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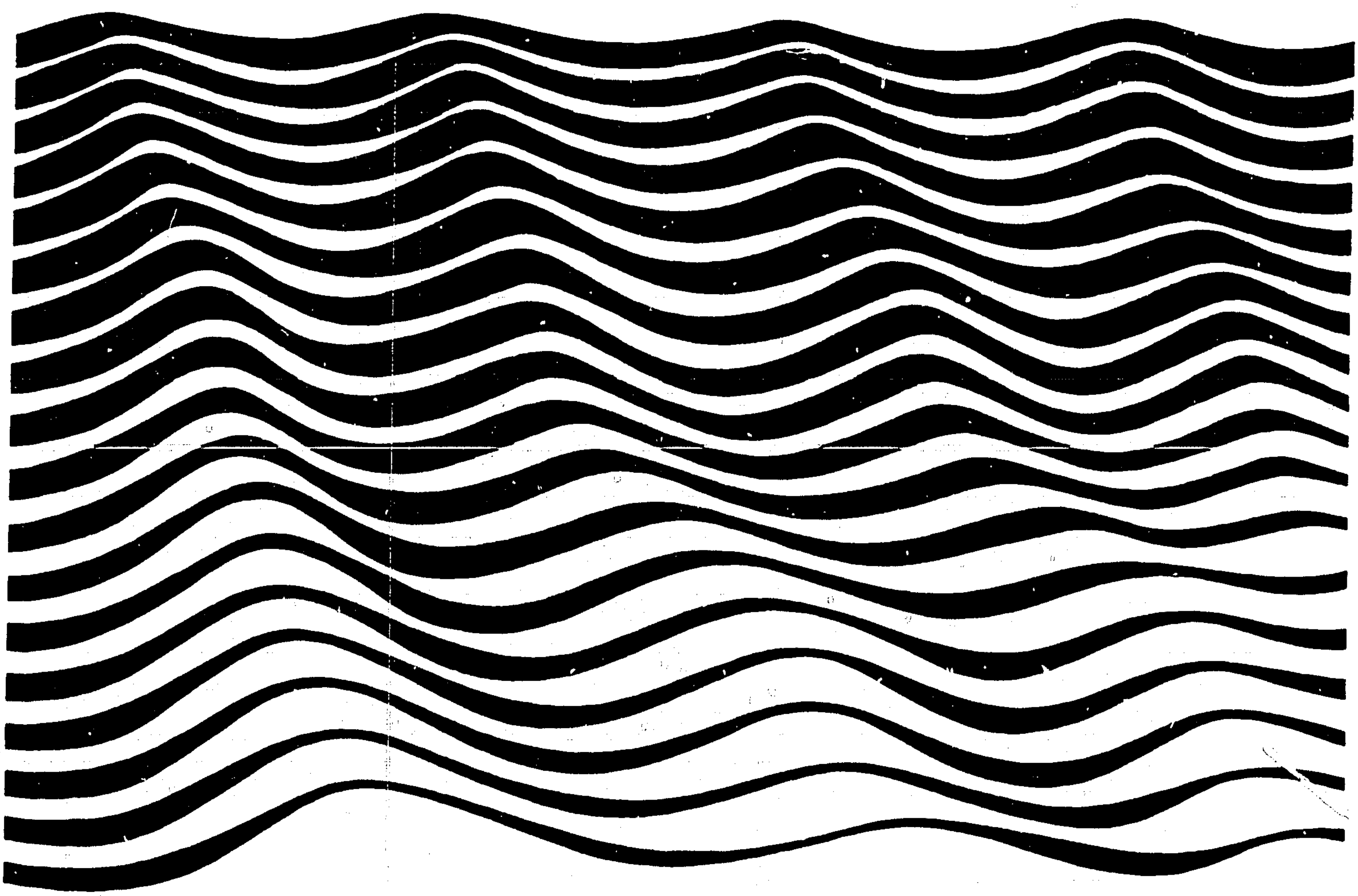

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11.	An intercomparison of some current meters, report on an experiment at WHOI Mooring Site "D", 16-24 July 1967 by the working group on Continuous Current Velocity Measurements; sponsored by SCOR, IAPSO and Unesco	1969	WG 21
12.	Check-list of the fishes of the north-eastern Atlantic and of the Mediterranean (report of the third meeting of the Committee, Hamburg, 8-11 April 1969)	1969	—
13.	Technical report of sea trials conducted by the working group on photosynthetic radiant energy, Gulf of California, May 1968; sponsored by SCOR, IAPSO, Unesco	1969	WG 15
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16	Sixth report of the joint panel on oceanographic tables and standards, Kiel, 24-26 January 1973; sponsored by Unesco, ICES, SCOR, IAPSO	1974	WG 10
17.	An intercomparison of some current meters, report on an experiment of Research Vessel Akademik Kurchatov, March-April 1970, by the working group on Current Velocity Measurements; sponsored by SCOR, IAPSO, Unesco	1974	WG 21

Unesco technical papers
in marine science 17

An intercomparison of some current meters, II

Report on an experiment
carried out from the
Research Vessel
Akademik Kurchatov,
March - April, 1970,
by the Working Group
on Continuous Current
Velocity Measurements.

sponsored by
SCOR, IAPSO, and Unesco

SCOR Working Group 21

Unesco 1974

TABLE OF CONTENTS

		Page
	Abstract	2
	Acknowledgements	3
1.	Introduction	4
2.	Description of Instruments	5
3.	_Akademik Kurchatov_ Cruise	13
4.	Instrument Performance	19
5.	Data Processing	21
	a. Preparation and editing	21
	b. Standard processing	23
6.	Instrument Comparison	25
	a. Overall performance	25
	b. Sensor response	30
	c. Spectral characteristics	40
	d. Cross-spectral characteristics	51
7.	Conclusions and Recommendations	56
	References	60
Appendix:	Data Plots	

An intercomparison of some current meters, II.

ABSTRACT

Six types of recording current meter (Alexaev, Bergen, Braincon, Geodyne, LSK and Plessey) were compared during the U.S.S.R. *Polygon* experiment from the research vessel *Akademik Kurchatov*. The instruments were set on four moorings arranged in a rough square with approximately 10 km. on a side, centered about 16° 35'N, 32° 50'W for a twelve-day period in late March, 1970. Instruments were arranged in pairs or triads at depths of 50, 200, and 1000 m. One Alexaev instrument was included in each instrument pair or triad.

From the twenty-six records obtained, it was concluded that while the recorded currents were similar in the mean, there were large differences in the response to time-varying currents. Some of these differences are understandable in terms of known instrument characteristics, but two in particular are not. A systematic difference in incremental speed response was noted between Alexaev instruments and other types. The high-frequency energy density for LSK instruments was significantly lower than for other instruments. Further study of these differences is recommended.

Acknowledgements

The working group is indebted to the sponsoring international organizations, SCOR, IAPSO and UNESCO, for initiating the work and contributing essential funds in support of this experiment,

to the Academy of Sciences of the U.S.S.R., for permission to take part in the cruise of the Akademik Kurchatov,

to the parent institutions of its members, for making equipment funds and manpower available without which neither the experiment at sea nor the analysis of the data could have been attempted.

Many people, too numerous to name individually, contributed to the work described here. To all of them, the working group offers its grateful thanks.

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F. Webster

1. Introduction

Working Group 21 on Continuous Velocity Measurements was established by SCOR in 1966 with the following terms of reference: To design, and propose means for carrying out, an intercomparison at sea of the principal current measuring systems now employed for the continuous recording of current velocity on moored stations.

The Working Group decided that the most effective way of meeting the terms of reference was to carry out an intercomparison experiment at sea. An experiment was done in July, 1967, at Site "D" (39° 20'N, 70°W) using the facilities of the Woods Hole Oceanographic Institution. The results of that experiment have been reported as a UNESCO Technical Paper in Marine Science (SCOR W/G 21, 1969).

In the July, 1967 experiment, five types of recording current meters were compared during an eight-day period. One instrument of each type was installed near 500 m depth on each of three moorings. The instrument types used were: Geodyne film-recording meter, Geodyne tape-recording meter, Bergen meter, Plessey meter, and Hydrowerkstätten Tiefenstrommesser.

It had been planned to include Alexaev current meters in the experiment, but unfortunately it was not possible to do so. In the report of the July, 1967 experiment it was recommended that the work should be completed by including Alexaev current meters in an intercomparison, at least comparing Alexaev instruments with Geodyne instruments.

An opportunity for further intercomparison arose in the Polygon experiment of the U.S.S.R. Academy of Sciences in the Eastern North Atlantic during early 1970. Members of the working group had an opportunity to discuss the possibility of further intercomparison at the ICES Symposium on Physical Variability in the North Atlantic held at Dublin, Ireland during 25-27 September, 1969 (SCOR, 1969). The Group met and proposed that an intercomparison experiment be made from the Research Vessel Akademik Kurchatov.

The Akademik Kurchatov planned to set out an array of Alexaev current meters as part of the Polygon experiment. It was proposed to set out four other types of current meters (Bergen, Braincon, Geodyne, and Plessey) to be paired with Alexaev current meters for comparison. The arrangements for the experiment were approved and the experiment was carried out aboard the Akademik Kurchatov largely as planned. A fortunate departure from plans was the addition of Warnemunde LSK current meters, four of which were added to the intercomparison array at the suggestion of SCOR.

2. Description of Instruments, Specifications and Calibration Procedures.

Table 2.1 gives details of sensors, dimensions, etc. of each instrument. Further information is given below.

ALEXAEV BPV's.

Two types of Alexaev meter were used in this experiment, one type(the BPV-2) was used at the 50 and 200 m levels and the other type at the 1000 m level. Both types are normally used from a steel bracket clamped rigidly to the mooring wire. The recording system is identical in each type, but the speed sensors differ in that the shallow version has a shielded paddle wheel with four flat blades whereas the other has a 4-cup, unshielded rotor. The rotors are magnetically coupled through the pressure case and drive a

TABLE 2-1

INSTRUMENT CHARACTERISTICS

	Alexaev BPV-2	Alexaev BPV-6	Bergen RCM-4	Braincon 381	Geodyne 850	LSK 801.1	Plessey MO 21
SPEED SENSOR:							
Type	shielded flat-bladed paddle wheel	unshielded 4-cup rotor	6-cup Savonius-like rotor	Savonius rotor	Savonius rotor	propeller in tube	propeller
Diameter (cm.)	16.9		10.5	10.5	16	12	11
Height (cm.)	11.5		7	8.6	17		8
Axis	vertical	vertical	vertical	vertical	vertical	horizontal	horizontal
Threshold (cm./sec.)	2.0	2.0	2.6	2.0	1.8	4.0	3.6
Digitizing Interval (cm./sec.)	1.0	1.0	0.3	1.0	0.5	1.3	0.4
Sample Duration	3 min.	3 min.	15 min.	14 min.	29 each 2.47 min.	9.8 min.	15 min.
VANE:							
Type	double trailing fin	double trailing fin	trailing fin	trailing fin	freely rotating	crossed trailing fins	crossed trailing fins
Dimensions (cm.)	35 × 49	(see Fig. 3.1)	95 × 37	56 × 61	9.1 × 17.2	32 × 30 32 × 30	40 × 60 30 × 17
Digitizing Interval	5°	5°	0.351°	2°	2.81°	5°	0.351°
Recording Medium	paper strip	paper strip	digital magnetic tape	analog 16 mm. film	digital magnetic tape	waxed paper	digital magnetic tape

gearbox with a reduction ratio of 20:1. The output shaft is connected by a mechanical clutch to a disk with embossed numbers on it at the start of every (3 min) recording cycle. At the end of the cycle a similar concentric embossed disk which acts as a compass card is clamped and a print is made on the paper strip of the embossed numbers adjacent to a reference mark. After the printing the clutch to the speed disk is disengaged and the disk returns to its zero position ready for the next record to be taken.

The speed sensor is mounted at the base of the vertical cylindrical pressure case, the case being aligned in the current by two flat vertical fins. The speed disk is calibrated at the factory at the time of manufacture and there is provision for adjusting the recorder orientation for magnetic variation so that the direction values are given relative to true north. The current meter compasses used in the experiment had damping to reduce oscillations.

BERGEN RCM-4

The instrument has been described by Aanderaa (1964) and by Dahl (1969). The current speed sensor is a Savonius-like rotor mounted on top of the pressure case. The revolutions of the rotor are transferred by a magnetic coupling through the pressure case to a 6000:1 gearbox, the output shaft of which is connected to a precision potentiometer. The position of the wiper of the potentiometer is sensed once every 15 minutes by a bridge circuit and the resistance value is converted to a 10-bit binary number by an electromechanical encoder. The speed value is computed by taking the difference in successive encoder values. The instrument is aligned in the current by a flat vertical fin and the current direction is measured by finding the orientation of the pressure case relative to magnetic north once every 15 minutes. The compass consists of a pair of bar magnets attached to an electrical contact. This is clamped electromagnetically once every 15 minutes so that the contact touches a potentiometer. The resistance value is measured in the same way as for the speed. The compass is a sealed, oil-filled unit.

The time series is made up of the mean of two successive speed values combined with the direction recorded at the end of the first of the two speed encoding periods. In this way, the direction value is taken at the midpoint of the corresponding speed value.

In each cycle the water temperature, measured by a thermistor, and a reference number are also recorded.

Each instrument used in the experiment had been calibrated by towing in a tank and by measuring the encoded values of direction for 10° increments in orientation. Each instrument had a linear calibration line.

The instruments were standard production models with the exception of the clocks.

The current meter is normally mounted directly in the mooring wire and is pivoted at the centre of the suspension bar with freedom to tilt up to 30° from the horizontal in any orientation. In the experiment described here the Bergen instruments were suspended by short wire straps from large brackets clamped rigidly to the mooring wire (Fig 3-1).

BRAINCON 381

Current speed is measured by a Savonius rotor of 11 cm diameter turning on a vertical axis. Rotor turns are counted over a 15-minute interval. The output is in the form of an arc on film; the length of the arc is proportional to the number of rotor revolutions. The arc length, θ_n, assigned to the n^{th} film frame was calculated from the starting (S) and ending (E) positions of sequential frames by

$$\theta_n = \frac{(S_n - S_{n+1}) + (E_{n-1} - E_n)}{2} .$$

This procedure eliminates the need to know the arc length of the recording system itself or the film advance time. The rotor calibration data supplied by the manufacturer in April, 1970 was fitted at Bedford Institute by the equation:

$$V = .4169R + 4.3312 - 3.356e^{-.0356R}$$

where V = speed, in cm/sec

and

$$R = \frac{\theta \cdot G}{\Delta t \times 360} \text{ rev. per minute,}$$

where G = gear box reduction factor (7200 for this experiment), and Δt = sampling interval (15 min here).

The direction is measured as the orientation of the pressure case relative to magnetic north. The pressure case is aligned by a flat vertical fin 61 cm high and 56 cm long. The direction is again recorded as an arc on film, the density of the arc at each angle varying according to the frequency of occurrence of values at that angle. Non-linearities in the compass calibration were taken into account.

The film advance is controlled by an Accutron timer. Time is recorded on the film by photographing an independent watch face (this is not standard in Braincon instruments).

Instrument tilt is measured, but for the records used here, the tilt values are below the measurement threshold of 3°.

GEODYNE 850

The instrument is housed in a cylindrical case about 1.8 m long. At the lower end are a Savonius rotor of 16 cm diameter turning on a vertical axis and a vane turning on a vertical axis.

The sampling procedure is to obtain a set of 29 samples of speed and direction during 2.5 minutes once every 15 minutes. For speed, sixteen pulses are generated by each turn of the rotor and these pulses are counted over the nominal 5-second intervals. Speed is derived from the rotor pulses using the formula:

$$\text{Speed (mm/sec)} = 379.4 \times \frac{\text{Rotor count}}{16 \times \Delta t} + 17.9$$

where Δt = time of count in seconds. This formula is derived from the calibration curve of Fofonoff and Ercan (1967). The final values used as 15-minute samples are obtained as vector averages over the 2½-minute burst of samples.

The direction is measured by taking the sum of the compass and vane readings at five-second intervals. The compass gives the orientation of the case with respect to the earth's magnetic field. Since the instrument case is symmetric, the case is free to rotate. Both compass and vane are encoded in seven-level-binary so that 360° corresponds to 128 divisions, and the resolution is about 2.81°.

A time word derived from a crystal clock is written on the magnetic tape with every group of samples. The same clock paces the stepping motor for the tape advance. The worst-case clock inaccuracy does not exceed one second per day.

LSK 801.1

The LSK current meter is mounted directly on the mooring line and has a horizontal case 1.4 m long and about 11 cm in diameter with a propeller on the forward end and both vertical and horizontal fins, each about 30cm square, on the rearward end.

The propeller turns are counted over a 9.8-minute interval. The values are inscribed on a waxed-paper tape with a 4 cm scale width corresponding to 200 cm/sec. Speed resolution is about 1.3 cm/sec with a rotor threshold of 4 cm/sec.

A compass reading of the case orientation is taken every 4.9 minutes. Directions are given in 5° increments, and the waxed paper tape record is 1.8 cm wide corresponding to 360°.

A timing pulse is put on the record every four hours by a clock with a nominal error of less than 10 minutes/month. This clock also drives the waxed paper take-up spool.

PLESSEY MO21

The Plessey recording current meter design is derived from the Bergen meter and employs a similar recording system; the mechanical design, however, differs considerably.

The Plessey meter uses a propeller as a speed sensor, and the pressure case is mounted horizontally and is suspended from a bracket clamped to the mooring wire. Unlike the Alexaev brackets those of the Plessey meter are free to rotate about the wire. The pressure case is not restrained to remain horizontal but is stabilized by small horizontal trimming surfaces on the fin and by a weight. The registration both of speed and direction are identical with that of the Bergen meter, but in the instruments used in this experiment the additional temperature channel was not used.

3. Akademik Kurchatov Cruise

In addition to Dr. K. A. Chekotillo of the Institute of Oceanology, U.S.S.R. Academy of Sciences, other scientists participating in the experiment aboard the Soviet Research vessel Akademik Kurchatov were:

E. Francke, Institut für Meereskunde, G.D.R.

W. J. Gould, National Institute of Oceanography, U. K.

R. Heinmiller, Woods Hole Oceanographic Institution, U.S.A.

D. J. Lawrence, Bedford Institute, Canada

G. Plüschke, Institut für Meereskunde, G.D.R.

C. K. Ross, Bedford Institute, Canada

W. Zenk, Institut für Meereskunde, F.R.G.

The visiting scientists with their equipment joined the Akademik Kurchatov at Warnemünde, G.D.R., and Dover, U. K., in early March, 1970. The ship was on her 7th Oceanographic Cruise, under the leadership of Dr. G. N. Ivanov-Frantzkevich. Mooring operations were the responsibility of Dr. Chekotillo.

During the passage to the area of the polygon experiment, west of the Cape Verde Islands, the instruments were prepared for incorporation in the array. It is the practice on the Soviet moorings to have a continuous wire with the current meters suspended from brackets clamped to the wire. This method of suspension was used for all of the instruments. Brackets for the Bergen meters had been made at N.I.O., and the LSK and Plessey instruments could be suspended in their normal manner. All the other instruments were hung from standard or modified Alexaev brackets. Weights of 15 kg. were hung beneath the Bergen and Braincon instruments in order to stabilize them during lowering. A stand-off bar was mounted between the lower end of the Geodyne meters and the mooring wire in order to stop chafing (Fig. 3.1).

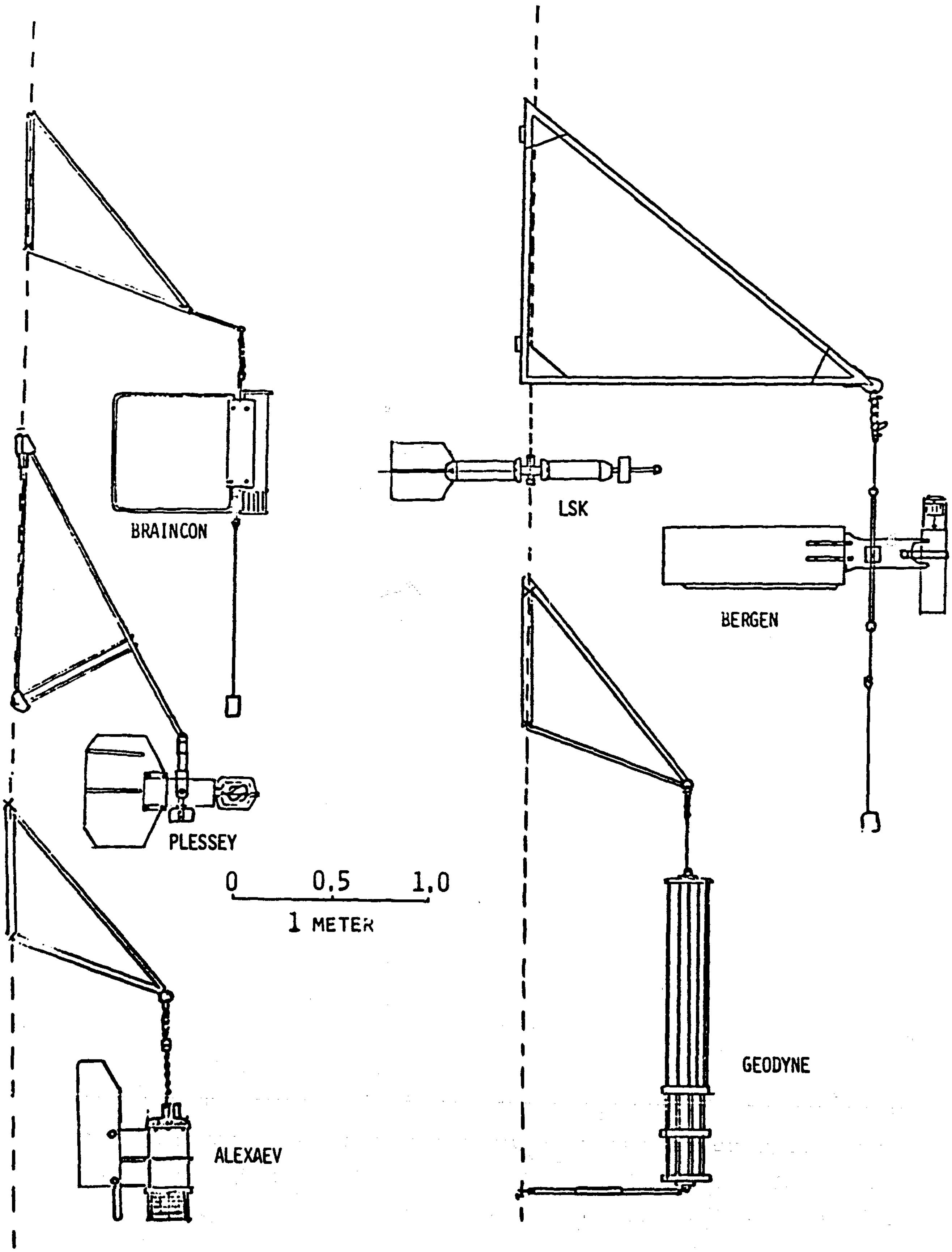


Figure 3-1 Sketch of instruments used in the intercomparison experiment showing means of mounting and relative instrument configurations.

For convenience during the launching operation and for increased safety of the instruments, the proposed depths of 25, 100 and 1000 m for the intercomparison were changed to 50, 200 and 1000 m. At each of these depths one of the visiting meters was paired with an Alexaev meter. One of the four LSK instruments was paired with one of each of the visiting instruments (Table 3.1). In each of the groupings the meters were positioned to give a 4 m vertical separation of speed sensors.

The Alexaev BPV meters were transferred at sea from the Research Vessel Dmitri Mendeleev which had brought them to the area earlier.

The moorings were laid on 20-21 March, 1970 at the corners of a rough square, having sides about 10-15 km (Figure 3.2) centered on 16° 33'N, 32° 49'W. All moorings had surface buoyancy. The wire had a scope of about 1% and was made up from differing diameters between 11.5 and 5.3 mm. During the 12-day period of the intercomparison the Akademik Kurchatov was engaged in other oceanographic work within the area of the polygon and so it was not possible to keep a constant check on the moorings. When the buoys were recovered it was found that moorings 3 and 4 had suffered some damage. A steel tube had fractured in each of the surface buoys and in the case of buoy 4 this had resulted in its floating upside down with the mooring attached by a pick-up wire. Fortunately all the moorings and instruments were recovered intact. On April 7th, the Akademik Kurchatov berthed in Monrovia, Liberia where the visiting scientists and their equipment left the ship.

TABLE 3-1
MOORINGS AND INSTRUMENTS

Mooring I 16°36.9N, 32°51.1W

Set: 1312/20-III-70 Recovered: 1155/2-IV-70
Water depth: 5180 m. Wire length: 5250 m.

Data name	Instrument	Depth
AK 11	Bergen B-155	46
AK 12	Alexaev 9412	50
AK 13	LSK-3	192
AK 14	Geodyne M-203	196
AK 15	Alexaev 8303	200
AK 16	Plessey 536	996
AK 17	Alexaev 9435	1000

Mooring II 16°30.2N, 32°55.7W

Set: 2225/20-III-70 Recovered: 1611/2-IV-70
Water depth: 5190 m. Wire length: 5250 m.

Data name	Instrument	Depth
AK 21	Plessey 532	46
AK 22	Alexaev 3267	50
AK 23	Braincon 124	196
AK 24	Alexaev 3323	200
AK 25	LSK-0	992
AK 26	Bergen B-153	996
AK 27	Alexaev 9434	1000

Mooring III 16°35.6N, 32°44.2W

Set: 1142/21-III-70 Recovered: 1948/2-IV-70
Water depth: 4990 m. Wire length: 5150 m.

Data name	Instruments	Depth
AK 31	LSK-10	46
AK 32	Alexaev 9071	50
AK 33	Braincon 134	54
AK 34	Alexaev 4242	200
AK 35	Bergen B-156	204
AK 36	Alexaev 9429	1000
AK 37	Goedyne M-213	1004

Mooring IV 16°29.0N, 32°46.1W

Set: 1805/21-III-70 Recovered: 1308/3-IV-70
Water depth: 5170 m. Wire length: 5260 m.

Data name	Instrument	Depth
AK 41	Alexaev 8352	50
AK 42	Geodyne M-212	54
AK 43	LSK-8	196
AK 44	Alexaev 8348A	200
AK 45	Plessey 534	204
AK 46	Alexaev 9440	1000
AK 47	Braincon 127	1004

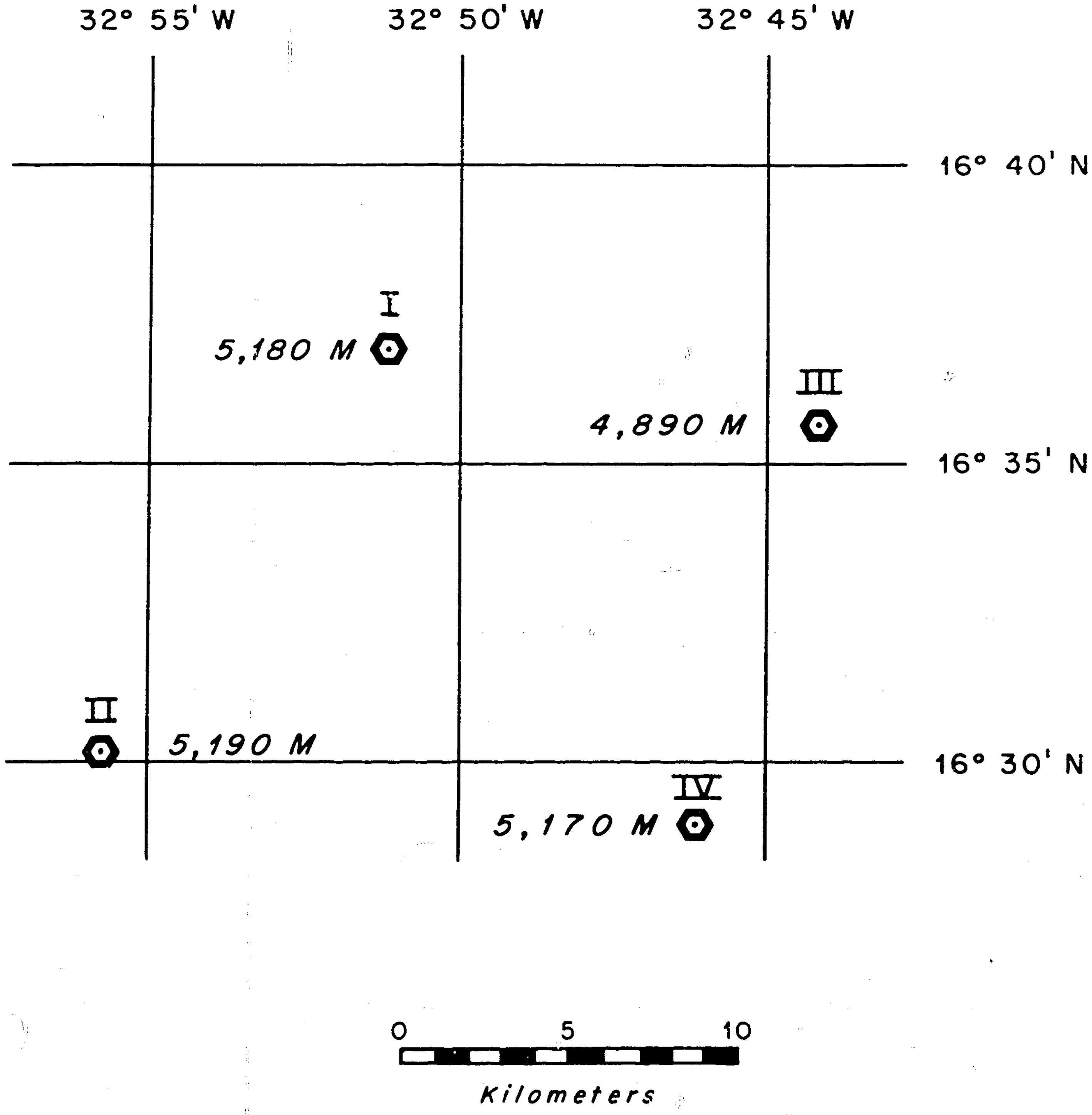


Figure 3-2 Chart of intercomparison experiment showing relative position of moorings.

Copies of all data obtained were sent to the Woods Hole Oceanographic Institution for processing by the end of September, 1970. K. A. Chekotillo (U.S.S.R.) participated in a detailed analysis of the data from mid-October, 1970 to February, 1971. For a two-week period in December, 1970 W. J. Gould (U.K.) and D. J Lawrence (Canada) joined in a working session to draft the outline and most of the substance of this report. The draft report was then circulated for comment to other members of the Working Group. The final form of the report was agreed upon at a meeting of the Working Group during the 15th General Assembly of the I.U.G.G. in Moscow in August, 1971.

At the Woods Hole Oceanographic Institution, the data analysis was supervised by F. Webster. J. Maltais prepared a number of special computer programs for the purposes of the analysis. S. Tarbell and C. Harlow carried out the basic processing and prepared many of the figures.

4. Instrument Performance

The instruments are reviewed below by type. The data files are referred to by their numbers. The numbering system adopted is as follows:
The first digit refers to the mooring number. The second digit refers to the position of the instrument on the mooring, counting down from the top. All data files are prefixed by the letters "AK".

			Time error on recovery (sec.)
(1) Alexaev (ALX)			
AK	12	Ran for only 6 days	uncertain
AK	15	Performed normally	+ 360
AK	17	Performed normally	+ 360
AK	22	Performed normally	- 120
AK	24	Ran for only 4 days	uncertain
AK	27	Performed normally	- 60
AK	32	Performed normally	+ 180
AK	34	Performed normally	+ 180
AK	36	No data	
AK	41	Ran for only 4 days; abnormal decrease of speeds	uncertain
AK	44	Performed normally	+ 120
AK	46	Performed normally	- 60
(2) Bergen (BER)			
AK	11	Performed normally	+ 20
AK	26	Performed normally	+ 60
AK	35	Performed normally (Replaced rotor during launch)	+ 75
(3) Braincon (BRA)			
AK	23	Performed normally	- 10
AK	33	Data not readable. Film cartridge misaligned	
AK	47	Performed normally	+ 57

			Time error on recovery (sec.)
(4) Geodyne (GEO)			
AK	14	Performed normally	- 6
AK	37	Performed normally	- 9
AK	42	Performed normally	- 5
(5) LSK			
AK	13	One of the 8 propeller blades was missing on recovery. Considerable wear of meter case against wire clamp.	uncertain
AK	25	Performed normally	+ 80
AK	31	Performed normally	+ 505
AK	43	Performed normally	+ 120
(6) Plessey (PLE)			
AK	16	Part of tail fin was missing on recovery. Compass stuck almost entire time	- 7
AK	21	Compass stuck for 30 hours	- 167
AK	45	Compass stuck for last 6 days	- 326

The external appearance of the instruments was good on recovery. Corrosion was generally slight. Goose barnacles (lepas) were growing on the 50-meter instruments but did not appear to affect their operation. All rotors and propellers were turning freely.

5. Data Processing

(a) Preparation and Editing

The records from all of the instruments were processed at their "home laboratories" by the procedures normally employed by each of the participants. An outline of the preliminary processing is given below.

ALEXAEV

The speed and direction values were read from the printed paper tape and entered onto special forms aboard the Akademik Kurchatov immediately after instrument retrieval. The numbers were checked for accuracy at the Institute of Oceanology, U.S.S.R. Academy of Sciences in Moscow; the data were not edited. A summary of the data was typed, checked, and mailed to Woods Hole.

BERGEN & PLESSEY

The 1/4" magnetic tapes from the Bergen instruments were read in Bergen, Norway by the manufacturer. The Plessey records were read at the Fisheries laboratory, Lowestoft, U. K. Data from both types of instruments thereafter were processed at the National Institute of Oceanography, U. K.

The processing procedure consisted of the application of calibration equations to the digital values of speed, direction and temperature received from the tape readings. Any obvious errors from readings taken in the rotor potentiometer dead-space were replaced by a linear interpolation. The edited data were sent on computer magnetic tape to Woods Hole for further processing.

BRAINCON

The Braincon films were processed and read at the Bedford Institute. The directions were taken as those indicated by the densest part of the exposed arc on each film frame. The arc lengths were often very great, indicating a large spread of directions. In one of the records several frames were exposed without the film moving on. These data were identified by the watch face and were corrected by linear interpolation.

A program was used to reveal gross errors introduced in the film reading process and the data were edited. The calibration curve used to convert the arc lengths to speeds was derived at the Bedford Institute, Canada, from data supplied by the manufacturer. The first set of data sent to Woods Hole was calibrated using an incorrect curve fit. The curve was re-fitted and a second computer magnetic tape was sent to Woods Hole with corrected speed. In the data processing the corrected Braincon data are identified with the suffix "A" (e.g., AK23A, AK47A).

GEODYNE

The Geodyne data were first translated at Woods Hole from the instrument tape cartridge onto a 7-track computer magnetic tape. This in turn was converted, and speed and direction were put into final form on a 9-track computer tape in the standard W.H.O.I. tape format (Maltais, 1969).

The data were not edited.

Geodyne directions were corrected to compensate for non-linearities in the compass calibration. When first applied, the compensation was used with the opposite sign to the correct one. After the error was found,the data were corrected by applying the non-linear compensation with the proper sign. The corrected Geodyne data are identified with the suffix "A" (e.g., AK4A, AK37A, AK42A).

LSK

The LSK samples were taken every 4.9 minutes for direction and every 9.8 minutes for propeller count. The waxed paper tape is driven by rotating the take-up spool at a constant speed, so that the paper advance changes from 91 mm./day to 125 mm./day. The inscribed paper record was smoothed by drawing a line through the end points of the pulses and then was automatically digitized at constant distances. The resulting "raw" series of values had a sample rate that varied between about 6 and 7 minutes. The 15-minute samples were obtained by taking the numerical average of the raw values between +7 and -7 minutes from the nominal sample time.

Listings of the raw and 15-minute samples were sent to Woods Hole. A few bad values were edited from the series at Woods Hole.

(b) Standard Processing

Following the preliminary processing, further data analysis was carried out on each record at the Woods Hole Oceanographic Institution. A standard set of computations were performed to obtain comparable derived results for each record.

A set of plots resulting from the standard processing are presented in the Appendix to this report (published as a separate volume). In this volume, progressive vector diagrams, vector distribution plots, and some spectral plots are presented. In the Appendix, time histograms, cartesian components, progressive vector diagrams, spectra, and statistics (STATS) are presented. Those plots are described there.

For the plots given in this volume, descriptions follow:

PROGRESSIVE VECTOR DIAGRAM

Progressive displacements are computed using cartesian (east and North) components derived from the original 15-minute speed and direction values. The beginning of the plot is marked with an asterisk (*). At the beginning of each day the position is marked with a cross (+) and the date is printed alongside. Note that, although a plot of this kind has the appearance of a particle trajectory, it is not. It is a virtual displacement computed by integrating a time series of vector measurements at a single point.

VECTOR DISTRIBUTION PLOT

The East and North components of each 15-minute value are plotted against each other. The resulting "scatter plot" is useful for identifying systematic instrument performance characteristics. Individual points are not generally identifiable. Where possible, Vector Distribution Plots have been computed over the standard time interval. Shorter records have been used but are flagged with a diagonal line.

SPECTRA

The spectral analysis program uses the Fast Fourier Transform algorithm over the 1024 15-minute values of the standard time interval. East and North components are separately analysed, then the resulting spectral estimates are averaged to give an estimate of horizontal kinetic energy in each frequency band.

With 1024 data points, a raw spectrum is first computed over 512 frequency bands. This has been then averaged over three adjacent frequency bands to provide increased stability of estimates. The final spectral estimates shown have a bandwidth of 0.0117 cycles per hour (cph) and 12 degrees of freedom.

6. Instrument Comparison

(a) Overall performance

METHOD OF COMPARISON

The results presented in this chapter begin with net properties determined over the duration of the experiment and go on to time-variable properties of progressively shorter scale. It is not possible to present these results without occasional reference to their interpretation.

As an introduction to the presentation of comparative instrument performance, Table 6-1 gives a brief summary of data quality.

In order to standardize the comparison between instruments all estimates involving averaging were made over a uniform time interval from 0000 hrs., GMT, 22 March, 1970
to 1559 hrs., GMT, 1 April, 1970.
This interval covers nearly the entire period that is common to all full data series and has the advantage that its length, with 1024 15-minute samples, is convenient for spectral analysis.

Table 6-2 summarizes speed and direction of the vector mean current over the uniform time interval. Only time series in which both direction and speed values are reliable over the uniform time interval are included. An exception is AK21(PLE) in which the compass stuck for about 30 hours. The mean current for AK21 is included parenthetically in Table 6-2.

MOORING I	MOORING II	MOORING III	MOORING IV	DEPTH (m.)
AK11 BER	AK21 PLE Compass stuck for 30 hours	AK31 LSK		46
AK12 ALX Short record 6 days	AK22 ALX	AK32 ALX	AK41 ALX 4-day record Abnormal decrease of speeds	50
		AK33 BRA No data	AK42 GEO	54
AK13 LSK Time base uncertainties				192
AK14 GEO	AK23 BRA		AK43 LSK	196
AK15 ALX	AK24 ALX Short record 4 days	AK34 ALX	AK44 ALX	200
		AK35 BER	AK45 PLE Compass stuck last 6 days	204
	AK25 LSK			992
AK16 PLE Compass stuck for nearly entire record	AK26 BER			996
AK17 ALX	AK27 ALX	AK36 ALX No data	AK46 ALX	1000
		AK37 GEO	AK47 BRA	1004

Table 6-1 Data Quality

MOORING I	MOORING II	MOORING III	MOORING IV	DEPTH (m.)
AK11 BER 15.8, 308°	AK21 PLE (18.8, 308°)	AK31 LSK 11.3, 294°		46
AK12 ALX ————	AK22 ALX 19.4, 306°	AK32 ALX 9.7, 300°	AK41 ALX ————	50
		AK33 BRA ————	AK42A GEO 15.6, 325°	54
AK13 LSK 7.9, 326°				192
AK14 A GEO 9.6, 324°	AK23A BRA 8.3, 302°		AK43 LSK 10.4, 305°	196
AK15 ALX 11.1, 324°	AK24 ALX ————	AK34 ALX 11.2, 320°	AK44 ALX 13.3, 303°	200
		AK35 BER 8.9, 325°	AK45 PLE ————	204
	AK25 LSK 3.8, 273°			992
AK16 PLE ————	AK26 BER 7.6, 294°			996
AK17 ALX 3.2, 334°	AK27 ALX 4.6, 293°	AK36 ALX ————	AK46 ALX 8.6, 301°	1000
		AK37A GEO 4.5, 333°	AK47A BRA 7.1, 299°	1004

TABLE 6-2

VECTOR MEAN CURRENT: CM/SEC

NET CURRENT DIRECTION

With one exception the difference in net direction between instruments in pairs and triplets is less than 6°. This is not much larger than the quantizing interval for direction in at least one member of each triplet or pair. The exception is AK25(LSK) which is about 20° less than the other two instruments at its depth. Because of probable differences in the pattern of currents over the array, comparisons between instruments on different moorings may not be valid. The net directions among all instruments range from 273° to 338°, making a total spread of 65°.

NET CURRENT AMPLITUDE

The net current amplitudes, summarized in Table 6-2, shows differences within each pair or triplet extending from 0.6 to 3.8 cm/sec. A bias in net current amplitude associated with any of the instruments is difficult to detect.

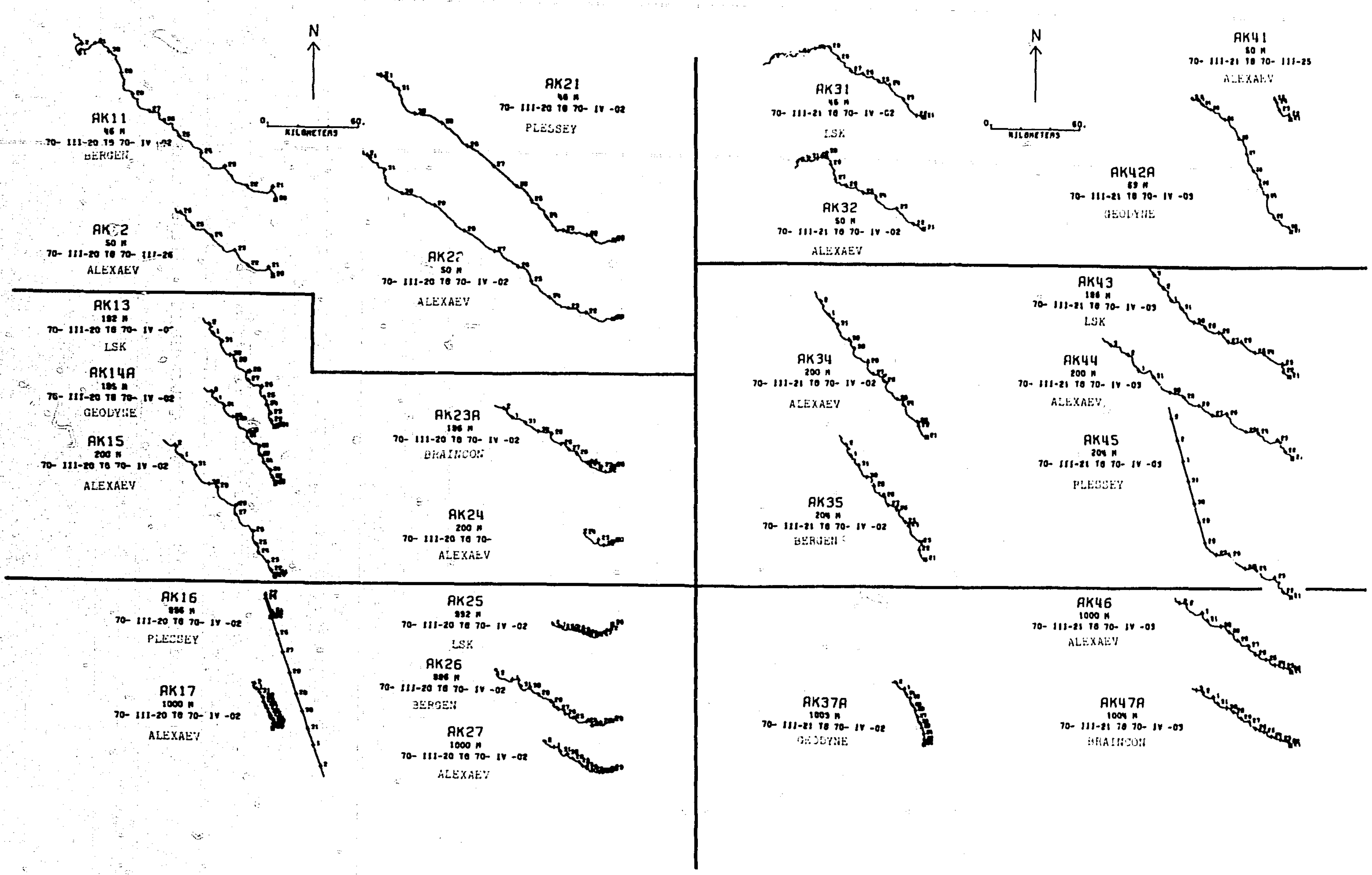
PROGRESSIVE VECTOR DIAGRAMS

The net current can be considered as the velocity associated with the displacement vector drawn directly from the beginning to the end of a progressive vector diagram. The progressive vector diagrams in Fig. 6-1 show that the current is not constant either in space over the array or in time at each point. The many variations associated with higher-frequency processes are discussed in the next section.

CURRENT VARIABILITY

A study of the deviations of the currents from the net or mean values can provide much insight into the comparative response of the instruments and is the basis of the sections which follow. The vector variance of each series

Figure 6-1 PROGRESSIVE VECTOR DIAGRAMS



over the standard time interval is given in Table 6-3. An understanding of the differences between the variances of paired instruments can be aided by examining the patterns of current variability.

Figure 6-2 shows a set of vector distribution plots corresponding to the 26 data records available. In these plots, each separate vector measurement is plotted as one point with the north component as ordinate and east component as abscissa. The ensemble of points shows the range of variability of the velocity vectors. The plots use the data over the uniform time interval with the exception of the three short records: AK12(ALX), AK24(ALX), and AK41(ALX); for these, all data available were used, and the plots are flagged with a diagonal line.

The time histogram plots given in the Appendix to this report are valuable for examining the scatter of speed in direction as it varies with time. Since long-term averages are not used, it is possible to use the time histograms for those records that are short or have partial sensor failure. They are particularly useful, for example, for showing the extent and character of compass failure on the Plessey instrument.

The dominant differences in these plots are related to instrument performance. A detailed discussion of the apparent instrumental differences is presented in the following sections.

(b) Sensor response

The vector distribution and time histogram plots reveal large differences in the range of speeds registered on some pairs and triplets of instruments. Since the vertical

MOORING I	MOORING II	MOORING III	MOORING IV	DEPTH (m.)
AK11 BER 204	AK21 PLE 162	AK31 LSK 80		46
AK12 ALX	AK22 ALX 168	AK32 ALX 121	AK41 ALX	50
		AK33 BRA	AK42 A GEO 58	54
AK13 LSK 53				192
AK14A GEO 44	AK23 A BRA 46		AK43 LSK 60	196
AK15 ALX 117	AK24 ALX	AK34 ALX 140	AK44 ALX 112	200
		AK35 BER 87	AK45 PLE 82	204
	AK25 LSK 31			992
AK16 PLE 78	AK26 BER 107			996
AK17 ALX 25	AK27 ALX 31	AK36 ALX	AK46 ALX 46	1000
		AK37A GEO 20	AK47A BRA 19	1004

Table 6-3 Vector variance (CM^2/SEC^2)

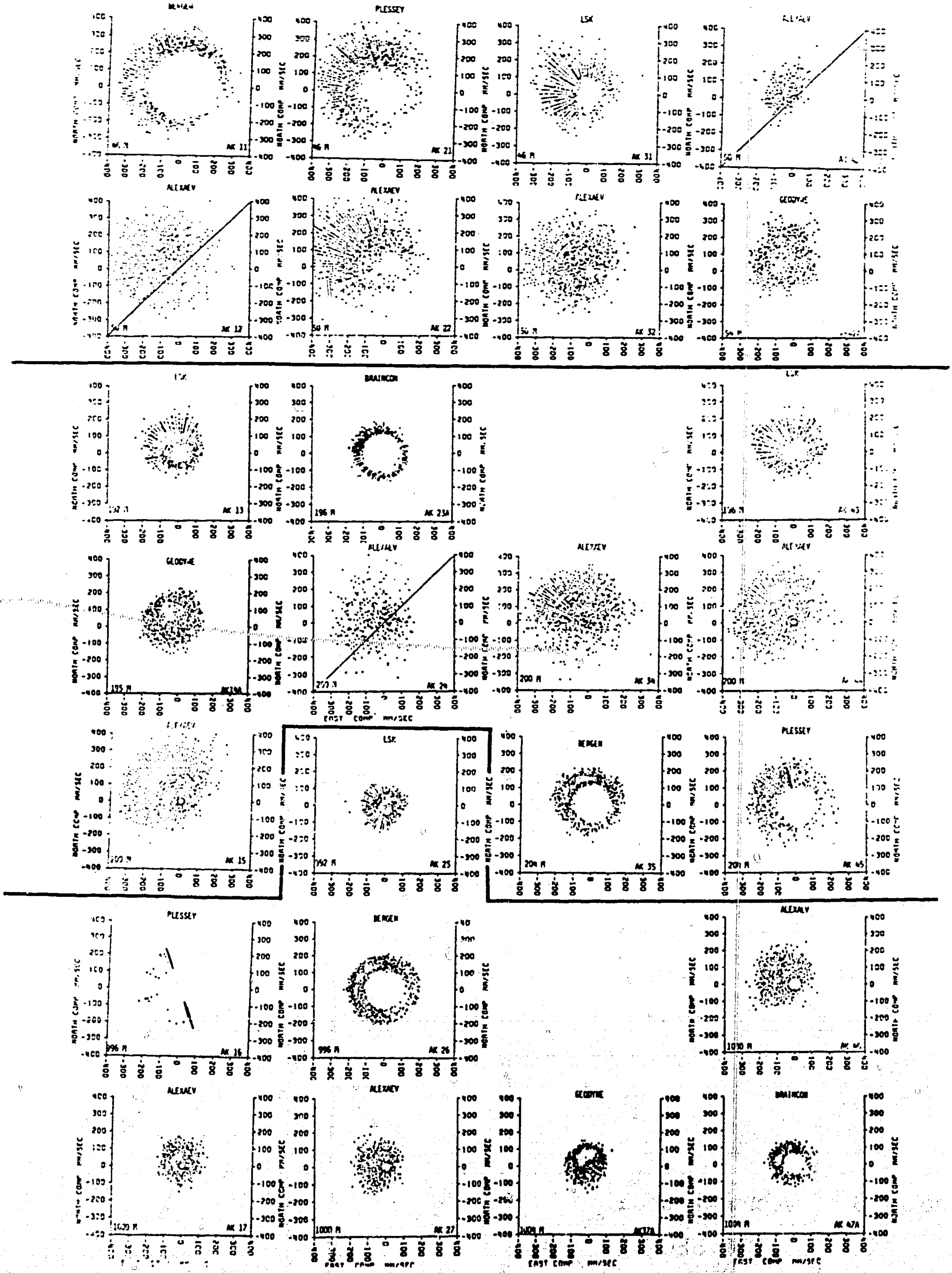


Figure 6-2 Vector distribution plots.

separation of the speed sensors in each pair was only 4 m. such large differences, in the light of past experience of vertical shears, seem unlikely to be explainable in terms of variability within the ocean. We must look for an explanation in terms of the response of the speed sensors themselves and in terms of the means of mounting the current meters on the mooring.

The most striking feature is the absence of low speed values on all the records from the Plessey, Bergen and Braincon instruments. The minimum speed registered on each of these instruments is dependent on depth, being highest near the surface and decreasing with depth. This is clearly illustrated by the vector distribution plots shown in Fig. 6-2. In these plots the lack of low speed values is characterised by a "hole" in the center of the plots. None of the Geodyne records show any loss of low speeds. Only in one case, at 200 m. (AK22), does a shallow Alexaev show a "hole". In the case of the LSK meters there are holes for records AK13, 31, and 43. As similar plots were not shown in the report of the first intercomparison experiment (SCOR W/G 21, 1969), Fig. 6-2a gives vector distribution plots of the data of this earlier experiment for comparison. Here, no holes with a radius exceeding the threshold speed can be seen at any instrument.

The hole in the vector distribution plots can arise in two ways. First, from an inappropriate combination of speed and direction sampling rates, and secondly from a mismatch in response of the speed and direction sensors themselves. These effects become more pronounced in the presence of high-frequency, high-wavenumber fluctuations.

The data from the Geodyne meters show no holes in the vector distribution plots at any depth. This can be explained by the sampling regime used in this meter which takes 29 samples of speed and direction at 5-second intervals for 2½ minutes and then sums these vectorially. The vane is small and orients independent of the pressure case. It is thus free to respond to high frequencies. It is possible to have a high rotor speed throughout the recording cycle but to have sufficient variability in directions to give a zero vector summation.

The sampling procedure used in some of the other instruments was simulated using Geodyne data by taking a scalar mean speed from the set of 29 values and combining this with a single direction derived from the sum of sines and cosines of the 29 directions. The resulting vector distribution plots are shown in Fig. 6-3 (Geodyne Q vector distribution plots). A comparison of these with the originals (Fig. 6-2) illustrates the consequences of integrating rotor counts in the presence of high-frequency fluctuations.

The size of the hole depends partly on the behavior of the speed sensors themselves, as well as on the sampling regime. In the LSK meter, the speed sensor is a propeller made up of flat, angled blades on the ends of radial spokes, and is mounted in a short tube. It has little response to components of flow at right angles to its axis and is free to reverse if the axial flow reverses. With such a sensor, fluctuations of current on a scale too small to cause significant changes of vane orientation would tend to be integrated vectorially and might produce little net effect. In contrast, the Savonius rotor of the Braincon and the rotor of the Bergen meter have an omnidirectional response, and tend to indicate the total length of water going past the rotor instead of only the component in the vane direction. This may account for the relatively small size of the LSK "hole" compared to those of the Bergen and Braincon records. The Plessey propeller is capable of some response to flow at right angles to its axis and is shielded from reversals

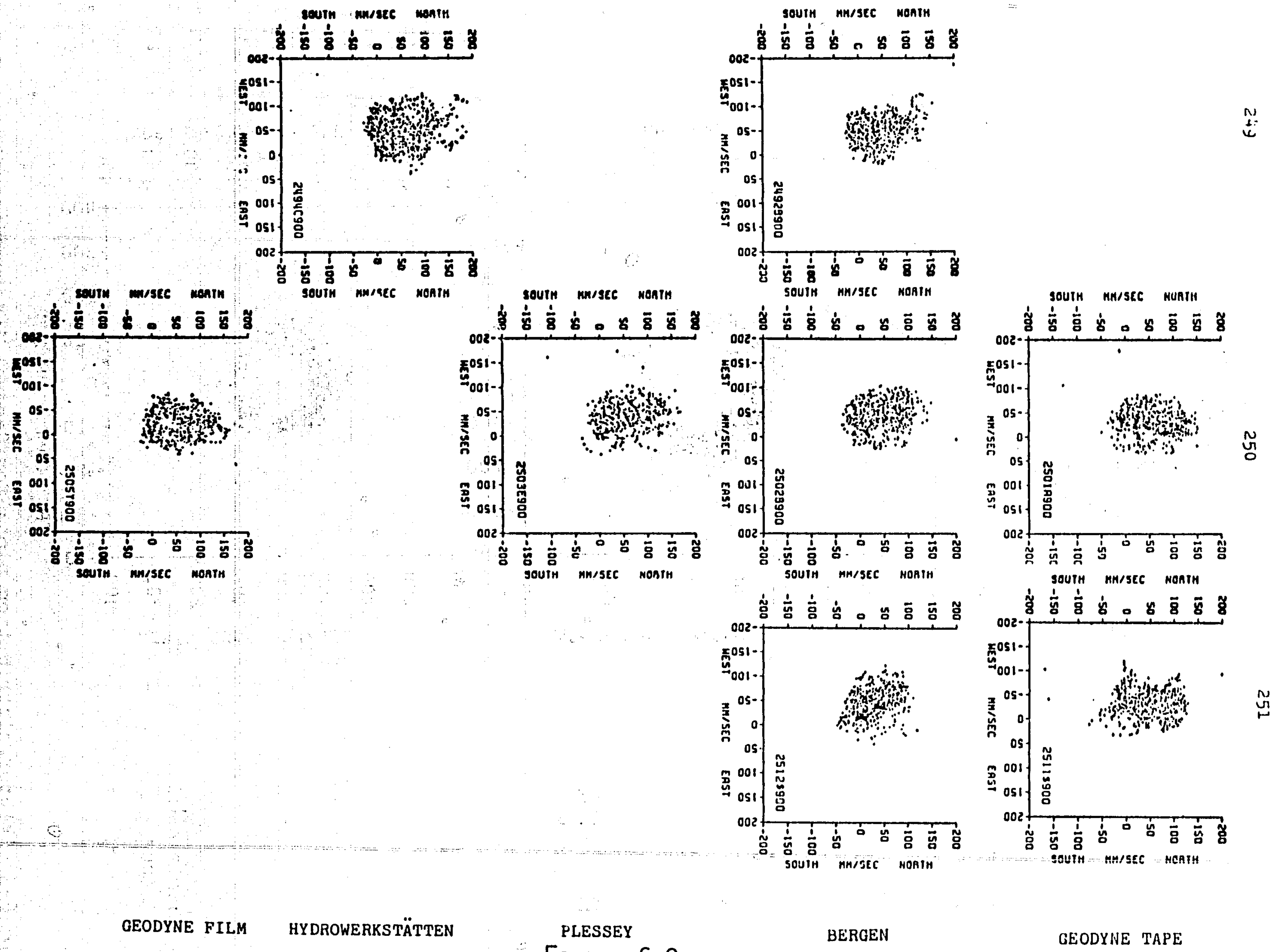


FIGURE 6-2A

VECTOR DISTRIBUTION PLOTS FOR FIRST INTERCOMPARISON EXPERIMENT

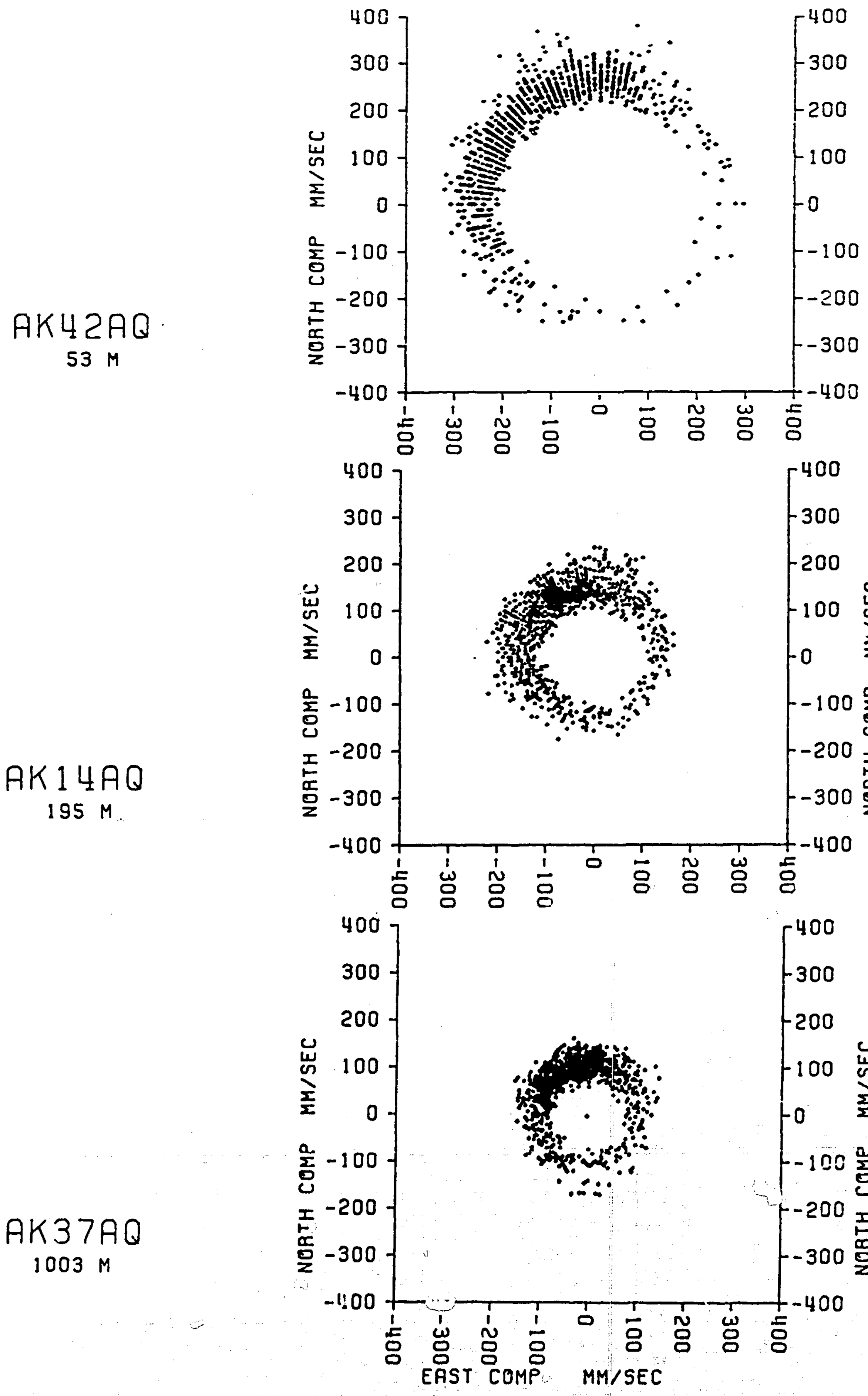


Figure 6-3 Vector distribution plots for Geodyne instruments using scalar speed over 2½ minute interval instead of vector average (Q-version Geodyne).

of flow by its pressure case. Its response to small-scale fluctuations might be expected to be intermediate between that of the LSK and the Bergen. This can be seen in the vector distribution plots, Fig. 6-2, records AK11, 21, 31. The response of the Alexaev speed sensors to small-scale fluctuations is not known, but the records from those instruments show no significant lack of low speeds.

A way of directly comparing the speeds on pairs and triplets of instruments is to plot the speed on one instrument against that of the other. This has been done and the resulting plots are shown in Fig. 6-4. A certain amount of distortion is introduced by the lack of low speeds in some of the records. In spite of this, few of the plots have a distribution of points centered on the 45° line. The only ones which do are AK45/43 (PLE/LSK), AK14A/13 (GEO/LSK), AK25/27 (LSK/ALX).

In comparisons with all other instruments, there is a tendency for the Alexaev meter to read high at high speeds and low at low speeds (or for all the other instruments to read the reverse). The LSK instrument is the only one which is paired with meters other than the Alexaev. Its speed performance appears to be consistent with both Geodyne and Plessey instruments.

The discrepancy in speeds between Geodyne and Alexaev instruments can be examined further by plotting their speed ratio against the variance derived from the directions in the bursts of the Geodyne record. The pair of records AK14A(GEO) and AK15 (ALX) were matched and a plot was made of speed ratio vs. Geodyne direction variance (Fig. 6-5). It shows a tendency for the ratio to be low at high variance and greater than unity at low variance. An extrapolation to zero variance (the analog to towing the instruments in a tank) gives a speed ratio of 1.5 .

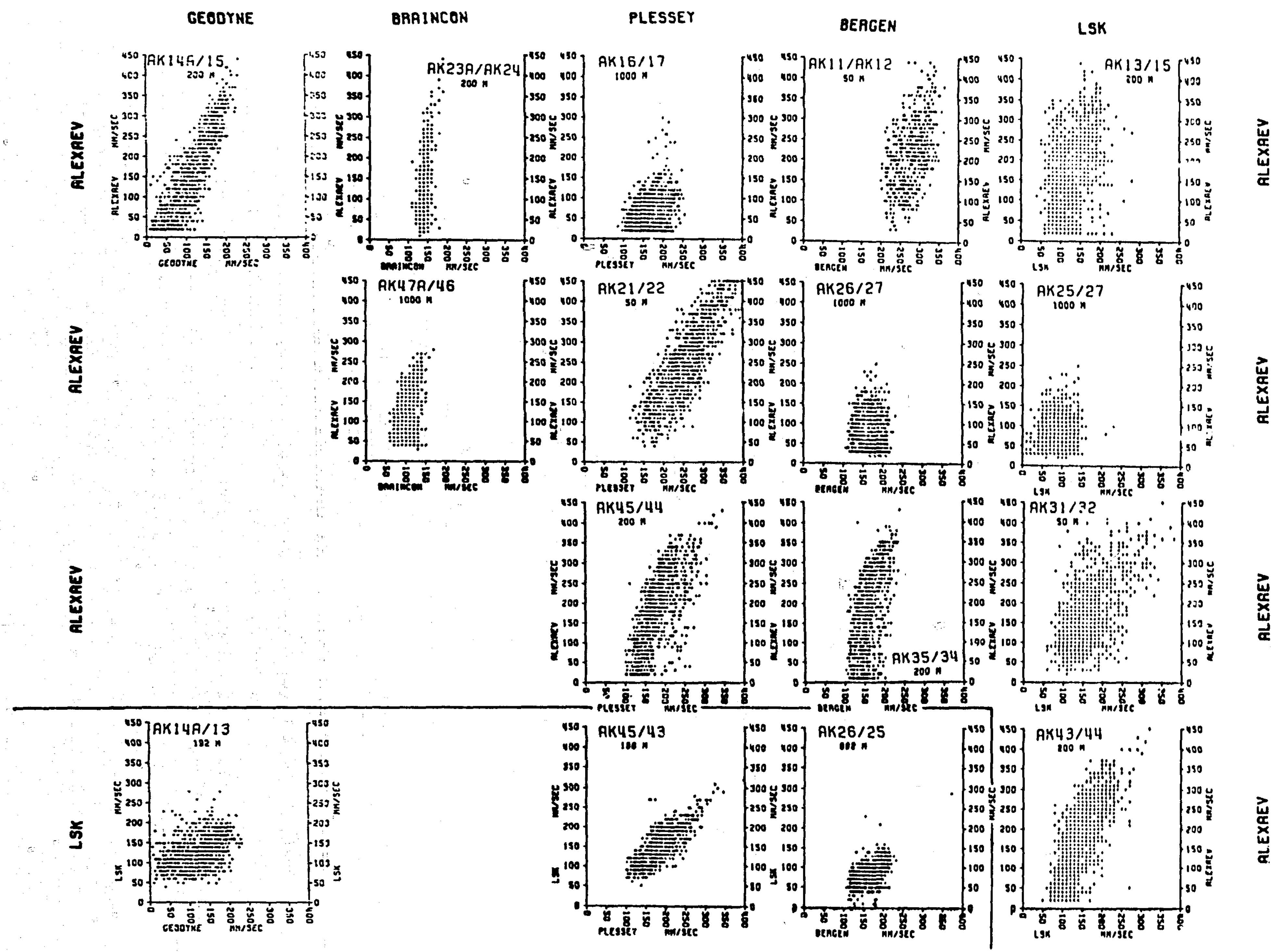


Figure 6-4 Speed versus speed plots for paired instruments.

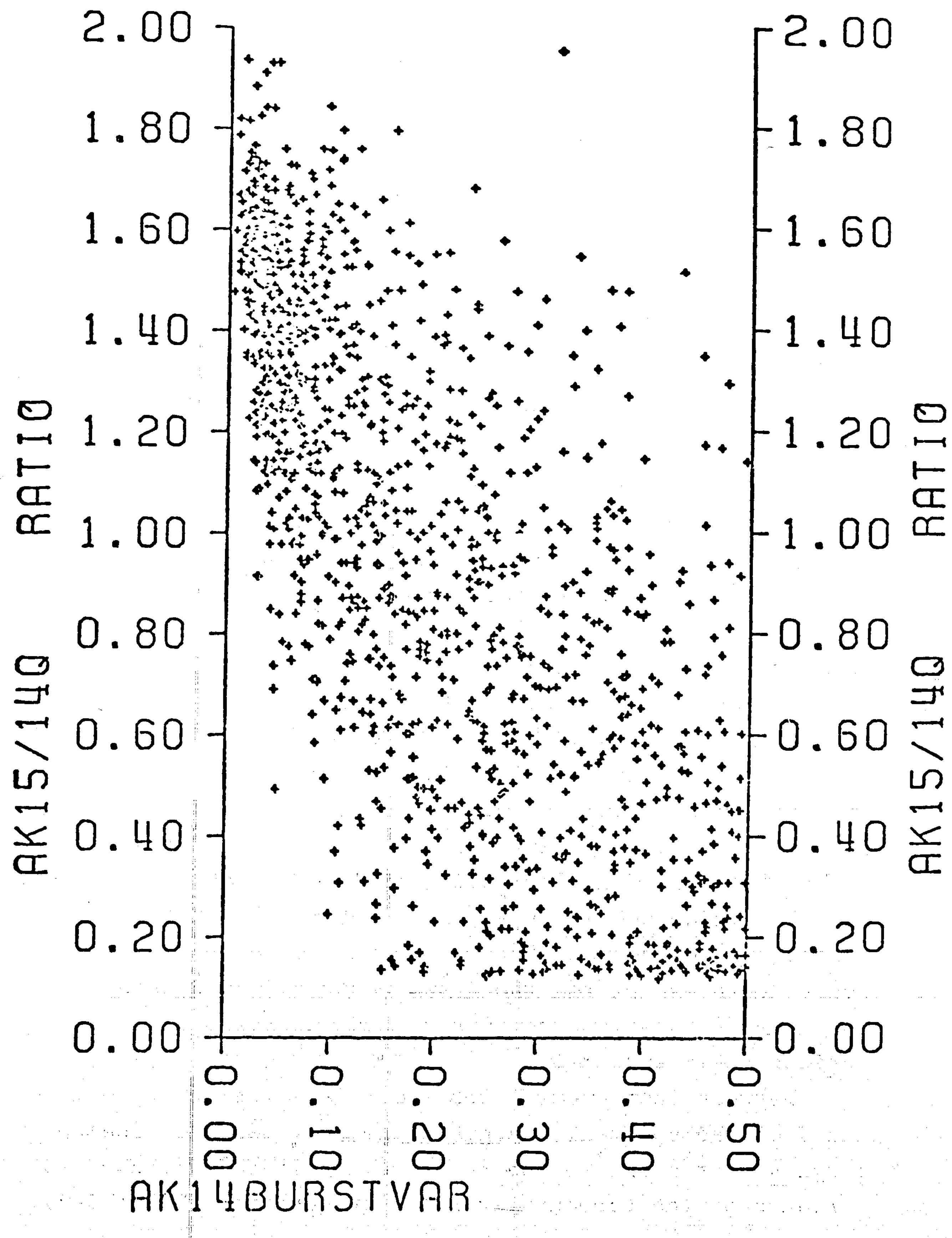


Figure 6-5 The ratio of speeds for AK 15 (ALX) to AK 14 Q (Geo) against the variance of the velocity within each corresponding burst of measurements for the AK 14 measurement.

(c) Spectral characteristics

Comparative time-dependent response can be examined by computing the spectrum of currents from each instrument over the standard time interval. A set of such spectra are included in Appendix I. General spectral properties are considered in the following section.

LOW FREQUENCY PEAKS

At low frequencies the instruments are consistent in responding to tidal and inertial-period motions. With only 12 days of measurements, the inertial-period peak, with a period of about 42.6 hours, can barely be resolved. In spite of this, a pattern in inertial-period intensity can be seen. As an example, Fig. 6-6 shows representative spectra from each of the three depths. At 50 m., no inertial peak occurs on any record. Although the 1000-m. record shows a broad spectral plateau centered on frequencies above inertial, the general pattern of 1000-m. spectra is more complex. No 1000-m. record shows an inertial peak as clearly as is found in every record from 200 m. On mooring 2, each of the three spectra from 1000-m. depth shows a peak at the adjacent higher frequency band, with a center period of 28.44 hours.

The lunar semi-diurnal tidal spectral peak (12.42 hours period) is found as a sharp clear peak on every spectrum at every depth except for those two records from Plessey instruments in which the compass was stuck for extensive periods (AK16 and AK45).

Between instrument pairs and triads the relative magnitudes of the spectral energy of the inertial and tidal peaks roughly correspond to the relative magnitude of the vector variance of the currents over all frequencies (Table 6-3).

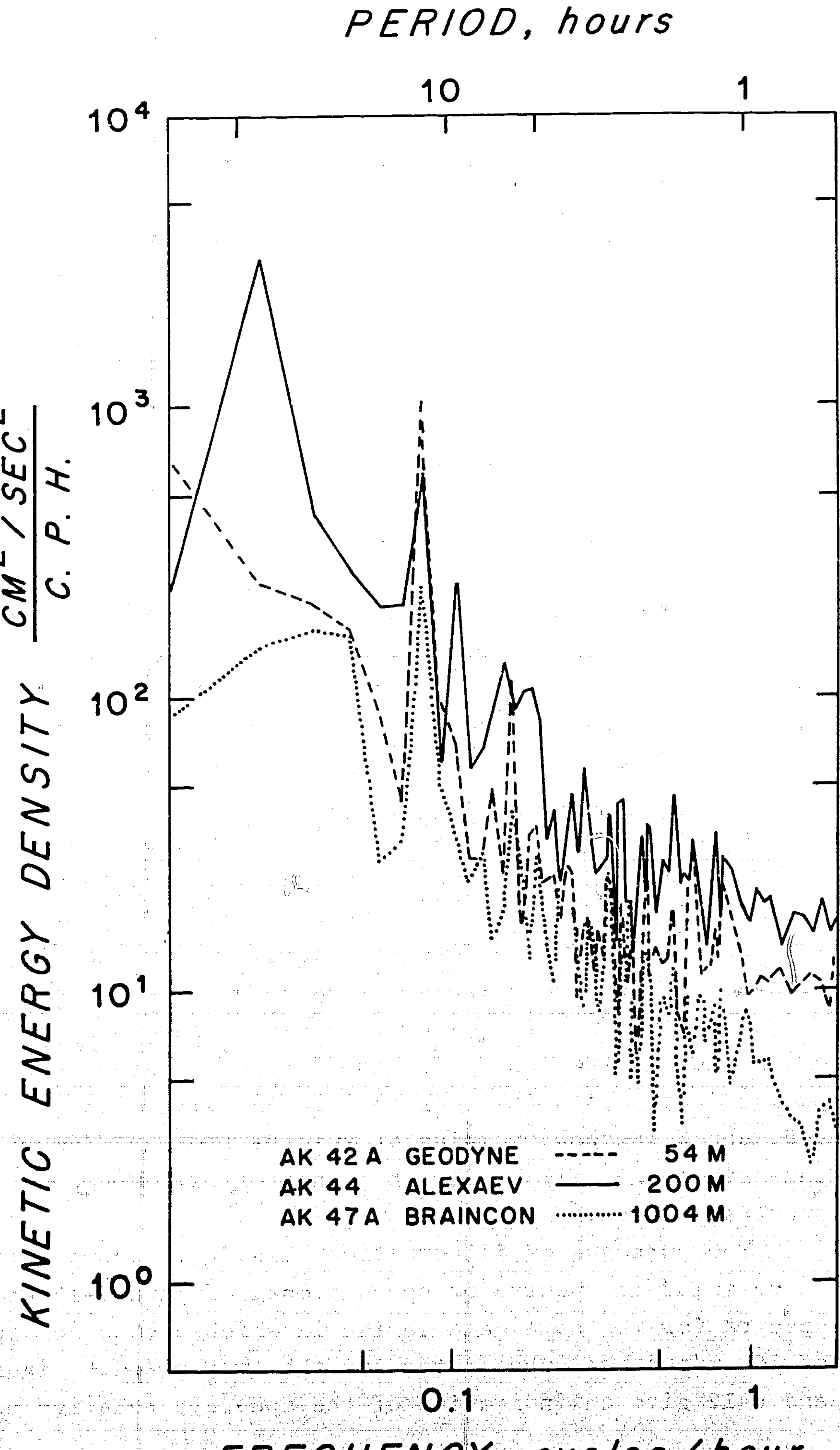


Figure 6-6 Kinetic energy density spectra from three sample depths on a log-log scale.

The spectral peaks represent averages over the length of the standard time interval. During this interval there were, however, significant time variations in the amplitudes of the tidal and inertial motions. Using the method of complex demodulation, their energy as a function of time can be estimated. The results again show that within triads and pairs the relative energy levels are roughly proportional to the variances. Figure 6-7 shows, as an example, a plot of the complex demodulate estimates at inertial period (42.67 hours) for all data from 200 m.

HIGH-FREQUENCY LEVELS

At higher frequencies, the spectra show significant differences in their relative shape. Some drop with frequency up to the Nyquist frequency (e.g. AK13, LSK). Others have an approximately level behavior above some frequency (e.g. AK22, ALX). Examples can be found for intermediate shapes. An examination of the high-frequency kinetic energy density can aid in understanding comparative instrument response.

Table 6-4 gives the kinetic energy in the band of frequencies from 1.895 to 1.973 cph. A number of patterns are evident. The LSK is always the lowest at each level. The Geodyne is the second lowest at each level, and the Braincon is generally low. The other instruments have high-frequency energy levels that can be up to 15 times greater even for paired instruments (AK13 (LSK)/AK15 (ALX)). Figures 6-8, 6-9, and 6-10 show examples of spectra from instrument pairs and triads that illustrate the range of high frequency spectral shapes.

For purposes of illustration, Fig. 6-11 shows a comparative triad of spectra of speed alone. Figure 6-12 shows spectra for the same data series in which a constant speed of 10 cm/sec was substituted for the true speed. Figures 6-11 and 6-12 give an indication of the spearate relative contribu-

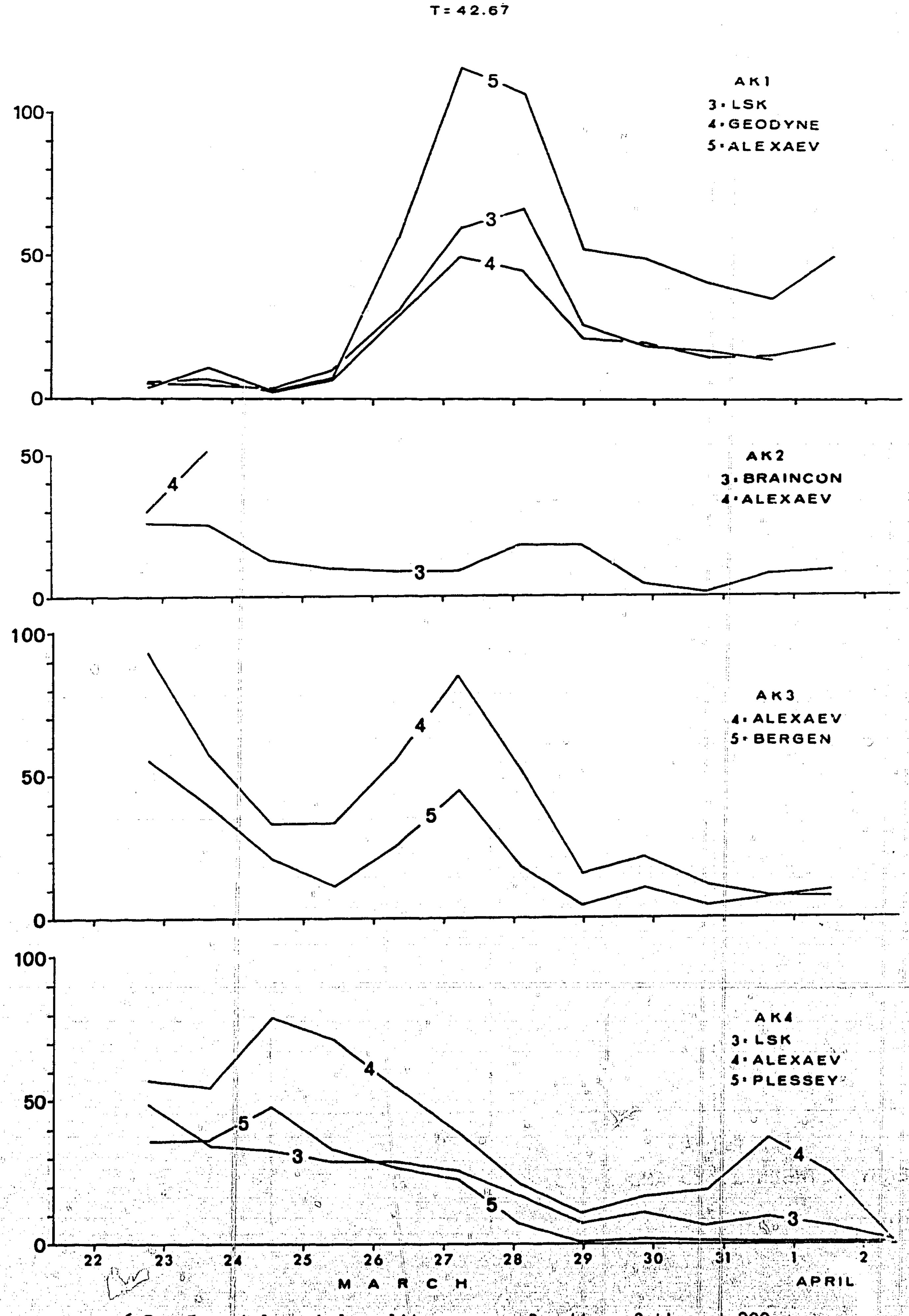


Figure 6-7 Inertial period amplitures as a function of time at 200 m.

DEPTH (m.)	MOORING I	MOORING II	MOORING III	MOORING IV
46	AK11 BEF 28	AK21 PLE 56	AK31 LSK 4	
50	AK12 ALX	AK22 ALX 33	AK32 ALX 19	AK41 ALX
54			AK33 BRA	AK42A GEO 12
192	AK13 LSK 1			
196	AK14 A GEO 5	AK23 A BRA 6		AK43 LSK 3
200	AK15 ALX 16	AK24 ALX	AK34 ALX 11	AK44 ALX 15
204			AK35 BER 8	AK45 PLE 13
992		AK25 LSK 2		
996	AK16 PLE 9	AK26 BER 19		
1000	AK17 ALX 3	AK27 ALX 5	AK36 ALX	AK46 ALX 6
10[illegible]			AK37A GEO 2	AK47A PRA 3

TABLE 6-4
ENERGY BETWEEN 1.895 AND 1.973 CPH. (cm^2/sec^2)

tion to the high-frequency energy from speed and direction sensors. Note that, for both, the LSK spectra drop steadily to low values at high frequency.

One possible interpretation for the low LSK energy levels might be that the instrument is slow in responding to high-frequency motions. However, the period corresponding to the Nyquist frequency in the spectra presented here is half an hour. It is unlikely, with the speeds encountered in this experiment, the LSK could produce such a long time constant. Furthermore, filtering during data recording and processing is unlikely to have accounted for the low energy levels of the LSK data at high frequency. The evidence from the spectra is consistent with the conclusion that the LSK instrument was exposed to a different high-frequency motion from the other instruments.

The differences in high-frequency energy levels may be related to differences in the mounting of instruments on these moorings. It should be noted that the Geodyne, Bergen, and Braincon instruments are normally inserted in the mooring line, but in this case were offset on brackets.

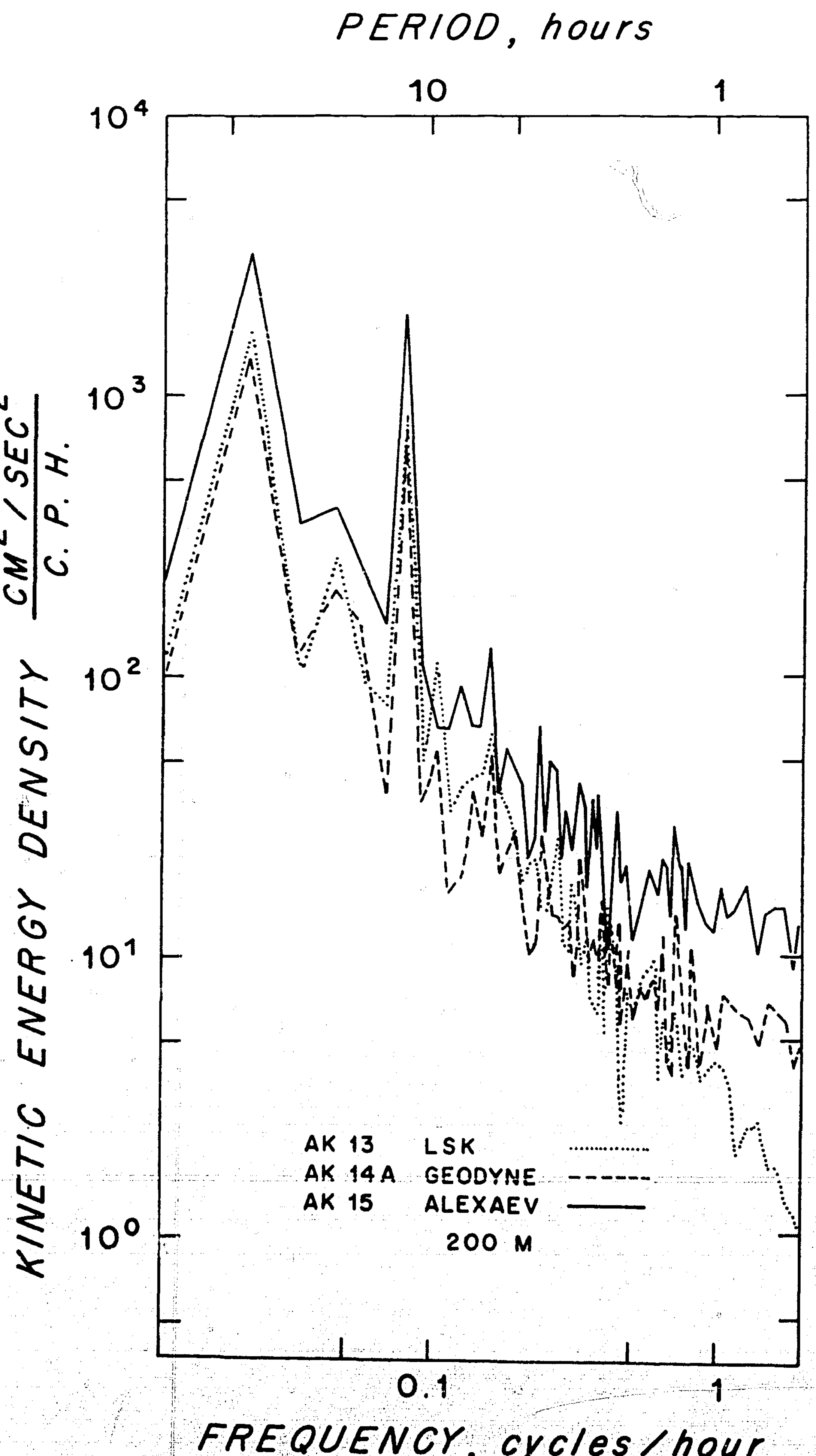


Figure 6-8 Representative spectra from 200 meters

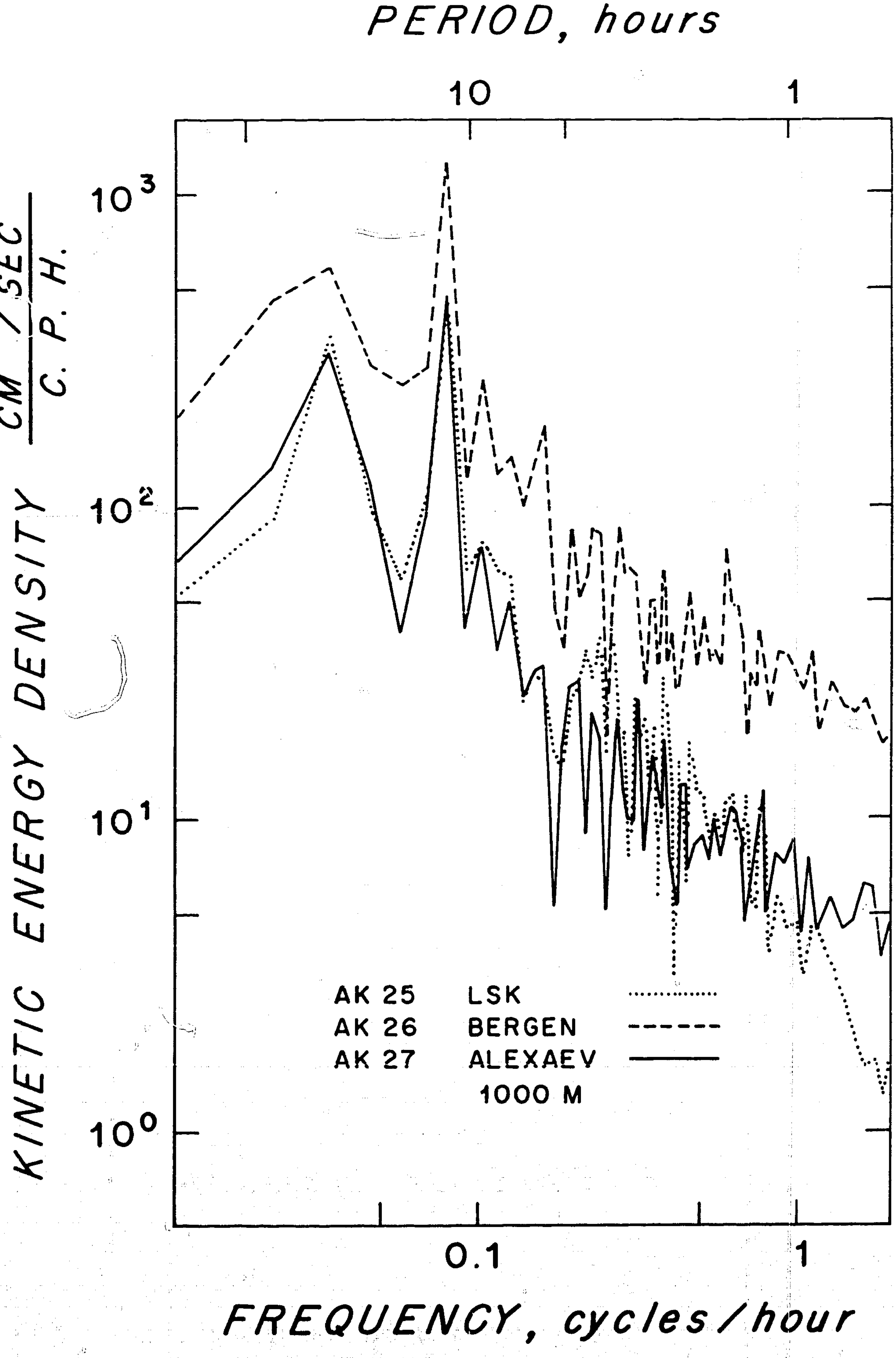


Figure 6-9 Representative spectra from 1000 m.

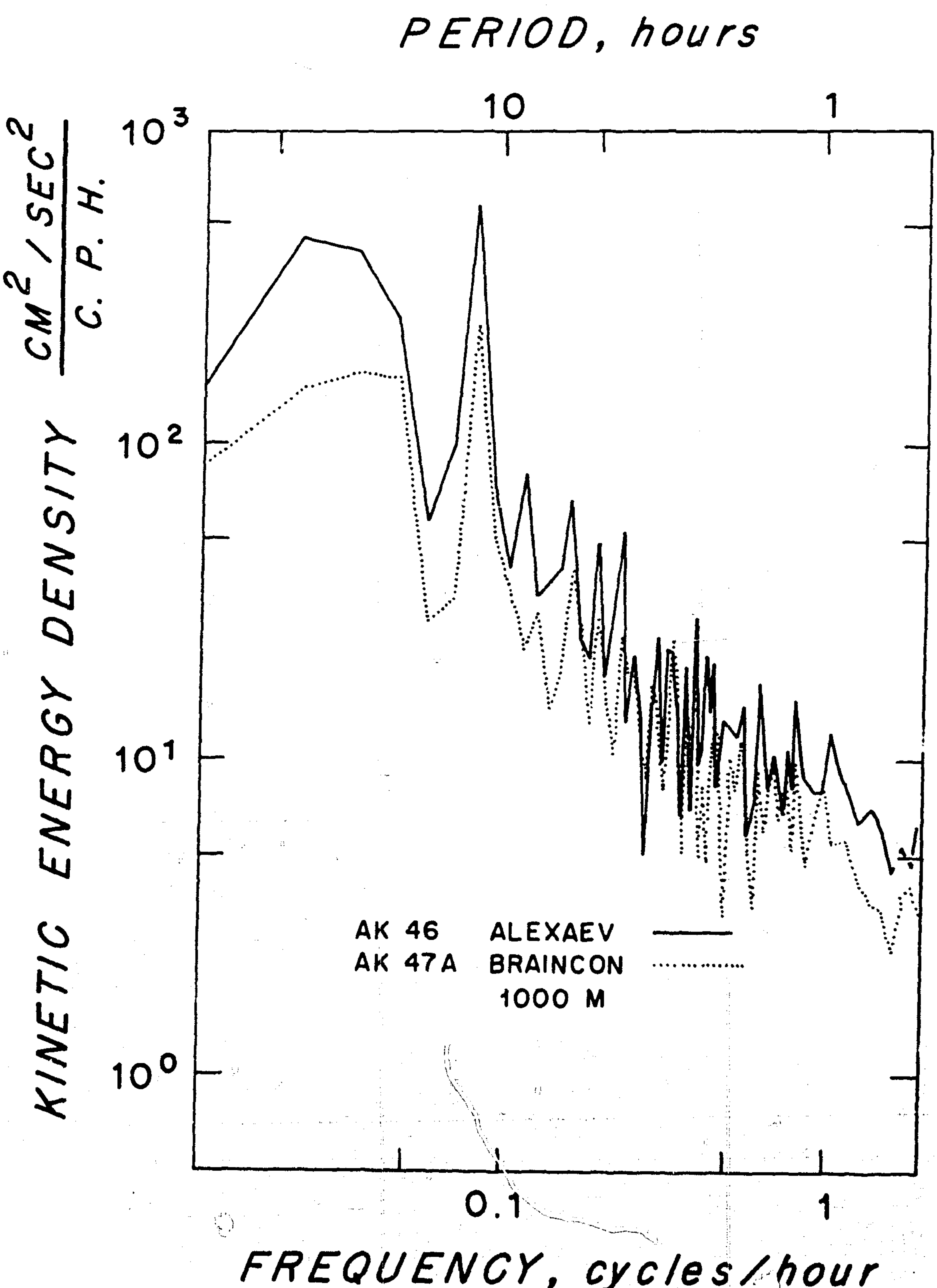


Figure 6-10 A spectral pair from 1000 m.

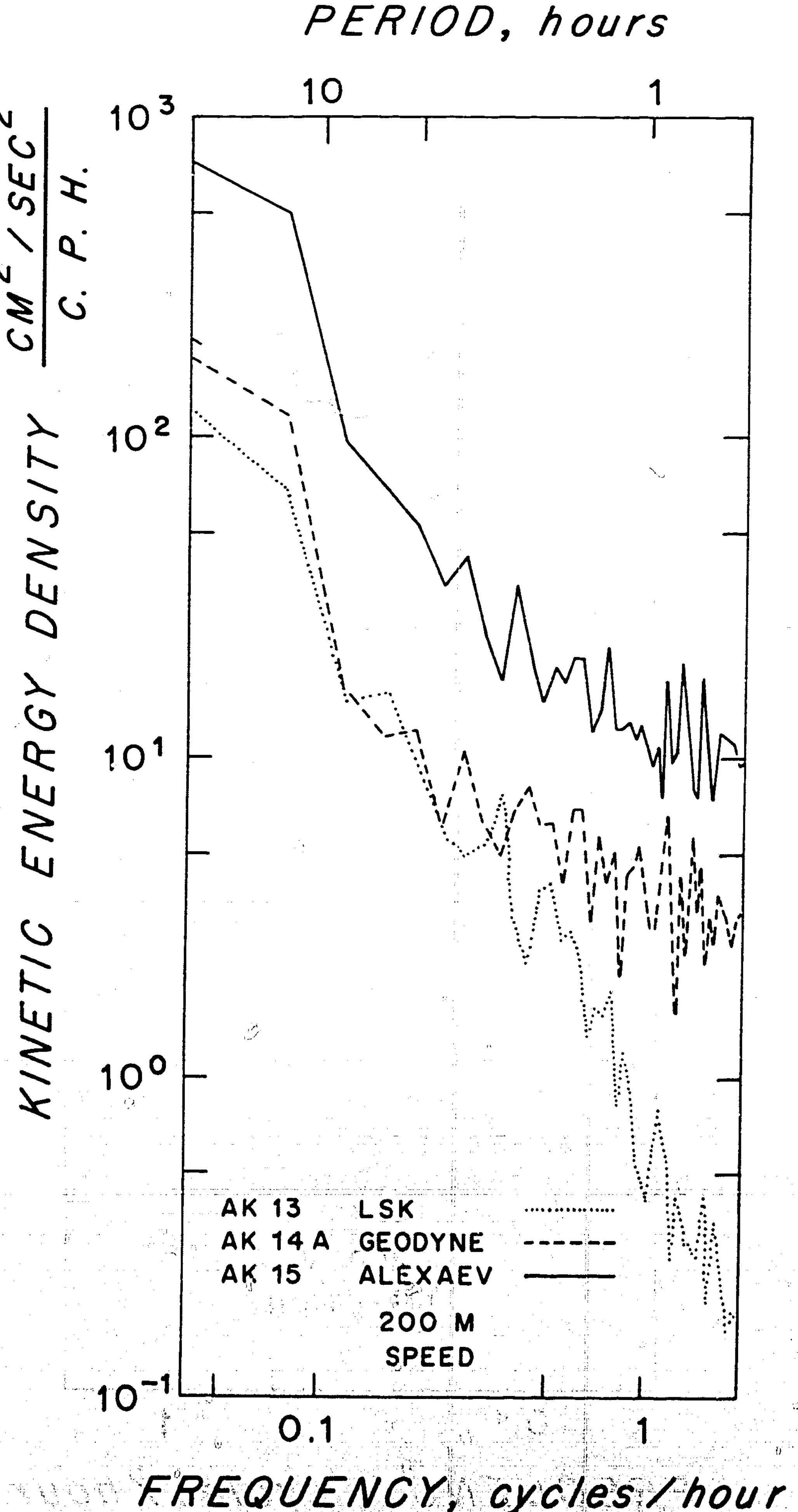


Figure 6-11 Spectrum of speed from 200 m.

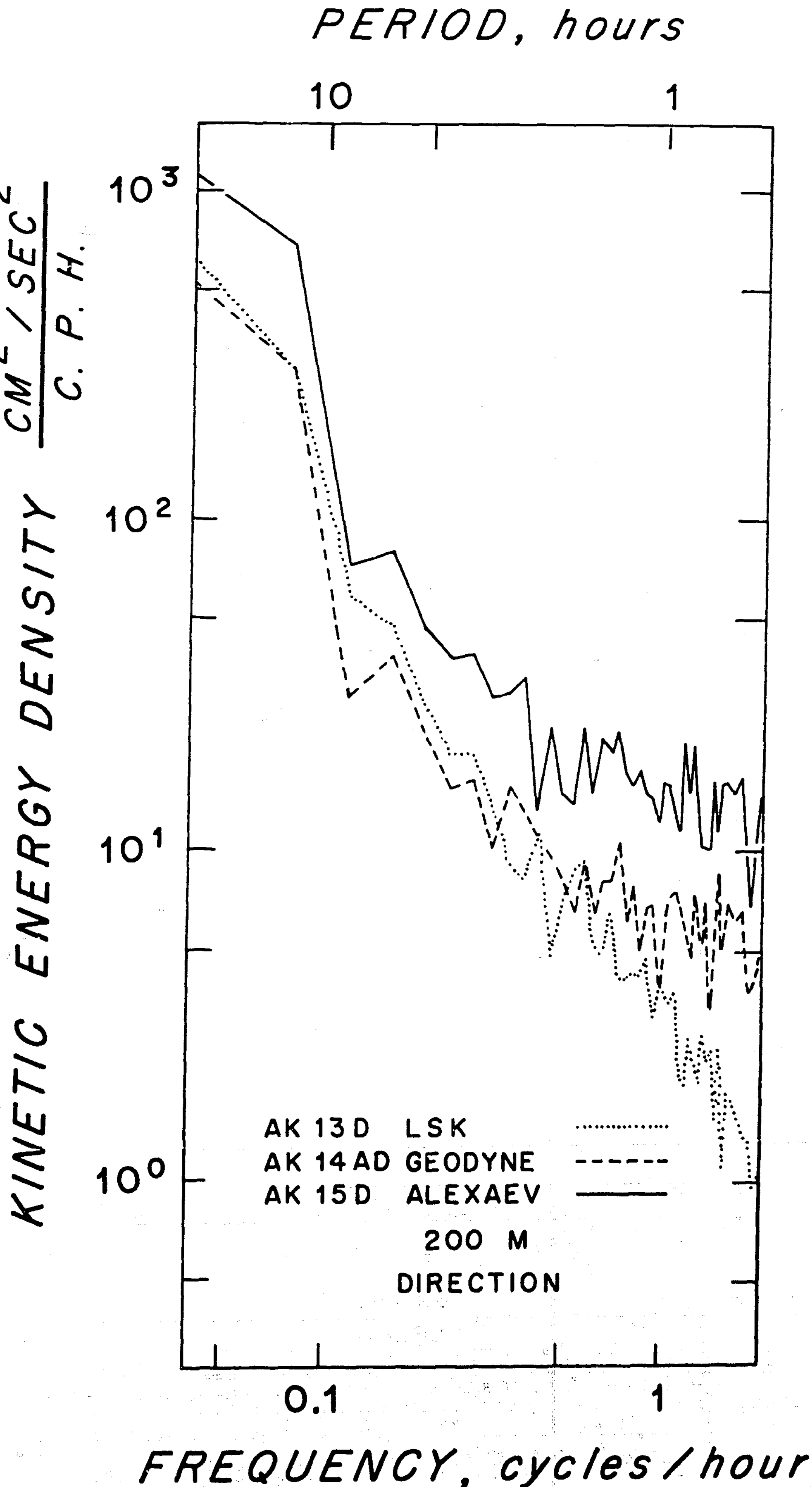


Figure 6-12 Spectra using constant speed value

(d) Cross-spectral characteristics

The correlation between pairs of instruments as it depends upon frequency can be examined by computing the coherence. The method used here is one in use at the Woods Hole Oceanographic Institution based on a program (TWOCROSS) prepared by Perkins (1970). The method has been described in detail by Gonella (1972).

The motion at each current meter is considered in terms of clockwise and anticlockwise motion. By this approach a more concise, and perhaps a more physically interpretable, form for the vector coherence can be obtained. In the first SCOR-21 report (1970) vector coherences were expressed as the average of the coherence between north components and the coherence between east components. The diagonal coherences between an east component on one instrument and a north component on the other were presumed small and ignored. Here, using the rotary form, the diagonal terms are incorporated, and the full linear coherence is included in the two curves presented for each instrument pair. The average of these curves is generally close to what would be obtained by the method used in the first SCOR-21 report. The advantages in physical understanding gained by using both clockwise and anticlockwise coherence curves makes this presentation preferable to the single average value used earlier.

For the coherences used here, there are 50 degrees of freedom corresponding to a 95% confidence level of 0.38 (Amos and Koopmans, 1963).

COHERENCE BETWEEN PAIRS

There are 13 paired data series from pairs and triads of instruments for which coherences can be estimated. These 13 pairs include 3 pairs using data from two Plessey current meters for which the compass was stuck for part of the time. In at least one case, a pair including a Plessey instrument showed moderately high coherence in spite of the compass malfunction.

Three instrument pairs have coherences that exceed 0.5 for at least one sense of rotation over the entire range of frequencies covered (0.1 cph to 2 cph). These are:

AK26/AK27	(BER-ALX)	1000 m.
AK14A/AK15	(GEO-ALX)	200 m.
AK47A/AK46	(BRA-ALX)	1000 m.

All other instrument pairs show coherences that are below 0.5 for both senses of rotation for all or part of the range of frequencies covered. For those with coherences above 0.1 for part of the frequency range, the general pattern is for the coherence to drop with increasing frequency. There is thus some frequency above which the coherence is less than 0.5 for both senses of rotation. The value of this frequency is:

Pair	Type	Depth	Frequency at which coherence drops below 0.5
AK25/AK27	(LSK-ALX)	1000 m.	0.81 cph
AK25/AK26	(LSK-BER)	1000 m.	0.74
AK34/AK35	(ALX-BER)	200 m.	0.55
AK43/AK44	(LSK-ALX)	200 m.	0.35
AK44/AK45	(ALX-PLE)	200 m.	0.30
AK31/AK32	(LSK-ALX)	50 m.	0.27
AK43/AK45	(LSK-PLE)	200 m.	0.26
AK21/AK22	(PLE-ALX)	50 m.	0.24

Two other instrument pairs, AK13/AK14A (LSK-GEO), 200 m., and AK13/AK15 (LSK-ALX), 200 m., have coherences above 0.5 at the lowest frequency estimate (0.1 cph) but at no other estimate.

No clear patterns based on instrument type emerge from the coherence calculations. The high-coherence pairs involve three different instrument types (BER, GEO, BRA) paired with Alexaev meters. The only instrument not among the highly coherent pairs is the Plessey, but this is possibly due to compass malfunction.

The two pairs involving AK13 (LSK) possibly have low coherences because of time-base irregularities. The low coherence is possibly not related to any general characteristic of the LSK instrument.

Figure 6-13 shows the coherence curves for the four instrument pairs that are most highly coherent. Figure 6-14 shows examples of other pairs that are less coherent.

COHERENCES BETWEEN MOORINGS

About a quarter of the possible horizontal pairs of instruments at the same depth were examined for coherence (14 pairs out of a possible 51). In no case did the coherence for both senses of rotation rise above 0.5. In general, the coherences are not significantly different from zero at any frequency in the range resolved (0.1 cph to 2 cph).

The progressive vector diagrams (Figure 6-1) show similar low-frequency patterns for some records at the same depth on different moorings. However, the coherence estimates over the relatively short records available do not resolve this. If there is a linear low-frequency correlation between adjacent moorings, longer records than those available here are needed to resolve it.

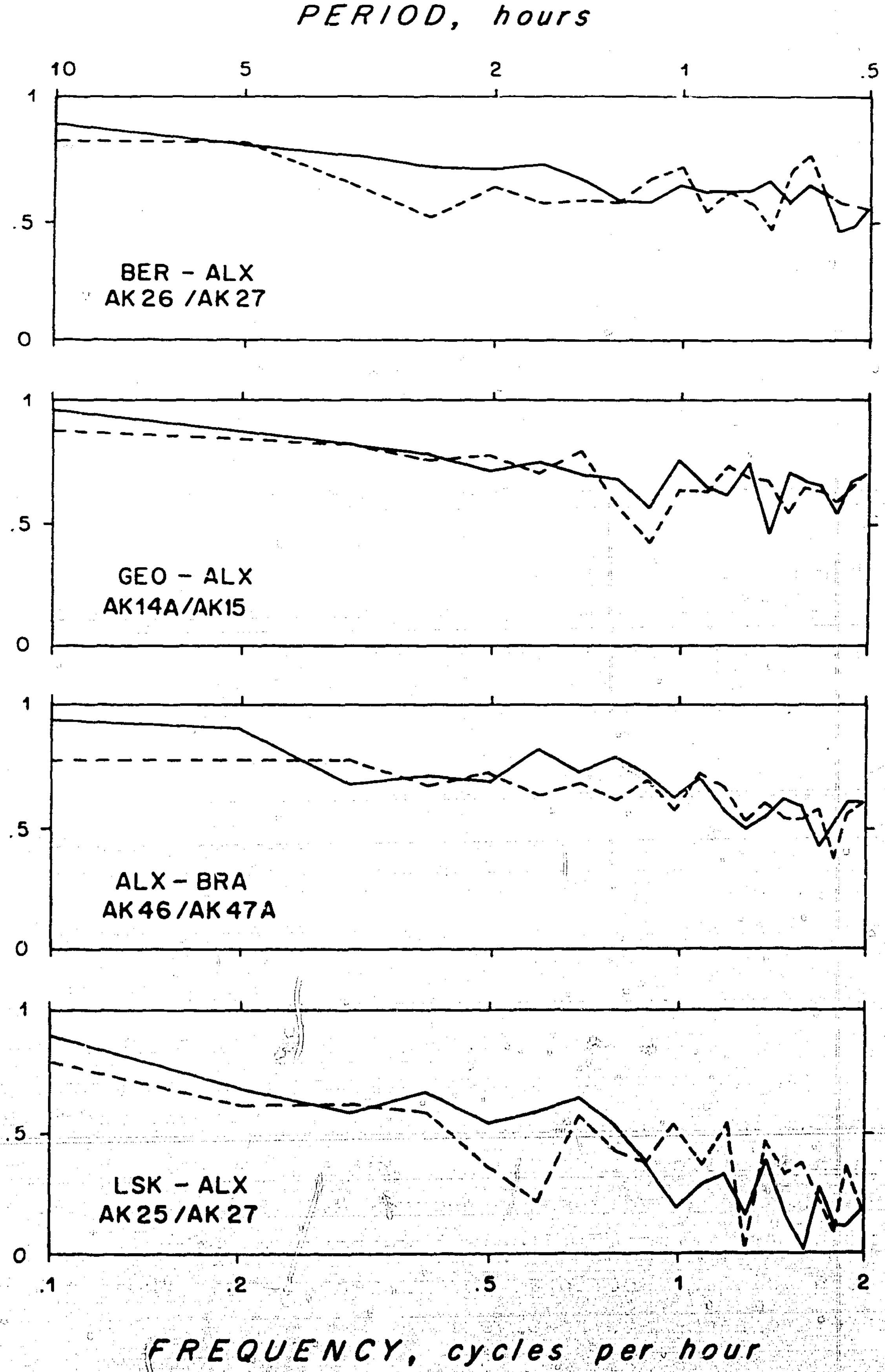


Figure 6-13 Coherences for those instrument pairs having the highest values of coherence. The solid line is the coherence for the clockwise component of motion. The dashed line is the coherence for anticlockwise component of motion. The 95% confidence level of coherence is 0.38 corresponding to 50 degrees of freedom.

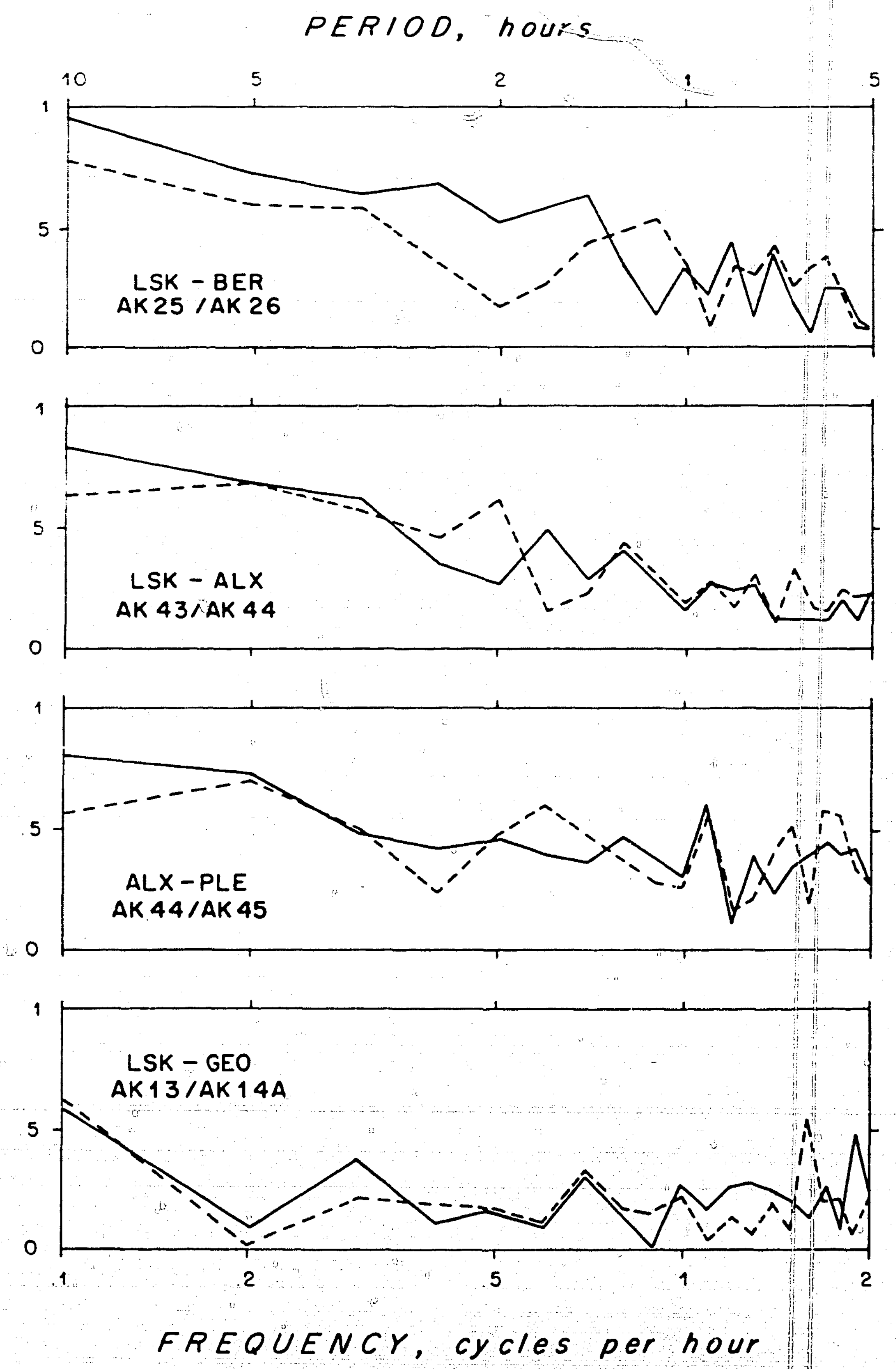


Figure 6-14 Coherences for four instrument pairs having lower values of coherence. The curves have the same interpretation as those in Figure 6-13.

7. Conclusions and Recommendations

CONCLUSIONS

1. The intercomparison experiment showed that, in the conditions encountered, paired instruments behaved with encouraging similarity in some respects (mean velocities, progressive vector diagrams). There were large differences, however, in the response of instruments to time-varying currents. Some of these differences are understandable in terms of the known characteristics of the instruments, and some are not.

2. In trying to make more precise statements about the results, some difficulties arise. For example, if we omit only the direction of AK25 it can be said that the differences between estimates of the mean velocity (Table 6-2) given by paired instruments did not exceed the tolerances for speed and direction given in the manufacturers' handbooks. However, if the speed differences are to be interpreted as being due to differences of calibration, it is implied that differences occur systematically through the whole range of speeds encountered in the experiment. It is not clear how much of the manufacturer's tolerance can be assigned to systematic errors of calibration over that speed range. Moreover, users sometimes believe that instruments differ in calibration by appreciably less than the manufacturer's tolerance, but without tow tank calibrations on the individual instruments near the time of the experiment it is not possible to be precise about what lower values to apply. The users of Bergen and LSK meters involved in the experiment

think however that the 3.8 cm/sec difference between records AK25 and AK26 in Table 6-2 is unlikely to be explainable in terms of calibration bias.

Manufacturers' tolerances for direction measurement are intended to apply to individual readings of direction, and they include the effects of both the size of the digitizing interval, and the alignment of the divisions between the intervals. With the vector mean, many samples spread over a wide range of angles are involved and the effect of the size of the digitizing interval will be much reduced. It is not known what lower value of tolerance on directions should be used. However, the observed 6° spread of directions (omitting AK25) between pairs in Table 6-2 may be contrasted with the results of the first intercomparison experiment, when systematic differences in modal direction of 20° to 34° were found. In the case of AK 25 (LSK) the control of the instrument by the manufacturer after the experiment showed an unexpected high friction of the bearing for direction setting, a defect which could be eliminated by using more effective fins.

3. The agreement in estimates of mean velocities is however largely fortuitous. The plots of speeds of paired instruments (Fig. 6-4) show that the incremental response in, for example, AK14 (Geodyne) was approximately half that of AK15 (Alexaev). A discrepancy in the same sense between other instruments and the Alexaev is less clearly indicated, due to lack of low speeds. Similar discrepancies were not observed during the 1967 intercomparison experiment. Observed differences in vector variance (Table 6-3) and in spectral distribution of kinetic energy in the 1970 data are partly due to this unexplained discrepancy in speed response.

4. The records from the Bergen, Braincon and Plessey instruments showed a striking absence of low speeds, due to the presence of appreciable energy at frequencies too high

to be resolved by the sampling regimes of those instruments. Its presence was known from the scatter within the bursts of rapid sampling in the Geodyne records. The effect of scalar averaging through the sampling period could be clearly demonstrated by contrasting plots of scalar average values from the Geodyne burst samples with those of the original vector averages. The less pronounced lack of low speeds in the LSK records could be related to the design of its speed sensor, in contrast to the omnidirectional Savonius rotor. A similar lack of low speeds was not observed during the 1967 intercomparison experiment.

Without more knowledge of the spectra of these unresolved fluctuations both in frequency and wave number, and more detailed study of the transient response of the current meters, it is not possible to determine precisely the extent to which these fluctuations contaminate the estimates of spectral energy density and mean velocities. It seems likely, though, that the observed high energy densities at high frequencies in the Bergen, Braincon and Plessey records are due to such contamination. Its effect would be expected to be more pronounced at low mean speeds, and it seems likely that in record AK26 (Bergen, 996 m) even the estimate of the vector mean is severely contaminated.

5. The relatively low estimates of energy density at high frequencies given by the LSK records seem unlikely to be wholly due to the response characteristics of the instrument or to smoothing during processing. The energy level corresponding to the speed digitizing interval in the curve follower used for reading the LSK records is at least an order of magnitude below the observed minimum values. One

might speculate that the LSK was exposed to a lower amplitude of high frequency fluctuations due to its manner of mounting directly on the mooring line instead of being offset on a bracket, but we have no positive evidence of this and the effect remains unexplained.

RECOMMENDATIONS

1. Another intercomparison should be designed to resolve the discrepancies mentioned in conclusions 3 and 5 above. Comparison should be made on both surface and subsurface moorings and instruments should preferably be mounted in the manner in which they are most commonly used. Not all the types of instrument used in this experiment need be involved; it would be sufficient if Alexaev, LSK and Geodyne were used.

2. It is recommended that users of moored current meters should study the effects of mooring design, and mounting of instruments, on the intensity of high frequency fluctuations, and the consequences of such fluctuations in contaminating the records obtained should also be studied.

3. Users of Braincon current meters might consider the possibility of extracting more information from the recorded histogram of directions, as an aid in avoiding contamination by high frequencies.

References

(a) Manufacturers' instruction manuals.

Alexaev:

Automatic recording current meters of Alexaev system, type BPV-2 and BPV-2p. Izdatelstvo "Morskoi Transport", Leningrad, 1963, 56 pp. (in Russian).

Bergen:

Operating manual for recording current meter, serial no. 42-66. (undated) I. R. Aanderaa, Nesttun, Norway.

Braincon:

Instruction manual, type 381 Histogram current meter. (1968) Braincon Corp., Marion, Massachusetts, 17 pp. and appendices.

Rotor calibration sheets, April, 1970.

Geodyne:

Model 850 Magnetic tape recording current meter. Instruction Manual No. B-3921, Geodyne Division, EG&G International (1968), 48 pp.

LSK:

Description of instrument and operating instruction for Ocean Current Meter LSK 801.1. (1969) Institut für Meereskunde, Warnemünde, D.D.R.

Plessey:

Service manual for Recording Current Meter model MO21, Issue 1 6/66. The Plessey Co. Ltd., Ilford, Essex, England.

(b) Other references

Aanderaa, I. (1964) A recording and telemetering instrument. NATO subcomm. on Oceanogr. Res., Tech Rept. No. 16., Chr. Michelsen Inst., Bergen, Norway.

Amos, D. E., and L. H. Koopmans (1963) Tables of the distribution of the coefficient of coherence for stationary bivariate Gaussian processes. Sandia Corp. Monograph SCR-483, 327 pp.

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Fofonoff, N. P., and Y. Ercan (1967) Response characteristics of a Savonius rotor current meter. W.H.O.I. Ref. 67-33. 46 pp. (unpublished manuscript).

Gonella, J. (1972) A rotary-components method for analysing the coupling between wind and surface current. Deep-Sea Research 19, 833-846.

Maltais, J. A. (1969) A nine channel digital magnetic tape format for storing oceanographic data. W.H.O.I. Ref. 69-55, 11 pp. (unpublished manuscript).

Perkins, H. T. (1970) Inertial oscillations in the Mediterranean. Ph.D. thesis, M.I.T.-W.H.O.I. Joint Program.

SCOR Working Group 21 (1969) An intercomparison of some current meters. UNESCO Tech. Paps. in Marine Sci., 11. UNESCO, Paris, 70 pp.

Appendix

DATA PLOTS

STATS

E = EAST   UNITS = MM/SEC
N = NORTH   UNITS = MM/SEC

SPEED
UNITS = MM/SEC

DATE	MID TIME HR	MIN	SEC	MEAN (E)	MEAN (N)	VECTOR MEAN	VARIANCE (E)	VARIANCE (N)	VECTOR VARIANCE	COVARIANCE (E & N)	SPEED MEAN (S)	SPEED VARIANCE (S)
70- III-22	12	0	3	-175.	149.	229.	17781.78	11842.20	14811.99	7066.62	286.	463.02
70- III-23	12	0	3	-185.	96.	236.	27754.37	27052.31	27403.34	8051.16	312.	470.22
70- III-24	12	0	3	-170.	124.	210.	17659.00	14161.79	15910.39	9563.63	275.	441.45
70- III-25	12	0	3	-124.	115.	169.	11754.74	14839.93	13297.31	5059.48	234.	305.29
70- III-26	12	0	3	-112.	73.	134.	23765.23	16855.97	20310.59	7645.79	241.	426.44
70- III-27	12	0	3	-129.	120.	176.	23823.27	17713.25	20768.26	10749.84	269.	485.93
70- III-28	12	0	3	-92.	162.	187.	21594.72	11648.09	16621.41	7046.61	260.	521.28
70- III-29	12	0	3	-95.	158.	185.	8281.18	10799.04	9540.11	5176.47	229.	748.46
70- III-30	12	0	3	-105.	61.	121.	9150.80	24046.22	16598.51	3781.97	218.	405.49
70- III-31	12	0	3	-120.	-89.	150.	12731.36	10451.54	11591.45	-2420.15	213.	384.40
70- IV - 1	12	0	3	17.	77.	79.	28730.51	34312.47	31521.48	3991.29	255.	195.16

STATS

*** EAST ***
*** MM/SEC ***

MEAN = -124.41   STD ERR = 3.35
VARIANCE = [illegible]
STD. DEV. = 139.24
KURTOSIS = 3.43
SKEWNESS = 1.01

*** NORTH ***
*** MM/SEC ***

MEAN = 94.36   STD ERR = 4.58
VARIANCE = 21049.23
STD. DEV. = 145.05
KURTOSIS = 2.36
SKEWNESS = -0.0541

*** SPEED ***
*** MM/SEC ***

MEAN = 251.75   STD ERR = 1.14
VARIANCE = 1327.29
STD. DEV. = 36.43
KURTOSIS = 2.55
SKEWNESS = 0.33

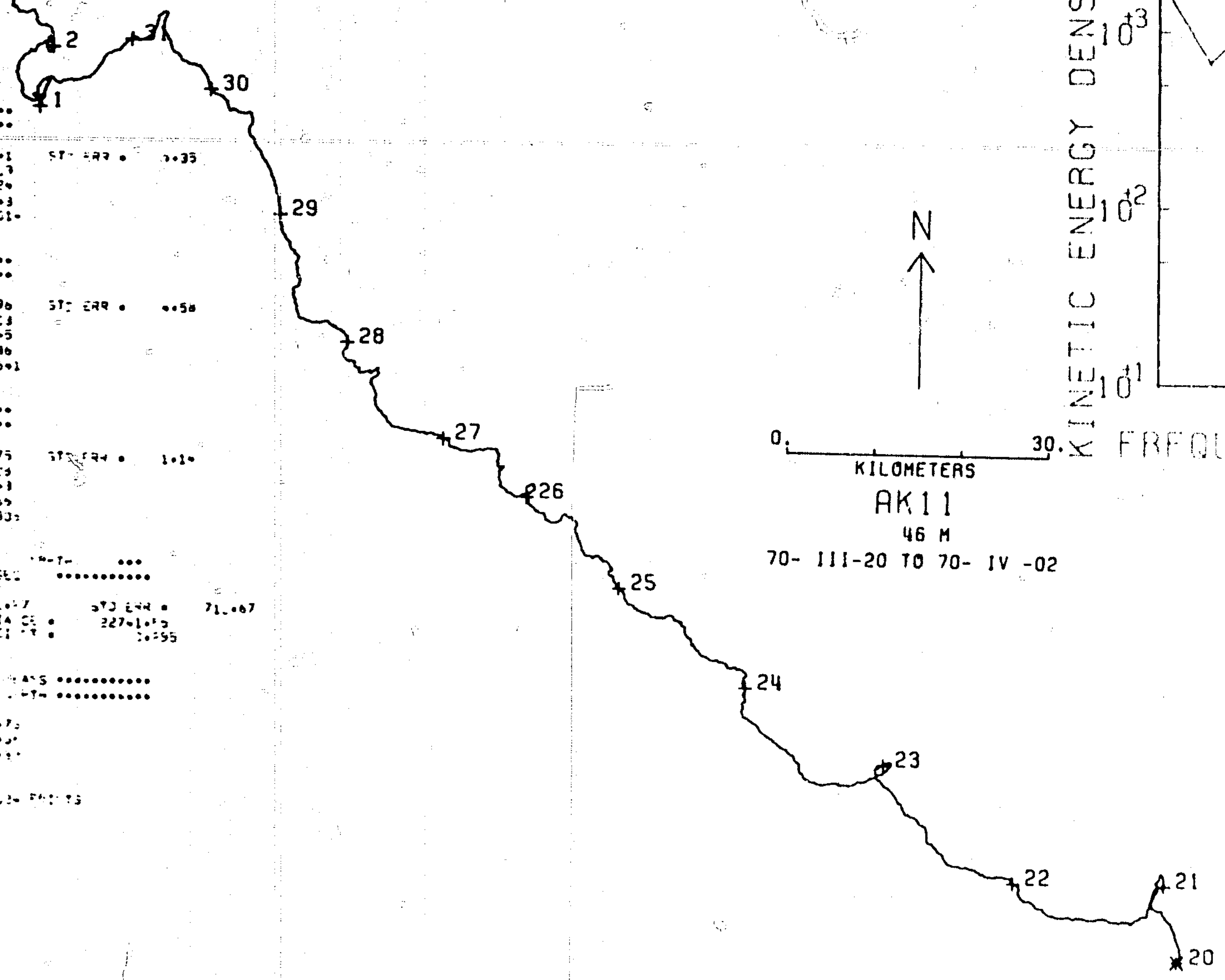
*** EAST & NORTH ***
*********** MM/SEC ***********

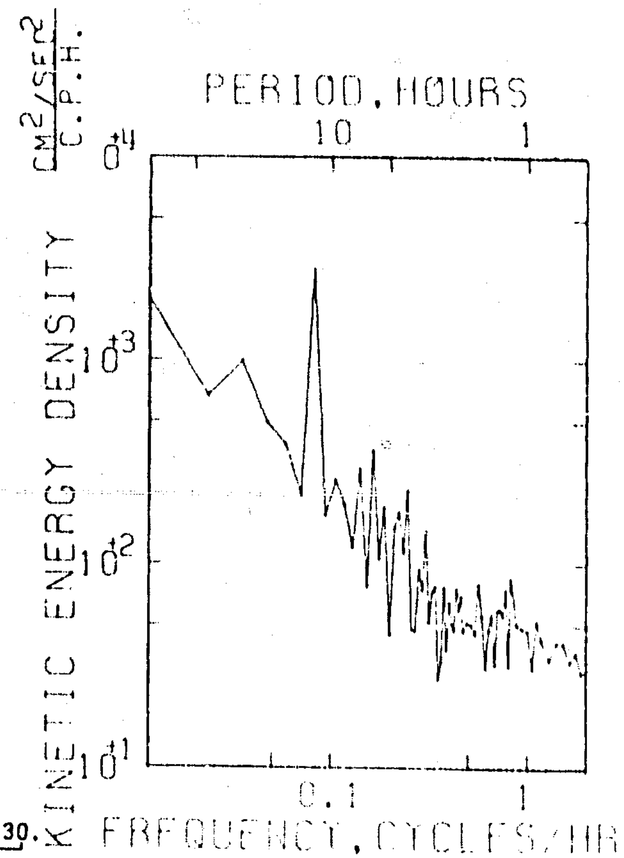
COVARIANCE = 4621.47   STD ERR = 71.67
STD. DEV. OF COVARIANCE = 2274.15
CORRELATION COEFFICIENT = [illegible]

*********** VECT. MEANS ***********
*********** EAST & NORTH ***********

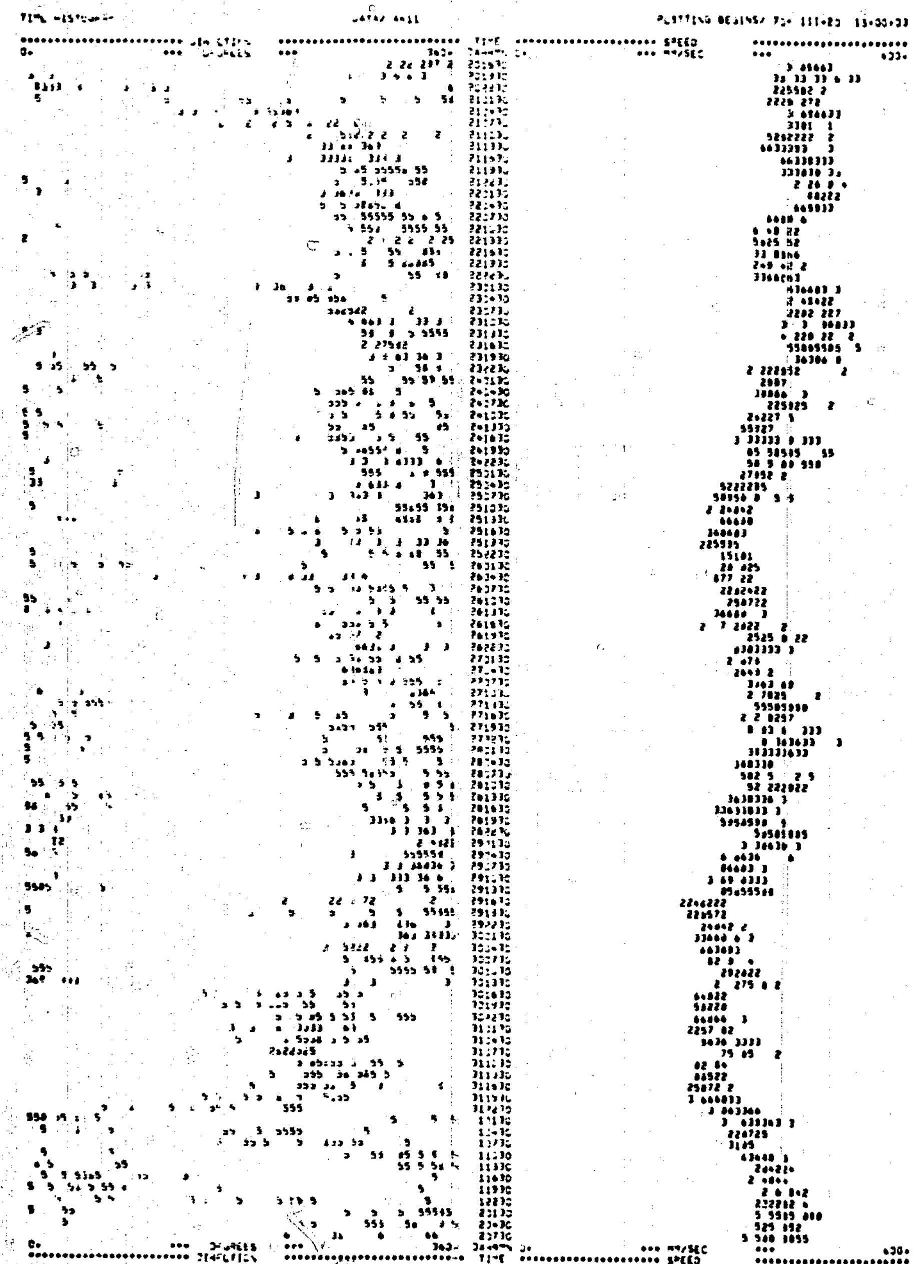
MEAN = [illegible]
VARIANCE = [illegible]
STD. DEV. = [illegible]

SAMPLE SIZE = [illegible] POINTS





AK11
BERGEN



DATA/ AK11

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FROM [illegible]
TO [illegible]

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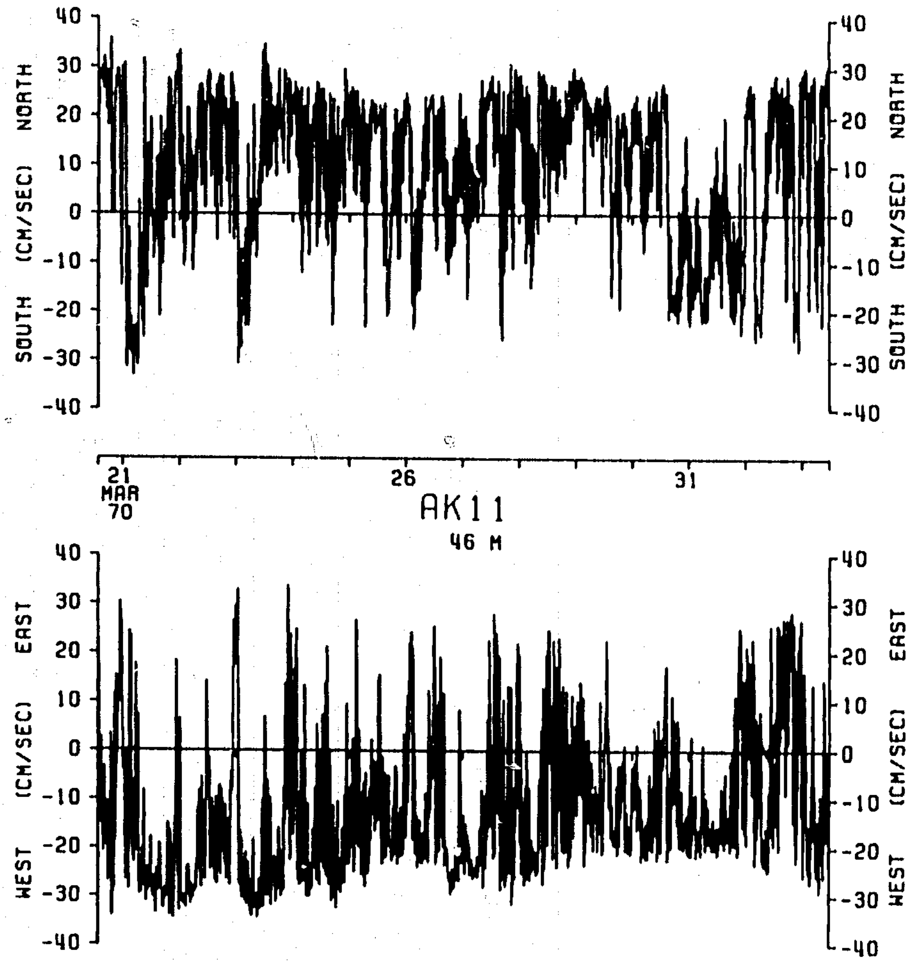
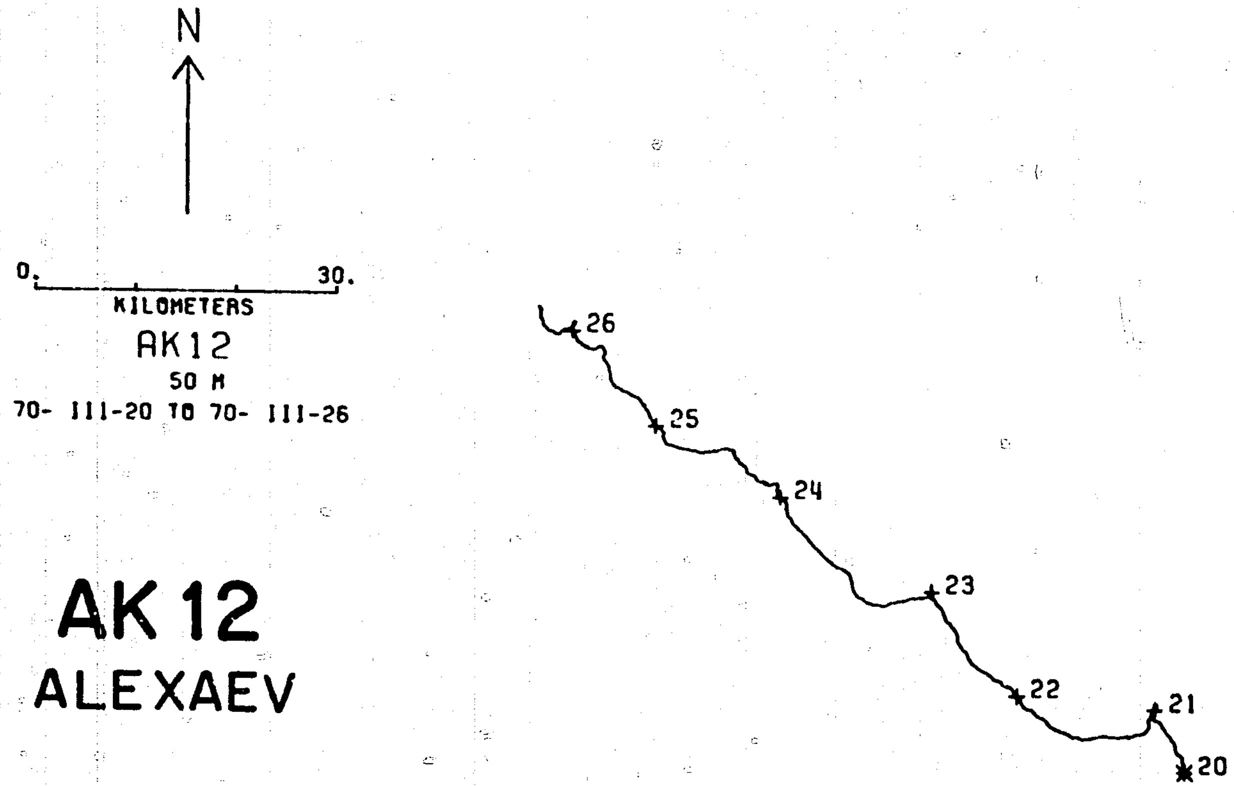
TOTAL NUMBER OF DATA SAMPLES = 102

NUMBER OF VACUOUS DATA SAMPLES = 0

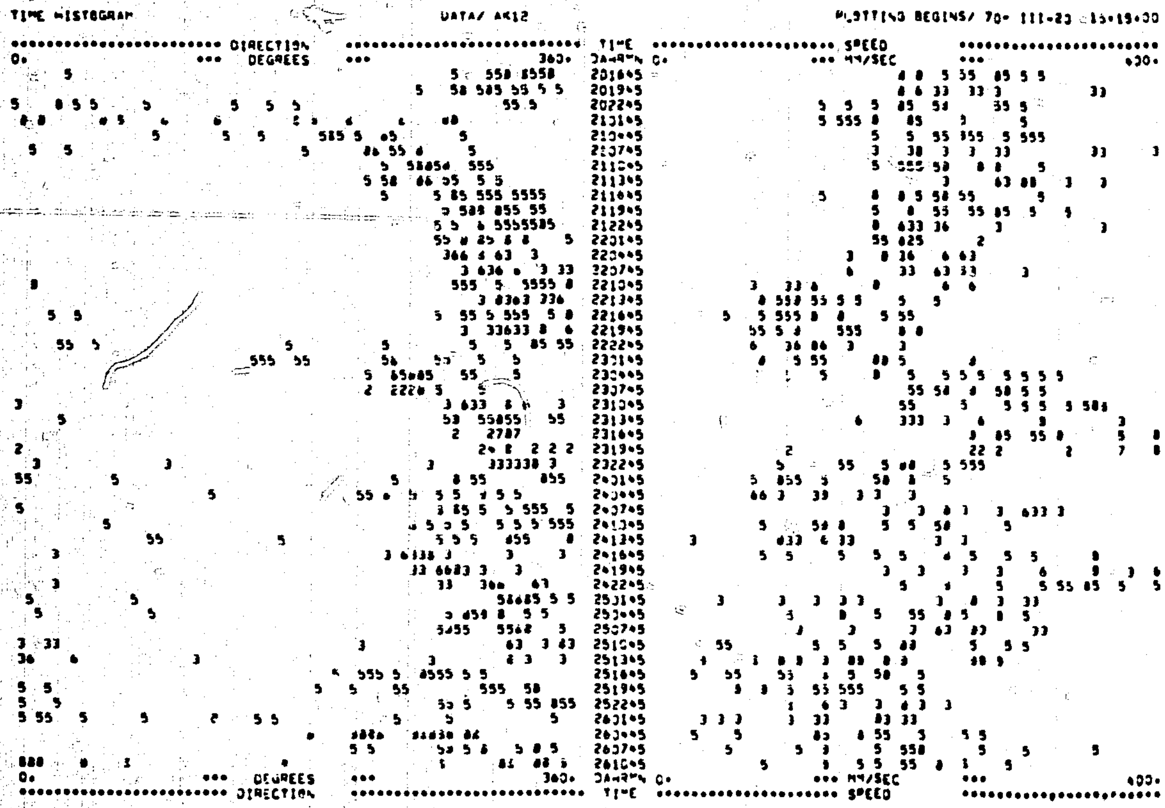


AK11

BERGEN



AK 12
ALEXAEV

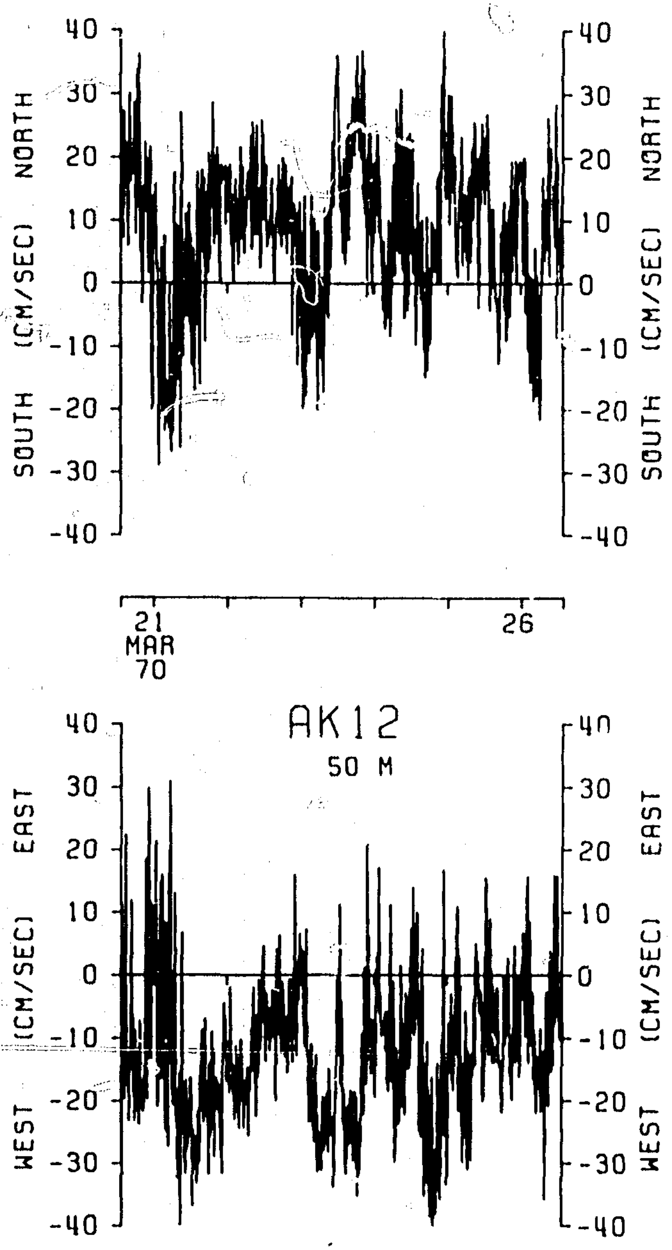


DATA/ AK12

SAMPLE SIZE = 10800.000 SECONDS

AK12

ALEXAEV



STATS

E = EAST UNITS = MM/SEC
N = NORTH UNITS = MM/SEC

DATE	MID TIME HR	MID TIME MIN	MID TIME SEC	MEAN (E)	MEAN (N)	VECTOR MEAN	VARIANCE (E)	VARIANCE (N)	VECTOR VARIANCE	COVARIANCE (E & N)	SPEED (UNITS = MM/SEC) MEAN (M)	SPEED VARIANCE (M)
70- III-22	12	0	0	-3.	59.	59.	3554.27	3791.48	3672.87	-27.34	102.	291.13
70- III-23	12	0	0	-34.	63.	72.	2844.80	2058.79	2451.79	499.87	98.	406.24
70- III-24	12	0	0	-21.	62.	65.	2499.22	2709.05	2604.13	948.59	95.	462.49
70- III-25	12	0	0	-18.	79.	81.	5064.32	5012.20	5038.26	332.35	124.	1330.16
70- III-26	12	0	0	-103.	41.	111.	1446.51	5792.85	3619.68	-1004.13	135.	1370.79
70- III-27	12	0	0	10.	69.	70.	7550.05	10137.95	8844.00	-679.06	145.	1554.16
70- III-28	12	0	0	-111.	74.	133.	4282.11	7658.09	5970.10	1876.40	169.	1018.06
70- III-29	12	0	0	-43.	48.	64.	2826.23	4642.87	3734.55	364.93	104.	790.58
70- III-30	12	0	0	-65.	102.	121.	5918.95	2734.67	4326.81	1060.05	148.	1515.01
70- III-31	12	0	0	-69.	59.	91.	1580.13	2206.82	1893.48	133.21	106.	937.11
70- IV - 1	12	0	0	-33.	71.	78.	6497.47	4103.62	5300.54	-374.93	130.	1129.47

STATS

*** EAST ***
*** MM/SEC ***

MEAN = [illegible] ST ERR = 2.32
VARIANCE = [illegible]
STD. DEV. = [illegible]
KURTOSIS = [illegible]
SKEWNESS = [illegible]

*** NORTH ***
*** MM/SEC ***

MEAN = [illegible] ST ERR = 2.20
VARIANCE = [illegible]
STD. DEV. = [illegible]
KURTOSIS = [illegible]
SKEWNESS = [illegible]

*** SPEED ***
*** MM/SEC ***

MEAN = [illegible] ST ERR = 1.22
VARIANCE = [illegible]
STD. DEV. = [illegible]
KURTOSIS = [illegible]
SKEWNESS = [illegible]

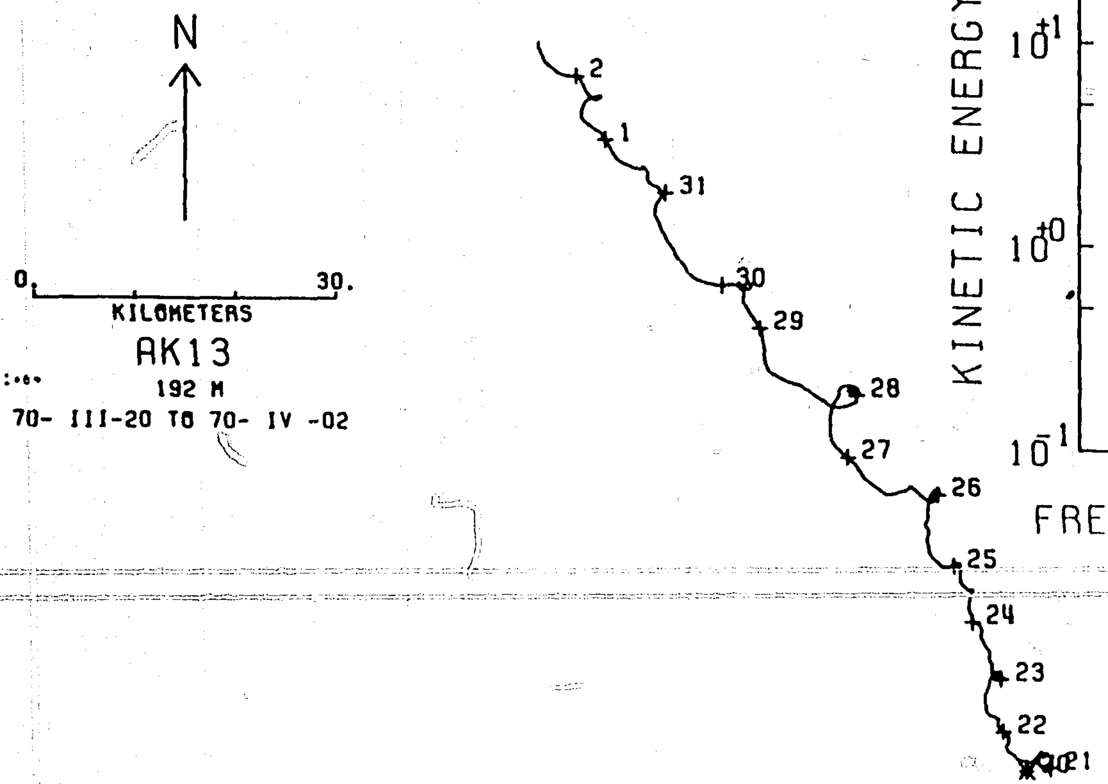
*** EAST NORTH ***
*********** MM/SEC ***********

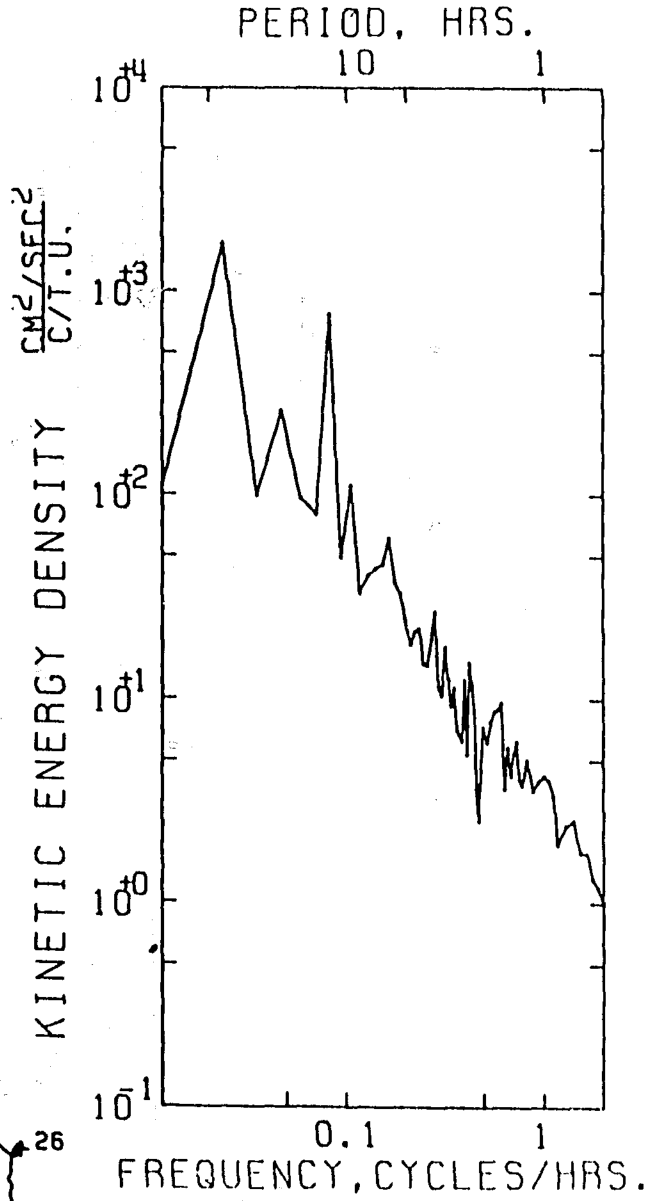
COVARIANCE = [illegible] STD ERR = [illegible]
STD. DEV. OF COVARIANCE = [illegible]
CORRELATION COEFFICIENT = [illegible]

*********** VECTOR MEANS ***********
*********** EAST & NORTH ***********

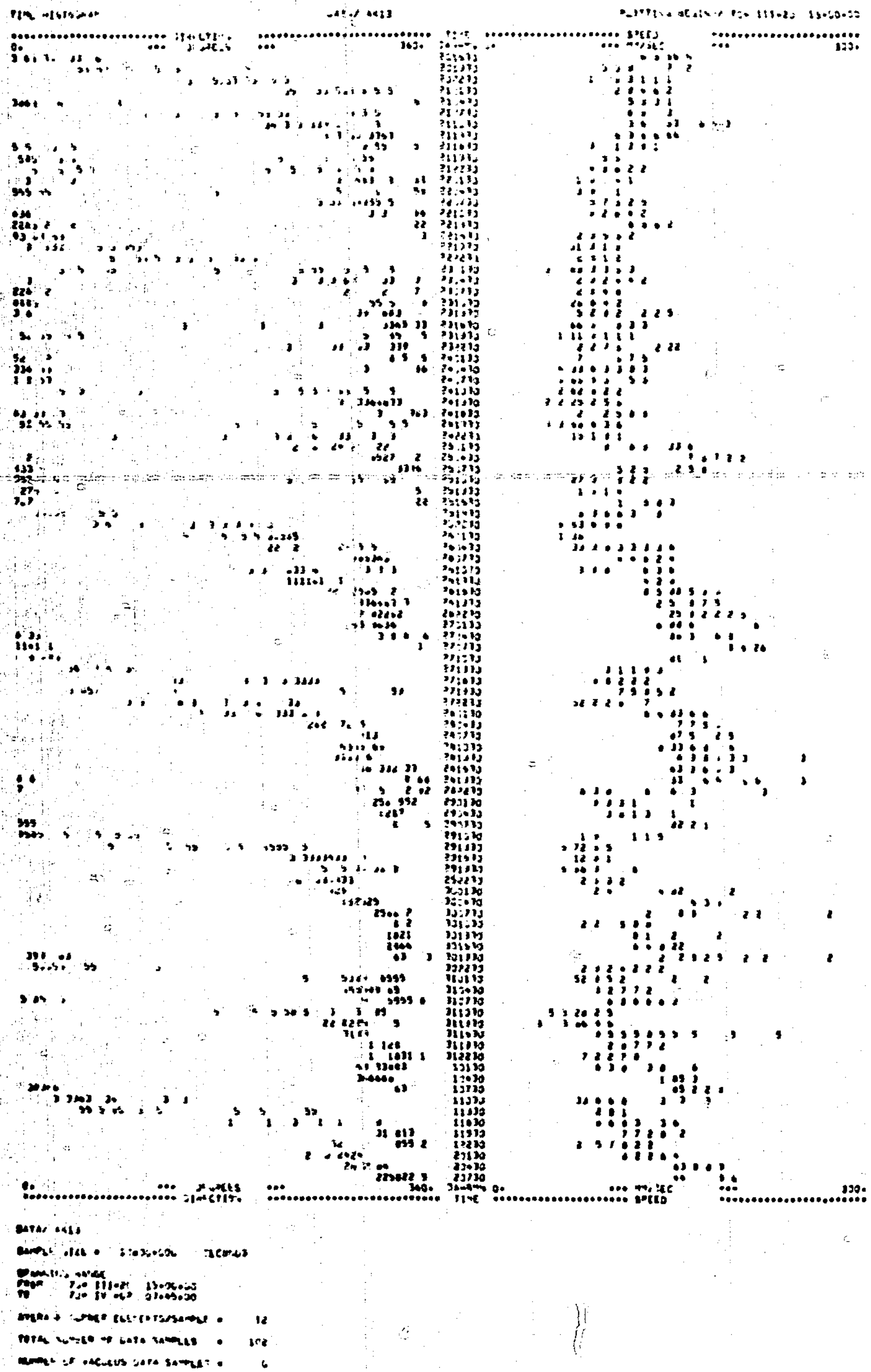
MEAN = [illegible]
VARIANCE = [illegible]
STD. DEV. = [illegible]

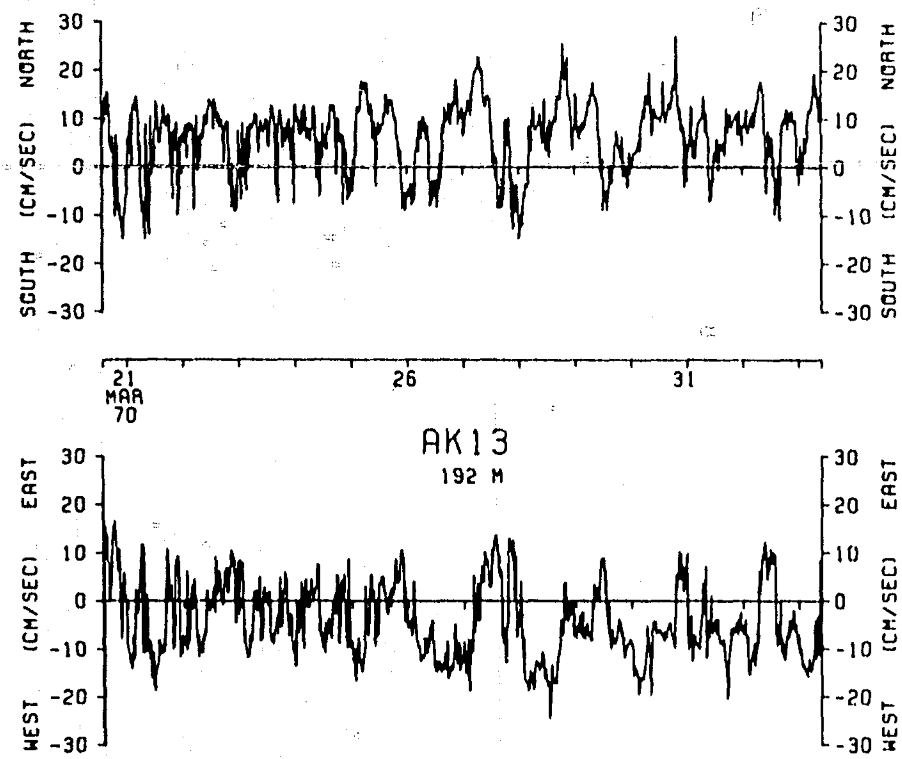
SAMPLE [illegible] POINTS





AK13
LSK





SOUTH (CM/SEC) NORTH
30
20
10
0
-10
-20
-30
21
MAR
70
26
31
AK13
192 M
WEST (CM/SEC) EAST

AK13

LSK

STATS06

E = EAST UNITS = MM/SEC
N = NORTH UNITS = MM/SEC

DATE	MID TIME CMR HR. SEC	MEAN (E)	MEAN (N)	VECTOR MEAN	VARIANCE (E)	VARIANCE (N)	VECTOR VARIANCE	COVARIANCE (E & N)	SPEED MEAN (M)	SPEED VARIANCE (M)
70- III-22	12:11:19	-18.	53.	55.	2632.78	5670.58	4136.68	622.34	92.	1657.66
70- III-23	12:11:19	-55.	63.	84.	2130.96	2877.56	2507.26	525.26	103.	1189.46
70- III-24	12:11:19	-75.	57.	58.	2857.66	5470.65	4164.15	1732.42	91.	1386.08
70- III-25	12:11:19	-13.	64.	45.	4572.18	6256.25	5414.21	303.72	106.	1834.23
70- III-26	12:11:19	-52.	71.	118.	1874.86	5558.56	3716.71	1046.28	111.	2126.68
70- III-27	12:11:19	16.	41.	44.	5211.55	9798.85	7505.20	2071.49	118.	1642.22
70- III-28	12:11:19	-93.	89.	129.	5180.69	3863.83	4522.22	1882.12	144.	2487.44
70- III-29	12:11:19	-34.	22.	40.	2639.43	3943.68	3291.56	67.86	137.	2513.55
70- III-30	12:11:19	-65.	83.	105.	4913.99	3352.40	4133.19	1263.23	110.	2244.10
70- III-31	12:11:19	-68.	46.	82.	2867.29	3246.54	3054.92	-434.89	113.	2281.72
70- IV -01	12:11:19	-24.	75.	78.	7970.03	5154.85	6562.44	624.32	97.	2233.24

STATS06

*** EAST ***
*** MM/SEC ***

MEAN = -43.30 STD ERR = 2.18
VARIANCE = 4881.71
STD. DEV. = 69.87
KURTOSIS = 2.50
SKEWNESS = .087

*** NORTH ***
*** MM/SEC ***

MEAN = 59.36 STD ERR = 2.29
VARIANCE = 5362.14
STD. DEV. = 73.23
KURTOSIS = 2.92
SKEWNESS = -.324

*** SPEED ***
*** MM/SEC ***

MEAN = 115.53 STD ERR = 1.50
VARIANCE = 2295.48
STD. DEV. = 47.91
KURTOSIS = 2.22
SKEWNESS = -.029

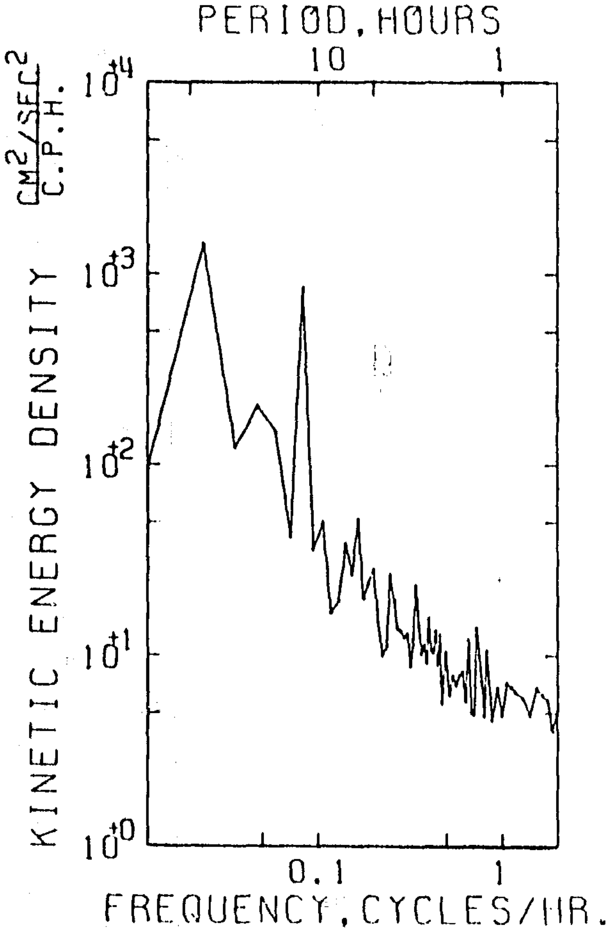
*** EAST & NORTH ***
*********** MM/SEC ***********

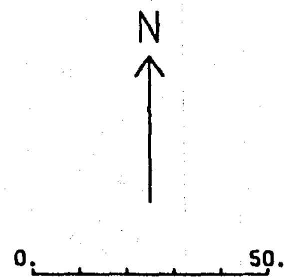
COVARIANCE = 946.30 STD ERR = 201.26
STD. DEV. OF COVARIANCE = 6440.34
CORRELATION COEFFICIENT = .107

*********** VECTOR MEANS ***********
*********** EAST & NORTH ***********

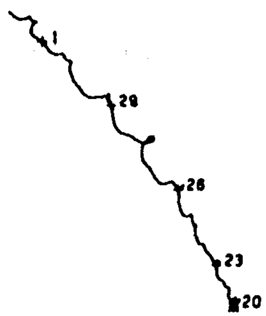
MEAN = 73.48
VARIANCE = 5121.92
STD. DEV. = 71.57

SAMPLE SIZE = 1024 POINTS

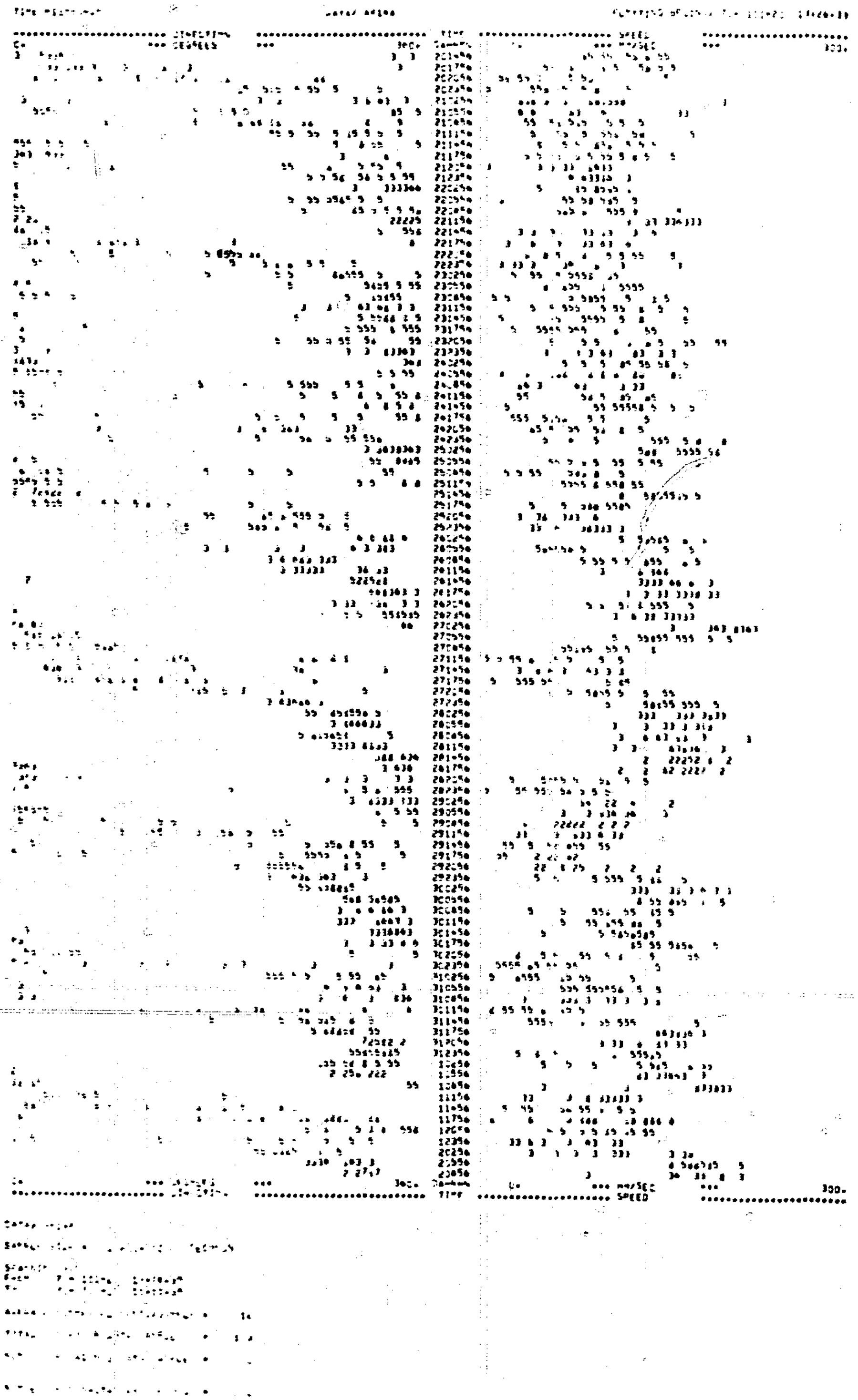


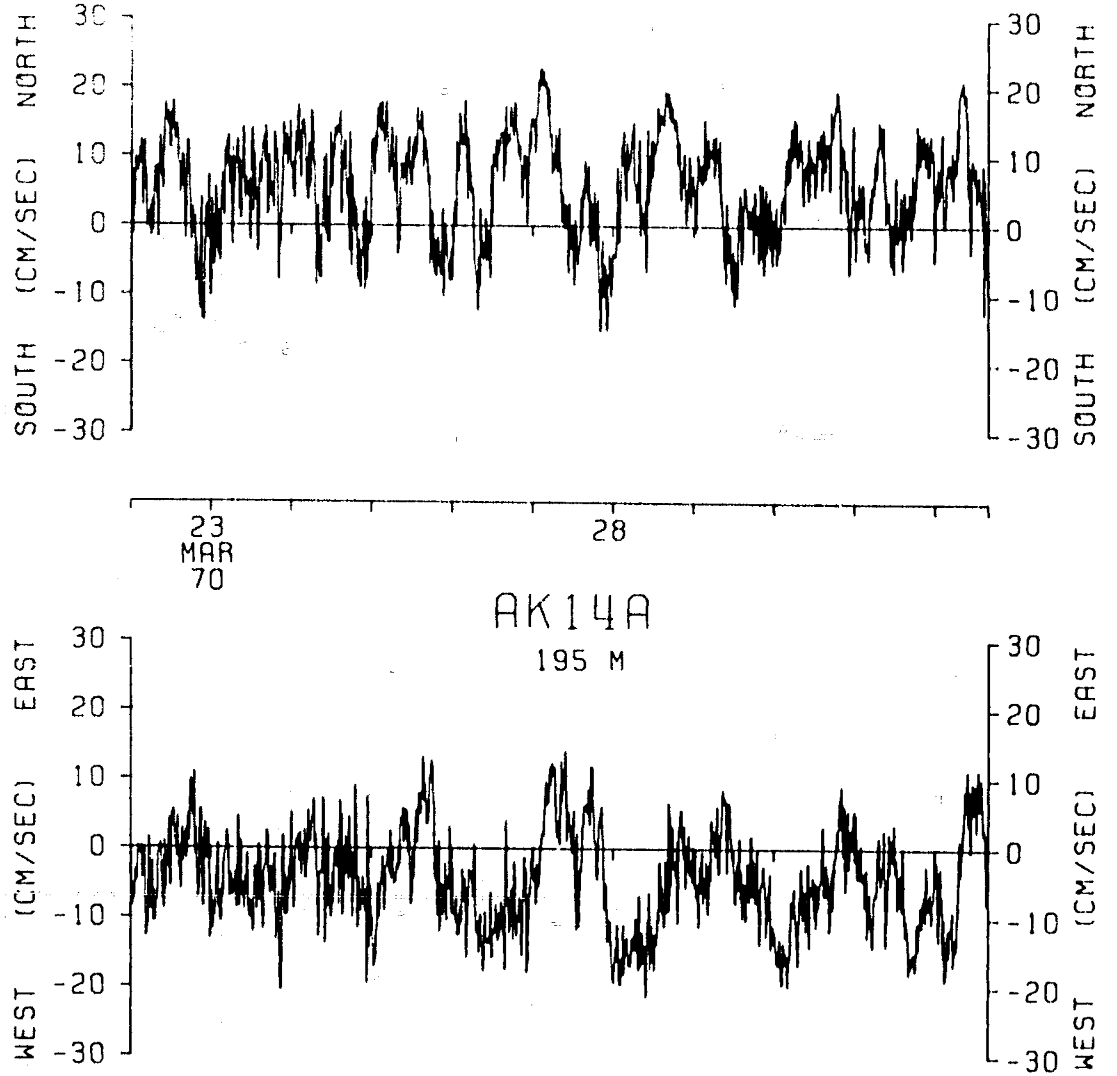


AK14A
195 M
70- III-20 TO 70- IV -02



AK14A
GEODYNE





AK 14A

GEODYNE

STATS

E = EAST UNITS = MM/SEC
N = NORTH UNITS = MM/SEC

DATE	MID TIME HR	MID TIME MIN	MID TIME SEC	MEAN (E)	MEAN (N)	VECTOR MEAN	VARIANCE (E)	VARIANCE (N)	VECTOR VARIANCE	COVARIANCE (E & N)	SPEED (UNITS = MM/SEC) MEAN (+)	SPEED VARIANCE (+)
70- III-22	12	0	0	-23.	65.	69.	3468.20	8055.09	5761.64	112.23	105.	5164.49
70- III-23	12	0	0	-71.	72.	102.	5536.65	7234.69	6385.66	-546.21	131.	6000.51
70- III-24	12	0	0	-20.	67.	70.	6341.42	9513.63	7927.52	3327.69	120.	6321.66
70- III-25	12	0	0	-17.	97.	98.	9608.69	11830.75	10704.72	882.24	154.	7359.33
70- III-26	12	0	0	-129.	137.	188.	5740.22	13642.46	9691.34	2601.66	221.	6177.65
70- III-27	12	0	0	6.	65.	66.	12335.51	21993.39	17164.45	7373.45	160.	13102.04
70- III-28	12	0	0	-141.	140.	199.	16544.90	10433.16	13489.03	3826.38	240.	9325.94
70- III-29	12	0	0	-62.	28.	68.	5810.65	7972.48	6891.56	1765.93	122.	3512.92
70- III-30	12	0	0	-99.	142.	174.	13470.39	8011.46	10740.92	2275.29	212.	6626.91
70- III-31	12	0	0	-101.	71.	124.	8718.41	8207.93	8463.17	-1323.81	156.	7750.25
70- IV - 1	12	0	0	-55.	87.	103.	12092.68	11702.56	11897.62	1227.81	181.	11005.63

STATS

*** EAST ***
*** MM/SEC ***

MEAN = -64.78 STD ERR = 3.34
VARIANCE = 11392.16
STD. DEV.= 106.73
KURTOSIS = 2.84
SKEWNESS = -0.222

*** NORTH ***
*** MM/SEC ***

MEAN = 90.14 STD ERR = 3.44
VARIANCE = 12149.39
STD. DEV.= 110.22
KURTOSIS = 2.60
SKEWNESS = 0.199

*** SPEED ***
*** MM/SEC ***

MEAN = 163.26 STD ERR = 3.00
VARIANCE = 9209.28
STD. DEV.= 95.97
KURTOSIS = 2.15
SKEWNESS = 0.266

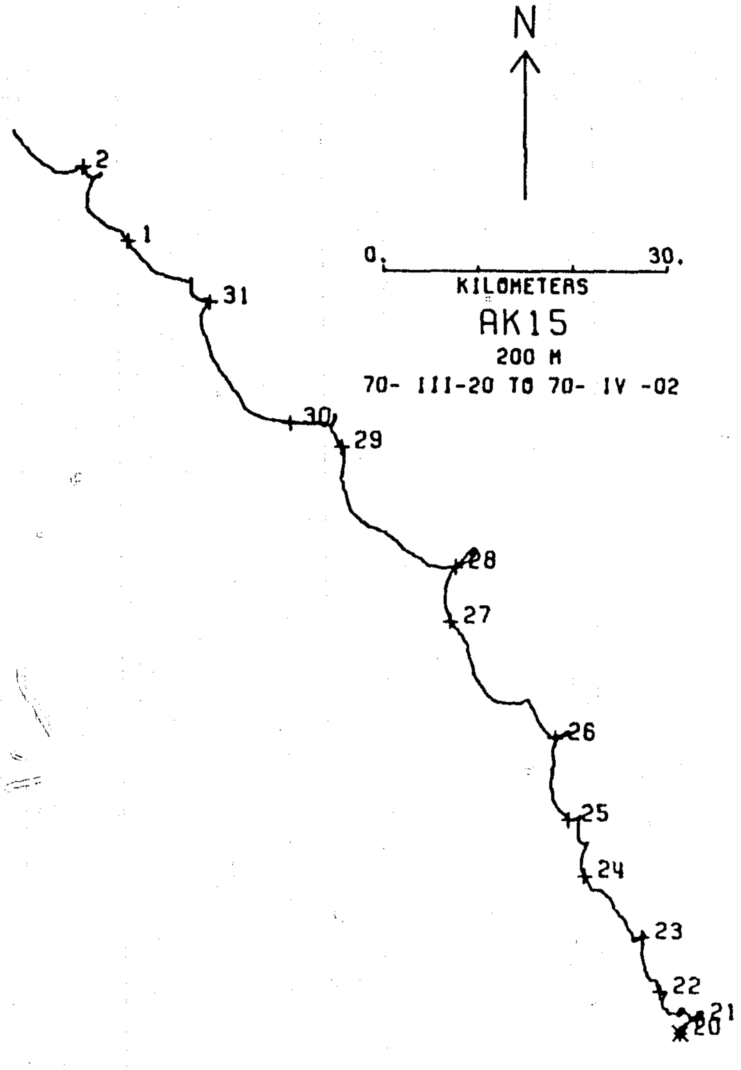
*** EAST & NORTH ***
*********** MM/SEC ***********

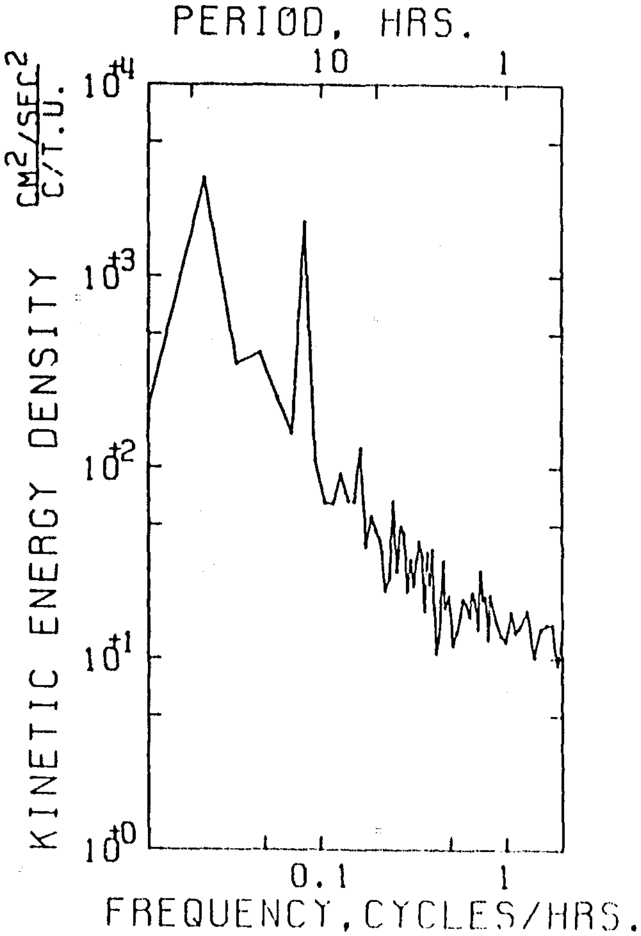
COVARIANCE = 910.36 STD ERR = 537.49
STD. DEV. OF COVARIANCE = 17193.42
CORRELATION COEFFICIENT = 0.077

*********** VECTOR MEANS ***********
*********** EAST & NORTH ***********

MEAN = 111.03
VARIANCE = 11770.77
STD. DEV.= 108.49

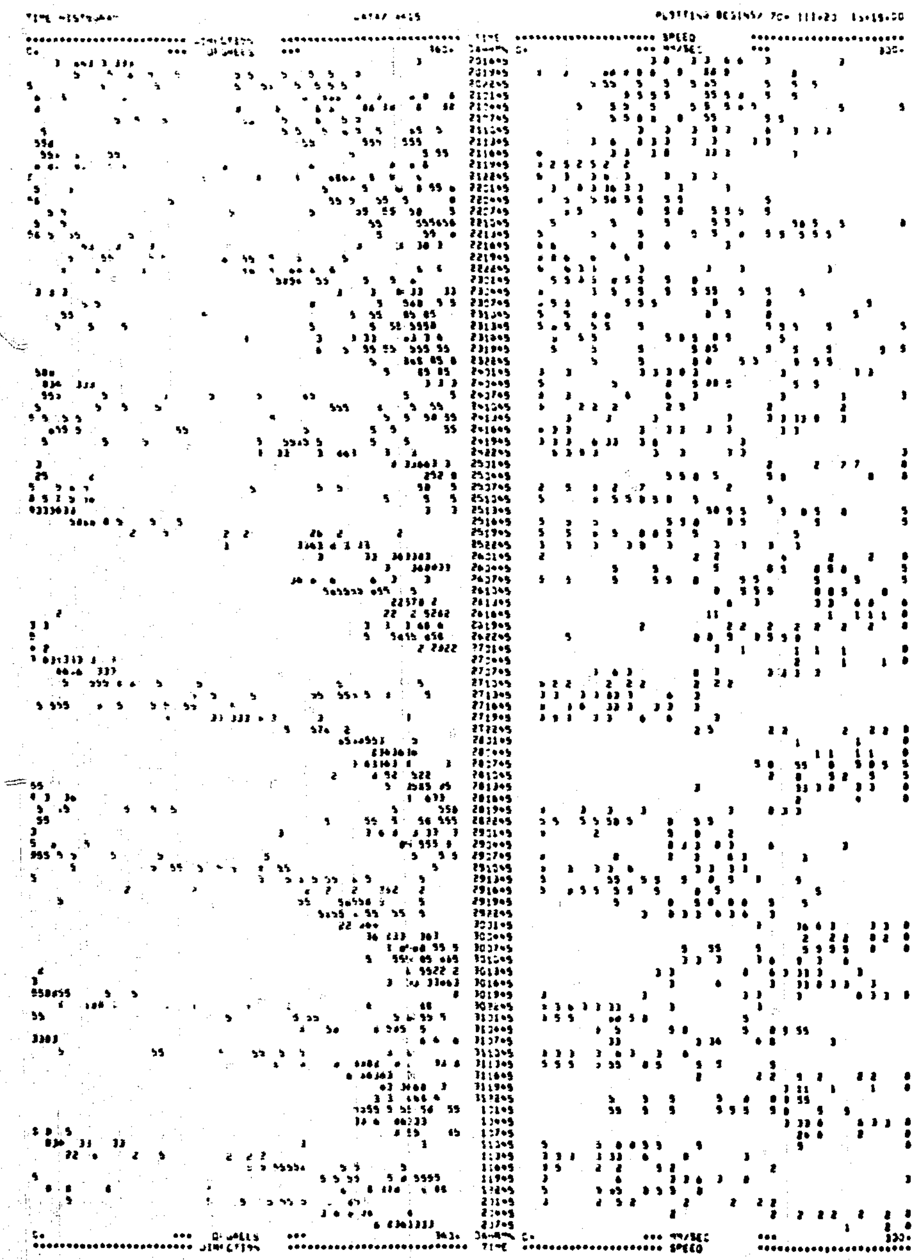
SAMPLE SIZE = 1024 POINTS





AK 15

ALEXAEV



DATA/ AK15

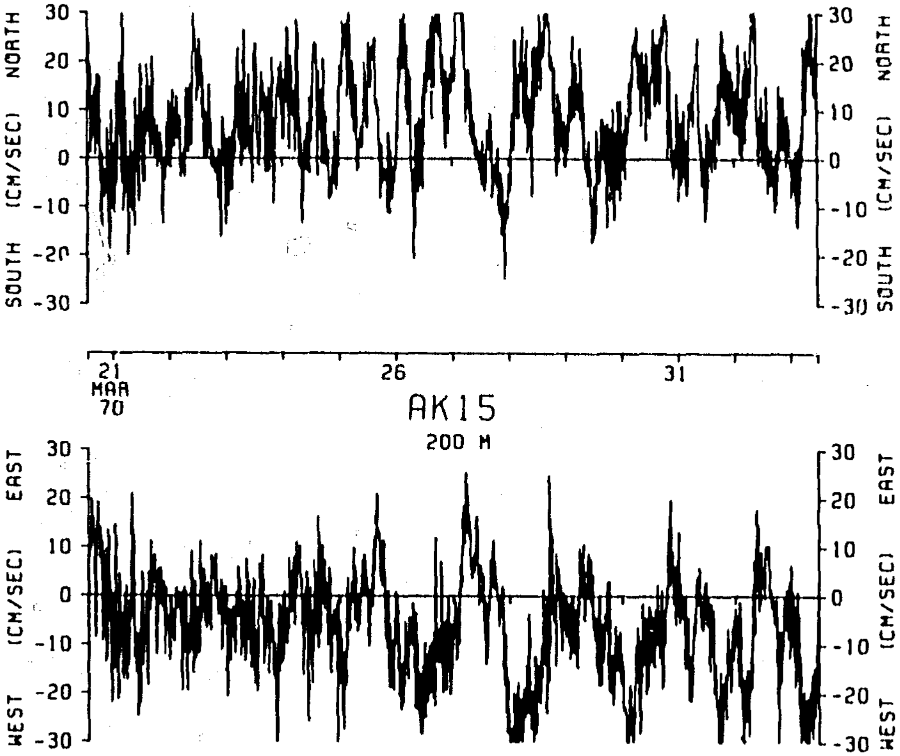
SAMPLE SIZE = [illegible] SECONDS

[illegible]
FROM [illegible]
TO [illegible]

AVERAGE NUMBER ELEMENTS/SAMPLE = 12

TOTAL NUMBER OF DATA SAMPLES = 10[illegible]

NUMBER OF VACUOUS DATA SAMPLE = 0



AK15
ALEXAEV

STATS

E = EAST UNITS = MM/SEC
N = NORTH UNITS = MM/SEC

DATE	MID TIME HR	MID TIME MIN	MID TIME SEC	MEAN (E)	MEAN (N)	VECTOR MEAN	VARIANCE (E)	VARIANCE (N)	VECTOR VARIANCE	COVARIANCE (E & N)	SPEED (UNITS = MM/SEC) MEAN (M)	SPEED VARIANCE (M)
70- III-22	12	0	0	-56.	151.	161.	1225.45	8119.99	4672.72	-2811.59	197.	319.76
70- III-23	12	0	0	1.	-36.	36.	6634.75	35036.99	20835.87	-12628.76	193.	532.92
70- III-24	12	0	0	47.	-145.	152.	1547.22	5513.94	3530.58	-2226.47	200.	444.25
70- III-25	12	0	0	44.	-125.	133.	421.75	1432.52	927.14	-701.93	190.	620.44
70- III-26	12	0	0	47.	-135.	143.	365.75	1883.60	1124.68	-679.62	150.	581.91
70- III-27	12	0	0	53.	-160.	168.	1311.15	3064.46	2187.80	-1601.43	143.	323.89
70- III-28	12	0	0	56.	-160.	169.	577.20	1022.91	800.05	-711.52	165.	554.67
70- III-29	12	0	0	47.	-131.	139.	139.22	1087.40	613.31	-389.08	180.	372.11
70- III-30	12	0	0	44.	-129.	137.	153.12	1196.03	674.58	-427.95	159.	548.10
70- III-31	12	0	0	44.	-124.	133.	284.46	1431.05	857.75	-619.83	129.	270.60
70- IV - 1	12	0	0	56.	-160.	170.	86.24	334.88	210.56	-75.49	144.	488.18

STATS

*** EAST ***
*** MM/SEC ***

MEAN = [illegible] STD ERR = [illegible]
VARIANCE = [illegible]
STD. DEV. = [illegible]
KURT SIG = [illegible]
SKEW SIG = [illegible]

*** NORTH ***
*** MM/SEC ***

MEAN = [illegible] STD ERR = 3.6[illegible]
VARIANCE = [illegible]
STD. DEV. = [illegible]
KURT SIG = [illegible]
SKEW SIG = [illegible]

*** SPEED ***
*** MM/SEC ***

MEAN = [illegible] STD ERR = [illegible]
VARIANCE = [illegible]
STD. DEV. = [illegible]
KURT SIG = [illegible]
SKEW SIG = [illegible]

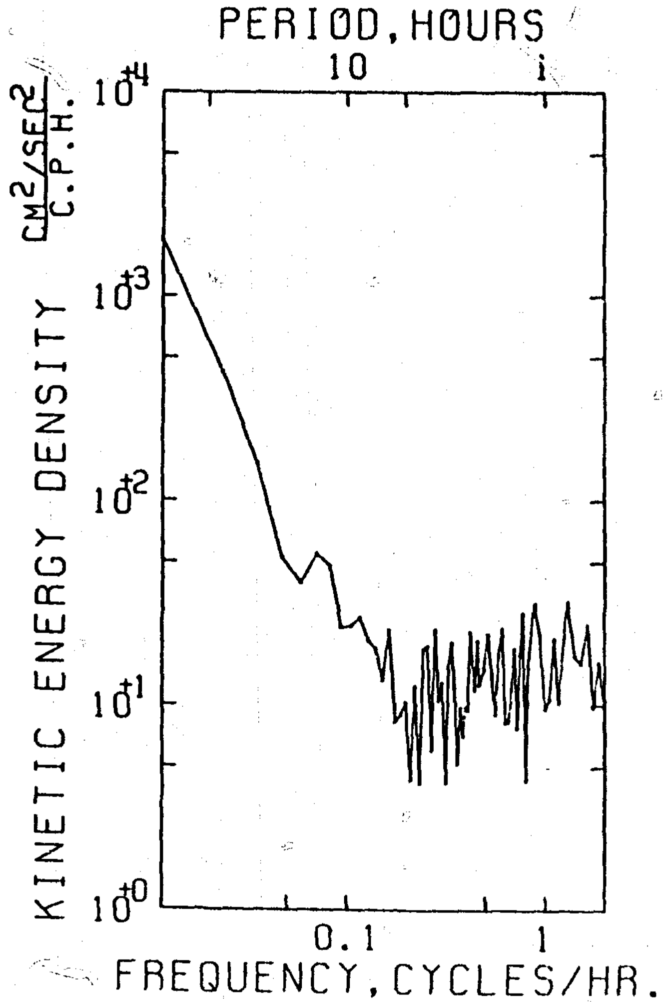
*** EAST NORTH ***
*********** MM/SEC ***********

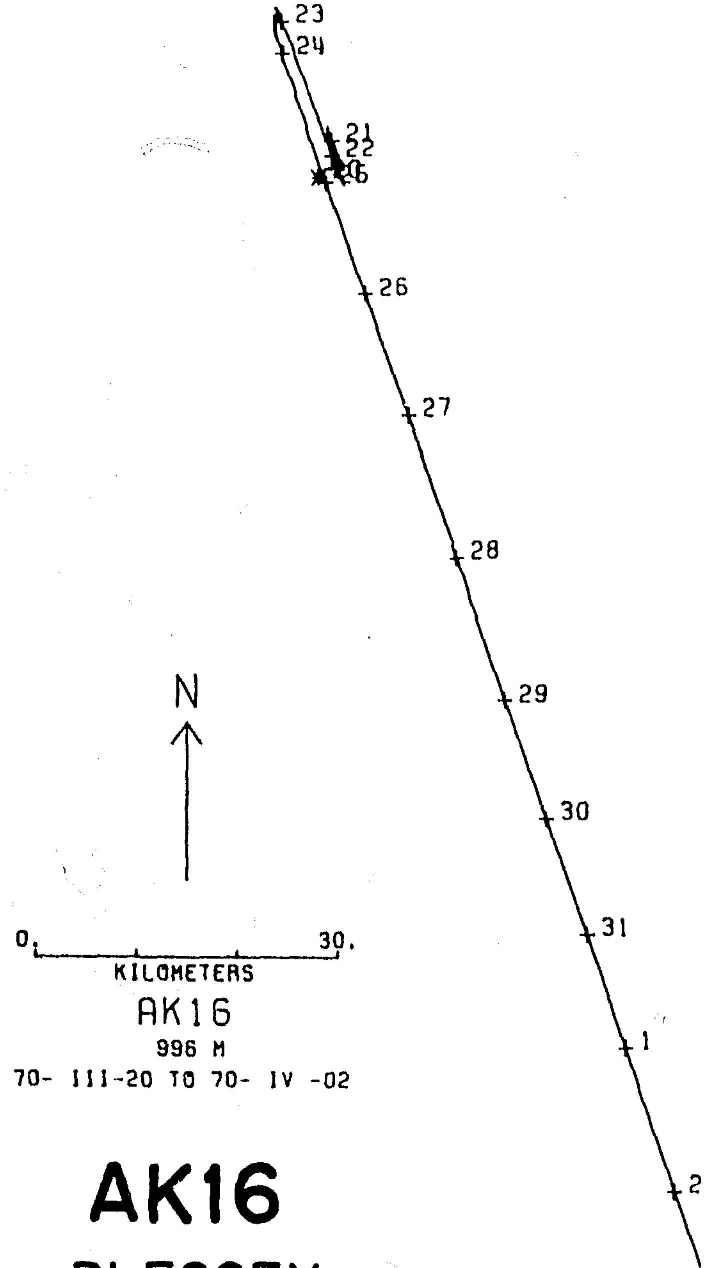
COVARIANCE = [illegible] STD ERR = [illegible]
STD. DEV. OF COVARIANCE = [illegible]
CORRELATION COEFFICIENT = [illegible]

*********** VECT - MEANS ***********
*********** EAST , NORTH ***********

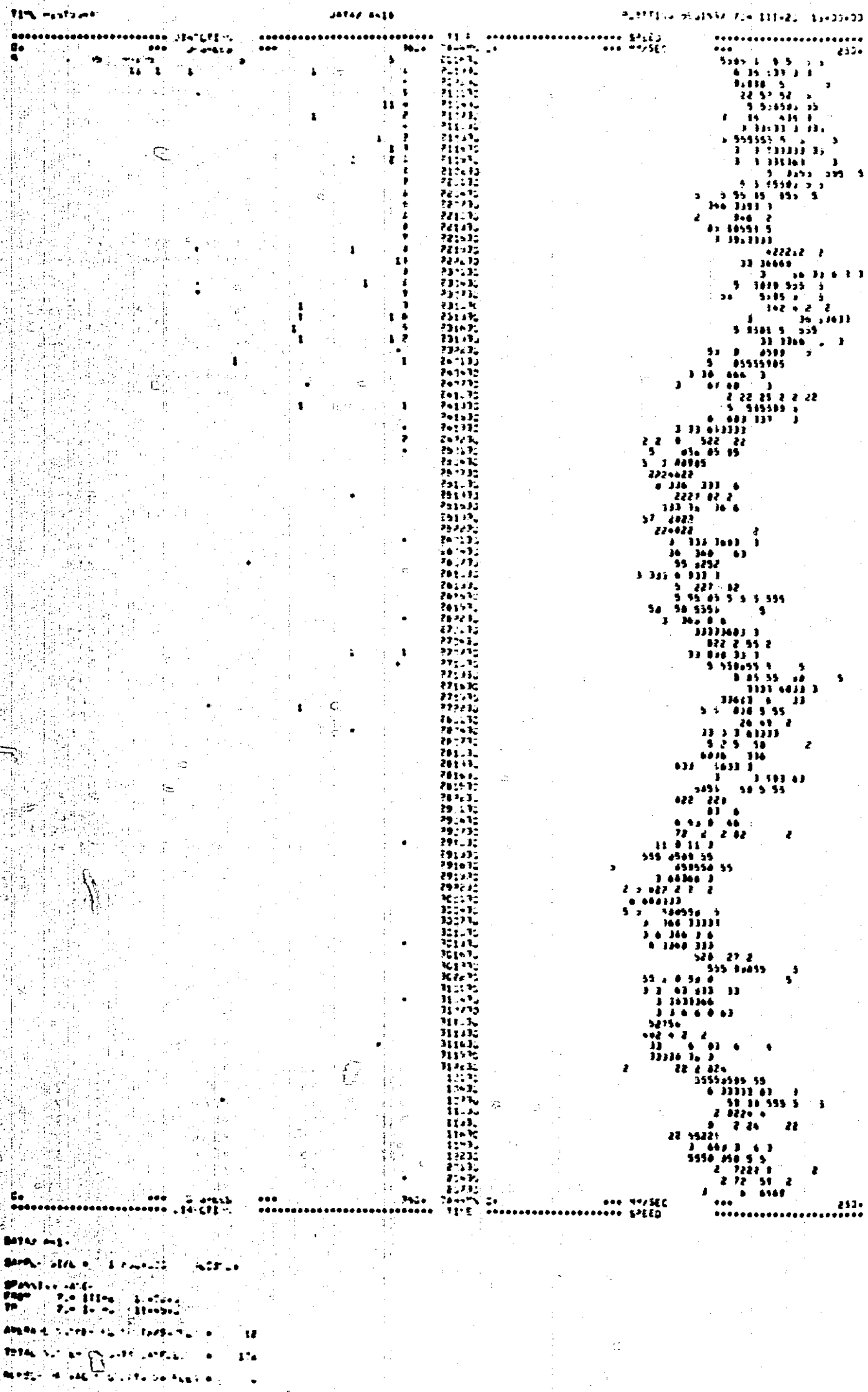
MEAN = [illegible]
VARIANCE = [illegible]
STD. DEV. = [illegible]

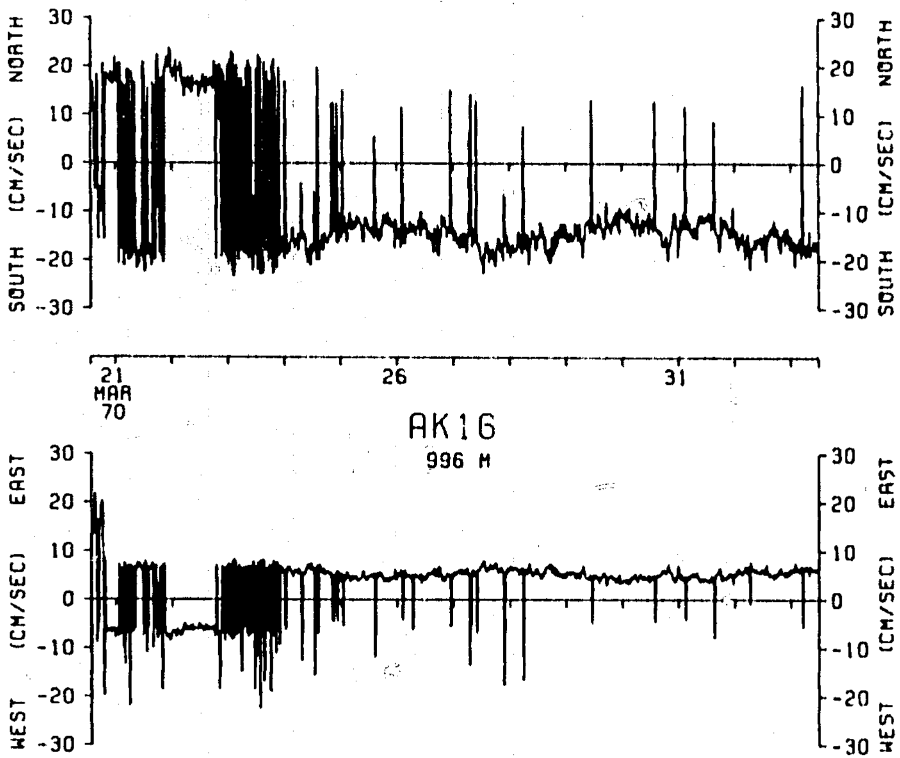
SAMPLE SIZE = [illegible] POINTS





AK16
PLESSEY





AK16
PLESSEY

STATS

E = EAST
N = NORTH

UNITS = MM/SEC
UNITS = MM/SEC

DATE	MID TIME HR	MIN	SEC	MEAN (E)	MEAN (N)	VECTOR MEAN	VARIANCE (E)	VARIANCE (N)	VECTOR VARIANCE	COVARIANCE (E & N)	SPEED UNITS = MM/SEC MEAN (N)	VARIANCE (N)
70- III-22	12	0	0	6.	10.	12.	1403.38	2164.26	1783.82	512.79	53.	867.70
70- III-23	12	0	0	-10.	23.	25.	2966.99	3415.20	3191.10	-144.12	78.	989.58
70- III-24	12	0	0	-20.	31.	36.	3302.40	2596.55	2949.47	-151.80	75.	1662.33
70- III-25	12	0	0	-13.	22.	25.	2219.61	1493.24	1856.43	585.27	59.	871.43
70- III-26	12	0	0	-11.	31.	33.	2477.70	2229.00	2353.35	124.98	69.	1017.18
70- III-27	12	0	0	-10.	26.	28.	1370.06	1608.88	1489.47	95.76	57.	555.20
70- III-28	12	0	0	-18.	28.	33.	1961.40	2109.92	2035.66	-866.80	63.	1197.74
70- III-29	12	0	0	-4.	34.	34.	1549.31	2406.92	1988.11	-1.13	66.	782.25
70- III-30	12	0	0	-27.	37.	46.	1370.63	2991.63	2181.13	-268.40	71.	1405.98
70- III-31	12	0	0	-26.	26.	37.	2621.45	3679.13	3150.29	232.92	83.	793.13
70- IV - 1	12	0	0	-15.	39.	42.	3002.05	3575.99	3289.02	-454.04	98.	1319.31

STATS

... EAST ...
... MM/SEC ...

MEAN = -14.13 STD ERR = 1.49
VARIANCE = 2284.63
STD. DEV.= 47.54
KURTOSIS = 2.72
SKEWNESS = 0.190

... NORTH ...
... MM/SEC ...

MEAN = 28.64 STD ERR = 1.61
VARIANCE = 2650.13
STD. DEV.= 51.48
KURTOSIS = 2.63
SKEWNESS = -0.017

... SPEED ...
... MM/SEC ...

MEAN = 69.24 STD ERR = 1.07
VARIANCE = 1164.85
STD. DEV.= 34.13
KURTOSIS = 2.77
SKEWNESS = 0.473

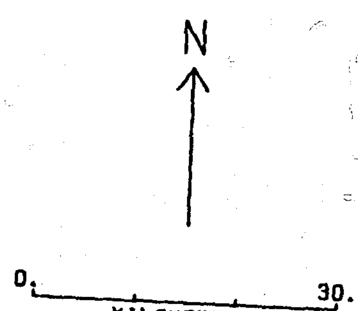
... EAST & NORTH ...
.... MM/SEC ....

COVARIANCE = -55.56 STD ERR = 91.63
STD. DEV. OF COVARIANCE = 2935.41
CORRELATION COEFFICIENT = -0.023

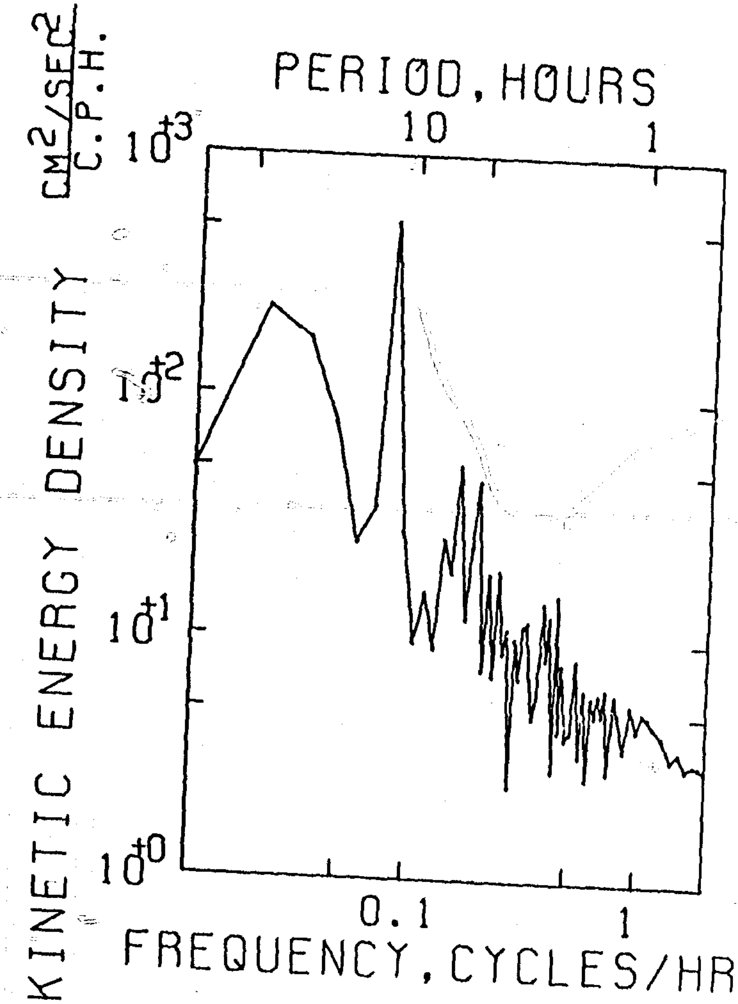
.... VECTOR MEANS ....
.... EAST & NORTH ....

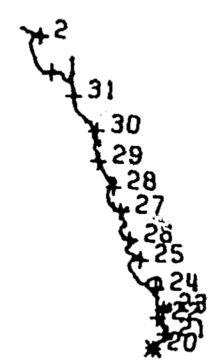
MEAN = 31.94
VARIANCE = 2469.35
STD. DEV.= 49.69

SAMPLE SIZE = 102. POINTS

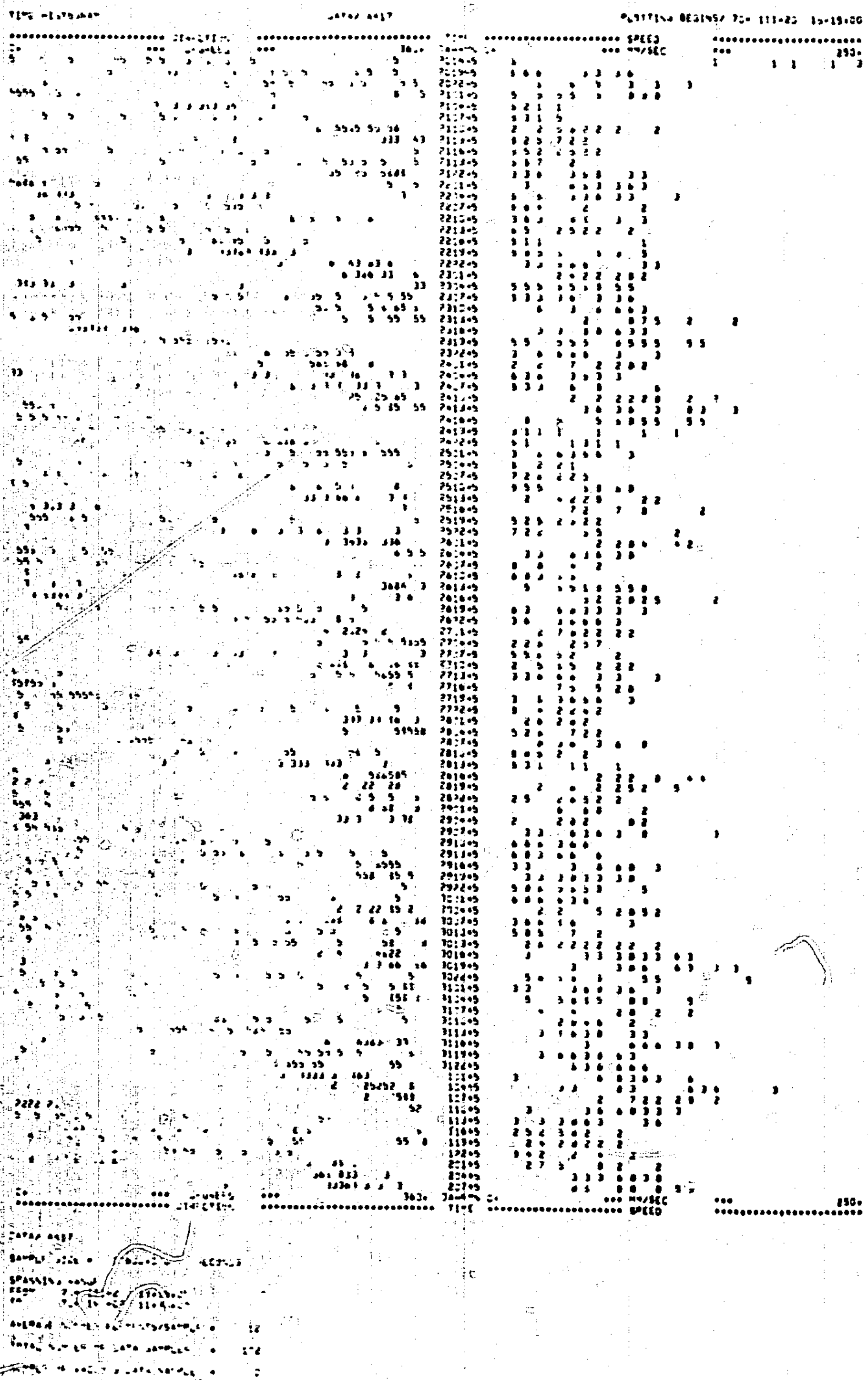


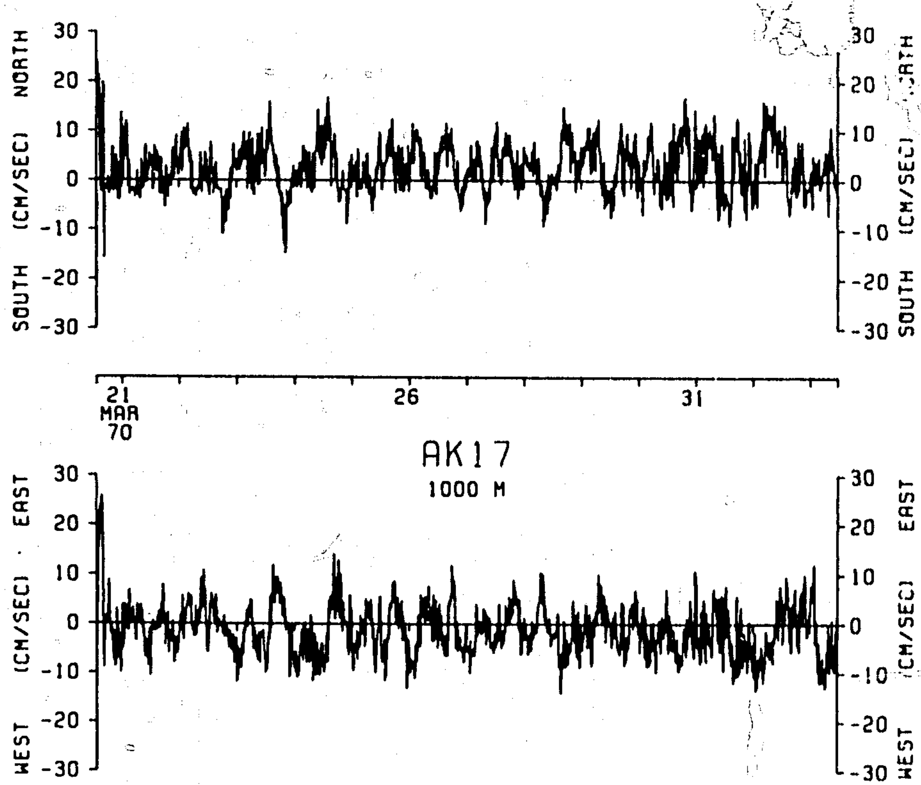
AK17
1000 M
70- III-20 TO 70- IV -02





AK17
ALEXAEV





AK17
ALEXAEV

STATS

E = EAST UNITS = MM/SEC
N = NORTH UNITS = MM/SEC

DATE	MID TIME HR	MIN	SEC	MEAN (E)	MEAN (N)	VECTOR MEAN	VARIANCE (E)	VARIANCE (N)	VECTOR VARIANCE	COVARIANCE (E & N)	SPEED UNITS = MM/SEC MEAN (4)	VARIANCE (4)
70- III-22	12	0	1	-122.	38.	186.	6485.47	24067.58	15276.52	3307.46	252.	1339.81
70- III-23	12	0	1	-132.	102.	167.	17596.10	26218.06	21907.08	10377.59	266.	965.42
70- III-24	12	0	1	-114.	123.	168.	18648.23	15968.66	17308.47	7730.44	248.	1380.26
70- III-25	12	0	1	-111.	114.	159.	9966.81	12954.03	11475.42	3660.20	215.	1822.98
70- III-26	12	0	1	-179.	156.	237.	1413.20	3052.17	2232.69	451.33	244.	943.97
70- III-27	12	0	1	-199.	153.	251.	9048.4[illegible]	15461.65	12255.03	3929.54	291.	2396.66
70- III-28	12	0	1	-193.	174.	260.	14112.44	19125.66	16619.05	10052.26	312.	3190.18
70- III-29	12	0	1	-209.	77.	222.	6578.87	21447.24	14013.05	3863.97	275.	1980.11
70- III-30	12	0	1	-117.	183.	217.	21517.28	10629.36	16073.32	2014.44	268.	7153.35
70- III-31	12	0	1	-100.	91.	135.	13885.54	12846.28	13365.91	2713.59	208.	1602.64
70- IV - 1	12	0	1	-37.	212.	38.	17206.95	15108.22	16157.58	-582.03	186.	1060.11

STATS

*** EAST ***
*** MM/SEC ***

MEAN = -147.42 STD ERR = 3.73
VARIANCE = 14243.79
STD. DEV. = 119.35
KURTOSIS = 1.48
SKEWNESS = 0.391

*** NORTH ***
*** MM/SEC ***

MEAN = 114.29 STD ERR = 4.20
VARIANCE = 18101.54
STD. DEV. = 134.54
KURTOSIS = 2.39
SKEWNESS = -0.743

*** SPEED ***
*** MM/SEC ***

MEAN = 253.56 STD ERR = 1.81
VARIANCE = 3366.87
STD. DEV. = 58.02
KURTOSIS = 3.16
SKEWNESS = 0.394

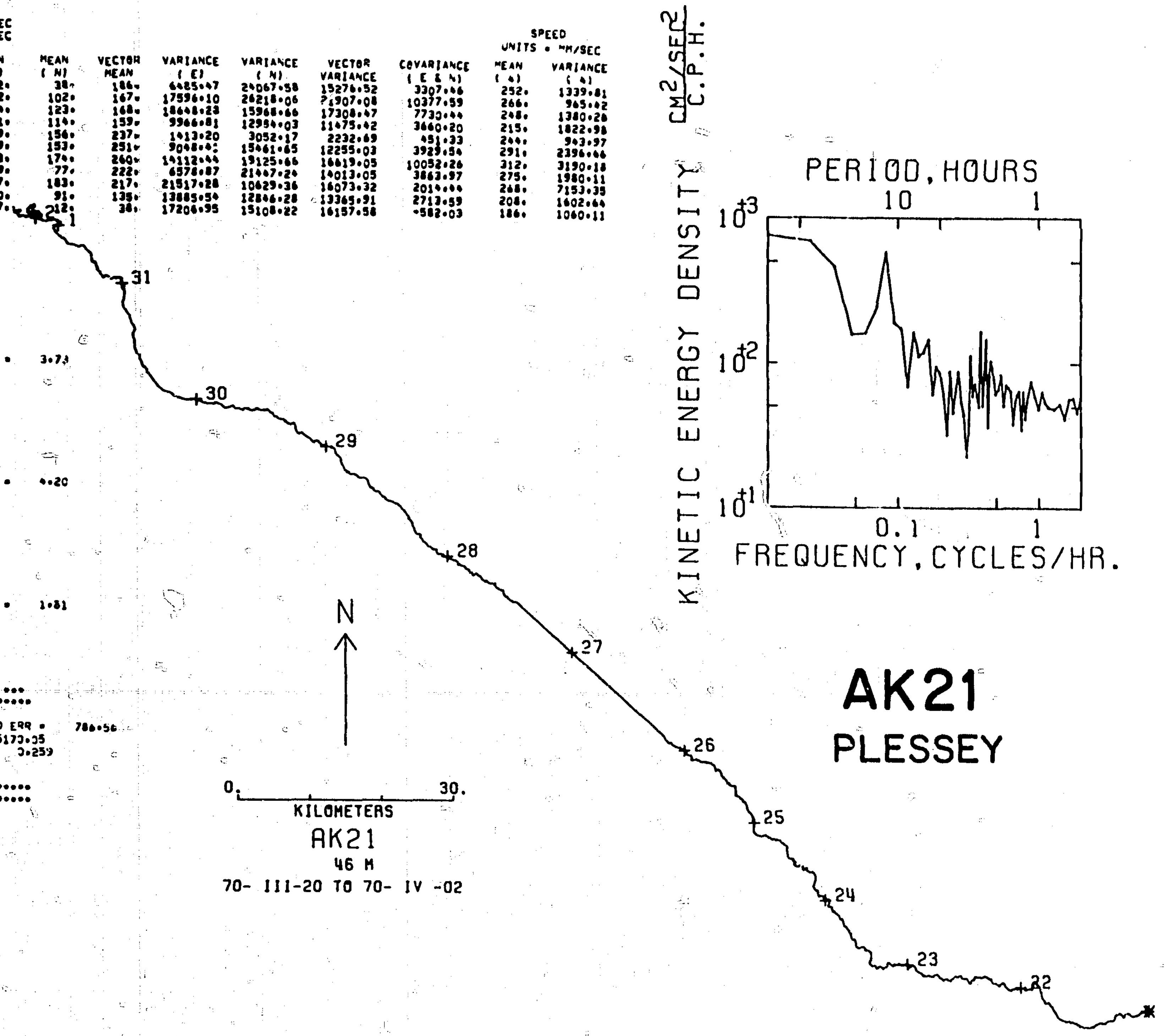
*** EAST & NORTH ***
************ MM/SEC ************

COVARIANCE = 4155.44 STD ERR = 786.56
STD. DEV. OF COVARIANCE = 25170.05
CORRELATION COEFFICIENT = 0.259

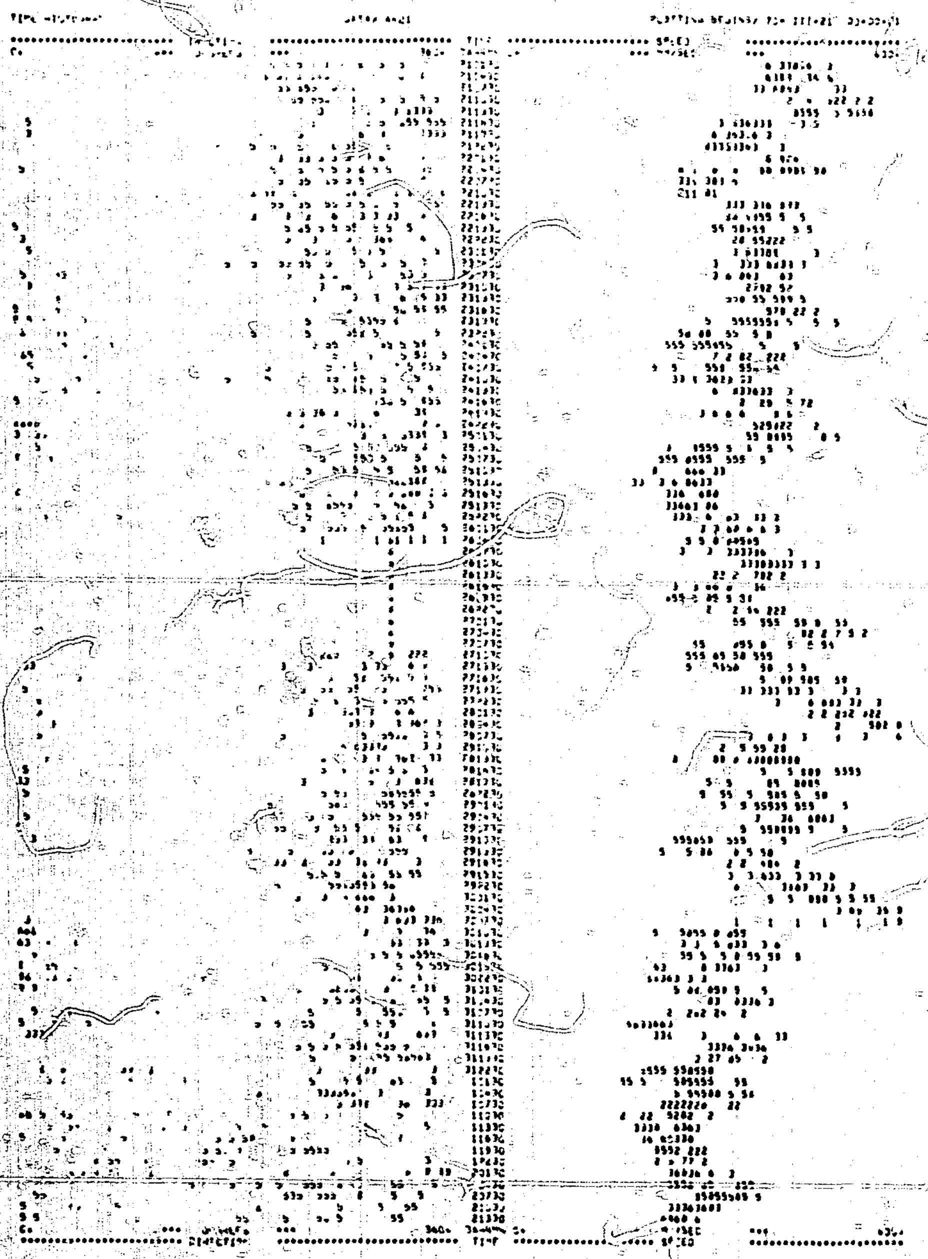
************ VECTOR MEANS ************
************ EAST & NORTH ************

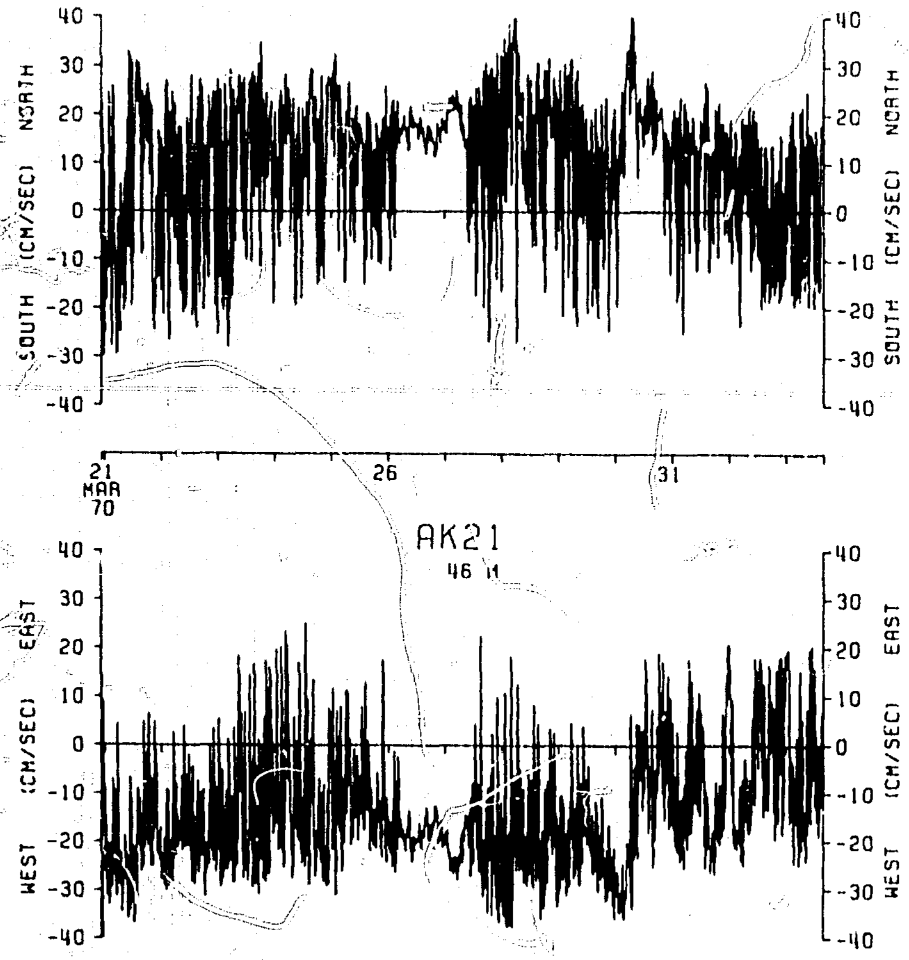
MEAN = 137.93
VARIANCE = 16172.65
STD. DEV. = 127.17

SAMPLE SIZE = 1024 POINTS



AK21
PLESSEY





AK21
PLESSEY

STATS

E = EAST   UNITS = MM/SEC
N = NORTH   UNITS = MM/SEC

DATE	MID TIME HR	MID TIME MIN	MID TIME SEC	MEAN (E)	MEAN (N)	VECTOR MEAN	VARIANCE (E)	VARIANCE (N)	VECTOR VARIANCE	COVARIANCE (E & N)	SPEED UNITS = MM/SEC MEAN (S)	SPEED VARIANCE (S)
70- III-22	12	0	0	-135.	36.	140.	10469.72	13698.70	12084.21	3797.80	200.	3511.36
70- III-23	12	0	0	-144.	40.	165.	12033.53	16332.22	14182.87	3959.51	227.	4066.49
70- III-24	12	0	0	-140.	124.	187.	10392.16	15295.99	12844.07	3223.49	231.	7235.15
70- III-25	12	0	0	-100.	108.	147.	8015.82	16483.46	12249.64	5583.43	200.	6080.11
70- III-26	12	0	0	-183.	120.	219.	9[illegible]2.68	12144.92	10578.80	4581.77	256.	3550.77
70- III-27	12	0	0	-229.	152.	275.	17250.41	13038.56	15144.48	4193.74	313.	7905.63
70- III-28	12	0	0	-232.	192.	301.	13793.21	12916.84	13355.02	3926.48	332.	7223.34
70- III-29	12	0	0	-248.	93.	265.	10767.47	14929.33	12848.40	2264.51	300.	5794.78
70- III-30	12	0	0	-132.	176.	220.	35442.71	12675.67	24059.19	-4758.10	288.	13726.00
70- III-31	12	0	0	-111.	93.	145.	18121.08	10329.35	14225.21	2263.48	209.	5561.19
70- IV - 1	12	0	0	-28.	21.	35.	12751.40	9771.64	11261.52	699.66	159.	2737.87

STATS

*** EAST ***
*** MM/SEC ***

MEAN = -157.15   STD ERR = 4.20
VARIANCE = 18035.50
STD. DEV.= 134.30
KURTOSIS = 2.69
SKEWNESS = 0.293

*** NORTH ***
*** MM/SEC ***

MEAN = 113.10   STD ERR = 3.91
VARIANCE = 15640.82
STD. DEV.= 125.06
KURTOSIS = 2.88
SKEWNESS = -0.284

*** SPEED ***
*** MM/SEC ***

MEAN = 249.68   STD ERR = 2.94
VARIANCE = 8825.78
STD. DEV.= 93.95
KURTOSIS = 2.57
SKEWNESS = 0.378

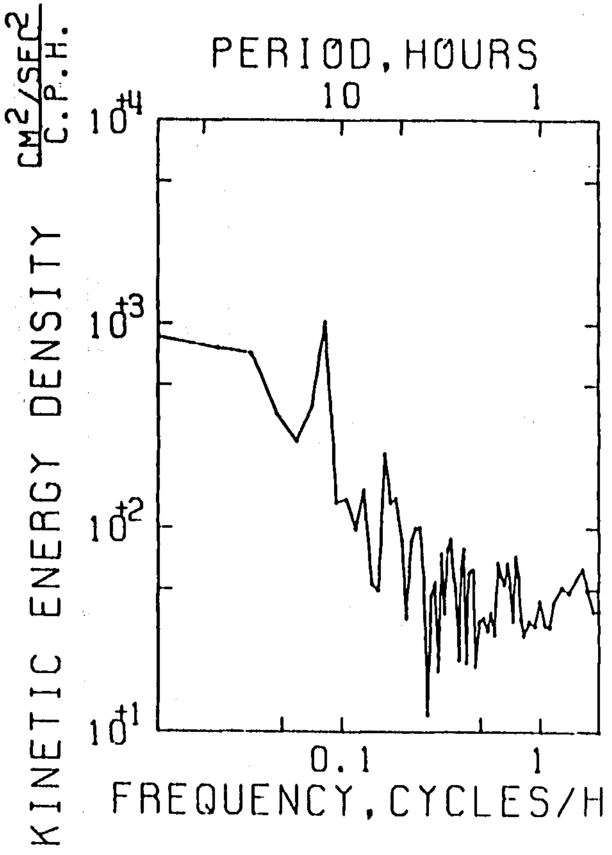
*** EAST & NORTH ***
*********** MM/SEC ***********

COVARIANCE = 1524.21   STD ERR = 895.91
STD. DEV. OF COVARIANCE = 28663.09
CORRELATION COEFFICIENT = 0.091

*********** VECTOR MEANS ***********
*********** EAST & NORTH ***********

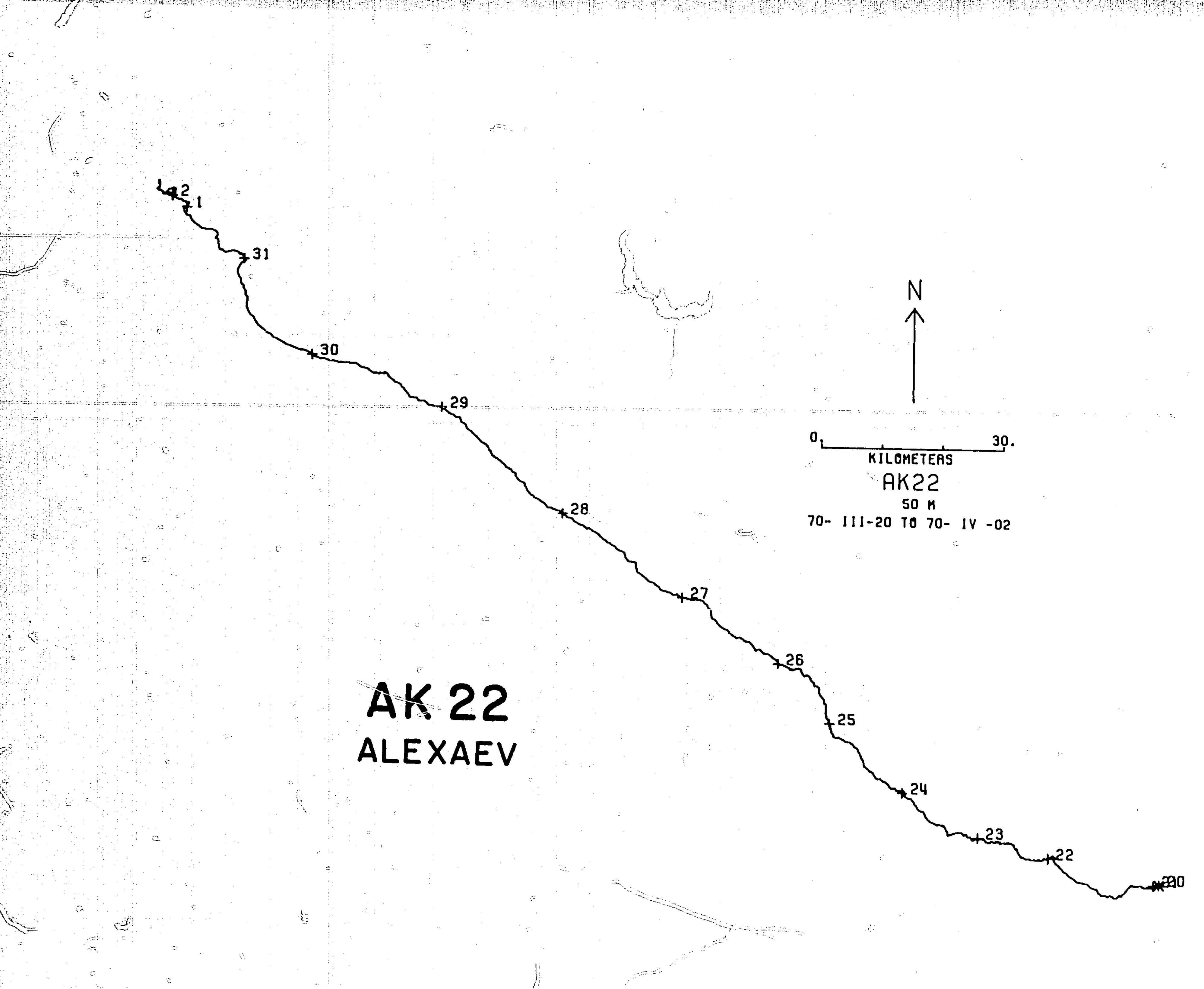
MEAN = 193.62
VARIANCE = 16838.14
STD. DEV.= 129.76

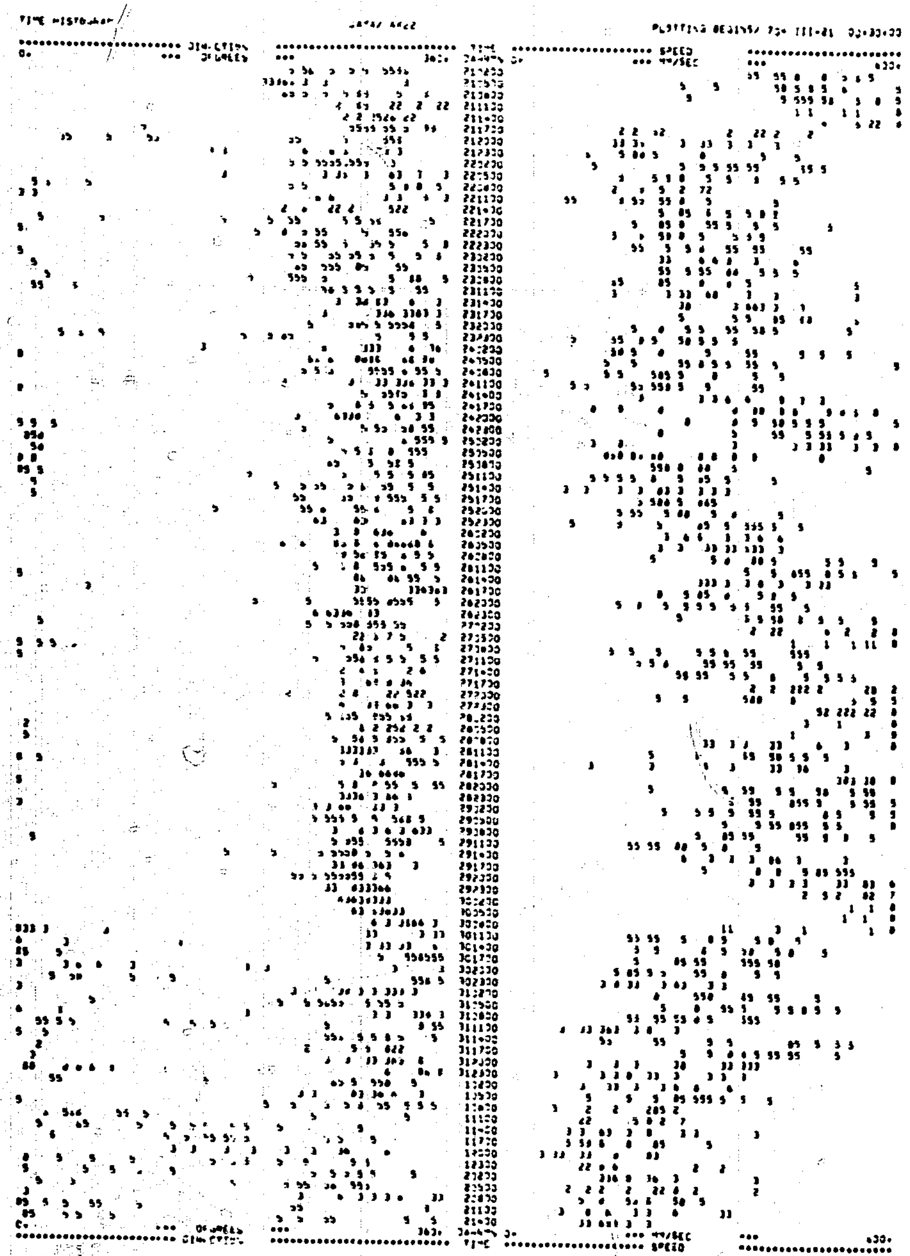
SAMPLE SIZE = 102. POINTS



AK22

ALEXAEV


2
1
31
30
29
28
27
26
25
24
23
22
N
0
30.
KILOMETERS
AK22
50 M
70- III-20 TO 70- IV -02
AK 22
ALEXAEV



DATA/ AK22

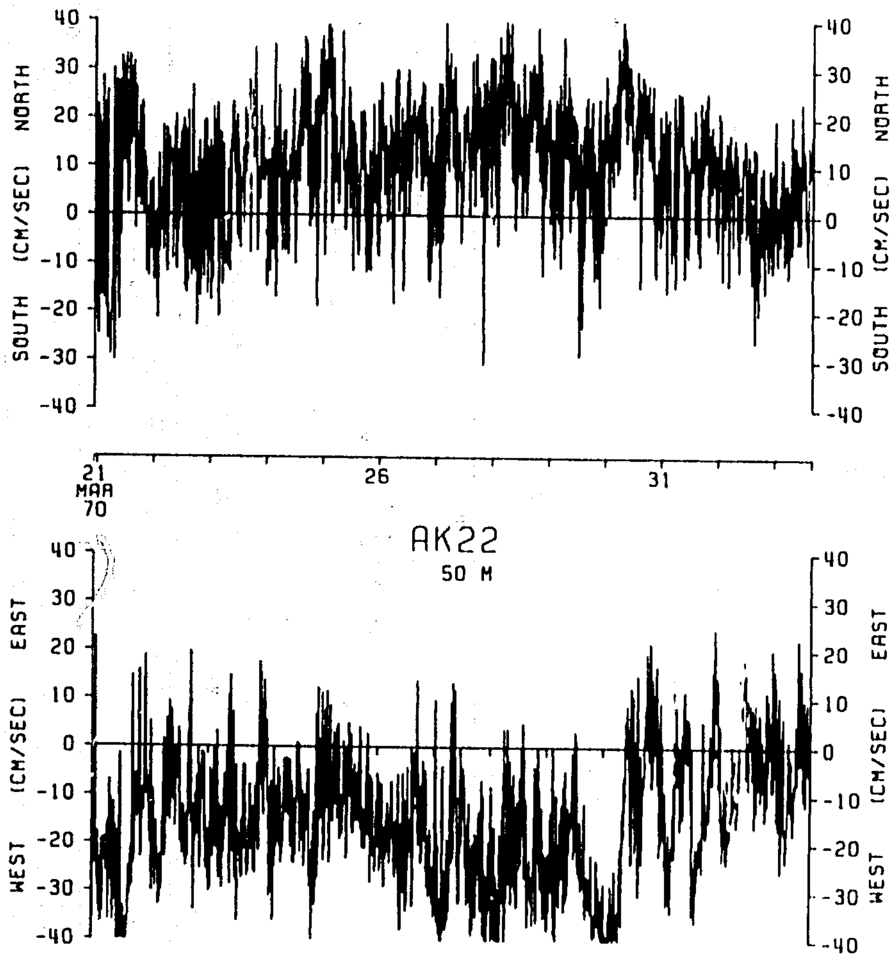
SAMPLE SIZE = 10800.000 SECONDS

SPANNING RANGE
FROM 70- III-21 02:30:00
TO 70- IV -02 [illegible]

AVERAGE NUMBER ELEMENTS/SAMPLE = 12

TOTAL NUMBER OF DATA SAMPLES = 101

NUMBER OF VACUOUS DATA SAMPLES = 0



AK 22
ALEXAEV

STATS

E = EAST   UNITS = MM/SEC
N = NORTH   UNITS = MM/SEC

DATE	MID TIME HR	MID TIME MIN	MID TIME SEC	MEAN (E)	MEAN (N)	VECTOR MEAN	VARIANCE (E)	VARIANCE (N)	VECTOR VARIANCE	COVARIANCE (E & N)
70- III-22	12	0	0	-28.	42.	51.	9705.83	8052.12	8878.98	-814.88
70- III-23	12	0	0	-89.	8.	90.	4591.07	9464.15	7027.61	-2723.63
70- III-24	12	0	0	-22.	15.	27.	9328.92	8980.25	9154.59	333.58
70- III-25	12	0	0	-82.	69.	107.	3065.24	3265.38	3165.31	979.66
70- III-26	12	0	0	-61.	33.	70.	6753.73	6276.62	6515.17	155.46
70- III-27	12	0	0	-61.	43.	74.	6161.63	6815.18	6488.40	267.03
70- III-28	12	0	0	-70.	79.	105.	7451.82	3656.44	5554.13	483.72
70- III-29	12	0	0	-103.	16.	104.	3166.81	3289.07	3227.94	-7.75
70- III-30	12	0	0	-100.	64.	119.	1854.36	1463.08	1658.72	817.82
70- III-31	12	0	0	-102.	43.	111.	4443.93	2400.01	3421.97	720.98
70- IV - 1	12	0	0	-69.	72.	100.	4232.87	5299.56	4766.21	810.05

STATS

*** EAST ***
*** MM/SEC ***

MEAN = -71.03   STD ERR = 2.49
VARIANCE = 634[illegible].52
STD. DEV. = 79.68
KURTOSIS = 3.39
SKEWNESS = 1.105

*** NORTH ***
*** MM/SEC ***

MEAN = 43.62   STD ERR = 2.42
VARIANCE = 5985.34
STD. DEV. = 77.36
KURTOSIS = 3.05
SKEWNESS = -0.544

*** SPEED ***
*** MM/SEC ***

MEAN = 138.13   STD ERR = 0.45
VARIANCE = 203.71
STD. DEV. = 14.27
KURTOSIS = 4.33
SKEWNESS = .693

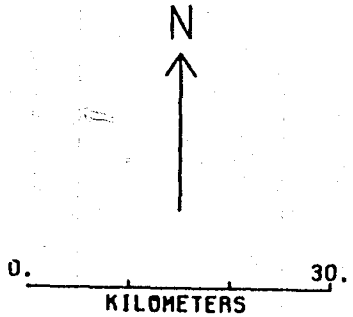
*** EAST & NORTH ***
*********** MM/SEC ***********

COVARIANCE = -11.26   STD ERR = 188.87
STD. DEV. OF COVARIANCE = 6043.79
CORRELATION COEFFICIENT = -0.002

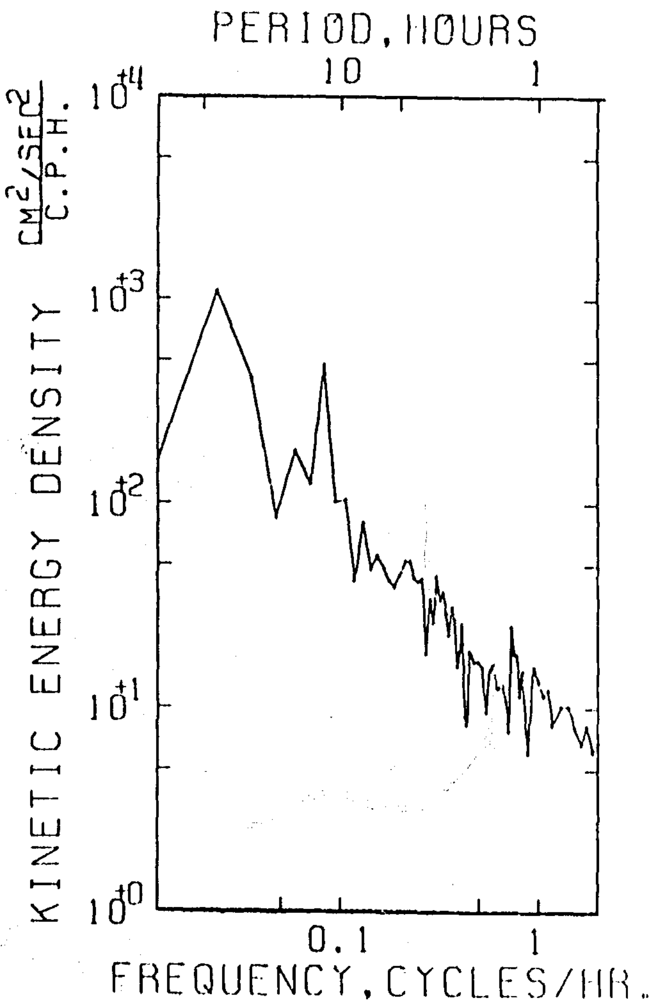
*********** VECTOR MEANS ***********
*********** EAST & NORTH ***********

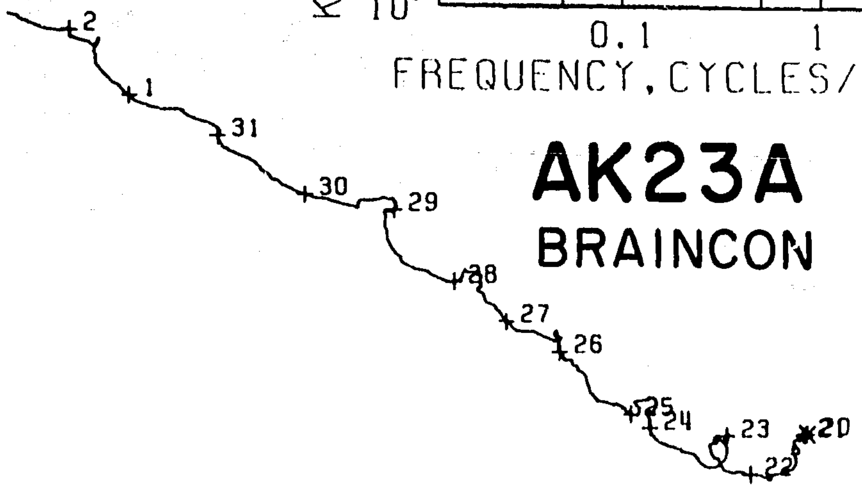
MEAN = [illegible]3.36
VARIANCE = 6166.77
STD. DEV. = [illegible]

SAMPLE SIZE = 1.2[illegible] POINTS

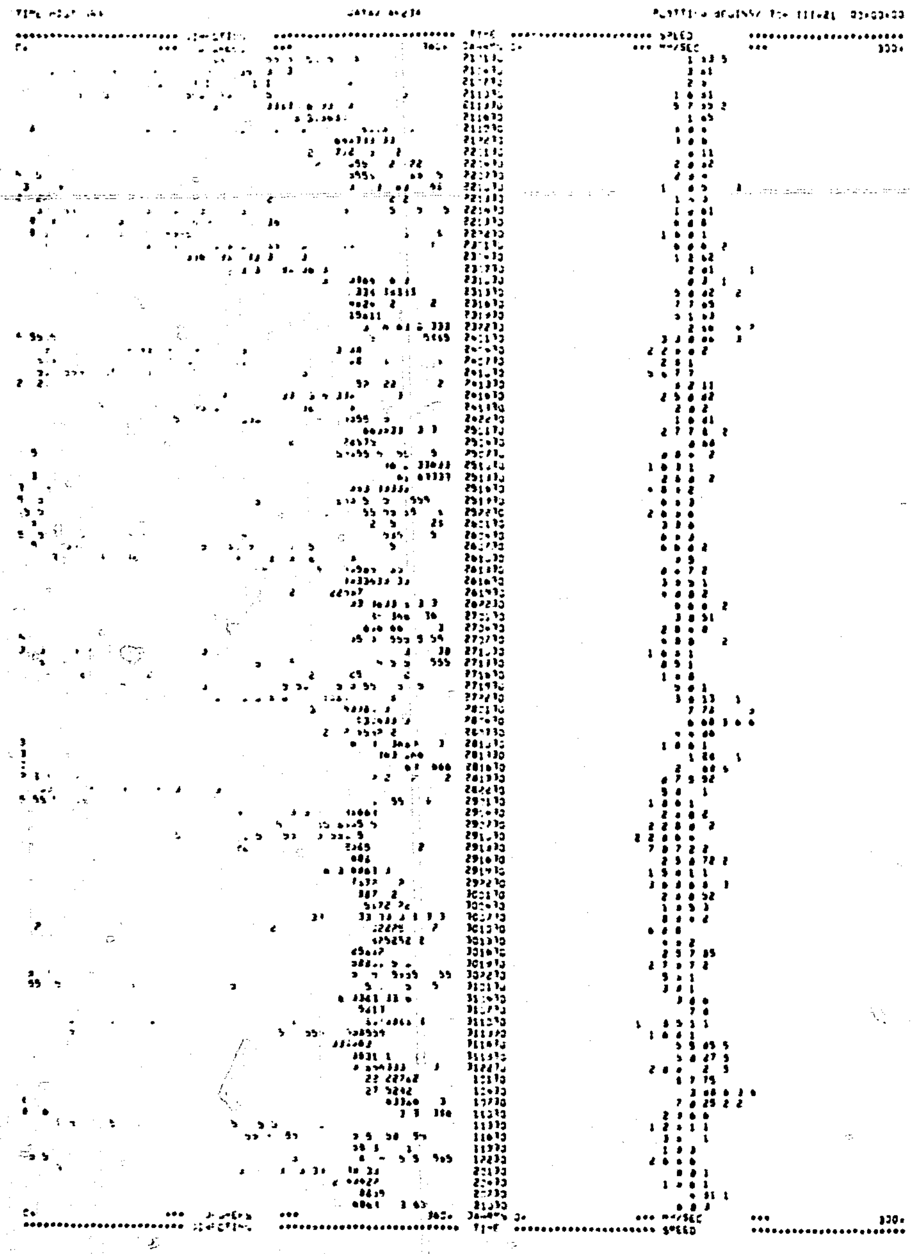


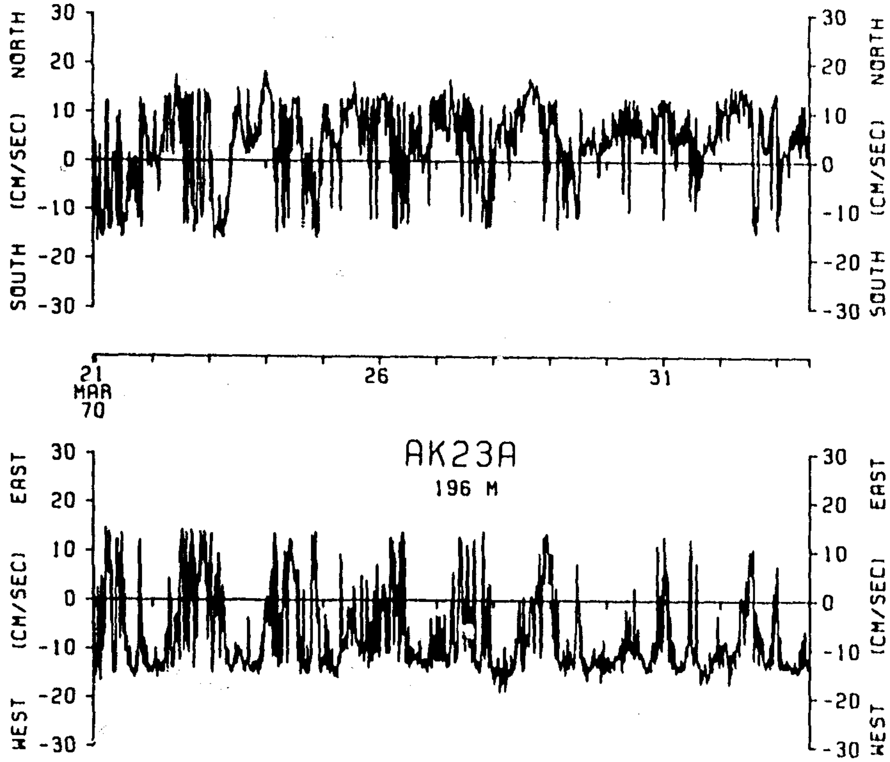
AK23A
196 M
70- III-20 TO 70- IV -02



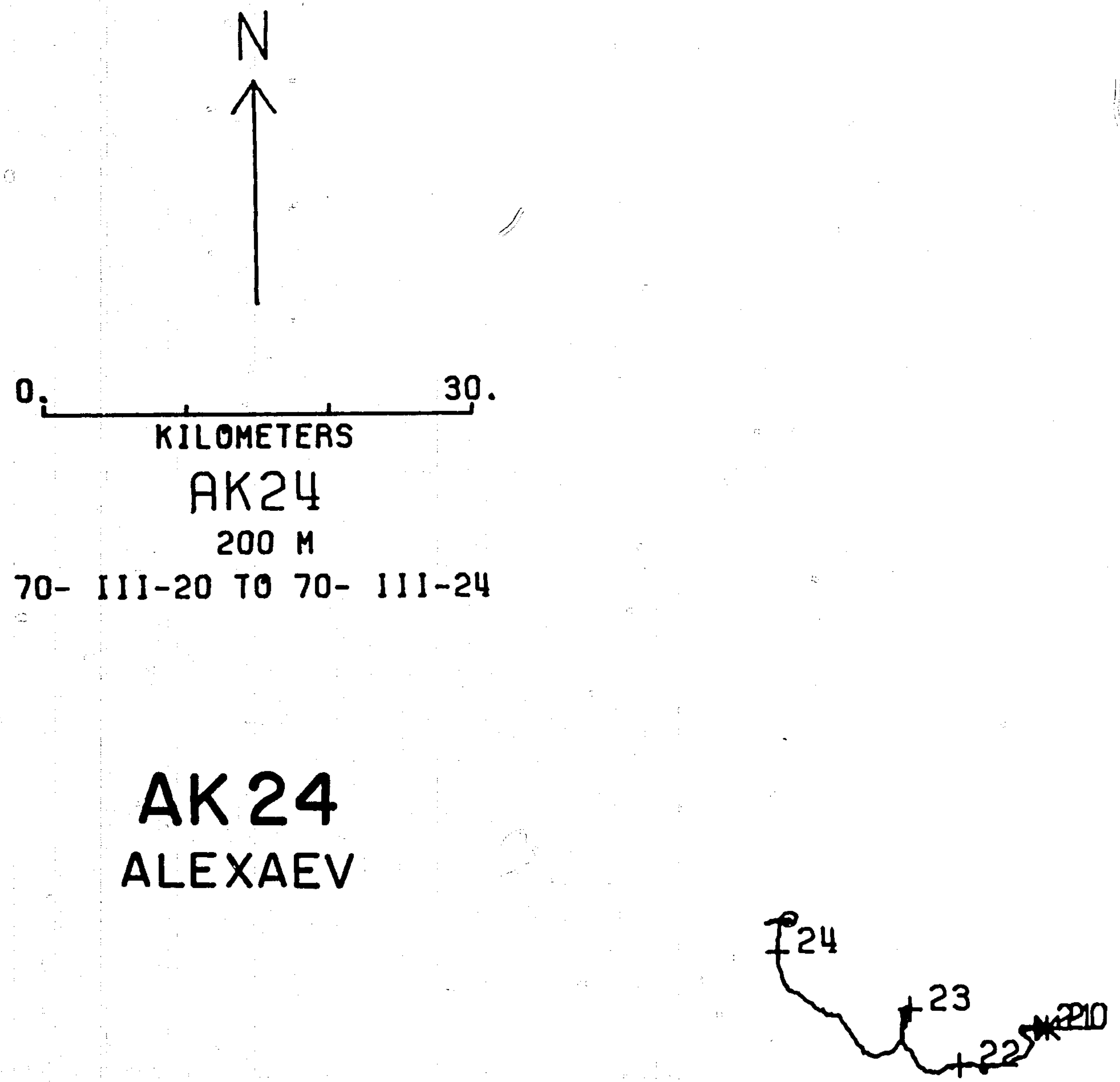


AK23A
BRAINCON





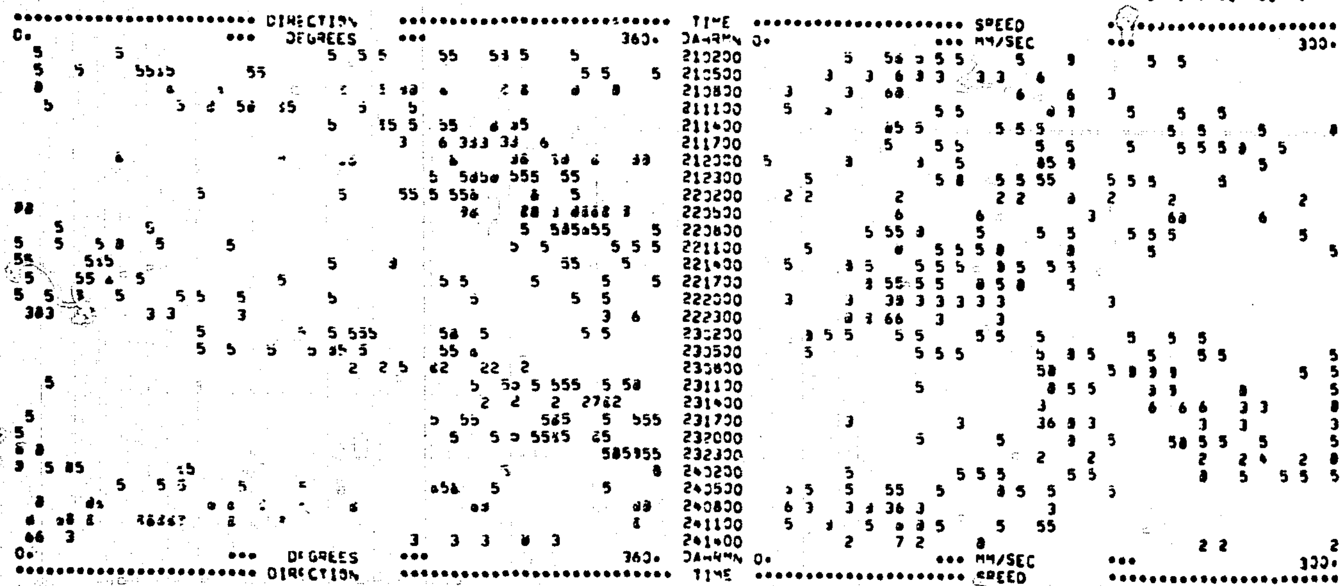
AK23A
BRAINCON



AK24
ALEXAEV

10:32 OCT 08.'70

TIME HISTOGRAM DATA/ AK24 PLOTTING BEGINS/ 70, III,21 00,30,00



DATA/ AK24

SAMPLE SIZE = 10800.000 SECONDS

SPANNING RANGE
FROM 70, III,21 00.30.00
TO 70, III,24 17.45.00

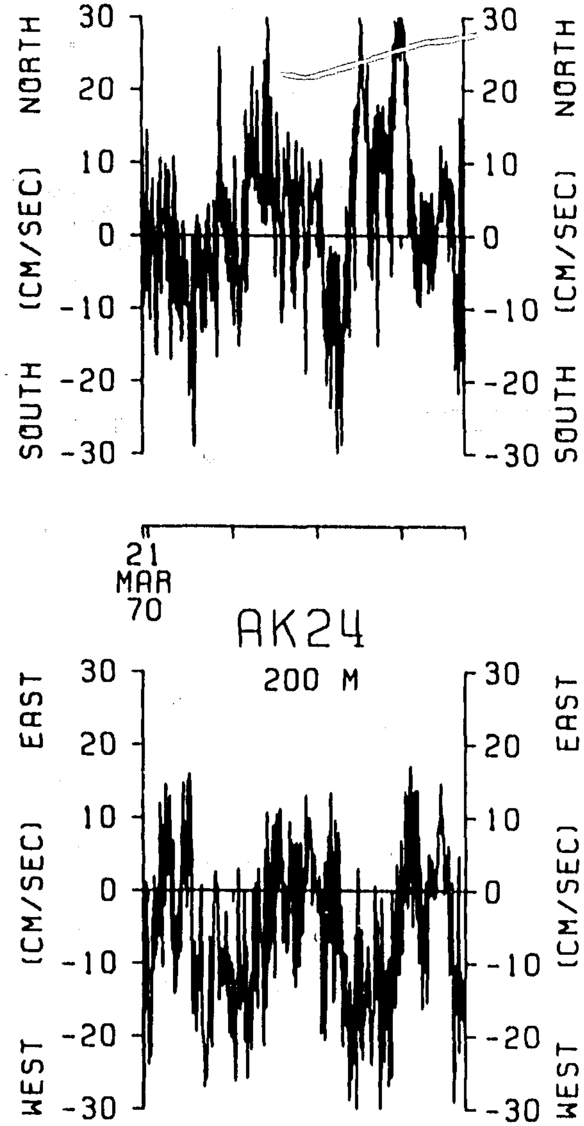
AVERAGE NUMBER ELEMENTS/SAMPLE = 12

TOTAL NUMBER OF DATA SAMPLES = 2

NUMBER OF VACUOUS DATA SAMPLES = 0

NUMBER OF NON-STANDARD RECORDS = 0

JOB END/ 1,15, OCT 02,'70



AK24
ALEXAEV

STATS

E = EAST UNITS = MM/SEC
N = NORTH UNITS = MM/SEC

DATE	MID TIME HR	MIN	SEC	MEAN (E)	MEAN (N)	VECTOR MEAN	VARIANCE (E)	VARIANCE (N)	VECTOR VARIANCE	COVARIANCE (E & N)	SPEED (UNITS = MM/SEC) MEAN (+)	VARIANCE (+)
70- III-22	12	0	0	-47.	-36.	59.	3741.17	5246.93	4494.04	-853.06	109.	444.52
70- III-23	12	0	0	-29.	-13.	32.	5590.23	5177.46	5383.84	-183.15	107.	273.91
70- III-24	12	0	0	-48.	3.	49.	2320.81	4737.11	3528.96	286.55	96.	228.47
70- III-25	12	0	0	-30.	7.	30.	2166.21	3595.85	2881.03	300.92	80.	320.79
70- III-26	12	0	0	-24.	6.	25.	2851.13	3080.09	2965.61	105.26	78.	406.93
70- III-27	12	0	0	-35.	18.	39.	3579.19	2882.51	3230.85	130.52	88.	190.27
70- III-28	12	0	0	-43.	11.	44.	2087.02	1985.97	2036.49	-637.26	76.	236.19
70- III-29	12	0	0	-48.	10.	49.	1572.38	1837.81	1705.10	-45.00	75.	239.49
70- III-30	12	0	0	-40.	-0.	40.	2302.67	3248.59	2775.63	-981.72	77.	1268.39
70- III-31	12	0	0	-24.	13.	27.	1755.89	1565.78	1660.83	137.45	62.	213.79
70- IV - 1	12	0	0	-53.	15.	55.	649.56	1946.12	1297.84	-614.96	66.	341.77

STATS

*** EAST ***
*** MM/SEC ***

MEAN = -37.43 STD ERR = 1.64
VARIANCE = 2754.33
STD. DEV. = 52.49
KURTOSIS = [illegible]
SKEWNESS = [illegible]

*** NORTH ***
*** MM/SEC ***

MEAN = [illegible] STD ERR = 1.83
VARIANCE = 3032.44
STD. DEV. = 55.03
KURTOSIS = 2.13
SKEWNESS = -0.297

*** SPEED ***
*** MM/SEC ***

MEAN = [illegible] STD ERR = 0.76
VARIANCE = 494.77
STD. DEV. = 22.47
KURTOSIS = [illegible]
SKEWNESS = [illegible]

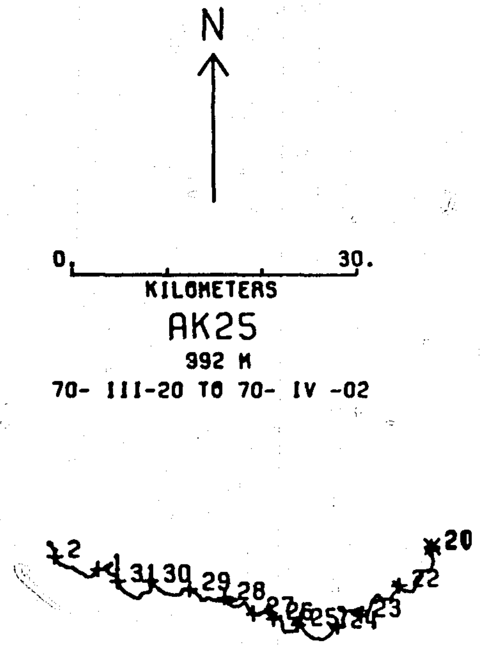
*** EAST & NORTH ***
************ MM/SEC ************

COVARIANCE = [illegible] STD ERR = 94.40
STD. DEV. OF COVARIANCE = 3034.77
CORRELATION COEFFICIENT = [illegible]

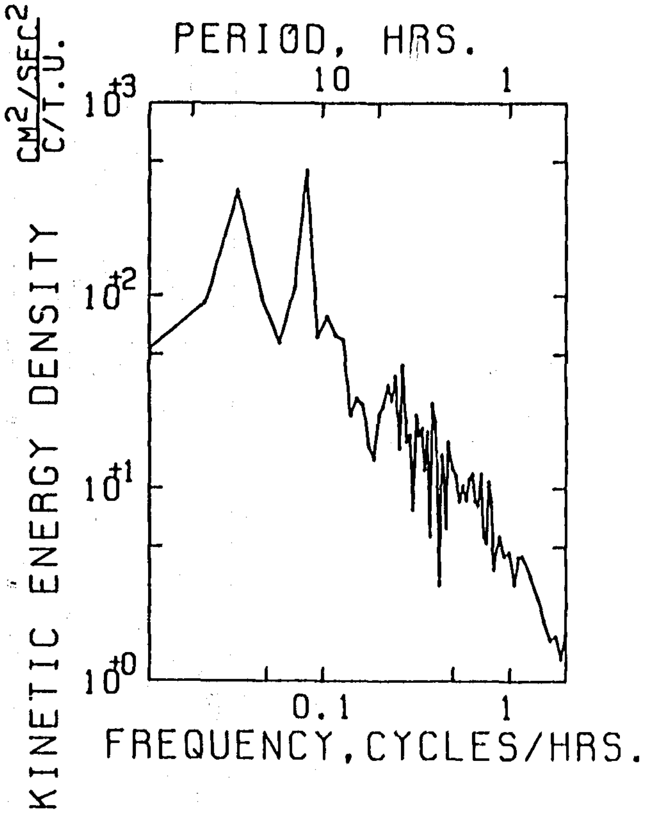
************ VECT. STATS ************
************ EAST & NORTH ************

MEAN = [illegible]
VARIANCE = [illegible]
STD. DEV. = [illegible]

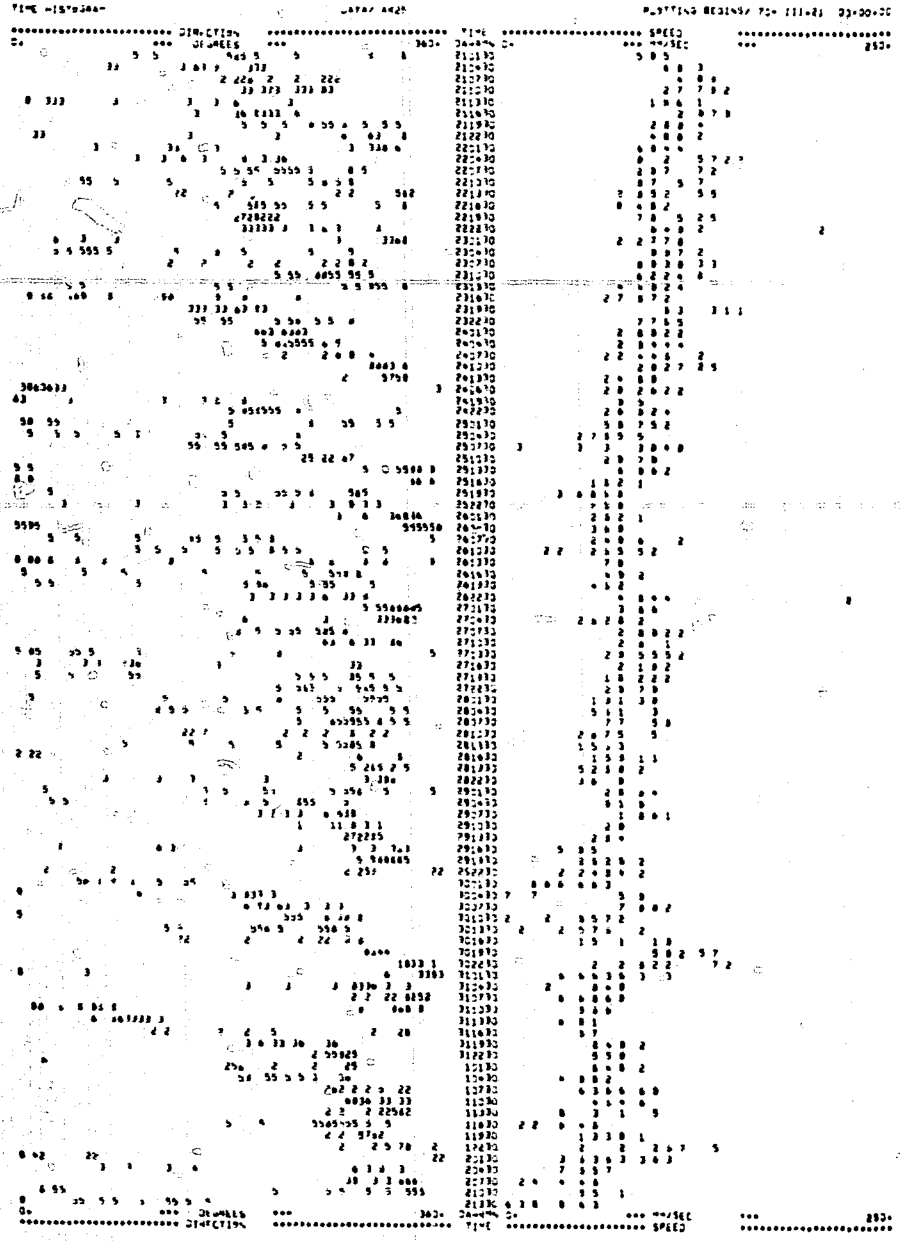
SAMPLE SIZE = [illegible] POINTS



AK25
992 M
70- III-20 TO 70- IV -02



AK25
LSK



DATA: AK25

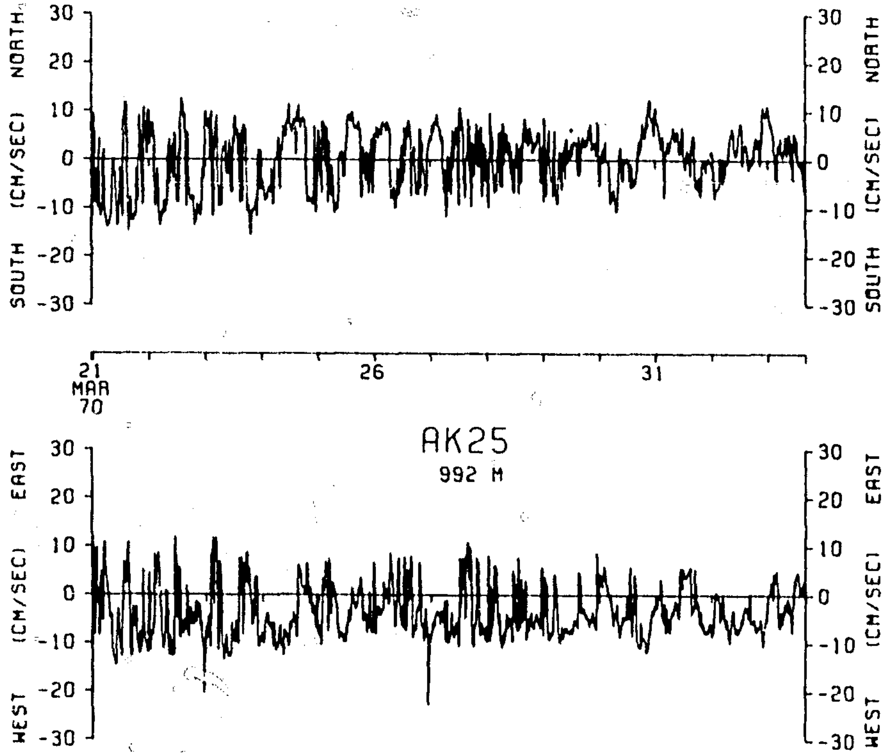
SAMPLE SIZE = [illegible] SECONDS

SPANNING RANGE
FROM 70- III-21 [illegible]
TO [illegible]

AVERAGE NUMBER ELEMENTS/SAMPLE = 12

TOTAL NUMBER OF DATA SAMPLES = 131

NUMBER OF VACUOUS DATA SAMPLES = 0



AK25

LSK

STATS

E = EAST　　UNITS = MM/SEC
N = NORTH　　UNITS = MM/SEC

DATE	MID TIME HR	MID TIME MIN	MID TIME SEC	MEAN (E)	MEAN (N)	VECTOR MEAN	VARIANCE (E)	VARIANCE (N)	VECTOR VARIANCE	COVARIANCE (E N)	SPEED (UNITS = MM/SEC) MEAN (M)	SPEED VARIANCE (M)
70- III-22	12	14	55	-66.	-22.	69.	14123.13	18551.29	16337.21	667.50	193.	110.53
70- III-23	12	14	55	-40.	26.	48.	18161.30	17457.52	17809.41	1297.63	194.	107.28
70- III-24	12	14	55	-105.	26.	108.	8135.17	11960.15	10047.66	3551.19	178.	135.82
70- III-25	12	14	55	-58.	33.	67.	9086.32	10200.23	9643.27	2328.38	154.	75.36
70- III-26	12	14	55	-52.	34.	62.	8041.30	11290.11	9665.70	875.81	152.	69.49
70- III-27	12	14	55	-52.	57.	77.	10274.59	13815.36	12044.98	1701.64	173.	156.33
70- III-28	12	14	55	-98.	53.	111.	7245.17	7455.62	7350.39	2862.72	164.	132.57
70- III-29	12	14	55	-68.	51.	85.	4982.09	7131.40	6056.74	2004.60	139.	203.67
70- III-30	12	14	55	-70.	8.	70.	3784.18	8994.36	6389.27	-242.65	132.	220.76
70- III-31	12	14	55	-63.	52.	81.	9732.26	5355.09	7543.68	2889.50	146.	385.91
70- IV - 1	12	14	55	-117.	37.	123.	4970.90	11813.38	8392.14	-658.86	173.	125.67

STATS

*** EAST ***
*** MM/SEC ***

MEAN = -7[illegible]　STD ERR = 3.04
VARIANCE = [illegible]
STD. DEV. = [illegible]
KURTOSIS = [illegible]
SKEWNESS = [illegible]

*** NORTH ***
*** MM/SEC ***

MEAN = [illegible]　STD ERR = 3.39
VARIANCE = 1177[illegible].71
STD. DEV. = [illegible]
KURTOSIS = [illegible]
SKEWNESS = [illegible]

*** SPEED ***
*** MM/SEC ***

MEAN = [illegible]　STD ERR = [illegible]
VARIANCE = [illegible]
STD. DEV. = [illegible]
KURTOSIS = [illegible]
SKEWNESS = [illegible]

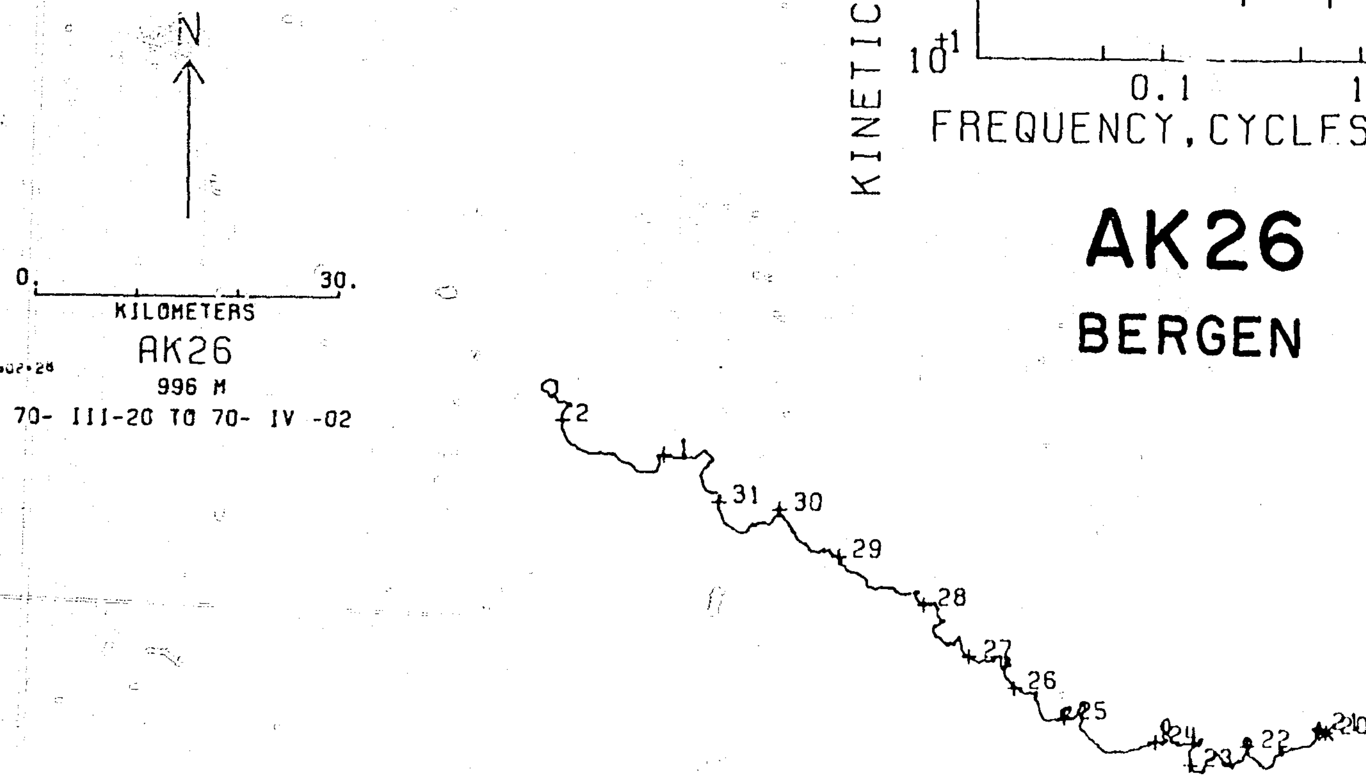
*** EAST & NORTH ***
*********** MM/SEC ***********

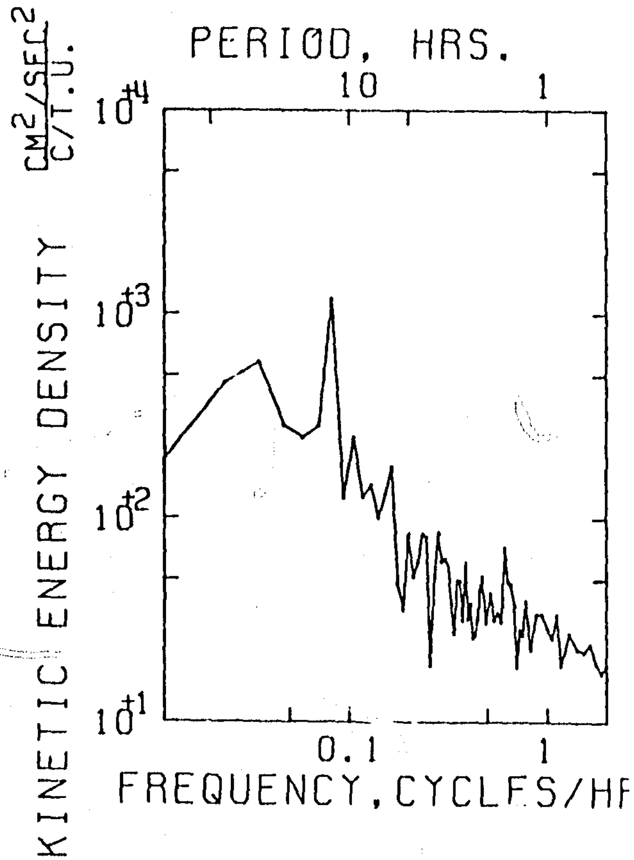
COVARIANCE = [illegible]　STD ERR = [illegible]
STD. DEV. OF COVARIANCE = [illegible]
CORRELATION COEFFICIENT = [illegible]

*********** VECT - [illegible] ***********
*********** EAST & NORTH ***********

MEAN = [illegible]
VARIANCE = [illegible]
STD. DEV. = [illegible]

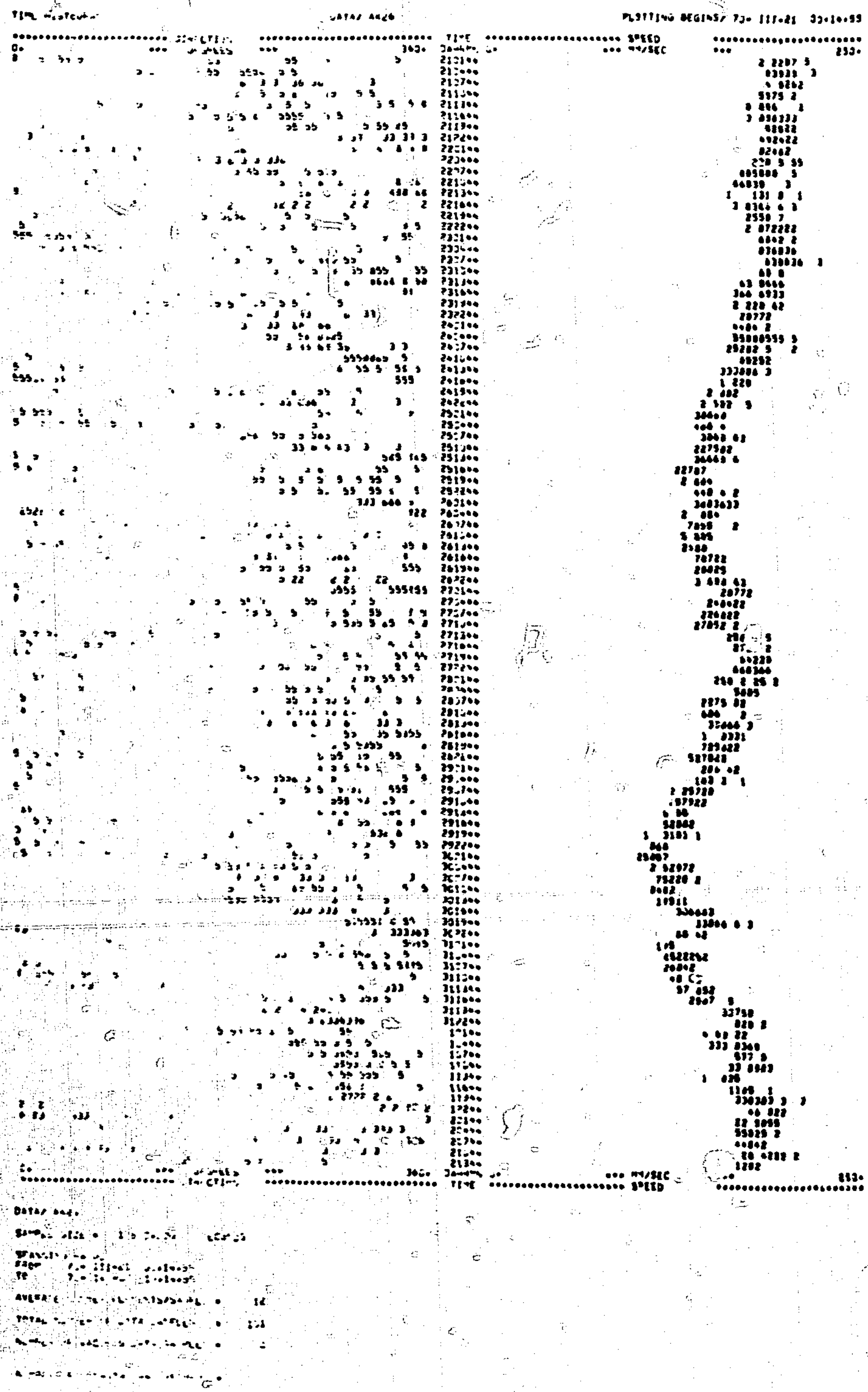
SAMPLE SIZE = [illegible]

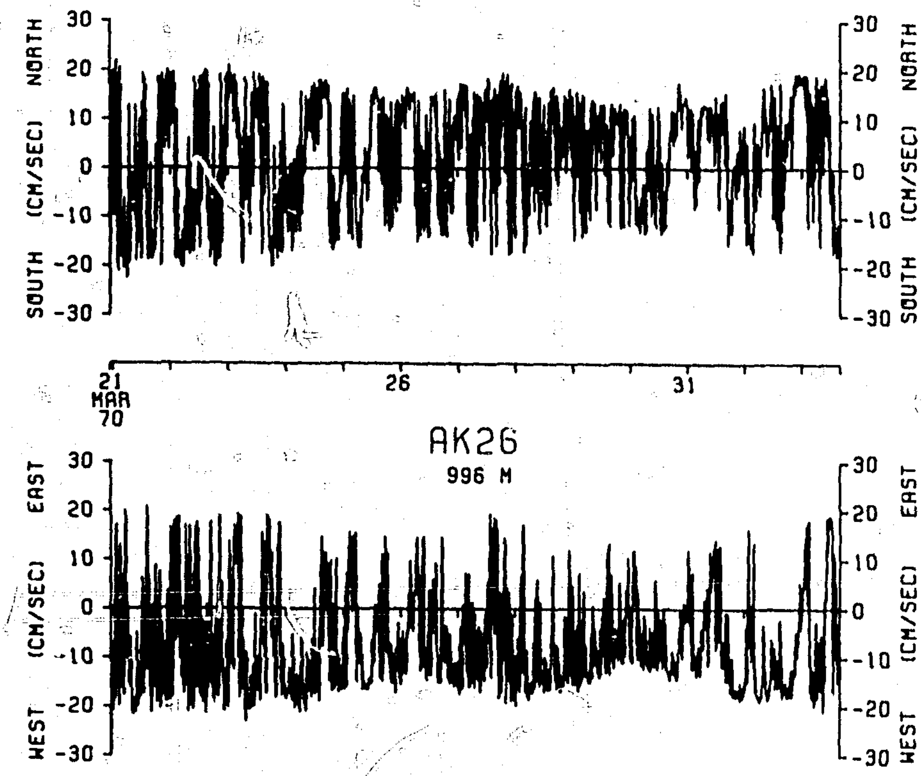




AK26

BERGEN


TIME
SPEED
CM/SEC


SOUTH (CM/SEC) NORTH
30
20
10
0
-10
-20
-30
21
MAR
70
26
31
AK26
996 M
WEST (CM/SEC) EAST

AK26
BERGEN

STATSC6

E = EAST   UNITS = MM/SEC
N = NORTH   UNITS = MM/SEC

DATE	MID TIME HR MN SEC	MEAN (E)	MEAN (N)	VECTOR MEAN	VARIANCE (E)	VARIANCE (N)	VECTOR VARIANCE	COVARIANCE (E & N)	SPEED UNITS = MM/SEC MEAN (S)	VARIANCE (S)
70- III-22	12.00.00	-36.	-16.	40.	1767.79	2698.80	2223.30	299.41	60.	928.99
70- III-23	12.00.00	-23.	3.	24.	1853.42	1835.81	1844.62	159.34	66.	1297.04
70- III-24	12.00.00	-55.	11.	56.	2384.71	3250.19	2817.45	733.85	60.	816.67
70- III-25	12.00.00	-43.	16.	46.	2908.97	4474.51	3691.74	524.10	84.	1247.65
70- III-26	12.00.00	-32.	16.	35.	2389.63	3282.17	2835.90	-74.52	89.	1679.94
70- III-27	12.00.00	-28.	31.	42.	2117.81	2630.88	2374.35	38.47	73.	930.20
70- III-28	12.00.00	-48.	27.	56.	2365.21	1852.53	2109.87	149.85	76.	1333.85
70- III-29	12.00.00	-39.	36.	53.	1981.06	3313.21	2647.13	668.61	81.	908.08
70- III-30	12.00.00	-56.	20.	59.	3291.83	7587.19	5439.51	-1119.79	81.	1129.33
70- III-31	12.00.00	-50.	32.	59.	4460.05	3427.01	3943.53	1708.04	104.	3104.94
70- IV -01	12.00.00	-67.	24.	71.	2754.76	2415.29	2585.02	-363.38	98.	1468.74

STATS

*** EAST ***
*** MM/SEC ***

MEAN = -42.66   STD ERR = 1.63
VARIANCE = 2709.73
STD. DEV. = 52.06
KURTOSIS = 2.62
SKEWNESS = -0.168

*** NORTH ***
*** MM/SEC ***

MEAN = 18.02   STD ERR = 1.87
VARIANCE = 3582.75
STD. DEV. = 59.86
KURTOSIS = 2.81
SKEWNESS = -0.074

*** SPEED ***
*** MM/SEC ***

MEAN = 82.63   STD ERR = 1.25
VARIANCE = 1609.41
STD. DEV. = 40.12
KURTOSIS = 3.19
SKEWNESS = 0.645

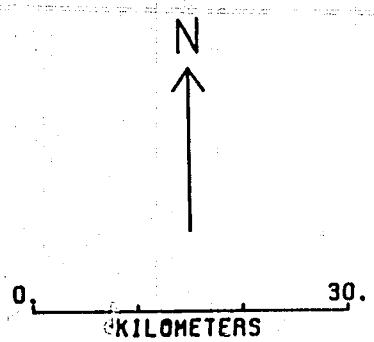
*** EAST & NORTH ***
*********** MM/SEC ***********

COVARIANCE = 223.63   STD ERR = 132.23
STD. DEV. OF COVARIANCE = 4231.29
CORRELATION COEFFICIENT = 0.072

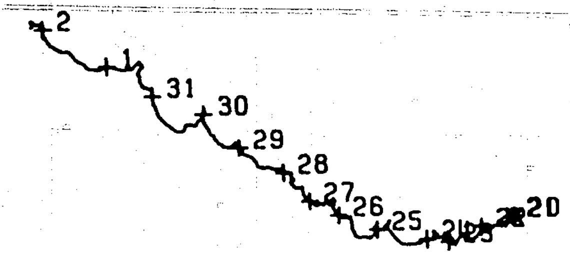
*********** VECTOR MEANS ***********
*********** EAST & NORTH ***********

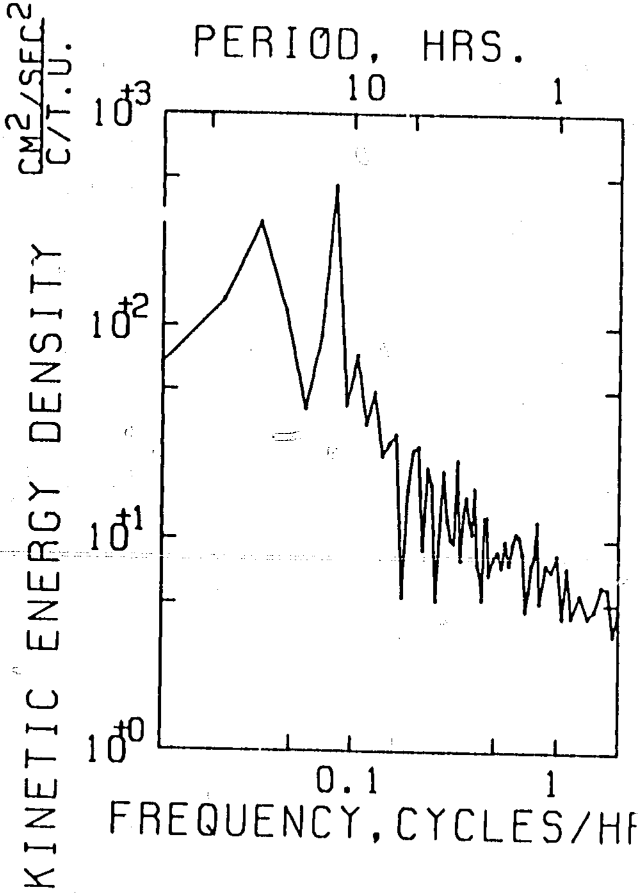
MEAN = 46.35
VARIANCE = 3146.24
STD. DEV. = 56.09

SAMPLE SIZE = 1024 POINTS

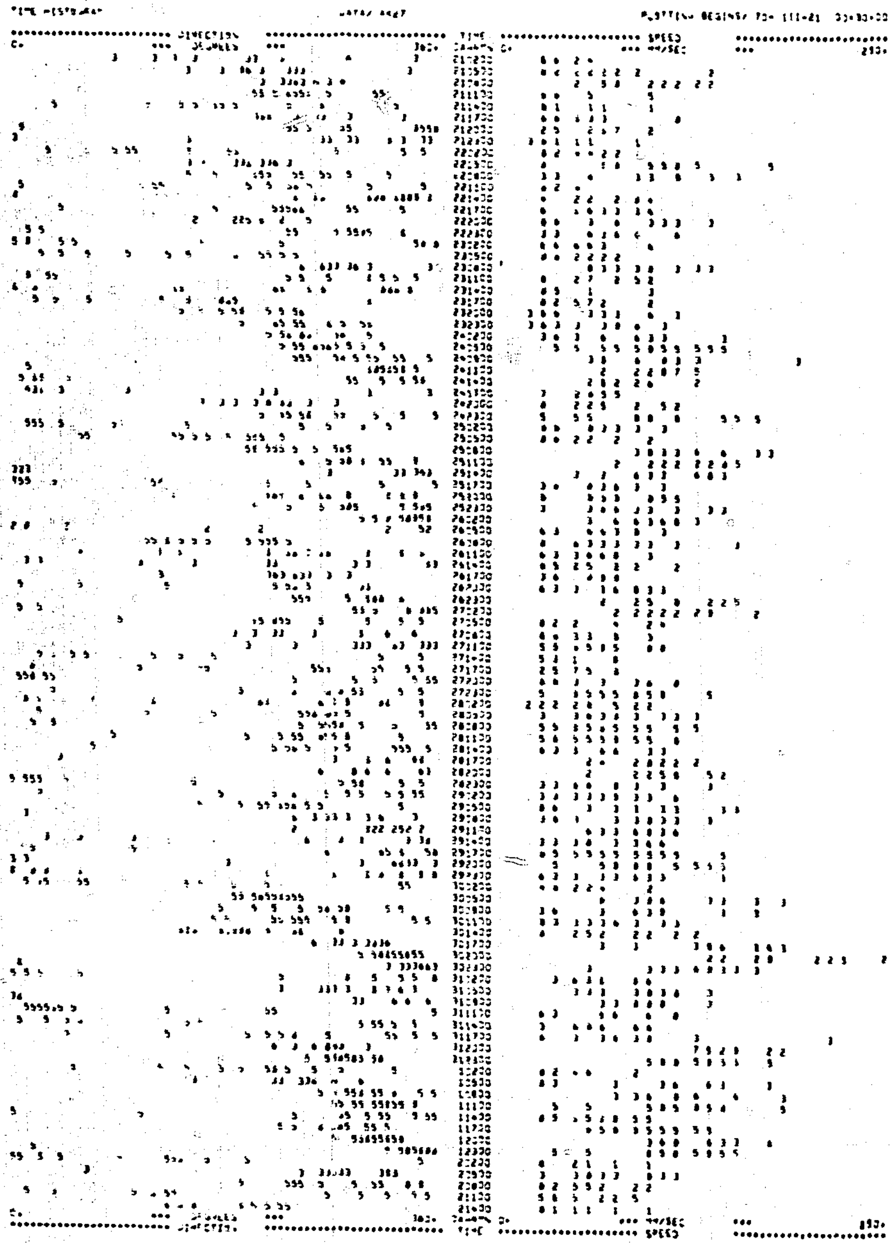


AK27
1000 M
70- III-20 TO 70- IV -02





AK27
ALEXAEV



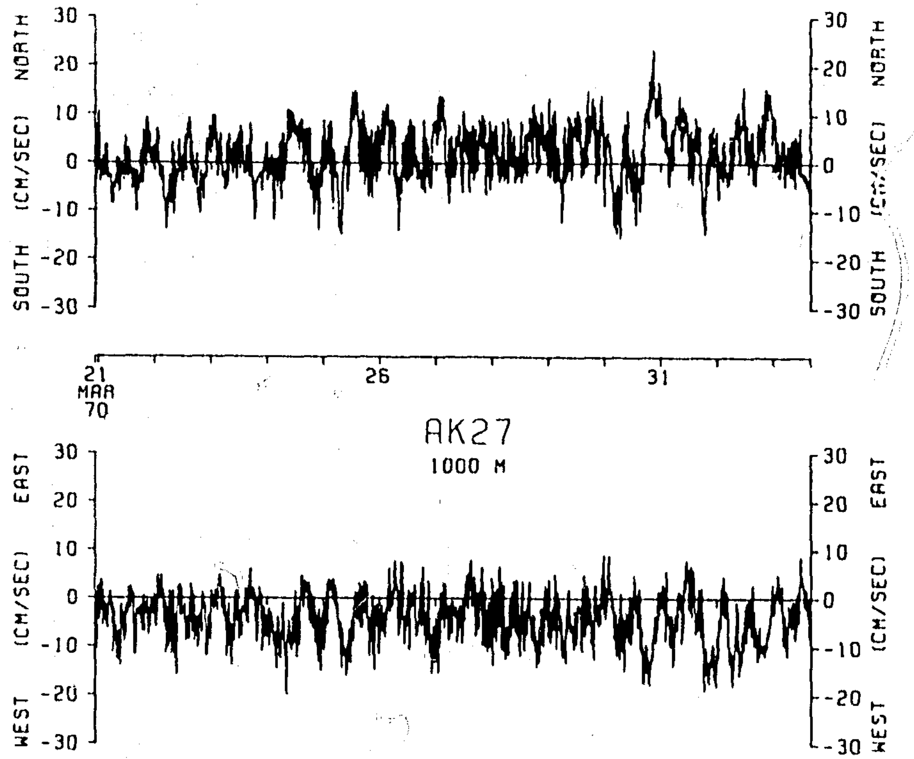
SAMPLE SIZE = [illegible]

SPANNING RANGE
FROM [illegible]
TO [illegible]

AVERAGE NUMBER ELEMENTS/SAMPLE = 12

TOTAL NUMBER OF DATA SAMPLES = [illegible]

NUMBER OF VACUOUS DATA SAMPLES = [illegible]



AK27

ALEXAEV

STATS DATA/ AK31

E = EAST UNITS = MM/SEC
N = NORTH UNITS = MM/SEC

DATE	MID TIME HR	MIN	SEC	MEAN (E)	MEAN (N)	VECTOR MEAN	VARIANCE (E)	VARIANCE (N)	VECTOR VARIANCE	COVARIANCE (E & N)	SPEED UNITS = MM/SEC MEAN (=)	VARIANCE (=)
70- III-22	12	0	0	-100.	126.	161.	13120.17	6275.14	9472.65	-255.52	200.	5467.61
70- III-23	12	0	0	-113.	115.	161.	8483.74	3834.14	6383.95	-227.15	145.	4631.24
70- III-24	12	0	0	-86.	28.	70.	11111.98	6742.15	8877.06	2011.77	154.	2143.06
70- III-25	12	0	0	-121.	56.	134.	9538.55	7029.56	8284.07	539.10	174.	4227.94
70- III-26	12	0	0	-86.	26.	39.	8939.14	7579.72	8257.43	880.93	155.	1213.16
70- III-27	12	0	0	-97.	34.	137.	5140.64	5561.82	5501.23	1153.35	164.	2742.67
70- III-28	12	0	0	-67.	84.	111.	6514.79	4155.97	5333.39	-572.92	144.	2137.60
70- III-29	12	0	0	-114.	-11.	115.	1704.78	5035.63	3355.20	1285.96	135.	1783.16
70- III-30	12	0	0	-122.	-30.	126.	5301.79	5352.39	5327.09	527.56	159.	1220.52
70- III-31	12	0	0	-110.	-25.	113.	3062.32	5455.16	5755.74	-1051.91	150.	1689.58
70- IV - 1	12	0	0	-104.	-14.	105.	2716.75	6865.87	4791.30	194.36	133.	640.99

STATS DATA/ AK31

*** EAST ***
*** MM/SEC ***

MEAN = -103.56 STD ERR = 2.65
VARIANCE = 7214.06
STD. DEV. = 84.94
KURTOSIS = 4.39
SKEWNESS = 0.888

*** NORTH ***
*** MM/SEC ***

MEAN = 45.04 STD ERR = 2.94
VARIANCE = 8834.57
STD. DEV. = 93.99
KURTOSIS = 2.77
SKEWNESS = -0.134

*** SPEED ***
*** MM/SEC ***

MEAN = 160.81 STD ERR = 1.70
VARIANCE = 2942.41
STD. DEV. = 54.24
KURTOSIS = 4.73
SKEWNESS = 1.150

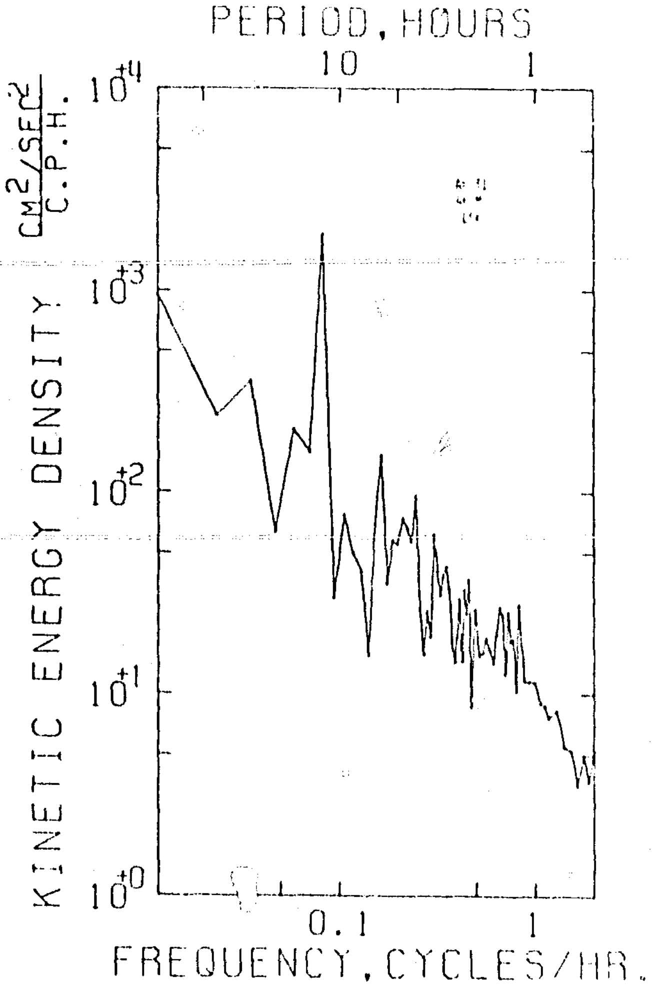
*** EAST & NORTH ***
*********** MM/SEC ***********

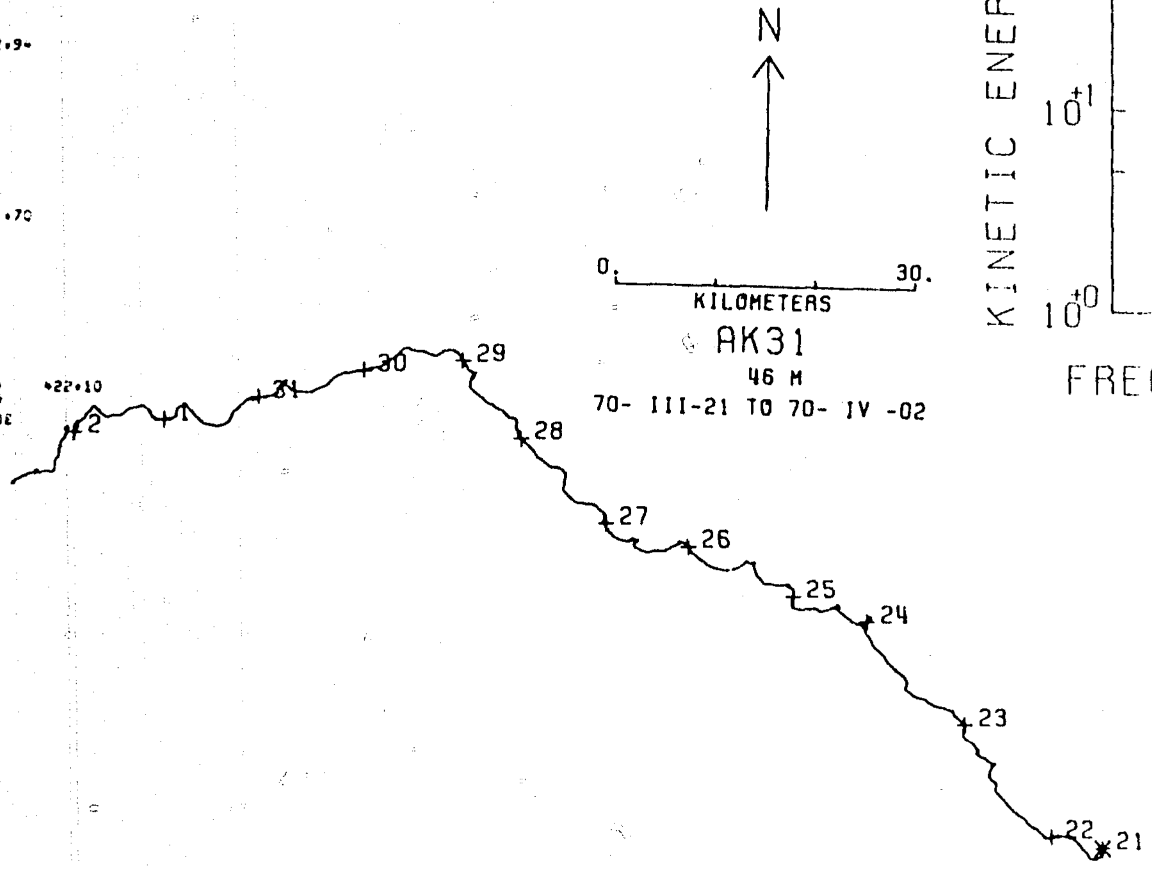
COVARIANCE = 863.23 STD ERR = 422.10
STD. DEV. OF COVARIANCE = 13507.27
CORRELATION COEFFICIENT = 0.102

*********** VECTOR MEANS ***********
*********** EAST & NORTH ***********

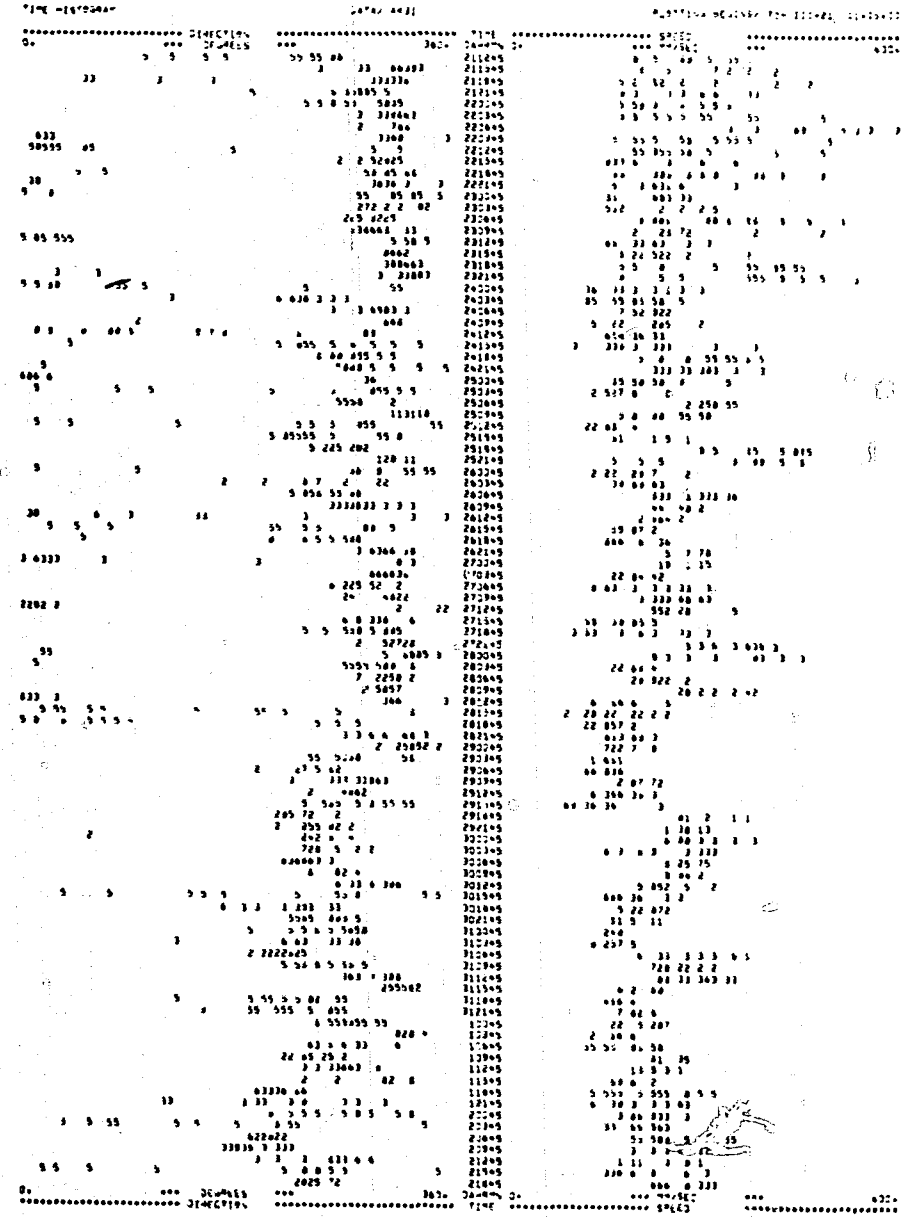
MEAN = 112.93
VARIANCE = 8024.31
STD. DEV. = 89.58

SAMPLE SIZE = 1024 POINTS





AK31
LSK



DATA: AK31

SAMPLE SIZE = [illegible] SECONDS

SPANNING RANGE
FROM [illegible]
TO [illegible]

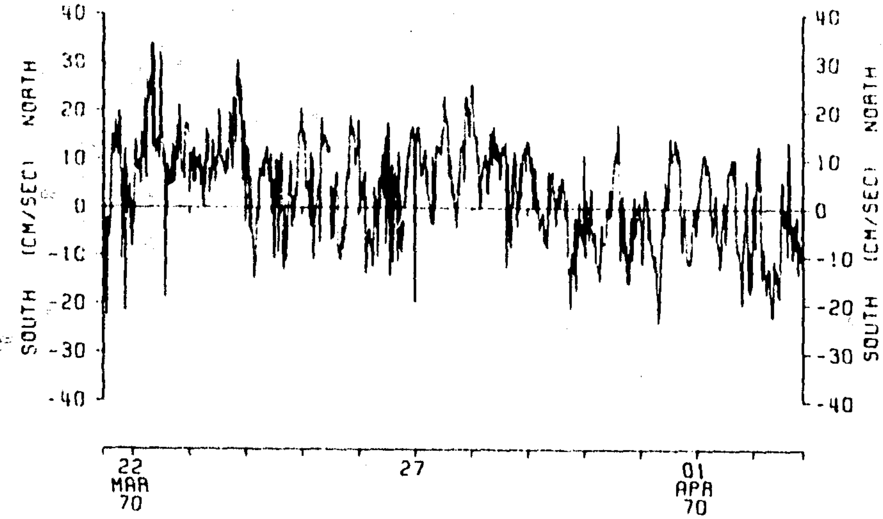
AVERAGE NUMBER ELEMENTS/SAMPLE = [illegible]

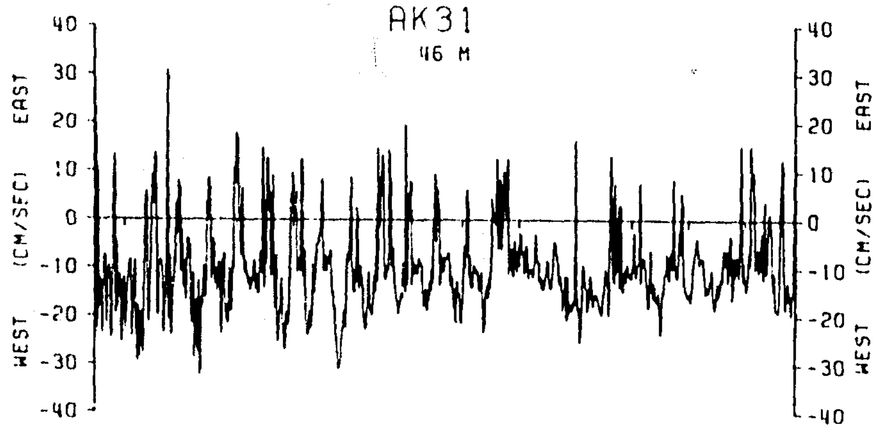
TOTAL NUMBER OF DATA SAMPLES = [illegible]

NUMBER OF VACUOUS DATA SAMPLES = [illegible]

NUMBER OF NON-STANDARD RECORDS = [illegible]

[illegible]





AK31
LSK

STATS

E = EAST
N = NORTH

UNITS = MM/SEC
UNITS = MM/SEC

DATE	MID TIME HR	MIN	SEC	MEAN (E)	MEAN (N)	VECTOR MEAN	VARIANCE (E)	VARIANCE (N)	VECTOR VARIANCE	COVARIANCE (E & N)	SPEED UNITS = MM/SEC MEAN (M)	SPEED VARIANCE (M)
70- III-22	12	0	0	-129.	125.	179.	12435.36	11375.20	11905.27	800.79	216.	9476.61
70- III-23	12	0	0	-162.	91.	186.	20353.49	13135.39	16744.44	2796.55	244.	8791.62
70- III-24	12	0	0	-98.	34.	104.	16661.23	11366.97	14014.10	3868.37	179.	6613.01
70- III-25	12	0	0	-133.	57.	144.	12316.21	7538.40	9927.30	2595.31	183.	7379.68
70- III-26	12	0	0	-91.	54.	105.	6014.80	9711.30	8063.35	1833.04	153.	3680.89
70- III-27	12	0	0	-33.	120.	124.	8593.19	7479.51	8036.35	795.78	167.	3741.31
70- III-28	12	0	0	-28.	91.	95.	9329.52	6566.51	7948.01	-60.18	146.	3722.22
70- III-29	12	0	0	-74.	-48.	88.	7169.05	9790.83	8479.94	3140.63	142.	4455.72
70- III-30	12	0	0	-67.	8.	67.	7378.37	7843.58	7613.97	3027.27	127.	3544.75
70- III-31	12	0	0	-53.	-12.	55.	6454.72	9957.49	8206.10	-350.92	126.	3424.96
70- IV - 1	12	0	0	-38.	-16.	41.	3231.49	6900.52	5066.00	771.14	98.	1121.07

STATS

*** EAST ***
*** MM/SEC ***

MEAN = -83.81 STD ERR = 3.43
VARIANCE = 12037.51
STD. DEV.= 109.72
KURTOSIS = 3.23
SKEWNESS = -0.297

*** NORTH ***
*** MM/SEC ***

MEAN = 49.21 STD ERR = 3.44
VARIANCE = 12094.02
STD. DEV.= 109.99
KURTOSIS = 2.74
SKEWNESS = -0.100

*** SPEED ***
*** MM/SEC ***

MEAN = 163.88 STD ERR = 2.56
VARIANCE = 6726.08
STD. DEV.= 82.01
KURTOSIS = 3.20
SKEWNESS = 0.813

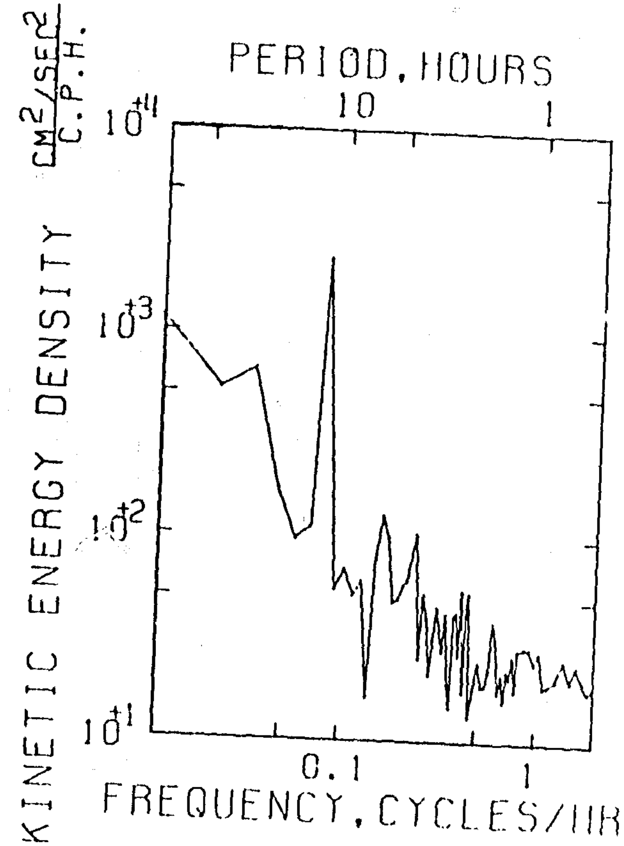
*** EAST & NORTH ***
************ MM/SEC ************

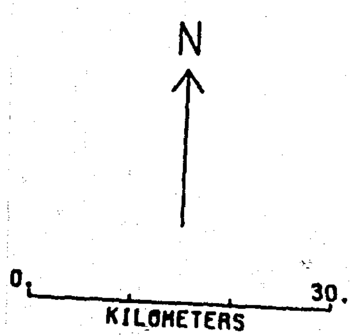
COVARIANCE = 1278.95 STD ERR = 501.36
STD. DEV. OF COVARIANCE = 16059.40
CORRELATION COEFFICIENT = 0.106

************ VECTOR MEANS ************
************ EAST & NORTH ************

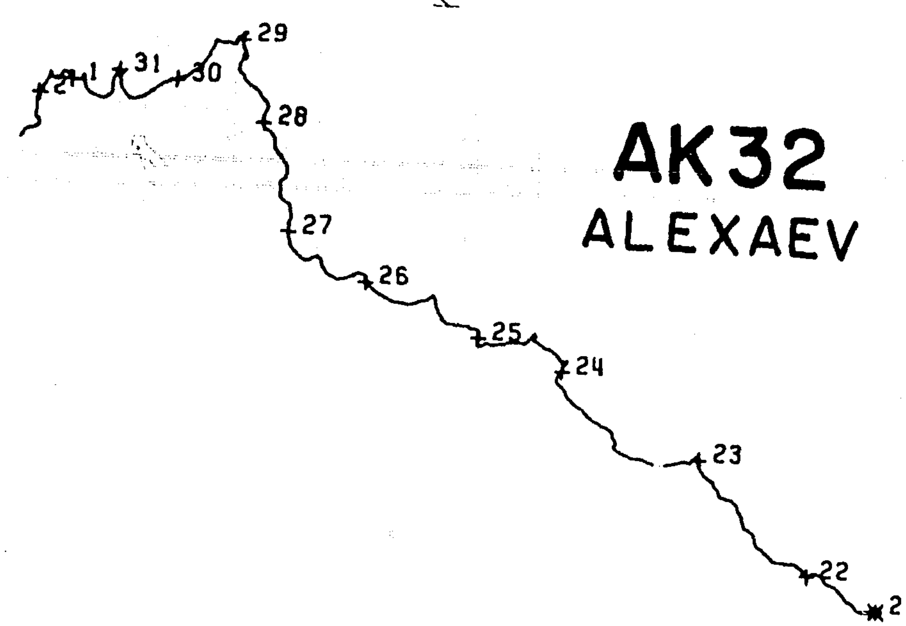
MEAN = 97.13
VARIANCE = 12067.77
STD. DEV.= 109.85

SAMPLE SIZE = 1.2[illegible] POINTS

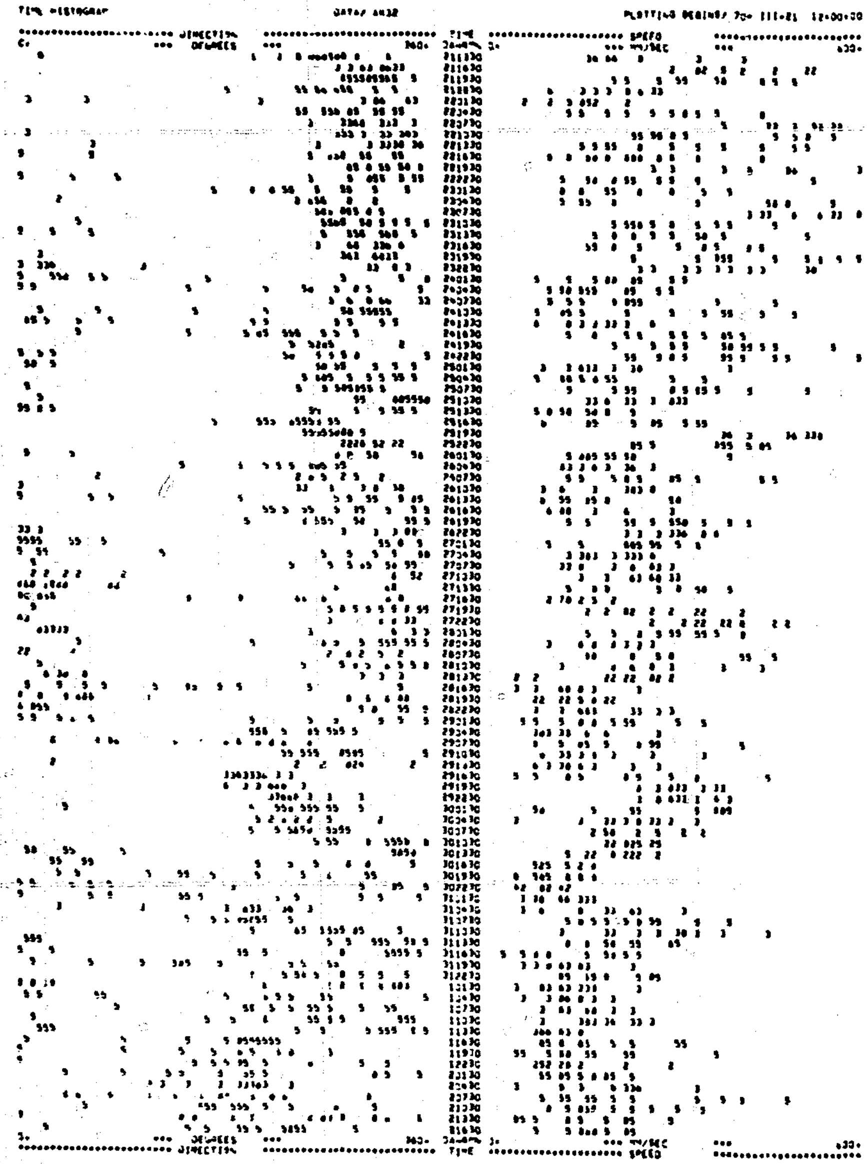




AK32
50 M
70- III-21 TO 70- IV -02



AK32
ALEXAEV



DATA/ AK32

SAMPLE SIZE = 10800.000 SECONDS

SPANNING RANGE
FROM 70- III-21 12:00:00
TO 70- IV -02 14:15:00

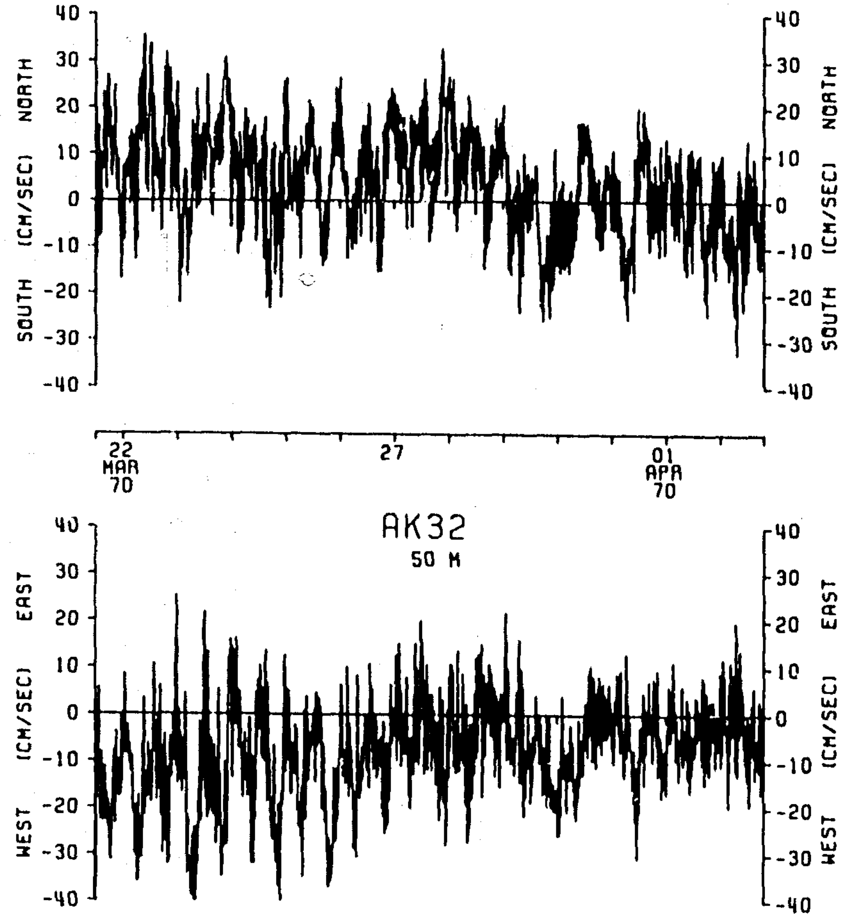
AVERAGE NUMBER ELEMENTS/SAMPLE = 12

TOTAL NUMBER OF DATA SAMPLES = [illegible]

NUMBER OF VACUOUS DATA SAMPLES = 0

NUMBER OF NONSTANDARD RECORDS = 0

[illegible]



AK32
ALEXAEV

STATS

E = EAST UNITS = MM/SEC
N = NORTH UNITS = MM/SEC

DATE	MID TIME HR	MIN	SEC	MEAN (E)	MEAN (N)	VECTOR MEAN	VARIANCE (E)	VARIANCE (N)	VECTOR VARIANCE	COVARIANCE (E & N)	SPEED MEAN (M)	SPEED VARIANCE (M)
70- III-22	12	0	0	-10.	33.	34.	19928.99	13846.76	16887.88	4594.07	156.	10582.02
70- III-23	12	0	0	-113.	123.	[illegible]	11817.10	9195.67	10506.38	-1748.58	200.	10127.04
70- III-24	12	0	0	-48.	43.	65.	23589.85	14237.36	18897.11	707.83	183.	8646.34
70- III-25	12	0	0	-104.	134.	171.	15995.67	7731.65	11663.66	1403.84	214.	7386.19
70- III-26	12	0	0	-89.	54.	105.	19119.90	17806.87	18463.38	4093.14	207.	4944.26
70- III-27	12	0	0	-44.	96.	106.	15475.35	21126.36	18300.85	-4551.31	184.	12732.02
70- III-28	12	0	0	-112.	107.	155.	16792.06	10828.41	13810.23	2610.82	207.	8660.93
70- III-29	12	0	0	-40.	64.	76.	6992.21	4437.75	5714.98	-991.91	113.	4493.75
70- III-30	12	0	0	-91.	115.	147.	11334.45	6453.57	8894.01	702.53	181.	6676.69
70- III-31	12	0	0	-75.	78.	[illegible]	8869.71	6789.57	7829.64	-2076.37	147.	5715.58
70- IV - 1	12	0	0	-62.	108.	120.	9855.24	7418.83	8637.02	-723.62	165.	7068.73

STATS

*** EAST ***
*** MM/SEC ***

MEAN =	-71.91	STD ERR =	3.94
VARIANCE =	15872.49		
STD. DEV. =	125.99		
KURTOSIS =	2.53		
SKEWNESS =	0.046		

*** NORTH ***
*** MM/SEC ***

MEAN =	85.76	STD ERR =	3.45
VARIANCE =	12190.54		
STD. DEV. =	110.41		
KURTOSIS =	3.10		
SKEWNESS =	-0.249		

*** SPEED ***
*** MM/SEC ***

MEAN =	178.31	STD ERR =	2.93
VARIANCE =	8793.60		
STD. DEV. =	93.76		
KURTOSIS =	2.12		
SKEWNESS =	-0.042		

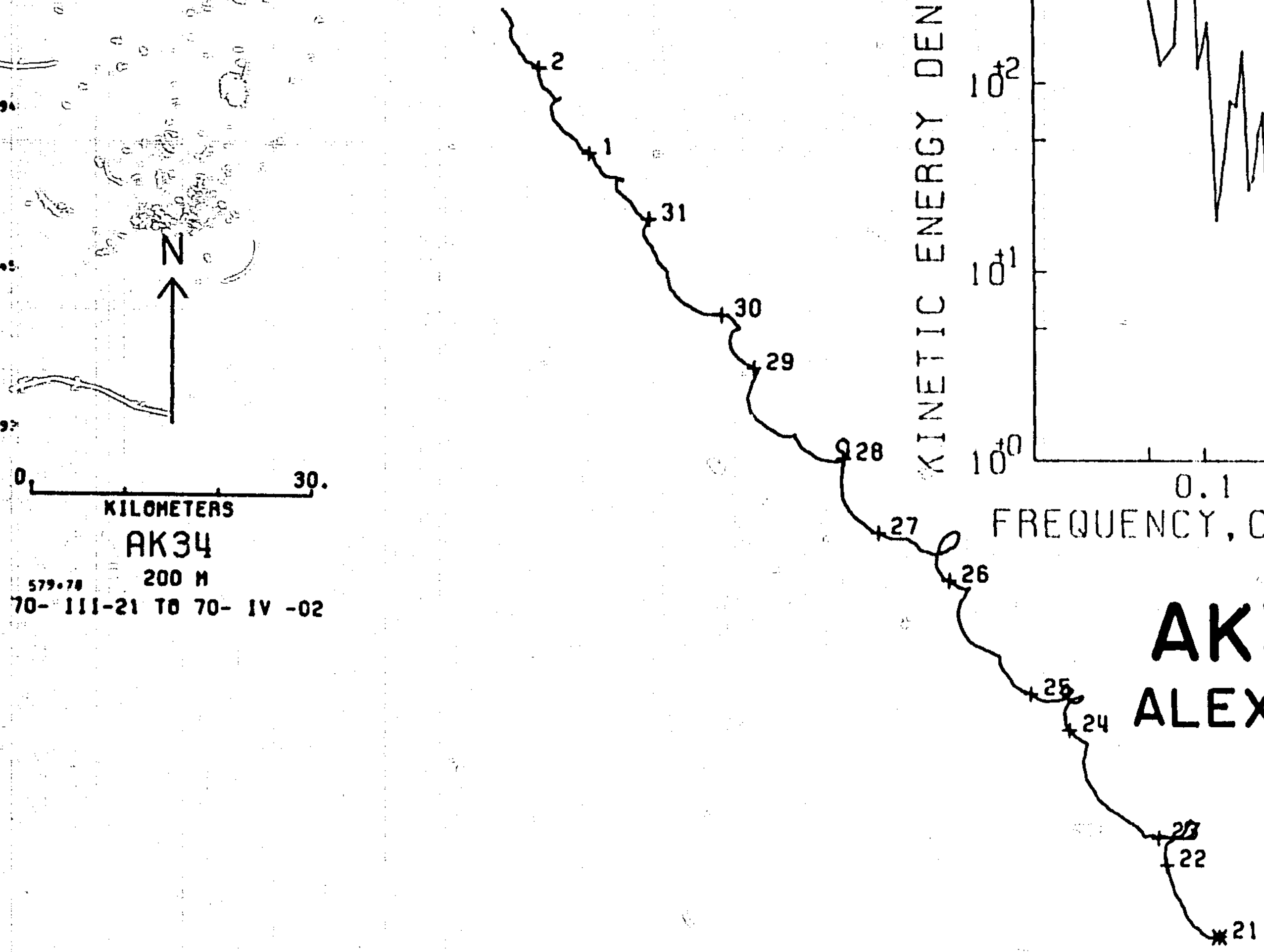
*** EAST & NORTH ***
************ MM/SEC ************

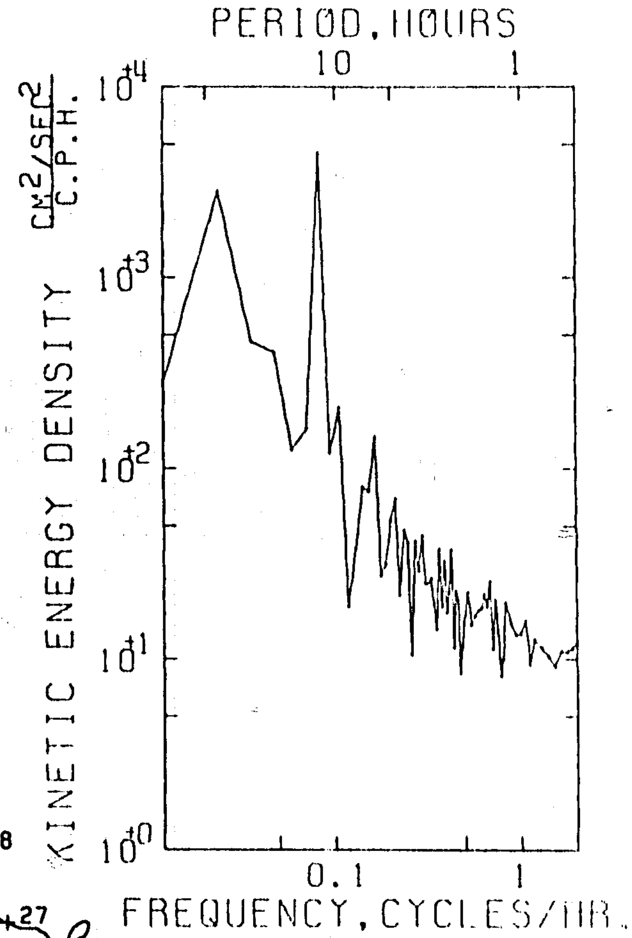
COVARIANCE = -483.49 STD ERR = 579.78
STD. DEV. OF COVARIANCE = 18552.44
CORRELATION COEFFICIENT = -0.035

************ VECTOR MEANS ************
************ EAST & NORTH ************

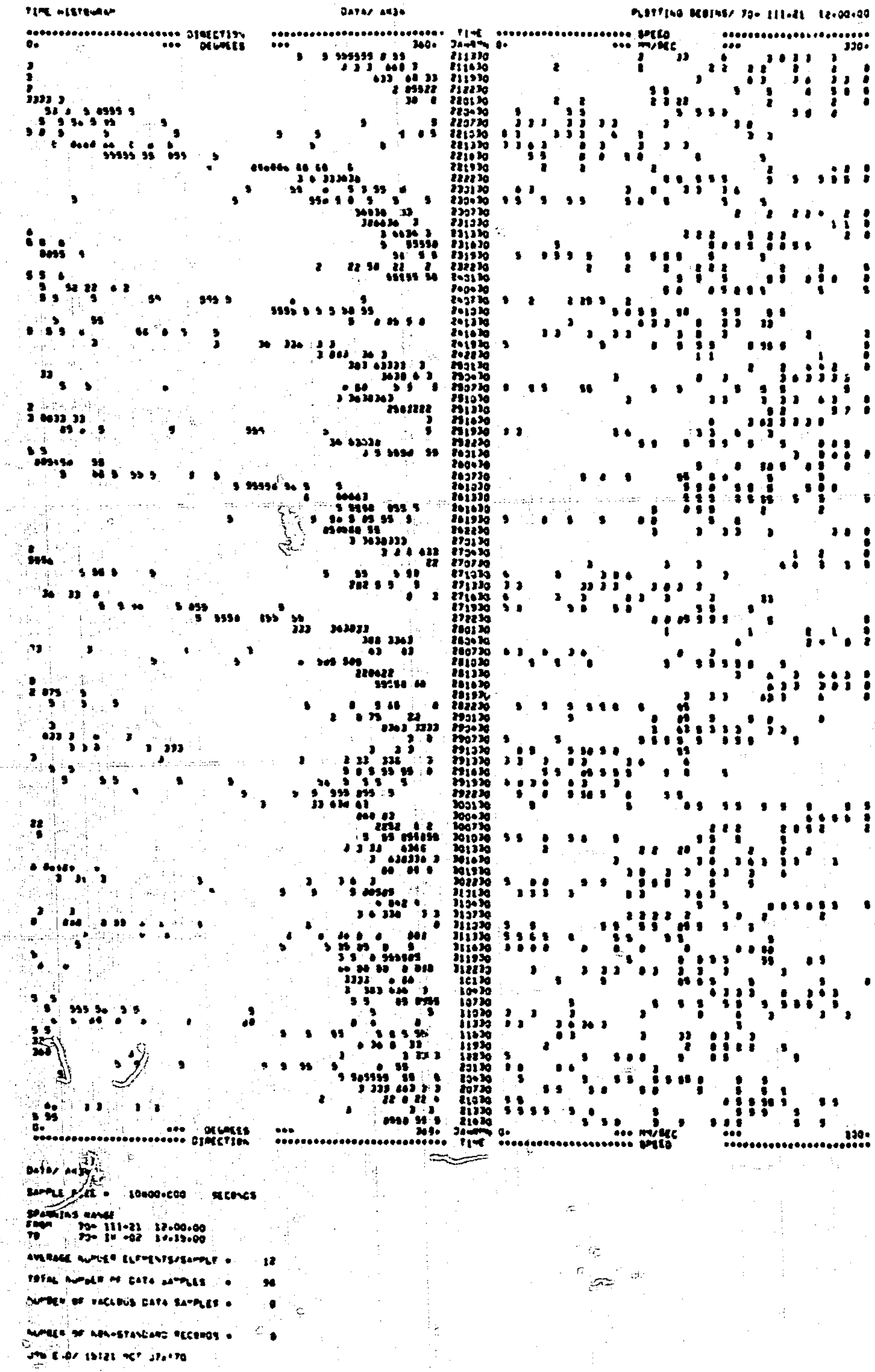
MEAN = 111.90
VARIANCE = 14031.52
STD. DEV. = 118.45

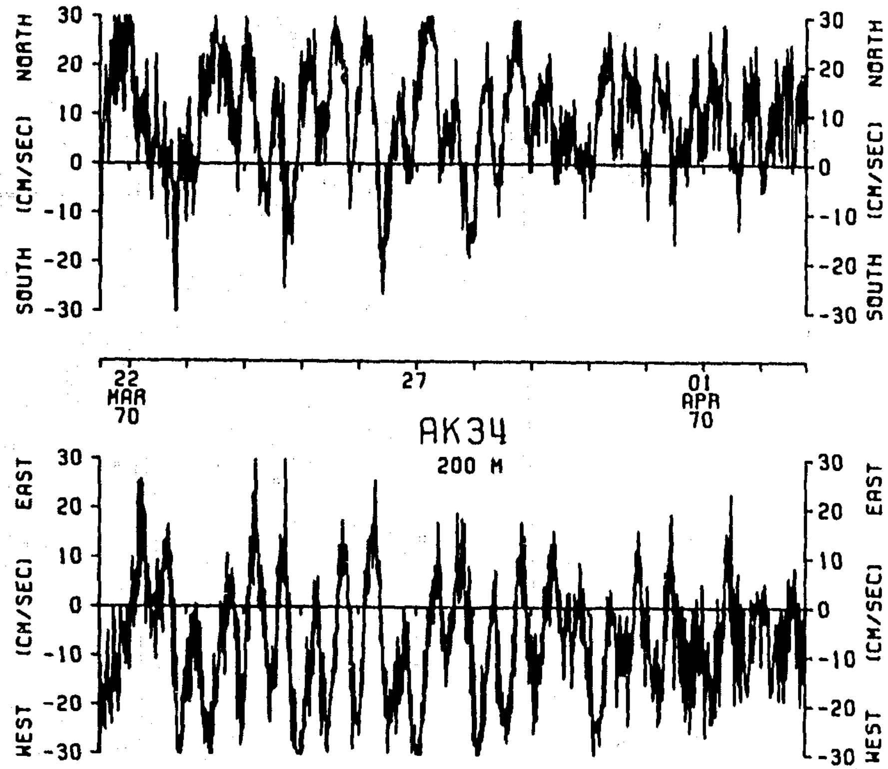
SAMPLE SIZE = 132. POINTS





AK34
ALEXAEV





AK34
ALEXAEV

STATS

E = EAST UNITS = MM/SEC
N = NORTH UNITS = MM/SEC

DATE	MID TIME HR	MIN	SEC	MEAN (E)	MEAN (N)	VECTOR MEAN	VARIANCE (E)	VARIANCE (N)	VECTOR VARIANCE	COVARIANCE (E & N)	SPEED UNITS = MM/SEC MEAN (S)	VARIANCE (S)
70- III-22	12	12	30	12.	62.	63.	17256.17	14097.24	15676.70	2813.92	187.	278.57
70- III-23	12	12	30	-93.	122.	153.	4694.00	3011.90	3852.95	1813.18	175.	495.33
70- III-24	12	12	30	-24.	30.	38.	14170.12	10892.31	12031.21	2125.46	161.	455.17
70- III-25	12	12	30	-64.	98.	117.	6282.37	4573.05	5427.71	1791.88	156.	368.65
70- III-26	12	12	30	-69.	36.	78.	9493.47	8767.70	9130.58	1049.95	155.	407.57
70- III-27	12	12	30	-36.	69.	78.	9589.03	12672.87	11130.95	-1121.64	167.	512.84
70- III-28	12	12	30	-75.	82.	111.	8087.32	6733.78	7410.54	1393.55	164.	508.42
70- III-29	12	12	30	-56.	69.	88.	4942.76	4224.70	4583.73	574.71	129.	205.50
70- III-30	12	12	30	-61.	89.	108.	5368.44	4162.97	4765.70	1078.73	143.	564.62
70- III-31	12	12	30	-67.	76.	102.	4440.03	4502.37	4471.20	628.21	138.	244.19
70- IV - 2	12	12	30	-38.	88.	93.	8752.77	5801.57	7277.17	-1080.34	151.	180.80

STATS

... EAST ...
... MM/SEC ...

MEAN = -53.[illegible] STD ERR = 3.03
VARIANCE = 53[illegible].34
STD. DEV.= 34.95
KURTOSIS = 2.[illegible]1
SKEWNESS = [illegible].69[illegible]

... NORTH ...
... MM/SEC ...

MEAN = 73.29 STD ERR = 2.79
VARIANCE = 796[illegible].34
STD. DEV.= [illegible].22
KURTOSIS = 3.12
SKEWNESS = -[illegible].98[illegible]

... SPEED ...
... MM/SEC ...

MEAN = 157.[illegible] STD ERR = [illegible]
VARIANCE = 6[illegible].37
STD. DEV.= 25.[illegible]6
KURTOSIS = 2.83
SKEWNESS = [illegible].[illegible]3

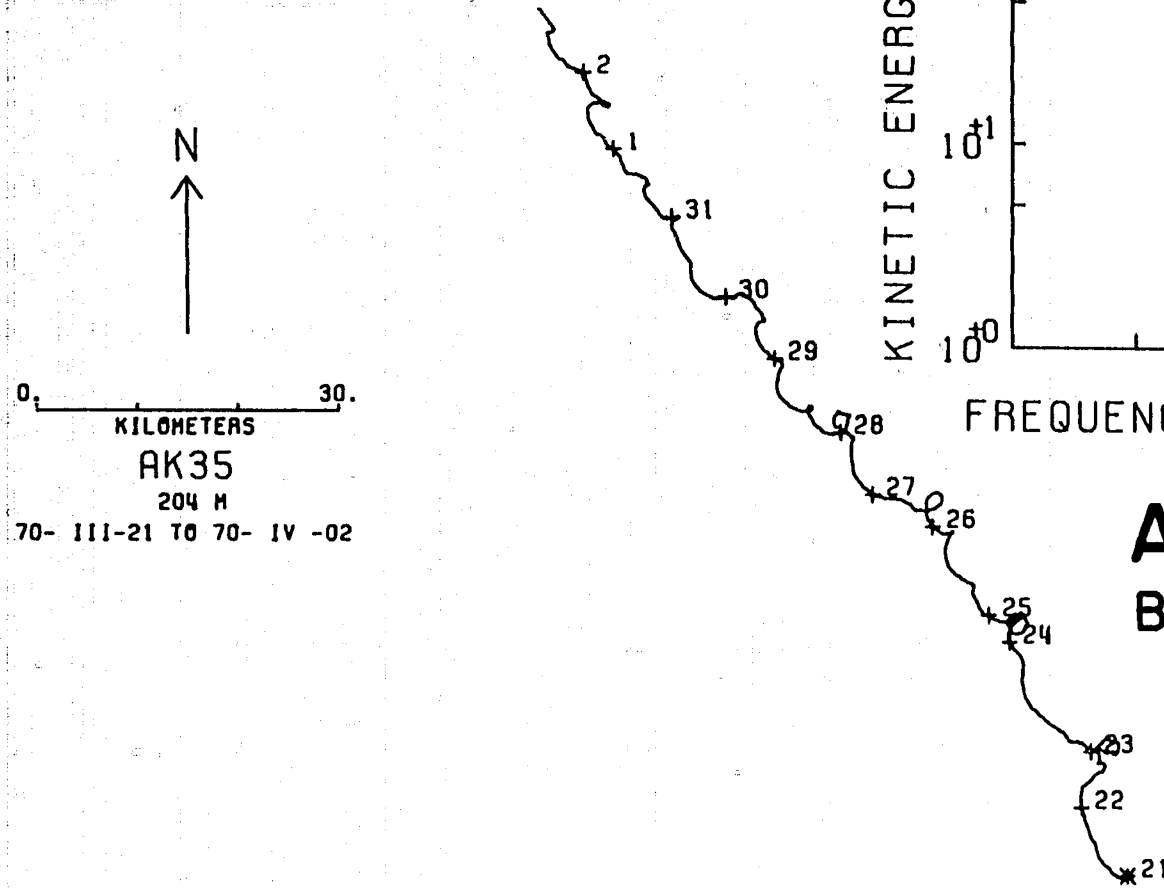
... EAST & NORTH ...
.... MM/SEC ....

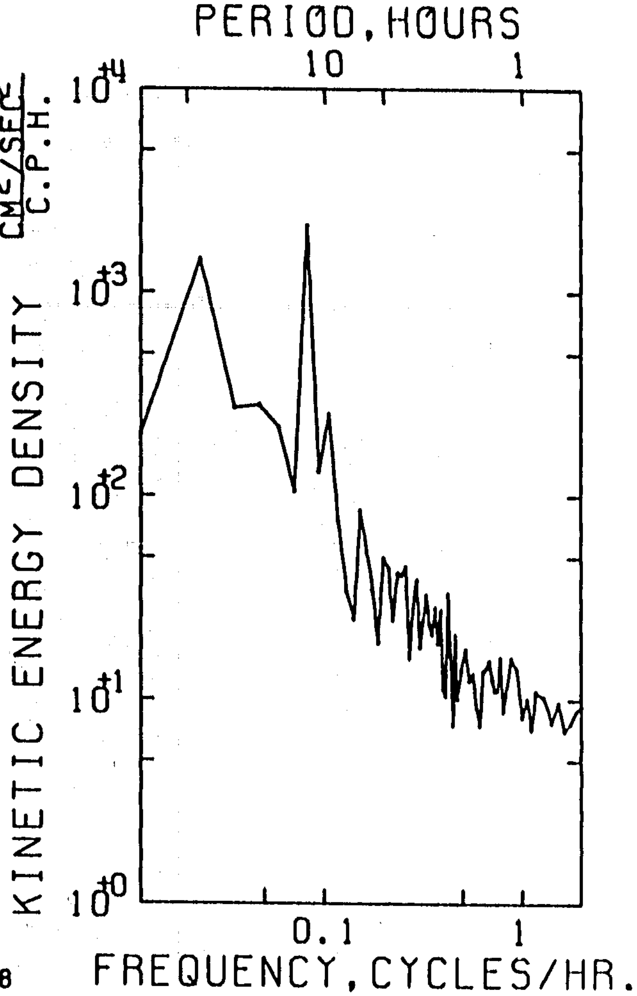
COVARIANCE = [illegible] STD ERR = 24[illegible].[illegible]5
STD. DEV. OF COVARIANCE = 917[illegible].19
CORRELATION COEFFICIENT = [illegible]

.... VECTOR MEANS ....
.... EAST & NORTH ....

MEAN = [illegible].[illegible]2
VARIANCE = [illegible]7[illegible].2[illegible]
STD. DEV.= [illegible].[illegible]

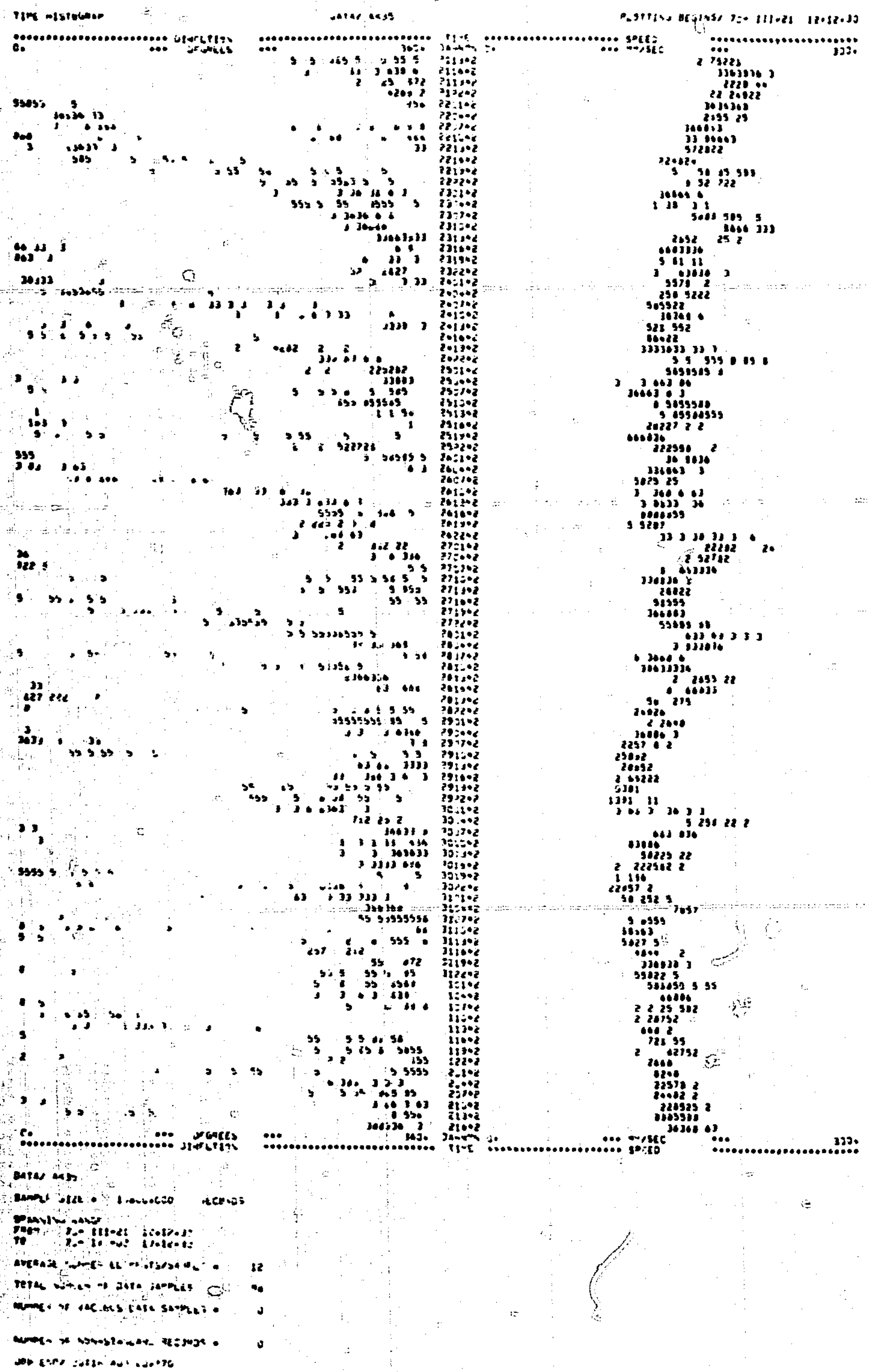
SAMPLE SIZE = [illegible] POINTS

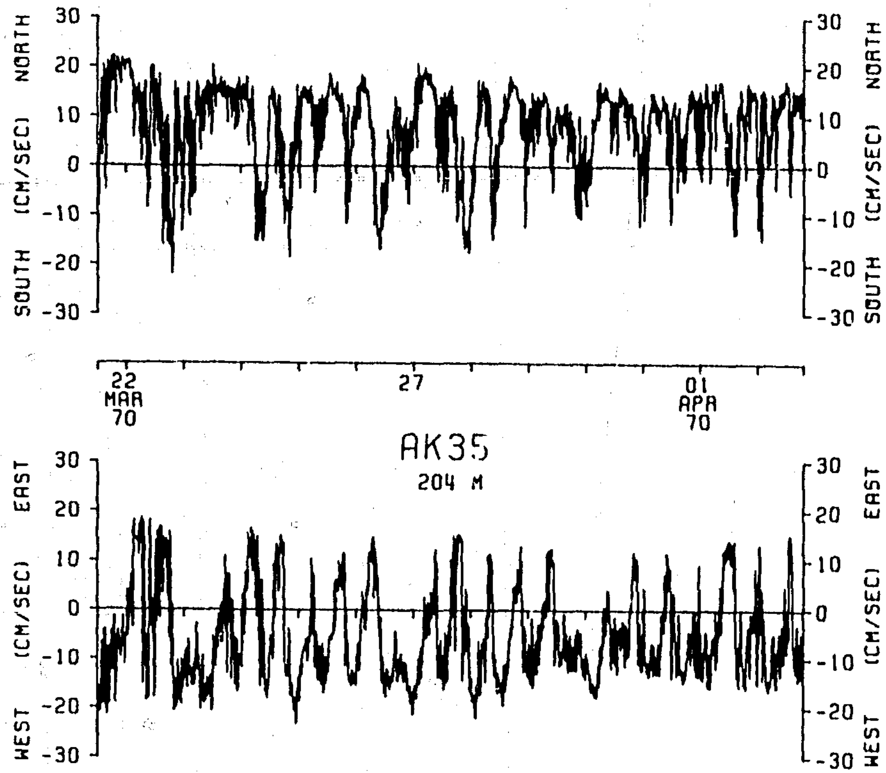




AK35
BERGEN

66





NORTH
SOUTH
(CM/SEC)
EAST
WEST
30
20
10
0
-10
-20
-30
22 MAR 70
27
01 APR 70
AK35
204 M

AK35
BERGEN

STATS06

E = EAST UNITS = MM/SEC
N = NORTH UNITS = MM/SEC

DATE	MID TIME HR MN SEC	MEAN (E)	MEAN (N)	VECTOR MEAN	VARIANCE (E)	VARIANCE (N)	VECTOR VARIANCE	COVARIANCE (E & N)	SPEED (UNITS = MM/SEC) MEAN (S)	SPEED VARIANCE (S)
70- III-22	12.01.16	5.	27.	27.	2620.56	4492.06	3556.31	214.37	77.	660.14
70- III-23	12.01.16	-5.	[illegible]	48.	2062.67	3122.54	2593.60	229.99	86.	921.42
70- III-24	12.01.16	-19.	48.	52.	1754.48	2023.27	1888.88	164.83	80.	709.46
70- III-25	12.01.16	-14.	37.	39.	2431.81	1801.44	2116.62	211.79	72.	478.59
70- III-26	12.01.16	-12.	45.	46.	1984.77	2293.96	2139.36	354.06	77.	807.49
70- III-27	12.01.16	-14.	55.	56.	1739.27	1927.01	1833.14	-116.89	70.	616.37
70- III-28	12.01.16	-22.	36.	43.	2478.56	1236.25	1857.41	103.03	75.	946.13
70- III-29	12.01.16	-14.	59.	61.	2298.96	2036.41	2167.69	-244.96	82.	778.37
70- III-30	12.01.16	-31.	27.	41.	1307.54	1826.44	1566.99	535.10	69.	940.91
70- III-31	12.01.16	-16.	44.	47.	1442.51	2024.24	1733.38	-400.51	66.	509.50
70- IV -01	12.01.16	-72.	27.	76.	606.85	2499.49	1553.17	388.72	84.	546.03

STATS06

*** EAST ***
*** MM/SEC ***

MEAN = -17.98 STD ERR = 1.46
VARIANCE = 2195.79
STD. DEV.= 46.86
KURTOSIS = 2.50
SKEWNESS = .094

*** NORTH ***
*** MM/SEC ***

MEAN = 41.59 STD ERR = 1.53
VARIANCE = 2406.58
STD. DEV.= 49.06
KURTOSIS = 3.83
SKEWNESS = -.938

*** SPEED ***
*** MM/SEC ***

MEAN = 76.71 STD ERR = .87
VARIANCE = 770.78
STD. DEV.= 27.76
KURTOSIS = 2.63
SKEWNESS = .068

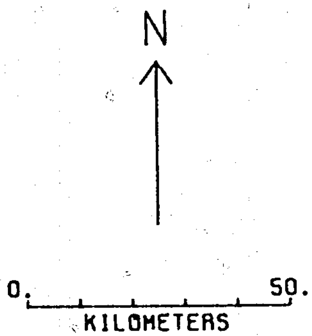
*** EAST & NORTH ***
*********** MM/SEC ***********

COVARIANCE = 181.63 STD ERR = 87.67
STD. DEV. OF COVARIANCE = 2805.56
CORRELATION COEFFICIENT = .079

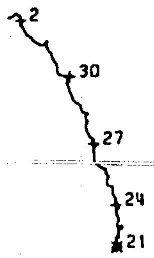
*********** VECTOR MEANS ***********
*********** EAST & NORTH ***********

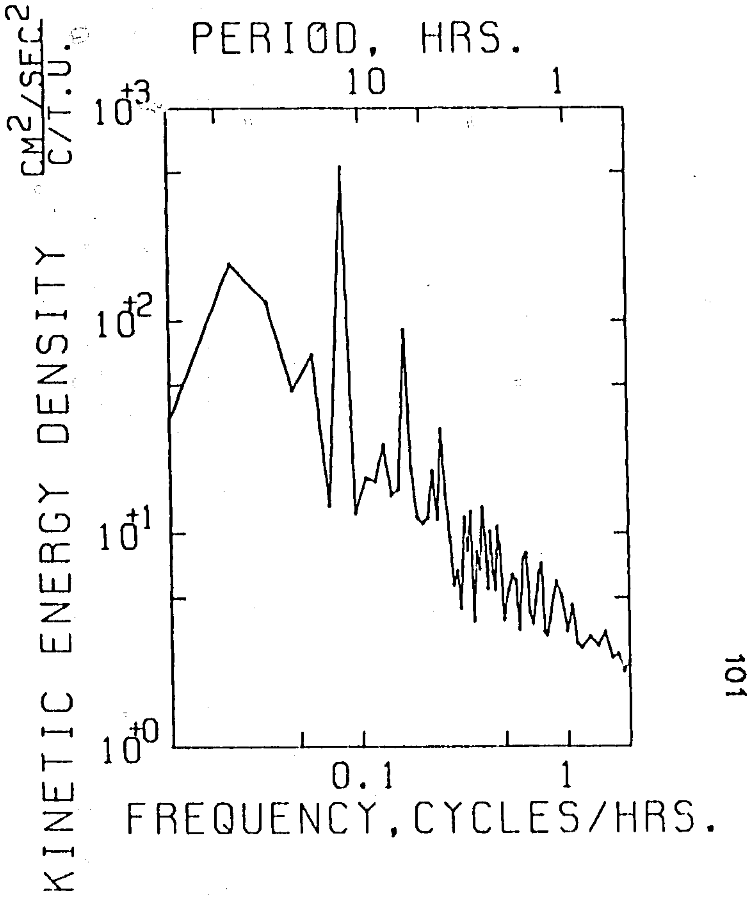
MEAN = 45.31
VARIANCE = 2301.19
STD. DEV.= 47.97

SAMPLE SIZE = 1024 POINTS



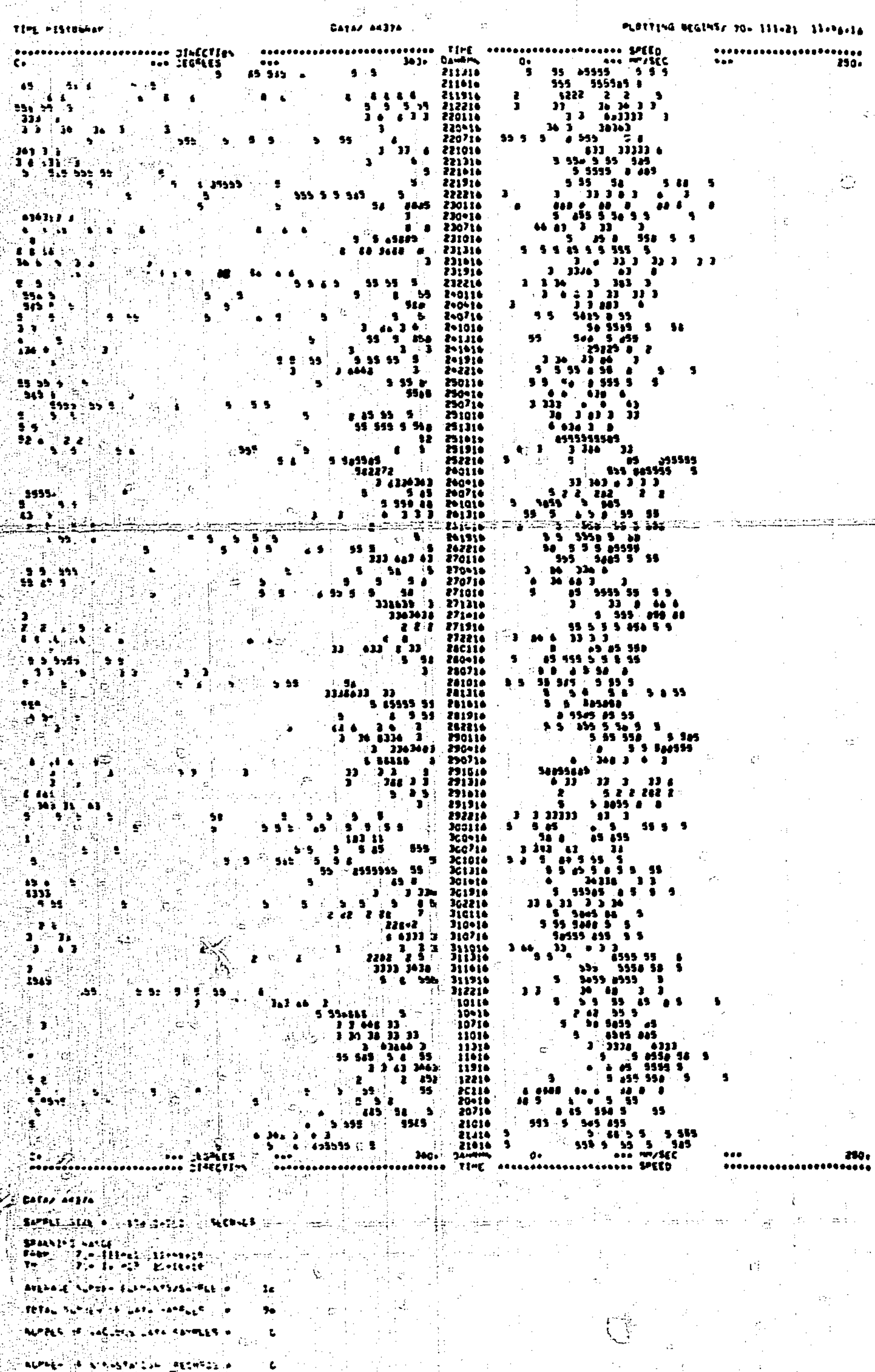
AK37A
1003 M
70- III-21 TO 70- IV -02

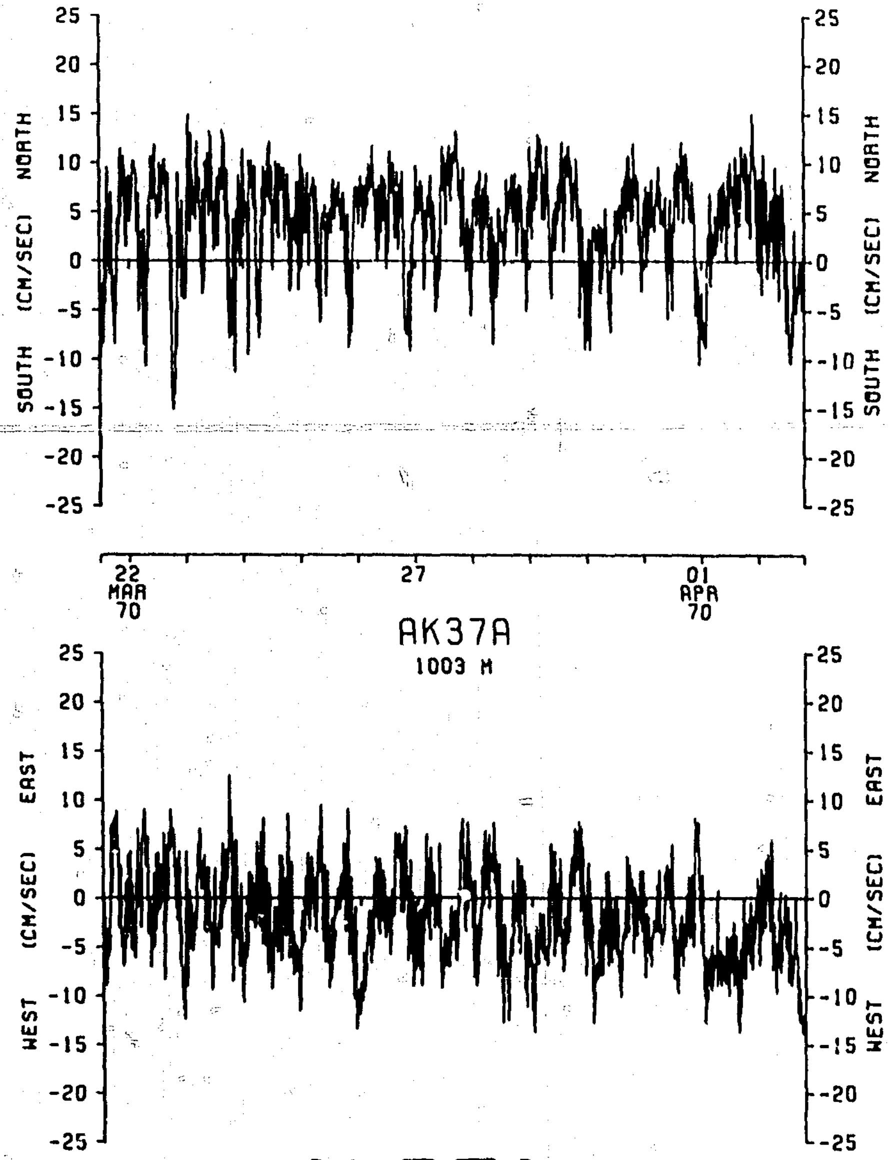




AK37A

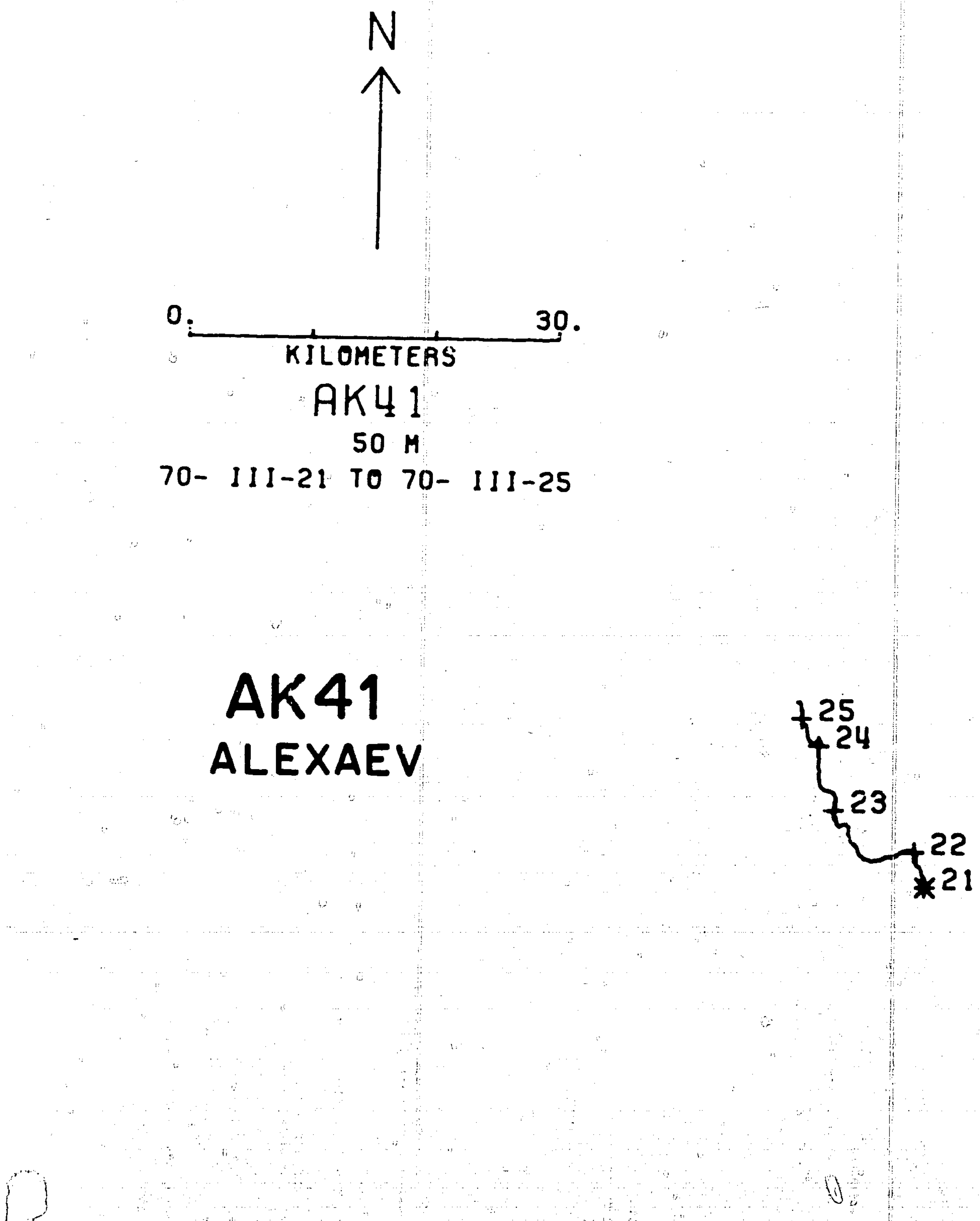
GEODYNE

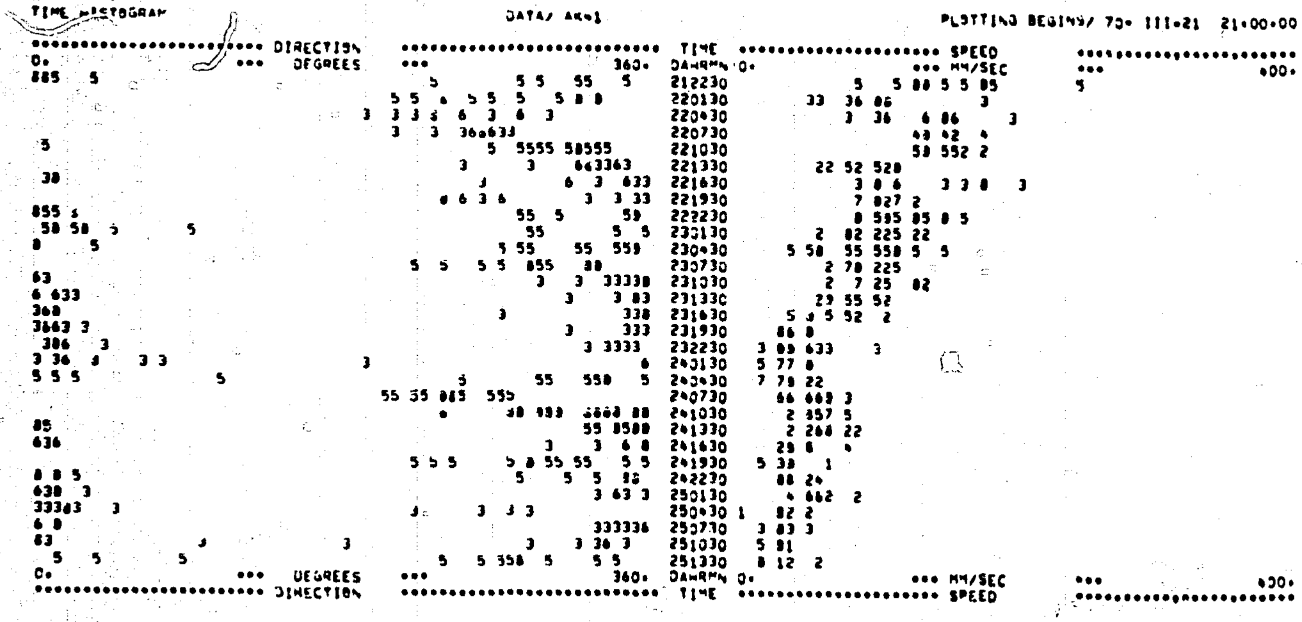




AK37A

GEODYNE


N
0.
30.
KILOMETERS
AK41
50 M
70- III-21 TO 70- III-25
AK41
ALEXAEV
25
24
23
22
21



DATA/ AK41

SAMPLE SIZE = 10800.000 SECONDS

SPANNING RANGE
FROM 70. III.21 21.00.00
TO 70. III.25 15.15.00

AVERAGE NUMBER ELEMENTS/SAMPLE = 12

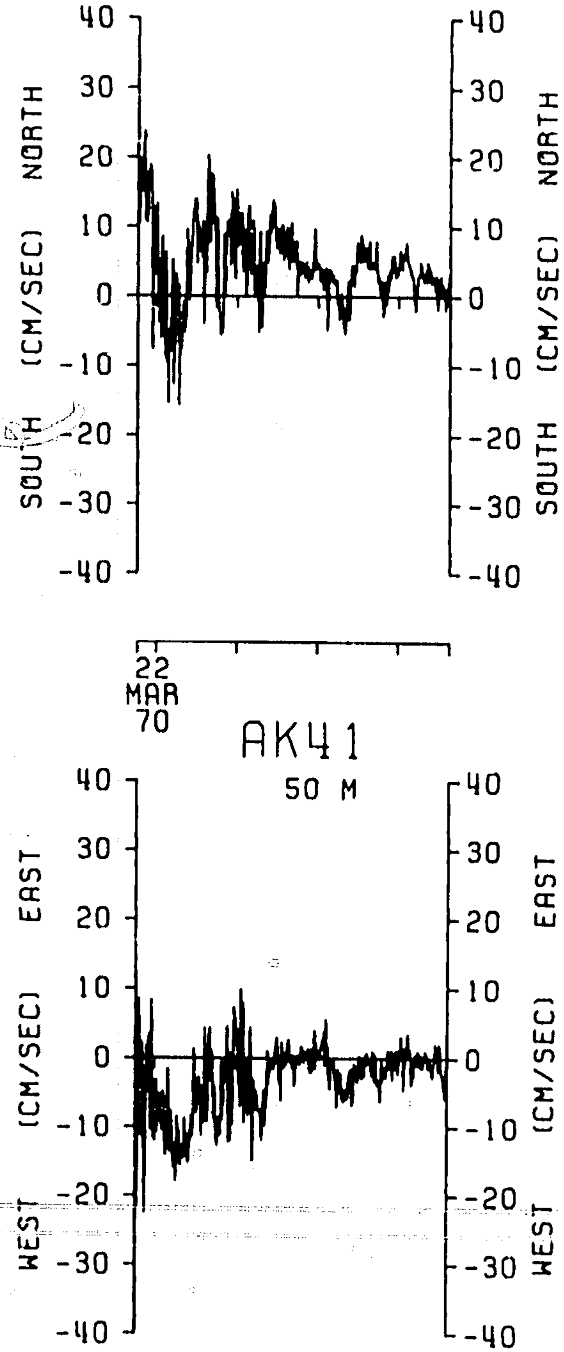
TOTAL NUMBER OF DATA SAMPLES = 30

NUMBER OF VACUOUS DATA SAMPLES = 0

NUMBER OF NON-STANDARD RECORDS = 0

JOB END/ 1932 OCT 07,'70

AK41
ALEXAEV



STATSO6

E = EAST UNITS = MM/SEC
N = NORTH UNITS = MM/SEC

SPEED UNITS = MM/SEC

DATE	MID TIME HR MN SEC	MEAN (E)	MEAN (N)	VECTOR MEAN	VARIANCE (E)	VARIANCE (N)	VECTOR VARIANCE	COVARIANCE (E & N)	SPEED MEAN (N)	SPEED VARIANCE (N)
70- III-22	12-01-16	-113.	79.	138.	4604.27	6646.51	5625.39	2891.41	162.	3336.47
70- III-23	12-01-16	-45.	163.	169.	7425.09	5914.75	6669.92	3166.39	204.	2108.66
70- III-24	12-01-16	-63.	97.	116.	6835.65	9760.13	8297.89	3681.72	171.	3386.48
70- III-25	12-01-16	-48.	109.	119.	5058.89	6465.90	5762.39	3660.47	151.	3111.91
70- III-26	12-01-16	-53.	133.	144.	3076.13	3372.03	3224.08	1377.83	162.	2177.63
70- III-27	12-01-16	-56.	121.	133.	5872.36	5893.03	5882.69	2021.10	145.	3264.87
70- III-28	12-01-16	-111.	149.	186.	3484.27	8114.49	5799.38	2356.31	209.	4027.88
70- III-29	12-01-16	-113.	81.	139.	2928.51	4942.16	3935.33	1187.84	169.	1705.53
70- III-30	12-01-16	-62.	40.	74.	2581.94	3396.77	2989.35	1407.97	110.	1702.76
70- III-31	12-01-16	-23.	31.	38.	3011.70	3127.35	3069.52	964.77	75.	1217.03
70- IV -01	12-01-16	-27.	21.	34.	5210.15	3619.98	4415.06	166.53	89.	1704.27

STATSO6

*** EAST ***
*** MM/SEC ***

MEAN = -66.05 STD ERR = 2.32
VARIANCE = 5498.51
STD. DEV.= 74.15
KURTOSIS = 2.66
SKEWNESS = .084

*** NORTH ***
*** MM/SEC ***

MEAN = 95.40 STD ERR = 2.72
VARIANCE = 7603.61
STD. DEV.= 87.20
KURTOSIS = 2.51
SKEWNESS = .109

*** SPEED ***
*** MM/SEC ***

MEAN = 149.64 STD ERR = 2.02
VARIANCE = 4174.97
STD. DEV.= 64.61
KURTOSIS = 2.68
SKEWNESS = .170

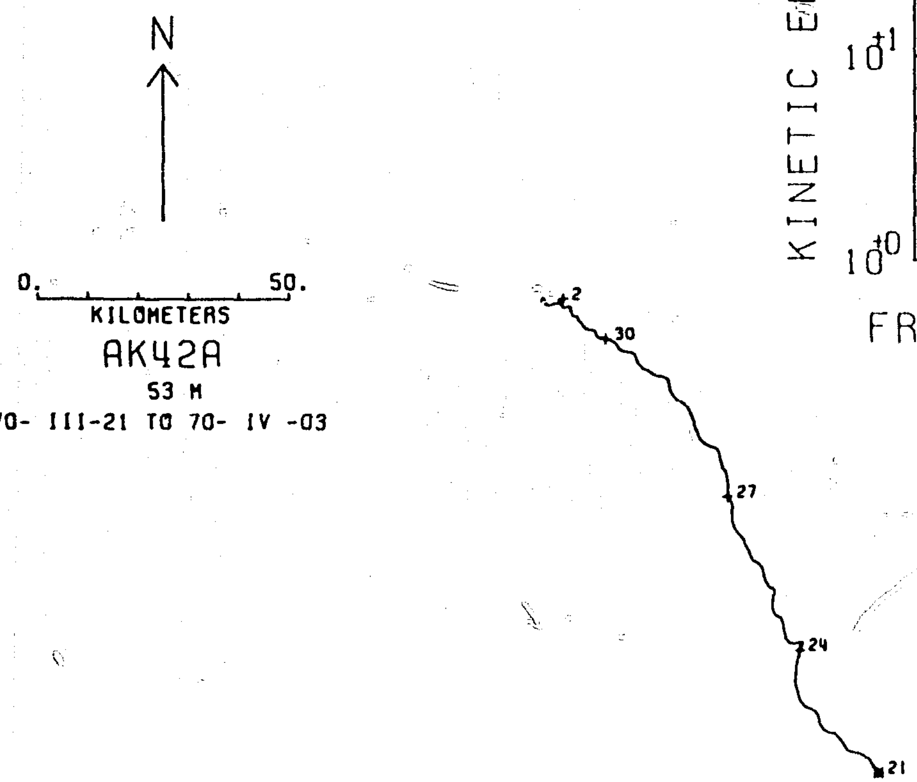
*** EAST & NORTH ***
*********** MM/SEC ***********

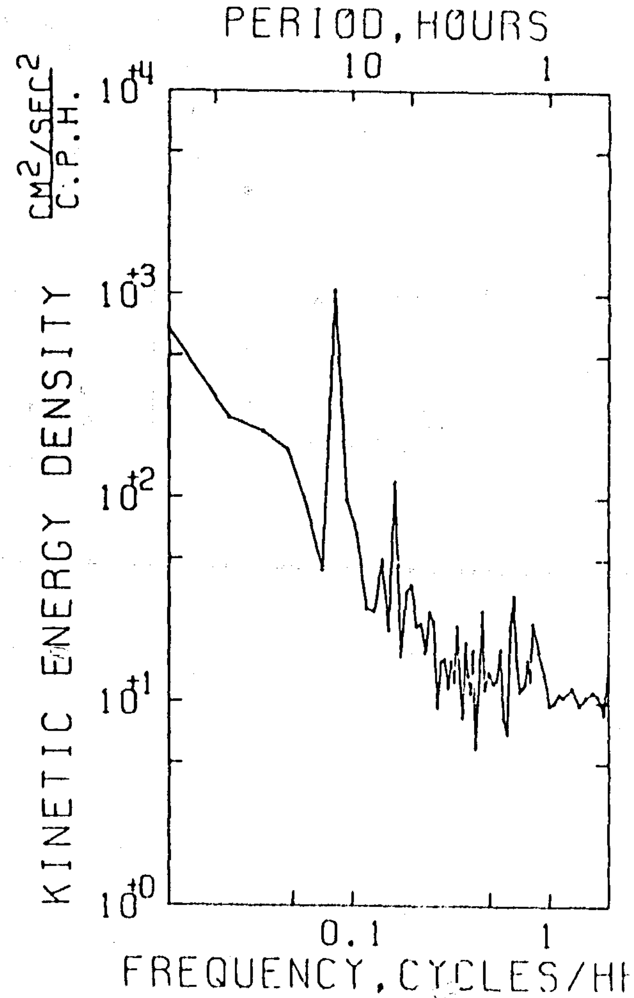
COVARIANCE = 1805.59 STD ERR = 305.07
STD. DEV. OF COVARIANCE = 9762.39
CORRELATION COEFFICIENT = .279

*********** VECTOR MEANS ***********
*********** EAST & NORTH ***********

MEAN = 116.03
VARIANCE = 6551.06
STD. DEV.= 80.94

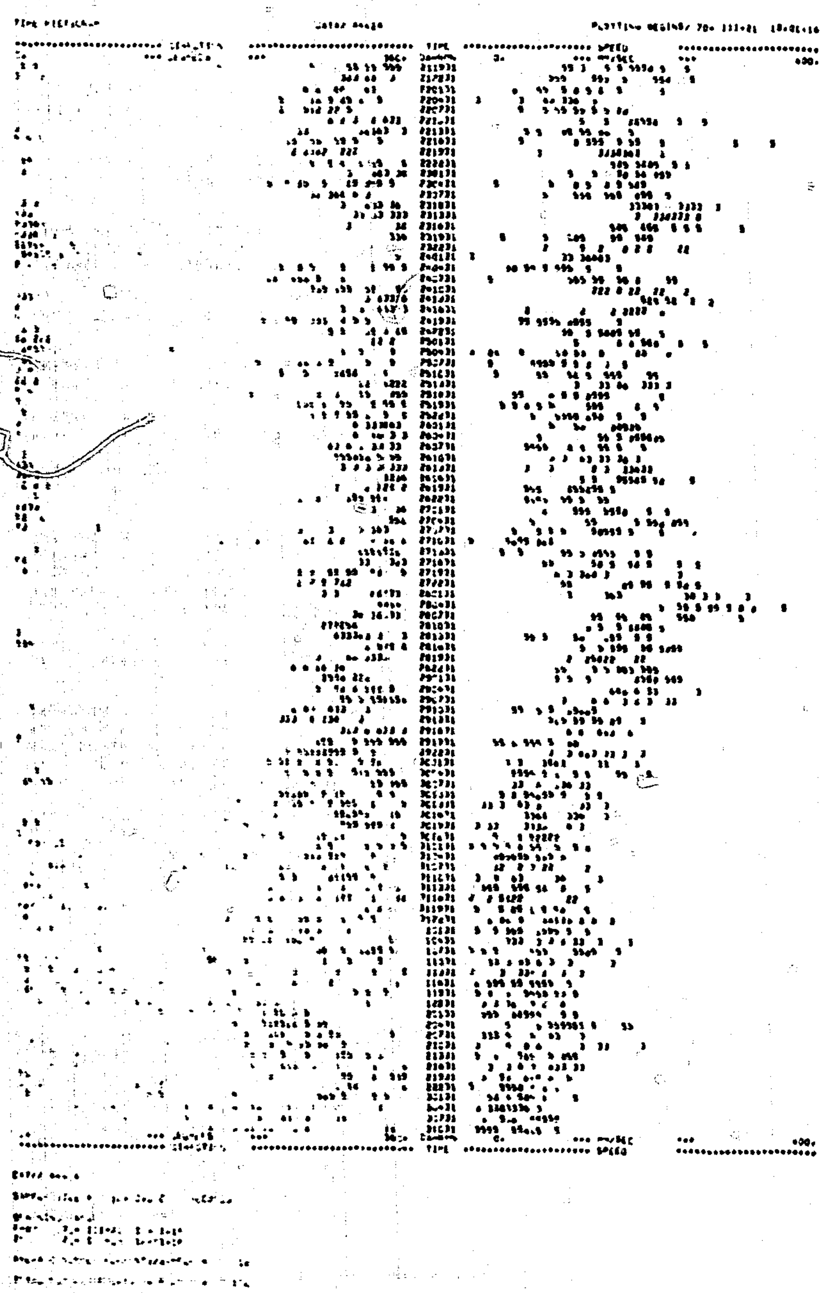
SAMPLE SIZE = 1024 POINTS

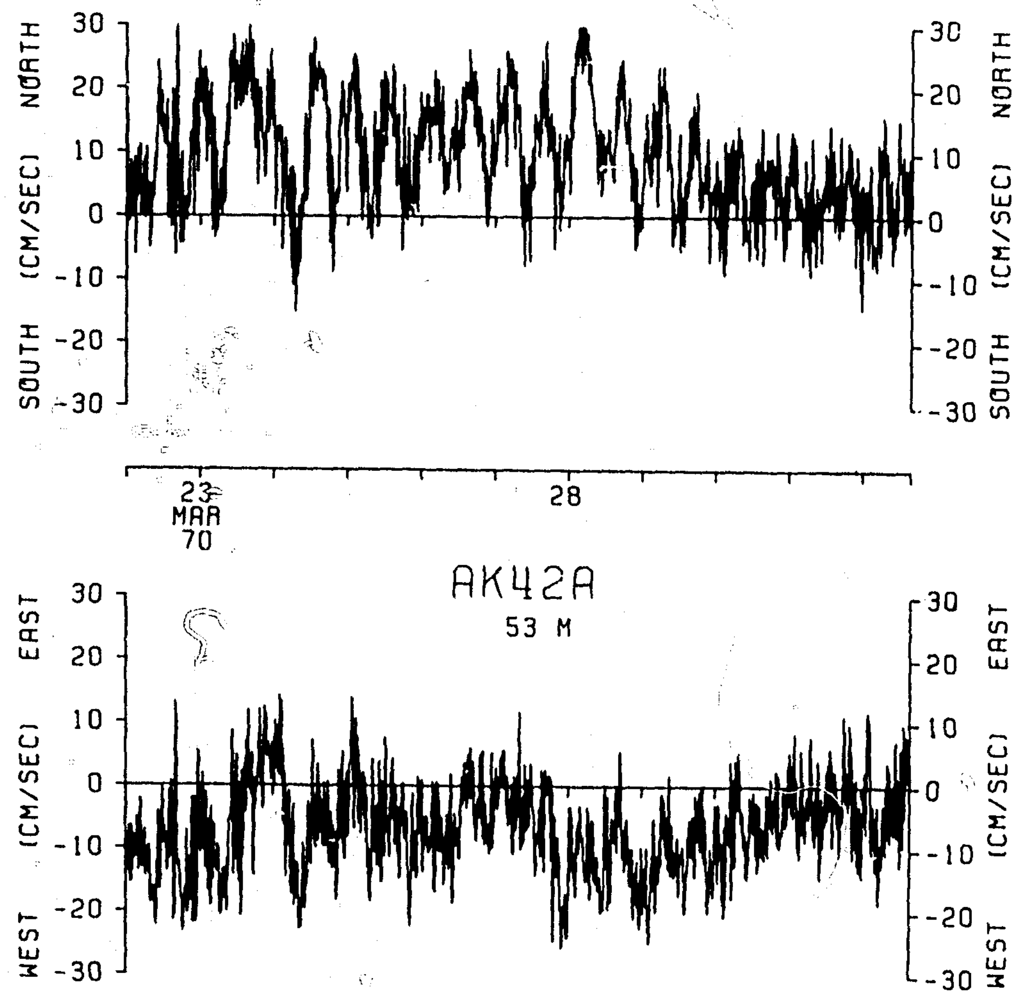




AK42A

GEODYNE





AK42A

GEODYNE

STATS

E = EAST　　UNITS = MM/SEC
N = NORTH　　UNITS = MM/SEC

DATE	MID TIME HR	MID TIME MIN	MID TIME SEC	MEAN (E)	MEAN (N)	VECTOR MEAN	VARIANCE (E)	VARIANCE (N)	VECTOR VARIANCE	COVARIANCE (E & N)	SPEED (UNITS = MM/SEC) MEAN (+)	SPEED VARIANCE (+)
70- III-22	12	0	0	-8.	59.	60.	18638.70	7572.76	13103.73	-373.52	169.	1133.78
70- III-23	12	0	0	-149.	85.	171.	3725.22	2364.26	3044.74	-93.50	155.	1231.24
70- III-24	12	0	0	-69.	8.	69.	8701.90	5093.41	6592.65	1349.29	130.	1575.94
70- III-25	12	0	0	-136.	64.	135.	3866.69	1976.02	2931.35	-17.45	151.	1363.75
70- III-26	12	0	0	-99.	-3.	99.	6204.56	3539.38	5871.96	-417.94	138.	2345.14
70- III-27	12	0	0	-75.	73.	105.	4794.29	5696.13	5245.21	-2390.51	141.	1697.53
70- III-28	12	0	0	-108.	43.	116.	1801.25	3753.40	2777.33	89.45	139.	647.67
70- III-29	12	0	0	-87.	40.	96.	1727.95	1769.98	1764.97	529.37	111.	373.44
70- III-30	12	0	0	-99.	105.	145.	3008.02	2431.87	2719.95	1171.29	160.	727.08
70- III-31	12	0	0	-81.	64.	123.	3490.09	4318.39	3904.24	2060.46	132.	1042.87
70- IV - 1	12	0	0	-57.	98.	113.	3874.78	2545.52	3210.15	556.50	144.	732.73

STATS

*** EAST ***
*** MM/SEC ***

MEAN = -84.72　　STD ERR = 2.58
VARIANCE = 6798.04
STD. DEV.= 82.45
KURTOSIS = 4.29
SKEWNESS = 1.255

*** NORTH ***
*** MM/SEC ***

MEAN = 59.59　　STD ERR = 2.24
VARIANCE = 5144.39
STD. DEV.= 71.72
KURTOSIS = 2.75
SKEWNESS = -0.420

*** SPEED ***
*** MM/SEC ***

MEAN = 145.26　　STD ERR = 1.24
VARIANCE = 1568.29
STD. DEV.= 39.60
KURTOSIS = 2.61
SKEWNESS = 0.389

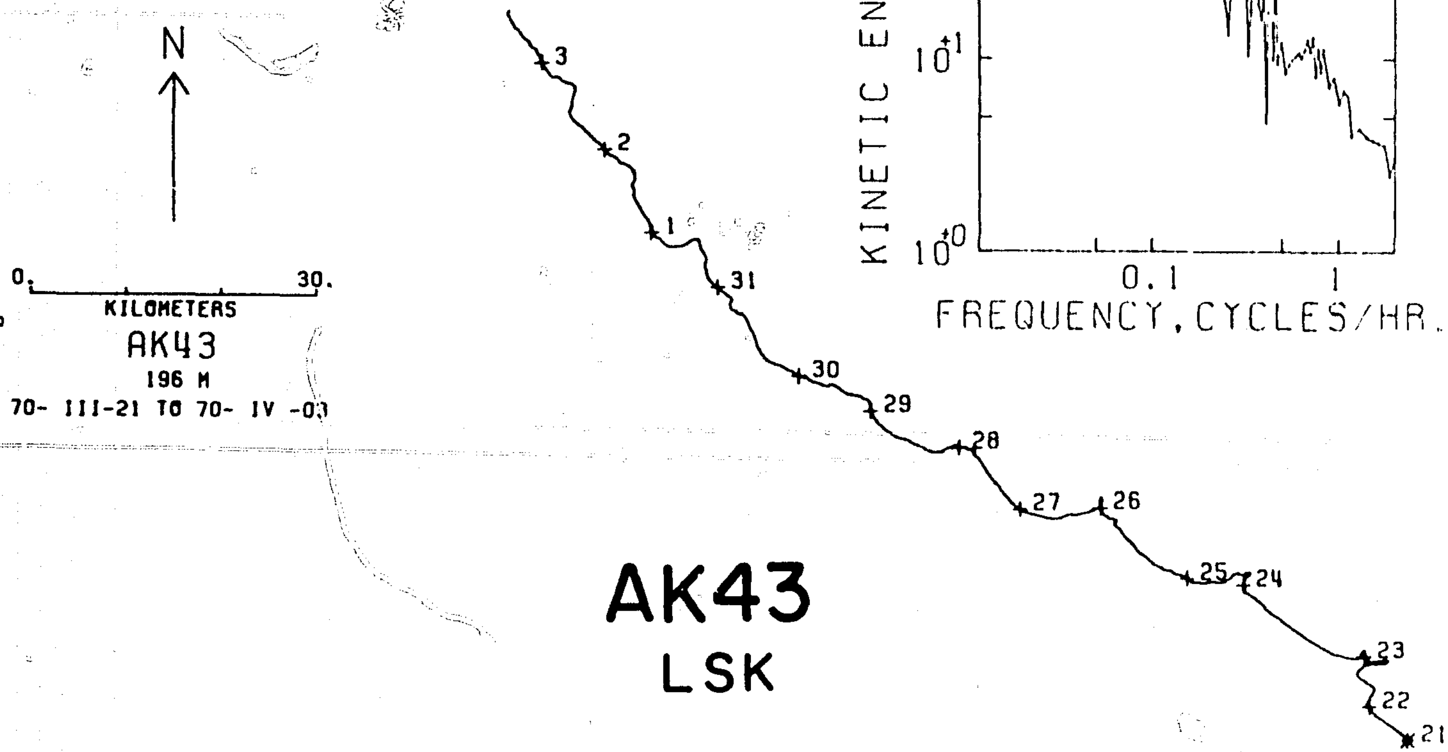
*** EAST & NORTH ***
*********** MM/SEC ***********

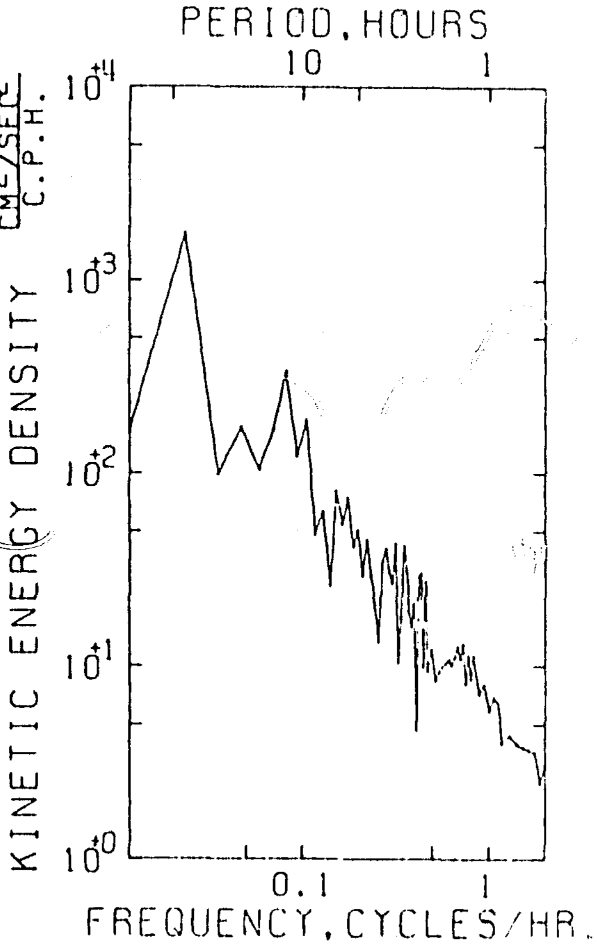
COVARIANCE = 118.03　　STD ERR = 274.00
STD. DEV. OF COVARIANCE = 8768.12
CORRELATION COEFFICIENT = 0.020

*********** VECTOR MEANS ***********
*********** EAST & NORTH ***********

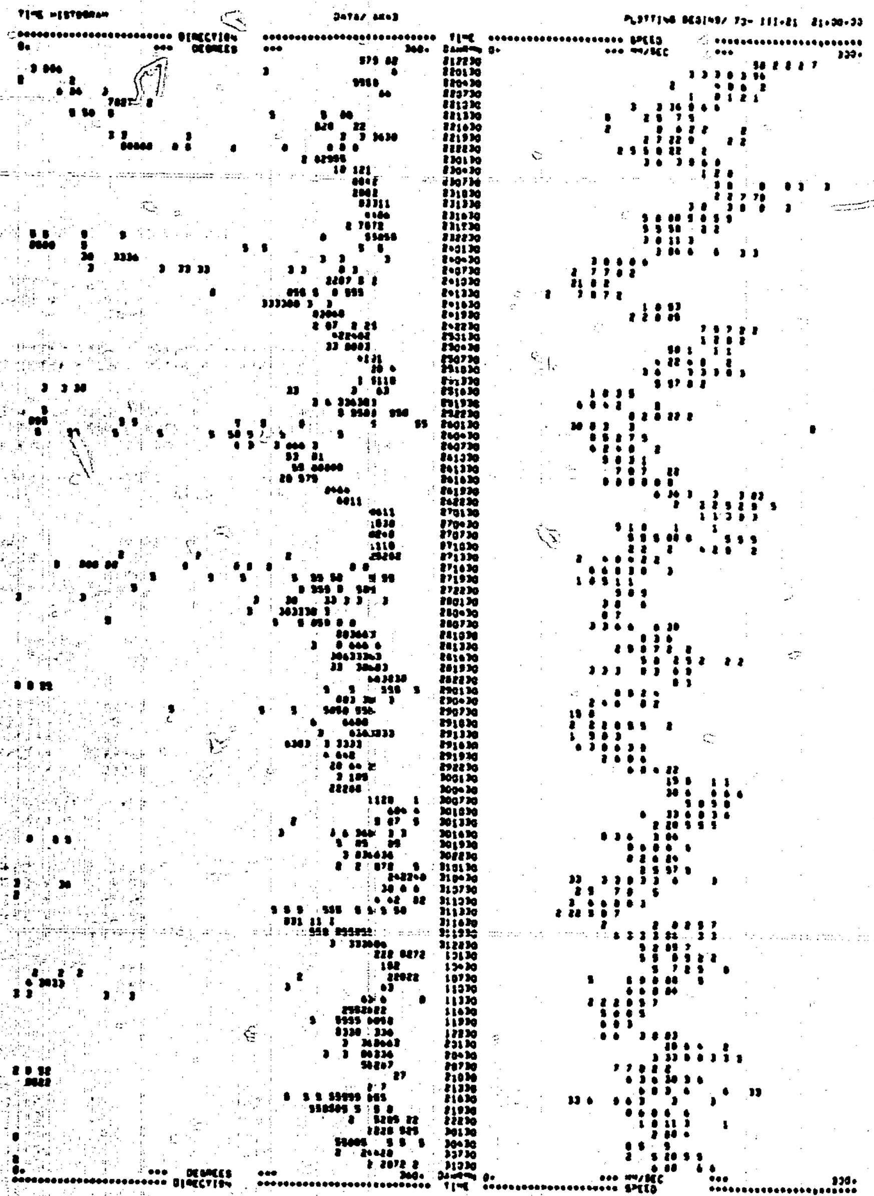
MEAN = 103.57
VARIANCE = 5971.21
STD. DEV.= 77.27

SAMPLE SIZE = 1024 POINTS





AK43
LSK



DATA/ AK43

SAMPLE SIZE = 10800.000 SECONDS

SPANNING RANGE
FROM 70- III-21 21.00.00
TO 70- IV -03 18.15.00

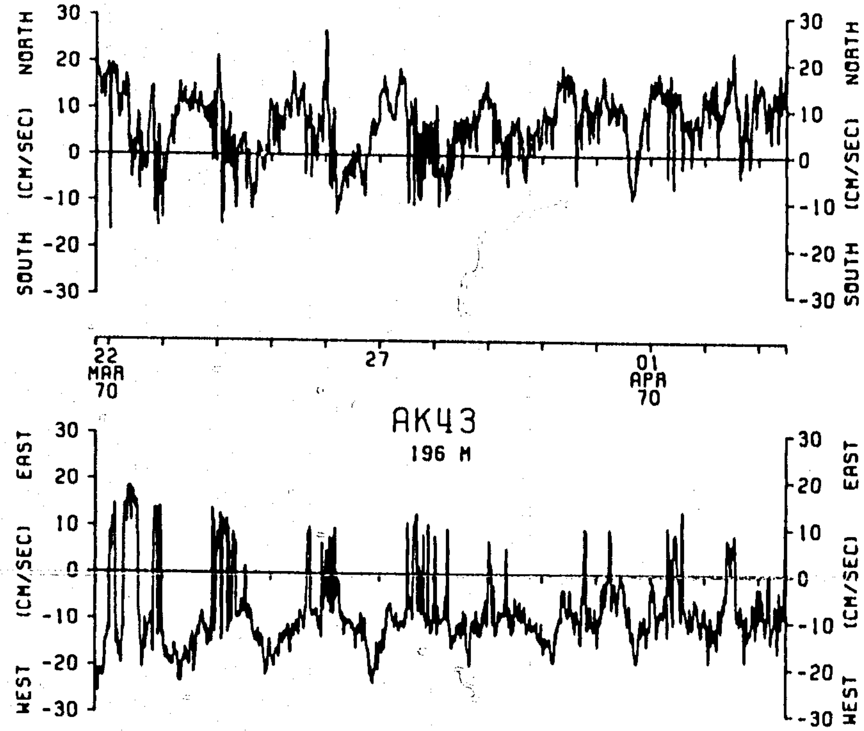
AVERAGE NUMBER ELEMENTS/SAMPLE = 12

TOTAL NUMBER OF DATA SAMPLES = 101

NUMBER OF VACUOUS DATA SAMPLES = 0

NUMBER OF NONSTANDARD RECORDS = 0

JOB END/ 20:19 AUG 25,'70



AK43
LSK

STATS

E = EAST UNITS = MM/SEC
N = NORTH UNITS = MM/SEC

DATE	MID TIME HR	MIN	SEC	MEAN (E)	MEAN (N)	VECTOR MEAN	VARIANCE (E)	VARIANCE (N)	VECTOR VARIANCE	COVARIANCE (E & N)	SPEED UNITS = MM/SEC MEAN (S)	VARIANCE (S)
70- III-22	12	0	0	-56.	95.	110.	15863.25	15219.19	15541.22	1173.62	191.	6560.94
70- III-23	12	0	0	-153.	60.	164.	9754.00	15679.81	12716.91	1330.67	214.	6818.71
70- III-24	12	0	0	-94.	13.	95.	15838.99	15478.26	15658.63	4519.87	170.	11416.67
70- III-25	12	0	0	-148.	139.	203.	10556.65	5644.44	8100.55	893.22	229.	4937.66
70- III-26	12	0	0	-112.	-6.	112.	12761.00	6411.47	9556.23	-538.23	150.	9255.11
70- III-27	12	0	0	-105.	79.	131.	9263.20	6738.05	8033.63	-3608.39	154.	9578.47
70- III-28	12	0	0	-114.	66.	132.	5264.83	9239.87	6752.34	-68.12	158.	6027.51
70- III-29	12	0	0	-108.	42.	116.	4272.53	5580.44	4926.46	325.68	138.	4267.09
70- III-30	12	0	0	-130.	120.	176.	6026.00	6795.47	6410.73	859.16	202.	3177.73
70- III-31	12	0	0	-116.	56.	129.	10847.55	12133.19	11490.52	1029.85	178.	7831.90
70- IV - 1	12	0	0	-83.	127.	151.	7309.59	7711.38	7510.48	513.95	203.	4254.59

STATS

*** EAST ***
*** MM/SEC ***

MEAN = -111.39 STD ERR = 3.22
VARIANCE = 10644.45
STD. DEV.= 103.17
KURTOSIS = 2.90
SKEWNESS = 0.144

*** NORTH ***
*** MM/SEC ***

MEAN = 72.12 STD ERR = 3.36
VARIANCE = 11705.96
STD. DEV.= 108.19
KURTOSIS = 2.61
SKEWNESS = -0.155

*** SPEED ***
*** MM/SEC ***

MEAN = 179.86 STD ERR = 2.73
VARIANCE = 7609.14
STD. DEV.= 87.22
KURTOSIS = 2.12
SKEWNESS = -0.114

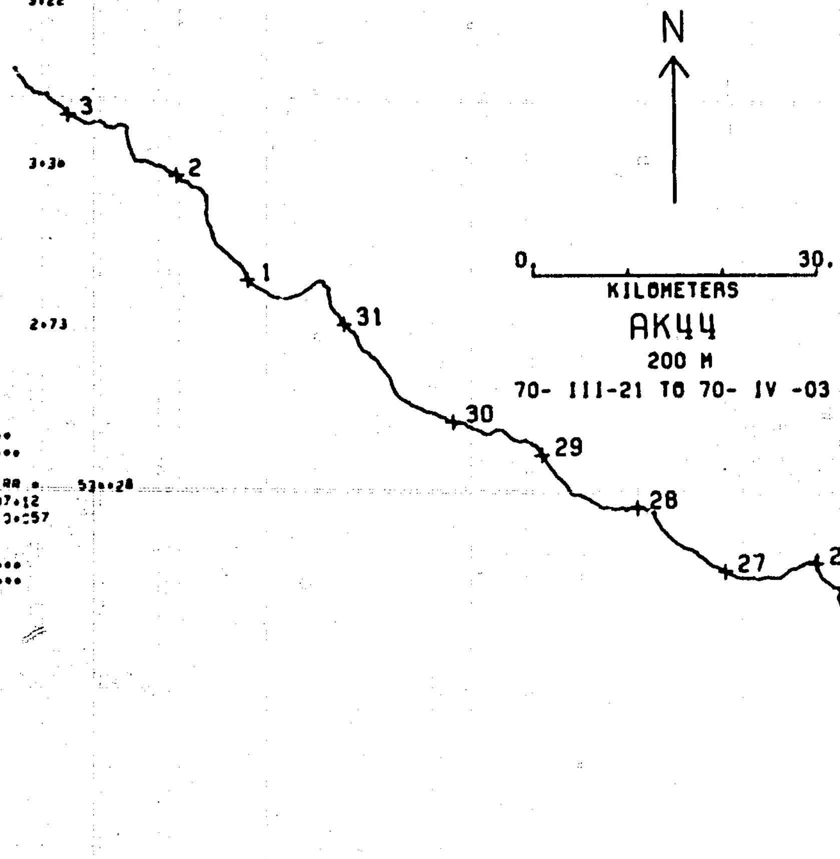
*** EAST & NORTH ***
*********** MM/SEC ***********

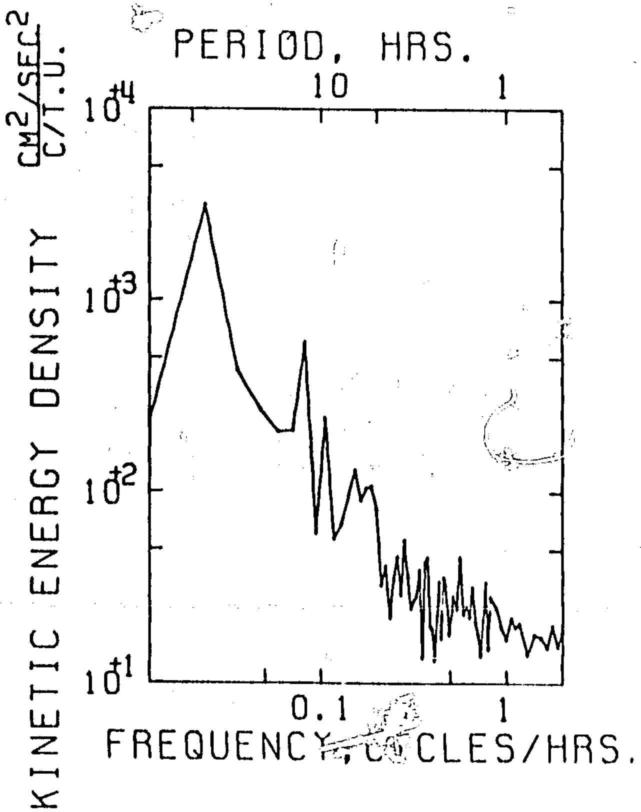
COVARIANCE = 436.79 STD ERR = 534.28
STD. DEV. OF COVARIANCE = 17097.12
CORRELATION COEFFICIENT = 0.037

*********** VECTOR MEANS ***********
*********** EAST & NORTH ***********

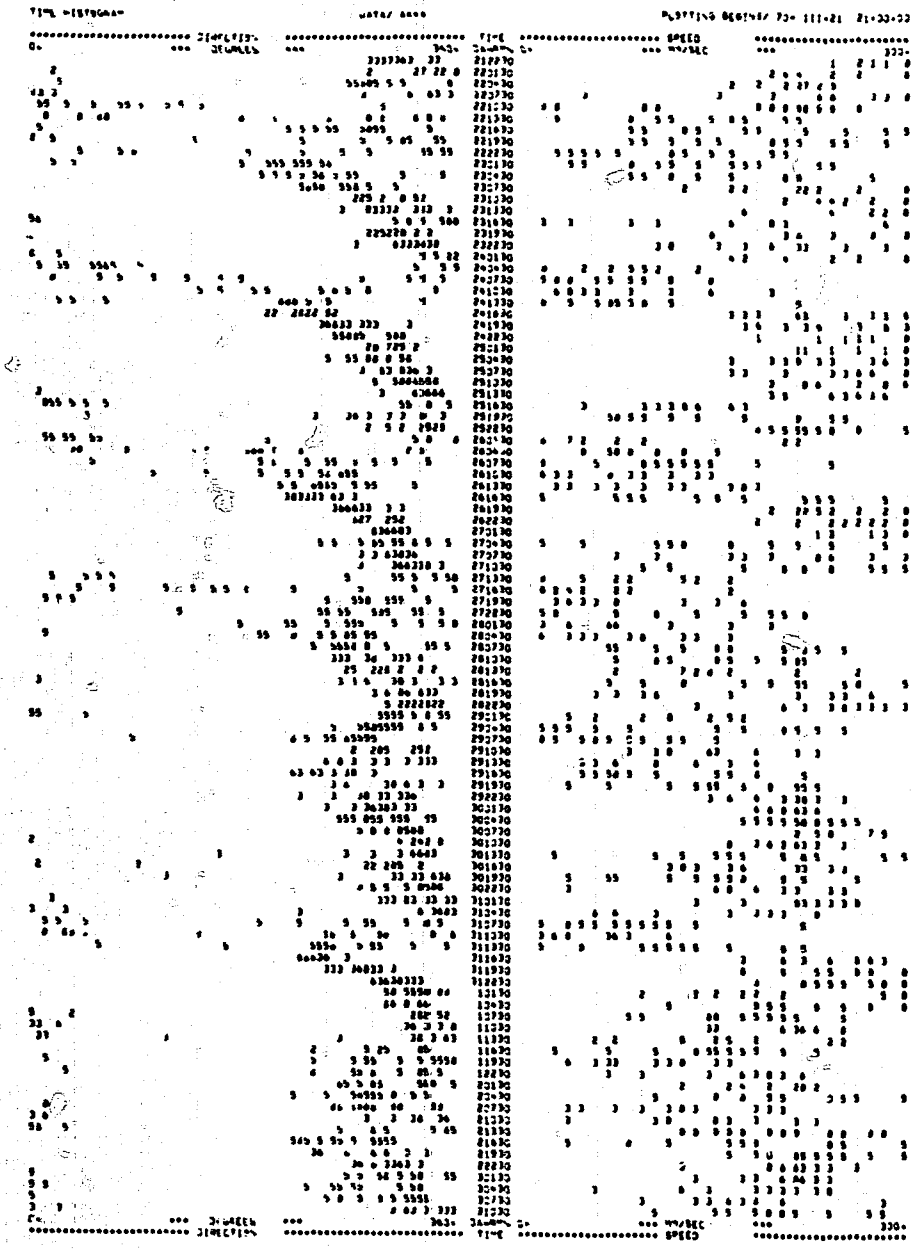
MEAN = 132.71
VARIANCE = 11175.17
STD. DEV.= 105.71

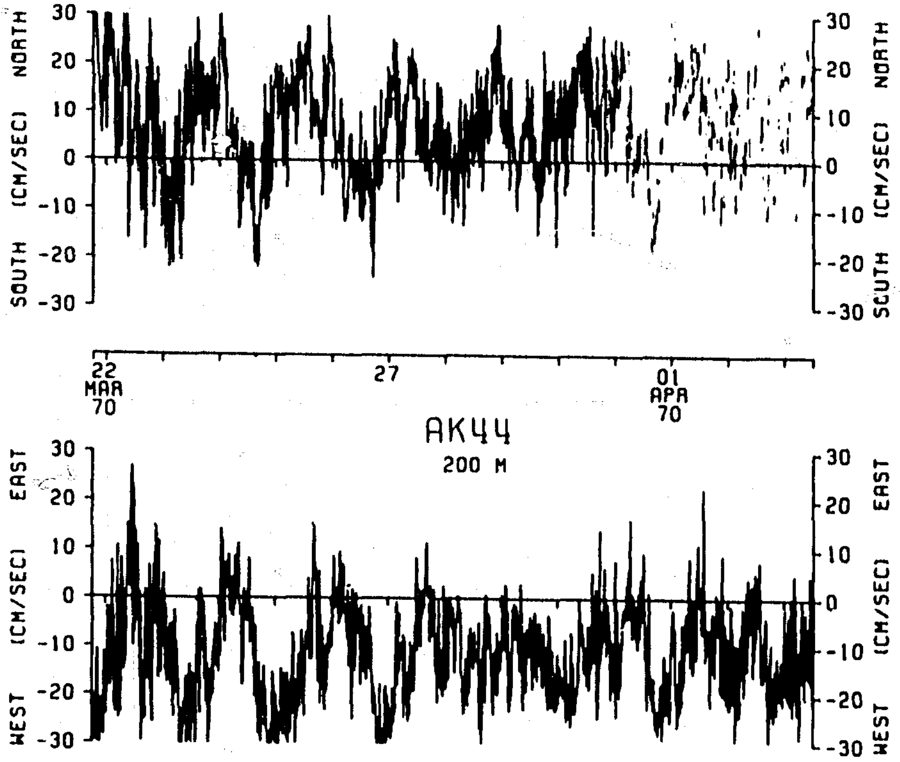
SAMPLE SIZE = 1.24 POINTS





AK44
ALEXAEV





AK44

ALEXAEV

STATS

E = EAST   UNITS = MM/SEC
N = NORTH   UNITS = MM/SEC

DATE	MID TIME HR	MIN	SEC	MEAN (E)	MEAN (N)	VECTOR MEAN	VARIANCE (E)	VARIANCE (N)	VECTOR VARIANCE	COVARIANCE (E & N)	SPEED UNITS = MM/SEC MEAN (S)	VARIANCE (S)
70- III-22	12	0	27	-66.	117.	134.	19287.30	16229.29	17743.29	1281.76	230.	437.83
70- III-23	12	0	27	-145.	64.	159.	10353.03	17262.78	13807.91	1299.13	228.	842.92
70- III-24	12	0	27	-87.	11.	88.	10229.40	13753.00	11991.20	3652.35	175.	1126.66
70- III-25	12	0	27	-121.	106.	161.	4555.14	3477.78	4016.46	1239.95	182.	872.50
70- III-26	12	0	27	-106.	4.	106.	6430.46	8291.00	7363.73	318.19	157.	1211.01
70- III-27	12	0	27	-89.	97.	132.	6272.93	6486.24	6379.58	512.23	171.	790.71
70- III-28	12	0	27	-41.	163.	168.	25.03	398.90	211.97	-99.92	168.	423.93
70- III-29	12	0	27	-38.	146.	150.	150.41	741.94	446.17	112.06	152.	418.83
70- III-30	12	0	27	-43.	171.	177.	22.55	359.38	190.97	-90.02	177.	381.94
70- III-31	12	0	27	-39.	156.	161.	55.33	881.85	468.59	-220.90	161.	937.19
70- IV - 1	12	0	27	-41.	163.	168.	119.02	1467.06	793.04	-416.46	175.	558.76

STATS

*** EAST ***
*** MM/SEC ***

MEAN = -75.25 STD ERR = 2.56
VARIANCE = 6487.77
STD. DEV.= 81.74
KURTOSIS = 4.03
SKEWNESS = 0.226

*** NORTH ***
*** MM/SEC ***

MEAN = 107.61 STD ERR = 3.08
VARIANCE = 5734.44
STD. DEV.= 97.65
KURTOSIS = 4.16
SKEWNESS = -1.362

*** SPEED ***
*** MM/SEC ***

MEAN = 179.66 STD ERR = 1.16
VARIANCE = 1363.44
STD. DEV.= 37.19
KURTOSIS = 2.01
SKEWNESS = 0.037

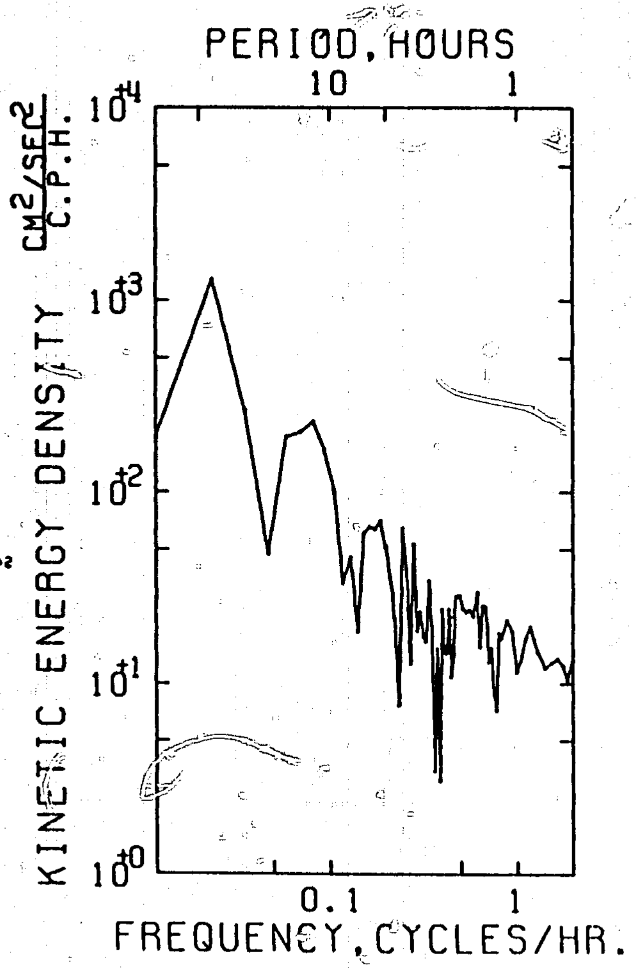
*** EAST & NORTH ***
*********** MM/SEC ***********

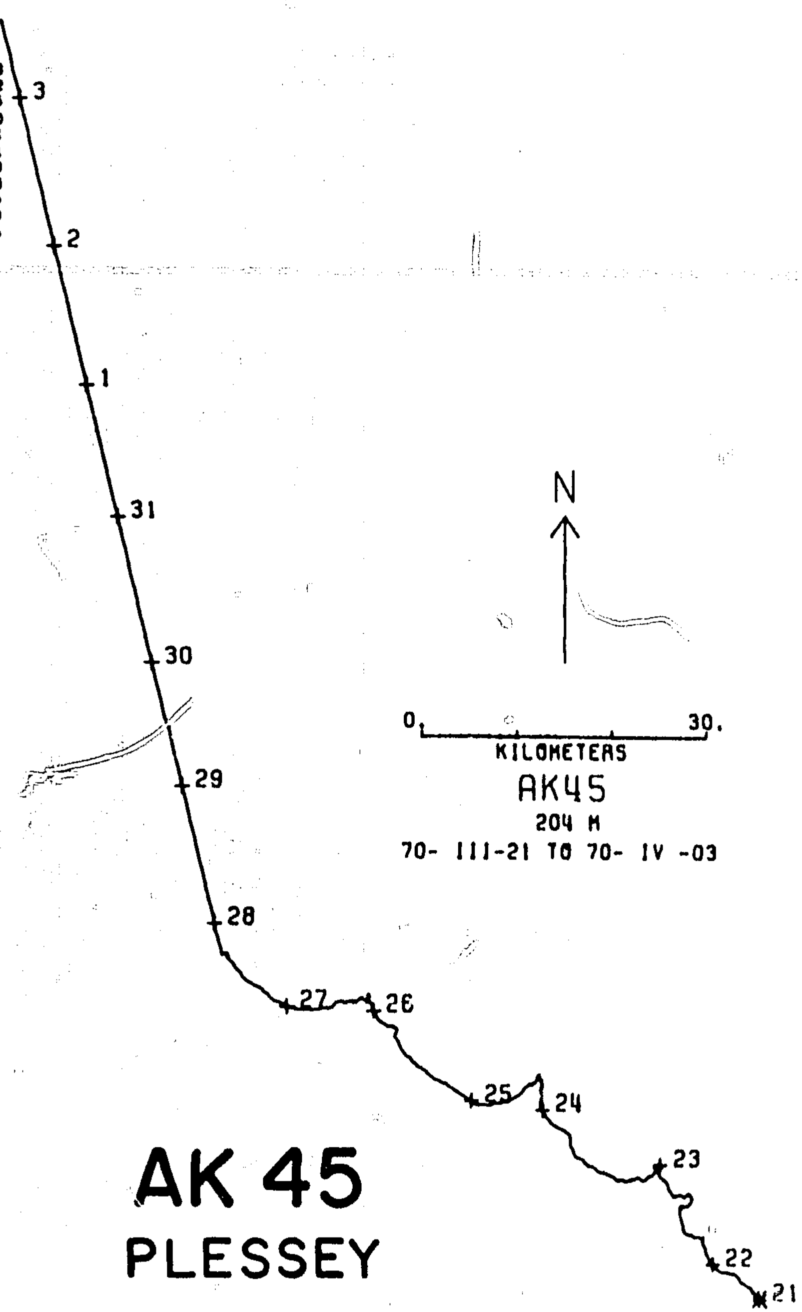
COVARIANCE = 225.09 STD ERR = 331.42
STD. DEV. OF COVARIANCE = 10573.74
CORRELATION COEFFICIENT = 0.273

*********** VECTOR MEANS ***********
*********** EAST & NORTH ***********

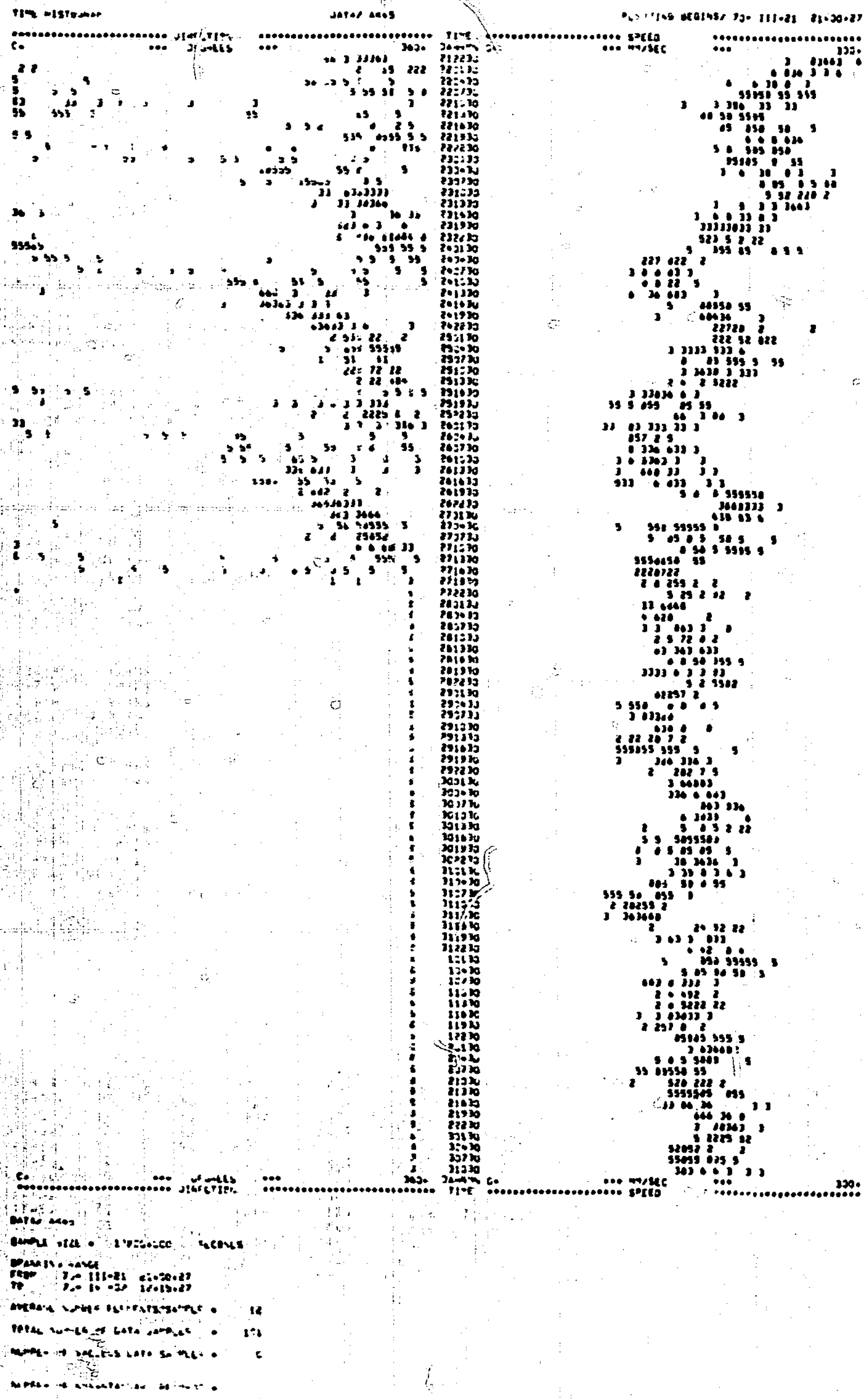
MEAN = 131.31
VARIANCE = 3214.11
STD. DEV.= 57.54

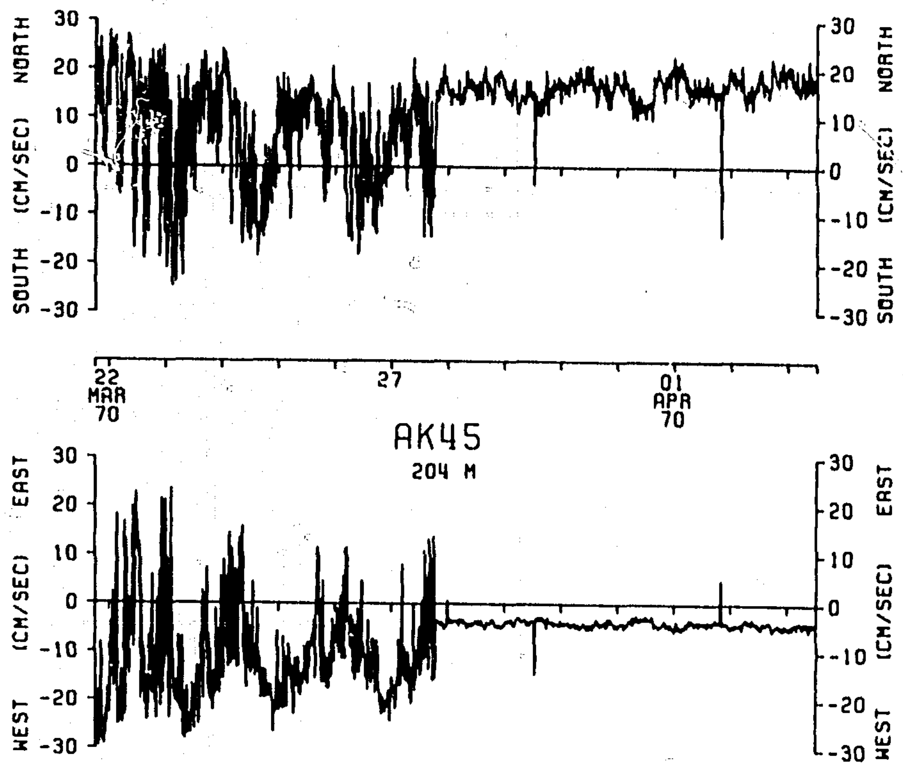
SAMPLE SIZE = 1024 POINTS





AK 45
PLESSEY





AK45
PLESSEY

STATS

E = EAST UNITS = MM/SEC
N = NORTH UNITS = MM/SEC

DATE	MID TIME HR	MIN	SEC	MEAN (E)	MEAN (N)	VECTOR MEAN	VARIANCE (E)	VARIANCE (N)	VECTOR VARIANCE	COVARIANCE (E & N)	SPEED (UNITS = MM/SEC) MEAN (S)	VARIANCE (S)
70- III-22	12	0	0	-51.	16.	54.	2712.35	2765.23	2738.79	2.92	82.	1639.41
70- III-23	12	0	0	-67.	22.	70.	4222.13	2566.41	3394.25	-30.24	96.	2555.56
70- III-24	12	0	0	-69.	43.	81.	4706.69	5230.03	4993.36	2406.84	121.	1985.58
70- III-25	12	0	0	-87.	43.	97.	3677.86	3391.69	3529.78	382.07	119.	2201.39
70- III-26	12	0	0	-55.	66.	86.	4701.26	2818.62	3759.94	51.33	114.	1809.88
70- III-27	12	0	0	-85.	46.	96.	3381.06	5854.13	4617.60	576.57	126.	2730.86
70- III-28	12	0	0	-67.	66.	94.	6245.80	3413.93	4829.86	486.92	125.	2889.58
70- III-29	12	0	0	-67.	46.	81.	3483.06	4825.25	4154.16	-311.78	111.	2477.60
70- III-30	12	0	0	-104.	49.	115.	3526.26	3958.05	3742.16	1413.42	136.	2257.45
70- III-31	12	0	0	-37.	61.	71.	4391.62	4788.92	4590.27	-462.48	110.	2184.28
70- IV- 1	12	0	0	-127.	67.	144.	4478.45	9297.49	6887.97	2982.67	181.	2175.95

STATS

*** EAST ***
*** MM/SEC ***

MEAN = -74.13 STD ERR = 2.13
VARIANCE = 4724.18
STD. DEV. = 68.73
KURTOSIS = 2.67
SKEWNESS = [illegible]

*** NORTH ***
*** MM/SEC ***

MEAN = 44.55 STD ERR = 2.33
VARIANCE = [illegible]
STD. DEV. = 67.00
KURTOSIS = 2.45
SKEWNESS = [illegible]

*** SPEED ***
*** MM/SEC ***

MEAN = 119.15 STD ERR = 1.63
VARIANCE = 2734.61
STD. DEV. = 52.28
KURTOSIS = 2.59
SKEWNESS = [illegible]

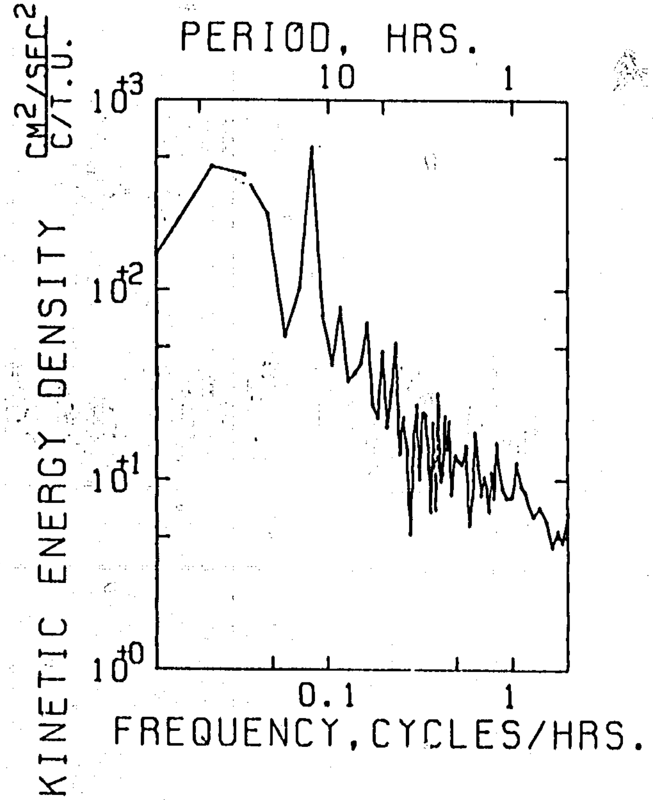
*** EAST & NORTH ***
************ MM/SEC ************

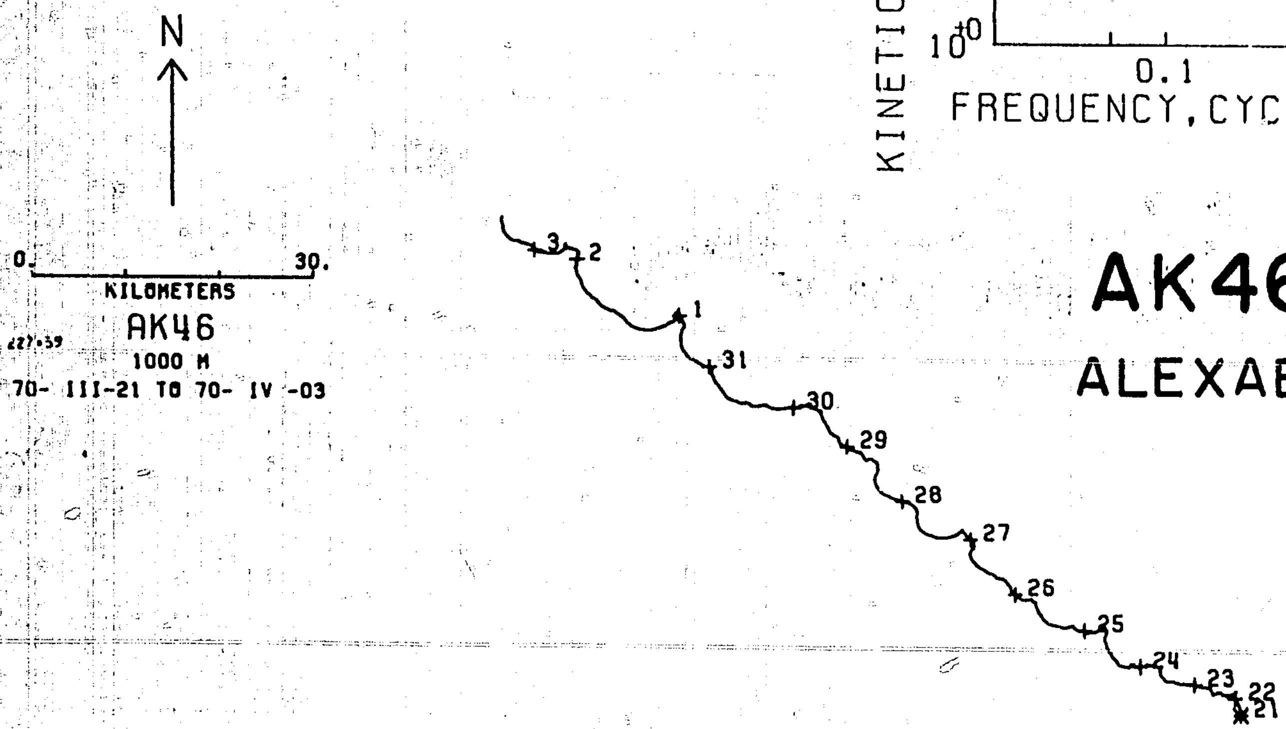
COVARIANCE = [illegible] STD ERR = 227.39
STD. DEV. OF COVARIANCE = 7262.97
CORRELATION COEFFICIENT = [illegible]

************ VECTOR MEANS ************
************ EAST & NORTH ************

MEAN = [illegible]
VARIANCE = [illegible]
STD. DEV. = [illegible]

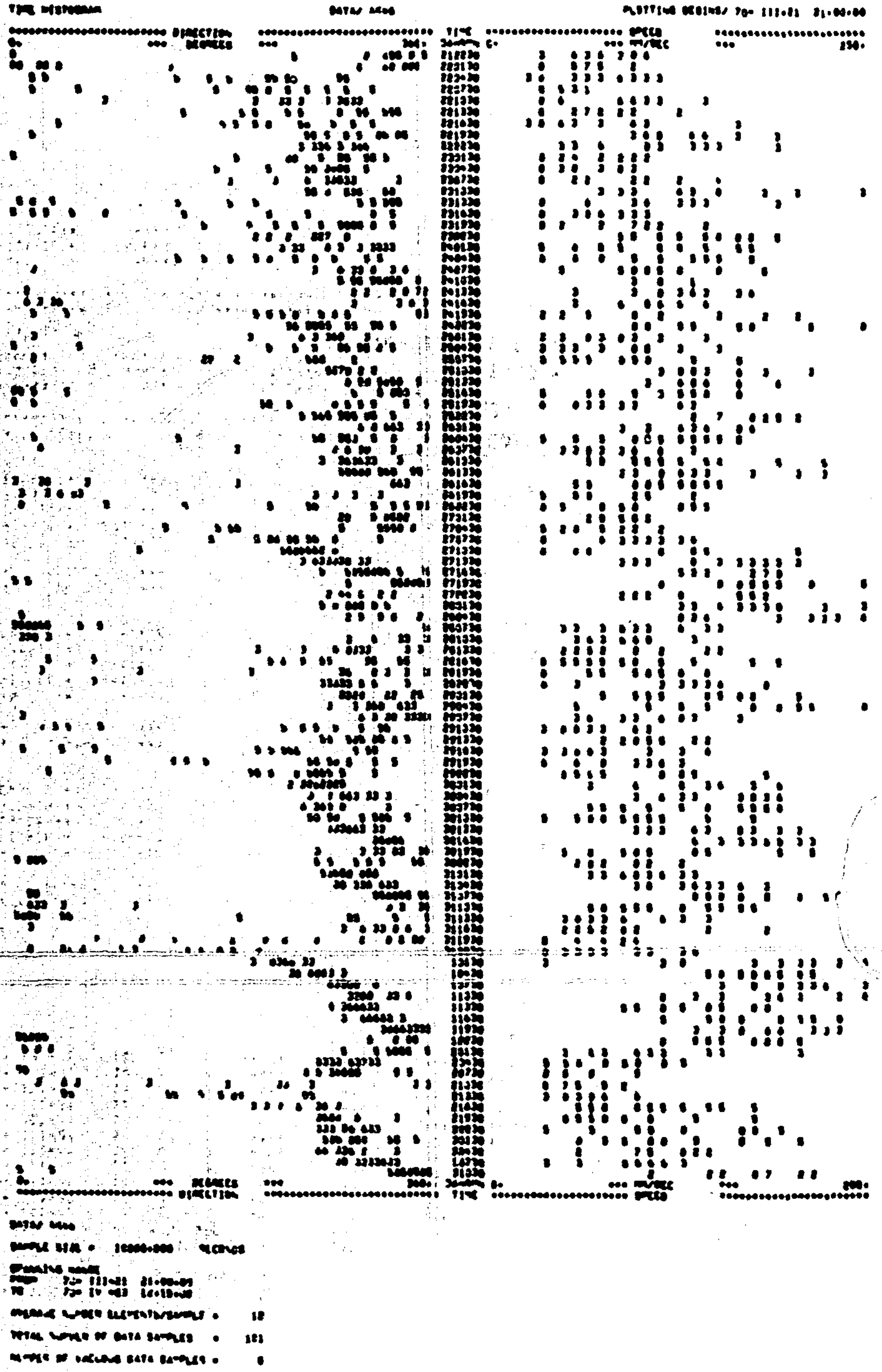
SAMPLE SIZE = [illegible] POINTS

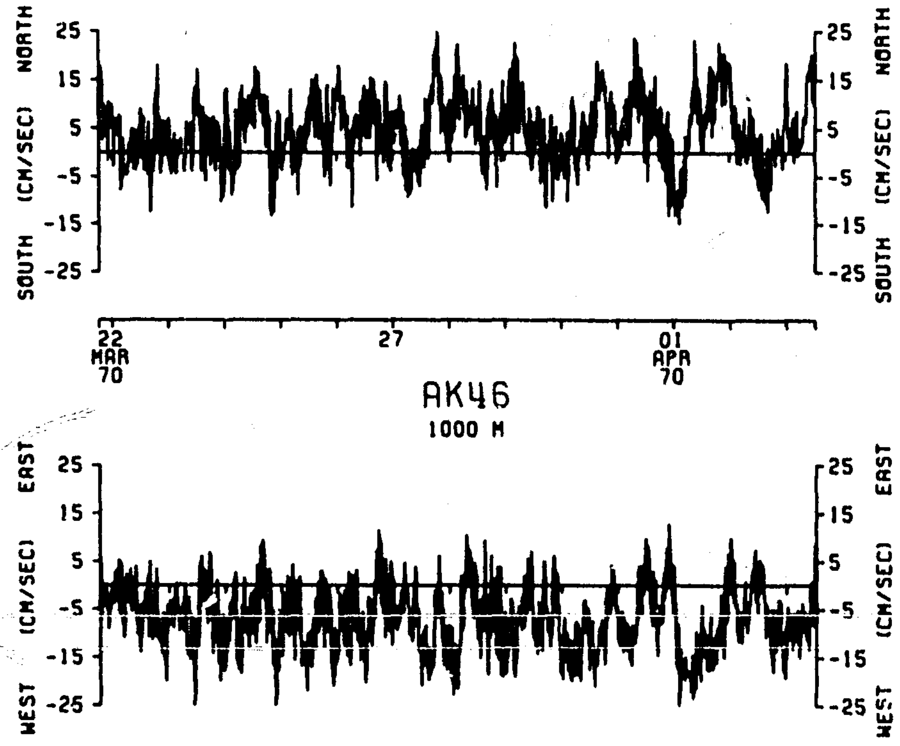




AK46

ALEXAEV





AK46
ALEXAEV

STATS

E = EAST   UNITS = MM/SEC
N = NORTH   UNITS = MM/SEC

DATE	MID TIME HR	MID TIME MIN	MID TIME SEC	MEAN (E)	MEAN (N)	VECTOR MEAN	VARIANCE (E)	VARIANCE (N)	VECTOR VARIANCE	COVARIANCE (E & N)	SPEED UNITS = MM/SEC MEAN (S)	SPEED VARIANCE (S)
70- III-22	12	1	0	-67.	21.	70.	4182.10	5543.01	4863.05	221.35	121.	110.93
70- III-23	12	1	0	-71.	24.	75.	3613.52	3049.01	3331.27	208.31	110.	186.05
70- III-24	12	1	0	-59.	37.	70.	1821.46	3274.57	2548.01	826.66	99.	177.25
70- III-25	12	1	0	-68.	24.	72.	1305.37	1675.44	1490.41	885.11	90.	154.12
70- III-26	12	1	0	-51.	51.	72.	2080.67	1240.85	1645.76	508.43	91.	243.36
70- III-27	12	1	0	-67.	28.	73.	1664.19	3450.66	2557.83	-210.81	101.	291.28
70- III-28	12	1	0	-56.	52.	76.	2509.19	1799.02	2154.10	775.47	98.	363.18
70- III-29	12	1	0	-56.	27.	63.	1500.97	2166.06	1843.52	-127.55	86.	207.38
70- III-30	12	1	0	-71.	36.	80.	903.11	1102.74	1002.92	888.08	90.	290.61
70- III-31	12	1	0	-35.	48.	59.	2417.19	2024.24	2220.71	-41.46	88.	162.49
70- IV - 1	12	1	0	-83.	36.	91.	922.88	3437.76	2180.17	664.67	109.	249.88

STATS

*** EAST ***
*** MM/SEC ***

MEAN = -62.37   STD ERR = 1.49
VARIANCE = 2265.36
STD. DEV.= 47.60
KURTOSIS = 4.08
SKEWNESS = 1.245

*** NORTH ***
*** MM/SEC ***

MEAN = 33.27   STD ERR = 1.62
VARIANCE = 2685.79
STD. DEV.= 51.82
KURTOSIS = 3.11
SKEWNESS = -0.677

*** SPEED ***
*** MM/SEC ***

MEAN = 94.35   STD ERR = 0.57
VARIANCE = 334.46
STD. DEV.= 18.29
KURTOSIS = 2.93
SKEWNESS = 0.588

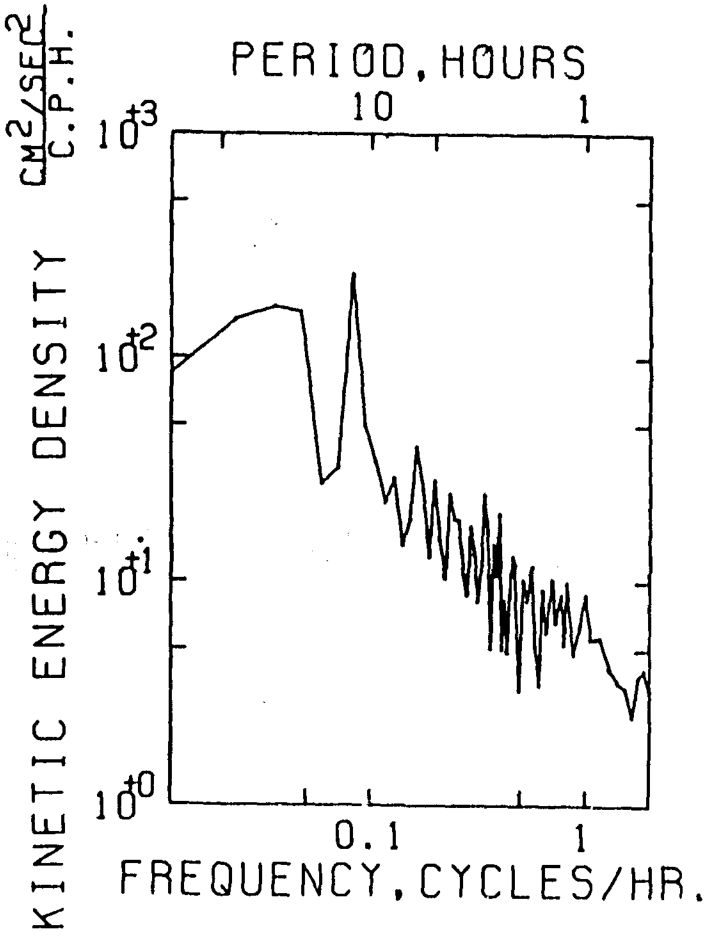
*** EAST & NORTH ***
*********** MM/SEC ***********

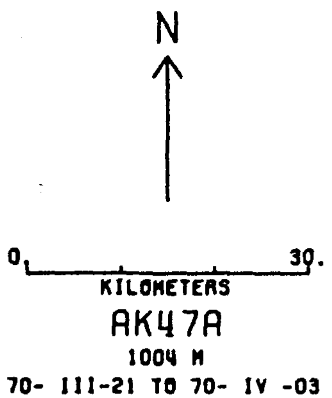
COVARIANCE = [illegible]   STD ERR = 102.42
STD. DEV. OF COVARIANCE = 3277.55
CORRELATION COEFFICIENT = 0.172

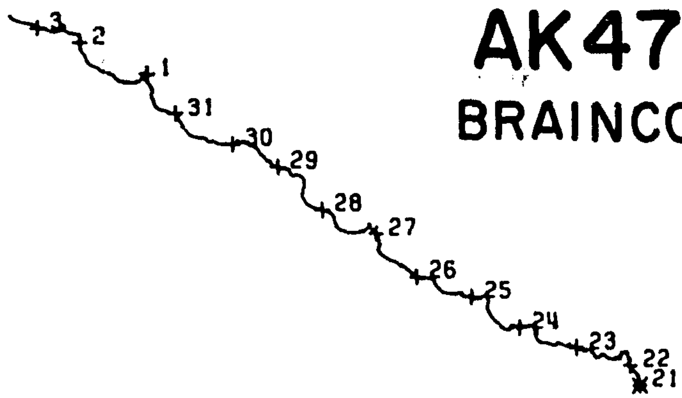
*********** VECTOR MEANS ***********
*********** EAST & NORTH ***********

MEAN = 76.69
VARIANCE = 2475.50
STD. DEV.= 49.75

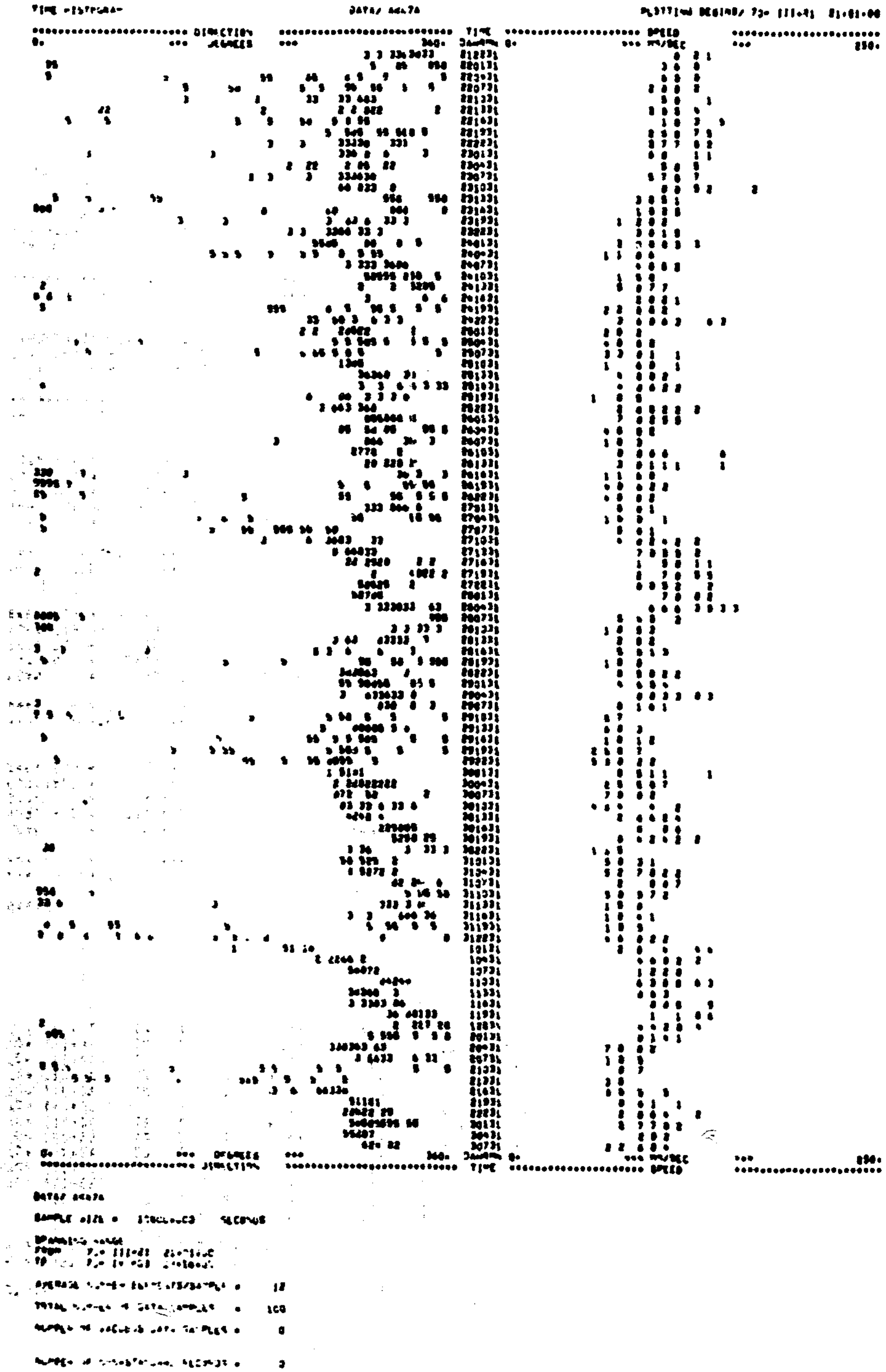
SAMPLE SIZE = 1324 POINTS

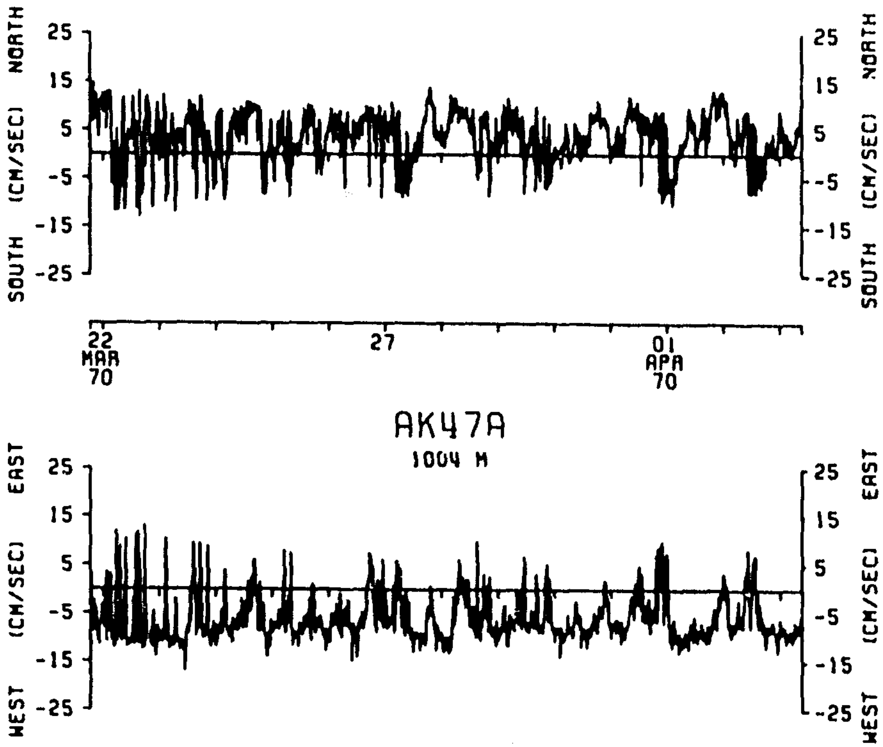






AK47A
BRAINCON





AK47A

BRAINCON