		ACCESSION NUMBERS	690769

DATA DOCUMENTATION FORM

700928
720520

NOAA FORM 24-13
(4-72)

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL OCEANOGRAPHIC DATA CENTER
RECORDS SECTION
ROCKVILLE, MARYLAND 20852

FORM APPROVED
O.M.B. No. 41-R2651

This form should accompany all data submissions to NODC. Section A, Originator Identification, must be completed when the data are submitted. It is highly desirable for NODC to also receive the remaining pertinent information at that time. This may be most easily accomplished by attaching reports, publications, or manuscripts which are readily available describing data collection, analysis, and format specifics. Readable, handwritten submissions are acceptable in all cases. All data shipments should be sent to the above address.

A. ORIGINATOR IDENTIFICATION

THIS SECTION MUST BE COMPLETED BY DONOR FOR ALL DATA TRANSMITTALS

1. NAME AND ADDRESS OF INSTITUTION, LABORATORY, OR ACTIVITY WITH WHICH SUBMITTED DATA ARE ASSOCIATED

University of Hawaii; Department of Oceanography; 1801 University Avenue; Honolulu, Hawaii

2. EXPEDITION, PROJECT, OR PROGRAM DURING WHICH DATA WERE COLLECTED

ONR Contract No. Nonr-3748(06), 1969 Data: Sea Spider site

3. CRUISE NUMBER(S) USED BY ORIGINATOR TO IDENTIFY DATA IN THIS SHIPMENT

—

4. PLATFORM NAME(S)	5. PLATFORM TYPE(S) (E.G., SHIP, BUOY, ETC.)	6. PLATFORM AND OPERATOR NATIONALITY(IES): PLATFORM	OPERATOR	7. DATES FROM: MO/DAY/YR	TO: MO/DAY/YR
1969 Data: CGS BUTTONWOOD & R/V MAHI	BUOYS	MOORED Buoys	University of HAWAII	2/11/65	11/24/69

8. ARE DATA PROPRIETARY?

☑ NO ☐ YES

IF YES, WHEN CAN THEY BE RELEASED FOR GENERAL USE? YEAR____ MONTH____

9. ARE DATA DECLARED NATIONAL PROGRAM (DNP)?
(I.E., SHOULD THEY BE INCLUDED IN WORLD DATA CENTERS HOLDINGS FOR INTERNATIONAL EXCHANGE?)

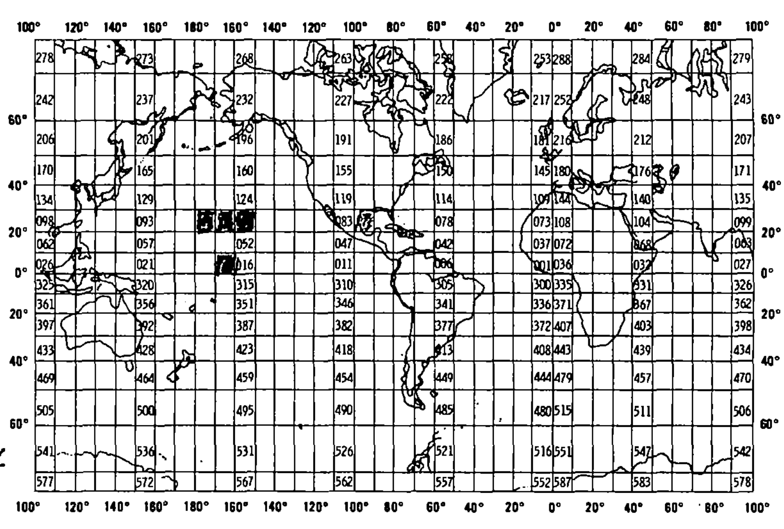
☐ NO ☐ YES ☐ PART *(SPECIFY BELOW)*

10. PERSON TO WHOM INQUIRIES CONCERNING DATA SHOULD BE ADDRESSED WITH TELEPHONE NUMBER *(AND ADDRESS IF OTHER THAN IN ITEM-1)*

Dr. KLAUS WYRTKI
Professor of Oceanography

11. PLEASE DARKEN ALL MARSDEN SQUARES IN WHICH ANY DATA CONTAINED IN YOUR SUBMISSION WERE COLLECTED.

GENERAL AREA



B. SCIENTIFIC CONTENT

Include enough information concerning manner of observation, instrumentation, analysis, and data reduction routines to make them understandable to future users. Furnish the minimum documentation considered relevant to each data type. Documentation will be retained as a permanent part of the data and will be available to future users. Equivalent information already available may be substituted for this section of the form (i.e., publications, reports, and manuscripts describing observational and analytical methods). If you do not provide equivalent information by attachment, please complete the scientific content section in a manner similar to the one shown in the following example.

EXAMPLE (HYPOTHETICAL INFORMATION)

NAME OF DATA FIELD	REPORTING UNITS OR CODE	METHODS OF OBSERVATION AND INSTRUMENTS USED (SPECIFY TYPE AND MODEL)	ANALYTICAL METHODS (INCLUDING MODIFICATIONS) AND LABORATORY PROCEDURES	DATA PROCESSING TECHNIQUES WITH FILTERING AND AVERAGING
Salinity	‰	Nansen bottles	Inductive salinometer (Hytech model S 510)	N/A (Not applicable)
		STD Bissett-Berman Model 9006	N/A	Values averaged over 5-meter intervals
Water color	Forel scale	Visual comparison with Forel bottles	N/A	N/A
Sediment size	ϕ units and percent by weight	Ewing corer	Standard sieves. Carbonate fraction removed by acid treatment	Same as "Sedimentary Rock Manual," Folk '65

(SPACE IS PROVIDED ON THE FOLLOWING TWO PAGES FOR THIS INFORMATION)

B. SCIENTIFIC CONTENT

NAME OF DATA FIELD	REPORTING UNITS OR CODE	METHODS OF OBSERVATION AND INSTRUMENTS USED (SPECIFY TYPE AND MODEL)	ANALYTICAL METHODS (INCLUDING MODIFICATIONS) AND LABORATORY PROCEDURES	DATA PROCESSING TECHNIQUES WITH FILTERING AND AVERAGING
Date-Time	Gregorian Calender. Time based on GMT.	NA	NA	NA
Number of data Cards	Arabic Numerals	NA	NA	NA
Latitude and Longitude	Degrees and tenths of degrees.	By use of ranges, soundings and horizontal sextant angels	NA	NA
Number assigned to current meters	NA	NA	NA	NA
Depth to Bottom	meters	soundings		
Depth of Instrument	meters	Based on Taut and semi-taut-wire Mooring station-determined depths along mooring Line	NA	NA
Time Zone	Longitude degrees	NA	NA	NA
No. Readings	Arabic Numerals	NA	NA	NA
Hours Recording	Arabic numerals to hundredths	counted from current meter readings	NA	NA

NOAA FORM 24-13 (3-72)

USCOMM-DC 44289-P72

B. SCIENTIFIC CONTENT

NAME OF DATA FIELD	REPORTING UNITS OR CODE	METHODS OF OBSERVATION AND INSTRUMENTS USED (SPECIFY TYPE AND MODEL)	ANALYTICAL METHODS (INCLUDING MODIFICATIONS) AND LABORATORY PROCEDURES	DATA PROCESSING TECHNIQUES WITH FILTERING AND AVERAGING
START of Record	hours after 1 Jan 1900 in hours to hundredths. (GMT)	—	NA	NA
Start of Record	hours after 1 Jan 1965 (GMT)	—	NA	NA
Current SPEED and True Direction	cm/sec and True Degrees in whole units, respectively	Paddle Wheel, Geodyne (both film and magnetic tape recording) and Aanderaa (magnetic tape recording) current meters		See University of Hawaii, Hawaii Institute of Geophysics Publications: "Current observations in the Hawaiian Archipelago; By Klaus Wyrtki, Veo Graefe, and Wm. Patzert; July 1969, HIG-69-15;" and, University of Hawaii, Hawaii Institute of Geophysics: "Current Measurements in The Central North Pacific; By W.C. Patzert, Klaus Wyrtki, and Howard J. Santamore, Nov. 1970, HIG-70-31."

NODC Accession No 68-0217

Exhibit A

NOV 22 REC'D

UNIVERSITY OF HAWAII

Department of Oceanography

30 October 1968

Mr. W. L. Molo
N O D C - Services Division
Washington, D.C. 20390

Dear Mr. Molo:

I am sending you data from 29 current meter stations. These measurements were made in the Hawaiian Archipelago and near Palmyra between 1965 and 1968. The data are being submitted in the form of punched cards. For each current meter station you will find that the first seven punched cards contain information relevant to the station in clear text, such as station number, dates, position, depth, time zone, and some information regarding absolute times. The following cards are data cards, each one containing 12 sets of current speed and current direction for a given three-hour period at 15-minute intervals. Current speed is given by the first three digits in centimeters per second without decimals. Current direction is given by the next three digits from 001° to 360°. The direction given is the true direction (not the magnetic) into which the current flows. Twelve such pairs fill a three-hour interval at the recording interval of 15 minutes. Columns 74 through 76 on the punched cards repeat the number of the current meter station, and columns 78 through 80 give the running card number. This information has been added in order to avoid confusion of cards between different sets. I am including a listing of the punched cards for current meter station #206 as an example.

The records from current meter stations 1 through 27 were obtained with paddle-wheel current meters manufactured by Hydrowerkstatten of Kiel, Germany, and were recording at five-minute intervals. Those data were reduced to 15-minute intervals.

The records from current meter stations 102 through 107 were obtained with Geodyne magnetic-tape-recording current meters, recording at 15-minute intervals.

The records from current meter stations 200 through 207 were obtained with Geodyne film-recording current meters, also measuring at 15-minute intervals.

I hope that the data are useful to you. We are including a National Marine Data Inventory sheet listing them. We intend to submit more data of this nature in the future as our operations continue.

Very truly yours,

Klaus Wyrtki
Professor of Oceanography

Encls-2
3 boxes of punched cards under separate cover

C. DATA FORMAT

This information is requested only for data transmitted on punched cards or magnetic tape. Have one of your data processing specialists furnish answers either on the form or by attaching equivalent readily available documentation. Identify the nature and meaning of all entries and explain any codes used.

1. List the record types contained in your file transmittal (e.g., tape label record, master, detail, standard depth, etc.).

2. Describe briefly how your file is organized.

3-13. Self-explanatory.

14. Enter the field name as appropriate (e.g., header information, temperature, depth, salinity.

15. Enter starting position of the field.

16. Enter field length in number columns and unit of measurement (e.g., bit, byte, character, word) in unit column.

17. Enter attributes as expressed in the programming language specified in item 3 (e.g., "F 4.1," "BINARY FIXED (5.1)").

18. Describe field. If sort field, enter "SORT 1" for first, "SORT 2" for second, etc. If field is repeated, state number of times it is repeated.

*Note: The data were originally forwarded to NODC on punched cards in the format described by exhibit A. However, the data reside at NODC on magnetic tape in card image on NODC tape library number 012358. See next page for particulars of tape storage

C. DATA FORMAT

COMPLETE THIS SECTION FOR PUNCHED CARDS OR TAPE, MAGNETIC TAPE, OR DISC SUBMISSIONS.

1. LIST RECORD TYPES CONTAINED IN THE TRANSMITTAL OF YOUR FILE
   GIVE METHOD OF IDENTIFYING EACH RECORD TYPE

   See Attachment Exhibit A

2. GIVE BRIEF DESCRIPTION OF FILE ORGANIZATION

   See Attachment Exhibit A

3. ATTRIBUTES AS EXPRESSED IN
   - [ ] PL-1
   - [ ] FORTRAN
   - [ ] ALGOL
   - [x] COMMON LANGUAGE
   - [ ] COBOL

4. RESPONSIBLE COMPUTER SPECIALIST:
   NAME AND PHONE NUMBER ______
   ADDRESS ______

COMPLETE THIS SECTION IF DATA ARE ON MAGNETIC TAPE

5. RECORDING MODE
   - [ ] BCD
   - [ ] BINARY
   - [ ] ASCII
   - [x] EBCDIC
   - [ ] ______

6. NUMBER OF TRACKS (CHANNELS)
   - [ ] SEVEN
   - [x] NINE
   - [ ] ______

7. PARITY
   - [x] ODD
   - [ ] EVEN

8. DENSITY
   - [ ] 200 BPI
   - [x] 1600 BPI
   - [ ] 556 BPI
   - [ ] 800 BPI
   - [ ] ______

9. LENGTH OF INTER-RECORD GAP (IF KNOWN)
   - [ ] 3/4 INCH
   - [x] 0.6 INCH

10. END OF FILE MARK
    - [ ] OCTAL 17
    - [x] ______

11. PASTE-ON-PAPER LABEL DESCRIPTION *(INCLUDE ORIGINATOR NAME AND SOME LAY SPECIFICATIONS OF DATA TYPE, VOLUME NUMBER)*

    WYRTKI
    CHARACTOR DATA OF INSTRMENTED CURRENTS

    VOL=SER=012358, DSN=UNHACUR

12. PHYSICAL BLOCK LENGTH IN BYTES

    3200

13. LENGTH OF BYTES IN BITS

    8

RECORD FORMAT DESCRIPTION

RECORD NAME UNHACUR

14. FIELD NAME	15. POSITION FROM-1 MEASURED IN [illegible] (e.g., bits, bytes)	16. LENGTH		17. ATTRIBUTES	18. USE AND MEANING
		NUMBER	UNITS		
[illegible]	[illegible]				
[illegible]	[illegible]				
[illegible]	[illegible]				

RECORD FORMAT DESCRIPTION

RECORD NAME ______________________________

14. FIELD NAME	15. POSITION FROM - 1 MEASURED IN ______ (e.g., bits, bytes)	16. LENGTH		17. ATTRIBUTES	18. USE AND MEANING
		NUMBER	UNITS		

RECORD FORMAT DESCRIPTION

RECORD NAME ______________________________

14. FIELD NAME	15. POSITION FROM - 1 MEASURED IN ______ (e.g., bits, bytes)	16. LENGTH		17. ATTRIBUTES	18. USE AND MEANING
		NUMBER	UNITS		

RECORD FORMAT DESCRIPTION

RECORD NAME ______________________

14. FIELD NAME	15. POSITION FROM - 1 MEASURED IN ______ (*e.g., bits, bytes*)	16. LENGTH		17. ATTRIBUTES	18. USE AND MEANING
		NUMBER	UNITS		

D. INSTRUMENT CALIBRATION

This calibration information will be utilized by NOAA's National Oceanographic Instrumentation Center in their efforts to develop calibration standards for voluntary acceptance by the oceanographic community. Identify the instruments used by your organization to obtain the scientific content of the DDF (i.e., STD, temperature and pressure sensors, salinometers, oxygen meters, velocimeters, etc.) and furnish the calibration data requested by completing and/or checking ("✓") the appropriate spaces. Add the interval time (i.e., 3 months, 6 months, 9 months, etc.) if the fixed interval calibration cycle is checked.

INSTRUMENT TYPE (MFR., MODEL NO.)	DATE OF LAST CALIBRATION	INSTRUMENT WAS CALIBRATED BY		CHECK ONE: INSTRUMENT IS CALIBRATED					INSTRUMENT IS NOT CALIBRATED (√)
		YOUR ORGANIZATION (√)	OTHER ORGANIZATION (GIVE NAME)	AT FIXED INTERVALS (√)	BEFORE OR AFTER USE (√)	BEFORE AND AFTER USE (√)	ONLY AFTER REPAIR (√)	ONLY WHEN NEW (√)	

NUMBER 690769 720520

680217 700928

DATA DOCUMENTATION FORM

NOAA FORM 24-13
(4-72)

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL OCEANOGRAPHIC DATA CENTER
RECORDS SECTION
ROCKVILLE, MARYLAND 20852

FORM APPROVED
O.M.B. No. 41-R2651

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THIS SECTION MUST BE COMPLETED BY DONOR FOR ALL DATA TRANSMITTALS

1. NAME AND ADDRESS OF INSTITUTION, LABORATORY, OR ACTIVITY WITH WHICH SUBMITTED DATA ARE ASSOCIATED

UNIVERSITY OF HAWAII; DEPARTMENT OF OCEANOGRAPHY
1801 UNIVERSITY AVENUE
HONOLULU, HAWAII

2. EXPEDITION, PROJECT, OR PROGRAM DURING WHICH DATA WERE COLLECTED

~~ONR CONTRACT NO. NONR-3748(06).~~
~~1964 DATA: "SEA SPIDER" SITE.~~

3. CRUISE NUMBER(S) USED BY ORIGINATOR TO IDENTIFY DATA IN THIS SHIPMENT

4. PLATFORM NAME(S)	5. PLATFORM TYPE(S) (*E.G., SHIP, BUOY, ETC.*)	6. PLATFORM AND OPERATOR NATIONALITY(IES): PLATFORM	OPERATOR	7. DATES FROM: MO/DAY/YR	TO: MO/DAY/YR
BUOYS	BUOYS	USA	USA	2/11/65	11/24/69

8. ARE DATA PROPRIETARY?

[✓] NO [ ] YES

IF YES, WHEN CAN THEY BE RELEASED FOR GENERAL USE? YEAR ___ MONTH ___

9. ARE DATA DECLARED NATIONAL PROGRAM (DNP)? (I.E., SHOULD THEY BE INCLUDED IN WORLD DATA CENTERS HOLDINGS FOR INTERNATIONAL EXCHANGE?)

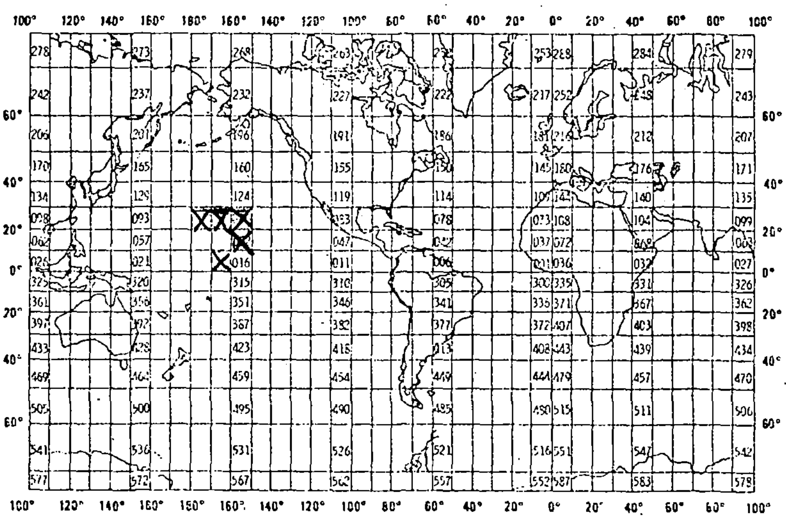
[✓] NO [ ] YES [ ] PART (*SPECIFY BELOW*)

10. PERSON TO WHOM INQUIRIES CONCERNING DATA SHOULD BE ADDRESSED WITH TELEPHONE NUMBER (*AND ADDRESS IF OTHER THAN IN ITEM-1*)

DR. KLAUS WYRTKI
PROFESSOR OF OCEANOGRAPHY

11. PLEASE DARKEN ALL MARSDEN SQUARES IN WHICH ANY DATA CONTAINED IN YOUR SUBMISSION WERE COLLECTED.

GENERAL AREA



RECORD FORMAT DESCRIPTION

RECORD NAME RECORD TYPE 6 (CONTINUED)

14. FIELD NAME	15. POSITION ~~FROM 1~~ MEASURED IN BYTES (e.g., bits, bytes)	16. LENGTH NUMBER	16. LENGTH UNITS	17. ATTRIBUTES	18. USE AND MEANING
Header Information	58	7	BYTES	7A1	'ZEROES' IS WRITTEN
Blank	65	16		16X	
Record Type	81	1		I1	Always '6'
~~Station number~~	~~82~~	~~3~~		~~I3~~	
RECORD TYPE 7					
Header Information	1	6		6A1	'START' IS WRITTEN
GREGORIAN HOURS	7	10		F10.2	NUMBER OF HOURS (TO HUNDREDTHS) FROM FIXED TIME
HEADER Information	17	30		30A1	'HRS AFTER 1JAN1900 0000 GMT...OR' IS WRITTEN.
GREGORIAN HOURS	47	10		F10.2	NUMBER OF HOURS (TO HUNDREDTHS) FROM START OF YEAR
Header Information	57	24		24A1	'HRS AFTER 1JAN 19?? (varies) 0000 GMT' IS WRITTEN
Record Type	81	1		I1	Always '7'
~~Station number~~	~~82~~	~~3~~		~~I3~~	
RECORD TYPE 8					
Current Speed	1, 7, 13, 19, 25, 31, 37, 43, 49, 55, 61, 67	12x3		12(I3, 3X)	
Current Direction	4, 10, 16, 22, 28, 34, 40, 46, 52, 58, 64, 70	12x3		12(3X, I3)	
Blank	73	1		1X	
Station Number	74	3		I3	
Card Number	77	4		I4	
Record type	81	1		I1	Always '8'
~~Station number~~	~~82~~	~~3~~		~~I3~~	

		ACCESSION NUMBER	

DATA DOCUMENTATION FORM

NOAA FORM 24-13
(4-72)

U.S. DEPARTMENT OF COMMERCE
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4. PLATFORM NAME(S)	5. PLATFORM TYPE(S) *(E.G., SHIP, BUOY, ETC.)*	6. PLATFORM AND OPERATOR NATIONALITY(IES)		7. DATES	
		PLATFORM	OPERATOR	FROM: MO/DAY/YR	TO: MO/DAY/YR

8. ARE DATA PROPRIETARY?

☐ NO ☐ YES

IF YES, WHEN CAN THEY BE RELEASED FOR GENERAL USE? YEAR____ MONTH____

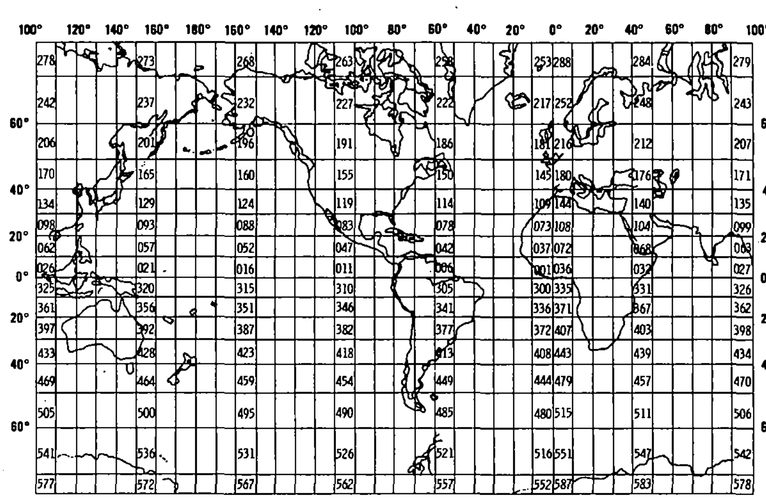
9. ARE DATA DECLARED NATIONAL PROGRAM (DNP)?
(I.E., SHOULD THEY BE INCLUDED IN WORLD DATA CENTERS HOLDINGS FOR INTERNATIONAL EXCHANGE?)

☐ NO ☐ YES ☐ PART *(SPECIFY BELOW)*

10. PERSON TO WHOM INQUIRIES CONCERNING DATA SHOULD BE ADDRESSED WITH TELEPHONE NUMBER *(AND ADDRESS IF OTHER THAN IN ITEM-1)*

11. PLEASE DARKEN ALL MARSDEN SQUARES IN WHICH ANY DATA CONTAINED IN YOUR SUBMISSION WERE COLLECTED.

GENERAL AREA



B. SCIENTIFIC CONTENT

Include enough information concerning manner of observation, instrumentation, analysis, and data reduction routines to make them understandable to future users. Furnish the minimum documentation considered relevant to each data type. Documentation will be retained as a permanent part of the data and will be available to future users. Equivalent information already available may be substituted for this section of the form (i.e., publications, reports, and manuscripts describing observational and analytical methods). If you do not provide equivalent information by attachment, please complete the scientific content section in a manner similar to the one shown in the following example.

EXAMPLE (HYPOTHETICAL INFORMATION)

NAME OF DATA FIELD	REPORTING UNITS OR CODE	METHODS OF OBSERVATION AND INSTRUMENTS USED (SPECIFY TYPE AND MODEL)	ANALYTICAL METHODS (INCLUDING MODIFICATIONS) AND LABORATORY PROCEDURES	DATA PROCESSING TECHNIQUES WITH FILTERING AND AVERAGING
Salinity	‰	Nansen bottles	Inductive salinometer (Hytech model S510)	N/A (Not applicable)
		STD Bissett-Berman Model 9006	N/A	Values averaged over 5-meter intervals
Water color	Forel scale	Visual comparison with Forel bottles	N/A	N/A
Sediment size	φ units and percent by weight	Ewing corer	Standard sieves. Carbonate fraction removed by acid treatment	Same as "Sedimentary Rock Manual," Folk '65

(SPACE IS PROVIDED ON THE FOLLOWING TWO PAGES FOR THIS INFORMATION)

B. SCIENTIFIC CONTENT

NAME OF DATA FIELD	REPORTING UNITS OR CODE	METHODS OF OBSERVATION AND INSTRUMENTS USED (SPECIFY TYPE AND MODEL)	ANALYTICAL METHODS (INCLUDING MODIFICATIONS) AND LABORATORY PROCEDURES	DATA PROCESSING TECHNIQUES WITH FILTERING AND AVERAGING
DATE-TIME	GMT			
Depths	meters			
Current speed	cm/sec (whole units)	3. Instruments used —		
Current direction	Degrees (true direction)	1. Paddle-wheel current meter - manufactured by Hydrowerkstätten of Kiel, Ger.		Recorded at 5-minute intervals and reduced to 15-minute intervals
		2a. Geodyne magnetic-tape-recording current meters		Recorded at 15-minute intervals
		2b. Geodyne film recording current meters		
		3 Aanderaa Current meter (for station 301)		Recorded at 10-minute intervals and reduced to 15-minute intervals

References:

1. Current Observations in the Hawaiian Archipelago By Klaus Wyrtki, Volker Graefe & Wm. Patzert, July 1969

2. Current Measurements in the Central North Pacific Ocean By William C. Patzert, Klaus Wyrtki, & Howard J. Santamore; Nov. 1970

B. SCIENTIFIC CONTENT

NAME OF DATA FIELD	REPORTING UNITS OR CODE	METHODS OF OBSERVATION AND INSTRUMENTS USED (SPECIFY TYPE AND MODEL)	ANALYTICAL METHODS (INCLUDING MODIFICATIONS) AND LABORATORY PROCEDURES	DATA PROCESSING TECHNIQUES WITH FILTERING AND AVERAGING

C. DATA FORMAT

This information is requested only for data transmitted on punched cards or magnetic tape. Have one of your data processing specialists furnish answers either on the form or by attaching equivalent readily available documentation. Identify the nature and meaning of all entries and explain any codes used.

1. List the record types contained in your file transmittal (e.g., tape label record, master, detail, standard depth, etc.).

2. Describe briefly how your file is organized.

3-13. Self-explanatory.

14. Enter the field name as appropriate (e.g., header information, temperature, depth, salinity.

15. Enter starting position of the field.

16. Enter field length in number columns and unit of measurement (e.g., bit, byte, character, word) in unit column.

17. Enter attributes as expressed in the programming language specified in item 3 (e.g., "F 4.1," "BINARY FIXED (5.1)").

18. Describe field. If sort field, enter "SORT 1" for first, "SORT 2" for second, etc. If field is repeated, state number of times it is repeated.

C. DATA FORMAT

COMPLETE THIS SECTION FOR PUNCHED CARDS OR TAPE, MAGNETIC TAPE, OR DISC SUBMISSIONS.

Originators File

1. LIST RECORD TYPES CONTAINED IN THE TRANSMITTAL OF YOUR FILE
   GIVE METHOD OF IDENTIFYING EACH RECORD TYPE

No way to differentiate record types

2. GIVE BRIEF DESCRIPTION OF FILE ORGANIZATION

In station sequence which is not in chronological order

3. ATTRIBUTES AS EXPRESSED IN ☐ PL-1 ☐ ALGOL ☐ COBOL ☑ FORTRAN ☐ ____________ LANGUAGE

4. RESPONSIBLE COMPUTER SPECIALIST:
   NAME AND PHONE NUMBER Dr. Klaus Wyrtki
   ADDRESS ____________

COMPLETE THIS SECTION IF DATA ARE ON MAGNETIC TAPE

5. RECORDING MODE: ☐ BCD ☐ BINARY ☐ ASCII ☑ EBCDIC ☐ ____________

6. NUMBER OF TRACKS (CHANNELS): ☐ SEVEN ☑ NINE ☐ ____________

7. PARITY: ☐ ODD ☐ EVEN

8. DENSITY: ☐ 200 BPI ☑ 1600 BPI ☐ 556 BPI ☐ 800 BPI ☐ ____________

9. LENGTH OF INTER-RECORD GAP (IF KNOWN): ☐ 3/4 INCH ☐ ____________

10. END OF FILE MARK: ☐ OCTAL 17 ☐ ____________

11. PASTE-ON-PAPER LABEL DESCRIPTION *(INCLUDE ORIGINATOR NAME AND SOME LAY SPECIFICATIONS OF DATA TYPE, VOLUME NUMBER)*

Tape no = 012358
Standard Label tape ... DSN=UNHACUR

12. PHYSICAL BLOCK LENGTH IN BYTES

3200 -- (LRECL=80)

13. LENGTH OF BYTES IN BITS

C. DATA FORMAT

USER FILE

COMPLETE THIS SECTION FOR PUNCHED CARDS OR TAPE, MAGNETIC TAPE, OR DISC SUBMISSIONS.

1. LIST RECORD TYPES CONTAINED IN THE TRANSMITTAL OF YOUR FILE
   GIVE METHOD OF IDENTIFYING EACH RECORD TYPE

Eight record types simply called record type 1 → 8
Byte 81 differentiates the record type

2. GIVE BRIEF DESCRIPTION OF FILE ORGANIZATION

In originators station sequence

3. ATTRIBUTES AS EXPRESSED IN
- [ ] PL-1
- [x] FORTRAN
- [ ] ALGOL
- [ ] ______ LANGUAGE
- [ ] COBOL

4. RESPONSIBLE COMPUTER SPECIALIST:
   NAME AND PHONE NUMBER ______
   ADDRESS ______

COMPLETE THIS SECTION IF DATA ARE ON MAGNETIC TAPE

5. RECORDING MODE
- [ ] BCD
- [ ] BINARY
- [ ] ASCII
- [x] EBCDIC
- [ ] ______

6. NUMBER OF TRACKS (CHANNELS)
- [ ] SEVEN
- [x] NINE
- [ ] ______

7. PARITY
- [ ] ODD
- [ ] EVEN

8. DENSITY
- [ ] 200 BPI
- [x] 1600 BPI
- [ ] 556 BPI
- [ ] 800 BPI
- [ ] ______

9. LENGTH OF INTER-RECORD GAP (IF KNOWN)
- [ ] 3/4 INCH
- [ ] ______

10. END OF FILE MARK
- [ ] OCTAL 17
- [ ] ______

11. PASTE-ON-PAPER LABEL DESCRIPTION *(INCLUDE ORIGINATOR NAME AND SOME LAY SPECIFICATIONS OF DATA TYPE, VOLUME NUMBER)*

USER TAPE = V02 = SER =
~~003720~~ 11535
NON LABEL

12. PHYSICAL BLOCK LENGTH IN BYTES

~~3360 (LRECL = 84)~~ 3240 (LRECL = 81)

13. LENGTH OF BYTES IN BITS

NOAA FORM 24-13 USCOMM-DC 44289-P72

RECORD FORMAT DESCRIPTION

RECORD NAME Originators File

14. FIELD NAME	15. POSITION ~~FROM 1~~ MEASURED IN BYTES LRECL = 80 (e.g., bits, bytes)	16. LENGTH NUMBER	16. LENGTH UNITS	17. ATTRIBUTES	18. USE AND MEANING
Header Information	1	7x80	BYTES	7x 80A1	POSITION, STARTING TIME NUMBER OF DATACARDS ETC. SPELLED OUT IN THESE FIRST SEVEN "CARDS". However errors occur in these fields and there is no good way to differentiate between these seven logical records
Current speed	1,7,13,19, 25,31,37, 43,49,55, 61,67	12(3)	BYTES	12(I3,3X)	
Current direction	4,10,16, 22,28,34, 40,46,52, 58,64,70	12(3)	BYTES	12(3X,I3)	
BLANK	73	1	"	1X	A '9' appears in some stations but appears to have no meaning
STATION NUMBER	74	3	"	I3	
CARD NUMBER	77	4	"	I4	

RECORD FORMAT DESCRIPTION

RECORD NAME RECORD TYPE 4 (ALICE .. DO AFTER 3)

14. FIELD NAME	15. POSITION ~~FROM 1~~ MEASURED IN BYTES (e.g., bits, bytes)	16. LENGTH NUMBER	16. LENGTH UNITS	17. ATTRIBUTES	18. USE AND MEANING
Header Information	1	30	BYTES	30A1	TYPE OF CURRENT METER
Header Information	31	7	"	7A1	'BOTTOM' IS WRITTEN
Depth to bottom	38	4		I4	
Header Information	42	1		A1	'M' is written
Comma	43	1		A1	',' is written
Header Information	44	20		20A1	'Depth of Instrument'
Depth of meter	64	4		I4	
Header Information	68	1		A1	'M' is written
Blank	69	12		12X	
Record Type	81	1		I1	Always '4'
~~Station Number~~	~~82~~	~~3~~		~~I3~~	
RECORD TYPE 5					
Header Information	1	62		62A1	'SPEED IN CM/SEC, TRUE DIRECTION OF FLOW IN DEGREES, TIME ZONE' IS WRITTEN.
TIME ZONE	63	3		I3	E.G. 150
Header Information	66	5		A5	E.G. 'WEST'
Blank	71	10		10X	
Record Type	81	1		I1	Always '5'
~~Station number~~	~~82~~	~~3~~		~~I3~~	
CARD TYPE 6					
No of Readings	1	5		I5	A reading equals a speed and a direction
Header Information	6	14		14A1	'READINGS' IS WRITTEN
NUMBER OF HOURS	20	7		F7.2	Number of hours of OBSERVATIONS TO HUNDREDTHS OF HOURS
HEADER INFORMATION	27	4		4A1	'HRS' IS WRITTEN
HEADER INFORMATION	31	25		25A1	A REMINDER OF HOW MANY DAYS IN A MONTH
NUMBER OF ZEROES	56	2		I2	NUMBER OF READINGS IN FIRST CARD THAT CONTAIN ZEROES

USER FILE
RECORD FORMAT DESCRIPTION

RECORD NAME RECORD TYPE 1

14. FIELD NAME	15. POSITION ~~FROM 1~~ MEASURED IN BYTES (e.g., bits, bytes)	16. LENGTH NUMBER	16. LENGTH UNITS	17. ATTRIBUTES	18. USE AND MEANING
Header Information	1	22	BYTES	22A1	'CURRENT METER STATION' IS WRITTEN
Station number	23	3	"	I3	
Header Information	26	55	"	55A1	BRIEF DESCRIPTION OF STATION LOCATION
Record Type	81	1	"	I1	Always '1'
~~Station number~~	~~82~~	~~3~~		~~I3~~	
RECORD TYPE 2					
BLANK	1	1	"	1X	
STARTING MONTH	2	3	"	A3	'JAN', 'FEB', ETC.
BLANK	5	1	"	1X	
Starting Day	6	2	"	I2	1-31
Comma	8	1		A1	',' IS WRITTEN
BLANK	9	1		1X	
Starting Year	10	2		I2	LAST TWO DIGITS OF YEAR
Comma	12	1		A1	',' IS WRITTEN
Blank	13	1		1X	
Starting Time	14	4		I4	0-2400
Blank	18	2		2X	
TO	20	2		A2	'TO' IS WRITTEN
Blank	22	2		2X	
Ending Month	24	3		A3	'MAR', 'APR', ETC.
Blank	27	1		1X	
Ending Day	28	2		I2	1-31
Comma	30	1		A1	',' IS WRITTEN
Blank	31	1		1X	
Ending Year	32	2		I2	LAST TWO DIGITS OF YEAR

RECORD FORMAT DESCRIPTION

RECORD NAME RECORD TYPE 2 (CONTINUED)

14. FIELD NAME	15. POSITION ~~FROM 1~~ MEASURED IN BYTES (e.g., bits, bytes)	16. LENGTH NUMBER	UNITS	17. ATTRIBUTES	18. USE AND MEANING
COMMA	34	1	Bytes	A1	',' IS WRITTEN
Blank	35	1		1X	
Ending Time	36	4		I4	0 – 2400
Blank	40	41		41X	
Record Type	81	1		I1	Always '2'
~~Station Number~~	~~82~~	~~3~~		~~I3~~	
RECORD TYPE 3					
Header Information	1	17		17A1	'UNIV. OF HAWAII, ' IS WRITTEN
Number of data cards	18	4		I4	
Header Information	22	26		26A1	' DATA CARDS, POSITION LAT ' IS WRITTEN
Latitude (Degrees)	48	2		I2	
Blank	50	1		1X	
Latitude (minutes)	51	2		I2	
Decimal	53	1		A1	'.' is written
Latitude (tenths of minutes)	54	1		A1	
Hemisphere	55	1		A1	'N' is written
Comma	56	1		A1	',' is written
Header Information	57	6		A6	' LONG '
Longitude (Degrees)	63	3		A3	
Blank	66	1		1X	
Longitude (Minutes)	67	2		I2	
Decimal	69	1		A1	'.' is written
Longitude (tenths of minutes)	70	1		I1	
Hemisphere	71	1		A1	'W' is written
Blank	72	9		9X	
Record Type	81	1		I1	Always '3'
~~Station Number~~	~~82~~	~~3~~		~~I3~~	

D. INSTRUMENT CALIBRATION

This calibration information will be utilized by NOAA's National Oceanographic Instrumentation Center in their efforts to develop calibration standards for voluntary acceptance by the oceanographic community. Identify the instruments used by your organization to obtain the scientific content of the DDF (i.e., STD, temperature and pressure sensors, salinometers, oxygen meters, velocimeters, etc.) and furnish the calibration data requested by completing and/or checking ("✓") the appropriate spaces. Add the interval time (i.e., 3 months, 6 months, 9 months, etc.) if the fixed interval calibration cycle is checked.

INSTRUMENT TYPE (MFR., MODEL NO.)	DATE OF LAST CALIBRATION	INSTRUMENT WAS CALIBRATED BY		CHECK ONE: INSTRUMENT IS CALIBRATED					INSTRUMENT IS NOT CALIBRATED (√)
		YOUR ORGANIZATION (√)	OTHER ORGANIZATION (GIVE NAME)	AT FIXED INTERVALS (√)	BEFORE OR AFTER USE (√)	BEFORE AND AFTER USE (√)	ONLY AFTER REPAIR (√)	ONLY WHEN NEW (√)	

FINAL DDF

ACCESSION NUMBER 690109 720920
680217 700928
TRD022

DATA DOCUMENTATION FORM

NOAA FORM 24-13

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL OCEANOGRAPHIC DATA CENTER
RECORDS SECTION
ROCKVILLE, MARYLAND 20852

FORM APPROVED
O.M.B. No. 41-R2651

This form should accompany all data submissions to NODC. Section A, Originator Identification, must be completed when the data are submitted. It is highly desirable for NODC to also receive the remaining pertinent information at that time. This may be most easily accomplished by attaching reports, publications, or manuscripts which are readily available describing data collection, analysis, and format specifics. Readable, handwritten submissions are acceptable in all cases. All data shipments should be sent to the above address.

A. ORIGINATOR IDENTIFICATION

THIS SECTION MUST BE COMPLETED BY DONOR FOR ALL DATA TRANSMITTALS

1. NAME AND ADDRESS OF INSTITUTION, LABORATORY, OR ACTIVITY WITH WHICH SUBMITTED DATA ARE ASSOCIATED

University of Hawaii; Department of Oceanography
1801 University Avenue
Honolulu, Hawaii

2. EXPEDITION, PROJECT, OR PROGRAM DURING WHICH DATA WERE COLLECTED

3. CRUISE NUMBER(S) USED BY ORIGINATOR TO IDENTIFY DATA IN THIS SHIPMENT

4. PLATFORM NAME(S): Buoys

5. PLATFORM TYPE(S) *(E.G., SHIP, BUOY, ETC.)*: Buoys

6. PLATFORM AND OPERATOR NATIONALITY(IES)

PLATFORM	OPERATOR
USA	USA

7. DATES

FROM: MO/DAY/YR	TO: MO/DAY/YR
2/11/65	11/24/69

8. ARE DATA PROPRIETARY?

[x] NO [ ] YES

IF YES, WHEN CAN THEY BE RELEASED FOR GENERAL USE? YEAR ____ MONTH ____

9. ARE DATA DECLARED NATIONAL PROGRAM (DNP)? (I.E., SHOULD THEY BE INCLUDED IN WORLD DATA CENTERS HOLDINGS FOR INTERNATIONAL EXCHANGE?)

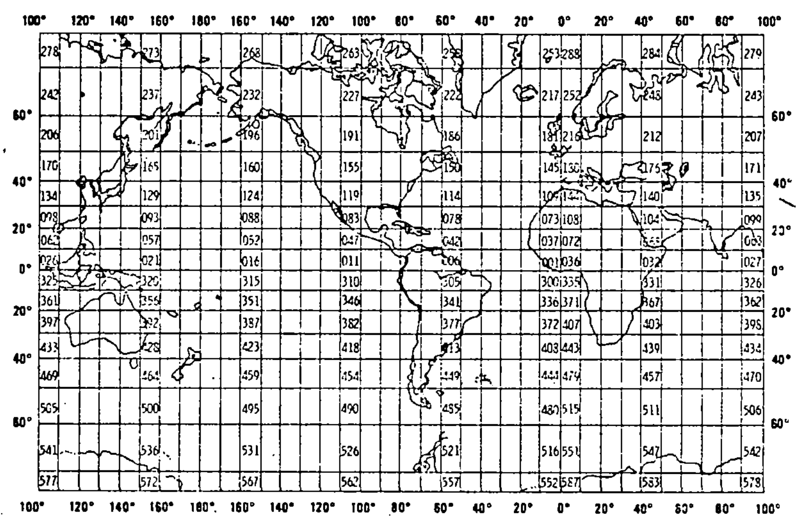
[X] NO [ ] YES [ ] PART *(SPECIFY BELOW)*

10. PERSON TO WHOM INQUIRIES CONCERNING DATA SHOULD BE ADDRESSED WITH TELEPHONE NUMBER *(AND ADDRESS IF OTHER THAN IN ITEM-1)*

Dr. Klaus Wyrtki
Professor of Oceanography

11. PLEASE DARKEN ALL MARSDEN SQUARES IN WHICH ANY DATA CONTAINED IN YOUR SUBMISSION WERE COLLECTED.

GENERAL AREA



NOAA FORM 24-13

USCOMM-DC 44289-P72

B. SCIENTIFIC CONTENT

NAME OF DATA FIELD	REPORTING UNITS OR CODE	METHODS OF OBSERVATION AND INSTRUMENTS USED (SPECIFY TYPE AND MODEL)	ANALYTICAL METHODS (INCLUDING MODIFICATIONS) AND LABORATORY PROCEDURES	DATA PROCESSING TECHNIQUES WITH FILTERING AND AVERAGING
Date - Time	GMT			
Depths	Meters			
Current Speed	cm/sec(whole units)	3 Instruments used -		
Current Direction	Degrees(true direction)	1. Paddle - wheel current meter - manufactured by Hydrowerk Staten of Kiel, Ger.		Recorded at 5-minute intervals and reduced to 15-minute intervals
		2a. Geodyne magnetic - tape - recording current meters		Recorded at 15-minute intervals
		2b. Geodyne film recording current meters		
		3. Aanderaa current meter (for station 301)		Recorded at 10-minute intervals and reduced to 15-minute intervals
	Reference:	1. Current observations in the Hawaiian Archipelago by Klaus Wyrtki, Volker Graefe and Wm. Patzert, July 1969		
		2. Current measurements in the Central North Pacific Ocean by William C. Patzert, Klaus Wyrtki, and Howard J. Santamore; November 1970		

C. DATA FORMAT

This information is requested only for data transmitted on punched cards or magnetic tape. Have one of your data processing specialists furnish answers either on the form or by attaching equivalent readily available documentation. Identify the nature and meaning of all entries and explain any codes used.

1. List the record types contained in your file transmittal (e.g., tape label record, master, detail, standard depth, etc.).

2. Describe briefly how your file is organized.

3-13. Self-explanatory.

14. Enter the field name as appropriate (e.g., header information, temperature, depth, salinity.

15. Enter starting position of the field.

16. Enter field length in number columns and unit of measurement (e.g., bit, byte, character, word) in unit column.

17. Enter attributes as expressed in the programming language specified in item 3 (e.g., "F 4.1," "BINARY FIXED (5.1)").

18. Describe field. If sort field, enter "SORT 1" for first, "SORT 2" for second, etc. If field is repeated, state number of times it is repeated.

C. DATA FORMAT

COMPLETE THIS SECTION FOR PUNCHED CARDS OR TAPE, MAGNETIC TAPE, OR DISC SUBMISSIONS.

Originators File

1. LIST RECORD TYPES CONTAINED IN THE TRANSMITTAL OF YOUR FILE
GIVE METHOD OF IDENTIFYING EACH RECORD TYPE

No Way to differentiate record types

2. GIVE BRIEF DESCRIPTION OF FILE ORGANIZATION

In station sequence which is not in chronological order

3. ATTRIBUTES AS EXPRESSED IN
- [ ] PL-1
- [ ] ALGOL
- [ ] COBOL
- [X] FORTRAN
- [ ] ______ LANGUAGE

4. RESPONSIBLE COMPUTER SPECIALIST:
NAME AND PHONE NUMBER Dr. Klaus Wyrtk
ADDRESS ______

COMPLETE THIS SECTION IF DATA ARE ON MAGNETIC TAPE

5. RECORDING MODE
- [ ] BCD
- [ ] BINARY
- [ ] ASCII
- [X] EBCDIC
- [ ] ______

6. NUMBER OF TRACKS (CHANNELS)
- [ ] SEVEN
- [X] NINE
- [ ] ______

7. PARITY
- [ ] ODD
- [ ] EVEN

8. DENSITY
- [ ] 200 BPI
- [X] 1600 BPI
- [ ] 556 BPI
- [ ] 800 BPI
- [ ] ______

9. LENGTH OF INTER-RECORD GAP (IF KNOWN)
- [ ] 3/4 INCH
- [ ] ______

10. END OF FILE MARK
- [ ] OCTAL 17
- [ ] ______

11. PASTE-ON-PAPER LABEL DESCRIPTION *(INCLUDE ORIGINATOR NAME AND SOME LAY SPECIFICATIONS OF DATA TYPE, VOLUME NUMBER)*

Tape No = 012358

Standard Label Tape - DSN=UNHACUR

12. PHYSICAL BLOCK LENGTH IN BYTES
3200- (LRECL=80)

13. LENGTH OF BYTES IN BITS

RECORD FORMAT DESCRIPTION

RECORD NAME Originators File

14. FIELD NAME	15. POSITION FROM-1 MEASURED IN ___ (e.g., bits, bytes)	16. LENGTH NUMBER	UNITS	17. ATTRIBUTES	18. USE AND MEANING
Header Information	1	7x80	Bytes	7x80A1	Position, starting time, number of Data Cards Etc. spelled out in these first seven "Cards". However errors occur in these fields and there is no good way to differentiate between these seven logical records.
Current Speed	1,7,13,19, 25,31,37 43,49,55, 61,67	12(3)	Bytes	12 (I3,3x)	
Current Direction	4,10,16, 22,28,34, 40,46,52 58,64,70	12(3)	Bytes	12(3x,I3)	
Blank	73	1	"	1x	A '9' appears in some stations but appears to have no meaning
Station Number	74	3	"	I3	
Card Number	77	4	"	I4	

C. DATA FORMAT

COMPLETE THIS SECTION FOR PUNCHED CARDS OR TAPE, MAGNETIC TAPE, OR DISC SUBMISSIONS.

User File

1. LIST RECORD TYPES CONTAINED IN THE TRANSMITTAL OF YOUR FILE
GIVE METHOD OF IDENTIFYING EACH RECORD TYPE

Eight record types simply called record type 1 - 8
Byte 81 differentiates the record type

2. GIVE BRIEF DESCRIPTION OF FILE ORGANIZATION

In originators station sequence

3. ATTRIBUTES AS EXPRESSED IN
- [ ] PL-1
- [ ] ALGOL
- [ ] COBOL
- [X] FORTRAN
- [ ] ______ LANGUAGE

4. RESPONSIBLE COMPUTER SPECIALIST:
NAME AND PHONE NUMBER ______
ADDRESS ______

COMPLETE THIS SECTION IF DATA ARE ON MAGNETIC TAPE

5. RECORDING MODE
- [ ] BCD
- [ ] BINARY
- [ ] ASCII
- [X] EBCDIC
- [ ] ______

6. NUMBER OF TRACKS (CHANNELS)
- [ ] SEVEN
- [X] NINE
- [ ] ______

7. PARITY
- [ ] ODD
- [ ] EVEN

8. DENSITY
- [ ] 200 BPI
- [X] 1600 BPI
- [ ] 556 BPI
- [ ] 800 BPI
- [ ] ______

9. LENGTH OF INTER-RECORD GAP (IF KNOWN)
- [ ] 3/4 INCH
- [ ] ______

10. END OF FILE MARK
- [ ] OCTAL 17
- [ ] ______

11. PASTE-ON-PAPER LABEL DESCRIPTION *(INCLUDE ORIGINATOR NAME AND SOME LAY SPECIFICATIONS OF DATA TYPE, VOLUME NUMBER)*

User Tape = Vol = Ser = ~~003720~~ M535

Non Label

12. PHYSICAL BLOCK LENGTH IN BYTES

~~3360~~ (LRECL=84) 3240 (LRECL=81)

13. LENGTH OF BYTES IN BITS

User File

RECORD FORMAT DESCRIPTION

RECORD NAME Record Type 1

14. FIELD NAME	15. POSITION FROM-1 MEASURED IN Bytes (e.g., bits, bytes)	16. LENGTH NUMBER	16. LENGTH UNITS	17. ATTRIBUTES	18. USE AND MEANING
Header Information	1	22	Bytes	22A1	'Current Meter Station' is written
Station Number	23	3	"	I3	
Header Information	26	55	"	55A1	Brief Description of station location
Record Type	81	1	"	I1	Always '1'
~~Station Number~~	~~82~~	~~3~~		~~I3~~	
		RECORD TYPE 2			
Blank	1	1	"	1x	
Starting Month	2	3	"	A3	'Jan', 'Feb', Etc.
Blank	5	1	"	1x	
Starting Day	6	2	"	I2	1 - 31
Comma	8	1	"	A1	',' is written
Blank	9	1	"	1x	
Starting Year	10	2	"	I2	Last two digits of year
Comma	12	1	"	A1	',' is written
Blank	13	1	"	1x	
Starting Time	14	4	"	I4	0-2400
Blank	18	2	"	2x	
To	20	2	"	A2	'To' is written
Blank	22	2	"	2x	
Ending Month	24	3	"	A3	'Mar', Apr', Etc.
Blank	27	1	"	1x	
Ending Day	28	2	"	I2	1 - 31
Comma	30	1	"	A1	',' is written
Blank	31	1	"	1x	
Ending Year	32	2	"	I2	Last two digits of year

RECORD FORMAT DESCRIPTION

RECORD NAME Record Type 2 (continued)

14. FIELD NAME	15. POSITION FROM-1 MEASURED IN ____ (e.g., bits, bytes)	16. LENGTH NUMBER	UNITS	17. ATTRIBUTES	18. USE AND MEANING
Comma	34	1	Bytes	A1	',' is written
Blank	35	1	"	1x	
Ending Time	36	4	"	I4	0 - 2400
Blank	40	41	"	41x	
Record Type	81	1	"	I1	Always '2'
~~Station Number~~	~~82~~	~~3~~	"	~~I3~~	
		RECORD TYPE 3			
Header Information	1	17	"	17A1	'Univ. of Hawaii," is written
Number of data cards	18	4	"	I4	
Header Information	22	26	"	26A1	'Data Cards, Position LAT' is written
Latitude (Degrees)	48	2	"	I2	
Blank	50	1	"	1x	
Latitude (Minutes)	51	2	"	I2	
Decimal	53	1	"	A1	'.' is written
Latitude (Tenths of Minutes)	54	1	"	A1	
Hemisphere	55	1	"	A1	'N' is written
Comma	56	1	"	A1	',' is written
Header Information	57	6	"	A6	'Long' is written
Longitude (Degrees)	63	3	"	A3	
Blank	66	1	"	1x	
Longitude (Minutes)	67	2	"	I2	
Decimal	69	1	"	A1	'.' is written
Longitude (Tenths of Minutes)	70	1	"	I1	
Hemisphere	71	1	"	A1	'W' is written
Blank	72	9	"	9x	
Record Type	81	1	"	I1	Always '3'
~~Station Number~~	~~82~~	~~3~~	"	~~I3~~	

RECORD FORMAT DESCRIPTION

RECORD NAME Record Type 4

14. FIELD NAME	15. POSITION FROM-1 MEASURED IN Bytes (e.g., bits, bytes)	16. LENGTH NUMBER	16. LENGTH UNITS	17. ATTRIBUTES	18. USE AND MEANING
Header Information	1	30	Bytes	30A1	Type of current meter
Header Information	31	7	"	7A1	'Bottom' is written
Depth to Bottom	38	4	"	I4	
Header Information	42	1	"	A1	'M' is written
Comma	43	1	"	A1	'1' is written
Header Information	44	20	"	20A1	'Depth of Instrument'
Depth of Meter	64	4	"	I4	
Header Inforamtion	68	1	"	A1	'M' is written
Blank	69	12	"	12x	
Record Type	81	1	"	I1	Always '4'
~~Station Number~~	~~82~~	~~3~~	~~"~~	~~I3~~	
		RECORD	TYPE	5	
Header Information	1	62		62A1	'Speed in cm/sec, true direction of flow in degrees, time zone' is written
Time Zone	63	3	"	I3	E.G. 150
Header Information	66	5	"	A5	E.G. 'West'
Blank	71	10	"	10x	
Record Type	81	1	"	I1	Always '5'
Station Number	82	3	"	I3	
		RECORD	TYPE	6	
No of Readings	1	5	"	I5	A reading equals a speed and a direction
Header Information	6	14	"	14A1	'READINGS' is written
Number of Hours	20	7	"	F7.2	Number of hours of observations to hundredths of hours
Header Information	27	4	"	4A1	'HRS' is written
Header Information	31	25	"	25A1	A reminder of how many days in a month
Number of Zeroes	56	2	"	I2	Number of readings in first card that contain zeroes

RECORD FORMAT DESCRIPTION

RECORD NAME Record Type 6 (continued)

14. FIELD NAME	15. POSITION FROM-1 MEASURED IN Bytes (e.g., bits, bytes)	16. LENGTH NUMBER	16. LENGTH UNITS	17. ATTRIBUTES	18. USE AND MEANING
Header Information	58	7	Bytes	7A1	'ZEROES' is written
Blank	65	16	"	16x	
Record Type	81	1	"	I1	'Always '6'
~~Station Number~~	~~82~~	~~3~~	~~"~~	~~I3~~	
		RECORD TYPE 7			
Header Information	1	6	"	6A1	'Start' is written
Gregorian Hours	7	10	"	F10.2	Number of hours (To hundredths) from fixed time
Header Information	17	30	"	30A1	'HRS after 1 Jan. 1900 0000 GMT OR' is written
Gregorian Hours	47	10	"	F10.2	Number of hours (to hundredths) from start of year
Header Information	57	24	"	24A1	'HRS after 1 Jan. 19?? (varies) 0000 GMT' is written
Record Type	81	1	"	I1	Always '7'
~~Station Number~~	~~82~~	~~3~~	~~"~~	~~I3~~	
		RECORD TYPE 8			
Current Speed	1,7,13, 19,25,31, 37,43,49, 55,61,67	12x3	"	12 (I3,3x)	
Current Direction	4,10,16 22,28,34 40,46,52, 58,64,70	12x3		12 (3x,I3)	
Blank	73	1		1x	
Station Number	74	3		I3	
Card Number	77	4		I4	
Record Type	81	1		I1	Always '8'
~~Station Number~~	~~82~~	~~3~~		~~I3~~	

DINDB QUERY LISTING
11/23/1990

*	ACC-NO	REFNO	F-A	PROJ	INST	PLAT	CRUISE	***CRUISE START	DATES*** END	STA IN	STA OUT
*	6800217	TR0022	L105	****	31R2	313C		02/01/1965	07/01/1968	9773	9773
*		TR0022	L105	****	31R2	313C		02/01/1965	07/01/1968	9662	9662
*		TR0022	L105	****	31R2	313C		02/01/1965	07/01/1968	9210	9210
*		TR0022	L105	****	31R2	313C		02/01/1965	07/01/1968	9557	9557
*		TR0022	L105	****	31R2	313C		02/01/1965	07/01/1968	5739	5739
*		TR0022	L105	****	31R2	313C		02/01/1965	07/01/1968	9559	9559
*		TR0022	L105	****	31R2	313C		02/01/1965	07/01/1968	7102	7102
delete entry		310020	F022	****	31R2	31SU	was C148*	02/01/1967	03/01/1967	74	0
*		319456	C022	****	31R2	31SU	TT3072	02/13/1967	03/01/1967	78	76
*		TT3072	F022	****	31R2	31SU		02/13/1967	03/01/1967	78	76
*		319457	C022	****	31R2	31SU	TT3073	03/22/1967	03/22/1967	3	3
*		TT3073	F022	****	31R2	31SU		03/22/1967	03/22/1967	3	3
*			C100	****	31R2	3199	01 ①	04/01/1967	05/01/1967	63	0
*		318019	C100	****	31R2	31TU	16	04/30/1967	05/06/1967	63	63
*			C100	****	31R2	3199	17 ①	06/01/1967	06/01/1967	37	0
*		319554	C022	****	31R2	31TU	TT3206	06/14/1967	06/17/1967	37	37
*		TT3206	F022	****	31R2	31TU		06/14/1967	06/17/1967	37	37

>

11/23/1990

*	ACC-NO	REFNO	F-A	PROJ	INST	PLAT	CRUISE	***CRUISE START	DATES*** END	STA IN	STA OUT
***											
*	6800217	TR0022	L105	****	31R2	313C		02/01/1965	07/01/1968	9210	9210
		TR0022	L105	****	31R2	313C		02/01/1965	07/01/1968	9773	9773
		TR0022	L105	****	31R2	313C		02/01/1965	07/01/1968	9662	9662
*		TR0022	L105	****	31R2	313C		02/01/1965	07/01/1968	9559	9559
*		TR0022	L105	****	31R2	313C		02/01/1965	07/01/1968	7102	7102
*		TR0022	L105	****	31R2	313C		02/01/1965	07/01/1968	5739	5739
*		TR0022	L105	****	31R2	313C		02/01/1965	07/01/1968	9557	9557

>=C1020=,OB C29 WH C11 EQ 6800100;

* converted to F022

① - Data probably lost as no cr # was assigned in DINDB.

Re-process C100

DINDB QUERY LISTING
11/23/1990

*								***CRUISE DATES***		STA	STA
	ACC-NO	REFNO	F-A	PROJ	INST	PLAT	CRUISE	START	END	IN	OUT
*	6900769		L105	****	31R2	313C		08/01/1968	12/01/1968	3601	0
*			L105	****	31R2	313C		08/01/1968	12/01/1968	3705	0
*			L105	****	31R2	313C		08/01/1968	12/01/1968	2427	0
*			L105	****	31R2	313C		08/01/1968	12/01/1968	2075	0
*			L105	****	31R2	313C		08/01/1968	12/01/1968	3573	0
*			L105	****	31R2	313C		08/01/1968	12/01/1968	396	0
*			L105	****	31R2	313C		08/01/1968	12/01/1968	3475	0
*			L105	****	31R2	313C		08/01/1968	12/01/1968	2087	0
*			L105	****	31R2	313C		08/01/1968	12/01/1968	3925	0
*			L105	****	31R2	313C		08/01/1968	12/01/1968	1574	0
*			L105	****	31R2	313C		08/01/1968	12/01/1968	3560	0

>

delete accession # - all entries
duplicated under acc # 7000928

*	ACC-NO	REFNO	F-A	PROJ	INST	PLAT	CRUISE	***CRUISE START	DATES*** END	STA IN	STA OUT
*	[illegible]800217	TR0022	L105	****	31R2	313C		02/01/1965	07/01/1968	9557	9557
*		TR0022	L105	****	31R2	313C		02/01/1965	07/01/1968	5739	5739
*		TR0022	L105	****	31R2	313C		02/01/1965	07/01/1968	7102	7102
*		TR0022	L105	****	31R2	313C		02/01/1965	07/01/1968	9559	9559
*		TR0022	L105	****	31R2	313C		02/01/1965	07/01/1968	9662	9662
*		TR0022	L105	****	31R2	313C		02/01/1965	07/01/1968	9773	9773
*		TR0022	L105	****	31R2	313C		02/01/1965	07/01/1968	9210	9210
*	7000928	TR0022	L105	****	31R2	313C		08/01/1968	06/01/1969	3573	3573
*		TR0022	L105	****	31R2	313C		08/01/1968	06/01/1969	6100	6100
*		TR0022	L105	****	31R2	313C		08/01/1968	06/01/1969	3475	3475
*		TR0022	L105	****	31R2	313C		08/01/1968	06/01/1969	2427	2427
*		TR0022	L105	****	31R2	313C		08/01/1968	06/01/1969	6324	6324
*		TR0022	L105	****	31R2	313C		08/01/1968	06/01/1969	6330	6330
*		TR0022	L105	****	31R2	313C		08/01/1968	06/01/1969	3601	3601
*		TR0022	L105	****	31R2	313C		08/01/1968	06/01/1969	2075	2075
*		TR0022	L105	****	31R2	313C		08/01/1968	06/01/1969	3560	3560
*		TR0022	L105	****	31R2	313C		08/01/1968	06/01/1969	396	396
*		TR0022	L105	****	31R2	313C		08/01/1968	06/01/1969	6621	6621
*		TR0022	L105	****	31R2	313C		08/01/1968	06/01/1969	6442	6442
*		TR0022	L105	****	31R2	313C		08/01/1968	06/01/1969	6701	6701
*		TR0022	L105	****	31R2	313C		08/01/1968	06/01/1969	1574	1574
*		TR0022	L105	****	31R2	313C		08/01/1968	06/01/1969	6146	6146
*		TR0022	L105	****	31R2	313C		08/01/1968	06/01/1969	3705	3705
*		TR0022	L105	****	31R2	313C		08/01/1968	06/01/1969	5756	5756
*		TR0022	L105	****	31R2	313C		08/01/1968	06/01/1969	3925	3925
		TR0022	L105	****	31R2	313C		08/01/1968	06/01/1969	2087	2087
	7200520	TR0022	L105	****	31R2	313C		06/01/1969	11/01/1969	577	577
*		TR0022	L105	****	31R2	313C		06/01/1969	11/01/1969	3070	3070
*		TR0022	L105	****	31R2	313C		06/01/1969	11/01/1969	581	581
*		TR0022	L105	****	31R2	313C		06/01/1969	11/01/1969	577	577
*		TR0022	L105	****	31R2	313C		06/01/1969	11/01/1969	573	573
*		TR0022	L105	****	31R2	313C		06/01/1969	11/01/1969	370	370

ACCESSION NO. 6800217 FILETYPE C100, FØ15 TRACK NO. ________ PROJECT IDENTIFICATION ________

University of Hawaii - Current meter + Station Data

STEP	DATE	INIT.	TAPE OR DISK DSN	NO. FILES	LRECL	BLK SIZE	NO. RECORDS
ORIG. TAPE	11/27/90	MEC	DØØ7Ø9 AØ1317	1	80	3200	13,835
DUPLICATE TAPE			DØ1321 AØ1318	3	"	"	37,443
REFORMATTED TAPE	11/31/90		WØ9769 *1	4	"	"	13,842
REFORMATTED DISK			WØ9764 *2	3	"	"	37,443
FIRST MULCHEK							
FINAL MULCHEK							
MPD75 OR F022							
DATA SET FINALIZED							

ERRORS REPORTED TO PRINCIPAL INVESTIGATOR: [1] DNODC*6800217.01

[2] DNODC*6800217.02

ADDITIONAL ERRORS/CORRECTIONS (NOT REPORTED TO P.I.)

COMMENTS (TRACKS DELETED, FIELDS DELETED, ETC.)

LENGTH OF RECORDS WITH WORD MARKS

NC_{MASTER} = # CHARACTERS IN MASTER RECORD = 107

NC_{DETAIL} = # CHARACTERS IN DETAIL SUBRECORD = 74

ND = # OF DETAIL SUBRECORDS

TNC = TOTAL # OF CHARACTERS IN STATION RECORD

$$TNC = NC_m + ND \times NC_{DET.}$$

WORD SEPARATORS AT FOLLOWING CHARACTER POSITIONS

1, 5, 7, 14, 17, 21, 24, 29, 32, 35, 38, 41, 44, 47, 52, 57,
62, 66, 70, 74, 78, 82, 84, 86, 101, 104, 106

107 + 1, 6, 12, 18, 22, 27, 31, 36, 41, 45, 49, 53, 68, 71, 73

107 + 74 + ...

107 + 2·74 + ...

107 + 3·74 + ...

107 + 4·74 + ...

⋮

10 (ND-1)·74 + ...

DATA TABULATING INSTRUCTIONS

GENERAL DIRECTIONS

1. Change all weather to the single digit code.
2. Change all times to EST
3. Ø = O (Oh!), not zero... You will write this as follows: [illegible]
4. Rivers do not have an area code, but all Bay stations and off-shore stations do have an area code.
5. Zeros should be prefixed and suffixed when appropriate.

Two IBM cards have been designed for the recording of our oceanographic data. A third card is being worked on, and others will probably be added at a later date. The cards now in use are the CBI Master Station Card, and the CBI Detail Station Card. These cards have been patterned, as nearly as possible, after the format adopted by the NODC.

Each oceanographic station will have a single Master Station Card which records the general surface environmental and meteorological information at the station. Each depth at which physical and chemical data were taken will have a Detail Station Card which records the information obtained at that depth. A Cruise Master Card is being developed which will carry information common to the cruise as a whole, as well as codes indicating observational techniques and accuracy. Additional detail cards for biological, geological, chemical, and other data can be added at a later date.

CODING THE INFORMATION

General instructions for entries on the data form:

1. Use standard rounding procedures whenever rounding is necessary.

   Example: >5 add one (1) to preceding column
   <5 drop
   5 round to nearest even number

2. When necessary, 0's are prefixed and suffixed.

   Example: A temperature of 6.30°C should be recorded and punched in columns 26-30 as 0630 with column 30 left blank.

ENTRIES FOR SURFACE ENVIRONMENTAL INFORMATION (MASTER STATION CARD)

COLUMNS 1-3 CRUISE NO.

Enter the number or the alpha-numeric designator in these spaces. Bay cruises have only a number.

Example: Bay Cruise XXV = 025

COLUMN 4 SHIP CODE

Enter the first letter of the ship's name (e.g. M = Maury, L = Lydia Louise).
If ship is unknown, leave column 4 blank. (J - Joan Bar, B- Balanus, R - Ridgely Warfield)

COLUMNS ~~M-MM 1-6, 7-12, etc.~~ 5-10 STATION NUMBER

Enter the assigned station number in these columns as shown in the examples below.

Example: Station No. 938 should be recorded in columns 6,7,and 8.

Station 938A should be recorded in columns 6,7,8, and 9.

Station Ø631AA should be recorded as Ø631AA in columns 5,6,7,8,9,10.

COLUMNS 11-12 YEAR

Enter last two digits of year.

COLUMNS 13-15 MONTH

Abbreviate month and record in letters.

Example: September = Sep

July = Jul

COLUMNS 16-17 DAY

Prefix 0 if less than ten

COLUMNS 18-21 HOUR

Enter time as EST

COLUMNS 22-27 LATITUDE

Enter latitude in degrees, minutes and seconds.

Example: 39°37'06" = 393706

COLUMNS 28-33 LONGITUDE

Enter longitude in degrees, minutes and seconds.

COLUMNS 34-37 DEPTH TO BOTTOM

If depth is in feet, punch an F in column 37. If depth is in meters, column 37 will be the tenths place. Depths in feet should be recorded to the nearest foot. Depths in meters should be recorded to the nearest tenth of a meter.

Example: 56 ft. = 056F

36.2m = 0362

121 m = 1210

COLUMNS 38-41 MAXIMUM SAMPLE DEPTH

Record as above.

COLUMNS 42-45 WATER (Color and Transparency)

COLUMNS 46-51 WIND DIRECTION AND SPEED (or FORCE)

Direction is recorded in degrees true.

Example: 35° = 035

165° = 165

If wind is recorded according to the Beaufort Scale, put a B after the number.

Example: A wind force of 8 = 08B

If speed is recorded, column 51 will be blank.

COLUMNS 52-54 BAROMETER

Enter barometric pressure in millibars. Enter tens, units and tenths only.

COLUMNS 55-60 AIR TEMP., DRY BULB, WET BULB

Enter dry bulb temperature in columns 55-57 and wet bulb temperature in columns 58-60 in °C to tenths. Indicate negative temperature by a prominent red dash over the numeral(s) in column(s) 55 and/or 58.

COLUMN 61 WEATHER

Record all weather according to the single digit WMO code. Convert all two digit readings to this code.

COLUMN 62 BOTTOM

COLUMNS 63-67 SPECIAL OBSERVATIONS

COLUMN 79 AREA CODE

COLUMN 80 CARD CODE

ENTRIES FOR SUBSURFACE OBSERVATIONS (DETAIL STATION CARD)

COLUMNS 1-21 — IDENTIFICATION ENTRIES

These columns are identical to the MASTER STATION CARD.

COLUMNS 22-25 — DEPTH OF SAMPLE

If depth is in feet, put an F in column 25, and record to the nearest foot.

Example: 161 ft. = 161F
56 ft. = 056F

If depth is in meters, record to the nearest tenth of a meter.

Example 161 m = 1610
56.2m = 0562

COLUMNS 26-30 — TEMPERATURE

Enter temperature in ° C to hundredths in columns 26-29; column 30 is for an additional decimal or precision indicator. To indicate a negative temperature, place a prominent minus sign in red before the numerical entry in column 26.

COLUMNS 31-35 — SALINITY

Enter salinity in parts per thousand to hundredths in columns 31-34. Column 35 is for an additional decimal.

COLUMNS 36-38 — pH

Example: 7.97 = 797

COLUMNS 39-42 — O_2

Example: 8.21 ml/1 = 0821

COLUMNS 43-49 — CURRENT: DIRECTION & SPEED

Direction is recorded in columns 43-45 in degrees true. If speed is recorded in knots, record a K in column 49. If current is in m/sec, column 49 will be blank.

COLUMNS 50-53 — δ_T

COLUMNS 54-59 — PO_4

Record to the nearest hundredth.

COLUMNS 60-62 — CHLOROPHYLL

Record to the nearest tenth.

COLUMN 79 — AREA CODE

COLUMN 80 — CARD CODE

DATA BANK LIBRARY AS OF 6/1/68

OC001
BAY CRUISES

CRUISE NO.	DATA REPORT NO.
001	1
002	1
003	2
004	3
005	4
006	4
007	5
008	6
009	9
010	10
011	12
012	18
013	26
014	33
015	34
016	35
017	36
018	38
019	39
020	40
021	41
022	42
023	43
024	44
025	45
026	46
027	47
028	48
029	50
030	50
031	50
032	--
033	--

OCQO2

RIVER CRUISES

CRUISE NO.	PROJECT NAME	DATA REPORT NO.
A01	Operation Rappahannock	8
A02	St. Mary's River Cruise	11
A03	James River Winter Cruise	13
A04	Patuxent River Spring Cruise	16
A05	Choptank River Spring Cruise	17
A06	Patuxent River Summer Cruise	19
A07	Choptank River Summer Cruise	20
A08	Patuxent River Autumn Cruise	21
A09	Choptank River Autumn Cruise	22
A10	Patuxent River Winter Cruise	23
A11	Choptank River Winter Cruise	24
A12	James River Winter Cruise II	25
A13	Upper Choptank Spring Cruise I	28
A14	Upper Choptank Spring Cruise II	28
A15	Broad Creek Cruise I	29
A16	Broad Creek Cruise II	29
A17	York River Cruise	30
A18	Magothy River Oct. 1956	
A19	Magothy River 1958	
A20	Magothy River Background	
A21	Magothy River Dye I	
A22	Magothy River Dye II	
A23	Rock Egg May 1956	
A24	Patuxent River Dye I	
A25	Patuxent River Chalk Point II	
A26	James River	
A27	York River Dye Run	
A28	Pamunkey River Dye	
A29	Mattaponi Dye Run	
A30	Upper York Dye Run	
A31	James River Dye	
A32	Elizabeth River Dye	
A33	Rappahannock River 1955	
A34	Operation Rappahannock 02	
A35	Rappahannock River 1956	
A36	Rappahannock River May - Oct. 1957	
A37	Rappahannock River 1958	
A38a	Severn River Book I	
A38b	Severn River Book II	
A39	Severn River 1963	
A40	Choptank River Salinity Sept. 1964	

CBI004

SPECIAL CRUISES

CRUISE NO.	PROJECT NAME	DATA REPORT NO.
Z01	Operation Oyster Spat I	7
Z02	Operation Oyster Spat II	7
Z03	Piney Point Study	14
Z04	Chemical and Physical Data - Chincoteague Bay	15
Z05	Temperature and Salinity Data Feb. 1956	49
Z06	Blue Crab Survey I	27
Z07	Blue Crab Survey II	27
Z08	Blue Crab Survey III	27
Z09	Operation Hisal Nov. 1954	
Z10	Bayhead Nov. - Dec. 1954	
Z11	Operation Losal Mar. - Apr. 1955	
Z12	Operation Eastern Bay	
Z13	Bayhead Calcium 1956	
Z14	Special 1958 and Freshwater Check	
Z15	Baycheck	
Z16	Cruise Jerry Sept. 1954	
Z17	Operation Oxygen	
Z18	Ulcer Project Oct. - Nov. 1961	
Z19	Gunpowder River Dye June - July 1963	
Z20	Havre De Grace Dyes I & II	
Z21	Fishkill 1961	
Z22	Fishkill 1963	
Z23	Fishkill 1966	
Z24	Potomac River Salinity Check	

HIG-69-15

CURRENT OBSERVATIONS IN THE HAWAIIAN ARCHIPELAGO

By

Klaus Wyrtki, Volker Graefe, and Wm. Patzert

July 1969

Prepared for

Office of Naval Research
under Contract No. Nonr-3748(06)

Approved by Director

[signature]

Date: 31 July 1969

LIST OF FIGURES

Figure

[illegible]

[illegible] current measurements with moored [illegible] in the Hawaiian Archipelago for periods of from two to six weeks. Data from each of the [illegible] current meter [illegible] are given as progressive vector diagrams, frequency distribution of direction and speed, and computed tidal ellipses.

The mooring techniques, data reduction, and computation of the tidal ellipses are described. A discussion of the results shows that [illegible] resulting flow takes place through the archipelago. The semidiurnal tide governs most of the current patterns. The flow associated with the semidiurnal [illegible] is a progressive tidal wave approaching the Archipelago from the northeast. Typical amplitudes of the tidal current are 20 to 30 cm/sec, but locally they may be as high as 50 cm/sec. The diurnal tide does not show the same consistent pattern, and coherence with Honolulu sea level is weaker than it is for the semidiurnal tide. It appears, however, that the diurnal tide wave is composed of a standing wave between the eastern and western North Pacific Ocean and a progressive wave approaching the islands from the west.

[illegible] the results of current measure- [illegible] from February 1965 [illegible] Office of Naval [illegible]. The purpose of the investigation was [illegible] circulation in the vicinity of [illegible] the thought that measurements of [illegible] in various locations would yield [illegible] and around the Archipelago, [illegible] and seasons. Consequently, observations were concentrated in the channels between the various islands and on the northern and southern points of the islands. Most of the islands possess only a very narrow shelf and then drop off extremely steeply to the deep ocean. Most current meters, therefore, were placed rather close to shore, within a few nautical miles, in order to avoid the use of [illegible] moorings which are difficult to place on a steeply sloping bottom.

After a number of measurements had been taken it became apparent that little could be learned from these current measurements about the mean circulation through the Archipelago. This circulation appeared to be rather weak and very variable, and showed little relation to the wind. However, strong semidiurnal and diurnal tides showed up in all the measurements. Since only a few observations on tidal currents in the ocean, away from the continents, are available, it seemed worthwhile to continue the program with an emphasis on studying the tidal currents in the Hawaiian Archipelago. The location of the large amphidromic tide waves in the big ocean basins has been inferred chiefly from measurements of sea level heights around the continental coasts and on a few island stations. Very little is known about the current velocities associated with these amphidromic waves. Consequently, our study should provide some new information on the relationship between tidal currents and tidal heights in the central parts of the ocean.

INSTRUMENTS AND [illegible]

[illegible] of current meters were [illegible] the [illegible] wheel current meter, [illegible] in Kiel, Germany, and the Richardson current meter [illegible] tured by Geodyne Corporation, [illegible], Massachusetts [illegible].

The [illegible] phase of the [illegible] instrument [illegible] ment [illegible] unit (Fig. [illegible] planting and recovery [illegible]. This meter was designed for a recording length of [illegible] days at [illegible]-minute intervals. [illegible] meter [illegible] the current and the direction [illegible] minutes [illegible] is averaged [illegible] response [illegible].

The Richardson current meter, on the other hand, is not buoyant and needs to be supported by a buoy, which adds another unit to the mooring. This current meter takes 12 or 24 readings during one minute every 15 minutes or at other selected intervals. Usually the individual readings during the 1-minute recording time will be averaged and considered as one measurement. The Richardson current meter has a velocity response as low as 2 cm/sec, but the vane is so small that all the turbulent components of the flow are recorded and add considerable uncertainty to the determination of the mean direction. The length of the recording time of this meter at 15-minute intervals is in excess of 40 days.

The current meters were planted using a taut wire mooring, with a subsurface buoy for buoyancy and a small marker buoy on the sea surface (Fig. 1). Although most of the moorings were made in water depths of from 30 to 200 m, several instruments were moored in depths as great as 1000 m. In order to reduce the effect of surface-wave motions and to avoid possible damage from passing ships, the subsurface buoy—a steel sphere 0.7 m in diameter—was planted approximately 10 to 15 m below the surface. To minimize the wire inclination induced by horizontal currents, the mooring was designed so that the wire tension was 100 kg for the Geodyne meters and 175 kg for the

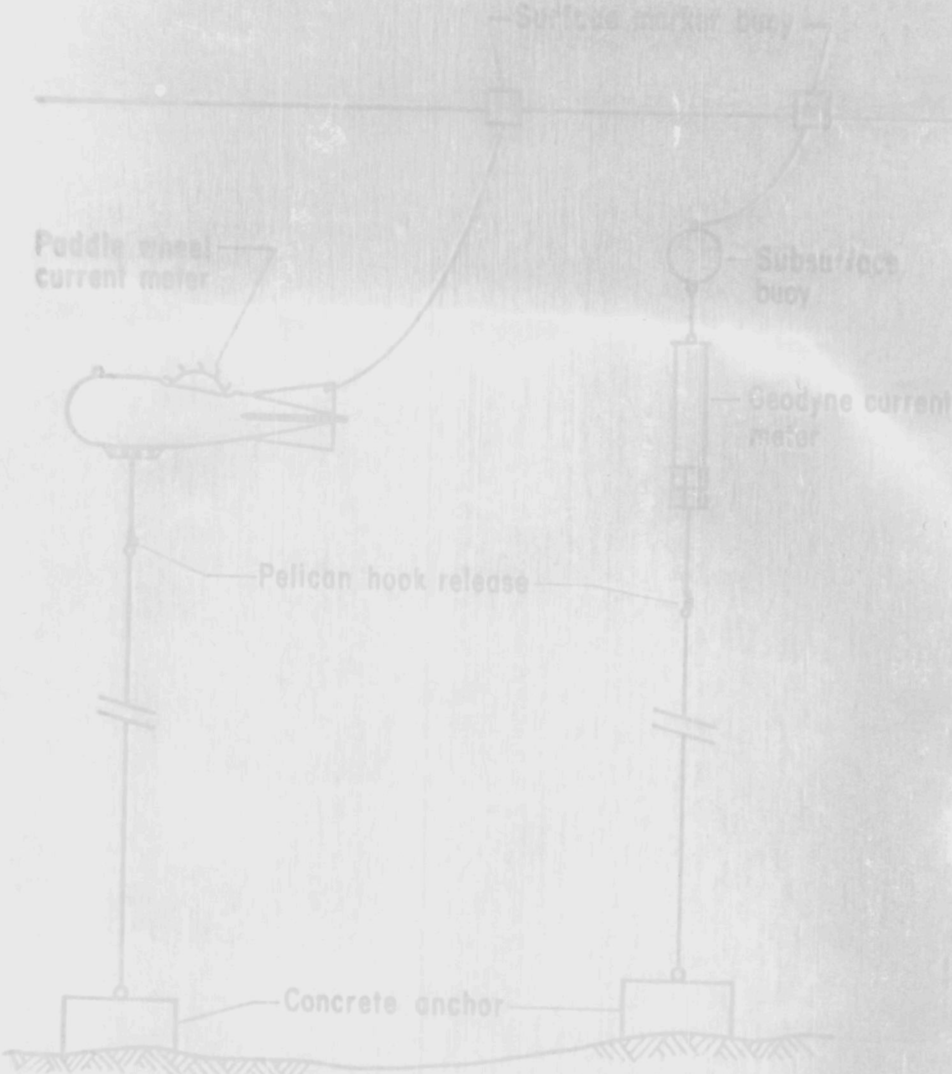


Fig. 1. Types of current meter moorings used during these investigations.

[illegible] of the [illegible] current meters [illegible] -degree [illegible] of five [illegible] locations [illegible] consisted of con- crete blocks [illegible] to 500 [illegible] sea water.

The [illegible] shown in Figure [illegible], was [illegible] "teeter-totter," which [illegible] dropping of the heavy anchor blocks. The teeter-totter is a steel box 2.5 m long by [illegible] m wide with one end open. It was specifically designed for the launching of the anchors. This box was pivoted in the middle—hence the name "teeter-totter"—and was mounted on a metal bar so that the open end extended over the taffrail of the ship.

On approaching the mooring site, the concrete anchor was lifted into the teeter-totter. The mooring was assembled on board the ship while the [illegible] was surveyed with the echo-sounder. After finding a proper location, the assembled surface float, marker line, subsurface buoy, current meter, and cable were put into the water, connected with the anchor on the teeter-totter, and trailed behind the ship. When the ship reached the desired position and depth, the inboard end of the teeter-totter was lifted by a winch, thus slipping the concrete anchor into the water and planting the mooring. During reasonable weather and sea conditions, this operation took less than an hour.

The location of the mooring was fixed using ranges and bearings along the shoreline and a sounding at the location. During the course of this work the most accurate method developed for relocating the moorings was to take a series of photographs of the shoreline at the time the anchor was released. These photographs were later enlarged to provide a panoramic view of the nearby coast. This method gave multiple ranges along most of the Hawaiian coasts and was a very accurate way to relocate the moorings. Horizontal sextant angles were also used when there were no visible ranges and proved an excellent method for determining the position of the moorings. The pictures had the advantage that small boats with no sophisticated navigational aids could be used for relocation of the current meters.

The majority of the current meters were recovered by scuba divers. Once the mooring was located, divers entered the water and released a pelican slip-hook located in the mooring cable immediately below the current meter. This caused the meter and buoy to surface. The anchor and cable were not retrieved. The meters located farther offshore were released from their anchors by Geodyne Model [illegible]

[illegible] Hawaiian waters [illegible] In many cases the [illegible] presum- [illegible] to [illegible] the instru- [illegible] surface moor- [illegible] from a [illegible] bottom topography of [illegible] valley and ridge topography [illegible] in many areas. [illegible] selecting and sur- veying an area for [illegible]

During the four years of these investigations, 52 moorings were planted. Five of these moorings with seven current meters were lost, and four moorings did not result in any recorded data. Forty-three [illegible] current meter records were obtained but not all of these were perfect. Some were cut short because of instrument failures.

Instrument failures [illegible] by failures of the driving clockwork [illegible] current meters and by electrical failures in [illegible] current meters. In several instances it was not [illegible] recover the instrument on time, before the clock or the batteries ran out, and consequently the end-time of the recording could not be very well established. During the entire operation seven current meters were lost. Three of these meters were located in areas where fishing by local fishermen is rather heavy, and it is suspected that the losses were due to inadvertent interference from their operations. Four current meters were lost in deep moorings attempted in the Alenuihaha Channel and north of Oahu, and in these cases it is suspected that the time releases did not function properly.

The Standardized [illegible]

Since [illegible] study, the initial phase of the data reduction is discussed separately for the two types. Every five minutes the paddle-wheel current meters record the current direction at that particular moment and the current speed averaged over the previous five minutes. The recording is done by taking a photographic picture of a compass and of a revolution counter for the paddle-wheel. The resulting film is not machine readable, which makes the reading of the data rather tedious and somewhat error-prone. After the film has been read, the data are punched on cards and processed by a computer program which contains the following steps:

- Check if all cards are present and in sequence.
- Check if all directions are between 0 and 360 degrees.
- Convert directional reference from magnetic to true north.
- Convert revolution counts to current speeds.
- Check if the difference between each speed value and the previous speed value is within certain limits.
- Check if the difference between each speed value and the average of the two previous speed values is within certain limits.
- Print histograms for direction, speed, and first differences of speed.
- Store the data on magnetic tape.

If any of the error checks were applicable, a message was printed. If after comparison with the original film it was determined that one or more messages were triggered by genuine errors, and not by unusually rapid changes of the current speed, the corresponding values were corrected in the card deck and the programs were run again.

The finally accepted values were used to generate plots of speed and direction versus time on a Benson-Lehner automatic plotter, as well as histograms of current direction and speed. If a visual inspection of those plots did not [illegible] ... data [illegible] ... and the time-[illegible] were capable of [illegible] our attention to [illegible] of the current meters.

[illegible] record [illegible] every 10, [illegible] minutes, which can be selected, and each record [illegible] of instrument [illegible] orientation [illegible] relative to magnetic north, and current direction relative to the instrument [illegible] M is a number [illegible] on the individual instrument. The recording [illegible] on 16mm film in binary [illegible] or on 1/2 inch magnetic tape.

The [illegible] Division of [illegible] International, Incorporated [illegible] (film or tape). This company [illegible] an analog record showing compass direction, vane direction, current direction, and speed [illegible] ranges as a function of record number. It also computer-averages the measurements over each one-minute recording interval and supplies these digital data on computer standard magnetic tape. From the digital information supplied by Geodyne we generated a time-sequence plot of direction and speed and compared it with their analog strip chart records. Unfortunately, these two types of data presentation generated by Geodyne do not agree in all cases, thus considerable cross-checking was required as well as checking against the original film to establish the true values. After this final checking, the Geodyne data were then handled in the same manner as the paddle-wheel data.

For the further evaluation of the data it was necessary to have them available in a standard form that did not depend on the particular instrument that had recorded them originally. We devised a standard data format that could be used for both types of meters and for all similar instruments that we might use in the future. The data consisting of speed and direction at 15-minute intervals are recorded in such a form that a simple listing of the cards can be read with relative ease. Header cards which precede the actual data cards make the deck self-descriptive. For details, see Figure 2.

The conversion from the original five-minute data as recorded by the paddle-wheel current meters to 15-minute intervals is done by first converting speed and direction into vector components, then low-passing both components to remove all frequencies above two cycles per hour, decimating the resulting series, and converting back to speed and direction.

The data in the form illustrated in Figure 2 are the basis for all further evaluation. Copies of these decks

```
CURRENT METER STATION 218 [illegible]
 OCT 17, 68,  945 [illegible]
UNIV. OF HAWAII, [illegible]
GEODYNE FILM RECORDING [illegible]
SPEED IN CM/SEC, [illegible]
  395 READINGS
 START [illegible]
 0  0  0  0 [illegible]                                                    1
 32227 [illegible] 218   2
 34277 [illegible]   3
 27 74 26 [illegible] 218   4
 17121 [illegible] 218   5
 40 31 39 29 [illegible]   6
 41 36 41 [illegible] 218   7
 23164 24109 [illegible]   8
 26255 [illegible]   9
 22 68 21 61 [illegible] 218  10
 53 36 49 [illegible]  11
 31 30 32 41 [illegible]  12
 23108 [illegible]  13
 20153 21162 [illegible]  14
 20 74 22 84 [illegible]  15
 19170 18175 21173 [illegible] 218  16
 23221 23236 24241 26242 26246 28251 27251 26251 27253 29258 27257 28258 218  17
 28260 27263 25266 [illegible] 23294 23301 [illegible] 25356 218  18
 26 11 24 29 [illegible] 218  19
 28 52 26 51 26 58 [illegible] 23 65 218  20
 23 68 22 69 [illegible] 27145 218  21
 18123 19108 [illegible] 218  22
 20 68 22 65 [illegible]  23
 22 76 20 79 [illegible] 21138 [illegible]  24
 18203 19211 20236 [illegible] 26236 25231 [illegible] 25234 [illegible]  25
 27243 28248 25256 25268 [illegible] 24306 23316 22324 [illegible] 24343 218  26
 23358 25 21 26 [illegible] 41 47 41 50 42 46 [illegible]  27
 38 56 36 58 [illegible] 29 53 26 56 27 58 26 61 28 62 [illegible]  28
 25 74 23 81 [illegible] 22 64 [illegible] 22 78 21 88 22 90 [illegible]  29
 21103 21108 [illegible] 20107 21106 19103 21103 21106 19106 [illegible]  30
 19 94 19 92 19 88 [illegible] 20 61 20 51 18 52 18 56 20 68 [illegible] 218  31
 21 81 20 82 19 85 [illegible] 19 86 17 89 19 96 17101 18106 17108 [illegible] 218  32
 20146 20181 20226 [illegible] 19316 21326 21331 21335 21336 [illegible]  33
 22351 21353  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0 [illegible] 218  34
CURRENT METER STATION 218 - MAKUAIKI, NORTHWEST OF KAUAI
 OCT 17, 68,  945  TO  OCT 21, 68, 1215
```

Fig. 2. Listing of a standard data deck. Seven cards with descriptive information precede the actual data, facilitating both the handling and the machine processing of the deck. Each data card is uniquely labelled with a sequence number (columns 77 to 80) and a station identification number that is common to all data cards in a deck (columns 74 to 76). Columns 1 to 72 contain twelve pairs of speed and direction of flow, covering a three-hour period. The data are aligned on the cards in such a way that the first pair on each card corresponds to either 00:00 o'clock, or 03:00 o'clock or ...21:00 o'clock, local time. If the series of measured values does not start at one of these times, the series is preceded on the first card by a number of (0.0)-pairs in order to have all following cards properly aligned. Similarly, if the last card cannot be filled with data, the remaining positions on it are filled with (0.0)-pairs. Columns 40 to 80 on the second descriptive card may be used to enter special circumstances or events (such as instrument malfunctions) related to the set of data.

are made available to [illegible] Data Center, Washington, D. C.

The Progressive Vector Diagram

For each current [illegible] a graph is presented that in a sense resembles the trajectory of a certain water particle. The graph shows a series of points with coordinates (x_n, y_n), n = 0, ... N, where N is the number of 15-minute intervals covered by the station. The coordinates are defined as

$$x_n = x_o + s \sum_1^n u_n ,$$

$$y_n = y_o + s \sum_1^n v_n , \qquad (1)$$

where u_n and v_n are the east and north components of the current vector at the end of the n-th 15-minute interval in the series, s is a scale factor, and x_o and y_o are essentially integration constants with no particular significance.

Equations (1) can be considered approximations of

[illegible] (2)

[illegible] $= s' \int_o$ [illegible]

Equations (2) make the similarity between the graph presented here and a trajectory more apparent. If in equations (2) u and v were the components of the current vector at the location of a specific particle of water, then (2) would describe the trajectory of that particle; however, here u and v stand for [illegible] at the fixed [illegible] therefore be clearly [illegible] actual trajectory [illegible] lected at one [illegible] true trajectory [illegible] a particle or at least [illegible] current observations [illegible]

The [illegible] matic plotter [illegible] scale factors [illegible] approximately [illegible] or every fourth [illegible]

<u>Spectra and [illegible]</u>

Currents at all locations [illegible] substantial tidal components. These components were separated from components at other frequencies by a numerical filter with a pass band from approximately [illegible] to approximately 2 cpd. The filter was applied to [illegible] and v components of the current vectors and its [illegible] was to remove low frequency components from the [illegible]. Power spectra of the filtered series and of the predicted tide for Honolulu for the same period of time were computed, as well as cross spectra between the vector components and the predicted sea level (Fig. 3). The confidence interval for coherence and phase [illegible] Groves (1966). [illegible] herence between [illegible] for tidal frequencies [illegible] that in a number [illegible] ence. If [illegible] lized tidal [illegible] semidiurnal [illegible] to the predicted [illegible] ellipses were [illegible] component [illegible] with phases and [illegible] taken from computer [illegible] like the one shown in Figure 3. The ellipses are defined by

$$u(t) = a_u \cos [\text{illegible}]$$

$$(7)$$

$$v(t) = a_v \cos [\text{illegible}]$$

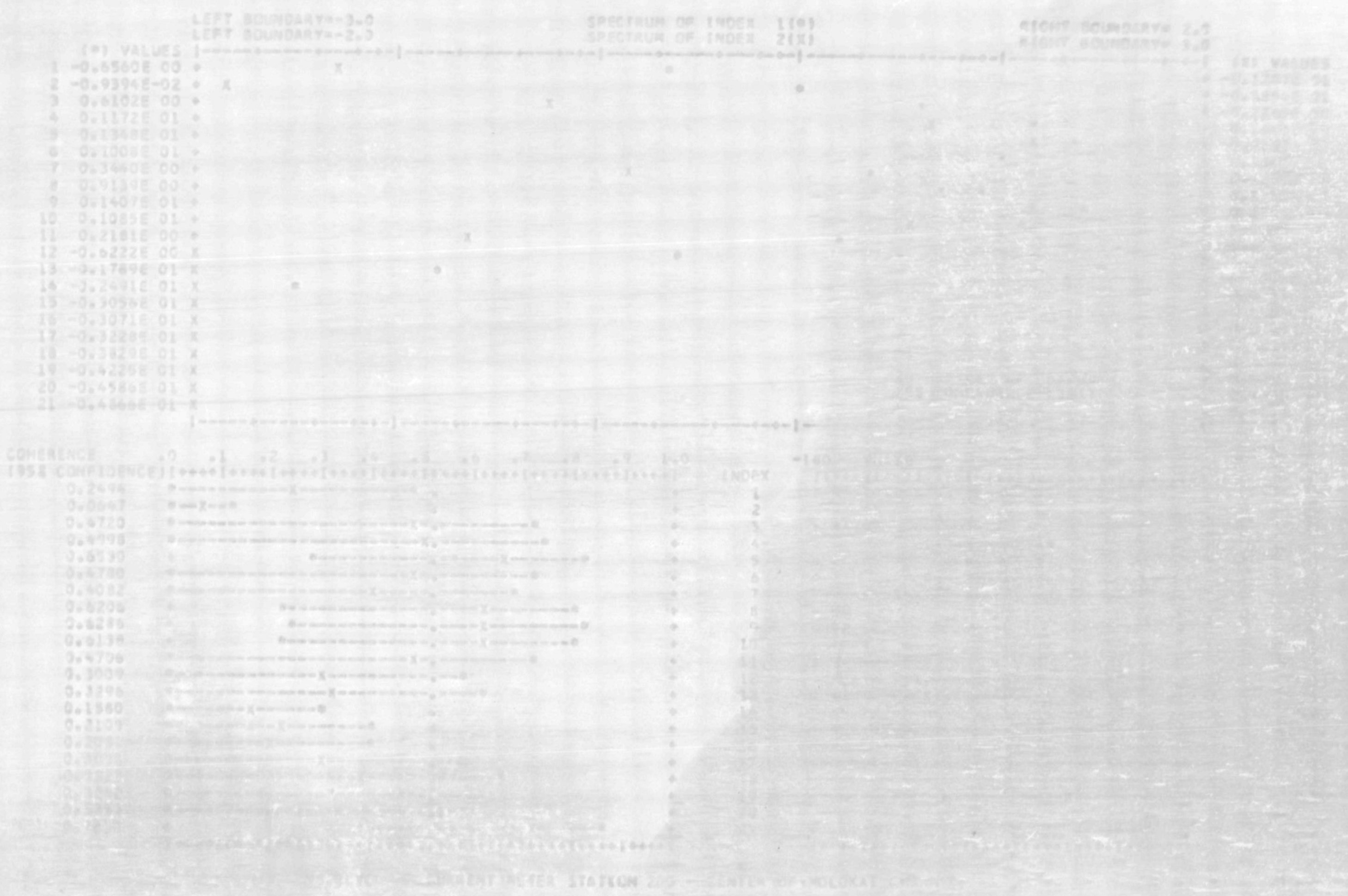


Fig. 3. A typical printout showing power spectra, coherence, and phase of the east component of the current (after the filtering) and the predicted tide in Honolulu. The logarithmic scale for the power spectrum covers five orders of magnitude. The 95% confidence interval is indicated by dashed lines; for two unrelated series of the same length as the data series, 95% of all computed coherence estimates would be exp[illegible] to lie to the left of the dotted vertical line in the coherence [illegible]

Three [illegible] current [illegible] vant to the [illegible] the tidal [illegible] vector [illegible] the [illegible] third page [illegible] and speed.

The [illegible] meter station [illegible] Next, the [illegible] gether with [illegible] observation [illegible] the total [illegible] related. [illegible] imately ±5 [illegible] to soundings. [illegible] lapse between individual records. [illegible] progressive vector diagrams is usually 60 minutes [illegible] short records, shorter intervals of 30 or 15 minutes have been used. The resulting drift is the average [illegible] velocity during the entire length of the record. [illegible] directions are given relative to true north.

The computed parameters of the tidal ellipses are outlined in the previous section. The computed data are listed separately for the diurnal and the semidiurnal current components. The direction of the main axis is that direction which is closest to the current vector which coincides with high water in Honolulu. The amplitude of the major and minor axes in cm/sec were determined graphically from the ellipses. The rotational sense of the tidal current is given as cyclonic or anticyclonic. The u- and v-components of the tidal currents are the original computed parameters. Their amplitude is given in cm/sec and their phase in degrees. The tidal ellipsis can be computed from this information according to equation (3) in the preceding section. Because the accuracy with which the phase difference between sea level and current components can be estimated depends on the coherence of the two variables and on the length of the data series, the 95% confidence interval of these estimates (rounded to the nearest multiple of 10 degrees) is also given in each case. The next two lines give the [illegible] components [illegible] with the [illegible] line [illegible] after given [illegible] two [illegible] of the same [illegible] amplitudes [illegible] and the semidiurnal [illegible] time are given [illegible] should [illegible] tidal current [illegible] tudes to the [illegible] remarks are [illegible] observed flow and the [illegible] of tidal currents [illegible] as well as occasional comments with [illegible] the record [illegible]

The progressive vector diagram gives the time integral of the u- and v-components of the current from the start of a record [illegible] equation [illegible] previous section. The time interval between the data points is given in the data sheet. Every day the symbol indicating the day's data is alternated to allow an easy inspection of the diagram. Dates are given for every second day. A scale in kilometers allows an estimate of the displacement or of the speed.

For most stations three diagrams are given on the last of the three data pages. The first one gives the frequency distribution of the observed current direction as a polar diagram. The frequency is given in percent per 10 degrees angle. The next diagram shows the tidal current ellipses for the diurnal and the semidiurnal components. The scale is in cm/sec. The diurnal tidal current ellipse is marked from 0 to 24 hours, usually at four-hour intervals. The point marked 0=24 indicates the current vector at the time of the high water of the diurnal sea-level variation. The rotational sense of the ellipse is shown by arrows as well as by the progress of the numbers indicating hours after Honolulu high water. The same situation applies to the semidiurnal tidal ellipse. The 0=12 on the ellipse indicates the current vector at the time of the high water of the semidiurnal sea-level variation in Honolulu.

The last diagram shows the frequency of observed current speeds. The frequency scale is in arbitrary units.

No tidal ellipsis could be computed for a few of the current meter stations because of the shortness of the record. For very brief records the frequency diagrams of current speed and direction were also omitted. Relevant information could then be sought in the progressive vector plots.

University of Hawaii at Manoa

Department of Oceanography
2525 Correa Road • Honolulu, Hawaii 96822
Cable Address: UNIHAW

June 25, 1975

Robert P. Stein, Oceanographer
Data Systems Formulation and Integration Branch
National Ocean and Atmospheric Administration
Environmental Data Service
National Oceanographic Data Center
Washington, D. C. 20235

Dear Dr. Stein:

Thank you very much for your letter of 12 June inquiring about Indian Ocean data tapes and University of Hawaii current meter data. We have copied our Indian Ocean tape containing stations 1-8200 and a copy is sent to you under separate cover by air parcel post.

We have found that from the current meter data you are missing the following stations: 104, 106, 107, 200, 201, 203, 204, 205, 206 and 207. We have copied our set of punched cards and are sending to you the missing stations in the form of punched cards by ordinary parcel post. With regard to your further inquiries I can inform you that station 10 should contain 133 cards with 1586 readings. I do not know where you get the information listed in your 12 June letter. All data were submitted as readings at 15 minute intervals although the data were originally taken at 5 minute intervals. The records from station 10 should be approximately as long as the record from station 15. I am sure you have our publication Hawaii Institute of Geophysics report 69-15 which was forwarded to you with the original data.

Station 17 was actually taken in 1964. The station was taken by members of the Department of Ocean Engineering before we started our program. It was the only station taken by them and we later included the data into our data set. I hope the information will be of help to you. Thanks for your interest in our data. Best regards.

Very truly yours,

Klaus Wyrtki
Professor of Oceanography

KW:sev

University of Hawaii at Manoa

Department of Oceanography
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Professor of Oceanography

KW:sev

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1975

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US Airmail

Robert P. Stein, Oceanographer
Data Systems Formulation and Integration Branch
National Ocean and Atmospheric Administration
Environmental Data Service
National Oceanographic Data Center
Washington, D. C. 20235

Waters

HIG-70-31

NODC.

CURRENT MEASUREMENTS IN THE CENTRAL NORTH PACIFIC OCEAN

By

WILLIAM C. PATZERT, KLAUS WYRTKI, and HOWARD J. SANTAMORE

NOVEMBER 1970

Prepared for

OFFICE OF NAVAL RESEARCH
UNDER CONTRACTS NO. NONR-3748(06)
and
N00014-70-A-0016-0001

HAWAII INSTITUTE OF GEOPHYSICS
UNIVERSITY OF HAWAII

NAPIS Accession No. 68-0217

NOV 22 REC'D

UNIVERSITY OF HAWAII

Department of Oceanography

30 October 1968

Mr. W. L. Molo
N O D C - Services Division
Washington, D.C. 20390

Dear Mr. Molo:

I am sending you data from 29 current meter stations. These measurements were made in the Hawaiian Archipelago and near Palmyra between 1965 and 1968. The data are being submitted in the form of punched cards. For each current meter station you will find that the first seven punched cards contain information relevant to the station in clear text, such as station number, dates, position, depth, time zone, and some information regarding absolute times. The following cards are data cards, each one containing 12 sets of current speed and current direction for a given three-hour period at 15-minute intervals. Current speed is given by the first three digits in centimeters per second without decimals. Current direction is given by the next three digits from 001° to 360°. The direction given is the true direction (not the magnetic) into which the current flows. Twelve such pairs fill a three-hour interval at the recording interval of 15 minutes. Columns 74 through 76 on the punched cards repeat the number of the current meter station, and columns 78 through 80 give the running card number. This information has been added in order to avoid confusion of cards between different sets. I am including a listing of the punched cards for current meter station #206 as an example.

The records from current meter stations 1 through 27 were obtained with paddle-wheel current meters manufactured by Hydrowerkstatten of Kiel, Germany, and were recording at five-minute intervals. Those data were reduced to 15-minute intervals.

The records from current meter stations 102 through 107 were obtained with Geodyne magnetic-tape-recording current meters, recording at 15-minute intervals.

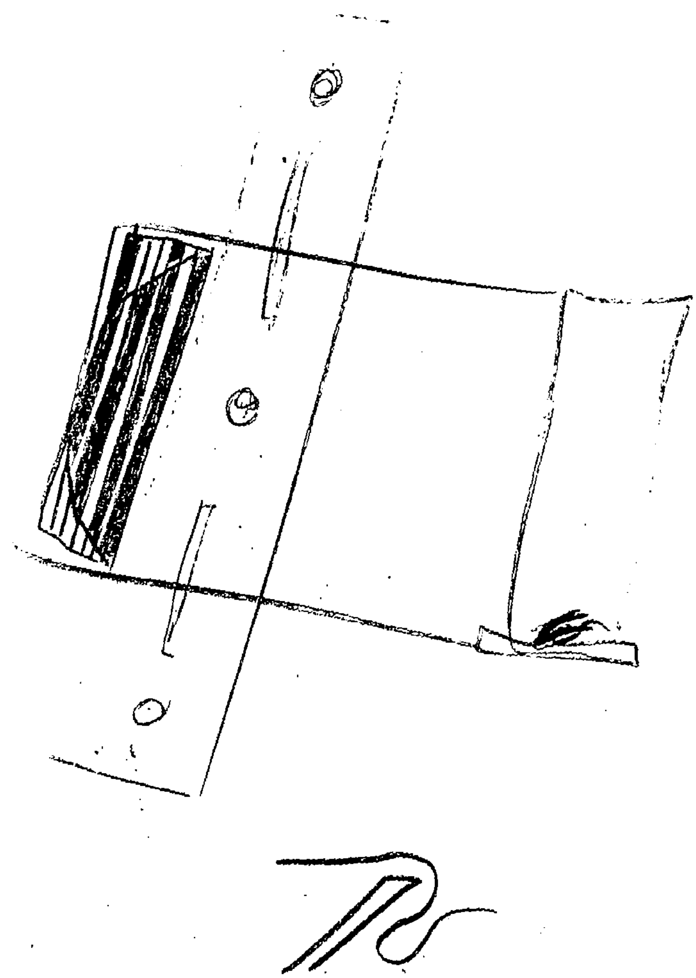
The records from current meter stations 200 through 207 were obtained with Geodyne film-recording current meters, also measuring at 15-minute intervals.

I hope that the data are useful to you. We are including a National Marine Data Inventory sheet listing them. We intend to submit more data of this nature in the future as our operations continue.

Very truly yours,

Klaus Wyrtki
Professor of Oceanography

Encls-2
3 boxes of punched cards under separate cover



HIG-70-31

CURRENT MEASUREMENTS IN THE CENTRAL NORTH PACIFIC OCEAN

by

William C. Patzert, Klaus Wyrtki, and Howard J. Santamore

November 1970

Prepared for

Office of Naval Research
under Contracts No. Nonr-3748(06)
and
N00014-70-A-0016-0001

Approved by Director

George P. Woollard

Date: 30 November 1970

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ABSTRACT

This report presents the results of eight simultaneous current measurements made with moored current meters anchored in the Leeward Islands of the Hawaiian chain. Also included are the data from a current meter that was anchored on Penguin Bank (southwest of Molokai Island) during approximately the same period. Data from the nine current meter stations are given as progressive vector diagrams, frequency distributions of direction and speed, and computed tidal ellipses.

The mooring techniques, data reduction, and computation of the tidal ellipses are described. The results show that the mean flow through the Leeward Islands is 4.6 cm/sec to the north. This northerly drift is probably indicative of an anticyclonic gyre centered northeast of the Hawaiian chain (Sverdrup *et al.*, 1942). Amplitudes of the tidal currents vary from 3.0 to 32.5 cm/sec and the average amplitude is 13.0 cm/sec.

Also discussed are current measurements at several depths from two taut-line, deep-sea moorings anchored at 27.5°N latitude and 157.8°W longitude. The results show that the tidal currents at different depths are not in phase.

INTRODUCTION

From February 1965 through December 1968, current measurements were collected off the main islands of the Hawaiian chain from Hawaii to Niihau (Wyrtki et al., 1969). The primary purpose of this survey was to study drift and tidal currents in the Hawaiian Archipelago. Early in 1969 it was decided to extend these measurements to the Leeward Islands of the Hawaiian chain. These islands are located in a line that stretches 1200 miles to the northwest of the main islands of the Hawaiian group. It was thought that measurements near these northern islands would provide valuable supplementary information on the flow and tidal currents in the central Pacific. This report presents the results of the eight current measurements near the Leeward Islands from March to June 1969. During approximately the same period an Aanderaa Current Meter, being a new type of current meter, was moored on Penguin Bank southwest of Molokai Island. These data are also included in the report.

During September and November 1969, two taut-line, deep-sea moorings were planted north of the island of Hawaii at a latitude of 28°N. The purpose of these measurements was to support the acoustical studies at the "Sea Spider" site and to gain further information concerning the vertical structure of drift and tidal currents in the central Pacific. The five current records from the deep-sea moorings are also presented in this report.

OBSERVATIONS AND INSTRUMENTATION

Twice yearly the U. S. Coast Guard dispatches a ship to service the navigation equipment at French Frigate Shoals and Midway Islands. Arrangements were made to dispatch Mr. William C. Patzert on the March cruise of the Coast Guard Ship BUTTONWOOD to plant current meters offshore at as many islands as conditions permitted. The CGS BUTTONWOOD left Honolulu 19 March 1969. With the assistance of the officers and crew of the BUTTONWOOD, nine current meters were moored offshore at seven of the islands. Two meters were moored offshore at both the Laysan Islands and the Midway Islands.

The instruments used were Richardson film-recording current meters manufactured by Geodyne Corporation, Waltham, Massachusetts, that record during thirty seconds every 15 minutes. The length of recording time of this instrument is in excess of 80 days. The meters were planted using a taut-wire mooring (see Wyrtki et al., 1969). The location of the instruments was fixed using ranges, soundings and horizontal sextant angles. These fixes were made by officers on the BUTTONWOOD. The position, depth to bottom, and duration of record of each instrument are listed in Table 1.

A group headed by Mr. Patzert was dispatched on the R/V MAHI to recover the nine moorings. Due to the excellent weather and sea conditions all nine instruments were recovered. The R/V MAHI departed Honolulu 28 May 1969 and returned 11 June 1969. Inspection of the data shows that all meters operated correctly during their mooring in the water except the meter located at Laysan (SE) which was the only magnetic-tape-recording current meter used in this operation.

During approximately the same period as the above operation an Aanderaa current meter manufactured by Ivar R. Aanderaa, Bergen, Norway, was moored on Penguin Bank southwest of Molokai Island—26 April to 16 June. This station yielded 31 days of good records, from 26 April to 27 May, which were used to supplement the data collected between Kauai and Midway.

From September 18 to 24, 1969 a string of four current meters was moored at 27°30.0'N, 157°52.0'W, near the "Sea Spider" site. The instruments were planted using a semi-taut wire mooring (Figure 1).

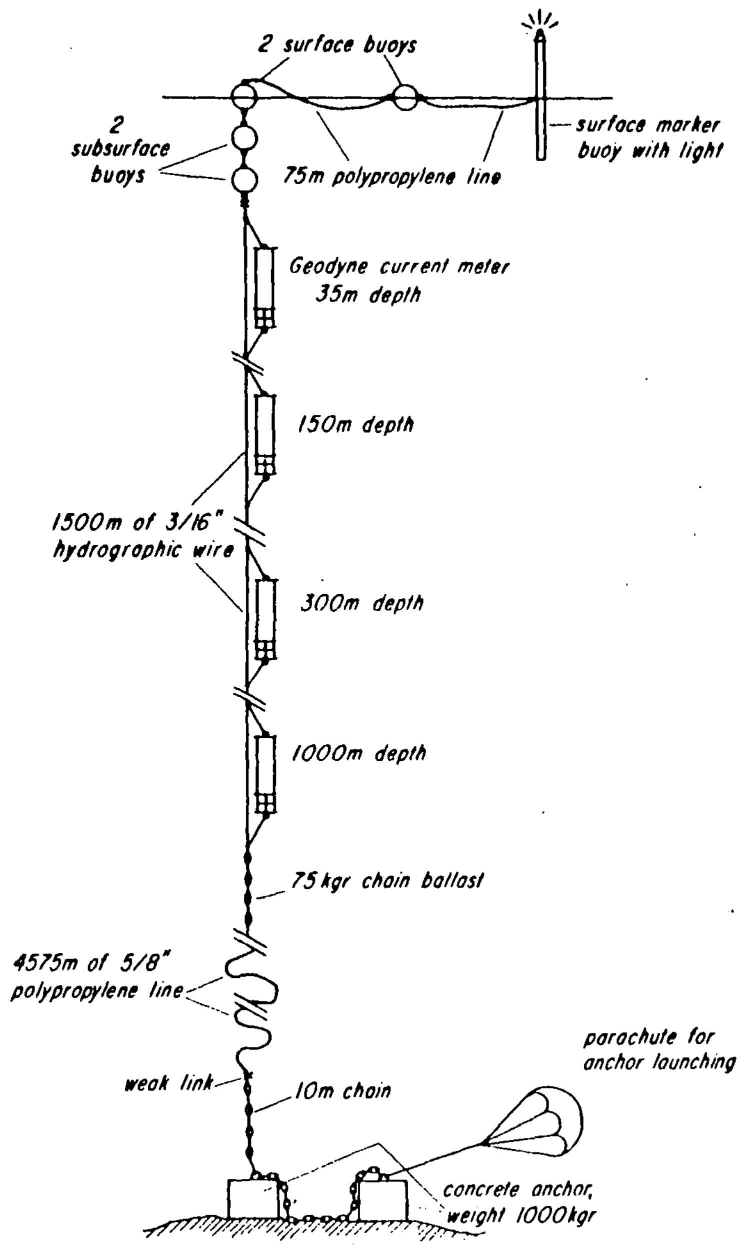

Fig. 1. Semi-taut deep morring used at Deep Mooring E site.

Table 1. Position and Duration of Records of Current Meters Moored near the Leeward Islands of the Hawaiian Archipelago, 20 March to 6 June 1969

Location	Latitude	Longitude	Depth to Bottom	Instrument Anchored	Instrument Recovered
Nihoa	23°03.6'N	161°57.6'W	50 m	20 Mar 1969	29 May 1969
Necker	23°35.0'N	164°43.2'W	32 m	22 Mar 1969	30 May 1969
French Frigate Shoals	23°47.9'N	166°19.1'W	31 m	24 Mar 1969	31 May 1969
Laysan (NW)	25°48.0'N	171°45.5'W	34 m	26 Mar 1969	2 Jun 1969
Laysan (SE)	25°44.9'N	171°42.5'W	30 m	26 Mar 1969	2 Jun 1969
Lisianski	26°03.9'N	174°03.6'W	35 m	30 Mar 1969	4 Jun 1969
Pearl and Hermes Reef	27°45.7'N	175°47.7'W	71 m	31 Mar 1969	5 Jun 1969
Midway (W)	28°12.6'N	177°26.5'W	66 m	5 Apr 1969	6 Jun 1969
Midway (E)	28°11.7'N	177°18.0'W	66 m	3 Apr 1969	6 Jun 1969

The procedure for planting Mooring E was to lower the top end of the string first. The spar buoy with a light, 75 m of polypropylene line connected to a surface float (yellow steel sphere 0.7 m in diameter), and another 75 m of polypropylene line were trailed behind the ship. Next, three yellow steel spheres connected to each other by 3 m of 3/8" wire were trailed. Following was one piece of 3/16" hydrographic wire 1500 m long. The four Richardson current meters were attached by clamps to the hydrographic wire at depths of 35 m, 150 m, 300 m, and 1000 m from the uppermost ball. It was necessary to measure the distance by running the wire out over a meter reel. On the end of the hydrographic wire 75 kgr of chain ballast was shackled in and then 4575 m of 5/8" polypropylene line. On the end of the polypropylene line a weak-link and 10 m of small chain were connected to two concrete anchors of 1000 kgr each, which were connected by 10 m of chain. With the anchors still on board, the ship made the final approach to the mooring site. A parachute was connected to the last anchor and launched. The parachute drags the anchors overboard and insures a slow sinking of the entire mooring. To insure that the mooring would be anchored at the correct depth, a site with rather uniform depths over several miles distance was chosen.

The water depth at the mooring site was 5490 m. The length of the mooring was in excess of 6100 m (including the stretch of the polypropylene line). This gave a safety factor of >600 m. The safety factor insured that the mooring would not sink beneath the surface and collapse the buoyant spheres.

The mooring was recovered by breaking the weak-link and winching the mooring aboard ship from the top first.

Mooring F was planted near the "Sea Spider" site during the MAHI cruise from November 18 to 26. The mooring was planted in the same way as Mooring E, by streaming it behind the ship and dropping the anchors last. This mooring contained four Richardson current meters at 200, 450, 900, and 1800 m depths. The only instrument to give a usable record was the meter at 450 m. Instrument malfunctions were due mainly to electrical failures in the Geodyne current meters.

DATA REDUCTION

The Standardized Data Format

Since two types of current meters were used for this study, the initial phase of the data reduction is best discussed separately for the two types. The Richardson current meter produces a record every 10, 15, or 30 minutes, which can be selected, and each record consists of M samples of instantaneous speed, orientation of the instrument relative to magnetic north, and current direction relative to the instrument, where M is a number between 12 and 31, depending on the individual instrument. The recording is done either on 16 mm film in binary, machine-readable form, or on 1/4-inch magnetic tape.

The Geodyne Division of EG&G International, Incorporated, machine-processes these films or tapes. This company produces an analog record showing compass direction, vane direction, current direction, and speed in two ranges as a function or record number. It also computer-averages the measurements over each one-minute recording interval and supplies these digital data on computer standard magnetic tape. From the digital information supplied by Geodyne we generated a time-sequence plot of direction and speed and compared it with their analog strip-chart record. Unfortunately, these two types of data presentations generated by Geodyne do not agree in all cases, thus considerable cross-checking was required as well as checking against the original film to establish the true values. The Geodyne data is then processed by a computer program which contains the following steps:

- Check if all cards are present and in sequence.
- Check if all directions are between 0 and 360 degrees.
- Convert directional reference from magnetic to true north.
- Convert revolution counts to current speed.
- Check if the difference between each speed value and the previous speed value is within certain limits.
- Check if the difference between each speed value and the average of the two previous speed values is within certain limits.
- Print histograms for direction, speed, and first differences of speed.
- Store the data on magnetic tape.

If any of the error checks were applicable, a message was printed. If after comparison with the original film or tape it was determined that one or more messages were triggered by genuine errors, and not by unusually rapid changes of the current speed, the corresponding values were corrected in the card deck and the programs were run again.

The finally accepted values were used to generate plots of speed and direction versus time on a Benson-Lehner automatic plotter, as well as histograms of circuit direction and speed. If a visual inspection of those plots did not reveal obvious errors, especially in direction, the data were accepted as correct. Both the histograms and the time-sequence plots were capable of calling our attention to certain malfunctions of the current meters.

The Aanderaa current meter records every ten minutes the current direction, current rotor count, the temperature and the pressure. These records are read in order and recorded in a serial binary format onto a single-track magnetic tape. This tape is played back on a standard HIFI tape deck which is interfaced to a General Automation SPC-12 computer. A paper tape and teletype listing of the data are produced. The paper tape is read into an IBM 1401 computer which produces a punched-card deck. Next, a computer program converts the difference between two successive rotor counts into a current speed value and then simulates a 15-minute series of data by rejecting every third value of speed and direction. The temperature and pressure readings are listed and the 15-minute speed and direction readings are placed on cards. The Aanderaa data were then handled in the same manner as the Geodyne data.

For the further evaluation of the data it was necessary to have them available in a standard form that did not depend on the particular instrument that had recorded them originally. We devised a standard data format that could be used for both types of meters and for all similar instruments that we might use in the future. The data consisting of speed and direction at 15-minute intervals are recorded in such a form that a simple listing of the cards can be read with relative ease. Header cards which precede the actual data cards made the deck self-descriptive. Copies of these decks are made available to the National Oceanographic Data Center, Washington, D. C.

The Progressive Vector Diagram

For each current meter station a graph is presented that in a sense resembles the trajectory of a certain water particle. The graph shows a series of points with coordinates (x_n, y_n), $n=0...N$, where N is the number of 15-minute intervals covered by the station. The coordinates are defined as

$$x_n = x_o + s \sum_{1}^{n} u_n ;$$

$$y_n = y_o + s \sum_{1}^{n} v_n , \qquad (1)$$

where u_n and v_n are the east and north components of the current vector at the end of the n-th 15-minute interval in the series, s is a scale factor, and x_o and y_o are essentially integration constants with no particular significance.

Equations (1) can be considered approximations of

$$x(t) = s' \int_{o}^{t} u d\tau ;$$

$$y(t) = s' \int_{o}^{t} v d\tau . \qquad (2)$$

Equations (2) make the similarity between the graph presented here and a trajectory more apparent: If in equations (2) u and v were the components of the current vector at the location of a particle moving with the water, then (2) would describe the trajectory of the particle; however, here u and v stand for the components of the current vector at the fixed location of the current meter. It should therefore be clearly understood that this graph is not an actual trajectory, since it was produced using data collected at one fixed location, while in order to determine a true trajectory it would be necessary to follow the path of a particle or at least to conduct a number of simultaneous current observations in different locations.

The graphs presented here were produced on an automatic plotter under the control of a computer program. The scale factors were adjusted automatically to make all graphs approximately the same size, and for some runs every other or every fourth point only was plotted.

Spectra and Tidal Ellipses

Currents at all locations covered by this study have substantial tidal components. These components were separated from components at other frequencies by a numerical filter with a pass band from approximately 1 cpd to approximately 2 cpd. The filter was applied to the u- and v-components of the current vectors and its main purpose was to remove low frequency components from the series. Power spectra of the filtered series and of the predicted tide for Honolulu for the same period of time were computed, as were cross spectra between the vector components and the predicted sea level (Fig. 2). The confidence interval for coherence and phase was computed according to Hannan and Groves (1968). As expected, we found a high degree of coherence between current vector components and sea level for tidal frequencies in most cases, but it should be noted that in a number of cases there was no significant coherence. If the coherence was significant, we computed idealized tidal ellipses, one for the diurnal and one for the semidiurnal tide, to show the magnitude and phase (relative to the predicted Honolulu tide) of the tidal current. The ellipses were generated by combining a sinusoidal east-west component with a sinusoidal north-south component, both with phases and amplitudes as taken from computer printouts like the one shown in Figure 2. The ellipses are defined by

$$u(t) = a_u \cos\left(\frac{2\pi}{\tau} t + \phi_u\right)$$

$$v(t) = a_v \cos\left(\frac{2\pi}{\tau} t + \phi_v\right) \qquad (3)$$

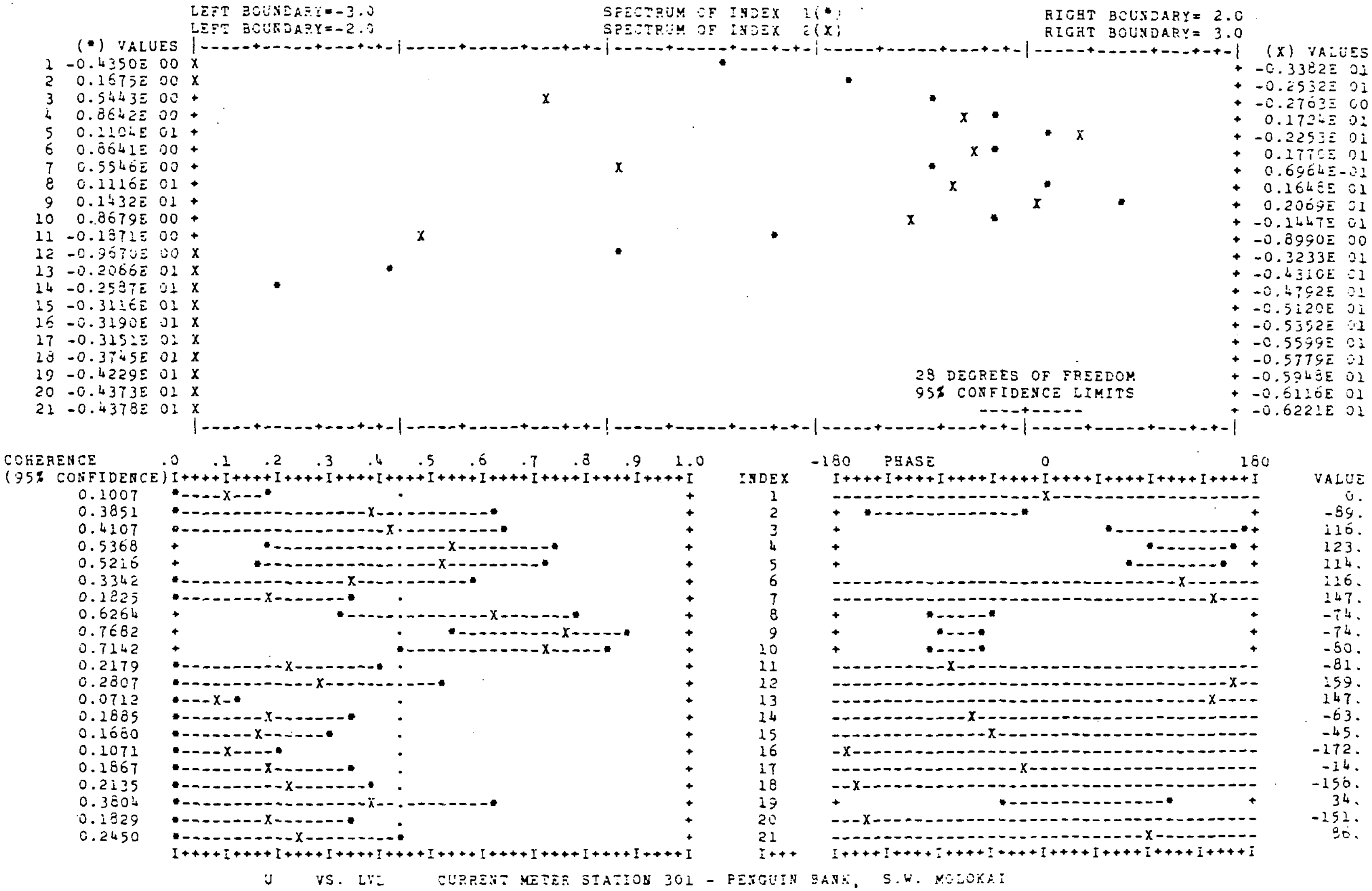

Fig. 2. A typical computer printout showing power spectra, coherence, and phase of the east component of the current (after the filtering) and the predicted tide in Honolulu. The logarithmic scale for the power spectrum covers five orders of magnitude. The 95% confidence interval is indicated by dashed lines; for two unrelated series of the same length as the data series, 95% of all computed coherence estimates would be expected to lie to the left of the dotted vertical line in the coherence plot.

where t is the time running from 0 to T, a_u and a_v are the amplitudes of the tidal current components, ϕ_u and ϕ_v are the phase angles relative to the Honolulu tide, and τ is 24.7 hours for the diurnal ellipse and 12.35 hours for the semidiurnal ellipse. The velocity component u is positive in the east direction, v is positive in the north direction. These ellipses should be interpreted as a presentation of a current with sinusoidal vector components that would produce the same spectral power and the same phase relationships at its frequency as the observed current. Since it is not obvious how the size, shape, and orientation of the computed ellipses change with small variations of the phases of the sinusoidal components, a few examples where the ellipses were drawn using a phase angle not corresponding to the center of the confidence interval but rather to its end points in various combinations are shown in Wyrtki et al., 1969.

DATA PRESENTATION

Three pages of data presentation are given for each current meter station. The first page includes data relevant to the station as well as the computed parameters of the tidal ellipses; the second page gives the progressive vector diagram for the entire duration of the run; and the third page shows tidal ellipses, frequency of direction, and speed.

The data sheet contains the number of the current meter station and the type and number of the instrument. Next, the geographical name of the location is given together with latitude and longitude. The period of the observation is given to the nearest 15 minutes, as are also the total time and the time zone to which the data are related. The depth of the current meter is known to approximately ±5 m and the bottom depth is given according to soundings. The sampling interval states the actual time lapse between individual records. The time interval on the progressive vector diagrams is usually 60 minutes; for short records, shorter intervals of 30 or 15 minutes have been used. The resulting drift is the average vector velocity during the entire length of the record. All directions are given relative to true north.

The computed parameters of the tidal ellipses are outlined in the previous section. The computed data are listed separately for the diurnal and the semidiurnal current components. The direction of the main axis is that direction which is closest to the current vector which coincides with high water in Honolulu. The amplitude of the major and minor axes in cm/sec were determined graphically from the ellipses. The rotational sense of the tidal current is given as cyclonic or anticyclonic. The u- and v-components of the tidal currents are the original computed parameters. Their amplitude is given in cm/sec and the phase in degrees. The tidal ellipsis can be computed from this information according to equations (3) in the preceding section. Because the accuracy with which the phase difference between sea level and current components can be estimated depends on the coherence of the two variables and on the length of the data series, the 95% confidence interval of these estimates (rounded to the nearest multiple of 10 degrees) is also given in each case. The next two lines give coherence of the u- and v-component of the current with the sea level in Honolulu. The line following thereafter gives the expected coherence for two unrelated series of the same length. The tidal amplitudes of the diurnal and semidiurnal tide in Honolulu during the observation time are given. This information may be valuable if it should appear desirable to reduce the tidal current amplitudes to the same sea-level amplitude. Finally, some remarks are made about the observed flow and the dominance of tidal currents at the station, as well as occasional comments with regard to the quality of the record.

The progressive vector diagram gives the time integral of the u- and v-component of the current from the start of a record to its end according to equations (1) of the previous section. The time interval between the data points is given in the data sheet. Every day the symbol indicating the day's data is alternated to allow an easy inspection of the diagram. Dates are given for every second day. A scale in kilometers allows an estimate of the displacement or of the speed.

For most stations three diagrams are given on the last of the three data pages. The first one gives the frequency distribution of the observed current direction in a polar diagram. The frequency is given in percent per 3-degree angle. The next diagram shows the tidal current ellipses for the diurnal and the semidiurnal components. The scale is in cm/sec. The diurnal tidal current ellipse is marked from 0 to 24 hours, usually at four-hour intervals. The point marked 0=24 indicates the current vector at the time of the high water of the diurnal sea-level variation. The rotational sense of the ellipse is shown by arrows as well as by the progress of the numbers indicating hours after Honolulu high water. The same situation applies to the semidiurnal tidal ellipse. The 0=12 on the ellipse indicates the current vector at the time of the high water of the semidiurnal sea-level variation in Honolulu. A common length of data from April 14, 1969, 0000 hr to May 28, 1969, 2345 hr was used to compute the tidal ellipses and progressive vector diagrams for stations 220 to 227.

The last diagram shows the frequency of observed current speeds. The frequency scale is in arbitrary units.

No tidal ellipsis could be computed for a few of the current meter stations because of the shortness of the record. Due to the short record at station 232, the frequency diagram of current speed and direction was omitted. Relevant information could then be sought in the progressive vector plots.

RESULTS

In the following a brief discussion of some results of these current measurements will be presented. A more detailed analysis will be presented elsewhere (Santamore, 1971).

Average Flow

In the beginning of this study it was anticipated that information concerning the mean flow through the Hawaiian Archipelago could be obtained from measurements near these islands. Observations near the islands from Hawaii to Niihau have shown, however, that currents are rather variable and are generally inconsistent from place to place (Wyrtki et al., 1969). From March to June, 1969, continuous current measurements were obtained at eight locations extending from Nihoa to Midway Islands in the northwestern part of the island chain (Fig. 3). These measurements have been analyzed for a common time period. The resulting drift from each station is presented in Figure 3. Included in Figure 3 is the resultant drift from station 301 on Penguin Bank.

Figure 3 shows that a northerly drift of 1.2 to 6.6 cm/sec was observed at all stations except the Midway East and Penguin Bank stations. The flow was 6.0 cm/sec to the southwest at the Midway East station and 8.4 cm/sec to the southeast at the Penguin Bank station. The mean flow to the north for the remaining seven stations was 4.6 cm/sec.

One might expect a general flow from east to west through the Archipelago, coinciding with the trade-wind drift. This does not appear to be the case. Robinson (1969) has inferred from BT data that an eastward flow might be present through the Archipelago during certain times of the year. This does not explain the observed northerly drift. Sverdrup et al. (1942) has described an anticyclonic gyre in the Eastern North Pacific Ocean. This clockwise-rotating gyre is centered to the northeast of the Hawaiian Islands and generates a mean flow to the north through the Hawaiian Archipelago. Recent results by Bathen (1970) require the existence of this eastern gyre.

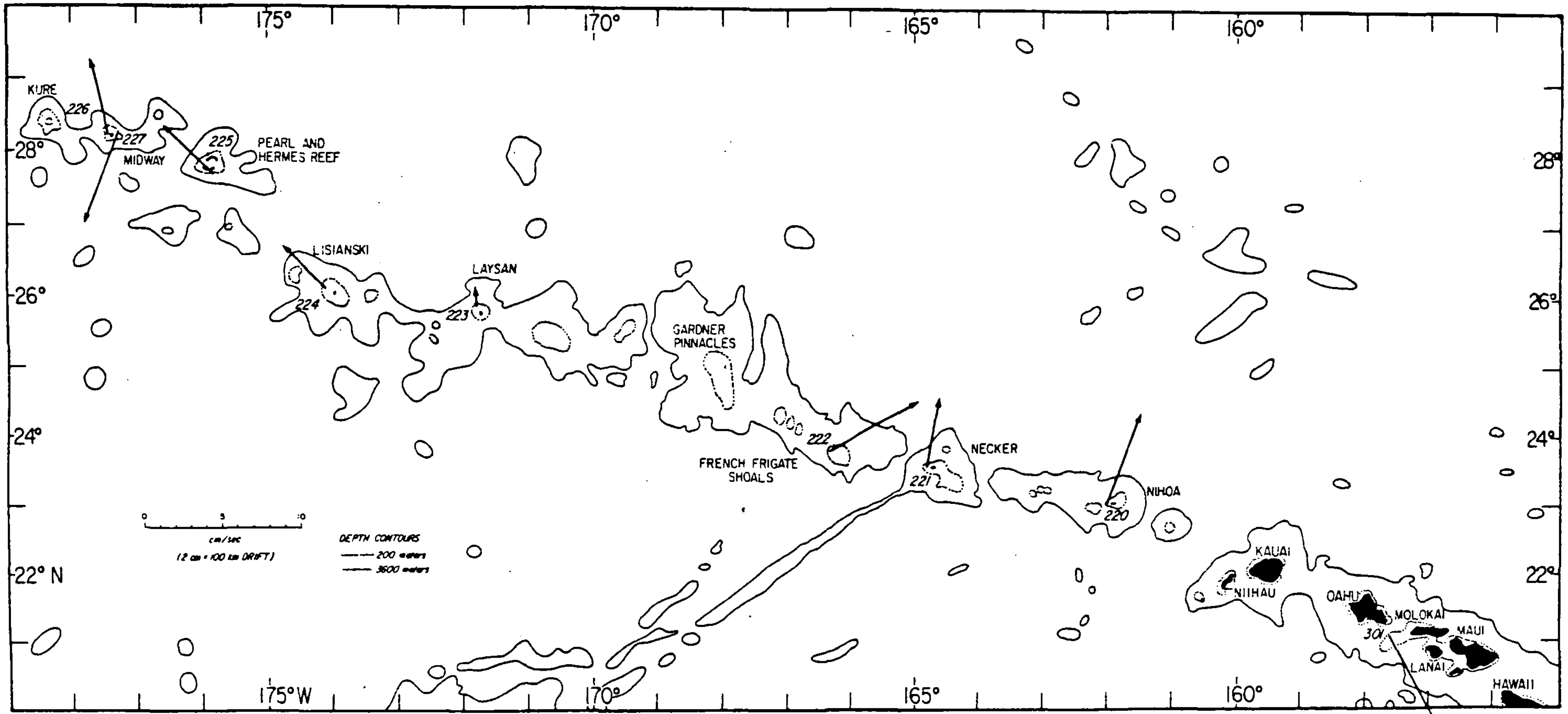

Fig. 3. Resulting drift or average vector velocity of current measurements in the Hawaiian Archipelago fro m Molokai Island to Midway Islands.

The two stations around the Midway Islands show an anticyclonic flow around the islands (Fig. 3). This anticyclonic flow was also indicated around the main Hawaiian Islands (Wyrtki et al., 1969). The causes of such an anticyclonic circulation around oceanic islands have been discussed by Stockmann (1966).

Tidal Flow

Figures 4, 5, and 6 show typical progressive currents. Tidal variations are evident as daily and semi-daily changes in both speed and direction. The Necker Island observations (Fig. 4) show a rotary semidiurnal tidal current with variations in direction but little variation in speed. Nihoa observations (Fig. 5) show the same rotary tidal-current variations for the diurnal tide. An alternating tidal current can show marked changes in both speed and direction. This is illustrated by the progressive vector diagram for station 227, which was located east of Midway Islands (Fig. 6).

The speed of the semidiurnal and diurnal current in the direction of the major axis of the tidal ellipse for stations 220 to 227 and station 301 are shown in Figures 7 and 8. The maximum tidal current does not necessarily coincide with high water in Honolulu and consequently on each arrow the time in hours of the occurrence of the maximum current before (-) or after (+) high water in Honolulu is given. For the semidiurnal tide, stations 220 to 223 showed high coherence with sea level in Honolulu. It is interesting to note that the maximum semidiurnal current for stations 220, 222, 223 and 224 is one to two hours before Honolulu high tide. If the semidiurnal current were purely barotropic, these data could be interpretted as a wave approaching from north or northeast. Generally, Figures 7 and 8 show an inconsistent pattern in direction, amplitude and phase. A more detailed analysis of these data will be presented elsewhere (Santamore, 1971).

From Midway to Penguin Bank the diurnal and semidiurnal tidal currents have a maximum strength that varies from 3.0 to 32.5 cm/sec (see Figs. 7 and 8) and the average amplitude is 13.0 cm/sec. The two Midway stations (226 and 227) show an enhancement of the diurnal current over the semidiurnal current of 2:1 and 3:1. The latitude of Midway Islands is the same latitude as that of the diurnal inertial period and inertial currents are probably responsible for this behavior.

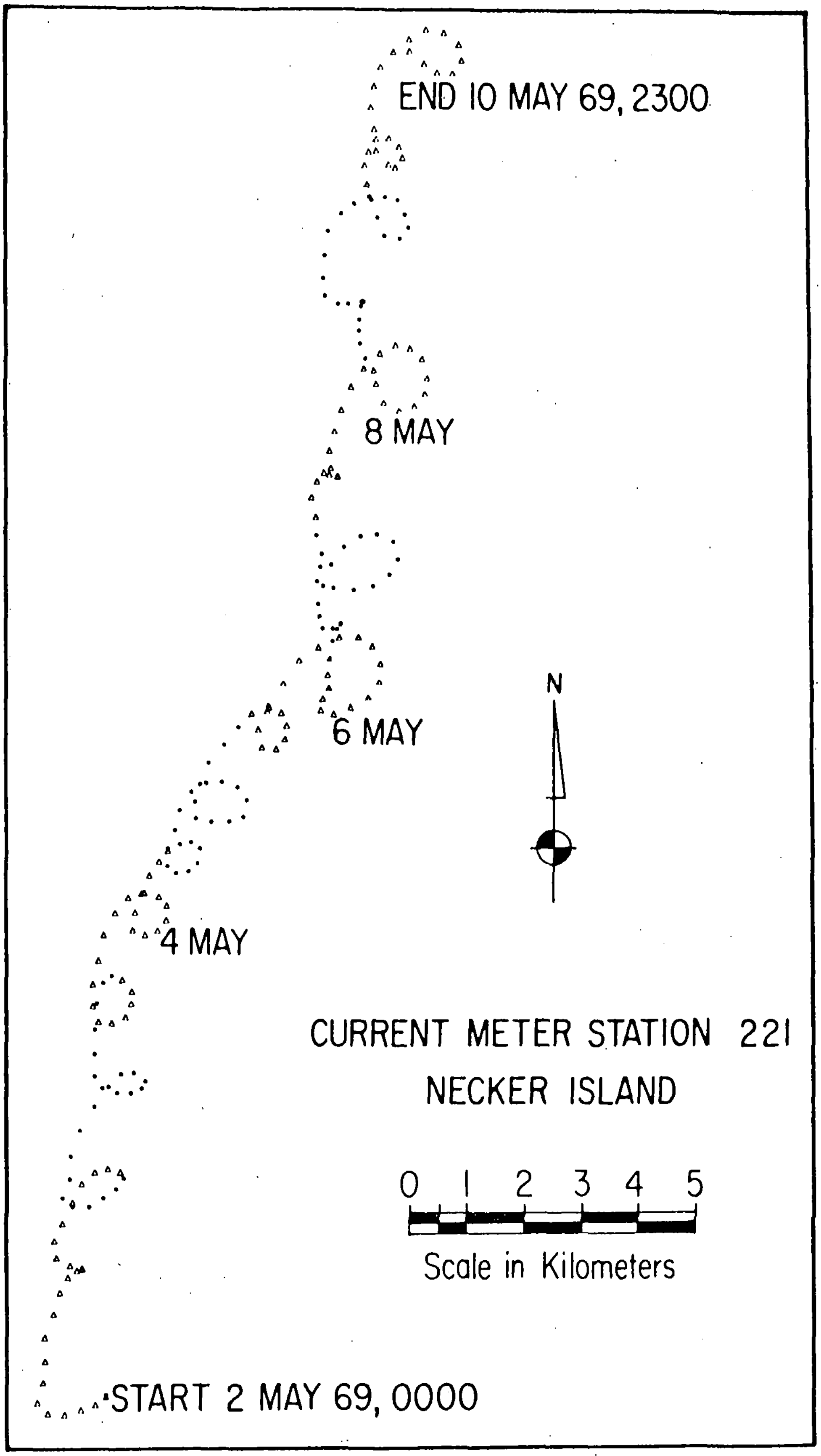

Fig. 4. Progressive vector diagram of the currents at station 221, Necker Island.

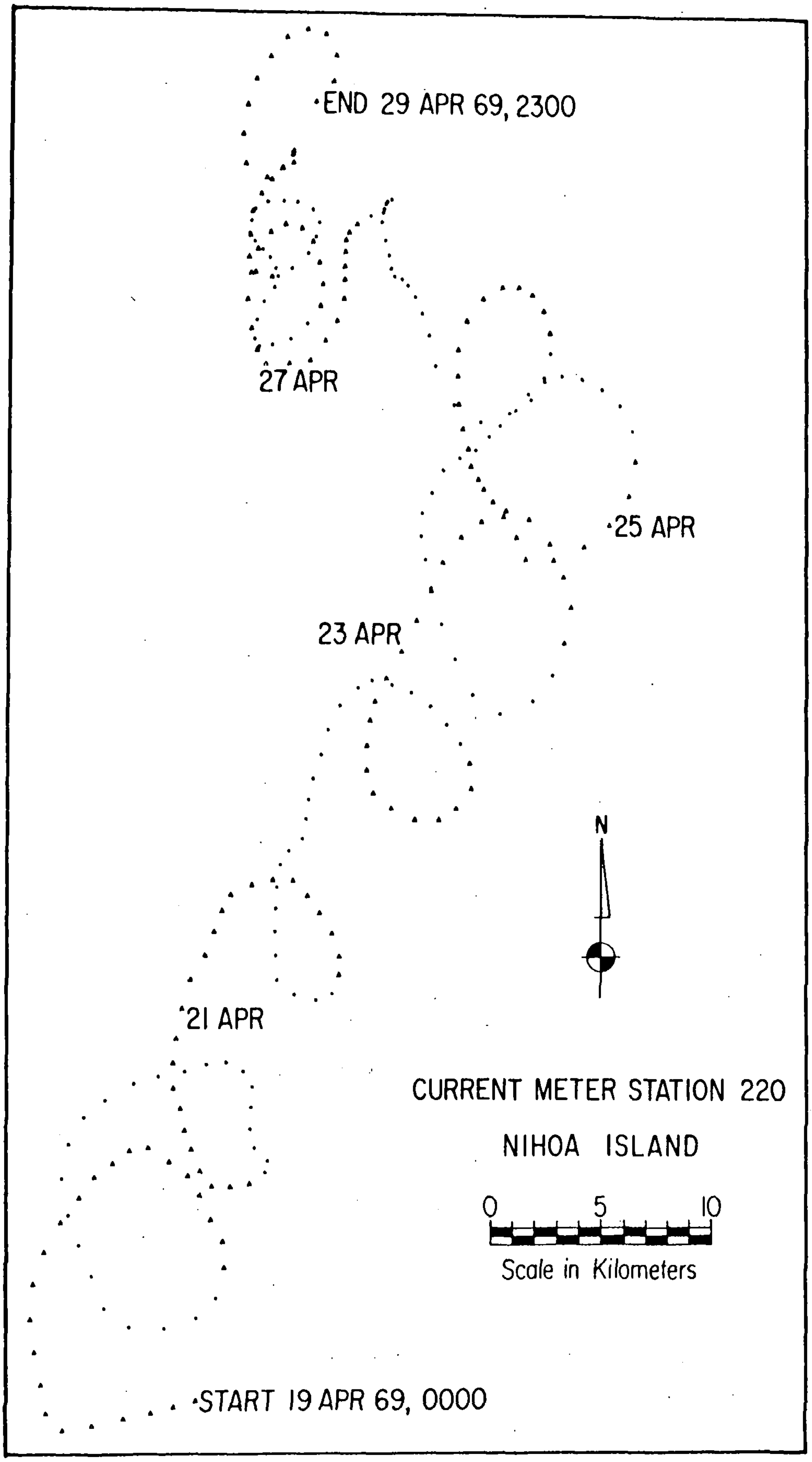

Fig. 5. Progressive vector diagram of the currents at station 220, Nihoa Island.

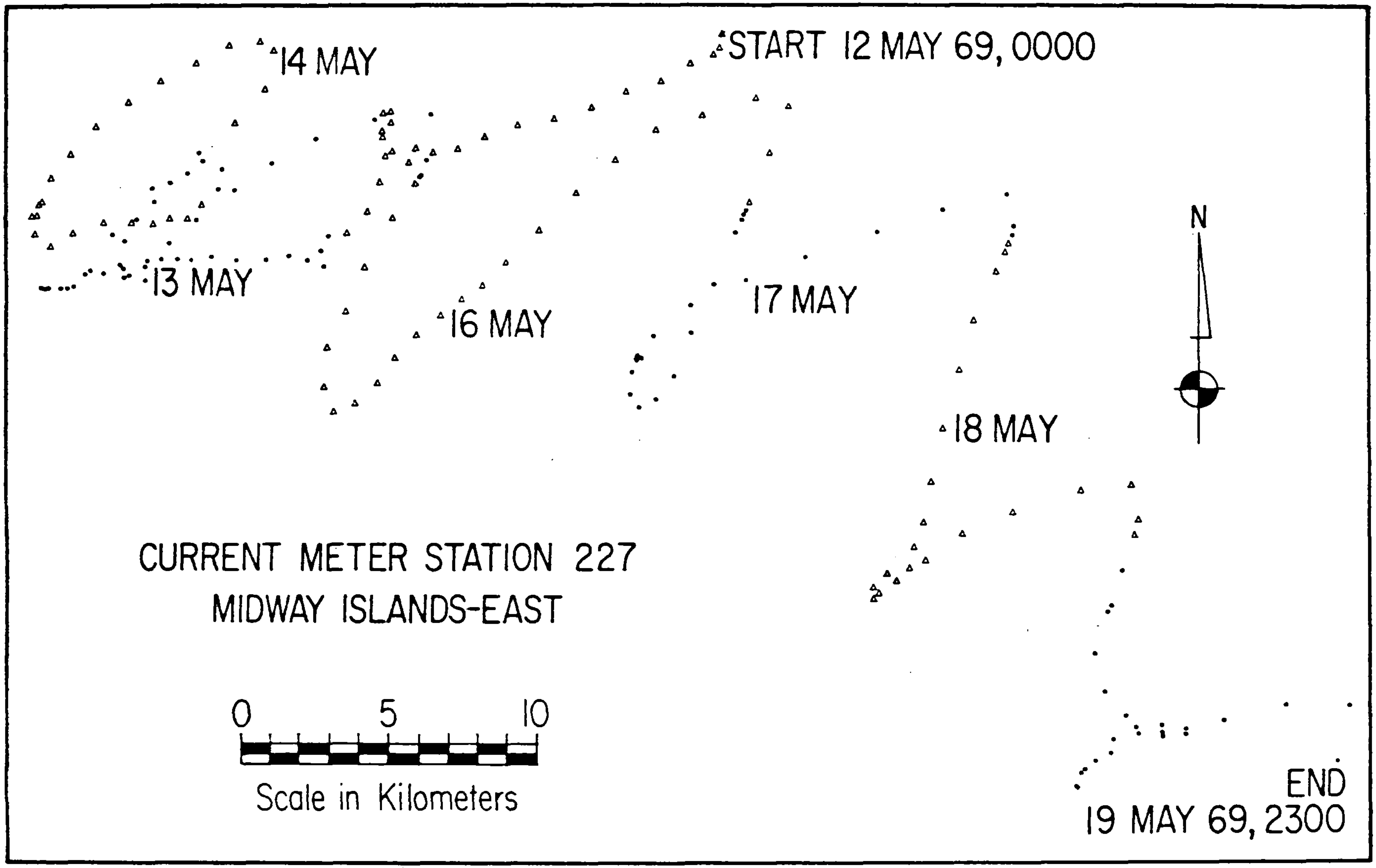

Fig. 6. Progressive vector diagram of the currents at station 227, east of Midway Islands.

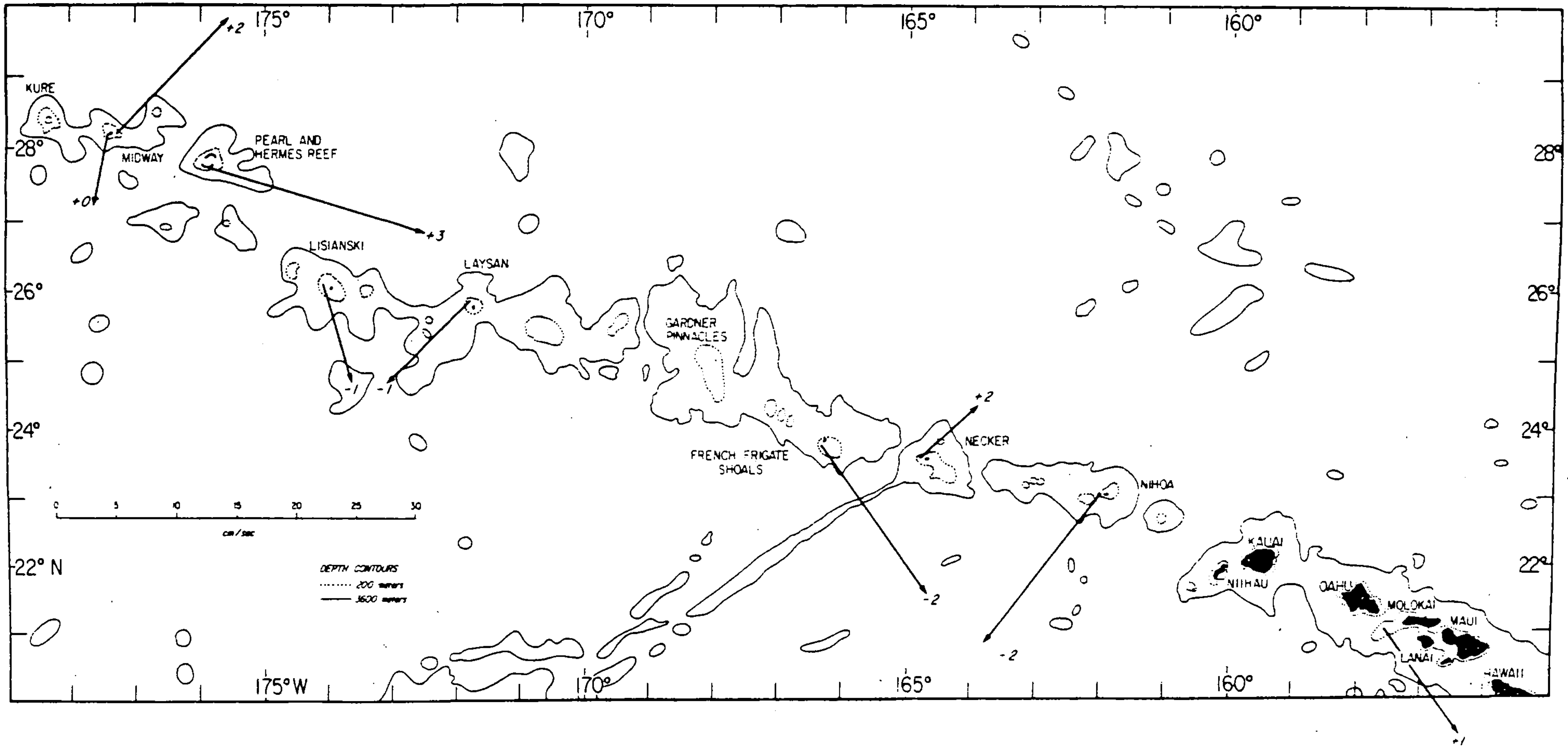

Fig. 7. Semidiurnal tidal currents in the direction of the major axis of the tidal ellipses in the Hawaiian Archipelago from Molokai Island to Midway Islands.

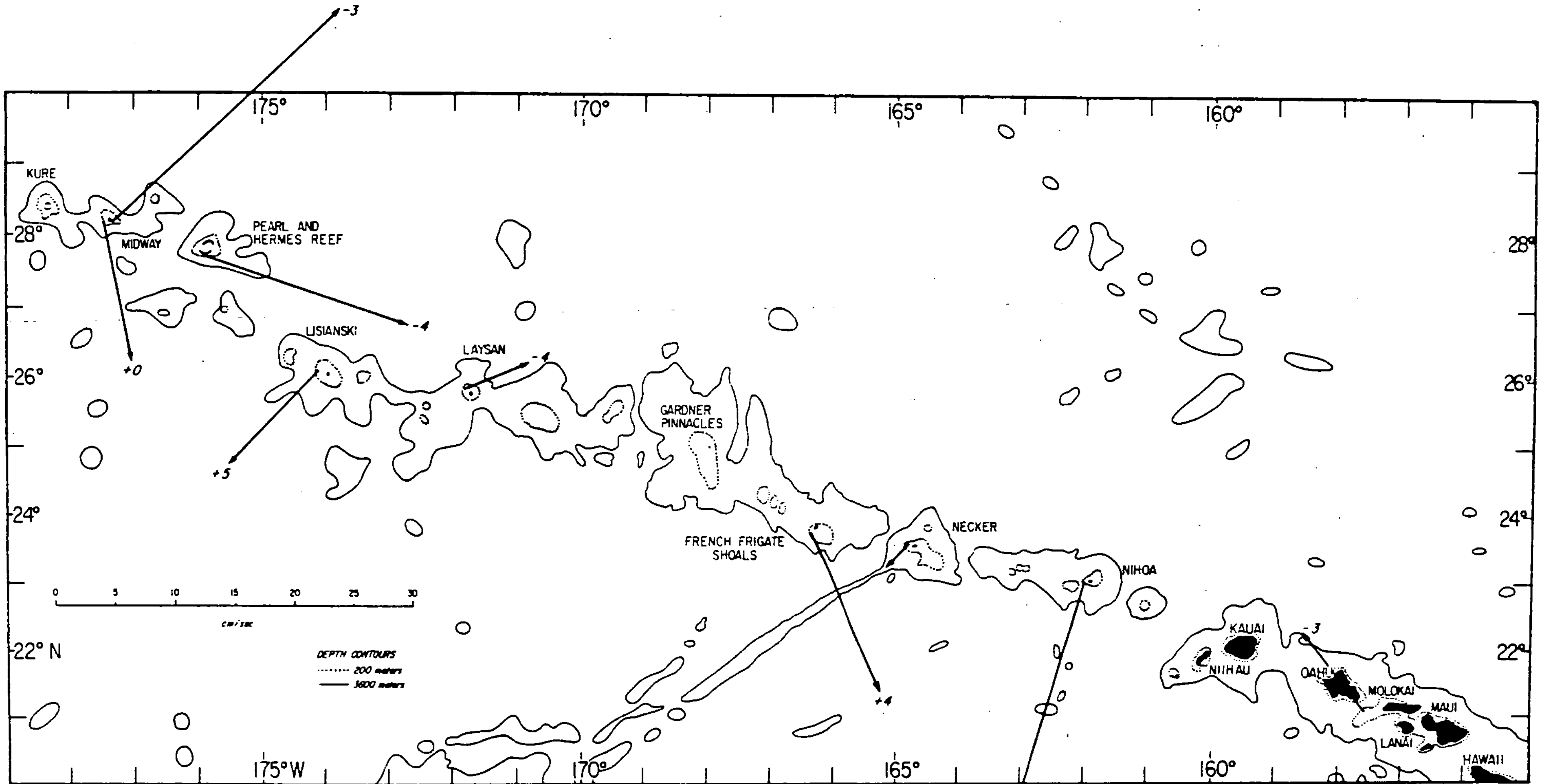

Fig. 8. Diurnal tidal currents in the direction of major axis of the tidal ellipses in the Hawaiian Archipelago from Molokai Island to Midway Islands.

Deep Moorings

The net flow at Mooring E was to the north-northwest and decreased from 19.9 cm/sec at 35 m depth and 11.3 cm/sec at 150 m depth to 9.2 cm/sec at 300 m depth. The observations at 1000 m show a strong flow to the north-northeast of 20.2 cm/sec. Because current speeds at 1000 m were unusually high, this current meter was later tested in the laboratory. The tests showed that the instrument was operating correctly. No tidal ellipses could be computed for these records because of the shortness of the records.

The inertial period for the latitude of the deep moorings is approximately the same as for the diurnal tide, and diurnal current variations are to be expected. A weak semidiurnal tidal current is present at 35 m for Mooring E. The deeper measurements show a diurnal tidal current superimposed on the drift. Note that the diurnal tidal currents are not in phase with each other as would be required in the case of a barotropic wave.

Almost two months after Mooring E was recovered, Mooring F was anchored in the same region. Only one instrument gave a usable record. The net flow at 450 m was 4.8 cm/sec to the south with diurnal tidal currents superimposed. Due to the short record at this station, the tidal ellipses and frequency diagram of current speed and direction have been omitted.

ACKNOWLEDGMENTS

We would like to express sincere thanks to Captain Haugen, of the U. S. Coast Guard Ship BUTTONWOOD, and to his officers and crew for their helpful assistance and valuable cooperation in our program.

We would also like to thank Mr. E. G. Gilley for his efforts and ingenuity during this project.

The entire program was supported by the Office of Naval Research under Nonr Contracts 3748(06) and N00014-70-A-0016-0001, and this continuous support is gratefully acknowledged.

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DATA FOR CURRENT METER STATIONS

NOTE: At end of data for Station 231 there is a figure showing frequency of the current direction and speed for stations 228, 229, 230, and 231. No tidal ellipses were computed for these stations because of the shortness of the records.

CURRENT METER STATION #220

Geodyne Film-Recording Current Meter #301

Location: Nihoa
Position: Latitude: 23°03.6'N
Longitude: 161°57.6'W

Period: From: March 20, 1969, 1445
To: May 29, 1969, 0945
Total Time: 69 days, 19 hours, 00 minutes*
Time Zone: 150°W

Depth of Current Meter: 10 m
Bottom Depth: 50 m

Sampling Interval: 15 minutes
Time Interval on Progressive Vector Diagram: 60 minutes

Resulting Drift: Direction: 20°true. Speed: 6.2 cm/sec

Tidal Ellipses:	Diurnal	Semidiurnal
Direction of Major Axis	196°	218°
Amplitude in Major Axis, cm/sec	25.2	15.9
Amplitude in Minor Axis, cm/sec	18.1	12.4
Rotational Sense of Tidal Current	Anticyc.	Anticyc.
u-Component:		
Amplitude, cm/sec	17.7	13.2
Phase	-21°	+174°
95% Confidence Interval	-10° to -30°	+160° to +180°
v-Component:		
Amplitude, cm/sec	24.8	15.0
Phase	-101°	+95°
95% Confidence Interval	-90° to -110°	+70° to +120°
Coherence with (uh)	0.877	0.772
Honolulu Sea Level (vh)	0.907	0.623
Expected Coherence for Unrelated Series (95% Confidence)	0.36	
Tidal Amplitude in Honolulu, cm (h)	18.2	15.5

REMARKS:

General flow to the north and northeast with prevailing diurnal tidal currents.

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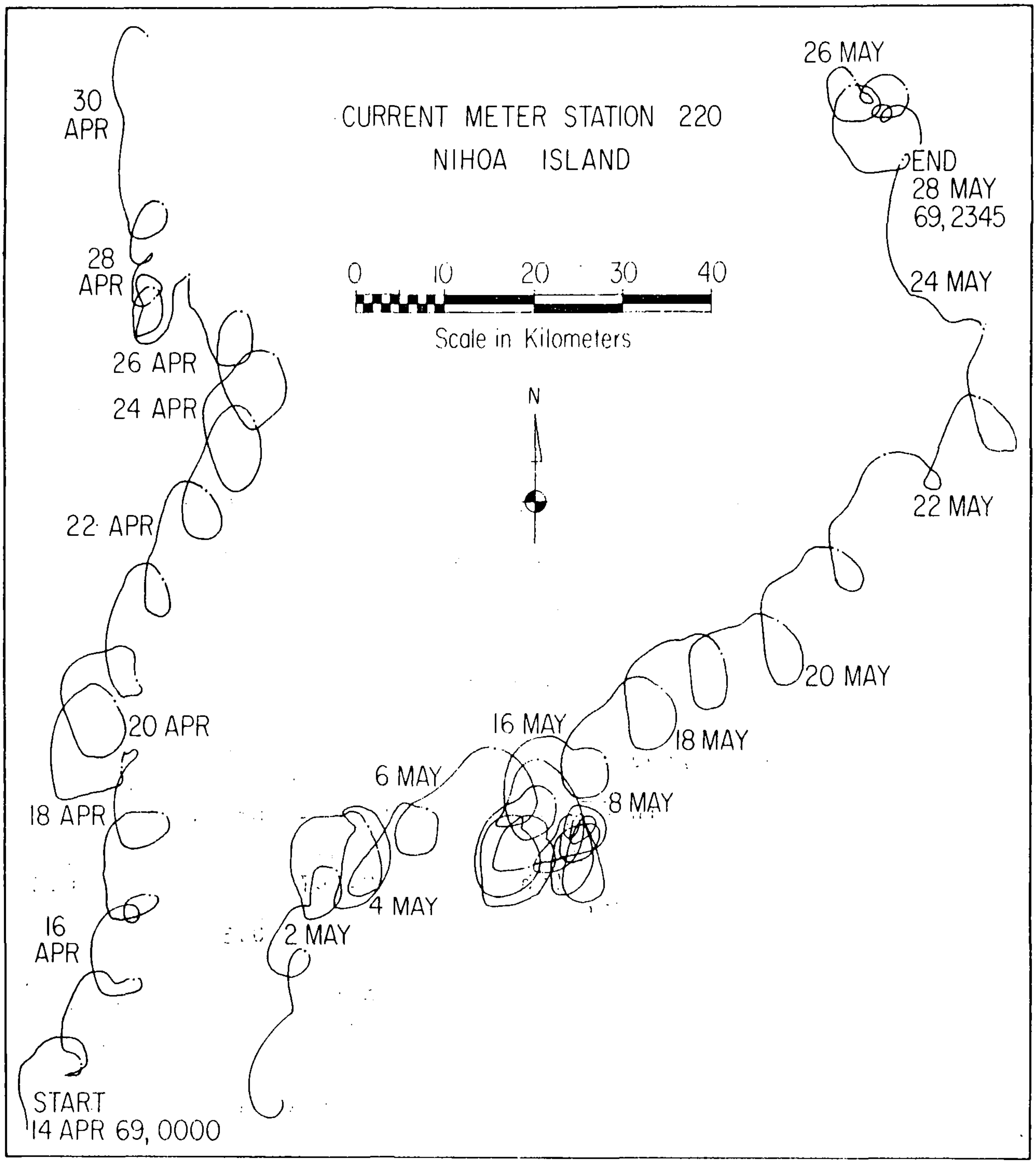
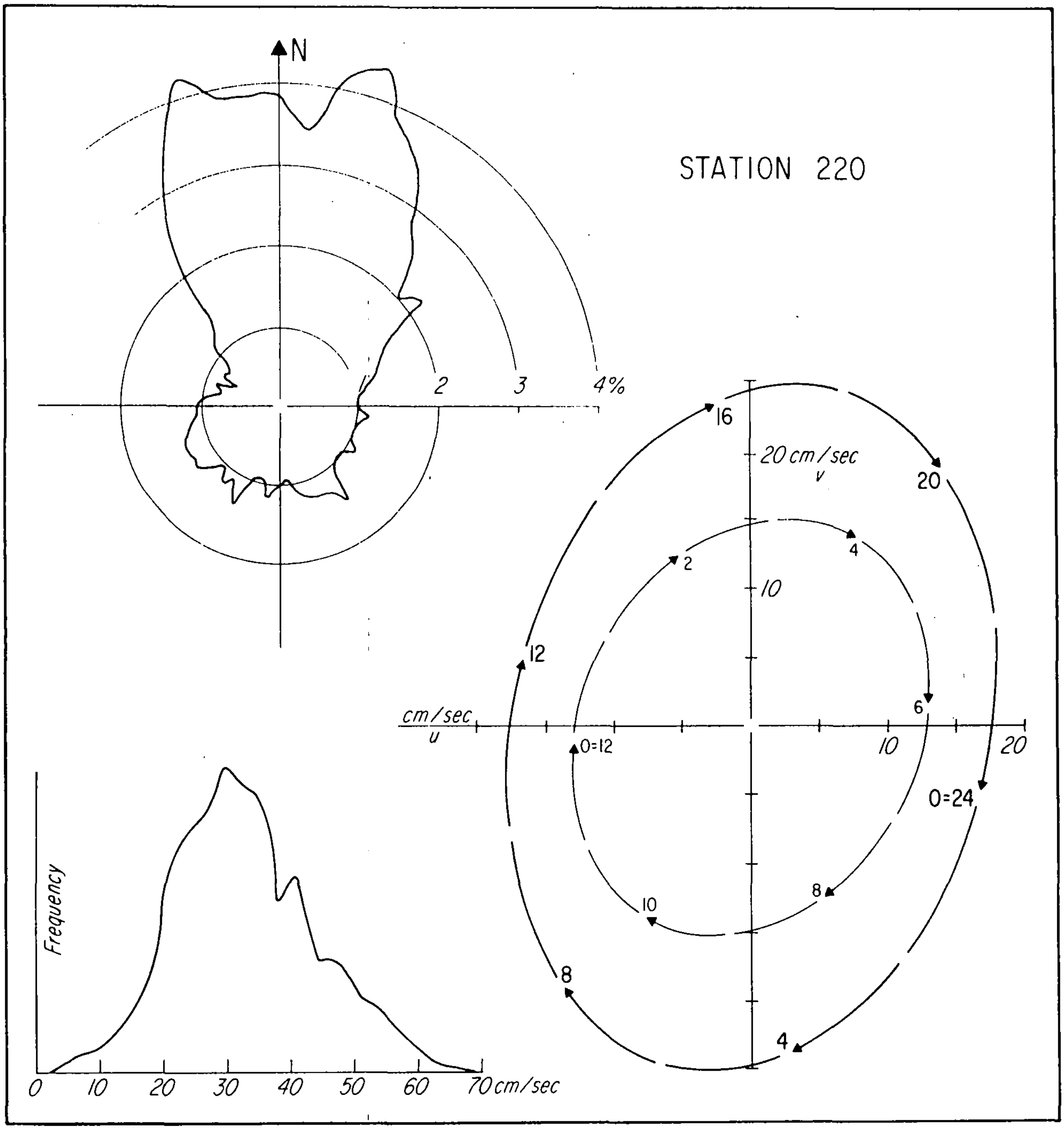
*A common length of data from April 14, 1969, 0000 hr to May 28, 1969, 2345 hr was used to compute the tidal ellipses and progressive vector diagrams for stations 220 to 227.



CURRENT METER STATION 220
NIHOA ISLAND
0 10 20 30 40
Scale in Kilometers
N
START
14 APR 69, 0000
16
APR
18 APR
20 APR
22 APR
24 APR
26 APR
28
APR
30
APR
2 MAY
4 MAY
6 MAY
8 MAY
16 MAY
18 MAY
20 MAY
22 MAY
24 MAY
26 MAY
END
28 MAY
69, 2345


N
1
2
3
4%
STATION 220
16
20 cm/sec
v
20
4
2
10
12
6
cm/sec
u
0=12
10
20
0=24
8
10
8
4
Frequency
0
10
20
30
40
50
60
70 cm/sec

CURRENT METER STATION #221

Geodyne Film-Recording Current Meter #724

Location: Necker Island
Position: Latitude: 23°35.0'N
Longitude: 164°43.2'W

Period: From: March 22, 1969, 1045
To: May 30, 1969, 0930
Total Time: 68 days, 22 hours, 45 minutes*

Depth of Current Meter: 8 m
Bottom Depth: 32 m

Sampling Interval: 15 minutes
Time Interval on Progressive Vector Diagram: 60 minutes

Resulting Drift: Direction: 10°true. Speed: 4.6 cm/sec

Tidal Ellipses:		Diurnal	Semidiurnal
Direction of Major Axis		221°	47°
Amplitude in Major Axis, cm/sec		3.0	6.7
Amplitude in Minor Axis, cm/sec		1.8	4.5
Rotational Sense of Tidal Current		Anticyc.	Anticyc.
u-Component:			
Amplitude, cm/sec		2.7	5.8
Phase		-155°	+102°
95% Confidence Interval		-130°to -180°	+90° to +110°
v-Component:			
Amplitude, cm/sec		2.5	5.5
Phase		+143°	+35°
95% Confidence Interval		+90° to +180°	+20° to +50°
Coherence with	(uh)	0.612	0.913
Honolulu Sea Level	(vh)	0.380	0.676
Expected Coherence for Unrelated Series (95% Confidence)		0.36	
Tidal Amplitude in Honolulu, cm	(h)	18.2	15.5

REMARKS:

Steady flow to the north with weak, chiefly semidiurnal tidal currents superimposed.

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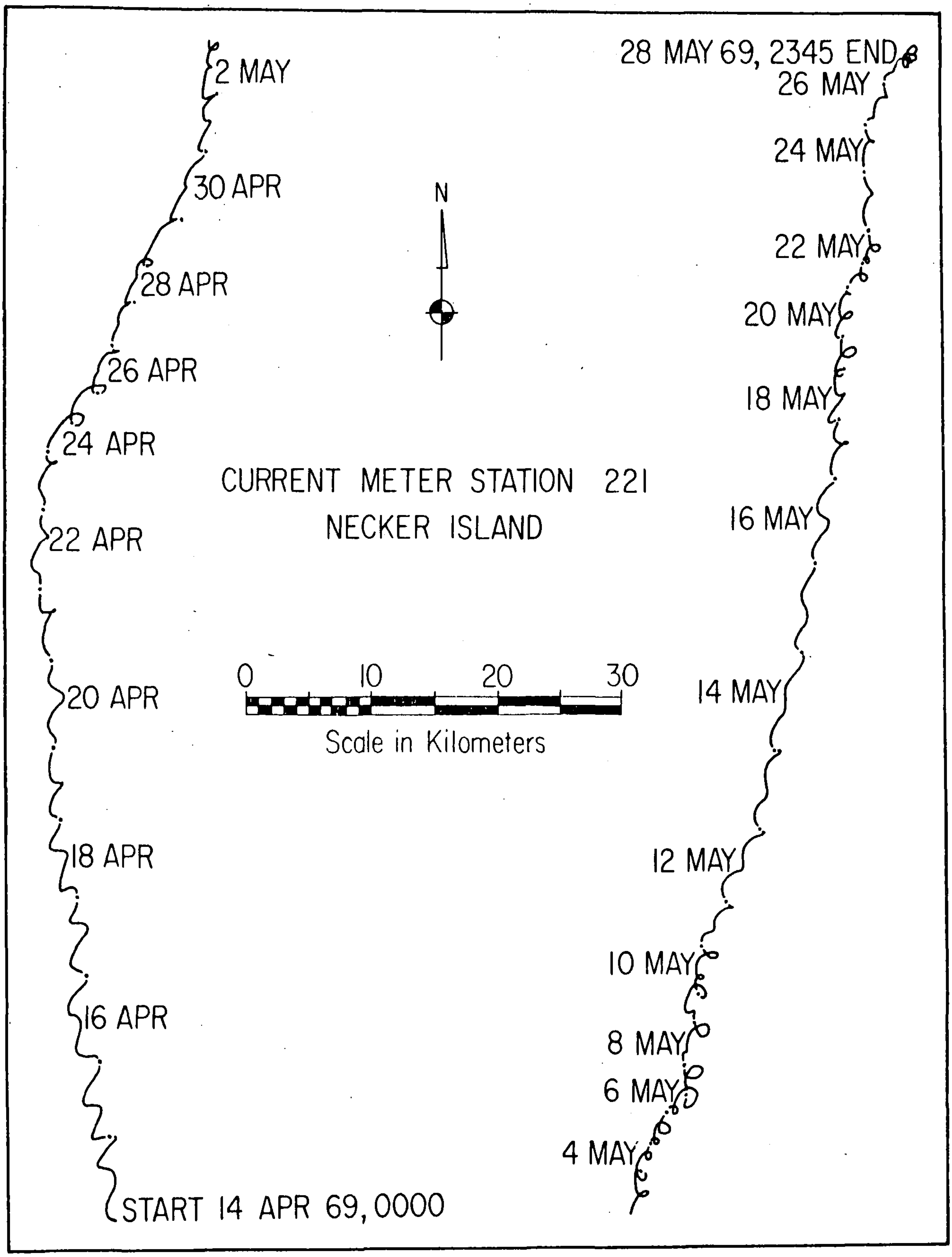
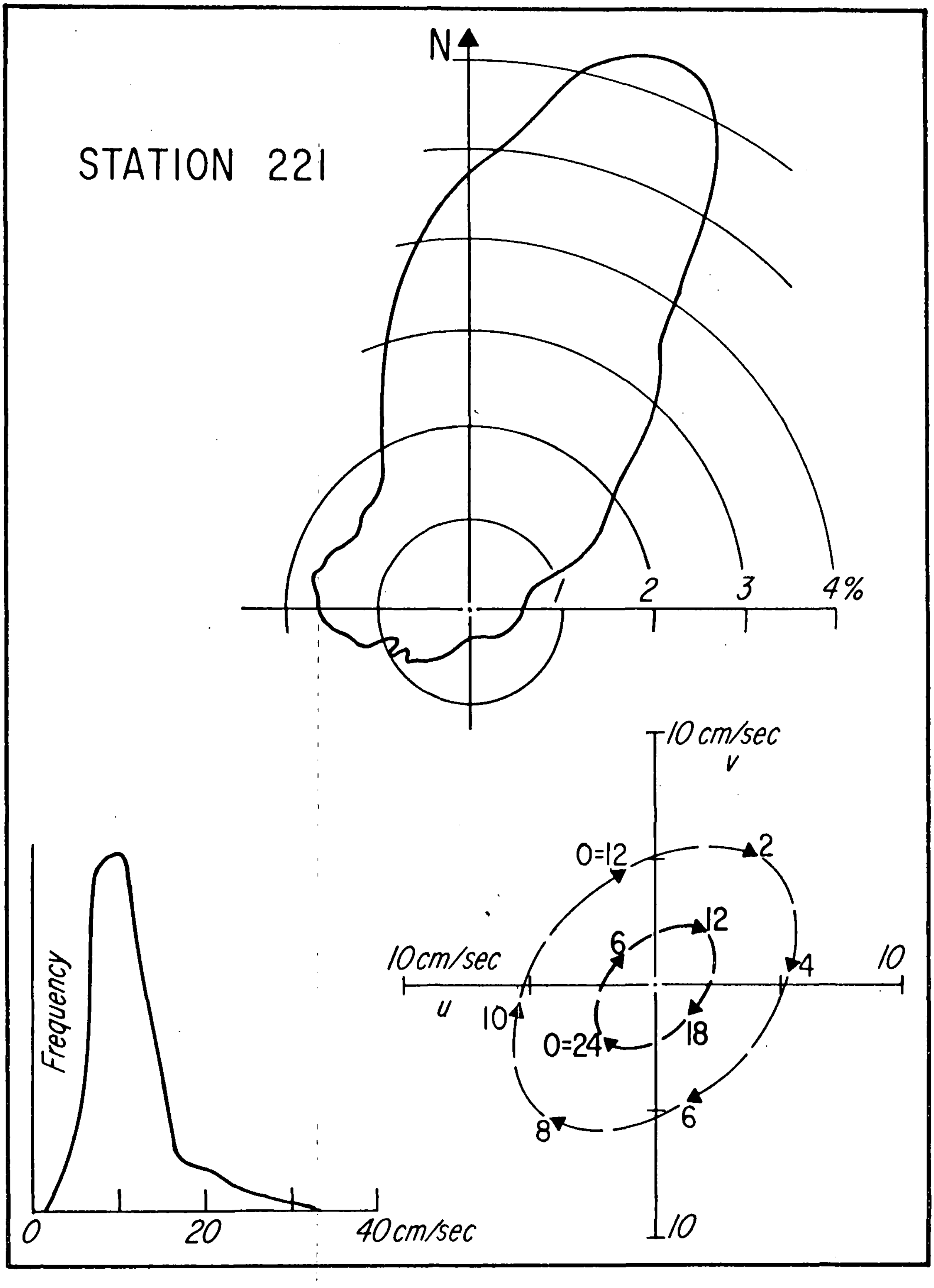
*A common length of data from April 14, 1969, 0000 hr to May 28, 1969, 2345 hr was used to compute the tidal ellipses and progressive vector diagrams for stations 220 to 227.



CURRENT METER STATION 221
NECKER ISLAND
START 14 APR 69, 0000
16 APR
18 APR
20 APR
22 APR
24 APR
26 APR
28 APR
30 APR
2 MAY
4 MAY
6 MAY
8 MAY
10 MAY
12 MAY
14 MAY
16 MAY
18 MAY
20 MAY
22 MAY
24 MAY
26 MAY
28 MAY 69, 2345 END
N
0
10
20
30
Scale in Kilometers



STATION 221
N
1
2
3
4%
10 cm/sec
v
0=12
2
12
6
10 cm/sec
4
10
u
10
18
0=24
6
8
10
Frequency
0
20
40 cm/sec

CURRENT METER STATION #222

Geodyne Film-Recording Current Meter #320

Location:	French Frigate Shoals
Position:	Latitude: 23°47.9'N
	Longitude: 166°19.1'W
Period:	From: March 24, 1969, 1830
	To: May 31, 1969, 1115
Total Time:	67 days, 16 hours, 45 minutes*
Time Zone:	150°W
Depth of Current Meter:	10 m
Bottom Depth	31 m
Sampling Interval:	15 minutes
Time Interval on Progressive Vector Diagram:	60 minutes

Resulting Drift: Direction: 60°true. Speed: 6.6 cm/sec

Tidal Ellipses:	Diurnal	Semidiurnal
Direction of Major Axis	155°	146°
Amplitude in Major Axis, cm/sec	14.6	14.8
Amplitude in Minor Axis, cm/sec	4.3	0.3
Rotational Sense of Tidal Current	Anticyc.	Cyclonic
u-Component:		
Amplitude, cm/sec	7.0	8.5
Phase	+25°	-65°
95% Confidence Interval	0° to +40°	-50° to -70°
v-Component		
Amplitude, cm/sec	13.3	12.3
Phase	-112°	+112°
95% Confidence Interval	-100° to -130°	+100° to +130°
Coherence with Honolulu Sea Level (uh)	0.647	0.879
Coherence with Honolulu Sea Level (vh)	0.864	0.832
Expected Coherence for Unrelated Series (95% Confidence)	0.36	
Tidal Amplitude in Honolulu, cm (h)	18.2	15.5

REMARKS:

General flow to the northeast with mixed tidal currents superimposed.

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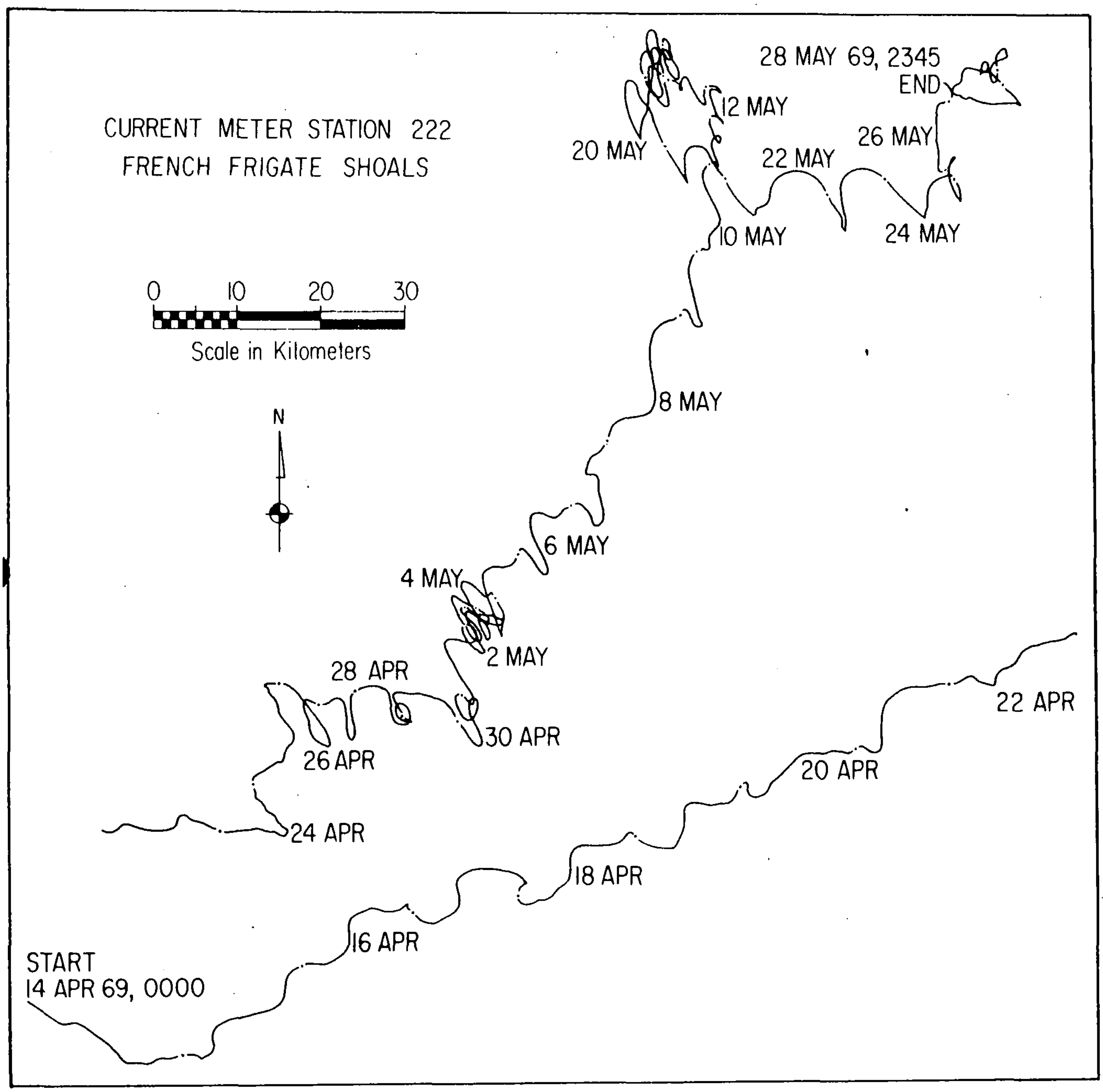
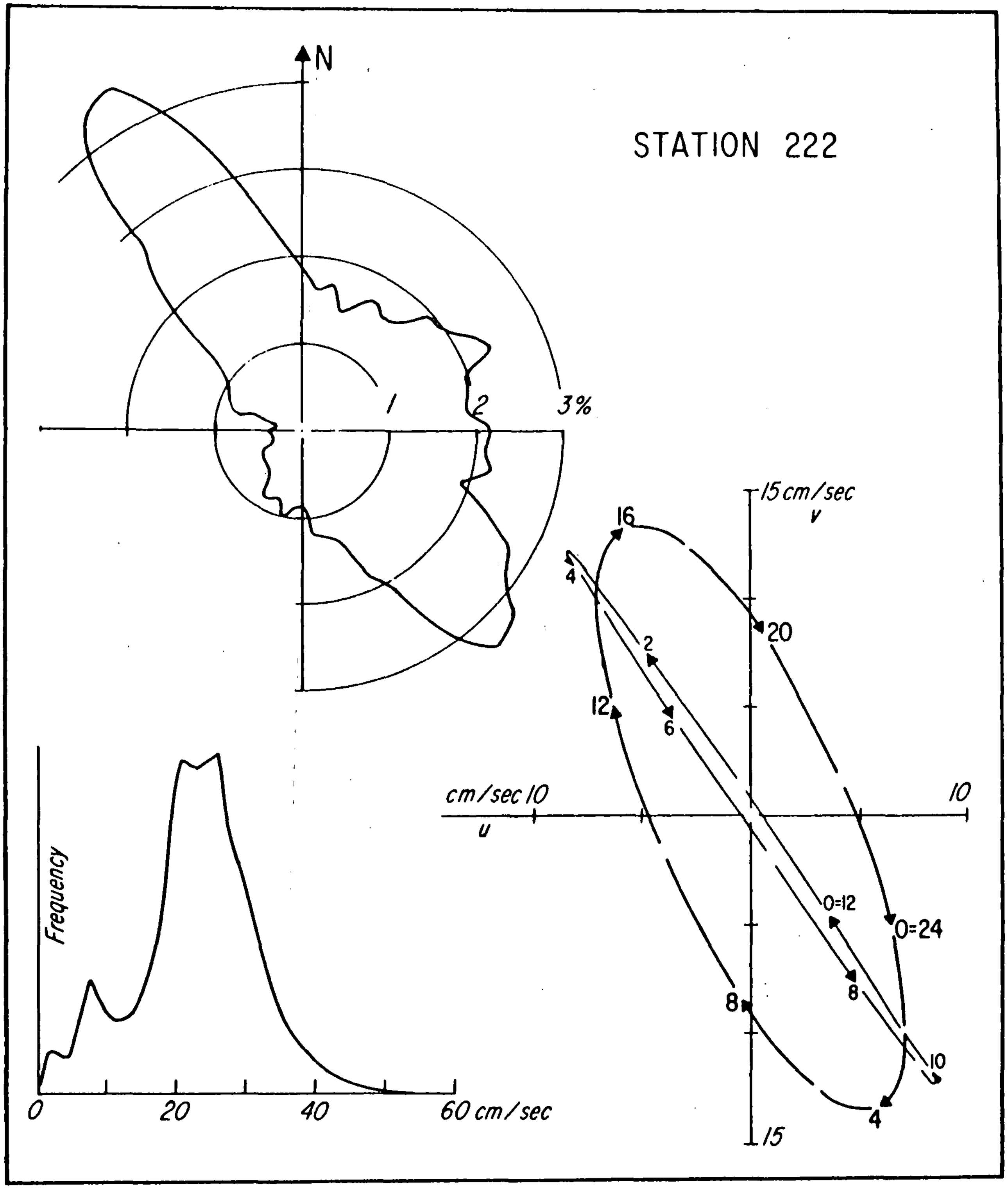
*A common length of data from April 14, 1969, 0000 hr to May 28, 1969, 2345 hr was used to compute the tidal ellipses and progressive vector diagrams for stations 220 to 227.


CURRENT METER STATION 222
FRENCH FRIGATE SHOALS
0 10 20 30
Scale in Kilometers
N
28 MAY 69, 2345
END
12 MAY
20 MAY
26 MAY
22 MAY
10 MAY
24 MAY
8 MAY
6 MAY
4 MAY
2 MAY
28 APR
30 APR
26 APR
24 APR
22 APR
20 APR
18 APR
16 APR
START
14 APR 69, 0000



N
STATION 222
1
2
3%
15 cm/sec
v
16
4
20
2
12
6
cm/sec 10
10
u
0=12
0=24
8
8
10
4
15
Frequency
0
20
40
60 cm/sec

CURRENT METER STATION #223

Geodyne Film-Recording Current Meter #693

Location: Laysan Island (NW)
Position: Latitude: 25°48.0'N
Longitude: 171°45.5'W

Period: From: March 27, 1969, 0715
To: June 2, 1969, 1500
Total Time: 67 days, 7 hours, 45 minutes*
Time Zone: 150°W

Depth of Current Meter: 10 m
Bottom Depth: 34 m

Sampling Interval: 15 minutes
Time Interval on Progressive Vector Diagram: 60 minutes

Resulting Drift: Direction: 357°true. Speed: 1.2 cm/sec

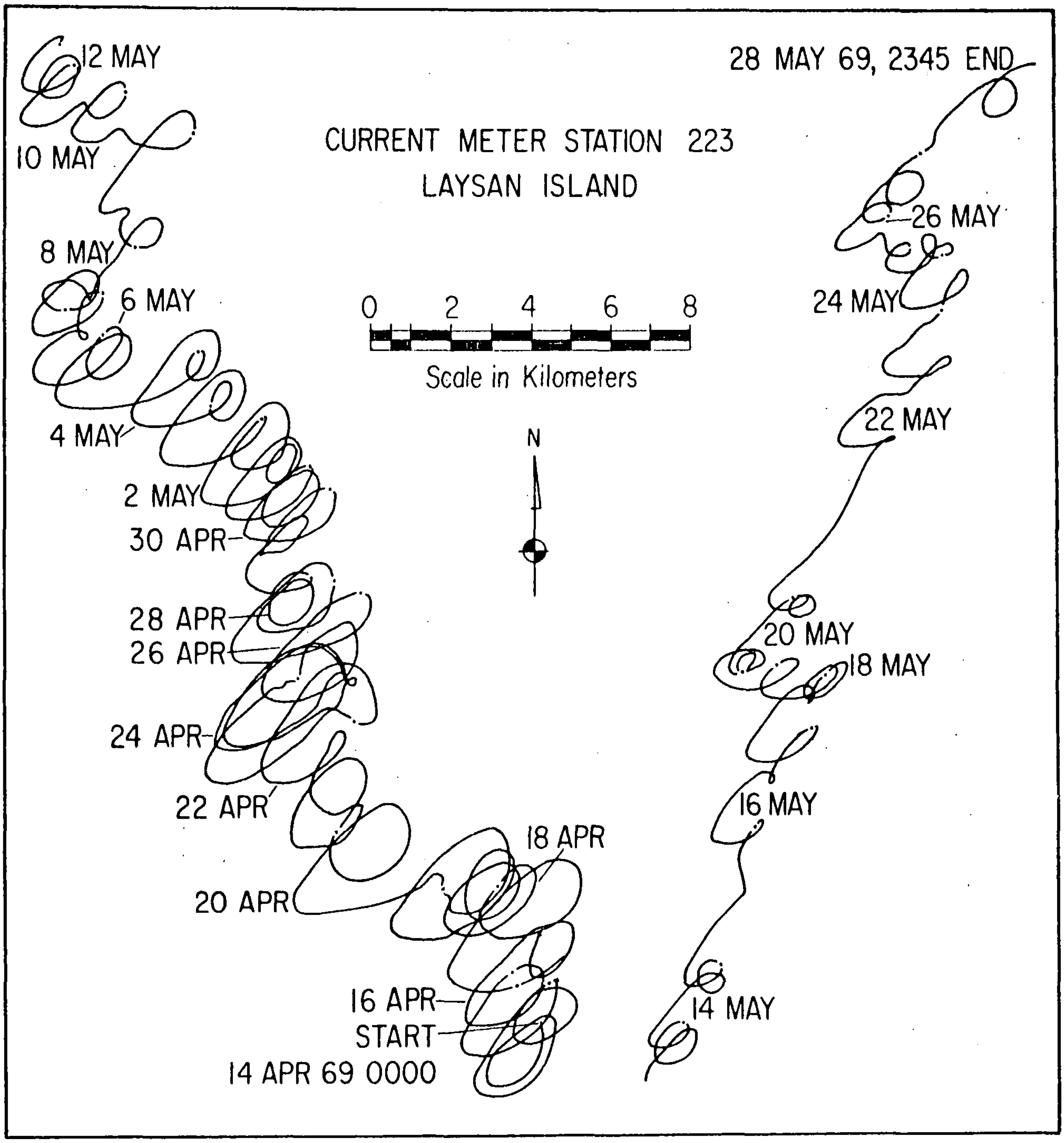
Tidal Ellipses:	Diurnal	Semidiurnal
Direction of Major Axis	64°	226°
Amplitude in Major Axis, cm/sec	5.5	9.8
Amplitude in Minor Axis, cm/sec	2.1	4.4
Rotational Sense of Tidal Current	Anticyc.	Anticyc.
u-Component:		
Amplitude, cm/sec	5.0	7.7
Phase	-63°	+178°
95% Confidence Interval	-40° to -80°	+170° to +180°
v-Component:		
Amplitude, cm/sec	3.0	7.7
Phase	-112°	+124°
95% Confidence Interval	-90° to -130°	+120° to +140°
Coherence with (uh)	0.752	0.906
Honolulu Sea Level (vh)	0.664	0.883
Expected Coherence for Unrelated Series (95% Confidence)	0.36	
Tidal Amplitude in Honolulu, cm (h)	18.2	15.5

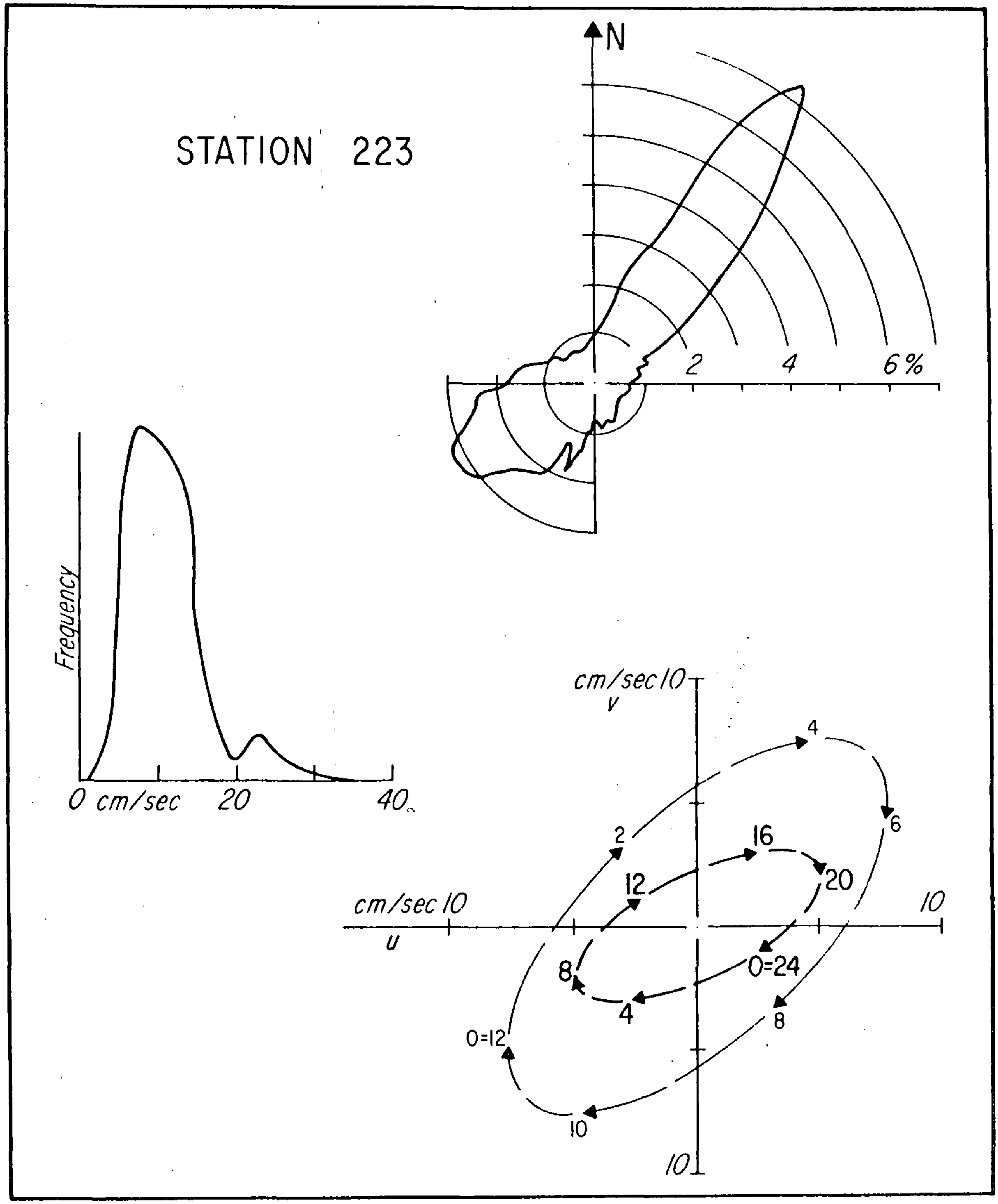
REMARKS:

Weak, predominantly semidiurnal tidal currents with very weak resultant flow to the north.

---

*A common length of data from April 14, 1969, 0000 hr to May 28, 1969, 2345 hr was used to compute the tidal ellipses and progressive vector diagrams for stations 220 to 227.


CURRENT METER STATION 223
LAYSAN ISLAND
0 2 4 6 8
Scale in Kilometers
N
12 MAY
10 MAY
8 MAY
6 MAY
4 MAY
2 MAY
30 APR
28 APR
26 APR
24 APR
22 APR
20 APR
18 APR
16 APR
START
14 APR 69 0000
28 MAY 69, 2345 END
26 MAY
24 MAY
22 MAY
20 MAY
18 MAY
16 MAY
14 MAY


STATION 223
N
2
4
6%
Frequency
0 cm/sec
20
40
cm/sec 10
v
u
10
4
6
2
16
20
12
8
0=24
4
8
0=12
10

CURRENT METER STATION #224

Geodyne Film-Recording Current Meter #231

Location: Lisianski Island
Position: Latitude: 26°03.9'N
Longitude: 174°03.6'W

Period: From: March 30, 1969, 0945
To: June 4, 1969, 0800
Total Time: 65 days, 22 hours, 15 minutes*
Time Zone: 150°W

Depth of Current Meter: 10 m
Bottom Depth: 35 m

Sampling Interval: 15 minutes
Time Interval on Progressive Vector Diagram: 60 minutes

Resulting Drift: Direction: 315°true. Speed: 3.9 cm/sec

Tidal Ellipses:	Diurnal	Semidiurnal
Direction of Major Axis	226°	162°
Amplitude in Major Axis, cm/sec	10.7	8.6
Amplitude in Minor Axis, cm/sec	1.3	3.8
Rotational Sense of Tidal Current	Anticyc.	Anticyc.
u-Component:		
Amplitude, cm/sec	7.6	4.3
Phase	-92°	-79°
95% Confidence Interval	-30° to -150°	-40° to -120°
v-Component:		
Amplitude, cm/sec	7.5	8.1
Phase	-106°	+166°
95% Confidence Interval	-50° to -150°	+150° to +180°
Coherence with Honolulu Sea Level (uh)	0.336	0.411
Coherence with Honolulu Sea Level (vh)	0.380	0.717
Expected Coherence for Unrelated Series (95% Confidence)	0.36	
Tidal Amplitude in Honolulu, cm (h)	18.2	15.5

REMARKS:

Weak, irregular currents; mixed, not very pronounced tidal currents.

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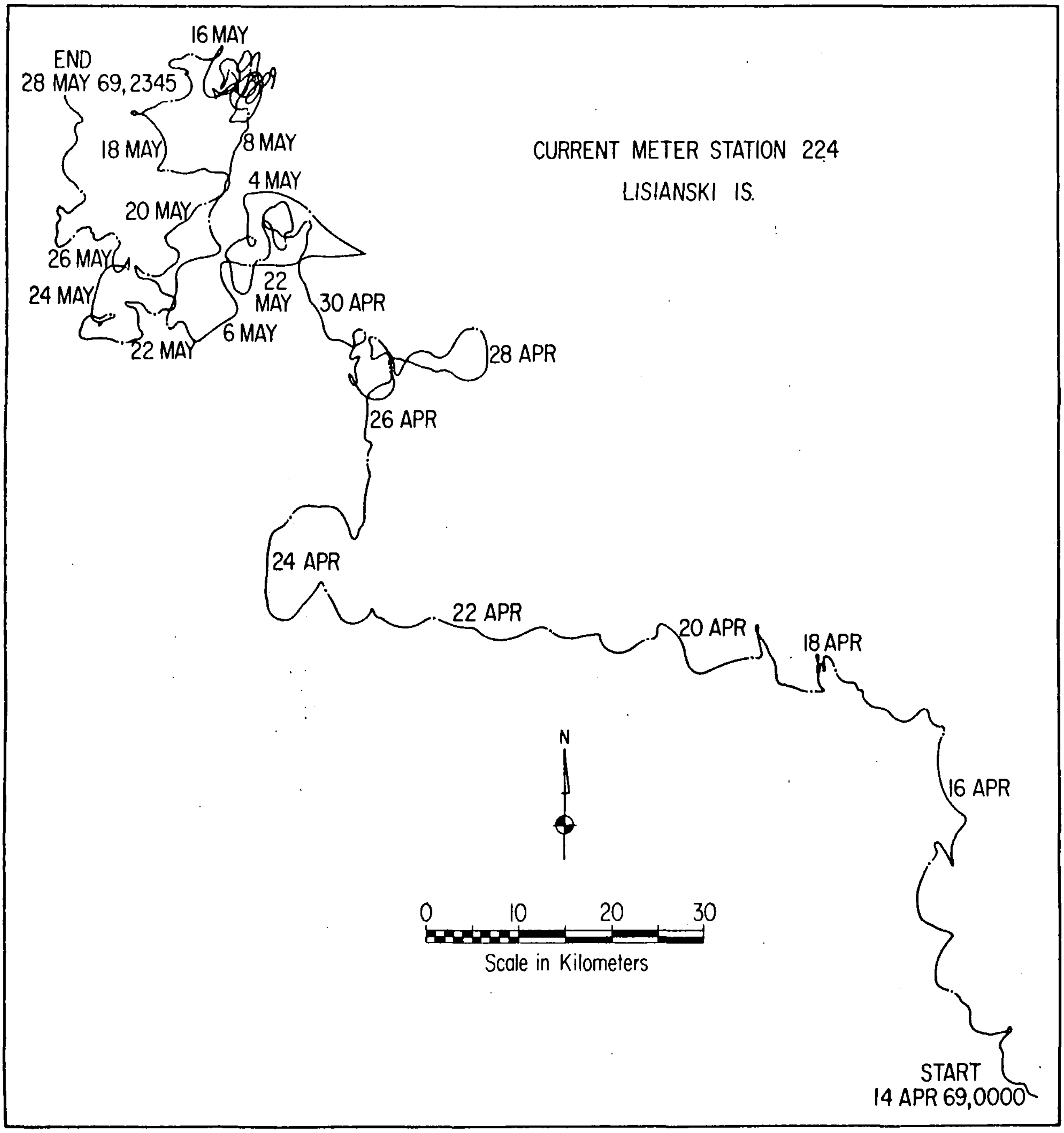
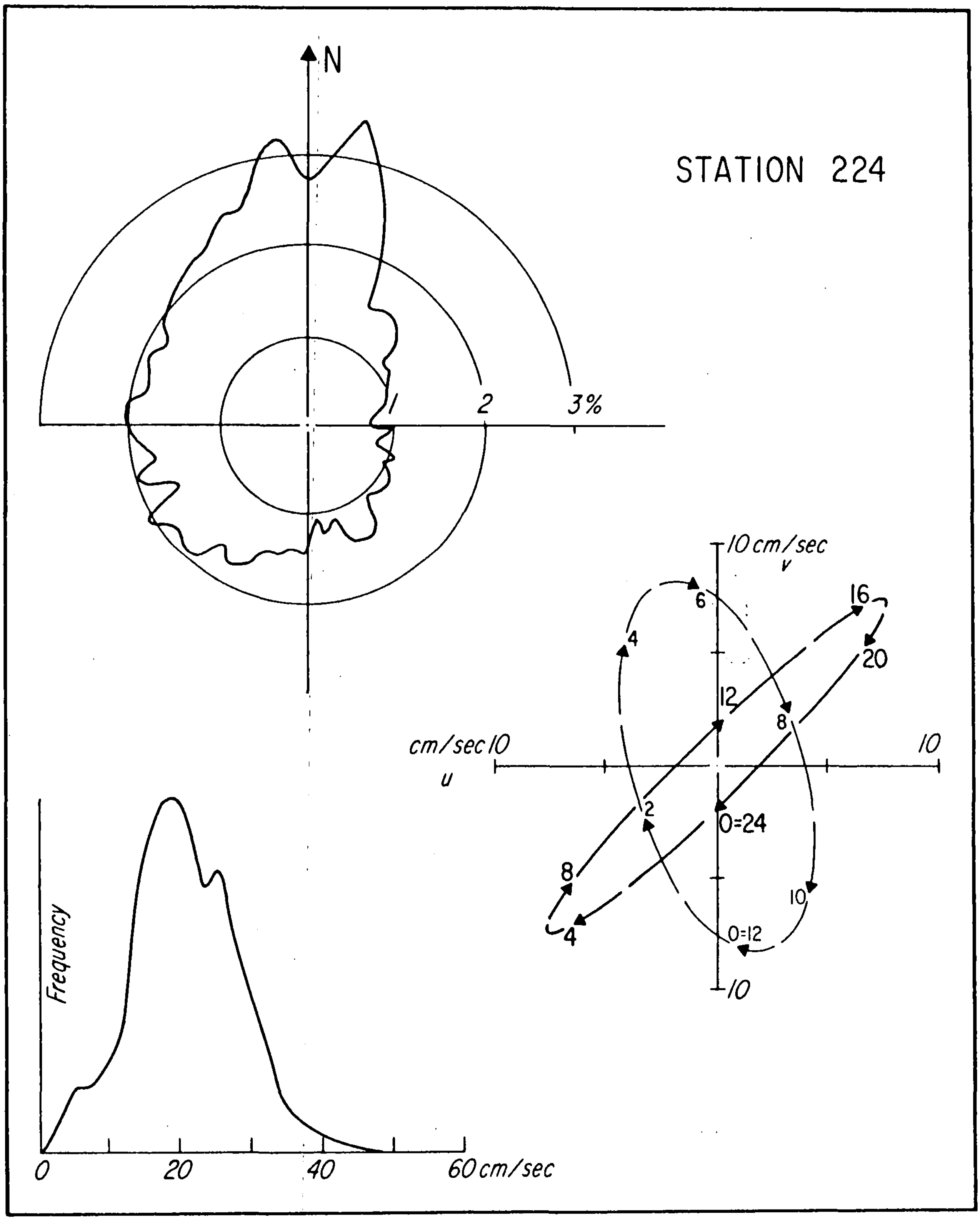
*A common length of data from April 14, 1969, 0000 hr to May 28, 1969, 2345 hr was used to compute the tidal ellipses and progressive vector diagrams for stations 220 to 227.


CURRENT METER STATION 224
LISIANSKI IS.
END
28 MAY 69, 2345
START
14 APR 69, 0000
16 MAY
18 MAY
8 MAY
4 MAY
20 MAY
26 MAY
22
MAY
24 MAY
30 APR
6 MAY
22 MAY
28 APR
26 APR
24 APR
22 APR
20 APR
18 APR
16 APR
N
0
10
20
30
Scale in Kilometers



STATION 224
N
1
2
3%
10 cm/sec
v
cm/sec 10
u
10
10
6
4
16
20
12
8
2
0=24
8
4
10
0=12
Frequency
0
20
40
60 cm/sec

CURRENT METER STATION #225

Geodyne Film-Recording Current Meter #304

Location:	Pearl and Hermes Reef	
Position:	Latitude:	27°45.7'N
	Longitude:	175°47.7'W
Period:	From:	March 31, 1969, 1130
	To:	June 5, 1969, 0815
Total Time:		65 days, 20 hours, 45 minutes*
Time Zone:		150°W

Depth of Current Meter: 8 m
Bottom Depth: 71 m

Sampling Interval: 15 minutes
Time Interval on Progressive Vector Diagram: 60 minutes

Resulting Drift: Direction: 315°true. Speed: 4.5 cm/sec

Tidal Ellipses:		Diurnal	Semidiurnal
Direction of Major Axis		108°	106°
Amplitude in Major Axis, cm/sec		16.0	18.0
Amplitude in Minor Axis, cm/sec		1.7	0.3
Rotational Sense of Tidal Current		Anticyc.	Anticyc.
u-Component:			
Amplitude, cm/sec		15.2	17.0
Phase		-37°	+95°
95% Confidence Interval		-20° to -50°	+80° to +110°
v-Component:			
Amplitude, cm/sec		5.3	5.0
Phase		+160°	-85°
95% Confidence Interval		+110° to -150°	-40° to -130°
Coherence with	(uh)	0.776	0.742
Honolulu Sea Level	(vh)	0.357	0.433
Expected Coherence for Unrelated Series (95% Confidence)		0.36	
Tidal Amplitude in Honolulu, cm	(h)	18.2	15.5

REMARKS:

Weak flow to the north and northwest with mixed, not very pronounced tidal currents.

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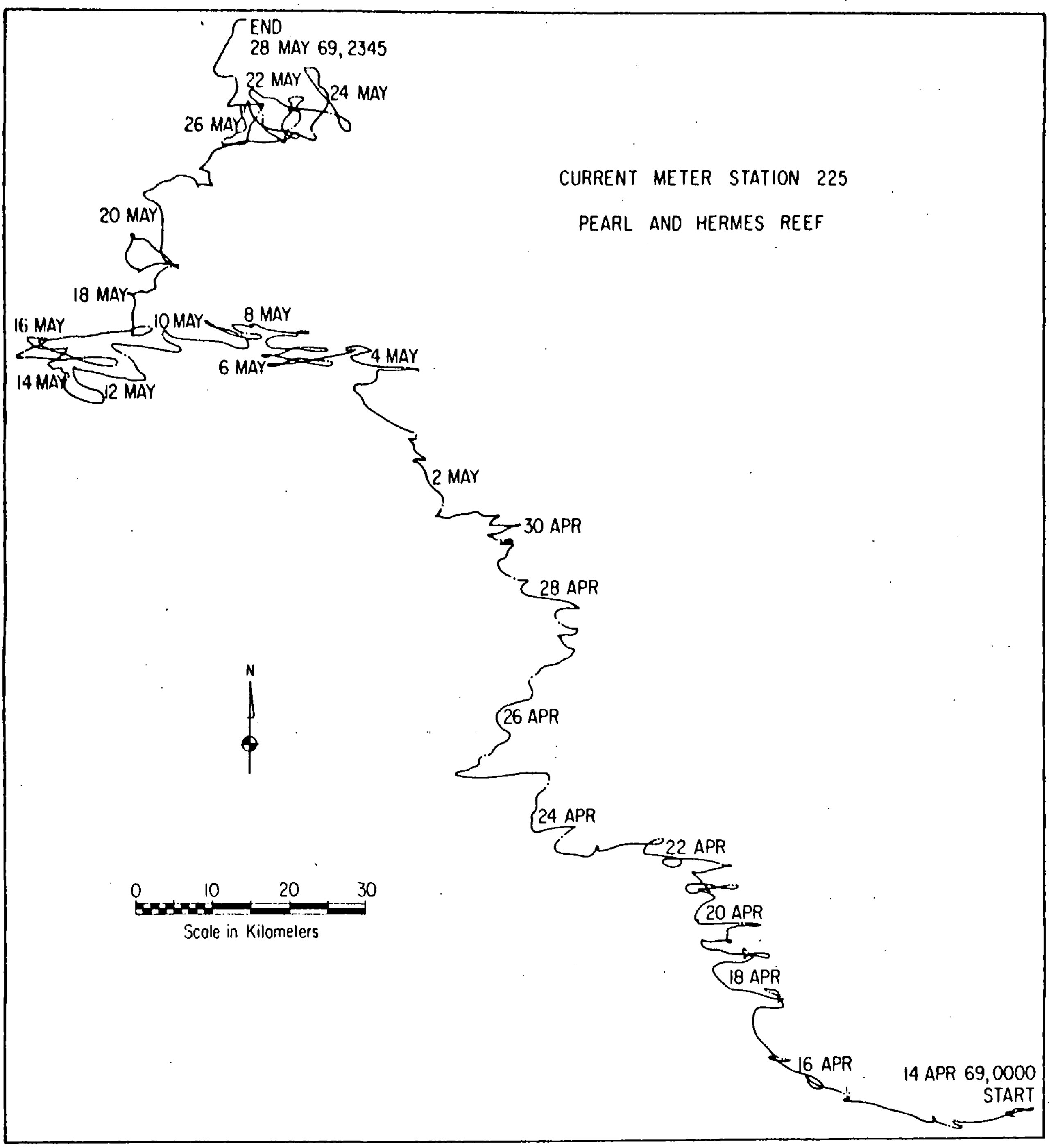
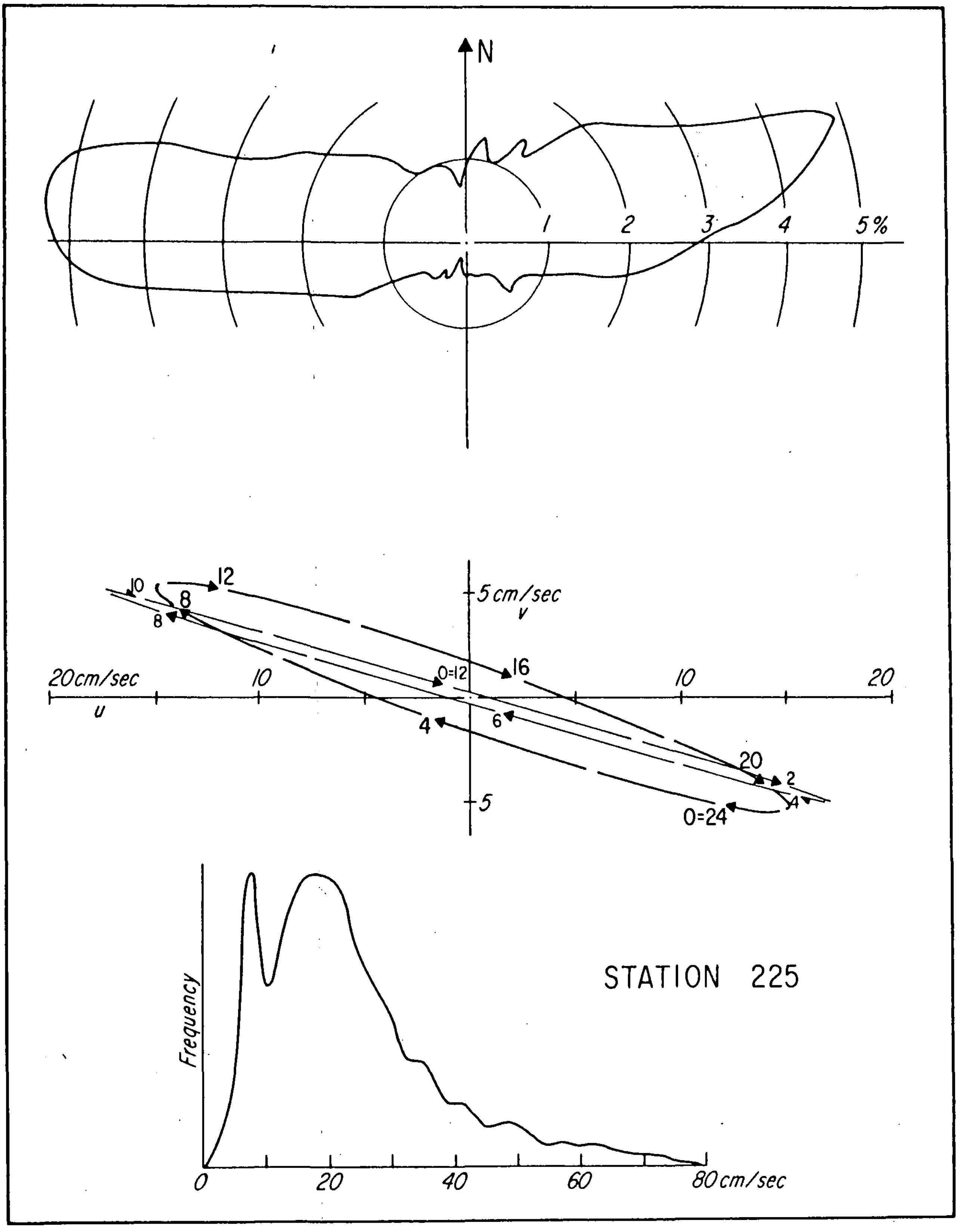
*A common length of data from April 14, 1969, 0000 hr to May 28, 1969, 2345 hr was used to compute the tidal ellipses and progressive vector diagrams for stations 220 to 227.



END
28 MAY 69, 2345
22 MAY
24 MAY
26 MAY
CURRENT METER STATION 225
PEARL AND HERMES REEF
20 MAY
18 MAY
16 MAY
10 MAY
8 MAY
4 MAY
6 MAY
14 MAY
12 MAY
2 MAY
30 APR
28 APR
N
26 APR
24 APR
22 APR
0
10
20
30
Scale in Kilometers
20 APR
18 APR
16 APR
14 APR 69, 0000
START


N
1
2
3
4
5%
5 cm/sec
v
20cm/sec
u
10
10
20
12
10
8
8
16
0=12
6
4
20
2
4
5
0=24
Frequency
STATION 225
0
20
40
60
80 cm/sec

CURRENT METER STATION #226

Geodyne Film-Recording Current Meter #631

Location: Midway West
Position: Latitude: 28°12.6'N
Longitude: 177°26.5'W

Period: From: April 5, 1969, 2015
To: June 4, 1969, 1900
Total Time: 59 days, 22 hours, 45 minutes*
Time Zone: 150°W

Depth of Current Meter: 9 m
Bottom Depth: 66 m

Sampling Interval: 15 minutes
Time Interval on Progressive Vector Diagram: 60 minutes

Resulting Drift: Direction: 348°true. Speed: 5.2 cm/sec

Tidal Ellipses:		Diurnal	Semidiurnal
Direction of Major Axis		171°	190°
Amplitude in Major Axis, cm/sec		11.4	6.2
Amplitude in Minor Axis, cm/sec		2.8	1.5
Rotational Sense of Tidal Current		Anticyc.	Cyclonic
u-Component:			
Amplitude, cm/sec		3.3	1.7
Phase		-51°	-116°
95% Confidence Interval		-40° to -60°	-90° to -150°
v-Component:			
Amplitude, cm/sec		11.2	6.2
Phase		-168°	+172°
95% Confidence Interval		-160° to -180°	+150° to +180°
Coherence with	(uh)	0.821	0.581
Honolulu Sea Level	(vh)	0.922	0.707
Expected Coherence for Unrelated Series (95% Confidence)		0.36	
Tidal Amplitude in Honolulu, cm	(h)	18.2	15.5

REMARKS:

Steady weak flow to the north with mainly diurnal tidal currents superimposed.

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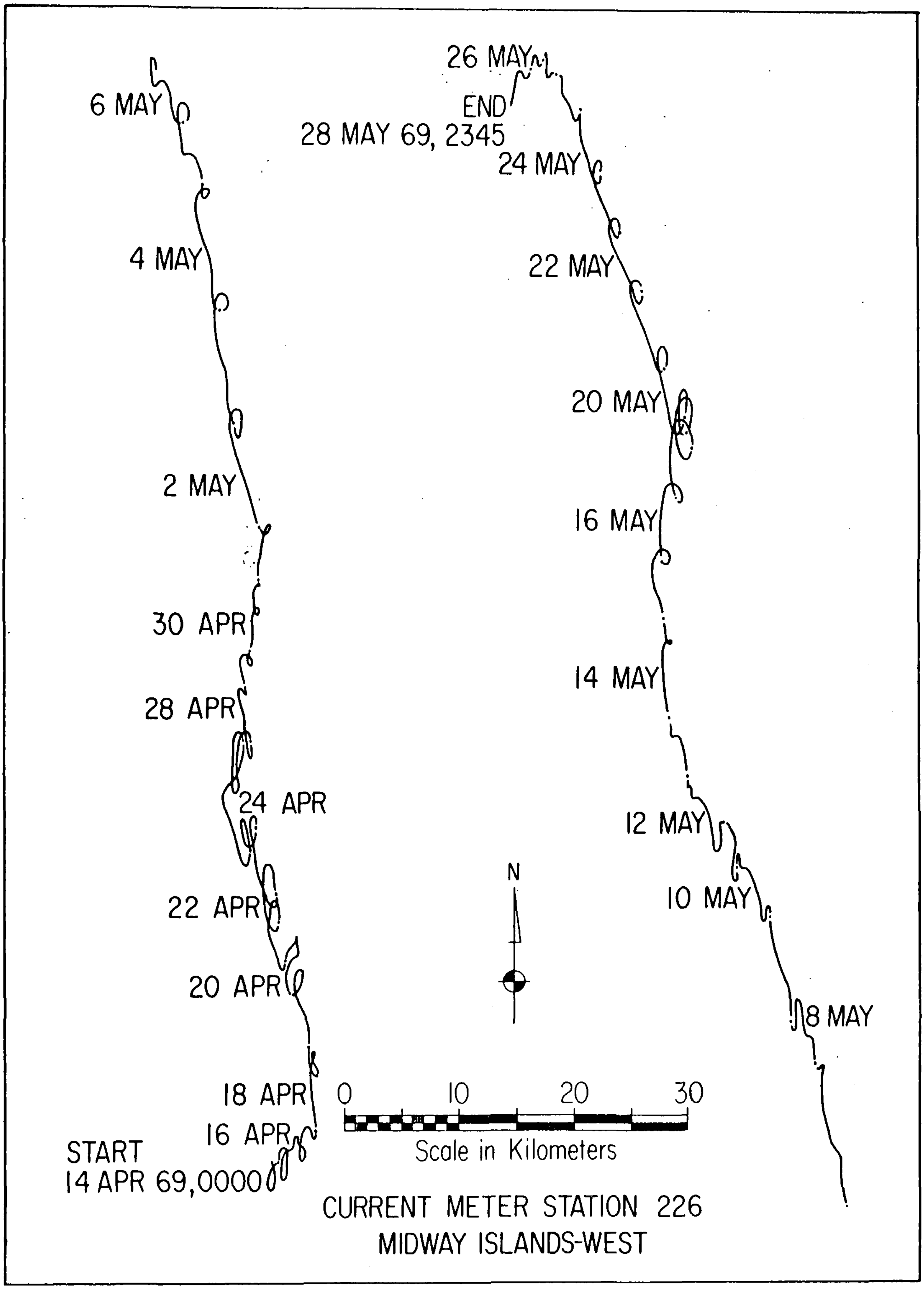
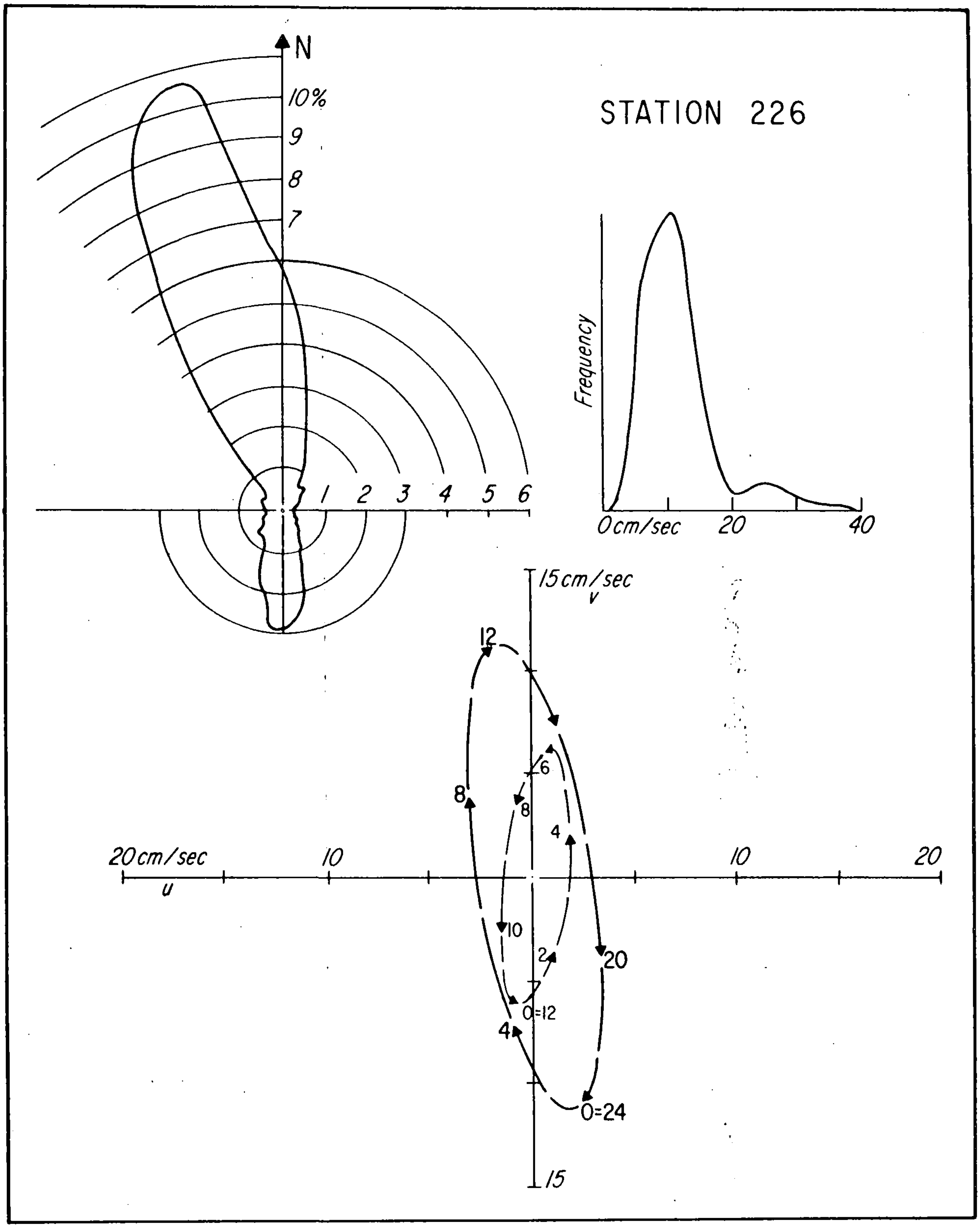
*A common length of data from April 14, 1969, 0000 hr to May 28, 1969, 2345 hr was used to compute the tidal ellipses and progressive vector diagrams for stations 220 to 227.



CURRENT METER STATION 226
MIDWAY ISLANDS-WEST



STATION 226
N
10%
9
8
7
1
2
3
4
5
6
Frequency
0 cm/sec
20
40
15 cm/sec
v
20 cm/sec
u
10
10
20
15
12
8
6
8
4
10
2
20
0=12
4
0=24

CURRENT METER STATION #227

Geodyne Film-Recording Current Meter #305

Location:	Midway East	
Position:	Latitude:	28°11.7'N
	Longitude:	177°18.0'W
Period:	From:	April 3, 1969, 1015
	To:	June 6, 1969, 1030
Total Time:		64 days, 00 hours, 15 minutes*
Time Zone:		150°W

Depth of Current Meter: 15 m
Bottom Depth: 66 m

Sampling Interval: 15 minutes
Time Interval on Progressive Vector Diagram: 60 minutes

Resulting Drift: Direction: 203°true. Speed: 6.0 cm/sec

Tidal Ellipses:		Diurnal	Semidiurnal
Direction of Major Axis		49°	45°
Amplitude in Major Axis, cm/sec		32.5	12.3
Amplitude in Minor Axis, cm/sec		11.9	0.7
Rotational Sense of Tidal Current		Anticyc.	Cyclonic
u-Component:			
Amplitude, cm/sec		25.5	9.0
Phase		-29°	+45°
95% Confidence Interval		-10° to -50°	-180° to +180°
v-Component:			
Amplitude, cm/sec		23.0	9.3
Phase		-68°	+46°
95% Confidence Interval		-50° to -90°	-180° to +180°
Coherence with	(uh)	0.618	0.097
Honolulu Sea Level	(vh)	0.665	0.261
Expected Coherence for Unrelated Series (95% Confidence)		0.36	
Tidal Amplitude in Honolulu, cm	(h)	18.2	15.5

REMARKS:

Intermittent flow to the southwest with strong diurnal tidal currents superimposed. Note that the inertial period at the latitude is approximately the same as the period of the diurnal tide.

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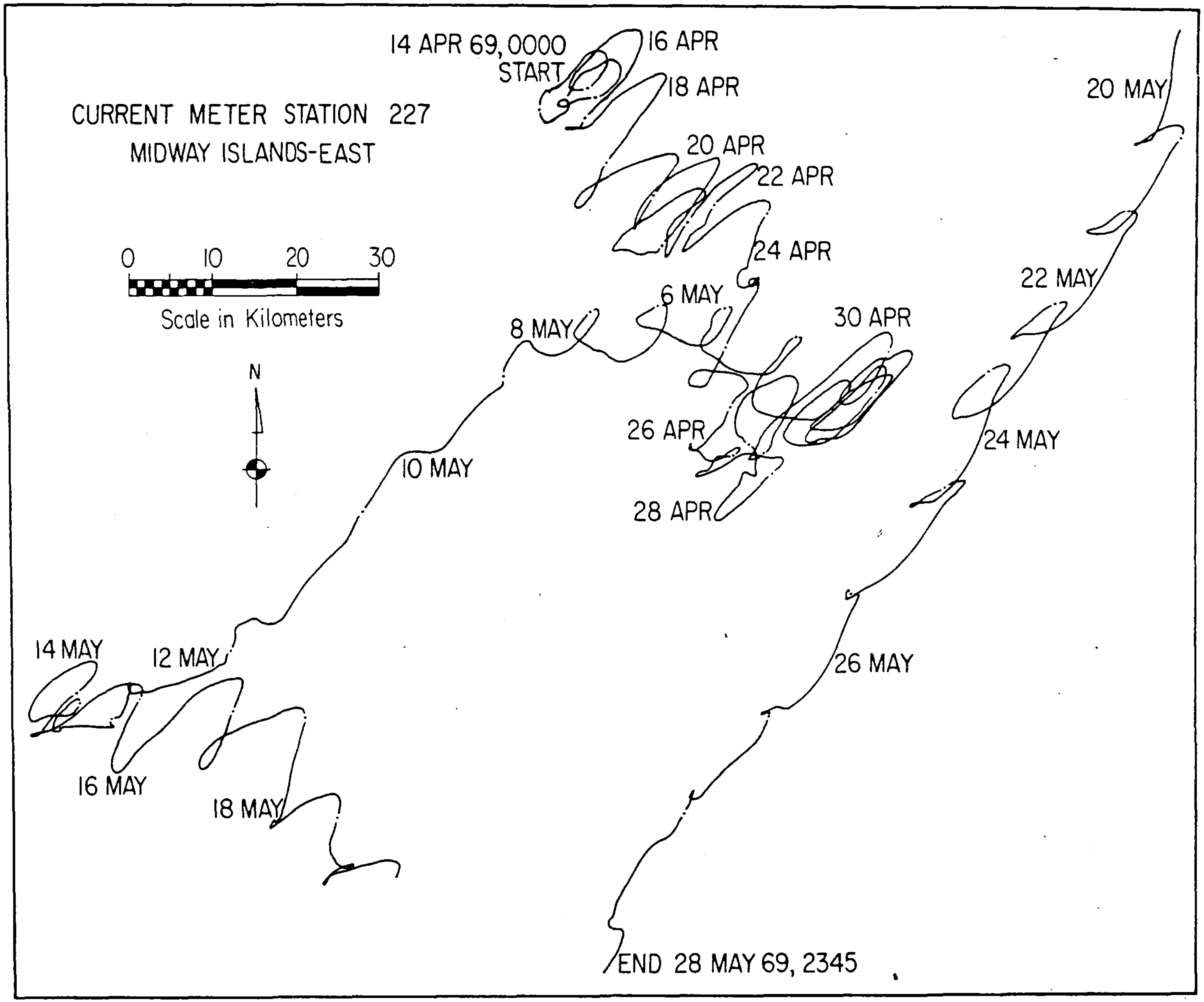
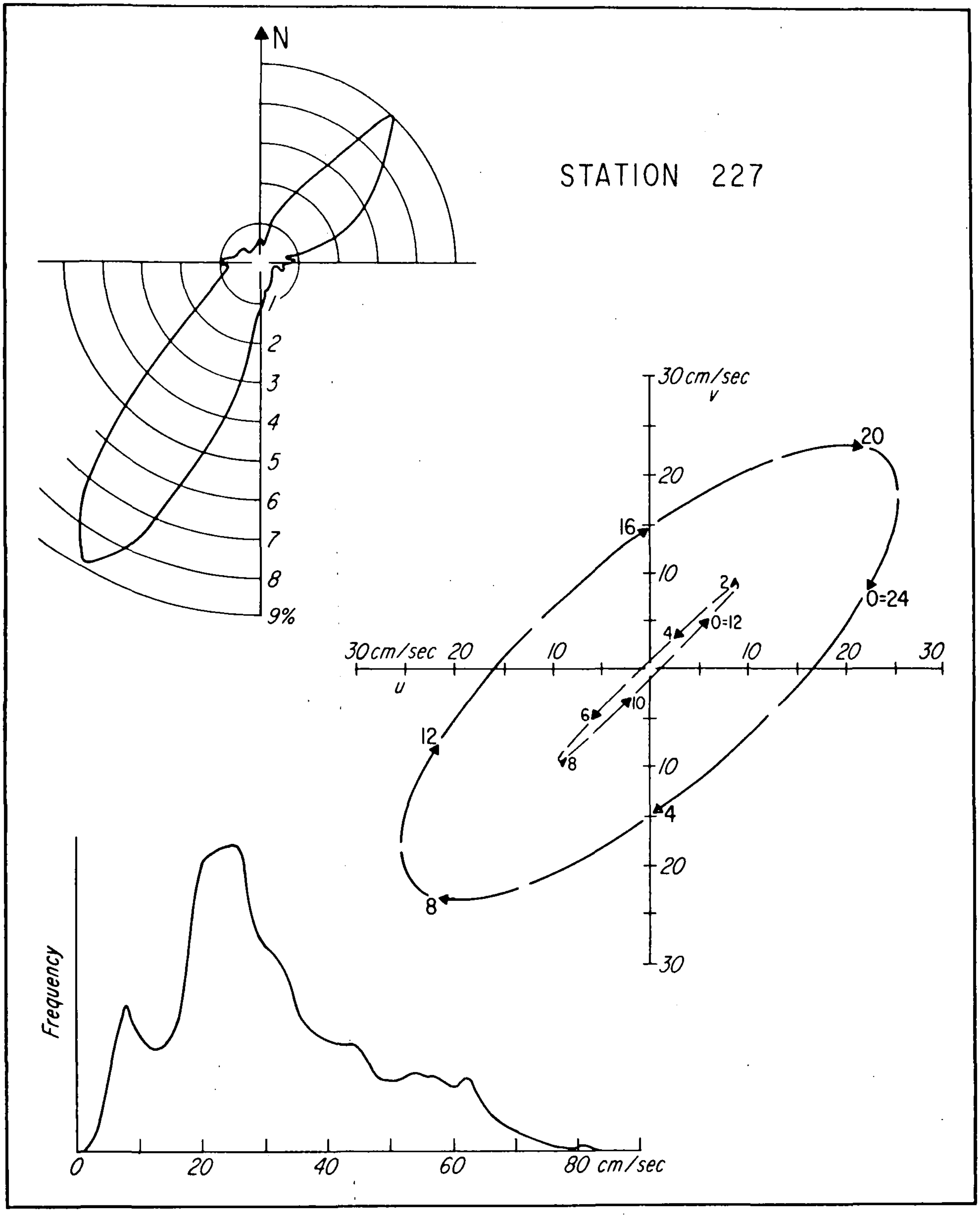
*A common length of data from April 14, 1969, 0000 hr to May 28, 1969, 2345 hr was used to compute the tidal ellipses and progressive vector diagrams for stations 220 to 227.



CURRENT METER STATION 227
MIDWAY ISLANDS-EAST
0 10 20 30
Scale in Kilometers
N
14 APR 69, 0000
START
16 APR
18 APR
20 APR
22 APR
24 APR
26 APR
28 APR
30 APR
6 MAY
8 MAY
10 MAY
12 MAY
14 MAY
16 MAY
18 MAY
20 MAY
22 MAY
24 MAY
26 MAY
END 28 MAY 69, 2345

STATION 227



N
1
2
3
4
5
6
7
8
9%
30 cm/sec
v
20
10
10
20
30
30 cm/sec
u
20
10
10
20
30
20
16
0=24
2
4
0=12
6
10
8
12
4
8
Frequency
0
20
40
60
80 cm/sec

CURRENT METER STATION #228

Geodyne Film-Recording Current Meter #325

Location: Deep Mooring E
Position: Latitude: 27°30.0'N
Longitude: 157°52.0'W

Period: From: September 18, 1969, 1115
September 24, 1969, 1015
Total Time: 5 days, 23 hours, OC minutes
Time Zone: 150°W

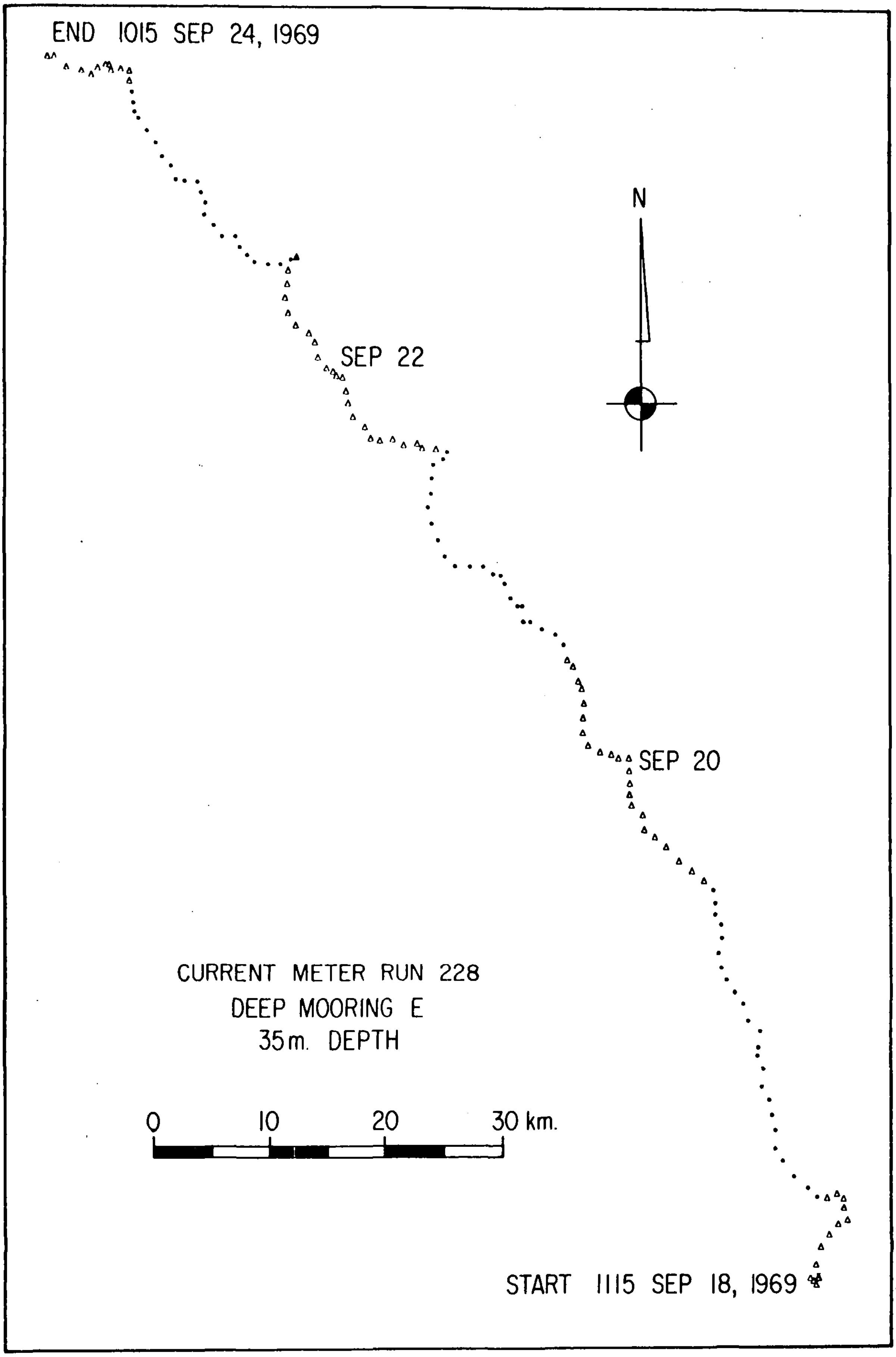
Depth of Current Meter: 35 m
Bottom Depth: 5490 m

Sampling Interval: 15 minutes
Time Interval on
Progressive Vector Diagram: 60 minutes

Resulting Drift: Direction: 328°true. Speed: 19.9 cm/sec

REMARKS:

Flow to the northwest with weak semidiurnal tidal currents superimposed.



END 1015 SEP 24, 1969
N
SEP 22
SEP 20
CURRENT METER RUN 228
DEEP MOORING E
35m. DEPTH
0
10
20
30 km.
START 1115 SEP 18, 1969

CURRENT METER STATION #229

Geodyne Film-Recording Current Meter #331

Location: Deep Mooring E
Position: Latitude: 27°30.0'N
Longitude: 157°52.0'W

Period: From: September 18, 1969, 1115
To: September 24, 1969, 1015
Total Time: 5 days, 23 hours, 00 minutes
Time Zone: 150°W

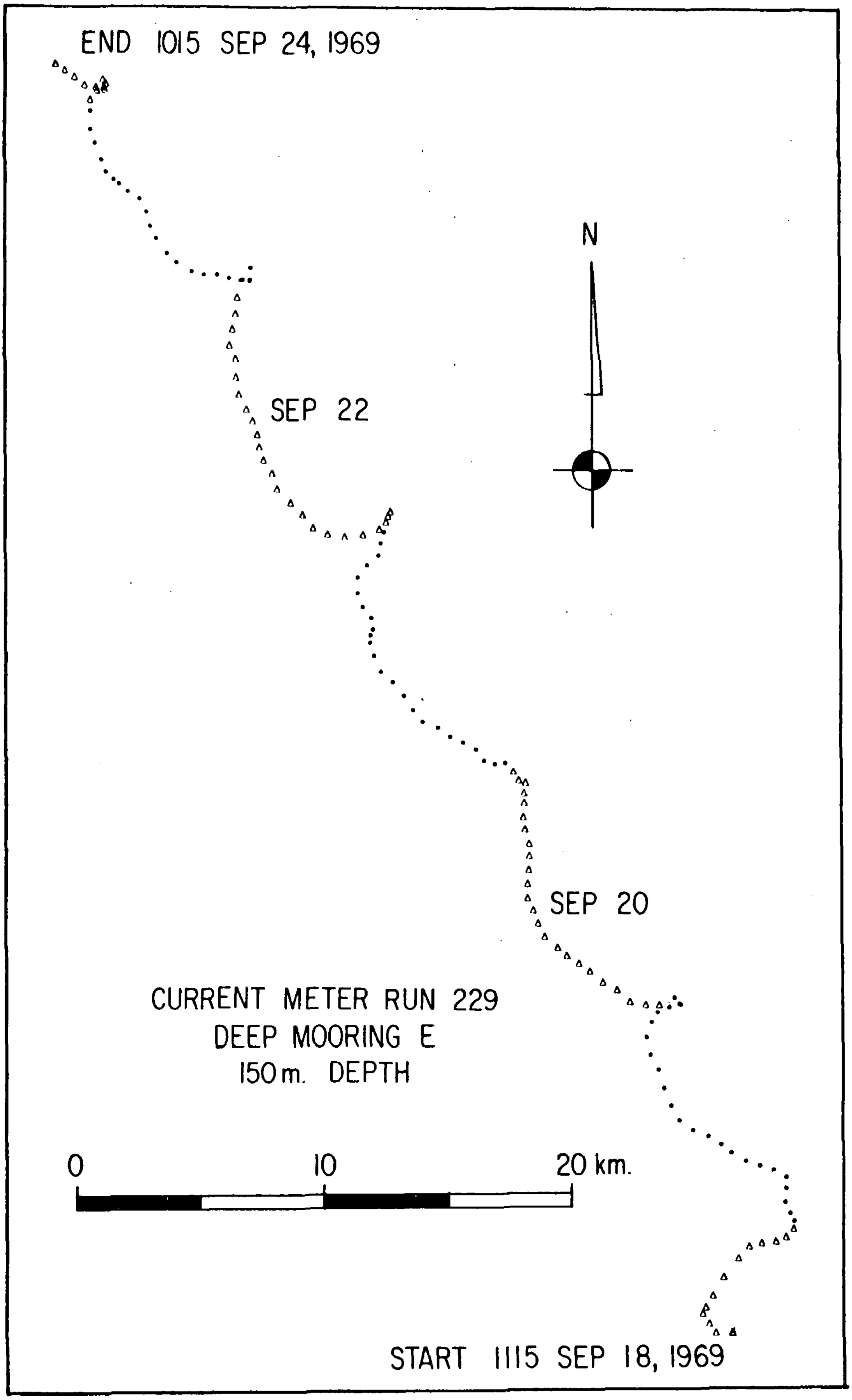
Depth of Current Meter: 150 m
Bottom Depth: 5490 m

Sampling Interval: 15 minutes
Time Interval on Progressive Vector Diagram: 60 minutes

Resulting Drift: Direction: 333°true. Speed: 11.3 cm/sec

REMARKS:

Moderate flow to the northwest with weak diurnal tidal current superimposed.



END 1015 SEP 24, 1969
N
SEP 22
SEP 20
CURRENT METER RUN 229
DEEP MOORING E
150 m. DEPTH
0
10
20 km.
START 1115 SEP 18, 1969

CURRENT METER STATION #230

Geodyne Film-Recording Current Meter #337

Location:	Deep Mooring E	
Position:	Latitude:	27°30.0'N
	Longitude:	157°52.0'W
Period:	From:	September 18, 1969, 1115
	To:	September 24, 1969, 1015
Total Time:		5 days, 23 hours, 00 minutes
Time Zone:		150°W

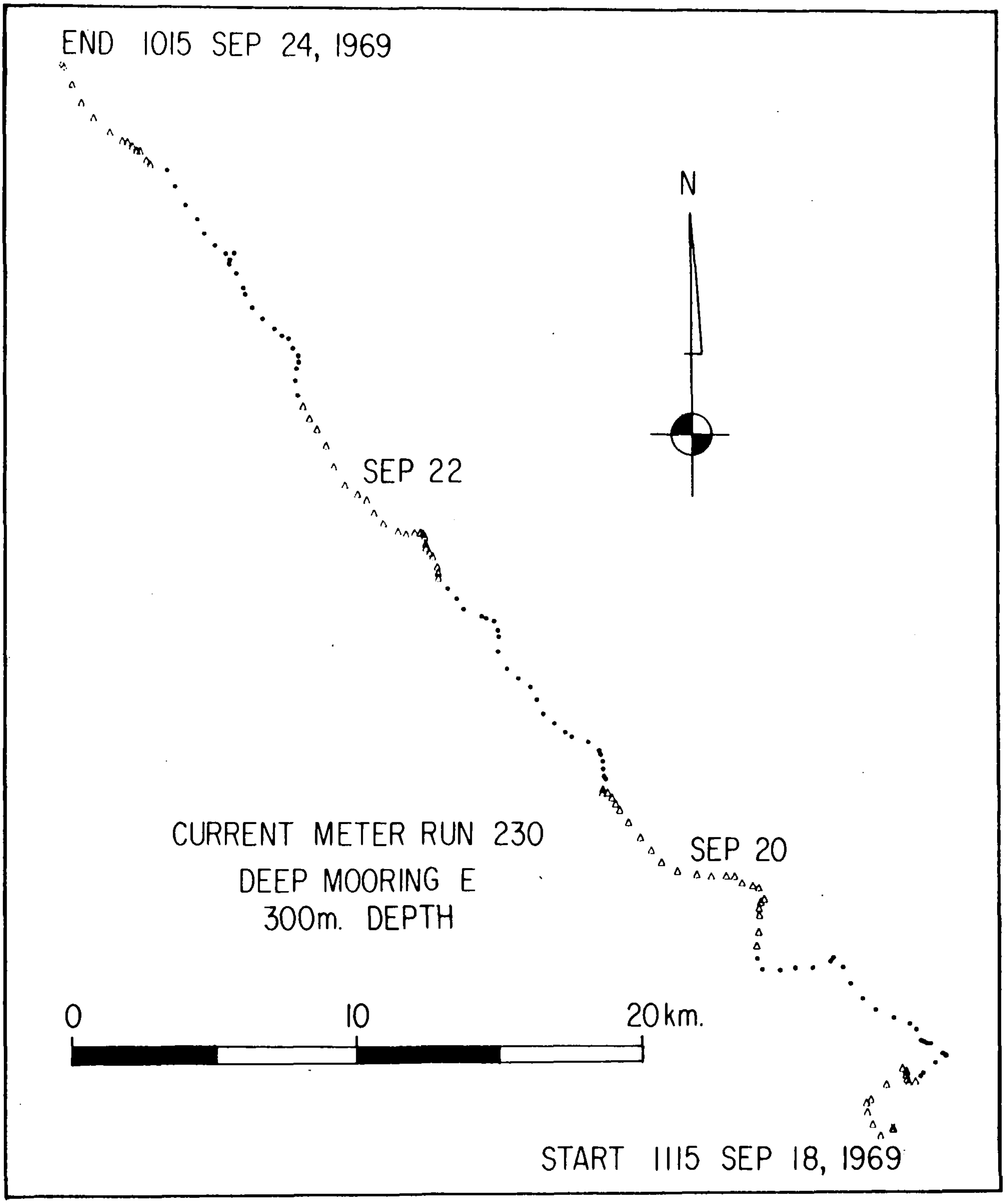
Depth of Current Meter: 300 m
Bottom Depth: 5490 m

Sampling Interval: 15 minutes
Time Interval on
Progressive Vector Diagram: 60 minutes

Resulting Drift: Direction: 322°true. Speed: 9.2 cm/sec

REMARKS:

Moderate flow to the northwest with weak mixed tidal currents superimposed.


END 1015 SEP 24, 1969
N
SEP 22
CURRENT METER RUN 230
DEEP MOORING E
300m. DEPTH
SEP 20
0
10
20 km.
START 1115 SEP 18, 1969

CURRENT METER STATION #231

Geodyne Film-Recording Current Meter #342

Location: Deep Mooring E
Position: Latitude: 27°30.0'N
Longitude: 157°52.0'W

Period: From: September 18, 1969, 1115
To: September 24, 1969, 1015
Total Time: 5 days, 23 hours, 00 minutes
Time Zone: 150°W

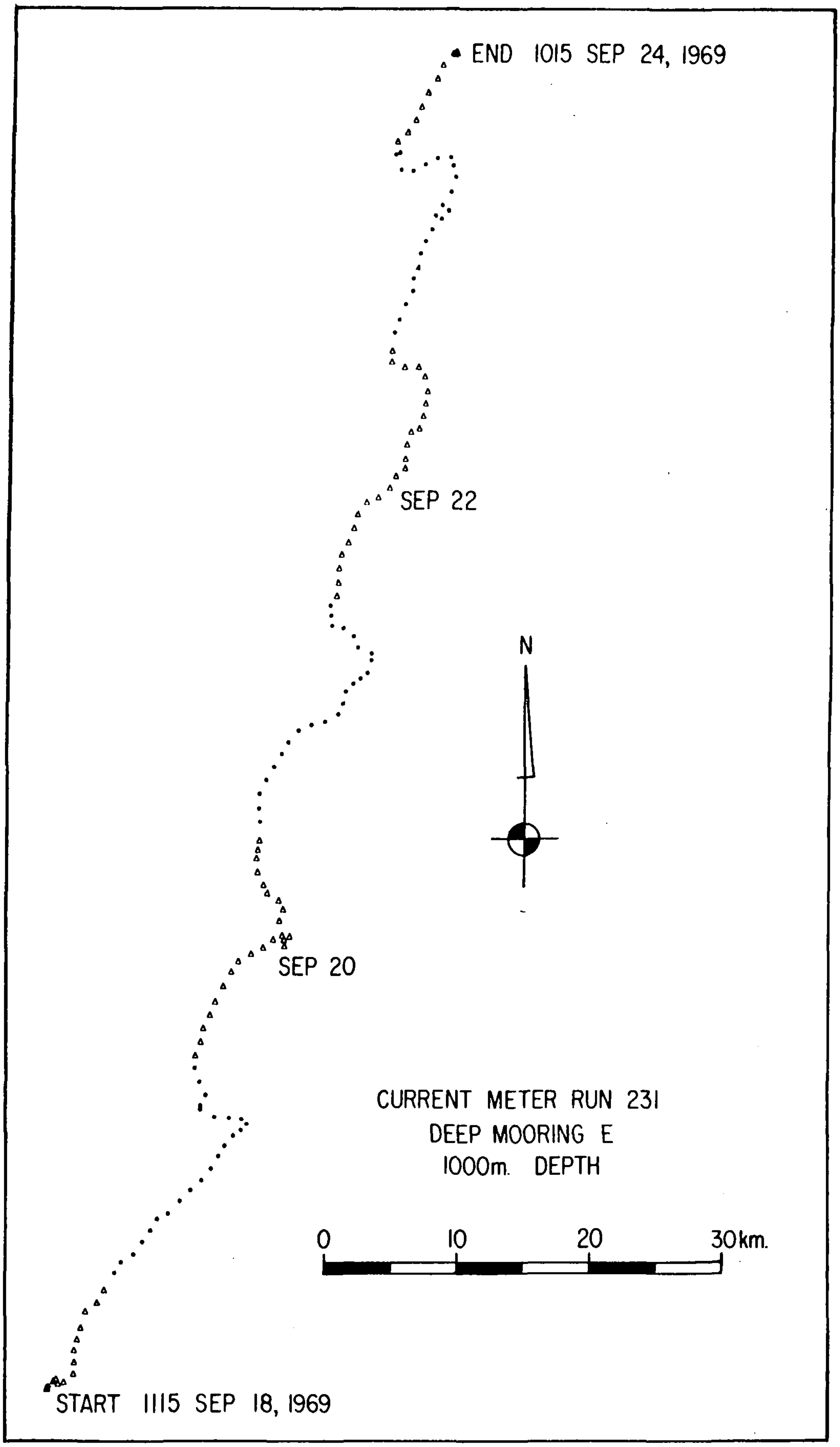
Depth of Current Meter: 1000 m
Bottom Depth: 5490 m

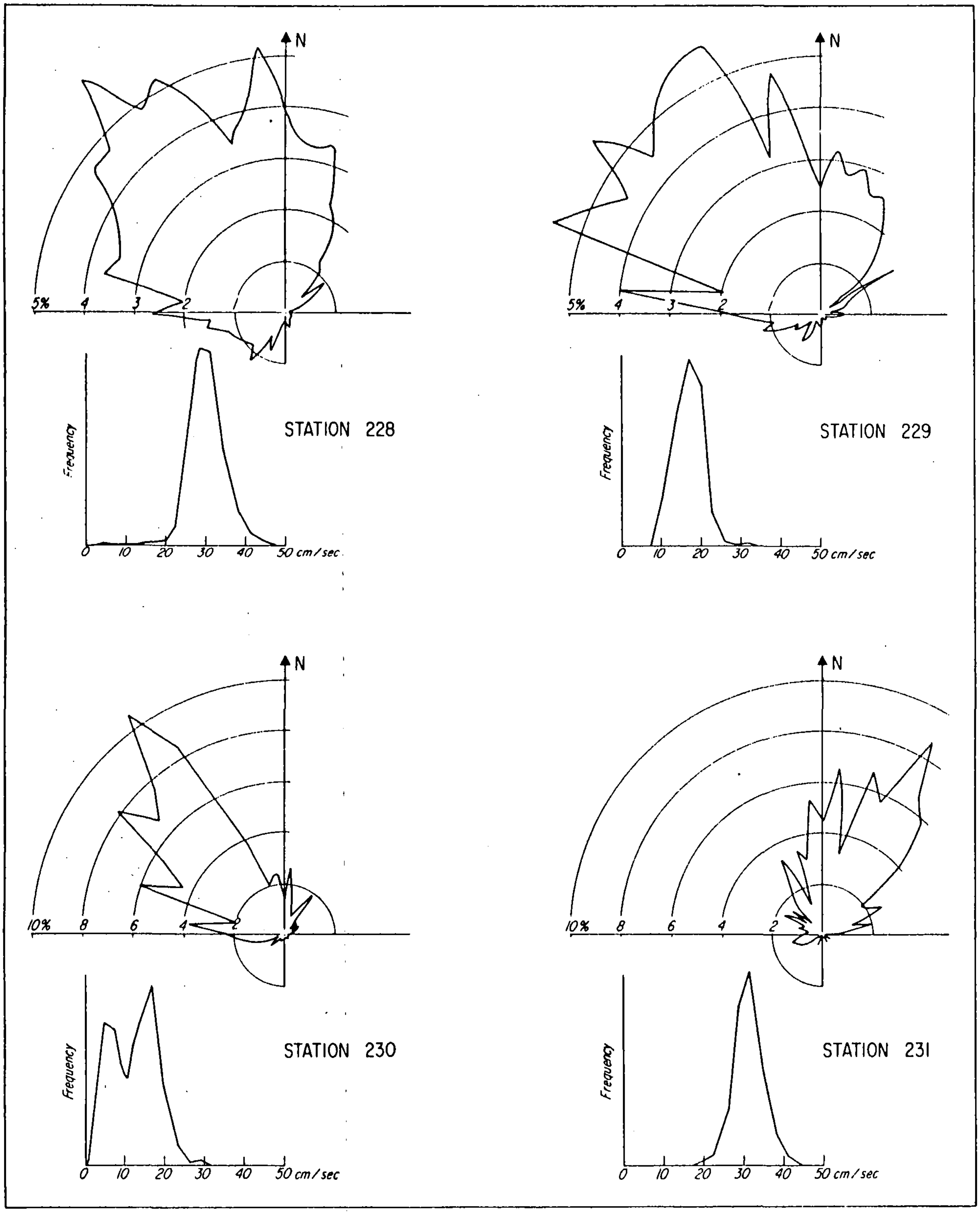
Sampling Interval: 15 minutes
Time Interval on
Progressive Vector Diagram: 60 minutes

Resulting Drift: Direction: 17°true. Speed: 20.2 cm/sec

REMARKS:

Strong flow to the north with strong diurnal tidal currents superimposed.


END 1015 SEP 24, 1969
SEP 22
N
SEP 20
CURRENT METER RUN 231
DEEP MOORING E
1000m. DEPTH
0
10
20
30km.
START 1115 SEP 18, 1969


N
5%
4
3
2
Frequency
0
10
20
30
40
50 cm/sec
STATION 228
N
5%
4
3
2
Frequency
0
10
20
30
40
50 cm/sec
STATION 229
N
10%
8
6
4
2
Frequency
0
10
20
30
40
50 cm/sec
STATION 230
N
10%
8
6
4
2
Frequency
0
10
20
30
40
50 cm/sec
STATION 231

CURRENT METER STATION #232

Geodyne Film-Recording Current Meter #342

Location: Deep Mooring F
Position: Latitude: 27°30.0'N
Longitude: 157°43.0'W

Period: From: November 20, 1969, 1600
To: November 24, 1969, 1030
Total Time: 3 days, 18 hours, 30 minutes
Time Zone: 150°W

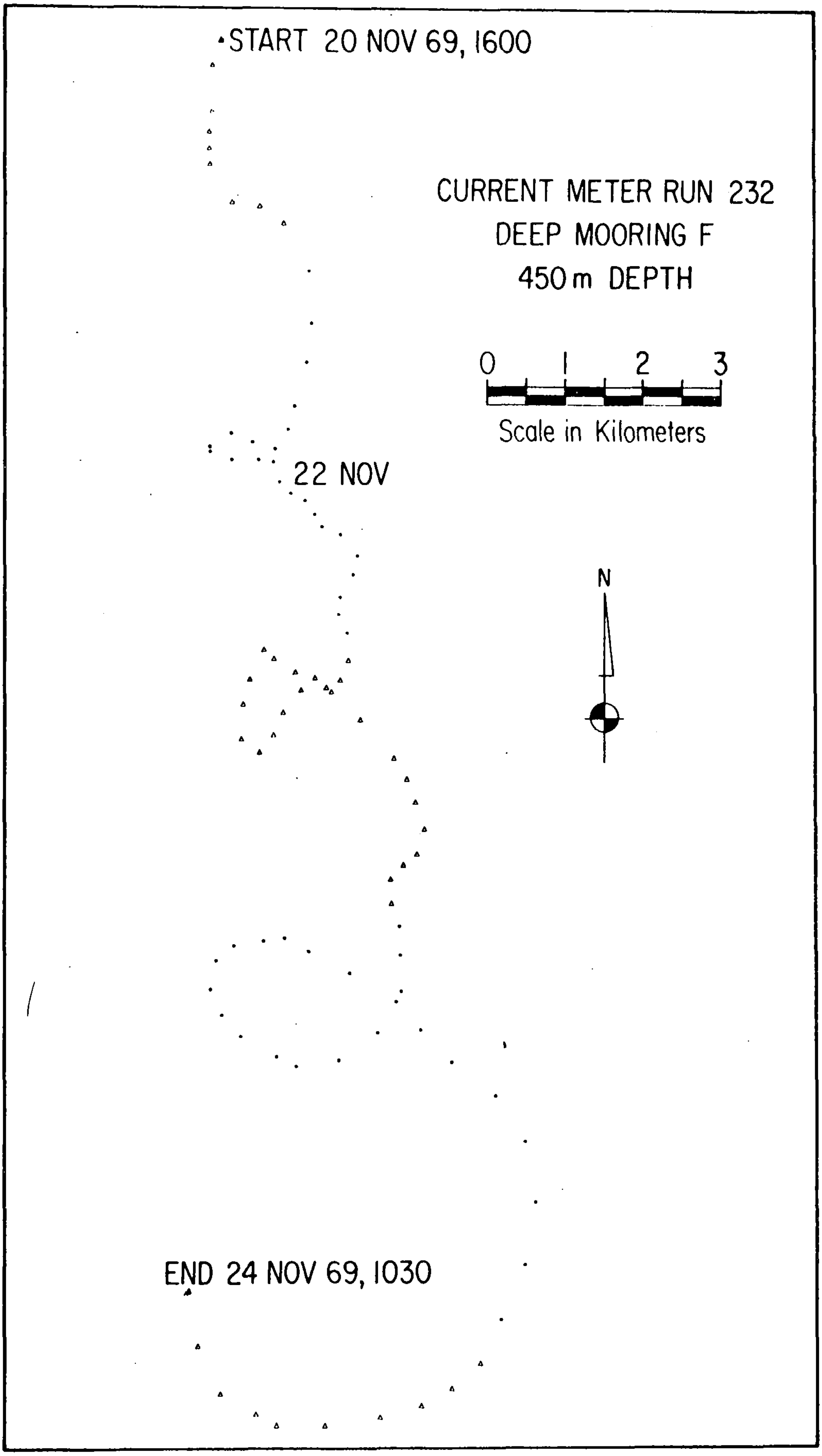
Depth of Current Meter: 450 m
Bottom Depth: 5490 m

Sampling Interval: 15 minutes
Time Interval on
Progressive Vector Diagram: 60 minutes

Resulting Drift: Direction: 182°true. Speed: 4.8 cm/sec

REMARKS:

This is the only current meter from Mooring F which operated successfully. The observations indicate a weak flow to the south with diurnal tidal currents superimposed.



START 20 NOV 69, 1600
CURRENT METER RUN 232
DEEP MOORING F
450 m DEPTH
0 1 2 3
Scale in Kilometers
N
22 NOV
END 24 NOV 69, 1030

CURRENT METER STATION #301

Aanderaa Current Meter

Location: Penguin Bank, Southwest Molokai
Position: Latitude: 20°59.0'N
Longitude: 157°41.5'W

Period: From: April 26, 1969, 1315
To: May 27, 1969, 1545
Total Time: 31 days, 2 hours, 30 minutes
Time Zone: 150°W

Depth of Current Meter: 10 m
Bottom Depth: 47 m

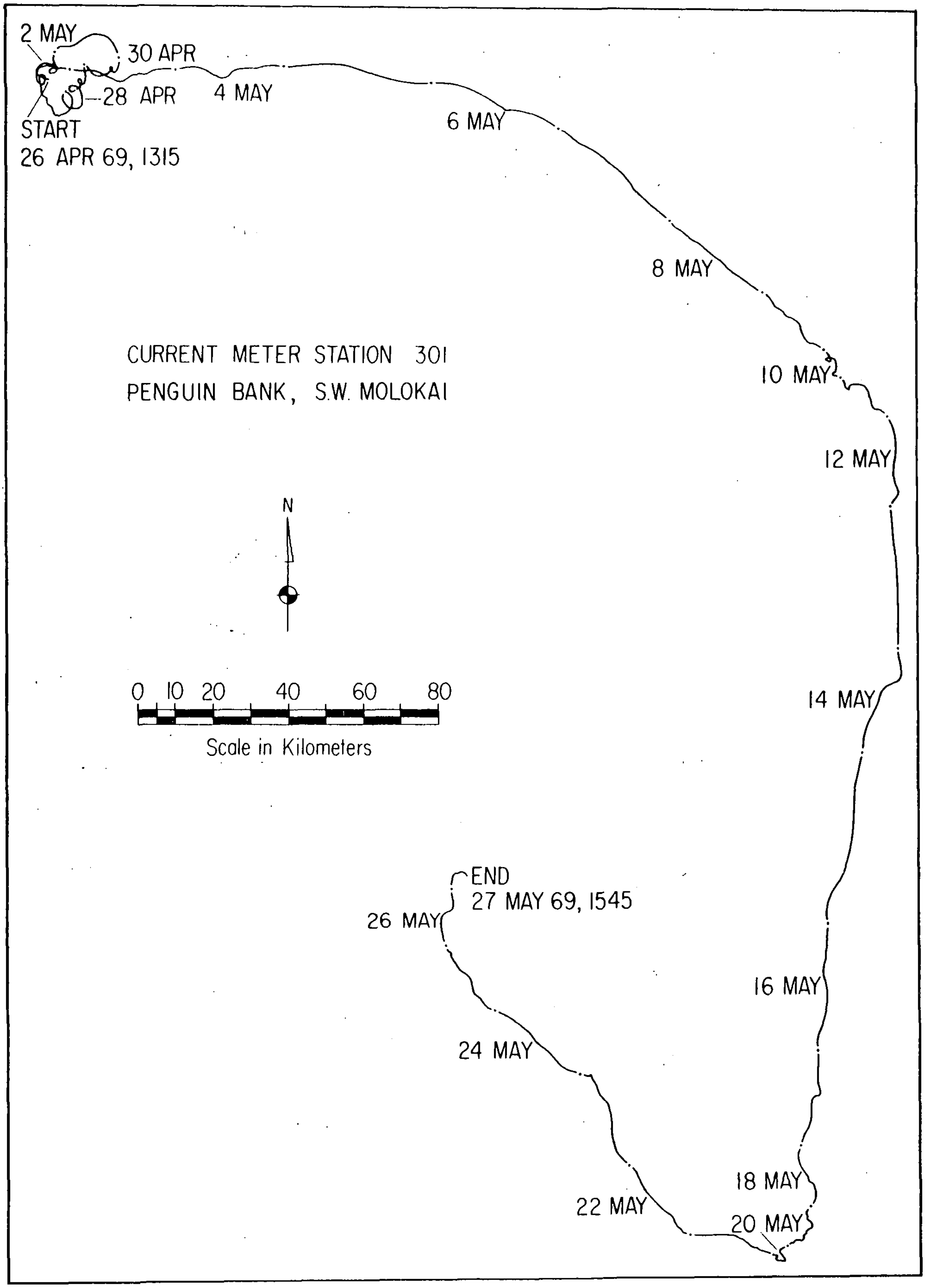
Sampling Interval: 10 minutes
Time Interval on Progressive Vector Diagram: 60 minutes

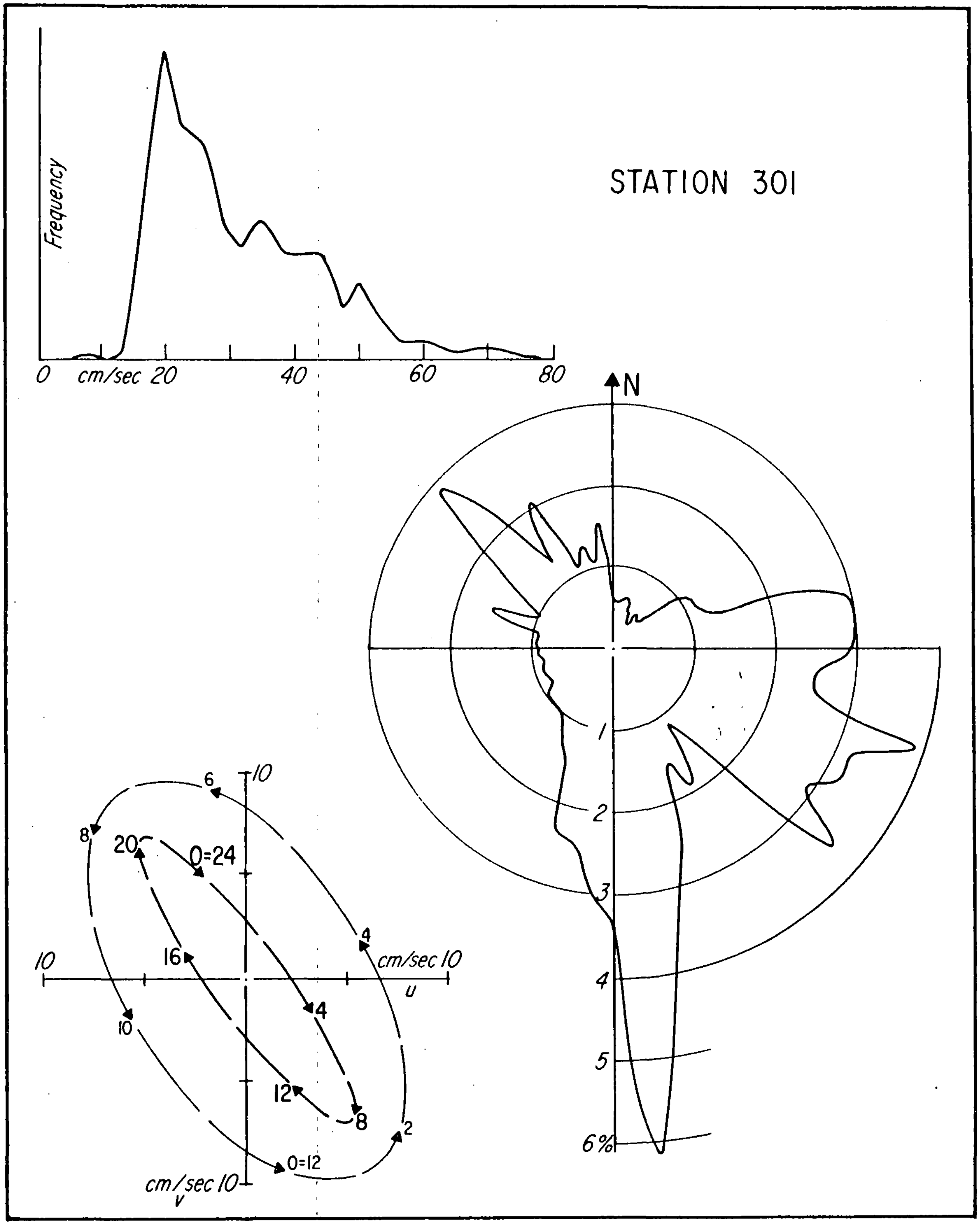
Resulting Drift: Direction: 154°true. Speed: 8.4 cm/sec

Tidal Ellipses:		Diurnal	Semidiurnal
Direction of Major Axis		324°	145°
Amplitude in Major Axis, cm/sec		8.6	11.3
Amplitude in Minor Axis, cm/sec		1.8	5.8
Rotational Sense of Tidal Current		Anticyc.	Cyclonic
u-Component:			
Amplitude, cm/sec		5.5	7.9
Phase		+114°	-74°
95% Confidence Interval		+70° to +150°	-50° to -100°
v-Component:			
Amplitude, cm/sec		6.8	9.4
Phase		-42°	+164°
95% Confidence Interval		0° to -80°	+130° to -170°
Coherence with	(uh)	0.521	0.768
Honolulu Sea Level	(vh)	0.509	0.608
Expected Coherence for Unrelated Series (95% Confidence)		0.44	
Tidal Amplitude in Honolulu, cm	(h)	18.3	13.0

REMARKS:

Strong currents of variable direction with weak tidal currents superimposed.


2 MAY
30 APR
28 APR
4 MAY
START
26 APR 69, 1315
6 MAY
8 MAY
CURRENT METER STATION 301
PENGUIN BANK, S.W. MOLOKAI
10 MAY
12 MAY
N
0 10 20 40 60 80
Scale in Kilometers
14 MAY
END
27 MAY 69, 1545
26 MAY
16 MAY
24 MAY
18 MAY
22 MAY
20 MAY



STATION 301
Frequency
0
cm/sec 20
40
60
80
N
1
2
3
4
5
6%
10
cm/sec 10
u
v
6
8
20
0=24
4
16
10
12
8
2
0=12

Unclassified

Security Classification

DOCUMENT CONTROL DATA - R&D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

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10. AVAILABILITY/LIMITATION NOTICES

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None	Office of Naval Research

13. ABSTRACT

This report presents the results of eight simultaneous current measurements made with moored current meters anchored in the Leeward Islands of the Hawaiian chain. Also included are the data from current meter that was anchored on Penguin Bank (southwest of Molokai Island) during approximately the same period. Data from the nine current meter stations are given as progressive vector diagrams, frequency distributions of direction and speed, and computed tidal ellipses.

The mooring techniques, data reduction, and computation of the tidal ellipses are described. The results show that the mean flow through the Leeward Islands is 4.6 cm/sec to the north. This northerly drift is probably indicative of an anticyclonic gyre centered northeast of the Hawaiian chain (Sverdrup et al., 1942). Amplitudes of the tidal currents vary from 3.0 to 32.5 cm/sec and the average amplitude is 13.0 cm/sec.

Also discussed are current measurements at several depths from two taut-line, deep-sea moorings anchored at 27.5°N latitude and 157.8°W longitude. The results show the tidal currents at different depths are not in phase.

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14. KEY WORDS	LINK A		LINK B		LINK C	
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