27
5-15-81

24 to 21715

(1)

R-4353

Ocean Thermal Energy Conversion
Program

Argonne National Laboratory

sponsored by

U. S. Department of Energy

under Contract W-31-109-Eng-38

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

ARGONNE NATIONAL LABORATORY
9700 South Cass Avenue
Argonne, Illinois 60439

ANL/OTEC-TM-3

MASTER

CURRENT METER DATA REPORT
September 1980 - December 1980
Mooring OTEC-HB

by

T.M. Roman and D.-P. Wang

Energy and Environmental Systems Division
Applied Geoscience and Engineering Group

March 1981

DISCLAIMER

This book was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

Work conducted as part of the
Argonne Ocean Thermal Energy Conversion Program

Sponsored by

U.S. DEPARTMENT OF ENERGY
Assistant Secretary for Conservation and Renewable Energy
Division of Ocean Energy Systems

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

CONTENTS

Text	1
----------------	---

TABLE

1 Summary of Statistics for Mooring OTEC-HB, Keahole Point, Island of Hawaii	4
---	---

FIGURES

1 Bathymetry near Keahole Point, Island of Hawaii, and Location of the OTEC-HB Current Meter Mooring	3
2-5 Graphic Displays of Low-Pass Current Velocity Distributions, 47 m, 70 m, 154 m, and 829 m	5-8
6-9 Low-Pass, Low-Low-Pass, and Band-Pass Current Velocity Time Series, 47 m	9-12
10-11 Low-Pass, Low-Low-Pass, and Band-Pass Current Velocity Time Series, 70 m	13-14
12-14 Low-Pass, Low-Low-Pass, and Band-Pass Current Velocity Time Series, 154 m	15-17
15-17 Low-Pass, Low-Low-Pass, and Band-Pass Current Velocity Time Series, 829 m	18-20
18 Stick Diagrams of Low-Low-Pass Current Velocity, 47 m, 70 m, 154 m, and 829 m	21
19-22 Power Spectrum Diagrams of Low-Low-Pass Current Velocity Time Series	22-25

CURRENT METER DATA REPORT
September 1980 - December 1980
Mooring OTEC-HB
by
T.M. Roman and D.-P. Wang

Data tapes received from EG&G, Environmental Consultants, contained current meter records from instrumented mooring OTEC-HB. The mooring was deployed on September 23, 1980, at $19^{\circ}54.88'N$ and $156^{\circ}08.93'W$ near the OTEC-1 site approximately 14 nautical miles northwest of Keahole Point, Island of Hawaii (see Fig. 1). Deployed in 1345 m of water, the mooring had five Aanderaa RCM-5 current meters, one at each of the following depths: 47 m, 70 m, 99 m, 154 m, and 829 m. Data from the 99 m depth were of poor quality and were not included on the data tapes.

Raw data consisted of east-west (U) velocity, north-south (V) velocity, temperature (T), and pressure (P) time series from September 23, 1980, through December 20, 1980, with a recording interval of 15 min. EG&G's conventions of Greenwich mean time and direction measured clockwise from north were maintained throughout data processing.

Since pressure/time series consisted of constant values at all four current meters, the pressure data were not processed. The remaining series (U,V,T) were filtered into various frequency domains, thereby removing very high frequencies and separating tidal oscillations from very low frequencies. Spectral analyses were performed on the nontidal U and V time series.

In order to filter out high-frequency noise of periods of 2 hr or less, a Lanczos taper was applied to the original data. The resulting low-pass time series (periods greater than 2 hr) were resampled at 1-hr intervals, and the basic statistics of mean, variance, minimum value and maximum value were computed (see Table 1). Figures 2-5 show the distribution of low-pass velocity data via three types of graphs:

1. Scatter Diagram. A plot of the U velocity component vs. the V velocity component.
2. Frequency Distribution Map. A mapping of the concentration of current data points with respect to

speed and direction components of velocity. The map is based on a two-dimensional histogram, with the frequency represented in the third dimension and with the cumulative sum of volumes equaling one (i.e., 100% of the data). In a frequency distribution map, "contours" bound the smallest areas (i.e., the smallest number of regions) containing 20%, 40%, 60%, 80%, and 100% of the total data set.

3. Speed Histogram. A plot of frequency of velocity data points with respect to the given speed intervals.

A second application of a Lanczos taper yielded low-low-pass U, V, and T time series with periods greater than or equal to 34 hr. U, V, and T band-pass time series consisting of periods of 2-34 hr were then obtained by subtracting the 34-hr low-low-pass time series from the 2-hr low-pass series. Figures 6-17 show total low-pass and low-low-pass time series for each of the four current meters, along with a select period of each band-pass series. Two sections of bad temperature data found in the 154 m depth records were excluded from Figs. 12(c) and 13(c). The stick plots in Fig. 18 combine low-low-pass U velocity and V velocity components.

Spectral analyses were then carried out for U and V low-low-pass time series. The method employed was that of Cooley-Tukey, i.e., a Fourier transform of the correlation function. Calculations yielded U and V power spectra in units of $(\text{cm/s})^2/(\text{c/day})$, a bandwidth of 1.9×10^{-3} c/day, and 50 degrees of freedom. Power spectra are displayed along with coherence squared and phase difference in Figs. 19-22.

Fig. 1 Bathymetry near Keahole Point, Island of Hawaii, and location of the OTEC-HB current meter mooring

Table 1 Summary of Statistics for Mooring OTEC-HB,
Keahole Point, Island of Hawaii

Mooring	Instrument	Location		Depth (m)		Data Type	Start Time (GMT)				Data Hours	Basic Statistics *			
		Lat (N)	Long (W)	Bottom	Instrument		Yr	Mo	Day	Hr		Mean	Variance	Minimum	Maximum
OTEC-HB	RCM-5	19 54.88	156 8.93	1345	47	U	80	9	23	2300	2107	12.43	300.55	-54.33	69.17
OTEC-HB	RCM-5	19 54.88	156 8.93	1345	47	V	80	9	23	2300	2107	10.45	375.43	-59.10	69.10
OTEC-HB	RCM-5	19 54.88	156 8.93	1345	47	T	80	9	23	2300	2107	28.44	1.00	24.66	30.10
OTEC-HB	RCM-5	19 54.88	156 8.93	1345	70	U	80	9	23	2300	2107	11.17	284.20	-49.93	61.87
OTEC-HB	RCM-5	19 54.88	156 8.93	1345	70	V	80	9	23	2300	2107	8.18	294.38	-63.54	61.82
OTEC-HB	RCM-5	19 54.88	156 8.93	1345	70	T	80	9	23	2300	2107	27.72	1.96	23.00	29.74
OTEC-HB	RCM-5	19 54.88	156 8.93	1345	154	U	80	9	23	2300	2107	2.56	89.02	-30.00	34.39
OTEC-HB	RCM-5	19 54.88	156 8.93	1345	154	V	80	9	23	2300	2107	0.81	153.02	-33.54	47.68
OTEC-HB	RCM-5	19 54.88	156 8.93	1345	154	T	80	9	23	2300	2107	21.47	0.44	19.64	23.63
OTEC-HB	RCM-5	19 54.88	156 8.93	1345	829	U	80	9	23	2300	2109	-2.06	27.86	-22.61	17.57
OTEC-HB	RCM-5	19 54.88	156 8.93	1345	829	V	80	9	23	2300	2109	-0.90	50.71	-29.74	21.20
OTEC-HB	RCM-5	19 54.88	156 8.93	1345	829	T	80	9	23	2300	2109	5.23	0.03	4.70	5.69

* Velocity in units of cm/s; temperature in units of °C.

Fig. 2 a) Scatter diagram of east-west (U) vs. north-south (V) velocity, b) frequency distribution map, and c) speed histogram, of the low-pass current records

STATION HB 70M

Fig. 3

a) Scatter diagram of east-west (U) vs. north-south (V) velocity, b) frequency distribution map, and c) speed histogram, of the low-pass current records.

Fig. 4 a) Scatter diagram of east-west (U) vs. north-south (V) velocity, b) frequency distribution map, and c) speed histogram, of the low-pass current records.

Fig. 5 a) Scatter diagram of east-west (U) vs. north-south (V) velocity, b) frequency distribution map, and c) speed histogram, of the low-pass current records

Fig. 6 a) East-west (U) velocity component, b) north-south (V) velocity component, and c) temperature, of the low-pass current records

STATION HB 47M

Fig. 7 a) East-west (U) velocity component, b) north-south (V) velocity component, and c) temperature, of the low-low-pass current records (period greater than 24 hr).

Fig. 8 For a 12-day period, a) east-west (U) velocity component, b) north-south (V) velocity component, and c) temperature, of the band-pass current records.

STATION HB 70M

Fig. 9 a) East-west (U) velocity component, b) north-south (V) velocity component, and c) temperature, of the low-pass current records

Fig. 10 a) East-west (U) velocity component, b) north-south (V) velocity component, and c) temperature, of the low-low-pass current records (period greater than 24 hr).

STATION HB 70M

Fig. 11 For a 12-day period, a) east-west (U) velocity component, b) north-south (V) velocity component, and c) temperature, of the band-pass current records

Fig. 12 a) East-west (U) velocity component, b) north-south (V) velocity component, and c) temperature, of the low-pass current records.

STATION HB 154M

Fig. 13 a) East-west (U) velocity component, b) north-south (V) velocity component, and c) temperature, of the low-low-pass current records (period greater than 24 hr)

Fig. 14 For a 12-day period, a) east-west (U) velocity component, b) north-south (V) velocity component, and c) temperature, of the band-pass current records.

Fig. 15 a) East-west (U) velocity component, b) north-south (V) velocity component, and c) temperature, of the low-pass current records

Fig. 16 a) East-west (U) velocity component, b) north-south (V) velocity component, and c) temperature, of the low-low-pass current records (period greater than 24 hr)

STATION HB 829M

Fig. 17 For a 12-day period, a) east-west (U) velocity component, b) north-south (V) velocity component, and c) temperature, of the band-pass current records.

STATION HB

Fig. 18 Stick diagrams of low-low-pass current velocity (period greater than 24 hr).

STATION HB 47M

22

DOF: 15.0
LAGS: 50.00 HRS
BW: 1.90×10^{-3} C/DAY

Fig. 19 a) Power spectrum for east-west (U) and b) north-south (V) velocity components, c) coherence squared, and d) phase between the two velocity components, for the low-low-pass current records (period greater than 24 hr)

DOF: 15.0
LAGS: 50.00 HRS
BW: 1.90×10^{-3} C/DAY

Fig. 20 a) Power spectrum for east-west (U) and b) north-south (V) velocity components, c) coherence squared, and d) phase between the two velocity components, for the low-low-pass current records (period greater than 24 hr)

STATION HB 154M

DOF: 15.0
LAGS: 50.00 HRS
BW: 1.90×10^{-3} C/DAY

Fig. 21 a) Power spectrum for east-west (U) and b) north-south (V) velocity components, c) coherence squared, and d) phase between the two velocity components, for the low-low-pass current records (period greater than 24 hr)

DOF: 15.0
LAGS: 50.00 HRS
BW: 1.90×10^{-3} C/DAY

Fig. 22 a) Power spectrum for east-west (U) and b) north-south (V) velocity components, c) coherence squared, and d) phase between the two velocity components, for the low-low-pass current records (period greater than 24 hr)