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DATA REPORT

?OHER ~ OTEC CRUISE

Compiled and Edited

by

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CENTER FOR ENERGY AND ENVIRONMENT RESEARCH

UNIVERSITY OF PUERTO RICO ~ US. DEPARTMENT OF ENERGY

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DATA REPORT

?uER - OTEC CRUISE

JULY 30 - AUG. 3, 1980

Compiled and Eaitea

By

José Manuel tépez, PhD.

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Vertical distribution of chlorophyll at Benchmark in

successive hydrocasts during July 30-31, 1980.

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?The ability to detect the effects of an OfEC plant on the marine environment is dependent upon the magnitude of its effects relative to the scale and intensity of variability (pattern) within this ecosystem. ?The scale of pattern examined in this study ie approximately 10 kn?

Which has been estimated to be the area whose alteration by the operation of an OMEc plant can be physically measured, In addition, we studied the

structure of the ocean in transects extending 50 km south of the site.

?The purpor

of this cruise was to determine the magnitude of variability to various ecosystem components within and between such areas. small scale and large scale transects were run to deteraine the presence of environmental gradients, if any, and the magnitude of between station variability. The cruise was conducted on the R/V CRANFORD during July 30 through Aug. 2, 1980, this was the fifth cruise in our series of

bicnonthly cruises.

Hydrographic Data

Hydrocasts were made with 5 Liter or 12 Liter Niskin bottles
usually lovered to depths of 1000 m. pottles were placed at nominal
Septhe of 0, 10, 25, 50, 75, 100, 150, 200, 250, 300, 400, 500, 650,
900, 1000 m for determinations of temperature, salinity, oxygen,

chlorophyll and nutrients (nitra

nitrite, phosphate, and eilicate).
Temperature was measured with paired doep sea reversing

thermoneters. the thermometers were recently calibrated at the

Physical Chemical Occanographic Data Facility (PCODF) at Scripps

Institution of Oceanography and measurements vere considered accurate

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to 0.01°C. Unprotected thermometers woxe placed on bottles sampling
fat depths of. 100 meters or greater.
Salinity was determined with a lytech induction salinoneter.

Roadings are considered accurate to 0.003°,

Dissolved oxygen vas determined by the Winkler method as xevised hy Caxpenter (1965) and modified by Anderson (1971). Measurements

are accurate to 0.02 mt/t. Nutrients were measured with a Technicon Automnalyzer using methods described by Strickland and Parsons (1968). Chtorophyli was measured with a Turner Model 111 fluorometer using nethods described by Strickland and Parsons (1968).

Station depths were obtained through an #.D.0. Depth Recorder permanently installed on the ship of estimated fron a chart, Os 26659. Sonic depths obtained in Fathoms were converted to neters but were not, corrected for speed of sound variations. chart depths are indicated by (C) and sonic depths by an (6) besides the number. All depths are

Densities (0,) were calculated from a handbook of Oceanographic Tables (Bialek, 1966).

Station tines are given in Greenwich Mean ime (GH), Plankton

?Tow Times are in local time. Puerto Rico is 4 hours behind G.M.7.

Not tows

?Zooplankton tows were made with a 75 cm opening-closing net

?equipped with 202 um mesh. Volune of water filtered was calculated

from a flowmeter suspended off center in the mouth of the net.

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Figure 4.

XBP graphs for the series of

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Figure 5.

XBT graphs for a
series of stations
in the vicinity of
Benchmark on July 31
?and Aug. 1,1980.

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Progression of XBT graphs from

casts while underway from 6-6

towards Vieques on Aug. 1, 1980.

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Figure 7.

XBT graphs in a transect

while underway from V-6

Towards Pt-6 on Aug. 1,

1980.

---Page Break---

Figure 8, XBT graphs in a transect.

while undervay fron J-6

towards G-6 on Aug. 2, 1960.

---Page Break---

XBT graphs from casts while

?underway from Guayanilla to

?cabo Rojo on Aug. 3, 1980.

---Page Break---

DEPTH IN METERS

504

100.

Figure 10, Salinity versus depth at Benchmark stations

fon July 30-31, 1980.

*

35.00 | 36.00 37.00 37.50

SALINITY 0/00

---Page Break---

?

50: «

100

?

| .

250 rod

«

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5004

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. Figure 12. nengerature versus depth at Benchnark

ations en July socne, as50"

i004 ¢

aus

3.05.0 10,00 15,00 20,00 25,00 30,00

TEMPERATURE °C

39

---Page Break---

TEMPERATURE °C

21

5.0

10.04

Aad

8

So

25.0

30.0

34,50

Pee :

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WE igure 12. satinity versus

*. July 30 ~"noge

?

*

35,00 36.00

saLinity 0/00

Temperature composi

3, 1980. posite,

37,00 37,50

---Page Break---

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°

100

2504

3

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DEPTH IN METERS

1000 4

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x

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¥ igure 19: salinity versus nepth composite,

M6 gq

34,50

35,00 36.00 37,00 37.50

SALINITY °/,,

a

---Page Break---

50

100

250.4

500

DEPTH IN METERS

1000

116

Figure 14.

Temperature versus depth composite,

suly 30 ~ Aug. 3, 1980,

Sa

3.0 5.0 10.00 15,00 20,00 25,00 30.00

TEMPERATURE °C

---Page Break---

TEMPERATURE °C

21

5.04

10.04

So

2

5

25.0

30.0

34.50

: Figure 15. Temperature versus salinity at Benchmark

: stations on July 30-31, 1980.

?

35.00 36,00 37.00 37,50

sacinity 0/00

---Page Break---

DEPTH IN METERS

04 $

504 .

.

1004 .

.

2504 .

5004

Figure 16. Dissolved oxygen versus depth at Benchmark

station July 31, 1980.

10004 .

ge

25 3.0 4.0 5.0 5.5

DISSOLVED OXYGEN ML/L

---Page Break---

as]

1004

2504 ~*

oe

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+

4

5004

g -

E

2 *

z .

= :

Figure 17. Dissolved omygen versus depth at Boncheae®

stations on Zuhy 30-31, 1980,

.

.

10004 ?

16

25 3.0 4,0 5.0 5,5

DISSOLVED OXYGEN ML/L

48

---Page Break---

50

100

250

8

DEPTH IN METERS

1000:

aete

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4 ue

wae

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a, Fisure 18. pissoived oxygen versus depth composite,

ate uly 30-~ aug. 3, 1980.

ae

hoe

we

tHe

25 3.0 4.0 5.0 5.5

DISSOLVED OXYGEN ML/L

---Page Break---

100

200

300

400

500

600,

DEPTH IN METERS

700.

200.

900,

1000.

Figure 19.

°

PHOSPHATE UGAT PO4-P/L

0,2 04 6 08 19 12 14 16 18 20

a

3

2

+

v

.

*

Phosphate versus depth at Benchmark, July 20-31, 1980.

?7

---Page Break---

°c

TEMPERATURE IN

27

26

25

24

23

22

2a

20

19

a8

uv

16

15

4

a3

2

an

20

*

PHOSPHATE UGAT PO4-P/L

Qt O65 0,8 19 12 14 16 1,

Figure 20.

Phosphate concentrations versus temperature at enchmatk

1757.38, 65°51.5N during July 30 and 31, 1980.

4

---Page Break---

PHOSPHATE UGAT PO4-P/L

8 oA of 98 10 12 14 46 18 20

1004 «

2004

300,

400.

5004

600. .

DEPTH IN METERS

700.

800

900.

1000.

Figure 21. Moan phosphate concentrations versus mean depth at Benchmark 17957.3, 65°51.5H during July 30 and 31, 1980.

---Page Break---

°

100

200

300

400

500

600

DEPTH IN METERS

700

800

900

1000

1100.

o

PHOSPHATE UGAT P04 P/t.

0,2 0.4 06 08 19 12 14 16 18 20 22

M4 vel 0.5 mi offshore

V3 3.5 aL offshore

V5 15.5 mi offshore

9-6 31.8 mi offshore

Figure 22.? Phosphate concentrations versus

* depth in a transect south of

Vieques on Aug. 1y 1980.

50

---Page Break---

o

°

°

100

200

300

400

DEPTH IN METERS

700

800

900

1000

PHOSPHATE UGAT PO4-P/L

0,2 O4 0,6 08 1,012 14 1.6 18 20

© Pt 0.5 mi

O Pt-3 3.5 mi

a PLS 15.5 ai

. fo Pt-6 31.5 mi

ea

e o

oe

offshore

offshore

offshore

offshore

Figure 23. phosphate concentrations versus depth in a transect south of

Punta Tuna, Aug. 12, 1980.

---Page Break---

9

PHOSHPATE UGAT POg P/L

o Ogi 84 06 0819 12 14 16 18

100

200

300

400

500

600

DEPTH IN METERS

700

800

900

1000

Figure 24

:

*

9-5 15.5 mi

o 5-5 31.5 mt

eo

. *

Phosphate concentrations versus depth in a transect south of Jobos

Bay on Aug. 2, 1980.

52

offshore

offshore

offshore

offshore

---Page Break---

°

100

200

300

400

500

600

700

DEPTH IN METERS

800

900

1000

1100

Figure 25

PHOSPHATE UGAT Pog P/t,

0.6 08

19 12 14

*

ca

16 La 20

G1 0.5 mi

23 3.5 wf

B65 15.5 mi

© ce 21.5 mi

offshore

offshore

offshore

offehore

Phosphate concentrations versus dopth in a transect south of

Guayanilla on Aug.

3, 1980.

33

---Page Break---

100

200

300

400

500

600

DEPTH IN METERS

700

800

900

1000

1100

NITRATE - NITRITE UGAT W/L

002 44 Q6 ge 10 i,2 1,4 16 12 29 22 24 26 28 30 32

. Figure 26. Niteite-witrate concentrations

oe versus depth at Benchmark,

: Baly 30-31, 1980.

5a

---Page Break---

°c

?TEMPERATURE IN

29

28

27

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18

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16

15

14

13

12

an

10

o

NITRATE ~ NITRITE UGAT W/L

02 of 06 08 10 12 Lf 16 18 20 22 2.4 2.6 2,8 3.0

Figure 27. Nitrate-witrite concentrations. versus temperature at

Benchmark 17°57.3N, 65°51.5W during July 30 and 31, 1980.

:

---Page Break---

o

100

200

300

400

600

DEPTH IN METERS

700

800

900

1000

5004

NITRATE - NITRITE UGAT W/L

o (2 M06 98 10 12 Le 26 1p 20 2.2 24 26 2

Figure 26. Mean Witrate-Mitrite concentrations

. versus mean depth at Benchmark

17°57.34, 65°51.5W during July

. 30-31, 1980.

se

---Page Break---

NITRATE - NITRITE UGAT N/L

O02 a4 0.6 98 19 12 14 16 18 29 22 24 26 28 30

°

Vel 0.5 mi offshore

100 fe v9 35 mi offshore

%

200) ye * V6 31.5 mi offshore

«

eo

300 +* .

*

° 400 * .

*

2 .

E 500 *

° 2

z

& *

E 600

a " «

o

700

*

° 800 *

Pigure 29, witrate-Nitrite concentrations versus

Gepth ina transect. south of

900 Vieques on Aug. 1, 1980. *

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1000

---Page Break---

°

100

200

300

400

500

?600

DEPTH IN METERS

700

800

900

1000

o

NITRATE - NITRITE UGAT N/t

2 Q4 06 0.8 1,012 14 16 18 20 22 24 26 28

x

*

*

Pigure 30.

se

Ptl 0.5 mi

Pt-3 3.5 mi

Pt-5 15.5 mi

Pt-6 31.5 mt

offshore

offshore

offshore

offshore

a0 32

Nitvate-Nierite concentrations

versus depth in a transect south

of Punta Tuna on Aug.

1-2, 1980.

---Page Break---

DEPTH IN METERS

100

200

300

400

500

600

700.

800.

900.

1000

NITRATE - NITRITE UGAT N/L

Q2 04 06 0,8 1,0 1,2 14 16 18 20 22 24 26 2.8 30

J-1 0.5 mi offshore

. @ 5-3 3.5 mi offshore

95 15.5 mi offshore

oy © 5-6.31.5 mi offshore

Pigure 31. Nitrate-Nitrite concentrations versus depth

in a transect south of Jobos Bay on Aug. 2, 1980.

. *

59

---Page Break---

DEPTH IN METERS

02

20%

2004

300

400.

500.

600.

700.

800.

900.

1000

0,2 a4

Pigure 32.

Nitrate-nitrice concentrations vw

jet south of Guayanila on Aug. 3, 1980.

NITRATE - NITRITE UGAT N/L

60

Q6 43 10 1,2 1,4 1,6 1,8 29 2.2 2,4 2,6 28 3,0 32

% Gel 0.5 mi offshore

@ 6-3 3.5 mi offshore

6515.5 mi offshore

© 6631.5 mi offshore

?sus depth in a

---Page Break---

9

9

DEPTH IN METERS

100

200

300

500

600

700

200

900

1000

02

SILICATE UGAT Si/L

0.4 0.6 08 10 1,2 14 1.6 1,829 22

Figure 33. Silicate concentrations versus

Septh (m) at Benchmark 17°57.9N,

65°51.5W during July 30 and 31, 1989.

o

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°

°c

?TEMPERATURE IN

26

25

24

23

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a

20

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ae

v7

16

a5

14

a3

2

an

20.

0.2

SILICATE UGAT Si/1

Q4 06 0,810 12 14 6 18 20 22

Figure 34. siticate concentrations versus temperature at

Benchmark 17°53.5N, 65°51.5W during July 30 and

31, 1980.

a

---Page Break---

»

100

200

300

400

500

600

DEPTH IN METERS

700

800

900

1000

◦

a2

SILICATE UGAT 8i/L

a4 a6 a8 10 12 144

a

Figure 35.

48 2p

Mean Silicate concentrations

versus depth at Benchmark

17957.34, 65°51.5W during July

30 and 31, 1980.

---Page Break---

SILICATE UGAT Si/L

0 02 a4 a6 08 1,0 1,2 14 16 18 20 22 24

V1 0.5 ak offshore

100} 2 V3 3.5 mi offshore

° V5 15.5 mi offshore

200. V6 31-5 ml offshore

° 300F

soo

°

*

500, .

¢

E

° E +

Z 600.

° * 700;

e

800. .

°

900 *

9 .

.

1000.

2 1100!

*

Figure 36. Silicate concentrations versus depth in a transect south of

?Vieques on Aug. 1, 1960

2 6a

---Page Break---

SILICATE UGAT Si/L.

0 02 a4 06 0.8 10 1.2 14 1.6 1.8 2.0 2.2

°

3

100. & Pt-3 3.5 mi offshore

: .

° :

° @ og

5 : oe

&

B 600.

oo

o

; .

?

Figure 37. siticate concentrations versus depth in a transect south of

Punta Tune on Aug. 1 and 2, 1980.

---Page Break---

SILICATE UGA? Si/L.

° 2 02 af 06 a8 10 12 14 16 1,8 29 22 24 26

% 5-1 0.5 mi offshore

100 #5 3.5 al oftohore

°

5-5 15.5 al offahore

200 9631.5 al offehore

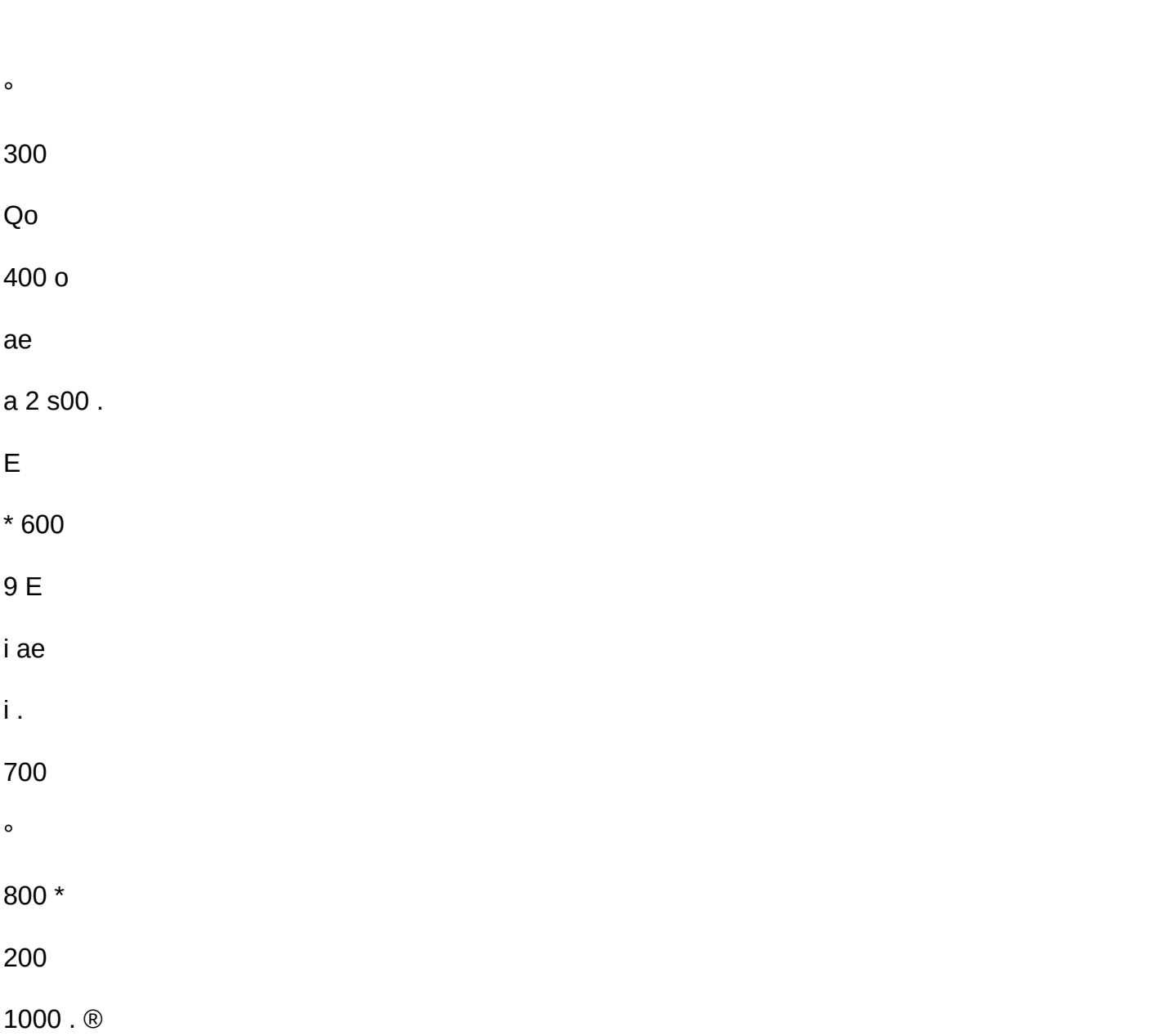

Figure 38. Silicate concentrations versus depth in a transect south of Jobos Bay on Ang. 2, 1980.

---Page Break---

SILICATE UGAT? Si/L

002 a4 06 a8 10 12 14 16 1,8 22 22

0.5 mi

100, 3.5 mi

15.5

é

200.

300

400

500

600

DEPTH IN METERS

700

800

900

1000

offenore

offshore

offshore

offshore

Figure 39. Silicate concentrations versus depth in a Ke ransect south of

Guayanitia en Aug. 3, 1980.

---Page Break---

se Ma/n? ca

e 0.2 0.3 0.4 0.5,

»

*

40

a *

80. *o

a *

. 2

120 % . 3

160 ° *

200:

o*

$ Pt-L 6.5 mt offshore

PES 3.5 mi offahore

O Pts 15.5 mi offshore

280 Pt-6 31.5 mi ofsh

Figure 40. Vertical distribution of chlorophyll in

42 trahsect south of Punta Tuna on Aus.

T ant 2, 1980,

9

---Page Break---

Depth in Meters

40

80

120

160.

200:

240

280

320

Figure 41

MG/m? HEA *

0,2

Vertical distribution of chlorophy11 at Bonchnark

in successive hyarocasts during July 30-31, 1980.

Benchmark 1

Benchmark 2

Benchmark 3

Boncheark §-5

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3 e39223

B3Ss3s

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pay

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1600

0600

0800

1000

3200

1200

1300

1400

1500

1600

1700

1930

2020

2120

2230

2330

030

0130

0330

0530

(0630

ons

2000

1130

SUDY 1980 CRUISE PLAN 8007

Depart Malecén

Arrive Benchmark station 17° $7.36 65° 51.5

xer

Hydrocast (primary productivity), 15 depths

xer

Oblique net tows (0-100, 100-200a)

Vertical net tow (1000-200), xan

Light profile, secehs.

Oblique net tows (0-100, 100-200m)

Vertical net tow (1000-200n), xen

Oblique net tow (0-100, 100-200m)

Vertical net tow (1000-2008)

Rydrocast_

XBT

Vertical net tow (100-200), xen

Oblique net tows (0-200, 100-200m)

Vertical net tow (1000-200m)

Oblique net tows (0-100, 100-2008)

Vertical net tow (1000-200m)

XBT

Oblique net tows (0-100, 100-2008)

yarocast,

xer

Begin small scale pattern study

?Steam for station &1

Arrive S-1 17° 52.5N 65° 53.90

Hydrocast at station 5-1 (primary productivity)

Obligue net tow (0-200m) station $1, xBt

?Steam for station S-2 17° $4.28 65° 50.2¥

Oblique net tow (0-100a), x8F

Steam for station S-3 17° 55.8 65° 46.5H

---Page Break---

av 2 (comes) exorse 8007

ras bLique net tow (0-100a), <P

2300 Steam for station $4 17* 56.0 65* $5.58

165 Obiigue not tow (0-2008), KBr

1430 Stoam for station 5-5 (Benchmark) 17° 57.64 65* 51.9%

asis Coiigue net tow (0-200m), Kar

11600 Stoan for station 5-6 17959.2H 65° 48.2

60s, Oblique net tow (0-200a), xe

saturn to bencimark

170 lydrocest at benchnazk.

1930 Begin night series

9 Steam for S-1 17° 52.28 65° 53.0%

2000 ?obtique net tow (0-100m) , x87

Stoam for $-2 17° 54.28 65° 50.24

2100 ?ObLique net tow (0-108), XBT

Steam for 6-3 17° 55.4 65° 46,58

9 2200 Oblique net tow (0-1008), xr

ydrocast

Steam for 6-4 27° 56.00 65° 55.5H

2400 Oblique net tow (0-100), xT

Stoan for 5-5 (benchmark) 17" 57.68 65* 51.98

par a

000 ?bLique net tow (0-200n), XB

?Steam for 8:6 17° 59.20 65* 48.28

9 100 Oblique net tow (0-108), xr

0200 Stoan to Views

Begin large scate study

XBr's at 30 min. intervals

o 0330 - x87 (underway)

ous Acrive station V2 18° 06.48 65 32.647

Hydeocast (2 deptne)

Shallow net tow

. Stean for V-2 16* 03.64 65* 32.69

9 Shallow net tow

oss ?Steam for V-3 18° 01.0% 65* 22.68

ygrocase

bLique net tow (0-100)

Steam for V-

17° 57.7% 65* 32.68

---Page Break---

Dar 3 (eon) ?cmurse 8007

830 ?Ligue net tov (0-100)

° Steam for V-5 17° 48.54 65 32.6%

Oblique net tow (0-200a)

1200 Byarocast

1500 Stean for V-6

mydrocast 17° 32.59% 65° 32.65

Lique net tow (0-200m)

Steam for PI-6

XBT's at 30 min intervals

2000 Arrive PR6 17* 28'' 65° 53'¥

o ydrocast net tow

Oblique net tow (0-100)

2300 Steas for PIS

Arrive PIS

° oblique net tow (0-100) 17°

Hy@rocast

Steam for PR-4

2! 65° sa"

° 100 Aerive PE4 17" 52.0n 65° 53°"

Oblique net tow (0-108)

Steam for PE3 (benchmark)

0200 Arrive PE-3 17" 56.08 65° 53'W

Mydrocast

Borique net tow (0-100m)

Steam for PR-2

0430 Arrive P12 17" 58.1m 65* 53"

ootique net tow

° ?Stan for PEI

0630 Arrive PI-1 17° 58.258 65* 534

Shalloe hyarocast (2 depths)

Shantow net tow

Stean for 3-2

0920 Aerive J-2 17° 54.0 66° 16.8

Shallow hydrocast. p depths)

Shallow net tow

Steam for 3-2

---Page Break---

pay 4 (ont

1000

1055

1430

4700

1800

1930

2100

2230

000

0n20

2600

ccwonér: 2007

Aerive 3-2:179 53.7°H 66°16.0'%

brique not tow

Areive J-3 17° 51.71N 66° 16.0%

ydrocast

Obtique net tow (0-100m)

Steam for 3-1

Arrive J-4 17° 47.74 66° 16.08

Oblique net tow (0-108)

Steam for 3-5

Arrive J-5 17° 39.74 66" 16.08

ydrocast

btique net tow (0-200)

Steam for 3-6

Aerive J-6 17° 24.50 66° 16.08

Hydzocast

Oblique net tow (01008)

Depart for 6-6

xr (underway?

Arrive G-6 17° 26.5°K 66* 6549

Ligue net tow (02000)

ydzocast

Depart for 6-5

Arcive G-5 17" 41.60N 66% 45"

ydrocast

?bLique net tow (0-200m)

Depart for G4

Arrive G-4 17° 49.3°H 66% 459%

Oblique net tov (0-100)

Depart for 6-3

Arrive 6-3 17° 53.40N 66* 450%

optique net tow (0-1008)

ydrocast

Depart for 6-2

Areive 6-2 17" 54.9°N 66*45"m

Obtigue net tow (01005)

Depart for 6-2

---Page Break---

pay 5 feone

ons

eas.

ons

095s

Arrive G-1 179564 66" 45°

oblique net tow

Shallow hydrocast

Depart 6-0

Areive G-0 17° 58'% 66" 45.71%

Sai back to 6-2

?Test comparison between Bongo nets and conventional

nets sailing straight west 270°

Surface tows

oblique tovs 0-109 100-200

Vertical toxe 100-200

Depart for Malecon

---Page Break---

2

LIST OF PARTICIPANTS

1. suan 6. Gonsitex - Chie# Sotentist

2. dos A. Ramtron - Schentist

3. Brie Hawk - Scientist

4. gorge Garcia - Technician

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10. Terrence Morrigan - ?Technician

1, Dennis Corales - ?Technician

12, Alfredo Mercado - ?Technician

2 13. Rawin Gonséa - Technician

14. 1van Rosas - ?Technician

15. Ramén Gomes - ?Technician

a1

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WEATHER Cove

Clear (no cloud at any level)

Partly cloudy (scattered or broken clouds)

Continuous layer (8) of cloud (s)

Sandstorm, duststorm, or blowing snow

Fog, thick dust, or laze

Drizsie

Rain

Snow, oF rain and snow mixed

shower (8)

?Thunderstorm (s)

2

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