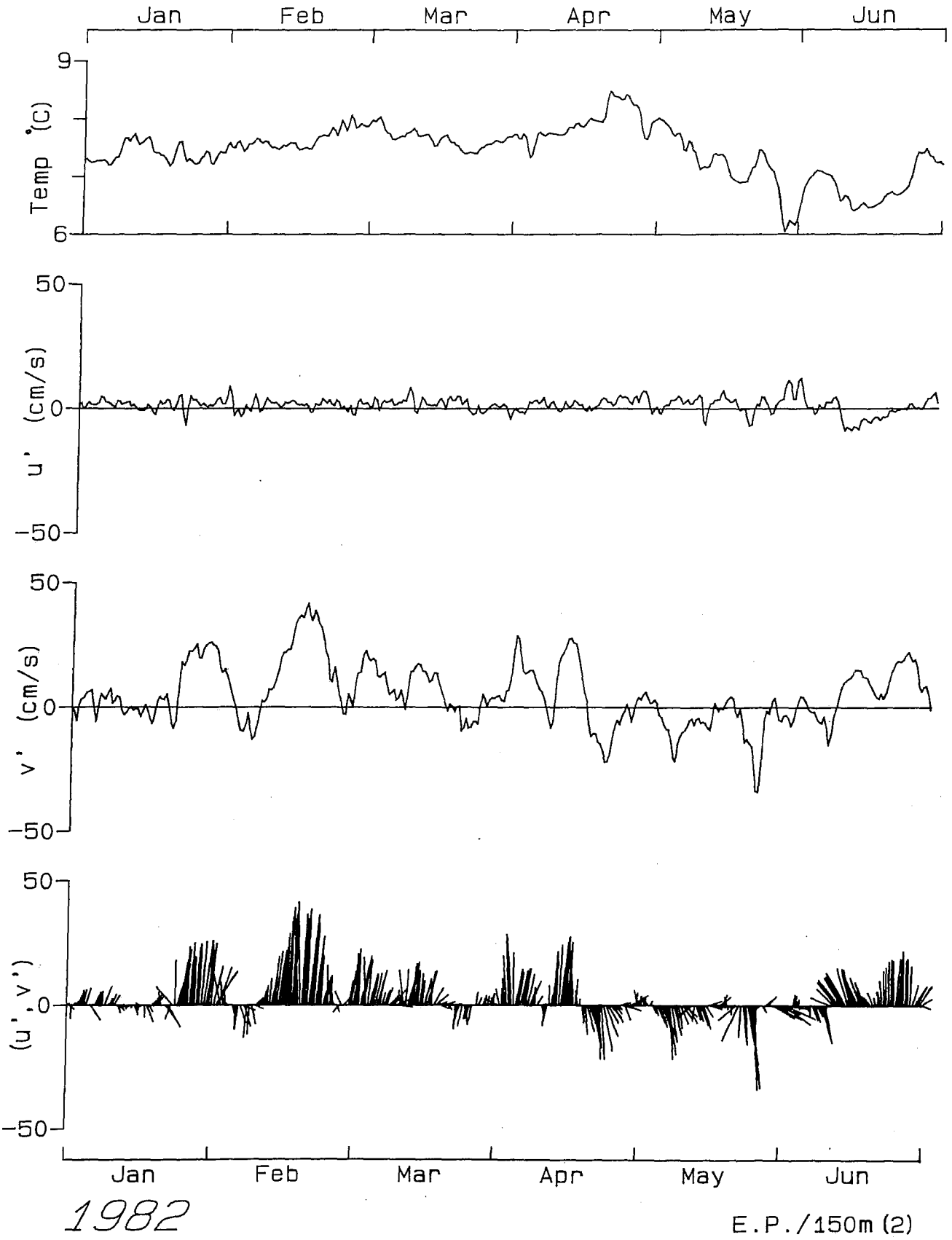
1981
E.P./150m (1)


Jan
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Temp °(C)
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u' (cm/s)
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v' (cm/s)
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(u', v')
Jan
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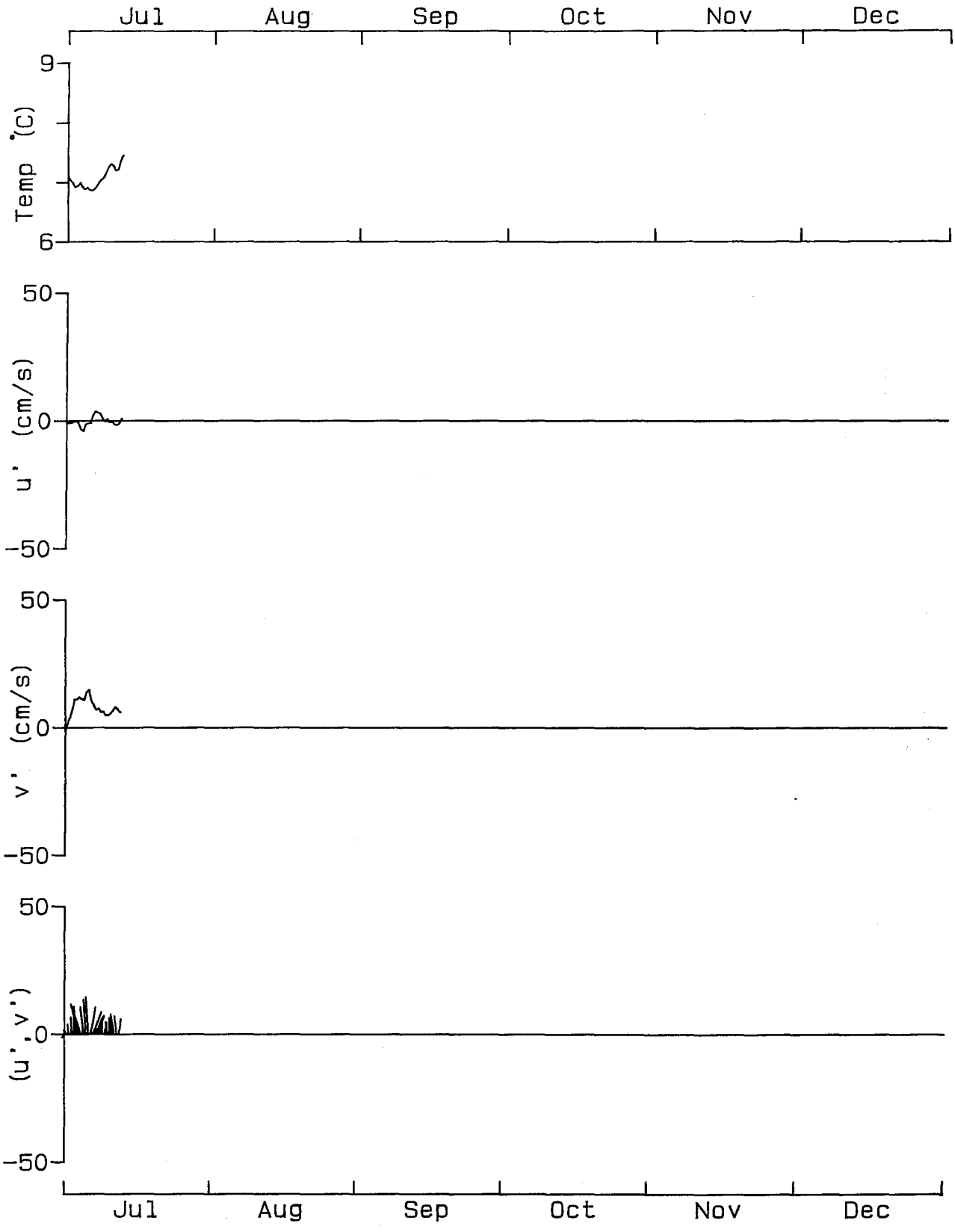
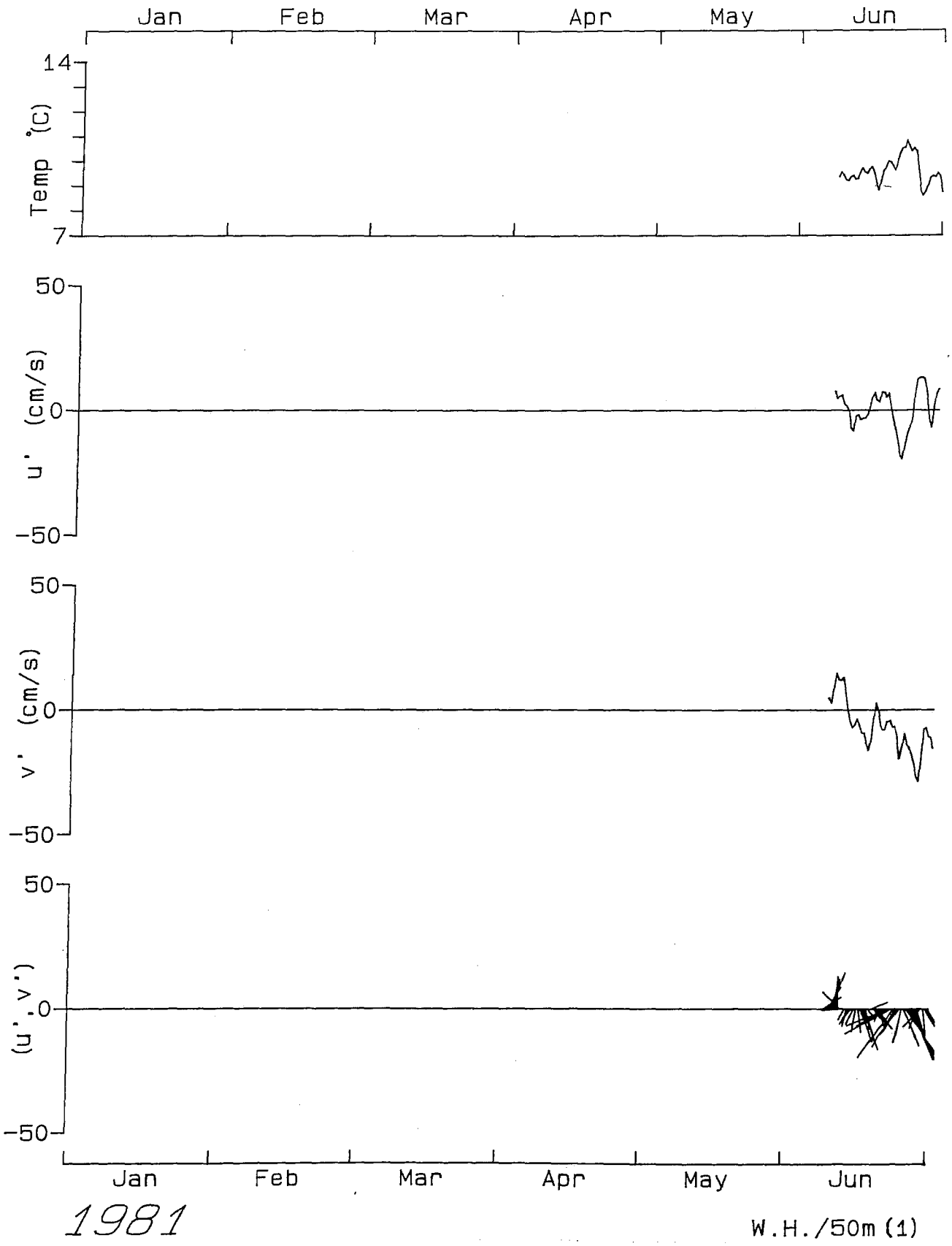
1982
E.P./150m (2)



1982

E.P./150m (3)


Jan
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14
Temp °(C)
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u' (cm/s)
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-50
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v' (cm/s)
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-50
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(u',v')
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-50
Jan
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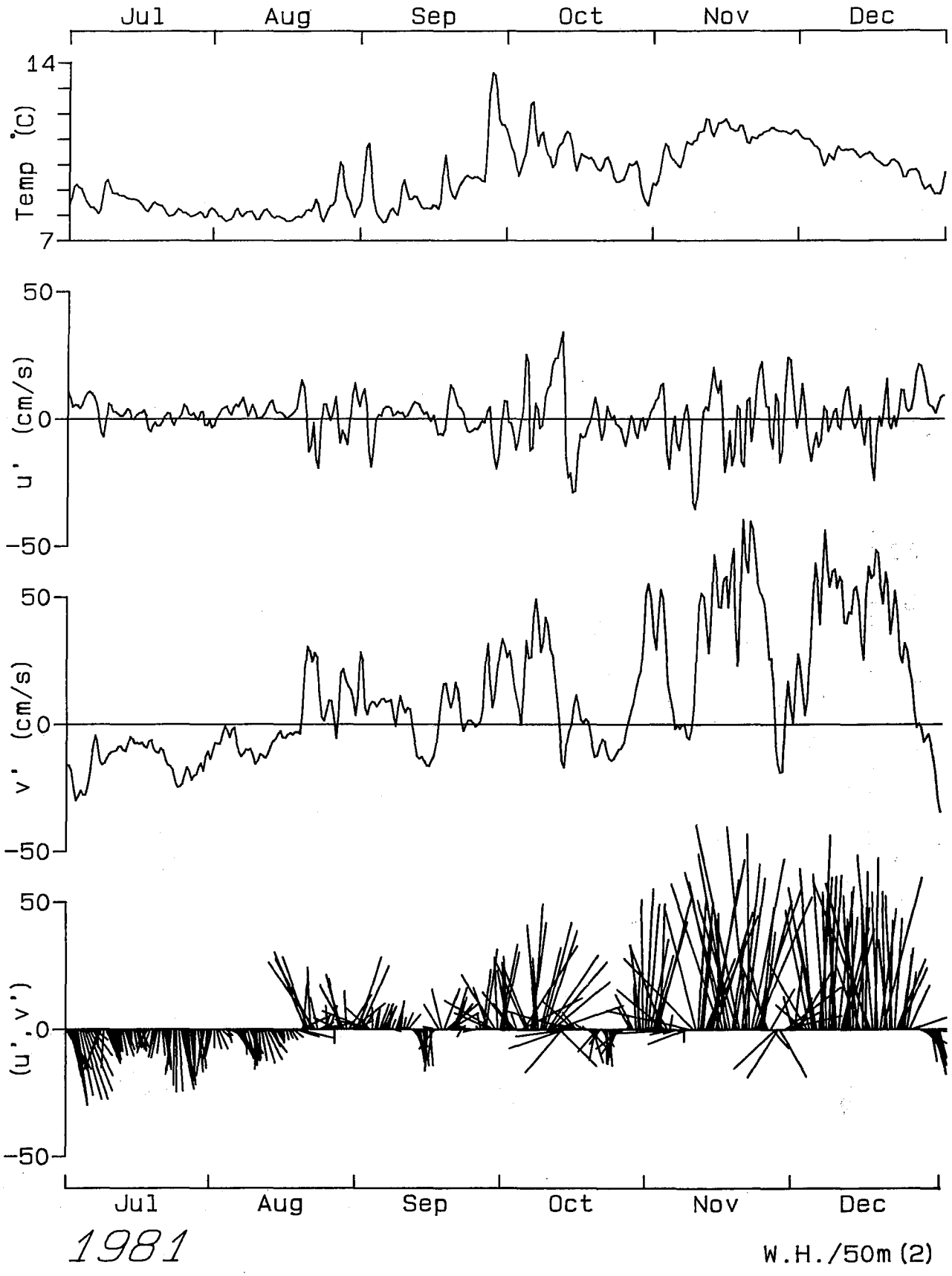
May
Jun
1981
W.H./50m (1)


Jul
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Temp °(C)
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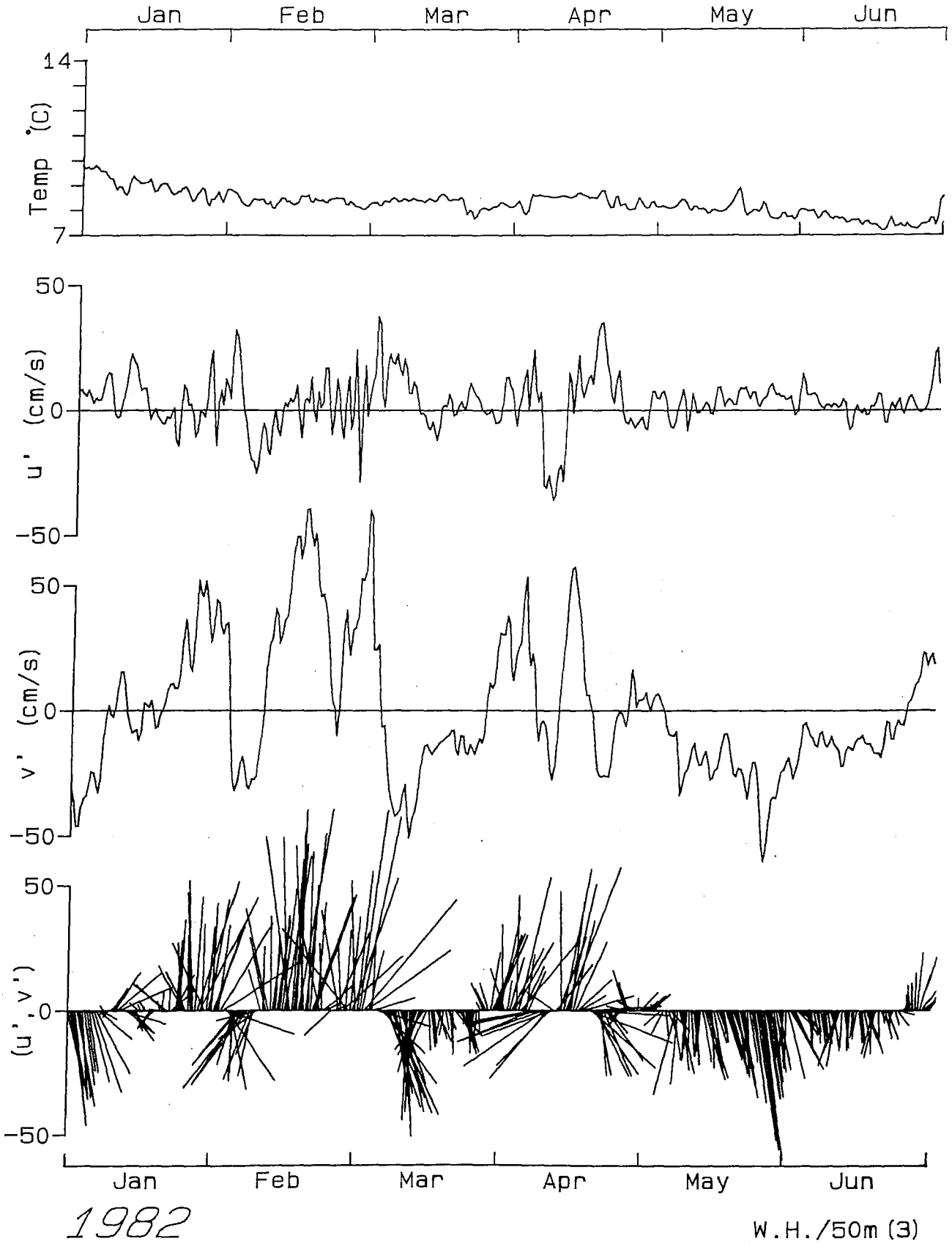
u' (cm/s)
v' (cm/s)
(u',v')
1981
W.H./50m (2)


Jan
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Temp °(C)
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u' (cm/s)
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v' (cm/s)
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(u',v')
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Jan
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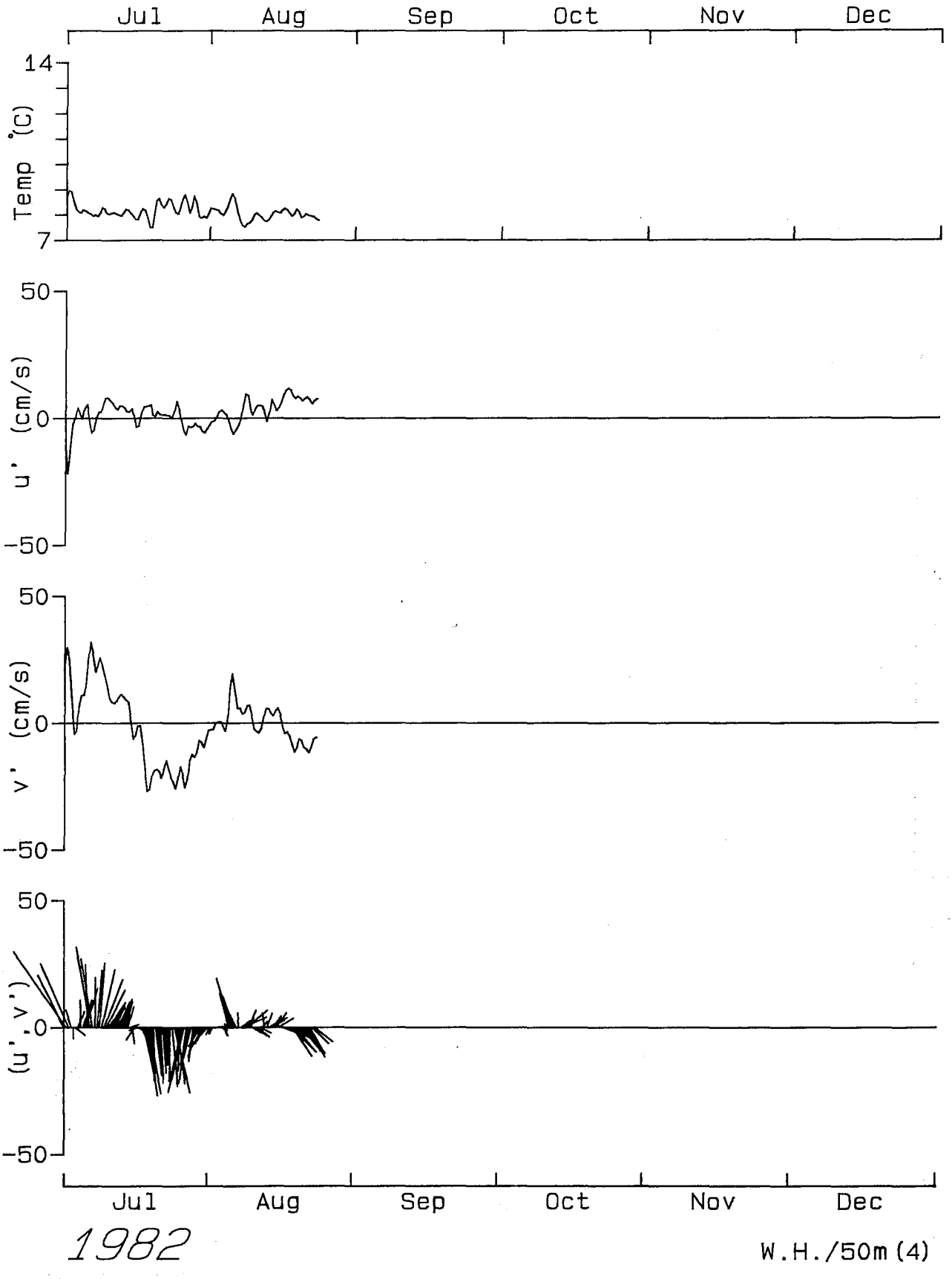
1982
W.H./50m (3)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Temp °(C)
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v' (cm/s)
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(u',v')
Jul
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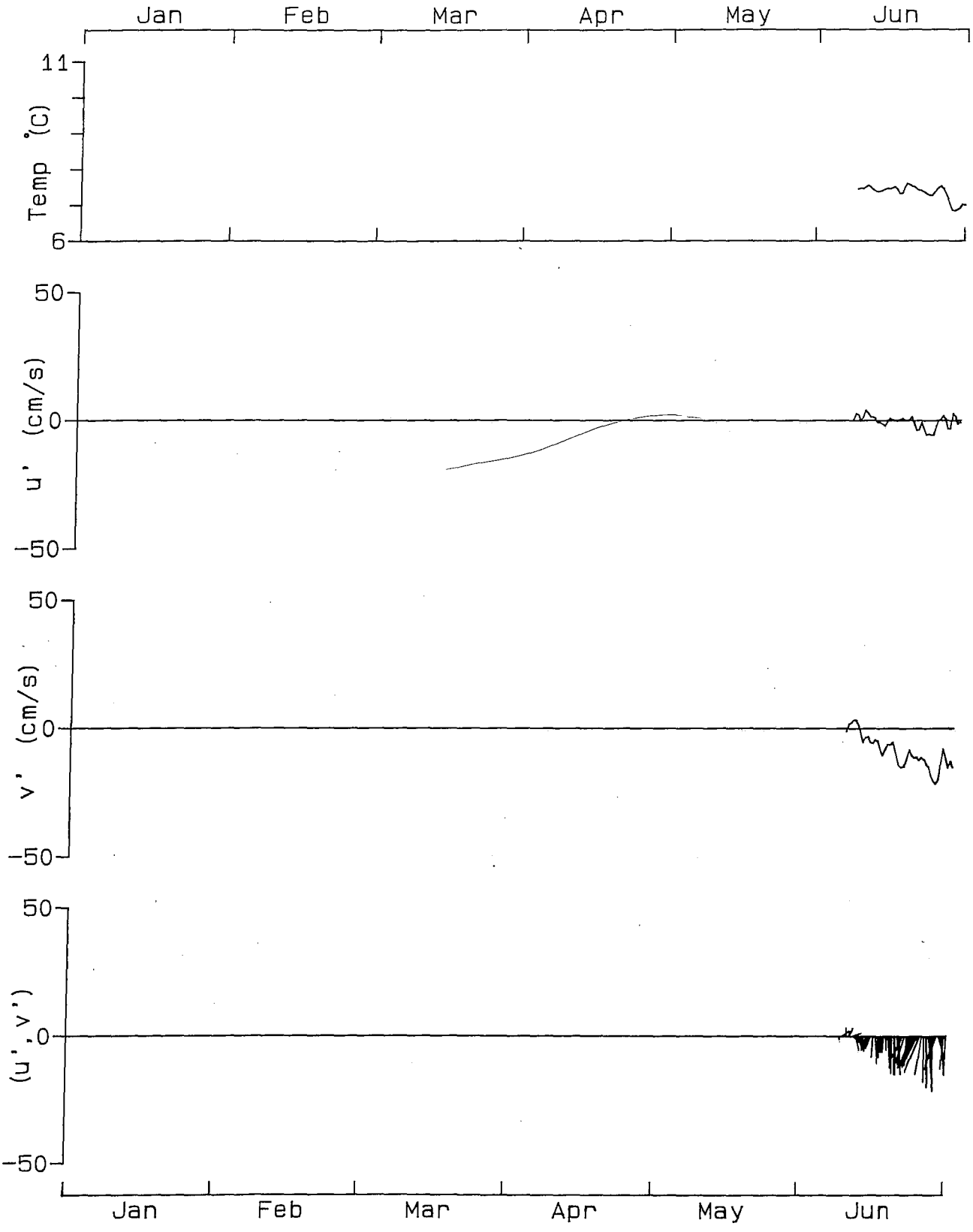
1982
W.H./50m (4)


Jan
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Temp °C)
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u' (cm/s)
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v' (cm/s)
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Jan
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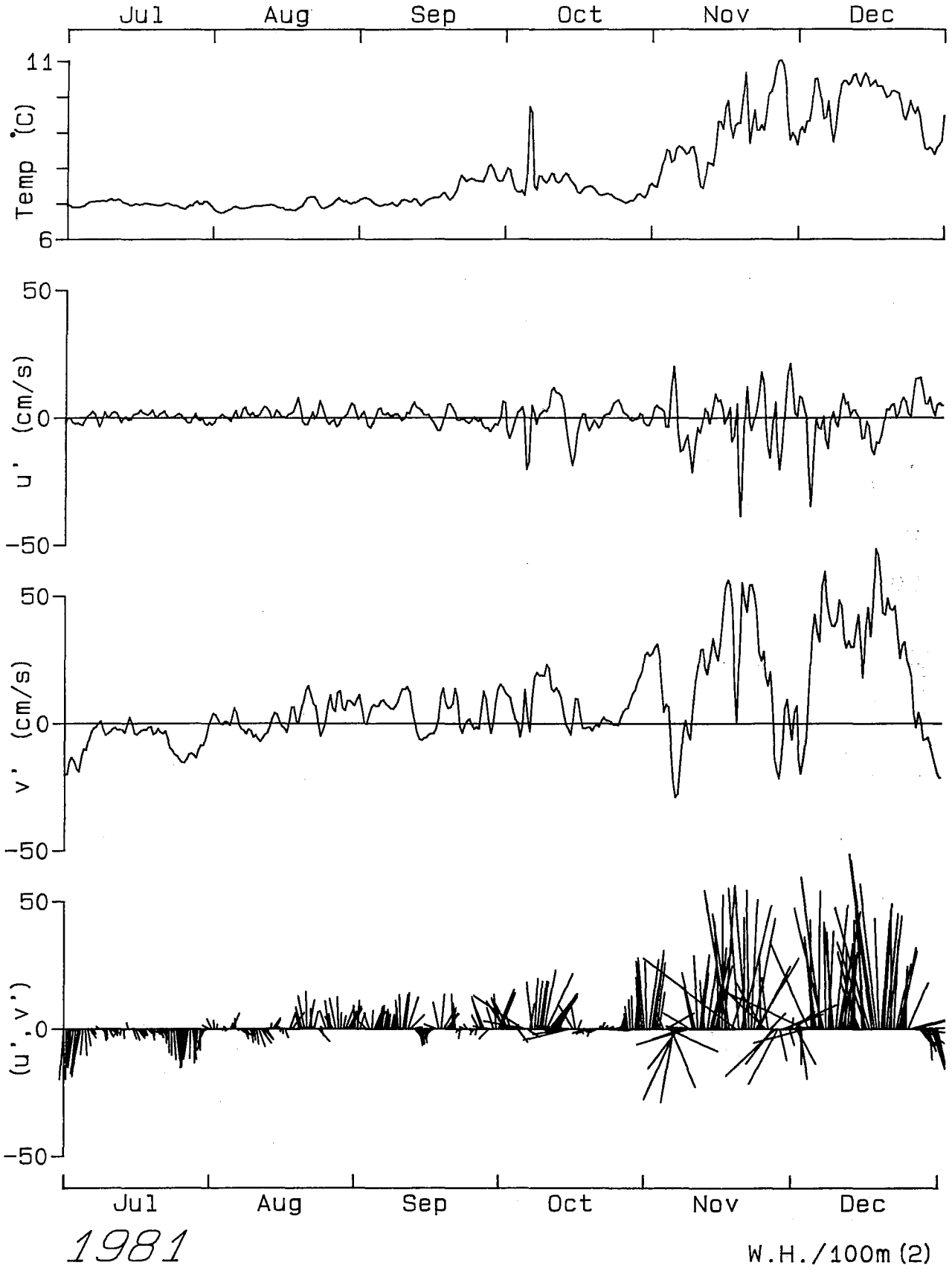
1981
W.H./100m(1)


Jul
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Temp °(C)
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u' (cm/s)
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v' (cm/s)
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(u',v')
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Jul
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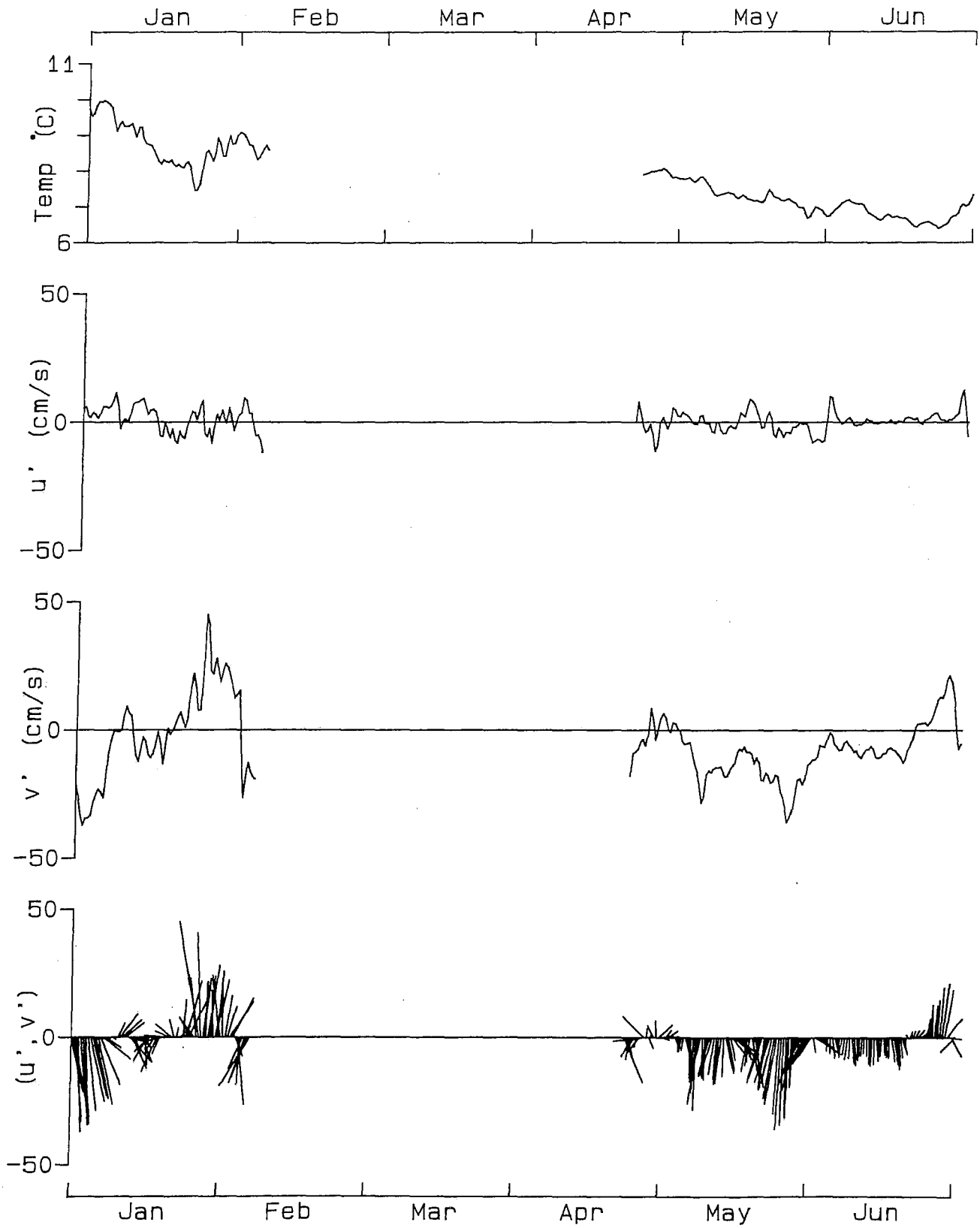
1981
W.H./100m (2)


Jan
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Temp °(C)
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v' (cm/s)
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Jan
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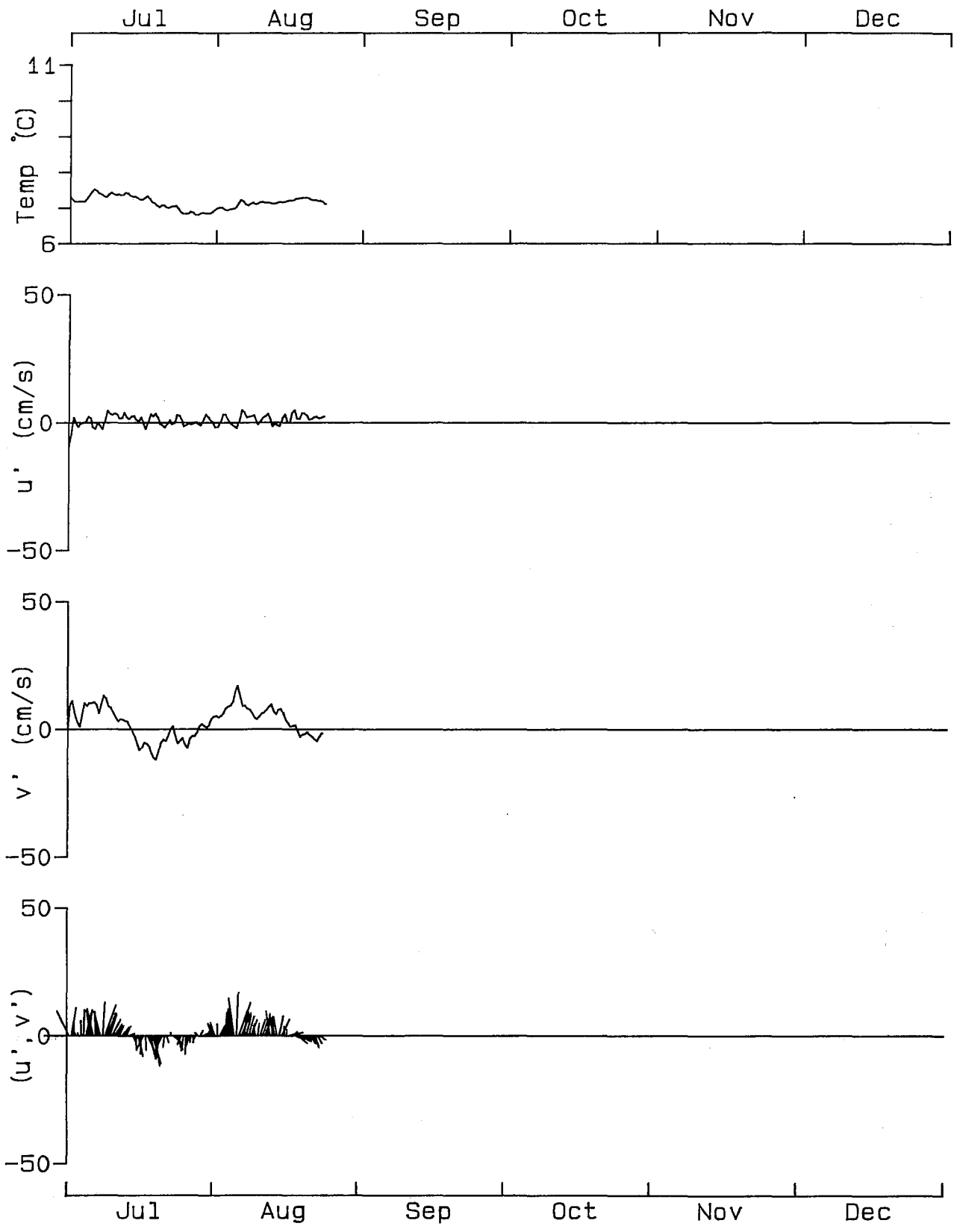
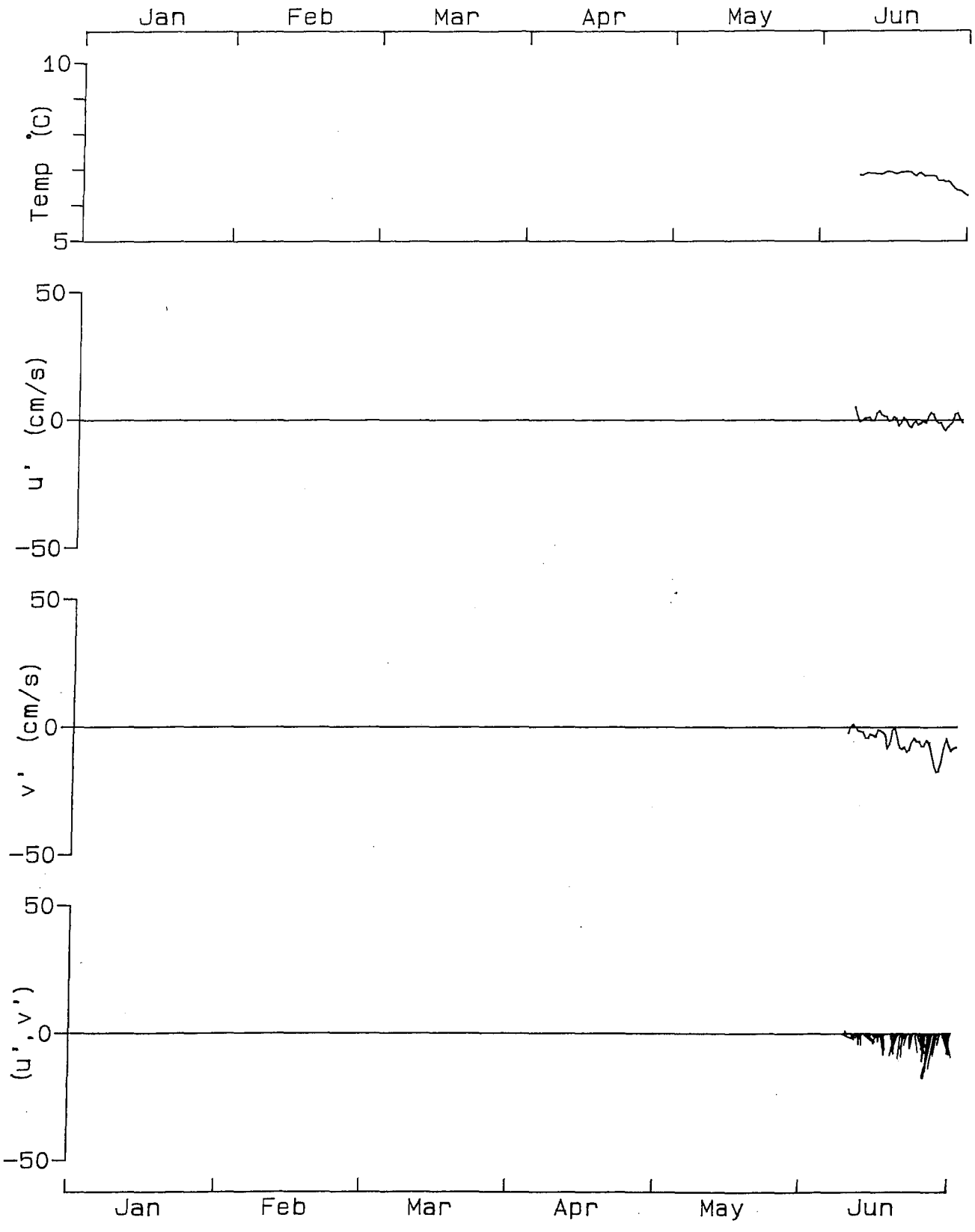
1982
W.H./100m (3)



1982

W.H./100m (4)


Jan
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Temp °(C)
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u' (cm/s)
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v' (cm/s)
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(u',v')
Jan
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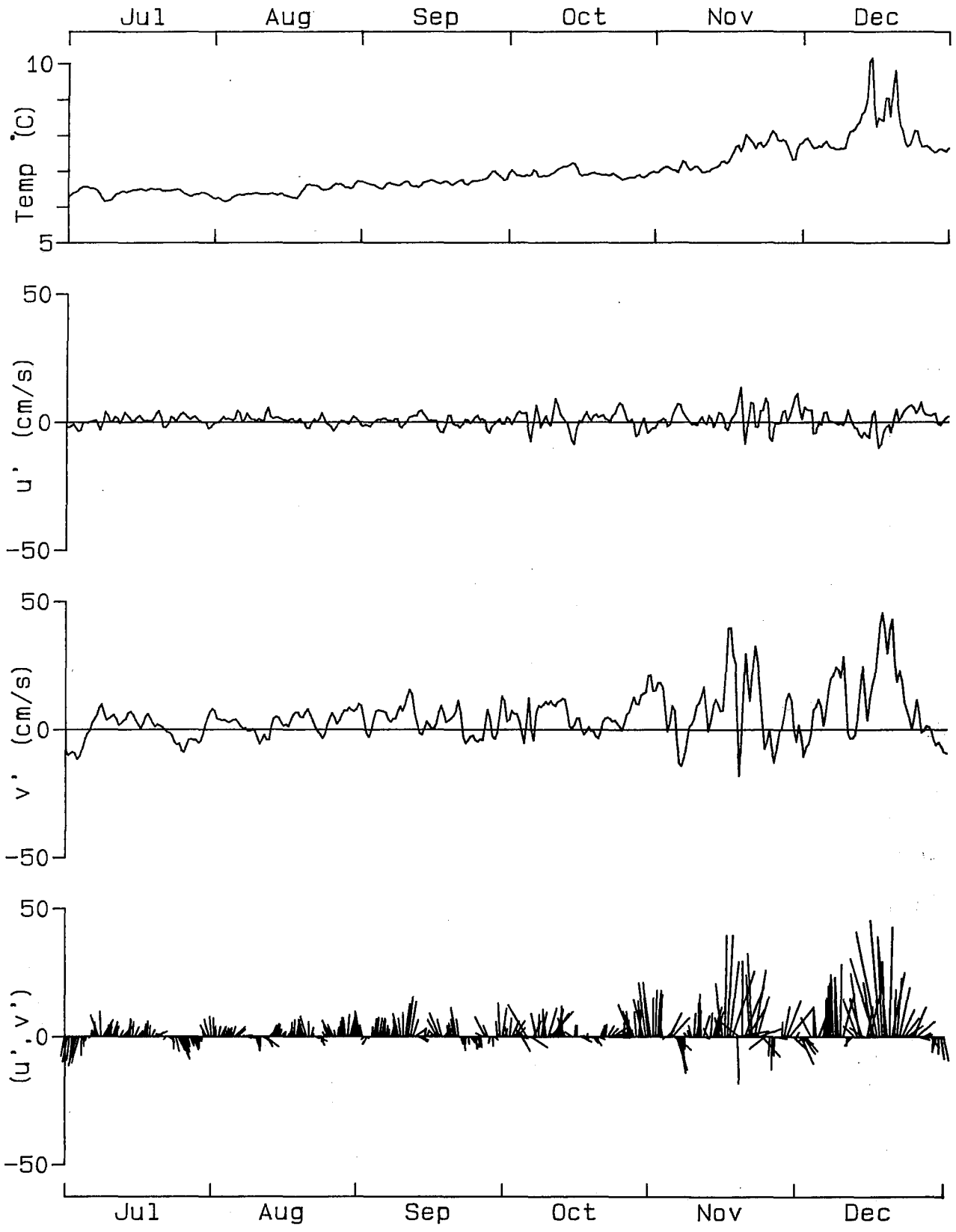
1981
W.H./150m (1)


Jul
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Temp °(C)
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v' (cm/s)
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(u', v')
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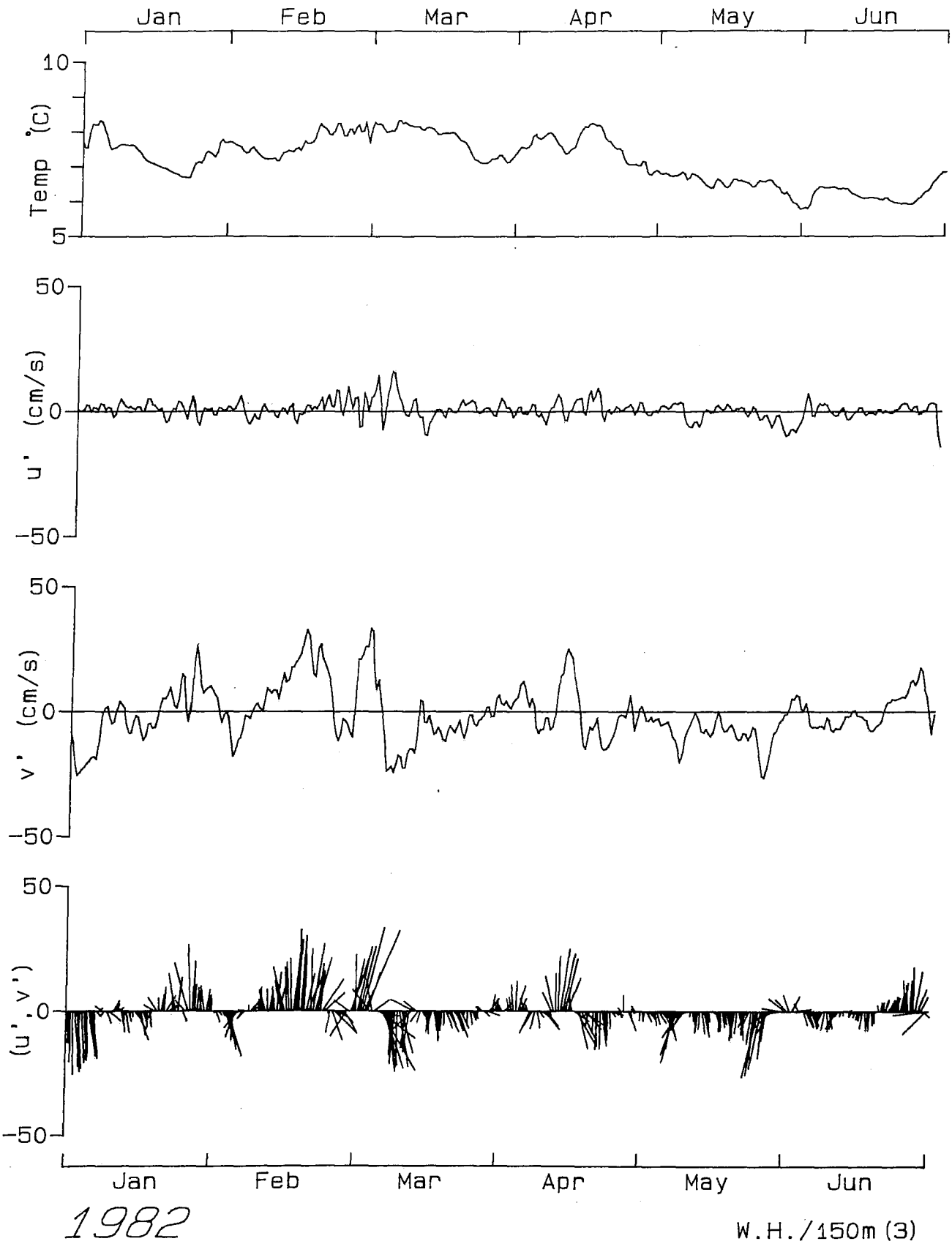
1981
W.H./150m (2)


Jan
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Temp °(C)
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v' (cm/s)
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(u', v')
Jan
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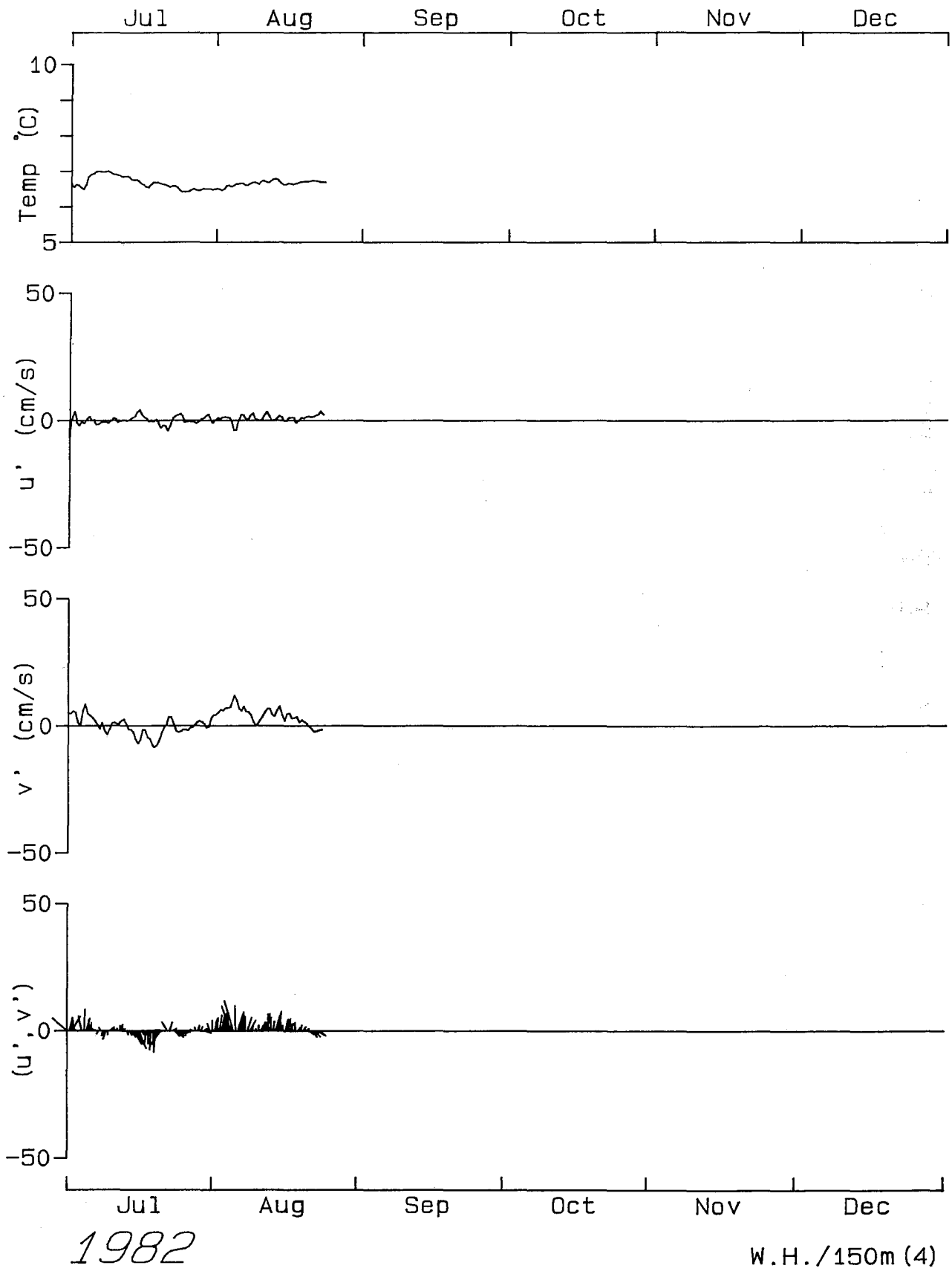
1982
W.H./150m (3)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Temp °(C)
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v' (cm/s)
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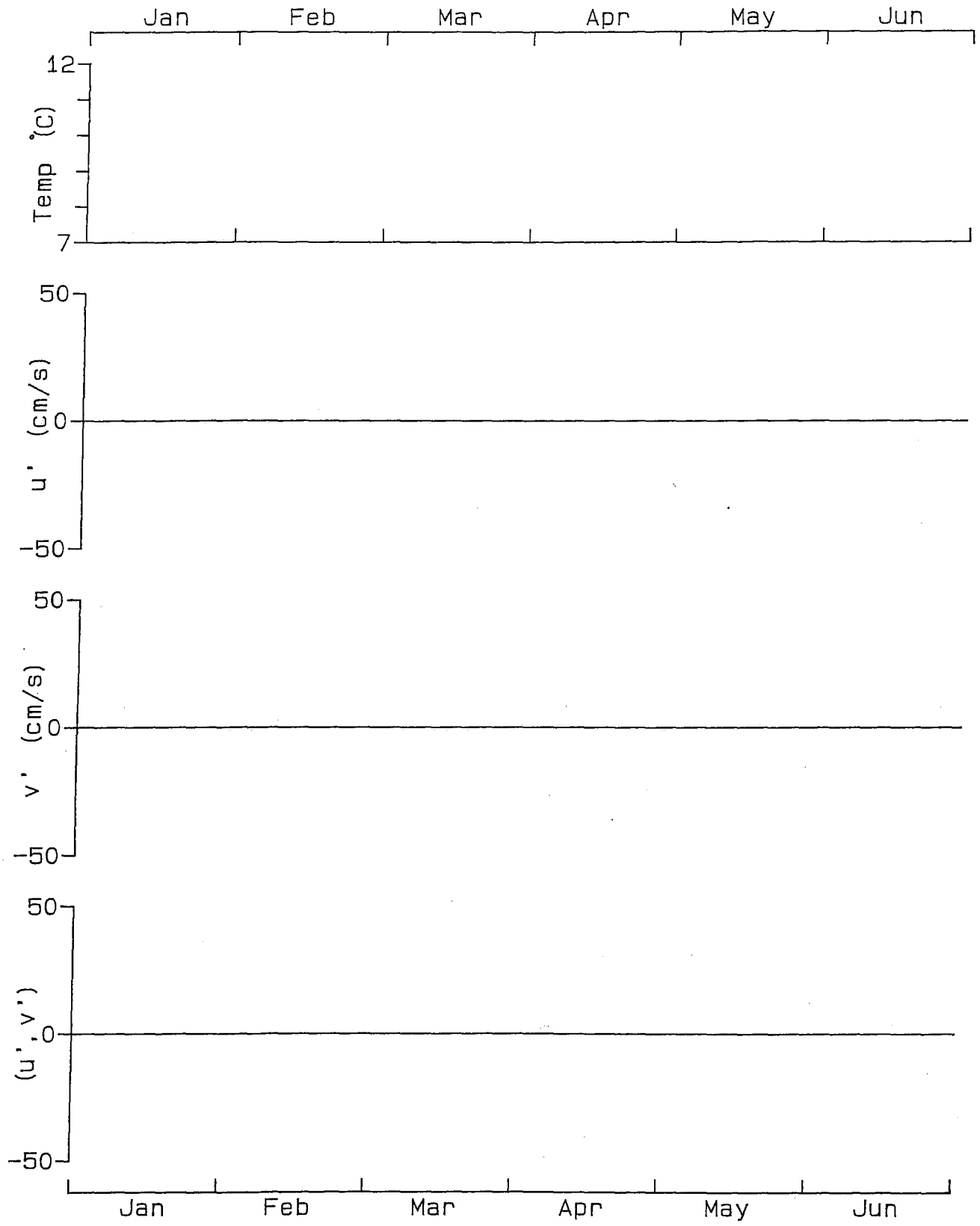
1982
W.H./150m (4)


Jan
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Temp °(C)
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Jan
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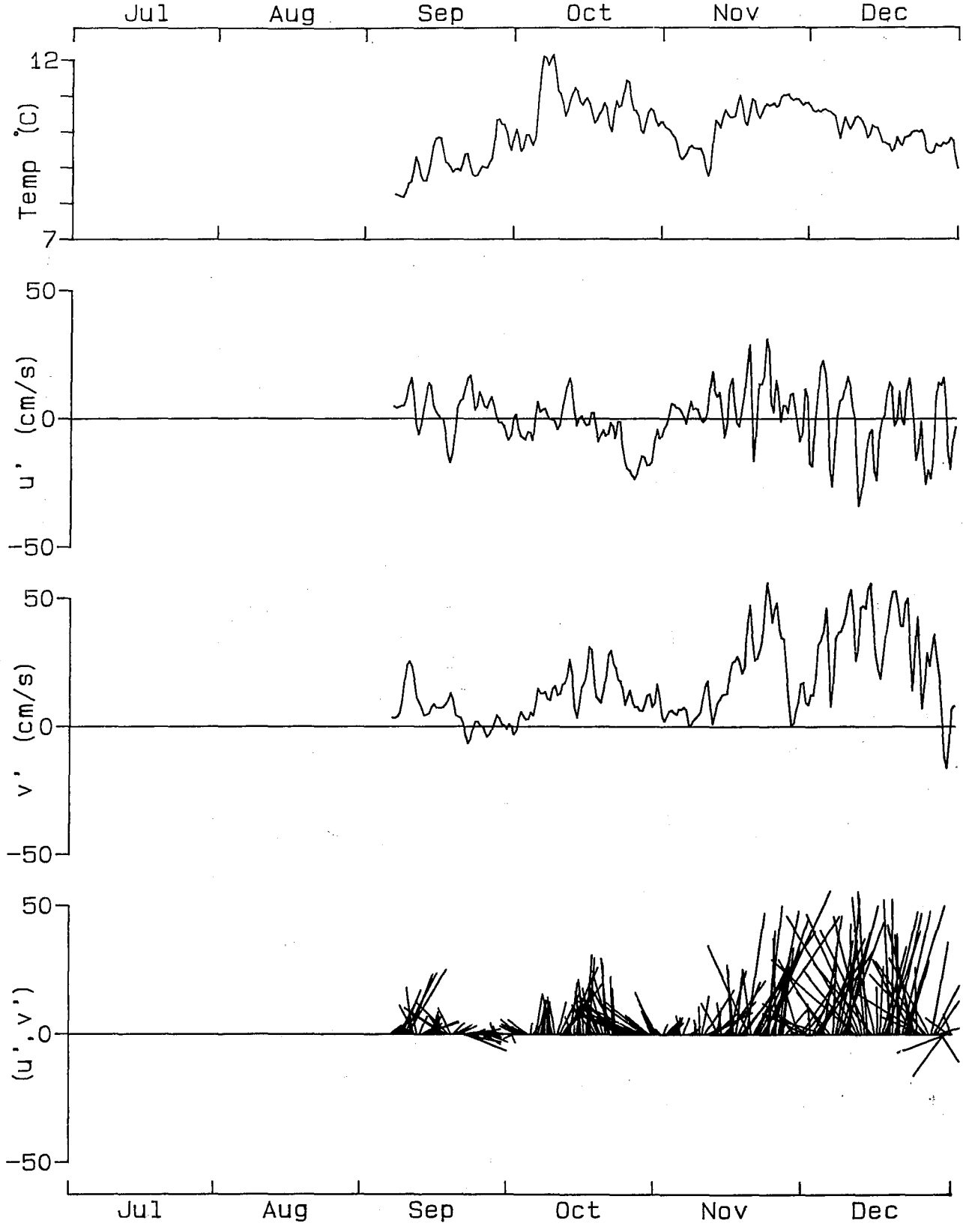
1981
Q.C.S.S./50m (0)


Jul
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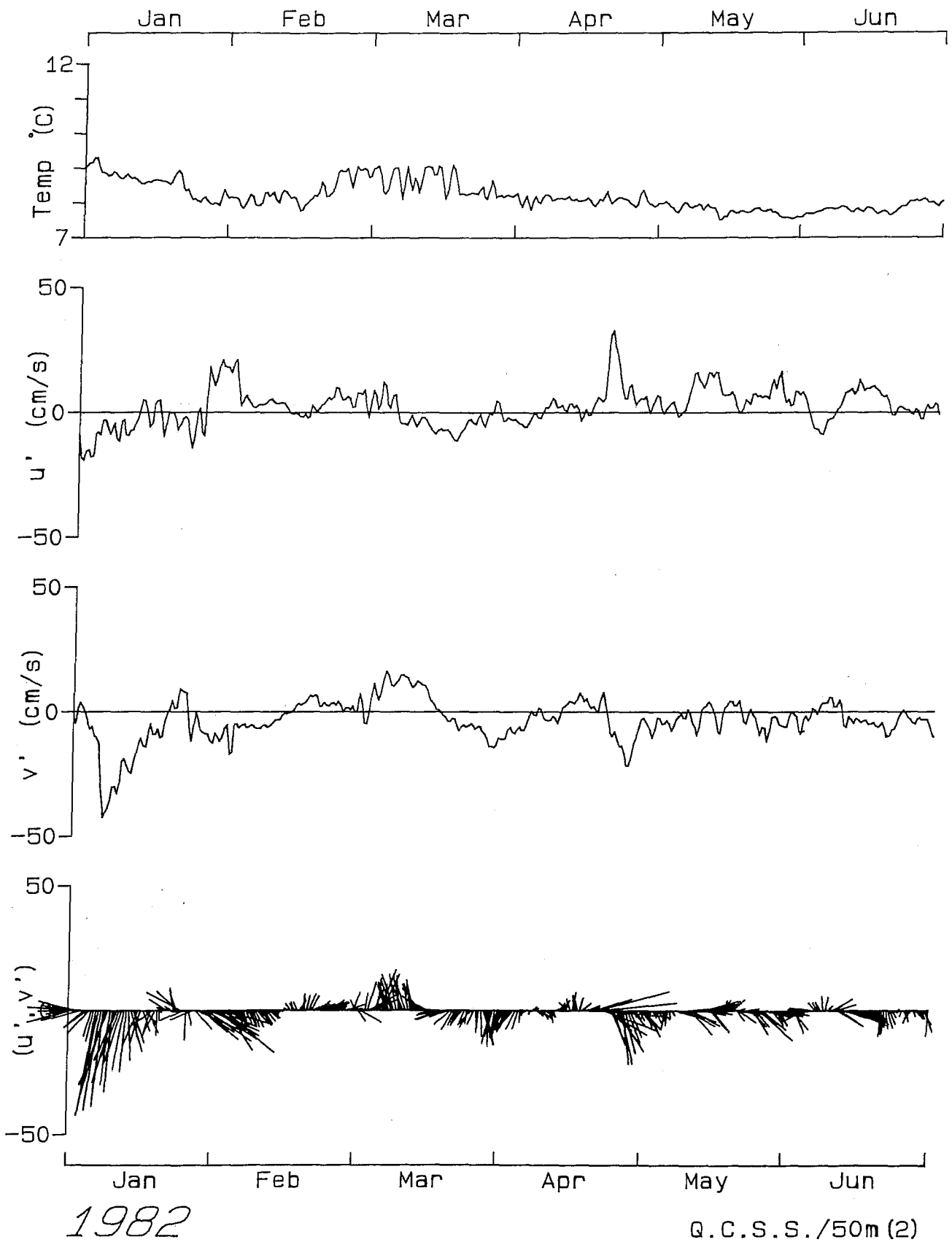
1981
Q.C.S.S./50m(1)


Jan
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Temp °(C)
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u' (cm/s)
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v' (cm/s)
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(u'v')
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Jan
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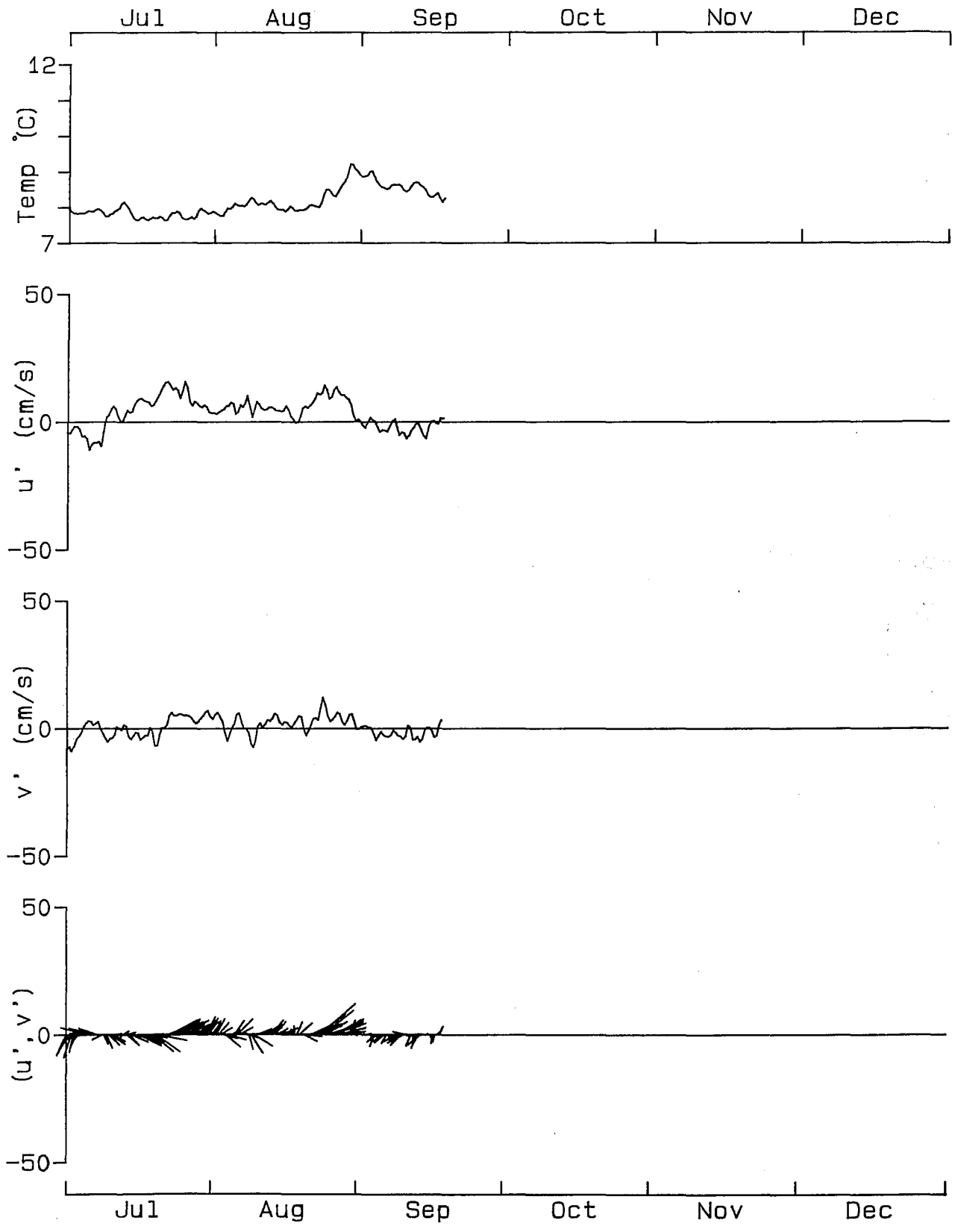
1982
Q.C.S.S./50m (2)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Temp °(C)
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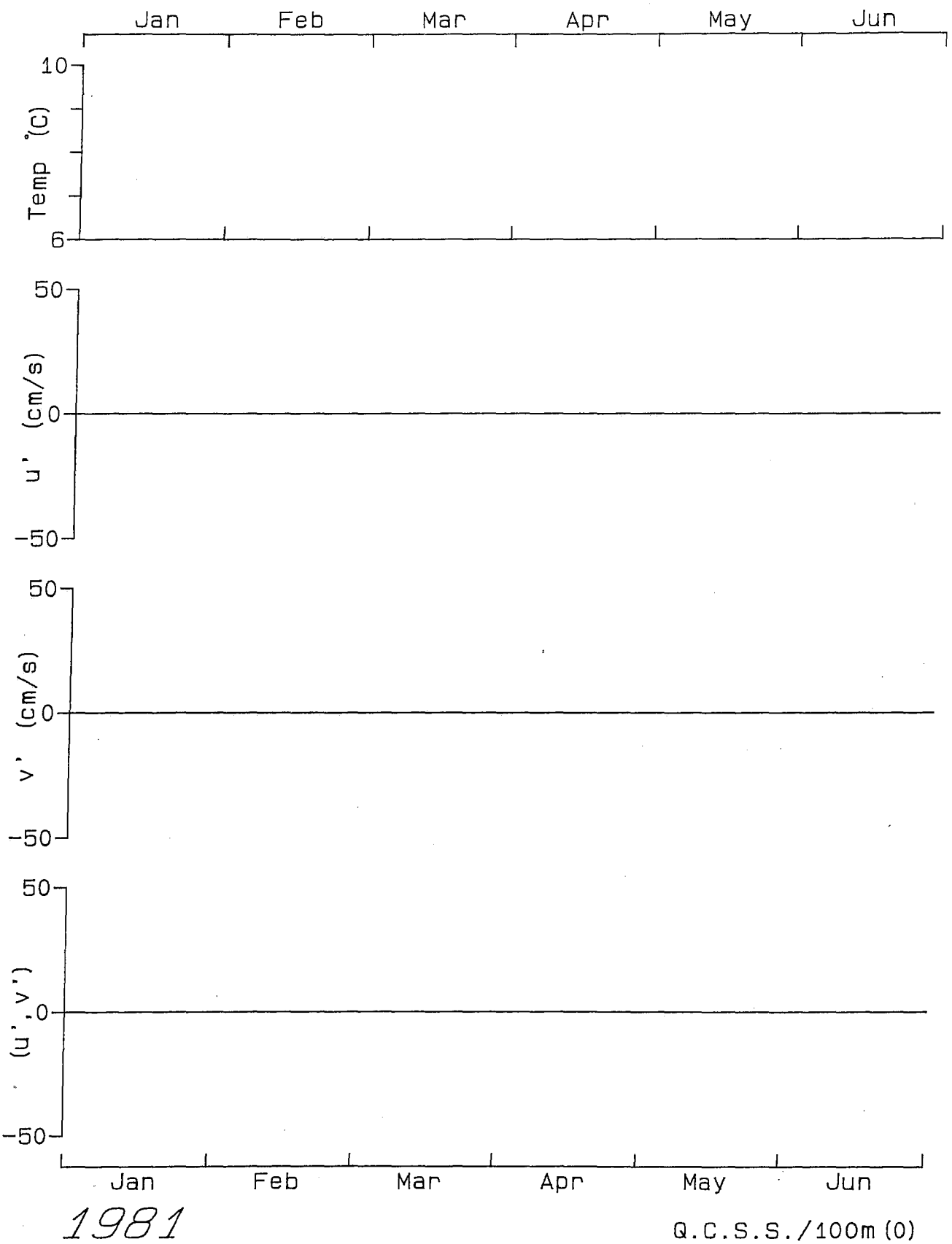
1982
Q.C.S.S./50m (3)


Jan
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Temp °(C)
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Jan
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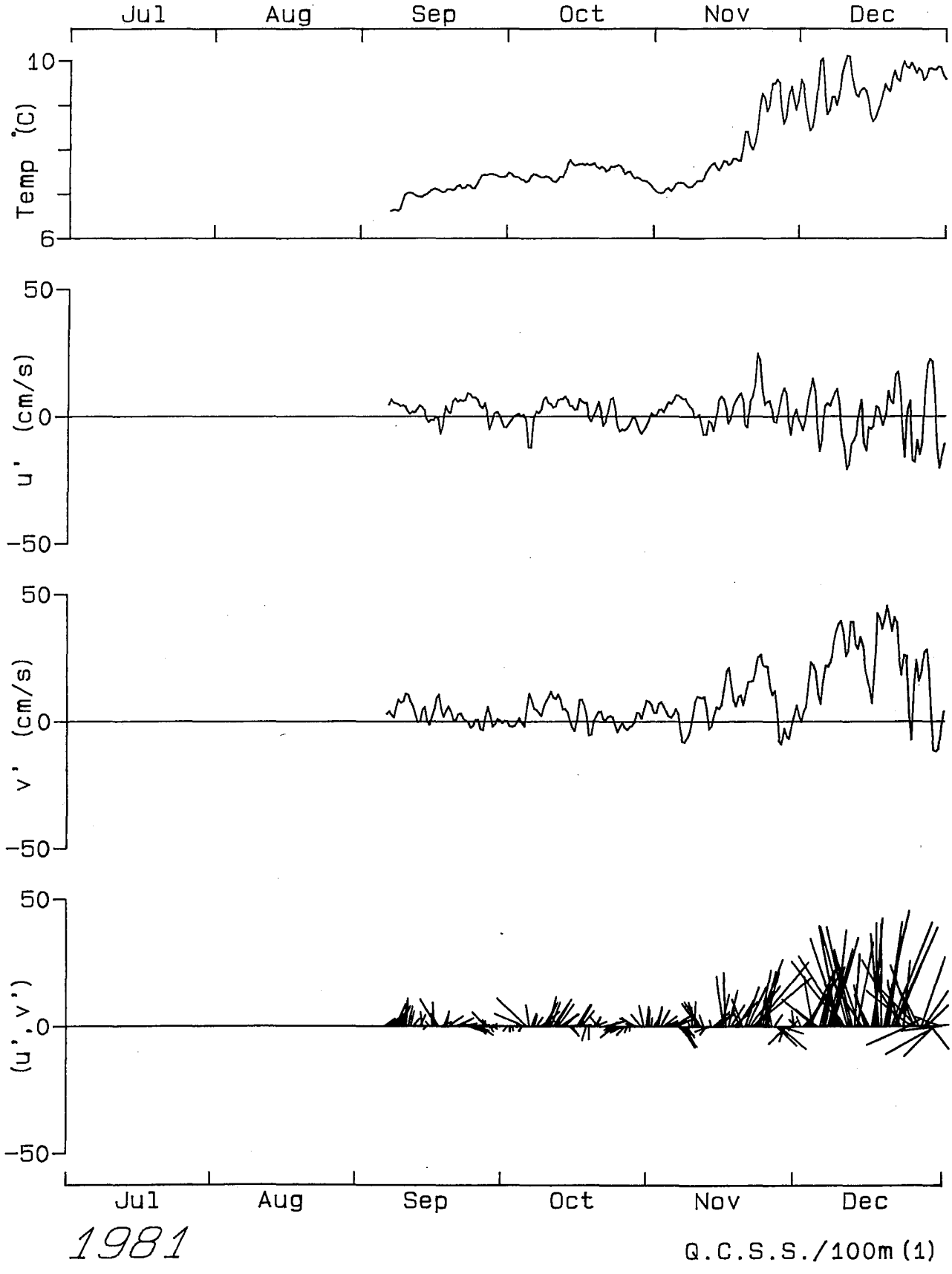
1981
Q.C.S.S./100m (0)


Jul
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Temp °(C)
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u' (cm/s)
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v' (cm/s)
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(u',v')
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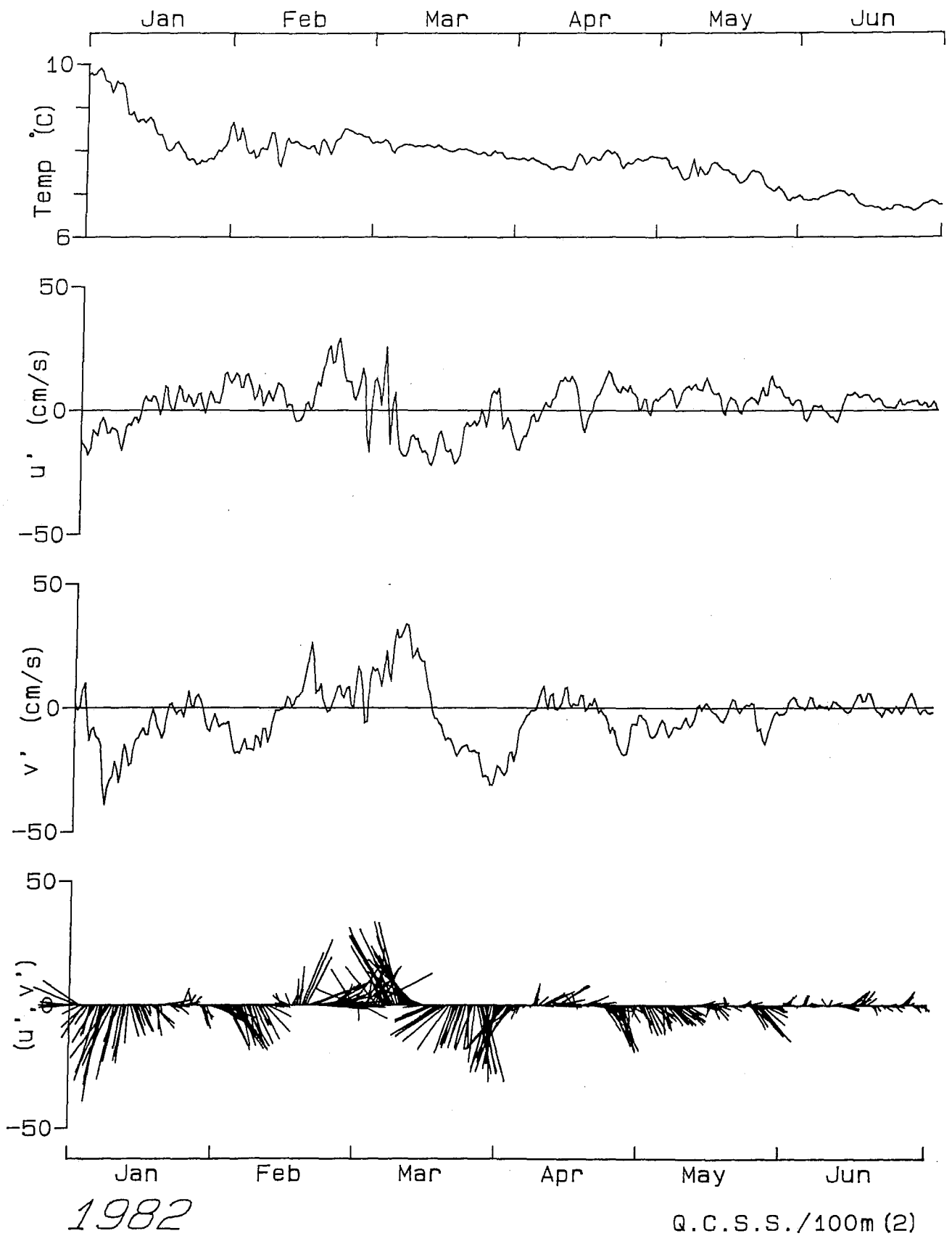
1981
Q.C.S.S./100m (1)


Jan
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Temp °(C)
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u' (cm/s)
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v' (cm/s)
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(u', v')
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Jan
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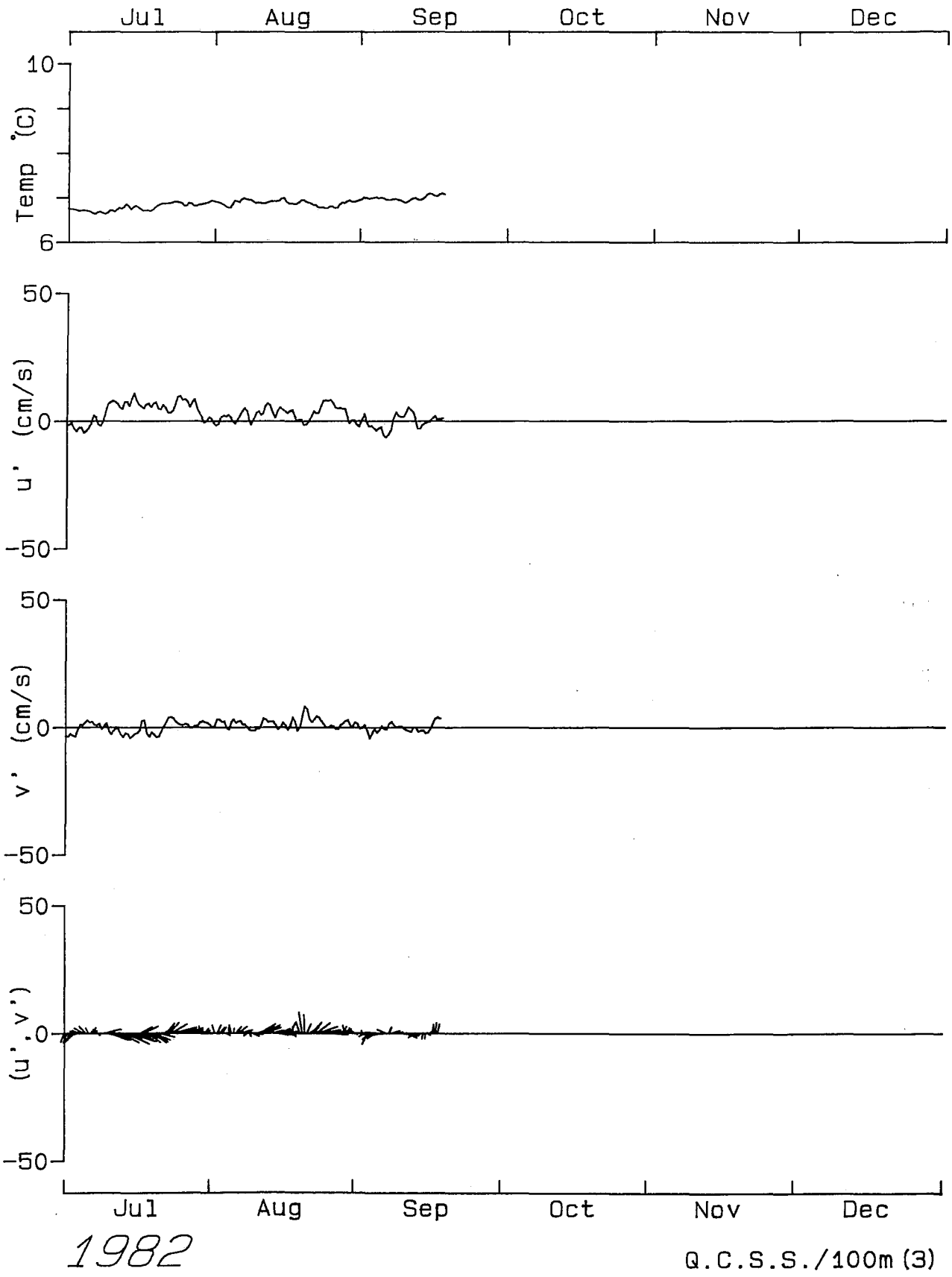
1982
Q.C.S.S./100m (2)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Temp °(C)
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u' (cm/s)
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v' (cm/s)
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(u',v')
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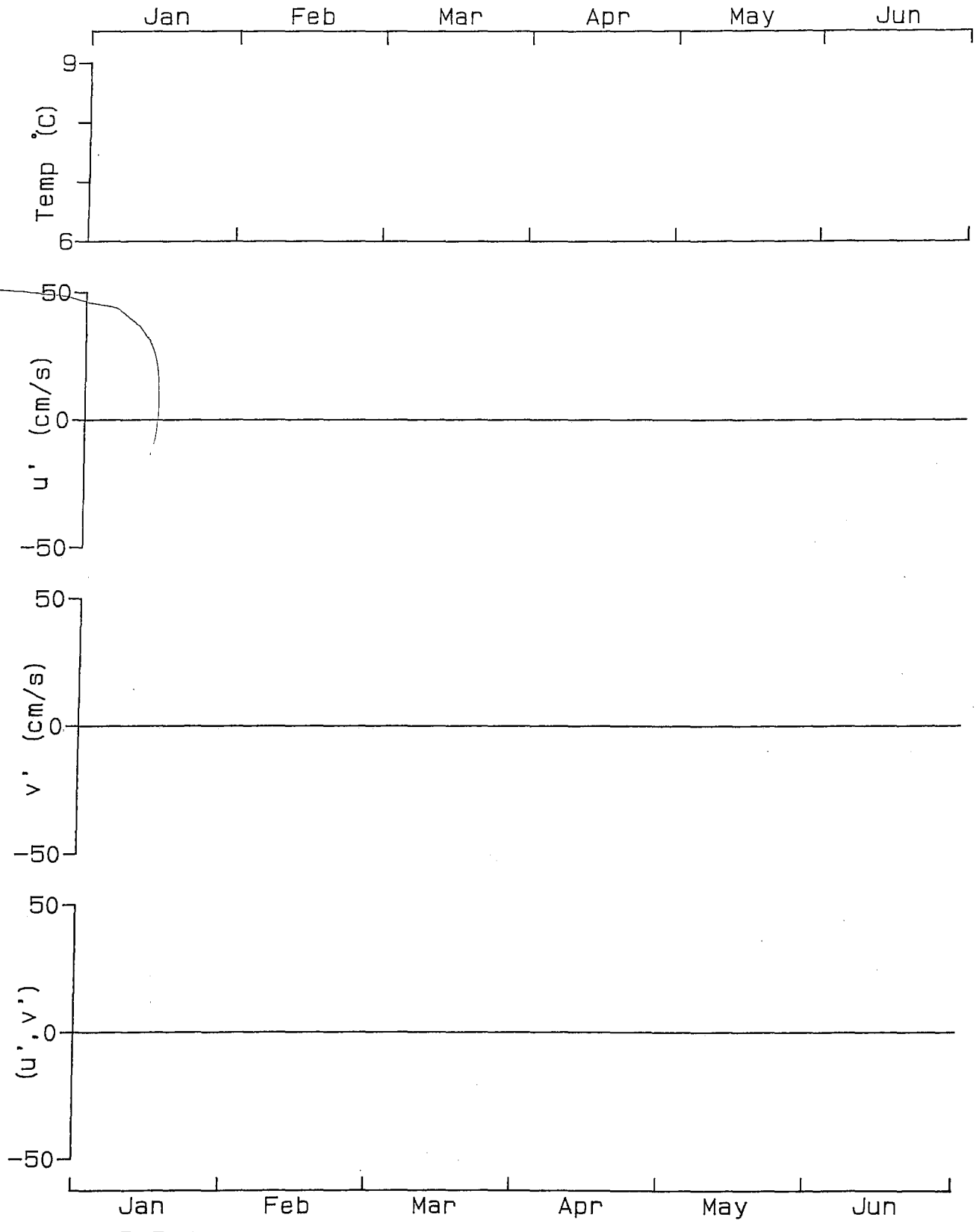
1982
Q.C.S.S./100m (3)


Jan
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Temp °(C)
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u' (cm/s)
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v' (cm/s)
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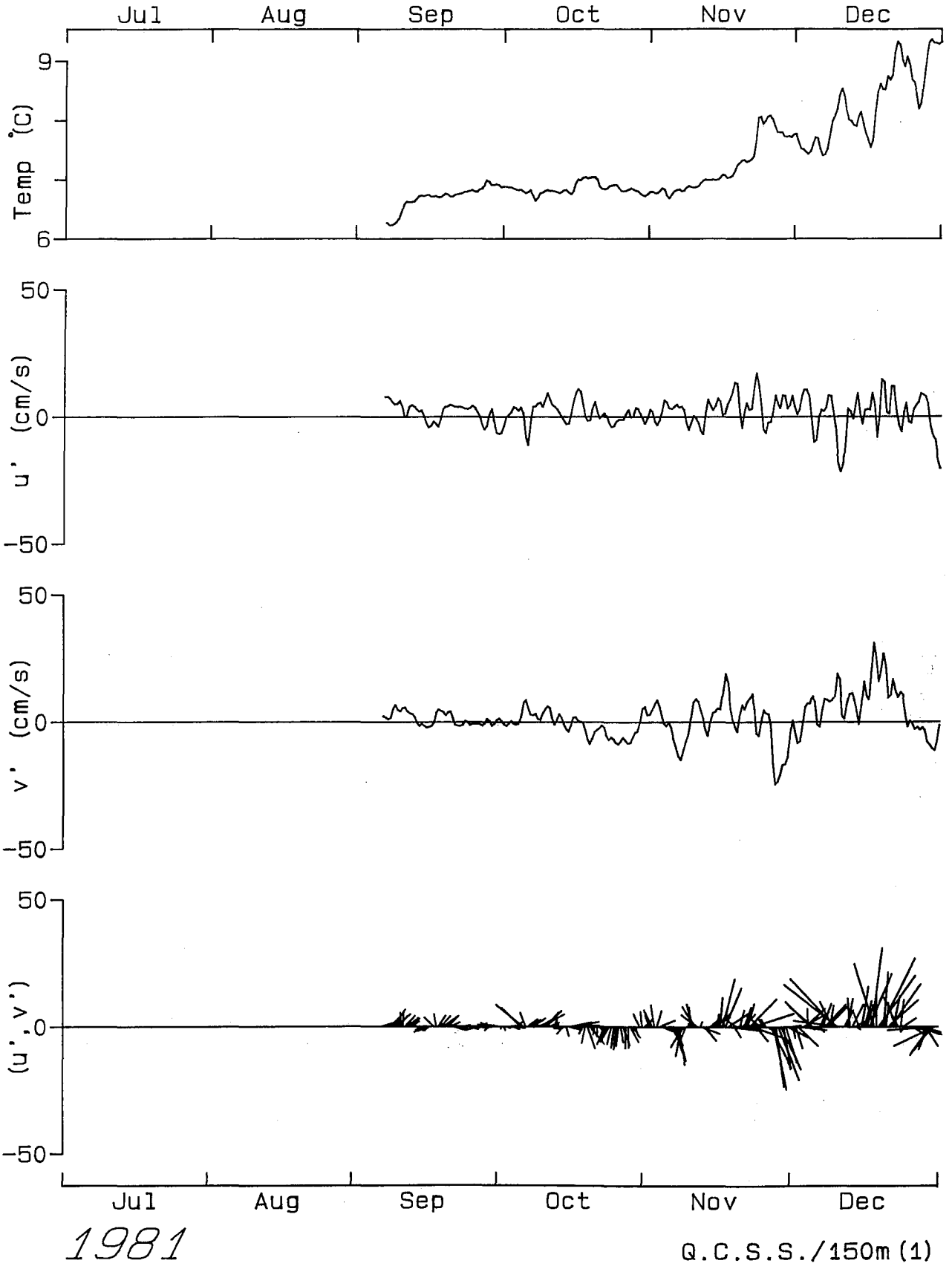
1981
Q.C.S.S./150m (0)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Temp °(C)
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u' (cm/s)
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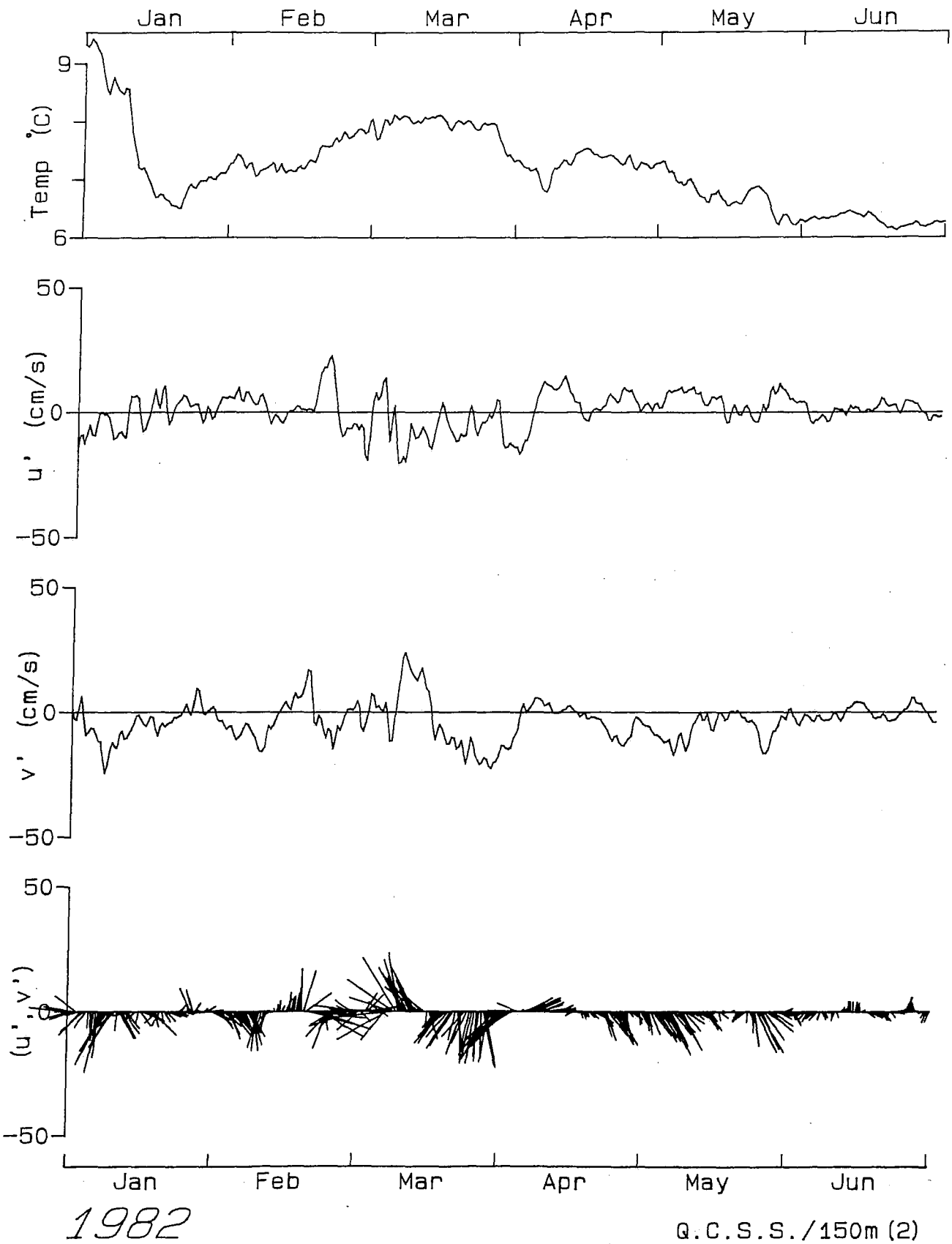
1981
Q.C.S.S./150m (1)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Temp °(C)
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u' (cm/s)
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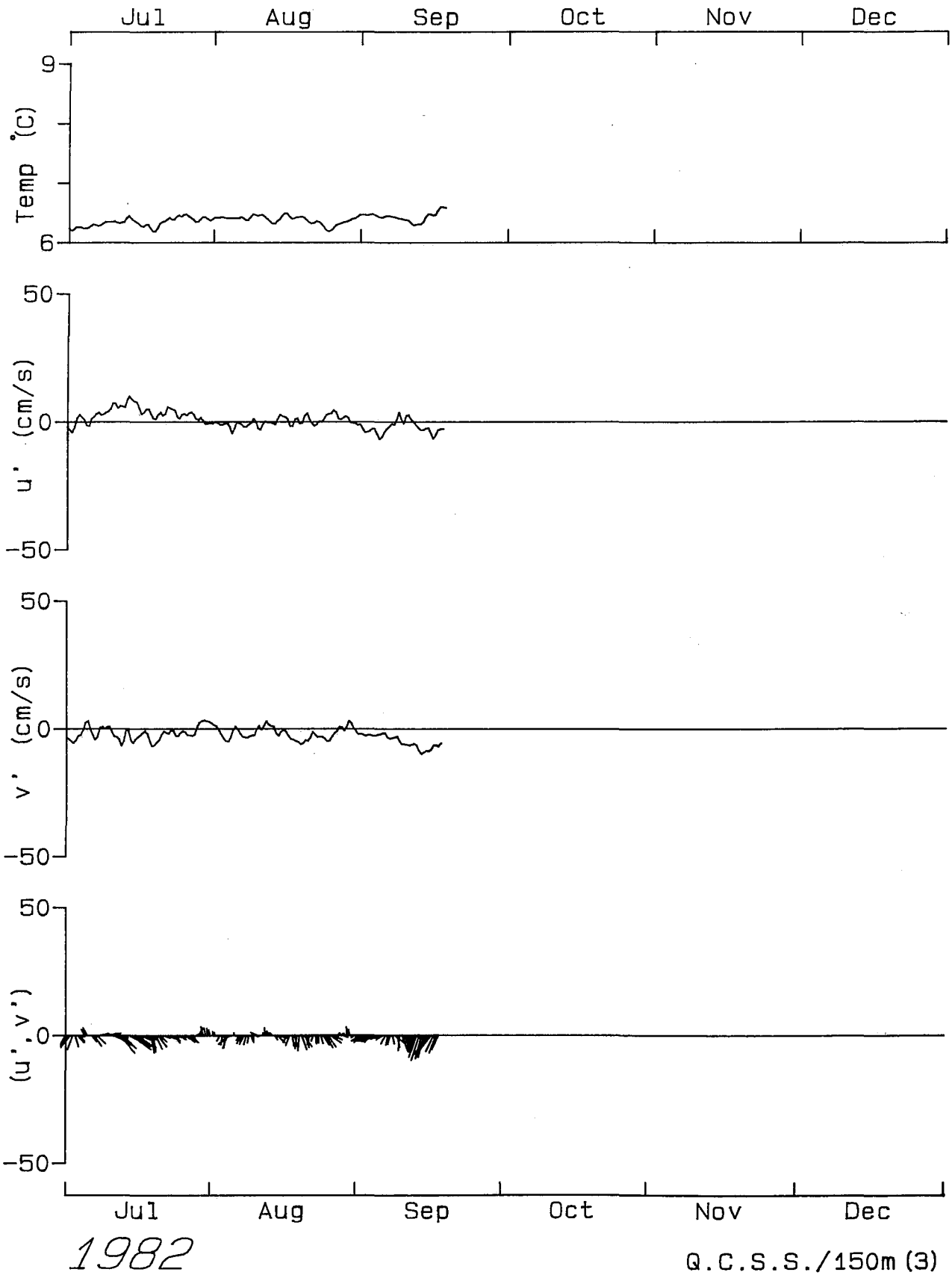
1982
Q.C.S.S./150m (2)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Temp °(C)
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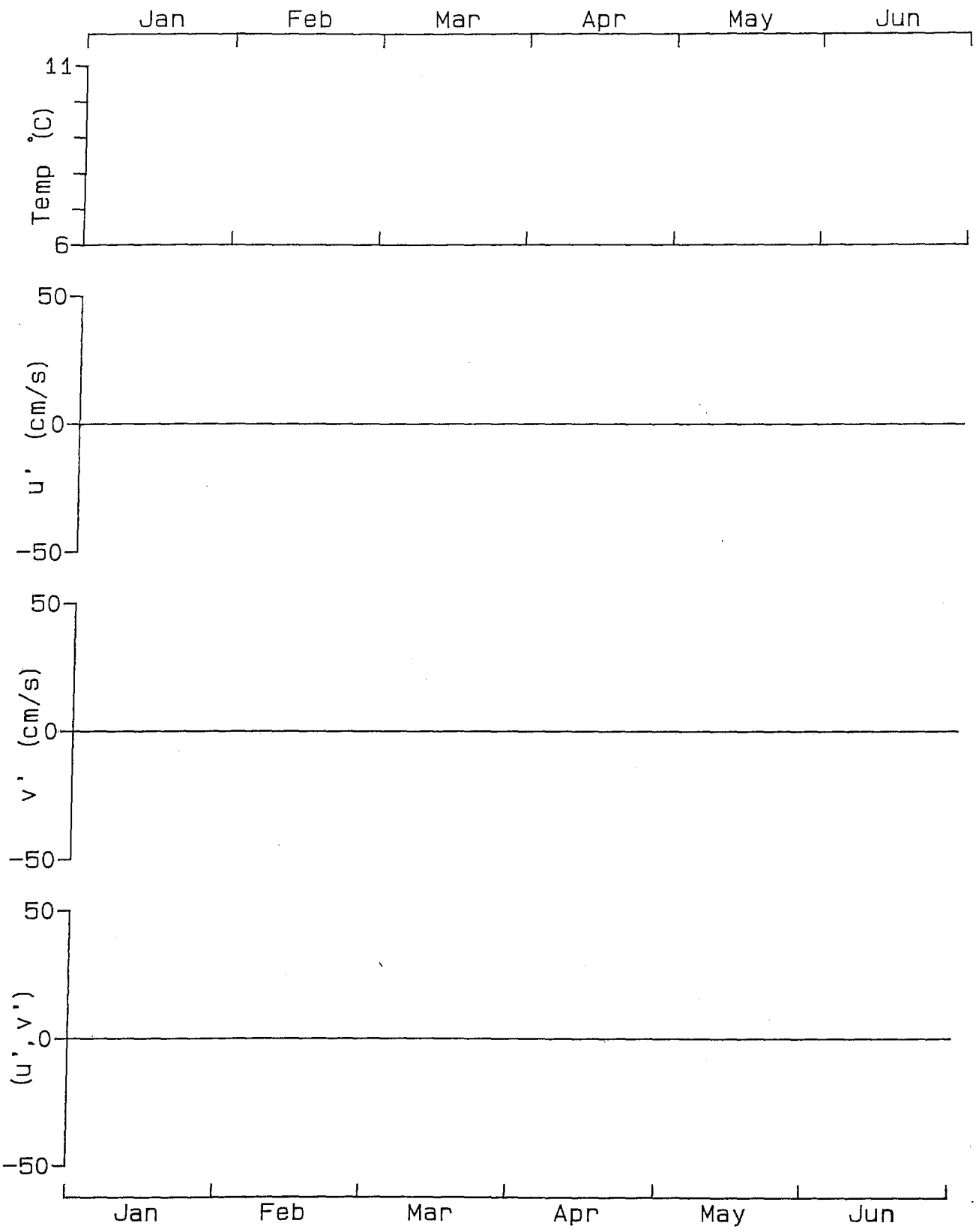
1982
Q.C.S.S./150m (3)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Temp °(C)
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(u',v')
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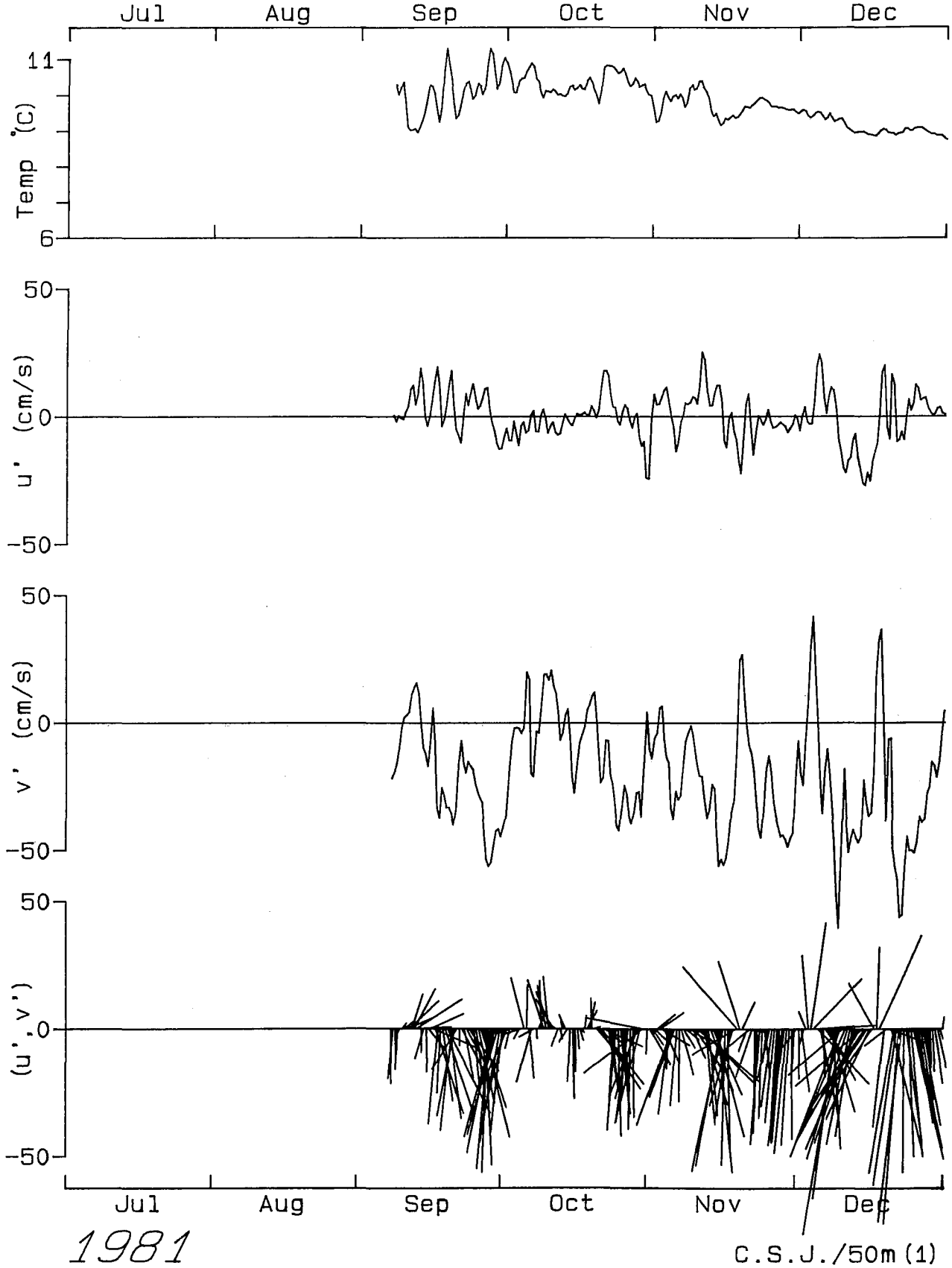
1981
C.S.J./50m (0)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Temp °(C)
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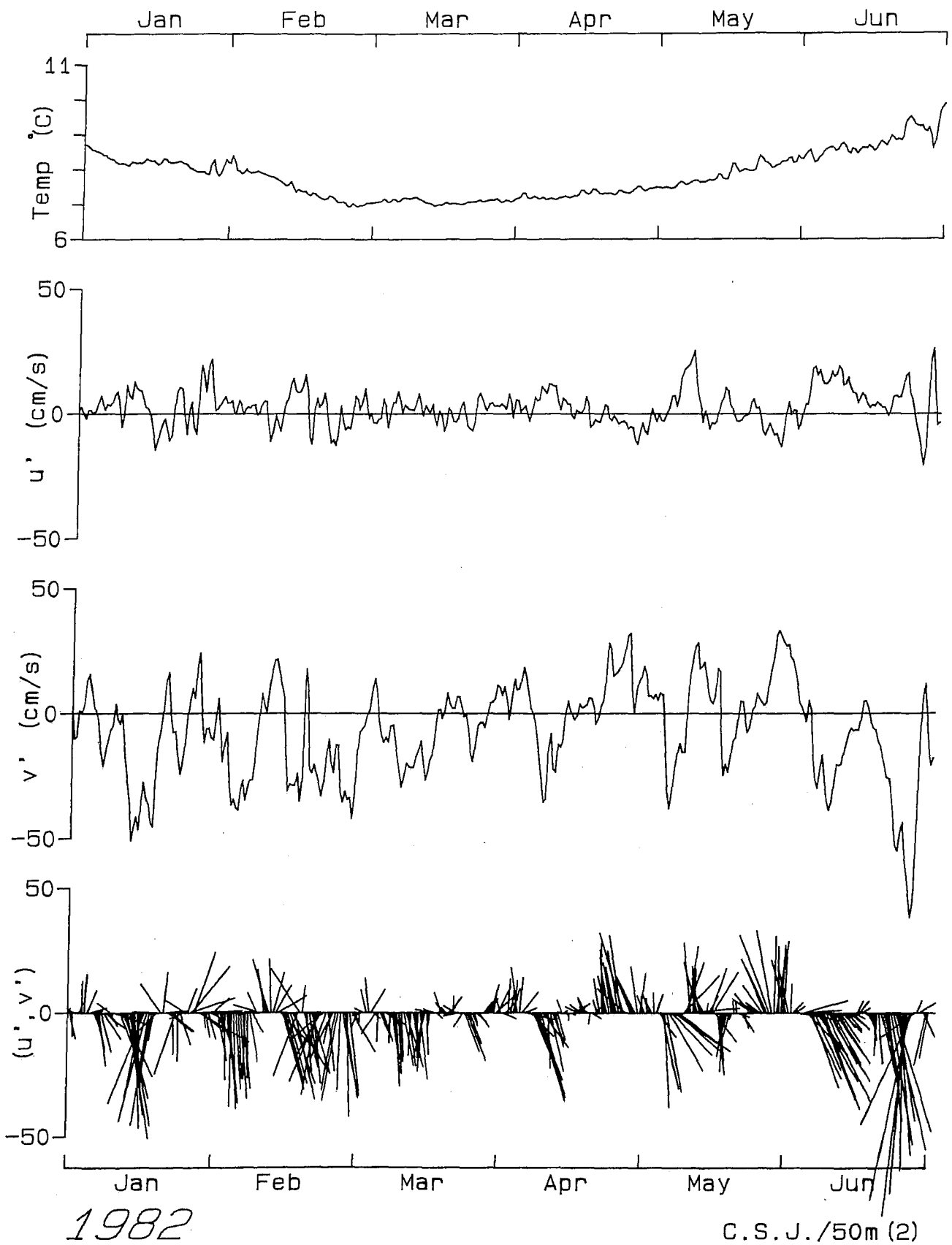
1981
C.S.J./50m (1)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Temp °(C)
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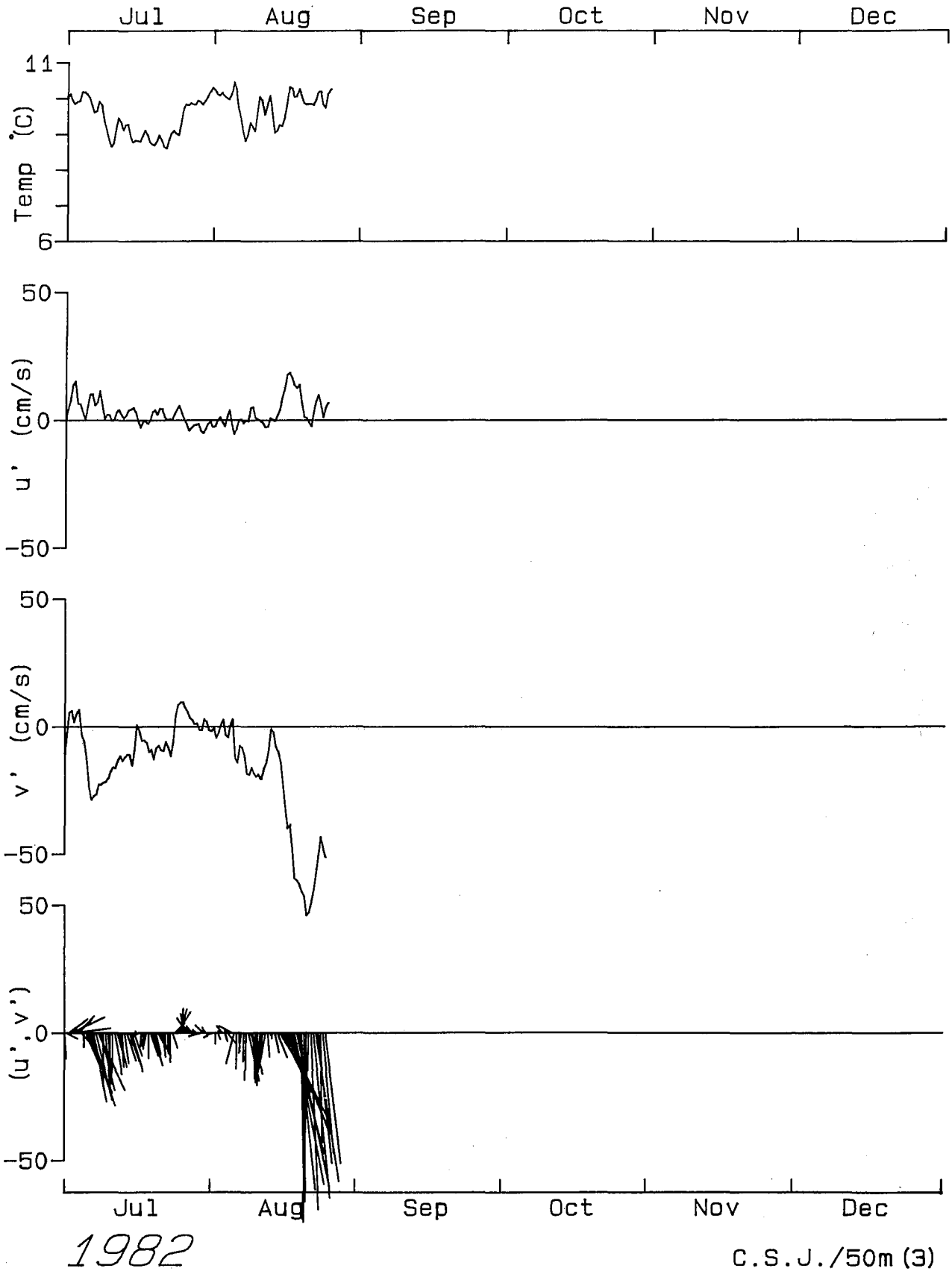
1982
C.S.J./50m (2)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Temp °(C)
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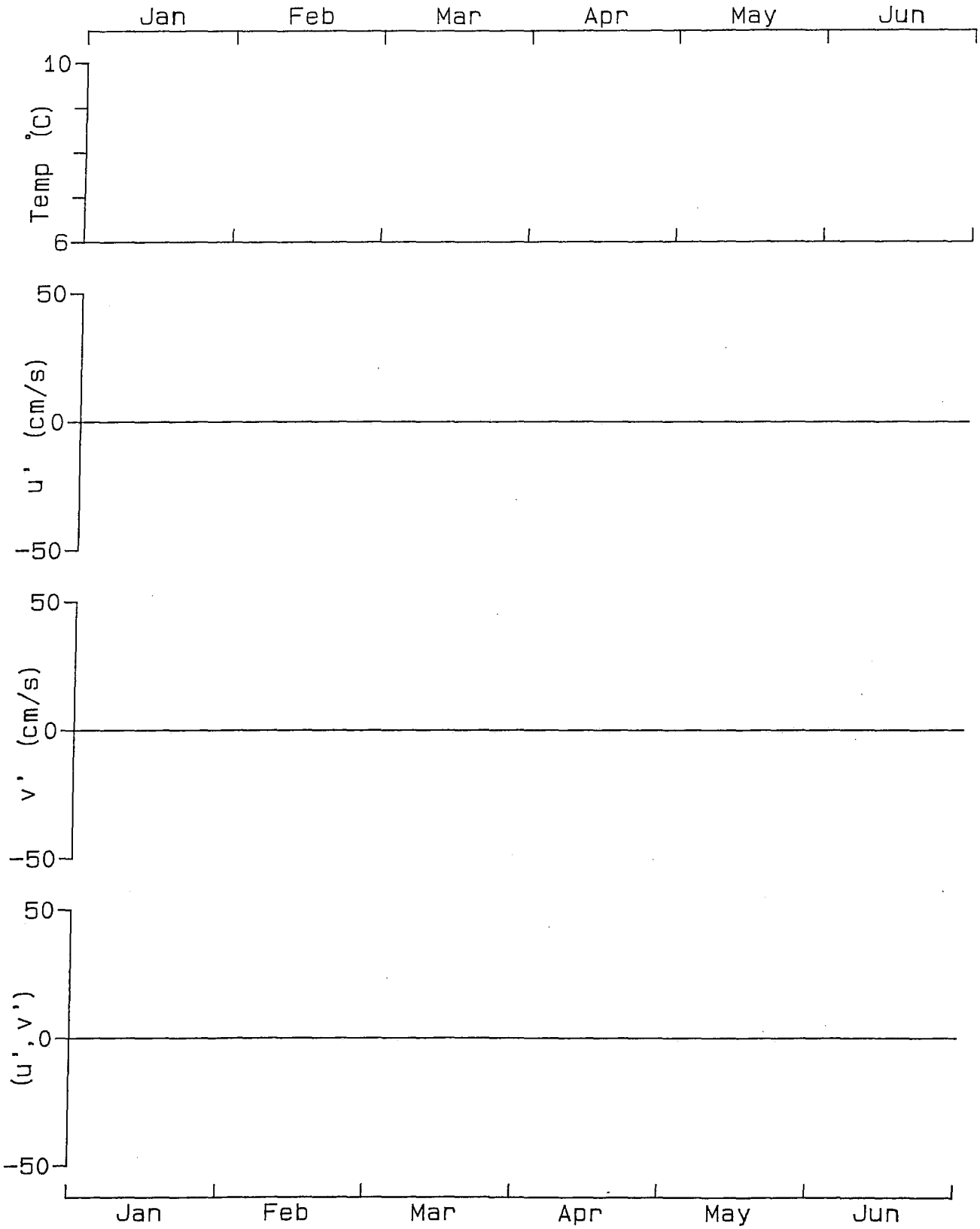
1982
C.S.J./50m (3)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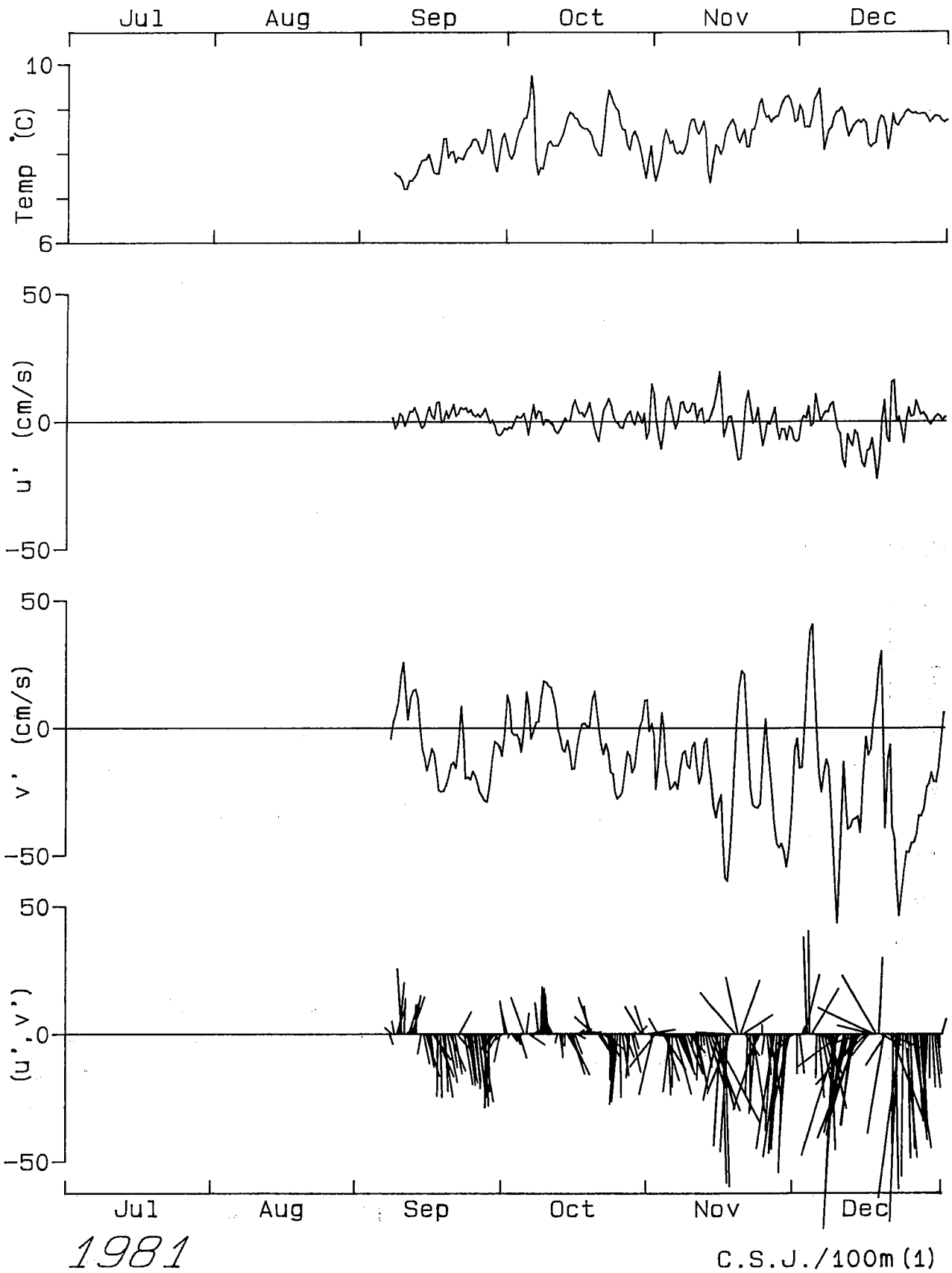
1981
C.S.J./100m (0)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Temp °(C)
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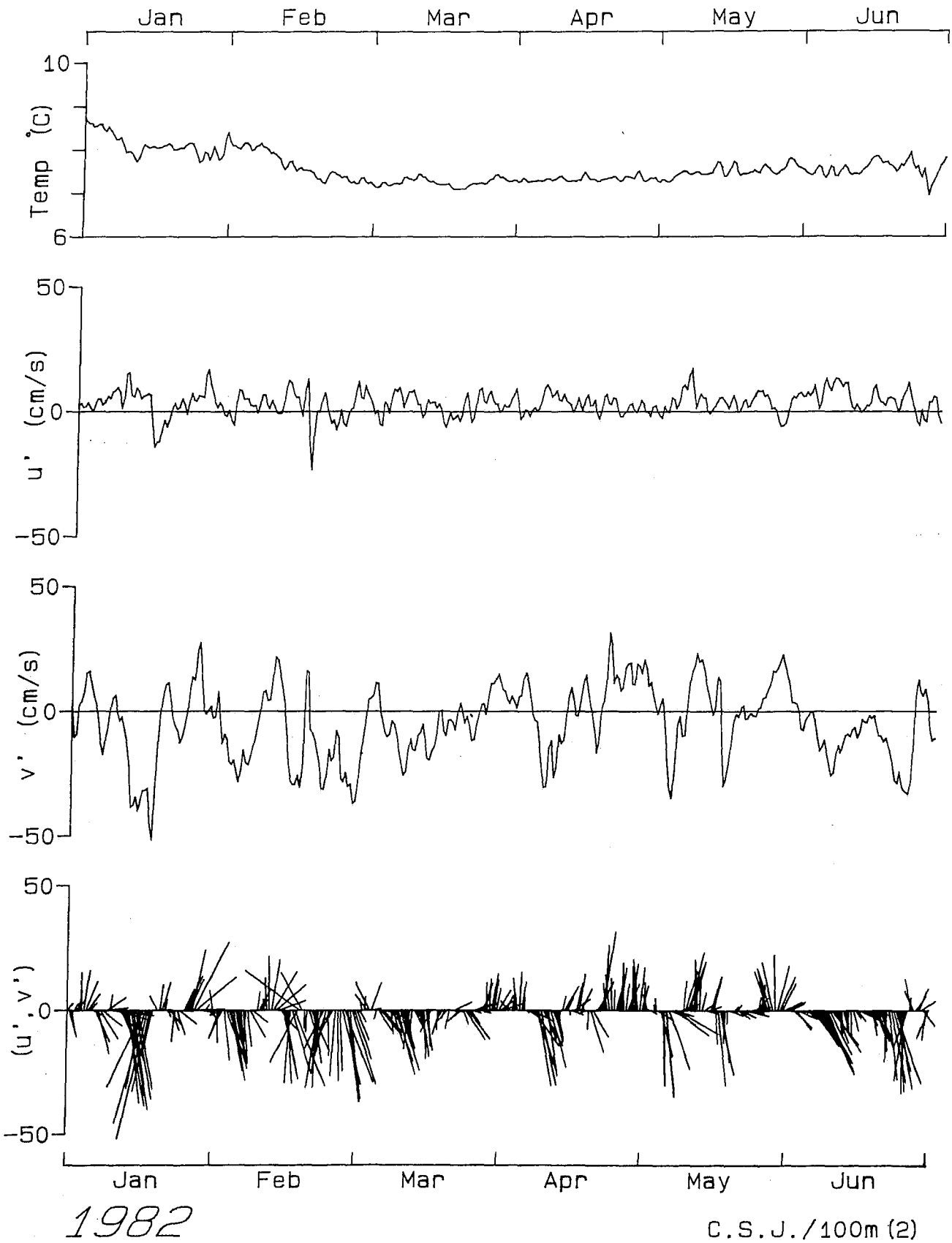
1981
C.S.J./100m(1)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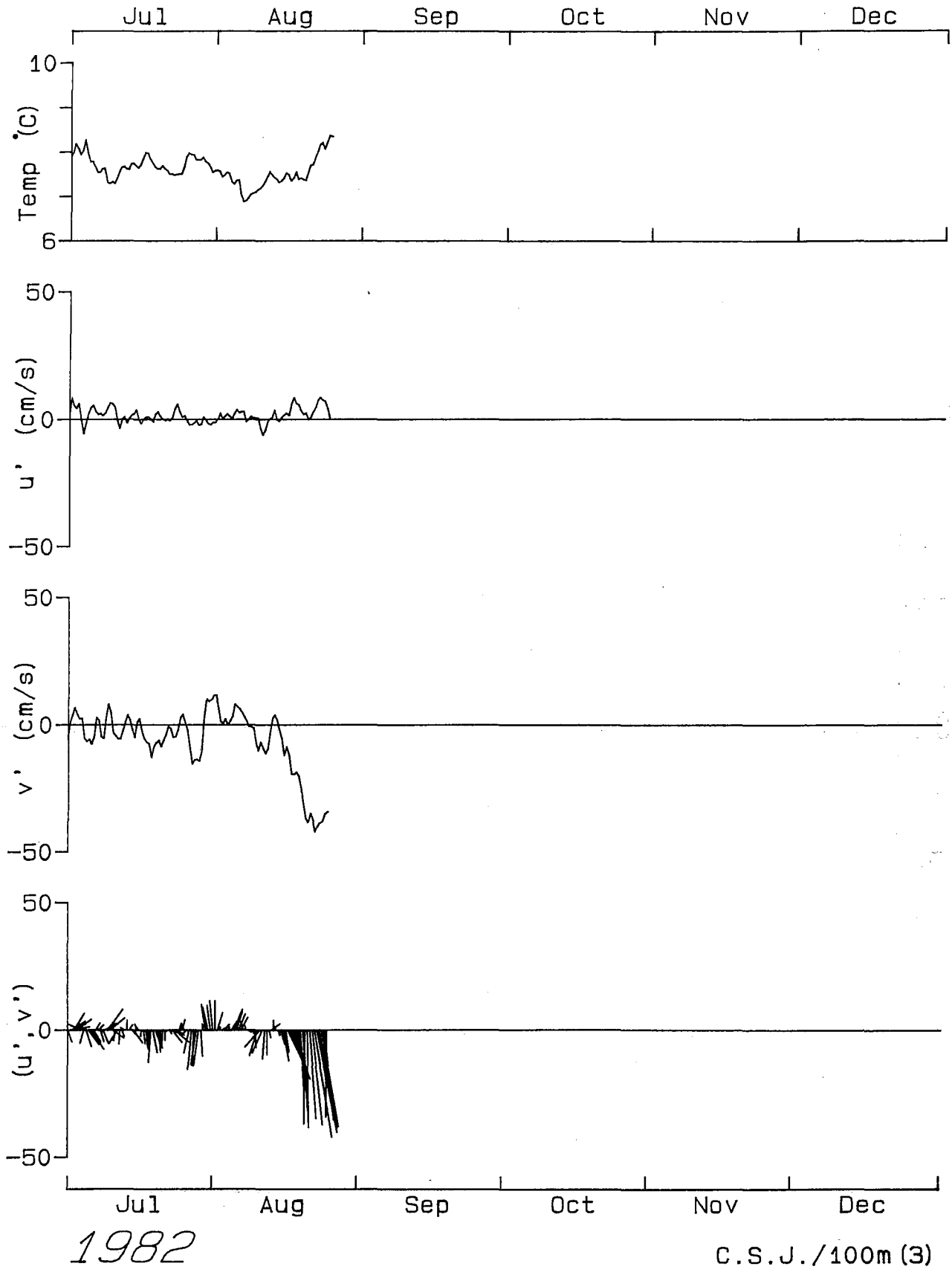
1982
C.S.J./100m (2)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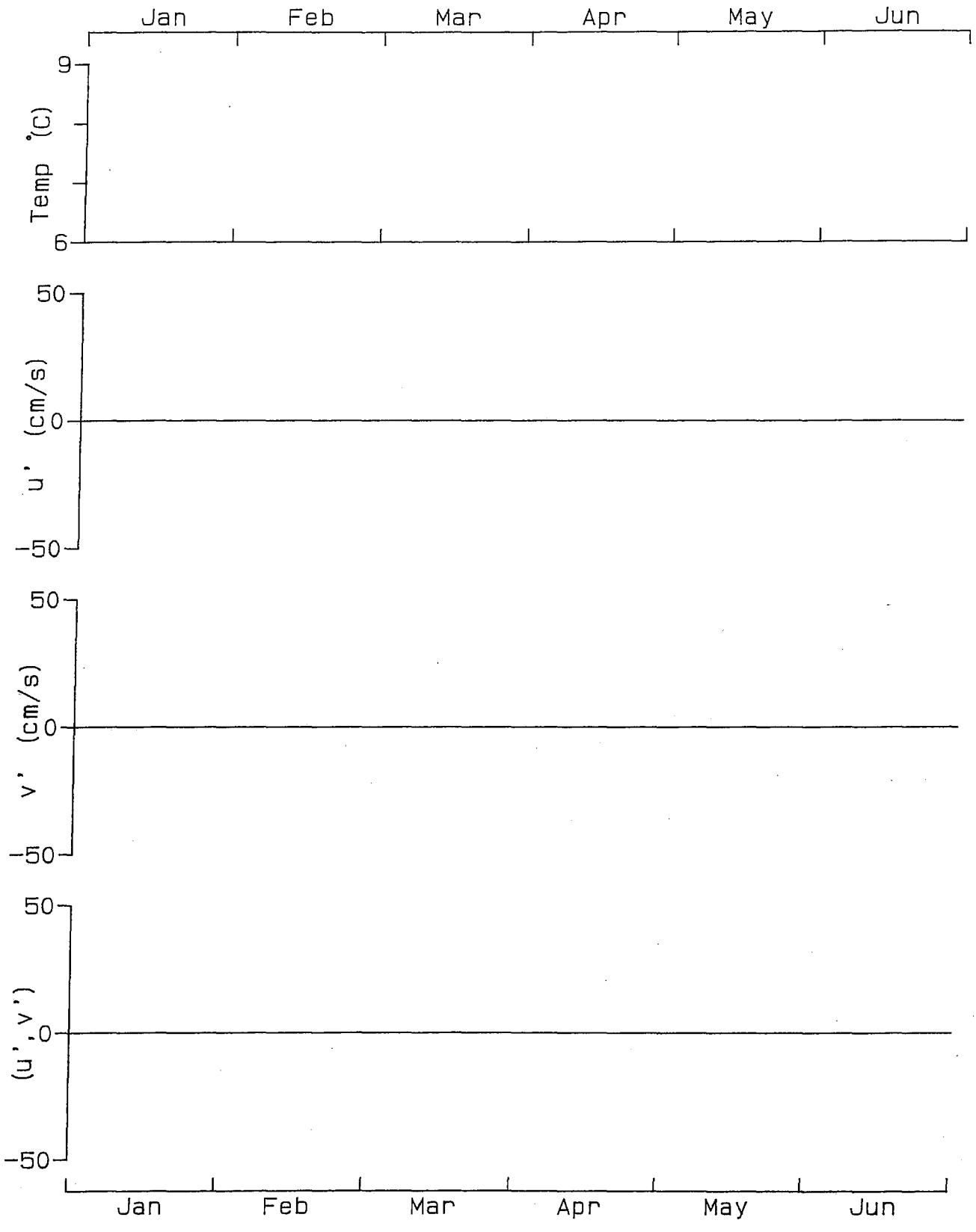
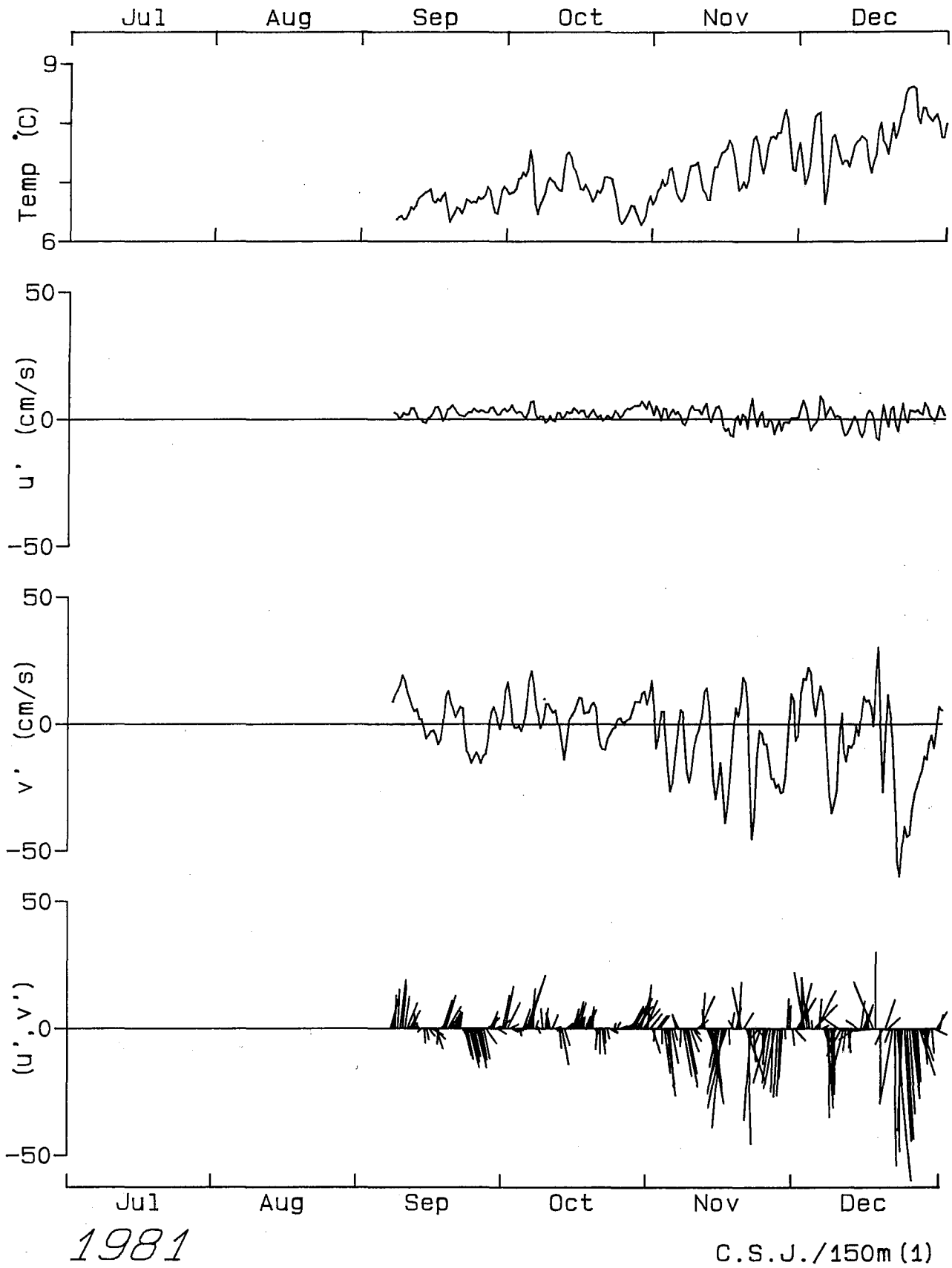
1982
C.S.J./100m (3)



1981

C.S.J./150m (0)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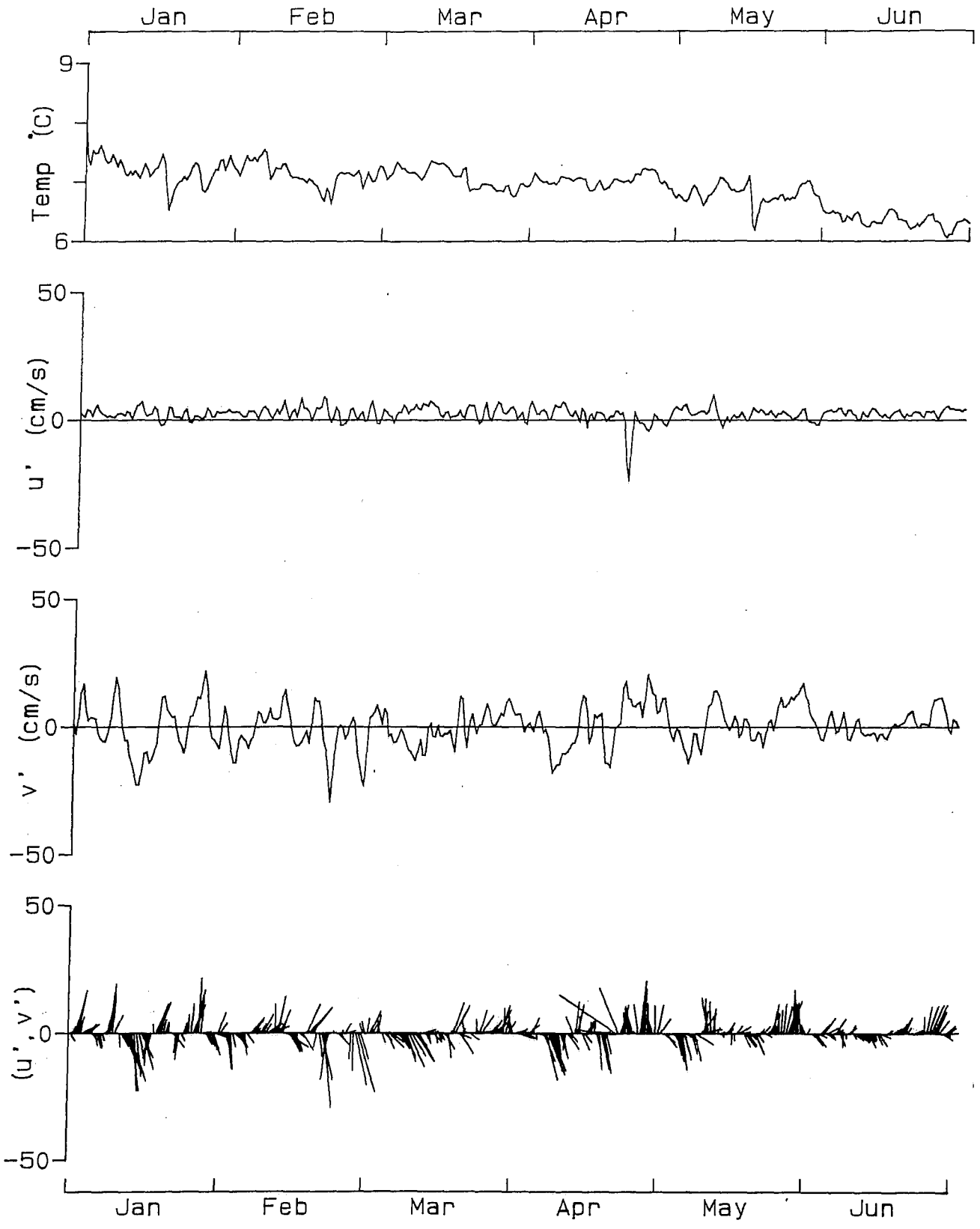
1981
C.S.J./150m (1)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Temp °(C)
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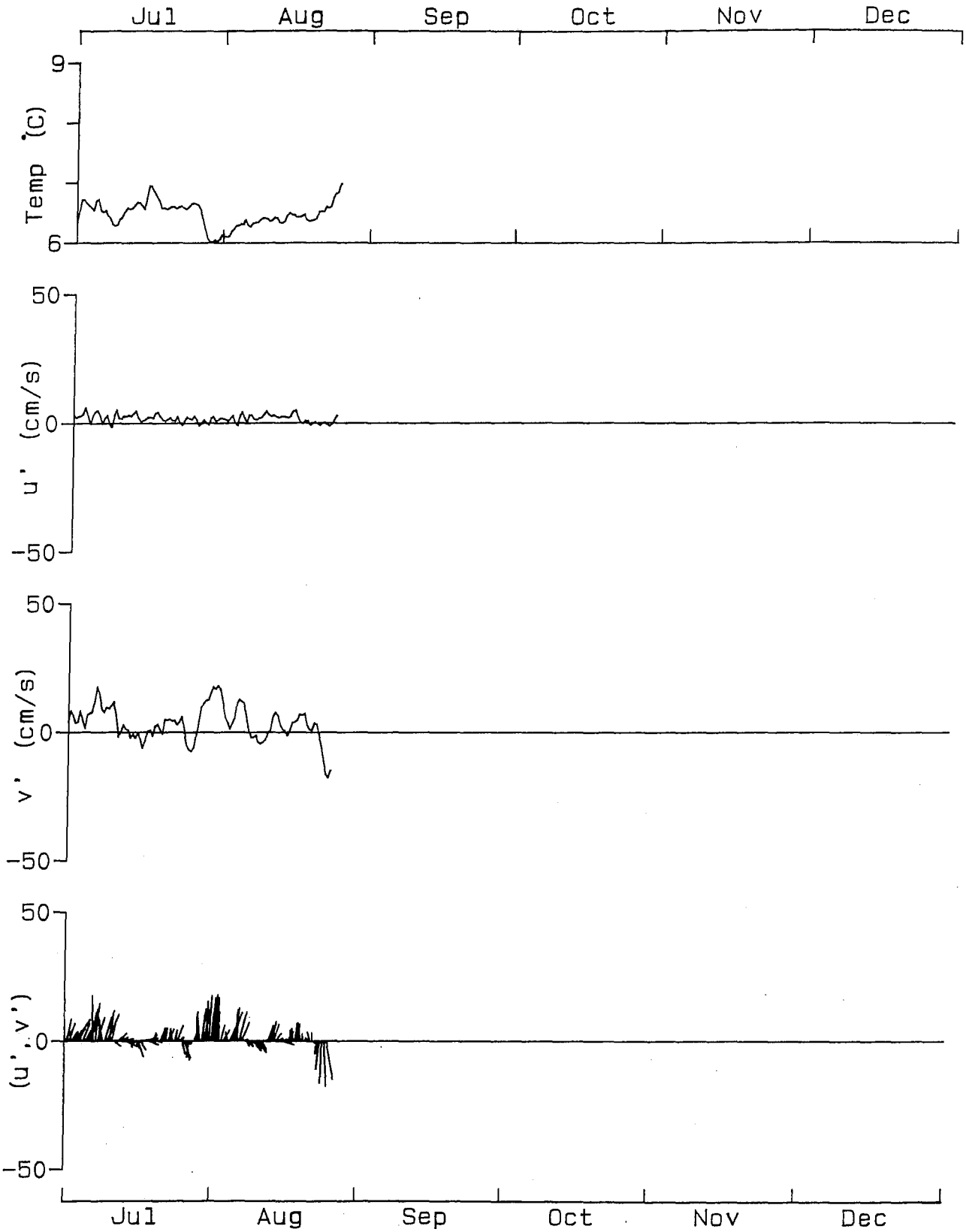
1982
C.S.J./150m (2)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Temp °(C)
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1982
C.S.J./150m (3)